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KOSTAC SR-21/22 Ladder Type Programmable Controller Technical Manual

KOYO ELECTRONICS INDUSTRIES CO., LTD.

$25

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KOSTAC SR-21/22

This manual is mainly referring to SR−21 because of the difference of memory size compared to SR−22.

SR−21 (Memory size : 1.7 K words)

SR−22 (Memory size : 3.7 K words)

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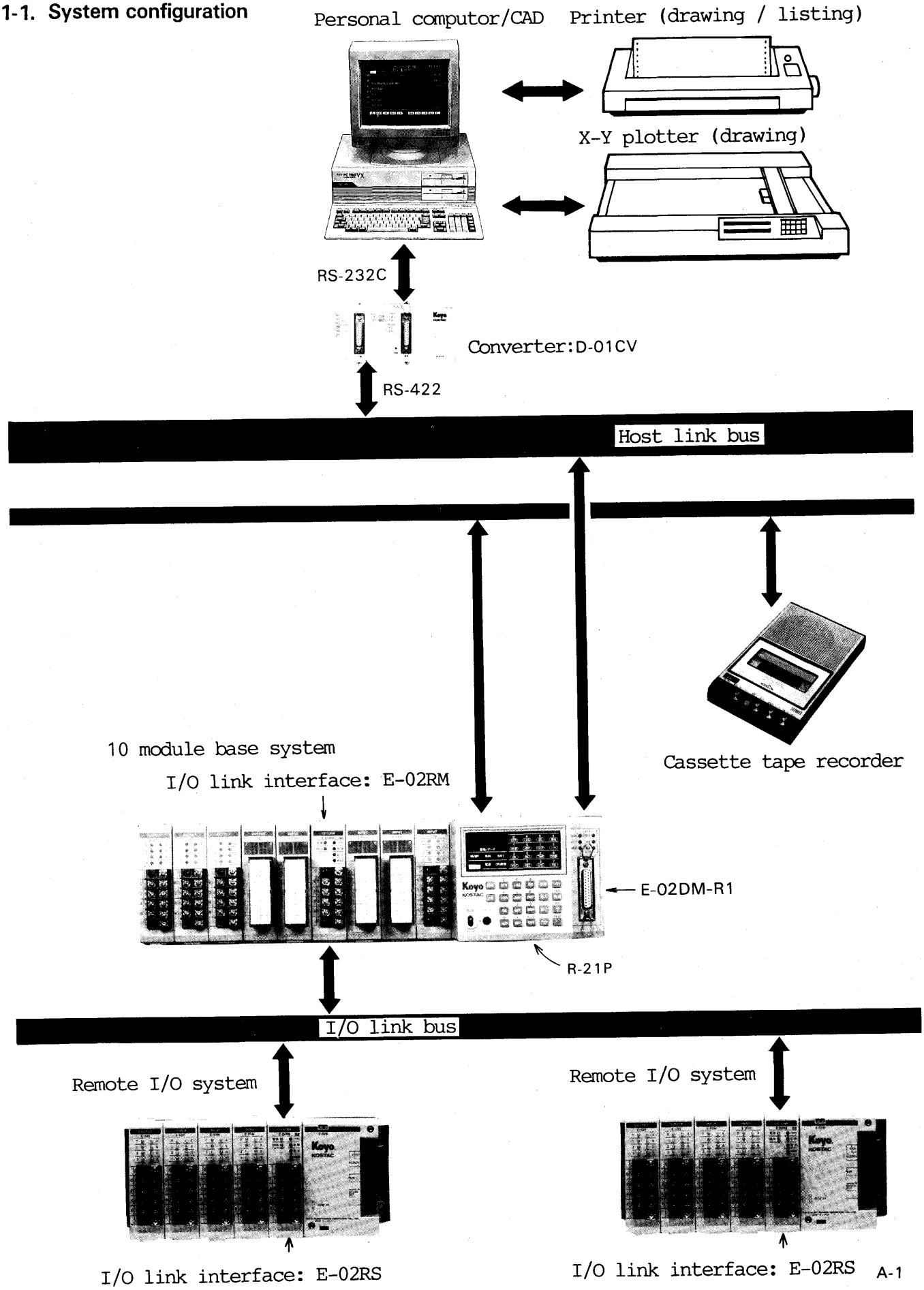
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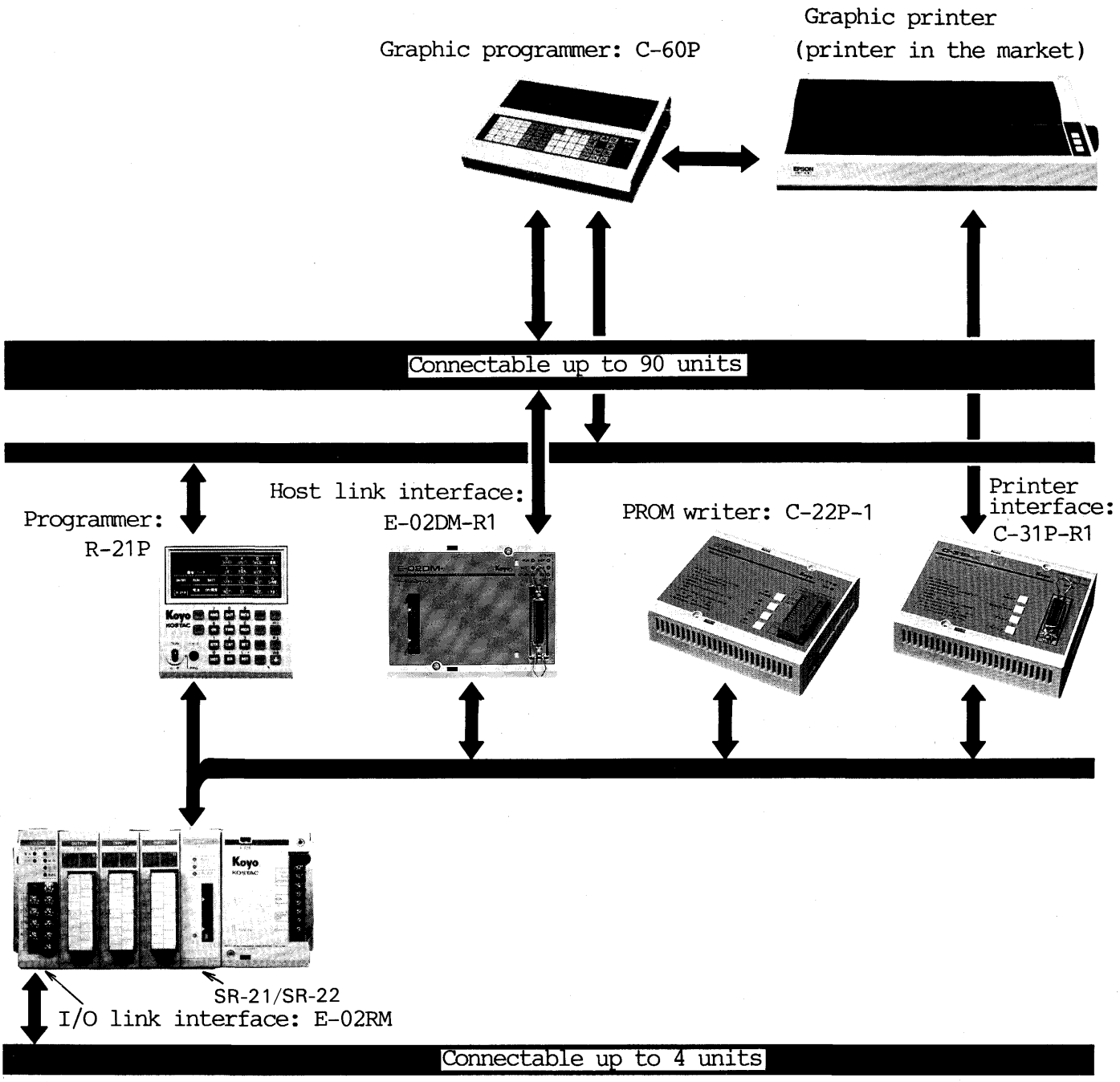
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1. SYSTEM EQUIPMENT AND CONFIGURATION

1-1. System configuration

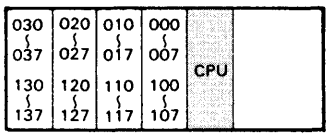
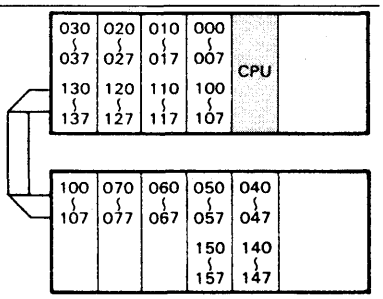
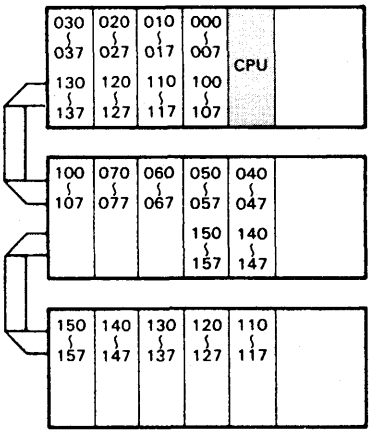
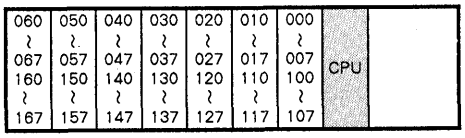
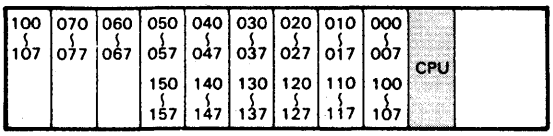
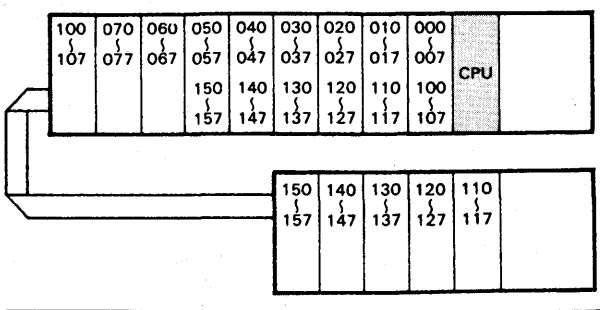


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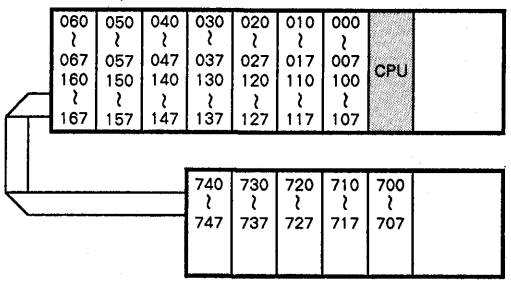
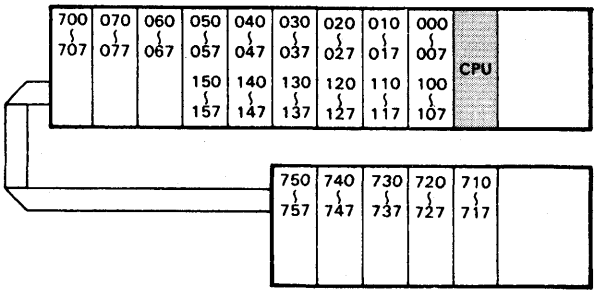
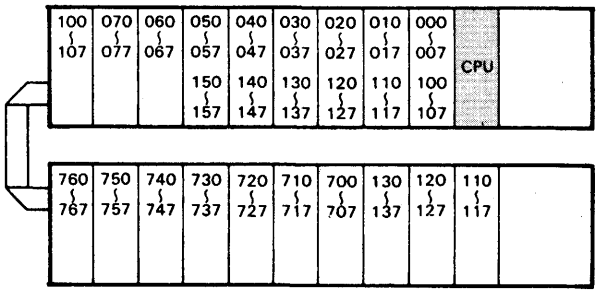


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1-2. I/O module configuration

Base type	I/O module type			I/O point	Configuration (Base with power supply)
	Total	8-point module	16-point module		
E-01BJ, E-02B, E-02B-C — Use one of these bases	4	4	—	32	
		3	1	40	
		2	2	48	
		1	3	56	
		—	4	64	
E-02B, E-02B-C — Use two of these bases	9	9	—	72	
		8	1	80	
		7	2	88	
		6	3	96	
		5	4	104	
		4	5	112	
	8	2	6	112	
E-02B, E-02B-C — Combinations with three of these bases	14	14	—	112	
	13	12	1	112	
	12	10	2	112	
	11	8	3	112	
	10	6	4	112	
	9	4	5	112	
E-05B — Use one of these bases	7	7		56	
		6	1	64	
		5	2	72	
		4	3	80	
		3	4	88	
		2	5	96	
		1	6	104	
			7	112	
E-03B, E-03B-C, E-04B, E-04B-C — Use one of this base	9	9	—	72	
		8	1	80	
		7	2	88	
		6	3	96	
		5	4	104	
		4	5	112	
	8	2	6	112	
E-03B, E-03B-C — Use one of these bases + E-02B, E-02B-C — Use one of these bases	14	14	—	112	
	13	12	1	112	
	12	10	2	112	
	11	8	3	112	
	10	6	4	112	
	9	4	5	112	

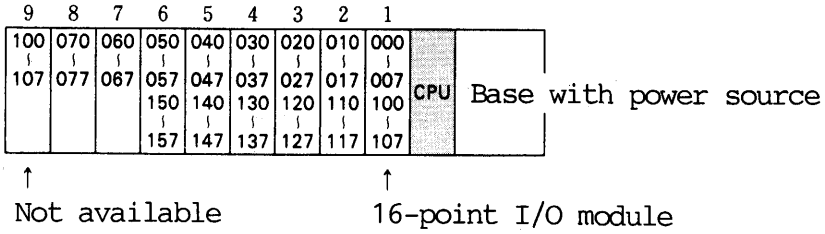
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Base type		I/O module type			I/O point	Configuration (Base with power supply)
		Total	8-point module	16-point module		
E-05B	Use one of this base	12	12		96	
			11	1	104	
			10	2	112	
	+		9	3	120	
			8	4	128	
			7	5	136	
E-02B	Use one of this base		6	6	144	
			5	7	152	
E-04B E-04B-C	Use one of these bases	14	14	—	112	
			13	1	120	
			12	2	128	
	+		11	3	136	
			10	4	144	
E-02B E-02B-C	Use one of these bases		9	5	152	
			8	6	160	
E-04B	Use two bases	19	19	—	152	
			18	1	160	
			17	2	168	
		18	15	3	168	
		17	13	4	168	
		16	11	5	168	
		15	9	6	168	

Note: 1. For installing a 16-point I/O module on the E-01BJ base, special care must be paid to the relation between the capacity of power source and current consumption.

2. When a 16-point I/O module is used, I/O numbers written on the lower part of the slot are assigned. It should be noticed that an 8-point I/O module cannot be installed in the slot if the same I/O numbers (written on the upper part of the slot) are found in the system configuration.

Example: If a 16-point I/O module is installed in the first slot, the 9th slot cannot be used.



For the I/O link configuration, refer to the instructions for I/O link module handling.

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1-3. Table of system configuration equipment

CPU module

Model number	Feature	
SR-21	Ladder-type program language	Program memory capacity: 701 words (expandable up to 1 K words)
SR-21-1		Program memory capacity: 1,724 words
SR-22		Program memory capacity: 3,701 words

Base (with power supply)

Model No.	No. of modules to be installed	Power source voltage	Power source for sensor	Expansion feature	Remarks
E-01BJ	5	115/230 VAC	None	No	Single use only
E-02B	5	115/230 VAC	24 VDC 100 mA	Yes	Expandable up to 112 points of I/Os with 3 bases. These bases can be used as an expansion base for E-03B, E-03B-C, E-04B, and E-04B-C.
E-02B-C	5	24 VDC	None		
E-05B	8	115/230 VAC	24 VDC 100 mA	Yes	Maximum 112 points of I/Os even for one module.
E-03B	10	115/230 VAC	24 VDC 100 mA	Yes	Expandable up to 112 points of I/Os when E-02B, or E-02B-c is used for expansion.
E-03B-C	10	24 VDC	None		
E-04B	10	115/230 VAC	24 VDC 100 mA	Yes	Expandable up to 168 points of I/Os with 2 E-04B bases for expansion. Expandable up to 160 points of I/Os with (E-04B/E-04B-C) + (E-02B/E-02B-C).
E-04B-C	10	24 VDC	None		

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I/O module

Model No.	Kind	Specifications	Number of circuits	Display LED	External connection
E-01N	Input	24V DC source input 11mA	8	Yes	Through terminal block
E-02N		24V AC/DC sink input	8		
E-05N		24V DC source input 12mA	16		
E-20N		115V AC input	8		
E-21N		115V AC input	4		
E-22N		230V AC input	8		
E-25N		100/115V AC input	16		
E-35N		24V DC source input 12mA	16		Through connector
E-55N		24V DC sink input 12mA	16		Through terminal block
E-01T	Output	Relay contact, 250V AC/4A (resistive load)	8	Yes	Through terminal block
E-05T		Relay contact, 250V AC/2A (resistive load)	16		
E-10T		24V DC sink output 0.5A	8		
E-12T		24V DC sink output 2A	4		
E-15T		24V DC sink output 0.5A	16		
E-20T		115/230V AC/ 1A	8		
E-21T		115/230V AC/ 2A	4		Through isolated common line of terminal block
E-35T		24V DC sink output 0.5A	16		Through connector
E-52T		24V DC sink output 2A	4		Through isolated common line of terminal block
E-55T		24V DC source output 0.5A	16		Through terminal block
E-01NT	Input and Output	4 circuits for E-01N type of input 4 circuits for E-01T type of output	8	Yes	Through terminal block
E-10NT		4 circuits for E-01N type of input 4 circuits for E-10T type of circuit	8		

Note: Namings of DC type I/Os are conforming to NECA standard 5502.

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Special I/O module

Model No.	Kind	Feature
E-01D	T/C external setting	Interface to internally input the set value of 4 external digital switches
E-01Z	Additon/subtraction counter	Built-in 4-digit addition/subtraction counter input response of 10kHz comparative output circuit
E-01H	High-speed processing	2 circuits, 2 inputs and 1 output per circuit (relay output)
E-01H-1	High-speed processing	2 circuits, 2 inputs and 1 output per circuit (open collector output)
E-01AD	Analog input	1 - 5V or 4 - 20mA input, 8 bits of 4-channel multiplexer resolution
E-02AD	Analog input	1 - 5V or 0 - 10V or 4 - 20mA input, 12 bits of 1-channel resolution
E-01DA	Analog output	0 - 10V and 4 - 20mA output, 8 bits of 2-channel resolution
E-02DA	Analog output	0 - 10V or 4 - 20mA output, 12 bits of 1-channel resolution
E-01S	Simulation input	For input simulstion with 8 switches
E-DMY	Dummy panel	Blinder for the slot not in use
E-02RM	I/O link	
E-02RS	I/O link	

Connector cable

Model No.	Feature	Length
E-05J	For I/O base expansion (separate sale)	50 cm
E-15PJ	For R-21P expansion (separate sale)	150 cm
C-08RJ	For cassette tape recorder connection (attached with R-21P)	80 cm

Special unit

Model No.	Kind	Feature
F-10D	T/C external setting unit	Built-in 4 digits x 4 digital switches Special bezel required for mounting on the panel (separate sale)
E-02DM-R1	Host link interface	Interface unit for host link bus connection RS-422

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Programming equipment

Model number / Kind		Feature
R-21P	Handy type of programmer	Instruction key-in type, mounting type on the CPU Writing and reading of instruction Function as the operation monitor/cassette interface
C-60P	Graphic programmer	Ladder-type operation diagram display Reading for program preparation Operation monitor/printer interface Host link interface Counter interface
C-22P-1	PROM writer	Mounting-type on the CPU
C-31P-R1	Printer interface	Mounting-type on the CPU Print-out of ladder diagram, I/O list, and instruction by connecting with the regular kind of printer in the market

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2. SYSTEM SPECIFICATIONS

2-1. General specifications

Item	Rating
Power source voltage	85 - 132/170 - 264 VAC 50/60 Hz 24 VDC + 6 V, - 4 V (base with power supply and model number with suffix C)
Ambient temperature for operation	0°C - 55°C
Storing temperature	-20°C to 80°C
Ambient humidity	5% to 90% RH (noncondensing)
Ambient air	No corrosive gases permitted
Dielectric strength	1500 VAC, 50/60 Hz, 1 minute between power supply and external terminal
Insulation resistance	More than 20 MΩ, 500 VDC between power supply and external terminal
Vibration resistance	Complying with JIS C 0911 Withstanding vibration: Displacement amplitude --- 0.5mm, 10 - 55 Hz for 3 axis directions Tolerant movement vibration: Displacement amplitude --- 0.35mm, 10 - 55 Hz for 3 axis directions
Shock resistance	Complying with JIS C 0912 Withstanding shock: 50 G, 11 mS for 3 axis directions Tolerant movement shock: 10 G, 11 mS for 3 axis directions
Noise immunity	Complying with NEMA (ICS3-304) 1 μS width rectangular wave pulse 1,000 V
Weight	Maximum 2.7 Kg =(E-02B)+(SR-21)+(E-01N x 2)+(E-01T x 2) Maximum 4 Kg = (E-04B)+(SR-21)+(E-01N X 5)+(E-01T x 4)

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2-2. Functional specifications

Item			Specifications
Program	Control		Stored program cyclic operation processing
	Language		Ladder type (relay circuit diagram or special instruction)
	Number of instructions		40 of sequence instructions 25 of data processing instructions
	Processing speed		Average 10 mS (0.5 KW of sequence instructions)
	Program size	SR-21	For RAM: 701 words (basic) + 1,023 words (expansion) For ROM: 1,724 words
		SR-22	For RAM: 3701 words (basic) For ROM: 3701 words
	Power failure backup		Lithium battery, 5 years of life (25°C)
	Storage		Cassette tape or PROM
	Protection		Password registration
Input/output	Composition		Free locationing
	Control		Block transferring
	Number of points		168 maximum (112 maximum for E-02B and E-03B)
Communication	Host link		RS-422
	I/O link		Complying with RS-422
Self-diagnosing			CPU abnormality (watchdog timer) Memory abnormality Battery abnormality Grammar check I/O base voltage abnormality

2-3. I/O numbers

150	140	130	120	110	100	070	060	050	040	030	020	010	000
151	141	131	121	111	101	071	061	051	041	031	021	011	001
152	142	132	122	112	102	072	062	052	042	032	022	012	002
153	143	133	123	113	103	073	063	053	043	033	023	013	003
154	144	134	124	114	104	074	064	054	044	034	024	014	004
155	145	135	125	115	105	075	065	055	045	035	025	015	005
156	146	136	126	116	106	076	066	056	046	036	026	016	006
157	147	137	127	117	107	077	067	057	047	037	027	017	007

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760	750	740	730	720	710	700
761	751	741	731	721	711	701
762	752	742	732	722	712	702
763	753	743	733	723	713	703
764	754	744	734	724	714	704
765	755	745	735	725	715	705
766	756	746	736	726	716	706
767	757	747	737	727	717	707

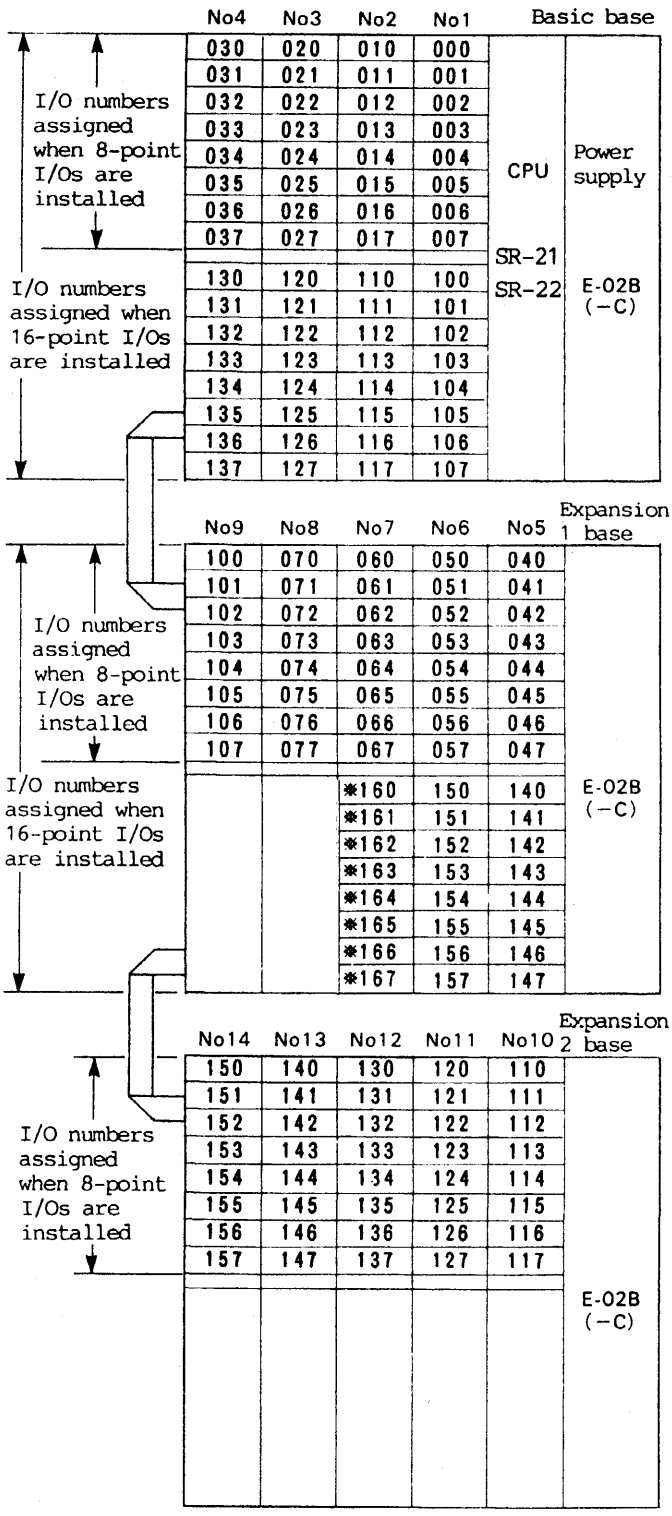
- Total 168 I/O numbers of 112 from 000 to 157 and 56 from 700 to 767 are assigned. I/O numbers are limited for use depending on the base.

Basic base	Expansion base (1)	Expansion base (2)	Maximum number of I/O points	I/O numbers
E-01BJ E-02B(-C)			64	000 - 037, 100 - 137 (for use of 16-point I/O)
E-02B(-C)	E-02B(-C)		112	000 - 157 (110 - 157 only for use of 16-point I/O)
E-02B(-C)	E-02B(-C)	E-02B(-C)	112	000 - 157
E-05B			112	000 - 167 (only for use of 16-point I/O)
E-05B	E-02B		152	000 - 167, 700 - 747 (000 - 167 only for use of 16-point I/O)
E-03B(-C)			112	000 - 157 (110 - 157 only for use of 16-point I/O)
E-03B(-C)	E-02B(-C)		112	000 - 157
E-04B(-C)			120	000 - 157, 700 - 707 (100 - 157 only for use of 16-point I/O)
E-04B(-C)	E-02B(-C)		160	000 - 157, 700 - 757 (100 - 157 only for use of 16-point I/O)
E-04B(-C)	E-04B(-C)		168	000 - 157, 700 - 767 (140 - 157 only for use of 16-point I/O)

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(1) I/O number assignments for 5-module-slot base

I/O numbers: 000 - 157 Number of I/O points: 112

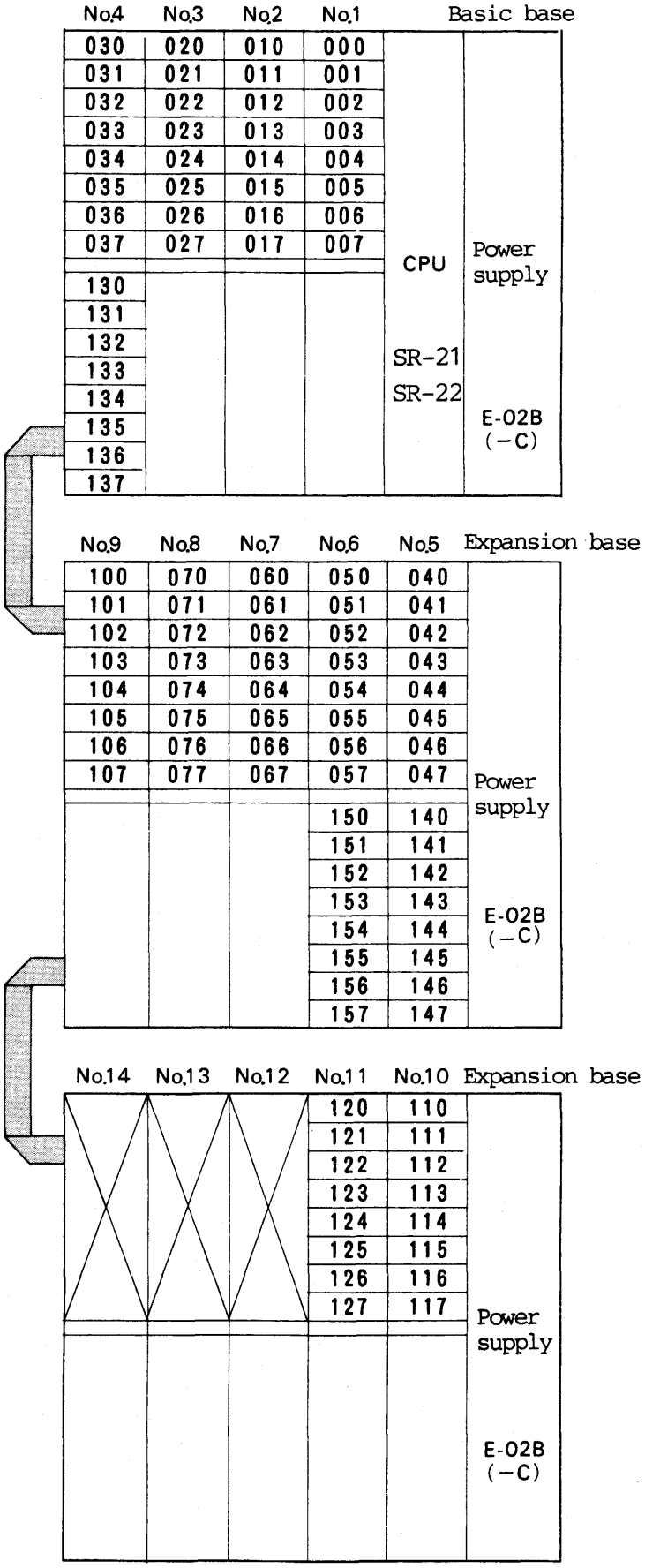


- Locations available for installing 16-point I/O modules are from #1 slot to #6 slot in which numbers are assigned on the upper side and lower side of slot.
- When the 16-point I/O is installed, a total 16 I/O numbers, 8 numbers on the upper side and 8 numbers on the lower side (numbers on the upper side plus 100), are assigned. Because of these assignments, a slot of the same numbers with 8 numbers of the lower side used by the 16-point I/O cannot accept a module.
- When two bases for 5-module slots are used and fewer than five 16-point I/O modules are used, you can use bases effectively unless you install a 16-point I/O module in the #1 slot.
- E-01BJ is suited when less than 4 I/O modules are used. However, you must be careful with the current consumption when you use the 16-point I/O module.
- The change switch on the base must be turned to the left on the basic base, to the right side on the expansion 1 base, and to the left side on the expansion 2 base.
- If the internal relays from 160 to 167 are not used for that purpose, the 16-point I/O module can be inserted in the slot of No.7 to increase the I/O points up to 120. But even if one of E-01Z modules is used, the relays from 160 to 167 cannot be used.

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- Example of I/O number assignments when the 5-module slot base is used

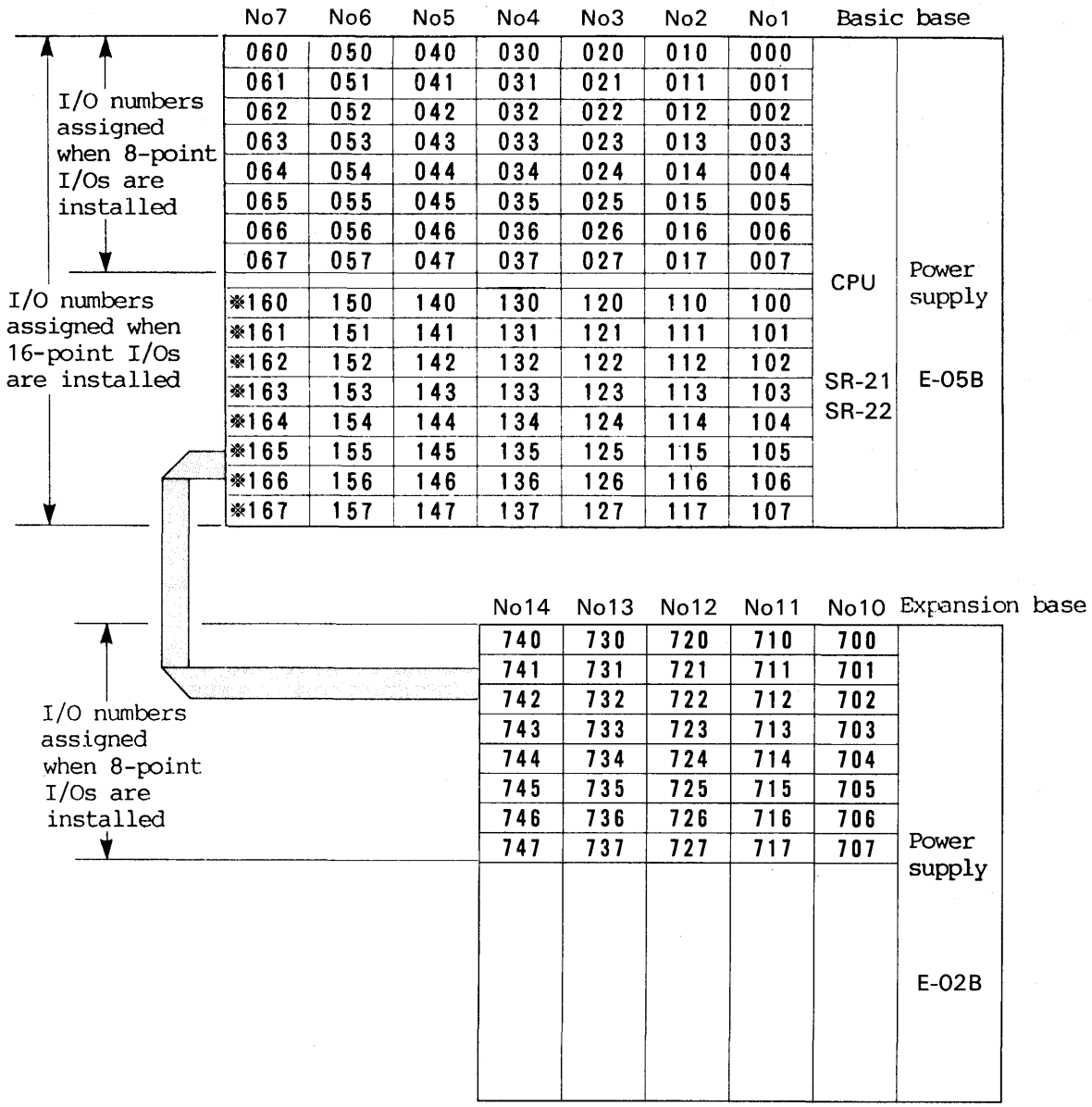
  Example of using total 112 I/O points with three 16-I/O point modules and eight 8 I/O point modules



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(2) I/O number assignments when E-05B is used

I/O numbers: 000 - 157 Number of I/O points: 112



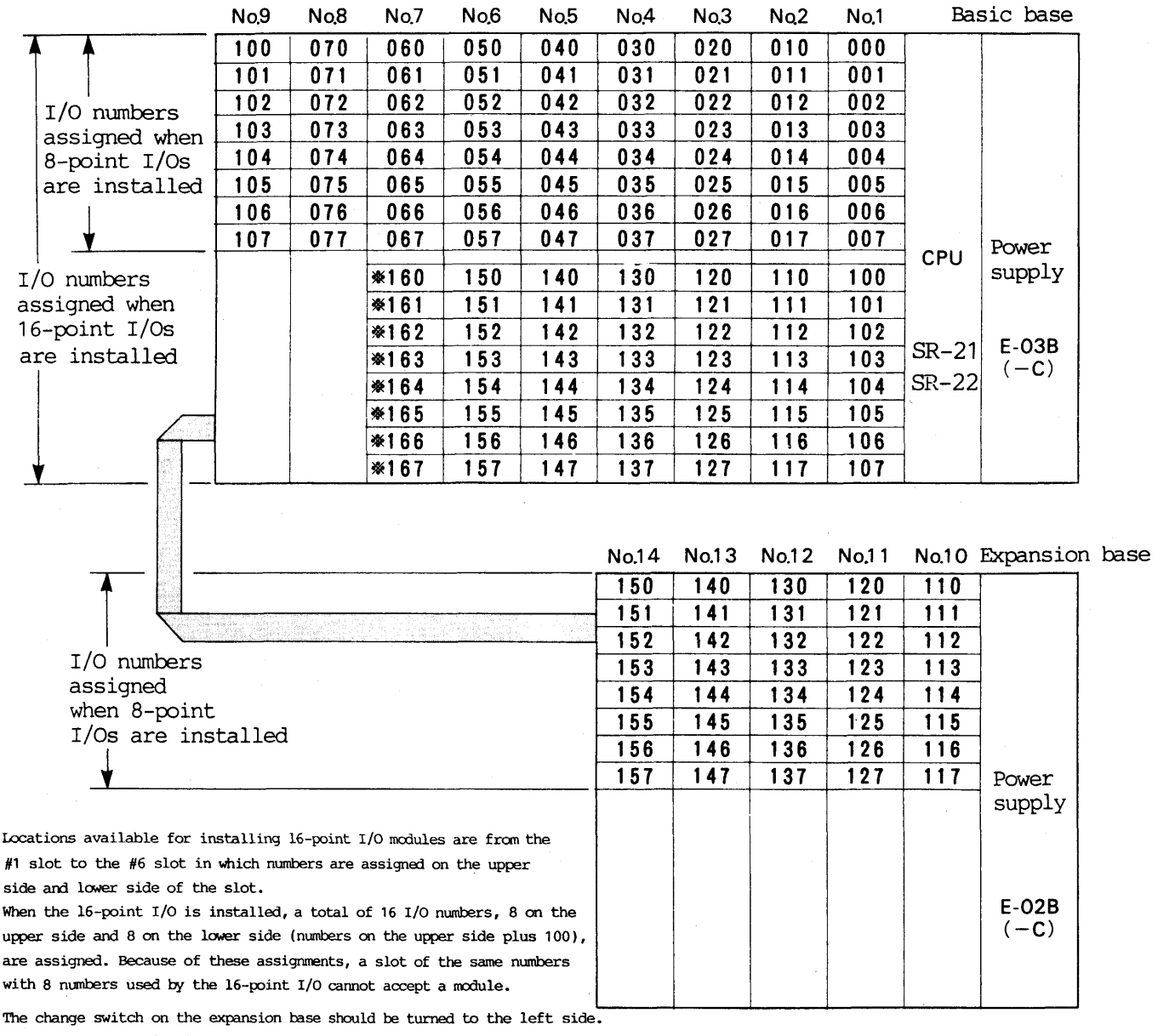
- Locations available for installing 16-point I/O modules are from the #1 slot to the #6 slot in which numbers are assigned on the upper side and lower side of the slot.
- When the 16-point I/O is installed, a total of 16 I/O numbers, 8 on the upper side and 8 on the lower side (numbers on the upper side plus 100), are assigned. Because of these assignments, a slot of the same numbers with 8 numbers of the lower side used by the 16-point I/O cannot accept a module.
- The change switch on the expansion base should be turned to the left side.

※ When the internal relay numbers from 160 to 167 are not used for internal relays and E-01Z is not used, the 16-point I/O can be used on the #7 slot with a maximum of 152 I/O points.

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(3) I/O number assignments when E-03B (-C) is used

I/O numbers: 000 - 157 Number of I/O points: 112



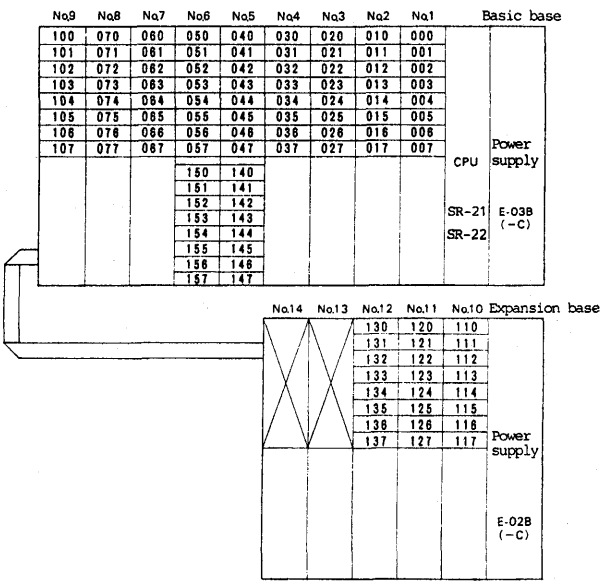
- Locations available for installing 16-point I/O modules are from the #1 slot to the #6 slot in which numbers are assigned on the upper side and lower side of the slot.
- When the 16-point I/O is installed, a total of 16 I/O numbers, 8 on the upper side and 8 on the lower side (numbers on the upper side plus 100), are assigned. Because of these assignments, a slot of the same numbers with 8 numbers used by the 16-point I/O cannot accept a module.
- The change switch on the expansion base should be turned to the left side.

* When the internal relay numbers from 160 to 167 are not used for internal relays and E-01Z is not used, the 16-point I/O can be used on the #7 slot with a maximum of 120 I/O points.

● Example of I/O number assignments when E-03B (-C) is used

Example:

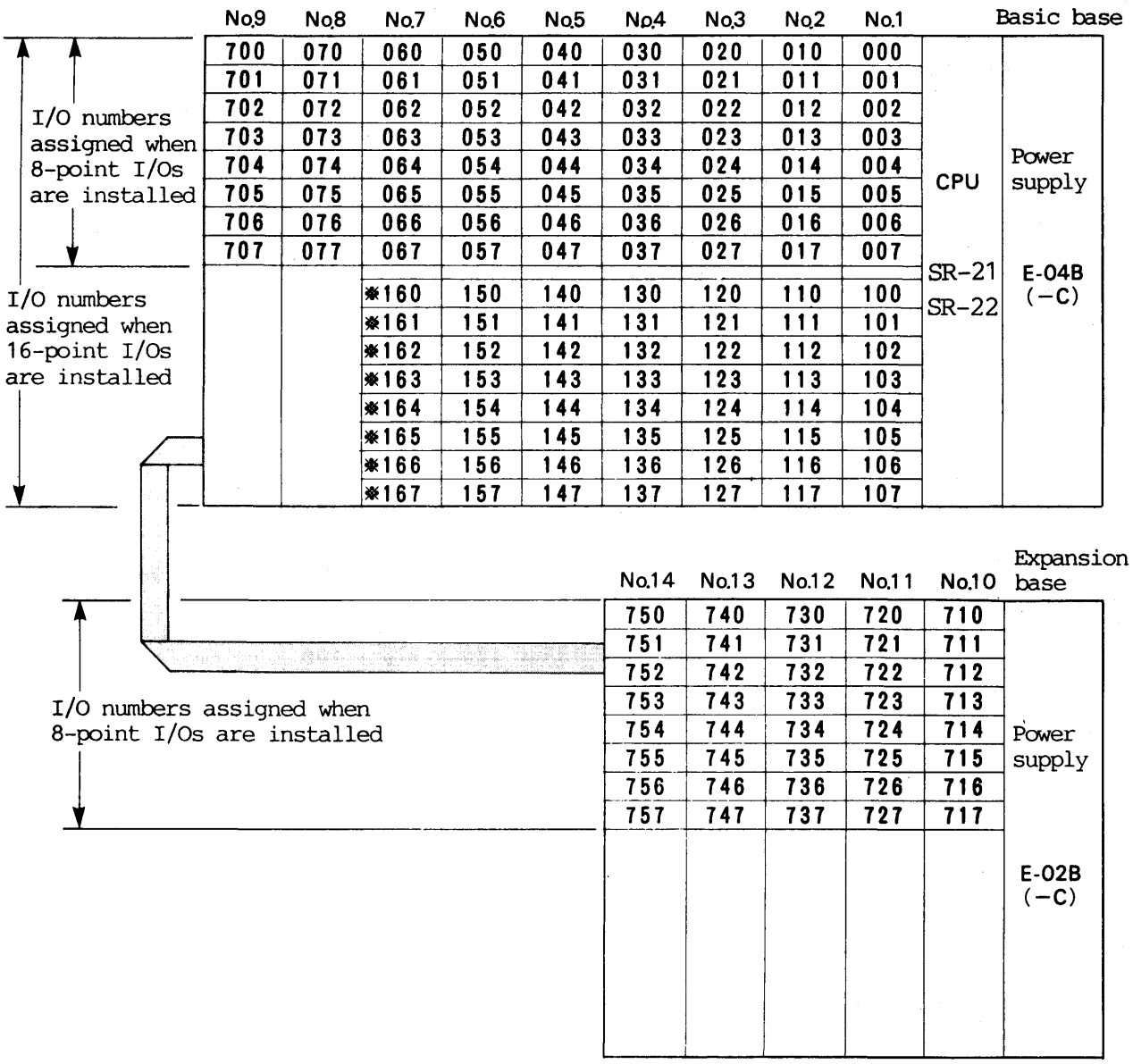
In the case of a total 112 I/O points with two 16-point I/O modules and ten 8-point I/O modules.



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(4) I/O number assignments in configurations with E-04B (-C) basic base and E-02B (-C) expansion base

Total 160 I/O points from 000 to 157 and from 700 to 757 I/O numbers



- Locations available for installing 16-point I/O modules are from the #1 slot to the #6 slot in which numbers are assigned on the upper side and lower side of slot.
- Any slots can be used, even when the 16-point I/O module is installed.
- Turn the bridge connector SW1 in the basic base to the right (CPU side) and SW2 to the left (700 side). (Refer to A-44.)
- Turn the change switch in the expansion base to the left.
- When only one basic base is used and SW1 is turned to the right (CPU side), it is possible to install up to 120 points of I/Os because the I/O numbers from 700 to 707 become usable when SW 2 is turned to the left (700 side). (For locations to short the bridge connector, refer to A-44.)

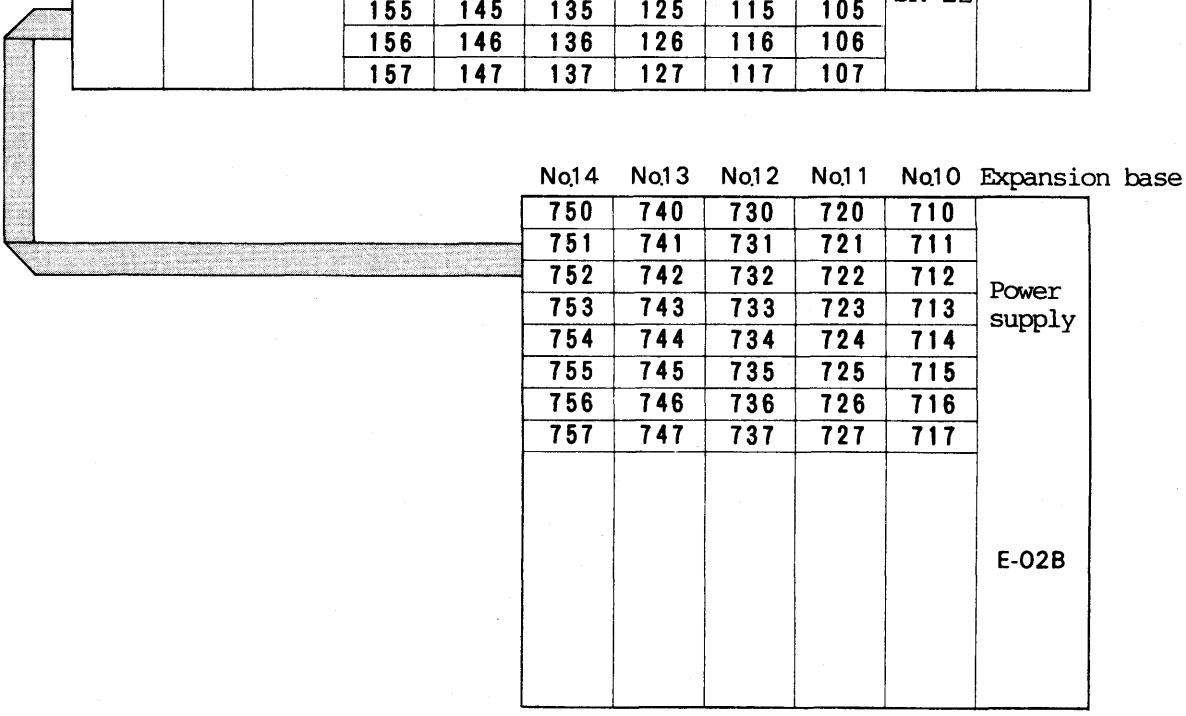
  * When the internal relays from 160 to 167 are not used for internal relays and E-01Z is not used, the 16-point I/O can be used on the #7 slot with a maximum of 168 I/O points.

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● I/O number assignments in configurations with E-04B basic base and E-02B expansion base

Example:

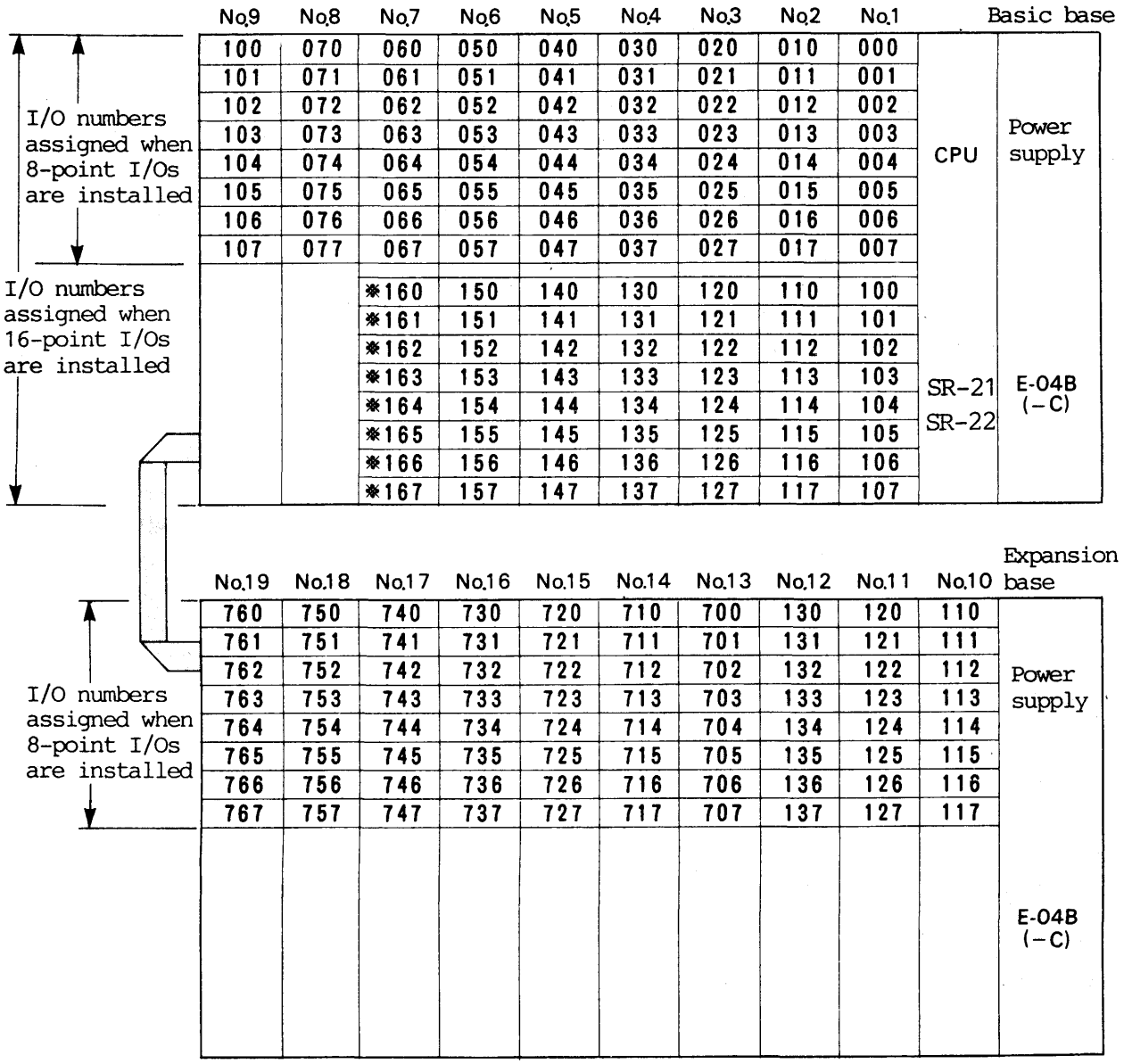
In the case of a total of 160 I/O points with six 16-point I/O modules and eight 8-point I/O modules.



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(5) I/O number assignment when two E-04B (-C)s are used

Total 168 I/O points from 000 to 157 and from 700 to 767 I/O numbers



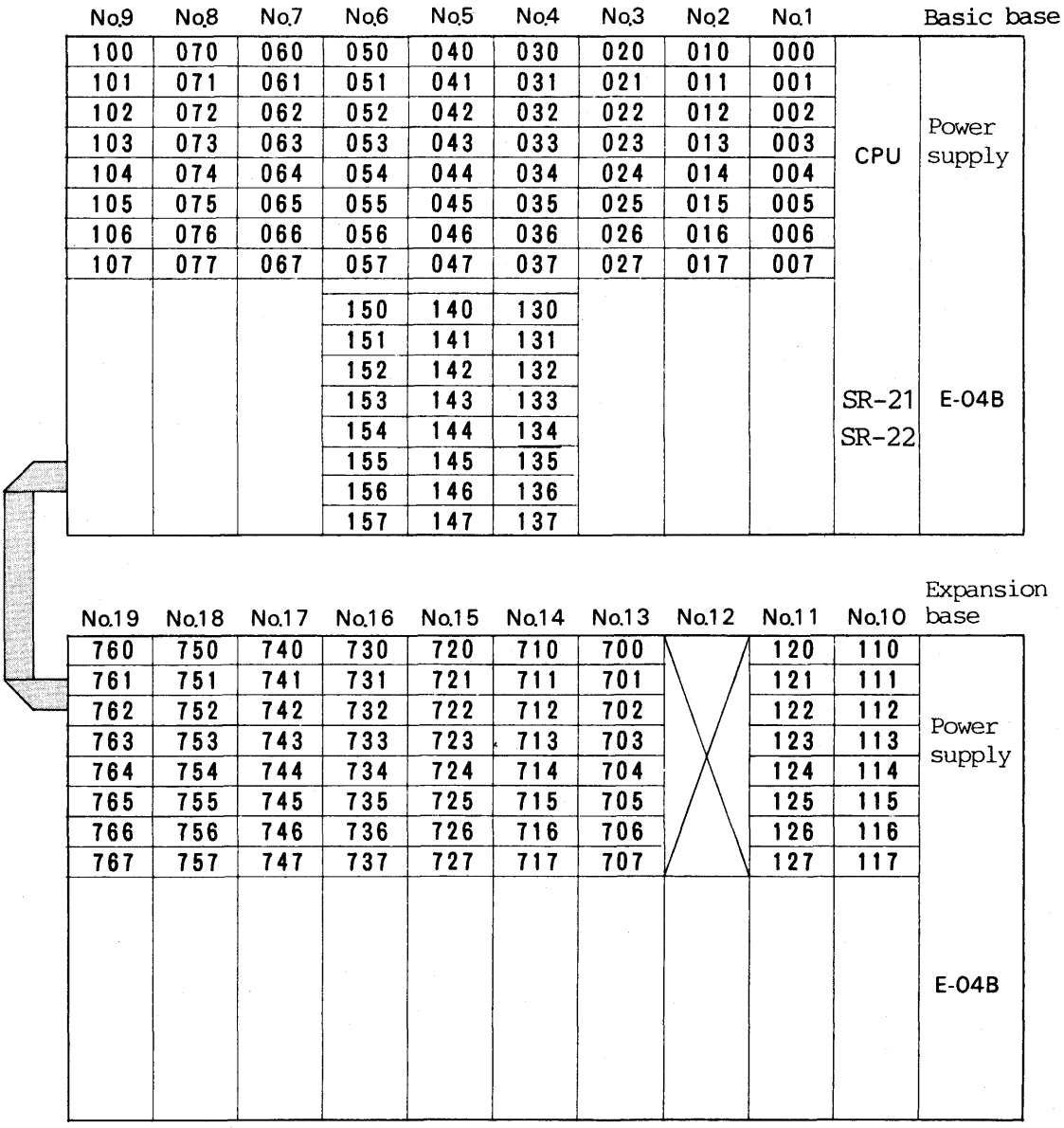
- Locations available for installing 16-point I/O modules are from the #1 slot to the #6 slot in which numbers are assigned on the upper side and lower side of the slot.
- When the 16-point I/O is installed, a total of 16 I/O numbers, 8 numbers on the upper side and 8 numbers on the lower side (numbers on the upper side plus 100) are assigned. Because of this assignment, a slot of the same numbers with 8 numbers used by the 16-point I/O cannot accept a module.
- Turn the bridge-connector SW1 in the basic base to the right (CPU side) and SW2 to the right (100 side). (Refer to A-45.)
- Turn the change switch SW1 in the expansion base to the left (EXP side) and SW2 to the right (EXP side).

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● When only one basic base is used and I/O numbers of the #9 slot of the basic base used from 100 to 107 as shown above, turn the bridge-connector switches SW1 to the right (CPU side) and SW2 to the left (100 side).
(For locations to short the bridge connector, refer to A-45.)

● I/O number assignments when two E-04Bs are used

Example:
In the case of total 168 I/O points with three 16-point I/O modules and fifteen 8-point I/O modules



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Note: If the bridge connector is shorted as shown above to use I/O numbers from 100 to 107 in the #9 slot of the basic base, the 5-module base cannot be used for the expansion base.

When the internal relays from 160 to 167 are not used for internal relays and E-01Z is not used, the 16-point I/O can be used on the #7 slot with a maximum of 176 I/O points.

2-4. Function memory numbers

(1) Input/output relay numbers

Bit number								Register number
007	006	005	004	003	002	001	000	R#000
017	016	015	014	013	012	011	010	R#001
027	026	025	024	023	022	021	020	R#002
037	036	035	034	033	032	031	030	R#003
047	046	045	044	043	042	041	040	R#004
057	056	055	054	053	052	051	050	R#005
067	066	065	064	063	062	061	060	R#006
077	076	075	074	073	072	071	070	R#007
107	106	105	104	103	102	101	100	R#000
117	116	115	114	113	112	111	110	R#011
127	126	125	124	123	122	121	120	R#012
137	136	135	134	133	132	131	130	R#013
147	146	145	144	143	142	141	140	R#014
157	156	155	154	153	152	151	150	R#015
707	706	705	704	703	702	701	700	R#070
717	716	715	714	713	712	711	710	R#071
727	726	725	724	723	722	721	720	R#072
737	736	735	734	733	732	731	730	R#073
747	746	745	744	743	742	741	740	R#074
757	756	755	754	753	752	751	750	R#075
767	766	765	764	763	762	761	760	R#076

- The register number consists of 8 bits to be used by the data processing instruction or for the T/C set value.
- The ranges not used for I/Os can be used for internal relays.

(2) Internal relay numbers, special relay numbers, and flag numbers

Bit number								Register number
167	166	165	164	163	162	161	160	R#016
177	176	175	174	173	172	171	170	R#017
207	206	205	204	203	202	201	200	R#020
217	216	215	214	213	212	211	210	R#021
227	226	225	224	223	222	221	220	R#022
237	236	235	234	233	232	231	230	R#023
247	246	245	244	243	242	241	240	R#024
257	256	255	254	253	252	251	250	R#025
267	266	265	264	263	262	261	260	R#026
277	276	275	274	273	272	271	270	R#027
307	306	305	304	303	302	301	300	R#030
317	326	315	314	313	312	311	310	R#031
327	326	325	324	323	322	321	320	R#032
337	336	335	334	333	332	331	330	R#033
347	346	345	344	343	342	341	340	R#034
357	356	355	354	353	352	351	350	R#035
367	366	365	364	363	362	361	360	R#036
377	376	375	374	373	372	371	370	R#037
		↖ Special relay						
777	776	775	774	773	772	771	770	R#077
			Flag					

- 340 - 373 (28 points): To be retained against power failure
- Special relays

  374: Initial reset relay
  This relay will be on for RUN.

  375: 0.1 sec clock
  0.05 sec/ON
  0.05 sec/OFF

  376: Pause relay
  When this relay is turned on, it causes the external output written by the OUT instruction to be turned off.

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377: For battery abnormality
This relay will be on when the battery voltage drops.

770: Relay to speed up the timer ten times. When this relay is turned on, all timers will function as 0.01 sec timers and react instantaneously by the speed of 1/10 to the set value (applicable from August 1986).

771: For external diagnosing

772: > flag (greater accumulator)

773: = flag (match)

774: < flag (smaller accumulator)

775: C (carry) flag

776: Z (zero) flag

777: E (over) flag

(3) Shift register numbers

Bit number								Register number
407	406	405	404	403	402	401	400	R#040
417	416	415	414	413	412	411	410	R#041
427	426	425	424	423	422	421	420	R#042
437	436	435	434	433	432	431	430	R#043
447	446	445	444	443	442	441	440	R#044
457	456	455	454	453	452	451	450	R#045
467	466	465	464	463	462	461	460	R#046
477	476	475	474	473	472	471	470	R#047
507	506	505	504	503	502	501	500	R#050
517	516	515	514	513	512	511	510	R#051
527	526	525	524	523	522	521	520	R#052
537	536	535	534	533	532	531	530	R#053
547	546	545	544	543	542	541	540	R#054
557	556	555	554	553	552	551	550	R#055
567	566	565	564	563	562	561	560	R#056
577	576	575	574	573	572	571	570	R#057

- All areas will be retained against power failure.
- These can be used for shift registers, or keep relays, or data registers.

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(4) T/C number and T/C accumulated value number

T/C number	Accumulated value number	T/C number	Accumulated value number	
600	R#600	640	R#640	
601	R#601	641	R#641	
602	R#602	642	R#642	
603	R#603	643	R#643	
604	R#604	644	R#644	
605	R#605	645	R#645	
606	R#606	646	R#646	
607	R#607	647	R#647	
610	R#610	650	R#650	
611	R#611	651	R#651	
612	R#612	652	R#652	
613	R#613	653	R#653	
614	R#614	654	R#654	
615	R#615	655	R#655	
616	R#616	656	R#656	
617	R#617	657	R#657	
620	R#620	660	R#660	
621	R#621	661	R#661	
622	R#622	662	R#662	
623	R#623	663	R#663	
624	R#624	664	R#664	
625	R#625	665	R#665	
626	R#626	666	R#666	
627	R#627	667	R#667	
630	R#630	670	R#670	
631	R#631	671	R#671	
632	R#632	672	R#672	
633	R#633	673	R#673	
634	R#634	674	R#674	Only for external setting
635	R#635	675	R#675	
636	R#636	676	R#676	
637	R#637	677	R#677	

(5) Data register numbers

Register number	Register number	Register number	Register number		
R#400	R#440	R#500	R#540		
R#401	R#441	R#501	R#541		
R#402	R#442	R#502	R#542		
R#403	R#443	R#503	R#543		
R#404	R#444	R#504	R#544		
R#405	R#445	R#505	R#545		
R#406	R#446	R#506	R#546		
R#407	R#447	R#507	R#547		
R#410	R#450	R#510	R#550		
R#411	R#451	R#511	R#551		
R#412	R#452	R#512	R#552		
R#413	R#453	R#513	R#553		
R#414	R#454	R#514	R#554		
R#415	R#455	R#515	R#555		
R#416	R#456	R#516	R#556		
R#417	R#457	R#517	R#557		
R#420	R#460	R#520	R#560		
R#421	R#461	R#521	R#561		
R#422	R#462	R#522	R#562		
R#423	R#463	R#523	R#563		
R#424	R#464	R#524	R#564	1	*1
R#425	R#465	R#525	R#565		
R#426	R#466	R#526	R#566	2	
R#427	R#467	R#527	R#567		
R#430	R#470	R#530	R#570	3	
R#431	R#471	R#531	R#571		
R#432	R#472	R#532	R#572	4	
R#433	R#473	R#533	R#573		
R#434	R#474	R#534	R#574	External diagnosing register	
R#435	R#475	R#535	R#575		
R#436	R#476	R#536	R#576	Auxiliary accumulator	
R#437	R#477	R#537	R#577		

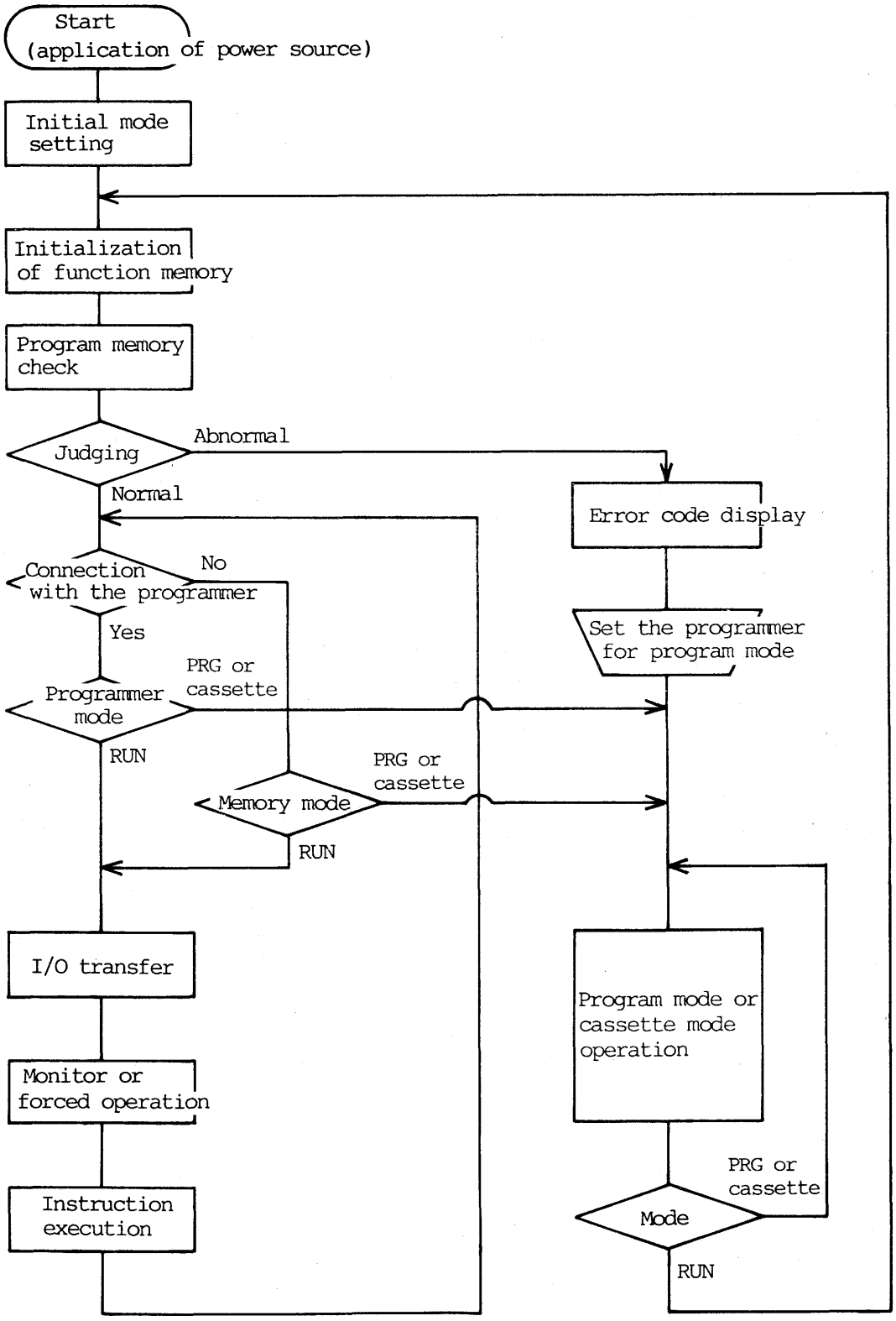
- When the number is used for the timer, the timer will be reset at 0 when to start RUN.
  For the rest of cases these will be retained against power failure.
- The range not used by the timer and counter can be used by the BCD 4-digit data register.

*1: When F-10D is installed, four set values of BCD 4 digits will be automatically put into the registers of these numbers.

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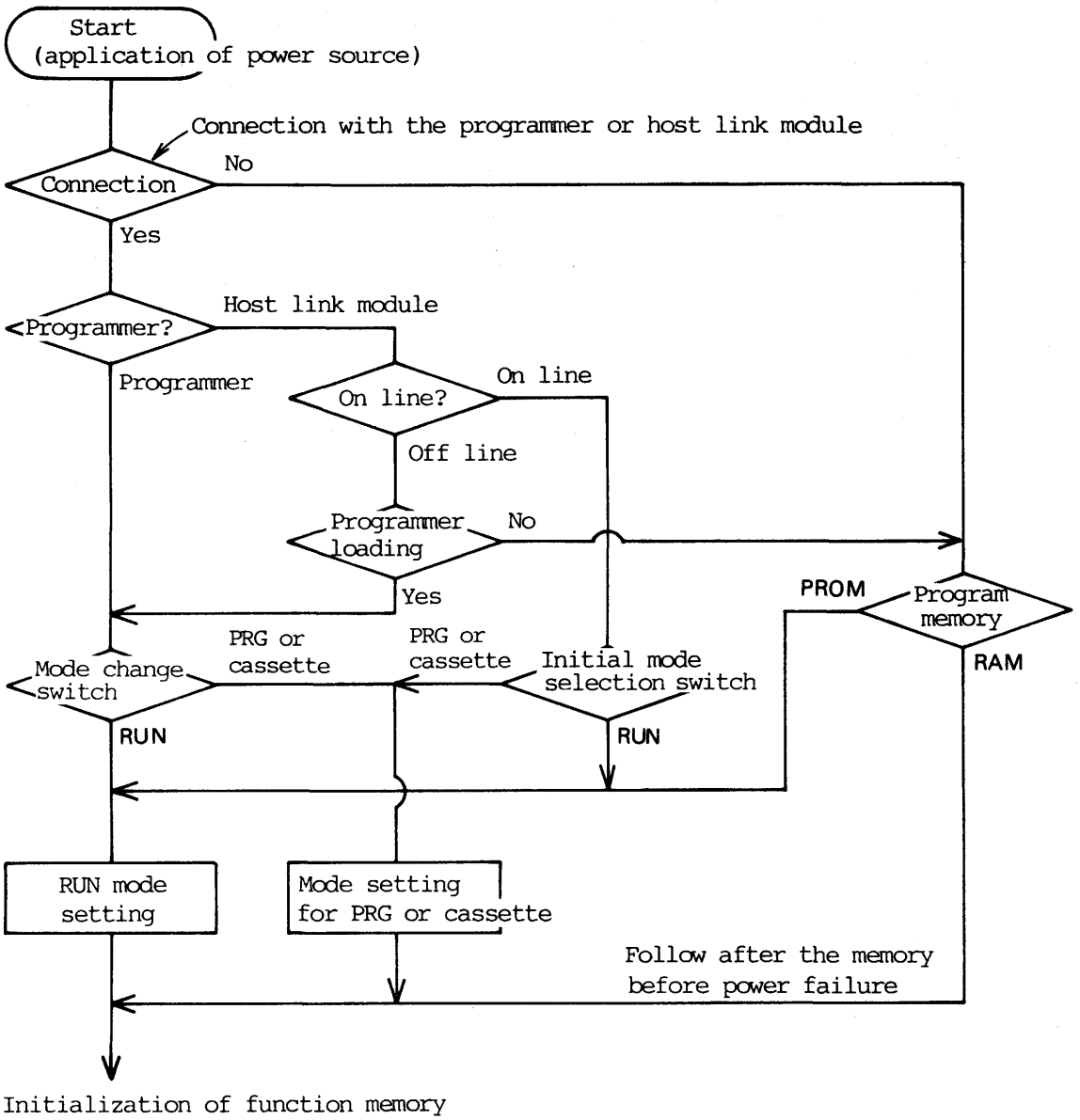
2-5. Operation

(1) Operation outline



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(2) Mode upon application of power source



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(3) Initialization of function memory

Item	Process
Input/output relay	Input: To be put under the condition of power source application Output: To be turned off
Internal relay	160 - 337: To be turned off 340 - 373: To retain the condition immediately before the power failure or to be turned off (switching)
Shift register	To retain the condition before the power failure
Timer, counter and accumulated value register	Only the numbers used by the timer will be reset and the numbers used by the counter or not in use will retain the condition immediately before the power failure.
Data register	To retain the condition immediately before the power failure

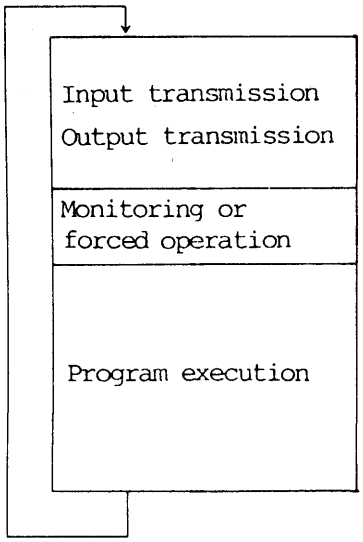
(4) Operation mode switching

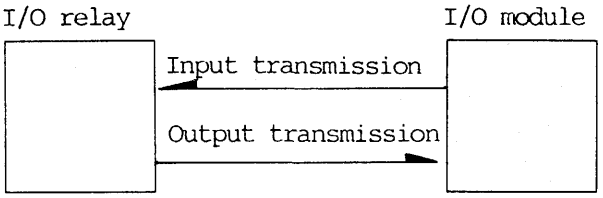
- When the programmer is installed, the operation mode will be selected always by the mode change switch.
- When the host link module is installed and if it is under the on-line operation, the operation mode will be specified by the instruction given by the host link module and retained until the next instruction is given.
- When the host link module is installed and if it is under the off-line operation and the programmer is installed on the host link module, the operation mode will always be selected by the mode change switch.
- The operation mode will be selected by the dip switch on the host link module when the power source is applied under the conditions that the host link module is installed but the programmer is not.

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(5) Input/output transmission

- Under the RUN mode, the input transmission (external input → input relay) and output transmission (output relay → external output) are processed first.

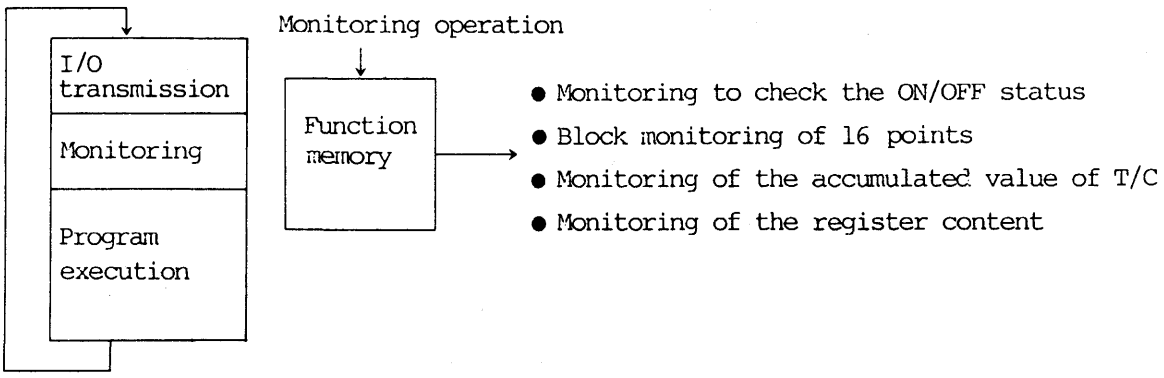




- The input is transferred at the beginning of scanning so that the condition will not change during the program execution.
- The output transfers the result of program execution in the previous scanning to the output module.

  If the pause relay is on, the output by the OUT instruction will be transferred under the forced OFF condition for output transmission.

(6) Monitoring

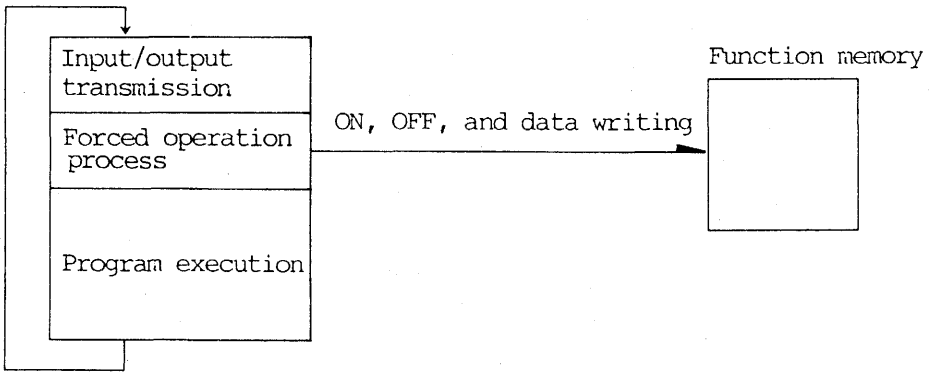


- Monitoring is to check a condition of the function memory after the input/output transmission.

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- If the pause relay is ON, and even when the external output is under the OFF condition, the display will be ON if the output relay (function memory) is ON.
- There must be something wrong with the I/O module or base if the input and output monitor display does not match the condition of the I/O module display.
- The reference data for the program execution may not sometimes match the result of monitoring if the multiple numbers of processings (SET, RST, and data processing instructions) are made to the same function memory for one program execution.

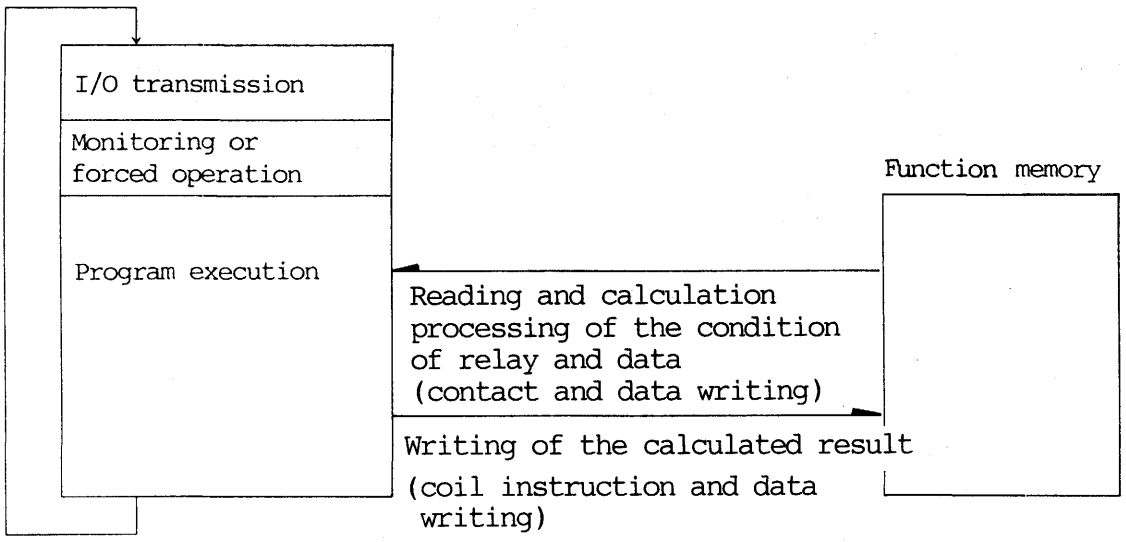
(7) Forced operation



- The forced operation of input will turn the input ON or OFF by force for one scan; then the condition of external input will take place later.
- If an object relay is written in the program in the forced operation of output or internal relay, the output or relay will react to the forced operation at the time of program execution. Thus, the external output may not be ON even for one scan if the condition is not satisfied. Or if the relay that has no coil instruction written is put under forced operation, it will retain the condition of forced operation.
- The data written by the forced writing of register will be retained until the next different data are written by the program instruction or forced operation.

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(8) Execution and processing speed of instruction



● Execution time for each instruction

Condition Instructions

Instruction		Processing time, μS	
STR		6.6	
STRNOT		9.1	
AND		5.3	
ANDNOT		8.4	
OR		6.6	
ORNOT		9.1	
STR T/C		6.6	
STRNOT T/C		9.1	
AND T/C		5.3	
ANDNOT T/C		8.4	
OR T/C		6.6	
ORNOT T/C		9.1	
STR	(Drum)	50.9	
STRNOT	(Drum)	61.5	
AND	(Drum)	59.1	(6.2)
ANDNOT	(Drum)	60.3	(6.2)
OR	(Drum)	60.3	(6.2)
ORNOT	(Drum)	62.5	(6.2)
ANDSTR		3.8	
ORSTR		3.8	
MCR		5.0	
MCR		3.0	

Numbers in the parenthesis are for the not-satisfied MCS condition.

Coil Instructions

Instruction		Processing time, μS	
		When the condition is satisfied	When the condition is not satisfied
OUT		7.5	7.5
SETOUT		10.0	10.0
SET		17.5	9.3
RST		17.5	9.3
SETOUTRST		29.1	23.4
TMR	Constant	90.9	27.1
	I/O	700.0	
	Data register	458.8	
CNT	Constant	92.9	27.1
	I/O	706.8	
	Data register	465.6	
SR		64.1 + (16.6 × Stage No.)	53.1

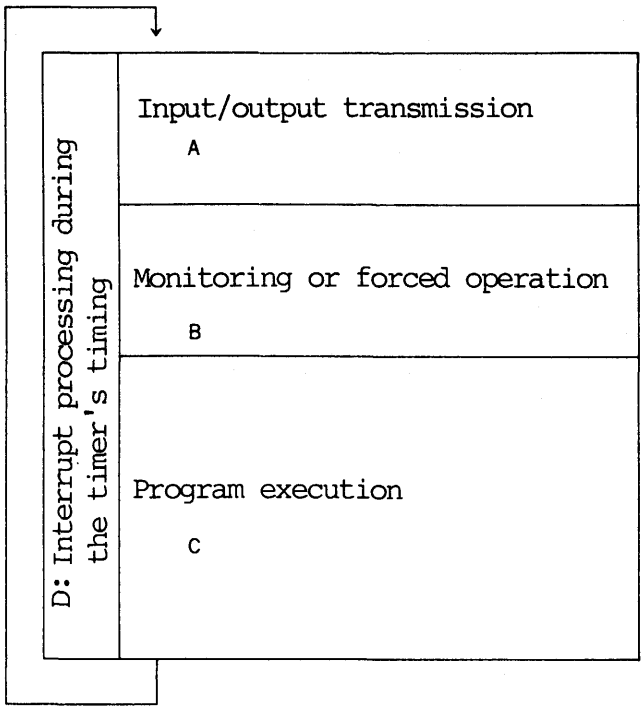
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● Processing time for data process instructions

Instruction	Processing time (μs)			
	When the condition is satisfied.			When the condition is not satisfied.
	Data register	I/O	Constant	
DSTR (F50)	80.7	321.9	14.3	6.3
DSTR1 (F51)	63.8	140.9		6.3
DSTR2 (F52)	95.0	172.2		6.3
DSTR3 (F53)	96.6	173.8		6.3
DSTR5 (F55)		326.2		6.3
DOUT (F60)	52.6	329.4		6.3
DOUT1 (F61)	39.1	160.1		6.3
DOUT2 (F62)	39.8	116.0		6.3
DOUT3 (F63)	55.0	108.1		6.3
DOUT5 (F65)		358.3		6.3
>=< (F70)	112.8	354.0	57.0	6.3
+ (F71)	456.8	698.0	262.0	6.3
− (F72)	315.8	557.0	275.0	6.3
× (F73)	290.0 ∿ 2644.0	497.0 ∿ 2851.0	223.0 ∿ 2576.0	6.3
÷ (F74)	742.0 ∿ 2645.0	1218.0 ∿ 2851.0	720.0 ∿ 2577.0	6.3
DAND (F75)	103.7	345.0	55.6	6.3
DOR (F76)	103.7	345.0	55.6	6.3
FALT (F20)	114.0	355.3	72.2	6.3
SFTR	216.0 + (13.4 x number of shifts)			6.3
SFTL	220.0 + (13.4 x number of shifts)			6.3
DECO	56.3			6.3
ENCO	282.0			6.3
COM	30.3			6.3
BIN	412.2			6.3
BCD	746.0			6.3

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(9) How to calculate the scan time



Input transmission time
Output transmission time
} = 3.3 ms

Monitor display time,
forced processing time,
or program processing time
} = 2,500 μs max.
0 μs under no processing

Program execution time = Total of instruction processing time

Interrupt processing time during timer's timing = one interrupt processing time x number of interrupts

$$D = 266\,\mu sec \times \frac{A+B+C+D}{2500}$$

1 scan time = A + B + C + D

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2-6. Self-diagnosing feature

The diagnosing feature provides self-diagnosing of the PC itself and detects operation errors and grammer errors of the program.

(1) Self-diagnosing feature of PC

Diagnosing item	Detail of detection	CPU operation	Display	RUN output	Internal relay
Power source voltage drop	Internal voltage (anytime)	Stops (*)	-------	OFF	------
CPU abnormality	Watchdog timer	Stops	CPU ● abnormality	OFF	------
Program memory parity abnormality	Program memory parity error, etc. (at the time of power source inputting or grammar checking)	Stops	E 2 1	OFF	_____
Battery abnormality	Battery voltage (anytime)	RUN	BATT ●	ON	#377 ON
Password abnormality	Password memory error (at the time of power source inputting or grammar checking)	Stops	E 22	OFF	
Execution preparation abnormality	Execution memory capacity overflow (at the start of RUN)	Stops	E 3 1	OFF	

(*): CPU stops in the case of voltage drop of the basic base when the CPU is mounted. The CPU operation will not stop when the voltage drop is detected in the expansion base, but only the RUN output of the expansion base of which the voltage drop is detected will be turned off.

Note: The RUN output will be ON when no error for malfunction is found when the power source is on and PC is under the RUN mode.

(2) Procedural abnormality detection feature

Procedural errors made by the operator when operating the program setting unit or for recording into the cassette recorder or to play back will be detected and displayed on the program setting unit.

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Operations	Display code
Incorrect program entry procedure	E01
Incorrect I/O number, internal relay number, or timer/counter number	
Incorrect writing operation of other instruction into the second word location of a two-word instruction	E08
No blank address available in program memory	E11
Unmatched contents of cassette tape recording	E25
Improper cassette recorder's playback level	E28
Undefined instruction searched	E99

(3) Grammatical program error detection

The grammatical checking for program preparation detects violations of the rules for circuit configuration and any other errors that could make the program impractical. If any error of this kind is detected, its error code will be displayed on the programmer together with displays of the error's memory address and instruction.
The grammar checking is also automatically made to start RUN.
The error codes and kinds of corresponding errors are shown in the following chart.
For details of grammatical check procedure, refer to the grammatical check in this manual, operation section 13.

Depress CLR and SCH. If any error occurs, its error code will be displayed. If not, the first blank address will be displayed.

Note: If the END instruction (if writing is not made) is found in the middle of the program, no checking will subsequently be made.

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Grammer error	Display code
Instruction error, I/O error, number error, and data error (Example: If the input number is used for output.)	E02
Stack over when AND STR, OR STR, or MCS are used in continuation more than eight of them	E03
Duplicate use of the output relay, internal relay, timer, and counter	E05
Unbalanced usage of MCS and MCR	E06
Missing of condition of CNT and SR (Example: When the reset condition is missing from CNT.)	E07
Missing of set values of TMR, CNT, and SR	E08
When no closing circuit is prepared.	E09
No blank address is available for the program.	E11
Program memory parity error	E21

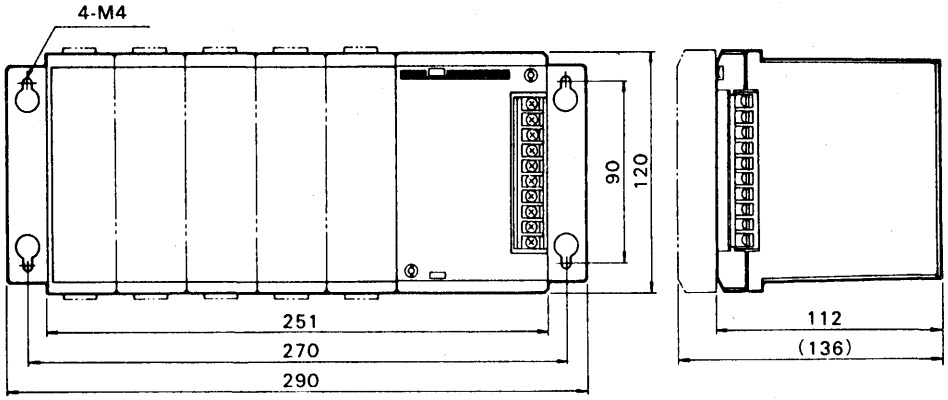
Grammatical checking can be made either by the RUN mode or PRG mode.

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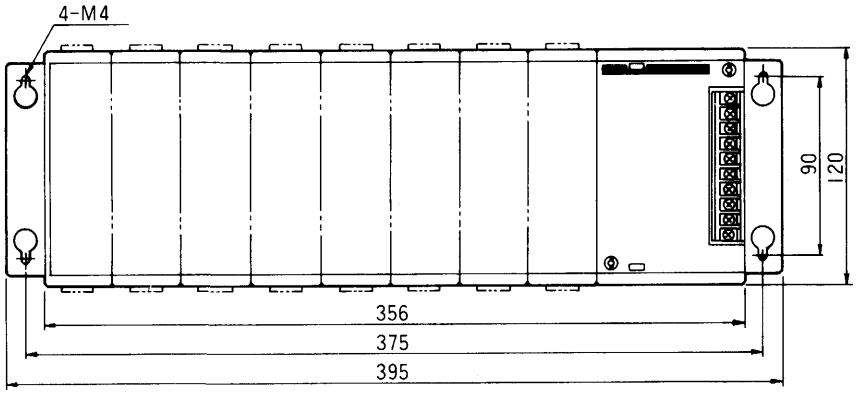
2-7. Dimensions (unit: mm)

I/O base and basic base (same sizes for the expansion base)

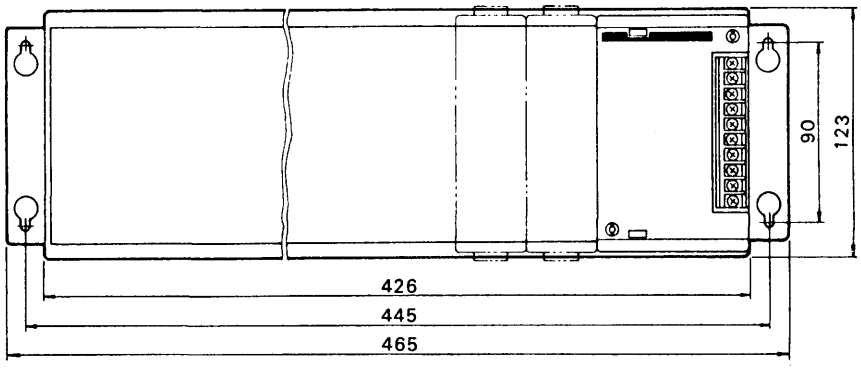
●E-01BJ／E-02B／E-02B-C



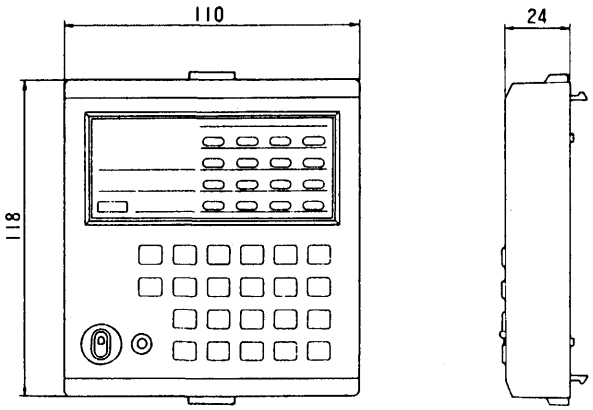
●E-05B



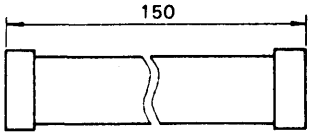
●E-03B／E-03B-C／E-04B／E-04B-C



Programmer: R-21P

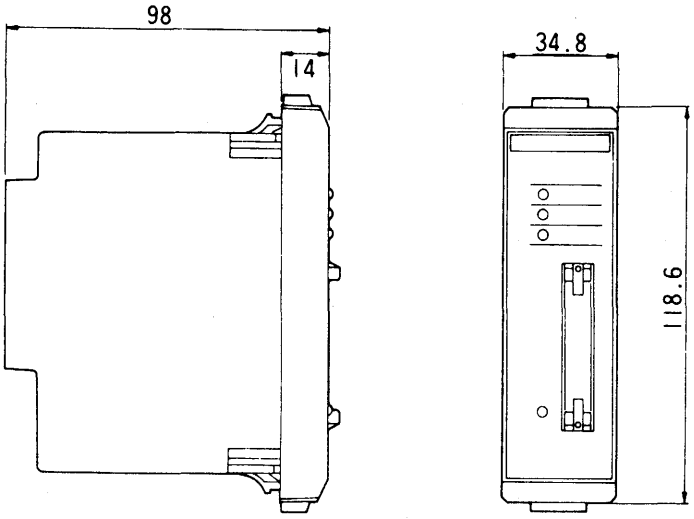


Programmer cable: E-15PJ
(option)

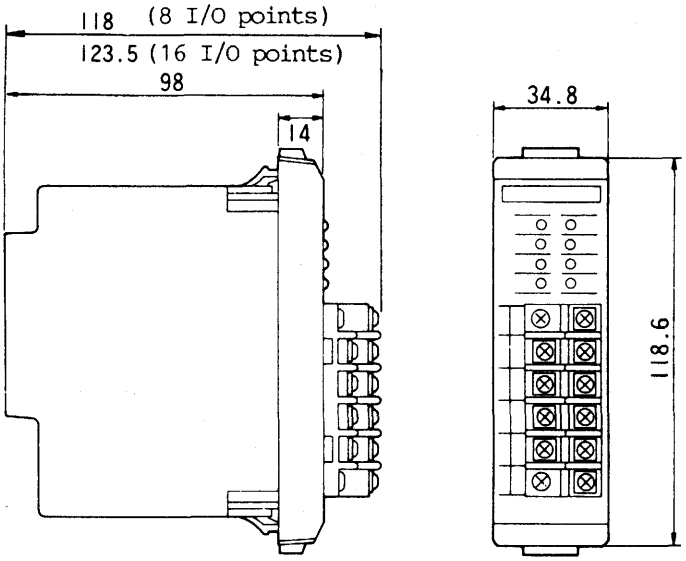


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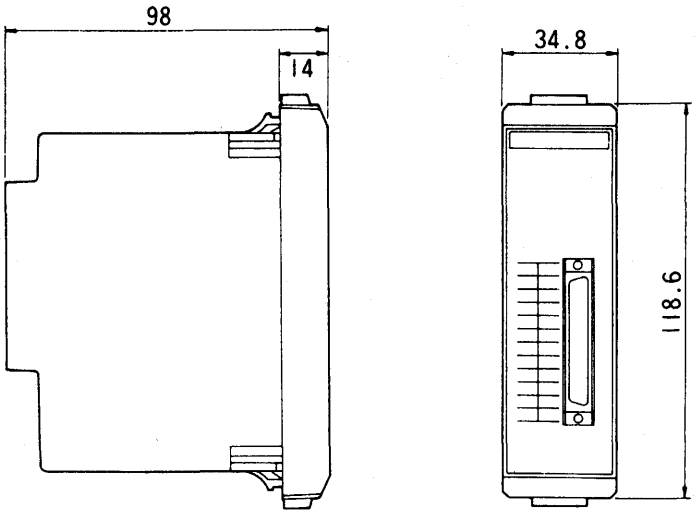
CPU module



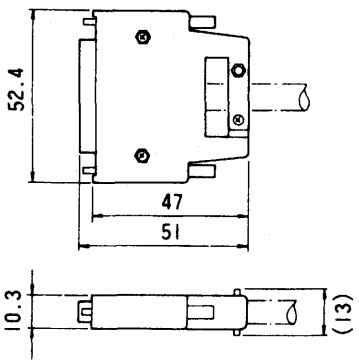
I/O module



I/O module: 24P-connector connection type



24P connector for I/O module



Model: FCN-361J024-AU case
FCN-360C024-B connector

Maker: Fujitsu

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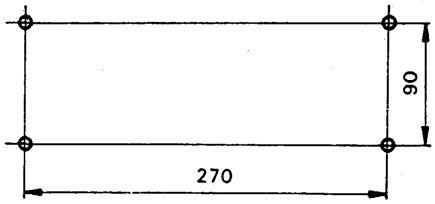
3. MOUNTING AND WIRING

3-1. Installation

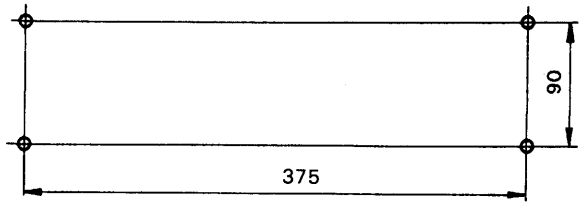
The basic base and expansion base are made in the same size and should be installed with four M4 screws.

Mounting-hole locations

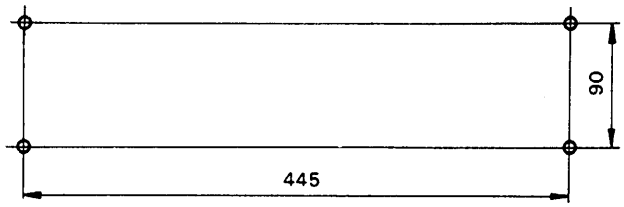
●E-01BJ
E-02B
E-02B-C



●E-05B

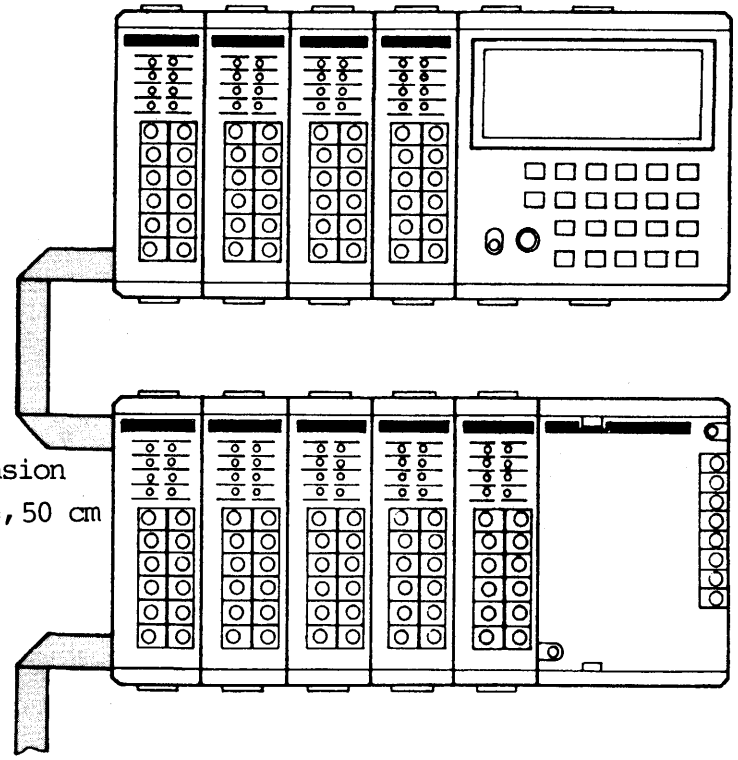


●E-03B
E-03B-C
E-04B
E-04B-C



Location for expansion base installation

The expansion base should be installed below the basic base (with CPU). Because of the limited length (50 cm) of expansion cable (E-05J) to connect the basic base with expansion base, the cable will not be long enough to make the connection in a horizontal direction.

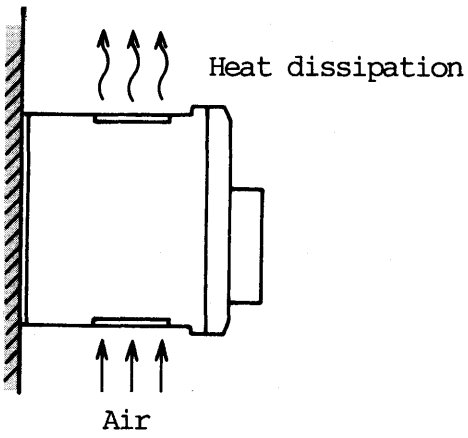


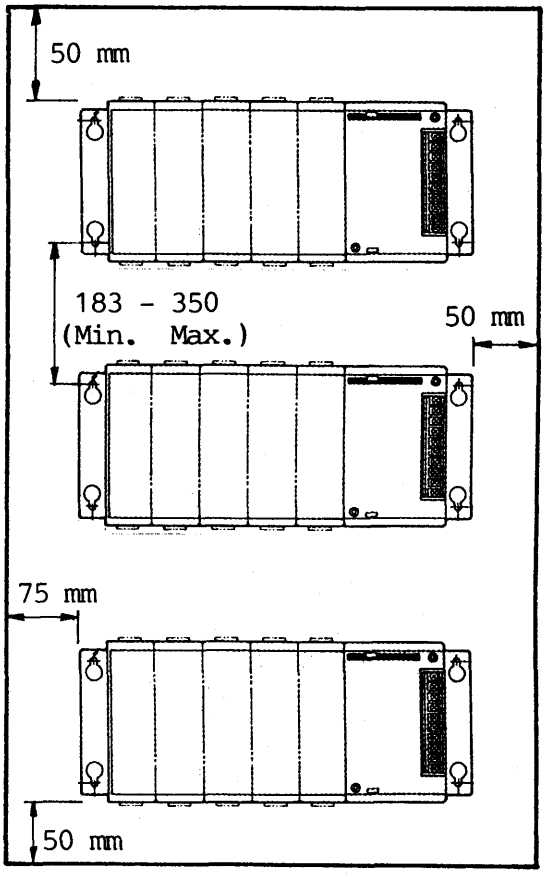
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Installation position

Vent holes are provided in the side of the basic base and expansion base to prevent heat buildup. Position the unit on an upright wall to ensure effective heat dissipation.

If there is any danger of getting foreign substance into the case, install a cover over the case for protective measure.





Cautions on installation

(1) Leave a space of at least 50 mm (75 mm for left side) around the PC for ventilation, maintenance, and inspection.

(2) Ambient temperature must be in the 0°C to 55°C range.
If the unit is installed in a panel, a ventilation fan must be provided on the top of the panel to remove heat.

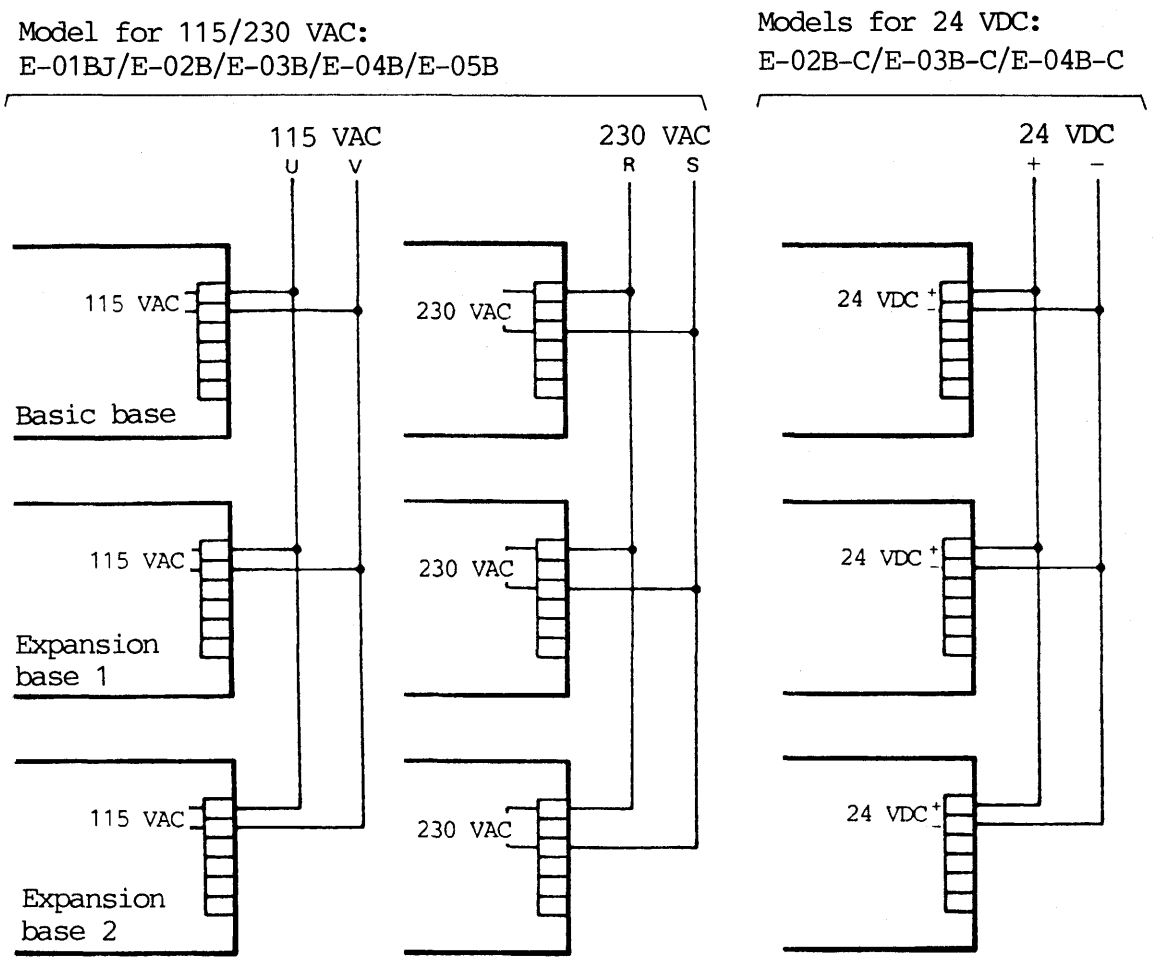
(3) Avoid areas where

- The temperature inside the panel may exceed 55°C or drop below 0°C.
- The ambient humidity may exceed 90% or drastic temperature changes will occur that could induce condensing.
- The atmosphere contains dust, iron particles, or corrosive gases.
- The main body may be directly exposed to vibration and impacts.
- Exposure of the unit to direct sunlight is unavoidable.

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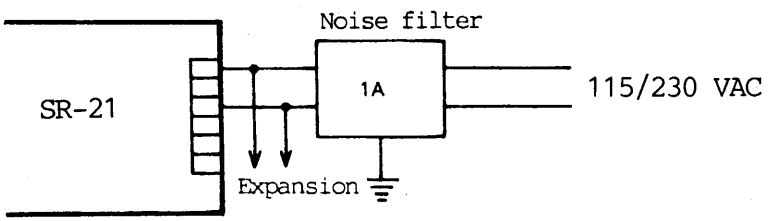
3-2. Power supply connection

Each base gets its own power source.



- Noise entry into power line

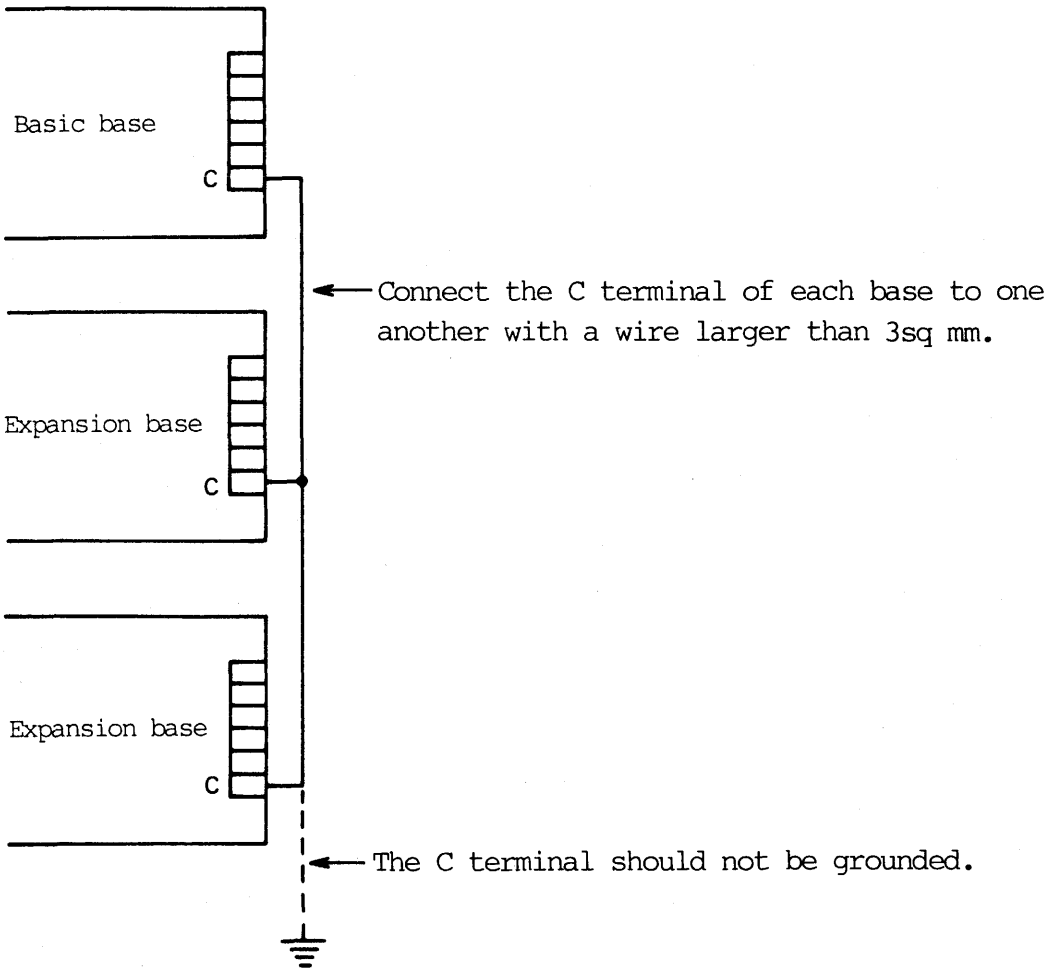
  The SR-21 requires no special noise prevention for its line because it has been designed to overcome problems of this kind in normal plant operations. A noise filter should be used, however, in the AC line if the area has many motors, AC solenoids, or other induction loads producing high levels of noise.



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3-3. C terminal connection

The C terminal on the base is not a ground terminal, but is connected to the 0 V side of the internal 5 V circuit.
When using an expansion base, all C terminals should be connected to one another with a large wire (more than 3 sq mm) to prevent a difference on the 0 V electric potential between bases. The C terminal should not be grounded. An incomplete grounding will easily allow noise interference.

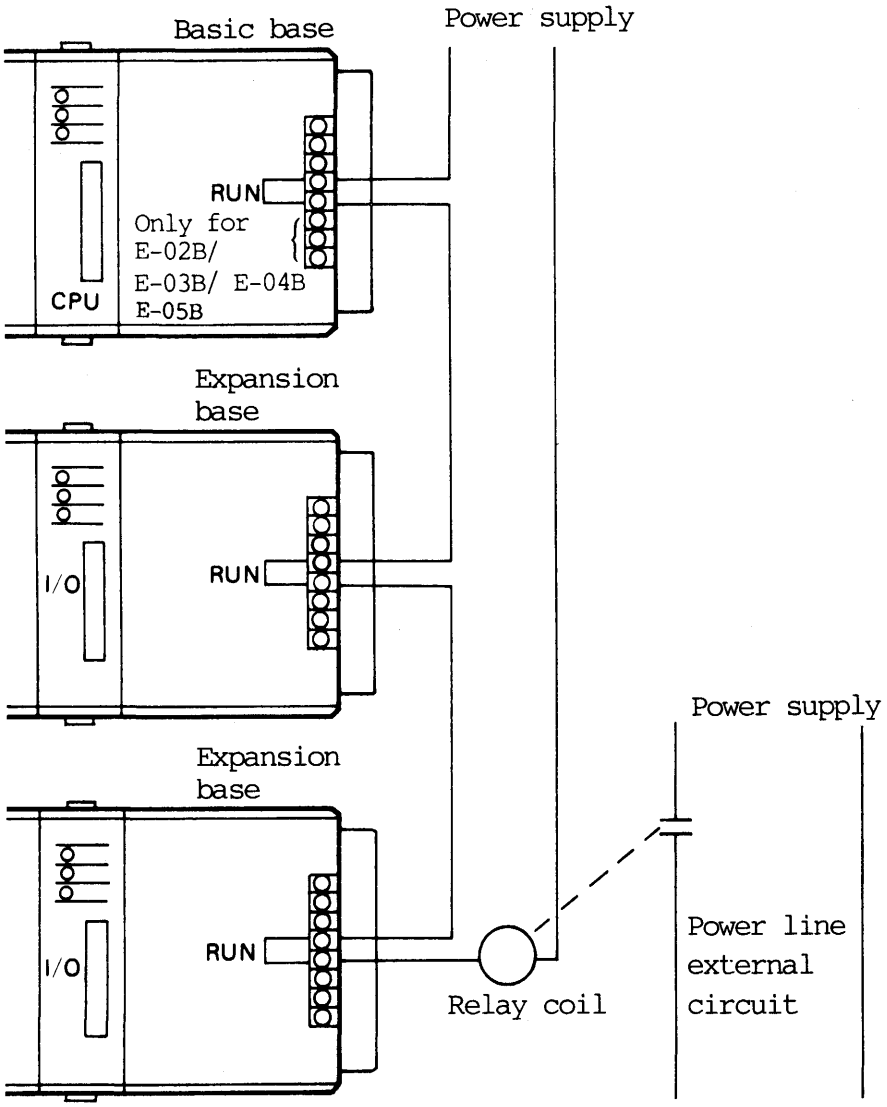


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3-4. RUN output connection

The RUN output is output from each base and will be ON when no malfunction is found under RUN mode operation in the basic base on which the CPU module is mounted, and it will be OFF when the power source voltage is low in the expansion base.

Note: The voltage of the power source should match the voltage for the relay coil.

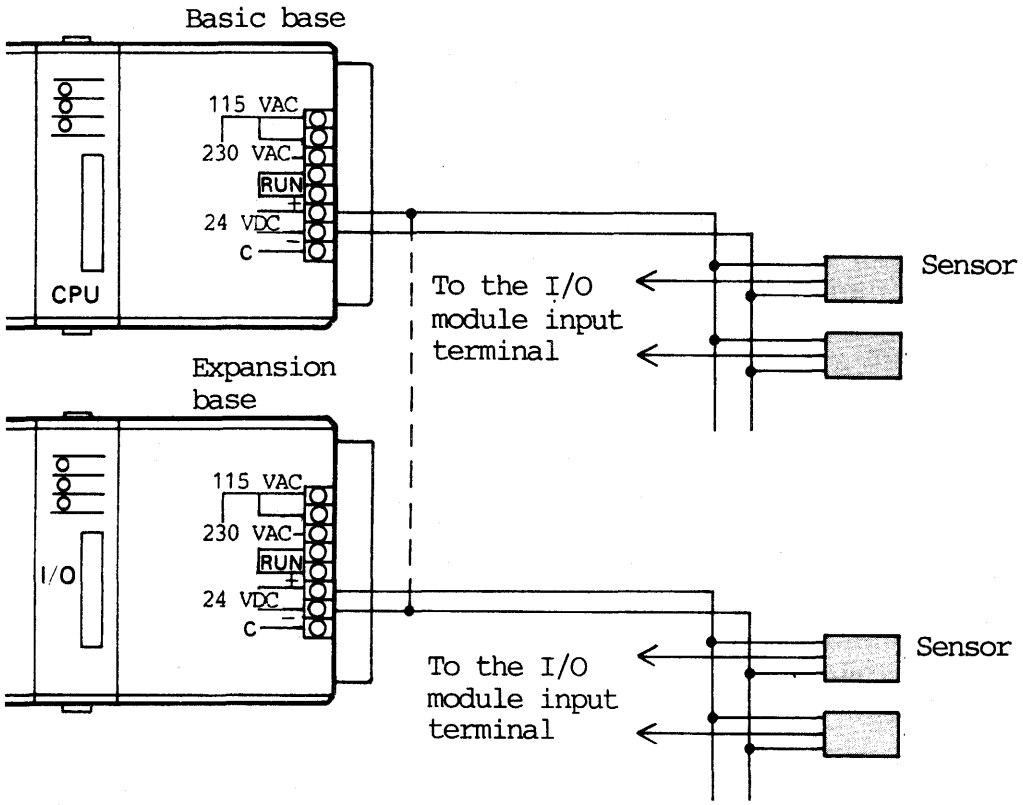


- The RUN output should be normally connected in a series.
- The power supply for the line should be turned on when the RUN output is turned on.

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3-5. Connection with the power source for external supply

The power source terminal for external supply (sensor use) is attached on E-02B, E-03B, E-04B, and E-05B. The 24 V are applied from the same power source for I/O module power supply. The common line is separated from the CPU 5 V common line (C terminal).



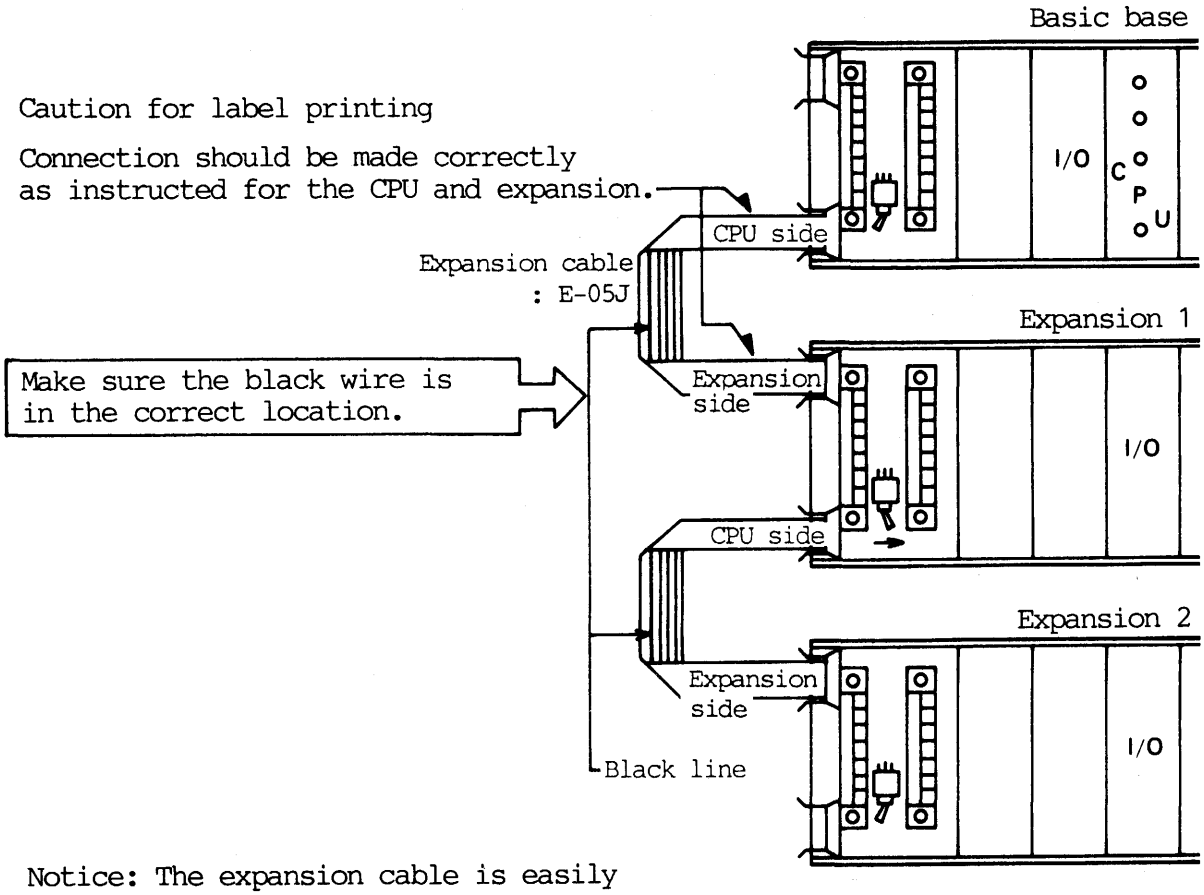
- The sensor use 24 VDC power source as a rule should be given from the base on which the input module is mounted to receive a signal from the sensor.
- If the different bases are used for sensor use 24 VDC power supply and for mounting an input module to receive a sensor signal, the 24 VDC minus common line should be connected with both these bases.

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3-6. Expansion cable connection

The expansion cable (E-05J) is flat. Wires are not symmetrically arranged on two ends. The connectors for the basic base and expansion base are separately fixed. The erroneous connection of these connectors will be a cause of unstable operation and many other troubles.

The direction of the expansion cable should be correctly arranged as shown below.

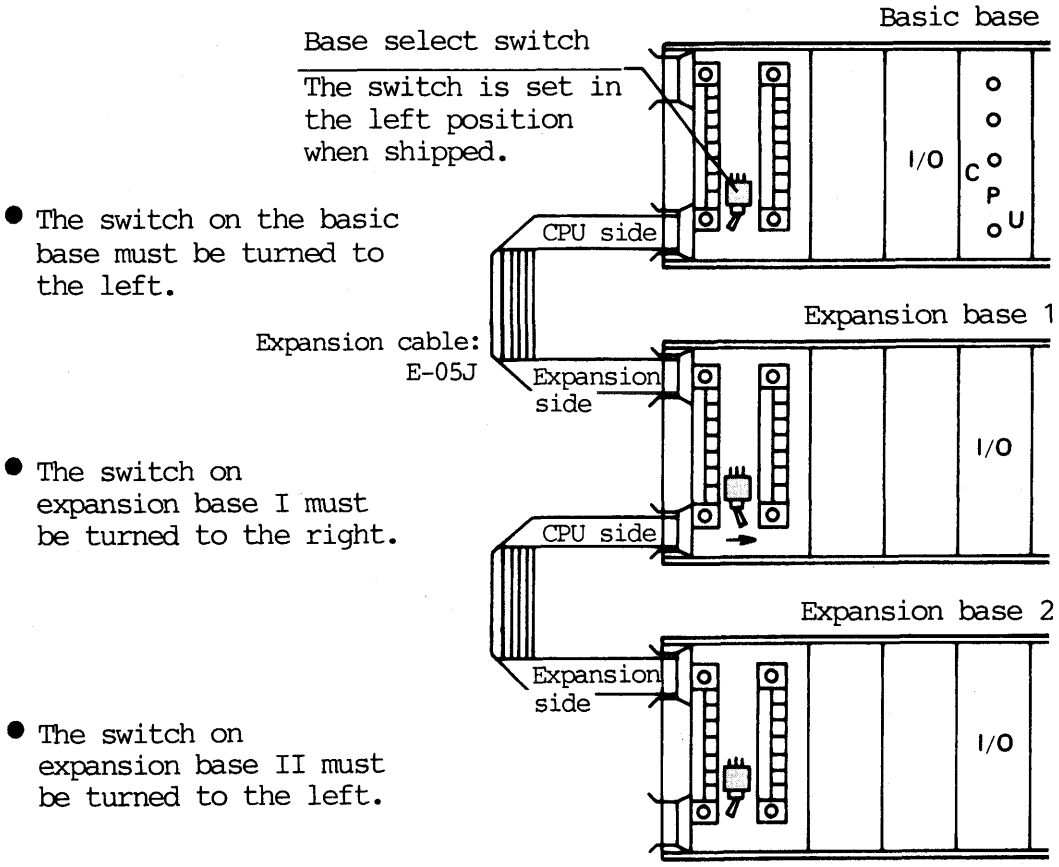


Notice: The expansion cable is easily influenced by noise. Avoid putting the expansion cable in the same duct with the input/output lines of the I/O module or power line or combining with these wires.

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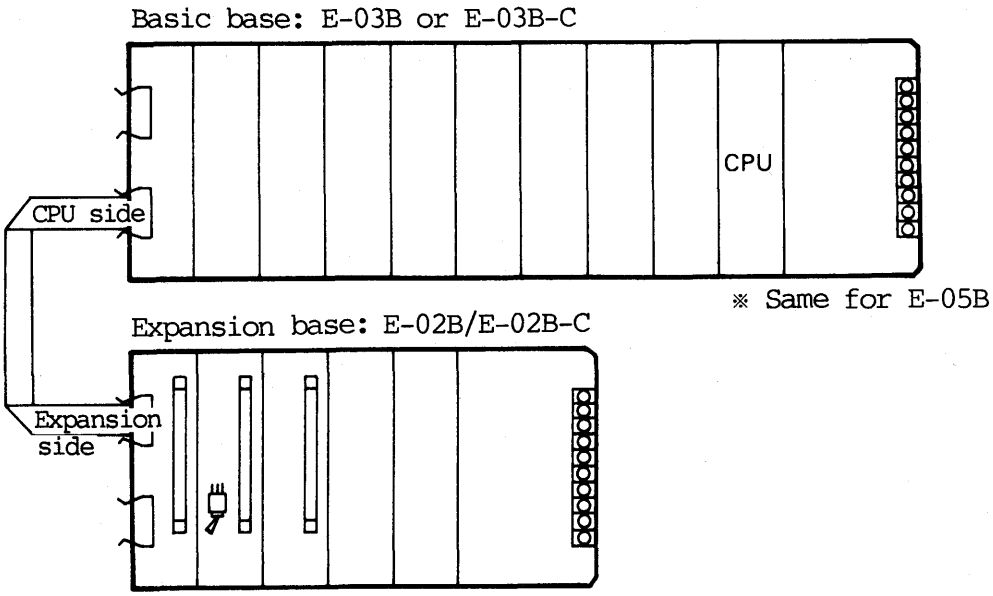
3-7. Base (connector) select switch

(1) Use of 5-module-slot bases (E-02B, E-02B-C) only



- The switch on the basic base must be turned to the left.
- The switch on expansion base I must be turned to the right.
- The switch on expansion base II must be turned to the left.

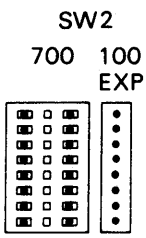
(2) Use of a 5-module-slot base for expansion from E-03B (-C)※



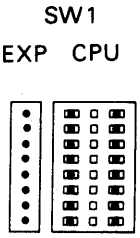
- The switch on the expansion base is turned to the left side.

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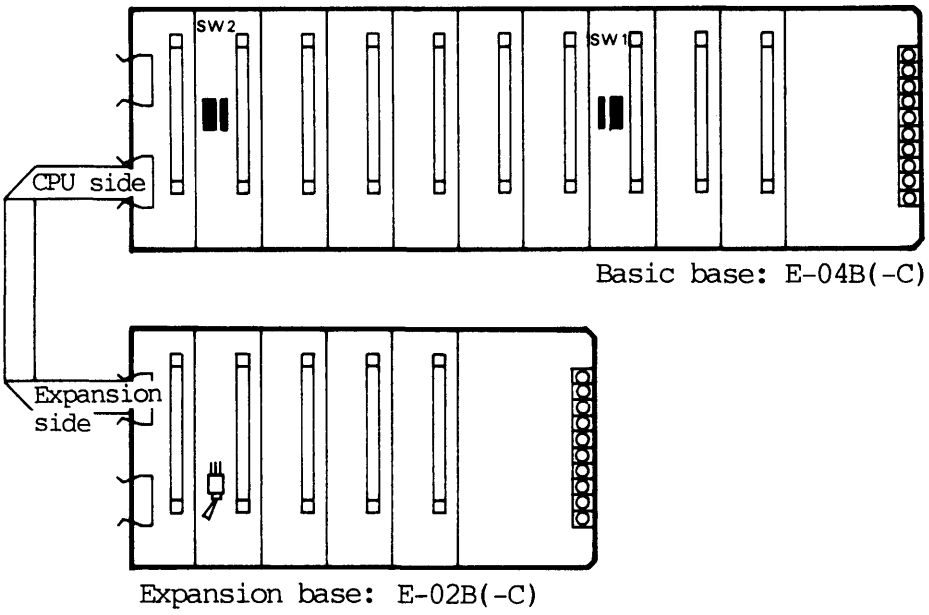
(3) Use of a 5-module-slot base for expansion from E-04B (-C)



Two lines of pins on the left side of switch 2 must be shorted by the bridge connector.



Two lines of pins on the right side of switch 1 must be shorted by the bridge connector.

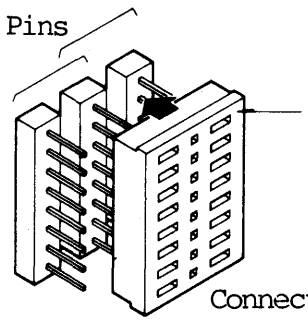


Basic base: E-04B(-C)

Expansion base: E-02B(-C)

The select switch on the expansion base must be turned to the left.

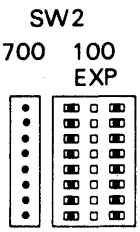
- When only one E-04B (-C) base and I/O numbers from 700 to 707 of the module on the end of the left side are used, two bridge connectors must be installed as shown on the above example of the basic base.
- Bridge connector



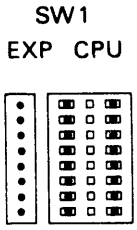
To short pins on either one of two lines by the connector

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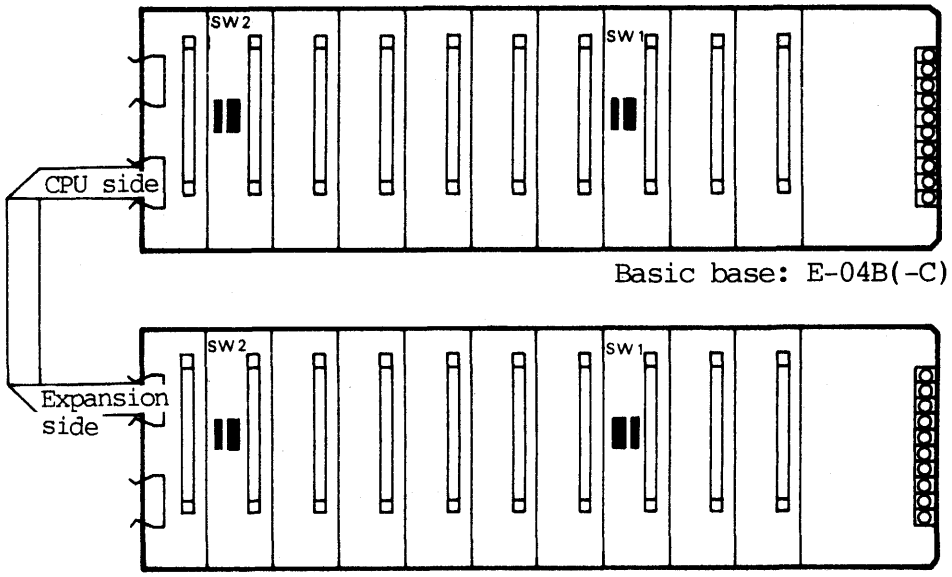
(4) Use of two E-04B (-C)s



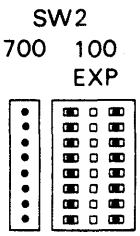
Two lines of pins on the right side of switch 2 must be shorted by the bridge connector.



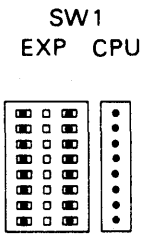
Two lines of pins on the right side of switch 1 must be shorted by the bridge connector.



Two lins of pins on the right side of switch 2 must be shorted by the bridge connector.



Two lines of pins on the left side of switch 1 must be shorted by the bridge connector.



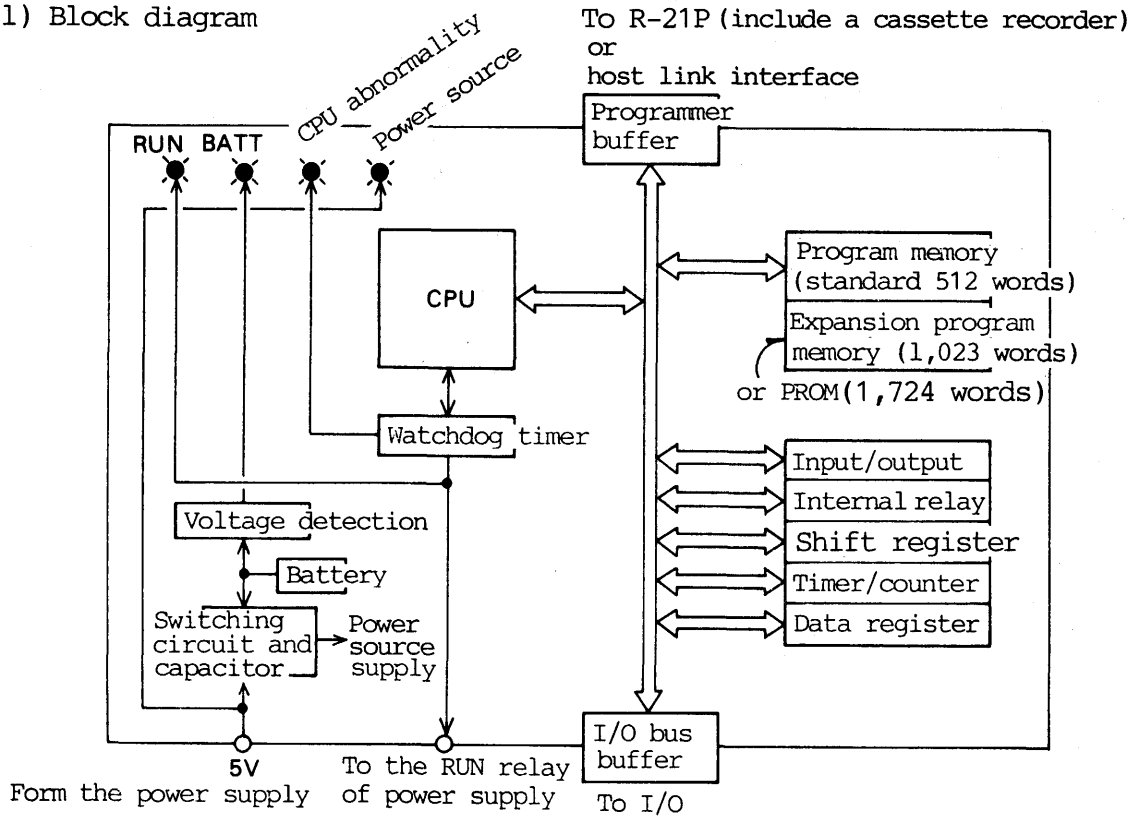
- When only one E-04B (-C) base and I/O numbers from 100 to 107 of the module on the end of the left side are used, two bridge connectors must be installed in the same locations as in the basic module, as shown above.

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4. SYSTEM SPECIFICATIONS

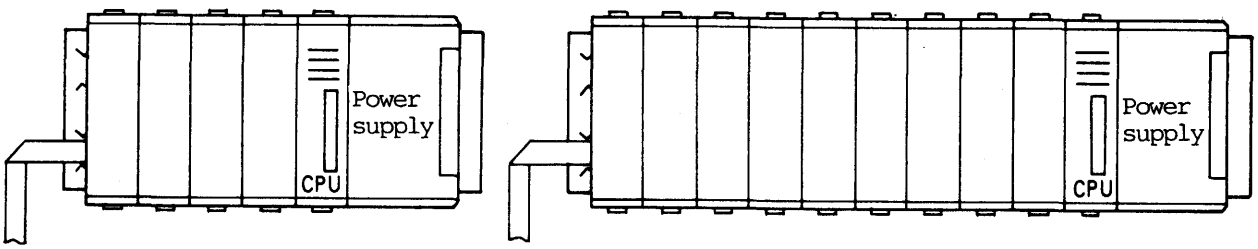
4-1. CPU module, SR-21 (weight: 200g)

(1) Block diagram



(2) Installation

- Installation bases: E-01BJ, E-02B (-C), E-05B, E-03B (-C), and E-04B (-C)
- Location for installation: #1 slot (next to the power supply) of the basic base (base to be installed on the top)



(3) Current consumption 5 VDC: 300 mA max.
9 VDC: 50 mA
(include current consumption of the base)

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(4) Program memory

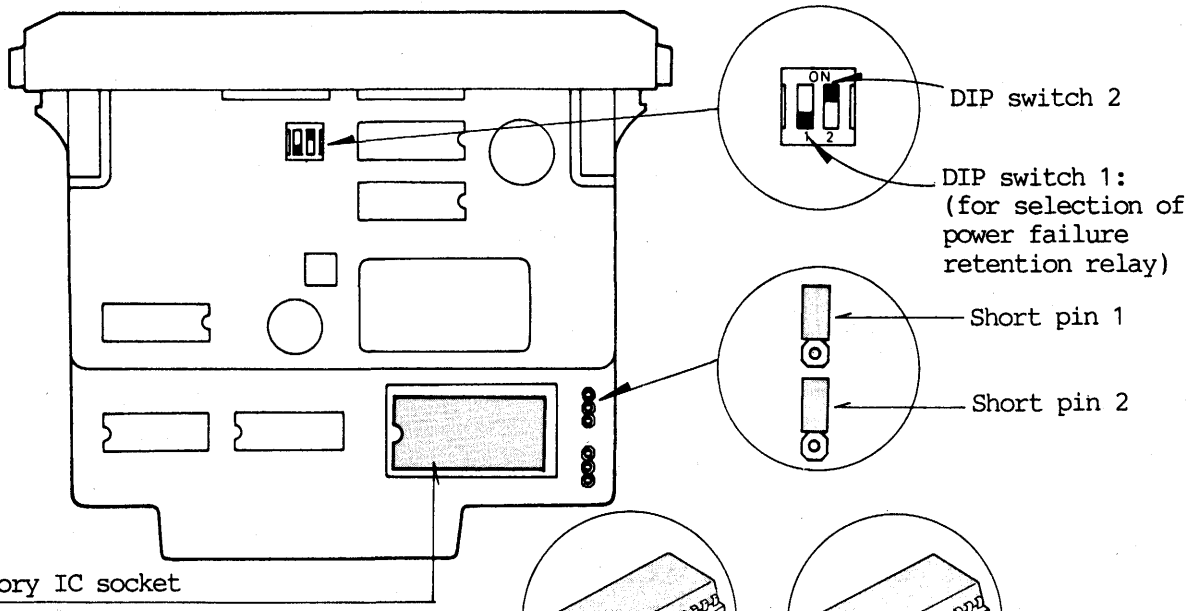
Arrangement by the selection of program memory

Memory specification / Switch	Standard specification RAM (701 words)	Increasing RAM RAM 1,724 words	EP-ROM 1,724 words
Memory IC socket	Not to be installed	Installation of HM6264LP·15	Installation of HN27256G·25
Dip switch 2	ON 2	ON 2	ON 2
Short pin 1			
Short pin 2			

SR-21-1 is installed with RAM from the beginning.

- Caution when increasing RAM: The clearing of all memories in RAM is necessary after installation because the memory content of RAM may be kept at random. Clearing causes a loss of the memory content of 0.7K of the standard RAM. Thus, it is necessary to record the memory content into the cassette recorder beforehand and reduce it into the memory after the operation for clearing all contents.

DIP switches and short pins on standard memory (RAM701 words) are set as shown in circles.



Memory IC should be mounted with its notch facing to the left as illustrated, and the IC pins must be correctly fit into the socket.

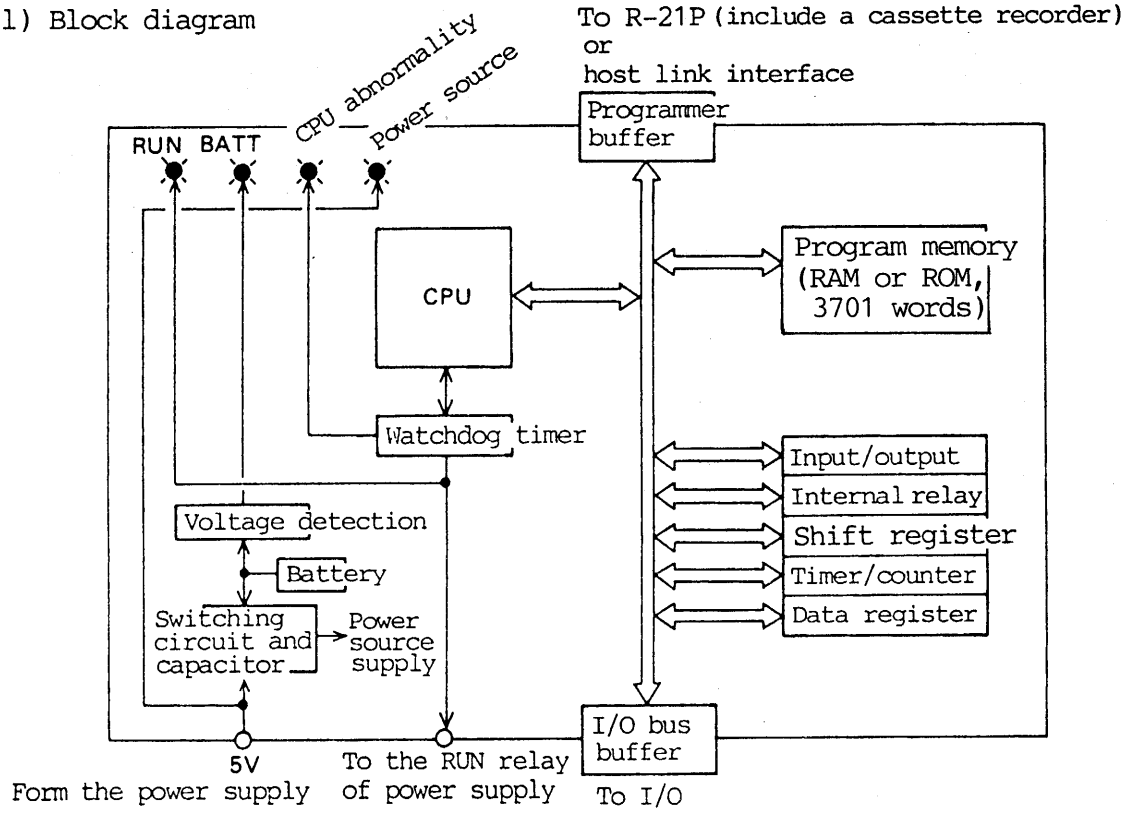
Good example of installation.

Bad example of installation. Some of IC pins have not yet been put into the socket.

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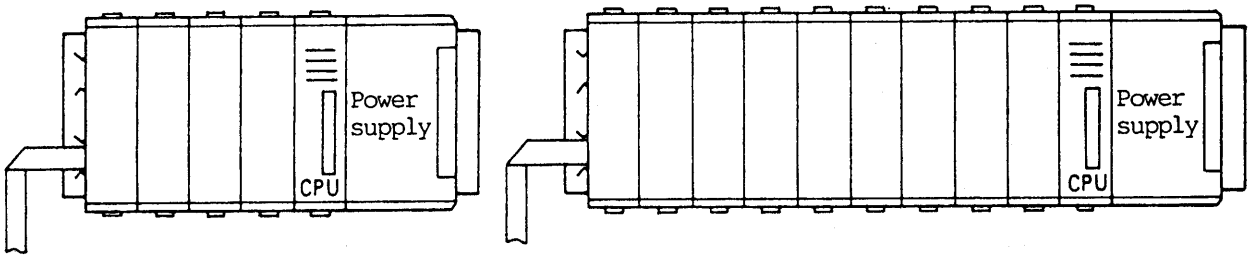
4-2. CPU module, SR-22 (weight: 200g)

(1) Block diagram



(2) Installation

- Installation bases: E-01BJ, E-02B (-C), E-03B (-C), E-04B (-C), and E-05B.
- Location for installation: #1 slot (next to the power supply) of the basic base (base to be installed on the top)



(3) Current consumption 5 VDC: 300 mA max.
9 VDC: 50 mA
(include current consumption of the base)

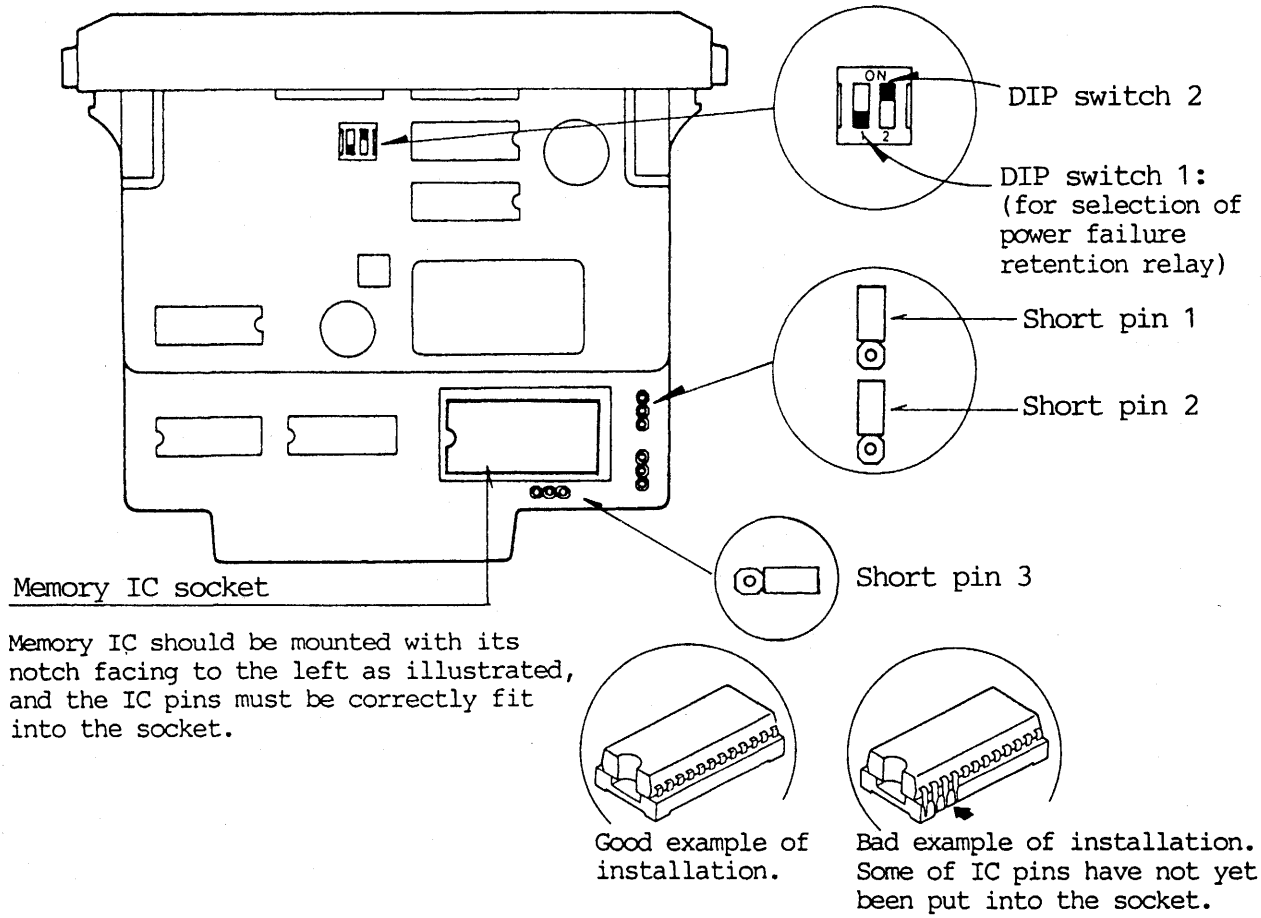
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(4) Program memory

Arrangement by the selection of program memory

Memory specification	Standard specification RAM (3701 words)	EP-ROM (3701 words)
Dip switch 2	ON 2	ON 2
Short pin 1		
Short pin 2		
Short pin 3		
Memory IC socket	HM62256LP-15	HN27256G-25

Dip switches and short pins on standard memory (RAM 3701 words) are set as shown in circles.



Memory IC should be mounted with its notch facing to the left as illustrated, and the IC pins must be correctly fit into the socket.

Good example of installation.

Bad example of installation. Some of IC pins have not yet been put into the socket.

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(5) Password

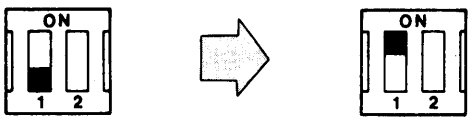
For the purpose of keeping the program memory contents secret, a feature is provided to register a password to the CPU. When the password is registered, the program reading or writing features are inhibited unless the CPU is opened by the password.

(6) Power failure retention

Items to be retained in case of power failure

Item		Detail of contents to be retained
Operation mode		RUN mode, PRG mode, and cassette mode
Program memory		Whole RAM area (ROM will not lose its memory even during power failure.)
Function memory	Internal relay	Relays from 340 to 373 only can be selected by the internal dip switch. (*)
	Shift register	Whole area from 400 to 577
	T/C accumulated value	R#600 to R#677 except the numbers used by the timer
	Data register	Whole area from 400 to 577
Password		Only at the time of registration

(*) Selection of internal relays from 340 to 373 for power failure retention will be made by switch 1 by turning to the ON side (upper side).



This setting makes it possible for internal relay to act as a power failure memory retention relay.

- Battery for memory retention

  Kind: Lithium battery (primary battery)

  Model number: RB-5

  (The battery is specially made and connected with the connector. It is recommended that the battery be purchased through KOYO.)

  Life: 5 years after production

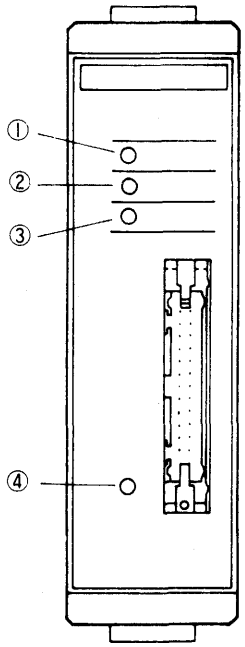
  (Expected life span under normal room temperature. It may be necessary to replace the battery a little earlier in the case of use in a bad environment.)

- Replacement of battery (refer to D-3 in the maintenance section and check for details.)

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The battery voltage is always checked when the power source is applied to the CPU. When the battery life nears its end, the display for battery abnormality status will be lighted and the battery abnormality relay 377 will be turned ON. The battery should be replaced within 10 days if the battery abnormality status is detected. When replacing the battery, apply the AC power for at least 5 seconds. This is needed to set the RAM to the standby mode to consume less current because the removal of the battery can destroy the power failure detector that directs the selection of the RAM's operation mode, and as a result the RAM may have been set in as operation mode requiring more current.
During battery replacement, the power source of RAM is energized by a large size of capacitor. After the AC power is turned OFF, the battery should be replaced as soon as possible (preferably within one hour).
If not, the program may be lost because the voltage of the capacitor may drop.

(7) CPU module operation status display



(1) RUN: It shows that the CPU is properly functioning.

(2) BATT: It shows that the lithium battery voltage for RAM backup is dropping. When this LED is lighted, replace the battery as soon as possible.

(3) CPU abnormality: The display will be lighted if the watchdog timer interruption for every 100 ms is not processed because of some failure of CPU operation. Should this happen, the RUN output from the power supply will also be turned off.

(4) Power supply: It shows the effectiveness of 5 V power supply.

Note: The program memory has a parity bit for use in parity checking when the power source is turned on or when the operation mode is changed to the RUN mode. If this check is completed satisfactorily, the PC will be put under the RUN status. If the parity error is detected, the PC will not be put under the RUN condition, but the CPU error LED remains unlit. Error code E21 will be displayed if programmer R-21P is mounted.

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(8) Be careful when storing and transporting the CPU module.

When removing the CPU module from the base, observe the following precautions.

Allow the internal voltage to drop to a level befor removing the CPU.
This takes about 1 minute after the AC power supply is shut OFF.
Since the CPU module contains a battery that backs up its memory, shorts of the connector terminals, printed patterns, or other parts may alter the program contents or change the operating mode of the RAM in the memory circuit.
This will result in increased battery current consumption and premature battery depletion; the battery will discharge completely in 10 to 30 days.

To avoid such short-induced troubles, after the CPU module is removed, it should be placed in a thick and soft paper bag or protected by other suitable means. Never wrap it in aluminum sheet, as is usually done with IC cards.

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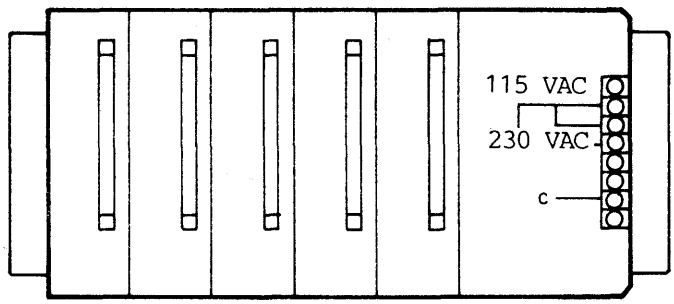
5. BASE WITH POWER SUPPLY

5-1. 5-module-slot base with power supply: E-01BJ

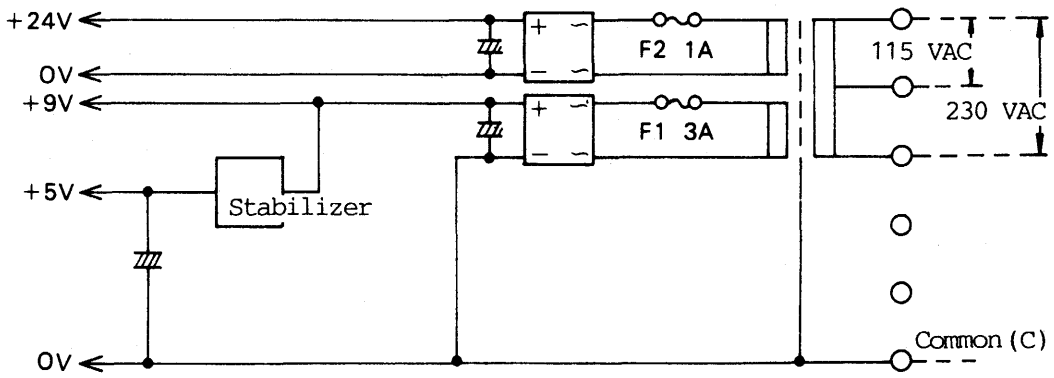
(1) Specifications

Item		Specifications			
Number of modules		5 (4 I/O modules)			
Base expandability		No			
RUN output		No			
Power source voltage		115/230 VAC, 50/60 Hz			
Allowable voltage tolerance		-15% ~ +32% of the voltage rating			
Power consumption		Less than 30 VA			
Sensor use power source		No			
Power supply capacity to the module	Voltage	Fluctuation range	Ripple	Allowable current (AC power source voltage drop Within 15%	Within 10%
	5 VDC	± 2.5%		0.4 A	0.4 A
	9 VDC	7 - 16 V	10%	0.3 A	0.6 A
	24 VDC	18 - 36 V	15%	0.2 A	0.2 A
Fuse		For 5/9 VDC (F1), 3 A minifuse, Model: MF51NN3 For 24 VDC (F2), 1 A minifuse, Model: MF51NN1			
Weight		1,500 g			

(2) Product design



(3) Power source circuit



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5-2. 5-module-slot base with power supply: E-02B

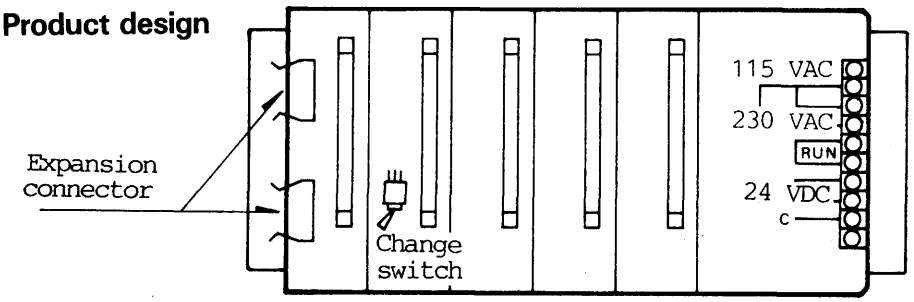
(1) Specifications

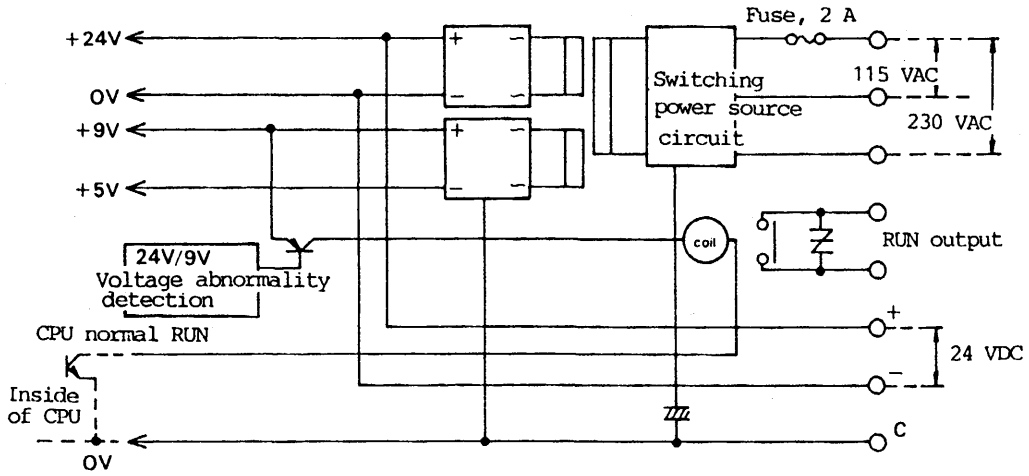
Item	Specifications			
Number of modules	5 (up to 4 I/O modules for the base to install a CPU module)			
Base expandability	Yes (Expansion bases: E-02B/E-02B-C)			
RUN output *1	Relay contact, 250 VAC, 4 A (resistive load)			
Power source voltage	115/230 VAC, 50/60 Hz			
Allowable voltage tolerance	-15% - +32% to the voltage rating			
Power consumption	Less than 30 VA			
Sensor use power source	24 VDC, 0.1 A (voltage fluctuation range: 20 - 28 V, less than 1.2 Vp-p of ripple)			
Power supply capacity to the module	Voltage	Fluctuation range	Ripple	Allowable current
	5 Vdc	4.8 - 5.2 V	Less than 0.1 Vp-p	1.4 A (Total 2.2 A)
	9 VDC	8.5 - 13.5 V	Less than 0.2 Vp-p	0.8 A
	24 VDC	20 - 28 V	Less than 1.2 Vp-p	0.4 A
Fuse	2 A minifuse, Model: MT4, 2 A (Sanno fuse)			
Weight	1,300 g			

*1. The RUN output will be ON if the following conditions are satisfied:

(1) The power source is turned ON.
(2) No abnormal conditions of the CPU under the RUN mode are observed. (This condition is not required for the expansion base.)
(3) 9/24 V power sources for the module are normal.

(2) Product design





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5-3. 5-module-slot base with power supply: E-02B-C

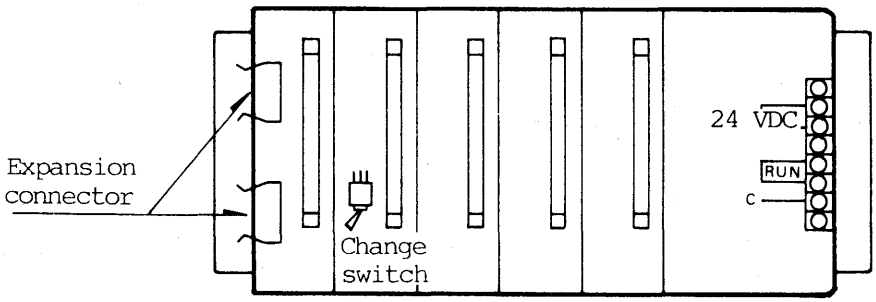
(1) Specifications

Item	Specifications			
Number of modules	5 (up to 4 I/O modules for the base to install a CPU module)			
Base expandability	Yes (Expansion bases: E-02B/E-02B-C)			
RUN output *1	Relay contact, 250 VAC, 4 A (resistive load)			
Power source voltage	24 VDC			
Allowable voltage tolerance	20 VDC - 30 VDC, less than 10% of ripple			
Power consumption	Less than 48 W			
Sensor use power source	No			
Power supply capacity to the module — Voltage	Fluctuation range	Ripple	Allowable current	
5 VDC	4.8 - 5.2 V	Less than 0.1 Vp-p	1.4 A	Total 2.7 A
9 VDC	8.5 - 13.5 V	Less than 0.2 Vp-p	0.8 A	
24 VDC	20 - 28 V	Less than 1.2 Vp-p	0.5 A	
Fuse	4 A minifuse, Model: MT4, 4 A (Sanno fuse)			
Weight	1,300 g			

*1. The RUN output will be ON if the following conditions are satisfied.

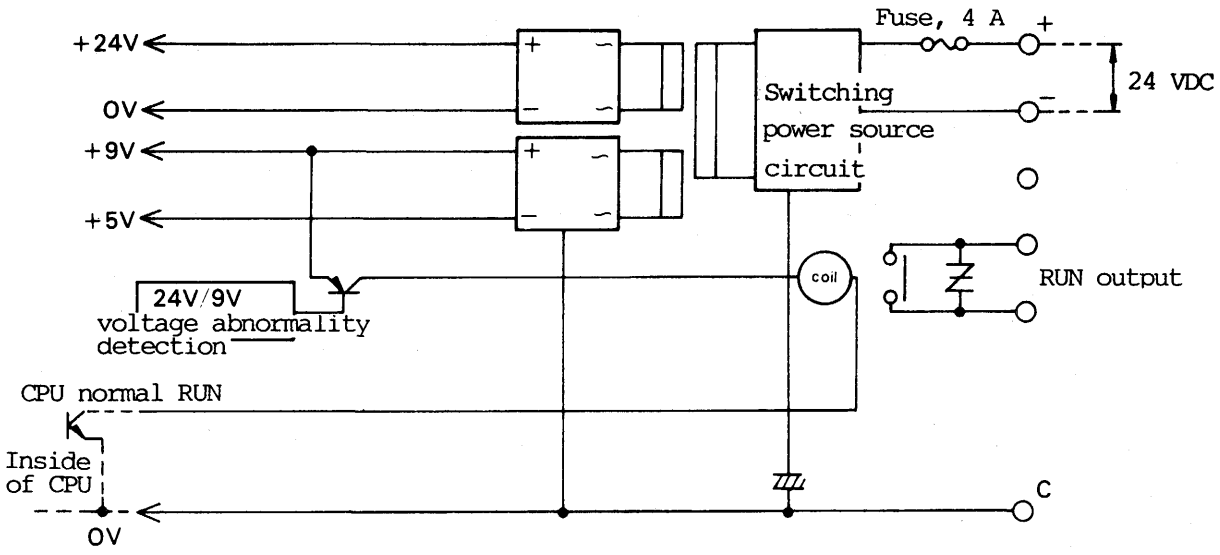
(1) The power source is turned ON.
(2) No abnormal conditions of the CPU under the RUN mode are observed. (This condition is not required for the expansion base.)
(3) 9/24 V power sources for the module are normal.

(2) Product design



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(3) Power source circuit



5-4. 10-module-slot base with power supply: E-03B

(1) Specifications

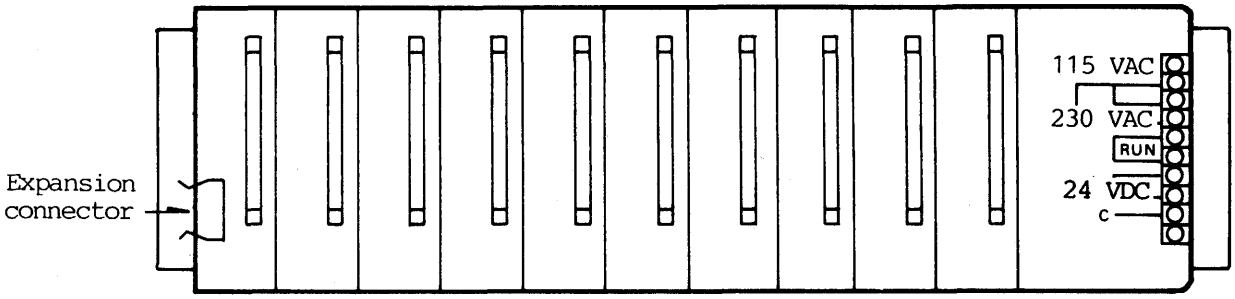
Item	Specifications			
Number of modules	10 (up to 9 I/O modules for the base to install a CPU module)			
Base expandability	Yes			
RUN output *1	Relay contact, 250 VAC, 4 A (resistive load)			
Power source voltage	115/230 VAC, 50/60 Hz			
Allowable voltage tolerance	-15% - +32% to the voltage rating			
Power consumption	Less than 65 VA			
Sensor use power source	24 VDC, 0.1 A (voltage fluctuation range: 20 - 28 V, less than 1.2 Vp-p of ripple)			
Power supply capacity to the module — Voltage	Fluctuation range	Ripple	Allowable current (Ambient temperature) Below 55°C	Below 50°C
5 VDC	4.7 - 5.25 V	Less than 0.1 Vp-p	1.0 A	1.4 A
9 VDC	8.0 - 12.0 V	Less than 0.2 Vp-p	1.4 A	1.7 A
24 VDC	20 - 28 V	Less than 1.2 Vp-p	0.5 A	0.6 A
Fuse	2 A minifuse, Model: MT4, 4 A (Sanno fuse)			
Weight	1,500 g			

*1. The RUN output will be ON if the following conditions are satisfied.

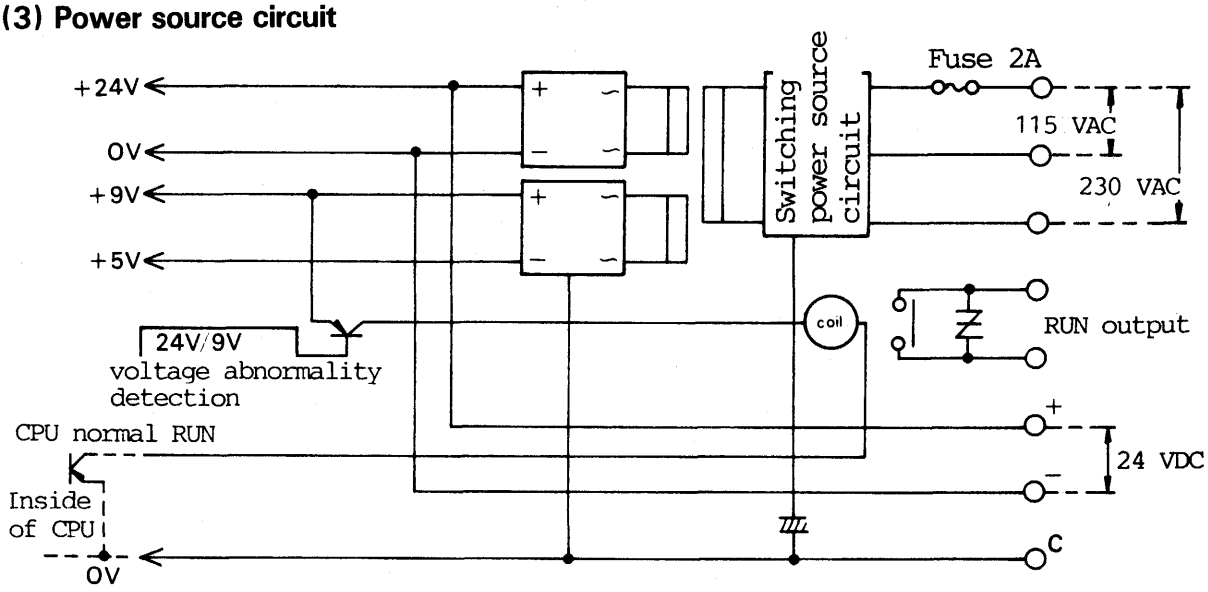
(1) The power source is turned ON.
(2) No abnormal conditions of the CPU under the RUN mode are observed. (This condition is not required for the expansion base.)
(3) 9/24 V power sources for the module are normal.

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(2) Product design



(3) Power source circuit



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5-5. 10-module-slot base with power supply: E-03B-C

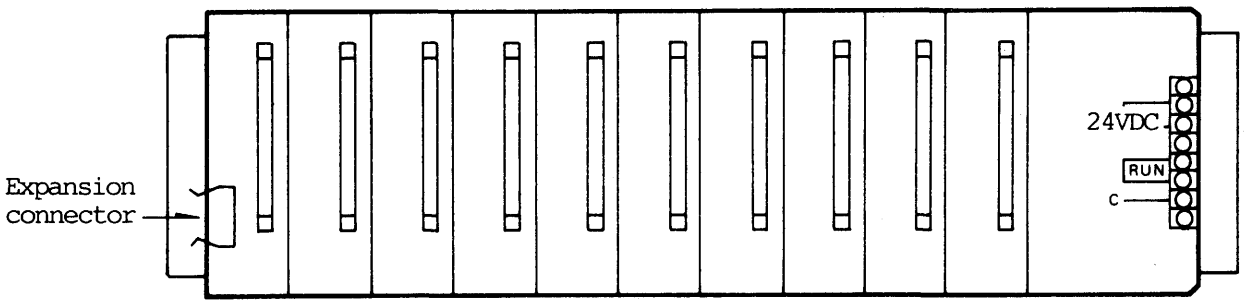
(1) Specifications

Item		Specifications			
Number of modules		10 (up to 9 I/O modules for the base to install a CPU module)			
Base expandability		Yes			
RUN output *1		Relay contact, 250 VAC, 4 A (resistive load)			
Power source voltage		24 VDC			
Allowable voltage tolerance		20 - 28 V, less than 10% of ripple rate			
Power consumption		Less than 63 W			
Sensor use power source		No			
Power supply capacity to the module	Voltage	Fluctuation range	Ripple	Allowable current (Ambient temperature) Below 55°C	Below 50°C
	5 VDC	4.75 - 5.25 V	Less than 0.1 Vp-p	1.0 A	1.4 A
	9 VDC	8.0 - 12.0 V	Less than 0.2 Vp-p	1.5 A	1.7 A
	24 VDC	20 - 28 V	Less than 1.2 Vp-p	0.5 A	0.5 A
Fuse		4 A minifuse, Model: MT4, 4 A (Sanno fuse)			
Weight		1,500 g			

*1. The RUN output will be ON if the following conditions are satisfied.

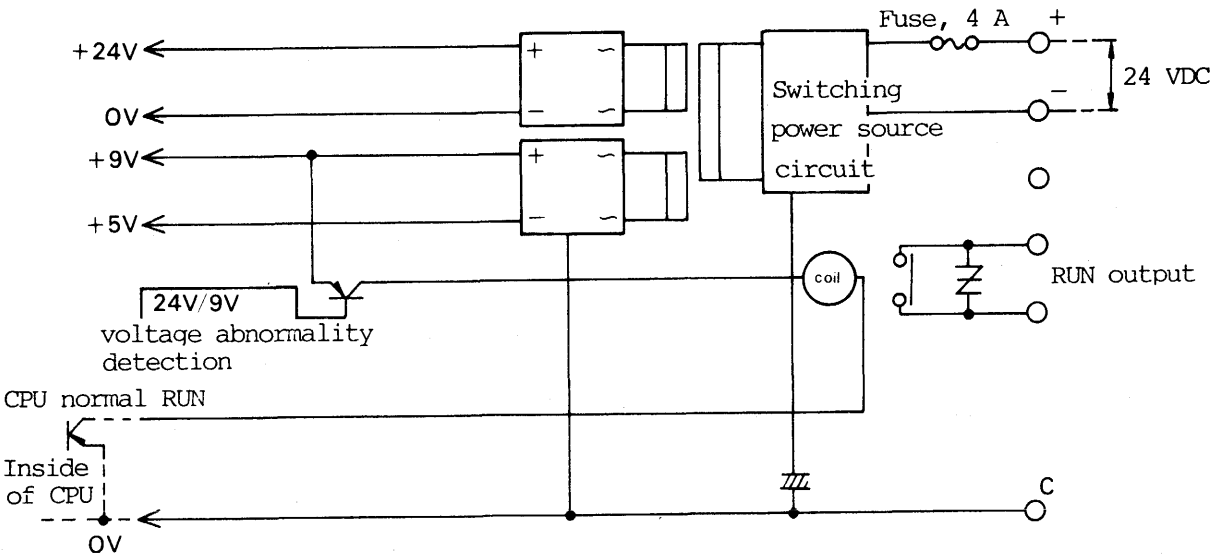
(1) The power source is turned ON.
(2) No abnormal conditions of the CPU under the RUN mode are observed. (This condition is not required for the expansion base.)
(3) 9/24 V power sources for the module are normal.

(2) Product design



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(3) Power source circuit



5-6. 10-module-slot base with power supply: E-04B

(1) Specifications

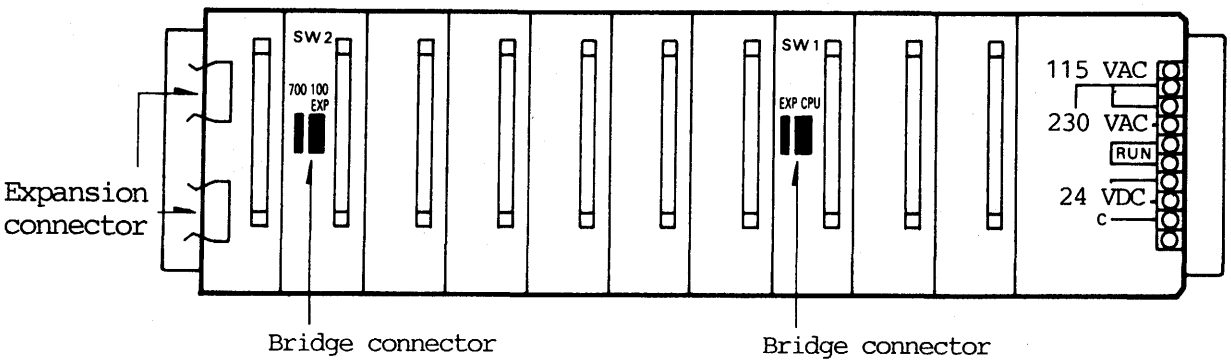
Item	Specifications			
Number of modules	10 (up to 9 I/O modules for the base to install a CPU module)			
Base expandability	Yes (Expansion base, E-02B/E-02B-C/E-04B E-04B-C)			
RUN output *1	Relay contact, 250 VAC, 4 A (resistive load)			
Power source voltage	115/230 VAC, 50/60 Hz			
Allowable voltage tolerance	- 15% - + 32% to the voltage rating			
Power consumption	Less than 65 VA			
Sensor use power source	24 VDC, 0.1 A (voltage fluctuation range: 20 - 28 V, less than 1.2 V P-P of ripple)			
Power supply capacity to the module	Voltage	Fluctuation range	Ripple	Allowable current (Ambient temperature) Below 55°C / Below 50°C
	5 VDC	4.75 - 5.25 V	Less than 0.1 Vp-p	1.0 A / 1.4 A
	9 VDC	8.0 - 12.0 V	Less than 0.2 Vp-p	1.4 A / 1.7 A
	24 VDC	20 - 28 V	Less than 1.2 Vp-p	0.5 A / 0.6 A
Fuse	2 A minifuse, Model: MT4, 2 A (Sanno fuse)			
Weight	1,500 g			

*1. The RUN output will be ON if the following conditions are satisfied.

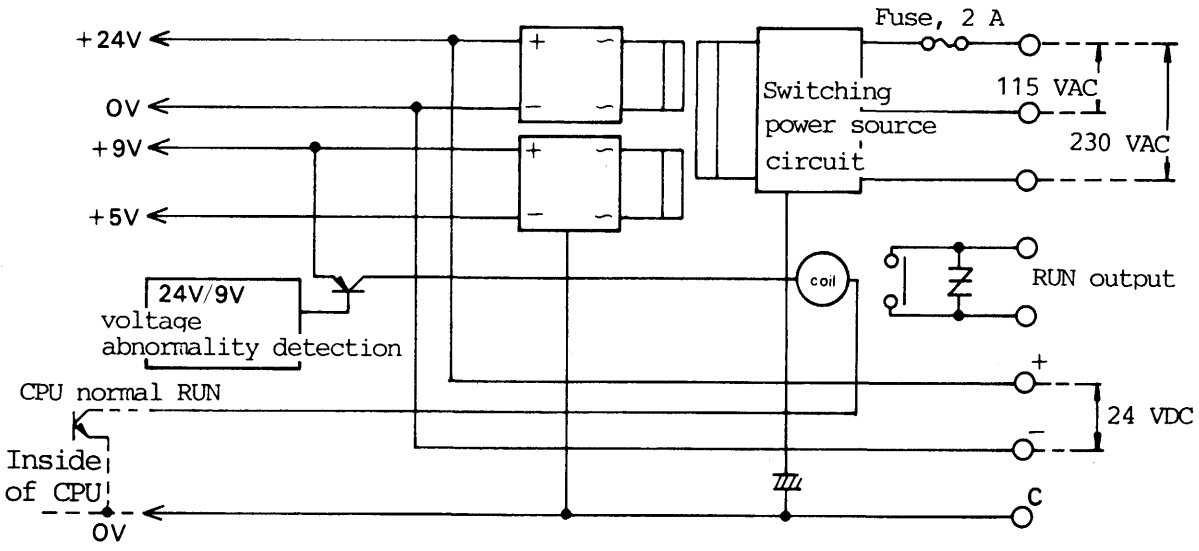
(1) The power source is turned ON.
(2) No abnormal conditions of the CPU under the RUN mode are observed. (This condition is not required for the expansion base.)
(3) 9/24 V power sources for the module are normal.

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(2) Product design



(3) Power source circuit



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5-7. 10-module-slot base with power supply: E-04B-C

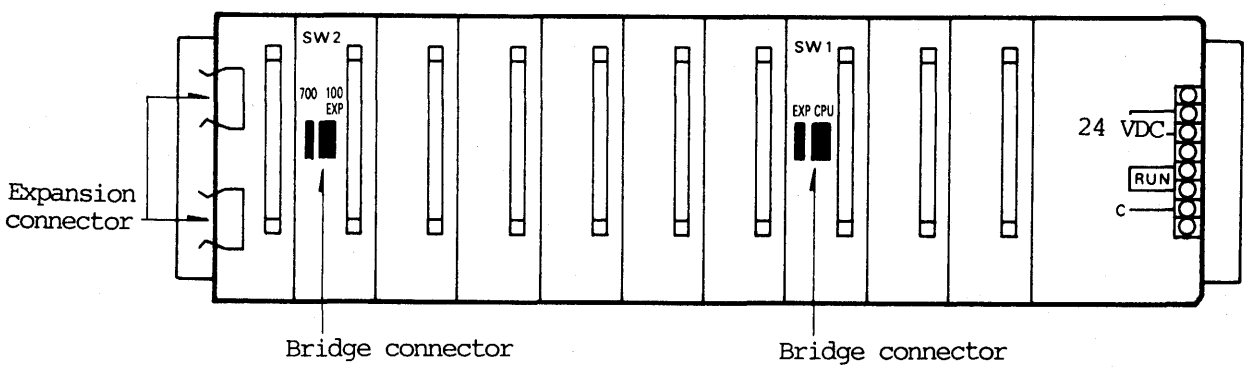
(1) Specifications

Item		Specifications			
Number of modules		10 (up to 9 modules for the base to install a CPU module)			
Base expandability		Yes (Expansion base, E-02B/E-02B-C/E-04B/ E-04B-C)			
RUN output *1		Relay contact, 250 VAC, 4 A (resistive load)			
Power source voltage		24 VDC			
Allowable voltage tolerance		20 - 28 V, less than 10% of ripple rate			
Power consumption		Less than 63 W			
Sensor use power source		No			
Power supply capacity to the module	Voltage	Fluctuation range	Ripple	Allowable current (Ambient temperature) Below 55°C	Below 50°C
	5 VDC	4.75 - 5.25 V	Less than 0.1 Vp-p	1.0 A	1.4 A
	9 VDC	8.0 - 12.0 V	Less than 0.2 Vp-p	1.5 A	1.7 A
	24 VDC	20 - 28 V	Less than 1.2 Vp-p	0.5 A	0.5 A
Fuse		4 A minifuse, Model: MT4, 4 A (Sanno fuse)			
Weight		1,500 g			

*1. The RUN output will be ON if the following conditions are satisfied.

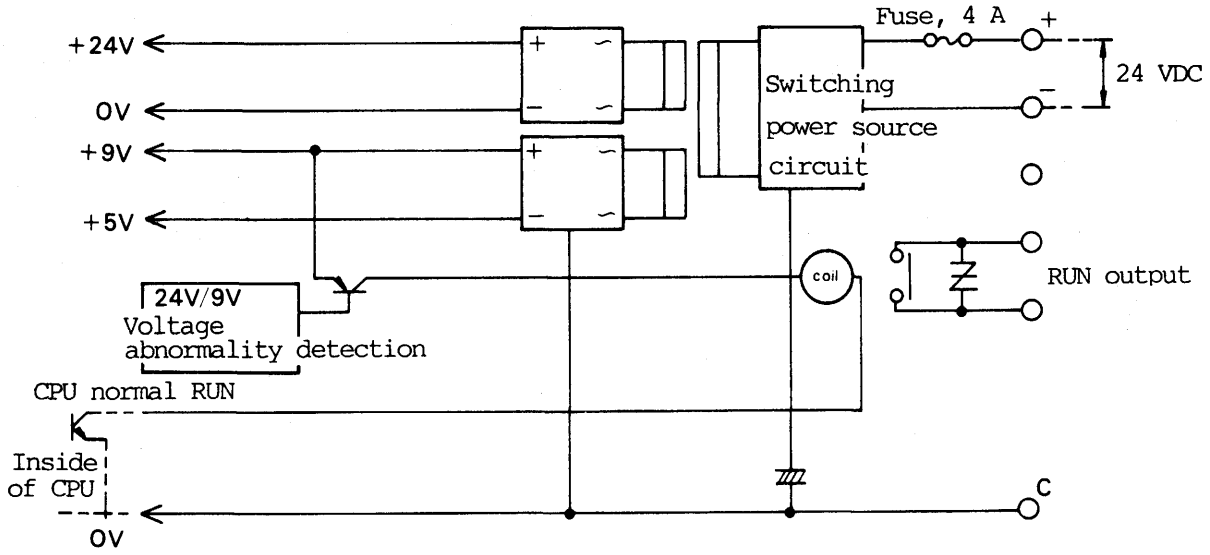
(1) The power source is turned ON.
(2) No abnormal conditions of the CPU under the RUN mode are observed. (This condition is not required for the expansion base.)
(3) 9/24 V power sources for the module are normal.

(2) Product design



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(3) Power source circuit



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5-8. 8-module-slot base with power supply: E-05B

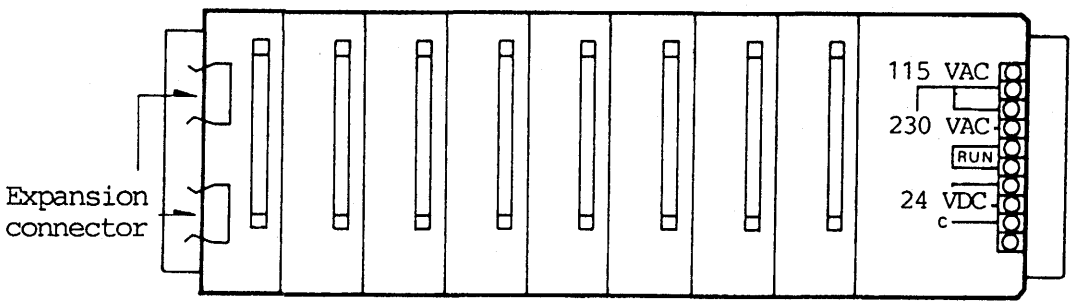
(1) Specifications

Item		Specifications			
Number of modules		8 (up to 7 modules for the base to install a CPU module)			
Base expandability		Yes (Expansion base, E-02B)			
RUN output *1		Relay contact, 250 VAC, 4 A (resistive load)			
Power source voltage		115/230 VAC, 50/60 Hz			
Allowable voltage tolerance		- 15% - + 32% to the voltage rating			
Power consumption		Less than 65 VA			
Sensor use power source		24 VDC, 0.1 A (voltage fluctuation range: 20 - 28 V, less than 1.2 V P-P of ripple)			
Power supply capacity to the module	Voltage	Fluctuation range	Ripple	Allowable current (Ambient temperature) Below 55°C	Below 50°C
	5 VDC	4.75 - 5.25 V	Less than 0.1 Vp-p	1.0 A	1.4 A
	9 VDC	8.0 - 12.0 V	Less than 0.2 Vp-p	1.4 A	1.7 A
	24 VDC	20 - 28 V	Less than 1.2 Vp-p	0.5 A	0.6 A
Fuse		2 A minifuse, Model: MT4, 2 A (Sanno fuse)			
Weight		1,310 g			

*1. The RUN output will be ON if the following conditions are satisfied.

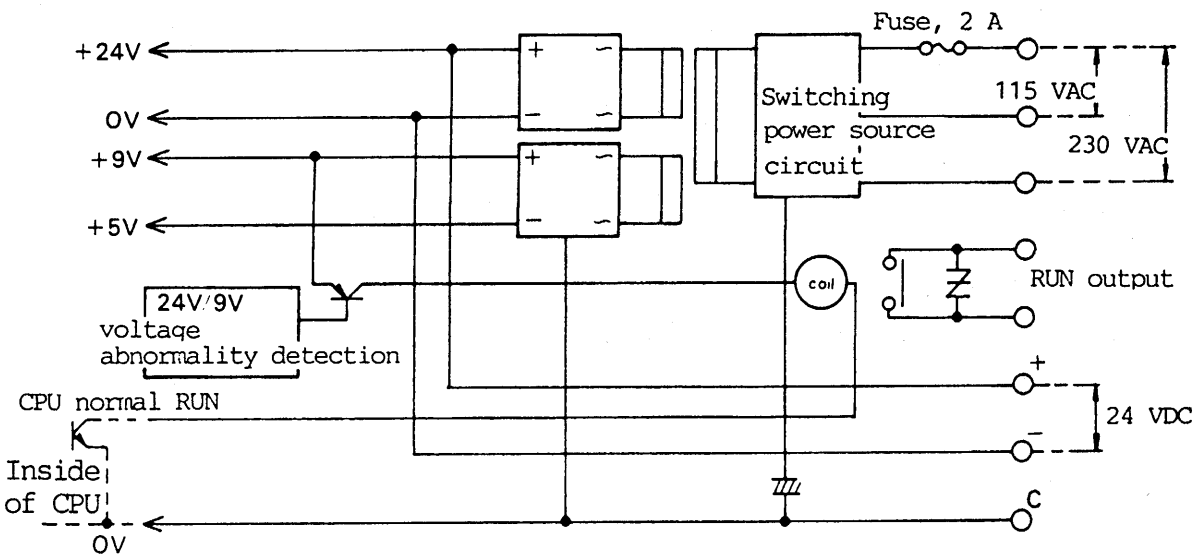
(1) The power source is turned ON.
(2) No abnormal conditions of the CPU under the RUN mode are observed. (This condition is not required for the expansion base.)
(3) 9/24 V power sources for the module are normal.

(2) Product design



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(3) Power source circuit



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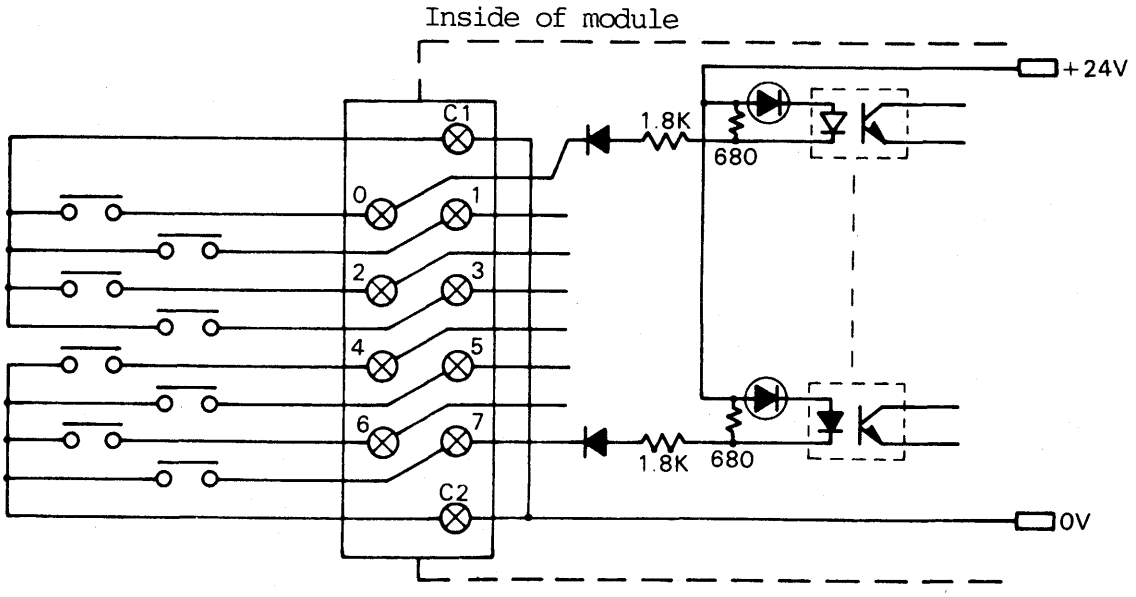
6. I/O MODULE SPECIFICATIONS

6-1. E-01N: 24 VDC input module

Specifications

Item	Ratings
Number of circuits	8 (each with LED display)
Adaptive input signal source	ON/OFF signals from no-voltage contact or open collector. Dielectric strength: 40 VDC Switching capacity: more than 17 mA
ON current	More than 7 mA
OFF current	Less than 3 mA
ON voltage	Less than 3 V
OFF voltage	Varies with supply voltage and number of inputs
Open voltage of input terminal	18 - 36 VDC (as measured between the input terminal and common terminal with input opened)
OFF to ON response	4 - 15 ms
ON to OFF response	4 - 15 ms
Current consumption of internal 24 V circuit	14 mA/circuit (Current is obtained from the power supply unit by mounting the module on the base.)
Current consumption of internal 9 V circuit	10 mA/module
Weight	120 g

Terminal connection and input circuit



Common terminals C1 and C2 are internally connected.

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Note: 1. The 24 V supply is obtained from the I/O power supply of base E-02B. This voltage varies from 18 V to 36 V, depending on supply voltage variation, number and type of I/O modules, and number of inputs that are ON. Each common terminal is connected inside the input module to a common terminal of the other input module.

2. Current may continue flowing after the input signal source is turned OFF if the signal source is made up of a semiconductor circuit. This also applies to contact type input signal sources where impedance is connected parallel to the contact. This current is commonly called a leakage current and must be less than the OFF current of the input module.

3. If the input signal source is made up of a semiconductor circuit or of a contact signal type where impedance is connected parallel, a residual voltage may be generated when the input signal is turned ON. This voltage must be lower than the ON voltage of the input module.

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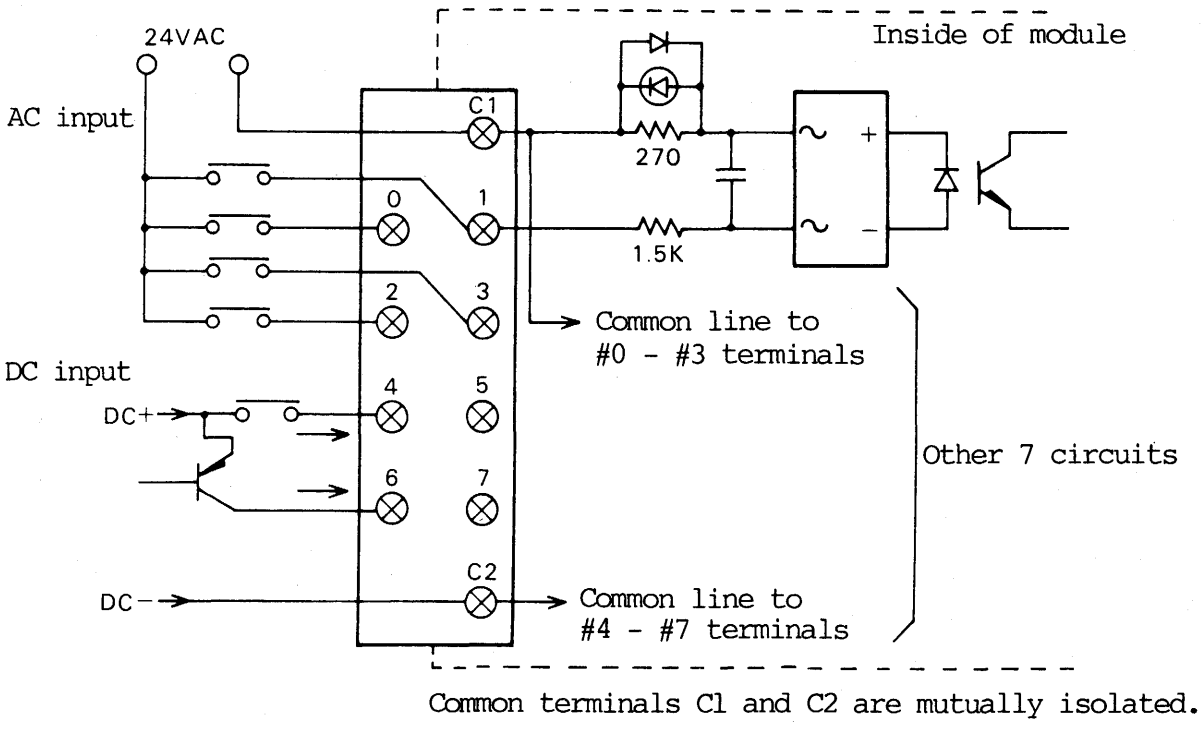
6-2. E-02N: 24 VAC/DC input module

The input is applicable to either 24 VAC or 24 VDC sink input.

Specifications

Item	Ratings	
Number of circuits	8 (each with input signal LED display)	
Input signal	AC input voltage	DC input voltage
	20 - 28 VAC (50/60 Hz)	20 - 28 VDC
ON current	More than 10 mA	
OFF current	Less than 2 mA	
ON voltage	More than 20 V	
OFF voltage	Less than 6 V	
OFF to ON response	5 - 50 ms	6 - 30 ms
ON to OFF response	5 - 60 ms	5 - 60 ms
Input current	13 mA (24 V/50 Hz) (Normal current) (19 mA max.)	13 mA (Normal current) (19 mA max.)
Dielectric strength	2 KVAC - 1 minute	
Current consumption of internal 9 V circuit	10 mA(Current is obtained from the power supply unit by mounting the module on the base.)	
Weight	120 g	

Terminal connection and input circuit



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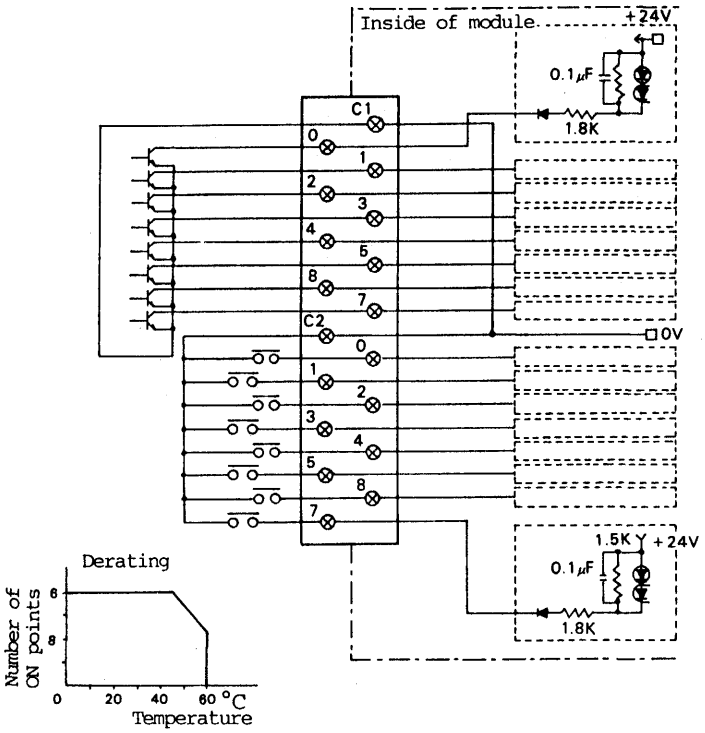
6-3. E-05N: 24 VDC input module with 16 displays

This is a 24 VDC input module for 16 inputs. Connections are made through terminal blocks.

Specifications

Item	Ratings
Number of circuits	16 (each with input signal LED display)
Adaptive input signal source	ON/OFF signals from no-voltage contact or open collector. Dielectric strength: 40 VDC Switching capacity: More than 30 mA of current
ON current	More than 5 mA
OFF current	Less than 1 mA
ON voltage	Less than 13 V (24 V), 7 V (18 V), and 25 V (36 V)
OFF voltage	More than 19 V (24 V), 13 V (19 V), and 31 V (36 V) Figures in parentheses are open voltages for input terminals.
Open voltage of input terminal	18 - 36 V DC
OFF to ON response	3.0 - 15.0 ms
ON to OFF response	4.0 - 15.0 ms
Current consumption of internal 24 V circuit	14 mA/circuit (Current is obtained form the power supply unit by mounting the module on the base.)
Current consumption of internal 9 V circuit	25 mA/module
Weight	180 g

Terminal connection and input circuit



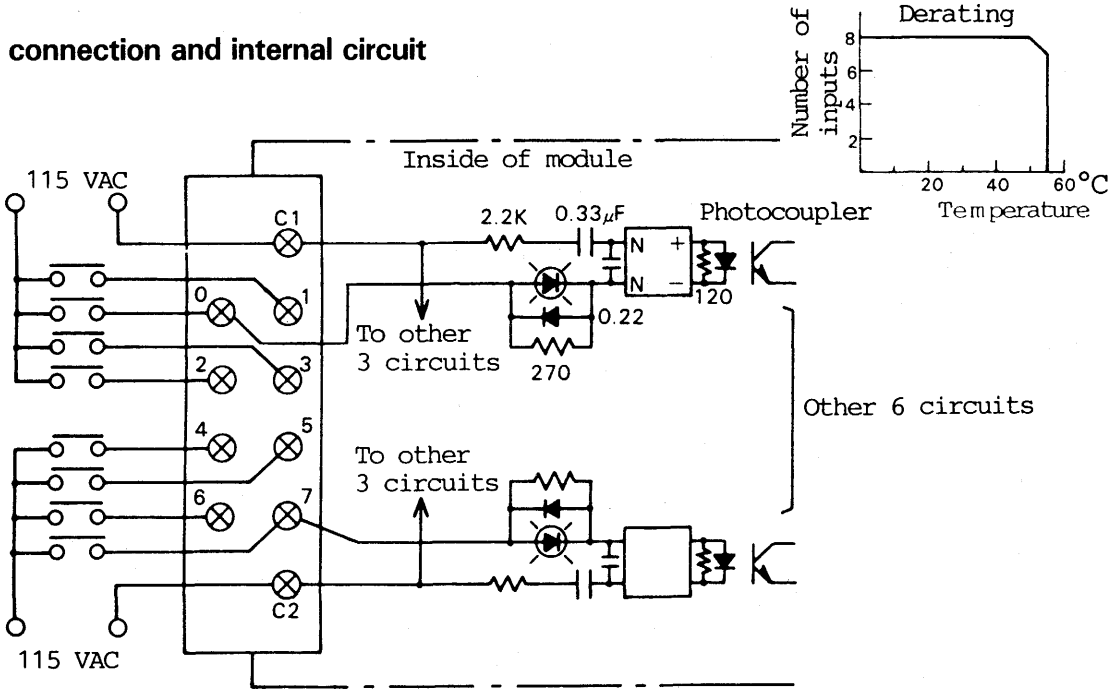
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6-4. E-20N: 100 VAC input module

Specifications

Item	Ratings
Number of circuits	8 (with LED input signal display)
Input voltage	100 VAC (allowable variation range 85 -132 VAC) 50/60 Hz
Input current	11 mA (100 V, 50 Hz), 13 mA (100 V, 60 Hz)
Input impedance	10 KΩ
ON voltage	More than 80 VAC
OFF voltage	Less than 20 VAC
OFF to ON response	10 ms - 30 ms
ON to OFF response	10 ms - 60 ms
Current consumption of internal 9 V circuit	10 mA (Current is obtained from the power supply unit by mounting the module on the base.)
Weight	140 g

Terminal connection and internal circuit



Note: 1. Common terminals C1 and C2 are isolated from each other. C1 is the common terminal for input terminals from 0 to 3, and C2 is the common terminal for input terminals from 4 to 7.

2. In the internal circuit, current is limited by a capacitor, as shown in the figure. For satisfactory operation, therefore, the input signal source must be of the type that allows current to flow in both directions, as with a contact.

3. If the input terminal voltage exceeds the maximum allowable OFF voltage of 20 V when the circuit is OFF, malfunction may result because of induction between input signal lines or leakage current from the signal source. If the leakage current or induction is large, check to be sure the input terminal voltage is below the OFF voltage.

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6-5. E-21N: 100 VAC input module

This module contains four isolated input circuits.

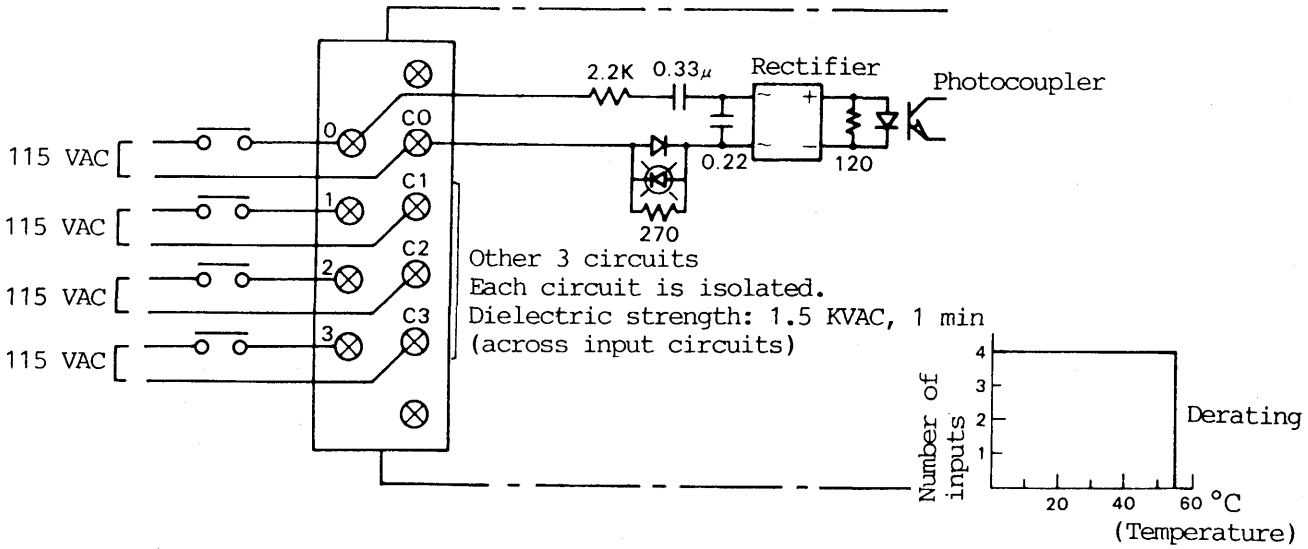
Specifications

Item	Ratings
Number of circuits	4 (each with LED input signal display) Isolated from the otehrs
Input voltage	100 VAC (allowable variation range: 80 - 132 VAC), 50/60 Hz
Input current	8 - 13.5 mA (at 80 - 132 V and 50 Hz) 9.5 - 16 mA (at 80 - 132 V and 60 Hz)
ON voltage	More than 80 VAC
OFF voltage	Less than 20 VAC
OFF to ON response	10 - 30 ms
ON to OFF response	10 - 60 ms
Current consumption of internal 9 V circuit	10 mA (Current is supplied from the power supply by inserting the module into the base)
Weight	120 g

Input number assignment

Although the E-21N is a 4-input module, 8 input numbers must be assigned from 0 to 7 as with an 8-input module. Of the 8 numbers, 4 from 0 to 3 are used by this module, and remaining 4, from 4 to 7, are ignored and cannot be used.

Terminal connection and internal circuit



Note: The three input circuits are completely isolated from one another; otherwise, this module has the same circuit composition as the E-20N. For cautionary instruction, refer to the notes for E-20N on the previous page.

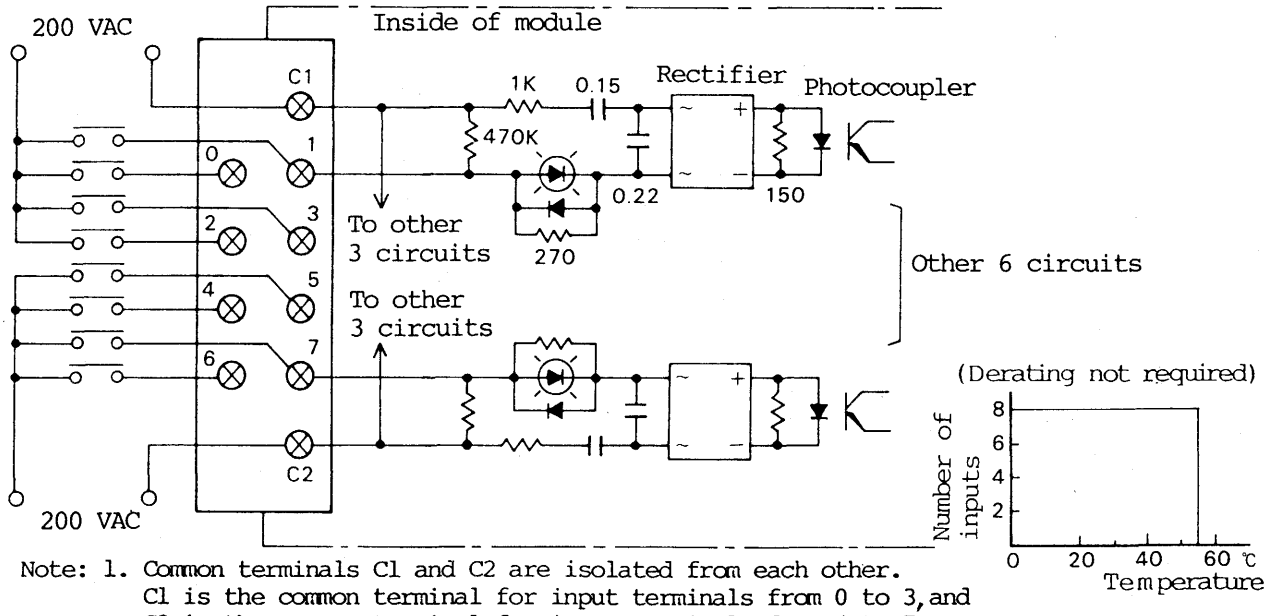
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6-6. E-22N: 200/220 VAC input module

Specifications

Item	Ratings
Number of circuits	8 (with LED input signal display)
Input voltage	200/220 VAC (allowable variation range: 180 - 265 VAC, 50/60 Hz)
Input current	11 mA (230 V, 50 Hz), 18 mA maximum
Input impedance	18 K ohms (60 Hz)
ON voltage	More than 180 V
OFF voltage	Less than 40 V
OFF current	Within 2 mA
OFF to ON response	5 - 50 ms
ON to OFF response	5 - 60 ms
Current consumption of internal 9 V circuit	10 mA (Current is supplied from the power supply by inserting the module into the base.)
Weight	140 g

Terminal connection and circuit



Note: 1. Common terminals C1 and C2 are isolated from each other. C1 is the common terminal for input terminals from 0 to 3, and C2 is the common terminal for input terminals from 4 to 7.

2. In the internal circuit, current is limited by a capacitor, as shown in the figure. For satisfactory operation, therefore, the input signal source must be of the type that allows current to flow in both directions, as with a contact.

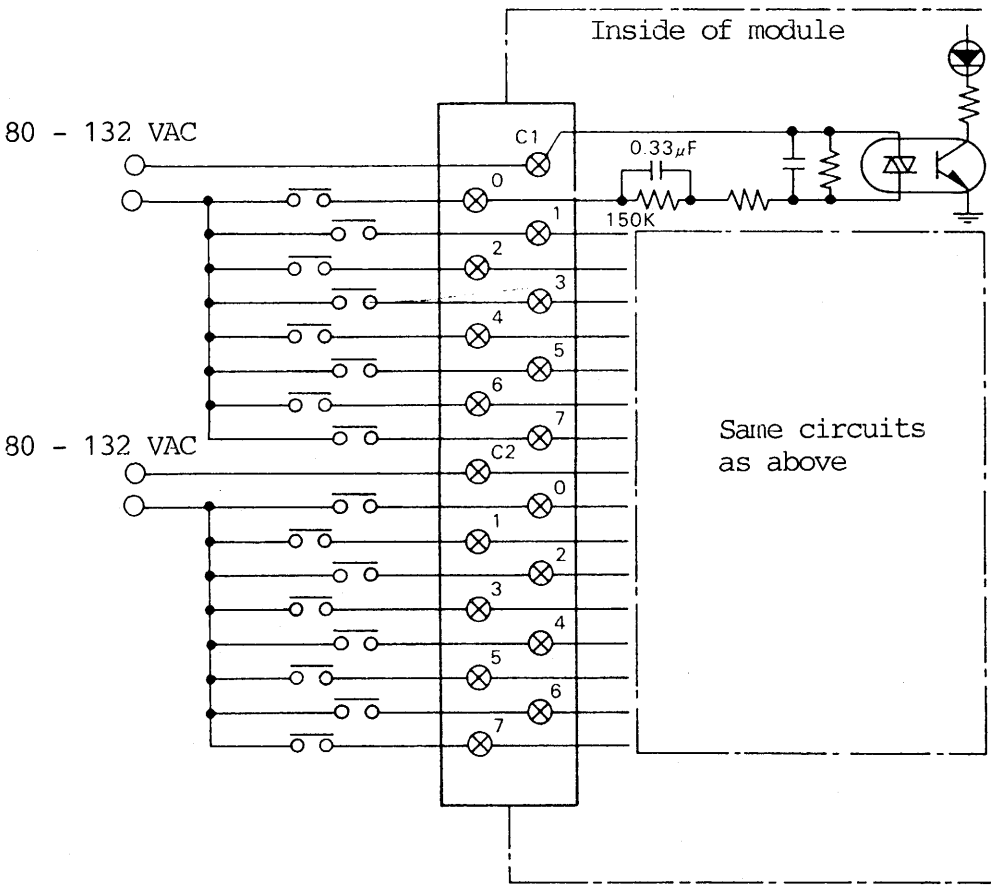
3. If the input terminal voltage exceeds the maximum allowable OFF voltage of 40 V when the circuit is OFF, malfunction may result because of induction between input signal lines or leakage current from the signal source. If the leakage current or induction is large, check to be sure the input terminal voltage is below the OFF voltge.

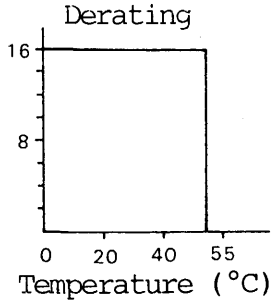
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6-7. E-25N: 100 VAC input module with 16 displays

Specifications

Item	Ratings
Number of circuits	16 (with LED input signal display)
Input voltage	85 - 132 VAC 50/60 Hz
Input current	10 mA (100 V, 50 Hz), 25 mA maximum
Input impedance	8 KΩ (60 Hz)
ON voltage	More than 80 V
OFF voltage	Less than 15 V
OFF current	Within 1.5 mA
OFF to ON response	5 - 50 ms
ON to OFF response	5 - 60 ms
Current consumption of internal 9 V circuit	100 mA (Current is supplied from the power supply section by inserting the module into the base.)
Weight	140 g





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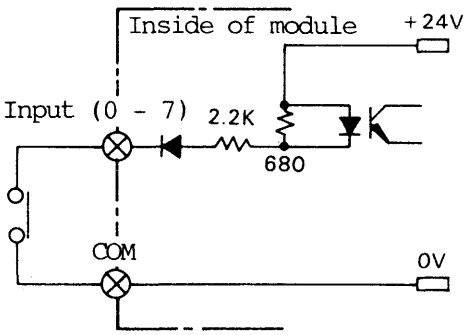
6-8. E-35N: 24 VDC input module with 16 displays

This is a 24 VDC input module for 16 inputs. Connections are made through connectors.

Specifications

Item	Ratings
Number of circuits	16 (each with operation status LED display)
Adaptive input signal source	ON/OFF input by the no-voltage contact or open collector. Dielectric strength: 40 V Switching capacity: More than 17mA of current
ON current	More than 5 mA
OFF current	Less than 2 mA
ON voltage	Less than 3 V
OFF voltage	———
Open voltage of input terminal	18 - 36 VDC
OFF to ON response	4 - 15 ms
ON to OFF response	4 - 15 ms
Current consumption of internal 24 V circuit	1 mA + 13 mA/circuit (Current is obtained from the power supply by mounting the module on the base.)
Current consumption of internal 9 V circuit	3 mA + 1.3 mA/circuit
Weight	150 g

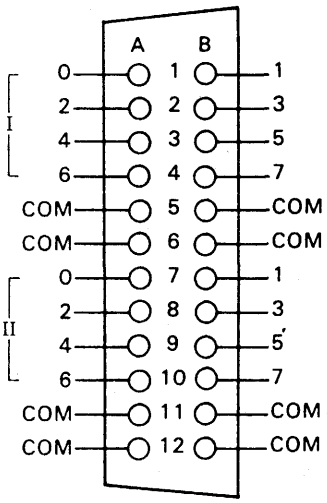
Internal circuit



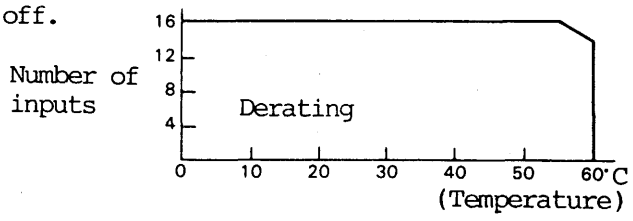
Eight COM terminals are all internally connected.

I : Basic I/O numbers
II: Basic I/O numbers + 100

Connector connection diagram



Note : The open voltage of the input terminal in regard to the OFF voltage fluctuates in a range of 18 V to 36 V. Thus it is difficult to express the terminal voltage quantitatively when the input circuit is cut off.
Adjust the value of the leakage current flowing toward the input signal source to be less than the rated value of the power source when it is off.



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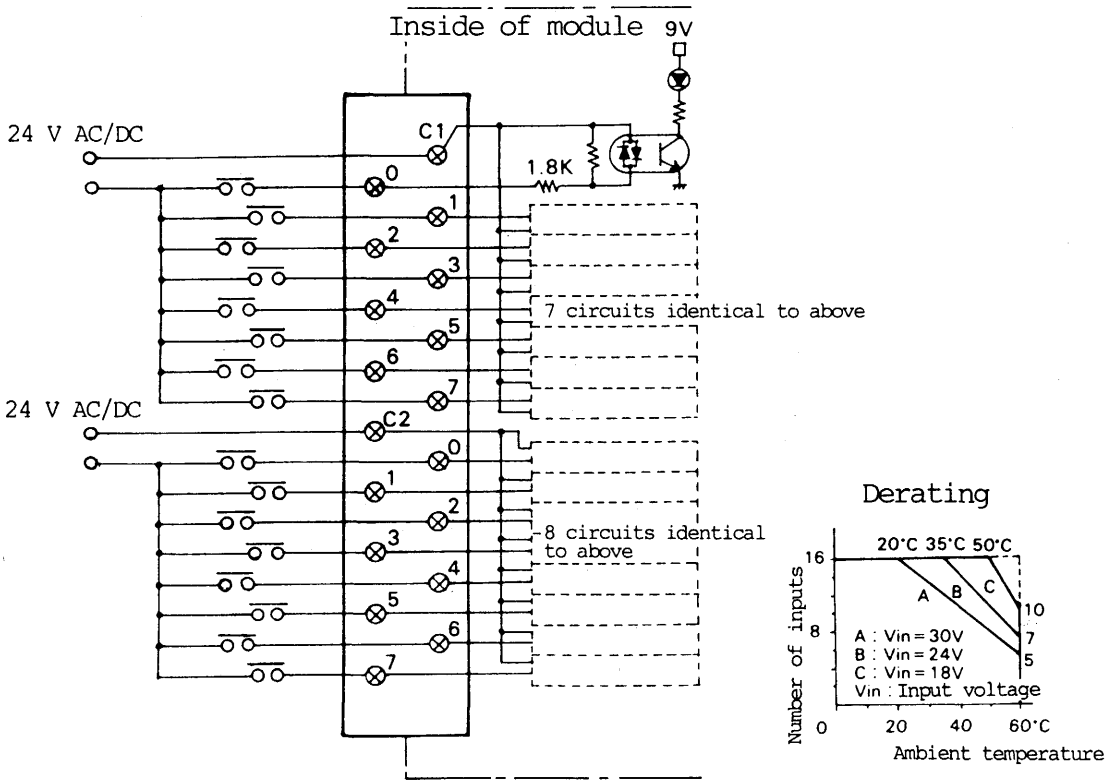
6-9. E-55N: 24 VAC/DC input module

This is a 24 VAC/DC input module for 16 inputs. Connections are made through terminal blocks.

Specifications

Item	Ratings	
Number of circuits	16 (each with operation status LED display) 8 for common	
Input signal	DC voltage input	AC voltage input
Rated input voltage	14 - 30 VDC	14 - 30 VAC, 50/60 Hz
ON current	More than 7 mA	More than 7 mA
OFF current	Less than 2 mA	Less than 2 mA
ON voltage	More than 14 V	More than 14 V
OFF voltage	Less than 3 V	Less than 3 V
Input impedance	1.8 KΩ	1.8 KΩ
Input current	12 mA/24 VDC	12 mA/24 VAC
ON/OFF response	5 - 25 ms	5 - 30 ms
Current consumption of internal 9 V circuit	130 mA maximum/module, 4.5 mA (normal)/number of ON inputs + 2.5 mA	
Current consumption of internal 24 V circuit	Not in use	
Weight	170 g	

Terminal connection and internal circuit



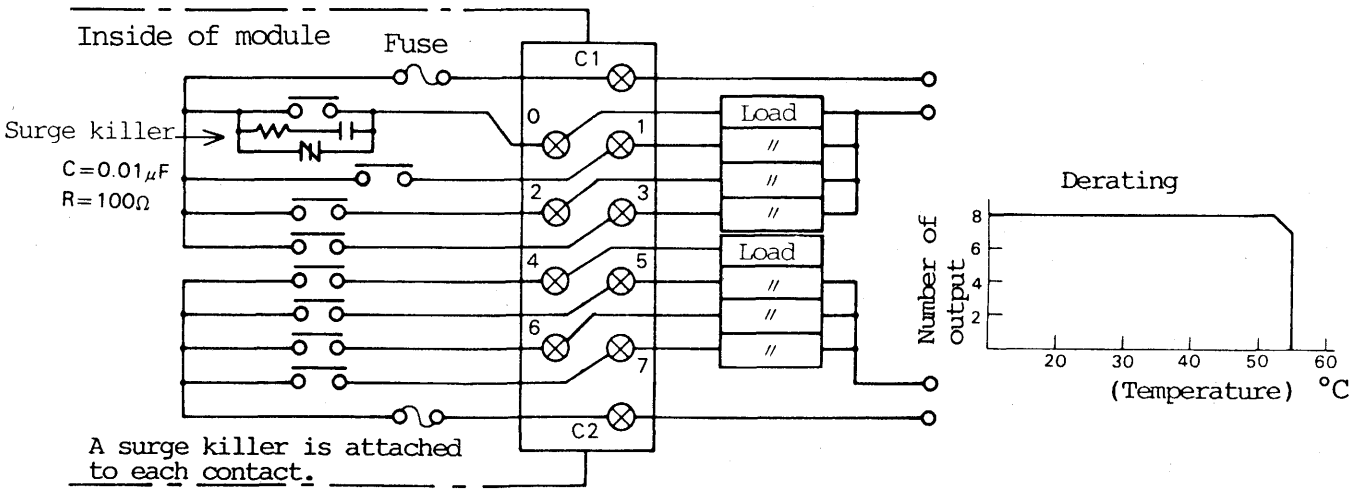
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6-10. E-01T: Relay output module

Specifications

Item	Ratings
Number of circuits	8 normally open contacts (with LED display)
Maximum switching capacity	220 VAC, 4 A Resistive load (withstands more than 100,000 switchings) 220 VAC, 0.5 A (withstands more than 100,000 switchings) 220 VAC, 0.05A (withstands more than 800,000 switchings) 110 VAC, 0.5 A (withstands more than 100,000 switchings) 110 VAC, 0.1 A (withstands more than 650,000 switchings) Lamp/Solenoid loads 24 VDC, 5 A Resistive load (withstands more than 100,000 switchings) 24 VDC, 0.5 A Lamp load (withstands more than 100,000 switchings)
Leakage current across contacts	Less than 1 mA (220 V, 60 Hz)
Minimum switching capacity	5 mA, 5 V
Current consumption of internal 9 V circuit	45 mA/circuit (Current is obtained from the power supply unit by mounting the module on the base.)
Fuse	10 A (One is provided in each common line of 4 circuits and is replaceable.)
Weight	200 g

Terminal connection and internal circuit



Note: Because of surge killer, leakage current can activate loads requiring very low current, such as a neon lamp.

Solenoid load: Ten times normal current with a power factor of 0.65 at rising. Normal current with a power factor of 0.35 at falling.

Lamp load: Ten times normal current with a power factor of 1 at rising. Normal current with a power factor of 1 at falling.

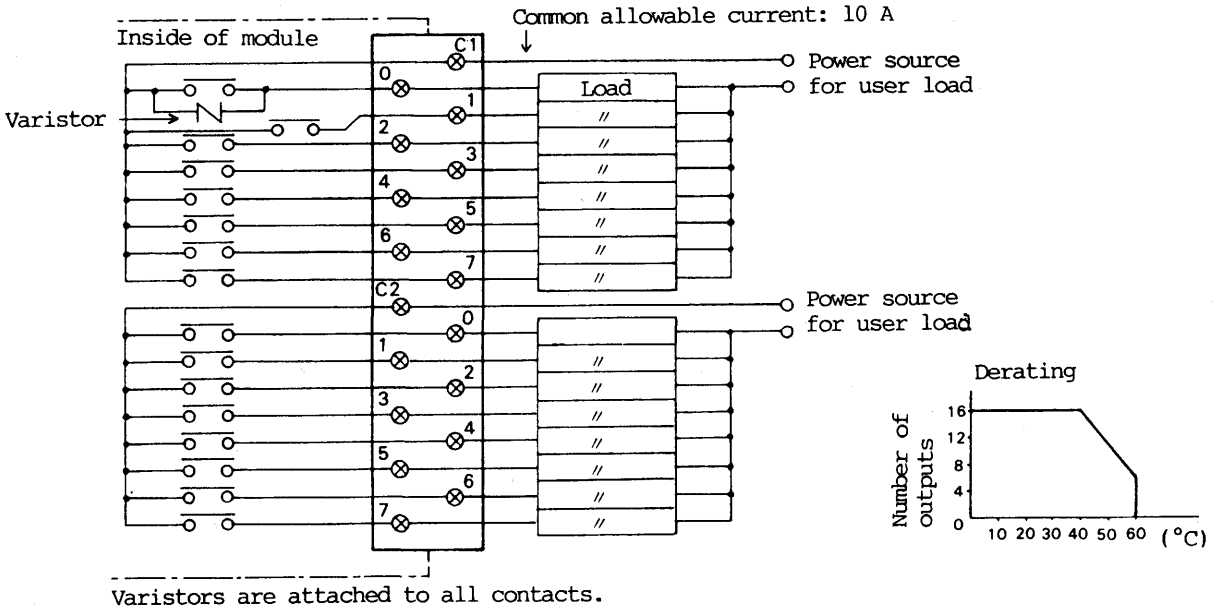
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6-11. E-05T: Relay output module (16 points)

Specifications

Item	Ratings
Number of circuits	16 (with LED operation status display)
Output type	Relay contact output
Maximum switching capacity	220 VAC, 2 A Resistive load (withstands more than 100,000 switchings) 220 VAC, 0.25 A (withstands more than 100,000 switchings) 220 VAC, 0.03 A (withstands more than 800,000 switchings) 110 VAC, 0.25 A (withstands more than 100,000 switchings) 110 VAC, 0.05 A (withstands more than 650,000 switchings) Lamp/Solenoid loads 24 VDC, 2.0 A Resistive load (withstands more than 100,000 switchings) 24 VDC, 0.25 A Lamp load (withstands more than 100,000 switchings)
Leakage current across contacts:	Less than 0.1 mA (220 V, 60 Hz)
Minimum switching capacity	5 mA, 5 V
OFF to ON response	Less than 12 ms
ON to OFF response	Less than 12 ms
Current consumption of internal 9 V circuit	30 mA/circuit (Current is obtained from the power supply unit by mounting the module on the base.)
Fuse	None
Weight	240 g

Terminal connection and internal circuit



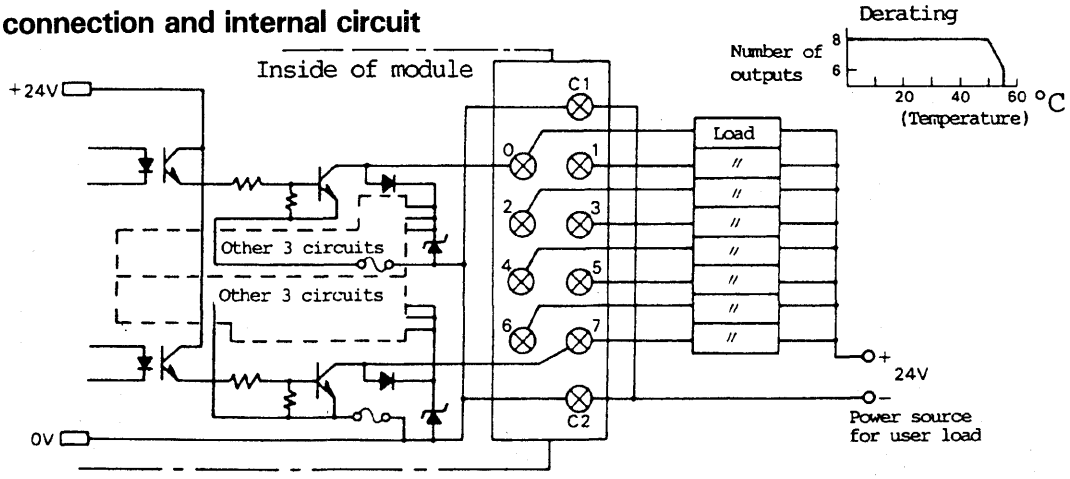
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6-12. E-10T: Open collector output module

Specifications

Item	Ratings
Number of circuits	8 (with LED display)
Output type	NPN open collector output
Switching capacity	24 VDC, 0.5 A
Leakage current	Less than 100 μA (40 V voltage application)
Residual voltage	0.65 V (0.1A), 0.7 V (0.25A), 0.8 V (0.5A)
Allowable peak voltage	45 V (peak value of load power supply voltage including ripple)
OFF to ON response	0.1 ms
ON to OFF response	0.1 ms
Current consumption of internal 9 V circuit	20 mA (Current is obtained from the power supply unit by mounting the module on the base.)
Current consumption of internal 24 V circuit	3 mA/ circuit
Fuse capacity	3 A (One fuse is provided in common line for each group of 4 circuits.)
Weight	120 g

Terminal connection and internal circuit



Note: 1. Common terminals C1 and C2 are connected to each other inside the module and also to the 0 V terminal of the base unit E-02B's 24 V power supply.

2. Elements are included to absorb counterelectromotive voltage, which is energized by the switching of an inductive load. The maximum allowable frequency of switching an inductive load of 24 VDC/0.5 A with a time constant of 100 mS is 25 switchings/min for each group of 4 circuits. An absorbing element is used for each group of 4 output circuits, that is, one for outputs 0 through 3 and one for outputs 4 through 7.
If the load-switching frequency is higher than the allowable value, a clamp diode should be connected to the load.

3. Each fuse is soldered directly to the inside of the module and therefore cannot be replaced.

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6-13. E-12T: Open collector output (4-point) module

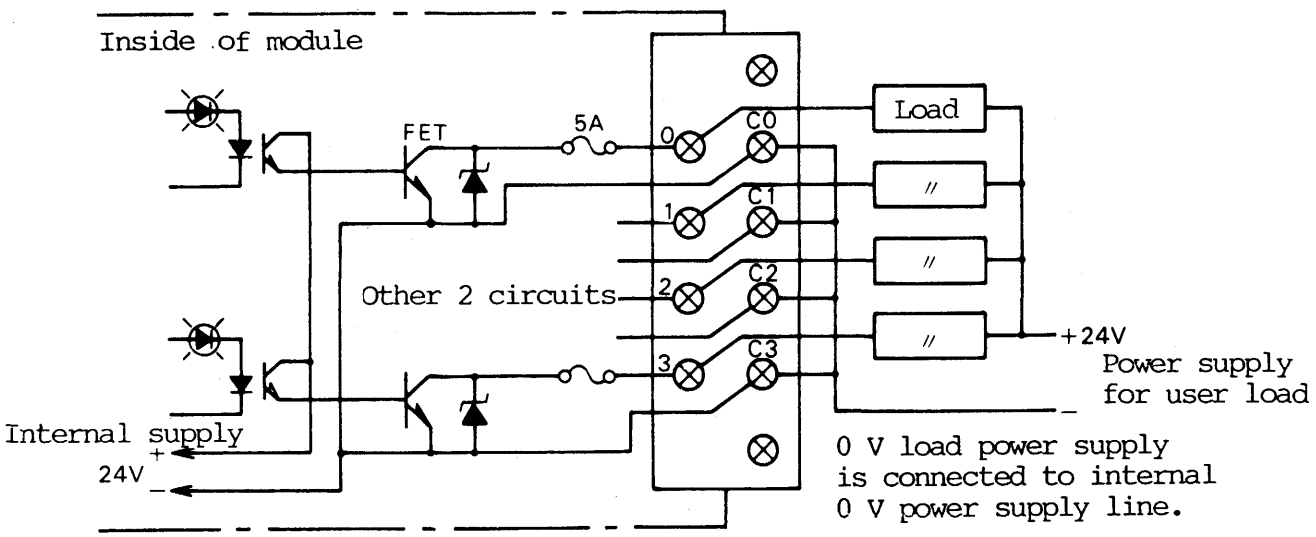
FET (field effect transistor) is the output transistor used by this module.

Specifications

Item	Ratings
Number of circuits	4 (with LED display)
Output type	Equivalent to NPN open collector output
Switching capacity	24 V, 2 A (ambient temperature 60°C inductive load with time constant of 100 mS), maximum 6 A
Leakage current	Less than 0.4 mA (under application of 40 V)
Residual voltage	0.15 V (1 A), 0.3 V (2 A), 0.6 V (4 A), 0.9 V (6 A)
Allowable peak voltage	45 V (peak of power supply load, including ripple)
Response time	0.1 mS (for both OFF to ON and ON to OFF)
Current consumption of internal 9 V circuit	12 mA
Current consumption of internal 24 V circuit	5 mA
Fuse	5 A (replaceable) Type MF51SH5
Weight	120g

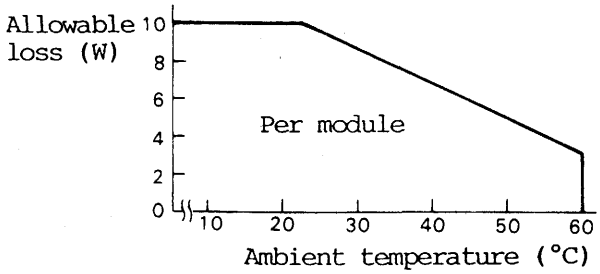
Output number assignment

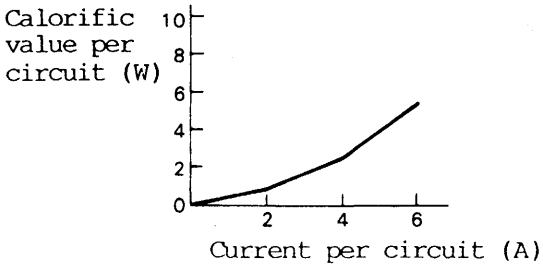
Although E-12T is a 4-point output module, 8 I/O numbers are assigned.
Numbers 0 through 3 are effective, and numbers 4 through 7 are ignored.



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Characteristics





Switching cycle limits

At each switching cycle indicated in the table shown below, 1.5 W is produced per circuit. The calorific value increases proportionally as switching cycle is increased. An asterisk (*) indicates that a diode should be connected in parallel with the load.

Load type	Time constant of load	load current (under 24 V)			
		1 A	2 A	4 A	6 A
Resistive load	———	No limit on switching cycle			
Inductive load	7 ms	1,000/min	500/min	250/min	20/min
	40 ms	180/min	90/min	*	*
	100 ms	70/min	15/min	*	*
Lamp load	———	0.8 maximum (rating)			

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6-14. E-15T: Open collector output (16-point) module

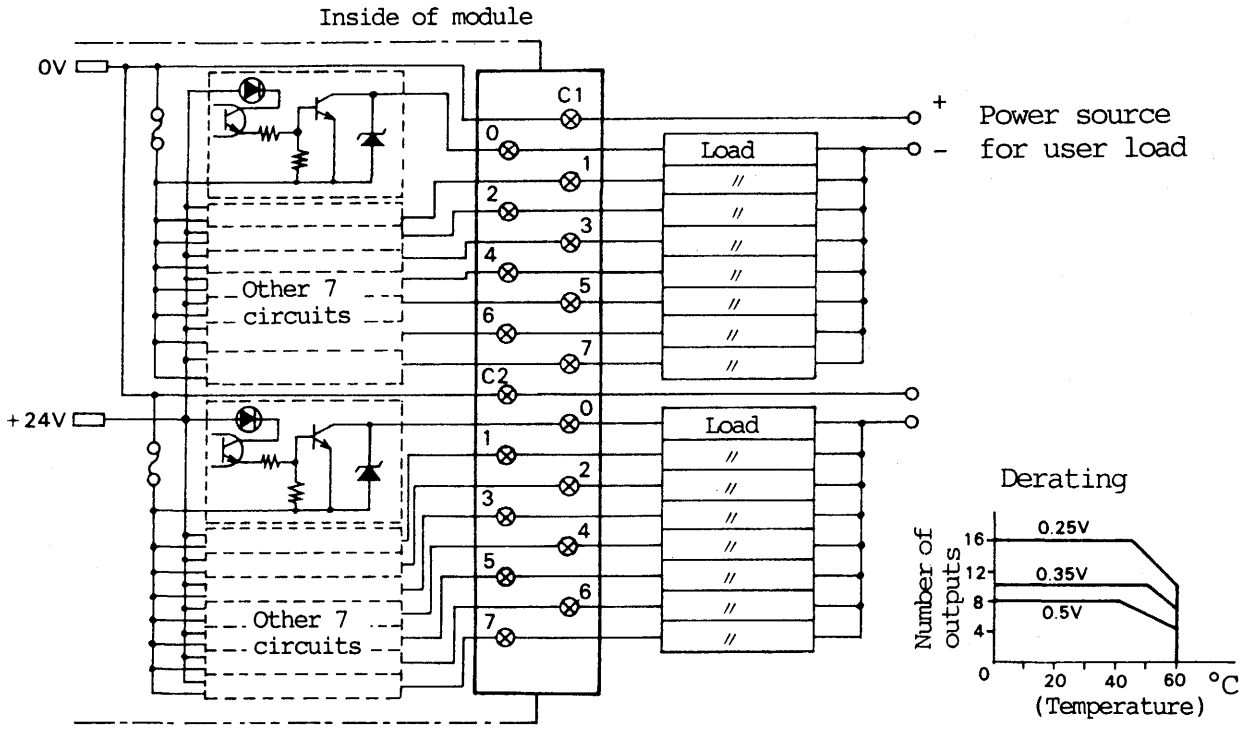
This is a 24 VDC output module for 16 points with LED operation status displays.

Specifications

Item	Ratings
Number of circuits	16 (with LED operation status display)
Output type	NPN open collector output
Switching capacity	24 VDC, 0.5 A
Leakage current	Less than 100 μA (application of 40 V of voltage)
Residual voltage	2.0 V (0.5 A)
Allowable peak voltage	45 V (Peak value of power source voltage for user load including ripple)
OFF to ON response	0.1 ms
ON to OFF response	0.1 ms
Current consumption of internal 9 V circuit	3 mA + 2.3 mA/circuit (Current is obtained from the power supply unit by mounting the module on the base.)
Current consumption of internal 24 V circuit	6 mA/circuit
Fuse	3 A (Fuse to be installed on each common line for 8 outputs), soldering type fuse
Weight	160 g

* It should be less than 2 A per common line.

Terminal connection and internal circuit



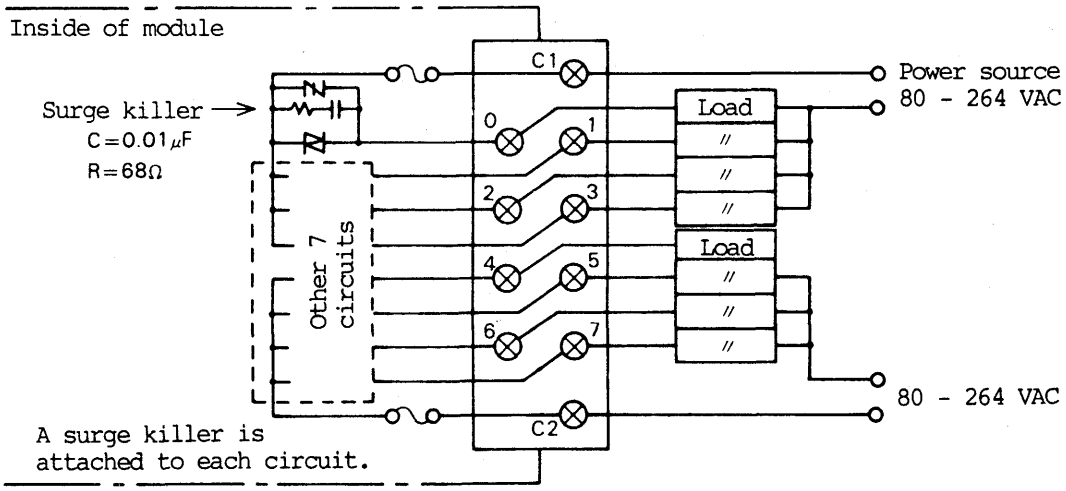
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6-15. E-20T: Triac output module

Specifications

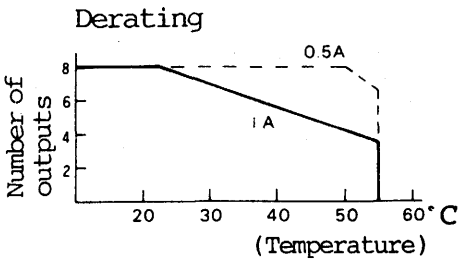
Item	Ratings
Number of circuits	8 (with LED display)
Maximum switching capacity	80 - 264 VAC, 1 A (within 1 cycle of peak 10 A)
Minimum switching capacity	80 - 264 VAC, 25 mA
Leakage current	0.45 mA (50 Hz, 110 V), 1 mA (50 Hz, 220 V) 0.52 mA (60 Hz, 110 V), 1.2 mA (60 Hz, 220 V)
Residual voltage	0.8 V (0.5 A), 0.9 V (1 A)
OFF to ON response	1 ms
ON to OFF response	Within $\frac{1}{2}$ cycle
Current consumption of internal 9 V circuit	20 mA per circuit (Circuit is obtained from the power supply unit by mounting the module on the base.)
Fuse	5 A (One fuse is provided for each common line of 4 circuits.) , soldering type fuse
Weight	180 g

Terminal connection and internal circuit



Note:

1. Because of surge killer, leakage current can activate loads requiring very low current, such as a neon lamp.
2. One common terminal is used for 4 circuits and each is separated from the other common terminals.
3. Fuses are soldered in place and cannot be replaced.



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6-16. E-21T: Triac output (4-point) module

4-point outputs are isolated from one another.

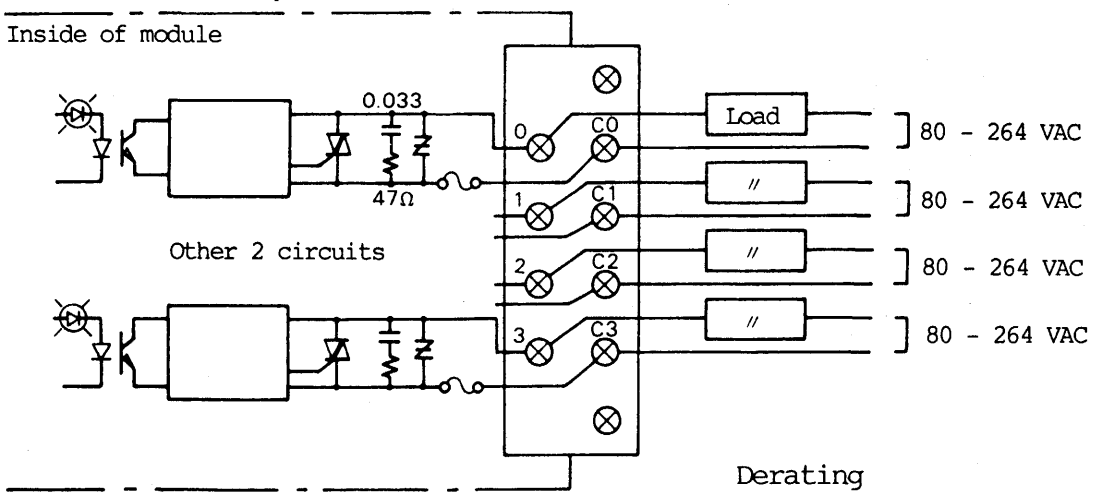
Specifications

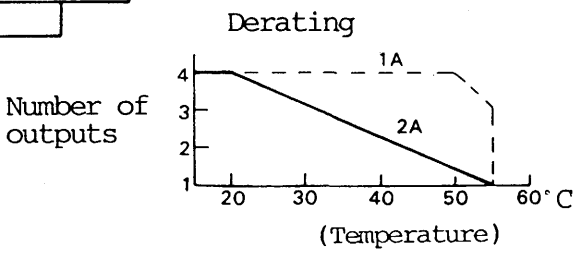
Item	Ratings
Number of circuits	4 (with LED operation status display)
Maximum switching capacity	80 - 264 VAC, 2 A (continuation)
Minimum switching capacity	80 - 264 VAC, 10 mA
Leakage current	3 mA (50Hz, 110 V), 6 mA (50 Hz, 220 V) 3.5 mA (60 Hz, 110 V), 7 mA (60 Hz, 220 V)
Residual voltage	0.8 V (2A), 1.0 V (5 A), 1.5 V (10 A)
OFF to ON response	Within 1 ms
ON to OFF response	Within $\frac{1}{2}$ cycle
Current consumption of internal 9 V circuit	12 mA per circuit
Fuse	3 A (replaceable), Type MF51SH3
Weight	160g

Output number assignment

Although E-21T is a 4-point output module, 8 I/O numbers are assigned. Of these numbers, 0 through 3 are effective, and numbers 4 through 7 are ignored.

Terminal connection and input circuit





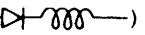
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In-rush current characteristics

20 A	Within 1 cycle if duty cycle turns on at 0.5 sec intervals
15 A	Within 4 cycles if duty cycle turns on at 1.2 sec intervals
10 A	Within 1 sec if duty cycle turns on at 13 sec intervals

Note: 1. With solenoid or lamp load, in-rush current is about 10 times the normal current. Check the in-rush current and fuse. The fuse will blow within 0.5 sec for 6 A and within 6 min for 4 A.

2. Load currents of less than 10 mA can be a cause of undependable operation. In this case, connect a parallel resistance to the load so that the load current is increased to 10 mA or higher.

3. Loads with a diode can also be used. ()

6-17. E-35T: Open collector output module with 16 displays

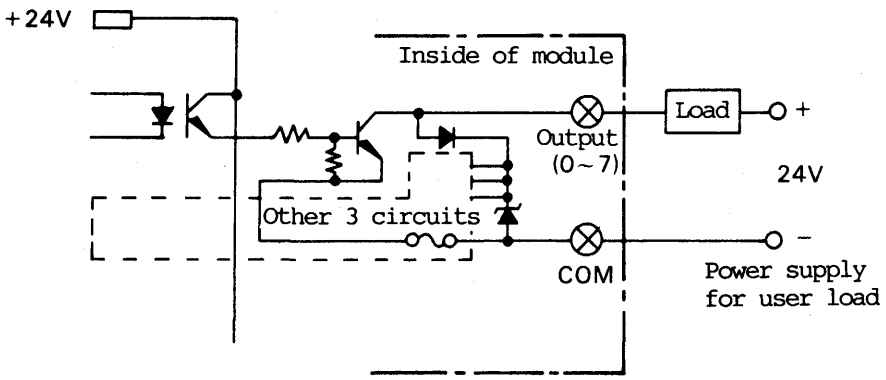
This is a 16 output module. Connections are made through connectors.

Specifications

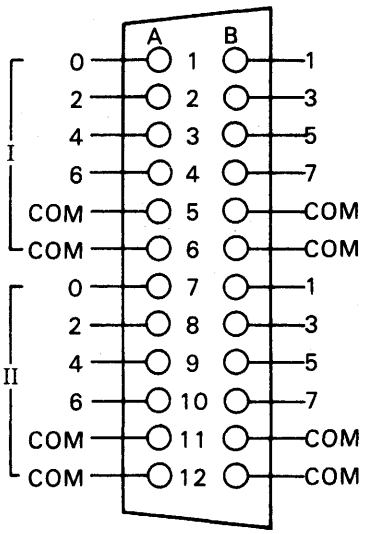
Item	Ratings
Number of circuits	16 (with LED operation status display)
Output type	NPN open collector output (active on low level)
Switching capacity	24 VDC, 0.5 A
Leakage current	Less than 3 mA
Residual voltage	Less than 2.0 V (under 0.5 A)
Allowable peak voltage	50 V (Peak value of power source voltage for user load including ripple)
OFF to ON response	0.1 ms
ON to OFF response	0.1 ms
Current consumption of internal 9 V circuit	3 mA + 2.3 mA/circuit (Current is obtained from the power supply unit by mounting the module on the base.)
Current consumption of internal 24 V circuit	6 mA/circuit
Fuse	3 A (Fuse to be installed on each common line for 4 outputs), soldering type fuse
Weight	160 g

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Internal circuit



Connector connection diagram

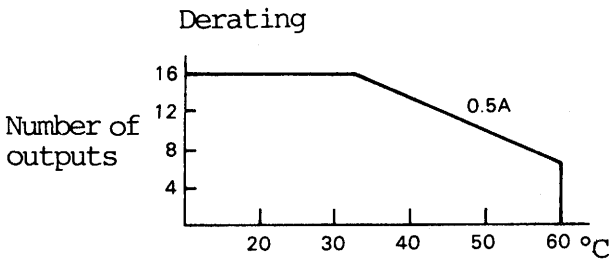


I: Basic I/O number
II: Basic I/O number + 100

Note: 1. All 8 common terminals are internally connected and also connected with the 0 V terminal of 24 V power supply of E-02B base.

2. Elements are included to absorb counterelectromotive voltage, which is energized by the switching of an inductive load. Refer to the note 2 of E-10T.

3. One fuse is provided for each common line of 4 outputs. Fuses are directly soldered in place and cannot be replaced.



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6-18. E-52T: 24 VDC output module (equivalent to open collector)

Specifications

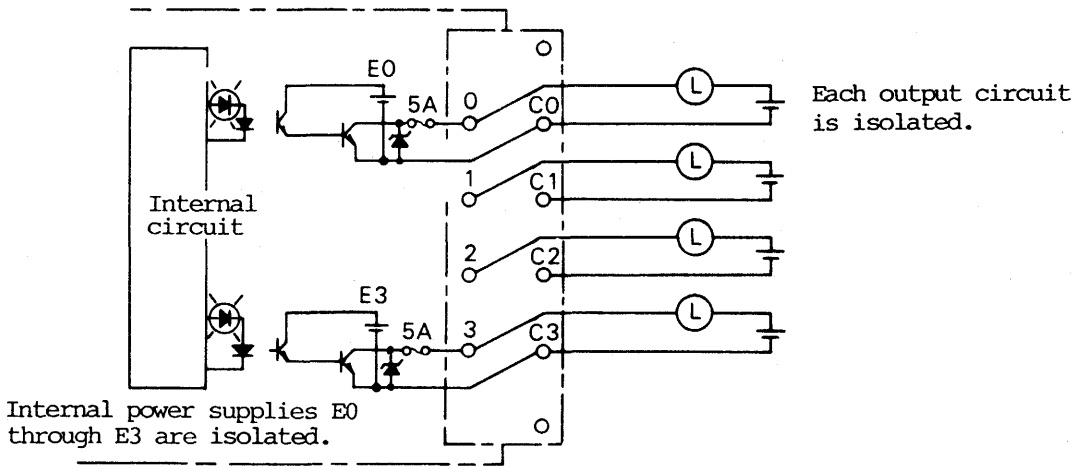
Item	Ratings
Number of outputs	4 (individually isolated) (with LED display)
Switching capacity	24 V, 2 A (continuous), 6 A (maximum momentary current)
Leakage current	Less than 0.4 mA (40 V application across output terminals)
Residual voltage	0.15 V (1 A), 0.3 V (2 A), 0.6 V (4 A), 1.0 V (6 A)
Allowable peak voltage (between output terminals)	45 V
Response time	0.1 ms (both OFF to ON and ON to OFF)
Current consumption of internal 9 V circuit	12 mA, less than 30 mA (current consumption of internal 24 V circuit)
Fuse	5 A (replaceable) Type MF51SH5
Dielectric strength (across outputs)	1.5 KV AC

Weight: 120g

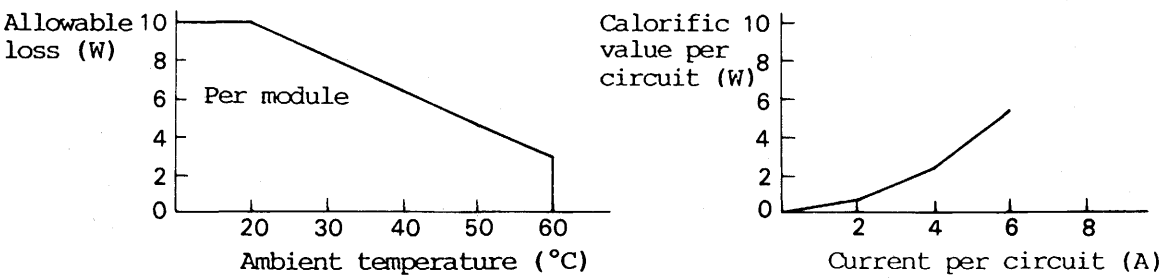
Output number assignment

This module has 4 outputs but is assigned to 8 I/O numbers. No. 0 through No. 3 are effective; No. 4 through No. 7 can be used for internal relays.

Internal connection diagram



Characteristics



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Allowable loss

Allowable loss per module can be determined by summation of the following two values:

(1) Loss determined by current per circuit
(2) Loss under inductive load

At maximum switching frequency under inductive load, the calorific value mounts to 1.5 W. This loss is proportional to the frequency.

Current can be increased by parallel connection. The break characteristic of inductive load determined from the maximum switching cycle table represents that of one circuit. Serial connection is also possible. In the case of lamp load, the lamp's rated current should be less than 0.8 A.

In each output circuit, FET is used, but the diagram shows an equivalent circuit using an NPN transistor. Because each output circuit is isolated from the other, a wide variety of circuit composition, whether SINK or SOURCE, is possible.

Maximum switching cycle table

Load type	Time constant of load	Load current (under 24 V)			
		1 A	2 A	4 A	6 A
Resistive load	———	No limit on switching cycle			
Inductive load	7 ms	1,000/min	500/min	250/min	20/min
	40 ms	180/min	90/min	*	*
	100 ms	70/min	15/min	*	*

* Diode is needed parallel to load.

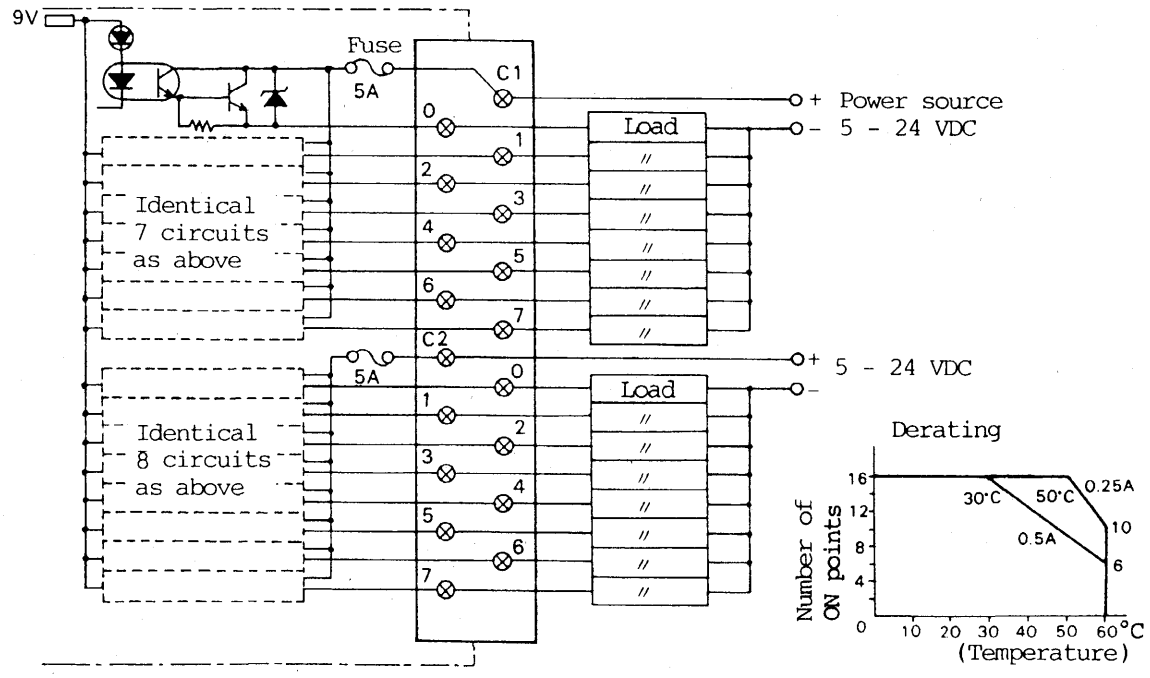
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6-19. E-55T: 24 VDC emitter follower output (16) module

Specifications

Item	Ratings
Number of circuits	16 (with LED status display), a common line for 8 circuits
Output type	NPN transistor emitter follower
Residual voltage (Between common line and output terminal)	Maximum 1.5 V 0.70 V (normal), (Load current = 0.1 A) 0.75 V (normal), (Load current = 0.25 A) 0.80 V (normal), (Load current = 0.5 A)
Switching voltage	5 - 24 VDC
Peak voltage for user load	40 V
Rated current	0.5 A (resistive load) 0.1 A (lamp load) 0.5 A, 7 ms (time constant) 0.3 A, 40 ms (time constant) } Inductive load 0.2 A, 100 ms (time constant)
OFF to ON response	Less than 0.1 ms (resistive load)
ON to OFF response	Less than 1 ms (resistive load)
Leakage current	Less than 10 μA (voltage application = 40 V)
Current consumption of internal 9 V circuit	7.5 mA (for typical cases)/number of ON outputs 180 mA maximum/number of all outputs
Current consumption of internal 24 V circuit	Not used
Fuse	5 A (Fuse to be installed on each common line for 8 outputs), Soldering type fuse
Weight	200 g

Terminal connection and internal circuit



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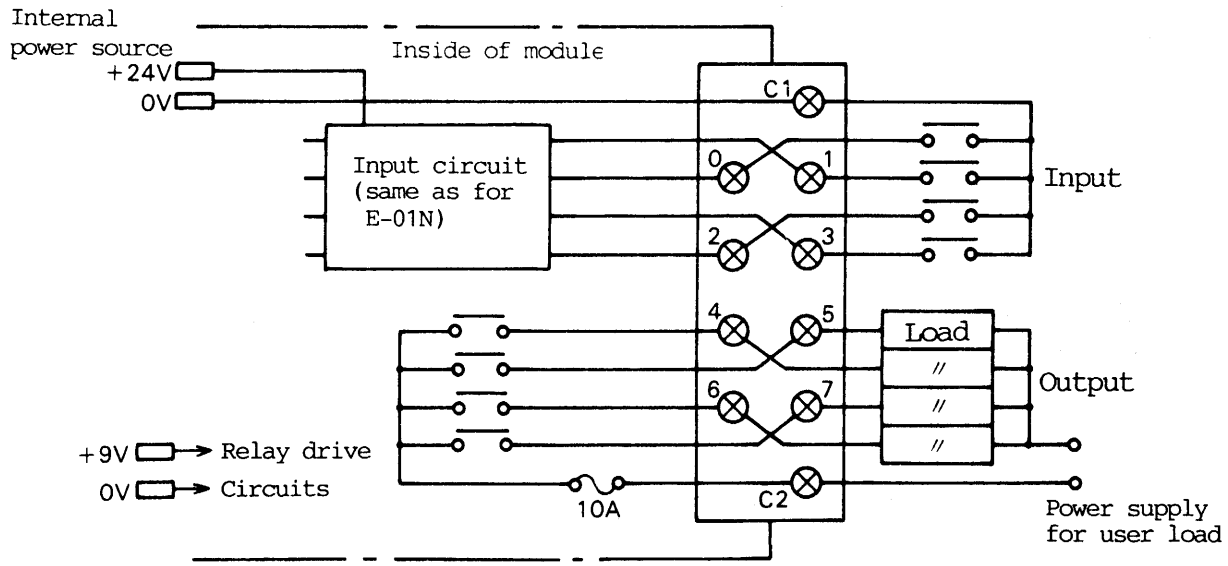
6-20. E-01NT: 24 VDC input/relay output module

Four input circuits and four output circuits are contained in a single E-01NT module.

Specifications

Item	Ratings
Number of circuits	4 inputs (24 VDC, with LED display) 4 outputs (4 normal open contact outputs, with LED display)
Input circuit	Same as for E-01N
Output circuit	Same as for E-01T
Current consumption of internal 24 V circuit	Input: 14 mA/circuit (Current is obtained from the power supply unit by mounting the module on the base.)
Current consumption of internal 9 V circuit	Output: 45 mA/ circuit + 20 mA
Fuse	10 A (for output) (Replaceable)
Weight	170 g

Terminal connection and internal circuit



Common terminal C1 is connected to 0 V terminal of internal 24 V power source.

Input/output number assignment

a) Input terminals: 0 - 3
b) Output terminals: 4 - 7

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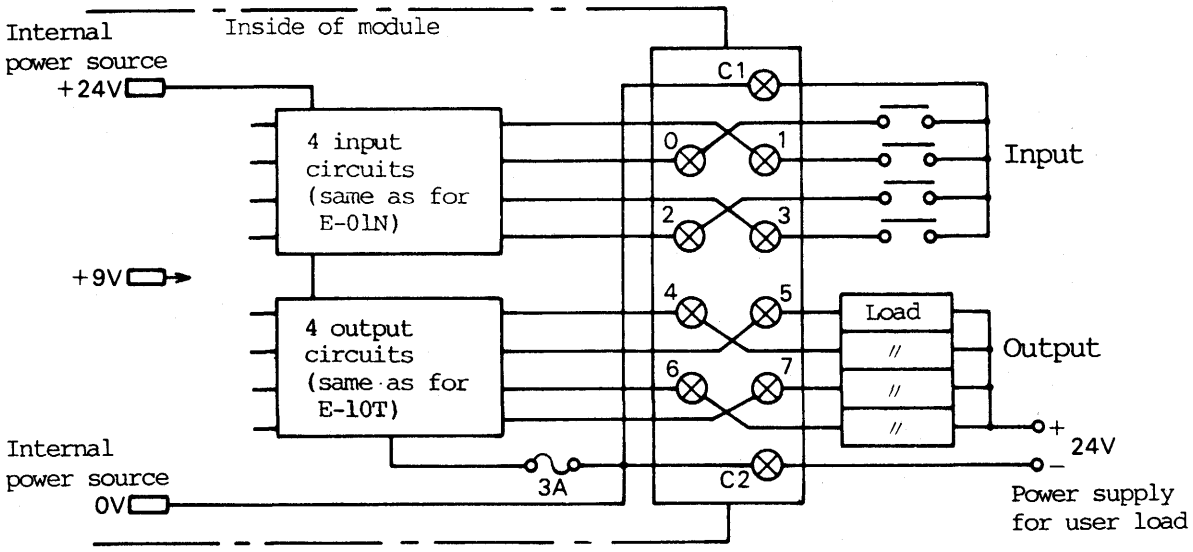
6-21. E-10NT: 24 VDC input/open collector output module

Four input circuits and four output circuits are contained in a single E-10NT module.

Specifications

Item	Ratings
Number of circuits	4 inputs (24 VDC, with LED display) 4 outputs (24 VDC, 0.5 A, with LED display)
Input circuit	Same as for E-01N
Output circuit	Same as for E-10T, open collector output
Current consumption of internal 24 V circuit	Input: 14 mA/circuit Output: 3 mA/circuit (Current is obtained from the power supply unit by mounting the module on the base.)
Current consumption of internal 9 V circuit	20 mA
Fuse	3 A (for output), Soldering type*
Weight	130 g

Terminal connection and internal circuit



Common terminals C1 and C2 are internally connected to 0 V power supply line.

* The fuse is soldered directry to the inside of the module and therfore cannot be replaced.

Input/output number assignment

a) Input terminals: 0 - 3
b) Output terminals: 4 - 7

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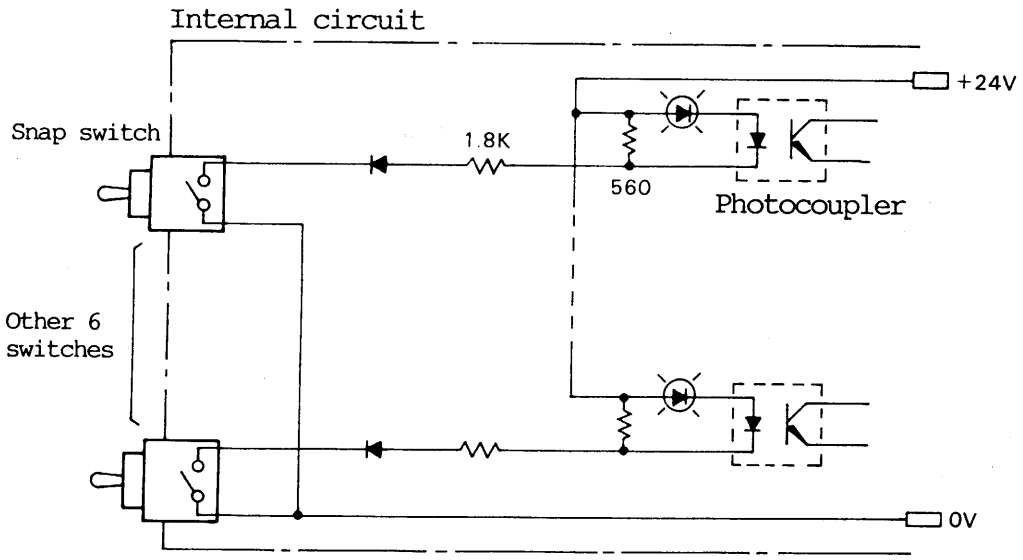
7. SPECIAL FEATURE MODULE

7-1. E-01S: Input simulation module

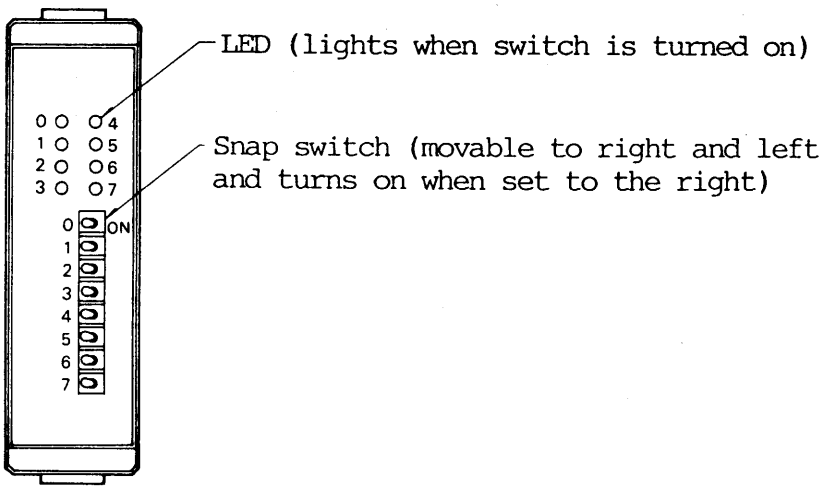
This is a specialized input simulation module with 8 snap switches instead of connector terminals.

Specifications

Item	Ratings	
Number of switches	8 (with LED displays)	
OFF to ON response	4 - 15 ms	
ON to OFF response	4 - 15 ms	
Current consumption of internal 24 V circuit	14 mA /switch	(Current is obtained from the power supply unit by mounting the module on the base.)
Current consumption of internal 9 V circuit	10 mA / module	
Weight	90 g	



Faceplate



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7-2. E-01D: Timer/counter external setting module

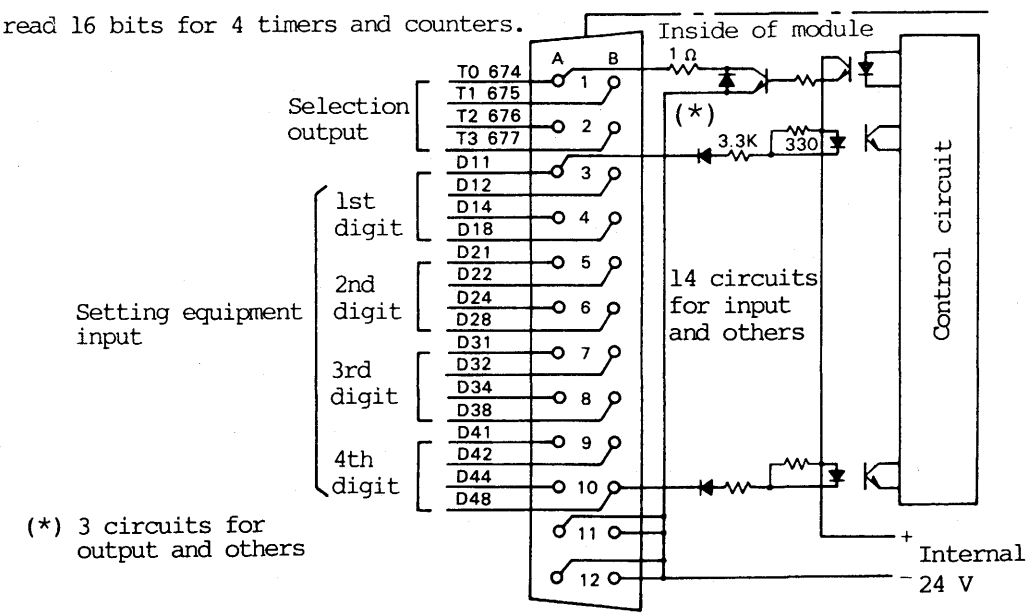
This is a module to operate with timer or counter values set by the external digital setting equipment.

Specifications

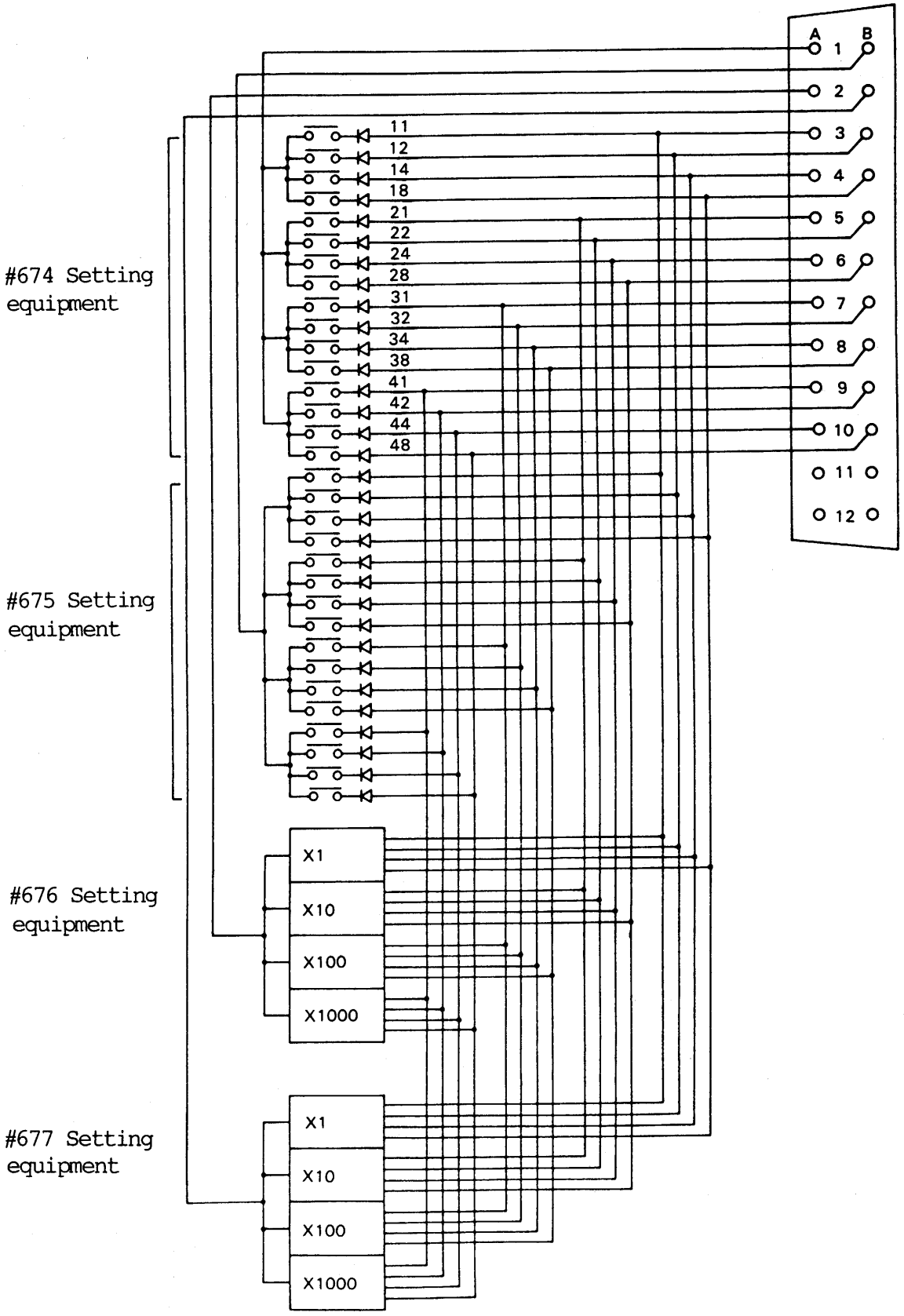
Item	Ratings	
Number of timers and counters : 4		
Setting range	Counter	Timer
	1 - 9999	0.1 - 999.9 sec
Maximum count speed Repeat precision	1,000 (C.P.S) (2 x program execution time) + 2 ms (C.P.S)	Larger value either + 1 scan time - 50 ms or ± 0.01% of count value
Operation	Incremental type	Incremental type ON-delay operation
Operation in case of power failure	Memory retention of count value	Reset
Counting	Counting at the edge of input ON	Counting by the 50 ms clock
Timer/counter number	674, 675, 676, and 677 (only applicable to these numbers)	
Current consumption of internal 24 V circuit	90 mA	(Current is obtained from the power supply unit by mounting the module on the base.)
Current consumption of internal 9 V circuit	100 mA	
Weight	120 g	

Connection with the setting equipment

Connection between the setting equipment and the module is made through connectors. The connectors have 24 pins. The setting equipment needs 64 pins (4 ea x 4 digits x 4 bits). Then the time sharing method is employed to read 16 bits for 4 timers and counters.



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Four setting equipment are connected in parallel.
This requires a diode to be installed with the setting equipment.

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Specifications for setting equipment connectors

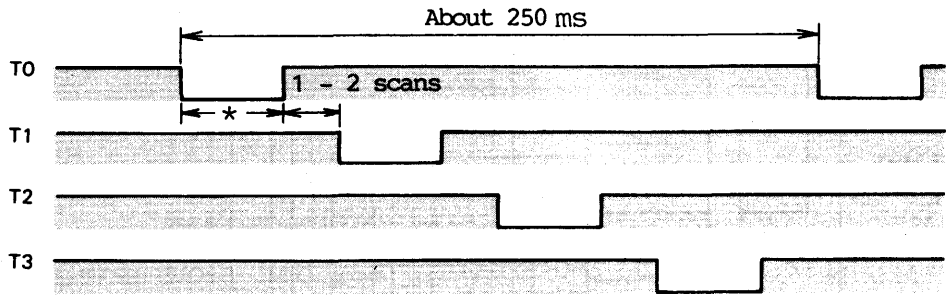
1. Set value signal input (connectors A/B 3 - 10)

Input signal	BCD signal, no-voltage contact signal (possible of open collector signal)
Input terminal voltage in case of OFF status	18 - 36 V
Input current	6 - 15 mA (current to be flowed into the setting equipment)
ON current	More than 6 mA
OFF current	Less than 2 mA
ON voltage	Less than 3 V
OFF to ON response	4 - 15 ms
ON to OFF response	4 - 15 ms

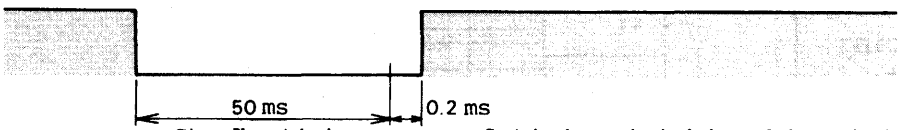
2. Selected (timing) output (connectors A1, A2, B1, and B2)

OUtput type	NPN open collector output
Maximum current	200 mA
Residual voltage	Less than 0.5 V (under 200 mA of current)
Leakage current	Less than 50 μA (under 40 V application)
Peak resistance	45 V (externally applicable voltage peak value)

3. Selected output timing



*: Partial enlargement



Read timing (Within this timing, 16 input conditions are read.)

A standby timing of 50 ms is given because it takes 4 to 15 ms for the input circuit response time even when the selected output rises to make the input active. Reading of the data input will be processed in the last 0.2 ms after 50 ms of standby timing.

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Setting equipment

The digital switch (thumbwheel switch) with diode is usually used for the setting equipment. The diode is indispensable because four contacts are connected with one input terminal.

The no-voltage contact such as the digital switch is best suited for the setting input. But it is also possible to use the open collector output for the input signal. It is then necessary to control all outputs (16) to be off during the rest of the period, but the output should be active while the selected output is on the low level because reading is processed under time sharing. The input signal becomes active on the low level.

Set value correction during operation

It is possible to correct the set value of the external setting equipment during the operation under RUN. Be careful, however, with the following conditions.

a. About 4 - 300 ms of time delay will be observed for reading the new set value into the CPU.

b. Correcting the set value will sometimes cause a time-up or count-up condition because of the strange code that may be generated while changing the process of numbers.

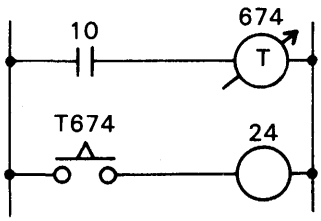
c. The time-up or count-up output will not be OFF even when the set value is corrected in excess of the accumulated value (count value).

Location for installing the module

E-01D can be installed anywhere on the basic base (the base with the CPU installed), but it cannot be installed on the expansion base.

But for installing on E-03B and E-04B bases, only four slots next to the CPU slot are accessible.

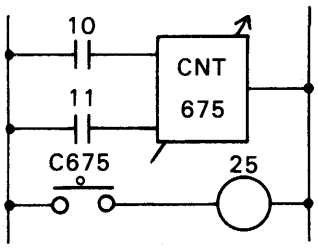
Example of timer



Program

STR	10
TMR	674
STR TMR	674
OUT	24

Example of counter



Program

STR	10
STR	11
CNT	675
STR CNT	675
OUT	25

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7-3. E-01H: High-speed I/O module (relay contact output)

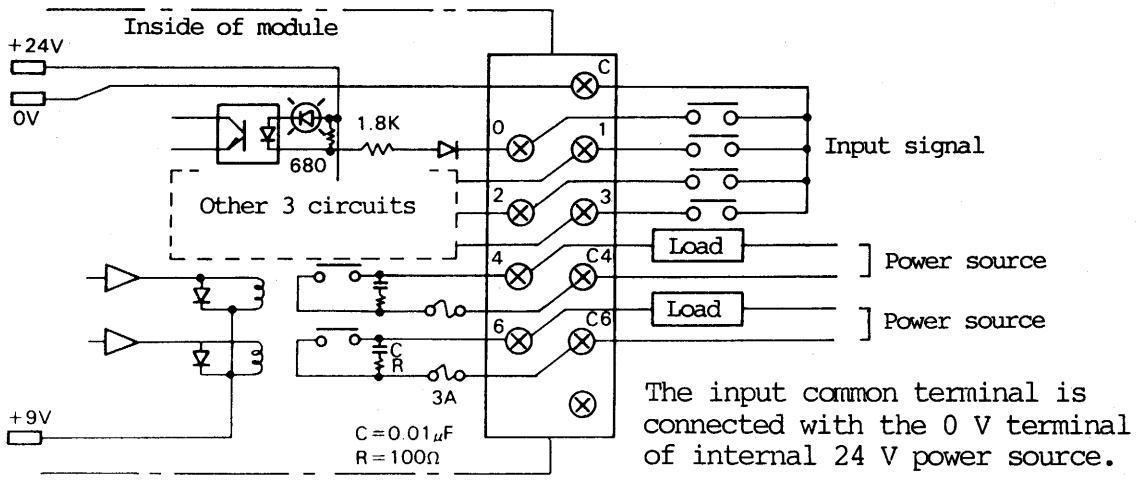
This is an I/O module that can directly control the output signal's rising and falling by the input signal so that the user can avoid the problem of delaying response and irregularity in connection with the cyclic operation processing that until now has been unavoidable with the PC.

Specifications

Item	Ratings
Number of circuits	2 (with I/O status display LEDs)
Applicable input signal source	ON/OFF signal by the no-voltage contact or open collector Should have a switching capacity of more than 40 V of dielectric force and 17 mA of current
Input ON current	More than 7 mA
Input OFF current	Less than 3 mA
Input ON voltage	Less than 3 V
Input terminal open voltage	18 - 36 VDC (between the input terminal and the common terminal under the input open condition)
Input OFF to ON response	1.2 ms (typical cases) (0.7 - 3 ms)
Input ON to OFF response	80 ms (typical cases) (50 - 150 ms)
Output type	Relay contact output
Switching capacity	220 VAC, 4 A with resistive load (Other load characteristics are the same with the cases of E-01T.)
Leakage current between contacts	1 mA (typical cases) (200 VAC, 50 Hz)
Minimum switching capacity	5 ms, 5 V
Output response speed	5 ms (under ON), 5 - 10 ms (under OFF)
Current consumption of internal 24 V line	15 mA/input
Current consumption of internal 9 V line	50 mA + 53 mA/relay (under ON)
Fuse	3 A (replaceable)
Weight	130 g

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Terminal connection and internal circuit



● Operation mode

The following two operation modes are available for E-01H.

a) High-speed mode

This is the essential mode of E-01H. It is possible to ignore delaying of the response time in the CPU because the output signal reacts to the input signal regardless of CPU.

b) Regular mode

Under this mode E-01H operates as a regular I/O module of 4 inputs and 2 relay outputs because the input circuit is isolated from the output circuit and they have no relation with each other.

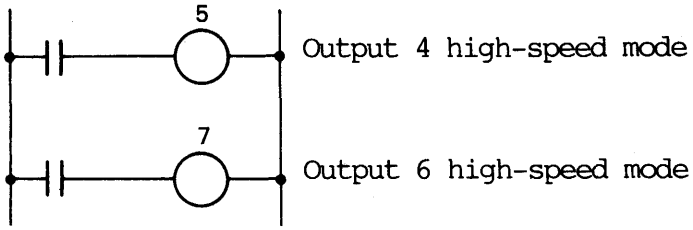
● Operation mode switching

Switching will be made by the program. The high-speed mode is available when the mode select output is turned on. The regular mode is available when the mode select output is turned off.

I/O number	Item	Function
0	Input 0	Output 4 will be turned on under the high-speed mode.
1	Input 1	Output 4 will be turned off under the high-speed mode.
2	Input 2	Output 6 will be turned on under the high-speed mode.
3	Input 3	Output 6 will be turned off under the high-speed mode.
4	External output 4	Output signal to the external equipment
5	Mode select output 5	This is used for switching of the mode. Output 4 will be turned for the high-speed mode when this mode is turned on.
6	External output 6	Output signal to the external equipment
7	Mode select output 7	This is used for switching of the mode. Output 6 will be turned for the high-speed mode when this mode is turned on.

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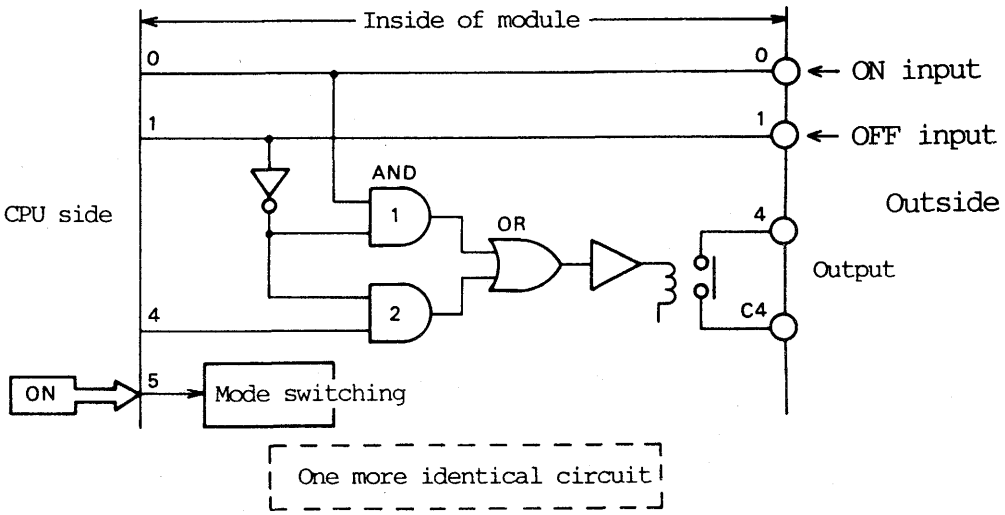
Example of the mode switching operation chart



Two identical circuits are installed and can be independently set for the operation mode by the mode switching operation.

● High-speed mode

Equivalent circuit diagram.(This equivalent circuit diagram is drawn with logic symbols. The actual input signal activates at a low level, but should be observed as if activating at the high level in this circuit.)



Relation between input and output (truth table)

Condition	Input 0 (2)	Input 1 (3)	External output 4 (6)
1	0	0	Activates as instructed by the CPU output
2	1	0	1
3	0	1	0
4	1	1	0

Conditional descriptions

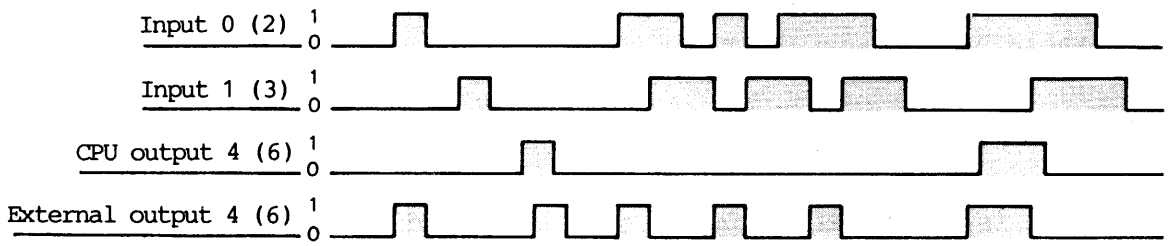
1. When #4 (or #6) output of the CPU side is turned on, it causes the output relay to be on through AND 2. The response speed of output under this condition will be the normal speed because it includes a delay time in the PC.

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2. The condition of AND 1 will be satisfied and the output relay will be turned on when the ON input (input 0 or 2) is made for 1 while the OFF input (input 1 or 3) is set for 0. Under this condition the output relay will be on regardless of the condition of the CPU output. Then the response speed is the high speed.

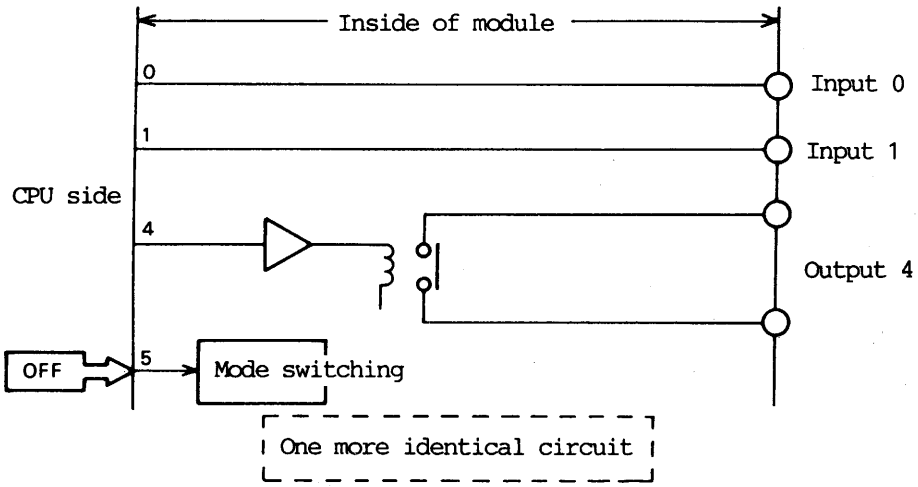
3/4. If the OFF input (input 1 or 3) is made for 1, the output relay will be turned off regardless of the condition of ON input (input 0 or 2) and the output from the CPU.
In this case, the operation is processed under high speed.

Time chart under high speed



● Regular mode

Equivalent circuit diagram

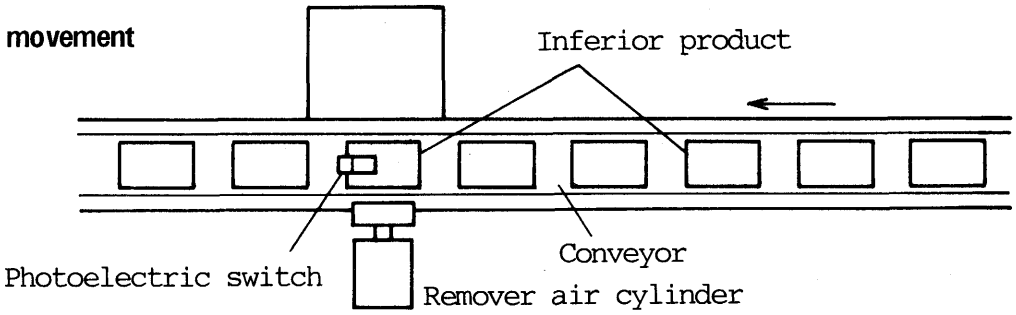


When the operation mode is set for the regular mode, the module will operate as the I/O module of 4 inputs and 2 outputs (for 2 circuits) because the input signal has no relation with the output signal, as shown above in the equivalent circuit of E-01H.

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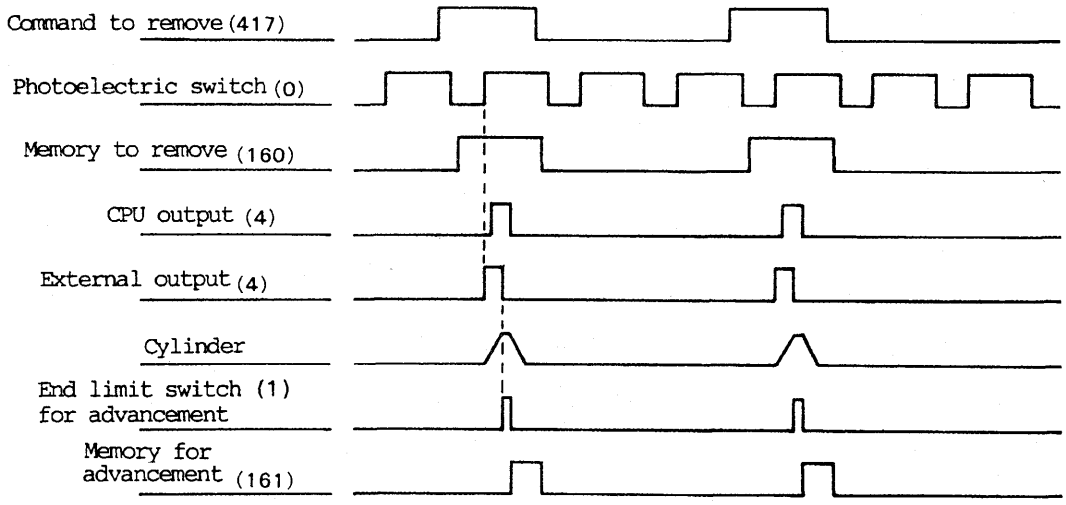
Application program

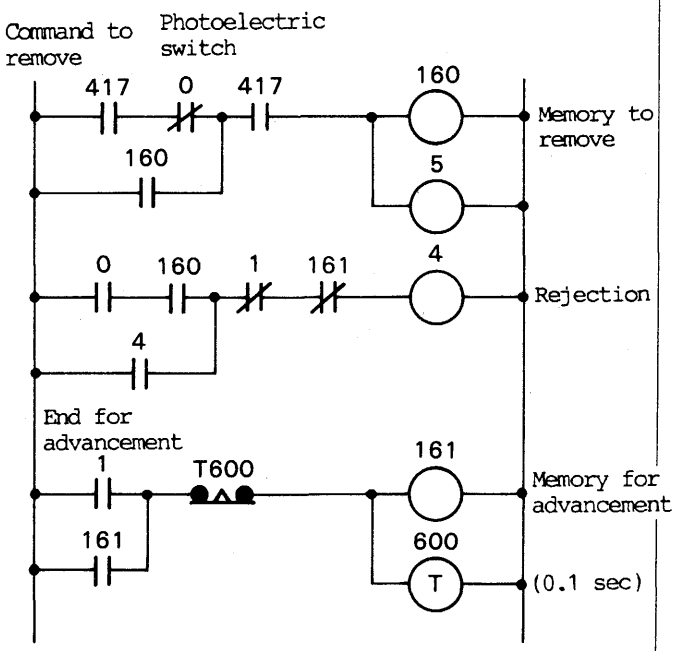
● **Rapid movement**



An inferior product will be removed out from the conveyor line by the immediate operation of the remover whenever the photoelectric switch detects the inferior product by getting command to remove it.

Timing chart





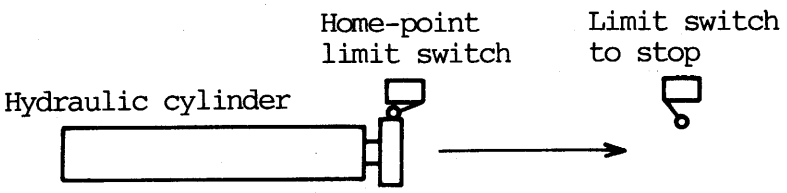
Program

STR	417
AND NOT	0
OR	160
AND	417
OUT	160
OUT	5
STR	0
AND	160
OR	4
AND NOT	1
AND NOT	161
OUT	4
STR	1
OR	161
AND NOT TMR	600
OUT	161
TMR	600
	0.1

I/O numbers are arranged for the case when E-01H is installed next to the left from the CPU.

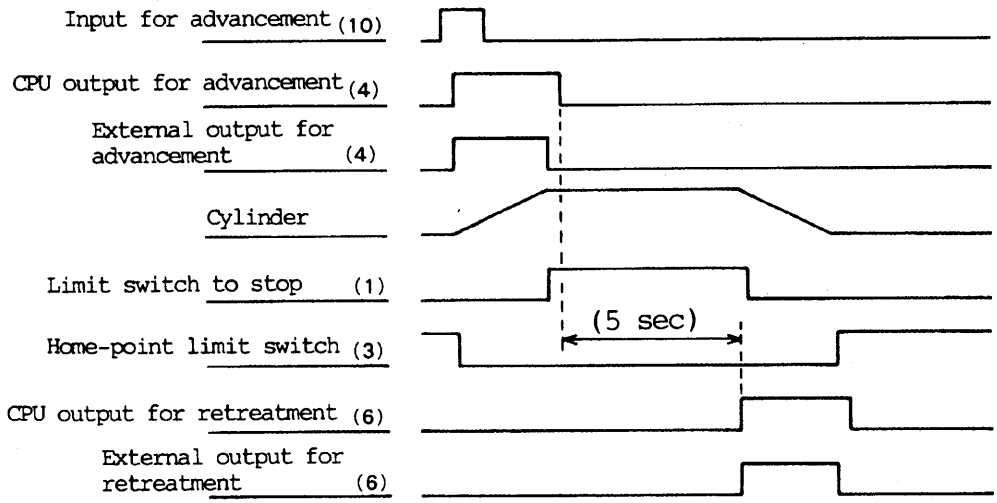
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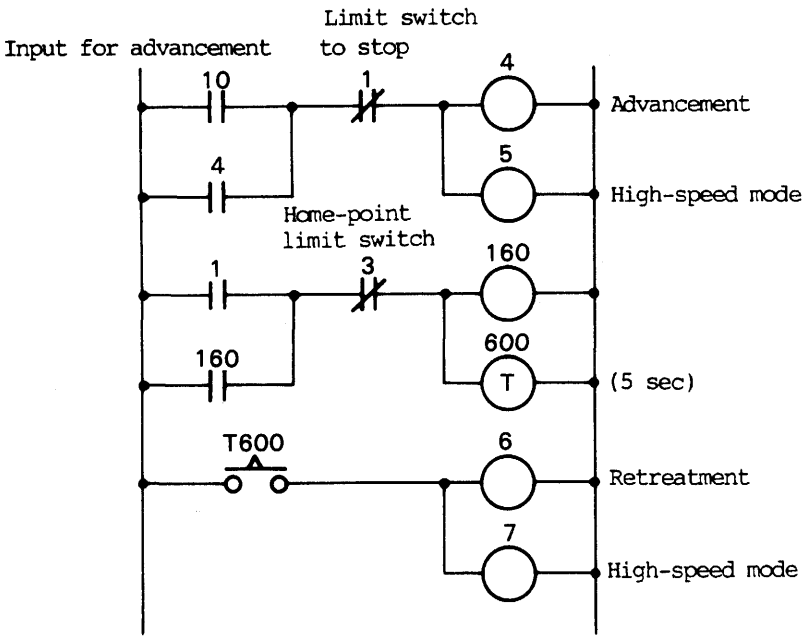
● **Rapid stop**



The cylinder will be stopped instantly whenever it touches the limit switch to stop during the cylinder operation for advancement.
It stops for five seconds and starts to return. Then it stops instantly whenever it touches the home-point limit switch.

Timing chart





Program

STR	10
OR	4
AND NOT	1
OUT	4
OUT	5
STR	1
OR	160
AND NOT	3
OUT	160
TMR	600
	5
STR TMR	600
OUT	6
OUT	7

I/O numbers are arranged for the case when E-01H is installed next to the left from the CPU.

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7-4. E-01H-1: High-speed I/O module (transistor open collector output)

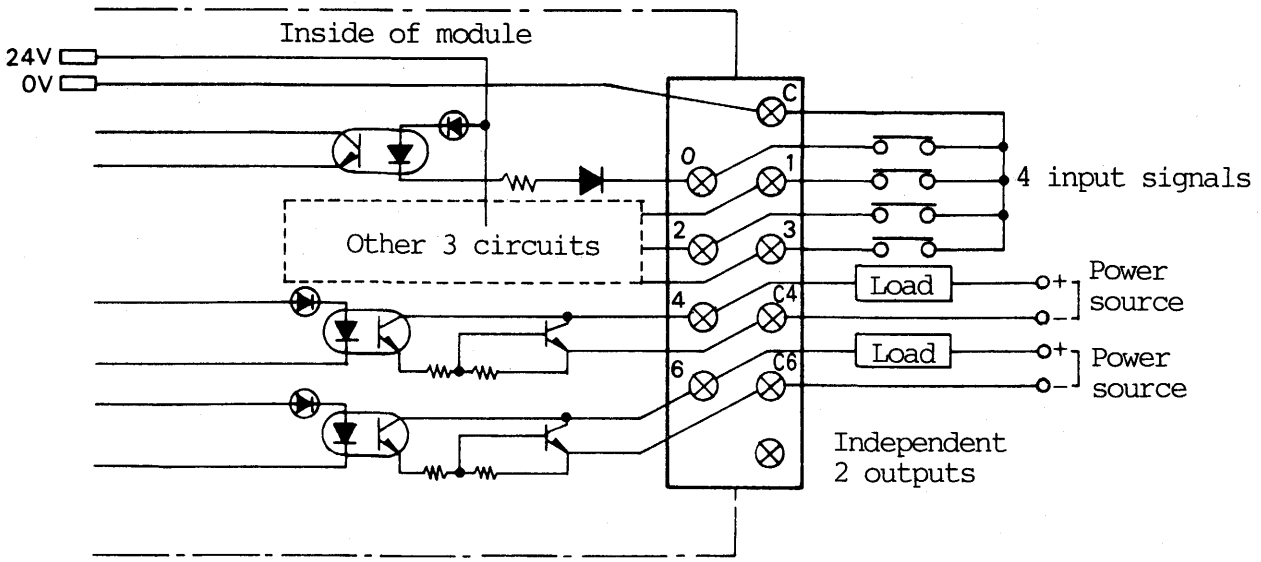
This is a high-speed control module to control the output by the change of input signal condition sooner than program processing by the CPU of the PC. This module uses the open collector for E-01H output.

Specifications

Item	Ratings
(Input) Input type	24 VDC by the no-voltage contact or open collector
Number of circuits	4 (with operation status display LEDs)
ON current	More than 7 mA
OFF current	Less than 3mA
ON voltage	Less than 3 V
OFF voltage	Changes by the power source voltage and the number of inputs in use
Input terminal open voltage	18 - 36 VDC
OFF to ON response	0.5 ms (typical cases) (0.3 - 1 ms)
ON to OFF response	80 ms (typical cases) (50 - 150 ms)
Input signal width	Minimum 1 ms
(Output) Output type	NPN open collector output
Number of circuits	2 (independent), (with operation status display LEDs)
Maximum switching capacity	24 VDC, 0.5 A
Leakage current	Less than 100 μA (under application of 40 V of voltage)
Residual voltage	0.70 V (0.1 A), 0.75 V (0.25 A), and 0.85 V (0.5 A)
Allowable peak voltage	40 V (peak value of user load power source voltage including ripple)
OFF to ON response	0.1 ms
ON to OFF response	0.1 ms
Select output	2 (with operation status display LEDs)
Dielectric force	2 KVAC, 1 minute
Insulation resistance	More than 100 Ω
Current consumption of internal 9 V line	Maximum 70 mA
Current consumption of internal 24 V line	15 mA/input
Weight	130 g

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Terminal connection and internal circuit



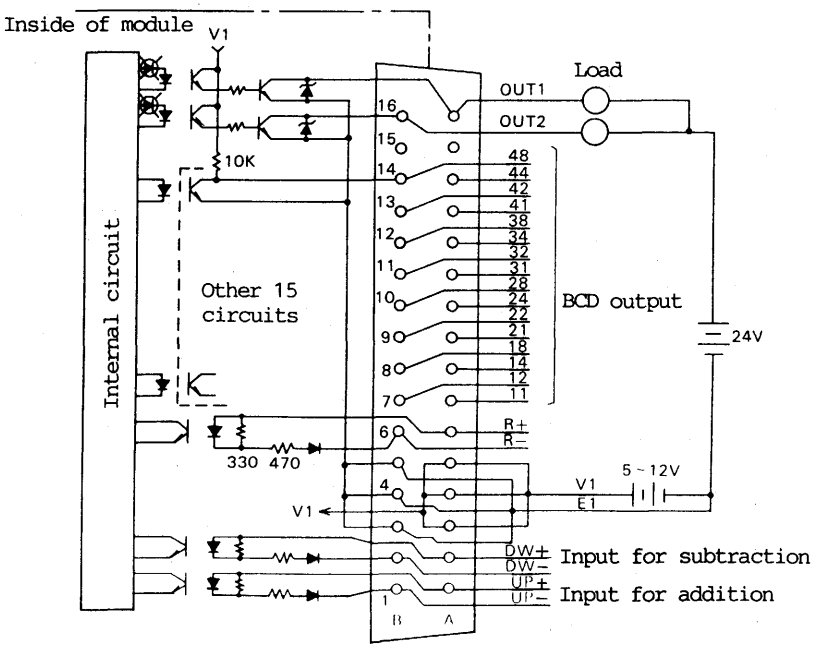
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7-5. E-01Z: High-speed addition/subtraction counter module

Specifications

Item	Ratings
(Counter)	Addition and subtraction counter circuit
Number of digits	4 (0000 - 9999)
Counter speed	10 Kcps (under 25% of ON/OFF duty), available for switching to 500 cps
Count input method	Independent addition and subtraction pulses
Reset	Available for external resetting at any time
Memory retention against power failure	No (Count value is reset when power is OFF.)
Count value writing	Program writing from the CPU; 4 digits of writing value
(Comparison) Number of digits for comparison	4 (0000 - 9999)
Method of writing	Program writing from the CPU
Comparison outputs	3 comparison outputs for CPU input Counter < value for comparison Counter = value for comparison Counter > value for comparison
(External output) Count value output	4-digit BCD, voltage output
Output response	Less than 10 μS
External outputs 1 & 2	Open collector; 24 V, 0.3 A
Current consumption of internal 9 V line	Less than 70 mA
Weight	130 g

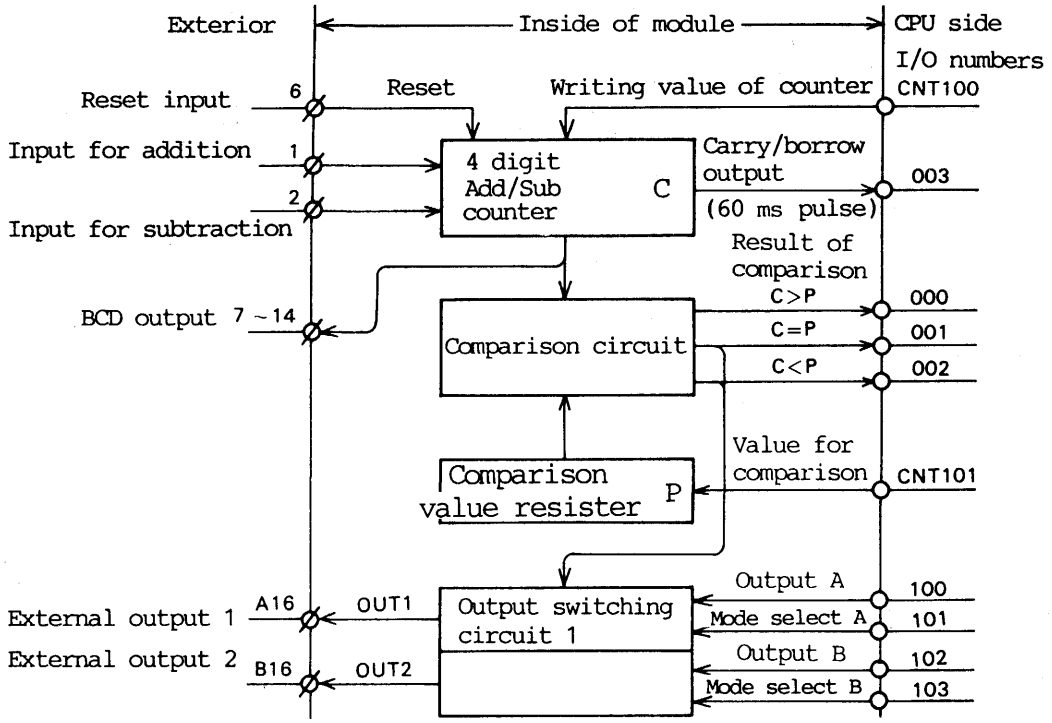
Terminal connection and internal circuit



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Internal block diagram

(I/O numbers are assigned when E-01Z is mounted next to the CPU in the left.)



Functional descriptions

1. Input for addition — Input signal for counting of the counter toward the plus direction (0→1→2→3 ----)
2. Input for subtraction — Input signal for counting of the counter toward the minus direction (23→22→21 ---)
3. Reset input — Counter reset signal. Counter resetting will be continued as long as this signal is input.
4. BCD output — External output of counter's counting. Four digits of counter value are simultaneously output in parallel in the form of a voltage signal and can be displayed on a digital display (LDC-10C) if connected.
5. External output — Output A and output B from the CPU will be output to external output terminals 1 and 2 through the output switching circuit.

   When the mode select signal is off, output A and output B are output in the original form to external output 1 and external output 2.

   When the mode select signal is turned on, the result of comparison will be kept in memory at the timing when the compared value is written.

   Output A or B will be reversed and output to external

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output 1 or 2 when the result of comparison is changed from the previous memory condition as a result of increase or decrease of the counter value.

6. Writing of count value — Set signal for the counter to be put under the initial condition. Unlike the reset signal, any desired value including 0 can be set. The counter number varies by the location of the module to be installed.

7. Value for comparison — Signal to write a value for comparison into the register for the value to compare.
Any value including 0 can be written. The counter number varies by the location of the module to be installed.

8. Result of comparison — Output for the comparison circuit. Three outputs for C < P, C = P, C > P will be input into the CPU if C is given for the counter's count value and P for the value for comparison.

9. Carry/borrow — Output for the counter value whenever it exceeds the normal range of count value (0000 to 9999).

10. Outputs A and B — Signals output from the CPU and can be used as output signals through the output switching circuit.

11. Mode selects A and B — Signal to determine to operate or not to operate the output switching circuit. If this signal is turned OFF, the output switching circuit will operate under the normal mode, permitting output A to be used for external output 1 and output B to be used in the original form.
If this signal is turned on, the output switching circuit will be put under the switching mode. If this circuit is set for the switching mode, the external output will be affected by the result of comparison. And output A or B will be reversed, to be used for the external output when a change is observed by an increase or decrease of the later count value as a result of comparison at the time of writing the compared value into the register for the value to compare.

Example: If C = 0 and P = 100 are set for the initial values, the result of comparison is C < P. The moment C reaches 100 by the accumulation of count value with inputs being added, C = P is established. Then the comparison result changes from the initial condition (C < P), and this causes the external output to be reversed at this moment. The switching operation for reversion is processed by hardware at an externaly high

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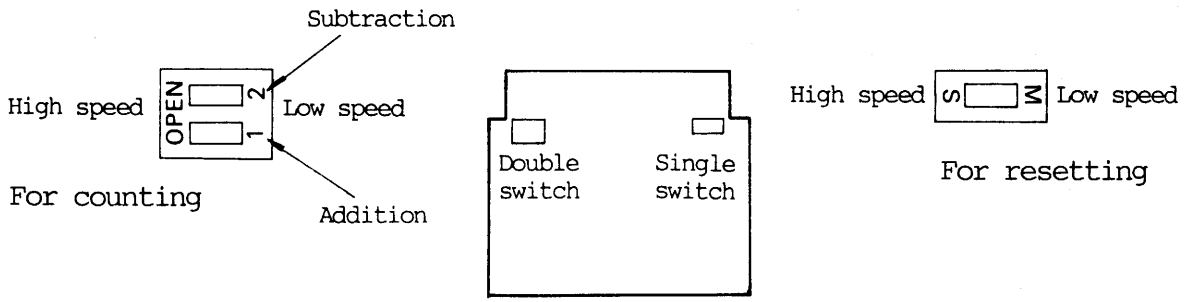
speed so that no timing delay or irregularity of program processing is observed.

Caution:

The initial setting of the counter must be either C < P or C > P for changing a result of comparison. If C = P is set for the initial condition, the external output is reversed already at the initial stage. The external output returns to the original condition by stopping the reversion if one pulse is added and the result turns out to be C > P. But if one pulse is subtracted and the result turns out to be C < P, the external output keeps the initial condition.

● How to switch the response

The counter response speed can be selected for 10 Kcps or 500 cps by the select switches. To select 500 cps, turn both select switches shown below to low speed. For 10 Kcps, turn them to high speed. These switches are set at high speed for shipping.



Relations between mode select signal and external output

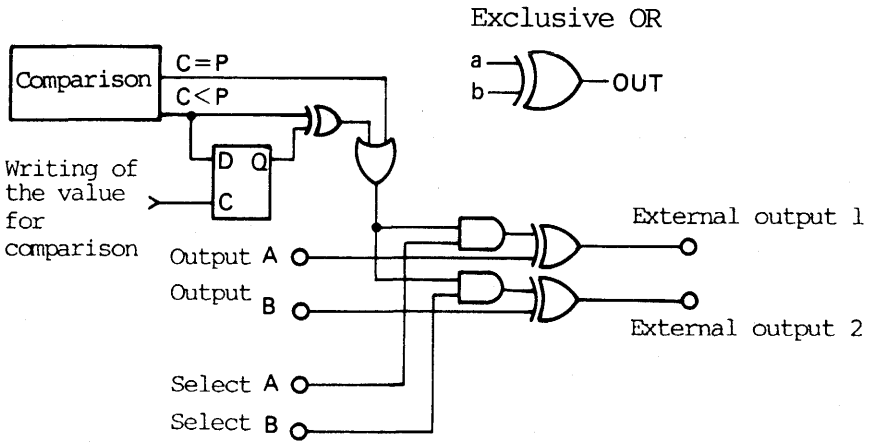
Mode select A or B	Output A or B	Result of comparison	External output 1 or 2	Operations
OFF	OFF	Ignored	OFF	When the mode select output from the CPU is turned OFF, the result of comparison is ignored and the external output becomes the same as output A or B from the CPU.
	ON		ON	
ON	OFF	Initial state (C < P) *	OFF	The result of comparison in the initial state is stored in memory. Under this condition, the external output will be the same as output A or B.
	ON		ON	
	OFF	Equal (C = P)	ON	The result of comparison is changed from the initial state. The external output will be sent out by reversing output A or B from the CPU.
	ON		OFF	
	OFF	Excess counting (C > P) *	ON	
	ON		OFF	

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* For addition, the initial condition is C < P because it usually starts from the conditions that the count value is 0 and the value for comparison is greater than 0.
For subtraction, the initial condition is C > P because it starts from the condition that the counter value is greater than the result of comparison.

In either case, the relation between output A or B, and the external output in the initial stage or when the count is equal or greater will be as shown above.

Output switching circuit composition



Exclusive OR logic

a	b	OUT
0	0	0
0	1	1
1	0	1
1	1	0

The result of comparison will be memorized in the D flip-flop to be checked with the changes from the initial condition.

Power source application

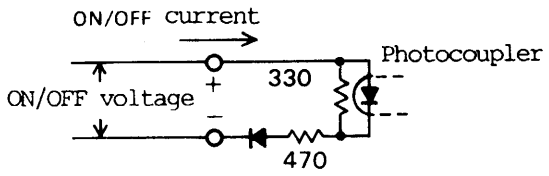
The moment power is applied or RUN mode is selected, both the counter and the register of the value for comparison will get an initial reset and will be set at 0000 with the result that the comparison signal for C = P is given.

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Input specifications

Item	Count input	Reset input
Applicable input signal source	Open collector output, than 20 V and 30 mA of	ON/OFF signal, and more dielectric strength
Minimum input pulse width	25 µS	100 µS (ON/OFF delay within 100 µS for each input)
Signal direction	ON / OFF Count made at falling of ON	ON Reset during the ON period
Power source voltage	12 VDC ±10%	12 VDC ±10%
ON current	10 - 25 mA (0 in this case)	10 - 25 mA (1 in this case)
OFF current	Less than 3 mA (1 in this case)	Less than 3 mA (0 in this case)
ON voltage	More than 7 V	More than 7 V
OFF voltage	Less than 3 V	Less than 3 V

Input circuit composition (count, reset)

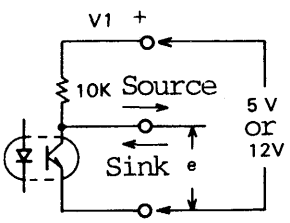


Circuit is independent and can be used either as the plus common circuit or minus common circuit.

The count input is shown as 0 for the condition when the input current is flowing and 1 when it is not flowing. Counting will then be made when the input current for addition or subtraction for counting is turned OFF, but the input current for addition or subtraction is always flowed.

BCD output specifications

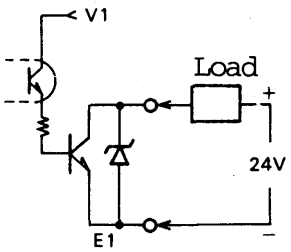
Item		Ratings		Circuit composition
Output type		Voltage output 1 = H / 0 = L		
Power source voltage		5 V ±5%	12 V ±10%	
Current consumption		Less than 10 mA	Less than 25 mA	
Allowable ripple		Less than 1%	Less than 3%	
Output current (source)				
Output voltage	3.5 V	0.1 mA	———	
	6 V	———	0.4 mA	
Output current (sink)				
Residual voltage	0.4 V	2 mA	———	
	1.0 V	———	3 mA	



e: Output voltage or residual voltage

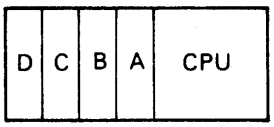
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External output specifications

Item	Ratings	Circuit composition
Output type	NPN open collector output	
Switching capacity	24 V, 0.3 A	
Residual voltage	Less than 0.4 V at 0.3 A	
Leakage current	Less than 50 µA at 40 V application	
Allowable peak voltage	Less than 45 V	
Induction load switching	No limit because of the built-in surge absorbing element	
Temperature derating	None up to + 55°C	

Counter number and I/O number assignment

- Counter numbers and I/O numbers will be changed where E-01Z is installed.
- E-01Z can be mounted only with the basic base.
- Numbers are assigned to E-01Z as a 16-point I/O module.



E-01Z can be installed in any of the slots such as A, B, C, and D, if it is the basic base.

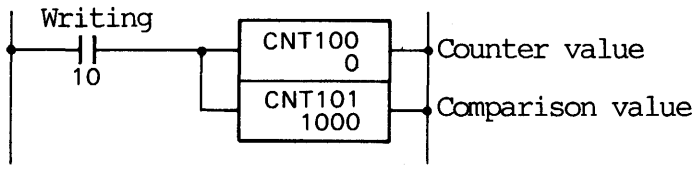
Description	Type of I/O signal	Installed location of the counter (see above drawing)			
		A	B	C	D
Setting of the writing value into the counter or the value for comparison will be written by the CNT command	Writing into the counter	CNT 100	CNT 102	CNT 104	CNT 106
	Setting of the value for comparison	CNT 101	CNT 103	CNT 105	CNT 107
Input signal to the CPU by the signal from E-01Z	C > P (greater than)	000	010	020	030
	C = P (equal)	001	011	021	031
	C < P (smaller than)	002	012	022	032
	Carry/borrow	003	013	023	033
I/O numbers in the right are exclusively used for the internal processing, user can not use.		004	014	024	034
		005	015	025	035
		006	016	026	036
		007	017	027	037
Signals to be given from the CPU to E-01Z by the output command	Output A	100	110	120	130
	Mode select A	101	111	121	131
	Output B	102	112	122	132
	Mode select B	103	113	123	133
I/O numbers in the right are exclusively used for the internal processing, user can not use.		104	114	124	134
		105	115	125	135
		106	116	126	136
		107	117	127	137

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Counter value writing

The count value of the counter can be set at any value.
But "0" is normally written after resetting.

* To enter the counter value and the comparison value, both writing must be made at the same time.

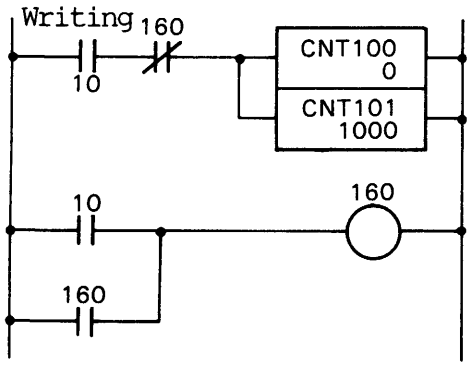


Program

STR	10
CNT	100
	0
CNT	101
	1000

Writing will be made at rising of write signal 10.
The counter can continue its counting during the writing operation.

* Method of one-scan writing
If the self-retentive relay rung is made after the counter write instruction and writing is inhibited at the normal closed contact, one-scan writing will be completed.

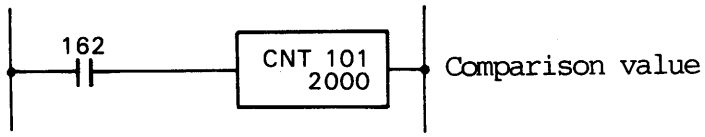


Program

STR	10
AND NOT	160
CNT	100
	0
CNT	101
	1000
STR	10
OR	160
OUT	160

Comparison value writing

As far as the operation is concerned there will be no problemeven if writing of comparison value is processed in one scan or in sequence. Also the comparison value can be individually written.



Program

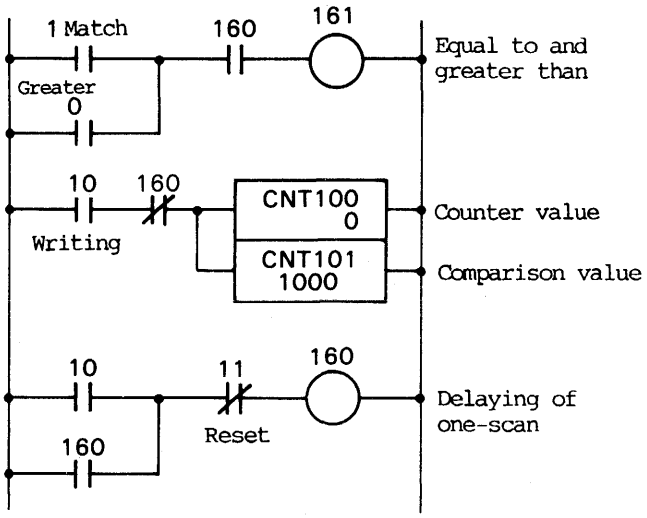
STR	162
CNT	101
	2000

Contact 162 is the contact to be ON after the matching operation of the first counter value and comparison value is processed.

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Match signal program

The match signal program will be written before writing the counter and comparison value setting programs. Because it takes one-scan time before the comparison output is changed from the time when the counter and comparison values are written.



Program

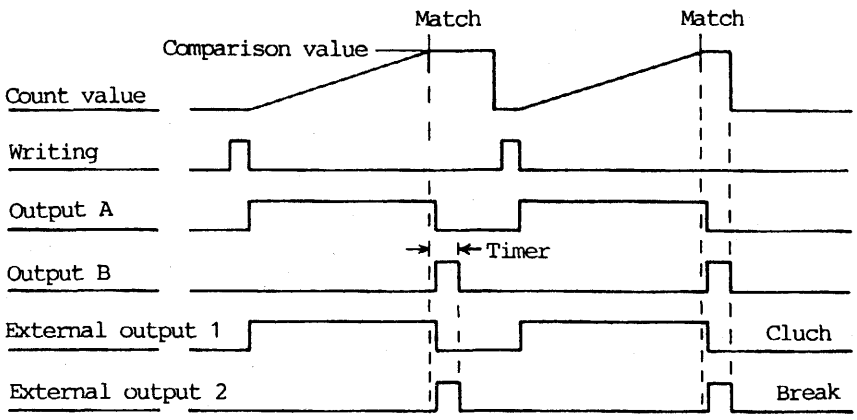
STR	1
OR	0
AND	160
OUT	161
STR	10
AND NOT	160
CNT	100
	0
CNT	101
	1000
STR	10
OR	160
AND NOT	11
OUT	160

* Comparison output when the power source is turned on and RUN is started.

The counter and comparison register values at this time are at "0000." Then it is necessary to include a contact to be ON after completion of writing (160 in the above example) for the match output program.

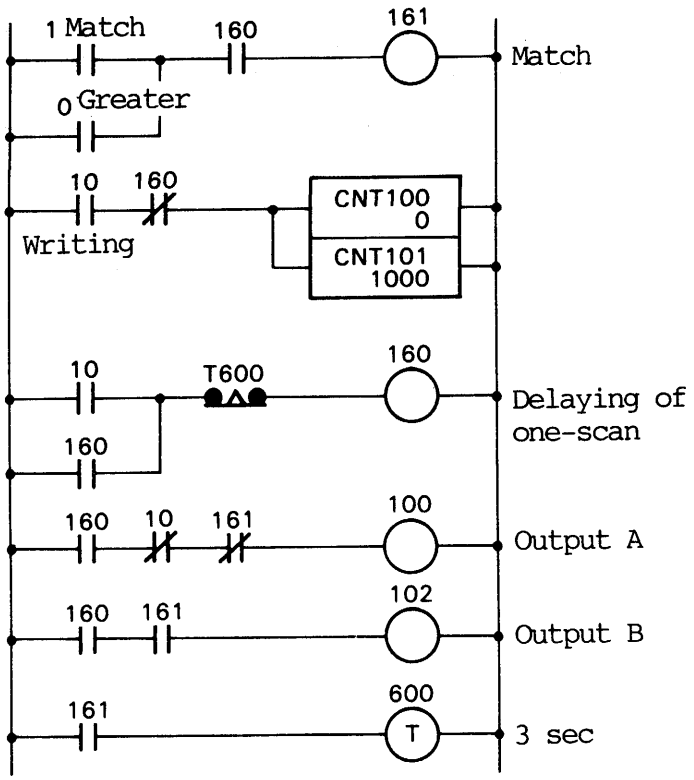
Example 1: Positioning of the one-stage preset counter

Time chart



The mode selection for the output change circuit should be OFF.
Thus the operation will be the same for output A and output B from the CPU and for external output 1 and external output 2.
The program processing will be delayed for the time to change from matching to external output 1 and external output 2.

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Program

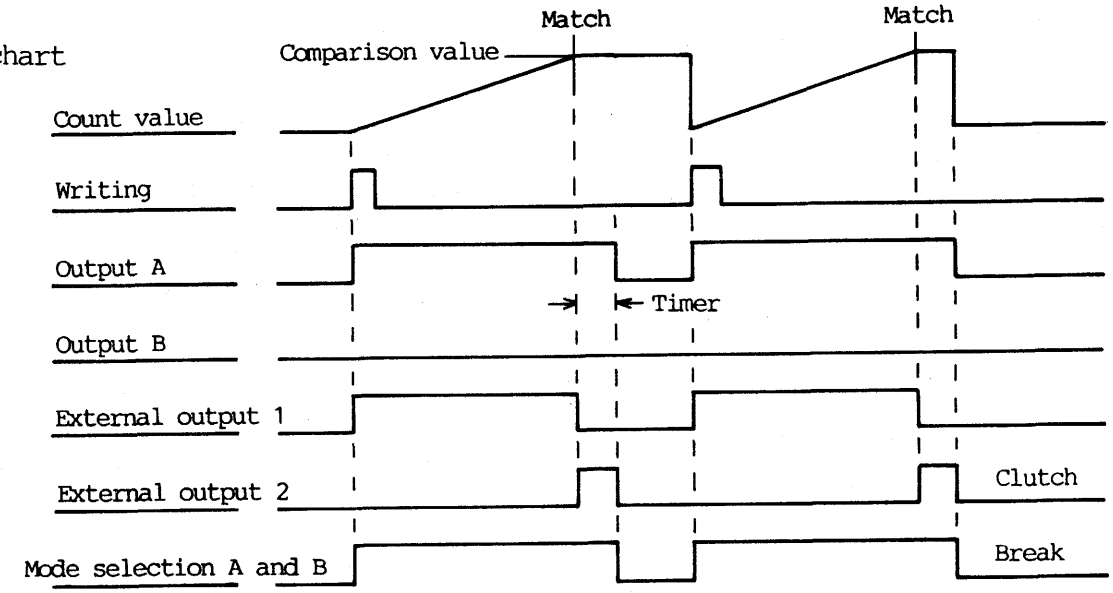
STR	1
OR	0
AND	160
OUT	161
STR	10
AND NOT	160
CNT	100
	0
CNT	101
	1000
STR	10
OR	160
AND NOT TMR	600
OUT	160
STR	160
AND NOT	10
AND NOT	161
OUT	100
STR	160
AND	161
OUT	102
STR	161
TMR	600
	3

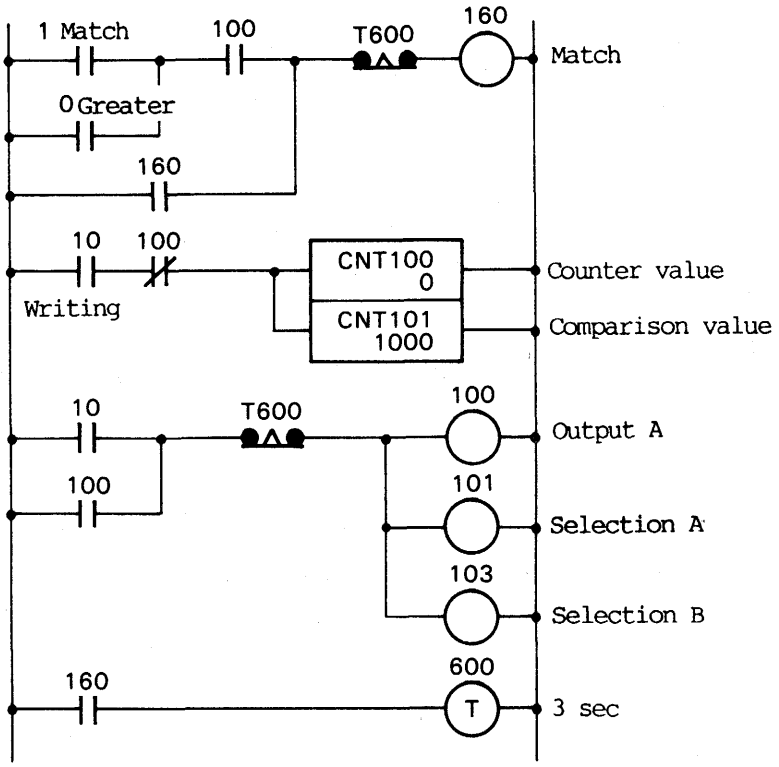
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Example 2: Positioning of the one- scan preset counter

The basic operation of this example is the same as example 1.
Since the mode selection to the output circuit, however, is made, the external output will be controled because the output change circuit in the module will be converted without passing the inside of CPU internaly when the counter value matches the comparison value. Because of the feature as mentioned above, there will be no delay for program processing as in the case of example 1.

Time chart





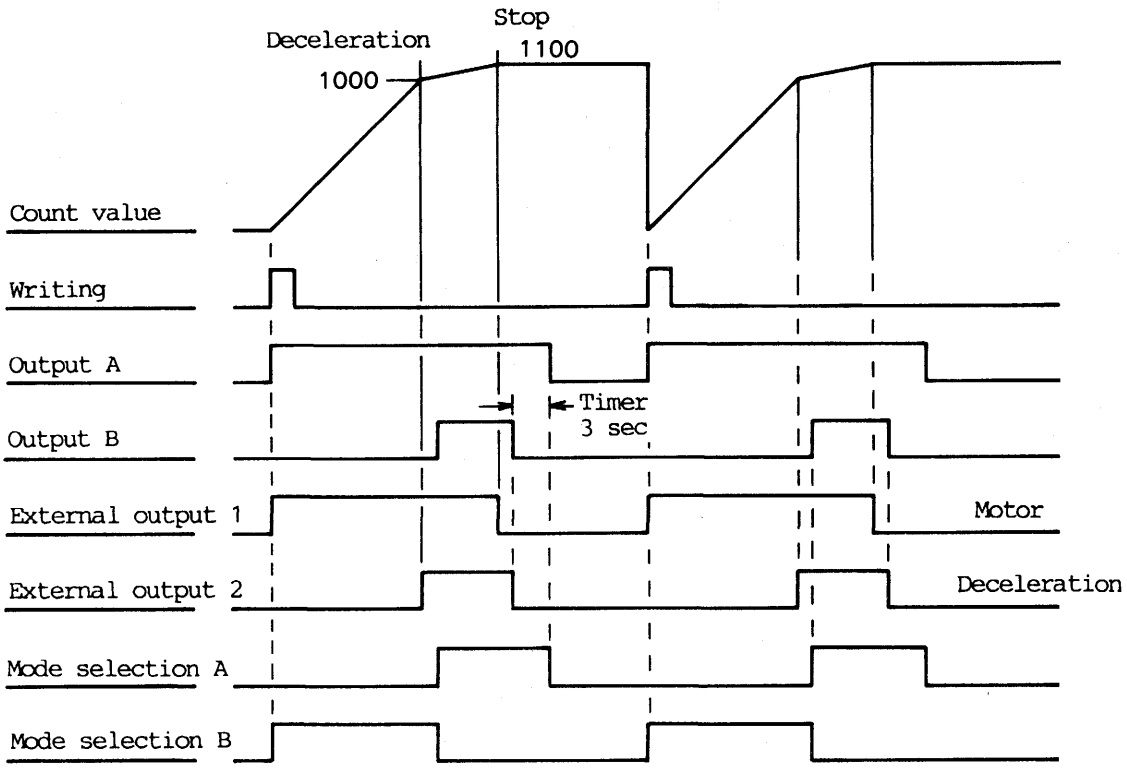
Program

STR	1
OR	0
AND	100
OR	160
AND NOT TMR	600
OUT	160
STR	10
AND NOT	100
CNT	100
	0
CNT	101
	1000
STR	10
OR	100
AND NOT TMR	600
OUT	100
OUT	101
OUT	103
STR	160
TMR	600
	3

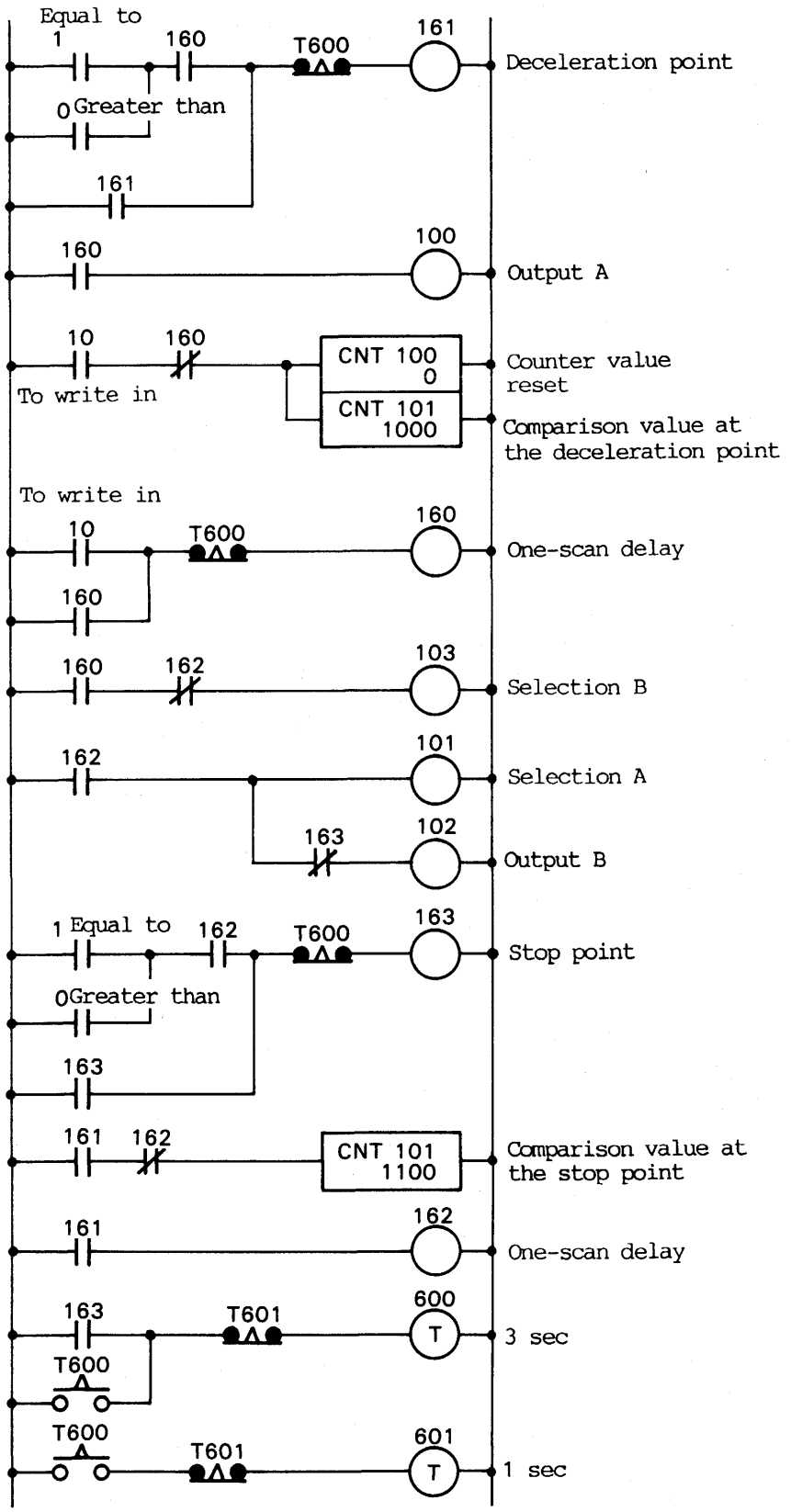
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Example: Two-stage preset deceleration positioning

External output 1 and external output 2 will be turned ON and OFF without delay by selecting modes both for the points to decelerate and to stop.



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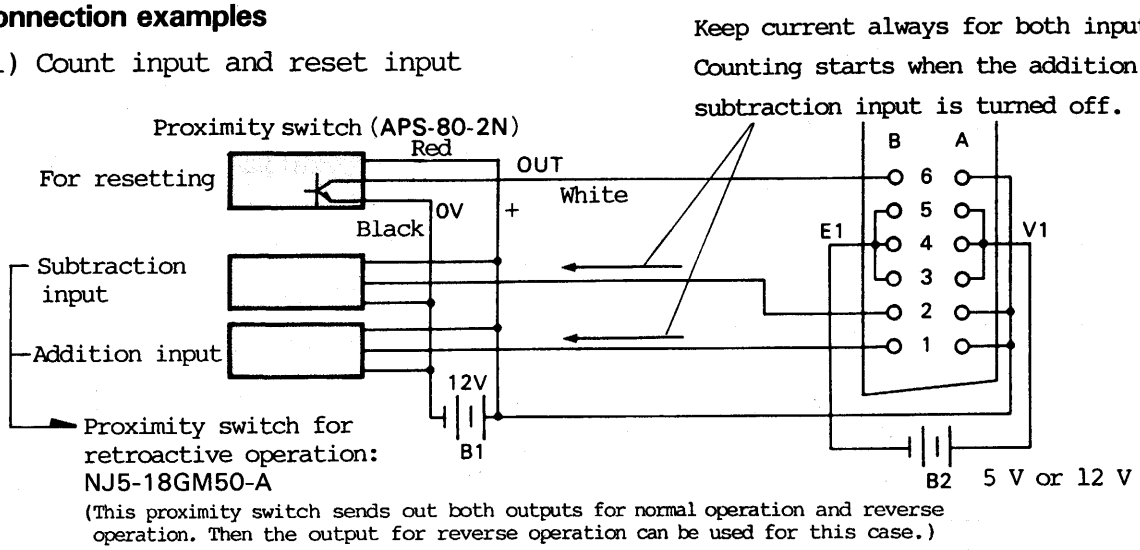
Program

STR	1
OR	0
AND	160
OR	161
AND NOT TMR	600
OUT	161
STR	160
OUT	100
STR	10
AND NOT	160
CNT	100
	0
CNT	101
	1000
STR	10
OR	160
AND NOT TMR	600
OUT	160
STR	160
AND NOT	162
OUT	103
STR	162
OUT	101
AND NOT	163
OUT	102
STR	1
OR	0
AND	162
OR	163
AND NOT TMR	600
OUT	163
STR	161
AND NOT	162
CNT	101
	1100
STR	161
OUT	162
STR	163
OR TMR	600
AND NOT TMR	601
TMR	600
	3
STR TMR	600
AND NOT TMR	601
TMR	601
	1

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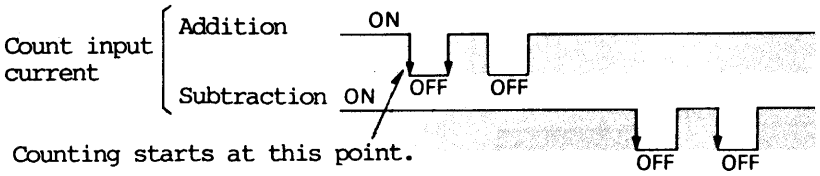
Connection examples

(1) Count input and reset input



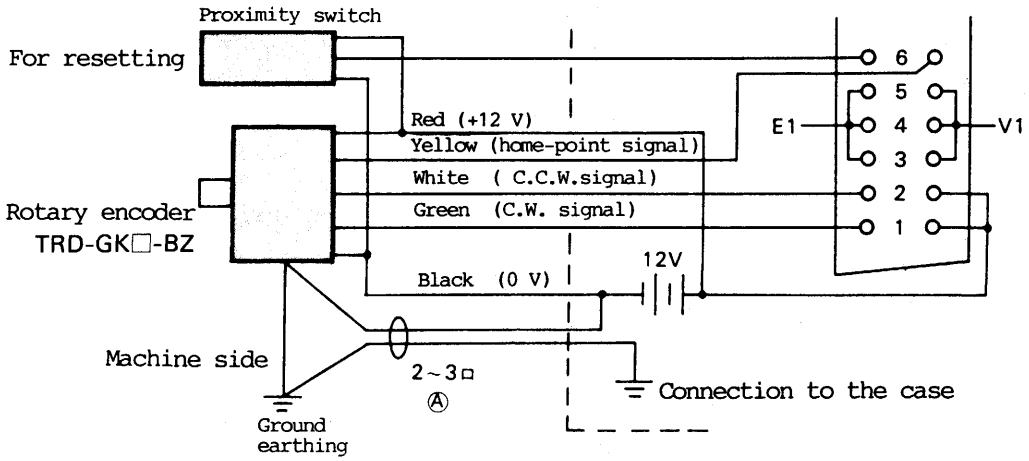
(This proximity switch sends out both outputs for normal operation and reverse operation. Then the output for reverse operation can be used for this case.)

B1 and B2 are used in common if the voltage of power source B2 is 12 V and there is no noise induction in the input circuit.



For use only for addition or subtraction, connection should be made to keep the current always in the input not in use.

(2) Resetting by the encoder home-point pulse and AND condition of the proximity switch



Note: 1. The independent power source is recommended for the use of the encoder and proximity switch because of noise problems.

2. A switching power supply is not recommended for this use, because the AC line and the output line are grounded for high-frequency waves.

3. The wiring in (A) is used to reduce the voltage difference between the machine and the control panel to greatly increase noise immunity. If even in this method a voltage difference is still detected, isolate the area of metal of the encoder from

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the machine for installation and ground it near the minus terminal of the power supply.

4. To avoid noise induction, separate wiring of the input circuit (including a reset circuit) from other wires.

7-6. E-01AD: Analog input module

This is a module to convert the analog signal into the digital signal.

- The independent 4-channel analog input signal will be converted into the 8-bit binary signal by the time-sharing operations, and the output will be made for one channel at a time for each scanning of PC.
- The input signal is given by the voltage input method of 1 - 5 V, but can be changed to the current input method of 4 - 20 mA by connecting short pins on the module.

Specifications

Item	Ratings
Number of channels	4
Input range	1 - 5 V, 4 - 20 mA
Input impedance	1 MΩ min. (voltage input) and 250 Ω (current input)
Resolution	1/256
Output	8-bit binary, 4-bit channel status
Linearity	±0.8% max.
Total tolerance	1% max. under 25°C
Accuracy/temperature	±70 PPM/°C max.
Conversion	Sequential comparison
Conversion time	2 ms max.
Absolute input range	Voltage input: 0 - +10 V, current input: 0 - +30 mA
Input	Differential input
Operation display	8-bit data display, channel selection display, display channel number
External power source	+24 V, ±10%, 65 mA max.
Internal power source	9 V, 25 - 55 mA (power supply on the base)
Weight	200 g

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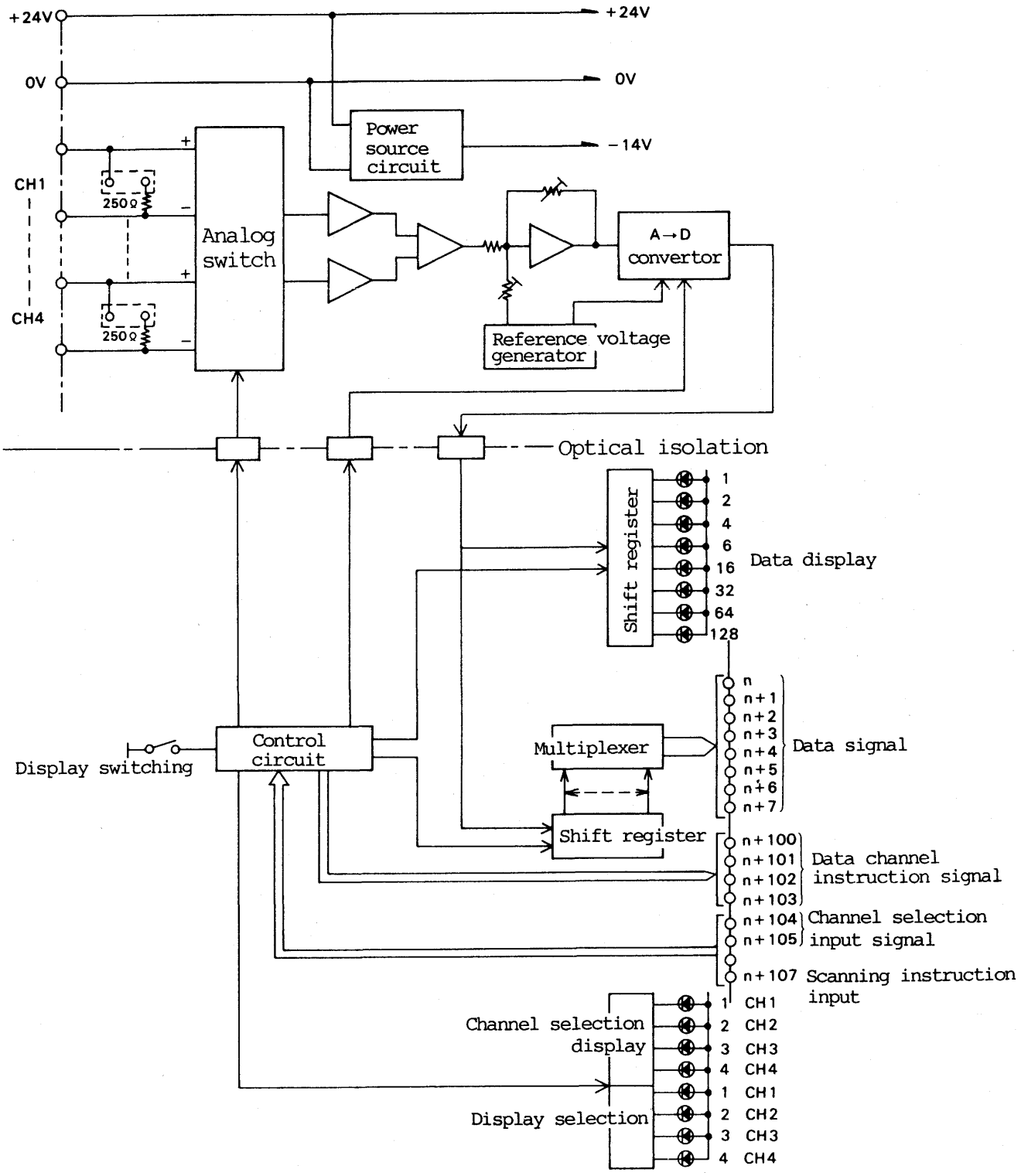
Address assignment

Address		Weight		Input/output
First No. n	DATA 0 BIT	1		
n+1		2		
n+2		4	Conversion from channel 1 to channel 4. Sequential output of data by one channel per scan.	Input when observed from the PC (SR-21) side.
n+3		8		
n+4		16		
n+5		5		
n+6		64		
n+7		128		
n+100	CH 1			
n+101	2		Signal to indicate data source of the channel.	
n+102	3			
n+103	4			
n+104	0 1 0 1 ┐ Channel			
n+105	0 0 1 1 ┘ selection			Output when observed from the PC (SR-21) side.
n+106	CH 1-2-3-4 Not in use			
n+107	"0": Channel scan stop "1": Channel scan			

Note. "n" is the first I/O number to be decided by location to install a module.

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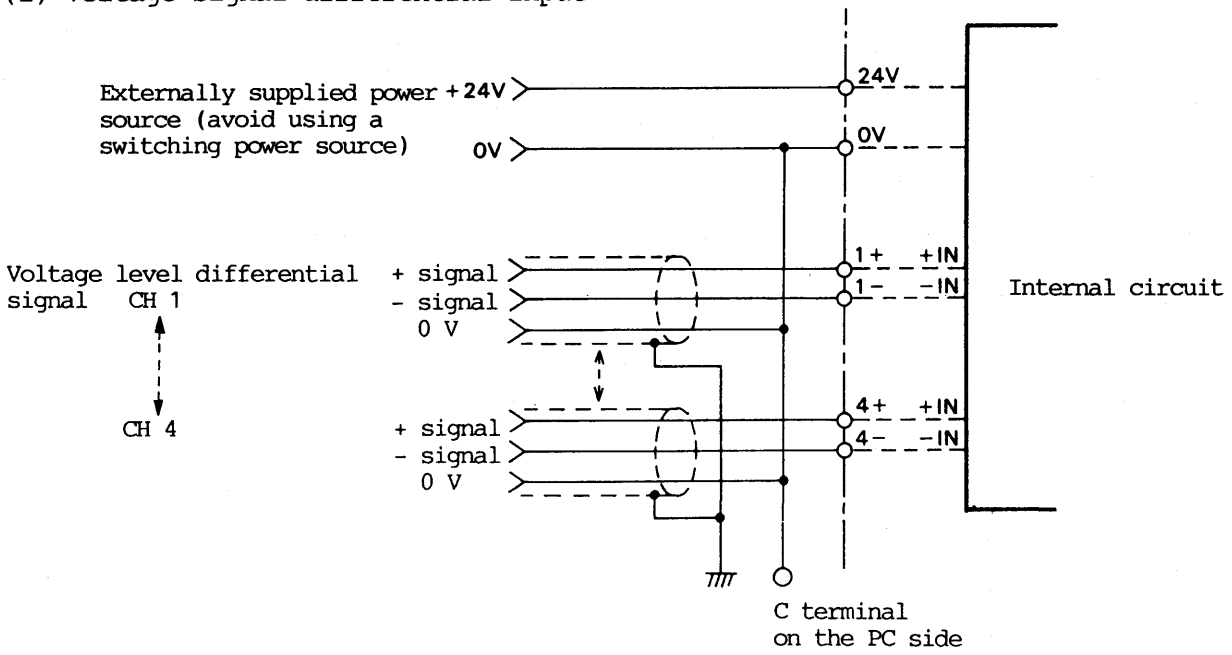
Block diagram



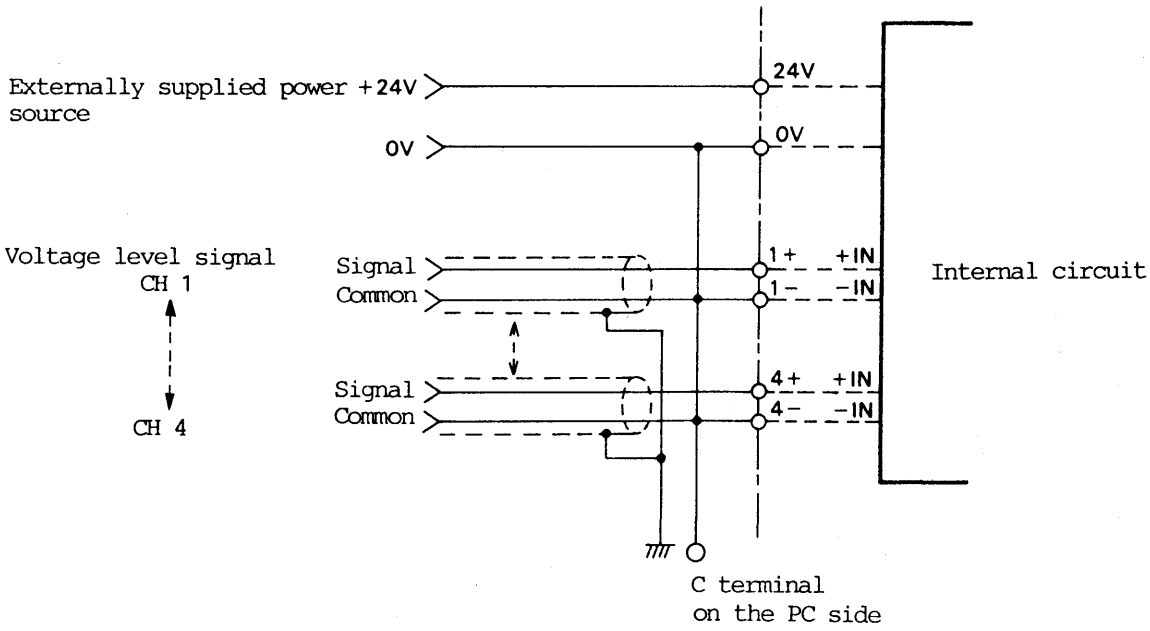
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External connection example

(1) Voltage signal differential input



(2) Voltage signal common input

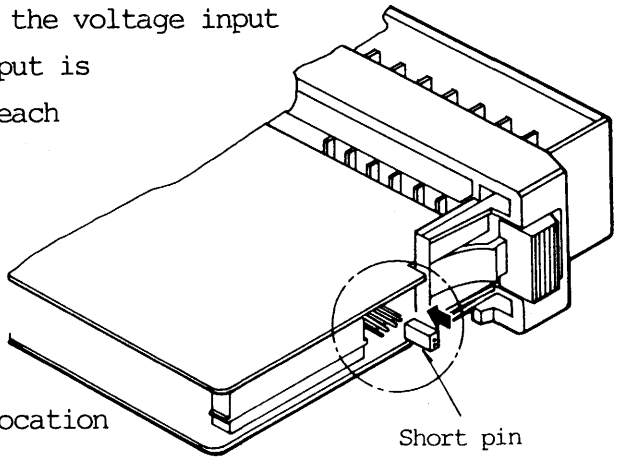


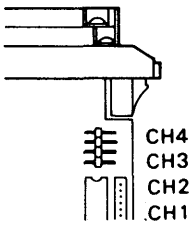
(3) Connect the attached short pin if the external input is used for the current signal differential input or current signal common input.

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Switching for the voltage input or current input is possible for each channel.

Connect the short pin in the circled location of the drawing.





The short pins are arranged in such a way that CH 1 is placed on the bottom and CH 4 on the top.

Notes for external connection

(1) Avoid using a switching method as much as possible for applying a +24 V power source supplied from the outside, but a series method is recommended. The switching method may be a cause of generating noise.
Avoid using the same power source for +24 V. It should be an independent power source.

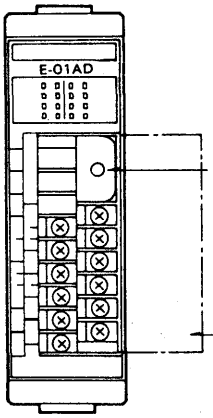
(2) Grounding for 0 V line and the shielded wire should be made at one point.

(3) The CH input terminal not in use should be grounded or switched for the use of the current input method by connecting it with the short pin.

(4) Use the separate shielded wire of the analog signal input for channel 1 to channel 4.

(5) In the case of the voltage or current differential input, a voltage range of ⊕ signal must be from 1 V to 5 V. The exceeded voltage from this range may be the cause of defective accuracy of data conversion.

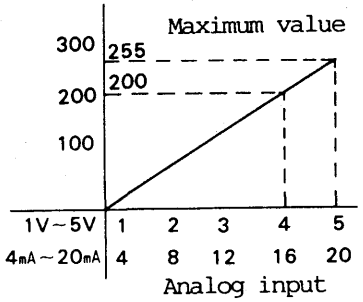
Face plate arrangement



● Display channel

	Channel indication	Data display channel	Data display	
Display channel	1	1	1	16
	2	2	2	32
	3	3	4	64
	4	4	8	128

Example of 200 bits:
4.137 V / 16.5 mA

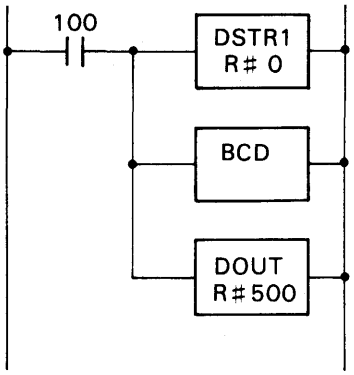


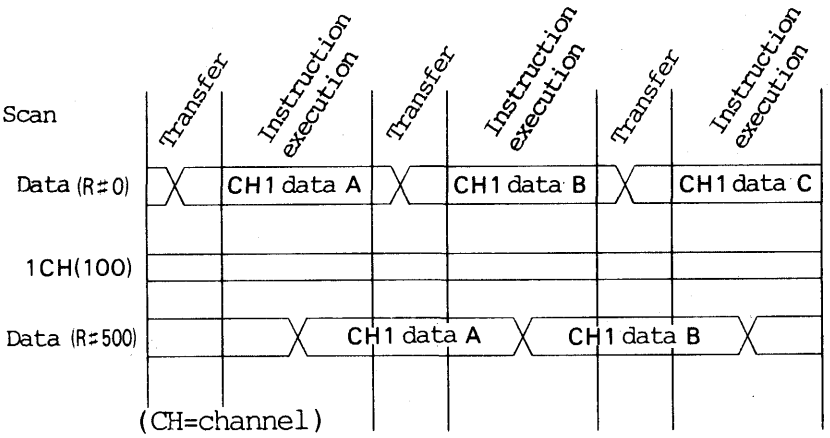
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Program and operation

(1) In the case of only using CH 1

(The example is for the I/O number when E-01AD is installed in the #1 slot.)

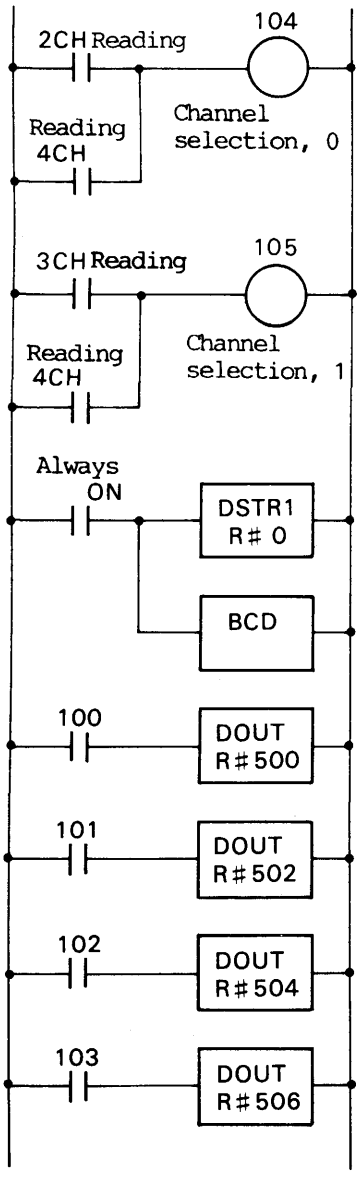


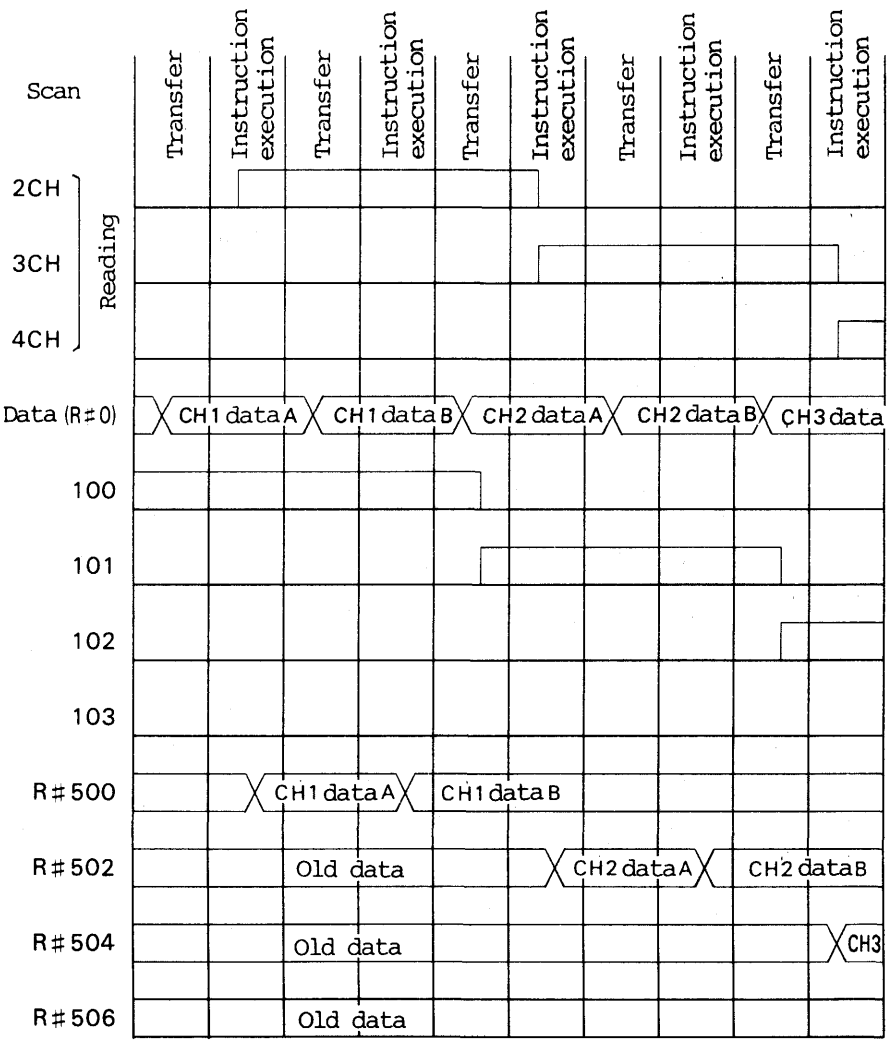


(2) Reading based on the read instruction of each channel

(It is impossible to read more than 2 channels at the same time.)

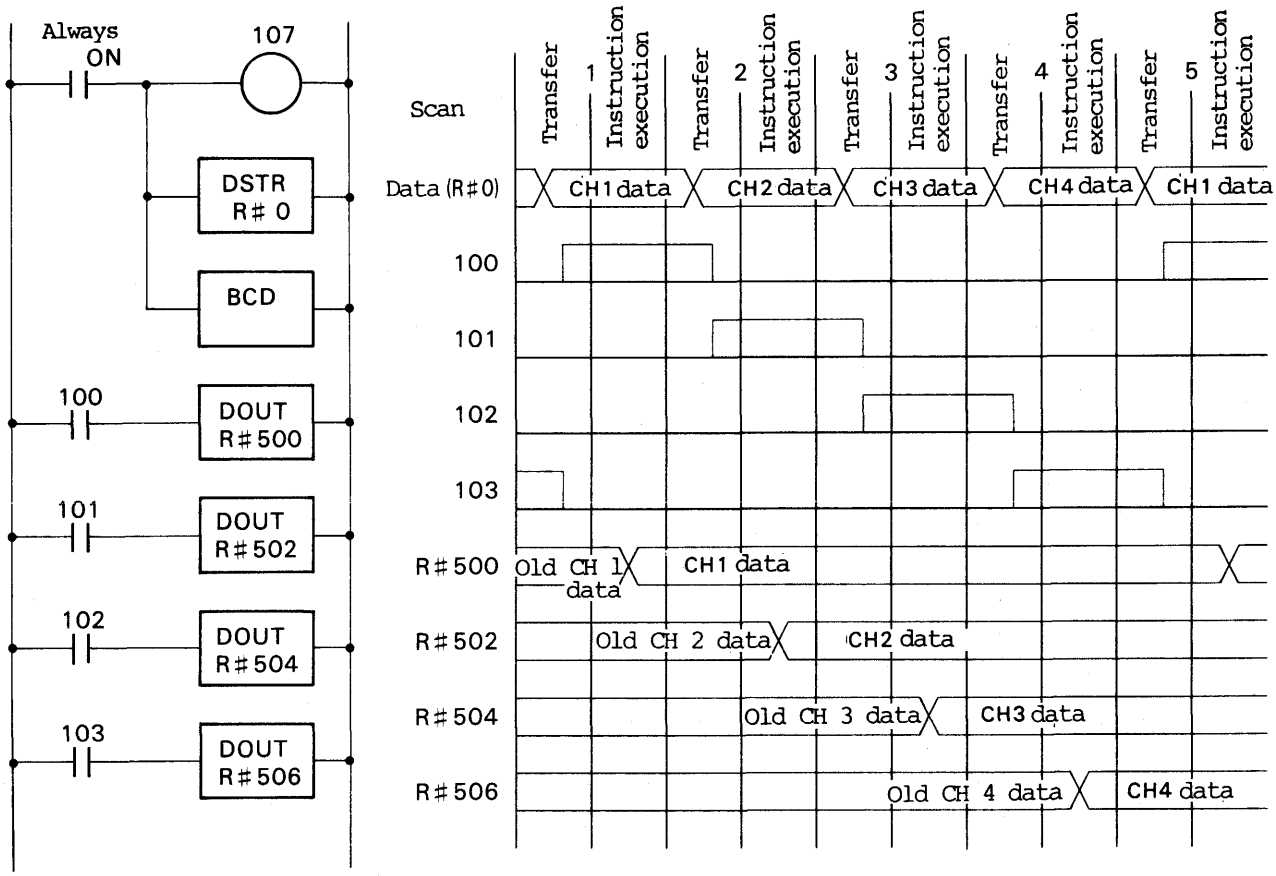
If the read instruction is not given, the data for 1 channel will be read.





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(3) In the case of reading all channels by the automatic scanning



(4) How to use the program

- For using the program only for one channel, connect the analog input with CH 1 and use the program as mentioned in the above item (1).
- For using the program for many channels, the program should be processed by the method as mentioned in the above item (2) to read the data by specifying the channel when the data is required, or by the method as mentioned in the above item (3) to always read the data. But avoid using these two methods at the same time.

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7-7. E-02AD: Analog input module

This is an A/D convertor to input the analog signal into the PC in the digital signal of 12 bits.

- It is possible to use the analog signal as an input signal in a range of 1 V to 5 V with 4 mA to 20 mA of current and 0 V to 10 V. It is also possible to set it for any range by adding an external auxiliary resistance when the input of 0 V to 10 V is specified.

Specifications

Item	Ratings		
Number of inputs for exclusive use: 16			
Number of circuits and resolution: 1 circuit, 1/4096 (12 bits)			
Input signal	Voltage input 1 - 5 V	Voltage input 0 - 10 V	Current input 4 - 20 mA
Absolute input signal range	± 15 V max.	± 15 V max.	± 30 V max.
Input impedance	About 1 MΩ	About 1 MΩ	250 Ω
Input type	Differential input		
	If the external resistance is added under the 0 - 10 V of input specification, it is possible to use the input signal as the current input of 0 - 2 mA, 0 - 5 mA, 0 - 10 mA, and 0 - 20 mA.		
Linearity	± 0.1% max.	In the case of maximum signal	
Accuracy/temperature	± 0.007 % /°C max.		
Total tolerance	± 0.4 % under 25°C		
Conversion	Differential method		
Conversion time	41 ms max. (50 ms + scanning time of PC in the case of the time for repetition)		
Rate for removing a normal mode ripple	About 6 dB in the case of 200 Hz		
Rate for removing a common mode ripple	More than 60 dB in the case of 60 Hz		
Operation display	Display by the binary code of the output value by digital conversion (12 bits)		
Insulation	Photocoupler		
External power source	Voltage: Within ±15V ± 5% with less than 1% of allowable ripple noise Current: Less than 70 mA		
Current consumption of internal 9 V circuit	55 mA max.		
Weight	200 g		

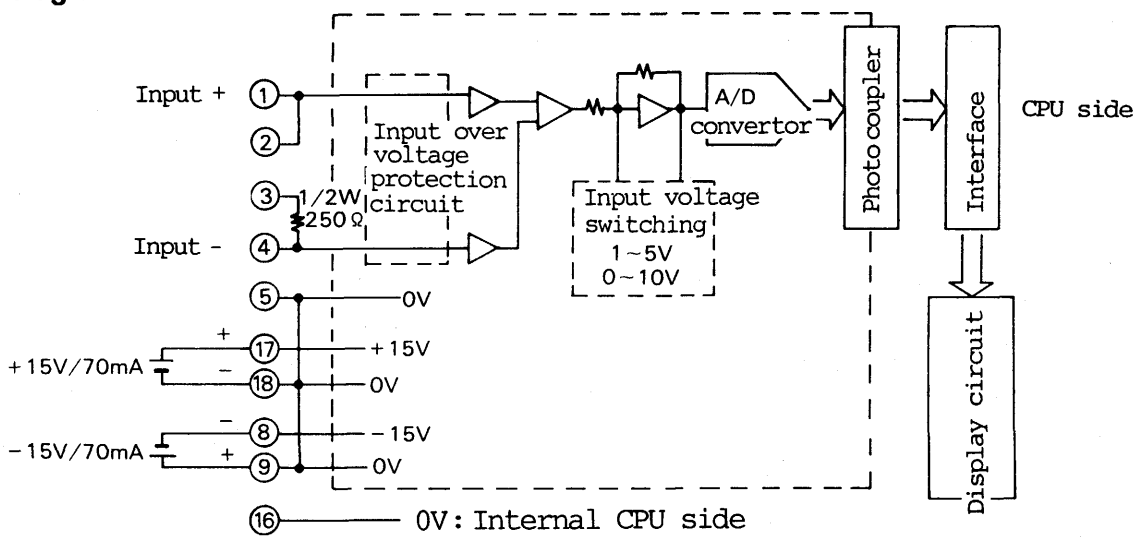
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Address assignment

Address	Data weight	Address	Data weight
n+0	1	n+100	256
n+1	2	n+101	512
n+2	4	n+102	1024
n+3	8	n+103	2048
n+4	16	n+104	——
n+5	32	n+105	——
n+6	64	n+106	——
n+7	128	n+107	——

Note: n is the first I/O number to be assigned according to the location of the installed module.

Block diagram



The terminal numbers are arranged from 1 to 9 from top to bottom on the left side and from 10 to 18 from top to bottom on the right side.

Notes for handling

(1) Avoid using the switching type of power source as much as possible. (The primary side and the secondary side of the power supply are connected through the filter capacitor, and the module tends to receive influence of the induction noise.)

(2) Avoid using the same power source of ±15 V with other loads. The combined use of the power source will be the cause of a bad influence to E-02AD.

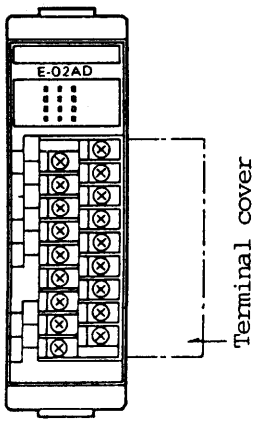
(3) The terminal (16) is connected to the 0 V terminal of the internal CPU, but it should not be normally connected. It is sometimes possible to

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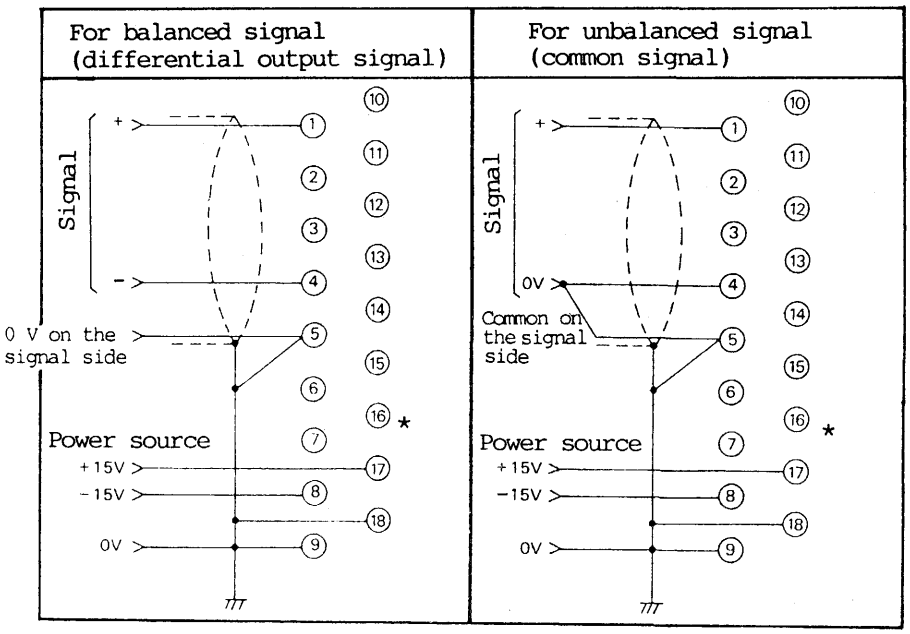
increase the S/N ratio of E-02AD or noise immunity of SR-21 by connecting the terminal (16) with the 0 V terminal (Terminal (18) and terminal (9)) on the ±15 V power supply.

(4) Do not touch the potentiometer on the print board for adjustment.

Face plate

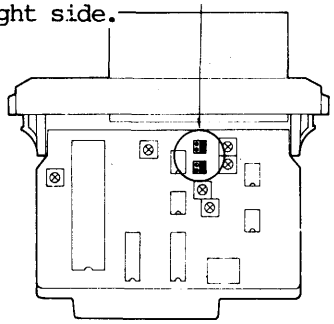
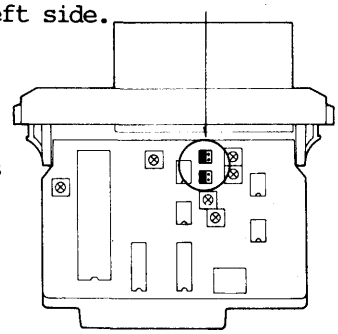


External connection



* 0 V on the internal CPU

Locations to set a short pin for terminal connection to meet the input specification

Input specification	Between terminals (2) and (3)	External auxiliary resistance	Setting location of short pin
4 ~20mA	To be shorted	———	Set both short pins on the right side. 
1 ~ 5 V	To be opened	———	
0 ~ 2 mA	To be opened	5KΩ ±0.1% 1/4W	Set both short pins on the left side. 
0 ~ 5 mA		2KΩ ±0.1% 1/4W	
0 ~10mA		1KΩ ±0.1% 1/4W	
0 ~20mA		500Ω ±0.1% 1/2W	
	(By adding resistances between terminals 1 and 4 as written in the above, the current input may be used with the generation of 0 V to 10 V.)		
0 ~10V	To be opened	———	

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7-8. E-01DA: Analog output module

This is a module to convert the digital output into the analog signal.

- The 8-bit binary digital signal is output as the analog signal of 0 V to 10 V and 4 mA to 20 mA by conversion.
- The module can be operated independently with 2 circuits of the above functions.

Specifications

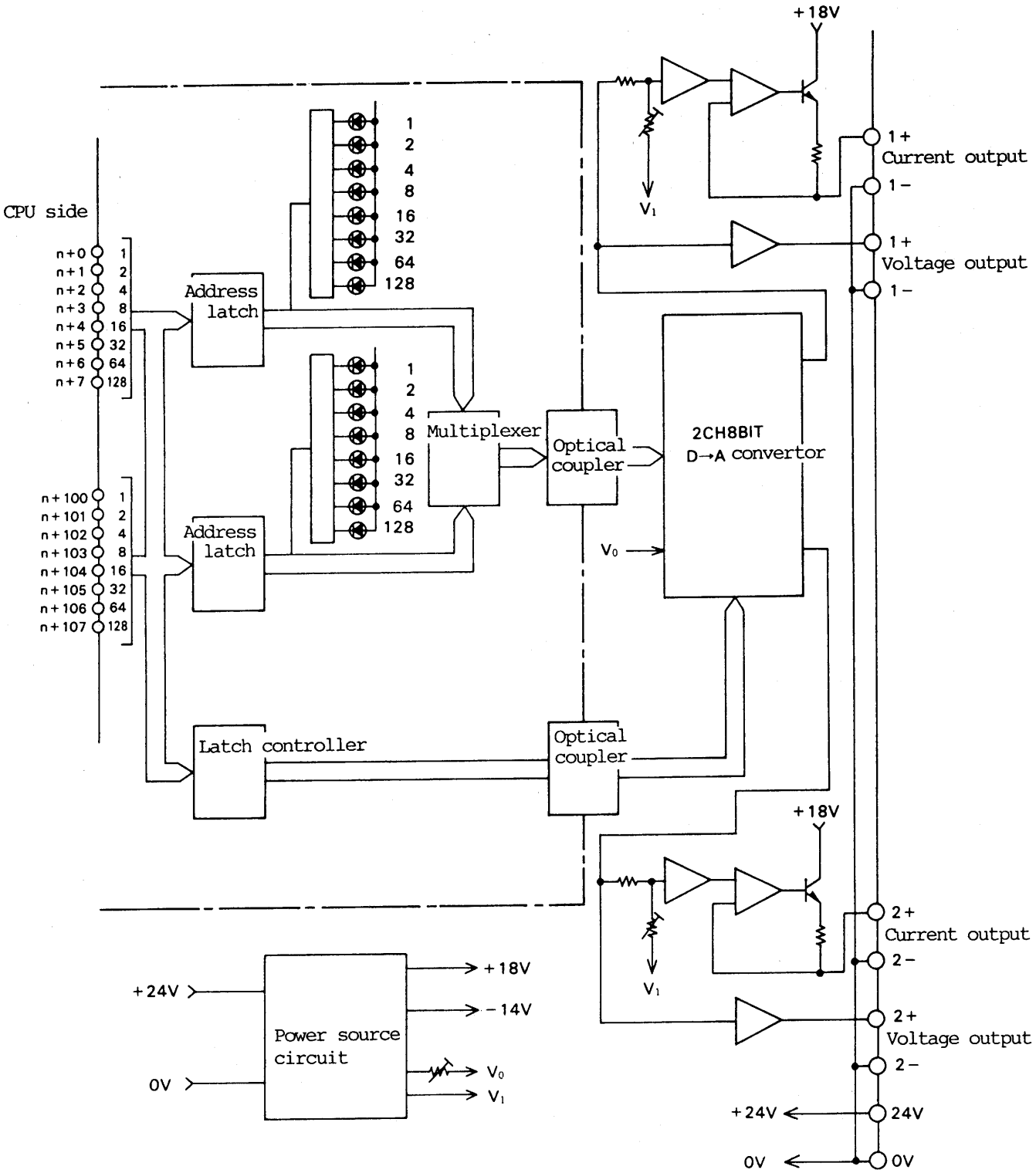
Item	Ratings
Number of channels	2
Output signal	0 V - +10 V, 4 mA - 20 mA (source output)
Output impedance	0.5Ω max. (voltage output)
Output current	10 mA max. (voltage output)
External resistance	550Ω max., 5Ω min. (current output)
Resolution	1/256
Input data	8-bit binary code
Accuracy	± 0.4% max. under 25°C
Accuracy/temperature	± 50 RPM/1°C max.
Conversion time	100 µs max.
Operation display	8-bit binary LED operation status display (for 2 channels)
Start of conversion	Start by the PC program
External power source	+ 24 V, maximum 170 mA, ±5% of stability
Internal power source	9 V (power supply on the base), maximum 80 mA

Address assignment

Address	Output		Weight
n+0	CH1	BIT 0	1
n+1		1	2
n+2		2	4
n+3		3	8
n+4		4	16
n+5		5	32
n+6		6	64
n+7		7	128
n+100	CH2	BIT 0	1
n+101		1	2
n+102		2	4
n+103		3	8
n+104		4	16
n+105		5	32
n+106		6	64
n+107		7	128

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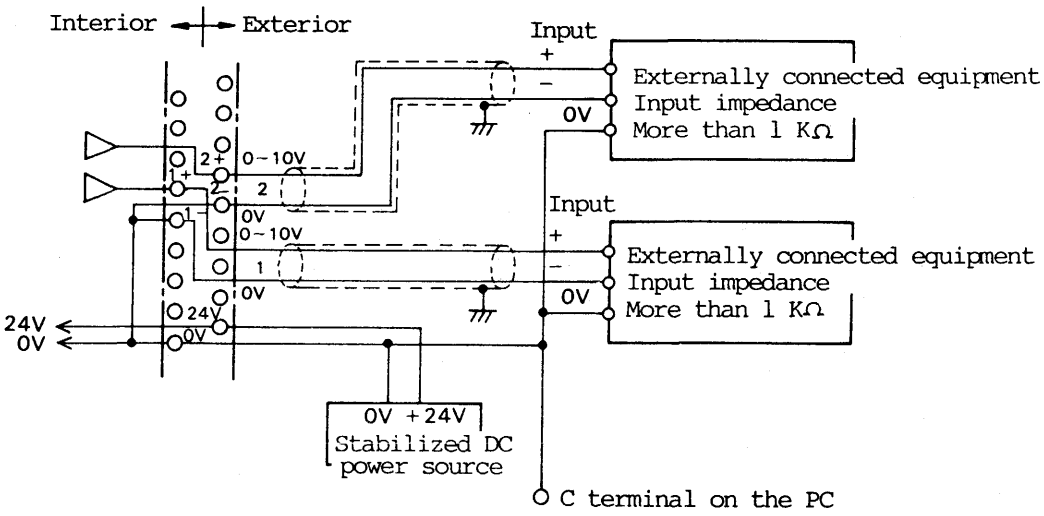
Block diagram



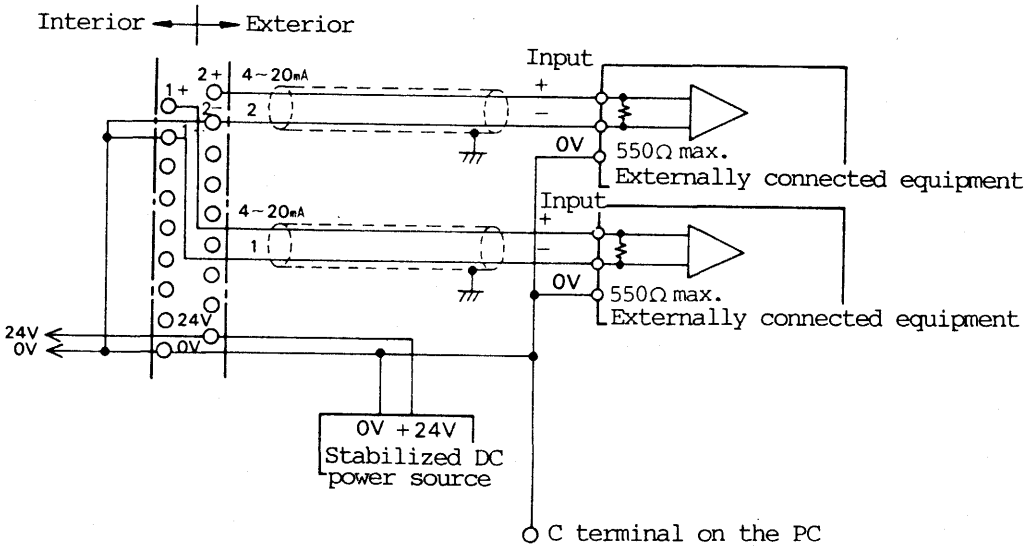
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Example for external connection

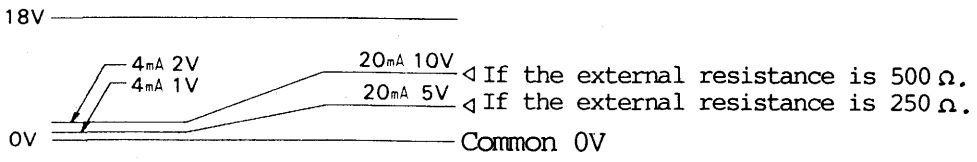
(1) Voltage output



(2) Current output (for connecting with the common line)

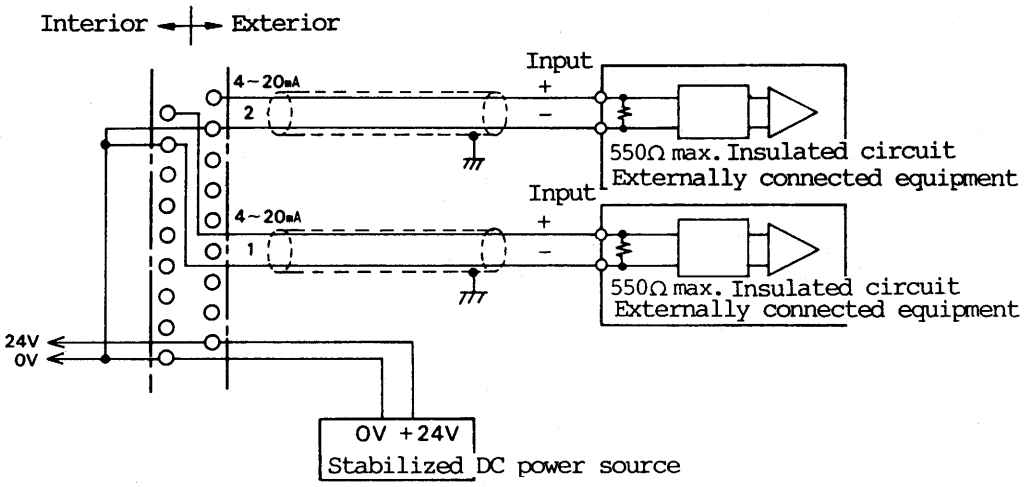


Note: Use the equipment with the voltage capacity of more than the input voltage range shown below. The input voltages to the common line on the externally connected equipment are as shown below if the common lines are connected.
If the current output terminal is not connected with the 0 V terminal, the voltage is 18 V.



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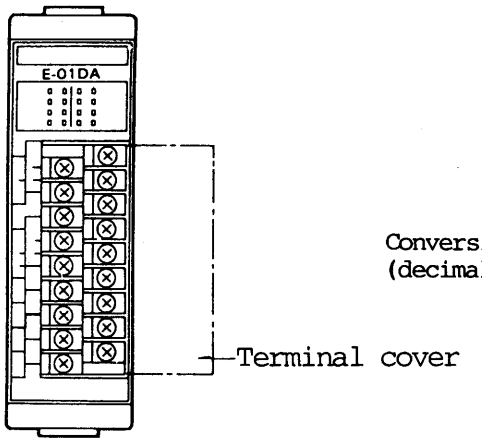
(3) Current output (if the input of the connected equipment is the isolated type)

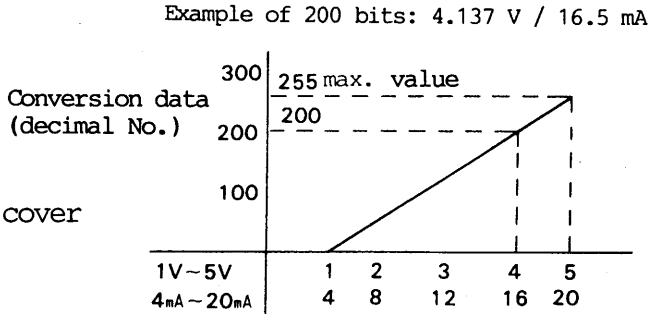


- Note for the externally connected equipment

  Avoide using the switching power supply for the stabilized DC power source to externally supply as much as possible, but use the linear power supply.

Face plate arrangement



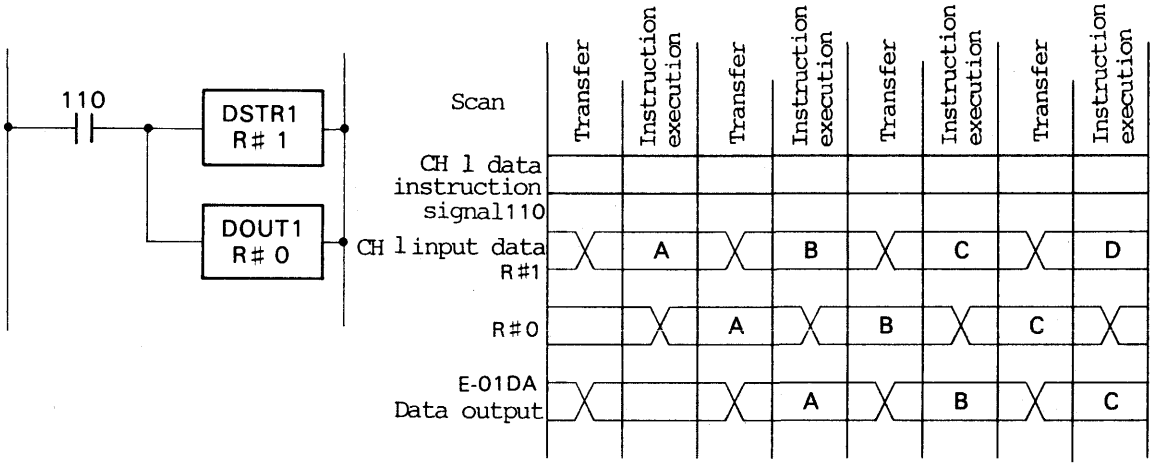


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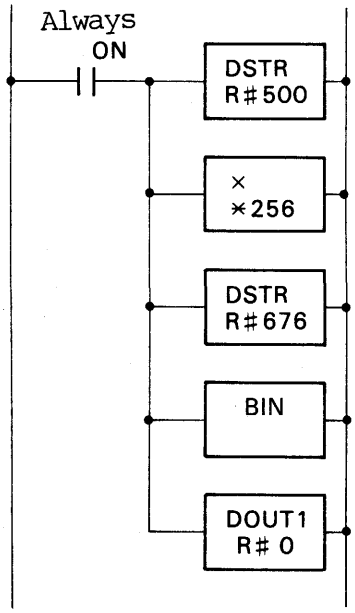
Program and operation

(The example is for the I/O number when E-01DA is installed in #1 slot.)

Example 1:
The output is given by the same ratio of the analog signal input of E-01AD (under the condition that E-01AD is installed in #2 slot).



Example 2:
Output of the data to change from 0 to 9999 into E-01DA



* Read the data for the variation from 0 through 9999.

* Multiply the data of R#500 by 256 first to calculate as below: $(0 - 9999) \times \frac{256}{10000}$

* The answer is multiplied by 1/10,000 by reading 4 digits (from the 5th digit to the 8th digit) of 8 digits of the answer.
The data 0 through 9999 will change to the data 0 through 255.

* Convert the answer into the binary code.

* Output the answer into CH 1 of E-01DA.

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7-9. E-02DA: Analog output module

This is a D/A convertor to output the analog signal of 0 V to 10 V and 4 mA to 20 mA by converting a binary signal of 12 bits of the PC.

Specifications

Item	Ratings	
Number of outputs to exclusive use: 16		
Number of circuits and resolution	1 circuit, 1/4096 (12 bits)	
Output signal	Voltage output: 0 - 10 V	Current output: 4 - 20 mA
Output voltage	----------	11 V min.
Output impedance	0.5Ω max.	----------
Output current	5 mA max.	----------
Load resistance	2 KΩ min.	5 - 550Ω
Output type	Unbalanced	Unbalanced
Linearity	± 0.1 % max.	Under the full-scale condition
Accuracy/temperature	± 0.0007 %/°C	
Total accuracy	± 0.2 % max. (under 25°C)	
Conversion time	1 ms max.	
Operation display	12-bit binary LED operation status display	
Insulation	Photocoupler	
External power source	Voltage: ±15 V within 5%, less than 1% of allowable ripple, less than 80 mA of current consumption	
Current consumption of internal 9 V circuit	80 mA max.	
Weight	200 g	

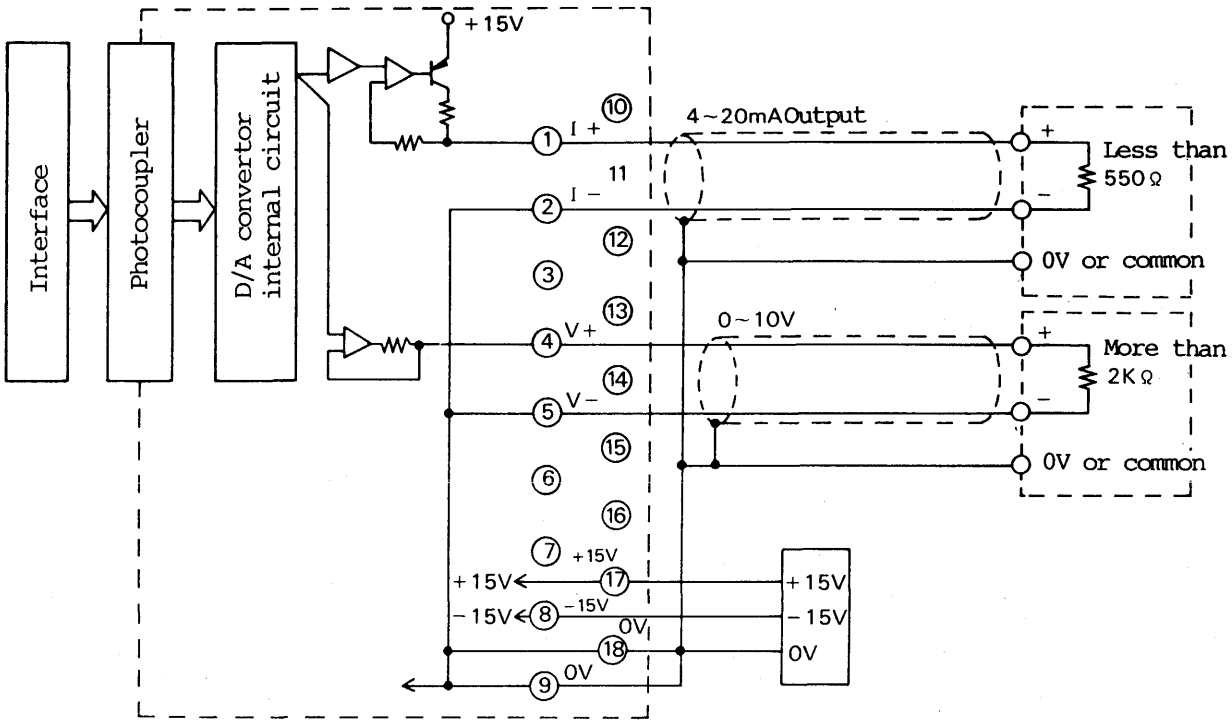
Address assignment

Address	Data weight	Address	Data weight
n+0	1	n+100	256
n+1	2	n+101	512
n+2	4	n+102	1024
n+3	8	n+103	2048
n+4	16	n+104	——
n+5	32	n+105	——
n+6	64	n+106	——
n+7	128	n+107	——

Note: n is the first I/O number to be assigned according to the location of the installed module.

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Block diagram



Notes for handling

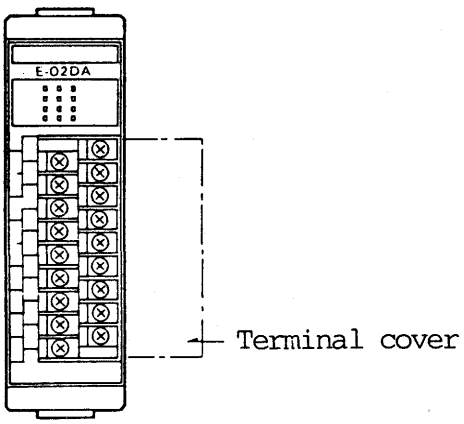
(1) The current output (4 - 20 mA) can be used as the voltage output (1 - 5 V) by attaching a load resistance (250Ω ± 0.1 % including an input resistance on the receiving side).

(2) Avoid using the same power source of ± 15 V with other equipment, which may give a bad influence to E-02DA and the load.

(3) Avoid as much as possible using the product of switching type for the power source of ± 15 V.

(4) Do not touch the potentiometer (variable resistor for adjustment) on the printed board.

Face plate arrangement



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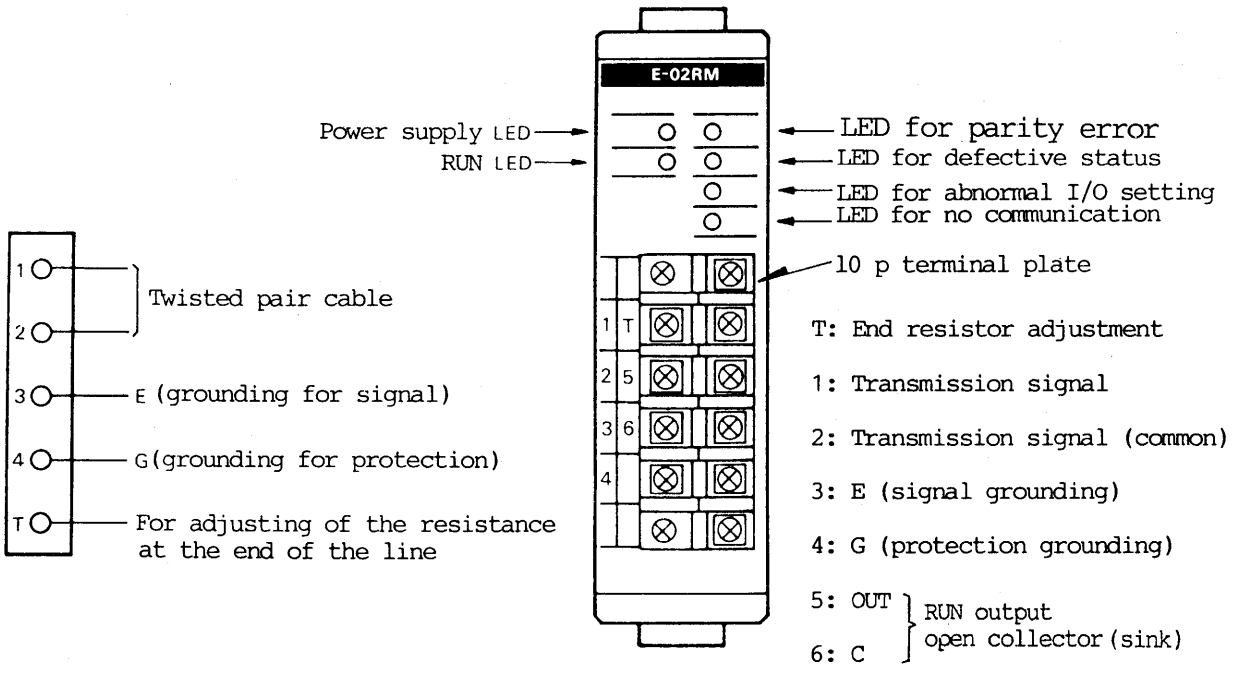
7-10. E-02RM and E-02RS: I/O link module

- This serves as an I/O link between SR-21s.
- This serves as a remote I/O for E-02RS when E-02RS functions as a slave station.
- This can function as a slave station of the I/O link when SR-400 is used for the master station.

Specifications

Item	Ratings
Voltage variation	5 VDC less than ± 5 %
Ambient temperature	0 - 55°C
Ambient humidity	5% - 95% (no condensation)
Current consumption	Less than 0.6 A, 5 VDC
Number of points for transmission	Depends on the combination of dip switches connected in series of 3 and 8 switches
Route for transmission	One pair of twisted-pair cable (comply with EIA standard RS-422)
Transmission speed	19.2 K BPS
Link	1:3 party-line system (in the case of data link between SR-21)
Synchronization	Start-stop synchronization (assynchronization)
Transmission distance	Maximum 1 km of total cable length
I/O setting	Possible to set I/O by every 16 points (both for master and slave stations)
RUN output	24 VDC 0.5 A NPN open collector

Connection and face plate arrangement



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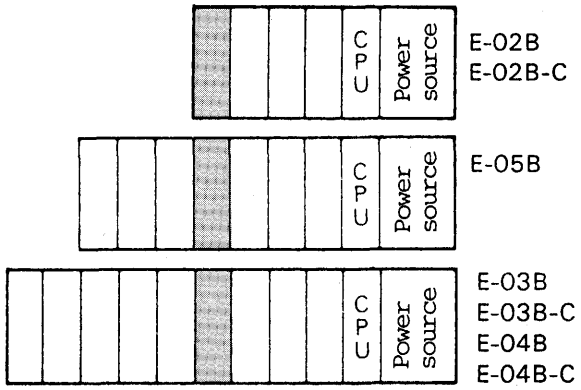
● Differences between E-02RM and E-02RS

E-02RM: Used in the system in which the CPU is installed

Applicable bases

E-02B
E-02B-C
E-05B
E-03B
E-03B-C
E-04B
E-04B-C

Where to install an I/O link module

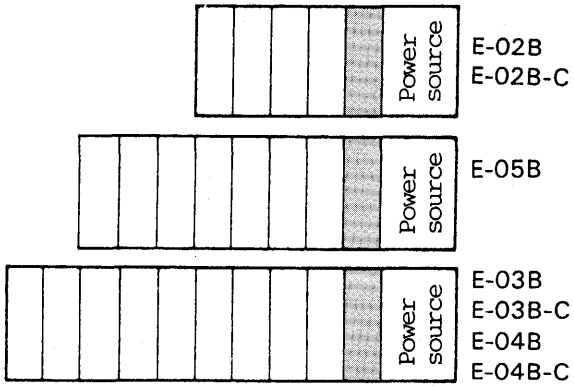


E-02RS: Used in the system organized only with I/O modules
(remote I/O for slave station)

Applicable bases

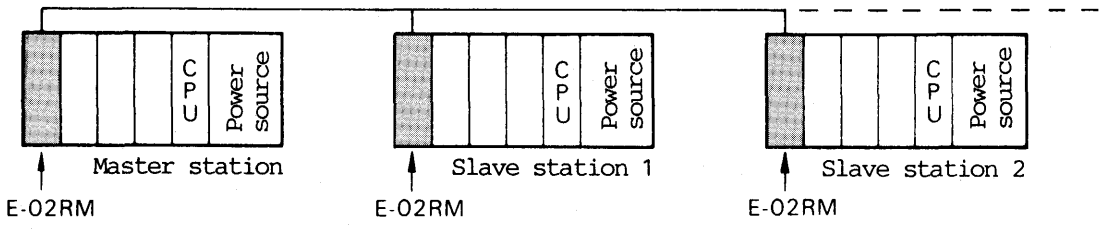
E-02B
E-02B-C
E-05B
E-03B
E-03B-C
E-04B
E-04B-C

Where to install an I/O link module



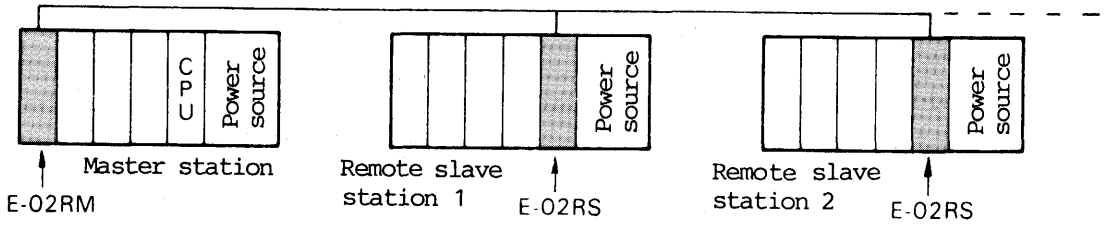
● I/O communications

Total number of I/O points for transmission: 32, 48, 64, 96
Number of slave stations: 1 - 3 (switching for setting)
I/O settings: For every 16 points



● Remote I/O

Total number of I/O points for transmission: 32, 48, 64, 96
Number of slave stations: 1 - 3 (switching for setting)
I/O settings: For every 16 points



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8. SPECIAL FEATURE UNIT

8-1. E-02DM-R1: Host link interface

It is possible to organize a data communications system between the programmmable controller and the personal computer in the market through E-02DM-R1(host link interface). Besides the traditional application in the field of sequential control for all kinds of machines, it is possible to use the plant's total system in the field of factory automation.

Specifications

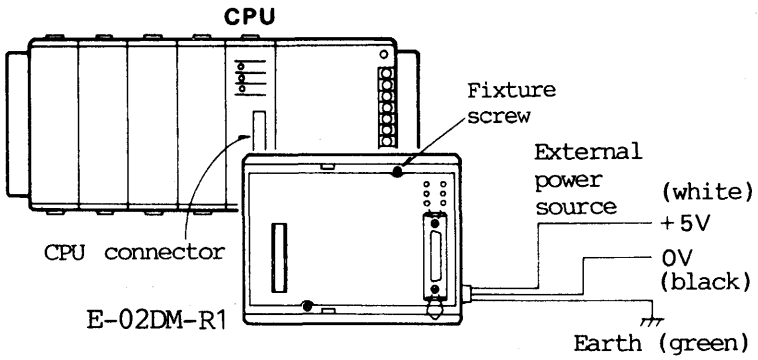
Item	Ratings
Power source voltage	5 VDC, 0.5 A (external stabilized power supply) Not needed for E-02B, E-03B, E-05B, and E-04B
Ambient temperature	0 - 55°C
Humidity	5% - 95% RH (no condensation)
Storing temperature	- 20°C ~ 80°C
Vibration	JIS C0911 IIB Class 3
Grounding	JIS Class 3

Specifications for transmission

Item	Specifications
Transmission	Half-duplex communication Conforming to RS - 422 (EIA) Half-duplex 4 wiring system Multidropping Asynchronous 8 bits/character
Note: If the master computer uses RS-232C, the conversion unit (D-01CV) must be used for converting from RS-232C to RS-422.	
Master computer	Minicomputer or personal computer (with RS-232C or RS-422 port) Recommended model: PC-9801 series (NEC)
Slave unit	Koyo PCs, such as SR-10, SR-20, SR-21, and SR-22 must be used through E-02RM-R1.
Transmission speeds	300, 1200, 9600, 19.2 K (B.P.S.) (dip-switch selection)
Transmission distance	Maximum cable expansion: 1 km
Transmission procedure	Messaging system
Transmission mode	JIS-ASCII mode or HEX mode (dip-switch selection)
Transmission cable	2-core twisted cable (RG-108/V or equivalent) 100Ω (special impedance) (under 100 KHz)

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- This module should be connected with the CPU connector, not like the regular I/O module.



If the external power source is used, the connection should be made with the attached cable. In this case, the power source switch on the rear side of the module should be set at EXT (external).

General function codes

- Table of writing functions

Function code (Basic) / Function	Application	Function memory No.
31 (H) Writing to the timer/counter accumulated value register and data register	Timer/Counter Data register	600 - 677 400 - 577
33 (H) Forced ON or OFF operation to the I/O, internal relay, and shift register	Input/output Internal relay Shift register	000 - 177 160 - 377 400 - 577
36 (H) Changing of operation mode Specification and releasing of password User program grammer check	Reference address 00 (H)	Write data RUN 0101 PRG 8080
37 (H) User program writing	Program memory	0 - 1723
39 (H) Clearing of diagnosing status	Reference address 00 (H) Writing of 0 to all status memories (5 bytes)	Write data

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● Table of reading functions

Function code (Basic)	Function	Application		Function memory No.
31 (H)	Reading of the timer/counter accumulated value register and data register	Timer/Counter Data register		600 - 677 400 - 577
33 (H)	Reading of the ON/OFF status of the I/O, internal relay, and shift register Reading of time-up and count-up conditions	Input/Output Internal relay Shift register Timer/counter		000 - 157 160 - 377 400 - 577 600 - 677
36 (H)	Inquiry of the model (SR-10/20/21/22) Reading of the operation mode (RUN or PRG) Reading of the address where the error is found or error code after grammer check Reading of the revision number of ROM of the PC system Reading of the revision number of ROM of E-02DM system	Reference address		Read data
		Model	16 (H)	0202 (SR-10) 1010 (SR-20) 0303 (SR-21) 0505 (SR-22)
		Mode	00 (H)	RUN 0101 PRG 8080
37 (H)	Reading of the user program	Program memory		0 - 1723
39 (H)	Reading of the diagnosing status Reference address: 00 (H) Contents to be read: 1. Error code trasmitted at the end 2. Number of succeeded transmissions 3. Number of transmissions cut in the middle 4. Number of transmission retries of the header 5. Number of transmission retries of data			

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8-2. D-01CV: RS-232C/422 convertor

Outline

The D-01CV convertor has the following features.

(1) RS-422 ⇄ RS-232C signal conversion

(2) RS-422 → RS-422 signal relay

It makes easier connection of E-01DM-R1 or S-01DM (data communications interface) possible with the computer and modem by using D-01CV.
D-01CV also has the increased noise immunity because of the photocoupler's grounding isolation between the primary circuit and the secondary circuit.

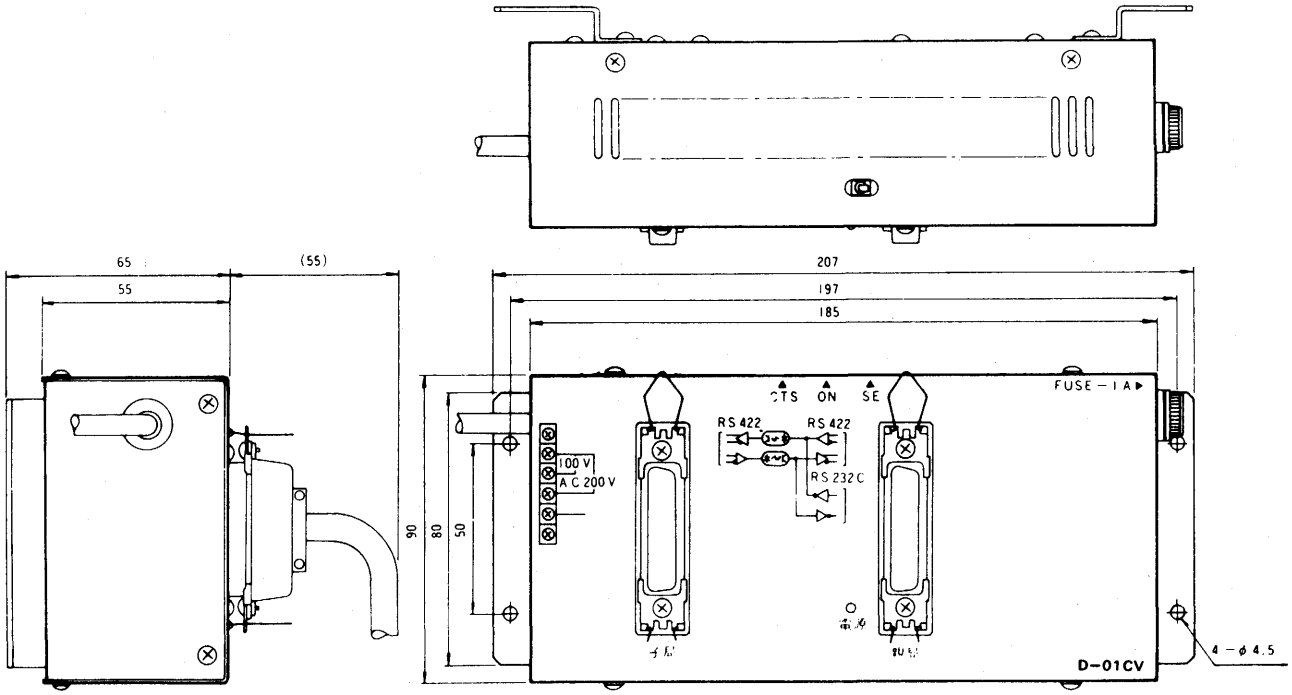
Specifications and appearance

Power source voltage: 85 - 132/170 - 264 VAC, 50/60 Hz

Current consumption: Maximum 100 mA (AC)

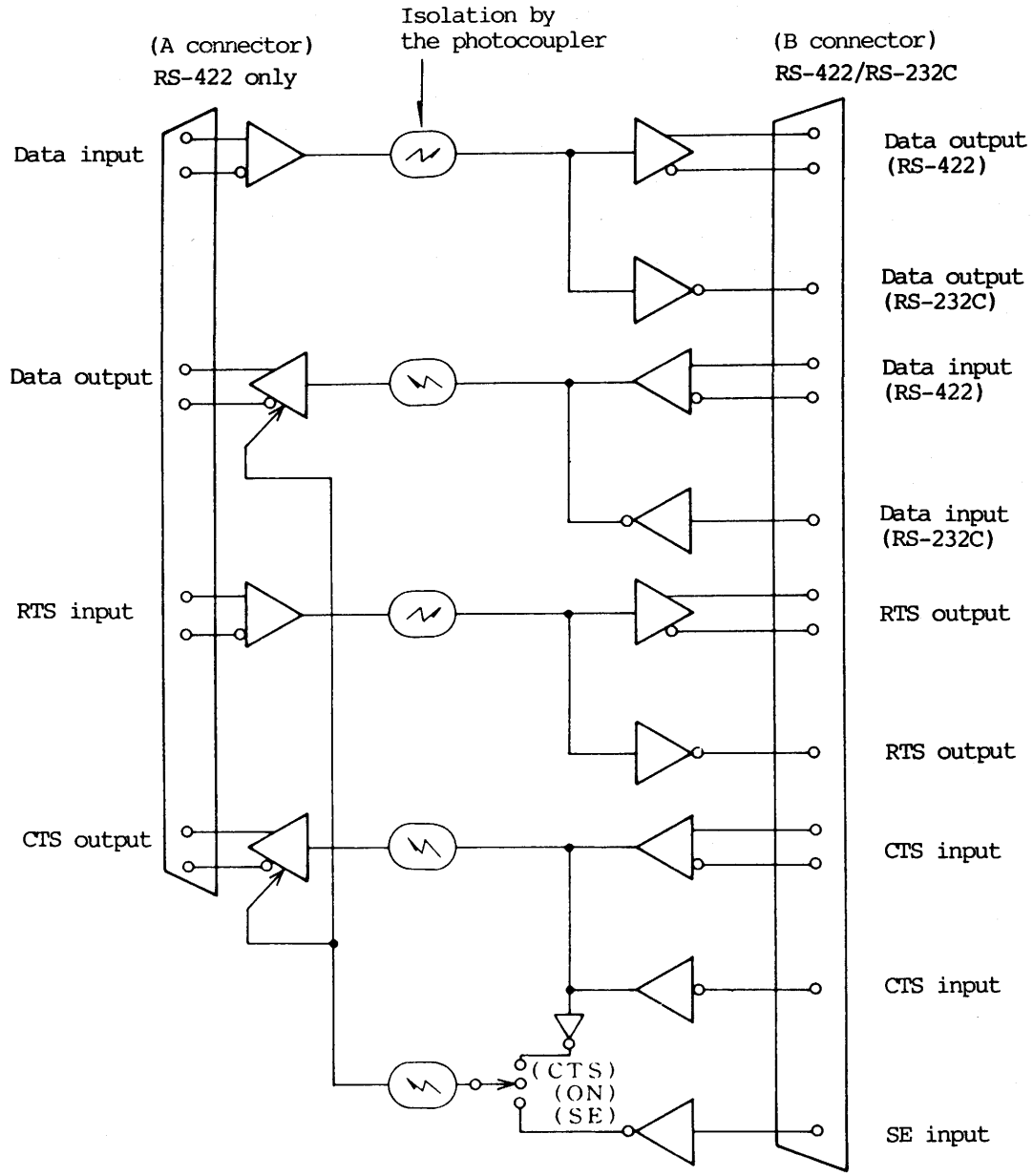
Ambient temperature: 0°C -55°C

Ambient humidity: 5% - 95% RH (noncondensing)

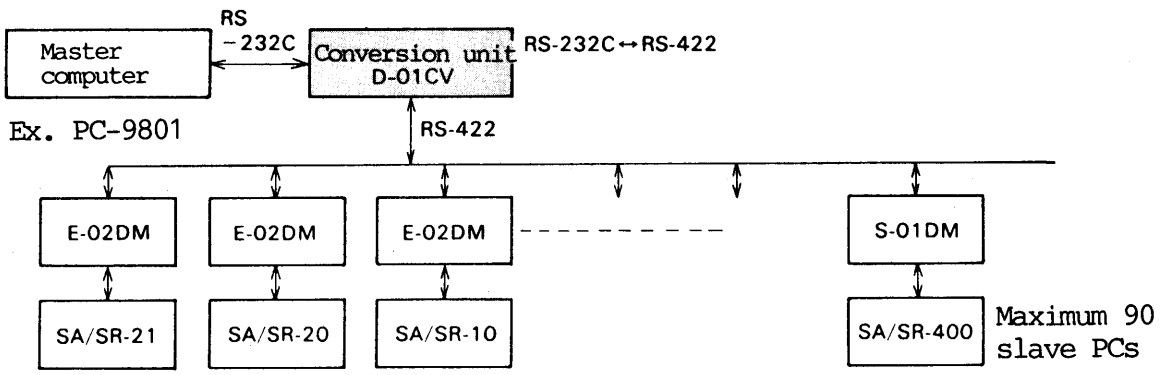


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Construction



System configuration



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8-3. F-10D: External setting unit

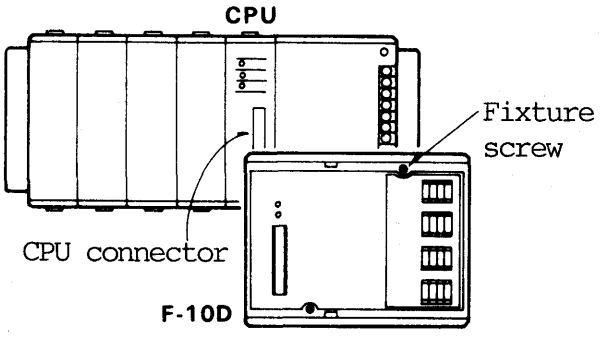
This unit becomes operable when connected to the CPU connector and functions as both timer and counter. Four digits of BCD codes can always be set by the 4 kinds of digital switches.

The set values by this unit while it was installed are memorized even after it is disconnected when the power source of the CPU is turned off. And the CPU continues to operate with the same set value.

Specifications

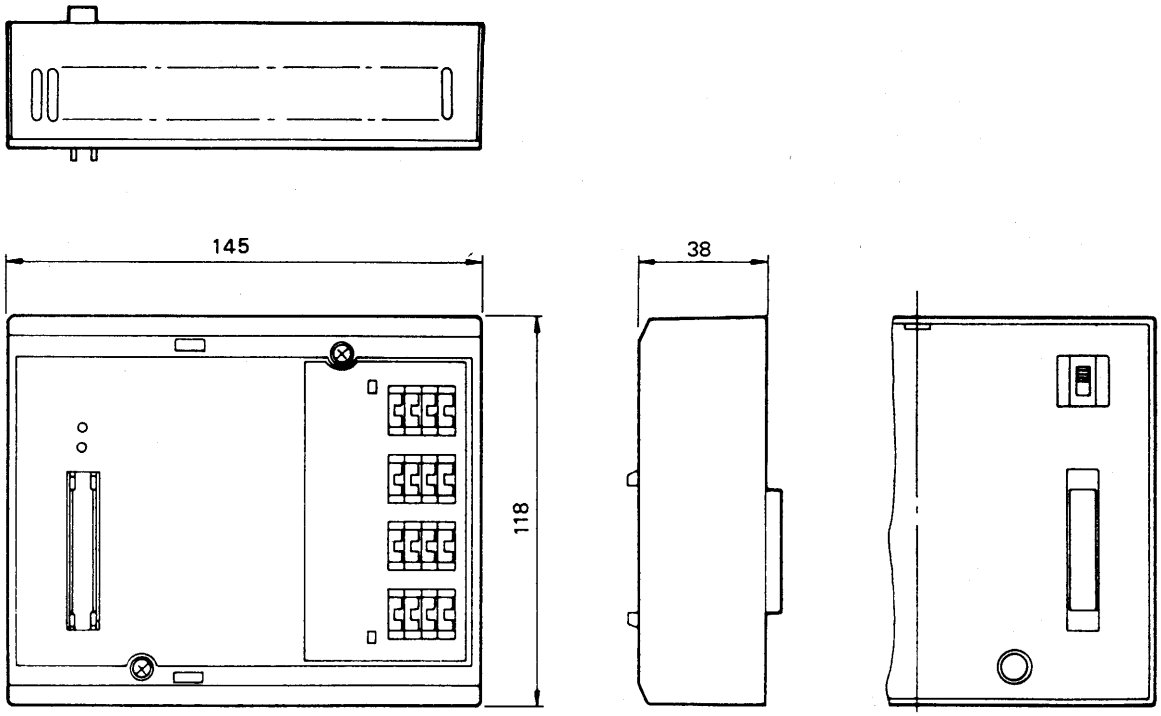
Item	Ratings
Current consumption of internal 5 V circuit	50 mA
Current consumption of internal 9 V circuit	10 mA
Ambient temperature for operation	0°C - 50°C
Humidity	5% - 90% RH (no condensation)
Storing temperature	-20°C — 80°C
Vibration	Conforming to JIS C0911IIB Class 3
Ambient air	No corrosive gases
Number of circuits	4
Setting range	Timer: 0.1sec - 999.9sec Counter: 1 - 9999 Data: 0 - 9999
Address number	T/C674, T/C675, T/C676, T/C677 (T/C set values of these numbers) Data: R#565/R#564, R#567/R#566, R#571/R#570, R#573/R#572 (The data of the setting unit are memorized in the data register of these numbers)
Switch life	10,000 times of switching
Expansion cable	E-15PJ-1, maximum 1.5 m

Loading



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DIMENSIONS (unit: mm)



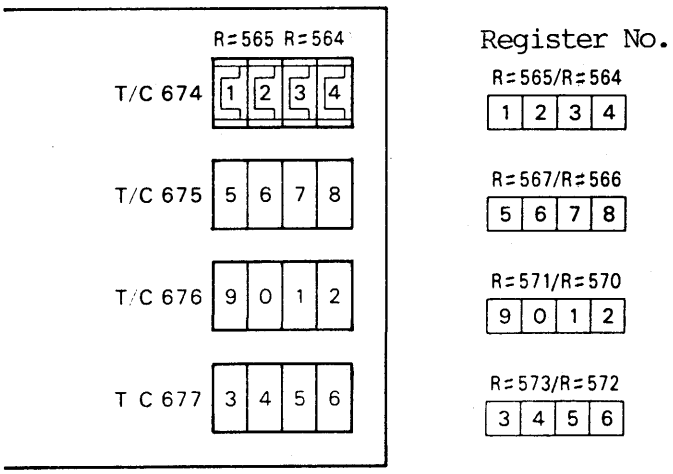
- Caution for installation

  Separate the main unit (F-10D) and shielded programmer expansion cable (E-15PJ-1) as much as possible from the equipment and wires which may generate noise.

- Address number and register number

  The address numbers of the digital switches are arranged in such a way like 674, 675, 676 and 677 from the top.

  The register numbers of upper 2 digits and lower 2 digits are separately assigned. (See below.)



Register No.

R=565/R=564
1 2 3 4

R=567/R=566
5 6 7 8

R=571/R=570
9 0 1 2

R=573/R=572
3 4 5 6

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9. PERIPHERAL EQUIPMENT

9-1. R-21P: Handy programmer

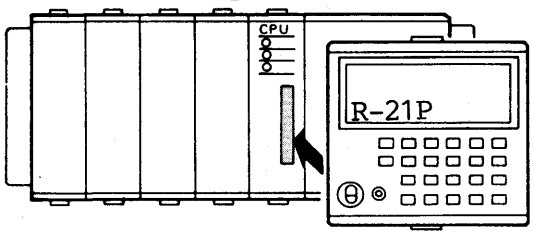
This is a unit to write, read, and monitor the program by connecting with the CPU (SR-21/22).

Specifications

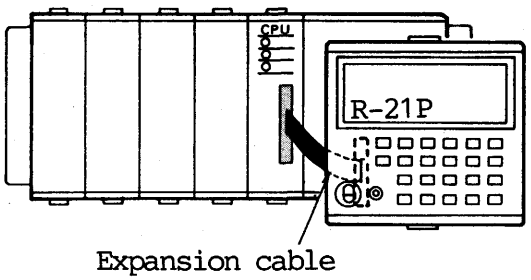
Item	Ratings
Applicable CPU	SR-10, SR-20, SR-21, and SR-22 (FUN R# keys are not used by SR-10 and SR-20)
Power source	Supply is made through the CPU connector by connecting with the CPU.
Current consumption of internal 5 V circuit	50 mA (typical)
Current consumption of internal 9 V circuit	50 mA (typical)
External dimensions	110 (w) x 118 (d) x 24 (h) (mm) (exclude the protruded sections)
Weight	210 g

Connection for R-21P

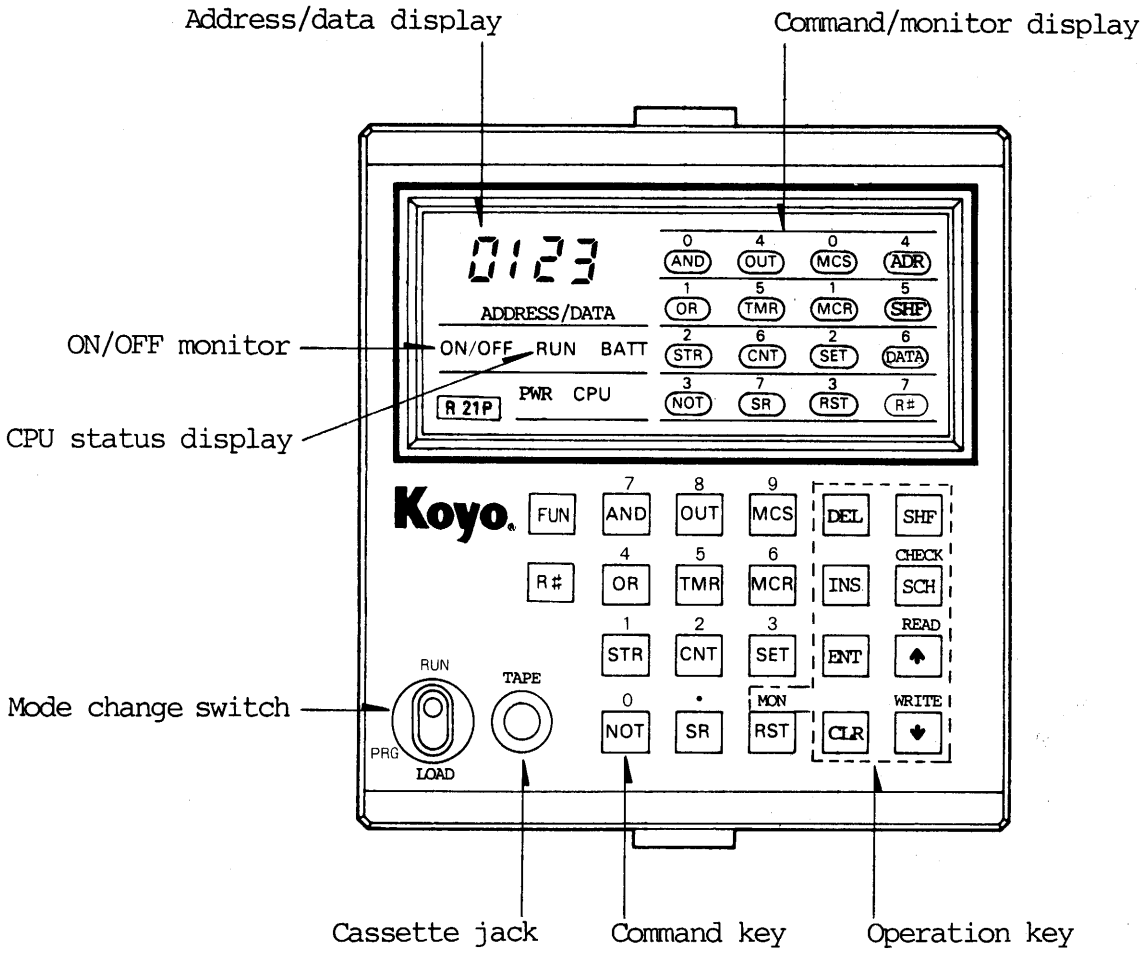
Direct mounting



Connection with the expansion cable



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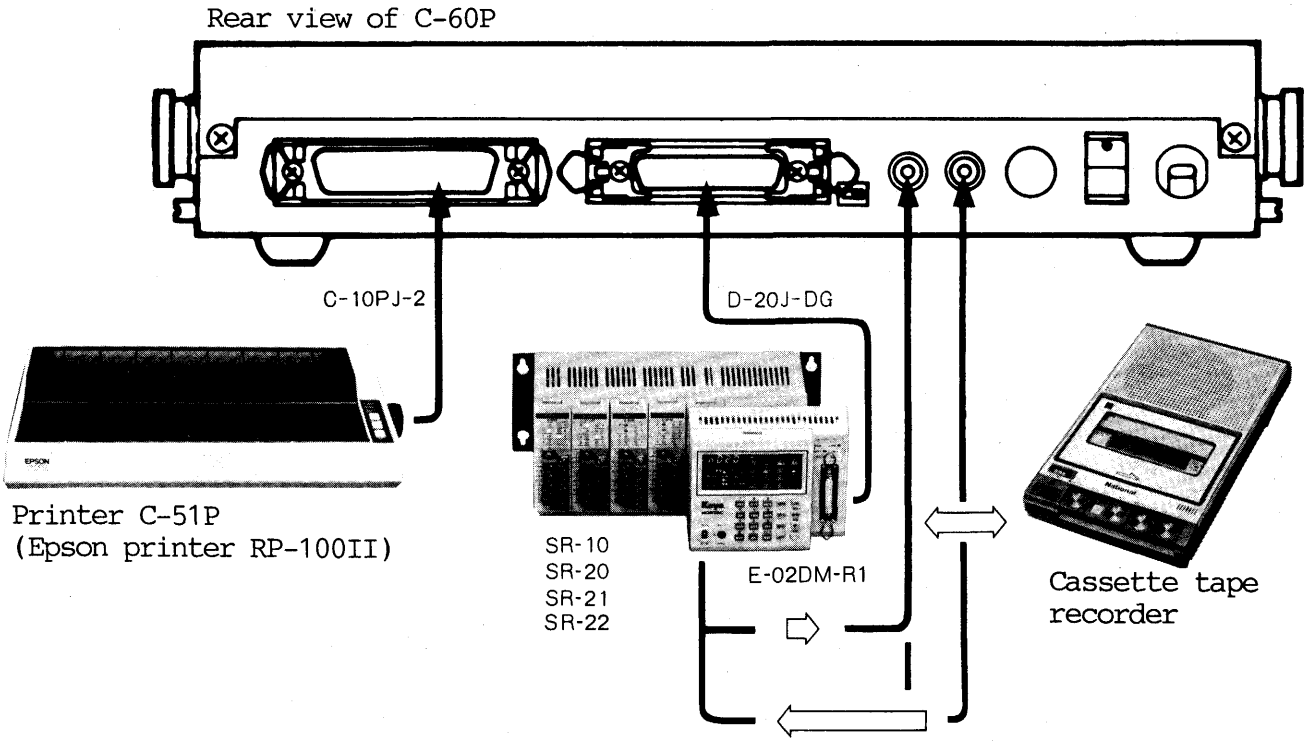
9-2. C-60P: Graphic programmer

C-60P is an LCD type ladder graphic display programmer and specially developed peripheral equipment for the use with the ladder type programmable controller (PC) made by KOYO. (ROM cassette C06R1 is also required.(Separately sold))

The main features of this programmer is to prepare the program for PC, display, monitor on line, print out the ladder diagram and mnemonic codes, and record/play back/compare with the cassette tape.

For transmitting the program with PC, there are two ways such as the on-line method via the RS-422 interface and off-line method by the cassette interface.

● Connectable equipment



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General specifications

Power source voltage	100/115 VAC, 50/60 Hz
Range of voltage tolerance	+15 %, -10 %
Power consumption	Less than 20 VA
Ambient temperature for operation	0°C - 40°C (Avoid the continuous operation more than 12 hours in the case of use above 35°C)
Storing temperature	-20°C to +60°C
Ambient humidity	30% to 85%
Ambient air	No corrosive gasses permitted
Dielectric strength	1500 VAC, 1 minute (between power supply and case)
Insulation resistance	500 VDC, more than 10MΩ (between power supply and case)
Vibration resistance	Complying with JIS C0911 IIB Class 3
Shock resistance	Complying with JIS C0912 (10G for 3 axis directions (XYZ))
Fuse for replacement	Fuse in the mini-glass tube, 2A (One fuse attached)
External dimensions	280 x 215 x 50 mm (Exclude the projected portion)
Weight	3.0 Kg (C-60P), 0.3 Kg (ROM cassette)

Characteristic specifications

Models for use	SR-10, SR-20, SR-21, SR-22
Buffer memory	CMOS RAM 4 K words
Backup battery	Lithium battery (life: about 5 years), Model number: RB-5
Display	480 x 128 dot matrix LCD
Size of display	(For program preparation) 6 lines (ladder graphic area) 1 line: 10 elements (9 contacts + 1 coil) 2 lines x 32 characters (message area)
Effective circuit(max.)	16 lines x 10 elements max. per circuit
System ROM (Separately sold)	ROM cassette type (Replacement required by the applicable model) For SR-10: C-6R05 For SR-20/SR-21/SR-22: C-6R1

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Features to prepare programs and display feature

1. Circuit reading
2. Preparation of new circuit and insertion (circuit block)
3. Correction to the current circuit
   a. General deletion and circuit element deletion
   b. Correction of circuit element
   c. Insertion of contact element
4. Coil searching of output coil, timer and counter, and function
5. Display in repetition
6. Display expansion
7. Searching

On-line feature

1. Monitoring: This feature is only good for SR-21 and SR-22.

   The host link interface (E-02DM) is necessary for SR-21.

   a. Circuit monitoring (Display of conductance and non-conductance of contact)
   b. I/O monitoring (ON/OFF status display of any I/O)
   c. Display of current value of timer and counter
   d. Register monitoring
   e. Forced setting and resetting
   f. Correction of set value or current value of timer and counter during operation of PC
2. Program transfer: Between the PC and C-60P for two ways

   (The host link interface (E-02DM) is necessary for SR-10, SR-20, SR-21, and SR-22.)

Cassette interface

1. Program transfer and comparison between the PC and C-60P for two directions
2. Program recording, playback, and comparison between the cassette player and C-60P for two directions

Printing

1. Ladder diagram print out
2. Instruction print out
3. Search table print out

Abnormality print out

Display of the errorneous operation and error during circuit preparation

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9-3. C-22P-1: PROM writer

C-22P-1 is a PROM writer specially developed for KOYO-made PCs, such as SA/SR-10, -20, -21, and -22.

Specifications

Item	Ratings
Power source voltage	5 VDC ±0.25 V, Ripple: less than 100 mA The external power source is needed when some unit other than the CPU needing 5 V is used and if E-02B/05B/03B/04B are also used.
Current consumption	800 mA max.
Ambient temperature	0°C - 55°C
Ambient humidity	5% - 90% (no condensation)
Storing temperature	-25°C — 80°C
ROM	HN27256G-25 (SA/SR-21/22), INTEL2732A (SA/SR-10/20)
Weight	330g

Features:
1. The sequence program stored in the program memory of the PC is read to be written into PROM.
2. The sequence program stored in PROM is transferred to the program memory of the PC.
3. Feature to delete and check the content of PROM
4. Feature to compare the content of PROM with the sequence program in the program memory of the PC

Operation (table 1)

Function	Key operation	LED display	Remarks
To write the content of the program memory into PROM	WRITE	WRITE	Automatic comparison is made after deletion, checking, and writing.
To transfer the content of PROM into the program memory	WRITE CMPR	WRITE CMPR	Depress two keys at the same time. Comparison is made after transferring.
To compare the content of PROM with the program memory	CMPR	CMPR	
To delete and check the content of PROM	BLANK	BLANK	
Error reset	ERR	ERR	Return to the initial condition by depressing the key in case of error.

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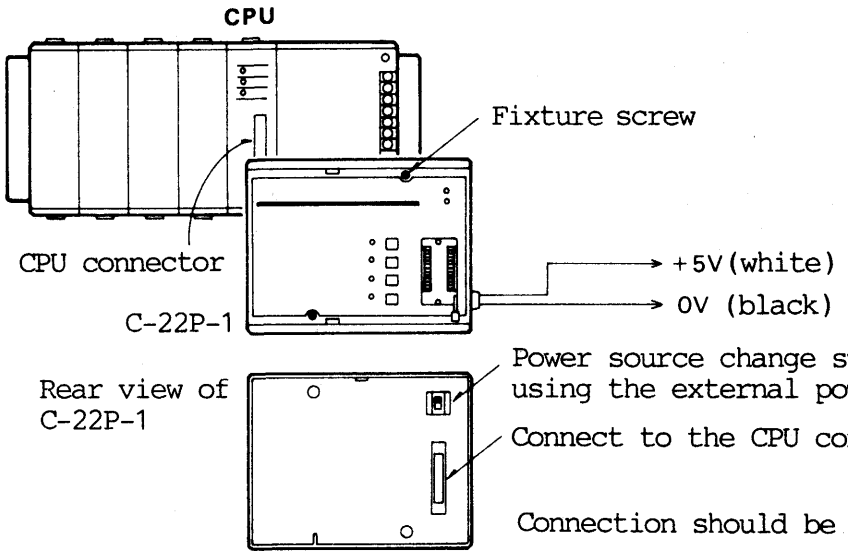
The LED will be turned off when the operation of each function (except the error reset function) is completed.
If any error is generated, one of the LEDs as listed in table 2 will be lighted and the function under execution will be stopped.

Error display (table 2)

Error	LED display	Contents of error
Deletion error	BLANK	The error will be generated if any non-deleted address on PROM for deletion and checking is found.
Write error	WRITE	The error will be generated if any address impossible to write into PROM is found.
Unmatched comparison error	CMPR	The error will be generated if any address of unmatched contents between PROM and the program memory are found for comparison.

The avobe errors will be reset to the initial condition when the reset operation as mentioned in table 1 is made.

Installation and the external power supply



Connection should be made as shown at the left for connecting with the CPU connector.

Connection should be made with the attached cable for applying the external power source. The change switch for power source on the rear of the main unit should be turned to EXT (exterior).

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Operation for applying the power source

1. Turn on the power source change switch on the rear of the main unit of C-22P-1 to INT (interior) or EXT (exterior).

2-1. Turn off the power source of the PC if the internal power supply is used, and install C-22P-1 on the PC to apply the power source. Then the LED for the power source is lighted.

2-2. Turn off the power source of the PC if the external power source is used, and install C-22P-1 on the PC. Connect the attached power source connector on the side of the main unit of C-22-1, and apply the power source to C-22P-1 first and to the PC next. The LED for the power source status will be lighted when the power source is applied both to C-22P-1 and the PC.

3. C-22P-1 will not accept any key operations for several seconds after the power source is applied because of the judging operation of PC model. During the above processing the LED will be lighted for BLANK, WRITE, CMPR, or ERR. In the case of SR-21,it takes about 7 seconds without password and about 10 seconds with password before the key operation is accepted.
   LED will be turned OFF when the key operation is acceptable.

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9-4. C-31P-R1: Graphic printer interface

C-31P-R1 is the interface to connect the KOYO-made PC and the printer. The user program of the PC can be printed out in the instruction or ladder diagram.

Specifications

Item	Ratings
Power source voltage	+ 5 V ±5% (CPU supply through the connector or external supply)
Current consumption	260 mA
Ambient temperature	0 - 55°C
Ambient humidity	5 - 95% (no condensation)
Storing temperature	-20 - 80°C
Weight	330g
Printable range	Ladder diagram: Within 16 lines in total of 14 elements per line for one circuit (13 contacts, one coil) Instruction: 3701 steps in total of 200 steps per page (50 steps x 4 vertical rows)

Feature:

The user program can be output by instructions on the regular type of dot printer in the market by means of the CENTRONICS interfacing system. If the instruction printing is processed, the I/O MAP and register MAP will also be automatically printed out.

Applicable printer

1. It should be accessible with the CENTRONICS interfacing system.
2. The printer should have a character code of 7CH("1") for ASCII.
3. Control codes such as ØEH (SO), ØFH (SI), 12H (DC 2), and 14H (DC 4) should be accessible.
   SO: Double width enlargement specification
   SI: Shrinking specification
   DC2: Cancellation of shrinking
   DC4: Cancellation of double width enlargement
   Others
   ESC + P(1B50): Pica pitch specification
   ESC + Q + 1(1B5188): Right margin setting
4. More than 132 printer printing columns should be accessible.

Note: If the 80-column printer for the regular type of personal computer is used, it is possible to print out the character by harf the size by turning the toggle switch on the side of C-31P-R1, provided that S1 code is included.

For 132-column printing: Set the toggle switch at 132.

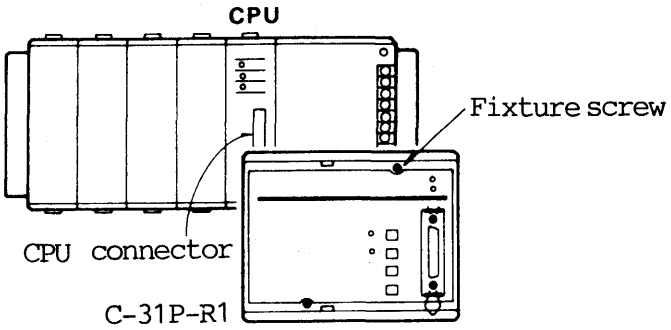
For 80-column printing: Set the toggle switch at 80.

Printers recommended:(EPSON)

FX-100 (136 column)
compatible

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Loading



Connection should be made with the attached cable for applying the external power source.
The change switch for the power source on the rear of the main unit should be turned to EXT (exterior).

Power source application procedure

1. For internal power source
   (a). Turn on the power source change switch on the rear of the main unit of C-31P-R1 to INT (interior).
   (b). Be sure the PC's power source is turned off before loading C-31P-R1 on the CPU.
   (c). Turn ON the PC's power source.

2. For external power source (5 VDC ±5%, more than 280 mA)
   (a). Turn on the power source change switch of C-31P-R1 to EXT (exterior).
   (b). Be sure the power sources of the PC and the C-31P-R1 are turned OFF before loading C-31P-R1 on the CPU.
   (c). Turn ON the power source for the PC first and C-31P-R1 next.

Print operation

1. The user program will be transferred into C-31P-R1 through the cassette port from the PC 75 seconds after the application of power source.
   If the program transfer is correctly completed, the green light LED will illuminate.

   Note: Repeat processing from the begining to apply the power source if the red light LED starts flashing or if it does not flash even after 2 minutes.

2. Depress the type switch to light green LEDs.
3. Select for printing of ladder or instructions by depressing the mode switch.
   Printing of ladder : Green
   Printing of instructions : Red

   Note: Depress the switch repeatedly until you get a required mode because the switches for mode selection and model selection are made for the alternative selection.

4. Printing will start if the print switch is depressed.
5. In the case of printing the instructions, the paper feeding will be made after all areas are printed. Printing of the maps for the output coil and register in use will then be made.

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Break operation

A break for ladder printing will be given for each line per circuit.
Or a break for printing of the instructions will be given for each line.

Note: A break is possible by depressing a stop key at any timing during the operation of printer.
When the printer is stopped during printing of the instruction, depressing of the stop switch will cause printing of the instruction to stop. Then the paper feeding will be made to print the map.
A break cannot made during printing of the map.

Table of print errors

1. Ladder print

Error display	Description of error
* RAM OVER *	In the case of more than 16 digits per circuit
* COLUMN OVER *	In the case of connection of circuit blocks of more than 12 horizontal contacts by AND STR or OR STR In the case of more than 16 lines of printing
* STACK ERROR(SR)*	Inthe case of missing of clock contact and reset contact for the shift register
* STACK ERROR(CNT)*	In the case of missing of reset contact for the counter
* STACK OVER *	In the case of more than eight stack levels of AND STR and OR STR
* STACK OVER(MCS)*	In the case of more than eight stack levels of MCS
* MC ERROR *	In the case of larger number of MCRs than MCSs
* PROGRAM ERROR *	In the case of other errors observed than the above errors * In the case of abnormal data input

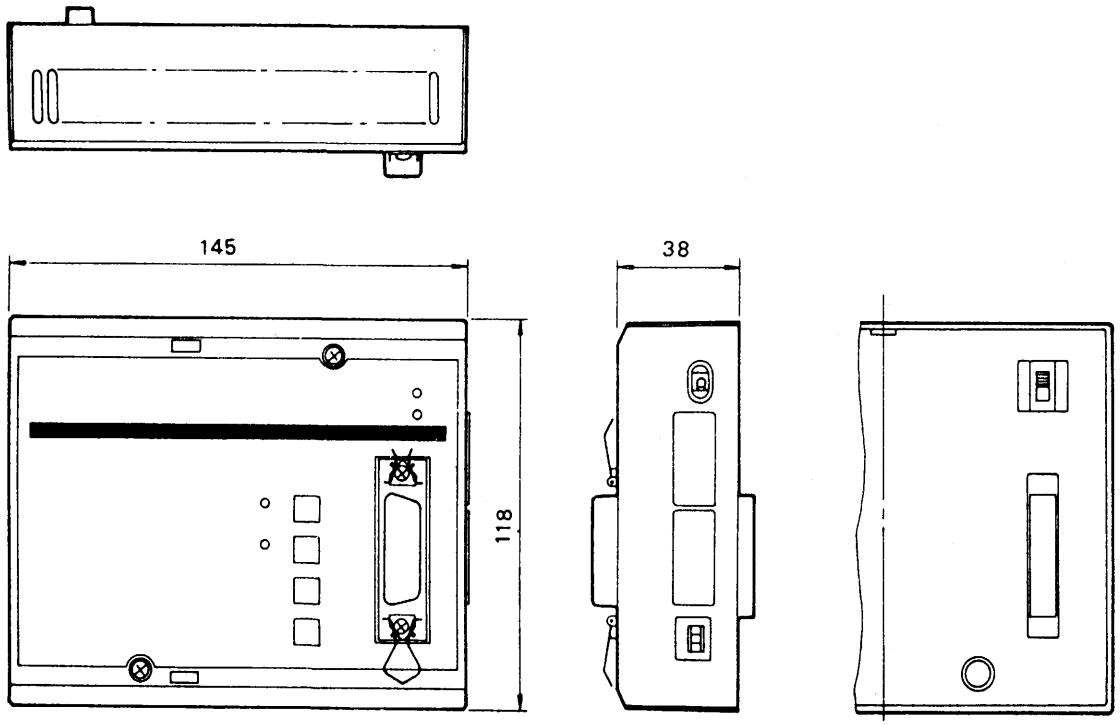
Note: In the case of ladder printer, above eight kinds of erors will be detected. Whenever RAM OVER or COLUMN OVER is generated, printing will be automatically moved to the next circuit after the error display. For other cases, PRINTER STOP will be printed after the error display, then the paper feeding will be made to stop the printer operation.

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2. Printing of the instruction

Error display		Comment
Instruction	Operand	The instruction not registered is found.
*** ERROR ***	? ? ?	The operand is not correct.

DIMENSIONS (unit: mm)



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1. TABLE OF COMMANDS

1-1. Table of sequence commands

	Command function	Command key	Objective memory I/O	IR	SR	T/C	R#	K	Symbol	Reference page
Condition command	Logical operation start contact	STR (NOT) SHF No. □□□	●	●	●				□□□	B-5
	AND operation contact	AND (NOT) SHF No. □□□	●	●	●				□□□	B-6
	OR operation contact	OR (NOT) SHF No. □□□	●	●	●				□□□	B-7
	Logical operation start Timer contact	STR (NOT) TMR SHF 6 Timer No. □□				●			T□□□	B-8
	AND operation Timer contact	AND (NOT) TMR SHF 6 Timer No. □□				●			T□□□	
	OR operation Timer contact	OR (NOT) TMR SHF 6 Timer No. □□				●			T□□□	
	Logical operation start Counter contact	STR (NOT) CNT SHF 6 Counter No. □□				●			C□□□	B-10
	AND operation Counter contact	AND (NOT) CNT SHF 6 Counter No. □□				●			C□□□	
	OR operation Counter contact	OR (NOT) CNT SHF 6 Counter No. □□				●			C□□□	
	Logical operation start drum sequencer contact	STR (NOT) SHF 6 Counter No. □□				●			D□□□	B-11
		SHF Set value □□□□ or R# Set value □□□					●	●	*□□□□ or R#□□	
	AND operation drum sequencer contact	AND (NOT) SHF 6 Counter No. □□				●				
		SHF Set value □□□□ or R# Set value □□□					●	●		
	OR operation drum sequencer contact	OR (NOT) SHF 6 Counter No. □□				●			D□□□	
		SHF Set value □□□□ or R# Set value □□□					●	●	*□□□□ or R#□□	
Condition subsidiary command	Logical block AND operation	AND STR								B-12
	Logical block OR operation	OR STR								B-13
	Master control start	MCS (F30)								B-14
	Master control release	MCR (F31)								

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Command function		Command key	Objective memory I/O	IR	SR	T/C	R#	K	Symbol	Reference page
Process command	Output operation	OUT SHF No. □□□	●	●					□□□	B-16
	Output operation	SET OUT (F35) SHF No. □□□	●						□□□ S.O.	B-17
	Output set	SET (F33) SHF No. □□□	●	●	●				□□□ S	B-17
	Output reset	RST (F34) SHF No. □□□	●	●	●				□□□ R	B-18
	Differencial	SET OUT RST (F38) SHF No. □□□	●	●					□□□ △	B-19
	Timer	TMR SHF Timer No. 6□□				●			□□□ T	B-20
		SHF Set value □□□□ or R# Register No. □□□					●	●	×□□□.□ or R#□□□	
	External set timer	TMR SHF Timer No. 6 7 □				674 675 676 677			□□□ T	B-24
	Counter	CNT SHF Counter No. 6□□				●			C □□□ C R ×□□□□	B-21
		SHF Set value □□□□ or R# Register No. □□□					●	●	or R#□□□	
	External set counter	CNT SHF Counter No. 6 7 □				674 675 676 677			C □□□ C R	B-24
	Shift register	SR (F32) SHF First No. □□□			●				D SR C □□□ R □□□	B-22
		SHF Last No. □□□			●					
	High-speed counter module count value writing	CNT SHF Special No. □□□							C □□□ ×□□□ C R# □□□	B-25
		SHF Write value □□□ or R# Register No. □□□					●	●		
	High-speed counter module comparison value writing	CNT SHF Special No. □□□							C □□□ ×□□□ C R# □□□	B-26
		SHF Comparison value □□□□ or R# Register No. □□□					●	●		

Objective memory table

Memory	Abbreviation	Range
Input/Output	I/O	000 - 157 700 - 767
Internal relay	IR	160 - 377 770 - 777
Shift register	SR	400 - 577
Timer/Counter	T/C	600 - 677 (Specialized for external setting: 674 to 677)
Register	R#	000 - 057 070 - 077 600 - 677 400 - 577
Constant	K	0000 - 9999 (But for timer set values: 000.0 to 999.9)

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1-2. Table of data processing commands

	Command function	Command key	Data type ACC	Data type R#	Data type K	Distination ACC	Distination R#	Flag	Symbol	Reference page
Read command	16-bit reading	FUN 5 0 (D STR) R# Register No. □□□ or SHF Constant □□□□		S	S	D			D STR R#□□□ / D STR ✱□□□□	B-58
	8-bit reading	FUN 5 1 (D STR1) R# Register No. □□□		S		D			D STR1 R#□□□	B-62
	Upper 4-bit reading	FUN 5 2 (D STR2) R# Register No. □□□		S		D			D STR2 R#□□□	B-64
	Lower 4-bit reading	FUN 5 3 (D STR3) R# Register No. □□□		S		D			D STR3 R#□□□	B-66
	16-point module	FUN 5 5 (D STR5) R# Register No. □□□		S		D			D STR5 R#□□□	B-68
Write command	16-bit writing	FUN 6 0 (D OUT) R# Register No. □□□	S				D		D OUT R#□□□	B-70
	8-bit writing	FUN 6 1 (D OUT1) R# Register No. □□□	S				D		D OUT1 R#□□□	B-72
	Upper 4-bit writing	FUN 6 2 (D OUT2) R# Register No. □□□	S				D		D OUT2 R#□□□	B-74
	Lower 4-bit writing	FUN 6 3 (D OUT3) R# Register No. □□□	S				D		D OUT3 R#□□□	B-76
	16-point module	FUN 6 5 (D OUT5) R# Register No. □□□	S				D		D OUT5 R#□□□	B-78
Operation command	16-bit comparison	FUN 7 0 (>=<) R# Register No. □□□ or SHF Constant □□□□	S1	S2	S2			>=<	>=< R#□□□ / >=< ✱□□□□	B-80
	BCD 4-digit addition	FUN 7 1 (+) R# Register No. □□□ or SHF Constant □□□□	S1	S2	S2	D		C Z O	+ R#□□□ / + ✱□□□□	B-84
	BCD 4-digit subtraction	FUN 7 2 (−) R# Register No. □□□ or SHF Constant □□□□	S1	S2	S2	D		C Z O	− R#□□□ / − ✱□□□□	B-88
	BCD 4-digit multiplication	FUN 7 3 (×) R# Register No. □□□ or SHF Constant □□□□	S1	S2	S2	D	D 576 577	Z O	× R#□□□ / × ✱□□□□	B-92
	BCD 4-digit division	FUN 7 4 (÷) R# Register No. □□□ or SHF Constant □□□□	S1	S2	S2	D	D 576 577	Z O	÷ R#□□□ / ÷ ✱□□□□	B-96

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	Command function	Command key	Data type ACC	Data type R#	Data type K	Distination ACC	Distination R#	Flag	Symbol	Reference page
Operation command	16-bit AND	FUN 7 5 (D AND) R# □□□ Register No. or SHF □□□□ Constant	S1	S2	S2	D		Z O	D AND R# □□□ / D AND *□□□□	B-100
Operation command	16-bit OR	FUN 7 6 (D OR) R# □□□ Register No. or SHF □□□□ Constant	S1	S2	S2	D		Z O	D OR R# □□□ / D OR *□□□□	B-104
Conversion command	Right shift	FUN 8 0 (SFTR) R# □□ No. of shifts	S1		S2	D		C	SFTR R# □□	B-108
Conversion command	Left shift	FUN 8 1 (SFTL) R# □□ No. of shifts	S		S2	D		C	SFTL R# □□	B-110
Conversion command	Decode	FUN 8 2 (DECO)	S			D		O	DECO	B-112
Conversion command	Encode	FUN 8 3 (ENCO)	S			D		O	ENCO	B-114
Conversion command	Inversion	FUN 8 4 (INV)	S			D			INV	B-116
Conversion command	Binary code conversion	FUN 8 5 (BIN)	S			D		O	BIN	B-118
Conversion command	BCD code conversion	FUN 8 6 (BCD)	S			D			BCD	B-120
Special command	External equipment diagnosing	FUN 2 0 (FALT) R# □□□ Register No. or SHF □□□□ Constant		●	●		574 575		FALT R# □□□ / FALT *□□□□	B-122

Description of data operation

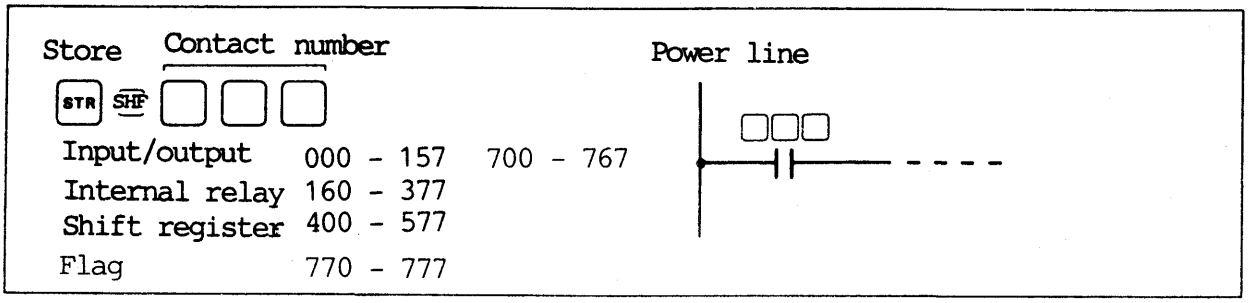
SI (ACC)	Data operation instruction such as +, −, x, ÷	S2 (Specific data)	=	D (ACC)

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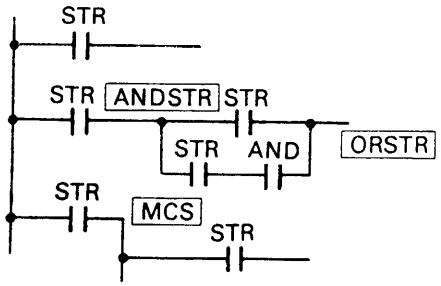
2. EXPLANATION OF SEQUENCE INSTRUCTIONS

2-1. Relay contact

(1) STR: Store instruction

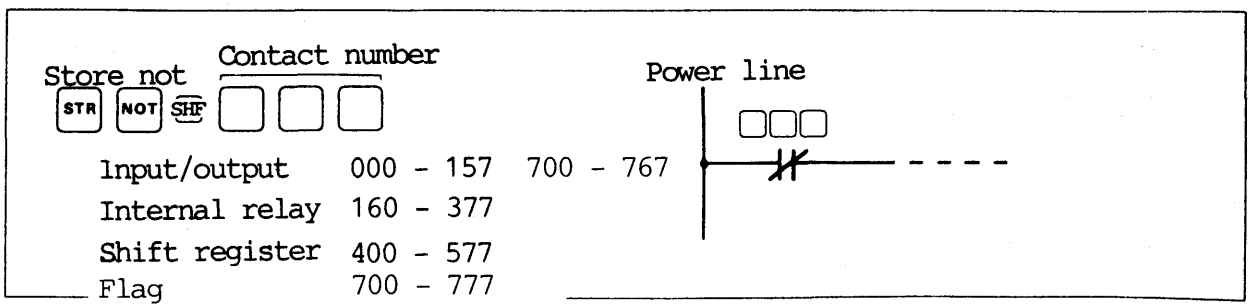


Features: 1. First condition to start from the power line, and also a normal open contact
2. Four kinds of contacts to be directed are input, output, internal relay, and shift register. The numbers of these contacts are assigned by the function memory assignment table.
3. Besides the contact starting from the power line, the beginning of condition blocks to be connected with the power line attached with master control, AND STR and OR STR, are also started by the store instruction.
4. Example of usage



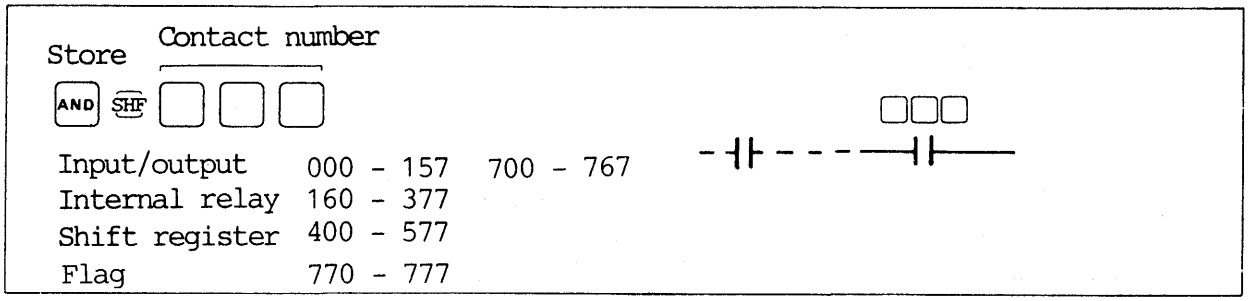
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(2) STR NOT: Store not instruction

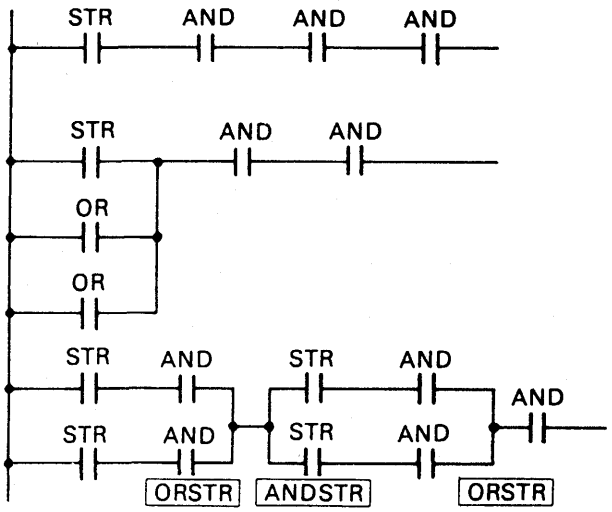


Features: 1. First condition to start from the power line, and also a normal close contact.
2. The contacts to be directed and the method of use are the same as with store instruction.

(3) AND instruction



Features: 1. This instruction will be used to connect in series with the condition already programmed.
2. The contacts to be directed are four kinds : input, output, internal relay, and shift register.
3. Example of usage



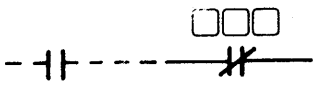
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(4) AND NOT instruction

And not Contact number

AND NOT SHF □□□

Input/output	000 - 157	700 - 767
Internal relay	160 - 377	
Shift register	400 - 577	
Flag	770 - 777	



Features: 1. Normally closed contact to be connected in series with the condition already programmed
2. The contacts to be directed and the method of use are the same as with AND instruction.

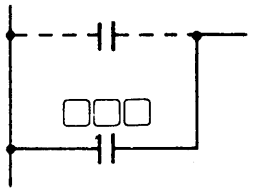
(5) OR instruction

Or Contact number

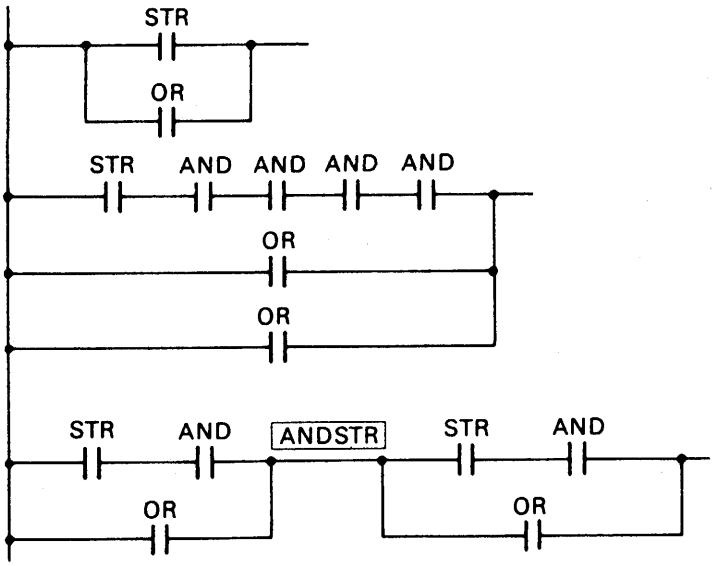
OR SHF □□□

Input/output	000 - 157	700 - 767
Internal relay	160 - 377	
Shift register	400 - 577	
Flag	770 - 777	

Power line

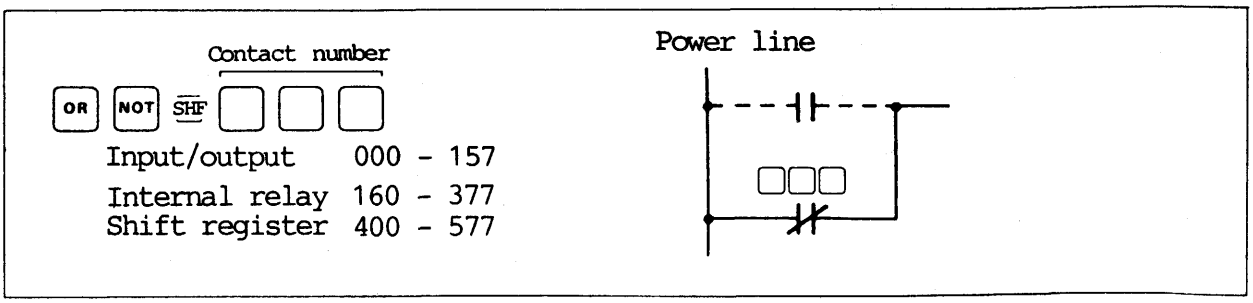


Features: 1. Connection will be made in parallel with all conditions already programmed.
2. The contacts to be directed are four kinds: input, output, internal relay, and shift register.
3. The block to start connection in parallel is from the front edge of the STR (include STR NOT) instruction. The last edge will be connected with the instruction in front of the OR instruction.
4. Example of usage



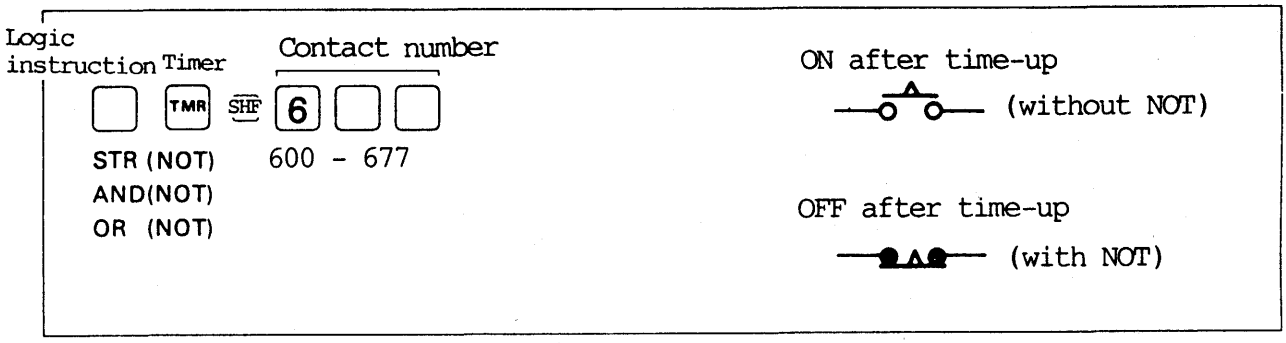
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(6) OR NOT instruction



Features: 1. Normally closed contact to be connected in parallel with all conditions already programmed
2. The contacts to be directed and the method of use are the same as with OR instruction.

2-2. TMR: Timer contact instruction



Feature: 1. The timer contact instruction will be made by connecting a logical instruction with/before TMR.

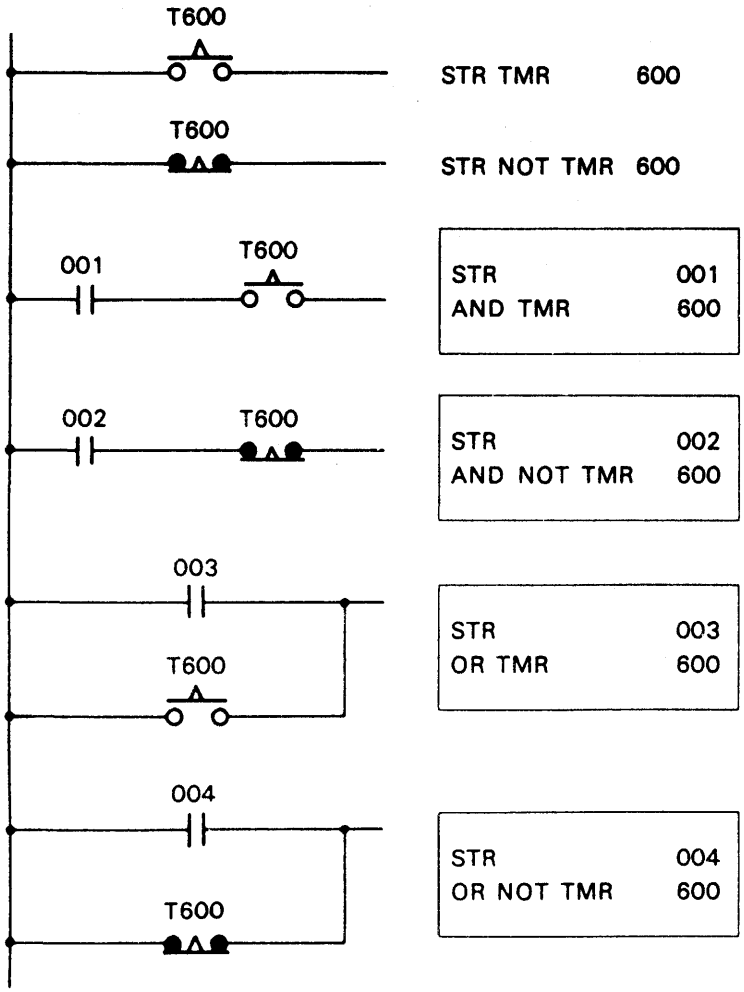
2. In the condition without NOT, the contact will be ON by time-up, and the ON status will be continued until resetting of the timer.

3. In the condition with NOT, the contact is normally closed and will be off by time-up. The OFF status will be continued until resetting of the timer.

4. There is no limit of used number of contacts both for normally closed or open for the timer contact instruction of one timer.

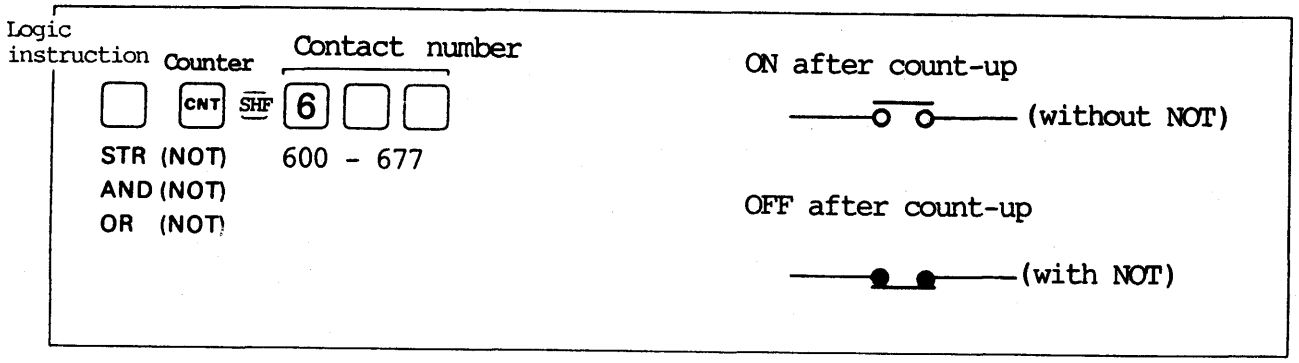
5. The following examples are for the use of combinable logics.

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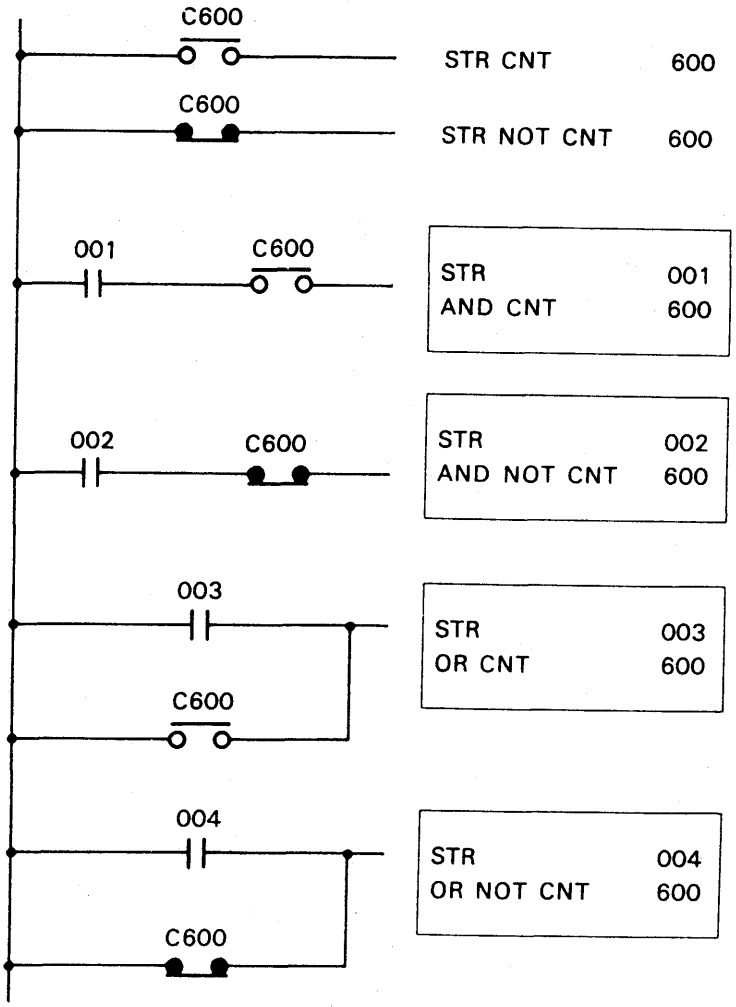


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2-3. Counter contact instruction



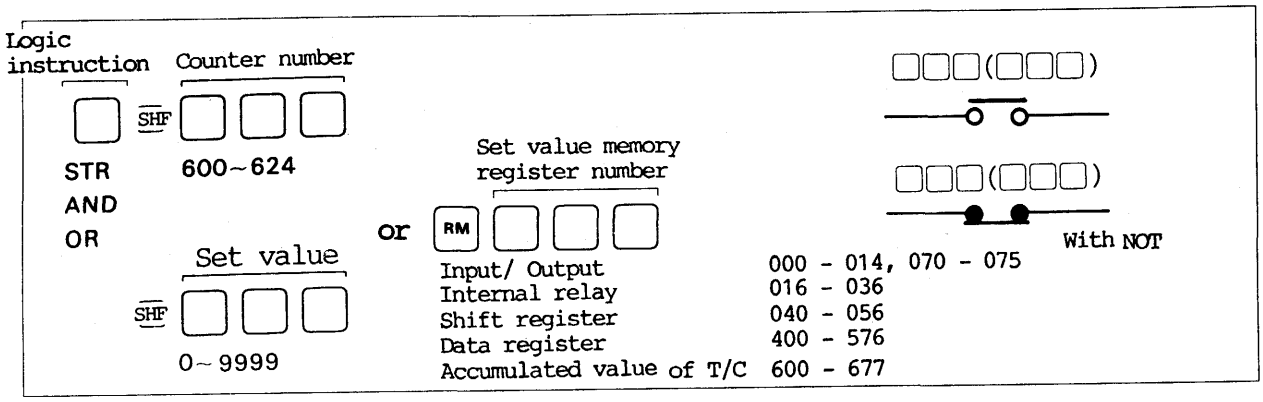
Features:
1. The counter contact instruction will be made by connecting a logical instruction with/before CNT.
2. In the condition without NOT, the contact will be ON by count-up, and the ON status will be continued until the counter is reset.
3. In the case of the condition with NOT, the contact is normally closed and will be off by count-up. The OFF status will be continued until the counter is reset.
4. There is no limit of used number of contacts both for normally closed or normally opened for the counter contact instruction of one counter.
5. Example of usage



There is a counter contact instruction that will be ON only for the special count value.
Refer to the counter contact instruction for the drum of B-11.

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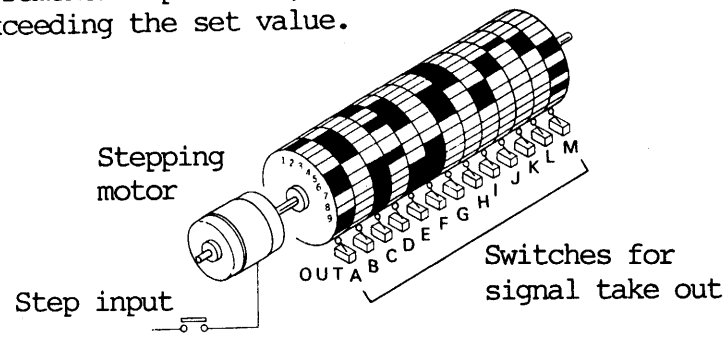
2-4. Counter contact instruction for drum sequencer



Features: 1. The contact will be on (the normally closed contact is off) only when the counter value matches the set value specified for the second word.

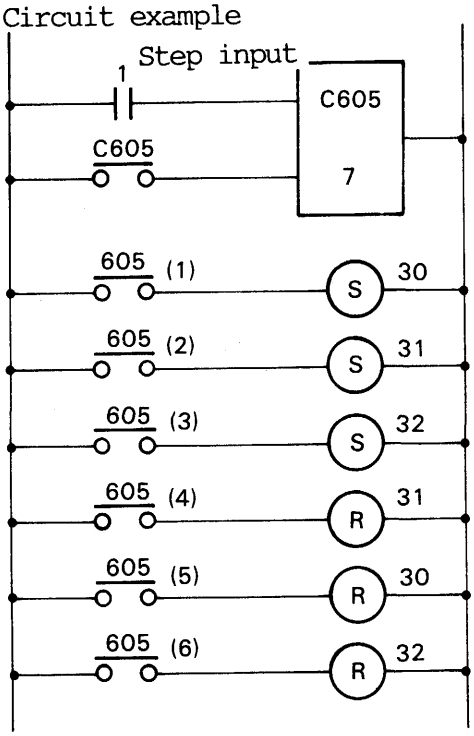
2. The set value for the counter instruction has no relation with the set value for this instruction. The counter of this equipment functions for incremental operation, and the count value will be accumulated by exceeding the set value.

● Drum sequencer



This is a device to set a sequence of the operation procedure of machine.
This device includes a drum unit to rotate for a certain fixed angle whenever the step input turns ON.
The drum unit is made with cams so that the limit switch turns ON or OFF according to the angle of cam rotation.

Circuit example



Process	0	1	2	3	4	5	6
Output 30							
Output 31							
Output 32							

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2-5. Contact block connection

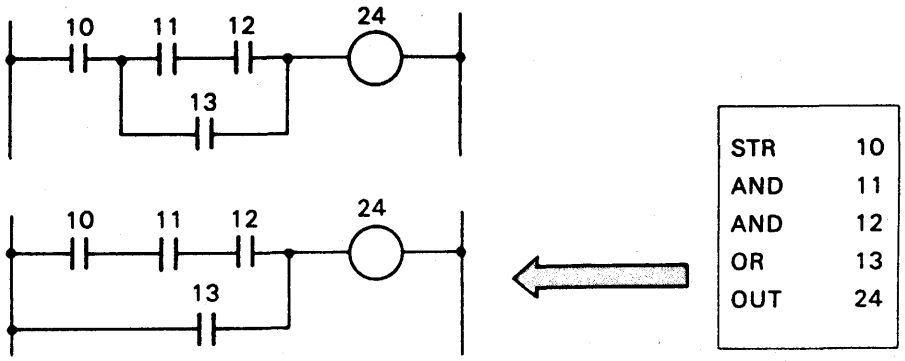
(1) AND STR

AND Store

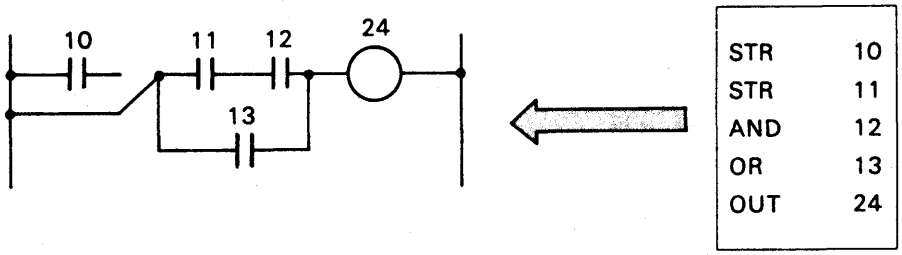
AND STR

Feature: 1. This is the instruction to connect contact circuit blocks to each other in a series. The circuit blocks are started with STR instructions.
2. It is possible to program up to eight blocks of contact circuits in succession before using the AND STR instruction.

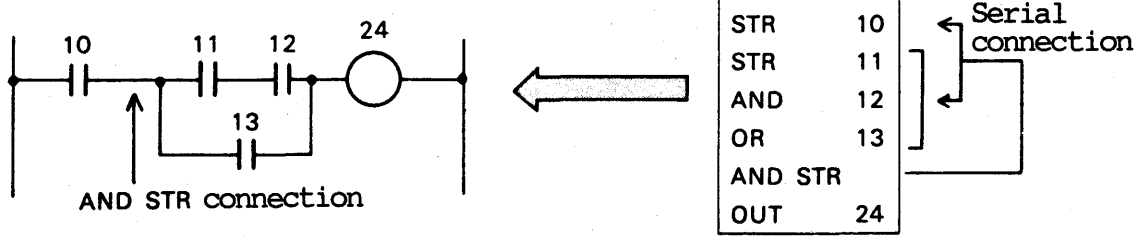
Usage 1. This circuit cannot be programmed only with STR, AND, and OR. For example, if you program as shown on the right, it will be configured as shown. The connection of OR13 is different.



Note that the OR instruction connection is in parallel with a group of instructions starting with STR. OR13 may be successfully connected as shown if input 11 functions as the STR instruction.
But input 10 is left open.



If you use AND STR instruction as shown here, two circuits can be connected in series as shown.



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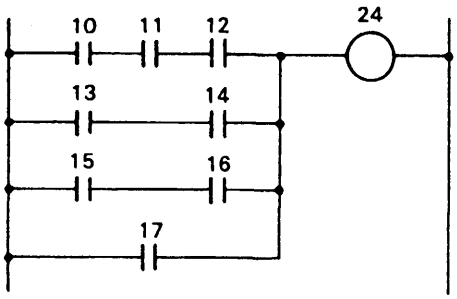
(2) OR STR

OR Store

OR STR

Feature: 1. This is the instruction to connect contact circuit blocks to each other in parallel. The circuit blocks are started with STR instructions.
2. It is possible to program up to eight blocks of contact circuits in succession before using the OR STR instruction.

Usage 1.



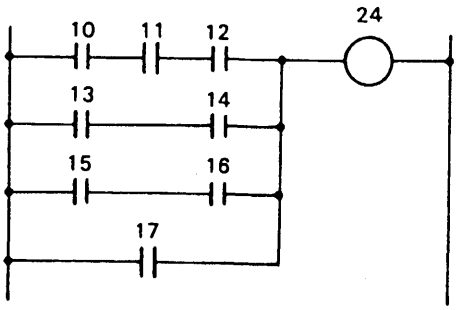
Program

STR	10
AND	11
AND	12
STR	13
AND	14
STR	15
AND	16
STR	17
OR STR	
OR STR	
OR STR	
OUT	24

Parallel connection

Possible to have up to 7 instruction in parallel

2. The above example is programmed with OR STR instruction three times in succession. But each connection may be made as shown below.



Program

STR	10
AND	11
AND	12
STR	13
AND	14
OR STR	
STR	15
AND	16
OR STR	
STR	17
OR STR	
OUT	24

If you use this method of connection, you can connect as many times as you want because you are not using OR STR instruction in succession. This method can be used also for AND STR instruction.

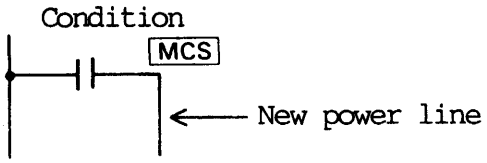
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2-6. Master control

MCS

Master control set

MCS



Feature: 1. This is the instruction to build a new power line for conditioning the STR instruction (or a group of instructions to start with STR).

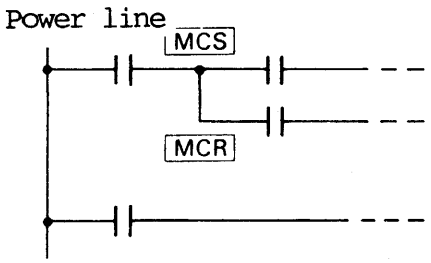
2. If you write with MCS instruction, all programs starting with STR will be connected with the new power line for all cases after writing the MCS instruction.

3. MCS instruction can be used in repetition up to seven levels in succession.

MCR

Master control reset

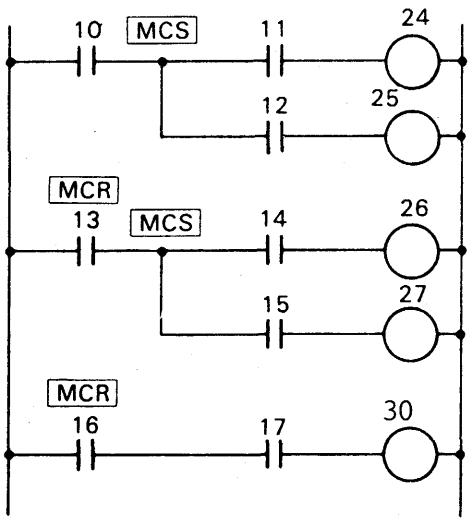
MCR



Feature : 1. Use the MCR instruction for returning to the original power line after processing the master control with the MCR instruction.

2. The same number of MCR instructions as MCS instructions is needed.

Usage 1.



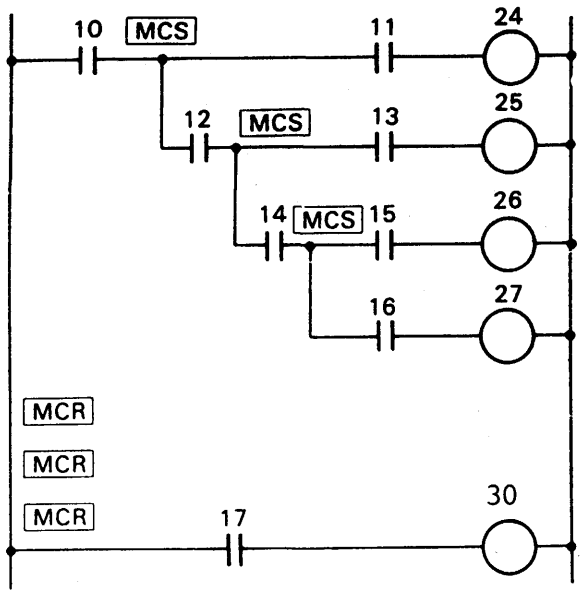
In this case, the number of MCS is two, but the number of level in use is one.

Program

STR	10
MCS	
STR	11
OUT	24
STR	12
OUT	25
MCR	
STR	13
MCS	
STR	14
OUT	26
STR	15
OUT	27
MCR	
STR	16
AND	17
OUT	30

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Usage 2. Repetitious use of MCS (1)



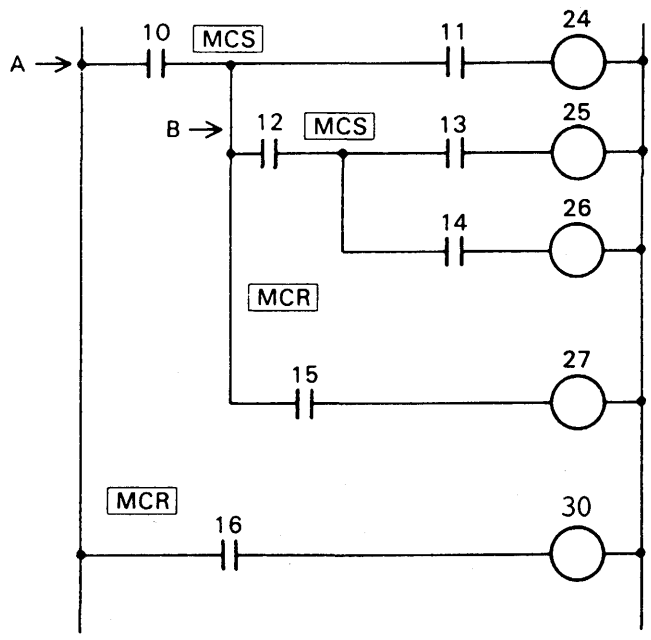
In this case, the number of MCS levels is three.

Program

STR	10
MCS	
STR	11
OUT	24
STR	12
MCS	
STR	13
OUT	25
STR	14
MCS	
STR	15
OUT	26
STR	16
OUT	27
MCR	
MCR	
MCR	
STR	17
OUT	30

} The same number of MCR as MCS is needed.

Usage 3. Repetitious use of MCS (2)



Program

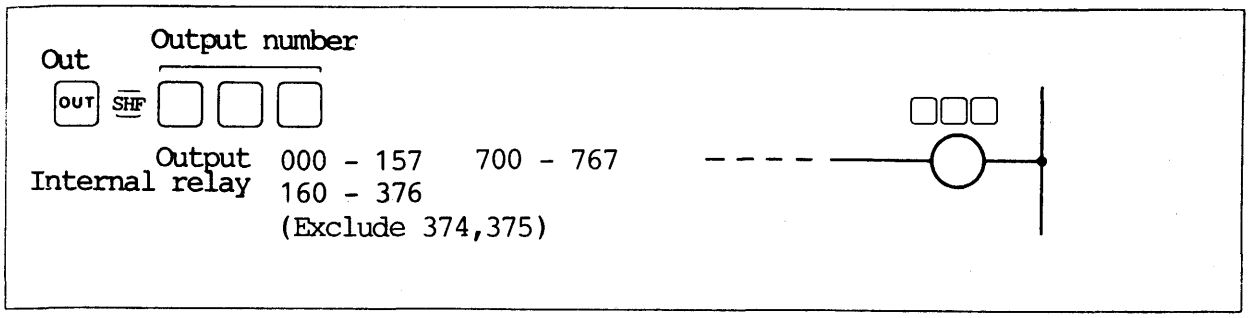
STR	10
MCS	
STR	11
OUT	24
STR	12
MCS	
STR	13
OUT	25
STR	14
OUT	26
MCR	
STR	15
OUT	27
MCR	
STR	16
OUT	30

If MCR is used once after repetitious use of MCS, the power line will return to the previous condition for one step. In this example, MCS is used twice. Then the condition will return to power line (B) to which MCS was processed first. For returning to power line (A), MCR must be used one more time.

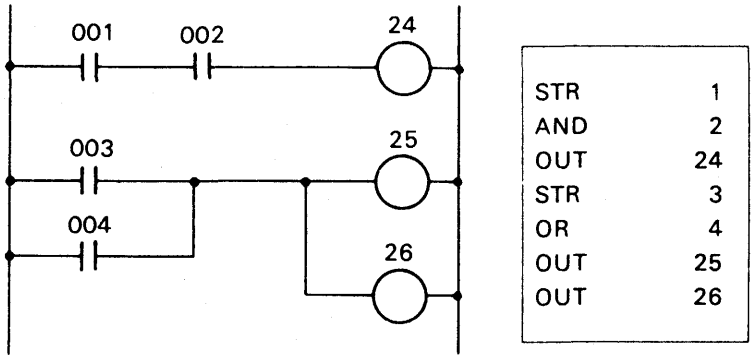
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2-7. Relay coil

(1) OUT: OUT instruction

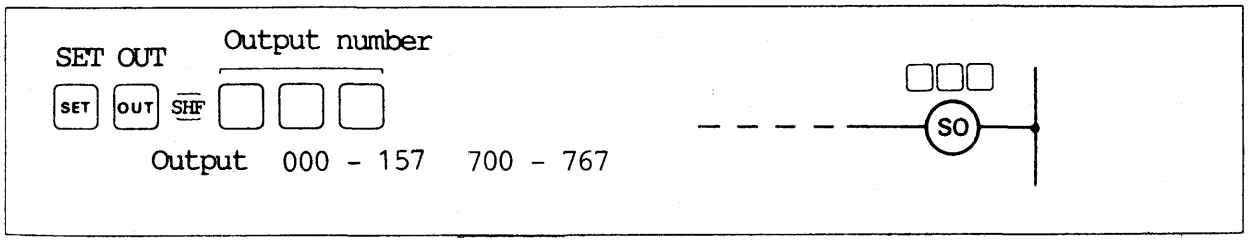


Features:
1. This is the instruction to output or operate the internal relay. If all conditions (contact instructions) programmed before this instruction are satisfied, the proper output or internal relay will be on. But if all conditions are not satisfied, the proper output or internal relay will be off.
2. Only one OUT instruction to one output or internal relay can be written.
3. The output written by the OUT instruction will be off whenever the pause relay is on regardless of the condition satisfied. But the output to be off is only the output sent out from the output module, and the internal realy is not influenced. When the output is used for the contact as the condition, the contact used in the internal circuit will not be off even if the ouput module is off.
4. Example of usage

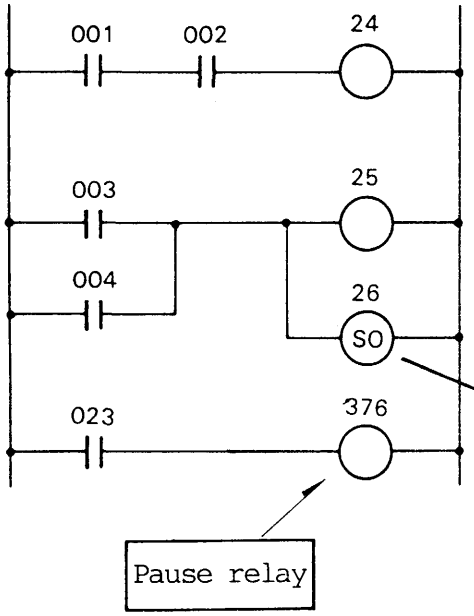


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(2) SET OUT: Set out instruction



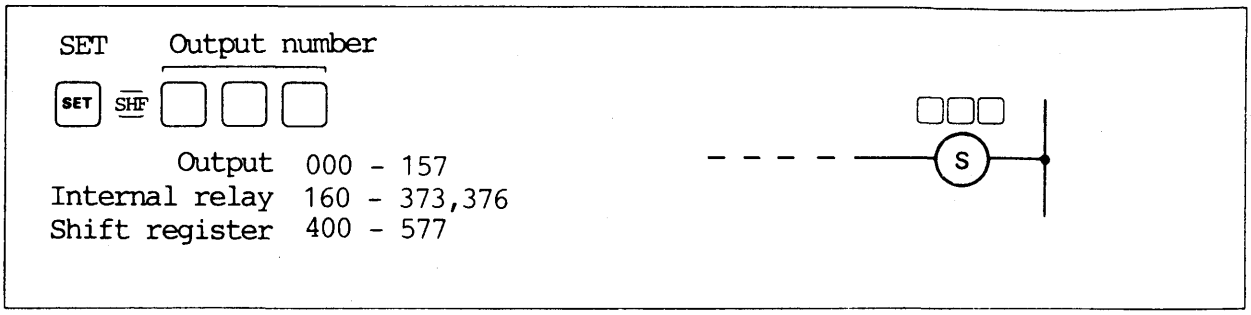
Features: 1. This is the output instruction not influenced by the pause relay. Other features are same as with the OUT instruction.
2. Use this SET OUT instruction for the instruction that should not be OFF even when the external output will be turned OFF by the pause relay.
3. Example of usage



STR	1
AND	2
OUT	24
STR	3
OR	4
OUT	25
SET OUT	26
STR	23
OUT	376

The output 26 is not turned OFF even when the pause relay is turned ON.
The outputs 24 and 25 are turned OFF when the pause relay is turned ON.

(3) SET instruction



Features: 1. This is the instruction to output or turn ON internal relay but different with OUT instruction. If the output or internal relay are once ON, it will continue to be ON even when the condition is not satisfied, and it will not be OFF. This is the instruction equal to the coil of the keep relay.
2. It is possible to write SET instruction many times to one output or internal relay.
3. It is possible to turn on any bit of the shift register by the SET instruction.
4. The external output which is turned ON by the SET instruction will not be inhibited even when the pause relay is ON.

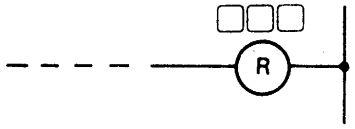
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(4) RESET instruction

Reset Output number

RST SHF □□□

Output	000 - 157
Internal relay	160 - 373, 376
Shift register	400 - 577

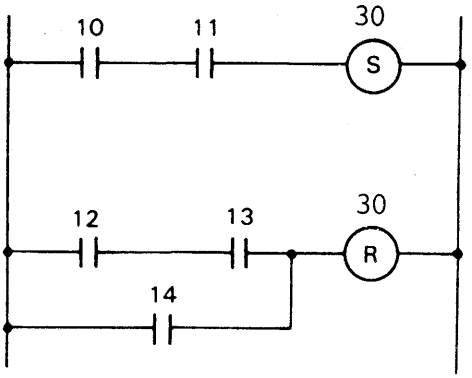


Feature: 1. This is the instruction to turn OFF the output or internal relay turned ON by SET instruction.

2. When the SET instruction is not satisfied but the RESET instruction is the output or internal relay will be turned OFF from the ON status.

3. It is possible to turn OFF any bit of the shift register turned ON by the RESET instruction.

4. Example of usage



Program

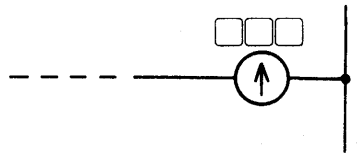
STR	10
AND	11
SET	30
STR	12
AND	13
OR	14
RST	30

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(5) Differential instruction

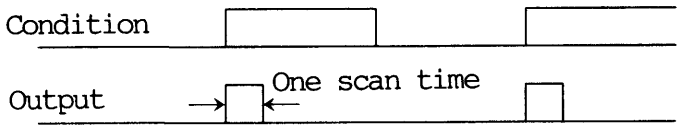
SET OUT RESET Output number



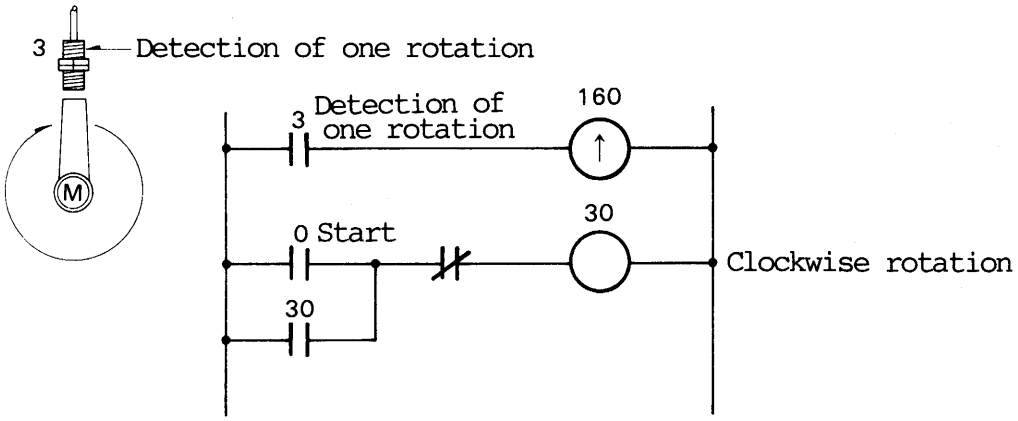


Output 000 - 157, 700 - 767
Internal 160 - 373, 376
relay

Feature: 1. This is the output instruction to instantaneously turn ON only for one scan when the condition is satisfied.

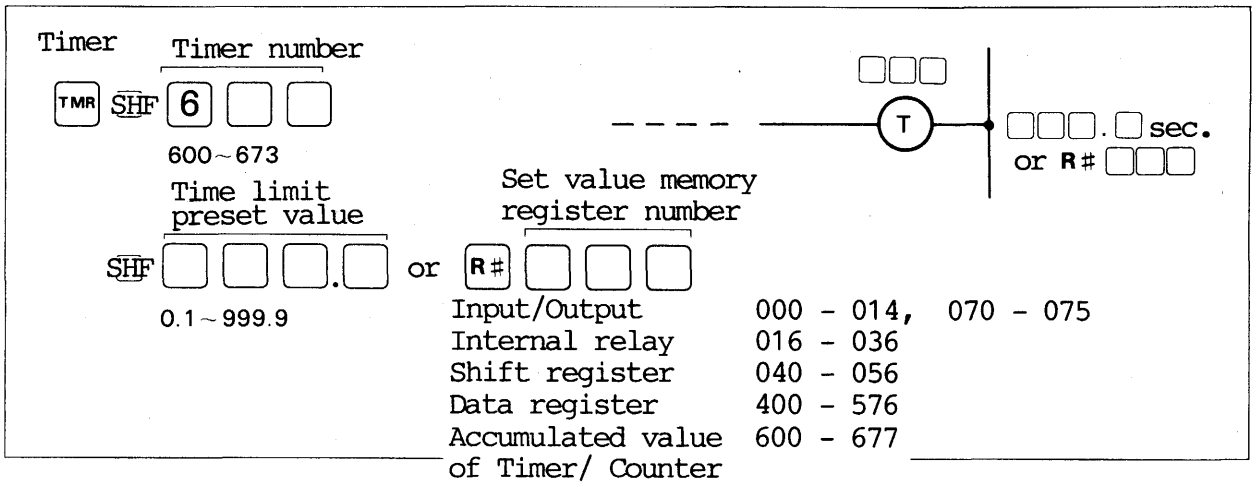


2. One output or internal relay number cannot be used in duplicate.
3. Example of usage: Operation to stop after one rotation when the start instruction is turned ON



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2-8. Timer



Feature: 1. This is the instruction to operate a timer, and fubctions the same as the coil of the timer does.

2. The TMR instruction is composed of two words. It is necessary to have a time-limit preset value in the second word.

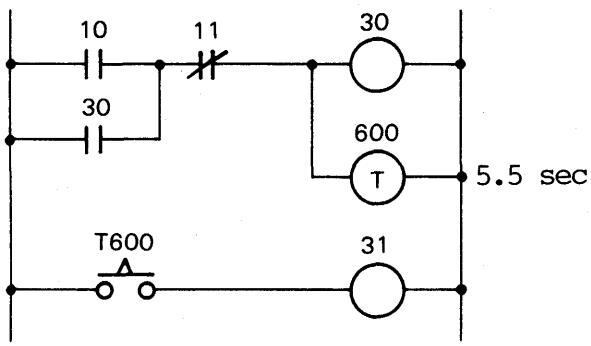
3. The time-limit preset value can be set in units of 0.1 sec from 0.1 sec to 999.9 sec. It may be all right to omit the setting for the number after the decimal point if not necessary.

4. When the condition is satisfied, the timer will start counting of the time in a clock counting of 50 ms.

5. The tolerance of time is -50ms for negative counting and two-scan time for positive counting. the precision of the basic clock for the long period of clock is within 0.01%.

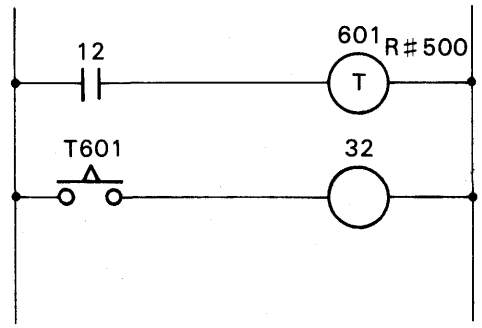
6. If the time limit preset value is set by the register number, the specified time-out operation will not be made in the case of the BCD code not used as the data memorized in the register number.

7. Example of usage (1)



STR	10
OR	30
AND NOT	11
OUT	30
TMR	600
	5.5
STR TMR	600
OUT	31

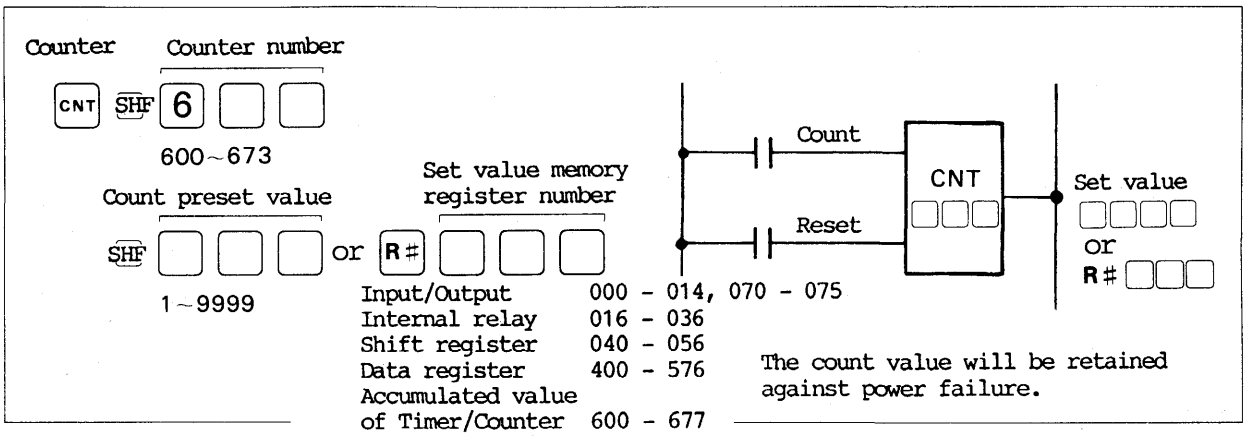
8. Example of usage (2)



STR	12	
TMR	601	
	R# 500	
STR TMR	601	The data memorized in the data
OUT	32	registers 500 and 501 will be
		the set values.

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2-9. Counter



Feature: 1. This is the instruction to operate a counter.

2. The CNT instruction is composed of two words. It is necessary to have a count preset value in the second word.

   For specifying a direct set value for the method of specifying the count preset value, write in the preset value after depressing the [SHF] key. For the method to specify by the register number which memorizes the preset value, write in the register number after depressing the [R#] key. If the preset value is specified by the register number, the specified count-out operation will not be made in the case of the BCD code not used as the data memorized in the register.

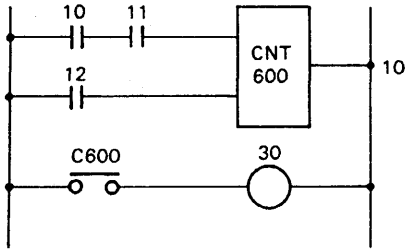
3. There are two inputs for the counter. One is the count input and the other is the reset input.
   The reset input is used for the STR instruction (or a group of instructions to start with STR) just before the CNT instruction. The count input is used for the STR instruction (or a group of instructions to start with STR) just before the previous STR instruction to the CNT instruction.

4. The number assigned for the counter can be from 600 to 673 is in the same range with the timer. But the same number used for the timer cannot be used for the counter. The same counter number cannot be used for other counter in duplicate.

5. The maximum count speed is for one-scan ON and one-scan OFF. But at least four scan-times will be needed in consideration of delaying of the input module or gap of the phases between the input and the scan.

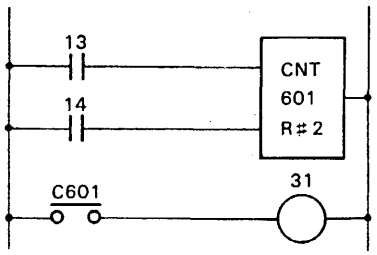
   Thus, if it takes 10 ms for one scan (in case of about 500 words of the number of program), the maximum count speed is about 25 counts per second.

6. Example of usage (1)



STR	10
AND	11
STR	12
CNT	600
	10
STR CNT	600
OUT	30

Example of usage (2)

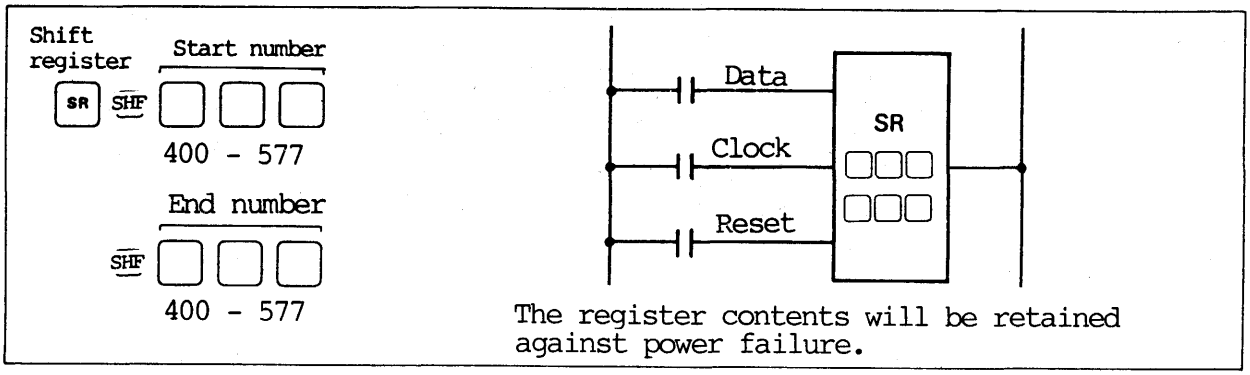


STR	13
STR	14
CNT	601
	R# 2
STR CNT	601
OUT	31

The preset values (BCD codes) will be the ON/OFF statuses of inputs 20 to 37.

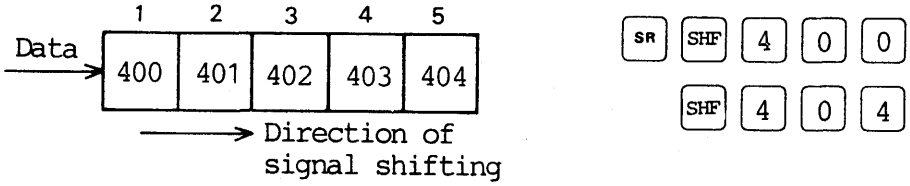
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2-10. Shift register



Feature: 1. This is the instruction to organize and operate the shift register.

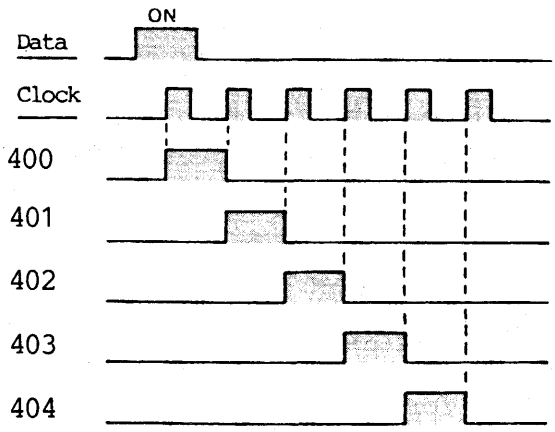
2. The SR instruction is composed of two words. The first bit of bits to be assigned for the shift register is the start number, and the last bit is the end number.



As shown above, the start number is 400 and the end number is 404 in the case of 5-bit shift register.

3. When the clock input rises (to be ON) under the ON condition of the data input, the start bit will be ON. Then the bit being ON in the register will be shifted (moved) at the same time for one bit toward the end number.

Time chart

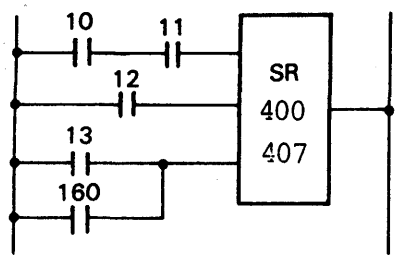


4. When the reset input is turned ON, all bits in the shift register will be OFF.

5. There are three inputs such as the data input, clock input, and reset input for inputs of the shift register.
The reset input is used for the STR instruction (or a group of instructions to start with STR) just before the SR instruction. The clock input is used for the STR instruction (or a group of instructions to start with STR) just before the above STR instruction.
The data input is used for the STR instruction (or a group of instructions to start with STR) before the above two STR instructions.

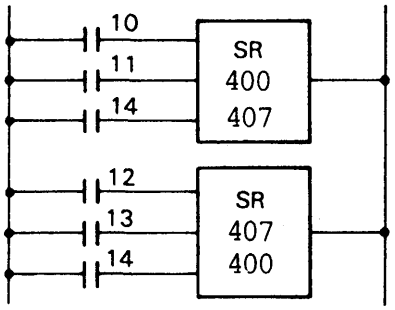
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Example

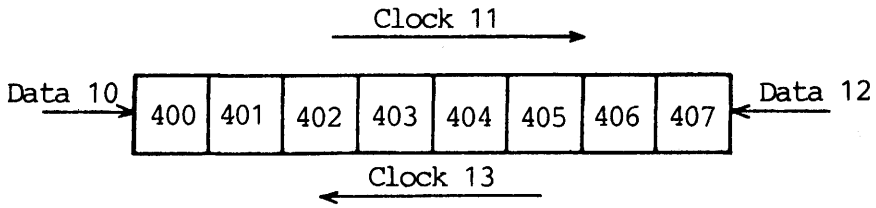



```
STR   10 ]
AND   11 ]  Data input
STR   12    Clock input
STR   13 ]
OR   160 ]  Reset input
SR   400 ]
     407 ]  Shift register instruction
```

6. The response speed is about 25Hz at maximum.
   It is necessary to check for OFF of one scan and ON of one scan at leasst to detect a rising of the clock signal. And four scans in total are necessary in consideration of phases of the scan time and clock signal because two scans for ON/OFF operation are required for each. The scan time is about 10ms in the case of 500 words of the program number. Then 10ms times four is 40ms. Thus the maximum response speed is 25Hz.
7. Two-directional shift register is organized as shown below.



As shown in the left, a two-directional shift register is organized if two shift registers are organized in the same range by connecting a start bit of one shift register with an end bit of other shift register.

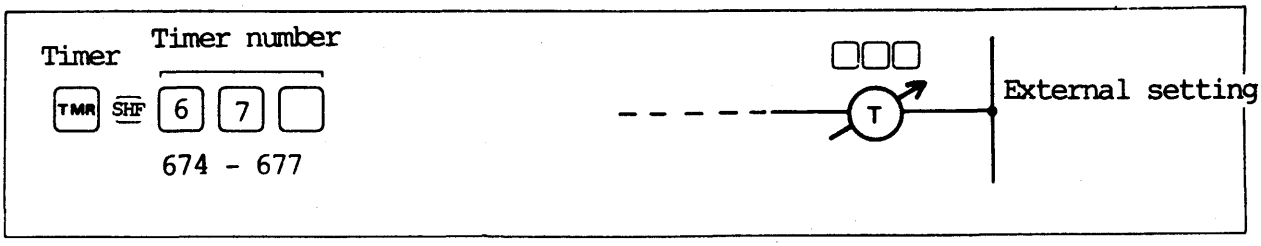


8. Set and reset operations in the middle of shift register
   This is the output instruction used for the keep-relay. By using the SET instruction and RST instruction, it is possible to turn ON or OFF any bit which is a part of the shift register. The ON or OFF bits will be shifted by the clock signal. However you must be careful with the timing of SET instruction and RST instruction application not to apply before and after the clock at the same time. Because these application of instructions before and after the clock will turn ON or OFF two bits in continuation.

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2-11. Timer/Counter specialized for external setting

Timer instruction



Feature: 1. This is the instruction to operate the external setting module (E-01D) as a timer.

2. Time setting can be made by the external setting unit. Then the second word for time setting is not necessary.

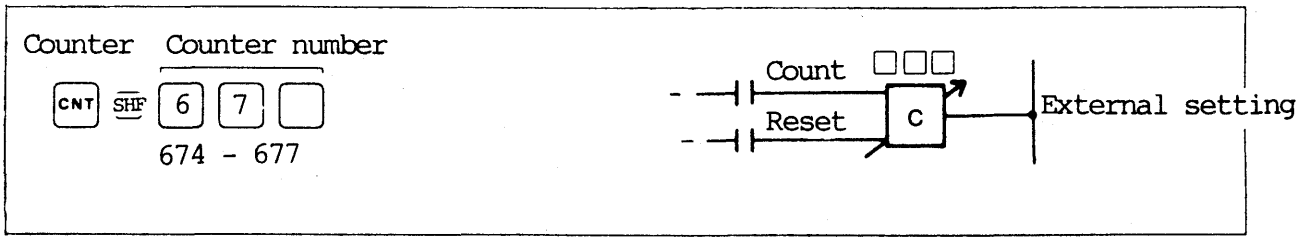
3. Timer numbers from 674 to 677 are assigned. Other numbers cannot be assigned.

4. The digit number of the external setting unit is four. It is possible to set any number from 0.1sec to 999.9sec.

5. One unit of E-01D has four timers/counters and uses up all the above assigned numbers (674 - 677).

6. E-01D can be installed in any location of the basic base (base with CPU).

Counter instruction



Feature: 1. This is the instruction to operate the external setting module (E-01D) as a counter.

2. Count setting can be made by the external setting unit. Then the second word for count setting is not necessary.

3. Counter numbers from 674 to 677 are assigned. Other numbers cannot be assigned.

4. The digit number of the external setting unit is four. It is possible to set any number from 1 to 9999.

5. Only one E-01D can be used for one system. Any combination can be made for using four timers and counters in total to function them as timers or counters.

Example: #674, #675, #676 used as timers

#677: used as a counter

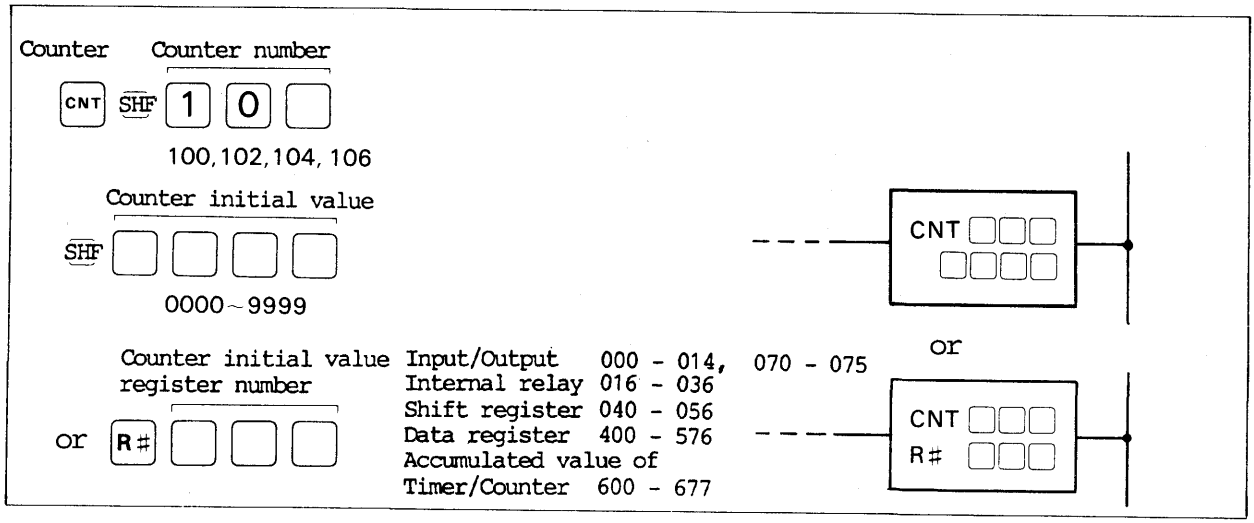
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2-12. High-speed up-down counter

E-01Z has a high-speed up-down counter circuit and comparison circuit composed of the hardware for direct counting of the external count input. The initial value of the counter and comparison preset value can be written by the program instruction.

Refer to page A-101 for the method of usage in the specifications.

Counter intial value writing instruction



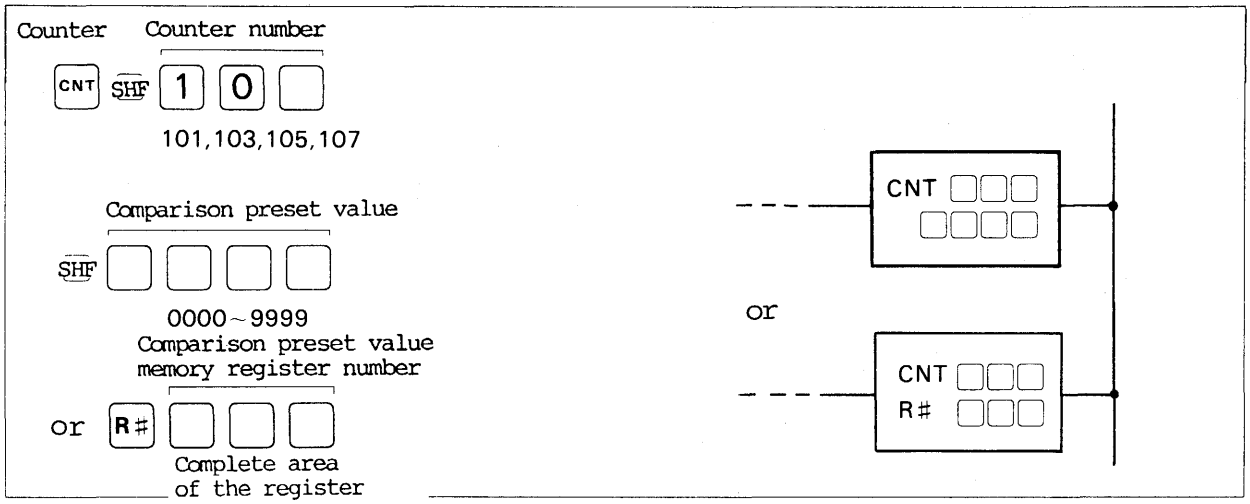
Feature: 1. The initial value will be written into the counter. For resetting the counter, write in 0000 by this instruction.

2. The counter number can be 100, 102, 104, or 106 depending on the location of the installed counter module.

3. For specifying the initial value by the register number, be sure to use the BCD code for the data of the register. The specified operation cannot be made if the binary code is used.

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Comparison preset value writing instruction



Feature: 1. The comparison value will be written into the comparison register of the counter.

2. The counter number can be 100, 102, 104, or 106 depending on the location of the installed counter module.

3. Writing can be made either in one scan or in continuation.

4. Write in the counter initial value if writing of the counter initial value and comparison preset value must be made at the same time.

5. For specifying the comparison preset value by the register number, be sure to use the BCD code for the specified register content. The specified operation cannot be made if the binary code is written.

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3. PROGRAMMING CONCEPT AND CIRCUIT EXAMPLE

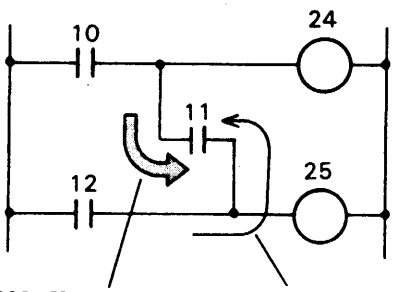
3-1. Programming concept

To use the programmable controller, programming must be processed according to the rule set for the relay circuit. The concept may be different by the difference of principle of basic operation between the magnetic relay panel and the programmable controller panel.

● Program processing in the progammable controller

1. The program will be read from address 0 to process operation. Then the flow of the signal will be forwarded to one direction only from front to back. The program written first will not be influenced by the program written later.

Example



STR	10
OUT	24
AND	11
OR	12
OUT	25

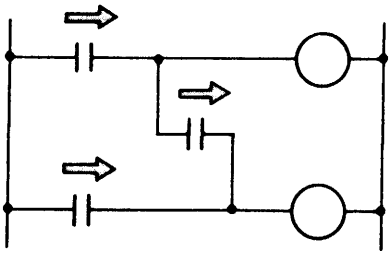
The signal will flow only in this direction.

No signal flow will be made in this direction.

In the above drawing, output 24 will be operated by the ON/OFF operation of input 10, but no influence will be given by inputs 11 and 12.

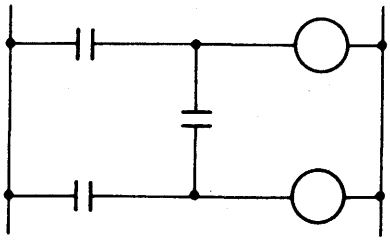
However, output 25 will be on if both inputs 10 and 11 turn on with input 12. A contact point must be drawn vertically. The signal should be defined to flow left to right.

Correct writing



(The direction of signal flow can be understood.)

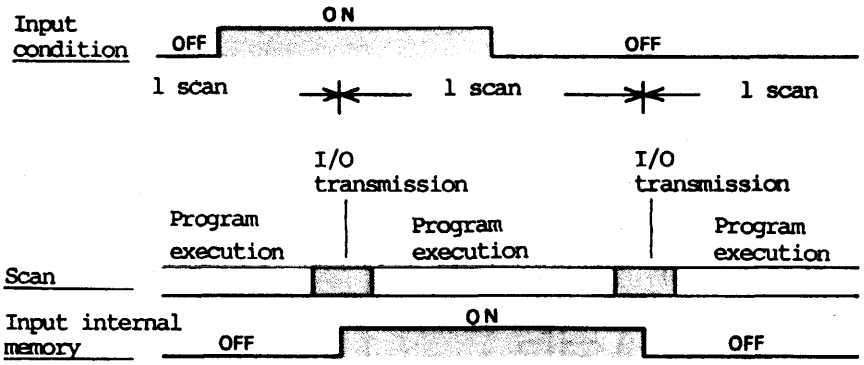
Incorrect writing



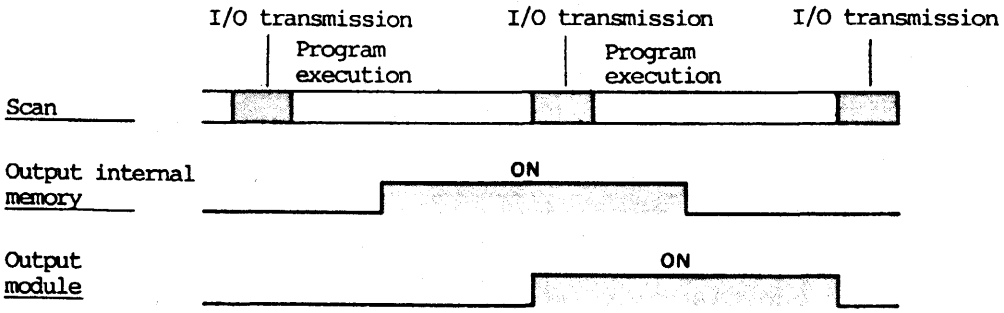
(The direction of signal flow is uncertain.)

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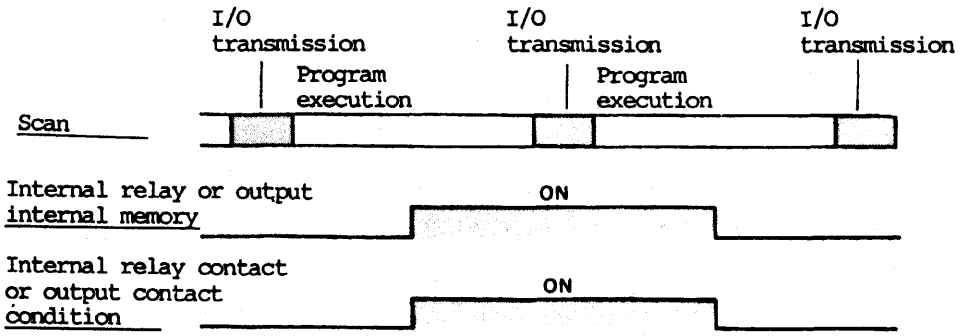
2. All inputs are received at once at the beginning of scan and kept in the memory of internal memory. (Receiving made during the time of I/O transmission.)
Receiving of input during program execution is made for the input signal kept in the internal memory. Thus the input signal during one scan will not be changed.
This means that input instructions before and after the program will receive signals of the same condition.



3. The output processed by the execution of program is kept once in the internal memory. And all outputs will be given to the output module at once during the time of I/O transmission after program execution.



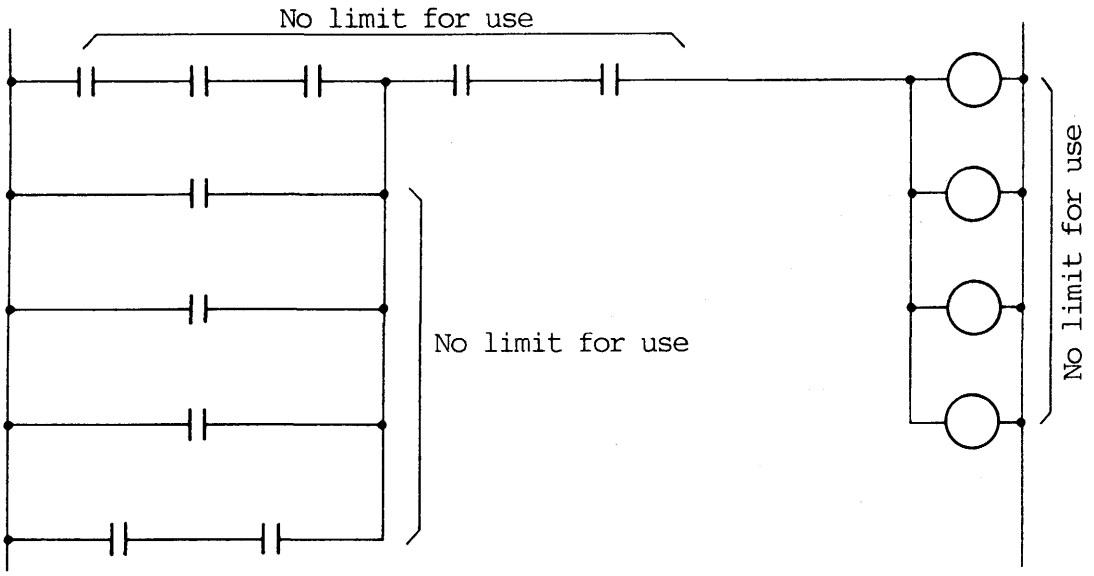
4. The operation of internal relay will be changed immediately by the program execution. The time delay will not be observed as in the case of input and output.
The output signal can be used for internal relay and will be changed immediately by the program execution as in the case of internal relay because the memory of output internal memory is also used in this case.



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● Number of uses of circuit elements

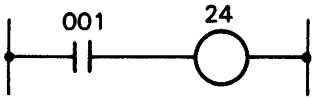
1. The input contacts connected with the programmable controller can be used as many times as necessary on the circuit and as the normal close contacts with NOTs attached to the instructions.
2. The number of uses of contacts for the internal relay, timer, counter, and shift register are not limited. These contacts can be used as normal close contacts by attaching NOTs to the instructions.
3. The output to the output module will function as the internal relay and can be used for functioning as a contact in the circuit. This output can be a normal close contact with NOT attached to the instruction. The number of uses of this output are also not limited.
4. The same number for the output, internal relay, timer, and counter cannot be used for programming by such commands as OUT, TMR, and CNT in duplicate, but can be used by such instructions as SET and RST.
5. The I/O number assigned for the I/O module not in use can be used for the internal relay.
6. The contacts and outputs for configuring a circuit block can be used as much as necessary with no limit on numbers.



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3-2. Circuit examples of relay contacts

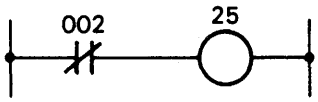
● Normal open contact



Program

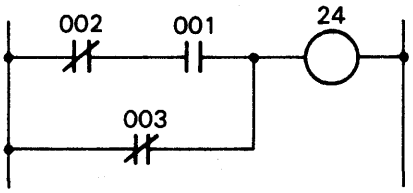
STR	1
OUT	24

● Normal close contact

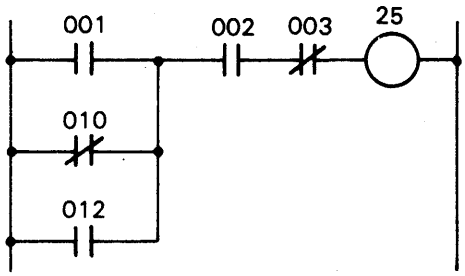


STR NOT	2
OUT	25

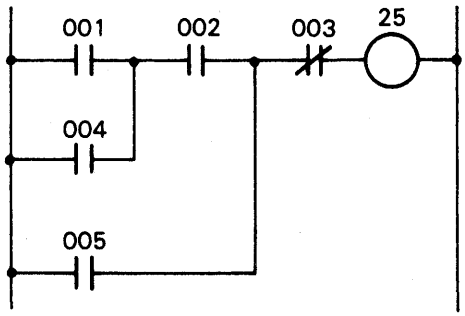
● Combination of AND and OR



STR NOT	2
AND	1
OR NOT	3
OUT	24



STR	1
OR NOT	10
OR	12
AND	2
AND NOT	3
OUT	25



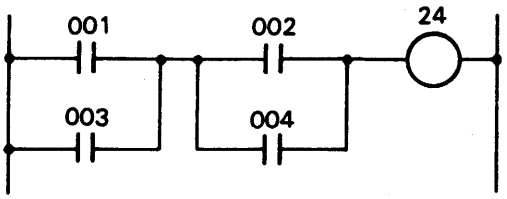
STR	1
OR	4
AND	2
OR	5
AND NOT	3
OUT	25

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3-3. Combination of contact block

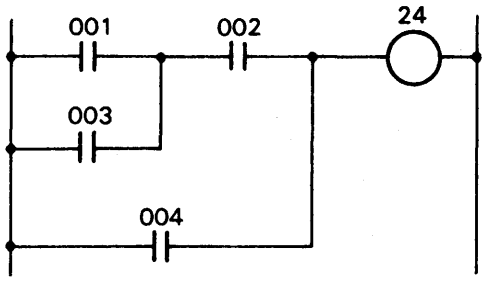
The following circuit cannot be connected by the combination of STR, AND, and OR. In this case, divide the circuit into a circuit block that can be connected first. Then combine each with blocks after completing connections in the block.

Example

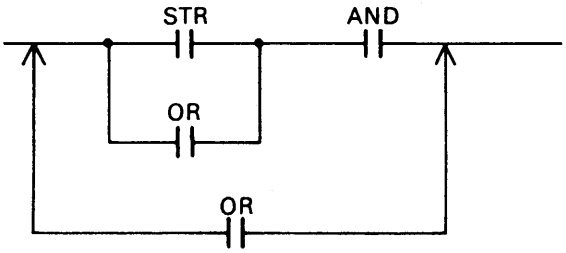


If programming is made like this

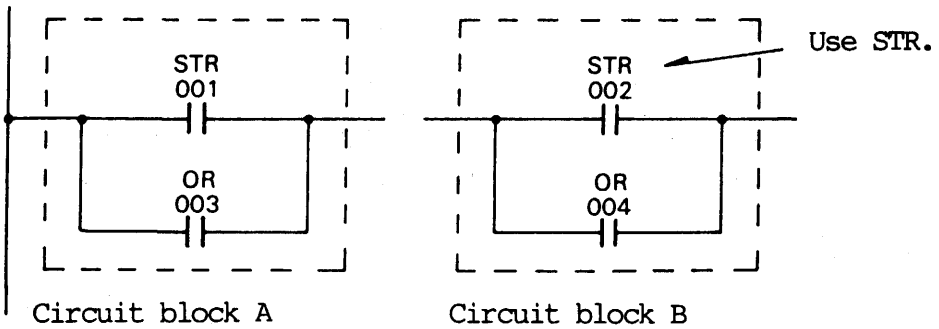
STR	1
OR	3
AND	2
OR	4
OUT	24



The reason to reach the above result is that the combination is made in parallel with OR instruction and a group of contacts starting with STR. with STR.



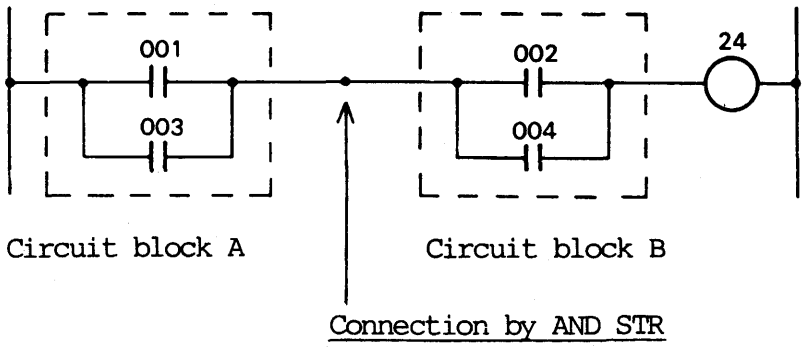
(1) Divide the circuit into the following groups of circuit to configure a circuit as specified.



Use STR instruction at the beginning of contact with the concept that the independent circuit is configured within a block of circuit.

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(2) Then connect the circuit blocks to each other.



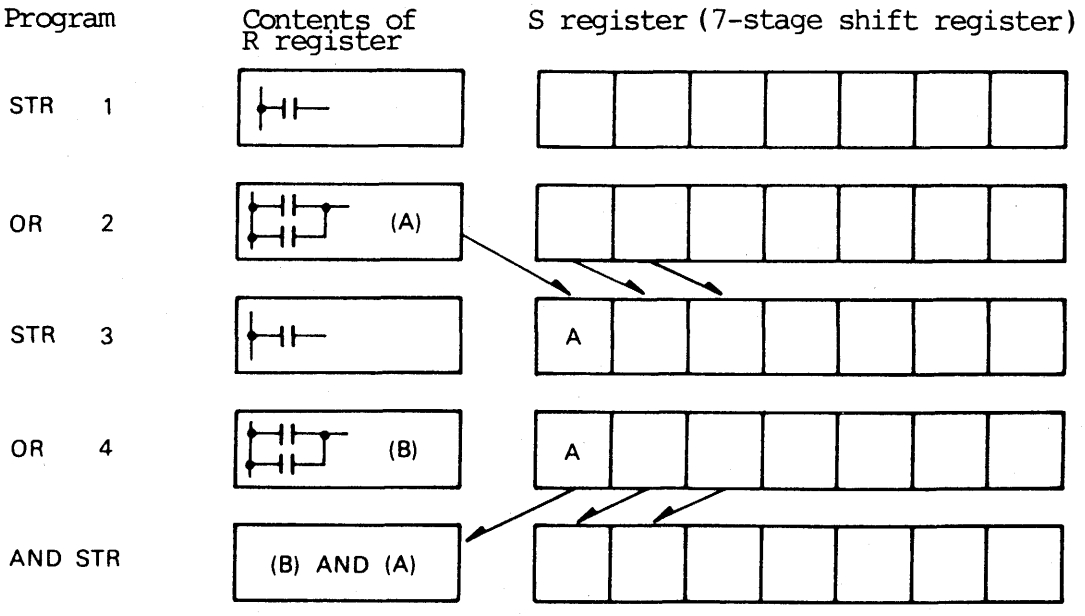
(3) Program

STR	1	Block A
OR	3	
STR	2	Block B
OR	4	
AND STR		Serial connection of A and B
OUT	24	

(4) Reason to be possible of block combination

The operation result register (R register) to retain the operation result is always found in the operation process unit (ALU) to carry out the operation according to the program.

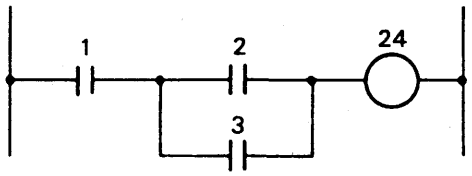
When the STR instruction is executed, a new signal (to show if the stored) contact point is ON or OFF) will be given into the R register. In this case, the operation result up to this moment must be put aside into the S register for later use.



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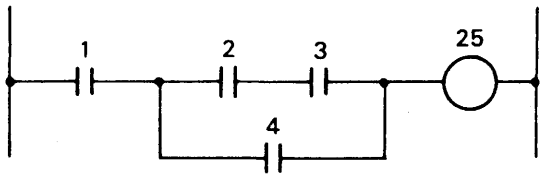
When the block connection instruction (AND STR) is executed, the operation result finished before the beginning of S register will be called out for AND operation (serial connection) with the content of the R register to complete the connection of the blocks to each other.

● AND STR instruction connection in series



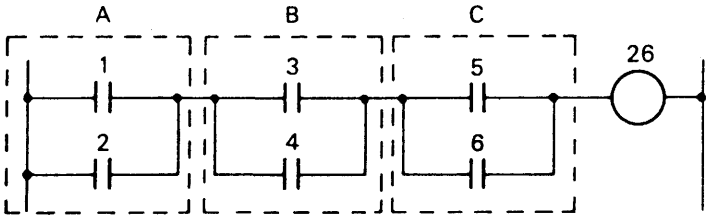
Program

STR	1
STR	2
OR	3
AND STR	
OUT	24



STR	1
STR	2
AND	3
OR	4
AND STR	
OUT	25

● Three-block connection in series



In the above example, there are two ways for block connection.

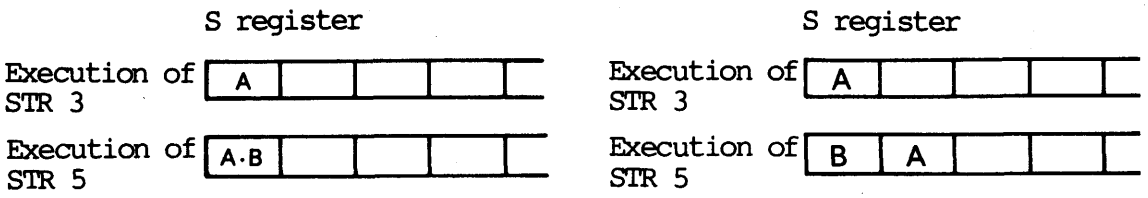
A. Programming for each step of connection

STR	1	Block A
OR	2	
STR	3	Block B
OR	4	
AND STR		Connection of A and B
STR	5	Block C
OR	6	
AND STR		Connection of (A·B) and C
OUT	26	

B. Programming for connecting in a group

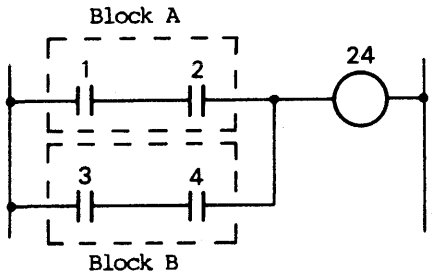
STR	1	Block A
OR	2	
STR	3	Block B
OR	4	
STR	5	Block C
OR	6	
AND STR		Connection of C and B
AND STR		Connection of (C B) and A
OUT	26	

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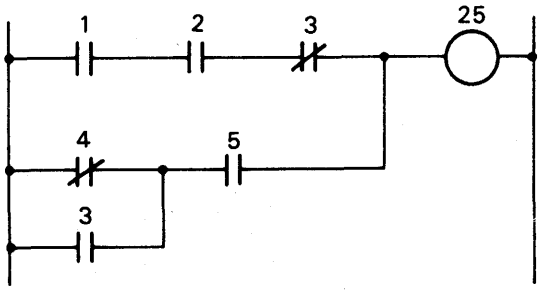
Two levels of the S register memory in the case of method B. Method A is recommended for connecting more than eight blocks because the memory capacity of S register has a maximum of seven levels.

● OR STR connection in parallel



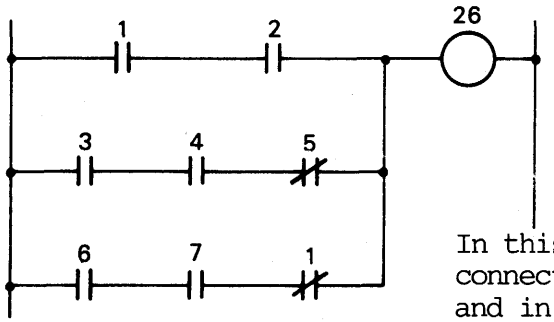
Program

STR	1	Block A
AND	2	
STR	3	Block B
AND	4	
OR STR		Connection of A and B
OUT	24	



STR	1
AND	2
AND NOT	3
STR NOT	4
OR	3
AND	5
OR STR	
OUT	25

● Three-block connection in parallel



In this example, there are also two ways of connection, such as connecting for each step and in a group, as in the serial connection. Either connection can be made, but the limit of connectable blocks for group connection is eight. (Seven instructions in the case of using OR STR for connection.)
More than eight blocks of connection are possible for connecting each step.

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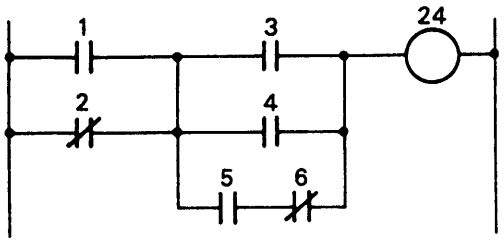
Programming

STR	1	Block A
AND	2	
STR	3	Block B
AND	4	
AND NOT	5	
OR STR		Connection of A and B
STR	6	Block C
AND	7	
AND NOT	1	
OR STR		Connection of (A + B) and C
OUT	26	

Programming

STR	1	Block A
AND	2	
STR	3	Block B
AND	4	
AND NOT	5	
STR	6	Block C
AND	7	
AND NOT	1	
OR STR		Connection of C and B
OR STR		Connection of (C + B) and A
OUT	26	

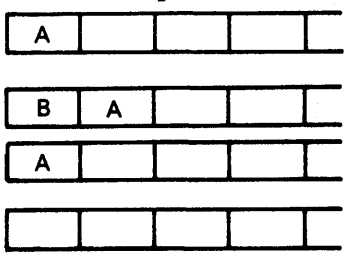
● Connection by using both AND STR and OR STR



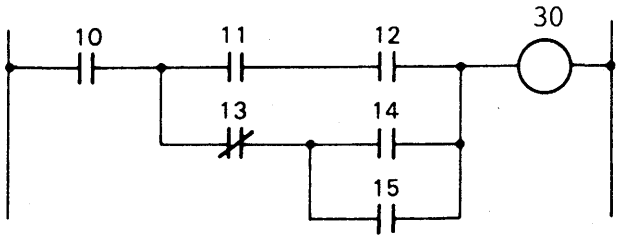
Program

STR	1	Block A
OR NOT	2	
STR	3	Block B
OR	4	
STR	5	Block C
AND NOT	6	
OR STR		Connection of C and B
AND STR		Connection of (C + B) and A

S register



For group connection, the connection should be made backward from the last block to the previous block. Because the construction enables picking up the block earlier even it was put in later for picking up the memory from the S register.

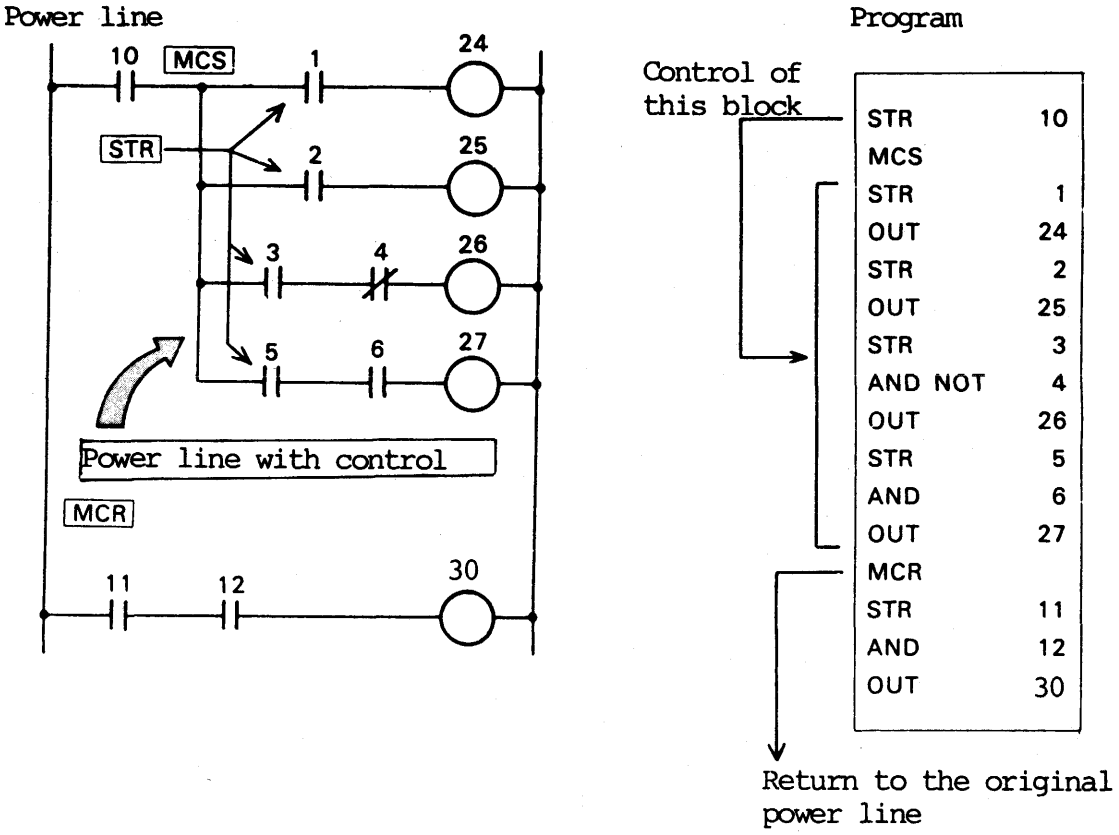


STR	10
STR	11
AND	12
STR NOT	13
STR	14
OR	15
AND STR	
OR STR	
AND STR	
OUT	30

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3-4. Master control (power line control)

● It is possible to build up a power line with a control feature to include a contact point condition by the MCS instruction.



Program a condition to control a power line for entering the MCS. The circuit to start with the STR instruction for later programming will be connected to the point where MCS is entered.

● MCR instruction

MCR instruction is necessary to return to the original power line after power line control by the MCS instruction.

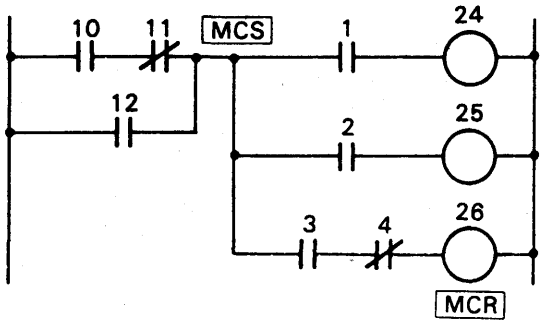
Caution:

MCS instruction should be used in a pair by having the same number of instructions. If the number is different, correct operation cannot be made.

E06 (error code) will be displayed if the number of MCR instructions is larger than the number of MCS instructions as a result of the grammer check for comparing the number of MCS instructions and MCR instructions.

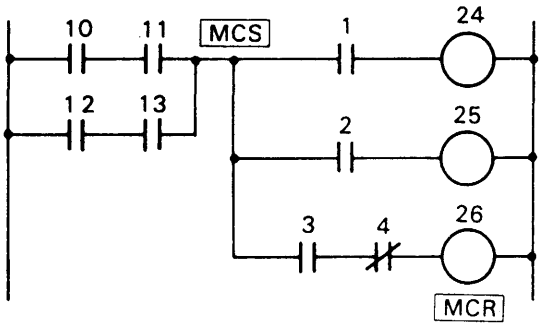
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● Combination of master control condition

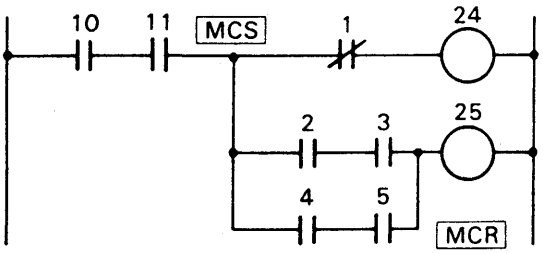


Program

STR	10
AND NOT	11
OR	12
MCS	
STR	1
OUT	24
STR	2
OUT	25
STR	3
AND NOT	4
OUT	26
MCR	



STR	10
AND	11
STR	12
AND	13
OR STR	
MCS	
STR	1
OUT	24
STR	2
OUT	25
STR	3
AND NOT	4
OUT	26
MCR	

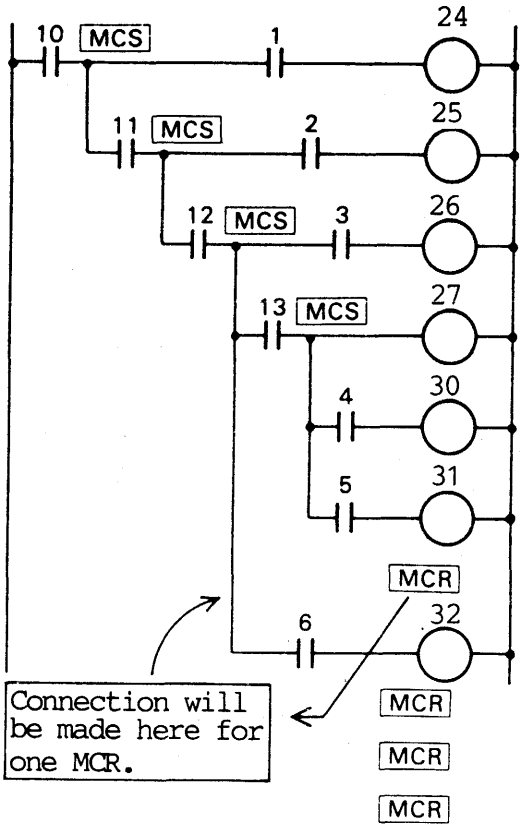


STR	10
AND	11
MCS	
STR NOT	1
OUT	24
STR	2
AND	3
STR	4
AND	5
OR STR	
OUT	25
MCR	

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● Multiple use of master control

It is possible to accumulate the master control condition up to seven blocks. When the MCS instruction is used for multiple numbers in accumulation, the same number of MCR instructions with MCS instructions is necessary for returning to the original power line because one MCR instruction will return one level backward of MCS instruction.



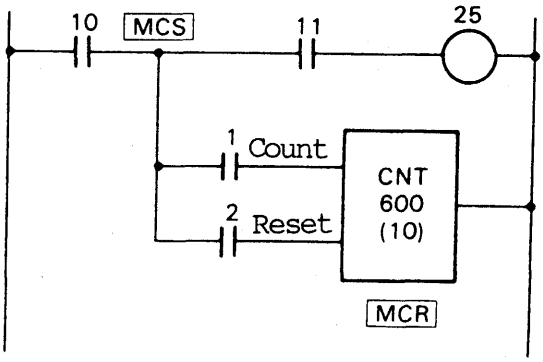
Program

STR	10	STR	5
MCS		OUT	31
STR	1	MCR	
OUT	24	STR	6
STR	11	OUT	32
MCS		MCR	
STR	2	MCR	
OUT	25	MCR	
STR	12		
MCS			
STR	3		
OUT	26		
STR	13		
MCS			
OUT	27		
STR	4		
OUT	30		

● Counter in the process of master control

(1) Counting and reset will not be made until the master control condition is satisfied.

(2) One count will be made if the master control condition is satisfied when the count contact point is on.



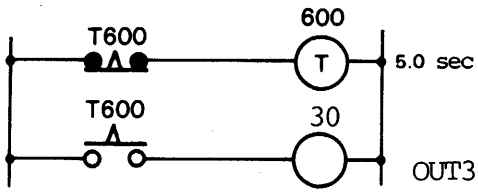
Program

STR	10
MCS	
STR	11
OUT	25
STR	1
STR	2
CNT	600
	10
MCR	

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3-5. Example of timer circuits

● resetting by the timer's own contact
(The timer is reset in one scan.)

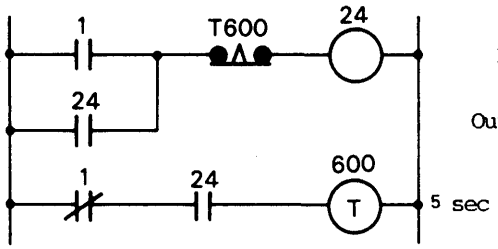


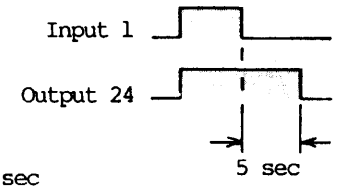
OUT30 will be ON
once for one scan
for every five seconds.

Program

STR NOT TMR	600
TMR	600
	5
STR TMR	600
OUT	30

● Off-delay timer

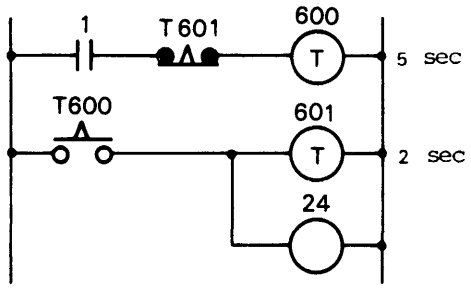


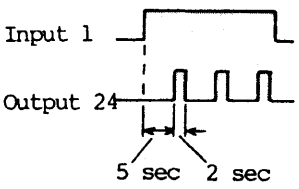


Program

STR	1
OR	24
AND NOT TMR	600
OUT	24
STR NOT	1
AND	24
TMR	600
	5

● Flicker timer



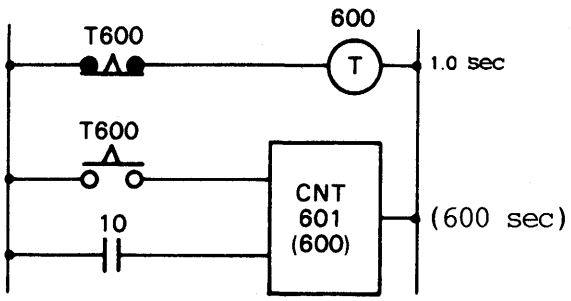


Program

STR	1
AND NOT TMR	601
TMR	600
	5
STR TMR	600
TMR	601
	2
OUT	24

● Power failure retention timer

The timer will be reset when the power source is turned off.
The counter for power failure retention can be used instead
of the timer to keep the memory of accumulated time, even during
power failure.



Program

STR NOT TMR	600
TMR	600
	1
STR TMR	600
STR	10
CNT	601
	600

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● Long-time timer

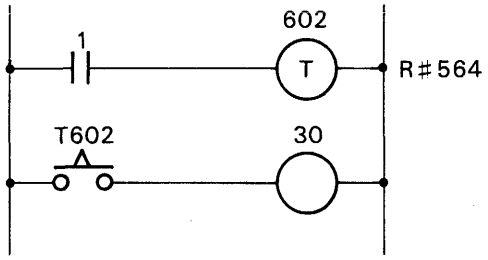
The power failure retention timer mentioned in page B-39 ("Power failure retention timer") can serve as a long-time timer by setting T600 for a larger number (for example, 60 sec).

● Contacts of timer

The contacts of the timer accessible on one timer are not limited in numbers, either for normal open contact or normal close contact.

● External setting timer

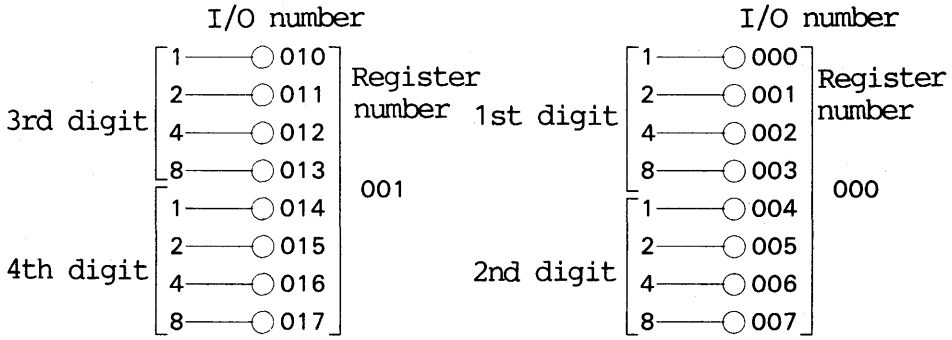
1. If the timer/counter external setting module (E-01D or F-10D) is installed, the timer/counter numbers from 674 to 677 can be used only for the external setting timer.
2. If the timer/counter external setting module (F-10D) is installed, the set value will automatically be written in the data register from 564 to 573. If the register number is specified as the set value, the regular timer can also function as the external setting timer.

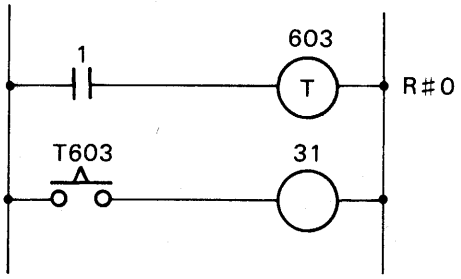


Program

STR	1
TMR	602
	R#564
STR TMR	602
OUT	30

3. If the register number to correspond to the input number is written into the second word (set value) of the timer command, the data input in the I/O module will be the set value.





Program

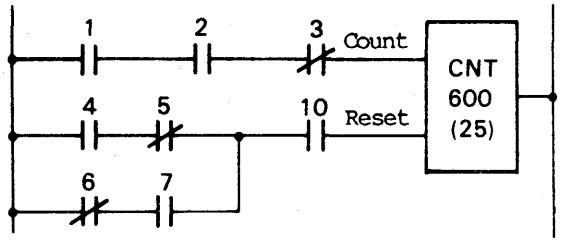
STR	1
TMR	603
	R# 0
STR TMR	603
OUT	31

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3-6. Example of counter circuits

● Input condition

There will be no limit on the count and reset input conditions.
Any combinations of AND, OR, NOT, and others are possible.



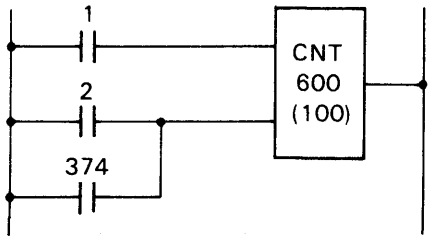
Program

STR	1
AND	2
AND NOT	3
STR	4
AND NOT	5
STR NOT	6
AND	7
OR STR	
AND	10
CNT	600
	25

● Counter output contact

There will be no limit on the number of uses of normal open contact and normal close contact.

● Counter resetting when the power source is turned ON
(The count value of the counter will be retained during power failure.)



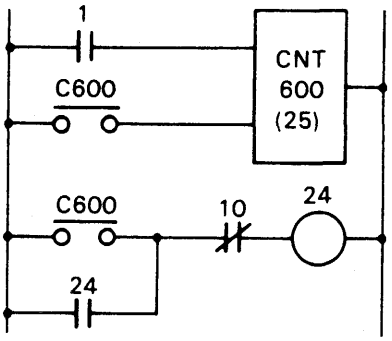
Program

STR	1
STR	2
OR	374
CNT	600
	100

Number 374 is the initial reset relay and will be ON only for one scan at the start of RUN.

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● Self-reset operation



Program

STR	1
STR CNT	600
CNT	600
	25
STR CNT	600
OR	24
AND NOT	10
OUT	24

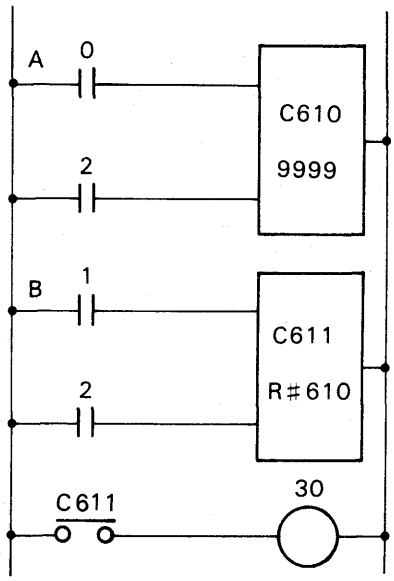
The output of counter 600 will be on for only one scan for count out, and will be off for the next scan. Thus, the self-retention by OUT 24 is necessary.

● External setting counter

1. If the timer/counter external setting module (E-01D or F-10D) is installed, the timer/counter number from 674 to 677 can be used only for the external setting counter.
2. If the timer/counter external setting module (F-10D) is installed, the set value will automatically be written in the data register from 564 to 573. If the register number is specified as the set value, the set value of the digital switch of F-10D will function as the set value of the counter.
3. If the register number to correspond to the input number is written into the second word (set value) of the counter command, the set value of the counter will be the value according to the condition of the external input.

● Trace counter

When the signal of B turns ON and OFF for the same number of ONs and OFFs of the signal of A, the accumulated value of the counter to count the number of the signal of A will be the set value of the counter to count the number of the signal of B.



Program

STR	0
STR	2
CNT	610
	9999
STR	1
STR	2
CNT	611
	R# 610
STR CNT	611
OUT	30

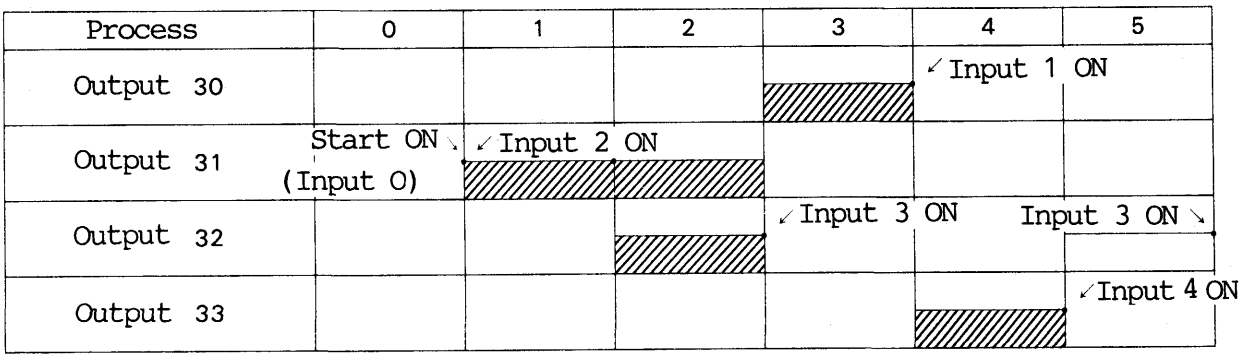
The accumulated value of CNT610 is the set value.

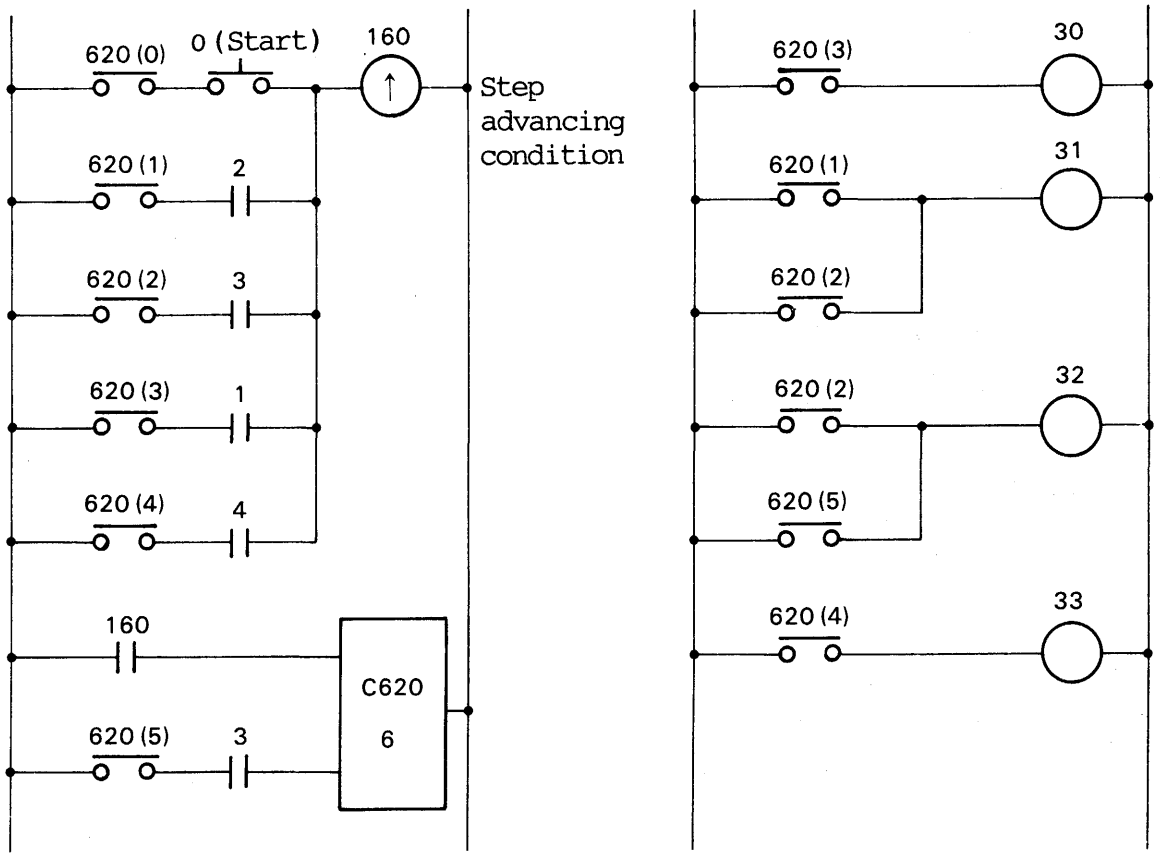
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● How to use as the drum sequencer

For programming the sequence by the process stepping method, you must write in a step advancing condition for the count input of the counter. The final process completion condition must be written for the reset condition of the counter. (The preset value of the counter can be any number.) The counter contact with the preset value must be used for the output condition of each process.

Time chart



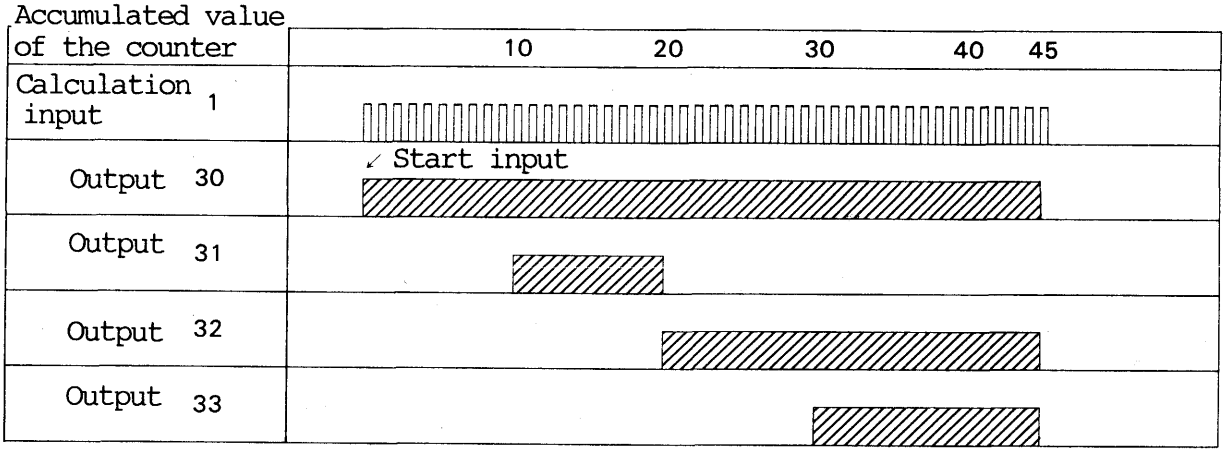


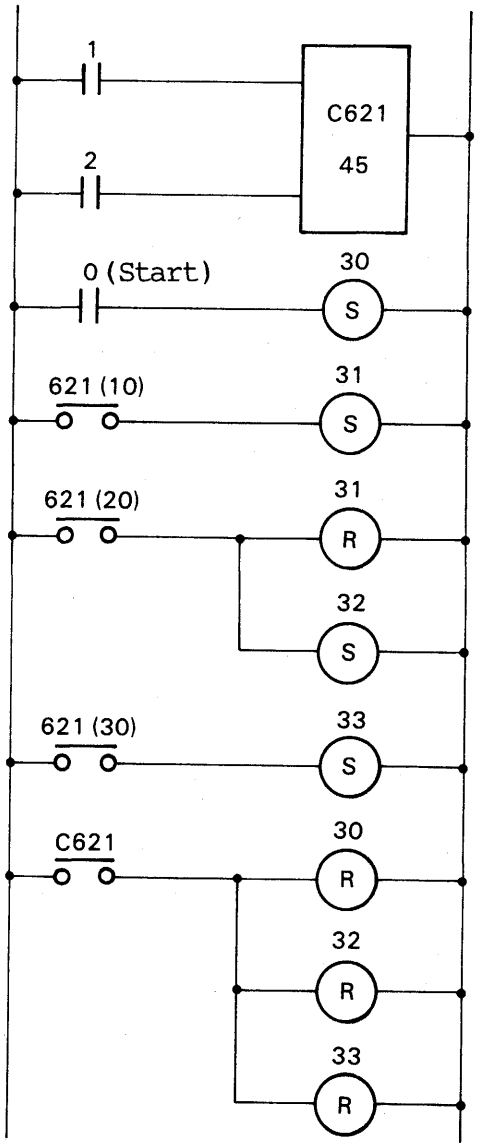
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● How to use as the multistage setting counter

If possible to meet with the count speed, the multistage setting counter can be accessible by using the counter contact with the set value.
(The constant is specified for the preset value in the example. But it is possible to use the external setting.)

Time chart





Program

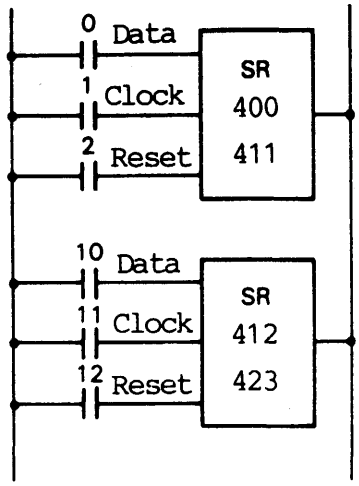
STR	1
STR	2
CNT	621
	45
STR	0
SET	30
STR	621
	10
SET	31
STR	621
	20
RST	31
SET	32
STR	621
	30
SET	33
STR CNT	621
RST	30
RST	32
RST	33

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3-7. Shift register

There is no special area assigned for the shift register.
Any number in the area of the internal relay can be used.

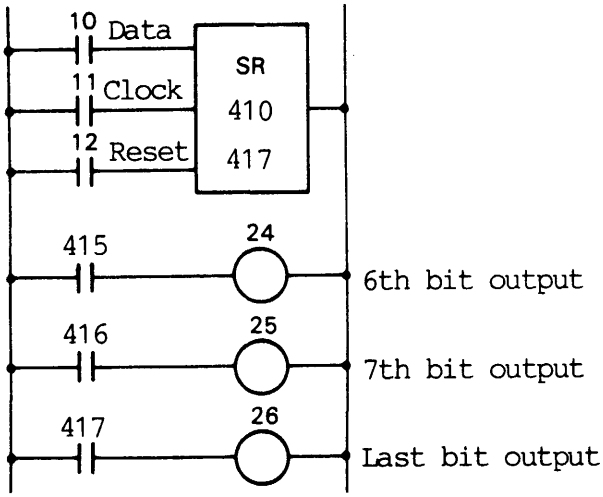
● Plural numbers of shift registers



Program

STR	0
STR	1
STR	2
SR	400
	411
STR	10
STR	11
STR	12
SR	412
	413

● Calling



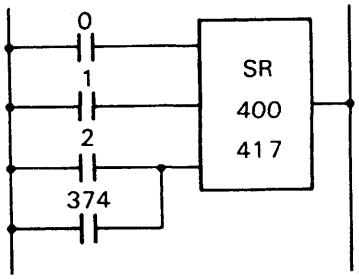
Program

STR	10
STR	11
STR	12
SR	410
	417
STR	415
OUT	24
STR	416
OUT	25
STR	417
OUT	26

Any coil can be used as the shift register. The contact of the coil can be freely used, as with regular output coil.

● Reset when the power source is turned ON

The shift register will retain memory during power failure.
The following arrangement is required whenever the reset operation is necessary for turning on the power source.



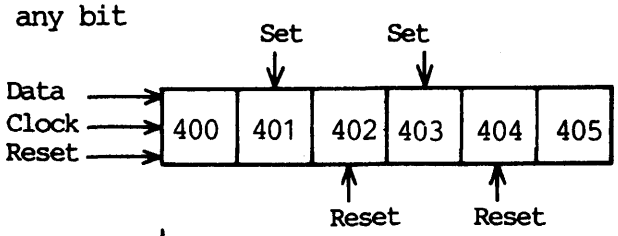
* "374" is the initial reset relay.

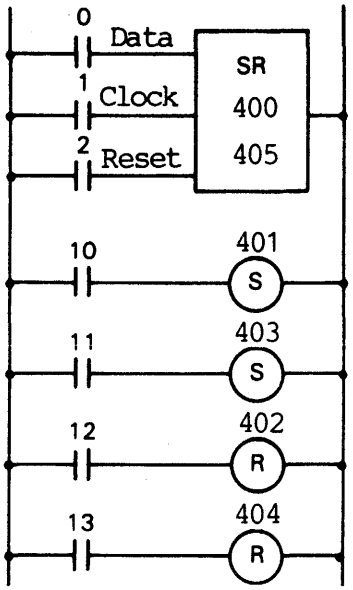
Program

STR	0
STR	1
STR	2
OR	374
SR	400
	417

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● SET and RESET of any bit



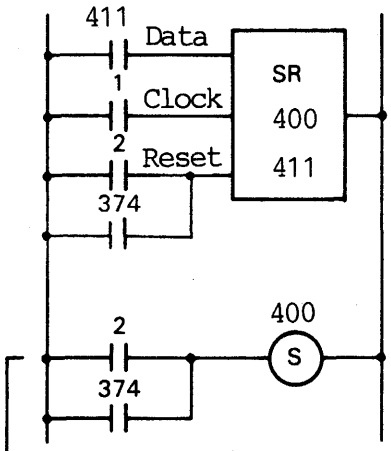


Program

STR	0
STR	1
STR	2
SR	400
	405
STR	10
SET	401
STR	11
SET	403
STR	12
RST	402
STR	13
RST	404

● Ring counter

The ring counter is accessible by using a signal of the last bit for data input of the shift register.



This command should be written after the SR instruction.

Program

STR	411
STR	1
STR	2
SR	400
	411
STR	2
OR	374
SET	400

This circuit is for turning on register 400 when the power source is turned on or reset is made.
Remove 374 of this area for memory retention in case of power failure.

● Set and reset type of keep relay

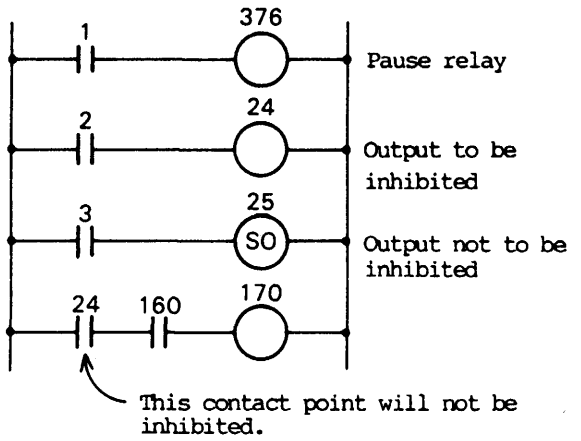
The bits of shift registers numbered from 400 to 577 and not used as shift registers can be used as keep relays, which can retain their memories against power failure by the SET instruction and RST instruction.

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3-8. Usage of special internal relay

● Pause relay (internal relay 376)

If this relay is turned ON, the external outputs written by the OUT instruction or SET instruction will be inhibited and will all be OFF at once. But the inhibited outputs will be for output modules only, and the output contacts used for the internal circuits will not be inhibited. The external outputs written by the SET OUT instruction will not be effected by inhibit.



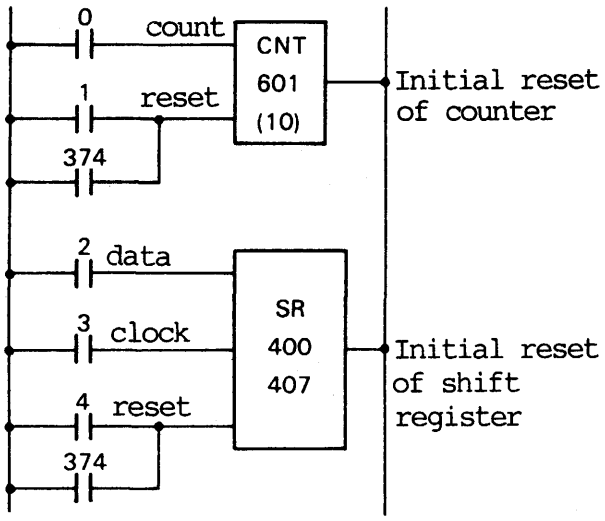
Program

STR	1
OUT	376
STR	2
OUT	24
STR	3
SET·OUT	25
STR	24
AND	160
OUT	170

Operation If input 2 is turned on, output 24 will be turned on. If input 3 is turned on, output 25 will be turned on. When pause relay 376 is turned on by turning input 1 on, output 25 will continue to be on, but output 24 will be turned off. And output contact point 24 will continue to be on without being influenced by the pause ralay.

● Initial reset relay (internal relay 374)

This is the relay to be on during the first scan only when the power source is turned on or when the mode is changed to the RUN mode. It will be used for the initial resetting of the counter or the shift register.



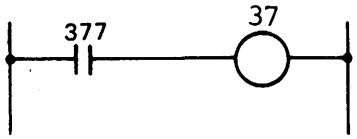
Program

STR	0
STR	1
OR	374
CNT	601
	10
STR	2
STR	3
STR	4
OR	374
SR	400
	407

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● Battery abnormality output (internal relay 377)

Whenever the voltage of the back up lithium battery for power failure of the memory circuit drops lower than a certain level, this relay will be turned on. To pick up the signal of the battery voltage drop, use the following circuit.

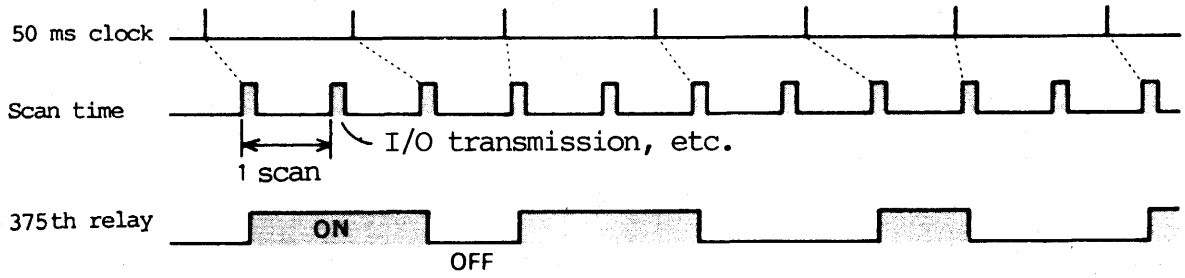


Program

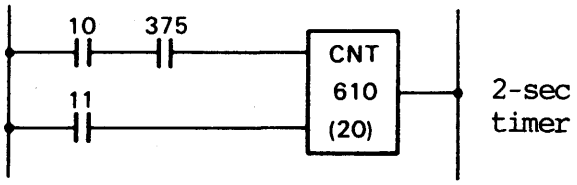
STR	377
OUT	37

● 0.1 sec clock relay (internal relay 375)

ON and OFF will be repeated by the clock signal every 50 ms. But the time length of being ON or OFF will not be constant because of the relation with the scan time. The normal operation will not be observed when the scan time exceeds 50 ms.



The counter input will operate as the timer when the clock relay contact is used for the counter input.



Program

STR	10
AND	375
STR	11
CNT	610
	20

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4. OUTLINE OF THE DATA PROCESS COMMAND

4-1. What is data?

(1) Bit and data

In the case of a normal sequence operation, two conditions of one point (ON and OFF) are handled. These operations may be enough for controlling the equipment limited only with ON and OFF conditions, such as the solenoid valve. But for controlling temperature and speed, it becomes necessary to know the condition in numerical values. It is also impossible to express by only two conditions of one point for classifying the kinds of products and dividing by rank of the inspected results. The data are the collection of these many conditions to be handled in the form of consolidation.

One data

ON (1)	OFF (0)	OFF (0)	ON (1)	ON (1)	OFF (0)	OFF (0)	OFF (0)	ON (1)	OFF (0)	ON (1)	ON (1)	OFF (0)	OFF (0)	ON (1)	ON (1)

For controlling the operation by the ON/OFF condition, as in the case of PC memory, many memories can be handled in the form of one data.

(2) Kinds of data

(a) Binary code data (binary number)

One bit (binary digit) is a unit to express either ON or OFF condition. A meaning of numerical value (weight of bit) is given according to the position of each bit for expressing the numerical value in a group of these bits.
The binary code is the most efficient method of giving weight to the bit for collecting two conditions and for giving a double weight to the bit whenever it is moved to the left by one. This kind of code is thus called the binary code (binary number).

Binary code data

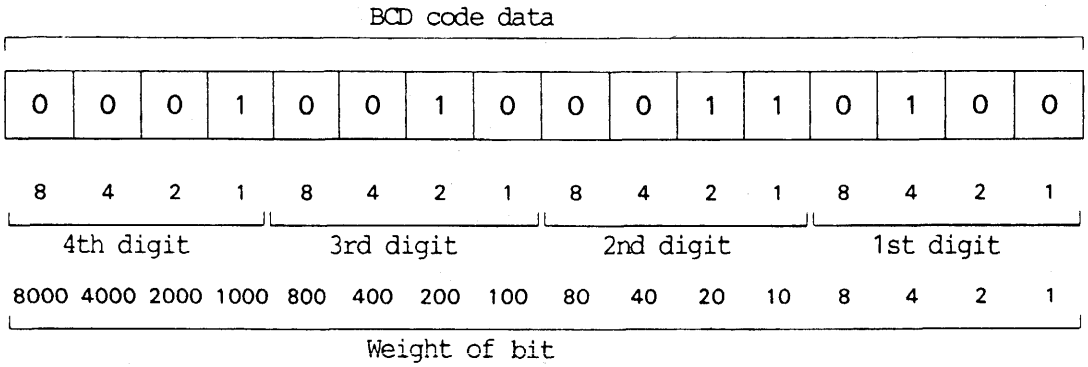
0	0	1	0	1	0	0	1	1	0	1	1	0	0	0	1
2^{15} (32768)	2^{14} (16384)	2^{13} (8192)	2^{12} (4096)	2^{11} (2048)	2^{10} (1024)	2^{9} (512)	2^{8} (256)	2^{7} (128)	2^{6} (64)	2^{5} (32)	2^{4} (16)	2^{3} (8)	2^{2} (4)	2^{1} (2)	2^{0} (1)

Weight of bit

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(b) BCD code data (binary coded decimal number)

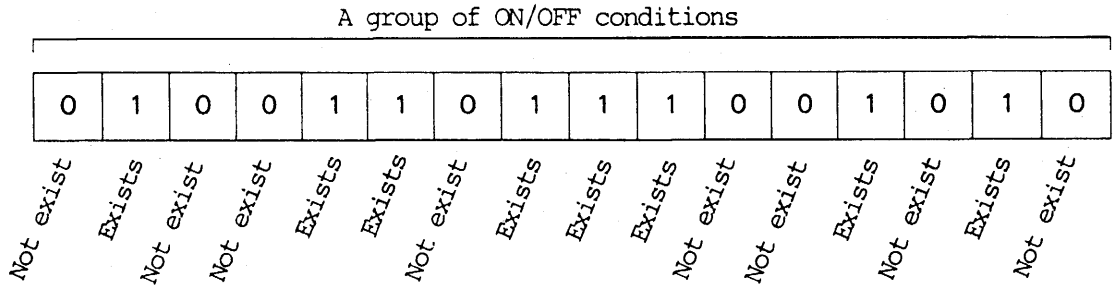
Usually, people use decimal numbers for numerical values. Then the BCD code is commonly used in the form of binary coding for each digit of the decimal number because of the difficulty of converting the binary code mentioned into the decimal number.



The BCD code data means 1 at the locations of 1,000, 200, 20, 10, and 4. If you then add all the weights of these bits, the result is the decimal number expressed as 1234. In the case of SR-21, numeric value is calculated by the BCD code.

(c) Data in the form of no numerical value

The data have a meaning of numeric value to express the weight of the bit according to its position, as in the case of binary code data or BCD code data. They also have one way of simply handling conditions all in one by deciding if the status of the position is ON or OFF to express the existence or nonexistence of the workpiece.

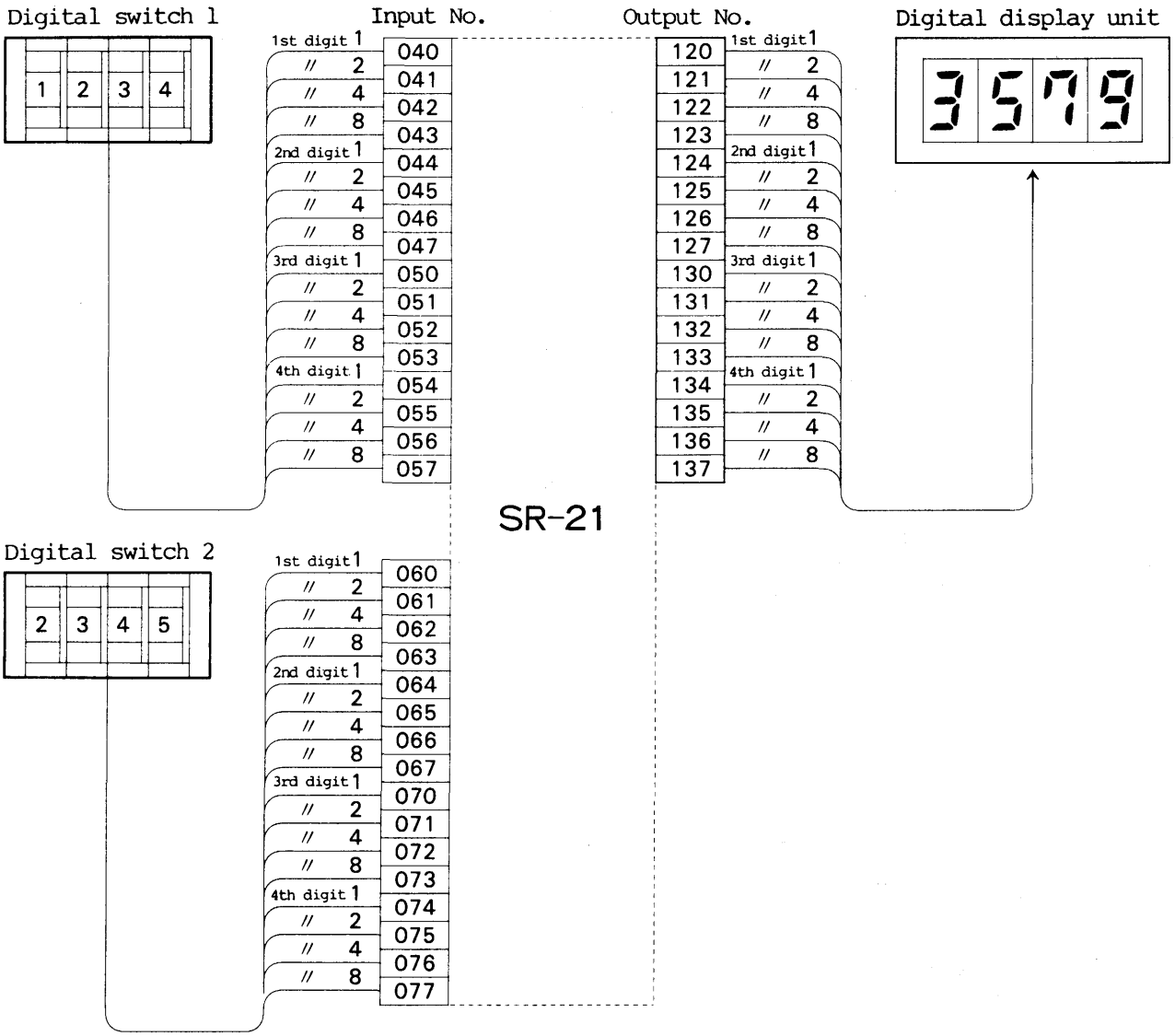


These data cannot be processed by the numerical calculation because they have no meaning of numerical values, but they can be processed for temporary memory, transferring, and logical operation.

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4-2. Example of data processing

The format of the data process command of KOSTAC series PCs is made to carry out the necessary data processing by combining the basic elemental commands the same as the bit process command. The following program describes a practical example to output the answer externally by adding data of two kinds of external inputs.



Data number

- The input signal of 4-digit BCD code from digital switch 1 is connected with input numbers 040 to 057. Then it is expressed as R#4 for the number to be handled as data.
- The input signal of 4-digit BCD code from digital switch 2 is connected with input numbers 060 to 077. Then it is expressed as R#6 for the number to be handled as data.
- The output signal of 4-digit BCD code to the digital display unit is connected with output numbers 120 to 137. Then it is expressed as R#12 for the number to be handled as data.

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Calculative equation

Content (1234) of register number 4 + content (2345) of register number 6

Programming command

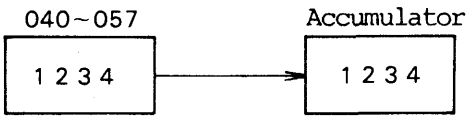
DSTR R# 4	+ R# 6	DOUT R#12
To the data input in R#4 (Digital switch 1)	Adding the data input in R#6 (Digital switch 2)	The answer is output to R#12. (Digital display unit)

Calculation example: 1 2 3 4 + 2 3 4 5 = 3 5 7 9

Program command execution procedure:

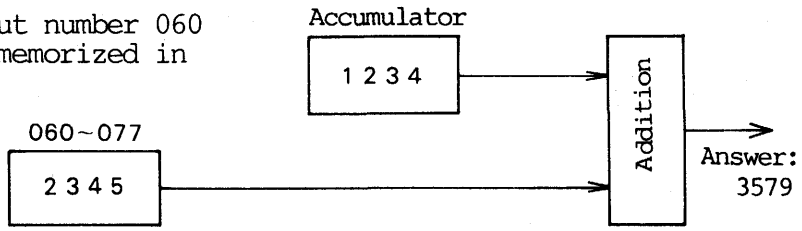
(1) DSTR R#4

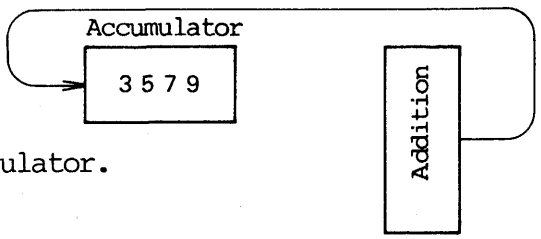
Read the data of input number 040 to 057 into the accumulator.



(2) + R#6

Add the data of input number 060 to 077 to the data memorized in the accumulator.

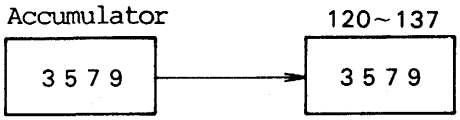




Memorize the answer in the accumulator.

(3) D OUT R#12

Output the data memorized in the accumulator to output numbers 120 to 137.



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4-3. How to designate data

(1) Direct designation and designation of number

There are two ways to designate an objective part of the command. One is to directly designate data, and the other is to designate the register number in which data are memorized.

(a) Direct designation of numerical value

This is to directly write data into the objective part of the command for handling. Designation can be made in a range of numbers from 0 to 9999. (The number is processed in the BCD code.)

Example:

```
DSTR
*1234
```

When this command is executed, 1234 is memorized in the BCD code into the accunulator.

(b) Designation of register number

This is to write the designation to memorize data into the objective part of the command for handling. For executing the command, the content of data in the designation for memory is used, and the symbol R# must be attached to designate a register number.

Example:

```
DSTR
R#4
```

If this command is executed, the data memorized in the register numbers 4 and 5 will be memorized into the accumulator.

(2) Register number

(a) Input/output, internal relay, and shift register

The input/output, internal relay, and shift register have both the bit number and the register number. To express the register number, the first digit of the bit number is omitted.

Bit number	000	010	400	410
	001	011	401	411
	002	012	402	412
	003	013	403	413
	004	014	404	414
	005	015	405	415
	006	016	406	416
	007	017	407	417
	↓↓	↓↓	↓↓	↓↓
Register number	000 R#	001 R#	040 R#	041

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As shown above, the register number is expressed by representing 8-bit numbers. The data process command uses the data of 16 bits, combining 8 bits of the designated register number and 8 bits of the next register number, because this command must normally be expressed in 16 bits.

(b) Data register

The data register is attached with the register number by the unit of 8 bits for the special use of the data process command.

(c) Accumulated value of timer and counter

The accumulated value of timer and counter is the BCD code image, memorized in the register of the same number with the timer and counter. The timer and counter receive only the BCD code value; thus, the binary code cannot be written into them.

(d) Table of register numbers

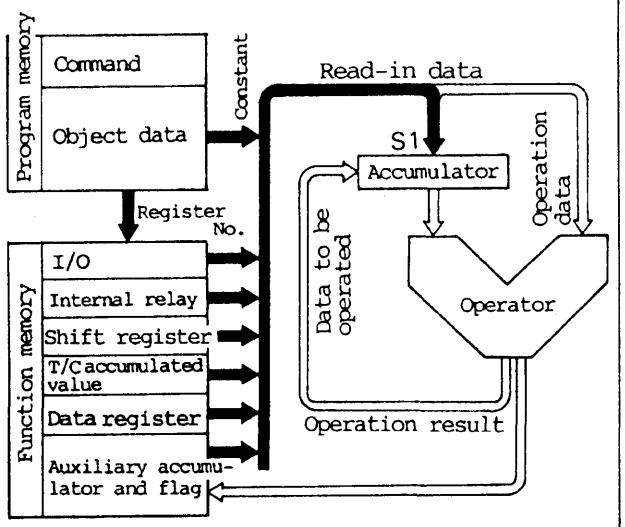
Item	Register number (Key in "R#" in front of the number)								
Input/Output	000	001	002	003	004	005	006	007	Numbers in 8-bit units
	010	011	012	013	014	015			
	070	071	072	073	074	075	076	077	077: Special relay
Internal relay							016	017	Numbers in 8-bit units
	020	021	022	023	024	025	026	027	
	030	031	032	033	034	035	036	037	
Shift register	040	041	042	043	044	045	046	047	Numbers in 8-bit units
	050	051	052	053	054	055	056	057	
Data register	400	401	402	403	404	405	406	407	Numbers in 8-bit units
	410	411	412	413	414	415	416	417	
	420	421	422	423	424	425	426	427	
	430	431	432	433	434	435	436	437	
	440	441	442	443	444	445	446	447	
	450	451	452	453	454	455	456	457	
	460	461	462	463	464	465	466	467	
	470	471	472	473	474	475	476	477	
	500	501	502	503	504	505	506	507	
	510	511	512	513	514	515	516	517	
	520	521	522	523	524	525	526	527	
	530	531	532	533	534	535	536	537	
	540	541	542	543	544	545	546	547	
	550	551	552	553	554	555	556	557	
	560	561	562	563	564	565	566	567	
	570	571	572	573	574	575	576	577	
Accumulated value of T/C	600	601	602	603	604	605	606	607	Number in BCD 16-bit (BCD code) units Note: Other codes than BCD code cannot be memorized.
	610	611	612	613	614	615	616	617	
	620	621	622	623	624	625	626	627	
	630	631	632	633	634	635	636	637	
	640	641	642	643	644	645	646	647	
	650	651	652	653	654	655	656	657	
	660	661	662	663	664	665	666	667	
	670	671	672	673	674	675	676	677	

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4-4. Data processing function

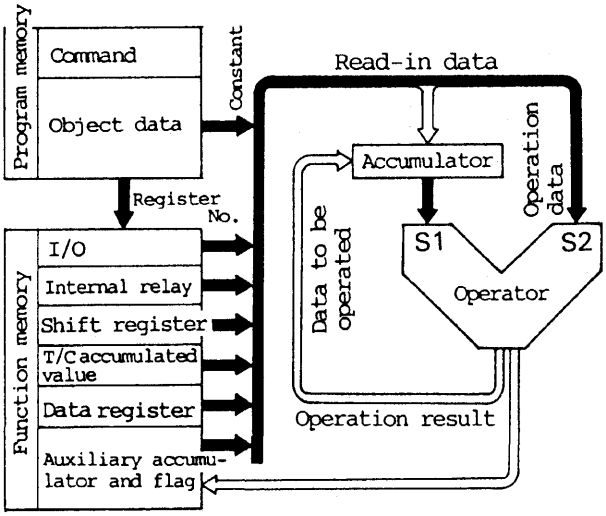
(1) Basic data flow

Data reading



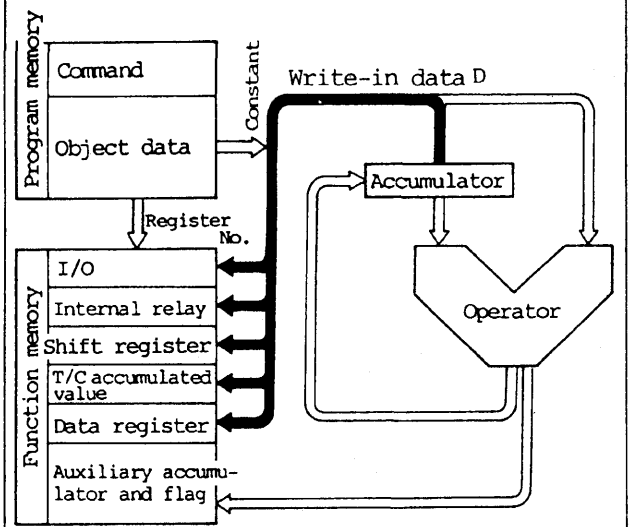
The designated numeric value by the command objective data and the content of the designated function memory number are read into the accumulator.

Two data operation

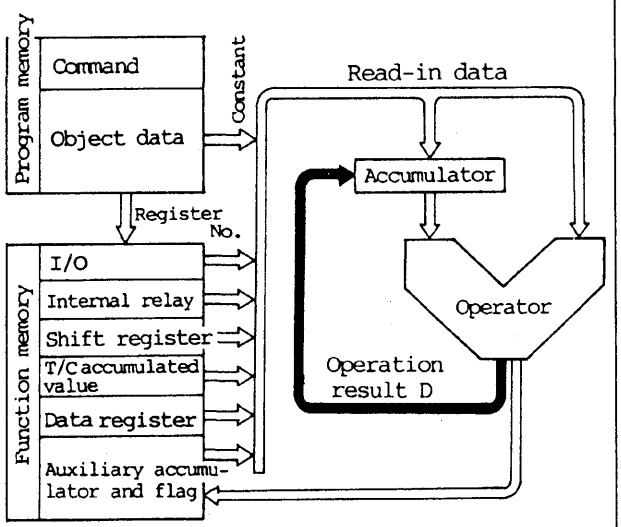


Suppose that the accumulator content is the data to be operated and the numeric value designated by the command objective data or function memory is the operation data; the operation should then be processed by the operation method designated by the command.
(The conversion command does not have S 2)

Data writing



The accumulator content is written into the function memory of the designated number by the command objective data.



The operation result is memorized in the accumulator.

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(2) Characters of the special registers

Item	Number	Objective command	Function
Accumulator (ACC)	None	All data process commands rather than the external diagnosing command	• The executed result of the command is memorized. • The contents of the accumulator are the data to be operated for the operation command. • The contents of the accumulator are the data to be converted for the conversion command. • The contents of the accumulator do not change for the data writing and comparison commands.
Auxiliary accumulator	R# 576 R# 577	Multiplication and division	• The answer from the 5th digit to the 8th digit is memorized for the multiplication command. • The 4-digit answer after the decimal point is memorized for the division command. • The contents of the auxiliary accumulator will be changed only by the multiplication command or division command.
External diagnosing register	R# 574 R# 575	External diagnosing command	• When the external diagnosing command is executed, the specified code is memorized. • If more than two commands are executed, the final command has the priority.

(3) Characters of the flag

The flag is used to show any result except the result of data for executing the data process command. Flags are arranged for certain commands and will change only when the arranged commands are executed, but they will keep their conditions if other commands are executed.

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Item	Number	Objective command	Function
Accumulator greater than	772	Comparison	Accumulator is greater than the compared data.
Accumulator equal	773	Comparison	Accumulator matches the compared data.
Accumulator smaller than	774	Comparison	Accumulator is smaller than the compared result.
Carry (borrow)	775	Addition Subtraction Right shift Left shift	Carry is ON for taking a figure up in addition and for taking a figure down in subtraction and when "1" is given for discarding fractions for shifts.
Zero	776	Operation Shift	The result of the command execution is "0".
Over	777	Arithmetic operation Write Conversion	The command objective data are not processed by the command.

(4) Locations of command designated data and accumulator

Input/Output Internal relay Shift register	Number designated by the command + 1								Number designated by the command							
	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
T/C accumulated value	T/C accumulated value number designated by the command															
	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
Data register	Number designated by the command + 1								Number designated by the command							
Constant	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
Accumulator	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Left (high order) — Right (low order)

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5. DESCRIPTION OF THE DATA PROCESS COMMAND

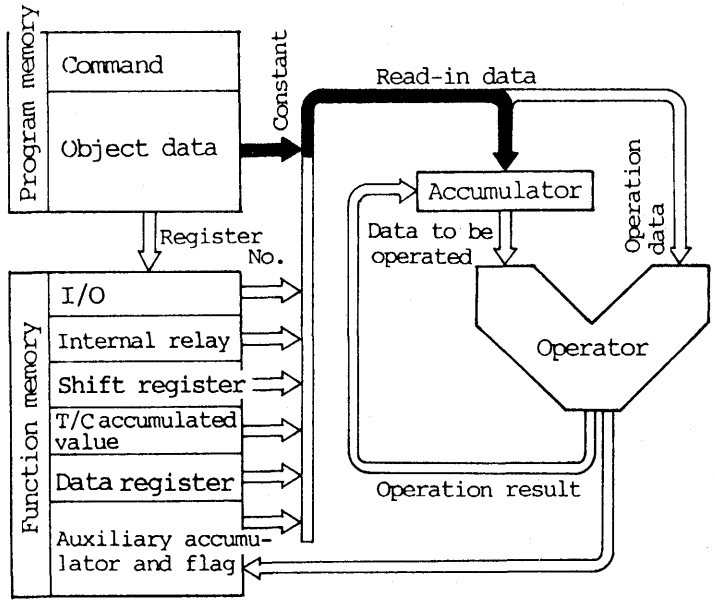
5-1. 16-bit reading, D STR (FUN50)

Reading data constant specification

The accumulator reads 4 digits of numerical value specified by the command in BCD code.

Symbol		DSTR F50 ✳□□□□
Instruction	Section for the command (1st word)	FUN 5 0
	Section for the object (2nd word)	SHF □ □ □ □ Data content to be read Constant 0000 - 9999
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	The content before execution of the command is cleared, and the read content is memorized.

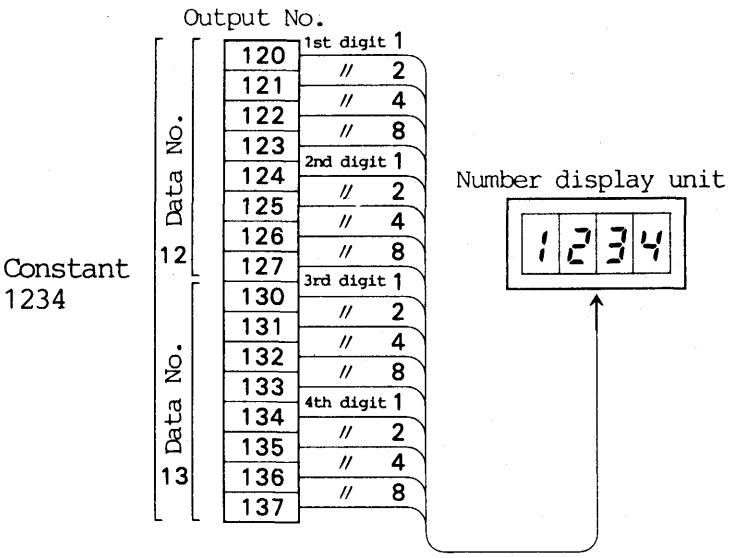
Data flow



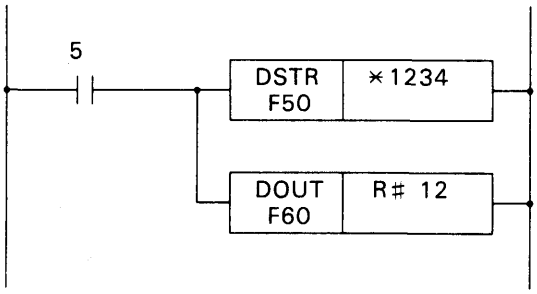
The accumulator reads 4 digits of constant specified by the second word of the command in BCD code.

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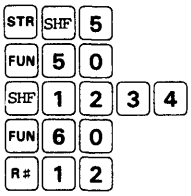
Example: Outputting of the constant 1234 to the output numbers 120 to 137.



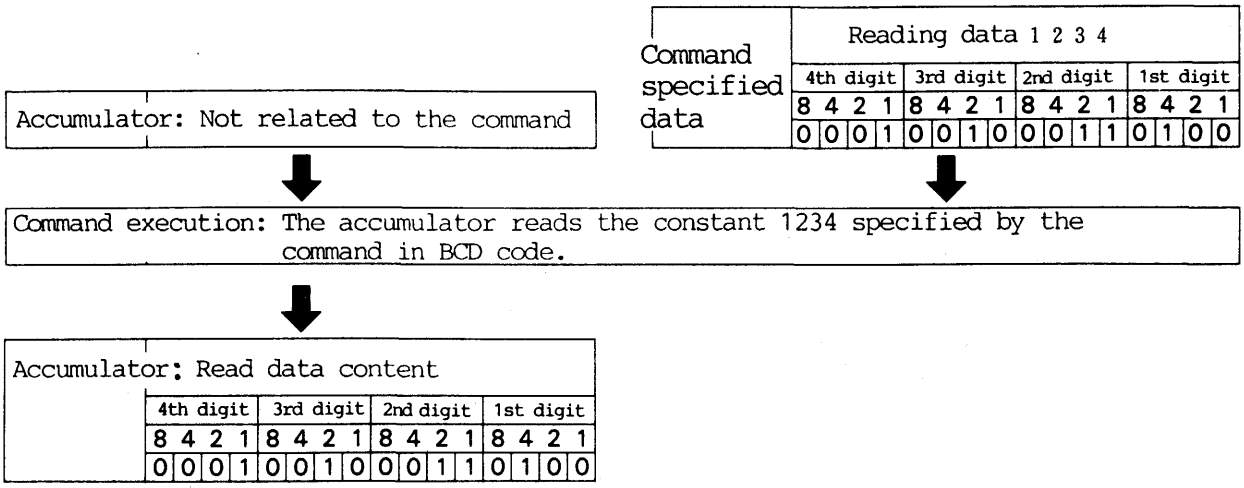
Circuit diagram



Command key



Movement when D STR command is executed



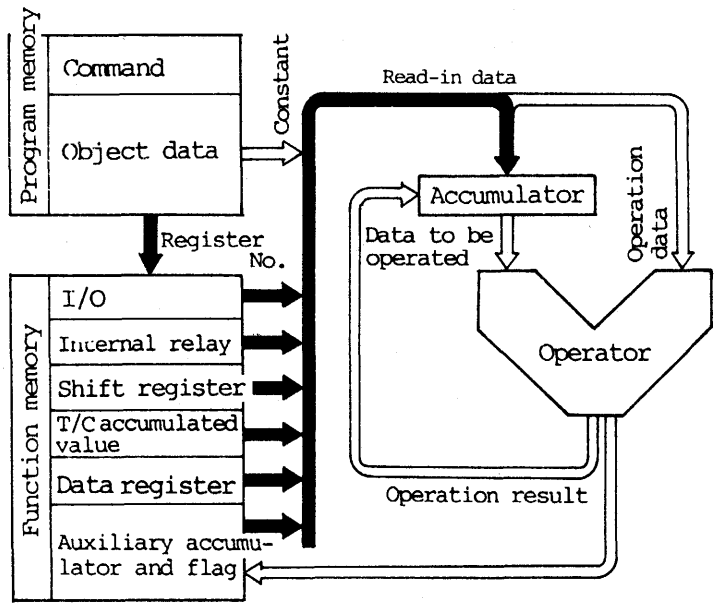
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Reading data number specification

The accumulator reads 16 bits of data from the register of the number specified by the command.

Symbol		DSTR F50 | R# □□□
Instruction	Section for the command (1st word)	FUN 5 6
	Section for the object (2nd word)	R # □ □ □ Register No. to receive reading Input/Output 000~014, 070~075 Internal relay 016~036 Shift register 040~056 Data register 400~576 T/C accumulated value 600~677
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	The content before execution of the command is cleared, and the read content is memorized.

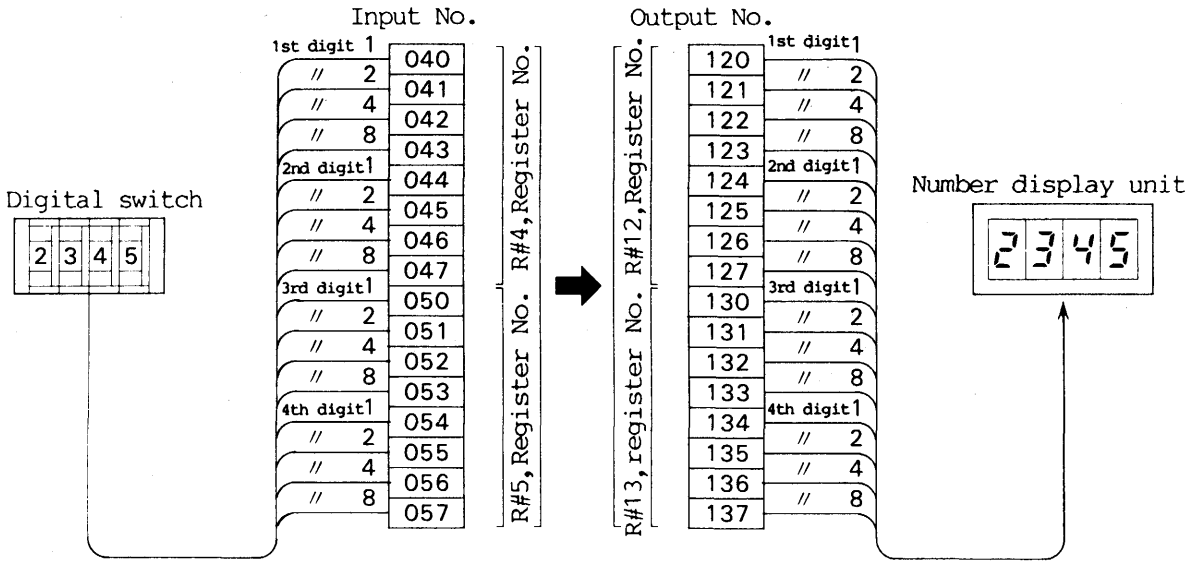
Data flow



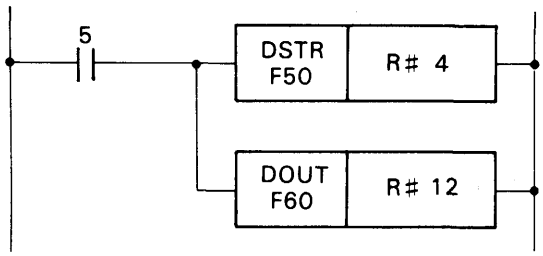
The accumulator reads and memorizes 16 bits of data from the register of the specified number by the second word of instruction.

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Example: Outputting of the input data of input numbers 40 to 57
to output numbers 120 to 137.



Circuit diagram



Command key



Movement when D STR command is executed

Command specification	R#4, register number to receive reading															
	R# 5								R# 4							
	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Data content	Reading data 2 3 4 5															
	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
	0	0	1	0	0	0	1	1	0	1	0	0	0	1	0	1

Accumulator: Not related to the command

Command execution: The accumulator reads the data content 2345 put in R#4 register number specified by the command.

Accumulator: Read data content 2345

4th digit				3rd digit				2nd digit				1st digit			
8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
0	0	1	0	0	0	1	1	0	1	0	0	0	1	0	1

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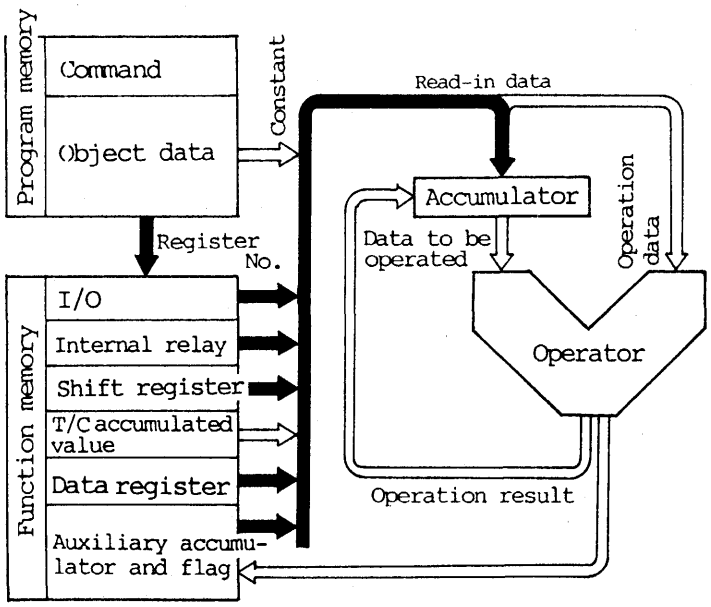
5-2. 8-bit reading, D STR1 (FUN51)

Reading data number specification

The accumulator reads 8 bits of data from the register of the number specified by the command.

Symbol		DSTR F51 | R# □□□
Instruction	Section for the command (1st word)	FUN 5 1
	Section for the object (2nd word)	R # □ □ □ Register No. to receive reading Input/Output 000~015, 070~076 Internal relay 016~037 Shift register 040~057 Data register 400~577
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	The content before execution of the command is cleared, and the read content is memorized.

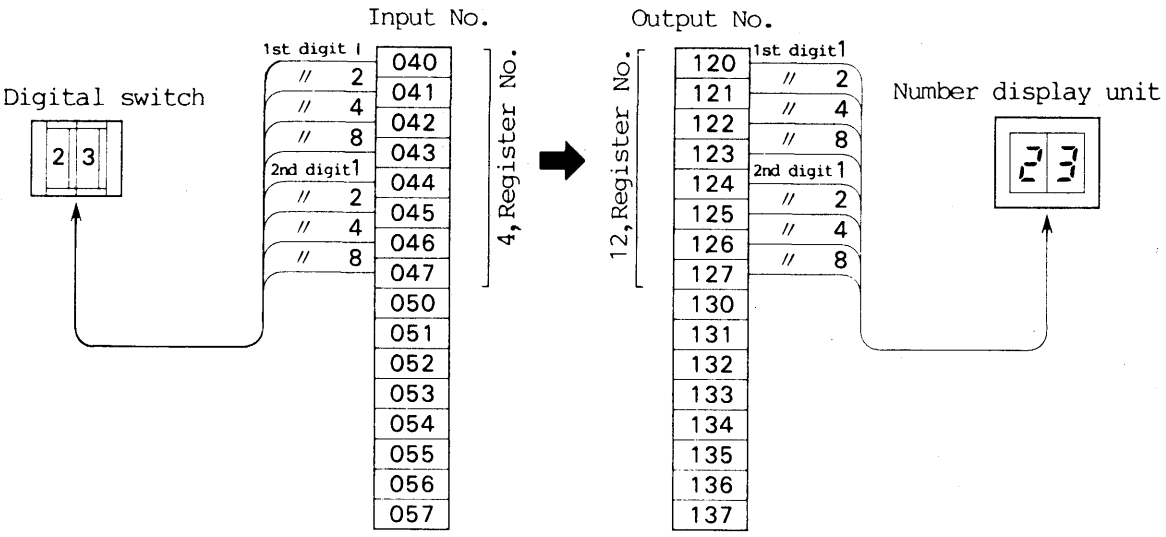
Data flow



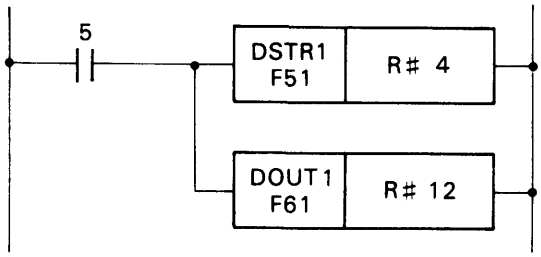
The accumulator reads and memorizes 8 bits of data from the register of the specified number by the second word of command. In this case, the 8th bit of the higher order of the accumulator is 0.

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Example: Outputting of the input data of input numbers 40 to 47 to output numbers 120 to 127.



Circuit diagram



Command key



Movement when D STR1 command is executed

Command specification	Register number to receive reading
	R# 4
	7 6 5 4 3 2 1 0
Data content	Reading data 23
	2nd digit / 1st digit
	8 4 2 1 / 8 4 2 1
	0 0 1 0 / 0 0 1 1

Accumulator: Not related to the command

Command execution: The data content 23 memorized in R#4 of the specified register number by the command is read into the low order 8 bits of the accumulator.

Accumulator: Read data content 23

	2nd digit	1st digit
	8 4 2 1	8 4 2 1
0 0 0 0 0 0 0 0	0 0 1 0	0 0 1 1

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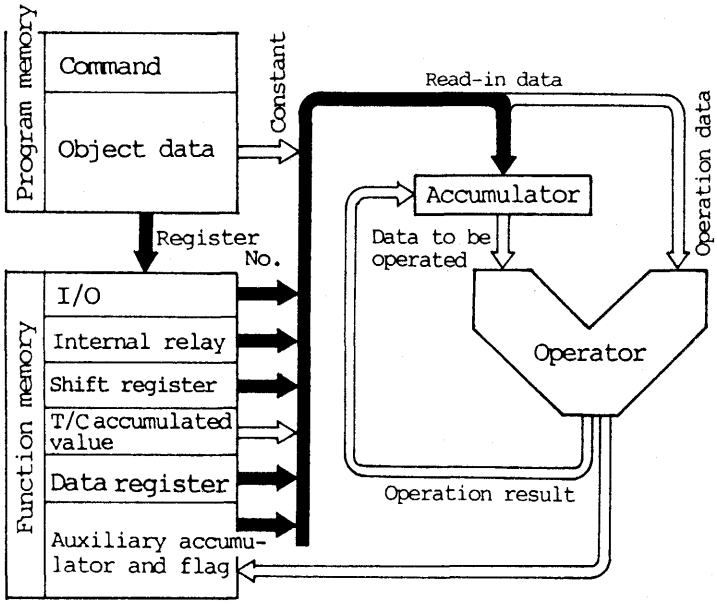
5-3. Reading of 4 bits of higher order, D STR2 (FUN52)

Reading data number specification

The upper 4 bits of data of the register of the command specified number will be read into the accumulator.

Symbol		DSTR2 F52 — R# □□□
Instruction	Section for the command (1st word)	FUN 5 2
	Section for the object (2nd word)	R # □ □ □ Register No. to receive reading Input/Output 000~015, 070 ~076 Internal relay 016~037 Shift register 040~057 Data register 400~577
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	The content before execution of the command is cleared, and the read content is memorized.

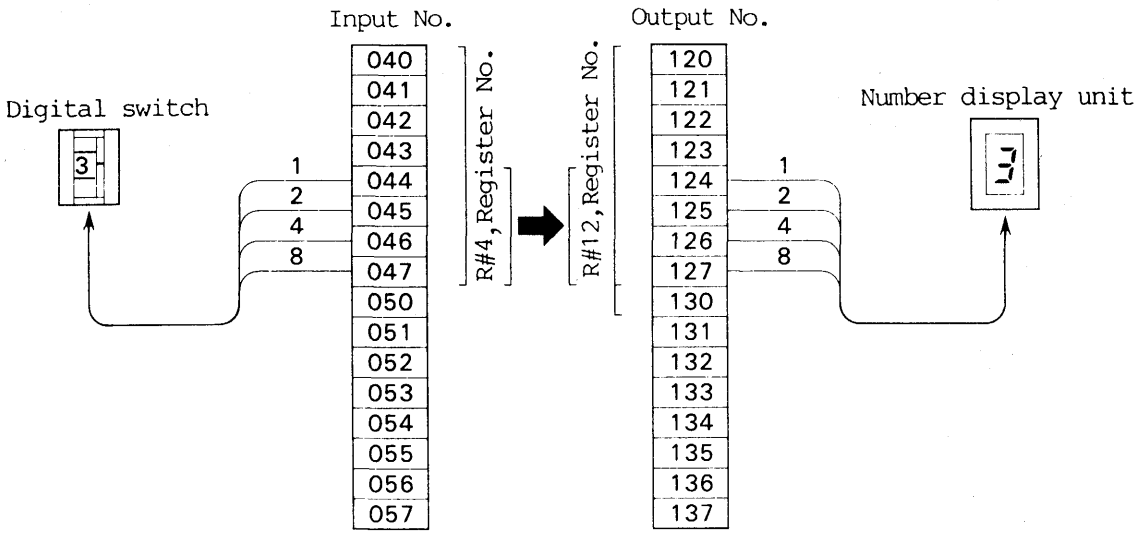
Data flow



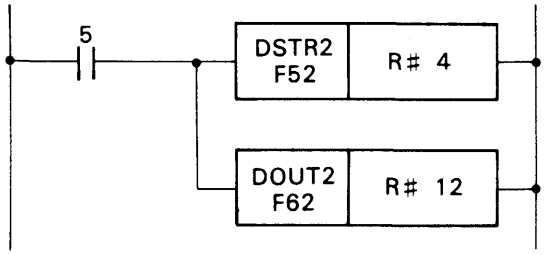
The upper 4 bits of data of the register of the specified number by the second word of the command will be read out and memorized in the lower 4 bits of the accumulator. In this case, the upper 12 bits of the accumulator are expressed in 0.

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Example: Outputting of the input data of input numbers 44 to 47 to output numbers 124 to 127.



Circuit diagram



Command key



Movement when D STR2 command is executed

Command specification	Register number to receive reading R# 4							
	7	6	5	4	3	2	1	0
Data content	Reading data 3							
	8	4	2	1				
	0	0	1	1				

Accumulator: Not related to the command

Command execution: The data content 3 of 4 bits of the higher order of the specified register number R#4 by the command is read into 4 bits of the lower order of the accumulator.

Accumulator: Read data content 3

													8	4	2	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	

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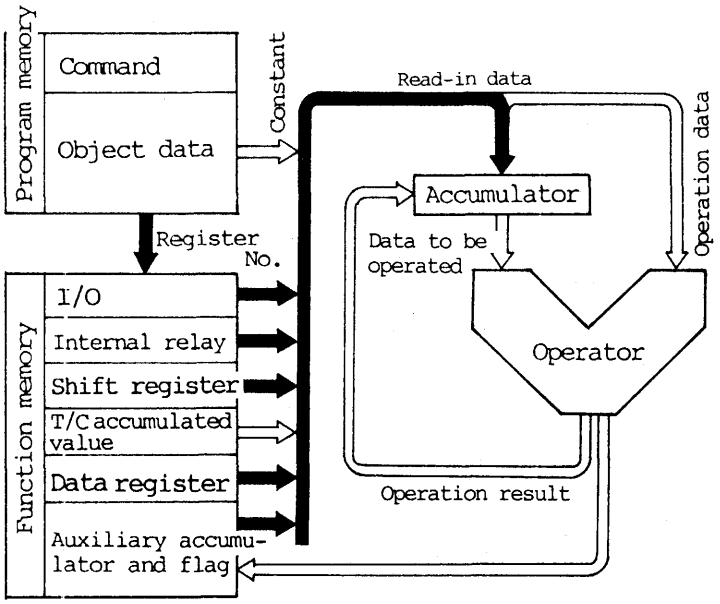
5-4. Reading of 4 bits of lower order, D STR3 (FUN53)

Reading data number specification

The lower 4 bits of data of the register of the command specified number will be read into the accumulator.

Symbol		DSTR 3 F53 | R# □□□
Instruction	Section for the command (1st word)	FUN 5 3
	Section for the object (2nd word)	R # □ □ □ Register No. to receive reading Input/Output 000~015, 070~076 Internal relay 016~037 Shift register 040~057 Data register 400~577
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	The content before execution of the command is cleared, and the read content is memorized.

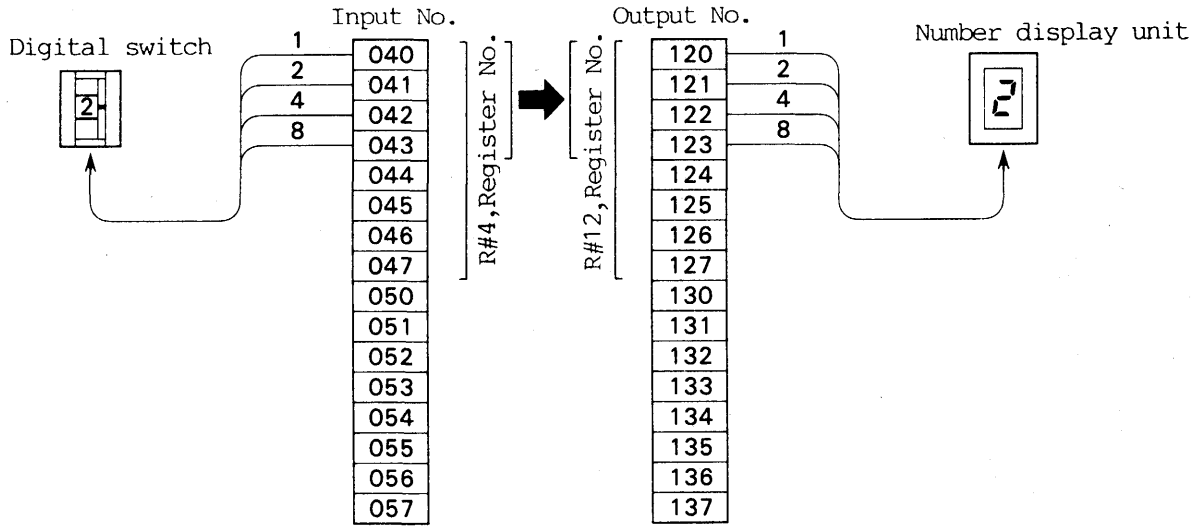
Data flow



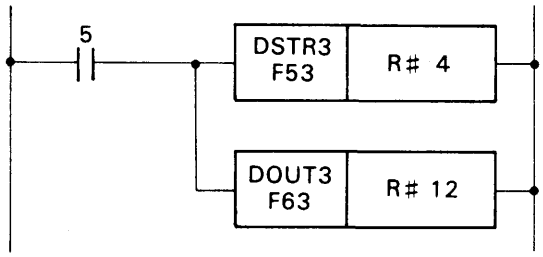
The lower 4 bits of data of the register of the specified number by the second word of the command will be read out and memorized in the lower 4 bits of the accumulator. In this case, the upper 12 bits of the accumulator are expressed in 0.

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Example: Outputting of the input data of input number 40 to 43 to output numbers 120 to 123.



Circuit diagram



Command key



Movement when D STR3 command is executed

Command specification	Register number to receive reading
	R# 4
	7 6 5 4 3 2 1 0
Data content	Reading data 2
	8 4 2 1
	0 0 1 0

Accumulator: Not related to the command

Command execution: The data content 2 of 4 bits of the lower order of the specified register number R#4 by the command is read into 4 bits of the lower order of the accumulator.

Accumulator: Read data content 2															
												8	4	2	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

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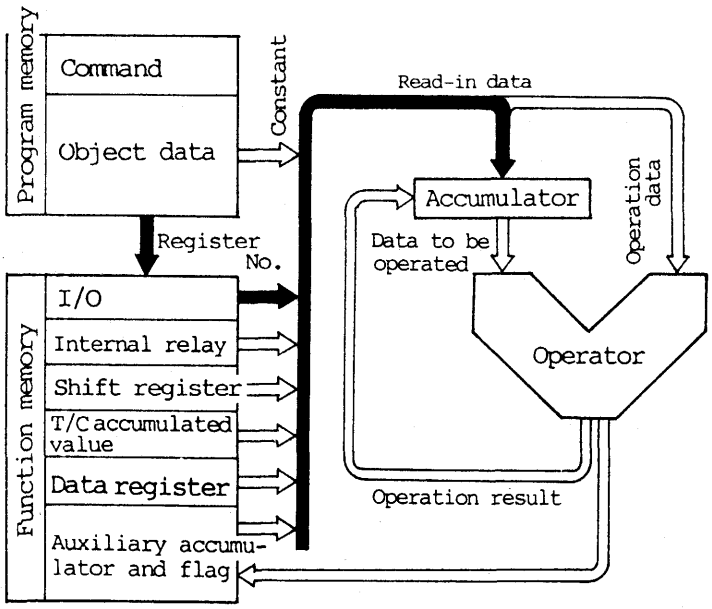
5-5. 16-point module reading, D STR5 (FUN55)

Reading data number specification

The accumulator reads and memorizes the data of the registers (for I/O) of the specified number by the command and the number that is the result of adding 10 to the specified number.

Symbol		DSTR5 F55 | R# □□□
Instruction	Section for the command (1st word)	FUN 5 5
	Section for the object (2nd word)	R# □ □ □ Register No. to receive reading Input/Output 000 (010) 001 (011) 002 (012) 003 (013) 004 (014) 005 (015)
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	The data before execution of the command is cleared, and 8 bits of the register content (I/O status) of the specified number by the command and the register content of the number, which is the result of adding 10 to the specified number, are memorized.

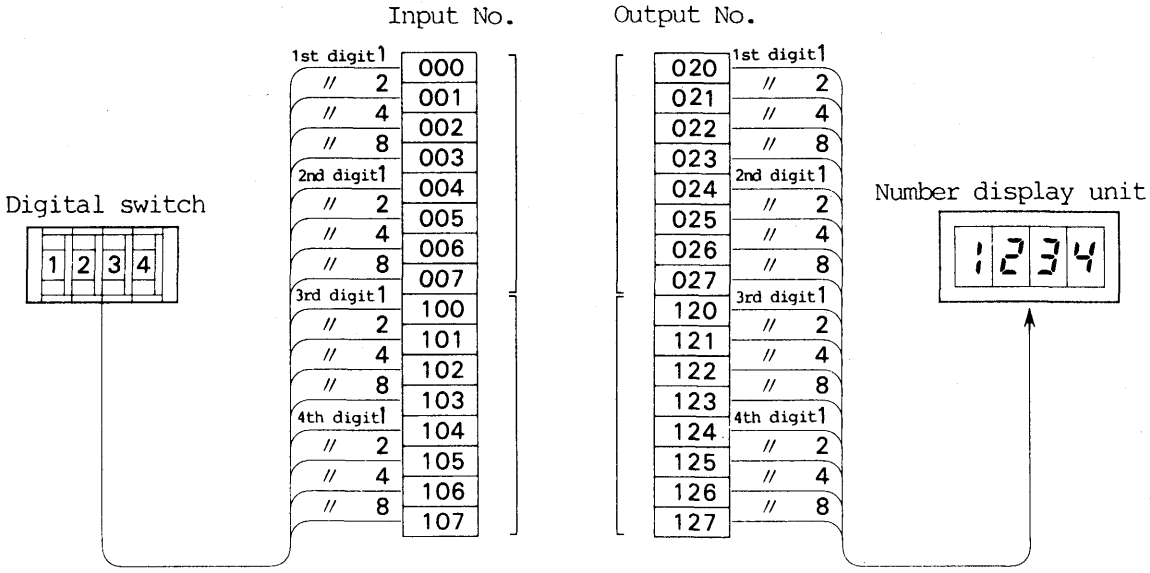
Data flow



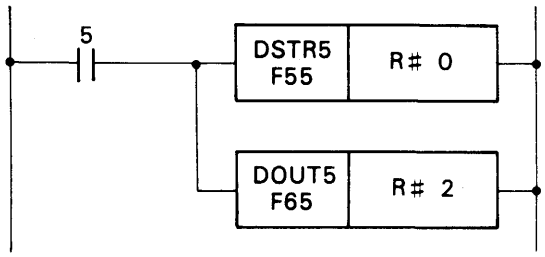
When the 16-point I/O module is installed on SR-21, I/O numbers are assigned in two separate groups, such as 000 to 007 and 100 to 107. This one command reads an entire 16 bits of data in the combined form of these numbers separated into 2 groups of 8 bits. The command specifies the smaller register number of these 2 numbers.

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Example: Outputting of the input data of the input numbers 000 to 007 and 100 to 107 to the output numbers 20 to 27 and 120 to 127.



Circuit diagram



Command key



Movement when D STR5 command is executed

Command specification	Register No. to receive reading, R#000															
	R#010								R#000							
	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Data content	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
	0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0

Command execution: The accumulator reads and memorizes 16-bit data of the command specified register number 000 (input number 000 to 007) and the register number 010 (input number 100 to 107).

Accumulator: Read data 1 2 3 4

	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
	0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0

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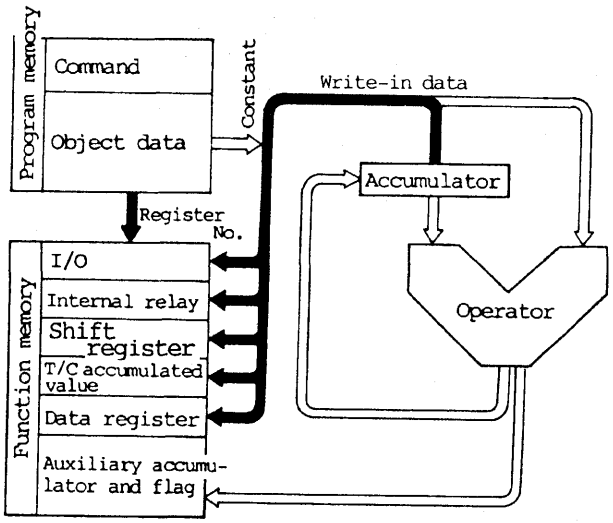
5-6. 16-bit writing, D OUT (FUN60)

The accumulator content is written into the command specified number register.

Symbol		DOUT F60 | R# □□□
Instruction	Section for the command (1st word)	FUN 6 0
	Section for the object (2nd word)	R# □ □ □ Register No. to receive writing Input/Output 000~014, 070~075 Internal relay 016~036 Shift register 040~056 Data register 400~576 T/C accumulated value 600~677
Before execution of the command	Accumulator	The data to be put into the register for writing are memorized.
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	No change as before execution of command.
	Over flag 777	The flag continues to be ON if the writing data are not in the BCD code under the condition that the T/C accumulated value is to receive writing of the data.
	Object to receive writing	The accumulator content is written. After this writing, these data are retained until new writing is made.

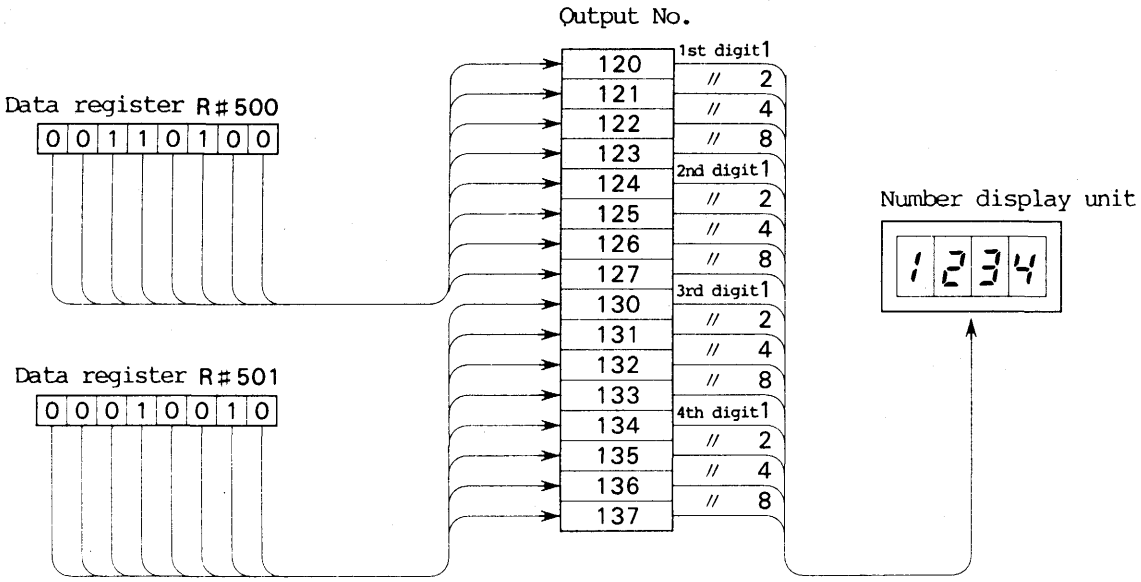
Data flow

The 16-bit data memorized in the accumulator are written into the register of the specified number by the second word of the command and the register of the next number.

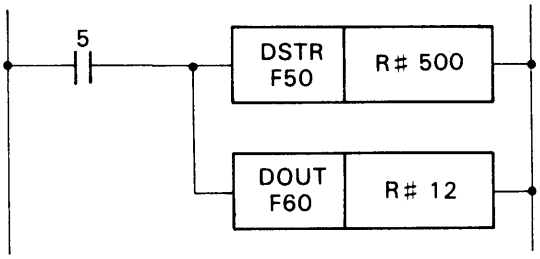


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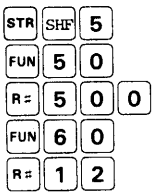
Example: Outputting of data memorized of 500 and 501 to the output numbers 120 to 137.



Circuit diagram



Command key



Movement when D OUT command is executed

Accumulator: Writing data (1234)															
	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
	0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0

Command specification	Register No. to receive writing (12)															
	R# 13								R# 12							
	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0

Command execution: The data (1234) memorized in the accumulator are written into the specified register number by the command for writing, R#12 (output number 120 to 137).

Accumulator: No change (1234)															
	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
	0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0

No. to receive writing	Register No. R#12 (ouput No. 120 - 137)															
	R# 13								R# 12							
	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Written data content	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
	0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0

Flag	Over
	777

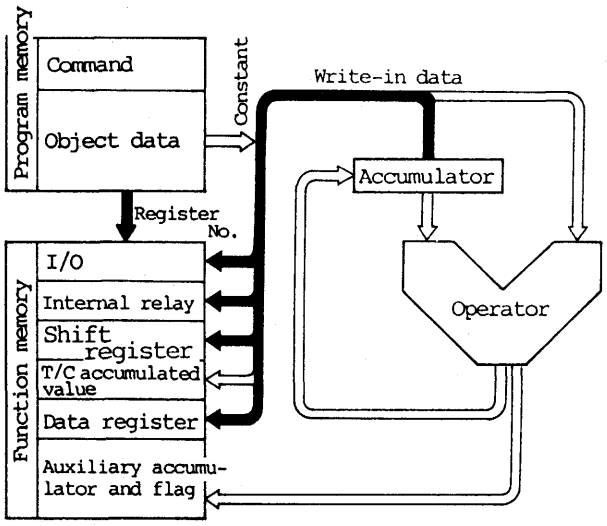
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5-7. 8-bit writing, D OUT1 (FUN61)

The data for 8 bits of the lower order in the accumulator are written into the command specified register.

Symbol		DOUT1 F61 | R# □□□
Instruction	Section for the command (1st word)	FUN 6 1
	Section for the object (2nd word)	R# □ □ □ (Register No. to receive writing) Input/Output 000~015, 070~076 Internal relay 016~037 Shift register 040~057 Data register 400~577
Before execution of the command	Accumulator	The data to be put into the register for writing are memorized in 8 bits of the lower order.
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	No change as before the execution of command.
	Object to receive writing	The 8-bit data of lower order of the accumulator are written. The written data are retained until other data are newly written.

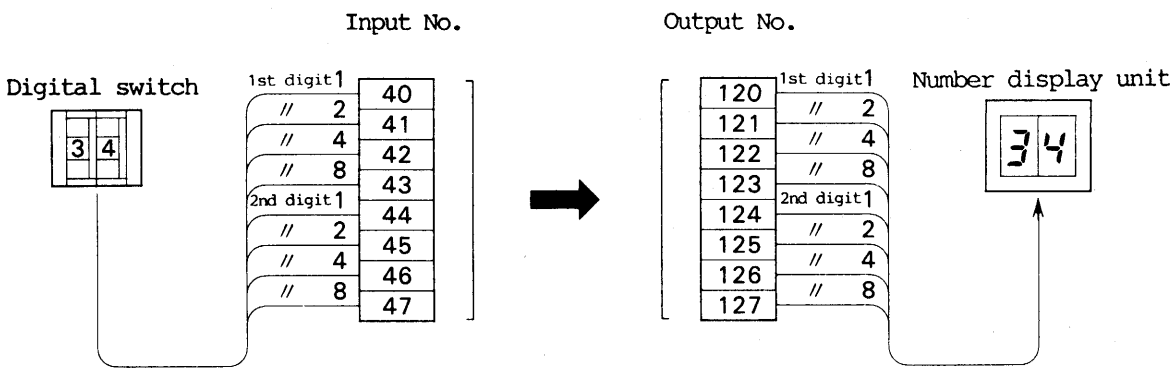
Data flow



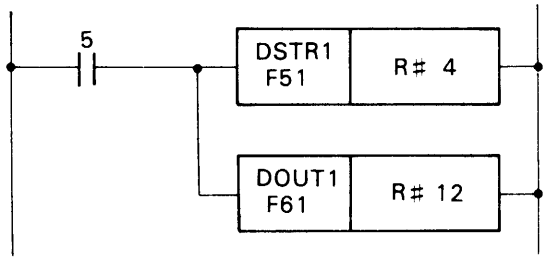
The 8-bit data of the lower order of the 16-bit data memorized in the accumulator are written into the register of the command specified number.

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Example: The input condition of input numbers 40 to 47 is output to output numbers 120 to 127 in the same way.



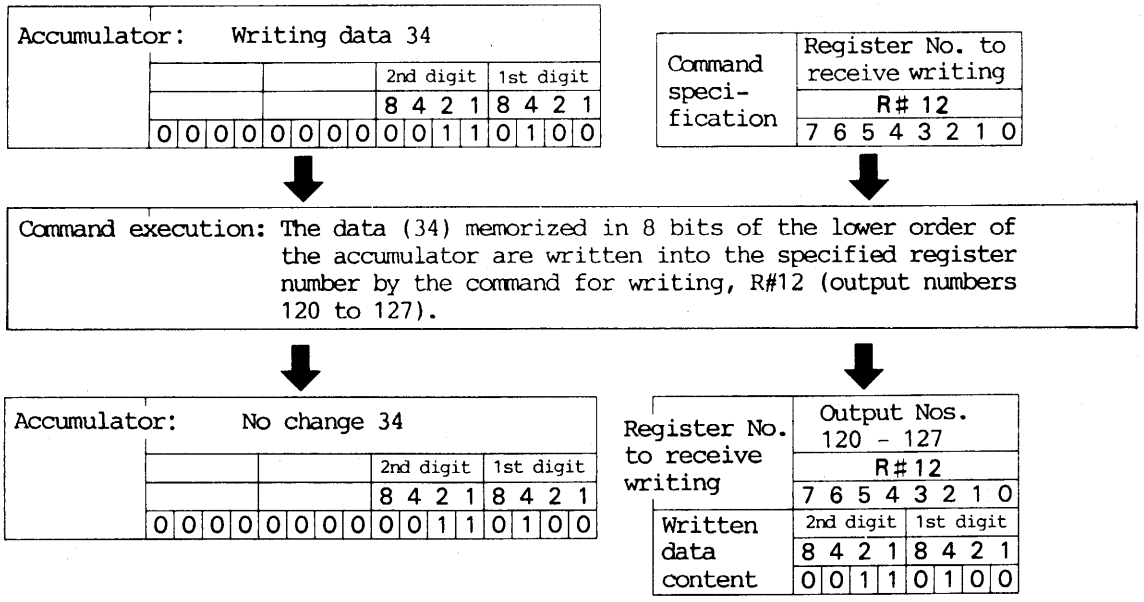
Circuit diagram



Command key



Movement when D OUT1 command is executed



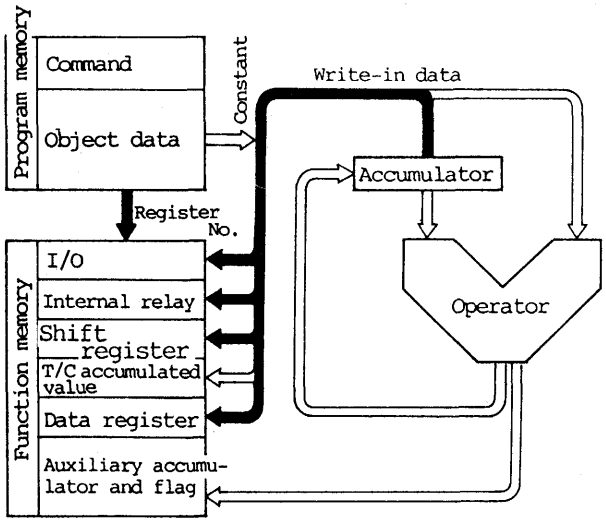
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5-8. 4-bit writing of higher order, D OUT2 (FUN62)

The data for 4 bits of lower order in the accumulator are written into 4 bits of the higher order of the command specified register.

Symbol		DOUT2 F62 | R# □□□
Instruction	Section for the command (1st word)	FUN 6 2
	Section for the object (2nd word)	R# □ □ □ Register No. to receive writing Input/Output 000~015, 070~076 Internal relay 016~037 Shift register 040~057 Data register 400~577
Before execution of the command	Accumulator	The data to be put into the register for writing are memorized in 4 bits of the lower order of the accumulator.
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	No change as before the execution of command.
	Object to receive writing	The 4-bit data of lower order of the accumulator are written into 4 bits of the higher order of the command specified register.

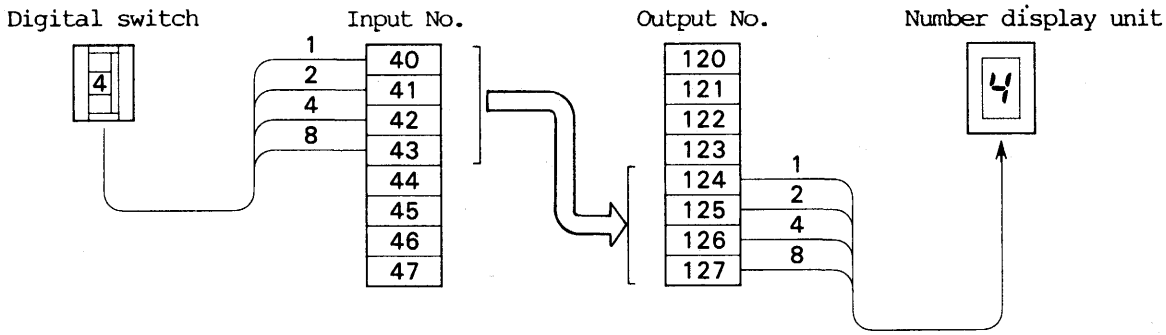
Data flow



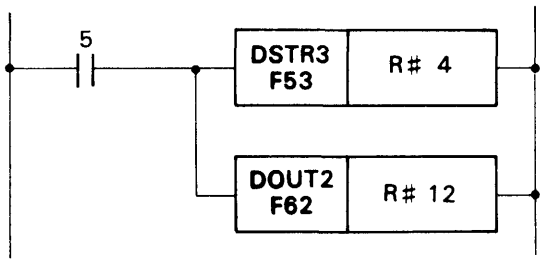
The data memorized in 4 bits of the lower order in the accumulator are memorized in 4 bits of higher order of the command specified register.

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Example: The input condition of the input numbers 40 to 43 is output to the output numbers 124 to 127 in the same way.



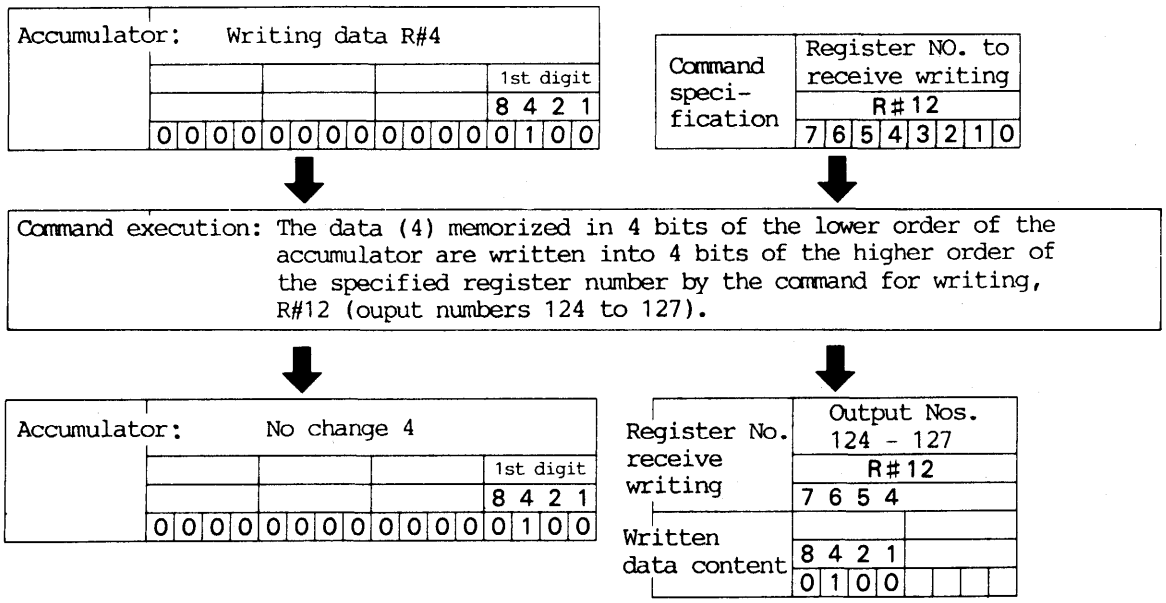
Circuit diagram



Command key



Movement when D OUT2 command is executed



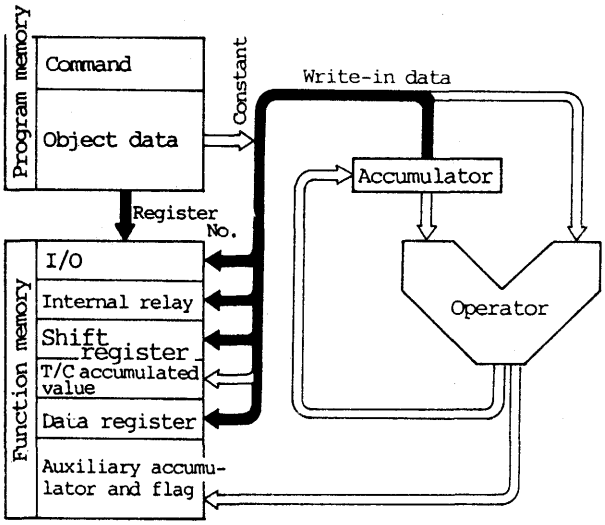
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5-9. 4-bit writing of lower order, D OUT3 (FUN63)

The data for 4 bits of the lower order in the accumulator are written into 4 bits of the lower order of the command specified register.

Symbol		DOUT3 F63 — R# □□□
Instruction	Section for the command (1st word)	FUN 6 3
	Section for the object (2nd word)	R# □ □ □ Register No. to receive writing Input/Output 000~015, 070~076 Internal relay 016~037 Shift register 040~057 Data register 400~577
Before execution of the command	Accumulator	The data to be put into the register for writing are memorized in 4 bits of the lower order of the accumulator.
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	No change as before the execution of command.
	Object to receive writing	The 4-bit data of lower order of the accumulator are written into 4 bits of the lower order of the command specified register.

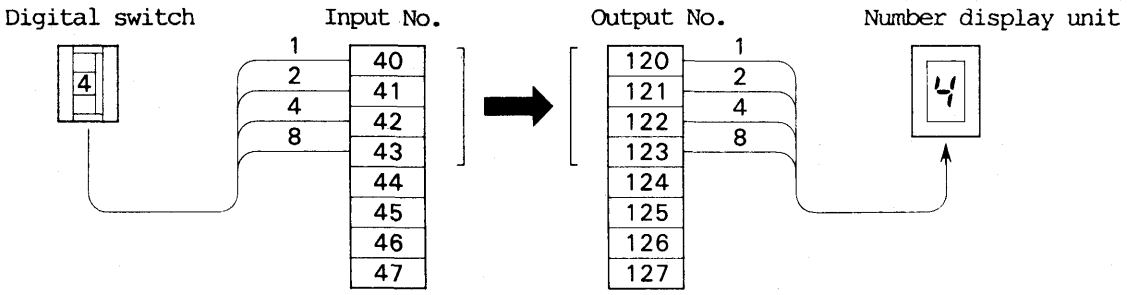
Data flow



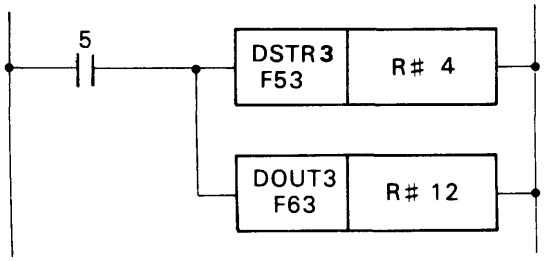
The 4-bit data of the lower order of the accumulator are memorized in 4 bits of the lower order of the command specified register.

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Example: The input condition of the input numbers 40 to 43 is output to the output numbers 120 to 123.



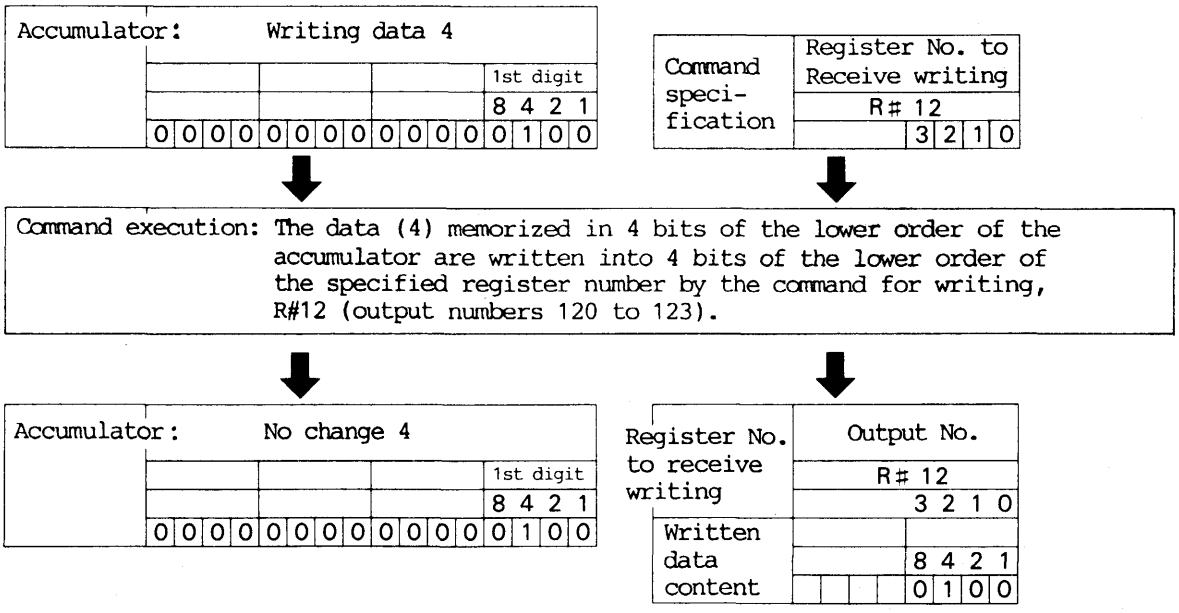
Circuit diagram



Command key



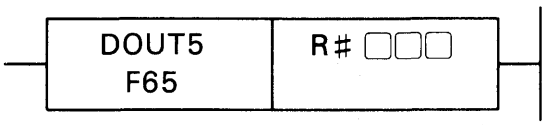
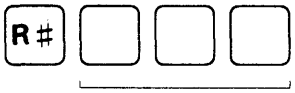
Movement when D OUT3 command is executed



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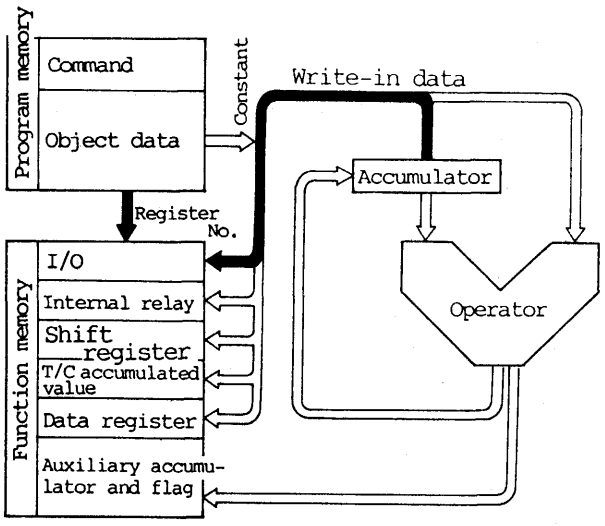
5-10. 16-point module writing, D OUT5 (FUN65)

The accumulator content is written into 16 points in a total of 8 bits of the command specified register number and 8 bits of the register number, which is the result of adding 10 to the command specified register number.

<table>
<tr><td colspan="2">Symbol</td><td>
</td></tr>
<tr><td rowspan="2">Instruction</td><td>Section for the command (1st word)</td><td>
</td></tr>
<tr><td>Section for the object (2nd word)</td><td>

Input/Output
000 (010)
001 (011)
002 (012)
003 (013)
004 (014)
005 (015)</td></tr>
<tr><td>Before execution of the command</td><td>Accumulator</td><td>The data to output to the 16-point module are memorized.</td></tr>
<tr><td colspan="2">Condition to executie the command</td><td>Execution when the condition is satisfied.
No execution when the condition is not satisfied.</td></tr>
<tr><td rowspan="2">After execution of the command</td><td>Accumulator</td><td>No change as before the execution of command.</td></tr>
<tr><td>Object to receive writing</td><td>The 8-bit data of the lower order of the accumulator are written into the command specified output. The 8-bit data of the higher order of the accumulator are written into the output register of the number, which is the result of adding 10 to the command specified number.</td></tr>
</table>

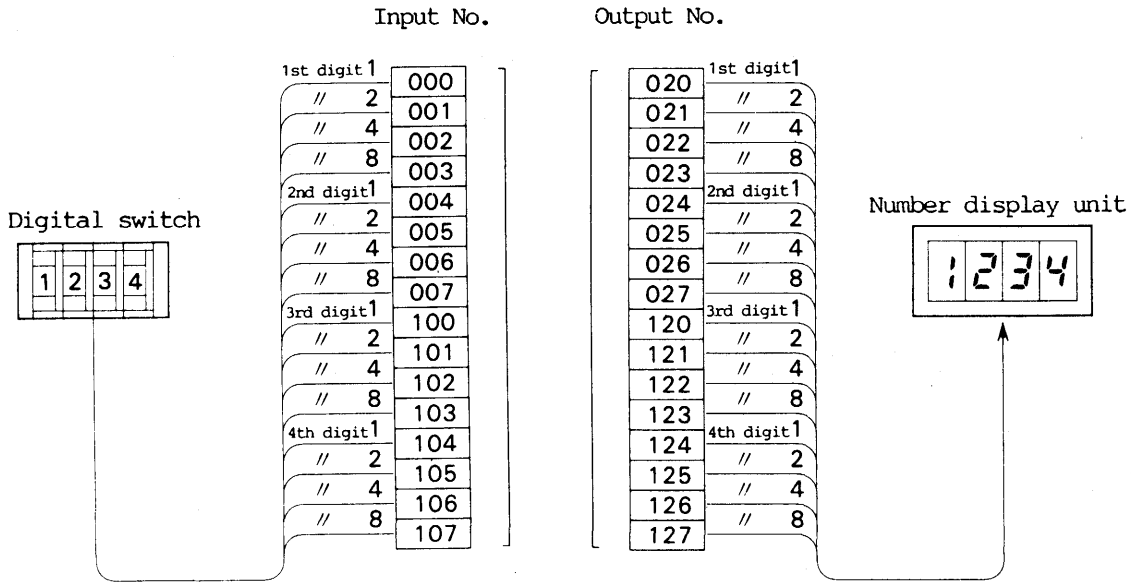
Data flow



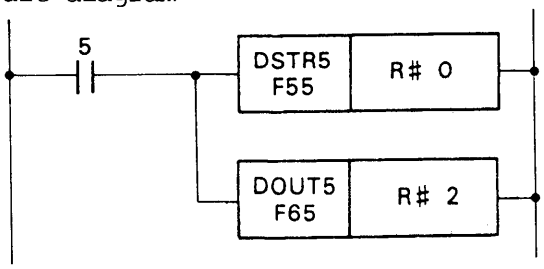
When the 16-point output module is installed on SR-21, the output numbers are assigned in two separate groups, such as 20 to 27 and 120 to 127. This command writes the accumulator contents at once into outputs of these separate numbers of 8 bits. The smaller register number is specified for the command specified number.

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Example: The input data from the input numbers 000 to 007 and 100 to 107 are output to the output numbers 20 to 27 and 120 to 127.



Circuit diagram



Command key



Movement when D OUT5 command is executed

Accumulator: Writing data 1234															
	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
	0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0

Command specification	Register No. to receive writing R#2															
	R# 12								R# 2							
	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0

Command execution: The 8-bit data of the lower order of the accumulator are written into the command specified register (output numbers 20 to 27). The 8-bit data of the higher order of the accumulator are written into the register number, which is the result of adding 10 to the command specified register number (output numbers 120 to 127).

Accumulator: No change															
	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
	0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0

Destination to write in	Register No. to receive writing, R#2															
	R# 12								R# 2							
	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Data content	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
	0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0

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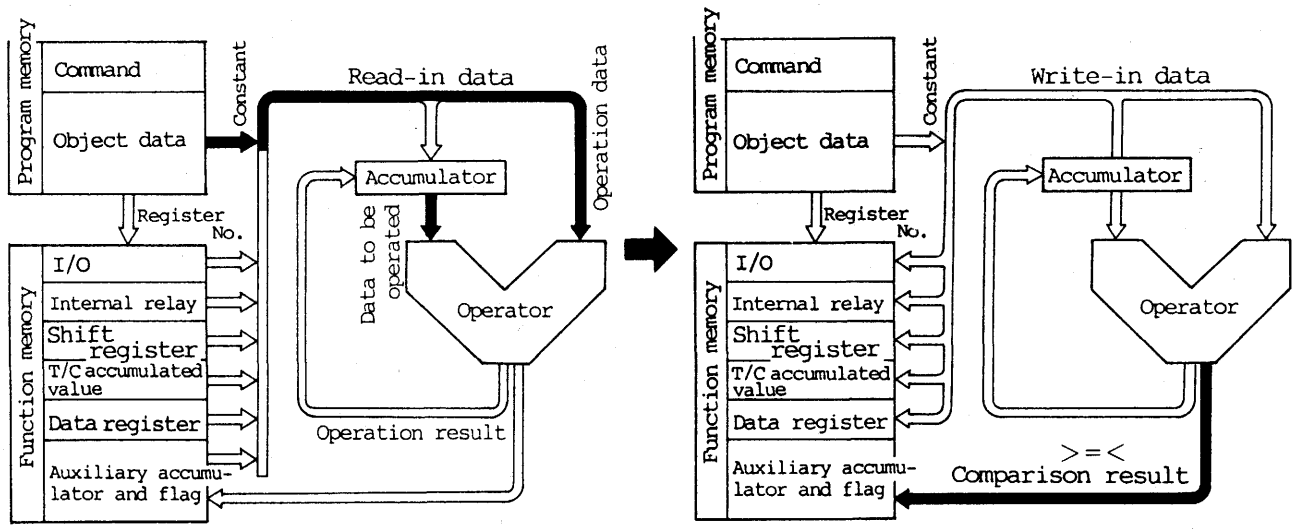
5-11. 16-bit comparison, > = < FUN70

Comparison data constant specification

The comparison result of the accumulator data to the command specified constant is output to the flag.

Symbol		>=< F70 ✱□□□□
Instruction	Section for the command (1st word)	FUN 7 0
	Section for the object (2nd word)	✱ □ □ □ □ (Comparison data) Constant 0000 - 9999
Before execution of the command	Accumulator	The data to be compared are memorized.
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	No change as before the execution of command.
	Greater accumulator flag >772	ON if (data of the accumulator) > (command specified constant)
	Equal flag =773	ON if (data of the accumulator) = (command specified constant)
	Smaller accumulator flag <774	ON if (data of the accumulator) < (command specified constant)

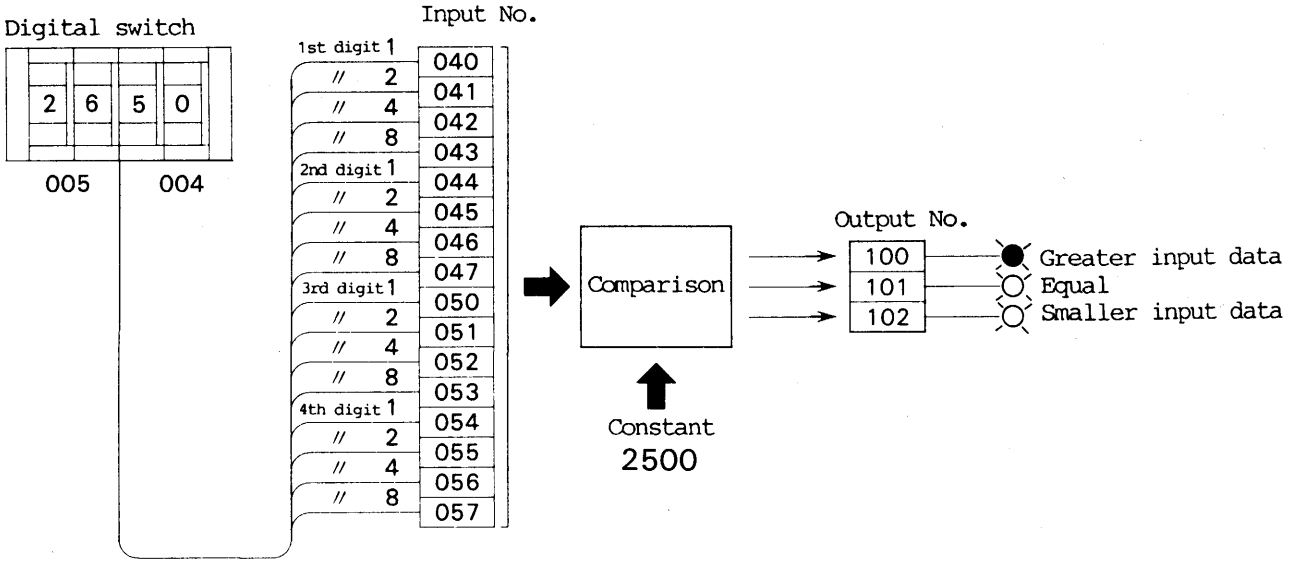
Data flow



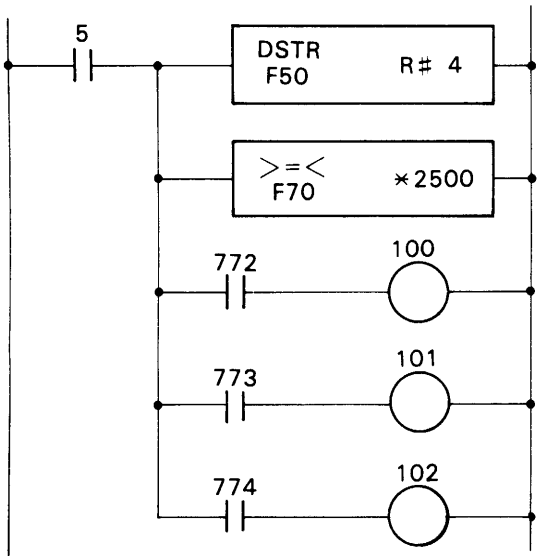
As a result of a comparison of the accumulator data to the command specified constant, the flag given is ON and other flags are OFF.

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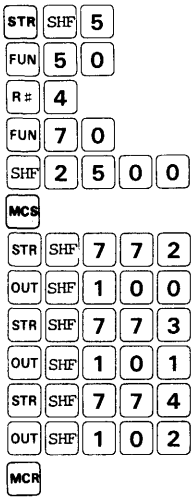
Example: If the 4-digit input number of the numbers 40 to 57 is greater than constant 2500, the output number 100 is ON. If the comparison result is equal, the output number 101 is ON. If the number is smaller, the output number 102 is ON.



Circuit diagram



Command key



Movement when >=< command is executed.

Accumulator:	Data to be compared (content of R#4) 2650															
	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
	0	0	1	0	0	1	1	0	0	1	0	1	0	0	0	0

Command specification	Comparison data constant 2500															
	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0

Command execution: As a result of comparison of 2650 data of the accumulator to 2500, the command specified constant, the flag for > is ON because of the greater accumulator. And the rest of the flags are OFF.

Accumulator: No change (content of R#4) 2650																
	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
	0	0	1	0	0	1	1	0	0	1	0	1	0	0	0	0

Flag	>	=	<
	772	773	774
	ON	OFF	OFF

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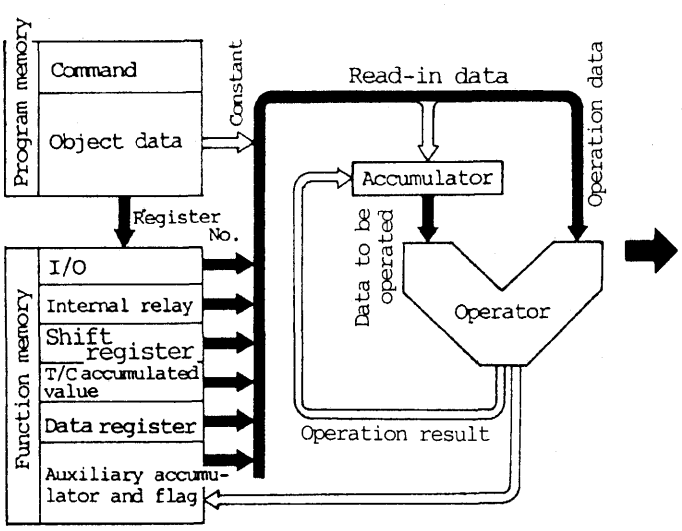
Comparison data number specification

The comparison result of the accumulator data to the data of the command specified register is output to the flag.

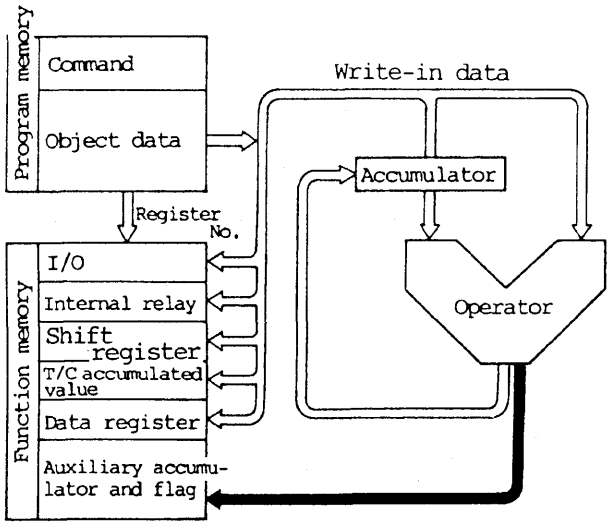
Symbol		>=< F70 R# □□□
Instruction	Section for the command (1st word)	FUN 7 0
	Section for the object (2nd word)	R# □ □ □ Comparison data memory register No. Input/Output 000~014, 070~075 Internal relay 016~036 Shift register 040~056 Data register 400~576 T/C accumulated value 600~677
Before execution of the command	Accumulator	The data to be compared are memorized.
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	No change as before the execution of command.
	A > flag 772	ON if (data of the accumulator) > (data of the command specified register)
	A = flag 773	ON if (data of the accunulator) = (data of the command specified register)
	A < flag 774	ON if (data of the accunulator) < (data of the command specified register)

Supplement: Two data can be either in the BCD code or binary code for comparison, but should be compared in the same code.

Data flow



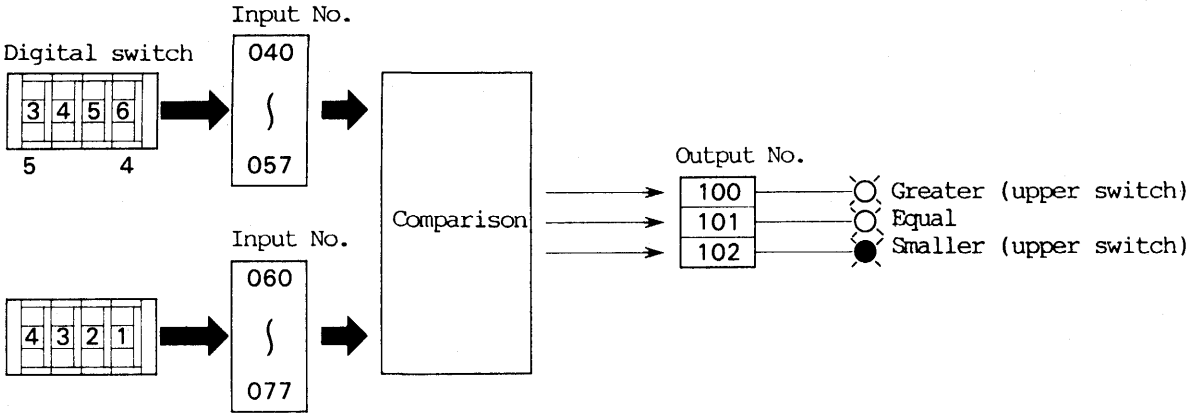
Compare the accumulator data to the data of the command specified data.



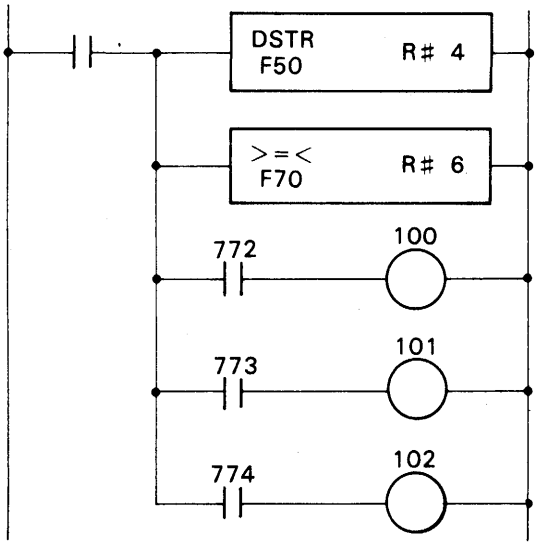
Turn ON the flag according to the compared result; turn OFF other flags.

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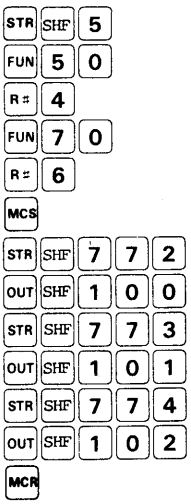
Example: Comparison of 4-digit input number of input numbers 40 to 57 with 4-digit input number of input numbers 60 to 77.
Then output is made for greater than, equal to, or smaller than.



Circuit diagram



Command key



Movement when >=< command is executed

Command specification	Register No. of the memory location of compared data															
	R# 7								R# 6							
	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Data content	Comparison data 4321															
	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	1

Accumulator: Data to be compared (content of R#4) 3456															
	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
	0	0	1	1	0	1	0	0	0	1	0	1	0	1	1	0

Command execution: As a result of comparison of 3456 data of the accumulator to 4321, the content of the command specified register number R#6, the flag 774 is ON and other flags are OFF because of the smaller accumulator data.

Accumulator: No change (content of R#4) 3456															
	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
	0	0	1	1	0	1	0	0	0	1	0	1	0	1	1	0

Flag	>	=	<
	772	773	774
	OFF	OFF	ON

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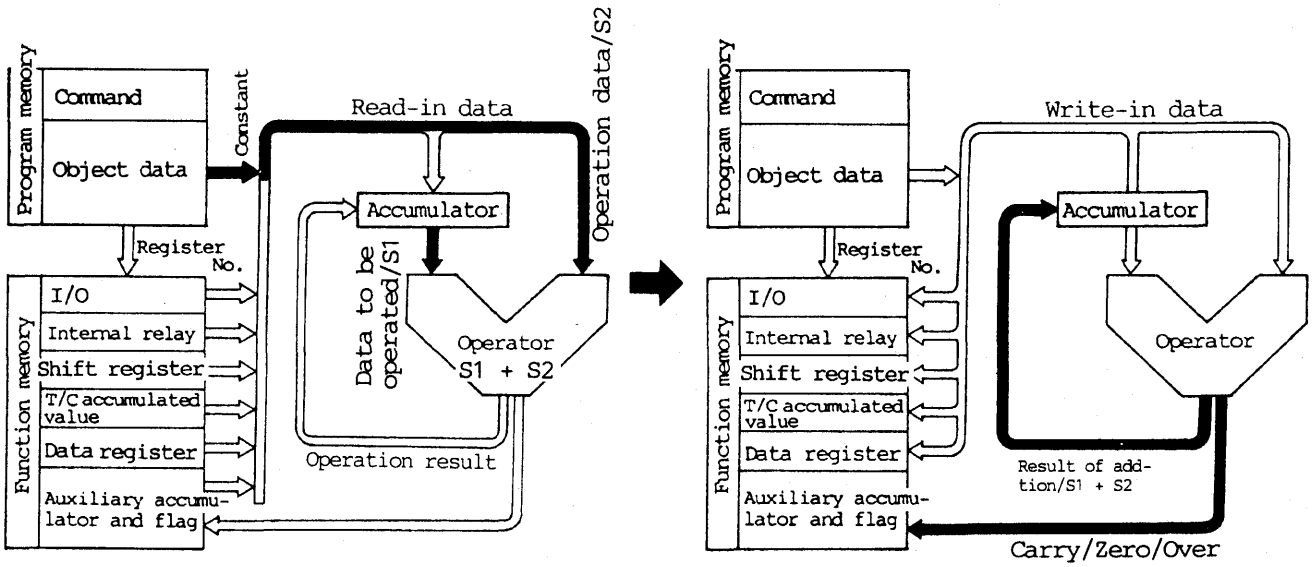
5-12. BCD 4-digit addition, + (plus) FUN71

Addition data constant specification

Addition of the accumulator data to the command specified register data

Symbol		+ F71 ∗ □□□□
Instruction	Section for the command (1st word)	FUN 7 1
	Section for the object (2nd word)	SHF □ □ □ □ Addition data Constant 0000 - 9999
Before execution of the command	Accumulator	The data to get addition (4 digits in BCD code) is memorized.
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution	Accumulator	The result of added data, (accumulator data) + (command specified constant), is memorized.
	Carry flag 775	ON as a signal to take a figure up if the added result is more than 10,000
	Zero flag 776	ON if the added result is 0
	Over flag 777	ON if the accumulator data are not in the BCD code

Data flow

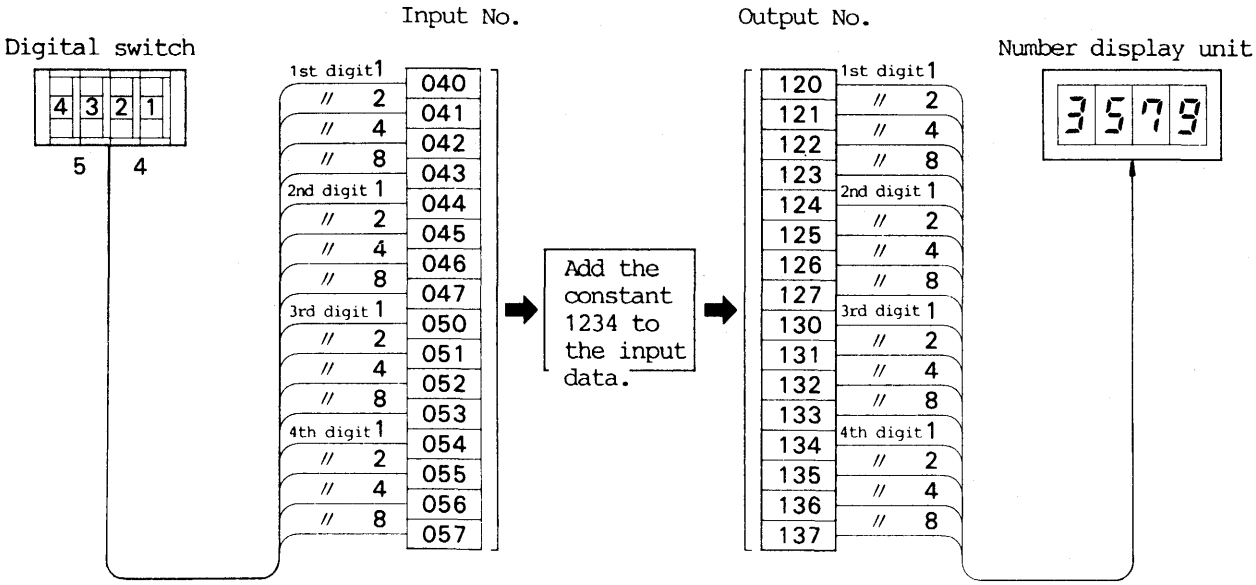


Add a 4-digit constant specified by the command to the data memorized in the accumulator.

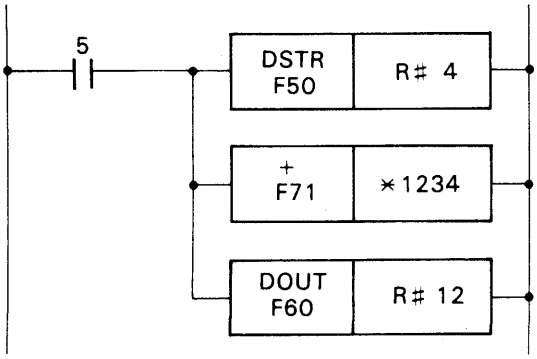
Memorize the answer (addition) into the accumulator and turn each flag ON or OFF for carry, zero, and over at the same time.

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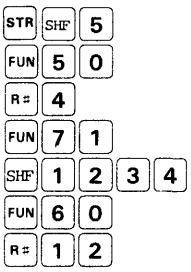
Example: Add the constant 1234 to the input number of input numbers 40 to 57, and output the result to output numbers 120 to 237.



Circuit diagram



Command key



Movement when + command execution is made

Accumulator: Data to be added (content of R#4) 2345

4th digit				3rd digit				2nd digit				1st digit			
8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
0	0	1	0	0	0	1	1	0	1	0	0	0	1	0	1

Command specification: Adding data constant 1234

4th digit				3rd digit				2nd digit				1st digit			
8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0

Command execution: Add the constant 1234 specified by the command to the data (2345) memorized in the accumulator and to be added, and write the answer into the accumulator.

Accumulator: Data to be added + adding data = 3579

4th digit				3rd digit				2nd digit				1st digit			
8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
0	0	1	1	0	1	0	1	0	1	1	1	1	0	0	1

Flag	Carry	Zero	Over
	775	776	777

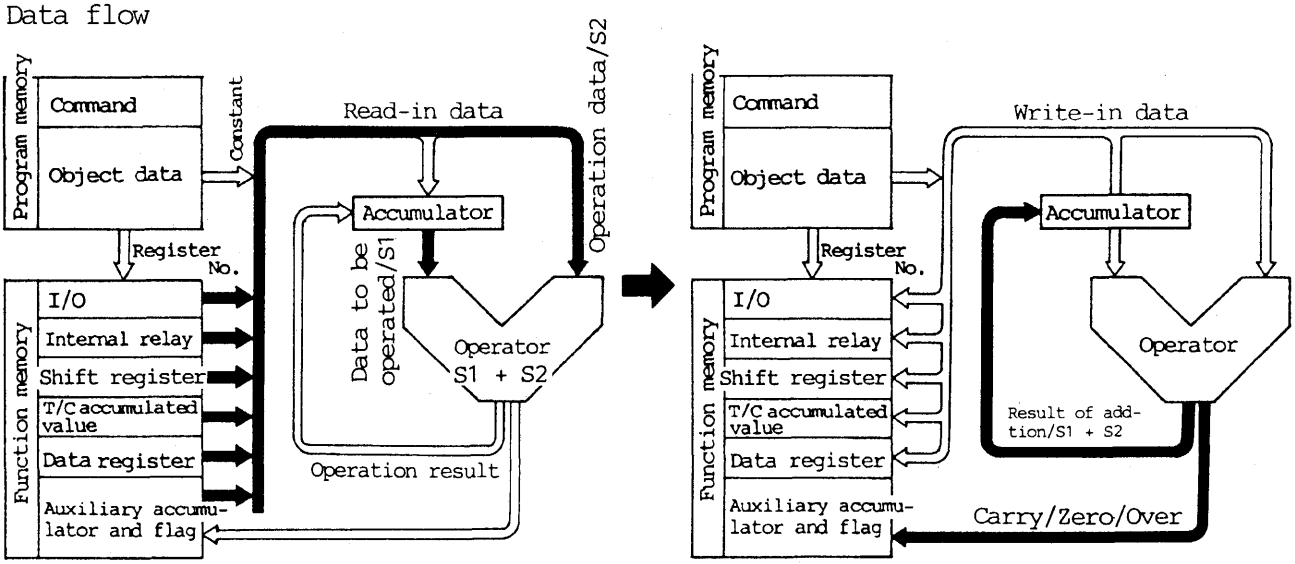
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Addition data number specification

The data memorized in the register of the command specified number is to be added to the accumulator data.

Symbol		+ F71 R# □□□
Instruction	Section for the command (1st word)	FUN 7 1
	Section for the object (2nd word)	R# □ □ □ (Addition data memory register No.) Input/Output 000~014, 070~075 Internal relay 016~036 Shift register 040~056 Data register 400~576 T/C accumulated value 600~677
Before execution of the command	Accumulator	Memorize the data to be added. (4-digit BCD code)
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	Memorize the result of addition, (accumulator data) + (command specified register data).
	Carry flag 775	ON as a signal to take a figure up if the added result is more than 10,000
	Zero flag 776	ON if the added result is 0
	Over flag 777	ON if (accumulator data) or (command specified register data) is not the BCD code

Data flow

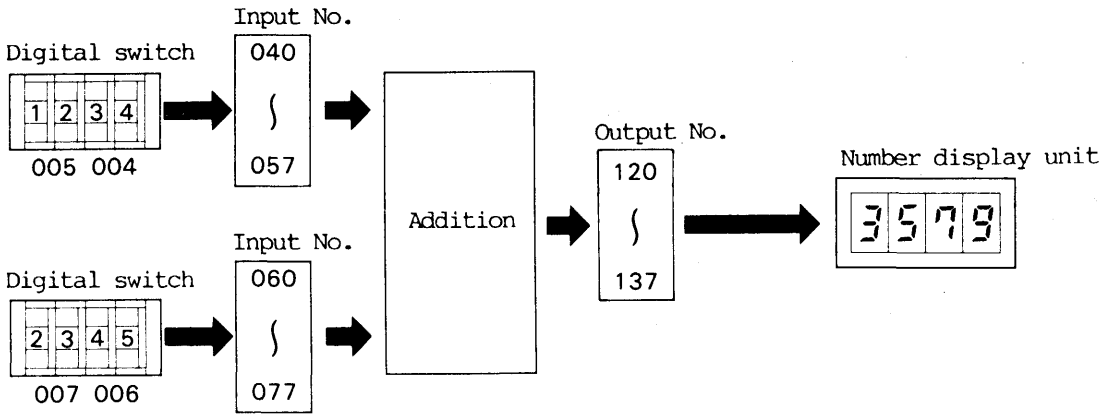


Add the accumulator data to the data in the register of the command specified register.

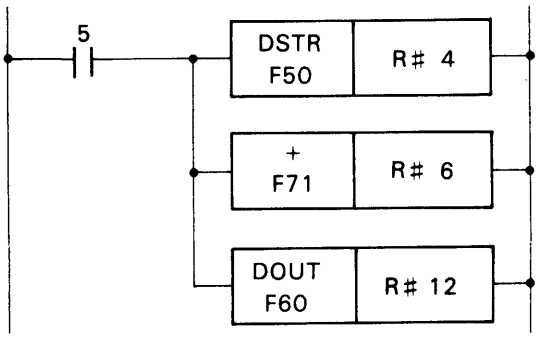
The answer (addition) will be memorized in the accumulator, and each flag for carry, zero, and over will be ON or OFF.

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Example: Add the input number of the input numbers 40 to 57 to the input number of the input numbers 60 to 77, and output the answer to the output numbers 120 to 137.



Circuit diagram



Command key



Movement when + command execution is made

Accumulator: Data to be added (content of R#4) 1234

4th digit				3rd digit				2nd digit				1st digit			
8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0

Command specification	Memorized register No. of the added data															
	R#7								R#6							
	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Data content	Adding data 2345 (content of R#6)															
	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
	0	0	1	0	0	0	1	1	0	1	0	0	0	1	0	1

Command execution: Add 2345 data content of the command specified register number R#6 to the memorized data in the accumulator for addition (1234), and write the answer into the accumulator.

Accumulator: Data to be added + adding data = 3 5 7 9

4th digit				3rd digit				2nd digit				1st digit			
8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
0	0	1	1	0	1	0	1	0	1	1	1	1	0	0	1

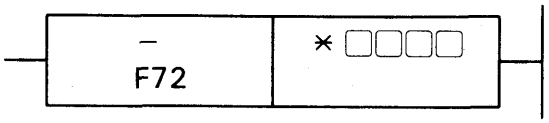
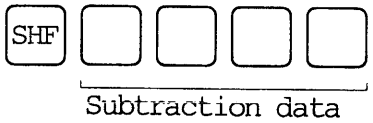
Flag	Carry	Zero	Over
	775	776	777

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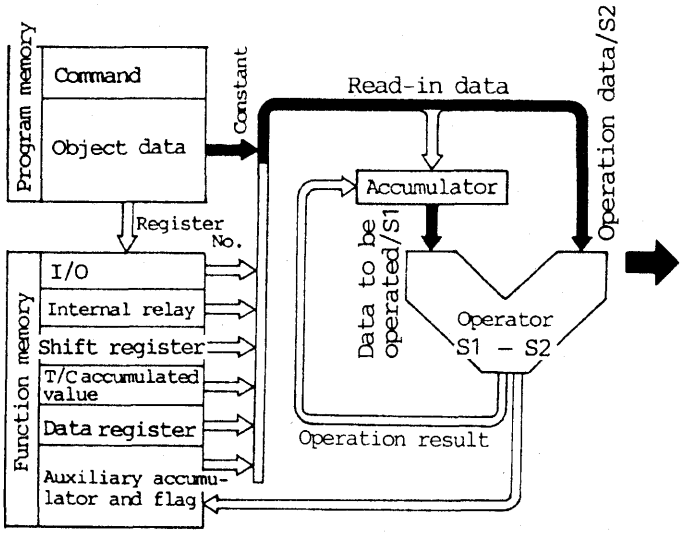
5-13. BCD 4-digit subtraction, −(minus) FUN72

Subtraction data constant specification

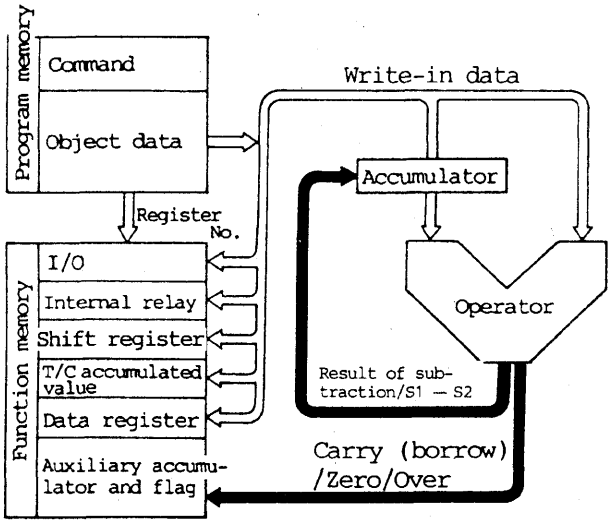
Subtraction of the command specified constant from the accumulated data

Symbol		
Instruction	Section for the command (1st word)	
	Section for the object (2nd word)	
Before execution of the command	Accumulator	The data to be subtracted is memorized.
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	The result of subtracted data, (accumulator data) - (command specified data), is memorized.
	Carry flag 775	If (data to be subtracted) < (subtracting data), add 10,000 to the subtracting data for subtraction. Put the carry (borrow) flag as a signal to take a figure down.
	Zero flag 776	ON if the subtracted result is 0
	Over flag 777	ON if the accumulator data are not in the BCD code

Data flow



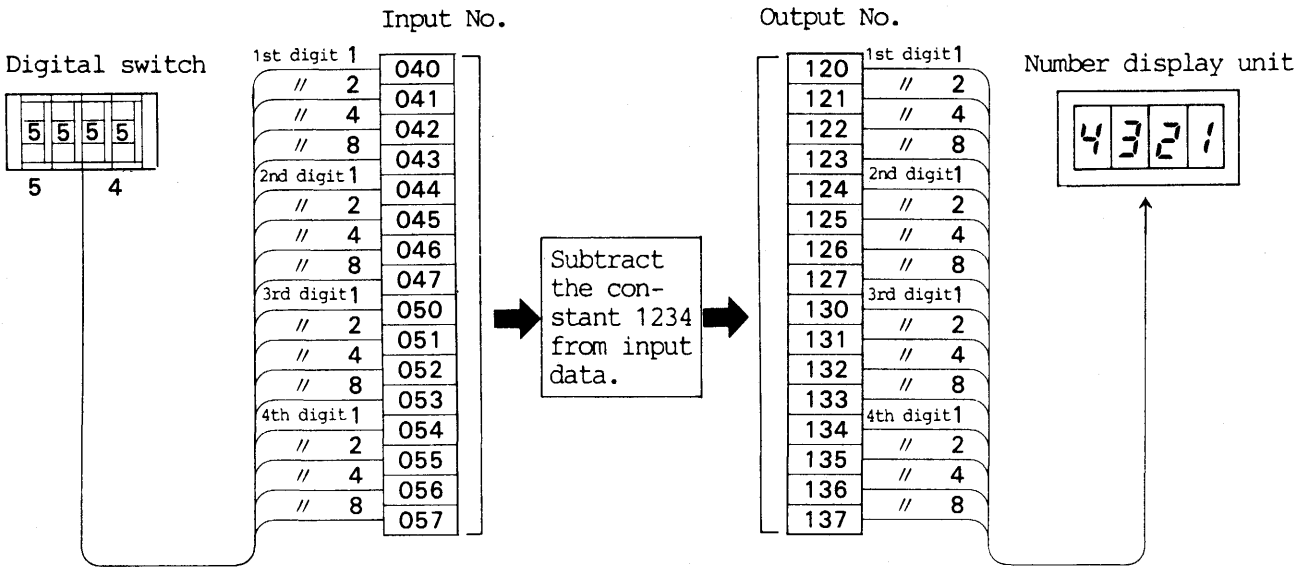
Subtract a command specified constant from the data memorized in the accumulator.



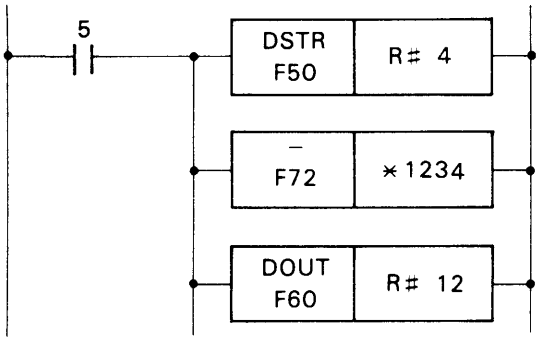
Memorize the answer into the accumulator and turn each flag ON or OFF for carry (borrow), zero, and over at the same time.

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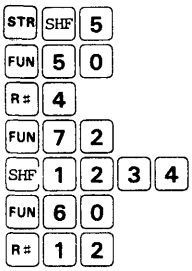
Example: Subtract the constant 1234 from the input number of input numbers 40 to 57, and output the answer to output numbers 120 to 137.



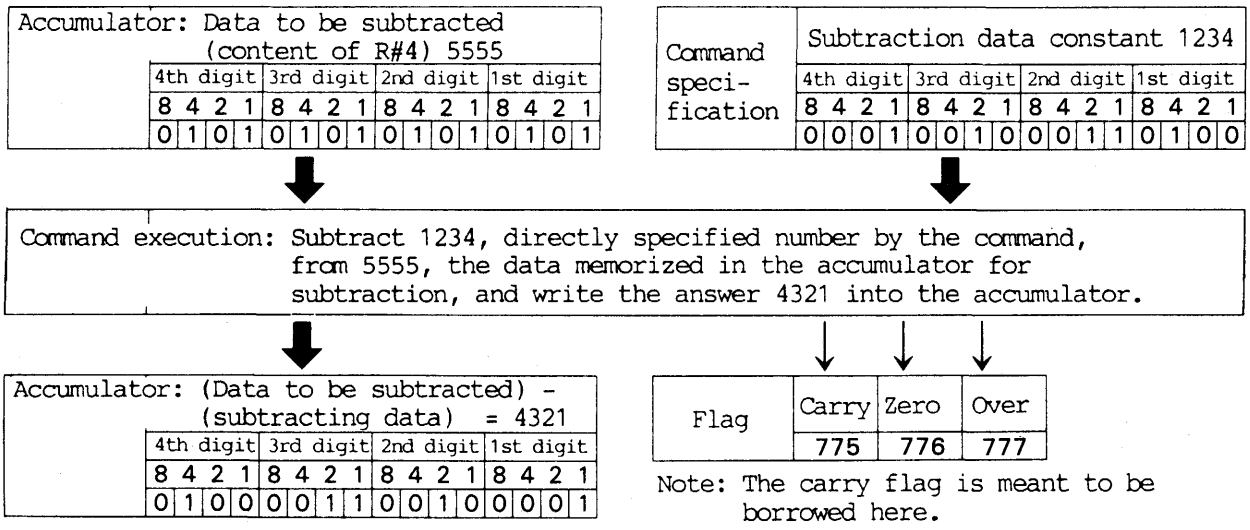
Circuit diagram



Command key



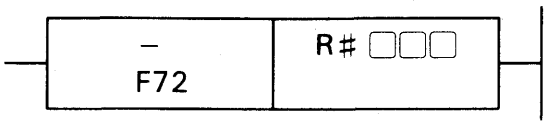
Movement when - command execution is made.



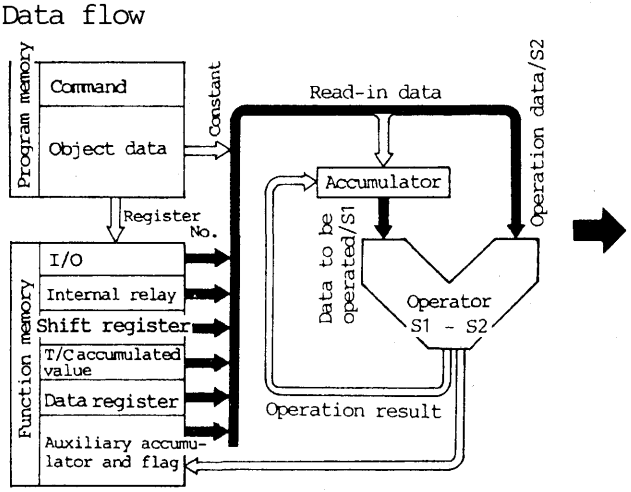
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Subtraction data number specification

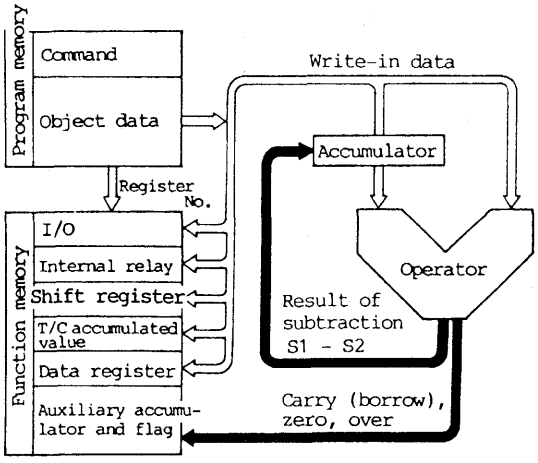
Subtraction of the data in the specified register from the accumulator data

Symbol		
Instruction	Section for the command (1st word)	FUN 7 2
	Section for the object (2nd word)	R# □ □ □ Subtraction data memory register number Input/Output 000~014, 070~075 Internal relay 016~036 Shift register 040~056 Data register 400~576 T/C accumulated value 600~677
Before execution of the command	Accumulator	Memorize the data to be subtracted (4-digit BCD code).
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	Memorize the result of subtraction, (accumulator data) - (command specified register data).
	Carry flag 775	If (data to be subtracted) < (subtracting data), add 10,000 to the subtracting data for subtraction. Put the carry (borrow) flag as a signal to take a figure down.
	Zero flag 776	ON if the subtracted result is 0
	Over flag 777	ON if the accumulator data or command specified data are not in the BCD code

Data flow



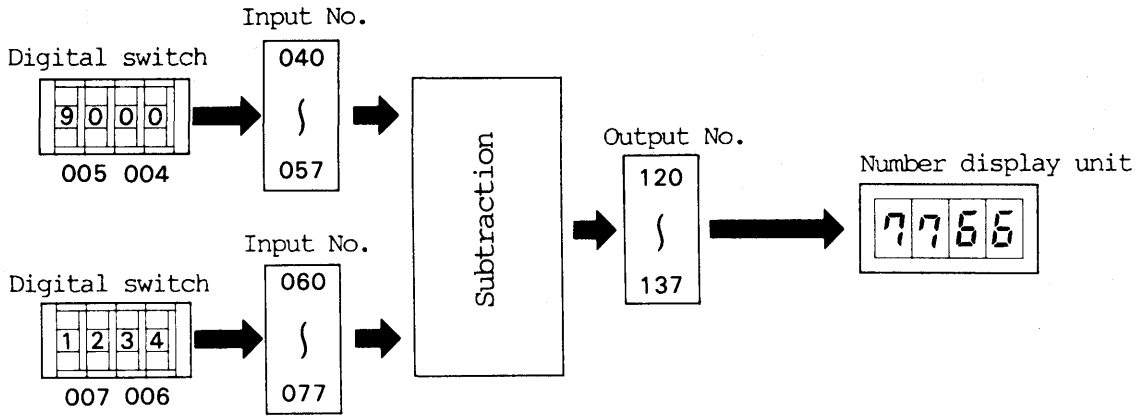
Subtract a command-specified register data from the accumulator data.



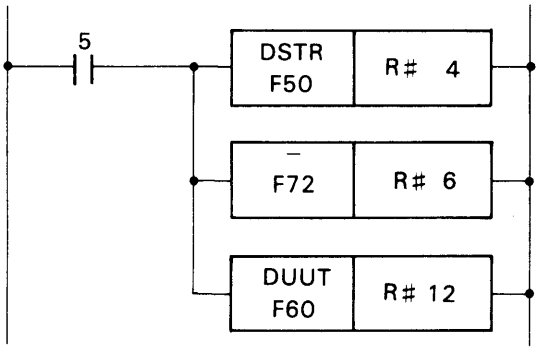
Memorize the answer into the accumulator, and turn each flag ON or OFF for carry (borrow), zero, and over at the same time.

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Example: Subtract the input number of input numbers 60 to 77 from the input number of input numbers 40 to 57, and output the answer to output numbers 120 to 137.



Circuit diagram



Command key



Movement when — command is executed

Accumulator:	Data to be subtracted (content of R#4) 9000			
	4th digit	3rd digit	2nd digit	1st digit
	8 4 2 1	8 4 2 1	8 4 2 1	8 4 2 1
	1 0 0 1	0 0 0 0	0 0 0 0	0 0 0 0

Command specification	Memorized register No. of the subtracted data	
	R# 7	R# 6
	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0
Data content	Subtracting data 1234 (content of R#6)	
	4th digit / 3rd digit / 2nd digit / 1st digit	
	8 4 2 1 / 8 4 2 1 / 8 4 2 1 / 8 3 2 1	
	0 0 0 1 / 0 0 1 0 / 0 0 0 1 / 1 0 1 0 0	

Command execution: Subtract 1234, data content of the command specified register No. R#6, from the memorized data in the accumulator for subtraction (9000), and write the answer into the accumulator.

Accumulator	(Data to be subtracted) - (subtracting data) = 7766			
	4th digit	3rd digit	2nd digit	1st digit
	8 4 2 1	8 4 2 1	8 4 2 1	8 4 2 1
	0 1 1 1	0 1 1 1	0 1 1 0	0 1 1 0

Flag	Carry	Zero	Over
	775	776	777

Note: The carry flag is meant to be borrowed (to take a figure down).

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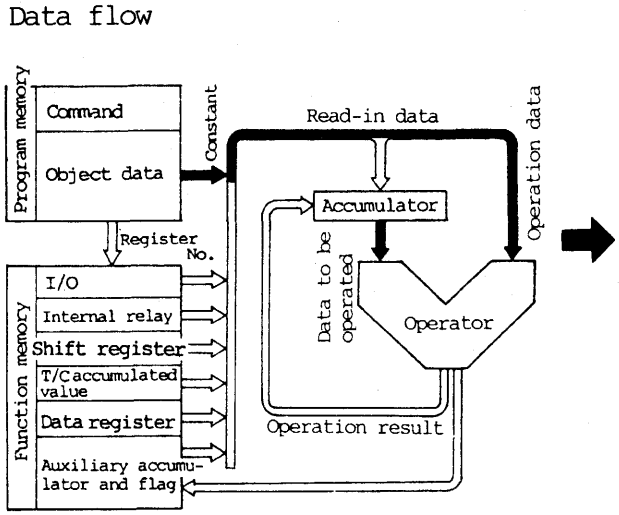
5-14. BCD 4-digit multiplication, × FUN73

Multiplication data constant specification

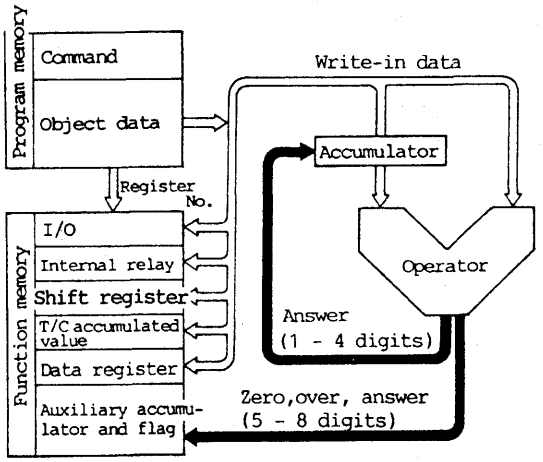
Multiplication of the command specified constant with the accumulated data

Symbol		× F73 ∗□□□□
Instruction	Section for the command (1st word)	FUN 7 3
	Section for the object (2nd word)	SHF □ □ □ □ (Multiplication data) Constant 0000 - 9999
Before execution of the command	Accumulator	Memorize the data to be multiplied.
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	Memorize the data of 4 digits of the lower order of the multiplied result of (accumulator data) x (command specified constant).
	Auxiliary accumulator R#577, R#576	Memorize the data of 4 digits of the higher order of the multiplied result of (accumulator data) x (command specified constant).
	Zero flag 776	ON if the multiplied result is 0
	Over flag 777	ON if the accumulator data are not in the BCD code

Data flow



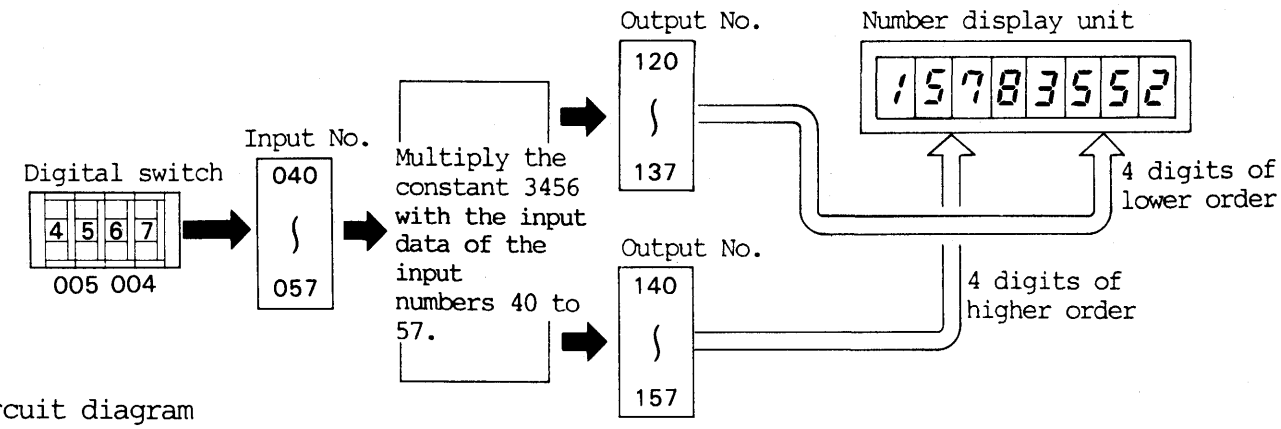
Multiply the command-specified constant with the accumulator data.



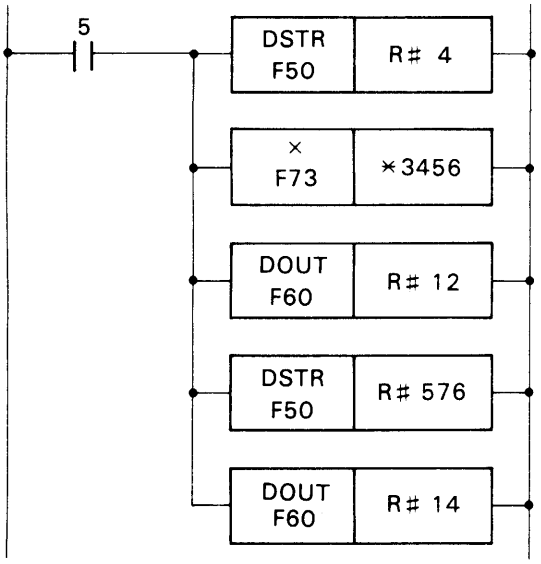
Memorize 4 digits of the lower order of the answer in the accumulator and 4 digits of the higher order of the answer in the auxiliary accumulator. Put the zero flag and over flag ON or OFF at the same time.

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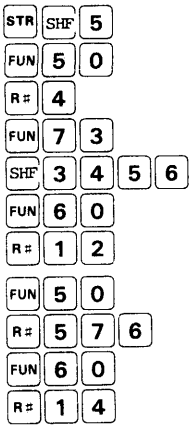
Example: Multiply the content 3456 with the input number of input numbers 40 to 57. Output the answer of 4 digits of the lower order to output numbers 120 to 137, and 4 digits of the higher order to output numbers 140 to 157.



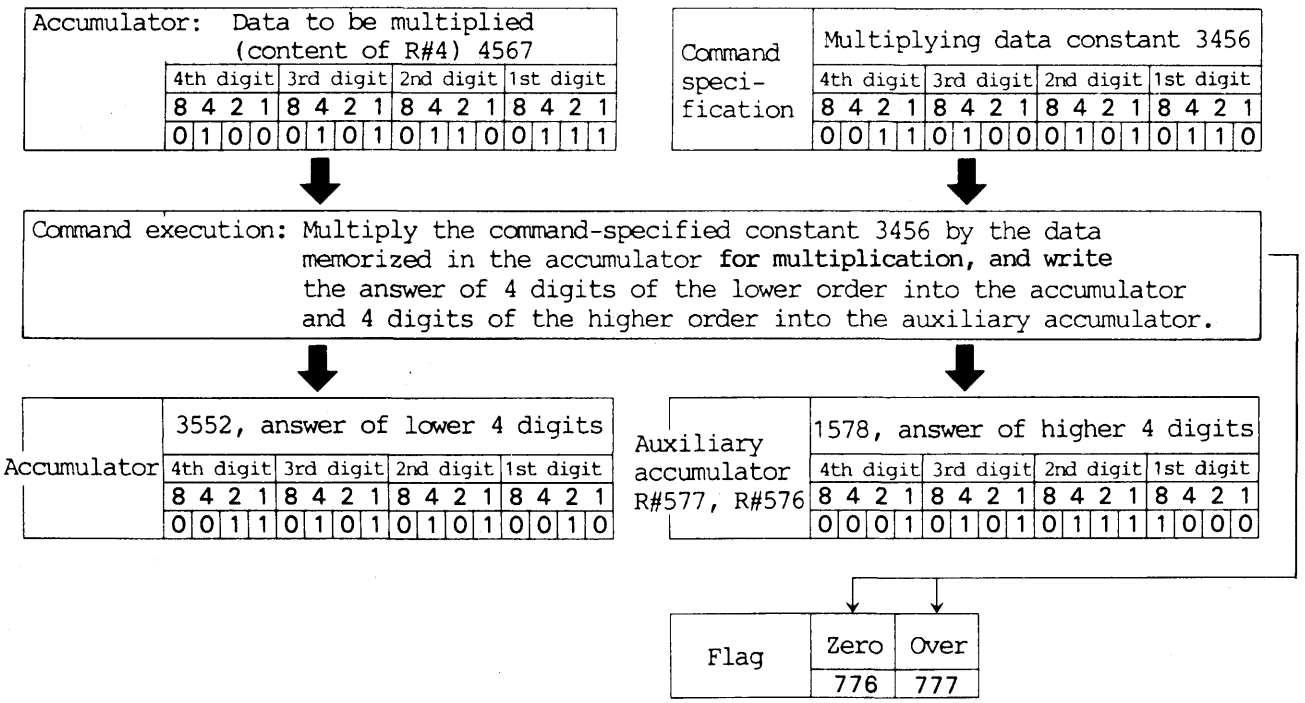
Circuit diagram



Command key



Movement when X command is executed



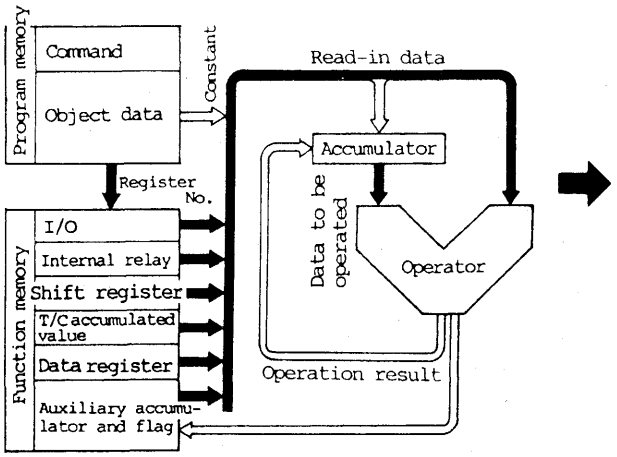
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Multiplication data number specification

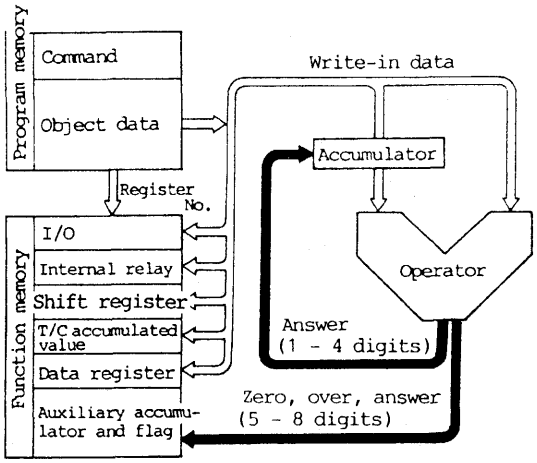
Multiplication of the data in the specified register with the accumulator data

Symbol		× F73 R# □□□
Instruction	Section for the command (1st word)	FUN 7 3
	Section for the object (2nd word)	R# □ □ □ Data memory register number to be multiplied Input/Output 000~014, 070~075 Internal relay 016~036 Shift register 040~056 Data register 400~576 T/C accumulated value 600~677
Before execution of the command	Accumulator	Memorize the data to be multiplied (4-digit BCD code).
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	Memorize the answer of 4 digits of the lower order of (accumulator data) x (data in the command specified register).
	Auxiliary accumulator R#577, R#576	Memorize the answer of 4 digits of the higher order of (accumulator data) x (data in the command specified register).
	Zero flag 776	ON if the multiplied result is 0
	Over flag 777	ON if the accumulator data or the data in the command specified register is not in the BCD code

Data flow



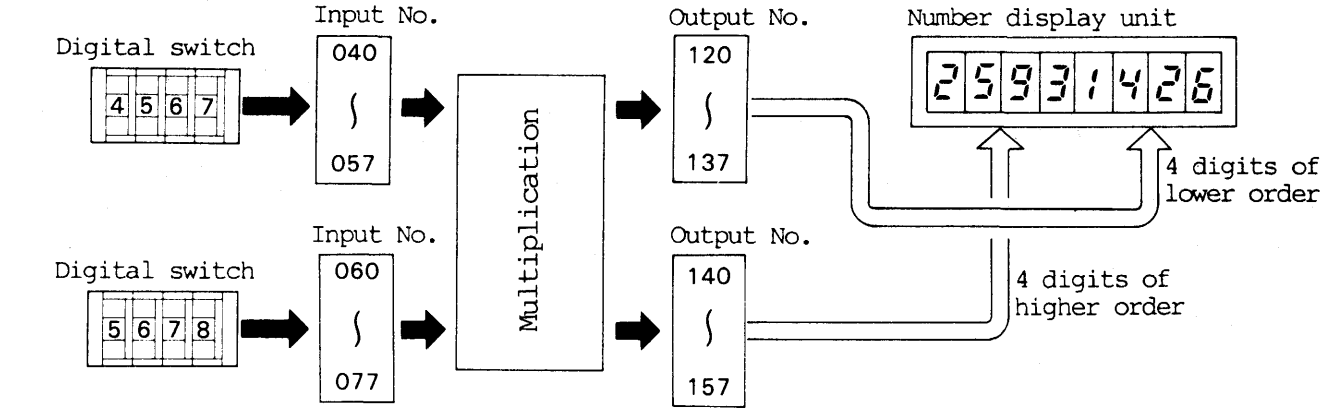
Multiply the accumulator data with the data in the command-specified register.



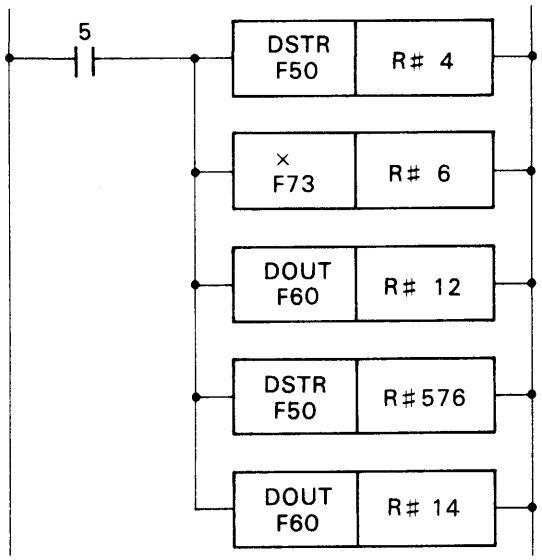
Memorize 4 digits of the lower order of the answer in the accumulator and 4 digits of the higher order of the answer in the auxiliary accumulator. Put the zero flag and over flag ON or OFF at the same time.

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Example: Multiply the input number of input numbers 60 to 77 with the input number of input numbers 40 to 57. Output the answer of 4 digits of the lower order to output numbers 120 to 137 and 4 digits of the higher order to output numbers 140 to 157.



Circuit diagram



Command key

STR SHF 5
FUN 5 0
R# 4
FUN 7 3
R# 6
FUN 6 0
R# 1 2
FUN 5 0
R# 5 7 6
FUN 6 0
R# 1 4

Movement when X command is executed

Accumulator: Data to be multiplied (content of R#4) 4567

4th digit				3rd digit				2nd digit				1st digit			
8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
0	1	0	0	0	1	0	1	0	1	1	0	0	1	1	1

Command specification	Register number to memorize the multiplying data															
	R# 7								R# 6							
	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Data content	Multiplying data (content of R#6) 5678															
	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
	0	1	1	0	1	0	1	0	0	1	1	1	1	0	0	0

Command execution: Multiply the data memorized in the accumulator and to be multiplied by the data memorized in the memory of the command specified register number, and write the answer of 4 digits of the lower order into the accumulator and 4 digits of the higher order into the auxiliary accumulator.

Accumulator: Answer of 4 digits of lower order 1426

4th digit				3rd digit				2nd digit				1st digit			
8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
0	0	0	1	0	1	0	0	0	0	1	0	0	1	1	0

Auxiliary accumulator R#577, R#576	Answer of 4 digits of higher order 2593															
	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
	0	0	1	0	0	1	0	1	1	0	0	1	0	0	1	1

Flag	Zero	Over
	776	777

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5-15. BCD 4-digit division, ÷ FUN74

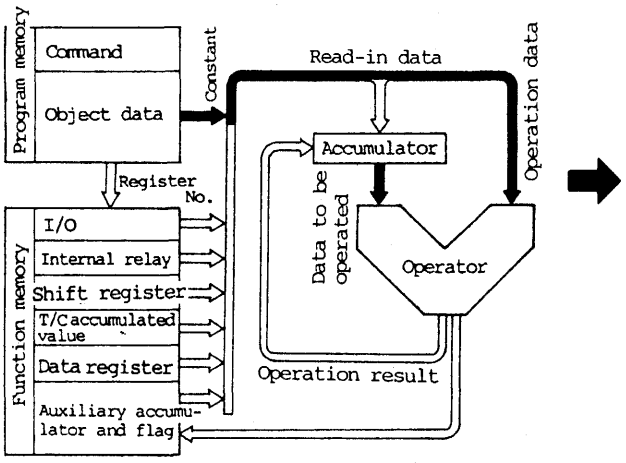
Division data constant specification

Division of the accumulator data by the command-specified constant

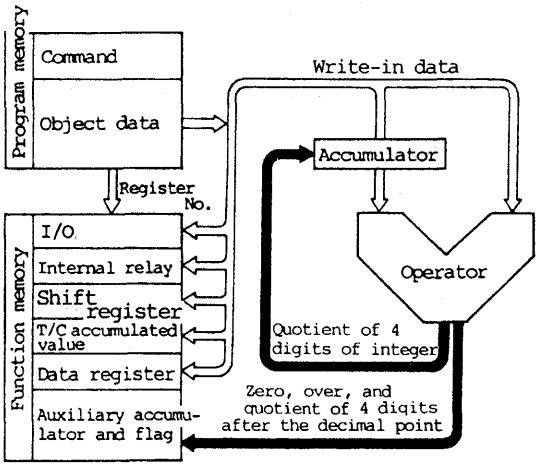
Symbol		÷ F74 ∗ □□□□
Instruction	Section for the command (1st word)	FUN 7 4
	Section for the object (2nd word)	SHF □ □ □ □ (Division data) Constant 0000 - 9999
Before execution of the command	Accumulator	Memorize the data to be divided (4-digit BCD code).
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	Memorize the integer of 4 digits of the divided result of (accumulator data) ÷ (command specified constant).
	Auxiliary accumulator R#577, R#576	Memorize the answer of 4 digits after the decimal point of the divided result of (accumulator data) ÷ (command specified constant)
	Zero flag 776	ON if (accumulator data) or (command specified constant) is 0
	Over flag 777	ON if the command-specified constant is 0 or accumulator data are not in the BCD code

Note: The numbers after five places of decimals are discarded.

Data flow



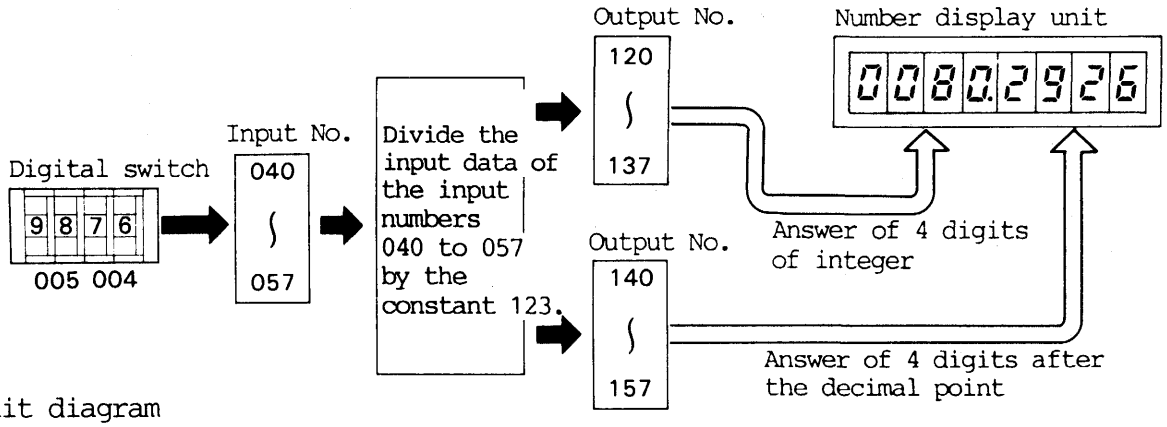
Divide the accumulator data by the command-specified constant.



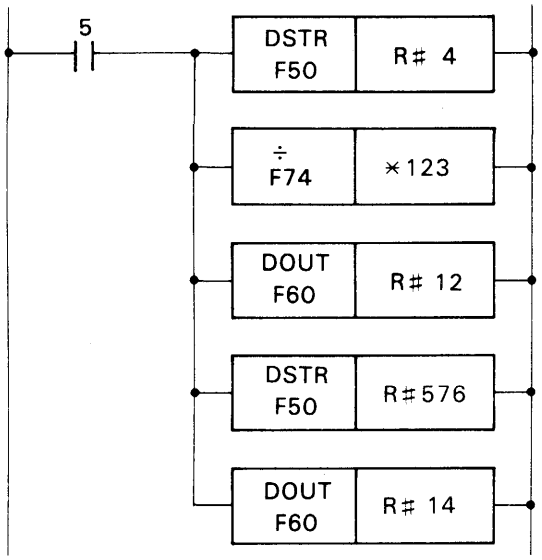
Memorize the quotient of 4 digits of the integer in the accumulator and 4 digits after the decimal point into the auxiliary accumulator. Put the zero flag or over flag ON or OFF at the same time.

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Example: Divide the input number of input numbers 40 to 57 by the constant 123, and output the answer of 4 digits of the integer to output numbers 120 to 137 and 4 digits after the decimal point to output numbers 140 to 157.



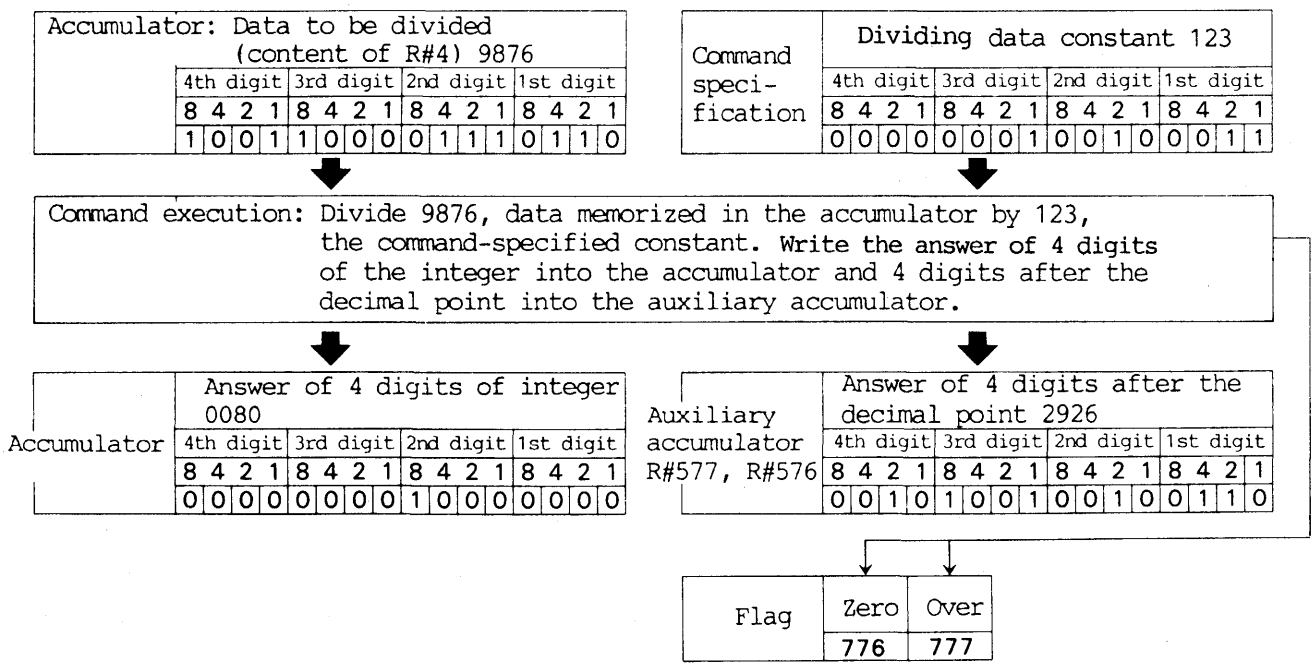
Circuit diagram



Command key



Movement when ÷ command is executed.



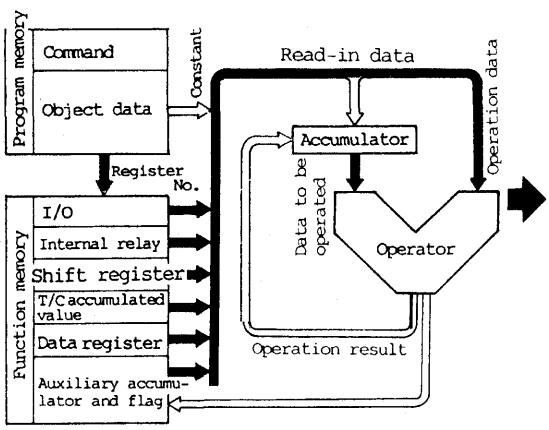
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Divison data number specification

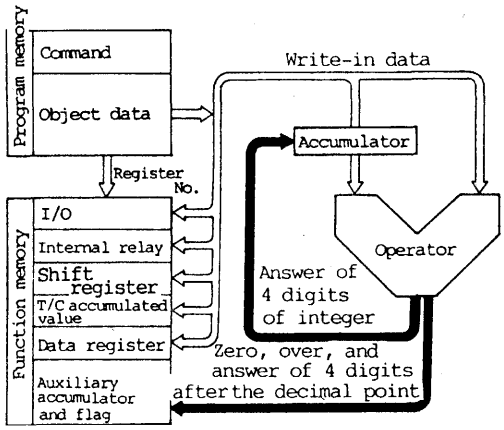
Division of the accumulator data by the data in the command-specified register

Symbol		÷ F74 | R# □□□
Instruction	Section for the command (1st word)	FUN 7 4
	Section for the object (2nd word)	R# □ □ □ Data memory register number to be divided Input/Output 000~014, 070~075 Internal relay 016~036 Shift register 040~056 Data register 400~576 T/C accumulated value 600~677
Before execution of the command	Accumulator	Memorize the data to be divided (4-digit BCD code).
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	Memorize the data of 4 digits of the integer of the answer of (accumulator data) ÷ (data in the command-specified register).
	Auxiliary accumulator R#577, R#576	Memorize 4 digits after the decimal point of the answer of (accumulator data) ÷ (data in the command-specified register).
	Zero flag 776	ON if the accumulator data or data in the command-specified register are 0
	Over flag 777	ON if the accumulator data or data in the command-specified register is not in the BCD code, or if the data in the command-specified register are 0

Data flow



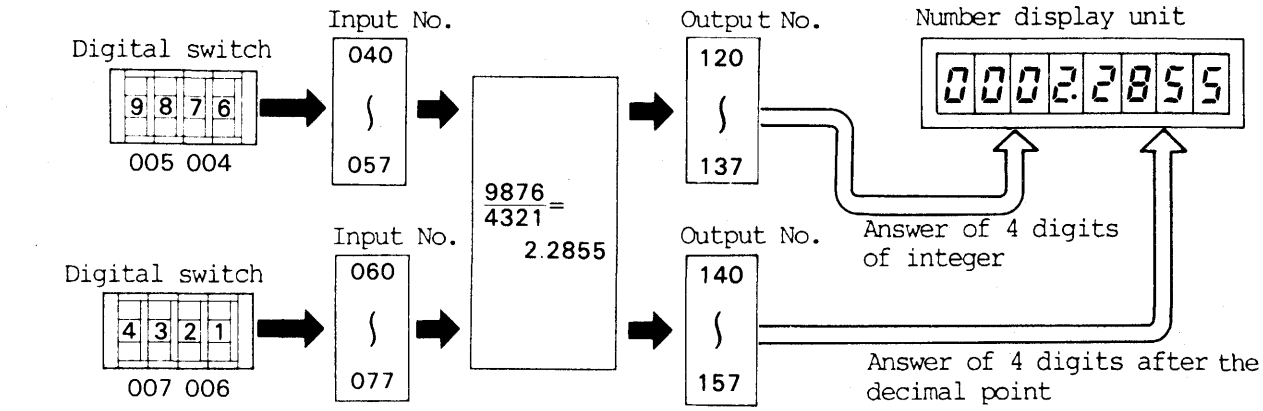
Divide the accumulator data by the data in the command-specified register.



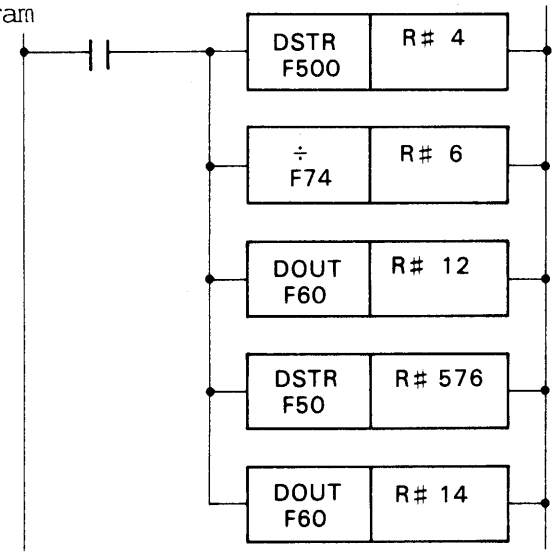
Memorize the answer of 4 digits of the integer into the accumulator and 4 digits after the decimal point into the auxiliary accumulator. Put the zero flag and over flag ON or OFF at the same time.

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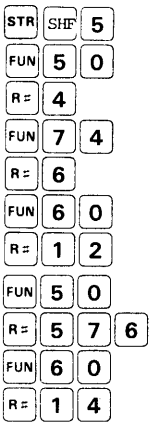
Example: Divide the input number of input numbers 40 to 57 by the input number of input numbers 60 to 77; then output the answer of 4 digits of the integer to output numbers 120 to 137 and 4 digits after the decimal point to output numbers 140 to 157.



Circuit diagram



Command key



Movement when ÷ command is executed

Accumulator: Data to be divided (content of R#4) 9876

4th digit				3rd digit				2nd digit				1st digit			
8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
1	0	0	1	1	0	0	0	0	1	1	1	0	1	1	0

Command specification	Register number to memorize the dividing data															
	R# 7								R# 6							
	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Data content	Dividing data (content of R#6) 4321															
	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	1

Command execution: Divide 9876 memorized in the accumulator by 4321, data memorized in the command-specified register No. R#6. Write the answer of 4 digits of the integer into the accumulator and 4 digits after the decimal point into the auxiliary accumulator.

Accumulator: Answer of 4 digits of integer 0002

4th digit				3rd digit				2nd digit				1st digit			
8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	

Auxiliary accumulator R#577, R#576: Answer of 4 digits after decimal point 2855

4th digit				3rd digit				2nd digit				1st digit			
8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
0	0	1	0	1	0	0	0	0	1	0	1	0	1	0	1

Flag	Zero	Over
	776	777

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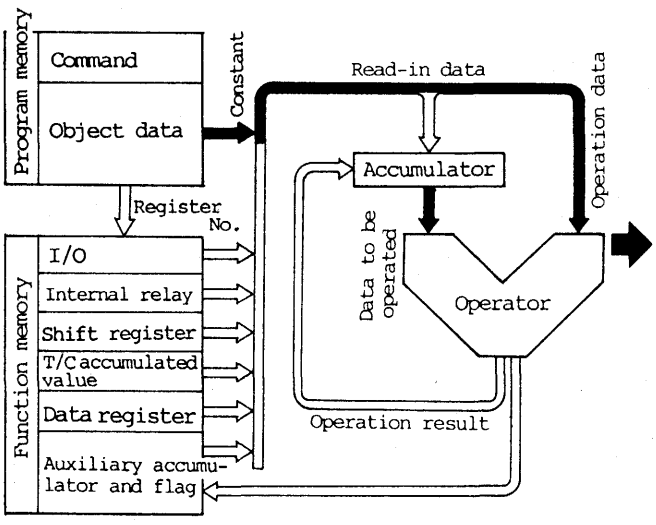
5-16. 16-bit AND, D AND (FUN75)

AND data constant specification

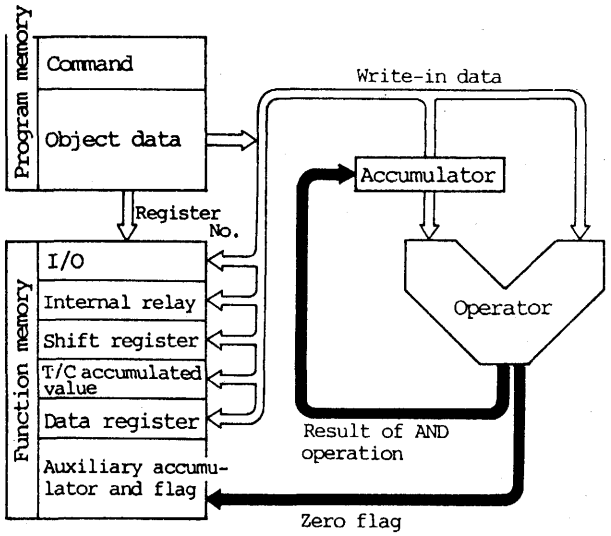
AND operation of the accumulator data to the command-specified constant

Symbol		DAND F75 ＊□□□□
Instruction	Section for the command (1st word)	FUN 7 5
	Section for the object (2nd word)	SHF □ □ □ □ (AND data) Constant 0000 - 9999
Before execution of the command	Accumulator	Memorize the data to be AND operated.
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	Memorize the result of AND operation of each bit to correspond with (accumulator data) and (command-specified constant).
	Zero flag 776	ON if the result of AND operation is 0

Data flow



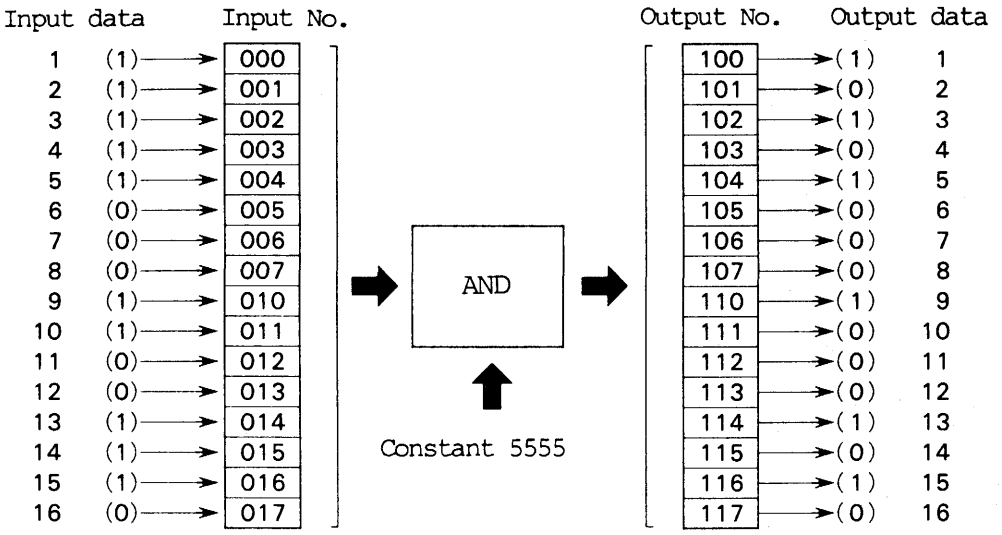
AND operation of each bit to correspond with the accumulator data and the command-specified constant (BCD code)



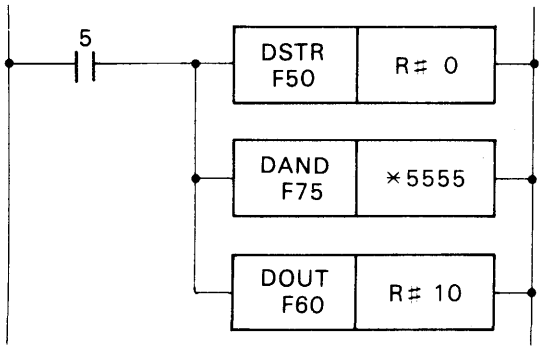
Memorize the result of AND operation into the accumulator. Put the zero flag ON or OFF at the same time.

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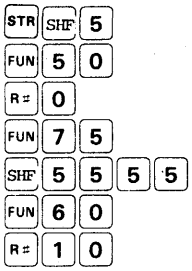
Example: The 16-bit input data from input numbers 0 to 17 will be AND operated with the constant 5555 (BCD code), and the result will be output to output numbers 100 to 117.



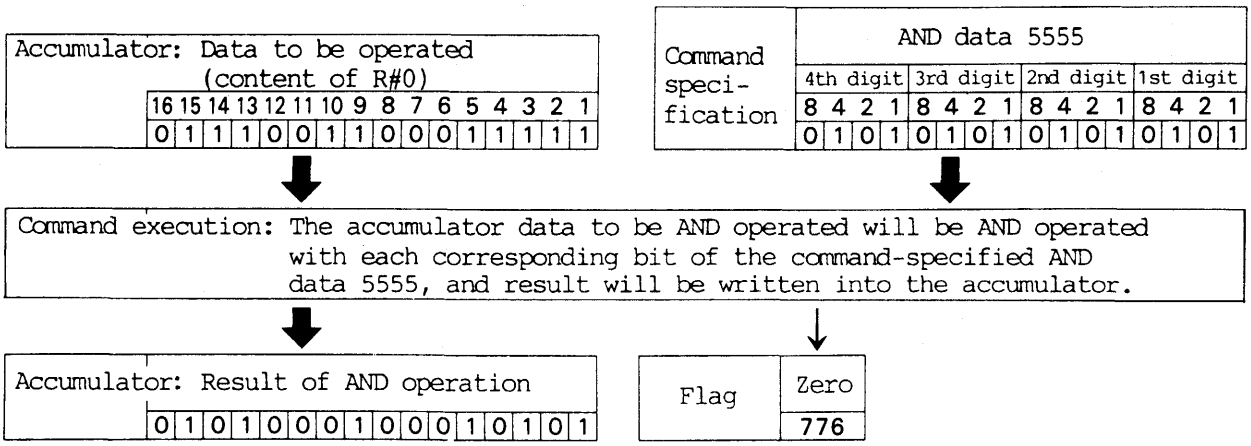
Circuit diagram



Command key



Movement when AND command is executed



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AND data number specification

AND specification of the accumulator data and the data in the command specified register

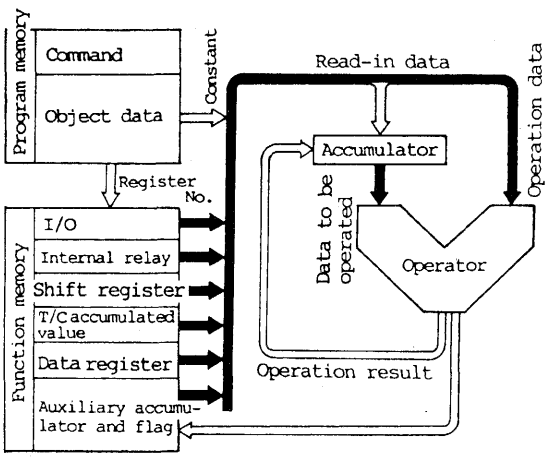
Symbol		DAND F75 R# □□□
Instruction	Section for the command (1st word)	FUN 7 5
	Section for the object (2nd word)	R# □ □ □ (AND data memory register number) Input/Output 000~014, 070~074 Internal relay 016~036 Shift register 040~056 Data register 400~576 T/C accumulated value 600~677
Before execution of the command	Accumulator	Memorize the data to be AND operated.
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	Memorize the result of AND operation of each bit to correspond with (accumulator data) and (data in the command specified register).
	Zero flag 776	ON if the result of AND operation is 0

AND operation truth table:

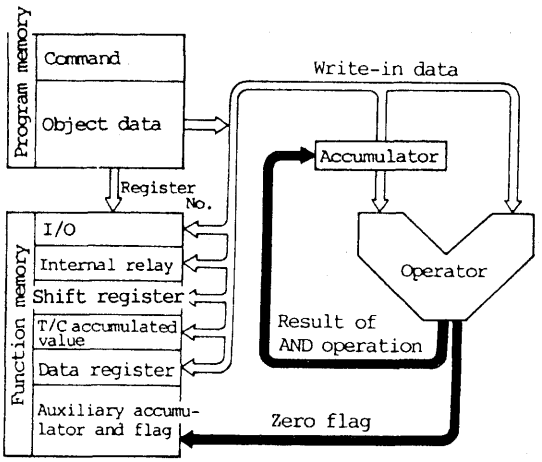
Data to be AND operated	0	0	1	1
AND data	0	1	0	1
Result of AND operation	0	0	0	1

This operation is processed between each corresponding bit by this command.

Data flow



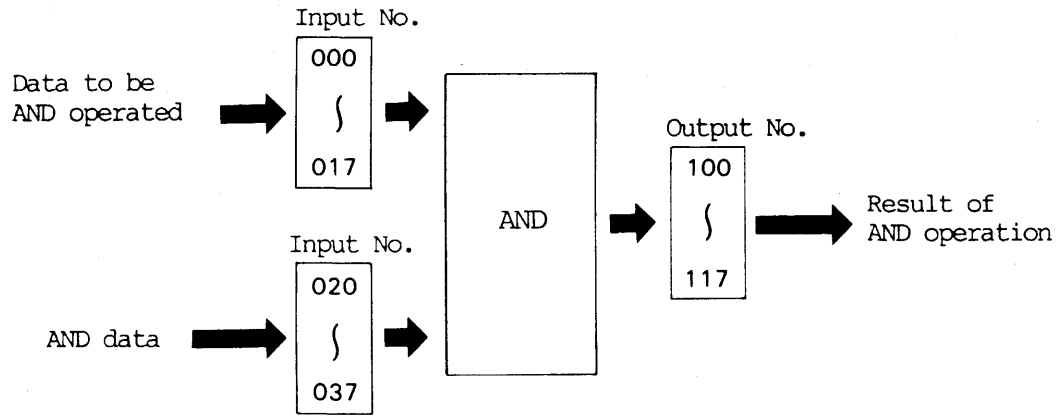
AND opeation of each corresponding bit of the accumulator data and the data in the command-specified register



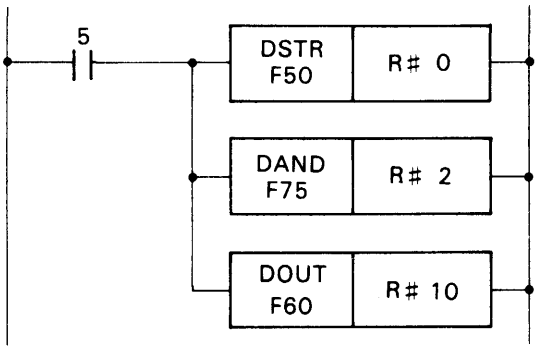
Memorize the result of AND operation in the accumulator, and put the zero flag ON or OFF at the same time.

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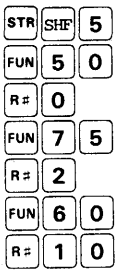
Example: Leave out only the bits when both bits corresponding with the 16-bit input data of input numbers 0 to 17 and input numbers 20 to 37 are 1. Assign 0 to the other bits and output to output numbers 100 to 117.



Circuit diagram



Command key



Movement when D AND command is executed

Command specification	Register number to memorize the AND data	
	R# 3	R# 2
	7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0
Data content	AND data (content of R#2)	
	16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1	
	0 1 1 1 0 1 1 0 0 1 0 1 0 1 0 0	

Accumulator: Data to be AND operated (content of R#0)

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
0	1	0	0	0	1	0	1	0	1	1	0	0	1	1	1

Command execution: Operate by AND the data to be operated and memorized in the accumulator and the AND data memorized in the command-specified register number memory, and write the answer in the accumulator.

Accumulator: Result of AND operation

0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0

Flag	Zero
	776

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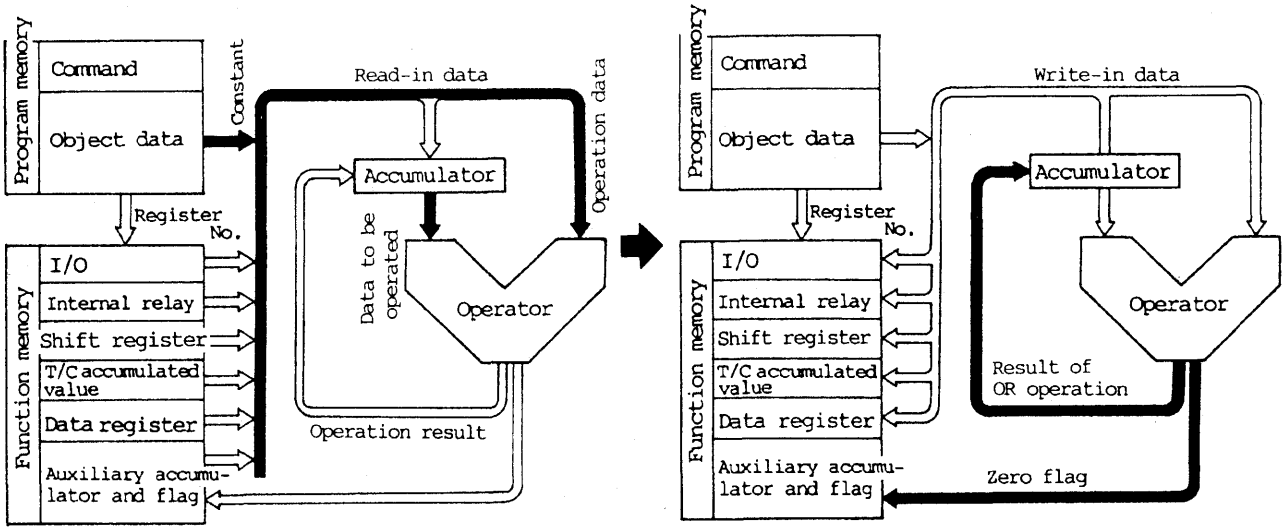
5-17. 16-bit OR, D OR (FUN76)

OR data constant specification

OR operation of the accumulator data to the command-specified constant

Symbol		DOR F76 ✳ □□□□
Instruction	Section for the command (1st word)	FUN 7 6
	Section for the object (2nd word)	SHF □ □ □ □ (OR data) Constant 0000 - 9999
Before execution of the command	Accumulator	Memorize the OR data.
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	Memorize the result of OR operation of each bit to correspond with (accumulator data) and (command-specified constant).
	Zero flag 776	ON if the result of OR operation is 0

Data flow

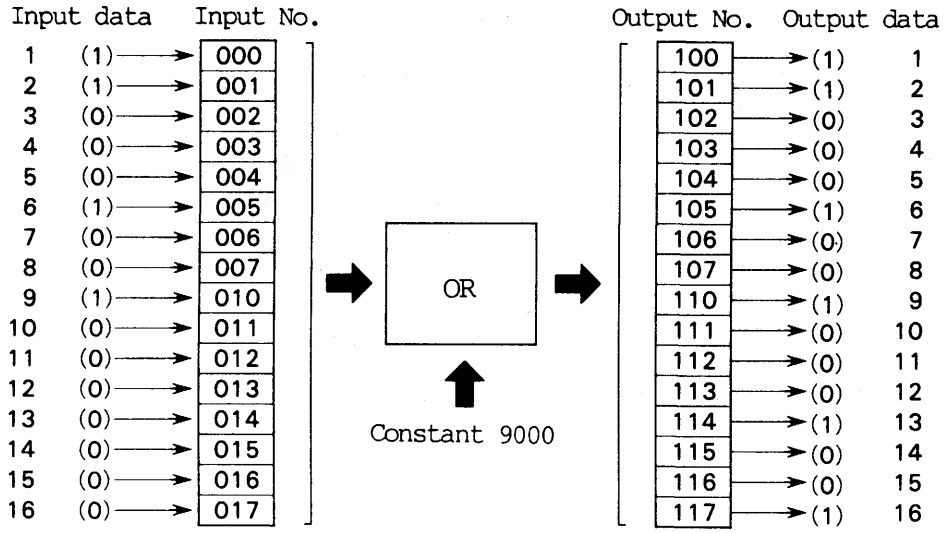


OR opeation of each bit to correspond with the accumulator data and the command-specified constant

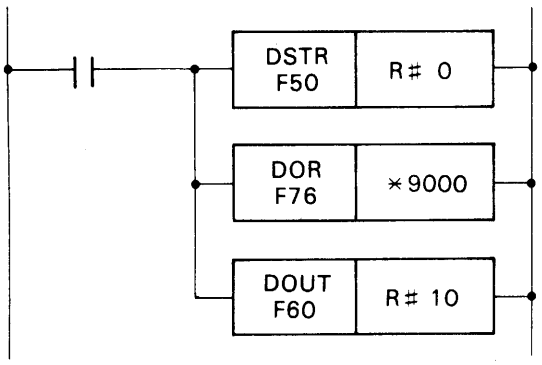
Memorize the result of OR operation in the accumulator. Put the zero flag ON or OFF at the same time.

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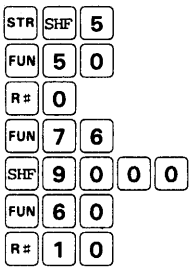
Example: The 16-bit data input numbers 0 to 17 will be OR processed with the constant 9000 (BCD), and the result will be output to output numbers 100 to 117.



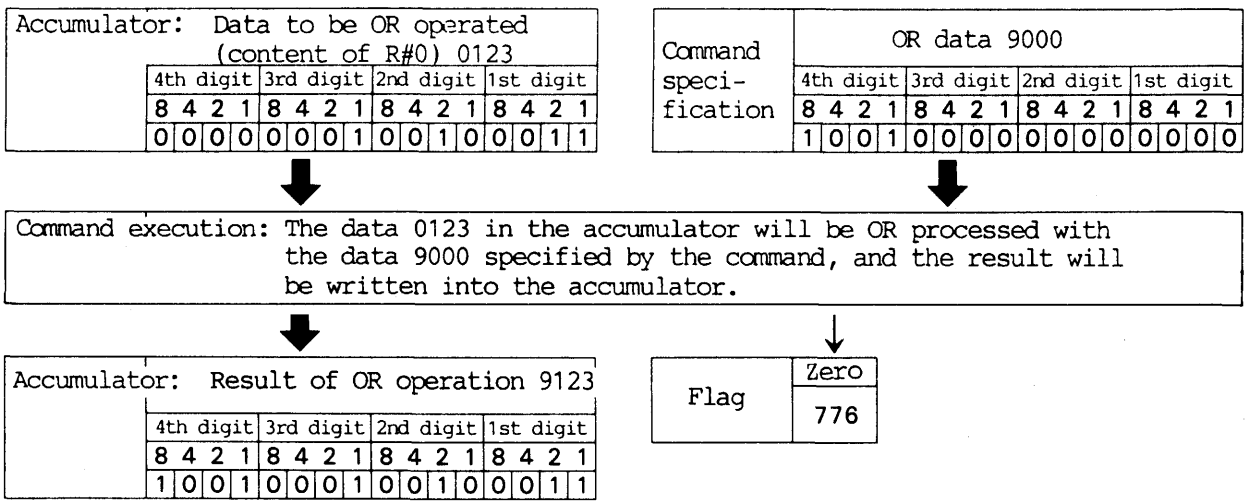
Circuit diagram



Command key



Movement when D OR command is executed

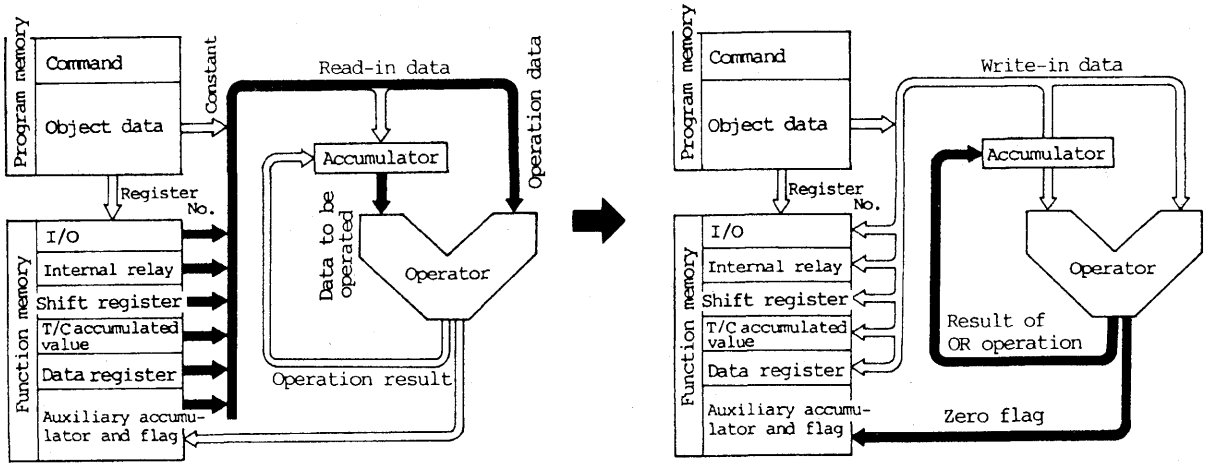


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OR data number specification

Symbol		DOR | R# □□□
Instruction	Section for the command (1st word)	FUN 7 6
	Section for the object (2nd word)	R# □ □ □ OR data memory register number Input/ Output 000~014, 070~074 Internal relay 016~036 Shift register 040~056 Data register 400~576 T/C accumulator value 600~677
Before execution of the command	Accumulator	Memorize the data to be OR operated.
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	Memorize the result of OR operation of each bit to correspond with (accumulator data) and (data in the command-specified register).
	Zero flag 776	ON if the result of OR operation is 0

Data flow

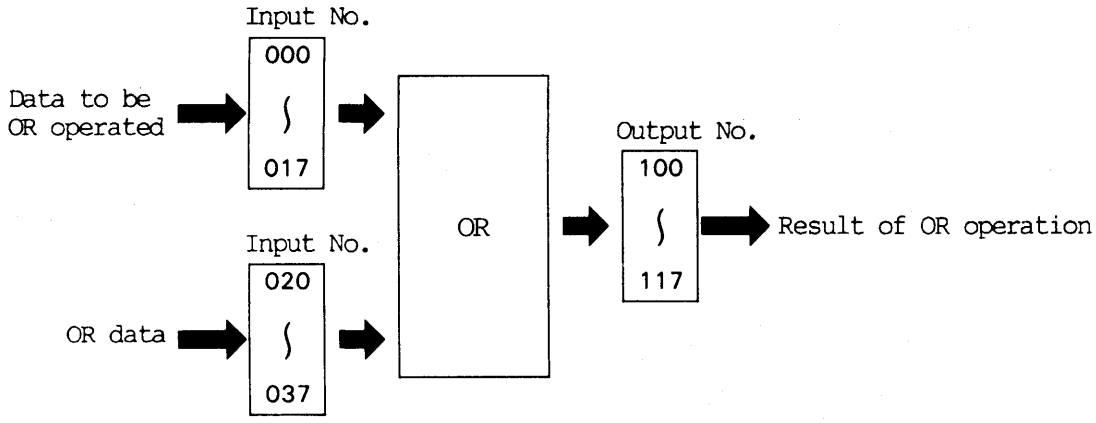


OR operation of each bit to correspond with the accumulator data and the data in the command-specified register

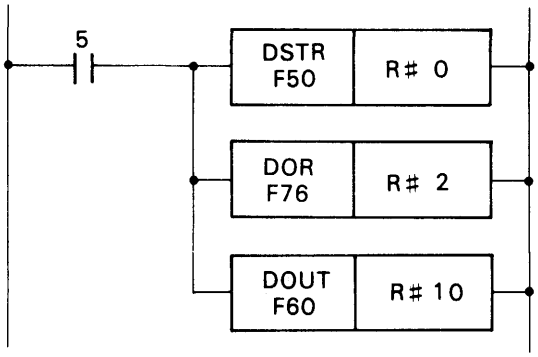
Memorize the result of OR operation in the accumulator. Put the zero flag ON or OFF at the same time.

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Example: If either bit of the corresponding 16-bit input data of input numbers 0 to 17 or the 16-bit input data of input numbers 20 to 37 is 1, prepare the data for 1 to output to output numbers 100 to 117.



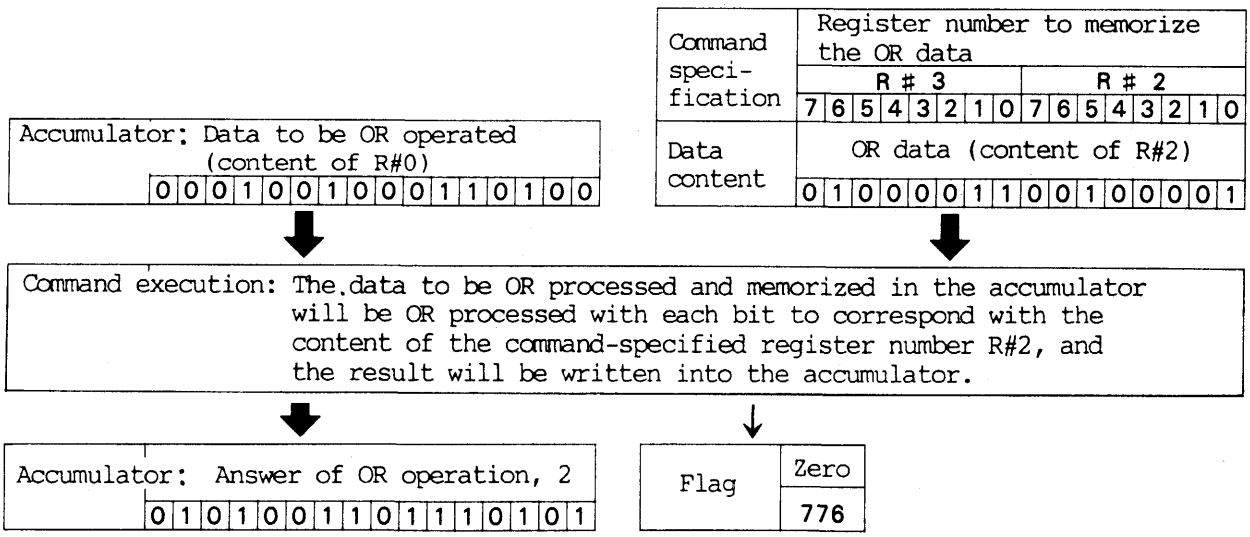
Circuit diagram



Command key



Movement when D OR command is executed



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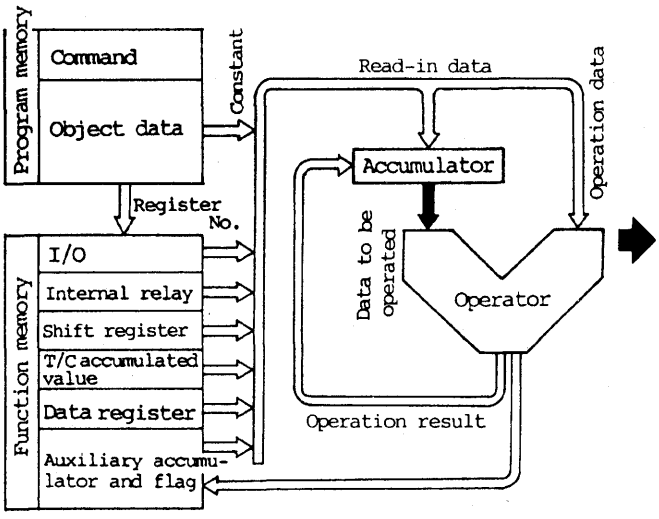
5-18. Right shift, SFTR (FUN80)

Shifting of the accumulator data to the right for the command-specified number

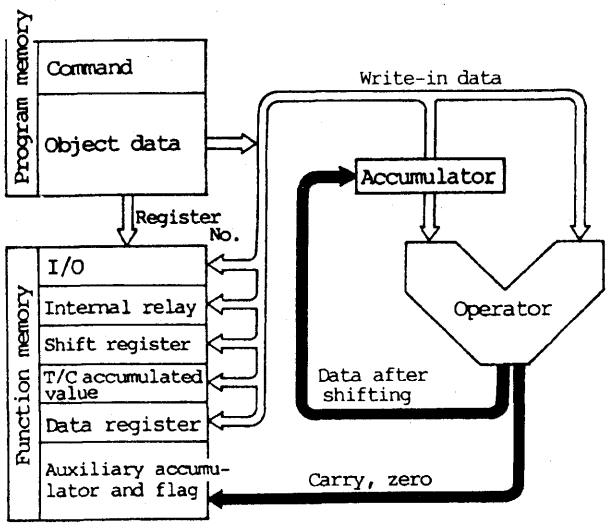
Symbol		SFTR F80 ＊ □□
Instruction	Section for the command (1st word)	FUN 8 0
	Section for the object (2nd word)	SHF □ □ (Number of shifts) Constant 1 - 16
Before execution of the command	Accumulator	Memorize the data for shifting.
Condition to execute the command		Execution when the condition is satisfied. NO execution when the condition is not satisfied.
After execution of the command	Accumulator ＊	Memorize the data of the accumulator data shifted to the right for the command-specified number from the condition before execution of the command.
	Carry flag 775	ON if any ON bit is left in the data shifted from the accumulator
	Zero flag 776	ON when the accumulator content is 0

＊ : 0 will be put into the left side of the accumulator for the number of shift.

Data flow



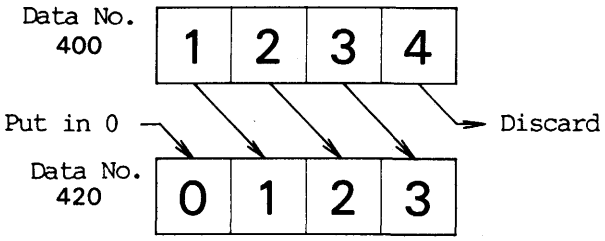
Shift the accumulator data to the right for the command-specified constant.



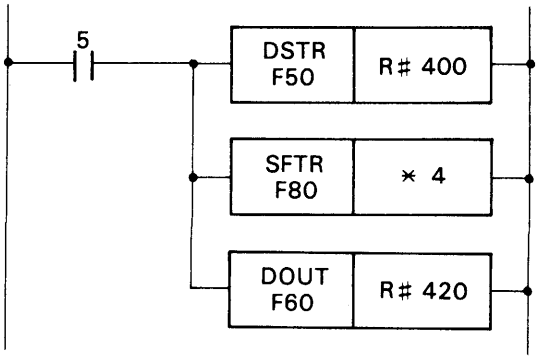
Memorize the shifted data in the accumulator and zeros for the blanks made in the left side for the number of shifts. Put the carry flag and zero flag ON or OFF at the same time.

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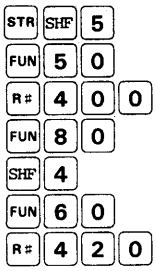
Example: Memorize the data memorized in the number 400 into the data number 420 for 3 digits of the higher order.



Circuit diagram



Command key



Movement when SFT R command is executed

Accumulator	1 2 3 4															
	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
	0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0

Accumulator: Shift 4 bits (1 digit) of the accumulator data before execution to the right.

Accumulator	0 1 2 3															
	4th digit				3rd digit				2nd digit				1st digit			
	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	1

Flag	Carry	Zero
	775	776

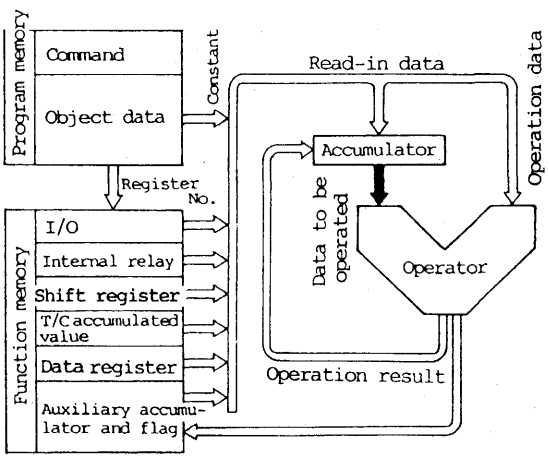
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5-19. Left shift, SFTL (FUN81)

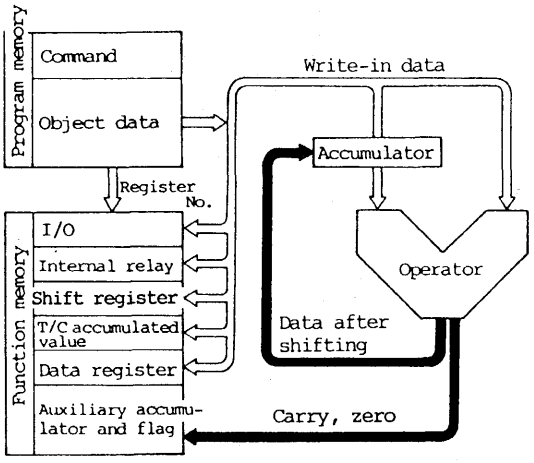
Shifting of the accumulator data to the left for the command-specified number

Symbol		SFTL F81 ✳ □□
Instruction	Section for the command (1st word)	FUN 8 1
	Section for the object (2nd word)	SHF □ □ (Number of shifts) Constant 1 - 16
Before execution of the command	Accumulator	Memorize the data for shifting.
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	Memorize the data of the accumulator data shifted to the left for the command-specified number from the condition before execution of the command.
	Carry flag 775	ON if any ON bit is left in the data shifted from the accumulator
	Zero flag 776	ON when the accumulator content is 0

Data flow



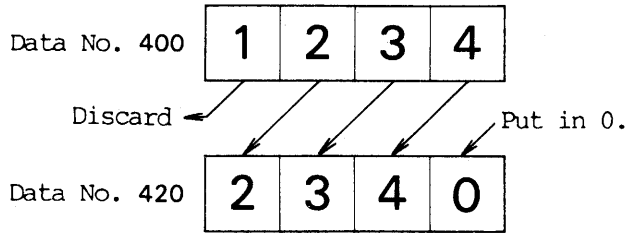
Shift the accumulator data to the left for the command-specified constant.



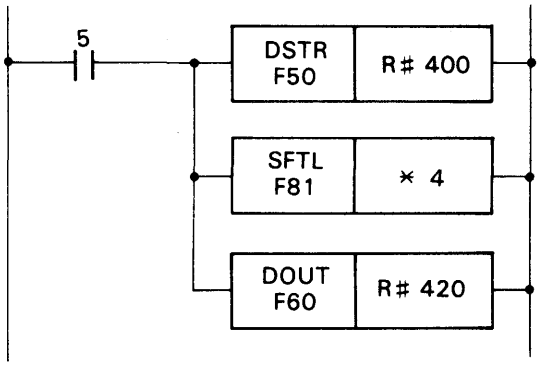
Memorize the shifted data in the accumulator and zeros for the blanks made in the left side for the number of shifts. Put the carry flag and zero flag ON or OFF at the same time.

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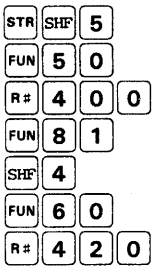
Example: The data memorized in data number 400 will be memorized in data number 420 by shifting one digit to the left.



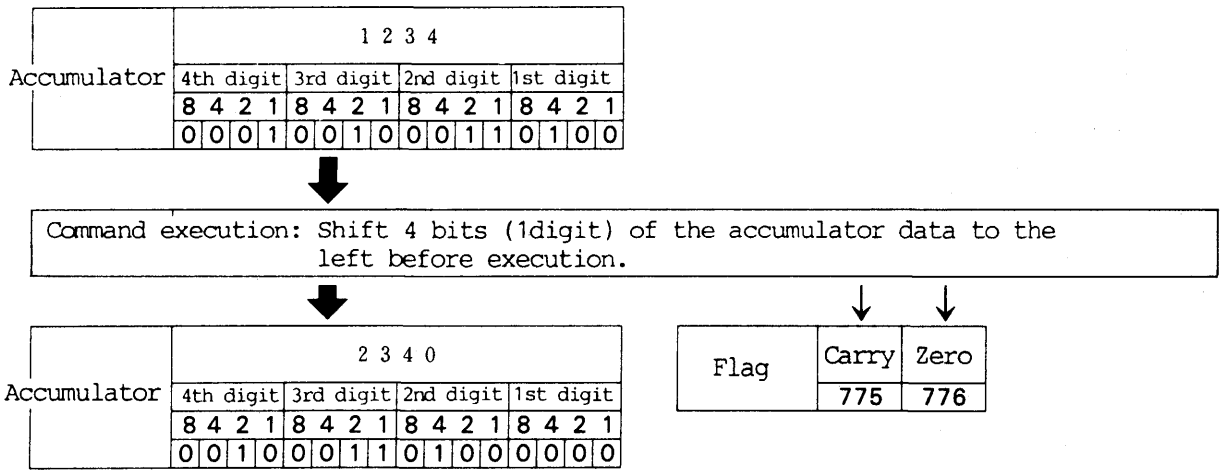
Circuit diagram



Command key



Movement when SFT L command is executed



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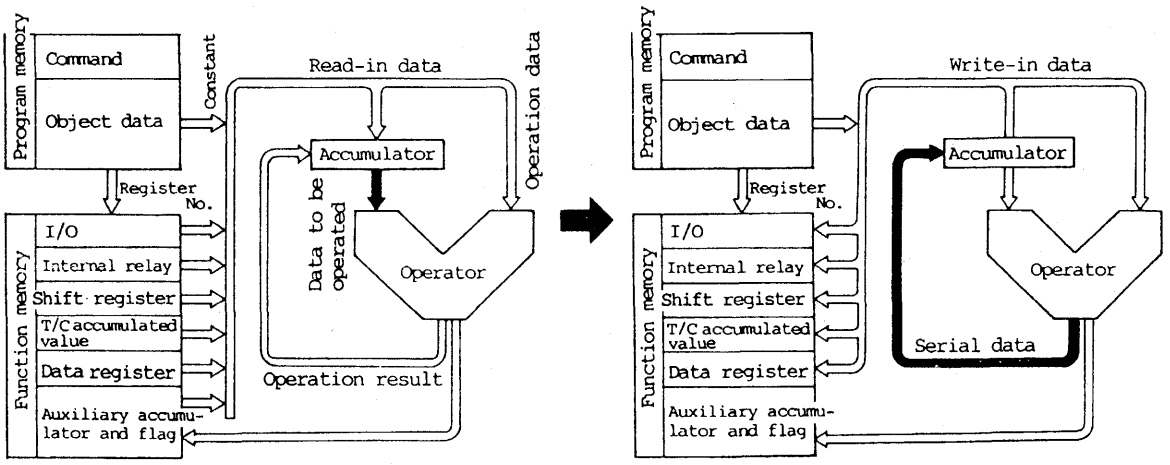
5-20. Decode, DECO (FUN82)

Convert the binary code of 4 bits of the lower order in the accumulator into the serial data, and memorize the result in the accumulator.

Symbol		DECO F82
Instruction		FUN 8 2
Before execution of the command	Accumulator	Memorize the binary code data for decoding (effective only for 4 bits of lower order).
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	The bits in the location of the accumulator corresponding to the numbers of binary code data turn to 1, and other bits turn to 0.

	Binary code				Serial data after conversion													
	8	4	2	1	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
3	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
5	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
6	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
7	0	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
8	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
9	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
10 (A)	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
11 (B)	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
12 (C)	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
13 (D)	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
14 (E)	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 (F)	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Data flow

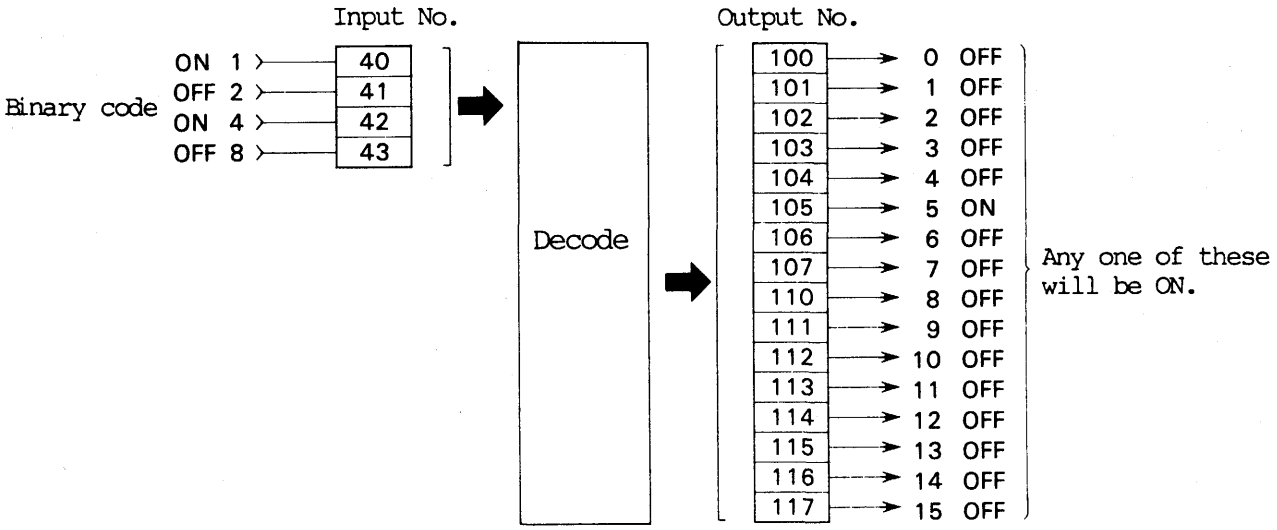


Decode the binary code data memorized in 4 bits of the lower order in the accumulator.

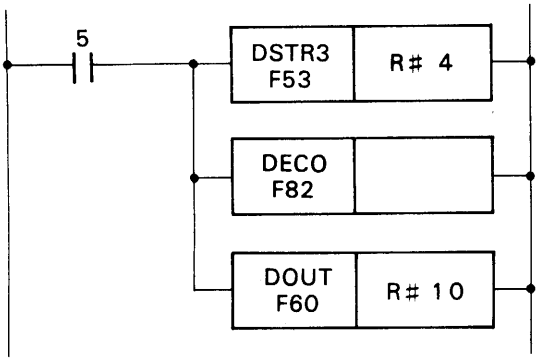
Memorize the serial data (the data to be 1 only for the location of the accumulator to correspond with the binary code) in the accumulator.

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Example: Decode the binary code input by input numbers 40 to 43, and output to output numbers 100 to 117.



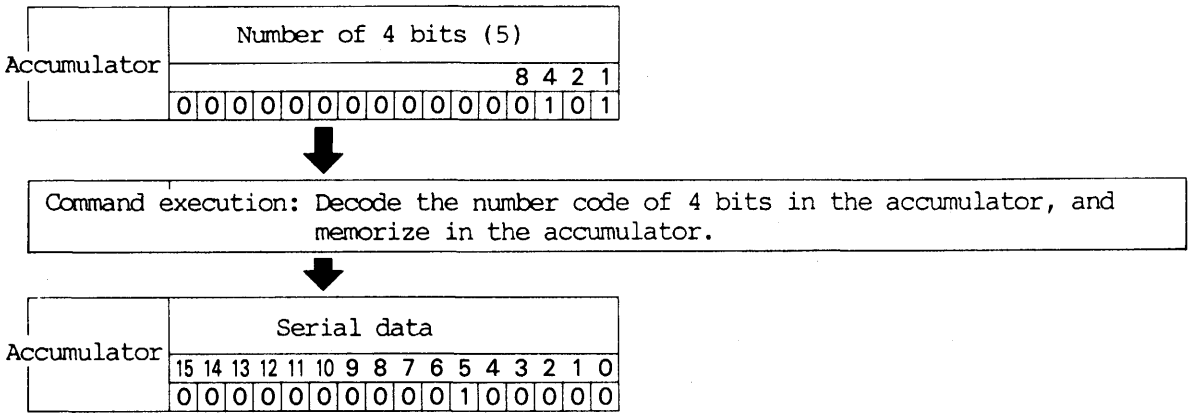
Circuit diagram



Command key



Movement when DECO command is executed



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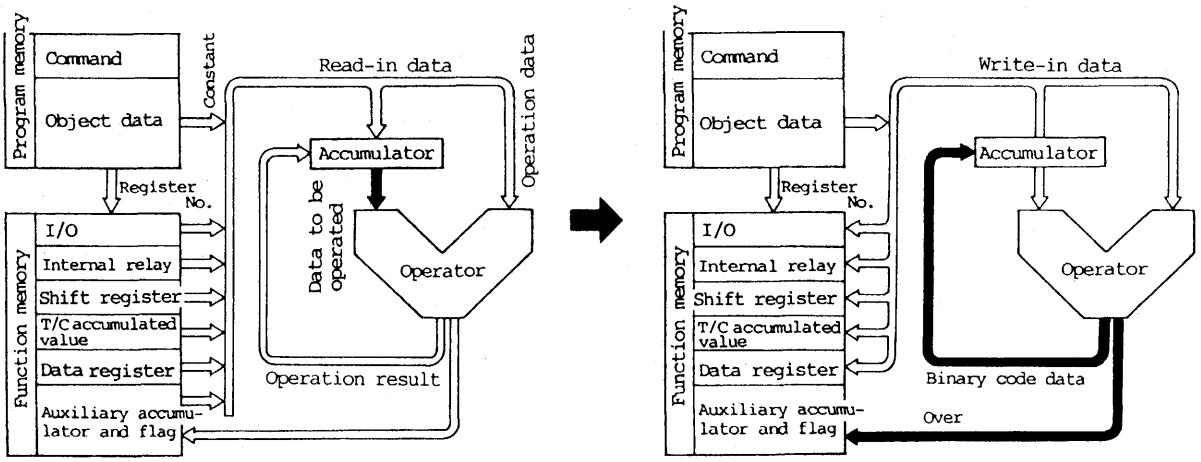
5-21. Encode, ENCO (FUN83)

Memorize the binary code in 4 bits. The binary code corresponds to the location where 1 bit is ON in the accumulator.

Symbol		ENCO F83
Instruction		FUN 8 3
Before execution of the command	Accumulator	Memorize the serial data (the data of which only 1 bit is ON).
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	Memorize 4 bits of the lower order of the binary code corresponding to the position of 1 bit that is ON in the accumulator.
	Over flag 777	When more than 2 bits of the accumulator data before execution are ON, the over flag will be ON, making the lower bits effective for use. The over flag will also be ON when there are no ON bits in the accumulator.

	Serial data																Binary data			
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	8	4	2	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0
3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
4	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1
6	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0
7	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1
8	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0
9	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1
10(A)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0
11(B)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
12(C)	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
13(D)	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1
14(E)	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0
15(F)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1

Data flow

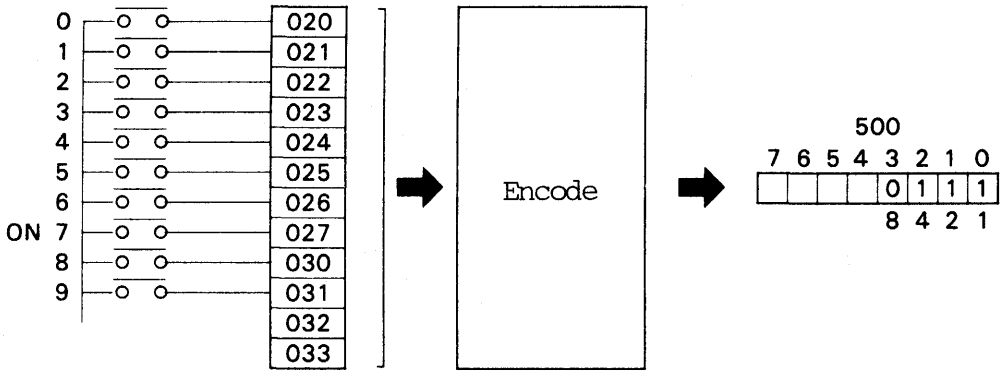


Prepare a binary code to correspond to the position of 1 bit that is ON in the accumulator.

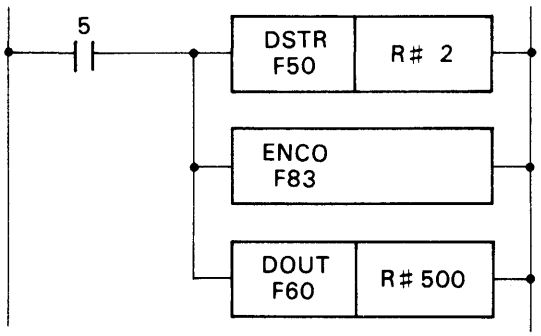
Memorize the binary code into 4 bits of the lower order of the accumulator. Put the over flag ON or OFF at the same time.

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Example: Convert the 10-key input that is input by input numbers 20 to 31 into 1 digit of the BCD code.



Circuit diagram

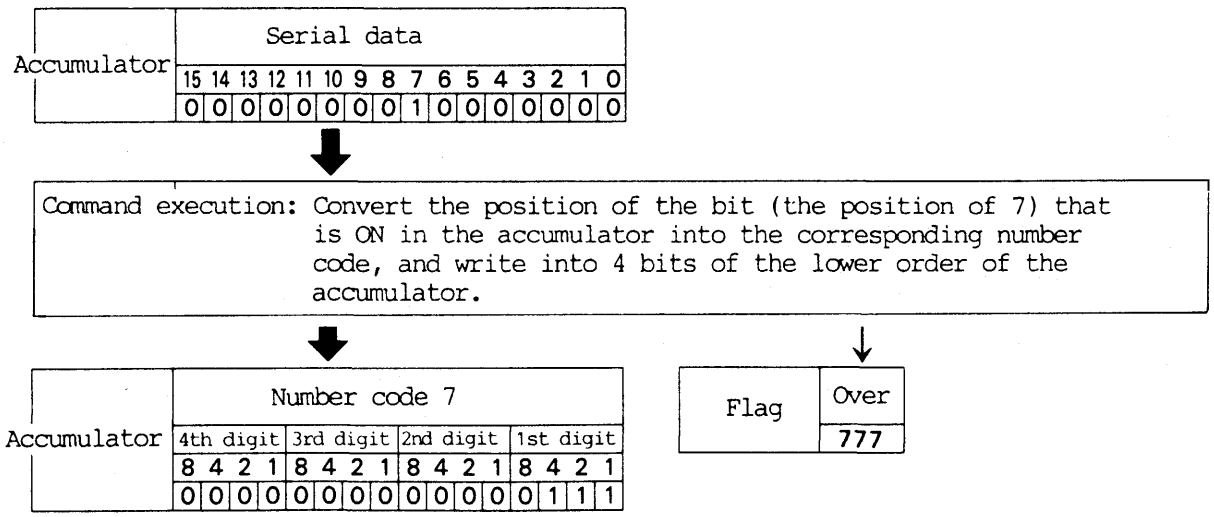


Command key



Note: When the different input is connected to input numbers 32 to 37, try to remove the unnecessary data by executing FUN81 ✳ 6 and FUN80 ✳ 6 after D STR2.

Movement when ENCO command is executed

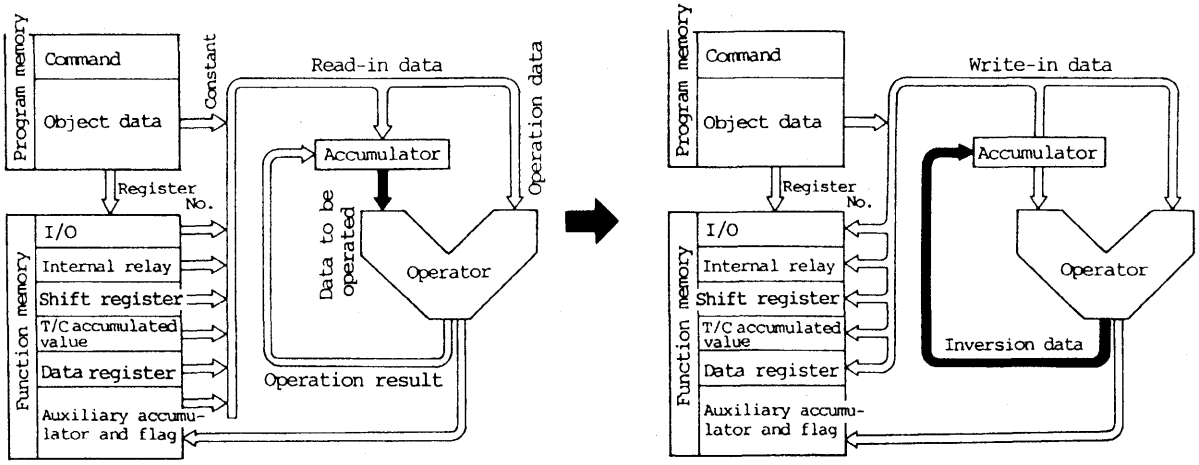


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5-22. 16-bit inversion, INV (FUN84)

Symbol		INV F84
Instruction		FUN 8 4
Before execution of the command	Accumulator	Memorize the data to be inverted.
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	Invert the conditions of each bit of the accumulator from 1 to 0 or 0 to 1 and memorize the conditions.

Data flow

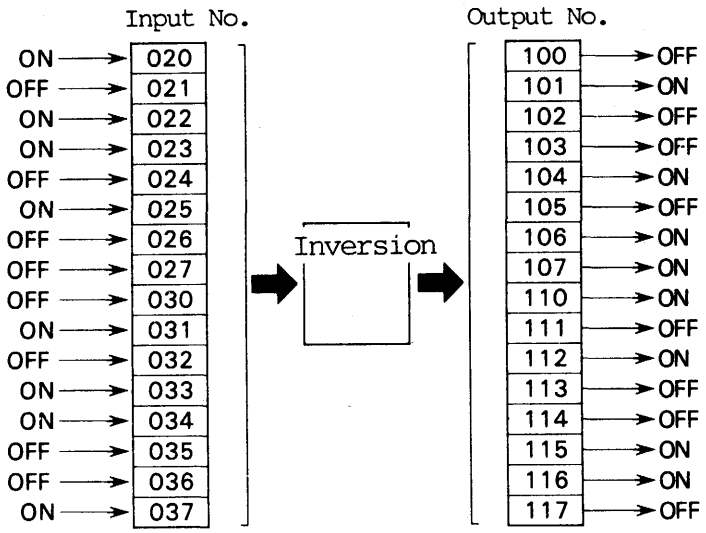


Invert conditions of each bit of the accumulator.

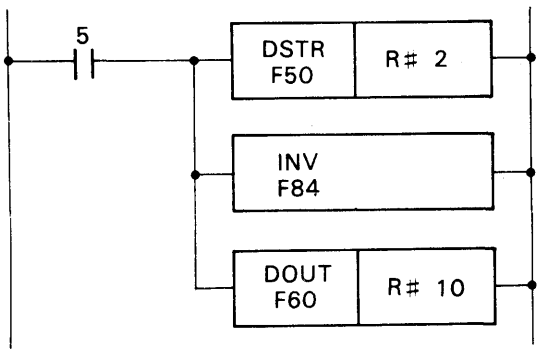
Memorize in the accumulator.

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Example: Invert the input data of input numbers 20 to 37 and output to output numbers 100 to 117.



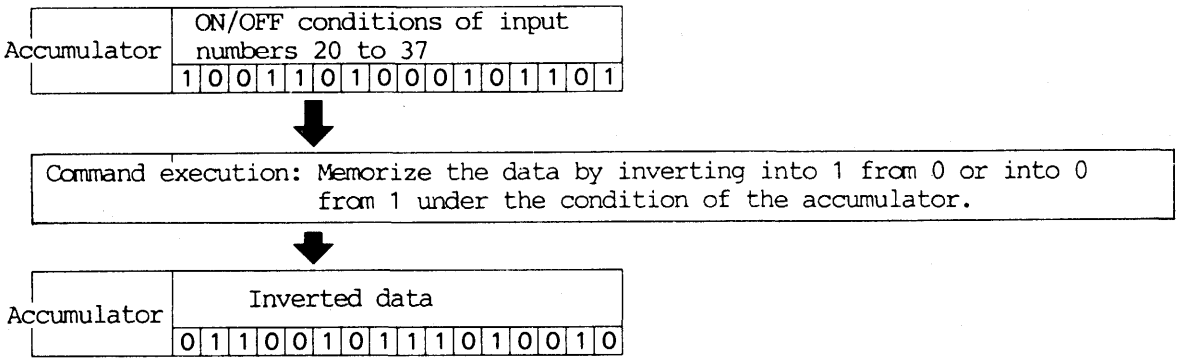
Circuit diagram



Command key



Movement when INV command is executed



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5-23. BCD 4-digit → Binary code conversion, BIN (FUN85)

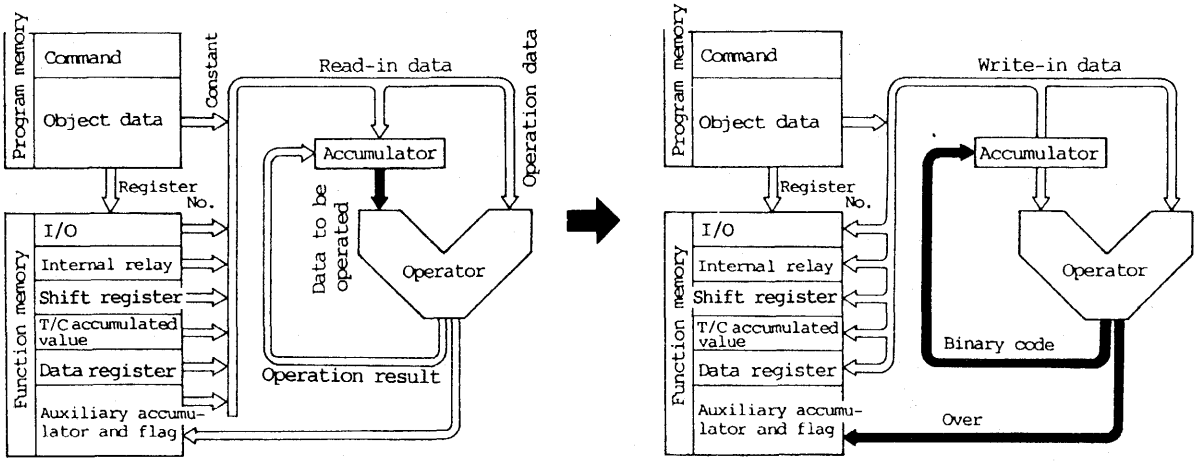
Conversion of 4-digit BCD code in the accumulator into 16-bit binary code

Symbol		BIN F85
Instruction		FUN 8 5
Before execution of the command	Accumulator	Memorize 4 digits of BCD code.
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	Memorize the converted binary code data.
	Over flag 777	ON if the accumulator data before execution of the command is not in the BCD code

Weight of bit																	
	BCD code	8×10^3	4×10^3	2×10^3	1×10^3	8×10^2	4×10^2	2×10^2	1×10^2	8×10	4×10	2×10	1×10	8	4	2	1
	BIN code	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Note: In the case of BCD to BIN conversion, the locations of 2^{14} and 2^{15} of binary code should be 0.

Data flow

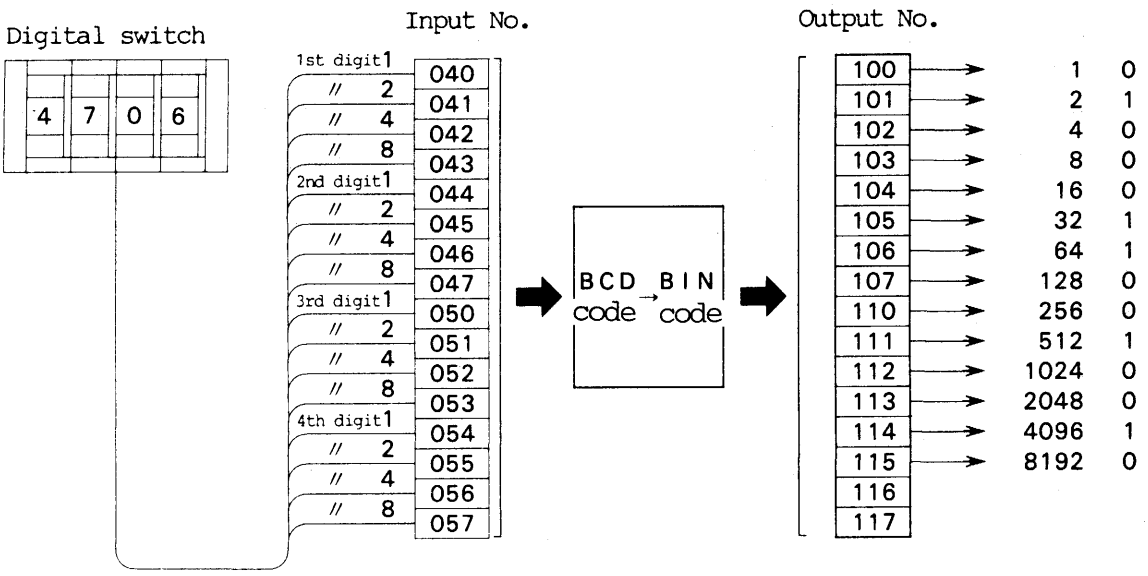


Convert 4 digits of the BCD code in the accumulator into the binary code.

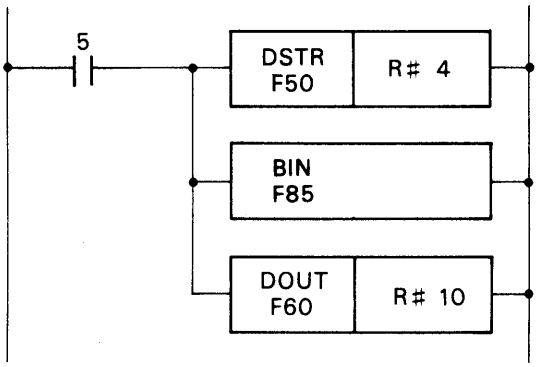
Memorize in the accumulator. Put the over flag ON or OFF at the same time.

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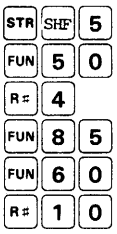
Example: Convert the input number of BCD 4 digits of input numbers 40 to 57 into the binary code, and output to output numbers 100 to 117.



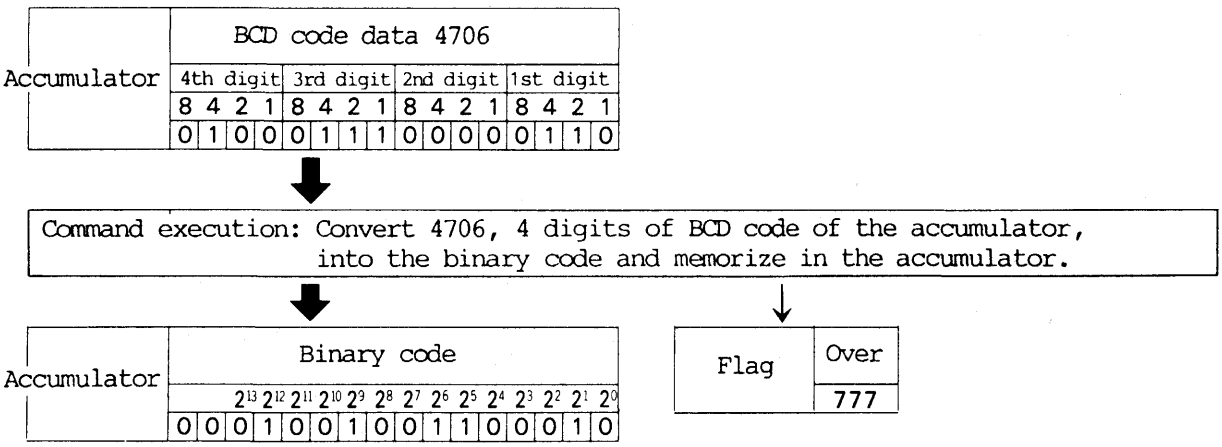
Circuit diagram



Command key



Movement when BIN command is executed



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5-24. BIN → BCD code conversion, BCD (FUN86)

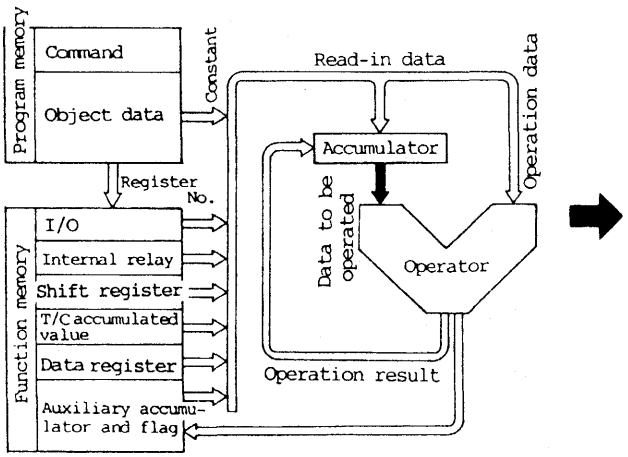
Conversion of the accumulator binary code into the BCD code

Symbol		BCD F86
Instruction		FUN 8 6
Before execution of the command	Accumulator	Memorize the BIN code value not to exceed 9999 when converted into the BCD code.
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Accumulator	Memorize the converted BCD code.
	Over flag 777	ON if the converted data exceed 4 digits of the BCD code (In this case, 4 digits of the lower order will be memorized in the accumulator.)

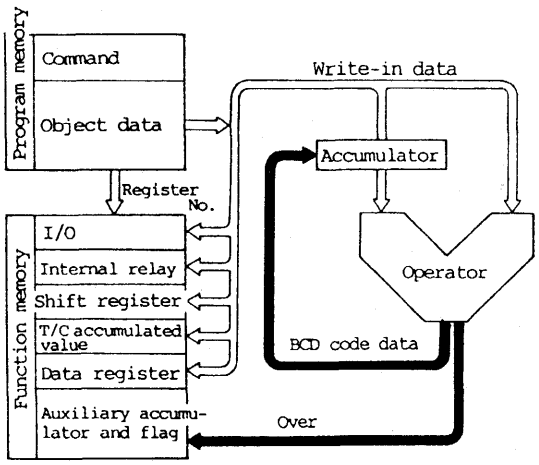
		(8192)	(4096)	(2048)	(1024)	(512)	(256)	(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)
Weight of bit	BIN code			2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}
	BCD code	8×10^{3}	4×10^{3}	2×10^{3}	1×10^{3}	8×10^{2}	4×10^{2}	2×10^{2}	1×10^{2}	8×10	4×10	2×10	1×10	8	4	2	1

Note: If the BIN code data before conversion exceed 9999, conversion into 4 digits of the BCD code is impossible. The over flag will then be ON.

Data flow



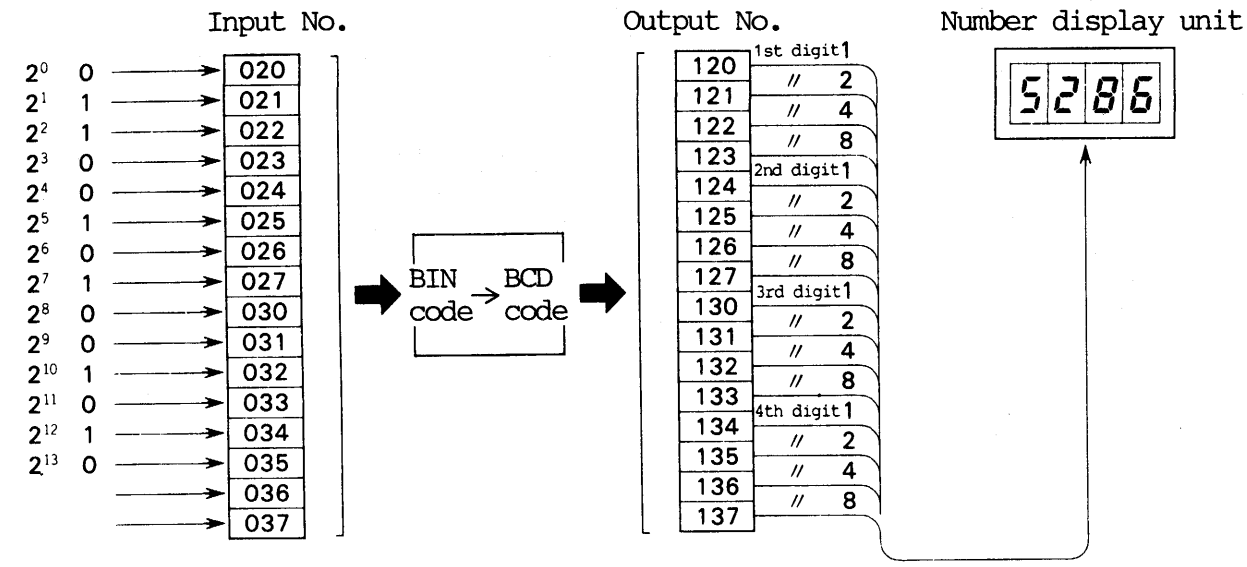
Convert the binary code data in the accumulator into the BCD code data.



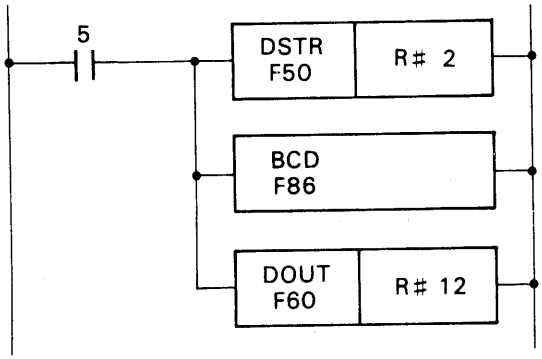
Memorize the BCD code data in the accumulator. Put the over flag ON or OFF at the same time.

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Example: Convert the input 14-bit binary code data of input numbers 20 to 35 into the BCD code, and output to output numbers 120 to 137.



Circuit diagram



Command key



When BCD command is executed

Accumulator: Binary code data

2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
0	0	0	1	0	1	0	0	1	0	1	0	0	1	1	0

Command execution: Convert the accumulator binary code into 4 digits of BCD code, and memorize in the accumulator.

Accumulator: BCD code 5286

4th digit				3rd digit				2nd digit				1st digit			
8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
0	1	0	1	0	0	1	0	1	0	0	0	0	1	1	0

Flag	Over
	777

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5-25. External diagnosing, FALT (FUN20)

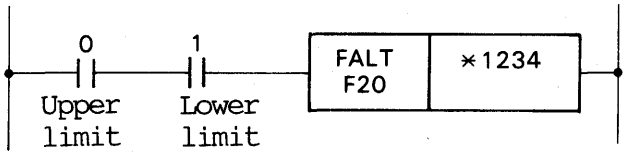
Diagnostic code number specification

The number specified by the 2nd word will be displayed to inform the detail of the problem on the programmer if the diagnostic condition is specified.

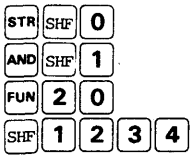
Symbol		FALT F20 ∗□□□□
Instruction	Section for the command (1st word)	FUN 2 0
	Section for the object (2nd word)	SHF □ □ □ □ (Diagnostic code) Constant 0000 - 9999
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Program display	If the programmer is installed, the diagnostic code is displayed and continues the display until the clear key is depressed.
	External diagnostic relay 771	The relay continues to be ON as long as any one of the FALT commands is executed, but it will be OFF if the FALT command is not executed. (The relay continues to be ON as long as the FALT command is executed, even if the clear key is depressed.)
	External diagnostic register R#575, R#574	The diagnostic code is written in the BCD code whenever the FALT command is executed and will be retained even if the FALT command is not executed.

Example: When the upper limit (input number 0) and lower limit (input number 1) of one cylinder are ON at the same time, the external display will be ON for abnormal detection and the diagnostic code 1234 will be displayed on the data display unit.

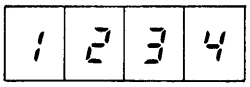
Circuit diagram



Command key



Programmer diagnostic code display



Content of external diagnostic register

R#575								R#574							
4th digit				3rd digit				2nd digit				1st digit			
8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0

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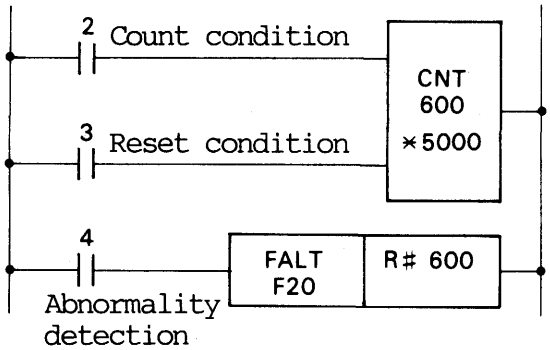
Diagnostic code number specification

When the diagnostic condition is satisfied, the data of the register number specified by the 2nd word are displayed for showing the detail of the problem on the programmer.

Symbol		FALT F20 / R# □□□
Instruction	Section for the command (1st word)	FUN 2 0
	Section for the object (2nd word)	R# □ □ □ (Diagnostic code memory register number) Input/Output 000~014, 070~075 Internal relay 016~036 Shift register 040~056 Data register 400~576 T/C accumulated value 600~677
Condition to execute the command		Execution when the condition is satisfied. No execution when the condition is not satisfied.
After execution of the command	Program display	If the programmer is installed, the diagnostic code is displayed and continues the display until the clear key is depressed.
	External diagnostic relay 771	The relay continues to be ON as long as any one of the FALT commands is executed, but it will be OFF if the FALT command is not executed. (The relay continues to be ON as long as the FALT command is executed, even if the clear key is depressed.)
	External diagnostic register R#575, R#574	The diagnostic code (data in the specified register) is always written whenever the FALT command is executed and will be retained even if the FALT command is not executed.

Example: The accumulated value of the counter is displayed on the data display unit on the panel when the abnormality is detected.

Circuit diagram

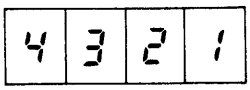


Command key

STR SHF 2
STR SHF 3
CNT SHF 6 0 0
SHF 5 0 0 0

STR SHF 4
FUN 2 0
R# 6 0 0

Programmer diagnostic code display



Content of external diagnostic register

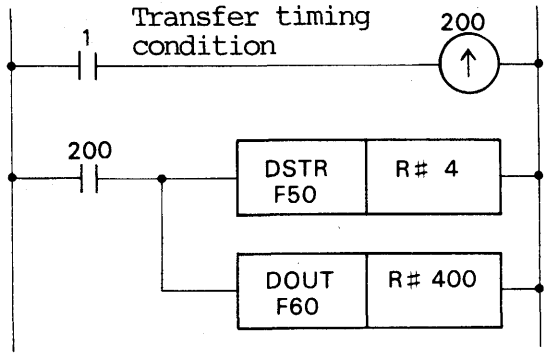
Content of R#600 (accumulated value of CNT600) 4321															
R#575								R#574							
4th digit				3rd digit				2nd digit				1st digit			
8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	1

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6. APPLICATION OF THE DATA PROCESS COMMAND

6-1. Data transfer

(1) Timing transfer



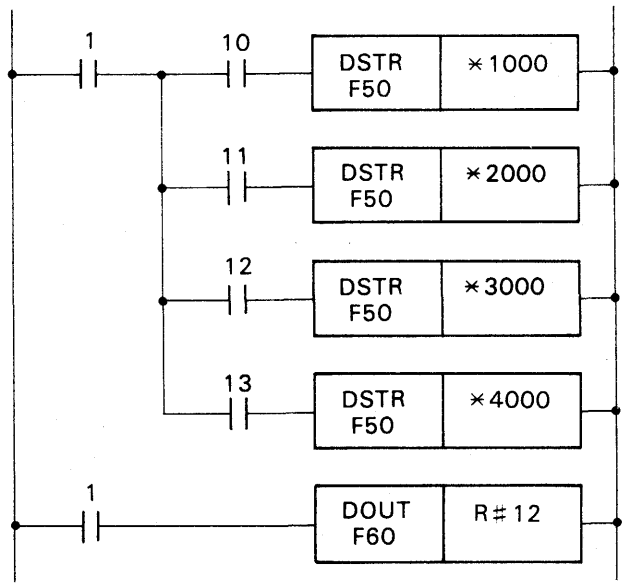

```
STR          1
SET OUT RST 200

STR        200
F50    R#    4

F60    R# 400
```

Operation: When condition 1 of transfer timing turns ON, internal relay 200 will be ON only for one scan. Then the data in R#4 will be written into R#400. The data in R#400 will not change until condition 1 of transfer timing turns OFF and ON again.

(2) Selection of write-in data




```
STR          1
MCS
STR         10
F50    SHF 1000
STR         11
F50    SHF 2000

STR         12
F50    SHF 3000

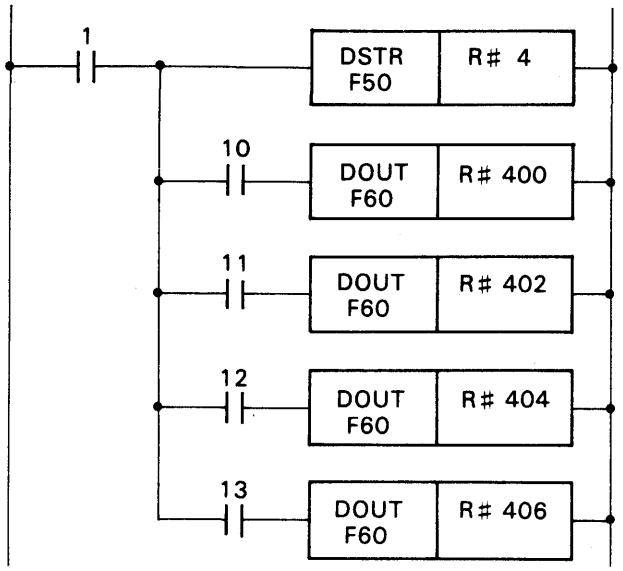
STR         13
F50    SHF 4000
MCR
STR          1
F60    R#   12
```

Operation: When write-in timing 1 turns ON, the read-in data will be written into R#12. The read-in data must be the one written under the condition which is turned ON at that time and one of three selection conditions (11, 12, 13).

Note: If more than 2 of selection conditions are ON, the later one will get priority for processing.

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(3) Selection of the destination for data writing




```
STR      1
F50      R# 4

MCS
STR      10
F60      R# 400

STR      11
F60      R# 402

STR      12
F60      R# 404

STR      13
F60      R# 406
```

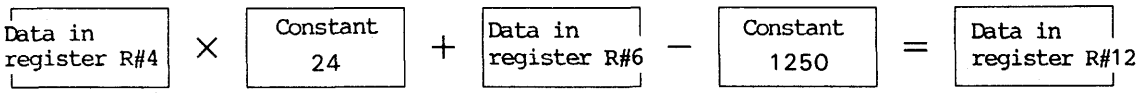
Operation: When write-in timing 1 turns ON, the data in R#4 will be written into the destination to write-in.
The destination must be written under the condition which is ON.

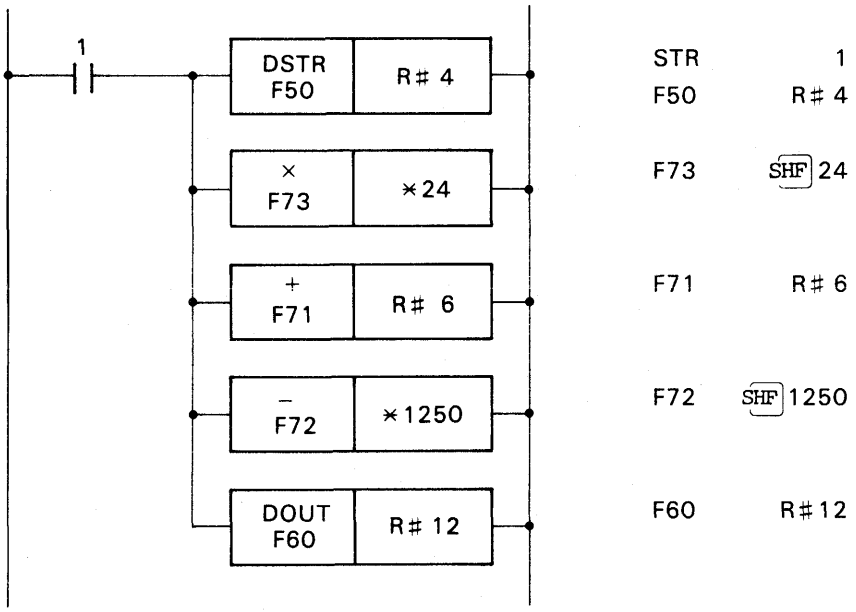
Note: If more than two of write-in destination selection conditions are turned ON, the data in R#4 will be written into all destinations which are written under the ON conditions.

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6-2. Operation

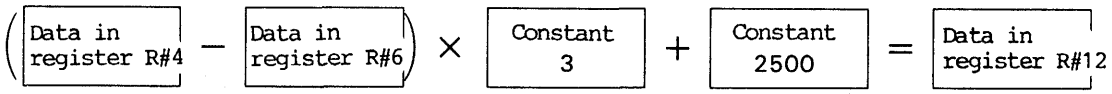
(1) Continuous operation 1

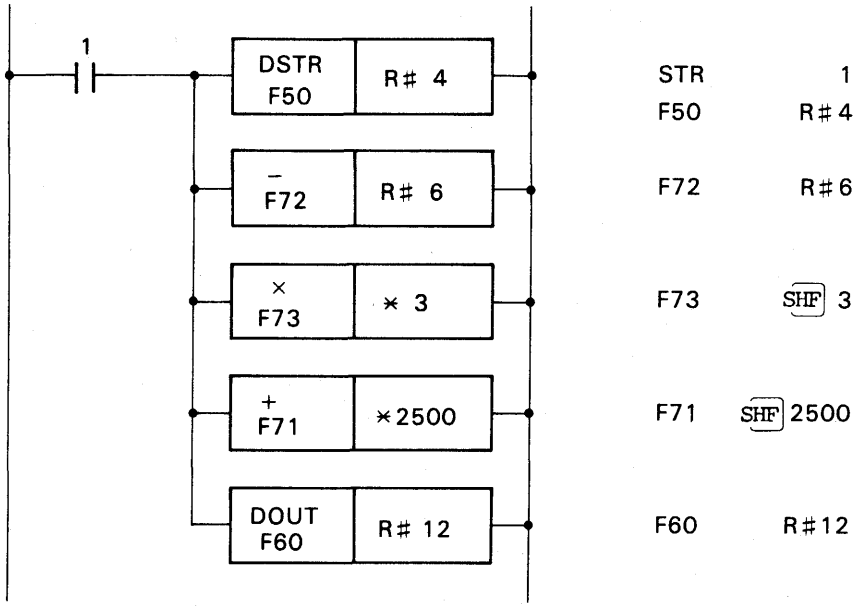




STR	1
F50	R# 4
F73	SHF 24
F71	R# 6
F72	SHF 1250
F60	R#12

(2) Continuous operation 2

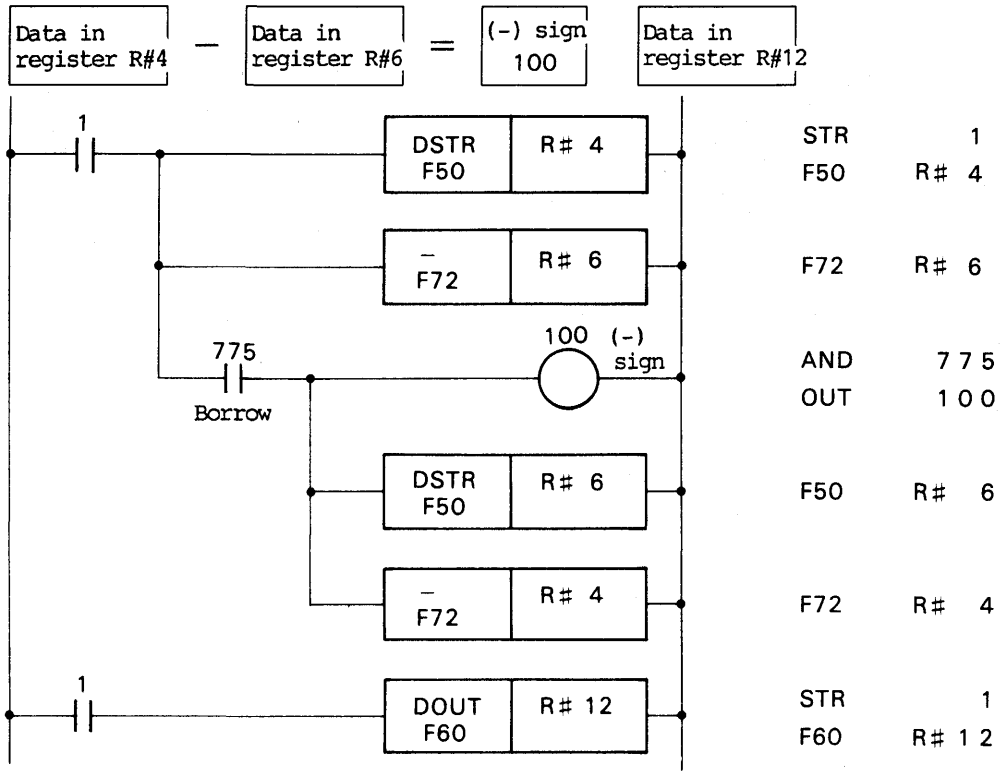




STR	1
F50	R#4
F72	R#6
F73	SHF 3
F71	SHF 2500
F60	R#12

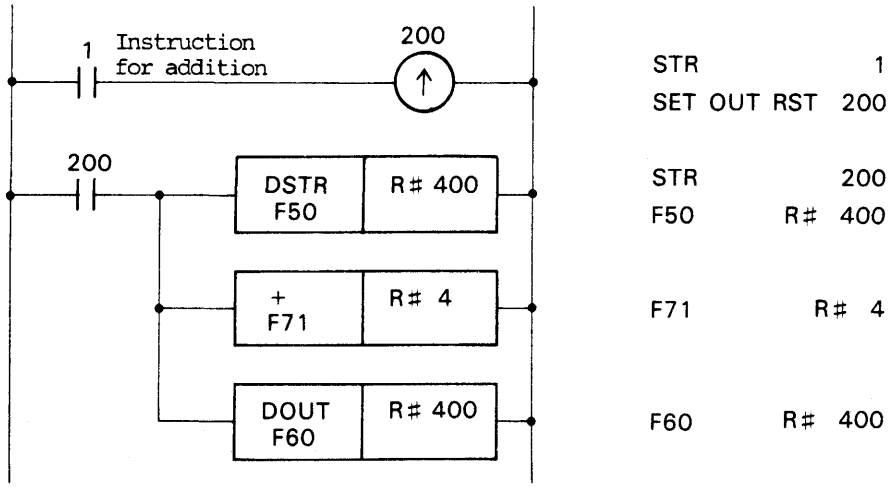
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(3) Operation with sign



Operation: The data in register R#4 is subtracted by the data in register R#6. If BORROW is OFF, the data will be output to register R#12. If BORROW is ON, reverse subtraction will be processed by turning ON the minus sign.

(4) Data accumulation



Operation: If the instruction for addition is turned ON, internal relay 200 will be ON for one scan. As a result of one scan operation, the data for addition (data in R#4) will be added to the accumulated value until that time (data in R#400), and the result will be memorized in register R#400.

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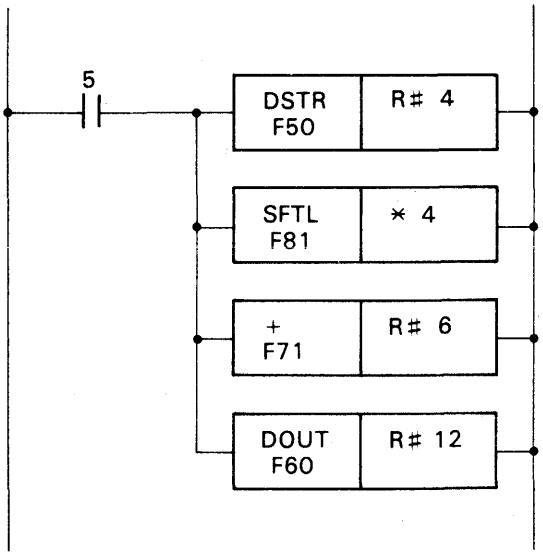
(5) Addition by matching the digit

Data in register R#4 [2] [6] [5]

Data in register R#6 + [5] [7].[3]

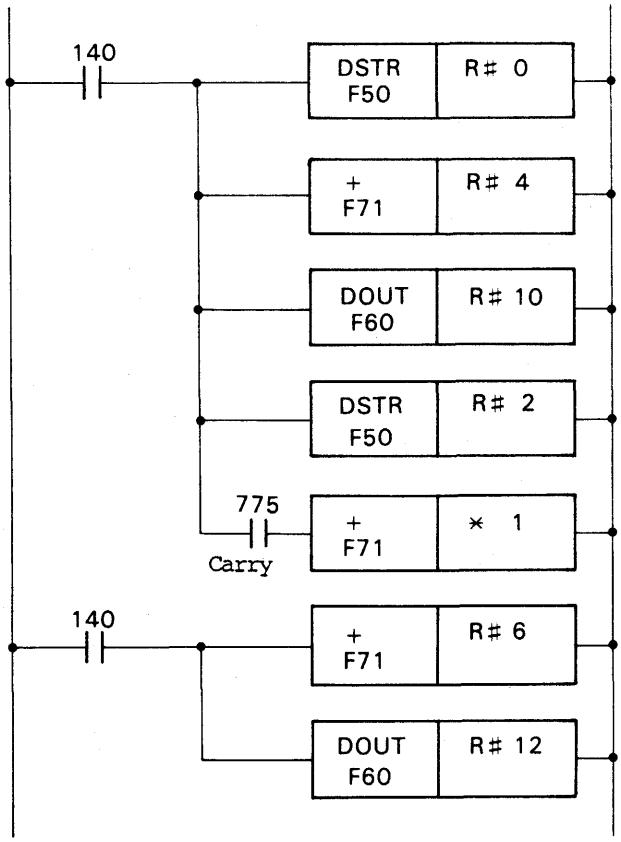
Data in register R#12 [3] [2] [2].[3]

If the unit is different for the data to add and to be added, the data to be added must be shifted first to match the unit of the data to add for addition.



STR 5
F50 R# 4 2 6 5
F81 SHF 4 2 6 5.0
F71 R# 6 5 7.3
F60 R# 12 3 2 2.3

(6) Addition for eight digit data

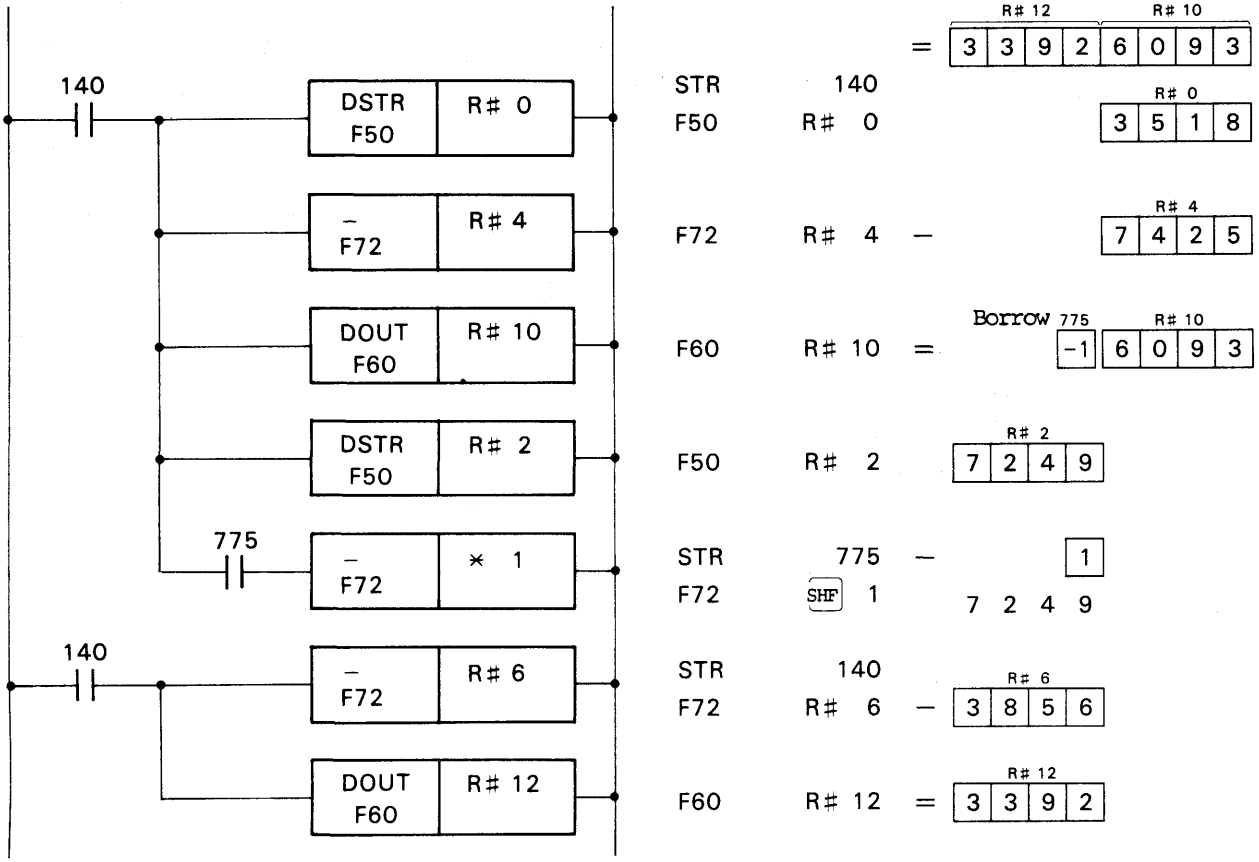


R# 2				R# 0			
1	4	9	3	3	6	2	5
R# 6				R# 4			
2	7	6	4	8	1	7	4
R# 12				R# 10			
4	2	5	8	1	7	9	9

STR 140
F50 R# 0 (R# 0: 3 6 2 5)
F71 R# 4 + (R# 4: 8 1 7 4)
F60 R# 10 = Carry 775 (R# 10: 1 1 7 9 9)
F50 R# 2 (R# 2: 1 4 9 3)
AND 775
F71 SHF 1 + Carry 775 (1)
1 4 9 4
STR 140
F71 R# 6 + (R# 6: 2 7 6 4)
F60 R# 12 = (R# 12: 4 2 5 8)

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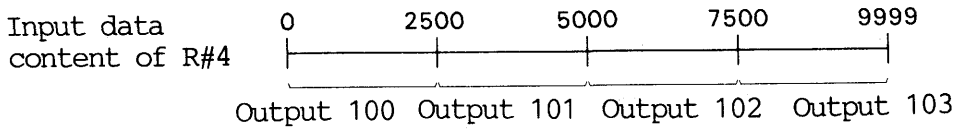
(7) Subtraction for eight digit data

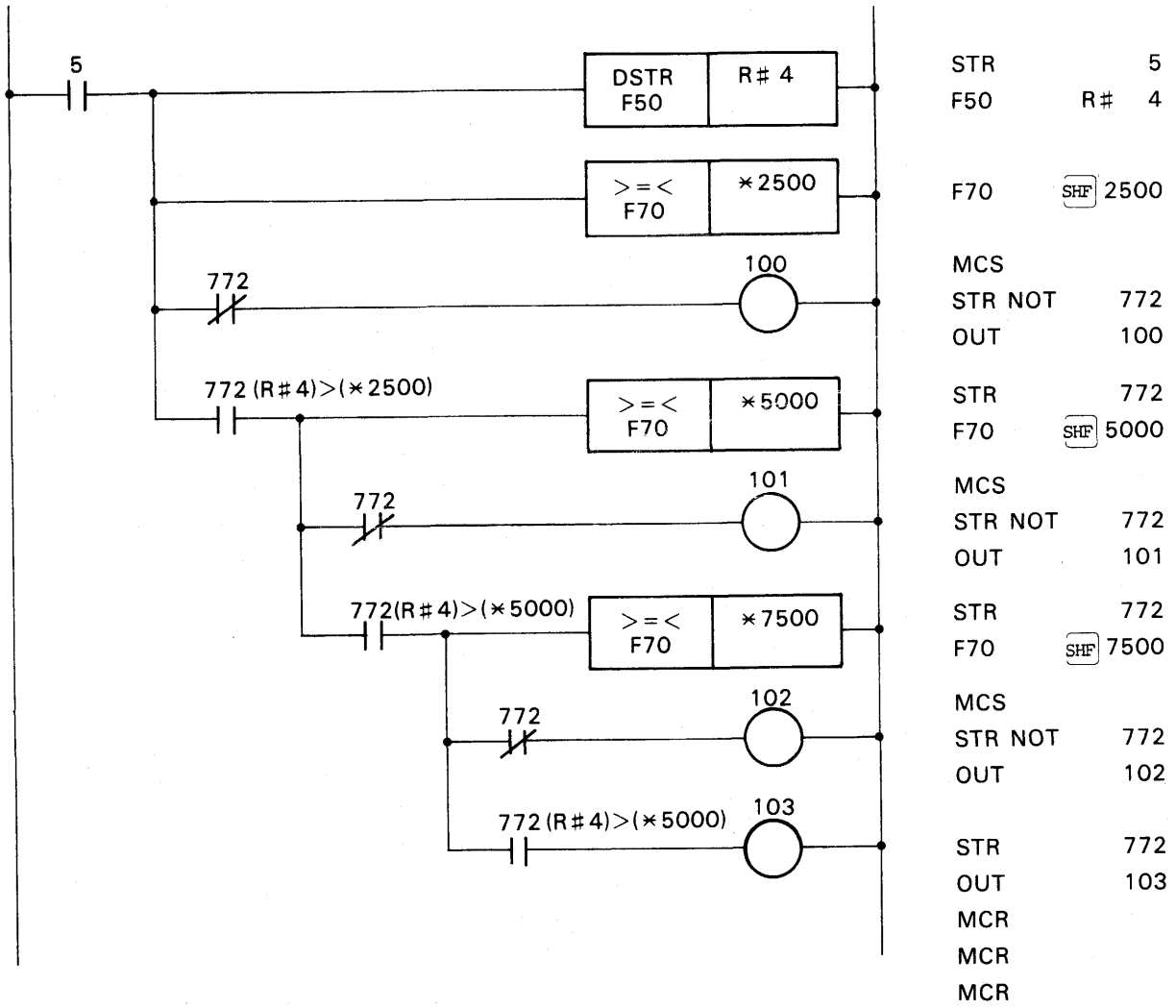


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6-3. Comparison

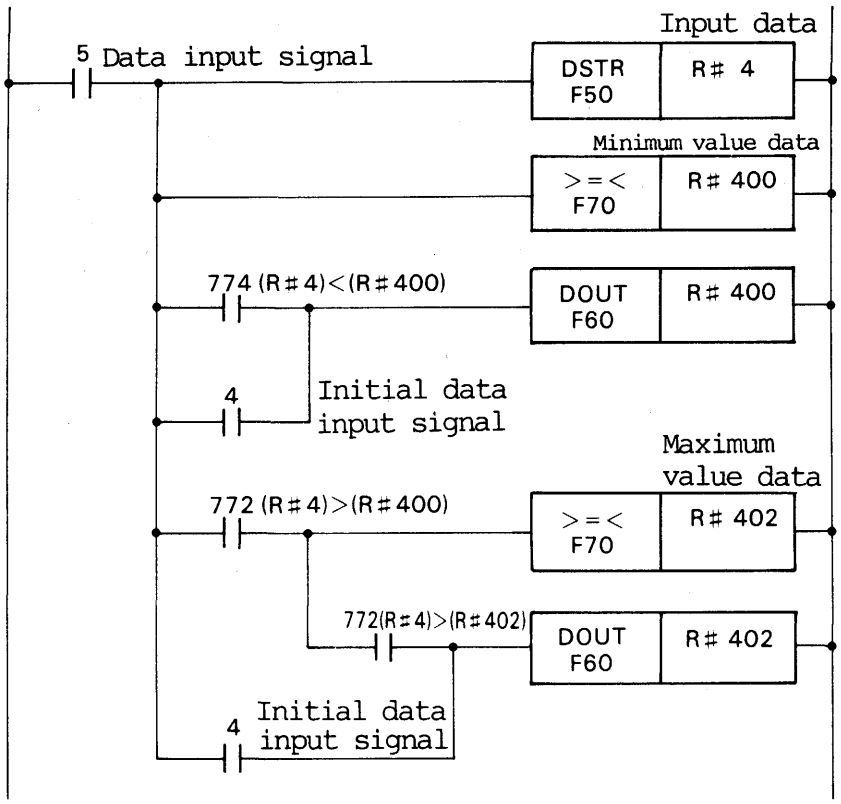
(1) Classification of input data range





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(2) Detection of minimum value data and maximum value data

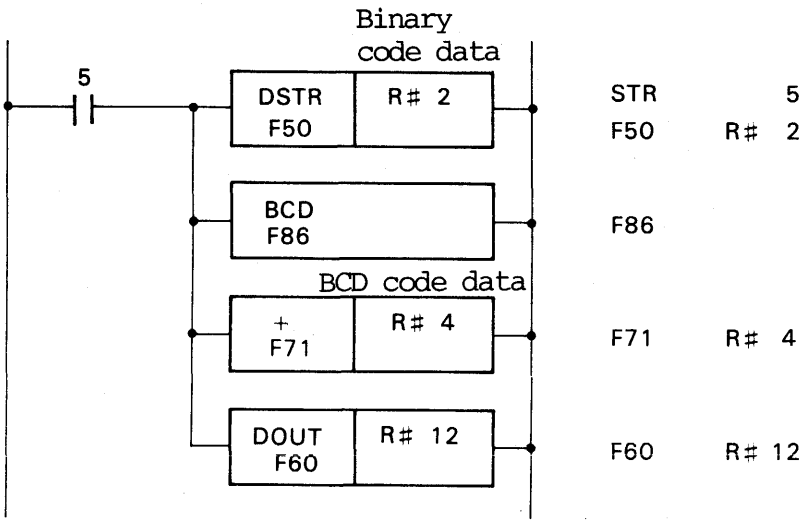


Operation: When the initial data is input, the data in R#4 will be written into R#400 and R#402. Then the minimum value and maximum value will be the initial data. If the different data is input, it will be compared with the minimum value data first. If the input data smaller than the minimum value data, the minimum value data will be corrected. If the input data is greater than the minimum value data, it will be compared with the maximum value data. If the input data is greater than the maximum value data, the maximum value data will be corrected.

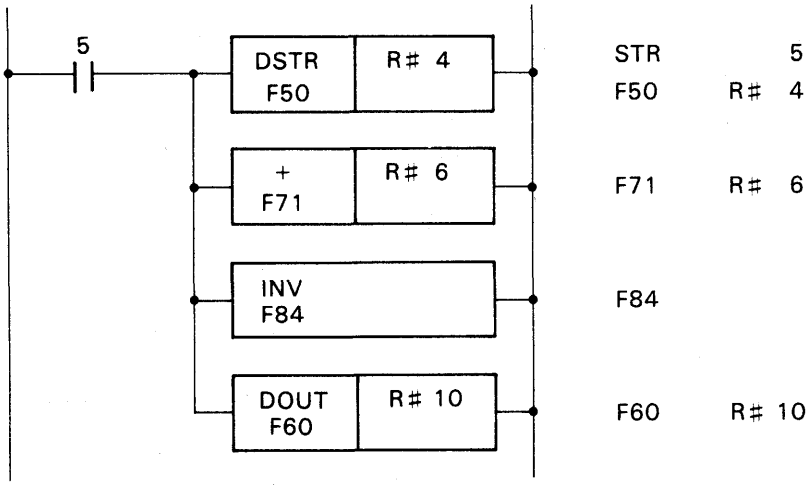
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6-4. Conversion

(1) Binary code data addition



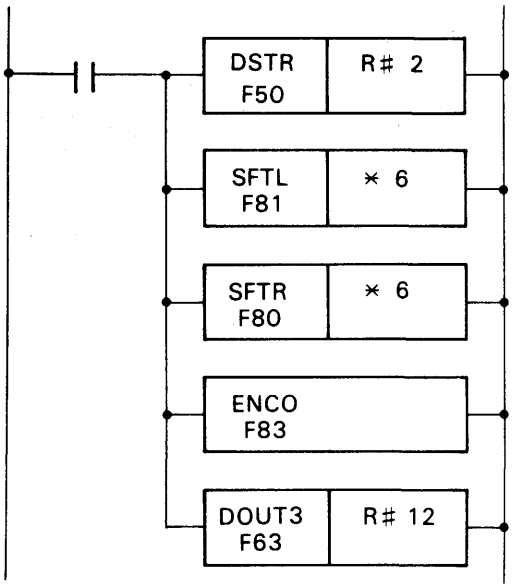
(2) Negative logic output after addition



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(3) Deletion of unnecessary data

If the 10-key input is connected with 20 to 31 and other input is connected with the numbers after 32, the unnecessary data will be read in when the data are read by DSTR instruction.
You must shift to delete these unnecessary data.




```
STR      5
F50   R#  2
F81   SHF 6
F80   SHF 6
F83
F63   R#  12
```

The data to be read here is just the ON/OFF conditions.

The unnecessary data will be deleted by shifting to the left for six bits.

The input data will be returned to the original position by shifting to the right for six bits.

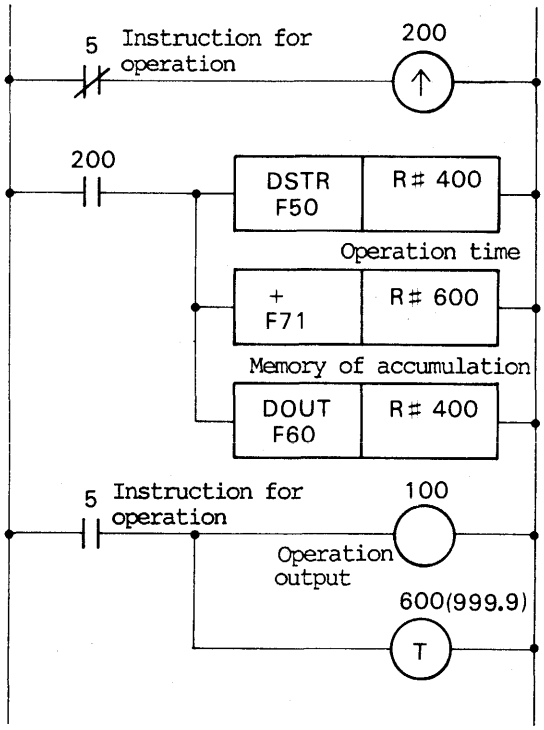
The data of ON/OFF conditions of 10-key will be converted into one-digit number.

One-digit number (BCD code) will be output.

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6-5. Time counting

(1) Accumulation of operation time




```
STR NOT          5
SET OUT RST    200

STR            200
F50        R# 400

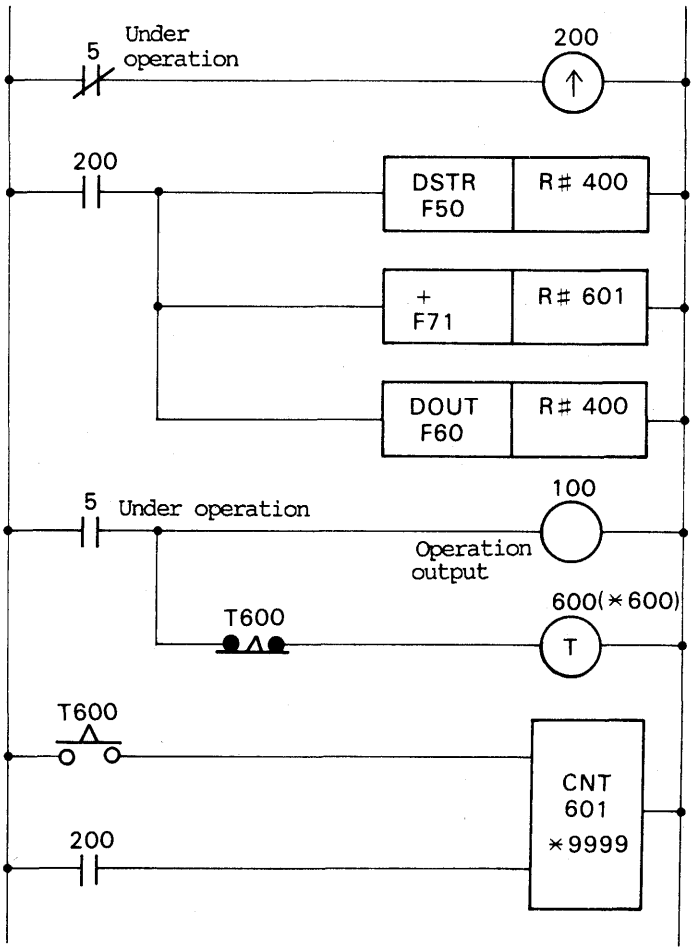
F71        R# 600

F60        R# 400

STR              5
OUT            100

TMR            600
SHF 9999
```

(2) Accumulation of the operated time




```
STR NOT          5
SET OUT RST    200

STR            200
F50        R# 400

F71        R# 601

F60        R# 400

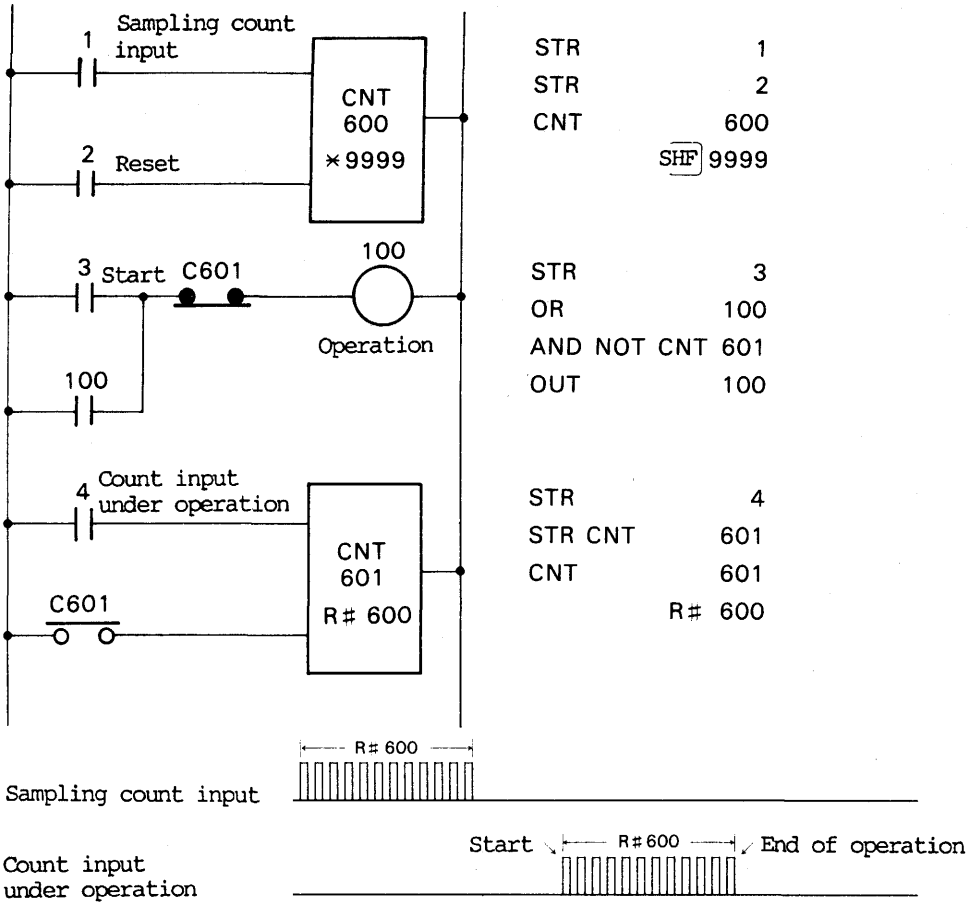
STR              5
OUT            100

AND NOT TMR    600
TMR            600
SHF 600

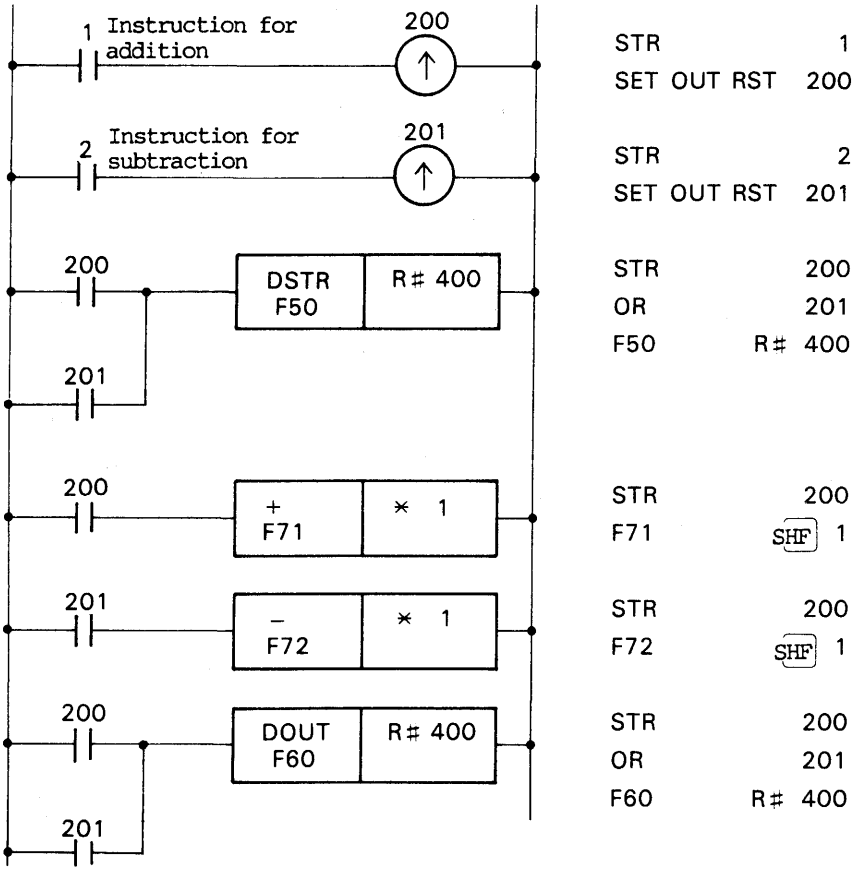
STR TMR        600
STR            200
CNT            601
SHF 9999
```


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(3) Tracing operation of the counter

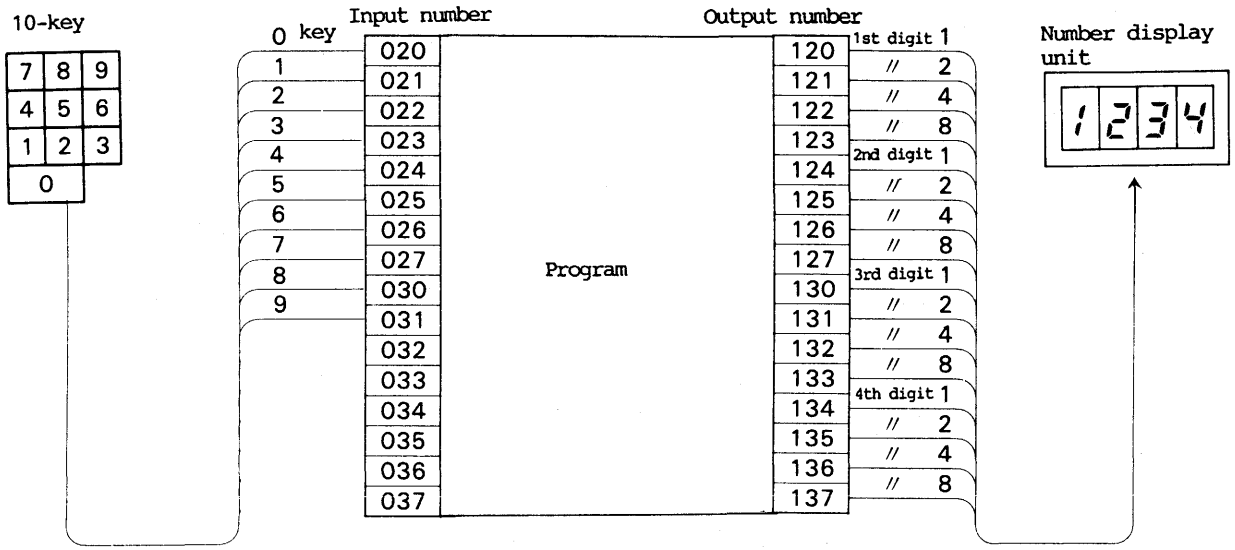


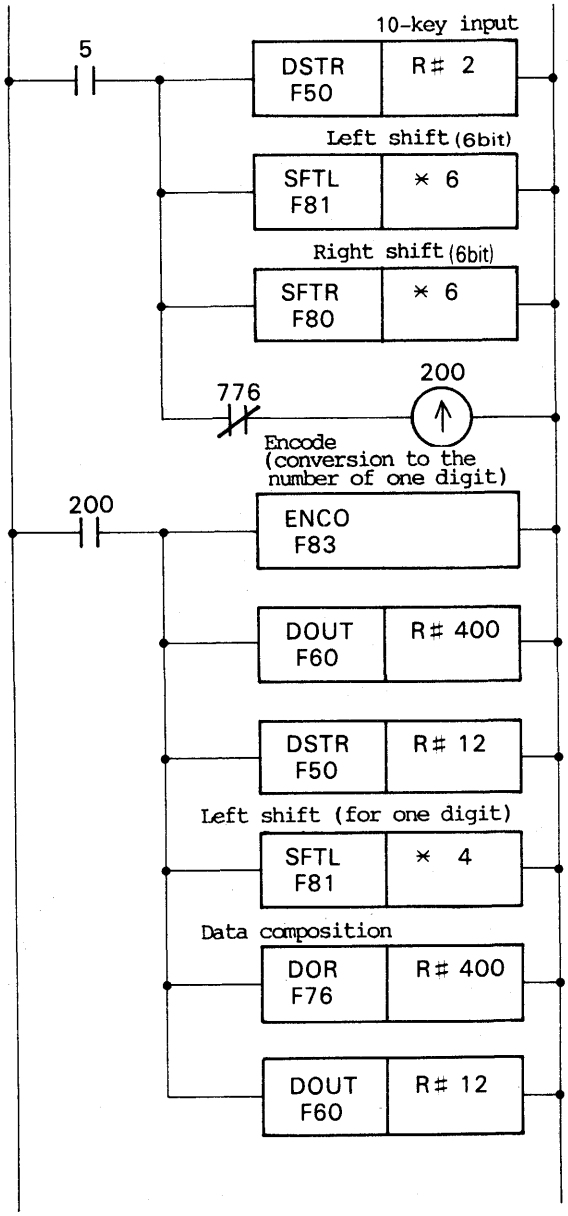
(4) Up-down counter



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6-6. Number registration by 10-key





STR 5 Reading of ON/OFF conditions
F50 R# 2 of 10-key

F81 SHF 6 Deletion of unnecessary data of inputs from 32 to 37

F81 SHS 6 Returning of the data to the original location

AND NOT 776 If the data in the accumulator is not "0", assume that "0" is
SET OUT RST 200 input by the key to execute the rest after rising.

STR 200 Convert the 10-key signal into
F83 the number of one digit.

F60 R# 400 Temporary memorization of the number of one digit input by the key

F50 R# 12 Data reading up to this point

F81 SHF 4 Shifting of the digit for one digit

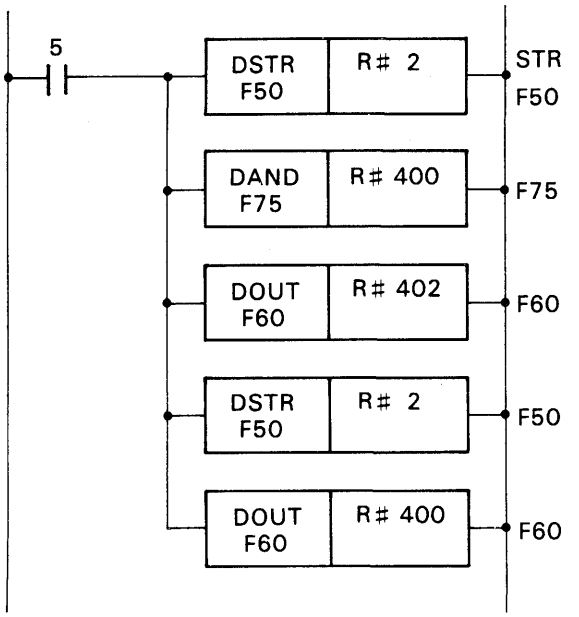
F76 R# 400 Input of new data (for one digit of 10-key input) in the first digit

F60 R# 12 Output of the completed data

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6-7. Software filter

(1) Continuous two scan ON-bit extraction

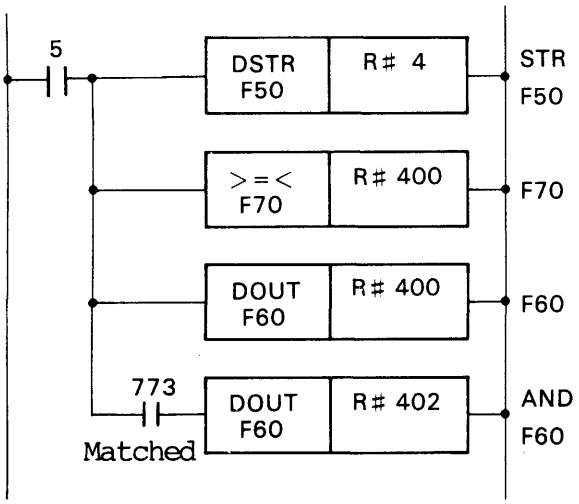


Reading of input data

Only the data of ON-bit(s) as a result of AND operation with the input data of the previous operation and of this time will be written into R#402.

The previous data at the next scan will be written into R#400.

(2) Extraction of the same data for two scans



Reading of input data

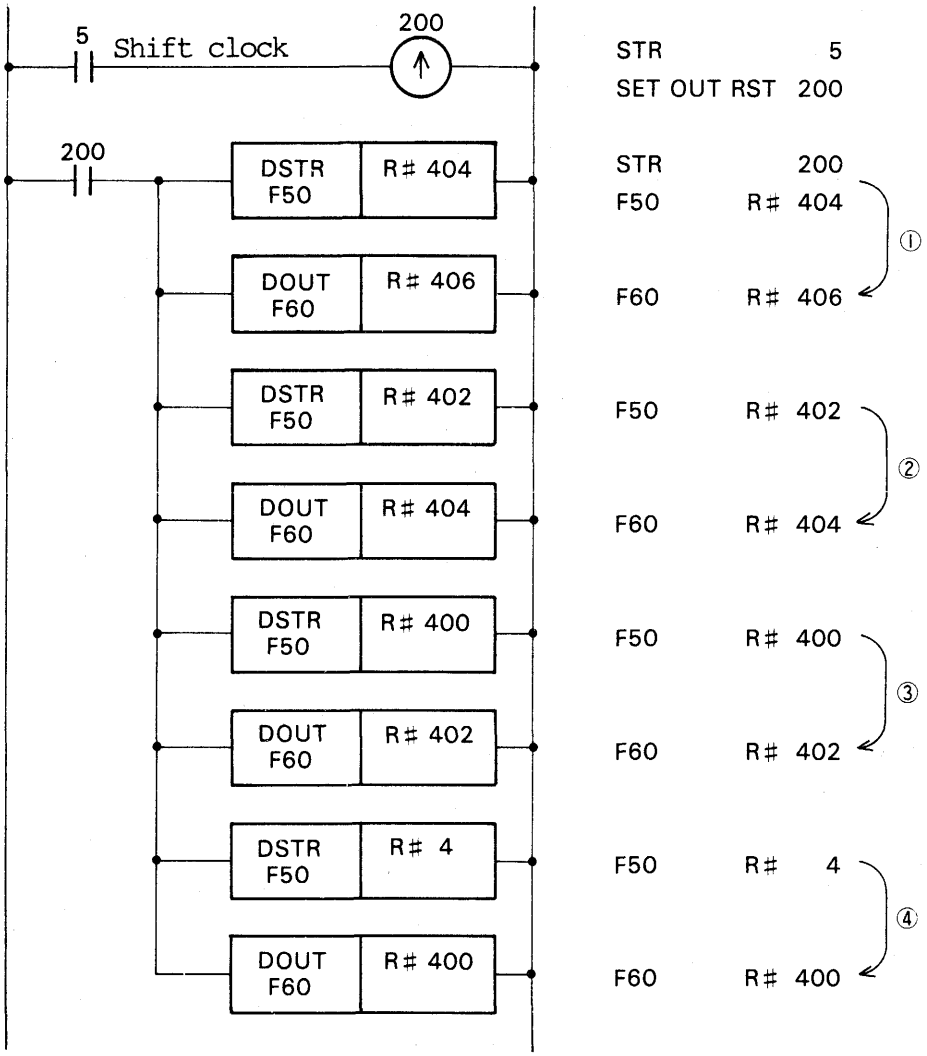
Comparing with the previous data

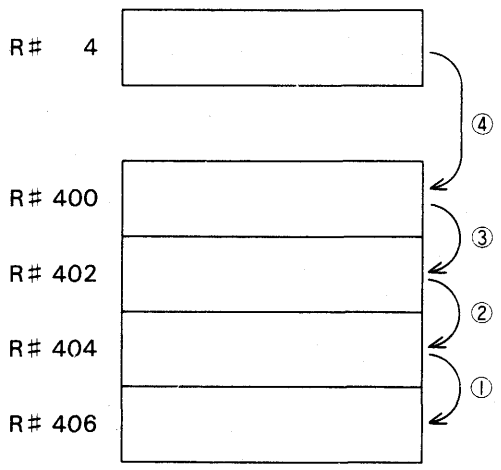
The previous data at the next scan will be written into R#400.

The matched data as a result of comparison of the previous data with the data of this time will be written into R#402.

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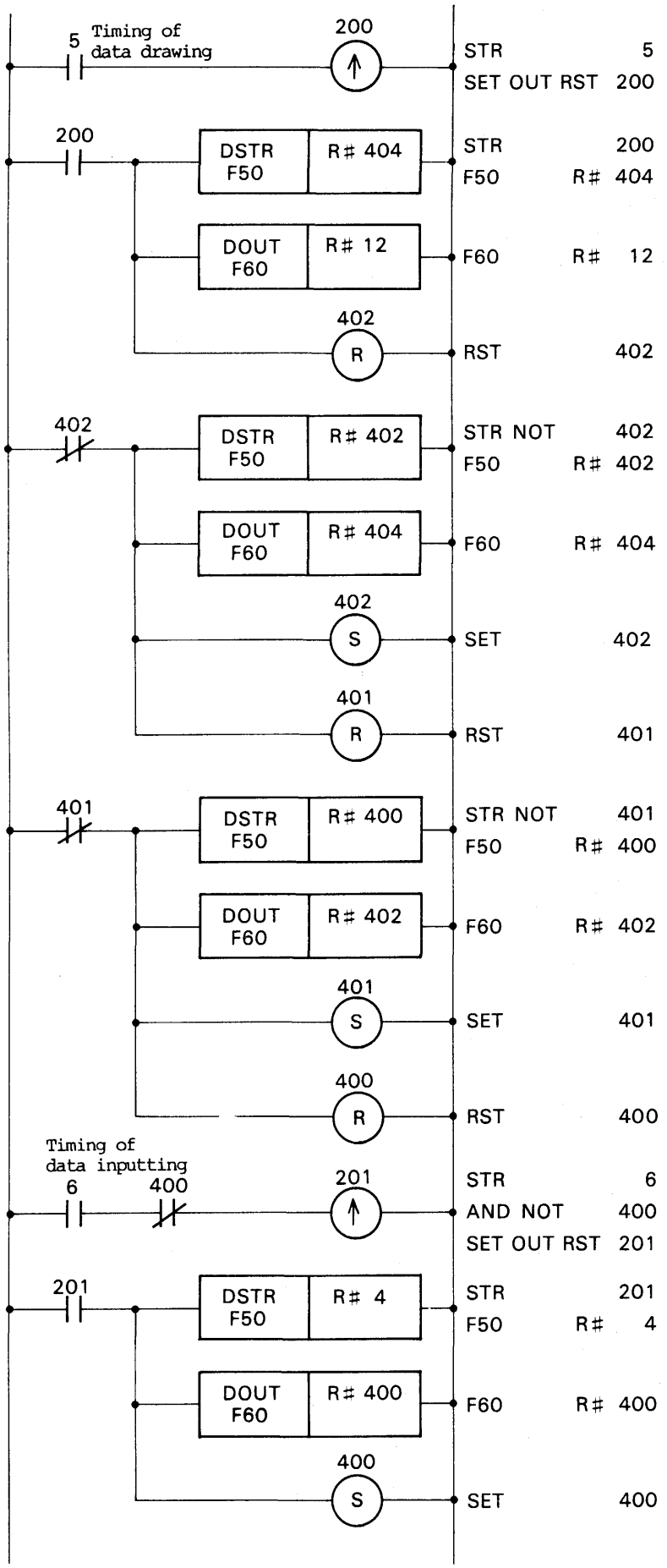
6-8. Data shift register

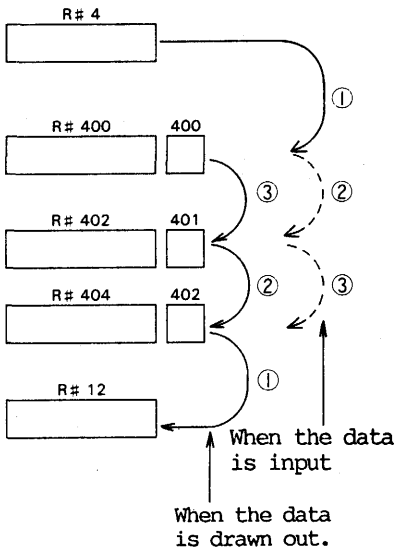




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6-9. First inputting and first drawing of date





For inputting the data, shifting will be processed to the point that the data is not found.

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OPERATION

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17. CASSETTE INTERFACE OPERATION: LOADER MODE C-60

17-1. Interface specification C-60

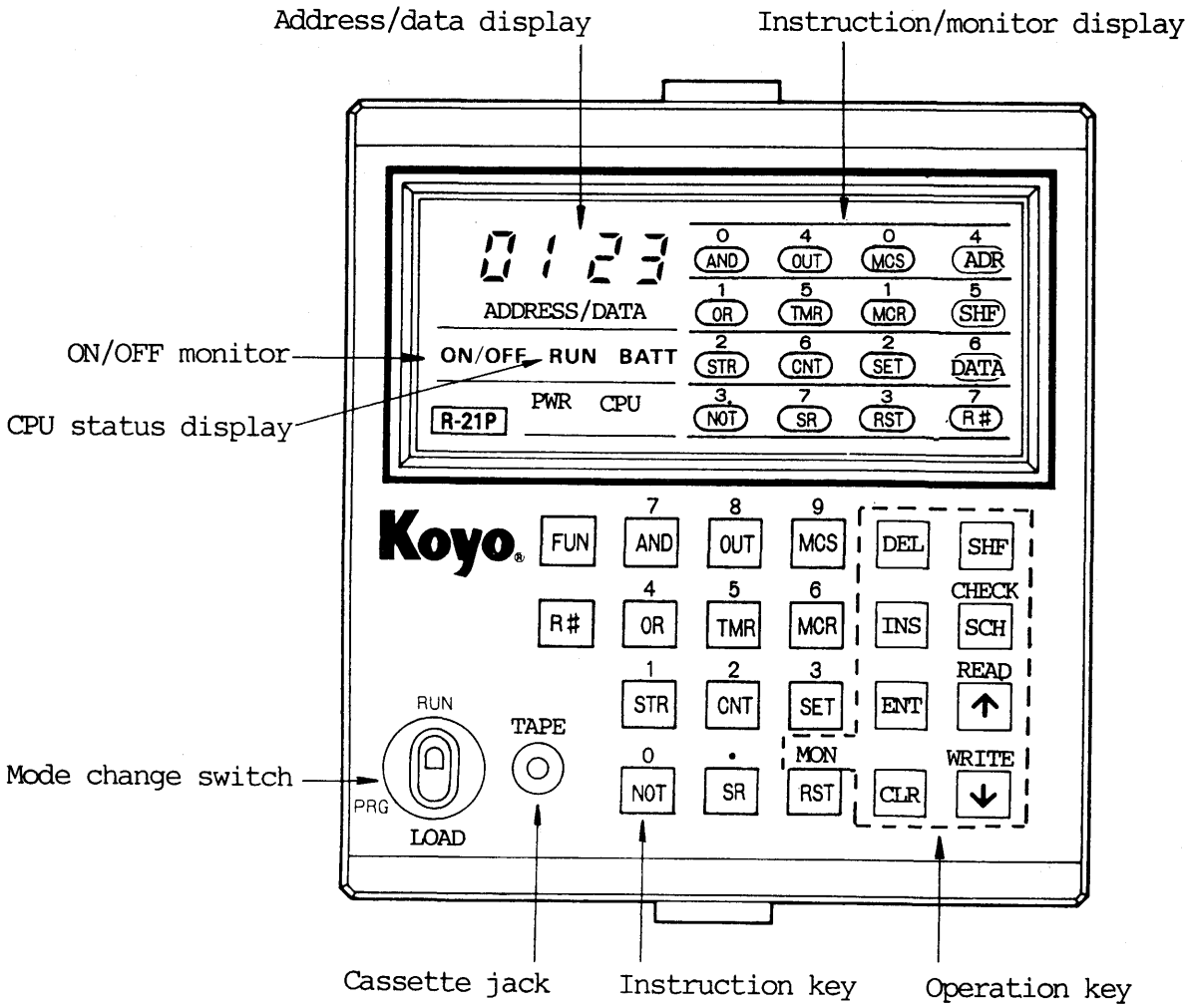
17-2. Writing from PC to tape C-61

17-3. Checking of PC with tape C-63

17-4. Entering from tape to PC C-66

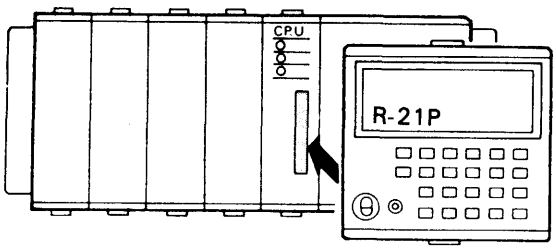
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1. OPERATION PANEL

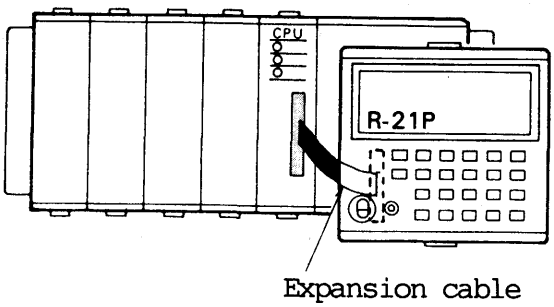


● Connection with R-21P

Direct mounting



Expansion by the cable



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(1) Mode change switch

When R-21P is installed on the CPU, a mode selected by this switch will be given. When R-21P is disconnected, the mode selected before disconnection will be retained.

- RUN mode: The CPU module is set for the command execution status. (The forced operation of the monitor also becomes possible.)
- PRG mode: The command execution of the CPU module is stopped. This is the mode to read or write the program. When the switch is changed from PRG to RUN, the initial resetting and memory checking are made.
- Cassette mode: The command execution of the CPU module is stopped. It becomes possible to make operations for recording, playback, and checking.

(2) Cassette jack

This is the jack for connecting with the cassette tape recorder or C-60P. The cassette use cable is attached with R-21P.

(3) Command key

All 14 keys can be used for command setting. The 10 keys from 0 to 9 and the key for decimal point are effective until the shift key and operation key are depressed.

- For commands: AND OR STR NOT OUT TMR CNT SR MCS MCR SET RST
- For operand: 0 1 2 3 4 5 6 7 8 9 •
- For application commands: Set the function number according to the command after depressing the FUN key. (The shift key is not needed for this.)
- For specifying the register number: Depress the R# key if the operand is used for the register number and set by the number key. (The shift key is not needed for this case before depressing the number key.)

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(4) Operation key

- For program writing: [ENT] [INS] [DEL]
- For program reading and monitor reading: [SCH] [↑] [↓] [MON]

  (The [↓] key is also used as the execution key.)
- For specifying the number key:

  If the [SHF] key is depressed, the number keys are effective.
- For canceling of the setting:

  Depress the [CLR] key to cancel the errorneous setting or monitor.

(5) Address/Data display

This is the display for program address, operand (number) for instruction, T/C accumulated value, and value for register monitoring.
For displaying the program address, the digital points for all digits are lighted.

(6) Command/monitor display

The description in ⬭ is for confirming the command key setting and displaying the command reading. The numbers from 0 to 7 show the last digit number for monitoring.

(7) ON/OFF monitor display

When reading of the instruction under the RUN mode is made, the ON/OFF status of the instruction operand number will be shown.

(8) CPU status display

RUN display: Lights to show the normal RUN status of the CPU.
BATT display: Lights to show voltage dropping of the battery for power failure backup.
Power source display: Lights to show if 5V is applied to the CPU.
CPU abnormality display: Lights to show the watchdog timer error of the CPU.

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2. TABLE OF OPERATION

	Function		Operation procedure	Execution mode RUN	PRG	LOAD
1	Switching to RUN mode		 Set mode select switch to RUN (up). Then the grammar check and initial reset are processed.		●	
2	Switching to PRG mode		 Set mode select switch to PRG (center). Then RUN for CPU stops.	●		●
3	Switching to LOAD mode		 Set mode select switch to LOAD (down). Then RUN for CPU stops.		●	
4	All clear of program memory		CLR SHF 3 4 8 DEL ↓		●	
5	Setting memory address display back to 0		SHF ↓	●	●	
6	Setting up address		SHF No. □□□ ↓	●	●	
7	Displaying instruction in address N		Specify address N and ↓.	●	●	
8	Clear of instruction display		CLR Instruction display disappears and address display appears.	●	●	
9	Reading of program		Memory address reading in plus direction. ↓ Memory address reading in minus direction. ↑	●	●	
10	Writing and rewriting of instruction	1 word instruction	Instruction □□□ SHF Data □□□ ENT		●	
		2 word instruction	Instruction □ SHF No. □□□ ENT or FUN No. □□ ENT SHF Data or No. □□□□ ENT or R# register No. □□□ ENT	※1 ▲	●	
11	Inserting of instruction	1 word instruction	Call the address to be inserted or the next instruction, then Instruction □□□ SHF Data □□□ INS ↓		●	
		2 word instruction	Instruction □ SHF No. □□□ INS ↓ or FUN No. □□ INS ↓ Call the address to be inserted or the next instruction, then SHF Data or No. □□□□ ENT R# Register No. □□□ ENT		●	
12	Deleting of instruction		Display the instruction to be deleted, then DEL ↑. In the case of the 2-word instruction, the 2nd word will be deleted at the same time when the 1st word is deleted.		●	
13	Inserting of END		CLR SHF INS ↓		●	
14	Search	Instruction	Instruction □□□ SHF Data □□□ SCH Display the desired address by entering these key operations. Depress ↓ key to display the instruction.	●	●	
		Input/Output contact	Display the address containing the instruction by entering SHF No. □□□ SCH. Depress ↓ key to display the instruction. Depressing SCH key for a second time will display the next address.	●	●	
		Timer/Counter contact				
		Blank address	Used for grammatical checking. If no grammatical error is found, the blank address will be displayed.		●	
15	Program grammar check		CLR SCH	●	●	
16	Multipoint operation monitor Input/Output ON/OFF		SHF No. □□□ MON	●		
	Timer/Counter ON/OFF		TMR (CNT) SHF 6 No. □□ MON ON/OFF statuses of total 16 points will be displayed simultaneously: before and after the desired number and the next digit of 0 to 7. ↑ or ↓ will make a move of 8 points forward or backward.			

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	Function		Operation procedure	Execution mode RUN	PRG	LOAD
17	Accumulated timer/ counter value		SHF [No. 6 □ □] MON The last two digits of the timer/counter number are displayed by LEDs of the multipoint monitor. ↑ or ↓ will make a move forward or backward of the monitoring point.	●		
18	Register data content monitoring		R≠ [Register No. □ □ □] MON Display of the data content of the specified register number. Depress the R≠ key again to display the register number of the data content on display. ↑ or ↓ will make a move forward or backward of the monitoring point.	●		
19	ON/OFF check		ON/OFF check lamp lights to indicate if the displayed content is ON status when the coil, contact, or stage is read out and the content is displayed.	●		
20	Forced operation	Input/Output internal relay Timer/Counter	ON SET SHF [No. □ □ □] ENT OFF RST SHF [No. □ □ □] ENT	●		
		Forced writing of accumulated value of T/C or register data:	Display the register data content, then SHF [No. to write in □ □ □ □] ENT.	●		
21	Cassette operation	Recording on tape	[File No. □ □ □ □] WRITE ↓			●
		Writing from tape into memory	[File No. □ □ □ □] READ ↑			
		Checking of tape and memory	[File No. □ □ □ □] CHECK SCH			
22	Password	Registration of password	CLR SHF 9 8 7 6 DEL SHF [Password □ □ □ □] ENT	●	●	
		Open (make effective of the program operation)	CLR SHF 5 6 7 8 DEL SHF [Password □ □ □ □] ENT	●	●	
		Close (make invalid of the program operation)	CLR SHF 1 2 3 4 DEL ↓	●	●	

*1. Rewriting instruction during RUN is possible only for set values of timer and counter.

- Each key serves both as an instruction key and a number key.
  To use a key as a number key, the shift key SHF must be depressed to shift to the number keys. Confirm by the illuminated LED (shift key operation confirmation LED) that the shift has been accomplished before using any key as a number key. But it is not necessary to depress the shift key SHF for the register number after R≠ and the function number after FUN.

- For operating with R-20P
  (1) Depress SHF SHF instead of FUN key of R-21P. (Display: F)
  (2) Depress SHF SCH instead of R≠ key of R-21P. (Display: r)

- Unless the open operation is made, program reading and writing are inhibited in the case of the CPU if the password is registered.
  (However, monitoring is possible.)

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3. MODE CHANGE SWITCH

3-1. Operating functions by the individual modes

Mode	Operations related with the program memory	Operations related with the function memory
RUN mode (CPU execution)	* (1) Sequential program reading ON/OFF check monitoring is automatically made whenever the reading operation of program memory is made. * (2) Searching of the command and contact ON/OFF monitoring is also made for this case. * (3) Searching of the blank address (grammar check) * (4) Rewriting of the T/C constant set value * (5) Password registration and closing (6) Password opening	(1) 16-point block monitoring (ON/OFF) • Input/output • Internal memory • Shift register • Timer/counter (2) Monitoring of the accumulated value of T/C (3) Monitoring of the register data content • Input/output • Internal relay • Shift register • Data register • Accumulated value of T/C *(4) Forced ON/OFF • Input/output • Internal relay • Shift register • T/C (ON: 9999, OFF: 0) *(5) Forced writing into the register • Input/output • Internal relay • Shift register • Data register • Accumulated value of T/C
PRG mode (CPU stop)	* (1) Sequential program memory reading * (2) Searching of the command and contact * (3) Searching of the blank address (grammar check) * (4) Writing, rewriting, inserting, and deleting of the instruction * (5) Password registration and closing (6) Password opening	
LOADER mode (CPU stop)	* (1) Recording from PC to tape * (2) Checking of PC with tape * (3) Playback from tape to PC	

Items with (*) are inhibited under the condition of password closing.

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3-2. Mode change

(1) Mode and processing upon application of the power source

- In the case of the programmer installed:
  The mode selected by the mode change switch of the programmer will be given after checking initial resetting and memory. But if monitoring was processed before power failure under the RUN mode, monitoring will be continued.
- In the case of the programmer not installed:
  The mode before failure will be continued after checking initial resetting and memory.

  Note: If the EP-ROM program memory is installed, the RUN mode will be given after initial resetting.

(2) Processing and the mode when the mode change switch operation is made

- For changing from RUN to PRG:
  The CPU stops to RUN and goes back to the program mode.
  (Memory checking is also made.)
- For changing from PRG to RUN:
  Initial resetting and memory checking (including grammar checking) will be processed before RUN mode.
- For changing from PRG to LOAD: The LOAD mode will be given.

(3) Whenever the memory check error is found

- Whenever the abnormality of memory or grammar error is found as a result of memory checking for inputting the power source or changing from PRG to RUN, RUN will not be made and the error number will be displayed. Rewrite the program after changing to the PRG mode.

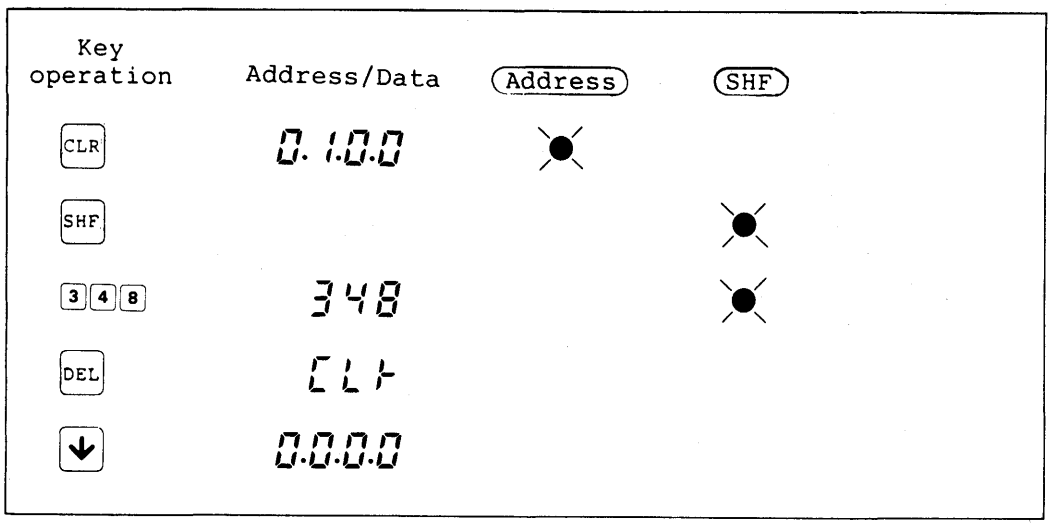
4. TOTAL DELETION OF PROGRAM MEMORY

This operation must be processed for the following cases.

- To write in a program for the first time
- To rewrite a completely new program
- When the program memory is expanded

The operation to delete the program memory completely will be done under the program mode. It is possible to process the operation if the password is not registered or opened.
END instruction will be written into the whole program memory area whenever the total deletion of program memory is made.

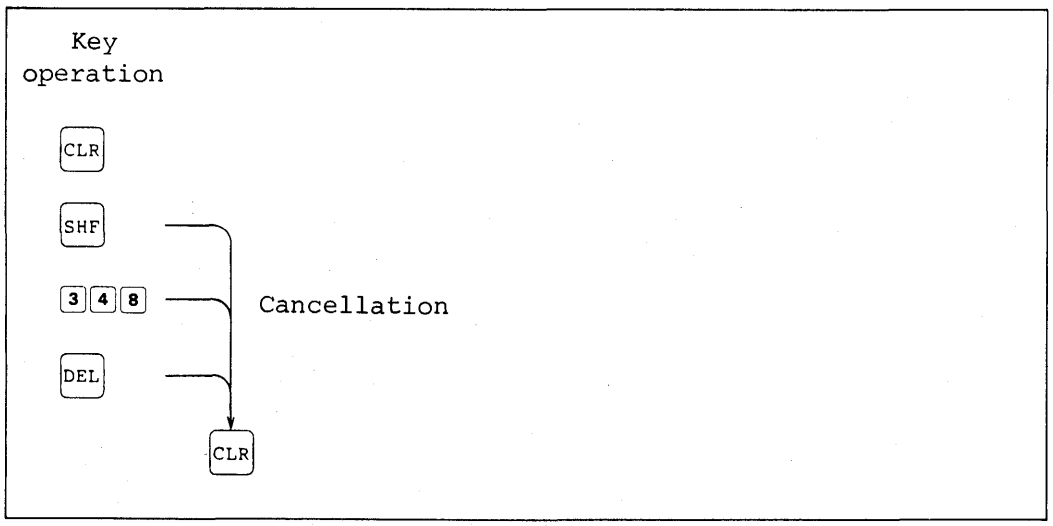
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The address displayed at the time of total deletion is the address that was displayed before total deletion was made. After total deletion,the address shows 0.

Cancellation of total deletion

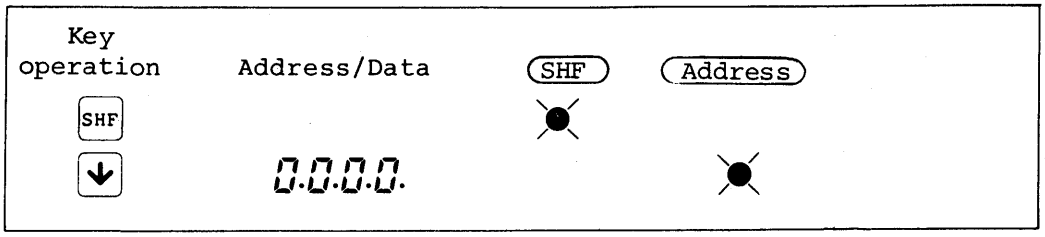
The instruction for total deletion can be cancelled by depressing the CLR key if the ↓ key is not yet depressed.



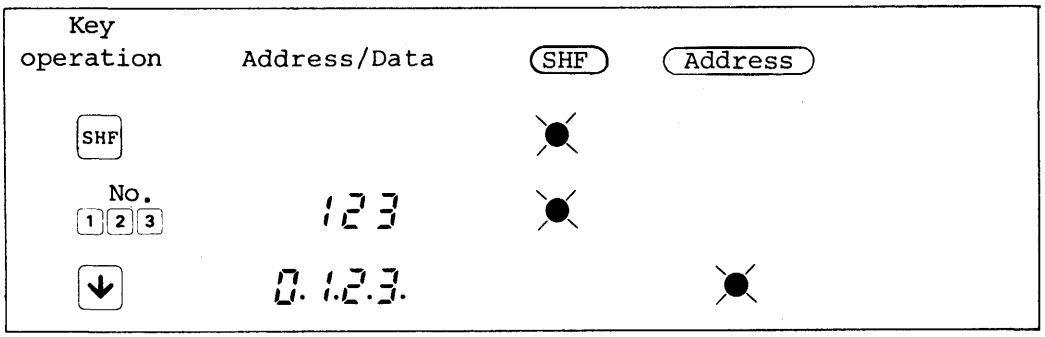
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5. MEMORY ADDRESS SETTING

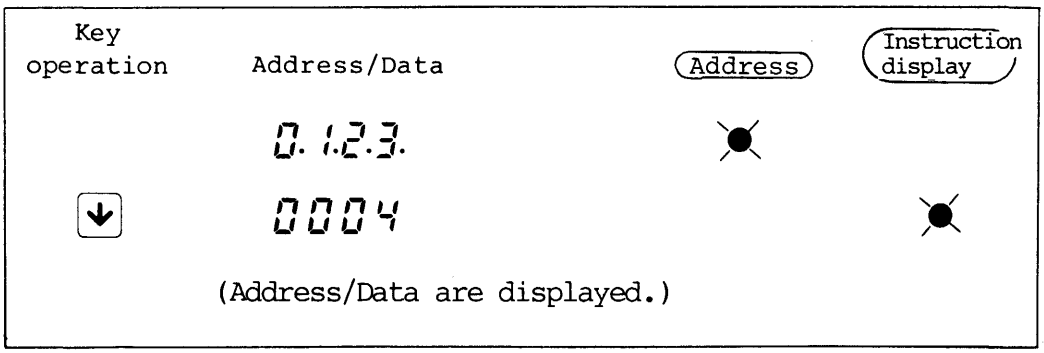
(1) Address 0 setting



(2) Optional address setting

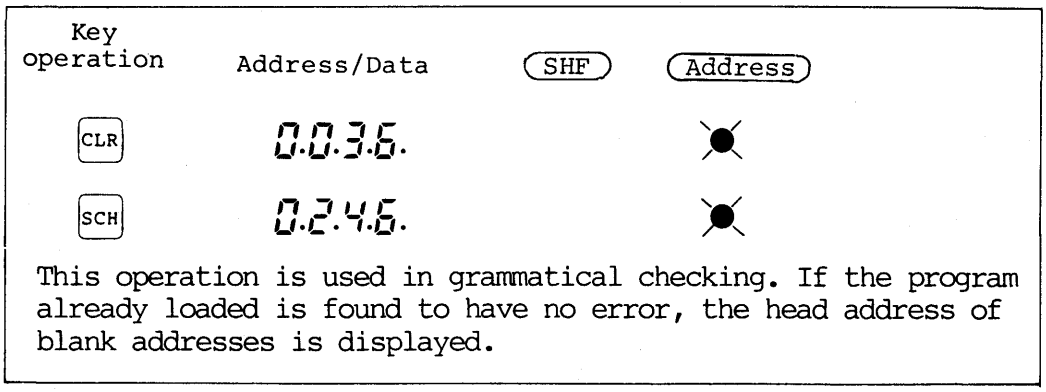


(3) Switching of display from address to instruction



(4) Setting of the last address for adding a program

Searching of END instruction is made.



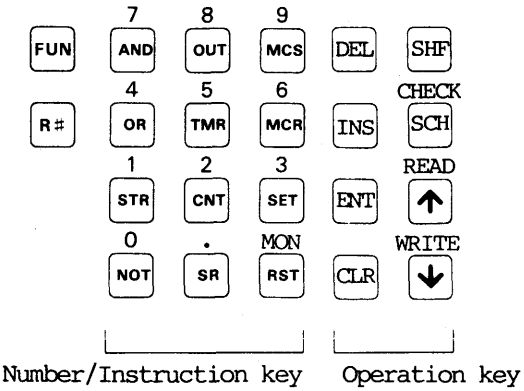
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6. INSTRUCTION SETTING

6-1. How to use key

(1) Kinds and usages of keys

● Key arrangement



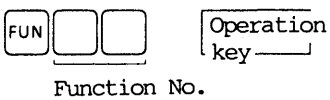
Instruction key: AND OR STR NOT OUT TMR CNT SR MCS MCR SET RST

There are 12 instruction keys on the panel. By depressing these keys once, twice, and thrice and by combining them, up to 31 different instructions can be formed. When a instruction key is accepted, an LED in the display section is lit indicating that the instruction has been accepted.
However, if keys are depressed in wrong combinations, that instruction is rejected, and the LEDs do not light. In case the first key entry is correct but the second or third entry is incorrect, the LED indication will be made only for the correct entry.
The instruction by the erroneous key operation will not be accepted, and the LED will not be lighted.

At the start of instruction setup operation, the number/instruction keys will serve as the instruction keys.

● Function key [FUN]

The function key is used to set a instruction not prepared for the instruction key. If the number key is depressed after the function key, the function number will be set.



Only two digits of function numbers are valid.

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- Shift key [SHF]

  The shift key is used to specify the bit number and to set the constant (also to set the address).

  Instruction [SHF] [ ][ ][ ] (Bit No.) — [Operation key] — Only three digits of bit numbers are valid.

  [SHF] [ ][ ][ ][ ] (Constant) — [Operation key] — Four digits of constant are valid (exclude the number of shifting steps).

- [R#] key: The [R#] key is used to specify the register number.

  [R#] [ ][ ][ ] (Register No.) — [Operation key] — Three digits of register number are valid.

- Number key

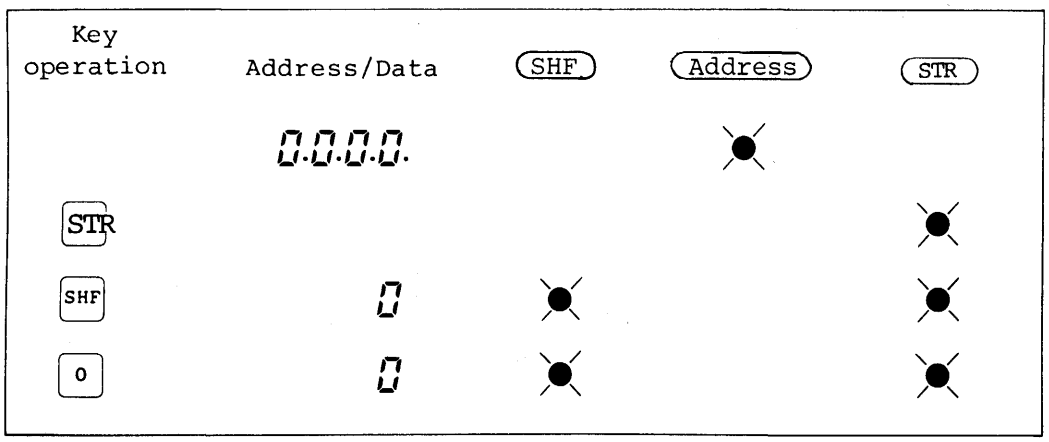
  [1] [2] [3] [4] [5] [6] [7] [8] [9] [.]

  The number key continues to be valid until the operation key is depressed after the key operation of [FUN] or [SHF] or [R#] key.

6-2. Instruction setting procedure

(1) For one instruction

OUT, STR, AND, OR, SET, RST



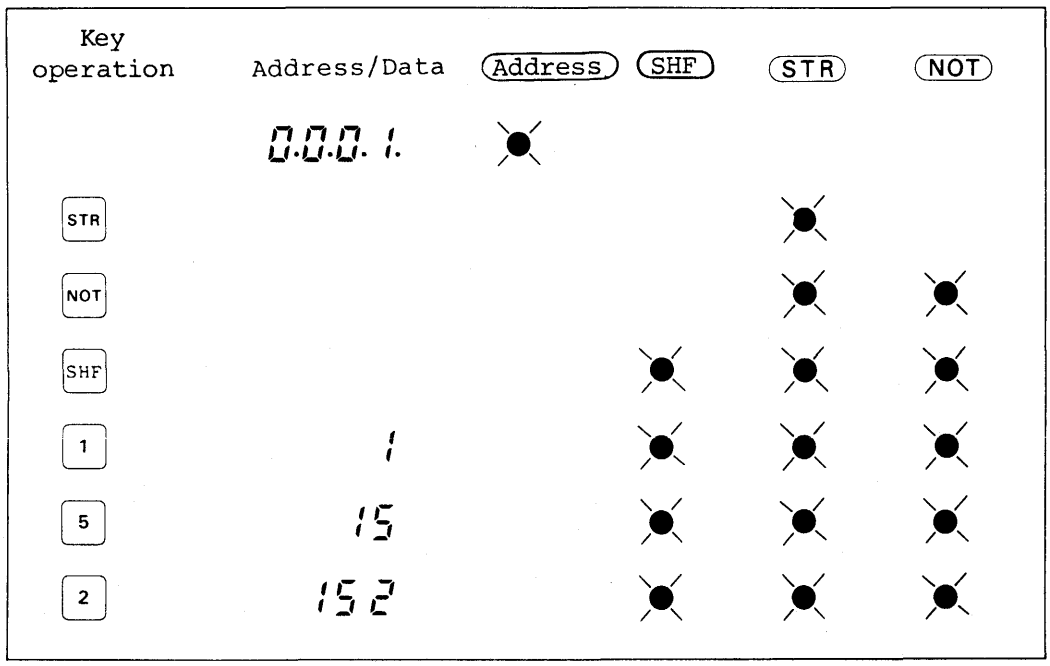
The instruction thus prepared is written into program memory by depressing [ENT] key.

If writing is completed, the address display will automatically be moved up for one address to be ready for the preparation of the next instruction.

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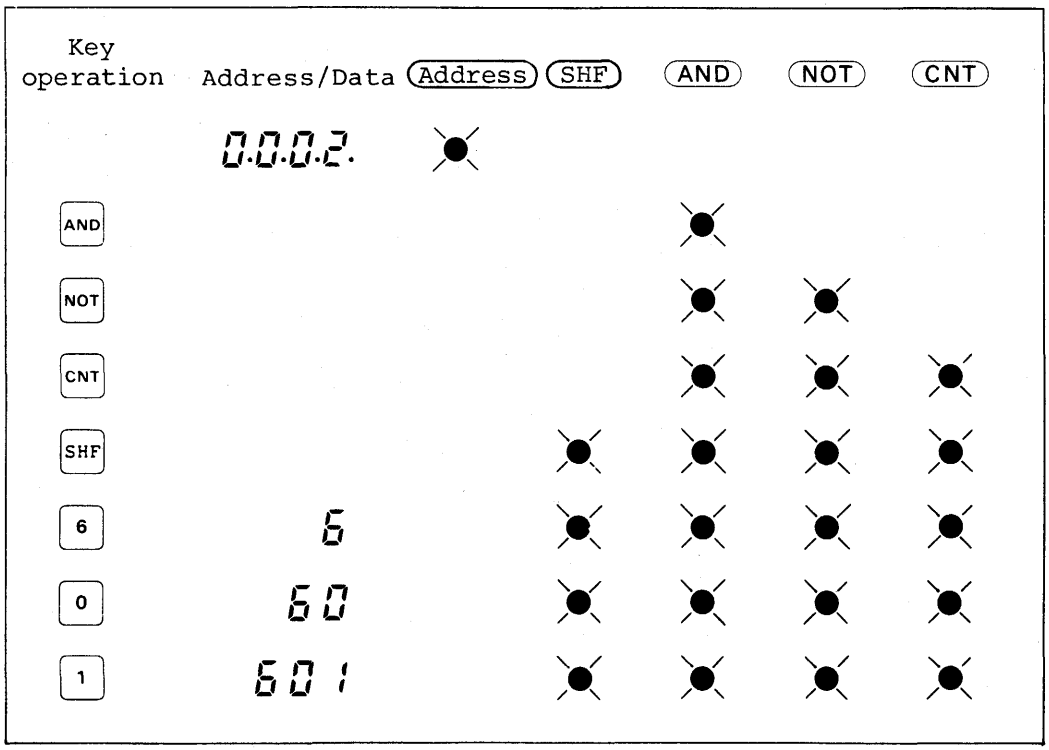
(2) For combining two instructions

SET OUT, STR NOT, AND NOT, OR TMR, and others



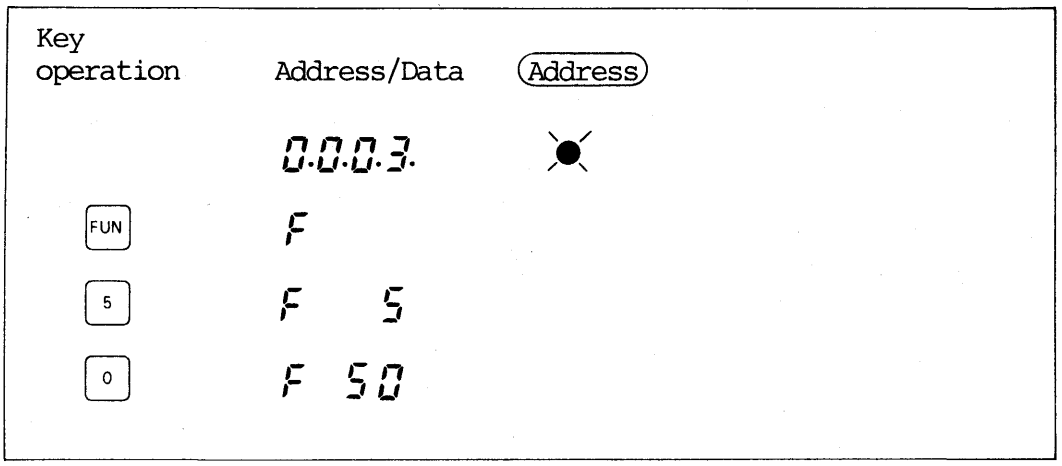
(3) For combining three instructions

STR NOT TMR, AND NOT CNT, and others

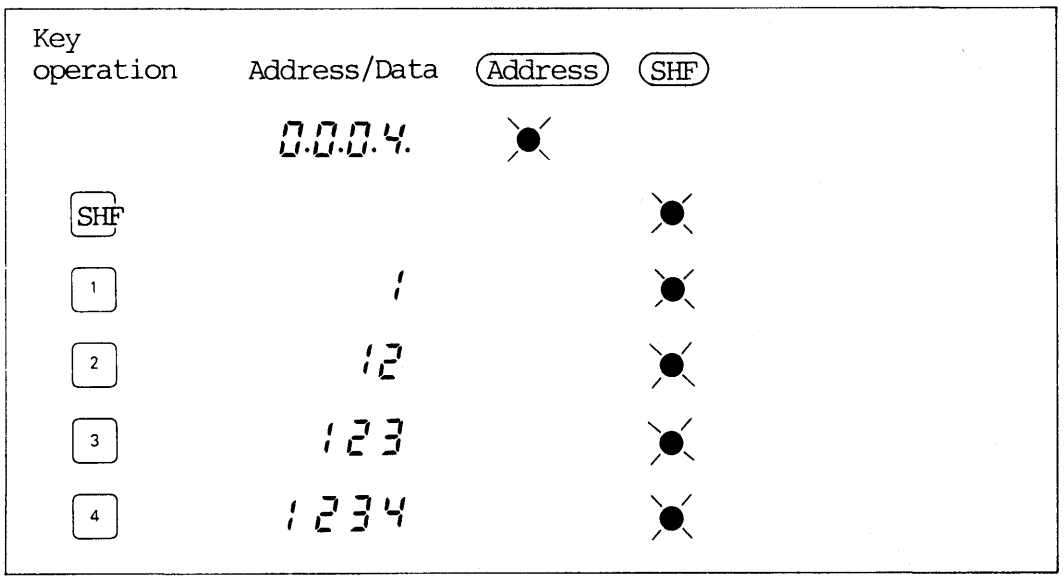


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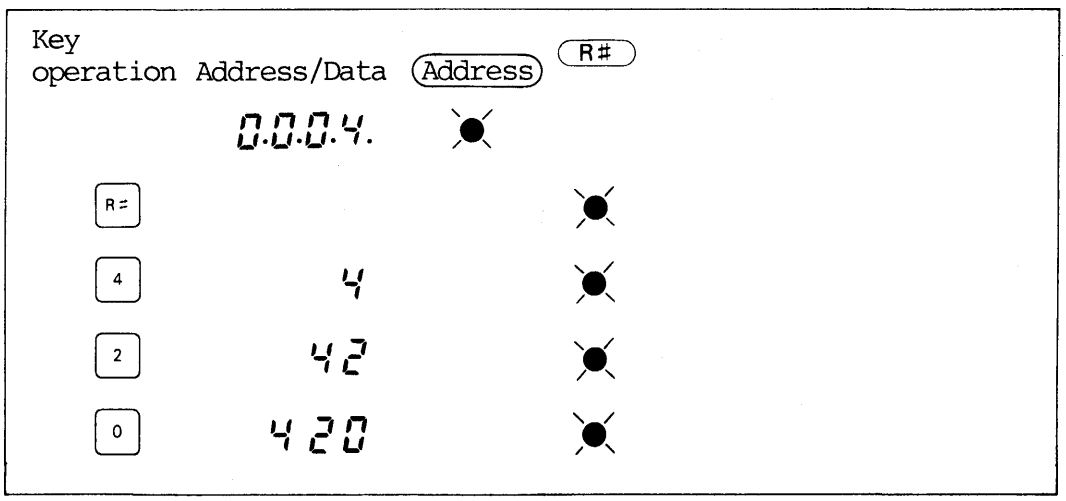
(4) For function instruction



(5) For the second word constant instruction



(6) For the second word register number instruction



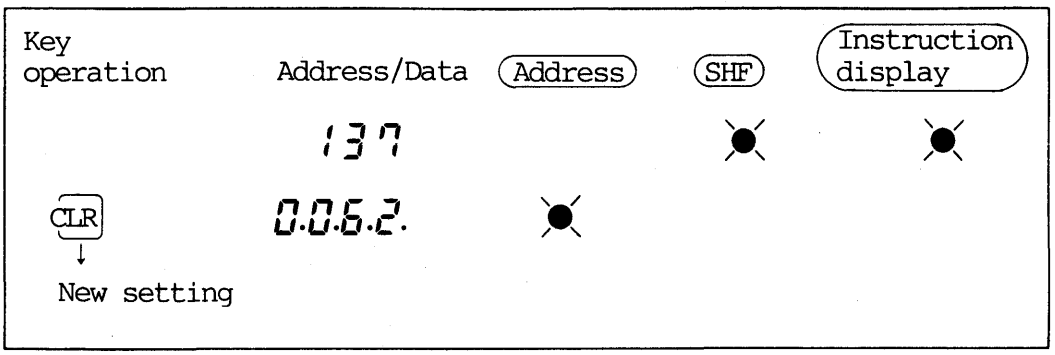
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6-3. Correction of instruction settings

Use the following procedures to correct settings before writing is made.

Method 1: By depressing CLR key

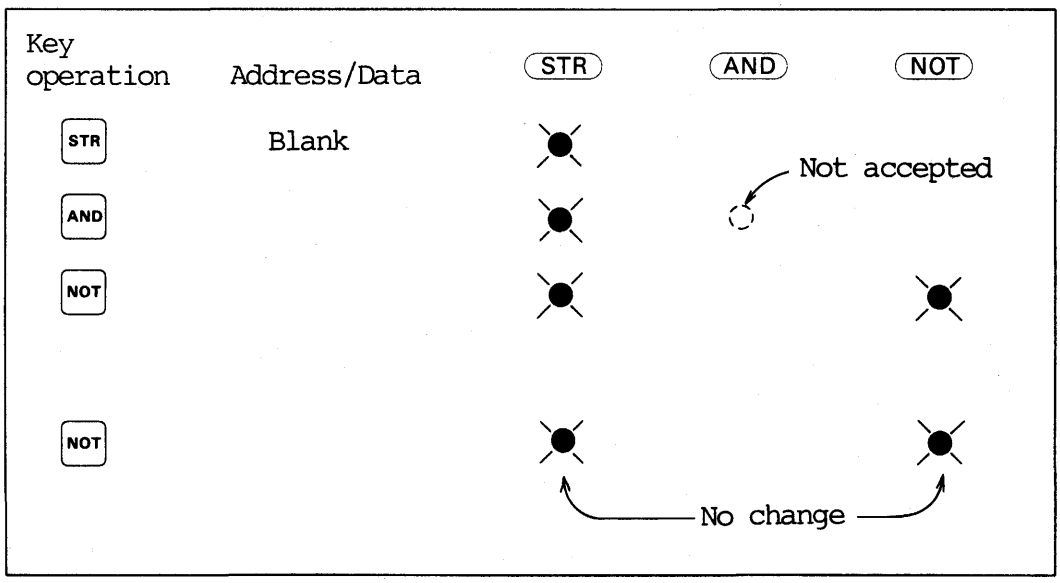
Setup instructions and numbers are all cleared and the display returns to show addresses. New instructions and numbers must be input from the beginning. This correction method is the most basic and, after depression of the shift key, is the only method to correct the instruction.



Method 2: Correction of instruction

If more than two instructions are combined (for example, AND NOT TMR), the correctly entered instructions will be accepted and the incorrectly entered instructions will be ignored.

Example: If keys STR, AND, and NOT are depressed, AND will be ignored, and STR NOT will be accepted. If key NOT is depressed after STR NOT, NOT will be ignored.

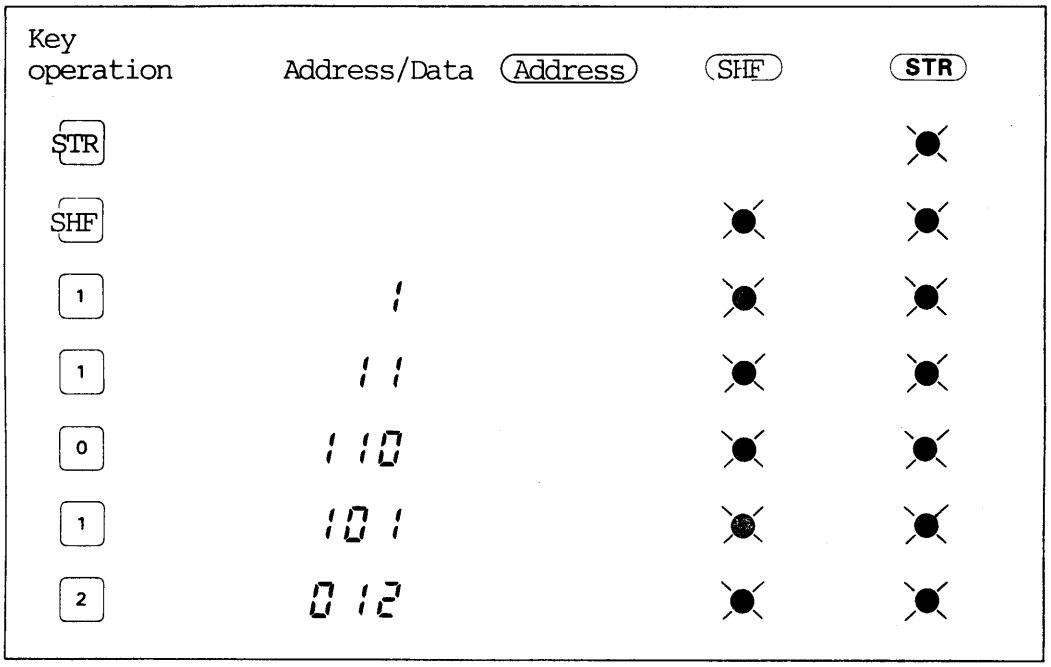


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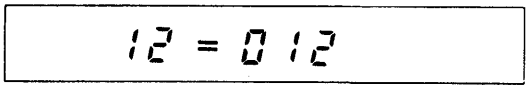
Method 3: Correction of address/data

Depressing the shift key shfts the keys from instruction to number, enabling the operator to setup address/data. The number display is for 3 digits. When a number key is depressed, the number appears in the least significant digit. A second key entry appears in the least significant digit, moving the previously displayed number to the left one digit at a time. In this way, new numbers can be entered one after another because the number farthest to the left is moved off the display each time a new number is entered. This allows the operator to correct entries.

Example: Correct STR 11 as STR 12



Enter 0 followed by 12 so that 012 (that is, STR 12) will be displayed. (If 12 is entered following 11, 112 will be displayed.)



When the shift key is depressed, the address/data display becomes blank (unlit). When a number key is next depressed, the number is displayed in the least significant digit of the display, leaving the remaining top two positions blank. The valid digit range of I/O addresses and data are three digits (four digits for memory addresses), and high-order zeros will not be necessary to key in. They can be specified, however, if desired.

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7. PROGRAM WRITING

7-1. Writing procedure: Program mode

This operation is to write a setup instruction into the program memory.

(1) Setup a desired memory address for writing according to the procedure for "memory address setting", section 5 (page C-9) of this manual.

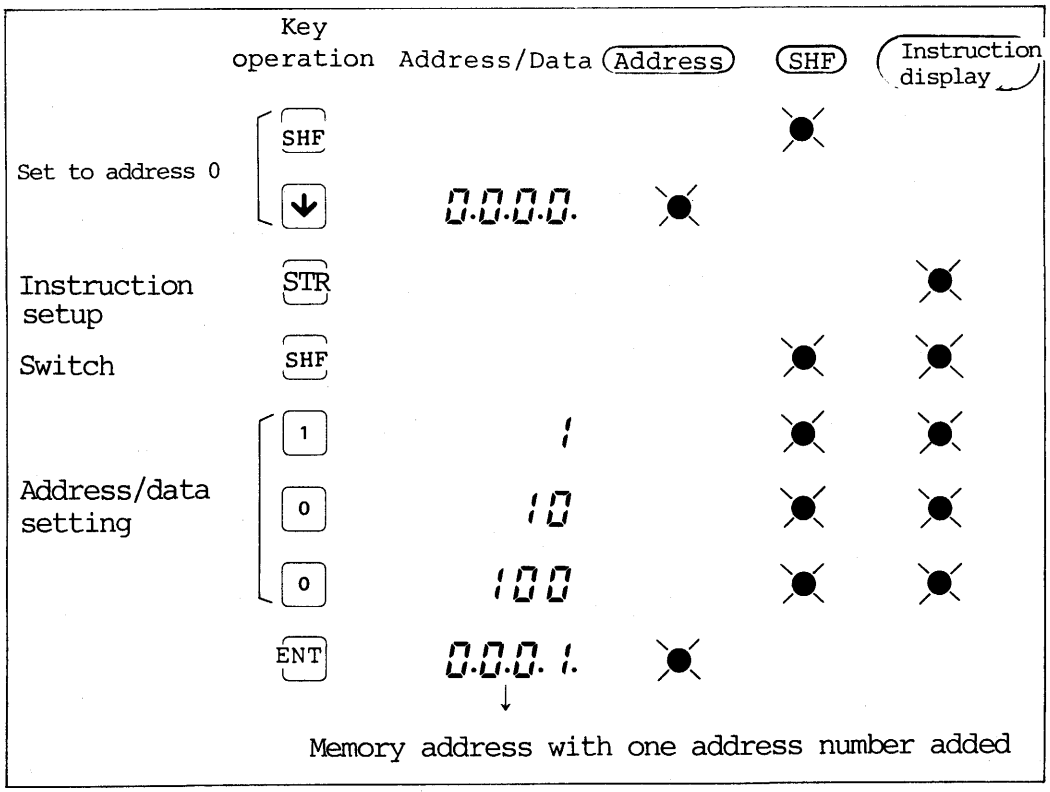
(2) Setup the instruction correctly according to the procedure for "instruction setting", section 6 (page C-10).

(3) Depress [ENT] key after making sure that the instruction and address/data are correctly setup.

(4) When [ENT] key is depressed, writing will be made. And the memory address will be displayed on the panel. Also the memory address automatically added by 1 will be displayed.

(5) Proceed to setup the next instruction.
Repeat above steps 2, 3, and 4 to write the program in sequence.

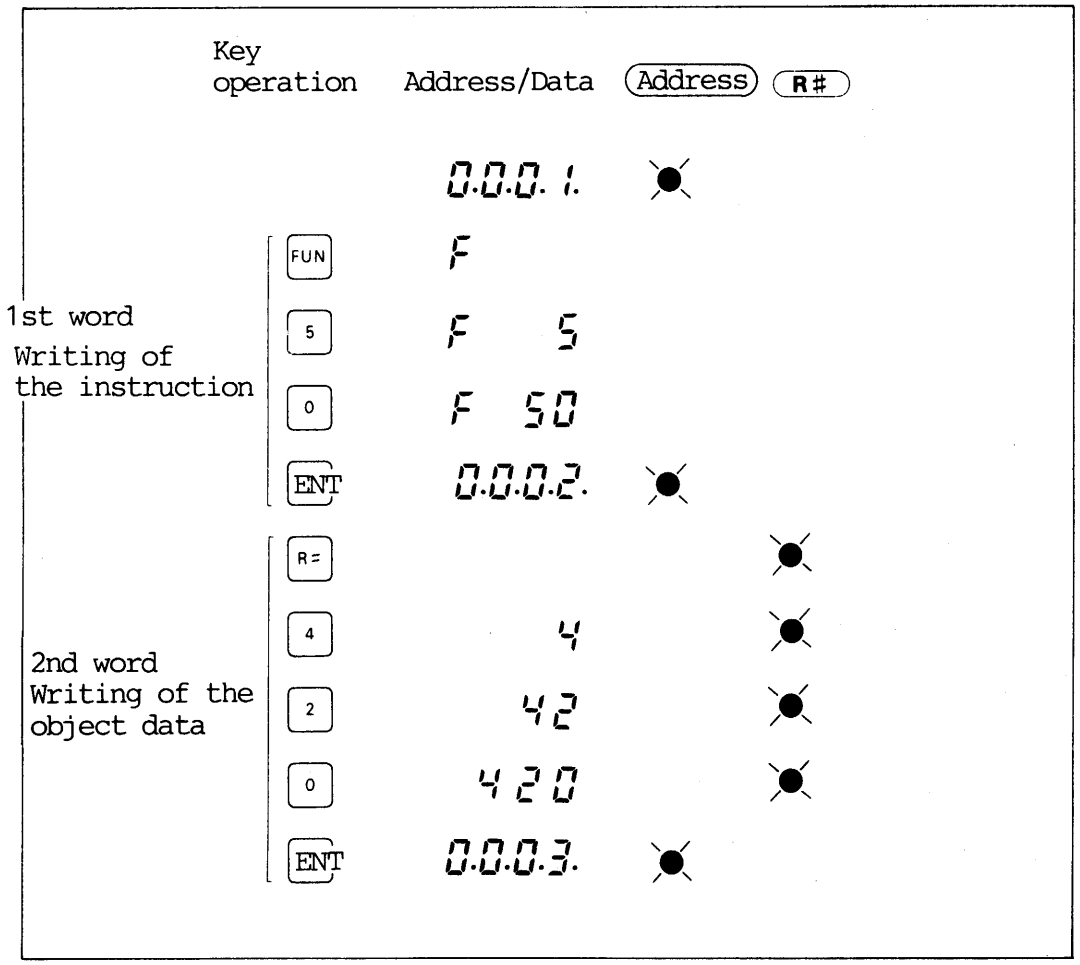
To write from the head program memory address 0000



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Caution: The program of SR-21 cannot have a blank address (where the program is not written) at the head or in the middle of the program.
Be sure to start writing from address 0 for writing the program because the blank address will be judged as END instruction and the following program will not be executed.

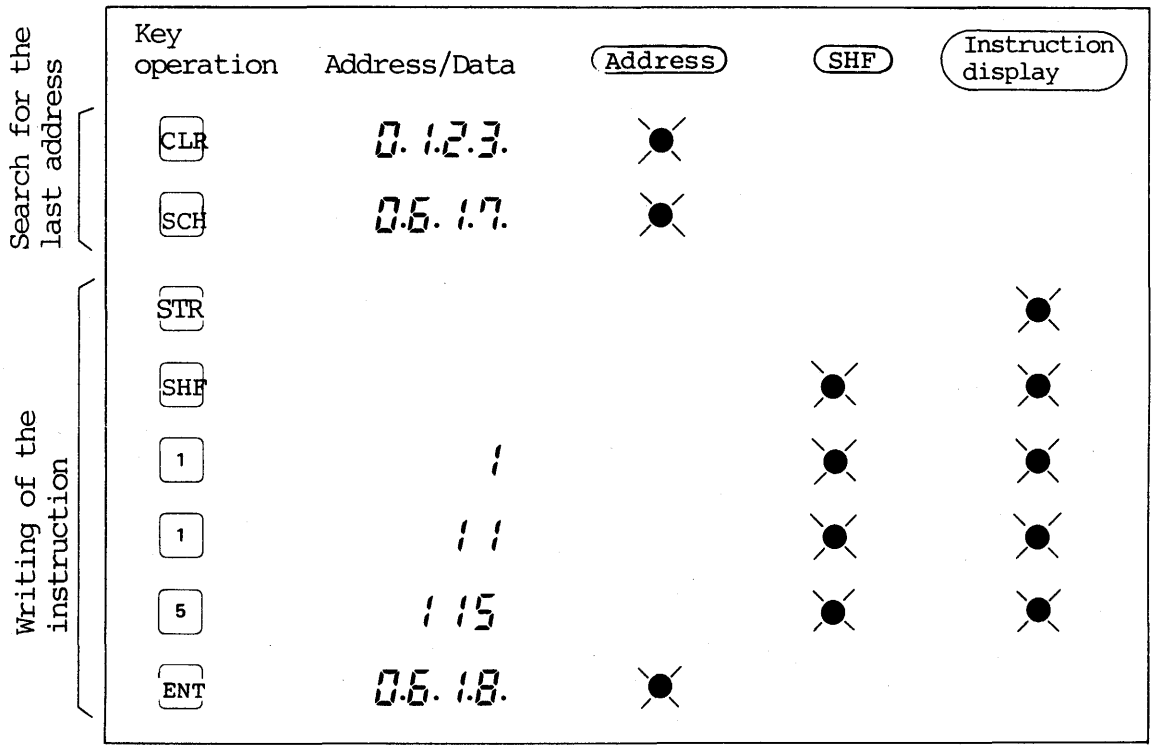
Writing of the function instruction



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To write immediately after last program already written

For this case, search for the last address of the program.



To find the last address, proceed with the grammar check. This check can be accomplished by depressing [CLR] and [SCH] keys. If no program error is made, checking will be completed by displaying a vacant address next to the last address.

Because the address being displayed is the head address of vacant address, the operator can write the desired instruction immediately.

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7-2. Invalid [ENT] key writing

For the following cases the [ENT] key operation will not be accepted. The operation will be invalid, and no writing into the program memory will be made.

(1) If the [ENT] key is depressed without any instruction setting.

(2) If the [ENT] key is depressed after only instruction keys or number keys are used for setting (except for the second word data of the timer/counter instruction).
Error code E01 will be displayed in this case.

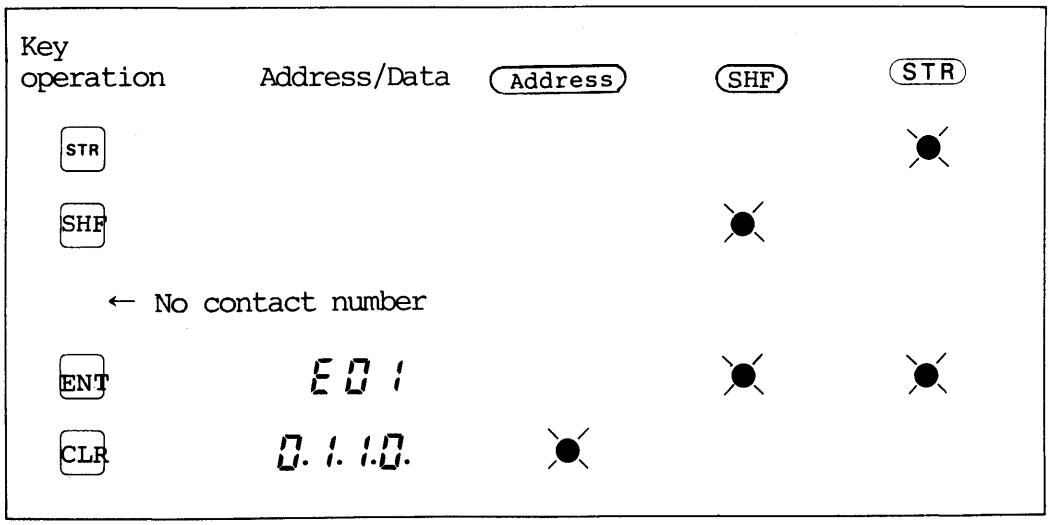
(3) If the length of number or data is exceeding the effective setting range. Error code E01 will be displayed in this case.

(4) The coil instruction for the timer and counter is the two-word instruction in combination of the instruction and set value to express a number of timer and counter.
If the [ENT] key is depressed when the instruction other than the set value is set, the error code E08 will be displayed, and no writing will be made.

To clear the error code: Depress the [CLR] key

The error code E01 indicates incorrect key operation.
To setup the instruction again correctly, the error code must be cleared first. Depressing the [CLR] key clears the error code and restores the memory address display to allow the operator to setup and write the correct instruction.

Example: When writing is made without setting of the contact number for the input contact.



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7-3. Generation of the code during writing

The PC detects operation errors made in the course of key entry of a program and indicates the appropriate error code. In this instance, the program cannot be written into memory.

There are two error codes used for indication of errors that may be made in entering programs:

a) E01: Operation error. This error code is issued in the following cases:

- ENT key is depressed after only instruction keys or number keys are used for setting.
- Setting of I/O number, or timer/counter number overflows an allocated range.
- The numbers mentioned above are specified by the decimal numbers (8 or 9) instead of the octal notation.

b) E08: The error is detected when other instruction is written into the second word of two-word instruction.

- The next instruction is written despite time setting of the timer is missing.
- The next instruction is written despite a set value of the counter is missing.
- Other instruction is written into the second word of the function instruction.

C) E11: No empty address

- A two-word instruction is written when the program memory address reaches the last address.
- All program addresses are filled up, but instruction is inserted. The instruction of the new instruction is executed. The preoccupying instruction in the last address is pushed out of the memory.

Caution:

When a new instruction is written after program memory addresses are filled up with programs down to the last address (No.700 or 1723), it will not cause an error. At this time, the address display shows 700 or 1723, and the contents of the address will be changed to the newly written instruction.

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8. PROGRAM REWRITING PROCEDURE: PROGRAM MODE

This operation is to make a partial correction to the program already written.

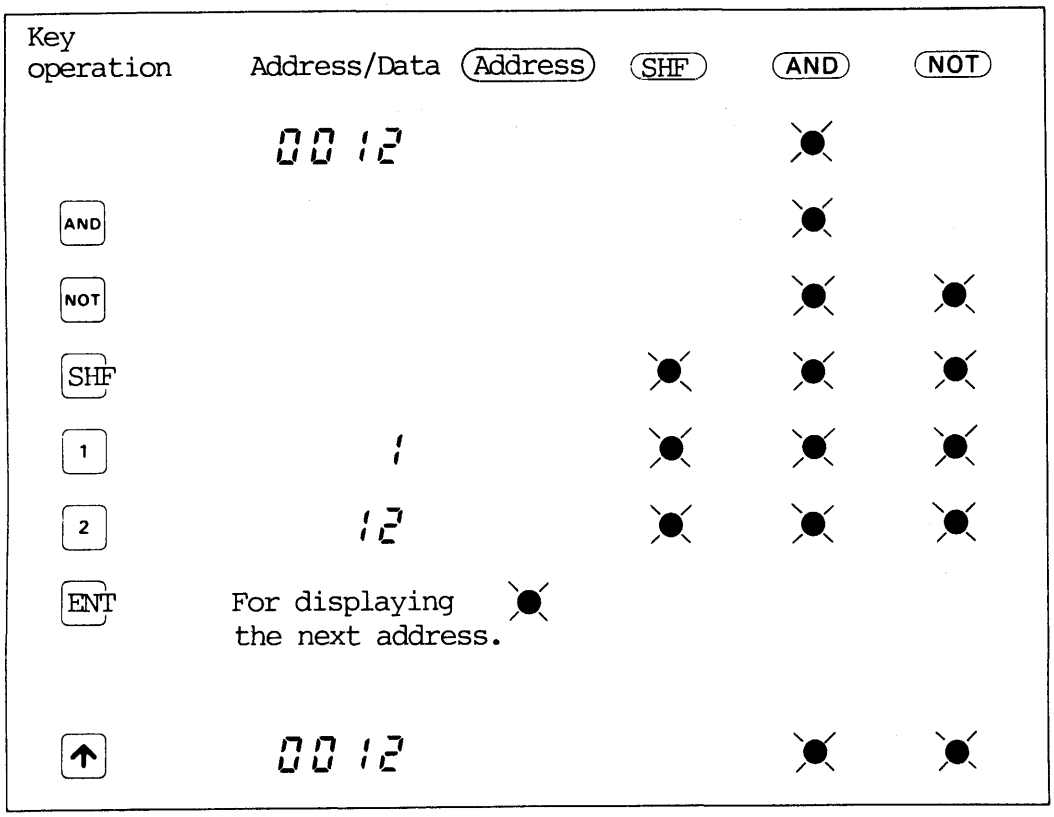
8-1. Program rewriting in general

The procedure for rewriting a one-word instruction is as follows:

(1) Display the desired instruction by using any method described in "Reading operation", section 11 (Page C-33) of this manual.

(2) Rewrite the program according to the following procedure.

Example: Rewrite AND 12 to AND NOT 12.



(3) Depress the ↑ key to roll back for one address to make sure that the correct rewriting is made.

CAUTION:

- The procedure for rewriting is the same as writing.
- For the instruction to be rewritten, key in everything, including data (number).

  Rewriting of the instruction on data alone cannot be made. For example, AND 12 cannot be separated into two parts.

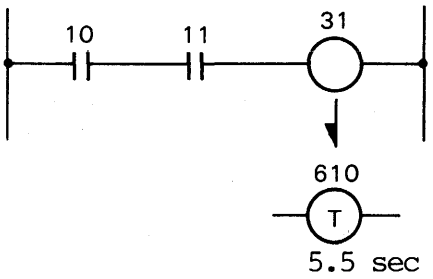
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8-2. Rewriting of timer/counter instructions

To rewrite ordinary output instruction to timer/counter coil instruction

Although the ordinary output instructions are the one-word instructions, the timer/counter coil instructions are the two-word instructions. To rewrite an ordinary instruction to a timer/counter coil instruction, a space for one word is necessary. To this end, the entire program is pushed one address downword automatically to provide a required space when the rewrite operation is performed.

Example:



Rewriting of OUT 31 to the timer

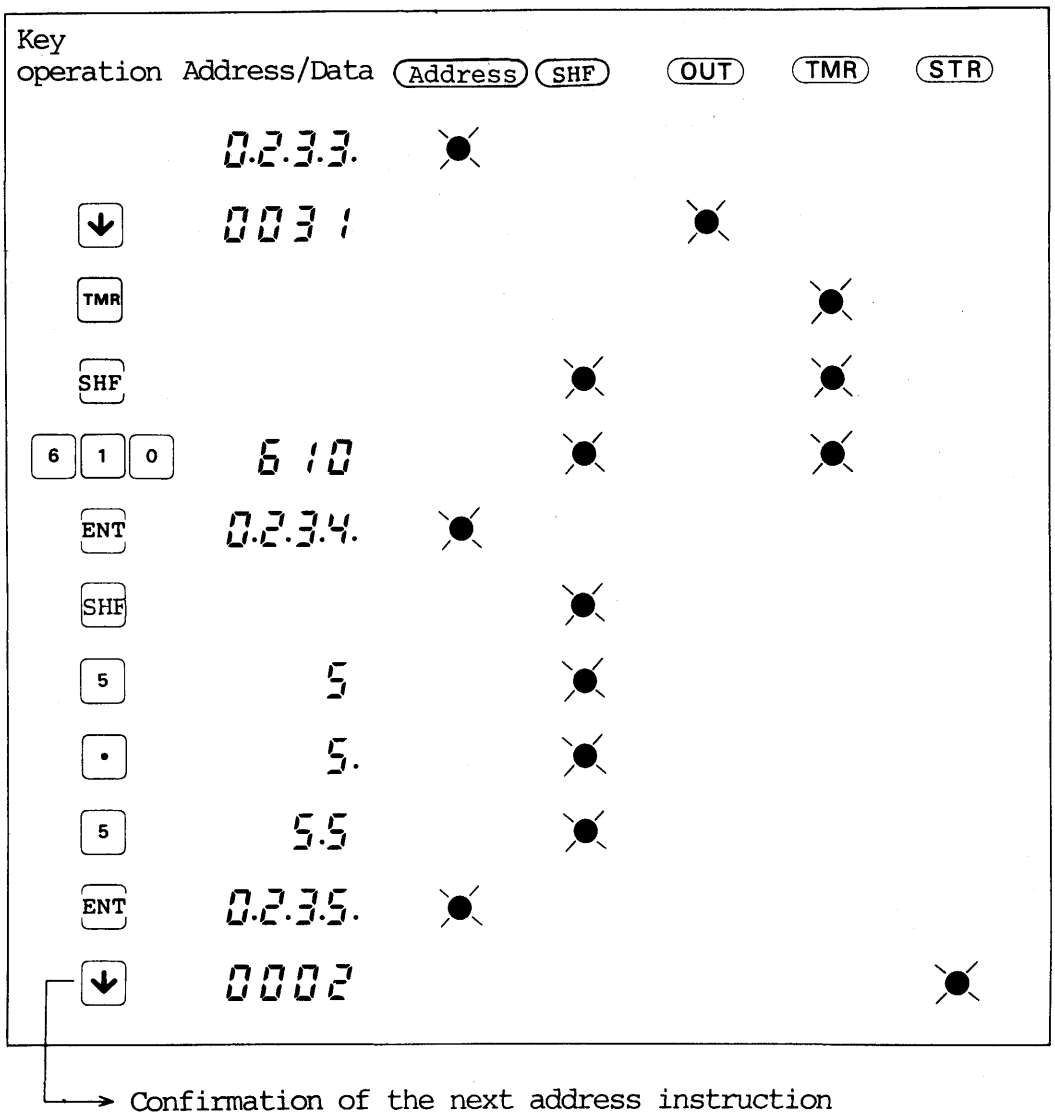
Address	Instruction	Data	Instruction	Data	
231	STR	10	STR	10	
232	AND	11	AND	11	
233	OUT	31	TMR	610	Two-word instruction
234	STR	2		5.5	
235	OR	20	STR	2	Move this backward for one word
236			OR	20	

CAUTION:

- A timer/counter coil instruction is a two-word instruction. It is necessary to set numbers of seconds or counts as shown above. Be sure not to forget the setting. If this setting is missing, it is regarded as 0 and the condition is satisfied immediately.
- Rewriting to a timer/counter instruction is impossible where there is no vacant address space available because the program has already occupied all available addresses before rewriting. If rewriting to a timer/counter instruction is attempted where there is no vacant address space, error code E11 will be displayed to indicate that no vacant address space is available.

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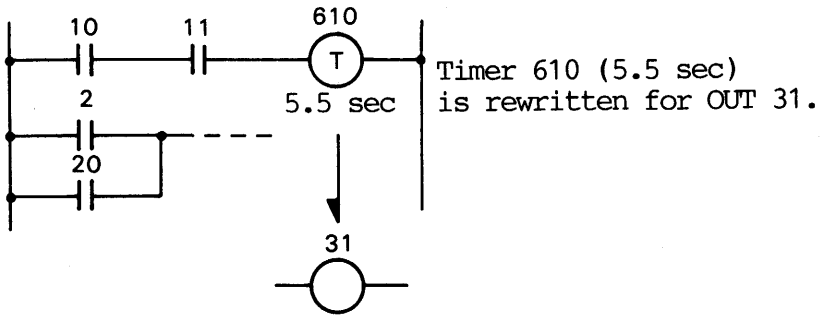
Writing procedure for the previous example



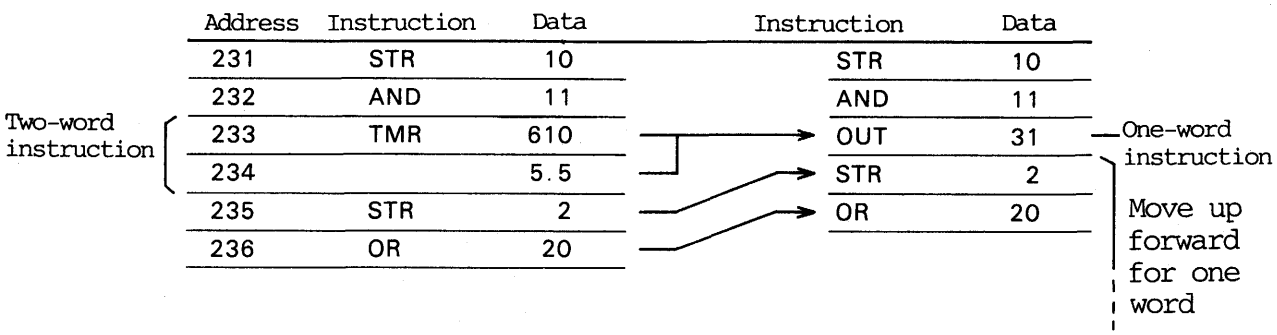
To rewrite a timer/counter coil instruction to an ordinary output instruction

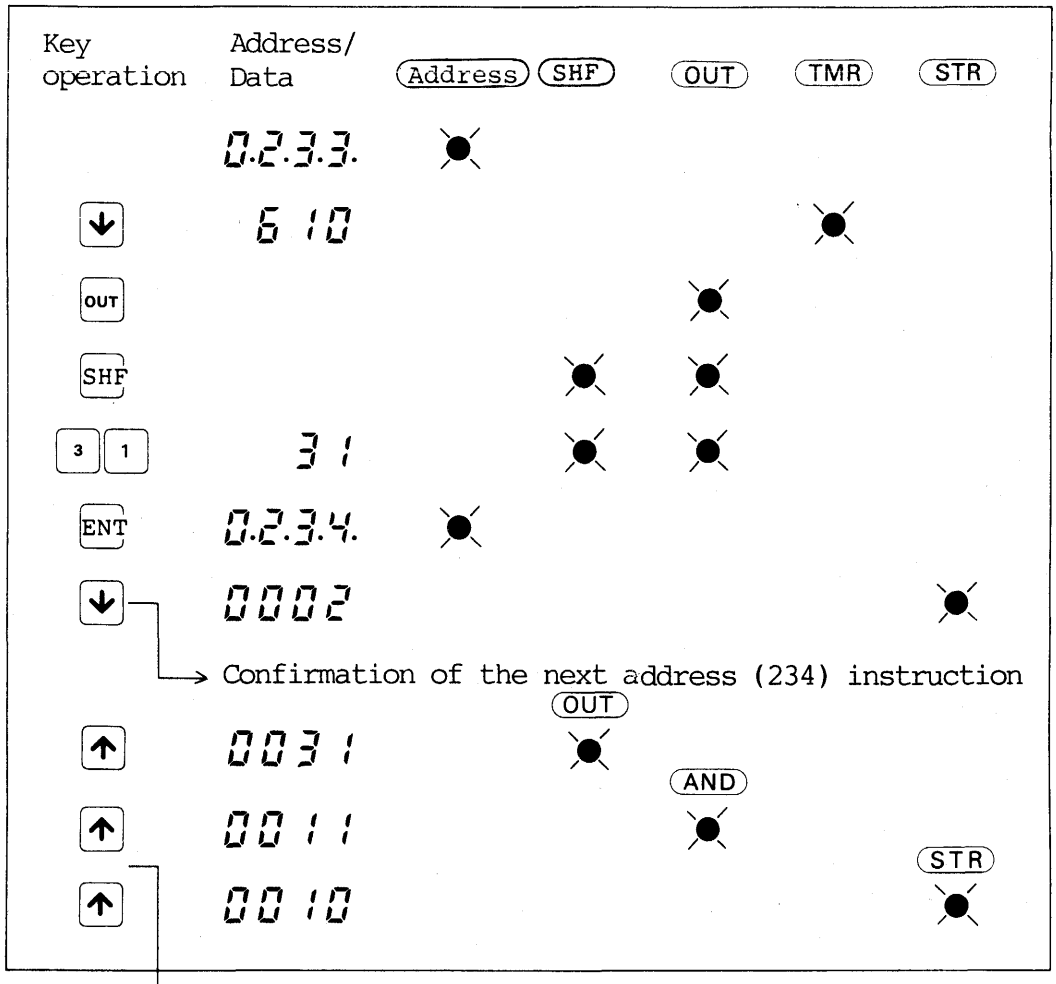
A timer/counter coil instruction is a two-word instruction. Rewriting to an ordinary output instruction, which is a one-word instruction, causes a vacant address space to be made. This vacant address will not be left opened. Because the instruction in the next addresses will be moved up forward automatically when a rewrite operation is made.

Example:



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8-3. Rewriting of the timer/counter set value during RUN: RUN mode

Rewriting of the program during RUN is possible only for the timer/counter constant set value.

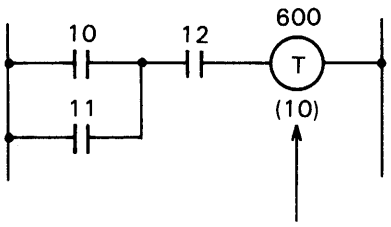
The operation procedure is as follows.

(1) Read out the timer/counter coil instruction to be rewritten by the method to read out the instruction.

(2) Display the second word (set value) of the instruction.

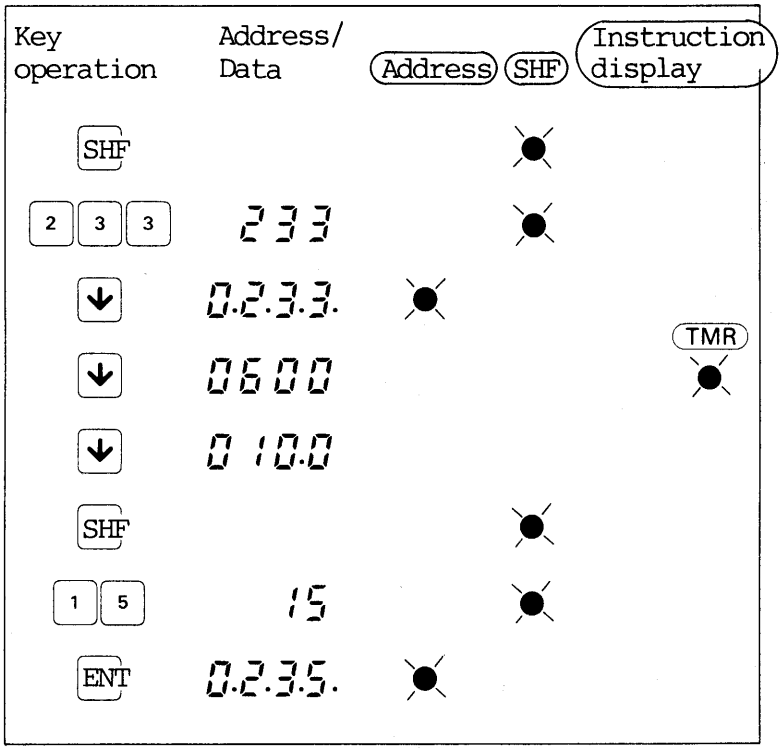
(3) Rewrite a data into a new set value.

Example:



Change from 10 sec to 15 sec.

Address	Instruction	Data
230	STR	10
231	OR	11
232	AND	12
233	TMR	600
234		10



Caution:

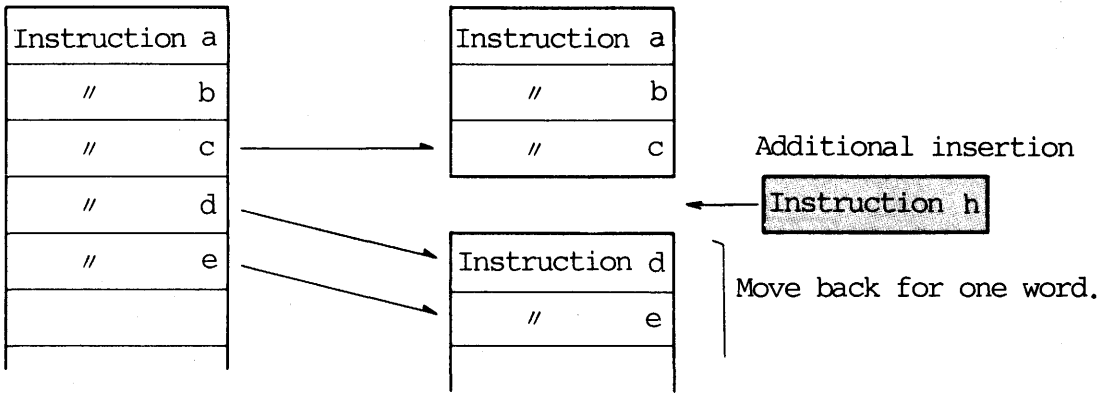
(1) If the set value is rewritten into a value smaller than the accumulated value at that time, the timer/counter output contact will be immediately ON.

(2) In reverse the output contact will not be OFF even if the set value is rewritten into a larger value than the accumulated value at that time.

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9. PROGRAM INSERTION: PROGRAM MODE

It is possible to insert a new instruction in the middle of the completed program. To do this, all addresses for additional insertion and the instructions to be written thereafter must be moved back one or two words to provide a blank address for program insertion. This kind of movement in series will automatically be made whenever the operation for insertion is made.



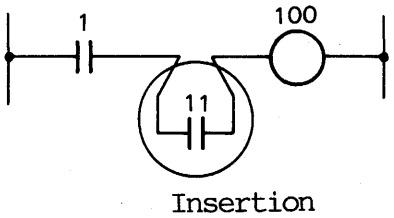
9-1. Operation procedure for insertion

(1) Setup the desired address for interrupt insertion, and display the instruction according to the procedure for read operation, section 11 (Page C-33) of this manual.

(2) Setup the instruction and data to be inserted according to the procedure described in the method for instruction setup, section 6, of this manual.(Not for writing)

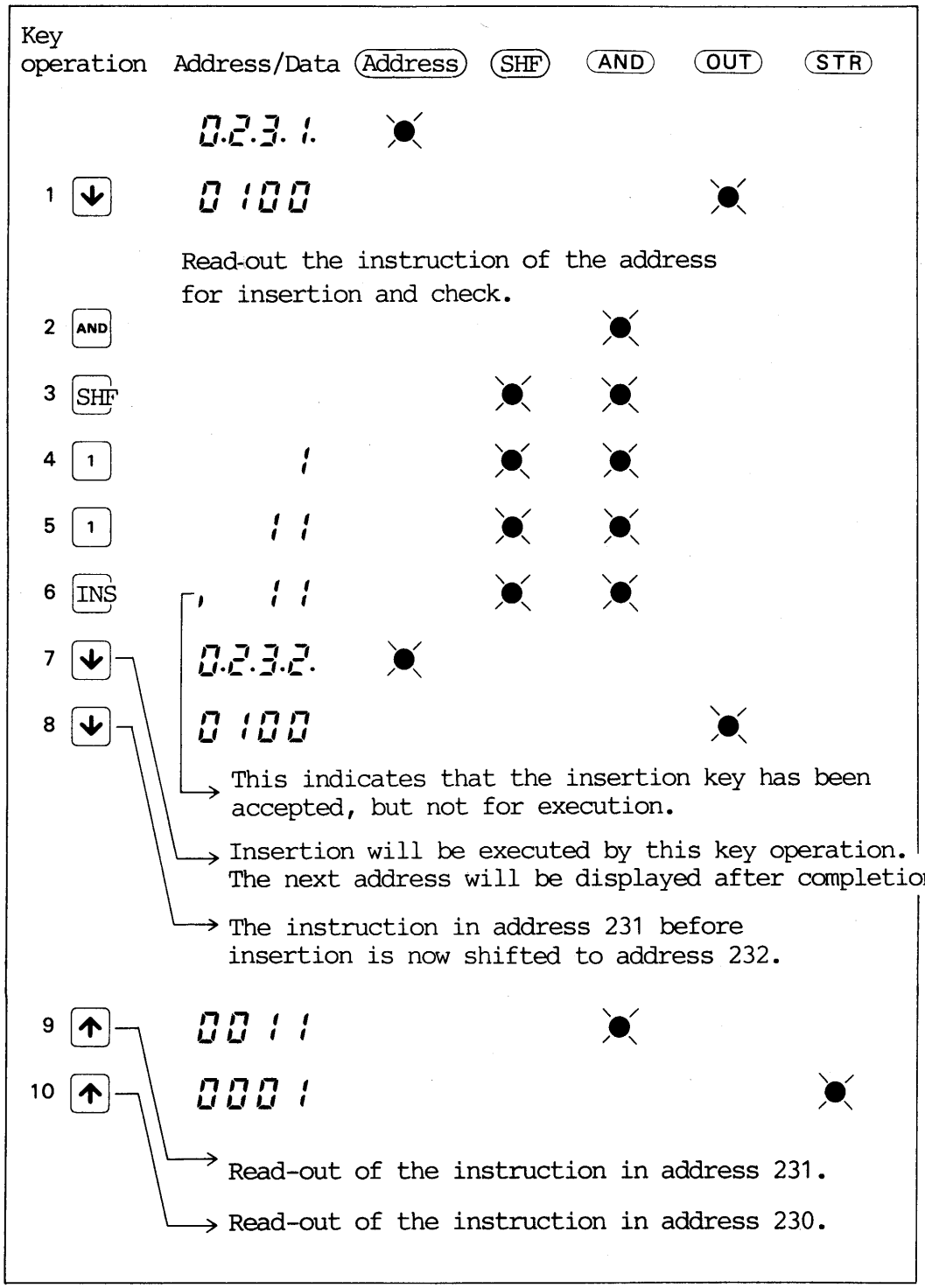
(3) Depress the [INS] key first, and then the [↓] key for insertion. This causes the next address to be displayed.

Example:



Address	Instruction	Data		Instruction	Data	
230	STR	1		STR	1	
231	OUT	100		AND	11	← Insertion
232				OUT	100	

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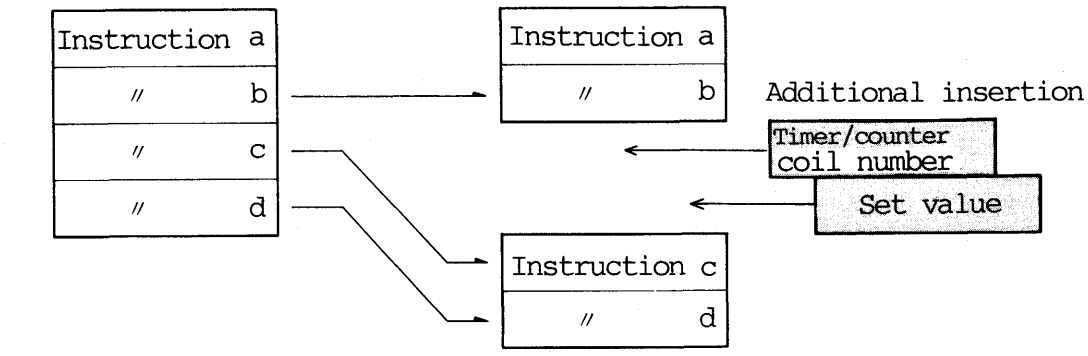
Note:

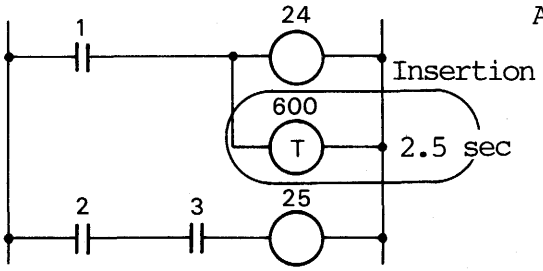
The operation of insertion is completed in the above procedures from 1 to 7. The procedures from 8 to 10 are for checking to see if insertion is made. These procedures may be omitted.

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9-2. Operation procedure of two-word instruction insertion

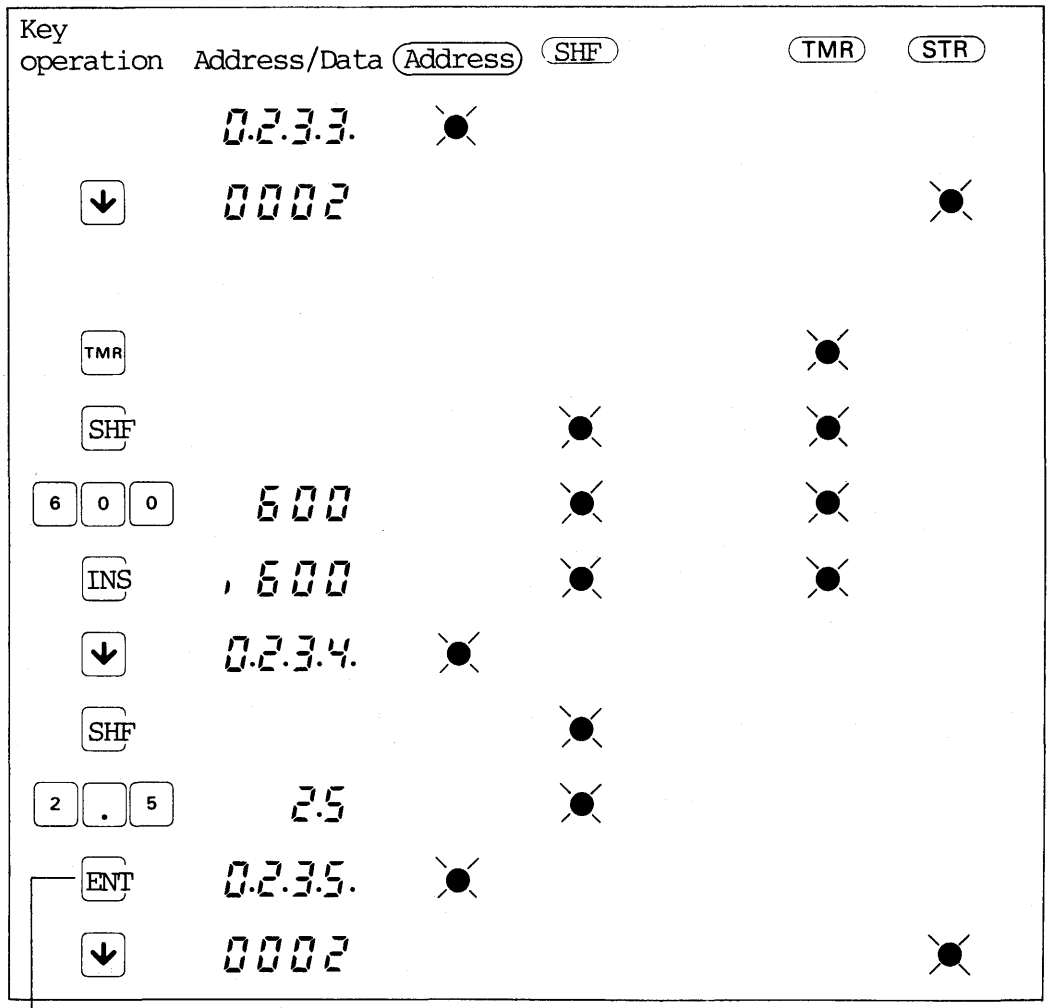
The timer/counter coil instruction is the two-word instruction.
If the inserting operation is made, a space for two words will be prepared for these and the timer/counter coil instruction will be inserted here.





Address	Instruction	Data	Instruction	Data
231	STR	1	STR	1
232	OUT	24	OUT	24
233	STR	2	TMR	600
234	AND	3		2.5
235	OUT	25	STR	2

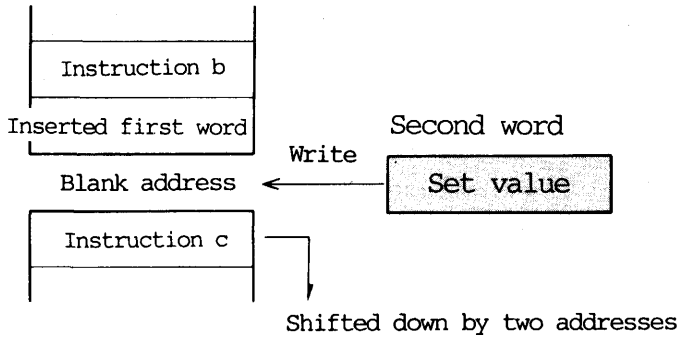
Two-word insertion



→ Note: The second word (set value) is not for insertion, but for writing.

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Caution:
The timer/counter coil instruction is the two-word instruction and consists of the unit number of the timer/counter and the set value.
When the insertion of the two-word instruction is made, the program in the memory will be shifted down two addresses after the inserted address by the inserting operation of the first part of the unit number.



For this operation, the location to write the second word (set value) of the timer/counter coil instruction will be the blank address.
Writing, but not insertion, will then be made.

- If the INS ↓ key operations are made by mistake for writing, the set value will not be written and the zero setting will be made.
- Be sure you make no error by reading the inserted instruction for insertion.

It is necessary to have enough margin in the memory address for insertion.
When the inserting operation is made, the programs after the address inserted will be shifted down one or two addresses. For this operation, it is necessary to have enough margin for inserting at least one or two addresses into the program memory (blank address without any program).

If the blank address is not available and the inserting operation is made, error code E11 will be displayed, but the inserting operation is completed and the instruction written in the last address of the program before the inserting operation will be moved out from the memory area.
To return to the original condition, delete the inserted instruction so that the rest of the instruction will be shifted up and that the instruction moved out and erased can be rewritten again.

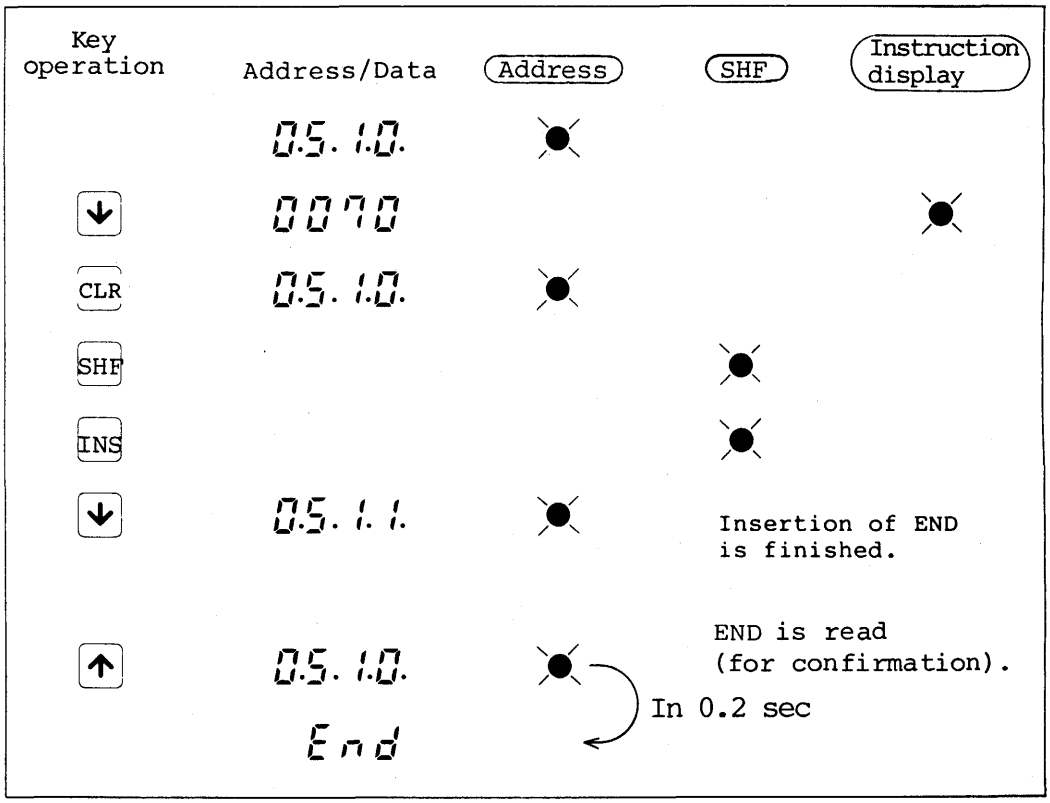
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9-3. Insertion of END

It is important that the SR-21 program must be continued to the end without having a blank address in the middle because the program is designed to immediately return to address 0 of the memory whenever the blank address is detected during the program execution to increase the processing speed.

If the blank address is given in the middle of program, the programs before it will be executed, but those after it will be ignored. Therefore, END (NOP for blank address) should be given when the rest of the programs after some point are not needed or are needed to be inhibited temporarily.

Example: Insertion of END in address 510



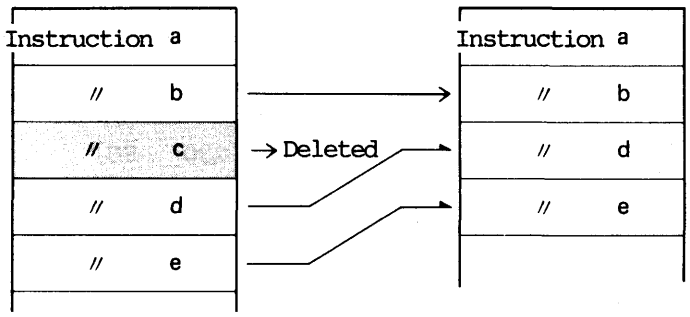
When the insertion of END is completed, be sure to confirm by reading. When the ↑ key is depressed, the address with END written will be read out. Since this address is blank, the address display will be made first and the character of END will be displayed about 0.2 sec later.

For removing the inserted END, process by the deletion operation explained in the next chapter.

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10. METHOD OF PROGRAM DELETION: PROGRAM MODE

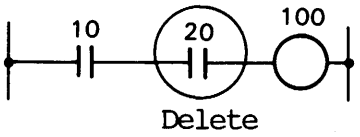
This is to delete the unnecessary instructions from the written program. If NOP is given in the middle of program for SR-21, the portion for such writing will be taken as the END of the program, and the rest of the programs after END will be ignored.
For this feature, the deletion of an unnecessary command will cause the programs to move up in order to fill up the blank address, as shown below.



10-1. Method of deleting operation

(1) Search and display the instruction (refer to the method of searching).
(2) Depress the DEL key and ↑ key for making deletion.

Example:



Address	Instruction	Data
230	STR	10
231	AND	20
232	OUT	100

→ Delete

Instruction	Data
STR	10
OUT	100

Key operation	Address/Data	Address	AND
	0.2.3. 1.	●	
↓	0020		●
DEL	d020		●
↑	0.2.3. 1.	●	

When the DEL key is depressed, d will be displayed in the fourth digit of the data display unit to show that the display key operation is accepted. Yet it is possible to cancel the deleting operation at this stage by depressing the CLR key.

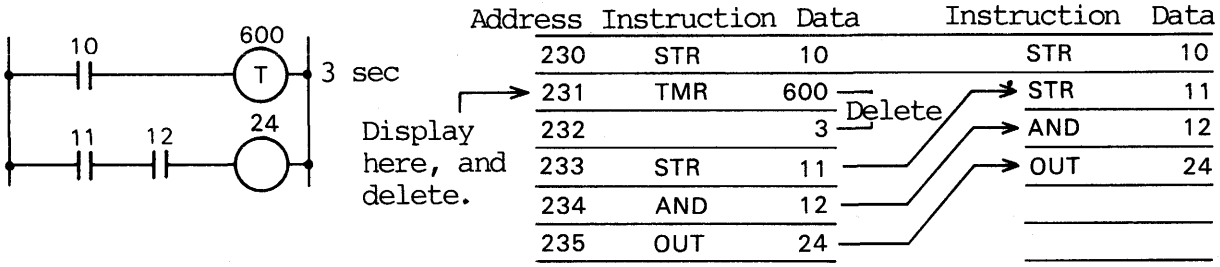
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10-2. Deletion of timer/counter and shift register instructions

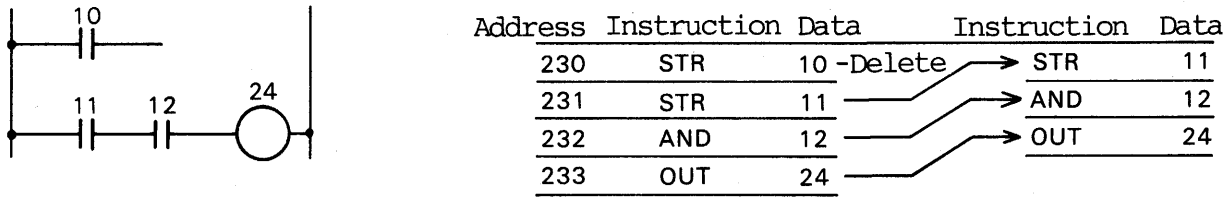
The timer/counter coil instruction and the shift register instruction are the two-word instructions. Because of a two-word instruction, rest of the programs after the deletion of the timer/counter coil instruction will be moved up by two addresses. For deleting the timer/counter coil instruction, display the first word (a unit number is displayed). Deletion will not be made even for the deleting operation by displaying the second word (set value).

Example:

Procedure 1: To delete timer 600



Procedure 2: To delete STR 10 since this is left yet



10-3. Deletion of blank address (END)

The blank address (NOP) in the middle of the program has a meaning to END the program so that the programs after END will not be executed.

For this function, NOP is not used for the regular method of program preparation. But it is possible to insert NOP as the END signal in the middle of a program after completing the program. (Refer to section 9-3 for inserting END.)

The END signal (NOP) inserted for this purpose can be deleted by the deleting method mentioned in this section.

(1) Search the address of END signal, and display END in the display unit of data.

(2) If [DEL] key is depressed, dEnd will be displayed.

(3) Depress the [↑] key to finish the deleting operation.

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11. METHOD OF READING OPERATION: PROGRAM/RUN MODE

This is the method to read out the instruction written into the program memory.

11-1. Read-out operation procedure

- **General read-out operation**

(1) Set and display the address needed to be read-out according to the procedure explained in the method of memory address setting 5.(Page C-9)

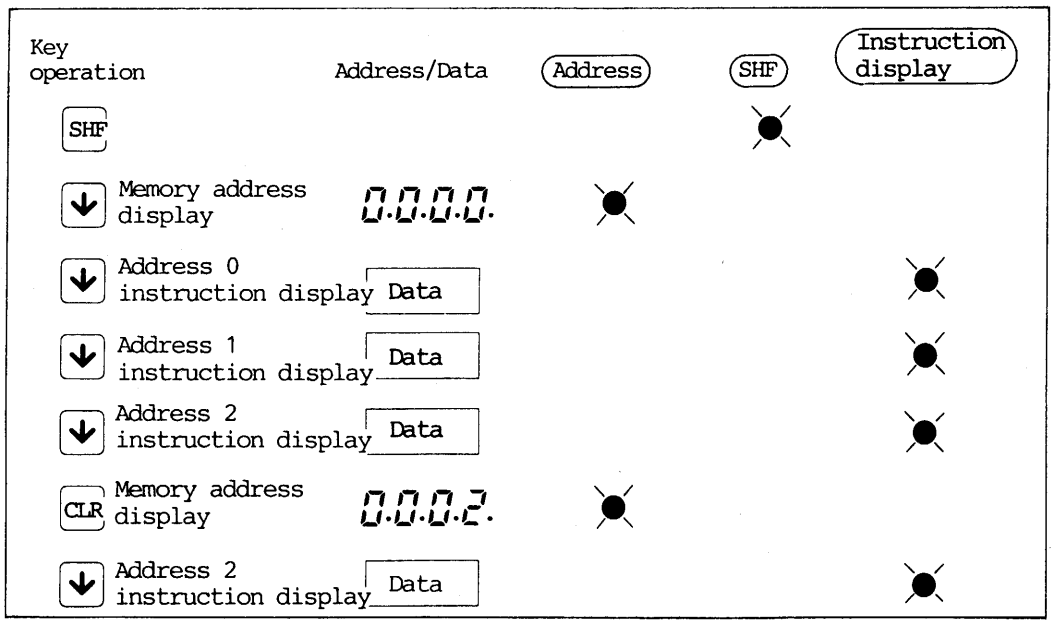
(2) When the [↓] key is then depressed, the display will be switched to the instruction display.

(3) When the [↓] key is depressed in succession, one will be added to the address number, and the instruction of that address will be displayed.

(4) When the [↑] key is depressed, one will be subtracted from the memory address number and the instruction of that address will be displayed.

(5) Whenever the [↓] key or [↑] key is depressed, one address number will be added or subtracted for each depression of the key, and the program instruction can be read in succession, but the memory address where the instruction is written will not be displayed.
Depress the [CLR] key to find the memory address, then it will be displayed. Depress the [↓] key for returning to the instruction display. In this case, one will not be added to the address number and the instruction of the address shown before the [CLR] key will be shown.

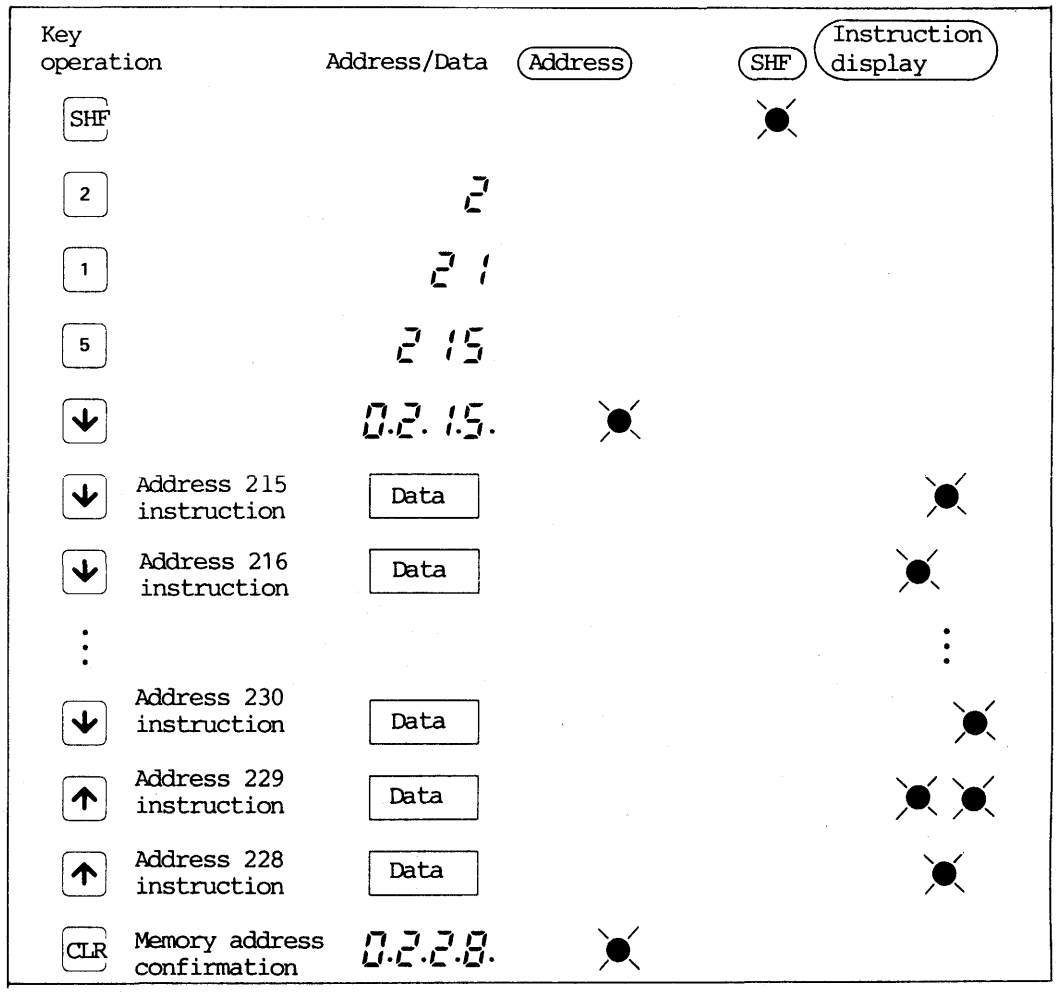
Method to read-out from the first address 0000 of program memory



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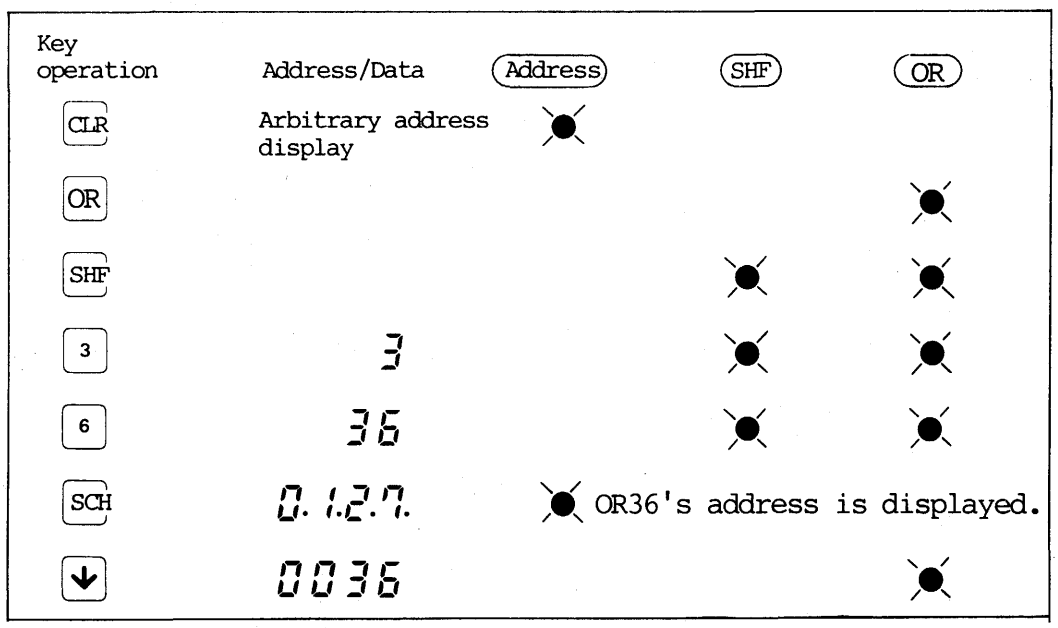
Reading from the middle of program

(a) When the address is known. Example: Reading of address 215



(b) When searching for a desired instruction display.

Example: Searching OR36



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Reading at the END of the program

By depressing the [↓] key, it becomes possible to read out the programmed instructions in order. When the reading of the last instruction of a program is completed, the next address will be blank because of no instruction. Then the method of display on the surface of the panel will be changed as follows to show that the program has been completed.

(1) Display of the last instruction of program (blank in the next address).

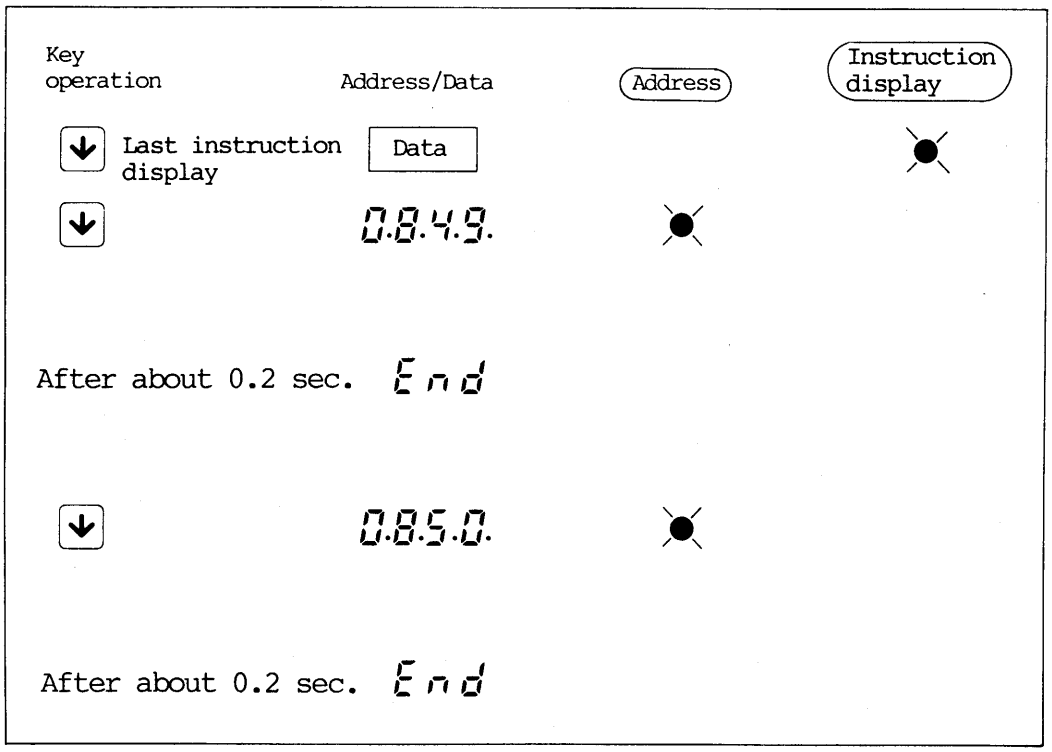
(2) The address display will be changed by the operation of the [↓] key operation. The number of the blank address will be displayed for about 0.2 sec.

(3) The display of the blank address will be extinguished, and the character END will be displayed.

(4) If the [↓] key is depressed again, the blank address added by one to the previous address number will be displayed for about 0.2 sec, then the character END will be displayed.

(5) Whenever the [↓] key is again depressed, operation (4) will be repeated.

(6) If the [↑] key is depressed, the address subtracted by one from the previous one will be displayed for about 0.2 sec, and the character END will be displayed.



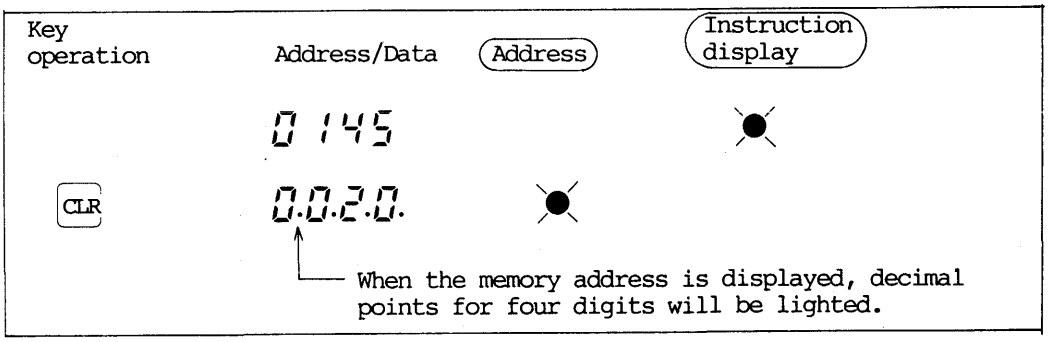
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11-2. Switching of display

The display of R-21P cannot put up two displays at the same time, both the instruction and the memory address containing the instruction. The display must be for only one item. Switching of the display can be done by the CLR key and the ↓ key.

Switching of display from instruction to memory address

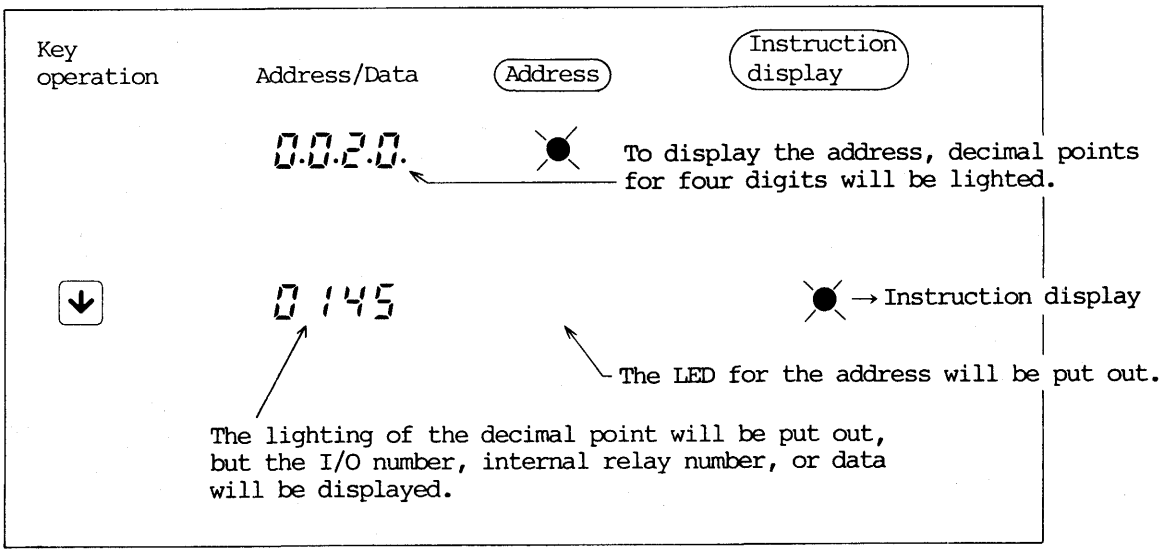
When the CLR key is depressed, the display of the memory address will be given.



The CLR key can be depressed repatedly.

Switching of display from memory address to instruction

When the ↓ key is depressed, the display of the instruction will be given.



Caution:

When the ↓ key is depressed, the display of the memory address will be changed to the display of the instruction. If the ↓ key is depressed once more, it causes the memory address to be added by one automatically to display the instruction of the next address.

To return to the original address of the instruction, depress the ↑ key.

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12. SEARCHING OF INSTRUCTION: PROGRAM/RUN MODE

This instruction search operation is used to search for a instruction's unknown memory address in the program memory.

Instruction that can be searched for are

(1) Instruction

(2) Input/output contact, internal relay contact, and timer/counter contact

12-1. Searching operation procedure for instruction

(1) Set up the instruction to be searched for by the following procedure:

□□□ Instruction (Either a single or combined instruction is possible)

SHF

□□□ Data

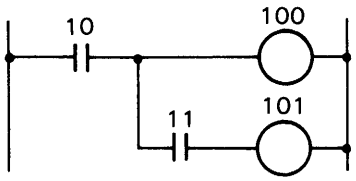
} Same procedure for the instruction setting

(2) Depress the SCH key so that the address with the instruction will be displayed.

(3) Depress the ↓ key to check if the correct instruction has been found.

(4) Depress the CLR key so that the address with the instruction will be displayed again.

Example: Searching for OUT100 for the following diagram



Address	Instruction	
230	STR	10
231	OUT	100
232	AND	11
234	OUT	101

Key operation	Address/Data	Address	SHF	OUT
OUT				●
SHF			●	●
1	1		●	●
0	10		●	●
0	100		●	●
SCH	0.2.3.1.	●		
↓	0100			●

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Operation when using plural numbers of the same instruction

Plural numbers of the same instructions except the output instruction may be used. The first instruction written in the program will be searched for by the searching method mentioned above.

In the following operations, searching of the same instruction will be continued in succession.

(1) Search the first instruction to display.

(2) Whenever the SCH key is depressed, the memory address of the same instruction written in the next location will be displayed.

(3) Whenever it is again depressed, the memory addresses of the same instruction in the different locations will be displayed in order.

(4) If searching is continued to the end of the program, it goes back to the address zero to continue endless searching.

(5) If only one instruction exists in the program for searching and the SCH key is depressed again, searching will be made by going back to the address 0 because the second instruction is not found. The address display will be made for the address where the instruction is located.

When the instruction searched for is nonexisting

The search operation will be completed by displaying error code E99 if the instruction searched for is not present in the program.
E99 means that the instruction searched for does not exist.

Searching for an END signal

The grammatical check method will be used to search for an END signal inserted in the middle of the program.
The method of operation is as follows.

Key operation	Address/Data	Address
CLR	(Note)	✱
SCH	0.1.2.3.	✱
↓	End	

Note: The address display when the CLR key is depressed will depend on the previous condition before depressing the key.

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12-2. Method of searching for a contact

Besides the aforementioned method by the instruction, there is another method for searching by the contact number.

(1) Input/output contact
(2) Internal relay contact and shift register contact
(3) Timer/counter contact

Searching by the contact is an effective method when the keyed-in instruction is not known, because this needs only the contact number as the source of information.

Operation procedure

(1) Depress the SHF key.

(2) Depress the contact number to display it on the data display unit.

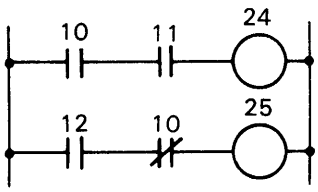
(3) Depress the SCH key to execute searching and to display the address.

(4) If the SCH key is depressed in succession, the address used by the same contact number will be displayed.

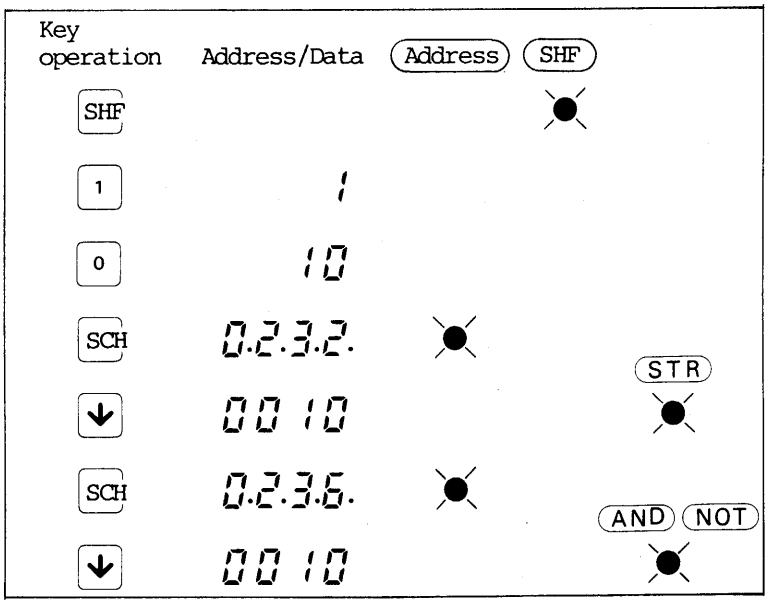
(5) If searching is continued to the last address, it will be the endless operation by continuing to search by returning to the address zero.

(6) Error code E99 will be displayed if the searched contact does not exist in the program.

Example: Searching of contact 10



Address	Instruction	Data
232	STR	10
233	AND	11
234	OUT	24
235	STR	12
236	AND NOT	10
237	OUT	25

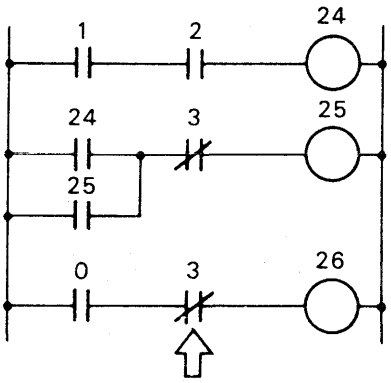


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12-3. Tips for searching

Because the same contact point instruction can be programmed for plural numbers, the operator may find it necessary to determine that the instruction searched for and displayed belong to the location of interest.
A method to find the exact instruction desired is to use an output instruction.
Since the output instruction cannot be used in duplicate, the operator has no chance of making an error because the directive output instruction exists in only one place.

Example



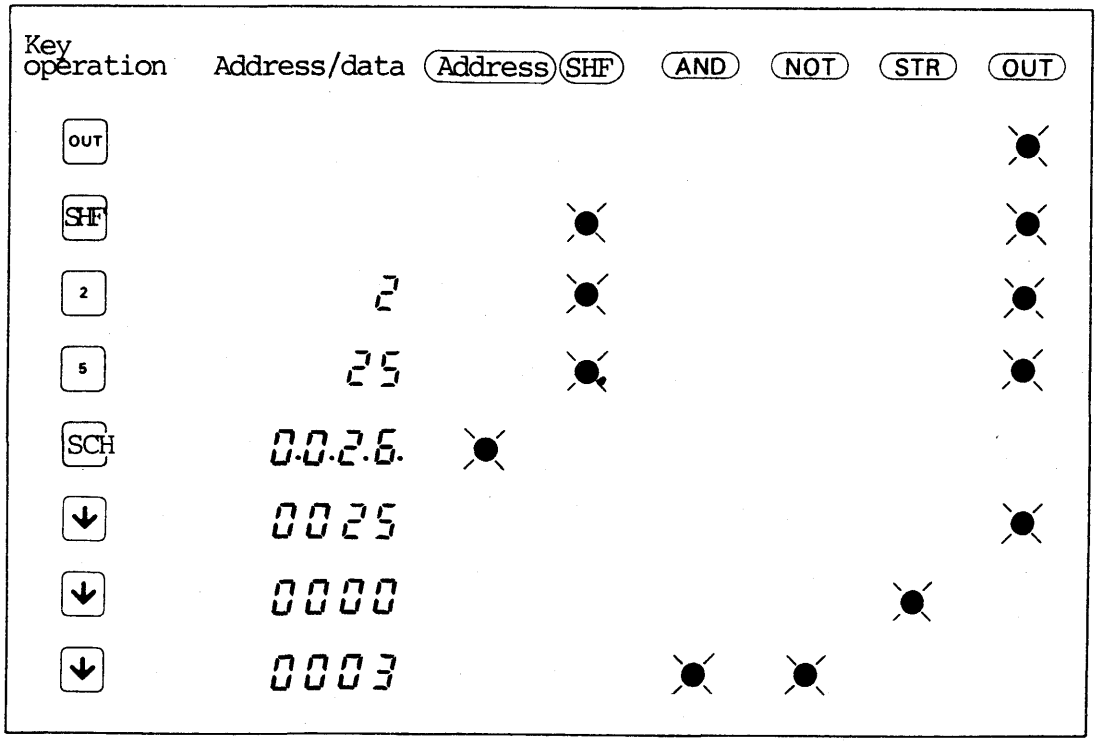
Searching for the command pointed to by the arrow

Address	Command	Data	
20	STR	1	
21	AND	2	
22	OUT	24	
23	STR	24	
24	OR	25	
25	AND NOT	3	
26	OUT	25	
27	STR	0	
28	AND NOT	3	◀
29	OUT	26	

Method of searching

(1) Depress the ↓ key to confirm the command searching for OUT25.

(2) Depress the ↓ key twice to display the desired command.



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13. GRAMMATICAL CHECK OF PROGRAM: PROGRAM/RUN MODE

A completed program will be checked for grammatical errors.
If any is found, an error code will be displayed.

13-1. Method of grammatical checking operation

(1) Depress the [CLR] key.
(2) Depress the [SCH] key to start searching.
(3) If no grammatical error is found, the search will be completed by displaying the address next to the last address in the program.
(4) If a grammatical error is found, an error code will be displayed.
(5) If the error is detected, depress the [CLR] key to display the address. And depress the [↓] key to display the instruction. Make correction (rewriting), since the erroneous instruction is read.
(6) Proceed with grammatical checking again when the correction is made for one location to check any other possibility of error.
(7) Any address may be displayed before grammatical checking, but address 0000 is recommended for address display before checking because the address to be displayed at the end of checking will be the address next to the last address of program. In this way the end of checking can be definitely known.

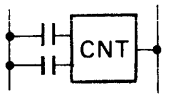
With other addresses, the operator may be confused since the address displayed when the check is completed is the one next to the last address in the program.

This is especially true when the check is made immediately after program-write operation because the operator will see that the address displayed at this time is the same as the one displayed at the end of the check.

To return to 0000 for address display, depress the [SHF] and [↓] keys.

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13-2. Table of grammatical errors

Error codes	Description of errors	Countermeasures
E02	I/O error Output instruction is used in input module number.	Remove the output instruction number or input instruction number for the correct number.
E03	Excessive use of stacks (AND STR, OR STR, MCS), more than nine times.	Correct the program to keep the number of stacks less than eight.
E05	Duplicate use of output coil, timer, and counter	Correct the program not to duplicate the coil number.
E06	Excessive number of MCR more than MCS	Keep the same number of MCS and MCR.
E07	 ← Missing of counter condition or shift register condition	Insert a condition in front of the counter instruction or shift register instruction.
E09	Process instruction line is disconnected. The circuit is not closed.	Check the condition before the detected process instruction, and correct the program.
E21	Parity error	Rewrite the instruction of the address.
E22	Password abnormality	Delete the password by depressing the CLR CLR keys for registration.

13-3. Circuit to get error and the countermeasure

(1) E02 Error

There is no program to write output instruction to the number assigned for the input module. Thus, the error display will be given at the address where the output instruction is read.

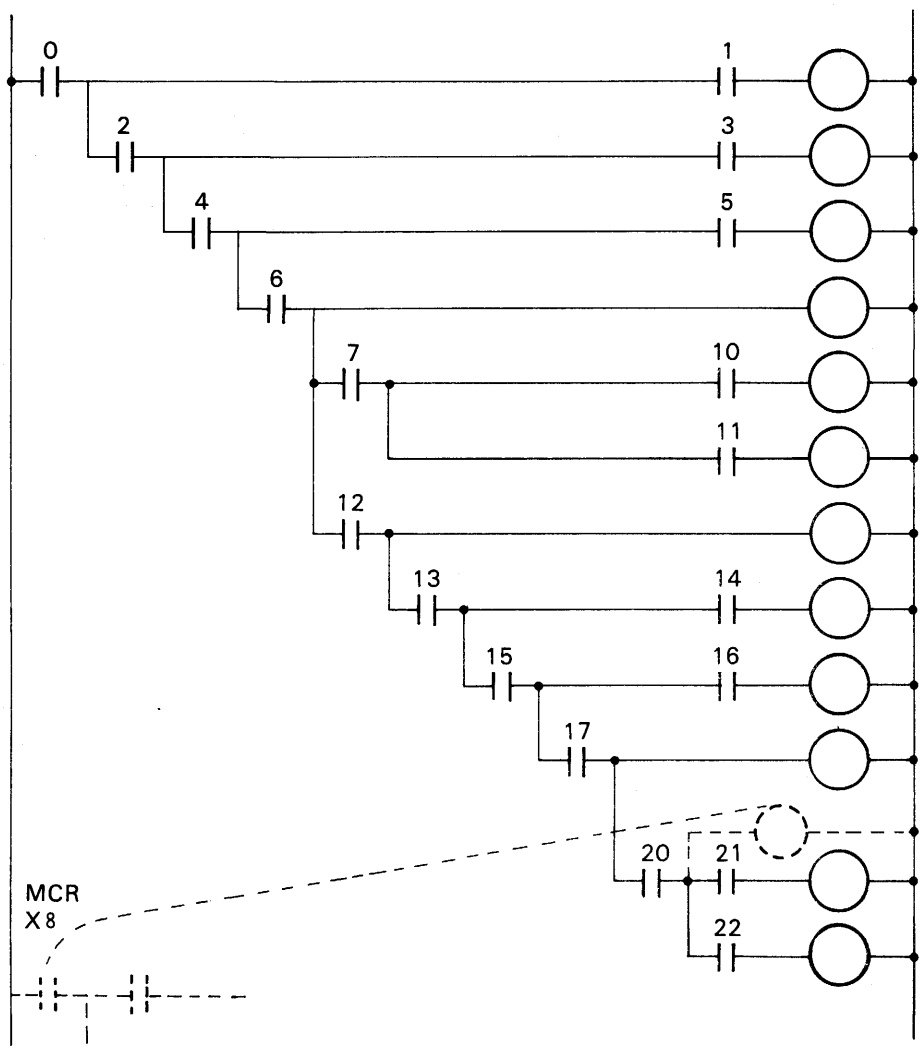
Countermeasure

- Read the program to check the output number. Rewrite the number in case of error.
- If the error is given in spite of the correct output number, check the location of the switch (connector) on the base or the connection of the expansion cable.

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(2) **E03 Error**

If more than nine MCSs are given, the error code will be generated for the nineth MCS.



	Depth of MCS
STR 0	0
MCS	1
STR 1	1
OUT	1
STR 2	1
MCS	2
STR 3	2
OUT	2
STR 4	2
MCS	3
STR 5	3
OUT	3
STR 6	3
MCS	4
OUT	4
STR 7	4
MCS	5
STR 10	5
OUT	5
STR 11	5
OUT	5
MCR	4
STR 12	4
MCS	5
OUT	5
STR 13	5
MCS	6
STR 14	6
OUT	6
STR 15	6
MCS	7
STR 16	7
OUT	7
STR 17	7
MCS	8
OUT	8
STR 20	8
MCS	9
STR 21	↑
OUT	
STR 22	
OUT	

E03 will be generated at this point.

Countermeasure: Operate the relay once under the condition of number 20 from the eighth power line, and write MCR eight times then to correct a circuit to the circuit of the condition with relay contact.

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(3) E05 Error

Cause: If coil (operation) instructions of output, internal relay, timer, and counter are programmed more than twice, E05 will be generated at the address of the second coil (operation) instruction. But the duplicate use of SET coil and RST coil instruction are accessible.

Countermeasure: Give a different number to the one of coils (operations) used twice.

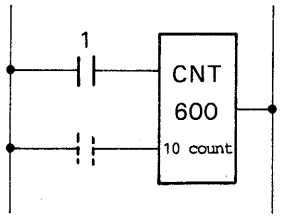
(4) E06 Error

Cause: MCR instruction is written in the unnecessary location.

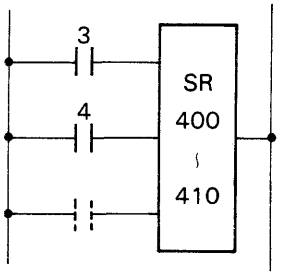
Countermeasure: Delete the unnecessary MCR instruction.

(5) E07 Error

Cause: Shortage of the number of conditions needed for the counter or shift register instruction.



STR 1
CNT 600
10
{ Add a condition

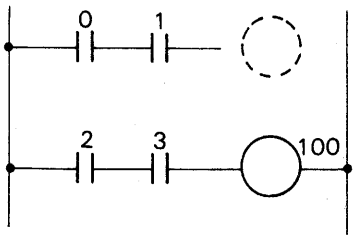


STR 3
STR 4
SR 400
410
{ Add a condition

Countermeasure: Add a condition.

(6) E09 Error

Cause: Excess conditions on the circuit. The output instruction or AND STR/ OR STR instruction may be missing.



STR 0
AND 1
} A coil instruction is missing in this condition.

STR 2
AND 3
OUT 100

Countermeasure: Correct the circuit by checking it.

(7) E21/E22 Error

Cause: The program memory is changed by some cause.

Countermeasure:
1. Rewrite the program.
2. Check the battery voltage (if the error is given when the power source is applied).
3. Check the base with the power supply (the base installed with the CPU).
4. Check the environmental condition for noise.

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14. OPERATION MONITOR: RUN MODE

While the PC is running, it is possible to read the panel to monitor the input/output, internal relay, shift register, and timer/counter ON/OFF status, and also the counter's accumulated value, CPU abnormality, and battery voltage abnormality on the panel of the programmer.

14-1. Input/output operation display

If the input and output numbers are specified, the input and output conditions in total of 16 points before and after these numbers will be displayed on the LED lamps.

Operation procedure:

(1) Depress [SHF] key and change to set the number.

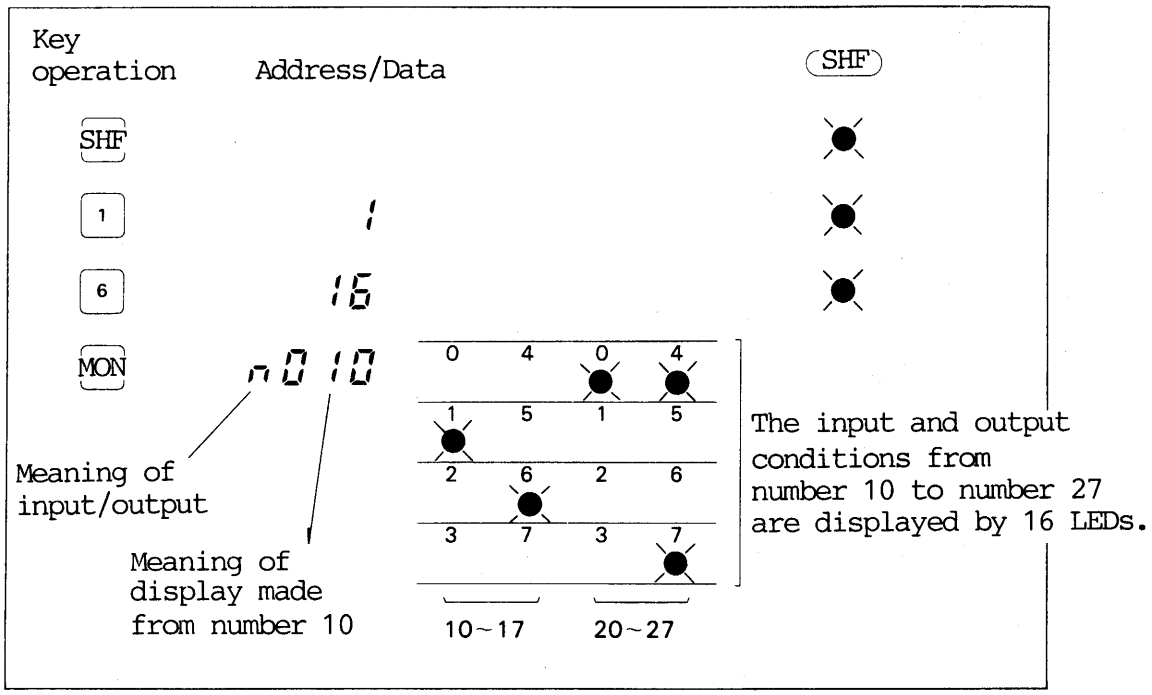
(2) Set the input/output number.

(3) If the [MON] key is depressed, it causes the monitor display to be made. Then the 16 input and output conditions will be displayed.

(4) If [↓] key is depressed, the display numbers will be increased in units of 10 and shifted.

(5) If [↑] key is depressed, the display numbers will be decreased in units of 10 and shifted.

Example: Monitoring of input number 16



The operation of [CLR] key will release the input/output monitor display.

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14-2. Switching of display range of 16 operation statuses

It is possible to display operation statuses of inputs and outputs as explained above by changing the number for display.

(a) Input/output: Number from 0 to 157

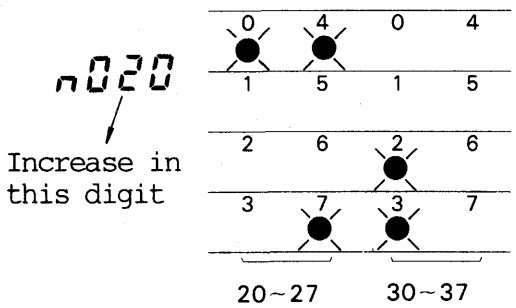
(b) Internal relay: Number from 160 to 377

(c) Shift register: Number from 400 to 577

Two methods are possible to change a range of display.

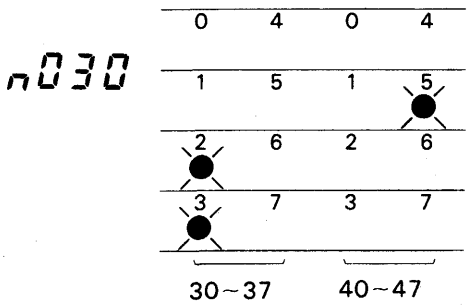
Changing method 1: Shift a range of display by depressing the ↓ key or ↑ key.

Example: If the ↓ key is depressed for the above example



Display of above numbers

If the ↓ key is depressed again



Display of above numbers

By this method it is possible to change a range of display in turn for numbers from 0 to 577, increasing by 10 (for 8 points).
If the ↓ key is depressed when the numbers reached a range of 570, the display will return to 0.
If the ↑ key is depressed, the number on the display will decrease and 570 will be shown after 0.

Changing method 2:

- Depress the CLR key for clearing the monitor display once.
- Set a new range of display according to the process of operations for monitor display. (Refer to the operation procedure mentioned above.)

The monitor display mode is kept in memory until the CLR key is depressed. The monitor display will become possible if the power is applied again or the mode switch is changed to RUN mode even after cutting off the power source or changing the mode switch to PRG mode.
Depress the CLR key for releasing the display from monitoring.

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14-3. Timer/counter accumulated value display

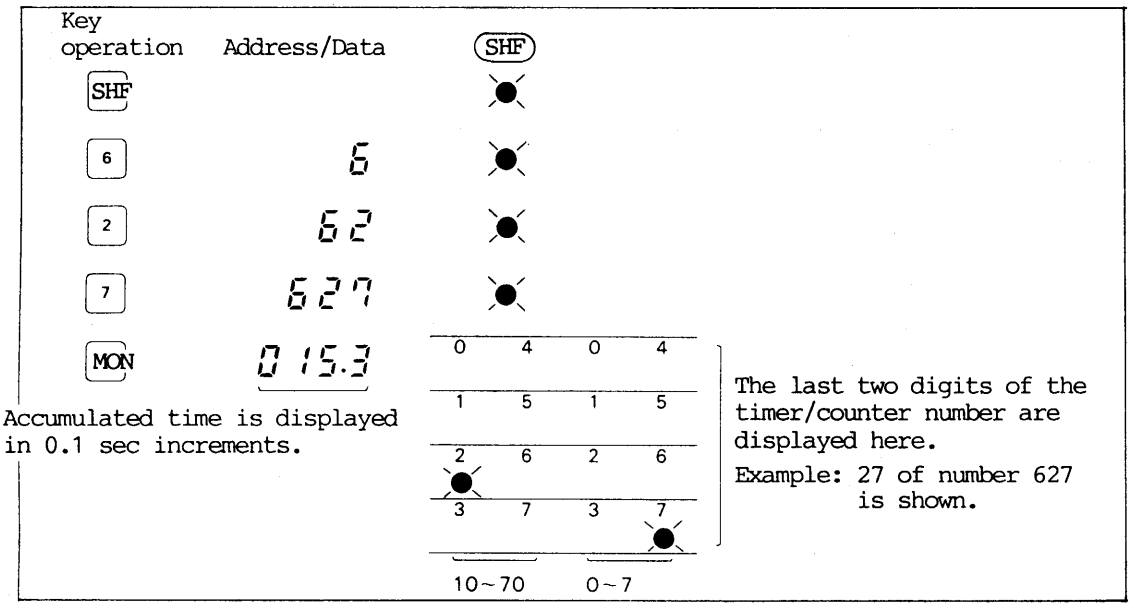
Operation procedure:

(1) Depress the SHF key to shift to number setting.

(2) Set up the desired timer/counter number.

(3) Depress the MON key to display the timer/counter accumulated value on the data display section.

Example: Displaying accumulated time of timer 627



(4) The displayed accumulated time changes in 0.1 sec increments up to 999.9 sec.

(5) With a counter, the data display shows the count value. Operating procedure and counter number display method are the same as for timers.

(6) To clear the monitor display, depress the CLR key.

● How to change the display number

Method 1:

(1) Display the desired timer/counter accumulated value according to the above method.

(2) The displayed timer/counter number will be increased by 1 if the ↓ key is depressed. Then the display will change to show the timer/counter accumulated value.

(3) If the ↓ key is depressed in continuation, the number display reaches 677 and returns to 600. The timer/counter display increases in such a way, showing 601, and showing 602 if the ↓ key continues to be depressed.

(4) Depressing of the ↑ key decreases the displayed timer/counter number in order.

Method 2:

(1) Depress the CLR key to clear the accumulated value display once.

(2) Display a new timer/counter accumulated value according to the operation procedure for displaying the timer/counter accumulated value.

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14-4. Displaying of the register content (4-digit number display)

First monitoring:

(1) Depress the [R#] key to specify the register number.
(2) Set the register number for monitoring.
(3) Depress the [MON] key to display the data content memorized in the register on the data display screen.

Consecutive monitoring:

(1) If the [↓] key is depressed during the register monitoring operation, the register content for the number added by 1 to the register number on display will be displayed.
(2) If the [↑] key is depressed during the register monitoring operation, the register content for the number subtracted by 1 from the register number on the display will be displayed.

Switching of the display from the date content to the register number

(1) If the [R#] key is depressed when the data content is on display, the register number on the process of monitoring will be displayed.
(2) If the [R#] key is depressed when the register number is on display, the data content of the register will be displayed.

Example: Displaying of the data content in order, starting from register number 400

Key operation	Address/Data	(R#)	(Data content)	
	0.0.0.0.			
[R#]		●		
[4]	4	●		
[0]	40	●		
[0]	400	●		
[MON]	1234		●	Data content display of R#400
[↓]	3456		●	Data content display of R#401
[↓]	5678		●	Data content display of R#402
[R#]	402	●		Register number display of R#402
[↑]	3456		●	Data content display of R#401

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14-5. ON/OFF status display

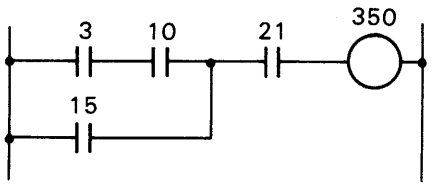
(1) Function

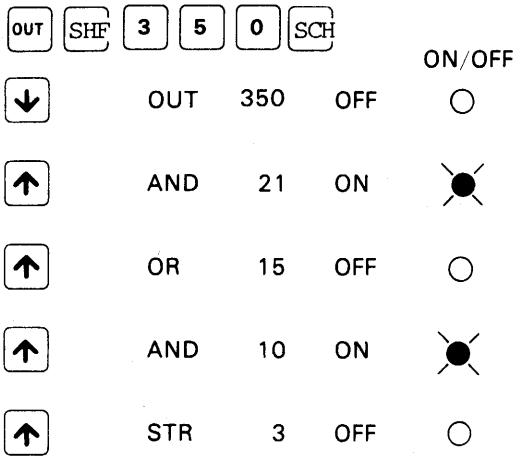
- If the program instruction is read out during RUN, the operation status of the function memory number specified by the instruction will be displayed.
- For the relay contact instruction and coil instruction of input/output, internal relay, and shift register, the display will be lighted if the coil of the specified number is ON and will not be lighted for OFF.
- For the contact and operation instruction of the timer/counter, the ON/OFF status display will be lighted if the condition of the operation instruction is satisfied and will not be lighted for the rest.
- For the contact instruction of the drum sequencer of the counter, the ON/OFF status display will be lighted only when the contact is ON status. (But the ON/OFF display will not be made if the set value of the drum sequence contact is the register number.)
- For the shift register instruction, the display will be lighted if the top of the register (the number for the first word) is ON and will not be lighted for OFF.

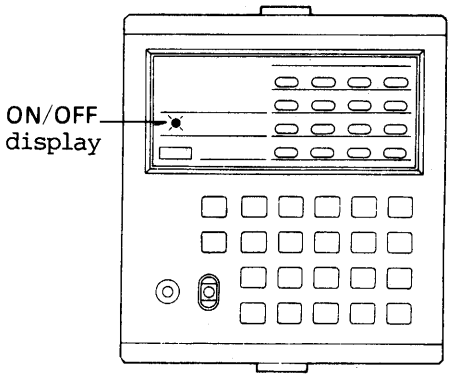
(2) Operation

Reading-out of the instruction by some method during RUN.

Example:







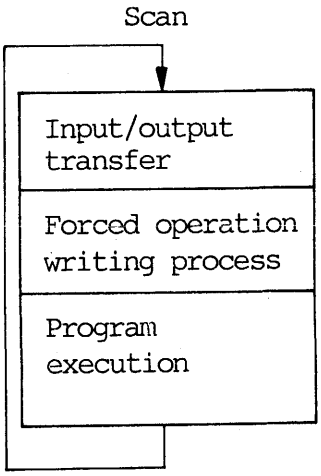
The ON/OFF status of internal relay 170 can be checked.
If it is OFF, it is possible to check which contact is OFF.

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15. FORCED OPERATION: RUN MODE

15-1. Movement for the forced operation

For the forced operation, besides the writing into the function memory by the execution of the program instruction, another execution will be made even by the writing operation for once directly into the function memory from the programmer.



When the forced operation is made, the writing operation into the function memory after transferring input/output will be made only once, depending on the operated content.

Thus the function memory written by the forced operation will be changed by the result of the later program execution or input transfer.

Item	Operation
Forced SET/RST into the input	After one scan of the forced ON/OFF operation, the operation will be made according to the input condition.
Forced SET/RST to the output Forced SET/RST to the internal relay Forced SET/RST to the shift register	● The status of the forced operation will be retained if the coil instruction is not programmed. ● The status of the forced operation of writing will be retained until the execution of the coil instruction, if the coil instruction is programmed. Then the operation will be processed according to the execution of the instruction. For the SET/RST instruction, the operation status written by the forced operation will be retained until the execution of the SET/RST instruction.
Forced SET/RST to the timer Forced SET/RST to the counter	● In the case of the forced operation of SET, the time-up or count-up status will be made whenever the accumulated value of the timer or counter reaches 9999. ● In the case of the forced operation of RST, the execution by the instruction will be processed after the accumulated value of the timer or counter reaches 0000.
Forced data writing into the register	The forced writing of 4 digits (16 bits) of BCD can be made into the register. The written data will be retained until the next instruction execution or the forced operation is made.

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15-2. Operation procedure of the forced SET/RST: RUN mode

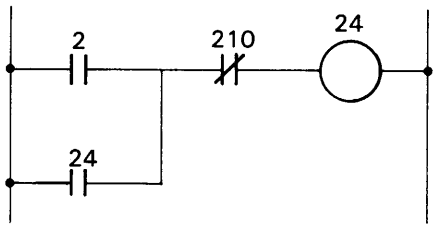
Operation procedure

Forced SET [SET] [SHF] [No.□□□] [ENT]

Only the number must be specified even for the forced operation to the timer/counter.

Forced RST [RST] [SHF] [No.□□□] [ENT]

For input/output and internal relay



Example 1: Forced SETting of input 2 of the above circuit

Key operation	Address/Data	SET	SHF
SET		●	
SHF		●	●
2	2	●	●
ENT	Address before the operation		

When input 2 of the above circuit is set by force, the scan will be made for ON of input 2, then OUT 24 will be ON if 210 is OFF.
On the case of this circuit, OUT 24 will continue to be ON until relay 210 turns ON and the condition is cut off because this circuit is self-retentive.
As far as this circuit is concerned, the result will be the same even if OUT 24 is set by force. If internal relay 240 is ON but the condition is not satisfied, the external output will not turn ON at all.

Example 2: Output 24 will be reset by force in the case of the above circuit.

Key operation	Address/Data	RST	SHF
RST		●	
SHF		●	●
2	2	●	●
4	24	●	●
ENT	Address before the operation		

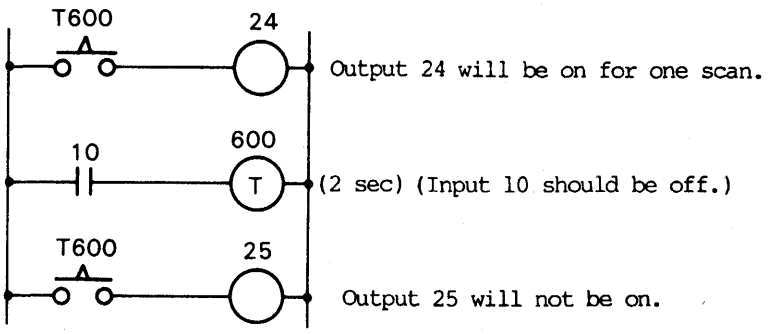
If output 24 is reset by force in the above circuit, output 24 will be OFF because the condition of OUT 24 is not satisfied if input 2 is OFF at that time.
In this case, if input 2 is ON and relay 240 is OFF, external output 24 will not be OFF at all.
If OUT 24 is ON in this circuit, the output will not be OFF even when input 2 is reset by force.

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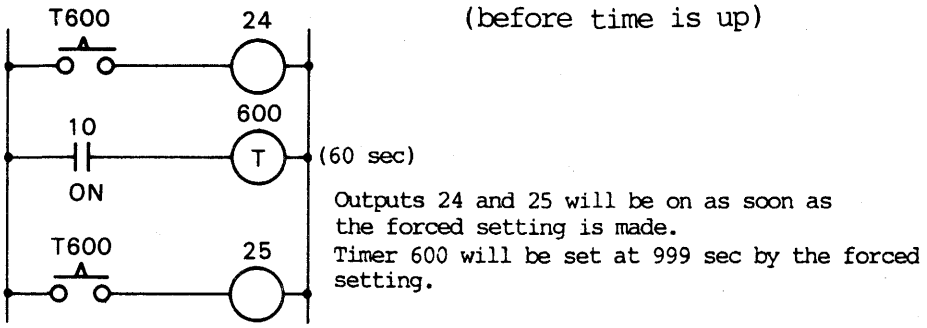
For timer

Example 1: Forced setting of timer 600 during OFF

The operation procedure is the same as with input.

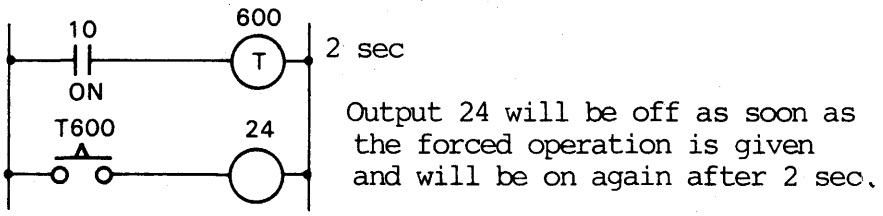


Example 2: Forced setting during the operation of timer 600 (before time is up)



Example 3: Forced resetting of timer 600 after time is up

The operation procedure is the same as with input.



If the timer is reset by force during the operation (regardless of timing if it is before or after time up), the timer will be reset at 0 sec once and will start counting again.

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For counter

1. Forced setting causes the counter to show 9999.
2. Forced resetting causes the counter to show 0000.
3. The result of the counter's forced operation is continual and will never return after one scan.
4. The operation procedure is the same as forced operation procedure for input/output, internal relay, and timer.

For shift register

1. The shift register bit will be ON by the forced setting. The bit to be turned ON will remain the same and will never be OFF after one scan, but will be normally shifted if the shift signal is given.
2. The shift register ON bit will be turned OFF by the forced resetting. The bit turned OFF will remain the same and will never be ON after one scan.
3. The operation procedure is the same as with input.

15-3. Forced data writing into register

Operation procedure:

Key in [R#] [□□□ Register No.] [MON] for monitoring the register data content.

Then key in [SHF] [□□□□ Data for writing] [ENT] to write in the data.

It is possible to write into all the register area by the forced writing.

Example: Writing of the following data from the register 400 to 404

Register No./ Data content

Register number	Data content
401, 400	1 2 3 4
403, 402	5 6 7 8
405, 404	9 0 1 2
407, 406	3 4 5 6

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Key operation	Address/Data	
R# 4 0 0 MON	0000	Data contents of R#401 and R#400 before writing
SHF 1 2 3 4 ENT	1234	Data contents of R#401 and R#400 after writing
↓	0012	Data contents of R#402 and R#401
↓	0000	Data contents of R#403 and R#402 before writing
SHF 5 6 7 8 ENT	5678	Data contents of R#403 and R#402 after writing
↓	0056	Data contents of R#404 and R#403
↓	0000	Data contents of R#405 and R#404 before writing
SHF 9 0 1 2 ENT	9012	Data contents of R#405 and R#404 after writing
↓	0090	Data contents of R#406 and R#405
↓	0000	Data contents of R#407 and R#406 before writing
SHF 3 4 5 6 ENT	3456	Data contents of R#407 and R#406 after writing

Note 1: It is necessary to write in every other register number in continuation because the data writing for the forced writing operation is made by 4 digits of BCD (2 bytes).
But for forced writing into the accumulated value of timer/counter, one data can be written into one number because one register of the accumulated value is equal to the data length of 4 digits.

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16. PASSWORD: PROGRAM/RUN MODE

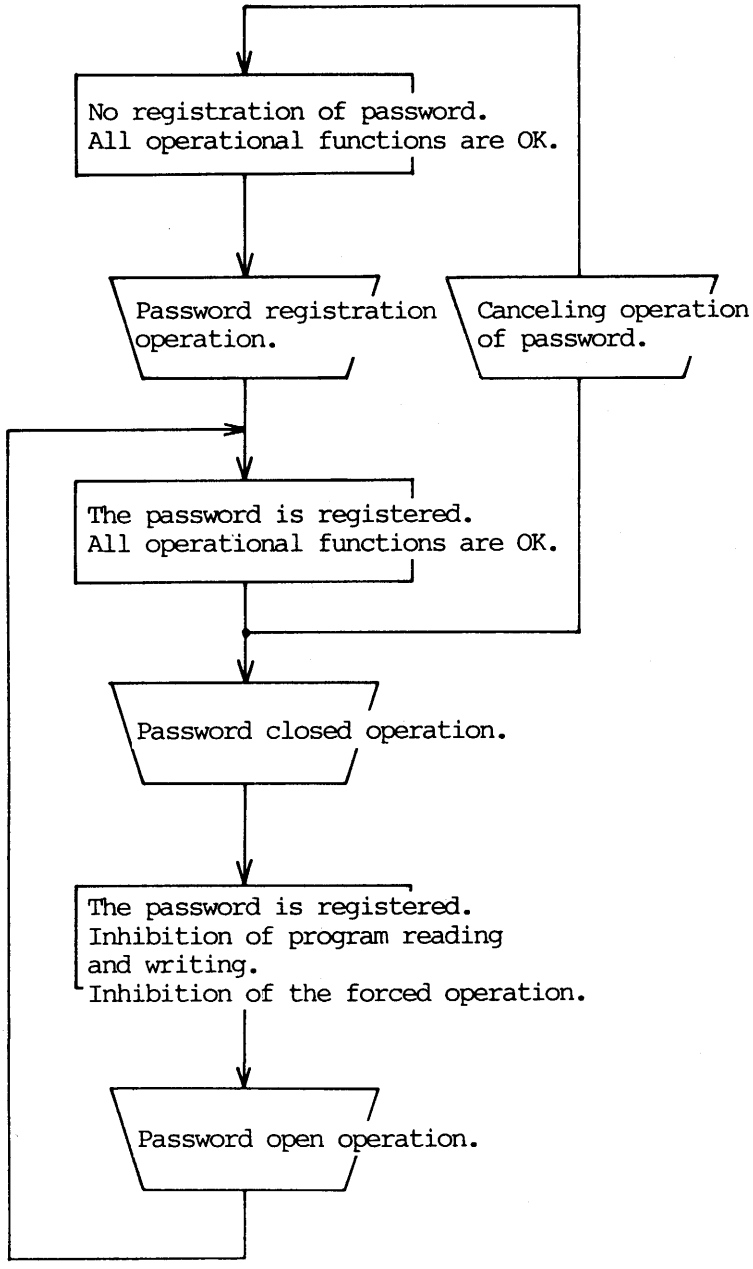
16-1. Password function

The password is prepared for the purpose of keeping the secret of the CPU program memory content. If it is not necessary to keep the secret, this section is not needed at all.

(1) How to use the password

During power failure under the password open condition, the password will return to the closed condition automatically whenever the power source is recovered.

(If the password is not registered, it will not be closed even when the power source is recovered.)



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- Operations to be inhibited in the case of the closed password
  (1) Complete erasing of the program memory
  (2) Reading of the program address and the instruction
  (3) Searching of the instruction and the contact
  (4) Program writing, rewriting, insertion, and deletion
  (5) Recording, playback, and comparison with the cassette tape
  (6) ON/OFF check monitoring
  (7) Forced operation
  (8) Grammar check

- Operations not to be inhibited in the case of the closed password
  (1) Switching of the operation mode
  (2) 16-point block monitoring
  (3) Timer/counter accumulated value monitoring
  (4) Register content monitoring

(2) Password function

- Password registration and cancellation

  The password is a function to keep the secrecy of program by memorizing a key code of BCD 4 digits in the CPU (SR-21) and by inhibiting operations related to the program unless the password is opened.
  The password can be freely registered at the beginning because it is not registered yet when the CPU is shipped (password = 0000). But if it is registered once, it will be retained unless the cancelling operation is processed. (Register the password for 0000 under the open condition of password.)
  For changing the password, register a different code of password under the open condition of password.

- Password opening and closing

  The CPU with the registered password is under the closed condition of password when the power source is turned on or after the closing operation of password.
  For starting the operation related to the program memory under the closed condition, it is necessary to process the password opening operation by the same registered password.
  For changing to the closed condition from the opened condition of password, process the closing operation of password or turn off the power source once.

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16-2. Password registration and cancelling operation: RUN/Program mode

Operation procedure:

Password registration [CLR] [SHF] [9] [8] [7] [6] [DEL] [SHF] Password [□□□□] [ENT]

Password cancellation [CLR] [SHF] [9] [8] [7] [6] [DEL] [SHF] [0][0][0][0] [ENT]

Example: Registration of password 1357

Precondition: When the password is not registered or open.

Key operation	Addrss/Data	SHF
CLR	0.0.0.0.	
SHF		●
9	9	●
8	98	●
7	907	●
6	9876	●
DEL	9876	●
SHF		●
1	1	●
3	13	●
5	135	●
7	1357	●
ENT		

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16-3. Password opening operation: RUN/Program mode

Operation procedure: CLR SHF 5 6 7 8 DEL SHF Password ENT

If the password set here is different with the registered password, the operation error (E-01) will be generated.

Example: Opening of the CPU with password 1357 registered.

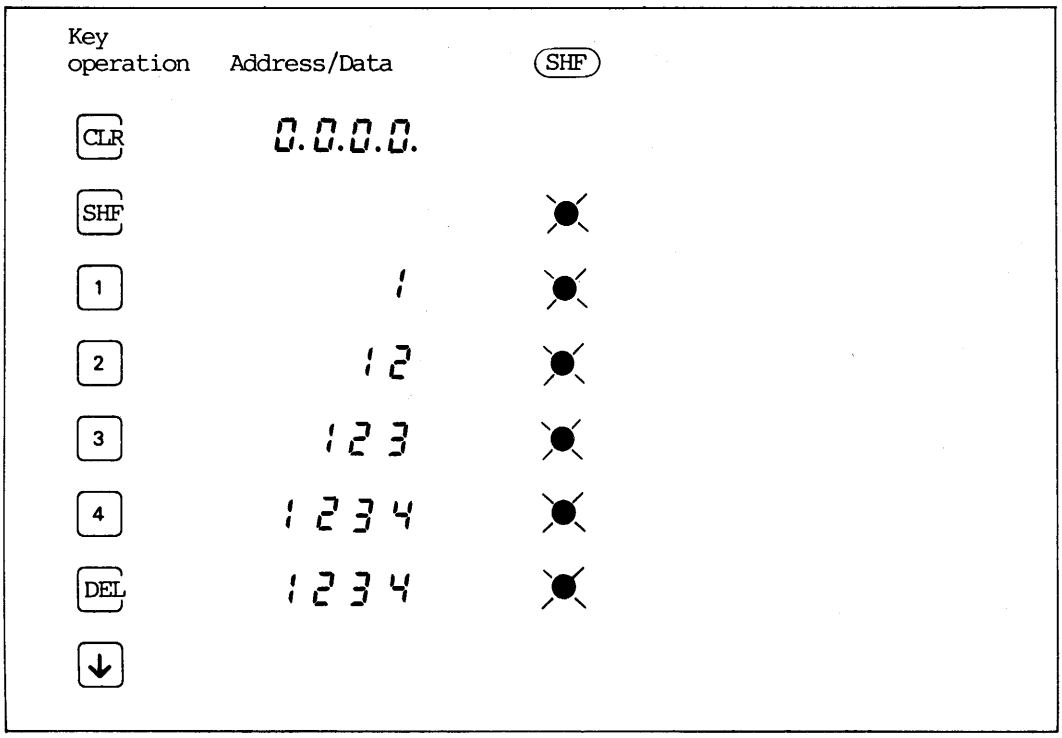
Key operation	Address/Data	SHF
CLR	0.0.0.0.	
SHF		●
5	5	●
6	5 6	●
7	5 6 7	●
8	5 6 7 8	●
DEL	5 6 7 8	●
SHF		●
1	1	●
3	1 3	●
5	1 3 5	●
7	1 3 5 7	●
ENT		

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16-4. Password closing operation: RUN/Program mode

Operation procedure: [CLR] [SHF] [1] [2] [3] [4] [DEL] [↓]

Example:



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17. CASSETTE INTERFACE OPERATION: LOADER MODE

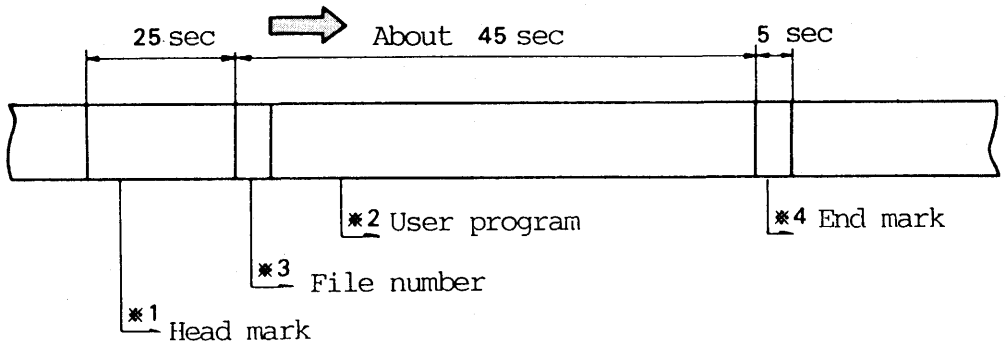
A cassette interface is built into the PC so that a loaded program is written onto a cassette tape and a written program is entered into the PC. A multifiling system is employed in which a desired program can be selected automatically from programs loaded and entered into the PC by just specifying the desired program number.

17-1. Interface specifications

Transmission speed	830 bauds/sec (75 sec average for 1.5 K words)
Method of modulation	Frequency modulation Signal"1": 2 kHz / Signal "0": 1 kHz
File number	0000 - 9999 (possible to specify any number)

Tape format

A tape in the following format is used. Data are automatically recorded from the PC.



*1, *4: The head and end marks are written with 2 kHz signals.

*2: Signal "1" is at 2 kHz and signal "0" is at 1 kHz.

*3: This can be omitted if program indentification by file number is not needed.

Cassette recorder specifications

Write input terminal	Microphone jack
Read output terminal	Earphone jack Output power: More than 300 mW Output impedance: 4 - 16 ohms
Frequency characteristics	Less than 300 Hz - more than 4 kHz
Wow flutter	Less than 0.5%
Power source	Should be operable with battery

Use the cassette data recorder sold in the market for the use with the personal computer and with an adjustable feature of the recording level. The cassette tape should be the one sold in the market for audio recording. The radio use cassette recorder is not suited because of the unbalance recording level for many cases.

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Caution

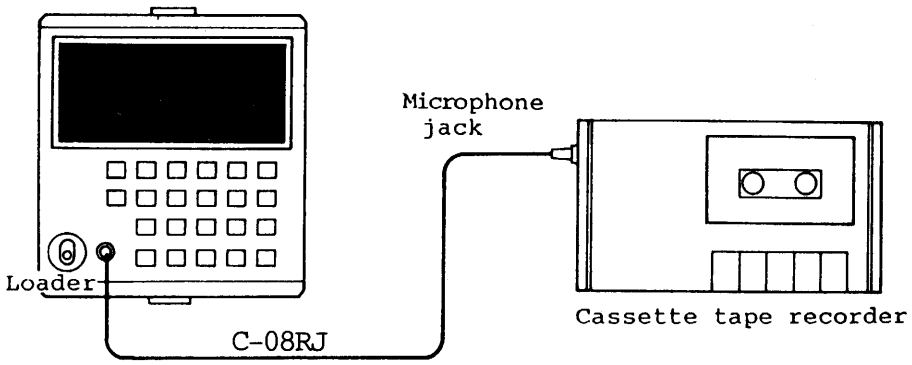
(1) Be careful with the recorder in which the serial resistor is installed for earphone output resulting with a high output impedance.

(2) Contamination on the tape head will cause defective frequency characteristics. Special care is needed in cleaning the tape head.

(3) The recorder attached with the tone control should be adjusted for setting at the flat level of tone characteristics.

17-2. Writing from PC to tape

Connection: Connect the microphone jack on the tape recorder to the PC cassette jack by using the furnished connection cable.
(The cable is identified by its red stripe.)

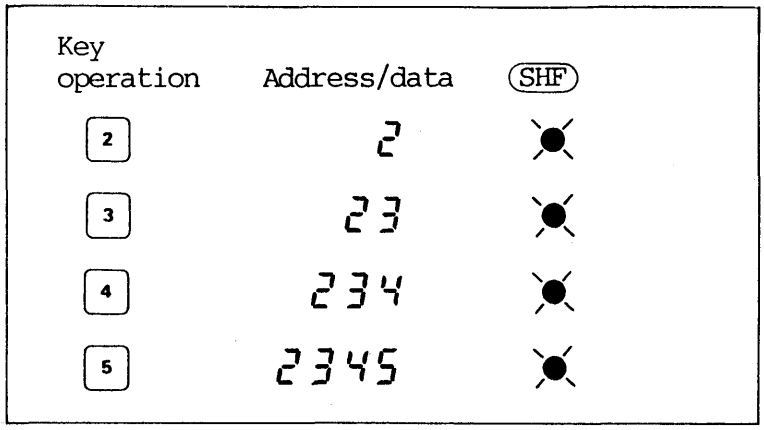


Operation procedure

(1) Set the mode select switch to the loader side.
The address/data display is blank, and (SHF) LED is lit.

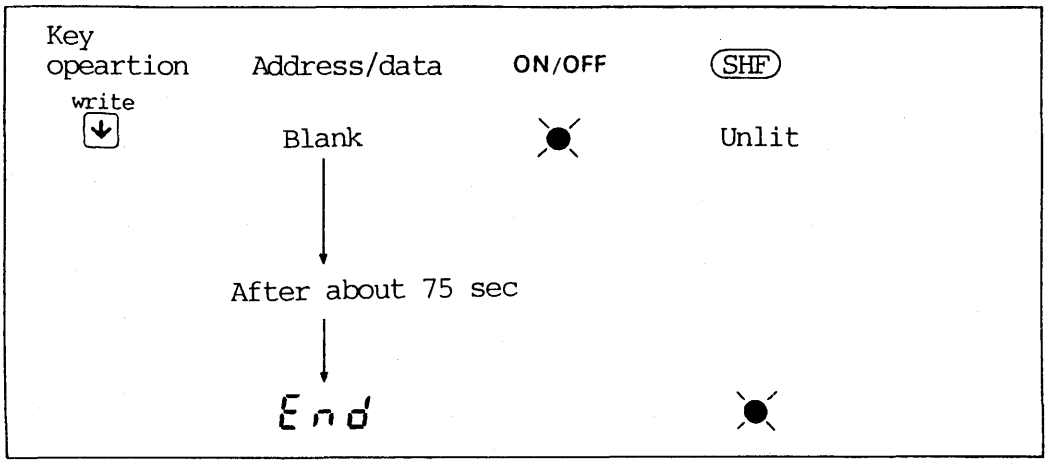
(2) Key in the file number.

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(3) Set the cassette tape recorder to the write mode.

(4) Depress write key to start writing.



(5) Writing is completed in about 75 seconds.

Note: 1. File number may be omitted. When omitted, the file number is written on the tape as 0.

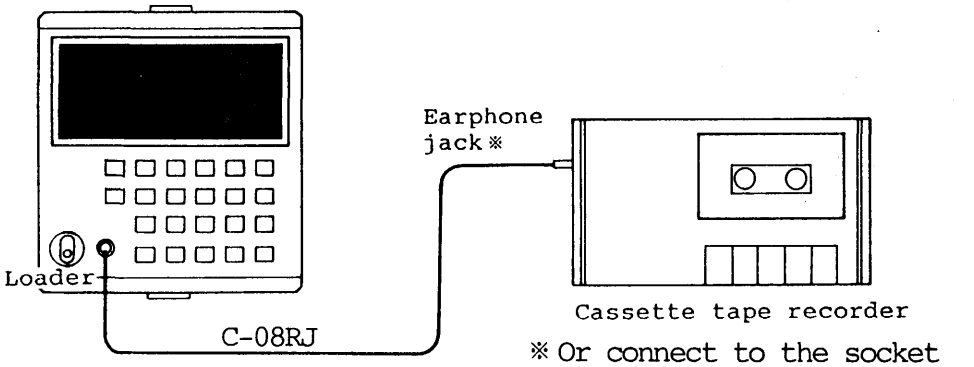
2. After writing, be sure to check the tape with the original data stored in the PC to make certain the data have been written properly.

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17-3. Checking of PC with tape

The user program in the PC is compared with the content of program written in the tape.

Connection: Using the furnished connection cable, connect one cable end at the cassette jack on the PC and the other at the earphone jack on the recorder.



※ Or connect to the socket such as EXT.SP or MONITOR.

Operation procedure

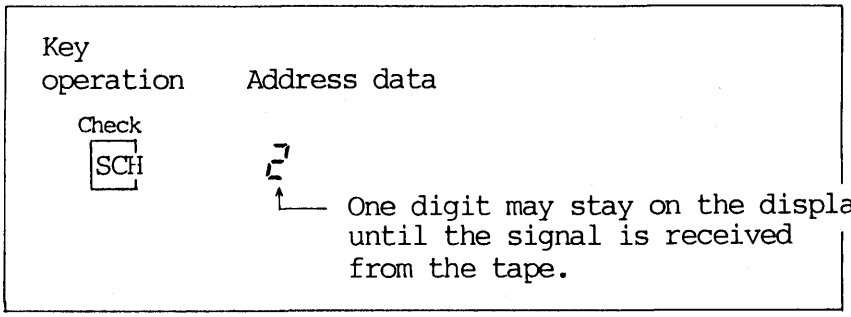
(1) Set the mode select switch to the loader side.
The address/data display is blank, and (SHF) LED is lit.

(2) Key in the file number.

Key operation	Address/data	(SHF)
2	2	●
3	23	●
4	234	●
5	2345	●

(3) Depress [CHECK] key.

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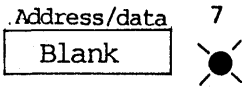


(4) Set the recorder to the read mode.

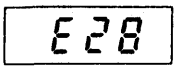
(5) Adjustment of read level

Level adjustment should be made while the 2 kHz head mark signal is being read. Until the head mark signal is received, E28 appears on the data display section, and LED7 on its right flickers to indicate that tape noise is being detected and judged.
After the head mark signal is received, the LED 7 lights continuously. Adjust a volume adjust switch on the recorder while this LED is lit. The LED 7 lamp is lit for 12 seconds. If the level adjustment is made after the LED is turned off, tape checking may become impossible.

Proper read level is indicated by:



Improper read level is indicated by:



Set the recorder's volume adjust switch in the central portion so that E28 is not displayed. If the switch is set in an excessively low position, the LED 7 will go out.

Note: a) Always start reading the tape from the first head mark. If it is started intermediately from elsewhere in the head mark section, the starting position may not be captured and an error will be issued because the PC still requires the head mark signal for a certain time period following the 12 sec duration used for level adjustment.

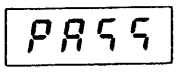
b) If more than one program is written on a tape and these programs are identified by file numbers, use the first head mark for level adjustment. After that, never adjust the volume adjust switch.
If the read level varies with each program and an error is caused when adjustment is made by the above-mentioned procedure, start reading from the first head mark of the desired program and adjust the level.

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(6) File number checking:

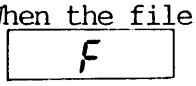
When a file number is specified, checking of file number is made.

a) When the file number does not agree with the specified number,



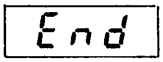
(PASS) is displayed for disagreement of number and checking is not performed.

b) When the file number agrees with the specified number,



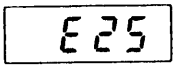
is displayed to indicate that checking is going to be performed.

(7) End of checking

a) After the check is completed satisfactorily, 

is displayed. Depress CLR key to stop the tape.

b) If the tape fails the check,



E25 indicates that disagreement is present. In this case, stop the tape and depress CLR key. Then adjust the level, clean the tape head, and take other corrective means if necessary; then repeat the process from the beginning. Similarly, correct the fault if E28 (improper level) is issued during checking.

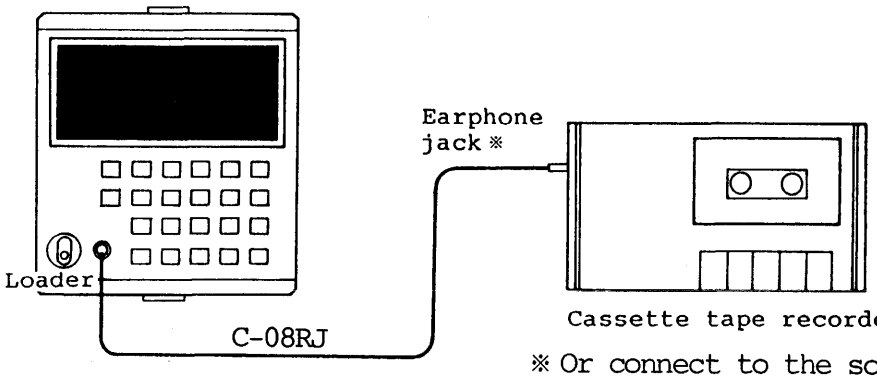
(Note): The file number may be omitted. In this case, checking will be made from the program caught first.

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17-4. Entering from tape to PC

The program recorded and kept in the tape is written into program memory in the PC.

Connection: Using the furnished cable, connect one cable end at the cassette jack on the PC and the other end at the earphone jack on the recorder.



※ Or connect to the socket such as EXT.SP or MONITOR.

Operation procedure

(1) Set the mode select switch to the loader side. The data display section becomes blank, and (SHF) LED lamp is lit.

(2) Specify the file number.

Key operation	Address/data	(SHF)
2	2	●
3	23	●
4	234	●
5	2345	●

(3) Depress Read [↑] key to place the PC in the ready condition for entering.

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Key operation	Address/data	(SHF)
Read (↑)	Blank	Unlit

One digit of number may stay on the display until the signal is received from the tape.

(4) Set the recorder to the read mode.

(5) Adjustment of read level

Level adjustment should be made while the 2 kHz head mark signal is being read. The same level adjustment method is used as for checking. Refer to the tape-checking section.

Proper read level is indicated by Address/data: Blank, 7: ✸

Improper read level is indicated by E28

(6) File number checking

When a file number is specified, agreement between the specified number and the data number being read is checked. If they agree, the PC takes from the tape those data (program) that are covered by the specified number and enters them into memory.
If they do not agree, the PC ignores the data covered by the specified number and skips to the next written program.

a) When the specified number does not agree with the file number, PASS is displayed.
When more than one program is in the tape, the PC continues to pass the disagreed program until agreement is reached.

b) When the specified number agrees with the file number, F is displayed and the program is entered into memory.

(7) End of entering End

After the program entering is completed, END is displayed.
Depress CLR key to stop the tape recorder so that the entering operation is completed.

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Note: 1. File number may be omitted. In this case, the program that is caught first will be entered into memory.

2. After entering is completed, be sure to check the loaded data in the PC with the tape data to make certain they are loaded properly.

3. If error code E28 (improper leveling) is displayed during reading, stop the recorder, depress CLR key, and repeat the reading process from the beginning, being careful of the level.

4. The CLR key is ineffective if the operation is stopped during checking and reading (entering). In this case, shut off the power supply to the PC.

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MAINTENANCE AND INSPECTION

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TABLE OF ERRORS D-13

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1. TROUBLESHOOTING

1-1. Causes of troubles

The following causes may be considered for defective operations to drive the PC.

(1) Problems to supply power to the system including the PC
- The power is not supplied.
- The power source voltage is low.
- The power source is intermittently cut off.
- A large noise is given to the power source.

(2) Damage to the equipment by accident or erroneous operation
- Application of a higher voltage to the power source (by lightening, etc.)
- Short circuit on the load
- Damage to the power equipment (valve, motor, for example) because of mechanical defects
- Damage to the detector because of mechanical defects

(3) Incomplete control circuit
- No matching of the control circuit timing (PC programming, for example) with the mechanical timing
- Generation of unexpected conditions on the control circuit

(4) Deterioration and wearing of equipment
- Defective contact (limit switch, relay, electromagnetic switch, for example)
- Voltage dropping of the memory backup battery in the PC
- Deterioration of the PC caused by high-voltage noise

(5) Changes made on the program by noise or erroneous operation
- Changing of the program by mistake as a result of the monitoring operation
- Plugging or withdrawing of the module made while the power source is on
- Changing of the program memory by a large noise

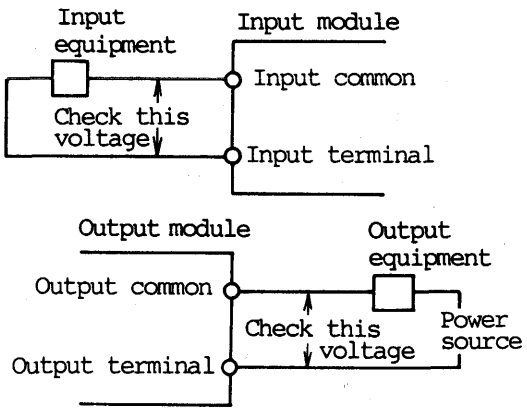
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1-2. Places to check in case of trouble

To check trouble on the control system using a PC(s), use the I/O display or monitoring features of the PC to define whether the trouble occurred on input/output before the PC operation, in the PC, or after the PC operation. This is the quickest way to provide any countermeasure to the cause of the trouble.

● What to check

(1) Display on the CPU module or programmer (power source display, CPU abnormality display, RUN display, error display, and BATT display)
(2) RUN output on the base
(3) Power source voltage
(4) Fuse
(5) I/O module operation display
(6) Operation monitoring by the programmer
(7) Program checking by the programmer
(8) Voltage checking of I/O terminals



● Materials necessary for checking

(1) Operation chart, wiring diagram, and program (circuit diagram)
(2) Programmer (R-21P or C-60P)
(3) Technical manual or operation manual for the PC
(4) Tester

● Points to check

(1) Investigation of the troubling condition
  • Find out if the operation is partially or completely stopped.
  • Find out if the trouble occurs without fail or sometimes.
(2) Find out if the CPU is running or not should the operation completely stop (RUN display and output).
(3) Check input/output condition if the problem of partial operation constantly continues.
(4) Check the timing of the program and machine, the condition of the power source, or noises should the problem occur only sometimes.

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2. MEMORY BACKUP BATTERY REPLACEMENT

A long-lasting lithium battery is used to backup the memory at power shutoff. Normally, it operates satisfactorily for about 5 years, although the replacement time may be shortened under difficult working conditions (high temperature and high humidity, for instance). When the battery voltage is dropped, immediately replace the battery because low voltage can ruin the memory.

2-1. Battery voltage drop detection

When the battery voltage drops, the BATT LED indicators provided on both the CPU panel and the programmer are lit, turning ON the internal relay 377 to signal that the battery should be replaced.

2-2. Battery replacement procedure

After the battery voltage drop is detected, replace the battery within 10 days.

- **Battery type: RB-5**

  Replacement batteries are fitted with a lead wire and a connector at the KOYO plant and are available from KOYO.

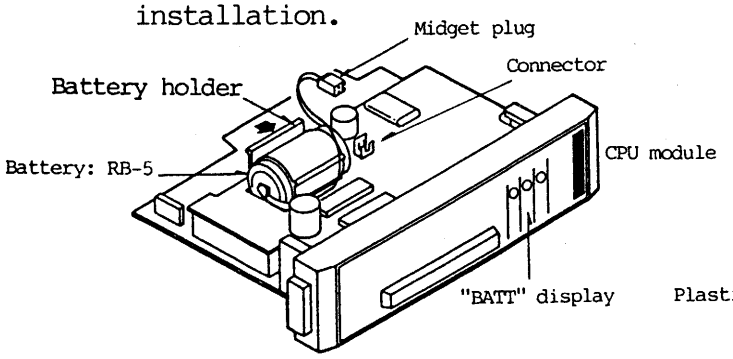
- **Replacement procedure**

(1) Remove the CPU module from the standard base after about one minuts when the AC power source is turned off.
(2) Withdraw a midget plug connecting battery and CPU board.
(3) Move the battery holder by picking up the hook of the holder enough to have an opening so that the old battery can be removed.
(4) Install a new battery and fix it with the battery holder.
(5) Insert a plug on the top of the battery lead wire into the connector on the board.
(6) Reinstall the CPU module on the standard base when the replacement work is completed.
(7) Confirm if the BATT LED is OFF after applying the AC power.

Note: For CPUs made before with lot numbers 8905, internal relay 377 must be forcibly turned off by the programmer.
Depress keys as shown below.

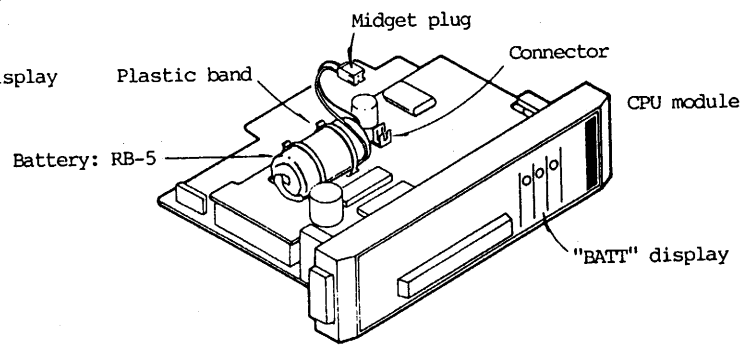
RST SHF 3 7 7 ENT

The power source for RAM while the battery is being replaced is maintained by the large size of capacitor. Battery replacement should be done immediately after cutting OFF the AC power.
Make sure the voltage of the (new) replacement battery is more than 3 V before installation.



* In case of an old model

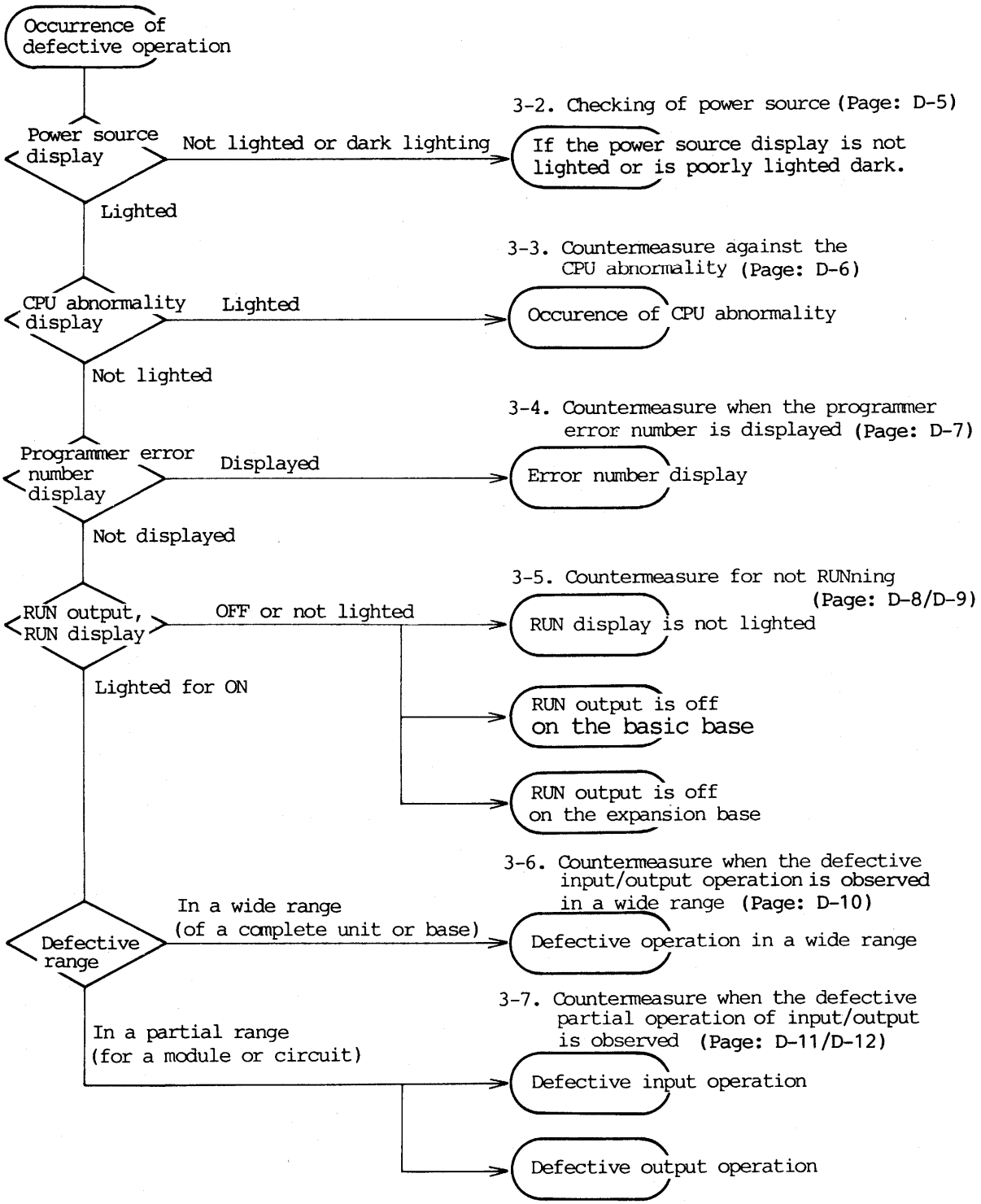
Remove the old battery by cutting off the plastic bands that hold it in place.



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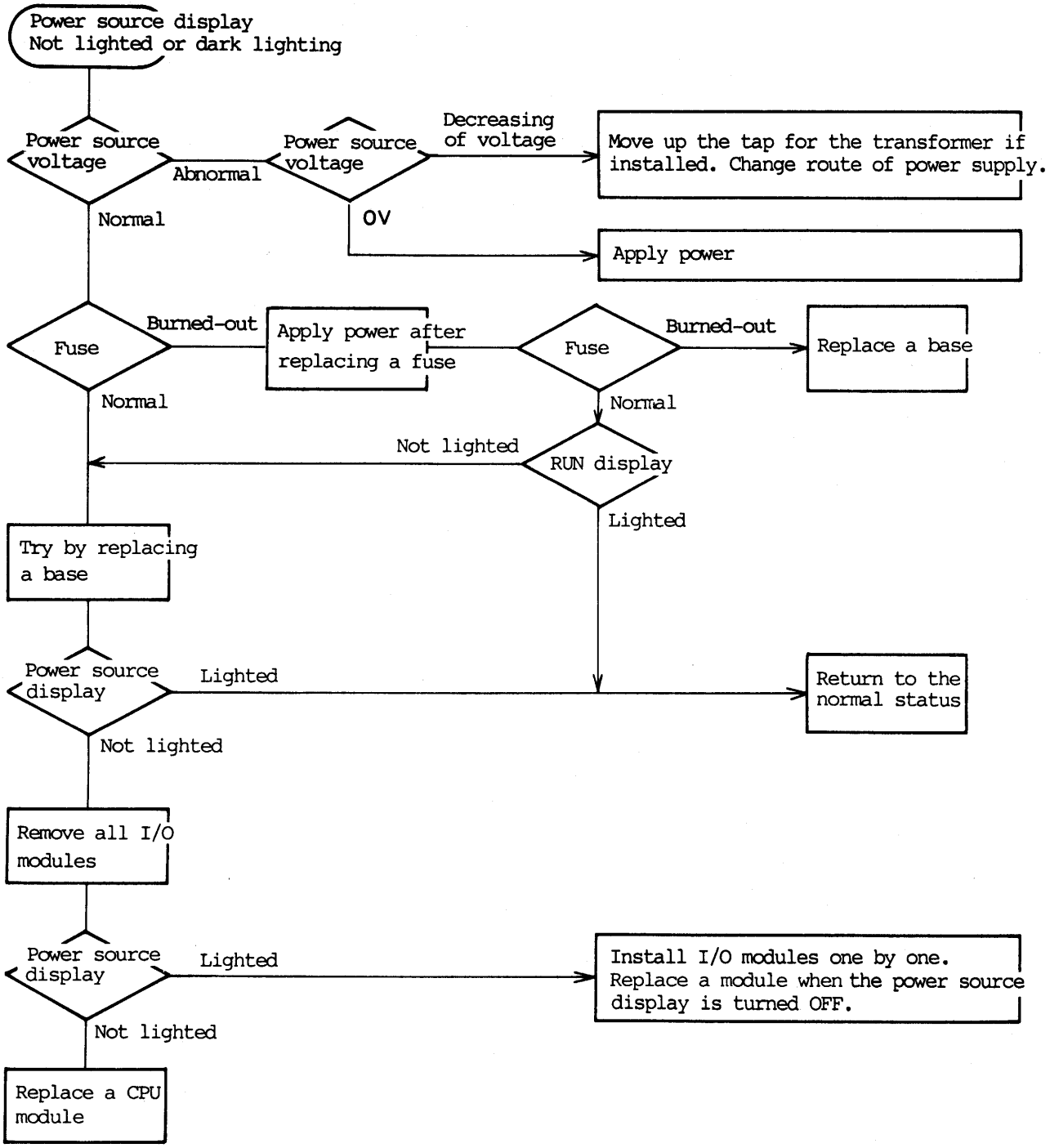
3. CHECKING AND COUNTERMEASURE WHENEVER THE DEFECTIVE OPERATION IS FOUND

3-1. Basic checking



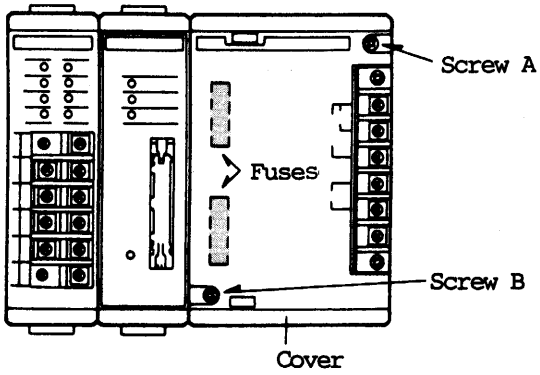
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3-2. Checking of power source



How to replace a fuse

Remove screws A and B (shown in drawing) to remove the cover plate.
One or two fuses are installed in the locations circled by the dotted chain line. (Number of fuses differs by model number.) Use an attached new fuse for replacement or of the same model number.



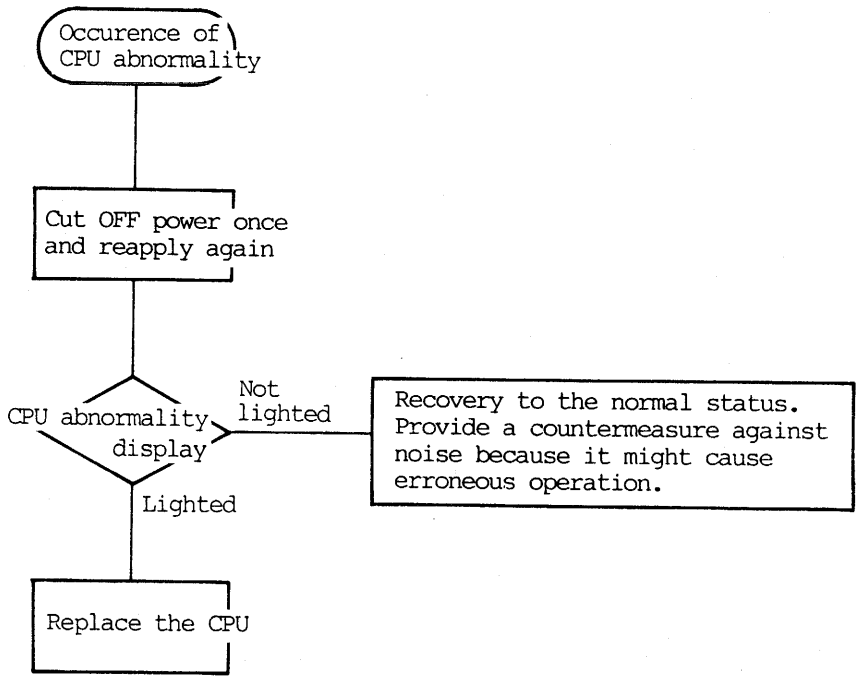
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3-3. Countermeasure against CPU abnormality

● Detection of CPU abnormality

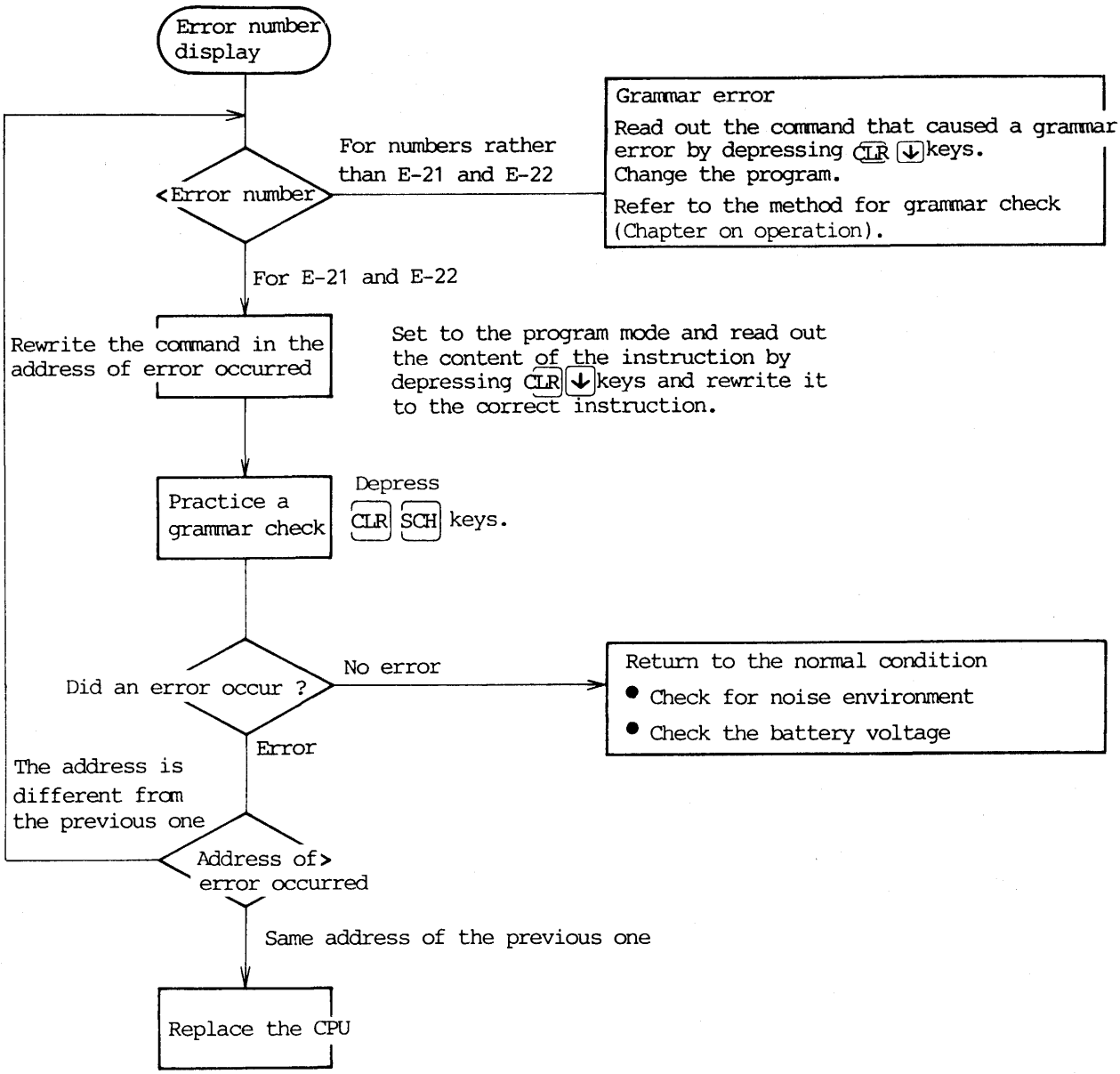
When the CPU makes an erroneous operation because of the defective hardware or noise, the erroneous operation will be detected within about 100 ms (by the watchdog timer) to reset the CPU and I/O module at the same time the output is turned OFF.

● Countermeasure against CPU abnormality



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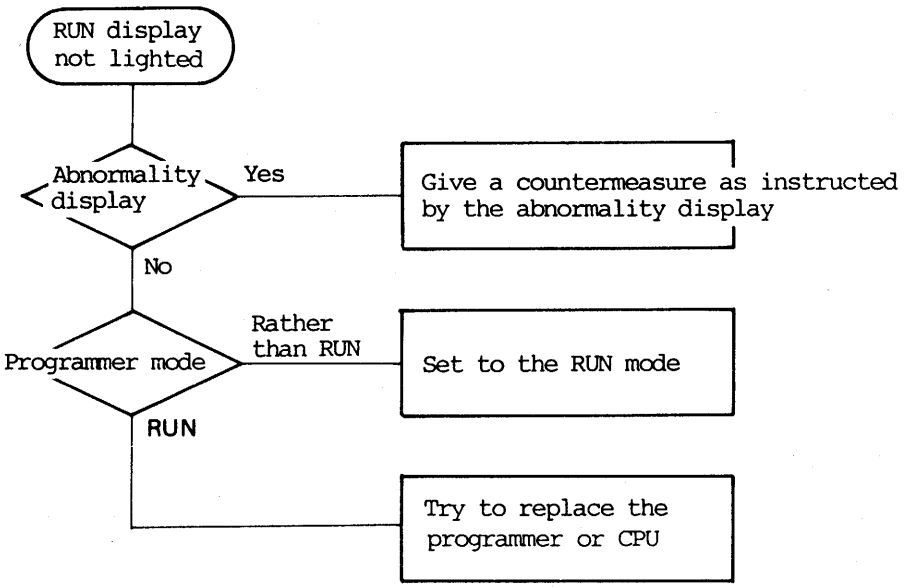
3-4. Countermeasure when the programmer error number is displayed



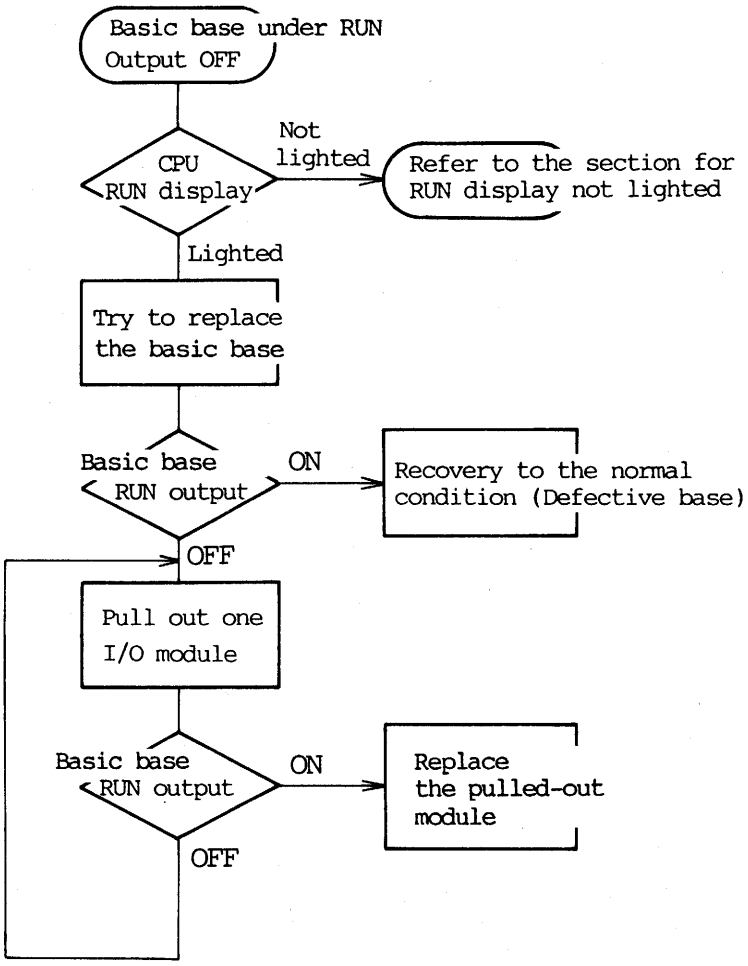
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3-5. Countermeasure for not RUNning

● Countermeasure when the RUN display is not lighted

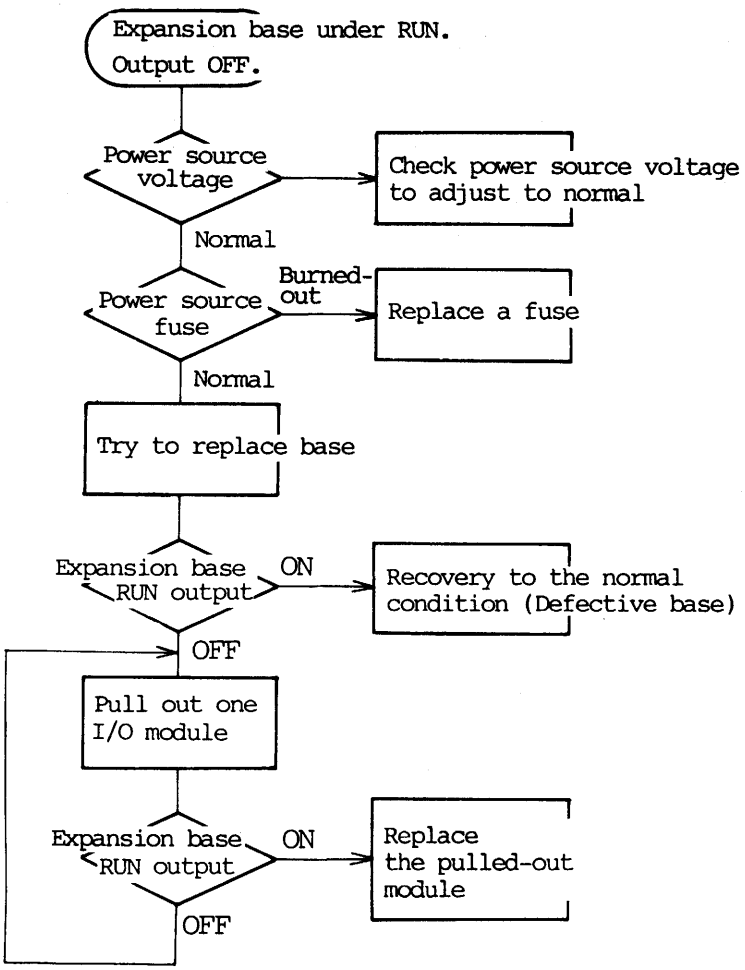


● When the RUN output is OFF on the basic base



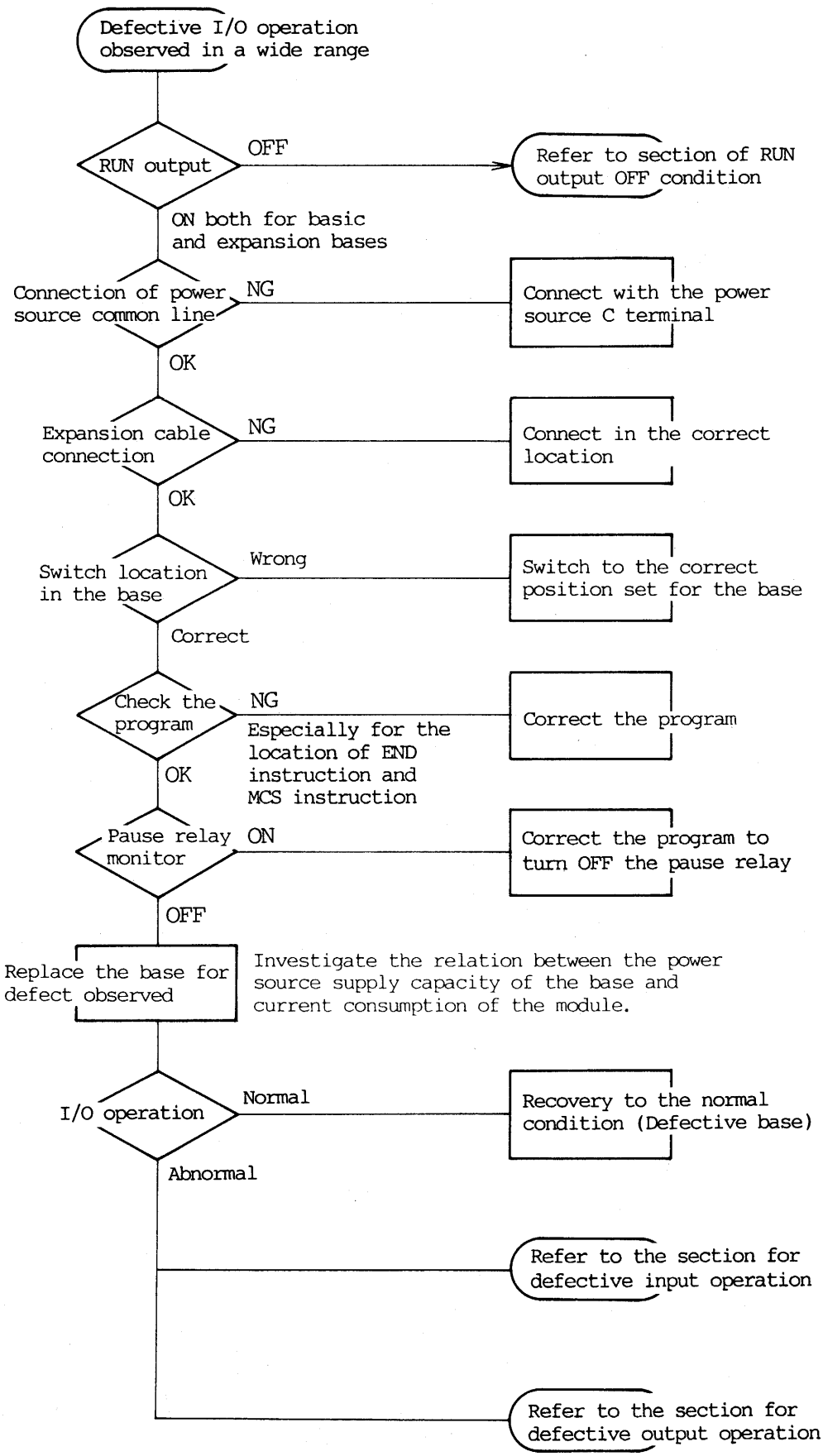
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● When the RUN output is OFF on the expansion base



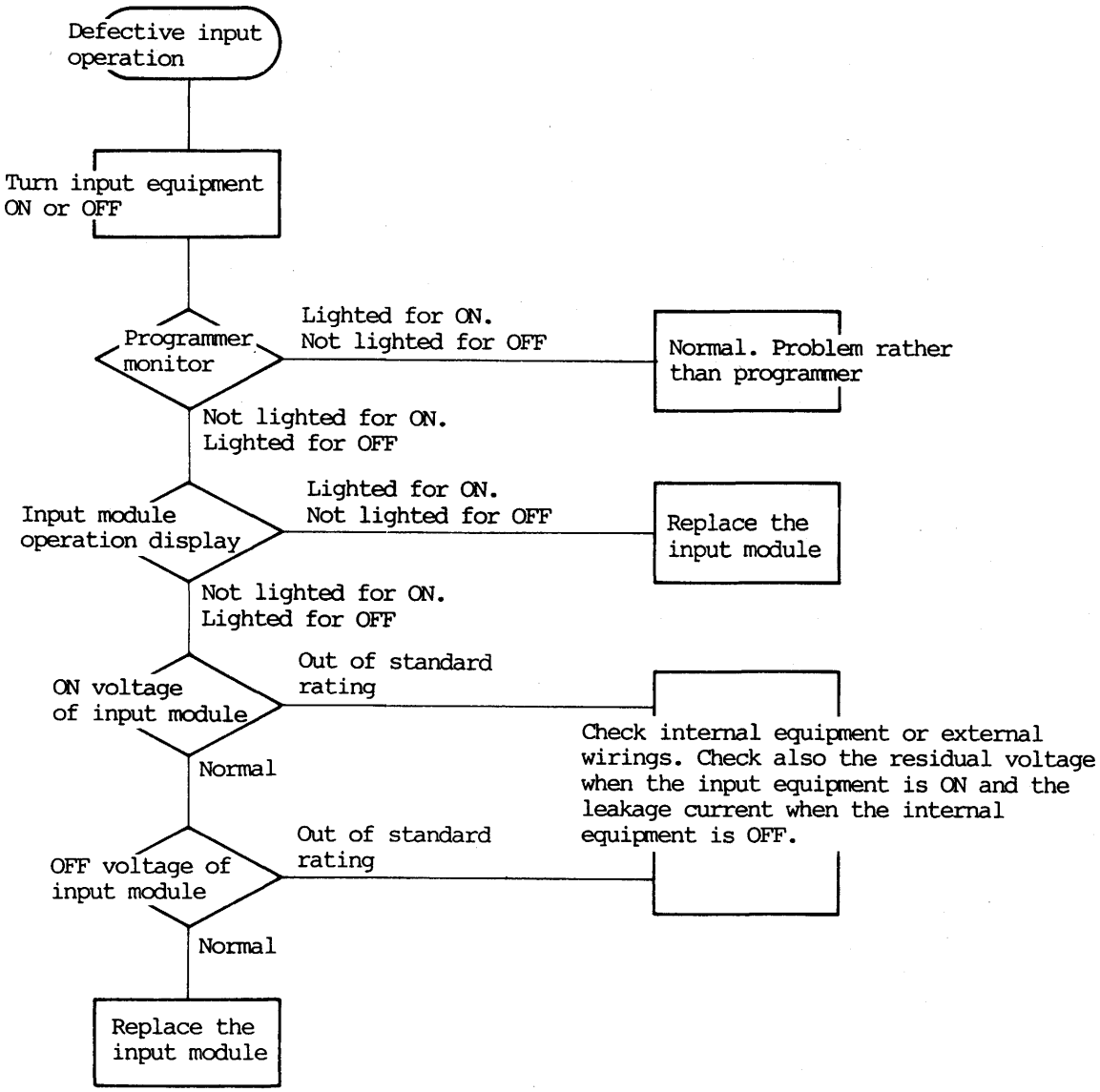
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3-6. Countermeasure when the defective I/O operation is observed in a wide range

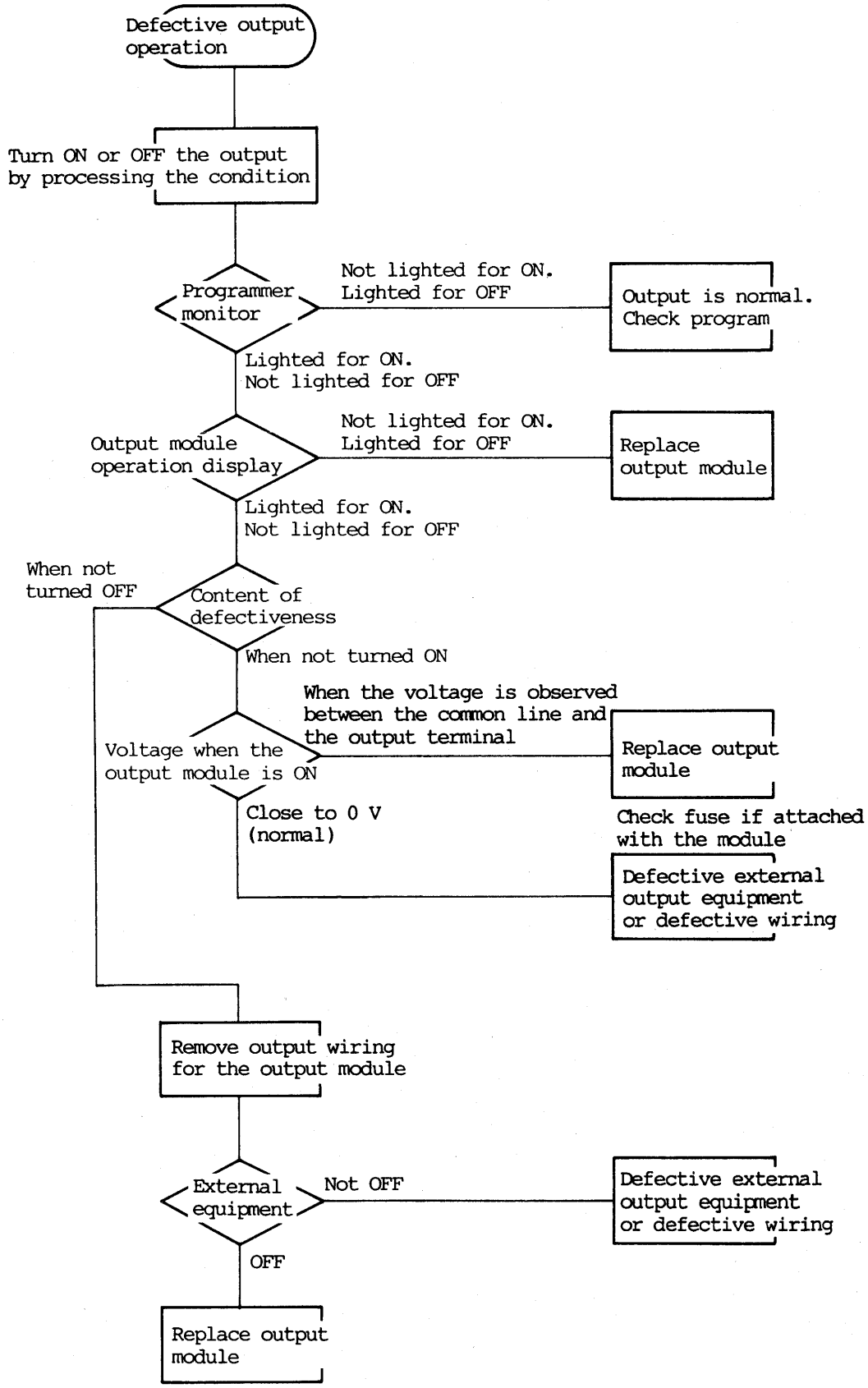


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3-7. Countermeasure when the defective partial operation of I/O is observed



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TABLE OF ERRORS

Classification	Item	Error display	CPU status	Timing of error detection: Under all operations	On power up rising	On rising of RUN	On checking of grammar	On program operation	
System error	CPU abnormality	CPU abnormal	Stop	○					
	Battery voltage dropping	BATT		○					
	Program memory abnormality	E21	Stop		○	○	○		
	Password memory abnormality	E22	Stop		○	○	○		
	Inadequate execution preparation	E31	Stop		○	○			
Grammar error	Output number error	E02	Stop		○	○	○		
	MCS stack over	E03	Stop		○	○	○		
	Duplicate use of the output coil	E05	Stop		○	○	○		
	MCR stack over	E06	Stop		○	○	○		
	Shortage of counter condition	E07	Stop		○	○	○		
	Incomplete circuit	E09	Stop		○	○	○		
Operation error	Erroneous key operation	E01						○	
	Erroneous writing of different instruction in the second-word address	E08						○	
	No vacant address in the program memory	E11						○	
	Missing of search instruction	E99						○	
Cassette error	Unmatched comparison	E25						○	
	Improper cassette leveling	E28						○	

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Error code	Description of error	Countermeasure
CPU abnormal ● CPU	CPU watchdog timer error detection (Erroneous operation of CPU)	Retry to turn ON the power source after turning OFF once. It is allright if the CPU is put under RUN state. If not, replace the CPU.
● BATT	Dropping of battery voltage. Diminishing life of the battery	Replace the battery within a week.
E21	Changed instruction for program memory	Rewrite the instruction that caused error when written under the program mode. Replace the CPU if the abnormal state is again found.
E22	Changed memory of the password	Register the password again because it is canceled by the CLR CLR key operation.
E31	Capacity shortage of RAM for execution	Shorten the program.
E02	The output instruction is programmed to the number to which the input module is installed.	Rewrite the program. (Check the base unit because of the possibility of erroneous switching of the switch in the base unit.)
E03	Excess use of MCS instruction more than nine to the number of MCR	Reduce the number of MCS instruction by changing the program.
E05	Duplicate use of the same operation (coil) instruction of output, relay, timer, and counter more than twice	Change the number of relay, timer, and counter in duplicate use.
E06	Excess use of MCR instruction more than MCS instruction	Reduce the number of MCR instruction by changing the program.
E07	Shortage of conditions for the counter and shift register instructions	Change the program to the program prepared with count condition and reset condition.
E09	Incomplete programming without the operation (coil) instruction but only with the condition circuit	Correct the circuit by checking the program.
E01	Erroneous writing order of program (Erroneous operation mode, instruction, and number)	Proceed with the correct operation after depressing the CLR key.
E08	Erroneous writing of another instruction into the second word of two word instruction	Write the second word of the instruction that is written in the previous address in the address that had an error.
E11	Erroneous instruction or operation to write a two-word instruction even when the program memory is full	Expand the program memory, or shorten the program.
E99	The instruction in search is not found before the END instruction	Depress the CLR key.
E25	Unmatched tape program to the CPU program content	Repeat to check or playback. Repeat recording if the same error is found.
E28	Unmatched playback leveling (volume controlling) of cassette tape recorder	Repeat the operation by adjusting the volume controller on the cassette tape recorder.

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