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6. GPIB INTERFACE

This section describes control of the meter with the GPIB.

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6.1 Outline

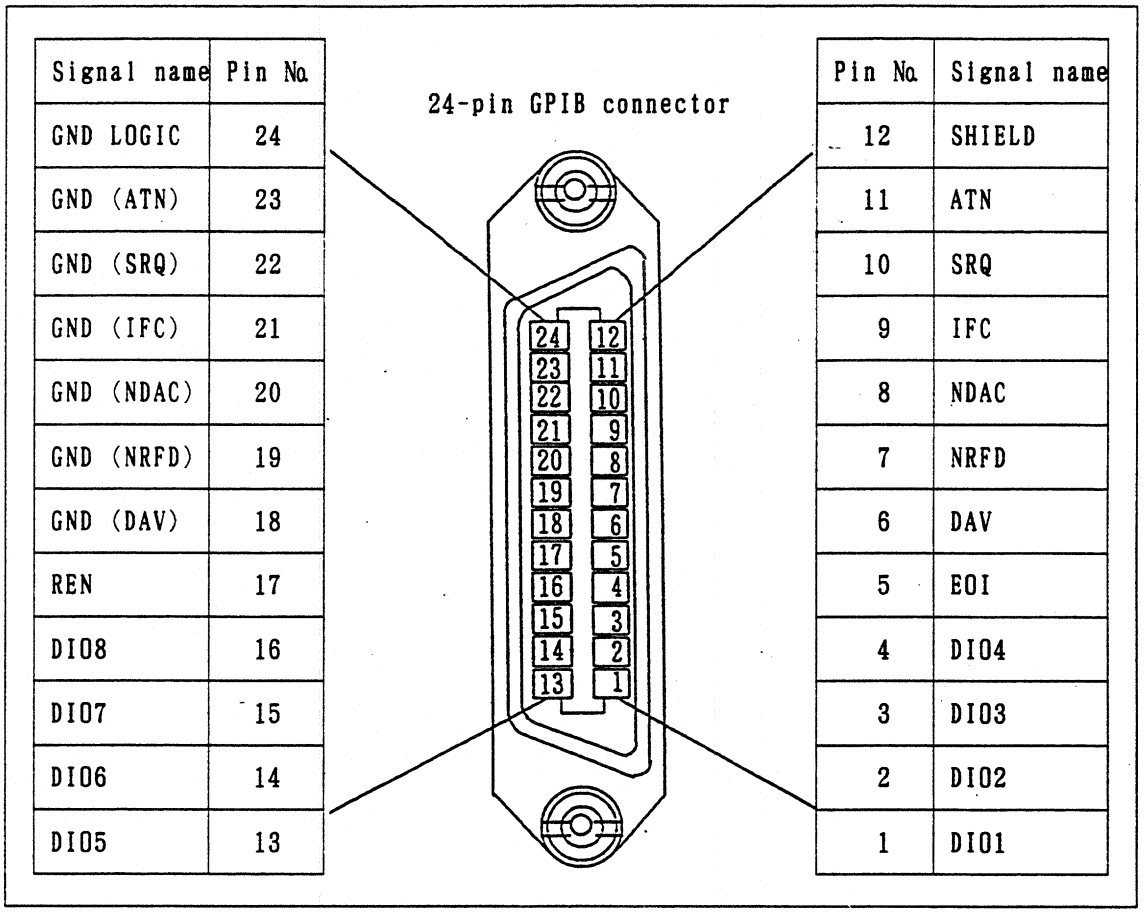
The GPIB interface is used to connect the meter with the measuring bus based on the IEEE488-1978.
The meter is normally equipped with the GPIB interface, easily configuring a measuring system storing the GPIB using personal computers. Therefore, measurement automation and data processing can be easily realized. Because the remote program through the GPIB can control almost all set items given to the meter panel switch, the interface can correspond to wide applications.

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6.2 GPIB Standard

Standard used : IEEE Standard 488-1978
Code used : ASCII code
Connector pin arrangement :

Signal name	Pin No.
GND LOGIC	24
GND (ATN)	23
GND (SRQ)	22
GND (IFC)	21
GND (NDAC)	20
GND (NRFD)	19
GND (DAV)	18
REN	17
DIO8	16
DIO7	15
DIO6	14
DIO5	13



Pin No.	Signal name
12	SHIELD
11	ATN
10	SRQ
9	IFC
8	NDAC
7	NRFD
6	DAV
5	EOI
4	DIO4
3	DIO3
2	DIO2
1	DIO1

Figure 6 - 1 GPIB Connector Pin Arrangement

Logic level : Logic 0(HIGH state) +2.4V or higher
Logic 1(Low state) +0.4V or lower
Signal conductor termination: Sixteen bus lines are terminated as shown in Figure 6-2.

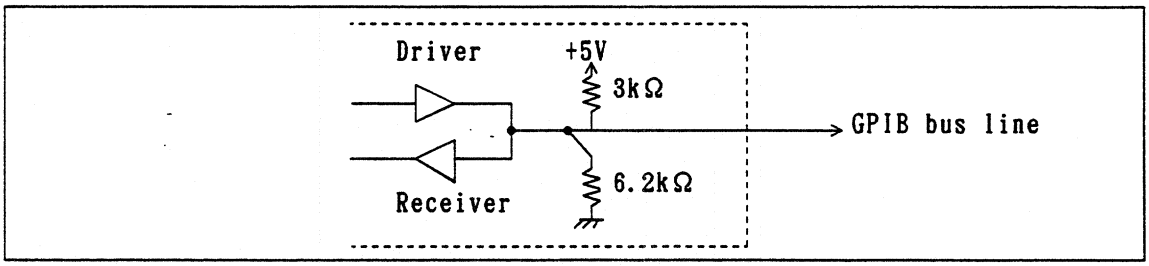


Figure 6 - 2 Signal Conductor Termination

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Driver specification: Tristate system
Low-state output voltage:+0.4V or lower 48mA
High-state output voltage:+2.4V -5.2mA
Receiver
specification: Low state for +0.6V or lower
High state for +2.0V or higher
Bus cable length : The overall bus cable length should be (number of units connected to bus)×2m or less and must not exceed 20m.
Addressing : Talk address and listen address of 31 types can optionally be set according to the GPIB address setting on the front panel.
Interface function : Table 6-1 shows interfaces and their functions.

Table 6 - 1 Interfaces and Their Functions

Code	Function
SH1	Source handshake function
AH1	Acceptor handshake function
T5	Basic talker function, Talk-only mode function, Serial polling function, Listener-designated talker cancel function
L4	Basic listener function, Talker-designated listener cancel function
SR1	Service request function
RL1	Remote/local changeover function
PP0	With no parallel polling function
DC1	Device clearing function ("SDC" and "DCL" commands can be used.)
DT1	Device trigger function ("GET" command can be used.)
C0	With no controller function
E2	Tristate output

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6.3 Connection with Component Units

Because the GPIB system consists of several units, configure the system by paying attention to the following points.

Precautions for configuring the system

(1) Check the condition (preparation) and operation of each unit before connection according to the operation manual of the meter, controller, and peripheral equipment.

(2) Minimize the length of cables connecting with measuring instruments and bus cables connecting with controllers. Keep the cable length at 20m or less.
We prepare the cables in Table 6-2 as the standard bus cable.

Table 6 - 2 Standard Bus Cable

Length	Name
0.5m	408JE-1P5
1m	408JE-101
2m	408JE-102
4m	408JE-104

(3) Bus cable connectors are the piggyback type, which can be used by overlapping them because one connector has a male and female connectors.
When connecting the bus cables, do not overlap three or more cables. Be sure to secure them with connector setscrews.

(4) Check the power condition, earthing state, and, if necessary, setting condition of each component unit before turning it on. Be sure to turn on every unit connected to the bus. If any unit is not turned on, the operation of the whole system may not be guaranteed.

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6.4 Address Setting and Header on/off Selection

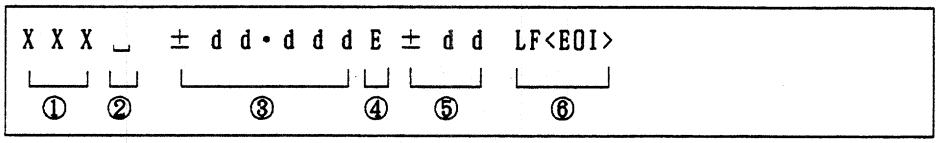
Perform the GPIB talk/listen addressing and header on/off selection with the panel key on the meter. For addressing and header setting, see Item 4.5.3 "GPIB". It is possible to set the header to ON or OFF using an external controller.

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6.5 Talker Specification (Data Output)

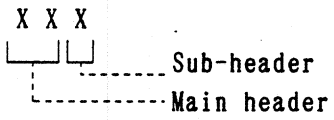
6.5.1 Basic Format

Basic Format



① Header
For header OFF, no space is given before the mantissa part of data but data is left-justified.

Three digits (The third digit is a sub-header.)



Main Header
DI: DC measurement
RM: Resistance measurement
RV: Volume resistivity
RS: Surface resistivity

Sub-header
O : Over-range *
D : Data after NULL operation
H : COMPARE-operation result "HI"
G : COMPARE-operation result "GO"
L : COMPARE-operation result "LO"
E : Measured data error *
M : Data when VS is caught by the current limiter
␣ : Cases other than the above

*:For the above "O" and "E", both data and exponent part are expressed as 99999.99 like DIO␣+99.999E+99 because data is incorrect.

The following is the sub-header priority:
High priority Low priority
O → E → L/G/H → M → D

② Space
For header ON, one space is always given after the header.

③ Mantissa part data
The polarity "+" or "-" is always given to the top of data. Data consists of a value shown as a decimal point plus four- or five digit number. However, only current measured values are expressed as a four-digit number if the integration time is set to 2ms.

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④ E
The character "E" represents an exponent.

⑤ Exponent Part Data
The polarity "+" or "-" is always given to the top of data. Data consists of a value shown as the polarity plus two-digit number according to the unit indication (exponent and symbol). Table 6-3 shows the mantissa- and exponent-part data under each measuring condition.

⑥ Block Delimiter
This can be changed with the program command "DLd" as follows.
DL0:CRLF <EOI> (<EOI> simultaneously with L)
DL1:LF
DL2:<EOI> simultaneously with the final byte
DL3:LF<EOI> (<EOI> simultaneously with L)

Table 6 - 3 Mantissa- and Exponent-part Data

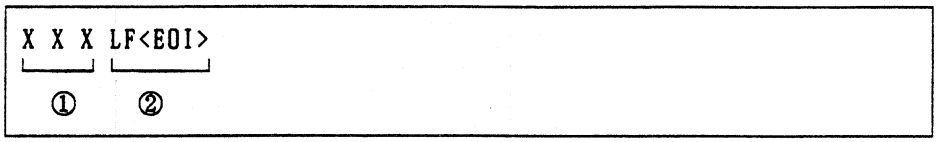
	Range	Unit=Symbol (Indication)		Unit=Exponent (Indication)	
		Mantissa part	Exponent part	Mantissa part	Exponent part
Direct current [DI]	200pA	±ddd.dd	-12	±d.dddd	-10
	2nA	±dddd.d	-12	±d.dddd	-09
	20nA	±dd.ddd	-09	±d.dddd	-08
	200nA	±ddd.dd	-09	±d.dddd	-07
	2μA	±dddd.d	-09	±d.dddd	-06
	20μA	±dd.ddd	-06	±d.dddd	-05
	200μA	±ddd.dd	-06	±d.dddd	-04
	2mA	±dddd.d	-06	±d.dddd	-03
	20mA	±dd.ddd	-03	±d.dddd	-02
Resistance measurement [RM RV RS]	One-digit indication	+0000d.	00 to 15	+0000d.	01 to 23
	Two-digit indication	+000dd.	00 to 15	+000d.d	01 to 16
	Three-digit indication	+00dd.d to +00ddd.	00 to 15	+00d.dd	02 to 15
	Four-digit indication	+0dd.dd to +0dddd.	00 to 15	+0d.ddd	03 to 14

When the integration time is set to 2ms, no above least significant digit of current measured data is output.

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6.5.2 Response to Query Command

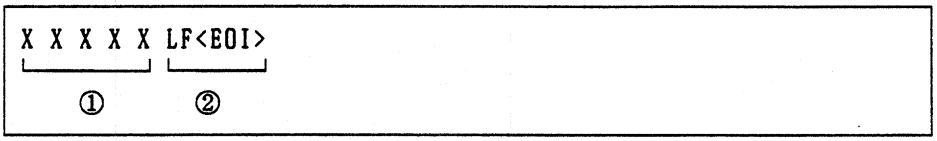
(1) Status Query Response



① For three-digit integer data, the integer data is output with the range between 000 and 255.
For two-digit integer data, the integer data is output with the range between 010 and 099.
For one-digit integer data, the integer data is output with the range between 001 and 009.

② Terminator
The terminator is set with the "DLd" command.

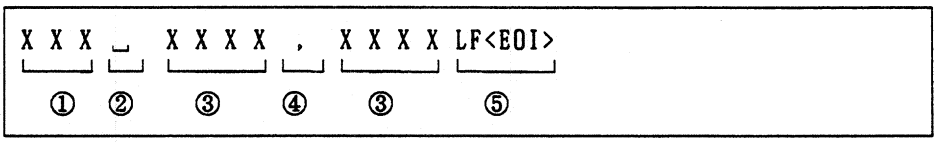
(2) Set Query Response



① The response is expressed by alphabetical upper-case and numeric characters. Integer data ranges between -32768 and +32768.

② Terminator
The terminator is set with the "DLd" command.

(3) Data Query Response



① The response is expressed by alphabetical upper-case characters.

② One space is always given.

③ Data is expressed as any one of integer data, data with decimal point, and decimal-point data + exponent data.
The number of data values and data format depend on commands.

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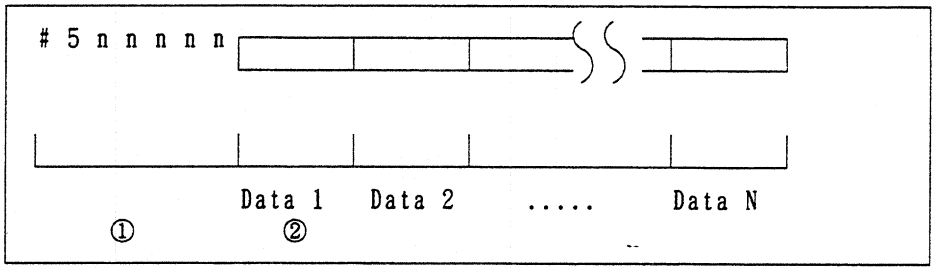
④ Data Separator
A comma "," is given.

⑤ Terminator
The terminator is set with the "DLd" command.

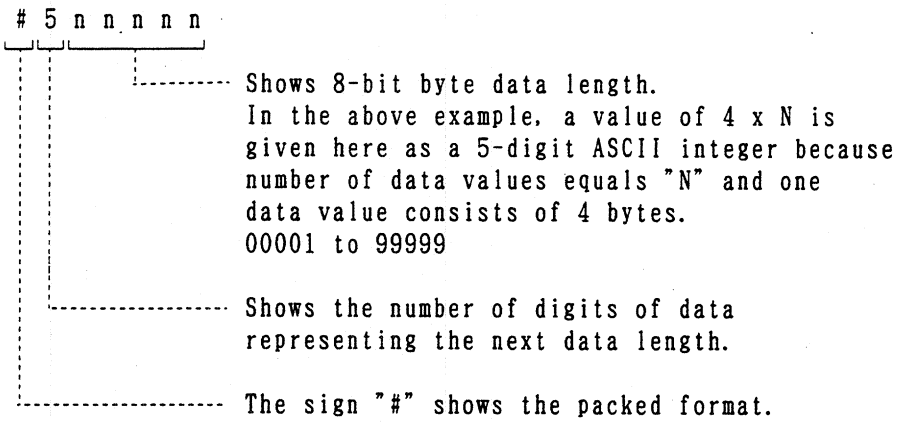
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6.5.3 Binary Packed Format

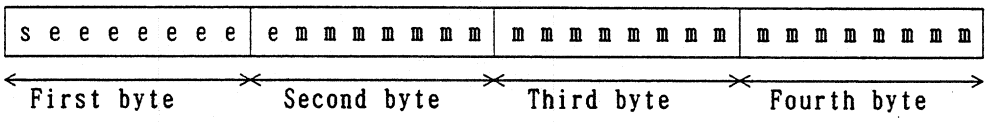
Binary packed format



① Preface
This consists of ASCII data and is sent with the following format.



② Data format
Data is sent as 32-bit floating-point notation based on IEEE754-1985.

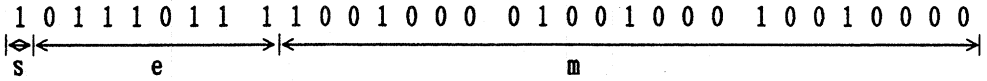


s : Sign bit 0: Positive 1:Negative
e : Exponent part of "2" based on 127 (2^{*}) 8bit
m : Mantissa part 23bit
Where,
1. For e=255 and m≠0:Non-numeric value
(Over-range or error data)
2. For e=255 and m=0 :$X=-1^{s}$ (∞)
3. For 0<e<255 :$X=-1^{s}$ $(2^{e-127})(1+m)$ Normalization
4. For e=0 and m≠0 :$X=-1^{s}$ $(2^{-126})(0+m)$ Non-normalization
5. For e=0 and m=0 :$X=-1^{s}$ (0) +/- zero

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This meter outputs any one of data in Item ①, ③, and ⑤ but does not output data in Item ② or ④. For Item ①, error data such as over-range and operation error is shown. For Item ⑤, the value "-0" is not generated.

Example)



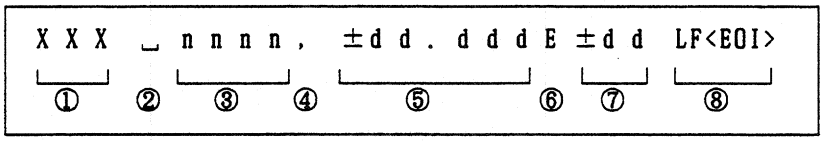
In the above case, the exponent and mantissa parts are expressed respectively as follows:

Exponent part: $2^6+2^5+2^4+2^2+2^1+2^0=119 \rightarrow e=119-127=-8$
Mantissa part: $2^{-1}+2^{-4}+2^{-8}+2^{-12}+2^{-16}+2^{-19}=0.56471443177$
$\rightarrow m=1+0.56471443177=1.56471443177$
$X=1.56471443177\times 2^{-8}=-6.1121657491E-3$

As for 1, "e" and "m" bits of data are 1.

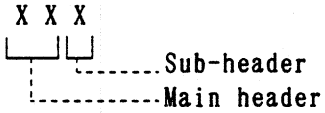
6.5.4 Format of Recall Data with Data Number

Format of recall data with data number



① Header
For header OFF, no space is given before the mantissa part of data but data is left-justified.

Three digits (The third digit is a sub-header.)



Main header
DI: DC measurement
RM: Resistance measurement
RV: Volume resistivity
RS: Surface resistivity

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Sub-header
O : Over-range *
D : Data after NULL operation
H : COMPARE-operation result "HI"
G : COMPARE-operation result "GO"
L : COMPARE-operation result "LO"
E : Measured data error *
M : Data when VS is caught by the current limiter
␣ : Cases other than the above

* : For the above "O" and "E", both data and exponent part are expressed as 99999.99 like DIO␣+99.999E+99 because data is incorrect.

The following is the sub-header priority:
Hith priority Low priority
O → E → L/G/H → M → D

② Space
For header ON, one space is always given after the header.

③ Data Number
The number consists of a 4-digit integer between 0001 and 1000.

④ Data Separator
A comma "," is given.

⑤ Mantissa Part Data
The polarity "+" or "-" is always given to the top of data.
Data consists of a value shown as a decimal point plus 5-digit number.

⑥ E
The character "E" represents an exponent.

⑦ Exponent Part Data
The polarity "+" or "-" is always given to the top of data.
Data follows the present unit setting.
Table 6-3 shows the mantissa or exponent-part data under each measuring condition.

⑧ Block Delimiter
This can be changed with the program command "DLd" as follows:
DL0:CRLF<EOI> (<EOI> simultaneously with LF)
DL1:LF
DL2:<EOI> simultaneously with the final byte
DL3:LF<EOI> (<EOI> simultaneously with LF)

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6.6 Listener Specification

The listener command of the meter is roughly divided into the following three types.

(1) Command Consisting of Only Header

Example)① Command to designate device parameters such as as RI0 and R0

② Command to execute measurement and AD CAL function such as *TRG, AD0, and E

(2) Command Consisting of "Header + Data"

Example)① Command to set data such as PVS ±1.0E+2 and PHL-199.99E-10

② Command used for setting related to status register such as *SRE24 and DSE1

(3) Query Command

Example) RNG?, CNT?, and *STB?
When the meter receives the above commands, it outputs the response for them to the output buffer.

6.6.1 Header Part

(1) Space in Header
The space in header results in a syntax error.

Example)① R1 ····· OK
R␣1 ····· Syntax error

② *STB? ····· OK
*STB␣ ····· Syntax error

(2) One-character Command
Be sure to give the block delimiter after one-character commands "E", "C", and "Z".

Example) AC1ELF<EOI> ····· OK
AC1EEERR?LF<EOI> ····· Syntax error

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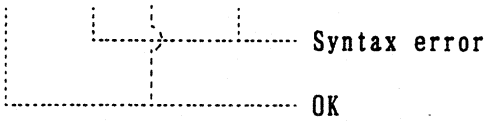
6.6.2 Data Part

(1) Separator Between Data
Be sure to give a comma "," to the separator between data.

Example) PGM␣1, 1.2E-2, 3E-1

(2) Space in Data
Among spaces in data, the space in mantissa and exponent data results in a syntax error.

例) PVS␣1.99␣99␣E-1␣2



(3) Data
Data can be set with NR1 (integer), NR2 (fixed-point data excluding exponents), and NR3 (floating-point data including exponents).

If data with the specified effective number of digits or more is received, the digit one-order lower than the effective digit is rounded to the nearest whole number.

Example) 1.234E-99→0
-1.23456789→-1.2346

6.6.3 Terminator

The block delimiter detects the following:
LF<EOI>, <EOI>, CRLF, LF,
CR<EOI>, CRLF<EOI>

6.6.4 Query Command

The query command is defined as the command to execute the set parameters, status information, and self-tests and obtain the results of execution. When a query command is received, information corresponding to the command is output to the output buffer. Data is output in the form of NR1, NR2, or NR3. For response data to be output, see the program code in Table 6-4.

Example)① PVS? (VS set value?)
→Response data : PVS␣10.000

② STB? (Status byte?)
→Response data : 8

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Table 6 - 4 Program Code

Header	Contents	Initial value
RI0	IM (Current measurement)	○
RI1 RI2 RI3 RIX?	RM (Resistance measurement) RV (Volume resistivity measurement) RS (Surface resistivity measurement) The query for the present measurement contents, response is RI0 through RI3.	
R0	AUTO Range	○
R2 R3 R4 R5 R6 R7 R8 R9 R10 RNG?	200pA Range 2nA Range 20nA Range 200nA Range 2μA Range 20μA Range 200μA Range 2mA Range 20mA Range The query for range, response is R0 and R2 through R10.	
M00	Sampling:RUN	○
M01 MOX?	Sampling:HOLD The query for sampling, response is M00 and M01.	
AD0	AD auto calibration:ON	○
AD1 ADX?	AD auto calibration:OFF The query for AD auto calibration, response is AD0 and AD1.	
AZ1	Input zero cancel execution	
IT0 IT1 IT2	Integration time:2mS Integration time:1PLC Integration time:5PLC	
IT3	Integration time:10PLC	○
IT4 IT5 IT6 ITX?	Integration time:10PLC×4 Integration time:10PLC×8 Integration time:10PLC×16 IT Query, response is IT0 through IT6.	

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Table 6 - 4 Program Code (Cont'd)

Header	Contents	Initial value
AL0	Auto range level:UP20000 DOWN 1799	○
AL1 AL2 ALX?	Auto range level:UP2000 DOWN 179 Auto range level:UP200 DOWN 17 AL Query, response is AL0 through AL2.	
LF0 LF1 LFX?	Power frequency:50Hz Power frequency:60Hz LF Query, response is LF0 and LF1.	
GA0	Input amplifier gain: ×1	
GA1	Input amplifier gain: ×10	○
GA2 GA3 GAX?	Input amplifier gain: ×100 Input amplifier gain: ×10000 GA Query, response is GA0 through GA3.	
MD0	MEASURE	○
MD1 MD2 MDX?	CHARGE DISCHARGE MD Query, response is MD0 through MD2.	
OT0	Stand-by	○
OT1 OTX?	Operate OT Query, response is OT0 and OT1.	
NM0	NULL operation:OFF	○
NM1 NMX?	NULL operation:ON NM Query, response is NM0 and NM1.	
RM0	Compare operation:OFF	○
RM1 RMX?	Compare operation:ON RM Query, response is RM0 and RM1.	
DS0	Indication:ON, Unit indication=Symbol (mA, etc.)	○
DS1 DS2 DSX?	Indication:ON, Unit indication=Exponent ($x10^{-3}$, etc.) Indication:OFF DS Query, response is DS0 through DS2.	

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Table 6 - 4 Program Code (Cont'd)

Header	Contents	Initial value
BZ0	Buzzer:ON	○
BZ1 BZX?	Buzzer:OFF BZ Query, response is BZ0 and BZ1.	
ST0	Data storage:OFF	○
ST1 STX?	Data storage:ON ST Query, response is ST0 and ST1.	
OM0	Data output mode Basic format Header:ON	○
OM1 OM2 OM3 OM9 OMX?	Data output mode Basic format Header:OFF Data output mode Recall data with data No. Header:ON Data output mode Recall data with data No. Header:OFF Data output mode Binary packed format IEEE754 OM Query, response is OM0 through OM3 and OM9.	
DL0	Block delimiter CRLF<EOI> (<EOI> simultaneously with LF)	○
DL1 DL2 DL3 DLX?	Block delimiter LF Block delimiter <EOI> (<EOI> simultaneously with final byte) Block delimiter LF<EOI> (<EOI> simultaneously with LF) DL Query, response is DL0 through DL3	
S0	SRQ ON	
S1	SRQ OFF	○
SRQ?	S0 and S1 Query, response is S0 and S1.	
IL0	VS current limiter:300mA	○
IL1 IL2 ILX?	VS current limiter:100mA VS current limiter:10mA IL Query, response is IL0 through IL2.	
DA0 DA1 DA2 DA3 DA4 DA5 DA6 DA7 DA8 DAX?	ANALOG OUT (D/A OUT) OFF ANALOG OUT (D/A OUT) ON AAA99 ANALOG OUT (D/A OUT) ON 1AAA9 ANALOG OUT (D/A OUT) ON 19AAA ANALOG OUT (D/A OUT) ON 199AA ANALOG OUT (D/A OUT) ON BBB99 ANALOG OUT (D/A OUT) ON 1BBB9 ANALOG OUT (D/A OUT) ON 19BBB ANALOG OUT (D/A OUT) ON 199BB DA Query, response is DA0 through DA8.	* R8340A only, A syntax error occurs for R8340.

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Table 6 - 4 Program Code (Cont'd)

Header	Contents	Initial value
BD0 BD1 BD2 BDX?	BCD OUT OFF BCD OUT BCD BCD OUT BINARY (16bit+10ⁿ) BD Query, response is BD0 through BD2.	* R8340A only, A syntax error occurs for R8340.
CL0 CL1 CL2	Contact checking level:×10 Contact checking level:×5 Contact checking level:×2	
CL3	Contact checking level:×1	○
CL4 CL5 CL6 CLX?	Contact checking level:×0.5 Contact checking level:×0.2 Contact checking level:×0.1 CL Query, response is CL0 through CL6.	
CI1 CI2 CI1?	Contact initialization measurement execution (2ms) Contact initialization measurement execution (1PLC) Contact initialization measurement is executed and outputs the data at initialization (2ms) Respense is to 0 to 32767. measurement data (0000.0 to 32767(unit : pF) 99999 at an initial error)	
CI2?	Contact initialization measurement is executed and outputs the data at initialization (1PLC) Respense is to 0 to 32767. measurement data (0000.0 to 32767(unit : pF) 99999 at an initial error)	
ABT	Sequence program operation is interrupted.	
Special command (Terminator is always needed after the command.)		
E	Measurement start and program start, Same with *TRG and GET	
C	Device initialization, Same with SDC and DCL	
Z	Device and parameter initialization, Same with *RST	

CAUTION

The command to interrupt the sequence program operation includes SDC and DCL in addition to ABT. The operation is not interrupted by other commands.

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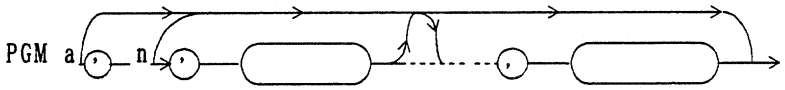
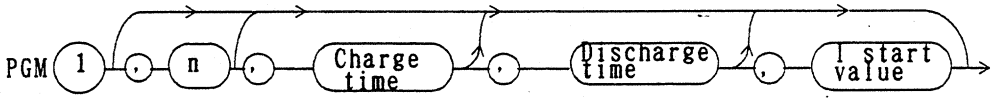
Table 6 - 4 Program Code (Cont'd)

Header	Format	Contents
PVS PVS?	PVS ±dd.dddE ±dd PVS → [Data] →	Voltage generation data It is allowed to use <NR1>, <NR2> and <NR3> for the data part. PVS Query, response is PVS␣XX.XXX
PHL PHL?	PHL ±hh.hhhE ±hh, ±11.111E ±11 PHL → [h] →, → [l] →	Compare Upper/Lower setting h :Upper data l :Lower data Error except for h>l It is allowed to use <NR1>, <NR2> and <NR3> for the data part. PHL Query, response is PHL±hh.hhhE ±hh ±11.111E±11
PEL PEL?	PEL 0, tt.tt PEL 1, tt.tt PEL 2, tt.tt,vv.vv, ss.ss PEL 0, → [t] → PEL 1, → [t] → PEL 2, → [t] →, → [v] →, → [s] →	50mm-dia-electrode coefficient 70mm-dia-electrode coefficient Optional-electrode coefficient t;Thickness (Unit:mm) v;Volume-resistivity electrode coefficient s;Surface-resistivity electrode coefficient The previously set value is used when "t", "v", and "s" are omitted. It is allowed to use <NR1>, <NR2>, and <NR3> for the data part. Response uses <NR1> or <NR2> PEL␣d, tt.tt,vv.vv,ss.ss d=0 to 2 There is no omission.
PTD PTD?	PTD dd.ddd PTD → [Data] →	Trigger delay It is allowed to use <NR1>, <NR2>, and <NR3> for the data part. PTD Query, response is PTD␣dd.ddd.
PAD PAD?	PAD dd.ddd PAD → [Data] →	Autorenge delay It is allowed to use <NR1>, <NR2>, and <NR3> for the data part. PAD Query, response is PAD␣dd.ddd.

<NR1> : Integer data (Example:+123)
<NR2> : Fixed-point data (Example:+12.34)
<NR3> : Floating-point data (Example:123.4E −10)

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Table 6 - 4 Program Code (Cont'd)

Header	Contents
PGM	 a=0, 1 0;Normal, 1;Sequence program  For n=1 to 3 : Charge time and discharge time only For n=4 : Charge time, discharge time, and I start value For n=5 : Charge time, discharge time, and measurement time. When the above is omitted, the previously set value is used. Example: PGM1, 4,,,100E-12
PGM?	The query response for PGM is the same with the PGM command. (No omission) Example: PGM␣1, 4, 10, 10, 100E-12
PRE	PRE dddd dddd:1 to 1000 (Data number) It is allowed to use <NR1>, <NR2>, and <NR3> for the data part. ・Specify the recall data No. (When the OM2 and OM3 are specified, specify the data to be output with the command.)
PRE?	The query response for PRE is PRE␣dddd.

CAUTION

Program No. 0 of the sequence program cannot be used with GPIB.

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Table 6 - 4 Program Code (Cont'd)

Header	Data, Characters in parentheses show response.	Contents (Processing)
CNT?	(0 or 1)	Contact checking is executed and the checking results are output. When the response is "0", checking is OK. If the response is "1", checking is NG.
CNX?	(0 to 32767)	Contact checking is executed and the checking results are output. 0, 0 to 32767 1, 0 to 32767 measurement data (0000.0 to 32767 (unit:pF) / at measurement over 99999) 0 : OK 1 : NG
DNO?	(0 to 1000)	The number of recall data values in the buffer memory is output. The response is 0 through 1000.
ERR?	(0 to 32767)	The contents of device, execution, and self-test errors are output. The response is output by converting 16-bit error flag into ASCII data. (No error for "0") See Item 6.7.4.
*IDN?	(ASCII Character)	The meter ID is output. ADVANTEST, R8340, 0, 01010101. Maker name / Model / Revision No. (No serial No.)
*OPT?	(ASCII Character)	Option numbers are output. The value "0" is output when there is no option.
*TST?	(0 to 4095)	The self-test is executed and the results are output. The response is output by converting the error flag into ASCII data. When the value "0" is output, the self-test is OK. See Item 6.7.5.
*TRG		Start of measurement and start of program is specified. GET: Same with the "E" command
*RST		Reset: Same with the "Z" command. The set parameter is initialized. For details, see Section 6.8.

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Table 6 - 4 Program Code (Cont'd)

Header	Data, Characters in parentheses show response.	Contents (Processing)
*CLS		Status byte registers other than MAV and the SESR and DESR are cleared, and also the output buffer related to status is cleared.
*SRE	0 to 255	The service request enable register is set. The service request enable register decides the bit of the status register to transmit SRQ.
*SRE?	(0 to 63) (128 to 191)	The contents of the service request enable register are output. Because the RQS bit (bit 6) is not set, the response results in 0 through 63 and 128 through 191.
*STB?	(0 to 255)	The contents of the status register are output. The bit 6 outputs ORed data of all other bits not as the RQS bit but as the MSS bit.
*ESE	0 to 255	The standard event status enable register (SESER) is set. See Item 6.7.2.
*ESE?	(0 to 255)	The contents of the SESER are output. The response is 0 through 255.
*ESR?	(0 to 255)	The contents of the standard event status register (SESR) are output. When the output data is read, the SESR is cleared. The response is 0 through 255. See Item 6.7.2.
DSE	0 to 255	The device event status enable register (DESER) is set. See Item 6.7.3.
DSE?	(0 to 255)	The contents of the DESER are output. The response is 0 through 255.
DSR?	(0 to 255)	The contents of the device event status register (DESER) are output. When the output data is read, the DESER is cleared. The response is 0 through 255. See Item 6.7.3.

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Table 6 - 4 Program Code (Cont'd)

Header	Data, Characters in parentheses show response.	Contents (Processing)
*PSC	-32768 to 32767	The power-on clear flag is set or reset. * When PSC is "0", the power-on clear flag is reset. As a result, the service request enable registers SESER and DESER are not cleared when the power is on. * When PSC ranges between 32768 and 32767 (other than 0), the power-on clear flag is set. As a result, the service request enable registers SESER and DESER are cleared when the power is on.
*PSC?	(0 or 1)	The state of the power-on clear flag is output. The power-on clear flag is reset when the response is 0 and set when the response is 1.

6.6.5 Command Buffer and Measured Data Buffer

The meter, in order to shorten the GPIB occupying time, stores program codes in the command buffer under the listener mode and receives the block delimiter before analyzing and executing the stored program codes. During execution of the codes, it is possible to control other units. By setting measured data to "ST1", the data is successively stored in the measured data buffer and the output request is set to the "OM2", "OM3", or "OM9". When the talker mode is specified, data can be transferred in order of measurement.
The buffer size is shown in the table below.

Buffer	Size
Command buffer	256 bytes
Measured data buffer	1000 data value

6.6.6 Controller Interruption During Data Transfer Between Units

The GPIB system makes it possible to transfer data between units other than controllers. When the controller executes interruption to add a new listener during data transfer between units (during handshake), data transfer between units is completed and the priority is given to the interruption by the controller. When the controller changes the mode to the serial polling mode, data transfer between units is interrupted and the priority is given to the interruption by the controller.

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6.7 Status Byte

6.7.1 Structure of Status Byte Register

Figure 6-3 shows the structure of the status byte register. Table 6-5 shows the description of each bit of the register. The contents of the register are read with the serial-polling or *STB? command. Data in the bit 6 is read as MSS (logic OR of other bits) with the *STB? command.
Transmission of SRQ is controlled by the service request enable register. The register corresponds to the status byte register in 1 to 1 and SRQ can be transmitted by the bit set to "1".
The setting is made with the *SRE command and the set contents can be read with the *SRE? command.

Example) When *SRE1 is set, SRQ is transmitted at the end of measurement.

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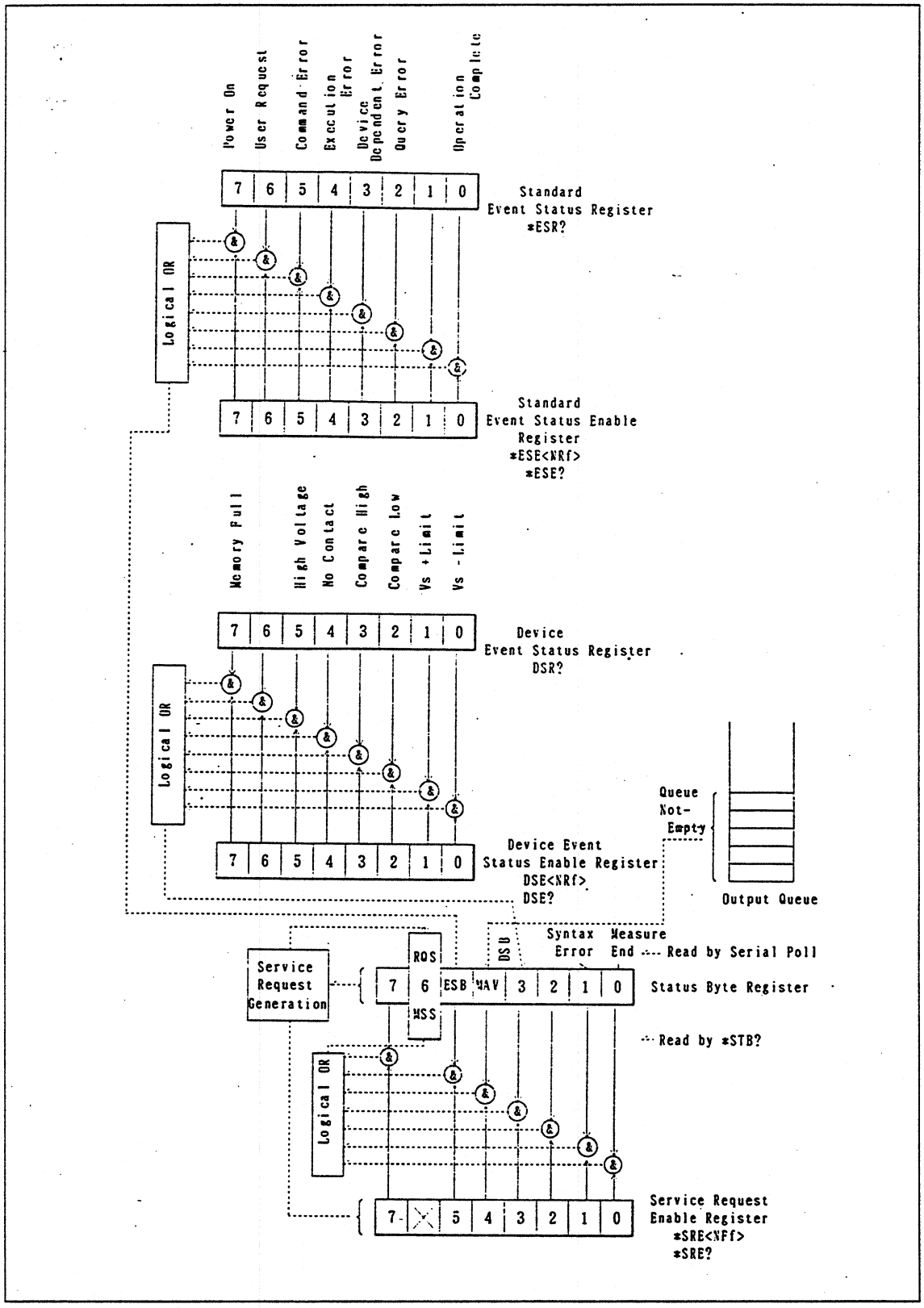


Figure 6 - 3 Structure of Status Byte Register

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Table 6 - 5 Status Byte Register

bit	Name	Contents
0	Measure End	This is set at the end of measurement and reset at the start of measurement or end of measured data output.
1	Syntax Error	This is set when the command error (program data error, listener command error, or listener command buffering overflow) occurs.
2	END	This is set when contact checking, contact initialization measurement, and sequence program end.
3	DSB	This is set when a factor of the DESR bit concerned is generated while any one of DESER bits is set to ENABLE and reset when DESER is read. See Item 6.7.3.
4	MAV	This is set when output data is set to the output buffer and reset when output data is read.
5	ESB	This is set when a factor of the SESR bit concerned is generated while any one of SESER bits is set to ENABLE and reset when SESR is read. See Item 6.7.2.
6	RQS(MSS)	This is set when bits 0 through 5 are set.
7	——	Not in use.

CAUTION

1. For the status byte register, only the RQS bit (bit6) is cleared by serial polling.
2. Though the register and output buffer related to status are cleared with the *CLS command, the measured-data output buffer is not cleared with the command. Therefore, the MAV bit (bit4) is not cleared even if the *CLS command is received when measured data is present in the output buffer.
3. If the power switch is turned on when the power-on reset flag is set for *PSC ranging between -32767 and 32768 (other than 0), the status byte enable registers SESER and DESER are cleared but SRQ is not transmitted.

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6.7.2 Structure of Standard Event Status Register

Figure 6-4 shows the structure of the standard event status register (SESR). Table 6-6 shows the description of each bit of this register. The register is controlled by the standard event status enable register (SESER). When the SESER is set, the bit5 of the status byte register is set if a factor of the bit concerned is generated. In this case, if the bit5 of the status byte enable register is set to ENABLE, the bit6 of the status byte register is set and SRQ is transmitted.
The SESR can be read with the *ESR? command.
The SESER can be written with the *ESE command and read with the *ESE? command.

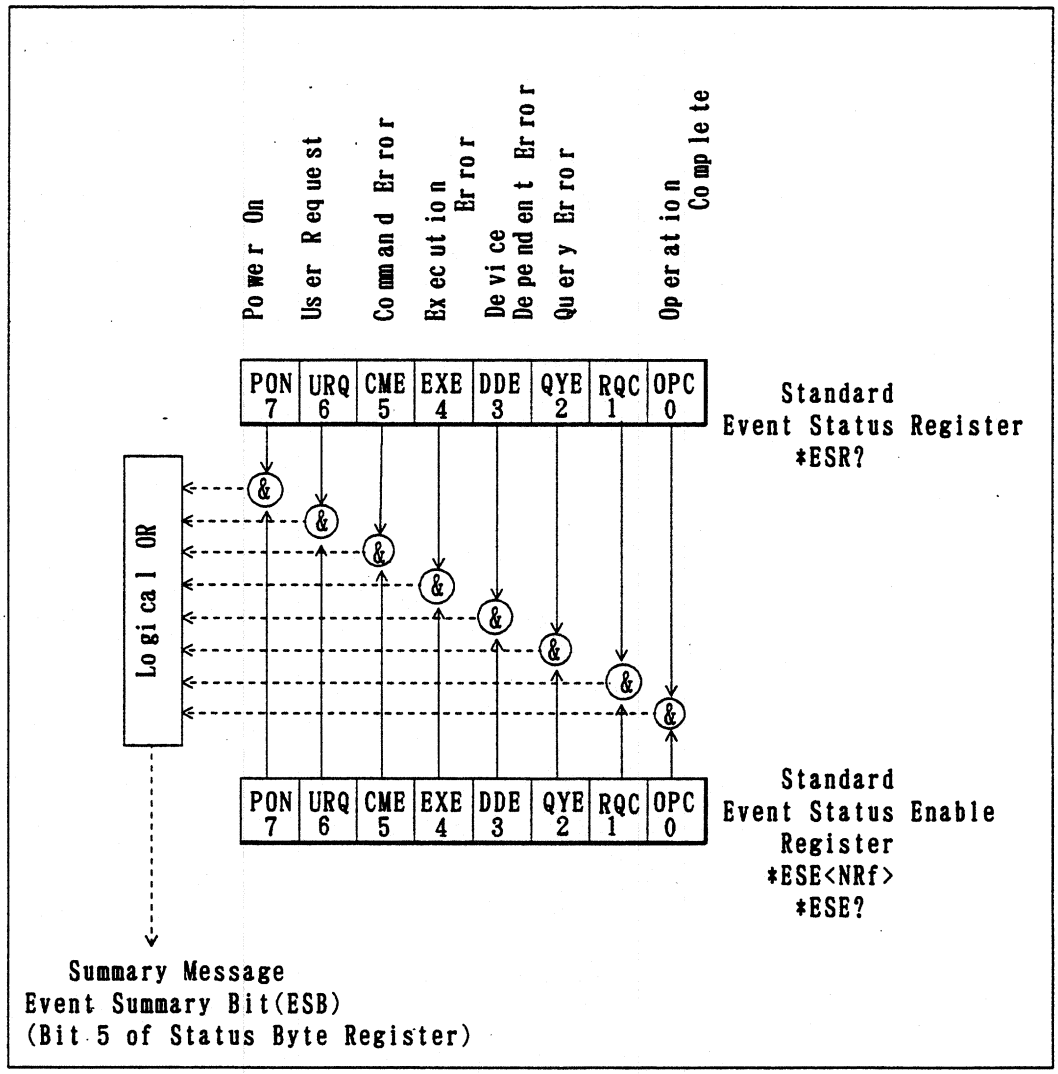


Figure 6 - 4 Standard Event Status Register

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Table 6 - 6 Standard Event Status Register

bit	Name	Contents
0	OPC (Operation Complete)	Not in use.
1	RQC	Not in use.
2	QYE (Query Error)	This is set when data is read though no output data is present or the output buffer is overflowed or overloaded.
3	DDE (Device Dependent Error)	This is set when an error occurs during the operation including over-range and overload or a failure occurs.
4	EXE (Execution Error)	This is set when input data is out of the internally set range or a command cannot be executed.
5	CME (Command Error)	This is set when the header is undefined, the data format is incorrect, a syntax error is found in a command, or GET arrives while a command is received.
6	URQ	Not in use.
7	PON (Power On)	This is set when the power is turned on.

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6.7.3 Structure of Device Event Status Register

Figure 6-5 shows the structure of the device event status register. Table 6-7 shows the description of each bit of this register. The register is controlled by the device event status enable register (DESER). The DESR output is collected in the bit3 of the status byte register.
The DESR is read with the DSR? command.
The DESER is written with the DSE command and read with the DSE? command. The register notifies the condition of internal operation unlike the DDE bit of the SESR which notifies errors.

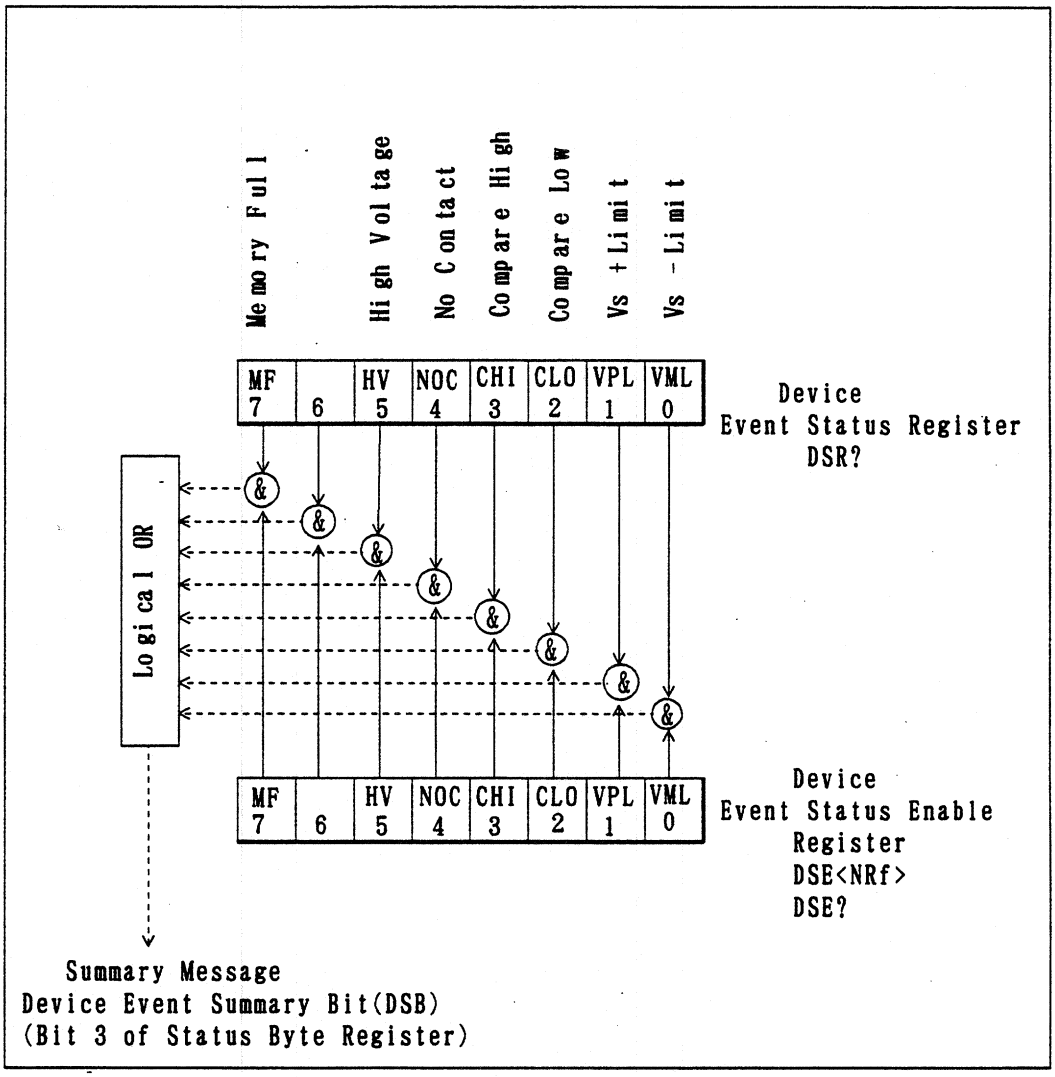


Figure 6 - 5 Device Event Status Register

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Table 6 - 7 Device Event Status Register

bit	Name	Contents
0	VML Vs -Limit	This is set when the V-SOURCE negative current limiter (sink limiter) operates.
1	VPL Vs +Limit	This is set when the V-SOURCE positive current limiter (source limiter) operates.
2	CLO Compare Low	This is set when LO is judged as the result of COMPARE operation.
3	CHI Compare High	This is set when HI is judged as the result of COMPARE operation.
4	NOC No Contact	This is set when NG (imperfect contact) is detected as the result of contact checking.
5	HV High Voltage	This is set when V SOURCE is set to 100V or more or 100V or more is applied to the V-SOURCE terminal.
6	——	Not in use.
7	MF Memory Full	This is set when the data buffer memory is full (1000 data values).

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6.7.4 Error Register

The contents of the internal error register is output as the response of the ERR? command. This register consists of 16 bits and each bit is as shown in Table 6-8.
The ERR? command response is output as data value between 0 and 32767 by converting the error register contents into ASCII data.

Table 6 - 8 Error Register

bit	Set bit of SESR		Error contents	Error Indication
	Name	bit		
0	EXE	bit4	Vs is set to zero for RM measurement.	VERR
1	EXE	bit4	Contact checking cannot be judged.	ERROR
2	EXE	bit4	Contact initialization cannot be checked.	C.INIT ERROR
3	QYE	bit2	Recall is executed when there is no output data.	——
4	CME	bit5	Program data format error	——
5			Listener command error	——
6			Listener command input buffer overflow	——
7	DDE	bit3	Over-range	OL
8			Overload	OVL
9			Operation error	ERR 5
10			Overvoltage detection	OVER VIN
11			Input fuse melting	FUSE OPEN
12			Overheat	OVER HEAT
13			Internal serial transfer error	ERR4
14			Self-test error	See Table 6-9.
15	—	—	Not in use	——

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6.7.5 Self-test Error Register

As the response of the *TST? command, the contents of the 16-bit self-test error register are converted into ASCII data and output as the data values between 0 and 4095. When an error is detected in the self-test, the bit 3 DDE of the SESR is set. When the response is "0", the self-test is OK.

Table 6 - 9 Self-test Error Register

bit	Error contents	Error Indication
0	Defect of input amplifier	ERR IA
1	Defect of AD converter	ERR AD
2	Defect of 100V amplifier	ERR HV
3	Defect of 1000V amplifier	ERR KV
4	Serial transfer error	ERR 4
5	Breakdown of calibration primary data	ERR 2
6	Breakdown of calibration secondary data	ERR 3
7	Breakdown of backup parameter (Panel backup, etc.)	ERR 1
8	RAM read/write error	ERR RA
9	E^2PROM read/write error	ERR EP
10	Logic ROM error	ERR LR
11	Analog ROM error	ERR AR
12	Not in use	
13	Not in use	
14	Not in use	
15	Not in use	

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6.8 Status at Initialization and Command Reception

Table 6 - 10 Status Change by Each Command

Command	Talker (TLK)	Listener (LTN)	SRQ (RQS bit)	Status byte SESR DESR	SRQ enable SESER DESER	Data output buffer	Set parameter
Power On	Clear	Clear	By power-on clear flag	Bits other than PON bit are cleared.	By power-on clear flag	Clear	*1
"*RST" "Z"							Initial-ization
DCL, SDC "C"				Only MAV bit is cleared.		Clear	
IFC	Clear	Clear					
"*CLS"			By MAV bit	Bits other than MAV bit are cleared.			
GET, "E" "*TRG"				Measure end bit is cleared.			
Talker designation	Set	Clear					
Talker cancel designation	Clear						
Listener designation	Clear	Set					
Listener cancel designation		Clear					
Serial polling			Clear				

DCL : Device Clear
SDC : Selected Device Clear
GET : Group Execute Trigger
*1 : When pressing the auto key immediately after the power is on, the parameter is initialized.

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6.9 Program Example

The following shows the program using HP-9816 for a personal computer and its description.
In the above program examples, the address of the meter is set to "1".

- Example of charging the insulation resistance of a sample for 10ms before measuring the resistance and outputting the measurement results. ····· See (1)
- Example of judging the insulation resistance of a sample with a comparator when executing contact checking and starting measurement with external trigger signal. ····· See (2)
- Example of dielectric strength test on a transistor. ····· See (3)

(1) Example of charging the insulation resistance of a sample for 10ms before measuring the resistance and outputting the measurement results

Measurement condition ····· Vs:100V, Charge time:10ms

• Program example1

```
10   !
20   !      EXAMPLE 1
30   !
40   DIM A$[20]
50   CLEAR 701
60   !
70   OUTPUT 701;"RI1,RO,M01"
80   OUTPUT 701;"IT0,GA1,AL0"
90   OUTPUT 701;"PVS100"
100  !
110  OUTPUT 701;"MD2"
120  OUTPUT 701;"OT1"
130  OUTPUT 701;"MD1"
140  WAIT .01
150  OUTPUT 701;"MD0"
160  !
170  TRIGGER 701
180  ENTER 701;A$
190  PRINT A$
200  END
```

• Data example

```
RM 010.09E+09
```


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• Description of program example1

Line number	Description
10 to 30	Comment sentence
40	Reserving the measured data area
50	Initializing the GPIB interface device
70 to 90	Setting the meter parameter "RI1 " ····· Resistance measurement "R0 " ····· Auto range "MO1 " ····· Sampling:HOLD "IT0 " ····· Integration time:2ms "GA1 " ····· Input amplifier gain: ×10 "AL0 " ····· Auto range level:20000 "PVS100 "····· VS100V
100	Comment sentence
110	Setting the discharge state
120	Setting the operation state
130	Setting the discharge state
140	Waiting for 10ms
150	Setting the measurement state
160	Comment sentence
170	Starting the measurement
180	Receiving the data
190	Displaying the data
200	Ending the program

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(2) Example of judging the insulation resistance of a sample with a comparator when executing contact checking and starting measurement with external trigger signal

Criterion: The case of $1\times10^{7}\Omega \leqq RX \leqq 1\times10^{12}\Omega$ is judged as pass.

• Program example2

```
10    !
20    !     EXAMPLE 2
30    !
40    !
50    ON INTR 7 GOSUB Srq
60    CLEAR 701
70    OUTPUT 701;"*CLS"
80    OUTPUT 701;"SO,RI1,RO,MO1"
90    OUTPUT 701;"ITO,GA1,AL1,RM1"
100   OUTPUT 701;"PVS50,PHL1E+12,1E+7"
110   OUTPUT 701;"*SRE24,DSE12"
120   !
130   OUTPUT 701;"MD2"
140   OUTPUT 701;"OT1"
150   OUTPUT 701;"MD1"
160   WAIT .01
170   OUTPUT 701;"MDO"
180   !
190   OUTPUT 701;"CNT?"
200   ENTER 701;B
210   IF B=1 THEN 240
220   K$="CONTACT"
230   GOTO 250
240   K$="NO_CONTACT"
250   !
260   ENABLE INTR 7;2
270   !
280   !     EXT TRIGGER WAIT
290   !
300   GOTO 300
310 Srq:  !
320       S=SPOLL(701)
325       ENTER 701;D$
330       IF BIT(S,3)=0 THEN 410
340       OUTPUT 701;"DSR?"
350       ENTER 701;A
360       IF BIT(A,2)=1 THEN 390
365       IF BIT(A,3)=0 THEN 410
370       L$="HIGH"
380       GOTO 415
390       L$="LOW"
400       GOTO 415
410       L$="GO"
415       PRINT D$,K$,L$
420       ENABLE INTR 7;2
430       RETURN
440   END
```

• Data example

```
RMH +0008.9E+09
CONTACT
HIGH
```


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• Description of program example2

Line number	Description
10 to 40	Comment sentence
50	Defining the interrupt processing routine
60	Initializing the GPIB interface device
70	Clearing the status byte register
80 to 110	Setting the meter parameter "S0" ····· Transmitting SRQ "RI1" ····· Resistance measurement "R0" ····· Auto range "MO1" ····· Smpling:HOLD "IT0" ····· Integration time:2ms "GA1" ····· Input amplifier gain: ×10 "AL1" ····· Auto range level:2000 "RM1" ····· COMPARE operation ON "PVS50" ····· VS50V "PHL1E+12,1E+7" ····· Upper limit value:$1\times10^{12}\Omega$, Lower limit value:$1\times10^{7}\Omega$, "*SRE24" ····· Setting the service request enable register to "24" "DSE12" ····· Setting the device event status enable register to "12"
120	Comment sentence
130	Setting the discharge state
140	Setting the operation state
150	Setting the charge state
160	Waiting for 10ms
170	Setting the measurement state
180	Comment sentence
190	Executing the contact checking
200	Receiving the contact checking result data
210	Branching to the line number 240 if the result data is "1" (NG)
220	Saving the "CONTACT" indication
230	Branching to the line number 250
240	Saving the "NO_CONTACT" indication
250	Comment sentence
260	Enabling the interrupt form the GPIB
270 to 290	Comment sentence
300	Waiting for the external trigger to be applied at the line number 300
310	Interrupt processing routine name
320	Reading the status byte by polling the meter
325	Receiving measured data
330	Branching to the line number 410 if the bit 3 of the status byte is "0"
340	Executing the read command of the device event register

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• Description of program example2 (Continued)

Line number	Description
350	Reading the device event register
360	Branching to the line number 390 if data bit 2 is "1"
365	Branching to the line number 410 if the data bit 3 is "0"
370	Saving the "HIGH" indication
380	Branching to the line number 415
390	Saving the "LOW" indication
400	Branching to the line number 415
410	Saving the "GO" indication
415	Displaying the measured data, and results of contact checking and COMPARE operation
420	Enabling the interrupt from the GPIB
430	Returning to the main processing routine
440	Ending the program

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(3) Example of Dielectric Strength Test on a Transistor

The current at puncture is set to 100 μA and generated voltage is read when the applied voltage is increased 1V by 1V starting with 101V and the current exceeds 100 μA.

• Program example3

```
10    !
20    !     EXAMPLE 3
30    !
40    DIM A$[20]
50    CLEAR 701
60    !
70    OUTPUT 701;"S1,RI0,R0,M01"
80    OUTPUT 701;"IT1,GA3,AL0,RM1"
90    OUTPUT 701;"PHL100E-6,0E-12"
100   OUTPUT 701;"*SRE9,DSE8"
110   !
120   OUTPUT 701;"MD2"
125   OUTPUT 701;"PVS0"
130   OUTPUT 701;"OT1"
140   OUTPUT 701;"MD1"
150   WAIT .01
160   OUTPUT 701;"MD0"
170   OUTPUT 701;"*CLS"
180   Vs_data=101
190   OUTPUT 701;"PVS";Vs_data
200   TRIGGER 701
210   S=SPOLL(701)
220   IF BIT(S,0)=0 THEN 210
230   IF BIT(S,3)=1 THEN 270
240   Vs_data=Vs_data+1
245   IF Vs_data=1001 THEN 295
250   GOTO 190
260   !
270   OUTPUT      "PVS?"
280   ENTER 701;A$
290   PRINT A$
295   OUTPUT 701;"OT0"
300   END
```

• Data example

```
PVS 0205.0
```


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• Description of program example3

Line number	Description
10 to 30	Comment sentence
40	Reserving the data area
50	Initializing the GPIB interface device
60	Comment sentence
70 to 100	Setting the meter parameter "S1" ····· SRQ stop "RI0" ····· Current measurement "R0" ····· Auto range "M01" ····· Sampling:HOLD "IT1" ····· Integration time:1PLC "GA3" ····· Input amplifier gain: ×10000 "AL0" ····· Auto range level:20000 "RM1" ····· COMPARE operation ON "PHL100E-6,0E-12" ····· Upper limit value:100 μA Lower limit value:0 pA "*SRE9" ····· Setting the service request enable register to "9" "DSE8" ····· Setting the device event status enable register to "8"
110	Comment sentence
120	Setting the discharge state
125	Setting the VS data to 0V
130	Setting the operation state
140	Setting the charge state
150	Waiting for 10ms
160	Setting the measurement state
170	Clearing the status byte register
180	Setting the initial value (101V) of VS data variable
190	Setting the VS data
200	Starting the measurement
210	Polling the meter to read the status byte
220	Branching to the line number 210 if the bit 0 of the status byte is "0"
230	Branching to the line number 270 if the bit 3 of the status byte is "1"
240	Adding "1" to the VS data variable data
245	Branching to the line number 295 when VS data is set up to 1000V
250	Branching to the line number 190
260	Comment sentence
270	Executing the command to read VS data
280	Receiving the VS set data
290	Displaying the data
295	Setting the stand-by state
300	Ending the program

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