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DL305 User Manual

Manual Number: D3-USER-M

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Or Not If Greater Than Counter (OR NOT CNT) DL330P Only 12-15
And If Greater Than or Equal To Timer (AND TMR) DL330P Only 12-16
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1

Getting Started

In This Chapter. . . .

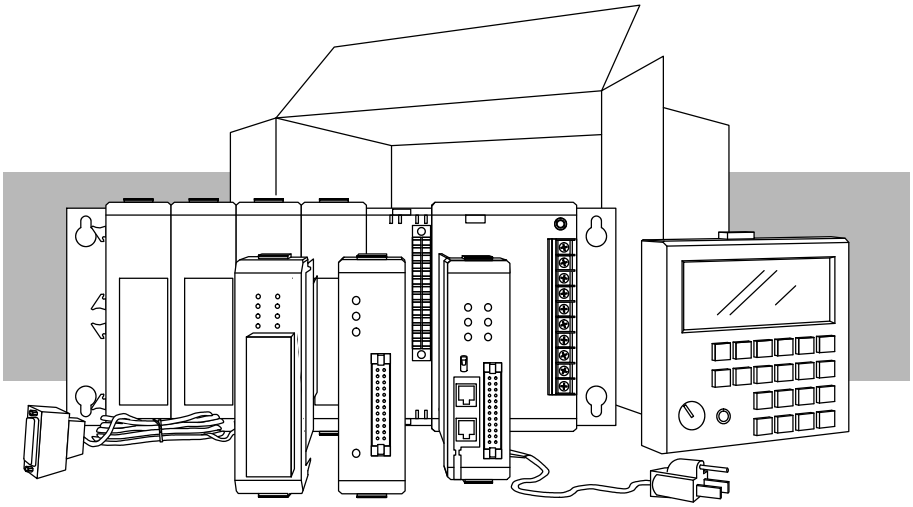
— Introduction
— DL305 System Components
— *Direct*LOGIC™ Part Numbering System
— A Few Steps to a Successful System

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Introduction

The Purpose of this Manual

Thank you for purchasing our DL305 family of automation products. This manual shows you how to install the equipment, and it also helps you understand the system operation characteristics.



Since we constantly try to improve our product line, we occasionally issue addenda that document new features and changes to the products. If an addendum is included with this manual, please read it to see which areas of the manual or product have changed.

Who Should Read this Manual

If you understand PLC systems our manuals will provide all the information you need to get and keep your system up and running. We will use examples and explanations to clarify our meaning and perhaps help you brush up on specific features used in the DL305 system. This manual is not intended to be a generic PLC training manual, but rather a user reference manual for the DL305 system.

Where to Begin

If you are in a hurry and already understand the DL305 system please read Chapter 2, Installation and Safety Guidelines, and proceed on to the chapter pertaining to your needs. Be sure to keep this manual handy for reference when you run into questions. If you are a new DL305 customer, we suggest you read this manual completely so you can understand the wide variety of products, configurations, and procedures used with the DL305 family of products. We believe you will be pleasantly surprised with how much you can accomplish with ***AutomationDirect*** products.

If you're really in a hurry, check out Appendix A. This appendix has a quick start that will show you how to quickly connect and program a very simple system.

Supplemental Manuals

Depending on the products you have purchased, there may be other manuals that are necessary for your application. If you have purchased analog I/O, specialty modules, or ***Direct***SOFT, or you will be using remote I/O or networking, you will want to supplement this manual with the manuals written for these products.

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How this Manual is Organized

Ch 1: Getting Started – provides an overview of all the components that can be used to make up one or many DL305 systems. This chapter shows the basic concepts of how the pieces fit together. It also explains the DL305 part numbering system, which will help you quickly identify the various types of modules.

Ch 2: Installation and Safety Guidelines – shows you how to prepare for system installation, and gives you guidelines for providing a safe environment for your personnel and process. Be sure to read this chapter so potential safety problems can be avoided. In this chapter you will find topics you must consider when installing a system, the environmental specifications, component dimensions, safety guidelines, installation guidelines, etc.

Ch 3: DL330/DL330P/DL340 CPU Specifications – provides details of each of the DL305 CPUs. This chapter contains the operating specifications for the CPUs, detailed information on the different types of program storage media available, and some basic procedures needed to get the CPU ready for programming.

Ch 4: System Configuration, Bases and Expansion Bases – provides selection and installation criteria for Local I/O and Local Expansion I/O. This chapter also discusses the system power budget, which is an important part of the planning and installation process.

Ch 5: I/O Module Selection Criteria – contains specific considerations which affect I/O selection such as sinking, sourcing, and temperature derating characteristics.

Ch 6: Discrete Input Modules – explains each term you will find on our specification sheets, provides specifications, wiring diagrams and derating curves (where applicable) for the DL305 Discrete Input Modules.

Ch 7: Discrete Output Modules – explains each term you will find on our specification sheets, provides specifications, wiring diagrams and derating curves (where applicable) for the DL305 Discrete Output Modules.

Ch 8: System Operation – explains how the DL305 CPUs control the system operation. This includes information on I/O updates, application program execution and memory structure.

Ch 9 : RLL Programming Concepts – explains the basic concepts used in RLL programming.

Ch 10: RLL*PLUS* Programming Concepts – explains the basic concepts used in the RLL*PLUS* programming. This programming method greatly reduces program design time and simplifies machine startup and troubleshooting.

Ch 11: Instruction Set – explains how each individual instruction operates.

Ch 12: RLL*PLUS* Instruction Set – explains the instructions used with the DL330P CPU. It also shows some instructions that operate differently with this CPU.

Ch 13: Maintenance and Troubleshooting – is a guide designed to aid you in diagnosing, repairing and avoiding system problems.

Appendices A – D – there are several appendices referred to throughout the manual. These include things such as a quick start, error code listing, instruction execution times, etc.

Technical Assistance

We realize even though we strive to be the best, we may have arranged our information in such a way you cannot find what you are looking for. If you need assistance, please, call us at 1-800-633-0405. Our technical support group is glad to work with you in answering your questions. They are available weekdays from 8:00 a.m. to 6:00 p.m. eastern standard time. If you find a problem with any of our products, services or manuals, please fill out and return the Suggestions card included with this manual.

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DL305 System Components

The DL305 product family is one of the most versatile and widely accepted PLCs used for small control applications. These CPUs are small yet powerful. Their modular design and expansion capability blend well with todays fast moving industry. The following is a summary of the major DL305 system components.

CPUs

There are three CPUs in this product line, the DL330, the DL330P and the *new* DL340. Details of these CPU are covered in Chapter 3, DL330/DL330P/DL340 CPU Specifications.

Bases

Three base sizes are available in the system: 5 slot, 8 slot and 10 slot.

I/O Configuration

The DL330 and DL330P CPUs support up to 128 local I/O and 176 local expansion I/O. The DL340 supports 136 local I/O and 184 local expansion I/O. Each of these I/O configurations is explained in Chapter 4, Bases and Expansion Bases and I/O Configuration.

I/O Modules

The DL305 has one of the most diverse I/O module selections in the industry. A complete range of discrete modules which support 24 VDC, 125 VDC, 110/220 VAC and up to 10A relay outputs are offered. The analog modules provide 12 bit resolution and several selections of input and output signal ranges (including bipolar). The specialty modules include 10KHz high speed input, thermocouple, general purpose communication, and more.

Programming Methods

There are two programming methods available, RLL (Relay Ladder Logic) and RLL^{PLUS}. RLL^{PLUS} combines the added feature of flow chart programming (stages) to the standard RLL language. RLL^{PLUS} is only available for the DL330P CPU. All of the DL305 CPUs support RLL programming. ***Direct***SOFT supports both RLL and RLL^{PLUS} programming. Two handheld programmers are available, the D3-HPP which supports RLL^{PLUS} and the D3-HP which only supports RLL programming. The key pads for each handheld programmer differ, so it is recommended the handheld programmer that directly supports your CPU be used for programming.

DirectSOFT **Programming for Windows™**

The DL305 can be programmed with one of the most advanced programming packages in the industry — ***Direct***SOFT. ***Direct***SOFT runs under Windows and supports many of the windows based features you are already familiar with such as cut and paste between applications, point and click editing, viewing and editing multiple application programs at the same time, browsers, etc. ***Direct***SOFT universally supports the ***Direct***LOGIC CPU families. This means you can use the *same* ***Direct***SOFT package to program DL205, DL305, DL405 or any new CPUs we add to our product line. There is a separate manual that discusses ***Direct***SOFT programming software.

Handheld Programmer

All DL305 CPUs have a built-in programming port for use with the handheld programmers (D3-HPP and D3-HP). Handheld programmers can be used to create, modify and store programs to cassette tape, as well as debug your application program. There is also a separate manual that discusses the DL305 Handheld Programmers.

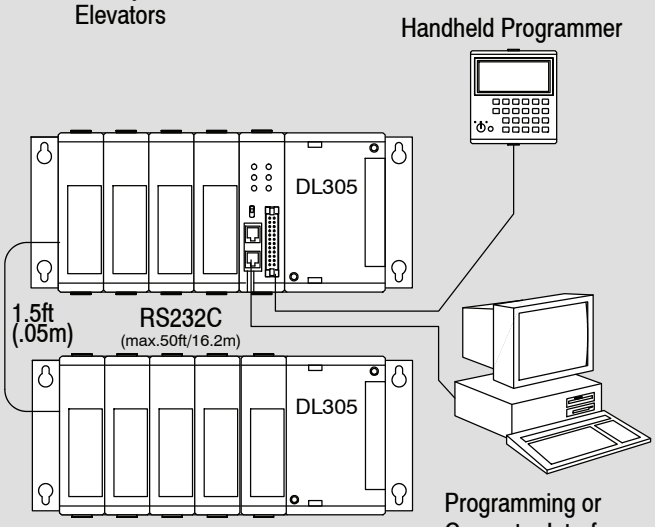
DL305 System Diagrams

The next page shows a generic example highlighting the major components and configurations of the DL305 system. The following two pages highlight the specific components which can be used to build your system.

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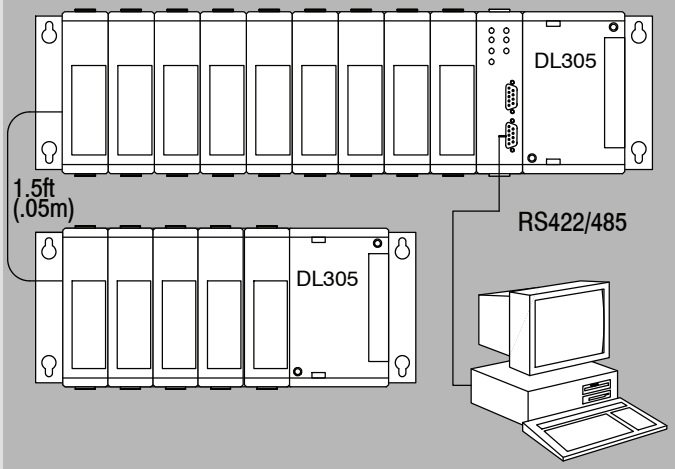
Machine Control

Packaging
Conveyors
Elevators

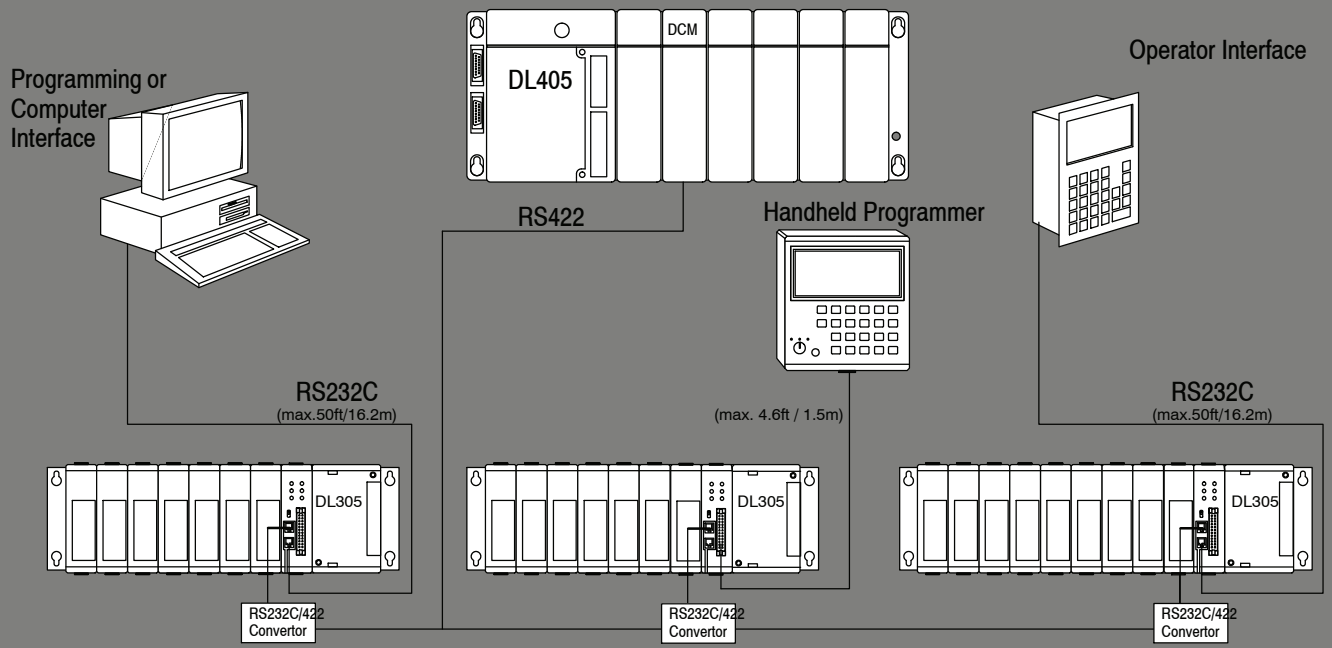


Computer Controlled I/O

Industry Standard Computer I/O Protocol
OPTOMUX™ (Serial RS422/485)
PAMUX™ (Parallel)

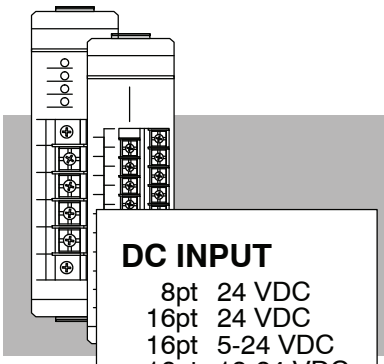


Networking

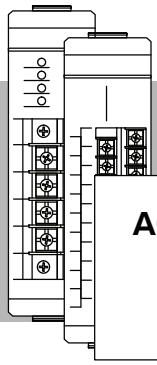


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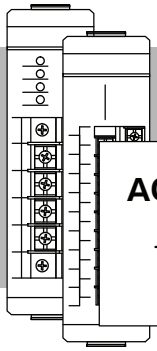
*Direct*LOGIC DL305 Family



DC INPUT
8pt 24 VDC
16pt 24 VDC
16pt 5-24 VDC
16pt 12-24 VDC



AC INPUT
8pt 110 VAC
16pt 110 VAC

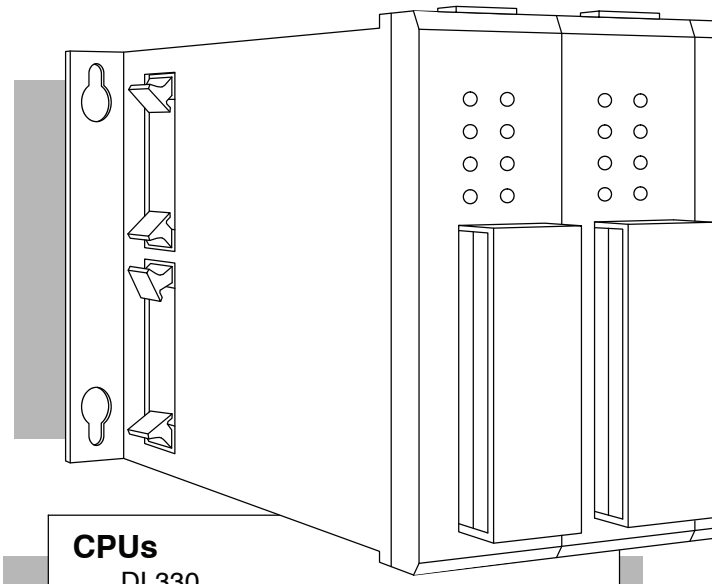


AC/DC INPUT
8pt 24 VAC/DC
16pt 24 VAC/DC



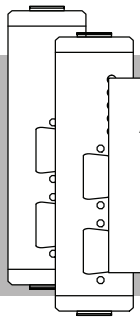
PROGRAMMING
Handheld Programmer for RLL CPUs
Handheld Programmer for RLL*PLUS* CPUs

DirectSOFT Programming for Windows™



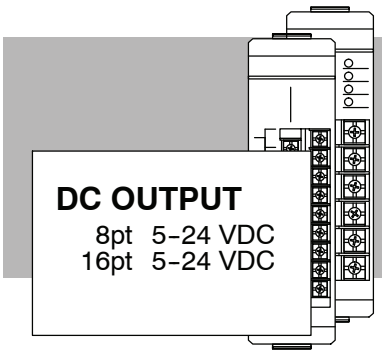
CPUs
DL330
3.7K RAM RLL Programming
DL330P
3.7K RAM RLL*PLUS* Programming
DL340
3.7K RAM RLL Programming
and 2 Built-in RS232C Ports
DL330/DL330P/DL340 EPROM
Memory Chips

BASES
5 Slot Base w/Expansion Capability,
110/220 VAC P/S
5 Slot Base w/Expansion Capability,
24 VDC Supply
8 Slot Base w/Expansion Capability,
110/220 VAC P/S
10 Slot Base w/Expansion Capability,
110/220 VAC P/S



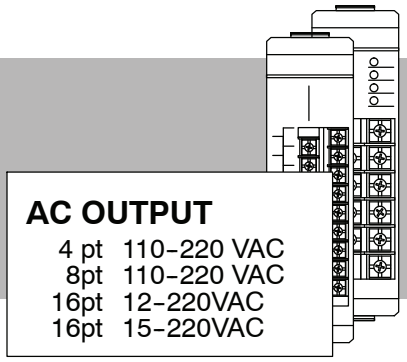
ASCII BASIC Modules
RS232C / RS422 / RS485
Built-in Radio Modem
Built-in Telephone Modem
Program Memory 64K/128K

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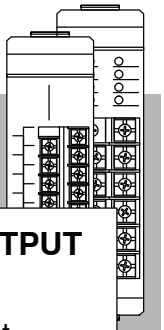
DC OUTPUT

8pt 5–24 VDC
16pt 5–24 VDC



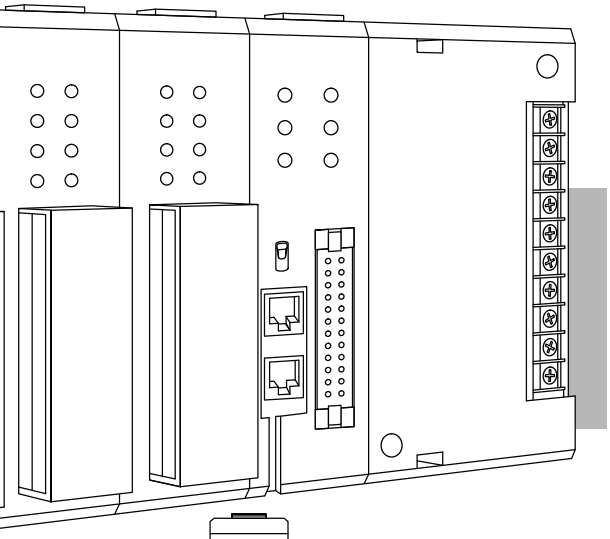
AC OUTPUT

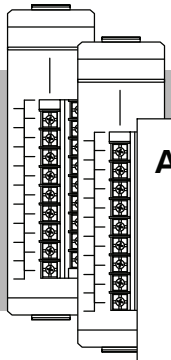
4 pt 110–220 VAC
8pt 110–220 VAC
16pt 12–220VAC
16pt 15–220VAC



RELAY OUTPUT

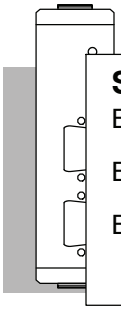
8pt 4A/pt
8pt 5A/pt
8pt 10A/pt
16pt 2A/pt





ANALOG

4ch INPUT
8ch INPUT
16ch INPUT
2ch OUTPUT
4ch OUTPUT
8ch TEMPERATURE TRANSDUCER INPUT
8ch THERMOCOUPLE INPUT



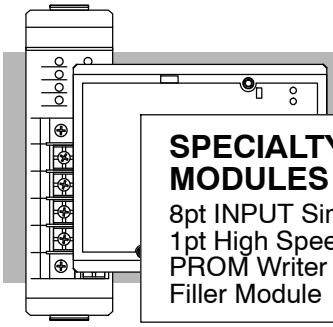
SPECIALTY CPUs

Bridge CPU to connect to host w/OPTOMUX™ Driver
Bridge CPU w/FACTS Extended Basic Programming
Bridge CPU to connect to High-speed PAMUX™ compatible host

NETWORKING

RS232C Data Communication Unit
RS422 Data Communication Unit
MODBUS® Slave Module
MODBUS® Slave Module w/Radio Modem

Universal connector:
RS232C / RS422/485 Convertor



SPECIALTY MODULES / UNITS

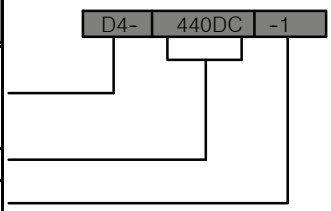
8pt INPUT Simulator
1pt High Speed Counter
PROM Writer Unit
Filler Module

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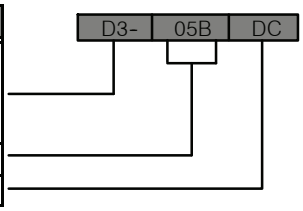
*Direct*LOGIC Part Numbering System

As you examine this manual, you'll notice there are many different products available. Sometimes it is difficult to remember the specifications for any given product. However, If you take a few minutes to understand the numbering system, it may save you some time and confusion. The charts below show how the part numbering systems work for each product category. Part numbers for accessory items such as cables, batteries, memory cartridges etc. are typically an abbreviation of the description for the item.

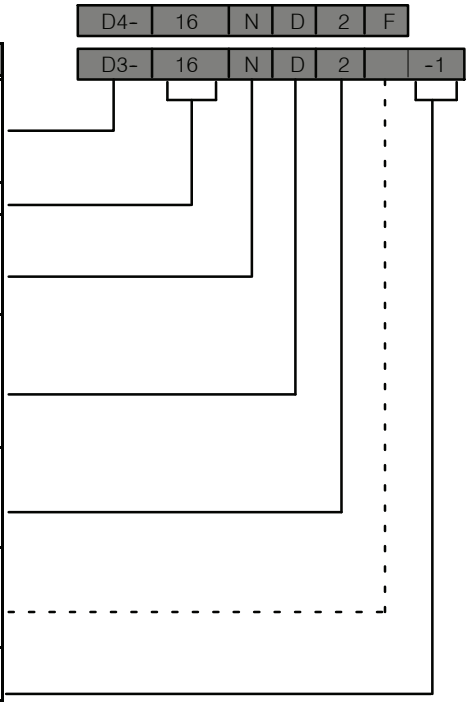
CPUs **Specialty CPUs**	
Product family	D2/F2 D3/F3 D4/F4
Class of CPU / Abbreviation	230...,330...,430...
Denotes a differentiation between Similar modules	-1, -2, -3, -4



Bases	
Product family	D2/F2 D3/F3 D4/F4
Number of slots	##B
Type of Base	DC or empty



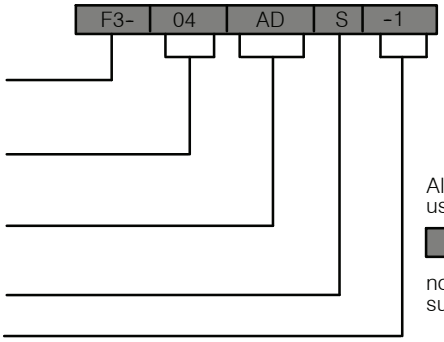
Discrete I/O	
DL205 Product family	D2/F2
DL305 Product family	D3/F3
DL405 Product family	D4/F4
Number of points	04/08/12/16/32
Input	N
Output	T
Combination	C
AC	A
DC	D
Either	E
Relay	R
Current Sinking	1
Current Sourcing	2
Current Sinking/Sourcing	3
High Current	H
Isolation	S
Fast I/O	F
Denotes a differentiation between Similar modules	-1, -2, -3, -4



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*Direct*LOGIC Part Numbering System (cont.)

Analog I/O	
DL205 Product family	D2/F2
DL305 Product family	D3/F3
DL405 Product family	D4/F4
Number of channels	02/04/08/16
Input (Analog to Digital)	AD
Output (Digital to Analog)	DA
Combination	AND
Isolated	S
Denotes a differentiation between Similar modules	-1, -2, -3, -4

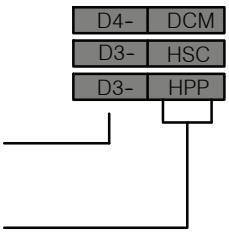


Altermate example of Analog I/O using abbreviations



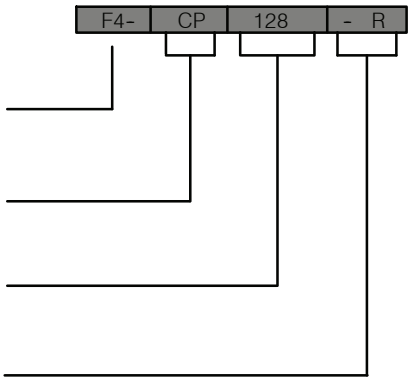
note: -n indicates thermocouple type such as: J, K, T, R, S or E

Communication and Networking, Special I/O and Devices Programming	
DL205 Product family	D2/F2
DL305 Product family	D3/F3
DL405 Product family	D4/F4
Name Abbreviation	see example



DCM (Data Communication Module)
HSC (High Speed Counter)
HPP (RLL PLUS Handheld Programmer)

CoProcessors and ASCII BASIC Modules	
DL205 Product family	D2/F2
DL305 Product family	D3/F3
DL405 Product family	D4/F4
CoProcessor	CP
ASCII BASIC	AB
64K memory	64
128K memory	128
512K memory	512
Radio modem	R
Telephone modem	T

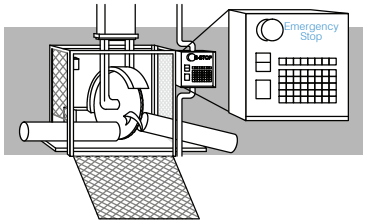


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A Few Steps to a Successful System

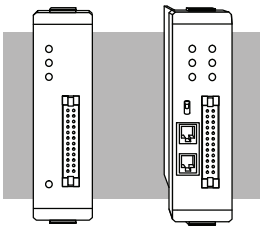
Step 1: Review the Installation Guidelines

You should always make safety your first priority in any system application. Chapter 2 provides several guidelines that will help provide a safer, more reliable system. This chapter also includes wiring guidelines for the various system components.



Step 2: Understand the CPU Setup Procedures

The CPU is the heart of your automation system. Make sure you take the time to understand the various features and setup requirements.

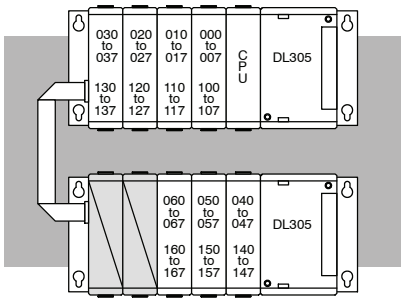


Step 3: Understand the I/O System Configurations

It is important to understand how the I/O system can be configured. You have two different types of systems.

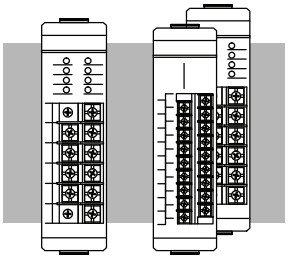
- Local System
- Local Expansion System

It is also important to understand how the system Power Budget is calculated. This can affect your I/O placement and/or configuration options.



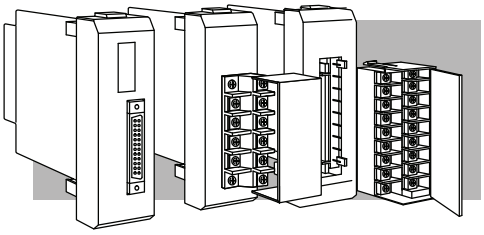
Step 4: Review the I/O Selection Criteria

There are many considerations involved when you select your I/O modules. Take time to understand how the various types of electrical connections can affect your choice of I/O modules.



Step 5: Determine the I/O Module Specifications and Wiring Characteristics

There are many different I/O modules available with the DL305 system. Chapters 6 and 7 provide the specifications and wiring diagrams for the discrete I/O modules.

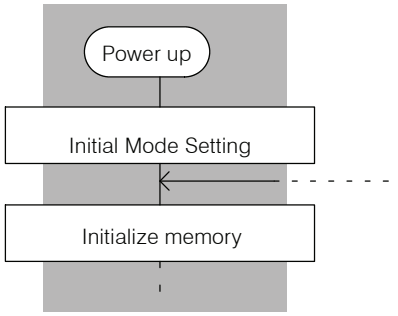


NOTE: Specialty modules have their own manuals and are not included in this manual

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Step 6: Understand the System Operation

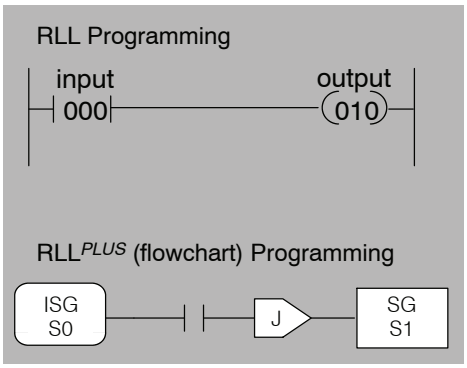
Before you begin to enter a program, it is very helpful to understand how the DL305 system processes information. This involves not only program execution steps, but also involves the various modes of operation and memory layout characteristics.



Step 7: Review the Programming Concepts

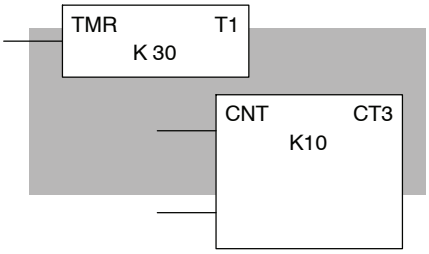
All control systems differ in some areas. The DL305 CPUs offer two different types of programming. RLL programming available for all the DL305 CPUs, uses conventional ladder diagram type solutions for many application problems.

RLL*PLUS* is available for the DL330P CPU. This method of programming greatly reduces the program design time and makes program troubleshooting and machine startup considerably easier.



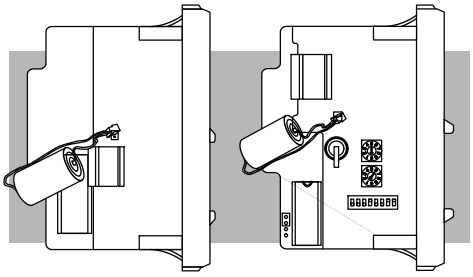
Step 8: Choose the Instructions

Once you have installed the system and understand the theory of operation, you can choose from a diverse instruction set to implement your application.



Step 9: Understand the Maintenance and Troubleshooting Procedures

Many things can happen on the factory floor. Switches fail, batteries need to be replaced, etc. In most cases, the majority of the troubleshooting and maintenance time is spent trying to locate the problem. Chapter 13 provides some information that will help you quickly identify problems, so you can look like a hero if you take time to understand them.



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2

Installation and Safety Guidelines

In This Chapter. . . .

- Safety Guidelines
- Panel Design Specifications
- Component Dimensions
- Base Mounting Dimensions
- Installing Components in the Base
- I/O Wiring

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Safety Guidelines



WARNING: Providing a safe operating environment for personnel and equipment is your responsibility and should be your primary goal during system planning and installation. Automation systems can fail and may result in situations that can cause serious injury to personnel or damage to equipment. Do not rely on the automation system alone to provide a safe operating environment. You should use external electromechanical devices, such as relays or limit switches, that are independent of the PLC system to provide protection for any part of the system that may cause personal injury or damage.

Every automation application is different, so there may be special requirements for your particular application. Make sure you follow all National, State, and local government requirements for the proper installation and use of your equipment.

Plan for Safety

The best way to provide a safe operating environment is to make personnel and equipment safety part of the planning process. You should examine *every* aspect of the system to determine which areas are critical to operator or machine safety.

If you are not familiar with PLC system installation practices, or your company does not have established installation guidelines, you should obtain additional information from the following sources.

- **NEMA** — The National Electrical Manufacturers Association, located in Washington, D.C., publishes many different documents that discuss standards for industrial control systems. You can order these publications directly from NEMA. Some of these include:
  ICS 1, General Standards for Industrial Control and Systems
  ICS 3, Industrial Systems
  ICS 6, Enclosures for Industrial Control Systems
- **NEC** — The National Electrical Code provides regulations concerning the installation and use of various types of electrical equipment. Copies of the NEC Handbook can often be obtained from your local electrical equipment distributor or your local library.
- **Local and State Agencies** — many local governments and state governments have additional requirements above and beyond those described in the NEC Handbook. Check with your local Electrical Inspector or Fire Marshall office for information.

Safety Techniques

The publications mentioned provide many ideas and requirements for system safety. At a minimum, you should follow these regulations. Also, you should use the following techniques, which may help reduce the risk of safety concerns.

- Orderly system shutdown sequence in the PLC control program.
- System power disconnects (guard limits, emergency stop switches, etc.)

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Three Levels of Protection

The publications mentioned provide many ideas and requirements for system safety. At a minimum, you should follow these regulations. Using the techniques listed below will further help reduce the risk of safety problems.

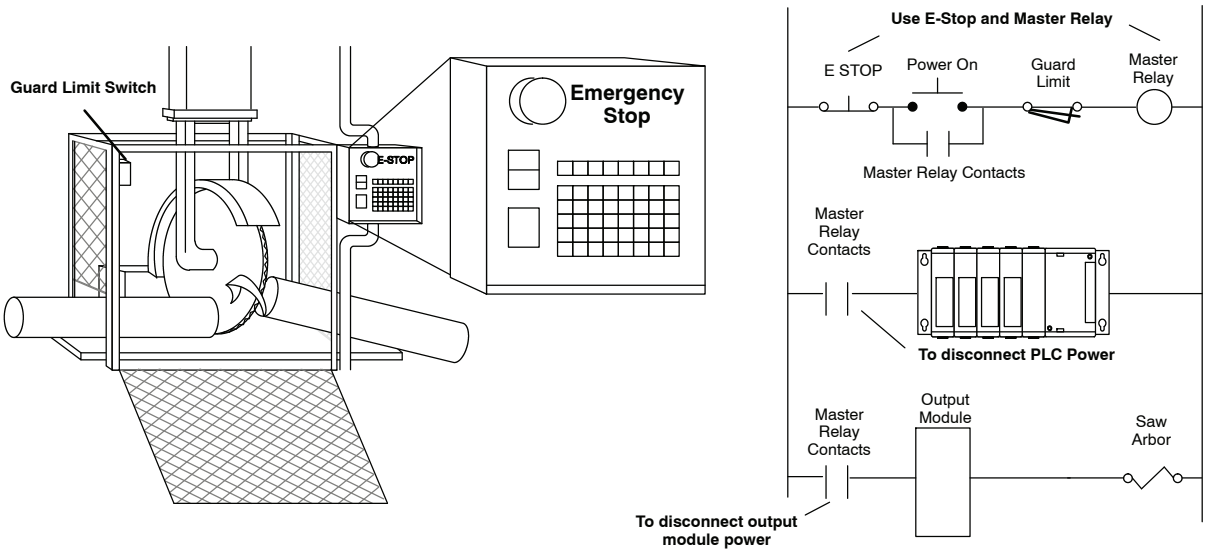
- Emergency stop switch for disconnecting system power.
- Mechanical disconnect for output module power.
- Orderly system shutdown sequence in the PLC control program.

Emergency Stops

It is recommended that emergency stop circuits be incorporated into the system for every machine controlled by a PLC. For maximum safety in a PLC system, these circuits must not be wired into the controller, but should be hardwired external to the PLC. The emergency stop switches should be easily accessed by the operator and are generally wired into a master control relay (MCR) or a safety control relay (SCR) that will remove power from the PLC I/O system in an emergency.

MCRs and SCRs provide a convenient means for removing power from the I/O system during an emergency situation. by de-energizing an MCR (or SCR) coil, power to the input (optional) and output devices is removed. This event occurs when any emergency stop switch opens. However, the PLC continues to receive power and operate even though all its inputs and outputs are disabled.

The MCR circuit could be extended by placing a PLC fault relay (closed during normal PLC operation) in series with any other emergency stop conditions. This would cause the MCR circuit to drop the PLC I/O power in case of a PLC failure (memory error, I/O communications error. etc.).



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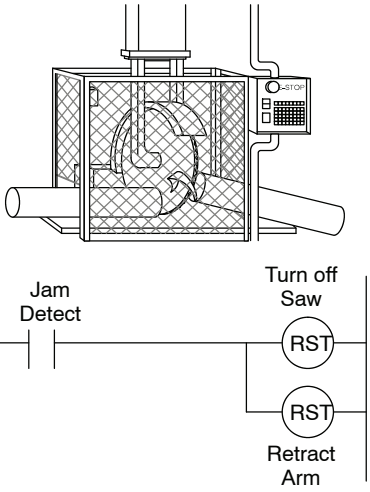
Emergency Power Disconnect

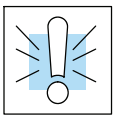
A properly rated emergency power disconnect should be used to power the PLC controlled system as ameans of removing the power from the entire control system. It may be necessary to install a capacitor across the disconnect to protect against a condition known as “outrush“. This condition occurs when the output triacs are turned off by powering off the disconnect, thus causing the energy stored in the inductive loads to seek the shortest distance to ground, which is often through the triacs.

After an emergency shutdown or any other type of power interruption, there may be requirements that must be met before the PLC control program can be restarted. For example, there may be specific register values that must be established (or maintained from the state prior to the shutdown) before operations can resume. In this case, you may want to use retentive memory locations, or include constants in the control program to ensure a known starting point.

Orderly System Shutdown

The first level of protection should be included in the PLC control program, which can be used to identify machine problems. You should analyze your application and identify any shutdown sequences that must be performed. These types of problems are usually things such as jammed parts, etc. that do not pose a risk of personal injury or equipment damage.

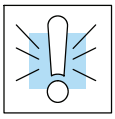




WARNING: The control program *should not* be the only form of protection for any problems that may result in a risk of personal injury or equipment damage.

Class 1, Division 2 Approval

This equipment is suitable for use in Class 1, Division 2, groups A, B, C and D or non-hazardous locations only.



WARNING: Explosion Hazard! Substitution of components may impair suitability for Class 1, Division 2.

Do not disconnect equipment unless power has been switched off or area is known to be non-hazardous.

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Panel Design Specifications

It is important to design your panel properly to help ensure the DL305 products operate within their environmental and electrical limits. Proper installation of your DL305 system requires an in-depth understanding of electrical control systems. The system installation should comply with the appropriate electrical codes and standards for your area. It is important that your system also conforms to the operating standards for the application to insure proper performance. The DL305 equipment should only be installed by personnel familiar with electrical/industrial applications. The DL305 installation should provide proper ventilation, spacing, and grounding to ensure the equipment will operate as specified. The diagram on the next page references the items in the following list.

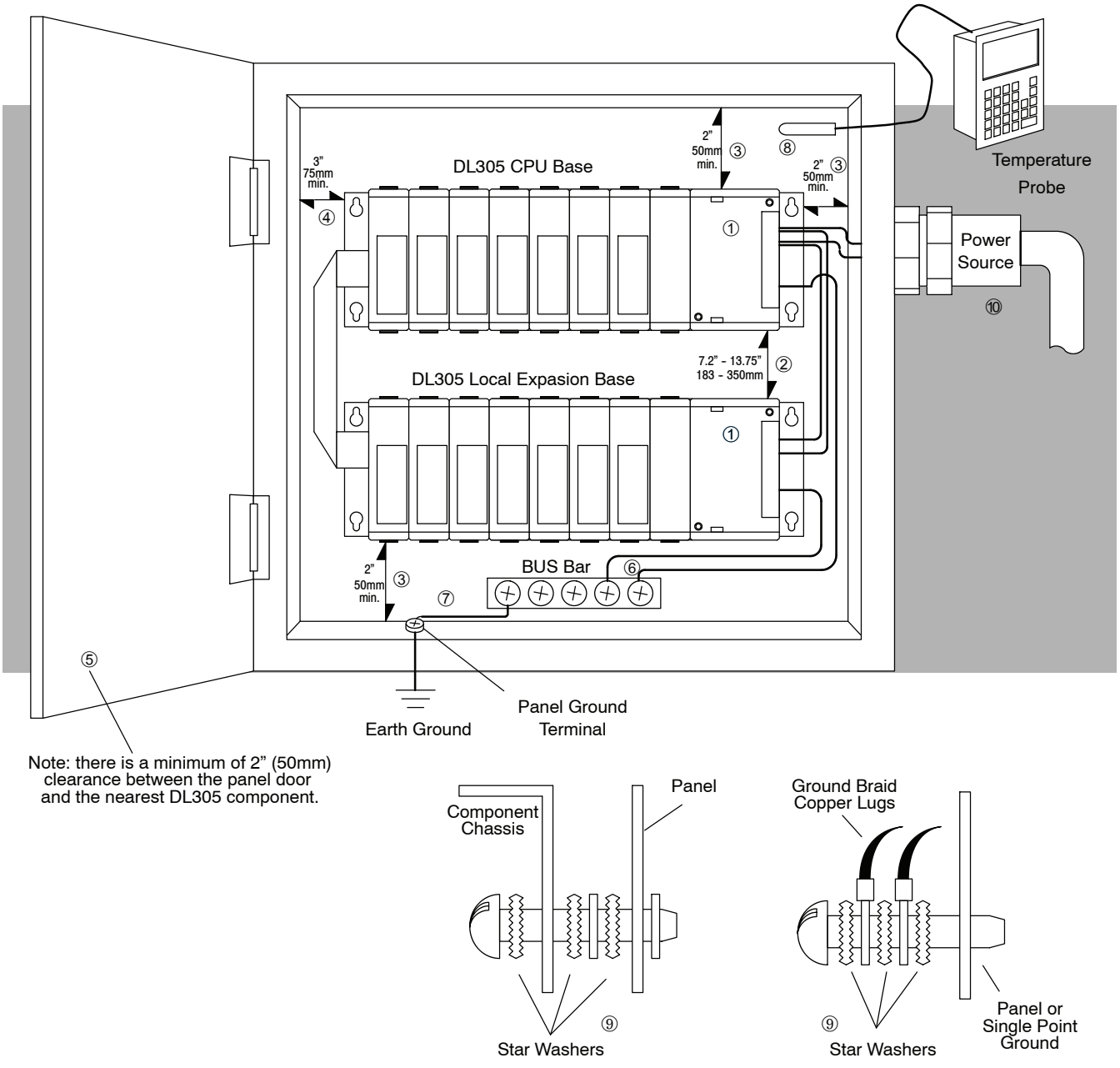
1. The bases should be mounted horizontally to provide proper ventilation.
2. There should be a minimum of 7.2" (183mm) and a maximum of 13.75" (350mm) between bases.
3. A minimum clearance of 2" (50mm) between the base and the top, bottom and right side of the cabinet should be provided.
4. A minimum clearance of 3" (75mm) between the base and the left side of the cabinet should be provided.
5. There must be a minimum of 2" clearance between the panel door and the nearest DL305 component.
6. The ground terminal on the DL305 base must be connected to a single point ground. Copper stranded wire should be used for this connection to achieve a low impedance. Copper eye lugs should be crimped and soldered to the ends of the stranded wire to assure good surface contact. You should also remove anodized finishes and use copper lugs and star washers at termination points. A rule of thumb is to achieve a 0.1 ohm of DC resistance between the DL305 base and the single point of ground.
7. There must be a single point of ground (i.e. copper bus bar) for all devices in the panel requiring an earth ground return. The single point of ground must be connected to the panel ground termination.

   The panel ground termination must be connected to earth ground. For this connection you should use #12 AWG stranded copper wire as a minimum. Minimum wire sizes, color coding, and general safety practices should comply with appropriate electrical codes and standards for your area.

   A good common ground reference (Earth ground) is essential for proper operation of the DL305. The DL305 system and components are designed to operate with a common ground reference. There are several methods of providing an adequate common ground reference. These methods include:
   a) Installing a ground rod as close to the panel as possible.
   b) Connection to the incoming power system ground.
8. Installations where the ambient temperature may approach the lower or upper limits of the specifications should be evaluated properly. To do this place a temperature probe in the panel, close the door and operate the system until the ambient temperature has stabilized. If the ambient temperature is not within the operating specification for the DL305 system, measures such as installing a cooling/heating source must be taken to get the ambient temperature within the DL305 operating specifications.

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9. Device mounting bolts and ground braid termination bolts should be #10 copper bolts or equivalent. Tapped holes instead of nut-bolt arrangements should be used whenever possible. To assure good contact on termination areas impediments such as paint, coating or corrosion should be removed in the area of contact.
10. The DL305 systems are designed to be powered by 110 VAC , 220 VAC, or 24 VDC normally available throughout an industrial environment. Isolation transformers and noise suppression devices are not normally necessary, but may be helpful in eliminating/reducing suspected power problems.



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In addition to the panel layout guidelines, there are other specifications that can affect the definition and installation of a PLC system. You should always consider the following areas whenever you install any PLC system.

- Environmental Specifications
- Power Supply Specifications
- Agency Approvals
- Enclosure Selection and Component Dimensions

Environmental Specifications

The following table lists the environmental specifications that generally apply to the DL305 system (CPU, Bases I/O modules). I/O module operation may fluctuate depending on the ambient temperature and your application. Please refer to the appropriate I/O module chapters for the temperature derating curves applying to specific modules.

Specification	Rating
Storage temperature	-4° F to 158° F (-20° C to 70° C)
Ambient operating temperature	32° F to 140° F (0° C to 60° C)
Ambient humidity	5% to 95% relative humidity (non-condensing)
Vibration resistance	MIL STD 810C, Method 514.2
Shock resistance	MIL STD 810C, Method 516.2
Noise immunity	NEMA (ICS3-304) 1 uS width rectangular wave
Atmosphere	No corrosive gases

Power

The power source must be capable of suppling voltage and current complying with the base power supply specifications.

Specifications	D3-05B	D3-05BDC	D3-08B	D3-10B
Input Voltage Range	100-240 VAC +10% / -15% 47-63Hz	20.5-30 VDC <10% ripple	100-240 VAC +10% / -15% 47-63Hz	100-240 VAC +10% / -15% 47-63Hz
Base Power Consumption	70 VA max (46W)	48 Watts	70 VA max (57W)	70 VA max (57W)
Inrush Current max.	30A	30A	30A	30A
Dielectric Strength	1500VAC for 1 minute between terminals of AC P/S, Run output, Common, 24VDC	1500VAC for 1 minute between 24VDC input terminals and Run output	1500VAC for 1 minute between terminals of AC P/S, Run output, Common, 24VDC	2000VAC for 1 minute between terminals of AC P/S, Run output, Common, 24VDC
Insulation Resistance	>10MΩ at 500VDC	>10MΩ at 500VDC	>10MΩ at 500VDC	>10MΩ at 500VDC
Power Supply Output (Voltage Ranges and Ripple)	(5VDC) 4.75-5.25V less than 0.1V p-p (9VDC) 8.5-13.5V less than 0.2 V p-p (24VDC) 20-28V less than 1.2V p-p	(5VDC) 4.75-5.25V less than 0.1V p-p (9VDC) 8.5-13.5V less than 0.2 V p-p (24VDC) 20-28V less than 1.2V p-p	(5VDC) 4.75-5.25V less than 0.1V p-p (9VDC) 8.0-12.0V less than 0.2 V p-p (24VDC) 20-28V less than 1.2V p-p	(5VDC) 4.75-5.25V less than 0.1V p-p (9VDC) 8.0-12.0V less than 0.2 V p-p (24VDC) 20-28V less than 1.2V p-p

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Agency Approvals

Some applications require agency approvals. Typical agency approvals which your application may require are:

- UL (Underwriters' Laboratories, Inc.)
- CSA (Canadian Standards Association)
- FM (Factory Mutual Research Corporation)
- CUL (Canadian Underwriters' Laboratories, Inc.)

Enclosures

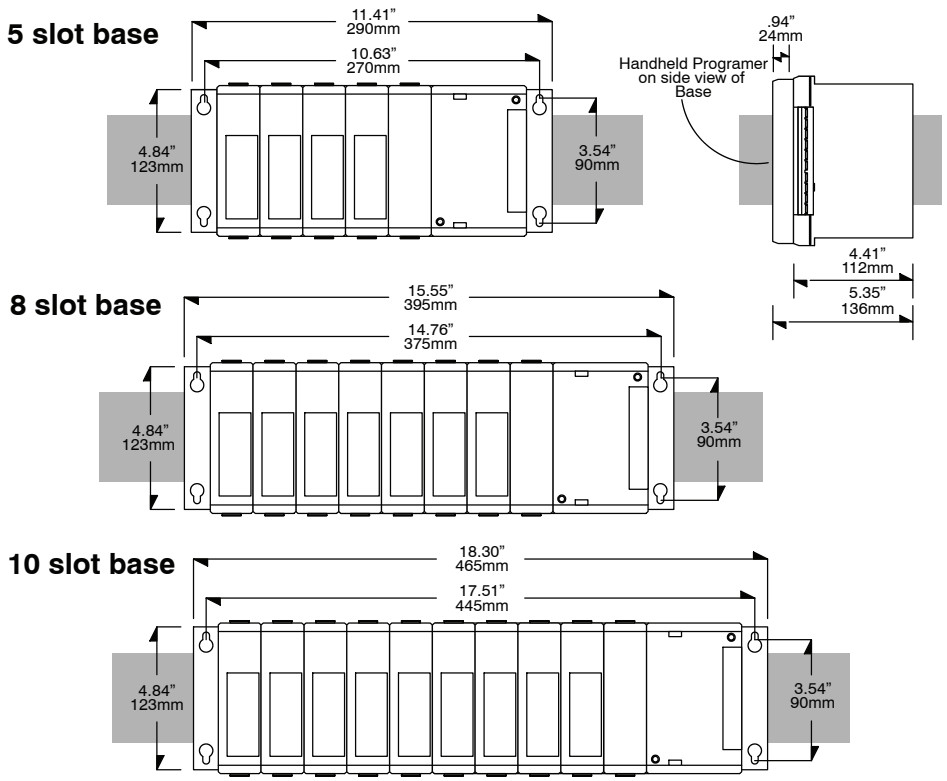
Your selection of a proper enclosure is important to ensure safe and proper operation of your DL305 system. Applications of DL305 systems vary and may require additional features. The minimum considerations for enclosures include:

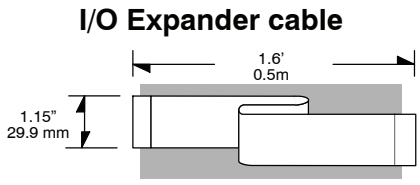
- Conformance to electrical standards
- Protection from the elements in an industrial environment
- Common ground reference
- Maintenance of specified ambient temperature
- Access to equipment
- Security or restricted access
- Sufficient space for proper installation and maintenance of equipment

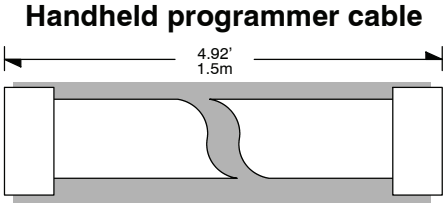
Component Dimensions

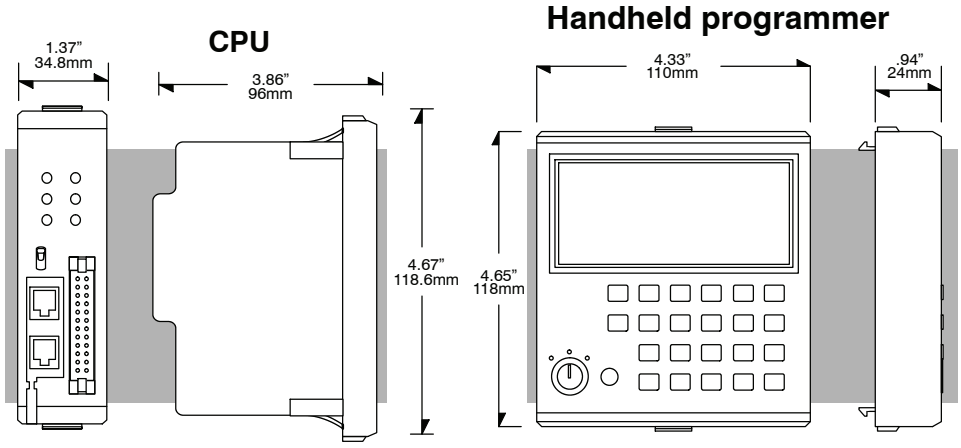
Before installing your PLC system you will need to know the dimensions for the components in your system. The diagrams on the following pages provide the component dimensions and should be used to define your enclosure specifications. Remember to leave room for potential expansion. Appendix D provides the weights for each component.

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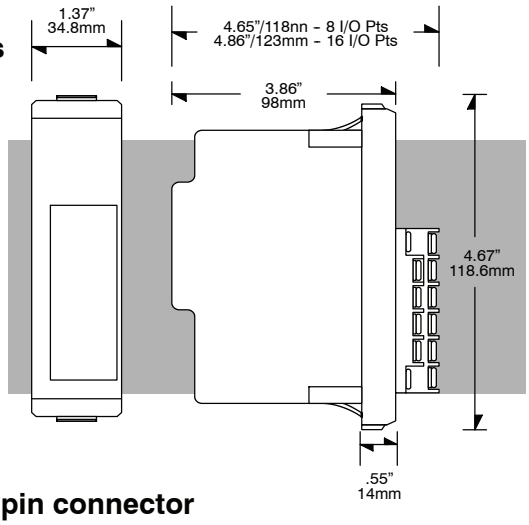




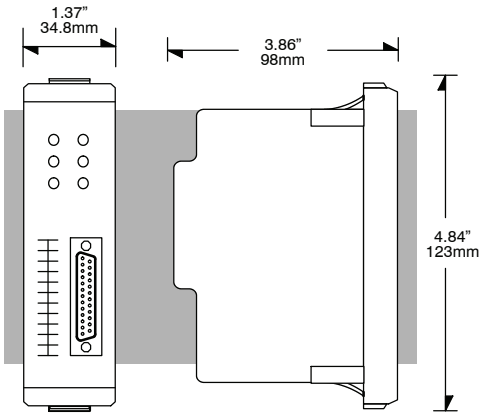
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Component Dimensions Part 2

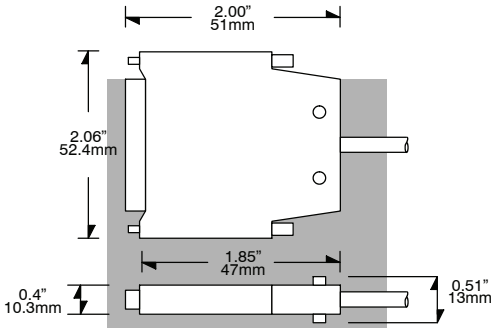
I/O modules



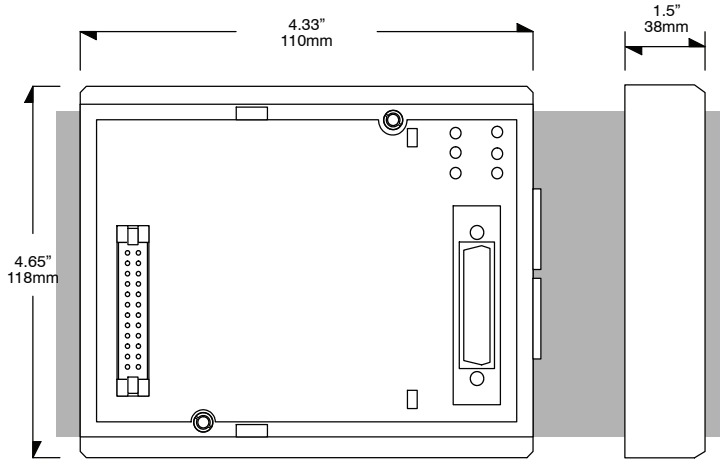
I/O module w/24 pin connector



24 pin connector



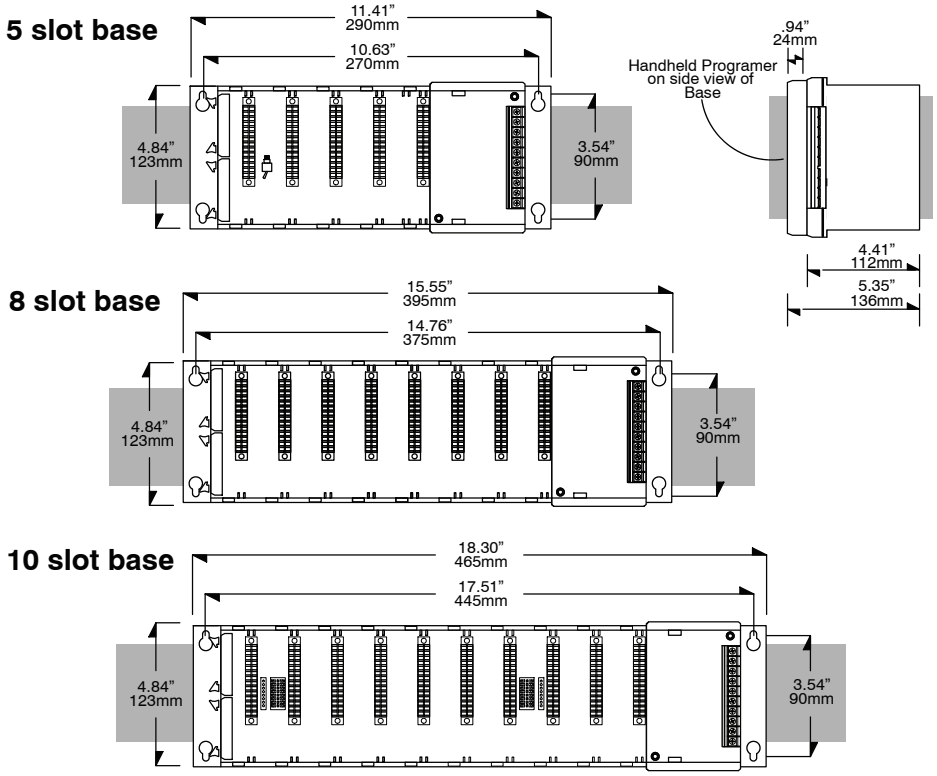
Data communication units (Prom Writer Unit has the same dimensions)



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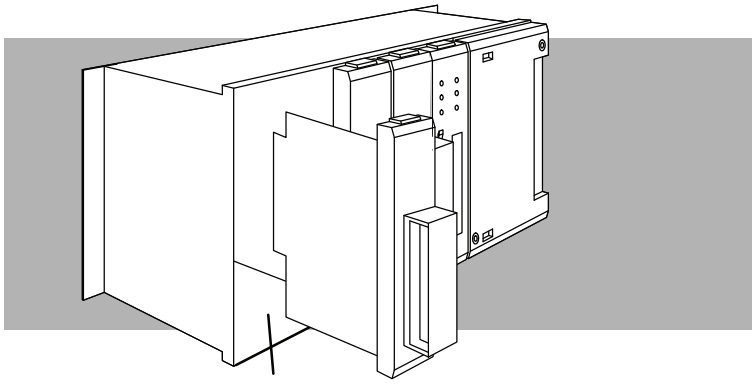
Base Mounting Dimensions

Below are the mounting dimensions which should be used when mounting DL305 bases. Make sure you have followed the installation guidelines for proper spacing.



Installing Components in the Base

When inserting components into the base, align the PC board(s) of the module with the grooves on the top and bottom of the base. Push the module straight into the base until it is firmly seated in the backplane connector.



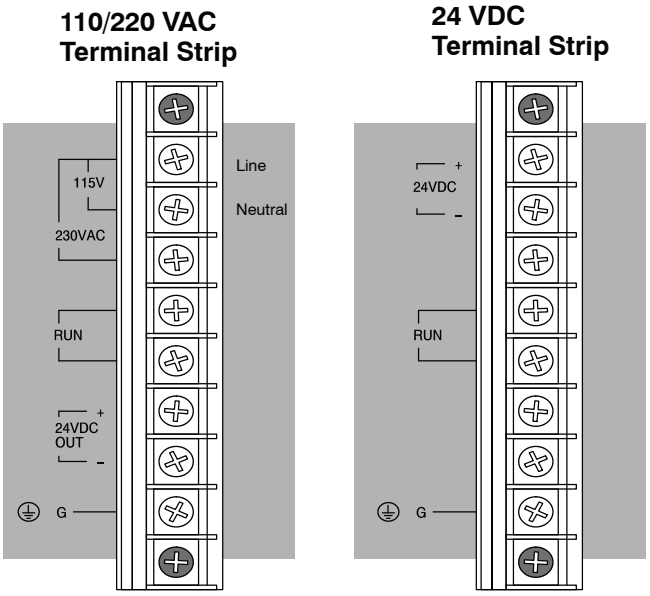
Align module to
slots in base and slide in

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Base Wiring

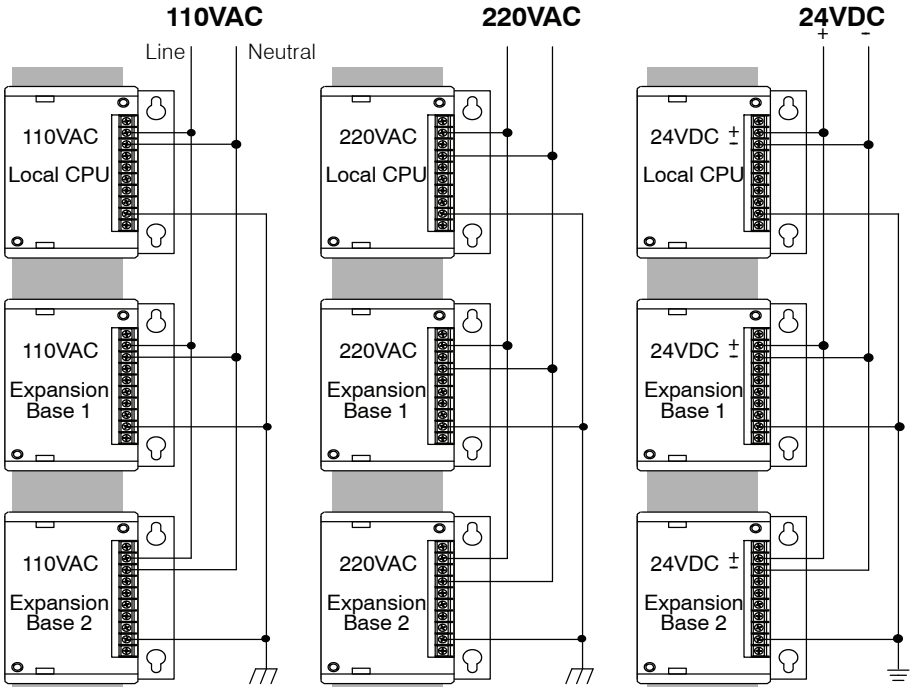
The following diagram shows the terminal connections located on the power supply of the DL305 bases.

WARNING: Damage will occur to the base power supply if 220 VAC is connected to the 115 VAC terminal connections. Once the power wiring is connected, install the protective cover. When the cover is removed there is a risk of electrical shock if you accidentally touch the connection terminals.



Expansion Base Wiring

This is an example of how to connect power when using local CPU and Expansion bases.



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I/O Wiring

This information provides a general idea on how to wire the different types of modules in the DL305 system. For specific information on wiring a particular module refer to the specification sheet in the appropriate I/O chapter or manual.

I/O Wiring Guidelines

You should consider these guidelines when wiring your system.

1. There is a limit to the size of wire the modules can accept. The table below lists the maximum AWG for each module type. Smaller AWG is acceptable to use for each of the modules.

Module type	Maximum AWG
8 point	12
16 point	16

2. Always use a continuous length of wire, do not combine wires to attain a needed length.
3. Use the shortest possible cable length.
4. Use wire trays for routing where possible
5. Avoid running wires near high energy wiring.
6. Avoid running input wiring in close proximity to output wiring where possible.
7. To minimize voltage drops when wires must run a long distance , consider using multiple wires for the return line.
8. Avoid running DC wiring in close proximity to AC wiring where possible.
9. Avoid creating sharp bends in the wires.

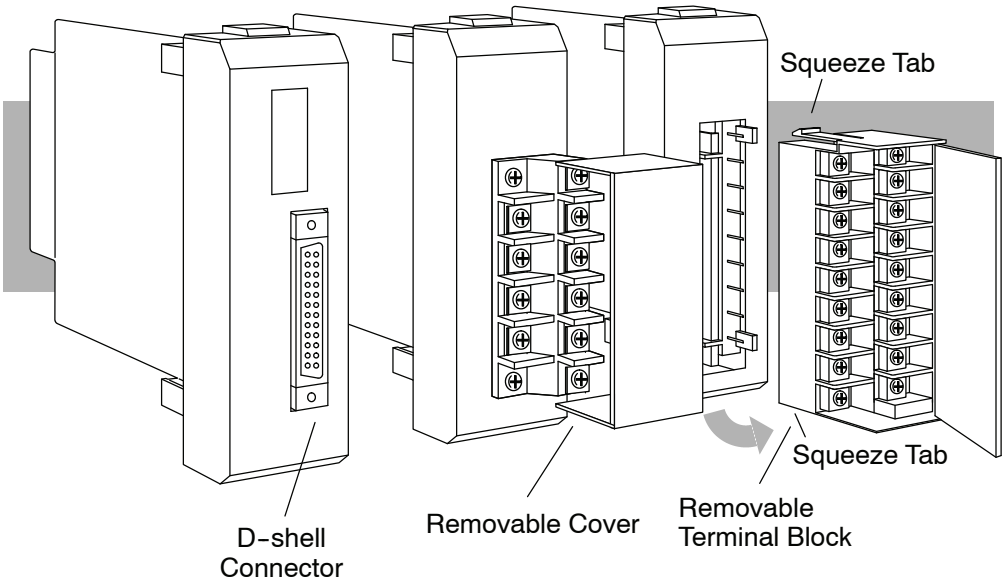
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Wiring the Different Module Types

There are three main types of module faces for the DL305 I/O. These module faces are: lift covers over terminal blocks, flip covers over terminal blocks and D–shell compatible sockets. If the module you are using has a cover you can remove the cover either by lifting from the bottom or by flipping the door open. Some of the modules have removable terminal blocks. These modules can be recognized by the squeeze tabs on the top and bottom of the terminal block. To remove the terminal block, press the squeeze tabs and pull the terminal block away from the module.



WARNING: For some modules, field device power may still be present on the terminal block even though the PLC system is turned off. To minimize the risk of electrical shock, check all field device power *before* you remove the connector.



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3

DL330/DL330P/DL340 CPU Specifications

In This Chapter. . . .

— Overview
— CPU Hardware Features
— CPU Specifications
— Selecting CPU Memory Options
— DL330/DL330P CPU Setup
— DL340 CPU Setup
— DL340 Port Setup
— Battery Backup
— Installing the CPU
— CPU Setup and System Functions

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Overview

The CPU is the heart of the control system. Almost all system operations are controlled by the CPU, so it is important that it is set-up and installed correctly. This chapter provides the information needed to understand:

- the differences between the different models of CPUs
- the different memory options
- the steps required to setup and install the CPU.

DL330 CPU Features

The DL330 modular CPU is capable of controlling 176 I/O points and has 3.7K words of program storage. This CPU supports the RLL programing language and can save programs internally to RAM or UVPROM. There is a built-in programming port that directly supports the handheld programmer.

DL330P CPU Features

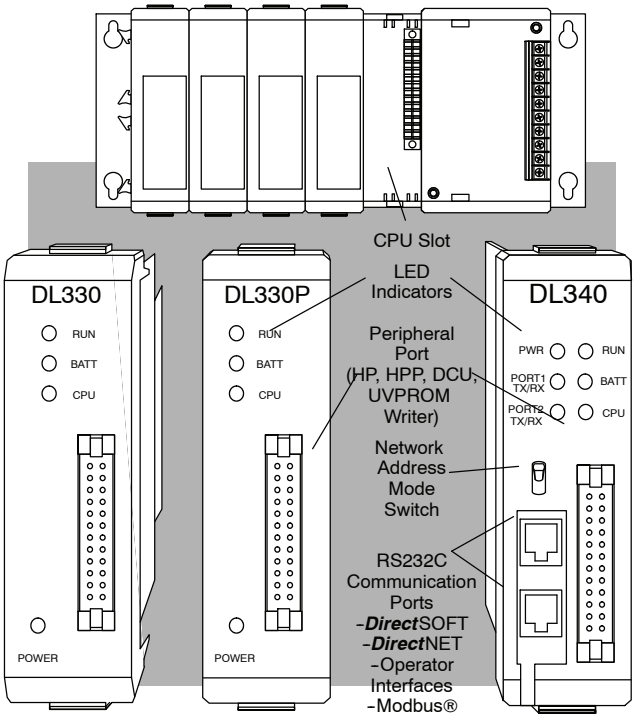
The DL330P modular CPU is capable of controlling 176 I/O points and has 3.7K words program storage. This CPU supports the RLL*PLUS* programing language and can save programs internally to RAM or UVPROM. RLL*PLUS* provides a structured programming environment for Relay Ladder Logic through the addition of stage logic. There is a built-in port that directly supports the handheld programmer.

DL340 CPU Features

The DL340 modular CPU is capable of controlling 184 I/O points and has 3.7K words program storage. This CPU supports the RLL programming language and can save programs internally to RAM, UVPROM or EEPROM. There is a handheld programming port and two built-in RS232C ports for PC programming, operator interfaces, or networking. If you are using the DL340 in a ***Direct***NET network, you can use either port as a slave port and the bottom port as a master. The bottom port has the additional capability of being configured as a slave on a Modbus® network.

CPU Hardware Features

CPU Status Indicators		
RUN	ON OFF	CPU is in RUN mode CPU is in Program mode
BATT	ON OFF	Memory backup voltage low Memory backup voltage good
CPU	ON OFF	CPU failure (Error detected when the watchdog timer is not processed within 100ms. The run output from the power supply will be turned off.) CPU good
PWR	ON OFF	CPU power good CPU power failure
RX	ON OFF	CPU communication port receiving data CPU communication port not receiving data
TX	ON OFF	CPU communication port transmitting data CPU communication port not transmitting data



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CPU Specifications

Feature	DL330	DL330P	DL340
Program memory (words)	3.7K	3.7K	3.7K
Scan time/K ladder (boolean)	8 ms	20 ms	.87 ms
Supports Overrides	No	No	Yes
RLL (Relay Ladder Logic) Programming	Yes	Yes	Yes
RLL*PLUS* Programming	No	Yes	No
Handheld programmer with cassette tape interface	Yes	Yes	Yes
DirectSOFT programming for Windows™	Yes	Yes	Yes
Built-in communication ports (RS232C / ***Direct***NET)	No	No	Yes
CMOS RAM	Yes	Yes	Yes
UVPROM	Optional	Optional	Optional
EEPROM	No	No	Optional
Compatible with:			
ASCII Basic modules	Yes	Yes	Yes
Networking modules	Yes	Yes	Yes
RS232C Data Communications Unit	Yes	Yes	Yes
RS422 Data Communications Unit	Yes	Yes	Yes
Base Power Supply Available			
110/220 VAC	Yes	Yes	Yes
24 VDC (5 slot base only)	Yes	Yes	Yes
Total I/O points using;			
Local I/O	128	128	136
Local expansion I/O	176	176	184
Remote I/O	NA	NA	NA
Number of instructions available	61	65	61
Control relays	140	77	196
Shift register bits	128	uses CRs	128
Special relays (system defined)	12	11	20
Stages (RLL*PLUS* only)	None	128	None
Timer/Counters	64	64	64
Data registers	128	128	192
Analog input channels max.	112	112	128
Analog output channels max.	28	28	32
Internal diagnostics	Yes	Yes	Yes
Password security	Yes	Yes	Yes
Battery backup	Yes	Yes	Yes

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Selecting CPU Memory Options

Internal Retentive Memory

In addition to different choices for program storage, you can also select some memory areas to be retentive. Retentive memory retains its state after a power cycle or a program to run transition occurs, as long as the memory backup battery is functional. Non-retentive memory resets to a logical "0" after a power cycle or a program to run transition occurs. You have to use dipswitch to select the retentive memory options (the switches are discussed in the next section.)

The following table shows the how the types of memory are defined. Some types of memory are automatically defined as retentive and other memory types can be defined as retentive as necessary for your application. The types of memory available depend on the type of CPU selected for your application.

Retentive Memory	Pre-defined	User defined
Application program	Yes	
Stages (DL330P only)		Yes
Internal relays		Yes
Current count values	Yes (full range)	
Shift register bits	Yes (full range)	
Data registers	Yes (full range)	
Password		Yes

External Program Storage

All DL305 CPUs allow for program storage to be captured on external media such as cassette tape, floppy disk and hard disk. Refer to the DL305 Handheld Programmer manual for details on storing the CPU program to cassette tape. The ***Direct***SOFT manual provides details on storing the CPU program to floppy or hard disk.

Volatile and Non-volatile Memory

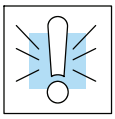
There are two types of memory storage available, volatile and non-volatile. Volatile memory will retain your data as long as proper voltage is maintained to the storage media. Non-volatile memory does not require power to retain data. The DL305 CPUs maintain the proper voltage either through the base power supply or the use of the memory backup battery.

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Program Storage Memory Types (Internal)

The type of program storage memory available to you depends on the CPU you are using. All DL305 CPUs support application program storage to either CMOS RAM or the optional UVPROM. The DL340 has the added option of supporting program storage in EEPROM. The application program can be up to 3.7K words.

- CMOS RAM memory (Random Access Memory) is standard on all the DL305 CPUs. It is a volatile memory which can be modified or changed easily with a handheld programmer or PC programming software.
- UVPROM (Ultraviolet Programmable Read Only Memory) is optional for all the DL305 CPUs. This type of memory is non-volatile and can only be erased with an ultraviolet light source. The PROM Writer Unit (D3-PWU) is used to copy your application program from the CPU's RAM to a UVPROM. If the UVPROM has a program to be changed, it must be removed from the CPU and erased before another program can be copied on the UVPROM.
- EEPROM (Electrically Erasable Programmable Read Only Memory) is an option only on the DL340 CPU. This type of memory is non-volatile, but can be electrically erased. The EEPROM can be electrically reprogrammed without being removed from the CPU, and without the use of a special external programming device.



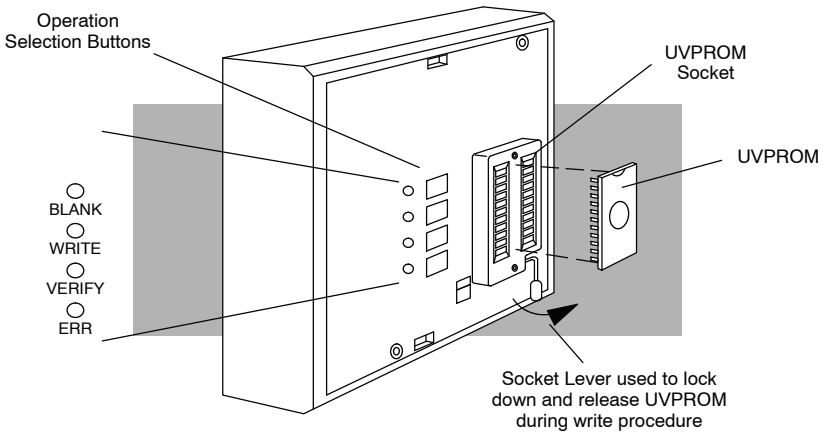
WARNING: Be sure to use proper grounding techniques when touching UVPROMS and EEPROMS. A static discharge from you may cause damage to the PROM. If you do not have a ground strap, then ground yourself by touching the controller chassis before you make contact with the PROM. Also ensure that the surface where you place the PROM is properly grounded.

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Storing Programs on UVPROMs

The PROM Writer Unit is only compatible with DL305 CPUs and UVPROMs. It can perform the following three functions:

- Copy a program from the CPU's RAM to a UVPROM
- Copy a program from the UVPROM to the CPU's RAM
- Compare the program in the UVPROM with the CPU's RAM



The LED for the selected function will turn off when completed (except for the error reset function). If any error is encountered, one of the LEDs in the following table will be on and the execution of the selected function will be stopped.

Function	Key Operation	LED Display	Remarks	Errors Flagged
Copies the content of the CPU RAM into the UVPROM	WRITE	WRITE	Automatic comparison is made after checking and writing.	Constant on indicates a write failure.
Copies the content of the UVPROM into the CPU RAM	WRITE VERIFY	WRITE VERIFY	Depress two keys at the same time. Comparison is made after transferring.	
To verify the content of the UVPROM with the CPU RAM	VERIFY	VERIFY		Constant on indicates an unmatched address.
To check if the UVPROM is blank.	BLANK	BLANK		Constant on indicates a non-blank address is found.
Error reset	ERR	ERR	Return to the initial condition by pressing this key if an error condition is noted.	On indicates an error.
		CPU	Red	On indicates failure.
		PWR	Green	On indicates DC power is within tolerance. Off indicates DC power not within tolerance.

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Setting up the PROM Writer Unit

The PROM Writer Unit connects directly to either a DL330, DL330P or DL340 CPU. Use the following steps to connect the PROM Writer Unit:

1. Set the power supply source switch (on the back of the unit) to the appropriate power source setting, (INT for using base power and EXT for an external power source). The PROM Writer Unit can either use the local CPU base power or use an external power source.



NOTE: If you are using the local CPU base power you will need to include the Prom Writer Unit power consumption in your power budget. The power budget is covered in Chapter 4.

2. If using an external power source attach the supplied cable to the power source socket on the back of the unit. The white wire should be connected to +5VDC and the black wire should be connected to DC ground.
3. Turn off the power source to the base before attaching the PROM Writer Unit.
4. Attach the PROM Writer Unit to the CPU. The connector on the back of the unit will mate with the programming port (PRG) of the CPU. Tighten the fixture screw to secure the two units together.
5. Apply power to the local CPU base and if necessary to the PROM Writer Unit. Once the PWR LED is on it will take approximately 10 seconds for the unit to initialize. During this time keystrokes will not be recognized.

Copying a Program From the CPU RAM to a UVPROM

The following steps explain how to copy a program from the CPU RAM to a UVPROM:

1. Turn power on.
2. Raise the UVPROM socket lever.
3. Insert the UVPROM (notch up) in the socket and lower the lever.
4. Press the “WRITE” button. The following sequence of events will take place:
   - The WRITE LED will turn on then off.
   - The BLANK LED will come on. (This notes the checking sequence to ensure that the UVPROM is blank has started.)
   - The BLANK LED will turn off and the WRITE LED will turn on.
   - The WRITE LED will turn off and the VERIFY LED will turn on. (This indicates that the write is complete. While the VERIFY LED is on, a comparison between the UVPROM and the CPU RAM is being made.)
   - The VERIFY LED will turn off. (This indicates the end of the copying function.)
   - If an error has been detected, the ERR LED will come on. If this happens press the “ERR” key to clear the error and the “WRITE” key to repeat the procedure. If this does not correct the problem, repeat the procedure using a different UVPROM.
5. Turn power off, raise the UVPROM socket lever and remove UVPROM.

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Copying a Program From the UVPROM to the CPU RAM

The following steps explain how to copy a program from the UVPROM to the CPU RAM:

1. Turn power on.
2. Raise the UVPROM socket lever.
3. Insert the UVPROM (notch up) in the socket and lower the lever.
4. Simultaneously press “WRITE” and “VERIFY” buttons. The following sequence of events will take place:
   - The BLANK, WRITE and VERIFY LEDs will all come on momentarily.
   - The WRITE LED turns off.
   - The VERIFY LED will stay on till the operation is completed.
   - If an error has been detected, the ERR LED will come on. If this happens, press the “ERR” key to clear the error and repeat step 4.
5. Turn power off, raise the UVPROM socket lever and remove UVPROM.

Comparing a Program From the UVPROM to the CPU RAM

The following steps show how to compare a UVPROM program to the CPU RAM:

1. Turn power on.
2. Raise the UVPROM socket lever.
3. Insert the UVPROM (notch up) in the socket and lower the lever.
4. Press the “VERIFY” button. The following sequence of events will take place:
   - The VERIFY LED indicator will come on.
   - If verification is successful, the VERIFY LED will go off.
   - If there is an error in the comparison the VERIFY LED will remain on.
5. Turn power off, raise the UVPROM socket lever and remove UVPROM.

Erasing a UVPROM

UVPROMS can be erased through exposure to an ultraviolet light source. Make sure that the window to the UVPROM is not covered so that it may receive full exposure to the light source. A typical exposure would be: 12,000μ w/cm^2 lamp @ 2.5 cm for 15–20 minutes.

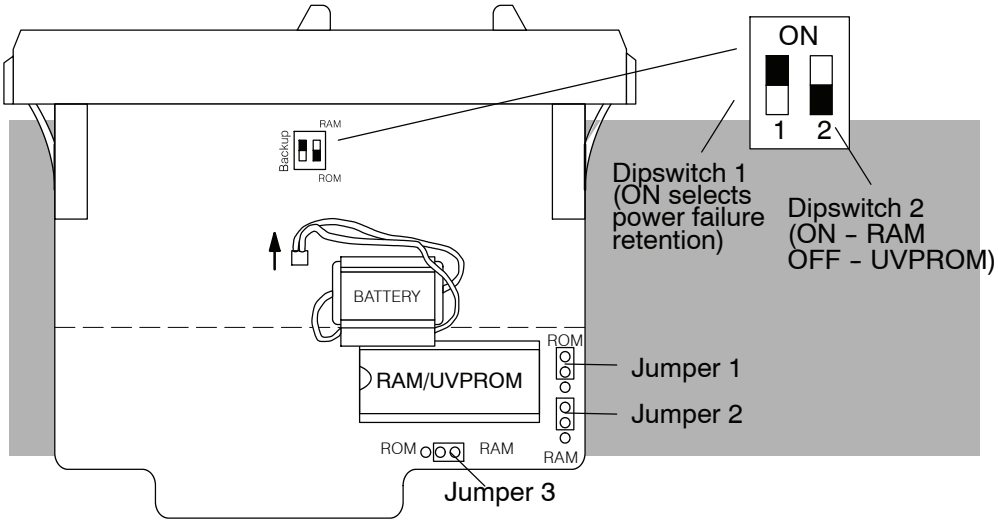
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DL330/DL330P CPU Setup

Installing the UVPROM Option in the DL330 / DL330P CPU

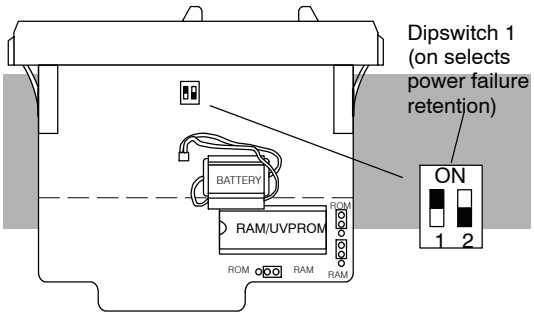
- Disconnect the power from the base and allow approximately 60 seconds for the capacitor to discharge before removing the CPU.
- Disconnect the battery wires from the CPU.
- Remove the RAM chip from IC socket.
- Align the UVPROM notch with the IC socket notch on the CPU card.
- Carefully insert the UVPROM in the IC socket.
- Set dip switch 2 and Jumpers 1 – 3 for UVPROM (ROM).
- Reconnect the battery wires to CPU.

Memory Type / Switch	RAM	UVPROM (ROM)
JUMPER 1		
JUMPER 2		
JUMPER 3		
DIPSWITCH 2	 (on)	 (off)



Selecting Retentive Memory for the DL330 / DL330P

The DL330 and DL330P have a dipswitch which can be used to turn on or off power failure retention for specific relays and stages. (Some memory types are automatically retentive.) The following diagram lists the range of retentive memory for the memory types that are covered by the selection switch.



Internal relays in the DL330 range from 160 – 373, only 340 – 373 can be set retentive or non-retentive.

Internal relays in the DL330P range from 160 – 277, only 200 – 277 can be set retentive or non-retentive.

Stages in the DL330P range from SG000 to SG177, only SG000 to SG137 can be set retentive or non-retentive.

DL330/DL330P Networking

Networking for the DL330 and DL330P is accomplished by using a DCU, (Data Communications Unit, RS232C part number D3-232-DCU, RS422 part number D3-422-DCU).

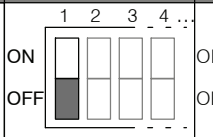
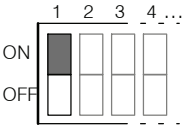
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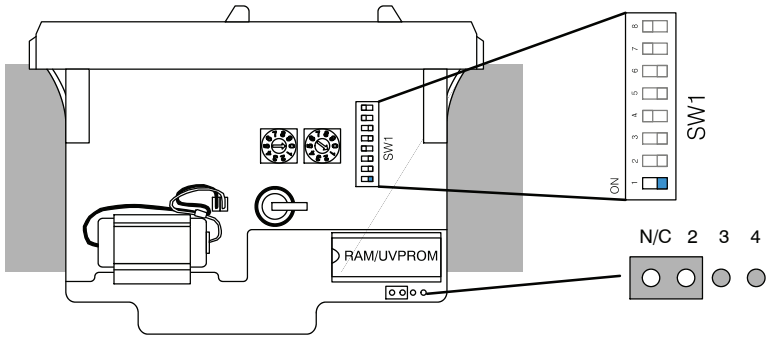
DL340 CPU Setup

Installing the optional UVPROM or EEPROM in the DL340 CPU

Complete the following steps to install the optional memory.

1. Disconnect the power from the base and allow approximately 60 seconds for the capacitor to discharge before removing the CPU.
2. Disconnect the battery wires from the CPU.
3. Align the UVPROM/EEPROM notch with the IC socket notch on the CPU.
4. Carefully insert the UVPROM/EEPROM into the IC socket.
5. Set dipswitch SW1, bit 1 and the short Jumpers N/C – 4 for the option you have installed.
6. Reconnect the battery wires to the CPU.

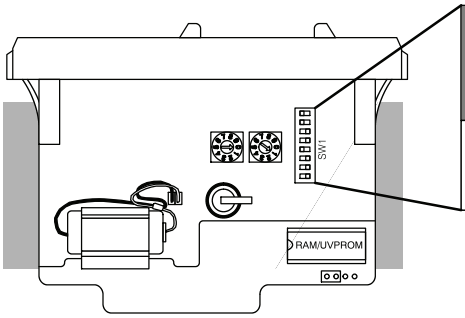
Memory Type / Switch	RAM	EEPROM	EEPROM (WRITE PROTECTED)	UVPROM (ROM)
DIPSWITCH SW1 - Bit 1				
SHORT PIN JUMPERS				



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Selecting Retentive Memory for the DL340

The DL340 uses the same dipswitch for selecting memory retention as was used for memory type selection. Dipswitch SW1, bit 2 is used to set memory retention for the ranges of internal relays shown in the following diagram.



Switch	Retentive Memory	Non-Retentive Memory
DIPSWITCH SW1 - Bit 2	ON 1 2 3 4 5 6 7 8 OFF	ON 1 2 3 4 5 6 7 8 OFF

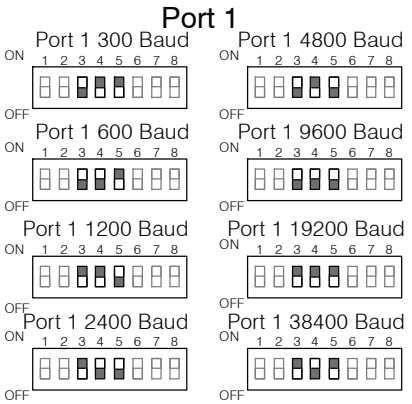
Internal relays in the DL340 range from 160 to 373 and 1000 to 1067, only 340 - 373 can be set retentive or non-retentive.

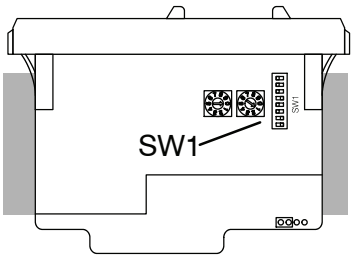
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DL340 Port Setup

DL340 Baud Rate Selection

The following chart shows how to configure the baud rate for Port 1 (RS232C) of the DL340 using dipswitch SW1, switches 3, 4 and 5. Port 2 baud rate is set by using a programming device to enter the baud rate in address R773 (in BCD or HEX).

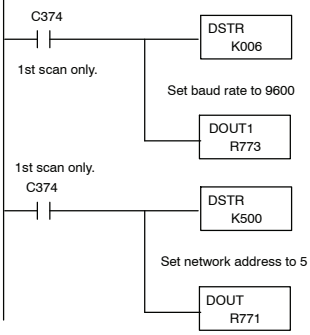




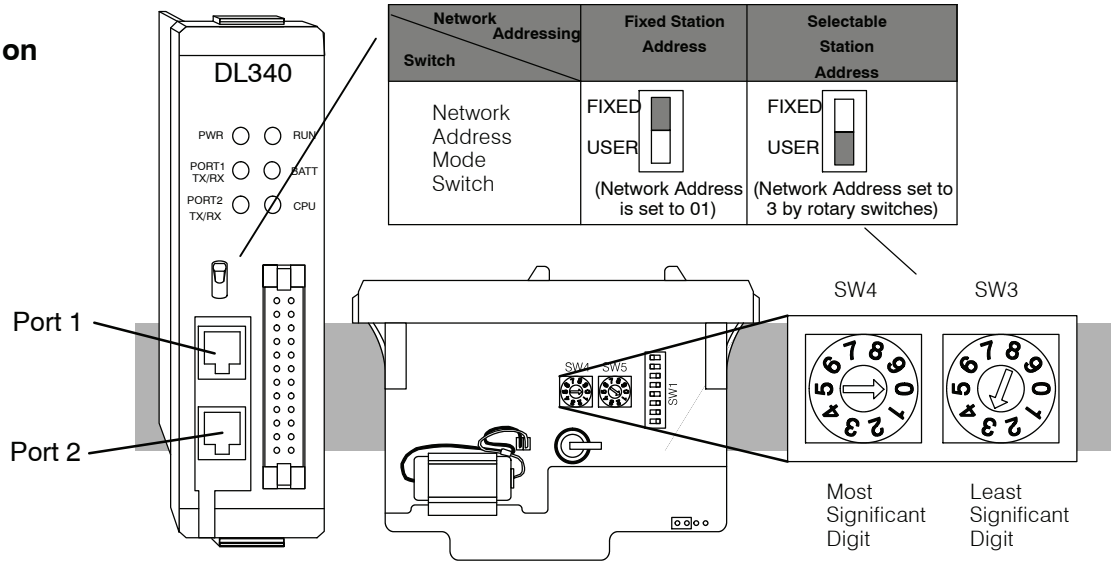
Port 2

Baud	R773
300	1
600	2
1200	3
2400	4
4800	5
9600	6
19200	7
38400	8
9600	0, 9 to FF

Sample Setup Ladder Logic



DL340 Network Address Selection



Port 1 (RS232C): Network address selection is accomplished with the Network Address Mode Switch and the two rotary switches 3 and 4. The address is set in BCD.

Network Address Mode Switch sets fixed or selectable network address.
Rotary Switch 3 sets the least significant decimal digit of the network address.
Rotary Switch 4 sets the most significant decimal digit of the network address.

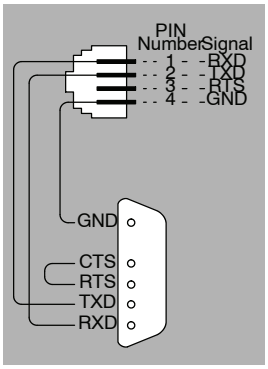
In the example above, when the Network mode switch is set to FIXED the network address will default to 01, when the Network mode switch is set to USER the network address (set with the rotary switches) is 03. Note, if the rotary switches are set to 00, the network address will default to 01.

Port 2 (RS232C): Network address selection is set by using a programming device to enter the value for the most significant digit and least significant digit in addresses R771 and R772 respectively. The address is set in BCD.

If you're using MODBUS RTU protocol on Port 2, the MODBUS address is set in decimal, not BCD. Load the lower two digits in R771 and the upper two digit(s) in R772.

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DL340 RS232C Port (1 and 2) Pin Outs



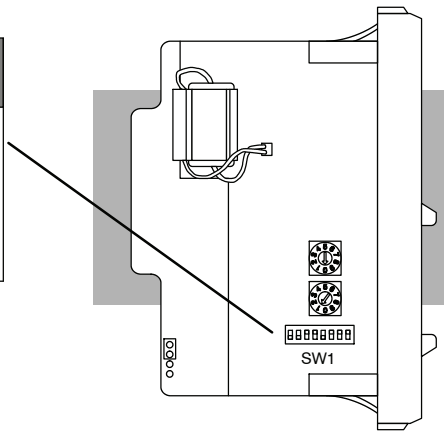
RS232C Communication Port Specifications

Connector	RJ11 (handset connector)
Network Address	01 to 90
Baud Rate	38400, 19200, 9600, 4800, 2400, 1200, 600, 300
Parity	None / Odd
Transfer Mode	Hex / ASCII Half-duplex Asynchronous
Data bits	8
Start bits	1
Stop bits	1
Turn Around Delay	0 to 1980 in 20 ms intervals (preset with R777)

DL340 Station Type Selection and Address Ranges

The station type for Port 1 is fixed as a Slave and cannot be changed. The station type for Port 2 can be selected by setting the appropriate switch positions (6 and 7) on the SW1 switch bank.

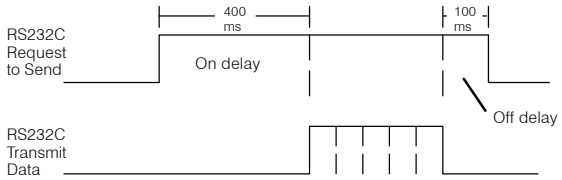
Port	Bit 6	Bit 7	Protocol	Address Range
1	N/A	N/A	Slave	1 - 90
2	Off	Off	Slave/***Direct***NET	1 - 90
	Off	On	Master/***Direct***NET	1 - 90
	On	Off	Peer/***Direct***NET	1 - 90
	On	On	Modbus®/RTU	1 - 247



DL340 Selecting the Response Delay Time

You can use the Handheld Programmer or ***Direct***SOFT to select an on and off response delay time of up to 1980 ms. The time delay is calculated based on a preset number that is loaded into two memory locations. These presets indicate the number of 20 ms intervals that will be used as the delay. For example, an entry of 2 would result in a 40 ms response delay time.

Port	On Delay	Off Delay
Port 1	R776	R777
Port 2	R774	R775



R776 = 20, 20 x 20ms intervals = 400ms on delay
R777 = 5, 5 x 20ms intervals = 100ms off delay

DL340 Selecting Data Format (ASCII/HEX)

A special propose control relay is used to select between ASCII and HEX transmission modes on the ***Direct***NET network. When this relay is off, HEX mode is used. When this relay is turned on, ASCII mode is used. Off is the default state.

- Port 1 C1077
- Port 2 C1076

DL340 Selecting Parity for Port 2

DL340 CPUs with firmware V2.7 or later allow you to select the parity for Port 2. The default setting is none. A special propose control relay (C1072) is used to select between odd parity (relay is on) and no parity (relay is off).

- Port 2 C1072

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Battery Backup

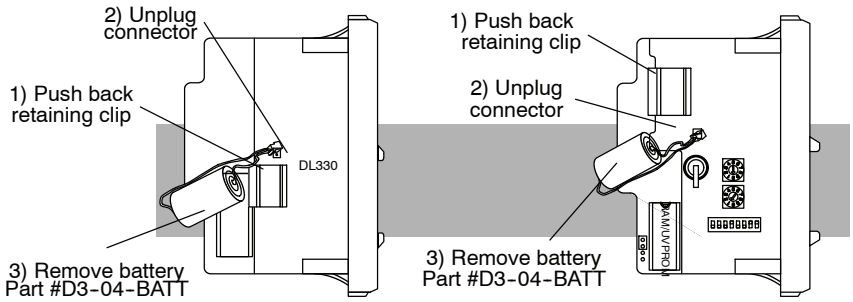
Memory Battery Backup

The DL305 CPUs have a lithium battery to retain the application program and retentive memory when the system is not receiving power from the power supply. Typical battery life is five years. This time period includes PLC runtime and normal shutdown periods such as preventative maintenance and power outages.

The CPU has indicators which tell when it is necessary to change the battery. However, if your battery has been in your system for an extended period of time, you may wish to take added precautions to ensure that the system memory will be retained by installing a new battery when shutting the system down for a period of more than ten days.

NOTE: Before replacing your CPU battery, you should back-up your application program. This can be done by saving the program to hard/floppy disk on a personal computer or using the handheld programmer along with a cassette tape recorder. The CPU has a built-in capacitor to retain the memory for several minutes while the battery is being replaced.

WARNING: If the battery connector is not connected to the PC board or the battery is not installed, the indicator will not notify you of the error. Be sure the battery is in place and the connector is firmly seated before you install the CPU into the base.



DL330, DL330P, DL340 CPU Battery Replacement

To replace the CPU battery:

1. Turn power off to the system.
2. Wait 60 seconds then remove the CPU. Do not short any connectors or components on the CPU since it may alter the program memory.
3. Unlatch and tilt the clip covering the battery.
4. Pull the two wire battery connector from the PC board and remove the battery.

WARNING: Do not attempt to recharge the battery or dispose of it by fire. The battery may explode or release hazardous materials.

To install the CPU battery:

1. Plug the (keyed) two wire battery connector on the battery into the connector on the PC board.
2. Push gently till the connector snaps closed
3. Slide the battery under the battery retaining clip till the battery is positioned in the socket.
4. Push the retaining clip down over the battery snapping the clip over the edge of the PC board.
5. Note the date the battery was changed.

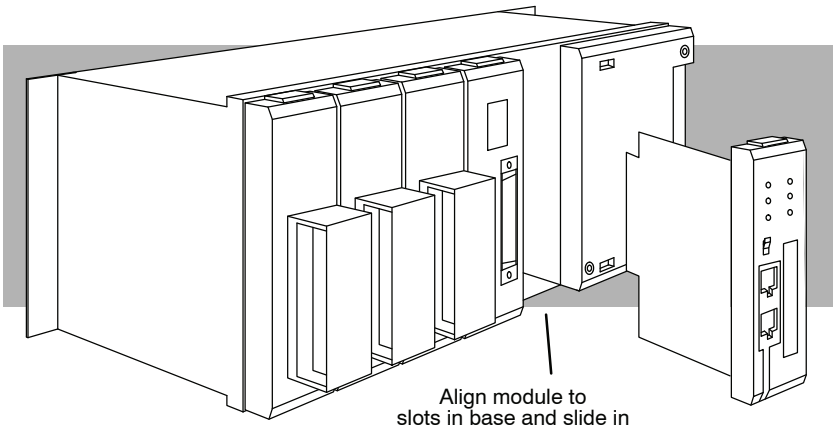
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Installing the CPU

Before you complete these steps, make sure you have set the dipswitches and/or jumpers needed to support your application.

WARNING: To minimize the risk of electrical shock, personal injury, or equipment damage, always disconnect the system power before installing or removing any system component.

When inserting the CPU into the base, align the PC board with the grooves on the top and bottom of the base. Push the CPU straight into the base until it is firmly seated in the backplane connector.



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CPU Setup and System Functions

A Few Things to Know

Even if you have years of experience using PLCs, there are a few things you need to do before you can start entering programs. This section includes some basic things, such as changing the CPU mode and connecting a programming device. Here is a list of the items that are discussed.

- Auxiliary Functions
- Connecting a Programming Device
- Changing the CPU Modes
- Clearing the CPU memory

The following paragraphs provide the setup information necessary to get the CPU ready for programming. The actual setup information depends on the type of programming device you are using. For example, the DL305 Handheld Programmer manual provides the Handheld keystrokes required to perform all of these operations. The ***Direct***SOFT manual provides a description of the menus and keystrokes required to perform the setup procedures via ***Direct***SOFT.

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What are Auxiliary Functions?

Many CPU tasks involve the use of predefined functions. These are often called Auxiliary (AUX) Functions. The AUX Functions perform many different operations, ranging from simple operating mode changes to determining the firmware revision number.

You can access all of the AUX Functions from ***Direct***SOFT menu options, but not from the DL305 Handheld Programmer. You can still perform some of the operations with the Handheld Programmer, but they are accomplished by using a certain series of keystrokes rather than by entering a specific AUX function.



NOTE: Neither ***Direct***SOFT or the Handheld Programmer utilize the numbers shown for the AUX functions. These numbers have been included because many of you may already have existing software packages that can be used with these CPUs. If you do already have an existing software package, remember that any additional features (such as added I/O, CRs, etc. available with the DL340 CPU) may not be accessible.

AUX Function and Description		DL330, DL330P, DL340	
AUX 1* — Diagnostics and PLC Modes		**Software**	**HP**
10	Program Syntax Check (Grammar check)	❍	❍
11	Compare PLC to Disk	❍	×
12	PLC Operational Mode	❍	❍
13	Revision Number	❍	×
AUX 3* — Clear PLC Memory		**Software**	**HP**
31	Ladders	❍	❍
32	Data Registers	❍	×
33	Timer / Counter Accumulators	❍	×
AUX 6* — Save Data from PLC		**Software**	**HP**
61	Ladders	❍	❍
62	Data Registers	❍	×
AUX 9* — Load Data to PLC			
91	Ladders	❍	❍
92	Data Registers	❍	×
Password Operations			
None	Password	❍	❍

❍ — Function or keystrokes available

X — Not available

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Connecting the Programming Devices

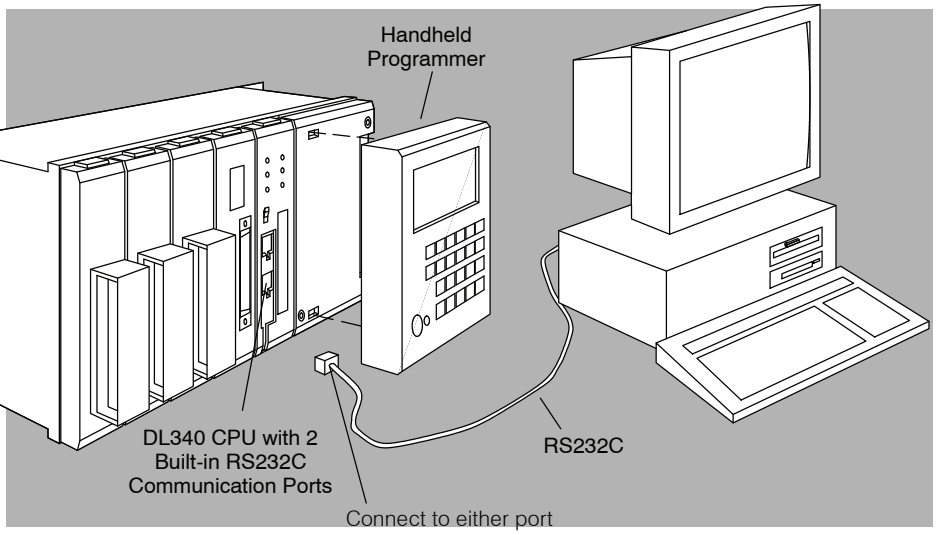
You can mount the Handheld directly to the port of the CPU, or you can use a cable. The cable, part number D3-HPCBL, is approximately 4.5 feet (1.5m) in length and provides more flexibility. There are two different handheld programmers for the DL305 CPUs. The D3-HP can be used with either the DL330 or the DL340. The D3-HPP can only be used with the DL330P. The D3-HPP supports the RLL*PLUS* features.

If you're using a Personal Computer with the ***Direct***SOFT programming package, a Data Communications Unit (either RS232C or RS422) must be used to interface to the DL330/DL330P CPUs. DCUs may also be used to establish a connection between the DL305 and an operator interface or a network.

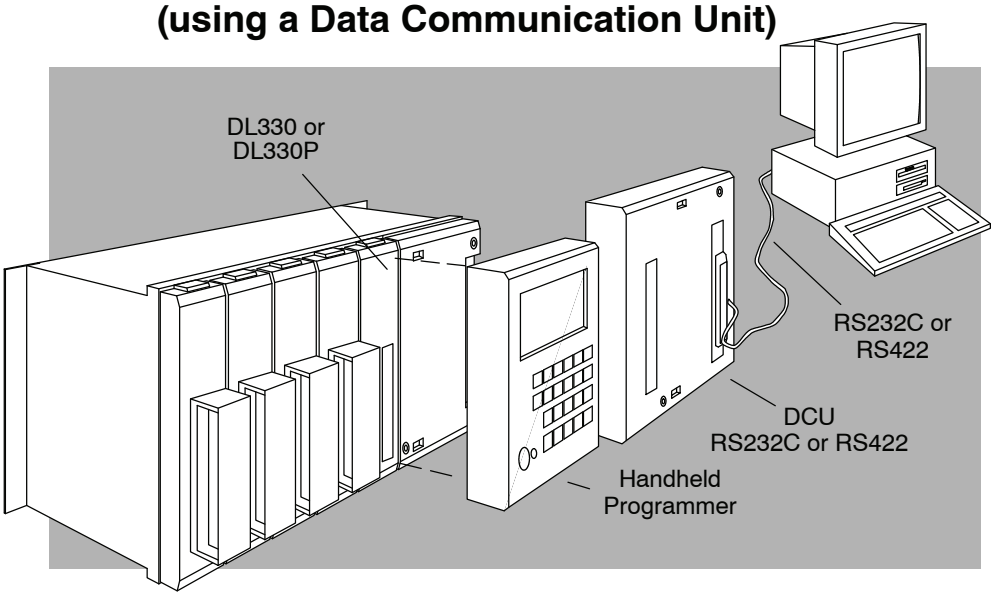
The DL340 CPU provides two built-in RS232C ports which can be used to directly connect to a personal computer, operator interface or network. The DCU may also be used with the DL340 if the built-in ports are otherwise occupied.

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Programming the DL340 CPU with either the Handheld programmer or the PC



Programming the DL330 CPU with either the Handheld programmer or the PC (using a Data Communication Unit)



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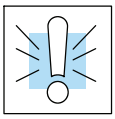
Changing the CPU Mode of Operation

There are two modes of operation for the DL305 CPUs:

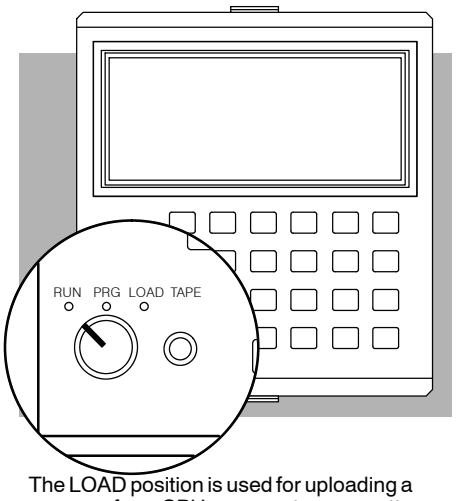
- RUN — executes the application program and updates I/O modules
- PGM — allows program entry, does not execute the application program or update I/O modules

The CPU modes for all DL305 CPUs can be changed by using either a Handheld Programmer or ***Direct***SOFT. The DL330 and DL330P require a Data Communications Unit when using ***Direct***SOFT. This is discussed later in this chapter.

Since the DL340 has the possibility of being accessed through multiple ports at the same time, the Handheld Programmer and DCU have priority over the built-in RS232C ports during mode change operations. If no Handheld Programmer or DCU is online, ***Direct***SOFT can perform mode changes through either of the built-in ports. When the Handheld Programmer or DCU is online and a mode change is attempted with ***Direct***SOFT, the Handheld Programmer or DCU will immediately change the mode back to the original mode. This forces the CPU mode to always correspond with the keyswitch position on the Handheld Programmer.



WARNING: The CPU will automatically change modes when you connect the Handheld Programmer if the keyswitch is set for a different mode of operation. For example, if the CPU is in Run mode and the Handheld Programmer keyswitch is set to the PRG (Program) position, the CPU will automatically enter Program mode when the Handheld is connected.



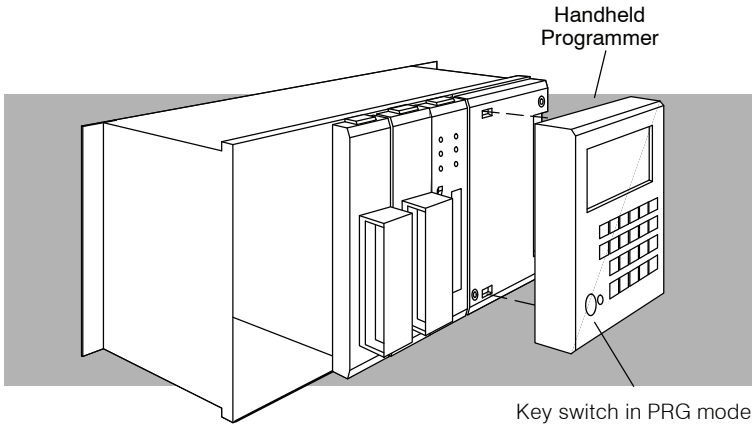
The LOAD position is used for uploading a program from CPU memory to a cassette tape, or downloading a program from cassette tape to CPU memory.

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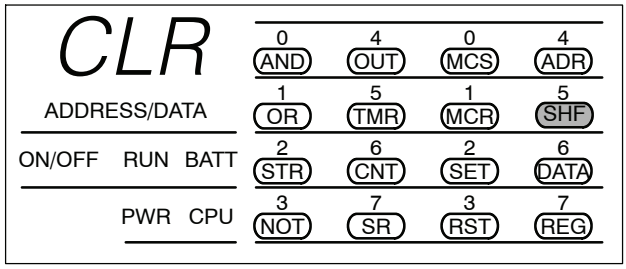
Clearing the CPU Memory

Before you enter a new program, you should always clear the CPU memory. Only a few keystrokes are required. The next few steps show how to clear the CPU memory using the handheld programmer.

Put the handheld programmer's key switch in the PRG position. Attach the handheld programmer directly to the front of the CPU making sure that the port on the back of the programmer aligns properly with the port on the CPU and the programmer's latches connect with the slots in the base power supply. Apply power to the base. LED's on the programmer will display indicating a good connection.



You can clear the memory by using the PLC/Clear PLC sub-menu from within ***Direct***SOFT, or you can use the following Handheld Programmer keystrokes.



CLR | SHF | 3 | 4 | 8 | DEL | NXT (Clears the CPU memory)



NOTE: This Handheld Programmer operation only clears the program memory. Any values stored in data registers are not cleared. You do have an additional menu option within ***Direct***SOFT that allows you to clear the data registers.

CPU Checklist

Before you proceed with the I/O configuration or programming information, make sure you have:

- set the CPU dipswitches
- selected and installed the EEPROM/UVPROM (if chosen.)
- a good understanding of the various system functions needed to setup the CPU.

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4

Bases, Expansion Bases, and I/O Configuration

In This Chapter. . . .

- Understanding I/O Numbering and Module Placement Rules
- Base Specifications and Wiring
- Using Bases for Local or Expansion I/O Systems
- Setting the Base Switches
- Example I/O Configurations
- I/O Configurations with a 5 Slot Local CPU Base
- I/O Configurations with an 8 Slot Local CPU Base
- I/O Configurations with a 10 Slot Local CPU Base
- Calculating the Power Budget

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Understanding I/O Numbering and Module Placement Rules

Before you install any I/O modules or begin installing or using the bases, it is very helpful to understand how the DL305 I/O numbering and module placement restrictions can sometimes dictate how your system is put together.

DL305 I/O Configuration History

The DL305 product family has had several enhancements over the years. Each time the product family has grown or has been enhanced, compatibility with the earlier products has been of the utmost concern. Some of these enhancements such as increasing the I/O count and supporting 16 point modules have impacted the numbering system. To help you understand our numbering scheme we have provided the following account of how the numbering system has been affected.

- When the 16 point I/O modules were introduced to the standard line of 8 point modules, the I/O numbering system was not modified to count in 16 consecutive units. This was done to maintain compatibility with the 8 point systems. This means each 16 point module uses two groups of eight consecutive numbers such as 000 through 007 and 100 through 107.
- When the I/O count was increased from the original 112 maximum to 176 maximum (for the DL330/DL330P CPU) and 184 maximum (for the DL340 CPU), most of the new I/O addresses were not set up to be consecutive with the the original 112 I/O. This means you will see a large jump in the I/O number ranges.

Octal Numbering System

The DL305 I/O points are numbered in octal (base 8.) The octal numbering system does not include the numbers 8 and 9. The following table lists the first few octal numbers with the equivalent decimal numbers so you can see the numbering pattern.

Octal Numbers	0	1	2	3	4	5	6	7	10	11	12	13	14	15	16	17	20	21	22	23	24	...
Decimal Numbers	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	...

Fixed I/O Numbering

The DL305 base I/O numbering is fixed, you cannot choose the I/O address of specific points since the system allocates the addresses for each slot. The I/O number ranges are 0–177 and 700–767. The I/O numbering for each slot in the base depends on two things:

1. The base configuration, which is determined by the size of the base and whether you are using an expansion base.
2. The number of I/O points per module and the location of the I/O modules in the base.

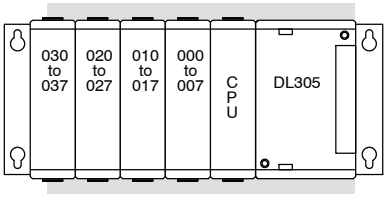
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I/O Numbering Guidelines

I/O numbering begins with address "000" which is the slot adjacent to the CPU. Each module uses increments of eight I/O points. For 8 point modules the I/O addresses are made up of eight contiguous points for each module. For 16 point modules the I/O addresses are made up of two groups of eight contiguous points, the first group follows the same scheme as the 8 point module and the second group adds 100 to the values of the first group.

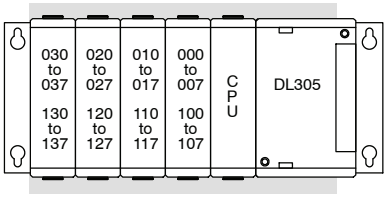
The examples below show the I/O numbering for a 5 slot local CPU base with 8 point I/O and a 5 slot local CPU base with 16 point I/O.

5 Slot Base Using 8 Point I/O Modules



Slot Number: 3—2—1—0

5 Slot Base Using 16 Point I/O Modules



Slot Number: 3—2—1—0

Number of I/O Points Required for Each Module

DC Input Modules	
D3-08ND2	8
D3-16ND2-1	16
D3-16ND2-2	16
D3-16ND2F	16
F3-16ND3	16
AC Input Modules	
D3-08NA-1	8
D3-08NA-2	8
D3-16NA	16
AC/DC Input Modules	
D3-08NE3	8
D3-16NE3	16

DC Output Modules	
D3-08TD1	8
D3-08TD2	8
D3-16TD1-1	16
D3-16TD1-2	16
D3-16TD2	16
AC Output Modules	
D3-04TAS	8*
F3-08TAS	8
D3-08TA-1	8
D3-08TA-2	8
F3-16TA-1	16
D3-16TA-2	16

Relay Output Modules	
D3-08TR	8
F3-08TRS-1	8
F3-08TRS-2	8
D3-16TR	16
Analog Modules	
D3-04AD	16
F3-04ADS	16
F3-08AD	16
F3-08TEMP	16
F3-08THM-n	16
F3-16AD	16
D3-02DA	16

Analog Modules (cont.)	
F3-04DA-1	16
F3-04DA-2	16
F3-04DAS	16
ASCII BASIC Modules	
F3-AB128-R	16
F3-AB128-T	16
F3-AB128	16
F3-AB64	16
Specialty Modules	
D3-08SIM	8
D3-HSC	16

* This is a 4-point module, but each slot is assigned a minimum of 8 I/O points.

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I/O Module Placement Rules

There are some limitations that determine where you can place certain types of modules. Some modules require certain locations and may limit the number or placement of other modules. We have tried to give clearly written explanations of the rules governing module placement, but we realize a picture can sometimes be worth a thousand words. If you have difficulty with some of our explanations, please look ahead to the illustrations in this chapter. They should clear up any gray areas in the explanation and you will probably find the configuration you intend to use in your installation.

In all of the configurations mentioned the number of slots from the CPU that are to be used can roll over into an expansion base if necessary. For example if a rule states a module must reside in one of the six slots adjacent to the CPU, and the system configuration is comprised of two 5 slot bases, slots 1 and 2 of the expansion base are valid locations.

The following table provides the general placement rules for the DL305 components.

Module	Restriction
CPU	The CPU must reside in the first slot of the local CPU base. The first slot is the closest slot to the power supply.
16 Point I/O Modules	There can be a maximum of eight 16 point modules installed in a system depending on the CPU type and I/O modules used. The 16 point modules must be in the first 8 slots adjacent to the CPU rolling over into an expansion base if necessary. If any of the eight slots adjacent to the CPU are not used for 16 point modules, they can be used for 8 point modules.
Analog Modules	Analog modules must reside in any valid 16 point I/O slot.
ASCII Basic Modules	ASCII Basic modules must reside in any valid 16 point I/O slot.
High Speed Counter	High Speed Counters may be used in one of the first 4 slots in the local CPU base.

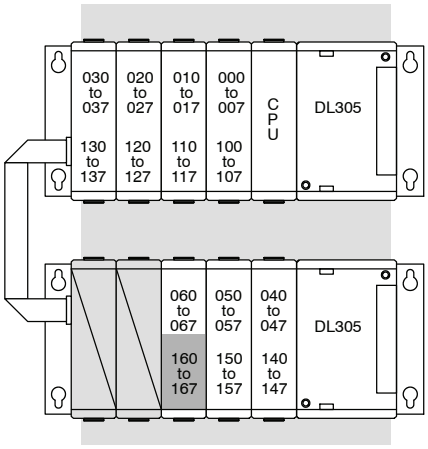
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DL330/DL330P Rules for 16 Point Modules

The DL330 CPU can address up to seven 16 point modules as long as they reside in the seven slots adjacent to the CPU, however; there is one circumstance where the number of 16 point modules can be limited.

- Only six 16 point modules can be used if High Speed Counter modules are installed in the system. The 16 point modules must reside in the six slots adjacent to the CPU.

NOTE: The High Speed Counter module is considered to be a 16 point module.



• Addresses 160 - 167 are not available as I/O if High Speed Counter modules are used in the system

NOTE: Addresses 160–167 are normally used as CRs, but they can also be used as I/O for 16 point modules. You cannot use the points as both CRs and I/O. Also, when you use these as I/O points, you still enter them as C160–C167 in ***Direct***SOFT.

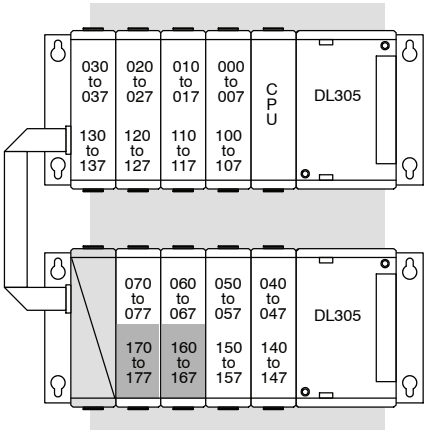
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DL340 Rules for 16 Point Modules

The DL340 CPU can address up to eight 16 point modules as long as they reside in the eight slots adjacent to the CPU, however; there are circumstances where the number of 16 point modules can be limited.

1. Only seven 16 point modules can be used if a Thumbwheel Interface module is installed in the system. The 16 point modules must reside in the seven slots adjacent to the CPU.
2. Only seven 16 point modules can be used if High Speed Counter modules are installed in the system. The 16 point modules must reside in the six slots adjacent to the CPU, skipping one slot, and using the 8th slot from the CPU for the last of the 16 point modules.
3. Only six 16 point modules can be used if a High Speed Counter and a Thumbwheel Interface module are installed in the system. The 16 point modules must reside in in the six slots adjacent to the CPU .

NOTE: Both High Speed Counter and Thumbwheel Interface modules are considered to be 16 point modules.



- Addresses 170 – 177 are not available as I/O if a Thumbwheel Interface module is used in the system
- Addresses 160 – 167 are not available as I/O if High Speed Counter modules are used in the system
- Addresses 160 – 167 and 170 – 177 are not available as I/O if both High Speed Counters and a Thumbwheel interface module are used in the system.

NOTE: Addresses 160 – 177 are normally used as CRs, but they can also be used as I/O points if you are using 16 point modules. Remember, if you use these locations as I/O points you cannot use them as CRs. Also, when you use these as I/O points, you still enter them as C160–C177 in ***Direct***SOFT.

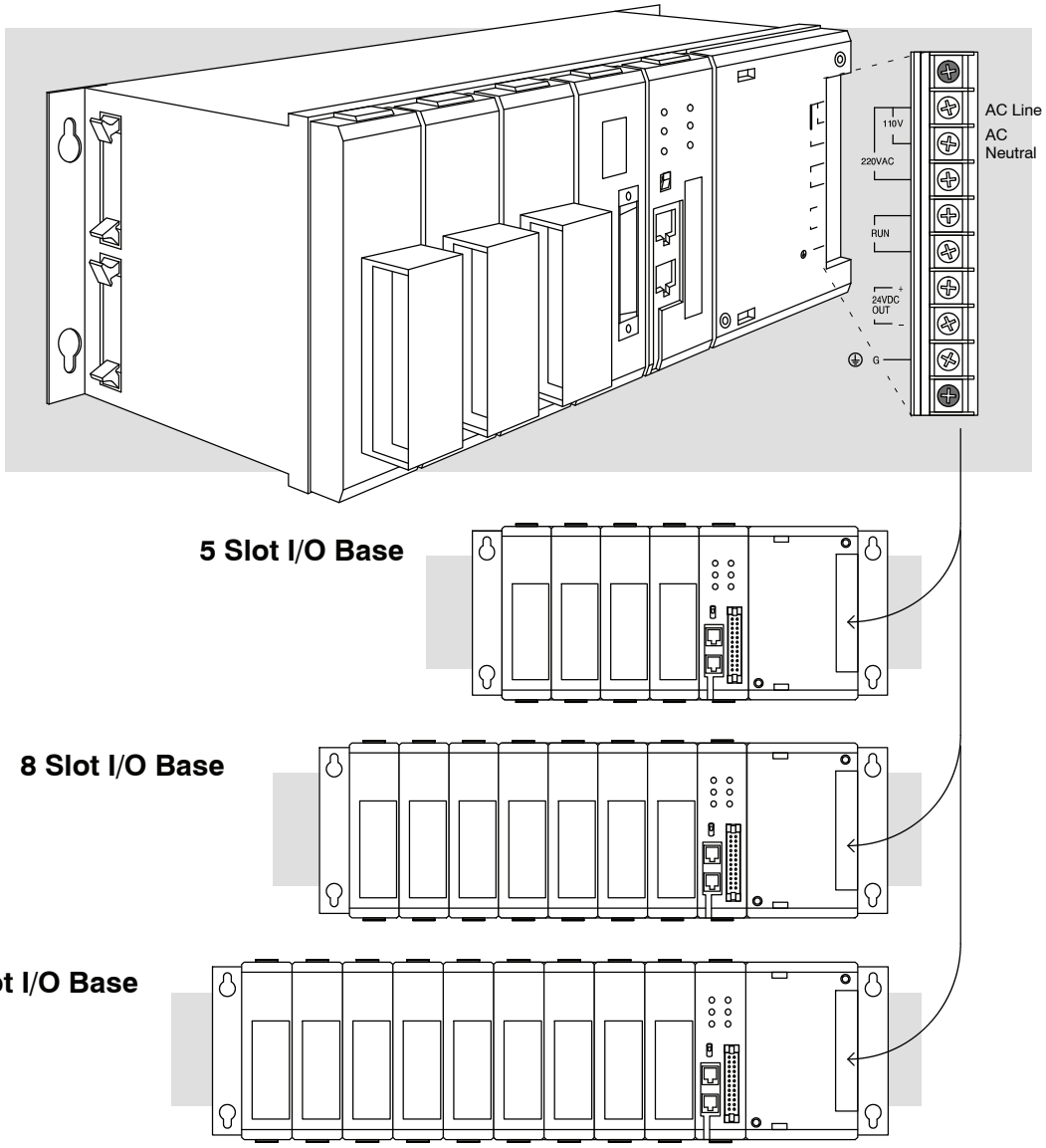
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Base Specifications and Wiring

Three Sizes of Bases

There are three base sizes available to hold your I/O modules: 5, 8 and 10 slot. The 5 and 10 slot bases can be used as either a local CPU base or an expansion base. The 8 slot base can only be used as a local CPU base. The 5, 8, and 10 slot bases are available with a built-in 110/220 VAC power supply. The 5 slot base is also available with a built-in 24 VDC power supply.

Remote I/O is not offered in the DL305 product family. All DL305 products, with the exception of the DL340 CPU, are compatible with remote I/O systems previously offered by GE FANUC® and TEXAS INSTRUMENTS®



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Bases and Maximum I/O Supported

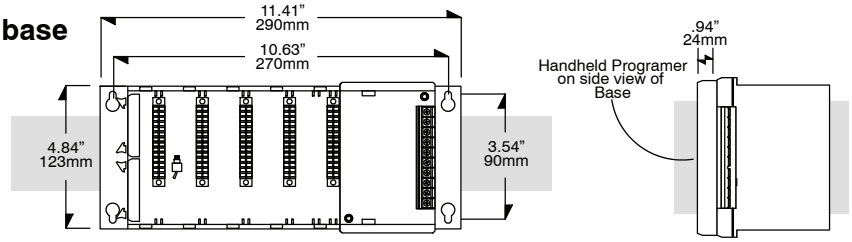
The maximum I/O for the base combinations is shown below. The number of I/O points supported also depends on the which CPU is used in the system.

Base Configuration	DL330 / DL330P CPU	DL340 CPU
5 slot local CPU base system	64 I/O max.	64 I/O max
5 slot local CPU base system with a 5 slot expansion base	120 I/O max.	128 I/O max.
5 slot local CPU base system with two 5 slot expansion bases	120 I/O max.	128 I/O max.
8 slot local CPU base system	112 I/O max.	112 I/O max.
8 slot local CPU base system with a 5 slot expansion base	152 I/O max.	152 I/O max.
10 slot local CPU base system	128 I/O max.	136 I/O max.
10 slot local CPU base system with a 5 slot expansion base	168 I/O max.	176 I/O max.
10 slot local CPU base system with a 10 slot expansion base	176 I/O max.	184 I/O max.

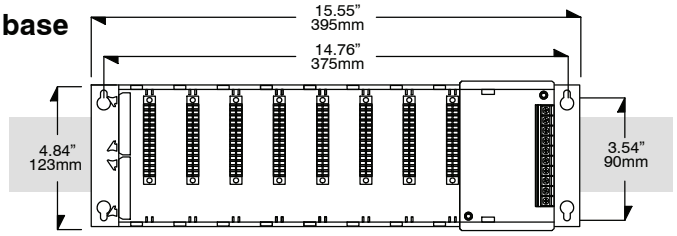
Base Mounting Dimensions

Use these mounting dimensions when you install the DL305 bases. Make sure you have followed the installation guidelines shown in Chapter 2 for proper spacing.

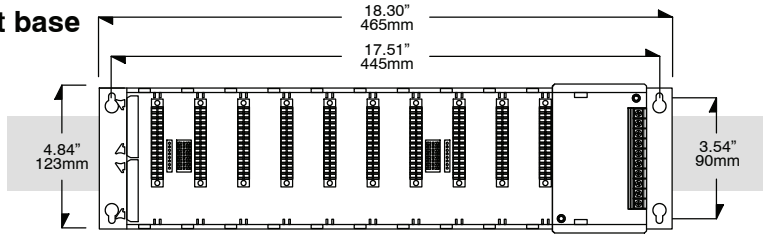
5 slot base



8 slot base



10 slot base

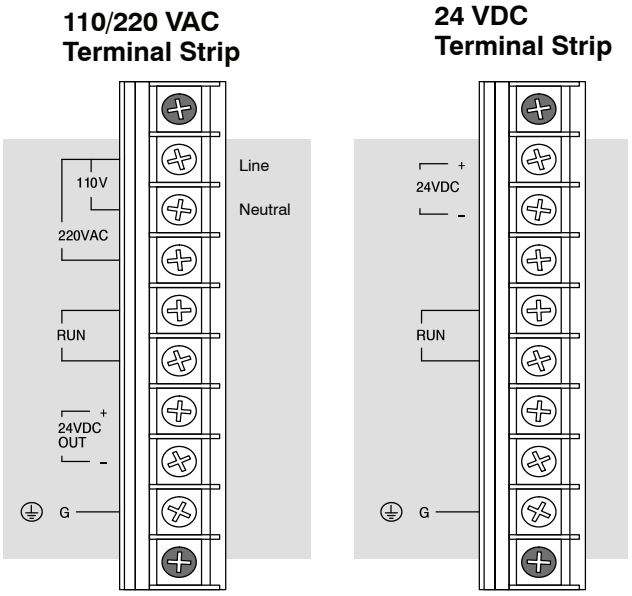


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Connecting the Power Supply

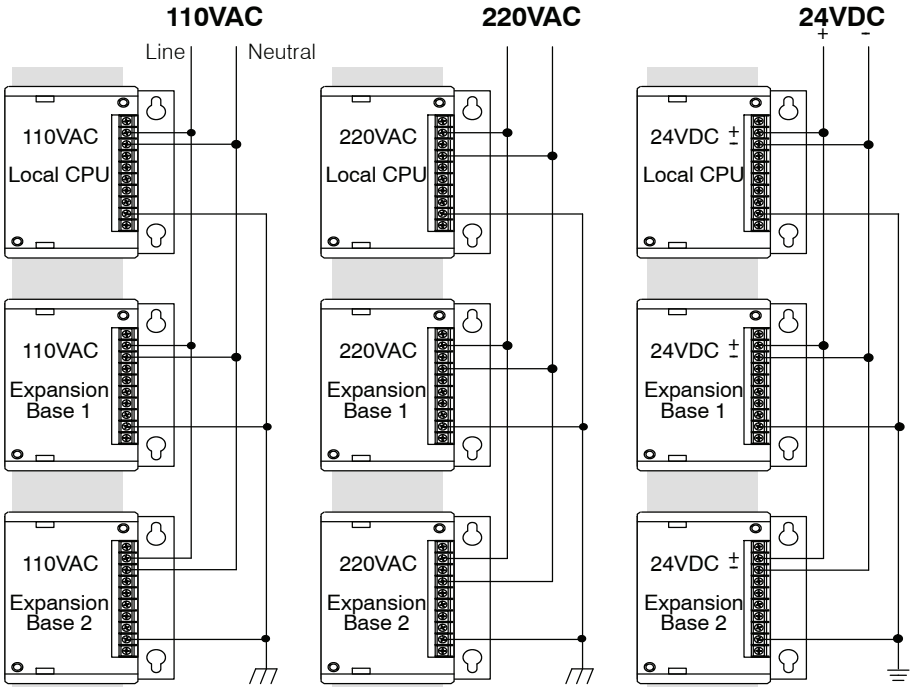
The following diagram shows the terminal connections located on the power supply of the DL305 bases.

WARNING: Damage will occur to the base power supply if 230 VAC is connected to the 115 VAC terminal connections. Once the power wiring is connected, install the protective cover. When the cover is removed there is a risk of electrical shock if you accidentally touch the connection terminals.



Expansion Base Power Supply Wiring Example

The following diagram shows how to connect the power when you use both local CPU and Expansion bases.



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Base Specifications

	D3-05B	D3-05BDC	D3-08B	D3-10B
Number of Slots	5	5	8	10
Local CPU Base	Yes	Yes	Yes	Yes
Expansion Base	Yes	Yes	No	Yes
Input Voltage Range	97-132 VAC 194-264 VAC 47-63Hz	20.5-30 VDC <10% ripple	97-132 VAC 194-264 VAC 47-63Hz	97-132 VAC 194-264 VAC 47-63Hz
Base Power Consumption	70 VA max (46W)	48 Watts	70 VA max (57W)	70 VA max (57W)
Inrush Current max.	30A	30A	30A	30A
Dielectric Strength	1500VAC for 1 minute between terminals of AC P/S, Run output, Common, 24VDC	1500VAC for 1 minute between 24VDC input terminals and Run output	1500VAC for 1 minute between terminals of AC P/S, Run output, Common, 24VDC	2000VAC for 1 minute between terminals of AC P/S, Run output, Common, 24VDC
Insulation Resistance	>10MΩ at 500VDC	>10MΩ at 500VDC	>10MΩ at 500VDC	>10MΩ at 500VDC
Power Supply Output (Voltage Ranges and Ripple)	(5VDC) 4.75-5.25V less than 0.1V p-p (9VDC) 8.5-13.5V less than 0.2V p-p (24VDC) 20-28V less than 1.2V p-p	(5VDC) 4.75-5.25V less than 0.1V p-p (9VDC) 8.5-13.5V less than 0.2V p-p (24VDC) 20-28V less than 1.2V p-p	(5VDC) 4.75-5.25V less than 0.1V p-p (9VDC) 8.0-12.0V less than 0.2V p-p (24VDC) 20-28V less than 1.2V p-p	(5VDC) 4.75-5.25V less than 0.1V p-p (9VDC) 8.0-12.0V less than 0.2V p-p (24VDC) 20-28V less than 1.2V p-p
5 VDC current available	1.4A *	1.4A	1.4A @ 122° F (50° C) 1.0A @ 140° F (60° C)	1.4A @ 122° F (50° C) 1.0A @ 140° F (60° C)
9 VDC current available	0.8A *	0.8A	1.7A @ 122° F (50° C) 1.4A @ 140° F (60° C)	1.7A @ 122° F (50° C) 1.4A @ 140° F (60° C)
24 VDC current available	0.5A *	0.5A	0.6A	0.6A
Auxiliary 24 VDC Output	100mA max	None	100mA max	100mA max
Run Relay	250 VAC, 4A (resistive load)	250 VAC, 4A (resistive load)	250 VAC, 4A (resistive load)	250 VAC, 4A (resistive load)
Fuses	2A (250V) User replaceable	4A (250V) User replaceable	2A (250V) User replaceable	2A (250V) User replaceable
Dimensions WxHxD	11.42x4.85x4.41 in. (290x123x112 mm)	11.42x4.85x4.41 in (290x123x112 mm)	15.55x4.85x4.41 in (395x123x112 mm)	18.3x4.85x4.41 in. (465x123x112 mm)
Weight	34 oz. (964g)	34 oz. (964g)	44.2 oz. (1253g)	50.5 oz. (1432g)

* The total current for the D3-05B must not exceed 2.3A.

Auxiliary 24VDC Output at Base Terminal

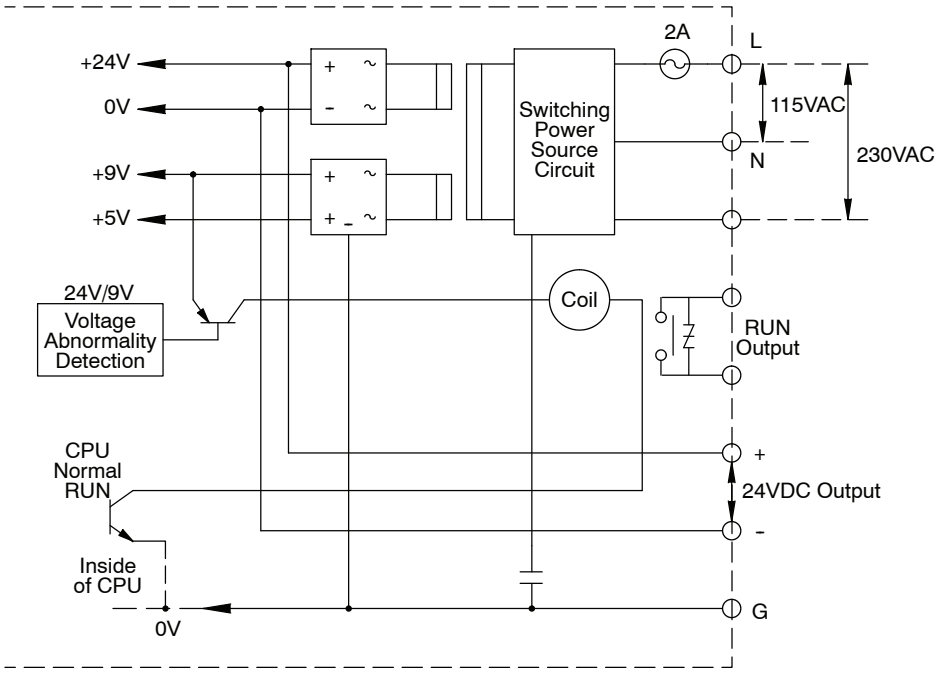
There is 24 VDC available from the 24 VDC output terminals on all bases except the 5 slot DC version (D3-05BDC). The 24 VDC supply can be used to power external devices or DL305 modules that require external 24 VDC. The power used from the this 24 VDC output reduces the internal system 24 VDC available to the modules by an equal amount. So if you use this power supply, make sure you consider this when you calculate the power budget. (The power budget is discussed in more detail later in this chapter.)

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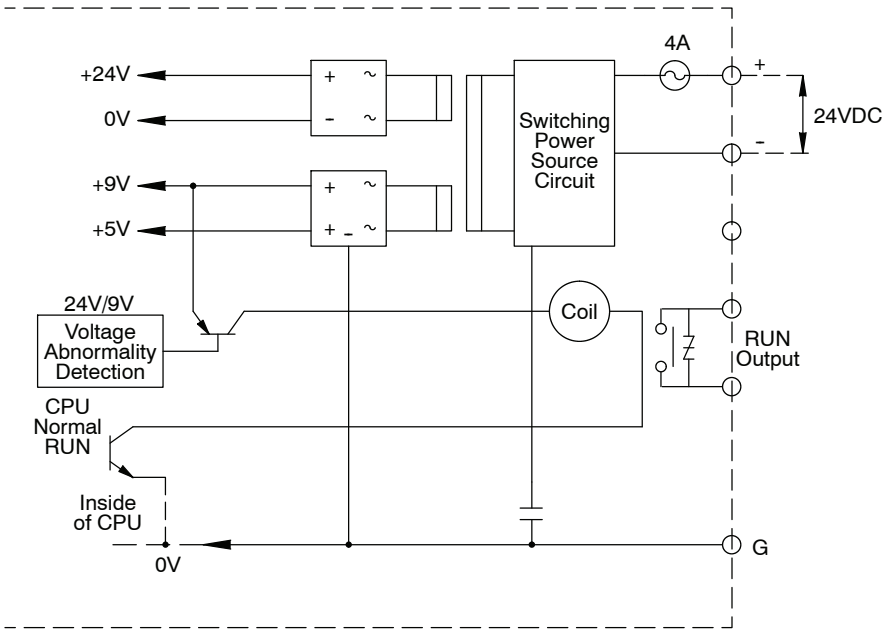
Power Supply Schematics

The following diagram shows the details of how the DL305 base provides many of the specifications listed on the previous page.

Schematic for D3-05B, D3-08B, D3-10B



Schematic for D3-05BDC



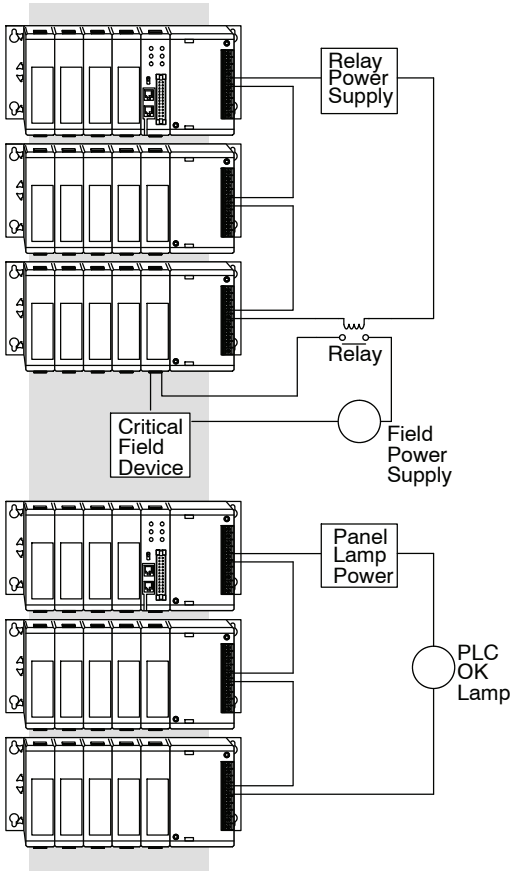
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Using the Run Relay on the Base Power Supply

The RUN relay output, located on the DL305 base power supply, can be used to detect an undesired failure on the local CPU base or an expansion base. The following table shows the operating characteristics of the RUN relay for a local CPU base or an expansion base.

Event	Local CPU Base RUN Relay Would:	Expansion Base RUN Relay Would:
PROGRAM to RUN mode Transition	Energize	Not change
The CPU detects a fatal error	De-energize	Not change
CPU Local Base is Removed Form the RUN Mode	De-energize	Not change
Power Source to the Power Supply is Turned OFF	De-energize	De-energize
9 VDC or 24 VDC Failure on the Power Supply	De-energize	De-energize

The following example demonstrates possible uses for the RUN relay on the DL305 bases.



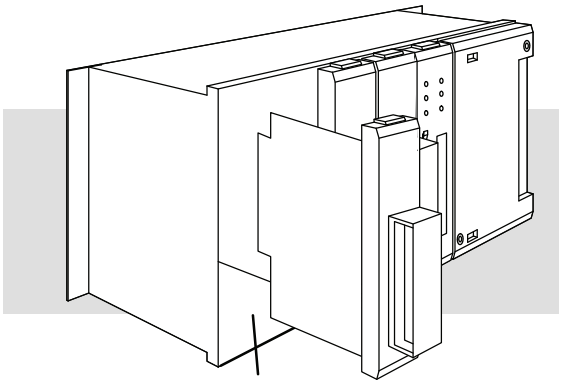
Use of the RUN relay to shutdown critical field devices upon error detection

Use of the RUN relay to monitor system operation

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Installing CPUs and I/O Modules

The CPU must go into first slot (next to the power supply) on the far right side of the base. When inserting components into the base, align the PC board(s) of the module with the grooves on the top and bottom of the base. Push the module straight into the base until it is firmly seated in the backplane connector. To remove a module from the base squeeze the tabs on the top and bottom of the faceplate and pull the module straight out.



Align module to
slots in base and slide in



WARNING: Do not remove any system component when system power is on. This may cause damage to the system or unpredictable system operation that can result in a risk of personal injury.

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Using Bases for Local or Expansion I/O Systems

Base Uses Table

It is helpful to understand how you can use the various DL305 bases in your control system. The following table shows how the bases can be used.

Base Part #	Number of Slots	Can Be Used As A Local CPU Base	Can Be Used As An Expansion Base
D3-05B	5	Yes	Yes
D3-05BDC	5	Yes	Yes
D3-08B	8	Yes	No
D3-10B	10	Yes	Yes

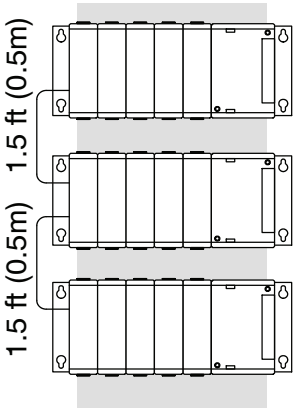
Local/Expansion Connectivity

The configurations below show the valid combinations of local CPU bases and expansion bases.

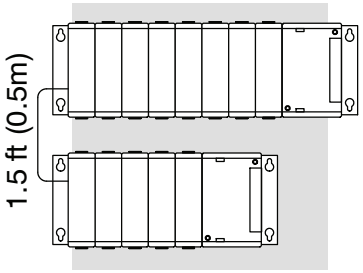


NOTE: You should use one of the configurations listed below when designing an expansion system. If you use a configuration not listed below the system will not function properly.

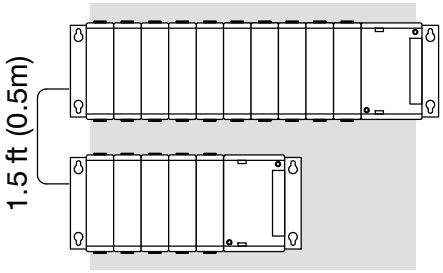
5 slot local CPU base with a maximum of two 5 slot expansion bases



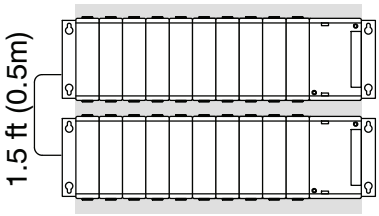
8 slot local CPU base with a 5 slot expansion base



10 slot local CPU base with a 5 slot expansion base



10 slot local CPU base with a 10 slot expansion base

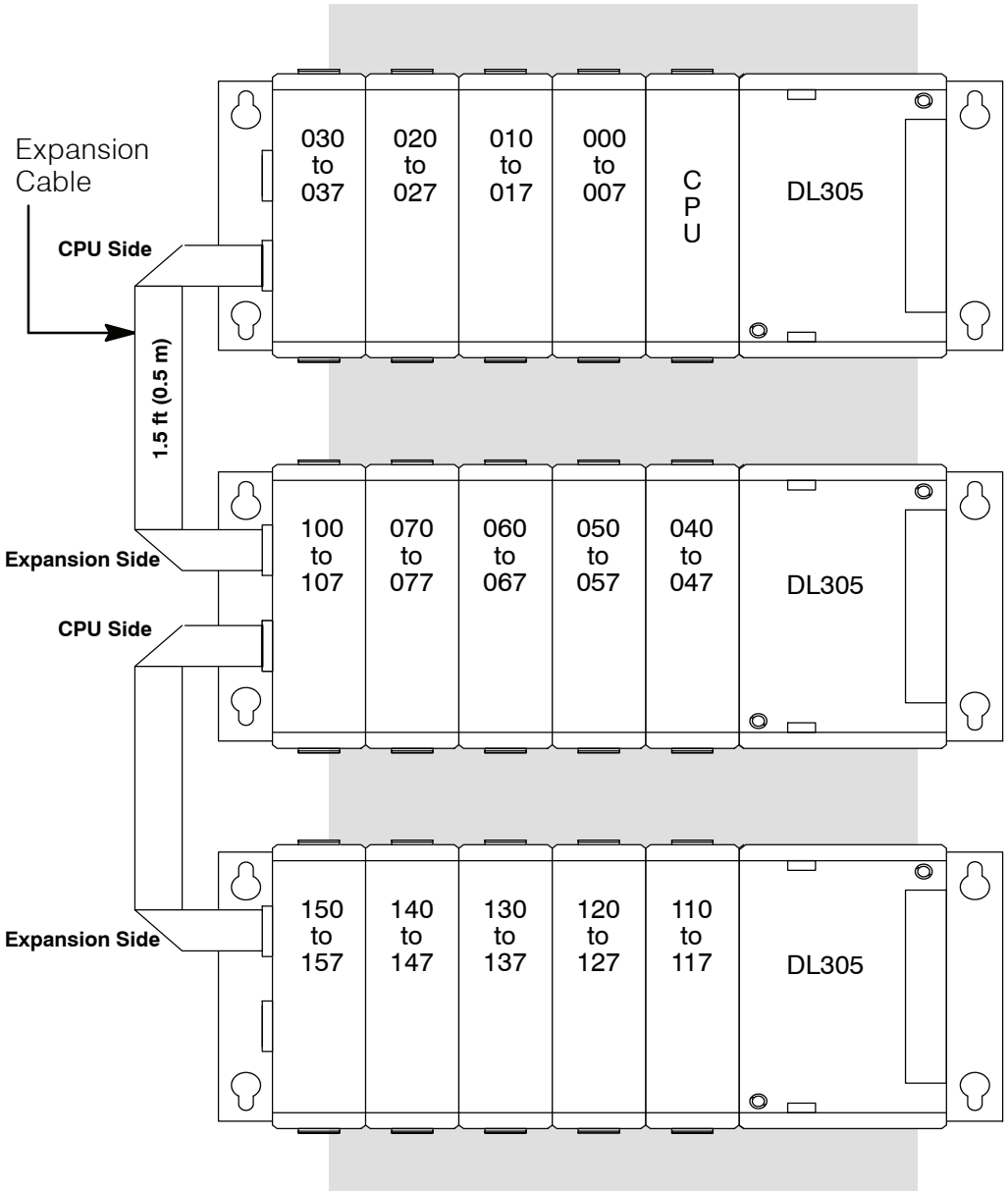


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Connecting Expansion Bases

The local CPU base is connected to the expansion base using a 1.5 ft. cable (D3-EXCBL). The base must be connected as shown in the diagram below.

The top expansion connector on the base is the input from a previous base. The bottom expansion connector on the base is the output to an expansion base. The expansion cable is marked with “CPU Side” and “Expansion Side”. The“ CPU Side” of the cable is connected to the bottom port of the base and the “Expansion Side” of the cable is connected to the top port of the next base.



Note: Avoid placing the expansion cable in the same wiring tray as the I/O and power source wiring.

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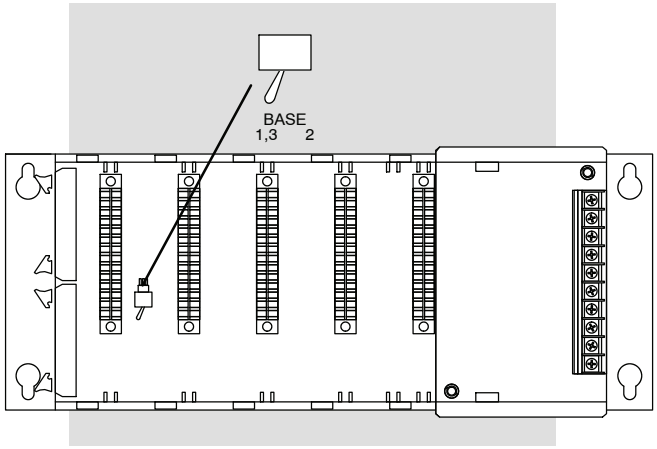
Setting the Base Switches

The 5 slot and 10 slot bases have jumper switches that need to be set depending on which system configuration is used. The 8 slot base does not have any switches.

5 Slot Bases

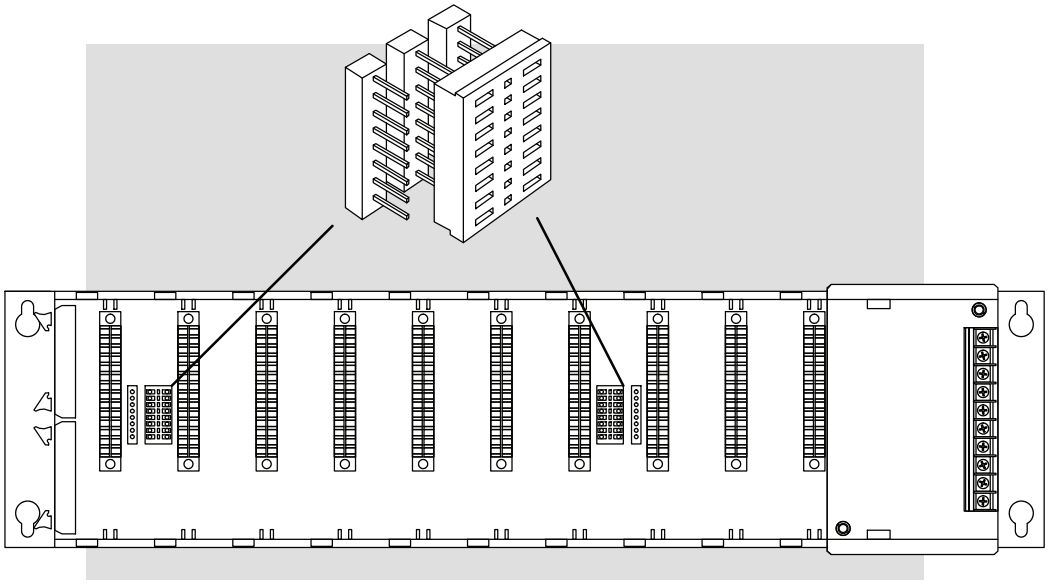
The 5 slot bases have a two position toggle switch which is used to set the base as the CPU local base, the first expansion base, or the second (last) expansion base.

The switch is set to the “1,3” position if the base is the local CPU base or the third base in the system. The switch is set to the “2” position if the base is the 2nd base in the system. If the 5 slot base is used as an expansion base for a 10 slot local CPU base the switch is set in the “1,3” position.



10 Slot Base

The 10 slot base has a jumper switch between slot 3 and 4 used to set the base to local CPU base or expansion base. There is also a jumper switch between slot 9 and 10 that sets slot 10 to the 100–107 I/O address range or to the 700–707 I/O address range.



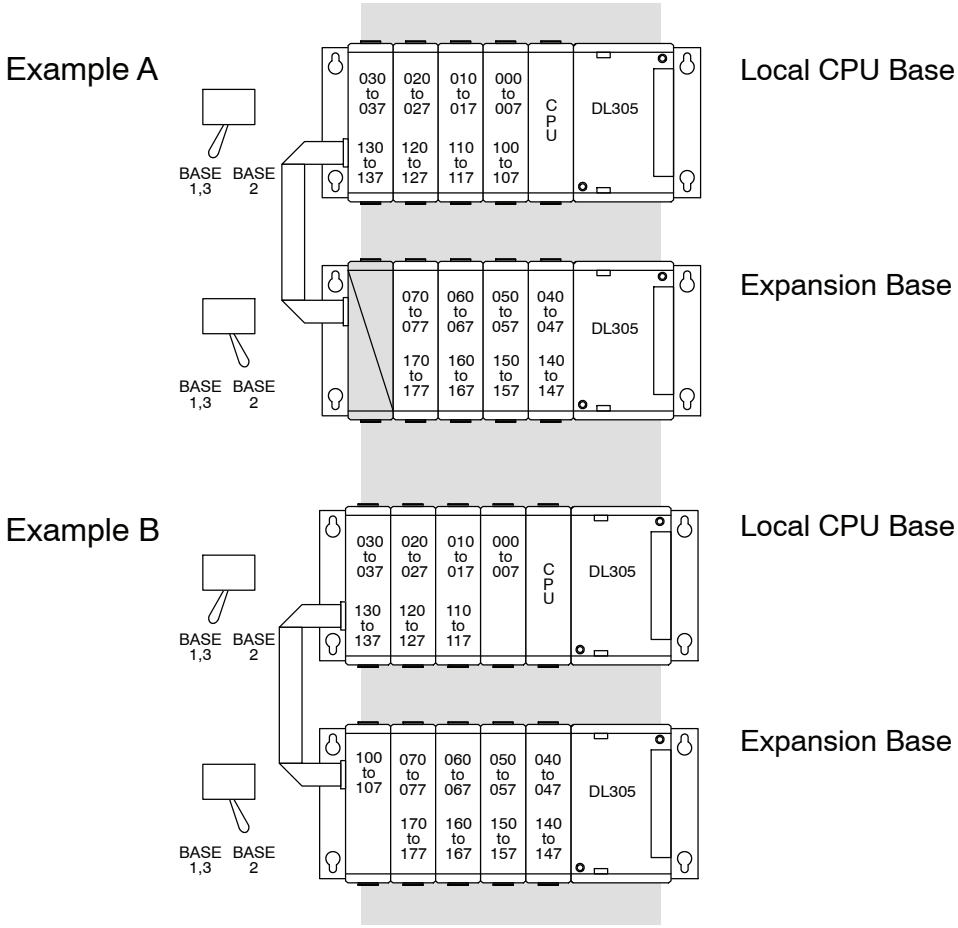
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Example I/O Configurations

The following system configurations will allow you to quickly configure your system by using examples. These system configurations show the I/O numbering and the base switch settings for every valid base configuration for a DL305 system.

16 Point I/O Allocation Example

When a 16 point I/O module is used the last 8 I/O addresses of each 16 point module could have been used in another base slot. In the illustration below Example A shows a 16 point module in the slot next to the CPU using address 000–007 and 100–107. The expansion I/O cannot use the last slot of the expansion base since it is assigned addresses 100–107 and the 16 point module next to the CPU has already used these addresses. Example B shows an 8 point module in the slot next to the CPU and an 8 point module in the last slot of the expansion base. Both examples are valid configurations .



Examples Show Maximum I/O Points Available

For the following examples the configurations using 16 point I/O modules are shown with the maximum I/O points supported so you can always reduce the I/O count in one of our examples and the configuration will still be valid. Substitution of 8 point I/O modules can be made in place of any of the 16 point modules without affecting the I/O numbering for any of the other I/O modules. When a 16 point module is replaced with a 8 point I/O module the last 8 I/O addresses of that 16 point module may or may not be useable in another slot location, depending on the system configuration used

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I/O Configurations with a 5 Slot Local CPU Base

The configurations below and on the next few pages show a 5 slot base with 8 point I/O modules, 16 point modules, one expansion base and two expansion bases.

Switch settings

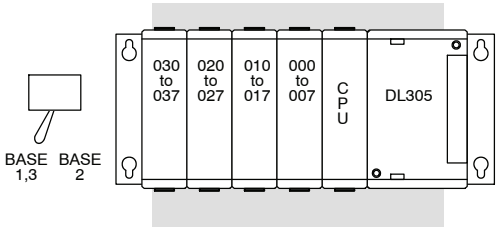
The 5 slot base has a toggle switch on the inside of the base between slots 4 and 5 which allows you to select:

Type of Base	Switch Position
Local CPU	Base 1,3
First Expansion	Base 2*
Last Expansion	Base 1,3

*used only with a 5 slot local CPU base

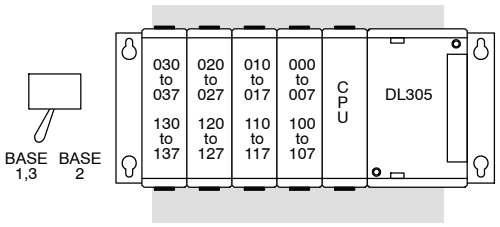
5 Slot Base with 8 Point I/O

Total I/O: 32



5 Slot Base with 16 Point I/O

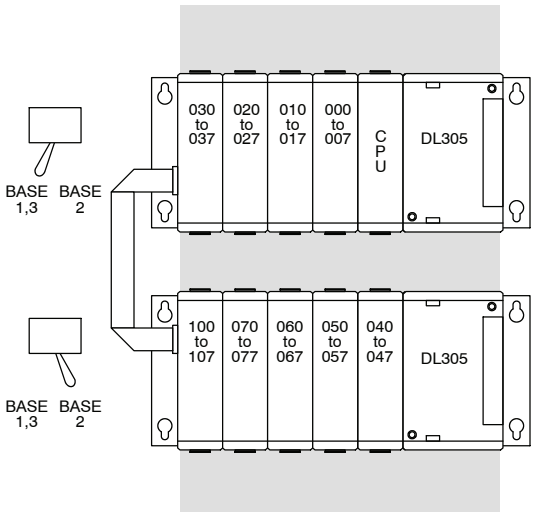
Total I/O: 64



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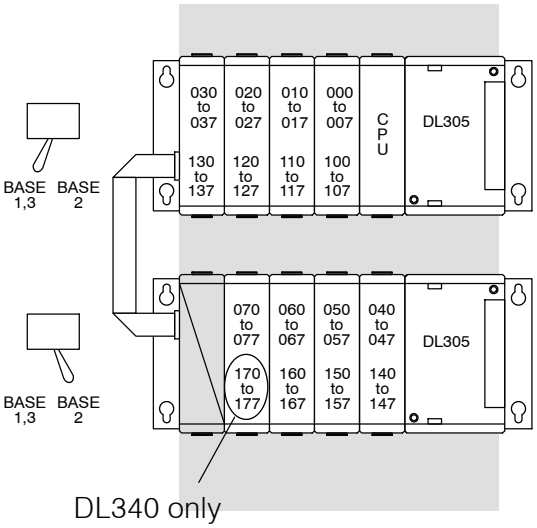
5 Slot Base and 5 Slot Expansion Base with 8 Point I/O

Total I/O: 72



5 Slot Base and 5 Slot Expansion Base with 16 Point I/O

Total I/O: 128

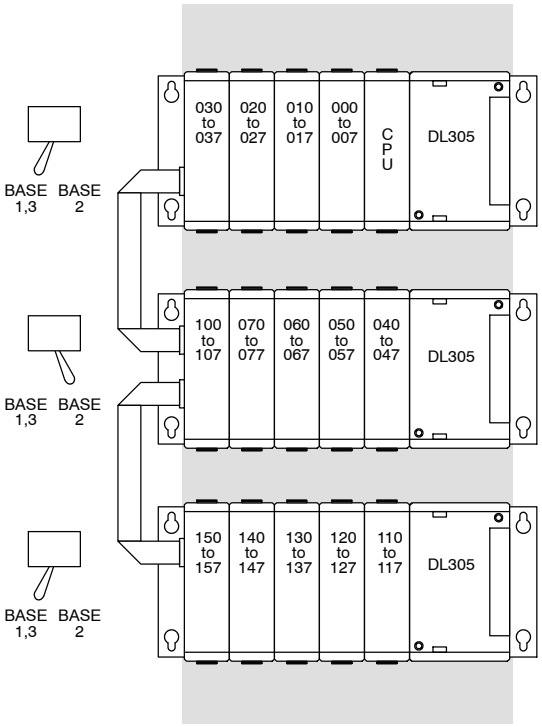


NOTE: If a 16pt module is used in the last two available slots of the expansion base, 160 through 177 will not be available for control relay assignments. Also, even though you are using these points as I/O, you still enter them as C160–C177 in ***Direct***SOFT.

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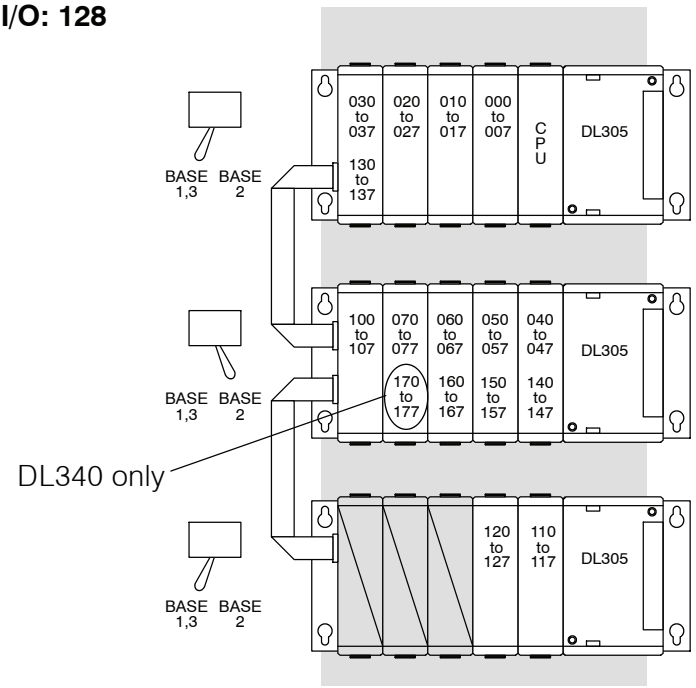
5 Slot Base and Two 5 Slot Expansion Bases with 8 Point I/O

Total I/O: 112



5 Slot Base and Two 5 Slot Expansion Bases with 16 and 8 Point I/O

Total I/O: 128



NOTE: If a 16pt module is used in the last two available slots of the expansion base, 160 through 177 will not be available for control relay assignments. Also, even though you are using these points as I/O, you still enter them as C160–C177 in ***Direct***SOFT.

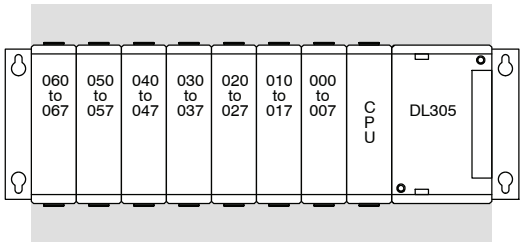
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I/O Configurations with an 8 Slot Local CPU Base

The configurations below show an 8 slot base with 8 point I/O modules, 16 point modules, one 5 slot expansion base and two 5 slot expansion bases.

8 Slot Base with 8 Point I/O

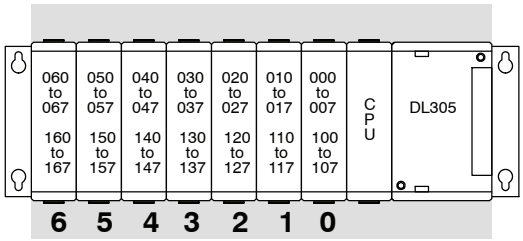
Total I/O: 56



8 Slot Base with 16 Point I/O

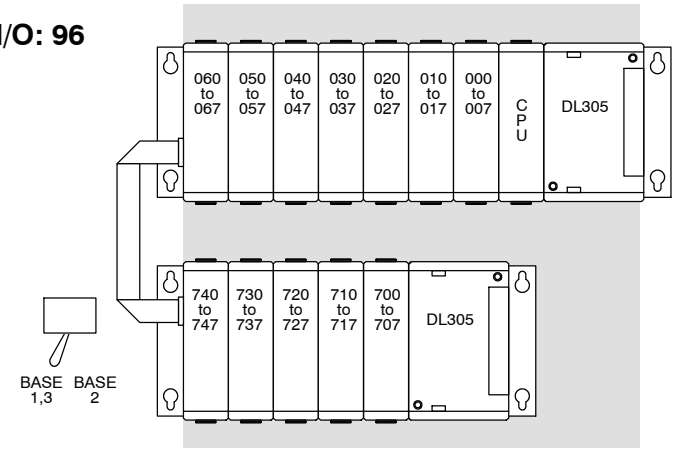
Total I/O: 112

***See note below regarding points 160–167**



8 Slot Base and 5 Slot Expansion Base with 8 Point I/O

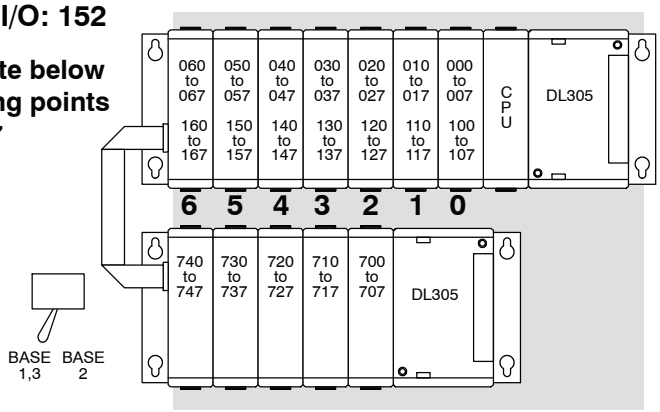
Total I/O: 96



8 Slot Base and 5 Slot Expansion Base with 16 Point I/O

Total I/O: 152

***See note below regarding points 160–167**



NOTE: If a 16pt module is used in Slot 6, 160 through 167 will not be available for control relay assignments. Also, even though you are using these points as I/O, you still enter them as C160–C167 in ***Direct***SOFT.

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I/O Configurations with a 10 Slot Local CPU Base

The configurations below and on the next few pages show a 10 slot base with 8 point I/O modules, with 16 point modules, with a 5 slot expansion base and with a 10 slot expansion base.

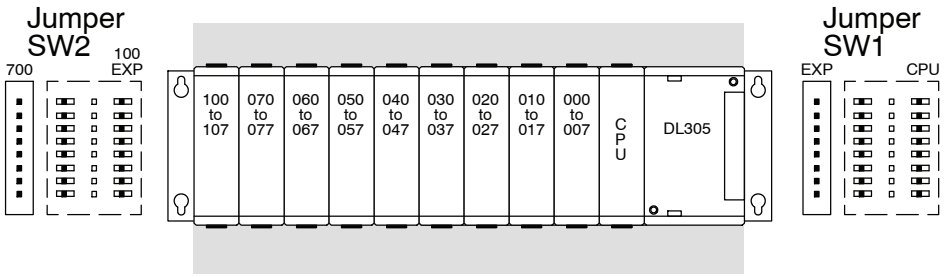
Switch settings

The 10 slot base has two jumper switches to select the base type and the address ranges to use. These switches can be found on the base between slots 3 and 4 (SW1) and slots 9 and 10 (SW2). Jumper switch SW1 is used to select if the base is a local CPU base or an expansion base. Jumper switch SW2 determines the I/O address range (100 – 107 or 700 – 707) for the 10th slot on the local CPU base. By selecting the address range of 700 to 707 for slot 10, it is possible to use a 16 point module next to the CPU (which uses the ranges of 000 to 007 and 100 to 107), however; the position of this switch will affect the I/O numbering for the expansion I/O if used.

NOTE: Jumper switch SW2 must be set to “100 EXP” on the expansion base.

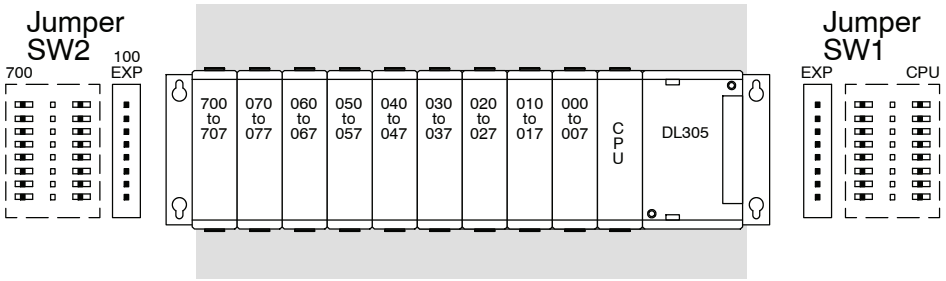
Last Slot Address Range 100 to 107

Total I/O: 72



Last Slot Address Range 700 to 707

Total I/O: 72



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10 Slot Expansion Base with 16 Point I/O

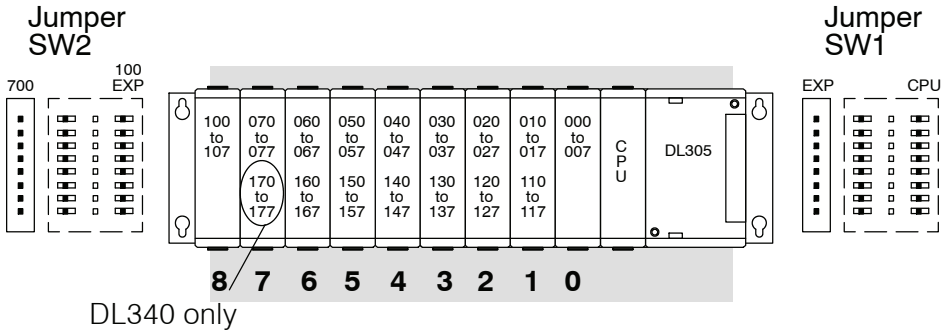
The next two configurations show a local CPU base using 16 point I/O modules and the two possibilities for how to configure the base to use the maximum number of I/O points.

Configuration 1

Configuration 1 shows an 8 point I/O module the slot next to the CPU and the address range of 100–107 for the last slot. When jumper switch SW2 is set to the "100 EXP" position, the address range for the last slot is set to 100–107, thereby limiting the address range for the first module to 000–007. This means if you use this configuration, the first module must be an 8 point I/O module. You will have more available addresses for an expansion base as you will see in the example using a 10 slot expansion base.

Total I/O:128

Configuration 1



DL340 only

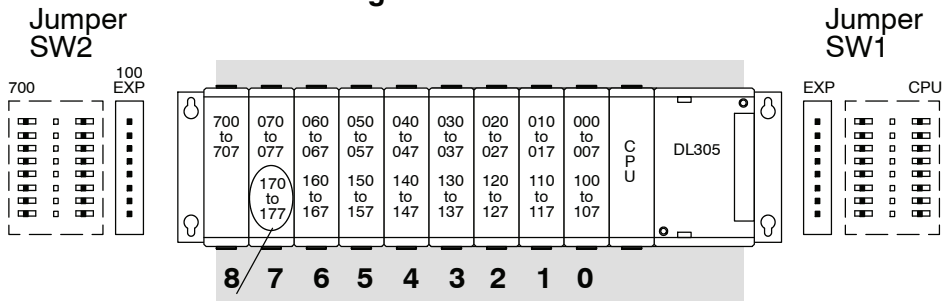
***See note below regarding points 160–167 and 170–177.**

Configuration 2

Configuration 2 shows a 16 point I/O module in the slot next to the CPU and the address range of 700–707 for the last slot. This is the maximum I/O configuration for a 10 slot local CPU base. When jumper switch SW2 is set to the "700" position the address range for the last slot is set to 700–707 making addresses 000–007 and 100–107 available for use in the first slot. The position of jumper switch SW2 can limit the amount of I/O addresses available to the larger expansion bases since expansion I/O numbering would normally start with address 700.

Total I/O: 136

Configuration 2



DL340 only

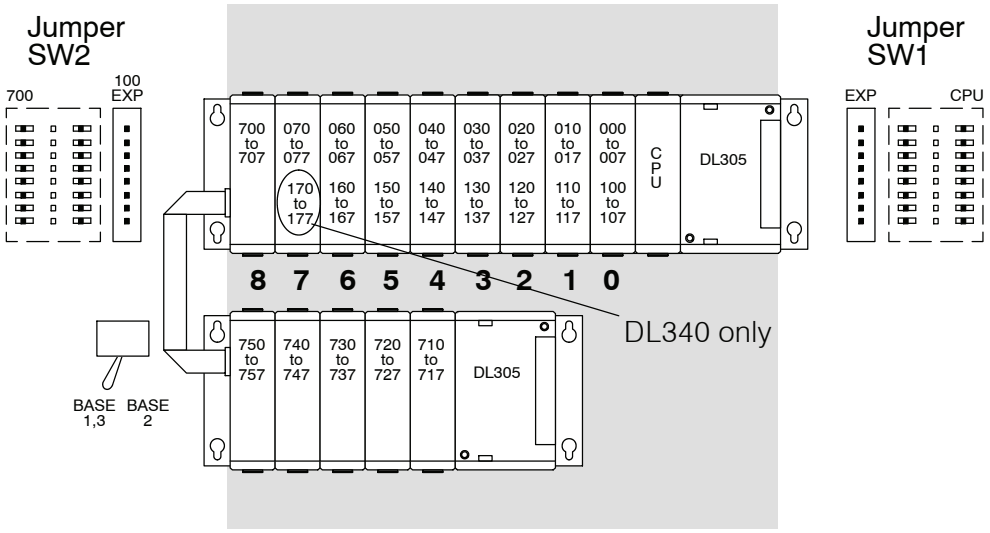
***See note below regarding points 160–167 and 170–177.**

NOTE: If a 16pt module is used in Slot 6 for the DL330 or DL330P CPU, 160 through 167 will not be available for control relay assignments. If a 16pt module is used in Slot 6 and/or Slot 7 for a DL340 CPU, 160–167 and/or 170–177 are not available for control relay assignments. Also, even though you are using these points as I/O, you still enter them as C160–C167/C170–C177 in ***Direct***SOFT.

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10 Slot Base and 5 Slot Expansion Base with 16 Point I/O

Total I/O: 176



NOTE: If a 16pt module is used in Slot 6 for the DL330 or DL330P CPU, 160 through 167 will not be available for control relay assignments. If a 16pt module is used in Slot 6 and/or Slot 7 for a DL340 CPU, 160–167 and/or 170–177 are not available for control relay assignments. Also, even though you are using these points as I/O, you still enter them as C160–C167/C170–C177 in ***Direct***SOFT.

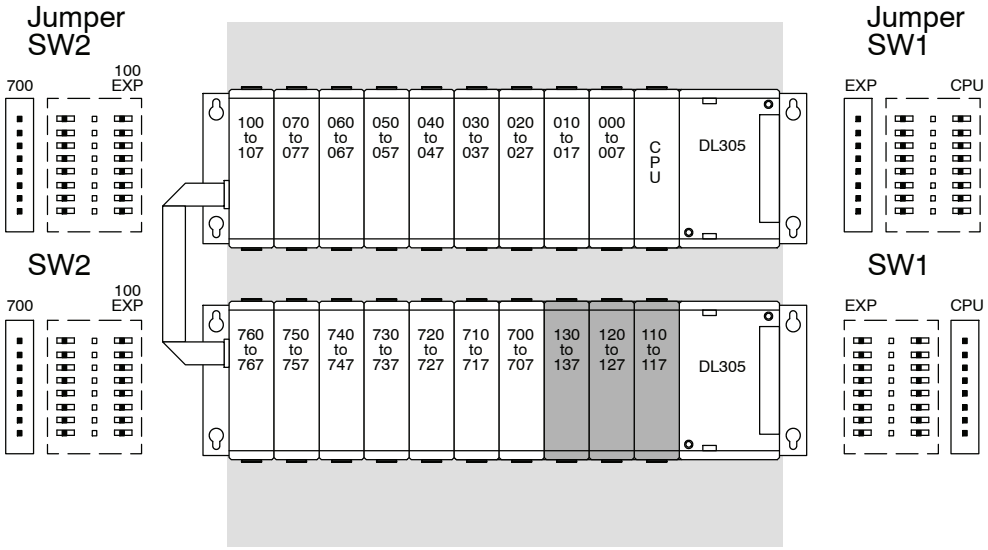
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Expansion Addresses Depend on Local CPU Base Configuration.

I/O addresses change depending on the point configuration in the local CPU base. Notice, when the local CPU base contains only 8 point I/O modules, addresses 110–117, 120–127 and 130–137 are available for use in the expansion base. When the local CPU base has 16 point I/O modules, which use the I/O addresses 110–117, 120–127 and 130–137, these addresses are taken up and are not available for use in the expansion base.

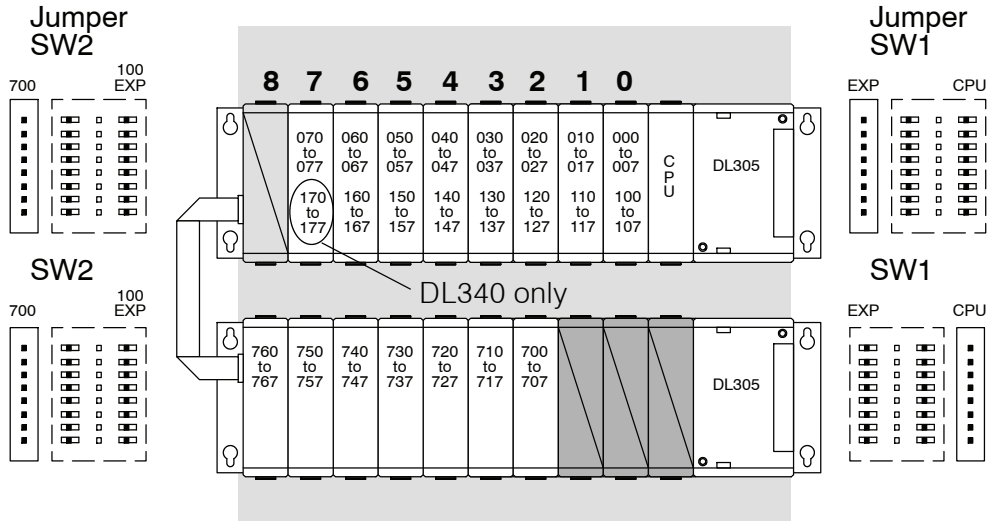
10 Slot Base and 10 Slot Expansion Base with 8 Point I/O

Total I/O: 152



10 Slot Base and 10 Slot Expansion Base with 16 Point I/O

Total I/O: 184



NOTE: If a 16pt module is used in Slot 6 for the DL330 or DL330P CPU, 160 through 167 will not be available for control relay assignments. If a 16pt module is used in Slot 6 and/or Slot 7 for a DL340 CPU, 160–167 and/or 170–177 are not available for control relay assignments. Also, even though you are using these points as I/O, you still enter them as C160–C167/C170–C177 in ***Direct***SOFT.

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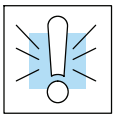
Calculating the Power Budget

Managing your Power Resource

When you determine the types and quantity of I/O modules you will be using in the DL305 system it is important to remember there is a limited amount of power available from the power supply. We have provided a chart to help you easily see the amount of power available with each base. The following chart will help you calculate the amount of power you need with your I/O selections. At the end of this section you will also find an example of power budgeting and a worksheet for your own calculations.

If the I/O you choose exceeds the maximum power available from the power supply you can resolve the problem in one of two ways:

- Shift some of the modules to an expansion base which contains another power supply.
- If a 5 slot base is being used, replace it with an 8 or 10 slot base. This will provide more power on the 9V and 24V power supplies.



WARNING: It is *extremely* important to calculate the power budget. If you exceed the power budget, the system may operate in an unpredictable manner which may result in a risk of personal injury or equipment damage.

Auxiliary Base Power Source

There is 24 VDC available from the 24 VDC output terminals on the bases (except D3-05BDC). The 24 VDC can be used to power external devices or DL305 modules that require external 24 VDC. The power used from this supply reduces the internal system 24 VDC available to the modules by an equal amount. When using the 24 VDC output at the base terminal it is not recommended to exceed 100mA.

Base Power Specifications

This chart shows the amount of current available for the three voltages supplied on DL305 bases. Use these currents when calculating the power budget for your system.

Bases	5V Power Supplied in mA	9V Power Supplied in mA	24V Power Supplied in mA	Auxiliary 24 VDC Output at Base Terminal
D3-05B	1400	800	500	Yes
D3-05BDC	1400	800	500	None
D3-08B	1400	1700	600	Yes
D3-10B	1400	1700	600	Yes



NOTE: The total current for the D3-05B and D3-05BDC should not exceed 2.3 Amps. The base currents listed for the D3-08B and the D3-10B are for operating ambient temperatures between 0° C and 50° C.

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Module Power Requirements

The next three pages show the amount of maximum current required for each of the DL305 modules. The column labeled "External Power Source Required" is for module operation and is not for field wiring. Use these currents when calculating the power budget for your system. If 24 VDC is needed for external devices, the 24 VDC (100mA maximum) output at the base terminal strip may be used as long as the power budget is not exceeded.

	5V Power Required in mA	9V Power Required in mA	24V Power Required in mA	External Power Source Required
CPUs				
D3-330	300	50	0	None
D3-330P	300	50	0	None
D3-340	300	20	0	None
Specialty CPUs				
F3-OMUX-1	300	0	0	None
F3-OMUX-2	300	0	150	None
F3-PMUX	500	0	0	None
F3-RTU	300	0	0	0
DC Input Modules				
D3-08ND2	0	10	112	None
D3-16ND2-1	0	25	224	None
D3-16ND2-2	0	24	209	None
D3-16ND2F	0	25	224	None
F3-16ND3F	0	148	68	None
AC Input Modules				
D3-08NA-1	0	10	0	None
D3-08NA-2	0	10	0	None
D3-16NA	0	100	0	None
AC/DC Input Modules				
D3-08NE3	0	10	0	None
D3-16NE3	0	130	0	None

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Module Power Requirements (continued)

	5V Power Required in mA	9V Power Required in mA	24V Power Required in mA	External Power Source Required
DC Output Modules				
D3-08TD1	0	20	24	None
D3-08TD2	0	30	0	None
D3-16TD1-1	0	40	96	None
D3-16TD1-2	0	40	96	None
D3-16TD2	0	180	0	None
AC Output Modules				
D3-04TAS	0	12	0	None
F3-08TAS	0	80	0	None
F3-08TAS-1	0	25	0	None
D3-08TA-1	0	96	0	None
D3-08TA-2	0	160	0	None
F3-16TA-2	0	250	0	None
D3-16TA-2	0	400	0	None
Relay Output Modules				
D3-08TR	0	360	0	None
F3-08TRS-1	0	296	0	None
F3-08TRS-2	0	296	0	None
D3-16TR	0	480	0	None
Analog				
D3-04AD	0	55	0	24VDC @ 65mA max
F3-04ADS	0	183	50	None
F3-08AD	0	25	37	None
F3-08TEMP	0	25	37	None
F3-08THM-n	0	50	34	None
F3-16AD	0	33	47	None
D3-02DA	0	80	0	24VDC @ 170mA max
F3-04DA-1	0	144	108	None
F3-04DA-2	0	144	108	None
F3-04DAS	0	154	145	None

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	5V Power Required in mA	9V Power Required in mA	24V Power Required in mA	External Power Source Required
Communications and Networking				
D3-232-DCU	500	0	0	Optional 5VDC @ 500mA
D3-422-DCU	500	0	0	Optional 5VDC @ 500mA
F3-UNICON	0	0	0	(24 VDC or 5 VDC) @ 100mA
ASCII BASIC Modules				
F3-AB128-R	0	205	0	None
F3-AB128-T	0	205	0	None
F3-AB128	0	90	0	None
F3-AB64	0	90	0	None
Specialty Modules				
D3-08SIM	0	10	112	None
D3-HSC	0	70	0	None
D3-PWU	800	0	0	Optional 5VDC @ 800mA
Programming				
D3-HP	50	50	0	Optional
D3-HPP	50	50	0	Optional

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Power Budget Calculation Example

The following example shows how to calculate the power budget for the DL305 system.

Base # 1	Module Type	5 VDC (mA)	9 VDC (mA)	24 VDC (mA) and/or Auxiliary Base Power Source 24 VDC Output (mA)
Base Used	D3-05B	**1400**	**800**	**500**
Slot 1	D3-330	+ 300	+ 50	+ 0
Slot 2	D3-16NE3	+ 0	+ 130	+ 0
Slot 3	D3-16NE3	+ 0	+ 130	+ 0
Slot 4	F3-16TA-2	+ 0	+ 250	+ 0
Slot 5	F3-16TA-2	+ 0	+ 250	+ 0
Slot 6				
Slot 7				
Slot 8				
Slot 9				
Slot 10				
Other	D3-232-DCU	+ 500	+ 0	+ 0
Maximum power required		**800**	**630**	**0**
Remaining Power Available		1400 - 800 = **600**	800 - 630 = **170**	500 - 0 = **500**

1. Using the tables at the beginning of the Power Budgeting section of this chapter fill in the information for the Base, CPU, I/O modules, and any other devices that will use system power including devices that use the 24 VDC output. Pay special attention to the current supplied by the base which you have selected since they do differ. Devices which fall into the "**Other**" category are devices such as the Data Communications Unit and the Handheld programmer which plug onto the CPU.
2. Add the current columns starting with slot 1 and put the total in the row labeled "**Maximum power required**".
3. Subtract the row labeled "**Maximum power required**" from the row labeled "**Base Used**". Place the difference in the row labeled **"Remaining Power Available**".
4. If **"Maximum Power Required"** is greater than **"Base Used"** in any of the three columns, the power budget will be exceeded. It will be unsafe to use this configuration and you will need to restructure your base/module configuration.

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Power Budget Calculation Worksheet

This blank chart is provided for you to copy and use in your power budget calculations.

Base # _____	Module Type	5 VDC (mA)	9 VDC (mA)	24 VDC (mA) and/or Auxiliary Base Power Source 24 VDC Output (mA)
Base Used				
Slot 1				
Slot 2				
Slot 3				
Slot 4				
Slot 5				
Slot 6				
Slot 7				
Slot 8				
Slot 9				
Slot 10				
Other				
Maximum power required				
Remaining Power Available				

1. Using the tables at the beginning of the Power Budgeting section of this chapter fill in the information for the Base, CPU, I/O modules, and any other devices that will use system power including devices that use the 24 VDC output. Pay special attention to the current supplied by the base which you have selected since they do differ. Devices which fall into the "**Other**" category are devices such as the Data Communications Unit and the Handheld programmer which plug onto the CPU.
2. Add the current columns starting with slot 1 and put the total in the row labeled "**Maximum power required**".
3. Subtract the row labeled "**Maximum power required**" from the row labeled "**Base Used**". Place the difference in the row labeled **"Remaining Power Available**".
4. If **"Maximum Power Required"** is greater than **"Base Used"** in any of the three columns, the power budget will be exceeded. It will be unsafe to use this configuration and you will need to restructure your base/module configuration.

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5

I/O Module Selection & Wiring Guidelines

In This Chapter. . . .

— I/O Selection Considerations
— Sinking and Sourcing Circuits
— DL305 Input Module Configuration Chart
— DL305 Output Module Configuration Chart
— Configuration #1 DL305 DC Current Sourcing Input Module
— Configuration #2 DL305 DC Current Sinking/Sourcing Input Module
— Configuration #3 DL305 DC Current Sinking Input Module
— Configuration #4 DL305 AC/DC Input Module
— Configuration #5 DL305 AC Input Module
— Configuration #6 DL305 DC Current Sinking Output Module
— Configuration #7 DL305 DC Current Sourcing Output Module
— Configuration #8 DL305 AC/DC Current Sink/Source (Relay) Output Module
— Configuration #9 DL305 AC Output Module
— Solid State Field Device Wiring to DC Input Modules
— Derating Characteristics
— I/O Wiring Guidelines
— Fuse Protection

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I/O Selection Considerations

I/O Module Selection

The DL305 product family offers various types of I/O modules for interfacing many different field devices to the PLC system. There are several electrical characteristics that should be considered when choosing the proper I/O module for a field device or for obtaining required system performance. Electrical characteristics for discrete input modules and discrete output modules are discussed in Chapters 6 and 7. The DL305 family also offers several specialized modules such as analog, ASCII BASIC modules, network interface modules, high speed counter modules, etc. These modules have their own manuals, so if you are using them you should supplement this manual with the manual specifically designed for the special module.

Sinking and Sourcing Circuits

The charts on the following page supply information on the current sinking and current sourcing configurations using DL305 discrete I/O modules. If you have a question about the type of device required to connect to a particular module please refer to the following charts. The charts show nine common input and output module configurations. Match the module part number you are considering to the applicable configuration(s) to ensure the module type will work in your application.

For additional clarification we have included nine diagrams depicting the configurations listed in the charts. These diagrams show the module category, type of device and how they are connected to each other. The diagrams and two examples of wiring a solid state switch to an input module follow the charts on the next page.

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DL305 Input Module Configuration Chart

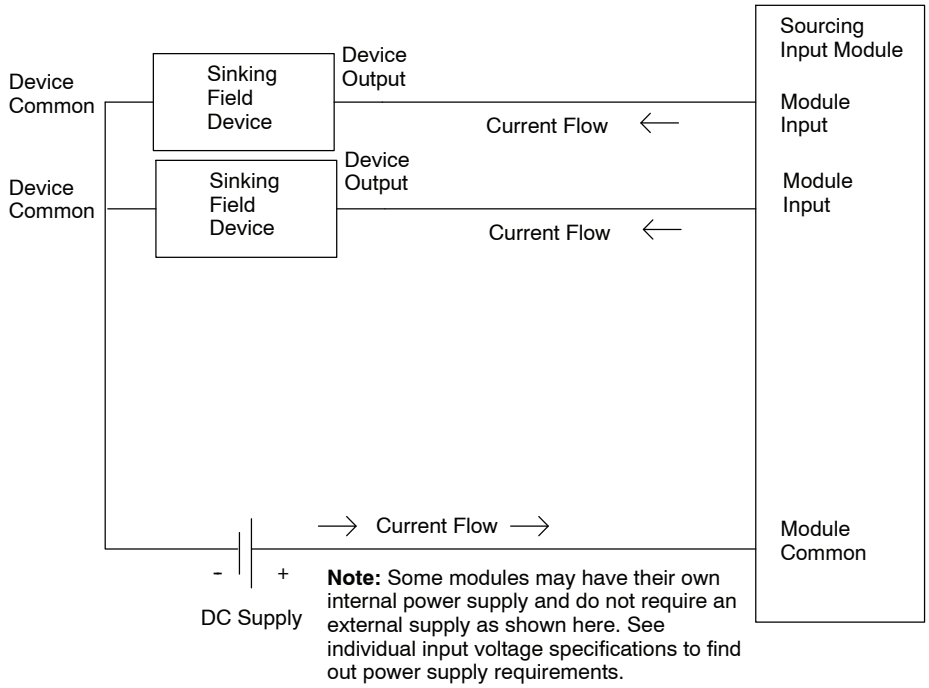
DL305 Input Module Type	**Config #1** DC Current Sourcing Input	**Config #2** DC Current Sink/Source Input	**Config #3** DC Current Sinking Input	**Config #4** AC/DC Input	**Config #5** AC Input
D3-08ND2	✓				
D3-16ND2-1	✓				
D3-16ND2-2	✓				
D3-16ND2F	✓				
F3-16ND3F		✓			
D3-08NA-1					✓
D3-08NA-2					✓
D3-16NA					✓
D3-08NE3	✓	✓	✓	✓	✓
D3-16NE3	✓	✓	✓	✓	✓

DL305 Output Module Configuration Chart

DL305 Output Module Type	**Config #6** DC Current Sinking Output	**Config #7** DC Current Sourcing Output	**Config #8** AC/DC Current Sink/Source Output	**Config #9** AC Output
D3-08TD1	✓			
D3-08TD2		✓		
D3-16TD1-1	✓			
D3-16TD1-2	✓			
D3-16TD2		✓		
D3-08TA-1				✓
D3-08TA-2				✓
F3-16TA-2				✓
D3-16TA-2				✓
D3-08TR			✓	
F3-08TRS-1			✓	
F3-08TRS-2			✓	
D3-16TR			✓	
D3-04TAS				✓
F3-08TAS				✓
F3-08TAS-1				✓

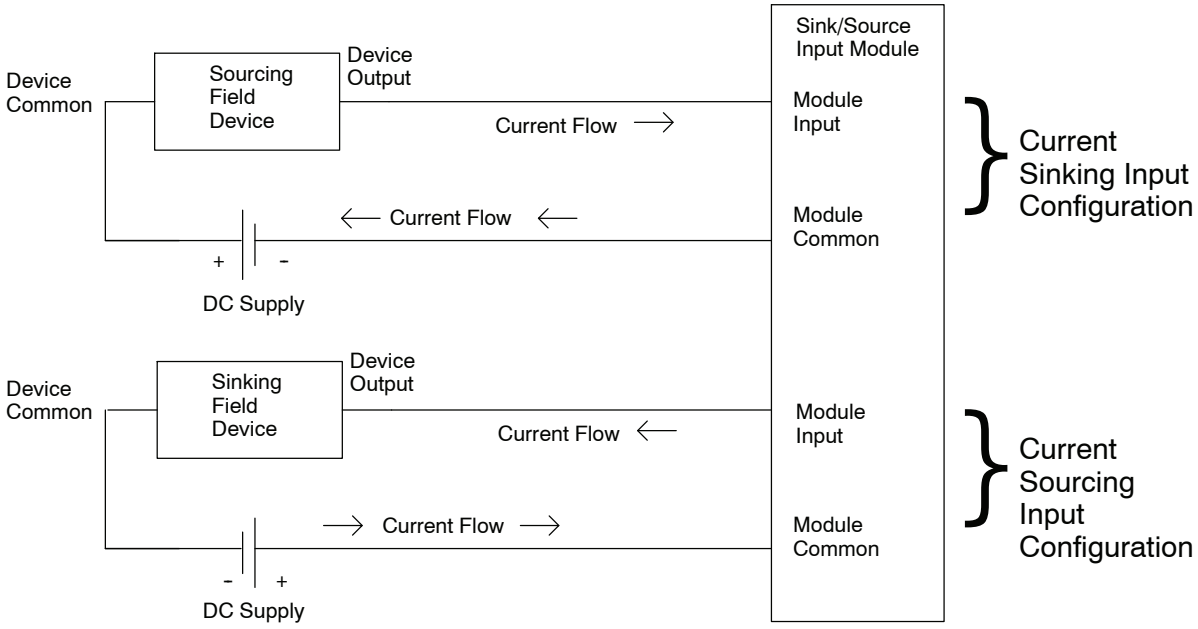
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Configuration #1
DL305 DC Current Sourcing Input Module



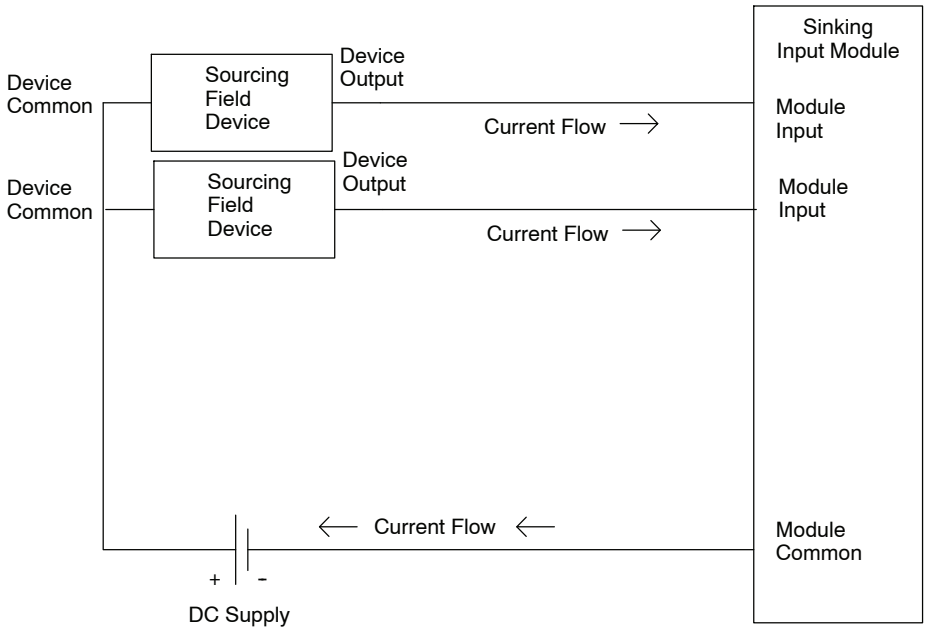
Note: Some modules may have their own internal power supply and do not require an external supply as shown here. See individual input voltage specifications to find out power supply requirements.

Configuration #2
DL305 DC Current Sinking/Sourcing Input Module

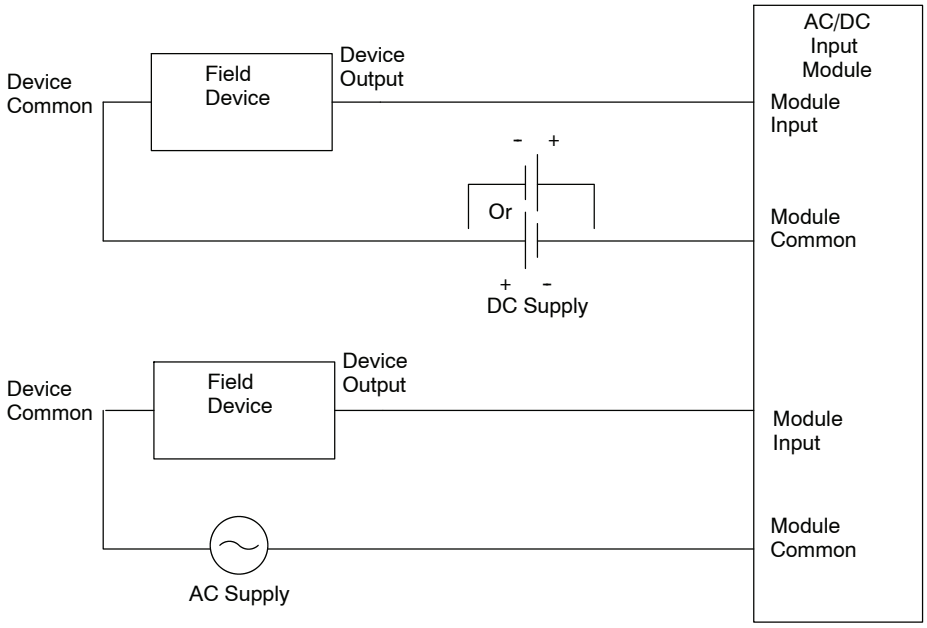


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Configuration #3
DL305 DC Current Sinking Input Module

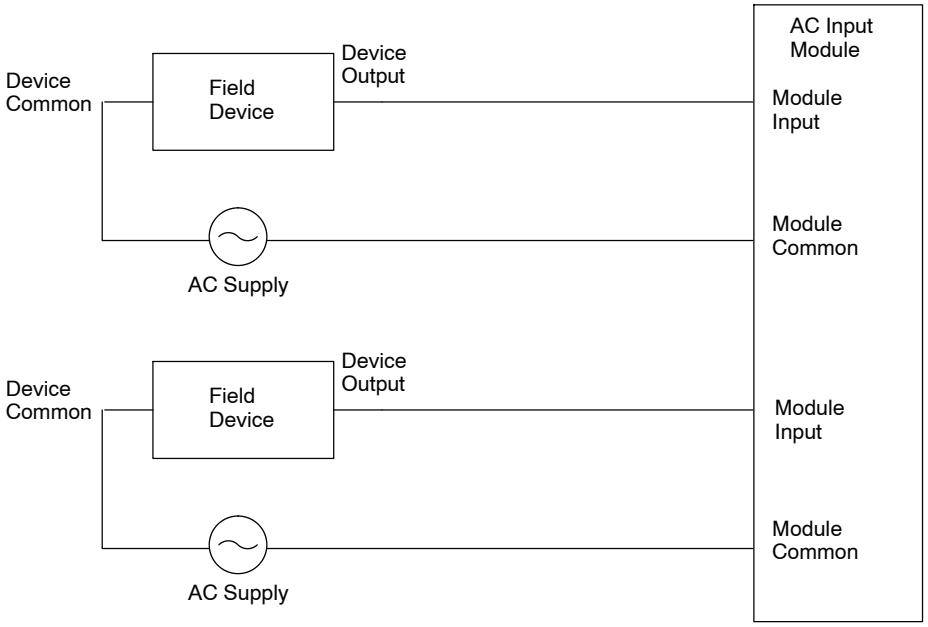


Configuration #4
DL305 AC/DC Input Module



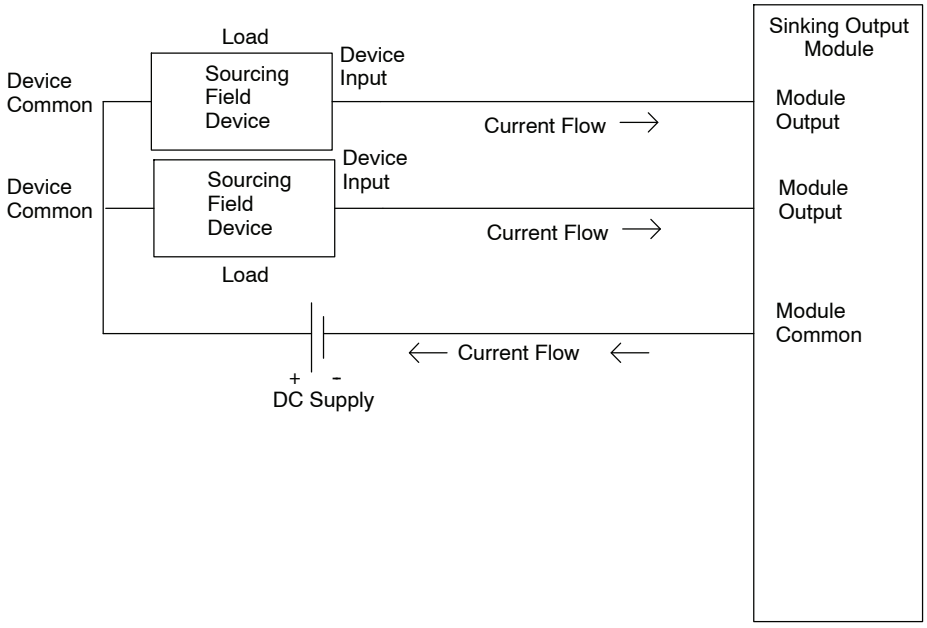
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Configuration #5
DL305 AC Input Module

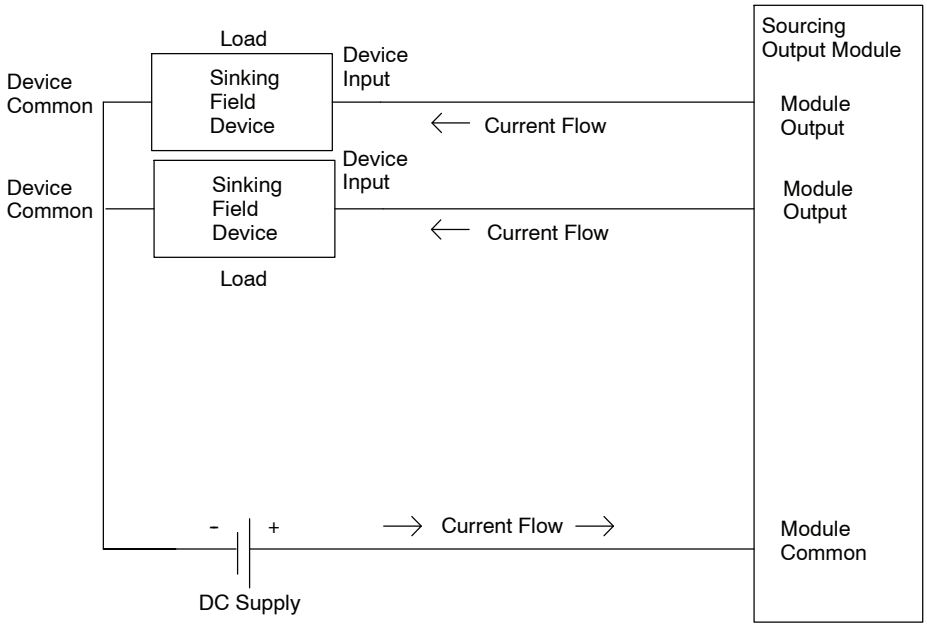


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Configuration #6
DL305 DC Current Sinking Output Module

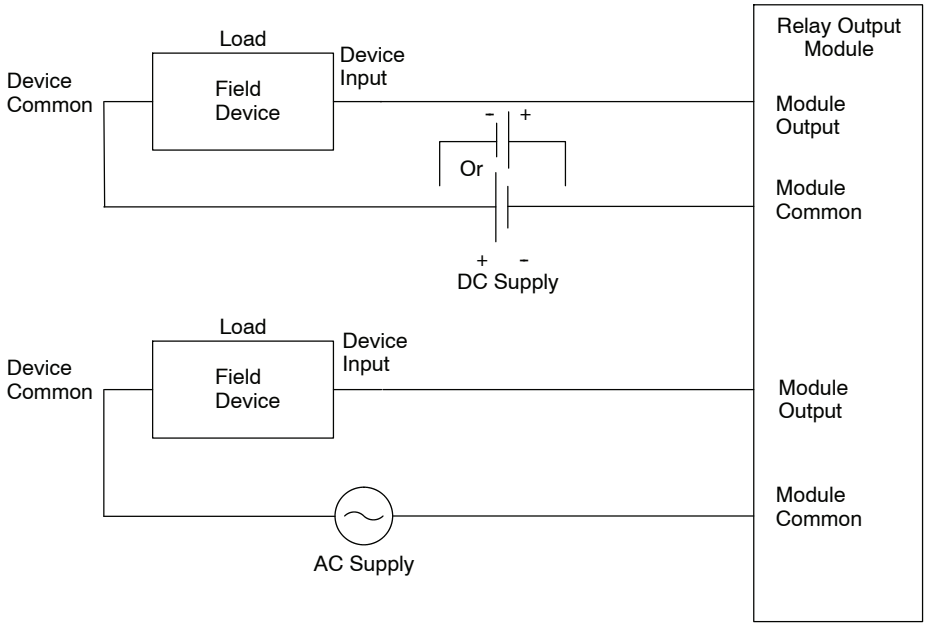


Configuration #7
DL305 DC Current Sourcing Output Module

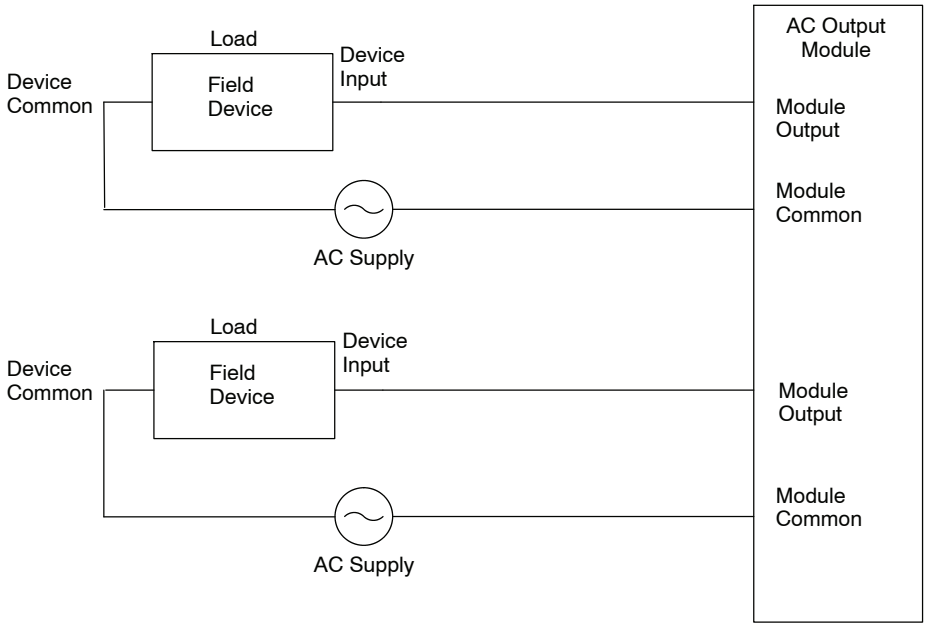


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Configuration #8
DL305 AC/DC Current Sink/Source (Relay) Output Module



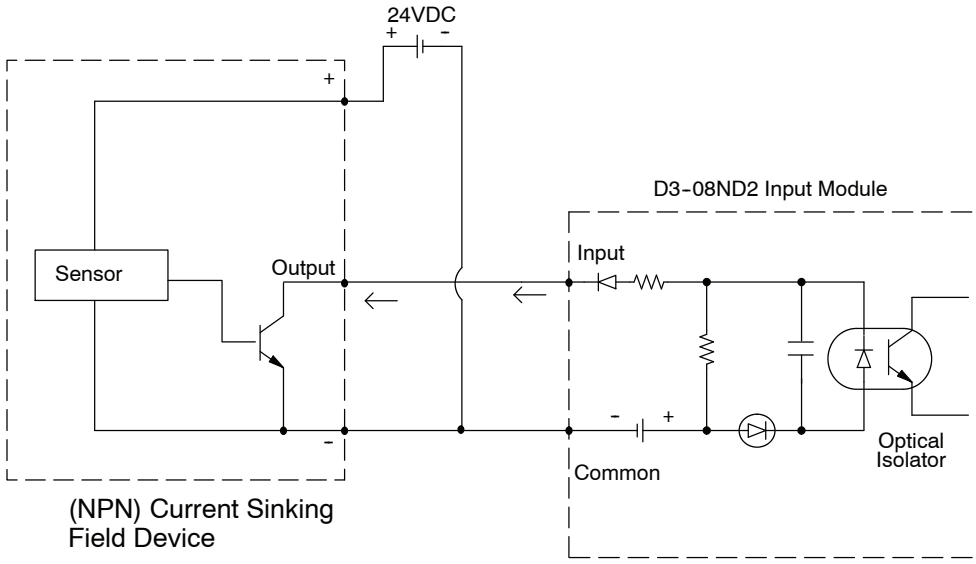
Configuration #9
DL305 AC Output Module



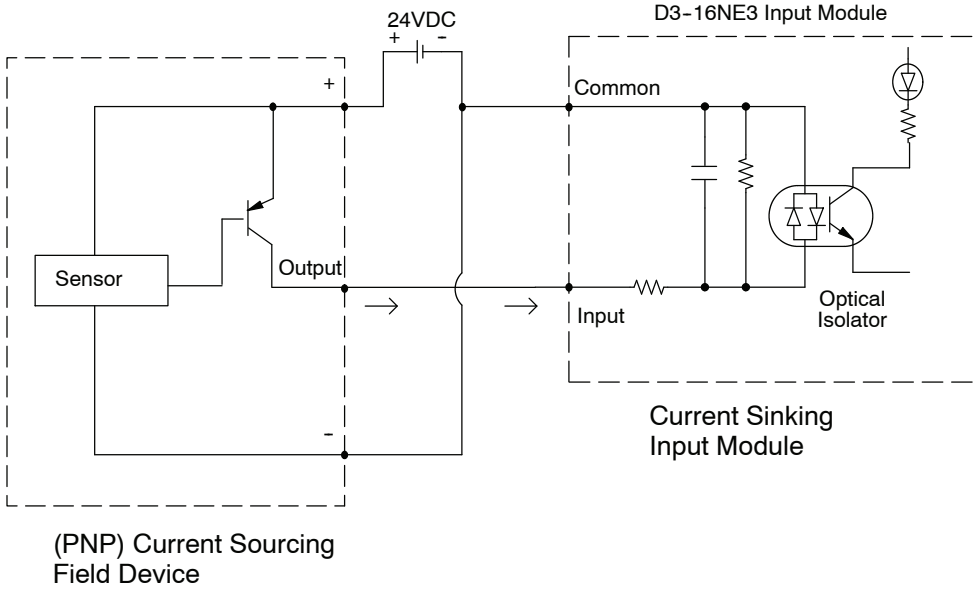
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Solid State Field Device Wiring to DC Input Modules

NPN Field Device Example



PNP Field Device Example

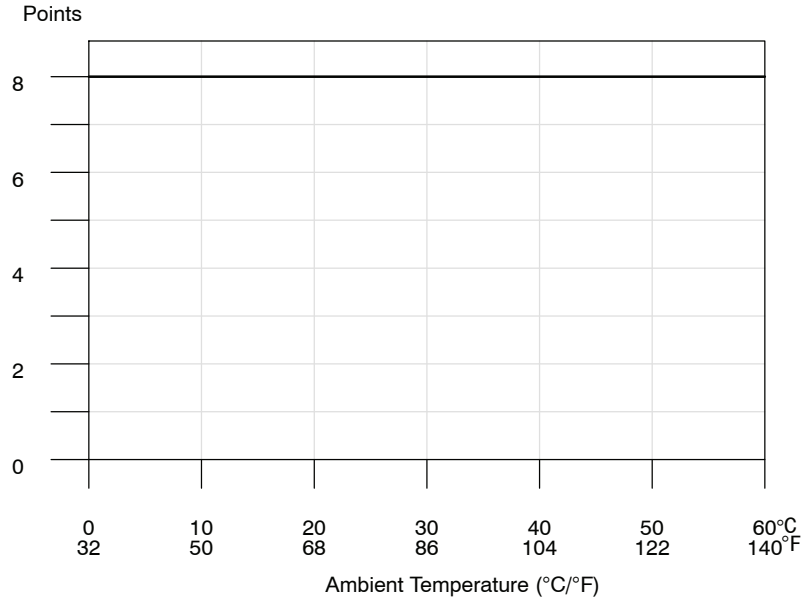


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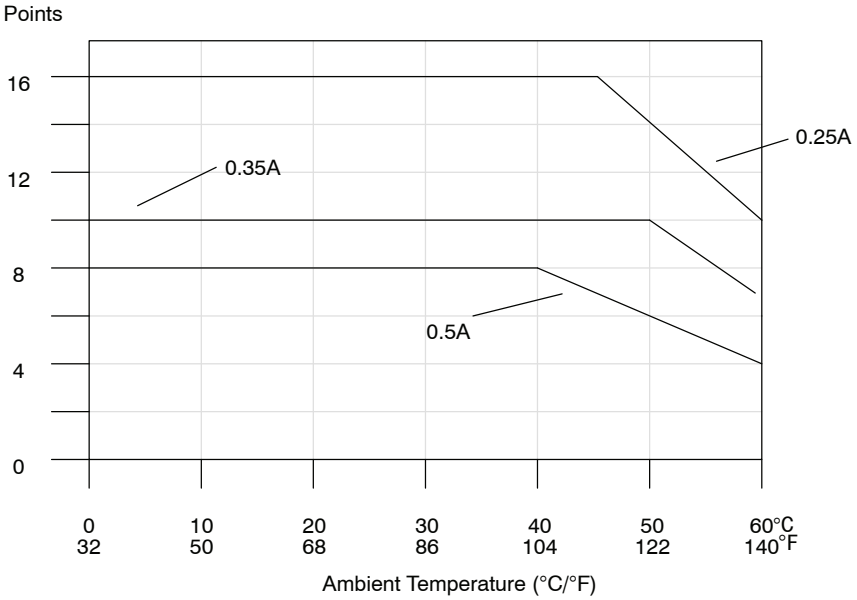
Derating Characteristics

The DL305 input and output module operating specifications change depending on ambient temperature. The I/O specifications have a derating chart for each module which shows functionality in respect to ambient temperature.

The example below shows a derating curve for a D3-08ND2 discrete input module where the operating specifications do not change within the specified temperature operating range.



The example below shows a derating curve for a D3-16TD-1 discrete output module where the operating specifications are affected depending on ambient temperature.



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I/O Wiring Guidelines

General Considerations

The following information is to give you a general idea on how to wire the different types of modules in the DL305 system. For specific information on wiring a particular module refer to the specification sheet in the appropriate I/O chapter.

Consider the following guidelines when connecting the field wring.

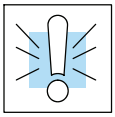
1. There is a maximum AWG the modules can accept. You can uses a smaller AWG than is noted in the table below.

Module type	Maximum AWG
8 point	12
16 point	16

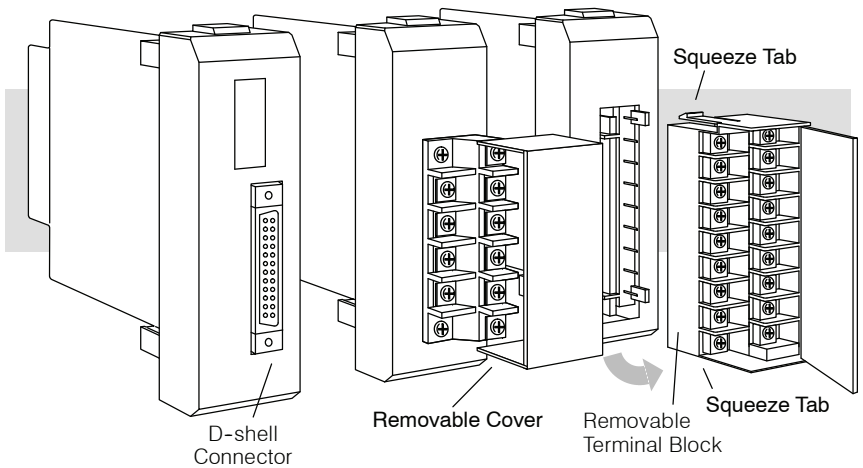
2. Always use a continuous length of wire, do not combine wires to attain a desired length.
3. Use the shortest possible cable length.
4. Use wire trays for routing where possible
5. Avoid running wires near high energy wiring.
6. Avoid running input wiring in close proximity to output wiring where possible.
7. To minimize voltage drops when wires must run a long distance , consider using multiple wires for the return line.
8. Avoid running DC wiring in close proximity to AC wiring where possible.
9. Avoid creating sharp bends in the wires.

Wiring the Different Module Types

There are three main types of module faces for the DL305 I/O. These module faces are: lift covers over terminal blocks, flip covers over terminal blocks and D–shell compatible sockets. If the module you are using has a cover you can remove the cover either by lifting from the bottom or by flipping the door open. Some of the modules have removable terminal blocks. These modules can be recognized by the squeeze tabs on the top and bottom of the terminal block. To remove the terminal block, press the squeeze tabs and pull the block away from the module.



WARNING: For some modules, field device power may still be present on the terminal block even though the PLC system is turned off. To minimize the risk of electrical shock, check all field device power *before* you remove the connector.

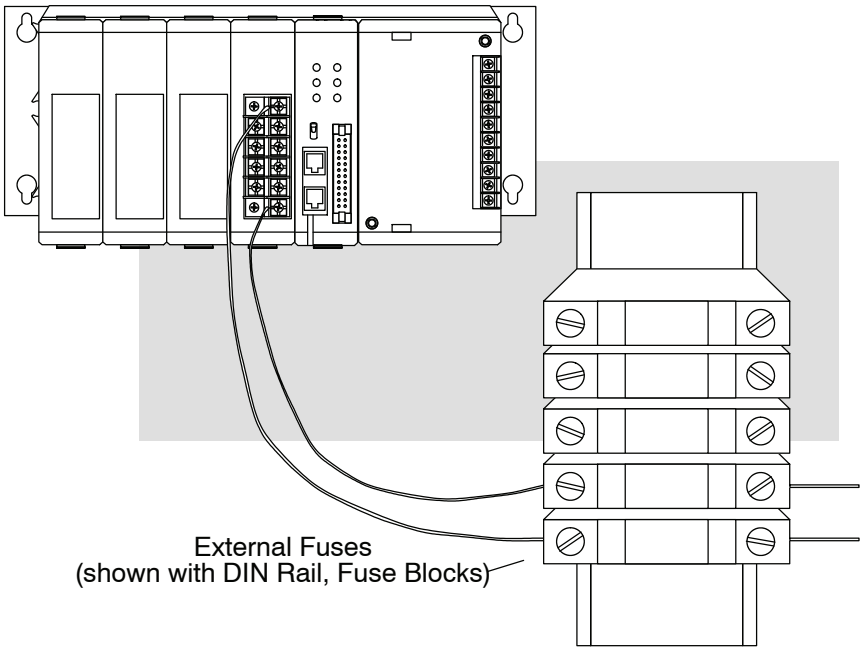


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Fuse Protection

To help avoid blowing the internal module fuses, we suggest you add external fuses to your I/O wiring. A fast blow fuse with a lower current rating than the I/O module fuse can be added to each common. Or, you can add a fuse with a rating of slightly less than the maximum current per output point to each output. Refer to the I/O module specification sheets to find the maximum current per point or per common for output modules. Adding the external fuse does not guarantee the prevention of module damage, but it will provide added protection.

External Fuse Example



WARNING: For modules which have soldered-in or non-replaceable fuses, we recommend that you return the module to us and let us replace your blown fuse(s) since the module fuses are attached to the board and disassembling the module will void your warranty.

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6

Discrete Input Modules

In This Chapter. . . .

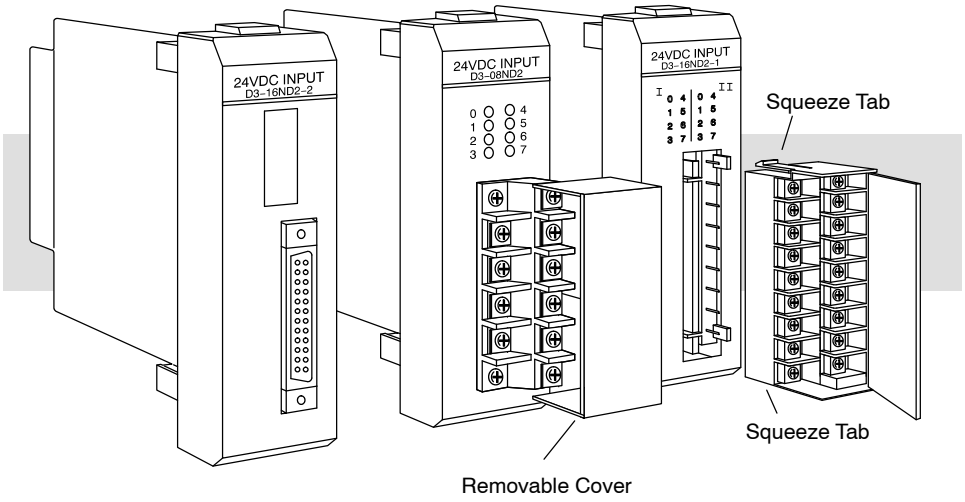
— Discrete Input Module Identification and Terminology
— D3-08ND2, 24 VDC Input Module
— D3-16ND2-1, 24 VDC Input Module
— D3-16ND2-2, 24 VDC Input Module Module
— D3-16ND2F, 24 VDC Fast Response Input Module
— F3-16ND3F, TTL/24 VDC Fast Response Input Module
— D3-08NA-1, 110 VAC Input Module
— D3-08NA-2, 220 VAC Input Module
— D3-16NA, 110 VAC Input Module
— D3-08NE3, 24 VAC/DC Input Module
— D3-16NE3, 24 VAC/DC Input Module
— D3-08SIM, Input Simulator

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Discrete Input Module Identification and Terminology

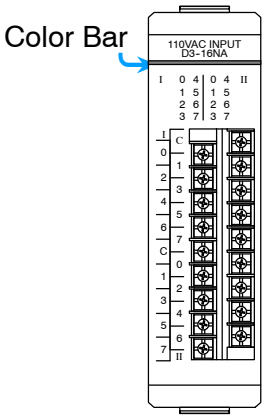
This chapter contains I/O specification sheets for the discrete input modules. The diagram below shows the status indicator location for some of the most common discrete input modules.

Discrete Input Module Status Indicators



Color Coding of I/O Modules

The DL305 family of I/O modules has a color coding scheme to help you identify whether the module is an input module, an output module or a special module. This is done through a color bar indicator located on the front of each module below the part number. The following color scheme is used.



Module Type	Color Code
Discrete/Analog Output	Red
Discrete/Analog Input	Blue
Other	White

Input Module Selection

Your input module selection depends on the field devices used and system performance requirements. The input module specifications in this chapter list the information needed for choosing the correct module for a field device and to assure it meets the system requirements. The following list defines the specifications listed in this chapter.

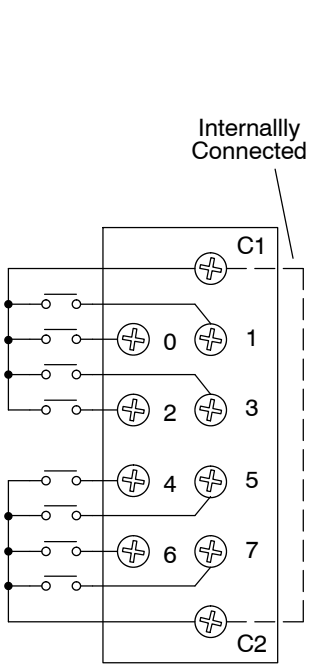
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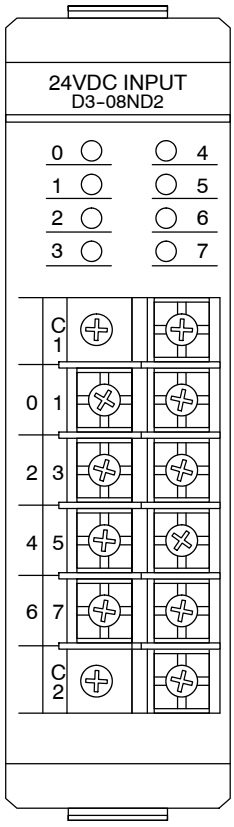
Inputs Per Module	Indicates number of input points per module and designates current sinking, current sourcing, or either.
Commons Per Module	Number of commons per module and their electrical characteristics.
Input Voltage Range	The operating voltage range of the input circuit. DL305 input modules require either an internal or external power supply for the operating voltage. The base power supply will provide the internal voltage.
Peak Voltage	Maximum voltage allowed for the input circuit.
AC Frequency	AC modules are designed to operate within a specific frequency range. 60 Hz is the standard AC frequency in the U.S., 50 Hz is common in other countries.
ON Voltage Level	The voltage level at which the input point will turn ON.
OFF Voltage Level	The voltage level at which the input point will turn OFF.
Input Current	Typical operating current for an active (ON) input.
Input Impedance	Input impedance can be used to calculate input current for a particular operating voltage.
Minimum ON Current	The minimum current for the input circuit to operate reliably in the ON state.
Maximum OFF Current	The maximum current for the input circuit to operate reliably in the OFF state.
Base Power Required	Power from the base power supply is used by the DL305 input modules and varies between different modules. The guidelines for using module power is explained in the power budget configuration section in chapter 4.
OFF to ON Response	The time the module requires to process an OFF to ON state transition.
ON to OFF Response	The time the module requires to process an ON to OFF state transition.
Terminal Type	Indicates whether the terminal type is a removable or non-removable connector or terminal.
Status Indicators	LEDs indicate the ON/OFF status of an input point. These LEDs are electrically located on either the logic side or the field device side of the input circuit.
Weight	Indicates the weight of the module. (See Appendix D for a complete listing of DL305 component weights.)

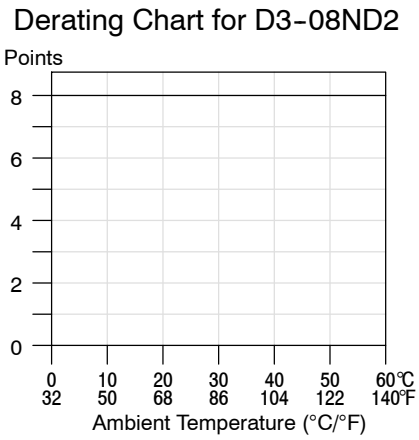
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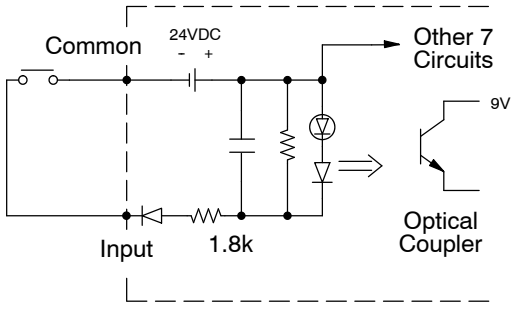
D3-08ND2, 24 VDC Input Module

Inputs per module	8 (current sourcing)		Base power required	9V 10 mA Max 24V 14mA/ON pt. (112 mA Max)
Commons per module	2 (internally connected)			
Input voltage range	18-36VDC			
Input voltage	Internally supplied		OFF to ON response	4-15 ms
Peak voltage	40 VDC		ON to OFF response	4-15 ms
AC frequency	N/A		Terminal type	Non-removable
ON voltage level	< 3 V		Status indicators	Field side
OFF voltage level	>18 V		Weight	4.2 oz. (120 g)
Input impedance	1.8 K ohm			
Input current	12 mA Max			
Minimum ON current	7 mA			
Maximum OFF current	3 mA			





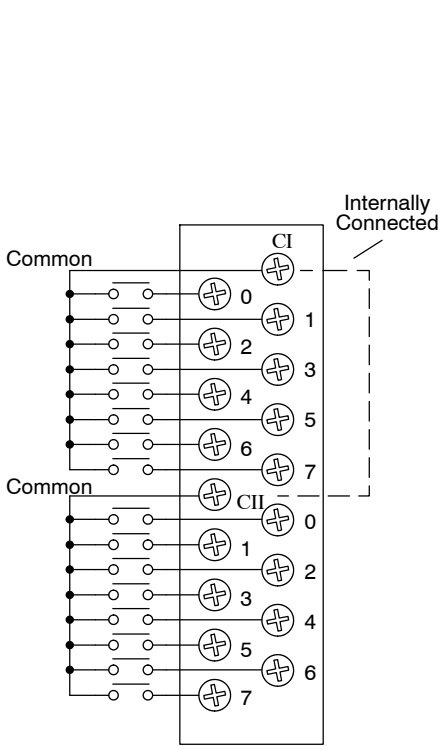


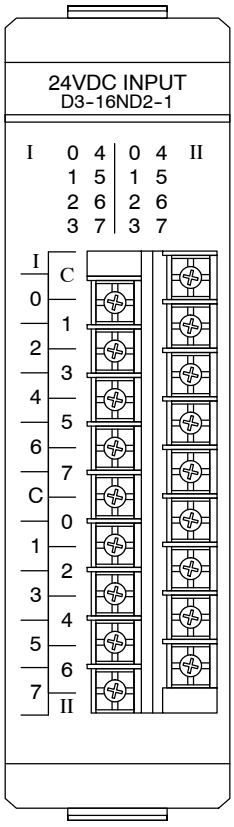


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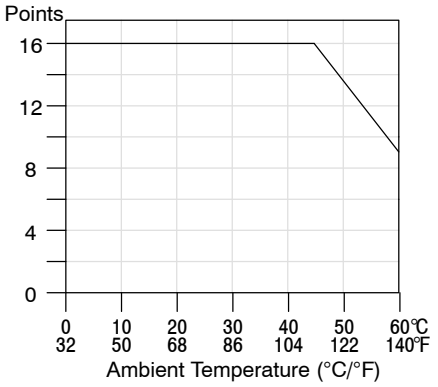
D3-16ND2-1, 24 VDC Input Module

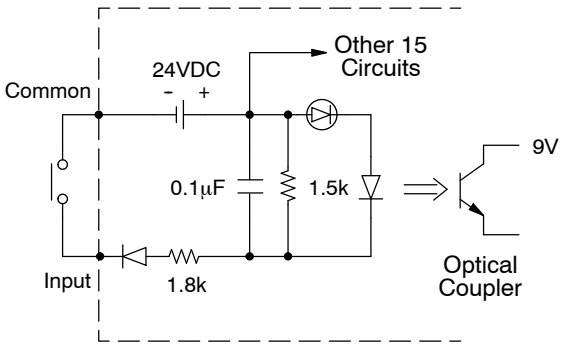
Inputs per module	16 (current sourcing)		Base power required	9V 25 mA Max 24V 14mA/ON pt. (224 mA Max)
Commons per module	2 (internally connected)			
Input voltage range	18-36VDC		OFF to ON response	3-15 ms
Input voltage	Internally supplied		ON to OFF response	4-15 ms
Peak voltage	36VDC		Terminal type	Removable
AC frequency	N/A		Status indicators	Field side
ON voltage level	< 3V		Weight	6.3 oz. (180 g)
OFF voltage level	>19 V			
Input impedance	1.8 K ohm			
Input current	20 mA Max			
Minimum ON current	5 mA			
Maximum OFF current	1 mA			





Derating Chart for D3-16ND2-1

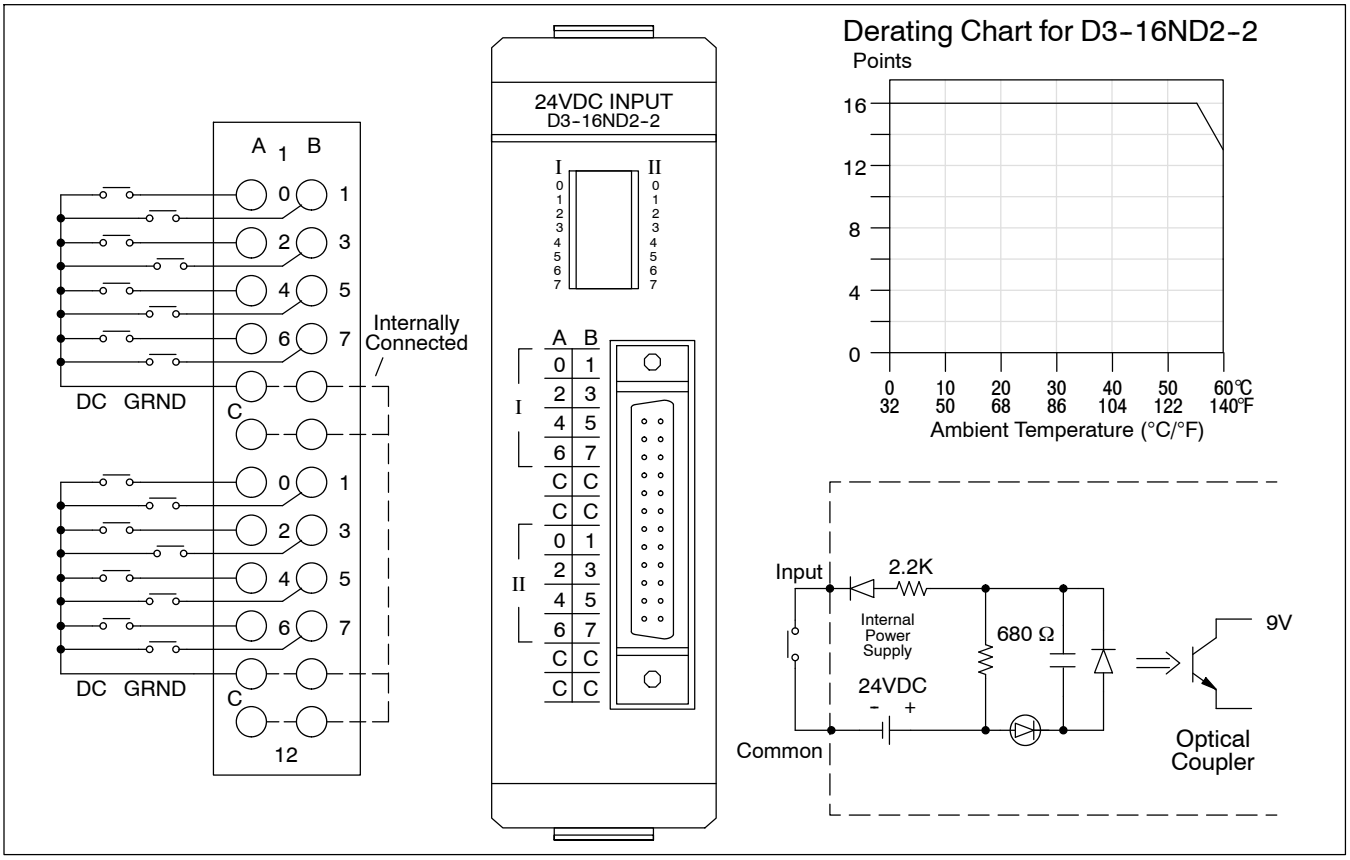




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D3-16ND2-2, 24 VDC Input Module Module

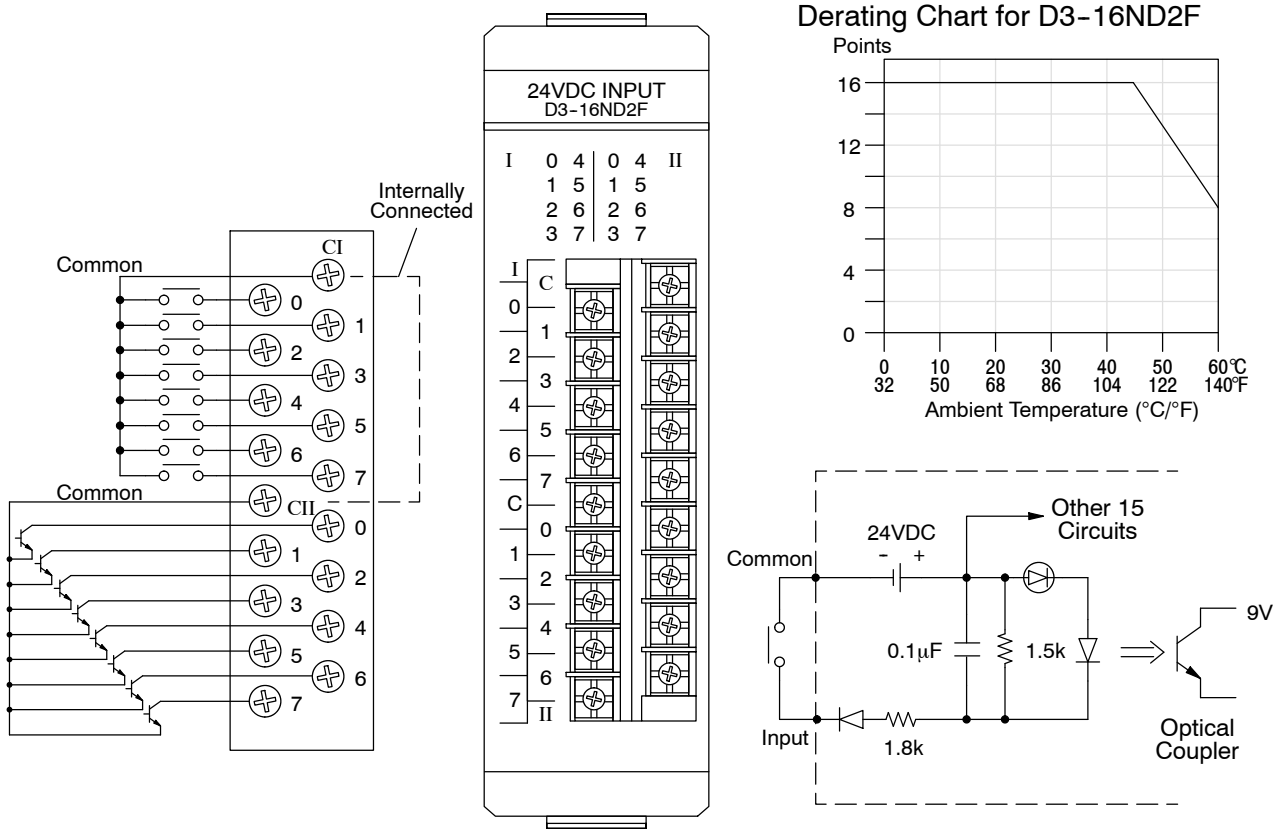
Inputs per module	16 (current sourcing)		Base power required	9V 3mA+1.3mA/ON pt (24 mA Max) 24V 1mA+13mA/ON pt (209 mA Max)
Commons per module	8 internally connected			
Input voltage range	18–36 VDC			
Input voltage	Internally supplied			
Peak voltage	36 VDC		OFF to ON response	4–15 ms
AC frequency	N/A		ON to OFF response	4–15 ms
ON voltage level	< 3 V		Terminal type	24 Pin Removable connector
OFF voltage level	> 19 V			
Input impedance	2.2 K ohm		Status indicators	Field side
Input current	20 mA Max		Weight	5.3 oz. (150 g)
Minimum ON current	5 mA			
Maximum OFF current	2 mA			



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D3-16ND2F, 24 VDC Fast Response Input Module

Inputs per module	16 (current sourcing)		Base power required	9V 25 mA Max 24V 14 mA/ON pt. (224 mA Max)
Commons per module	2 (internally connected)			
Input voltage range	18–36VDC			
Input voltage	Internally supplied		OFF to ON response	0.8 ms
Peak voltage	36VDC		ON to OFF response	0.8 ms
AC frequency	N/A		Terminal type	Removable
ON voltage level	< 13V		Status indicators	Field side
OFF voltage level	>19 V		Weight	6.3 oz. (180 g)
Input impedance	1.8 K ohm			
Input current	20 mA Max			
Minimum ON current	5 mA			
Maximum OFF current	1 mA			



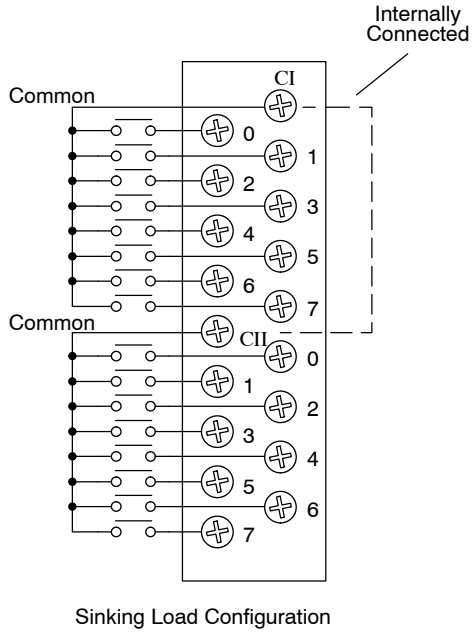
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F3-16ND3F, TTL/24 VDC Fast Response Input Module

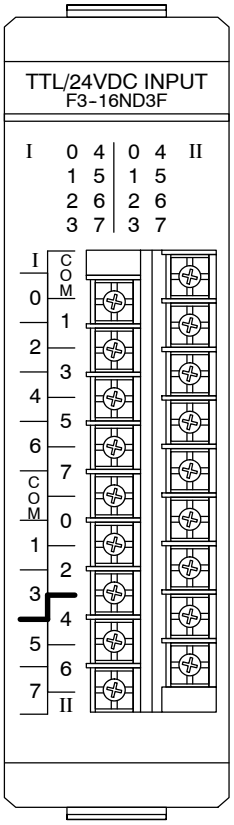
Inputs per module	16 sink/source (jumper selectable sink/source)*		Base power required	9V 148 mA Max 24V 68 mA Max
			Input current	1 mA @ 5VDC 3 mA @ 12-24 DC
Commons per module	2 (non-isolated)		Input impedance	4.7K
Input voltage range	5 VDC TTL & CMOS, 12-24 VDC (jumper selectable)*		OFF to ON response	1 ms
			ON to OFF response	1 ms
Input voltage supplied	Internal (used with sinking loads) External (used with sourcing loads)		Maximum input rate	500 Hz
			Minimum ON current	0.4 mA @ 5VDC 0.9 mA @ 12-24VDC
Peak voltage	100 VDC (35 VDC Continuous)		Maximum OFF current	0.8 mA @ 5VDC 2.2 mA @ 12-24VDC
AC frequency	N/A		Terminal type	Removable
ON voltage level	0-1.5VDC @ 5VDC 0-4VDC @ 12-24VDC		Status indicators	Logic side
OFF voltage level	3.5-5VDC @ 5VDC 10-24VDC @12-24VDC		Weight	5.4 oz. (153 g)

* 12 Inputs are jumper selectable for 5VDC/12-24VDC and Sink Load/Source Load

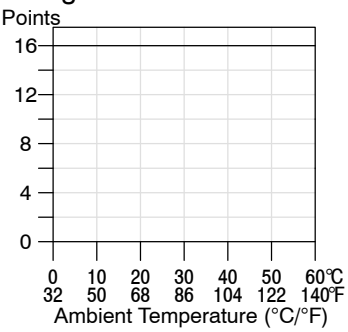
4 Inputs are jumper selectable for 5VDC/12-24VDC and Sink Load/Source Load



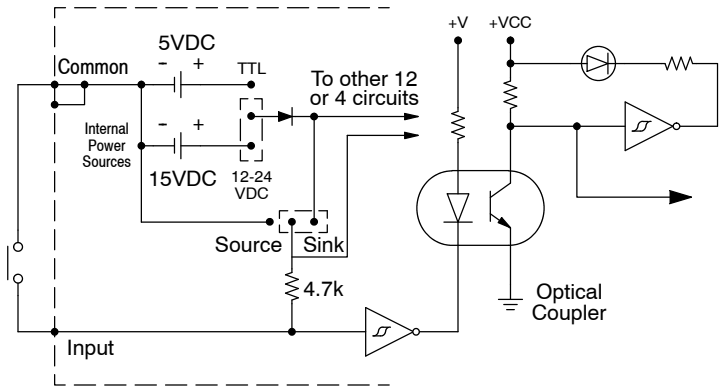
Sinking Load Configuration



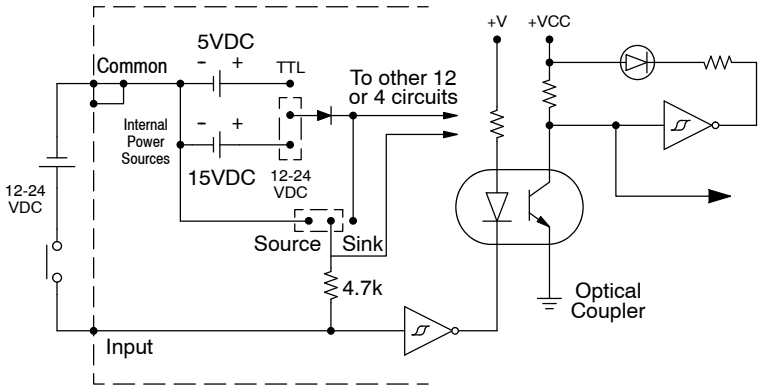
Derating Chart for F3-16ND3F



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Jumper selected for 12-24VDC, sinking load configuration



Jumper selected for sourcing load configuration. An external power supply must be used in this configuration.

The DC power to sense the state of the inputs when jumpers are installed for sinking type signals is provided by the rack power supply. Sinking type inputs are turned ON by switching the input circuit to common. Source type input signals assume the ON state until the input device provides the voltage to turn the input OFF.

Selection of Operating Mode:

The mode of operation, either 5VDC or 12-24VDC sink or source, for each group of circuits is determined by the position of jumper plugs on pins located on the edge of the circuit board. There are four sets of pins (3 pins in each set), with two sets for each group of inputs. The first two sets of pins are used to configure the first 12 inputs (eg. 0 to 7 and 100 to 103) and are labeled 12 CIRCUITS. Above the first set of pins are the labels 12/24V and 5V. Above the second set of pins are the labels SINK and SRC (source). To select an operating mode for the first 12 circuits, place a jumper on the two pins nearest the appropriate labels. For example, to select 24VDC Sink input operation for the first 12 inputs, place a jumper on the two pins labeled 12/24V and on the two pins labeled SINK. The last two sets of pins are used to configure the last 4 inputs (eg. 104 to 107) and are labeled 4 CIRCUITS. The operating mode selected for the last group of 4 inputs can be different than the mode chosen for the first group of 12 inputs. Correct module operation requires each set of three pins have a jumper installed (four jumpers total).



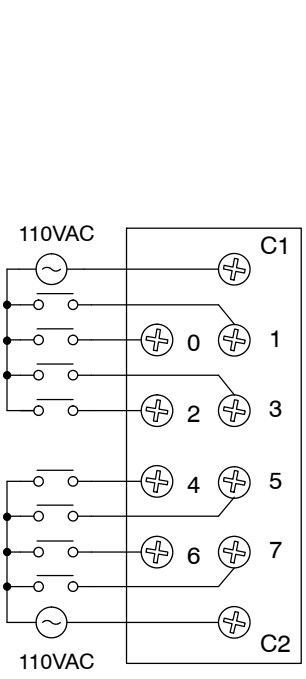
NOTE: When a group of inputs are used with TTL logic, select the SINK operating mode for that group. “Standard” TTL can sink several milliamps but can source less than 1 mA.

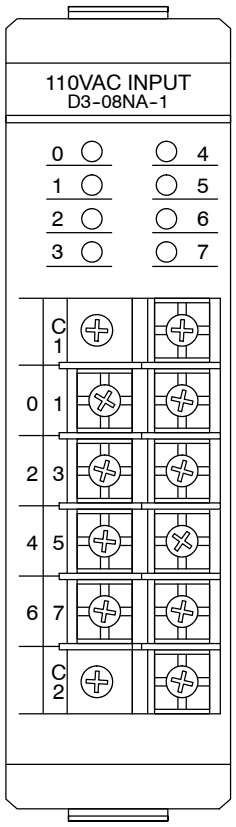
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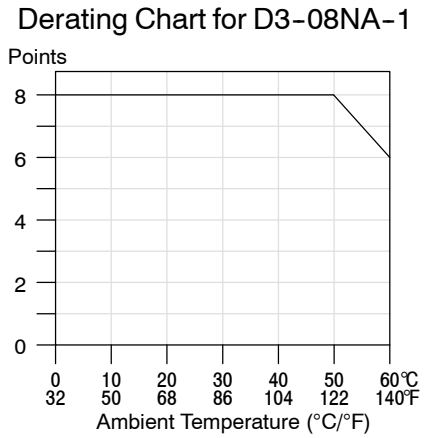
D3-08NA-1, 110 VAC Input Module

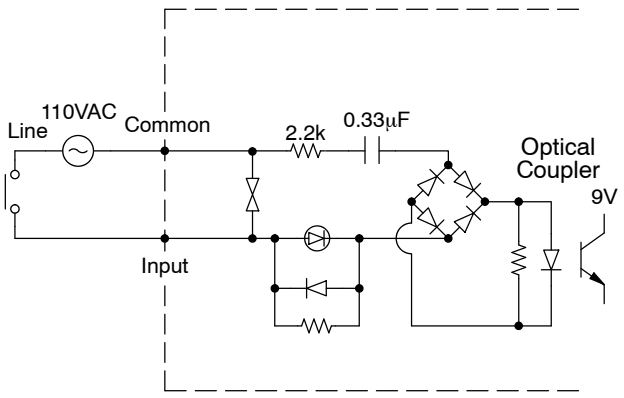
Inputs per module	8
Commons per module	2 (isolated)
Input voltage range	85-132VAC
Input voltage supply	External
Peak voltage	132VAC
AC frequency	47-63 Hz
ON voltage level	>80 VAC
OFF voltage level	<20 VAC
Input impedance	10 K ohm
Input current	15 mA @ 50 Hz 18 mA @ 60 Hz

Minimum ON current	8 mA
Maximum OFF current	2 mA
Base power required	9V 10 mA Max 24V N/A
OFF to ON response	10-30 ms
ON to OFF response	10-60 ms
Terminal type	Non-removable
Status indicators	Field side
Weight	5 oz. (140 g)





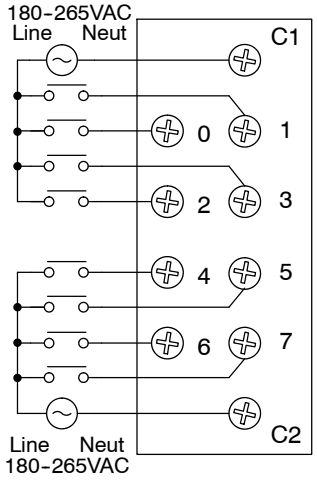


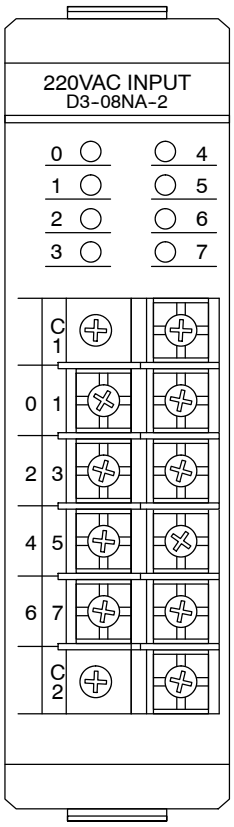


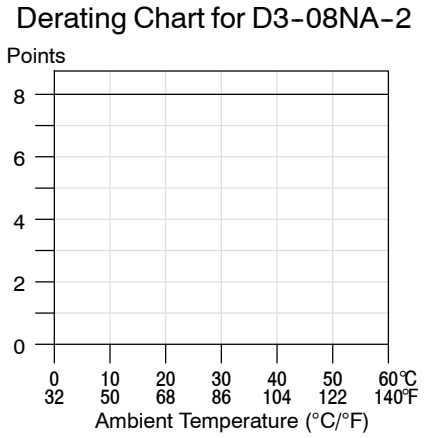
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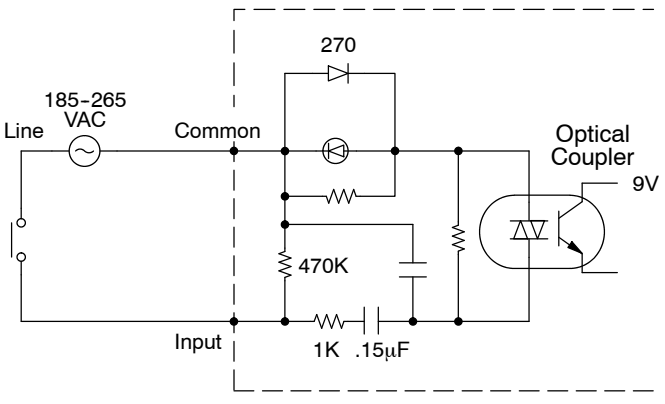
D3-08NA-2, 220 VAC Input Module

Inputs per module	8		Minimum ON current	10 mA
Commons per module	2 (isolated)		Maximum OFF current	2 mA
Input voltage range	180-265VAC		Base power required	9V 10 mA max 24V N/A
Input voltage supply	External			
Peak voltage	265 VAC		OFF to ON response	5-50 ms
AC frequency	50-60Hz		ON to OFF response	5-60 ms
ON voltage level	>180 VAC		Terminal type	Non-removable
OFF voltage level	< 40 VAC		Status indicators	Field side
Input impedance	18 K ohm		Weight	5 oz. (140 g)
Input current	13 mA @ 50 Hz 18 mA @ 60 Hz			







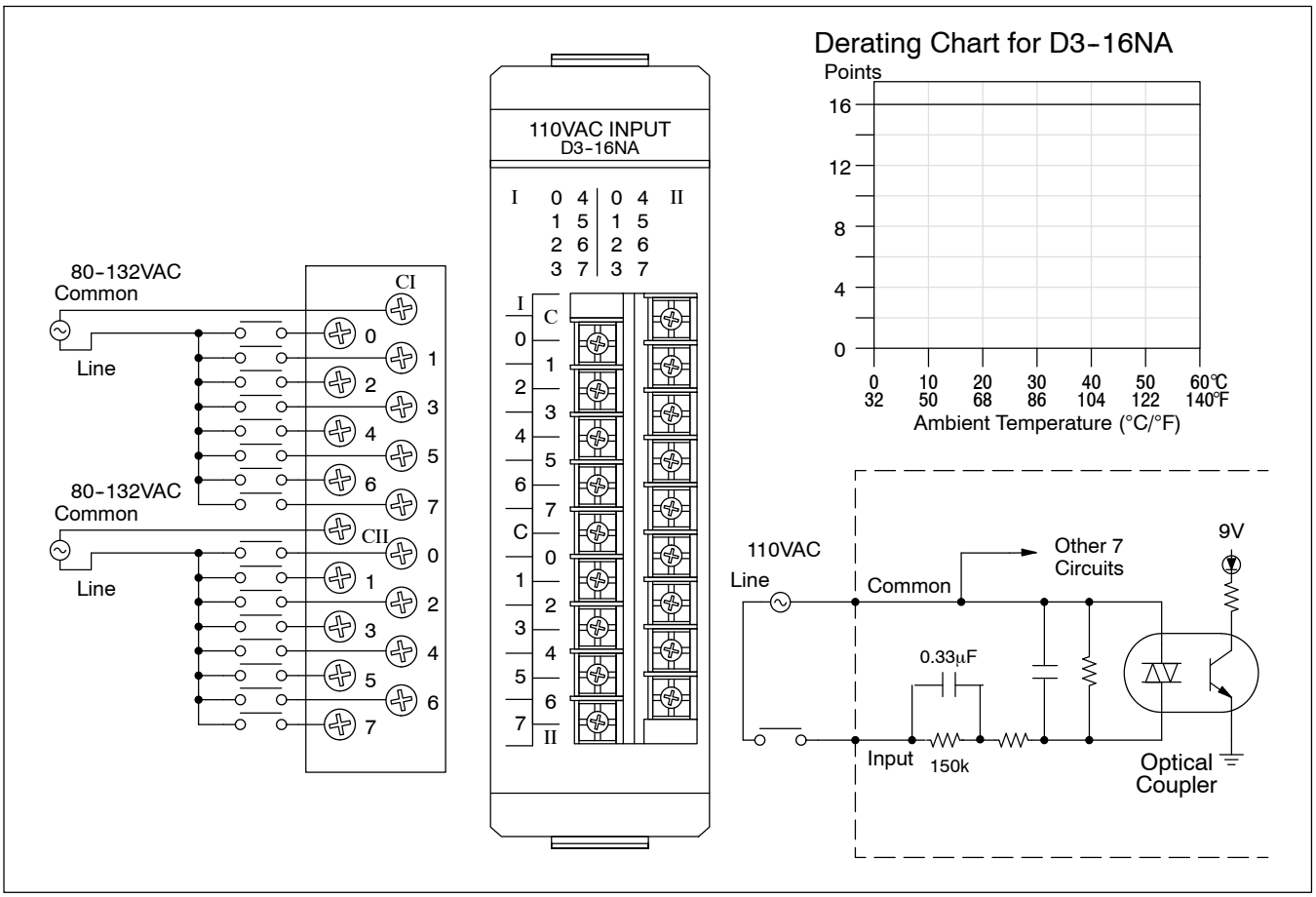


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D3-16NA, 110 VAC Input Module

Inputs per module	16		Minimum ON current	8 mA
Commons per module	2 (isolated)		Maximum OFF current	1.5 mA
Input voltage range	80-132VAC		Base power required*	9V 6.25 mA Max/ON pt. 100mA max
Input voltage supply	External			
Peak voltage	132VAC		OFF to ON response	5-50 ms
AC frequency	50-60 Hz		ON to OFF response	5-60 ms
ON voltage level	>80 VAC		Terminal type	Removable
OFF voltage level	<15 VAC		Status indicators	Logic side
Input impedance	8 K ohm		Weight	6.4 oz. (180 g)
Input current	16 mA @ 50 Hz 25 mA @ 60 Hz			

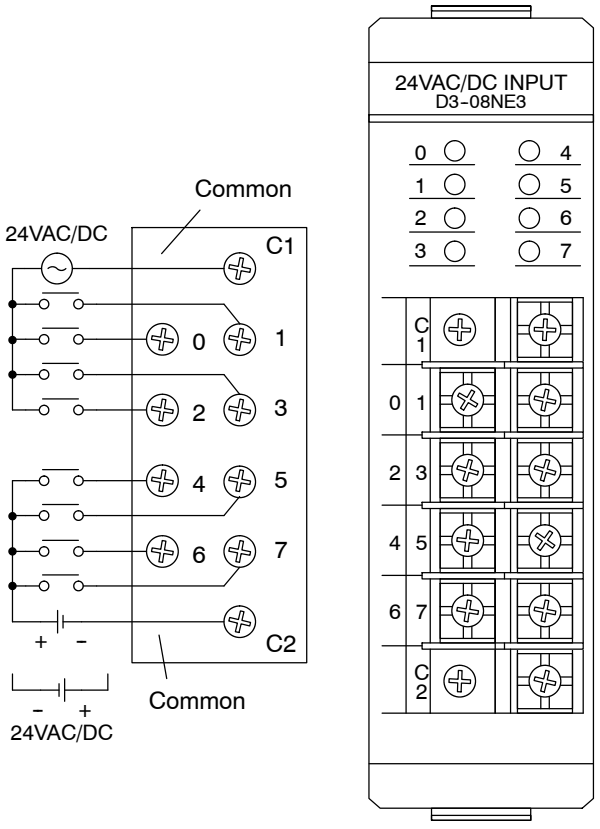
* 9V typical values are 4 mA/ON pt., 64 mA total

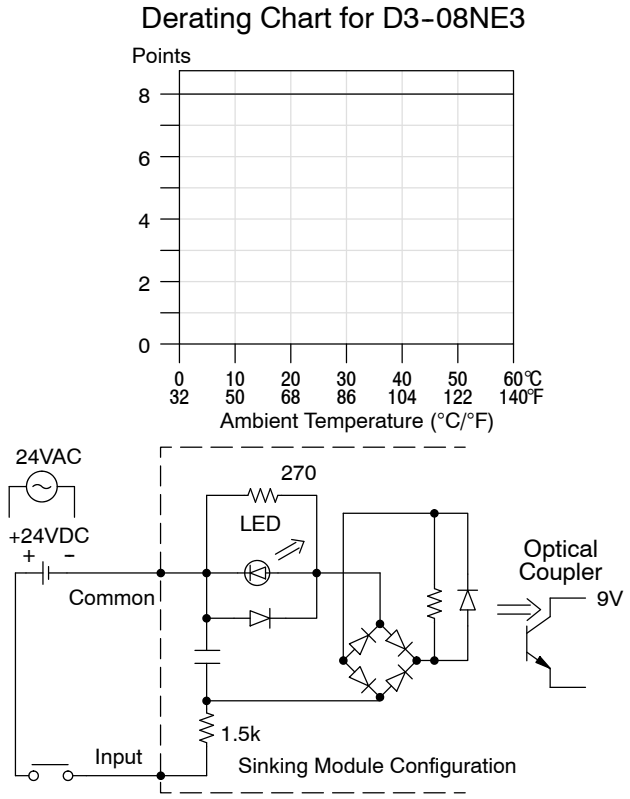


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D3-08NE3, 24 VAC/DC Input Module

Inputs per module	8 (sink/source)		Base power required	9V 10 mA max 24V N/A
Commons per module	2 (isolated)			
Input voltage range	20-28 VAC/VDC		OFF to ON response	AC: 5-50 ms DC: 6-30 ms
Input voltage	External			
Peak voltage	28 VAC/VDC		ON to OFF response	AC/DC: 5-60 ms
AC frequency	47-63 Hz		Terminal type	Non-removable
ON voltage level	>20 V		Status indicators	Field side
OFF voltage level	<6V		Weight	4.2 oz. (120 g)
Input impedance	1.5 K ohm			
Input current	19 mA Max			
Minimum ON current	10 mA			
Maximum OFF current	2 mA			



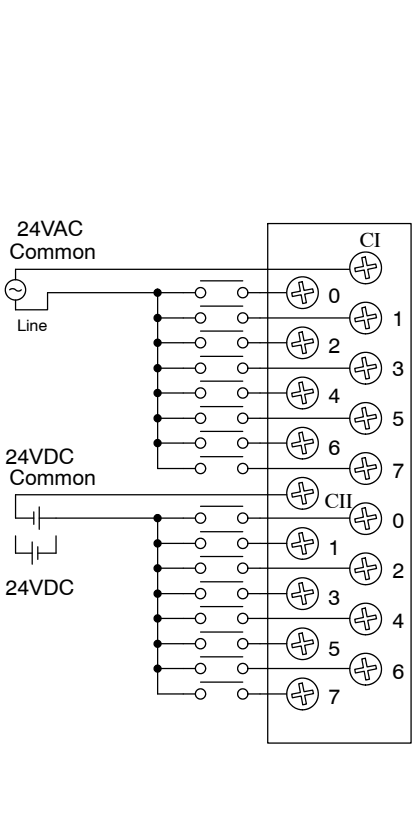


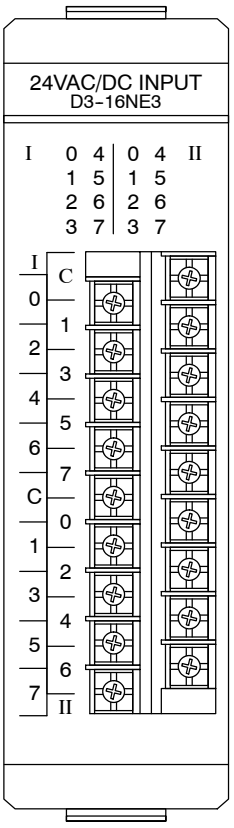
NOTE: This module can be wired in a sourcing configuration and it will be operational except there will be no module LED indication for each input.

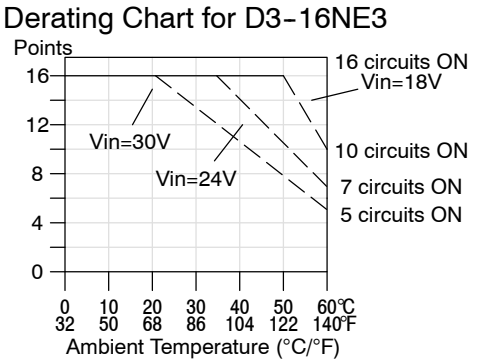
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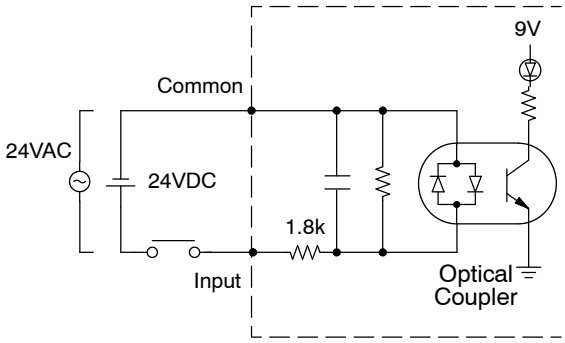
D3-16NE3, 24 VAC/DC Input Module

Inputs per module	16 (sink/source)		Base power required	9V 2.5 mA.+4.5mA/ ON pt.(130 mA max) 24V N/A
Commons per module	2 (isolated)			
Input voltage range	14-30VAC/VDC			
Input voltage supplied	External		OFF to ON response	AC 5-30 ms DC 5-25 ms
Peak voltage	30 VAC/VDC			
AC frequency	47-63 Hz		ON to OFF response	AC 5-30 ms DC 5-25 ms
ON voltage level	>14 V			
OFF voltage level	<3 V		Terminal type	Removable
Input impedance	1.8 K ohm		Status indicators	Logic side
Input current	16 mA Max		Weight	6 oz. (170 g)
Minimum ON current	7 mA			
Maximum OFF current	2 mA			







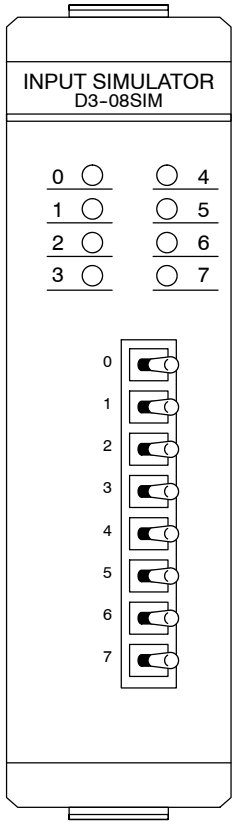


Sinking Module Configuration

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D3-08SIM, Input Simulator

Inputs per module	8			
Base Power required	10mA @ 9VDC 112mA max @ 24VDC			
OFF to ON response	4–15 ms			
ON to OFF response	4–15 ms			
Terminal type	None			
Status indicators	Switch side			
Weight	3.0 oz. (85 g)			



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7

Discrete Output Modules

In This Chapter. . . .

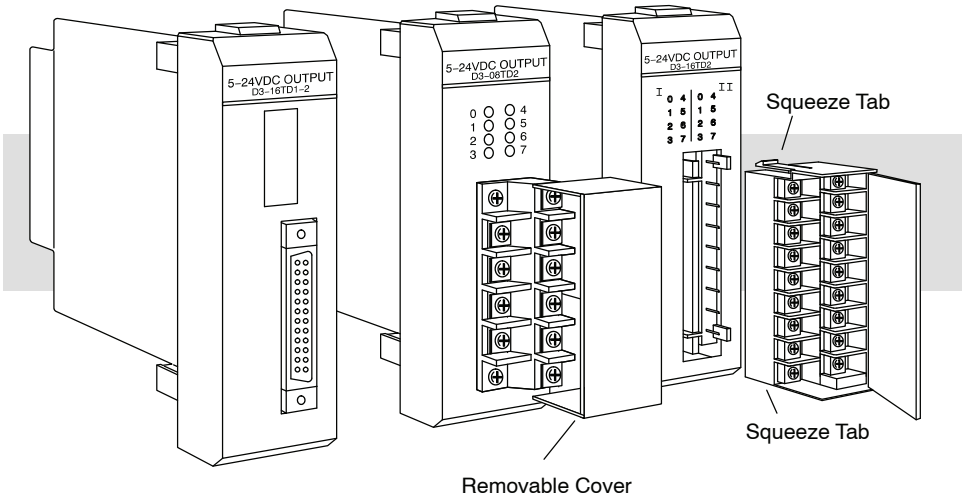
— Discrete Output Module Identification and Terminology
— Relay Arc Suppression - DC and AC Applications
— D3-08TD1, 24 VDC Output Module
— D3-08TD2, 24 VDC Output Module
— D3-16TD1-1, 24 VDC Output Module
— D3-16TD1-2, 24 VDC Output Module
— D3-16TD2, 24 VDC Output Module
— D3-04TAS, 110-220 VAC Output Module
— F3-08TAS, 250 VAC Isolated Output Module
— F3-08TAS-1, 125 VAC Isolated Output Module
— D3-08TA-1, 110-220 VAC Output Module
— D3-08TA-2, 110-220 VAC Output Module
— F3-16TA-2, 20-125 VAC Output Module
— D3-16TA-2, 110-220 VAC Output Module
— D3-08TR, Relay Output Module
— F3-08TRS-1, Relay Output Module
— F3-08TRS-2, Relay Output Module
— D3-16TR, Relay Output Module

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Discrete Output Module Identification and Terminology

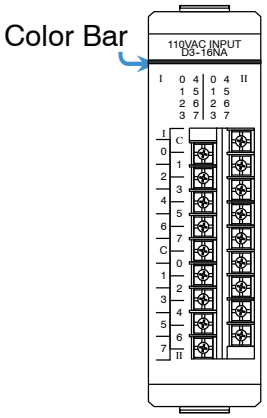
Discrete Output Module Status Indicators

This chapter contains I/O specification sheets for the DL305/FL305 discrete output modules. The following diagram shows the status indicator location for some of the most common discrete output modules.



Color Coding of I/O Modules

The DL305 family of I/O modules has a color coding scheme to help you identify whether the module is an input module, an output module or a special module. This is done through a color bar indicator located on the front of each module below the part number. The following color scheme is used.



Module Type	Color Code
Discrete/Analog Output	Red
Discrete/Analog Input	Blue
Other	White

Output Modules Selection

Your output module selection depends on the field devices used and system performance requirements. The output module specifications in this chapter list the information which is needed for choosing the correct module for a field device and to assure it meets the system requirements. The following list defines the specifications listed in this chapter.

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Outputs Per Module	Indicates number of output points per module and designates current sinking, current sourcing, or either.
Commons Per Module	Number of commons per module and their electrical characteristics.
Operating Voltage	The operating voltage range of the output circuit.
Output Type	The output circuit can be a transistor, a triac, or a relay. The NPN or PNP transistor outputs are normally used in low voltage or high speed DC applications. Triac outputs are used in AC voltage applications. The Form A or C relay outputs are normally used where a wide voltage range is needed. Relay output modules are capable of carrying more current than a transistor or a triac output and can pass AC or DC voltages. The disadvantage of a relay module is the internal power consumption and the relay life expectancy.
Peak Voltage	Maximum voltage the output circuit can control.
AC Frequency	AC modules are designed to operating within a specific frequency range. 60 Hz is the standard AC frequency in the U.S., 50 Hz is common in other countries.
ON Voltage Drop	The voltage between the output point and common during an active ON with a load.
Maximum Current (Resistive)	The maximum current for an output with a resistive load.
Maximum Leakage Current	The maximum current of the output circuit during an OFF state.
Maximum Inrush Current	The maximum current over a short period of time during the OFF to ON transition of a output point. It is greater than the normal ON state current and depends on the field device electrical characteristics.
Minimum Load	The minimum load across the output's circuit for the circuit to operate properly.
Base Power Required	Power from the base power supply is used by the DL305 output modules and varies between different modules. The guidelines for using module power is explained in the power budget configuration section in chapter 4.
OFF to ON Response Time	The processing time the module requires to transition from an OFF to ON state.
ON to OFF Response Time	The processing time the module requires to transition from an ON to OFF state.
Terminal Type	Indicates whether the terminal type is a removable or non-removable connector or terminal.
Status Indicators	LEDs indicate the ON/OFF status of an input point. These LEDs are electrically located on either the logic side or the field device side of the output circuit.
Fuses	Indicates the current rating of the replaceable or non-replaceable fuse(s).
Relay Life	Amount of closures typical for a relay point before failure.
Weight	Indicates the weight of the module.

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Relay Arc Suppression - DC and AC Applications

FL305 High Current Relay Output Module Arc Suppression

This application note describes the addition of external contact protection to high current isolated relay output modules. It supplements the wiring information for the F3-08TRS-1 and F3-08TRS-2 relay output modules.

Adding external contact protection may extend a relays life beyond the number of operations listed. High current inductive loads such as clutches, brakes, motors, direct acting solenoid valves, and motor starters will benefit the most from external contact protection.

Resistor and Capacitor Selection

$C\ (\mu F) = I^2 / 10$

$R\ (\Omega) = V / 10\ I^x$ where $x = (1 + 50 / E)$

Use peak AC values for I and V, see "Peak Voltage and Current" below.
Where I = Amperes of load current immediately prior to opening of contacts.
Where E = Source voltage immediately prior to closing of contacts.

R minimum = 0.5 Ω, 1/2 W

C minimum = 0.001 μF, the voltage rating of C must be ≥ E

Resistor Tolerance

For E < 70V, R may be 3 times indicated value.
For 70V < E < 100V, R may be ± 50% indicated value.
For 100V < E < 150V,R may be ± 10% indicated value.
For E > 150V, R may be ± 5% indicated value.

Peak Voltage and Current

The following equations can be used to determine I_{peak} and V_{peak}:

$I_{peak} = I_{rms} / .707$ Alternating Current

$V_{peak} = V_{rms} / .707$

$I_{peak} = I_{ave} / .636$ DC Rectified Alternating Current

Adding Contact Protection

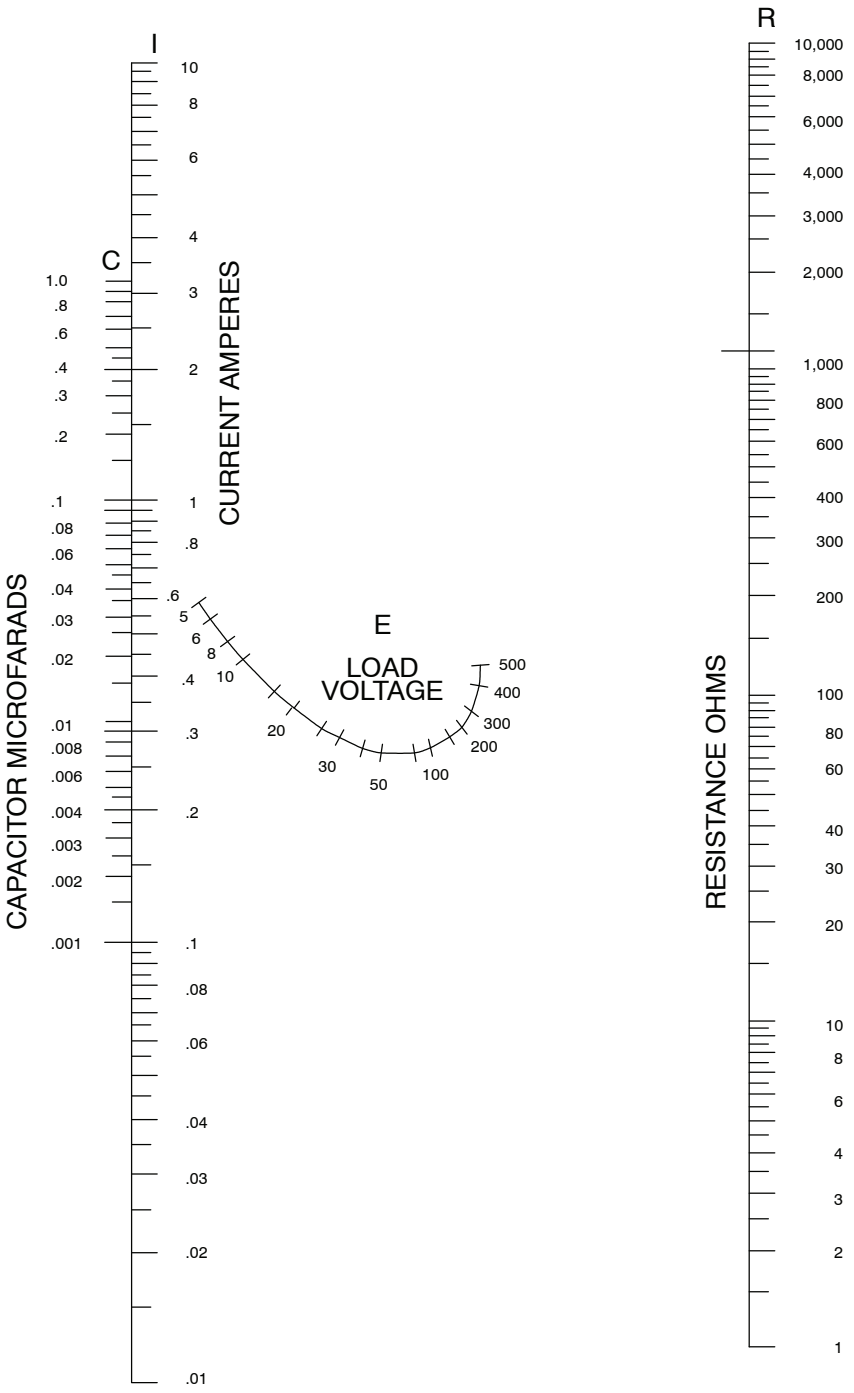
If the contact is switching a DC inductive load, add a diode across the load as near to load coil as possible. Add the RC network across the relay contacts as close to the relay as possible.

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Resistor and Capacitor Nomogram

The nomogram shown below affords a convenient method of selecting the proper contact protection for P & B relays used in F3-08TRS-1 and F3-08TRS-2 modules.
Example: Use a current (1) of 1.0 ampere and a voltage (E) of 50 volts.

Capacitance (C) in microfarads is found directly on the left side scale, opposite 1.0 amperes as 0.1. Resistance (R) in ohms is obtained using a straight edge. Locate 1.0 amperes (I) on the left side scale and 50 volts (E) on the center scale. Place the straightedge on these points. The junction of the straight edge and the right side determines R. In this example R is equal to 5.0 ohms.



(1) C = 1^2 / 10 microfarads
(2) R = E / 10 I^x ohms

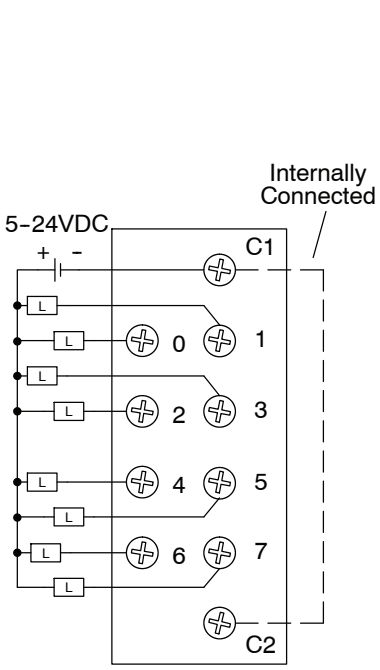
For DC. For AC, use peak values
Where x = (1 + 50/E)

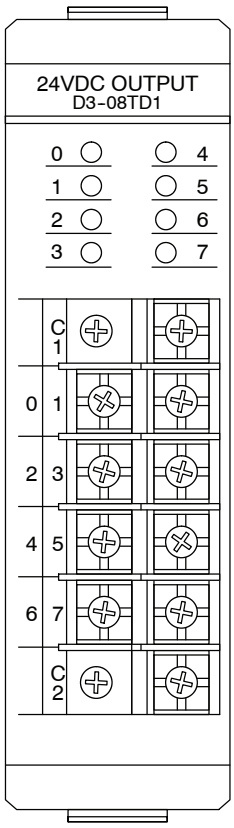
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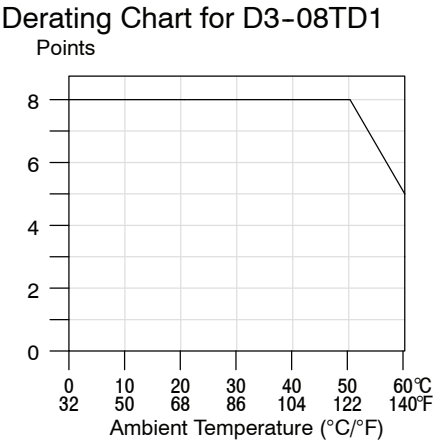
D3-08TD1, 24 VDC Output Module

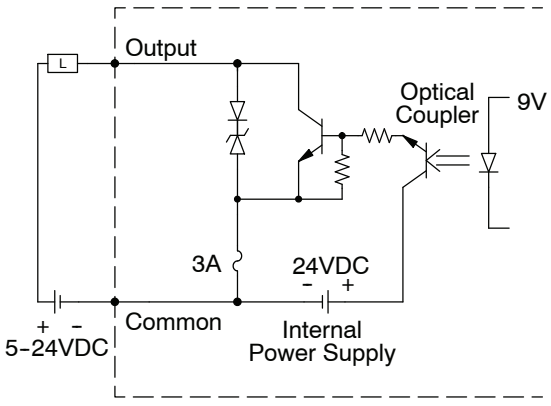
Outputs per module	8 (current sinking)
Commons per module	2(internally connected)
Operating voltage	5-24VDC
Output type	NPN (open collector)
Peak voltage	45VDC
AC frequency	N/A
ON voltage drop	0.8V @ 0.5A
Max current	0.5A / point 1.8 / common
Max leakage current	0.1 mA @ 40VDC
Max inrush current	3A / 20ms 1A / 100ms

Minimum load	1 mA
Base power required	9V 20 mA Max 24V 3mA/pt. (24mA Max)
OFF to ON response	0.1 ms
ON to OFF response	0.1 ms
Terminal type	Non-removable
Status indicators	Logic Side
Weight	4.2 oz. (120 g)
Fuses	(2) One 3A per common Non-replaceable





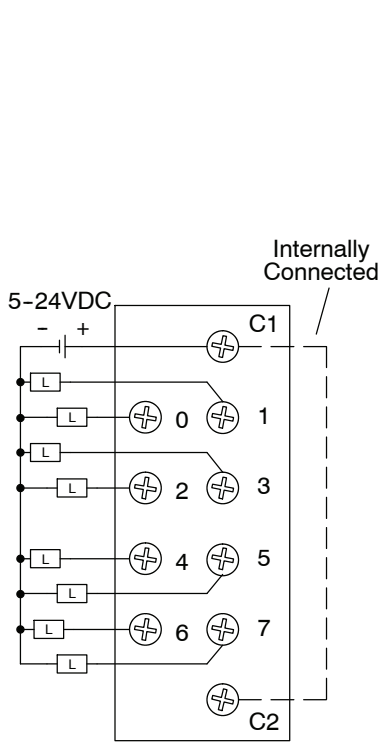


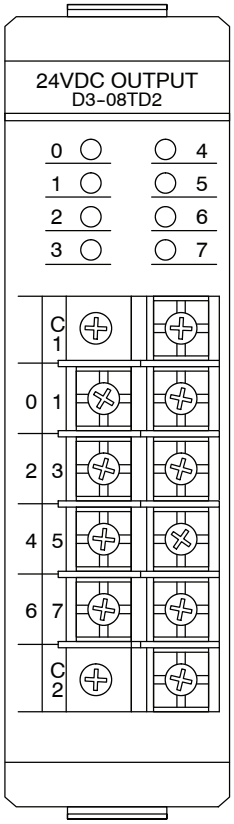


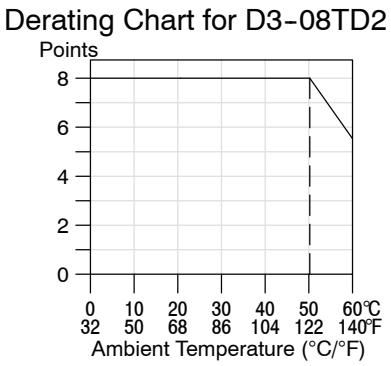
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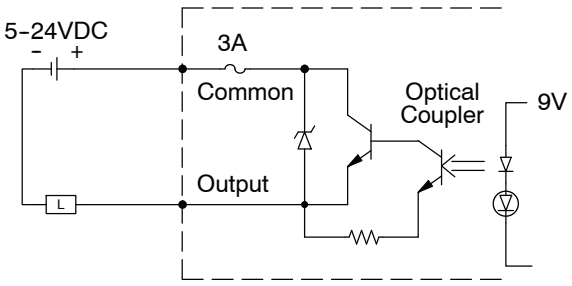
D3-08TD2, 24 VDC Output Module

Outputs per module	8 (current sourcing)		Minimum load	1 mA
Commons per module	2 (internally connected)		Base power required	9V 30 mA Max 24V N/A
Operating voltage	5-24VDC		OFF to ON response	0.1 ms
Output type	NPN Transistor (emitter follower)		ON to OFF response	0.1 ms
Peak voltage	40VDC		Terminal type	Non-removable
AC frequency	N/A		Status indicators	Logic Side
ON voltage drop	1V @ 0.5A		Weight	4.2 oz. (120 g)
Max current	0.5A / point 1.8A/ common		Fuses	(2) One 3A per common Non-replaceable
Max leakage current	0.1 mA @ 24VDC			
Max inrush current	3A / 20ms 1A / 100ms			





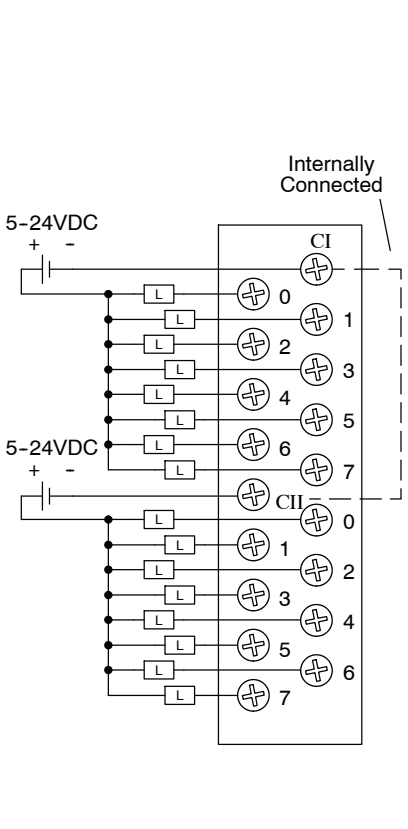


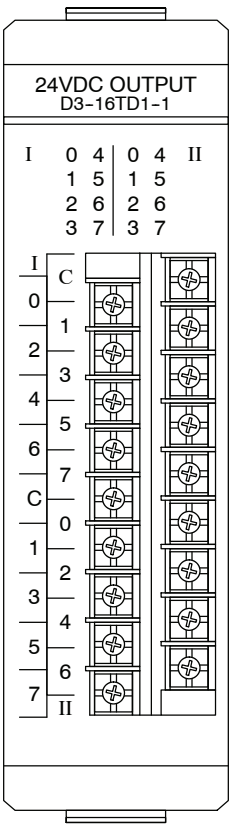


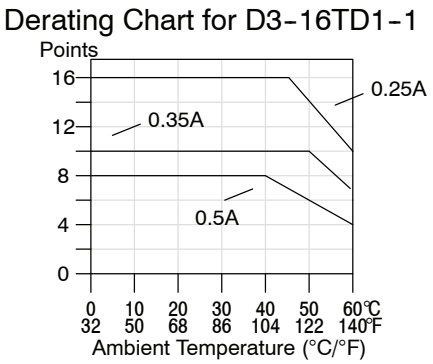
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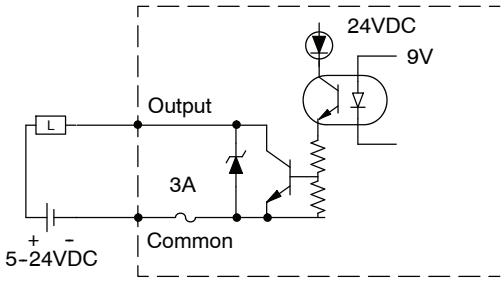
D3-16TD1-1, 24 VDC Output Module

Outputs per module	16 (current sinking)		Minimum load	1 mA
Commons per module	2 (internally connected)		Base power required	9V (40 mA Max) 3mA+2.3mA/ON pt. 24V 6 mA/ON pt. (96 mA Max)
Operating voltage	5-24VDC			
Output type	NPN transistor (open collector)			
Peak voltage	45VDC		OFF to ON response	0.1 ms
AC frequency	N/A		ON to OFF response	0.1 ms
ON voltage drop	2V @ 0.5A		Terminal type	Removable
Max current	0.5A/ point 2A/ common		Status indicators	Logic Side
			Weight	5.6 oz. (160 g)
Max leakage current	0.1mA @ 40VDC		Fuses	(2) One 3A per common Non-replaceable
Max inrush current	3A / 20 ms 1A / 100 ms			







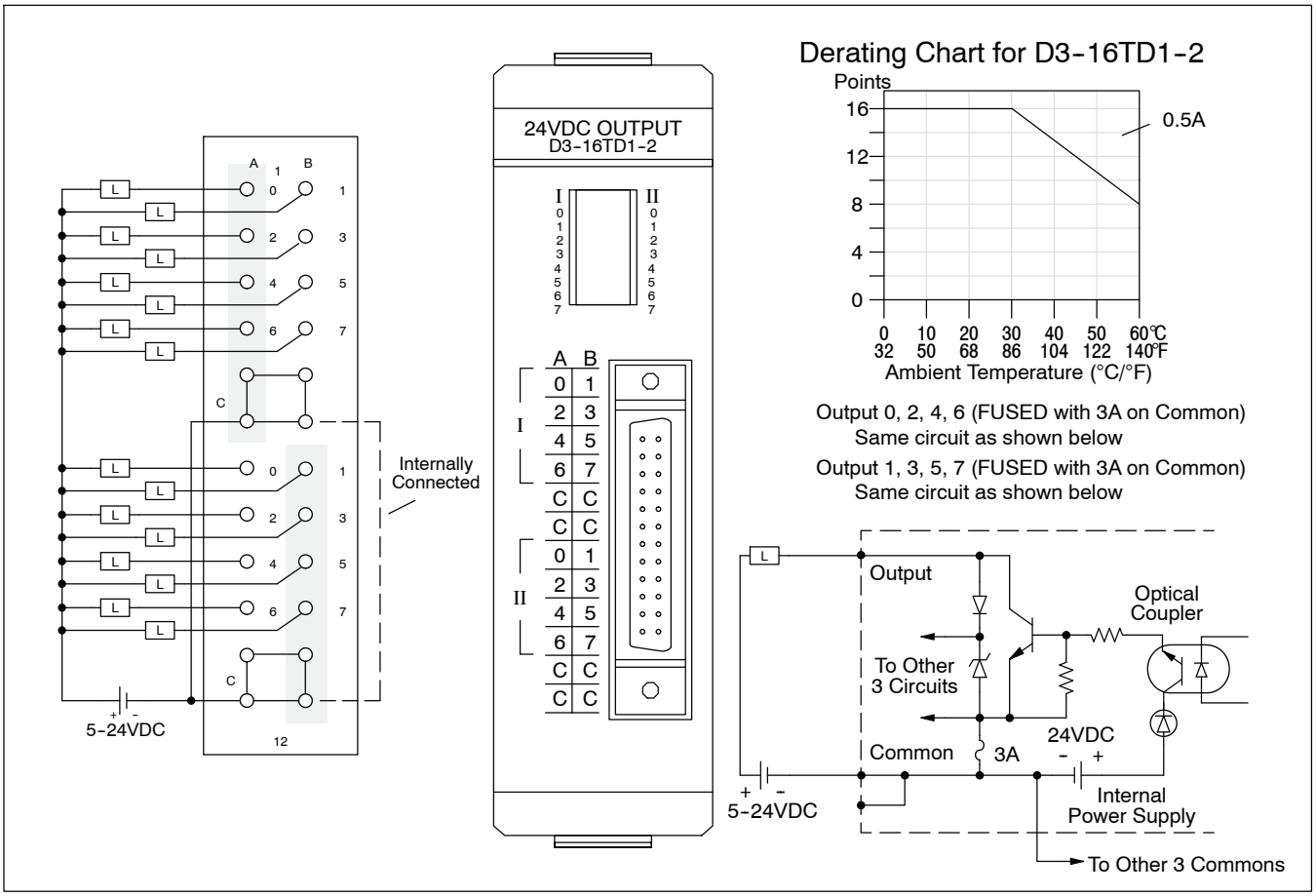


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D3-16TD1-2, 24 VDC Output Module

Outputs per module	16 (current sinking)
Commons per module	4 (internally connected)
Operating voltage	5-24VDC
Output type	NPN transistor (open collector)
Peak voltage	45VDC
AC frequency	N/A
ON voltage drop	2.0V @ 0.5A
Max current	0.5A / point 1.8A common
Max leakage current	0.3 mA @ 40VDC
Max inrush current	3A / 20ms 1A / 100ms

Minimum load	1 mA
Base power required	9V (40mA Max) 3mA+2.3mA/ON pt. 24V 6mA/ON pt. (96mA Max)
OFF to ON response	0.1 ms
ON to OFF response	0.1 ms
Terminal type	Removable connector
Status indicators	Logic Side
Weight	5.6 oz. (160 g)
Fuses	(4) One 3A per common Non-replaceable

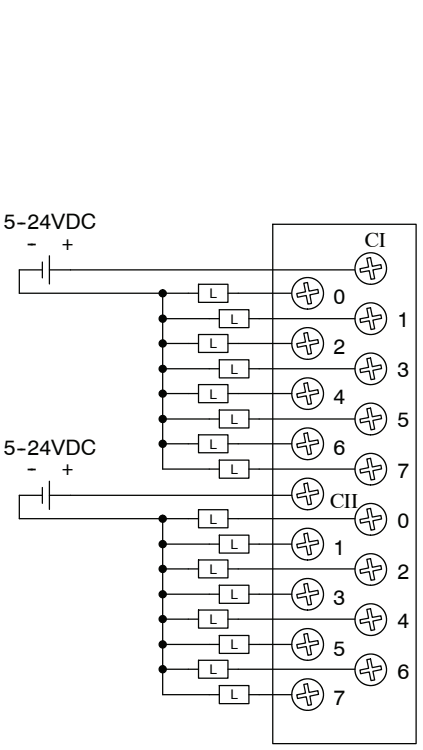


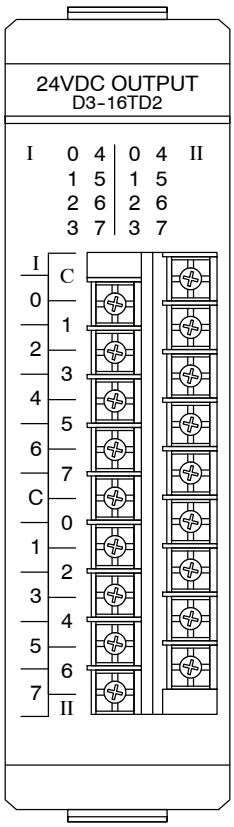
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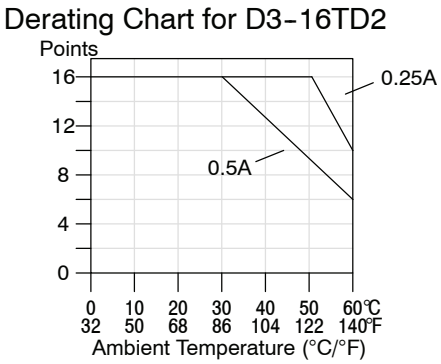
D3-16TD2, 24 VDC Output Module

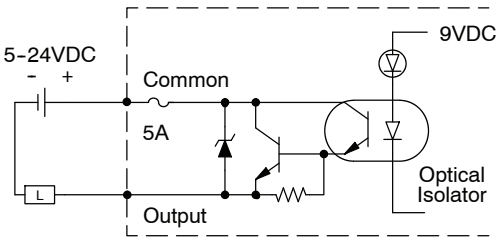
Outputs per module	16 (current sourcing)
Commons per module	2 (isolated)
Operating voltage	5-24VDC
Output type	NPN transistor (emitter follower)
Peak voltage	40VDC
AC frequency	N/A
ON voltage drop	1.5V @ 0.5A
Max current	0.5A / point 3A common
Max leakage current	0.01 mA @ 40VDC
Max inrush current	3A / 20ms 1A / 100ms

Minimum load	1 mA
Base power required	9V 7.5 mA/ON pt. (180 mA Max) 24V N/A
OFF to ON response	0.1 ms
ON to OFF response	1 ms
Terminal type	Removable
Status indicators	Logic Side
Weight	7.1 oz. (210 g)
Fuses	(2) One 5A per common Non-replaceable







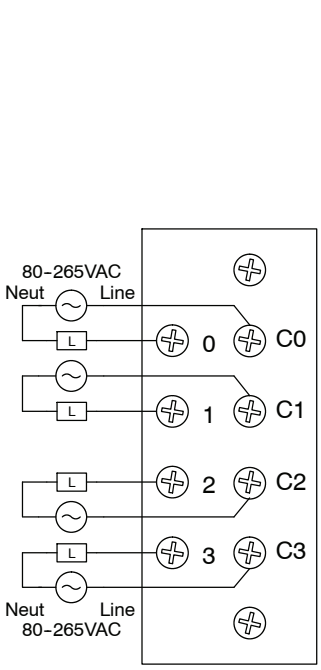


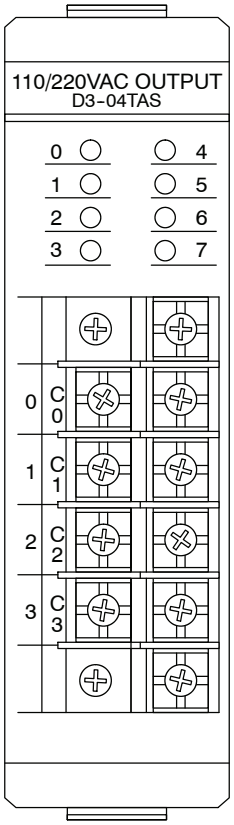
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D3-04TAS, 110-220 VAC Output Module

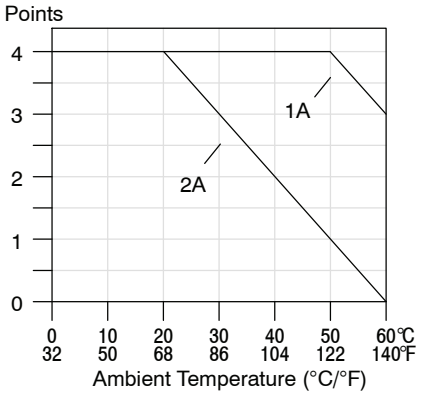
Outputs per module	4
Commons per module	4 (isolated)
Operating voltage	80-265VAC
Output type	Triac
Peak voltage	265 VAC
AC frequency	47-63 Hz
ON voltage drop	1.5 VAC @ 2A
Max current	2A / point 2A / common
Max leakage current	7 mA @ 220VAC 3.5 mA @ 110VAC
Max inrush current	20A for 16 ms 10A for 100 ms

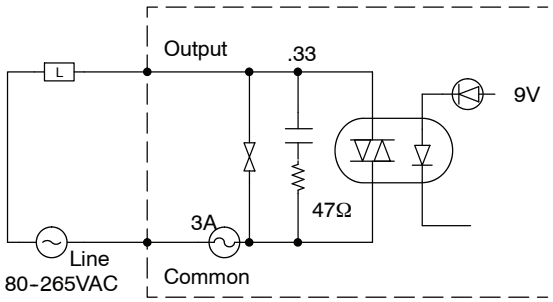
Minimum load	10 mA
Base power required	9V 12 mA Max 24V N/A
OFF to ON response	1 ms Max
ON to OFF response	10 ms Max
Terminal type	Non-removable
Status indicators	Logic Side
Weight	6.4 oz. (180 g)
Fuses	(4) One 3A per common User replaceable





Derating Chart for D3-04TAS



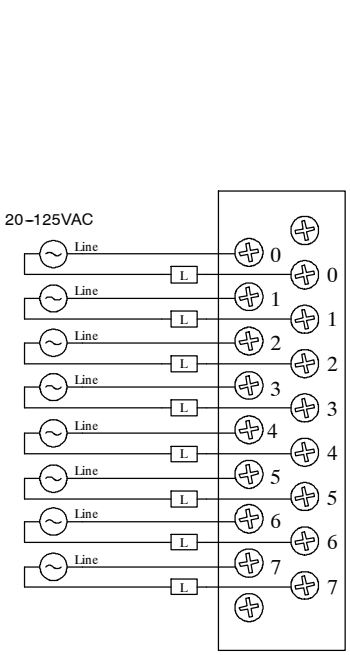


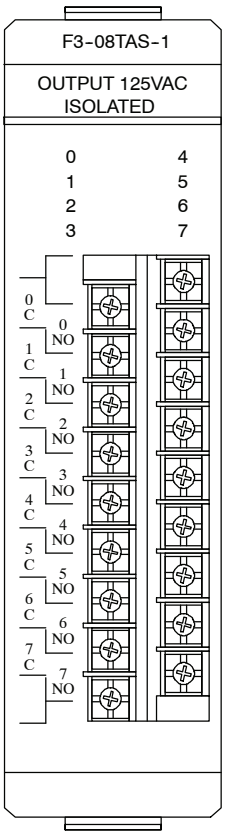
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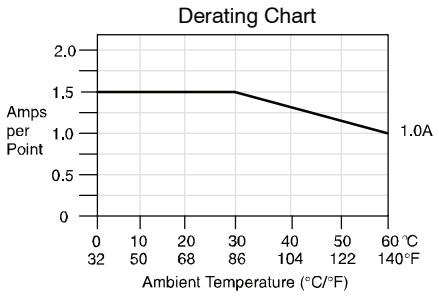
F3-08TAS, 250 VAC Isolated Output Module

Outputs per module	8 (500V point-to-point isolation)
Commons per module	8 (isolated)
Operating voltage	12-125 VAC 125-250 VAC requires external fuses
Output type	SSR Array (TRIAC)
Peak voltage	400 VAC
AC frequency	47 - 440 Hz
ON voltage drop	1 VAC @ 1A
Max current	1A / point
Max leakage current	10 μA @ 240 VAC
Max inrush current*	20A for 16 ms 3A for 100 ms
Minimum load	0.5 mA

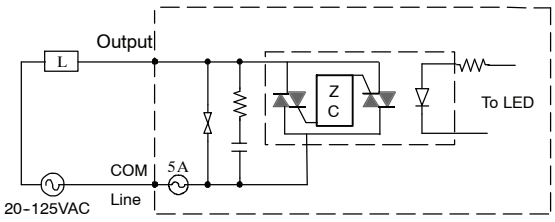
Base power required	9V 10mA / ON pt. 80mA Max. 24V N/A
OFF to ON response	8 ms Max
ON to OFF response	8 ms Max
Terminal type	Removable
Status indicators	Logic Side
Weight	6.3 oz. (177g)
Fuses BK/PCE-5 Bussman (One spare fuse included)	(8) fast blow One 5A (125V fast blow) per each circuit User replaceable







Derating Note: All outputs can be run at the current per point shown.

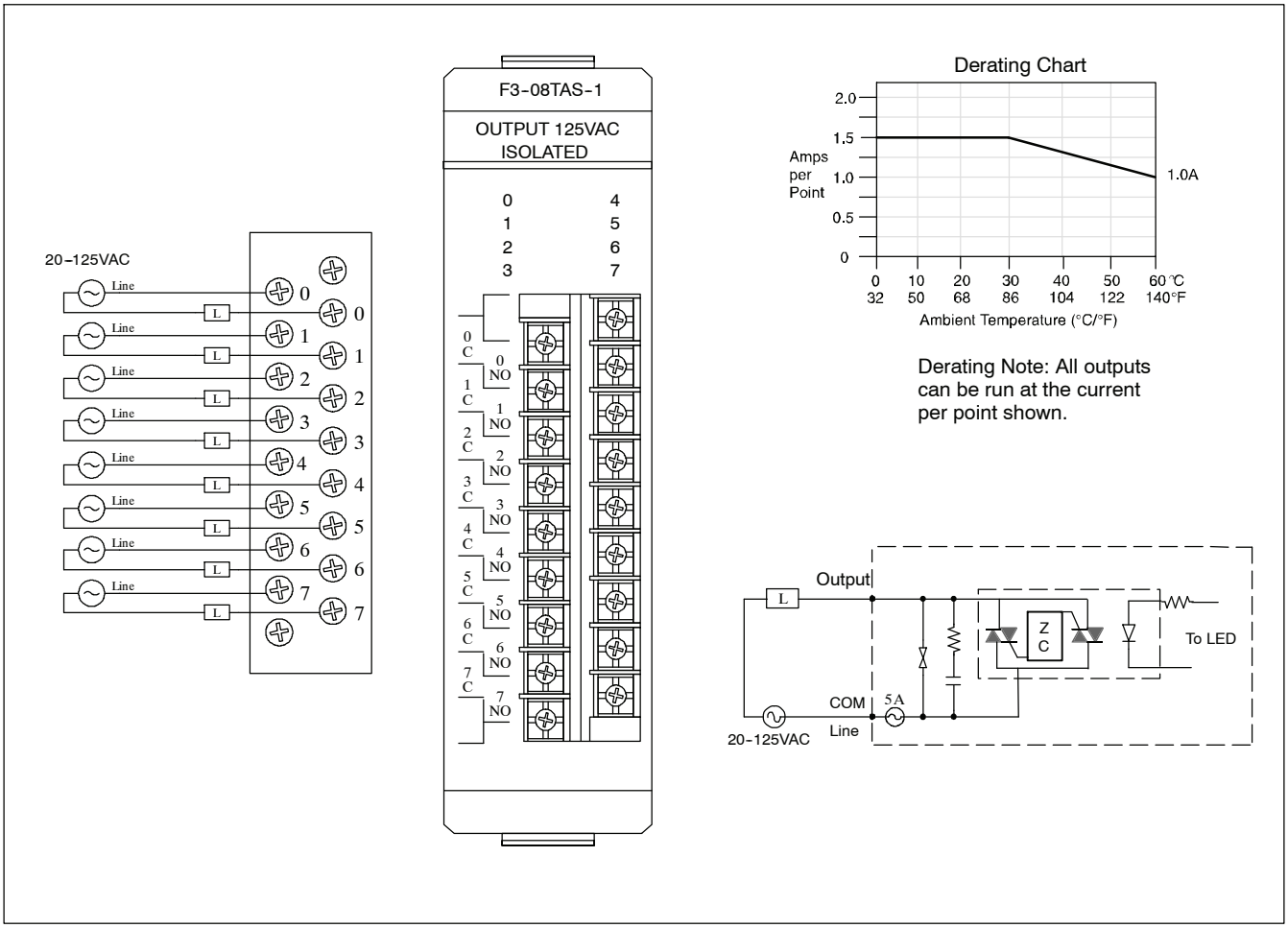


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F3-08TAS-1, 125 VAC Isolated Output Module

Outputs per module	8 (1500V point-to-point isolation)
Commons per module	8 (isolated)
Operating voltage	20-125VAC
Output type	SSR (TRIAC with zero cross-over)
Peak voltage	140VAC
AC frequency	47 - 63 Hz
ON voltage drop	1.6V(rms) @ 1.5A
Max current	1.5A/point
Max leakage current	0.7mA (rms)
Max inrush current*	15A for 20 ms 8A for 100 ms
Minimum load	50mA

Base power required	9V 25mA/ON pt. (200mA Max), 24V N/A
OFF to ON response	1 ms Max
ON to OFF response	9 ms Max
Terminal type	Removable
Status indicators	Logic Side
Weight	6.3 oz. (177g)
Fuses	8 (1 per common) 5A, 125V fast blow Order D3-FUSE-4 (5 per pack)

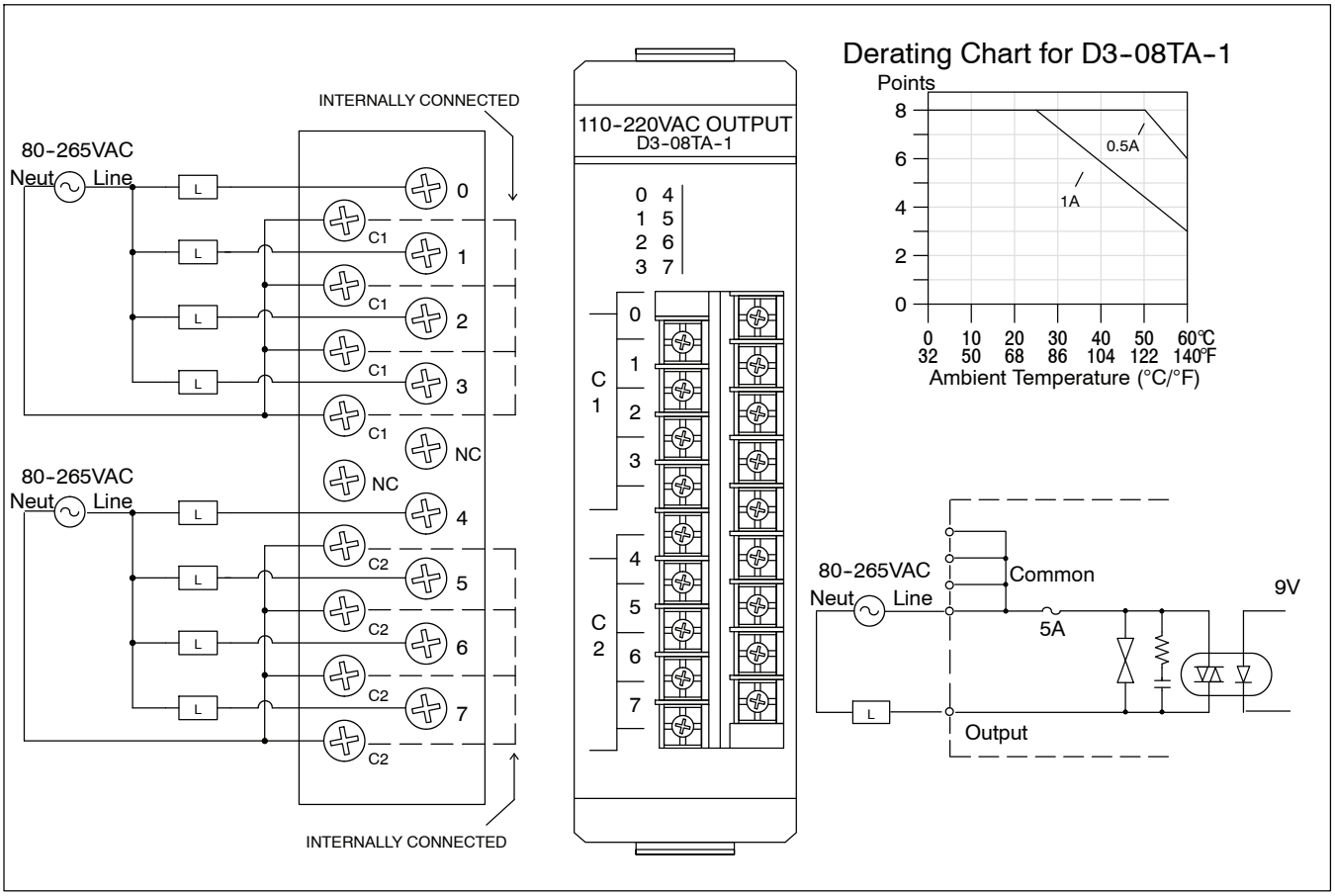


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D3-08TA-1, 110-220 VAC Output Module

Outputs per module	8
Commons per module	2 (isolated)
Operating voltage	80-265VAC
Output type	Triac
Peak voltage	265VAC
AC frequency	47-63 Hz
ON voltage drop	1.5 VAC @ 1A
Max current	1A / point 3A / common
Max leakage current	1.2 mA @ 220VAC 0.52 mA @ 110VAC
Max inrush current	10A for 16 ms 5A for 100 ms

Minimum load	25 mA
Base power required	9V 20mA/ON pt. (160 mA Max) 24V N/A
OFF to ON response	1 ms Max
ON to OFF response	8.33 ms Max
Terminal type	Removable
Status indicators	Logic Side
Weight	7.4 oz. (210 g)
Fuses	(2) One 5A per common Non-replaceable

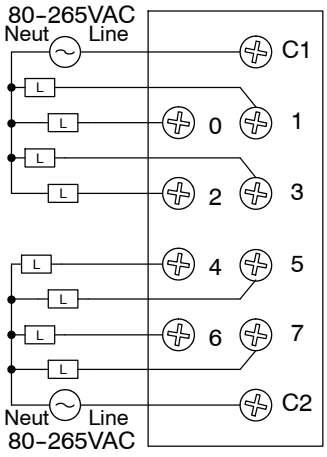


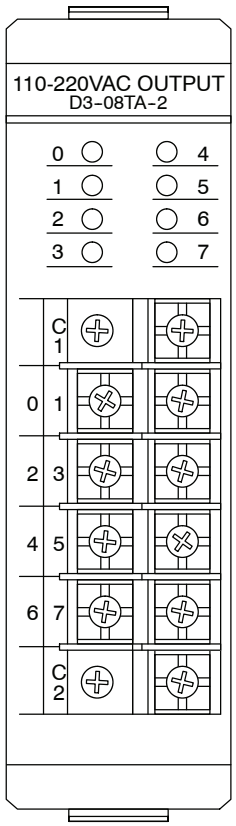
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D3-08TA-2, 110-220 VAC Output Module

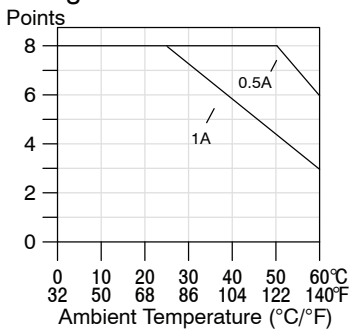
Outputs per module	8
Commons per module	2 (isolated)
Operating voltage	80-265VAC
Output type	Triac
Peak voltage	265VAC
AC frequency	47-63 Hz
ON voltage drop	1.5 VAC @ 1A
Max current	1A / point 3A / common
Max leakage current	1.2 mA @ 220VAC 0.52 mA @ 110VAC
Max inrush current	10A for 16 ms 5A for 100 ms
Minimum load	25 mA

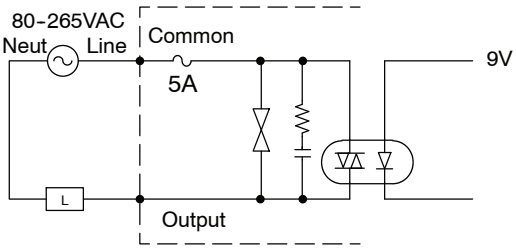
Base power required	9V 20mA/ON pt. (160 mA Max) 24V N/A
OFF to ON response	1 ms Max
ON to OFF response	8.33 ms Max
Terminal type	Non-removable
Status indicators	Logic Side
Weight	6.4 oz. (180 g)
Fuses	(2) One 5A per common Non-replaceable





Derating Chart for D3-08TA-2



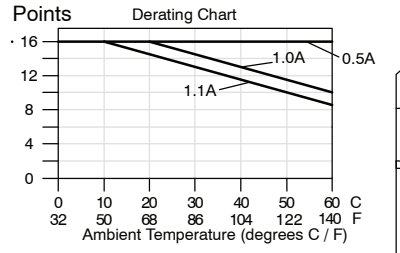


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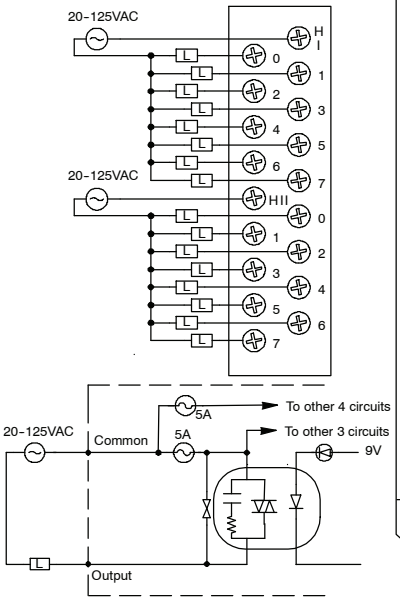
F3-16TA-2, 20-125 VAC Output Module

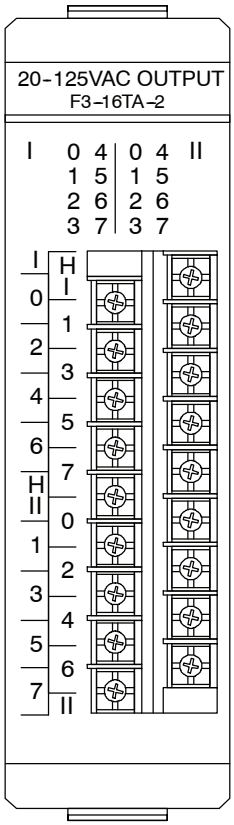
Outputs per module	16
Commons per module	2 (isolated)
Operating voltage	20 – 125VAC
Output type	SSR Array (TRIAC)
Peak voltage	140 VAC
AC frequency	47 – 63Hz
ON voltage drop	1.1VAC @ 1.1A
Max current	1.1A / point
Max leakage current	0.7mA @ 125VAC
Max inrush current*	15A for 20ms 8A for 100ms

Minimum load	50mA
Base power required	9V 14mA / ON pt. 250mA Max. 24V N/A
OFF to ON response	8ms Max.
ON to OFF response	8 ms Max.
Terminal type	Removable
Status indicators	Logic Side
Weight	7.7oz. (218g)
Fuses (One spare fuse included)	4 (One 5A 125V fast blow per each group of four outputs) Order D3-FUSE-4 (5 per pack)



*Fuse blows at 20 Amp surge
Motor starters up to and including a NEMA size 3 can be used with this module.



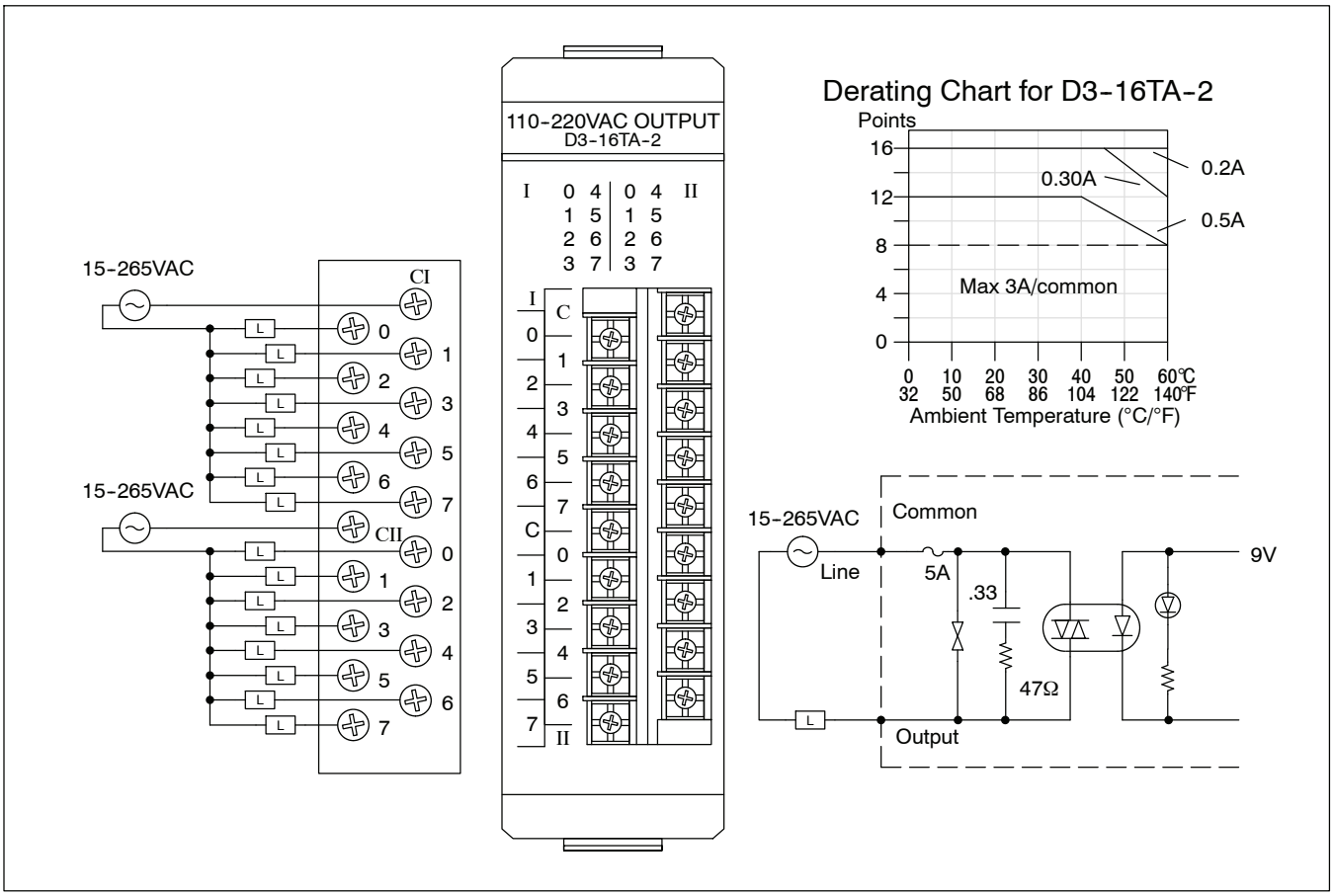


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D3-16TA-2, 110-220 VAC Output Module

Outputs per module	16		Minimum load	10 mA @ 15VAC
Commons per module	2 (isolated)		Base power required *	9V 25mA Max /ON pt. 400 mA Max 24V N/A
Operating voltage	15-265 VAC		OFF to ON response	1 ms Max
Output type	Triac		ON to OFF response	9 ms Max
Peak voltage	265 VAC		Terminal type	Removable
AC frequency	47-63 Hz		Status indicators	Logic Side
ON voltage drop	1.5 VAC @ 0.5A		Weight	7.2 0z. (210 g)
Max current	0.5A / point 3A / common 6A / per module		Fuses	(2) One 5A per common Non-replaceable
Max leakage current	4 mA @ 265 VAC			
Max inrush current	10A for 10 ms 5A for 100 ms			

* 9V typical values 17mA/ON pt., 272 mA total



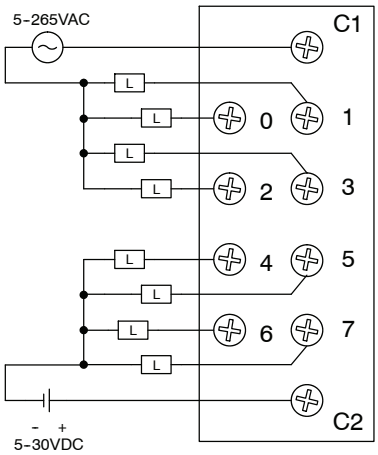
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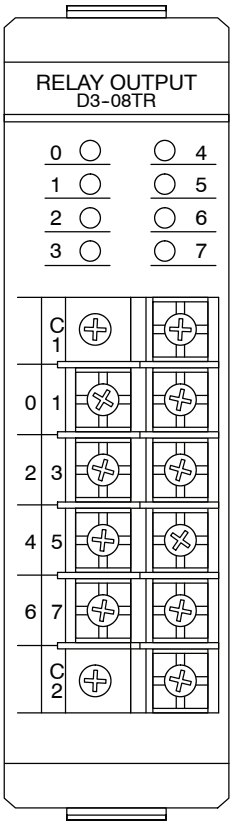
D3-08TR, Relay Output Module

Outputs per module	8		Minimum load	5 mA @ 5v
Commons per module	2 (isolated)		Base power required	9V 45 mA/ON pt. (360 mA Max) 24V N/A
Operating voltage	5-265VAC 5-30VDC			
Output type	Form A (SPST)		OFF to ON response	5 ms
Peak voltage	265VAC / 30VDC		ON to OFF response	5 ms
AC frequency	47-63 Hz		Terminal type	Non-removable
ON voltage drop	N/A		Status indicators	Logic Side
Max current	4A / point AC 5A / point DC 6A / common		Weight	7 oz. (200 g)
			Fuses	(2) One 10A per common User replaceable
Max leakage current	1 mA @ 220VAC			
Max inrush current	5A			

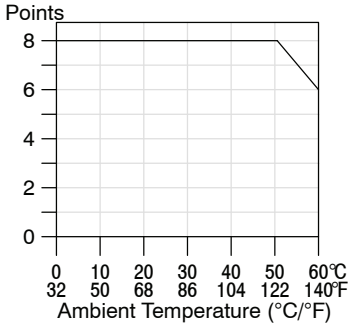
Typical Relay Life (Operations)

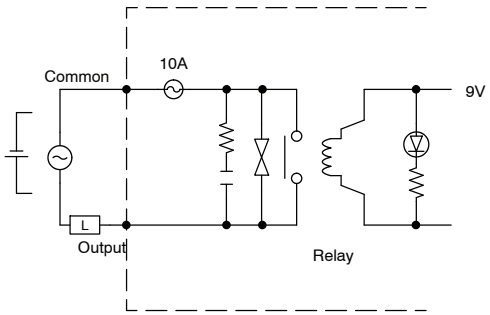
Voltage	Resistive	Solenoid	Closures
220VAC	4A	0.5A	100k
220VAC		0.05A	800k
110VAC	4A	0.5A	100k
110VAC		0.1A	650k
24VDC	5A	0.5A	100k





Derating Chart for D3-08TR





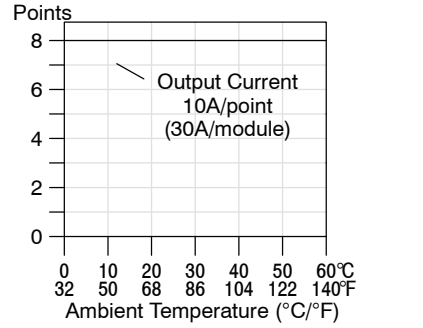
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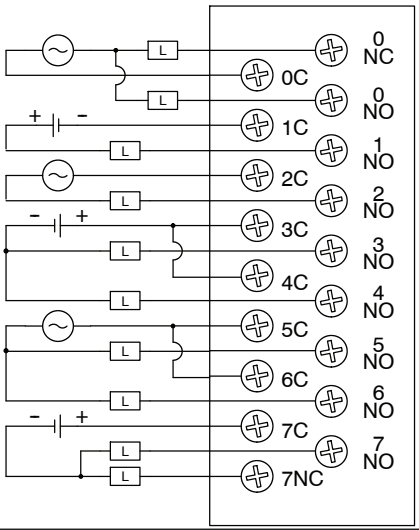
F3-08TRS-1, Relay Output Module

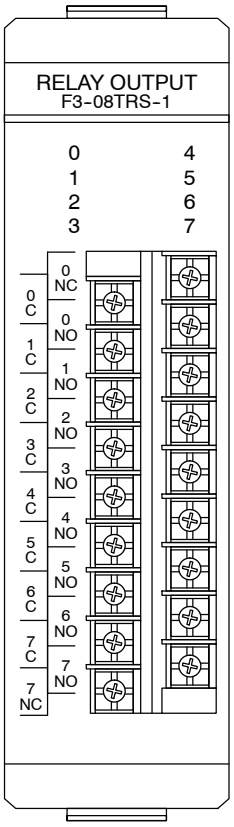
Outputs per module	8		Max leakage current	N/A
Commons per module	8 (isolated)		Max inrush current	10A Inductive
Operating voltage*	12-125 VAC 125-250 VAC requires external fuses 12-30 VDC		Minimum load	100 mA @12VDC
			Base power required	9V 37mA / ON pt. (296 mA Max) 24V N/A
Output type	6 Form A (SPST) 2 Form C (SPDT)		OFF to ON response	13 ms Max
			ON to OFF response	9 ms Max
Peak voltage	265 VAC / 120 VDC		Terminal type	Removable
AC frequency	47-63 Hz		Status indicators	Logic Side
ON voltage drop	N/A		Weight	8.9 oz. (252 g)
Max current (resistive)	10A / point AC/DC 30A / module AC/DC		Fuses	(8) One 10A (125V) per common Non-replaceable

NOTE: Contact life may be lengthened beyond those values shown by the use of an appropriate arc suppression. This technique is discussed earlier in this chapter.

Derating Chart for F3-08TRS-1

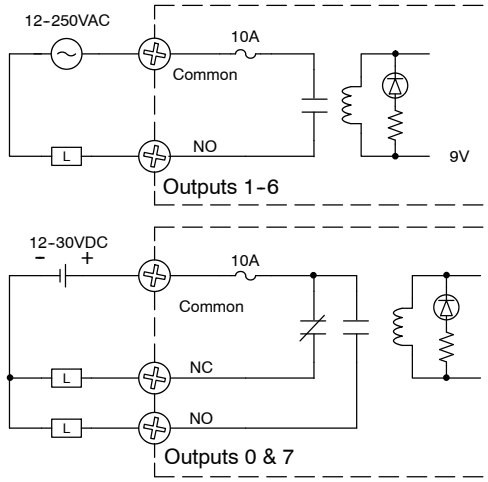






Typical Relay Life (Operations)

Maximum Resistive or Inductive Inrush Load Current	Operating Voltage		
	28VDC	120VAC	240VAC
1/4HP		25K	
10.0A	50K	50K	
5.0A	200K	100K	
3.0A	325K	125K	50K
.05A	>50M		



*Maximum DC voltage rating is 120 VDC at .5 Amp, 30,000 cycles typical

Motor starters up to and including a NEMA size 4 can be used with this module.

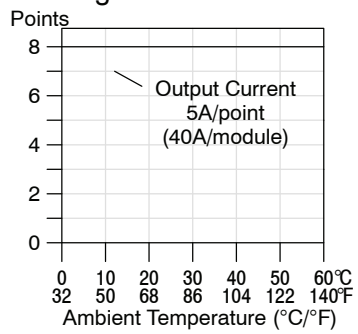
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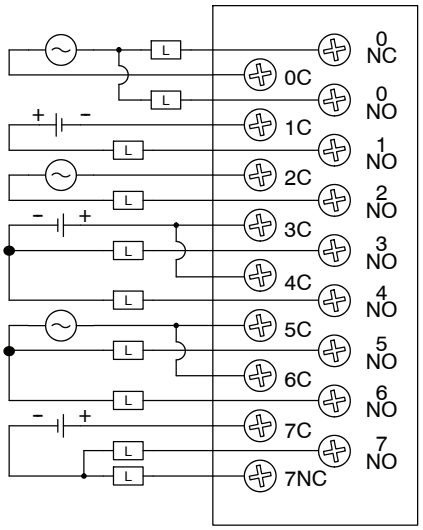
F3-08TRS-2, Relay Output Module

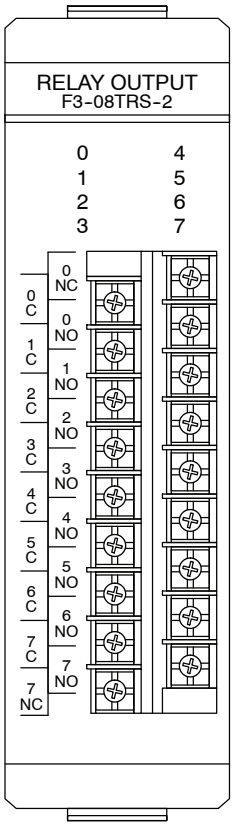
Outputs per module	8		Max leakage current	N/A
Commons per module	8 (isolated)		Max inrush current	10A Inductive
Operating voltage*	12-125 VAC 125-250 VAC requires external fuses 12-30 VDC		Minimum load	100 mA @12VDC
			Base power required	9V 37mA / ON pt. (296 mA Max) 24V N/A
Output type	6 Form A (SPST) 2 Form C (SPDT)		OFF to ON response	13 ms Max
			ON to OFF response	9 ms Max
Peak voltage	265 VAC / 120 VDC		Terminal type	Removable
AC frequency	47-63 Hz		Status indicators	Logic Side
ON voltage drop	N/A		Weight	9 oz. (255 g)
Max current (resistive)	5A / point AC/DC 40A / module AC/DC		Fuses 19379-K-10A Wickman	(8) One 5A (125V) per common User replaceable

NOTE: Contact life may be lengthened beyond those values shown by the use of an appropriate arc suppression. This technique is discussed earlier in this chapter.

Derating Chart for F3-08TRS-2



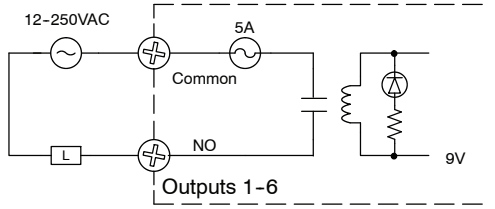


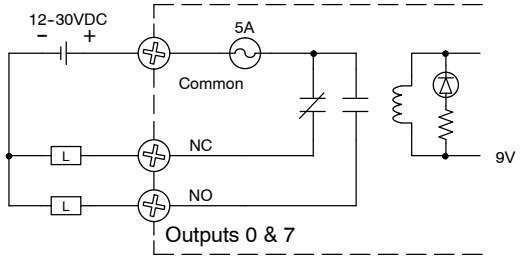


Typical Relay Life (Operations)

Maximum Resistive or Inductive Inrush Load Current	Operating Voltage		
	28VDC	120VAC	240VAC
5.0A	200K	100K	
3.0A	325K	125K	50K
.05A	>50M		

Expected mechanical relay life is 100 million operations.





*Maximum DC voltage rating is 120 VDC at .5 Amp, 30,000 cycles typical

Motor starters up to and including a NEMA size 3 can be used with this module.

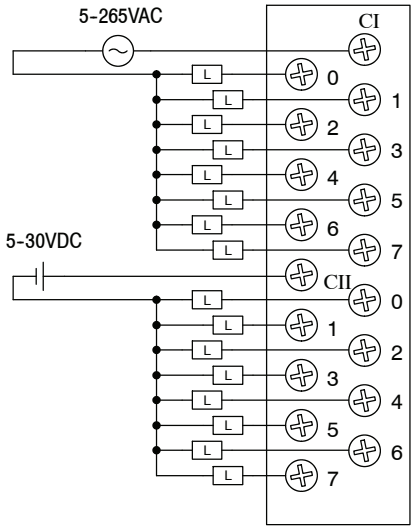
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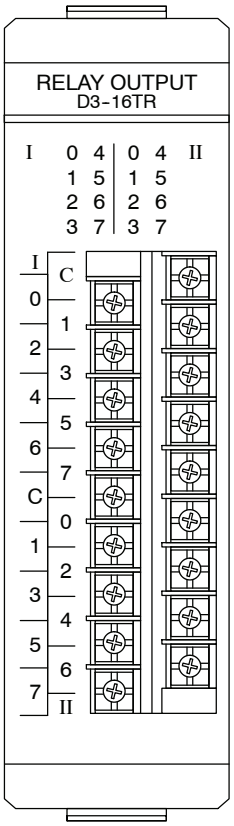
D3-16TR, Relay Output Module

Outputs per module	16		Minimum load	5 mA @ 5v
Commons per module	2 (isolated)		Base power required	9V 30 mA/ON pt. (480 mA Max) 24V N/A
Operating voltage	5-265 VAC 5-30 VDC		OFF to ON response	12 ms
Output type	16 Form A (SPST)		ON to OFF response	12 ms
Peak voltage	265 VAC / 30 VDC		Terminal type	Removable
AC frequency	47-63 Hz		Status indicators	Logic Side
ON voltage drop	N/A		Weight	8.5 oz. (248g)
Max current	2A / point AC/DC (resistive) 8A / common AC/DC		Fuses	None
Max leakage current	0.1mA @ 220 VAC			
Max inrush current	2A			

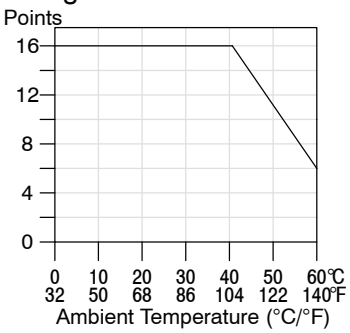
Typical Relay Life (Operations)

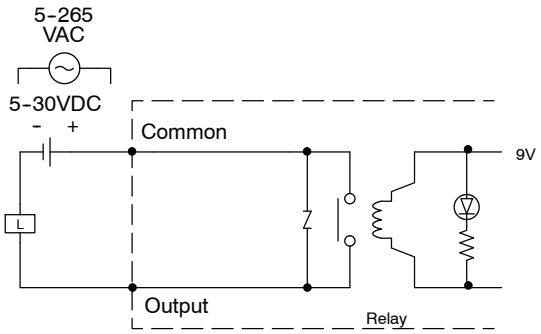
Voltage	Resistive	Solenoid	Closures
220VAC	2A	0.25A	100k
220VAC		0.03A	800k
110VAC	2A	0.25A	100k
110VAC		0.05A	650k
24VDC	2A	0.25A	100k





Derating Chart for D3-16TR





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8

System Operation

In This Chapter. . . .

- Introduction
- CPU Operating System
- Initial Mode Setting and Memory Initialization
- Program Mode Operation
- Run Mode Operation
- I/O Response Time
- CPU Scan Time Considerations
- Memory Map
- I/O Point Bit Map
- Control Relay Bit Map
- Special Relays
- Timer / Counter Registers and Contacts
- Data Registers
- Stage Control / Status Bit Map
- Shift Register Bit Map
- Special Registers

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Introduction

Achieving the proper control for your equipment or process requires a good understanding of how the DL305 CPUs control all aspects of the system operation. This includes many things, such as I/O updates, program execution, etc. Take a few minutes to understand how the CPU stores and processes information. For more complex applications, this knowledge will make it easier to program and debug your application program to meet your system performance requirements.

There are four primary things you need to understand before you create your application program

- **CPU Operating System** — the CPU is the heart of the system. It manages all aspects of system control. A quick overview of all the steps is provided in the next section.
- **CPU Operating Modes** — the CPU has different operating modes that allow different types of operations. There are two primary modes of operation, Program Mode and Run Mode.
- **CPU Timing** — it is important you understand how the CPU timing can affect the system operation. The two most important areas are the I/O response time and the CPU scan time.
- **CPU Memory Map** — The DL305 CPUs offer a wide variety of memory types, such as timers, counters, inputs, etc. It is important to understand what memory types are available and how the memory areas are organized.

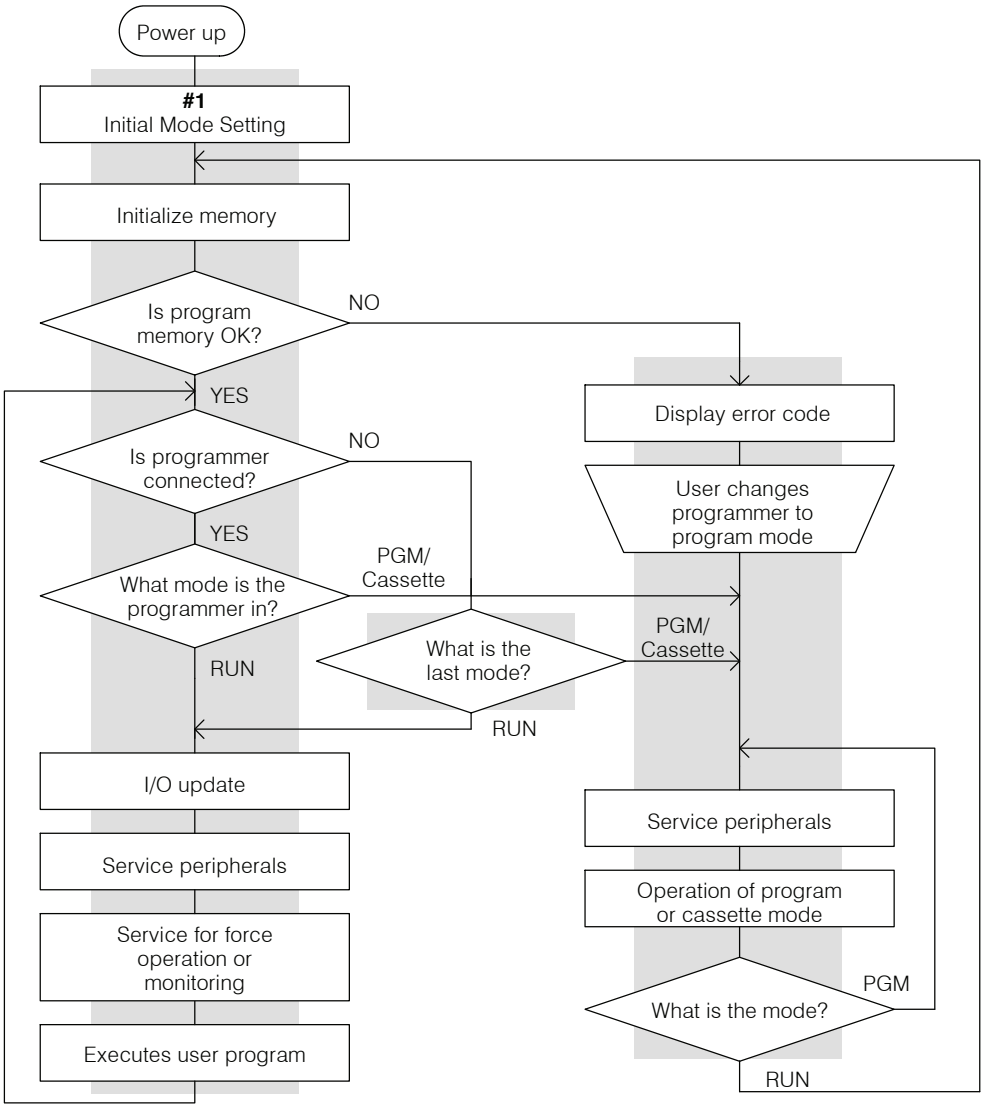
The remainder of this chapter discusses these items in detail.

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CPU Operating System

After the initial power-up sequence, the DL305 CPUs process data cyclically. There are several tasks the CPU must perform during each cycle, such as updating the I/O status, servicing external communications, executing the application program, etc. There are many different segments of execution, but the overwhelming majority of your concerns will be with the portion of the execution cycle that occurs during Run Mode. These operations will be discussed throughout the remainder of this chapter.

DL305 CPU Operational Flow Chart

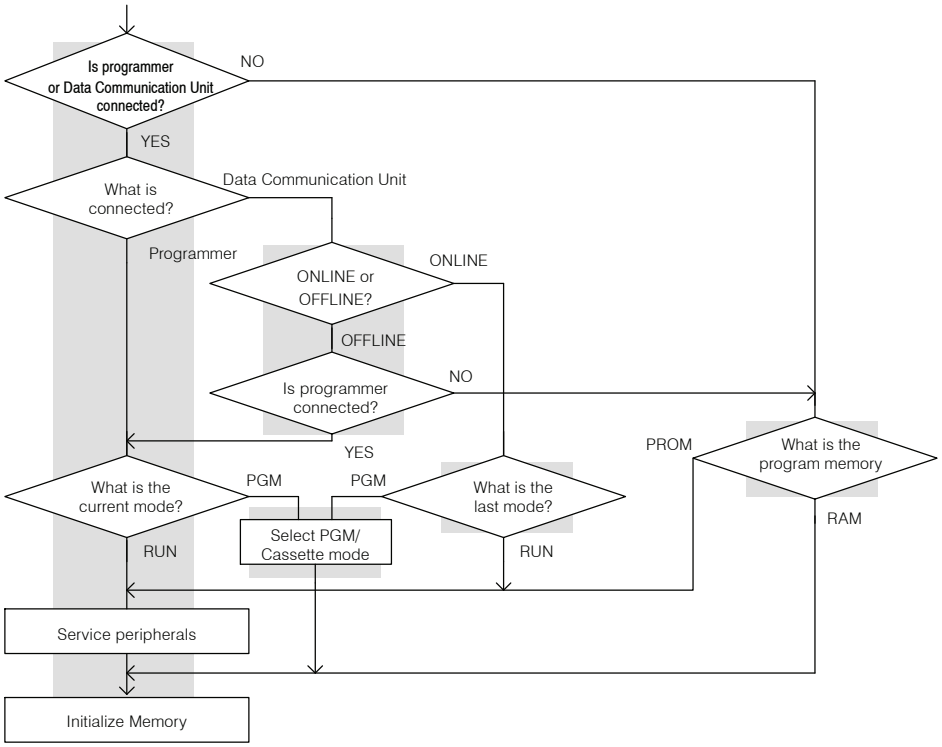


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Initial Mode Setting and Memory Initialization

Flow Chart for Initial Mode Setting (#1)

The previous flowchart contained a step called Initial Mode Setting. Once power has been connected to the system, the CPU executes the following procedure to determine which mode of operation should be entered.



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Memory Initialization

Before the CPU can begin normal operation, all memory areas are initialized. The CPU completes the following operations to initialize the memory areas.

Item	Procedure
I/O Points	Input Points: activated, CPU will monitor status. Output Points: turned off
Control Relays	Non-Retentive: turned off Retentive: retains the condition prior to the system power interruption.
Shift Registers	Retains the condition prior to the system power interruption.
Timer / Counter Current Values	Timers: reset to zero Counters: retains the current count prior to the system power interruption.
Stages	Non-Retentive: turned off Retentive: retains the condition prior to the system power interruption.
Data Registers	Retains the condition prior to the system power interruption.



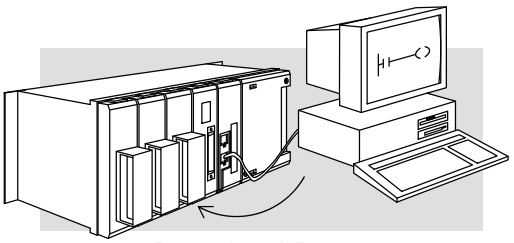
NOTE: Not all memory areas are retentive by default. See Chapter 3 for details on how to set the CPU to have retentive memory. Also, the memory map section provided later in this chapter shows the exact ranges that can be selected as retentive.

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Program Mode Operation

In Program Mode, the CPU does not execute the application program or update the output modules. The primary use for Program Mode is to enter or change an application program. You can also use the program mode to set up CPU parameters, such as the network address for the communication port on the DL340, retentive memory areas, etc.

You can use the Handheld Programmer key switch to select Program Mode operation, or you can use a ***Direct***SOFT menu option to change the CPU mode.



Download Program

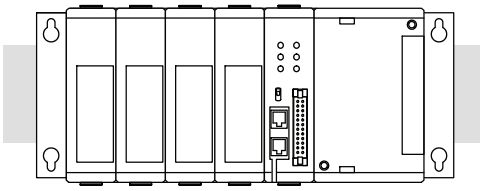
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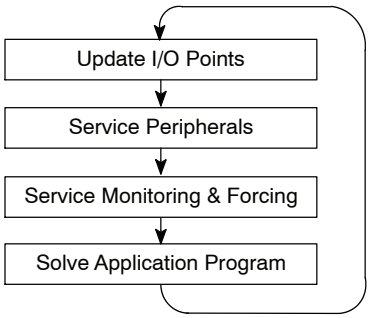
Run Mode Operation

In Run Mode, the CPU executes the application program and updates the I/O system. You can perform many operations during Run Mode. Some of these include:

- Monitor and change I/O point status
- Update timer/counter preset values
- Update Register memory locations

Even though there are many steps in the overall flowchart of operation, the Run Mode operation can be divided into a few key areas. It is very important you understand how each of these areas of execution can affect the results of your application program solutions.





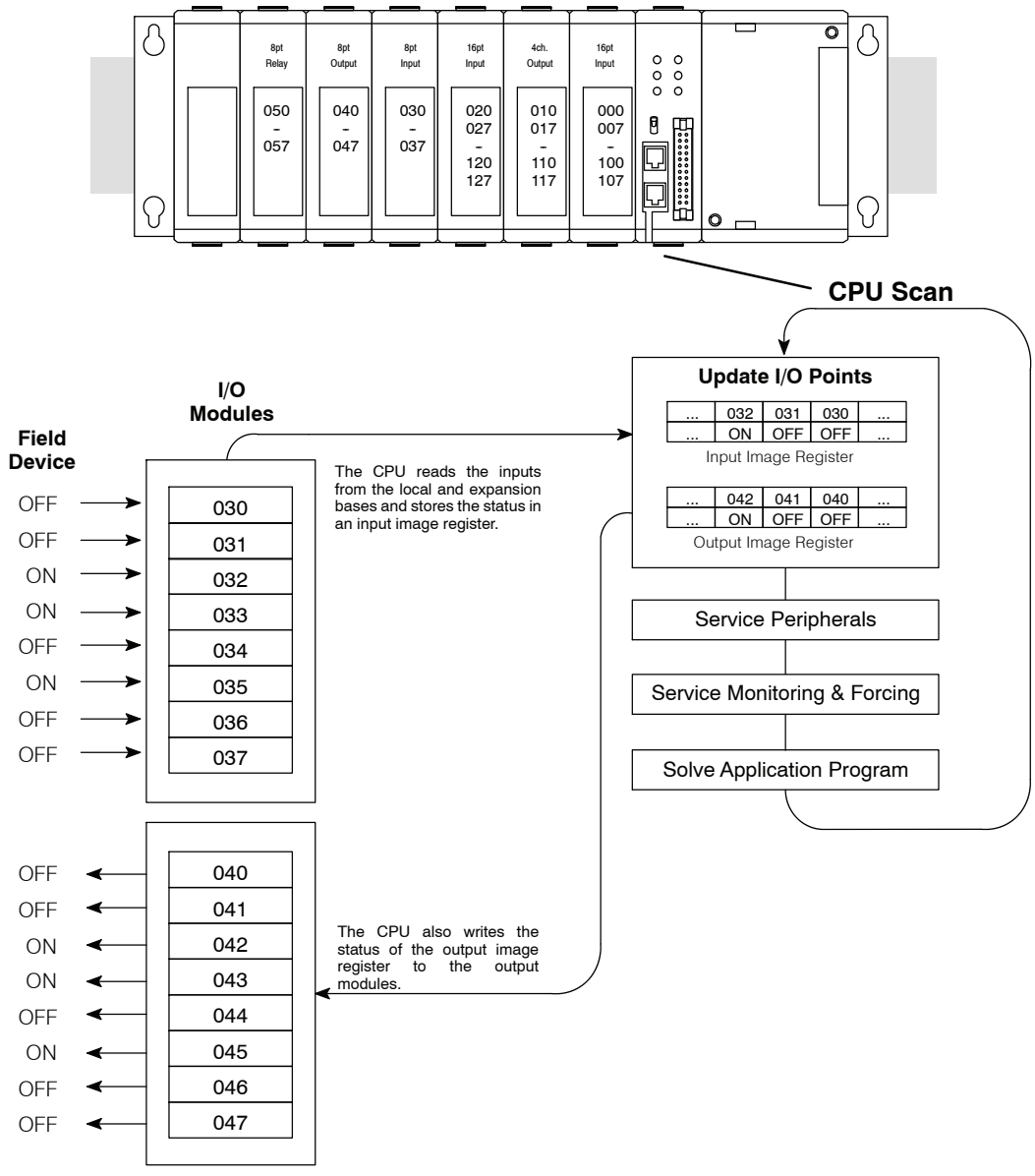
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Update I/O Points

The CPU reads the status of all input modules present in the local CPU base and local expansion bases. The status of each input is stored in the input image register area. The input image register data is used by the CPU when it solves the application program.

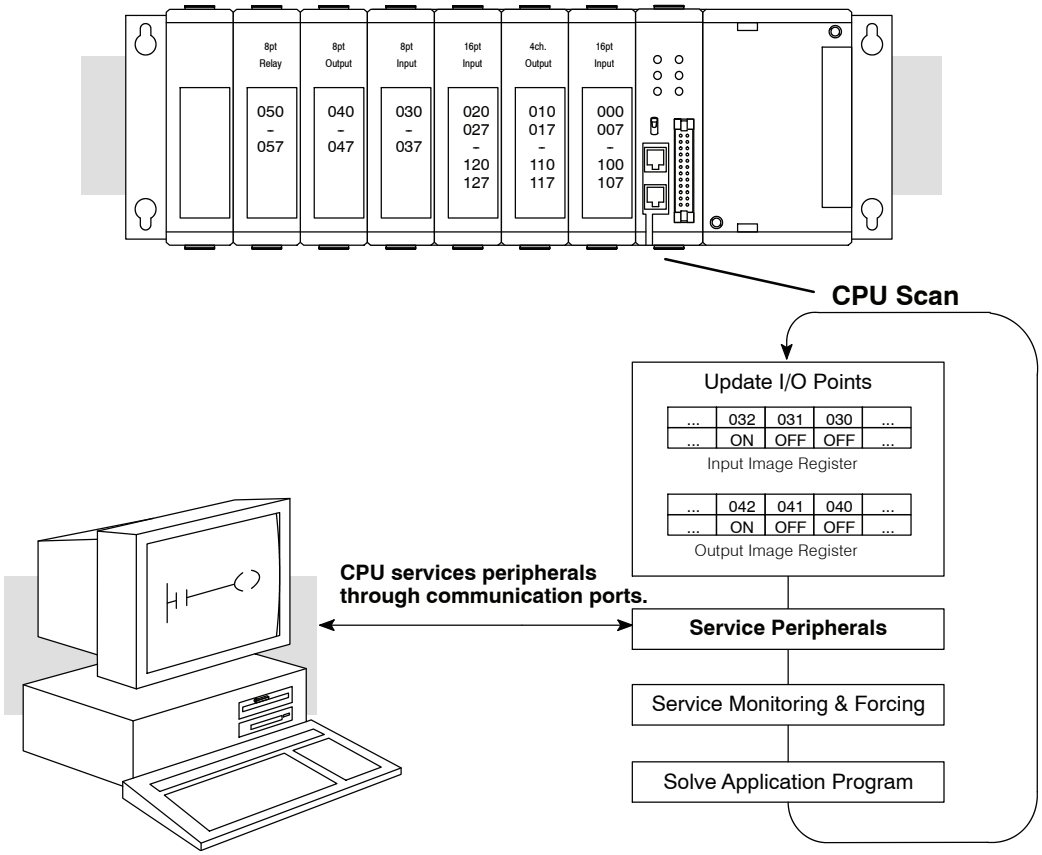
You may be thinking, “What if an input changes *after* the CPU has read the inputs?” Good question! Generally, the CPU program execution time is measured in milliseconds, so in most cases this is not a problem. If you need to know more, I/O response timing is explained in more detail later in this chapter.

The CPU also uses the output image register to update the output modules present in the local CPU base and local expansion bases.



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Service Peripherals After the CPU updates the I/O points, it reads any attached peripheral devices. This is primarily a communications service for any attached devices. For example, if you were using an operator interface to read or write data, the CPU would service these requests during this portion of the scan.

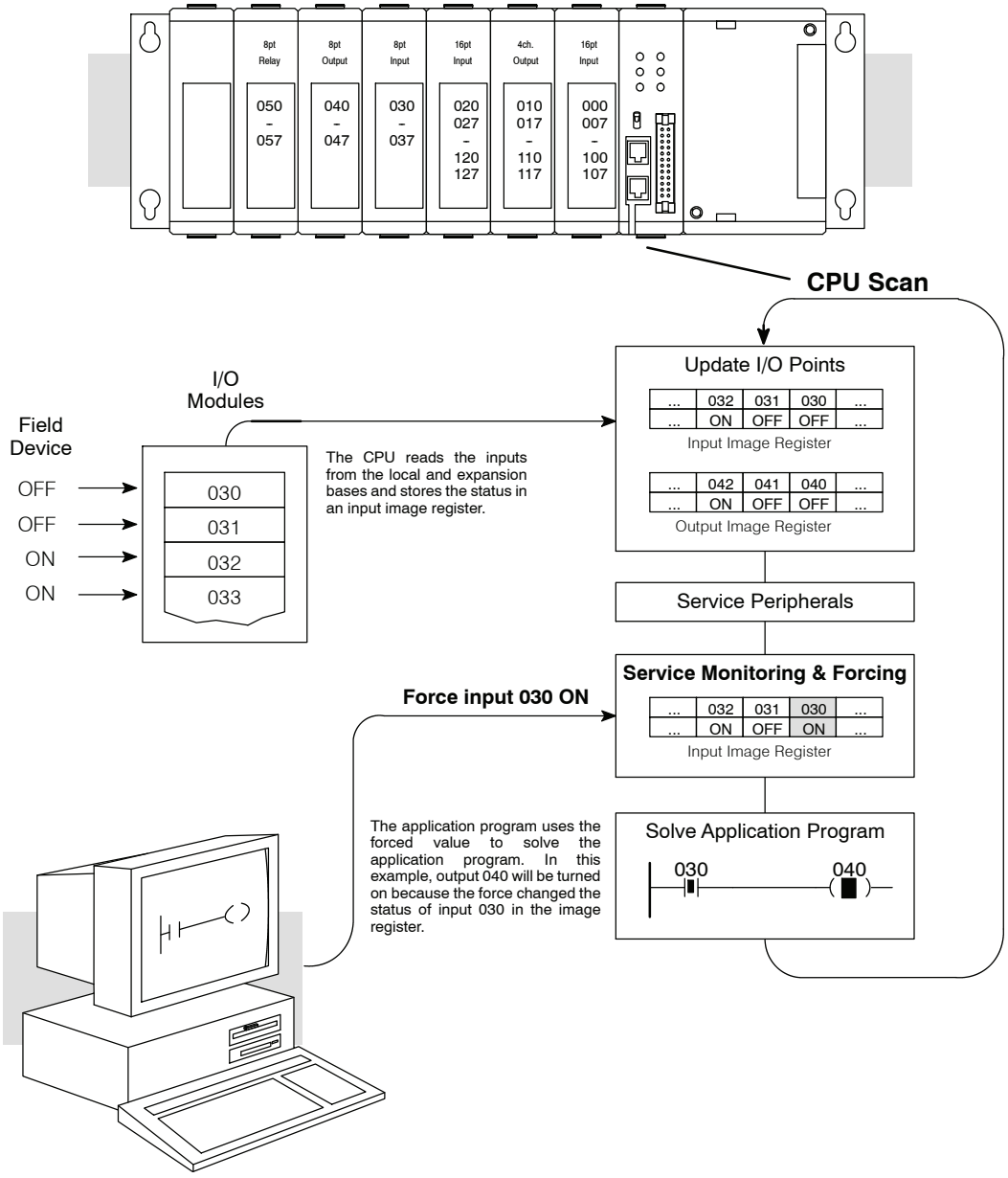


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Service for Monitoring and Forcing Operations

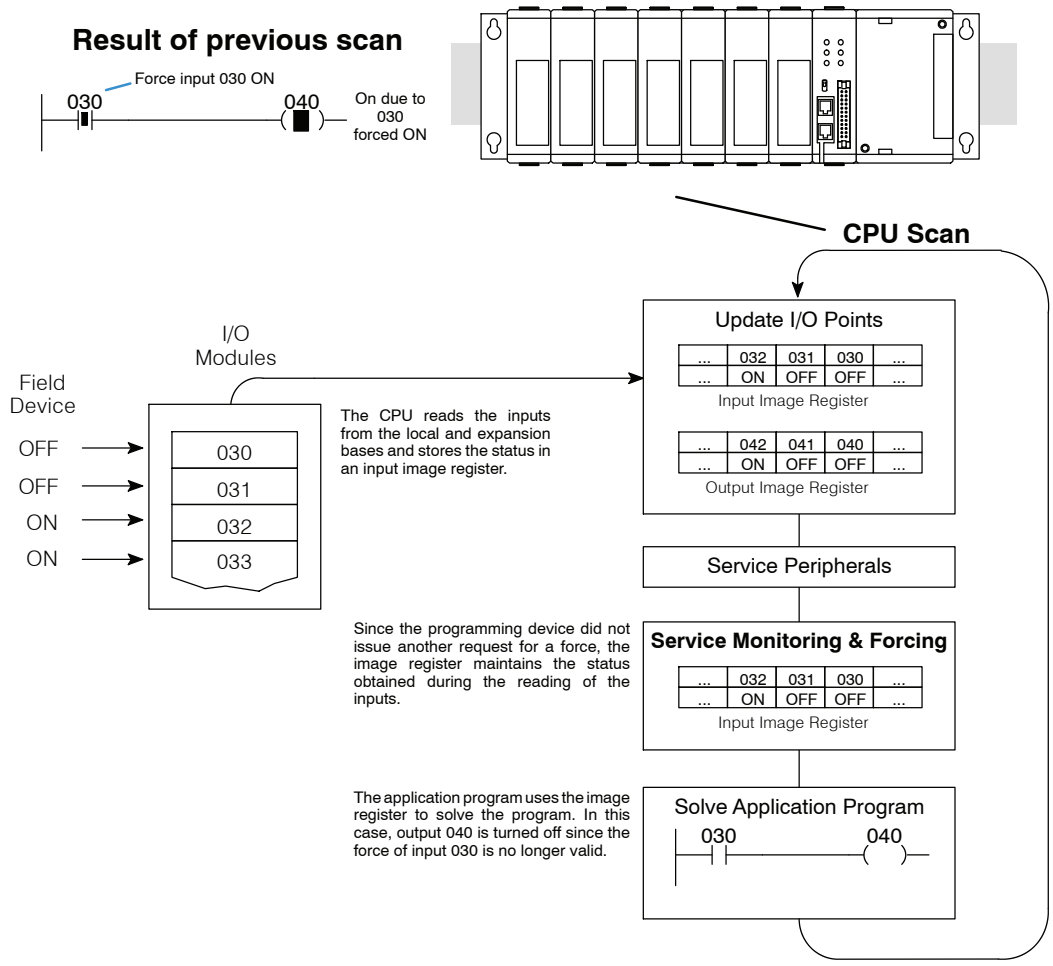
After the CPU updates any communications requests from peripheral devices, it determines if any forcing operations have been requested. The CPU also services any monitoring requests during this portion. For example, if you are using the Handheld Programmer to monitor the current value of a timer or counter, the CPU will provide this information during this portion of the scan.

Here's an example of one of the more popular requests. For example, you may want to force an input on, even though it is really off. This allows you to change the point status that was stored in the image register. This value will be valid until the image register location is written to during the Update I/O Points segment of the next scan.



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It is important to note the DL305 CPUs only retain the forced value for one scan if the input point used corresponds to a module that is installed in the base. The following example shows how the forcing actually works *on the next CPU scan*.



As you can see from the example, the input forcing will not be valid when the CPU reads the input status on the next scan.

Output point forcing works in a similar manner. That is, if you force an output on and the application program results dictate the output should be turned on, then the output image register will show the results of the application program instead of the forcing request. This is discussed in more detail in the next section.

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Solve Application Program

The CPU evaluates each instruction in the application program during this segment of the cycle. The instructions define the relationship between the input conditions and the desired output response.

The CPU uses the output image register area to store the status of the desired action for the outputs. The actual outputs are updated during the Update I/O Points segment of the cycle.

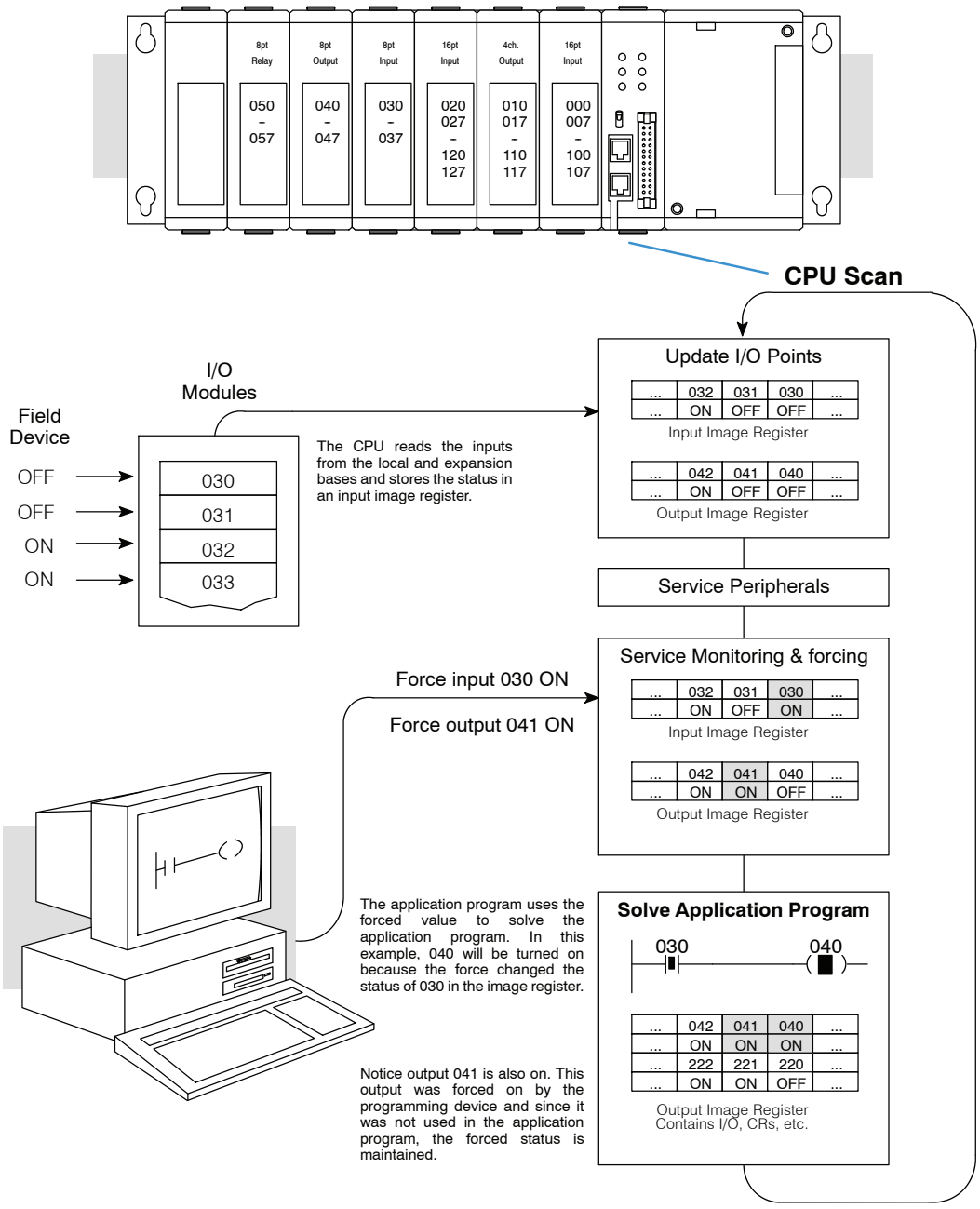
The internal control relays (C), stages (S), and data registers (R) are also updated in this segment.

You may recall the CPU may have obtained and stored forcing information when it serviced any peripheral devices. If any output points or register locations have been forced, the output image register also contains this information.



NOTE: If an output point was used in the application program, the results of the program solution will overwrite any forcing information that was stored. For example, if output 030 was forced on by the programming device, and a rung containing 030 was evaluated such that 030 should be turned off, then the output image register will show that 030 should be off. Of course, you can force output points that are not used in the application program. In this case, the point remains forced because there is no solution that results from the application program execution.

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I/O Response Time

Is Timing Important for Your Application?

I/O response time is the amount of time required for the control system to sense a change in an input point and update a corresponding output point. In the majority of applications, the CPU performs this task in such a short period of time you may never have to concern yourself with the aspects of system timing. However, some applications do require extremely fast update times. In these cases, you may need to know how to to determine the amount of time spent during the various segments of operation.

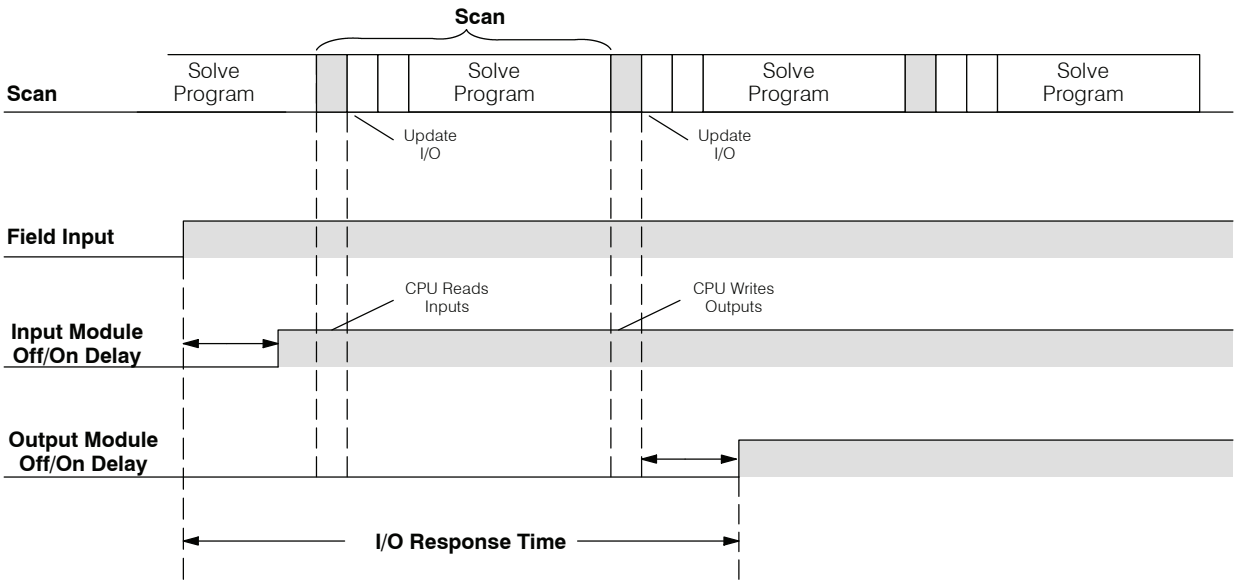
There are four things that can affect the I/O response time.

- The point in the cycle when the field input changes states
- Input module Off to On delay time
- CPU scan time
- Output module Off to On delay time

The next paragraphs show how these items interact to affect the response time.

Normal Minimum I/O Response

The I/O response time is shortest when the module senses the input change just before the I/O Update portion of the execution cycle. In this case the input status is read, the application program is solved, and the output point gets updated on the following scan. The following diagram shows an example of the timing for this situation.



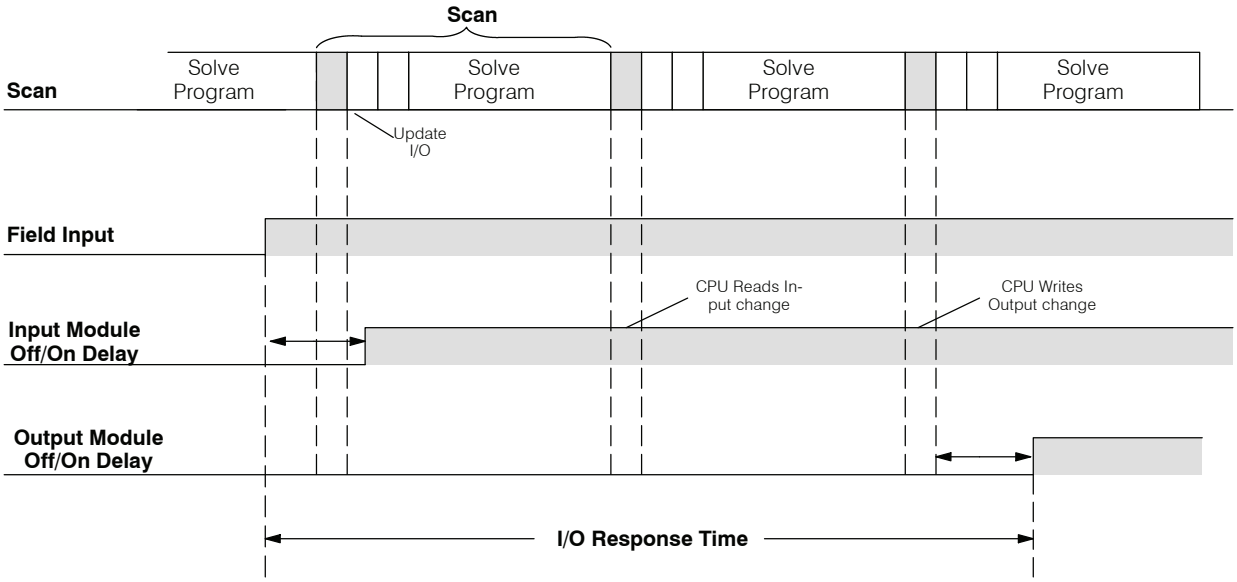
In this case, you can calculate the response time by simply adding the following items.

Input Delay + Scan Time + Output Delay = Response Time

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Normal Maximum I/O Response

The I/O response time is longest when the module senses the input change just after the Update I/O portion of the execution cycle. In this case the new input status does not get read until the following scan. The following diagram shows an example of the timing for this situation.



In this case, you can calculate the response time by simply adding the following items.
Input Delay +(2 x Scan Time) + Output Delay = Response Time

Improving Response Time

There are a few things you can do the help improve throughput.

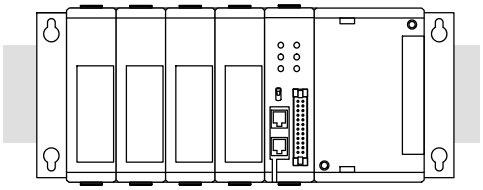
- You can try to choose instructions with faster execution times
- You can choose modules that have faster response times

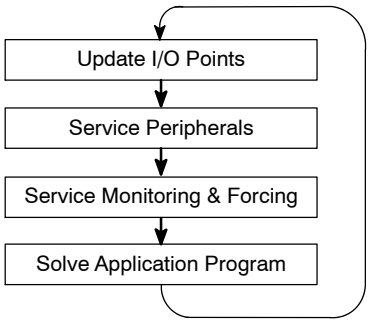
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CPU Scan Time Considerations

The scan time covers all the cyclical tasks that are performed by the operating system. This information can be very important when evaluating the performance of a system.

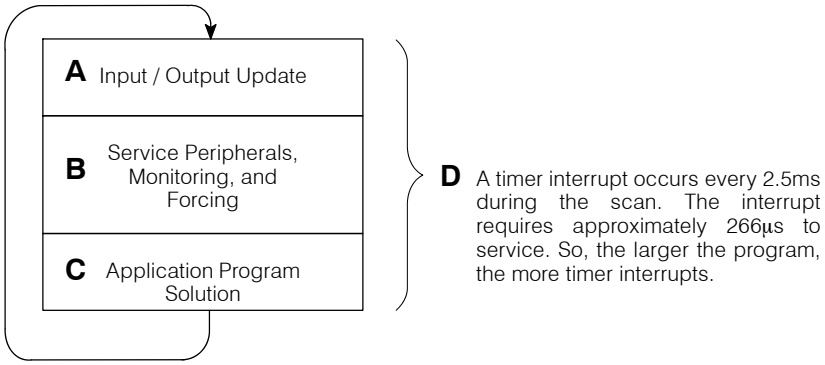
As we've shown previously there are several segments that make up the overall execution cycle. Each of these segments requires a certain amount of time to complete. Of all the segments, the only ones you really need to understand are those that occur during Run Mode. Even within this portion, your primary concern should be to understand the instruction execution times.





DL330 / DL330P Scan Calculation

The following table provides execution timing guidelines for the execution cycle.



A = 3.3 ms typical I/O update

B = 0 - 5.2 ms maximum to service peripherals, monitoring, and forcing

C = Total of instruction execution time

D = $266\mu s \times \frac{A + B + C + D}{2.5ms}$

Actual Scan = A + B + C + D

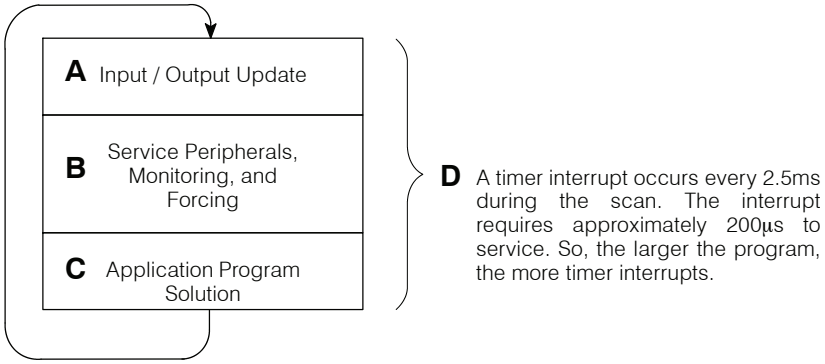


NOTE: There are other events that occur during the execution cycle, but the areas shown are the most important. This information is provided so you will understand the basic scan calculations. Scan time can vary from scan-to-scan.

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DL340 Scan Calculation

Typical scan overhead is from 2.5 – 3.5ms. However, the following table provides more precise execution timing guidelines for the execution cycle.



A = 2 ms typical I/O update

B = 0 – 1.2 ms maximum to service peripherals, monitoring, and forcing

C = Total of instruction execution time

D = $200\,\mu s \times \frac{A + B + C + D}{2.5ms}$

Actual Scan = A + B + C + D

NOTE: There are other events that occur during the execution cycle, but the areas shown are the most important. This information is provided so you will understand the basic scan calculations. Scan time can vary from scan-to-scan.

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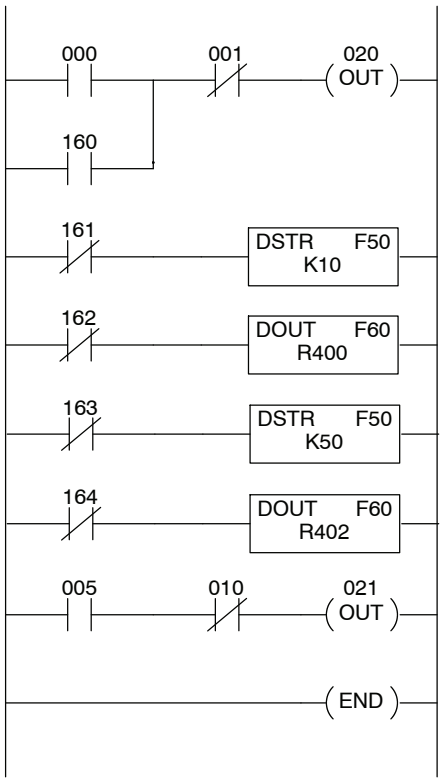
Application Program Execution

The CPU processes the program from address 0 to the END instruction. The CPU executes the program left to right and top to bottom. As each rung is evaluated the appropriate image register or memory location is updated.

The time required to solve the application program depends on the type and number of instructions used

You can add the execution times for all the instructions in your program to determine how much time is required to execute the instructions.

For example, the execution time for a DL330 running the program shown would be calculated as follows.



Instruction	Time
STR 000	6.6µs
OR 160	6.6µs
ANDN 001	8.4µs
OUT 020	7.5µs
STRN 161	9.1µs
DSTR K10	14.3µs
STRN 162	9.1µs
DOUT R400	52.6µs
STRN 163	9.1µs
DSTR K50	14.3µs
STRN 164	9.1µs
DOUT R402	52.6µs
STR 005	6.6µs
ANDN 010	8.4µs
OUT 021	7.5µs
END	~0µs
TOTAL	221.8µs

NOTE: Appendix C provides the instruction execution times for the DL305 CPUs.

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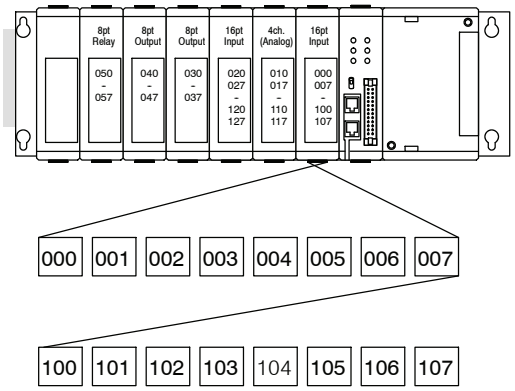
Memory Map

With any PLC system, you generally have many different types of information to process. This includes input device status, output device status, various timing elements, parts counts, etc. It is important to understand how the system represents and stores the various types of data. For example, you need to know how the system identifies input points, output points, data words, etc. The following paragraphs discuss the various memory types used in the DL305 CPUs.

NOTE: The DL305 CPUs do not all have the same memory ranges. Make sure you review the detailed memory maps at the end of this section to determine the available memory types for your particular model of CPU.

Octal Numbering System

All memory locations or areas are numbered in Octal (base 8). For example, the diagram shows how the octal numbering system works for the discrete input points. Notice the octal system does not contain any numbers with the digits 8 or 9.

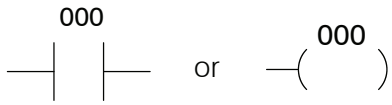


Two Basic Memory Types: Discrete and Word

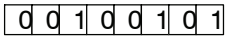
As you examine the different memory types, you'll notice two types of memory in the DL305, discrete and word memory. Discrete memory is one bit that can be either a 1 or a 0. Word memory is referred to as Data Register memory and is an 8-bit location normally used to manipulate data/numbers, store data/numbers, etc.

Some information is automatically stored in Register (R) memory. For example, the timer current values are stored in Registers that correspond to the timer or counter number. So, the current value for timer T600 is automatically stored in R600.

Discrete - On or Off, 1 bit



Word Locations - 8 bits



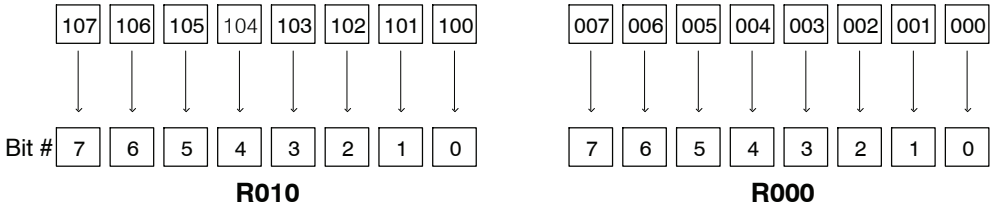
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R Memory Locations for Discrete Memory Areas

The discrete memory area is for inputs, outputs, control relays, etc. However, you can also access the bit data types as an R-memory word. Each R-memory location contains 8 consecutive discrete locations.

Remember, the DL305 system does not have a separate memory type for input and output points. The type of point assigned to the location depends on the type of module installed in the slot that corresponds to the register location. Also, the number of registers assigned to the module depends on the number of points. For example, a 16-point module would require two registers since each register only contains 8 bits. The following diagram shows how the points for a 16-point module installed in the slot next to the CPU would map into registers.

16 Discrete Input Module



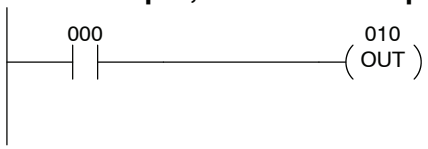
These discrete memory areas and their corresponding R-memory ranges are listed in the memory area tables at the end of this chapter.

I/O Points

The discrete input and output points do not have separate data types. The type of point assigned to the reference address depends on the type of module installed in the base. Depending on the type of CPU, you can have up to 184 I/O points in a DL305 system.

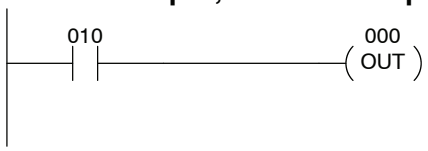
In the first example, output point 010 will be turned on when input 000 energizes. This assumes an 8-point input module is installed in the first slot and an 8-point output module is installed in the second slot.

1st Slot - Input, 2nd Slot - Output



1st Slot - Output, 2nd Slot - Input

The second example shows how the numbers can represent a different type of point. For this example, the module positions were reversed.



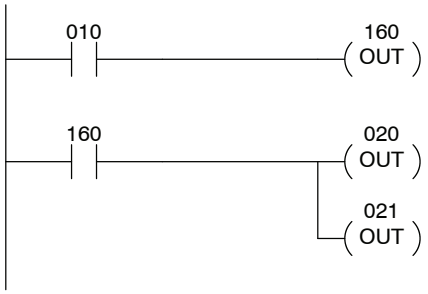


NOTE: Unused I/O references can be used as control relays in the application program.

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Control Relays

Control relays are discrete bits normally used to control the user program. The control relays do not represent a real world device, that is, they cannot be physically tied to switches, output coils, etc. They are internal to the CPU. Because of this, control relays can be programmed as discrete inputs or discrete outputs. These locations are used in programming the discrete memory locations (C) or the corresponding word location which contains 8 consecutive discrete locations.



In this example, memory location 160 will energize when input 010 turns on. The second rung shows a simple example of how to use a control relay as an input.



NOTE: Some of the references normally assigned as Control Relays can also be used to refer to a16-point I/O modules in some situations. Make sure you review the memory maps at the end of this chapter if you use 16-point modules.

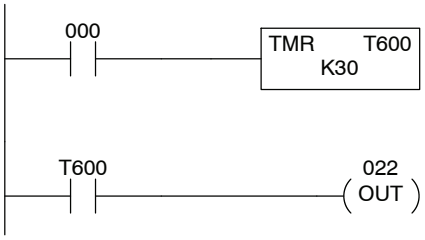
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Timers and Timer Status Bits (T Data type)

You can have up to 64 timers/counters in a DL305 CPU. Both the timers and counters share the same memory area. This means you cannot have a timer T600 and a counter CT600 in the same program.

When you use these locations for timers, each timer has a status bit that reflects the relationship between the current value and the timer preset value. The timer status bit will be on when the current value is equal or greater than the preset value of a corresponding timer. The DL330P does not support the status bit. Instead, you have to use comparative boolean contacts. See Chapter 12 for details.

In the example shown, input 000 turns on to start timer T600. When the timer reaches the preset of 3 seconds (K of 30) timer status contact T600 turns on. When contact T600 turns on, output 022 is energized.

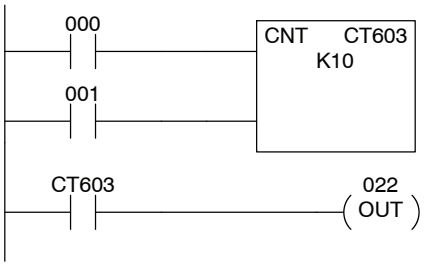


Counters and Counter Status Bits (CT Data type)

You can have up to 64 timers/counters in a DL305 CPU. Both the timers and counters share the same memory area. This means you cannot have a timer T600 and a counter CT600 in the same program.

When you use these locations for counters, each counter has a status bit that reflects the relationship between the current count and the preset value. The counter status bit will be on when the current value is equal to or greater than the counter preset value. The DL330P does not support the status bit. Instead, you have to use comparative boolean contacts. See Chapter 12 for details.

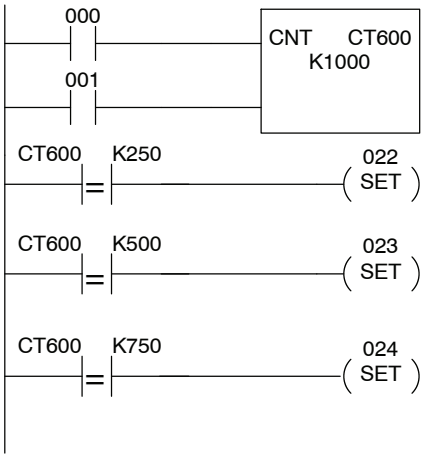
In the example shown, Each time contact 000 transitions from off to on, the counter increments by one. (If 001 comes on, the counter is reset to zero.) When the counter reaches the preset of 10 counts (K of 10) counter status contact CT603 turns on. When CT603 turns on, output 022 turns on.



Counter Current Values (R Data Type)

As mentioned earlier, some information is automatically stored in R memory. This is true for the current values associated with counters. For example, R600 holds the current value for counter 600, R601 holds the current value for counter 601, etc.

The primary reason for this is programming flexibility. The example shows how you can use comparative contacts to monitor several count values from a single counter.



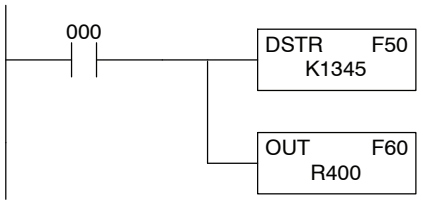
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Data Registers (R Data Type)

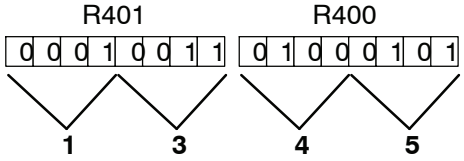
A word memory location is referred to as a Data Register, which is an 8-bit location normally used to manipulate data/numbers, store data/numbers, etc.

Some information is automatically stored in registers. For example, the timer current values are automatically stored in a register that corresponds to the timer or counter number being used.

The example shows how a four-digit BCD constant is loaded into the accumulator and then stored in a Register location. Notice two registers are required to hold the 4-digit number.



Word Locations - 8 bits

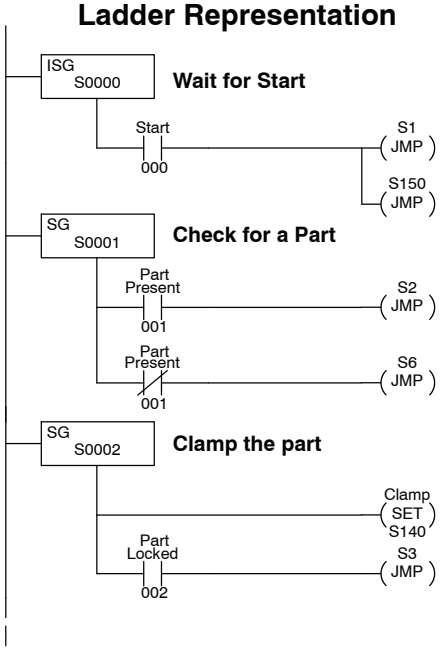


Stages (S Data type)

Stages are used in RLL*PLUS* programs to create a structured program, similar to a flowchart. Each program stage denotes a program segment. When the program segment or stage, is active, the logic within that segment is executed. If the stage is off or inactive, the logic is not executed and the CPU skips to the next active stage. (See Chapter 10 for a more detailed description of RLL*PLUS* programming.)

Each stage also has a discrete status bit that can be used as an input to indicate whether the stage is active or inactive. If the stage is active, then the status bit is on. If the stage is inactive, then the status bit is off. This status bit can also be turned on or off by other instructions, such as the SET or RESET instructions. This allows you to easily control stages throughout the program.

Ladder Representation



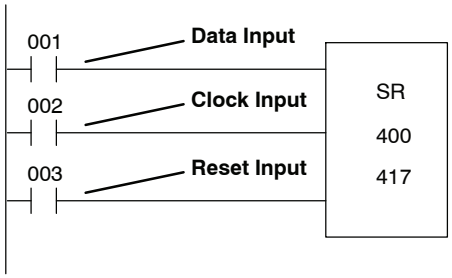
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Shift Registers

There are 128 bits available for use in Shift Registers with the DL330 and DL340 CPUs. You can still use Shift Registers in the DL330P CPU, but a separate range of bits is not provided. You have to use the control relay points in the Shift Register instructions. These are numbered from 400 to 577. Your first reaction may be to think these are somehow related to the Data Registers with the same numbers. They are completely separate areas and *are not* related.

The number of Shift Register instructions that can be used depends on how many bits are used with each Shift Register. For example, if you have a DL330 and you use 16 bits in each Shift Register, you can have up to 8 Shift Registers. If you only used 8 bits in each one, then you could have up to 16 Shift Registers.

In the example shown, contact 001 represents the data value (0 or 1) that will be loaded into the shift register when the clock input (002) is active. Each time the clock input comes on, the data values are shifted through the bit positions from 400 to 417. Input 003 resets the shift register and sets all the bit positions back to zero. Chapter 11 provides detailed instructions on how to use shift registers.



Special Relays

Special relays are discrete memory locations with pre-defined functionality. There are many different types of special relays. For example, some aid in programming, others provide system operating status information, etc.

In this example, special relay 375 will energize for 50 ms and de-energize for 50 ms because relay 375 is a pre-defined relay that will be on for 50 ms and off for 50 ms.



Special Registers (R Data Type)

There are also a few special registers that store various types of system information. For example, the DL340 communication port parameters are set in special registers. The detailed memory maps at the end of this chapter show special register assignments for each CPU.

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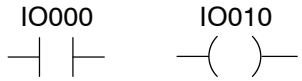
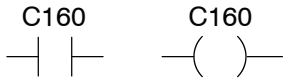
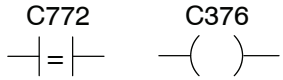
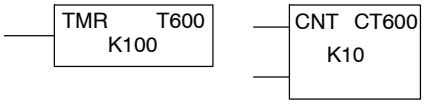
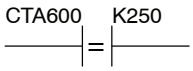
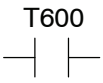
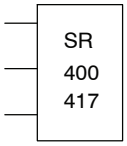
DL305 Aliases

An alias is an alternate way of referring to certain memory types, such as timer/counter current values, register locations for I/O points, etc.. This makes some instructions easier to understand. The use of the alias is optional, but some users may find the alias to be helpful when developing a program. The table below shows how the aliases can be used.

Address Start	Alias Start	Example
R0	RIO0	R0 is the 8-bit word memory reference for discrete bits IO0 through IO7, hence its alias is RIO0. R1 is the 8-bit word memory reference for discrete bits IO10 through IO17, hence its alias is RIO10.
R16	RC160	R16 is the 8-bit word memory reference for control relays C160 through C167, hence its alias is RC160. R17 is the 8-bit word memory reference for control relays C170 through C177, hence its alias is RC170.
R40	RS400	R40 is the 8-bit word memory reference for stage bits S400 through S407, hence its alias is RS400. R41 is the 8-bit word memory reference for stage bits S410 through S417, hence its alias is RS410.
R70	RIO700	R70 is the 8-bit word memory reference for discrete bits IO700 through IO707, hence its alias is RIO700. R71 is the 8-bit word memory reference for discrete bits IO710 through IO717, hence its alias is RIO710.
R77	RC770	R77 is the 8-bit word memory reference for control relays C770 through C777, hence its alias is RC770.
R100	RC1000	R100 is the 8-bit word memory reference for control relays C1000 through C1007, hence its alias is RC1000. R101 is the 8-bit word memory reference for control relays C1010 through C1017, hence its alias is RC1010.
R107	RC1070	R107 is the 8-bit word memory reference for control relays C1070 through C1077, hence its alias is RC1070.
R600	TCA600	R600 is the 16-bit timer/counter accumulator value for timer/counter 600, hence its alias is TCA600. R601 is the 16-bit timer/counter accumulator value for timer/counter 601, hence its alias is TCA601.

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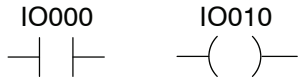
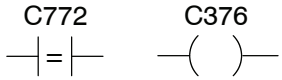
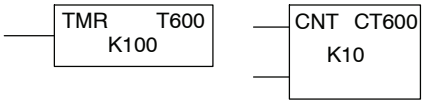
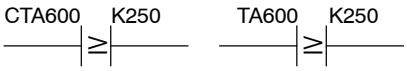
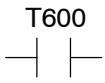
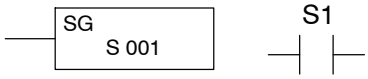
DL330 Memory Map

Memory Type	Discrete Memory Reference (octal)	Register Memory Reference (octal)	Qty. Decimal	Symbol
Input / Output Points	000 – 157 700 – 767	R000 – R015 R070 – R076	168 Total	
Control Relays	160 – 373	R016 – R037	140	
Special Relays	374 – 377 770 – 777	R037 R077	12	
Timers / Counters	600 – 673 674 – 677*	None	64	
Timer / Counter Current Values	None	R600 – R673 R674 – R677*	64	 Contact valid for counters only.
Timer / Counter Status Bits	T600 – T673 T674 – T677*	None	64	
Data Words	None	R400 – R563	116	None specific, used with many instructions
Shift Registers	400 – 577	None	128	
Special Registers	None	R574 – R577	4	R574 – R575 used with FAULT R576 – R577 Auxiliary Accumulator

* T/C Setpoint Unit Only. Can be used as data registers if the Timer/Counter Setpoint Unit or Thumbwheel Interface Module is not used. R564 – R573 contain the preset value used with the Timer / Counter Setpoint Unit. R674 – R677 contain the current values for these timers or counters.

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DL330P Memory Map

Memory Type	Discrete Memory Reference (octal)	Register Memory Reference (octal)	Qty. Decimal	Symbol
Input / Output Points	000 – 157 700 – 767	R000 – R015 R070 – R076	168 Total	
Control Relays	160 – 174 200 – 277	R016 – R017 R020 – R027	77	
Special Relays	175 – 177 770 – 777	R017 R077	11	
Timers / Counters	600 – 673 674 – 677*	None	64	
Timer / Counter Current Values	None	R600 – R673 R674 – R677*	64	
Timer / Counter Status Bits	T600 – T673 T674 – T677*	None	64	
Data Words	None	R400 – R563	116	None specific, used with many instructions
Stages	S0 – S177	R100 – R117	128	
Special Registers	None	R574 – R577	4	R574 – R575 used with FAULT R576 – R577 Auxiliary Accumulator

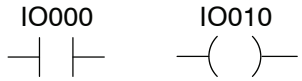
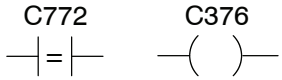
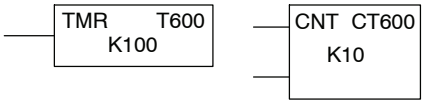
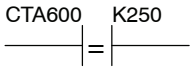
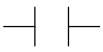
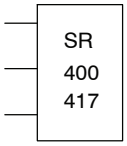
* T/ C Setpoint Unit Only. Can be used as data registers if the Timer/Counter Setpoint Unit or Thumbwheel Interface Module is not used, which provides a total of 128 data registers.

R564 – R573 contain the preset value used with the Timer / Counter Setpoint Unit. R674 – R677 contain the current values for these timers or counters

Timer / Counter Current Values Registers (T600 – T677) are 16-bit registers.

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DL340 Memory Map

Memory Type	Discrete Memory Reference (octal)	Register Memory Reference (octal)	Qty. Decimal	Symbol
Input / Output Points	000 – 157 700 – 767	R000 – R015 R070 – R076	168 Total	
Control Relays	160 – 373 1000 – 1067	R016 – R037 R100 – R106	180	
Special Relays	374 – 377 770 – 777 1070 – 1077	R037 R077 R107	20	
Timers / Counters	600 – 673 674 – 677*	None	64	
Timer / Counter Current Values	None	R600 – R673 R674 – R677*	64	 Contact valid for counters only.
Timer / Counter Status Bits	T600 – T673 T674 – T677*	None	64	
Data Words	None	R400 – R563 R700 – R767	172	None specific, used with many instructions
Shift Registers	400 – 577	None	128	
Special Registers	None	R574 – R577 R770 – R777	12	R574–R575 used with FAULT R576–R577 Auxiliary Accumulator R770–R777 Communications Setup

* T/C Setpoint Unit Only. Can be used as data registers if the Timer/Counter Setpoint Unit or Thumbwheel Interface Module is not used. R564 – R573 contain the preset value used with the Timer / Counter Setpoint Unit. R674 – R677 contain the current values for these timers or counters.

Registers T600 – T677 are 16-bit registers.

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I/O Point Bit Map

These tables provide a listing of the individual Input points associated with each register location for the DL330, DL330P, and DL340 CPUs.

MSB			I/O References				LSB	Register Number
007	006	005	004	003	002	001	000	R0
017	016	015	014	013	012	011	010	R1
027	026	025	024	023	022	021	020	R2
037	036	035	034	033	032	031	030	R3
047	046	045	044	043	042	041	040	R4
057	056	055	054	053	052	051	050	R5
067	066	065	064	063	062	061	060	R6
077	076	075	074	073	072	071	070	R7
107	106	105	104	103	102	101	100	R10
117	116	115	114	113	112	111	110	R11
127	126	125	124	123	122	121	120	R12
137	136	135	134	133	132	131	130	R13
147	146	145	144	143	142	141	140	R14
157	156	155	154	153	152	151	150	R15
167	166	165	164	163	162	161	160	n/a
177	176	175	174	173	172	171	170	n/a
707	706	705	704	703	702	701	700	R70
717	716	715	714	713	712	711	710	R71
727	726	725	724	723	722	721	720	R72
737	736	735	734	733	732	731	730	R73
747	746	745	744	743	742	741	740	R74
757	756	755	754	753	752	751	750	R75
767	766	765	764	763	762	761	760	R76



NOTE: 160 – 167 can be used as I/O in a DL330 or DL330P CPU under certain conditions. 160 – 177 can be used as I/O in a DL340 CPU under certain conditions. You should consult Chapter 4 to determine which configurations allow the use of these points.

These points may be used as control relays. You cannot use them as both control relays and as I/O points. Also, if you use these points as I/O, you cannot access these I/O points as a Data Register reference using the DSTR5 (F55) and DOUT5 (F65) functions.

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Control Relay Bit Map

The following tables provide a listing of the individual control relays associated with each register location for the DL305 CPUs.



NOTE: If a 16 pt module is used in Slot 6 for the DL330 or DL330P CPU, 160 through 167 will not be available for control relay assignments. If a 16pt module is used in Slot 6 and/or Slot 7 for a DL340 CPU, 160–167 and/or 170–177 are not available for control relay assignments. You cannot use these points as both control relays and as I/O points. If you use these points as I/O points, you still enter them as C160–C177 in ***Direct***SOFT.

Also, if you use these points as I/O, you cannot access these I/O points as a Data Register reference using the DSTR5 (F55) and DOUT5 (F65) functions.

MSB			DL330 Control Relay References				LSB	Register Number
167	166	165	164	163	162	161	160	R16
177	176	175	174	173	172	171	170	R17
207	206	205	204	203	202	201	200	R20
217	216	215	214	213	212	211	210	R21
227	226	225	224	223	222	221	220	R22
237	236	235	234	233	232	231	230	R23
247	246	245	244	243	242	241	240	R24
257	256	255	254	253	252	251	250	R25
267	266	265	264	263	262	261	260	R26
277	276	275	274	273	272	271	270	R27
307	306	305	304	303	302	301	300	R30
317	316	315	314	313	312	311	310	R31
327	326	325	324	323	322	321	320	R32
337	336	335	334	333	332	331	330	R33
347	346	345	344	343	342	341	340	R34
357	356	355	354	353	352	351	350	R35
367	366	365	364	363	362	361	360	R36
				373	372	371	370	R37

* Control relays 340 – 373 can be made retentive by setting a CPU dipswitch. See Chapter 3 for details on setting CPU dipswitches.

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MSB			DL330P Control Relay References				LSB	Register Number
167	166	165	164	163	162	161	160	R16
			174	173	172	171	170	R17
207	206	205	204	203	202	201	200*	R20
217	216	215	214	213	212	211	210	R21
227	226	225	224	223	222	221	220	R22
237	236	235	234	233	232	231	230	R23
247	246	245	244	243	242	241	240	R24
257	256	255	254	253	252	251	250	R25
267	266	265	264	263	262	261	260	R26
277*	276	275	274	273	272	271	270	R27

* Control relays 200 – 277 can be made retentive by setting a CPU dipswitch. See Chapter 3 for details on setting CPU dipswitches.

MSB			DL340 Control Relay References				LSB	Register Number
167	166	165	164	163	162	161	160	R16
177	176	175	174	173	172	171	170	R17
207	206	205	204	203	202	201	200	R20
217	216	215	214	213	212	211	210	R21
227	226	225	224	223	222	221	220	R22
237	236	235	234	233	232	231	230	R23
247	246	245	244	243	242	241	240	R24
257	256	255	254	253	252	251	250	R25
267	266	265	264	263	262	261	260	R26
277	276	275	274	273	272	271	270	R27
307	306	305	304	303	302	301	300	R30
317	316	315	314	313	312	311	310	R31
327	326	325	324	323	322	321	320	R32
337	336	335	334	333	332	331	330	R33
347	346	345	344	343	342	341	340*	R34
357	356	355	354	353	352	351	350	R35
367	366	365	364	363	362	361	360	R36
				373*	372	371	370	R37
1007	1006	1005	1004	1003	1002	1001	1000	R100
1017	1016	1015	1014	1013	1012	1011	1010	R101
1027	1026	1025	1024	1023	1022	1021	1020	R102
1037	1036	1035	1034	1033	1032	1031	1030	R103
1047	1046	1045	1044	1043	1042	1041	1040	R104
1057	1056	1055	1054	1053	1052	1051	1050	R105
1067	1066	1065	1064	1063	1062	1061	1060	R106

* Control relays 340 – 373 can be made retentive by setting a CPU dipswitch. See Chapter 3 for details on setting CPU dipswitches.

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Special Relays

The following table shows the Special Relays used with the DL305 CPUs. Note, our DL105, DL205, and DL405 product families use the data type "SP" to designate Special Relays. Even though we refer to the following relays as special relays, ***Direct***SOFT uses the letter "C" as a special relay prefix for the DL305 products. These letters aren't used with the handheld programmer.

CPUs	Special Relay	Description of Contents
DL330P	C175	100 ms clock, on for 50 ms and off for 50 ms.
	C176	Disables all outputs except for those entered with the SET OUT instruction.
	C177	Battery voltage is low.
DL330 DL340	C374	On for the first scan cycle after the CPU is switched to Run Mode.
	C375	100 ms clock, on for 50 ms and off for 50 ms.
	C376	Disables all outputs except for those entered with the SET OUT instruction.
	C377	Battery voltage is low.
DL330 DL330P DL340	C770	Changes timers to 0.01 second intervals. Timers are normally 0.1 second time intervals.
	C771	The external diagnostics FAULT instruction (F20) is in use.
	C772	The data in the accumulator is greater than the comparison value.
	C773	The data in the accumulator is equal to the comparison value.
	C774	The data in the accumulator is less than the comparison value.
	C775	An accumulator carry or borrow condition has occurred.
	C776	The accumulator value is zero.
	C777	The accumulator has an overflow condition.
DL340	C1072	Port 2 parity: on = odd, off = none
	C1074	The RX or WX instruction is active.
	C1075	An error occurred during communications with the RX or WX instructions.
	C1076	Port 2 communications mode: on = ASCII mode, off = HEX mode. ***Direct***NET supports both ASCII and HEX modes and Modbus® only supports HEX mode.
	C1077	Port 1 communications mode: on = ASCII mode, off = HEX mode

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Timer / Counter Registers and Contacts

The following table shows the locations used for programming timer or counters. Since timers and counters share the same data area, you cannot have timers and counters with duplicate numbers. For example, if you have Timer 600, you cannot have a Counter 600.
Each register contains the current value for the timer or counter. Each timer or counter also has a timer or counter contact with the same reference number.



NOTE: Counter current values are retentive and retain their state after a power cycle. These registers are 16-bit registers.

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

* Used with Timer / Counter Setpoint Unit and /or Thumbwheel Interface Module.

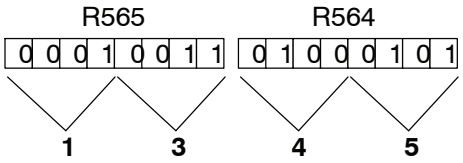
External Timer/Counter Setpoint Unit

Registers 674–677 are used in programming for use with the Timer/Counter Setpoint Unit and the Thumbwheel Interface Module that are available in some compatible product families. The registers contain the current time or count. There is also a status bit for each register with the same reference number. For example, the current value for Timer 674 is stored in R674 and the status contact is T674.

The presets for these modules are stored in R564 – R573 as follows.

- R564 – R565 — 1st T/C preset
- R566 – R567 — 2nd T/C preset
- R570 – R571 — 3rd T/C preset
- R572 – R573 — 4th T/C preset

The example shows how a 4-digit number would be represented in these registers.



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Data Registers

The following 8-bit data registers are primarily used with data instructions to store various types of application data. For example, you could use a register to hold a timer or counter preset value.

Some data instructions call for two bytes, which will correspond to two consecutive 8-bit data registers such as R401 and R400. The LSB (Least Significant Bit) will be in register R400 as bit0 and the MSB (Most Significant Bit) will be in register R401 as bit17.



NOTE: Data Registers are retentive.

DL330 / DL330P 8-Bit Data Registers							
407	406	405	404	403	402	401	400
417	416	415	414	413	412	411	410
427	426	425	424	423	422	421	420
437	436	435	434	433	432	431	430
447	446	445	444	443	442	441	440
457	456	455	454	453	452	451	450
467	466	465	464	463	462	461	460
477	476	475	474	473	472	471	470
507	506	505	504	503	502	501	500
517	516	515	514	513	512	511	510
527	526	525	524	523	522	521	520
537	536	535	534	533	532	531	530
547	546	545	544	543	542	541	540
557	556	555	554	553	552	551	550
				563	562	561	560

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DL340 8-Bit Data Registers							
407	406	405	404	403	402	401	400
417	416	415	414	413	412	411	410
427	426	425	424	423	422	421	420
437	436	435	434	433	432	431	430
447	446	445	444	443	442	441	440
457	456	455	454	453	452	451	450
467	466	465	464	463	462	461	460
477	476	475	474	473	472	471	470
507	506	505	504	503	502	501	500
517	516	515	514	513	512	511	510
527	526	525	524	523	522	521	520
537	536	535	534	533	532	531	530
547	546	545	544	543	542	541	540
557	556	555	554	553	552	551	550
				563	562	561	560
707	706	705	704	703	702	701	700
717	716	715	714	713	712	711	710
727	726	725	724	723	722	721	720
737	736	735	734	733	732	731	730
747	746	745	744	743	742	741	740
757	756	755	754	753	752	751	750
767	766	765	764	763	762	761	760

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Stage Control / Status Bit Map

This table provides a listing of the individual stages and stage control bits. These are only available with the DL330P CPU.

MSB			Stage References				LSB	Register Number
007	006	005	004	003	002	001	000	R100
017	016	015	014	013	012	011	010	R101
027	026	025	024	023	022	021	020	R102
037	036	035	034	033	032	031	030	R103
047	046	045	044	043	042	041	040	R104
057	056	055	054	053	052	051	050	R105
067	066	065	064	063	062	061	060	R106
077	076	075	074	073	072	071	070	R107
107	106	105	104	103	102	101	100	R110
117	116	115	114	113	112	111	110	R111
127	126	125	124	123	122	121	120	R112
137	136	135	134	133	132	131	130	R113
147	146	145	144	143	142	141	140	R114
157	156	155	154	153	152	151	150	R115
167	166	165	164	163	162	161	160	R116
177	176	175	174	173	172	171	170	R117

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Shift Register Bit Map

The shift register bits listed below are used in the shift register instruction. These outputs are discrete bits and are not the same locations as the 8 Bit Data Registers. These bits are retentive meaning they retain their state after a power cycle.



NOTE: The DL330P does not have Shift Register bits. Shift Register instructions in the DL330P use Control Relays memory references.

MSB	DL330 / DL340 Shift Register References						LSB	Register Number
407	406	405	404	403	402	401	400	R40
417	416	415	414	413	412	411	410	R41
427	426	425	424	423	422	421	420	R42
437	436	435	434	433	432	431	430	R43
447	446	445	444	443	442	441	440	R44
457	456	455	454	453	452	451	450	R45
467	466	465	464	463	462	461	460	R46
477	476	475	474	473	472	471	470	R47
507	506	505	504	503	502	501	500	R50
517	516	515	514	513	512	511	510	R51
527	526	525	524	523	522	521	520	R52
537	536	535	534	533	532	531	530	R53
547	546	545	544	543	542	541	540	R54
557	556	555	554	553	552	551	550	R55
567	566	565	564	563	562	561	560	R56
577	576	575	574	573	572	571	570	R57

With the DL340 CPU, these bits can also be used as control relays if they are not used with a Shift Register instruction.

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Special Registers

This table provides a listing of the special registers used with the DL305 CPUs.

CPUs	Special Register	Description of Contents
DL330 DL330P DL340	R574 – 575	Contains the error code used with the FAULT instruction.
	R576 – 577	Auxiliary accumulator used with the MUL and DIV instructions.
DL340 Only	R771	Sets the upper byte of the station address assigned to the bottom communication port. Therefore, this will contain the 1st and 2nd digits of the address.
	R772	Sets the lower byte of the station address assigned to the bottom communication port. This only contains one digit, which is the 3rd digit of the address.
	R773	Sets the baud rate for the bottom communication port.
	R774	Sets the leading communications delay time for the bottom communication port.
	R775	Sets the trailing communications delay time for the bottom communication port.
	R776	Sets the leading communications delay time for the top communication port.
	R777	Sets the trailing communications delay time for the top communication port.

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9

Programming Basics

In This Chapter. . . .

- Introduction
- Using Boolean Instructions
- Using Timers
- Using Counters
- Using the Accumulator

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Introduction

This chapter describes some basic programming concepts used with the DL305 CPUs. It doesn't provide detailed information on each instruction, but instead shows how you can use the most basic elements of the instruction set. If you have quite a bit of PLC programming experience, you may already know some of the information. However, we suggest you at least read the portion that discusses the accumulator operation. The accumulator is used in many different operations.

This chapter provides an overview of the following programming concepts.

1. Boolean Instructions
2. Timer Instructions
3. Counter Instructions
4. Shift Register Instruction
5. Accumulator Instructions

Detailed examples of all categories of instructions are included in Chapters 11 & 12.

The DL305 CPUs can be programmed with the ***Direct***SOFT PC-based programming package, or by using the DL305 handheld programmer. There is a separate manual available for each of these products. If your are not familiar with the chosen programming device we recommend you use the appropriate programming device manual along with this manual to program your DL305 system.

The following examples will help you understand how DL305 instructions are put together to create a program solution.

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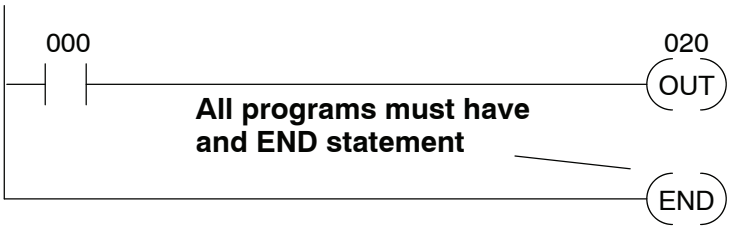
Using Boolean Instructions

Do you ever wonder why so many PLC manufacturers always quote the scan time for a 1K boolean program? Simple. Most all programs utilize many boolean instructions. These are typically very simple instructions designed to join input and output contacts in various series and parallel combinations. Since the ***Direct***SOFT package allows you to use graphic symbols to build the program, you don't absolutely *have* to know the boolean equivalents of the instructions. However, it may be helpful at some point, especially if you ever have to troubleshoot the program with a Handheld Programmer.

The following paragraphs show how these boolean instructions are used to build simple ladder programs.

END Statement

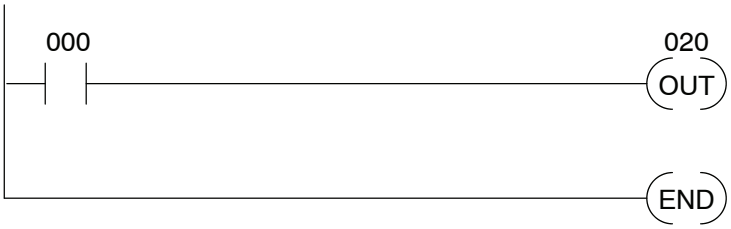
All DL305 programs require an END statement as the last instruction. This tells the CPU this is the end of the program. Any instructions placed after the END statement will not be executed. (This can be useful in some cases. See Chapter 13 for an example.)



Simple Rungs

You use a contact to start rungs that contain both contacts and coils. The boolean instruction that does this is called a Store or, STR instruction. The output point is represented by the Output or, OUT instruction. The following example shows how to enter a single contact and a single output coil.

DirectSOFT Example



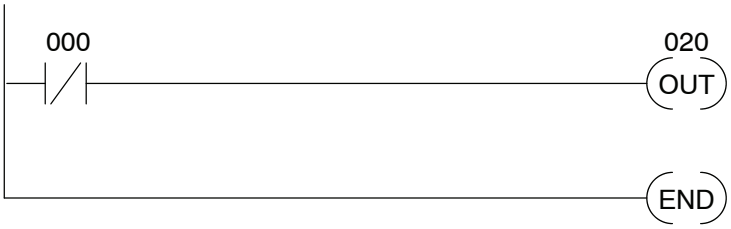
Handheld Mnemonics

```
STR 000
OUT 020
END
```

Normally Closed Contact

Normally closed contacts are also very common. This is accomplished with the Store Not or, STRN instruction. The following example shows a simple rung with a normally closed contact.

DirectSOFT Example



Handheld Mnemonics

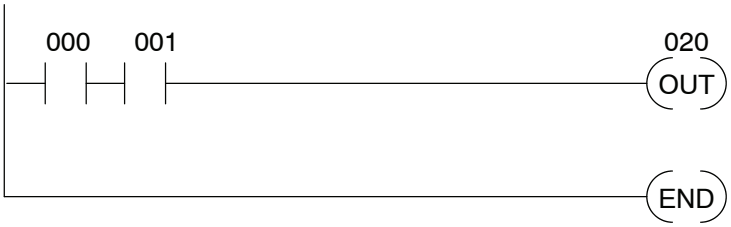
```
STRN 000
OUT 020
END
```


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Contacts in Series

Use the AND instruction to join two or more contacts in series. The following example shows two contacts in series and a single output coil.

DirectSOFT Example



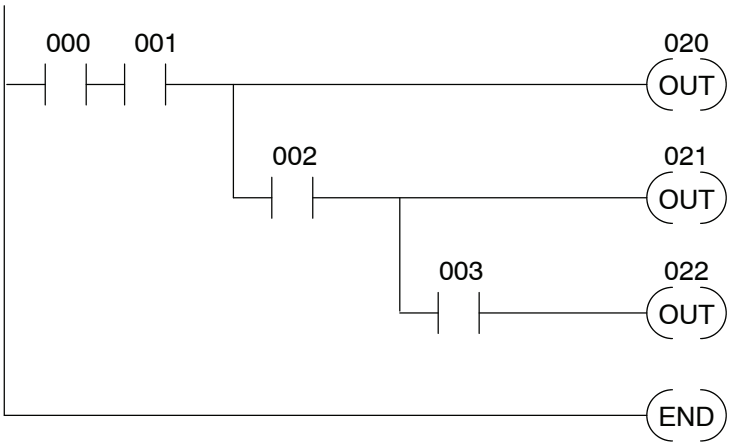
Handheld Mnemonics

```
STR 000
AND 001
OUT 020
END
```

Midline Outputs

Sometimes it is necessary to use midline outputs to get additional outputs that are conditional on other contacts. The following example shows how you can use the AND instruction to continue a rung with more conditional outputs.

DirectSOFT Example



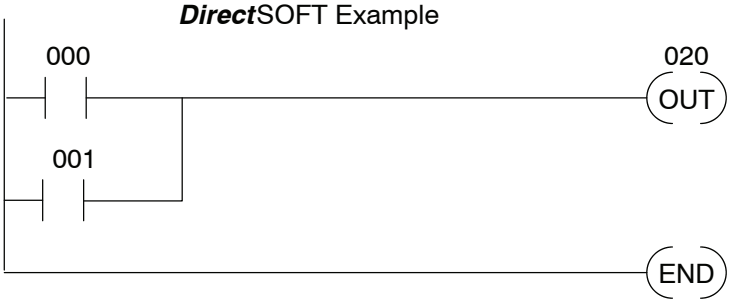
Handheld Mnemonics

```
STR 000
AND 001
OUT 010
AND 002
OUT 021
AND 003
OUT 022
END
```

Parallel Elements

You may also join contacts in parallel. The OR instruction allows you to do this. The following example shows two contacts in parallel and a single output coil.

DirectSOFT Example



Handheld Mnemonics

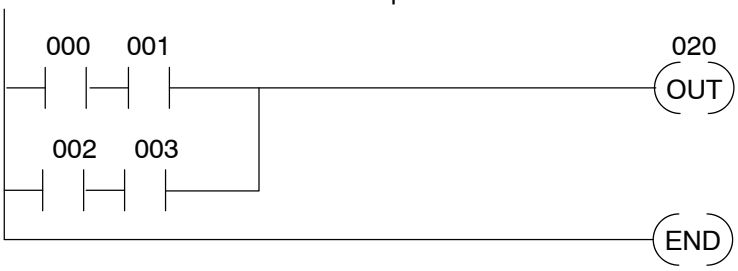
```
STR 000
OR 001
OUT 020
END
```


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Joining Series Branches in Parallel

Quite often it is necessary to join several groups of series elements in parallel. The Or Store (ORSTR) instruction allows this operation. The following example shows a simple network consisting of series elements joined in parallel.

DirectSOFT Example



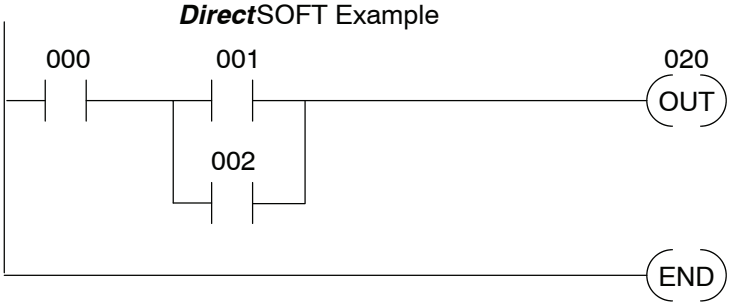
Handheld Mnemonics

```
STR 000
AND 001
STR 002
AND 003
ORSTR
OUT 020
END
```

Joining Parallel Branches in Series

Quite often it is also necessary to join one or more parallel branches in series. The And Store (ANDSTR) instruction allows this operation. The following example shows a simple network with contact branches in series with parallel contacts.

DirectSOFT Example



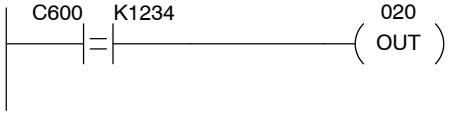
Handheld Mnemonics

```
STR 000
STR 001
OR 002
ANDSTR
OUT 020
END
```

Comparative Boolean

Many applications require comparisons of data values. This is especially true in applications that use counters. Some PLC manufacturers make it really difficult to do a simple comparison of a counter value and a constant or register. The DL330 and DL340 CPUs provide Comparative Boolean instructions that allow you to quickly and easily solve this problem. Comparative Boolean evaluates two 4-digit values using boolean contacts. The valid evaluations are equal and not equal.

In the following example when the value in counter C600 is equal to the constant value 1234, output 020 will energize.

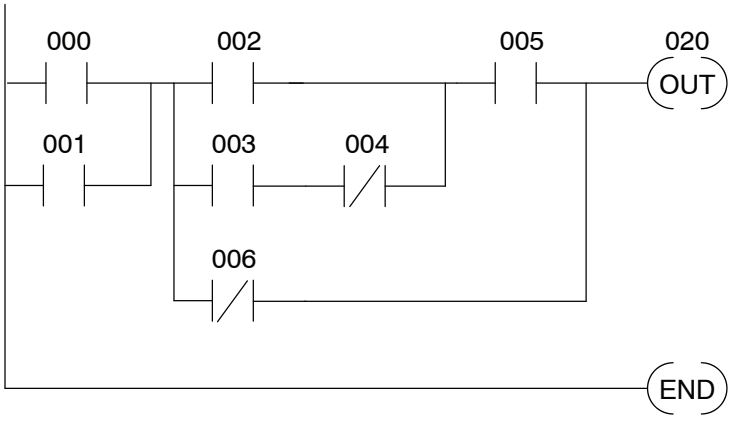


The DL330P also provides Comparative Boolean instructions, but they are greater than and less than instructions instead of equal and not equal.

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Combination Networks

You can combine the various types of series and parallel branches to solve most any application problem. The following example shows a simple combination network.



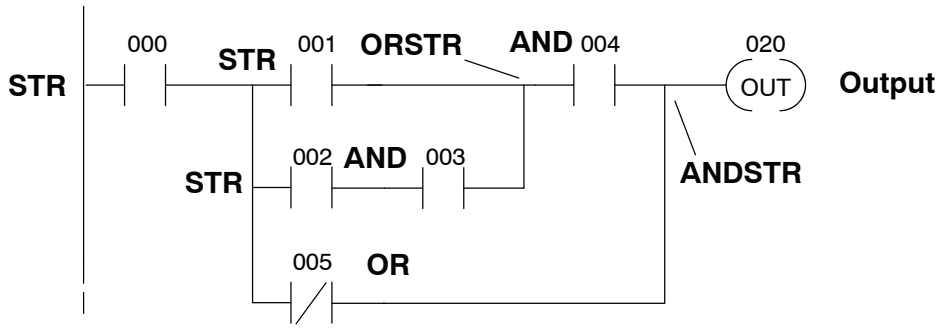
Boolean Stack

There are limits to how many elements you can include in a rung. This is because the DL305 CPUs use an 8-level boolean stack to evaluate the various logic elements. The boolean stack is a temporary storage area that solves the logic for the rung. Each time you enter a STR instruction, the instruction is placed on the top of the boolean stack. Any other instructions on the boolean stack are pushed down a level. The AND, OR, ANDSTR, and ORSTR instructions combine levels of the boolean stack when they are encountered. Since the boolean stack is only eight levels, an error will occur if the CPU encounters a rung that uses more than the eight levels of the boolean stack.

All of you software programmers may be saying, "I use ***Direct***SOFT, so I don't need to know how the stack works." Not quite true. Even though you can build the network with the graphic symbols, the limits of the CPU are still the same. If the stack limit is exceeded when the program is compiled, an error will occur.

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The following example shows how the boolean stack is used to solve boolean logic.



STR 000

1	STR 000
2	
3	
4	
5	
6	
7	
8	

STR 001

1	STR 001
2	STR 000
3	
4	
5	
6	
7	
8	

STR 002

1	STR 002
2	STR 001
3	STR 000
4	
5	
6	
7	
8	

AND 003

1	002 AND 003
2	STR 001
3	STR 000
4	
5	
6	
7	
8	

ORSTR

1	001 OR (002 AND 003)
2	STR 000
3	
⋮	
8	

AND 004

1	004 AND [001 OR (002 AND 003)]
2	STR 000
3	
⋮	
8	

OR 005

1	NOT 005 OR 004 AND [001 OR (002 AND 003)]
2	STR 000
3	
⋮	
8	

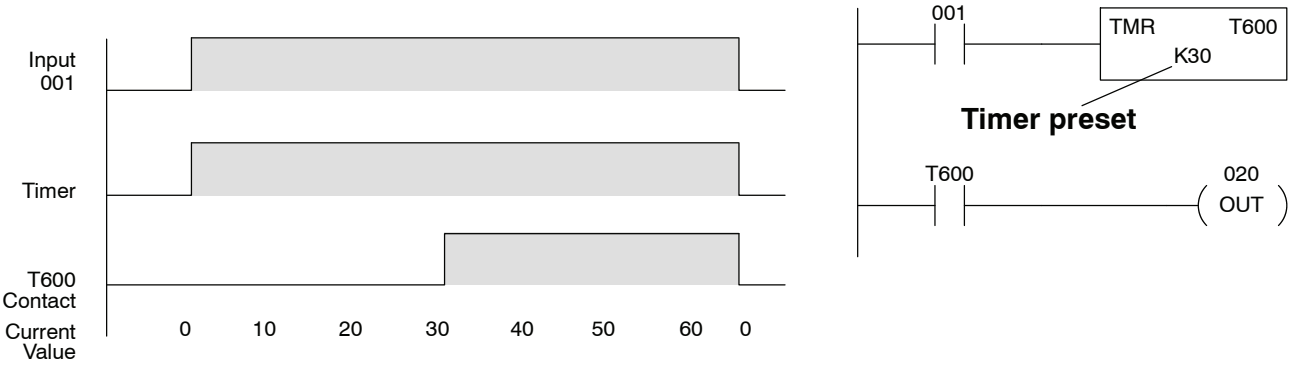
ANDSTR

1	000 AND (NOT 005 OR 004) AND [001 OR (002 AND 003)]
2	
3	
⋮	
8	

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Using Timers

Timers are used to time an event for a desired length of time. The single input timer will time as long as the input is on. When the input changes from on to off the timer current value is reset to 0. Timers normally time in tenth of a second intervals, but you can turn on Special Relay 770 to change the timers to hundredth of a second intervals. There is discrete bit associated with each timer to indicate the current value is equal to or greater than the preset value. The timing diagram below shows the relationship between the timer input, associated discrete bit, current value, and timer preset.



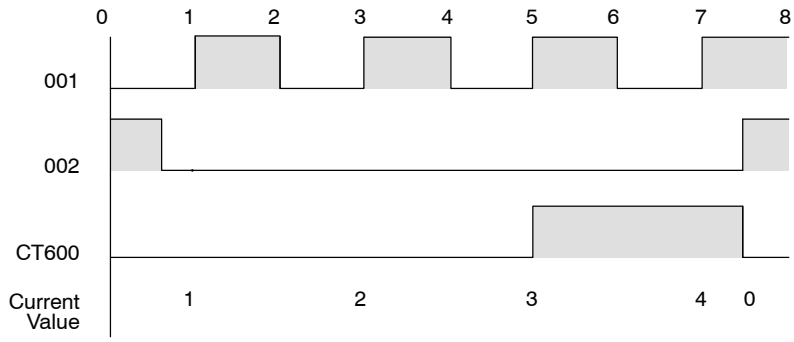
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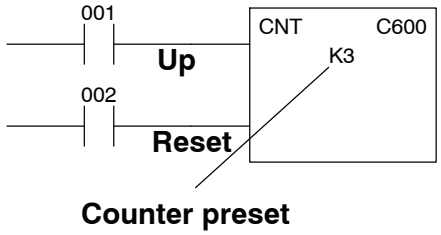
Using Counters

Counters are used to count events. There are two types of counters.

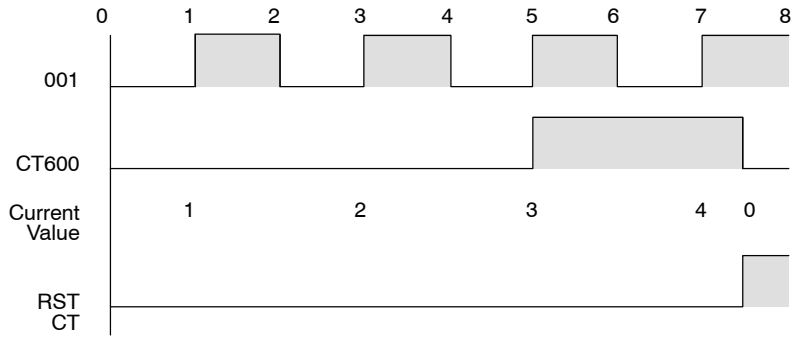
- Regular Up counters
- Stage counters (used with the RLL*PLUS* instructions)

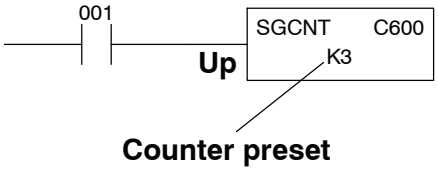
The up counter has two inputs, a count input and a reset input. The maximum count value is 9999. The timing diagram below shows the relationship between the counter input, counter reset, associated discrete bit, current value, and counter preset.





The stage counter has a count input and is reset by the RST instruction. This instruction is used with the RLL*PLUS* instructions. The maximum count value is 9999. The timing diagram below shows the relationship between the counter input, associated discrete bit, current value, counter preset and reset instruction.





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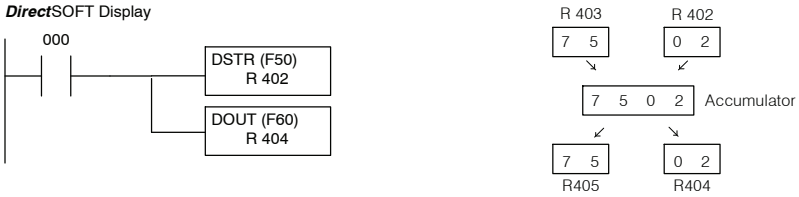
Using the Accumulator

The accumulator in the DL305 series CPUs is a 16 bit register which is used as a temporary storage location for data being copied or manipulated in some manor. For example, you have to use the accumulator to perform math operations such as add, subtract, multiply, etc. Since there are 16 bits, you can use up to a 4-digit BCD number. The accumulator is reset to 0 at the end of every CPU scan.

Copying Data to and from the Accumulator

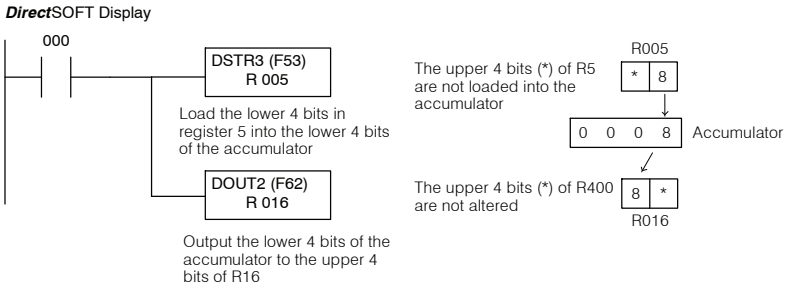
The Data Store (DSTR) and Data Out (DOUT) instructions and their variations are used to copy data from a register location to the accumulator, or to copy data from the accumulator to a register location.

In the following example, when input 000 is on the value (7502) in R402 and R403 is loaded into the accumulator using the Data Store (F50) instruction. The value in the accumulator is output to data registers R404 and R405 using the Data Out (F60) instruction.



You probably noticed it took two registers to hold a 4-digit BCD number. This is because each BCD digit requires four binary bit positions.

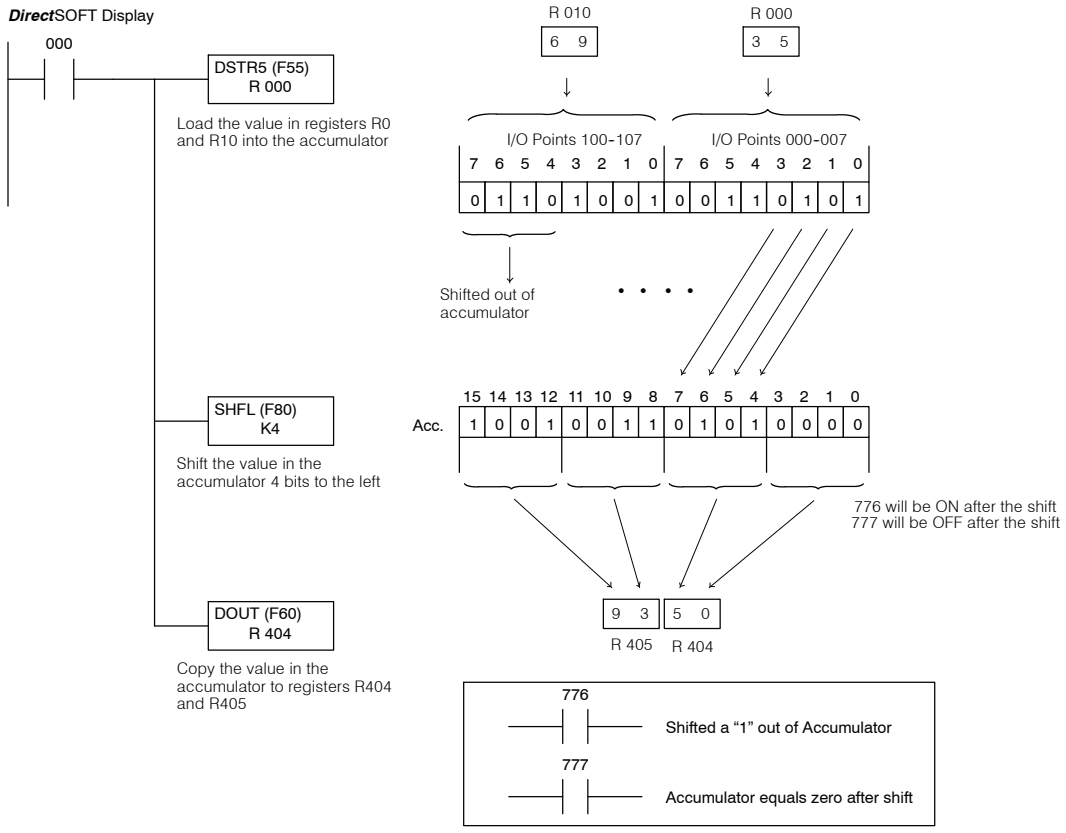
Since the accumulator is 16 bits and register locations are 8 bits, there are variations of the DSTR and DOUT instructions that allow you to copy a single register, or even half of a register (4 bits) either to or from the accumulator. The following example shows how you could use the DSTR3 and DOUT2 instructions to copy the lower 4 bits from register 5 to the upper 4 bits of register 16. (These registers correspond to I/O points and Control Relays respectively.)



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Changing the Accumulator Data

Instructions that change or manipulate data in some way also use the accumulator. The result of the change resides in the accumulator. The original data that was being changed is cleared from the accumulator. In the following example, when input 000 is on the value in R000 and R010 is loaded into the accumulator using the Data Store 5 (F55) instruction. The bit pattern in the accumulator is shifted to the left 4 bit positions using the Shift Left (F80) instruction. Notice how the result resides in the accumulator. The value in the accumulator is copied to data registers R404 and R405 using the Data Out (F60) instruction.



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Accumulator Operations

The following table lists several instructions that utilize the accumulator. Not all instructions allow you to use all the different memory types. Chapters 11 & 12 provide details on these instructions.

Category	Mnemonic	Description	Memory Areas					
			I/O	CRs	Data Register	Current Values	4-digit BCD Const.	Shift Register Coils
Data Load	DSTR (F50)	Load a 4-digit constant or a 2-bytes of register data into the accumulator	❍	❍	❍	❍	❍	❍
	DSTR 1 (F51)	Load 1-byte of register data into the accumulator	❍	❍	❍	×	×	❍
	DSTR 2 (F52)	Load the upper 4 bits of a register into the lower 4 bits of the accumulator	❍	❍	❍	×	×	❍
	DSTR 3 (F53)	Load the lower 4 bits of a register into the upper 4 bits of the accumulator	❍	❍	❍	×	×	❍
	DSTR 5 (F55)	Load the digital values of 16 I/O points (2 bytes) into the accumulator	❍	×	×	×	×	×
Data Out	DOUT (F60)	Write the accumulator to 2 sequential registers	❍	❍	❍	❍	❍	❍
	DOUT 1 (F61)	Write the lower byte of the accumulator to a register	❍	❍	❍	×	×	❍
	DOUT 2 (F62)	Write the lower 4 bits of the accumulator to the upper 4 bits of a register	❍	❍	❍	×	×	❍
	DOUT 3 (F63)	Write the lower 4 bits of the accumulator to the lower 4 bits of a register	❍	❍	❍	×	×	❍
	DOUT 5 (F65)	Write the contents of the accumulator to a 16-point output module (2 bytes)	❍	❍	❍	×	×	❍
Math	CMP (F70)	Compare a 2-byte BCD reference or a 4-digit BCD constant to the accumulator	❍	❍	❍	❍	❍	❍
	ADD (F71)	Add a 2-byte BCD reference or a 4-digit BCD constant to the accumulator	❍	❍	❍	❍	❍	❍
	SUBTRACT (F72)	Subtract a 2-byte BCD reference or a 4-digit BCD constant from the accumulator	❍	❍	❍	❍	❍	❍
	MULTIPLY (F73)	Multiply a 2-byte BCD reference or a 4-digit BCD constant by the value in the accumulator	❍	❍	❍	❍	❍	❍
	DIVIDE (F74)	Divide the accumulator by a 2-byte BCD reference or a 4-digit BCD constant	❍	❍	❍	❍	❍	❍

❍ — Memory Type available for use with the instruction

X — Not available

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Category	Mnemonic	Description	Memory Areas					
			I/O	CRs	Data Register	Current Values	4-digit BCD Const.	Shift Register Coils
Bit Manipulation	DAND (F75)	Performs a bit "AND" on a 2-byte reference or a 4-digit BCD constant and the bits in the accumulator	❍	❍	❍	❍	❍	❍
	DOR (F76)	Performs a bit "OR" on a 2-byte reference or a 4-digit BCD constant and the bits in the accumulator	❍	❍	❍	❍	❍	❍
	SHIFT RIGHT (F80)	Shifts the contents of the accumulator to the right a specified number of times. 1 – 15 bits can be shifted.	×	×	×	×	×	×
	SHIFT LEFT (F81)	Shifts the contents of the accumulator to the left a specified number of times. 1 – 15 bits can be shifted.	×	×	×	×	×	×
Data Conversion	DECODE (F82)	Decodes the first 4 bits of the accumulator into a decimal number.	×	×	×	×	×	×
	ENCODE (F83)	Encodes an accumulator bit into a 4-bit code that represents the decimal number (0–15).	×	×	×	×	×	×
	INV (F84)	Logically inverts the contents of the accumulator (1 to 0, 0 to 1).	×	×	×	×	×	×
	BCD–BIN (F85)	Converts the accumulator value from BCD to Binary	×	×	×	×	×	×
	BIN–BCD (F86)	Converts the accumulator value from Binary to BCD	×	×	×	×	×	×
Fault Detection	FAULT (F20)	Sends a 4-digit BCD number, from a 2-byte reference or a constant, to the programmer display	×	×	×	×	×	×

❍ — Memory Type available for use with the instruction

X — Not available

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10

RLL*PLUS* Programming Basics

In This Chapter. . . .

— Introduction
— An Example Machine
— An RLL Solution
— An RLL*PLUS* Solution
— Stage Instruction Execution
— Activating Stages
— Using Outputs in Stages
— Using Timers and Counters in Stages
— Using Data Instructions in Stages
— Using Comparative Contacts in Stages
— Parallel Branching Concepts
— Unusual Operations in Stages
— Two Ways to View RLL*PLUS* Programs
— Designing a Program Using RLL*PLUS* Instructions

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Introduction

If you've ever been around some *really* accomplished RLL programmers you have probably been amazed at how easily they seem to be able to create programs of incredible complexity. Well, not everyone has years of experience in programming PLCs. Because of this the DL330P CPU has RLL*PLUS* instructions that make it considerably easier to design and create programming solutions. These instructions are especially useful to those of you who aren't that familiar with the interlocking concepts commonly used in RLL programs.

You can still use the normal instructions you've already seen, plus you only have to become familiar with a few new instructions that help you organize your program into manageable pieces.

This programming method is similar to Sequential Function Chart programming and literally allows you to design a flowchart of the program operation sequence and load it into the CPU! You can expect to see several benefits by using this method.

- Considerably reduced program design time. We've seen many, many cases where these few instructions have cut program design time by well over 50%.
- Shorter, more simple programs. Later in this chapter we'll show you why your programs sometimes end up being a lot larger than you first anticipated. The RLL*PLUS* instructions can help make your programs simple for everyone to understand.
- Easier program troubleshooting. How many times have you tried to troubleshoot or modify a program that was written by someone else? If you've done this very often you know it's not an easy task. This chapter will show you a few instructions that will also help with this problem as well.

The following paragraphs discuss several RLL*PLUS* programming concepts. We'll use a simple example to show you how to use the various types of instructions. Also, we'll show you the equivalent program without RLL*PLUS* instructions to give you an idea of the differences between the two approaches.



NOTE: The DL330P has several instructions that do not operate quite the same as the equivalent instructions in the DL330 or DL340. If you want to take advantage of the benefits associated with the RLL*PLUS* instructions, make sure you also take time to review Chapter 12. This chapter discusses the instructions that are unique or different with the DL330P CPU.

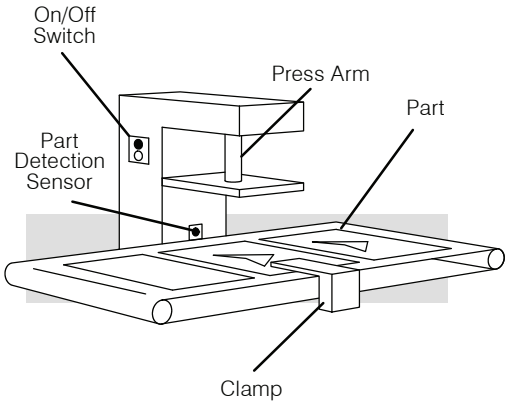
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An Example Machine

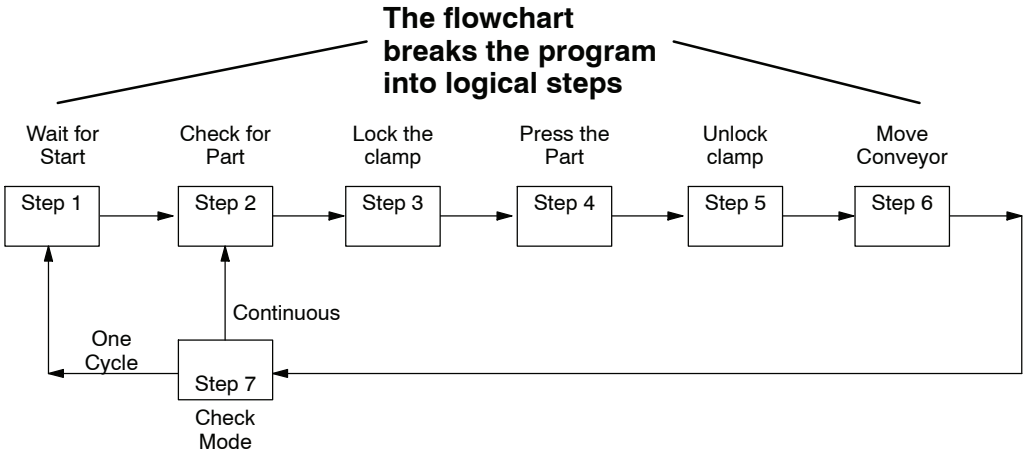
Machine Operation

Most any application can be described as a sequence of events. The PLC program merely makes sure the events are completed in a specific order. Not only does the program control normal operation, but it also has to allow for machine failures and emergency conditions. Consider a simple example.

1. The operator presses the start switch.
2. The machine checks for a part. If the part is present, the process continues. If not, the conveyor moves until a part is present.
3. The part is locked in place with a clamp.
4. The press stamps the part.
5. The clamp is unlocked and the finished piece is moved out of the press.
6. The process stops if the machine is in one-cycle mode, or the process continues if automatic mode is selected.



Machine Flowchart The following diagram provides a flowchart of this operations sequence.



Inputs		Outputs	
Start Switch	000	Clamp	020
Part Present	001	Press	021
Part Locked	002	Conveyor	022
Part Unlocked	003		
Lower Limit	004		
Upper Limit	005		
Conveyor Indexed	006		
One-Cycle Switch	007		

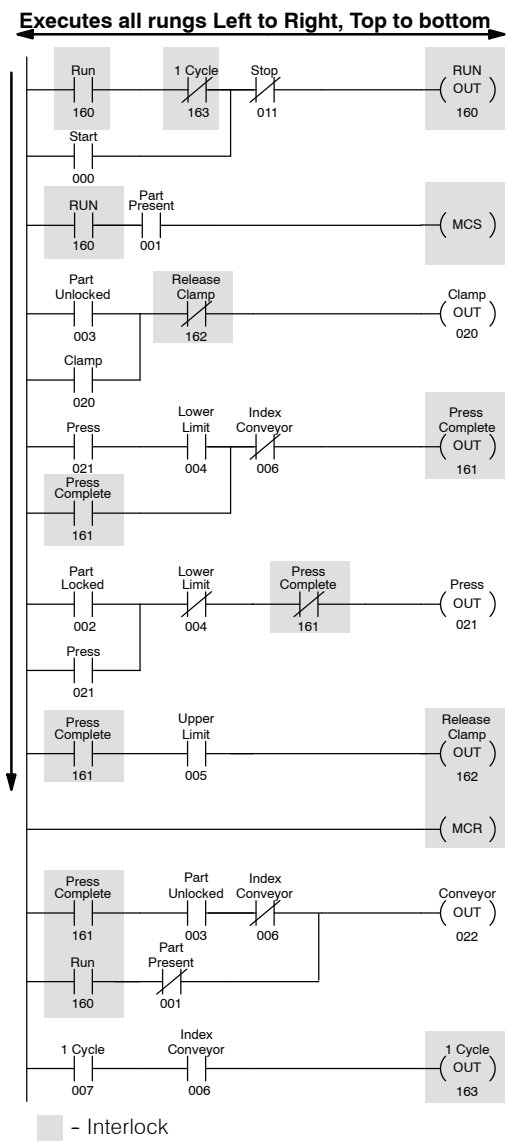
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An RLL Solution

Why is RLL so popular? Simple. Before the PLC arrived control problems were generally solved with hardwired relays and switches. About 30 years ago people started experimenting with a way to make quick and easy changes without changing the actual panel wiring. Thus, the PLC was born. Since the people developing and using this new technology were familiar with the relay and switch solution, it made sense to have this new technology emulate something that was familiar to them. That's why RLL programs emulate a relay panel solution.

When you supply power to a relay panel the combination of contact and coil status determines what actions take place. Since the RLL program emulates the relay panel solution, the entire program is scanned left-to-right, top-to-bottom. The program executes the operations sequence when a certain combination of contacts are activated. This process is known as interlocking.

Since many PLCs do not have instructions to help manage the operations sequence, the programmer has to make sure the program carries out the correct sequence by adding the required interlocks. One great thing about the RLL solution is the individual rungs are easy to understand. By examining the contacts you can easily determine if the output will be on or off.



Many accomplished RLL programmers use things such as Master Control Relays and Subroutines to reduce the amount of interlocking required. However, these instructions can sometimes make the program more difficult to understand. There are several things you should notice about our simple press program.

- Most all rungs use some amount of interlocking.
- The number of interlocks is usually proportional to the number of tasks in the operations sequence.
- Most of the instructions are devoted to processing the interlocks. (Plus, since the program is larger, it takes more time to process.)
- It usually requires several attempts until a program is designed that is not susceptible to inadvertent activation and deactivation.
- The program can be difficult to debug if you do not have a considerable amount of RLL programming experience.

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An RLL*PLUS* Solution

The RLL*PLUS* instructions keep the simplicity of the contacts and coils while removing some of the problems associated with the enormous amount of interlocks. There are several RLL*PLUS* instructions, but the most often used are the Initial Stage (ISG), Stage (SG), and Jump (JMP) instructions. Here's the example press program created using RLL*PLUS* instructions. There are two things you should notice.

- Control Relay interlocks are not required.
- The program directly follows the flowchart of the press operation.

How can this happen? Simple. The interlocks were added to the RLL program to keep the outputs from coming on at the improper time. This is because every rung of the RLL program was examined on every scan.

The Stage instructions (and the logic between the Stage instruction and the next stage instruction) are not necessarily examined on every scan. Only stages that are on are examined.

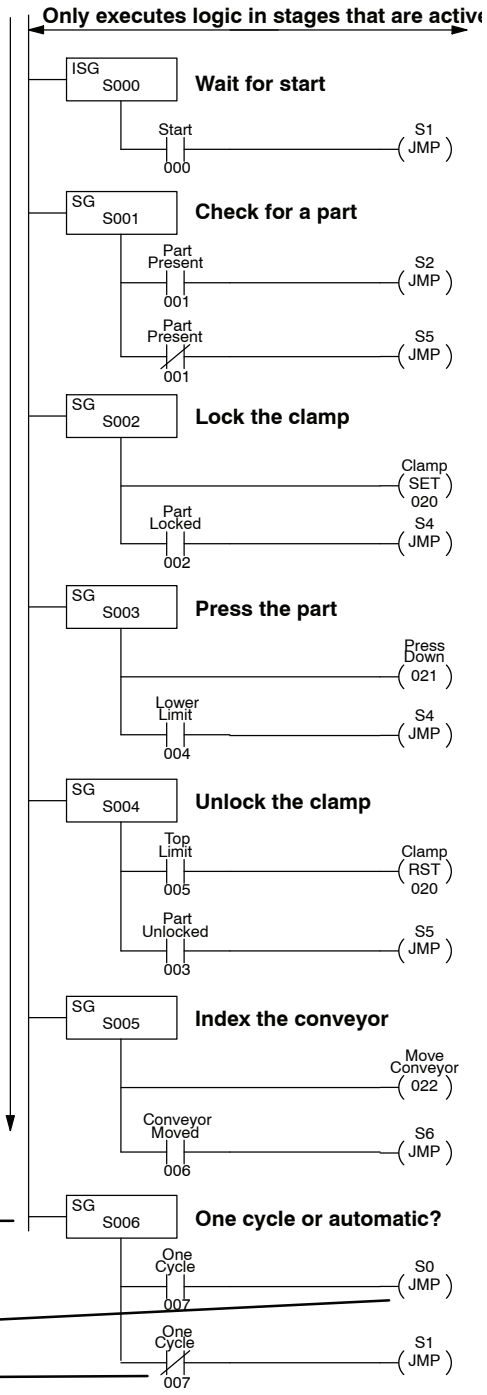
Each stage instruction has a status bit that is on when the stage is active, and off when the stage is inactive. On every scan the CPU examines which stage status bits are on and only examines the logic in those stages. If a stage is inactive, the CPU skips the logic between that stage and the next active stage.

The following pages will talk about several different aspects of the CPU execution for the Stage Instructions. It will help to understand the pieces of an individual stage.

Stage Nomenclature

As we discuss the examples it will be necessary for you to understand the various pieces that can make up a program stage.

- Stages — a instruction that denotes a piece of the program
- Actions— an event in the program, such as an output, jump, or some other instruction.
- Transitions — the event that causes the program to move to the next stage.



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Stage Instruction Execution

Stage Instruction Numbering

Stages are numbered in octal, so you can't have any stages with the numbers 8 or 9 in them. Notice the stages skipped from 7 to 10 since the numbers 8 and 9 are not used. There are 128 (decimal) stages available in the DL330P CPU, numbered 0 through 177.

Since each stage has a unique status bit, you cannot have stages with the same address number. For example, since the example program already has a Stage1, we wouldn't want to use that number again.

There's another advantage to having a status bit for each stage. This allows you to skip stage numbers as necessary. This is a good practice to follow because it makes it easier to insert stages later without affecting the appearance of the program flow.

The stage numbers do not necessarily have to be numbered sequentially, but it can be *extremely* helpful to use sequential numbers if you are working with large programs.

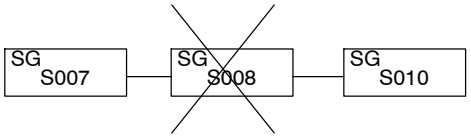
Also, the stages do not have to be entered sequentially with the programming device. For example, you could have Stage 100 be the first entry in the program. This is not a good programming practice, but since the CPU looks at the active status bits to determine which stages to execute, it doesn't care where the stages are physically located in the program.



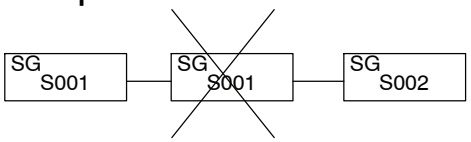
NOTE: Remember, machines do break. We recommend you use numbering that matches the machine flowchart. Also, we recommend you enter the program in the same order whenever possible. This will make troubleshooting much easier.

The section on Designing an RLL*PLUS* Program at the end of this chapter provides guidelines for assigning numbers to the stage instructions.

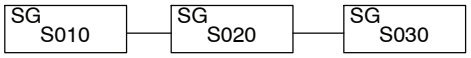
Octal Numbering



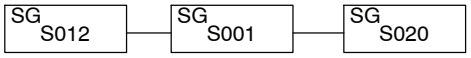
No Duplicate Numbers

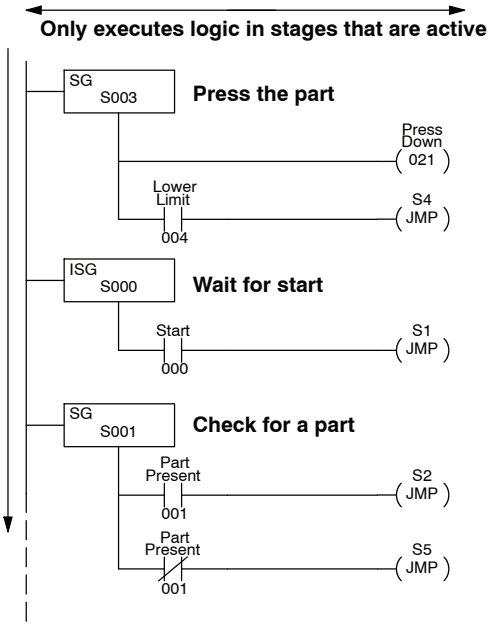


Skip Numbers if Necessary



Non-sequential Numbering





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A Few Simple Rules for Execution

Since the CPU will only examine the logic in those stages that are active, it is important you understand how stages can be turned on and off. There are a few simple rules that dictate how this works. This may seem like quite a few things to remember, but it's really pretty simple. We'll show examples in the following pages that show how each of these rules apply to the program execution.

1. Only active stages are executed. If a stage is inactive, the CPU skips the logic between that stage and the next active stage.
2. You can turn stages on by the following methods.
   - 2.a Initial Stages are automatically turned on when the CPU transitions from Program Mode to Run Mode.
   - 2.b A stage can be turned on when the program "jumps" from stage to stage with the Jump (JMP) instruction.
   - 2.c You can use the SET instruction to set a stage status bit just like you would SET an output.
   - 2.d A stage can be turned on when the program has power flow between two stages that are tied together by a single transition element.
3. You can turn stages off by the following methods.
   - 3.a An active stage is automatically turned off if the program jumps from the active stage to another stage.
   - 3.b You can use the Reset (RST) instruction to turn off a stage just like you use Reset to turn off an output point.
   - 3.c The current stage is automatically turned off if the program has power flow between the current stage and the next stage.

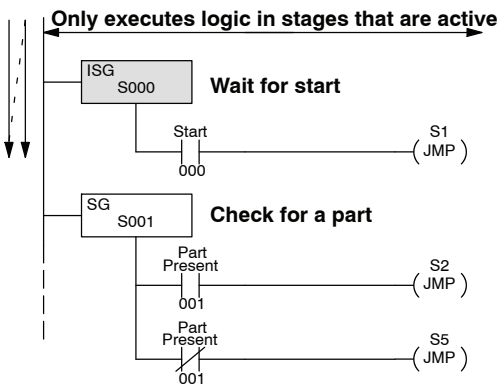
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Activating Stages

Using Initial Stages

Any initial stages (ISG instructions) are automatically turned on when the CPU goes from Program Mode to Run Mode. For example, when the CPU executing our example program enters Run Mode, the Initial Stage (ISG 000) will be turned on automatically. The other stages are off, so the CPU only scans the portion of the program associated with ISG 000.

Since there's only one rung in Stage 0, the CPU continually monitors the start switch. Nothing else will happen until the start switch is pressed.



Although it is unusual, there may be times when you need more than one initial stage. There is nothing at all wrong with this. If your application has a need for more than one starting point, you can use more than one initial stage. For example, if you had three initial stages, then those three stages would all be active when the CPU entered the Run Mode.

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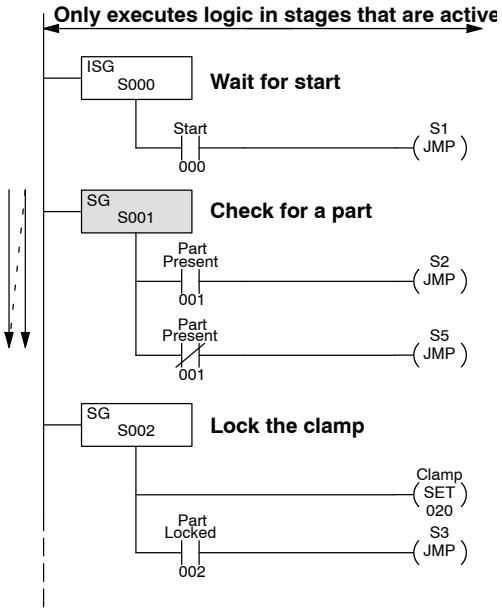
Using Jump Instructions

When the operator presses the start switch input 000 comes on. When 000 comes on the CPU executes the Jump instruction and "jumps" to Stage 1.

Now the CPU only scans Stage 1. Stage 0 is no longer scanned after the program jumped to stage 1. This means the Jump instruction did two things.

- It activated the destination stage. In this case, it activated stage 1.
- It deactivated the stage it came from, which was stage 0 in this case.

So, you can *jump to* a stage to turn it on, and when you *jump from* a stage it turns off.

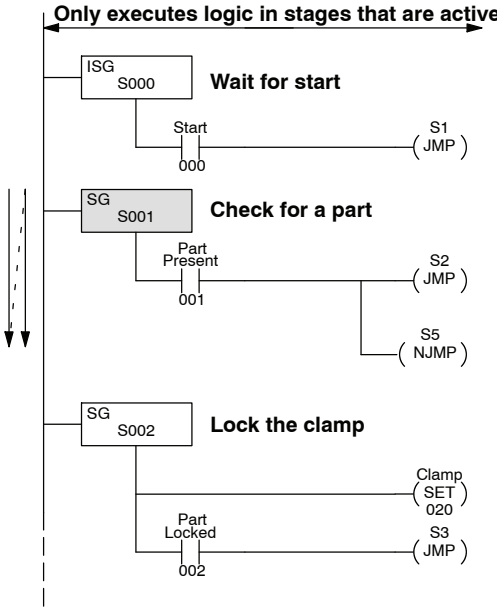


This example only shows an action that initiates a jump to one destination. You can use several jumps ORed together if necessary. Examples of this will be shown later.

There's also another type of Jump instruction called a Not Jump. This instruction only works if the input conditions are *not true*, whereas the regular JMP instruction only works if the input conditions *are true*.

In the previous example we examined a single contact to determine which part of the program to jump to next. If the part is present (001 closed), the program jumps to Stage 2. If a part is not present (001 open), the program jumped to Stage 5. We could have used a single contact and the NJMP instruction.

The program example to the right shows how the NJMP instruction would be used in this situation. Notice there is one less instruction required in this example compared to the previous one.





NOTE: We *strongly* recommend you *avoid* using the NJMP instruction. This is because program debugging can become more difficult, especially for those who are not so familiar with structured programming concepts.

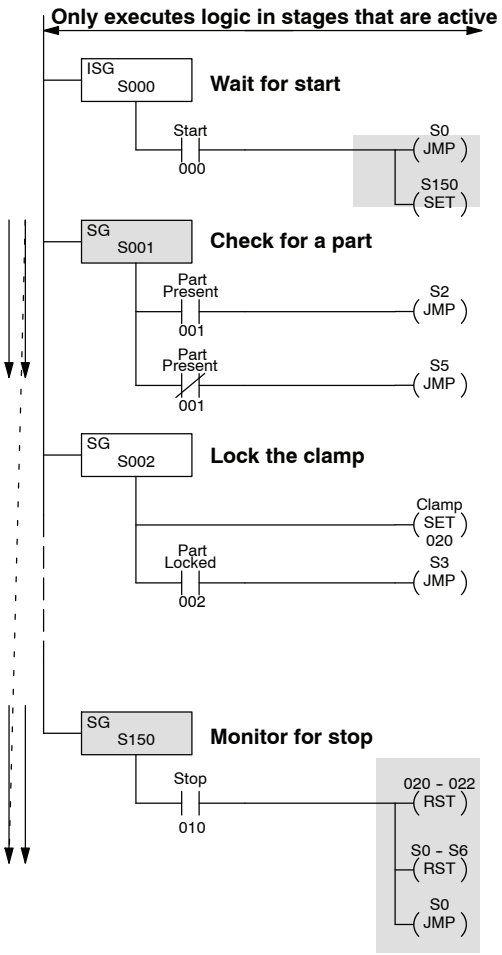
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Using Set Instructions with Stages

When you examine the instruction set more carefully you'll notice the DL330P CPU offers a Set (SET) instruction that works similarly to a latching operation. For example, you could use a SET instruction to latch an output point. The output point can then be unlatched with the Reset (RST) instruction.

You can also use a SET instruction to turn on a stage. To show how this works, we're going to add a stage to the program. You may have noticed the original flowchart did not contain a stop switch. Well, we don't want to make these little widgets forever, so we're adding Stage 150, which monitors for a stop switch. (This is also a good example of how you can skip stage numbers.)

Notice we added a SET instruction in the first stage. Now when the start switch is pressed, two stages will be activated. The CPU examines Stage 1, which monitors for a part, and it also examines Stage 150, which monitors the stop switch.



We did not absolutely have to use a SET instruction in the example. We could have used a Jump, since you can jump to more than one stage. We just used a SET to show how it works.

If you examine Stage 150, you'll notice we do three things when the stop switch is pressed.

- The RST 020 - 022 instruction makes sure all the outputs are turned off. (We'll discuss this in more detail in the next section.)
- The RST S0–S6 instruction resets (turns off) stages 0 through 6. We reset the entire range so that we guarantee we can stop the press no matter which stage is currently executing. Notice we reset stages that were not necessarily turned on with the SET instruction. The Reset (RST) instruction can be used to turn off stages, no matter how they were turned on. This is especially handy in larger, more complex programs.
- The program jumps back to Stage 0 and starts over again. Note, just because Stage 0 is an initial stage does not mean it can *only* be active at a transition to Run Mode. You can return to an Initial Stage at any time. It's just the CPU *automatically* activates Initial Stages at the Run Mode transition.

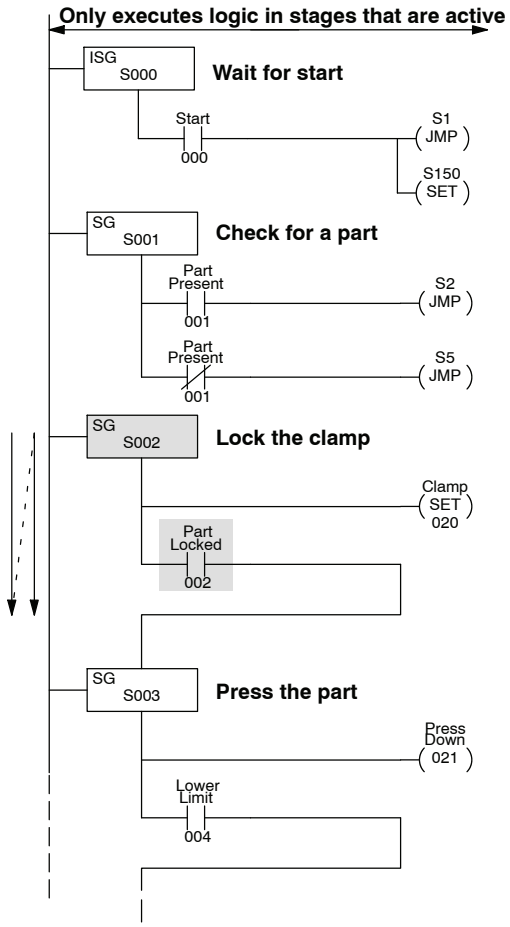
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Power Flow Transitions

You do not always have to use a Jump instruction to move from stage to stage. If you only move to one stage, instead of multiple stages, you can use what it is called a power flow transition. For example, we used Jump instructions in our sample program. For those stages that did not have multiple transition possibilities, we could have just used power flow transitions.

Look at Stage 2. Notice how the transition contact, 002 now is directly connected to the next stage, Stage 3. You can only do this if you are moving from one stage to one other stage.

If you examine Stage 1, you'll notice we have to use the Jump instructions because the program can transition to more than one stage.





NOTE: We suggest you use Jump Instructions instead of power flow transitions. This is because we've seen many cases where we had to come back and add things to the program. If you used Jumps from the beginning, you only have to add another Jump instruction. If you used power flow transitions, the program edits can take a little longer.

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Using Outputs in Stages

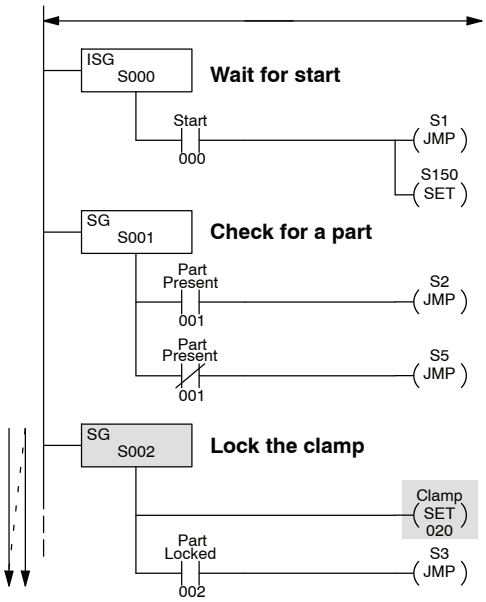
Since the CPU only examines the logic in stages that are on, you have a lot more flexibility in how you use outputs with the RLL*PLUS* instructions. Also, you don't have to worry about adding several permissive contacts to keep the output from coming on at an inappropriate time. (If the stage is not on,the CPU doesn't even scan the stage, so the output can't possibly be turned on by the logic in that stage.)

Setting Outputs with the SET Instruction

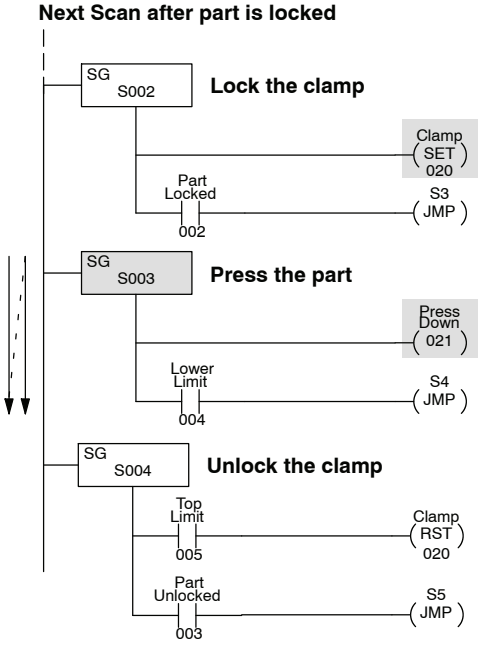
If you examine Stage 2, you'll notice we use a SET instruction to clamp the part in place. Why a set? Simple. If we used a regular output the clamp will be deactivated when the program transitions to Stage 3. Remember, when you leave a stage the CPU no longer scans that stage until it is turned on again. So if we had used a regular OUT instruction, the CPU would have automatically turned off the output, which would have unclamped the part.

The first example shows the program execution in Stage 2. The second example shows what happens on the next scan after the part is locked. Notice the clamp output is still on even though the CPU is not scanning this portion of the program. This is why we use the SET instruction in this case. We want the clamp to stay on while the press completes the cycle.

The clamp will stay on until the program enters Stage 4. Stage 4 unlocks the part by resetting output 020 when the press returns to the top limit.



Next Scan after part is locked



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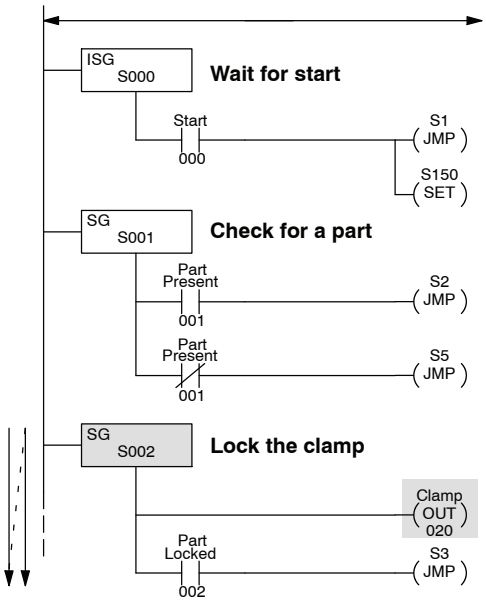
Using the OUT Instruction

One other benefit with RLL*PLUS* is the ability to use the same output in multiple places. Instead of using the SET instruction in Stage 2, we could have just put the clamp output, 020, in all the stages where we wanted the part to remain clamped.

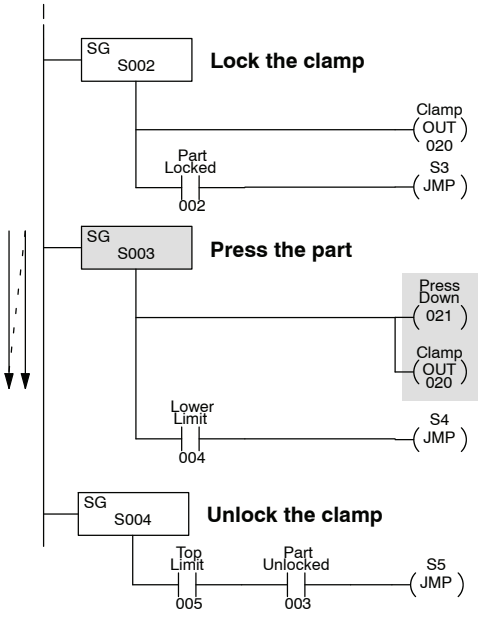
If you examine Stage 2 you'll notice output 020 is on because the stage is active. The next example shows what happens after the part is locked in place. The program moves to Stage 3 from Stage 2. Notice output 020 is now off in Stage 2. However, since we included the same clamp output in Stage 3, the part remains clamped in place.

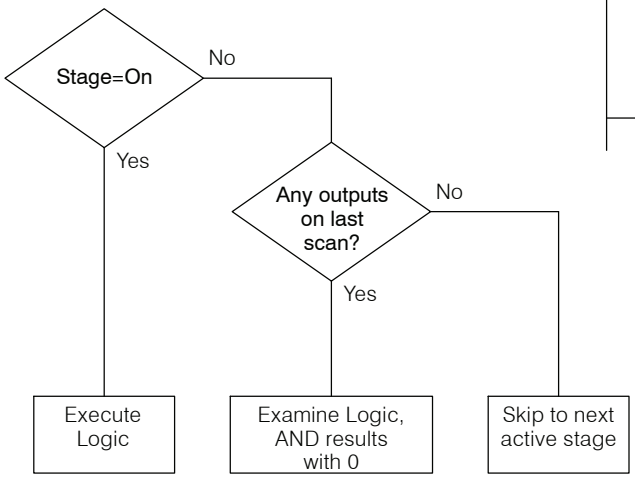
The clamp will automatically turn off when the program enters Stage 4. Notice Stage 4 does not have to have any kind of Reset instruction, since the output is automatically turned off when the program exits Stage 3.

The concept of automatically turning off the outputs sometimes confuses many people. However, the CPU just uses a very simple algorithm to determine if the output should be turned off. The following diagram shows how this algorithm works.



Next Scan after part is locked





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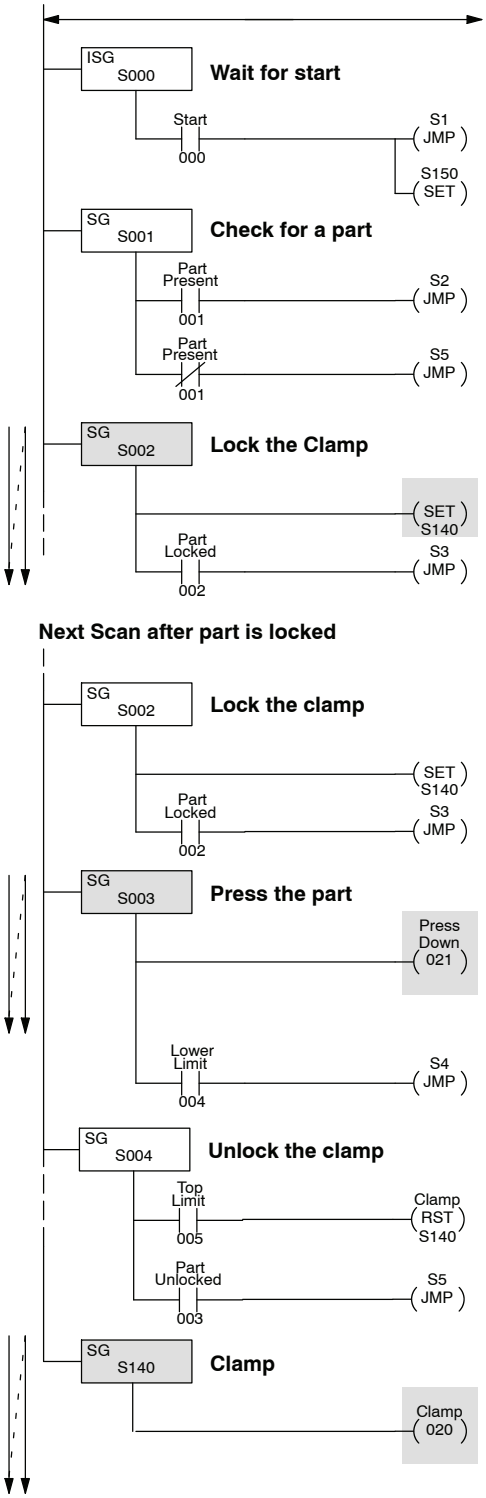
Latching Outputs with Stages

There's one more way to control outputs with the Stage instructions. You may recall once a stage is turned on, you can only turn it off by resetting it, or by having a transition from it, either by a Jump or a power flow.

What happens if you have a stage that does not have any kind of transition? What if it doesn't have a Jump instruction or any other kind of transition contact leading to another stage? Simple. The stage will stay on until it is reset by some other part of the program that uses a Reset instruction.

This makes it easy to use a stage without a transition to latch an output. For example, if you examine Stage 2 you'll notice we've now changed this part of the program again. Now this stage sets Stage 140,which will be used to control the clamp.

Notice Stage 140 does not have any type of transition. The only way to turn off the clamp is to Reset Stage 140. This instruction has now been included in Stage 4. So, after the program transitions to Stage 4, the Reset instruction will turn off Stage 140.



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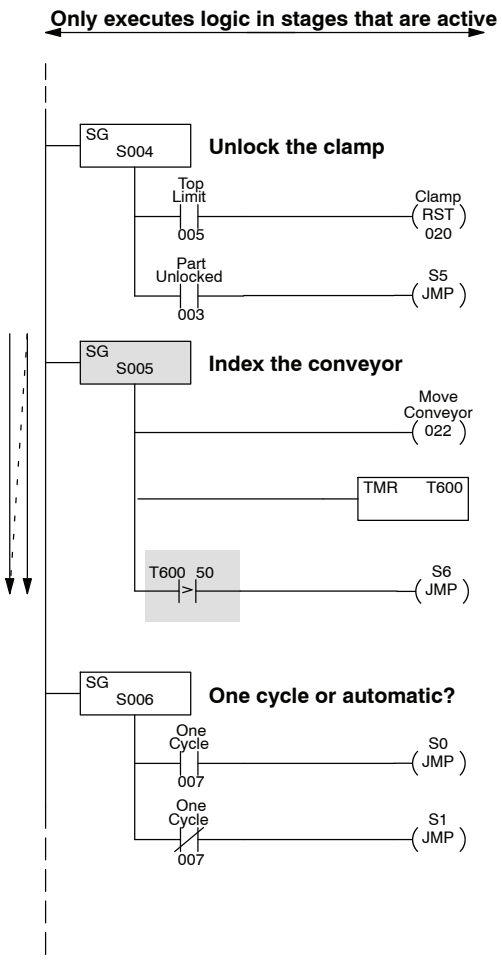
Using Timers and Counters in Stages

Time Based Transitions

Up to this point we've been using certain events that triggered the transition from stage to stage. There will probably be many cases where the transition should be related to a timer value. For example, if you know the speed of the conveyor you could use a timer to control the conveyor movement.

If we used this approach we would modify Stage 5 as shown. Notice the timer does not have a preset value. The timer begins incrementing as soon as it becomes active. Since the timer does not have a preset value, you do not have a timer contact, so you have to use a comparative instruction.

In the example shown, the conveyor will be turned on for 5 seconds and then the program will jump to the next stage.



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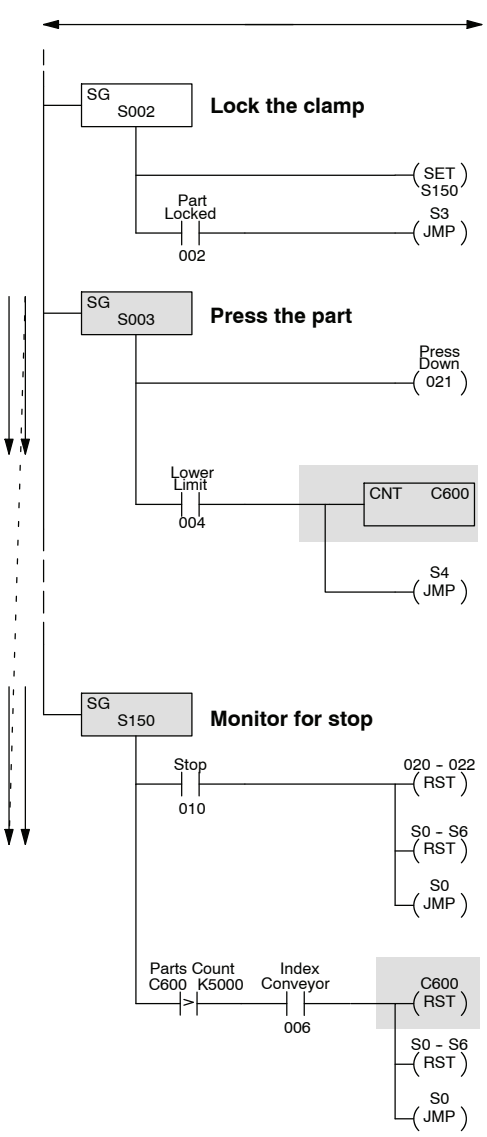
Using Counters

There will also be times when you need to count things that happen throughout the process. For example, you may want to know the number of parts produced during any given shift, or you may know the presses generally require some type of maintenance after a certain number of cycles.

If we wanted to count the number of widgets made on our simple press, we could just add a counter to Stage 4 to monitor how many times the press is used. We're also going to use the counter as an automatic shutdown when the press has made 5000 parts so we've added a new rung in Stage 150 to perform the shutdown operation.

Notice the counter does not have a reset leg. This is true only when you use a counter with the DL330P. (The other CPUs have counters with reset legs.) Even though this counter does not have a reset leg, it can be reset with a Reset instruction. This works just like an output reset, so you could place this reset wherever it is appropriate. We've placed it in Stage 150 for this example.

When the parts count reaches 5000, the program will finish the current cycle, reset the part counter, and jump to Stage 0 to wait for another start cycle. You may notice we added an additional input, 006. This is what allows the program to finish the current cycle. (You may recall 006 only came on after the part was unlocked and the conveyor was indexed.)



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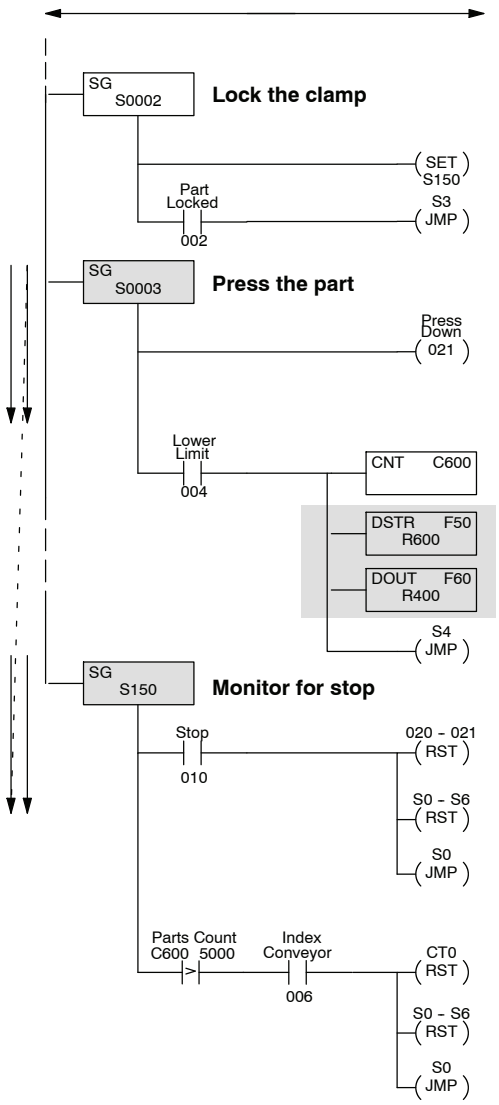
Using Data Instructions in Stages

Even though there are a few differences in the way some of the instructions operate between the various CPUs, there are many of the normal instructions that can be used inside an individual stage. For example, you may need to load data into the accumulator to perform some type of math, or, you may need to store values into register locations.

If you examine Stage 3, you'll notice we've added a couple of instructions. These instructions store the current parts count in a register.

Now the CPU will take the current parts count, stored in R600, and load it into the accumulator with the DSTR instruction. Then this 4-digit BCD count will be moved to R400 with the DOUT instruction.

This is just one example of how you can use the various types of data instructions. There are many other possibilities. Just remember, if the stage is active, the instructions can be executed. If the stage isn't active, the instructions will not even be examined.



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Using Comparative Contacts in Stages

You may recall you had to use a comparative instruction with the timers and counters. The DL330P provides several comparative contacts that are very useful. You can use these contacts to examine the relationship between a counter or timer value and a constant or register value.

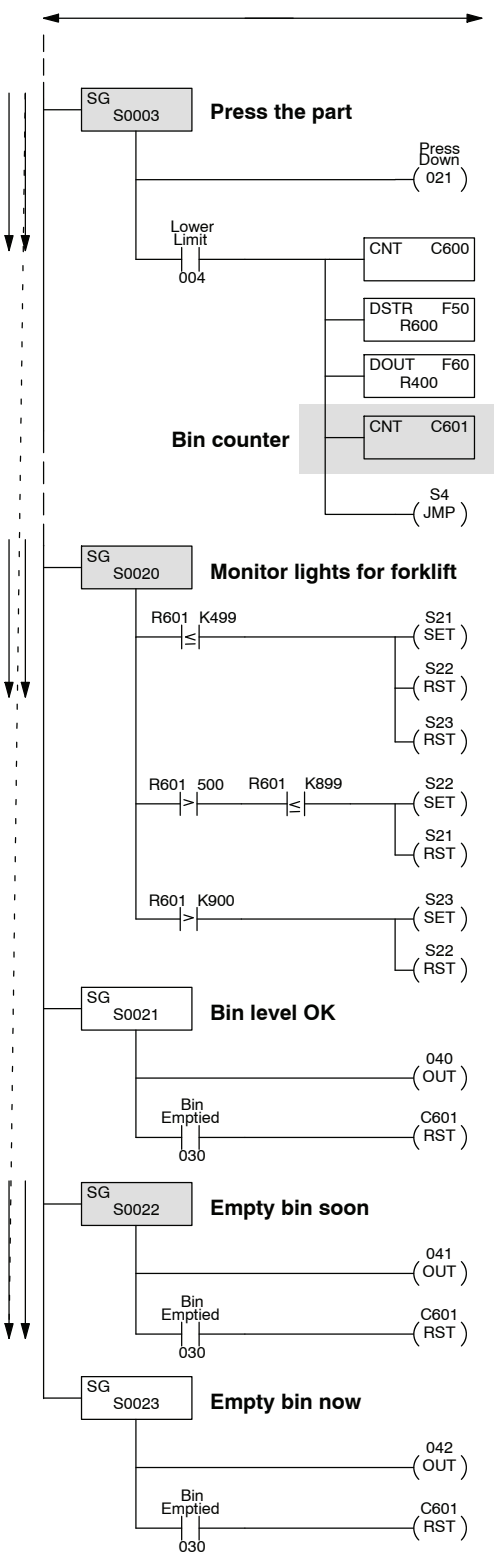
For example, let's assume the pressed widgets move off the conveyor into a holding bin. The bin can only hold 1000 widgets, so we'll add another counter, C601, to note how many widgets are in the bin. Also, we want to use different colored lights mounted on top of the press to alert a forklift driver the bin needs to be carried to the next operation. We'll use the following indicators.

Indicator	Meaning	Address	Stage
Green	OK	040	21
Yellow	Soon	041	22
Red	Urgent	042	23
Reset	Emptied	030	

Notice we've added a few more stages to monitor this condition. For this example, assume the press has made 750 widgets. This means the Yellow indicator (Stage 22) should be active.

We also need a way to reset the bin counter whenever the forklift driver empties the bin. If you examine Stage 21 through Stage 23, you'll notice we reset the bin counter whenever the bin reset (030) is active.

This example doesn't show it, but you would also have to make some changes to other parts of the program. For example, you'd need to modify the Stop Stage to shut off these stages when the machine was stopped.



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Parallel Branching Concepts

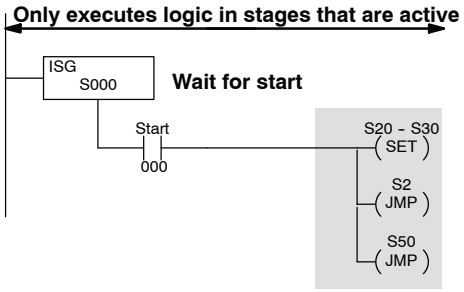
Branching Methods

As you examined some of the previous examples you saw we could have more than one stage being processed on any given scan. The CPU scanned the first active stage and then moved on to the next active stage, skipping any inactive stages in between. For some complex applications, you can easily have as many parallel paths as necessary. This is often called branching or divergence.

There are a couple of approaches you can take when you want to turn on more than one stage. The diagrams shown don't necessarily apply to our press example, but instead show the various approaches.

In this example, you use one transition contact to activate several stages.

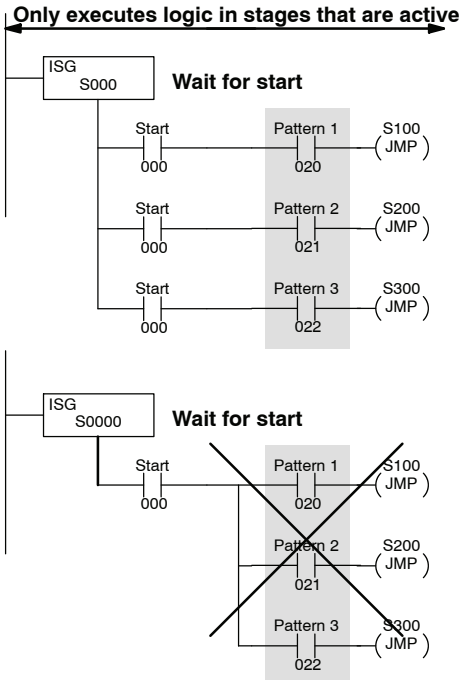
- The SET instruction sets a range of stages. These stages would remain on until they were reset, or, until any transition instructions contained within the stages were executed.
- There are two Jump instructions, both activating different stages.



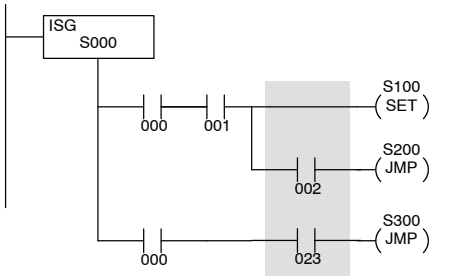
In this example, notice the stage that gets activated depends on an extra condition. For example, if the machine was capable of producing three different patterns, there may be a section of program for each pattern.

There are other types of contacts that can be used. For example, you may recall we used Comparative contacts in some earlier examples.

Notice we had to repeat the start switch in a separate rung each time. At first glance you would think you could simply have one Start switch contact and OR the remaining switches. The DL305 CPUs do support midline outputs (which is what this is called), but only in an AND situation.



You can also use midline outputs to control branching conditions. Here's an example of branching instructions that follow the guidelines for midline outputs. (This example is not for the press program, but merely shows how the midline outputs would appear.)



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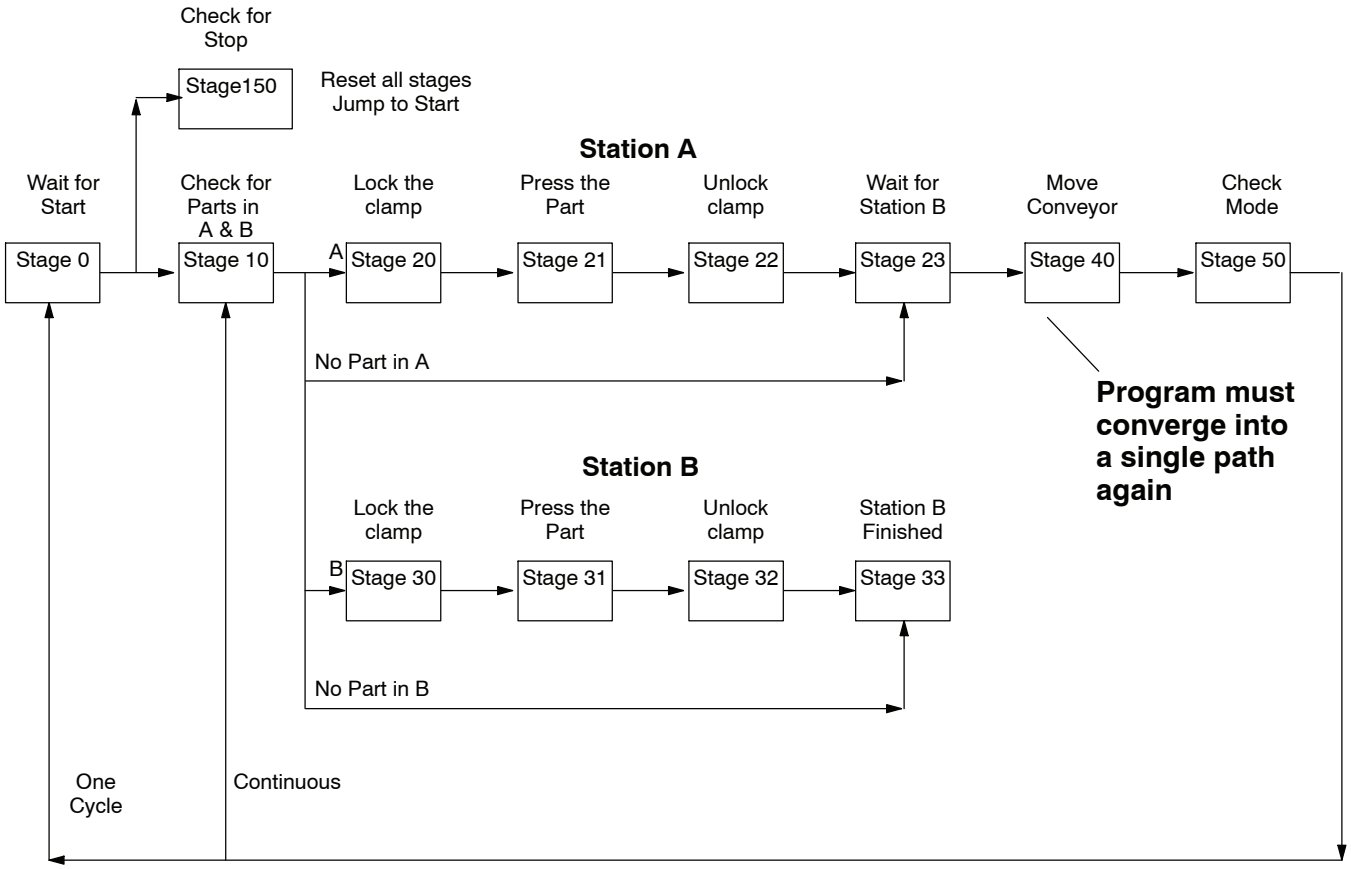
Joining Parallel Branches

There are many times you have to bring parallel branches back together at some point in the program. You may recall the stages have status bits associated with them. You can use this status bit as a contact to easily converge the parallel paths.

To illustrate this method, we're going to use a simple press with two stations. Now a widget must get pressed at each station before it is a finished product. Since there are two stations, we must make sure both operations are complete before we move the conveyor.

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Here's a flowchart that describes the two-station press. Please note we've changed some of the stage numbers, input numbers, and output numbers, so they won't necessarily match the previous examples.



You've already seen how the basic sequence of operations was executed. so we're only going to show the portions of the program that describe how the branches are joined together.

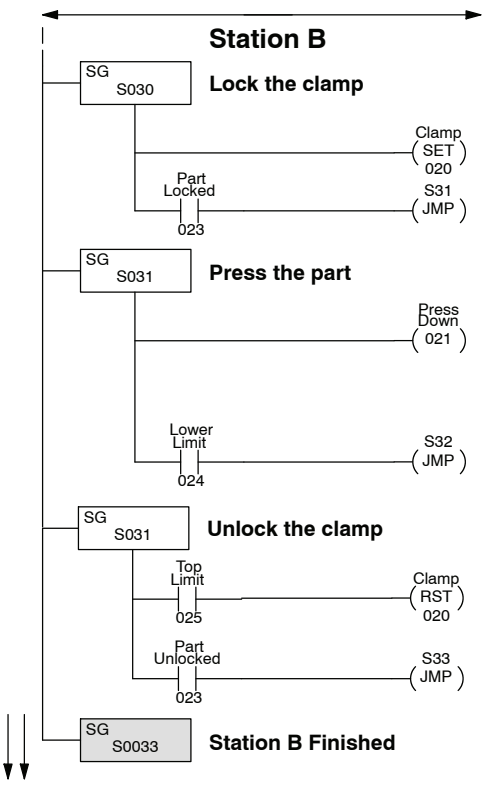
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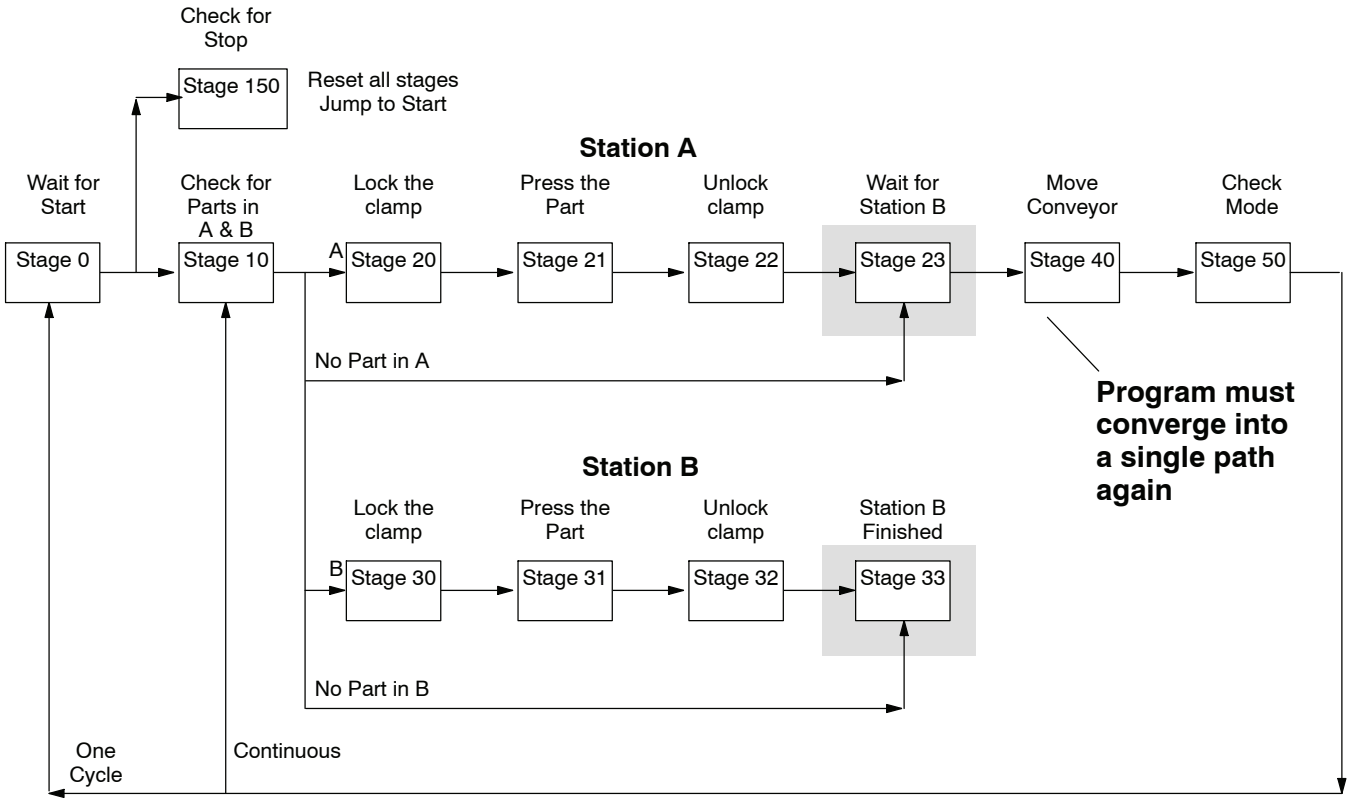
Using Stage Bits as Contacts

If you examine the flowchart you'll notice once the part is unclamped in station B, the program transitions to Stage 33 which indicates Station B is complete.

If you look at that portion of the program shown here, you'll notice there are no other instructions or actions that take place in this stage. This is why we call it a "dummy" stage. We're just going to use the status of the stage bit associated with this dummy stage as a contact elsewhere in the program to indicate station B is finished.

You may be wondering how we can turn off this stage. Since it does not have any type of jump or power flow transition, the only other option is to Reset the stage. We'll do this later in the program.



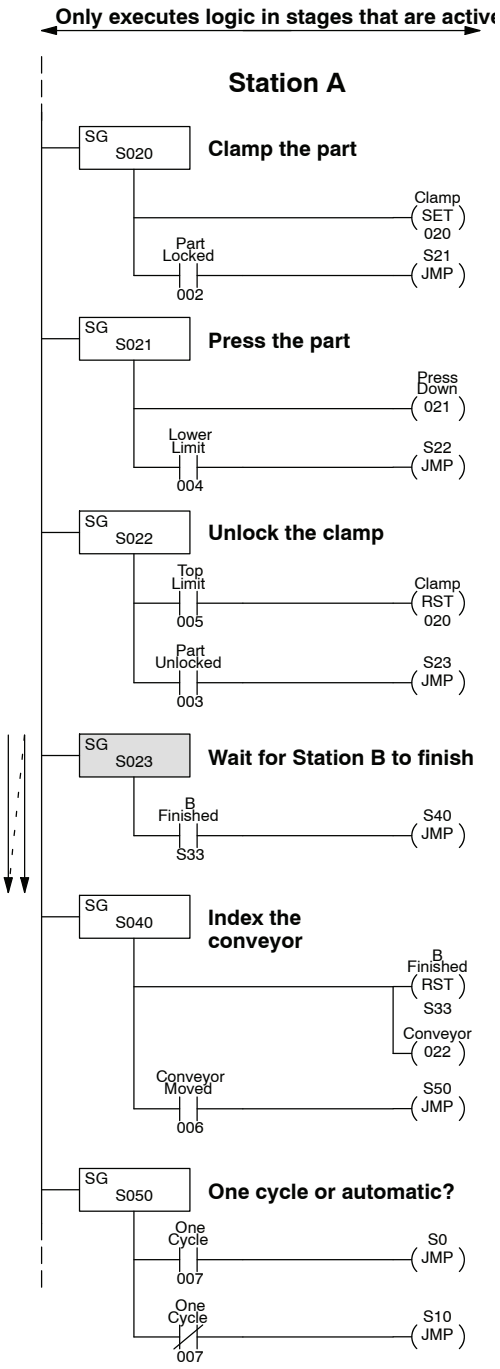


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Stage Contact Example

Since each stage has a status bit that is either on or off, you can use this bit as a contact in the program. If you examine Stage 23 you'll notice we've used a contact labeled S33. This contact reflects the status of Stage 33, which indicated Station B was finished.

When S33 is on, the contact labeled S33 is also on and the program will transition to Stage 40. In Stage 40 we use a reset instruction to reset Stage 33 before we move the conveyor.



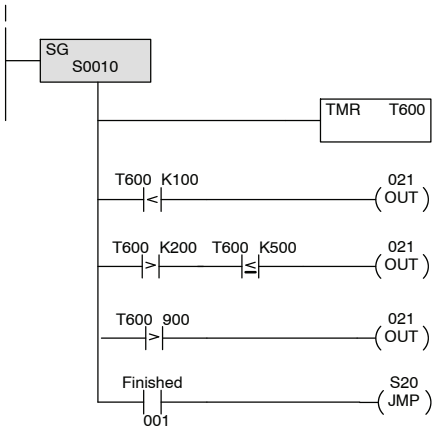
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Unusual Operations in Stages

Over the last few pages you've learned how the CPU executes the Stage instructions. However, there are a few unusual circumstances that may not work exactly as the appear.

Using the Same Output Multiple Times

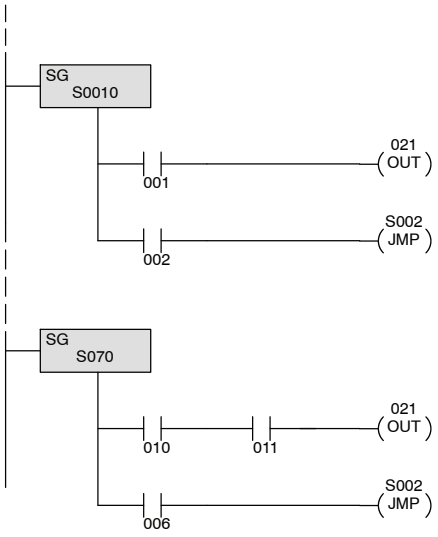
In the program shown it appears output 021 will be turned on at three separate times before the program jumps to the next stage. However, the only time the output actually comes on is when the final condition has been met.



Why? Remember if you use multiple outputs in a program, the last rung containing the output controls the status that will be written to the module. This is no different in a program that uses RLL*PLUS* instructions.

In this example, the last comparison rung says the output should be off until the timer value reaches 90 seconds.

In the previous example the same output was used multiple times in the same stage. The last use of the output controlled the status of the output.



There may be occasions when you have the same output in different stages. Even though it's not advisable to do this in normal RLL programs, this is perfectly acceptable with a program that uses RLL*PLUS* instructions. However, if both stages are active at the same time, then the logic in the last stage will control the status of the output.

In the example shown, if both stages are active, then the logic in Stage 70 will control the output status.

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Using a Set Out Reset (SET OUT RST) Instruction

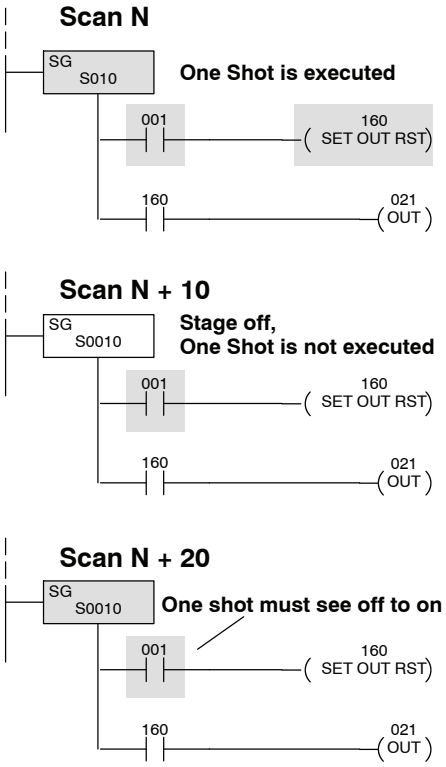
Many normal RLL programs use one-shot instructions. In the DL305 instruction set, this instruction is called a Set Out Reset (SET OUT RST).

In the program shown, input 001 will trigger the SET OUT RST 160 instruction, which will in turn activate output 021 for one scan.

However, what happens if 001 stays on and Stage 10 is activated, deactivated, and then activated again? At first glance it appears the one shot only gets executed one time since 001 stayed on while Stage 10 was turning on and off. It doesn't work this way.

The logic in an inactive stage is not executed. So even though the stage became active the SET OUT RST instruction did not see an off to on transition, so the instruction is not executed.

The SET OUT RST instruction will work in an active stage as long as the input transitions from off to on while the stage is active.



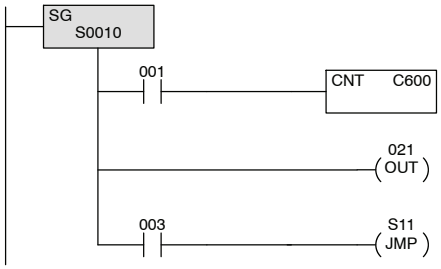
Output Placement

As you've seen in some of the previous examples, we always place unconditional outputs immediately following the Stage Instructions. There's a reason for doing this.

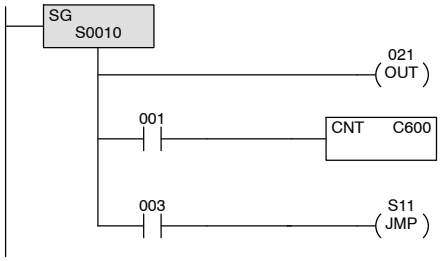
If you look at the example stage shown here, the output is placed after a counter box. The ***Direct***SOFT software and the Handheld Programmer will allow you to enter this as shown. However, the CPU will only turn on output 021 when the counter input 001 is turned on. This is because the CPU interprets the output as being tied to the counter input leg instead of the Stage power rail.

You can easily avoid this problem by placing any unconditional actions at the very beginning of the stage. Then, the output will work the way you expect.

Incorrect Placement



Correct Placement

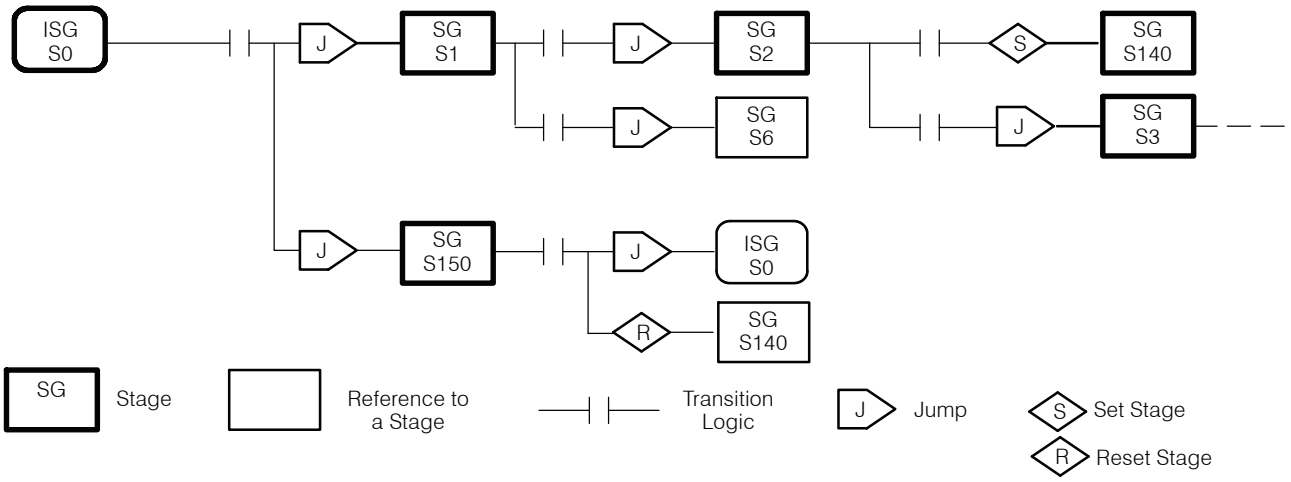


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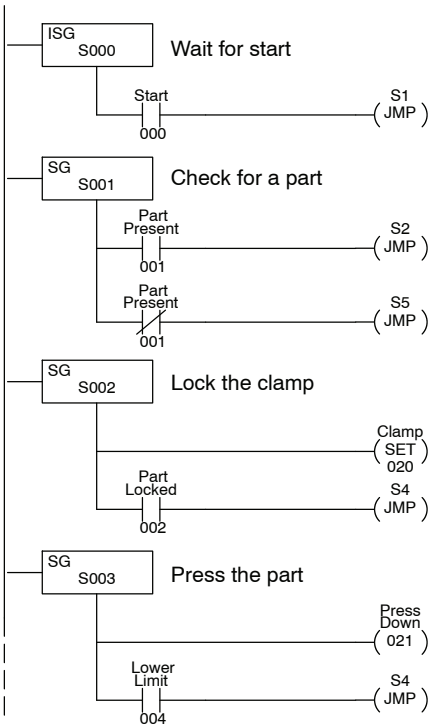
Two Ways to View RLL*PLUS* Programs

Throughout the example programs, we've consistently shown how the instructions appear in when viewed as ladder instructions. However, with ***Direct***SOFT, you also have the capability to view the program as a flowchart. You can even view the program flowchart (in Stage View) and view the ladder program at the same time with a split screen feature. The ***Direct***SOFT manual provides detailed information on how to view the programs in this manner.

DirectSOFT
Stage View



DirectSOFT
Ladder View



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Designing a Program Using RLL*PLUS* Instructions

As with most any application problem, a thorough understanding of the tasks combined with a good plan of execution often results in success. The RLL*PLUS* instructions provide an easy way to load the plan of execution directly into the CPU. The easiest way to make sure you understand the tasks is to make a flowchart. This is often the most critical part of creating a program that uses RLL*PLUS* instructions. There are a few simple steps you can follow to create a detailed flowchart.

1. Create a top-level flowchart.
2. Expand the flowchart by adding things that cause the transitions from step to step.
3. Add any actions that must occur in each step.
4. Add any conditions that control the actions.
5. Add any special monitoring or alarm steps that must be performed.
6. Assign numbers to the stages (steps).
7. Add the I/O instructions and addresses (input contacts, output coils, jump instructions, etc.)
8. Enter the program.

Use *Direct*SOFT to Save Time

The ***Direct***SOFT programming package allows you to quickly and easily create programs with RLL*PLUS* instructions. The software has special features that allow you to create the flowcharts, add the transitions, actions, etc. Even if your programs are fairly small, ***Direct***SOFT can make the job much easier.

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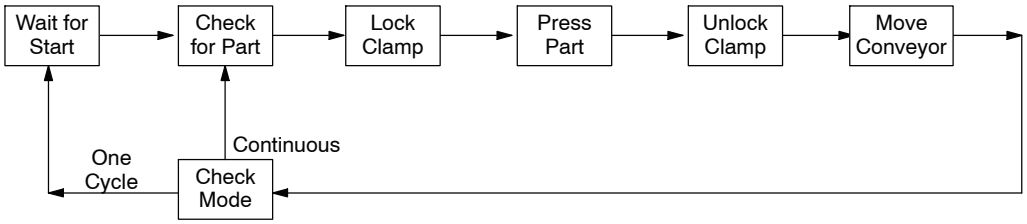
Step 1: Design a Top-level Flowchart

There are many different ways to design a flowchart of the application problem, but there are a few guidelines that will make the job easier.

1. Start with a “top-level” flowchart that breaks the operation sequence into simple pieces.
2. Each piece of the top-level flowchart should only represent one action. Resist the temptation to group several operations into one part of the flowchart.
3. Don’t try to add input or output addresses to the flowchart. Only use words to describe the things that are taking place.
4. Don’t worry about special conditions, such as stop conditions, alarms, etc at this point. These will be added later when you fully understand how the main part of the operations sequence is organized.

You can draw the flowchart horizontally or vertically at any point in the design process, the choice is yours. Here’s an example top level flowchart for our simple one-station press.

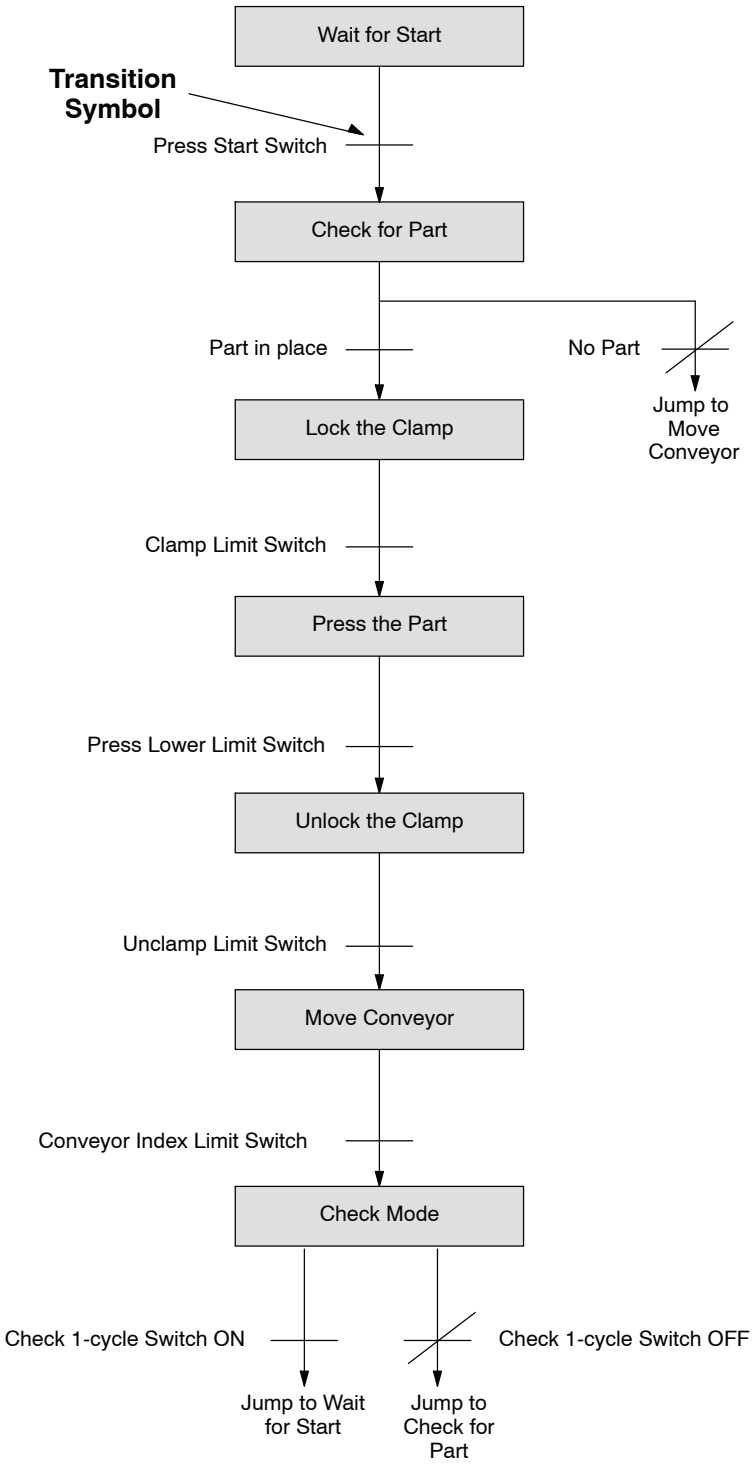
The flowchart breaks the program into logical steps



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Step 2: Add Flowchart Transitions

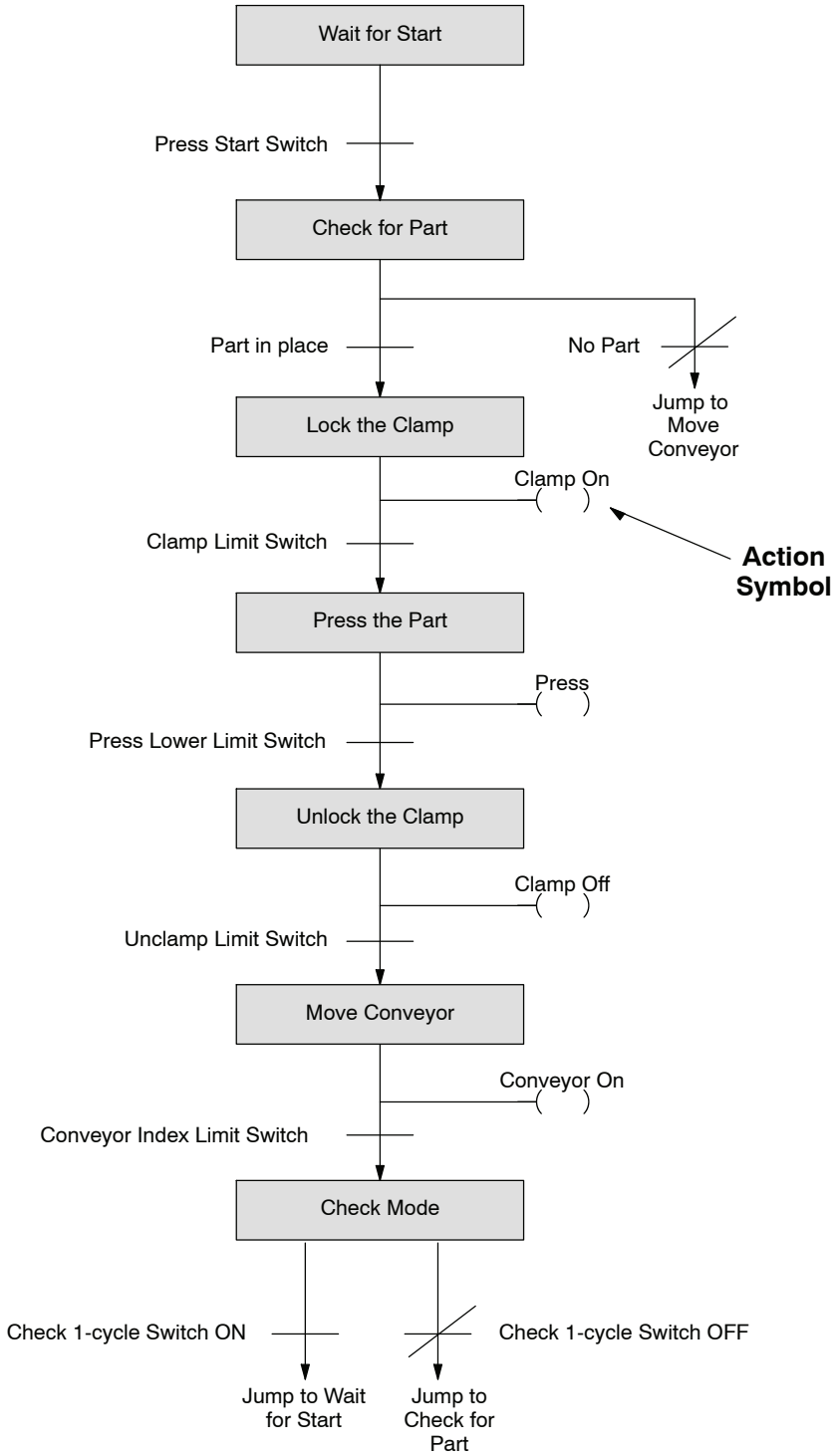
Once you have designed the basic operating sequence you should determine the events that cause a transition from step to step. During this phase you may find things need to be added to the flowchart. All you're really doing is adding more detail to the top-level flowchart. Once again, don't try to use addresses yet. Concentrate on using words to describe the events taking place. The following flowchart adds the transition conditions for our one-station press.



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Step 3:
Add Actions

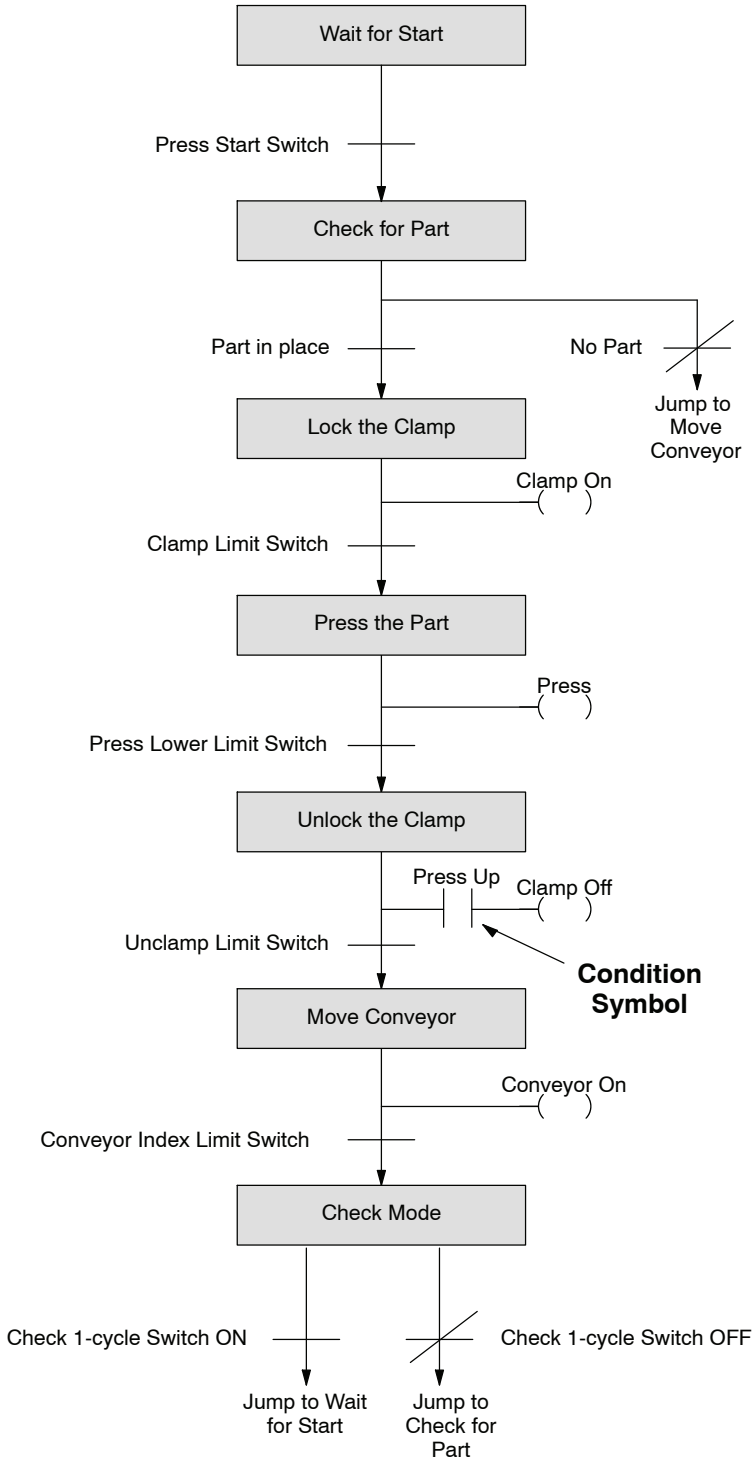
After you determine the events that cause a transition from step to step you should add any actions that need to take place during the sequence. Again, don't try to use addresses yet. Concentrate on using words to describe the actions taking place. The following flowchart adds the actions that take place during each part of the program.



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Step 4: Add Conditions for Actions

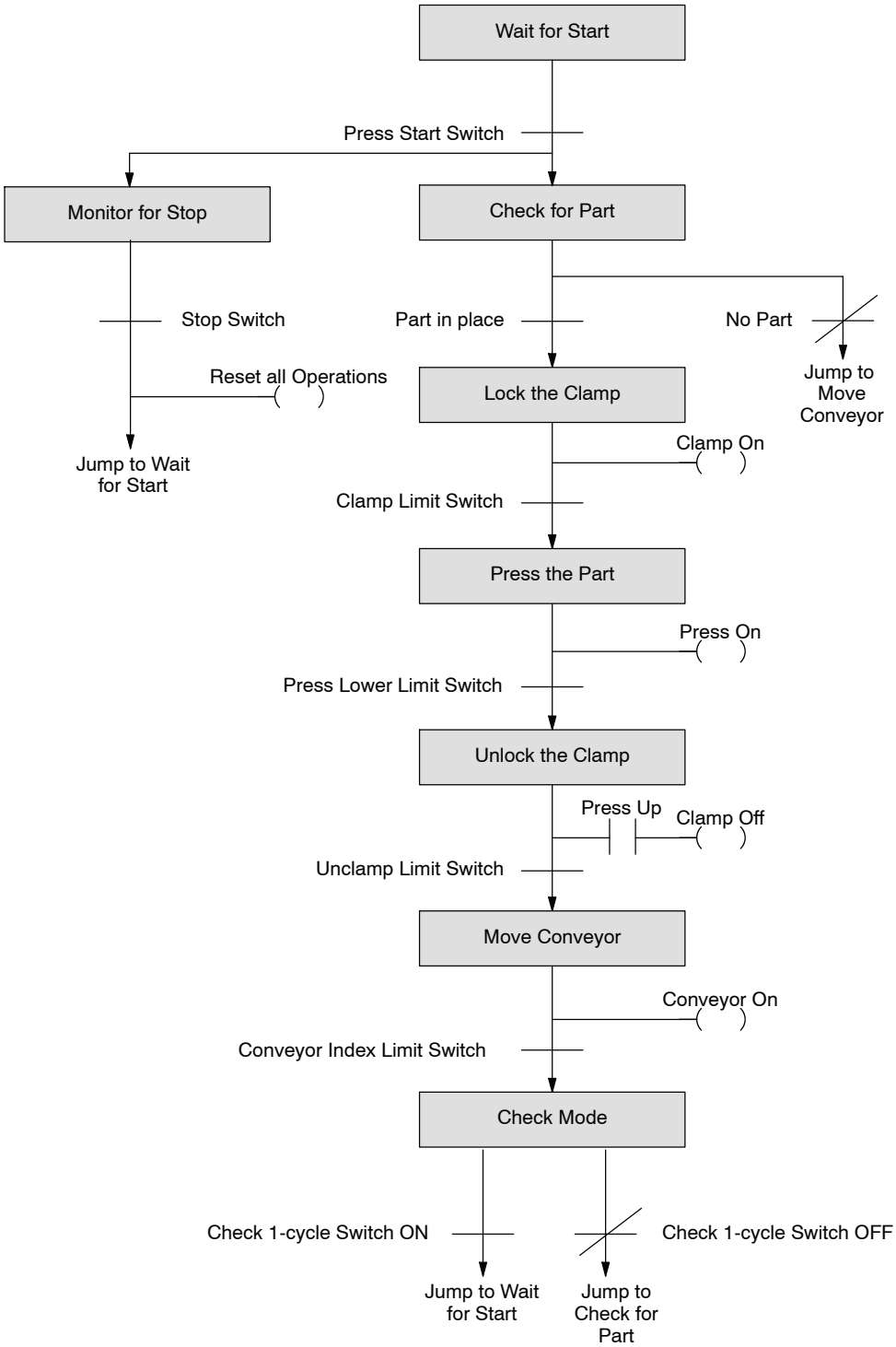
Some actions may only take place if certain conditions are met. Examine the program carefully to determine any conditions that should be added. The following flowchart adds any conditions for the actions that take place during each part of the program.



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Step 5: Add Alarm or Monitoring Operations

Many people are tempted to add alarm or monitoring operations earlier in the flowchart design process. It is almost always easier to add them last because then you know how they should affect the main part of the program. The following flowchart adds an operation that monitors for the conditions that will stop the press.



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Step 6: Determine Stage Numbering

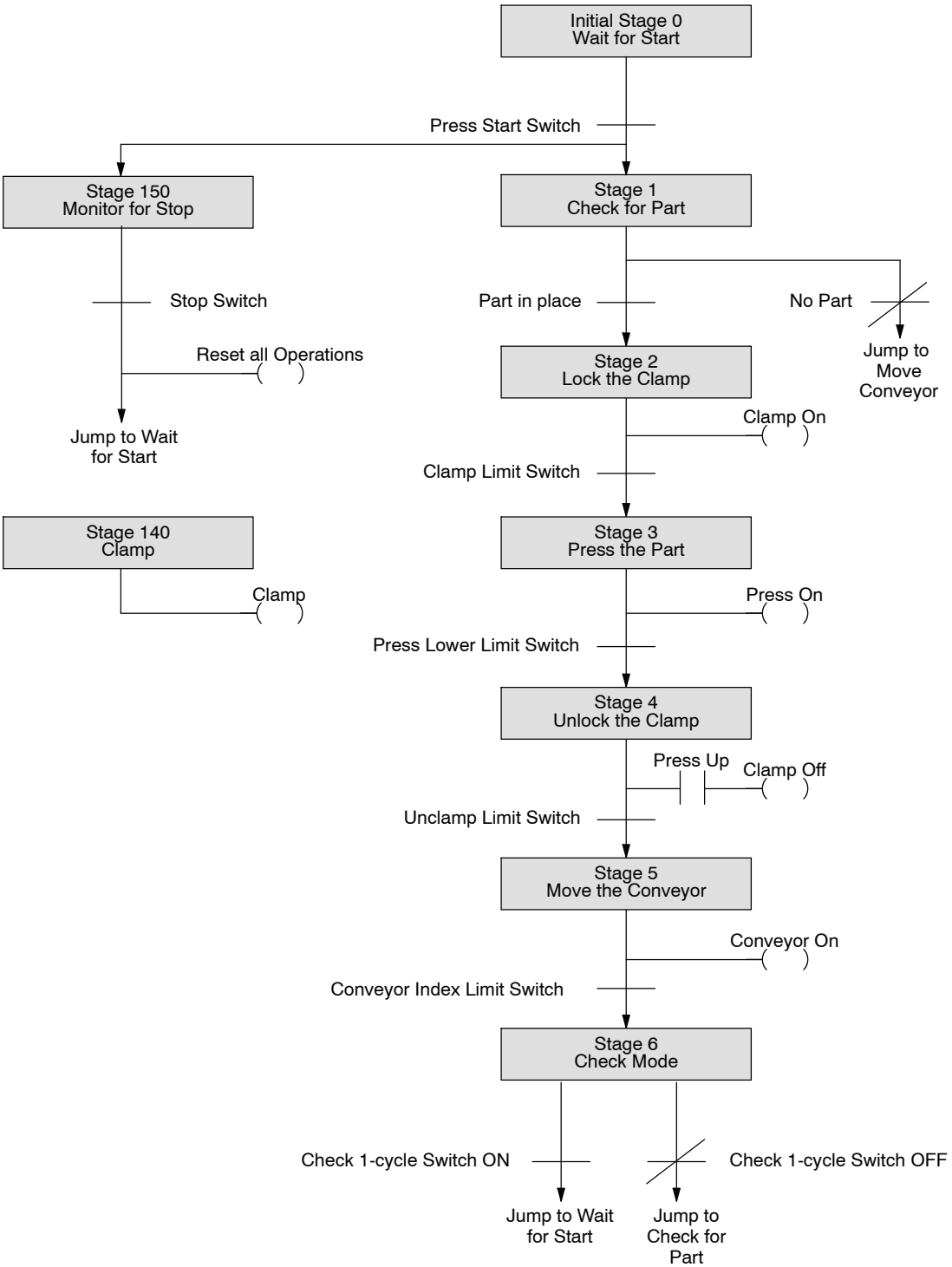
You can number the stages any way you would like, but it's usually best to follow some type of sequence that matches the flow of the program. This makes it much easier to understand. There are a few guidelines we have used to determine the best numbering sequence. You don't have to follow these guidelines, but they may help. You can typically find these types of operations in any program.

- Sequential Operations — a certain sequence of events, one after the other. This is usually the main part of the program. It's usually best to number these first. For example, you may want to always number these stages from 0 – 127 (octal).
- Independent Operations — these operations usually only perform one task, such as activating a motor or turning on a horn. For example, you may want to number all independent operations starting from 130 – 147 (octal).
- Alarm and Monitoring Operations — These operations usually monitor the main parts of the program. Since you may want to reset parts of the program during an alarm condition, it is usually best to number these last. This way you can use one Reset (RST) instruction to reset almost the entire program. Use stages 150 – 177 for alarming and monitoring stages.

These guidelines are especially helpful if you have many different programs. By using a standard numbering scheme, you always know where to look for the various types of operations.

The example shows how we assigned numbers for the example press. Notice we've also made a separate stage for the clamp. This was not an absolute requirement because there are several ways you could have done this. We just did it to show you an example of an independent operation.

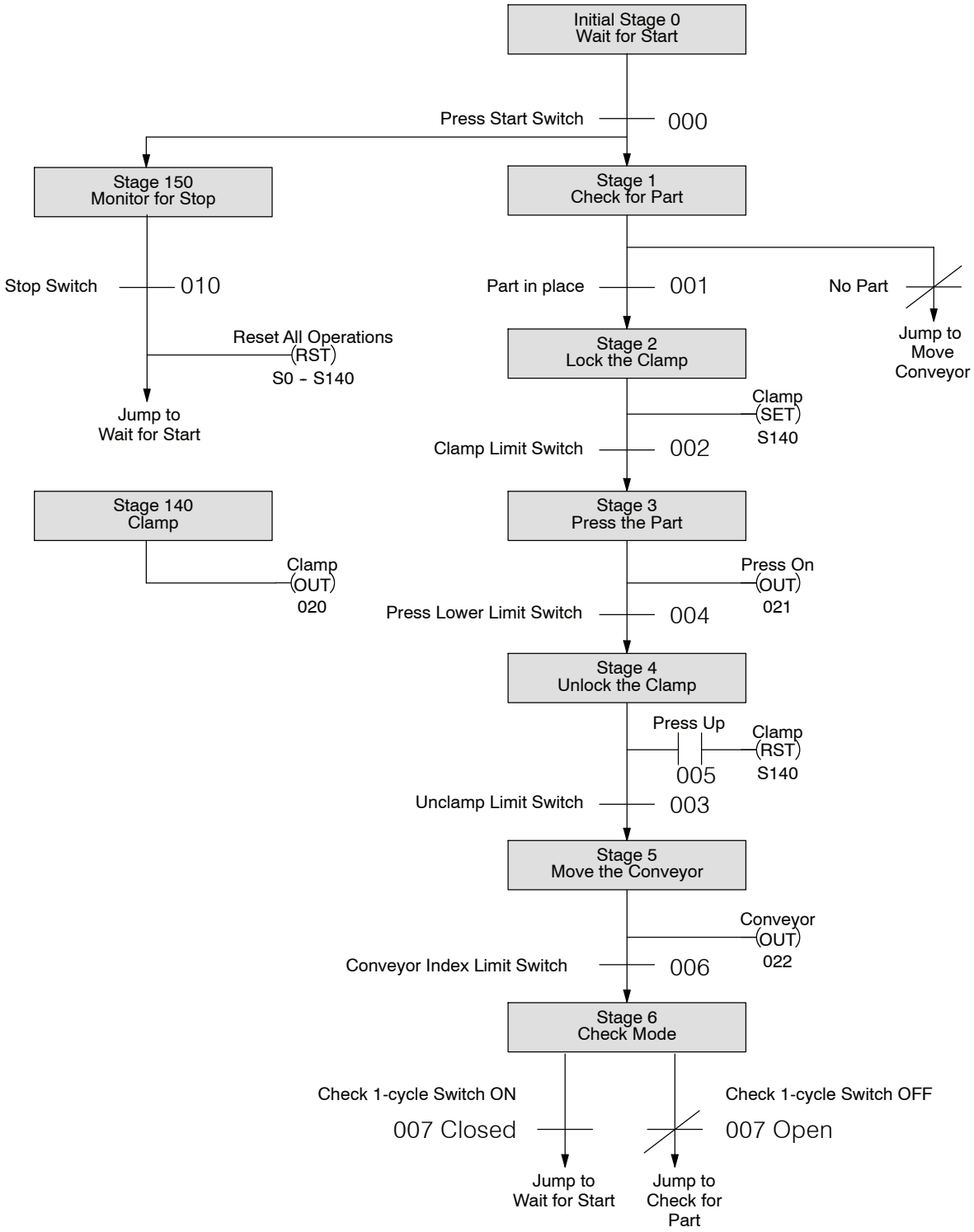
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Step 7: Assign I/O Addresses

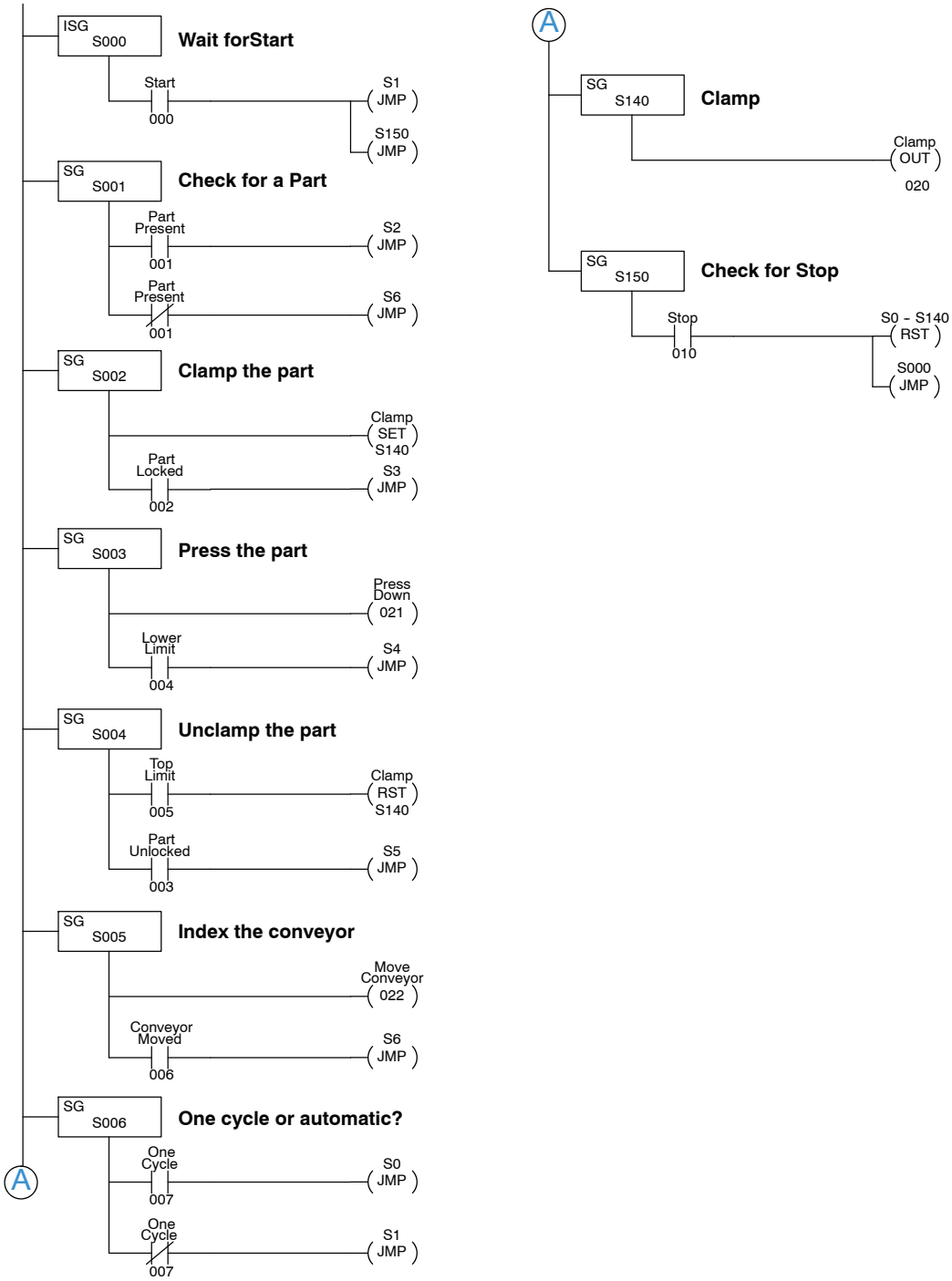
The final step before you enter the program is to assign the I/O addresses and the destinations for any Jump, Set, or Reset instructions.



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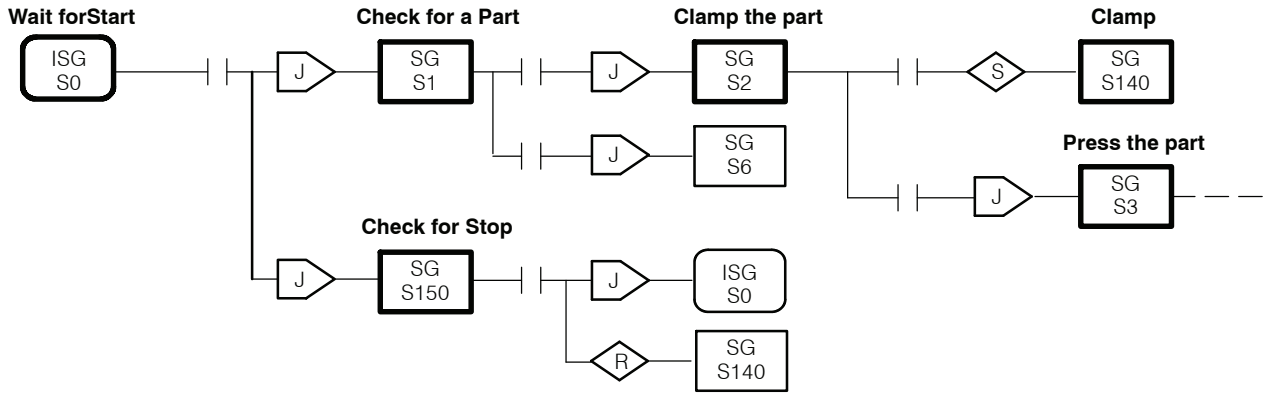
Step 8:
Enter the Program

The following diagram shows how the program would look when viewed as a ladder program.



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This diagram shows how a portion of the program would look when viewed as a Stage Diagram in ***Direct***SOFT.



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11

Instruction Set

In This Chapter. . . .

- Boolean Instructions
- Comparative Boolean Instructions
- Timer, Counter, and Shift Register Instructions
- Accumulator Load and Output Instructions
- Accumulator Logic Instructions
- Math Instructions
- Bit Operation Instructions
- Number Conversion Instructions
- Program Control Instructions
- Network Instructions
- Message Instructions

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Introduction

The DL305 CPUs offer a wide variety of instructions to perform many different types of operations. This chapter shows you how to use these individual instructions. The following table provides a quick reference listing of the instruction mnemonic and the page(s) defining the instruction. (The mnemonics are very similar to the instruction names and should be easy to become familiar with in a short time.) For example STR NOT (Comparative) is the mnemonic for Store Not Equal. Each instruction definition will show in parentheses the keystrokes used to enter the instruction.

There are two ways to quickly find the instruction you need.

- If you know the instruction category (Boolean, Comparative Boolean, etc.) just use the header at the top of the page to find the pages that discuss the instructions in that category.
- If you know the individual instruction mnemonic, use the following table to find the page that discusses the instruction.

The DL330 and DL340 instructions sets are very similar. However, the DL330P instruction set has several differences. Some of the instructions in this chapter will be labeled “DL330/DL340 Only.” There may be an equivalent instruction for the DL330P CPU, but it may also work slightly differently. The DL330P instructions that operate differently from these instructions are discussed in Chapter 12. Make sure you review the instructions carefully to make sure you can use the instruction with your CPU.

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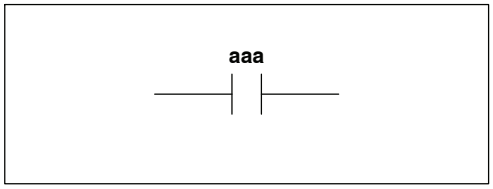
NOTE: See Chapter 12 for RLL*PLUS* instructions.

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Boolean Instructions

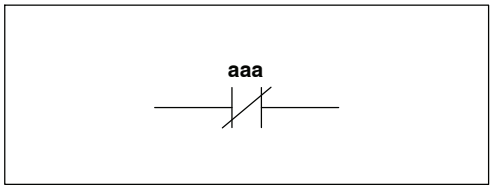
Store (STR)

The Store instruction begins a new rung or additional branch in a rung with a normally open contact. Status of the contact will be the same state as the associated image register point or memory location.



Store Not (STR NOT)

The Store Not instruction begins a new rung or additional branch in a rung with a normally closed contact. Status of the contact will be opposite the state of the associated image register point or memory location.



Data Type	D3-330 Range	D3-340 Range	D3-330P Range
	aaa	aaa	aaa
Inputs / Outputs	000-167 700-767	000-177 700-767	000-167 700-767
Control Relays	160-373	160-373 1000-1067	160-174 200-77
Special Control Relays	374-377 770-777	374-377 770-777 1074-1077	175-177 770-777
Shift Register Bits	400-577	400-577	--

In the following Store example, when input 000 is on, output 010 will energize.

***Direct*SOFT Display**



Handheld Programmer Keystrokes

STR	SHF	0	ENT	
OUT	SHF	1	0	ENT

In the following Store Not example, when input 000 is off output 010 will energize.

***Direct*SOFT Display**



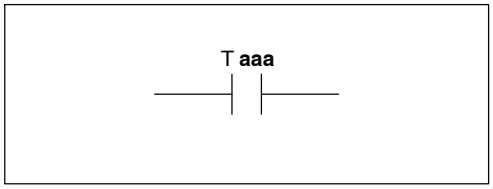
Handheld Programmer Keystrokes

STR	NOT	SHF	0	ENT
OUT	SHF	1	0	ENT

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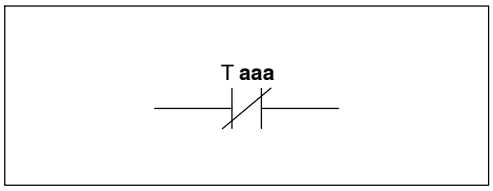
Store Timer (STR TMR) DL330/340 Only

The Store Timer instruction begins a new rung or additional branch in a rung with a normally open timer contact. The timer contact T aaa will be on when the timer current value is ≥ the preset value of the associated timer.



Store Not Timer (STR NOT TMR) DL330/340 Only

The Store Not Timer instruction begins a new rung or additional branch in a rung with a normally closed timer contact. The timer contact T aaa will be on when the timer current value is < the preset value of the associated timer.



Data Type		D3-330 Range	D3-340 Range	D3-330P Range*
		aaa	**aaa**	**aaa**
Timer	T	600-677	600-677	--

* See Chapter12 for similar RLL*PLUS* instructions

In the following Store Timer example, when the current value in timer 600 is ≥ the preset value output 017 will energize.

DirectSOFT Display



Handheld Programmer Keystrokes

STR	TMR	SHF	6	0	0	ENT
OUT	SHF	1	7	ENT		

In the following Store Not Timer example, when the current value in timer 600 is < the preset value output 017 will energize.

DirectSOFT Display



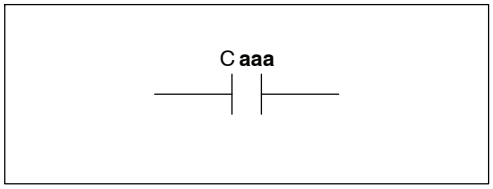
Handheld Programmer Keystrokes

STR	NOT	TMR	SHF	6	0	0	ENT
OUT	SHF	1	7	ENT			

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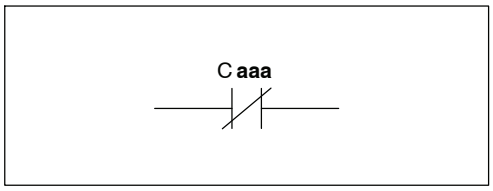
Store Counter (STR CNT) DL330/340 Only

The Store Counter instruction begins a new rung or additional branch in a rung with a normally open counter contact. The counter contact C aaa will be on when the counter current value ≥ the preset value of the associated counter.



Store Not Counter (STR NOT CNT) DL330/340 Only

The Store Not Counter instruction begins a new rung or additional branch in a rung with a normally closed counter contact. The counter contact C aaa will be on when the counter current value is < the preset value of the associated counter.



Data Type		D3-330 Range	D3-340 Range	D3-330P Range*
		aaa	aaa	aaa
Counter	C	600-677	600-677	--

* See Chapter 12 for similar RLL*PLUS* instructions

In the following Store Counter example, when the current value in counter 602 is ≥ the preset value output 015 will energize.

DirectSOFT Display



Handheld Programmer Keystrokes

STR	CNT	SHF	6	0	2	ENT
OUT	SHF	1	5	ENT		

In the following Store Not Counter example, when the current value in counter 602 is < the preset value output 015 will energize.

DirectSOFT Display



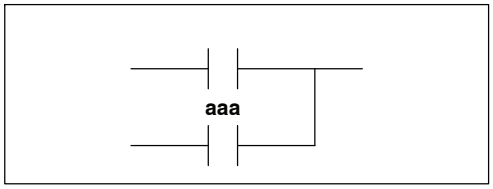
Handheld Programmer Keystrokes

STR	NOT	CNT	SHF	6	0	2	ENT
OUT	SHF	1	5	ENT			

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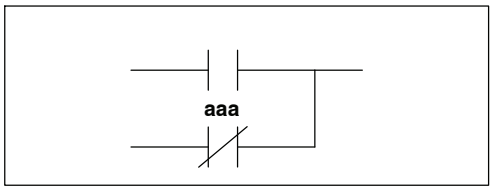
Or (OR)

The Or instruction logically ors a normally open contact in parallel with another contact in a rung. The status of the contact will be the same state as the associated image register point or memory location.



Or Not (OR NOT)

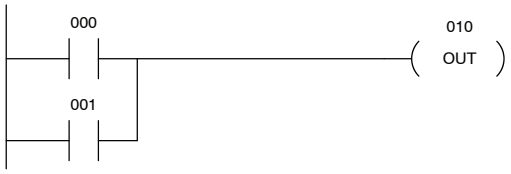
The Or Not instruction logically ors a normally closed contact in parallel with another contact in a rung. The status of the contact will be opposite the state of the associated image register point or memory location.



Data Type	D3-330 Range	D3-340 Range	D3-330P Range
	aaa	aaa	aaa
Inputs / Outputs	000-167 700-767	000-177 700-767	000-167 700-767
Control Relays	160-373	160-373 1000-1067	160-174 200-77
Special Control Relays	374-377 770-777	374-377 770-777 1074-1077	175-177 770-777
Shift Register Bits	400-577	400-577	--

In the following Or example, when input 000 or 001 is on output 010 will energize.

***Direct*SOFT Display**



Handheld Programmer Keystrokes

STR	SHF	0	ENT	
OR	SHF	1	ENT	
OUT	SHF	1	0	ENT

In the following Or Not example, when input 000 is on or 001 is off output 010 will energize.

***Direct*SOFT Display**



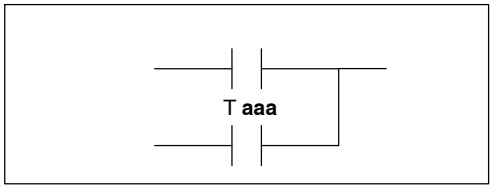
Handheld Programmer Keystrokes

STR	SHF	0	ENT	
OR	NOT	SHF	1	ENT
OUT	SHF	1	0	ENT

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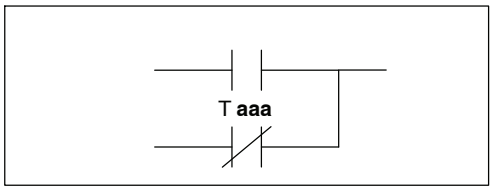
Or Timer (OR TMR) DL330/340 Only

The Or Timer instruction logically ors a normally open timer contact in parallel with another contact in a rung. The timer contact T aaa will be on when the timer current value is ≥ the preset value of the associated timer.



Or Not Timer (OR NOT TMR) DL330/340 Only

The Or Not Timer instruction logically ors a normally closed timer contact in parallel with another contact in a rung. The timer contact T aaa will be on when the timer current value is < the preset value of the associated timer.

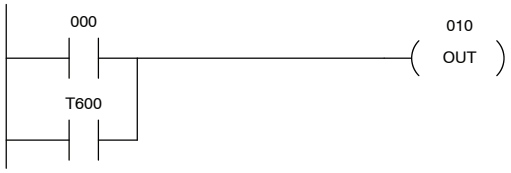


Data Type		D3-330 Range	D3-340 Range	D3-330P Range*
		aaa	aaa	aaa
Timer	T	600-677	600-677	--

* See Chapter 12 for similar RLL*PLUS* instructions

In the following Or Timer example, when input 000 is on or the current value in T600 is ≥ the preset value output 010 will energize.

DirectSOFT Display



Handheld Programmer Keystrokes

STR	SHF	0	ENT				
OR	TMR	SHF	6	0	0	ENT	
OUT	SHF	1	0	ENT			

In the following Or Not Timer example, when input 000 is on or the current value in T600 is < the preset value output 010 will energize.

DirectSOFT Display



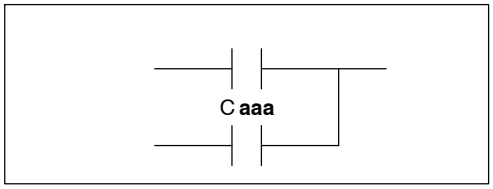
Handheld Programmer Keystrokes

STR	SHF	0	ENT				
OR	NOT	TMR	SHF	6	0	0	ENT
OUT	SHF	1	0	ENT			

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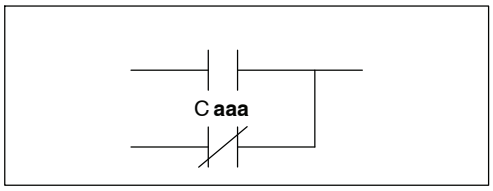
Or Counter (OR CNT) DL330/340 Only

The Or Counter instruction logically ors a normally open counter contact in parallel with another contact in a rung. The counter contact C aaa will be on when the counter current value is ≥ the preset value of the associated counter.



Or Not Counter (OR NOT CNT) DL330/340 Only

The Or Not Counter instruction logically ors a normally closed counter contact in parallel with another contact in a rung. The counter contact C aaa will be on when the counter current value is < the preset value of the associated counter.

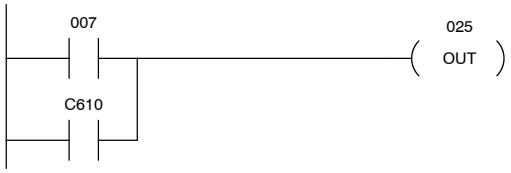


Data Type		D3-330 Range	D3-340 Range	D3-330P Range*
		aaa	aaa	aaa
Counter	C	600-677	600-677	--

* See Chapter 12 for similar RLL*PLUS* instructions

In the following Or Counter example, when input 007 is on or the current value in C610 is ≥ the preset value output 025 will energize.

DirectSOFT Display



Handheld Programmer Keystrokes

STR	SHF	7	ENT				
OR	CNT	SHF	6	1	0	ENT	
OUT	SHF	2	5	ENT			

In the following Or Not Counter example, when input location 007 is on or the current value in C610 is < the preset value output 025 will energize.

DirectSOFT Display



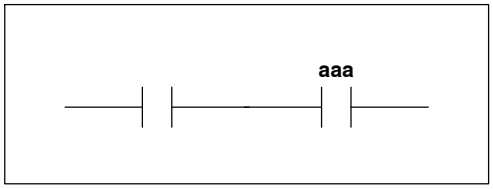
Handheld Programmer Keystrokes

STR	SHF	7	ENT				
OR	NOT	CNT	SHF	6	1	0	ENT
OUT	SHF	2	5	ENT			

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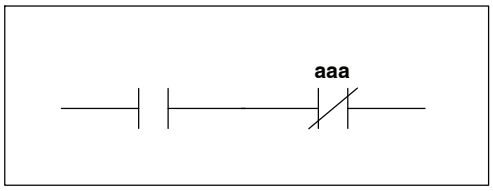
And (AND)

The And instruction logically ands a normally open contact in series with another contact in a rung. The status of the contact will be the same state as the associated image register point or memory location.



And Not (AND NOT)

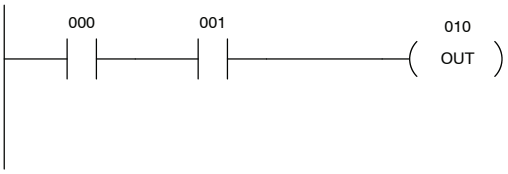
The And Not instruction logically ands a normally closed contact in series with another contact in a rung. The status of the contact will be opposite the state of the associated image register point or memory location.



Data Type	D3-330 Range	D3-340 Range	D3-330P Range
	aaa	aaa	aaa
Inputs / Outputs	000-167 700-767	000-177 700-767	000-167 700-767
Control Relays	160-373	160-373 1000-1067	160-174 200-77
Special Control Relays	374-377 770-777	374-377 770-777 1074-1077	175-177 770-777
Shift Register Bits	400-577	400-577	--

In the following And example, when input 000 and 001 is on output 010 will energize.

DirectSOFT Display

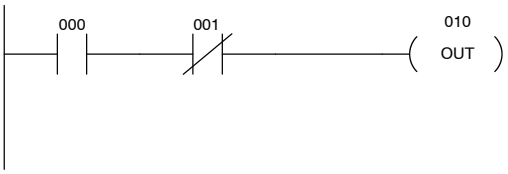


Handheld Programmer Keystrokes

STR	SHF	0	ENT	
AND	SHF	1	ENT	
OUT	SHF	1	0	ENT

In the following And Not example, when input 000 is on and 001 is off output 010 will energize.

DirectSOFT Display



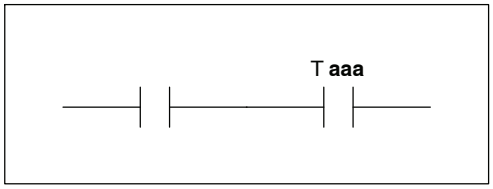
Handheld Programmer Keystrokes

STR	SHF	0	ENT	
AND	NOT	SHF	1	ENT
OUT	SHF	1	0	ENT

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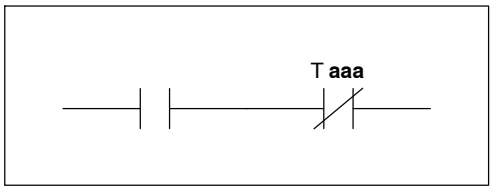
And Timer (AND TMR) DL330/340 Only

The And Timer instruction logically ands a normally open timer contact in series with another contact in a rung. The timer contact T aaa will be on when the timer current value ≥ the preset value of the associated timer.



And Not Timer (AND NOT TMR) DL330/340 Only

The And Not Timer instruction logically ands a normally closed timer contact in series with another contact in a rung. The timer contact T aaa will be on when the timer current value is < the preset value of the associated timer.

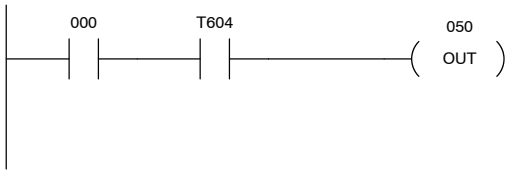


Data Type		D3-330 Range	D3-340 Range	D3-330P Range*
		aaa	aaa	aaa
Timer	T	600-677	600-677	--

* See Chapter 12 for similar RLL*PLUS* instructions

In the following And Timer example, when input 000 is on and the current value in timer 604 is ≥ the preset value output 050 will energize.

DirectSOFT Display

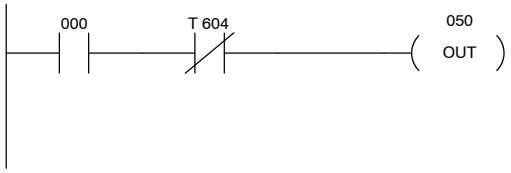


Handheld Programmer Keystrokes

STR	SHF	0	ENT			
AND	TMR	SHF	6	0	4	ENT
OUT	SHF	5	0	ENT		

In the following And Not Timer example, when input 000 is on and the current value in timer 604 is < the preset value output 050 will energize.

DirectSOFT Display



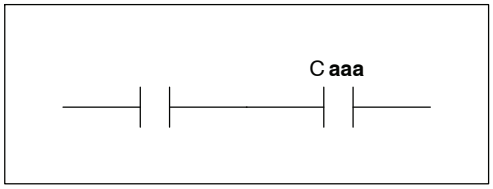
Handheld Programmer Keystrokes

STR	SHF	0	ENT				
AND	NOT	TMR	SHF	6	0	4	ENT
OUT	SHF	5	0	ENT			

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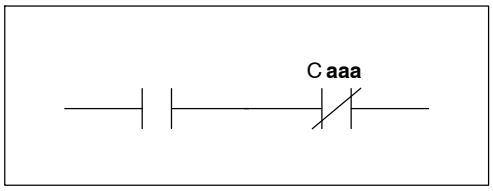
And Counter (AND CNT) DL330/340 Only

The And Counter instruction logically ands a normally open counter contact in series with another contact in a rung. The counter contact C aaa will be on when the counter current value is ≥ the preset value of the associated counter.



And Not Counter (AND NOT CNT) DL330/340 Only

The And Not Counter instruction logically ands a normally closed counter contact in series with another contact in a rung. The counter contact C aaa will be on when the counter current value is < the preset value of the associated counter.

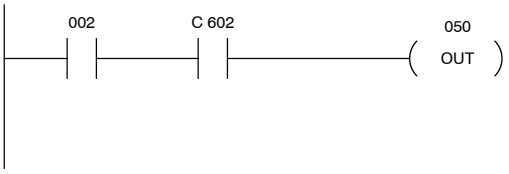


Data Type		D3-330 Range	D3-340 Range	D3-330P Range
		aaa	aaa	aaa
Counter	C	600-677	600-677	--

* See Chapter 12 for similar RLL*PLUS* instructions

In the following And Counter example, when input 002 is on and the current value in counter 602 is ≥ the preset value output 050 will energize.

DirectSOFT Display

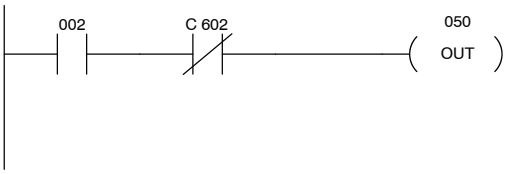


Handheld Programmer Keystrokes

STR	SHF	2	ENT			
AND	CNT	SHF	6	0	2	ENT
OUT	SHF	5	0	ENT		

In the following And Not Counter example, when input 002 is on and the current value in counter 602 is < the preset value output 050 will energize.

DirectSOFT Display



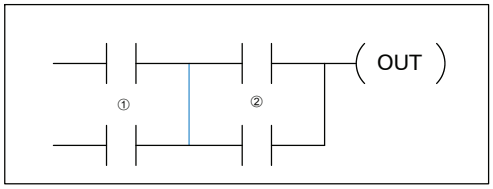
Handheld Programmer Keystrokes

STR	SHF	2	ENT			
AND	NOT	TMR	SHF	6	0	2	ENT
OUT	SHF	5	0	ENT		

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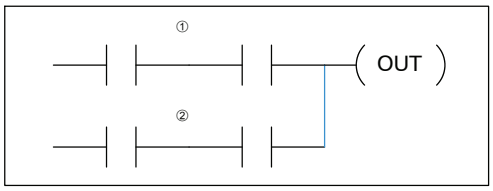
And Store (AND STR)

The And Store instruction logically ands two branches of a rung in series. Both branches must begin with the Store instruction.



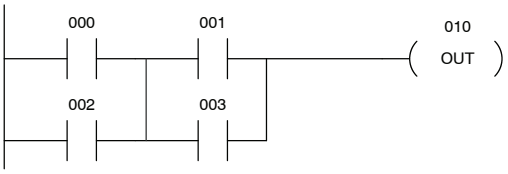
Or Store (OR STR)

The Or Store instruction logically ors two branches of a rung in parallel. Both branches must begin with the Store instruction.



In the following And Store example, the branch consisting of contacts 000 and 002 have been anded with the branch consisting of contacts 001 and 003.

DirectSOFT Display

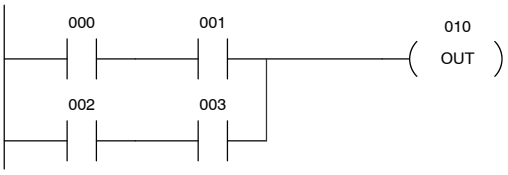


Handheld Programmer Keystrokes

STR	SHF	0	ENT	
OR	SHF	2	ENT	
STR	SHF	1	ENT	
OR	SHF	3	ENT	
AND	STR	ENT		
OUT	SHF	1	0	ENT

In the following Or Store example, the branch consisting of 000 and 001 have been ored with the branch consisting of 002 and 003.

DirectSOFT Display



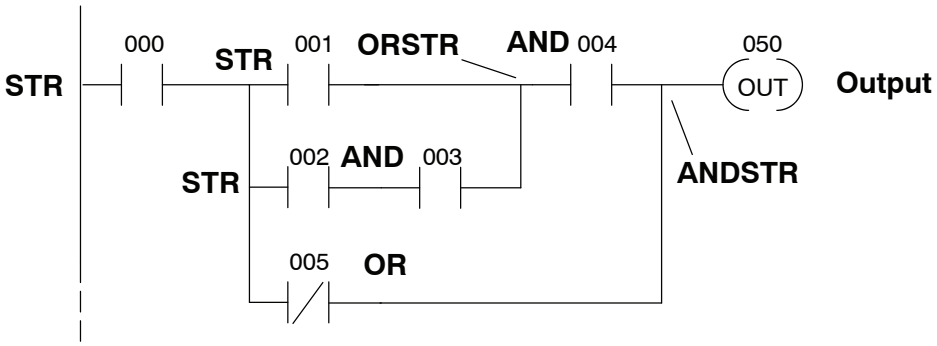
Handheld Programmer Keystrokes

STR	SHF	0	ENT	
AND	SHF	1	ENT	
STR	SHF	2	ENT	
AND	SHF	3	ENT	
OR	STR	ENT		
OUT	SHF	1	0	ENT

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There are limits to what you can enter with these simple boolean instructions. This is because the DL305 CPUs use an 8-level stack to evaluate the various logic elements. The stack is a temporary storage area that helps solve the logic for the rung. Each time you enter a Store instruction, the instruction is placed on the top of the stack. Any other instructions on the stack are pushed down a level. The And, Or, And Store, and Or Store instructions combine levels of the stack when they are encountered. Since the stack is only eight levels, an error will occur if the CPU encounters a rung that uses more than the eight levels of the stack.

The following example shows how the stack is used to solve simple boolean logic.



1 STR 000

1	STR 000
2	
3	
4	
5	
6	
7	
8	

2 STR 001

1	STR 001
2	STR 000
3	
4	
5	
6	
7	
8	

3 STR 002

1	STR 002
2	STR 001
3	STR 000
4	
5	
6	
7	
8	

4 AND 003

1	002 AND 003
2	STR 001
3	STR 000
4	
5	
6	
7	
8	

5 ORSTR

1	001 OR (002 AND 003)
2	STR 000
3	
.	
.	
8	

6 AND 004

1	004 AND [001 OR (002 AND 003)]
2	STR 000
3	
.	
.	
8	

7 OR 005

1	005 OR 004 AND [001 OR (002 AND 003)]
2	STR 000
3	
.	
.	
8	

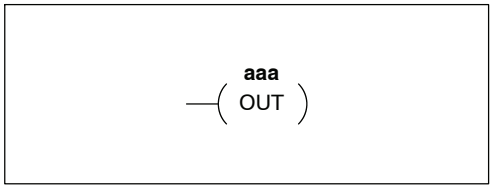
8 ANDSTR

1	000 AND (005 OR 004) AND [001 OR (002 AND 003)]
2	
3	
.	
.	
8	

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Out (OUT)

The Out instruction reflects the status of the rung (on/off) and outputs the discrete (on/off) state to the specified image register point or memory location. Multiple Out instructions referencing the same discrete location should not be used because only the last Out instruction in the program will control the physical output point.



Data Type	D3-330 Range	D3-340 Range	D3-330P Range
	aaa	**aaa**	**aaa**
Outputs	000-167 700-767	000-177 700-767	000-167 700-767
Control Relays	160-373	160-373 1000-1067	160-174 200-77
Shift Register Bits	400-577	400-577	--

In the following Out example, when input 000 is on output 010 will energize.

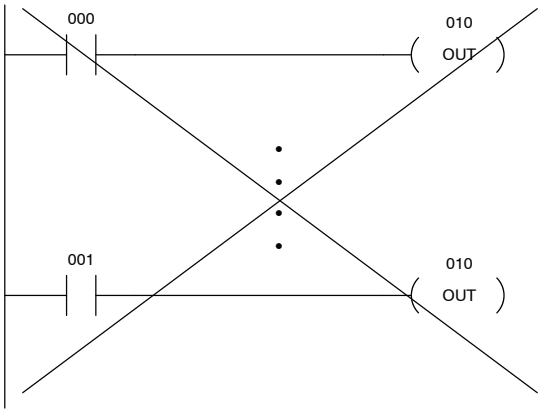
DirectSOFT Display



Handheld Programmer Keystrokes

STR	SHF	0	ENT	
OUT	SHF	1	0	ENT

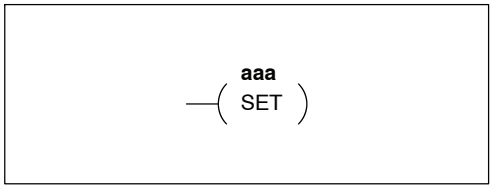
In the following Out example, two Out instructions using output 10 are used in the program. The status of output 010 being controlled by input 001 will override the instance of output 010 being controlled by input 000. The physical output would always be controlled by input 001.



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Set (SET) DL330/340 Only

The Set instruction sets or turns on an output. Once the output is set it will remain on until it is reset using the Reset instruction. It is not necessary for the input controlling the Set instruction to remain on. The Set instruction is sometimes known as a latch. The Reset instruction is used to reset the output.



Reset (RST) DL330/340 Only

The Reset instruction resets or turns off an output. Once the output is reset it is not necessary for the input to remain on. The Reset instruction is sometimes known as an unlatch instruction.



Data Type	D3-330 Range	D3-340 Range	D3-330P Range*
	aaa	aaa	aaa
Outputs	000-167 700-767	000-177 700-767	--
Control Relays	160-373	160-373 1000-1067	--
Shift Register Bits	400-577	400-577	--

* See Chapter 12 for similar RLL*PLUS* instructions

In the following Set example, when input 000 is on output 010 will be energized.

DirectSOFT Display



Handheld Programmer Keystrokes

STR	SHF	0	ENT	
SET	SHF	1	0	ENT

In the following Reset example, when input 001 is on output 010 will de-energize.

DirectSOFT Display



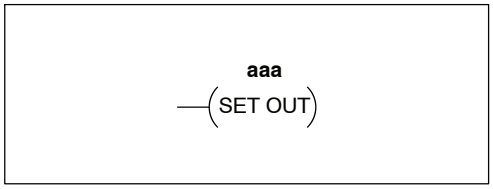
Handheld Programmer Keystrokes

STR	SHF	1	ENT	
RST	SHF	1	0	ENT

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Set Out (SET OUT)

The Set Out instruction reflects the status of the rung (on/off) and outputs the discrete (on/off) state to the specified image register location. This instruction is similar to the Out instruction except the output disable coil (special relay 376) will not override and disable the output. Multiple Set Out instructions referencing the same discrete location should not be used because only the last Set Out instruction in the program will control the physical output point.



Data Type	D3-330 Range	D3-340 Range	D3-330P Range
	aaa	aaa	aaa
Outputs	000-167 700-767	000-177 700-767	000-167 700-767

In the following Set Out example, when input location 000 is on output 020 will energize. The output disable coil (special relay 376) will not override this output coil.

DirectSOFT Display



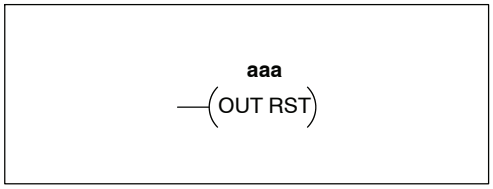
Handheld Programmer Keystrokes

STR	SHF	0	ENT		
SET	OUT	SHF	2	0	ENT

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Set Out Reset (SET OUT RST)

The Set Out Reset instruction is typically known as a one shot. When the input logic produces an off to on transition the output will turn on for one CPU scan.



Data Type	D3-330 Range	D3-340 Range	D3-330P Range
	aaa	**aaa**	**aaa**
Outputs	000-167 700-767	000-177 700-767	000-167 700-767
Control Relays	160-373	160-373 1000-1067	160-174 200-77

In the following Set Out Reset example, when input 007 transitions from off to on, control relay 160 will energize for the remainder of the CPU scan.

DirectSOFT Display



Handheld Programmer Keystrokes

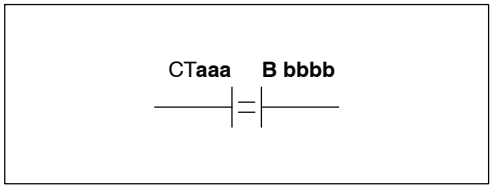
STR	SHF	7	ENT				
SET	OUT	RST	SHF	1	6	0	ENT

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Comparative Boolean Instructions

Store If Equal (STR) DL330/DL340 Only

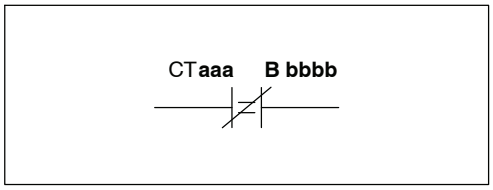
The Store If Equal instruction begins a new rung or additional branch in a rung with a normally open comparative counter contact. The contact will be on if the specified counter CT aaa = B bbbb.



CT

Store Not If Equal (STR NOT) DL330/DL340 Only

The Store Not If Equal instruction begins a new rung or additional branch in a rung with a normally closed comparative counter contact. The contact will be on if the specified counter CT aaa ≠ B bbbb.



Operand Data Type		D3-330 Range		D3-340 Range		D3-330P Range*	
	B	aaa	bbbb	aaa	bbbb	aaa	bbbb
Counters	CT	600-677	--	600-677	--	--	--
Data registers	R	--	400-577	--	400-577 700-777	--	--
Constant	K	--	0-9999	--	0-9999	--	--

* See Chapter 12 for similar RLL*PLUS* instructions

In the following Store If Equal example, when CT600 = 2510 output 012 will energize.

DirectSOFT Display



Handheld Programmer Keystrokes

STR	SHF	6	0	0	ENT
SHF	2	5	1	0	ENT
OUT	SHF	0	1	2	ENT

In the following Store Not If Equal example, when CT600 is ≠ the value in R400 output 020 will energize.

DirectSOFT Display



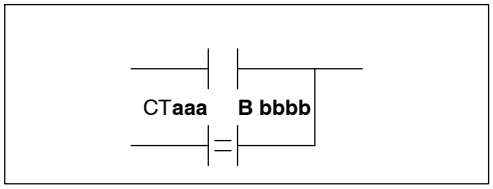
Handheld Programmer Keystrokes

STR	NOT	SHF	6	0	0	ENT
R	4	0	0	ENT		
OUT	SHF	0	1	2	ENT	

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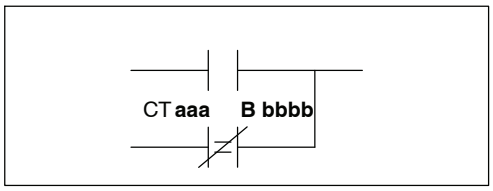
Or If Equal (OR) DL330/DL340 Only

The Or If Equal instruction connects a normally open comparative counter contact in parallel with another contact. The contact will be on if the specified counter CT aaa = B bbbb.



Or Not If Equal (OR NOT) DL330/DL340 Only

The Or Not If Equal instruction connects a normally closed comparative counter contact in parallel with another contact. The contact will be on if the specified counter
CT aaa ≠ B bbbb.

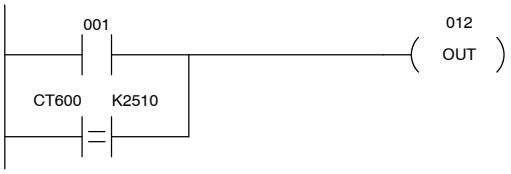


Operand Data Type		D3-330 Range		D3-340 Range		D3-330P Range*	
	B	aaa	bbbb	aaa	bbbb	aaa	bbbb
Counters	CT	600-677	--	600-677	--	--	--
Data registers	R	--	400-577	--	400-577 700-777	--	--
Constant	K	--	0-9999	--	0-9999	--	--

* See Chapter 12 for similar RLL*PLUS* instructions

In the following Or If Equal example, when input contact 001 is on or CT600 = 2510 output 012 will energize.

DirectSOFT Display

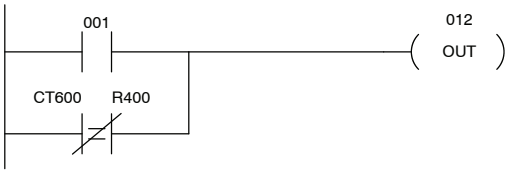


Handheld Programmer Keystrokes

STR	SHF	1	ENT		
OR	SHF	6	0	0	ENT
SHF	2	5	1	0	ENT
OUT	SHF	0	1	2	ENT

In the following Or Not If Equal example, when input contact 001 is on or CT600 ≠ the value in R400 output 012 will energize.

DirectSOFT Display



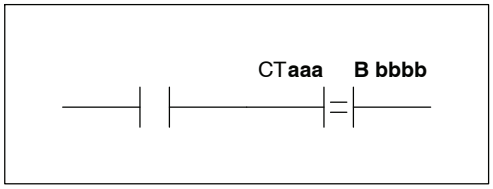
Handheld Programmer Keystrokes

STR	SHF	1	ENT		
OR	NOT	6	0	0	ENT
R	4	0	0	ENT	
OUT	SHF	0	1	2	ENT

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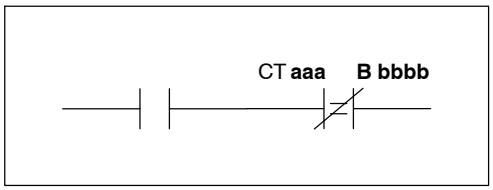
And If Equal (AND) DL330/DL340 Only

The And If Equal instruction connects a normally open comparative counter contact in series with another contact. The contact will be on if the specified counter CT aaa = B bbbb.



And Not If Equal (AND NOT) DL330/DL340 Only

The And Not If Equal instruction connects a normally closed comparative counter contact in series with another contact. The contact will be on if the specified counter CT aaa ≠ B bbbb.

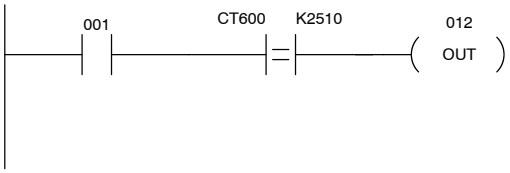


Operand Data Type		D3-330 Range		D3-340 Range		D3-330P Range*	
	B	aaa	bbbb	aaa	bbbb	aaa	bbbb
Counters	CT	600-677	--	600-677	--	--	--
Data registers	R	--	400-577	--	400-577 700-777	--	--
Constant	K	--	0-9999	--	0-9999	--	--

* See Chapter 12 for similar RLL*PLUS* instructions

In the following And If Equal example, when input contact 001 is on and CT600 = 2510 the contact will turn on and output 012 will energize.

DirectSOFT Display

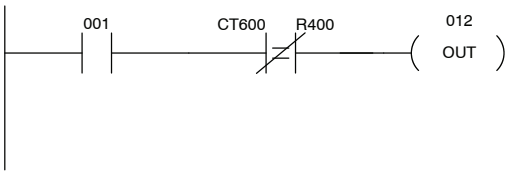


Handheld Programmer Keystrokes

STR	SHF	1	ENT		
AND	SHF	6	0	0	ENT
SHF	2	5	1	0	ENT
OUT	SHF	0	1	2	ENT

In the following And Not If Equal example, when input contact 001 is on and CT600 ≠ the value in R400 output 012 will energize.

DirectSOFT Display



Handheld Programmer Keystrokes

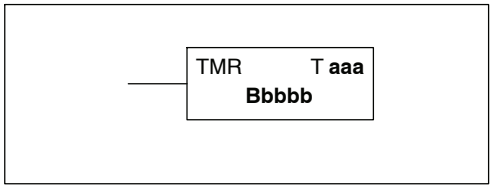
STR	SHF	1	ENT		
AND	NOT	6	0	0	ENT
R	4	0	0	ENT	
OUT	SHF	0	1	2	ENT

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Timer, Counter, and Shift Register Instructions

Timer (TMR) DL330/DL340 Only

The Timer instruction provides a single input timer with a 0.1 second increment (0-999.9 seconds) in the normal operating mode, or a 0.01 second increment (0-99.99 seconds) in the fast timer mode when relay 770 is turned on. The timer will time up to 9999 and stop. It will reset to zero when the input is turned off. The discrete bit associated with the timer will be on when the current value is equal to or greater than the preset value.

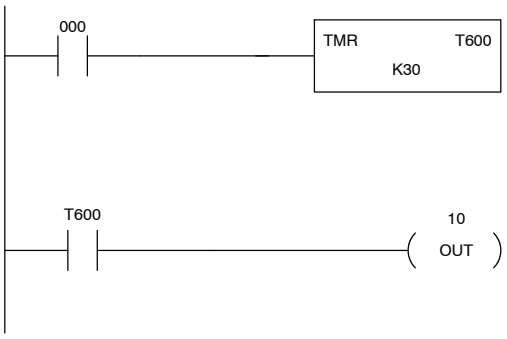


Operand Data Type		D3-330 Range		D3-340 Range		D3-330P Range	
	B	aaa	bbbb	aaa	bbbb	aaa	bbbb
Timers	T	600-677	--	600-677	--	--	--
Data registers	R	--	400-577	--	400-577 700-777	--	--
Constant	K	--	0-9999	--	0-9999	--	--

* See Chapter 12 for similar RLL*PLUS* instructions

In the following Timer example, timer 600 will begin timing up when input 000 turns on. The timer bit associated with timer 600 will turn on when the current value in timer 600 is $\geq$ the preset value K30 (3 seconds). When input 000 turns off the timer discrete bit and current value are reset.

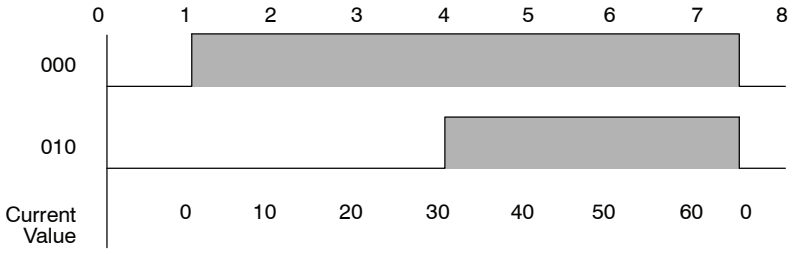
***Direct*SOFT Display**



Handheld Programmer Keystrokes

STR	SHF	0	ENT			
TMR	SHF	6	0	0	ENT	
K	3	ENT				

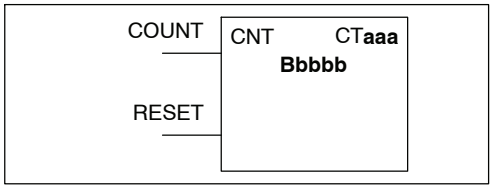
Timing Diagram



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Counter (CNT) DL330/DL340 Only

The Counter instruction provides a counter with a count and reset input. The range of this counter is 0–9999 and it will increment when the count input transitions from off to on. The counter is reset to 0 when you turn on the reset input. The counter bit associated with the counter will turn on when the current value is equal to or greater than the preset value.

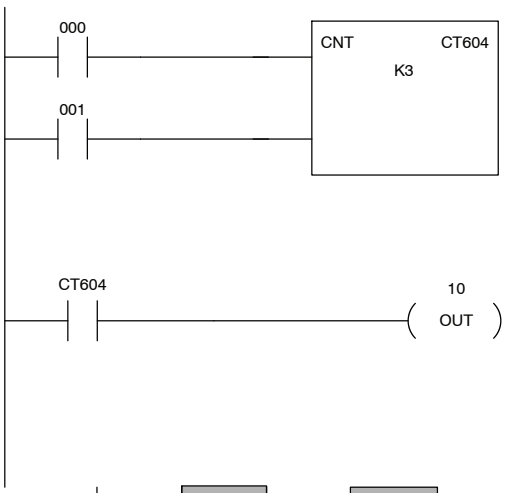


Operand Data Type		D3-330 Range		D3-340 Range		D3-330P Range	
	B	aaa	bbbb	aaa	bbbb	aaa	bbbb
Counters	CT	600-677	--	600-677	--	--	--
Data registers	R	--	400-577	--	400-577 700-777	--	--
Constant	K	--	0-9999	--	0-9999	--	--

* See Chapter 12 for similar RLL*PLUS* instructions

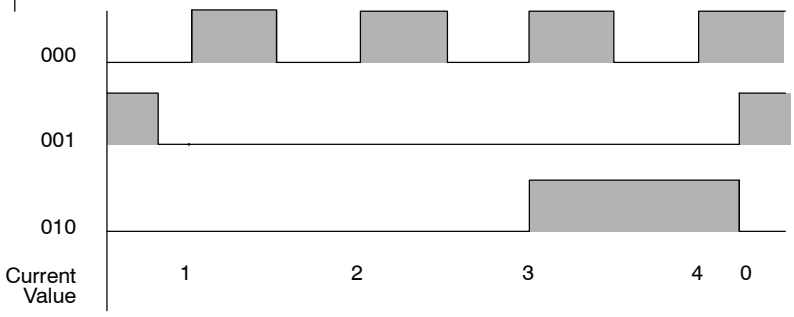
In the following Counter example, counter 604 will increment by one count when input 000 transitions from off to on. When input contact 001 is turned on the counter will reset to zero. The counter bit associated with counter 604 will turn on when the current value in counter 604 is ≥ the preset constant value K3 (3).

DirectSOFT Display



Handheld Programmer Keystrokes

STR	SHF	0	ENT		
STR	SHF	1	ENT		
CNT	SHF	6	0	4	ENT
SHF	3	ENT			



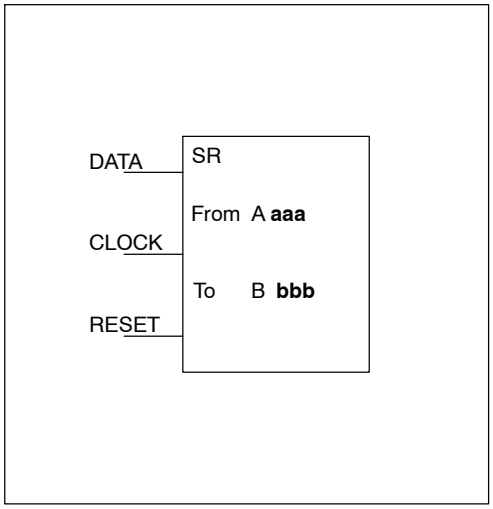
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Shift Register (SR) DL330/340 Only

The Shift Register instruction shifts data through a predefined number of shift register bits. There are 128 bits allocated for use in shift registers. There is no limit to the number of shift registers which can be used in a program, however the total number of bits used cannot exceed 128.

The Shift Register has three contacts.

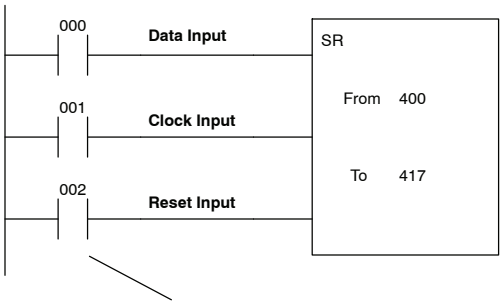
- Data — determines the value (1 or 0) that will enter the register
- Clock — shifts the bits one position on each off to on transition
- Reset —resets the Shift Register to all zeros.



With each off to on transition of the clock input, the bits which make up the shift register block are shifted by one bit position and the status of the data input is shifted into the starting bit position in the block. The direction of the shift depends on the entry in the From and To fields. From 400 to 407 would define a block of eight bits to be shifted from bit 400 to bit 407. From 407 to 400 would also define a block of eight bits, but would shift from bit 407 to bit 400. The maximum size of the shift register block is limited to 128 bits. There is no minimum block size.

Operand Data Type	D3-330 Range		D3-340 Range		D3-330P Range	
	aaa	bbbb	aaa	bbbb	aaa	bbbb
Shift Register Bits	400-577	400-577	400-577	400-577	--	--

DirectSOFT Display



Handheld Programmer Keystrokes

STR	SHF	0	ENT		
STR	SHF	1	ENT		
STR	SHF	2	ENT		
SR	SHF	4	0	0	ENT
SHF	4	1	7	ENT	

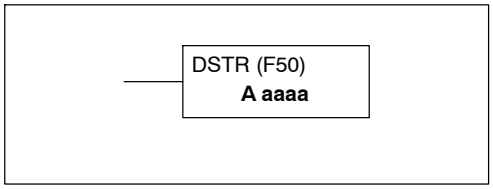


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Accumulator Load and Output Instructions

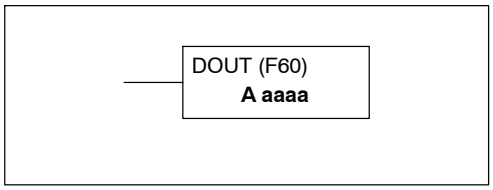
Data Store DSTR (F50)

The Data Store (F50) is a 16-bit instruction that loads the value of a 16-bit register, two consecutive 8-bit registers (specify starting location), or a 4-digit BCD value into the accumulator.



Data Out DOUT (F60)

The Data Out (F60) is a 16-bit instruction that copies the 16-bit value in the accumulator to a 16-bit reference or two consecutive 8-bit registers (specify starting location).

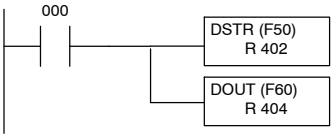


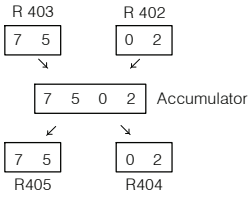
Data Type		D3-330 Range	D3-340 Range	D3-330P Range
	A	**aaaa**	**aaaa**	**aaaa**
Inputs / Outputs	R	000-014 070-075	000-014 070-075	000-014 070-075
Control Relays	R	016-036	016-036 100-105	016, 020-027
Shift Registers	R	040-056	040-056	--
Stages	R	--	--	100-116
Timer /Counters (16 bit)	R	600-677	600-677	600-677
Data Registers	R	400-577	400-577 700-777	400-577
*Constant (4-digit BCD)	K	0000-9999	0000-9999	0000-9999

* A constant is not a valid data type for the DOUT (F60) instruction.

In the following example, when input 000 is on the value (7502) in R402 and R403 is loaded into the accumulator using the Data Store (F50) instruction. The value in the accumulator is output to data registers R404 and R405 using the Data Out (F60) instruction.

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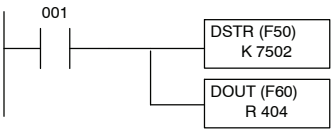


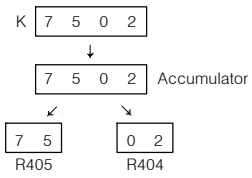
Handheld Programmer Keystrokes

STR	SHF	0	ENT	
F	5	0	ENT	
R	4	0	2	ENT
F	6	0	ENT	
R	4	0	4	ENT

In the following example, when input 001 is on the BCD constant value K7502 is loaded into the accumulator using the Data Store (F50) instruction. The value in the accumulator is output to data registers R404 and R405 using the Data Out (F60) instruction.

***Direct*SOFT Display**





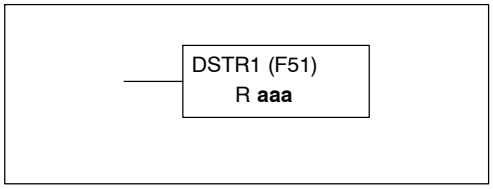
Handheld Programmer Keystrokes

STR	SHF	1	ENT		
F	5	0	ENT		
SHF	7	5	0	2	ENT
F	6	0	ENT		
R	4	0	4	ENT	

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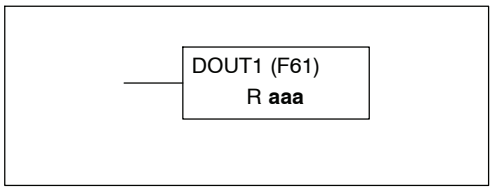
Data Store 1 DSTR (F51)

The Data Store 1 (F51) is an 8-bit instruction that loads the value from a specified 8-bit register into the lower 8 bits of the accumulator. The upper 8 bits of the accumulator are set to zero.



Data Out 1 DOUT (F61)

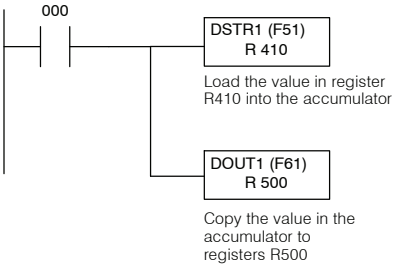
The Data Out 1 (F61) is an 8-bit instruction that copies the value in the lower 8 bits of the accumulator to a specified 8-bit register.

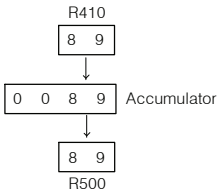


Data Type		D3-330 Range	D3-340 Range	D3-330P Range
		aaaa	aaaa	aaaa
Inputs / Outputs	R	000-014 070-075	000-014 070-075	000-014 070-075
Control Relays	R	016-036	016-036 100-105	016, 020-027
Shift Registers	R	040-056	040-056	--
Stages	R	--	--	100-116
Data Registers	R	400-577	400-577 700-777	400-577

In the following example, when input 000 is on the value (89) in R410 is loaded into the lower 8 bits of the accumulator using the Data Store 1 (F51) instruction. The value in the least significant 8 bits of the accumulator is output to data register R500 using the Data Out 1 (F61) instruction.

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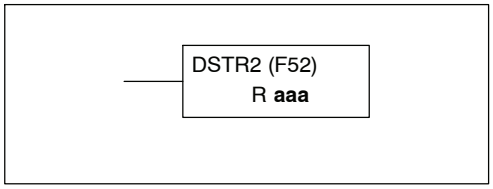
Handheld Programmer Keystrokes

STR	SHF	0	ENT	
F	5	1	ENT	
R	4	1	0	ENT
F	6	1	ENT	
R	5	0	0	ENT

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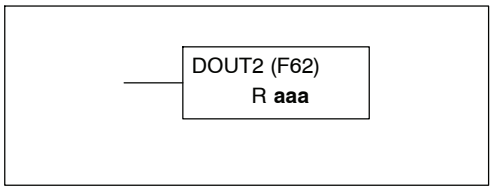
Data Store 2 DSTR (F52)

The Data Store 2 (F52) is a 4-bit instruction that loads the value of the most significant 4 bits of a specified 8-bit register into the least significant 4 bits of the accumulator. The remaining 12 bits of the accumulator are set to zero.



Data Out 2 DOUT (F62)

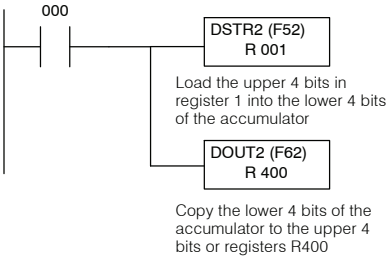
The Data Out 2 (F62) is a 4-bit instruction that copies the value in the least significant 4 bits of the accumulator into the most significant 4 bits of a specified 8-bit register. The lower 4 bits of the register are not altered .

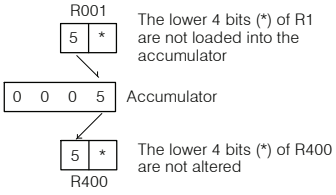


Data Type		D3-330 Range	D3-340 Range	D3-330P Range
		aaaa	aaaa	aaaa
Inputs / Outputs	R	000-014 070-075	000-014 070-075	000-014 070-075
Control Relays	R	016-036	016-036 100-105	016, 020-27
Shift Registers	R	040-056	040-56	--
Stages	R	--	--	100-116
Data Registers	R	400-577	400-577 700-777	400-577

In the following example, when input 000 is on the most significant 4 bits of R1 are loaded into the lower 4 bits of the accumulator using the Data Store 2 (F52) instruction. The value in the least significant 4 bits of the accumulator is output to most significant 4 bits of data register R400 using the Data Out 2 (F62) instruction.

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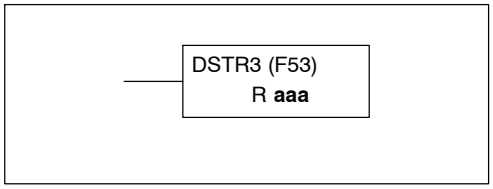
Handheld Programmer Keystrokes

STR	SHF	0	ENT	
F	5	2	ENT	
R	1	ENT		
F	6	2	ENT	
R	4	0	0	ENT

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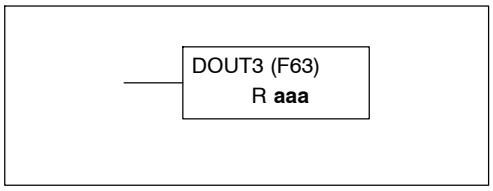
Data Store 3 DSTR (F53)

The Data Store 3 (F53) is a 4-bit instruction that loads the value of the least significant 4 bits of a specified 8-bit register into the least significant 4 bits of the accumulator. The upper 12 bits of the accumulator are set to zero.



Data Out 3 DOUT (F63)

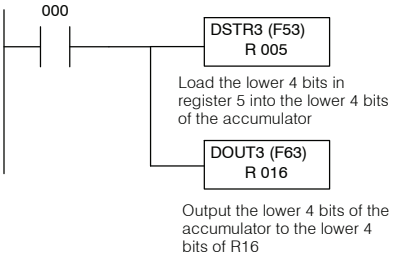
The Data Out 3 (F63) is a 4-bit instruction that copies the value in the least significant 4 bits of the accumulator to the least significant 4 bits of a specified 8 bit register. The upper 4 bits of the register are not altered.

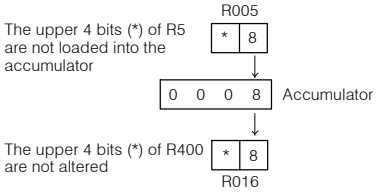


Data Type		D3-330 Range	D3-340 Range	D3-330P Range
		aaaa	aaaa	aaaa
Inputs / Outputs	R	000-014 070-075	000-014 070-075	000-014 070-075
Control Relays	R	016-036	016-036 100-105	016, 020-027
Shift Registers	R	040-056	040-056	--
Stages	R	--	--	100-116
Data Registers	R	400-577	400-577 700-777	400-577

In the following example, when input 000 is on the least significant 4 bits of R005 are loaded into the accumulator using the Data Store 3 (F53) instruction. The data in the least significant 4 bits of the accumulator is output to the least significant 4 bits of R016 using the Data Out 3 (F63) instruction.

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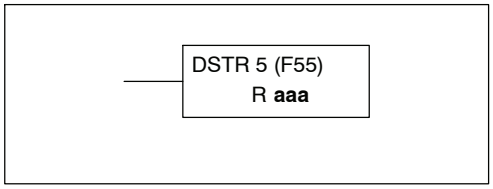
Handheld Programmer Keystrokes

STR	SHF	0	ENT
F	5	3	ENT
R	5	ENT	
F	6	3	ENT
R	1	6	ENT

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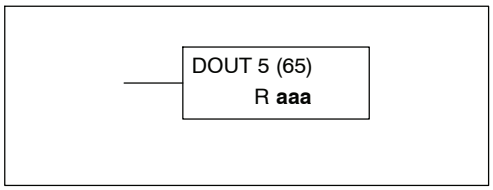
Data Store 5 DSTR (F55)

The Data Store 5 (F55) is a 16-bit instruction that loads the value of 16 image register locations for a specified 16 point input module into the accumulator.



Data Out 5 DOUT (F65)

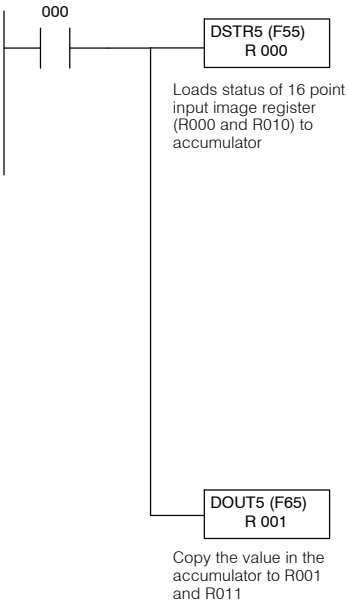
The Data Out 5 (F65) is a 16-bit instruction that outputs the 16 bit value in the accumulator to the image register of a specified 16 point output module.

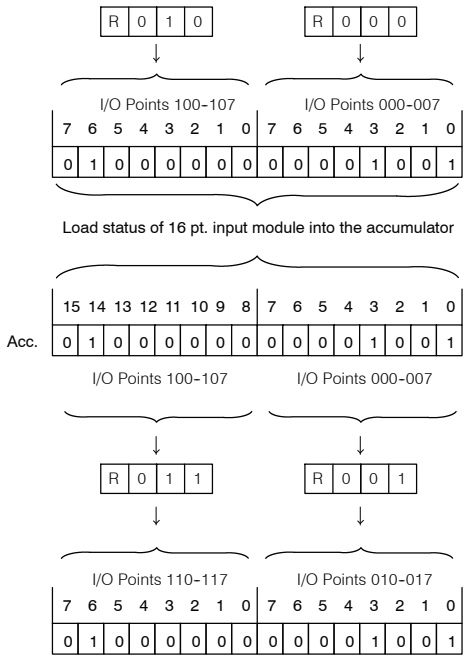


Data Type		D3-330 Range	D3-340 Range	D3-330P Range
		aaaa	aaaa	aaaa
Inputs / Outputs	R	000-014 070-075	000-014 070-075	000-014 070-075

In the following example, when input 000 is on the binary status of a 16 point I/O module in slot 1 (R000 and R010) is loaded into the accumulator using the Data Store 5 (F55) instruction. The value in the accumulator is copied to I/O register locations in slot 2 (R001 and R011) using the Data Out 5 (F65) instruction.

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Handheld Programmer Keystrokes

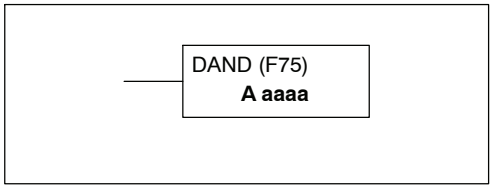
STR	SHF	0	ENT
F	5	5	ENT
R	0	ENT	
F	6	5	ENT
R	1	ENT	

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Accumulator Logic Instructions

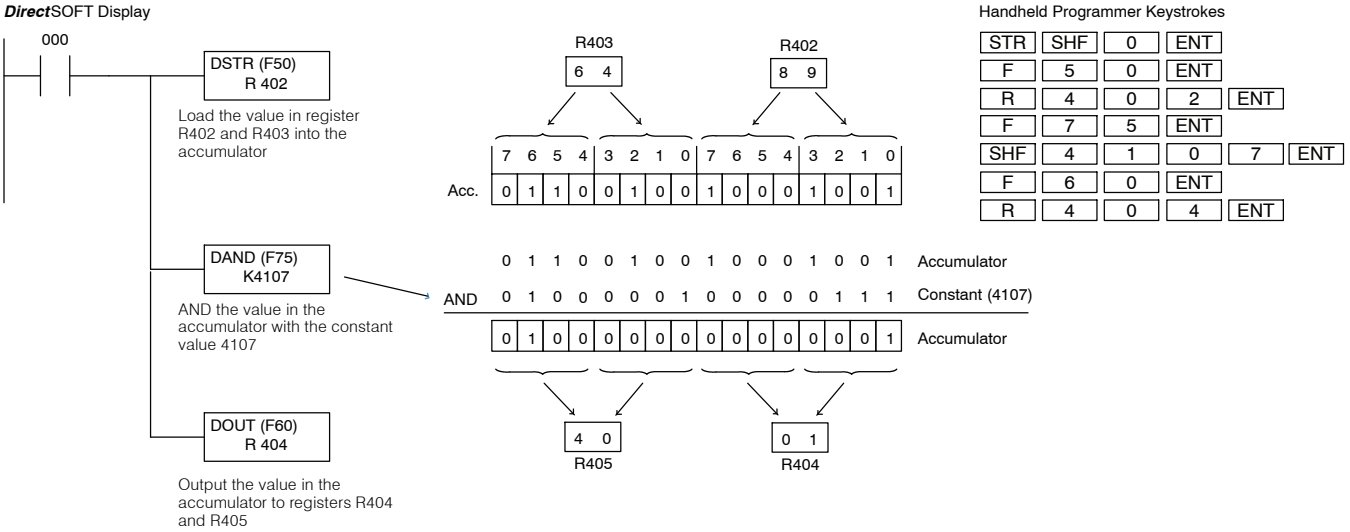
Data And DAND (F75)

The Data And (F75) is a 16-bit instruction that logical ands the value in a 16-bit reference, two consecutive 8-bit registers (specify starting location), or a 4-digit BCD constant with the value in the accumulator. The result resides in the accumulator.



Data Type		D3-330 Range	D3-340 Range	D3-330P Range
	A	**aaaa**	**aaaa**	**aaaa**
Inputs / Outputs	R	000-014 070-075	000-014 070-075	000-014 070-075
Control Relays	R	016-036	016-036 100-105	016, 020-027
Shift Registers	R	040-056	040-056	--
Stages	R	--	--	100-116
Timer /Counters (16 bit)	R	600-677	600-677	600-677
Data Registers	R	400-577	400-577 700-777	400-577
Constant (4-digit BCD)	K	0000-9999	0000-9999	0000-9999

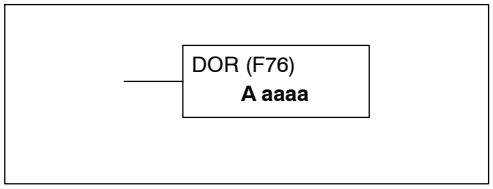
In the following example, when input 000 is on the value(6489) in R402 and R403 is loaded into the accumulator using the Data Store (F50) instruction. The data in the accumulator is logically anded with the constant K4107 with the result residing in the accumulator. The value in the accumulator is output to data register R404 and R405 using the Data Out (F60) instruction.



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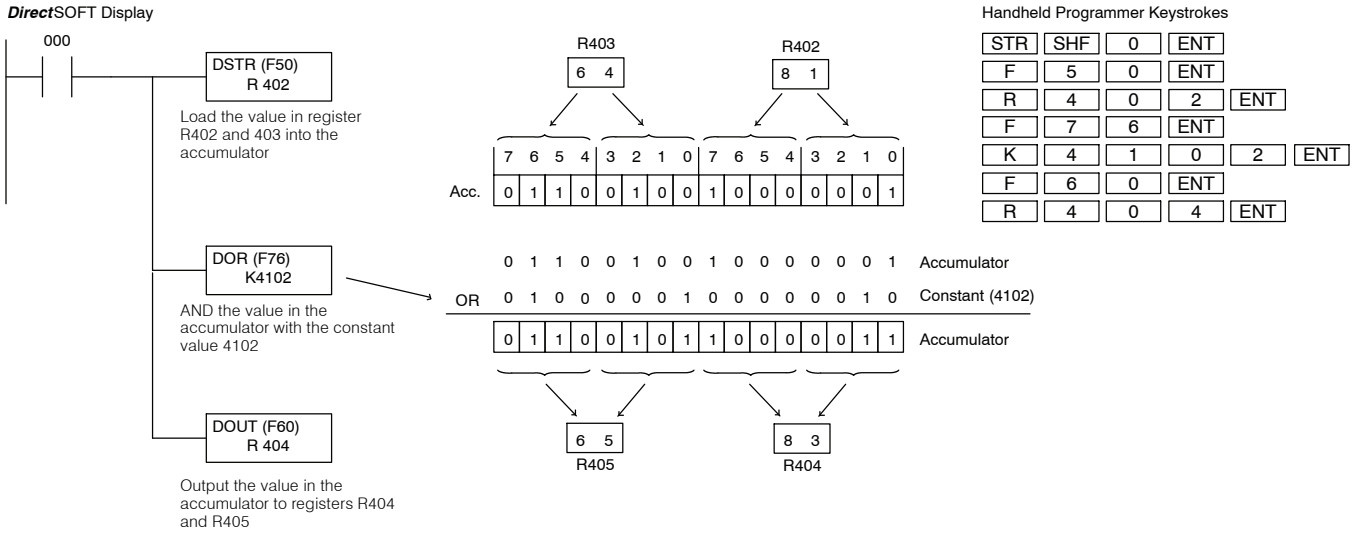
Data Or DOR (F76)

The Data Or (F76) is a 16-bit instruction that logically ors the value in a 16-bit reference, two consecutive 8-bit registers, (specify starting location) or a 4-digit BCD constant with the value in the accumulator. The result resides in the accumulator.



Data Type		D3-330 Range	D3-340 Range	D3-330P Range
	A	**aaaa**	**aaaa**	**aaaa**
Inputs / Outputs	R	000-014 070-075	000-014 070-075	000-014 070-075
Control Relays	R	016-036	016-036 100-105	016, 020-027
Shift Registers	R	040-056	040-056	--
Stages	R	--	--	100-116
Timer /Counters (16 bit)	R	600-677	600-677	600-677
Data Registers	R	400-577	400-577 700-777	400-577
Constant (4-digit BCD)	K	0000-9999	0000-9999	0000-9999

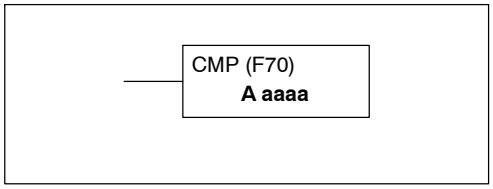
In the following example, when input 000 is on the value (6481) in R402 and R403 is loaded into the accumulator using the Data Store (F50) instruction. The data in the accumulator is logically ored with the constant K4102 with the result residing in the accumulator. The value in the accumulator is output to data registers R404 and R405 using the Data Out (F60) instruction.



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Compare CMP (F70)

The Compare (F70) is a 16-bit instruction that compares the value in a 16-bit reference, two consecutive 8-bit registers (specify starting location), or a 4-digit BCD against the value in the accumulator. Discrete bit flags are used to indicate if the result of the comparison was greater than, equal to, or less than the value in the accumulator.



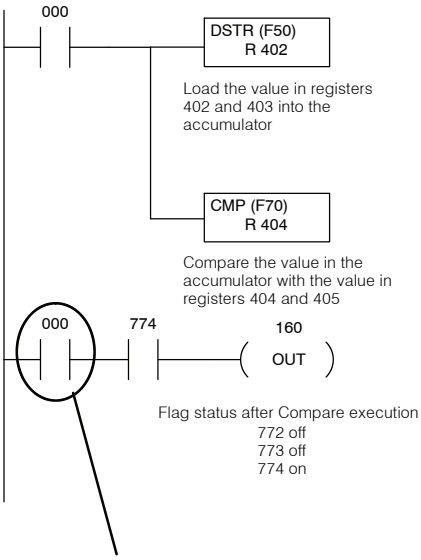
Data Type		D3-330 Range	D3-340 Range	D3-330P Range
	A	**aaaa**	**aaaa**	**aaaa**
Inputs / Outputs	R	000-014 070-075	000-014 070-075	000-014 070-075
Control Relays	R	016-036	016-036 100-105	016, 020-27
Shift Registers	R	040-056	040-56	--
Stages	R	--	--	100-116
Timer /Counters (16 bit)	R	600-677	600-677	600-677
Data Registers	R	400-577	400-577 700-777	400-577
Constant (4-digit BCD)	K	0000-9999	0000-9999	0000-9999

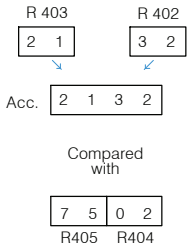
Discrete Bit Flags	Description
772	Will be on if the accumulator value is greater than the compare value
773	Will be on if the accumulator value is equal to the compare value
774	Will be on if the accumulator value is less than the compare value

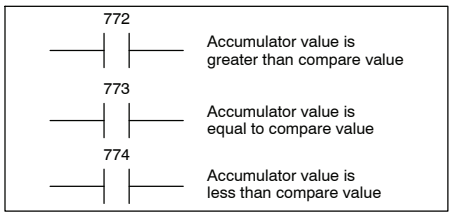
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In the following example, when input 000 is on the value (2132) in R402 and R403 is loaded into the accumulator using the Data Store (F50) instruction. The data in the accumulator is compared to value in data registers R404 and R405 using the Compare (F70) instruction. Discrete status flag 774 is used to indicate if the accumulator is less than the compare value in this example.

***Direct*SOFT Display**







Handheld Programmer Keystrokes

STR	SHF	0	ENT	
F	5	0	ENT	
R	4	0	2	ENT
F	7	0	ENT	
R	4	0	4	ENT
STR	SHF	0	ENT	
AND	SHF	7	7	4 ENT
OUT	SHF	1	6	0 ENT

NOTE: Input 000 has been used to interlock output 160. This is done since an earlier comparison could result in status flag 774 coming on when this particular comparison is not being executed thereby providing the opportunity for an unexpected output signal on output 160.

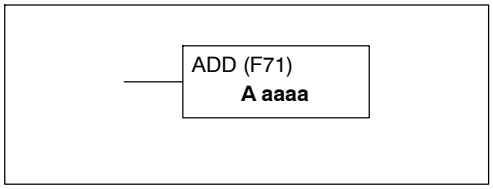
It is a common mistake to just use the status flags without interlocking to control outputs in a program but, status flags 772 – 774 can change several times during the same scan. Just as you should not use the status flags by themselves to control outputs, you also should not monitor status flags within the program. Instead you should monitor the interlocked outputs controlled by the status flags.

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Math Instructions

Add
ADD (F71)

The Add (F71) is a 16-bit instruction that adds the value of a 16 bit reference, two consecutive 8-bit registers (specify starting location), or a 4-digit BCD value with the value in the accumulator. The result resides in the accumulator. Discrete bit flags are used to indicate if the result had a carry digit or if the result was was zero.

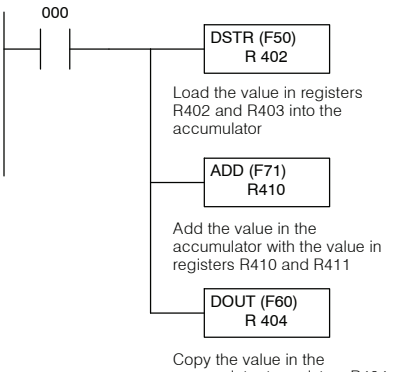


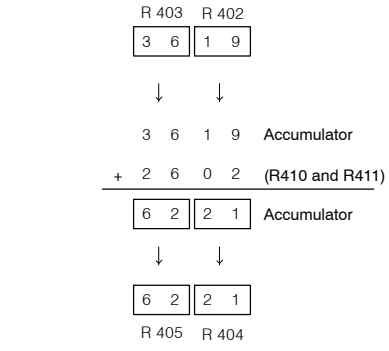
Data Type		D3-330 Range	D3-340 Range	D3-330P Range
	A	**aaaa**	**aaaa**	**aaaa**
Inputs / Outputs	R	000-014 070-075	000-014 070-075	000-014 070-075
Control Relays	R	016-036	016-036 100-105	016, 020-027
Shift Registers	R	040-056	040-056	--
Stages	R	--	--	100-116
Timer /Counters (16 bit)	R	600-677	600-677	600-677
Data Registers	R	400-577	400-577 700-777	400-577
Constant (4-digit BCD)	K	0000-9999	0000-9999	0000-9999

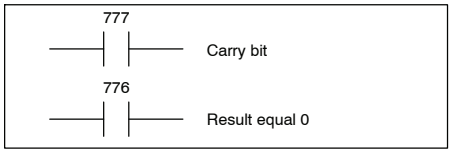
Discrete Bit Flags	Description
775	Will be on if the operation results in a carry
776	Will be on if the result is 0

In the following example, when input 000 is on the value (3619) in R402 and R403 is loaded into the accumulator using the Data Store (F50) instruction. The Add instruction (F71) adds the value (2602) in R410 and R411 to the value in the accumulator. The result in the accumulator is then copied to data registers R404 and R405 with the Data Out (F60) instruction.

***Direct*SOFT Display**







Handheld Programmer Keystrokes

STR	SHF	0	ENT	
F	5	0	ENT	
R	4	0	2	ENT
F	7	1	ENT	
R	4	1	0	ENT
F	6	0	ENT	
R	4	0	4	ENT

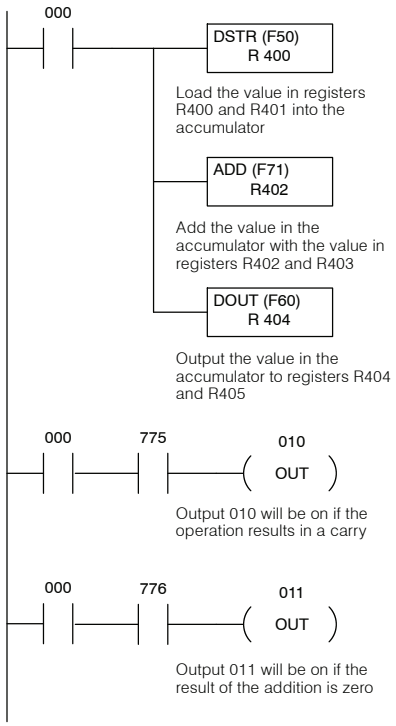
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Add Example

The following examples demonstrate how the discrete status flags are used to indicate if the result of the add has produced a number which exceeds the capacity of the accumulator. Remember, the accumulator has a 4 digit maximum. When a calculation produces a number larger than 4 digits, part of this number is lost. The following table shows different values being used in the logic example below. Notice how the discrete status flags change.

	Registers for DSTR Instruction R401/R400	Registers for ADD Instruction R403/R402	Registers for DOUT Instruction R405/R404	Discrete Status Flag 775	Discrete Status Flag 776
Example 1	500	400	0900	off	off
Example 2	5000	5000	0000	on	on
Example 3	5050	5000	0050	on	off

DirectSOFT Display



Handheld Programmer Keystrokes

STR	SHF	0	ENT		
F	5	0	ENT		
R	4	0	0	ENT	
F	7	1	ENT		
R	4	0	2	ENT	
F	6	0	ENT		
R	4	0	4	ENT	
STR	SHF	7	7	5	ENT
OUT	SHF	0	1	0	ENT
STR	SHF	7	7	6	ENT
OUT	SHF	0	1	1	ENT

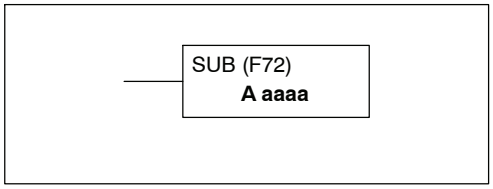
NOTE: An input has been used to interlock the outputs on the last two rungs. This is done since an earlier math instruction could result in the status flag coming on when this particular math instruction is not being executed thereby providing the opportunity for an unexpected output signal.

It is a common mistake to just use the status flags without interlocking to control outputs in a program but, the status flags can change several times during the same scan. Just as you should not use the status flags by themselves to control outputs, you also should not monitor status flags within the program. Instead you should monitor the interlocked outputs controlled by the status flags.

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Subtract SUB (F72)

The Subtract (F72) is a 16-bit instruction that subtracts the value in a 16-bit register, two consecutive 8-bit registers (specify starting location), or a 4-digit BCD value from the value in the accumulator. The result resides in the accumulator. Discrete bit flags are used to indicate if the result had a borrow digit or the result was zero.

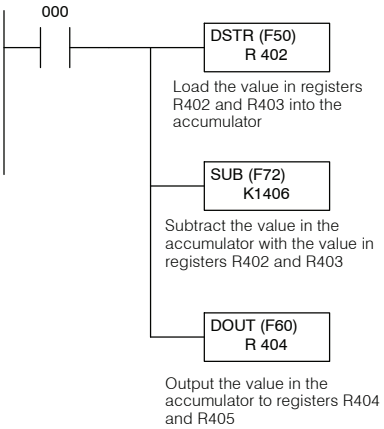


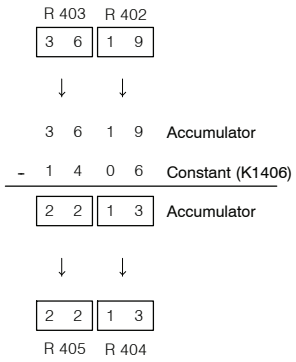
Data Type		D3-330 Range	D3-340 Range	D3-330P Range
	A	**aaaa**	**aaaa**	**aaaa**
Inputs / Outputs	R	000-014 070-075	000-014 070-075	000-014 070-075
Control Relays	R	016-036	016-036 100-105	016, 020-027
Shift Registers	R	040-056	040-056	--
Stages	R	--	--	100-116
Timer /Counters (16 bit)	R	600-677	600-677	600-677
Data Registers	R	400-577	400-577 700-777	400-577
Constant (4-digit BCD)	K	0000-9999	0000-9999	0000-9999

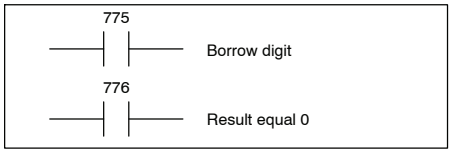
Discrete Bit Flags	Description
775	Will be on if the result if a borrow digit occurred
776	Will be on if the result is 0

In the following example, when input 000 is on the value (3619) in R402 and R403 is loaded into the accumulator using the Data Store (F50) instruction. The constant value K1406 is subtracted from the value in the accumulator using the Subtract (F72) instruction. The result in the accumulator is then copied to data registers R404 and R405 using the Data Out (F60) instruction.

***Direct*SOFT Display**







Handheld Programmer Keystrokes

STR	SHF	0	ENT	
F	5	0	ENT	
R	4	0	2	ENT
F	7	2	ENT	
SHF	1	4	0	6 ENT
F	6	0	ENT	
R	4	0	4	ENT

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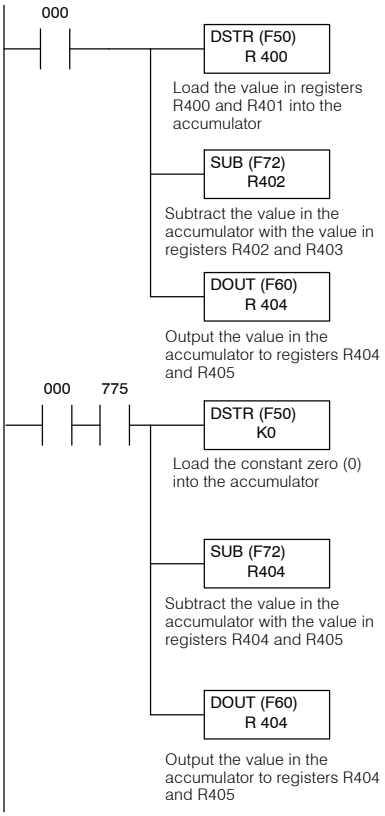
Subtract Example

The following examples demonstrate how the discrete status flags are used to indicate if the result of the Subtraction is a 0 or required a borrow digit. The following table shows different values being used in the logic example below. Notice how the discrete status flags change for each example.

	Registers for DSTR Instruction R401/R400	Registers for SUB Instruction R403/R402	Registers for DOUT Instruction R405/R404	Discrete Status Flag 775	Discrete Status Flag 776
Example 1	6050	5000	1050	off	off
Example 2	7050	7050	0000	off	on
Example 3	5000	6000	9000*	on	off

* The DL305 cannot process negative numbers. When the number being subtracted from the accumulator is larger than the number in the accumulator, a borrow digit occurs and the subtraction is completed. The value in the accumulator does not represent the difference between the two numbers. To get the difference between the two numbers in Example 3 the result (9000) in the accumulator is subtracted from 0. The final result is 1000, the difference between 6000 and 5000.

***Direct*SOFT Display**



Handheld Programmer Keystrokes

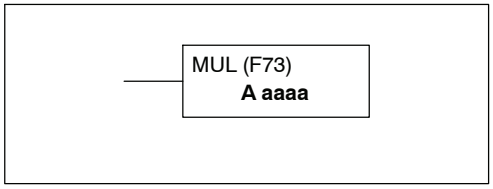
STR	SHF	0	ENT		
F	5	0	ENT		
R	4	0	0	ENT	
F	7	2	ENT		
R	4	0	2	ENT	
F	6	0	ENT		
R	4	0	4	ENT	
STR	SHF	0	ENT		
AND	SHF	7	7	5	ENT
F	5	0	ENT		
R	4	0	4		
F	7	2	ENT		
K	0	ENT			
F	6	0	ENT		
R	4	0	4	ENT	

NOTE: It is a common mistake to just use the status flags without interlocking to control outputs in a program, but the status flags can change several times during the same scan. Just as you should not use the status flags by themselves to control outputs, you also should not monitor status flags within the program. Instead you should monitor the interlocked outputs controlled by the status flags.

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Multiply MUL (F73)

The Multiply (F73) is a 16-bit instruction that multiplies the value in a 16-bit register, two consecutive 8-bit registers, or a 4-digit BCD value by the value in the accumulator. The least significant four digits of the result are stored in the accumulator and the most significant four digits are stored in the auxiliary accumulator (R575 and R577). A discrete bit flag is used to indicate if the result was zero.

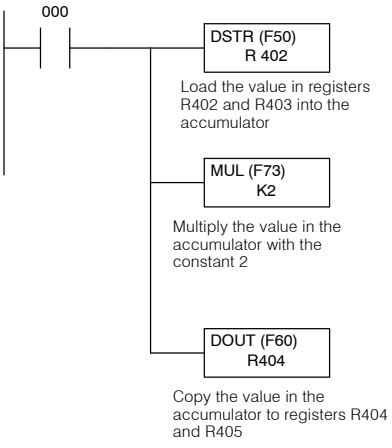


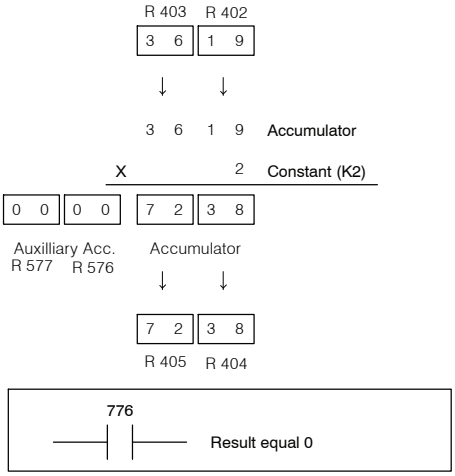
Data Type		D3-330 Range	D3-340 Range	D3-330P Range
	A	**aaaa**	**aaaa**	**aaaa**
Inputs / Outputs	R	000-014 070-075	000-014 070-075	000-014 070-075
Control Relays	R	016-036	016-036 100-105	016, 020-027
Shift Registers	R	040-056	040-056	--
Stages	R	--	--	100-116
Timer /Counters (16 bit)	R	600-677	600-677	600-677
Data Registers	R	400-577	400-577 700-777	400-577
Constant (4-digit BCD)	K	0000-9999	0000-9999	0000-9999

Discrete Bit Flags	Description
776	Will be on if the result is 0

In the following example, when input 000 is on the value (3619) in R402 and R403 is loaded into the accumulator using the Data Store (F50) instruction. The data in the accumulator is multiplied with the constant K2 with the result residing in the accumulator and auxiliary accumulator (R576 and R577) using the Multiply (F73) instruction. The value in the accumulator is output to data registers R404 and R405 using the Data Out (F60) instruction.

DirectSOFT Display





Handheld Programmer Keystrokes

STR	SHF	0	ENT	
F	5	0	ENT	
R	4	0	2	ENT
F	7	3	ENT	
SHF	2	ENT		
F	6	0	ENT	
R	4	0	4	ENT

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Multiply Example

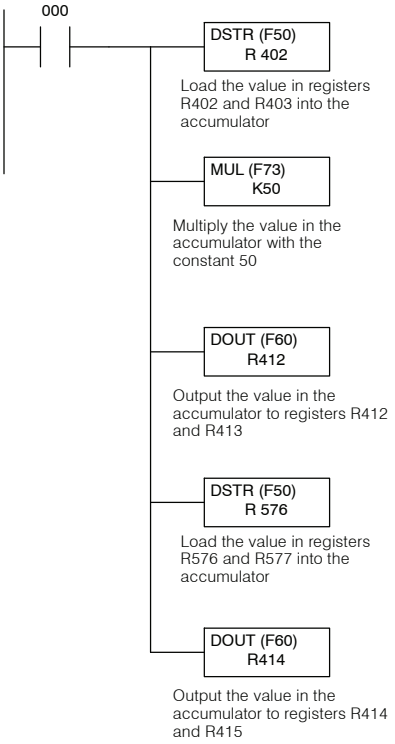
The multiply instruction allows you to multiply two 4-digit numbers together. The result is located in the accumulator and the auxiliary accumulator (R576 and R577) when necessary. The accumulator holds the lower 4 digits of the result and the auxiliary accumulator holds the upper 4 digits.

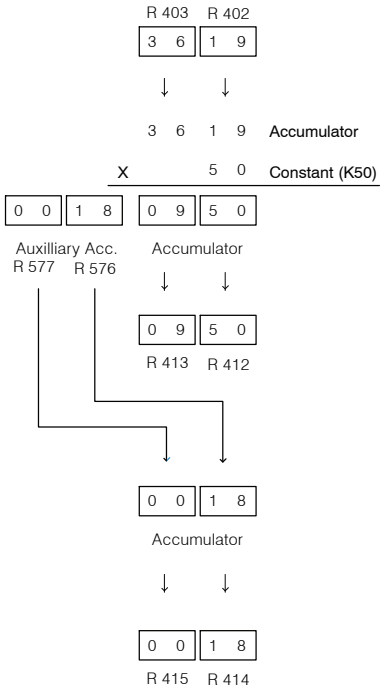
Whenever possible multiplications resulting in more than 4 digits should be avoided since the DL305 instruction set can only manipulate a maximum of two consecutive 8-bit registers (4 digits) at one time.

If the result of a multiplication is greater than 4 digits, the application program must be written to compensate for the instruction set 4 digit maximum for data manipulation. The example below shows how the auxiliary accumulator is used to store a result with more than 4 digits and how to access the upper 4 digits.

The example below shows how the auxiliary accumulator is used to process numbers larger than 4 digits when the multiplication instruction is used.

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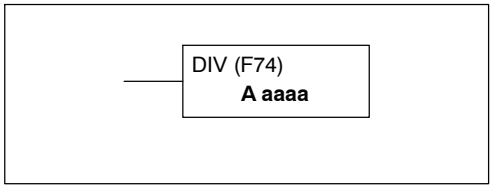
Handheld Programmer Keystrokes

STR	SHF	0	ENT	
F	5	0	ENT	
R	4	0	2	ENT
F	7	3	ENT	
SHF	5	0	ENT	
F	6	0	ENT	
R	4	1	2	ENT
F	5	0	ENT	
R	5	7	6	ENT
F	6	0	ENT	
R	4	1	4	ENT

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Divide DIV (F74)

The Divide (F74) is a 16-bit instruction that divides the value in the accumulator by the value in a 16-bit register, two consecutive 8-bit registers, or a 4-digit BCD value. The integer portion of the result is stored in the accumulator and the decimal fraction is stored in the auxiliary accumulator, R576 and R577. Discrete flags are used to indicate if the dividend or divisor is zero or if only the divisor is zero.

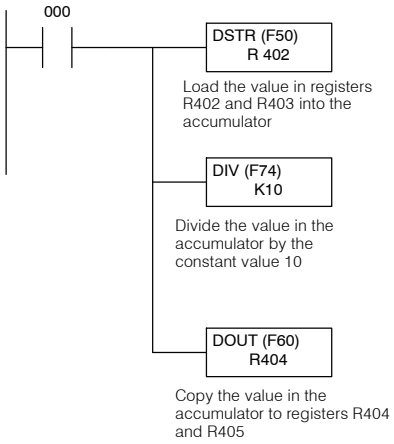


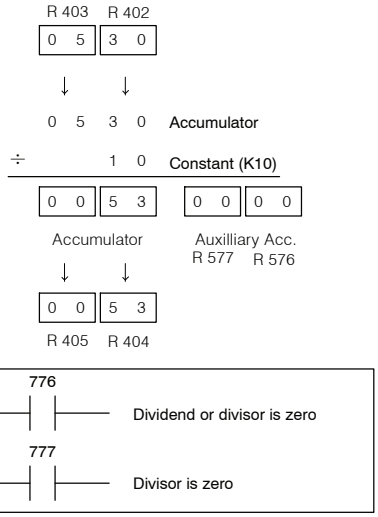
Data Type		D3-330 Range	D3-340 Range	D3-330P Range
	A	**aaaa**	**aaaa**	**aaaa**
Inputs / Outputs	R	000-014 070-075	000-014 070-075	000-014 070-075
Control Relays	R	016-036	016-036 100-105	016, 020-027
Shift Registers	R	040-056	040-056	--
Stages	R	--	--	100-116
Timer /Counters (16 bit)	R	600-677	600-677	600-677
Data Registers	R	400-577	400-577 700-777	400-577
Constant (4-digit BCD)	K	0000-9999	0000-9999	0000-9999

Discrete Bit Flags	Description
776	Will be on if the dividend or divisor is zero
777	Will be on if the divisor is zero

In the following example, when input 000 is on the value (530) in R402 and R403 is loaded into the accumulator using the Data Store (F50) instruction. The data in the accumulator is divided by the constant 10 (K10). The result in the accumulator and is copied to data registers R404 and R405 using the Data Out (F60) instruction. The remainder is in the auxiliary accumulator (R576 and R577).

***Direct*SOFT Display**





Handheld Programmer Keystrokes

STR	SHF	0	ENT	
F	5	0	ENT	
R	4	0	2	ENT
F	7	4	ENT	
SHF	1	0	ENT	
F	6	0	ENT	
R	4	0	4	ENT

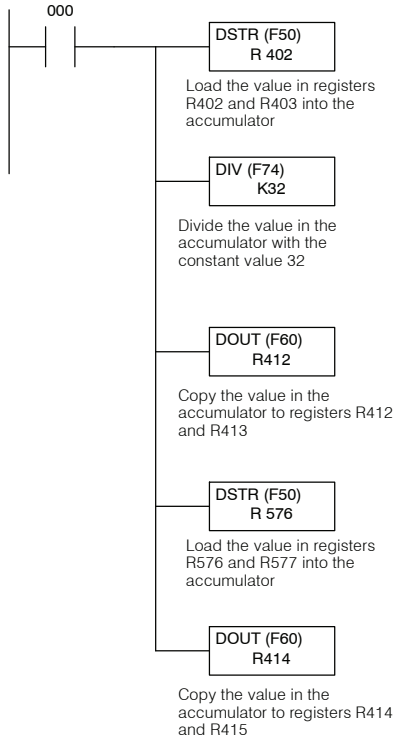
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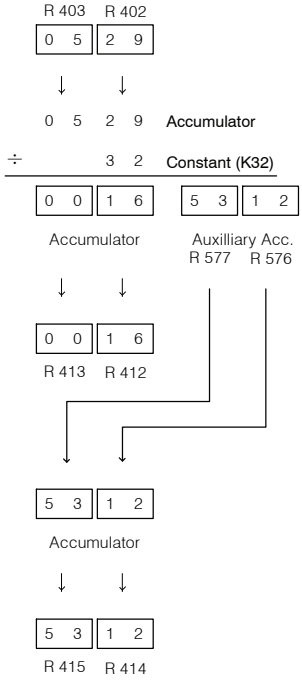
Divide Example

The divide instruction allows you to divide the value in the accumulator by 4 digits maximum. The divide instruction uses the accumulator for the integer value of the result and the auxiliary accumulator (R576 and R577) for fraction. The instruction set only allows manipulation on two consecutive registers at a time. For example, if the result was a 4 digit number with a remainder it would have to be treated like two 4-digit numbers in the program. Manipulating numbers over 4 digits should be avoided whenever possible. If it cannot be avoided the application program must be written to compensate for the 4-digit maximum for data manipulation.

The example below shows how the auxiliary accumulator is used to store the fractional portion of the result and how to access the remainder.

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Handheld Programmer Keystrokes

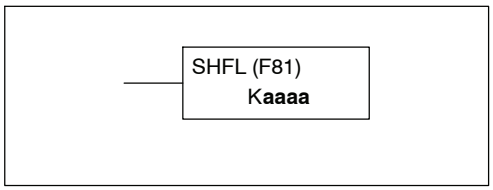
STR	SHF	0	ENT	
F	5	0	ENT	
R	4	0	2	ENT
F	7	4	ENT	
SHF	3	2	ENT	
F	6	0	ENT	
R	4	1	2	ENT
F	5	0	ENT	
R	5	7	6	ENT
F	6	0	ENT	
R	4	1	4	ENT

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Bit Operation Instructions

Shift Left SHFL (F81)

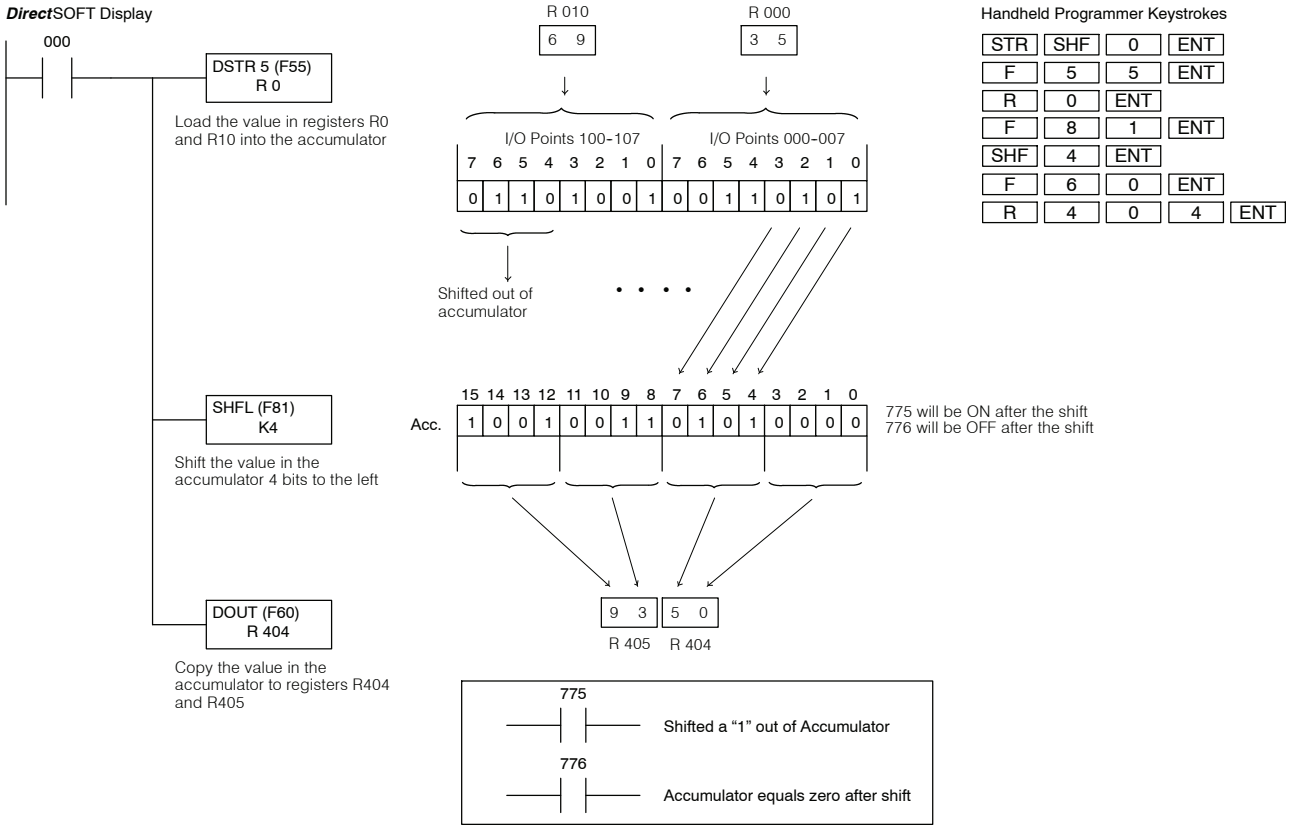
The Shift Left (F81) is a 16-bit instruction that shifts the value in the accumulator a specified number of bits (15 maximum) to the left. Discrete bit flags are used to indicate if a "1" was shifted out of the accumulator or if the accumulator equals "0" after the shift.



Data Type	D3-330 Range	D3-340 Range	D3-330P Range
	aaaa	**aaaa**	**aaaa**
Constant (4-digit BCD) K	1-16	1-16	1-16

Discrete Bit Flags	Description
775	Will be on if a"1" was shifted out of the accumulator.
776	Will be on if the accumulator equals zero after the shift instruction is executed.

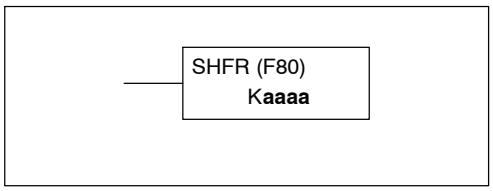
In the following example, when input 000 is on the value in R000 and R010 is loaded into the accumulator using the Data Store 5 (F55) instruction. The bit pattern in the accumulator is shifted to the left 4 bit positions using the Shift Left (F81) instruction with the result resides in the accumulator. The value in the accumulator is copied to data registers R404 and R405 using the Data Out (F60) instruction.



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Shift Right SHFR (F80)

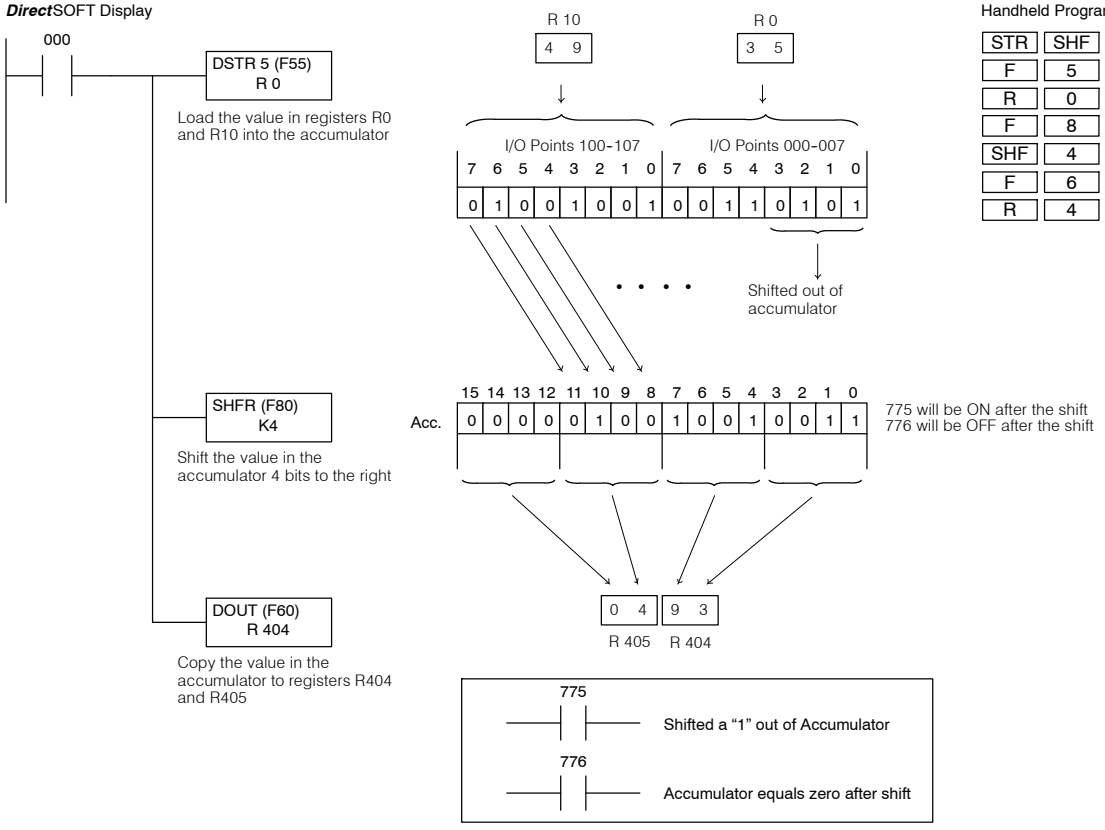
The Shift Right (F80) is a 16-bit instruction that shifts the value in the accumulator a specified number of bits (15 maximum) to the right. Discrete bit flags are used to indicate if a "1" was shifted out of the accumulator or if the accumulator equals "0" after the shift.



Data Type		D3-330 Range	D3-340 Range	D3-330P Range
		aaaa	**aaaa**	**aaaa**
Constant (4-digit BCD)	K	1-16	1-16	1-16

Discrete Bit Flags	Description
775	Will be on if a"1" was shifted out of the accumulator.
776	Will be on if the accumulator equals zero after the shift instruction is executed.

In the following example, when input 000 is on the value in R000 and R010 is loaded into the accumulator using the Data Store 5 (F55) instruction. The bit pattern in the accumulator is shifted 4 bit positions using the Shift Right (F80) instruction and the result resides in the accumulator. The value in the accumulator is copied to data registers R404 and R405 using the Data Out (F60) instruction.

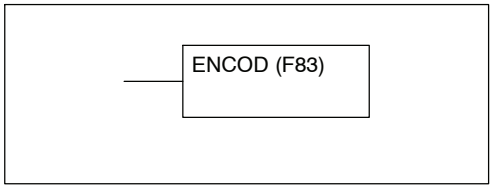


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Number Conversion Instructions

Encode
ENCOD (F83)

The Encode instruction encodes the accumulator bit position that contains a 1 by returning the corresponding binary representation. If the most significant bit is set to HEX F (decimal 15), the binary value 15 is returned to the accumulator. If the accumulator value is 0000 or 0001 a zero will be returned to the accumulator. If there is more than one bit position set to a “1” the least significant “1” will be encoded. The discrete bit flag 777 is used to indicate if there were multiple 1s in the accumulator.

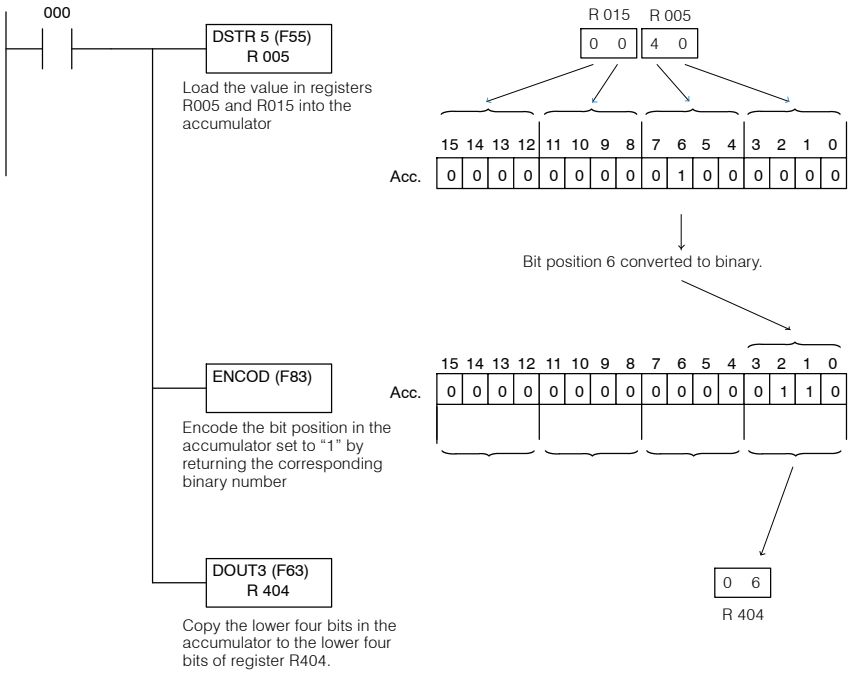


Discrete Bit Flags	Description
777	Will be on if there was more than one bit position set to a "1" in the accumulator.

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In the following example, when input 000 is on the 16-bit binary pattern from registers R005 and R015 is loaded in the accumulator by the Data Store 5 (F55) instruction. In this example the 6th bit (BCD 40) is on. When the Encode (F83) instruction executes the accumulator will contain the BCD value of 6. The lower four bits of the accumulator are copied to the lower four bits of register R404 by the Data Out 3 (F63) instruction.

***Direct*SOFT Display**



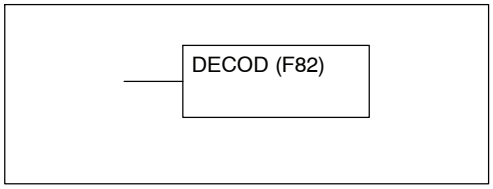
Handheld Programmer Keystrokes

STR	SHF	0	ENT	
F	5	5	ENT	
R	5	ENT		
F	8	3	ENT	
F	6	3	ENT	
R	4	0	4	ENT

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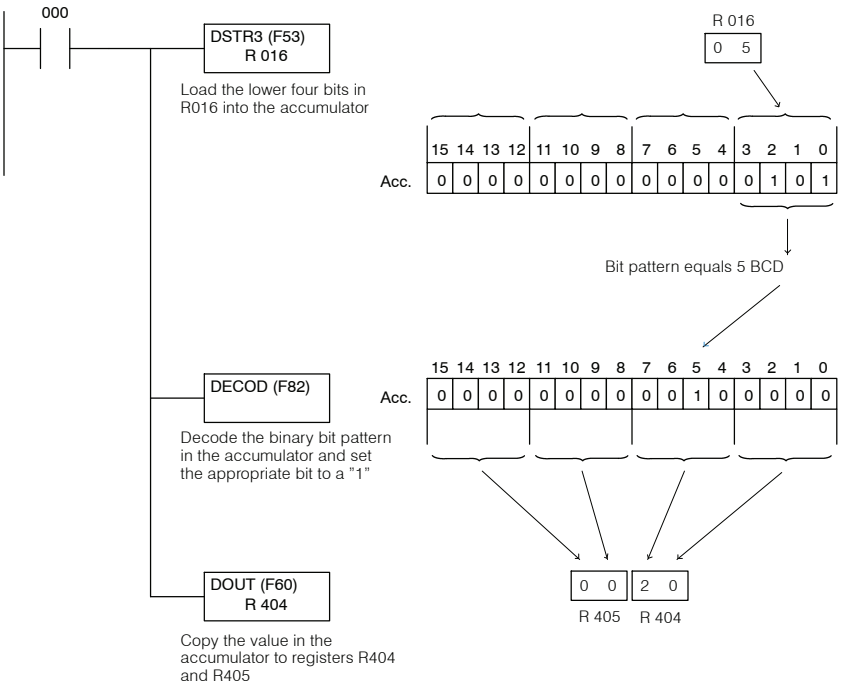
Decode DECOD (F82)

The Decode instruction decodes a four bit binary number (0–F) in the accumulator and sets the corresponding bit position to a one. If the accumulator contains a HEX F (decimal 15) the most significant bit (bit 15) will be set in the accumulator. If the accumulator contains a zero the least significant bit (bit 0) will be set to a one. All other bits in the accumulator will be set to a zero.



In the following example, when 000 is on the binary value of the lower four bits in R016 (5) will be loaded in the accumulator by the Data Store 3 (F53) instruction. The Decode instruction will then translate the value 5 to a 1 in the fifth bit position of the accumulator. The value 20 in the accumulator is copied to data registers R404 and R405 with the Data Out (F60) instruction.

***Direct*SOFT Display**



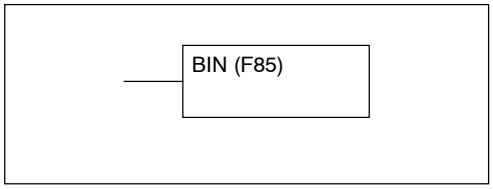
Handheld Programmer Keystrokes

STR	SHF	0	ENT	
F	5	3	ENT	
R	1	6	ENT	
F	8	2	ENT	
F	6	0	ENT	
R	4	0	4	ENT

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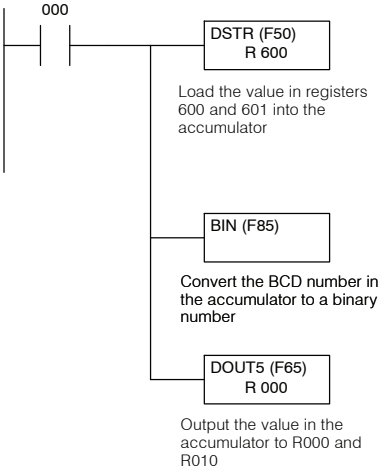
Binary BIN (F85)

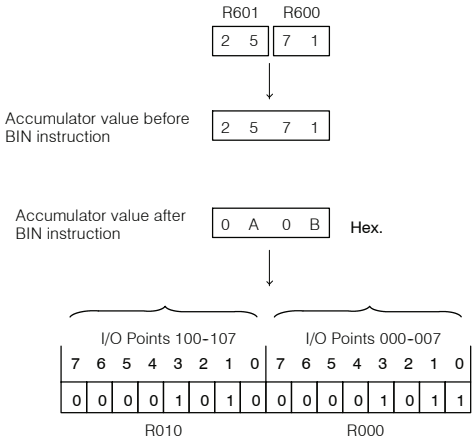
The Binary (F85) instruction converts a BCD value in the accumulator to the binary/HEX equivalent value. The result of the conversion resides in the accumulator.



In the following example, when input 000 is on the value (2571 BCD) in R600 is loaded into the accumulator using the Data Store (F50) instruction. The value in the accumulator is converted to a binary number (HEX 0A0B) using the Binary (F85) instruction with the result residing in the accumulator. The value in the accumulator is copied to I/O registers R000 and R010 (which corresponds to I/O points 0–7 and 100–107) with the Data Out 5 (F65) instruction.

DirectSOFT Display





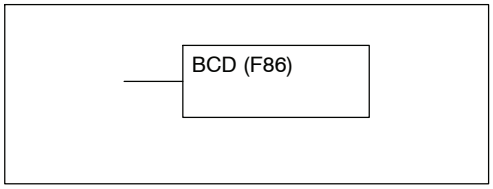
Handheld Programmer Keystrokes

STR	SHF	0	ENT	
F	5	0	ENT	
R	6	0	0	ENT
F	8	5	ENT	
F	6	5	ENT	
R	0	ENT		

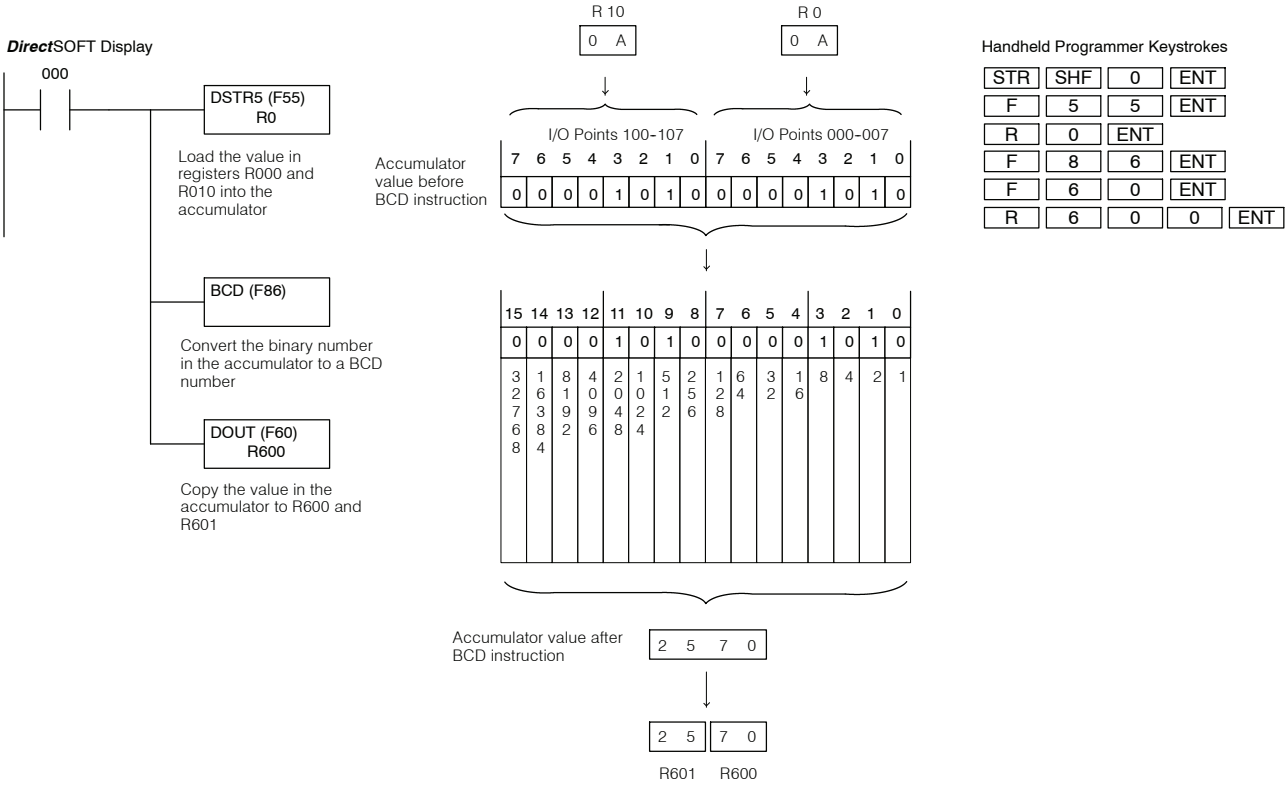
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Binary Coded Decimal BCD (F86)

The Binary Coded Decimal (F86) instruction converts a binary/HEX value in the accumulator to the BCD equivalent. The result of the conversion resides in the accumulator.



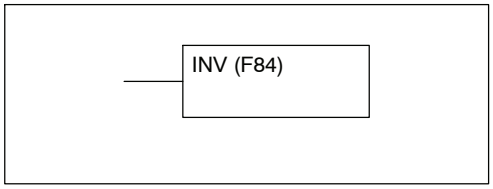
In the following example, when input 000 is on the value (HEX 0A0A) in R000 and R010 is loaded into the accumulator with the Data Store 5 (F55) instruction. The value in the accumulator is converted to a BCD number (BCD 2570) using the BCD (F86) instruction with the result residing in the accumulator. The value in the accumulator is output to register R600 using the Data Out (F60) instruction.



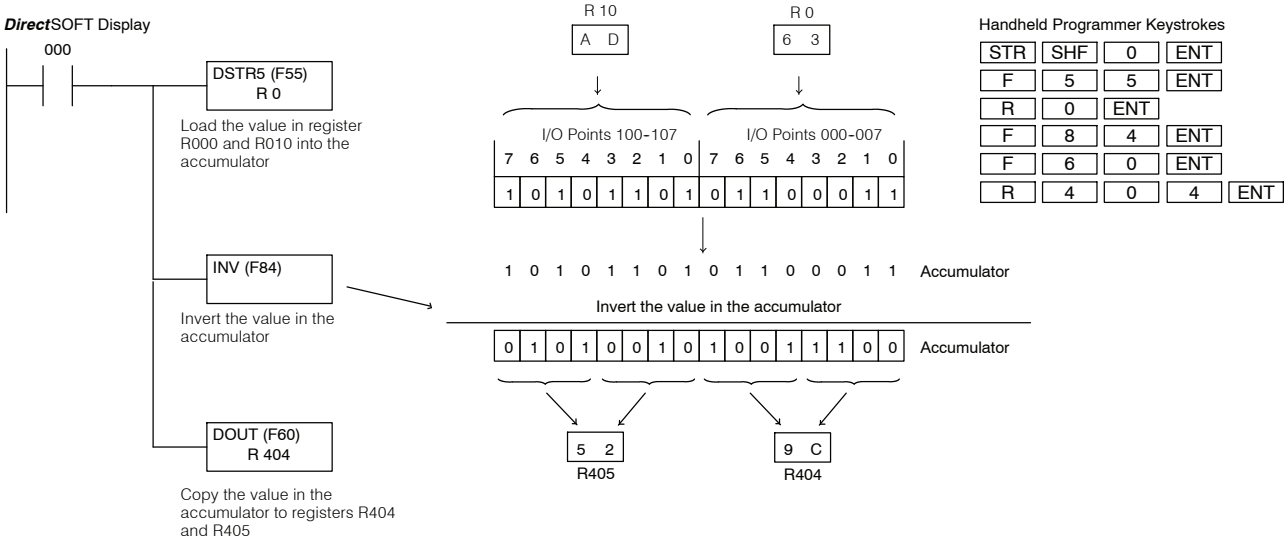
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Invert INV (F84)

The Invert instruction generates the one's complement of the number in the accumulator. The result is stored in the accumulator.



In the following example, when input 000 is on the value (AD63) in R000 and R010 is loaded into the accumulator using the Data Store (F55) instruction. The value in the accumulator is inverted with the result residing in the accumulator. The value (HEX 529C) is copied to registers R404 and R405 using the Data Out (F60) instruction.



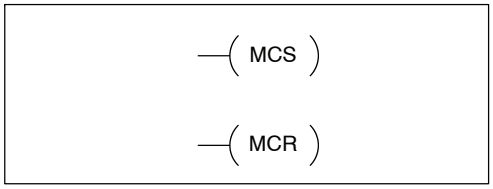
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Program Control Instructions

Master Control Set (MCS) DL330/DL340 Only

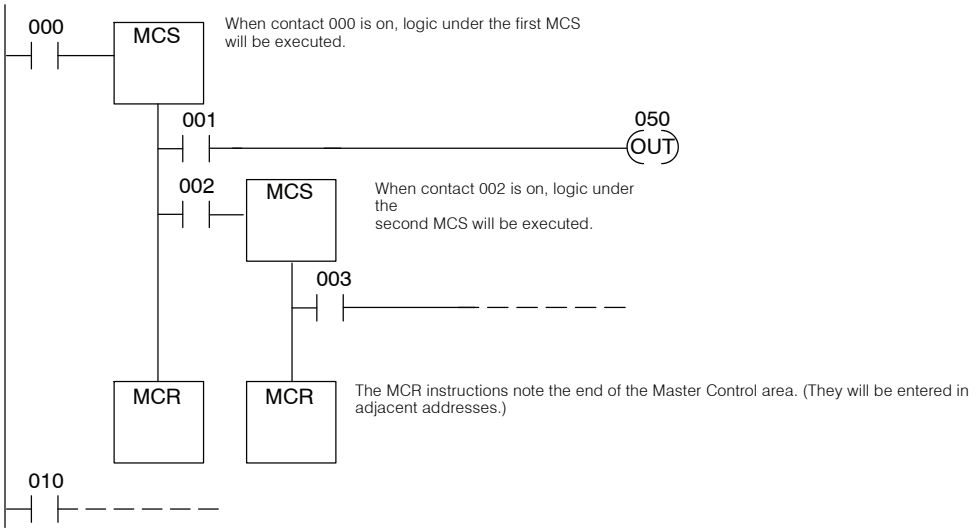
Master Control Reset (MCR) DL330/DL340 only

The Master Control Set and Master Control Reset instructions are used to provide an additional left power rail which is controllable by a input contact. This is sometimes known as a sub power rail. Any number of rungs of ladder logic can be disabled using these instructions.



Understanding Master Control Relays

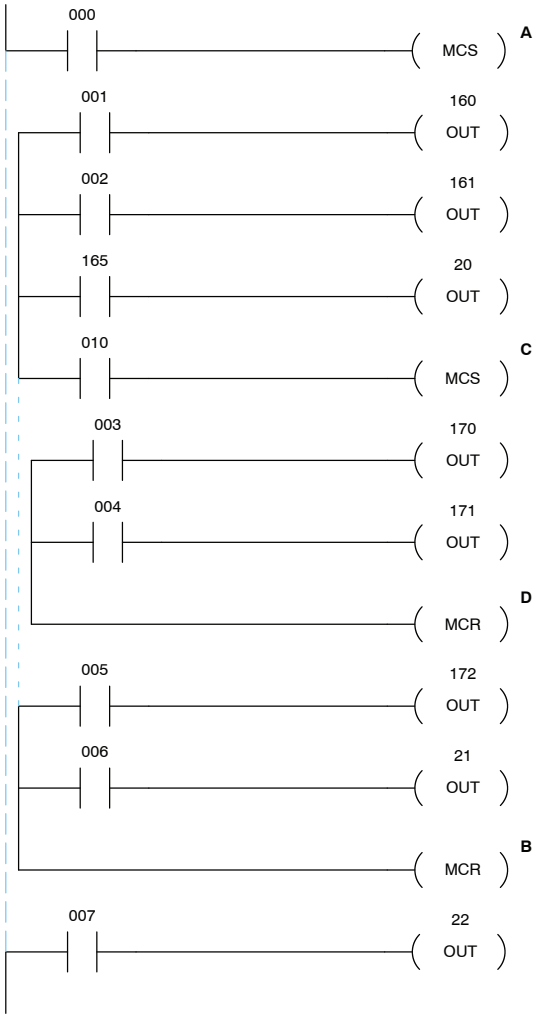
The Master Control Set (MCS) and Master Control Reset (MCR) instructions allow you to quickly enable (or disable) sections of the RLL program. This provides program control flexibility. The following example shows how the MCS and MCR instructions operate by creating a sub power rail for control logic.



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MCS/MCR Example In the following MCS/MCR example logic between the first MCS (A) and the last MCR (B) will function only if input 000 is on. The logic between the second MCS (C) and the next to last MCR (D) will function only if input 010 is on. The last rung is not controlled by either of the MCS coils.

***Direct*SOFT Display**



Handheld Programmer Keystrokes

STR	SHF	0	ENT		
MCS	ENT				
STR	SHF	1	ENT		
OUT	SHF	1	6	0	ENT
STR	SHF	2	ENT		
OUT	SHF	1	6	1	ENT
STR	SHF	1	6	5	ENT
OUT	SHF	2	0	ENT	
STR	SHF	1	0	ENT	
MCS	ENT				
STR	SHF	3	ENT		
OUT	SHF	1	7	0	ENT
STR	SHF	4	ENT		
OUT	SHF	1	7	1	ENT
MCR	ENT				
STR	SHF	5	ENT		
OUT	SHF	1	7	2	ENT
STR	SHF	6	ENT		
OUT	SHF	2	1	ENT	
MCR	ENT				
STR	SHF	7	ENT		
OUT	SHF	2	2	ENT	



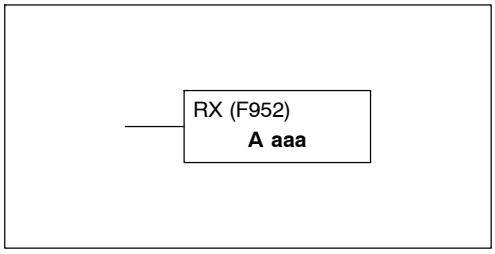
NOTE: When programming the MCS instruction, do not put any parallel coils in the rung with the MCS.

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Network Instructions

Read from Network RX (F952) DL340 Only

The Read from Network instruction is used by the master device on a ***Direct***NET network to read a block of data from another CPU or ***Direct***NET interface module. The function parameters are loaded into the accumulator and the first and second level of the accumulator stack by three additional instructions. Listed below are the steps necessary to program the Read from Network function.



Step 1: — Load the slave address (1-90 BCD) into the accumulator with the DSTR instruction. This must always be preceded by 00, so address 20 would be 0020. (Remember, D4-DCM slave device addresses are set with switches that use a hexadecimal format. Make sure you convert this address to the decimal equivalent for use with this instruction.)

Step 2: — Load the number of bytes (1 - 128 BCD) to be transferred from the network slave station.

Step 3: — Load the octal address for the data register that will be used to store the data obtained from the slave station.

Step 4: — Insert the RX instruction which specifies the starting address in the slave station. If you are getting the data from a DL305 station, just enter the Data Register number. If you are getting the data from a DL205 or DL405 station, enter a constant that corresponds to the memory address. For example, to get the current count for Timer 600 from a DL305 CPU, you would use R600 with the RX instruction. If you wanted to get Counter 0 from a DL405 CPU, you would use a constant of 1000 with the RX instruction. (V1000 stores the current count for Counter 0 in a DL405 CPU.)



NOTE: The ***Direct***NET manual provides further information on the use of the RX and WX network instructions.

Data Type		D3-330 Range	D3-340 Range	D3-330P Range
	A	**aaaa**	**aaaa**	**aaaa**
Inputs / Outputs	R	000-014 070-075	000-014 070-075	000-014 070-075
Control Relays	R	016-036	016-036 100-105	016, 020-027
Shift Registers	R	040-056	040-056	--
Stages	R	--	--	100-116
Timer /Counters (16 bit)	R	600-677	600-677	600-677
Data Registers	R	400-577	400-577 700-777	400-577
*Constant (4-digit BCD)	K	0000-9999	0000-9999	0000-9999

* A constant is used to obtain data from a DL205 or DL405 system.

Discrete Bit Flags	Description
777	Parameters are not properly set. Check the slave address, data length, or data address reference.
1074	Communication port busy.
1075	Communication error. Data was not transmitted.

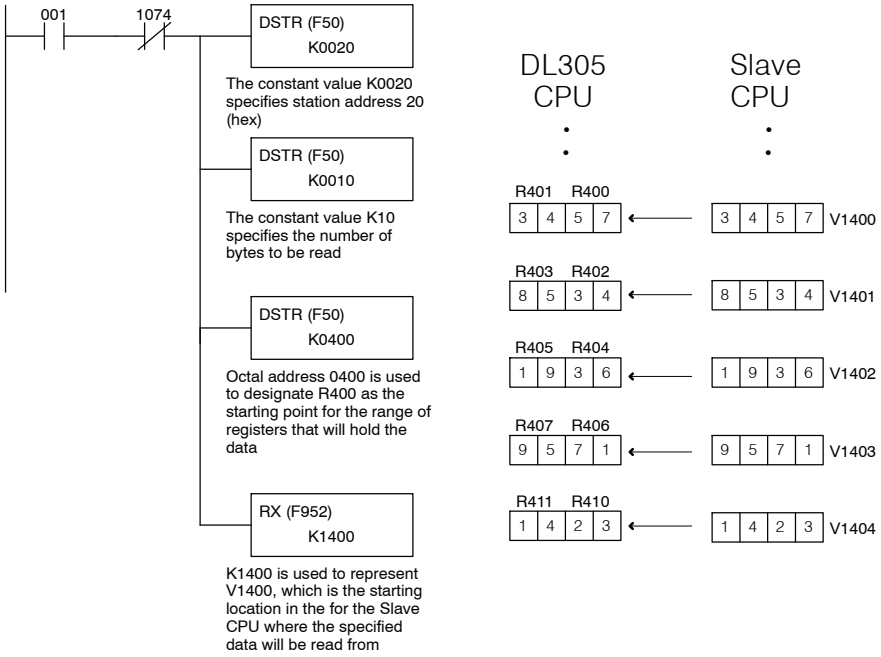
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NOTE: See the DL205 or DL405 User's Manuals for a listing of V-memory addresses available with these CPUs. Since the DL305 only supports a 4-digit constant, you will not be able to access the entire V-memory ranges of the DL205 and DL405 CPUs. For example, you could not directly access V40400 stored in a DL405 CPU. If you require data from a range outside the area available with a 4-digit constant (from V0 – V9999) then add a routine to the slave station program that moves this data down into one of the accessible areas.

In the following example, when input 001 is on and the CPU busy relay 1074 (see special relays, p. 8–32) is not on, the RX instruction will access a DL405 CPU that has been assigned station address 20. (Note, the D4–DCM slave station addresses are set with switches that indicate a hexadecimal number. Make sure you determine the decimal equivalent to be used with the first DSTR instruction in the sequence.)

Ten consecutive bytes of data (V1400 – V1404) will be read from the slave station and stored in registers R400 – R411. (Remember, the DL205 and DL405 V-memory locations are 16 bits. The DL305 registers are only 8 bits, so you have to use two data registers for each V-memory location.)

DirectSOFT Display



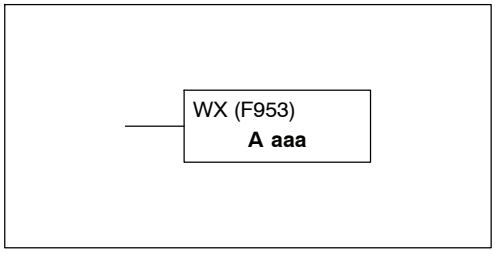
Handheld Programmer Keystrokes

STR	SHF	1	ENT				
AND	NOT	SHF	1	0	7	4	ENT
F	5	0	ENT				
SHF	0	0	2	0	ENT		
F	5	0	ENT				
SHF	1	0	ENT				
F	5	0	ENT				
SHF	4	0	0	ENT			
F	9	5	2	ENT			
SHF	1	4	0	0	ENT		

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Write to Network WX (F953) DL340 Only

The Write to Network instruction is used by the master device on a ***Direct***NET network to write a block of data to another station. The function parameters are loaded into the accumulator and the first and second level of the accumulator stack by three additional instructions. Listed below are the steps necessary to program the Write to Network function.



Step 1: — Load the slave address (1-90 BCD) into the accumulator with the DSTR instruction. This must always be preceded by 00, so address 20 would be 0020. (Remember, the D4-DCM slave device addresses are set with switches that use a hexadecimal format. Make sure you convert this address to the decimal equivalent for use with this instruction.)

Step 2: — Load the number of bytes (1 - 128 BCD) to be transferred to the network slave station.

Step 3: — Load the octal address for the data register that will be used to obtain the data that will be sent to the slave station.

Step 4: — Insert the WX instruction which specifies the starting address in the slave station. If you are sending data to a DL305 station, just enter the Data Register number. If you are sending data to a DL205 or DL405 station, enter a constant that corresponds to the memory address. For example, to send data to Register 500 in a DL305 CPU, you would use R500 with the RX instruction. If you wanted to send data to V1400 in a DL405 CPU, you would use a constant of 1400 with the WX instruction.



NOTE: The ***Direct***NET manual provides further information on the use of the RX and WX network instructions.

Data Type		D3-330 Range	D3-340 Range	D3-330P Range
	A	**aaaa**	**aaaa**	**aaaa**
Inputs / Outputs	R	000-014 070-075	000-014 070-075	000-014 070-075
Control Relays	R	016-036	016-036 100-105	016, 020-027
Shift Registers	R	040-056	040-056	--
Stages	R	--	--	100-116
Timer /Counters (16 bit)	R	600-677	600-677	600-677
Data Registers	R	400-577	400-577 700-777	400-577
*Constant (4-digit BCD)	K	0000-9999	0000-9999	0000-9999

* A constant is used to send data to a DL205 or DL405 system.

Discrete Bit Flags	Description
777	Parameters are not properly set. Check the slave address, data length, or data address reference.
1074	Communication port busy.
1075	Communication error. Data was not transmitted.

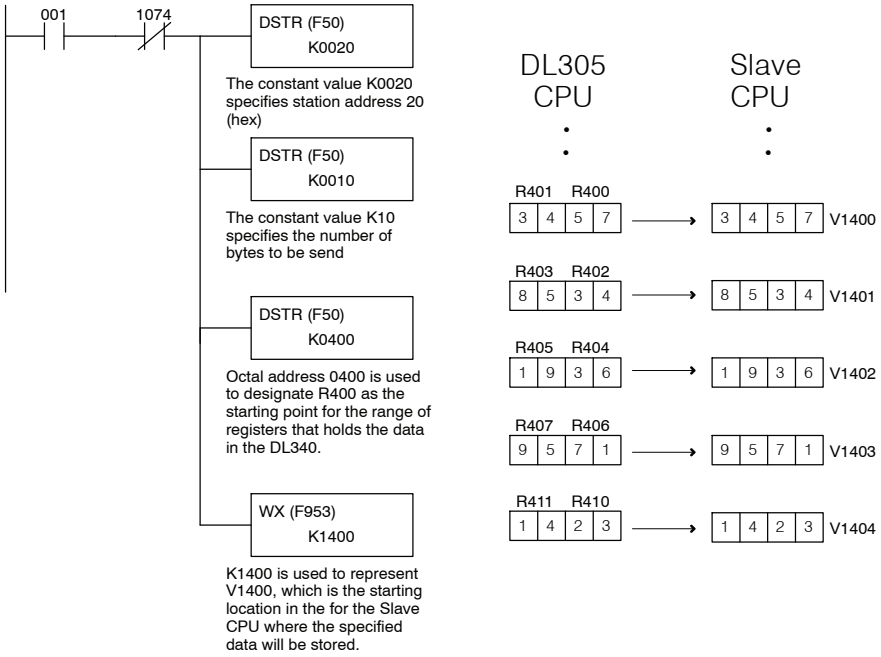
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NOTE: See the DL205 or DL405 User's Manuals for a listing of V-memory addresses available with these CPUs. Since the DL305 only supports a 4-digit constant, you will not be able to access the entire V-memory ranges of the DL205 and DL405 CPUs. For example, you could not directly access V40400 stored in a DL405 CPU. If you want to send data to a range outside the area available with a 4-digit constant (from V0 – V9999) then add a routine to the slave station program that moves the data from one of the accessible areas into the unavailable locations.

In the following example, when input 001 is on and the CPU busy relay 1074 (see special relays, p. 8–32) is not on, the WX instruction will access a DL405 CPU that has been assigned station address 20. (Note, the D4–DCM slave station addresses are set with switches that indicate a hexadecimal number. Make sure you determine the decimal equivalent to be used with the first DSTR instruction in the sequence.)

Ten consecutive bytes of data (R400 – R411) will be sent from the DL340 and stored in V-memory locations V1400 – V1404. (Remember, the DL205 and DL405 V-memory locations are 16 bits. The DL305 registers are only 8 bits, so you have to use two data registers for each V-memory location.)

DirectSOFT Display



Handheld Programmer Keystrokes

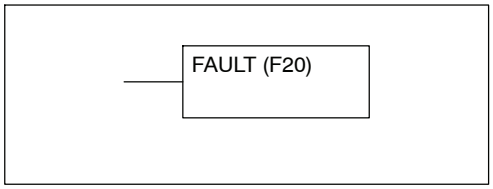
STR	SHF	1	ENT				
AND	NOT	SHF	1	0	7	4	ENT
F	5	0	ENT				
SHF	0	0	2	0	ENT		
F	5	0	ENT				
SHF	1	0	ENT				
F	5	0	ENT				
SHF	4	0	0	ENT			
F	9	5	3	ENT			
SHF	1	4	0	0	ENT		

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Message Instructions

Fault
FAULT (F20)

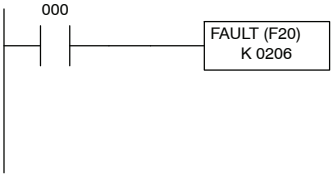
The Fault (F20) instruction is used to display a 4-digit BCD constant, 16-bit register, or two consecutive 8-bit data registers on the handheld programmer or in ***Direct***SOFT. When the fault instruction is executed the number being displayed will also be copied into the registers R574 and R575 and the discrete bit flag 771 will be on.



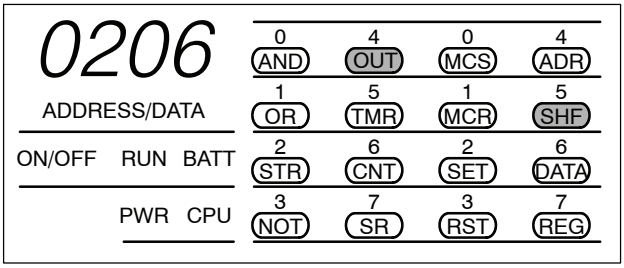
In the following example, when input 000 is on the number 0206 will be displayed on the programming device. This would typically be a user defined error code.

Data Type		D3-330 Range	D3-340 Range	D3-330P Range
	A	**aaaa**	**aaaa**	**aaaa**
Inputs / Outputs	R	000-014 070-075	000-014 070-075	000-014 070-075
Control Relays	R	016-036	016-036 100-105	016, 020-27
Shift Registers	R	040-056	040-56	--
Stages	R	--	--	100-116
Timer /Counters (16 bit)	R	600-677	600-677	600-677
Data Registers	R	400-577	400-577 700-777	400-577
Constant (4-digit BCD)	K	0000-9999	0000-9999	0000-9999

DirectSOFT Display



Handheld Programmer Display



Handheld Programmer Keystrokes

STR	SHF	0	ENT	
F	2	0	ENT	
SHF	2	0	6	ENT

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12

RLL*PLUS* Instruction Set

In This Chapter. . . .

— Introduction
— Stage Instructions
— Comparative Boolean Instructions
— Timer, Counter, and Shift Register Instructions

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Introduction

This chapter provides information concerning the instructions used with RLL*PLUS* CPUs. If you are not familiar with RLL*PLUS* programming concepts, you should read Chapter 10 first. Chapter 10 will help you understand the basic concepts. The following table provides a quick reference listing of the instruction mnemonic and the page(s) defining the instruction. (The mnemonics are very similar to the instruction names and should be easy to become familiar with in a short time.) For example ISG is the mnemonic for Initial Stage. Each instruction definition will show in parentheses the keystrokes used to enter the instruction.



NOTE: Don't assume that the instructions in this chapter are the only ones you can use with your RLL*PLUS* CPU. There are many others that are discussed in Chapter 11 that you can use as well. If you are using a RLL*PLUS* CPU, such as the DL330P, then you should always consult this chapter before you use one of the instructions shown in Chapter 11. There may be differences in the way the instruction operates in an RLL*PLUS* CPU.

This chapter provides a description of several instructions that are similar, but slightly different from their RLL CPU counterparts. For example, you'll notice that a Counter instruction has two input lines in a RLL CPU but only one input line in an RLL*PLUS* CPU.

There are two ways to quickly find the instruction you need.

- If you know the instruction category (Stage, Comparative Boolean, etc.) just use the header at the top of the page to find the pages that discuss the instructions in that category.
- If you know the individual instruction mnemonic, use the following table to find the page that discusses the instruction.

Instruction	Page
AND CNT	12-17
AND SG	12-9
AND TMR	12-16
ANDN CNT	12-17
ANDN SG	12-9
ANDN TMR	12-16
CNT	12-19
ISG	12-3
JMP	12-5
NJMP	12-5
OR CNT	12-15
OR SG	12-8
OR TMR	12-14
ORN CNT	12-15
ORN SG	12-8

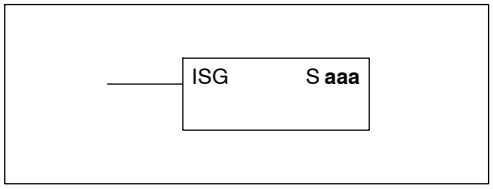
Instruction	Page
ORN TMR	12-14
RST	12-10
RST (counter)	12-20
RST SG	12-11
SET	12-10
SET SG	12-11
SG	12-3
SR	12-21
STR CNT	12-13
STR TMR	12-12
STR SG	12-7
STRN CNT	12-13
STRN SG	12-7
STRN TMR	12-12
TMR	12-18

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Stage Instructions

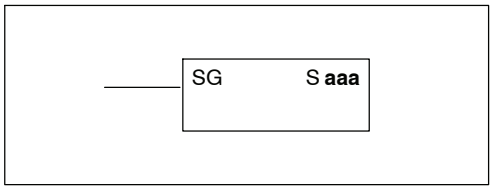
Initial Stage (ISG) DL330P Only

The Initial Stage instruction is normally used as the first segment of a RLL*PLUS* program. Initial stages are activated when the CPU enters the run mode, this creates a starting point in the program. The Initial Stage can be made inactive by either jumping from it or resetting it. Multiple Initial Stages are allowed in a program.



Stage (SG) DL330P Only

The Stage instruction creates segments of a RLL*PLUS* program. Stages are activated by transitional logic, a jump or set stage executed from an active stage. Stages are de-activated one scan after transitional logic, a jump, or a reset stage instruction is executed.

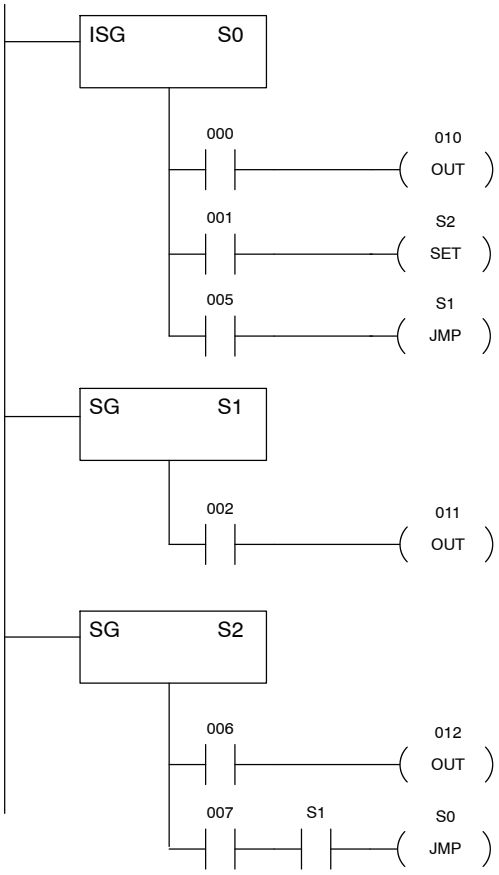


Data Type	D3-330 Range	D3-340 Range	D3-330P Range
	aaaa	aaaa	aaaa
Stages SG	--	--	0-177

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The following example is a simple RLL*PLUS* program. This program utilizes the Initial Stage, Stage, and Jump instructions to create a structured program.

DirectSOFT Display



Handheld Programmer Keystrokes

ISG	SHF	0	ENT	
STR	SHF	0	ENT	
OUT	SHF	1	0	ENT
STR	SHF	1	ENT	
SET	SG	SHF	2	ENT
STR	SHF	5	ENT	
JMP	SG	1	ENT	
SG	SHF	1	ENT	
STR	SHF	2	ENT	
OUT	SHF	1	1	ENT
SG	SHF	2	ENT	
STR	SHF	6	ENT	
OUT	SHF	1	2	ENT
STR	SHF	7	ENT	
AND	SG	1	ENT	
JMP	SG	0	ENT	

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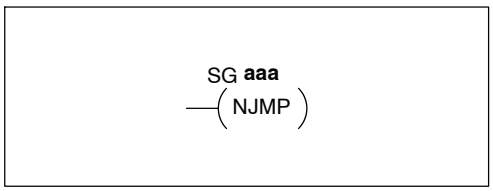
Jump (JMP) DL330P Only

The Jump instruction allows the program to transition from an active stage which contains the jump instruction to another which is specified in the instruction. The jump will occur when the input logic is true. The active stage that contains the Jump will be de-activated 1 scan after the Jump instruction is executed.



Not Jump (NOT JMP) DL330P Only

The Not Jump instruction allows the program to transition from an active stage which contains the jump instruction to another which is specified in the instruction. The jump will occur when the input logic is false. The active stage that contains the Not Jump will be de-activated 1 scan after the Not Jump instruction is executed.

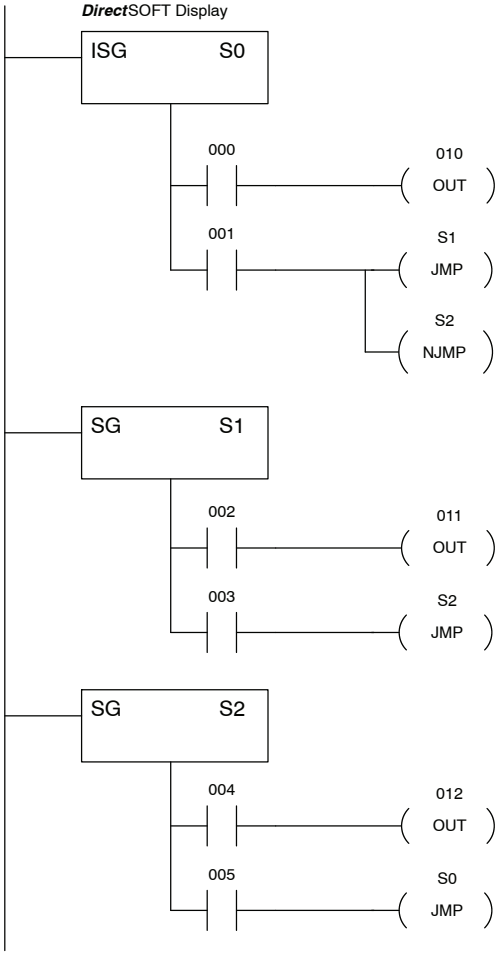


Data Type		D3-330 Range	D3-340 Range	D3-330P Range
		aaaa	aaaa	aaaa
Stages	SG	--	--	0-177

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The following example is a simple RLL*PLUS* program. This program utilizes the Initial Stage, Stage, Jump, and Not Jump instructions to create a structured program.

DirectSOFT Display



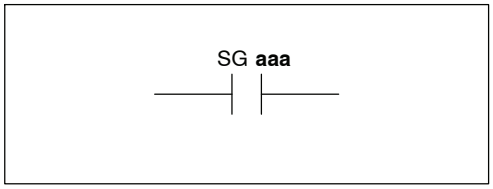
Handheld Programmer Keystrokes

ISG	SG	SHF	0	ENT
STR	SHF	0	ENT	
OUT	SHF	1	0	ENT
STR	SHF	1	ENT	
JMP	SG	SHF	1	ENT
JMP	NOT	SG	SHF	2 ENT
SG	SHF	1	ENT	
STR	SHF	002	ENT	
OUT	SHF	1	1	ENT
STR	SHF	3	ENT	
JMP	SG	SHF	2	ENT
SG	SHF	2	ENT	
STR	SHF	4	ENT	
OUT	SHF	1	2	ENT
STR	SHF	5	ENT	
JMP	SG	SHF	0	ENT

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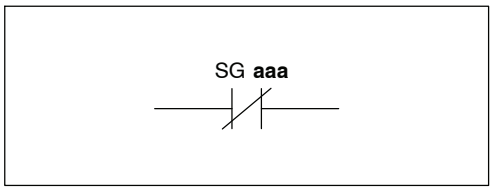
Store Stage (STR SG) DL330P Only

The Store instruction begins a new rung or additional branch in a rung with a normally open stage contact. Status of the contact will be the same state as the associated Stage memory location.



Store Not Stage (STR NOT SG) DL330P Only

The Store Not instruction begins a new rung or additional branch in a rung with a normally closed stage contact. Status of the contact will be opposite the state of the associated stage memory location.



Data Type	D3-330 Range	D3-340 Range	D3-330P Range
	aaaa	aaaa	aaaa
Stages SG	--	--	0-177

In the following Store example, when stage contact 000 is on, output 010 will energize.

DirectSOFT Display



Handheld Programmer Keystrokes

STR	SG	SHF	0	ENT
OUT	SHF	1	0	ENT

In the following Store Not example, when stage contact 000 is off output 010 will energize.

DirectSOFT Display



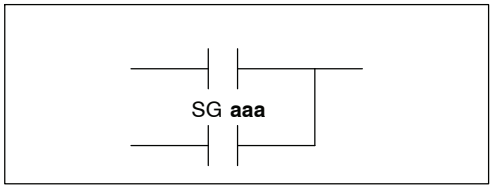
Handheld Programmer Keystrokes

STR	NOT	SG	SHF	0	ENT
OUT	SHF	1	0	ENT	

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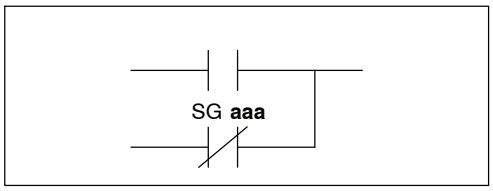
Or Stage (OR SG) DL330P Only

The Or instruction logically ors a normally open stage contact in parallel with another contact in a rung. The status of the contact will be the same state as the associated stage memory location.



Or Not Stage (OR NOT SG) DL330P Only

The Or Not instruction logically ors a normally closed stage contact in parallel with another contact in a rung. The status of the contact will be opposite the state of the associated stage memory location.



Data Type	D3-330 Range	D3-340 Range	D3-330P Range
	aaaa	aaaa	aaaa
Stages SG	--	--	0-177

In the following Or example, when input 000 or stage contact 001 is on output 010 will energize.

***Direct*SOFT Display**



Handheld Programmer Keystrokes

STR	SHF	0	ENT	
OR	SG	SHF	1	ENT
OUT	SHF	1	0	ENT

In the following Or Not example, when input 000 is on or stage contact 001 is off output 010 will energize.

***Direct*SOFT Display**



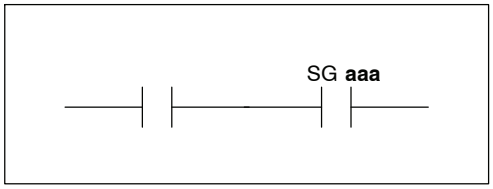
Handheld Programmer Keystrokes

STR	SHF	0	ENT		
OR	NOT	SG	SHF	1	ENT
OUT	SHF	1	0	ENT	

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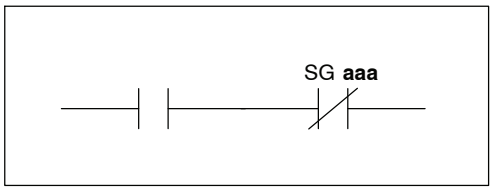
And Stage (AND Stage) DL330P Only

The And instruction logically ands a normally open stage contact in series with another contact in a rung. The status of the contact will be the same state as the associated stage memory location.



And Not Stage (AND NOT SG) DL330P Only

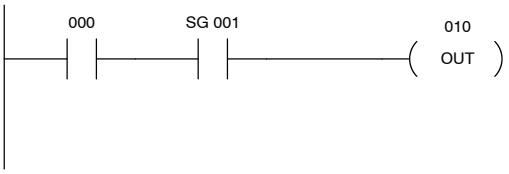
The And Not instruction logically ands a normally closed stage contact in series with another contact in a rung. The status of the contact will be opposite the state of the associated stage memory location.



Data Type	D3-330 Range	D3-340 Range	D3-330P Range
	aaaa	aaaa	aaaa
Stages SG	-	-	0-177

In the following And example, when input 000 and stage contact 001 is on output 010 will energize.

DirectSOFT Display

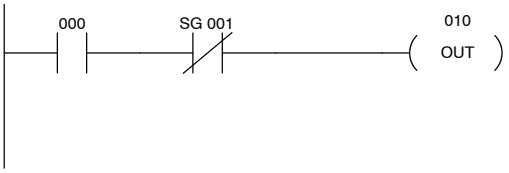


Handheld Programmer Keystrokes

STR	SHF	0	ENT	
AND	SG	SHF	1	ENT
OUT	SHF	1	0	ENT

In the following And Not example, when input 000 is on and stage contact 001 is off output 010 will energize.

DirectSOFT Display



Handheld Programmer Keystrokes

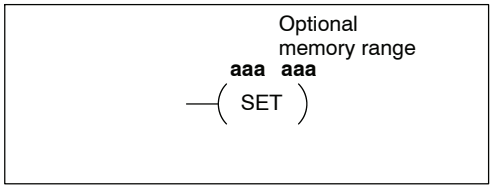
STR	SHF	0	ENT		
AND	NOT	SG	SHF	1	ENT
OUT	SHF	1	0	ENT	

RLL*PLUS* Instructions

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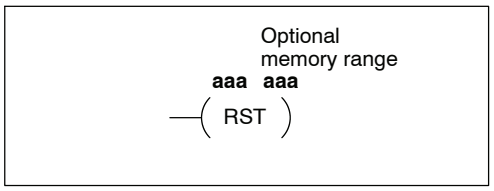
Set (SET) DL330P Only

The Set instruction sets or turns on a output or a consecutive range of outputs. Once the output is set it will remain on until it is reset using the Reset instruction. It is not necessary for the input controlling the Set instruction to remain on. The Set instruction is sometimes known as a latch. The Reset instruction is used to reset the output.



Reset (RST) DL330P Only

The Reset instruction resets or turns off an output or a consecutive range of outputs. Once the output is reset it is not necessary for the input to remain on. The Reset instruction is sometimes known as an unlatch instruction.



Data Type	D3-330 Range	D3-340 Range	D3-330P Range
	aaaa	aaaa	aaaa
Outputs	--	--	000-177 700-767
Control Relays	--	--	160 - 167 170 - 174 200 - 277

In the following Set example, when input location 005 is on, outputs 20-37 will be set on.

DirectSOFT Display



Handheld Programmer Keystrokes

STR	SHF	5	ENT	
SET	SHF	2	0	ENT
SHF	3	7	ENT	

In the following Reset example, when input location 006 is on, outputs 020-37 will be reset to the off state.

DirectSOFT Display



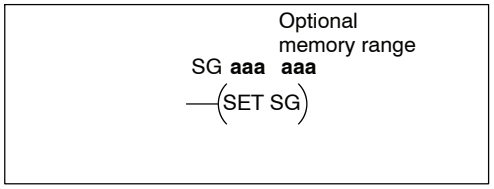
Handheld Programmer Keystrokes

STR	SHF	6	ENT	
RST	SHF	2	0	ENT
SHF	3	7	ENT	

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Set Stage (SET SG) DL330P Only

The Set Stage instruction sets or turns on a stage or a consecutive range of stages. Once the stage is set it will remain on until a transition is made to another stage or the stage is reset using the Reset Stage instruction. It is not necessary for the input controlling the Set Stage instruction to remain on.



Reset Stage (RST SG) DL330P Only

The Reset instruction resets or turns off a stage or a consecutive range of stages. Once the stage(s) is reset it is not necessary for the input to remain on.



Data Type	D3-330 Range	D3-340 Range	D3-330P Range
	aaa	**aaa**	**aaa**
Stage	--	--	000-177

In the following Set Stage example, when input 000 is on, stages 30-47 will be set on.

DirectSOFT Display



Handheld Programmer Keystrokes

STR	SHF	0	ENT		
SET	SG	SHF	3	0	ENT
SHF	4	7	ENT		

In the following Reset Stage example, when input 003 is on, stages 30-47 will be reset off.

DirectSOFT Display



Handheld Programmer Keystrokes

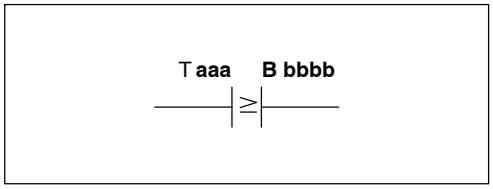
STR	SHF	3	ENT		
RST	SG	SHF	3	0	ENT
SHF	4	7	ENT		

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Comparative Boolean Instructions

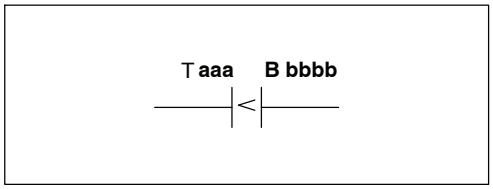
Store If Greater Than or Equal To Timer (STR TMR) DL330P Only

The Store If Greater Than or Equal To instruction begins a new rung or additional branch in a rung with a normally open comparative timer contact. The contact will be on if the specified timer T aaa ≥ B bbbb.



Store Not IF Greater Than Timer (STR NOT TMR) DL330P Only

The Store Not If Greater Than instruction begins a new rung or additional branch in a rung with a normally closed comparative timer contact. The contact will be on if the specified timer T aaa < B bbbb.



Operand Data Type		D3-330 Range		D3-340 Range		D3-330P Range	
	B	**aaa**	**bbbb**	**aaa**	**bbbb**	**aaa**	**bbbb**
Timers	T	--	--	--	--	600-677	--
Data registers	R	--	--	--	--	--	400-577
Constant	K	--	--	--	--	--	0-9999

In the following Store If Greater Than or Equal To example, when T602 ≥ the value 1538 the contact will turn on and output 014 will energize.

***Direct*SOFT Display**



Handheld Programmer Keystrokes

STR	TMR	SHF	6	0	2	ENT
SHF	1	5	3	8	ENT	
OUT	SHF	1	4	ENT		

In the following Store Not If Greater Than example, when T602 < the value in R404 the contact will turn on and output 020 will energize.

***Direct*SOFT Display**



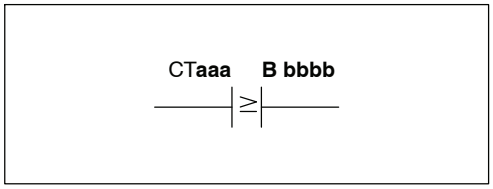
Handheld Programmer Keystrokes

STR	NOT	TMR	SHF	6	0	4	ENT
R	4	0	4	ENT			
OUT	SHF	2	0	ENT			

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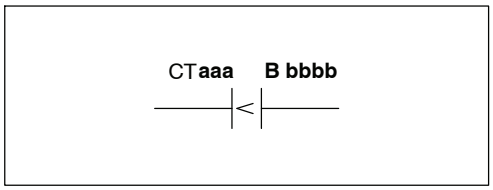
Store If Greater Than or Equal To Counter (STR CNT) DL330P Only

The Store If Greater Than or Equal To instruction begins a new rung or additional branch in a rung with a normally open comparative counter contact. The contact will be on if the specified counter CT aaa ≥ B bbbb.



Store Not If Greater Than Counter (STR NOT CNT) DL330P Only

The Store Not If Greater Than instruction begins a new rung or additional branch in a rung with a normally closed comparative counter contact. The contact will be on if the specified counter CT aaa < B bbbb.



Operand Data Type		D3-330 Range		D3-340 Range		D3-330P Range	
	B	aaa	bbbb	aaa	bbbb	aaa	bbbb
Counters	CT	--	--	--	--	600-677	--
Data registers	R	--	--	--	--	--	400-577
Constant	K	--	--	--	--	--	0-9999

In the following Store If Greater Than or Equal To example, when CT602 ≥ the value in R404 the contact will turn on and output 014 will energize.

DirectSOFT Display



Handheld Programmer Keystrokes

STR	CNT	SHF	6	0	2	ENT
R	4	0	4	ENT		
OUT	SHF	1	4	ENT		

In the following Store Not If Greater Than example, when CT602 < the constant value 4620 the contact will turn on and output 020 will energize.

DirectSOFT Display



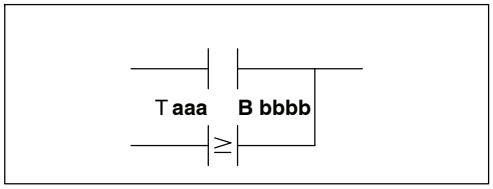
Handheld Programmer Keystrokes

STR	NOT	CNT	SHF	6	0	2	ENT
SHF	4	6	2	0	ENT		
OUT	SHF	2	0	ENT			

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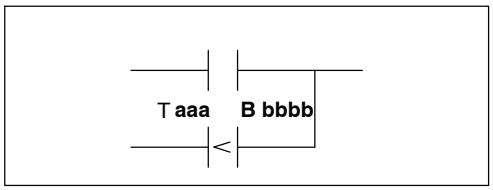
Or If Greater Than or Equal To Timer (OR TMR) DL330P Only

The Or If Greater Than or Equal To instruction connects a normally open comparative timer contact in parallel with another contact. The contact will be on if the specified timer T aaa ≥ B bbbb.



Or Not If Greater Than Timer (OR NOT TMR) DL330P Only

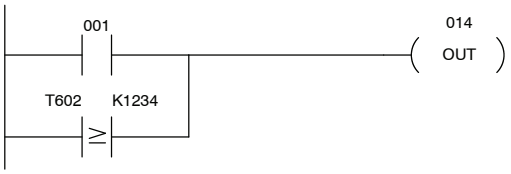
The Or Not If Greater Than instruction connects a normally closed comparative timer contact in parallel with another contact. The contact will be on if the specified timer T aaa < B bbbb.



Operand Data Type		D3-330 Range		D3-340 Range		D3-330P Range	
	B	**aaa**	**bbbb**	**aaa**	**bbbb**	**aaa**	**bbbb**
Timers	T	--	--	--	--	600-677	--
Data registers	R	--	--	--	--	--	400-577
Constant	K	--	--	--	--	--	0-9999

In the following Or If Greater Than or Equal To example, when input contact 001 is on or T602 ≥ the value 1234 the contact will turn on and output 014 will energize.

DirectSOFT Display

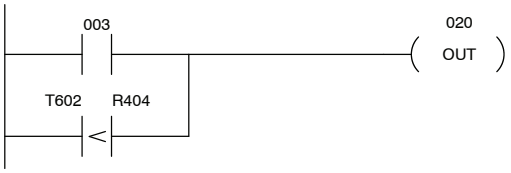


Handheld Programmer Keystrokes

STR	SHF	1	ENT			
OR	TMR	SHF	6	0	2	ENT
SHF	1	2	3	4	ENT	
OUT	SHF	1	4	ENT		

In the following Or Not If Greater Than example, when input contact 003 is on or T602 < the value in R404 the contact will turn on and output 020 will energize.

DirectSOFT Display



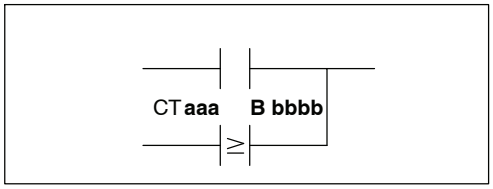
Handheld Programmer Keystrokes

STR	SHF	3	ENT				
OR	NOT	TMR	SHF	6	0	2	ENT
R	4	0	4	ENT			
OUT	SHF	2	0	ENT			

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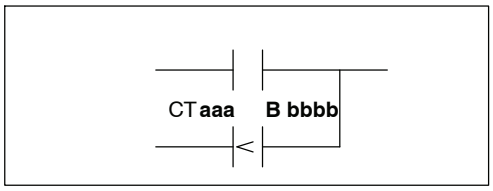
Or If Greater Than or Equal To Counter (OR CNT) DL330P Only

The Or If Greater Than or Equal To instruction connects a normally open comparative counter contact in parallel with another contact. The contact will be on if the specified counter CT aaa ≥ B bbbb.



Or Not If Greater Than Counter (OR NOT CNT) DL330P Only

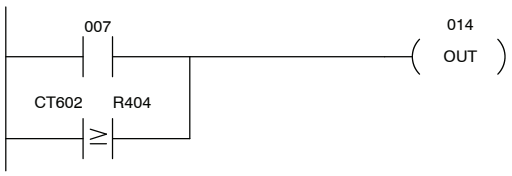
The Or Not If Greater Than instruction connects a normally closed comparative counter contact in parallel with another contact. The contact will be on if the specified counter CT aaa < B bbbb.



Operand Data Type		D3-330 Range		D3-340 Range		D3-330P Range	
	B	aaa	bbbb	aaa	bbbb	aaa	bbbb
Counters	CT	--	--	--	--	600-677	--
Data registers	R	--	--	--	--	--	400-577
Constant	K	--	--	--	--	--	0-9999

In the following Or If Greater Than or Equal To example, when input contact 007 is on or CT602 ≥ the value in R404 the contact will turn on and output 014 will energize.

DirectSOFT Display

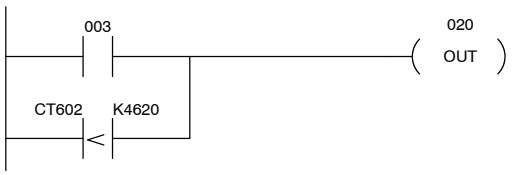


Handheld Programmer Keystrokes

STR	SHF	7	ENT				
OR	CNT	SHF	6	0	2	ENT	
R	4	0	4	ENT			
OUT	SHF	1	4	ENT			

In the following Or Not If Greater Than example, when input contact 003 is on or CT602 < the constant value 4620 the contact will turn on and output 020 will energize.

DirectSOFT Display



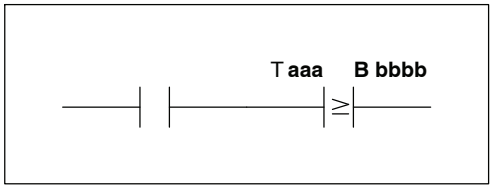
Handheld Programmer Keystrokes

STR	SHF	3	ENT				
OR	NOT	CNT	SHF	6	0	2	ENT
SHF	4	6	2	0	ENT		
OUT	SHF	2	0	ENT			

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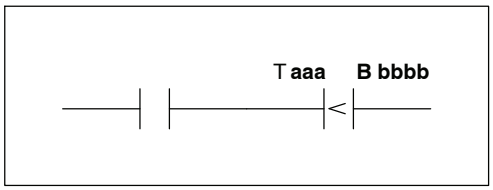
And If Greater Than or Equal To Timer (AND TMR) DL330P Only

The And If Greater Than or Equal To instruction connects a normally open comparative timer contact in series with another contact. The contact will be on if the specified timer T aaa ≥ B bbbb.



And Not If Greater Than Timer (AND NOT TMR) DL330P Only

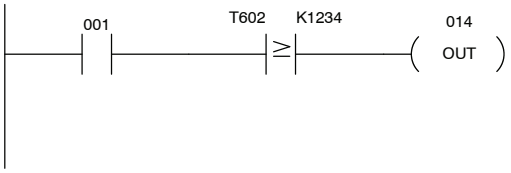
The And Not If Greater Than instruction connects a normally closed comparative timer contact in series with another contact. The contact will be on if the specified timer T aaa < B bbbb.



Operand Data Type		D3-330 Range		D3-340 Range		D3-330P Range	
	B	**aaa**	**bbbb**	**aaa**	**bbbb**	**aaa**	**bbbb**
Timers	T	--	--	--	--	600-677	--
Data registers	R	--	--	--	--	--	400-577
Constant	K	--	--	--	--	--	0-9999

In the following And If Greater Than or Equal To example, when input contact 001 is on and T602 ≥ the value 1234 the contact will turn on and output 014 will energize.

DirectSOFT Display

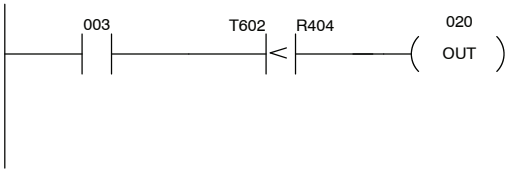


Handheld Programmer Keystrokes

STR	SHF	1	ENT				
AND	TMR	SHF	6	0	2	ENT	
SHF	1	2	3	4	ENT		
OUT	SHF	1	4	ENT			

In the following Store Not If Greater Than example, when input contact 003 is on and T602 < the value in R404 the contact will turn on and output 020 will energize.

DirectSOFT Display



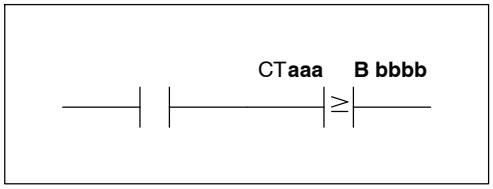
Handheld Programmer Keystrokes

STR	SHF	3	ENT				
AND	NOT	TMR	SHF	6	0	2	ENT
R	4	0	4	ENT			
OUT	SHF	2	0	ENT			

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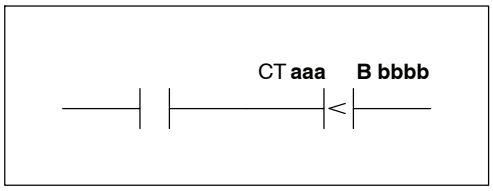
And If Greater Than or Equal To Counter (AND CNT) DL330P Only

The And If Greater Than or Equal To instruction connects a normally open comparative counter contact in series with another contact. The contact will be on if the specified counter CT aaa ≥ B bbbb.



And Not If Greater Than Counter (AND NOT CNT) DL330P Only

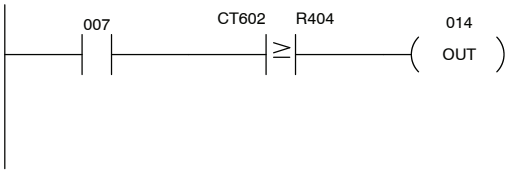
The And Not If Greater Than instruction connects a normally closed comparative counter contact in series with another contact. The contact will be on if the specified counter CT aaa < B bbbb.



Operand Data Type		D3-330 Range		D3-340 Range		D3-330P Range	
	B	**aaa**	**bbbb**	**aaa**	**bbbb**	**aaa**	**bbbb**
Counters	CT	--	--	--	--	600-677	--
Data registers	R	--	--	--	--	--	400-577
Constant	K	--	--	--	--	--	0-9999

In the following Or If Greater Than or Equal To example, when input contact 007 is on and CT602 ≥ the value in R404 the contact will turn on and output 014 will energize.

DirectSOFT Display

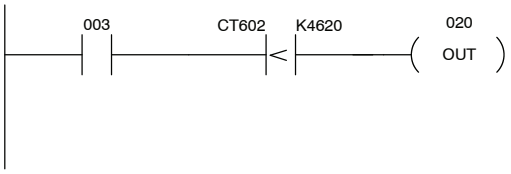


Handheld Programmer Keystrokes

STR	SHF	7	ENT				
AND	CNT	SHF	6	0	2	ENT	
R	4	0	4	ENT			
OUT	SHF	1	4	ENT			

In the following Or Not If Greater Than example, when input contact 003 is on and CT602 < the constant value 4620 the contact will turn on and output 020 energize.

DirectSOFT Display



Handheld Programmer Keystrokes

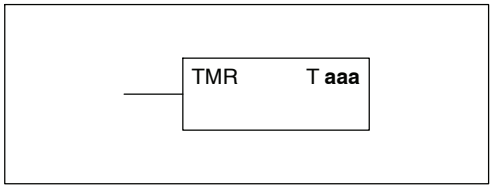
STR	SHF	3	ENT				
AND	NOT	CNT	SHF	6	0	2	ENT
SHF	4	6	2	0	ENT		
OUT	SHF	2	0	ENT			

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Timer, Counter, and Shift Register Instructions

Timer (TMR) DL330P Only

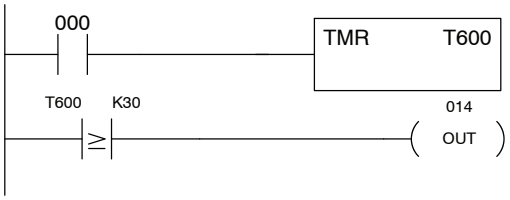
The Timer instruction used in the DL330P CPU provides a single input timer with a 0.1 second increment (0-999.9 seconds) in the normal operating mode, or a 0.01 second increment (0-99.99 seconds) in the fast timer mode with relay 770 on. The timer will time up to the maximum value (999.9 or 99.99) as long as the input logic remains on, once the input logic turns off the timer will reset to 0. There is no timer bit associated with this timer. Comparative boolean instructions must be used to monitor the current value of this timer.



Operand Data Type	D3-330 Range	D3-340 Range	D3-330P Range
	aaa	aaa	aaa
Time	--	--	600-677

In the following Timer example when input contact 000 is on timer 600 will time up. When input contact 000 goes off the timer will reset to zero. The comparative instruction will monitor the current value of the timer and energize when the current value of the timer is greater than or equal to the constant K30.

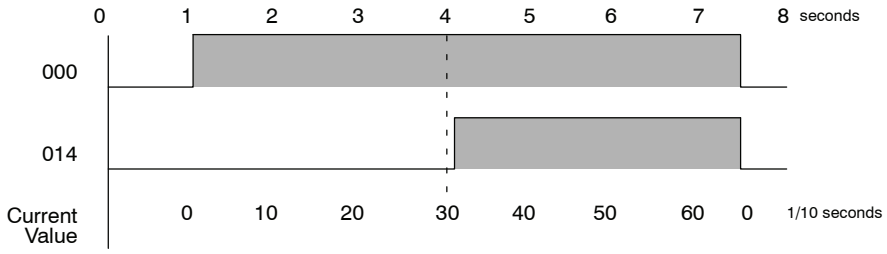
***Direct*SOFT Display**



Handheld Programmer Keystrokes

STR	SHF	0	ENT			
TMR	SHF	6	0	0	ENT	
STR	TMR	SHF	6	0	0	ENT
SHF	3	0	ENT			
OUT	SHF	1	4	ENT		

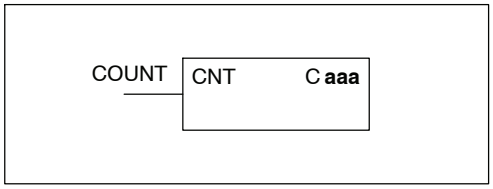
Timing Diagram



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Counter (CNT) DL330P Only

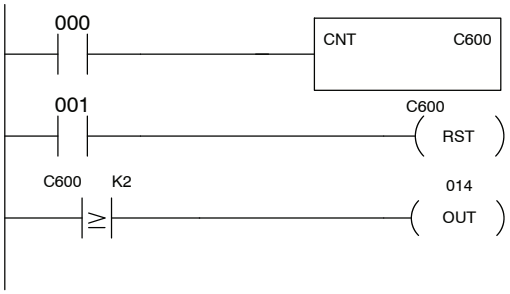
The Counter instruction used in the DL330P CPU provides a single input counter with a counting range of 0-9999. The counter will count up to 9999 and stop. The Reset Counter instruction must be used to reset this counter. There is no counter bit associated with this counter, so comparative boolean instructions must be used to monitor the current value of this counter.



Operand Data Type	D3-330 Range	D3-340 Range	D3-330P Range
	aaa	aaa	aaa
Counter	--	--	600-677

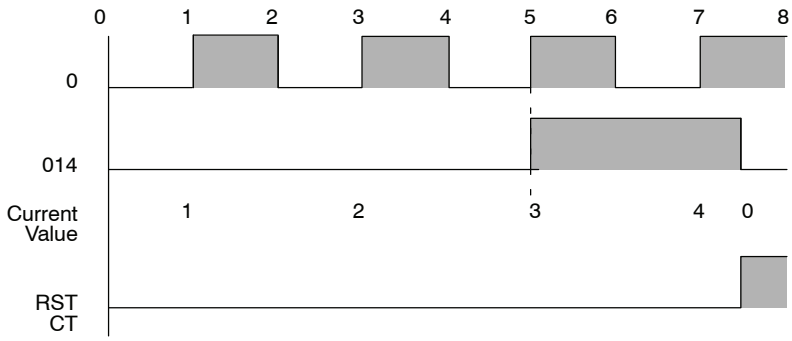
In the following Counter example when input contact 000 transitions from off to on counter 600 will increment by one. When input contact 001 is on the Reset Counter instruction will reset the counter to 0. The comparative instruction will monitor the current value of the counter and energize when the current value of the counter ≥ the constant K2.

DirectSOFT Display



Handheld Programmer Keystrokes

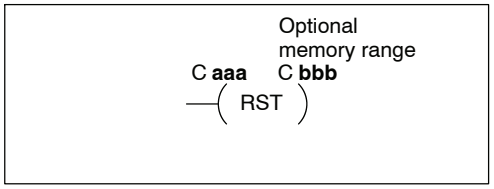
STR	SHF	0	ENT			
CNT	SHF	6	0	0	ENT	
STR	SHF	1	ENT			
RST	CNT	SHF	6	0	0	ENT
STR	CNT	SHF	6	0	2	ENT
SHF	2	ENT				
OUT	SHF	1	4	ENT		



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Reset Counter (RST) DL330P Only

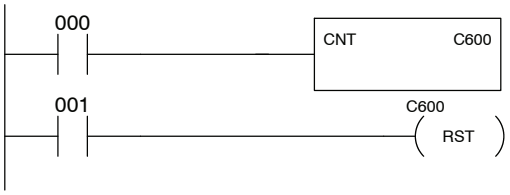
The Reset Counter instruction used in the DL330P CPU provides a reset for the counter instruction. One counter or a range of counters can be reset.



Operand Data Type	D3-330 Range		D3-340 Range		D3-330P Range	
	aaa	bbbb	aaa	bbbb	aaa	bbbb
Counters	--	--	--	--	600-677	600-677

In the following Reset Counter example when input contact 001 is on the Reset Counter instruction will reset counter 600.

DirectSOFT Display



Handheld Programmer Keystrokes

STR	SHF	0	ENT			
CNT	SHF	6	0	0	ENT	
STR	SHF	1	ENT			
RST	CNT	SHF	6	0	0	ENT

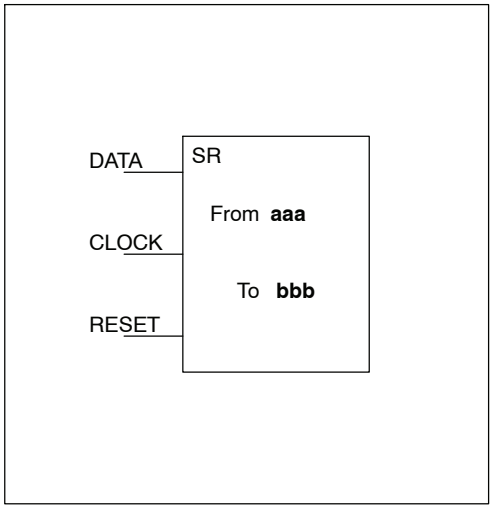
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Shift Register (SR) DL330P Only

The Shift Register instruction shifts data through a predefined number of control relays. There are 77 control relays which can be used for internal control relays or shift register bits. There is no limit to the number of shift registers which can be used in a program, however the total number of bits used cannot exceed 77.

The Shift Register has three input contacts.

- Data — determines the value (1 or 0) that will enter the register
- Clock — shifts the bits one position on each low to high transition
- Reset —resets the Shift Register to all zeros.

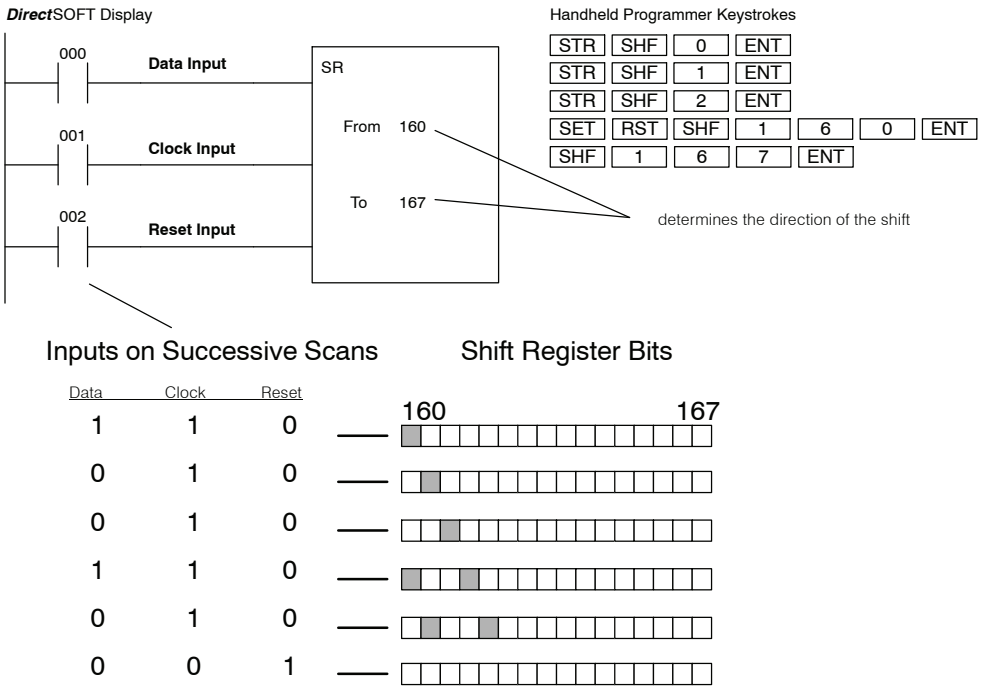


With each off to on transition of the clock input, the bits which make up the shift register block are shifted by one bit position and the status of the data input is placed into the starting bit position of the shift register. The direction of the shift depends on the entry in the From and To fields. From 160 to 167 would define a shift right block of eight bits to be shifted from bit left to right. From 167 to 160 would define a shift left block of eight bits, but would shift from right to left. The maximum size of the shift register block is limited to 77 bits. There is no minimum block size.

Operand Data Type	D3-330 Range		D3-340 Range		D3-330P Range	
	aaa	bbbb	aaa	bbbb	aaa	bbbb
Shift Register Bits	--	--	--	--	160-174 200-277	160-174 200-277

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In the following example, when the clock input transitions from low to high the value in the Data input is placed in the first bit position of the shift register and the successive successive bits are shifted to the right. When the Reset input transitions from low to high the entire shift register is set to zeros.



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13

Maintenance and Troubleshooting

In This Chapter. . . .

- Maintenance
- CPU Indicators
- Power Indicator
- RUN Indicator
- CPU Indicator
- BATT Indicator
- Expansion Base Power
- Testing Output Points
- I/O Module Troubleshooting
- Noise Troubleshooting
- Machine Startup and Program Troubleshooting

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Maintenance

The DL305 is a low maintenance system requiring only a few periodic checks to ensure your system stays up and running without problems. There are two things you should check periodically.

- Air quality (cabinet temperature, etc.)
- CPU battery

Air Quality Maintenance

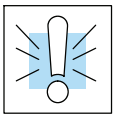
The quality of the air your system is exposed to can affect system performance. If you have placed your system in an enclosure, check to se the ambient temperature is not exceeding the operating specifications. If there are filters in the enclosure, you should clean or replace them as necessary. A good guideline is to check your system environment every one to two months and make sure the environment meets the system operating specifications.

CPU Battery Replacement

The CPU battery is used to retain the application program, data register, and retentive memory types. The life expectancy of this battery is five years.



NOTE: Before replacing your CPU battery, you should back-up your application program. This can be done by saving the program to hard/floppy disk on a personal computer or using the handheld programmer along with a cassette tape recorder. The CPU has a built-in capacitor to retain the memory for several minutes while the battery is being replaced. Saving the program prior to replacing the battery is just an added precaution.

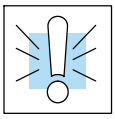


WARNING: If the battery connector is not connected to the PC board or the battery is left out of the system, the indicator light will not notify you of the error. Be sure the battery is in place and the connector is firmly seated before you place the CPU back into the base.

DL330, DL330P, DL340 CPU Battery Replacement

To replace the CPU battery:

1. Turn power off to the system.
2. Wait 60 seconds then remove the CPU. Do not short any connectors or components on the CPU since it may alter the program memory.
3. Unlatch and tilt the clip covering the battery.
4. Pull the two wire battery connector from the PC board.
5. Remove the battery.



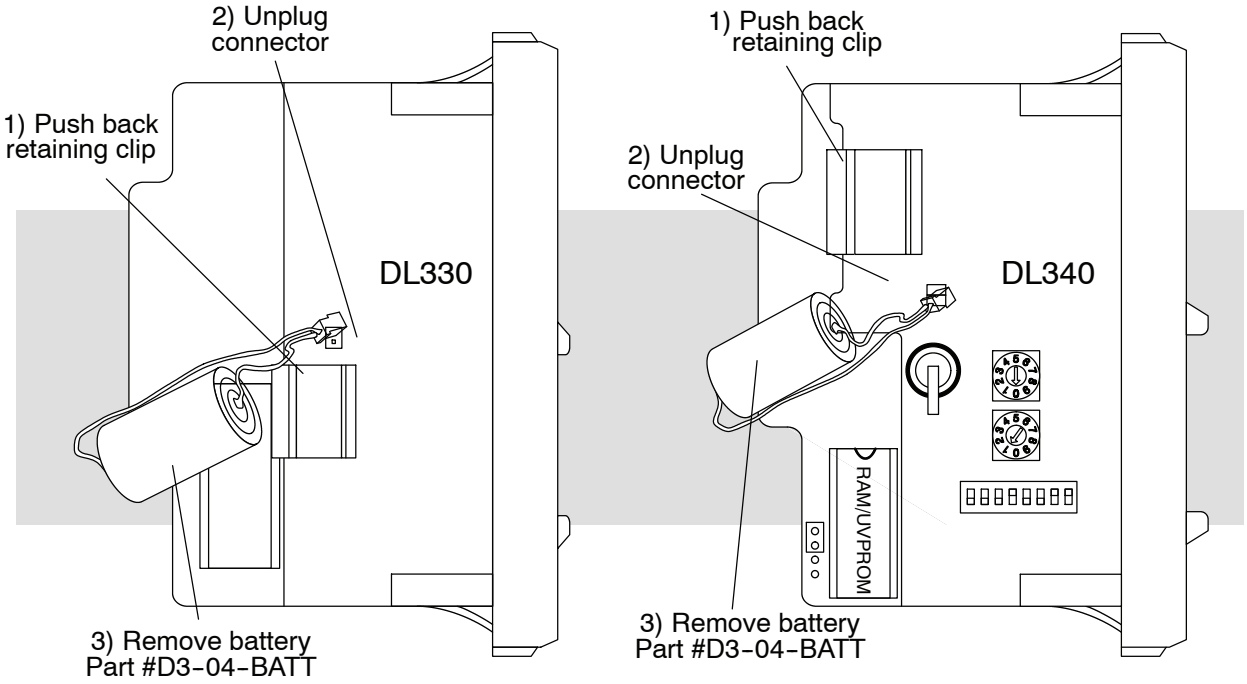
WARNING: Do not attempt to recharge the battery or dispose of it by fire. The battery may explode or release hazardous materials.

To install the CPU battery:

1. Plug the (keyed) two wire battery connector on the battery into the connector on the PC board.
2. Push gently till the connector snaps closed
3. Slide the battery under the battery retaining clip till the battery is positioned in the socket.
4. Push the retaining clip down over the battery snapping the clip over the edge of the PC board.
5. Note the date the battery was changed.

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Battery Removal



CPU Indicators

The DL305 CPUs have indicators on the front to help you diagnose problems with the system. The table below gives a quick reference of potential problems with each status indicator. Following the table will be a detailed analysis of each of these indicator problems.

Indicator Status	Potential Problems
Power (off)	1. Improper wiring 2. Power supply fuse is blown 3. Power supply/CPU is faulty 4. Other component such as an I/O module has power supply shorted 5. Power budget exceeded for the base power supply
RUN (will not come on)	1. CPU programming error 2. Key switch on handheld not in RUN mode
CPU (on)	1. CPU defective 2. Severe electrical noise interference
BATT (on)	CPU battery low
BATT (flashing)	CPU in update mode

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Power Indicator

In general there are four reasons for the CPU power status LED to be OFF:

1. Power to the base is incorrect or is not applied.
2. The power supply has a blown fuse.
3. Base power supply is faulty.
4. Other component(s) have the power supply shut down. This problem could be in the base or in the I/O modules.
5. Power budget for the base has been exceeded.

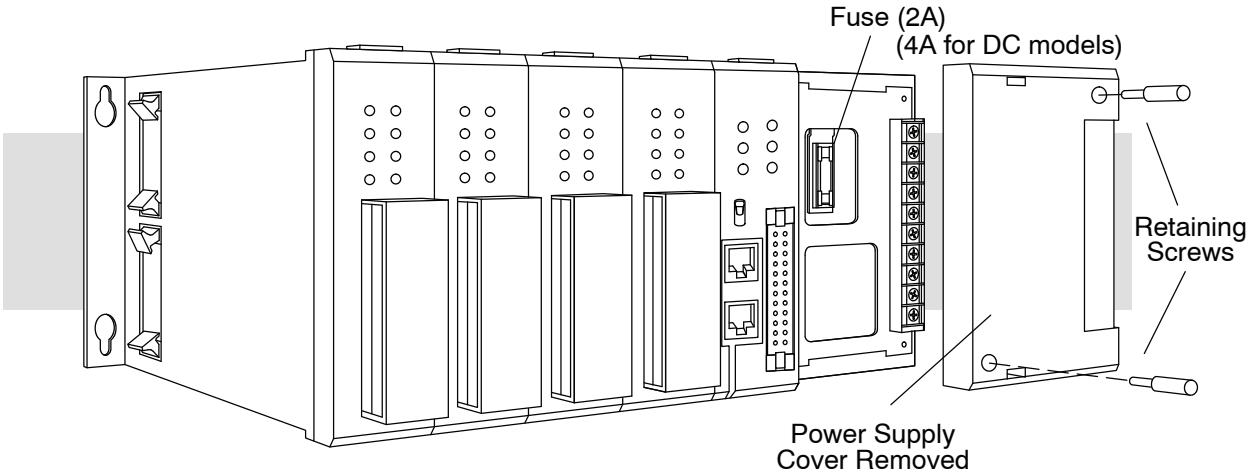
Incorrect Base Power

If the voltage to the power supply is not correct, the CPU may not operate properly or may not operate at all. If this is a new installation, first check the terminal strip on the local CPU base to insure the base is wired correctly. If it is wired for 110 VAC while using 220 VAC the power supply in the base will be damaged. If this has happened, you will need to replace your base. If the wiring is correctly installed for the AC or DC you are using, you should measure the voltage at the terminal strip to insure it is within specification for the base you are using. If the voltage is not correct shut down the system and correct the problem.

Power Supply Blown Fuse

The fuse for base power is located behind the power supply cover at the right side of the base.

1. Remove power from the base.
2. Remove the two slotted insert screws from the front cover.
3. Remove and replace the 2A 250V fuse. (4A 250V for the DC models)
4. Place the front cover back on the power supply and insert the screws.
5. Reapply power to the system.



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Faulty Base Power Supply

There is not a good check to test for a faulty power supply other than substituting a known good base to see if this corrects the problem. If you have experienced major power surges, it is possible the base and power supply have been damaged. If you suspect this is the cause of the power supply damage, a line conditioner which removes damaging voltage spikes should be used in the future.

Device or Module Causing the Power Supply to Shutdown

It is possible a faulty module or external device using the system power can shut down the power supply.

To test for a device causing this problem:

- Turn off power to the base.
- Disconnect all external devices (example Data Communication Unit, Prom Writer Unit) from the CPU.
- Reapply power to the base.

If the Power LED does not operate normally the problem is most likely in one of the modules in the base. To isolate which module is causing the problem remove one module at a time till the Power LED operates normally. Follow the procedure below:

- Turn off power to the base.
- Remove a module from the base.
- Reapply power to the base.

Power Budget Exceeded

This normally would not be the problem if the machine had been operating correctly for a considerable amount of time prior to the indicator going off. Power budgeting problems usually occur during system start-up when the PLC is under operation and the inputs/outputs are requiring more current than the base power supply can provide.



WARNING: The PLC may reset if the power budget is exceeded. If there is any doubt about the system power budget, please check it at this time. Exceeding the power budget can cause unpredictable results which can cause damage and injury. Verify the modules in the base operate within the power budget for the chosen base. You can find additional information on power budget calculations by reviewing Chapter 4.

CPU Firmware Update Mode

The D3-330 CPU firmware can be updated by replacing the EPROM with the new firmware programmed into it. The D3-340 CPU firmware can be updated with a firmware update tool. When this tool is used, the BATT indicator will flash as the CPU is being updated. Contact AutomationDirect Technical support team at 770-844-4200 for assistance.

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RUN Indicator

If the CPU will not enter the run mode (the RUN indicator is off), the problem is usually in the application program unless the CPU has a fatal error in which case the CPU LED should be on.

Both of the programming devices, handheld programmer and PC programming package, will return a error message and depending on the error may also recommend an AUX function to run that will aid in further diagnosing the problem. A complete list of error codes can be found in Appendix B.

CPU Indicator

If the CPU indicator is on, a fatal error has occurred in the CPU. Generally, this is not a programming problem but an actual hardware failure. You can power cycle the system to clear the error. If the error clears the system should be closely monitored and every effort should be made to try to determine the cause of the problem. You will find this problem is sometimes caused by high frequency electrical noise introduced into the CPU from a outside source. Check your system grounding and install electrical noise filters if the grounding is suspected. If power cycling the system does not reset the error or if the problem returns replace the CPU. The CPU indicator lights when the watchdog timer is not processed within 100 ms. The RUN output from the power supply will also turn off.

BATT Indicator

If the BATT indicator is on, the CPU battery is low and needs to be replaced. The battery voltage is continuously monitored while the system voltage is being supplied. The detection circuit will be activated when the voltage drops to 2.5 volts and CPU operation will still continue as normal. Internal relay 377 energizes when the BATT indicator is on.

Procedures for how to replace the battery can be found earlier in this chapter.

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Expansion Base Power

Because a expansion base contains no CPU the only method of determining if the base power supply if functioning correctly is the run relay provided for that base. This relay can be connected to an input point on the local CPU base or an external warning indicator to monitor the expansion base power supply. If the power supply fails, the run relay will open. The procedures for troubleshooting the expansion bases are the same as a local CPU base. Refer to the Power Indicator section for procedures.

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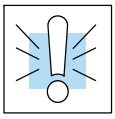
Testing Output Points

Testing Output Points

Output points can be set on or off in the DL305 series CPUs but they cannot be forced in such a way which overrides ladder logic. If you want to do an I/O check out independent of the application program follow the procedure below.

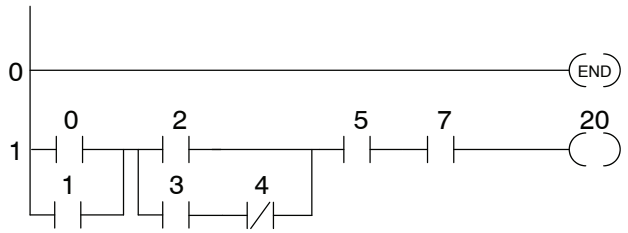
Step	Action
1	If you are using the handheld programmer, change the keyswitch to PRG, if you are using ***Direct***SOFT select program mode.
2	Go to address 0 (handheld SHF NXT keys) .
3	Insert a “END” (handheld CLR SHF INS NXT keys) statement at address 0. (This will cause program execution to occur only at address 0 and prevent the application program from turning the I/O points on or off).
4	Change to Run mode using the handheld programmer or ***Direct***SOFT.
5	Use the programming device to set (turn on) or reset (turn off) the points you wish to test.
6	When you finish testing I/O points go to address 0 (handheld SHF, NXT, NXT keys) and delete the “END” statement (handheld keys DEL PRV)

The following diagram shows the Handheld Programmer keystrokes used to test an output point.



WARNING: Depending on your application, forcing I/O points may cause unpredictable machine operation that can result in a risk of personal injury or equipment damage. Make sure you have taken all appropriate safety precautions prior to testing any I/O points.

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Insert a END statement at the beginning of the Program. This disables the remainder of the program.

To monitor the output point on the handheld programmer use the following keystrokes

SHF 2 0 MON

When the MON command is used, the LED display shows 16 consecutive status points. The MON command has designated this LED to be output number 20.

To turn on the output point use the following keystrokes

SET SHF 2 0 ENT

To turn off the output point use the following keystrokes

RST SHF 2 0 ENT

(20)	0 AND	4 OUT	0 MCS	4 ADR
(21)	1 OR	5 TMR	1 MCR	5 SHF
(22)	2 STR	6 CNT	2 SET	6 DATA
(23)	3 NOT	7 SR	3 RST	7 REG

(20)	0 AND	4 OUT	0 MCS	4 ADR
(21)	1 OR	5 TMR	1 MCR	5 SHF
(22)	2 STR	6 CNT	2 SET	6 DATA
(23)	3 NOT	7 SR	3 RST	7 REG

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I/O Module Troubleshooting

Important Notes About I/O Module Diagnostics

When troubleshooting the DL series I/O modules there are a few facts you should be aware of. These facts may assist you in quickly correcting an I/O problem.

- The output modules cannot detect shorted or open output points. If you suspect one or more points on a output module to be faulty, you should measure the voltage drop from the common to the suspect point. Remember when using a Digital Volt Meter, leakage current from an output device such as a triac or a transistor must be considered. A point which is off may appear to be on if no load is connected the point.
- If the I/O status indicators on the modules are logic side indicators. This means the LED which indicates the on or off status reflects the status of the point in respect to the CPU. On a output module the status indicators could be operating normally while the actual output device (transistor, triac etc.) could be damaged. With an input module if the indicator LED is on, the input circuitry should be operating properly. To verify proper functionality check to see the LED goes off when the input signal is removed.
- Leakage current can be a problem when connecting field devices to I/O modules. False input signals can be generated when the leakage current of an output device is great enough to turn on the connected input device. To correct this install a resistor in parallel with the input or output of the circuit. The value of this resistor will depend on the amount of leakage current and the voltage applied but usually a 10K to 20K ohm resistor will work. Insure the wattage rating of the resistor is correct for your application.
- The easiest method to determine if a module has failed is to replace it if you have a spare. However, if you suspect another device to have caused the failure in the module, that device may cause the same failure in the replacement module as well. As a point of caution, you may want to check devices or power supplies connected to the failed module before replacing it with a spare module.

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Noise Troubleshooting

Electrical Noise Problems

Noise is one of the most difficult problems to diagnose. Electrical noise can enter a system in many different ways and they fall into two categories, conducted or radiated. It may be difficult to determine how the noise is entering the system but the corrective actions for either of the types of noise problems are similar.

- Conducted noise is when the electrical interference is introduced into the system by way of a attached wire, panel connection ,etc. It may enter through an I/O module, a power supply connection, the communication ground connection, or the chassis ground connection.
- Radiated noise is when the electrical interference is introduced into the system without a direct electrical connection, much in the same manner as radio waves.

Reducing Electrical Noise

While electrical noise cannot be eliminated it can be reduced to a level that will not affect the system.

- Most noise problems result from improper grounding of the system. A good earth ground can be the single most effective way to correct noise problems. If a ground is not available, install a ground rod as close to the system as possible. Insure all ground wires are single point grounds and are not daisy chained from one device to another. Ground metal enclosures around the system. A loose wire is no more than a large antenna waiting to introduce noise into the system; therefore, you should tighten all connections in your system. Loose ground wires are more susceptible to noise than the other wires in your system. Review Chapter 2 Installation and Safety Guidelines if you have questions regarding how to ground your system.
- Electrical noise can enter the system through the power source for the CPU and I/O. Installing a isolation transformer for all AC sources can correct this problem. DC sources should be well grounded good quality supplies. Switching DC power supplies commonly generates more noise than linear supplies do.
- Separate input wiring from output wiring. Never run I/O wiring close to high voltage wiring.

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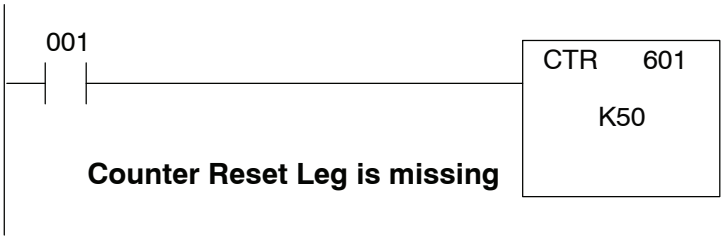
Machine Startup and Program Troubleshooting

Even after our your best attempts at creating application programs, there are still times when you need some assistance. This is especially true during machine startup and program troubleshooting. With the DL305 CPUs there are a few things that help make this task easier.

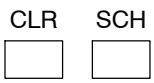
- Program Syntax Check—find problems before startup
- Pause Relay — monitor output status without enabling the actual output points or field devices
- End Statement — move the End statement to disable parts of the program.

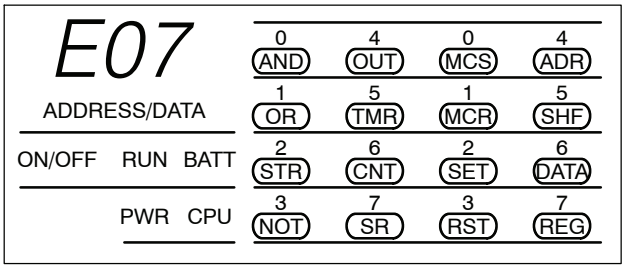
Syntax Check

Even though the Handheld Programmer and ***Direct***SOFT provide error checking during program entry, you may want to check a program that has been modified. Both programming devices offer a way to check the program syntax. For example, you can use check the program syntax from a Handheld Programmer, or you can use the PLC Diagnostics menu option within ***Direct***SOFT. This check will find a wide variety of programming errors. The following example shows how to use the syntax check with a Handheld Programmer.



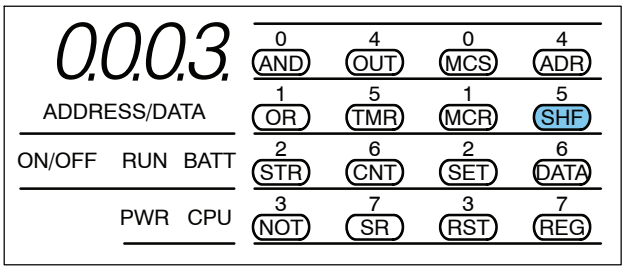
Execute the syntax check





Press CLR to display the address where the error occurred



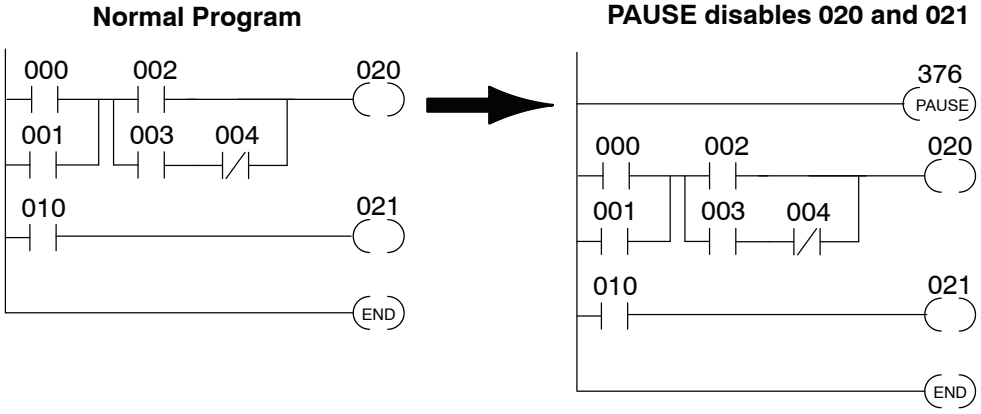


Correct the problem and continue running the Syntax check until the E07 message no longer appears.

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Using the Pause Relay

Special Relay 376 provides a quick way to allow the inputs (or other logic) to operate while disabling any output points used with an OUT instruction. The output image register is still updated, but the output status is not written to the modules. For example, you could make this conditional by adding an input contact or CR to control the instruction with a switch or a programming device. Or, you could just add the instruction without any conditions so the outputs would be disabled at all times.



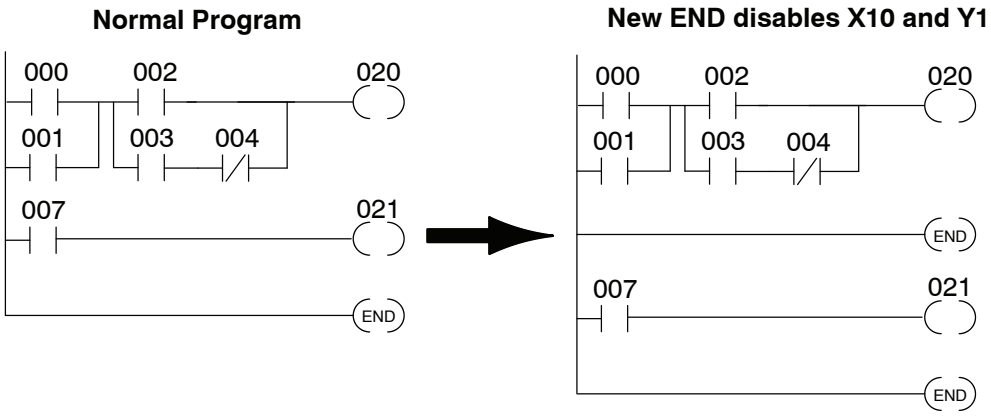
By using this relay, you can still monitor the output status with a programming device. The programming device will show that the output should be on, even though the CPU does not actually update the I/O point.



WARNING: This special relay only inhibits those outputs referenced by the OUT instruction. Output points referenced by the SET OUT instruction *are not* disabled.

END Instruction Placement

If you need a way to quickly disable part of the program, just insert an END statement prior to the portion that should be disabled. When the CPU encounters the END statement, it assumes that is the end of the program. The following diagram shows an example.



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Quick Start Example

A

In This Appendix. . . .

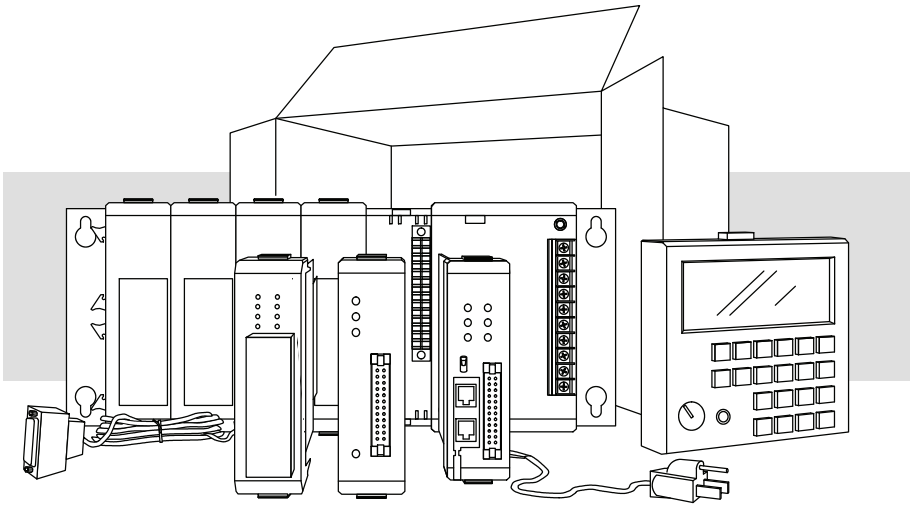
— Step 1: Unpack the DL305 Equipment
— Step 2: Configure the 5-slot Base as the Local CPU Base
— Step 3: Install the CPU and I/O Modules
— Step 4: Wire the I/O Modules to the Field Devices
— Step 5: Remove the Terminal Strip Access Cover
— Step 6: Connect the Power Wiring
— Step 7: Connect the Handheld Programmer
— Step 8: Connect the Power Source
— Step 9: Enter the Example Program

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Now, you have the material necessary to become confident and productive with the DL305. The rest of this chapter is dedicated to laying out all of the pieces necessary to put together a complete system. It will highlight where specific chapters apply to questions you will typically have during your system configuration. This example is not intended to tell you everything you need to start-up your system, warnings and helpful tips are in the rest of the manual. It is only intended to give you a general picture of what you will need to do to get your system powered-up.

Step 1: Unpack the DL305 Equipment

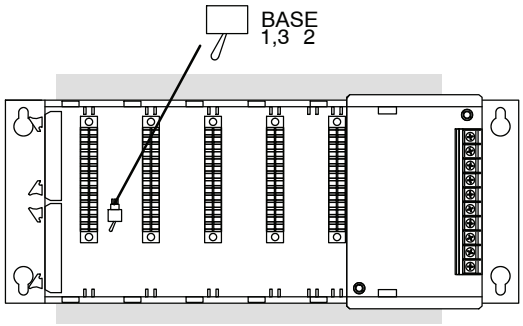
Unpack the DL305 equipment and verify you have the parts necessary to build your system. The minimum parts you will need are:
1 5-slot base
1 Handheld programmer
1 CPU
1 D3-08ND2 discrete input module or D3-08SIM input simulator (If you use any other discrete input module it will be necessary for you to look up the wiring information for the module you are using.)
1 D3-08TD2 discrete output module (Any of the DL305 output modules can be used for this example since we will just be looking at the status indicators.)
1 Power cord (which you supply)



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Step 2: Configure the 5-slot Base as the Local CPU Base

The 5 slot base must be configured for base 1 (the base where the CPU resides). Identification of this base as the local CPU base is made by placing the base toggle switch in the 1,3 position as indicated below the toggle switch. Refer to Chapter 4 for more information on base switches.

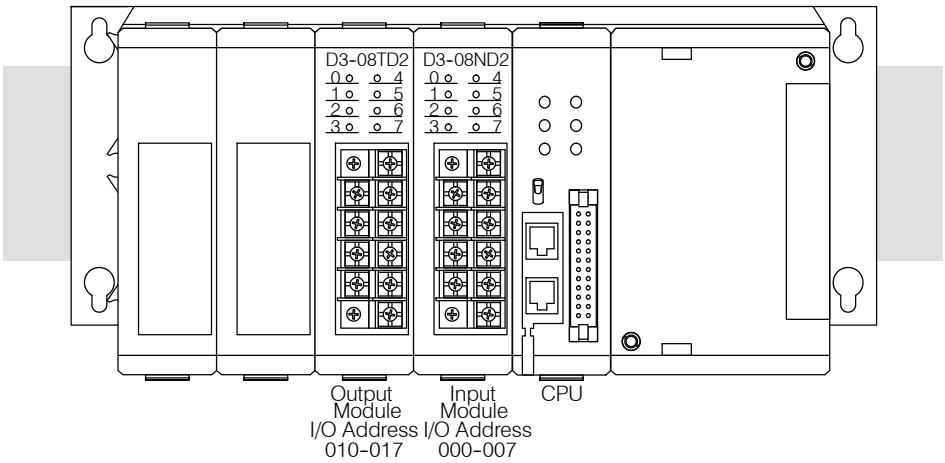


Step 3: Install the CPU and I/O Modules

Insert the CPU and I/O modules into the base as shown below. The CPU must go into the far right side of the base in the position next to the Power Supply.

When inserting components into the base, align the PC board(s) of the module with the grooves on the top and bottom of the base. Push the module straight into the base until it is firmly seated in the backplane connector.

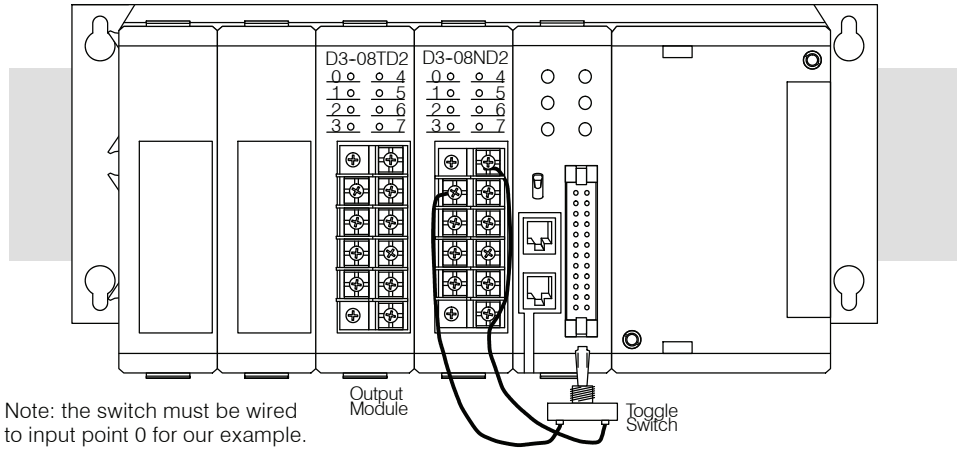
Placement of 8 point discrete and relay modules are not critical and may go in any slot in the local CPU base. Limiting factors for other types of modules are discussed in Chapter 4. You must also make sure you do not exceed the power budget for each base in your system configuration. Power budgeting is also discussed in Chapter 4.



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Step 4: Wire the I/O Modules to the Field Devices

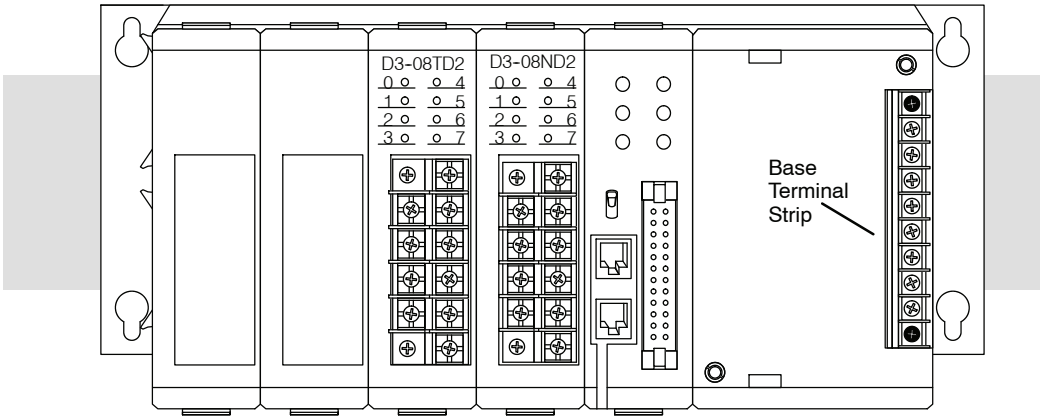
This step is not necessary if you are using an input simulator module. The toggle switch provides an external control point where you can interact with your system. Wire the I/O module to the field device prior to applying power to the system. (This will ensure that a point is not accidentally turned on during the wiring operation.) Wire the discrete input module as shown below. If you are using a module other than the D3–08ND2 you will need to refer to Chapter 6, Discrete Input Modules, for wiring information. Chapter 2, Installation and Safety Guidelines provides a list of I/O wiring guidelines. In the example below there is a discrete input module and a discrete output module in the base. The discrete input module is connected to an external switch.



Note: the switch must be wired to input point 0 for our example.

Step 5: Remove the Terminal Strip Access Cover

Remove the base terminal strip cover.



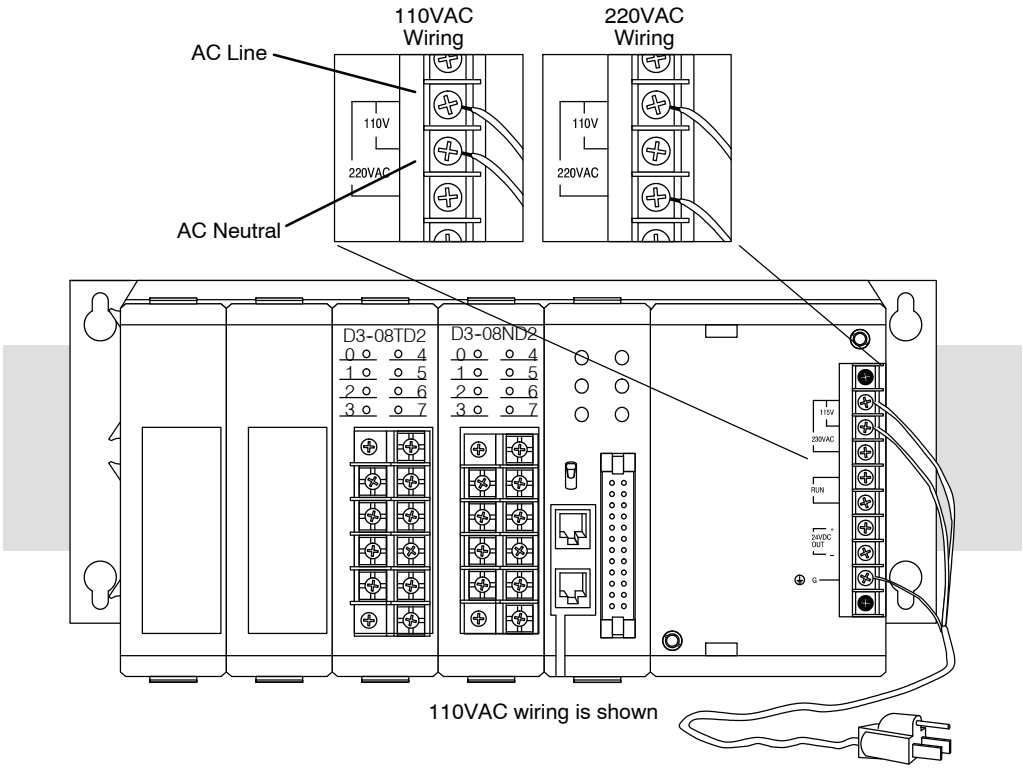
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Step 6: Connect the Power Wiring

If you are using 110VAC to power the base you must wire to the top 2 designated terminals. If you are using a 220VAC power source then you wire to the top and third designated terminals. You can find a detailed explanation of the terminal block on the bases in Chapter 2, Installation and Safety Guidelines.

WARNING:To minimize the risk of electrical shock, make sure the power source is disconnected before you connect the power wiring. Also, make sure you connect the power wiring correctly. The unit will be damaged if you connect 220 VAC to the 115 VAC terminals.

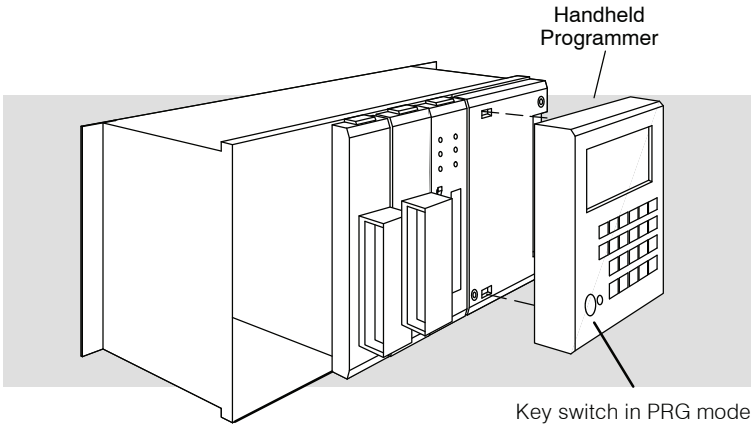
Wire the appropriate power connections to the base as shown below. Once wiring is completed insert the base terminal strip cover.



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Step 7: Connect the Handheld Programmer

Put the handheld programmer's key switch in the PRG position. Attach the handheld programmer directly to the front of the CPU making sure the port on the back of the programmer aligns properly with the port on the CPU and the programmer's latches connect with the slots in the base power supply. Apply power to the base. LEDs on the programmer will display indicating a good connection.



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Step 8: Connect the Power Source

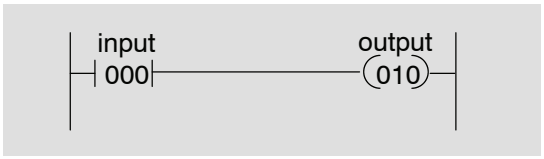
Apply power to the system and ensure the CPU PWR indicator is on. If the indicator is not on, disconnect the system power and check the wiring connections. If the wiring connections are correct, refer to Chapter 13 for additional assistance.



WARNING: To minimize the risk of electrical shock, make sure the power source is disconnected before you check the power wiring.

Step 9: Enter the Example Program

The switch wired to the input module and status indicator (LED) on the face of the output module will be the two I/O points used in the simple rung of ladder logic you will enter. The following diagram shows the ladder logic representation of the the program which will be entered on the handheld programmer.



Enter the key sequences on the handheld programmer as shown below.

CLR	SHF	3	4	8	DEL	NXT	(Clears the CPU memory)
STR	SHF	0	ENT				(Stores input 000)
OUT	SHF	1	0	ENT			(Outputs an on or off state to address 010)

With the programmer's key switch in the PRG position, open and close the field input switch and observe that only the 0 LED on the input module turns on and off. This indicates the input signal is being received.

Now put the programmers key switch in the run position. The RUN LED on the programer's display will turn on. Open and close the field input switch and observe the 0 LED on the face of the input module and the 0 LED on the face of the output module both turn on and off. This indicates the program is accurately reflecting the signals which it is receiving from the field device.

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DL305 Error Codes

B

In This Appendix. . . .

— Error Code Table

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DL305 Error Code	Description
E01 Invalid Keystrokes	Invalid keystroke or series of keystrokes entered into the handheld programmer. Refer to the DL305 Handheld Programmer manual for assistance in the operation you are trying to perform.
E02 Input Point Programmed as Output	An I/O point dedicated to an input module has been used as an output in the application program. Change the I/O reference number in the program which is causing the error.
E03 Stack Overflow	The maximum number of instructions utilizing the internal stack has exceeded eight. These instructions can be a combination of AND STRs, OR STRs and MCS/MCR groups. Reduce the number of these instructions which are pushed onto the stack at one time.
E05 (NON Stage) Duplicate Coil Reference	Two or more output coils have the same data type and number. Change the duplicate coil to correct the error. Duplicate coil references are valid with the SET instruction. E05 will be generated at the address of the second duplicated output.
E05 (Stage) Duplicate Stage Reference	Two or more Stages have the same reference number. Change the duplicate Stage number to correct the error. E05 will be generated at the address of the second duplicated stage number.
E06 MCR/MCS Mismatch	The number of MCR instructions do not match the number of MCS instructions. Each MCR must have an accompanying MCS.
E07 Missing CNT or SR Contact	A required input contact is missing from a CNT (example, RESET input) or a SR instruction.
E08 Invalid Data Values	The required data values for a TMR, CNT or SR are missing or incorrect. Refer to the DL305 Programming Manual Set for details on these instructions.
E09 Incomplete Program Rung	The rung does not terminate with an output as required. Program an output to terminate the rung properly.
E11 Program Full	There is no available program addresses in memory. Reduce the size of the program.
E21 Program Memory Parity Error	A parity error has occurred in the program memory of the CPU. Clear the memory and reload the program. If the error reoccurs replace the CPU. Severe electrical noise will cause this problem.
E22 Password Error	The password stored in the CPU is invalid. Press the “CLR” key twice on the handheld programmer and the password will be reset to 0000. Re-enter the password if required.
E25 Tape/Program Mismatch	A mismatch was found when a compare was performed on the program in CPU memory and the program stored on tape.
E28 Volume Incorrect On Tape Device.	The volume is incorrect on the tape player being used to load the program to the CPU. Adjust the volume and retry the operation. Refer to the DL305 Handheld Programmer manual for details on tape operation.
E31 RAM Limit Exceeded	The application program required more RAM for execution than is available. Reduce the length of the program.
E377 EEPROM Write Error	Write of EEPROM failed because EEPROM is write protected (remove write protect jumper), the EEPROM is bad (replace EEPROM), or UVPROM is installed instead of EEPROM (install EEPROM).
E99 Instruction Not Found	A search was performed and the specified instruction was not found in the application program.

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C

Instruction Execution Times

In This Appendix. . . .

— Introduction
— DL330 Instruction Execution Times
— DL330P Instruction Execution Times
— DL340 Instruction Execution Times

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Introduction

This appendix contains several tables that provide the instruction execution times for the DL330, DL330P, and DL340 CPUs. One thing you will notice is that many of the execution times depend on the type of data being used with the instruction. For example, some of the instructions have different execution times if you use a regular data register instead of a constant.

You'll also notice that some of the data instructions (such as DSTR) require differing amounts of execution time depending on the type of data. There are generally three options.

- Data Registers
- I/O Data Registers
- Constants

The following paragraphs may help you understand the differences between the register types.

Data Registers

Some data registers are primarily used to hold variable data and are considered true data registers. For example, the registers that store the timer or counter current values, or just regular variable data would be considered as a data register. Don't think that you cannot load a bit pattern into these types of registers, you can. It's just that their primary use is as a data register. The following locations are considered as data registers.

Type of Data	DL330	DL330P	DL340
Timer / Counter Current Values	R600 – R677	R600 – R677	R600 – R677
User Data Words	R400 – R563	R400 – R563	R400 – R563 R700 – R767

I/O Data Registers

You may recall that the I/O points are automatically mapped into data register locations. The following locations that contain this data are considered I/O registers and will take longer to execute with most instructions.

Type of Data	DL330	DL330P	DL340
I/O Points	R000 – R016* R070 – R 076	R000 – R016* R070 – R076	R000 – R017* R070 – R076



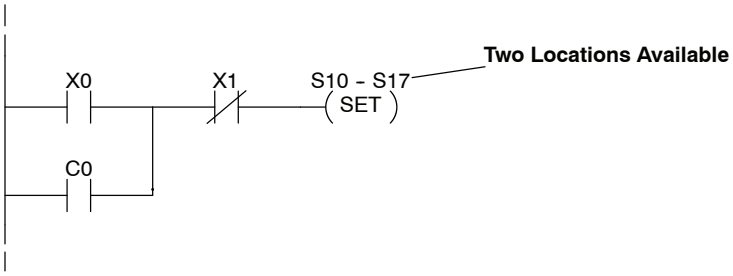
NOTE: 160 – 167 can be used as I/O in a DL330 or DL330P CPU under certain conditions. 160 – 177 can be used as I/O in a DL340 CPU under certain conditions. You should consult Chapter 4 to determine which configurations allow the use of these points.

These points are normally used as control relays. You cannot use them as both control relays and as I/O points. Also, if you use these points as I/O, you cannot access these I/O points as a Data Register reference.

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How to Read the Tables

Some of the instructions can have more than one parameter so the table shows execution times that depend on the amount and type of parameters. For example, the when you use the SET instruction to set a range of stages in a DL330P CPU, the execution time depends on how many stages are being set by the instruction.



Instruction	Stage Instruction		Stage Instruction not activated by a Jump instruction (ex. power flow)
SET SG	26.3 + 13.1µs x (n–1)	18.8 µs	Does not apply
RST SG	26.3 + 13.1µs x (n–1)	18.8 µs	Does not apply

Execution depends on numbers of locations and types of data used

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DL330 Instruction Execution Times

Basic Input Instructions

Instruction	Execute	Disabled by MCR
STR	6.6 µs	N/A
STR NOT	9.1 µs	N/A
AND	5.3 µs	N/A
AND NOT	8.4 µs	N/A
OR	6.6 µs	N/A
OR NOT	9.1 µs	N/A
STR T/C	10.3 µs	N/A
STR NOT T/C	12.8 µs	N/A
AND T/C	5.3 µs	N/A
AND NOT T/C	8.4 µs	N/A
OR T/C	6.6 µs	N/A
OR NOT T/C	9.1 µs	N/A
STR (Comparative Contact)	50.9 µs	N/A
STR NOT (Comparative Contact)	61.5 µs	N/A
AND (Comparative Contact)	59.1 µs	6.2 µs
AND NOT (Comparative Contact)	60.3 µs	6.2 µs
OR (Comparative Contact)	60.3 µs	6.2 µs
OR NOT (Comparative Contact)	62.5 µs	6.2 µs
AND STR	3.8 µs	N/A
OR STR	3.8 µs	N/A
MCR	5.0 µs	N/A
MCS	3.0 µs	N/A

Output Type Instructions

Instruction	Execute	Not Executed
OUT	7.5 µs	7.5 µs
SET OUT	10.0 µs	10.0 µs
SET	17.5 µs	17.5 µs
RST	9.3 µs	9.3 µs
SET OUT RST	19.3 µs	19.3 µs

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Timer, Counters, and Shift Registers

Instruction	Execute w/ Constant	Execute w/ Data Register	Execute w/ I/O Register	Not Executed
TMR	90.9 µs	458.8 µs	700.0 µs	27.1 µs
CNT	92.9 µs	465.6 µs	706.8 µs	27.1 µs
SR	64.1 µs+16.6 µs times (# of shifts)			53.1 µs

Data Operations

Instruction		Execute w/ Data Register	Execute w/ I/O Register	Execute w/ Constant	Not Executed
DSTR	F50	80.7 µs	321.9 µs	14.3 µs	6.3 µs
DSTR1	F51	63.8 µs	140.9 µs	N/A	6.3 µs
DSTR2	F52	95.0 µs	172.2 µs	N/A	6.3 µs
DSTR3	F53	96.6 µs	173.8 µs	N/A	6.3 µs
DSTR5	F55	N/A	326.2 µs	N/A	6.3 µs
DOUT	F60	52.6 µs	329.4 µs	N/A	6.3 µs
DOUT1	F61	39.1 µs	160.1 µs	N/A	6.3 µs
DOUT2	F62	39.8 µs	116.0 µs	N/A	6.3 µs
DOUT3	F63	55.0 µs	108.1 µs	N/A	6.3 µs
DOUT5	F65	N/A	358.3 µs	N/A	6.3 µs
CMP<=>	F70	112.8 µs	354.0 µs	57.0 µs	6.3 µs
ADD	F71	456.8 µs	698.0 µs	262.0 µs	6.3 µs
SUB	F72	315.8 µs	557.0 µs	275.0 µs	6.3 µs
MUL	F73	290–2664 µs	497–2851 µs	223–2576 µs	6.3 µs
DIV	F74	742–2645 µs	1218–2851µs	720–2557 µs	6.3 µs
DAND	F75	103.7 µs	345.0 µs	55.6 µs	6.3 µs
DOR	F76	103.7 µs	345.0 µs	55.6 µs	6.3 µs
SHFR	F80	216 µs+13.4 µs times (# of shifts)			6.3 µs
SHFL	F81	220 µs+13.4 µs times (# of shifts)			6.3 µs
DECO	F82	56.3 µs	N/A	N/A	6.3 µs
ENCO	F83	282.0 µs	N/A	N/A	6.3 µs
INV	F84	30.0 µs	N/A	N/A	6.3 µs
BIN	F85	412.2 µs	N/A	N/A	6.3 µs
BCD	F86	746.0 µs	N/A	N/A	6.3 µs
FAULT	F20	114.0 µs	355.3 µs	72.2 µs	6.3 µs

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DL330P Instruction Execution Times

Basic Input Instructions

Instruction	I/O, Control Relay		Stage		Timer / Counter	
	Executed	Not Executed	Executed	Not Executed	Executed	Not Executed
	* **	* **	* **	* **	* **	* **
STR	28.4 / 31.4µs	21.3 µs	25.6 / 30.9µs	22.2 µs	121.3/117.8µs	28.4 µs
STR NOT	28.4 / 31.4µs	21.3 µs	25.6 / 30.9µs	22.2 µs	121.3/117.8µs	28.4 µs
AND	13.4 / 20.0µs	13.4 / 20.0µs	13.4 / 20.0µs	13.4 / 20.0µs	123.1/119.6µs	20.3 µs
AND NOT	18.1 / 21.6µs	10.3 µs	18.1 / 21.6µs	10.3 µs	123.1/119.6µs	20.3 µs
OR	21.8 / 25.3µs	14.7 µs	21.8 / 25.3µs	14.7 µs	123.1/119.6µs	20.3 µs
OR NOT	20.6 / 24.1µs	14.7 µs	20.6 / 24.1µs	14.7 µs	123.1/119.6µs	20.3 µs

* Execution time when data type is ON. For example, STR 000 takes 28.4 µs if point 000 is on.

** Execution time when data type is OFF. For example, STR 000 takes 31.4 µs if point 000 is off.

Instruction	Executed	Not Executed
AND STR	25.9 µs	22.8 µs
OR STR	25.9 µs	22.8 µs

Output Type Instructions

Instruction	Execute	Not Executed
OUT	20.6 µs	20.6 µs
SET OUT	24.3 µs	16.6 µs
SET	24.3 µs	16.6 µs
RST	24.3 µs	16.6 µs
SET OUT RST	33.8 µs	29.4 µs

Timer, Counters, and Shift Registers

Instruction	Execute	Not Executed
TMR	92.8 µs	50.9 µs
CNT	97.5 µs	46.3 µs
RST CNT	25.9 µs	16.6 µs
SR	75.9 +11.5µs x (# of shifts)	41.9 µs

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Stage Instructions

Instruction	Stage Instruction		Stage Instruction not activated by a Jump instruction (ex. power flow)	
	Executed	Not Executed	Executed	Not Executed
ISG	35.3 µs	20.0 µs	50.9 µs	30.6 µs
SG	35.3 µs	20.0 µs	50.9 µs	30.6 µs
JMP	28.4 µs	16.6 µs	Does not apply	
NJMP	40.3 µs	28.4 µs	Does not apply	
SET SG	26.3 + 13.1µs x (n-1)	18.8 µs	Does not apply	
RST SG	26.3 + 13.1µs x (n-1)	18.8 µs	Does not apply	

Data Operation Instructions

Instruction		Execute w/ Data Register	Execute w/ I/O Register	Execute w/ Constant	Not Executed
DSTR	F50	80.7 µs	321.9 µs	14.3 µs	6.3 µs
DSTR1	F51	63.8 µs	140.9 µs	N/A	6.3 µs
DSTR2	F52	95.0 µs	172.2 µs	N/A	6.3 µs
DSTR3	F53	96.6 µs	173.8 µs	N/A	6.3 µs
DSTR5	F55	N/A	326.2 µs	N/A	6.3 µs
DOUT	F60	52.6 µs	329.4 µs	N/A	6.3 µs
DOUT1	F61	39.1 µs	160.1 µs	N/A	6.3 µs
DOUT2	F62	39.8 µs	116.0 µs	N/A	6.3 µs
DOUT3	F63	55.0 µs	108.1 µs	N/A	6.3 µs
DOUT5	F65	N/A	358.3 µs	N/A	6.3 µs
CMP<=>	F70	112.8 µs	354.0 µs	57.0 µs	6.3 µs
ADD	F71	456.8 µs	698.0 µs	262.0 µs	6.3 µs
SUB	F72	315.8 µs	557.0 µs	275.0 µs	6.3 µs
MUL	F73	290-2664 µs	497-2851 µs	223-2576 µs	6.3 µs
DIV	F74	742-2645 µs	1218-2851µs	720-2557 µs	6.3 µs
DAND	F75	103.7 µs	345.0 µs	55.6 µs	6.3 µs
DOR	F76	103.7 µs	345.0 µs	55.6 µs	6.3 µs
SHFR	F80	216 µs+13.4 µs times (# of shifts)			6.3 µs
SHFL	F81	220 µs+13.4 µs times (# of shifts)			6.3 µs
DECO	F82	56.3 µs	N/A	N/A	6.3 µs
ENCO	F83	282.0 µs	N/A	N/A	6.3 µs
INV	F84	30.0 µs	N/A	N/A	6.3 µs
BIN	F85	412.2 µs	N/A	N/A	6.3 µs
BCD	F86	746.0 µs	N/A	N/A	6.3 µs
FAULT	F20	114.0 µs	355.3 µs	72.2 µs	6.3 µs

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DL340 Instruction Execution Times

Basic Input Instructions

Instruction	Execute	Disabled by MCR
STR	0.875 µs	N/A
STR NOT	1.750 µs	N/A
AND	0.625 µs	N/A
AND NOT	1.5 µs	N/A
OR	1.125 µs	N/A
OR NOT	1.75 µs	N/A
STR T/C	0.875 µs	N/A
STR NOT T/C	1.75 µs	N/A
AND T/C	0.625 µs	N/A
AND NOT T/C	1.5 µs	N/A
OR T/C	1.125 µs	N/A
OR NOT T/C	1.75 µs	N/A
AND STR	0.75 µs	N/A
OR STR	0.75 µs	N/A
MCR	0.75 µs	N/A
MCS	1.125 µs	N/A

Comparative Contacts

Instructions	Execute w/ Data Register	Execute w/ I/O Register	Execute w/ Constant		Not Executed
			RAM	EE / UV	
STR	56.8 µs	95.0 µs	15.6 µs	15.6 µs	N/ A
STR NOT	56.8 µs	96.5 µs	15.6 µs	15.6 µs	N/A
AND	56.8 µs	95.0 µs	15.0 µs	15.0 µs	1.4 µs
AND NOT	56.8 µs	96.5 µs	15.6 µs	15.6 µs	1.4 µs
OR	56.8 µs	94.0 µs	15.6 µs	15.6 µs	1.4 µs
OR NOT	56.8 µs	94.0 µs	16.2 µs	16.2 µs	1.4 µs

Output Type Instructions

Instruction	Execute	Not Executed
OUT	1.188 µs	1.188 µs
SET OUT	1.563 µs	1.563 µs
SET	1.625 µs	1.4 µs
RST	1.625 µs	1.4 µs
SET OUT RST	7.5 µs	7.125 µs

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Timer, Counters, and Shift Registers

Instructions	Execute w/ Data Register	Execute w/ I/O Register	Execute w/ Constant		Not Executed
			RAM	EE / UV	
TMR	68.1 µs	113.8 µs	22.5 µs	22.5 µs	15.7 µs
CNT	67.3 µs	97.9 µs	22.5 µs	22.5 µs	25.6 µs
SR	21.8 µs+3.8 µs times (# of shifts)				8.3 µs

Data Operation Instructions

Instruction		Execute w/ Data Register	Execute w/ I/O Register	Execute w/ Constant	Not Executed
DSTR	F50	29.4 µs	60.6 µs	10.6 µs	1.4 µs
DSTR1	F51	24.3 µs	39.4 µs	N/A	1.4 µs
DSTR2	F52	25.0 µs	40.6 µs	N/A	1.4 µs
DSTR3	F53	96.6 µs	39.4 µs	N/A	1.4 µs
DSTR5	F55	N/A	76.8 µs	N/A	1.4 µs
DOUT	F60	18.8 µs	53.8 µs	N/A	1.4 µs
DOUT1	F61	13.1 µs	33.1 µs	N/A	1.4 µs
DOUT2	F62	16.3 µs	23.1 µs	N/A	1.4 µs
DOUT3	F63	15.6 µs	23.1 µs	N/A	1.4 µs
DOUT5	F65	N/A	59.3 µs	N/A	1.4 µs
CMP<=>	F70	30.0 µs	61.8 µs	15.6 µs	1.4 µs
ADD	F71	77.5 µs	108.0 µs	63.0 µs	1.4 µs
SUB	F72	70.6 µs	101.8 µs	57.0 µs	1.4 µs
MUL	F73	71.8 – 540.0 µs	102.5 – 571.2 µs	58.7 – 526.8 µs	1.4 µs
DIV	F74	73.7 – 568.1 µs	104.3 – 598.7 µs	58.7 – 553.1 µs	1.4 µs
DAND	F75	29.3 µs	60.0 µs	15.6 µs	1.4 µs
DOR	F76	31.2 µs	62.5 µs	15.6 µs	1.4 µs
SHFR	F80	18.1 µs+2.5 µs times (# of shifts)			1.4 µs
SHFL	F81	18.1 µs+2.5 µs times (# of shifts)			1.4 µs
DECO	F82	15.6 µs	N/A	N/A	1.4 µs
ENCO	F83	47.5 µs	N/A	N/A	1.4 µs
INV	F84	6.8 µs	N/A	N/A	1.4 µs
BIN	F85	48.1 µs	N/A	N/A	1.4 µs
BCD	F86	88.7 – 326.0 µs	N/A	N/A	1.4 µs
FAULT	F20	28.8 µs	60.1 µs	15.0 µs	1.4 µs

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D

DL305 Product Weight Tables

In This Appendix. . . .

— Product Weight Table

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Product Weight Table

CPUs	Weight
D3-330	6.3 oz. (178g)
D3-330P	6.3 oz. (178g)
D3-340	5.2 oz. (146g)
Specialty CPUs	
F3-OMUX-1	6.4 oz. (182g)
F3-OMUX-2	6.4 oz. (182g)
F3-PMUX	3.7 oz. (104g)
F3-RTU	6.7 oz. (190g)
Bases	
D3-05B	34.0 oz. (964g)
D3-05BDC	34.0 oz.(964g)
D3-08B	44.2 oz. (1253g)
D3-10B	50.5 oz. (1432g)
DC Input Modules	
D3-08ND2	4.2 oz. (120g)
D3-16ND2-1	6.3 oz. (178g)
D3-16ND2-2	5.3 oz. (150g)
D3-16ND2F	6.3 oz. (178g)
F3-16ND3F	5.4 oz. (153g)
AC Input Modules	
D3-08NA-1	5 oz. (140g)
D3-08NA-2	5 oz. (140g)
D3-16NA	6.4 oz. (180g)
AC/DC Input Modules	
D3-08NE3	4.2 oz. (120g)
D3-16NE3	6 oz. (170g)

DC Output Modules	Weight
D3-08TD1	4.2 oz. (120g)
D3-08TD2	4.2 oz. (120g)
D3-16TD1-1	5.6 oz. (160g)
D3-16TD1-2	5.6 oz. (160g)
D3-16TD2	7.1 oz. (210g)
AC Output Modules	
D3-04TAS	6.4 oz. (180g)
F3-08TAS	6.3 oz. (178g)
F3-08TAS-1	6.3 oz. (178g)
D3-08TA-1	7.4 oz. (210g)
D3-08TA-2	6.4 oz. (180g)
F3-16TA-2	7.7 oz. (218g)
D3-16TA-2	7.2 oz. (210g)
Relay Output Modules	
D3-08TR	7 oz. (200g)
F3-08TRS-1	8.9 oz. (252g)
F3-08TRS-2	9 oz. (255g)
D3-16TR	8.5 oz. (248g)
Analog Modules	
D3-04AD	7 oz. (200g)
F3-04ADS	6.9 oz. (195g)
F3-08AD	5.5 oz. (154g)
F3-08TEMP	5.2 oz. (147g)
F3-08THM-n	6 oz. (170g)
F3-16AD	5.4 oz. (152g)
D3-02DA	7 oz. (200g)
F3-04DA-1	6.3 oz. (180g)
F3-04DA-2	6.3 oz. (180g)
F3-04DAS	7 oz. (200g)

Communications and Networking	Weight
D3-232-DCU	15.0 oz. (427g)
D3-422-DCU	14.8 oz. (419g)
ASCII BASIC Modules	
F3-AB128-R	5.1 oz. (146g)
F3-AB128-T	6.2 oz. (175g)
F3-AB128	5.4 oz. (154g)
Specialty Modules	
D3-08SIM	3.0 oz. (85g)
D3-HSC	5.2 oz. (147g)
D3-PWU	13.0 oz. (368g)
D3-FILL	1oz. (30g)
Programming	
D3-HP	7.1 oz. (202g)
D3-HPP	7.2 oz. (204g)

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