

# GETTING STARTED

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# CHAPTER 1

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# Introduction

## The Purpose of this Manual

Thank you for purchasing a DL405 PLC. This manual shows you how to install, program, and maintain a D4-454 CPU. It also helps you understand how to interface them to other devices in a control system. This manual contains important information for both installing and programming PLC systems using the D4-454 CPU. This user manual will provide the information you need to get and keep your system up and running.

## Where to Begin

If you already understand PLCs please read Chapter 2, "Installation, Wiring and Specifications", and proceed on to other chapters as needed. Be sure to keep this manual handy for reference when you have questions. If you are new to the D4-454 PLC controller, we suggest you read this manual completely so you can understand the wide variety of features available. We believe you will be pleasantly surprised with how much you can accomplish with our products.

## Technical Support

We strive to make our manuals the best in the industry. We rely on your feedback to let us know if we are reaching our goal. If you cannot find the solution to your particular application, or, if for any reason you need technical assistance, please call us at:

**770-844-4200**

Our technical support group will work with you to answer your questions. They are available Monday through Friday from 9:00 a.m. to 6:00 p.m. Eastern Time. We also encourage you to visit our web site where you can find technical and non-technical information about our products and our company.

**<http://www.automationdirect.com>**

If you have a comment, question or suggestion about any of our products, services, or manuals, please let us know.

# Conventions Used



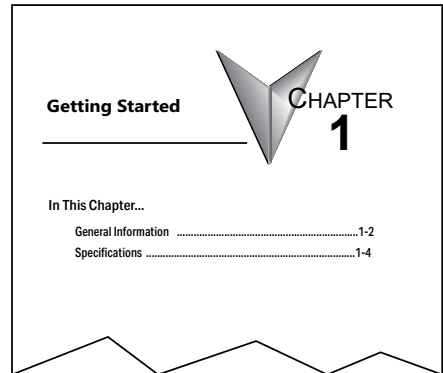
**WHEN** you see the “notepad” icon in the left-hand margin, the paragraph to its immediate right will be a special note. The word **NOTE:** in boldface will mark the beginning of the text.



When you see the exclamation point icon in the left-hand margin, the paragraph to its immediate right will be a warning. This information could prevent injury, loss of property, or even death in extreme cases. Any warning in this manual should be regarded as critical information that should be read in its entirety. The word **WARNING** in boldface type will mark the beginning of the text.

## Key Topics for Each Chapter

The beginning of each chapter will list the key topics that can be found in that chapter.



# DL405 System Components

## CPUs

There are two feature-enhanced CPUs in this product line, the D4-454 and D4-454DC-1. Both include a built-in power supply and communication ports. Each CPU offers a large amount of program memory, a substantial instruction set and advanced diagnostics. The D4-454 CPUs features drum timers, floating-point math, built-in PID loops, and additional communications ports. Details of these CPU features are covered in Chapter 3, CPU Specifications and Operation.

## Bases

Three base sizes are available in the system: 4 slot, 6 slot and 8 slot.

## I/O Configuration

The D4-454 can support up to 1024 local I/O. A maximum of 1536 I/O points for the D4-454 can be added to the system in the form of remote I/O bases and slice I/O blocks. Each of these I/O configurations is explained in Chapter 4, System Design and configuration.

## I/O Modules

The DL405 family has a complete range of discrete modules which support 24 VDC, 125 VDC, 110/220 VAC and up to 10A relay outputs. Analog modules provide 12-bit resolution and several selections of input and output signal ranges (including bipolar). Specialty modules include high-speed inputs and outputs, thermocouple, general purpose communication, magnetic pulse input, 16 loop PID function and more.

# Programming Methods

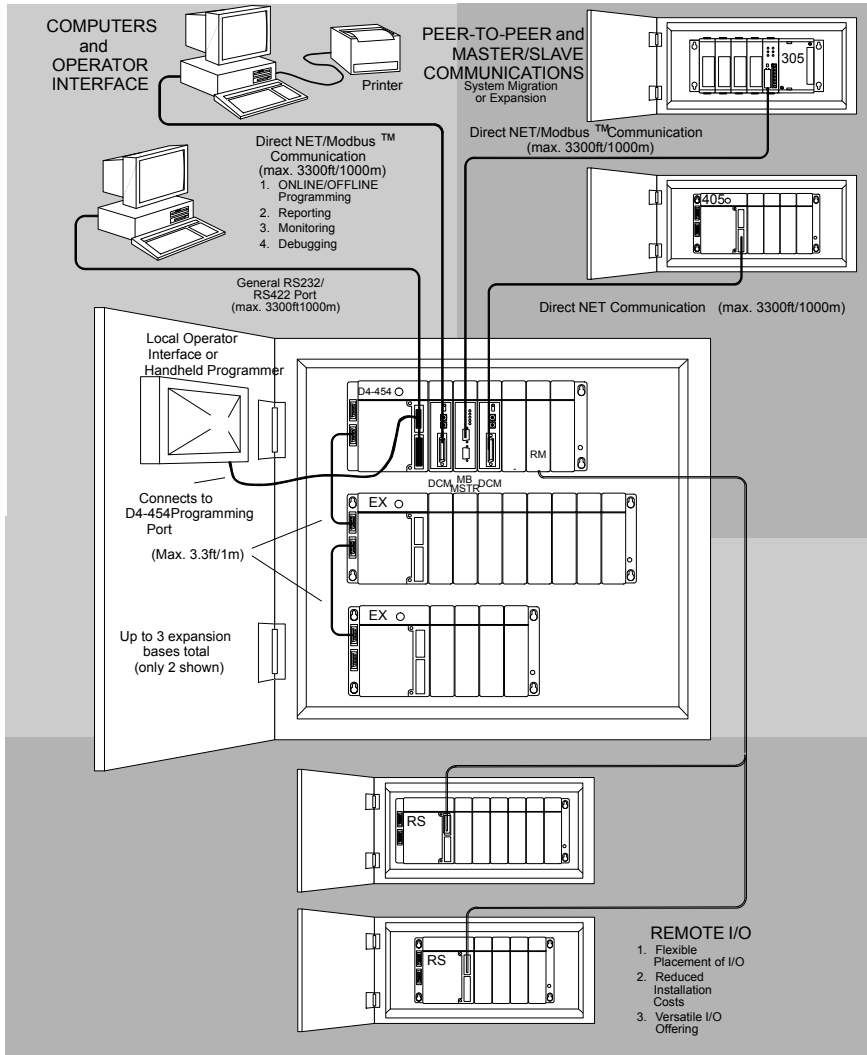
## DirectSOFT Programming for Windows™

There are two programming methods available for the D4-454 CPUs, RLL (Relay Ladder Logic) and RLLPLUS Stage Programming. Both the DirectSOFT programming package and the handheld programmer support RLL and stage.

The D4-454 CPUs can be programmed with DirectSOFT Version 6.1 or later. DirectSOFT is a Windows-based software package that supports many of the Windows features you already know, such as cut-and-paste between applications, point-and-click editing, viewing and editing multiple application programs at the same time, browsers, and Intelligent Box (IBox) Instructions which will help ease your programming tasks. DirectSOFT universally supports the DirectLOGIC™ CPU families. This means you can use the same DirectSOFT package to program DL05, DL06, DL105, DL205, DL305, DL405 or any new DirectLOGIC CPUs that we add to our product line. There is a separate manual for the DirectSOFT programming software and 1 copy is shipped with each purchase.

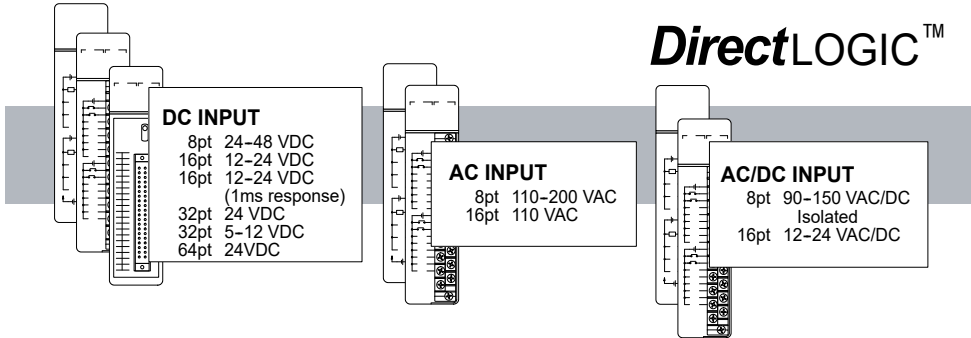
## DL405 System Diagrams

The diagram below shows the major components and configurations of the DL405 system. The next two pages show specific components for building your system.

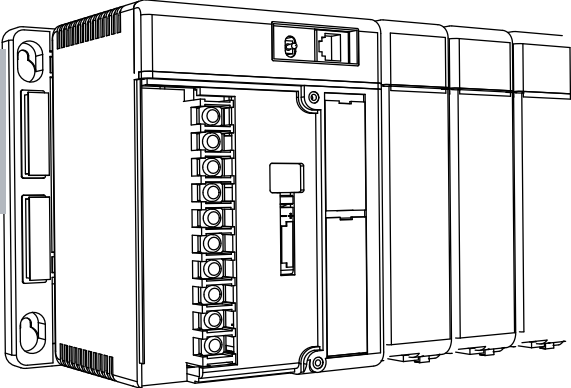


# DL405 Family

## DirectLOGIC™



**PROGRAMMING**  
*DirectSOFT*  
 Version 6.1 or higher



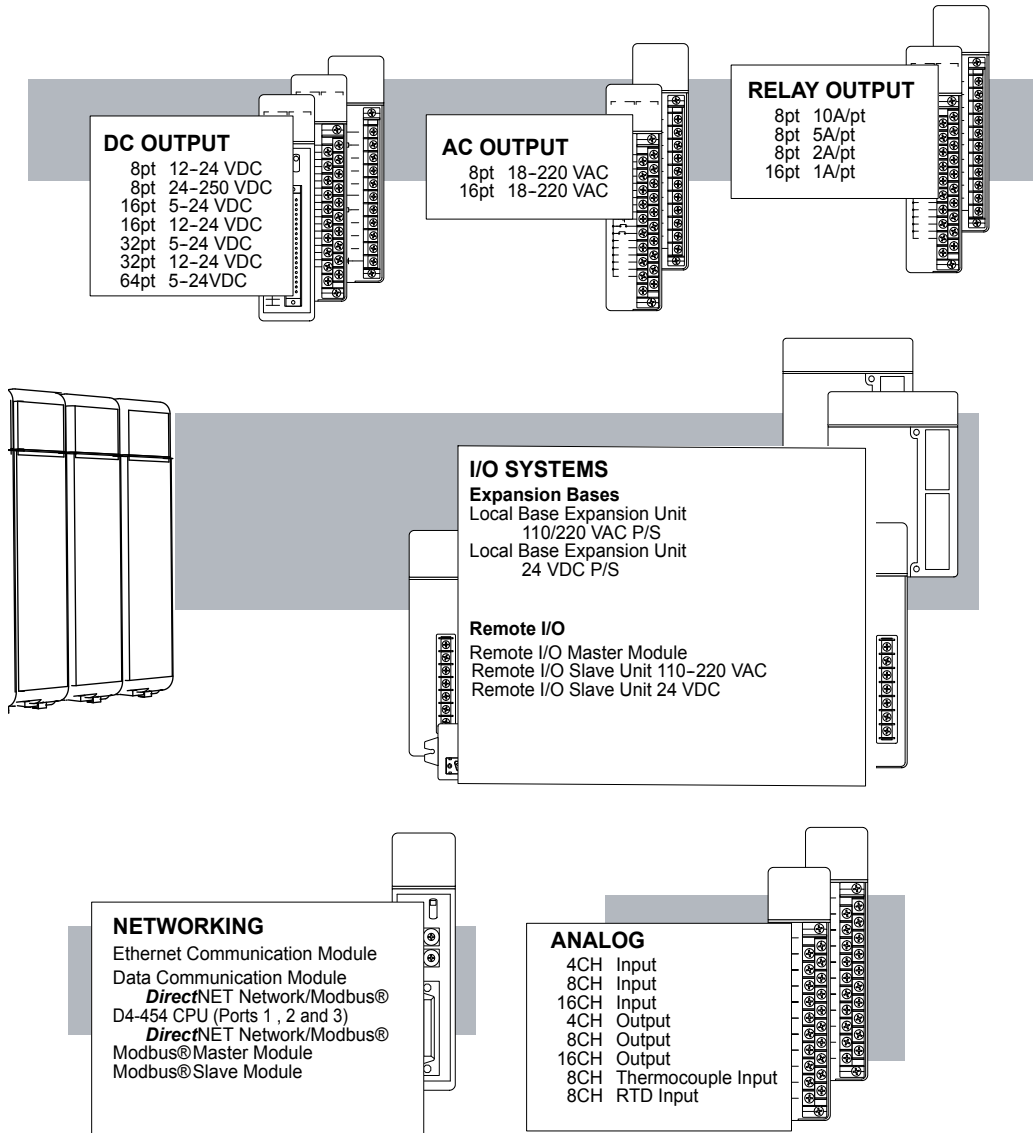
**COPROCESSOR™ MODULES**  
 RS232 / RS422 / RS485  
 Telephone Modem  
 Program Memory Ranges  
 from 128K to 512K

**SPECIALTY MODULES**

- 8/16pt Input Simulator
- High Speed Counter Module
- 8 pt. Magnetic Pulse Input Module
- 16 Loop PID Module
- 4 Loop Temperature Controller

- CPUs**
- D4-430: 110/220 VAC P/S  
6.5K Built-in EPROM Memory
  - D4-440: 110/220 VAC P/S  
22.5K Memory (Memory Cartridge Required)
  - D4-440: 24VDC or 125VDC P/S  
22.5K Memory (Memory Cartridge Required)
  - D4-450: 110 - 220 VAC P/S  
7.5K Built-in Flash Memory
  - D4-450: 24VDC or 125VDC P/S  
7.5K Built-in Flash Memory
  - D4-454: 110 - 220 VAC P/S  
7.5K Built-in Flash Memory
  - D4-454DC-1: 24 VDC P/S  
7.5K Built-in Flash Memory
- BASES**
- 4 Slot Base D4-04B-1
  - 6 Slot Base D4-06B-1
  - 8 Slot Base D4-08B-1
- MEMORY CARTRIDGES**
- CMOS RAM w/battery
  - UVEPROM
  - EEPROM

# DL405 Family



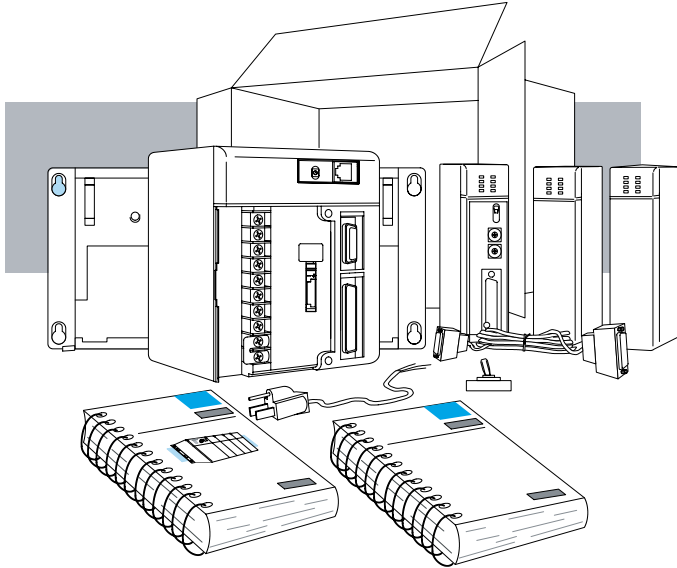
# Quick Start for PLC Checkout and Programming

If you have experience with PLCs, or if you just want to setup a quick example, this section is for you! This example is not intended to tell you everything you need to start up your system. 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 DL405 Equipment

Unpack the DL405 equipment and verify you have the parts necessary to build this demonstration system. The minimum parts you will need are:

- Base
- CPU
- D4-16ND2 DC input module or a D4-16SIM input simulator module
- D4-16TR
- Power Cord
- Hook up wire
- A 24 VDC toggle switch (if not using the input simulator module)
- A screwdriver, regular or Phillips type
- DirectSOFT Programming Software, DirectSOFT manual, and a programming cable (connects the CPU to a personal computer).





## Step 2: Install the CPU and I/O Modules

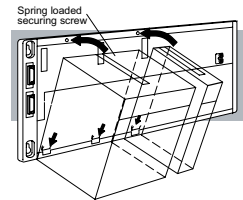
Insert the CPU and I/O into the base. The CPU must go into the far left side of the base in the position marked "CPU/Power Supply". When inserting components into the base, tilt the component slightly forward, sliding the tab on the bottom of the component into the slot in the base. Push the top of the component into the base until it is seated firmly, then tighten the securing screw at the top of the module/unit.



**WARNING:** To minimize the potential damage to the CPU/Module rear base connector(s), do not force the module into position. It should glide smoothly into place. If it does not glide smoothly into place, please check the following: 1) Visually inspect the base connector to make sure the mating holes are not blocked. 2) Visually inspect the pins on the rear connector making sure they are not bent or pushed in. 3) Make sure the plastic tabs on the bottom of the CPU/Module are level before tilting the module into position. Damage to the connectors may occur if the above information is not considered.

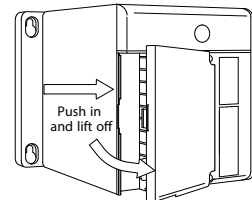
Placement of discrete, analog and relay modules are not critical and may go in any slot in any base, however, for this example install the output module in the slot next to the CPU (slot 0) and the input module in the next slot (slot 1). Limiting factors for other types of modules are discussed in Chapter 4, Bases, Expansion Units and I/O Configuration. You must also make sure you do not exceed the power budget for each base in your system configuration. Power budgeting is discussed in Chapter 4, System Design and Configuration.

- Each unit has a plastic tab at the bottom and screw at the top
- With the unit tilted slightly forward, hook the module's plastic tab on the base.
- Gently push the top of the unit back until it is firmly installed in the base.
- Secure the unit to the base by tightening the top screw.



## Step 3: Remove Terminal Strip Access Cover

- The terminal strip cover has a small retention cap on the left edge. Push in and up, then pull the cover off.

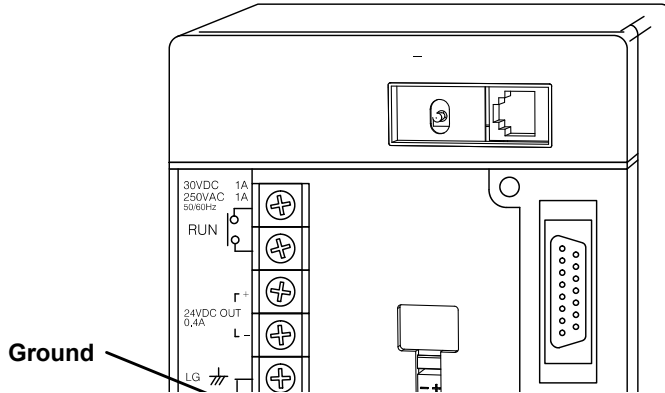


## Step 4: Select Operating Power Range

If you are using 110 VAC, install the voltage select jumper on the bottom two terminals. If you are using 220 VAC power, do not install the jumper. You can find a detailed explanation of the terminal block on both the CPU and expansion units in Chapter 2, Installation, Wiring and Specifications.



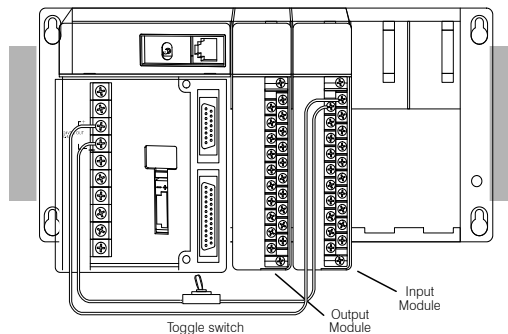
**WARNING:** Damage will occur to the power supply if 220 VAC is connected to the terminal connections with the 110 VAC jumper in place.



**NOTE:** The D4-454 only supports the -1 bases (D4-0xB-1). The D4-454 does not support the non -1 bases (D4-0xB).

### Step 5: Add I/O Simulation

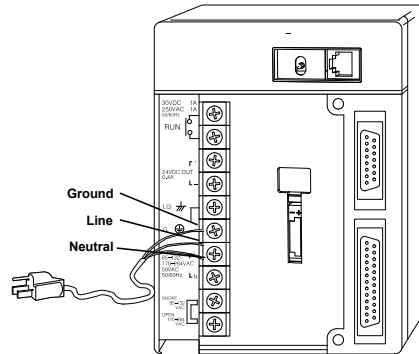
To finish this quick-start exercise or study other examples in this manual, you'll need to install an input simulator module (or wire an input switch as shown below), and add an output module. Using an input simulator is the quickest way to get physical inputs for checking out the system or a new program. To monitor output status, any discrete output module will do.



Wire the switches or other field devices prior to applying power to the system to ensure a point is not accidentally turned on during the wiring operation. Wire the input modules (X0) to the toggle switch and 24 VDC auxiliary power supply on the CPU terminal strip as shown below for the D4-16ND2 input module. Chapter 2, Installation, Wiring and Specifications provides a list of I/O wiring guidelines.

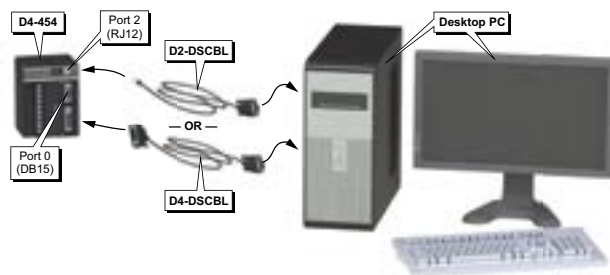
## Step 6: Connect the Power Wiring

Connect the wires as shown. Observe all precautions stated earlier in this manual. For details on wiring, see Chapter 2, Installation, Wiring and Specifications. When the wiring is complete, replace the CPU and module covers. Apply power to the system and ensure the PWR indicator on the CPU is on. If the PWR indicator does not come on, remove power from the system and check all wiring and refer to the troubleshooting section in Chapter 9 for assistance.



## Step 7: Connect Programming Device

Most programmers will use DirectSOFT programming software, installed in a personal computer, to program and monitor the PLC. There are three ports on the D4-454 that can be used for programming cables available from AutomationDirect. For port 0, the 15-pin port, you can use the D4-DSCBL cable. For port 2, the RJ12 port, you can use the D2-DSCBL cable. For port 1, the top portion of the 25-pin port, you can use the D3-DSCBL-2 cable. Also available is the FA-CABKIT. This is a universal kit that allows building a programming cable for all DirectLOGIC PLCs.



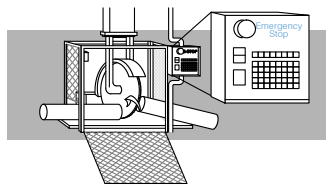
## Step 8: Enter the Program

Put the CPU's mode switch in the STOP position to ensure that the CPU is not running a program. Next, put the CPU mode switch in the TERM position. This puts the CPU in the program mode and allows access to the CPU program.

# Steps to Designing a Successful System

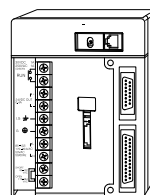
## 1: Review the Installation Guidelines

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.



## 2: Understand the CPU Setup Procedures

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



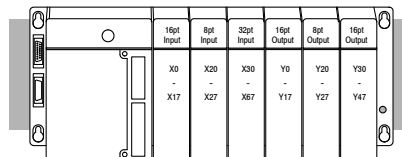
## 3: Understand the I/O System Configurations

It is important to understand how to configure the I/O system. You have several different types of systems:

- Local System
- Expansion System
- Remote I/O System
- Network Connections

It is also important to understand how the system Power Budget is calculated.

See Chapter 4 for more information.

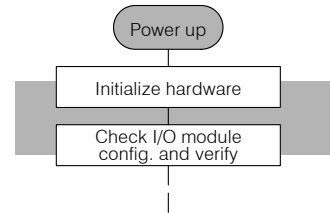


## 4: Determine the I/O Module Specifications and Wiring

There are many different I/O modules available with the DL405 system. Chapter 2 provides the specifications and wiring diagrams for the discrete I/O modules.

## 5: Understand the CPU Operation

Before you begin to enter a program, it is very helpful to understand how the D4-454 CPU processes information. This involves not only program execution steps, but also involves the various modes of operation and memory layout characteristics. See Chapter 3 for more information.

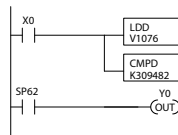


## 6: Review the Programming Concepts

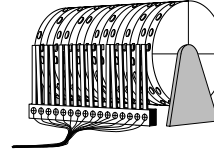
The DL405 PLC provides four main approaches to solving the application program, including the PID loop task depicted in the next figure.

- RLL diagram-style programming is the best tool for solving boolean logic and general CPU register/accumulator manipulation. It includes dozens of instructions which will augment drums stages and loops.
- The D4-454 CPUs have four timer/event drum types, each with up to 16 steps. They offer both time and/or event-based step transitions. Drums are best for repetitive process based on a single series of steps.
- Stage programming (also called RLL PLUS ) is based on state transition diagrams. Stages divide the ladder program into sections which correspond to the states in a flow chart you draw for your process.
- The DL405 PID Loop Operation uses setup tables to configure up to 16 loops. Features include alarms, SP ramp/soak generation and more.

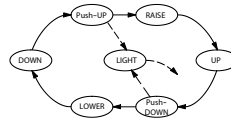
Standard RLL Programming  
(see Chapter 5)



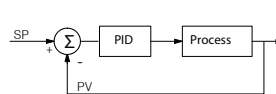
Timer/Event Drum Sequencer  
(see Chapter 6)



Stage Programming  
(see Chapter 7)

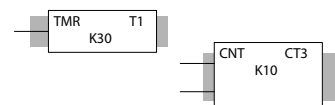


PID Loop Operation  
(see Chapter 8)



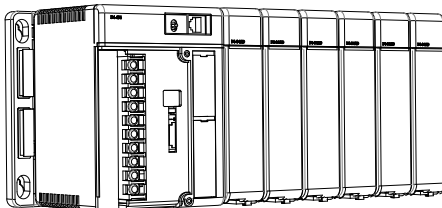
## 7: Choose the Instructions

After installation and studying the main programming concepts, you can begin writing the application program or configuring loop operation. You'll discover a powerful instruction set.



### 8: Understanding the Maintenance and Troubleshooting Procedures

Sometimes equipment failures occur when we least expect it. Switches fail, loads short and need replacement, etc. Often the majority of the troubleshooting time is spent in locating the problem. The DL405 system has many built-in features such as error codes that can help you quickly identify problems. See Chapter 9 for diagnostics and troubleshooting tips.



## Frequently Asked Questions

### Q. How do I reset my D4-454 CPU back to Factory Defaults?

- A. Resetting the processor to factory defaults is a two step process. First clear the processor memory using DirectSOFT PLC>CLEAR PL. Next initialize the scratchpad PLC>SETUP>INITIALIZE SCRATCHPAD. Be aware that initializing the scratchpad will reset the system V-memory to defaults. System V-memory contains parameters such as retentive ranges, communication port settings, etc.

### Q. How often should the CPU backup battery be changed?

- A. Both of the D4-454 CPUs have an LED indicator that will flash when the battery voltage is getting low. The typical battery life is 5 years.

### Q. Where can I obtain the most current firmware for the D4-454?

- A. In the tech support section of [www.automationdirect.com](http://www.automationdirect.com). The firmware and instructions on how to update the CPU are available.

### Q. Do the DL405 PLCs have Ethernet capability?

- A. Yes, the H4-ECOM100 module is needed to support Ethernet.

### Q. Are more FAQs available for the DL405 and other products.

- A. Yes, visit [www.automationdirect.com](http://www.automationdirect.com) for more FAQs and other technical information.