DL405 Family of Products

This page provides an overview of the variety of products found in the DL405 family.

CPUs

D4-454 – 110/220 VAC P/S
D4-454DC-1 – 24VDC P/S
30.8K total memory
16 PID loops with auto-tune

Memory cartridges

UVPROM - 15.5K (D4-UV-2)
EEPROM - 15.5K (D4-EE-2)

Programming

*Direct*SOFT Programming for Windows (PC-DSOFT6)
Handheld programmer (D4-HPP-1)

Bases

4-slot base (D4-04B-1)
6-slot base (D4-06B-1)
8-slot base (D4-08B-1)

Local expansion base power supplies

110/220 VAC P/S (D4-EX)
24VDC P/S (D4-EXDC)

Discrete input modules

DC input
16-point 12–24 VDC (D4-16ND2)
16-point 12–24 VDC (1ms response) (D4-16ND2F)
32-point 24VDC (D4-32ND3-1)
64-point 20–28 VDC (D4-64ND2)
AC input modules
8-point 110/220 VAC (D4-08NA)
16-point 110VAC (D4-16NA)
AC/DC input modules
16-pt 12–24 VAC/DC (D4-16NE3)

Discrete output modules

DC output modules
16-point 5–24 VDC (D4-16TD1)
16-point 12–24 VDC (D4-16TD2)
32-point 5–26 VDC (D4-32TD1)
32-point 12–24 VDC (D4-32TD2)
64-point 5–26 VDC (D4-64TD1)
AC output modules
8-point 18–220 VAC (D4-08TA)
16-point 18–220 VAC (D4-16TA)
Relay output modules
8-point 2A (D4-08TR)
8-point 5A/pt (isolated) (F4-08TRS-2)
8-point 10A/pt (isolated) (F4-08TRS-1)
16-point 1A/pt (D4-16TR)

Analog modules (12-bit)

Analog input
4-channel in, current/voltage (F4-04AD)
4-channel in, current/voltage (isolated) (F4-04ADS)
8-channel in, current/voltage (F4-08AD)
16-channel in, current (F4-16AD-1)
16-channel in, voltage (F4-16AD-2)
Analog output
4-channel out, current (F4-04DA-1)
4-channel out, voltage (F4-04DA-2)
8-channel out, current (F4-08DA-1)
8-channel out, voltage (F4-08DA-2)
16-channel out, current (F4-16DA-1)
16-channel out, voltage (F4-16DA-2)
Temperature Input
8-channel in, type J thermocouple (F4-08THM-J)

Analog modules (16-bit)

Temperature Input
8-channel in, RTD (F4-08RTD)
8-channel in, thermocouple (F4-08THM)
Analog output
4-channel out, current (isolated) (F4-04DAS-1)

Communications/ networking modules

Ethernet communications [H4-ECOM100]
Data communications (D4-DCM)
Modbus master (F4-MAS-MB)

Specialty modules

High-speed counter I/O (H4-CTRIO)
8/16 channel input simulator (D4-16SIM)
4-loop temperature controller (F4-4LTC)
BASIC CoProcessor Module
128K triple port (F4-CP128-1)

CPU-Slot slave controllers

Ethernet base controller (H4-EBC)

Remote I/O modules

Ethernet
Ethernet remote Master Module (H4-ERM100)
Ethernet base Controller (Slave) (H4-EBC)
Remote I/O protocol (serial)
Remote I/O Master Module (D4-RM)
Remote I/O Slave 110/220 VAC (D4-RS)

DL405 CPUs

System capacity

System capacity is the ability of the CPU to accommodate a variety of applications. Here are a few key considerations when determining system capacity:

How much memory do you need? Consider both ladder memory and data registers (V-memory). For ladder memory, most boolean instructions require one word. Some other instructions, such as timers, counters, etc., require two or more words. Our V-memory locations are 16-bit words and are useful for data storage, etc.

What type of memory do you need? The D4-454 has 15.5K of built in M-RAM ladder memory and no memory cartridge is needed.

How many I/O points are required? You will need to know how many field devices are required. Compare the D4-454 specifications tables on the next page with your application requirements.

Are there any remote I/O points? In many applications, the cost of bringing the individual control wiring back to the PLC control panel can be reduced by the use of remote I/O. The D4-454 CPU has built-in serial remote I/O connections on the lower 25-pin port; or use Ethernet Remote I/O for fast and easy set-up and communications.

Performance

If you have a time-critical application where every millisecond is important, then the D4-454 CPU, with the fastest overall scan time, is the right choice. The D4-454 is very fast at performing even the most basic of math or data instructions and will provide a faster overall scan time.

Programming and diagnostics

The D4-454 CPU offers a wide array of instructions and diagnostic features that can save you many hours of programming and debugging time. From basic boolean contact logic, to PID and floating point math, we have it covered! For the D4-454 CPU, IBox programming instructions simplify complex tasks with instructions such as Memory, Discrete Helper, Analog Helper, Math, Communications, and CTRIO. The chart on the next page lists the instructions by category. Beginning on page tDL4-69, you will find a detailed list showing the name and function of each instruction.

D4-454 Parameters	
Features	**D4-454**
Total Memory	46.8K
Ladder Memory	31.5K
DirectSOFT	Yes, version 6.1 or later
Memory Cartridge	No, (same amount of memory as the largest memory cartridge)
Battery	D2-BAT-1 (CR2354)
Mode Switch	Toggle Switch (Same position/function)
Port 1 and 3 Baud Rate	2400, 4800, 9600, 19200, 38400
Port 1 and 3 Settings	8 data bits, 1 start bit, 1 stop bit, Odd, Even or No parity
Port 2 Protocol	DirectNet (master/slave), K-sequence, Non-procedure, Modbus RTU (master/slave)
Firmware Update	Supported from all ports

NOTE: Any hardware with a date code less than 09X0 or with a first digit that is not 0, 1, or 2 may not work with the D4-454. We suggest that any hardware older than ten years and not currently sold on the AutomationDirect.com website be upgraded to a newer version.

Built-in CPU communications

The D4-454 CPU provides at least two built-in communications ports. Each CPU supports our *Direct*NET protocol on the lower port for easy, economical networking. Need Modbus RTU? Then the D4-454 CPU with built-in Modbus RTU Master and Slave capability is the right choice. Of course, we also offer a wide array of communications, such as our Ethernet Communications Module, Data Communications Module and Modbus Master module.

Specialty I/O modules

In addition to our cost-effective discrete and analog I/O, we also offer specialty modules to solve the really tough applications. Our D4-454 CPU supports specialty modules in the local CPU base, and can also support selected specialty modules in expansion bases.

D4-454 Unsupported Modules Table	
Bases	**Retired**
D4-04B, D4-04BNX	Yes
D4-06B, D4-06BNX	Yes
D4-08B, D4-08BNX	Yes
Input Modules	
D4-32ND3-2	Yes
D4-16NA-1	Yes
Output Modules	
D4-08TD1	Yes
Comm Modules	
H4-ECOM	Yes
Remote I/O Modules	
D4-ERM	Yes
D4-ERM-F	–
Specialty Modules	
D4-PULS	Yes
F4-CP128-R	Yes
F4-CP512-1	Yes

DL405 CPU Specifications

DL405 CPU Specifications	
	D4-454
System Capacity	
Total memory available (words)	46.8K
Ladder memory (words)	
built-in memory	31.5K
with memory cartridge	N/A
V-memory (words)	15.3K
Battery backup	Yes, MRAM*
Total CPU memory I/O pts. available **(actual I/O points depend on I/O configuration selected)**	8192 (X+Y+GX+GY)
I/O module point density	2/4/8/16/32/64
I/O module slots per base	4/6/8
Local/local expansion	1024 in/1024 out
Serial Remote I/O (including local & exp. I/O	4224 max.
Remote I/O Channels	3
I/O pts. per remote module channel	512, 2048
Ethernet Remote I/O (including local/exp. I/O)	Yes,
discrete I/O pts.	8192 max. (Including local and exp. I/O)
Analog I/O channels	Map into V-memory
Remote I/O channels	Limited by power budget
I/O per remote channel	16,384 (16 fully expanded H4-EBC slaves using V-memory and bit-of-word instructions)
Performance	
Contact execution (boolean)	0.96 µs
Typical scan (1K boolean)	4–5 ms
Programming and Diagnostics	
RLL ladder style	Yes
RLL PLUS/flowchart style (Stages)	Yes/1024
Run time editing	Yes
Supports Overrides	Yes
Variable/fixed scan	Fixed or variable
Instructions	210
Control relays	2048
Timers	256
Counters	256
Immediate I/O	Yes
Subroutines	Yes
For/next loops	Yes
Timed interrupt	Yes
Integer math	Yes
Floating-point math	Yes
Trigonometric functions	Yes
Table instructions	Yes
PID	Yes
Drum sequencers	Yes
Bit of word	Yes
Real-time clock/calendar	Yes
Internal diagnostics	Yes
Password security	Multi-level
System and User error log	Yes
IBox instructions	Yes
CPU Ports Communications	
Built-in ports	4 ports
K-sequence (proprietary protocol)	Yes
DirectNET	Yes
Modbus master/slave	Yes
ASCII out (Print)	Yes
Maximum baud rate	38.4K

*Battery used for Real Time Clock backup

D4-454 Key Features

D4-454 CPUs

D4-454
D4-454DC-1

D4-454 CPU*

The D4-454 CPUs provides tremendous capability using updated microprocessor technology allowing the D4-454 to be the CPU of choice for the DL405 family.

Built-in CPU Communications Ports

The D4-454 offers four built-in ports for extra convenience. The 15-pin port offers our proprietary K-sequence protocol and is primarily used for programming connections to a PC running *Direct*SOFT6 programming software (version 6.1 or later) or to a D4-HPP-1 handheld programmer. It can also be used to connect to a *C-more* panel or other operator interfaces. The 6-pin phone jack supports K-sequence; *Direct*NET master/slave, ASCII output and Modbus RTU master/ slave protocols. The bottom 25-pin port contains two logical ports with different pins for each port. It is primarily a networking port that supports *Direct*NET master/slave or Modbus master/slave protocols. The bottom port can be used as an ASCII output port for connections to devices that can accept ASCII input. It can also be used as a remote I/O Master. The Communications Ports table on the next page has a complete description of each port.

* The D4-454 CPU is a direct replacement for the retired D4-450 CPU.

16 PID Loops

The D4-454 CPU can process up to 16 PID loops directly in the CPU. You can select from various control modes including automatic control, manual control, and cascade control. There are a wide variety of alarms including Process Variable, Rate of Change, and Deviation. The various loop operation parameters are stored in V-memory, which allows easy access from operator interfaces. Setup is accomplished with our *Direct*SOFT6 Programming Software. An overview of the various loop specifications and features is on page mDL4-7.

Floating-point Math

The D4-454 CPU supports IEEE format floating-point math calculations. This feature means the D4-454 includes full trigonometric functions and various forms of integer/floating point number conversions.

Power Supplies

We offer a choice of two power supplies for the D4-454 CPUs. The power supplies are built into the CPU. Available power supplies are:
- 110/220 VAC version - D4-454
- 24VDC version - D4-454DC-1

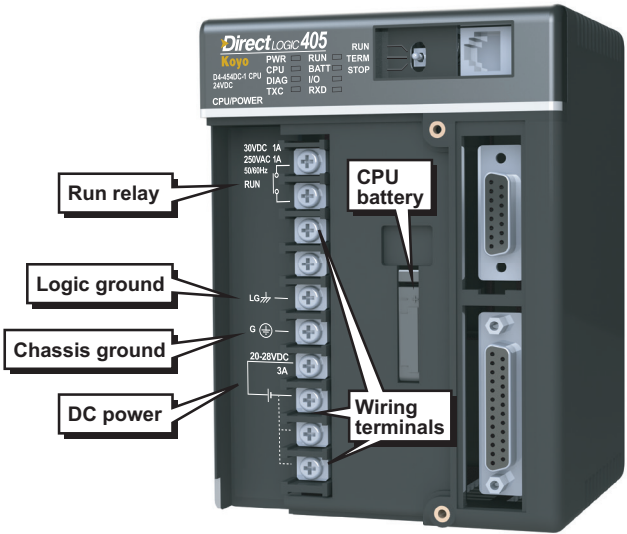**D4–454 offers four built-in communication ports**
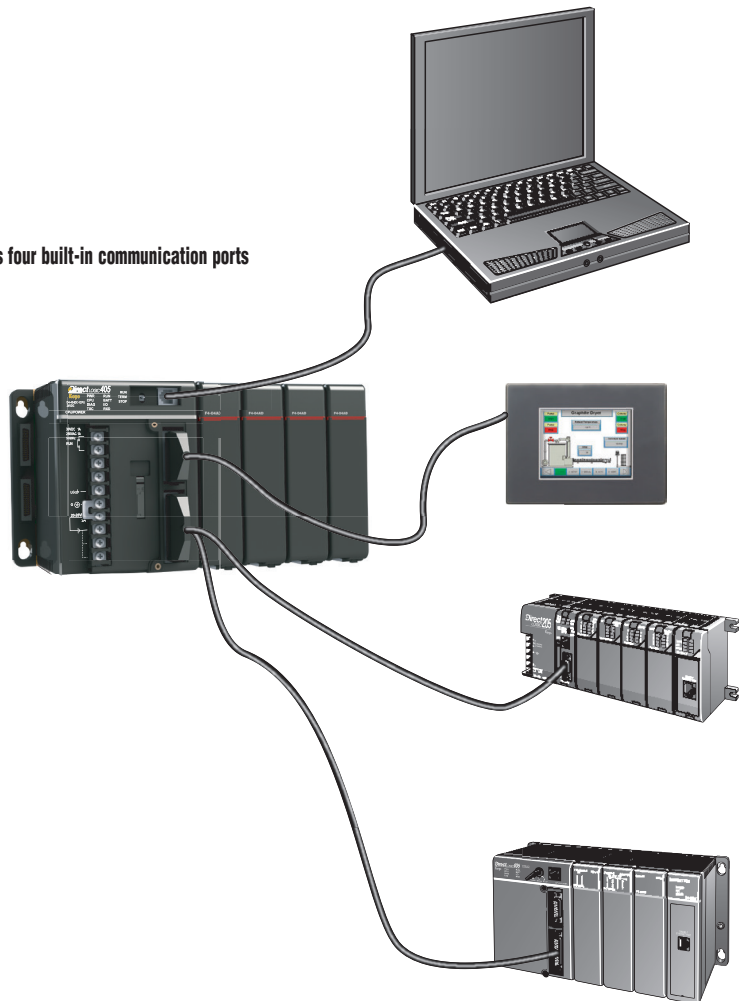
NOTE: Any hardware older than tens years old may not work with the D4-454. We suggest that any hardware older than ten years and not currently sold on the AutomationDirect.com website be upgraded to a newer version.
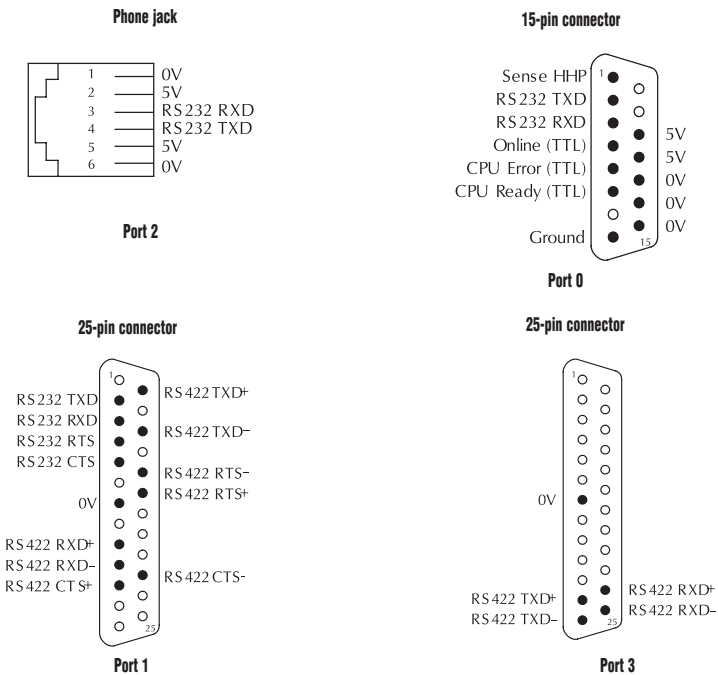
D4-454 Features

The diagram on this page shows the various hardware features found on the D4-454 CPU.

CPU Keyswitch	
RUN	Forces CPU to RUN mode. Locks Comm port - will not receive incoming data.
TERM	Allows peripherals (HPP, DCM, *Direct*SOFT, etc.) to select operating mode
STOP	Forces CPU out of RUN

CPU Status Indicators		
PWR	ON	CPU power good
	OFF	CPU power failure
RUN	ON	CPU is in RUN mode
	OFF	CPU is in STOP mode
CPU	ON	CPU self-diagnostics error
	OFF	CPU self-diagnostics good
BATT	ON	CPU battery is low
	OFF	CPU battery is good or disabled
DIAG	ON	CPU diagnostics or local bus error
	OFF	CPU diagnostics or local bus good
I/O	ON	I/O self-diagnostics error
	OFF	I/O self-diagnostics good
TXD	ON	Data is being transmitted
	OFF	No data is being transmitted
RXD	ON	Data is being transmitted
	OFF	No data is being transmitted

Communications Ports	
Phone Jack Port 2	General purpose port for RS232. Baud rate is selectable up to 38.4Kb. Connects to *Direct*SOFT programming software, C-more panels, network, etc. Supports K-sequence protocol, *Direct*NET (master or slave) protocol, Non-squence (ASCII out), and Modbus RTU (master or slave) protocol.
15-pin Port 0	Programming port, RS232, 9600 baud, connects to HPP, *Direct*SOFT, DV-1000, *C-more* panels, etc. K-sequence protocol (fixed station address=1)
25-pin Port 1 and Port 3	General purpose port for RS232 and RS422 (RS485 Remote I/O Master available on Port 3 only.) Baud rate selectable via software up to 38.4K baud. Connects to *Direct*SOFT, *C-more* panels, network,etc Two logical ports (separate pins on connector). Software selectable protocol includes:

Protocol	Port 1	Port 3
K-sequence	✓	✓
*Direct*NET Master/Slave	✓	✓
Modbus Master/Slave	✓	✓
Remote I/O	n/a	✓
ASCII Out	✓	✓

D4-454 CPU Hardware Features

D4-454 communications ports pin-out

D4-454 Features

D4-454 Scan control

The D4-454 CPU provides several scan control options, which are useful in some high-speed machine control applications.

Variable — The scan varies as necessary from scan to scan. The actual scan time depends on the instructions being executed.

Limited — This is similar to a variable scan in that the scan varies as necessary. However, if the actual scan time exceeds a specified target scan time, then a scan overrun condition is indicated.

Fixed — If the scan is finished before the time specified, idle time is added to ensure a fixed scan period. If the scan exceeds the time specified, the scan is extended to ensure all instructions are executed. A scan overrun condition is also reported.
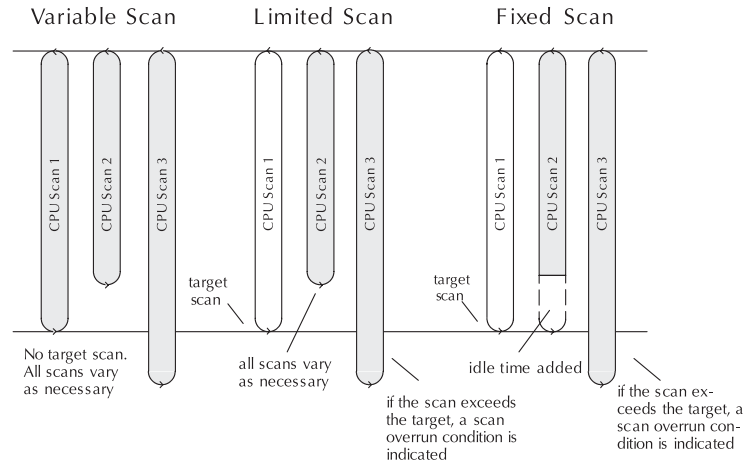
Memory — The memory of the

D4-454 is fully contained in the CPU and stored in MRAM which is a non-volatile form of memory. No memory card is required. The battery is used for retention of the Real Time Clock.

Variable Scan

CPU Scan 1 CPU Scan 2 CPU Scan 3

No target scan. All scans vary as necessary

Limited Scan

CPU Scan 1 CPU Scan 2 CPU Scan 3

target scan

all scans vary as necessary

if the scan exceeds the target, a scan overrun condition is indicated

Fixed Scan

CPU Scan 1 CPU Scan 2 CPU Scan 3

target scan

idle time added

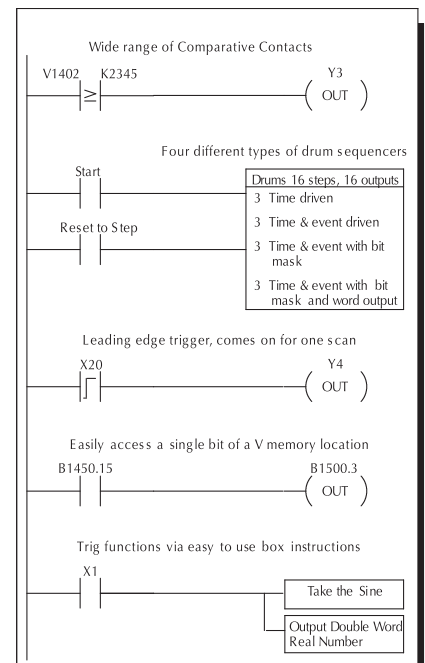if the scan exceeds the target, a scan overrun condition is indicated

DirectSOFT 6.1 or later, is required to program the D4-454.

Full array of instructions

Imagine if someone asked you to write a book, but then told you that you could only use 50 different words? That would be a tough job! The same is true for writing a PLC program. The right instruction can greatly simplify your control program.

The D4-454 supports over 200 powerful instructions. These include:

- **Four types of drum sequencers, each with 16 steps and up to 16 outputs**
- **Leading and trailing edge triggered oneshots**
- **Bit of word manipulation (bit set, reset, etc.)**
- **Trigonometric functions**
- **Floating point conversions**
- ***Ibox* instructions that simplify tasks such as configuring analog modules or performing complex math equations**

Wide range of Comparative Contacts

V1402 K2345 Y3 OUT

Four different types of drum sequencers

Start

Reset to Step

Drums 16 steps, 16 outputs
3 Time driven
3 Time & event driven
3 Time & event with bit mask
3 Time & event with bit mask and word output

Leading edge trigger, comes on for one scan

X20 Y4 OUT

Easily access a single bit of a V memory location

B1450.15 B1500.3 OUT

Trig functions via easy to use box instructions

X1 Take the Sine Output Double Word Real Number

D4-454 PID loops

PID Loop Specifications and Key Features	
Number of Loops	Selectable, 16 maximum
CPU V-memory Required	32 V-memory locations per loop selected (An additional 32 V-memory locations per loop required if using Ramp/Soak)
PID Algorithm	Position or velocity form of the PID equation. Optionally specify direct or reverse acting, square root of the error and error squared control.
Auto Tuning	Open loop step response method and closed loop limit cycle method.
Sample Rate	Specify the time interval between PV samples, 0.05 to 99.99 in units of seconds or minutes. If using all 16 loops, the smallest sample rate is limited to either 0.2 seconds or (PLC scan time x number of loops).
Loop Operation Modes	Loop can be in automatic control, manual (operator) control, or cascade control. PV alarm monitoring continues when loops are in manual mode.
Ramp/Soak	Up to 16 steps (8 ramp, 8 soak) per loop, with indication of Ramp/Soak step.
Square Root PV	Specify a square root of the PV for a flow control application.
Limit SP	Specify a maximum and minimum value for allowable setpoint changes.
Limit OUT	Specify a maximum and minimum value for the output range.
Gain	Specify proportional gain of 0.01 to 99.99.
Reset	Specify integral time of 0.1 to 99.98 in units of seconds or minutes.
Rate	Specify the derivative time, 0.00 to 99.99 seconds.
Rate Limiting	Specify a derivative gain limiting coefficient to filter the PV used in calculating the derivative term (0 to 20).
Bumpless Transfer I	Bias and setpoint are initialized automatically when the loop is switched from manual to automatic. This provides for a bumpless transfer, which reduces the chance of sharp changes in the output as a result of entering automatic mode.
Bumpless Transfer II	Bias is set equal to the Output when the module is switched from manual to automatic. This allows switching in and out of automatic mode without having to re-enter the setpoint.
Step Bias	Provides proportional bias adjustment for large setpoint changes. This may stabilize the loop faster and reduce the chance of the output going out of range. Step bias should be used in conjunction with the normal adjusted bias operation.
Anti-windup	If the position form of the PID equation is specified, the reset action is stopped when the PID output reaches 0 or 100%. Select adjusted bias or freeze bias operation.
Error Deadband	Specify an incremental value above and below the setpoint in which no change in output is made.
Error Squared	Squaring the error minimizes the effect a small error has on the Loop output, however, both Error Squared and Error Deadband control may be enabled.
Alarm Specifications	
Deadband	Specify 0.1% to 5% alarm deadband on all alarms except Rate of Change.
PV Alarm Points	Specify PV alarm settings for low-low, low, high, and high-high conditions. You can also specify a deadband to minimize the alarm cycles when the PV approaches alarm limits.
PV Deviation	Specify alarms to indicate two ranges of PV deviation from the setpoint value (yellow and red deviation).
Rate of Change	Specify a rate-of-change limit for the PV.

Need Temperature Control?
If you're only interested in controlling temperature, then there may be a better solution than the D4-454 CPU. Check out the F4-4LTC module. This module has the capabilities of our single loop controllers built into one economical module! Detailed specifications can be found later in this section. This module can directly control up to four loops and it even includes built-in relay outputs for heater or chiller control! If you use the built-in PID capability of the D4-454 CPU, you still have to purchase the analog input modules and the output modules (either discrete or analog) in order to complete the loop.
This can result in a much higher overall cost when compared to the F4-4LTC.

PID Loop Control Block Diagram
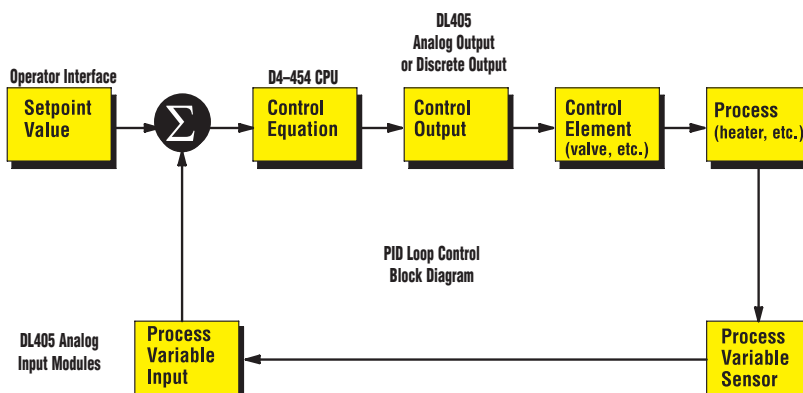
DL405 Programming Tools and Cables

Select a programming device

There are two tools for programming the DL405 CPUs: *Direct*SOFT PC-based programming software and the D4-HPP-1 handheld programmer.

*Direct*SOFT programming software

Our powerful Windows-based programming packages make it easy for you to program and monitor your DL405 PLC system. The version of the software that supports the DL405 CPUs is described in the table below. See the *Direct*LOGIC Overview Section DL in this catalog for detailed information on *Direct*SOFT.

| *Direct*Soft Part Number	Price	Description
PC-DSOFT6		Programs all PLC families DL05/06/105/205/305/405
PC-DS100	Free	Free version of *Direct*SOFT; programs all *Direct*LOGIC PLC CPUs; limited to 100 word program

DL405 programming cables

Choose the proper cable to connect the DL405 CPU to your PC running *Direct*SOFT.

CPU	Price	Port	Cable	Price
D4-454		Top port (15 pin)	**D4-DSCBL**	
		Lower port (25pin)	**D3-DSCBL-2**	
		Phone jack (RJ12)	**D2-DSCBL**	

Handheld programmer

The D4-HPP-1 handheld programmer connects to the 15-pin port on any of the DL405 CPUs. A memory cartridge is located on the side of the handheld programmer. This slot allows you to copy memory cartridges (including UV PROMs) and transfer data/programs between the CPU and a memory cartridge.
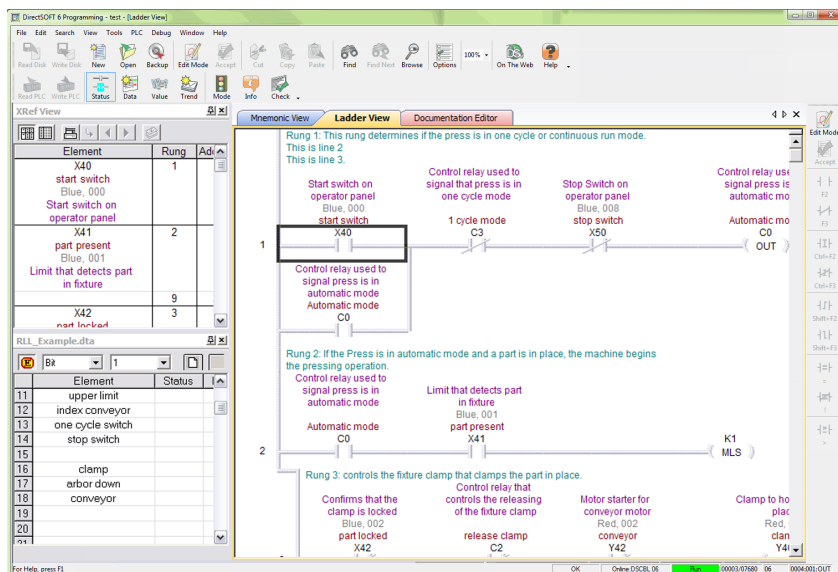
Pin labeling conforms to IBM DTE and DCE standards