

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 – 24 VDC P/S
30.8K total memory
16 PID loops with auto-tune

D4-450 – 110/220 VAC P/S

D4-450DC-2 – 125 VDC P/S
30.8K total memory
(7.5K built-in flash program memory or use optional memory cartridge)
16 PID loops with auto-tune

D4-440 – 110/220 VAC P/S
22.5K total memory
(memory cartridge required)

D4-440DC-1 – 24 VDC P/S
22.5K total memory
(memory cartridge required)

Memory cartridges

UVPROM - 15.5K (D4-UV-2)

EEPROM - 15.5K (D4-EE-2)

Programming

DirectSOFT 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)

24 VDC P/S (D4-EXDC)

Discrete input modules

DC input

8-point 24-48 VDC (D4-08ND3S)

16-point 12-24 VDC (D4-16ND2)

16-point 12-24 VDC (1 ms response)
(D4-16ND2F)

32-point 24 VDC (D4-32ND3-1)

64-point 20-28 VDC (D4-64ND2)

AC input modules

8-point 110/220 VAC (D4-08NA)

16-point 110 VAC (D4-16NA)

AC/DC input modules

8-pt 90-150 VAC/DC (isolated)
(F4-08NE3S)

16-pt 12-24 VAC/DC (D4-16NE3)

Discrete output modules

DC output modules

8-point 24-150 VDC (F4-08TD1S)

16-point 5-24 VDC (D4-16TD1)

16-point 12-24 VDC (D4-16TD2)

32-point 5-15 VDC (D4-32TD1-1)

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)

8-channel in, type K thermocouple
(F4-08THM-K)

8-channel in, type T thermocouple
(F4-08THM-T)

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)

4-channel out, voltage (isolated)
(F4-04DAS-2)

Communications/networking modules

Ethernet communications
[H4-ECOM100]

Data communications (D4-DCM)

Modbus master (F4-MAS-MB)

Specialty modules

8-point interrupt input (D4-INT)

High-speed counter I/O (H4-CTRIO)

8-point magnetic pulse input (F4-8MPI)

16-loop PID (w/ software) (F4-16PID)

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 110/220VAC (D4-RS)

Remote I/O Slave 24VDC (D4-RSDC)

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 D4-440 requires a memory cartridge, and you have a choice of several sizes and memory types. The D4-450 has 7.5K of built-in flash ladder memory, but you can also use a memory cartridge instead of the built-in memory. 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. Each CPU supports a different amount of local, expansion, and remote I/O. Check the Specifications tables on the next page to determine which CPU meets your application requirements.

Are there any remote I/O points? In many applications, the wiring cost of bringing the individual control wiring back to the PLC control panel can be reduced by the use of remote I/O. All DL405 CPUs can support remote I/O. The D4-454 and D4-450 CPUs have built-in serial remote I/O connections on the bottom 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 choose the CPU with the fastest overall scan time. For applications that only require boolean instructions (contacts and coils), the D4-440 is the fastest. However, if you use a few simple math or data instructions, then choose the D4-454 or D4-450. The D4-454 and D4-450 are considerably faster at performing even the most basic of math or data instructions and will provide a faster overall scan time.

Programming and diagnostics

Our CPUs offer a wide array of instructions and diagnostic features that can save you many hours of program and debug time. From basic boolean contact logic to PID and floating point math, we have it covered! For D4-454 and D4-450 CPUs, 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 and identifies which CPUs support each group. Beginning on page tDL4-82, you will find a detailed list showing the name and function of each instruction.

D4-450 and D4-454 Differences		
Differences	D4-450	D4-454
Total Memory	22.8K/30.8K	46.8K
Ladder Memory	7.5K/15.5K	31.5K
DirectSOFT	Yes	Yes, version 6.1 or later
Memory Cartridge	Yes	No, (same amount of memory as the largest memory cartridge)
Battery	D3-D4-BAT	D2-BAT-1 (CR2354)
Mode Switch	Keyswitch	Toggle Switch (Same position/function)
Port 1 and 3 Baud Rate	300, 600, 1200, 2400, 4800, 9600, 19200, 38400	2400, 4800, 9600, 19200, 38400
Port 1 and 3 Settings	8 data bits, 1 start bit, 1 stop bit, Odd, Even or No parity 7 data bits, 1 start bit, 1 stop bit, No parity	8 data bits, 1 start bit, 1 stop bit, Odd, Even or No parity
Port 2 Protocol	DirectNet (master/slave), K-sequence, Non-procedure	DirectNet (master/slave), K-sequence, Non-procedure, Modbus RTU (master/slave)
Firmware Update	Port 1 only	Supported from all ports

Built-in CPU communications

Every DL405 CPU provides at least two built-in communications ports. Each DL405 CPU supports our **DirectNET** protocol on the bottom port for easy, economical networking. Need Modbus RTU? Then, check our D4-454 or D4-450 CPUs, which have built-in Modbus RTU Master and Slave capability. 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. The D4-440 only supports specialty modules in the local base (CPU base). Our D4-454 and D4-450 CPUs support specialty modules in the local CPU base, and they 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
D4-INT	Yes
F4-CP128-R	Yes
F4-CP512-1	Yes

DL405 CPU Comparisons

DL405 CPU Specifications			
	D4-440	D4-450	D4-454
System Capacity			
Total memory available (words)	22.5K	30.8K	46.8K
Ladder memory (words)			
built-in memory	None, requires MC	7.5K flash	31.5K
with memory cartridge	up to 15.5K	up to 15.5K	N/A
V-memory (words)	7.0K	15.3K	15.3K
Battery backup	Yes	Yes	Yes, MRAM*
Total CPU memory I/O pts. available (actual I/O points depend on I/O configuration selected)	2688 (X+Y+CR+GX)	8192 (X+Y+GX+GY)	8192 (X+Y+GX+GY)
I/O module point density	2/4/8/16/32/64	2/4/8/16/32/64	2/4/8/16/32/64
I/O module slots per base	4/6/8	4/6/8	4/6/8
Local/local expansion			
Serial Remote I/O (including local & exp. I/O)	320 in/320 out	1024 in/1024 out	1024 in/1024 out
Remote I/O Channels	1664 max.	4224 max.	4224 max.
I/O pts. per remote module channel	2	3	3
I/O pts. per remote module channel	512	512; 2048 (port 3)	512, 2048
Ethernet Remote I/O (including local/exp. I/O)			
discrete I/O pts.	Yes	Yes	Yes,
	2688 max.	8192 max.	8192 max.
	(Including local and exp.I/O)	(Including local and exp.I/O)	(Including local and exp. I/O)
Analog I/O channels	map into V-memory	Limited by power budget	Limited by power budget
Remote I/O channels	Limited by power budget	16,384 (16 fully expanded H4-EBC slaves using V-memory and bit-of-word instructions)	16,384 (16 fully expanded H4-EBC slaves using V-memory and bit-of-word instructions)
I/O per remote channel	16,384 (limited to 2688)		
Performance			
Contact execution (boolean)	0.33µs	0.96µs	0.96µs
Typical scan (1K boolean)	2-3ms	4-5ms	4-5ms
Programming and Diagnostics			
RLL ladder style	Yes	Yes	Yes
RLL PLUS/flowchart style (Stages)	Yes/1024	Yes/1024	Yes/1024
Run time editing	Yes	Yes	Yes
Supports Overrides	No	Yes	Yes
Variable/fixd scan	Variable	Fixed or variable	Fixed or variable
Instructions	170	210	210
Control relays	1024	2048	2048
Timers	256	256	256
Counters	128	256	256
Immediate I/O	Yes	Yes	Yes
Subroutines	Yes	Yes	Yes
For/next loops	Yes	Yes	Yes
Timed interrupt	Yes	Yes	Yes
Integer math	Yes	Yes	Yes
Floating-point math	No	Yes	Yes
Trigonometric functions	No	Yes	Yes
Table instructions	Yes	Yes	Yes
PID	No	Yes	Yes
Drum sequencers	No	Yes	Yes
Bit of word	No	Yes	Yes
Real-time clock/calendar	Yes	Yes	Yes
Internal diagnostics	Yes	Yes	Yes
Password security	Yes	Multi-level	Multi-level
System and User error log	Yes	Yes	Yes
IBox instructions	No	Yes	Yes
CPU Ports Communications			
Built-in ports	2 ports	4 ports	4 ports
K-sequence (proprietary protocol)	Yes	Yes	Yes
DirectNET	Yes	Yes	Yes
Modbus master/slave	No	Yes	Yes
ASCII out (Print)	No	Yes	Yes
Maximum baud rate	19.2K	38.4K	38.4K

*Battery used for Real Time Clock backup

D4-450 Key Features



16 PID Loops

The D4-450 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 *DirectSOFT* Programming Software. An overview of the various loop specifications and features is on page tDL4-11.

Floating-point math

The D4-450 CPU supports IEEE format floating-point math calculations. This feature means the D4-450 includes full trigonometric functions and various forms of integer/floating point number conversions.

Power supplies

We offer a choice of three power supplies for the DL450 CPU. The power supplies are built into the CPU. Available power supplies are:

- 110/220 VAC version - D4-450
- 125 VDC version - D4-450DC-2

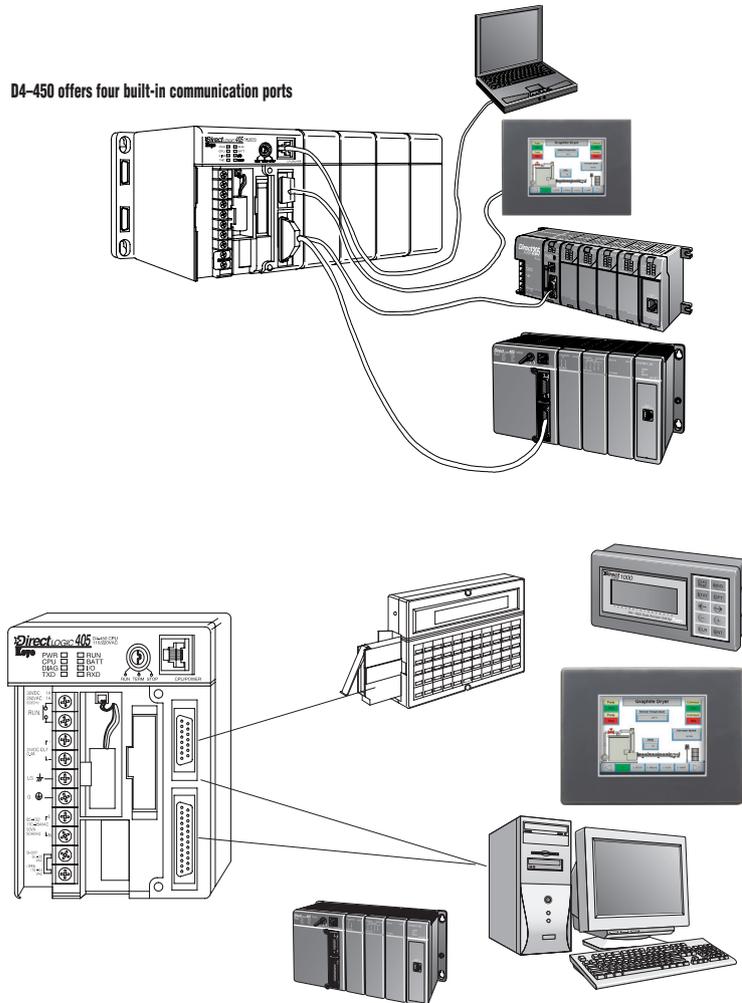
D4-450 CPU

The D4-450 provides all the capabilities of the D4-440 CPUs, plus several additional features such as *DirectSOFT6* IBox instructions.

Built-in CPU communications ports

The D4-450 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 D4-HPP-1 handheld programmer or to a PC running *DirectSOFT* software. It can also be used to connect to a *C-more* panel or other operator interfaces. The 6-pin phone jack also supports K-sequence; plus, it can be a *DirectNET* slave port or an ASCII output port. The bottom 25-pin port contains two logical ports with different pins for each port. It is primarily a networking port that supports *DirectNET* 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.

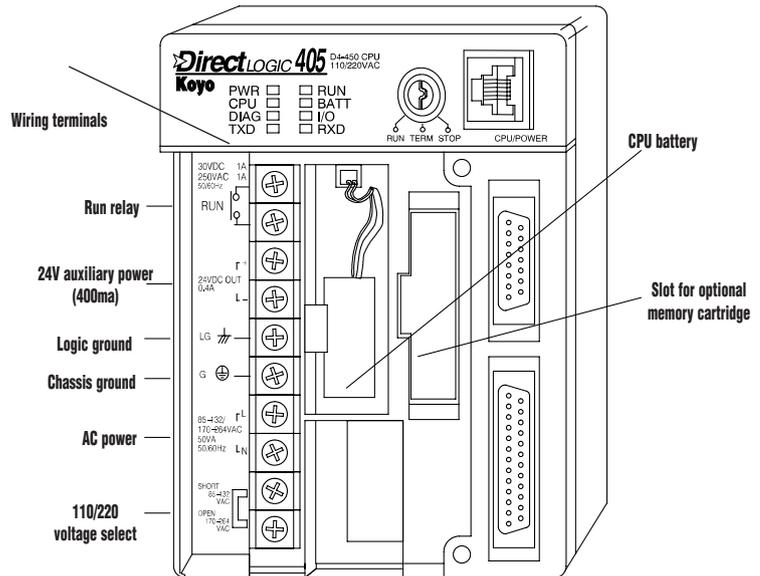
D4-450 offers four built-in communication ports



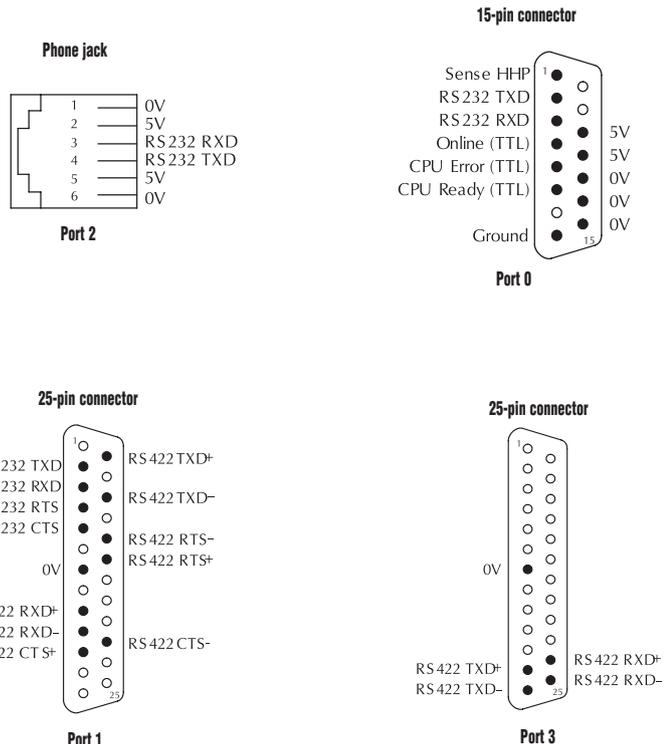
D4-450 Features

The diagrams on this page show the various hardware features found on the D4-450 CPU.

CPU Keyswitch																				
RUN	Forces CPU to RUN mode. Locks Comm port - will not receive incoming data.																			
TERM	Allows peripherals (HPP, DCM, <i>DirectSOFT</i> , etc.) to select operating mode																			
STOP	Forces CPU out of RUN																			
CPU Status Indicators																				
PWR	ON OFF	CPU power good CPU power failure																		
RUN	ON OFF	CPU is in RUN mode CPU is in STOP mode																		
CPU	ON OFF	CPU self-diagnostics error CPU self-diagnostics good																		
BATT	ON OFF	CPU battery is low CPU battery is good or disabled																		
DIAG	ON OFF	CPU diagnostics or local bus error CPU diagnostics or local bus good																		
I/O	ON OFF	I/O self-diagnostics error I/O self-diagnostics good																		
TXD	ON OFF	Data is being transmitted No data is being transmitted																		
RXD	ON OFF	Data is being transmitted No data is being transmitted																		
Communications Ports																				
Phone Jack Port 2	Programming Port, RS232 baud rate selectable up to 38.4Kb. Connects to <i>DirectSOFT</i> , DV-1000, <i>C-more</i> panels, network, etc. K-sequence protocol, <i>DirectNET</i> protocol (slave only), ASCII out																			
15-pin Port 0	Programming port, RS232 9600 baud, connects to HPP, <i>DirectSOFT</i> , DV-1000, <i>C-more</i> panels, etc. K-sequence protocol (fixed station address=1)																			
25-pin Port 1 and Port 3	<p>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 <i>DirectSOFT</i>, <i>C-more</i> panels, network, etc. Two logical ports (separate pins on connector). Software selectable protocol includes:</p> <table border="1"> <thead> <tr> <th>Protocol</th> <th>Port 1</th> <th>Port 3</th> </tr> </thead> <tbody> <tr> <td>K-sequence</td> <td>✓</td> <td>✓</td> </tr> <tr> <td>DirectNET Master/Slave</td> <td>✓</td> <td>✓</td> </tr> <tr> <td>Modbus Master/Slave</td> <td>✓</td> <td>✓</td> </tr> <tr> <td>Remote I/O</td> <td>n/a</td> <td>✓</td> </tr> <tr> <td>ASCII Out</td> <td>✓</td> <td>✓</td> </tr> </tbody> </table>		Protocol	Port 1	Port 3	K-sequence	✓	✓	DirectNET Master/Slave	✓	✓	Modbus Master/Slave	✓	✓	Remote I/O	n/a	✓	ASCII Out	✓	✓
Protocol	Port 1	Port 3																		
K-sequence	✓	✓																		
DirectNET Master/Slave	✓	✓																		
Modbus Master/Slave	✓	✓																		
Remote I/O	n/a	✓																		
ASCII Out	✓	✓																		



D4-450 communications ports pin-out



D4-450 Features

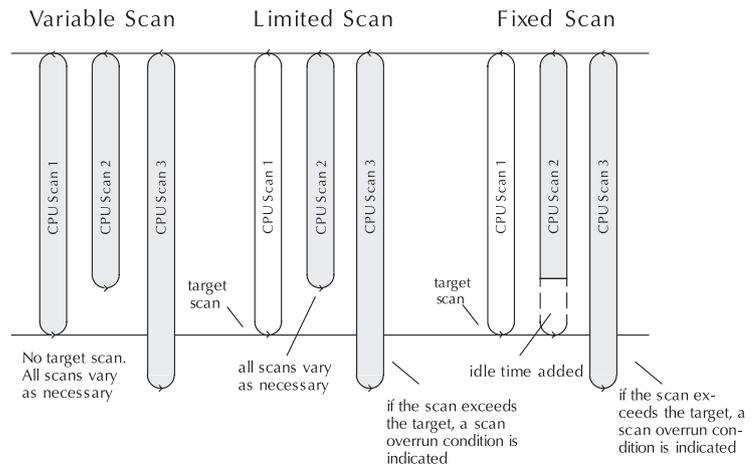
D4-450 Scan control

The D4-450 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 D4-450 has 7.5K of flash memory on board. Upgrade to 15.5K by choosing an optional memory cartridge, D4-EE-2. The memory cartridge is recommended since it is removable in the event of problems.

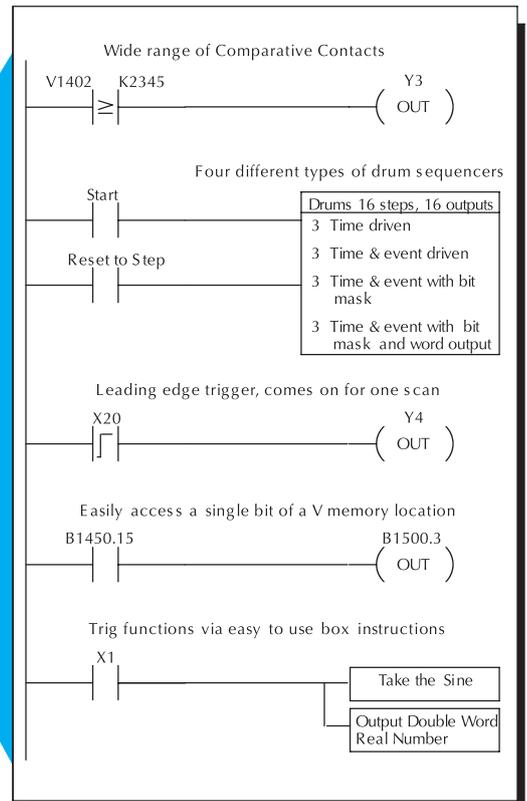
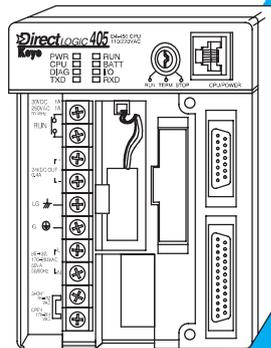
Full array of instructions

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 D4-450 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

DirectSOFT 2.1 or later, is required to program the D4-450.



D4-450 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?	
<p><i>If you're only interested in controlling temperature, then there may be a better solution than the D4-450 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 D4-450 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.</i></p>	

