# 16 Loop PID CoProcessor

**16 Loop PID CoProcessor Module**

**F4-16PID <--->**

## Overview

The F4-16PID is a Proportional Integral Derivative (PID) CoProcessor designed to execute up to 16 PID loops independent of the DL405 CPU. Using the high-speed Intelligent Bus Interface, the F4-16PID reads the process variable and writes the PID output directly into V-memory of the DL405 CPU. Configure the module PID loop using *Direct*SOFT Data View or ladder logic.

Minimal ladder logic is required in the CPU, therefore, the floating point math-intensive PID calculations in the CoProcessor have little effect on the CPU scan time. As a result, the CPU can perform high-speed discrete control while the CoProcessor performs high-speed PID.

## Operation

The process variable (PV) comes from an input module, usually an analog input or thermocouple. The user ladder logic copies the input value to the Process Variable location.

The PID module calculates the loop output value and places it at the Output location. The user can write this value to an analog output channel, use it as a time proportion for a discrete output, or send it to the setpoint or another loop for cascading loops.

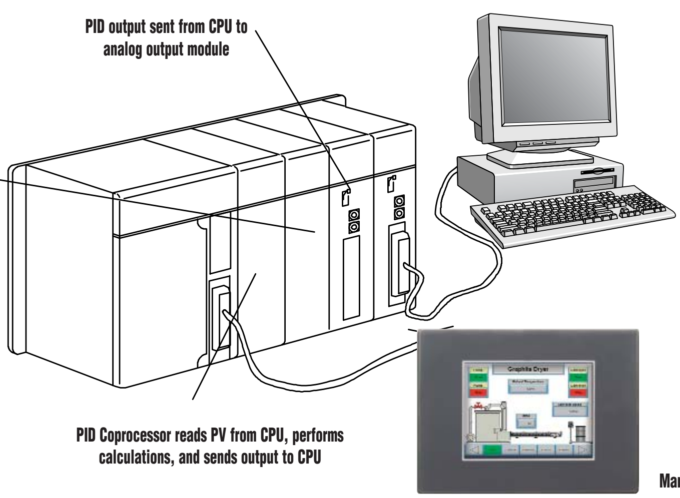
All loop information is read from and written to a user specified block of V-memory. Each loop that is enabled requires 32 V-memory locations. Since all loop parameters are stored in V-memory, any device capable of reading and writing DL405 V-memory can be used to configure, tune, and monitor loops.

The information included in each loop's block of V-memory includes:

- Bit Mapped Mode Word
- Process Variable (PV)
- Setpoint (SP)
- Bias
- Output
- Bit Mapped Alarm word
- Sample Rate (.1 to 999.9 sec. or min.)
- Gain
- Reset
- Rate
- PV Low Low Alarm
- PV Low Alarm
- PV High Alarm
- PV High High Alarm
- PV Yellow Deviation Limit
- PV Orange Deviation Limit
- Alarm Deadband
- Error Deadband Below SP
- Error Deadband Above SP
- Derivative Gain Limiting Coefficient
- Setpoint Low Limit
- Setpoint High Limit
- Maximum Output Clamp
- Minimum Output Clamp

Some variations of PID control are done with supporting ladder logic. Examples that are included in the PID manual are:

- Auto/Manual Mode Control
- Setpoint Ramp and Soak
- Alarm Word Decoding
- Time Proportioning Control Loops
- Cascading Loops
- Positioning Actuator Control Loops



# 16 Loop PID CoProcessor

| Specifications and Key Features | |
|---|---|
| ***Module Type*** | CoProcessor, Intelligent |
| ***Number of Loops*** | 16 maximum |
| ***Modules per CPU*** | Six maximum, any slot in CPU base |
| ***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. |
| ***Sample Rate*** | Specify the time interval between PV samples, 0.1 to 999.9 in units of seconds or minutes |
| ***Auto/Manual*** | A control relay, CR, which when energized places the corresponding loop into automatic mode. PV alarm monitoring continues when loops are in manual mode. |
| ***Square Root PV*** | Specify a square root of the PV for a flow control application. |
| ***Limit SP*** | Specify a high and low limit for allowable setpoint changes. |
| ***Gain*** | Specify proportional gain of 0.00 to 99.99. |
| ***Reset*** | Specify reset time of 0.1 to 999.9 minutes, seconds, milliseconds, or microseconds |
| ***Bumpless Transfer I*** | Bias and setpoint are initialized automatically when the module is switched from manual to automatic. This provides for a bumpless transfer. |
| ***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. |
| ***Limit Output*** | Optionally specify maximum and minimum output values |
| ***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. |
| ***Rate*** | Specify the derivative time, 0 to 999.9 in units of minutes or seconds. |
| ***Rate Limiting*** | Specify a derivative gain limiting coefficient to filter the PV used in calculating the derivative term (99.99 to 00.01). |
| ***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 |
| ***20% offset of PV*** | Specify a 20% offset of the PV to input a 4-20mA transmitter using a 0-20mA analog input module range. |
| ***Internal Power Consumption*** | 160mA at +5VDC, (supplied by base power supply) |
| ***Operating Environment*** | 0°C to 60°C (32°F to 140°F) 5% to 95% humidity (non-condensing) |
| ***Manufacturer*** | FACTS Engineering |
| **Alarm Specifications** | |
| ***Deadband*** | Specify 0.1% to 5% alarm deadband on all alarms except Rate of Change. |
| ***PV Alarm Points*** | A Y output or CR may be activated based on four PV alarm points. |
| ***PV Deviation*** | A Y output or CR may be activated based on four PV alarm points. Specify an alarm for PV deviation above or below the setpoint (Yellow Deviation) and an alarm for greater PV deviation from the setpoint (Orange Deviation). |
| ***Rate of Change*** | A Y output or CR may be activated when the PV changes faster than a specified rate of change limit. |
| ***Broken Transmitter*** | Monitor the PV for a broken transmitter. |

# Check the Power Budget

## Verify your power budget requirements

Your I/O configuration choice can be affected by the power requirements of the I/O modules you choose. When determining the types and quantity of I/O modules you will be using, it is important to remember there is a limited amount of power available from the power supply.

The chart on the opposite page indicates the power supplied and used by each DL405 device. The adjacent chart shows an example of how to calculate the power used by your particular system. These two charts should make it easy for you to determine if the devices you have chosen fit within the power budget of your system configuration.

If the I/O you have chosen exceeds the maximum power available from the power supply, you can resolve the problem by shifting some of the modules to an expansion base or remote I/O base (if you are using remote I/O).

***Warning: It is extremely important to calculate the power budget correctly. 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.***

## Use *ZIP*Links to reduce power requirements

If your application requires a lot of relay outputs, consider using the *Zip*Link AC or DC relay output modules. These modules can switch high current (10A) loads without putting a load on your base power budget. Refer to page 6-57 for more information.

This logo is placed next to I/O modules that are supported by the *ZIP*Link connection systems. See the I/O module specifications at the end of this section.

## Calculating your power usage

The following example shows how to calculate the power budget for the DL405 system. The example is constructed around a single 8-slot base using the devices shown. It is recommended you construct a similar table for each base in your system.

| A | | | | |
|---|---|---|---|---|
| | ***Base Number 0*** | ***Device Type*** | ***5 VDC (mA)*** | ***External 24 VDC Power (mA)*** |
| **B** | **CURRENT SUPPLIED** | | | |
| | ***CPU/Expansion Unit /Remote Slave*** | D4-440 CPU | 3700 | 400 |
| **C** | **CURRENT REQUIRED** | | | |
| | ***SLOT 0*** | D4-16ND2 | +150 | +0 |
| | ***SLOT 1*** | D4-16ND2 | +150 | +0 |
| | ***SLOT 2*** | F4-04DA | +120 | +100 |
| | ***SLOT 3*** | D4-08ND3S | +100 | +0 |
| | ***SLOT 4*** | D4-08ND3S | +100 | +0 |
| | ***SLOT 5*** | D4-16TD2 | +100 | +0 |
| | ***SLOT 6*** | D4-16TD2 | +100 | +0 |
| | ***SLOT 7*** | D4-16TR | +1000 | +0 |
| **D** | **OTHER** | | | |
| | ***BASE*** | D4-08B | +80 | +0 |
| | ***Handheld Programmer*** | D4-HPP | +320 | +0 |
| **E** | **Maximum Current Required** | | ***2820*** | ***100*** |
| **F** | **Remaining Current Available** | | ***3700-2820=880*** | ***400-100=300*** |

1. Using a chart similar to the 3one above, fill in column 2.
2. Using the tables on the opposite page, enter the current supplied and used by each device (columns 3 and 4). Pay special attention to the current supplied by the CPU, Expansion Unit, and Remote Slave since they differ. Devices which fall into the "Other" category (Row D) are devices such as the Base and the Handheld programmer, which also have power requirements, but do not plug directly into the base.
3. Add the current used by the system devices (columns 3 and 4) starting with Slot 0 and put the total in the row labeled "maximum current required" (Row E).
4. Subtract the row labeled "Maximum current required" (Row E), from the row labeled "Current Supplied" (Row B). Place the difference in the row labeled "Remaining Current Available" (Row F).
5. If "Maximum Current Required" is greater than "Current Supplied" in either column 3 or 4, the power budget will be exceeded. It will be unsafe to use this configuration and you will need to restructure your I/O configuration. Note the auxiliary 24 VDC power supply does not need to supply all the external power. If you need more than the 400mA supplied, you can add an external 24VDC power supply. This will help keep you within your power budget for external power.

## DL405 CPU power supply specifications and power requirements

| Specification | AC Powered Units | 24 VDC Powered Units | 125 VDC Powered Units |
|---|---|---|---|
| ***Part Numbers*** | D4-450, D4-440, D4-430,<br>D4-EX (expansion base unit),<br>D4-RS (remote slave unit) | D4-450DC-1, D4-440DC-1,<br>D4-EXDC (expansion base unit),<br>D4-RSDC (remote slave unit) | D4-450DC-2<br>D4-440DC-2 |
| ***Voltage Withstand (dielectric)*** | 1 minute @ 1,500 VAC between primary, secondary, field ground, and run relay | | |
| ***Insulation Resistance*** | > 10MΩ at 500VDC | | |
| ***Input Voltage Range*** | 85-132 VAC (110 range) 170-264 VAC (220 range | 20-28 VDC (24 VDC)<br>with less than 10% ripple | 90-146 VDC (125 VDC)<br>with less than 10% ripple |
| ***Maximum Inrush Current*** | 20 A | 20 A | 20 A |
| ***Maximum Power*** | 50 VA | 38 W | 30 W |

# Power Requirements

| Power Supplied | | | | | |
|---|---|---|---|---|---|
| *CPUs/Remote Units/ Expansion Units* | *5 VDC Current Supplied in mA* | *24V Aux Power Supplied in mA* | *CPUs/Remote Units/Expansion Units* | *5V Current Supplied in mA* | *24VAux. Power Supplied in mA* |
| D4-430 CPU | 3700 | 400 | D4-EX | 4000 | 400 |
| D4-440 CPU | 3700 | 400 | D4-EXDC | 4000 | NONE |
| D4-440DC-1 CPU | 3700 | NONE | D4-EXDC-2 | 3700 | NONE |
| D4-440DC-2 CPU | 3700 | NONE | D4-RS | 3700 | 400 |
| D4-450 CPU | 3100 | 400 | D4-RSDC | 3700 | NONE |
| D4-450DC-1 CPU | 3100 | NONE | H4-EBC | 3470 | 400 |
| D4-450DC-2 CPU | 3100 | NONE | H4-EBC-F | 3300 | 400 |

**Power Consumed**

| *Power-consuming Device* | *5V Current Consumed* | *External 24VD Current Required* |
|---|---|---|
| ***I/O Bases*** | | |
| D4-04B-1 | 80 | NONE |
| D4-06B-1 | 80 | NONE |
| D4-08B-1 | 80 | NONE |
| ***DC Input Modules*** | | |
| D4-08ND3S | 100 | NONE |
| D4-16ND2 | 150 | NONE |
| D4-16ND2F | 150 | NONE |
| D4-32ND3-1 | 150 | NONE |
| D4-32ND3-2 | 150 | NONE |
| D4-64ND2 | 300 max. | NONE |
| ***AC Input Modules*** | | |
| D4-08NA | 100 | NONE |
| D4-16NA | 150 | NONE |
| ***AC/DC Input Modules*** | | |
| D4-16NE3 | 150 | NONE |
| F4-08NE3S | 90 | NONE |
| ***DC Output Modules*** | | |
| D4-08TD1 | 150 | 35 |
| F4-08TD1S | 295 | NONE |
| D4-16TD1 | 200 | 125 |
| D4-16TD2 | 400 | NONE |
| D4-32TD1 | 250 | 140 |
| D4-32TD1-1 | 250 | 140 (15V) |
| D4-32TD2 | 350 | 120 (4A max including loads) |
| D4-64TD1 | 800 | NONE |
| ***AC Output Modules*** | | |
| D4-08TA | 250 | NONE |
| D4-16TA | 450 | NONE |
| ***Relay Output Modules*** | | |
| D4-08TR | 550 | NONE |
| F4-08TRS-1 | 575 | NONE |
| F4-08TRS | 575 | NONE |
| D4-16TR | 1000 | NONE |
| ***Analog Modules*** | | |
| F4-04AD | 85 | 100 |
| F4-04ADS | 270 | 120 |
| F4-08AD | 75 | 90 |

| *Power-consuming Device* | *5V Current Consumed* | *External 24VDC Current Required* |
|---|---|---|
| ***Analog Modules (continued)*** | | |
| F4-16AD-1 | 75 | 100 |
| F4-16AD-2 | 75 | 100 |
| F4-04DA-1 | 70 | 75+20per circuit |
| F4-04DA-2 | 90 | 90 |
| F4-04DAS-1 | 60 | 60 per circuit |
| F4-04DAS-2 | 60 | 60 per circuit |
| F4-08DA-1 | 90 | 100+20 per circuit |
| F4-08DA-2 | 80 | 150 |
| F4-16DA-1 | 90 | 100+20 per circuit |
| F4-16DA-2 | 80 | 25 max. |
| F4-08RTD | 80 | NONE |
| F4-08THM-n | 120 | 50 |
| F4-08THM | 110 | 60 |
| ***Remote I/O*** | | |
| H4-ERM | 320 | NONE |
| H4-ERM-F | 450 | NONE |
| D4-RM | 300 | NONE |
| ***Communications and Networking*** | | |
| H4-ECOM100 | 300 | NONE |
| H4-ECOM | 530 | NONE |
| H4-ECOM-F | 670 | NONE |
| D4-DCM | 500 | NONE |
| F4-MAS-MB | 235 | NONE |
| FA-UNICON | NONE | 65 |
| ***CoProcessors*** | | |
| F4-CP128-1 | 305 | NONE |
| ***Specialty Modules*** | | |
| H4-CTRIO | 400 | NONE |
| D4-INT | 100 | NONE |
| D4-HSC | 300 | NONE |
| F4-16PID | 160 | NONE |
| F4-8MPI | 225 | 170 |
| D4-16SIM | 150 | NONE |
| F4-4LTC | 280 | 75 |
| ***Programming*** | | |
| D4-HPP-1 (Handheld Prog.) | 320 | NONE |
| ***Operator Interface*** | | |
| DV-1000 | 150 | NONE |
| *C-more* Micro-Graphic | 210 | NONE |