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Getting Started

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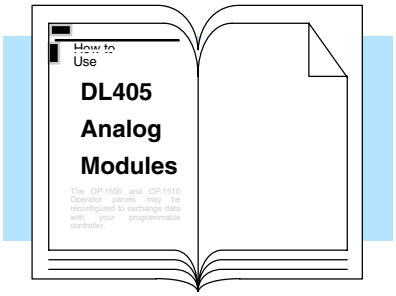
- Analog Made Easy – Four Simple Steps

Introduction

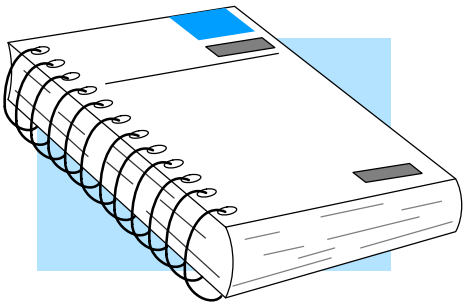
The Purpose of this Manual

This manual will show you how to select and install analog input and analog output modules. It also shows several ways to use the analog data in your PLC program. If you understand the DL405 instruction set and system setup requirements, this manual will provide the information you need to install and use the analog modules. This manual *is not* intended to be a tutorial on analog signal theory, but rather a user reference manual for the DL405 Analog I/O modules.



Supplemental Manuals

You may also want to have a copy of the DL405 User Manual (D4–USER–M) at hand when you are working with the analog modules. The DL405 User Manual is not absolutely necessary, but it does provide detailed descriptions of the instructions used to acquire the analog data. The User Manual also provides a more thorough description of how the I/O points are assigned to the module. Now, you have the material necessary to quickly understand the DL405 Analog I/O modules. So, let's get started!



Technical Support

We realize that 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. First, check these resources for help in locating the information:

- **Table of Contents** – chapter and section listing of contents, in the front of this manual
- **Quick Guide to Contents** – chapter summary listing on the next page
- **Appendices** – reference material for key topics, near the end of this manual

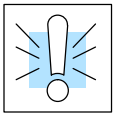
You can also check our online resources for the latest product support information:

- **Internet** – Our Web site is http://www.automationdirect.com

If you still need assistance, please call us at 770–844–4200. Our technical support group is glad to work with you in answering your questions. They are available Monday through Friday from 9:00 A.M. to 6:00 P.M. Eastern Standard Time. If you have a comment or question about any of our products, services, or manuals, please fill out and return the 'Suggestions' card that was shipped with this manual.

Conventions Used

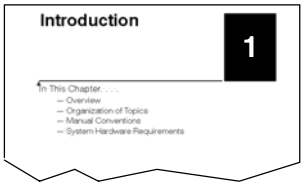
When you see the “notepad” icon in the left-hand margin, the paragraph to its immediate right will be a **special note**.
The word **NOTE:** in boldface will mark the beginning of the text.



When you see the “exclamation mark” 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).
The word **WARNING:** in boldface 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.



Analog Input Module Terminology

We use several different terms throughout the rest of this manual. You do not have to be an expert on analog terms to use the products, but it may help make it easier to select the appropriate modules if you take a few minutes to review these definitions.

Channels per Module	The total number of analog signals the module receives from field devices.
Input Ranges	The minimum to maximum spans in voltage or current the module will successfully convert to digital values.
Resolution	The number of binary weighted bits available on the digital side of the module for use in converting the analog value to a digital value.
Input Type	Specifies if the module accepts single ended, or differential input signals.
Input Impedance	The resistive load of the module as seen by a voltage or current input signal.
Conversion Method	The method the module uses to convert the analog signal to a digital value.
PLC Update Rate	Speed at which the analog signals are digitized and acknowledged in the PLC.
Linearity Error	The relative accuracy of the digital representation over the entire input range.
Maximum Inaccuracy	Maximum absolute error of the digital representation of the signal over the entire input range. Factors which contribute to maximum inaccuracy are also specified separately. These factors are full-scale calibration error, offset calibration error, and accuracy vs. temperature.
Accuracy vs. Temperature	The variations in the module's conversion accuracy with temperature over the module's operating temperature range.
I/O Points Required	The number of I/O points the CPU must dedicate to the module.
External Power Source	Some modules require a separate 24VDC power source. The 24VDC output supply at the local base can be used as long as you do not exceed the current rating of 400mA.
Base Power Required	The amount of base current required by the module. Use this value in your power budget calculations.
Operating Temperature	The minimum and maximum temperatures the module will operate within.
Relative Humidity	The minimum and maximum humidity the module will operate within.
Step Response	The time required for an analog input to reach 95% of its final value at the converter following a step change in the input signal level.

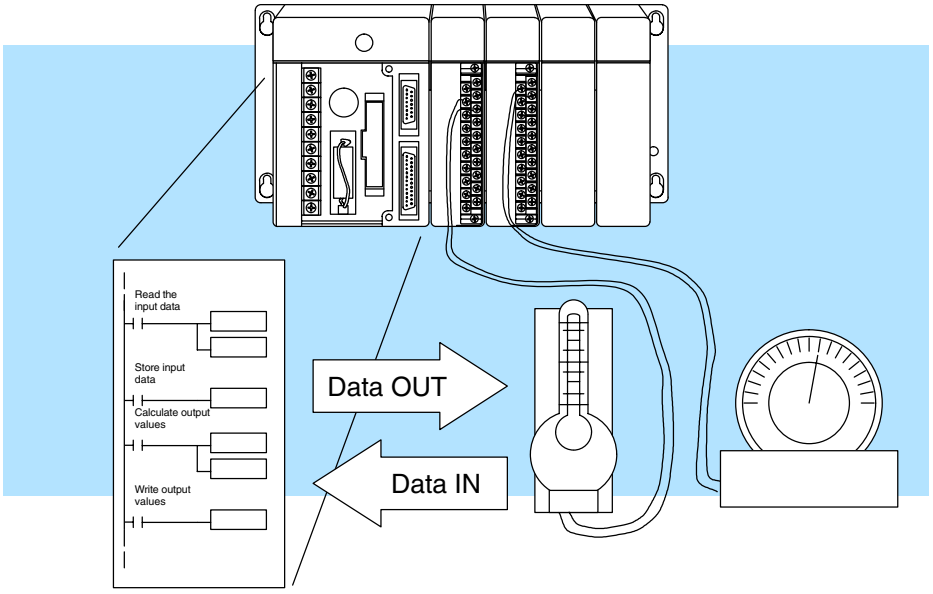
Analog Output Module Terminology

Channels per Module	The total number of analog signals the module sends to field devices.
Output Ranges	The minimum to maximum spans in voltage or current the module outputs, converted from digital values.
Resolution	The number of binary weighted bits available on the digital side of the module for use in converting the digital value to an analog signal.
Output Current	The maximum current the module will drive using a voltage output signal.
Output Impedance	The output impedance of the module using a voltage output signal.
Load Impedance	The minimum and maximum resistance the module can drive, specified for current and voltage output signals.
PLC Update Rate	The speed at which digital values in the PLC are converted to analog output signals.
Linearity Error	The relative accuracy of the digital representation over the entire output range.
Maximum Inaccuracy	Maximum absolute error of the digital representation of the signal over the entire output range. Factors which contribute to maximum inaccuracy are also specified separately. These factors are full-scale calibration error, offset calibration error, and accuracy vs temperature.
Accuracy vs. Temperature	The variations in the module's conversion accuracy with temperature over the module's operating temperature range.
External Power Source	Some output modules contain circuitry which is optically isolated from PLC-side logic. That circuitry requires field-side power from a separate 24VDC power source. The 24VDC output supply at the local base can be used as long as you do not exceed the current rating of 400mA.
Base Power Required	The amount of base current required by the module. Use this value in your power budget calculations.
Operating Temperature	The minimum and maximum temperatures the module will operate within.
Relative Humidity	The range of air humidity over which the module will operate properly.
I/O Points Required	The number of I/O points the CPU must dedicate to the module.

Selecting the Appropriate Module

Wide Variety of Modules

There are a wide variety of Analog I/O modules available for use with the DL405 family of automation products. These modules are well suited for monitoring and controlling various types of analog signals such as pressure, temperature, and so forth. No complex programming or module setup software is required. Simply install the module, add a few lines to your RLL program, and you're ready!



Analog input, temperature input and analog output modules are available. Most of these modules are designed and manufactured by FACTS Engineering. FACTS has been producing feature-packed products for the ***Direct***LOGIC families (and compatible products) for years! These modules are readily identifiable by their F4– prefix in the part number.

Diagnostic Features

The DL405 Analog Modules use an on-board microcontroller that automatically monitors module diagnostics. You can easily detect missing field-side supply 24 VDC voltage or a loose terminal block.

The following tables provide a condensed version of the information you need to select the appropriate module. The most important thing is to simply determine the number of channels required and the signal ranges that must be supported. Once you've determined these parameters, look in the specific chapter for the selected module to determine the installation and operation requirements.

Analog Input Modules

Specification	F4–04AD	F4–04ADS	F4–08AD
Channels	4	4	8
Input Ranges	0–20 mA, 4–20 mA, 1–5V, 0–5V, 0–10V, ±5V, ±10V	0–20 mA, 4–20 mA, 1–5V, 0–5V, 0–10V, ±5V, ±10V	0–20 mA, 4–20 mA, 1–5V, 0–5V, 0–10V, ±5V, ±10V
Resolution	12 bit (1 in 4096)	12 bit (1 in 4096)	12 bit (1 in 4096)
Input Type	Single ended	Isolated	Single ended
Maximum Inaccuracy	±0.4% at 25°C (77°F) ±0.55% at 0° to 60° C (32° to 140°F)	±0.4% at 25°C (77°F) ±0.7% at 0° to 60°C (32° to 140°F)	±0.3% at 25°C (77°F) ±0.5% at 0° to 60°C (32° to 140°F)
See Chapter	3	4	5
Specification	**F4–04AD**	**F4–04ADS**	**F4–08AD**
Channels	4	4	8
Input Ranges	0–20 mA, 4–20 mA, 1–5V, 0–5V, 0–10V, ±5V, ±10V	0–20 mA, 4–20 mA, 1–5V, 0–5V, 0–10V, ±5V, ±10V	0–20 mA, 4–20 mA, 1–5V, 0–5V, 0–10V, ±5V, ±10V
Resolution	12 bit (1 in 4096)	12 bit (1 in 4096)	12 bit (1 in 4096)
Input Type	Single ended	Isolated	Single ended
Maximum Inaccuracy	±0.4% at 25°C (77°F) ±0.55% at 0° to 60° C (32° to 140°F)	±0.4% at 25°C (77°F) ±0.7% at 0° to 60°C (32° to 140°F)	±0.3% at 25°C (77°F) ±0.5% at 0° to 60°C (32° to 140°F)
See Chapter	3	4	5
Specification	**F4–16AD–1**	**F4–16AD–2**	
Channels	16	4	
Input Ranges	0–20 mA, 4–20 mA	0–5V, 0–10V	
Resolution	12 bit (1 in 4096)	12 bit (1 in 4096)	
Input Type	Single ended	Single ended	
Maximum Inaccuracy	±0.4% at 25°C (77°F) ±0.55% at 0° to 60° C (32° to 140°F)	±0.4% at 25°C (77°F) ±0.7% at 0° to 60°C (32° to 140°F)	
See Chapter	6	7	

Special Input Modules

Specification	F4–08THM–n	F4–08RTD
Channels	8	8
Input Ranges	Type E: –270/1000°C (–450/1832°F) Type J: –210/760°C (–350/1390°F) Type K: –270/1370°C (–450/2500°F) Type R: 0/1768°C (–32/3214°F) Type S: 0/1768°C (–32/3214°F) Type T: –270/400°C (–450/752°F) Type C: 0/2320°C (–32/4208°F) Type B: 141/1820°C (286/3594°F) Type P: –99/1395°C (–146/2543°F) –1: 0 to 50mV –2: 0 to 100mV –3: 0 to 25mV	Pt100Ω: –200.0/850.0°C (–328/ 562°F) Pt1000Ω: –200.0/595.0°C (–328/1103°F) jPt100Ω: –38.0/450.0°C (–36/842°F) Cu. 25Ω, Cu. 10Ω: –200.0/260.0°C (–328/500°F)
Resolution	12 bit (1 in 4096)	15 bit (1 in 32768)
Maximum Inaccuracy	±1° C type J,K,E,T thermocouples ±3° C type R,S,B,C,P thermocouples	±0.2% at 25°C (77°F)
See Chapter	8	9

Specification	F4–08THM	
Channels	8	
Input Ranges	Type J –190 to 760°C	–310 to 1400°F
	Type E –210 to 1000°C	–346 to1832°F
	Type K –150 to 1372°C	–238 to 2502°F
	Type R 65 to 1768°C	149 to 3214°F
	Type S 65 to 1768°C	149 to 3214°F
	Type T –230 to 400°C	–382 to 752°F
	Type B 529 to 1820°C	984 to 3308°F
	Type N –70 to 1300°C	–94 to 2372°F
	Type C 65 to 2320°C	149 to 4208°F
Resolution	16 bit (1 in 65535)	
Maximum Inaccuracy	±3° C (excluding thermocouple error)	
See Chapter	10	

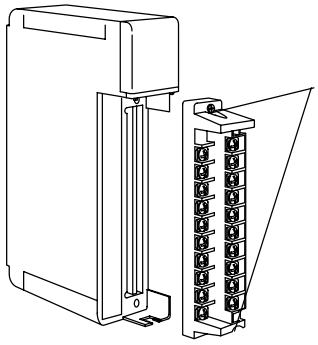
Analog Output Modules

Specification	D4–02DA	F4–04DA	F4–04DA–1
Channels	2	4	4
Output Ranges	4–20 mA, 1–5V, 0–10V	4–20 mA, 0–5V, 0–10V, ±5V, ±10V	4–20mA
Resolution	12 bit (1 in 4096)	12 bit (1 in 4096)	12 bit (1 in 4096)
Output Type	Independent	Single ended	Single ended
Maximum Inaccuracy	±0.2% at 25°C (77°F)	±0.5% at 60°C (unipo.) ±0.7% at 60°C (bipol.) ±0.8% at 60°C (curr.)	±0.1 % at 25°C (77°F) ±0.3 % at 0 to 60°C (32 to 140°F)
See Chapter	11	12	13
Specification	**F4–04DA–2**	**F4–08DA–1**	**F4-16DA-1**
Channels	4	8	16
Output Ranges	0–5V, 0–10V, ±5V, ±10V	4–20mA	4–20 mA
Resolution	12 bit (1 in 4096)	12 bit (1 in 4096)	12 bit (1 in 4096)
Output Type	Single ended	Single ended	Single ended
Maximum Inaccuracy	±0.2 % at 25°C (77°F) ± 0.4% at 0° to 60°C (32° to 140°F)	±0.2% at 25°C (77°F) ±0.4% at 0° to 60°C (32° to 140°F)	±0.2 % at 25°C (77°F) ±0.4 % at 0° to 60°C (32° to 140°F)
See Chapter	14	15	16
Specification	**F4–04DAS–1**	**F4–08DA–2**	**F4-16DA-2**
Channels	4, current sourcing	8	16
Output Ranges	4–20mA	0–5V, 0–10V	0–5V, 0–10V, combination of both
Resolution	16 bit (1 in 65536)	12 bit (1 in 4096)	12 bit (1 in 4096)
Output Type	Isolated	Single ended	Single ended
Maximum Inaccuracy	±0.07 % at 25° (77°F) ± 0.18% at 0° to 60°C 32° to 140°F)	±0.2 % at 25° (77°F) ± 0.4% at 0° to 60°C 32° to 140°F)	±0.2 % at 25° (77°F) ± 0.4% at 0° to 60°C 32° to 140°F)
See Chapter	17	18	19
Specification	**F4–04DAS–2**		
Channels	4		
Output Ranges	0–5V, 0–10V		
Resolution	16 bit (1 in 65536)		
Output Type	Isolated		
Maximum Inaccuracy	±0.07 % at 25° (77°F) ± 0.18% at 0° to 60°C 32° to 140°F)		
See Chapter	20		

Physical Characteristics

The DL405 Analog Modules provide many features that make the modules easy to use. With the exception of the Thermocouple module, the terminal blocks are removable, which makes wiring a simple task. All of the DL405 analog modules have normal screw terminal connectors. For ease of removal, there are captive screws on the top and bottom. To remove the terminal block, unscrew the screws at the ends to the terminal block 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.



Frequently Asked Questions

Q. How many discrete I/O points does my analog module occupy?

A. Analog modules will occupy either or both X and Y points. You must pay particular attention to this information because it varies depending on which module is being used. Care must be taken to determine the proper placement within the base (see the specific analog module specifications to determine the proper placement).

Q. Does my module detect a broken transmitter or loose terminal block?

A. Yes, most of the analog modules have this function. The loose terminal block is indicated by the error code E201. See error code information in the DL405 User Manual for further information.

Q. Can I use a FOR/NEXT loop program to read all channels in one scan in a remote/slave arrangement?

A. No. A FOR/NEXT loop program will not work in a remote/slave arrangement. Use a program that reads one channel per scan. Remember, FOR/NEXT loops can only be used with DL440 and DL450 CPUs.

Analog Made Easy – Four Simple Steps

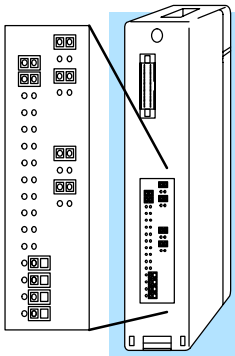
Once you've selected the appropriate module, use the chapter that describes the module and complete the following steps.

Step 1 . Take a minute to review the detailed specifications to make sure the module meets your application requirements.

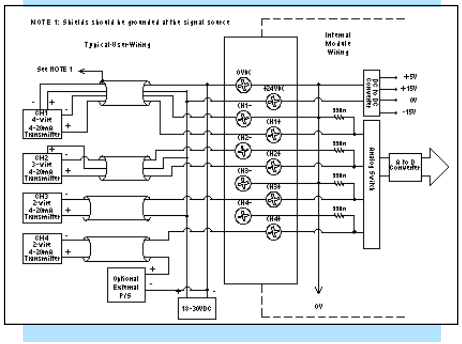
Specification		
Channels	2	2
Output Ranges	4 – 20 mA	0 – 5V 0 – 10V –5 – +5V –10 – +10V
Resolution	12 bit (1 in 4096)	12 bit (1 in 4096)
Channel Isolation	Non-isolated	Non-isolated
Output Type	Single ended	Single ended
Maximum Inaccuracy at 25 °C (77 °F) at 0° – 25° C (32° – 140° F)	± 0.1% ± 0.3%	± 0.3% unipolar ± 0.4% bipolar
See Chapter	4	5

Step 2 . Set the module switches and/or jumpers to select:

- number of channels
- the operating ranges



Step 3 . Connect the field wiring to the module connector.



Step 4 . Review the module operating characteristics and write the control program.