Errata Sheet

This Errata Sheet contains corrections or changes made after the publication of this manual.

Product Family:	DL405	**Date**:	September 12, 2018
Manual Number	D4-ANLG-M		
Revision and Date	5th Ed., Rev. A; July 2004		

Changes to Chapter 3: F4–04AD 4-Channel Analog Input

Page 3-3. Module Specifications; General Specifications

In the table, change the Power Budget Requirement value from “85 mA (power from base)” to “150 mA (power from base)”.

Page 3-11. Current Loop Transmitter Impedance

Replace the example drawing with this one. Connections were added between the power supply 0V terminal, the 0V CH1 terminal, and the CH1 common terminal. Also, the “See NOTE 3 below” note was added.

$R = Tr - Mr$

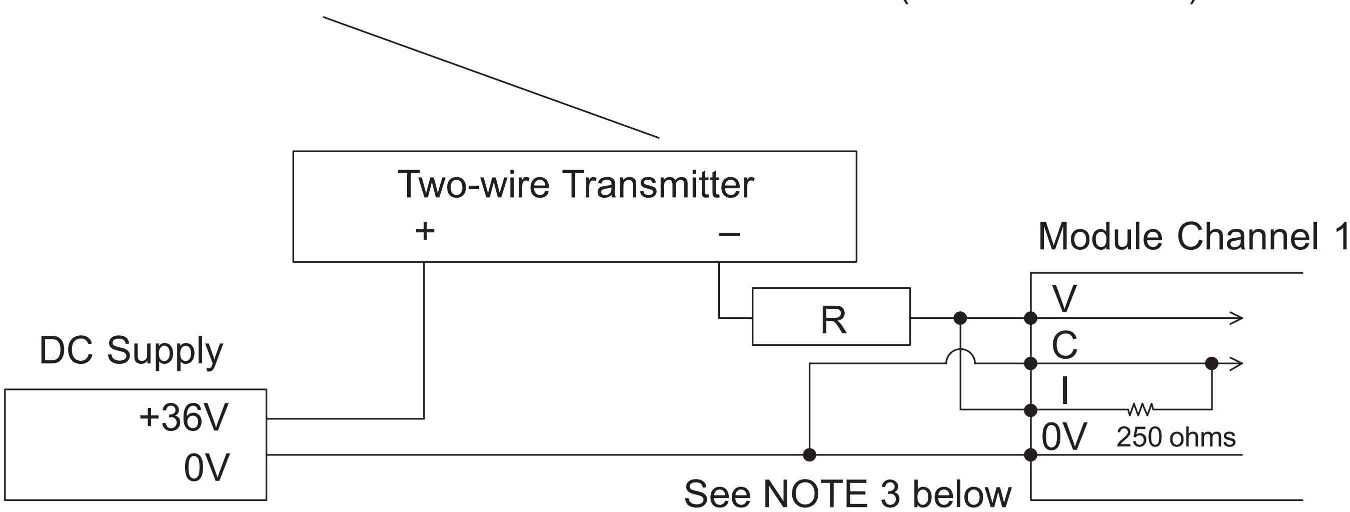
$R = 750 - 250$

$R \geq 500$

R – resistor to add

Tr – Transmitter Requirement

Mr – Module resistance (internal 250 ohms)



NOTE 3: When a differential input is not used, 0V should be connected to C of the channel.

Errata Sheet

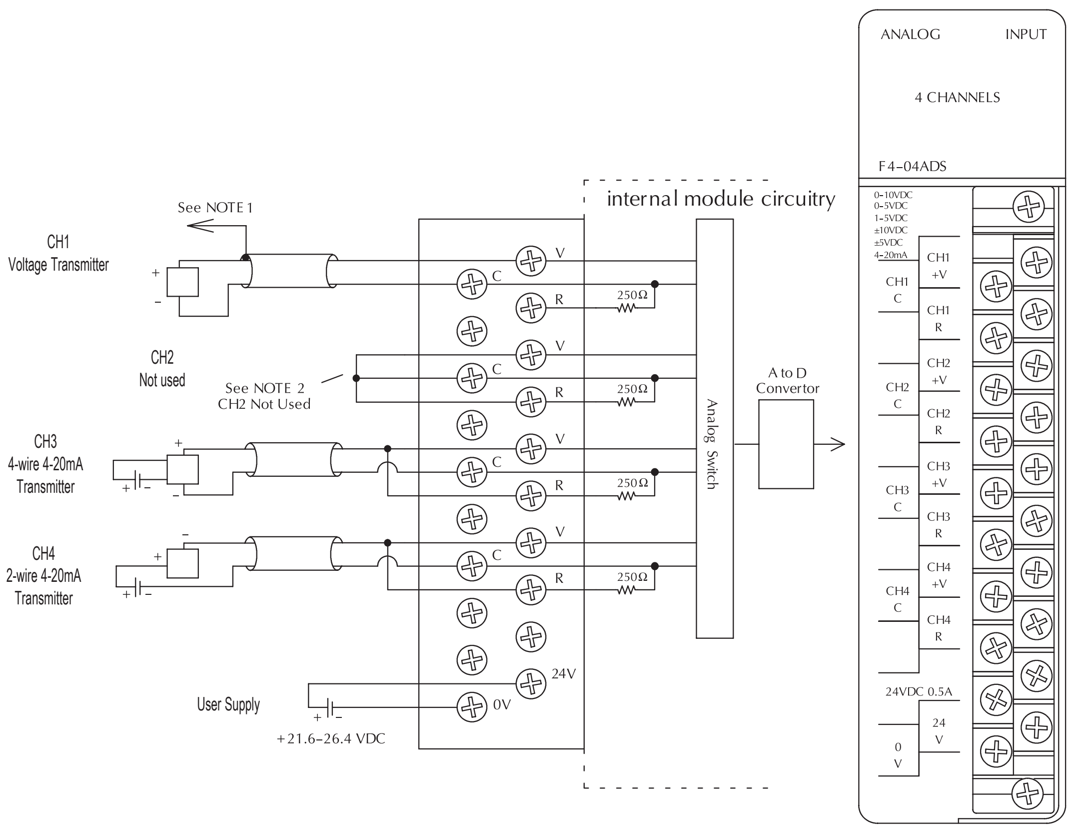
Changes to Chapter 4: F4-04ADS 4-Channel Isolated Analog Input

Page 4-3. Module Specifications; General Specifications

In the table, change the Power Budget Requirement value from “270 mA at 5 VDC (from base)” to “370 mA at 5 VDC (from base).”

Page 4-8. Wiring Diagram

Replace the wiring diagram with this one. The connections for CH3 and CH4 were incorrect. They did not show that external power is required. Examples for wiring 2-wire and 4-wire current transmitters was added.



Errata Sheet

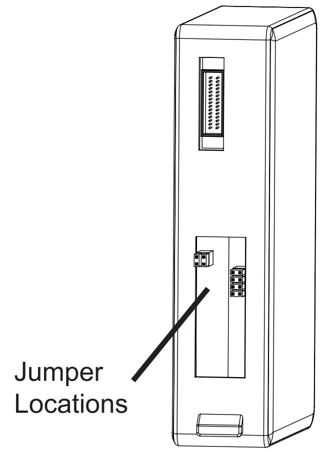
Changes to Chapter 6: F4–16AD-1 16-Channel Analog Input

Page 6-4. Setting the Module Jumpers

Changes to Chapter 7: F4–16AD-2 16-Channel Analog Input

Page 7-4. Setting the Module Jumpers

For both modules, the jumpers are now arranged differently. They are no longer in a straight line like the drawings on pages 6-4 and 7-4 show. They are now next to each other as shown here.



Changes to Chapter 7: Title page

The title page mistakenly calls this an 8-point module; it is actually 16 points

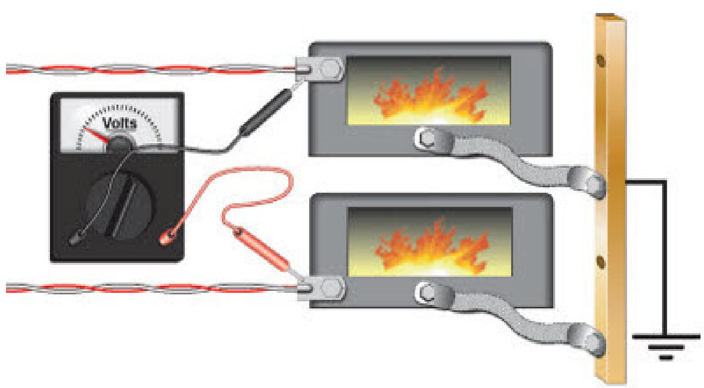
Changes to Chapter 8: F4-08THM-n 8-Channel Thermocouple Input

Changes to Chapter 10: F4-08THM 8-Channel Thermocouple Input

Pages 8-7 and 10-10. Wiring Diagram

Add the following note and drawing to the wiring diagrams for both of these thermocouple modules.

With grounded thermocouples, take precautions to prevent having a voltage potential between thermocouple tips. A voltage of 1.25V or greater between tips will skew measurements.

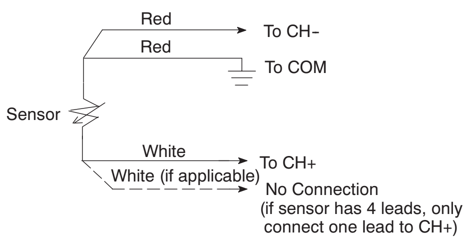


Errata Sheet

Changes to Chapter 9: F4-08RTD 8-Channel RTD Input

Page 9-7. Connecting the Field Wiring; RTD - Resistance Temperature Detector; Lead Detection for RTD Sensors

Replace the wiring diagram with this one. The wire lead colors changed. (The two black leads changed to red and the two red leads changed to white.)



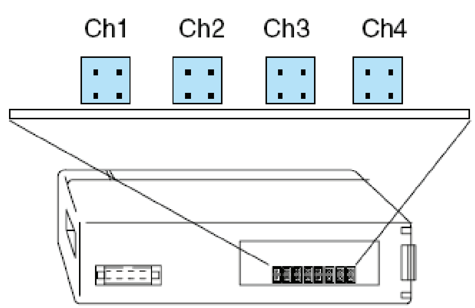
Changes to Chapter 18: F4-04DAS-2 4-Channel Isolated 0–5V, 0–10V Output

Page 18-4. Setting the Module Jumpers

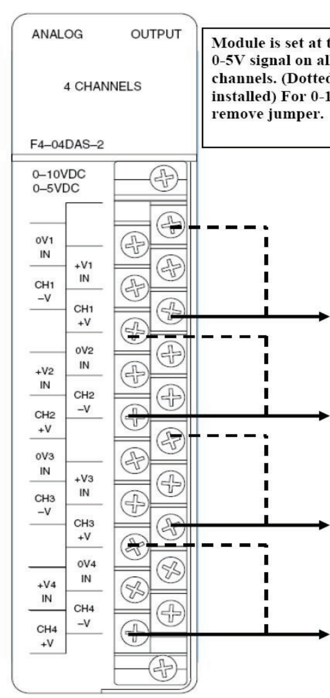
In 2008 the module was redesigned and the range selection jumpers on the back of the module (as described below on the left and on page 18-4) were eliminated. The range selection is now done by a wire jumper on the terminal block as shown here on the right.

"Old Version"

"New Version"



Channel Signal Range	"Old Version Jumper Settings"	"New Version Jumper Settings"
0-5 VDC Place jumper on LEFT		"Install on TB"
0-10 VDC Place jumper on RIGHT		"Remove from TB"



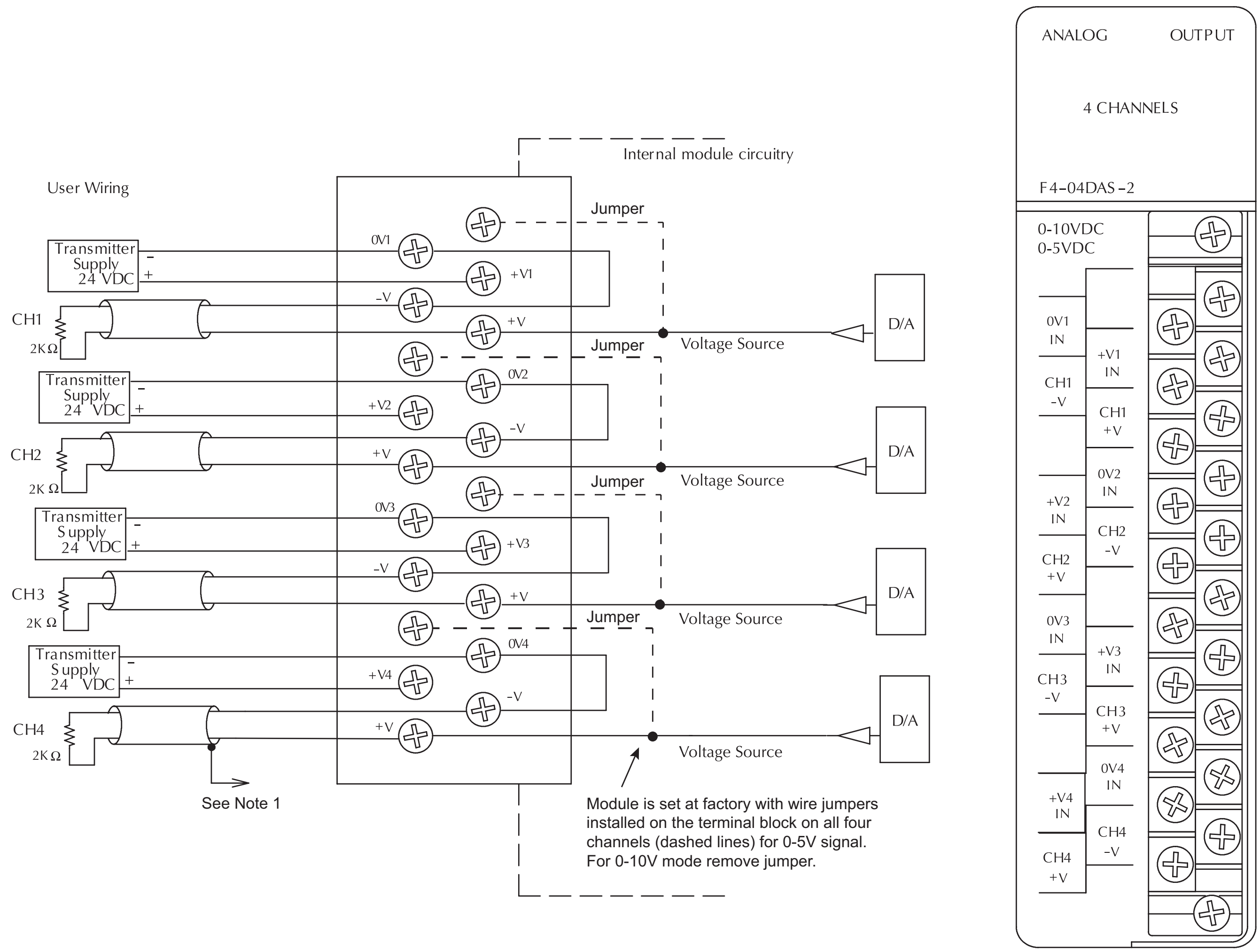
Module is set at the factory for 0-5V signal on all four channels. (Dotted line jumper installed) For 0-10V mode remove jumper.

Errata Sheet

Changes to Chapter 18: F4-04DAS-2 4-Channel Isolated 0–5V, 0–10V Output (continued)

Page 18-5. Wiring Diagram

In 2008 the module was redesigned and the range selection jumpers on the back of the module were eliminated. The range selection is now done by a wire jumper for each channel located on the terminal block. This wiring diagram was revised to show these jumpers.



10

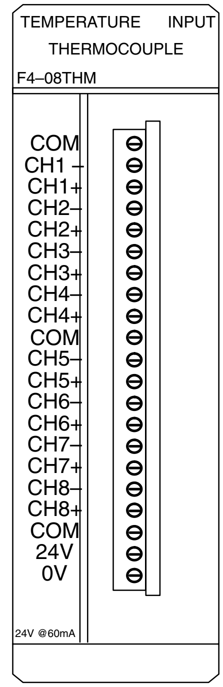
F4-08THM 8-Channel Thermocouple Input

In This Chapter. . . .

Module Specifications

The F4-08THM 8-Channel Thermocouple Input Module provides several features and benefits.

- Eight thermocouple input channels with 16-bit voltage resolution or 0.1 °C/°F temperature resolution.
- Automatically converts type E, J, K, R, S, T, B, N, or C thermocouple signals into direct temperature readings. No extra scaling or complex conversion is required.
- Temperature data can be expressed in °F or °C.
- Module can be configured as ±5V, ±156mV, 0–5V or 0–156 mV and will convert volts and millivolt signal levels into 16-bit digital (0–65535) values.
- Signal processing features include automatic cold junction compensation, thermocouple linearization, and digital filtering.
- The temperature calculation and linearization are based on data provided by the National Institute of Standards and Technology (NIST).
- Diagnostic features include detection of thermocouple burnout or disconnection.



The following tables provide the specifications for the F4-08THM Analog Input Module. Review these specifications to make sure the module meets your application requirements.

General Specifications

Number of Channels	8, differential
Common Mode Range	±5VDC
Common Mode Rejection	90dB min. @ DC, 150dB min. @ 50/60 Hz.
Input Impedance	1MΩ
Absolute Maximum Ratings	Fault-protected inputs to ±50 VDC
Accuracy vs. Temperature	±5 ppm/°C maximum full scale calibration (including maximum offset change)
PLC Update Rate	1 channel per scan
Digital Inputs Input Points Required	16 binary data bits, 3 channel ID bits, 8 diagnostic bits 32 point (X) input module
External Power Supply	60 mA maximum, 18 to 26.4 VDC
Power Budget Requirement	110 mA maximum, 5 VDC (supplied by base)
Operating Temperature	0 to 60° C (32 to 140° F)
Storage Temperature	–20 to 70° C (–4 to 158° F)
Relative Humidity	5 to 95% (non-condensing)
Environmental air	No corrosive gases permitted
Vibration	MIL STD 810C 514.2
Shock	MIL STD 810C 516.2
Noise Immunity	NEMA ICS3–304

One count in the specification table is equal to one least significant bit of the analog data value (1 in 65535).

Thermocouple Specifications

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
Display Resolution	± 0.1°C / ± 0.1°F
Cold Junction Compensation	Automatic
Warm-Up Time	30 min. typically ± 1°C repeatability
Linearity Error (End to End)	± .05°C maximum, ± .01°C typical
Maximum Inaccuracy	± 3°C (excluding thermocouple error)

Voltage Specifications

Voltage Ranges	Voltage: 0-5V, ±5V, 0-156.25mV, ± 156.25mVDC
Resolution	16 bit (1 in 65535)
Full Scale Calibration Error (Offset Error Included)	±13 counts typical, ±33 maximum
Offset Calibration Error	±1 count maximum, @ 0V input
Linearity Error (End to End)	±1 count maximum
Maximum Inaccuracy	±.02% @ 25°C (77°F)

Module Calibration

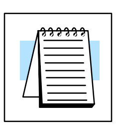
The F4-08THM module requires no calibration. The module automatically calibrates every five seconds, which removes offset and gain errors. For each thermocouple type, the temperature calculation and linearization performed by the microprocessor is accurate to within .01 °C.

Thermocouple Input Configuration Requirements

The F4-08THM module requires 32 discrete input points from the CPU. The module can be installed in any slot of a DL405 system. The limitations on the number of analog modules are:

- For local and expansion systems, the available power budget and number of discrete I/O points.
- For remote I/O systems, the available power budget and number of remote I/O points.

Check the user manual for your particular model of CPU and I/O base for more information regarding power budget and number of local or remote I/O points.



NOTE: This F4–08THM module differs from the F4–08THM–n module in that this single module can be used with the common thermocouple types (J, K, E, etc.) by setting internal jumpers. The F4–08THM–n modules require a separate module for each thermocouple type. For example, an F4–08THM–J only works with “J” type thermocouples.

Setting the Module Jumpers

Jumper Locations

Use the figure on the following page to locate the bank of ten jumpers on the PC board. Notice that the description of each jumper is just to the right of the jumpers on the PC board. To prevent losing a jumper when it is removed, store it in its original location by sliding one of its sockets over a single pin. You can select the following options by installing or removing the appropriate jumpers:

- Number of channels
- Input type
- Conversion units
- Calibrate enable

Calibrate Enable

See the following figure to locate the “Calibrate Enable” jumper. The jumper comes from the factory in the “jumper removed” setting (the jumper is installed over only one of the two pins). Installing this jumper disables the thermocouple active burn-out detection circuitry, which enables you to attach a thermocouple calibrator to the module.

To make sure that the output of the thermocouple calibrator is within the 5V common mode voltage range of the module, connect the negative side of the differential voltage input channel to the 0V terminal, then connect the thermocouple calibrator to the differential inputs (for example, Ch 3+ and Ch 3).

For the voltage input ranges, this jumper is inactive and can be installed or removed with no effect on voltage input.

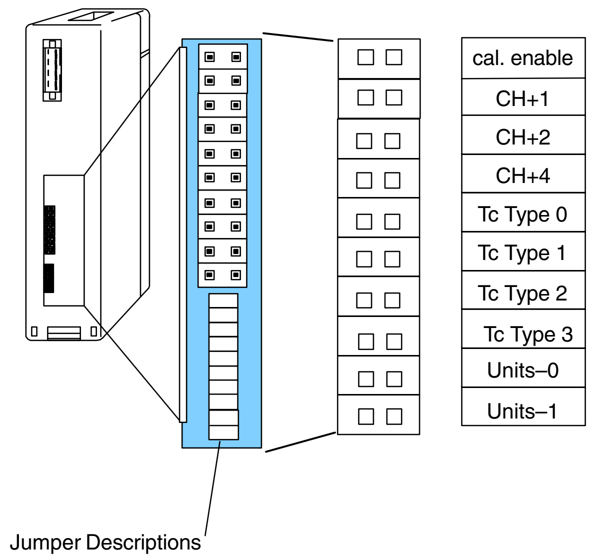
Selecting the Number of Channels

The next three jumpers labeled **CH+1**, **CH+2**, and **CH+4** determine the number of channels that will be used. The table shows how to set the jumpers for channels 1 thru 8. The module comes with three jumpers installed for eight channel operation. For example, to select channels 1 thru 3, remove the CH+1 and CH+4 jumpers and leave the CH+2 jumper installed. Any unused channels are not processed. For example, if you only select channels 1 thru 3, channels 4 through 8 will not be active.

X = jumper installed,

blank space = jumper removed

Number of Channels	Jumper		
	CH+1	**CH+2**	**CH+4**
1			
2	X		
3		X	
4	X	X	
5			X
6	X		X
7		X	X
8	X	X	X



Setting Input Type

The next four jumpers **(Tc Type 0, Tc Type 1, Tc Type 2, Tc Type 3)** must be set to match the type of thermocouple being used or the input voltage level. The module can be used with many types of thermocouples. Use the table to determine your settings.

The module comes from the factory with all four jumpers installed for use with a J type thermocouple. For example, to use an S type thermocouple, remove the jumper labeled Tc Type 2. All channels of the module must be the same thermocouple type or voltage range.

X = Jumper installed, and blank space = jumper removed.

Thermocouple / Voltage Inputs	Jumper			
	Tc Type 0	**Tc Type 1**	**Tc Type 2**	**Tc Type 3**
J	X	X	X	X
K		X	X	X
E	X		X	X
R			X	X
S	X	X		X
T		X		X
B	X			X
N				X
C	X	X	X	
0–5V.		X	X	
±5V.	X		X	
0–156mV.			X	
±156mV.	X	X		

Selecting the Conversion Units

Use the last two jumpers, **Units-0** and **Units-1**, to set the conversion unit used for either thermocouples or voltage inputs. The options are magnitude plus sign or 2's complement, plus Fahrenheit or Celsius for thermocouples. See the next two sections for jumper settings when using thermocouples or if using voltage inputs.

Thermocouple Conversion Units

All thermocouple types are converted into a direct temperature reading in either Fahrenheit or Celsius. The data contains one implied decimal place. For example, a value in V-memory of 1002 would be 100.2°C or °F.

For thermocouple ranges which include negative temperatures (J,E,K,T,N), the display resolution is from –3276.7 to +3276.7. For positive-only thermocouple ranges (R,S,B,C), the display resolution is 0 to 6553.5.

Negative temperatures can be represented in either 2's complement or magnitude plus sign form. If the temperature is negative, the most significant bit in the V-memory location is set (X17).

The 2's complement data format may be required to correctly display bipolar data on some operator interfaces. This data format could also be used to simplify averaging a bipolar signal. To view this data format in ***Direct***Soft, select Signed Decimal.

For unipolar thermocouple ranges (R,S,B,C), it does not matter if magnitude plus sign or 2's complement is selected.

Use the table to select settings. The module comes with both jumpers installed for magnitude plus sign conversion in Fahrenheit. For example, remove the Units-0 jumper and leave the Units-1 jumper installed for magnitude plus sign conversion in Celsius.

X = Jumper installed, and blank space = jumper removed.

Jumper	Temperature Conversion Units			
	Magnitude Plus Sign		2's Complement	
	°F	°C	°F	°C
Units-0	X		X	
Units-1	X	X		

Voltage Conversion Units

The bipolar voltage input ranges, ±5V or ±156mV (see previous page for ±5V and ±156mV settings), may be converted to a 15-bit magnitude plus sign or a 16-bit 2's complement value.

Use the table to select settings. The module comes with both jumpers installed for magnitude plus sign conversion. Remove the Units-1 jumper and leave the Units-0 jumper installed for 2's complement conversion.

X = Jumper installed, and blank space = jumper removed.

Jumper Pins	Voltage Conversion Units	
	Magnitude Plus Sign	2's Complement
Units-0	X	X
Units-1	X	

Connecting the Field Wiring

Wiring Guidelines

Your company may have guidelines for wiring and cable installation. If so, you should check those before you begin the installation. Here are some general things to consider:

- Use the shortest wiring route whenever possible.
- Use shielded wiring and ground the shield at the transmitter source. *Do not* ground the shield at both the module and the source.
- Do not run the signal wiring next to large motors, high current switches, or transformers. This may cause noise problems.
- Connect wiring from all unused channels to common.
- Route the wiring through an approved cable housing to minimize the risk of accidental damage. Check local and national codes to choose the correct method for your application.

User Power Supply Requirements

The F4–08THM requires a separate power supply. The CPU, D4–RS Remote I/O Controller and D4–EX Expansion Units have built–in 24 VDC power supplies that provide up to 400 mA of current. You can use this supply to power the Thermocouple Input Module. If you already have modules that are using all of the available power from this supply, or if you would rather use a separate supply, choose one that meets the following requirements: 24VDC $\pm$ 10%, Class 2, 75mA.

It is desirable in some situations to power the transmitters separately in a location remote from the PLC. This will work as long as the transmitter supply meets the voltage and current requirements and the transmitter's minus (–) side and the module supply's minus (–) side are connected together.

WARNING: If you are using the 24 VDC base power supply, make sure you calculate the power budget. Exceeding the power budget can cause unpredictable system operation that can lead to a risk of personal injury or damage to equipment.

The DL405 base has a switching type power supply. As a result of switching noise, you may notice some instability in the analog input data if you use the base power supply. If this is unacceptable, you should try one of the following:

1. Use a separate linear power supply.
2. Connect the 24VDC common to the frame ground, which is the screw terminal marked "G" on the base.

Unused temperature inputs should be shorted together and connected to common.

Thermocouples

Use shielded thermocouples whenever possible to minimize the presence of noise on the thermocouple wire. Ground the shield wire at one end only. For grounded thermocouples, connect the shield at the sensor end. For ungrounded thermocouples, connect the shield to the 0V (common) terminal.

Grounded Thermocouple Assembly

A grounded thermocouple provides better response time than an ungrounded thermocouple because the tip of the thermocouple junction is in direct contact with the protective case.

Ungrounded Thermocouple Assembly

An ungrounded thermocouple is electrically isolated from the protective case. If the case is electrically grounded it provides a low-impedance path for electrical noise to travel. The ungrounded thermocouple provides a more stable and accurate measurement in a noisy environment.

Exposed Grounded Thermocouple

The thermocouple does not have a protective case and is directly connected to a device with a higher potential. Grounding the thermocouple assures that the thermocouple remains within the common mode specifications. Because a thermocouple is essentially a wire, it provides a low-impedance path for electrical noise. The noise filter has a response of >100dB @ 50/60 Hz.

WARNING: A thermocouple can become shorted to a high voltage potential. Because common terminals are internally connected together, whatever voltage potential exists on one thermocouple will exist on the other channels.

Ambient Variations in Temperature

The F4-08THM module has been designed to operate within the ambient temperature range of 0°C to 60°C.

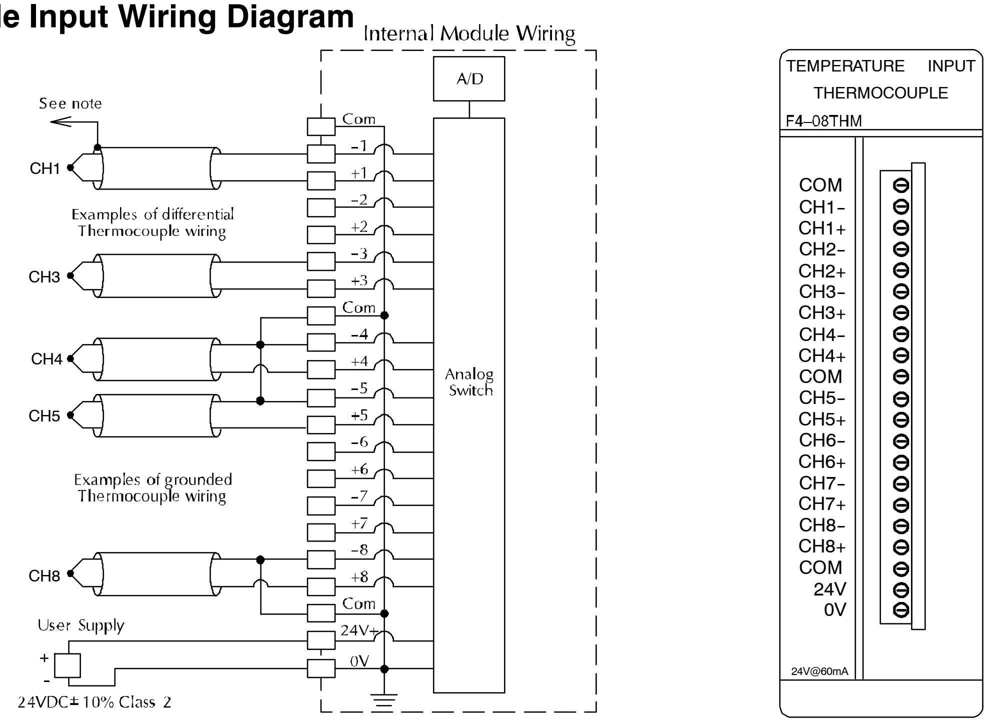
The cold junction compensation is calibrated to operate in a still-air environment. If the module is used in an application that has forced convection cooling, an error of 2–3°C may be introduced. To compensate for this you can use ladder logic to correct the values.

When configuring the system design it is best to locate any heat-producing devices above and away from the PLC chassis because the heat will affect the temperature readings. For example, heat introduced at one end of the terminal block can cause a channel-to-channel variation.

When exposing the F4-08THM module to abrupt ambient temperature changes it will take several minutes for the cold junction compensation and terminal block to stabilize. Errors introduced by abrupt ambient temperature changes will be less than 4°C.

Wiring Diagram Use the following diagrams to connect the field wiring.

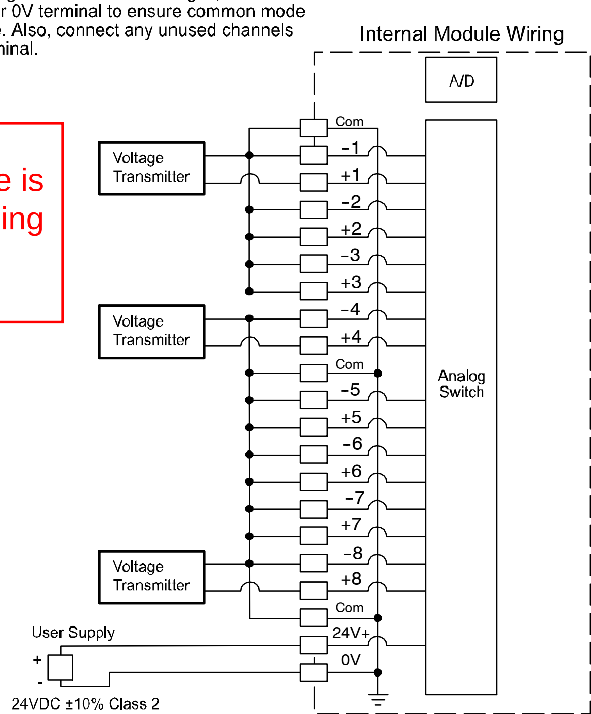
Thermocouple Input Wiring Diagram



Voltage Input Wiring Diagram

Note 3: When using 0-156mV and 5V ranges, connect CH- terminal to Com or 0V terminal to ensure common mode range acceptance. Also, connect any unused channels to Com or 0V terminal.

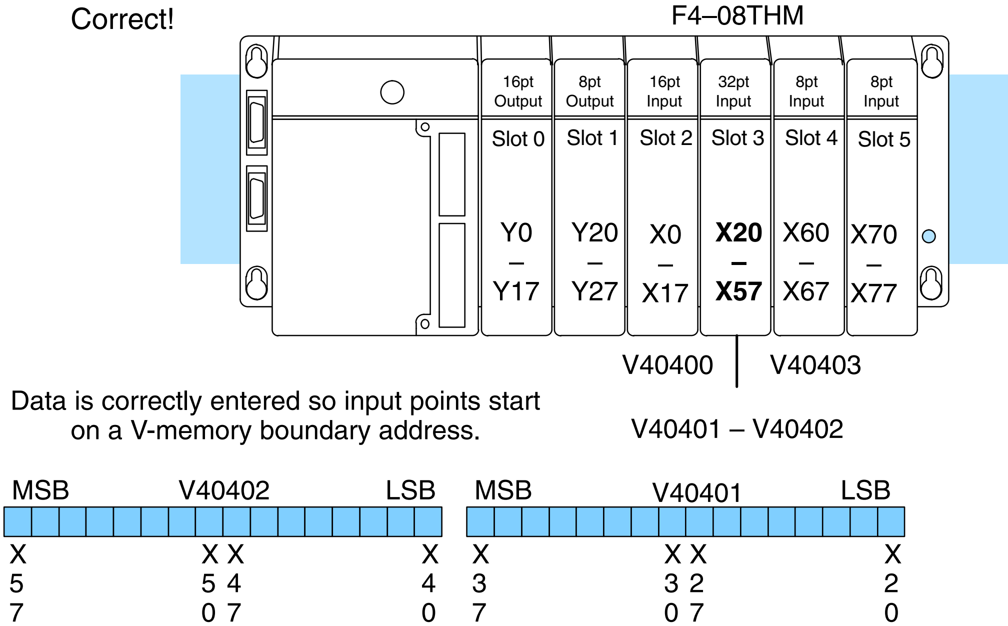
See Errata Sheet at the beginning of this file. There is a note and drawing regarding grounded thermocouples.

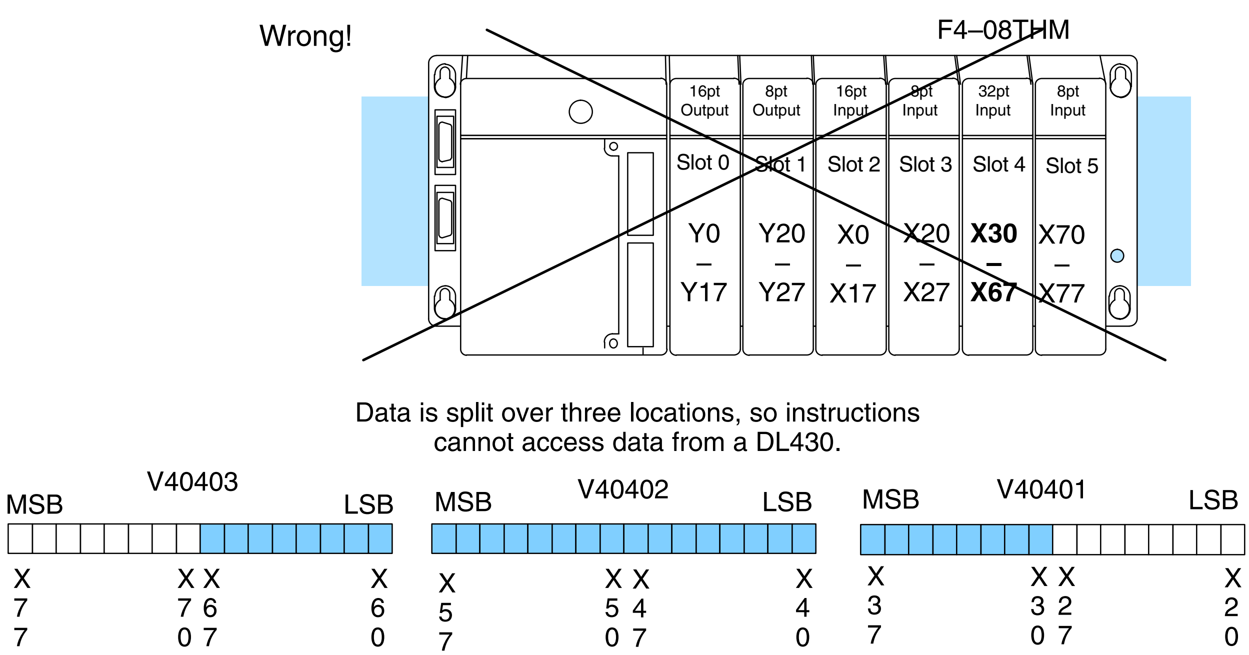


Module Operation

DL430 Special Requirements

Even though the module can be placed in any slot, it is important to examine the configuration if you are using a DL430 CPU. As you will see in the section on writing the program, you use V-memory locations to extract the analog data. As shown in the following diagram, if you place the module so that the input points do not start on a V-memory boundary, the instructions cannot access the data.



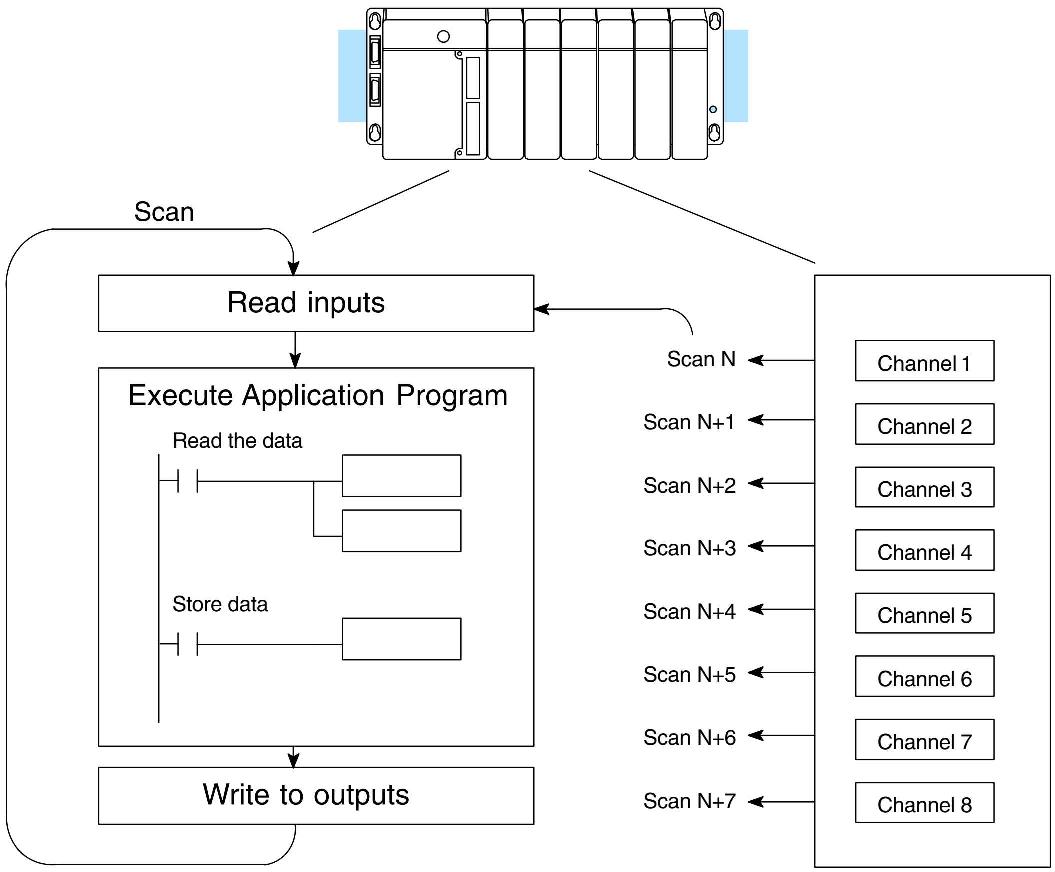


Channel Scanning Sequence

Before you begin writing the control program, it is important to take a few minutes to understand how the module processes and represents the analog signals.

The F4–08THM module supplies one channel of data per each CPU scan. Since there are eight channels, it can take up to eight scans to get data for all channels. Once all channels have been scanned the process starts over with channel 1.

Unused channels are not processed, so if you select only two channels, then each channel will be updated every other scan.



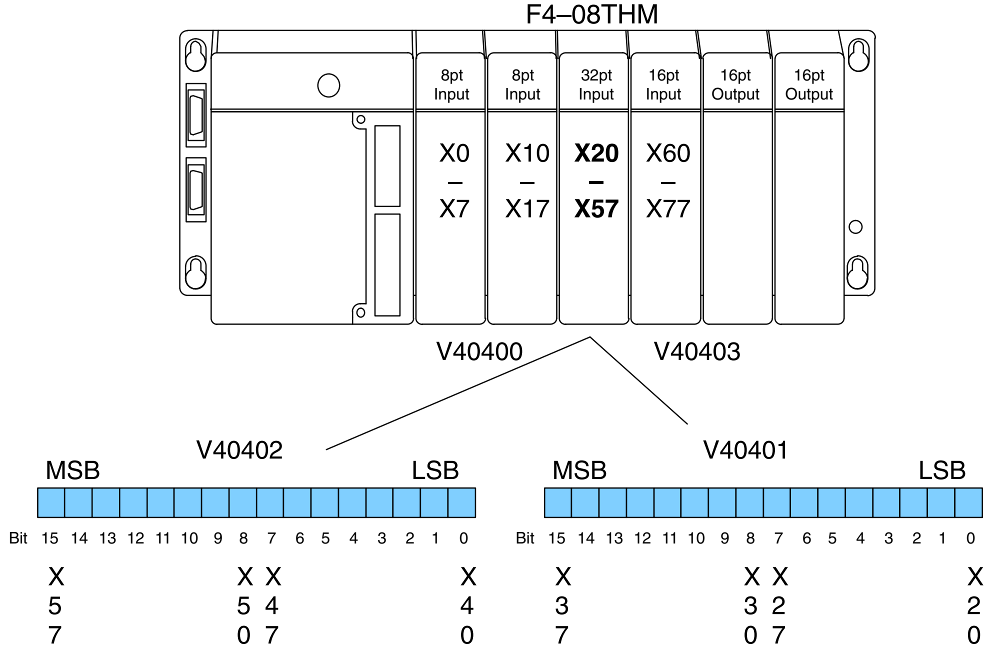
Even though the channel updates to the CPU are synchronous with the CPU scan, the module asynchronously monitors the thermocouple signal and converts the signal to a 16-bit binary representation. This enables the module to continuously provide accurate measurements without slowing down the discrete control logic in the RLL program.

Identifying the Data Locations

The F4–08THM module requires 32-point discrete input points (five bits are unused). These inputs provide:

- Three active channel bits
- A digital representation of the analog signal in 16 bits, including one sign bit.
- Individual broken transmitter detection bits for each channel.

Since all input points are automatically mapped into V-memory, it is very easy to determine the location of the two data words that will be assigned to the module.



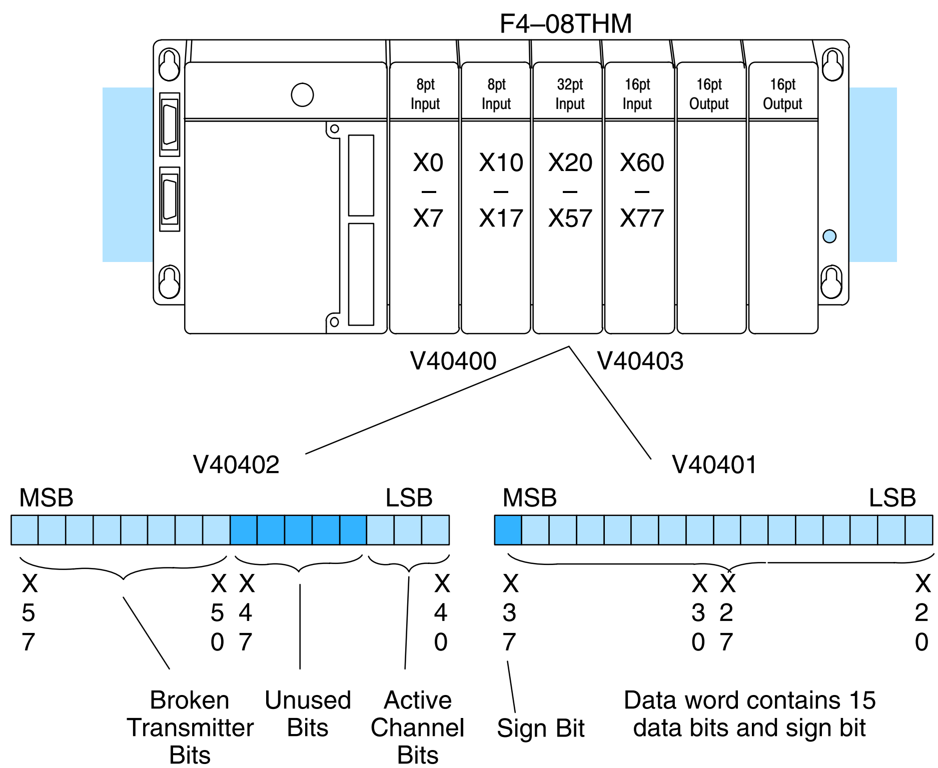
Writing the Control Program

After you have configured the F4–08THM module, use the following examples to get started writing the control program.

Multiple Active Channels

The analog data is multiplexed into the lower word and is presented in 16 bits. The upper word contains three groups of bits that contain active channel status, unused bits, and broken transmitter status.

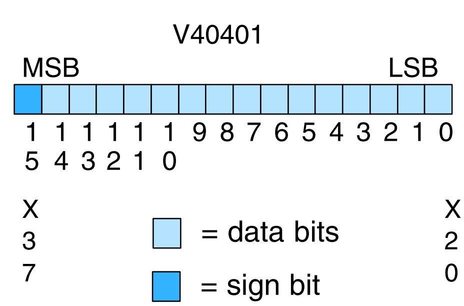
The control program must determine which channel's data is being sent from the module. If you have enabled only one channel, its data will be available on every scan. Two or more channels require demultiplexing the lower data word. Since the module communicates as X input points to the CPU, it is very easy to use the active channel status bits in the upper word to determine which channel is being monitored.



Analog Data and Sign Bits

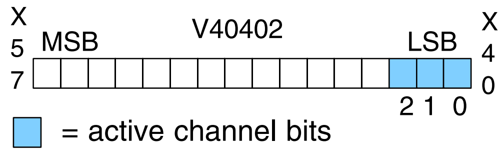
The first 16 bits represent the analog data in binary format. The MSB is the sign bit.

Bit	Value	Bit	Value
0	1	8	256
1	2	9	512
2	4	10	1024
3	8	11	2048
4	16	12	4096
5	32	13	8192
6	64	14	16384
7	128	15	32768



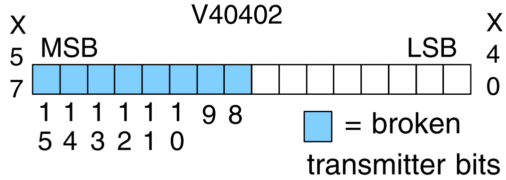
Active Channel Bits

The active channel bits represent the channel selections in binary format (000 = channel 1 is active, 001 = channel 2 is active, 111 = channel 8 is active, etc.).



Broken Transmitter Bits

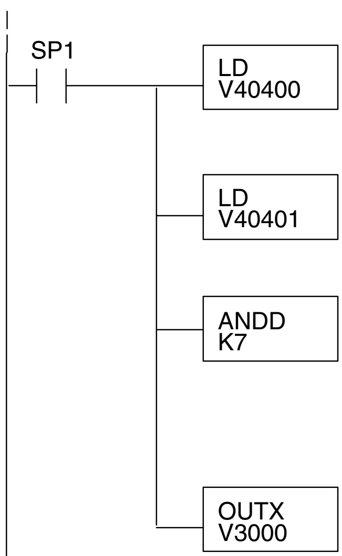
The broken transmitter bits are on when the corresponding thermocouple is open (00000001 = channel 1 is open, 00000010 = channel 2 is open, 11111111 = all eight channels are open, etc.).



Reading Values, DL430

430 440 450

This program example shows how to read the analog data into V-memory locations with the DL430 CPU (which does not support the LDF instruction) using the LD instruction. The example also works for DL440 and DL450 CPUs. The example reads one channel per scan, so it takes eight scans to read all the channels. Contact SP1 is used in the example because the inputs are continually being updated.



Loads all 16 bits of the channel data (first word) from the module into the lower 16 bits of the accumulator. This example assumes that the module location starts in the X0 position of the base.

Loads all 16 bits of the second data word from the module into the accumulator, and pushes the channel data (V40401) onto the first level of the stack.

ANDDs the value in the accumulator with the constant K7, which masks off everything except the three least significant bits (LSB) of V40401. The result is stored in the accumulator. The binary value of these bits (0–7, which is the offset) indicates which channel is being processed in that particular scan.

OUTX copies the 16-bit value from the first level of the accumulator stack to a source address offset by the value in the accumulator. In this case it adds the above binary value (0–7) to V3000. The particular channel data is then stored in its respective location: For example, if the binary value of the channel select bits is 0, then channel 1 data is stored in V-memory location V3000 (V3000 + 0), and if the binary value is 6, then channel 7 data is stored in location V3006 (V3000 + 6). See the following table.

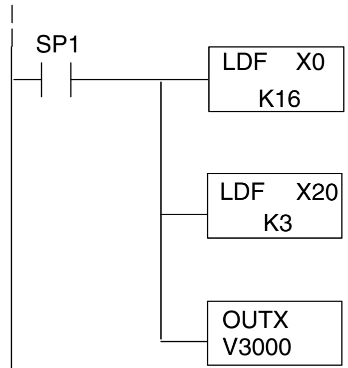
Module Reading	Acc. Bits	Offset	Data Stored in ...
Channel 1	000	0	V3000
Channel 2	001	1	V3001
Channel 3	010	2	V3002
Channel 4	011	3	V3003
Channel 5	100	4	V3004
Channel 6	101	5	V3005
Channel 7	110	6	V3006
Channel 8	111	7	V3007

Note: This example uses SP1, which is always on. You could also use an X, C, etc. permissive contact.

Reading Values, DL440/450

✗ 430 ✓ 440 ✓ 450

The following program example shows how to read the analog data into V-memory locations with DL440 and DL450 CPUs. Once the data is in V-memory, you can perform math on the data, compare the data against preset values, and so forth. This example will read one channel per scan, so it will take eight scans to read all eight channels. Contact SP1 is used in the example because the inputs are continually being updated. This example will not work with DL430 CPUs.



Loads the 16 bits of channel data (starting with location X0) from the module into the accumulator.

Loads the binary value of the active channel bits (0–7) into the accumulator, and pushes the channel data loaded into the accumulator from the first LDF instruction onto the first level of the stack.

OUTX copies the 16-bit value from the first level of the accumulator stack to a source address offset by the value in the accumulator. In this case it adds the above binary value (0–7, which is the offset) to V3000. The particular channel data is then stored in its respective location: For example, if the binary value of the channel select bits is 0, then channel 1 data is stored in V-memory location V3000 (V3000 + 0), and if the binary value is 6, then channel 7 data is stored in location V3006 (V3000 + 6). See the following table.

Module Reading	Acc. Bits	Offset	Data Stored in ...
Channel 1	000	0	V3000
Channel 2	001	1	V3001
Channel 3	010	2	V3002
Channel 4	011	3	V3003
Channel 5	100	4	V3004
Channel 6	101	5	V3005
Channel 7	110	6	V3006
Channel 8	111	7	V3007

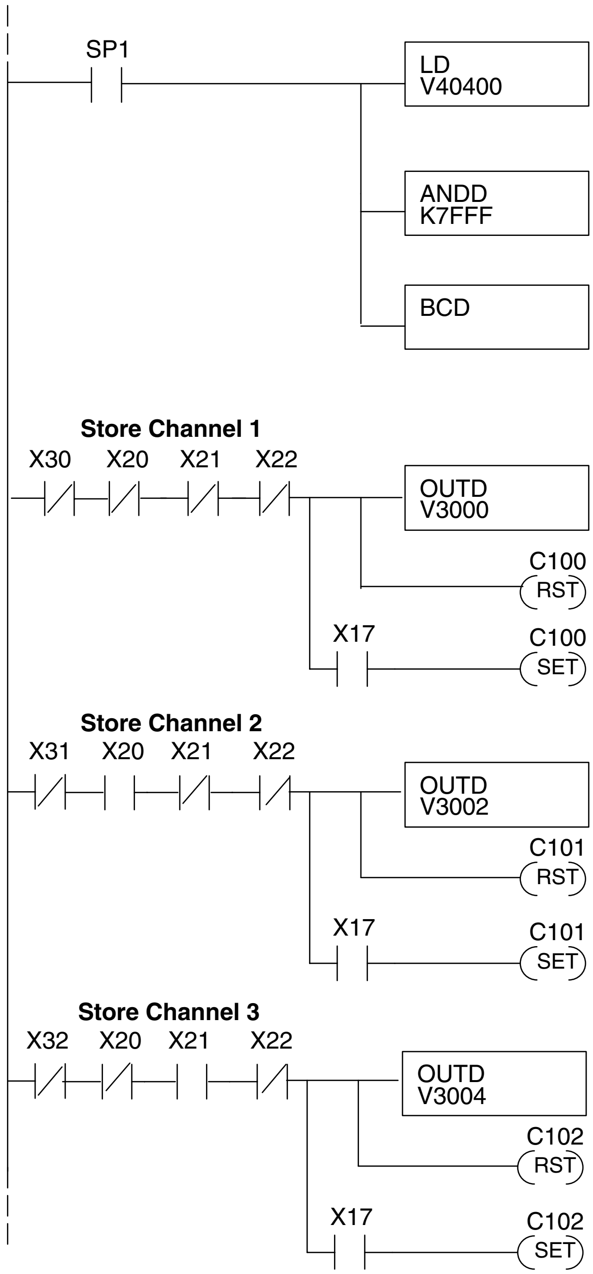
Note: This example uses SP1, which is always on. You could also use an X, C, etc. permissive contact.

Using Bipolar Ranges (Magnitude Plus Sign)

✓ ✓ ✓
430 440 450

With bipolar ranges, you need some additional logic because you need to know if the value being returned represents a positive voltage or a negative voltage. For example, you may need to know if the temperature is positive or negative.

The following program shows how you can accomplish this. Since you always want to know when a value is negative, these rungs should be placed *before* any operations that use the data, such as math instructions, scaling operations, and so forth. Also, if you are using stage programming instructions, these rungs should be in a stage that is always active. Although this example shows all eight channels, you only need the additional logic for those channels that are using bipolar input signals.



Loads the complete data word into the accumulator. The V-memory location depends on the I/O configuration. This example assumes the module is in the X0–X37 slot. See the CPU memory map.

This instruction masks off the channel data and excludes the sign bit. Without this, the values used will not be correct, so do not forget to include it.

It is usually easier to perform math operations in BCD, so it is best to convert the data to BCD immediately. You can leave out this instruction if your application does not require it. Do not use with internal PID loops because the PV requires binary data.

This rung looks at fault bit X30 (the broken transmitter bit for channel 1) ANDed with active channel bits X20–X22. When the active channel bits are true and there is no transmitter fault, channel 1 data is stored in V3000.

If the sign bit X17 is on, then control relay C100 is set. C100 can be used to indicate a negative channel 1 value or to call for a different message on an operator interface.

This rung looks at fault bit X31 (the broken transmitter bit for channel 2) ANDed with active channel bits X20–X22. When the active channel bits are true and there is no transmitter fault, channel 2 data is stored in V3002.

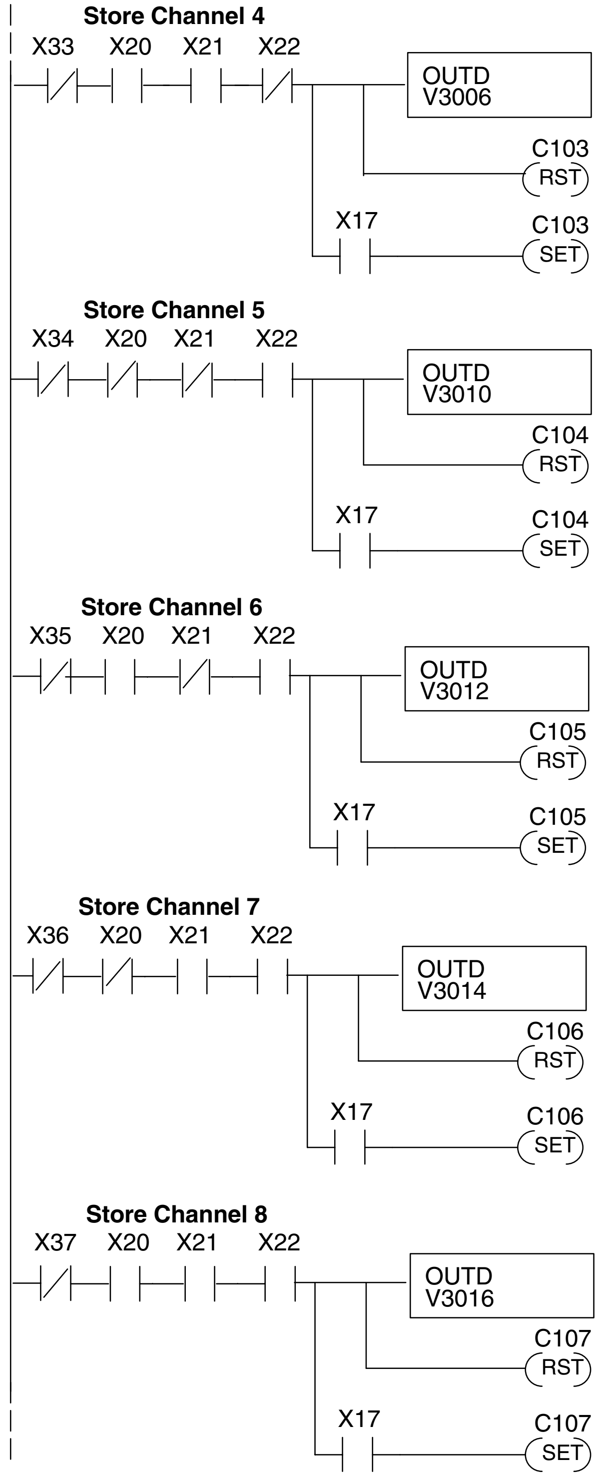
If the sign bit X17 is on, then control relay C101 is set. C101 can be used to indicate a negative channel 2 value or to call for a different message on an operator interface.

This rung looks at fault bit X32 (the broken transmitter bit for channel 3) ANDed with active channel bits X20–X22. When the active channel bits are true and there is no transmitter fault, channel 3 data is stored in V3004.

If the sign bit X17 is on, then control relay C102 is set. C102 can be used to indicate a negative channel 3 value or to call for a different message on an operator interface.

Program is continued on the next page.

Using Bipolar Ranges Example Continued



This rung looks at fault bit X33 (the broken transmitter bit for channel 4) ANDed with active channel bits X20–X22. When the active channel bits are true and there is no transmitter fault, channel 4 data is stored in V3006.

If the sign bit X17 is on, then control relay C103 is set. C103 can be used to indicate a negative channel 4 value or to call for a different message on an operator interface.

This rung looks at fault bit X34 (the broken transmitter bit for channel 5) ANDed with active channel bits X20–X22. When the active channel bits are true and there is no transmitter fault, channel 5 data is stored in V3010.

If the sign bit X17 is on, then control relay C104 is set. C104 can be used to indicate a negative channel 5 value or to call for a different message on an operator interface.

This rung looks at fault bit X35 (the broken transmitter bit for channel 6) ANDed with active channel bits X20–X22. When the active channel bits are true and there is no transmitter fault, channel 6 data is stored in V3012.

If the sign bit X17 is on, then control relay C105 is set. C105 can be used to indicate a negative channel 6 value or to call for a different message on an operator interface.

This rung looks at fault bit X36 (the broken transmitter bit for channel 7) ANDed with active channel bits X20–X22. When the active channel bits are true and there is no transmitter fault, channel 7 data is stored in V3014.

If the sign bit X17 is on, then control relay C106 is set. C106 can be used to indicate a negative channel 7 value or to call for a different message on an operator interface.

This rung looks at fault bit X37 (the broken transmitter bit for channel 8) ANDed with active channel bits X20–X22. When the active channel bits are true and there is no transmitter fault, channel 8 data is stored in V3016.

If the sign bit X17 is on, then control relay C107 is set. C107 can be used to indicate a negative channel 8 value or to call for a different message on an operator interface.

Reading the Input Data

The temperature readings have one implied decimal point. For example, a reading of 10273 is actually 1027.3 degrees.

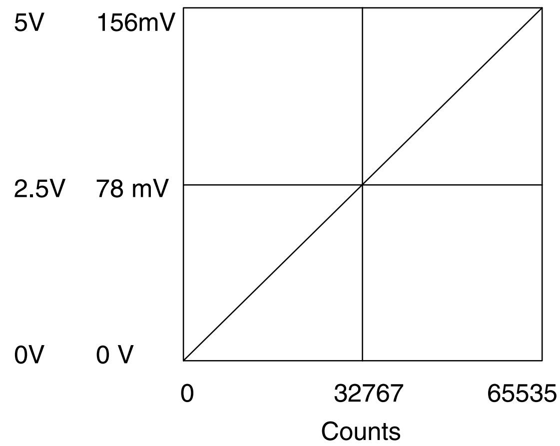
Module Resolution 16-Bit (Unipolar Voltage Input)

430 440 450

Unipolar analog signals are converted into 65536 counts ranging from 0 to 65535 (2^{16}). For example, with a 0 to 156mV signal range, 78mV would be 32767. A value of 65535 represents the upper limit of the range.

$$\text{Unipolar Resolution} = \frac{H - L}{65535}$$

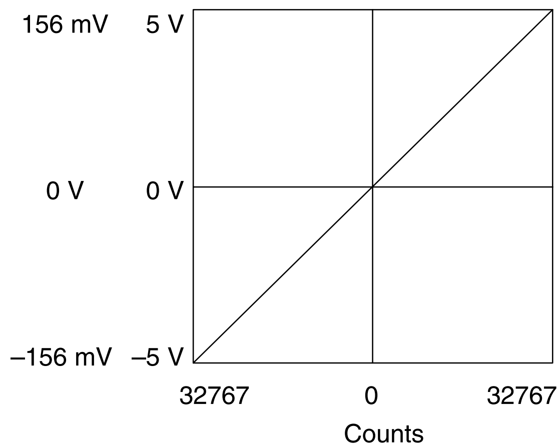
H or L = high or low limit of the range



Module Resolution 15-Bit Plus Sign (Bipolar Voltage Input)

430 440 450

The module has 16-bit unipolar or 15-bit + sign bipolar resolution. Bipolar analog signals are converted into 32768 counts ranging from 0 to 32767 (2^{15}). For example, with a –156mV to 156mV signal range, 156mV would be 32767. The bipolar ranges utilize a sign bit to provide 16-bit resolution. A value of 32767 can represent the upper limit of either side of the range. Use the sign bit to determine negative values.



$$\text{Bipolar Resolution} = \frac{H - L}{32767}$$

H or L = high or low limit of the range

Analog and Digital Value Conversions

430 440 450

Sometimes it is useful to be able to quickly convert between the signal levels and the digital values. This is especially helpful during machine startup or troubleshooting. Remember, this module *does not* operate like other versions of analog input modules that you may be familiar with. The bipolar ranges use 0–32767 for both positive and negative voltages. The sign bit allows this and it actually provides better resolution than those modules that do not offer a sign bit. The following table provides formulas to make this conversion easier.

Range	If you know the digital value ...	If you know the signal level ...
0 to 5V	$A = \frac{5D}{65535}$	$D = \frac{65535}{5}(A)$
0 to 156.25mV	$A = \frac{0.15625D}{65535}$	$D = \frac{65535}{0.15625}(A)$
±5V	$A = \frac{10D}{65535}$	$D = \frac{65535}{10}(A)$
±156.25mV	$A = \frac{0.3125D}{65535}$	$D = \frac{65535}{0.3125}(A)$

For example, if you are using the ±5V range and you have measured the signal at 2.5V, use the following formula to determine the digital value that is stored in the V-memory location that contains the data.

$$D = \frac{65535}{10}(A)$$

$$D = \frac{65535}{10}(2.5V)$$

$$D = (6553.5)(2.5)$$

$$D = 16383.75$$