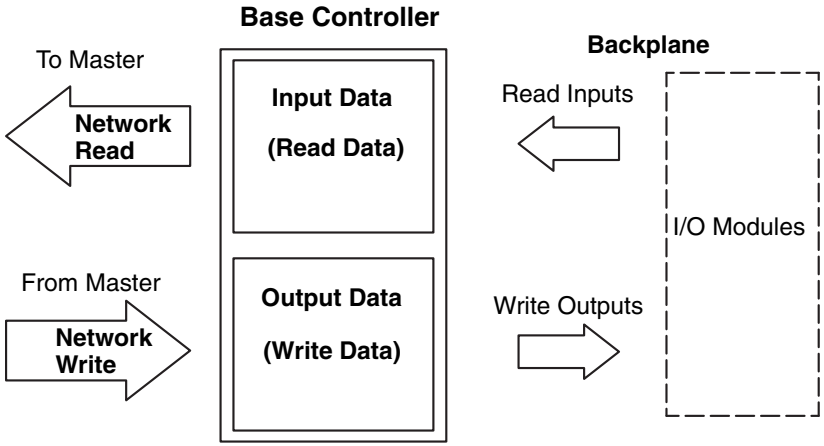
I/O Memory Map and Analog Module Resolution

In This Chapter...

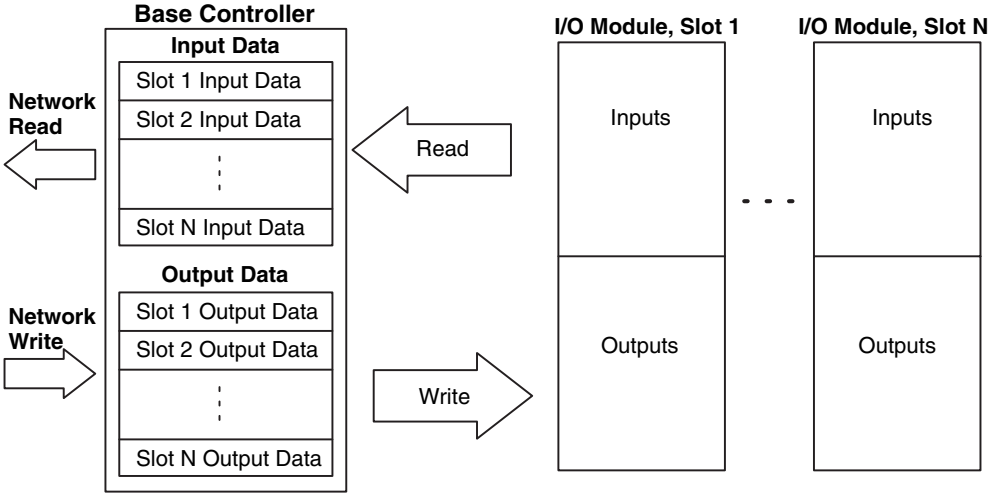
Master / Slave Communications

The base controller (slave) communicates with the master by sending Input Data and receiving Output Data. The base controller *reads* Inputs from I/O Modules and *writes* Outputs to I/O Modules.



Terminator I/O Backplane Communications

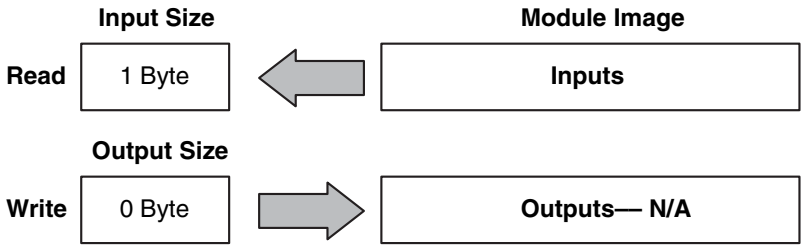
The base controller communicates with its I/O modules over the backplane. The I/O is mapped in consecutive order as shown



Discrete Input Module Memory Map

8-Point Discrete Input Modules (T1K–08NA–1 and T1K–08ND3)

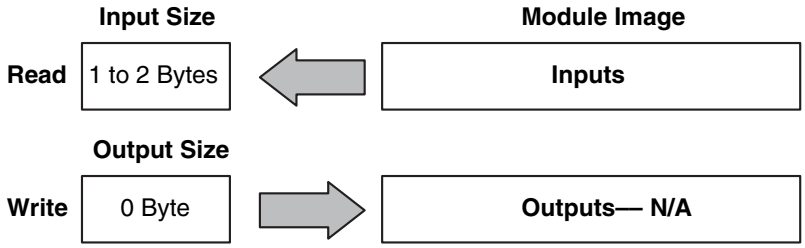
Image Table Mapping



Memory Map of 8-Point Discrete Input Modules									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	X7	X6	X5	X4	X3	X2	X1	X0	Read Byte 1
Not Used									Write Byte 1

16-Point Discrete Input Modules (T1K–16NA–1 and T1K–16ND3)

Image Table Mapping

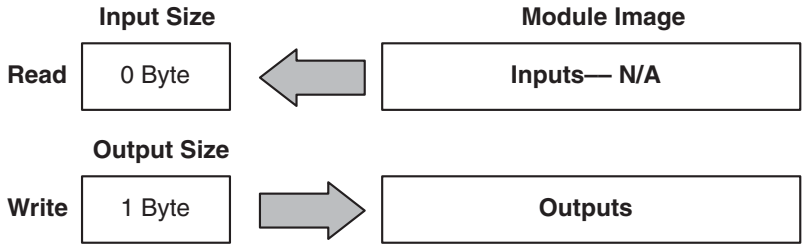


Memory Map of 16-Point Discrete Input Modules									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	X7	X6	X5	X4	X3	X2	X1	X0	Read Byte 1
	X17	X16	X15	X14	X13	X12	X11	X10	Read Byte 2
Not Used									Write Byte 1

Discrete Output Module Memory Map

8-Point Discrete Output Modules (T1K–08TA(S), T1K–08TD1, T1K–08TD2–1, T1K–08TR(S) and T1H-08TDS

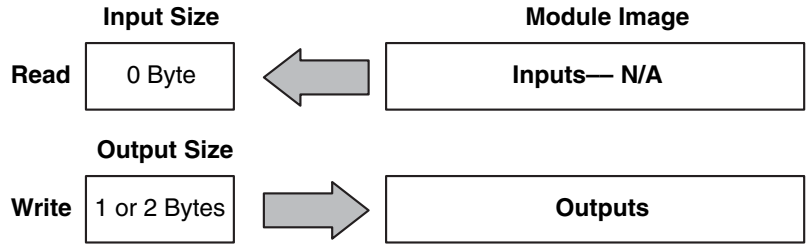
Image Table Mapping



Memory Map of 8-Point Discrete Output Modules									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
Not Used									Read Byte 1
	Y7	Y6	Y5	Y4	Y3	Y2	Y1	Y0	Write Byte 1

16-Point Discrete Output Modules (T1K–16TA, T1K–16TD1, T1K–16TD2–1 and T1K–16TR)

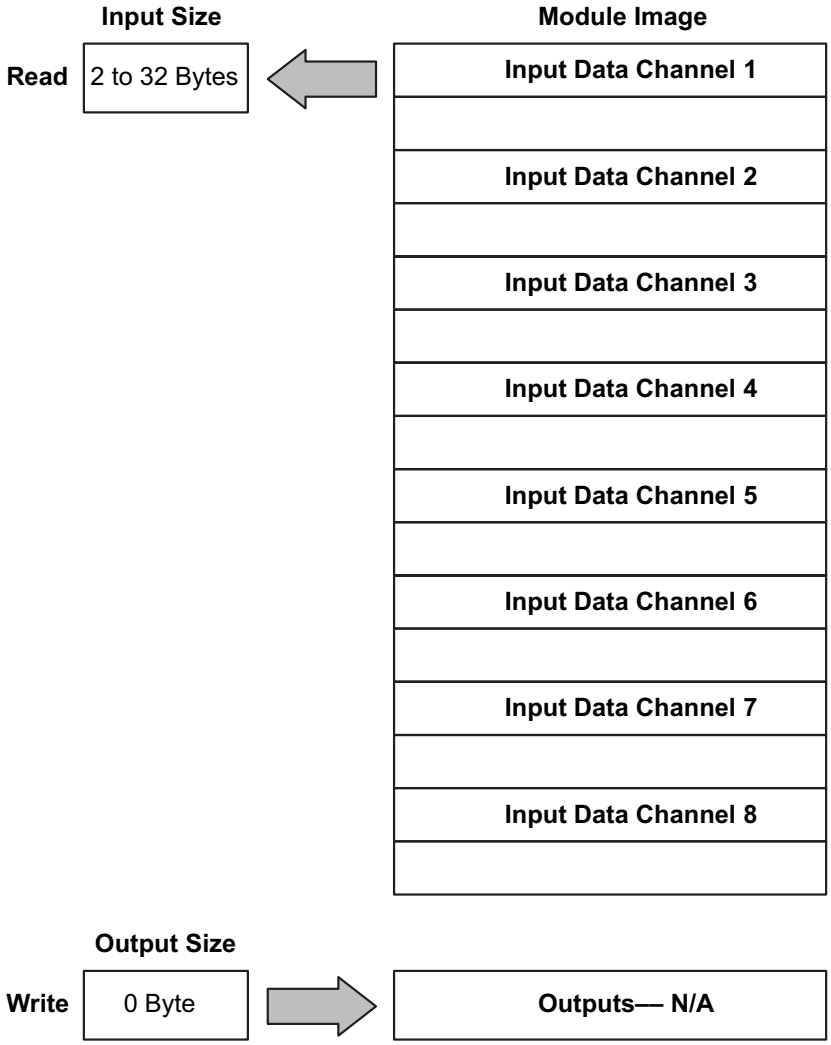
Image Table Mapping



Memory Map of 16-Point Discrete Output Modules									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
Not Used									Read Byte 1
	Y7	Y6	Y5	Y4	Y3	Y2	Y1	Y0	Write Byte 1
	Y17	Y16	Y15	Y14	Y13	Y12	Y11	Y10	Write Byte 2

8-Channel Analog Input Module Memory Map

8-Channel Analog Input Module (T1F–08AD–x) Image Table Mapping

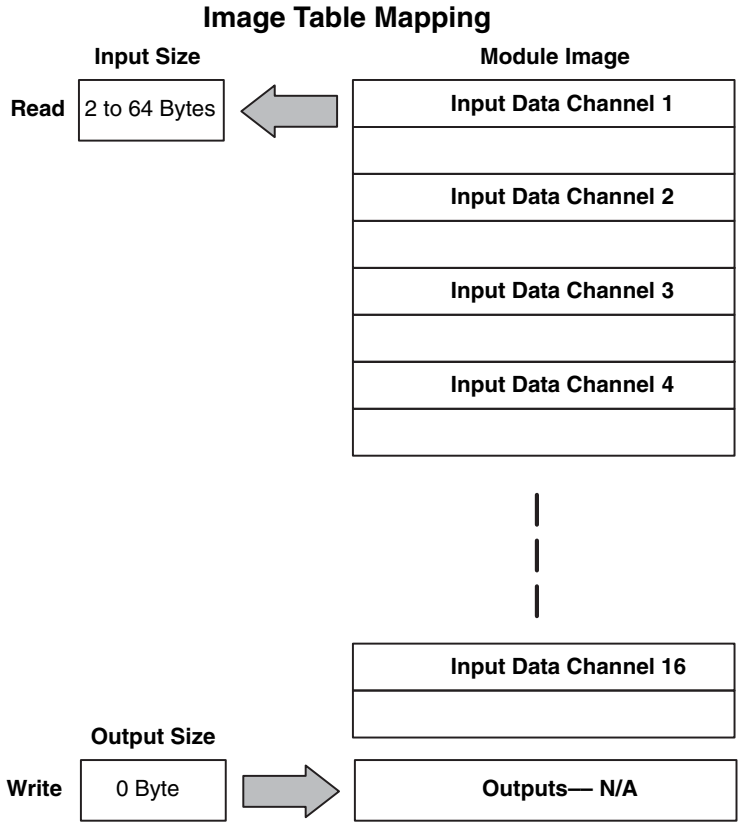


Analog Input Module Memory Map, cont'd

Memory Map of 8-Channel Analog Input Module									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	Analog Value Channel 1								Read Byte 1
	Analog Value Channel 1								Read Byte 2
	Not Used								Byte 3
	Reserved for future use								Byte 4
	Analog Value Channel 2								Read Byte 5
	Analog Value Channel 2								Read Byte 6
	Not Used								Byte 7
	Reserved for future use								Byte 8
	Analog Value Channel 3								Read Byte 9
	Analog Value Channel 3								Read Byte 10
	Not Used								Byte 11
	Reserved for future use								Byte 12
	Analog Value Channel 4								Read Byte 13
	Analog Value Channel 4								Read Byte 14
	Not Used								Byte 15
	Reserved for future use								Byte 16
	Analog Value Channel 5								Read Byte 17
	Analog Value Channel 5								Read Byte 18
	Not Used								Byte 19
	Reserved for future use								Byte 20
	Analog Value Channel 6								Read Byte 21
	Analog Value Channel 6								Read Byte 22
	Not Used								Byte 23
	Reserved for future use								Byte 24
	Analog Value Channel 7								Read Byte 25
	Analog Value Channel 7								Read Byte 26
	Not Used								Byte 27
	Reserved for future use								Byte 28
	Analog Value Channel 8								Read Byte 29
	Analog Value Channel 8								Read Byte 30
	Not Used								Byte 31
	Reserved for future use								Byte 32
	Not Used								Write Byte 1

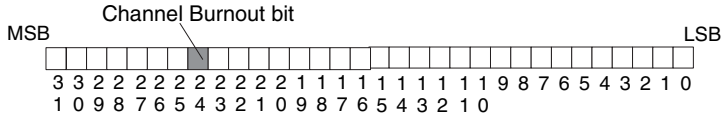
16-Channel Analog Input Module (T1F-16AD-x, T1F-16RTD, T1F-16TMST and T1F-14THM)

NOTE: *Even though the T1F-14THM only has 14 channels, the module consumes 16 channels of memory (16 double words). The first 14 channels are used for input data.*



T1F-14THM, T1F-16TMST and T1F-16RTD Channel Burnout Bit

NOTE: *The T1F-14THM can be configured for magnitude plus sign bit or 2's complement data format. The T1F-16RTD and T1F-16TMST process negative temperatures in 2's complement format only. See the module specifications pages in chapter 3 for configuration information.*



16-Channel Analog Input Module Memory Map

Memory Map of 16-Channel Analog Input Module									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	Analog Value Channel 1								Read Byte 1
	Analog Value Channel 1								Read Byte 2
	Not Used								Byte 3
	Reserved for future use								Byte 4
	Analog Value Channel 2								Read Byte 5
	Analog Value Channel 2								Read Byte 6
	Not Used								Byte 7
	Reserved for future use								Byte 8
	Analog Value Channel 3								Read Byte 9
	Analog Value Channel 3								Read Byte 10
	Not Used								Byte 11
	Reserved for future use								Byte 12
	Analog Value Channel 4								Read Byte 13
	Analog Value Channel 4								Read Byte 14
	Not Used								Byte 15
	Reserved for future use								Byte 16
	Analog Value Channel 5								Read Byte 17
	Analog Value Channel 5								Read Byte 18
	Not Used								Byte 19
	Reserved for future use								Byte 20
	Analog Value Channel 6								Read Byte 21
	Analog Value Channel 6								Read Byte 22
	Not Used								Byte 23
	Reserved for future use								Byte 24
	Analog Value Channel 7								Read Byte 25
	Analog Value Channel 7								Read Byte 26
	Not Used								Byte 27
	Reserved for future use								Byte 28
	Analog Value Channel 8								Read Byte 29
	Analog Value Channel 8								Read Byte 30
	Not Used								Byte 31
	Reserved for future use								Byte 32

(Memory Map table continued on following page.)

16-Channel Analog Input Module Memory Map, cont'd

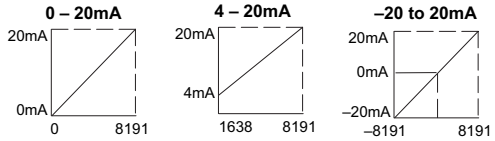
Memory Map of 16-Channel Analog Input Module									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	Analog Value Channel 9								Read Byte 33
	Analog Value Channel 9								Read Byte 34
	Not Used								Byte 35
	Reserved for future use								Byte 36
	Analog Value Channel 10								Read Byte 37
	Analog Value Channel 10								Read Byte 38
	Not Used								Byte 39
	Reserved for future use								Byte 40
	Analog Value Channel 11								Read Byte 41
	Analog Value Channel 11								Read Byte 42
	Not Used								Byte 43
	Reserved for future use								Byte 44
	Analog Value Channel 12								Read Byte 45
	Analog Value Channel 12								Read Byte 46
	Not Used								Byte 47
	Reserved for future use								Byte 48
	Analog Value Channel 13								Read Byte 49
	Analog Value Channel 13								Read Byte 50
	Not Used								Byte 51
	Reserved for future use								Byte 52
	Analog Value Channel 14								Read Byte 53
	Analog Value Channel 14								Read Byte 54
	Not Used								Byte 55
	Reserved for future use								Byte 56
	Analog Value Channel 15								Read Byte 57
	Analog Value Channel 15								Read Byte 58
	Not Used								Byte 59
	Reserved for future use								Byte 60
	Analog Value Channel 16								Read Byte 61
	Analog Value Channel 16								Read Byte 62
	Not Used								Byte 63
	Reserved for future use								Byte 64
	Not Used								Write Byte 1

Analog Input Module Resolution

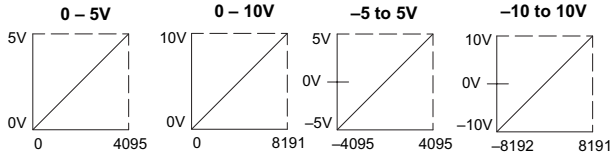
Input Module Resolution

Since the module has 13-bit resolution, the analog signal is converted into 8192 counts ranging from 0-8191 (2^{13}). For example, with a 0 to 10V scale, a 0V signal would be 0, and a 10 V signal would be 8191. This is equivalent to a binary value of 0000 0000 0000 to 0001 1111 1111 1111, or 000 to 1FFF hexadecimal. The following diagram shows how this relates to each signal range.

Current Input Module Resolution



Voltage Input Module Resolution

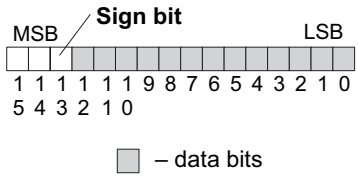


NOTE: *The 0–5 V and -5 to 5V range resolution is 4095, however, if the range is exceeded to 5.5 V, for example, the digital input reading will reflect the correct value up to 10 V (8191).*
The 4–20 mA range is 1638 to 8191. If the input current signal level falls below 4mA, the correct value will be read down to 0mA.

Channel Data Bits

The first thirteen bits represent the analog data in binary format. The Fourteenth bit is the data sign bit.

Bit	Value	Bit	Value
0	1	7	128
1	2	8	256
2	4	9	512
3	8	10	1024
4	16	11	2048
5	32	12	4096
6	64	13	**Sign Bit**



NOTE: *Each analog channel uses 4 bytes. The first and second byte contain the analog data. The third and fourth byte are not used at this time.*

Each count can also be expressed in terms of the signal level by using the equation shown. The following table shows the smallest signal level that will result in a change in the data value for each signal range.

$$\text{Smallest Detectable Change} = \frac{H - L}{\text{Resolution}}$$

H = high limit of the signal range

L = low limit of the signal range

Range	Signal Span (H - L)	Divide By	Smallest Detectable Change
±10V	20V	16383	1.22 mV
±5V	10V	8191	1.22 mV
0 to 5V	5V	4095	1.22 mV
0 to 10V	10V	8191	1.22 mV
0 to 20mA	20mA	8191	2.44 μA
4 to 20mA	16mA	(8191–1638)	2.44 μA
±20mA	40mA	16383	2.44 μA

Analog and Digital Value Conversions

Sometimes it is helpful to be able to quickly convert between the signal levels and the digital values. This is especially useful during machine startup or troubleshooting. The following table provides formulas to make this conversion easier.

Range	If you know the digital value…	If you know the analog value…
–10V to +10V	A = 20D / 8191 –10	D = 8191 / 20 (A + 10)
–5V to +5V	A = 10D / 4095 –5	D = 4095 / 10 (A + 5)
0 to 5V	A = 5D / 4095	D = 4095 / 5 (A)
0 to 10V	A = 10D / 8191	D = 8191 / 10 (A)
0 to 20mA	A = 20D / 8191	D = 4095 / 4 (A)
4 to 20mA	A = 16D / 6553	D = 6553 / 16 (A)
–20mA to +20mA	A = 40D / 8191 –20	D = 8191 / 40 (A + 20)

For example, if you are using the -10V to +10V range and you have measured the signal at 6V, you would use this formula to determine the digital value that should be stored in the V-memory location that contains the data.

D = 8191 / 20 (A + 10)

D = 8191 / 20 (6V + 10)

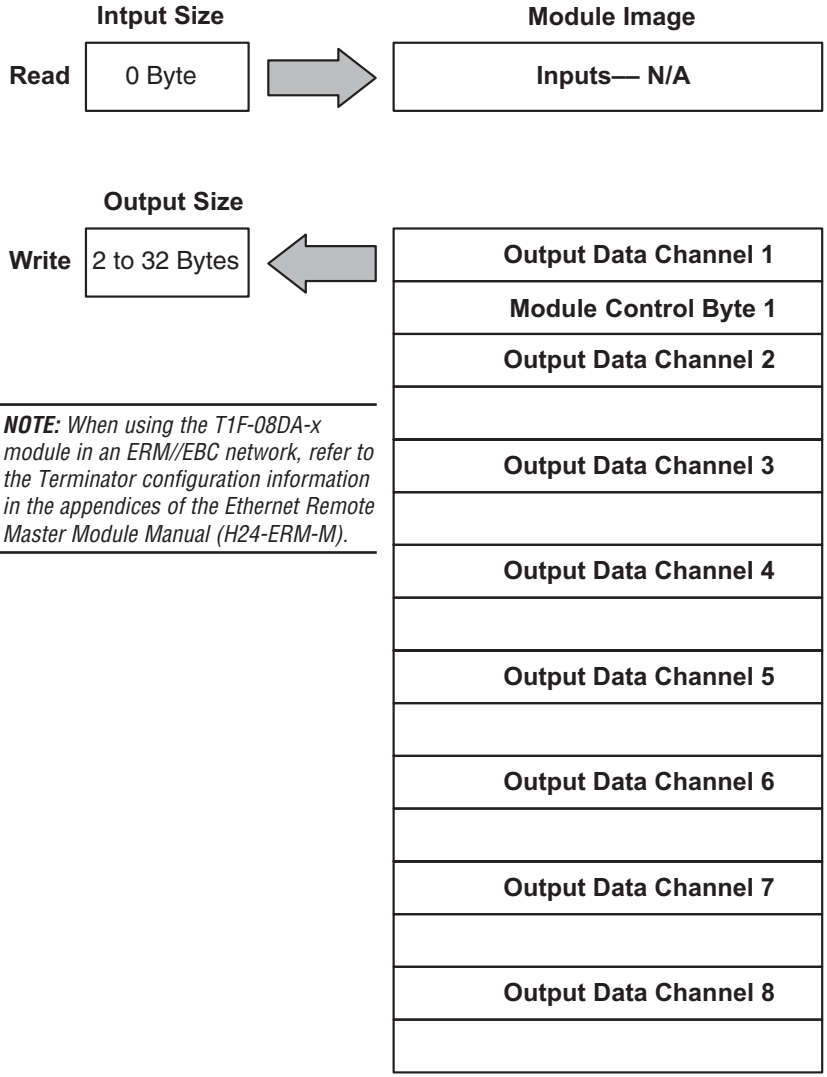
D = (409.55) (16)

D = 6552

T1F-08DA-x, Analog Output Module Memory Map

8-Channel Analog Ouput Module (T1F–08DA–x)

Image Table Mapping



NOTE: *When using the T1F-08DA-x module in an ERM//EBC network, refer to the Terminator configuration information in the appendices of the Ethernet Remote Master Module Manual (H24-ERM-M).*

NOTE: *Refer to page 4-21, Analog Output Module Control Byte.*

T1F-08DA-x, Analog Output Module Memory Map, cont'd

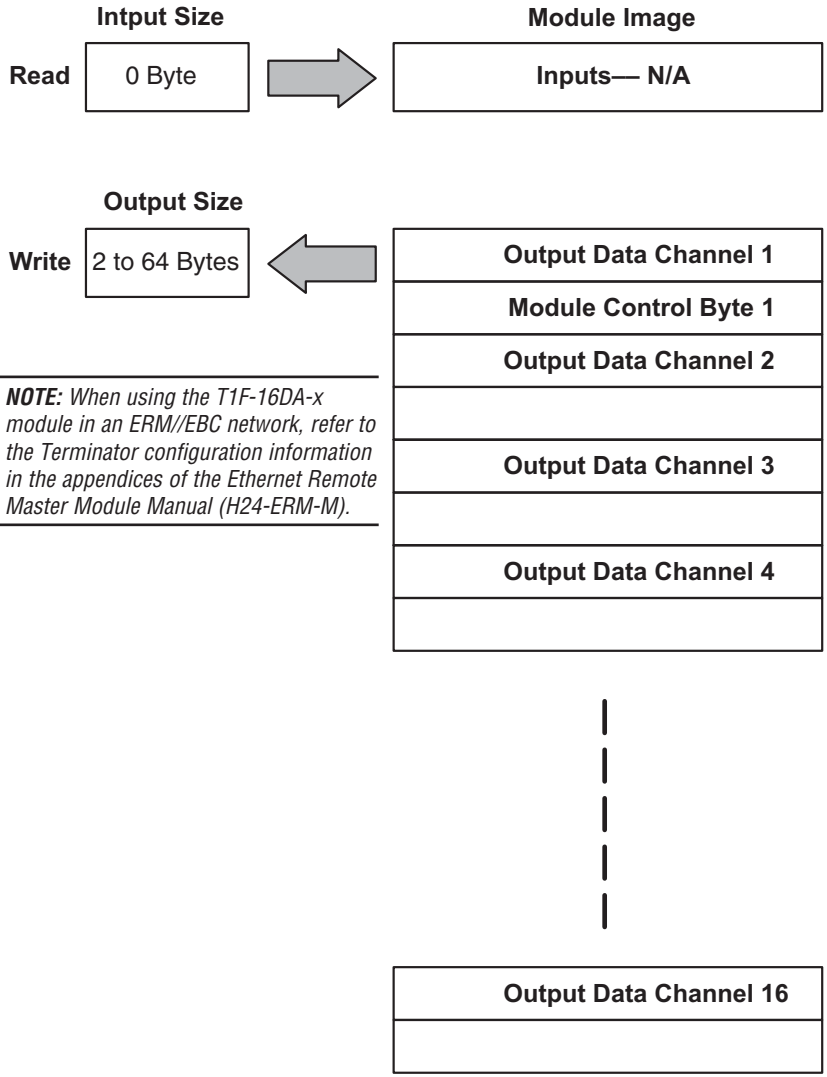
Memory Map of 8-Channel Analog Output Module									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	Not Used								Read Byte 1
	Analog Value Channel 1								Write Byte 1
	Analog Value Channel 1								Write Byte 2
	Not Used								Byte 3
	Module Control Byte 1								Write Byte 4
	Analog Value Channel 2								Write Byte 5
	Analog Value Channel 2								Write Byte 6
	Not Used								Byte 7
	Reserved for future use								Byte 8
	Analog Value Channel 3								Write Byte 9
	Analog Value Channel 3								Write Byte 10
	Not Used								Byte 11
	Reserved for future use								Byte 12
	Analog Value Channel 4								Write Byte 13
	Analog Value Channel 4								Write Byte 14
	Not Used								Byte 15
	Reserved for future use								Byte 16
	Analog Value Channel 5								Write Byte 17
	Analog Value Channel 5								Write Byte 18
	Not Used								Byte 19
	Reserved for future use								Byte 20
	Analog Value Channel 6								Write Byte 21
	Analog Value Channel 6								Write Byte 22
	Not Used								Byte 23
	Reserved for future use								Byte 24
	Analog Value Channel 7								Write Byte 25
	Analog Value Channel 7								Write Byte 26
	Not Used								Byte 27
	Reserved for future use								Byte 28
	Analog Value Channel 8								Write Byte 29
	Analog Value Channel 8								Write Byte 30
	Not Used								Byte 31
	Reserved for future use								Byte 32

NOTE: *Refer to page 4-21, Analog Output Module Control Byte*

T1F-16DA-x, Analog Output Module Memory Map, cont'd

16-Channel Analog Ouput Module (T1F–16DA–x)

Image Table Mapping



NOTE: *When using the T1F-16DA-x module in an ERM//EBC network, refer to the Terminator configuration information in the appendices of the Ethernet Remote Master Module Manual (H24-ERM-M).*

NOTE: *Refer to page 4-21, Analog Output Module Control Byte*

T1F-16DA-x, Analog Output Module Memory Map, cont'd

Memory Map of 16-Channel Analog Output Module									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	Not Used								Read Byte 1
	Analog Value Channel 1								Write Byte 1
	Analog Value Channel 1								Write Byte 2
	Not Used								Byte 3
	Module Control Byte 1 (See Note)								Write Byte 4
	Analog Value Channel 2								Write Byte 5
	Analog Value Channel 2								Write Byte 6
	Not Used								Byte 7
	Reserved for future use								Byte 8
	Analog Value Channel 3								Write Byte 9
	Analog Value Channel 3								Write Byte 10
	Not Used								Byte 11
	Reserved for future use								Byte 12
	Analog Value Channel 4								Write Byte 13
	Analog Value Channel 4								Write Byte 14
	Not Used								Byte 15
	Reserved for future use								Byte 16
	Analog Value Channel 5								Write Byte 17
	Analog Value Channel 5								Write Byte 18
	Not Used								Byte 19
	Reserved for future use								Byte 20
	Analog Value Channel 6								Read Byte 21
	Analog Value Channel 6								Read Byte 22
	Not Used								Byte 23
	Reserved for future use								Byte 24
	Analog Value Channel 7								Write Byte 25
	Analog Value Channel 7								Write Byte 26
	Not Used								Byte 27
	Reserved for future use								Byte 28
	Analog Value Channel 8								Write Byte 29
	Analog Value Channel 8								Write Byte 30
	Not Used								Byte 31
	Reserved for future use								Byte 32

(Memory Map table continued on following page.)

NOTE: *Refer to page 4-21, Analog Output Module Control Byte*

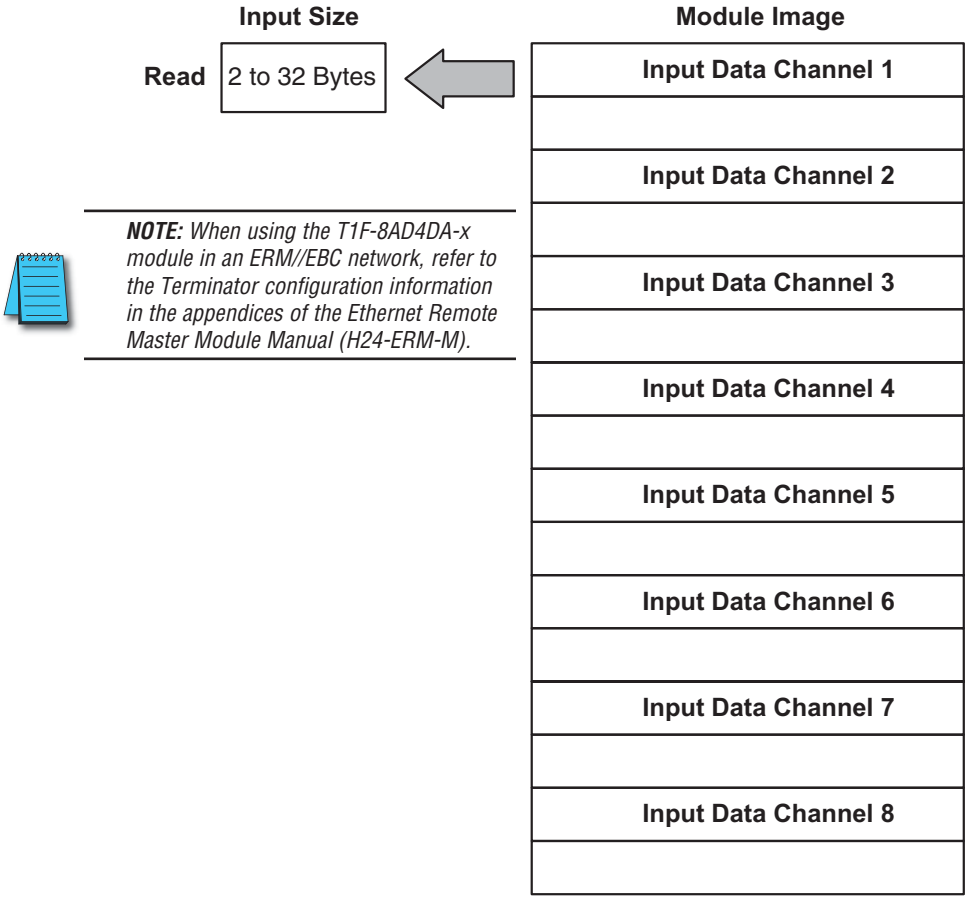
T1F-16DA-x, Analog Output Module Memory Map, cont'd

Memory Map of 16-Channel Analog Output Module									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	Analog Value Channel 9								Write Byte 33
	Analog Value Channel 9								Write Byte 34
	Not Used								Byte 35
	Reserved for future use								Byte 36
	Analog Value Channel 10								Write Byte 37
	Analog Value Channel 10								Write Byte 38
	Not Used								Byte 39
	Reserved for future use								Byte 40
	Analog Value Channel 11								Write Byte 41
	Analog Value Channel 11								Write Byte 42
	Not Used								Byte 43
	Reserved for future use								Byte 44
	Analog Value Channel 12								Write Byte 45
	Analog Value Channel 12								Write Byte 46
	Not Used								Byte 47
	Reserved for future use								Byte 48
	Analog Value Channel 13								Write Byte 49
	Analog Value Channel 13								Write Byte 50
	Not Used								Byte 51
	Reserved for future use								Byte 52
	Analog Value Channel 14								Write Byte 53
	Analog Value Channel 14								Write Byte 54
	Not Used								Byte 55
	Reserved for future use								Byte 56
	Analog Value Channel 15								Write Byte 57
	Analog Value Channel 15								Write Byte 58
	Not Used								Byte 59
	Reserved for future use								Byte 60
	Analog Value Channel 16								Write Byte 61
	Analog Value Channel 16								Write Byte 62
	Not Used								Byte 63
	Reserved for future use								Byte 64

T1F-8AD4DA-x, Analog Output Module Memory Map

8-Channel Analog Input / 4–Channel Analog Output Module (T1F–8AD4DA–x)

Input Image Table Mapping

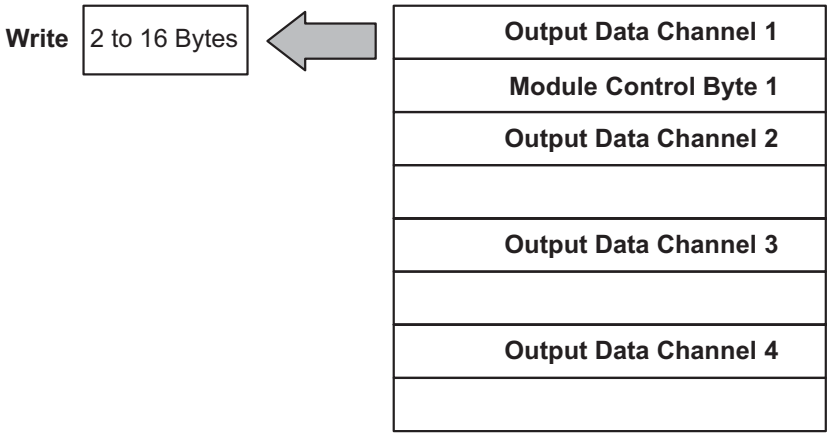


NOTE: *When using the T1F-8AD4DA-x module in an ERM//EBC network, refer to the Terminator configuration information in the appendices of the Ethernet Remote Master Module Manual (H24-ERM-M).*

T1F-8AD4DA-x, Analog Output Module Memory Map, cont'd

8-Channel Analog Input / 4–Channel Analog Output Module (T1F–8AD4DA–x)

Output Image Table Mapping



NOTE: *Refer to page 4-21, Analog Output Module Control Byte*

T1F-8AD4DA-x, Analog Output Module Memory Map, cont'd

Memory Map of 8 Analog Input Channels of the T1F-8AD4DA-x									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	Analog Value Channel 1								Read Byte 1
	Analog Value Channel 1								Read Byte 2
	Not Used								Byte 3
	Reserved for future use								Byte 4
	Analog Value Channel 2								Read Byte 5
	Analog Value Channel 2								Read Byte 6
	Not Used								Byte 7
	Reserved for future use								Byte 8
	Analog Value Channel 3								Read Byte 9
	Analog Value Channel 3								Read Byte 10
	Not Used								Byte 11
	Reserved for future use								Byte 12
	Analog Value Channel 4								Read Byte 13
	Analog Value Channel 4								Read Byte 14
	Not Used								Byte 15
	Reserved for future use								Byte 16
	Analog Value Channel 5								Read Byte 17
	Analog Value Channel 5								Read Byte 18
	Not Used								Byte 19
	Reserved for future use								Byte 20
	Analog Value Channel 6								Read Byte 21
	Analog Value Channel 6								Read Byte 22
	Not Used								Byte 23
	Reserved for future use								Byte 24
	Analog Value Channel 7								Read Byte 25
	Analog Value Channel 7								Read Byte 26
	Not Used								Byte 27
	Reserved for future use								Byte 28
	Analog Value Channel 8								Read Byte 29
	Analog Value Channel 8								Read Byte 30
	Not Used								Byte 31
	Reserved for future use								Byte 32

(Memory Map table continued on following page.)

T1F-8AD4DA-x, Analog Output Module Memory Map, cont'd

Memory Map of the 4-Analog Output Channels of the T1F-8AD4DA-x									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	Analog Value Channel 1								Write Byte 1
	Analog Value Channel 1								Write Byte 2
	Not Used								Byte 3
	Module Control Byte								Write Byte 4
	Analog Value Channel 2								Write Byte 5
	Analog Value Channel 2								Write Byte 6
	Not Used								Byte 7
	Reserved for future use								Byte 8
	Analog Value Channel 3								Write Byte 9
	Analog Value Channel 3								Write Byte 10
	Not Used								Byte 11
	Reserved for future use								Byte 12
	Analog Value Channel 4								Write Byte 13
	Analog Value Channel 4								Write Byte 14
	Not Used								Byte 15
	Reserved for future use								Byte 16

NOTE: *Refer to page 4-21 through 4-24 for Analog Output Module Control Byte configuration.*

Analog Output Module Control Byte

Terminator I/O analog input/output voltage and current combination analog modules require configuring via the module control byte. Analog input modules do not require configuration.

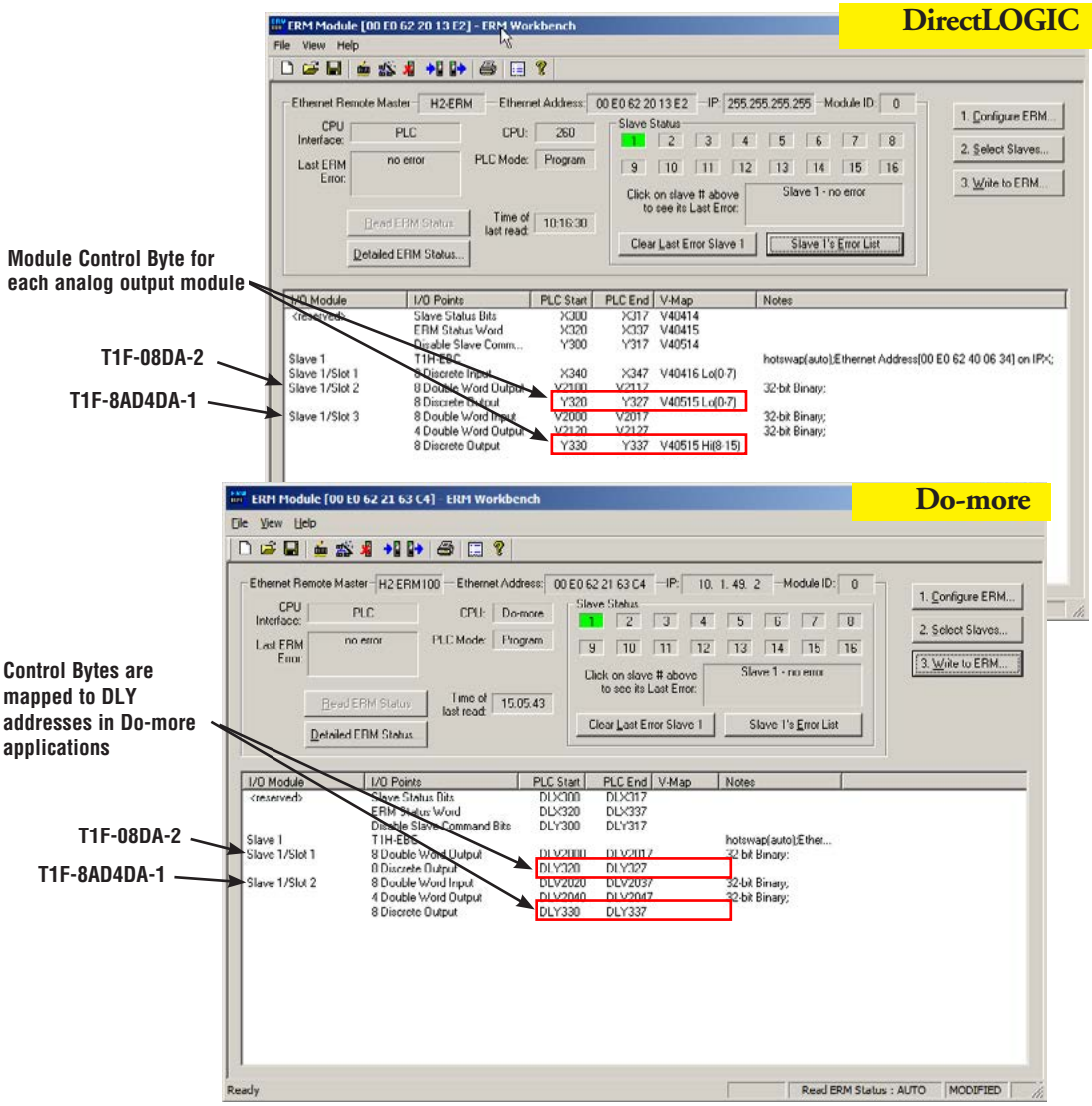
Channel 1 Memory Map of 8 & 16 Channel Analog Output Module									
Decimal Bit	07	06	05	04	03	02	01	00	Size
Octal Bit	07	06	05	04	03	02	01	00	
	Analog Value Channel 1								Write Byte 1
	Analog Value Channel 1								Write Byte 2
	Not Used								Byte 3
	Module Control Byte (See note 1)								Write Byte 4

Module Control Byte of 8 & 16 Channel Analog Output Module									
Decimal Bit	31	30	29	28	27	26	25	24	Read / Write
Octal Bit	37	36	35	34	33	32	31	30	
Bit 24	**Outputs Enable** 0 = All Outputs OFF 1 = All Outputs Enabled								Write
Bit 25	**Unipolar / Bipolar** 0 = Unipolar Selected 1 = Bipolar Selected								Write
Bit 26	**5V / 10V Range** 0 = 5V Range 1 = 10V Range								Write
Bit 27	**0–20 mA / 4–20 mA Range** 0 = 0–20 mA Range 1 = 4–20 mA Range								Write
Bit 28–31	Reserved for system use.								--

NOTE 1: *Module Control Byte is only used when used in an EBC/ERM rack configuration slot. See following pages for Module Control Byte setup.*

NOTE 2: *The 4-20 mA Range cannot be selected at the same time as the Bipolar or 10V Ranges.*

The DirectLOGIC example below shows an ERM network Terminator I/O slave with a discrete input module in slot 1, an analog voltage output module in slot 2 and a combination analog current module in slot 3. Note that the module control bytes are automatically mapped to the "Y" data type registers. The bits within the module control byte are used to enable or disable the analog outputs, select bipolar or unipolar output and select the voltage or current output range. For Do-more applications, the control bits are mapped to DLY addresses, an example is shown below.



The table below defines the bits of an analog module control byte. Example "Y" bit addresses are listed for the analog module control bytes from the ERM network example on the previous page, along with their equivalent Do-more addresses. The module control byte addresses will vary depending on the location of the analog module in the system, the number of slaves, the amount of output modules used in an ERM network and the starting discrete output address that is user specified. ERM Workbench will list the appropriate control byte for any Terminator analog module that requires configuration.

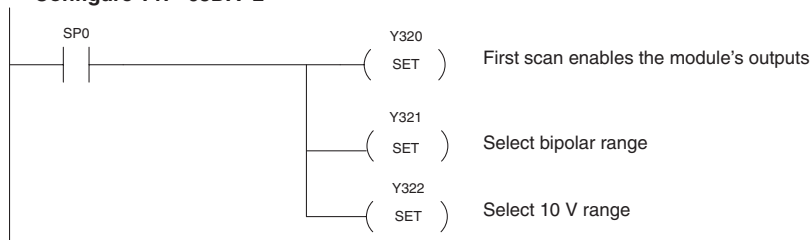
The following ladder logic code examples configure the analog output and combination analog modules used in the previous examples. The T1F–08DA–2 is configured for outputs enabled with 10V bipolar range. The T1F–8AD4DA–1 is configured for outputs enabled with 4–20mA unipolar range. The RST instruction can be used to reset the bits, if necessary.

Module Control Byte of 8 and 16-Channel Analog Output Modules and Analog Combination Modules

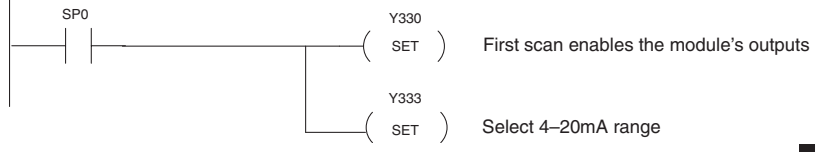
Bit Definitions		Example Bit Addresses for T1F–08DA–2	Example Bit Addresses for T1F–8AD4DA–1
Bit 0	Outputs Enable 0 = All outputs OFF 1 = All outputs Enabled	DL: Y320 Do-more: DLY320	DL: Y330 Do-more: DLY330
Bit 1	Unipolar / Bipolar 0 = Unipolar selected 1 = Bipolar selected	DL: Y321 Do-more: DLY321	DL: Y331 Do-more: DLY331
Bit 2	5V / 10V Range 0 = 5V range 1 = 10V range	DL: Y322 Do-more: DLY322	DL: Y332 Do-more: DLY332
Bit 3	0 – 20mA / 4–20mA Range 0 = 0 – 20mA range 1 = 4 – 20mA range	DL: Y323 Do-more: DLY323	DL: Y333 Do-more: DLY333
Bit 4–7	Reserved for system use	–	–

DirectSOFT

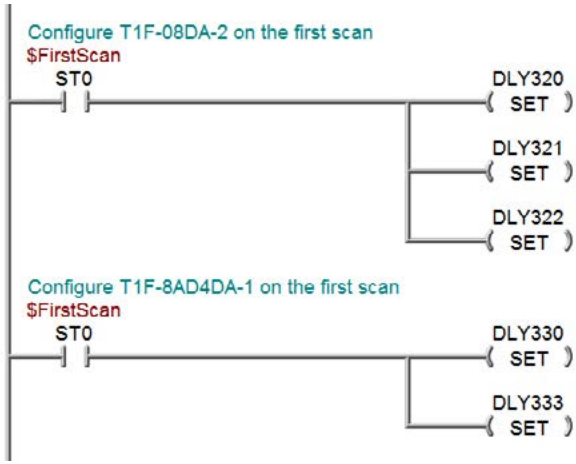
Configure T1F–08DA–2



Configure T1F–8AD4DA–1



Do-more Designer

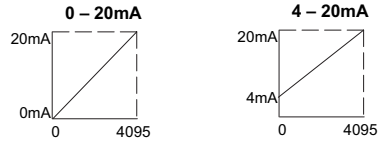


Analog Output Module Resolution

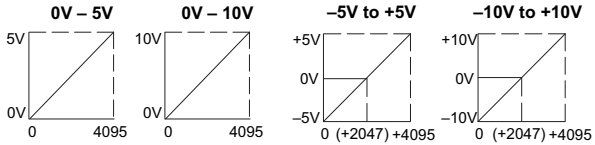
Output Module Resolution

Since the module has 12-bit resolution, the analog signal is converted into 4096 counts ranging from 0–4095 (2^{12}). For example, with a 0 to 10V scale, a 0V signal would be 0, and a 10V signal would be 4095. This is equivalent to a binary value of 0000 0000 0000 to 1111 1111 1111, or 000 to FFF hexadecimal. The following diagram shows how this relates to each signal range.

Current Output Module Resolution



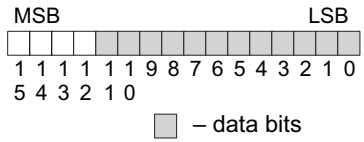
Voltage Output Module Resolution



Channel Data Bits

The first bits represent the analog data in binary format.

Bit	Value	Bit	Value
0	1	6	64
1	2	7	128
2	4	8	256
3	8	9	512
4	16	10	1024
5	32	11	2048



NOTE: *Each analog channel uses 4 bytes. The first and second byte contain the analog data. The third and fourth byte are not used at this time.*

Each count can also be expressed in terms of the signal level by using the equation shown at right. The following table shows the smallest signal level that will result in a change in the data value for each signal range.

$$\text{Smallest Detectable Change} = \frac{H - L}{\text{Resolution}}$$

H = high limit of the signal range

L = low limit of the signal range

Range	Signal Span (H - L)	Divide By	Smallest Detectable Change
±10V	20V	4095	4.88 mV
±5V	10V	4095	2.44 mV
0 to 5V	5V	4095	1.22 mV
0 to 10V	10V	4095	2.44 mV
0 to 20mA	20mA	4095	4.88 μA
4 to 20mA	16mA	4095	3.91 μA

Analog and Digital Value Conversions

Sometimes it is helpful to be able to quickly convert between the signal levels and the digital values. This is especially useful during machine startup or troubleshooting. The following table provides formulas to make this conversion easier.

Range	If you know the digital value…	If you know the analog value…
0 to 5V	A = 5D / 4095	D = 4095 / 5 (A)
0 to 10V	A = 10D / 4095	D = 4095 / 10 (A)
±5V	A = 10D / 4095 -5	D = 4095 / 10 (A + 5)
±10V	A = 20D / 4095 -10	D = 4095 / 20 (A + 10)
0 to 20mA	A = 20D / 4095	D = 4095 / 20 (A)
4 to 20mA	A = 16D / 4095 +4	D = 4095 / 16 (A - 4)

For example, if you are using the -10V to +10V range and you have measured the signal at 6V, you would use this formula to determine the digital value that should be stored in the V-memory location that contains the data.

D = 4095 / 20 (A + 10)

D = 4095 / 20 (6V + 10)

D = (204.75) (16)

D = 3276