USER MANUAL UMAX030341
Version V1.1

12 DIGITAL INPUTS, 3 UNIVERSAL INPUTS, 1 THERMOCOUPLE

With CANopen®

USER MANUAL

P/N: AX030341

Axiomatic Technologies Oy
Höytämöntie 6
33880 LEMPÄÄLÄ, Finland
Tel. +358 103 375 750
salesfinland@axiomatic.com
www.axiomatic.fi

Axiomatic Technologies Corporation
1445 Courtneypark Dr. E.
Mississauga, ON Canada L5T 2E3
Tel. 1 905 602 9270
sales@axiomatic.com
www.axiomatic.com

ACRONYMS

AI	Analog Input
CAN	Controller Area Network
CANopen®	CANopen® is a registered community trademark of CAN in Automation e.V.
CAN-ID	CAN 11-bit Identifier
CJ	Cold Junction
COB	Communication Object
CTRL	Control
DI	Digital Input
EDS	Electronic Data Sheet
EMCY	Emergency
LSB	Least Significant Byte (or Bit)
LSS	Layer Settling Service
LUT	Lookup Table
MSB	Most Significant Byte (or Bit)
NMT	Network Management
RPDO	Received Process Data Object
RW	Read/Write Object
SDO	Service Data Object
TC	Thermocouple
TPDO	Transmitted Process Data Object
WO	Write Only Object

REFERENCES

[DS-301] CiA DS-301 V4.1 – CANopen® Application Layer and Communication Profile. CAN in Automation 2005

[DS-305] CiA DS-305 V2.0 – Layer Setting Service (LSS) and Protocols. CAN in Automation 2006

[DS-401] CiA DS-401 V3.0 – CANopen® profile for generic I/O modules. CAN in Automation 2008

[DS-404] CiA DS-404 V1.2 – CANopen® profile for Measurement Devices and Closed Loop Controllers. CAN in Automation 2002

These documents are available from the CAN in Automation e.V. website http://www.can-cia.org/.

Contents

1. OVERVIEW OF CONTROLLER

1.1. Description of the Controller

This following User Manual describes the architecture and functionality of the 12 Digital Inputs, 3 Analog Inputs and 1 Thermocouple CANopen® controller.

This controller has 12 digital inputs that can read Digital ON/OFF signals. Of which 3 of them can be configured to measure PWM and frequency/RPM as well. It also has 3 fully programmable universal inputs that can be setup to read: voltage, current, PWM, frequency/RPM, resistance or digital ON/OFF. Its flexible circuit design gives the user a wide range of configurable input types. The sophisticated control algorithms allow the user to program the controller for a wide range of applications without the need for custom software. Figure 1 below shows the hardware features.

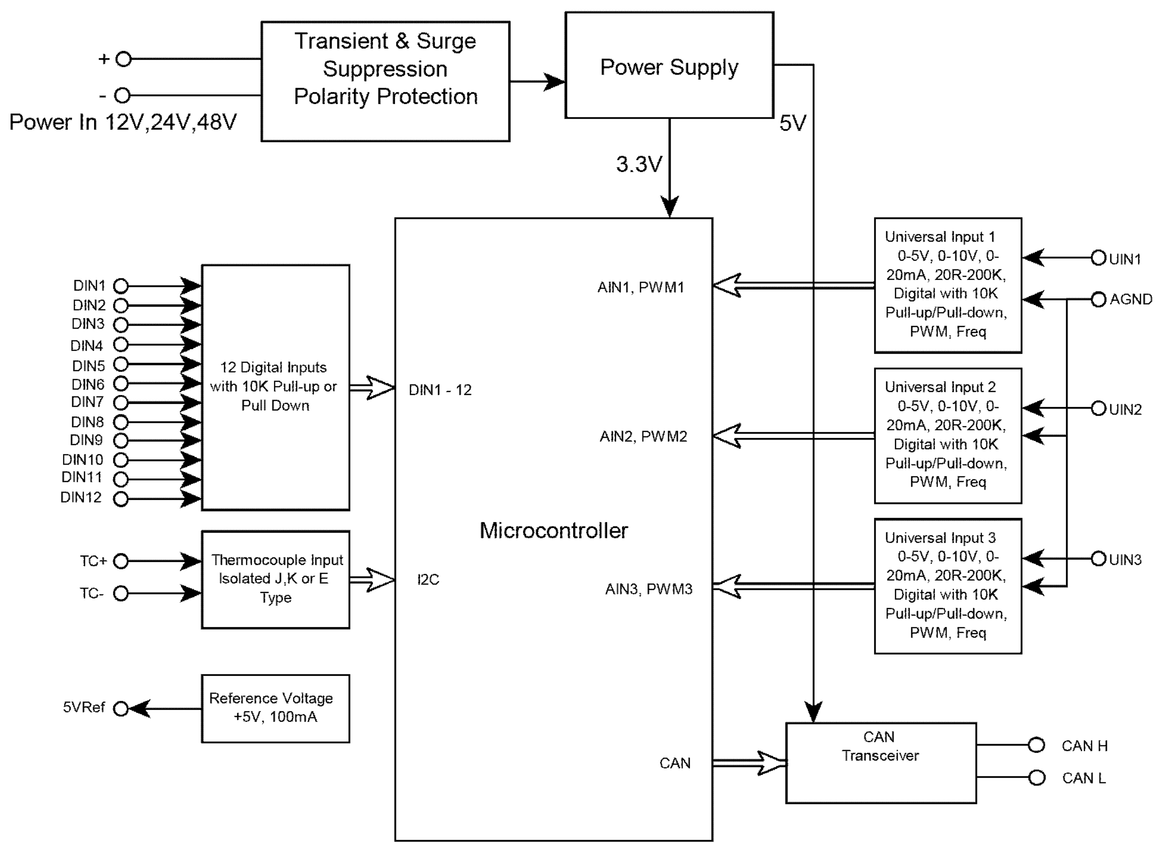


Figure 1 – Hardware Functional Block Diagram

All I/O and logical function blocks on the unit are inherently independent from one another but can be programmed to interact in many ways. They will be described in the following sections. All objects are user configurable using standard commercially available tools that can interact with a CANopen® Object Dictionary via an .EDS file.

1.2. Digital Input Function Block

The digital input (DI) function block is the default logic block associated with the digital inputs and it only becomes applicable on the analog inputs when object 6112h, **AI Operation**, is set to a digital input response, otherwise the objects related to DI function block will not apply.

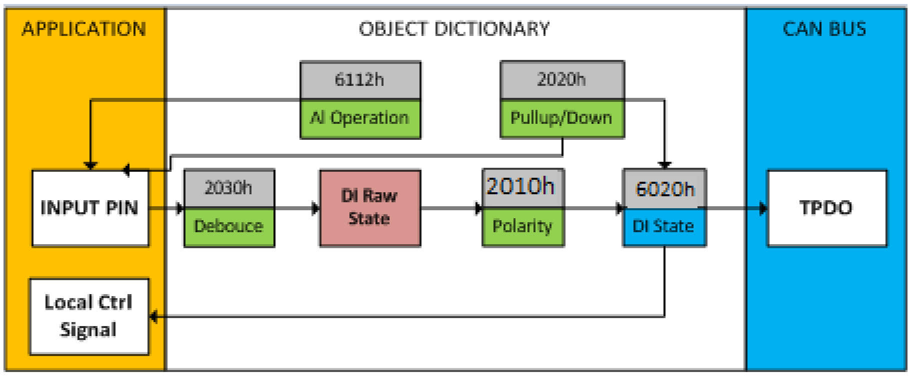


Figure 2 – Digital Input Objects

When 6112h is set to 10 = Digital Input, object 2020h **DI Pullup/Pulldown Mode** will choose between the internal pullup/pulldown resistors. The options for object 2020h are shown in Table 1, with the default bolded.

Value	Meaning
0	10kΩ Pullup Resistor Enabled
1	**10kΩ Pulldown Resistor Enabled**

Table 1 – DI Pullup/Pulldown Options

Figure 3 shows the hysteresis on the input when switching a discrete signal. A digital input can be switched up to +Vcc.

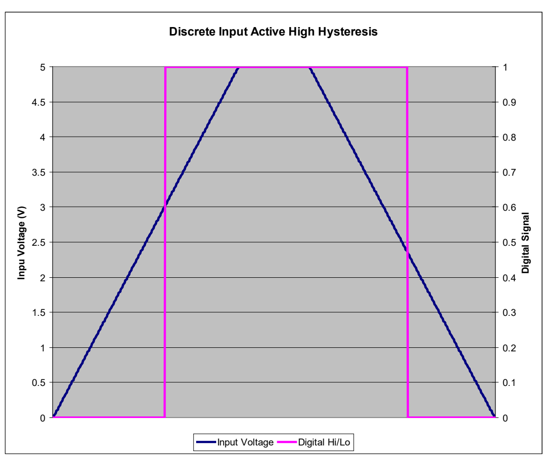


Figure 3 – Discrete Input Hysteresis

Object 2030h **DI Debounce Filter** is applied to the input before the state is read by the processor. The options for object 2030h are shown in Table 2, with the default bolded.

Value	Meaning
0	Filter Disabled
1	Filter 111ns
2	**Filter 1.78 us**
3	Filter 14.22 us

Table 2 – DI Debounce Filter Options

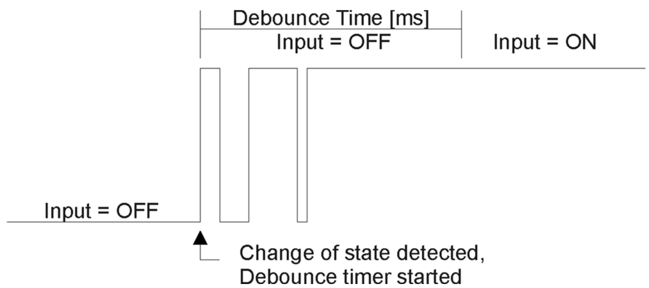


Figure 4 – Digital Input Debouncing

Once the raw state has been evaluated, the logical state of the input is determined by object 2010h **DI Polarity.** The options for object 2010h are shown in Table 3. The 'calculated' state of the DI that will be written to read-only object 6000h **DI Read State 8 Input Lines** will be a combination of active high/low and the polarity selected. By default, normal on/off logic is used.

Value	Meaning	Input Signal	State
0	**Normal On/Off**	HIGH	ON
		LOW or Open	OFF
1	Inverse On/Off	HIGH	OFF
		LOW or Open	ON
2	Latched Logic	HIGH to LOW	No Change
		LOW to HIGH	State Change (i.e. OFF to ON or ON to OFF)

Table 3 – DI Polarity Options versus DI State

The format of object 6000h **DI Read State 8 Input Lines** is as follows:

Sub-index 1 will determine the following inputs' polarities:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	**Bit 2**	**Bit 1**	**Bit 0**
-	-	-	-	-	AI3	AI2	AI1

Sub-index 2 will determine the following inputs' polarities:

Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
DI8	DI7	DI6	DI5	DI4	DI3	DI2	DI1

Sub-index 3 will determine the following inputs' polarities:

Bit 7	Bit 6	Bit 5	Bit 4	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
-	-	-	-	DI12	DI11	DI10	DI9

There is another type of 'digital' input that can be selected when 6112h is set to 20 = Analog On/Off. However, in this case, the input is still configured as an analog input, and therefore the objects from the Analog Input (AI) block are applied instead of those discussed above. (This case applies to all the analog inputs and digital input 5, 7, and 8 which are able to be configured as PWM/Frequency mode) Here, objects 2010h, 2020h and 2030h are ignored, and 6000h is written as per the logic shown in Figure 5. In this case, the MIN parameter is set by object 7120h **AI Scaling 1 FV**, and the MAX is set by 7122h **AI Scaling 2 FV**.

For all other operating modes, the corresponding bit in the object 6000h will always be zero.

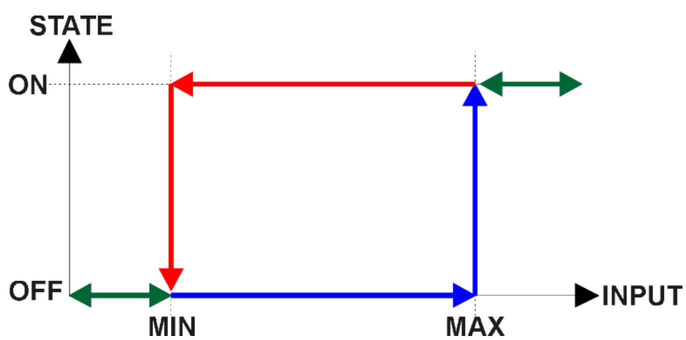


Figure 5 – Analog Input Read as Digital

1.3. Analog Input Function Block

The analog input (AI) function block is the default logic associate with the 3 analog inputs and it will become applicable for Digital Input 5, 7 and 8 when the corresponding sub-indices in object 6112h are set to *1, Normal Operation*.

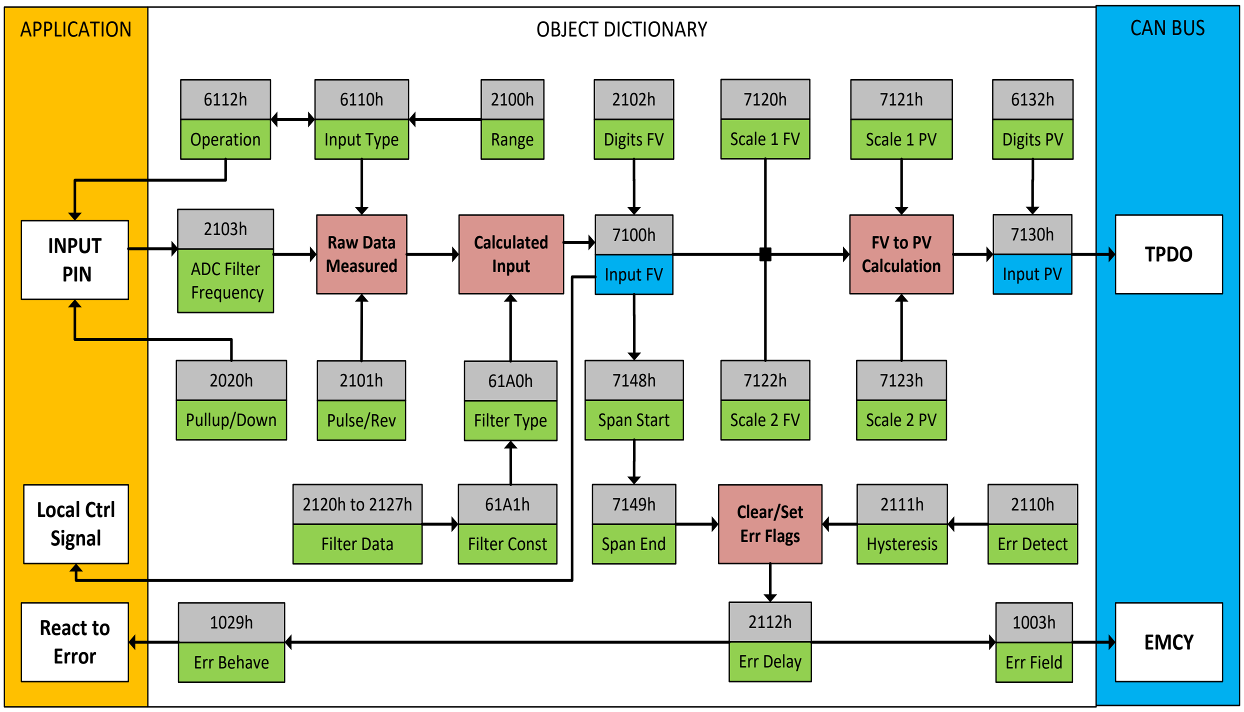


Figure 6 – Analog Input Objects

Object 6112h, **AI Operating Mode** determines whether the AI or DI function block is associated with an input. The options for object 6112h are shown in Table 4. No values other than what are shown here will be accepted. By default, all the analog inputs are set to *1, Normal Operation* and all the digital inputs are set to *10, Digital Input (On/Off)*.

Value	Meaning
0	Channel Off
1	**Normal Operation (analog)**
10	Digital Input (On/Off)
20	Analog On/Off

Table 4 – AI Operating Mode Options

The most important object associate with the AI function block is object 6110h **AI Sensor Type**. By changing this value, and associated with it, the object 2100h **AI Input Range**, other objects will be automatically updated by the controller. The options for object 6110h are shown in Table 5, and no values other than what are shown here will be accepted. (The first 8 options are for thermocouple only and they will not be acceptable value for analog inputs or digital inputs). By default, all analog inputs are set to *40, Voltage Input*. Frequency and PWM types are applicable for Digital Input 5,7 and 8.

Value	Meaning
1	Type J
2	Type K
4	Type N
5	Type R
6	Type S
7	Type T
8	Type B
9	Type E
40	Voltage Input
50	Current Input
60	Frequency Input (or RPM)
10000	PWM Input

Table 5 – AI Sensor Type Options

The allowable ranges will depend on the input sensor type and the input selected. Table 6 shows the relationship between the sensor type, and the associated range options. The default value for each range is bolded, and object 2100h **AI Range** will automatically be updated with this value when 6110h is changed. The grayed-out cells mean that the associate value is not allowed for the range object when that sensor type has been selected.

Value	Voltage	Current	Frequency	PWM
0	**0 to 5V**	**0 to 20mA**	**0.5Hz to 50kHz**	
1	0 to 10V	4 to 20mA		

Table 6 – AI Input Range Options Depending on Sensor Type

Not all objects apply to all input types. For example, object 2103h **AI Filter Frequency for ADC** is only applicable when a voltage or a current type is being measured. In these cases, the ADC will automatically filter as per Table 7, and is set for 50Hz noise rejection by default.

Value	Meaning
0	Input Filter Off
1	**Filter 50Hz**
2	Filter 60Hz
3	Filter 50Hz and 60Hz

Table 7 – ADC Filter Frequency Options

Conversely, frequency and PWM inputs use object 2020h **DI Pullup/Pulldown Mode** (see Table 1) while the other input types set this object to zero. Also, a frequency input can be automatically turned into an RPM measurement instead simply by setting object 2101h **AI Number of Pulses Per Revolution** to a non-zero value. All other input types ignore this object.

Regardless of type, however, all analog inputs can be further filtered once the raw data has been measured (either from ADC or Timer.) Object 61A0h **AI Filter Type** determines what kind of filter is used per Table 8. By default, additional software filtering is disabled.

Value	Meaning
0	**No Filter**
1	Moving Average
2	Repeating Average
3	Third-Order Low Pass

Table 8 – AI Filter Type Options

Object 61A1h **AI Filter Constant** is used with all three types of filters as per the formulas below:

Calculation with no filter:
Value = Input
The data is simply a 'snapshot' of the latest value measured by the ADC or timer.

Calculation with the moving average filter:

$$Value_N = Value_{N-1} + \frac{(Input - Value_{N-1})}{FilterConstant}$$

This filter is called every 1ms. The value FilterConstant stored in object 61A1h is 10 by default.

Calculation with the repeating average filter:

$$Value = \frac{\sum Input_N}{N}$$

At every reading of the input value, it is added to the sum. At every N^{th} read, the sum is divided by N, and the result is the new input value. The value and counter will be set to zero for the next read. The value of N is stored in object 61A1h which is 10 by default. This filter is called every 1ms.

Calculation with the 3rd Order Low Pass filter:

$$Value_N = \frac{[C_{IN0}*Input_N + C_{IN1}*Input_{N-1} + C_{IN2}*Input_{N-2} + C_{IN3}*Input_{N-3} + C_{OUT1}*Value_{N-1} + C_{OUT2}*Value_{N-2} + C_{OUT3}*Value_{N-3}]}{2^{Power}}$$

C_{IN0}	Coefficient for Input(n)		
C_{IN1}	Coefficient for Input(n-1)	C_{OUT1}	Coefficient for Output(n-1)
C_{IN2}	Coefficient for Input(n-2)	C_{OUT2}	Coefficient for Output(n-2)
C_{IN3}	Coefficient for Input(n-3)	C_{OUT3}	Coefficient for Output(n-3)

This filter uses 16-bit fixed point math. Object 2120h **AI Third-Order Filter Power** tells the controller the shift value used when the coefficients were selected.
The value of object 61A1h determines how often the filter is called (in ms) and is set to 10 by default. In between calls, the data of the input signal is the value which was calculated the last time the filter was called. The filter coefficients are stored in objects 2121h to 2127h.

The value from the filter is shifted according to read-only object 2102h **AI Decimal Digits FV** and then written to read-only object 7100h **AI Input Field Value.**

The value of 2102h will depend on the AI Sensor Type and Input Range selected and will be automatically updated per Table 9 when either 6110h or 2100h are changed. All other objects associated with the input field value also apply this object. These objects are 7120h **AI Scaling 1 FV**, 7122h **AI Scaling 2 FV**, 7148h **AI Span Start**, 7149h **AI Span End**, and 2111h **AI Error Clear Hysteresis**. These objects are also automatically updated when the Type or Range is changed.

Sensor Type and Range	**Decimal Digits**
Voltage: All Ranges	3 [mV]
Current: All Ranges	0 [mA]
Frequency: 0.5Hz to 50kHz	0 [Hz]
Frequency: RPM Mode	1 [0.1 RPM]
PWM	1 [0.1 %]
Digital Input	0 [On/Off]

Table 9 – AI Decimal Digits FV Depending on Sensor Type

It is the 7100h **AI Input Field Value** which is used by the application for error detection, and as a control signal for other logic blocks. Object 7100h is mappable to TPDO and is mapped to TPDO1 and TPDO2 by default.

Read-only object 7130h **AI Input Process Value** is also mappable. However, the default values for objects 7121h **AI Scaling 1 PV** and 7123h **AI Scaling 2 PV** are set to equal 7120h and 7122h respectively, while object 6132h **AI Decimal Digits PV** is automatically initialize to equal 2102h. This means that the default relationship between the FV and PV is one-to-one, so object 7130h is not mapped to a TPDO by default.

Should a different linear relationship between what is measured versus what is sent to the CANopen® bus be desired, objects 6132h, 7121h and 7123h can be changed. The linear relationship profile is shown in Figure 7 below. Should a non-linear response be desired, the lookup table function block can be used instead, as described in section 1.5.

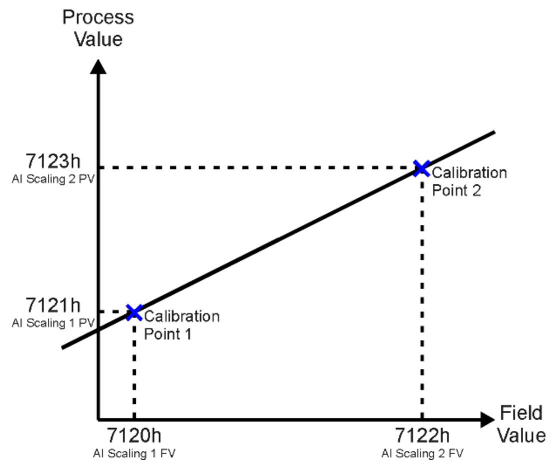


Figure 7 – Analog Input Linear Scaling FV to PV

As stated earlier, the FV scaling objects are automatically updated with the Sensor Type or Range changes. This is because objects 7120h and 7122h are not only used in a linear conversion from FV to PV as described above, but also as the minimum and maximum limits when the input is used to control another logic block. Therefore, the values in these objects are important, even when the 7130h **AI Input Process Value** object is not being used.

The objects 7148h **AI Span Start** and 7149h **AI Span End** are used for fault detection, so they are also automatically updated for sensible values as the Type/Range changes. The object 2111h **AI Error Clear Hysteresis** is also updated, as it too is measured in the same unit as the AI Input FV object.

Table 10 lists the default values that are loaded into objects 7120h, 7122h, 7148h, 7149h, and 2111h for each Sensor Type and Input Range combination. Recall that these objects all have the decimal digits applied to them as outlined in Table 9.

Sensor Type/ Input Range	7148h AI Span Start (i.e. Error Min)	7120h AI Scaling 1 FV (i.e. Input Min)	7122h AI Scaling 2 FV (i.e. Input Max)	7149h AI Span End (i.e. Error Max)	2111h Error Clear Hysteresis
Voltage: 0 to 5V	200 [mV]	500 [mV]	4500 [mV]	4800 [mV]	100 [mV]
Voltage: 0 to 10V	200 [mV]	500 [mV]	9500 [mV]	9800 [mV]	200 [mV]
Current: 0 to 20mA	0 [mA]	0 [mA]	20 [mA]	21 [mA]	0.25 [mA]
Current: 4 to 20mA	3 [mA]	4 [mA]	20 [mA]	21 [mA]	0.25 [mA]
Freq: 0.5Hz to 50kHz	100 [Hz]	150 [Hz]	30000 [Hz]	32000 [Hz]	5 [Hz]
Freq: RPM Mode	500 [0.1RPM]	1000 [0.1RPM]	30000 [0.1RPM]	32000 [0.1RPM]	100 [0.1RPM]
PWM: 0 to 100%	10 [0.1%]	50 [0.1%]	950 [0.1%]	990 [0.1%]	10 [0.1%]
Digital Input	OFF	OFF	ON	ON	0

Table 10 – AI Object Defaults Based on Sensor Type and Input Range

It might not be desired in particular application for the automatic updating of objects when a key object is changed, i.e. AI Sensor Type. In this case, object 5550h **Enable Automatic Updates** can be set to FALSE (true by default) in which case changing an object will have no impact on any other objects. In this mode, the user must manually change all the objects for sensible values, or the controller will not work as expected.

When changing these objects, Table 11 outlines the range constraints placed on each based on its Sensor Type and Input Range combination selected. In all cases, the MAX value is the upper end of the range (i.e. 5V or 10V). Object 7122h cannot be set higher than MAX whereas Object 7149h can be set up to 110% MAX. Object 2111h on the other hand can only be set up to maximum value of 10% of MAX. Table 11 uses the base unit of the input, but recall the limits will also have object 2102h apply to them as per Table 9.

<table>
<tr><th>Sensor Type/
Input Range</th><th>7148h</th><th>7120h</th><th>7122h</th><th>7149h</th><th>2111h</th></tr>
<tr><td>Voltage: 0 to 5V, 0 to 10V
Current: 0 to 20mA
RPM: 0 to 6000RPM
PWM: 0 to 100%</td><td>0 to 7120h</td><td>7148h to 7122h</td><td rowspan="3">7120h to 7149h
If(7149h>MAX)
7120h to MAX</td><td rowspan="3">7122h to 110% of MAX</td><td rowspan="3">10% of MAX</td></tr>
<tr><td>Current: 4 to 20mA</td><td>0 to 7120h</td><td>7148h to 7122h
If(7148h<4mA)
4mA to 7122h</td></tr>
<tr><td>Freq: 0.5Hz to 50kHz</td><td>0.1Hz to 7120h</td><td>7148h to 7122h
If(7148h<0.5Hz)
0.5Hz to 7122h</td></tr>
</table>

Table 11 – AI Object Ranges Based on Sensor Type and Input Range

The last objects associated with the analog input block left to discuss are those associated with fault detection. Should the calculated input (after measuring and filtering) fall outside of the allowable range, as defined by the AI Span Start and AI Span End objects, an error flag will be set in the application if and only if object 2110h **AI Error Detect Enabled** is set to TRUE (1).

When (7100h **AI Input Field Value** < 7148h **AI Span Start**), an “Out of Range Low” flag is set. If the flag stays active for the 2112h **AI Error Reaction Delay** time, an Input Overload Emergency (EMCY) message will be added to object 1003h **Pre-Defined Error Field**. Similarly, when (7100h **AI Input Field Value** > 7149h **AI Span End**), an “Out of Range High” flag is set and will create an EMCY message should it stay active throughout the delay period. In either case, the application will react to the EMCY message as defined by object 1029h **Error Behavior** at the sub-index corresponding to an Input Fault. Refer to section 3.2.4 and 3.2.13 for more information about objects 1003h and 1029h.

Once the fault has been detected, the associate flag will be cleared only once the input comes back into range. Object 2111h **AI Error Clear Hysteresis** is used here so that the error flag will not be set/cleared continuously while the AI Input FV hovers around the AI Span Start/End value.

To clear an “Out of Range Low” flag, AI Input FV >= (AI Span Start + AI Error Clear Hysteresis)
To clear an “Out of Range High” flag, AI Input FV <= (AI Span End - AI Error Clear Hysteresis)
Both flags cannot be active at once. Setting either one of these flags automatically clears the other.

The controller allows for the PV input can be selected from the list of the logical function blocks supported by the controller. As a result, any output from one function block can be selected as the control source for another. Keep in mind that not all options make sense in all cases, but the complete list of control sources is shown in Table 12.

Value	Meaning
0	Control Source Not Used (Ignored)
1	CANopen® Message (RPDO)
2	Analog Input Function Block
3	Digital Input Function Block
4	Cold junction Measured
5	Thermocouple Function Block
6	Constant Function Block
7	Lookup Table Function Block
8	Mathematical Function Block
9	Programmable Logic Function Block
10	Power Supply Measured
11	Processor Temperature Measured

Table 12 – Control Source Options

In addition to a source, each control also has a number which corresponds to the sub-index of the function block in question. Table 13 outlines the ranges supported for the number objects, depending on the source that had been selected.

Control Source	Range	Object (Meaning)
Control Source Not Used	0	Ignored
CANopen® Message (RPDO)	1	2500h sub-index 1 (Extra Received PV 1)
	2	2500h sub-index 2 (Extra Received PV 2)
	3	2500h sub-index 3 (Extra Received PV 3)
	4	2500h sub-index 4 (Extra Received PV 4)
	5	2500h sub-index 5 (Extra Received PV 5)
	6	2500h sub-index 6 (Extra Received PV 6)
	7	2500h sub-index 7 (Extra Received PV 7)
	8	2500h sub-index 8 (Extra Received PV 8)
	9	2500h sub-index 9 (Extra Received PV 9)
	10	2500h sub-index 10 (Extra Received PV 10)
	11	2500h sub-index 11 (Extra Received PV 11)
	12	2500h sub-index 12 (Extra Received PV 12)
Analog Input Function Block	1	*7100h sub-index 1 or 6000h sub-index 1 Bit 0
	2	*7100h sub-index 2 or 6000h sub-index 1 Bit 1
	3	*7100h sub-index 3 or 6000h sub-index 1 Bit 2
Digital Input Function Block	1	6000h sub-index 2 Bit 0
	2	6000h sub-index 2 Bit 1
	3	6000h sub-index 2 Bit 2
	4	6000h sub-index 2 Bit 3
	5	*7100h sub-index 8 or 6000h sub-index 2 Bit 4
	6	6000h sub-index 2 Bit 5
	7	*7100h sub-index 10 or 6000h sub-index 2 Bit 6
	8	*7100h sub-index 11 or 6000h sub-index 2 Bit 7
	9	6000h sub-index 3 Bit 0
	10	6000h sub-index 3 Bit 1
	11	6000h sub-index 3 Bit 2
	12	6000h sub-index 3 Bit 3
** Depending on AI Operation selected, either the AI Input FV or DI Read State will be used*		
Cold Junction Measured	N/A	2161h (Cold Junction Degree Measured)
Thermocouple Function Block	1	6100h sub-index 1
Constant Function Block	1	5010h sub-index 1 (always FALSE)
	2	5010h sub-index 2 (always TRUE)
	3	5010h sub-index 3 (Constant FV 3)
	4	5010h sub-index 4 (Constant FV 4)
	5	5010h sub-index 5 (Constant FV 5)
	6	5010h sub-index 6 (Constant FV 6)
	7	5010h sub-index 7 (Constant FV 7)
	8	5010h sub-index 8 (Constant FV 8)

	9	5010h sub-index 9 (Constant FV 9)
	10	5010h sub-index 10 (Constant FV 10)
	11	5010h sub-index 11 (Constant FV 11)
	12	5010h sub-index 12 (Constant FV 12)
	13	5010h sub-index 13 (Constant FV 13)
	14	5010h sub-index 14 (Constant FV 14)
	15	5010h sub-index 15 (Constant FV 15)
Lookup Table Function Block	1	3018h (Lookup Table 1 Output Y-Axis PV)
	2	3028h (Lookup Table 2 Output Y-Axis PV)
	3	3038h (Lookup Table 3 Output Y-Axis PV)
	4	3048h (Lookup Table 4 Output Y-Axis PV)
	5	3058h (Lookup Table 5 Output Y-Axis PV)
	6	3068h (Lookup Table 6 Output Y-Axis PV)
	7	3078h (Lookup Table 7 Output Y-Axis PV)
	8	3088h (Lookup Table 8 Output Y-Axis PV)
	9	3098h (Lookup Table 9 Output Y-Axis PV)
	10	3108h (Lookup Table 10 Output Y-Axis PV)
	11	3118h (Lookup Table 11 Output Y-Axis PV)
	12	3128h (Lookup Table 12 Output Y-Axis PV)
Mathematical Function Block	1	4030h sub-index 1 (Math Output PV 1)
	2	4030h sub-index 2 (Math Output PV 2)
	3	4030h sub-index 3 (Math Output PV 3)
	4	4030h sub-index 4 (Math Output PV 4)
	5	4030h sub-index 5 (Math Output PV 5)
	6	4030h sub-index 6 (Math Output PV 6)
Programmable Logic Function Block	1	3xy8h (Lookup Table Selected by Logic 1)
	2	3xy8h (Lookup Table Selected by Logic 2)
	3	3xy8h (Lookup Table Selected by Logic 3)
	4	3xy8h (Lookup Table Selected by Logic 4)
***NOTE**: The following options should be considered for diagnostic feedback, and should not be selected as a control source for logic inputs (i.e. lookup table X-Axis)*		
Power Supply Measured	N/A	5020h (Power Supply FV)
Processor Temperature Measured	N/A	5030h (Processor Temperature FV)

Table 13 – Control Number Options Depending on Source Selected

When using any control source as the X-Axis input to a function block, the corresponding scaling limits are defined as per Table 14. It is the responsibility of the user to make sure that the scaling objects for any function block are setup appropriately depending on the source selected for the X-Axis input.

Control Source	Scaling 1	Scaling 2	Dec Digits
CANopen Message – Num 1 to 12	2520h	2522h	2502h
Analog Input Function Block	7120h	7122h	6132h
Digital Input Function Block	7120h	7122h	6132h
Cold Junction Measured	N/A	N/A	1 (fixed)
Thermocouple Function Block	2170h	2171h	1 (fixed)
Constant Function Block	N/A	N/A	N/A (float)
Lookup Table yz Function Block (where yz = 01 to 12)	0 or lowest from 3yz6h(*)	100 or highest from 3yz6h(**)	3yz3h
Mathematical Function	4021h	4023h	4032h
Programmable Logic Function	0%	100%	1 (fixed)
Power Supply Measured	N/A	N/A	1 (fixed)
Processor Temperature Measured	N/A	N/A	1 (fixed)

***(*)** - Whichever value is smaller; **(**)** - Whichever value is larger*

Table 14 – Scaling Limits per Control Source

1.4. Thermocouple Input Function Block

The unit also has a Thermocouple input which supports temperature measurement with various thermocouples types. The TC type can be programmed using the last index in object 6110h **AI Sensor Type** shown in Table 5. By default, *2, Type K* is selected for TC.

A high accuracy digital temperature sensor is placed next to thermocouple connectors to provide cold junction compensation. By default, all temperatures are not compensated for the cold junction temperature, but it is possible to choose to use cold junction compensation, by setting object 2160h **TC CJ Enabled** to *TRUE*. Object 2161h **TC CJ PV** holds the cold junction value in Degree Celsius and 2162h **TC CJ Output FV** holds the cold junction value in mV. Both 2161h and 2162h are mappable to TPDO but only 2161h is mapped to TPDO5 by default. **Cold Junction Feature doesn't apply to Firmware v1.00.**

An analog to-digital converter, with programmable gain, is used to measure the thermocouple input voltage. As the voltage changes, the controller will adjust the gain accordingly to get the best resolution and accuracy of the signal. The raw microvolt reading will be written to object 6130h **TC Input PV**. The controller will process the raw microvolt reading and converts it into a temperature value in degrees Celsius, which is written to read-only mappable object 6100h **TC Input FV**. These objects are mappable to TPDO and they are mapped to TPDO4 by default.

Thermocouple block also has a few objects associated with fault detection. These objects will only be applied when object 2175h **TC Error Detect Enable** is set to *1, TRUE.* It is set to *0, FALSE* by default.

Once an overrange reading is received from the ADC, an open circuit fault is flagged. Other faults that the controller can detect, or error flags, are determined by the values in objects 2170h **TC Low Temperature Warning**, 2171h **TC High Temperature Warning**, 2172h **TC Low Temperature Shutdown** and 2173h **TC High Temperature Shutdown**. When the value in 6100h is not in the range limited by these objects, an out of range flag will be set. Then an EMCY message will be added to object 1003h. The EMCY will be discussed in more detail in Section 3.2,4 and 3.2.13. Once the out of range fault has been detected, the flag will be cleared only once the TC comes back into range. Object 2174h **TC Error Clear Hysteresis** is used for determining how much change in the TC will be considered error clear.

1.5. Lookup Table Function Block

The lookup table (LTyz) function blocks are not used by default, where yz can be 01 to 12.

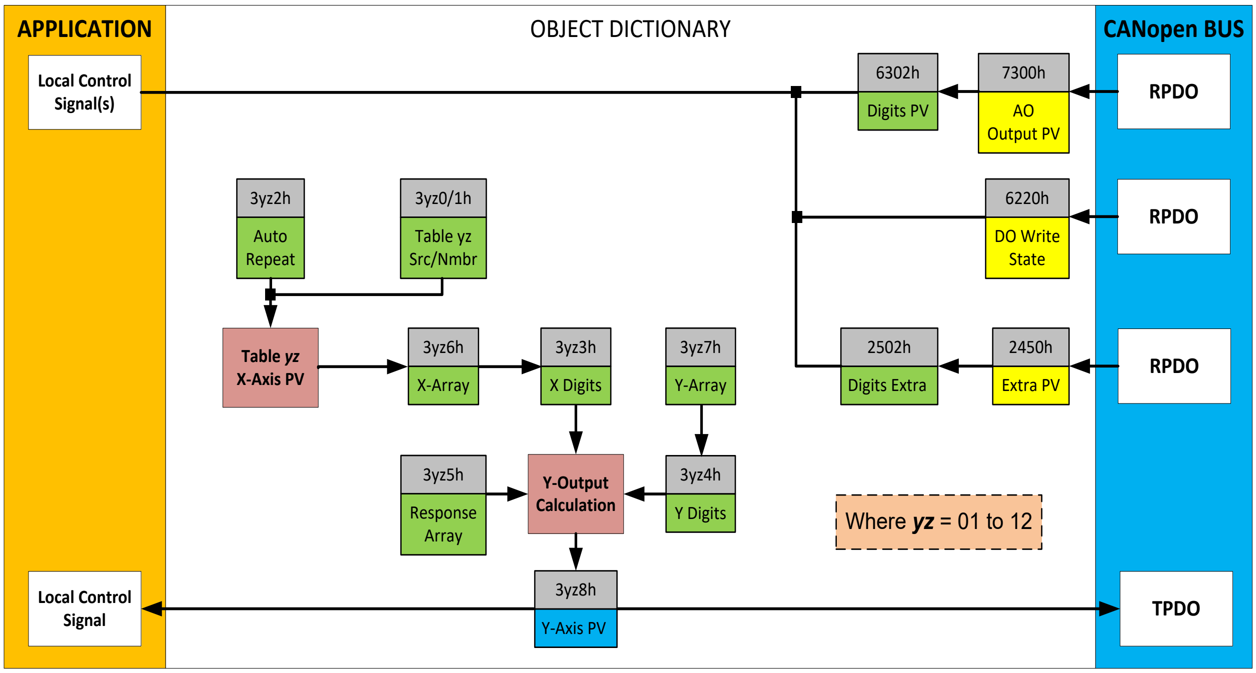


Figure 8 – Lookup Table Objects

Lookup tables are used to give an output response of up to 10 slopes per input. The array size of the objects 3yz5h **LTyz Point Response**, 3yz6h **LTyz Point X-Axis PV** and 3yz7h **Point Y-Axis PV** shown in the block diagram above is therefore 11.

Note: If more than 10 slopes are required, a Programmable Logic Block can be used to combine up to three tables to get 30 slopes, as is described in Section 1.6.

A parameter that will affect the function block is object 3yz5h **LTyz Point Response** sub-index 1 which defines the "**X-Axis Type**". By default, the table have a *'Data Response'* output (0). Alternatively, it can be selected as a *'Time Response'* (1).

There are two (or three) other key parameters that will affect how this function block will behave depending on the "**X-Axis Type**" chosen. If chosen *'Data Response'*, then the objects 3yz0h **Lookup Table yz Input X-Axis Source** and 3yz1h **Lookup Table yz Input X-Axis Number** together define the control source for the function block. When it is changed, the table values in object 3yz6h and 3yz3h **LTyz X-Axis Decimal Digits PV** need to be updated with new defaults based on the X-Axis source selected as described in Tables 9 and 10. If however, the "**X-Axis Type**" is chosen to be *'Time Response'*, an additional parameter is taken into consideration - object 3yz2h, **Lookup Table yz Auto Repeat**. These will be described in more detail in Section 1.5.4.

1.5.1 X-Axis, Input Data Response

In the case where the "**X-Axis Type**" = *'Data Response',* the points on the X-Axis represents the data of the control source.

However, should the minimum input be less than zero, for example a resistive input that is reflecting temperature in the range of -40ºC to 210ºC, then the object 3yz8h **LTyz Point X-Axis PV** sub-index 1 will be set to the minimum instead, in this case -40ºC.

The constraint on the X-Axis data is that the next index value is greater than or equal to the one below it, as shown in the equation below. Therefore, when adjusting the X-Axis data, it is recommended that X_{11} is changed first, then lower indexes in descending order.

$$\text{MinInputRange} <= X_1 <= X_2 <= X_3 <= X_4 <= X_5 <= X_6 <= X_7 <= X_8 <= X_9 <= X_{10} <= X_{11} <= \text{MaxInputRange}$$

As stated earlier, MinInputRange and MaxInputRange will be determined by the scaling objects associated with X-Axis Source that has been selected, as outlined in Table 10.

1.5.2 Y-Axis, Lookup Table Output

By default, it is assumed that the output from the lookup table function block will be a percentage value in the range of 0 to 100.

In fact, so long as all the data in the Y-Axis is 0<=Y[i]<=100 (where i = 1 to 11) then other function blocks using the lookup table as a control source will have 0 and 100 as the Scaling 1 and Scaling 2 values used in linear calculations shown in Table 10.

However, the Y-Axis has no constraints on the data that it represents. This means that inverse, increasing/decreasing or other responses can be easily established. **The Y-Axis does not have to be a percentage output but could represent full scale process values instead.**

In all cases, the controller looks at the **entire range** of the data in the Y-Axis sub-indexes and selects the lowest value as the MinOutRange and the highest value as the MaxOutRange. So long as they are not both within the 0 to 100 range, they are passed directly to other function blocks as the limits on the lookup table output. (i.e. Scaling 1 and Scaling 2 values in linear calculations.)

Even if some of the data points are *'Ignored'* as described in Section 1.5.3, they are still used in the Y-Axis range determination. If not all the data points are going to be used, it is recommended that Y10 be set to the minimum end of the range, and Y11 to the maximum first. This way, the user can get predictable results when using the table to drive another function block.

1.5.3 Point to Point Response

By default, all 12 lookup tables have a simple linear response from 0 to 100 in steps of 10 for both the X and Y axes. For a smooth linear response, each point in the 3yz5h **LTyz Point Response** array is setup for a *'Ramp To'* output.

Alternatively, the user could select a *'Step To'* response for 3yz5h sub-index N, where N = 2 to 11. In this case, any input value between X_{N-1} to X_N will result in an output from the lookup table function block of Y_N. *(Recall: LTyz Point Response sub-index 1 defines the X-Axis type)*

Figure 9 shows the difference between these two response profiles with the default settings.

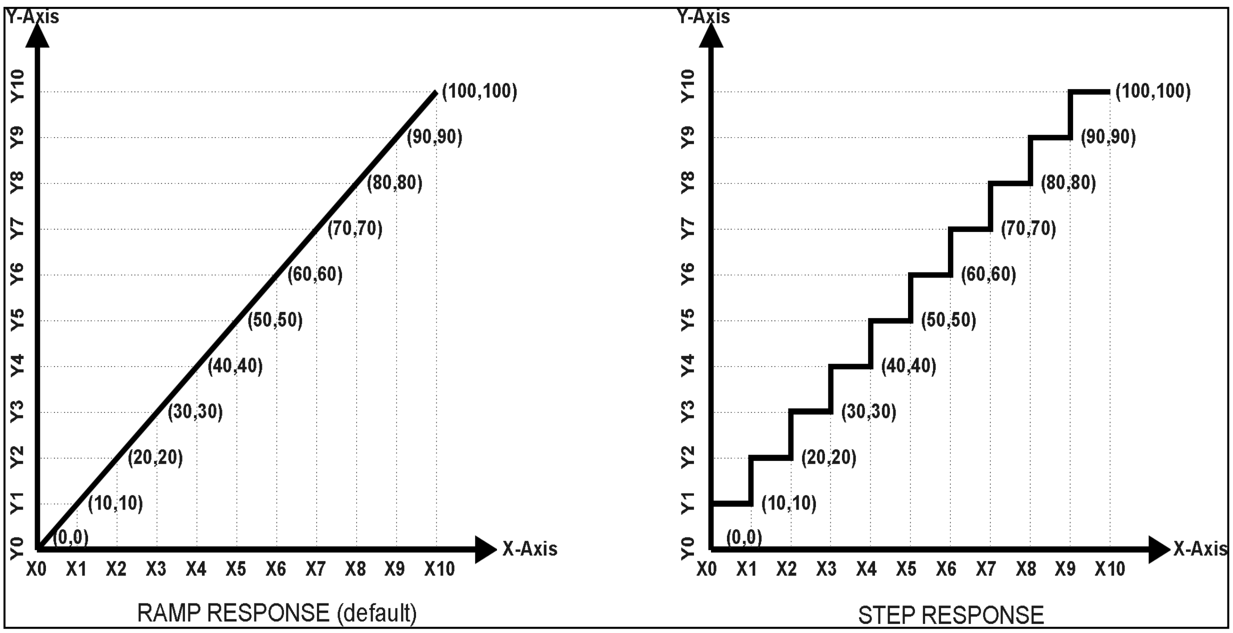


Figure 9 – Lookup Table Defaults with Ramp and Step Responses

Lastly, any point except (1,1) can be selected for an *'Ignore'* response. If object 3yz5h **LTyz Point Response** sub-index N is set to *Ignore*, then all points from (X_N, Y_N) to (X_{11}, Y_{11}) will also be ignored. For all data greater than X_{N-1}, the output from the lookup table function block will be Y_{N-1}.

A combination of *'Ramp To'*, *'Jump To'* and *'Ignore'* responses can be used to create an application specific output profile. An example of where the same input is used as the X-Axis for two tables, but where the output profiles 'mirror' each other for a deadband joystick response is shown in Figure 10. The example shows a dual slope percentage output response for each side of the deadband, but additional slopes can be easily added as needed.

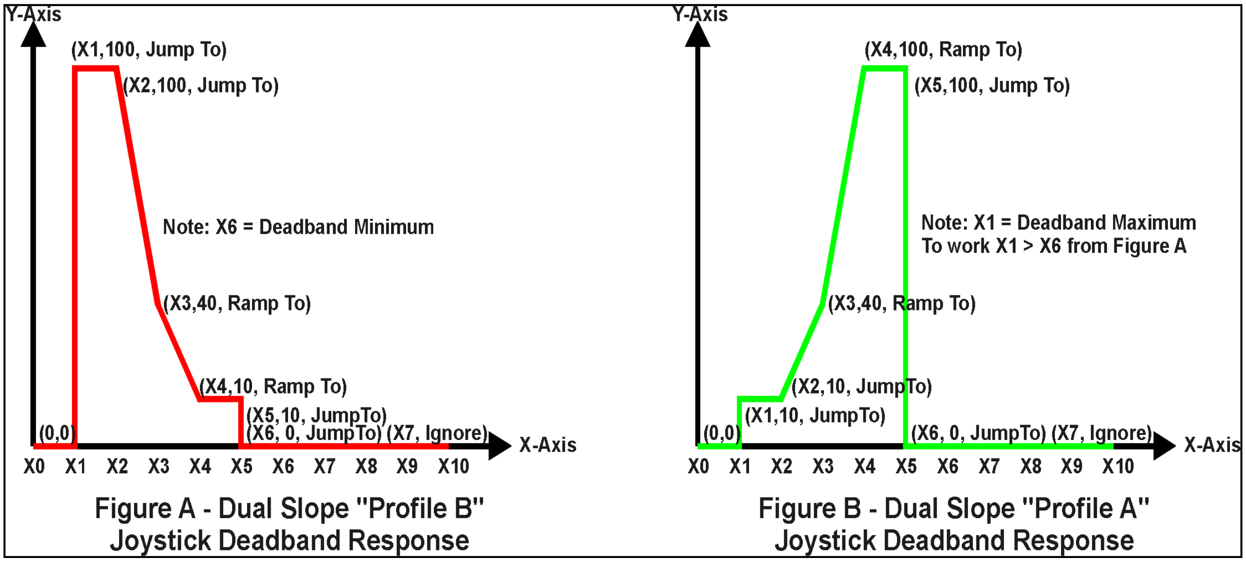


Figure 10 – Lookup Table Examples to Setup for Dual-Slope Joystick Deadband Response

To summarize, Table 15 outlines the different responses that can be selected for object 3yz4h, both for the X-Axis type and for each point in the table.

Sub-Index	Value	Meaning
1	0	Data Response (X-Axis Type)
2 to 11		Ignore (this point and all following it)
1	1	Time Response (X-Axis Type)
2 to 11		Ramp To (this point)
1	2	N/A (not an allowed option)
2 to 11		Jump To (this point)

Table 15 – LTyz Point Response Options

1.5.4 X-Axis, Time Response

As mentioned in Section 1.5.1, a lookup table can also be used to get a custom output response where the "**X-Axis Type**" is a *'Time Response'.* When this is selected, the X-Axis now represents time, in units of milliseconds, while the Y-Axis still represents the output of the function block.

With this response, the sequence will start depending on two parameters:

- **Lookup Table yz Input X-Axis Source** Object 3yz0h and;
- **Lookup Table yz Auto Repeat** Object 3yz2h

By default, the "Auto Repeat" object is set to FALSE (0). In this case, the lookup table will react in the following way:

> The X-Axis control source is treated as a digital input. When the control input is ON, the output will be changed over a period of time based on the profile in the lookup table. Once the profile has finished (i.e. reached index 11, or an 'Ignored' response), the output will remain at the last output at the end of the profile until the control input turns OFF.

However, when the "Auto Repeat" object is set to TRUE (1), the lookup table will react in the following way:

> When the control input is ON, the output will be changed over a period of time based on the profile in the lookup table. Once the profile has finished (i.e. reached index 11, or an 'Ignored' response), the lookup table will revert back to the first point in the table and Auto Repeat the sequence. This will continue for as long as the input remains ON. Once the input turns OFF, the lookup table sequence will stop and the output of the lookup table is zero.

Note: When the control input is OFF, the output is always at zero. When the input comes ON, the profile will **ALWAYS** start at position (X_1, Y_1) which is 0 output for 0ms.

In a time response, the data in object 3yz8h **LTyz Point X-Axis PV** is measured in milliseconds, and object 3yz3h **LTyz X-Axis Decimal Digits PV** is automatically set to 0. A minimum value of 1ms must be selected for all points other than sub-index 1 which is automatically set to [0,0]. The interval time between each point on the X-axis can be set anywhere from 1ms to 24 hours. [86,400,000 ms]

1.6 Programmable Logic Function Block

The programmable logic blocks (LB(x-3)) functions are not used by default.

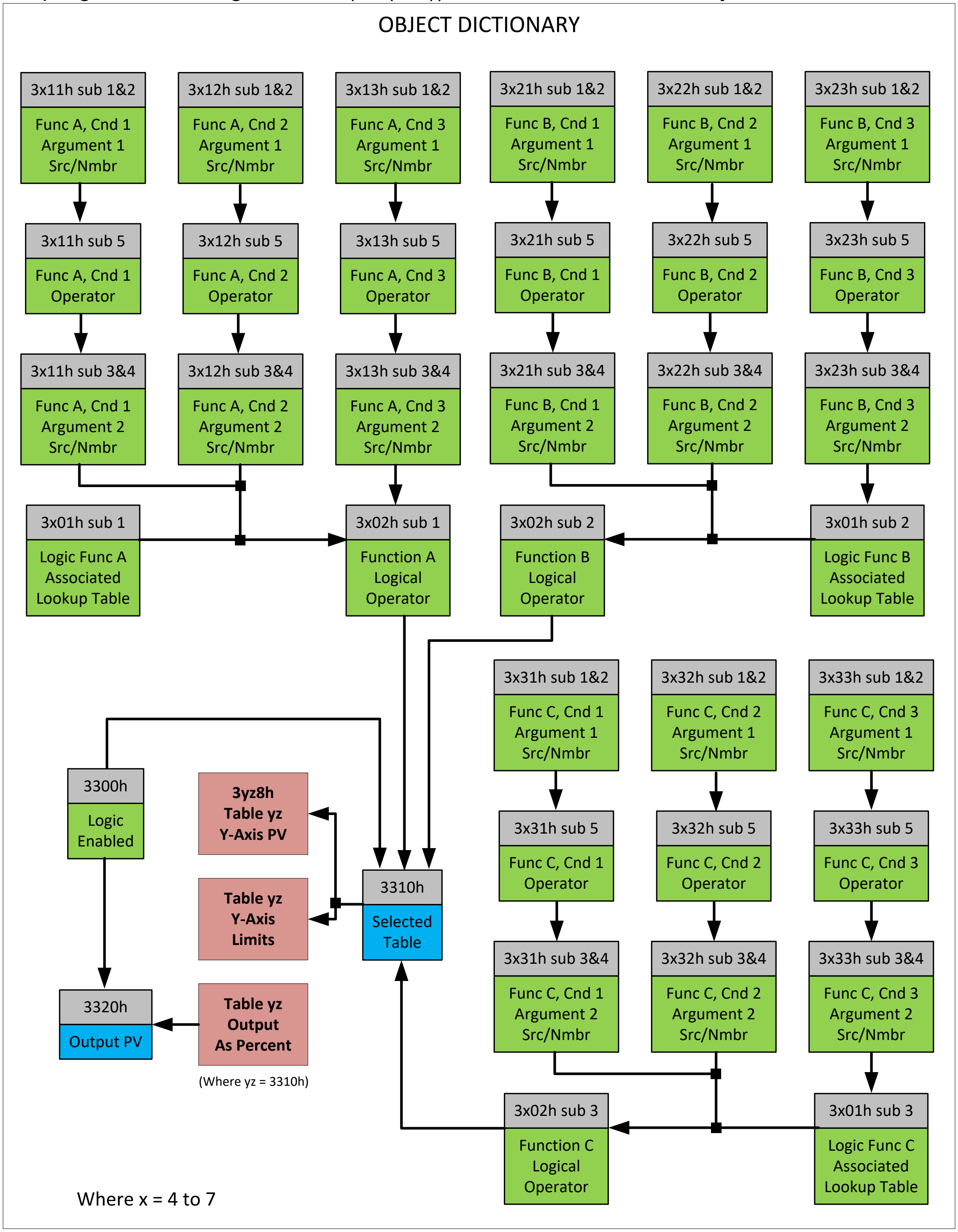


Figure 11 – Logic Block Objects

This function block is obviously the most complicated of them all, but very powerful. Any LB(x-3) (where X= 4 to 7) can be linked with up to three lookup tables, any one of which would be selected only under given conditions. Any three tables (of the available 12) can be associated with the logic, and which ones are used is fully configurable on object 3x01 **LB(x-3) Lookup Table Number**.

Should the conditions be such that a particular table (A, B or C) has been selected as described in Section 1.6.2, then the output from the selected table, at any given time, will be passed directly to LB(x-3)'s corresponding sub-index X in read-only mappable object 3320h **Logic Block Output PV**. The active table number can read from read-only object 3310h **Logic Block Selected Table**.

Note: In this document, the term *LB(x-3)* refers to Logic Blocks 1 to 4. Due to the CANopen® Object indices, Logic Block 1 begins at 3401h, where x, in this case, is 4.

Therefore, an LB(x-3) allows up to three different responses to the same input, or three different responses to different inputs, to become the control for another function block. Here, the "**Control Source**" for the reactive block would be selected to be the *'Programmable Logic Function Block,'* as described in Section 1.3.

In order to enable any one of logic blocks, the corresponding sub-index in object 3300h **Logic Block Enable** must be set to TRUE. They are all disabled by default.

Logic is evaluated in the order shown in Figure 17. Only if a lower indexed table (A, B, C) has not been selected will the conditions for the next table be looked at. **The default table is always selected as soon as it is evaluated. It is therefore required that the default table always be the highest index in any configuration.**

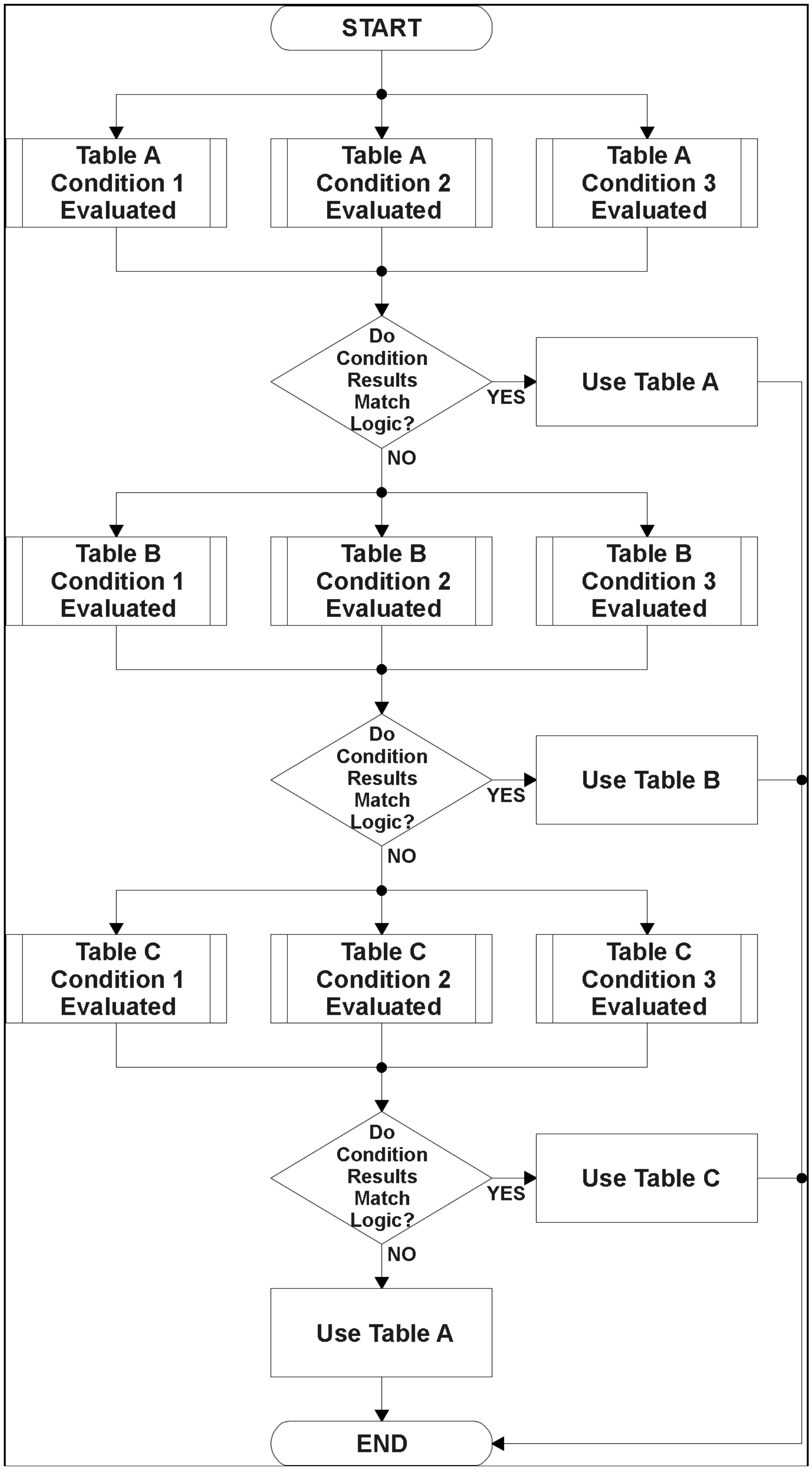


Figure 12 – Logic Block Flowchart

1.6.1 Conditions Evaluation

The first step in determining which table will be selected as the active table is to first evaluate the conditions associated with a given table. Each table has associated with it up to three conditions that can be evaluated. Conditional objects are custom DEFSTRUCT objects defined as shown in Table 16.

Index	Sub-Index	Name	Data Type
3xyz*	0	Highest sub-index supported	UNSIGNED8
	1	Argument 1 Source	UNSIGNED8
	2	Argument 1 Number	UNSIGNED8
	3	Argument 2 Source	UNSIGNED8
	4	Argument 2 Number	UNSIGNED8
	5	Operator	UNSIGNED8

** Logic Block X Function Y Condition Z, where X = 4 to 7, Y = A, B or C, and Z = 1 to 3*

Table 16 – LB(x-3) Condition Structure Definition

Objects 3x11h, 3x12h and 3x13h are the conditions evaluated for selecting Table A.
Objects 3x21h, 3x22h and 3x23h are the conditions evaluated for selecting Table B.
Objects 3x31h, 3x32h and 3x33h are the conditions evaluated for selecting Table C.

Argument 1 is always a logical output from another function block, as listed in Table 12. As always, the input is a combination of the functional block objects 3xyzh sub-index 1 **"Argument 1 Source"** and **"Argument 1 Number."**

Argument 2 on the other hand, could either be another logical output such as with Argument 1, OR a constant value set by the user. To use a constant as the second argument in the operation, set **"Argument 2 Source"** to *'Constant Function Block',* and **"Argument 2 Number"** to the desired sub-index. When defining the constant, make sure it uses the same resolution (decimal digits) as the Argument 1 input.

Argument 1 is evaluated against Argument 2 based on the **"Operator"** selected in sub-index 5 of the condition object. The options for the operator are listed in Table 17, and the default value is always *'Equal'* for all condition objects.

Value	Meaning
0	**=, Equal**
1	!=, Not Equal
2	>, Greater Than
3	>=, Greater Than or Equal
4	<, Less Than
5	<=, Less Than or Equal

Table 17 – LB(x-3) Condition Operator Options

By default, both arguments are set to *'Control Source Not Used'* which disables the condition, and automatically results in a value of N/A as the result. Although it is generally considered that each condition will be evaluated as either TRUE or FALSE, the reality is that there could be four possible results, as described in Table 18.

Value	Meaning	Reason
0	False	(Argument 1) Operator (Argument 2) = False
1	True	(Argument 1) Operator (Argument 2) = True
2	Error	Argument 1 or 2 output was reported as being in an error state
3	Not Applicable	Argument 1 or 2 is not available (i.e. set to *'Control Source Not Used'*)

Table 18 – LB(x-3) Condition Evaluation Results

1.6.2 Table Selection

In order to determine if a particular table will be selected, logical operations are performed on the results of the conditions as determined by the logic in Section 1.6.1. There are several logical combinations that can be selected, as listed in Table 19. The default value for object 3x02h **LB(x-3) Function Logical Operator** is dependent on the sub-index. For sub-index 1 (Table A) and 2 (Table B), the *'Cnd1 And Cnd2 And Cnd3'* operator is used, whereas sub-index 3 (Table C) is setup as the *'Default Table''* response.

Value	Meaning
0	Default Table
1	Cnd1 And Cnd2 And Cnd3
2	Cnd1 Or Cnd2 Or Cnd3
3	(Cnd1 And Cnd2) Or Cnd3
4	(Cnd1 Or Cnd2) And Cnd3

Table 19 – LB(x-3) Function Logical Operator Options

Not every evaluation is going to need all three conditions. For example, check if the Engine RPM is below a certain value only has one condition listed. Therefore, it is important to understand how the logical operators would evaluate an Error or N/A result for a condition, as outlined in Table 20.

Logical Operator	Select Conditions Criteria
Default Table	Associated table is automatically selected as soon as it is evaluated.
Cnd1 And Cnd2 And Cnd3	**Should be used when two or three conditions are relevant, and all must be True to select the table.** If any condition equals False or Error, the table is not selected. An N/A is treated like a True. If all three conditions are True (or N/A), the table is selected. If((Cnd1==True) &&(Cnd2==True)&&(Cnd3==True)) Then Use Table
Cnd1 Or Cnd2 Or Cnd3	**Should be used when only one condition is relevant. Can also be used with two or three relevant conditions.** If any condition is evaluated as True, the table is selected. Error or N/A results are treated as False If((Cnd1==True) || (Cnd2==True) || (Cnd3==True)) Then Use Table
(Cnd1 And Cnd2) Or Cnd3	**To be used only when all three conditions are relevant.** If both Condition 1 and Condition 2 are True, OR Condition 3 is True, the table is selected. Error or N/A results are treated as False If(((Cnd1==True)&&(Cnd2==True)) || (Cnd3==True)) Then Use Table
(Cnd1 Or Cnd2) And Cnd3	**To be used only when all three conditions are relevant.** If Condition 1 And Condition 3 are True, OR Condition 2 And Condition 3 are True, the table is selected. Error or N/A results are treated as False If(((Cnd1==True)||(Cnd2==True)) && (Cnd3==True)) Then Use Table

Table 20 – LB(x-3) Conditions Evaluation Based on Selected Logical Operator

If the result of the function logic is TRUE, then the associated lookup table (see object 3x01h) is immediately selected as the source for the logic output. No further conditions for other tables are evaluated. For this reason, the *'Default Table'* should always be setup as the highest letter table being used (A, B or C) If no default response has been setup, the Table A automatically becomes the default when no conditions are true for any table to be selected. This scenario should be avoided whenever possible so as to not result in unpredictable output responses.

The table number that has been selected as the output source is written to sub-index X of read-only object 3310h **Logic Block Selected Table.** This will change as different conditions result in different tables being used.

1.6.3 Logic Block Output

Recall that Table Y, where Y = A, B or C in the LB(x-3) function block does NOT mean lookup table 1 to 3. Each table has object 3x01h LB(x-3) **Lookup Table Number** which allows the user to select which lookup tables they want associated with a particular logic block. The default tables associated with each logic block are listed in Table 21.

Programmable Logic Block Number	Table A – Lookup Table Block Number	Table B – Lookup Table Block Number	Table C – Lookup Table Block Number
1	1	2	3
2	4	5	6
3	7	8	9
4	10	11	12

Table 21 – LB(x-3) Default Lookup Tables

If the associated Lookup Table YZ (where YZ equals 3310h sub-index X) does not have an **"X-Axis Source"** selected, then the output of LB(x-3) will always be "Not Available" so long as that table is selected. However, should LTyz be configured for a valid response to an input, be it Data or Time, the output of the LTyz function block (i.e. the Y-Axis data that has been selected based on the X-Axis value) will become the output of the LB(x-3) function block so long as that table is selected.

The LB(x-3) output is always setup as a percentage, based on the range of the Y-Axis for the associated table (see Section 1.6.2) It is written to sub-index X of read-only object 3320h **Logic Block Output PV** with a resolution of 1 decimal place.

1.7 Math Function Block

There are six mathematic function blocks that allow the user to define basic algorithms. Math function block y = 1 to 6 will be enabled based on sub-index y in object 4000h **Math Enable**.

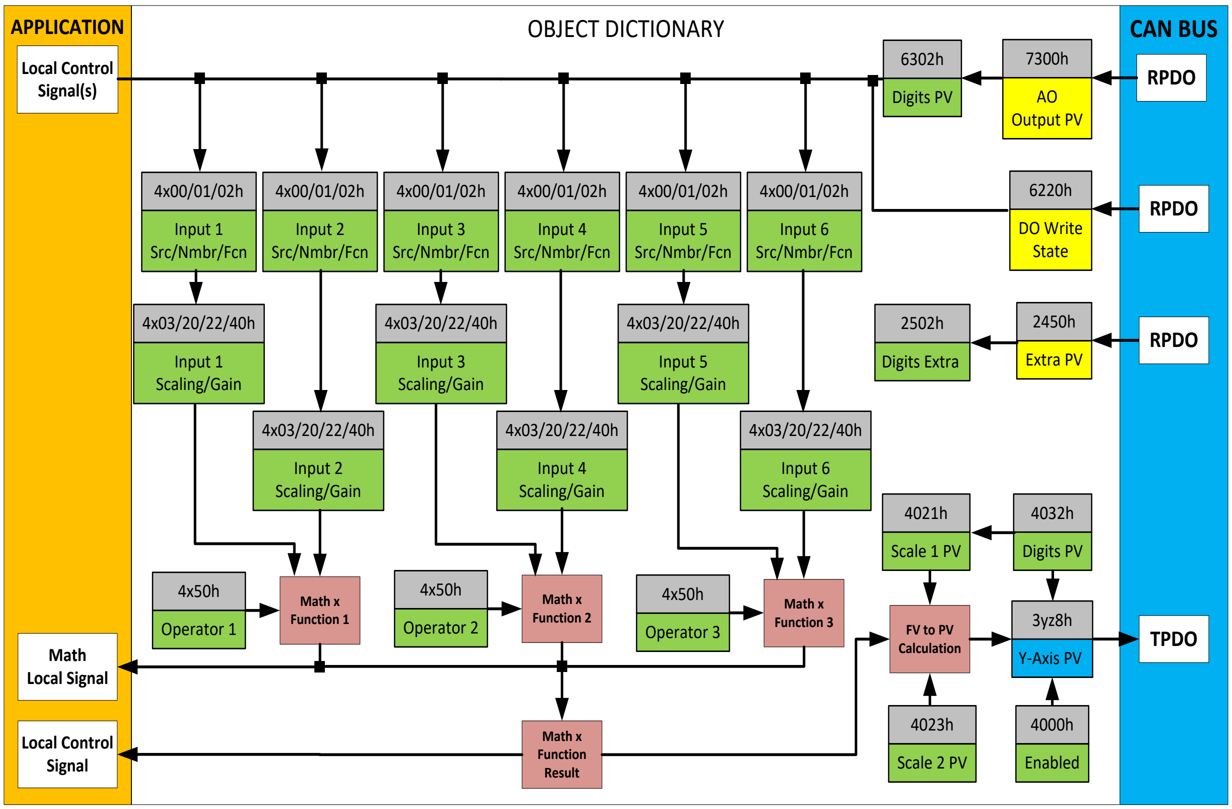


Figure 13 – Math Function Block Objects

A math function block can take up to six input signals, as listed in Table 12 in Section 1.3. Each input is then scaled according the associated scaling and gain objects. A "Math Input X" is determined by the corresponding sub-index X = 1 to 6 of the objects 4y00h **Math Y Input Source** and 4y01h **Math Y Input Number.** Here, y = 1 to 6; corresponding the Math 1- Math 6.

Inputs are converted into a percentage value based on objects 4y20h **Math Y Scaling 1 FV** and 4y22h **Math Y Scaling 2 FV**. Before being used in the calculation, these objects apply the resolution shift defined by object 4y03h **Math Y Decimal Digits FV**. As with any other function block using a control source for the X-Axis in a conversion, the scaling objects should be selected to match the values in the control's corresponding objects as per Table 14.

For additional flexibility, the user can also adjust object 4y40h **Math Y Input Gain.** This object has a fixed decimal digit resolution of 2, and a range of -100 to 100. By default, each input has a gain of 1.0.

For example, in the case where the user may want to combine two inputs such that a joystick (Input 1) is the primary control of an output, but the speed can be incremented or decremented based on a potentiometer (Input 2), it may be desired that 75% of the scale is controlled by the joystick position, while the potentiometer can increase or decrease the min/max output by up to 25%. In this case, Input 1 would have a gain of 0.75, while Input 2 uses 0.25. The resulting addition will give a command from 0 to 100% based on the combined positions of both inputs.

For each input pair, the appropriate arithmetic or logical operation is performed on the two inputs, InA and InB, according the associated function in sub-index of InB in object 4y50h **Math Y Operator**. The list of selectable function operations is defined in Table 22.

0	=	True when InA Equals InB
1	!=	True when InA Not Equal InB
2	>	True when InA Greater Than InB
3	>=	True when InA Greater Than or Equal InB
4	<	True when InA Less Than InB
5	<=	True when InA Less Than or Equal InB
6	OR	True when InA or InB is True
7	NOR	True when InA and InB are False
8	AND	True when InA and InB are True
9	NAND	True when InA and InB are not both True
10	XOR	True when InA/InB is True, but not both
11	XNOR	True when InA and InB are both True or False
12	+	Result = InA plus InB
13	-	Result = InA minus InB
14	x	Result = InA times InB
15	/	Result = InA divided by InB
16	MIN	Result = Smallest of InA and InB
17	MAX	Result = Largest of InA and InB

Table 22 – Object 4y50h Math Function Operators

For Function 1, InA and InB are Math Inputs 1 and 2, respectively.
For Function 2, InA and InB are Math Inputs 3 and 4, respectively.
For Function 3, InA and InB are Math Inputs 5 and 6, respectively.

Exclusively **within** a Math Block, there is a third control parameter: Object 4y02h, **Math Y Function Number.** This parameter allows for the result of any Function (1, 2 or 3) to be the input to any **Math Input Y** within the same Math Block. Therefore, **Math Y Input Source** must be a Math Block and **Math Y Input Number** must be the same number as being configured. When these four parameters match, if **Math Y Function Number** is set to 1, 2, or 3, the respective input will be the result of the Function selected. By default, **Math Y Function Number** is set to 0 – in which case this parameter is ignored and uses the Math Block output result. These functions can only be used **within** the Math Block. They can not be used for other Math Blocks or logic blocks.

This allows for more versatility within the Math Block. For a valid result in each Function, both inputs must be non-zero value (other than *'Control Source Not Used'*). Otherwise, the corresponding Function is ignored. Furthermore, for a valid/expected output result in each Math Block, it is necessary to keep in mind how the Functions link to one another within the Math Block. As an example, consider all 6 inputs to be CANopen® Messages 1 to 6 (thus using all 3 Functions). Since all 3 functions are used but Function 3 has no relation to Function 1 or 2, the result of the Math Block will be the result of Function 3, thus, ignoring Functions 1 and 2.

For logical operators (6 to 11), any SCALED input greater than or equal to 0.5 is treated as a TRUE input. For logic output operators (0 to 11), the result of the calculation for the function will always be 0 (FALSE) or 1 (TRUE).

Error data (i.e. input measured out of range) is always treated as a 0.0 input into the function.

For the arithmetic functions (12 to 17), it is recommended to scale the data such that the resulting operation will not exceed full scale (0 to 100%) and saturate the output result.

When dividing, a zero InB value will always result is a zero output value for the associated function. When subtracting, a negative result will always be treated as a zero, unless the function is multiplied by a negative one, or the inputs are scaled with a negative coefficient first.

The resulting final mathematical output calculation is in the appropriate physical units using object 4021h **Math Output Scaling 1 PV** and 4023h **Math Output Scaling 2 PV**. These objects are also considered the Min and Max values of the Math Block output and apply the resolution shift defined by object 4032h **Math Output Decimal Digits PV**. The result is written to read-only object 4030h **Math Output PV**. These scaling objects should also be taken into account when the Math Function is selected as the input source for another function block, as outlined in Table 14.

1.8 Miscellaneous Function Block

There are some other objects available which have not yet been discussed or mentioned briefly in passing (i.e. constants.) These objects are not necessarily associated with one another but are all discussed here.

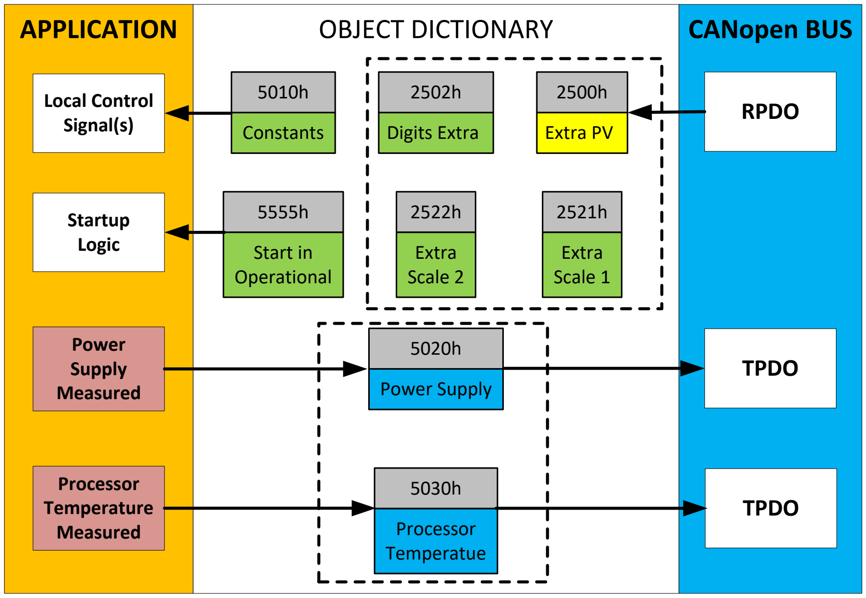


Figure 14 – Miscellaneous Objects

Extra RPDO Messages

Objects 2500h **Extra Control Received PV**, 2502h **EC Decimal Digits PV**, 2502h **EC Scaling 1 PV** and 2522h **EC Scaling 2 PV** have been mentioned in Section 1.3, Table 14. These objects allow for additional data received on a CANopen® RPDO to be mapped independently to various function blocks as a control source. The scaling objects are provided to define the limits of the data when it is used by another function block, as shown in Table 14.

Constant Values

Object 5010h **Constant Field Value** is provided to give the user the option for a fixed value that can be used by other function blocks. Sub-index 1 is fixed as FALSE (0) and sub-index 2 is always TRUE (1). There are 13 other sub-indexes provided for user selectable values.

The constants are read as 32-bit real (float) data, so no decimal digit object is provided. When setting up the constant, make sure to do it with the resolution of the object that will be compared with it.

The False/True constants are provided primarily to be used with the logic block. The variable constants are also useful with the logic or math blocks.

Automatic Update of Objects

Object 5550h **Enable Automatic Updates** allows for the controller to automatically update the objects related to the output to defaults when it is changed. By default, this object is set to TRUE, in which case the objects are set to their default values depending on the type selected.

On the other hand, when this object is FALSE, the objects are not set to defaults and are left with the same values previous to changing the type. In this case, these are to be configured manually.

Startup

The last object 5555h **Start in Operational** is provided as a ‘cheat’ when the unit is not intended to work with a CANopen® network (i.e. a stand-alone control), or is working on a network comprised solely as slaves so the OPERATION command will never be received from a master. By default, this object is disabled (FALSE).

When using the unit as a stand-alone controller where 5555h is set to TRUE, it is recommended to disable all TPDOs (set the Event Timer to zero) so that it does not run with a continuous CAN error when not connected to a bus.

2 INSTALLING INSTRUCTIONS

2.1 Dimensions and Pinout

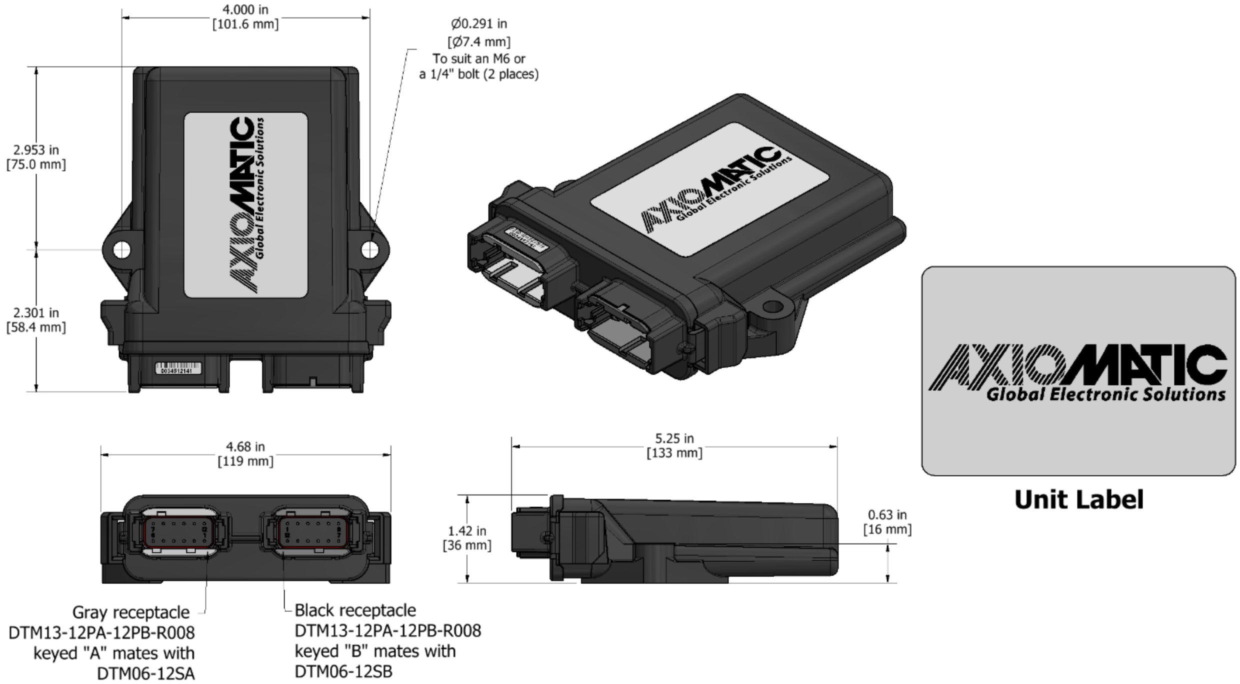


Figure 15 – Housing Dimensions

Grey Connector		Black Connector	
1	Digital Input 10	1	CAN_H
2	Digital Input 9	2	CAN_L
3	Digital Input 8	3	Universal Input 1
4	Digital Input 7	4	Universal Input 2
5	Digital Input 6	5	Universal Input 3
6	Power+	6	+5V Reference
7	Power -	7	Universal Input GND
8	Digital Input 5	8	TC_Input -
9	Digital Input 4	9	TC_Input +
10	Digital Input 3	10	Input GND
11	Digital Input 2	11	Digital Input 11
12	Digital Input 1	12	Digital Input 12

Table 23 – Connector Pinout

2.2 Installation Instructions

NOTES & WARNINGS

- Do not install near high-voltage or high-current devices.
- Note the operating temperature range. All field wiring must be suitable for that temperature range.
- Install the unit with appropriate space available for servicing and for adequate wire harness access (15 cm) and strain relief (30 cm).
- Do not connect or disconnect the unit while the circuit is live, unless the area is known to be non-hazardous.

MOUNTING

Mounting holes sized for ¼ inch or M6 bolts. The bolt length will be determined by the end-user's mounting plate thickness. The mounting flange of the controller is 0.63 inches (16 mm) thick. If the module is mounted without an enclosure, it should be mounted vertically with connectors facing left and right to reduce likelihood of moisture entry. The CAN wiring is considered intrinsically safe. The power wires are not considered intrinsically safe and so in hazardous locations, they need to be located in conduit or conduit trays at all times. The module must be mounted in an enclosure in hazardous locations for this purpose.

All field wiring should be suitable for the operating temperature range.

Install the unit with appropriate space available for servicing and for adequate wire harness access (6 inches or 15 cm) and strain relief (12 inches or 30 cm).

NETWORK TERMINATION

It is necessary to terminate the network with external termination resistors. The resistors are 120 Ohm, 0.25W minimum, metal film or similar type. They should be placed between CAN_H and CAN_L terminals at both ends of the network.

3 CANOPEN® OBJECT DICTIONARY

The CANopen® object dictionary of the controller is based on CiA device profile DS-404 V1.2 (device profile for Closed Loop Controllers). The object dictionary includes Communication Objects beyond the minimum requirements in the profile, as well as several manufacturer-specific objects for extended functionality.

3.1 NODE ID and BAUDRATE

By default, the controller ships factory programmed with a Node ID = 127 (0x7F) and with Baudrate = 125 kbps.

3.1.1 LSS Protocol to Update

The only means by which the Node-ID and Baudrate can be changed is to use Layer Settling Services (LSS) and protocols as defined by CANopen® standard DS-305.

Follow the steps below to configure either variable using LSS protocol. If required, please refer to the standard for more detailed information about how to use the protocol.

3.1.1.1 Setting Node-ID

- Set the module state to LSS-configuration by **sending** the following message:

Item	***Value***
COB-ID	0x7E5
Length	2
Data 0	0x04 (cs=4 for switch state global)
Data 1	0x01 (switches to configuration state)

- Set the Node-ID by **sending** the following message:

Item	***Value***
COB-ID	0x7E5
Length	2
Data 0	0x11 (cs=17 for configure node-id)
Data 1	Node-ID (set new Node-ID as a hexadecimal number)

- The module will send the following response (any other response is a failure).

Item	***Value***
COB-ID	0x7E4
Length	3
Data 0	0x11 (cs=17 for configure node-id)
Data 1	0x00
Data 2	0x00

- Save the configuration by **sending** the following message:

Item	***Value***
COB-ID	0x7E5
Length	1
Data 0	0x17 (cs=23 for store configuration)

- The module will send the following response (any other response is a failure):

Item	***Value***
COB-ID	0x7E4
Length	3
Data 0	0x17 (cs=23 for store configuration)
Data 1	0x00
Data 2	0x00

- Set the module state to LSS-operation by **sending** the following message:
(Note, the module will reset itself back to the pre-operational state)

Item	***Value***
COB-ID	0x7E5
Length	2
Data 0	0x04 (cs=4 for switch state global)
Data 1	0x00 (switches to waiting state)

3.1.1.2 Setting Baudrate

- Set the module state to LSS-configuration by **sending** the following message:

Item	***Value***
COB-ID	0x7E5
Length	2
Data 0	0x04 (cs=4 for switch state global)
Data 1	0x01 (switches to configuration state)

* Set the baudrate by **sending** the following message:

Item	***Value***
COB-ID	0x7E5
Length	3
Data 0	0x13 (cs=19 for configure bit timing parameters)
Data 1	0x00 (switches to waiting state)
Data 2	Index (select baudrate index per Table 24)

Index	***Bit Rate***
0	1 Mbit/s
1	800 kbit/s
2	500 kbit/s
3	250 kbit/s
4	125 kbit/s (default)
5	reserved (100 kbit/s)
6	50 kbit/s
7	20 kbit/s
8	10 kbit/s

Table 24 – LSS Baudrate Indices

* The module will send the following response (any other response is a failure):

Item	***Value***
COB-ID	0x7E4
Length	3
Data 0	0x13 (cs=19 for configure bit timing parameters)
Data 1	0x00
Data 2	0x00

* Activate bit timing parameters by **sending** the following message:

Item	***Value***
COB-ID	0x7E5
Length	3
Data 0	0x15 (cs=19 for activate bit timing parameters)
Data 1	<delay_lsb>
Data 2	<delay_msb>

The delay individually defines the duration of the two periods of time to wait until the bit timing parameters switch is done (first period) and before transmitting any CAN message with the new bit timing parameters after performing the switch (second period). The time unit of switch delay is 1 ms.

- Save the configuration by **sending** the following message (on the NEW baudrate):

Item	***Value***
COB-ID	0x7E5
Length	1
Data 0	0x17 (cs=23 for store configuration)

- The module will send the following response (any other response is a failure):

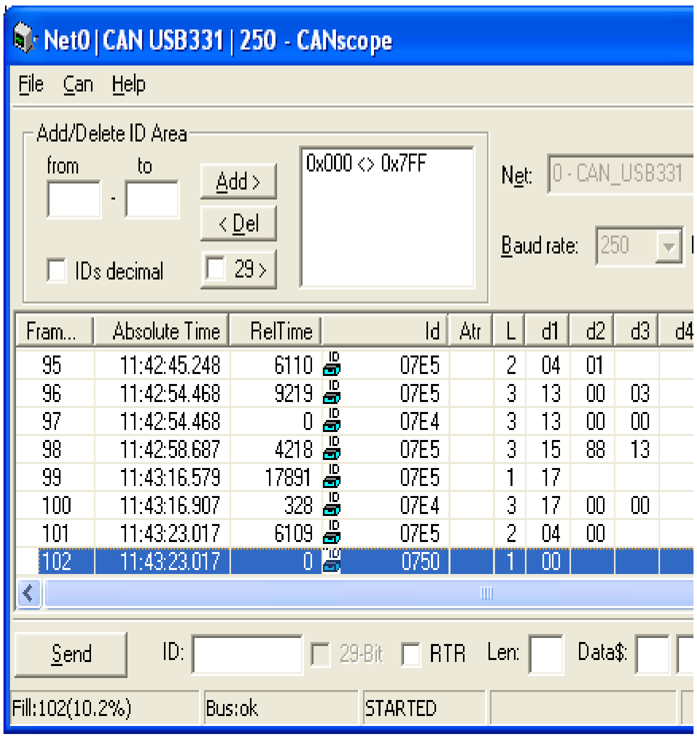
Item	***Value***
COB-ID	0x7E4
Length	3
Data 0	0x17 (cs=23 for store configuration)
Data 1	0x00
Data 2	0x00

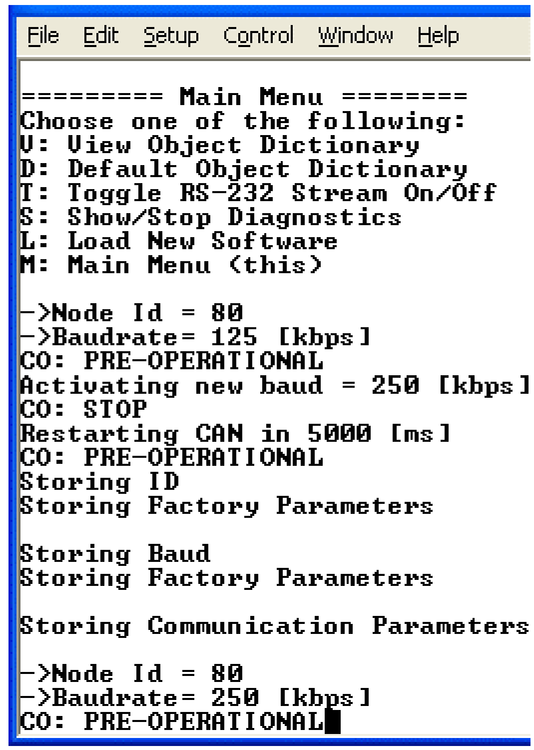
- Set the module state to LSS-operation by **sending** the following message:
  (Note, the module will reset itself back to the pre-operational state)

Item	***Value***
COB-ID	0x7E5
Length	2
Data 0	0x04 (cs=4 for switch state global)
Data 1	0x00 (switches to waiting state)

The following screen capture (left) shows the CAN data was sent (7E5h) and received (7E4h) by the tool when the baudrate was changed to 250 kbps using the LSS protocol. The other image (right) shows what was printed on an example debug RS-232 menu while the operation took place.

Between CAN Frame 98 and 99, the baudrate on the CAN Scope tool was changed from 125 to 250 kbps.





3.2 COMMUNICATION OBJECTS (DS-301 and DS-404)

The communication objects supported by this controller are listed in the following table. A more detailed description of some of the objects is given in the following subchapters. Only those objects that have device-profile specific information are described. For more information on the other objects, refer to the generic CANopen® protocol specification DS-301.

Index (hex)	***Object***	***Object Type***	***Data Type***	***Access***	***PDO Mapping***
1000	Device Type	VAR	UNSIGNED32	RO	No
1001	Error Register	VAR	UNSIGNED8	RO	No
1002	Manufacturer Status Register	VAR	UNSIGNED32	RO	No
1003	Pre-Defined Error Field	ARRAY	UNSIGNED32	RO	No
100C	Guard Time	VAR	UNSIGNED16	RW	No
100D	Life Time Factor	VAR	UNSIGNED8	RW	No
1010	Store Parameters	ARRAY	UNSIGNED32	RW	No
1011	Restore Default Parameters	ARRAY	UNSIGNED32	RW	No
1016	Consumer Heartbeat Time	ARRAY	UNSIGNED32	RW	No
1017	Producer Heartbeat Time	VAR	UNSIGNED16	RW	No
1018	Identity Object	RECORD		RO	No
1020	Verify Configuration	ARRAY	UNSIGNED32	RO	No
1029	Error Behaviour	ARRAY	UNSIGNED8	RW	No
1400	RPDO1 Communication Parameter	RECORD		RW	No
1401	RPDO2 Communication Parameter	RECORD		RW	No
1402	RPDO3 Communication Parameter	RECORD		RW	No
1403	RPDO4 Communication Parameter	RECORD		RW	No
1600	RPDO1 Mapping Parameter	RECORD		RO	No
1601	RPDO2 Mapping Parameter	RECORD		RO	No
1602	RPDO3 Mapping Parameter	RECORD		RO	No
1603	RPDO4 Mapping Parameter	RECORD		RO	No
1800	TPDO1Communication Parameter	RECORD		RW	No
1801	TPDO2 Communication Parameter	RECORD		RW	No
1802	TPDO3 Communication Parameter	RECORD		RW	No
1803	TPDO4 Communication Parameter	RECORD		RW	No
1804	TPDO5 Communication Parameter	RECORD		RW	No
1805	TPDO6 Communication Parameter	RECORD		RW	No
1A00	TPDO1 Mapping Parameter	RECORD		RW	No

1A01	TPDO2 Mapping Parameter	RECORD		RW	No
1A02	TPDO3 Mapping Parameter	RECORD		RW	No
1A03	TPDO4 Mapping Parameter	RECORD		RW	No
1A04	TPDO5 Mapping Parameter	RECORD		RW	No
1A05	TPDO6 Mapping Parameter	RECORD		RW	No

3.2.1 Object 1000h: Device Type

This object contains information about the device type as per device profile DS-404. The 32-bit parameter is divided into two 16-bit values, showing General and Additional information as shown below.

MSB	LSB
Additional Information = 0xE013	**General Information** = 0x0194 (404)

DS-404 defines the Additional Information field in the following manner:
0000h = reserved
0001h = digital input block
0002h = analog input block
0004h = digital output block
0008h = analog output block
0020h = alarm block
0040h … 0800h = reserved
1000h = reserved
2000h = lookup table block (manufacturer-specific)
4000h = programmable logic block (manufacturer-specific)
8000h = miscellaneous block (manufacturer-specific)

Object Description

Index	1000h
Name	Device Type
Object Type	VAR
Data Type	UNSIGNED32

Entry Description

Access	RO
PDO Mapping	No
Value Range	0xE0130194
Default Value	0xE0130194

3.2.2 Object 1001h: Error Register

This object is an error register for the device. Any time there is an error detected by the controller, the Generic Error Bit (bit 0) is set. Only if there is no error in the module, this bit will be cleared. No other bits in this register are used by the controller.

Object Description

Index	1001h
Name	Error Register
Object Type	VAR
Data Type	UNSIGNED8

Entry Description

Access	RO
PDO Mapping	No
Value Range	00h or 01h
Default Value	0

3.2.3 Object 1002h: Manufacturer Status Register

This object is used for manufacturer debug purposes.

3.2.4 Object 1003h: Pre-Defined Error Field

This object provides an error history by listing the errors in the order that they have occurred. An error is added to the top of the list when it occurs and is immediately removed when the error condition has been cleared. The latest error is always at sub-index 1, with sub-index 0 containing the number of errors currently in the list. When the device is in an error-free state, the value of sub-index 0 is zero.

The error list may be cleared by writing a zero to sub-index 0, which will clear all errors from the list, regardless of whether or not they are still present. Clearing the list does NOT mean that the module will return to the error-free behavior state if at least one error is still active.

The controller has a limitation of a maximum of 4 errors in the list. If the device registers more errors, the list will be truncated, and the oldest entries will be lost.

The error codes stored in the list are 32-bit unsigned numbers, consisting of two 16-bit fields. The lower 16-bit field is the EMCY error code, and the higher 16-bit field is a manufacturer-specific code. The manufacturer-specific code is divided into two 8-bit fields, with the higher byte indicating the error description, and the lower byte indicating the channel on which the error occurred.

MSB LSB

Error Description	**Channel-ID**	**EMCY Error Code**

If node-guarding is used (not recommended per the latest standard) and a lifeguard event occurs, the manufacturer-specific field will be set to 0x1000. On the other hand, if a heartbeat consumer fails to be received within the expected timeframe, the Error Description will be set to 0x80 and the Channel-ID (nn) will reflect the Node-ID of the consumer channel that was not producing. In this case, the manufacturer-specific field will therefore be 0x80nn. In both cases, the corresponding EMCY Error Code will be the Guard Error 0x8130.

When an analog input/thermocouple is not working as described in the previous sections, then the Error Description will reflect what channel(s) is at fault using the following table. Also, if an RPDO is not received within the expected "Event Timer" period, an RPDO timeout will be flagged. Table 25 outlines the resulting Error Field Codes and their meanings.

Error Field Code	Error Description	Meaning	ID	Meaning	EMCY Code	Meaning
00000000h	EMCY Error Reset (fault no longer active)					
2001F001h	20h	Positive Overload (Out of Range High)	01h	Analog Input 1	F001h	Analog Input Overload
4001F001h	40h	Negative Overload (Out of Range Low)	01h	Analog Input 1	F001h	Analog Input Overload
2002F001h	20h	Positive Overload	02h	Analog Input 2	F001h	Analog Input Overload
4002F001h	40h	Negative Overload	02h	Analog Input 2	F001h	Analog Input Overload
2003F001h	20h	Positive Overload	03h	Analog Input 3	F001h	Analog Input Overload
4003F001h	40h	Negative Overload	03h	Analog Input 3	F001h	Analog Input Overload
2001F002h	20h	Positive Overload	01h	Digital Input 1	F002h	Digital Input Overload
4001F002h	40h	Negative Overload	01h	Digital Input 1	F002h	Digital Input Overload
2002F002h	20h	Positive Overload	02h	Digital Input 2	F002h	Digital Input Overload
4002F002h	40h	Negative Overload	02h	Digital Input 2	F002h	Digital Input Overload
2003F002h	20h	Positive Overload	03h	Digital Input 3	F002h	Digital Input Overload
4003F002h	40h	Negative Overload	03h	Digital Input 3	F002h	Digital Input Overload
2004F002h	20h	Positive Overload	04h	Digital Input 4	F002h	Digital Input Overload
4004F002h	40h	Negative Overload	04h	Digital Input 4	F002h	Digital Input Overload
2005F002h	20h	Positive Overload	05h	Digital Input 5	F002h	Digital Input Overload
4005F002h	40h	Negative Overload	05h	Digital Input 5	F002h	Digital Input Overload
2006F002h	20h	Positive Overload	06h	Digital Input 6	F002h	Digital Input Overload
4006F002h	40h	Negative Overload	06h	Digital Input 6	F002h	Digital Input Overload
2007F002h	20h	Positive Overload	07h	Digital Input 7	F002h	Digital Input Overload
4007F002h	40h	Negative Overload	07h	Digital Input 7	F002h	Digital Input Overload
2008F002h	20h	Positive Overload	08h	Digital Input 8	F002h	Digital Input Overload
4008F002h	40h	Negative Overload	08h	Digital Input 8	F002h	Digital Input Overload

2009F002h	20h	Positive Overload	09h	Digital Input 9	F002h	Digital Input Overload
4009F002h	40h	Negative Overload	09h	Digital Input 9	F002h	Digital Input Overload
200AF002h	20h	Positive Overload	0Ah	Digital Input 10	F002h	Digital Input Overload
400AF002h	40h	Negative Overload	0Ah	Digital Input 10	F002h	Digital Input Overload
200BF002h	20h	Positive Overload	0Bh	Digital Input 11	F002h	Digital Input Overload
400BF002h	40h	Negative Overload	0Bh	Digital Input 11	F002h	Digital Input Overload
200CF002h	20h	Positive Overload	0Ch	Digital Input 12	F002h	Digital Input Overload
400CF002h	40h	Negative Overload	0Ch	Digital Input 12	F002h	Digital Input Overload
1001F010h	10h	Open Circuit on Thermocouple	01h	Thermocouple 1	F010h	Sensor Break
0101F011h	01h	Negative Warning (Out of Range Low)	01h	Thermocouple 1	F011h	Thermocouple Overload
0201F011h	02h	Positive Warning (Out of Range High)	01h	Thermocouple 1	F011h	Thermocouple Overload
0401F011h	04h	Negative Shutdown (Out of Range Low)	01h	Thermocouple 1	F011h	Thermocouple Overload
0801F011h	08h	Positive Shutdown (Out of Range High)	01h	Thermocouple 1	F011h	Thermocouple Overload
20004000h	20h	Positive Overload (Over Temp)	00h	Unspecified	4000h	Device Temperature
00008100h	00h	RPDO Timeout	00h	Unspecified	8100h	Communication - generic
10008130h	10h	Lifeguard Event	00h	Unspecified	8130h	Lifeguard/Heartbeat Error
80nn8130h	80h	Heartbeat Timeout	nn	Node-ID	8130h	Lifeguard/Heartbeat Error
00008140h	00h	Bus OFF Event	00h	Unspecified	8400h	Bus OFF Recovery

Table 25 – Pre-Defined Error Field Codes

Object Description

Index	1003h
Name	Pre-Defined Error Field
Object Type	ARRAY
Data Type	UNSIGNED32

Entry Description

Sub-Index	0h
Description	Number of entries
Access	RW
PDO Mapping	No
Value Range	0 to 5
Default Value	0

Sub-Index	1h to 5h
Description	Standard error field
Access	RO
PDO Mapping	No
Value Range	UNSIGNED32
Default Value	0

3.2.5 Object 100Ch: Guard Time

The objects at index 100Ch and 100Dh shall indicate the configured guard time respective to the life time factor. The life time factor multiplied with the guard time gives the life time for the life guarding protocol described in DS-301. The Guard Time value shall be given in multiples of ms, and a value of 0000h shall disable the life guarding.

It should be noted that this object, and that of 100Dh are only supported for backwards compatibility. The standard recommends that newer networks do not use the life guarding protocol, but rather heartbeat monitoring instead. Both life guarding and heartbeats can NOT be active simultaneously.

Object Description

Index	100Ch
Name	Guard Time
Object Type	VAR
Data Type	UNSIGNED16

Entry Description

Sub-Index	0h
Access	RW
PDO Mapping	No
Value Range	0 to 65535
Default Value	0

3.2.6 Object 100Dh: Life Time Factor

The life time factor multiplied with the guard time gives the life time for the life guarding protocol. A value of 00h shall disable life guarding.

Object Description

Index	100Dh
Name	Life Time Factor
Object Type	VAR
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Access	RW
PDO Mapping	No
Value Range	0 to 255
Default Value	0

3.2.7 Object 1010h: Store Parameters

This object supports the saving of parameters in non-volatile memory. In order to avoid storage of parameters by mistake, storage is only executed when a specific signature is written to the appropriate sub-index. The signature is “save”. The “save” action on either CAN buses will apply to the parameters on both buses.

The signature is a 32-bit unsigned number, composed of the ASCII codes of the signature characters, according to the following table:

MSB			LSB
e	v	a	s
65h	76h	61h	73h

On reception of the correct signature to an appropriate sub-index, the controller will store the parameters in non-volatile memory, and then confirm the SDO transmission.

By read access, the object provides information about the module’s saving capabilities. For all sub-indexes, this value is 1h, indicating that the controller saves parameters on command. **This means that if power is removed before the Store object is written, changes to the Object Dictionary will NOT have been saved in the non-volatile memory and will be lost on the next power cycle.**

Object Description

Index	1010h
Name	Store Parameters
Object Type	ARRAY
Data Type	UNSIGNED32

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	4
Default Value	4

Sub-Index	1h
Description	Save all parameters
Access	RW
PDO Mapping	No
Value Range	0x65766173 (write access) 1h (read access)
Default Value	1h

Sub-Index	2h
Description	Save communication parameters
Access	RW
PDO Mapping	No
Value Range	0x65766173 (write access) 1h (read access)
Default Value	1h

Sub-Index	3h
Description	Save application parameters
Access	RW
PDO Mapping	No
Value Range	0x65766173 (write access) 1h (read access)
Default Value	1h

Sub-Index	4h
Description	Save manufacturer parameters
Access	RW
PDO Mapping	No
Value Range	0x65766173 (write access) 1h (read access)
Default Value	1h

3.2.8 Object 1011h: Restore Parameters

This object supports the restoring of the default values for the object dictionary in non-volatile memory. In order to avoid restoring of parameters by mistake, the device restores the defaults only when a specific signature is written to the appropriate sub-index. The signature is “load”. The “load” action on either CAN buses will apply to the parameters on both buses.

The signature is a 32-bit unsigned number, composed of the ASCII codes of the signature characters, according to the following table:

MSB			LSB
d	a	o	l
64h	61h	6Fh	6Ch

On reception of the correct signature to an appropriate sub-index, the controller will restore the defaults in non-volatile memory, and then confirm the SDO transmission. **The default values are set valid only after the device is reset or power-cycled.** This means that the controller will NOT start using the default values right away, but rather continue to run from whatever values were in the Object Dictionary prior to the restore operation.

By read access, the object provides information about the module’s default parameter restoring capabilities. For all sub-indexes, this value is 1h, indicating that the controller restores defaults on command.

Object Description

Index	1011h
Name	Restore Default Parameters
Object Type	ARRAY
Data Type	UNSIGNED32

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	4
Default Value	4

Sub-Index	1h
Description	Restore all default parameters
Access	RW
PDO Mapping	No
Value Range	0x64616F6C (write access), 1h (read access)
Default Value	1h

Sub-Index	2h
Description	Restore default communication parameters
Access	RW
PDO Mapping	No
Value Range	0x64616F6C (write access), 1h (read access)
Default Value	1h

Sub-Index	3h
Description	Restore default application parameters
Access	RW
PDO Mapping	No
Value Range	0x64616F6C (write access), 1h (read access)
Default Value	1h

Sub-Index	4h
Description	Restore default manufacturer parameters
Access	RW
PDO Mapping	No
Value Range	0x64616F6C (write access), 1h (read access)
Default Value	1h

3.2.9 Object 1016h: Consumer Heartbeat Time

The controller can be a consumer of heartbeat objects for a single module. This object defines the expected heartbeat cycle time for that module, and if set to zero, it is not used. When the object is non-zero, the time is a multiple of 1ms, and monitoring will start after the reception of the first heartbeat from the module. If the controller fails to receive a heartbeat from a node in the expected timeframe, it will indicate a communication error, and respond as per object 1029h.

Bits	31-24	23-16	15-0
Value	Reserved 00h	Node-ID	Heartbeat time
Encoded as		UNSIGNED8	UNSIGNED16

Object Description

Index	1016h
Name	Consumer heartbeat time
Object Type	ARRAY
Data Type	UNSIGNED32

Entry Description

Sub-Index	0h
Description	Number of entries
Access	RO
PDO Mapping	No
Value Range	4
Default Value	4

Sub-Index	1h
Description	Consumer heartbeat time
Access	RW
PDO Mapping	No
Value Range	UNSIGNED32
Default Value	0

3.2.10 Object 1017h: Producer Heartbeat Time

The controller could be configured to produce a cyclical heartbeat by writing a non-zero value to this object. The value will be given in multiples of 1ms, and a value of 0 shall disable the heartbeat.

Object Description

Index	1017h
Name	Producer heartbeat time
Object Type	VAR
Data Type	UNSIGNED16

Entry Description

Sub-Index	0h
Access	RW
PDO Mapping	No
Value Range	10 to 65535
Default Value	0

3.2.11 Object 1018h: Identity Object

The identity object indicates the data of the controller, including vendor id, device id, software and hardware version numbers, and the serial number.

In the Revision Number entry at sub-index 3, the format of the data is as shown below

MSB LSB

Major revision number (object dictionary)	Hardware Revision	Software Version

Object Description

Index	1018h
Name	Identity Object
Object Type	RECORD
Data Type	Identity Record

Entry Description

Sub-Index	0h
Description	Number of entries
Access	RO
PDO Mapping	No
Value Range	4
Default Value	4

Sub-Index	1h
Description	Vendor ID
Access	RO
PDO Mapping	No
Value Range	0x00000055
Default Value	0x00000055 (Axiomatic)

Sub-Index	2h
Description	Product Code
Access	RO
PDO Mapping	No
Value Range	0xAA030341
Default Value	0xAA030341

Sub-Index	3h
Description	Revision Number
Access	RO
PDO Mapping	No
Value Range	UNSIGNED32
Default Value	0x00000001

Sub-Index	4h
Description	Serial Number
Access	RO
PDO Mapping	No
Value Range	UNSIGNED32
Default Value	No

3.2.12 Object 1020h: Verify Configuration

This object can be read to see what date the software (version identified in object 1018h) was compiled. The date is represented as a hexadecimal value showing day/month/year as per the format below. The time value at sub-index 2 is a hexadecimal value showing the time in a 24 hour clock

MSB		LSB
Day (in 1-Byte Hex)	Month (in 1-Byte Hex)	Year (in 2-Byte Hex)
00	00	Time (in 2-Byte Hex)

For example, a value of 0x30042014 would indicate that the software was compiled on April 30th, 2014. A time value of 0x00001842 would indicate it was compiled at 6:42pm.

Object Description

Index	1020h
Name	Verify configuration
Object Type	ARRAY
Data Type	UNSIGNED32

Entry Description

Sub-Index	0h
Description	Number of entries
Access	RO
PDO Mapping	No
Value Range	2
Default Value	2

Sub-Index	1h
Description	Configuration date
Access	RO
PDO Mapping	No
Value Range	UNSIGNED32
Default Value	No

Sub-Index	2h
Description	Configuration time
Access	RO
PDO Mapping	No
Value Range	UNSIGNED32
Default Value	No

3.2.13 Object 1029h: Error Behaviour

This object controls the state that the controller will be set into in case of an error of the type associated with the sub-index.

A network fault is flagged when an RPDO is not received within the expected time period defined in the "Event Timer" of the associated communication objects, (see Section 3.2.14 for more information) or if a lifeguard or heartbeat message is not received as expected. Input faults are defined in Section 1.3, and thermocouple faults are defined in Section 1.4.

For all sub-indexes, the following definitions hold true:

0 = Pre-Operational (node reverts to a pre-operational state when this fault is detected)
1 = No State Change (node remains in the same state it was in when the fault occurred)
2 = Stopped (node goes into stopped mode when the fault occurs)

Object Description

Index	1029h
Name	Error Behavior
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Number of entries
Access	RO
PDO Mapping	No
Value Range	5
Default Value	5

Sub-Index	1h
Description	Communication Fault
Access	RW
PDO Mapping	No
Value Range	See above
Default Value	1 (No State Change)

Sub-Index	2h
Description	Digital Input Fault
Access	RW
PDO Mapping	No
Value Range	See above
Default Value	1 (No State Change)

Sub-Index	3h
Description	Analog Input Fault (All Inputs and TC)
Access	RW
PDO Mapping	No
Value Range	See above

Default Value	1 (No State Change)

Sub-Index	4h
Description	Digital Output Fault (Not Used)
Access	RW
PDO Mapping	No
Value Range	See above
Default Value	1 (No State Change)

Sub-Index	5h
Description	Analog Output Fault (Not Used)
Access	RW
PDO Mapping	No
Value Range	See above
Default Value	1 (No State Change)

3.2.14 RPDO Behaviour

Per the CANopen® standard DS-301, the following procedure shall be used for re-mapping, and is the same for both RPDOs and TPDOs.

a) Destroy the PDO by setting bit **exists** (most significant bit) of sub-index 01h of the according PDO communication parameter to 1b
b) Disable mapping by setting sub-index 00h of the corresponding mapping object to 0
c) Modify the mapping by changing the values of the corresponding sub-indices
d) Enable mapping by setting sub-index 00h to the number of mapped objects
e) Create the PDO by setting bit **exists** (most significant bit) of sub-index 01h of the according PDO communication parameter to 0b

The controller can support up to four RPDO messages. All RPDOs on the controller use the similar default communication parameters, with the PDO IDs set according to the pre-defined connection set described in DS-301. Some RPDOs do not exist, there is no RTR allowed, they use 11-bit CAN-IDs (base frame valid) and they are all event-driven. While all four have valid default mappings defined (see below), none of them is enabled by default (i.e. RPDO exists).

RPDO1 Mapping at Object 1600h: Default ID 0x200 + Node ID

Sub-Index	***Value***	***Object***
0	4	Number of mapped application objects in PDO
1	0x25000110	Extra Received PV 1
2	0x25000210	Extra Received PV 2
3	0x25000310	Extra Received PV 3
4	0x25000410	Extra Received PV 4

RTPDO2 Mapping at Object 1601h: Default ID 0x300 + Node ID

Sub-Index	***Value***	***Object***
0	4	Number of mapped application objects in PDO

1	0x25000510	Extra Received PV 5
2	0x25000610	Extra Received PV 6
3	0x25000710	Extra Received PV 7
4	0x25000810	Extra Received PV 8

RPDO3 Mapping at Object 1602h: Default ID 0x400 + Node ID

Sub-Index	***Value***	***Object***
0	4	Number of mapped application objects in PDO
1	0x25000910	Extra Received PV 9
2	0x25000A10	Extra Received PV 10
3	0x25000B10	Extra Received PV 11
4	0x25000C10	Extra Received PV 12

RPDO4 Mapping at Object 1603h: Default ID 0x500 + Node ID

Sub-Index	***Value***	***Object***
0	0	Number of mapped application objects in PDO
1	0	Not used by default
2	0	Not used by default
3	0	Not used by default
4	0	Not used by default

None of them have the timeout feature enabled, i.e. the “Event Timer” on sub-index 5 is set to zero. When this is changed to a non-zero value, if the RPDO has not been received from another node within the time period defined (while in Operational mode), a network fault is activated, and the controller will go to the operational state define in Object 1029h sub-index 4.

Object Description

Index	1400h to 1403h
Name	RPDO communication parameter
Object Type	RECORD
Data Type	PDO Communication Record

Entry Description

Sub-Index	0h
Description	Number of entries
Access	RO
PDO Mapping	No
Value Range	5
Default Value	5

Sub-Index	1h
Description	COB-ID used by RPDO
Access	RW
PDO Mapping	No

X	***RPDOx ID***
1	0200h
2	0300h
3	0400h

Value Range	See value definition in DS-301
Default Value	C0000000h + RPDOx + Node-ID

4	0500h

Node-ID = Node-ID of the module. The RPDO COB-IDs are automatically updated if the Node-ID is changed by LSS protocol.
80000000h in the COB-ID indicates that the PDO does not exist (destroyed)
04000000h in the COB-ID indicates that there is no RTR allowed on the PDO

Sub-Index	2h
Description	Transmission type
Access	RO
PDO Mapping	No
Value Range	See value definition in DS-301
Default Value	255 (FFh) = Event Driven

Sub-Index	3h
Description	Inhibit Time
Access	RW
PDO Mapping	No
Value Range	See value definition in DS-301
Default Value	0

Sub-Index	4h
Description	Compatibility entry
Access	RW
PDO Mapping	No
Value Range	UNSIGNED8
Default Value	0

Sub-Index	5
Description	Event-timer
Access	RW
PDO Mapping	No
Value Range	See value definition in DS-301
Default Value	0

Recall: A non-zero event timer for an RPDO means that it will result in a network fault being flagged if it has not been received within this timeframe while in Operational mode.

3.2.15 TPDO Behaviour

This controller can support up to six TPDO messages. All TPDOs on the controller use the similar default communication parameters, with the PDO IDs set according to the pre-defined connection set described in DS-301. Some TPDOs do not exist, there is no RTR allowed, they use 11-bit CAN-IDs (base frame valid) and they are all time-driven. While all have valid default mappings defined (see below) only TPDO1, TPDO2, TPDO3 and TPDO4 are enabled by default (i.e. TPDO exists).

TPDO1 Mapping at Object 1A00h: Default ID 0x180 + Node ID

Sub-Index	***Value***	***Object***
0	3	Number of mapped application objects in PDO
1	0x71000110	Analog Input 1 Field Value
2	0x71000210	Analog Input 2 Field Value
3	0x71000310	Analog Input 3 Field Value
4	0	Not used by default

TPDO2 Mapping at Object 1A01h: Default ID 0x280 + Node ID

Sub-Index	***Value***	***Object***
0	3	Number of mapped application objects in PDO
1	0x71000810	Digital Input 5 Field Value
2	0x71000A10	Digital Input 7 Field Value
3	0x71000B10	Digital Input 8 Field Value
4	0	Not used by default

TPDO3 Mapping at Object 1A02h: Default ID 0x380 + Node ID

Sub-Index	***Value***	***Object***
0	3	Number of mapped application objects in PDO
1	0x60000108	Digital Read States (Analog Input 1 to 3)
2	0x60000208	Digital Read States (Digital Input 1 to 8)
3	0x60000308	Digital Read States (Digital Input 9 to 12)
4	0	Not used by default

TPDO4 Mapping at Object 1A03h: Default ID 0x480 + Node ID

Sub-Index	***Value***	***Object***
0	2	Number of mapped application objects in PDO
1	0x61000120	Thermocouple Measured in Degree
2	0x61300120	Thermocouple Measured in mV
3	0	Not used by default
4	0	Not used by default

TPDO5 Mapping at Object 1A04h: Default ID 0x181 + Node ID

Sub-Index	***Value***	***Object***
0	1	Number of mapped application objects in PDO
1	0x21610010	Cold Junction PV (degree)
2	0	Not used by default
3	0	Not used by default
4	0	Not used by default

TPDO6 Mapping at Object 1A05h: Default ID 0x281 + Node ID

Sub-Index	***Value***	***Object***
0	2	Number of mapped application objects in PDO
1	0x50200020	Power Supply Field Value (measured)
2	0x50300020	Processor Temperature Field Value (measured)

3	0	Not used by default
4	0	Not used by default

Since TPDO1, TPDO2, TPDO3 and TPDO4 have non-zero value transmission rates (i.e. Event Timer in sub-index 5 of communication object), they will be automatically broadcasted when the unit goes into OPERATIONAL mode.

Object Description

Index	1800h to 1805h
Name	TPDO communication parameter
Object Type	RECORD
Data Type	PDO Communication Record

Entry Description

Sub-Index	0h
Description	Number of entries
Access	RO
PDO Mapping	No
Value Range	5
Default Value	5

Sub-Index	1h
Description	COB-ID used by TPDO
Access	RW
PDO Mapping	No
Value Range	See value definition in DS-301
Default Value	40000000h + TPDO1 + Node-ID 40000000h + TPDO2 + Node-ID 40000000h + TPDO3 + Node-ID 40000000h + TPDO4 + Node-ID C0000000h + TPDOx + Node-ID

X	***TPDOx ID***
1	0180h
2	0280h
3	0380h
4	0480h
5	0181h
6	0281h

Node-ID = Node-ID of the module. The TPDO COB-IDs are automatically updated if the Node-ID is changed by LSS protocol.
80000000h in the COB-ID indicates that the PDO does not exist (destroyed)
04000000h in the COB-ID indicates that there is no RTR allowed on the PDO

Sub-Index	2h
Description	Transmission type
Access	RO
PDO Mapping	No
Value Range	See value definition in DS-301
Default Value	254 (FEh) = Event Driven

Sub-Index	3h
Description	Inhibit Time

Access	RW
PDO Mapping	No
Value Range	See value definition in DS-301
Default Value	0

Sub-Index	4h
Description	Compatibility entry
Access	RW
PDO Mapping	No
Value Range	UNSIGNED8
Default Value	0

Sub-Index	5
Description	Event-timer
Access	RW
PDO Mapping	No
Value Range	See value definition in DS-301
Default Value	100ms (on TPDO1 to TPDO4) 0ms (on TPDO5 and TPDO6)

3.3 APPLICATION OBJECTS (DS-404)

Index (hex)	***Object***	***Object Type***	***Data Type***	***Access***	***PDO Mapping***
6000	DI Read State 8 Input Lines	ARRAY	UNSIGNED8	RO	Yes
6100	TC Input FV (Degree)	ARRAY	FLOAT32	RO	Yes
6130	TC Input PV (mV)	ARRAY	FLOAT32	RO	Yes
6110	AI Sensor Type	ARRAY	UNSIGNED16	RW	No
6112	AI Operating Mode	ARRAY	UNSIGNED8	RW	No
6132	AI Decimal Digits PV	ARRAY	UNSIGNED8	RW	No
61A0	AI Filter Type	ARRAY	UNSIGNED8	RW	No
61A1	AI Filter Constant	ARRAY	UNSIGNED16	RW	No
7100	AI Input Field Value	ARRAY	INTEGER16	RO	Yes
7120	AI Input Scaling 1 FV	ARRAY	INTEGER16	RW	No
7121	AI Input Scaling 1 PV	ARRAY	INTEGER16	RW	No
7122	AI Input Scaling 2 FV	ARRAY	INTEGER16	RW	No
7123	AI Input Scaling 2 PV	ARRAY	INTEGER16	RW	No
7130	AI Input Process Value	ARRAY	INTEGER16	RO	Yes
7148	AI Input Span Start	ARRAY	INTEGER16	RW	No
7149	AI Input Span End	ARRAY	INTEGER16	RW	No

3.3.1 Object 6000h: DI Read State 8 Input Lines

This read-only object represents the digital input states in groups of 8 input lines as 8-bit information. Sub-index 1 represents the digital inputs states for Universal Input 1 to 3. Sub-index 2 holds the digital input states for Digital Input 1 to 8 while sub-index 3 holds the states information for Digital Input 9 to 12. Refer to Section 1.2 for more information.

Object Description

Index	6000h
Name	DI Read State 8 Input Lines
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	3
Default Value	3

Sub-Index	1h
Description	DI Read State 8 Input Lines 1 (Universal Inputs 1 to 3)
Access	RO
PDO Mapping	Yes
Value Range	0x00 (All 3 OFF) to 0x07 (All 3 ON)
Default Value	0

Sub-Index	2h
Description	DI Read State 8 Input Lines 2 (Digital Inputs 1 to 8)
Access	RO
PDO Mapping	Yes
Value Range	0x00 (All 8 OFF) to 0xFF (All 8 ON)
Default Value	0

Sub-Index	3h
Description	DI Read State 8 Input Lines 3 (Digital Inputs 9 to 12)
Access	RO
PDO Mapping	Yes
Value Range	0x00 (All 4 OFF) to 0x0F (All 4 ON)
Default Value	0

3.3.2 Object 6100h: TC Input Field Value

This read-only object represents the measured temperature of the associated thermocouple input in Degree Celsius. When the corresponding sub-index in object 2160h is set to TRUE, the calculated temperature is automatically adjusted for the cold junction temperature compensation.

Object Description

Index	6100h
Name	TC Input Field Value
Object Type	ARRAY
Data Type	FLOAT32

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	1
Default Value	1

Sub-Index	1h
Description	TC Input Field Value (in Degree Celsius)
Access	RO
PDO Mapping	Yes
Value Range	FLOAT32
Default Value	0

3.3.3 Object 6130h: TC Input Process Value

The read-only object represents the scaled value of the measured thermocouple temperature in mV.

Object Description

Index	6130h
Name	TC Input Process Value
Object Type	ARRAY
Data Type	FLOAT32

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	1

Default Value	1

Sub-Index	1h
Description	TC Input Process Value (in mV)
Access	RO
PDO Mapping	Yes
Value Range	FLOAT32
Default Value	0

3.3.4 Object 6110h: AI Sensor Type

This object defines the type of sensor (input) which is connected to the input pin.

Object Description

Index	6110h
Name	AI Sensor Type
Object Type	ARRAY
Data Type	UNSIGNED16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	16
Default Value	16

Sub-Index	1h to 3h (x = 1 to 3)
Description	AIx Sensor Type
Access	RW
PDO Mapping	No
Value Range	See Table 5
Default Value	40 (Voltage)

Sub-Index	4h to 15h (x = 4 to 15)
Description	DI(x-3) Sensor Type
Access	RW
PDO Mapping	No
Value Range	See Table 5
Default Value	10000 (PWM)

Sub-Index	16h
Description	TC Sensor Type
Access	RW
PDO Mapping	No
Value Range	See Table 5
Default Value	2 (Type K)

3.3.5 Object 6112h: AI Operating Mode

This object enables special operating modes for the input.

Object Description

Index	6112h
Name	AI Operating Mode
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (x = 1 to 3)
Description	AIx Operating Mode
Access	RW
PDO Mapping	No
Value Range	See Table 4
Default Value	1 (Normal Operation)

Sub-Index	4h to 15h (x = 4 to 15)
Description	DI(x-3) Operating Mode
Access	RW
PDO Mapping	No
Value Range	See Table 4
Default Value	10 (Digital ON/OFF)

3.3.6 Object 6132h: AI Decimal Digits PV

This object describes the number of digits following the decimal point (i.e. resolution) of the input data, which is interpreted with data type Integer16 in the process value object.

Example: A process value of 1.230 (Float) will be coded as 1230 in Integer16 format if the number of decimal digits is set to 3.

Object Description

Index	6132h
Name	AI Decimal Digits PV
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (x = 1 to 3)
Description	AIx Decimal Digits PV
Access	RW
PDO Mapping	No
Value Range	0 to 4
Default Value	3 [V to mV]

Sub-Index	4h to 15h (x = 4 to 15)
Description	DI(x-3) Decimal Digits PV
Access	RW
PDO Mapping	No
Value Range	0 to 4
Default Value	0 [ON/OFF]

3.3.7 Object 61A0h: AI Filter Type

This object defines the type of data filter that will be applied to the raw input data, as read from the ADC or Timer, before it is passed to the field value object. The types of data filters are defined in Table 8, and how they are used is outlined in Section 1.3.

Object Description

Index	61A0h
Name	AI Filter Type
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No

Value Range	15
Default Value	15

Sub-Index	1h to 3h (x = 1 or 3)
Description	AIx Filter Type
Access	RW
PDO Mapping	No
Value Range	See Table 8
Default Value	0 (no filter)

Sub-Index	4h to 15h (x = 4 or 15)
Description	DI(x-3) Filter Type
Access	RW
PDO Mapping	No
Value Range	See Table 8
Default Value	0 (no filter)

3.3.8 Object 61A1h: AI Filter Constant

This object defines the number of steps used in the various filters, as defined in Section 1.3.

Object Description

Index	61A1h
Name	AI Filter Constant
Object Type	ARRAY
Data Type	UNSIGNED16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (x = 1 to 3)
Description	AIx Filter Constant
Access	RW
PDO Mapping	No
Value Range	1 to 1000
Default Value	10

Sub-Index	4h to 15h (x = 4 to 15)
Description	DI(x-3) Filter Constant
Access	RW
PDO Mapping	No
Value Range	1 to 1000
Default Value	10

3.3.9 Object 7100h: AI Input Field Value

This object represents the measured value of an input that has been scaled as per manufacturer object 2102h AI Decimal Digits FV. The base unit for each type of input is defined in Table 9, as well as the read-only resolution (decimal digits) associated with the FV.

Object Description

Index	7100h
Name	AI Input Field Value
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (x = 1 to 3)
Description	Analog Input X FV
Access	RO
PDO Mapping	Yes
Value Range	Data Type Specific, see Table 9
Default Value	No

Sub-Index	4h to 15h (x = 4 to 15)
Description	Digital Input (x-3) FV
Access	RO
PDO Mapping	Yes
Value Range	Data Type Specific, see Table 9
Default Value	No

3.3.10 Object 7120h: AI Input Scaling 1 FV

This object describes the field value of the first calibration point for the analog input channel, as shown in Figure 7. It also defines the “minimum” value of the analog input range when using this input as a control source for another function block, as described in Table 14 in Section 1.3. It is scaled in the physical unit of the FV, i.e. object 2102h applies to this object.

Object Description

Index	7120h
Name	AI Input Scaling 1 FV
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (x = 1 to 3)
Description	AIx Scaling 1 FV
Access	RW
PDO Mapping	No
Value Range	See Table 11
Default Value	500 [mV]

Sub-Index	4h to 15h (x = 4 to 15)
Description	DI (x-3) Scaling 1 FV
Access	RW
PDO Mapping	No
Value Range	See Table 11
Default Value	0[OFF]

3.3.11 Object 7121h: AI Input Scaling 1 PV

This object defines the process value of the first calibration point for the analog input channel, as shown in Figure 7. It is scaled in the physical unit of the PV, i.e. object 6132h applies to this object.

Object Description

Index	7121h
Name	AI Input Scaling 1 PV
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (x = 1 to 3)
Description	AIx Scaling 1 PV
Access	RW
PDO Mapping	No
Value Range	Integer16
Default Value	500 [same as 7120h]

Sub-Index	4h to 15h (x = 4 to 15)
Description	DI (x-3) Scaling 1 PV
Access	RW
PDO Mapping	No
Value Range	Integer16
Default Value	OFF [same as 7120h]

3.3.12 Object 7122h: AI Input Scaling 2 FV

This object describes the field value of the second calibration point for the analog input channel, as shown in Figure 7. It also defines the "maximum" value of the analog input range when using this input as a control source for another function block, as described in Table 14 in Section 1.3. It is scaled in the physical unit of the FV, i.e. object 2102h applies to this object.

Object Description

Index	7122h
Name	AI Input Scaling 2 FV
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (x = 1 to 3)
Description	AIx Scaling 2 FV
Access	RW
PDO Mapping	No
Value Range	See Table 11
Default Value	4500 [mV]

Sub-Index	4h to 15h (x = 4 to 15)
Description	DI (x-3) Scaling 2 FV
Access	RW
PDO Mapping	No
Value Range	See Table 11
Default Value	1[ON]

3.3.13 Object 7123h: AI Input Scaling 2 PV

This object defines the process value of the second calibration point for the analog input channel, as shown in Figure 7. It is scaled in the physical unit of the PV, i.e. object 6132h applies to this object.

Object Description

Index	7123h
Name	AI Input Scaling 2 PV
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (x = 1 to 3)
Description	AIx Scaling 2 PV
Access	RW
PDO Mapping	No
Value Range	Integer16
Default Value	4500 [same as 7122h]

Sub-Index	4h to 15h (x = 4 to 15)
Description	DI (x-3) Scaling 2 PV
Access	RW
PDO Mapping	No
Value Range	Integer16
Default Value	ON [same as 7122h]

3.3.14 Object 7130h: AI Input Process Value

This object represents the result of the input scaling applied per Figure 7, and gives the measured quantity scaled in the physical unit of the process value (i.e. °C, PSI, RPM, etc) with the resolution defined in object 6132h AI Decimal Digits PV.

Object Description

Index	7130h
Name	AI Input Process Value
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (x = 1 to 3)
Description	AIx Process Value
Access	RO
PDO Mapping	Yes
Value Range	Integer16
Default Value	No

Sub-Index	4h to 15h (x = 4 to 15)
Description	DI (x-3) Process Value
Access	RO
PDO Mapping	Yes
Value Range	Integer16
Default Value	No

3.3.15 Object 7148h: AI Span Start

This value specifies the lower limit where field values are expected. Field values which are lower than this limit are marked as negative overload. It is scaled in the physical unit of the FV, i.e. object 2102h applies to this object.

Object Description

Index	7148h
Name	AI Span Start
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (x = 1 to 3)
Description	AIx Span Start (Error Min)
Access	RW
PDO Mapping	No
Value Range	See Table 11
Default Value	200 [mV]

Sub-Index	4h to 15h (x = 4 to 15)
Description	DI (x-3) Span Start (Error Min)
Access	RW
PDO Mapping	No
Value Range	See Table 11
Default Value	0[OFF]

3.3.16 Object 7149h: AI Span End

This value specifies the upper limit where field values are expected. Field values, which are higher than this limit, are marked as positive overload. It is scaled in the physical unit of the FV, i.e. object 2102h applies to this object.

Object Description

Index	7149h
Name	AI Span End
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (x = 1 to 3)
Description	AIx Span End (Error Max)
Access	RW
PDO Mapping	No
Value Range	See Table 11
Default Value	4800[mV]

Sub-Index	4h to 15h (x = 4 to 15)
Description	AIx Span End (Error Max)
Access	RW
PDO Mapping	No
Value Range	See Table 11
Default Value	1[ON]

3.4 MANUFACTURER OBJECTS

Index (hex)	***Object***	***Object Type***	***Data Type***	***Access***	***PDO Mapping***
2010	DI Polarity	ARRAY	UNSIGNED8	RW	No
2020	DI Pull Up/Down Mode 1 Input Line	ARRAY	UNSIGNED8	RW	No
2030	DI Debounce Filter 1 Input Line	ARRAY	UNSIGNED8	RW	No
2100	AI Input Range	ARRAY	UNSIGNED8	RW	No
2101	AI Number of Pulses Per Revolution	ARRAY	UNSIGNED16	RW	No
2102	AI Decimal Digits FV	ARRAY	UNSIGNED8	RW	No
2103	AI Filter Frequency for ADC	ARRAY	UNSIGNED8	RW	No
2110	AI Error Detect Enable	ARRAY	UNSIGNED8	RW	No
2111	AI Error Clear Hysteresis	ARRAY	INTEGER16	RW	No
2112	AI Error Reaction Delay	ARRAY	UNSIGNED16	RW	No
2120	AI Third-Order Filter Power	ARRAY	UNSIGNED16	RW	No
2121	AI Third-Order Filter Input Coefficient N0	ARRAY	INTEGER16	RW	No
2122	AI Third-Order Filter Input Coefficient N1	ARRAY	INTEGER16	RW	No
2123	AI Third-Order Filter Input Coefficient N2	ARRAY	INTEGER16	RW	No
2124	AI Third-Order Filter Input Coefficient N3	ARRAY	INTEGER16	RW	No
2125	AI Third-Order Filter Output Coefficient N1	ARRAY	INTEGER16	RW	No
2126	AI Third-Order Filter Output Coefficient N2	ARRAY	INTEGER16	RW	No
2127	AI Third-Order Filter Output Coefficient N3	ARRAY	INTEGER16	RW	No
2160	TC Cold Junction Enabled	ARRAY	UNSIGNED8	RW	No
2161	TC Cold Junction PV (	VARIABLE	INTEGER16	RO	Yes
2162	TC Cold Junction FV	ARRAY	INTEGER16	RO	Yes
2170	TC Low Temperature Warning	ARRAY	INTEGER16	RW	No
2171	TC High Temperature Warning	ARRAY	INTEGER16	RW	No
2172	TC Low Temperature Shutdown	ARRAY	INTEGER16	RW	No
2173	TC High Temperature Shutdown	ARRAY	INTEGER16	RW	No
2174	TC Error Clear Hysteresis	ARRAY	INTEGER16	RW	No
2175	TC Error Detect Enable	ARRAY	UNSIGNED8	RW	No
2500	EC Extra Received Process Value	ARRAY	INTEGER16	RW	Yes

2502	EC Decimal Digits PV	ARRAY	UNSIGNED8	RW	No
2520	EC Scaling 1 PV	ARRAY	INTEGER16	RW	No
2522	EC Scaling 2 PV	ARRAY	INTEGER16	RW	No
3yz0	LTyz Input X-Axis Source	VAR	UNSIGNED8	RW	No
3yz1	LTyz Input X-Axis Number	VAR	UNSIGNED8	RW	No
3yz2	LTyz Auto Repeat	VAR	UNSIGNED8	RW	No
3yz3	LTyz X-Axis Decimal Digits PV	VAR	UNSIGNED8	RW	No
3yz4	LTyz Y-Axis Decimal Digits PV	VAR	UNSIGNED8	RW	No
3yz5	LTyz Point Response	ARRAY	UNSIGNED8	RW	No
3yz6	LTyz Point X-Axis PV	ARRAY	INTEGER32	RW	No
3yz7	LTyz Point Y-Axis PV	ARRAY	INTEGER16	RW	No
3yz8	LTyz Output Y-Axis PV	VAR	INTEGER16	RO	Yes
3300	Logic Block Enable	ARRAY	BOOLEAN	RW	No
3310	Logic Block Selected Table	ARRAY	UNSIGNED8	RO	Yes
3320	Logic Output Process Value	ARRAY	INTEGER16	RO	Yes
3x01	LB(x-3) Lookup Table Number	ARRAY	UNSIGNED8	RW	No
3x02	LB(x-3) Function Logical Operator	ARRAY	UNSIGNED8	RW	No
3x11	LB(x-3) Function A Condition 1	RECORD	UNSIGNED8	RW	No
3x12	LB(x-3) Function A Condition 2	RECORD	UNSIGNED8	RW	No
3x13	LB(x-3) Function A Condition 3	RECORD	UNSIGNED8	RW	No
3x21	LB(x-3) Function B Condition 1	RECORD	UNSIGNED8	RW	No
3x22	LB(x-3) Function B Condition 2	RECORD	UNSIGNED8	RW	No
3x23	LB(x-3) Function B Condition 3	RECORD	UNSIGNED8	RW	No
3x31	LB(x-3) Function C Condition 1	RECORD	UNSIGNED8	RW	No
3x32	LB(x-3) Function C Condition 2	RECORD	UNSIGNED8	RW	No
3x33	LB(x-3) Function C Condition 3	RECORD	UNSIGNED8	RW	No
4000	Math Block Enable	ARRAY	BOOLEAN	RW	No
4021	Math Output Scaling 1 PV	ARRAY	INTEGER16	RW	No
4023	Math Output Scaling 2 PV	ARRAY	INTEGER16	RW	No
4030	Math Output Process Value	ARRAY	INTEGER16	RO	Yes
4032	Math Output Decimal Digits PV	ARRAY	UNSIGNED8	RW	No
4y00	Math Y Input Source	ARRAY	UNSIGNED8	RW	No
4y01	Math Y Input Number	ARRAY	UNSIGNED8	RW	No

4y02	Math Y Function Number	ARRAY	UNSIGNED8	RW	No
4y03	Math Y Input Decimal Digits FV	ARRAY	UNSIGNED8	RW	No
4y20	Math Y Input Scaling 1 FV	ARRAY	INTEGER16	RW	No
4y22	Math Y Input Scaling 2 FV	ARRAY	INTEGER16	RW	No
4y40	Math Y Input Gain	ARRAY	INTEGER8	RW	No
4y50	Math Y Operator	ARRAY	UNSIGNED8	RW	No
5010	Constant Field Value	ARRAY	FLOAT32	RW	No
5020	Power Supply Field Value	VAR	FLOAT32	RO	Yes
5021	Power Supply Error Detection Enable	VAR	UNSIGNED8	RW	No
5022	Under Voltage Threshold	VAR	UNSIGNED8	RW	No
5023	Over Voltage Threshold	VAR	UNSIGNED8	RW	No
5024	Hysteresis to Clear Power Supply Fault	VAR	UNSIGNED8	RW	No
5030	Processor Temperature Field Value	VAR	FLOAT32	RO	Yes
5031	Enable Error Detection on Temperature	VAR	UNSIGNED8	RW	No
5032	Over Temperature Threshold	VAR	UNSIGNED8	RW	No
5033	Hysteresis to Clear Temperature Fault	VAR	UNSIGNED8	RW	No
5550	Enable Auto Updates	VAR	UNSIGEND8	RW	No
5555	Start in Operational Mode	VAR	BOOLEAN	RW	No
5B50	Change Baud Rate	VAR	UNSIGNED8	RW	No
5B51	Change Node ID	VAR	UNSIGNED8	RW	No

*Where **yz** = 01 to 12 (LUT 1 to 12) and **x** = 4 to 7 (Logic 1 to 4) and **y** = 1 to 6 (Math 1 to 6)*

3.4.1 Object 2010h: DI Polarity 1 Input Line

This object determines how the state read on the input pin corresponds to the logic state, in conjunction with manufacturer object 2020h, as defined in Table 3.

Object Description

Index	2010h
Name	DI Polarity 1 Input Line
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (x = 1 to 3)
Description	Digital Input Polarity (Universal Input x)
Access	RW
PDO Mapping	No
Value Range	See Table 3
Default Value	0 (Normal On/Off)

Sub-Index	4h to 15h (x = 4 to 15)
Description	Digital Input Polarity (Digital Input (x-3))
Access	RW
PDO Mapping	No
Value Range	See Table 3
Default Value	0 (Normal On/Off)

3.4.2 Object 2020h: DI Pullup/Pulldown Mode 1 Input Line

This object determines how the state read on the input pin corresponds to the logic state, in conjunction with application object 2010h, as defined in Table 3. The options for this object are listed in Table 1, and the controller will adjust the input hardware according to what is specified.

Object Description

Index	2020h
Name	DI Pullup/Down Mode 1 Input Line
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (x = 1 to 3)
Description	Digital Input Pullup/Down (Universal Input x)
Access	RW
PDO Mapping	No
Value Range	See Table 1
Default Value	1 (pull down)

Sub-Index	4h to 15h (x = 4 to 15)
Description	Digital Input Pullup/Down (Digital Input (x-3))
Access	RW
PDO Mapping	No
Value Range	See Table 1
Default Value	1 (pull down)

3.4.3 Object 2030h: DI Debounce Filter 1 Input Line

This object will debounce the input signal applied on a single digital input as shown in Figure 4. The options for this object are listed in Table 2.

Object Description

Index	2030h
Name	DI Debounce Filter 1 Input Line
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (x = 1 to 3)
Description	Digital Input Debounce Filter (Universal Input x)
Access	RW
PDO Mapping	No
Value Range	See Table 2
Default Value	2 [Filter 1.78 us]

Sub-Index	4h to 15h (x = 4 to 15)
Description	Digital Input Debounce Filter (Digital Input (x-3))
Access	RW
PDO Mapping	No
Value Range	See Table 2
Default Value	2 [Filter 1.78 us]

3.4.4 Object 2100h: AI Input Range

This object, in conjunction with 6110h AI Sensor Type, defines the analog input defaults (Table 5) and allowable ranges (Table 6) for objects 2111h, 7120h, 7122h, 7148h and 7149h. The number and types of ranges will vary according to what type of sensor is connected to the input, as described in Table 6.

Object Description

Index	2100h
Name	AI Input Range
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (x = 1 to 3)
Description	Analog Input X Range
Access	RW
PDO Mapping	No
Value Range	See Table 6
Default Value	0 [0-5V]

Sub-Index	4h to 15h (x = 4 to 15)
Description	Digital Input (x-3) Range
Access	RW
PDO Mapping	No
Value Range	See Table 6
Default Value	0

3.4.5 Object 2101h: AI Number of Pulses Per Revolution

This object is only used when a “Frequency” input type has been selected by object 6110h. The controller will automatically convert frequency measurement from Hz to RPM when a non-zero value is specified. In this case, objects 2111h, 7120h, 7122h, 7148h and 7149h will be interpreted as RPM data. Object 2100h AI Input Range must still be specified in Hertz, and should be selected according to the expected frequencies that the RPM sensor will operate in.

Object Description

Index	2101h
Name	AI Number of Pulses Per Revolution
Object Type	ARRAY
Data Type	UNSIGNED16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (x = 1 to 3)
Description	AIx Pulses per Revolution
Access	RW
PDO Mapping	No
Value Range	0 to 1000
Default Value	0

Sub-Index	4h to 15h (x = 4 to 15)
Description	DI (x-3) Pulses per Revolution
Access	RW
PDO Mapping	No
Value Range	0 to 1000
Default Value	0

3.4.6 Object 2102h: AI Decimal Digits FV

This object describes the number of digits following the decimal point (i.e. resolution) of the input data, which is interpreted with data type Integer16 in the field value object.

Example: A field value of 1.230 (Float) will be coded as 1230 in Integer16 format if the number of decimal digits is set to 3.

In addition to the FV object 7100h, objects 2111h, 7120h, 7122h, 7148h and 7149h will also be specified with this resolution. This object is normally read-only and will be automatically adjusted by the controller as per Table 10 depending on the analog input type and range that has been selected. When object 5550h is set to FALSE (disables automatic updates), this object becomes writeable.

Object Description

Index	2102h
Name	AI Decimal Digits FV
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (x = 1 to 3)
Description	AIx Decimal Digits FV
Access	RW (only when object 5550h is false)
PDO Mapping	No
Value Range	See Table 9
Default Value	3 [Volt to mV]

Sub-Index	4h to 15h (x = 4 to 15)
Description	DI (x-3) Decimal Digits FV
Access	RW (only when object 5550h is false)
PDO Mapping	No
Value Range	See Table 9
Default Value	0 [OFF/ON]

3.4.7 Object 2103h: AI Filter Frequency for ADC

This object is used to specify the cutoff filter frequency for the ADC peripheral on the processor. The analog-to-digital converter is used with analog input types: voltage and current so it only applies to those three analog inputs. It is also used to measure power supply voltage, and processor temperature. The available filters are listed in Table 7.

Object Description

Index	2103h
Name	AI Filter Frequency for ADC
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	3
Default Value	3

Sub-Index	1h to 3h (x = 1 to 3)
Description	AIx ADC Filter Frequency
Access	RW
PDO Mapping	No
Value Range	See Table 7
Default Value	1 [Filter 50Hz]

3.4.8 Object 2110h: AI Error Detect Enable

This object enables error detection and reaction associated with the analog input function block. When disabled, the input will not generate an EMCY code in object 1003h Pre-Defined Error Field, nor will it disable any logic block controlled by the input should the input go out of range as defined by the objects 7148h AI Span Start and 7149h AI Span End.

Object Description

Index	2110h
Name	AI Error Detect Enable
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (x = 1 to 3)
Description	AIx Error Detect Enable
Access	RW
PDO Mapping	No
Value Range	0 (FALSE) or 1 (TRUE)
Default Value	0 [FALSE]

Sub-Index	4h to 15h (x = 4 to 15)
Description	DI (x-3) Error Detect Enable
Access	RW
PDO Mapping	No
Value Range	0 (FALSE) or 1 (TRUE)
Default Value	0 [FALSE]

3.4.9 Object 2111h: AI Error Clear Hysteresis

This object is used to prevent rapid activation/clearing of an input fault flag and sending of object 1003h to the CANopen® network. Once the input has gone above/below the thresholds that define the valid operating range, it must come back into range minus/plus this value to clear the fault. It is scaled in the physical unit of the FV, i.e. object 2102h applies to this object.

Object Description

Index	2111h
Name	AI Error Clear Hysteresis
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (x = 1 to 3)
Description	AIx Error Clear Hysteresis
Access	RW
PDO Mapping	No
Value Range	See Table 11
Default Value	100 [mV]

Sub-Index	4h to 15h (x = 4 to 15)
Description	DI (x-3) Error Clear Hysteresis
Access	RW
PDO Mapping	No
Value Range	See Table 11
Default Value	0[ON/OFF]

3.4.10 Object 2112h: AI Error Reaction Delay

This object is used to filter out spurious signals and to prevent saturating the CANopen® network with broadcasts of object 1003h as the fault is set/cleared. Before the fault is recognized (i.e. the EMCY code is added to the pre-defined error field list), it must remain active throughout a period of time defined in this object. The physical unit for this object is milliseconds.

Object Description

Index	2112h
Name	AI Error Reaction Delay
Object Type	ARRAY
Data Type	UNSIGNED16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (x = 1 to 3)
Description	AIx Error Reaction Delay
Access	RW
PDO Mapping	No
Value Range	0 to 60,000
Default Value	1000 [ms]

Sub-Index	4h to 15h (x = 4 to 15)
Description	DI (x-3) Error Reaction Delay
Access	RW
PDO Mapping	No
Value Range	0 to 60,000
Default Value	1000 [ms]

3.4.11 Object 2120h: AI Third-Order Filter Power

Third order filtering of the input data is done using 16-bit fixed point math. This object tells the controller the shift value (i.e. 2^x) that was used when the coefficients were selected. See Section 1.3 for more information on the third-order low pass filter.

Object Description

Index	2120h
Name	AI Third-Order Filter Power
Object Type	ARRAY
Data Type	UNSIGNED16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (x = 1 to 3)
Description	AIx Third-Order Filter Power
Access	RW
PDO Mapping	No
Value Range	0 to 16
Default Value	10 [2^{10} = 1024]

Sub-Index	4h to 15h (x = 4 to 15)
Description	DI (x-3) Third-Order Filter Power
Access	RW
PDO Mapping	No
Value Range	0 to 16
Default Value	10 [2^{10} = 1024]

3.4.12 Object 2121h: AI Third-Order Filter Input Coefficient N0
3.4.13 Object 2122h: AI Third-Order Filter Input Coefficient N1
3.4.14 Object 2123h: AI Third-Order Filter Input Coefficient N2
3.4.15 Object 2124h: AI Third-Order Filter Input Coefficient N3

These objects specify the 16-bit shifted input co-efficient values used in the third-order low pass filter calculation described in Section 1.3. They are all defined with a right shift value of 2^{10}. Since coefficient N3 is set to zero, the default filter is a second-order low pass.

Object Description

Index	2121h to 2124h (x = 0 to 3)
Name	AI 3rd Order Filter Input Coefficient Nx
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (y = 1 to 3)
Description	AIy 3rd Order Filter Input Coeff Nx
Access	RW
PDO Mapping	No
Value Range	-10000 to 10000
Default Value	N0=120, N1=241, N2=120, N3=0

Sub-Index	4h to 15h (y = 4 to 15)
Description	DI (y-3) 3rd Order Filter Input Coeff Nx
Access	RW
PDO Mapping	No
Value Range	-10000 to 10000
Default Value	N0=120, N1=241, N2=120, N3=0

3.4.16 Object 2125h: AI Third-Order Filter Output Coefficient N1
3.4.17 Object 2126h: AI Third-Order Filter Output Coefficient N2
3.4.18 Object 2127h: AI Third-Order Filter Output Coefficient N3

These objects specify the 16-bit shifted output co-efficient values used in the third-order low pass filter calculation described in Section 1.3. They are all defined with a right shift value of 2^{10}. Since coefficient N3 is set to zero, the default filter is a second-order low pass.

Object Description

Index	2125h to 2127h (x = 1 to 3)
Name	AI 3rd Order Filter Output Coefficient Nx
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1h to 3h (y = 1 to 3)
Description	AIy 3rd Order Filter Output Coeff Nx
Access	RW
PDO Mapping	No
Value Range	-10000 to 10000
Default Value	N1=704, N2=-164, N3=0

Sub-Index	4h to 15h (y = 4 to 15)
Description	DI (y-3) 3rd Order Filter Output Coeff Nx
Access	RW
PDO Mapping	No
Value Range	-10000 to 10000
Default Value	N1=704, N2=-164, N3=0

3.4.19 Object 2160h: TC Cold Junction Enabled

This object established whether the measured cold junction field value is added to the calculated thermocouple input value. When set to TRUE, the cold junction compensation is automatically performed on the reading.

Object Description

Index	2160h
Name	TC Cold Junction Enabled
Object Type	ARRAY
Data Type	UNSIGEND8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	1
Default Value	1

Sub-Index	1h
Description	TC Cold Junction Enabled
Access	RW
PDO Mapping	No
Value Range	0 (False) or 1 (True)
Default Value	0 (False)

3.4.20 Object 2161h: TC Cold Junction Input Process Value

The read-only object is holding the raw Degree Celsius reading measured by the ADC chip directly.

Object Description

Index	2161h
Name	TC Cold Junction Input PV
Object Type	VARIABLE
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	TC Cold Junction Input Process Value (in Degree Celsius)
Access	RO
PDO Mapping	Yes
Value Range	INTEGER16
Default Value	0

3.4.21 Object 2162h: TC Cold Junction Output Field Value

This read-only object reflected the calculated cold junction value in mV. It will be different for different thermocouple types.

Object Description

Index	2162h
Name	TC Cold Junction Output FV
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	1
Default Value	1

Sub-Index	1h
Description	TC Cold Junction Output FV (in mV)
Access	RO
PDO Mapping	Yes
Value Range	INTEGER16
Default Value	0

3.4.22 Object 2170h: TC Low Temperature Warning

This object sets the low threshold of the normal operating temperature range for each thermocouple's input field value (object 6100h). Any FV value below this limit will set a corresponding low warning flag to the unit, as well as an EMCY code in the object 1003h.

Object Description

Index	2170h
Name	TC Low Temperature Warning
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	1
Default Value	1

Sub-Index	1h
Description	TC Low Temperature Warning
Access	RW
PDO Mapping	No
Value Range	INTEGER16
Default Value	0xFFFFFFEC (-20 Degree C)

3.4.23 Object 2171h: TC High Temperature Warning

This object sets the high threshold of the normal operating temperature range for each thermocouple's input filed value (object 6100h). Any FV value above this limit will set a corresponding high warning flag, as well as an EMCY code in the object 1003h.

Object Description

Index	2171h
Name	TC High Temperature Warning
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	1
Default Value	1

Sub-Index	1h
Description	TC High Temperature Warning
Access	RW
PDO Mapping	No
Value Range	INTEGER16
Default Value	125 (Degree C)

3.4.24 Object 2172h: TC Low Temperature Shutdown

This object sets the low threshold of the shutdown operating temperature range for each thermocouple's input field value (object 6100h). Any FV value below this limit will set a corresponding low shutdown flag, as well as setting an EMCY code in the object 1003h.

Object Description

Index	2172h
Name	TC Low Temperature Shutdown
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	1
Default Value	1

Sub-Index	1h
Description	TC Low Temperature Shutdown
Access	RW
PDO Mapping	No
Value Range	INTEGER16
Default Value	0xFFFFFED4 (-300 Degree C)

3.4.25 Object 2173h: TC High Temperature Shutdown

This object sets the high threshold of the shutdown operating temperature range for each thermocouple's input field value (object 6100h). Any FV value below this limit will set a corresponding high shutdown flag, as well as setting an EMCY code in the object 1003h.

Object Description

Index	2173h
Name	TC High Temperature Shutdown
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	1
Default Value	1

Sub-Index	1h
Description	TC High Temperature Shutdown
Access	RW
PDO Mapping	No
Value Range	INTEGER16
Default Value	250

3.4.26 Object 2174h: TC Error Clear Hysteresis

This object is used to set the value by which the TC value needs to increase or decrease to clear the fault set by an out of range.

Object Description

Index	2174h
Name	TC Error Clear Hysteresis
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	1
Default Value	1

Sub-Index	1h
Description	TC Error Clear Hysteresis
Access	RW
PDO Mapping	No
Value Range	INTEGER16
Default Value	25

3.4.27 Object 2175h: TC Error Detection Enable

This object enables error detection and reaction associated with the thermocouple function block. When disabled, the thermocouple input will not generate an EMCY code in object 1003h Pre-Defined Error Field, if the thermocouple goes out of range as defined by the objects 2170h Low Temperature Warning and 2171h High Temperature Warning or the range as defined by the objects 2172h Low Temperature Shutdown and 2173h High Temperature Shutdown.

Object Description

Index	2175h
Name	TC Error Detect Enable
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	1
Default Value	1

Sub-Index	1h
Description	TC Error Detect Enable
Access	RW
PDO Mapping	No
Value Range	0 (FALSE) or 1 (TRUE)
Default Value	0 [FALSE]

3.4.28 Object 2500h: EC Extra Received Process Value

This object provides an extra control source in order to allow other function blocks to be controlled by data received from a CANopen® RPDO. It functions similarly to any other writeable, mappable PV object.

Object Description

Index	2500h

Name	EC Extra Received Process Value
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	12
Default Value	12

Sub-Index	1h to 12h (x = 1 to 12)
Description	ECx Received Process Value
Access	RW
PDO Mapping	Yes
Value Range	Integer16
Default Value	No

3.4.29 Object 2502h: EC Decimal Digits PV

This object describes the number of digits following the decimal point (i.e. resolution) of the extra control data, which is interpreted with data type Integer16 in the process value object.

Object Description

Index	2502h
Name	EC Decimal Digits PV
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	12
Default Value	12

Sub-Index	1h to 12h (x = 1 to 12)
Description	ECx Decimal Digits PV
Access	RW
PDO Mapping	No
Value Range	0 to 4
Default Value	1 (0.1 resolution)

3.4.30 Object 2520h: EC Scaling 1 PV

This object defines the minimum value of the extra control source. It used as the Scaling 1 value by other functions blocks when the EC has been selected as the source for the X-Axis data, i.e. as seen in Figure 9. There is no physical unit associate with the data, but it uses the same resolution as the received PV as defined in object 2502h, EC Decimal Digits PV. This object must always be smaller than object 2522h EC Scaling 2 PV.

Object Description

Index	2520h
Name	EC Scaling 1 PV
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	12
Default Value	12

Sub-Index	1h to 12h (x = 1 to 12)
Description	ECx Scaling 1 PV
Access	RW
PDO Mapping	No
Value Range	-32768 to 2522h sub-index X
Default Value	0

3.4.31 Object 2522h: EC Scaling 2 PV

This object defines the maximum value of the extra control source. It used as the Scaling 2 value by other functions blocks when the EC has been selected as the source for the X-Axis data, i.e. as seen in Figure 9. There is no physical unit associate with the data, but it uses the same resolution as the received PV as defined in object 2502h, EC Decimal Digits PV. This object must always be larger than object 2520h EC Scaling 1 PV.

Object Description

Index	2522h
Name	EC Scaling 2 PV
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	12
Default Value	12

Sub-Index	1h to 12h (x = 1 to 12)
Description	ECx Scaling 2 PV
Access	RW
PDO Mapping	No
Value Range	2520h sub-index X to 32767
Default Value	1000 (100.0)

3.4.32 Object 3yz0h: LTyz Input X-Axis Source

This object defines the type of input that will be used to determine the X-Axis input process value for the lookup table function. The available control sources on the controller are listed in Table 12. Not all sources would make sense to use as an X-Axis input, and it is the user's responsibility to select a source that makes sense for the application. A selection of "Control Source Not Used" disables the associated lookup table function block.

Object Description

Index	3yz0h (where yz = 01 to 12)
Name	LTyz Input X-Axis Source
Object Type	VARIABLE
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Access	RW
PDO Mapping	No
Value Range	See Table 12
Default Value	0 (control not used)

3.4.33 Object 3yz1h: LTyz Input X-Axis Number

This object defines the number of the source that will be used as the X-Axis input PV for the lookup table function. The available control numbers are dependent on the source selected, as shown in Table 13. Once selected, the limits for the points on the X-Axis will be constrained by the scaling objects of the control source/number as defined in Table 14.

Object Description

Index	3yz1h (where yz = 01 to 12)
Name	LTyz Input X-Axis Number
Object Type	VARIABLE
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Access	RW
PDO Mapping	No
Value Range	See Table 13
Default Value	0 (null control source)

3.4.34 Object 3yz2h: LTyz Auto Repeat

This object determines whether the lookup table sequence will repeat automatically once the last point in the lookup table has been completed. This object is only taken into effect when the response is set to *'Time Response'*. For more details on the functionality of this object and its effect on the lookup table, please refer to section 1.5.4

Object Description

Index	3yz2h (where yz = 01 to 12)
Name	LTyz X-Axis Decimal Digits PV
Object Type	VARIABLE
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Access	RW
PDO Mapping	No
Value Range	0 (OFF) to 1 (ON)
Default Value	0 [OFF]

3.4.35 Object 3yz3h: LTyz X-Axis Decimal Digits PV

This object describes the number of digits following the decimal point (i.e. resolution) of the X-Axis input data and the points in the lookup table. It should be set equal to the decimal digits used by the PV from the control source/number as defined in Table 9.

Object Description

Index	3yz3h (where yz = 01 to 12)
Name	LTyz X-Axis Decimal Digits PV
Object Type	VARIABLE
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Access	RW
PDO Mapping	No
Value Range	0 to 4 (see Table 9)
Default Value	0

3.4.36 Object 3yz4h: LTyz Y-Axis Decimal Digits PV

This object describes the number of digits following the decimal point (i.e. resolution) of the Y-Axis points in the lookup table. When the Y-Axis output is going to be the input to another function block, it is recommended that this value be set equal to the decimal digits used by the block that is using the lookup table as the control source/number.

Object Description

Index	3yz4h (where yz = 01 to 12)
Name	LTyz Y-Axis Decimal Digits PV
Object Type	VARIABLE
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Access	RW
PDO Mapping	No
Value Range	0 to 4
Default Value	0

3.4.37 Object 3yz5h: LTyz Point Response

This object determines the Y-Axis output response to changes in the X-Axis input. The value set in sub-index 1 determines the X-Axis type (i.e. data or time), while all other sub-indexes determine the response (ramp, step, ignore) between two points on the curve. The options for this object are listed in Table 15. See Figure 14 for an example of the difference between a step and ramp response.

Object Description

Index	3yz5h (where yz = 01 to 12)
Name	LTyz Point Response
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	11
Default Value	11

Sub-Index	1h
Description	X-Axis Type
Access	RW
PDO Mapping	No
Value Range	See Table 15 (0 or 1)
Default Value	0 (x-axis data response)

Sub-Index	2h to 11h (x = 2 to 11)
Description	LTyz Point X Response
Access	RW
PDO Mapping	No
Value Range	See Table 15 (0, 1 or 2)
Default Value	1 (ramp to response)

3.4.38 Object 3yz6h: LTyz Point X-Axis PV

This object defines the X-Axis data for the 11 calibration points on the lookup table, resulting in 10 different output slopes.

When a data response is selected for the X-Axis type (sub-index 1 of object 3yz5), this object is constrained such that X1 cannot be less than the Scaling 1 value of the selected control source/number, and X11 cannot be more than the Scaling 2 value. The rest of the points are constrained by the formula below. The physical unit associate with the data will be that of the selected input, and it will use the resolution defined in object 3yz3h, LTyz X-Axis Decimal Digits PV.

$MinInt16 <= X_1 <= X_2 <= X_3 <= X_4 <= X_5 <= X_6 <= X_7 <= X_8 <= X_9 <= X_{10} <= X_{11} <= MaxInt16$

When a time response has been selected, each point on the X-Axis can be set anywhere from 1 to 86,400,000ms.

Object Description

Index	3yz6h (where yz = 01 to 12)
Name	LTyz Point X-Axis PV
Object Type	ARRAY
Data Type	INTEGER32

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	11
Default Value	11

Sub-Index	1h to 11h (x = 1 to 11)	
Description	LTyz Point X-Axis PVx	
Access	RW	
PDO Mapping	No	
Value Range	See above (data)	1 to 86400000 (time)
Default Value	10*(x-1)	No

3.4.39 Object 3yz7h: LTyz Point Y-Axis PV

This object defines the Y-Axis data for the 11 calibration points on the lookup table, resulting in 10 different output slopes. The data is unconstrained and has no physical unit associate with it. It will use the resolution defined in object 3yz4h, LTyz Y-Axis Decimal Digits PV.

Object Description

Index	3yz7h (where yz = 01 to 12)
Name	LTyz Point Y-Axis PV
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	11
Default Value	11

Sub-Index	1h to 11h (x = 1 to 11)
Description	LTyz Point Y-Axis PVx
Access	RW
PDO Mapping	No
Value Range	Integer16
Default Value	10*(x-1) [i.e. 0, 10, 20, 30, … 100]

3.4.40 Object 3yz8h: LTyz Output Y-Axis PV

This read-only object contains the lookup table function block PV that can be used as the input source for another function block. The physical unit for this object is undefined, and it will use the resolution defined in object 3yz4h, LTyz Y-Axis Decimal Digits PV.

Object Description

Index	3yz8h (where yz = 01 to 12)
Name	LTyz Output Y-Axis PV
Object Type	VARIABLE
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Access	RO
PDO Mapping	Yes
Value Range	Integer16
Default Value	No

3.4.41 Object 3300h: Logic Block Enable

This object defines whether or not the logic shown in Figure 17 will be evaluated.

Object Description

Index	3300h
Name	Logic Block Enable
Object Type	ARRAY
Data Type	BOOLEAN

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	4
Default Value	4

Sub-Index	1h to 4h (x = 1 to 4)
Description	LBx Enable
Access	RW
PDO Mapping	No
Value Range	0 (FALSE) or 1 (TRUE)
Default Value	0 [FALSE]

3.4.42 Object 3310h: Logic Block Selected Table

This read-only object reflects what table has been selected as the output source for the logic block after the evaluation shown in Figure 17 has been performed.

Object Description

Index	3310h
Name	Logic Block Selected Table
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	4
Default Value	4

Sub-Index	1h to 4h (x = 1 to 4)
Description	LBx Selected Table
Access	RO
PDO Mapping	Yes
Value Range	1 to 12
Default Value	No

3.4.43 Object 3320h: Logic Block Output PV

This read-only object reflects the output from the selected table, interpreted as a percentage. The limits for the percentage conversion are based on the range of the lookup tables Y-Axis Output PV as shown in Table 14. This value has a fixed decimal digit value of 1 giving a resolution of 0.1%.

Object Description

Index	3320h
Name	Logic Block Output PV
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	4
Default Value	4

Sub-Index	1h to 4h (x = 1 to 4)
Description	LBx Output PV
Access	RO
PDO Mapping	Yes
Value Range	Dependent on Selected Table
Default Value	No

3.4.44 Object 3x01h: LB(x-3) Lookup Table Numbers

This object determines which of the six lookup tables supports on the controller are associated with a particular function within the given logic block. Up to three tables can be linked to each logic function.

Object Description

Index	3x01h (where x = 4 to 7)
Name	LB(x-3) Lookup Table Numbers
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	4
Default Value	4

Sub-Index	1h to 4h (y = A to C)
Description	LB(x-3) Lookup Table Y Number
Access	RW
PDO Mapping	No
Value Range	1 to 12
Default Value	See Table 21

3.4.45 Object 3x02h: LB(x-3) Function Logical Operator

This object determines how the results of the three conditions for each function are to be compared to one another to determine the overall state of the function output. There are up to three functions that can be evaluated in each logic block. The options for this object are defined in Table 19. See Section 1.6 for more information about how this object is used.

Object Description

Index	3x02h (where x = 4 to 7)
Name	LB(x-3) Function Logical Operator
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	4
Default Value	4

Sub-Index	1h to 4h (y = A to C)
Description	LB(x-3) Function Y Logical Operator
Access	RW
PDO Mapping	No
Value Range	See Table 19
Default Value	Function A = 1 (and all) Function B = 1 (and all) Function C = 0 (default)

3.4.46 Object 3x11h: LB(x-3) Function A Condition 1
3.4.47 Object 3x12h: LB(x-3) Function A Condition 2
3.4.48 Object 3x13h: LB(x-3) Function A Condition 3
3.4.49 Object 3x21h: LB(x-3) Function B Condition 1
3.4.50 Object 3x22h: LB(x-3) Function B Condition 2
3.4.51 Object 3x23h: LB(x-3) Function B Condition 3
3.4.52 Object 3x31h: LB(x-3) Function C Condition 1
3.4.53 Object 3x32h: LB(x-3) Function C Condition 2
3.4.54 Object 3x33h: LB(x-3) Function C Condition 3

These objects, 3xyzh, represent Logic Block z, Function y, Condition z, where x = 4 to 7, y = 1 (A) to 3 (C), and z = 1 to 3. All of these objects are a special type of record, defined in Table 16. Information on how to use these objects is defined in Section 1.6.

Object Description

Index	3xyzh
Name	LB(x-3) Function y Condition z
Object Type	RECORD
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	5
Default Value	5

Sub-Index	1h
Description	Argument 1 Source
Access	RW
PDO Mapping	No
Value Range	See Table 12
Default Value	1 (CANopen® Message)

Sub-Index	2h
Description	Argument 1 Number
Access	RW
PDO Mapping	No
Value Range	See Table 13
Default Value	0 (EC Received PV 1)

Sub-Index	3h
Description	Argument 2 Source
Access	RW
PDO Mapping	No
Value Range	See Table 12
Default Value	3 (Constant PV)

Sub-Index	4h
Description	Argument 2 Number
Access	RW
PDO Mapping	No
Value Range	See Table 13
Default Value	2 (Constant FV 1)

Sub-Index	5h
Description	Operator
Access	RW
PDO Mapping	No
Value Range	See Table 17
Default Value	0 (Equals)

3.4.55 Object 4000h: Math Function Enable

The corresponding sub-index of object must be set TRUE in order for a math function block to be enabled. Otherwise, the output will always be at 0.

Object Description

Index	4000h
Name	Math Function Enable
Object Type	ARRAY
Data Type	BOOLEAN

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	2
Default Value	2

Sub-Index	1h to 6h (Y = 1 to 6)
Description	Math Y Enable
Access	RW
PDO Mapping	No
Value Range	0 (FALSE) or 1 (TRUE)
Default Value	0 [FALSE]

3.4.56 Object 4021h: Math Output Scaling 1 PV

This object defines the process value that would correspond to 0% output from the math calculation. The object would apply the resolution defined in object 4532h Math Output Decimal Digits PV. The physical unit is undefined.

Object Description

Index	4021h
Name	Math Output Scaling 1 PV
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	6
Default Value	6

Sub-Index	1h to 6h (Y = 1 to 6)
Description	Math Y Output Scaling 1 PV
Access	RW
PDO Mapping	No
Value Range	-32768 to 32767
Default Value	0

3.4.57 Object 4023h: Math Output Scaling 2 PV

This object defines the process value that would correspond to 100% output from the math calculation. The object would apply the resolution defined in object 4532h Math Output Decimal Digits PV. The physical unit is undefined.

Object Description

Index	4023h
Name	Math Output Scaling 2 PV
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	6
Default Value	6

Sub-Index	1h to 6h (Y = 1 to 6)
Description	Math Y Output Scaling 2 PV
Access	RW
PDO Mapping	No
Value Range	-32768 to 32767
Default Value	10000 (100.00)

3.4.58 Object 4030h: Math Output Process Value

This read-only object reflects the output from the math function block after it has been scaled by objects 4021h and 4023h. The object would apply the resolution defined in object 4032h Math Output Decimal Digits PV. The physical unit is undefined.

Object Description

Index	4030h
Name	Math Output Process Value
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	6
Default Value	6

Sub-Index	1h to 6h (Y = 1 to 6)
Description	Math Y Output Process Value
Access	RO
PDO Mapping	Yes
Value Range	-32768 to 32767
Default Value	No

3.4.59 Object 4032h: Math Output Decimal Digits PV

This object describes the number of digits following the decimal point (i.e. resolution) of the output
data, which is interpreted with data type Integer16 in the process value object.

Object Description

Index	4032h
Name	Math Output Decimal Digits PV
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	6
Default Value	6

Sub-Index	1h to 6h (Y = 1 to 6)
Description	Math Y Decimal Digits PV
Access	RW
PDO Mapping	No
Value Range	0 to 4
Default Value	2 (0.01)

3.4.60 Object 4y00h: Math Y Input Source

This object defines the input sources that will be used in the mathematical calculations. Here, y = 1 to 6 – representing Math Block 1 to Math Block 6. If a control source is not used, the associate mathematical calculation would be ignored. The available control sources on the controller are listed in Table 12.

Object Description

Index	4y00h (y = 1 to 6)
Name	Math Y Input Source
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	6
Default Value	6

Sub-Index	1h to 6h (X = 1 to 6)
Description	Math Y Input X Source
Access	RW
PDO Mapping	No
Value Range	See Table 12
Default Value	0 (control source not used)

3.4.61 Object 4y01h: Math Y Input Number

This object defines the number of the input source that will be used in the math calculation. The available control numbers are dependent on the source selected, as shown in Table 13. Once selected, the input value will be used in the corresponding calculation as described in Section 1.7.

Object Description

Index	4y01h (y = 1 to 6)
Name	Math Y Input Number
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	6
Default Value	6

Sub-Index	1h to 6h (X = 1 to 6)
Description	Math Y Input X Number
Access	RW
PDO Mapping	No
Value Range	See Table 13
Default Value	0 (null input)

3.4.62 Object 4y02h: Math Y Input Function Number

This object defines the number of the function within the Math Block will be used in the math calculation. This object is applicable when the Input Source together with the Input Number match the Math Block that is being configured. If Input Source and Input Number match the Math Block being configured and the Function Number is 0, this object is ignored. For more details, refer to Section 1.7.

Object Description

Index	4y01h (y = 1 to 6)
Name	Math Y Input Number
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	6
Default Value	6

Sub-Index	1h to 6h (X = 1 to 6)
Description	Math Y Input X Function Number
Access	RW
PDO Mapping	No
Value Range	0 to 3
Default Value	0 (null input)

3.4.63 Object 4y03h: Math Y Input Decimal Digits FV

This object describes the number of digits following the decimal point (i.e. resolution) of the input data, which is interpreted with data type Integer16 in the field value object.

Object Description

Index	4y03h (y = 1 to 6)
Name	Math Y Input Decimal Digits FV
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	6
Default Value	6

Sub-Index	1h to 6h (X = 1 to 6)
Description	Math Y Input X Decimal Digits PV
Access	RW
PDO Mapping	No
Value Range	0 to 4
Default Value	2 (0.01)

3.4.64 Object 4y20h: Math Y Input Scaling 1 FV

This object defines the input field value that would correspond to 0% when scaling the input for use in the math calculation. All inputs are normalized to a percentage before being used by the math function block. The object would apply the resolution defined in object 4y03h Math Y Input Decimal Digits FV. The physical unit would match that of the input source.

Object Description

Index	4y20h (y = 1 to 6)
Name	Math Y Input Scaling 1 FV
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	6
Default Value	6

Sub-Index	1h to 6h (X = 1 to 6)
Description	Math Y Input X Scaling 1 FV
Access	RW
PDO Mapping	No
Value Range	INTEGER16
Default Value	0

3.4.65 Object 4y22h: Math Y Input Scaling 2 FV

This object defines the input field value that would correspond to 100% when scaling the input for use in the math calculation. All inputs are normalized to a percentage before being used by the math function block. The object would apply the resolution defined in object 4y03h Math Y Input Decimal Digits FV. The physical unit would match that of the input source.

Object Description

Index	4y22h (y = 1 to 6)
Name	Math Y Input Scaling 2 FV
Object Type	ARRAY
Data Type	INTEGER16

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	6
Default Value	6

Sub-Index	1h to 6h (X = 1 to 6)
Description	Math Y Input X Scaling 2 FV
Access	RW
PDO Mapping	No
Value Range	INTEGER16
Default Value	10000 (100.00%)

3.4.66 Object 4y40h: Math Y Input Gain

This object can be used to adjust the 'weight' of the input in the math calculation. It is a multiplier of the input after it has been converted into a percentage, before it is used in the math calculation. This object has a fixed resolution of 2 decimal digits.

Object Description

Index	4y40h (y = 1 to 6)
Name	Math Y Input Gain
Object Type	ARRAY
Data Type	INTEGER8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	6
Default Value	6

Sub-Index	1h to 6h (X = 1 to 6)
Description	Math Y Input X Gain
Access	RW
PDO Mapping	No
Value Range	-100 to 100
Default Value	100 (1.0)

3.4.67 Object 4y50h: Math Y Operator

This object defines the actual operators that will be used in each stage of a math calculation, as described in Section 1.7. The options for this object are listed in Table 22.

Object Description

Index	4y50h (y = 1 to 6)
Name	Math Y Operator
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	3
Default Value	3

Sub-Index	1h to 3h (X = 1 to 3)
Description	Math Y Function X Operator
Access	RW
PDO Mapping	No
Value Range	See Table 22
Default Value	12 (Plus)

3.4.68 Object 5010h: Constant Field Value

This object is provided to allow the user to compare against a fixed value, i.e. in a conditional evaluation for a logic block. The first two values in this object are fixed at FALSE (0) and TRUE (1). There are ten other sub-indexes provide for other unconstrained data.

Object Description

Index	5010h
Name	Constant Field Value
Object Type	ARRAY
Data Type	FLOAT32

Entry Description

Sub-Index	0
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	15
Default Value	15

Sub-Index	1
Description	Constant False
Access	RO
PDO Mapping	No
Value Range	0
Default Value	0 (false)

Sub-Index	2
Description	Constant True
Access	RO
PDO Mapping	No
Value Range	1
Default Value	1 (true)

Sub-Index	3
Description	Constant FV 3
Access	RW
PDO Mapping	No
Value Range	Float32
Default Value	3.141593

Sub-Index	4
Description	Constant FV 4
Access	RW
PDO Mapping	No
Value Range	Float32
Default Value	2.718282

Sub-Index	5
Description	Constant FV 5
Access	RW
PDO Mapping	No
Value Range	Float32
Default Value	1.414214

Sub-Index	6
Description	Constant FV 6
Access	RW
PDO Mapping	No
Value Range	Float32
Default Value	1.732051

Sub-Index	7
Description	Constant FV 7
Access	RW
PDO Mapping	No
Value Range	Float32
Default Value	2.236068

Sub-Index	8
Description	Constant FV 8
Access	RW
PDO Mapping	No
Value Range	Float32
Default Value	2.50

Sub-Index	9
Description	Constant FV 9
Access	RW
PDO Mapping	No
Value Range	Float32
Default Value	5.00

Sub-Index	10
Description	Constant FV 10
Access	RW
PDO Mapping	No
Value Range	Float32
Default Value	10.00

Sub-Index	11
Description	Constant FV 11
Access	RW
PDO Mapping	No
Value Range	Float32
Default Value	20.00

Sub-Index	12
Description	Constant FV 12
Access	RW
PDO Mapping	No
Value Range	Float32
Default Value	40.00

Sub-Index	13
Description	Constant FV 13
Access	RW
PDO Mapping	No
Value Range	Float32
Default Value	60.00

Sub-Index	14
Description	Constant FV 14
Access	RW
PDO Mapping	No
Value Range	Float32
Default Value	80.00

Sub-Index	15
Description	Constant FV 15
Access	RW
PDO Mapping	No
Value Range	Float32
Default Value	100.00

3.4.69 Object 5020h: Power Supply Field Value

This read-only object is available for diagnostic feedback purposes. It reflects the measured voltage powering the controller. The physical unit for this object is volts.

Object Description

Index	5020h
Name	Power Supply Field Value
Object Type	VARIABLE
Data Type	FLOAT32

Entry Description

Sub-Index	0h
Access	RO
PDO Mapping	Yes
Value Range	0 to 70 [V]
Default Value	No

3.4.70 Object 5021h: Enable Error Detection on Power Supply

This write-able object is available to enable faults on power supply measured in the system. When this object is enabled, objects 5022h-5024h are used to determine fault triggers and fault clear thresholds. For more information please refer to Section 1.8.

Object Description

Index	5021h
Name	Enable Error Detection on Power Supply
Object Type	VARIABLE
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Access	RW
PDO Mapping	No
Value Range	FALSE; TRUE
Default Value	TRUE (1)

3.4.71 Object 5022h: Under Voltage Threshold

This object is used to set the value at which a supply fault will trigger if the measured supply falls below it. If object 5021h is disabled, this value is ignored. For more information please refer to Section 1.8.

Object Description

Index	5022h
Name	Under Voltage Threshold
Object Type	VARIABLE
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Access	RW
PDO Mapping	No
Value Range	0V… Object 5023h
Default Value	8 (V)

3.4.72 Object 5023h: Over Voltage Threshold

This object is used to set the value at which a supply fault will trigger if the measured supply falls above it. If object 5021h is disabled, this value is ignored. For more information please refer to Section 1.8.

Object Description

Index	5023h
Name	Over Voltage Threshold
Object Type	VARIABLE
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Access	RW
PDO Mapping	No
Value Range	Object 5022h… 36V
Default Value	35 (V)

3.4.73 Object 5024h: Hysteresis to Clear Power Supply Fault

This object is used to set the value by which the supply voltage needs to increase or decrease to clear the fault set by an under voltage or over voltage, respectively. If object 5021h is disabled, this value is ignored. For more information please refer to Section 1.8.

Object Description

Index	5024h
Name	Hysteresis to Clear Supply Fault
Object Type	VARIABLE
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Access	RW
PDO Mapping	No
Value Range	1V…30V
Default Value	5 (V)

3.4.74 Object 5030h: Processor Temperature Field Value

This read-only object is available for diagnostic feedback purposes. It reflects the measured processor temperature of the controller. The physical unit for this object is Celsius.

Object Description

Index	5030h
Name	Processor Temperature Field Value
Object Type	VARIABLE
Data Type	FLOAT32

Entry Description

Sub-Index	0h
Access	RO
PDO Mapping	Yes
Value Range	-50 to 150 [DegC]
Default Value	No

3.4.75 Object 5031h: Enable Error Detection on Temperature

This write-able object is available to enable faults on temperature measured in the system. When this object is enabled, objects 5032h-5033h are used to determine fault triggers and fault clear thresholds. For more information please refer to Section 1.8.

Object Description

Index	5021h
Name	Enable Error Detection on Temperature
Object Type	VARIABLE
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Access	RW
PDO Mapping	No
Value Range	FALSE; TRUE
Default Value	TRUE (1)

3.4.76 Object 5032h: Over Temperature Threshold

This object is used to set the value at which a temperature fault will trigger if the measured microcontroller temperature falls above it. If object 5031h is disabled, this value is ignored. For more information please refer to Section 1.8.

Object Description

Index	5032h
Name	Over Temperature Threshold
Object Type	VARIABLE
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Access	RW
PDO Mapping	No
Value Range	0…150 (DegC)
Default Value	85 (DegC)

3.4.77 Object 5033: Hysteresis to Clear Temperature Fault

This object is used to set the value by which the temperature needs to decrease to clear the fault set by an over temperature event. If object 5031h is disabled, this value is ignored. For more information please refer to Section 1.8.

Object Description

Index	5033h
Name	Hysteresis to Clear Temperature Fault
Object Type	VARIABLE
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Access	RW
PDO Mapping	No
Value Range	0…150 (DegC)
Default Value	25 (DegC)

3.4.78 Object 5550h: Enable Automatic Updates

This object allows the controller to update objects to defaults automatically when an output type is changed. Be default this object is TRUE.

Object Description

Index	5550h
Name	Enable Auto Updates
Object Type	VARIABLE
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Access	RW
PDO Mapping	No
Value Range	0 (FALSE) or 1 (TRUE)
Default Value	1 [TRUE]

3.4.79 Object 5555h: Start in Operational Mode

This object allows the unit to start in Operational mode without requiring the presence of a CANopen® Master on the network. It is intended to be used only when running the controller as a stand-alone module. This should always be set FALSE whenever it is connected to a standard master/slave network.

Object Description

Index	5555h
Name	Start in Operational Mode
Object Type	VARIABLE
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Access	RW
PDO Mapping	No
Value Range	0 (FALSE) or 1 (TRUE)
Default Value	0 [FALSE]

3.4.80 Object 5B50h: Change Baud Rate

The controller could be configured to different baud rates by changing the value in this object. The options for this object are defined in Table 24.

Object Description

Index	5B50h
Name	Change Baud Rate
Object Type	VARIABLE
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Access	RW
PDO Mapping	No
Value Range	0…8
Default Value	4(125k)

3.4.81 Object 5B51h: Change Node ID

This object is used to change the node ID of the module.

Object Description

Index	5B51h
Name	Change Node ID
Object Type	VARIABLE
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Access	RW
PDO Mapping	No
Value Range	Unsigned8
Default Value	127

4 Technical Specifications

Technical Specifications:

Specifications are indicative and subject to change. Actual performance will vary depending on the application and operating conditions. Users should satisfy themselves that the product is suitable for use in the intended application. All our products carry a limited warranty against defects in material and workmanship. Please refer to our Warranty, Application Approvals/Limitations and Return Materials Process as described on https://www.axiomatic.com/service/.

Power:

Power Supply Input	12V, 24V, 48Vdc nominal (8…80Vdc power supply range)
Surge and Transients	Surge and transient protection up to 120 V is provided.
Reverse Polarity	Reverse polarity protection is provided up to -80V.
Under-voltage	Under-voltage protection is provided. Hardware shuts down at 6V.
Over-voltage	Over-voltage protection is provided. Hardware shuts down at 85 V.
Quiescent Current	69mA@12V, 36mA@24V
+5V Reference	One +5VDC, +/- 0.5%, 100mA maximum

Inputs:

Digital Inputs	9 Digital Signal Inputs 3 Digital/PWM Inputs Refer to Table 1.0.
Universal Inputs	3 Universal Signal Inputs selectable as Voltage, Current, Resistance, Frequency, PWM or Digital Refer to Table 2.0.
TC Input	One (1) Type B, E, J, K, N, R, S and T The device reads mV signals from the supported Thermocouples. B = 0 to13.82mV E = -9.835 to 76.373 mV J = -8.095 to 69.553 mV K = -6.458 to 54.886 mV N = -4.345 to47.513mV R = -0.226 to 21.101mV S = -0.236 to 18.693mV T = -6.258 to 20.872mV (Other TC types are available on request.)
Resolution	Temperature data is measured with a resolution of 0.1 °C.
Drift	Overall drift with temperature is 50ppm/°C of span (maximum).
Accuracy	+/-1 °C throughout the entire range of the thermocouple input
Input Functionality	Temperature is measured in °C. The input sends a message to the CAN bus.
Measurement Rate	The measurement rate is 5 scans/Sec. The update rate is 200 mSec.
Common Mode	Common mode rejection is >110 db@ 5V p-p (programmable for either 50 or 60 Hz). Common mode input range is +/- 4 V minimum.
Ground	2 signal ground connections are provided.

Table 1.0 – Digital Inputs

Digital Inputs	Up to 12 digital inputs are selectable by the user from the following. • 9 Digital Inputs • 3 PWM/Digital Inputs The digital inputs can be configured for any one of the following options. • Disable Input • Digital Input In addition, Digital Input 5, 7 and 8 are configurable as the following. • PWM Signal (Frequency: 1-10,000Hz, 0-100% D.C.) • Frequency • Pulse Counter Pull up/ Pull down 10 KOhm Input voltage maximum is +Vps.
Protection	Protected against shorts to GND or +Vsupply

Table 2.0: Universal Inputs

<table>
<tr><th>Parameter</th><th>Value</th></tr>
<tr><td>Universal Inputs</td><td>Three (3) Universal Signal Inputs are provided.</td></tr>
<tr><td>Analog Input Modes</td><td>Voltage, Current, Resistance</td></tr>
<tr><td>Voltage Input</td><td>
<table>
<tr><th>Input Range</th><th>Input Impedance</th><th>Resolution</th><th>Accuracy</th></tr>
<tr><td>0…5V</td><td>204 kOhm</td><td>12-bit</td><td>+/- 0.1%</td></tr>
<tr><td>0…10V</td><td>153 kOhm</td><td>12-bit</td><td>+/- 1%</td></tr>
</table>
</td></tr>
<tr><td>Current Input</td><td>
<table>
<tr><th>Input Range</th><th>Input Impedance</th><th>Resolution</th><th>Accuracy</th></tr>
<tr><td>0…20mA</td><td rowspan="2">124Ohm</td><td rowspan="2">12-bit</td><td rowspan="2">+/- 0.01%</td></tr>
<tr><td>4…20mA</td></tr>
</table>
</td></tr>
<tr><td>Resistive Input</td><td>
<table>
<tr><th>Input Range</th><th>Resolution</th></tr>
<tr><td>Auto Range
20…250kOhm[1]</td><td>12-bit</td></tr>
</table>
[1] Resistance <20 Ohm is measured as 0.
</td></tr>
<tr><td>Analog Update Rate</td><td>1ms minimum[1].
[1] Depends on the analog filter settings. In resistive mode also depends on the number of resistive inputs.</td></tr>
<tr><td>Digital Input Modes</td><td>Discrete Voltage Level, Frequency, PWM Duty Cycle</td></tr>
<tr><td>Input Polarity</td><td>Active High, Active Low</td></tr>
<tr><td>Input Impedance</td><td>>1MOhm, High Z, 10kOhm pull down, 10kOhm pull-up to +6V</td></tr>
<tr><td>Amplitude</td><td>Amplitude: 3.3V to +Vsupply</td></tr>
<tr><td>Input Level</td><td>5V CMOS Compatible. A direct connection to the power supply is acceptable.</td></tr>
<tr><td>Discrete Voltage Level Input</td><td>1ms sampling rate. Configurable debouncing</td></tr>
<tr><td>Frequency Input</td><td>
<table>
<tr><th>Input Number</th><th>Counter Resolution</th><th>Frequency Range</th><th>Resolution</th><th>Accuracy</th></tr>
<tr><td>Universal Input #1…3</td><td>16-bit</td><td>0.5Hz…50kHz</td><td>0.0001%...1%</td><td><0.5%</td></tr>
</table>
</td></tr>
<tr><td>PWM Duty Cycle Input</td><td>
<table>
<tr><th>Input Number</th><th>Counter Resolution</th><th>Frequency Range</th><th>Resolution</th><th>Accuracy</th></tr>
<tr><td>Universal Input #1…3</td><td>16-bit</td><td>1Hz…10kHz</td><td>0.0001%...1%</td><td>+/- 1%</td></tr>
</table>
0…100% Duty Cycle Range. DC is included.
1 MOhm impedance
</td></tr>
<tr><td>Protection</td><td>+36V maximum. Positive voltage only. No reverse polarity protection.</td></tr>
</table>

Control Logic:

Software Platform	Pre-programmed with standard logic. Refer to the user manual. (Application-specific control logic is available on request.)

General Specifications

Microprocessor	STM32F427VI, 32-bit, 2MByte flash memory
Isolation	Full isolation of TC input channel from the CAN line, other inputs and power supply. 200Vrms
CAN Interface	1 CAN port (CANopen®)
Protection for CAN port	Short circuit to ground
User Interface	EDS File Download from axiomatic.com log-in page. Contact sales@axiomatic.com for the password.
Compliance	CE mark: EMC Directive RoHS Directive Exempt from Low Voltage Directive
Vibration	Random Vibration: 7.65 Grms peak Sinusoidal Component: 10 g peak Based on MIL-STD-202G, Methods 204G and 214A
Shock	50 g half sine pulse, 6 x 6ms per axis Based on MIL-STD-202G, Method 213B, Test Condition A

ISO 11898	120Ohm terminated twisted pair, baud rate up to 1Mbit/s. External 120Ohm termination is required.
Operating Conditions	-40 to 85 °C (-40 to 185 °F)
Protection	IP67, PCB is conformal coated and protected by the housing.
Weight	0.55 lb. (0.23 kg) preliminary
Enclosure and Dimensions	High Temperature Nylon Enclosure - (equivalent TE Deutsch P/N: EEC-325X4B) Refer to dimensional drawing.

Note: CANopen® is a registered community trademark of CAN in Automation e.V.

5 VERSION HISTORY

Version	Date	Author	Modifications
1	January 13th, 2021	Jessica Chen	Initial Draft
1.1	July 31, 2023	Kiril Mojsov	Performed Legacy Updates

OUR PRODUCTS

AC/DC Power Supplies

Actuator Controls/Interfaces

Automotive Ethernet Interfaces

Battery Chargers

CAN Controls, Routers, Repeaters

CAN/WiFi, CAN/Bluetooth, Routers

Current/Voltage/PWM Converters

DC/DC Power Converters

Engine Temperature Scanners

Ethernet/CAN Converters, Gateways, Switches

Fan Drive Controllers

Gateways, CAN/Modbus, RS-232

Gyroscopes, Inclinometers

Hydraulic Valve Controllers

Inclinometers, Triaxial

I/O Controls

LVDT Signal Converters

Machine Controls

Modbus, RS-422, RS-485 Controls

Motor Controls, Inverters

Power Supplies, DC/DC, AC/DC

PWM Signal Converters/Isolators

Resolver Signal Conditioners

Service Tools

Signal Conditioners, Converters

Strain Gauge CAN Controls

Surge Suppressors

OUR COMPANY

Axiomatic provides electronic machine control components to the off-highway, commercial vehicle, electric vehicle, power generator set, material handling, renewable energy and industrial OEM markets. ***We innovate with engineered and off-the-shelf machine controls that add value for our customers.***

QUALITY DESIGN AND MANUFACTURING

We have an ISO9001:2015 registered design/manufacturing facility in Canada.

WARRANTY, APPLICATION APPROVALS/LIMITATIONS

Axiomatic Technologies Corporation reserves the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. Users should satisfy themselves that the product is suitable for use in the intended application. All our products carry a limited warranty against defects in material and workmanship. Please refer to our Warranty, Application Approvals/Limitations and Return Materials Process at https://www.axiomatic.com/service/.

COMPLIANCE

Product compliance details can be found in the product literature and/or on axiomatic.com. Any inquiries should be sent to sales@axiomatic.com.

SAFE USE

All products should be serviced by Axiomatic. Do not open the product and perform the service yourself.

This product can expose you to chemicals which are known in the State of California, USA to cause cancer and reproductive harm. For more information go to www.P65Warnings.ca.gov.

SERVICE

All products to be returned to Axiomatic require a Return Materials Authorization Number (RMA#) from sales@axiomatic.com. Please provide the following information when requesting an RMA number:

- Serial number, part number
- Runtime hours, description of problem
- Wiring set up diagram, application and other comments as needed

DISPOSAL

Axiomatic products are electronic waste. Please follow your local environmental waste and recycling laws, regulations and policies for safe disposal or recycling of electronic waste.

CONTACTS

Axiomatic Technologies Corporation
1445 Courtneypark Drive E.
Mississauga, ON
CANADA L5T 2E3
TEL: +1 905 602 9270
FAX: +1 905 602 9279
www.axiomatic.com
sales@axiomatic.com

Axiomatic Technologies Oy
Höytämöntie 6
33880 Lempäälä
FINLAND
TEL: +358 103 375 750
www.axiomatic.com
salesfinland@axiomatic.com