12 DIGITAL INPUT, 8 RELAY OUTPUT CONTROLLER

With CANopen®

USER MANUAL

P/N: AXDIO128CO

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VERSION HISTORY

Version	Date	Author	Modifications
1.0.0	June 27, 2011	Anna Murray	Initial Draft
2.0.0	Dec. 21, 2011	A. Wilkins	Updated for new hardware and 2A@277VAC
2.0.1	Sept. 10, 2015	A. Wikins	Added compliance information
--	Oct. 22, 2015	A. Wilkins	Upgraded to IP67 based on testing

ACRONYMS

CAN	Controller Area Network
CANopen®	CANopen® is a registered community trademark of CAN in Automation e.V.
CAN-ID	CAN 11-bit Identifier
COB	Communication Object
CTRL	Control
DI	Digital Input
DO	Digital Output (Relay)
EDS	Electronic Data Sheet
EMCY	Emergency
LSB	Least Significant Byte (or Bit)
LSS	Layer Settling Service
MSB	Most Significant Byte (or Bit)
NMT	Network Management
RO	Read Only Object
RPDO	Received Process Data Object
RW	Read/Write Object
SDO	Service Data Object
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 device profile for generic I/O modules. CAN in Automation 2008

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

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1. OVERVIEW OF CONTROLLER

1.1. Description of 12 Input, 8 Output Controller

The Discrete 12 Input, 8 Relay Output Module (DIO128) is designed to provide a simple interface between a CiA CANopen ® network and discrete electronic devices in a power generator set control system or industrial environment. It can translate voltage levels on the inputs to a bit in a TPDO data byte. The outputs can be either controlled by any discrete input on the DIO128, or it can receive and process a bit in an RPDO data byte to control the relays. The outputs can also be individually or globally enabled/disabled by a discrete input while being controlled by an RPDO message.

All twelve inputs on the unit accept an active low (i.e. switched to ground) digital signal. When the digital input (DI) is left open, the pin is internally pulled up to +5V with a 10kΩ resistor. When the input is connected to GND, the controller considers the input to be ON. Debounce filtering for each input is provided to prevent spurious signals from erroneously energizing/de-energize a relay or saturating the CAN network.

The eight outputs on the unit are Form C relays which are energized when the digital output (DO) is ON. See Appendix A for the full technical specification of the relays.

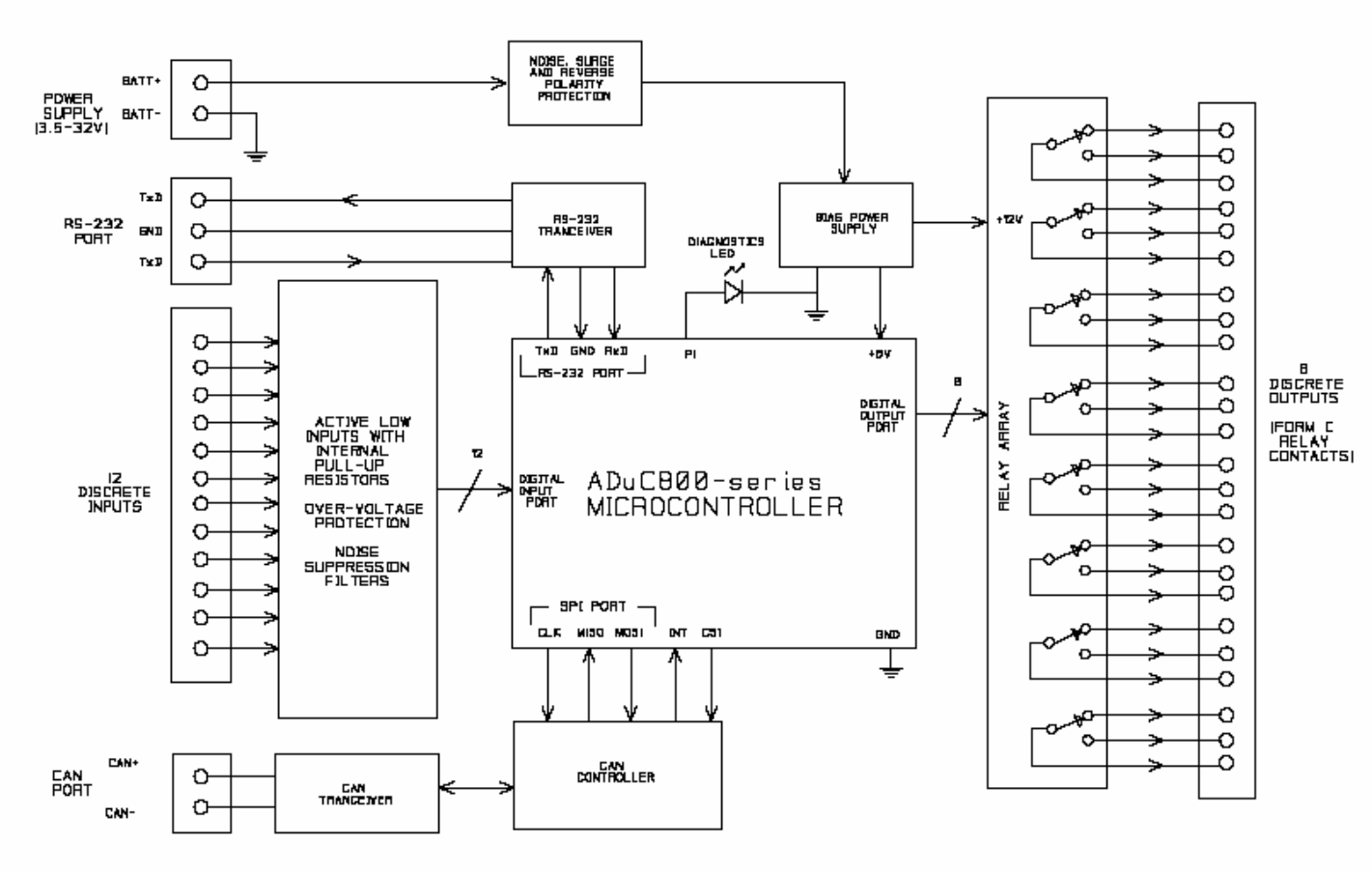


Figure 1 – Hardware Block Diagram

The DIO128 is a versatile controller compliant with the CiA standard DS-401. It supports many objects from that device profile as well as some manufacturer objects to provide expanded functionality. All objects are user configurable using standard commercially available tools that can interact with a CANopen ® Object Dictionary via an .EDS file.

Depending on how they set it up, the user can easily switch from having the relays respond to CAN commands; using the discrete inputs to drive some or all of the outputs; having them go to an individually preset state in error mode; or to enable/disable them using a discrete input(s).

1.2. LED Indicator

A front panel bi-color LED indicator allows user to observe the current state of DIO128 and easily identify a normal operating condition and situations when there is a network error or absence of network traffic. In case of an error on the network, power glitch or other emergency situation, the DIO128 will self-recover to the pre-operational mode immediately after the normal condition is restored.

State	**Relay Operation**	**LED Operation**	**Notes**
INITIALIZING	OFF	OFF	
PRE-OPERATIONAL	Respond only to discrete input (DI) commands	Solid GREEN	
OPERATIONAL	Respond to both DI and CAN data (RPDO1) commands	Blinking GREEN	If no CAN messages are received after 3 seconds, LED will alternate blinking RED and GREEN
STOPPED	OFF	Blinking RED	
BUSOFF	Error Value or per Pre-Op state	Solid RED	If bit in DO Error Mode object 6206h is set, the Error Value is applied
Lost Consumer Heartbeat	Error Value or per State selected by Error Behaviour object 1029h	Per node state	
RPDO1 Timeout			

Table 1 – Relay and LED Operation Depending on Node State

1.3. Error Detection and Reaction

As shown in the last columns of Table 1, there are three types of errors that the DIO128 can detect and react to:

1 = CAN Bus Error	Unit automatically enters BUSOFF state and stays there until reconnection to the network is established
2 = Lost Heartbeat	When object **1016h, Consumer Heartbeat Time** sub-index 1, has a non-zero valid entry. (Note: only one HB consumer is supported in this module)
3 = Lost RPDO1	When object **1400h, Receive PDO1 Parameter** sub-index 5 is written with a non-zero value, the unit will expect to receive the message within that timeframe (ms resolution) or else the unit will flag a lost RPDO1 error.

If any of these errors should occur, object **1001h, Error Register** will be set to 0x01 (generic error) and the error will be added to **1003h, Pre-Defined Error Field** as outlined in Section 3.2.3.

In the case of a CAN network fault, the module will remain in the BUSOFF mode until the problem is resolved, regardless of what is set in object **1029h, Error Behaviour** sub-index 1. Only once the conditions causing the error are gone and connection to the network has been successfully re-established will the unit evaluate 1029h.

If object **1017h, Producer Heartbeat Time** (default 0) is zero, the unit will send a heartbeat showing that it is in BUSOFF mode (255) every 3 seconds in order to determine when the network is present even if no other nodes are transmitting data at the time. If a heartbeat would be sent regularly due to a non-zero value in 1017h, this feature is not required.

For a lost heartbeat or RPDO1, however, the unit will immediately evaluate object 1029h sub-indexes 2 and 3 respectively, and change the node state accordingly. Both of these errors will also set object 1001h to 0x01.

Only once all errors in the module have been cleared will object 1001h be reset to 0x00.

1.4. Digital Input Function Block

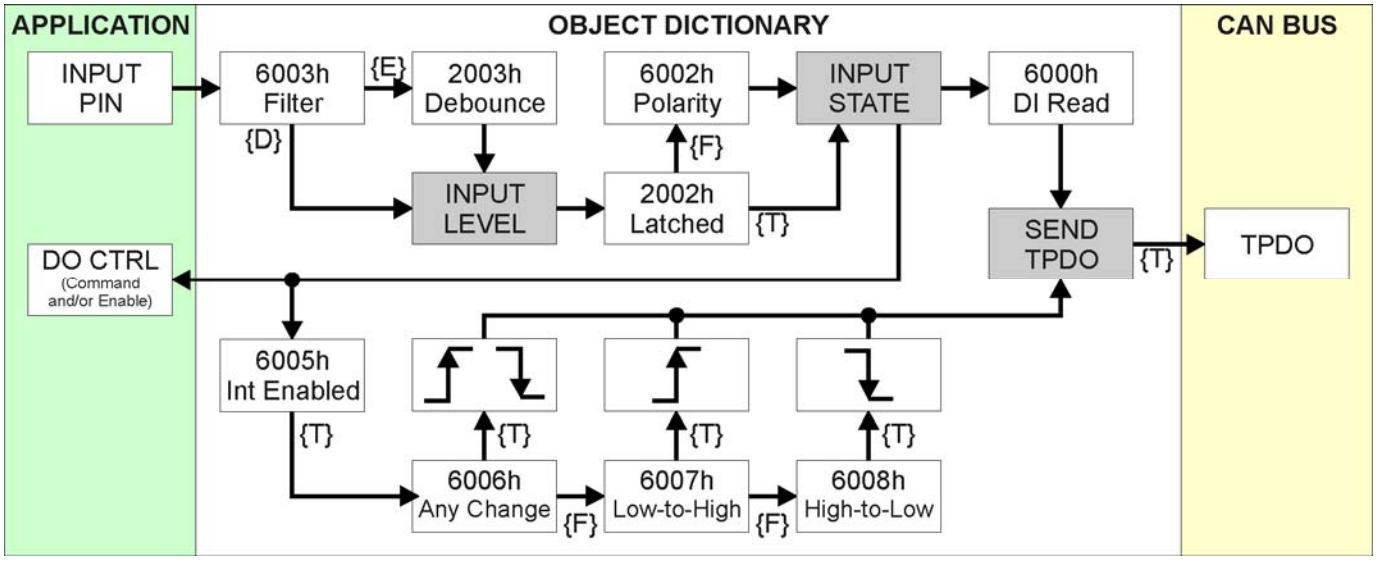


Figure 2 – Digital Input Objects

For the digital inputs (DI), all associated objects (except 2003h) are an 8-bit type. The table below shows the relationship between each bit and the corresponding input.

Subindex	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	DI8	DI7	DI6	DI5	DI4	DI3	DI2	DI1
2	-	-	-	-	DI12	DI11	DI10	DI9

Table 2 – Digital Input Bitmap

In all cases when talking about bit data, the following relationships hold true:

0 = OFF 1 = ON
0 = FALSE 1 = TRUE
0 = DISABLED 1 = ENABLED

When evaluating a DI, the controller will read the level (0,1) at the pin, and when it detects a change of state, it looks at object **6002h, DI Filter Input.** When filtering is ENABLED (default 1), the level change at the input will not be passed to the rest of the function block until after the time in **2003h, DI Debounce Time** (default 30ms) has elapsed, as shown in Figure 3. If and only if the input is the same after debouncing will the state change be reflected in the “Input Level” logic. If 6002h is DISABLED, the “Input Level” immediately reflects the state of the pin.

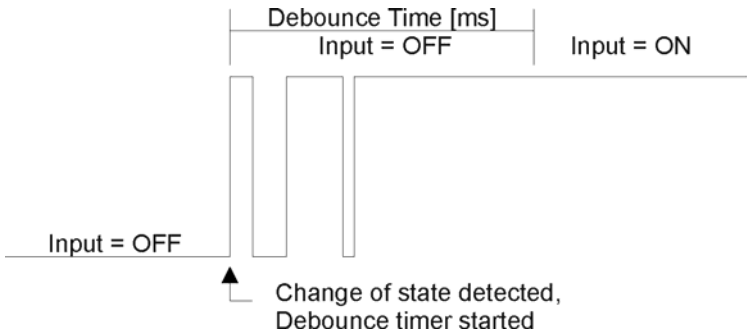


Figure 3 – Digital Input Debouncing

Next, the controller looks at object **2002h, DI Latched** (default 0), and if TRUE the “Input State” of the input will toggle only on the rising edge of the input, as shown in Figure 4. This type of input could be used with a momentary push-button. Note: When 2002h is true, object 6002h is ignored.

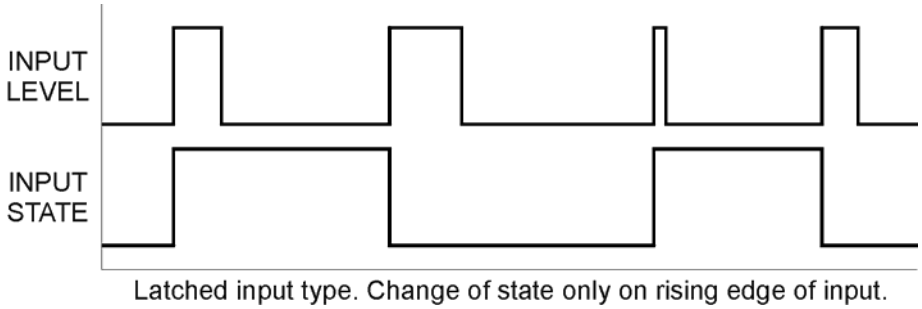


Figure 4 – Digital Input Latched Logic

If not using latched logic, the controller then evaluates object **6002h, DI Polarity** (default 0). When it is ENABLED, the “Input State” will be the opposite of the “Input Level.”

The “Input State” value is written to object **6000h, DI Read Input** a read-only object that is mapped to TPDO1 by default, as outlined in Section 3.2.13. When TPDO1 is defined to be an event driven transmission type (default 255), object **6005h, DI Global Interrupt Enable** (default 1) is applicable. In this case, the TPDO will only be sent when the “Input State” changes.

What kind of state change activates the transmission is determined by one, and only one, of the following objects. First, object **6006h, DI Interrupt Mask Any Change** (default 1) is evaluated. If it is TRUE, then TPDO1 is sent every time the “Input State” changes. If and only if 6006h is false, then object **6007h, DI Interrupt Mask Low-to-High** (default 0) is evaluated. If it is TRUE, then TPDO1 is sent only on the rising edge of the input, i.e. when the “Input State” changes from 0 to 1. Lastly, if and only if 6006h and 6007h are false, then object **6008h, DI Interrupt Mask High-to-Low** (default 0) is evaluated. If it is TRUE, then TPDO1 is sent only on the falling edge of the input, i.e. when the “Input State” changes from 1 to 0.

If 6005h is TRUE, but 6006h, 6007h and 6008h are all FALSE (should not be done!), then the controller will default to the 6006h behaviour, where any state change will cause TPDO1 to be sent.

1.5. Digital Output Function Block

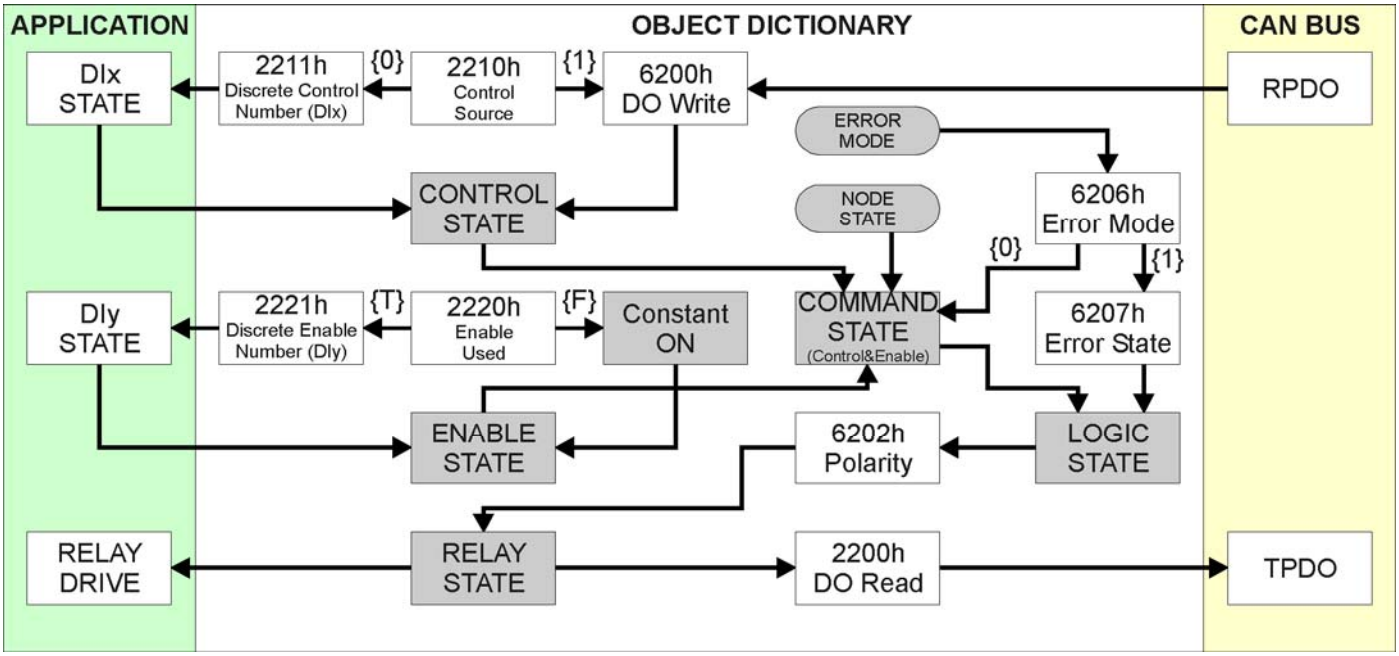


Figure 5 – Digital Output Objects

For the digital outputs (DO), all associated objects (except 2211h and 2221h) are an 8-bit type. The table below shows the relationship between each bit and the corresponding relay output.

Subindex	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	DO8	DO7	DO6	DO5	DO4	DO3	DO2	DO1

Table 3 – Digital Output Bitmap

When driving the outputs, the first thing the controller checks is that it is not in an error state by reading object **1001h, Error Register**. If an error is active, then object **6206h, DO Error Mode** (default 1) is evaluated, and if it is 1, then the "Logic State" is immediately set to the value in object **6207h, Error Value** (default 0). In this case, none of the other logic outlined below (except polarity) is applied.

If no error is active, or 6206h is 0, then the enable logic for the output is evaluated. Object **2220h, DO Enable Input Used** (default 0) is read, and if TRUE then the state of the input at the sub-index defined in object **2221h, DO Discrete Enable Number** (default 9) is read. If this input is OFF, then the "Logic State" is immediately set OFF and none of the other logic outlined below (except polarity) is applied.

If 2220h is FALSE, or the enable input is ON, then the controller checks the node state. If STOPPED, then the "Logic State" is automatically set OFF, unless 6206h is set in which case "Logic State" is set to 6207h. In all other modes (including BUSOFF), object **2210h, DO Control Source** (default 1) is read.

When 2210h is set (1) the output is controlled by the data in object **6200h, DO Write Output** (default 0) which is mapped to RPDO1 by default. Since PDOs do not exist in PRE-OPERATIONAL mode, the “Logic State” is always set OFF in this case. In OPERATIONAL mode, however, the “Logic State” will reflect the value in object 6200h.

When 2210h is clear (0), the output is controlled by the state of the input at the sub-index defined in object **2211h, DO Discrete Control Number** (default same as DO number, 1 to 8.) In PRE-OPERATIONAL, OPERATIONAL and BUSOFF modes, the outputs can be controlled directly by any one of the on-board discrete inputs. In these modes, the “Logic State” will reflect the selected “Input State” reflected in object 6000h.

Once the “Logic State” for the output has been established per the conditions above, object **6202h, DO Polarity** (default 0) is evaluated. When it is ENABLED, the “Relay State” will be the opposite of the “Logic State.”

The value “Relay State” is applied to the relay outputs. When ON, the relay is energized. Since the actual state of the relay output does not necessarily reflect the value in object 6200h, object **2200h, DO Read Output** a read-only object reflecting the actual output state which is mapped to TPDO1 by default, as outlined in Section 3.2.13.

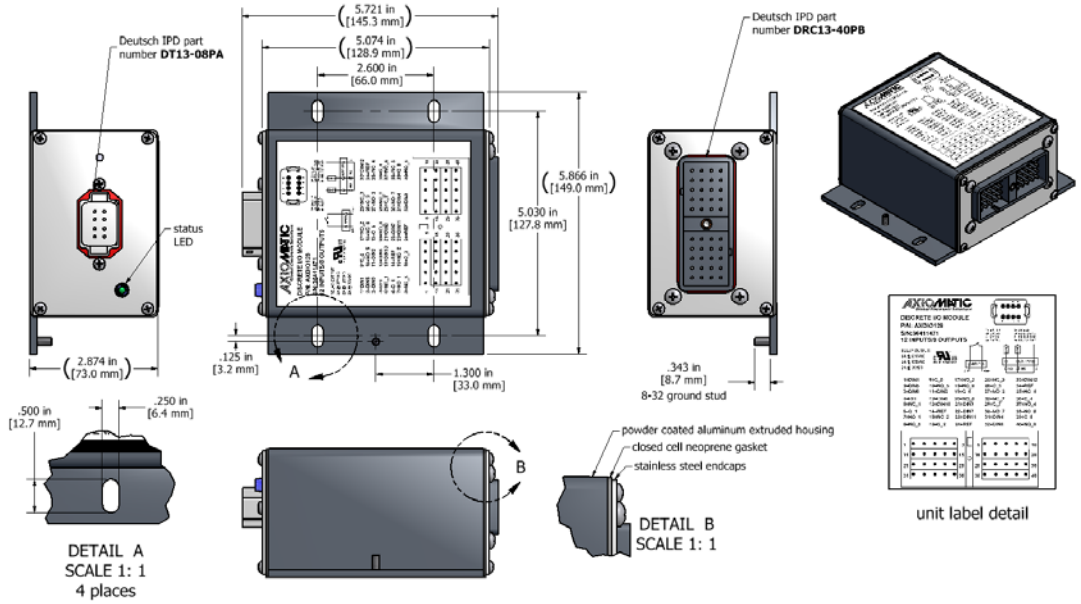
1.6. Miscellaneous Function Block

There are two other objects available which have not yet been discussed. The first object **3000h, CAN Slew Rate** (default 1) can be used to select either a FAST (1) or SLOW (0) slew rate for the bits sent to the CAN network.

The final object **5555h, Start in Operational** (default 0) 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).

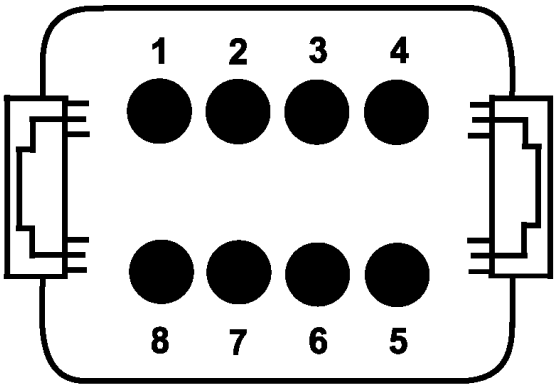
2. INSTALLATION INSTRUCTIONS

2.1. Dimensions and Pinout



NB. The AXDIO128 is shown here. The model AXDIO128CO has the same packaging, connectors, pin out and dimensions.

Figure 6 – Housing Dimensions

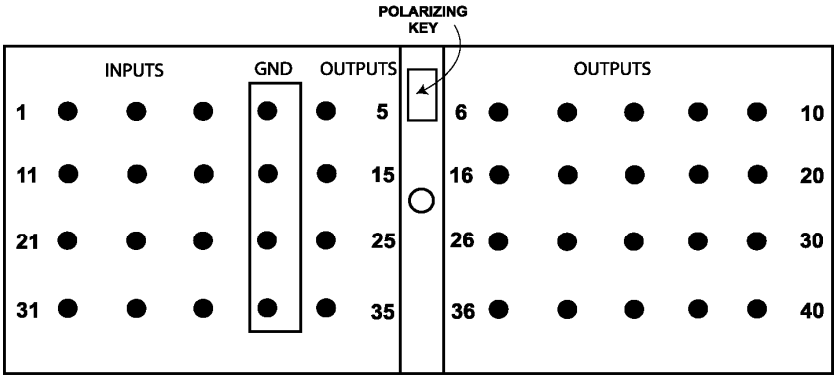


1 = PWR+ 5 = SHIELD
2 = CAN-H 6 = RS-232 GND
3 = CAN-L 7 = RS-232 TXD
4 = PWR- 8 = RS-232 RXD

FRONT VIEW
MODULE MOUNTED CONNECTOR
DEUTSCH P/N: DT13-08PA
(Mating plug is DT06-08SA with wedge W8S and sockets 0462-201-16141)

Figure 7 – 8-Pin Connections

FRONT VIEW OF
MODULE MOUNTED CONNECTOR
DEUTSCH P/N: DRC13-40PB



NO - Normally Open
NC - Normally Closed
C - Common

INPUTS	Pin	OUTPUTS	Pin
DIN1	1	NC_1	5
DIN2	11	C_1	6
DIN3	21	NO_1	7
DIN4	31	NC_2	15
DIN5	2	C_2	16
DIN6	12	NO_2	17
DIN7	22	NC_3	25
DIN8	32	C_3	26
DIN9	3	NO_3	27
DIN10	13	NC_4	35
DIN11	23	C_4	36
DIN12	33	NO_4	37
GND	4	NC_5	8
GND	14	C_5	9
GND	24	NO_5	10
GND	34	NC_6	18
		C_6	19
		NO_6	20
		NC_7	28
		C_7	29
		NO_7	30
		NC_8	38
		C_8	39
		NO_8	40

Connections – I/O

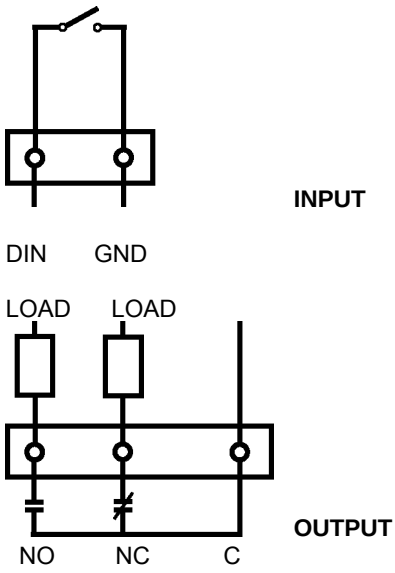


Figure 8 – 40-Pin Connections

2.2. Installation Instructions

NOTES & WARNINGS

- Do not install near high-voltage or high-current devices.
- Ground the chassis for safety purposes and proper EMI shielding.
- 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 (6 inches or 15 cm) and strain relief (12 inches or 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 ledges include holes sized for ¼ inch or M6 bolts. The bolt length will be determined by the end-user's mounting plate thickness. Typically ¾ inch (20 mm) is adequate.

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.

No wire or cable harness should exceed 30 meters in length. The power input wiring should be limited to 10 meters.

CONNECTIONS

Use the following Deutsch IPD mating plugs to connect to the integral receptacles. Wiring to these mating plugs must be in accordance with all applicable local codes. Suitable field wiring for the rated voltage and current must be used. The rating of the connecting cables must be at least 85°C. For ambient temperatures below –10°C and above +70°C, use field wiring suitable for both minimum and maximum ambient temperature.

Mating Connectors	DT06-8SA and wedge W8S (Power and CAN) DRC16-40SB (I/O Interface)
Sockets	0462-201-16141 or acceptable alternate Refer to www.laddinc.com for more information on the contacts available for this mating plug.

Axiomatic offers a mating plug kit for the product, P/N: **AX070200**.
This kit includes the following items.
NB. The sealing plugs are only needed in cases where not all of the 40 pins are used.

Deutsch IPD P/N:	***Description:***
0462-201-16141	48 16AWG SOCKETS SOLID 16-20AWG WIRE 6mm
114017	24 SEALING PLUGS SIZE 12-16 CAVITIES 12-18 AWG
DRC16-40S	40-PIN PLUG, No Key
DT06-08SA	DT SERIES PLUG 8 CONTACT
W8S	WEDGELOCK FOR DT 8 PIN PLUG

These items are also available from a local Deutsch IPD distributor.
A crimping tool from Deutsch IPD is required to connect wiring to the sockets, P/N: HDT 48-00 or equivalent (not supplied).

NOISE – ELECTRICAL CONNECTIONS AND SHIELDING

To reduce noise, separate all power and output wires from those of the input and CAN. Shielded wires will protect against injected noise. Shield wires should be connected at the power or input source, or at the output load.

The CAN shield can be connected at the controller using the CAN Shield pin provide on the connector. However the other end should not be connected in this case.

All wires used must be 16 or 18 AWG.

GROUNDING

Protective Earth (PE) must be connected to the module's grounding lug to reduce the risk of electric shock. The conductor providing the connection must have a ring lug and wire larger than or equal to 4 mm^2 (12 AWG). The ring lug should be placed between the nut and a star washer.

All chassis grounding should go to a single ground point designated for the machine and all related equipment. Axiomatic recommends that the ground strap that provides a low impedance path for EMI should be a ½ inch wide, flat, hollow braid, no more than 12 inches long .

FUSING

When installing the unit, an external 3A, 32Vdc fuse is required.

CAN WIRING

The CAN port is electrically isolated from all other circuits. The isolation is SELV rated with respect to product safety requirements. Refer to the CAN specification for more information.

Use CAN compatible cabling, recommended for on engine use.

Shielded CAN cable is required. The module provides the CAN port shield connection ac coupled to chassis ground. The chassis ground stud located on the mounting foot must be tied directly to Earth Ground.

CAN NETWORK CONSTRUCTION

Axiomatic recommends that multi-drop networks be constructed using a “daisy chain” or “backbone” configuration with short drop lines.

CAN TERMINATION

It is necessary to terminate the network; therefore an external CAN termination is required. No more than two network terminators should be used on any one single network. A terminator is a 121Ω, 0.25 W, 1% metal film resistor placed between CAN_H and CAN_L terminals at the end two nodes on a network.

3. CANOPEN ® OBJECT DICTIONARY

The CANopen object dictionary of the DIO128 Controller is based on CiA device profile DS-401 V3.0 (device profile for generic I/O modules). 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 DIO128 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 32)

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 32 – LSS Baudrate Indexes

- 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):

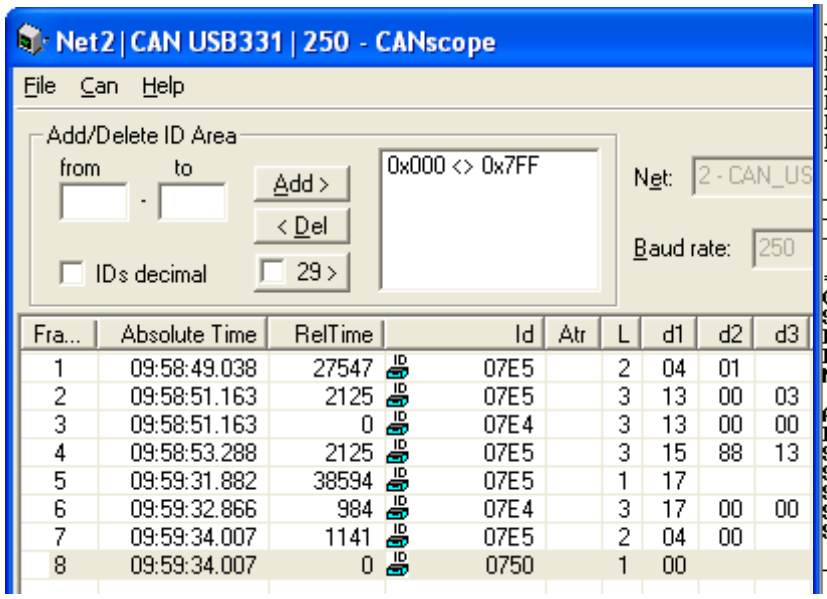
Item	*Value*	
COB-ID	0x7E4	
Length	3	
Data 0	0x17	(cs=23 for store configuration)
Data 1	0x00	
Data 2	0x00	

- 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 4 and 5, the baudrate on the CAN Scope tool was changed from 125 to 250 kbps.




```
+========================================+
I Project     : AXDIO128CO               I
I Version     : V1.1.1                   I
I Release Date: June 24, 2011            I
I                                        I
I (c) Axiomatic Technologies Corporation I
I www.axiomatic.com                      I
+========================================+

->Node Id   = 80
->Baudrate  = 125 [kbps]
->CAN Mode  = PRE-OPERATIONAL

================ Menu ================
O - View Object Dictionary
S - Show/Stop Diagnostics
R - Read Regulator Data
D - Restore Default Objects
M - Show Main Menu (this) Again

Activating new baud = 250 [kbps]
Restarting CAN in 5000 [ms]
Storing ID
Storing Factory Parameters
Storing Baud
Storing Factory Parameters
Storing Communication Parameters

->CAN Mode  = PRE-OPERATIONAL
```

3.2. COMMUNICATION OBJECTS (DS-301 and DS-401)

The communication objects supported by the DIO128 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
1003	Pre-Defined Error Field	ARRAY	UNSIGNED32	RO	No
100C	Guard Time	VAR	UNSIGNED16	RO	No
100D	Life Time Factor	VAR	UNSIGNED8	RO	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	RW	No
1029	Error Behaviour	ARRAY	UNSIGNED8	RW	No
1400	RPDO1 Communication Parameter	RECORD		RW	No
1401	RPDO2 Communication Parameter	RECORD		RO	No
1402	RPDO3 Communication Parameter	RECORD		RO	No
1403	RPDO4 Communication Parameter	RECORD		RO	No
1600	RPDO1 Mapping Parameter	RECORD		RW	No
1601	RPDO2 Mapping Parameter	RECORD		RO	No
1602	RPDO3 Mapping Parameter	RECORD		RO	No
1603	RPDO4 Mapping Parameter	RECORD		RO	No
1800	TPDO1 Communication Parameter	RECORD		RW	No
1801	TPDO2 Communication Parameter	RECORD		RO	No
1802	TPDO3 Communication Parameter	RECORD		RO	No
1803	TPDO4 Communication Parameter	RECORD		RO	No
1A00	TPDO1 Mapping Parameter	RECORD		RW	No
1A01	TPDO2 Mapping Parameter	RECORD		RO	No
1A02	TPDO3 Mapping Parameter	RECORD		RO	No
1A03	TPDO4 Mapping Parameter	RECORD		RO	No

3.2.1. Object 1000h: Device Type

This object contains information about the device type as per device profile DS-401. The 32-bit parameter is divided into two 16-bit values, showing General and Additional information as shown below.

MSB	LSB
Additional Information = 0x0003	**General Information** = 0x0191 (401)

DS-401 defines the Additional Information field in the following manner:

0000h = invalid, not allowed
0001h = digital input(s) implemented (1b = implemented)
0002h = digital output(s) implemented (1b = implemented)
0004h = analogue input(s) implemented (0b = not implemented)
0008h = analogue output(s) implemented (0b = not implemented)

0010h = reserved
0020h = reserved
0040h = reserved
0080h = M(apping of PDOs) (0b = pre-defined, generic PDO mapping is supported)

00xxh = specific functionality (00h = no specific joystick function)

Object Description

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

Entry Description

Access	RO
PDO Mapping	No
Value Range	0x00030191
Default Value	0x00030191

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 DIO128 Controller, the Generic Error Bit (bit 0) is set. Only if there is no errors in the module will this bit will be cleared. No other bits in this register are used by the DIO128 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 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 behaviour state if at least one error is still active.

The DIO128 Controller has a limitation of a maximum of 3 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**

Only if a heartbeat consumer fails to be received within the expected timeframe will the Channel-ID (nn) reflect the Node-ID of the consumer channel that was not producing. Otherwise, this field is set to 00h. In all cases, the Error Descriptions bits will be set to 00h. Table 4 outlines all the possible error codes generated by the DIO128 and their associated meaning.

Code	Error Description	Meaning	ID	Meaning	EMCY Code	Meaning
00000000h	EMCY Error Reset (fault no longer active)					
00008110h	00h	Unspecified	00h	Unspecified	8110h	CAN overrun (RPDO1 Lost)
00nn8130h	00h	Unspecified	nn	Node-ID	8130h	Heartbeat (Timeout) Error
00008140h	00h	Unspecified	00h	Unspecified	8140h	Recovered from Busoff

Table 4 – 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 3
Default Value	0

Sub-Index	1h to 3h
Description	Standard error field
Access	RO
PDO Mapping	No
Value Range	UNSIGNED32
Default Value	0

3.2.4. Object 100Ch and 100Dh: Guard Time and Lifetime Factor

The objects at index 100Ch and 100Dh have been provided to for backwards compatibility. However, since the standard recommends that newer networks do not use the life guarding protocol, but rather heartbeat monitoring instead, these objects are defined as read-only and are therefore not relevant in this product.

Object Description

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

Index	100Dh
Name	Life time factor
Object Type	VAR
Data Type	UNSIGNED8

Entry Description

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

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

3.2.5. 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 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 DIO128 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 DIO128 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

3.2.6. 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 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 DIO128 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 DIO128 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 DIO128 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

3.2.7. Object 1016h: Consumer Heartbeat Time

The DIO128 Controller can be a consumer of heartbeat objects for up to one module. This object defines the expected heartbeat cycle time for that module, and if set to zero, it is not used. When 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 DIO128 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 to 4h
Description	Consumer heartbeat time
Access	RW
PDO Mapping	No
Value Range	UNSIGNED32
Default Value	0

3.2.8. Object 1017h: Producer Heartbeat Time

The DIO128 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

3.2.9. Object 1018h: Identity Object

The identity object indicates the data of the DIO128 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	0x00011102
Default Value	0x00011102

Sub-Index	3h
Description	Revision Number
Access	RO
PDO Mapping	No
Value Range	UNSIGNED32
Default Value	0x00010101

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

3.2.10. 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 0x10082010 would indicate that the software was compiled on August 10th, 2010. A time value of 0x00001620 would indicate it was compiled at 4:20pm.

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

3.2.11. Object 1029h: Error Behaviour

This object controls the node state that the DIO128 Controller will be set into in case of an error of the type associated with the sub-index.

A CAN overrun fault is flagged when an RPDO is not received within the expected time period defined in the "Event Timer" of the associated communication object (see Section 3.2.12 for more information.) If a heartbeat message is not received as expected (see Section 3.2.8), a Heartbeat Error is flagged. See Sections 1.3 and 3.2.3 for more information about how the DIO128 reacts to errors.

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 Behaviour
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	Busoff Recovery (EMCY 8140h)
Access	RW
PDO Mapping	No
Value Range	See above
Default Value	0 (Pre-operational)

Sub-Index	2h
Description	Lost Heartbeat (EMCY 8130h)
Access	`RW
PDO Mapping	No
Value Range	See above
Default Value	1 (No State Change)

Sub-Index	3h
Description	Lost RPDO1 (EMCY 8110h)
Access	RW
PDO Mapping	No
Value Range	See above
Default Value	1 (No State Change)

3.2.12. 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 DIO128 Controller supports up to four RPDO messages for compatibility with DS-301, but only the first RPDO is useable. RPDO1 is set according to the pre-defined connection set described in DS-401. The other three RPDOs do not exist and are defined as read-only objects so they are not changeable. RPDO1 uses the default mapping defined in DS-401.

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

Sub-Index	***Value***	***Object***
0	1	Number of mapped application objects in PDO
1	0x62000108	DO Write Output 8-bit (DO1 to DO8)
2	0	Not used by default
3	0	Not used by default
4	0	Not used by default

RPDO2 Mapping at Object 1601h: Default ID 0x300 + Node ID
RPDO3 Mapping at Object 1602h: Default ID 0x400 + Node ID
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

On RPDO1, there is no RTR allowed, it uses 11-bit CAN-IDs (base frame valid) and it is event-driven (transmission type = 255). By default, it does not 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 3.

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
Value Range	See value definition in DS-301
Default Value	40000000h + RPDO1 + Node ID C0000000h + RPDOx + Node-ID

X	*RPDOx ID*
1	0200h
2	0300h
3	0400h
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	RO
PDO Mapping	No
Value Range	See value definition in DS-301
Default Value	0

Sub-Index	4h
Description	Compatibility entry
Access	RO
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.

3.2.13. TPDO Behaviour

The DIO128 Controller supports up to four TPDO messages for compatibility with DS-301, but only the first TPDO is useable. TPDO1 is set according to the pre-defined connection set described in DS-401. The other three TPDOs do not exist and are defined as read-only objects so they are not changeable. TPDO1 complies with the default mapping defined in DS-401, with the addition of the manufacture object 2200h.

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

Sub-Index	***Value***	***Object***
0	3	Number of mapped application objects in PDO
1	0x60000108	DI Read Object 8-bit (DI1 to DI8)
2	0x60000208	DI Read Object 8-bit (DI9 to DI12)
3	0x22000108	DO Read Object 8-bit (DO1 to DO8)
4	0	Not used by default

TPDO2 Mapping at Object 1A01h: Default ID 0x280 + Node ID
TPDO3 Mapping at Object 1A02h: Default ID 0x380 + Node ID
TPDO4 Mapping at Object 1A03h: Default ID 0x480 + 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

On TPDO1, there is no RTR allowed, it uses 11-bit CAN-IDs (base frame valid) and it is event-driven by interrupts (transmission type = 255, i.e. when a DI changes state). Alternatively, it can be set for a time based response by changing the transmission type to 254, and changing the “Event Timer” on sub-index 5 to a non-zero value. In this case, the TPDO1 will automatically be broadcasted every X milliseconds (as defined by the value in the event timer) while the unit is in the OPERATIONAL mode.

Object Description

Index	1800h to 1803h
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 C0000000h + TPDOx + Node-ID

X	*TPDOx ID*
1	0180h
2	0280h
3	0380h
4	0480h

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	254 (FEh) = Event Driven, Timed 255 (FFh) = Event Driven, Interrupts
Default Value	255 (FFh) = Event Driven, Interrupts

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

Sub-Index	4h
Description	Compatibility entry
Access	RO
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	0ms

Recall: A non-zero event timer for a TPDO is only valid with transmission type = 254 while in Operational mode

3.3. APPLICATION OBJECTS (DS-401)

Index (hex)	*Object*	*Object Type*	*Data Type*	*Access*	*PDO Mapping*
6000h	DI Read Input 8-bit	ARRAY	UNSIGNED8	RO	Yes
6002h	DI Polarity 8-bit	ARRAY	UNSIGNED8	RW	No
6003h	DI Filter Input 8-bit	ARRAY	UNSIGNED8	RW	No
6005h	DI Global Interrupt Enable 8-bit	ARRAY	UNSIGNED8	RW	No
6006h	DI Interrupt Mask Any Change 8-bit	ARRAY	UNSIGNED8	RW	No
6007h	DI Interrupt Mask Low-to-High 8-bit	ARRAY	UNSIGNED8	RW	No
6008h	DI Interrupt Mask High-to-Low 8-bit	ARRAY	UNSIGNED8	RW	No
6200h	DO Write Output 8-bit	ARRAY	UNSIGNED8	RW	Yes
6202h	DO Polarity 8-bit	ARRAY	UNSIGNED8	RW	No
6206h	DO Error Mode 8-bit	ARRAY	UNSIGNED8	RW	No
6207h	DO Error Value 8-bit	ARRAY	UNSIGNED8	RW	No

3.3.1. Object 6000h: DI Read Input 8-bit

This read-only object represents the digital input state from 8 input lines. Refer to Section 1.4 for more information. See Table 2 for bit order within the bytes. This object is mapped to TPDO1 by default.

Object Description

Index	6000h
Name	DI Read Input 8-bit
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

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

Sub-Index	1h
Description	DI1 to DI8 State
Access	RO
PDO Mapping	Yes
Value Range	FFh (255) [1111 1111b]
Default Value	No

Sub-Index	2h
Description	DI9 to DI12 State
Access	RO
PDO Mapping	Yes
Value Range	0Fh (15) [0000 1111b]
Default Value	No

3.3.2. Object 6002h: DI Polarity 8-bit

This object defines the polarity of a group of 8 input lines. Input polarity can be inverted individually.

1 = input inverted 0 = input not inverted

Object Description

Index	6002h
Name	DI Polarity 8-bit
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

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

Sub-Index	1h
Description	DI1 to DI8 Polarity
Access	RW
PDO Mapping	No
Value Range	FFh (255) [1111 1111b]
Default Value	00h (0) [0000 0000b]

Sub-Index	2h
Description	DI9 to DI12 Polarity
Access	RW
PDO Mapping	No
Value Range	0Fh (15) [0000 1111b]
Default Value	00h (0) [0000 0000b]

3.3.3. Object 6003h: DI Filter Input 8-bit

This object defines the in debouncing is applied to a group of 8 input lines. Debouncing can be enabled individually.

1 = debouncing enabled 0 = debouncing disabled

Object Description

Index	6003h
Name	DI Filter Input 8-bit
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

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

Sub-Index	1h
Description	DI1 to DI8 Debounce Enabled
Access	RW
PDO Mapping	No
Value Range	FFh (255) [1111 1111b]
Default Value	FFh (255) [1111 1111b]

Sub-Index	2h
Description	DI9 to DI12 Debounce Enabled
Access	RW
PDO Mapping	No
Value Range	0Fh (15) [0000 1111b]
Default Value	0Fh (15) [0000 1111b]

3.3.4. Object 6005h: DI Global Interrupt Enable 8-bit

This object shall enable and disable globally the interrupt behavior without changing the interrupt masks for a group of 8 inputs lines. In event-driven mode the device transmits the input values depending on the interrupt masks in objects 6006h, 6007h, and 6008h and the PDO transmission type. See Section 1.4 for more information on how the interrupts work.

1 = global interrupt enabled 0 = global interrupt disabled

Object Description

Index	6005h
Name	DI Global Interrupt Enable 8-bit
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

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

Sub-Index	1h
Description	DI1 to DI8 Interrupt Enabled
Access	RW
PDO Mapping	No
Value Range	FFh (255) [1111 1111b]
Default Value	FFh (255) [1111 1111b]

Sub-Index	2h
Description	DI9 to DI12 Interrupt Enabled
Access	RW
PDO Mapping	No
Value Range	0Fh (15) [0000 1111b]
Default Value	0Fh (15) [0000 1111b]

3.3.5. Object 6006h: DI Interrupt Mask Any Change 8-bit

This object determines if the input activates an interrupt on either positive and/or negative edge detection on a group of 8 input lines. See Section 1.4 for more information on how the interrupts work.

1 = interrupt enabled 0 = interrupt disabled

Object Description

Index	6006h
Name	DI Interrupt Mask Any Change 8-bit
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

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

Sub-Index	1h
Description	DI1 to DI8 Mask Any Change
Access	RW
PDO Mapping	No
Value Range	FFh (255) [1111 1111b]
Default Value	FFh (255) [1111 1111b]

Sub-Index	2h
Description	DI9 to DI12 Mask Any Change
Access	RW
PDO Mapping	No
Value Range	0Fh (15) [0000 1111b]
Default Value	0Fh (15) [0000 1111b]

3.3.6. Object 6007h: DI Interrupt Mask Low-to-High 8-bit

This object determines if the input activates an interrupt by positive edge detection (logical 0 to 1) on a group of 8 input lines. The values shall be in an ”OR” connection to the values of 6006h object (interrupt mask any change 8-bit). If inputs are inverted by 6002h object (polarity input 8-bit), the positive logical edge shall correspond to a negative physical edge. See Section 1.4 for more information on how the interrupts work.

1 = interrupt enabled 0 = interrupt disabled

Object Description

Index	6007h
Name	DI Interrupt Mask Low-to-High 8-bit
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

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

Sub-Index	1h		
Description	DI1 to DI8 Mask Low-to-High		
Access	RW		
PDO Mapping	No		
Value Range	FFh	(255)	[1111 1111b]
Default Value	00h	(0)	[0000 0000b]

Sub-Index	2h		
Description	DI9 to DI12 Mask Low-to-High		
Access	RW		
PDO Mapping	No		
Value Range	0Fh	(15)	[0000 1111b]
Default Value	00h	(0)	[0000 0000b]

3.3.7. Object 6007h: DI Interrupt Mask High-to-Low 8-bit

This object determines if the input activates an interrupt by negative edge detection (logical 1 to 0) on a group of 8 input lines. The values shall be in an ”OR”connection to the values of 6006h object (interrupt mask any change 8-bit). If inputs are inverted by 6002h object (polarity input 8-bit), the positive logical edge shall correspond to a positive physical edge. See Section 1.4 for more information on how the interrupts work.

1 = interrupt enabled 0 = interrupt disabled

Object Description

Index	6007h
Name	DI Interrupt Mask High-to-Low 8-bit
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

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

Sub-Index	1h		
Description	DI1 to DI8 Mask High-to-Low		
Access	RW		
PDO Mapping	No		
Value Range	FFh	(255)	[1111 1111b]
Default Value	00h	(0)	[0000 0000b]

Sub-Index	2h		
Description	DI9 to DI12 Mask High-to-Low		
Access	RW		
PDO Mapping	No		
Value Range	0Fh	(15)	[0000 1111b]
Default Value	00h	(0)	[0000 0000b]

3.3.8. Object 6200h: DO Write Output 8-bit

This object shall set a group of 8 output lines as a byte of information. Each output can be turned ON/OFF individually. See Table 3 in Section 1.5 for bit order within the bytes. This object is mapped to RPDO1 by default.

1 = output ON (relay engaged) 0 = output OFF

Object Description

Index	6200h
Name	DO Write Output 8-bit
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	DO1 to DO8 Write Output
Access	RW
PDO Mapping	Yes
Value Range	FFh (255) [1111 1111b]
Default Value	00h (0) [0000 0000b]

3.3.9. Object 6202h: DO Polarity 8-bit

This object defines the polarity of a group of 8 output lines. Output polarity can be inverted individually.

1 = output inverted 0 = output not inverted

Object Description

Index	6202h
Name	DO Polarity 8-bit
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	DO1 to DO8 Polarity
Access	RW
PDO Mapping	No
Value Range	FFh (255) [1111 1111b]
Default Value	00h (0) [0000 0000b]

3.3.10. Object 6206h: DO Error Mode 8-bit

This object indicates, whether an output is set to a pre-defined error value (see 6207h object) in case of an internal device failure or a 'Stop Remote Node' indication, for a group of 8 output lines.

1 = output value shall take the pre-defined condition specified in 6207h object

0 = output value shall be kept if an error occurs

Object Description

Index	6206h
Name	DO Error Mode 8-bit
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	DO1 to DO8 Error Mode
Access	RW
PDO Mapping	No
Value Range	FFh (255) [1111 1111b]
Default Value	FFh (255) [1111 1111b]

3.3.11. Object 6207h: DO Error Value 8-bit

On condition that the corresponding Error Mode bit is active, device failures (see Section 1.3 and 1.5) shall set the outputs to the value configured by this object for a group of 8 output lines

1 = output ON in error mode (relay engaged) 0 = output OFF in error mode

Object Description

Index	6207h
Name	DO Error Value 8-bit
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	DO1 to DO8 Error Value
Access	RW
PDO Mapping	No
Value Range	FFh (255) [1111 1111b]
Default Value	00h (0) [0000 0000b]

3.4. MANUFACTURER OBJECTS

Index (hex)	*Object*	*Object Type*	*Data Type*	*Access*	*PDO Mapping*
2002	DI Latched 8-bit	ARRAY	UNSIGNED8	RW	No
2003	DI Debounce Time	ARRAY	UNSIGNED16	RW	No
2200	DO Read Output 8-bit	ARRAY	UNSIGNED8	RO	Yes
2210	DO Control Source 8-bit	ARRAY	UNSIGNED8	RW	No
2211	DO Discrete Control Number	ARRAY	UNSIGNED8	RW	No
2220	DO Enable Input Used 8-bit	ARRAY	UNSIGNED8	RW	No
2221	DO Discrete Enable Number	ARRAY	UNSIGNED8	RW	No
3000	CAN Slew Rate	VAR	UNSIGNED8	RW	No
5555	Start in Operational Mode	VAR	UNSIGNED8	RW	No

3.4.1. Object 2002h: DI Latched 8-bit

This object defines the latched behaviour of a group of 8 input lines. When active, an input logic level will change state as per Figure 4 in Section 1.4. If an input is latched, object 6002h, DI Polarity, is ignored. Input latching can be enabled individually.

1 = input latched 0 = input not latched

Object Description

Index	2002h
Name	DI Latched 8-bit
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

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

Sub-Index	1h
Description	DI1 to DI8 Latched
Access	RW
PDO Mapping	No
Value Range	FFh (255) [1111 1111b]
Default Value	00h (0) [0000 0000b]

Sub-Index	2h
Description	DI9 to DI12 Latched
Access	RW
PDO Mapping	No
Value Range	0Fh (15) [0000 1111b]
Default Value	00h (0) [0000 0000b]

3.4.2. Object 2003h: DI Debounce Time

When enabled by object 6003h, DI Filter Input, this object determines the time, in milliseconds, that the input will used for a debouncing filter. For more information about debouncing, see Figure 3 in Section 1.4.

Object Description

Index	2003h
Name	DI Debounce Time
Object Type	ARRAY
Data Type	UNSIGNED16

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 Ch
Description	DI1 to DI12 Debounce Time
Access	RW
PDO Mapping	No
Value Range	10 to 10,000 [ms]
Default Value	30 [ms]

3.4.3. Object 2200h: DO Read Output 8-bit

This read-only object reflects the actual state of the output relays at any point for a group of 8 output lines. This object is mapped to TPDO1 by default.

1 = output ON (relay engaged) 0 = output OFF

Object Description

Index	2200h
Name	DO Read Output 8-bit
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	DO1 to DO8 Read Output
Access	RO
PDO Mapping	Yes
Value Range	FFh (255) [1111 1111b]
Default Value	00h (0) [0000 0000b]

3.4.4. Object 2210h: DO Control Source 8-bit

This object selects the source of the control signal which determines the logic for controlling an output in a group of 8 output lines. See Section 1.5 for more information about how this object is used in the control logic.

1 = CANopen Control (6200h) 0 = Discrete Input (selected by 2211h)

Object Description

Index	2210h
Name	DO Control Source 8-bit
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	DO1 to DO8 Control Source
Access	RW
PDO Mapping	NO
Value Range	FFh (255) [1111 1111b]
Default Value	FFh (255) [1111 1111b]

3.4.5. Object 2211h: DO Discrete Control Number

When object 2210h selects a discrete input as the source of the control logic for an output, this object is used to define which input (1 to 12) is used.

Object Description

Index	2210h
Name	DO Discrete Control Number
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	8
Default Value	8

Sub-Index	1h
Description	DO1 Discrete Control Number
Access	RW
PDO Mapping	NO
Value Range	1 to 12
Default Value	1 (DI1)

Sub-Index	2
Description	DO2 Discrete Control Number
Access	RW
PDO Mapping	NO
Value Range	1 to 12
Default Value	2 (DI2)

Sub-Index	3h
Description	DO3 Discrete Control Number
Access	RW
PDO Mapping	NO
Value Range	1 to 12
Default Value	3 (DI3)

Sub-Index	4h
Description	DO4 Discrete Control Number
Access	RW
PDO Mapping	NO
Value Range	1 to 12
Default Value	4 (DI4)

Sub-Index	5h
Description	DO5 Discrete Control Number
Access	RW
PDO Mapping	NO
Value Range	1 to 12
Default Value	5 (DI5)

Sub-Index	6h
Description	DO6 Discrete Control Number
Access	RW
PDO Mapping	NO
Value Range	1 to 12
Default Value	6 (DI6)

Sub-Index	7h
Description	DO7 Discrete Control Number
Access	RW
PDO Mapping	NO
Value Range	1 to 12
Default Value	7 (DI7)

Sub-Index	8h
Description	DO8 Discrete Control Number
Access	RW
PDO Mapping	NO
Value Range	1 to 12
Default Value	8 (DI8)

3.4.6. Object 2220h: DO Enable Used 8-bit

This object determines in an on-board digital input will be used to enable the output (in parallel with the control logic) for a group of 8 output lines. See Section 1.5 for more information about how this object is used.

1 = enable input used (selected by object 2221h) 0 = enable input not used

Object Description

Index	2220h
Name	DO Enable Used 8-bit
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	DO1 to DO8 Enable Used
Access	RW
PDO Mapping	NO
Value Range	FFh (255) [1111 1111b]
Default Value	00h (0) [0000 0000b]

3.4.7. Object 2221h: DO Discrete Enable Number

When object 2220h selects a discrete input as an enable input to the control logic for an output, this object is used to define which input (1 to 12) is used.

Object Description

Index	2220h
Name	DO Discrete Enable Number
Object Type	ARRAY
Data Type	UNSIGNED8

Entry Description

Sub-Index	0h
Description	Largest sub-index supported
Access	RO
PDO Mapping	No
Value Range	8
Default Value	8

Sub-Index	1h to 8h
Description	DO1 to DO8 Discrete Enable Number
Access	RW
PDO Mapping	NO
Value Range	1 to 12
Default Value	9 (DI9)

3.4.8. Object 3000h: CAN Slew Rate

This object selects the slew rate applied to the CAN bits sent to the network.

1 = fast slew rate 0 = slow slew rate

Object Description

Index	3000h
Name	CAN Slew Rate
Object Type	VARIABLE
Data Type	UNSIGNED8

Entry Description

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

3.4.9. 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 DIO128 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]

APPENDIX A – Technical Specifications

Power Supply

Power Supply Input	12 or 24VDC nominal (8…32VDC power supply range)
Quiescent Current	75 mA at 12V Typical, 40 mA at 24V Typical
Maximum Current	400 mA +/- 50mA at 12V with all relay outputs energized
Protection	Reverse polarity protection is provided. Power supply input section protects against transient surges and shorts. Overvoltage protection up to 100V is provided. Able to withstand long time engine cranking. Undervoltage protection down to ~7.5V is provided.

Inputs

Digital Inputs	12 digital active-low inputs with pull-up resistors. • ON voltage level: 0-0.8 V • OFF voltage level: 3.75V to +BAT • Input resistance: more than 5 kΩ (10kΩ pullup to +5Vdc) The inputs have internal over and under voltage protection.
References	Four DGND references for inputs are provided

Outputs

Relay Outputs	8 Form C relay outputs. Resistive load: • 2 A (NO)/2 A (NC) at 125 VAC • 2 A (NO)/2 A (NC) at 30 VDC Dielectric strength: • 4,000 VAC, 50/60 Hz for 1 min between coil and contacts • 750 VAC, 50/60 Hz for 1 min between contacts of same polarity There is no special overcurrent/overvoltage protection on the relay outputs. The user is advised to provide a fast acting 3A fuse or an adequate external protection if necessary.
Indicator	Front panel Red-Green LED indicator. (See Table 1)

Communication

CAN	1 CAN 2.0B port, protocol CiA CANopen ® Default baud rate 125 kbps, default Node-ID 127 By default, the DIO128 Controller transmits DI Read State 8-bit (6000h) and DO Read State 8-bit (2200h) on TPDO1
Network Termination	According to the CAN standard, 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.

General Specifications

Control Logic	User programmable functionality using SDO object access, per CiA DS-301
User Interface	.EDS provided to interface to standard CANopen ® tools
Operating Conditions	-40 to 85 °C (-40 to 185 °F) Protected against 95% humidity non-condensing, 30 to 60 °C (86 to 140 °F)
Storage	-50 to 120 °C (-58 to 248 °F)
Enclosure	Rugged aluminum housing, stainless steel end plates, neoprene gaskets Conformal coated PCB assemblies and partially encapsulated 145.30 x 149.00 x 73.00 mm (5.72 x 5.86 x 2.87”) L x W x H Connectors, Deutsch IPD P/N: 1 8-pin DT13-08PA, 1 40-pin DRC13-40PB See Figure 6.
Protection	IP67 Pollution Degree 3 rating per UL508
Weight	2.35 lb.(1.07 kg)
UL and cUL Compliance	UL508 (April 2010) (FTPM2) – Controls for Stationary Engine Driven Assemblies cUL C22.2 No. 14-10 (2010)
CE Compliance	2004/108/EC (EMC Directive) 2011/65/EU (RoHS Directive)
Vibration	4.3 G for off-engine mounting *The marine type approval process tested to 4.0 G per IEC 60068-2-6, Test Fc.*
Marine Type Approval	Lloyd’s Register, DNV, ABS, RINA, GL, BV, CCS, IRS, RS *The AXDIO128CO meets the environmental, EMC and vibration requirements of generator set applications in marine installations.*

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Battery Chargers

CAN bus Controls

Current Converters

DC/DC Power Converters

DC Voltage/Current Signal Converters

Engine Temperature Scanners

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I/O Controls

LVDT Simulators

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Signal Conditioners

Strain Gauge CAN Controls

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- Other comments as needed

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