

General Description

The CO4201 is a low cost, high performance Single Chip solution for CANopen remote I/O modules and especially designed for automotive and industrial applications. The device offers the complex implementation of the CANopen standards DS301 and DS401 in a single chip. It is suitable for simple low cost applications like sensor interfacing as well as for complex I/O systems.

CO4201 provides up to 27 input lines, 8 channels convert analog input signals with a resolution of 12 bit. 18 output lines are provided. 2 output lines may be used as analog voltage output lines with a resolution of 10 bit. 6 output pins support PWM generation.

To support output overload monitoring, a special error interrupt input is provided. All usual baud rates up to 1 MBit are supported.

The CO4201 Chip requires only few external components, just like a crystal, a CAN transceiver and capacitors. To minimize external interface recommendations all output pins have high current drive capability of 4 mA. For interfacing opto isolators no external drivers are required.



Features

- Single Chip CANopen Controller
- According to CiA Draft Standards DS301 Version 4.2 and DS401 Version 3.0
- Baud rate up to 1MBit
- Various I/O configurations
- Internal noise filtering for all inputs with individual setting for each channel
- Error interrupt input for output overload monitoring
- Output drivers with 4mA
- Watchdog output
- Temperature ranges up to -40 to 105 °C
- Package QFP80

Applications

The CO4201 CANopen Controller is optimised for automotive and industrial applications such as:

- Remote I/O Modules for CANopen
- CANopen Interface for keyboards and control panels
- Low Cost CANopen Interface for sensors like photoelectric reflex switches photo interrupters
- Low Cost CANopen Interface for actors like pneumatic valves, warning panels etc.

CANopen Features

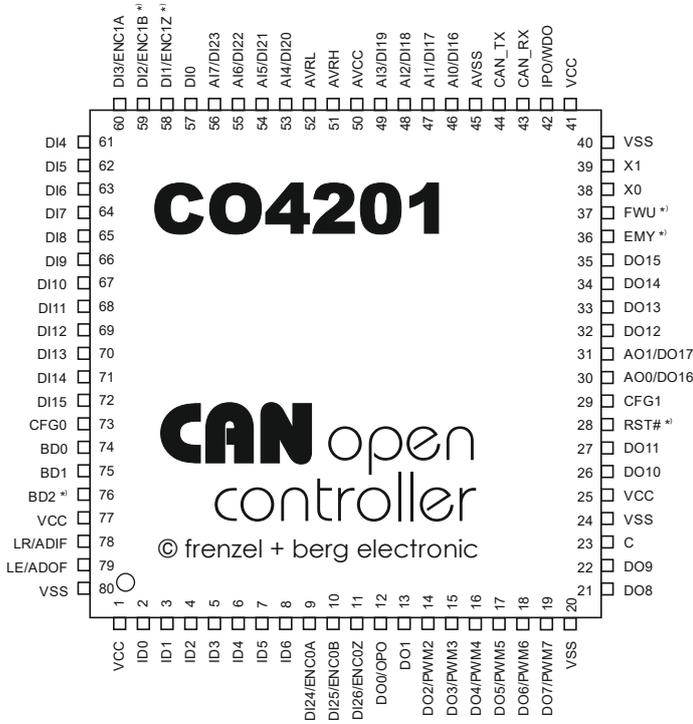
- 8 Transmit- and 8 Receive PDOs
- Dynamic PDO mapping
- Variable PDO identifier
- All CANopen specific PDO transmission types supported: synchronous, asynchronous, event driven, cyclic, acyclic and remote frame dependent.
- Event timer and inhibit timer features for all transmit PDOs.
- Nodeguarding
- Lifeguarding
- 1 heartbeat producer
- 4 heartbeat consumer
- Emergency messages
- Minimum boot up

Ordering Information

CO4201 Chip (programmed, licence included)

Part	Temp. Range	Package
CO4201A-FL	-40 °C to 105 °C	QFP80

Pin Assignment



Pin Listing

Pin No.	Pin Name	Funktion
2 to 8	ID0 to ID6	Node-Identifier configuration input pins
9, 10, 11	DI24/ENC0A, DI25/ENC0B, DI26/ENC0Z	Digital input pins 24 to 26 Special function: Encoder 0 : Track A, B, Z
12, 13, 14 to 19, 21, 22, 26, 27, 32 to 35	DO0/OPO, DO1, DO2/PWM2 to DO7/PWM7	Digital output pins 0, 1, 8 to 15 DO0/OPO selects output polarity DO2/PWM2 to DO7/PWM7 special function: PWM output channels 2 to 7
23	C	Filter capacitor
28*)	RST#*)	Reset input active low
29	CFG1	Configuration input pin 1 Selects default scaling values for objects 5308 and 5309

Pin Listing continued

Pin No.	Pin Name	Funktion
30, 31	AO0/DO16, AO1/DO17	Analog output channels 0, 1 or digital output pins 16, 17 depending on configuration
36*)	EMY*)	Output overload interrupt input active low
37*)	FWU*)	Firmware update pin
38	X0	Crystal oscillator input
39	X1	Crystal oscillator output
42	IPO/WDO	Input polarity configuration input / watch dog output
43	CAN_RX	Receiver input of CAN module
44	CAN_TX	Transmitter output of CAN module
46 to 49, 53 to 56	AI0/DI16 to AI3/DI19, AI4/DI20 to AI7/DI23	Input pins for analog input channels 0 to 7 and/or digital input pins 16 to 23 depending on configuration
57, 58*), 59*), 60, 61 to 72	DIO, DI1/ENC1Z*), DI2/ENC1B*), DI3/ENC1A, DI4 to DI15	Digital input pins 0 to 15 Digital input pins 1 to 3 with special function: Encoder 1 : Track A, B, Z
73	CFG0	Configuration input pin 0
74 to 76*)	BD0 to BD2*)	Baud rate configuration input
78	LR/ADIF	CANopen Run Led Analog/digital input pin functionality configuration pin Sets the pins AI0/DI16 to AI7/DI23 to either dual analog and digital input or to digital only input pins.
79	LE/ADOF	CANopen Error Led Analog/digital output pin functionality configuration pin Sets the pins AO0/DO16 and AO1/DO17 to either analog or digital output.
1, 25, 41, 77	VCC	Power supply
20, 24, 40, 80	VSS	Ground
45	AVSS	Ground for A/D converter
50	AVCC	Supply for A/D converter
51	AVRH	Positive reference voltage for A/D-Converter
52	AVRL	Negative reference voltage for A/D-Converter
*)		These pins are also used for firmware update

Handling the Device

Preventing latch up

The CO4201 is a CMOS device and may suffer latch up under the following conditions:

- 1) A voltage higher than VCC or lower than VSS is applied to any pin.
- 2) Absolute maximum ratings are exceeded
- 3) AVCC power is provided before VCC supply

Handling unused Pins

The CO4201 provides internal pull up devices, so unused pins may be left unconnected.

All Power Supply Pins

Connect the current supply source with each Power supply pin and ground pin of this device at low impedance. Do not leave any ground or power pins open. Connect at least two ceramic capacitors of 100 nF and a capacitor of 1 uF between VCC and VSS and also between AVCC and AVSS as close as possible to the device.

Power Supply for A/D converter

The power supply for the A/D converter must not be turned on before the power supply VCC.

If the A/D and D/A converters are not used, connect the pins as follows: AVCC = AVRH = VCC, AVSS = AVRL = VSS.

Input / Output pins

For all digital input and output pins the active polarity may be configured using external configuration.

Additional inverting capabilities using objects 6002.xx and 6202.xx are supported.

The output pins are not driven after a reset. One of the following conditions activate the internal output drivers:

- Object 6200.xx, 6300.xx or 6320.xx is written
- A PWM is activated for output
- The device receives a start node command.

This gives the possibility to keep output pins in a defined state using external pull devices until configuration (for example setting of active output polarity) is done.

Pull up/down resistors

All pins are high impedance during reset.

The CO4201 provides internal pull up resistors of approx 50 kOhms that are activated after Reset. For all pins that are used for digital signals that are active low, the pull up resistors are enabled by default. For the input pins that provide functionality for analog and digital input signals, the pull up resistors are disabled by default.

Please note:

Pins LR/ADIF and LE/ADOF that are used for configuration during reset and as LED outputs during standard operation, no internal pull up devices are implemented.

Pin Description

ID0 to ID6: Device Identifier input pins

With the pins ID0 to ID6 the CANopen node ID is set. The pins are active low and use inverted polarity. This means pulling the ID input pin to VSS will set the corresponding bit within the Node-ID. The IDx pins provide internal pull up resistors, so an external DIP switch may be used. See also chapter "Device Configuration" for additional information.

**DI0 to DI26: Digital input pins or encoder/counter
AI0 to AI7: Analog input pins**

The pins DI0 to DI26 are used as digital input pins. The active polarity may be set using pin IPO/WDO.

Pins AI0/DI16 to AI7/DI23 provide analog and digital input functionality.

The functionality may be set using pin LR/ADIF.

If dual analog and digital operation is selected, the internal pull up resistors are disabled by default. If digital only operation is selected, the internal pull up resistors are enabled by default.

The input pins provide additional features for event counting with count direction input and optional gate or directly reading encoders with tracks A, B, Z.

DI24/ENC0A	encoder 0 track A, event counter 0 direction
DI25/ENC0B	encoder 0 track B, event counter 0 count input
DI26/ENC0Z	encoder 0 track Z, event counter 0 gate
DI1/ENC1Z	encoder 1 track Z, event counter 1 gate
DI2/ENC1B	encoder 1 track B, event counter 1 count input
DI3/ENC1A	encoder 1 track A, event counter 1 direction

If a counter or encoder mode is set, the input object bits for the pins that are required for counter/encoder are set to 0.

**DO0 to DO17: Digital or PWM output pins
DO16 to DO17: Analog output pins**

The pins DO0 to DO17 are used as digital output pins. The polarity is set using output pin DO0/OPO.

Pin DO0/OPO is scanned during reset for the inactive polarity of the output channels. An internal pull up of approx 50 kOhms is implemented.

In order to set active high output pins, an external pull down resistor of approx 4.7 kOhms is required, otherwise the device will set the output channels to active low.

Output pins DO2/PWM2 to DO7/PWM7 provide PWM generation.

Additionally the PWM output can be enabled and disabled directly with the assigned digital output object. All output pins have high current drive capabilities of approximate 4 mA for direct interfacing of opto couplers without additional drivers.

The CO4201 provides optional output inverters with individual setting for each channel. See chapter "Object Dictionary" for details.

AO0/DO16 and AO1/DO17 may be used as analog output channels. The configuration is done using pin LE/ADOF.

CFG0 to CFG1: Configuration input pins

Set device configuration to preferred operation mode using CFG0 to CFG1. The CO4201 provides internal pull up devices. Do not use direct connection to VCC or VSS. CFG0 pin is reserved for future use, so it is recommended to leave this configuration input pin unconnected.

CFG1 is used to set the default values for the analog input scaling objects 5308 and 5309. If CFG1 is scanned with high level, the chip configures the scaling objects for the use without input divider. If CFG1 is scanned with low level, the scaling objects are initialized for the use of an input resistor divider. See objects 5308 and 5309 for additional information.

EMY: Emergency interrupt

This active low input pin is provided to support output overload monitoring. Connect the output from an output overload control circuit to this input pin. If the CO4201 scans a low level on pin EMY, the device automatically enters the error state given in Object 1029.02 (default enter preoperational state).

Furthermore the Error Register (index 1001) is set to 0x03, indicating an over current error.

Last but not least the device will send an emergency telegram with error code 0x2310 indicating an overload error.

An internal pull up resistor is implemented, so if output overload monitoring is not to be used in your application, leave pin EMY unconnected.

FWU: Firmware update input

This pin is used to enable the internal bootstrap loader in order to start a firmware update procedure.

An external pull down resistor of 1 kOhms is required for standard operation mode.

IPO/WDO: Input polarity select input / watchdog output

The pin is scanned during reset in order to set the inactive level for the digital input pins. If the pin is scanned with high level, the input pins DIx have inactive level high and work as active low digital input channels.

In order to select active high input channels, the pin IPO/WDO must be pulled low using an external pull down resistor of approx 4.7 kOhms.

After Reset, the pin is switched to output and drives a watch dog signal, which might be used to monitor a running chip to enable an output driver.

BD0 to BD2: CAN baud rate configuration pins

With the pins BD0 to BD2 the baud rate for the CAN interface set. The pins are active low and use inverted polarity. The BDx pins provide internal pull up resistors, so an external DIP switch may be used.

See also chapter "Device Configuration" for additional information.

LR/ADIF: Led CANopen Run / Analog Digital input pin function selector

The pin LR/ADIF is used as a configuration input pin during reset and is the switched to LED output for standard operation mode.

ADIF: The pin sets the default operation mode of the input pins AI0/DI16 to AI7/DI23. The operation mode may be changed using the object dictionary.

ADIF= 1: The AIx/DIx pins are used as dual use analog and digital input pins. The associated pull up resistors are disabled. The CANopen Run-LED output is active low. An external pull up resistor of approx 4.7 kOhms is required to select this operation mode.

Connect the CANopen Run LED as follows. Cathode to LR/ADIF. Anode using series resistor to VCC.

ADIF= 0: The AIx/DIx pins are used as digital input pins only. The associated pull up resistors are enabled. The CANopen Run-LED output is active high. An external pull down resistor of approx 4.7 kOhms is required to select this operation mode.

Connect the CANopen Run LED as follows. Anode to LR/ADIF. Cathode using series resistor to VSS.

The CANopen RUN LED shows the actual NMT state according to DRP303-3

Please note:

Pin LR/ADIF does not provide an internal pull up, so an external pull up/down resistor is required

LE/ADOF: Led CANopen Error / Analog Digital output pin function selector

The pin LE/ADOF is used as a configuration input pin during reset and is switched to LED output for standard operation mode.

ADOF: The pin sets the operation mode of the output pins AO0/DO16 to AO1/DO17.

ADOF= 1: The AOx/DOx pins are used as analog output pins. The CANopen Error LED output is active low. An external pull up resistor of approx 4.7 kOhms is required to select this operation mode.

Connect the CANopen Error LED as follows. Cathode to LE/ADOF. Anode using series resistor to VCC.

ADOF= 0: The AOx/DOx pins are used as digital output pins. The CANopen Error LED output is active high. An external pull down resistor of approx 4.7 kOhms is required to select this operation mode.

Connect the CANopen Error LED as follows. Anode to LE/ADOF. Cathode using series resistor to VSS.

The CANopen Error LED shows the actual Error state according to DRP303-3

Please note:

Pin LE/ADOF does not provide an internal pull up, so an external pull up/down resistor is required

CAN_RX, CAN_TX: CAN interface pins

The CAN interface pins may be used for direct connection to CAN transceivers like the 80C251. For longer bus length or noisy or disturbed environments it is strongly recommended to use galvanic isolation with opto couplers or magnetic iso loop couplers between bus interface and CANopen application, to improve system reliability.

Please note:

The CAN interface pins are high impedance pins during reset. In order to avoid unintended bus access during Reset, take care that a floating CAN_TX pin does not cause CAN bus write access. Use an external pull up resistor if required.

X0, X1: Crystal oscillator input

Connect a crystal of 16 MHz between X0 and X1. Use additional ceramic capacitors of 22 pF between X0 and X1 to VSS.

VCC, VSS: Power Supply Pins

Make sure that all ground and power supply pins are connected to the same potential. Do not leave any ground or power supply pins open. Connect decoupling capacitors as close as possible to the device. See chapter "Recommended Operation Conditions" for details

AVCC, AVSS: Analog Power Supply Pins

Power supply for the analog subsystem of the CANopen chip. It is recommended to connect VSS, AVSS and AVRL in one position as close as possible to the device. It is recommended to connect ceramic capacitors of 100 nF and 1 uF between AVCC and AVSS as close as possible to the device.

AVRH, AVRL: Analog Reference Voltage

The pin AVRL is used as negative Reference Voltage for the analog subsystem of the CANopen Chip. Pin AVRL must be connected to AVSS.

AVRH is use as positive reference voltage input for the analog subsystem of the CANopen chip.

It is recommended to connect ceramic capacitors of 100 nF and 1 uF between AVRH and AVRL as close as possible to the device.

C: Filter Capacitor input

For correct operation of the CO4201 a ceramic capacitor of 4.7 uF must be connected from Pin C to VSS. Place this components as close as possible to the chip.

RST#: Reset input pin

For a correct device reset, provide an active low reset signal according to recommended operation conditions to input RST#.

Device Configuration

The following sections describe the device configuration with meaning:

- 1: ViH logic high level
- 0: ViL logic low level

CAN Identifier

The CAN Identifier will be set with Pins ID0 to ID6. This configuration pins use internal inverter. The ID is set as follows:

ID6	ID5	ID4	ID3	ID2	ID1	ID0	CAN-Identifier
1	1	1	1	1	1	1	0 = reserved
1	1	1	1	1	1	0	1 = 0x01
1	1	1	1	1	0	1	2 = 0x02
1	1	1	1	1	0	0	3 = 0x03
1	1	1	1	0	1	1	4 = 0x04
		
1	0	0	0	0	0	0	63 = 0x3F
0	1	1	1	1	1	1	64 = 0x40
0	1	1	1	1	1	0	65 = 0x41
		
0	0	0	0	0	1	0	125 = 0x7C
0	0	0	0	0	0	1	126 = 0x7E
0	0	0	0	0	0	0	127 = 0x7F

All Identifiers from 1 to 127 are valid settings.

Baud rate

The baud rate configuration will be done with configuration inputs BD0 to BD2

BD2	BD1	BD0	CAN-Baud Rate / Bus length
1	1	1	1 Mbit/sec 25 m ^{*1)}
1	1	0	800 kbit/sec 50 m ^{*1)}
1	0	1	500 kbit/sec 100 m ^{*2)}
1	0	0	250 kbit/sec 250 m ^{*2)}
0	1	1	125 kbit/sec 500 m ^{*3)}
0	1	0	50 kbit/sec 1000 m ^{*3)}
0	0	1	20 kbit/sec 2500 m ^{*3)}

- *1) Calculation without optocouplers.
For optocouplers bus length is reduced for about 4m per 10 nsec propagation delay of employed optocoupler type
- *2) Calculation with 40 nsec optocoupler propagation delay
- *3) Calculation with 100 nsec optocoupler propagation delay

The calculation of the bus length is based on a line propagation delay of 5 nsec/m.

I/O Configuration

Configuration bits CFG0 to CFG1 have internal pull up resistors.

CFG Pins	I/O Configuration Description
1 0	
X	Analog Input and Output Scaling Default Values
1	Scaling for direct input Input-Multiplier 5322.xx= 10000 Input-Divider 5323.xx= 10000 Scaling for direct output Output-Multiplier 5422.xx= 10000 Output-Divider 5423.xx= 10000
0	Scaling for using input divider Input-Multiplier 5322.xx= 3000 Input-Divider 5323.xx= 2842 Scaling for using output amplifier Output-Multiplier 5422.xx= 10000 Output-Divider 5423.xx= 10555
X	Reserved

Please note:

In order to keep compatibility of your application with future versions of this CANopen controller, it is strongly recommended to leave reserved CFGx pins unconnected.

Object Dictionary

The CO4201 Single Chip CANopen Controller implements a complex object dictionary for CANopen I/O devices.

DS301: global Objects

Index	Sub-Index	Name	Acc.
0005	-	Dummy 8	wo
0006	-	Dummy 16	wo
0007	-	Dummy 32	wo
1000	-	Device Type	ro
1001	-	Error Register	ro
1002	-	Manufacturer Status Register	ro
1005	-	COB-ID Sync Identifier Sync Object	rw
1008	-	Device Name *2)	ro
1009	-	Hardware Version *2)	ro
100A	-	Software Version *2)	ro
100B	-	Node Id *5)	-
100C	-	Guard Time	rw
100D	-	Life Time Factor	rw
100E	-	COB-ID Guard *5)	-
1014	-	COB ID Emergency	rw
1015	-	Inhibit Time Emergency	rw
1016	0	Consumer Heartbeat Time	ro
	1	Consumer Heartbeat Time 1	rw
	2	Consumer Heartbeat Time 2	rw
	3	Consumer Heartbeat Time 3	rw
	4	Consumer Heartbeat Time 4	rw
1017	-	Producer Heartbeat Time	rw
1018	0	Identity Object	ro
	1	Vendor ID	ro
	2	Product Code	ro
	3	Revision Number	ro
	4	Serial Number	ro
1029	0	Error Behavior	ro
	1	In case of bus errors	rw
	2	In case of output errors	rw
2000	-	Device Manufacturer *3)	ro
2009	0	Silicon Serial Number	ro
	1	Silicon Serial Number L	ro
	2	Silicon Serial Number H	ro
2101	-	System Configuration	ro
2102	-	Remapping Enabled Info	ro
2103	-	Enable Guarding Warning	rw
2105	-	Internal Error Code	ro
2110	0	Test Object 01	ro
	1	Test Object 01.1	rw
2180	-	CAN Restart Time	rw
21C0	-	Timer Event Counter	ro
21C1	-	Timer Event Time	rw
2FFF	-	Factory Test Object *5)	rw

For the Object tables all values are shown in hexadecimal way.

For access type the following settings are valid

ro read only
wo write only
rw read and write access enabled

Notes:

- *1) This object cannot be written to in operational device state.
Only use this command in preoperational device state, otherwise the CO4201 will answer requests with SDO abort telegrams.
- *2) This objects show the chip type and version as visible strings.
- *3) This Objects shows "Frenzel + Berg" as visible string data type.
- *4) The New Node Id object gives the possibility to set a Node-Nr independent from the Node-Id Input Bits. With this feature the device may be configured by CAN bus line.
- *5) This object is not accessible for the application because of standard conforming reasons.

Note: All "Visible String" data type objects are restricted to a maximum of 20 characters.

The data type entries Index 0005 to 0007 are implemented for compatibility reasons. They may be mapped to RPDOs in order to define the appropriate space in the RPDO.

For the read only objects following data is set:

Index	Sub.	Name	Value in Hex.
1000		Device Type	008F 0191 h
1018	0	Identity Object	04h
	1	Vendor ID	0000 0058 h
	2	Product Code	0142 0100 h
	3	Revision Number	0 .. 0xFFFFFFFF
1029	4	Serial Number L	0 .. 0xFFFFFFFF
	0	Identity Object	02h
2009	1	Serial Number L	0 .. 0xFFFFFFFF
	2	Serial Number H	0 .. 0xFFFFFFFF
2101		System Configuration	Set according to the setting of the configuration input bits.

DS301: PDO Parameter Objects

Description of PDO Parameter objects:

These Objects enable dynamic PDO mapping, variable identifier distribution for PDOs and setting of the transmission mode, inhibit and event times.

For the CO4201 setting of all parameters may be done in the device state "operational" as well as in "preoperational" state.

Index	Sub-Index	Name	Acc.
1400	0	Receive PDO1 Communication Parameter	ro
	1	COB-ID	rw
	2	Transmission Type	rw
1401 ... 1407		Receive PDO2 to RPDO8 Communication Parameter same as 1400.00 .. 1400.02	rw
1600	0	Receive PDO1: Parameter mapping	rw
	1 to n	Mapped Object (max. 8 objects mappable)	rw
1601 ... 1607		Receive PDO2 to RPDO8 Parameter mapping Same as 1600	rw
1800	0	Transmit PDO1 Communication Parameter	ro
	1	COB-ID	rw
	2	Transmission Type	rw
	3	Inhibit Time	rw
	4	Reserved	rw
	5	Event Time	rw
1801 ... 1807		Transmit PDO2 to TPDO8 Communication Parameter same as 1800.00 .. 1800.05	rw
1A00	0	Transmit PDO1 Parameter mapping	rw
	1 to n	Mapped Object (max. 8 objects mappable)	rw
1A01 ... 1A07		Transmit PDO2 to TPDO8 Parameter mapping Same as 1A00	rw

Note:

The CO4201 supports 8 receive and 8 transmit PDOs. All Objects for higher PDO numbers are not implemented.

Note:

For detailed information about CANopen objects see additional brochure "Introduction to CANopen"

DS401: Digital Input Objects

Index	Sub-Index	Name	Acc.
5001	0 to n	Digital Input Filter Time	rw
5002	0 to n	Input Pull Up Enable	rw
6000	0 to n	Read digital input 8 bit	ro
6002	0 to n	Polarity input 8-bit	rw
6005		Global interrupt enable	rw
6006	0 to n	Interrupt mask: any change	rw
6007	0 to n	Interrupt mask rising edge	rw
6008	0 to n	Interrupt mask falling edge	rw
6100	0 to n	Read digital input 16 bit	ro
6120	0 to n	Read digital input 32 bit	ro

DS401: Digital Output Objects

Index	Sub-Index	Name	Acc.
5200	-	Reset Digital Output Object on Error	rw
5202	-	Output Overload Error Info	ro
6200	0 to n	Write Output 8 Bit	rw
6202	0 to n	Change Polarity Output 8 bit	rw
6206	0 to n	Error Mode Output	rw
6207	0 to n	Error State Output	rw
6300	0 to n	Write digital output 16 bit	wo
6320	0 to n	Write digital output 32 bit	wo

DS401: Analog Input Objects

Index	Sub-Index	Name	Acc.
5301	-	Analog Input Filter Size	rw
5302	0 to n	Analog Digital In Enable Analog	rw
5303	0 to n	Analog Digital In Enable Digital	rw
5320	-	Analog In Full Scale Value	rw
5322	0 to n	Analog Input Scaling Multiplier	rw
5323	0 to n	Analog Input Scaling Divider	rw
6401	0 to n	Read Analog Input 16 Bit	ro
6421	0 to n	Analog Input Interrupt Trigger	rw
6423		Analog Input global Interrupt Enable	rw
6424	0 to n	Analog Input Upper Limit	rw
6425	0 to n	Analog Input Lower Limit	rw
6426	0 to n	Analog Input Interrupt Delta	rw
6427	0 to n	Analog Input Interrupt Negative Delta	rw
6428	0 to n	Analog input interrupt positive delta	rw

DS401: Analog Output Objects

Index	Sub-Index	Name	Acc.
5400	-	Reset Analog Output Object on Error	rw
5420	-	Analog Out Full Scale Value	rw
5422	0 to n	Analog Output Scaling Multiplier	rw
5423	0 to n	Analog Output Scaling Divider	rw
6411	0 to n	Write Analog Output 16 Bit	rw
6443	0 to n	Analog Output Error Mode	rw
6444	0 to n	Analog Output Error Value	rw

PWM Control Objects

Index	Sub-Index	Name	Acc.
5100	0 to n	PWM Value	rw
5101	0 to n	PWM control	rw
5106	0 to n	PWM Base Timer Steps	rw
5107	0 to n	PWM Base Timer Prescaler	rw

Counter Control Objects

Index	Sub-Index	Name	Acc.
4000	0 to n	Counter Value	ro
4001	0 to n	Counter Control	rw
4002	0 to n	Counter Status	ro
4003	0 to n	Counter Speed	ro
4007	0 to n	Counter Preset Value	rw
4008	0 to n	Counter New Operation Mode	rw
4009	0 to n	Counter Speed Scaling	rw

Description of Object Dictionary

The following list gives a short description of all dictionary entries.

Index 0005

This object is implemented to enable reservation of data space in RPDOs by mapping dummy entries.

Index	0005
Name	Dummy 8
Description	
Data Type	Unsigned 8
Access modes	WO
PDO Mapping	Yes
Value Range	-
Default Value	0

Index 0006

This object is implemented to enable reservation of data space in RPDOs by mapping dummy entries.

Index	0006
Name	Dummy 16
Description	-
Data Type	Unsigned 16
Access modes	WO
PDO Mapping	Yes
Value Range	-
Default Value	0

Index 0007

This object is implemented to enable reservation of data space in RPDOs by mapping dummy entries.

Index	0007
Name	Dummy 32
Description	-
Data Type	Unsigned 32
Access modes	WO
PDO Mapping	Yes
Value Range	-
Default Value	0

DS301: Global Objects

Index 1000: Device Type

Description of the device type. The Object gives the CiA device profile number and additionally the functionality of the device.

Index	1000h	
Name	Device Type	
Description	-	
Data Type	Unsigned 32	
Access modes	RO	
PDO Mapping	No	
Value Range	-	
Default Value	Operation Mode	Value of Index
	CO4201	008F 0191 h

Index 1001: Error Register

This object holds an error of the device.

Index	1001h	
Name	Error Register	
Description	-	
Data Type	Unsigned 8	
Access modes	RO	
PDO Mapping	Yes	
Value Range	-	
Default Value	-	

The error register has the following structure

Bit	Meaning
0	Generic error. This bit is set, if any error is active
1	0
2	0
3	0
4	CAN bus or communication error
5	0
6	0
7	Device Error

Index 1002: Status Register

This object gives additional information for the device

Index	1002h
Name	Status Register
Description	-
Data Type	Unsigned 32
Access modes	RO
PDO Mapping	Yes
Value Range	-
Default Value	-

Index 1005: COB-ID Sync

Identifier of Can Object for the Synchronisation message. The CO4201 may only operate in Sync consumer mode. Generating of Sync messages is not possible. Therefore, the Identifier for the Sync message can only be set to the value range 1 ... 7FFh.

Index	1005h
Name	COB-ID Sync
Description	-
Data Type	Unsigned 32
Access modes	RW
PDO Mapping	No
Value Range	1 ... 7FFh
Default Value	80h

Index 1008: Device Name

This object shows the name of the device as visible string.

Index	1008h
Name	Device Name
Description	-
Data Type	Visible String
Access modes	RO
PDO Mapping	No
Value Range	The maximum string length is 20 characters
Default Value	"CO4201"

Index 1009: Hardware Version

This object shows the hardware version and firmware version as visible string.

Index	1009h
Name	Hardware Version
Description	-
Data Type	Visible String
Access modes	RO
PDO Mapping	No
Value Range	The maximum string length is 20 characters
Default Value	-

Index 100A: Software Version

This object shows the software version as visible string.

Index	100Ah
Name	Software Version
Description	-
Data Type	Visible String
Access modes	RO
PDO Mapping	No
Value Range	The maximum string length is 20 characters
Default Value	-

Index 100C: Guard Time

The objects at index 100Ch (Guard Time in milliseconds) and 100Dh (Life Time Factor) are used to implement the life guarding protocol. The Guard Time multiplied with the Life Time Factor gives the Life Time in milliseconds. It is 0 (zero) if not used.

Index	100Ch
Name	Guard Time
Description	-
Data Type	Unsigned 16
Access modes	RW
PDO Mapping	No
Value Range	
Default Value	0

Index 100D: Life Time Factor

The objects at index 100Ch (Guard Time in milliseconds) and 100Dh (Life Time Factor) are used to implement the life guarding protocol. The Guard Time multiplied with the Life Time Factor gives the Life Time in milliseconds. It is 0 (zero) if not used.

Index	100Dh
Name	Life Time Factor
Description	-
Data Type	Unsigned 8
Access modes	RW
PDO Mapping	No
Value Range	
Default Value	0

Index 100E: COB-ID Guard

Identifier of Can Object for the Node Guarding protocol. The Object is not represented in the object dictionary because of standard conforming reasons.

Index	100Eh
Name	COB-ID Guard
Description	-
Data Type	Unsigned 32
Access modes	-
PDO Mapping	No
Value Range	-
Default Value	700h + Node-ID

Index	1016h Subindex 0
Name	Largest SubIndex supported
Description	-
Data Type	Unsigned char
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	4

Index	1016h Subindex 1
Name	Consumer Heartbeat Time 1
Description	-
Data Type	Unsigned 32
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	0

Index 1014: COB-ID Emergency

Identifier of Can Object for the emergency messages.

Index	1014h
Name	COB-ID Emergency
Description	-
Data Type	Unsigned 32
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	80h + Node-ID

Index 1015: Inhibit Time Emergency

Inhibit Time for emergency messages. If the Inhibit Time is set to 0, inhibit delay is disabled. The Inhibit Time is a multiple of 100usec, but the CO4201 offers a maximum resolution of 1 millisecond.

Index	1015h
Name	Inhibit Time Emergency
Description	-
Data Type	Unsigned 16
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	0

Index 1016: Consumer Heartbeat Time

Index 1016 is used to monitor the Heartbeat Consuming of up to four nodes.

Index	1016h
Name	Consumer Heartbeat Time
Description	-
Data Type	Structure

Index	1016h Subindex 2
Name	Consumer Heartbeat Time 2
Description	-
Data Type	Unsigned 32
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	0

Index	1016h Subindex 3
Name	Consumer Heartbeat Time 3
Description	-
Data Type	Unsigned 32
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	0

Index	1016h Subindex 4
Name	Consumer Heartbeat Time 4
Description	-
Data Type	Unsigned 32
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	0

Note:
 Either Heartbeat or node guarding may be allowed at the same time. Do not use both protocols at the same time. See additional brochure for further information about heartbeat protocol.

Heartbeat monitoring starts with the reception of the first heartbeat. The Producer Time should be greater than the Consumer Time. Ahead of the first heartbeat, the Producers status is unknown.

Structure of the Consumer Heartbeat Time

MSB		LSB	
Byte 3	Byte 2	Byte 1	Byte 0
Reserved	Node-ID	Heartbeat time	

The time has to be a multiple of 1ms.

Index 1017: Producer Heartbeat Time

The producer heartbeat time defines the cycle time of the heartbeat. The producer heartbeat time is 0 if it is not used. The time has to be a multiple of 1ms.

Index	1017h
Name	Producer Heartbeat Time
Description	-
Data Type	Unsigned 16
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	0

Note:
 Either Heartbeat or node guarding may be allowed at the same time. Do not use both protocols at the same time. See additional brochure for further information about heartbeat protocol.

Index 1018: Identity Object

The object at index 1018h keeps general information about the device and the manufacturer frenzel + berg electronic. It cannot be modified.

Index	1018h
Name	Identity Object
Description	-
Data Type	Structure

Index	1018h Subindex 0
Name	Largest SubIndex supported
Description	-
Data Type	Unsigned char
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	4

Index	1018h Subindex 1
Name	Vendor ID
Description	Registration Code of frenzel + berg electronic at the CiA
Data Type	Unsigned 32
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	58h

Index	1018h Subindex 2
Name	Product Code
Description	Internal Product Code for CO4201 at frenzel + berg electronic
Data Type	Unsigned 32
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	0142 0100 h

Index	1018h Subindex 3
Name	Revision Code
Description	
Data Type	Unsigned 32
Access modes	RO
PDO Mapping	No
Value Range	0 ... 0xFFFFFFFF
Default Value	-

Index	1018h Subindex 4
Name	Serial Number (only lower 32 bits)
Description	
Data Type	Unsigned 32
Access modes	RO
PDO Mapping	No
Value Range	0 ... 0xFFFFFFFF
Default Value	-

Index 1029: Error Behaviour

With object 1029 the CANopen chip can be configured to enter alternatively the preoperational or the stopped state or remain in the current state in case of a device failure. Device failures shall include the following communication errors:

Bus-off conditions of the CAN interface, Life guarding error, Serious device errors also can be caused by device internal failures.

The value of the Error Classes is as follows:

- 0 = pre-operational (only if current state is operational)
- 1 = no state change
- 2 = stopped
- 3 ... 127 = reserved

Index	1029h
Name	Error Behaviour Object
Description	-
Data Type	Structure

Index	1029h Subindex 0
Name	Largest SubIndex supported
Description	-
Data Type	Unsigned char
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	2

Index	1029h Subindex 1
Name	Communication Error
Description	NMT state change in case of communication error
Data Type	Unsigned 8
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	00h

Index	1029h Subindex 2
Name	Application Error
Description	NMT state change in case of pin EMY is at low level
Data Type	Unsigned 8
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	00h

Index 2000: Device Manufacturer

This Object shows "FRENZEL + BERG" as visible string. If OEMs do not want to give access to this entry, it may be removed from the EDS (electronic data sheet).

Index	2000h
Name	Device Manufacturer
Description	-
Data Type	Visible String
Access modes	RO
PDO Mapping	No
Value Range	The maximum string length is 20 characters
Default Value	"FRENZEL + BERG"

Index 2101: System Configuration

This Object returns the operation mode of the CO4201. It represents the inverted Setting of the configuration input bits CFG0 to CFG1.

Index	2101h
Name	System Configuration
Description	-
Data Type	Unsigned 32
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	Depends on CFG0 to CFG1

Index 2009: Silicon Serial Number

This Object returns the internal 64bit serial number of the controller.

Index	2009h
Name	Silicon Serial Number
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	2

Index	Subindex 1
Name	Silicon Serial Number L
Description	
Data Type	Unsigned 32
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	0 .. 0xFFFFFFFF

Index	Subindex 2
Name	Silicon Serial Number H
Description	
Data Type	Unsigned 32
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	0 .. 0xFFFFFFFF

Index 2102: Remapping Enabled Info

This Object informs the user whether the system configuration enables remapping of the PDOs. A value of 0 means that remapping is disabled, all other values indicate that remapping of the PDOs is enabled.

Index	2102h
Name	Remapping Enabled Info
Description	-
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	1

Index 2103: Enabled Guarding Warning

This Object enables/disables transmission of emergency messages in case of a node guarding warning. The condition of a guarding warning is met, if the time between two node guarding frames increases the guarding time given in object 100C independent of the setting of the life time (object 100D). The node guarding warning does not cause any NMT state change or switching the output pins to the error state. It is implemented to give the CANopen master an early information that the guarding interval has already exceeded the predefined value.

- 0: Guarding Warning is disabled
- 1: Guarding Warning is enabled

Index	2103h
Name	Enable Guarding Warning
Description	-
Data Type	Unsigned 8
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	0

Index 2105: Internal Error Code

This Object holds error information of the CANopen controller.

Index	2105h
Name	Internal Error Code
Description	-
Data Type	Unsigned 32
Access modes	RO
PDO Mapping	Yes
Value Range	-
Default Value	0 (no error condition)

Index 2110: Test Object

This Object is implemented for testing purposes and should not be used.
 The test entry does not have any functional behavior.

Index	2110h
Name	Test Object 01
Description	-
Data Type	Structure

Index	2110h Subindex 0
Name	Largest SubIndex supported
Description	-
Data Type	Unsigned char
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	0x01

Index	2110h Subindex 1
Name	Test Object 01
Description	-
Data Type	Unsigned 16
Access modes	RW
PDO Mapping	No
Value Range	100 ... 1000
Default Value	500

Index 2180: CAN Restart Time

This Object gives the restart time out for the CAN communication layer in case of bus off errors in milliseconds.

If the restart time is set to 0 automatic restart of the device in case of bus off is prohibited.

Index	2180h
Name	CAN Restart Time
Description	-
Data Type	Unsigned 16
Access modes	RW
PDO Mapping	No
Value Range	0 .. 50000
Default Value	1000 (restart after one second)

Index 21C0: Timer Event Counter

This counter is incremented automatically at intervals according to index 21C1. Via mapping of this index into any TPDO, a cyclic transmission of this TPDO can be triggered.

Index	21C0h
Name	Timer Event Counter
Description	-
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	YES
Value Range	
Default Value	

Index 21C1: Timer Event Time

This index contains the time interval for incrementing the "Timer Event Counter" of index 21C0. If the time is set to 0, the counter will not be incremented.

Time is given in ms.

Index	21C1h
Name	Timer Event Time
Description	-
Data Type	Unsigned 16
Access modes	RW
PDO Mapping	NO
Value Range	0 ... 10000
Default Value	0

DS301: PDO Parameter Objects

Communication Parameter Objects

The following table shows the communication parameter objects for Index 140x (Receive PDOs) and Index 180x (Transmit PDOs). The tables show Index 1400 as an example for all PDOs

The transmission type (sub-index 2) defines the mode for transmission / reception of the PDO. See table for detailed description of this entry.

Description of transmission type:

Type	PDO transmission				
	cyclic	acyclic	Sync related	Async.	Only on remote
0		X	X		
1-240	X		X		
241-251	Reserved				
252			X		X
253				X	X
254				X	
255				X	

Synchronous transmission types 0-240 and 252 mean that the transmission of the PDO shall be related to the SYNC object. Asynchronous means that the transmission of the PDO is not related to the SYNC object.

A transmission type of zero means that the message shall be transmitted synchronously with the SYNC object but not periodically but only in case of data change.

A value between 1 and 240 means that the PDO is transferred synchronously and cyclically, the transmission type indicating the number of SYNC signals, which are necessary to trigger PDO transmissions or receptions.

The transmission types 252 and 253 mean that the PDO is only transmitted on reception of a remote frame. At transmission type 252, the data is updated (but not sent) immediately after reception of the SYNC object. At transmission type 253 the data is updated at the reception of the remote frame. These values are only possible for transmit PDOs.

Transmission type 255 means, the application event is defined in the device profile. For receive PDOs the reception of a PDO will update the mapped data (normally the analog or digital outputs).

Sub-index 3h contains the inhibit time. This time is a minimum interval for PDO transmission. The value is defined as multiple of 100ms.

In mode 254/255 additionally an event time can be used for TPDO. If an event timer exists for a TPDO (value not equal to 0) the elapsed timer is considered to be an event. The event time is a multiple of 1 ms. This event will cause the transmission of this TPDO in addition to otherwise defined events.

The PDO communication parameter objects have the same structure for all PDOs. The following Objects are used.

Sub-index 4h is reserved.

Index	PDO
1400h	Receive PDO1
1401h	Receive PDO2
1402h	Receive PDO3
1403h	Receive PDO4
1404h	Receive PDO5
1405h	Receive PDO6
1406h	Receive PDO7
1407h	Receive PDO8
1800h	Transmit PDO1
1801h	Transmit PDO2
1802h	Transmit PDO3
1803h	Transmit PDO4
1804h	Transmit PDO5
1805h	Transmit PDO6
1806h	Transmit PDO7
1807h	Transmit PDO8

Index	14xxh / 18xxh
Name	Receive / Transmit PDOx Communication Parameters
Description	-
Data Type	Structure

Index	14xxh / 18xxh Subindex 0
Name	Largest SubIndex supported
Description	-
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	2 / 5

Index	14xxh / 18xxh Subindex 1		
Name	COB-ID		
Description	Identifier for CAN-Object for PDO		
Data Type	Unsigned 32		
Access modes	RW		
PDO Mapping	No		
Value Range	-		
Default Value	1400.01	Node-Id + 200h	
	1401.01	Node-Id + 300h	
	1402.01	Node-Id + 400h	
	1403.01	Node-Id + 500h	
	1404.01	80000000h	
	1405.01	80000000h	
	1406.01	80000000h	
	1407.01	80000000h	
	1800.01	Node-Id + 180h	
	1801.01	Node-Id + 280h	
	1802.01	Node-Id + 380h	
	1803.01	Node-Id + 480h	
	1804.01	80000000h	
	1805.01	80000000h	
	1806.01	80000000h	
1807.01	80000000h		

An Identifier of 8xxxxxxh means, that this PDO is disabled by default and must be enabled from the CANopen master by assigning a valid PDO ID.

Index	14xxh / 18xxh Subindex 2		
Name	Transmission Type		
Description	-		
Data Type	Unsigned 8		
Access modes	RW		
PDO Mapping	No		
Value Range	-		
Default Value	1400.02	FFh	
	1401.02	FFh	
	1402.02	FFh	
	1403.02	FFh	
	1404.02	FFh	
	1405.02	FFh	
	1406.02	FFh	
	1407.02	FFh	
	1800.02	FFh	
	1801.02	FFh	
	1802.02	FFh	
	1803.02	FFh	
	1804.02	1	
1805.02	1		
1806.02	FFh		
1807.02	FFh		

Index	18xxh Subindex 3
Name	Inhibit Time
Description	-
Data Type	Unsigned 16
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	0

Index	18xxh Subindex 4
Name	Reserved
Description	-
Data Type	Unsigned 8
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	-

Index	18xxh Subindex 5
Name	Event Time
Description	-
Data Type	Unsigned 16
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	0

PDO Mapping Objects

The following table shows the PDO Mapping Objects. The principle of PDO mapping is the same for all PDOs. The PDO Mapping table is the cross reference between the Object dictionary entries (for example the data of an digital output byte) and the data field inside an PDO data field (position in the data field of a CAN message for PDO transfer).

Sub index 0 determines the valid number of objects that have been mapped. The CO4201 allows a maximum of 8 mapped objects for each PDO. For changing the PDO mapping first sub index 0 must be set to 0 (mapping is deactivated). Then the objects can be remapped. When a new object is mapped by writing a sub-index between 1 and 8, the device may check whether the object specified by index /sub index exists. If the object does not exist or the object cannot be mapped, the SDO transfer will be aborted.

Sub-indices 1 to 8 keep the pointers of the mapped objects as unsigned 32 values. The value is 0 if there is no mapped object. The structure for these pointers is as follows.

MSB		LSB	
Byte3	Byte2	Byte1	Byte0
Mapped index		Subindex	Length

Mapped Index and Sub index together are the Pointer to the Object dictionary data to be mapped at this location.
Length gives the length of the mapped object in bits.

Index	160xh / 1A0xh
Name	Receive / Transmit PDO Mapping Parameters
Description	-
Data Type	Array

Index	160xh / 1A0xh SubIndex 0
Name	Largest SubIndex supported
Description	Number of mapped objects
Data Type	Unsigned 8
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	See table below

Index	160xh / 1A0xh SubIndex 1 to 8
Name	Mapped object
Description	-
Data Type	Unsigned 32
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	See table below

Receive PDOs

The CANopen chip CO4201 uses the following default mapping entries for receive PDO mapping:

Index	Entry	Explanation
Receive-PDO1		
1600.00	3	RPDO1: 3 mapped objects
1600.01	62000108h	Digital Output Byte 1
1600.02	62000208h	Digital Output Byte 2
1600.03	62000308h	Digital Output Byte 3 *1)
Receive-PDO2		
1601.00	2	RPDO2: 2 mapped objects
1601.01	64110110h	Analog output 1 *1)
1601.02	64110210h	Analog output 2 *1)
Receive-PDO3		
1602.00	4	RPDO3: 4 mapped objects
1602.01	51000110h	PWM Value 1
1602.02	51000210h	PWM Value 2
1602.03	51000310h	PWM Value 3
1602.04	51000410h	PWM Value 4
Receive-PDO4		
1603.00	4	RPDO4: 4 mapped objects
1603.01	51000510h	PWM Value 5
1603.02	51000610h	PWM Value 6
1603.03	51000710h	PWM Value 7
1603.04	51000810h	PWM Value 8
Receive-PDO5		
1604.00	2	RPDO5: 2 mapped objects
1604.01	40010110h	Counter 1 Control
1604.02	40010210h	Counter 2 Control
Receive-PDO6		
1605.00	0	RPDO6: 0 mapped objects
Receive-PDO7		
1606.00	0	RPDO7: 0 mapped objects
Receive-PDO8		
1607.00	0	RPDO8: 0 mapped objects

*1) Only valid, if the object exists and is not disabled with configuration setting

Transmit PDOs

The CANopen chip CO4201 uses the following default mapping entries for transmit PDO mapping:

Index	Entry	Explanation
Transmit - PDO1		
1A00.00	4	TPDO1: 4 mapped objects
1A00.01	60000108h	Digital Input Byte 1
1A00.02	60000208h	Digital Input Byte 2
1A00.03	60000308h	Digital Input Byte 3
1A00.04	60000408h	Digital Input Byte 4
Transmit - PDO2		
1A01.00	4	TPDO2: 4 mapped objects
1A01.01	64010110h	Analog Input Integer 1 *1)
1A01.02	64010210h	Analog Input Integer 2 *1)
1A01.03	64010310h	Analog Input Integer 3 *1)
1A01.04	64010410h	Analog Input Integer 4 *1)
Transmit - PDO3		
1A02.00	4	TPDO3: 4 mapped objects
1A02.01	64010510h	Analog Input Integer 5 *1)
1A02.02	64010610h	Analog Input Integer 6 *1)
1A02.03	64010710h	Analog Input Integer 7 *1)
1A02.04	64010810h	Analog Input Integer 8 *1)
Transmit - PDO4		
1A03.00	0	TPDO4: 0 mapped objects
Transmit - PDO5		
1A04.00	3	TPDO5: 3 mapped objects
1A04.01	40000120	Counter 1 Value
1A04.02	40020110	Counter 1 Status
1A04.03	40030110	Counter 1 Incs/sec
Transmit - PDO6		
1A05.00	3	TPDO6: 3 mapped objects
1A05.01	40000220	Counter 2 Value
1A05.02	40020210	Counter 2 Status
1A05.03	40030210	Counter 2 Incs/sec
Transmit - PDO7		
1A06.00	0	TPDO7: 0 mapped objects
Transmit - PDO8		
1A07.00	0	TPDO8: 0 mapped objects

*1) Only valid, if the object exists and is not disabled with configuration setting

DS401: Digital Input Objects

The following objects are describing the functionality of the digital input lines of the CO4201. The CO4201 supports 8, 16 and 32bit access to the digital inputs.

The number of digital input bytes depends on the selected operation mode.

The mapping of the I/O lines to object 6000 is explained in chapter "Mapping I/O to Object Dictionary"

See also Index 5302 and 5303 that enable analog and digital functionality in Dual use mode for input pins Aix/Dix (ADIF = 1) in chapter DS401: Analog Input Objects.

Index 5001: Digital Input Filter Time

This object is implemented in order to configure the filter time of each digital input byte. The time has to be a multiple of 1ms.

Index	5001h
Name	Digital Input Filter Time
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	-
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	4

Index	Subindex 1 to 4 of input bytes
Name	Digital Input Filter Time Byte n
Description	
Data Type	Unsigned 16
Access modes	RW
PDO Mapping	No
Value Range	0 ... 30
Default Value	3

Index 5002: Input Pull Up Enable

This object enables/disables the pull up resistors at the digital input lines.

Index	5002h
Name	Input Pull Up Enable
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	4

Index	Subindex 1
Name	Input Pull Up Enable 1
Description	Pull Up for Input Byte 1
Data Type	Unsigned 8
Access modes	RW
PDO Mapping	No
Value Range	
Default Value	0xFF

Index	Subindex 2
Name	Input Pull Up Enable 2
Description	Pull Up for Input Byte 2
Data Type	Unsigned 8
Access modes	RW
PDO Mapping	No
Value Range	
Default Value	0xFF

Index	Subindex 3
Name	Input Pull Up Enable 3
Description	Pull Up for Input Byte 3
Data Type	Unsigned 8
Access modes	RW
PDO Mapping	No
Value Range	
Default Value	0

Index	Subindex 4
Name	Input Pull Up Enable 4
Description	Pull Up for Input Byte 4
Data Type	Unsigned 8
Access modes	RW
PDO Mapping	No
Value Range	
Default Value	0xFF

Index 6000: Read Digital Input 8 Bit

This object represents the digital input bytes. The value of the input lines is written to this object. Please note, that input pins are active low by default, so the inverted pin level is written to the input objects.

Index	6000h
Name	Digital Input 8 Bit
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	Number of digital input bytes

Index	Subindex 1 to Nr of input bytes
Name	Digital Input 8 Bit Byte n
Description	
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	Yes
Value Range	-
Default Value	-

Index 6100: Read Digital Input 16 Bit

This object enables 16-Bit access to the digital input bytes. The Object addresses the same data area as object 6000 but using unsigned integer data type. See Index 6000 for further details.

Index 6120: Read Digital Input 32 Bit

This object enables 32-Bit access to the digital input bytes. The Object addresses the same data area as object 6000 but using unsigned long data type. See Index 6000 for further details.

Index 6002: Polarity Input 8 Bit

With this object, the digital inputs may be inverted. See also Index 6000 for additional information.

Index	6002h
Name	Polarity Input 8 Bit
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	Number of digital input bytes

Index	Subindex 1 to Nr of input bytes
Name	Polarity Input 8 Bit Byte n
Description	
Data Type	Unsigned 8
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	0

Index 6005: Global Interrupt Enable

This object enables or disables globally the interrupt behaviour without changing the interrupt masks. 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.

TRUE (1) = global interrupt enabled
 FALSE (0) = global interrupt disabled

Index	6005h
Name	Global Interrupt Enable
Description	-
Data Type	Boolean
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	TRUE

Index 6007: Interrupt Mask Low to High

This object has the same structure and behaviour as object 6006h but will cause interrupts only on rising edge of object index 6000. Note that input lines are active low, so rising edge of input data (object 6000) means falling edge of input port line. Default value is 0.

Index 6008: Interrupt Mask High to Low

This object has the same structure and behaviour as object 6006h but will cause interrupts only on falling edge of object index 6000. Note that input lines are active low, so falling edge of input data (object 6000) means rising edge of input port line. Default value is 0.

Index 6006: Interrupt Mask Any Change

This object determines, which input lines shall activate an interrupt by any change of the input line. Both negative and positive edge will cause an interrupt, if enabled.

An interrupt will cause a PDO transmission in case of event driven transmission mode.

1 = interrupt enabled
 0 = interrupt disabled

Index	6006h
Name	Interrupt Mask any change
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	Number of digital input bytes

Index	Subindex 1 to Nr of input bytes
Name	Interrupt Mask any change
Description	
Data Type	Unsigned 8
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	0FFh (interrupt enabled)

DS401: Digital Output Objects

The following objects are describing the functionality of the digital output lines of the CO4201. The CO4201 supports 8, 16 and 32bit access to the digital outputs.

The number of digital output lines depends on the selected operation mode.

The mapping of the I/O lines to object 6200 is explained in chapter "Mapping I/O to Object Dictionary"

Index 5200: Output Reset on Error Option

This Object selects the function for error handling if a critical error is detected.

If the value is set to 0, the Outputs objects 6200.xx will keep unchanged. The ports will be set to their error state given in object 6207 as long as the error condition is active. If error condition ends, the outputs will return to the state according to the output object 6200h.

If the value is set to 1, the Outputs error handling depends on the objects 6206h and 6207h and the output object 6200 will be overwritten with the error output state according to objects 6206 and 6207.

Index	5200h
Name	Output Reset on Error Option
Description	-
Data Type	Unsigned 8
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	1

Index 5202: Output Overload Error Info

This Object returns the value 1 if a low level will be detected on Pin 36 EMY.

Index	5202h
Name	Output Overload Error Info
Description	-
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	Yes
Value Range	-
Default Value	-

Index 6200: Write to Digital Output

With object 6200, the digital outputs of the CO4201 can be written to. The Output port bits of the CO4201 device are active low by default, that means, that a bit value of "1" within the output object drives a low level on the output pin.

If an output channel is configured for analog PWM generation by setting the corresponding bit within object 5100.xx and digital control for this channel is activated by setting the corresponding bit within object 5101, the digital output object switches the PWM generation on or off. In this case, object 6202 (Polarity Output) is ignored and a bit value of "1" always switches PWM generation on.

Index	6200h
Name	Write to digital output
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	NO
Value Range	-
Default Value	Number of digital output bytes

Index	Subindex 1 to Nr of output bytes
Name	Write to digital output
Description	
Data Type	Unsigned 8
Access modes	RW
PDO Mapping	YES
Value Range	-
Default Value	0

Index 6300: Write Digital Output 16 Bit

This object enables 16-Bit access to the digital output bytes. The Object addresses the same data area as object 6200 but using unsigned integer data 16 bit type. See Index 6200 for further details.

Index 6320: Write Digital Output 32 Bit

This object enables 32-Bit access to the digital output bytes. The Object addresses the same data area as object 6200 but using unsigned long 32 bit data type. See Index 6200 for further details.

Index 6202: Polarity Output 8 Bit

With this object, the digital outputs may be inverted. See also Index 6200 for additional information.

Index	6202h
Name	Polarity Output 8 Bit
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	Number of digital output bytes

Index	Subindex 1 to Nr of input bytes
Name	Polarity Output 8 Bit Byte n
Description	
Data Type	Unsigned 8
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	0

Index 6206: Error Mode Output 8 Bit

This object indicates, whether an output is forced to a predefined value (given in object 6207) in case of a device error.

1 = Output will be forced to the value selected in object 6207

0 = Output will be unchanged even in case of an error condition.

Index	6206h
Name	Error Mode Output 8 Bit
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	Number of digital output bytes

Index	Subindex 1 to Nr of output bytes
Name	Error Mode Output 8 Bit Byte n
Description	
Data Type	Unsigned 8
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	0FFh (Take error condition from object 6207)

Index 6207: Error Value Output 8 Bit

This object selects the level the outputs are forced to in case of device error mode if the error mode (object 6206 is enabled)

1 = Output will be forced to active state

0 = Output will be forced to inactive state.

Note: Outputs of CO4201 are active low.

Index	6207h
Name	Error Value Output 8 Bit
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	Number of digital output bytes

Index	Subindex 1 to Nr of output bytes
Name	Error Value Output 8 Bit Byte n
Description	
Data Type	Unsigned 8
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	0 (Inactive, high level)

DS401: Analog Input Objects

The following objects are describing the functionality of the analog input lines of the CO4201.

Index 5301: Analog Input Filter Size

This object is implemented in order to configure the filter time of the analog inputs. The time has to be a multiple of 1ms.

Index	5301h
Name	Analog Input Filter Size
Description	
Data Type	Unsigned 16
Access modes	RW
PDO Mapping	No
Value Range	0 ... 20
Default Value	10

Index 5302: Analog Digital In Enable Analog

In Analog Digital Dual Use Mode ADIF = 1 (analog and digital processing enabled for input pins AI0/DI16 ... AI7/DI23) this object enables the analog processing for the input channels. Each bit represents 1 input channel.

Index	5302h
Name	Analog Digital In Enable Analog
Description	
Data Type	Array

Index	Subindex 0
Name	
Description	Nr of Subobjects
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	1

Index	Subindex 1
Name	Analog Digital In Enable Analog
Description	
Data Type	Unsigned 8
Access modes	RW
PDO Mapping	No
Value Range	0 ... 0xFF
Default Value	0xFF Analog processing is enabled for all 8 input channels

Index 5303: Analog Digital In Enable Digital

In Analog Digital Dual Use Mode ADIF = 1 (analog and digital processing enabled for input pins AI0/DI16 .. AI7/DI23) this object enables the digital processing for the input channels. Each bit represents 1 input channel.

Index	5303h
Name	Analog Digital In Enable Digital
Description	
Data Type	Array

Index	Subindex 0
Name	
Description	Nr of Subobjects
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	1

Index	Subindex 1
Name	Analog Digital In Enable Digital
Description	
Data Type	Unsigned 8
Access modes	RW
PDO Mapping	No
Value Range	0 ... 0xFF
Default Value	0xFF Digital processing is enabled for all 8 input channels

Index 5320: Analog In Full Scale Value

This object is implemented in order to configure the Full Scale of the analog inputs.

Index	5320h
Name	Analog In Full Scale Value
Description	
Data Type	Unsigned 16
Access modes	RW
PDO Mapping	No
Value Range	0 ... 0x7FFF
Default Value	10000

The full scale value object is implemented in order to adapt the analog input value to a hardware, for example to get an input voltage directly in mV.

See object 6401 for further information

Index 5322: Analog Input Scaling Multiplier

The Analog Input Scaling Multiplier is implemented in order to adapt the scaling of the analog input channels to the hardware.

Index	5322h
Name	Analog Input Scaling Multiplier
Description	
Data Type	Array

Index	Subindex 0
Name	
Description	Nr of Subobjects
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	Number of analog outputs

Index	Subindex 1 to Nr of outputs
Name	Analog Input Scaling Multiplier
Description	
Data Type	Unsigned 16
Access modes	RW
PDO Mapping	No
Value Range	0 ... 20000
Default Value	If pin 29 is set to high level 10000 If pin 29 is set to low level 3000

See object 6401 for further information

Index 5323: Analog Input Scaling Divider

The Analog Out Scaling Divider is implemented in order to adapt the scaling of the analog input channels to the hardware.

Index	5323h
Name	Analog Input Scaling Divider
Description	
Data Type	Array

Index	Subindex 0
Name	
Description	Nr of Subobjects
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	Number of analog outputs

Index	Subindex 1 to Nr of outputs
Name	Analog Input Scaling Divider
Description	
Data Type	Unsigned 16
Access modes	RW
PDO Mapping	No
Value Range	0 ... 20000
Default Value	If pin 29 is set to high level 10000 If pin 29 is set to low level 2842

See object 6401 for further information

Index 6401: Read Analog Input 16 Bit

Object 6401, represents the value of the analog channels. The 16 bit conversion result of the analog input voltage is a signed value. The input pins are scanned only for positive voltages. The value is displayed in millivolt.

The mapping of the I/O lines to object 6401 is explained in chapter "Mapping I/O to Object Dictionary"

Index	6401h
Name	Read Analog Input
Description	-
Data Type	Array

Index	Subindex 0
Name	
Description	Number of mapped objects
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	Number of analog input lines

Index	Subindex 1 to Nr of input lines
Name	Read Analog Input
Description	
Data Type	Signed 16
Access modes	RO
PDO Mapping	Yes
Value Range	-
Default Value	-

Scaling of the input data is done with the following formula:

$$ADC = 0xFFF * V_{in} / V_{ref}$$

$$AIV = ADC * [5322.xx] / [5323.xx]$$

$$[6401.xx] = AIV * [5320.xx] / 0xFFF$$

$$V_{out} = V_{ref} * DAC / 0x3FF$$

- V_{in} Input Voltage at input pin
- V_{ref} Reference Voltage supplied to controller pin 51 (AVRH)
- ADC A/D Converter Value
- AIV Analog Input Value

Index 6421: Analog Input Interrupt Trigger

Object 6421 selects the event that shall cause a transmission interrupt for the selected analog channel.

There is one Subindex for each channel to enable individual setting according to application requirements.

Table of possible Trigger Conditions:

Bit Nr	Interrupt Trigger Selection
0	Input voltage greater than Upper Limit
1	Input voltage less than Lower Limit
2	Input changed by more than Delta
3	Input reduced more than Negative Delta
4	Input increased more than Positive Delta
5 to 7	Reserved (must be forced to zero)

Index	6421h
Name	Analog Input Interrupt Trigger
Description	-
Data Type	Array

Index	Subindex 0
Name	
Description	Number of mapped objects
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	Number of analog input lines

Index	Subindex 1 to Nr of input lines
Name	Analog Input Interrupt Trigger
Description	Selects trigger condition
Data Type	Unsigned 8 (See Table of Trigger Conditions)
Access modes	RW
PDO Mapping	No
Value Range	0 ... 31
Default Value	7

Index 6423: Analog Input Interrupt Enable

This object enables or disables globally the interrupt behaviour without changing the interrupt masks. The interrupt is disabled by default, in order to avoid transmission of analog input values.

TRUE (1) = global interrupt enabled
FALSE (0) = global interrupt disabled

Index	6423h
Name	Analog Input Interrupt Enable
Description	-
Data Type	Boolean
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	FALSE

**Index 6424/5/6/7/8:
Analog Input Interrupt Limits**

These objects give the Limit for generation of interrupts. All objects have the same structure. The function of the interrupt limit is only enabled, if the corresponding bit of object 6421 is set. All values of limit parameters are signed 32. So the user must take care not to exceed the range of the input data objects.

Note especially for limit calculations
For calculation whether an interrupt (PDO transmission) must be generated or not, the analog input data object (6401.xx) is always evaluated as signed value, even if an offset is set to simulate an unsigned value.

Table of Limit Function

Object	Object Name and Function
6424	Analog Input Upper Limit Generate interrupt if input voltage is greater than or equal to Upper Limit (6424)
6425	Analog Input Lower Limit Generate interrupt if input voltage is less than Lower Limit (6425)
6426	Analog Input Interrupt Delta Generate interrupt if input voltage changed by more than Interrupt Delta
6427	Analog Input Negative Delta Generate interrupt if input voltage reduced by more than Negative Delta
6428	Analog Input Positive Delta Generate interrupt if input voltage increased by more than Positive Delta

Index	6424/5/6/7/8
Name	See table above
Description	-
Data Type	Array

Index	Subindex 0
Name	
Description	Number of mapped objects
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	NO
Value Range	-
Default Value	Number of analog input lines

Index	Subindex 1 to Nr of input lines
Name	See table above
Description	
Data Type	Integer 32
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	0

DS401: Analog Output Objects

The following objects are describing the functionality of the analog output lines of the CO4201.

Index 5400: Output Reset on Error Option

This object selects the function for error handling if a critical error is detected.

If the value is 0, the Outputs objects 6411.xx will keep unchanged. The ports will be set to their error state given in object 6444 as long as the error is active. If error ends, the outputs will return to the state according to the output object 6411h.

If the value is 1, the Outputs error handling depends on the objects 6443h and 6444h and the output object 6411 will be overwritten with the error output state according to objects 6443 and 6444.

Index	5400h
Name	Output Reset on Error Option
Description	-
Data Type	Unsigned 8
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	1

Index 5420: Analog Out Full Scale Value

This object is implemented in order to configure the Full Scale of the analog outputs.

Index	5420h
Name	Analog Out Full Scale Value
Description	
Data Type	Unsigned 16
Access modes	RW
PDO Mapping	No
Value Range	0 ... 0x7FFF
Default Value	10000

Index 5422: Analog Out Scaling Multiplier

The Analog Out Scaling Multiplier is implemented in order to adapt the scaling of the analog output channels to the hardware.

Index	5422h
Name	Analog Out Scaling Multiplier
Description	
Data Type	Array

Index	Subindex 0
Name	
Description	Nr of Subobjects
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	Number of analog outputs

Index	Subindex 1 to Nr of outputs
Name	Analog Out Scaling Multiplier
Description	
Data Type	Unsigned 16
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	10000

See object 6411 for further information

The object is only available, if the analog output channels are enabled

Index 5423: Analog Out Scaling Divider

The Analog Out Scaling Divider is implemented in order to adapt the scaling of the analog output channels to the hardware.

Index	5423h
Name	Analog Out Scaling Divider
Description	
Data Type	Array

Index	Subindex 0
Name	
Description	Nr of Subobjects
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	Number of analog outputs

Index	Subindex 1 to Nr of outputs
Name	Analog Out Scaling Divider
Description	
Data Type	Unsigned 16
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	If pin 29 is set to high level 10000 If pin 29 is set to low level 10555

See object 6411 for further information
 The object is only available, if the analog output channels are enabled

Index 6411: Write Analog Output

With object 6411, the analog outputs of the CO4201 can be written to. The scaling of the output voltage is done with objects 5420, 5422 and 5423.

Index	6411h
Name	Write to analog output
Description	-
Data Type	Array

Index	Subindex 0
Name	
Description	Nr of Subobjects
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	Number of analog outputs

Index	Subindex 1 to Nr of outputs
Name	Write to analog output
Description	
Data Type	Integer 16
Access modes	RW
PDO Mapping	Yes
Value Range	-
Default Value	0

Scaling of the output voltage is done with the following formula:

$$AOV = [6411.xx] * [5422.xx] / [5423.xx]$$

$$DAC = AOV * 0x3FF / [5420.xx]$$

$$Vout = Vref * DAC / 0x3FF$$

- AV Analog Output Value
- DAC D/A Converter Value
- Vout Output Voltage
- Vref Reference Voltage supplied to controller pin 51 (AVRH)

The object is only available, if the analog output channels are enabled

Index 6443: Error Mode

This object indicates, whether an output is forced to a predefined value (given in object 6444) in case of a device error.

- 0 = Output will be unchanged even in case of an error condition.
- 1 = Output will be forced to the value selected in object 6444

Index	6443h
Name	Error Mode Output 16 Bit
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	Number of analog outputs

Index	Subindex 1 to Nr of outputs
Name	Error Mode n
Description	
Data Type	Unsigned 8
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	1

Index 6444: Analog Output Error Value

This object selects the level the outputs are forced to in case of device error mode if the error mode (object 6443) is enabled.

Index	6207h
Name	Error Value Output 32 Bit
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	
Data Type	Unsigned 8
Access modes	RO
PDO Mapping	No
Value Range	-
Default Value	Number of digital output bytes

Index	Subindex 1 to Nr of outputs
Name	Error ValueInt n
Description	
Data Type	Integer 32
Access modes	RW
PDO Mapping	No
Value Range	-
Default Value	0

Counter Control Objects

The following objects are describing the objects for controlling the counter and encoder functionality.

Index 4000: Counter Value

This object returns the value of the Counter.

Index	4000h
Name	Counter Value
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	
Data Type	Unsigned 8
Access modes	Ro
PDO Mapping	No
Value Range	-
Default Value	2

Index	Subindex 1 to 2
Name	Counter Value 1 to 2
Description	-
Data Type	Unsigned 32
Access modes	Ro
PDO Mapping	Yes
Value Range	-
Default Value	-

Index 4001: Counter Control

This object is implemented in order to set up the counter channels. The object 4008 is also needed to configure the counter mode.

Index	4001h
Name	Counter Control
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	-
Data Type	Unsigned 8
Access modes	Ro
PDO Mapping	No
Value Range	-
Default Value	2

Index	Subindex 1 to Nr of Counter inputs		
Name	Counter Control 1 to n		
Description	There are several individual control bits for each input line.		
	Bit		
	0	0	counter disabled (stop)
		1	counter enabled (run)
	3...1	0	reserved
	4	0	no action
		1	on rising edge, the counter is reset
	5	0	no action
		1	on rising edge, the counter is set to the Preset value of object 4007.xx
	15...6	0	reserved
Data Type	Unsigned 16		
Access modes	RW		
PDO Mapping	Yes		
Value Range	-		
Default Value	0		

Index 4002: Counter Status

This object returns the status of counter channels.

Index	4002h
Name	Counter Status
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	-
Data Type	Unsigned 8
Access modes	Ro
PDO Mapping	No
Value Range	-
Default Value	2

Index	Subindex 1 to Nr of Counter inputs	
Name	Counter Status 1 to n	
Description	There are several status bits for each input line.	
	Bit	
	0	0 counter is disabled (stopped)
		1 counter is enabled (running)
	3...1	0 reserved
	7...4	shows actual setting of bit 4...7 of counter control object 4001.xx
15...8	shows setting of active counter mode	
Data Type	Unsigned 16	
Access modes	Ro	
PDO Mapping	Yes	
Value Range	-	
Default Value	0	

Index 4003: Counter Speed Inc / Sec

The value shows the actual speed of the counter in increments per second divided by speed scaling object 4009.xx.

If the value exceeds 30000 (-30000) increments per second, the value is fixed at 30001 (-30001).

Index	4003h
Name	Counter Speed Incs per Second
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	-
Data Type	Unsigned 8
Access modes	Ro
PDO Mapping	No
Value Range	-
Default Value	2

Index	Subindex 1 to Nr of Counter inputs	
Name	Counter Speed Incs/sec 1 to n	
Description	-	
Data Type	Unsigned 16	
Access modes	Ro	
PDO Mapping	Yes	
Value Range	-30001 ... 30001	
Default Value	-	

Index 4007: Counter Preset Value

This index holds a preset value, that is written to the actual counter value (Index 4000.xx) on a rising edge of bit 5 of the counter control object. (Index 4001.xx)

Index	4007h
Name	Counter Preset Value
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	-
Data Type	Unsigned 8
Access modes	Ro
PDO Mapping	No
Value Range	-
Default Value	2

Index	Subindex 1 to Nr of Counter inputs
Name	Counter Preset Value 1 to n
Description	-
Data Type	Unsigned 32
Access modes	Rw
PDO Mapping	Yes
Value Range	0 ... 0xFFFFFFFF
Default Value	0

Index 4008: Counter New Operation Mode

The counters support several operation modes:

01h: Encoder with track A, B:

The counter works in quadrature position counter mode. The 32-bit count value gives the position value.

02h: Encoder with track A, B, Z:

The counter works in quadrature position counter mode. The 32-bit count value is separated in 2 independent signed 16-bit values. The higher 16 bits count the revolutions detected from track Z. The lower 16 bits show the position value also as a signed 16 bits value that is controlled from signals A and B.

Each rising edge of the Z signal increments/decrements the revolution value and clears the position value. The 32 bits count value gives the position value.

03h: Encoder with track A, B and Gate-Function Z:

The counter works in quadrature position counter mode. The 32-bit count value gives the position value. The input Z works as a gate and enables/disables counting function. An active port level at input pin Z enables counting.

08h: Event counter rising edge:

The counter is running as an event counter. Input A is working as count direction input. Input B as count event input. The counter detects a rising edge at input B

09h: Event counter falling edge:

The counter is running as an event counter. Input A is working as count direction input. Input B as count event input. The counter detects a falling edge at input B

0Ah: Event counter rising edge with Gate

The counter is running as an event counter. Input A is working as count direction input. Input B as count event input. The counter detects a rising edge at input B. An active level at input pin Z enables counting.

0Bh: Event counter falling edge with Gate:

The counter is running as an event counter. Input A is working as count direction input. Input B as count event input. The counter detects a falling edge at input B. An active level at input pin Z enables counting.

Please note:

Setting of a new counter mode is only done, if the encoder channel is disabled. So setting of the counter mode object does not have any effect if the counter channel is enabled by using object 4001.xx Bit 0. If changing of the mode for an already running counter is required, the counter must be disabled in order to set the new mode with the next setting of the enable bit.

Index	4008h
Name	Counter New Operation Mode
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	-
Data Type	Unsigned 8
Access modes	Ro
PDO Mapping	No
Value Range	-
Default Value	2

Index	Subindex 1 to Nr of Counter inputs
Name	Counter New Operation Mode 1 to n
Description	There are several mode bits for each input line.
Bit	
7...0	
00h	Encoder is disabled
01h	Encoder with tracks A, B
02h	Encoder with tracks A, B and revolution counter Z
03h	Encoder with tracks A, B and Gate Z
04...07h	reserved
08h	Event counter rising edge at B
09h	Event counter falling edge at B
0Ah	Event counter rising edge at B and Gate Z
0Bh	Event counter falling edge at B and Gate Z
8	0 no action
	1 Input A and B are swapped
9	0 no action
	1 Invert Gate function for Z
15...10	0 reserved
Data Type	Unsigned 16
Access modes	Ro
PDO Mapping	Yes
Value Range	-
Default Value	0

Index 4009: Counter Speed Scaling

Index	4009h
Name	Counter Speed Scaling
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	-
Data Type	Unsigned 8
Access modes	Ro
PDO Mapping	No
Value Range	-
Default Value	2

Index	Subindex 1 to Nr of Counter inputs
Name	Counter Speed Scaling 1 to n
Description	-
Data Type	Unsigned 16
Access modes	Rw
PDO Mapping	Yes
Value Range	1 ... 1000
Default Value	1

PWM Control Objects

The following objects are describing the objects for controlling the PWM generation.

Index 5100: PWM Value

This object is implemented in order to configure the Duty Cycle of each PWM output channel

Index	5100h
Name	PWM Value
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	
Data Type	Unsigned 8
Access modes	Ro
PDO Mapping	No
Value Range	-
Default Value	8

Index	Subindex 1 to Nr of PWM outputs
Name	PWM Value 1 to n
Description	0 : 0% duty cycle 5000 : 50% duty cycle 10000 : 100% duty cycle
Data Type	Unsigned 16
Access modes	RW
PDO Mapping	Yes
Value Range	0 ... 10000
Default Value	0

Note:

This object is implemented for all output channels, but PWM generation is only supported for DO2/PWM2 ... DO7/PWM7.

Index 5101: PWM Control

This object is implemented in order to set up the PWM channels and the directly control or activation via digital output object.

Index	5101h
Name	PWM Control
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	-
Data Type	Unsigned 8
Access modes	Ro
PDO Mapping	No
Value Range	-
Default Value	8

Index	Subindex 1 to Nr of PWM outputs	
Name	PWM Control 1 to n	
Description	There are several individual control bits for each output line.	
	Bit	
	0	0 PWM disabled 1 PWM enabled
	1	0 PWM direct activation 1 PWM activation via digital output
	2	0 reserved
	3	0 reserved
	4	0 PWM value object 5100.xx is reset in case of a critical error condition 1 PWM value object 5100.xx is hold in case of a critical error condition
	5	0 Prefer duty cycle in case of change of base timer resolution 1 Prefer constant active time in case of change of base timer resolution
	6	0 reserved
	7	0 reserved
	9, 8	00 Assign PWM channel to timer channel 0 01 Assign PWM channel to timer channel 1 10 Assign PWM channel to timer channel 2 11 Assign PWM channel to timer channel 2
	15...10	0 reserved
Data Type	Unsigned 16	
Access modes	RW	
PDO Mapping	Yes	
Value Range	-	
Default Value	0	

Note:

This object is implemented for all output channels, but PWM generation is only supported for DO2/PWM2 ... DO7/PWM7.

Index 5106: PWM Base Timer Steps

This object is implemented in order to set the number of steps for the PWM Timer.
 There are three PWM timers that may be assigned to the PWM channels.

Index	5106h
Name	PWM Base Timer Steps
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	
Data Type	Unsigned 8
Access modes	Ro
PDO Mapping	No
Value Range	-
Default Value	3

Index	Subindex 1 to 3
Name	PWM Base Timer Steps 1 to n
Description	-
Data Type	Unsigned 16
Access modes	RW
PDO Mapping	Yes
Value Range	-
Default Value	1000

Index 5107: PWM Timer Prescaler

This object is implemented in order to configure the prescaler of each PWM timer clock.

Index	5107h
Name	PWM Timer Prescaler
Description	-
Data Type	Array

Index	Subindex 0
Name	Nr of Subobjects
Description	-
Data Type	Unsigned 8
Access modes	Ro
PDO Mapping	No
Value Range	-
Default Value	3

Index	Subindex 1 to 3
Name	PWM Timer Prescaler 1 to n
Description	0 16 MHz / 1 PWM timer clock 1 16 MHz / 2 2 16 MHz / 4 3 16 MHz / 8 4 16 MHz / 16 5 16 MHz / 32 6 16 MHz / 64 7 16 MHz / 128 8 16 MHz / 256
Data Type	Unsigned 16
Access modes	RW
PDO Mapping	Yes
Value Range	0 ... 8
Default Value	4

Emergency Messages

The CANopen chip supports several emergency messages. For all emergencies the same structure is used:

Byte								
0	1	2	3	4	5	6	7	
EMY-Code	1001	0	Chip-EC					

EMY-Code: Emergency-Error-Code according to DS301
 1001: Content of Object 1001
 Chip-EC: Chip-Error-Code as unsigned 32 value

Chip-Error-Code (hex)	May change		Description
	NMT	I/O	
8000 0000	X	X	CAN bus is bus off
4000 0000			CAN bus in error warning state
2000 0000			Node guarding warning
3000 0000	X	X	Life guarding error
0000 0001	X	X	Output Overload detected
0000 0000			Wake up from Power down

Emergency 2000 0000 (Node guarding warning) must be enabled with object 2103.

If more than one error is active at the same time, the bitmap of the CO4201-Codes for all active errors are combined with a logical or conjunction.

Some of the emergencies may cause a NMT state change and/or may force the output pins to the error state. This behaviour depends on the setting of object 1029.

If there is more than one error active at the same time, the Error Codes for all errors are logical OR combined and transmitted in one emergency message. This guarantees, that the last transmitted emergency message represents the complete system error state.

The ID for emergency transmission is fixed to: 0x80 + \$NodeID.

List of emergency messages:

Heartbeat Error							
30	81	01	00	00	00	00	10

This error occurs, if the monitored node fails to transmit the heartbeat within the specified Heartbeat Time in object 1016.

Node-Guarding Warning							
30	81	01	00	00	00	00	20

This warning occurs, if the masters fails to transmit the guarding remote frame within the specified Guard Time object 100C and if transmission is enabled in object 2103

Life-Guarding Error							
30	81	11	00	00	00	00	30

This error occurs, if the masters fails to transmit the guarding remote frame within the specified Life Time (Guard Time object 100C multiplied with Life Time Factor object 100D)

Output Overload Error							
10	23	01	00	01	00	00	00

This error occurs, if the output overload interrupt input pin (EMY pin 36) is active low.

CAN Bus in Error Warning state							
00	81	01	00	00	00	00	40

This error occurs, if the chips internal CAN module is in error warning state.

Return from CAN Bus OFF							
40	81	01	00	00	00	00	C0

This message indicates a return from Bus OFF state.

Mapping I/O to Object Dictionary

All possible configurations are shown in individual tables. Select the table for your application according to I/O requirements.

Summary of operation modes

The following table shows a summary of possible operation modes.

CFG Pins	I/O Configuration	
	Mode	Description
1 0		
1 1	0	27 input lines DI0 ... DI26 digital inputs (8) analog input lines (12 bit) AI0 ... AI7 (2) encoder input lines ENC0A, -B, -Z ENC1A, -B, -Z 18 output lines DO0 ... DO17 (2) analog output lines (10 bit) AO0 ... AO1 (6) PWM output lines PWM2 ... PWM7 () input/output lines which support special functionality
x x		Reserved *1)

*1) These modes are reserved for future use and must not be set. Selecting the reserved modes may cause improper operation of the device.

The selected operation mode may be read via object 2101h from the object dictionary.

CFG Mode 0: 27 in / 18 out

Operation mode 0 CFG1 = 1 CFG0 = 1 EDS-file: CO4201.EDS								
Data Mapping to Dictionary								
Index. SubIndex	Mapped I/O Signal bit/value							
	7	6	5	4	3	2	1	0
6000.01	DI7 to DI0							
6000.02	DI15 to DI8							
6000.03	DI23 to DI16							
6000.04	DI26-DI24							
6200.01	DO7 to DO0							
6200.02	DO15 to DO8							
6200.03 *2)	DO 17 16							
6401.01 *2)	AI0							
6401.02 *2)	AI1							
6401.03 *2)	AI2							
6401.04 *2)	AI3							
6401.05 *2)	AI4							
6401.06 *2)	AI5							
6401.07 *2)	AI6							
6401.08 *2)	AI7							
6411.01 *2)	AO0							
6411.02 *2)	AO1							

*2) Only valid, if the object exists and is not disabled with configuration setting

Default PDO Mapping	
PDO	Mapped Data
RPDO1	6200.01 digital output DO0 ... 7 6200.02 digital output DO8 ... 15 6200.03 digital output DO16 ... 17
RPDO2	6411.01 analog output 0 6411.02 analog output 1
RPDO3	5100.01 analog PWM value 1 5100.02 analog PWM value 2 5100.03 analog PWM value 3 5100.04 analog PWM value 4
RPDO4	5100.05 analog PWM value 5 5100.06 analog PWM value 6 5100.07 analog PWM value 7 5100.08 analog PWM value 8
RPDO5	4001.01 Counter Control 1 4001.02 Counter Control 2

Default PDO Mapping	
PDO	Mapped Data
TPDO1	6000.01 digital input DI0 ... I7 6000.02 digital input DI8 ... 15 6000.03 digital input DI16 ... 23 6000.04 digital input DI24 ...26
TPDO2	6401.01 analog input 0 6401.02 analog input 1 6401.03 analog input 2 6401.04 analog input 3
TPDO3	6401.05 analog input 4 6401.06 analog input 5 6401.07 analog input 6 6401.08 analog input 7
TPDO5	4000.01 Counter 1 Value 4002.01 Counter 1 Status 4003.01 Counter 1 Incs/sec
TPDO6	4000.02 Counter 2 Value 4002.02 Counter 2 Status 4003.02 Counter 2 Incs/sec

Absolute Maximum Ratings

Stresses greater than those listed parameters may cause permanent damage to the device. Functional operation should be restricted to recommended operation conditions. Exposure to absolute maximum rating conditions for extended times may affect reliability.

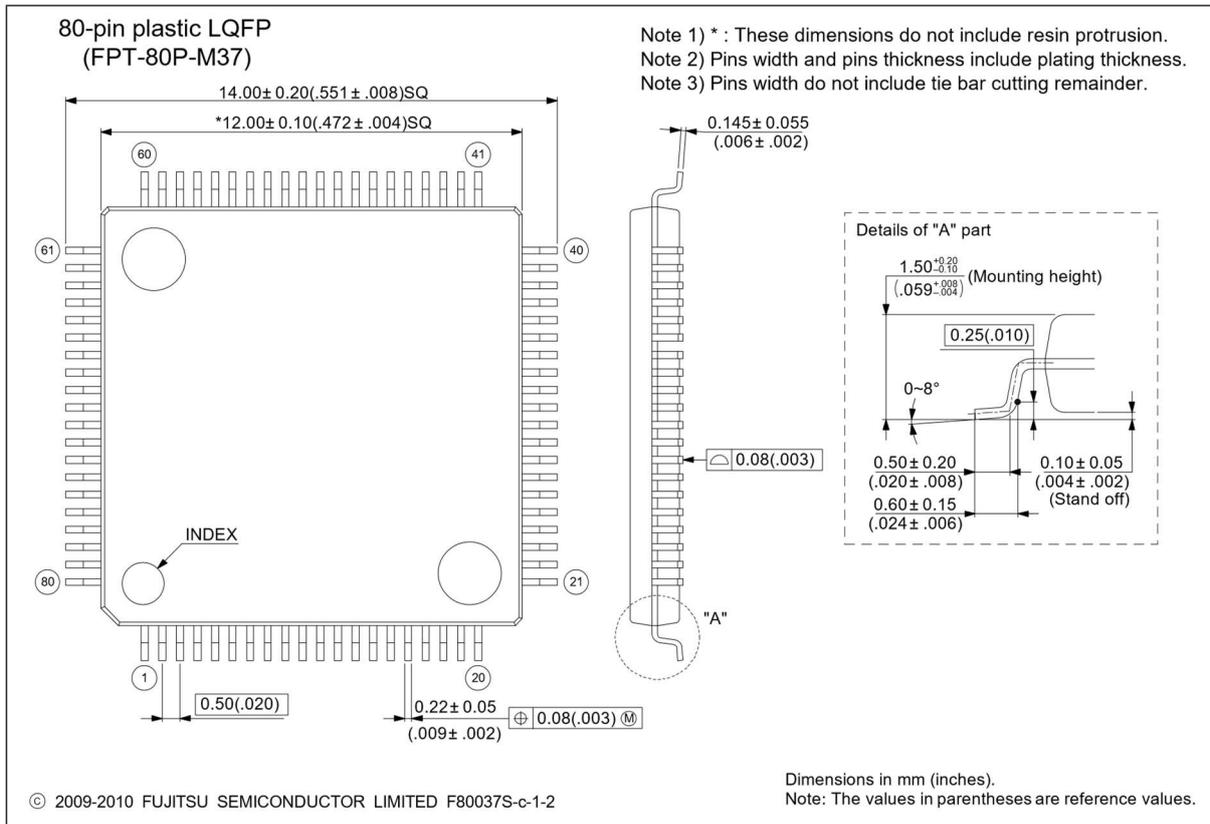
Parameter	Symbol	Rated Value		Units	Remarks
		Min.	Max.		
Power supply voltage	VCC	VSS – 0.5	VSS + 6.5	V	
Analog power supply voltage	AVCC	VSS – 0.5	VSS + 6.5	V	
Analog reference voltage	AVRH	VSS – 0.5	VSS + 6.5	V	
Input voltage	Vi	VSS – 0.5	VSS + 6.5	V	5V tolerant
Output voltage	Vo	VSS – 0.5	VSS + 6.5	V	
L level maximum output current	IOLMAX		12	mA	Time < 100 msec
L level maximum output current	IOL		4	mA	
H level maximum output current	IOHMAX		12	mA	Time < 100 msec
H level maximum output current	IOH		4	mA	
Maximum Power dissipation	P _{MAX}		300	mW	
Operating temperature	T _A	-40	+105	°C	CO4201
Storing temperature	T _A	-55	+150	°C	

Recommended Operation Conditions and Characteristics

Functional operation should be restricted to recommended operation conditions.

Parameter	Symbol	Rated Value			Units	Remarks
		Min.	Typ.	Max.		
Power supply voltage	VCC	3.0	3.3 / 5.0	5.5	V	
Analog power supply voltage	AVCC		VCC	VCC	V	
Analog reference voltage	AVREF	3.0		VCC	V	
Power supply current	I _{CC}		35	50	mA	All inputs V _{IL} or V _{IH} All outputs open
Input H voltage	V _{IH}	0.8 * VCC		VCC + 0.3	V	
Input L voltage	V _{IL}	VSS – 0.3		0.2 * VCC	V	
Output H voltage	V _{OH}	VCC – 0.5			V	I _{OH} = -4.0 mA
Output L voltage	V _{OL}			0.4	V	I _{OL} = 4.0 mA
Input leakage current	I _{LKC}	-5		5	uA	
Crystal frequency	f _{osc}		16		MHz	
Reset pulse width	t _{res}	10			us	
Power on rise time	t _{RESLH}	0.05		30	ms	
Maximum CANopen Delay input pin to bus telegram	t _{DITB}	0.05	0.5	2	ms	No additional bus distribution delay
Maximum CANopen Delay bus telegram to output pin	t _{DBTO}	0.05	0.5	2	ms	
Watchdog trigger periode	T _{WDT}	0		10	ms	Delayed max. 500 ms after reset
Maximum Power dissipation	P _{MAX}			300	mW	
Operating temperature	T _A	-40		+105	°C	CO4201

Package Dimension CO4201



Version History and Notes

The following table shows all relevant changes of the CO4201 during product life time.

Version	Date	Changes
2.320	Sep/06/2018	First version
2.601	Jul/23/2019	BugFix: Fixed a bug that avoids correct scanning of input data if ADIF=0 Work around for earlier versions: Use analog digital mixed mode ADIF=1
2.930	Oct/18/2022	Update of objects in datasheet

Attention please!

All rights reserved.

The information herein is given to describe certain components and shall not be considered as warranted characteristics. Terms of delivery and all rights to technical changes are reserved.

We hereby disclaim any and all warranties, including but not limited to warranties of non-infringement, regarding circuits, descriptions and charts stated herein.

The electronic product described in this document is designed, developed and manufactured as contemplated for general use, including without limitation, ordinary industrial use, general office use, personal use, and household use, but is not designed, developed and manufactured for use in applications accompanying fatal risks or dangers that, could have a serious effect to the public, and could lead to death, personal injury, severe physical damage or other loss (i.e., nuclear reaction control in nuclear facility, aircraft flight control, air traffic control, mass transport control, medical life support system, missile launch control in weapon system). The product is not designed, developed and manufactured for applications requiring extremely high reliability (i.e., submersible repeater and artificial satellites).

Please note that frenzel + berg electronic GmbH & Co.KG will not be liable against you and/or any third party for any claims or damages arising in connection with above-mentioned uses of the products.

Any semiconductor devices have an inherent chance of failure. You must protect against injury, damage or loss from such failures by incorporating safety design measures into your facility and equipment such as redundancy, fire protection, and prevention of over current levels and other abnormal operating conditions.

General Description	1	Index 1000: Device Type	10
Features	1	Index 1001: Error Register	10
Applications	1	Index 1002: Status Register.....	10
CANopen Features	1	Index 1005: COB-ID Sync.....	10
Ordering Information	1	Index 1008: Device Name.....	10
Pin Assignment	2	Index 1009: Hardware Version.....	11
Pin Listing	2	Index 100A: Software Version.....	11
Pin Listing continued	2	Index 100C: Guard Time.....	11
Handling the Device	3	Index 100D: Life Time Factor.....	11
Preventing latch up	3	Index 100E: COB-ID Guard	12
Handling unused Pins	3	Index 1014: COB-ID Emergency.....	12
All Power Supply Pins	3	Index 1015: Inhibit Time Emergency.....	12
Power Supply for A/D converter	3	Index 1016: Consumer Heartbeat Time	12
Input / Output pins.....	3	Index 1017: Producer Heartbeat Time	13
Pull up/down resistors	3	Index 1018: Identity Object	13
Pin Description	3	Index 1029: Error Behaviour	14
ID0 to ID6: Device Identifier input pins	3	Index 2000: Device Manufacturer	15
DI0 to DI26: Digital input pins or encoder/counter AI0 to		Index 2009: Silicon Serial Number	15
AI7: Analog input pins.....	3	Index 2101: System Configuration	15
DO0 to DO17: Digital or PWM output pins DO16 to		Index 2102: Remapping Enabled Info.....	15
DO17: Analog output pins.....	3	Index 2103: Enabled Guarding Warning	15
CFG0 to CFG1: Configuration input pins.....	4	Index 2105: Internal Error Code.....	16
EMY: Emergency interrupt	4	Index 2110: Test Object.....	16
FWU: Firmware update input	4	Index 2180: CAN Restart Time	16
IPO/WDO: Input polarity select input / watchdog output		Index 21C0: Timer Event Counter.....	16
.....	4	Index 21C1: Timer Event Time	16
BD0 to BD2: CAN baud rate configuration pins.....	4	DS301: PDO Parameter Objects	17
LR/ADIF: Led CANopen Run / Analog Digital input pin		Communication Parameter Objects	17
function selector	4	PDO Mapping Objects	19
LE/ADOF: Led CANopen Error / Analog Digital output		DS401: Digital Input Objects	21
pin function selector.....	5	Index 5001: Digital Input Filter Time	21
CAN_RX, CAN_TX: CAN interface pins.....	5	Index 5002: Input Pull Up Enable.....	21
X0, X1: Crystal oscillator input	5	Index 6000: Read Digital Input 8 Bit.....	22
VCC, VSS: Power Supply Pins	5	Index 6100: Read Digital Input 16 Bit.....	22
AVCC, AVSS: Analog Power Supply Pins.....	5	Index 6120: Read Digital Input 32 Bit.....	22
AVRH, AVRL: Analog Reference Voltage	5	Index 6002: Polarity Input 8 Bit	22
C: Filter Capacitor input.....	5	Index 6005: Global Interrupt Enable	23
RST#: Reset input pin	5	Index 6006: Interrupt Mask Any Change.....	23
Device Configuration	6	Index 6007: Interrupt Mask Low to High	23
CAN Identifier 6		Index 6008: Interrupt Mask High to Low	23
Baud rate 6		DS401: Digital Output Objects	24
I/O Configuration 6		Index 5200: Output Reset on Error Option.....	24
Object Dictionary	7	Index 5202: Output Overload Error Info	24
DS301: global Objects.....	7	Index 6200: Write to Digital Output	24
DS301: PDO Parameter Objects.....	8	Index 6300: Write Digital Output 16 Bit.....	24
DS401: Digital Input Objects	8	Index 6320: Write Digital Output 32 Bit.....	24
DS401: Digital Output Objects	8	Index 6202: Polarity Output 8 Bit	25
DS401: Analog Input Objects	8	Index 6206: Error Mode Output 8 Bit	25
DS401: Analog Output Objects	9	Index 6207: Error Value Output 8 Bit	25
PWM Control Objects.....	9	DS401: Analog Input Objects	26
Counter Control Objects.....	9	Index 5301: Analog Input Filter Size	26
Description of Object Dictionary	9	Index 5302: Analog Digital In Enable Analog.....	26
Index 0005	9	Index 5303: Analog Digital In Enable Digital	26
Index 0006	9	Index 5320: Analog In Full Scale Value	26
Index 0007	9	Index 5322: Analog Input Scaling Multiplier	27
DS301: Global Objects	10	Index 5323: Analog Input Scaling Divider	27
		Index 6401: Read Analog Input 16 Bit	28
		Index 6421: Analog Input Interrupt Trigger	28
		Index 6423: Analog Input Interrupt Enable.....	29
		Index 6424/5/6/7/8: Analog Input Interrupt Limits...29	
		DS401: Analog Output Objects	30

Index 5400: Output Reset on Error Option.....	30	Index 5106: PWM Base Timer Steps	38
Index 5420: Analog Out Full Scale Value.....	30	Index 5107: PWM Timer Prescaler	38
Index 5422: Analog Out Scaling Multiplier.....	30	Emergency Messages	39
Index 5423: Analog Out Scaling Divider.....	31	Mapping I/O to Object Dictionary	40
Index 6411: Write Analog Output	31	Summary of operation modes	40
Index 6443: Error Mode.....	32	CFG Mode 0: 27 in / 18 out.....	40
Index 6444: Analog Output Error Value.....	32	Absolute Maximum Ratings	42
Counter Control Objects.....	33	Recommended Operation Conditions and	
Index 4000: Counter Value.....	33	Characteristics	42
Index 4001: Counter Control	33	Package Dimension CO4201.....	43
Index 4002: Counter Status.....	34	Version History and Notes	44
Index 4003: Counter Speed Inc / Sec	34	Attention please!.....	44
Index 4007: Counter Preset Value	35		
Index 4008: Counter New Operation Mode.....	35		
Index 4009: Counter Speed Scaling.....	36		
PWM Control Objects.....	37		
Index 5100: PWM Value.....	37		
Index 5101: PWM Control	37		