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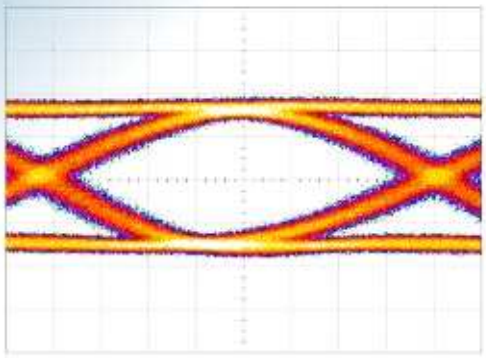

Data Sheet

EC-AOUT8

Preliminary

Data Sheet EC-AOUT8

Contents

1. Application Range

The EC-AOUT8 module was developed for the generation of analog peripheral signals. The data transfer is accomplished by the EtherCAT®[1] fieldbus. The module is designed for DIN rail assembly.

The module has eight analog outputs. Four different output ranges can be chosen independently for each channel.

The resolution is 12bit at a conversion time lower than 30µs. It is possible to assemble the modules with 14 or 16bit converters on request.

2. Output Voltage Ranges

The module has the following possible output ranges:

- 0..5V
- 0..10V
- ±5V
- ±10V

The determination of the output ranges is made by the range select register (s. chapter 4.2.3). The output voltage range can be determined for every channel separately.

3. Hardware Description

The module is made of four functional hardware blocks. These are:

- Analog output circuit
- Microcontroller
- EtherCAT®-connection
- Power supply

3.1. Analog Output Circuit

The module has 8 analog outputs. These outputs are able to drive min. 5mA. They are short circuit protected. The analog outputs can be operated with two different modes.

Over current power down: The channel powers down upon detection of an over current. A short circuit or over current case is signalized by the status word. The switch off of an output must be acknowledged by software. If the reason for the error is removed, the appropriate output will switch on again.

Current-limit clamp: The channel does not power down upon detection of an over current. The current is clamped at 20 mA.

[1] EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany

Furthermore the outputs are also over temperature protected. This case is signalized by the status word also. Because of using four channel DAC-circuits the over temperature condition is related to four channels simultaneously.

The outputs are galvanic isolated against the microcontroller and the Ethernet but not among each other.

3.2. Microcontroller

The microcontroller serves as a coupling device between the Ethernet and the analog outputs. It reads the data from the EtherCAT®-controller and writes it to the DAC-circuits and vice versa.
The software of the microcontroller is programmed into the flash by the producer.

3.3. EtherCAT®-Connection

The module has two Ethernet interfaces each with one yellow and one green LED. The yellow LED signalizes an Ethernet connection with 100MB, the green data transfer.
One interface serves as an output, the other as output to the next EtherCAT® slave or is unconnected if the module is the last inside the chain. Both interfaces support auto crossover (MDI/MDIX).
Furthermore there is a green LED at the front side displaying the EtherCAT® state with different blink sequences.

3.4. Power Supply

The module is powered by 24V±30%. All supply voltages necessary for the different functional blocks are generated internal. The power needed is about 3W plus output power of the DA-channels.

4. Programming and Memory Mapping of the EtherCAT®-Slave Controller

4.1. Summary

The integrated circuit ET1100 of Beckhoff Automation GmbH is used as the EtherCAT® – slave controller. It is responsible for the data exchange between application layer and microcontroller. There for two SyncManagers (SM) of the ET1100 are used. One serves for the output of data (DA-values, range select register, error acknowledge, watchdog). The other is used for reading the status word. Both SMs operate in 3 buffer mode ensuring data consistency. The SM for data output activates the interrupt line of the process data interface if there new output data were transmitted with the last frame. The microcontroller will serve the interrupt by reading the new output data. The status word is written into the slave controller by the microcontroller cyclically.

4.1.1. Programming of SyncManagers

SM	address	value	Explanation
SM0	0x800	0x2000	Start address of input data
	0x802	0x0002	Length of input data in Byte
	0x804	0x0010	read, 3buffer, ECAT IRQ
	0x806	0x0001	Enable (set after 0x800..804 are programmed)
SM1	0x808	0x2100	Start address of output data
	0x80A	0x0016	Length of output data in Byte
	0x80C	0x0024	write, 3buffer, PDI IRQ
	0x80E	0x0001	Enable (set after 0x808..80C are programmed)

4.1.2. Data Fields

Input data:

address	content
0x2000	Status word

Output data:

Address	content
0x2100	Analog value, channel0
0x2102	Analog value, channel1
0x2104	Analog value, channel2
0x2106	Analog value, channel3
0x2108	Analog value, channel4
0x210A	Analog value, channel5
0x210C	Analog value, channel6
0x210E	Analog value, channel7
0x2110	Range select register
0x2112	Error acknowledge
0x2114	Watchdog

4.2. Channel Registers

4.2.1. Status Word

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
TS7	OC7	TS6	OC6	TS5	OC5	TS4	OC4	TS3	OC3	TS2	OC2	TS1	OC1	TS0	OC0

Two status bits are available for every channels, one signalizes over temperature the other over current.

TSx: over temperature channel x (thermal shutdown)

OCx: over current channel x

4.2.2. Format of the DA-Values

The module EC-AOUT8 is delivered with 12bit DAC-circuits normally. The DA-values are straight binary coded and left aligned to a 16bit value. There for the compatibility to 14 or 16bit DAC-circuits is assured. 14 or 16bit DAC-circuits can be assembled on request.
In the following the coding of the output values is given depending on the output voltage range chosen:

- 0..5V

0V	2,5V	+5V-1LSB
0x000y	0x800y	0xFFFy

- 0..10V

0V	5V	+10V-1LSB
0x000y	0x800y	0xFFFy

- ±5V

-5V	0V	+5V-1LSB
0x000y	0x800y	0xFFFy

- ±10V

-10V	0V	+10V-1LSB
0x000y	0x800y	0xFFFy

Die hexadecimal digit „y“ stands for the following value:

- 12bit-DAC: xxxx
- 14bit-DAC: D1/D0/xx
- 16bit-DAC: D3/D2/D1/D0

The value of one LSB (least significant bit) is:

U_{LSB} = voltage range / ($2^{resolution}$-1)

e.g.: U_{LSB}(±10V, 12bit) = 20V / 4095 = 4,88mV

4.2.3. Range Select Register

The module EC-AOUT8 is parameterized with a range select register. It contains two bit per channel determining the output voltage range of the channel.

Structure of the range select register:

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
R71	R70	R61	R60	R51	R50	R41	R40	R31	R30	R21	R20	R11	R10	R01	R00

Rx(1..0) x = channel number
- 00: 0..5V
- 01: 0..10V
- 10: ±5V
- 11: ±10V

4.2.4. Error Acknowledge

The register “Error acknowledge” is to be written to acknowledge an error (over current, short circuit or over temperature) because an error results in an automatic switch off of an output.

Register Error acknowledge:

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
0	EA7	0	EA6	0	EA5	0	EA4	0	EA3	0	EA2	0	EA1	0	EA0

EAx Error Acknowledge of channel x
- 0: normal operation
- 1: Error acknowledge

4.2.5. Over Current Mode, Watchdog

The module EC-AOUT8 has a watchdog function. This assures that all outputs are switched to 0V if an error occurs. The watchdog function is activated if a value other than 0 is written into the watchdog register. The value specifies the duration of the watchdog time in 100µs-steps. An error would be an interruption of the Ethernet connection for instance. Furthermore the behavior of the analog outputs in the case of over current can be defined.

D15	D14	D13..D0
C1	C0	W13..W0

C1
- 0: Over current power down for channels 4..7
- 1: Current-limit clamp for channels 4..7

C0
- 0: Over current power down for channels 0..3
- 1: Current-limit clamp for channels 0..3

W13..0
- 0x0000: watchdog is switched off
- other: watchdog time in 100µs-steps

4.3. Version

The version of logic implemented can be determined by reading the memory cell 0xFE0 of the EtherCAT® slave controller. The cell is written by the slave logic while the slave is in the Init state.

5. Connector Pin Assignment

24V+	Power supply +
24V-	Power supply ground
GND	Analog ground
A0	Analog output 0
GND	Analog ground
A1	Analog output 1
GND	Analog ground
A2	Analog output 2
GND	Analog ground
A3	Analog output 3
GND	Analog ground
A4	Analog output 4
GND	Analog ground
A5	Analog output 5
GND	Analog ground
A6	Analog output 6
GND	Analog ground
A7	Analog output 7

6. Technical Data

EtherCAT®-Connection:

2 x RJ45 with yellow and green LED
Every connection with MDI/MDIX (auto crossover)
1 x status-LED, green

Analog Outputs:

No. of Channels:	8
Type:	voltage
Resolution:	12bit (optional 14 or 16bit)
Conversion Time:	< 30µs
Output Voltage:	0-5V or 0-10V or ±5V or ±10V
Output Current:	min. 5mA, short circuit protected
Total Unadjusted Error (TUE):	max ±0.3 % FSR, typ < ±2 LSB
Relative Accuracy (INL):	max ±1 LSB
Differential Nonlinearity (DNL):	max ±1 LSB
Bipolar Zero Error:	max ±6 mV *TA = 25°C, error at other temperatures obtained using bipolar zero error TC*
Bipolar Zero Error TC:	typ ±4 ppm FSR/°C
Zero-Scale Error:	max ±6 mV *TA = 25°C, error at other temperatures obtained using zero-scale error TC*
Zero-Scale Error TC:	typ ±4 ppm FSR/°C
Offset Error:	max ±6 mV *TA = 25°C, error at other temperatures obtained using offset error TC*
Offset Error TC:	typ ±4 ppm FSR/°C
Gain Error:	max ±0.025 % FSR *±10 V range, TA = 25°C, error at other temperatures obtained using gain error TC*
Gain Error:	−0.065..0 % FSR *+10 V and +5 V ranges, TA = 25°C, error at other temperatures obtained using gain error TC*
Gain Error:	0..+0.08 % FSR *±5 V range, TA = 25°C, error at other temperatures obtained using gain error TC*
Gain Error TC:	±8 ppm FSR/°C
Galvanic Isolation:	yes
Isolation Voltage:	1000Vrms (analog outputs - digital electronic) 1500Vrms (digital electronic - Ethernet)

Power Supply:

Output Voltage:	24V ±30%
Power Consumption:	<3W plus output power of the DA-channels

Housing:

Dimensions:	120 x 101 x 22.5 mm
Material:	Blend PC/ABS self-extinguishing
Color:	grey (other on request)
Assembly:	DIN rail
Weight:	135 g incl. connectors

Connector for Power Supply:

Type:	Phoenix FK-MC 1,5/2-STF-3,5
Type of Connection:	screw connection
Color:	green
No. of Positions:	2
Conductor Cross-Section:	0.14 - 1.5mm^2
Stripped insulation Length:	7 mm

Connectors for Peripheral Signals:

Type:	Phoenix FK-MC 0,5/12-ST-2,5
Type of Connection:	spring-cage
Color:	green
No. of Positions:	8
Conductor Cross-Section:	0.14 - 0.5mm^2
Stripped insulation Length:	8 mm

Ambient Conditions

Humidity:	5% until 95% without condensation
Operating Temperature:	0°C to + 55° C
Storage Temperature:	-40°C to +85° C

Electromagnetic Compatibility

Emissions:	EN61000-6-2:2001
Immunity:	EN61000-6-4:2001

7. Ordering Information

EC-AOUT8:	**100 43 12**

All necessary connectors are included.