

USER MANUAL

EtherCAT Converter

Edition 4

EtherCAT Converter Version 2.1

January 2019

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1 Preface

1.1 Target Audience

This document is intended for integrators who design and install complete robot applications. Personnel working with the gripper are expected to have the following expertise:

Basic knowledge of mechanical systems

Basic knowledge of electronic and electrical systems

Basic knowledge of the robot system

1.2 Intended Use

The Ethernet Converters are designed for gathering data from OnRobot sensors. OnRobot is not liable for any damage or injury resulting from misuse.

1.3 Important safety notice

The Ethernet Converter is *partly completed machinery* and a risk assessment is required for each application the Ethernet Converter is a part of. It is important that all safety instructions herein are followed. The safety instructions are limited to the sensor only and do not cover the safety precautions of a complete application.

The complete application must be designed and installed, in accordance with the safety requirements specified in the standards and regulations of the country where the application is installed.

1.4 Typographic Conventions

The following typographic conventions are used in this document.

Table 1: Conventions

Courier Text	File paths and file names, code, user input and computer output.
<i>Italicized text</i>	Citations and marking image callouts in text.
Bold text	UI elements, including text appearing on buttons and menu options.
Blue text	External links, or internal cross-references.
<angle brackets>	Variable names that must be substituted by real values or strings.

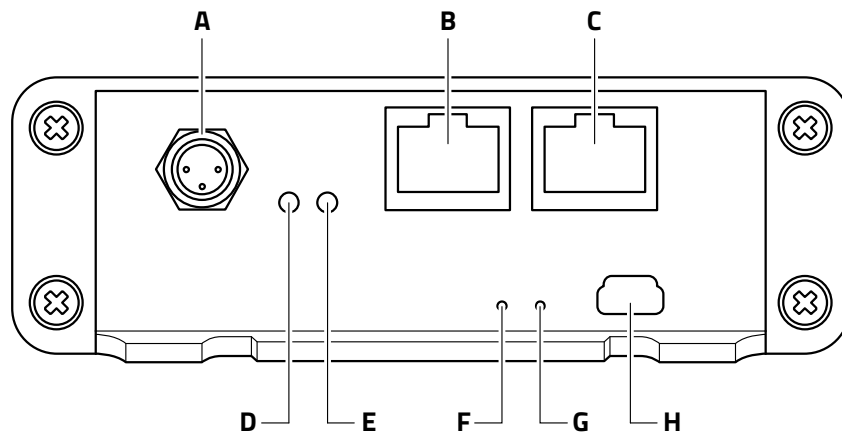
1. Numbered lists	Steps of a procedure.
A. Alphabetical lists	Image callout descriptions.

2 Connectors of the EtherCAT Converter

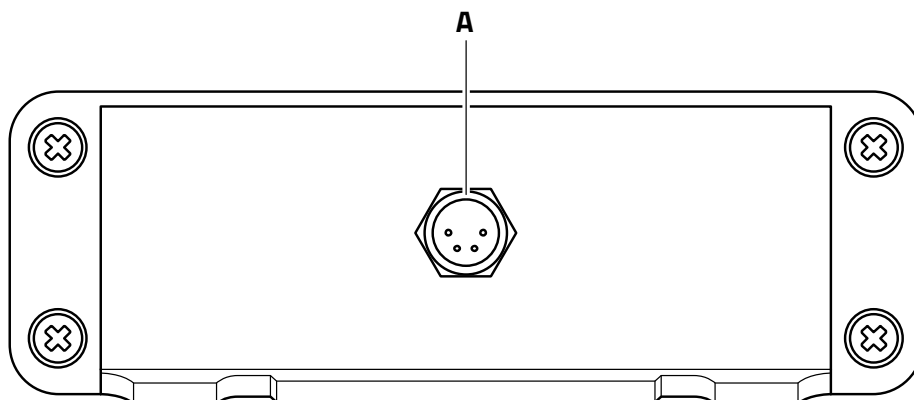
The following figures show the connectors and LEDs of the front and back panels.

A - Power connector
B - EtherCAT in port
C - EtherCAT out port
D - EtherCAT power LED

E - EtherCAT run LED
F - Converter run LED
G - F/T sensor transmitting LED
H - Optional USB connector



A. FT sensor

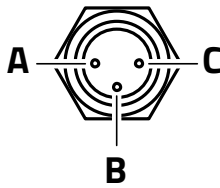


The converter must be powered via the power connector. Power-Over-Ethernet (PoE) is not supported.

Power Requirements	
Voltage	9V-24V
Power Consumption	2.5W

The power connector has the following pinout:

- A. Not in use
- B. Ground
- C. Power



3 Operation

3.1 Synchronization mode

The Converter is driven by a fixed 500Hz local timer (Free Run mode). The `SAMPLE_COUNTER` variable of the [Object 0x6020: Sensor Status](#) is incremented at each local timer execution (sampling).

3.2 Sampling rate

The sampling rate is fixed at 500Hz; however, the Force/Torque vales can be read at a lower read-out speed. To prevent aliasing always choose an appropriate cut-off frequency via the filter selection.

3.3 Filtering

An internal IIR low pass filter can be used to set the cut-off frequency of the force/torque signals. The filter index can be set at bit 0 – 2 of the `Object 0x7000: Sensor Configuration` at sub index 0x01.

Filter index (decimal)	Filter index (binary)	Cut-off frequency
0	0b000	No filter
1	0b001	500 Hz
2	0b010	150 Hz
3	0b011	50 Hz
4	0b100	15 Hz
5	0b101	5 Hz
6	0b110	1.5 Hz

3.4 Force/Torque Value Zeroing

The sensor can be set to zero any time by setting the `ZERO` field of the `Object 0x7000: Sensor Configuration` to 0x00FF.

The zero-setting request is sampled on every change of the `ZERO` field of the `Object 0x7000: Sensor Configuration`. Make sure that this is taken into consideration before modifying any other configuration settings.

The original force/torque values can be restored (UnZero) any time by setting 0x0000 to the `ZERO` field of the `Object 0x7000`, or it is automatically restored on power-off.

3.5 Error Reset

These settings are automatically cleared at power-off.

4 EtherCAT Interface

The following section describes the objects that are mapped into the TxPDO. Sensor properties can be read using the SDO protocol. For further information on the SDO, see [SDO Protocol](#).

4.1 PDO Interface

- TxPDO
 - Object 0x6000: Sensor Data(REAL)

(Fx_Real, Fy_Real, Fz_Real, Tx_Real, Ty_Real, Tz_Real)
 - Object 0x6010: Sensor Data(INTEGER)

(Fx_Int, Fy_Int, Fz_Int, Tx_Int, Ty_Int, Tz_Int, DIVIDER)
 - Object 0x6020: Sensor Status

(Sample counter, Status)
- RxPDO
 - Object 0x7000: Sensor Configuration (Filter, Zero)

4.1.1 Object 0x6000: Sensor Data(REAL)

This is a read-only object and it is mapped into the TxPDO input data.

Subindex	Name	Type	Description
0x01	Fx_Real	REAL	The units of force and torque values are in N/Nm represented as real32 values. For the current units, refer to the <code>Units</code> field of the <code>Sensor Properties</code> object at address 0x9000. Units = "N/Nm" For 3-axis force sensors Tx_Real, Ty_Real, and Tz_Real values are zero.
0x02	Fy_Real		
0x03	Fz_Real		
0x04	Tx_Real		
0x05	Ty_Real		
0x06	Tz_Real		

4.1.2 Object 0x6010: Sensor Data(INTEGER)

This is a read-only object and it is mapped into the TxPDO input data. The force and torque values are multiplied by the DIVIDER to store the values as integer numbers. This object can be used instead of the REAL representation of the data in cases when the REAL datatype is not supported. In this case, the user should divide the values by the DIVIDER to get the data in the specified units stated in the sensor properties data object at address 0x9000.

Subindex	Name	Type	Description
0x01	Fx_Int	DINT	<p>These fields show the force and torque values multiplied by the DIVIDER. To get the values in the units showing in the sensor properties object the force/torque values must be divided by the DIVIDER value at address 0x07. For the current units, refer to the <code>Units</code> field of the <code>Sensor Properties</code> object at address 0x9000.</p> <p>Units = "N/Nm"</p> <p>For 3-axis force sensors Tx_Int, Ty_Int, and Tz_Int values are zero.</p>
0x02	Fy_Int		
0x03	Fz_Int		
0x04	Tx_Int		
0x05	Ty_Int		
0x06	Tz_Int		
0x07	DIVIDER	INT	Divider for the Integer force and torque values.

4.1.3 Object 0x6020: Sensor Status

This is a read-only object shows the status of the sensor. It is mapped into the TxPDO input data.

Subindex	Name	Type	Description	
0x01	SAMPLE_COUNTER	UINT16	Counter that is incremented at each sampling.	
0x02	STATUS	UDINT	Bit	Function
			0-2	Sensor number (zero means no error)
			3	Single/Multiple errors
			4	OVERLOAD – in Tz
			5	OVERLOAD – in Ty
			6	OVERLOAD – in Tx
			7	OVERLOAD – in Fz
			8	OVERLOAD – in Fy
			9	OVERLOAD – in Fx
			10-12	000 = No error 001 = The sensor has not been detected 010 = Sensor failure
			13-15	000 = No error 001 = DAQ error 010 = Communication error
			16	Sensor calibration values are missing. If this flag is set, the force/torque values cannot be calculated and the values in the 0x6000 and 0x6010 objects are all zeros.

Subindex	Name	Type	Description	
			17-31	Reserved

The value of the STATUS field sets to 0xFFFFFFFF if the force/torque sensor is not connected. This can be used to detect cable error and to avoid malfunction during operation.

4.1.4 Object 0x7000: Sensor Configuration

This is a readable and writable object. It is mapped into the RxPDO output data.

Subindex	Name	Type	Description	
0x01	FILTER	UINT16	Bit	Function
			0-2	FILTER 000 = No filter 001 = 500 Hz 010 = 150 Hz 011 = 50 Hz 100 = 15 Hz 101 = 5 Hz 110 = 1.5 Hz
			3-15	Reserved
0x02	ZERO	UINT16	0-8	ZERO/UNZERO 0x00FF = Zero FORCE/TORQUE values 0x0000 = UnZero force/torque values
			9-15	Reserved

4.2 SDO Protocol

4.2.1 Object 0x9000: Sensor Properties

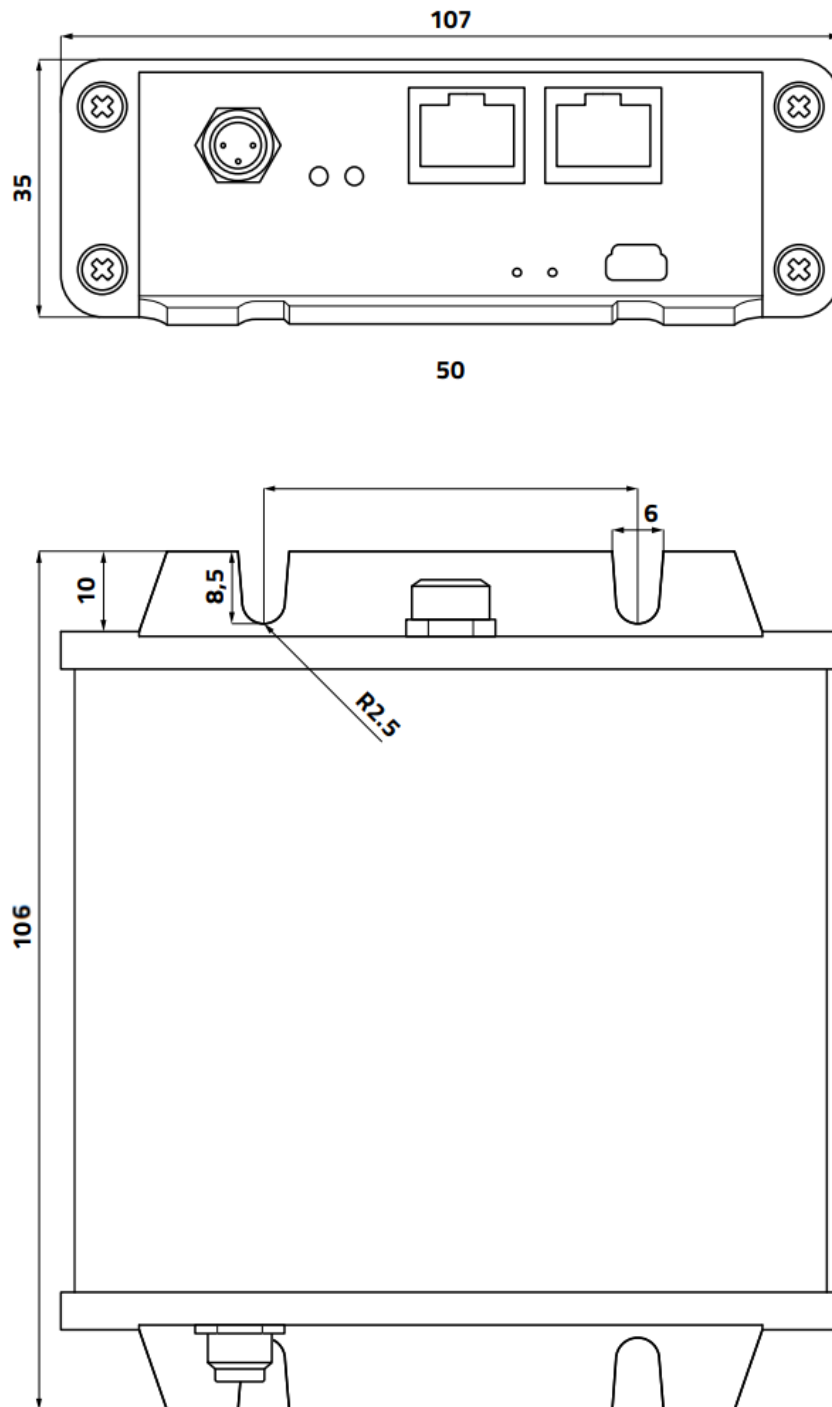
This is a read-only object that shows the sensor properties.

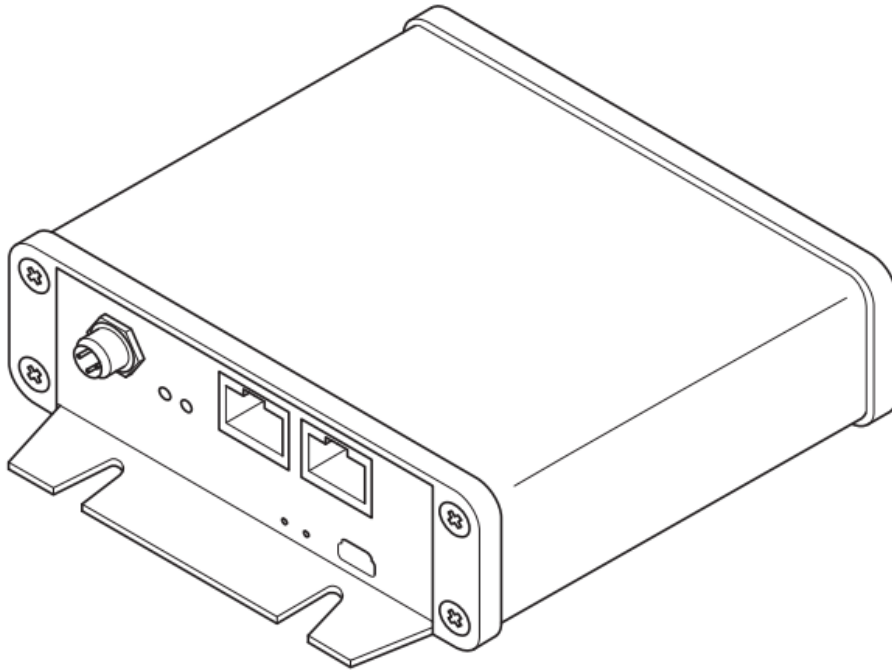
Subindex	Name	Type	Description
0x01	SERIAL	STRING(8)	The serial number of the DAQ
0x02	TYPE	UINT16	Type of the DAQ 31 = 3 axes, 1 channel 64 = 6 axes, 4 channels
0x03	UNITS	STRING(8)	The units of the measured force and torque values stored in the SENSOR DATA object. Units = "Counts"

Subindex	Name	Type	Description
			<p>The current force/torque values in numerical format (in Counts). Refer to the Sensitivity report to convert it to N or Nm.</p> <p>Units = "N/Nm"</p> <p>The current force/torque values are in N/Nm.</p>
0x04	CONVERTER_FW_VERSION	UINT	The firmware version of the EtherCAT converter.

5 Mechanical Drawing of the Converter

All dimensions are in mm.





6 List of Acronyms

Acronym	Expansion
DHCP	Dynamic Host Configuration Protocol
DIP	dual in-line package
F/T	Force/Torque
ID	Identifier
IP	Internet Protocol
IT	Information technology
MAC	media access control
PC	Personal Computer
RPY	Roll-Pitch-Yaw
SP	Starting Position
SW	software
TCP	Tool Center Point
UR	Universal Robots
URCap	Universal Robots Capabilities
USB	Universal Serial Bus
UTP	unshielded twisted pair

7 Appendix

7.1 Declarations and Certificates

CE/EU Declaration of Conformity (Original)

According to European EU Directives.

The manufacturer:

OnRobot A/S
Teglværskvej 47H
DK-5220, Odense SØ
DENMARK

declares that the product:

Type:	Force/Torque sensor
Model:	HEX with CAN-EtherCAT converter
Generation:	V2
Serial:	3010000000-3019999999

is in conformity with the following directives, according to which the product is CE marked:

2014/35/EU — Low Voltage Directive (LVD)
2014/30/EU — Electromagnetic Compatibility Directive (EMC)
2011/65/EU — Restriction of the use of certain hazardous substances (RoHS)

Relevant requirements of the following EU directives are also applied:

2012/19/EU — Waste of Electrical and Electronic Equipment (WEEE)

This declaration is issued under sole responsibility of OnRobot A/S. The object of this declaration includes both the HEX-E and HEX-H, with all flange variants, which are in conformity with relevant Union harmonization legislation, including Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (OJ L 174, 1.7.2011, p. 88.). This declaration is only valid for HEX and CAN-EtherCAT converter combined as one product; according to the assembly instructions.

Technical documentation is available in electronic form to national authorities upon legitimate request. Undersigned is based on the manufacturer address and authorized to compile this documentation.

A list of applied harmonized standards, including associated specifications, is provided in this manual.

Odense, January 2nd, 2019

Group Management



Niels Degn
CTO

Declaration of EMC test result



T-Network client

OnRobot Hungary Kft.
Aradi u. 16.
1043 Budapest
Hungary

Product identification

OnRobot HEX Force/Torque Sensor
S/N: HEXEX005 with CB1807B018

Manufacturer

OnRobot A/S

Technical report

T-Network Project EMC-180926/1, OnRobot HEX Force/Torque Sensor and Compute Box EMC Test Report,
dated 17 July 2018

Standards/Normative documents

EN 61000-6-2:2005
EN 61000-6-4:2007+A1:2011

T-Network has evaluated the products in various measurements, and the results verify the product's
EMC compliance.

Budapest, 05 October 2018

Sándor Tatár
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Report No.: SHES180600601401
Date of issue: 2018-09-25

TEST REPORT

Product name..... : 6-axis Force/Torque Sensor
 Product model..... : HEX-E v2
 Product description..... : Sensor
 Electrical Rating..... : -
 Applicant..... : OptoForce Ltd.
 Address..... : Aradi utca 16 1043 Budapest Hungary
 Manufacturer..... : OptoForce Ltd.
 Address..... : Aradi utca 16 1043 Budapest Hungary
 Testing Laboratory..... : SGS-CSTC Standards Technical Services (Shanghai) Co., Ltd.
 Address..... : No. 588 West Jindu Rd, Xinqiao Town, Songjiang District, Shanghai, CHINA
 Number of Samples received: 1
 Date of samples reception... : 2018-08-31
 Date Test Conducted..... : 2018-09-08 to 2018-09-09
 Test Requested..... : IP67 (as client's requirement)
 Test Method (standards)..... : IEC 60529 Clause 13.6 & Clause 14.2.7
 Test result..... : **Pass**
CONCLUSION..... : The submitted sample complies with the clauses examined.

Prepared and checked by:

Lewis Hua

Lewis Hua

Reviewed by:

Lucy Wang

Lucy Wang

7.2 Editions

Edition	Comment
Edition 2	New Look&Feel. Document restructured. List of Acronyms added. Appendix added. Target audience added. Intended use added. Copyright, Trademark, contact information, original language information added.
Edition 3	Box length updated
Edition 4	Status codes fixed Declaration of Conformity added