IO-Link Block

IOLB-7014

(4 Channel Analog Input)

User Guide

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First Edition, March 22, 2018

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Document Number: 2000645 Rev. A

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Overview

IOLB-7014 Module Overview

The IOLB-7014 provides four configurable differential analog inputs. The IOLB-7014 is intended to be connected directly to an IO-Link Master without an additional coupler box.

The small IOLB-7014 form factor of only 126 x 30 x 26.5 mm (h x w x d), which means that they are suitable for use where space is at a premium. The small mass of the IOLB-7014 module facilitates applications with mobile I/O interface (for example, a robot arm).

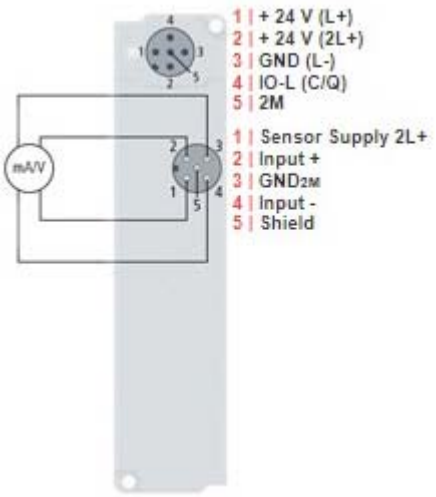
The robust design of the IOLB-7014 module enables them to be used directly at the machine. Control cabinets and terminal boxes are now no longer required. The module is fully sealed and therefore ideally prepared for wet, dirty or dusty conditions (IP67).

Pre-assembled cables significantly simplify IO-Link and signal wiring. Very few wiring errors are made, so that commissioning is optimized. In addition to pre-assembled IO-Link, power and sensor cables, field-configurable connectors and cables are available for maximum flexibility. Sensors and actuators are connected through M12 connectors.

Configurable Analog Differential Inputs

The IOLB-7014has four analog inputs that can be parameterized individually so that they process either signals in the range of -10 V to +10 V or in the range of 0/4 mA through 20 mA. The voltage or the input current is digitized with a resolution of 16 bits and transported galvanically separated to the higher-level automation device.

The four input channels are differential inputs and have a common, internal ground potential. The input filters and associated conversion times can be set in a wide range. The scaling of the inputs can be changed if necessary; Automatic limit monitoring is also available. Parameterization is done through IO-Link. The parameters are stored on the module.



Connector Assignment

IOLB-7014 LEDs

This subsection provides information about the IOLB-7014 LEDs.

X1 (IO-Link LED) 	Description
Off	IO-Link communication not active.
Flashing green (1 Hz)	IO-Link communication active.
Lit (Red)	Short circuit on C / Q line or overheating.

Power Supply LEDs 		Description
24V (L+)	Off	Voltage L+ Unavailable
	Green	Voltage L+ Ok
	Red	Voltage L+ Too Low
24 (2L+)	Off	Voltage 2L+ Unavailable
	Green	Voltage 2L+ Ok
	Red	Voltage 2L+ Too Low, Short Circuit

Analog LED 	Led Status	Description
R (Left LED)	Off	No data transmission to the A / D converter.
	Green	Data transfer to the A / D converter.
E (Right LED)	Off	Functioning properly.
	Red	Error: Wire break or measured value out of range.

IOLB-7014 Technical Specifications

IOLB-7014 Technical Specifications	
Hardware	
Communication Interface	IO-Link
Enclosure	Industrial housing PA6 (polyamide)
Ingress Protection Rating	IP65, IP66, IP67 (conforms to EN 60529)
Potting Compound	Polyurethane
Ports	1 – IO-Link 4 – Analog Inputs
Transmission Speed	COM3 = 230.4 Kbps
Connector Type (IO-Link)	M12, 5-poles, A-coded (male)
Connector Type (Analog inputs)	M12, 4-poles, A-coded (female)
Connector Contacts	Plated CuZn
Mounting Method	Machine or panel mount
Mounting Mechanism	Two mounting holes on the product for M3 screws
LED Indicators	IO-Link Communication status, Power Input L+, Power Input 2L+, Analog Input status
Dimensions (L x W x H)	126 x 30 x 26.5mm 5“ x 1.2“ x 1“
Weight	125g 4.4 oz
Electrical Specifications	
Operating Voltage	18 – 30 VDC
Nominal Voltage	24 VDC
Electronic Module Supply	L+ (Pin 1, 3 on IO-Link Connector X1)
Supply of Sensors	2L+ (Pin 2, 5 on IO-Link Connector X1)
Electrical Isolation	Yes (between L+ and 2L+)
Current Consumption (Module Electronics)	100 mA from L+

IOLB-7014 Technical Specifications	
IO-Link Communication Specifications	
Communication	IO-Link
Operating Mode	COM3 (230.4 kbps)
Standard	IEC61131-9
IO-Link Device ID	7014 (decimal) 00 1B 66 (hex)
IO-Link Connector	1 x M12, 5-poles, A-coded
Specification Version	IO-Link V1.1
Features	Data storage
Process Data Input (PDI)	16 Bytes
Process Data Input (PDO)	0 Bytes
Process Image	Inputs: 4 x 16 bit Status: 4 x 16 bit
Analog Input Specifications	
Number of Analog Inputs	4
Input Connectors	4 x M12, 5-pole, A-coded socket
Input Types	Configurable: • 0 V ... + 10 V • -10 V ... + 10V • 0 mA ... 20 mA • 4 mA ... 20 mA
Internal Resistance	> 200K ohms (typ. 85 ? + diode voltage)
Resolution	16 bits (incl. Sign)
Input Filter	Configurable
Input Filter Cut-off Frequency	5 kHz
Conversion Time	~ 100 microseconds
Measurement Error	<± 0.3% (relative to the full-scale value)
Common Mode Voltage UCM	Max. 35 V

IOLB-7014 Technical Specifications	
Environmental Specifications	
Operating Temperature	-25°C to +60°C
Storage Temperature	-40°C to +85°C
Operating Humidity	10% to 95%
Storage Humidity	10% to 95%
Shock and Vibrations	EN 60068-2-6 EN 60068-2-27
Regulatory Approvals	
Emissions	EN 61000-6-4 International Standard IEC 61000-6-4
Immunity	EN61000-6-2 International Standard IEC 61000-6-2
Safety Approvals	UL508
Other	IP65, IP66, IP67 (conforms to EN 60529) 2011/65/EU (RoHS2) Directive
Approvals	CE, UL, RoHS2

IO-Link Basics

IO-Link is a communications system for connecting intelligent sensors and actuators to an automation system in IEC 61131-9 under the name *Single-drop digital communication interface for small sensors and actuators* (SDCI).

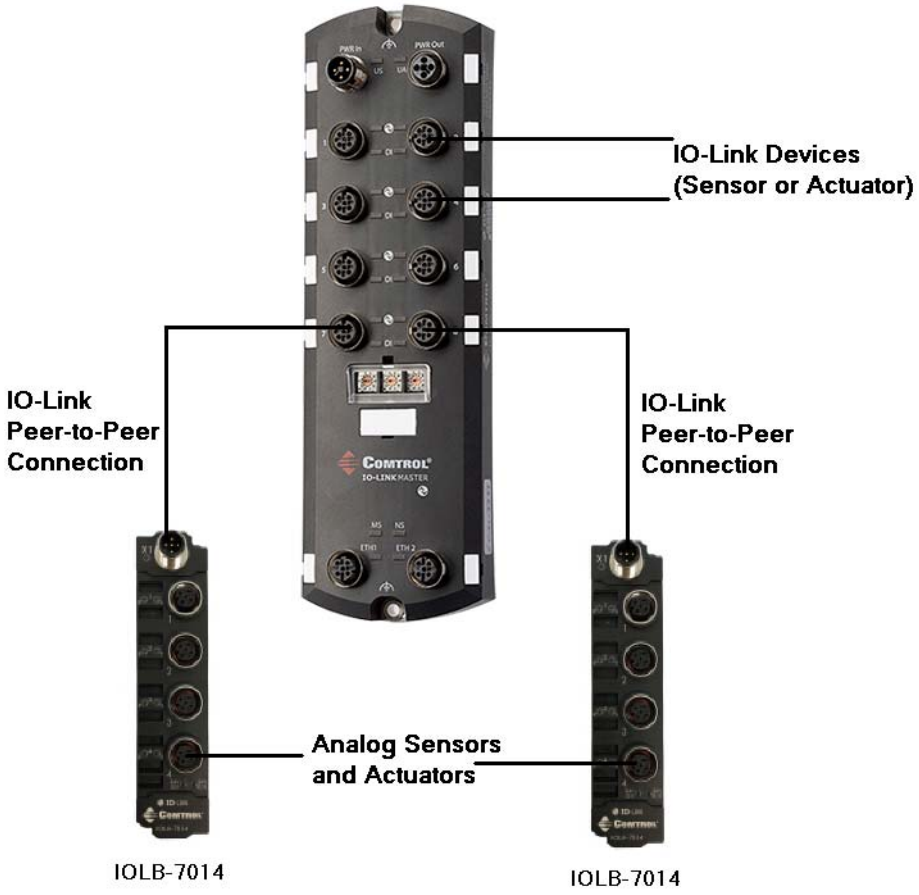
Both the electrical connection data and the communication protocol are standardized and in the IO-Link specification summarized.

IO-Link Specification

The development of IOLB-7014 was subject to the IO-Link specification 1.1. The IO-Link specification is included in the IEC standards and is accepted as IEC 61131-9 in an extended form. In this case, the new designation voltage SDCI is introduced. Comtrol supports as participants in the appropriate for the development of IO-Link and forms specification changes in its products from.

IO-Link System

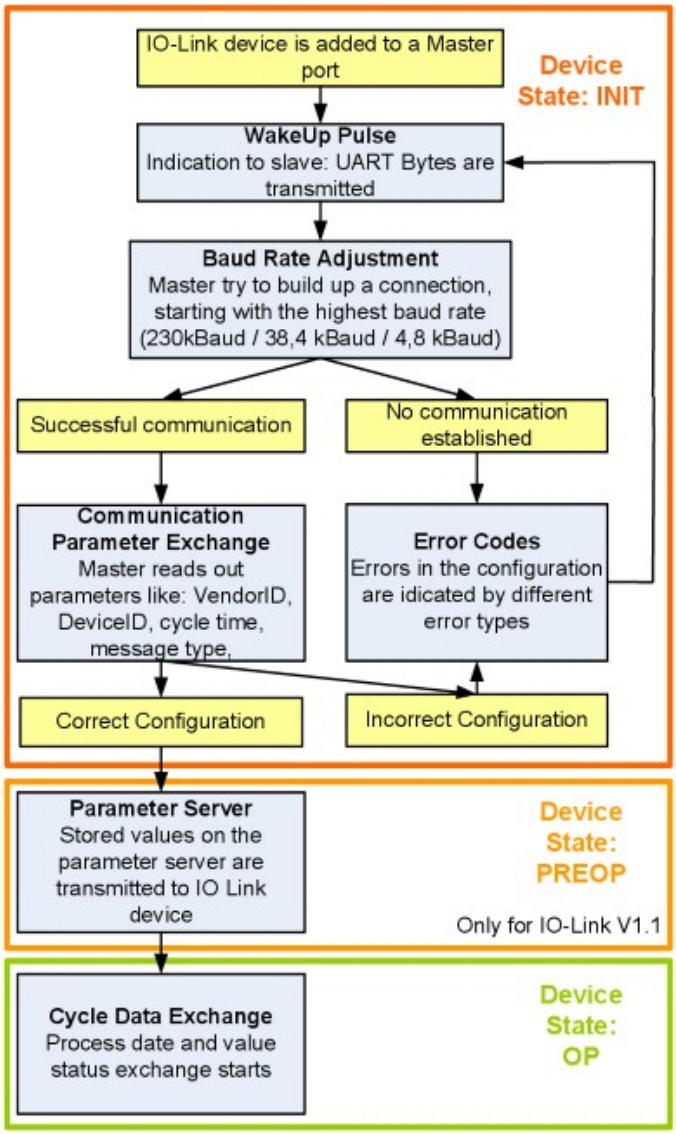
An IO-Link system consists of an IO-Link Master, one or more IO-Link devices and sensors or actuators. The IO-Link Master provides the interface to the higher-level controller and controls the communication with the connected IO-Link devices. The Comtrol IO-Link Master series has four or eight IO-Link ports at which each one IO-Link device can be connected. therefore IO-Link is not fieldbus, but rather is a peer-to-peer connection (see figure below).



The connected IO-Link devices have individual parameter information detected during automatic scanning with the Comtrol IO-Link Master. Refer to *Configuring the IOLB-7014* on Page 21 for more information.

Structure of IO-Link Communication

The structure of the IO-Link communication is shown in the following figure. In particular, this represents the sequence in the automatic scanning of the IO-Link ports.



- If the stored consistent with the read parameters, so changes the IO-Link device in the PREOP status.
- If it is an IO-Link device specification V1.1, the parameter server is now running. If it is in an IO-Link device according to V1.0, this step is omitted and connected directly in the operating room.
- Finally, the cycle time is written and switched the device in the operating room. After that is the master in the cyclical data exchange with the slave.

Hardware Installation

This section provides installation information for the IOLB-7014.

Mounting the IOLB-7014

The following table provide information that you may require for installation.

IOLB-7014	
Housing material	PA6 (polyamide)
Casting compound	Polyurethane
Mounting	two fastening holes Ø 3 mm for M3
Metal parts	Brass, nickel-plated
Contacts	CuZn, gold-plated
Power feed through (maximum)	4 A
Installation position	Any
Protection class	IP65, IP66, IP67 (conforms to EN 60529)
Dimensions (H x W x D)	126 x 30 x 26.5 mm
Weight	Approximately 125 g

Note: *While mounting the IOLB-7014, protect all connectors against contamination. All connectors must have either a cable or plug to guarantee IP67 rating.*

Keep the following in mind when mounting the IOLB-7014.

- Mount the IOLB-7014 with two M3 bolts.
- The bolts must be longer than 15 mm. The fixing holes of the modules are not threaded.
- When assembling, remember that the connectors increases the overall height.

Connecting Power to the IOLB-7014

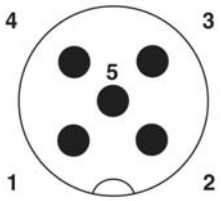
The power supply that you connect to the IOLB-7014 must meet the following requirements:

- 24VDC supplied by an isolating source and protected by means of a fuse (in accordance with UL248), rated maximum 4A or a 24VDC power source that satisfies NEC Class 2.
- A NEC Class 2 power supply shall not be connected in series or parallel with another (Class 2) power source.
- To meet the UL requirements, the IOLB-7014 must not be connected to unlimited power sources!

Note: *To meet the UL requirements, the IOLB-7014 must not be connected to telecommunications networks and must be operated at the ambient temperature range specified in the specifications.*

For additional information, see *IOLB-7014 Technical Specifications* on Page 7.

Pin	Input - Male
1	24V (L+)
2	24V (L2+)
3	GND (L-)
4	IO-Link (C/Q)
5	GND (2M)



The following Comtrol cables and M12 Y-splitter can be used to connect the IOLB-7014 to the Comtrol IO-Link Master.

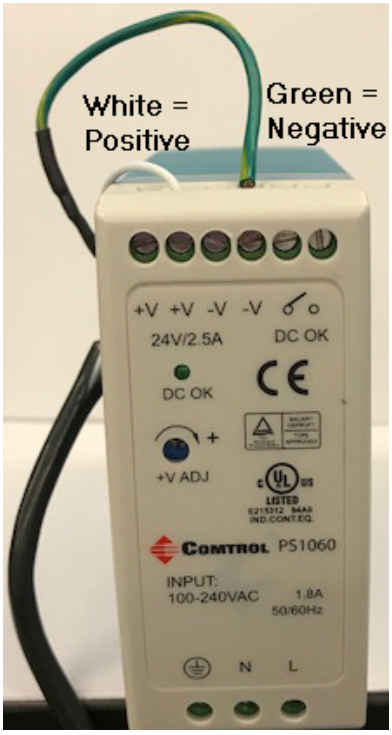
Comtrol Part Number	Description
1200143	Y Splitter, M12 5-poles, A-Coded, M to 2F
Varies by length†	Sensor cable, M12 5-poles, A-coded, M to F
Varies by length†	Power Cable, Comtrol IOLB, M12 A-Coded, M to wires
† Contact Comtrol Sales for the part number.	

Use the following procedure to apply power the IOLB-7014.

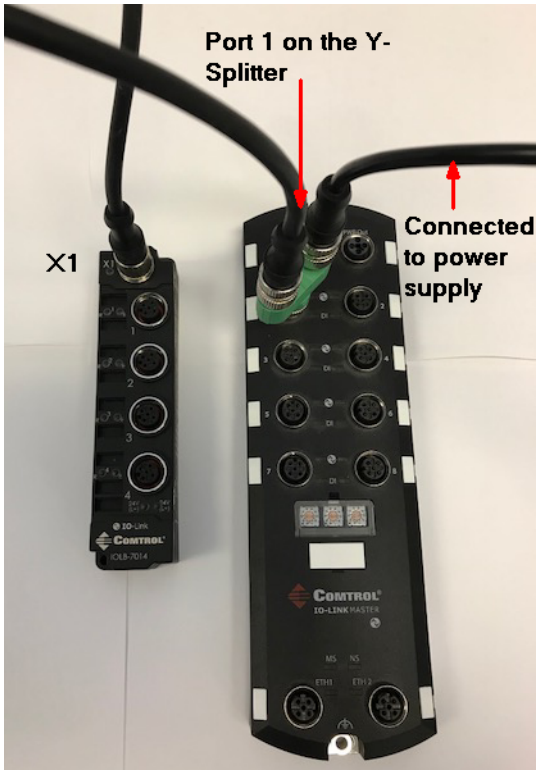
Note: *It is recommended to pull the M12 connectors tight with a nut torque of 0.6 Nm.*

1. Connect the M12 Y splitter to an available Comtrol IO-Link Master IO-Link port.

2. Connect the white and green wires of the Comtrol IOLB power cable to a 24V power supply.
   a. Make sure that the 24V power supply is not energized during the wiring.
   b. Connect the white wire to the positive 24V terminal.
   c. Connect the green wire to the negative 24V terminal on the power supply.
3. Connect the M12 connector end of the Comtrol IOLB power cable to Port 2 on the Y-Splitter.



4. Connect the 5-pole (M12) sensor cable between Port 1 on the Y-splitter and the IOLB-7014 IO-Link Port X1.

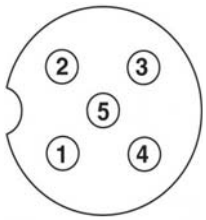


5. Apply power to the 24V power supply connected to the IOLB-7014.
6. Apply power to the Comtrol IO-Link Master
7. Verify that the following LEDs are lit:
   - Green 24V (L+) and 24V (2L+) LEDs on the IOLB-7014
   - Green IO-Link on the Comtrol IO-Link Master is lit
   - Amber DI LED on Comtrol IO-Link Master is lit (power is being injected into the DI pin to power the IOLB-7014)

Note: *Refer to IOLB-7014 LEDs on Page 6 for detailed LED information.*

Connecting Analog Devices

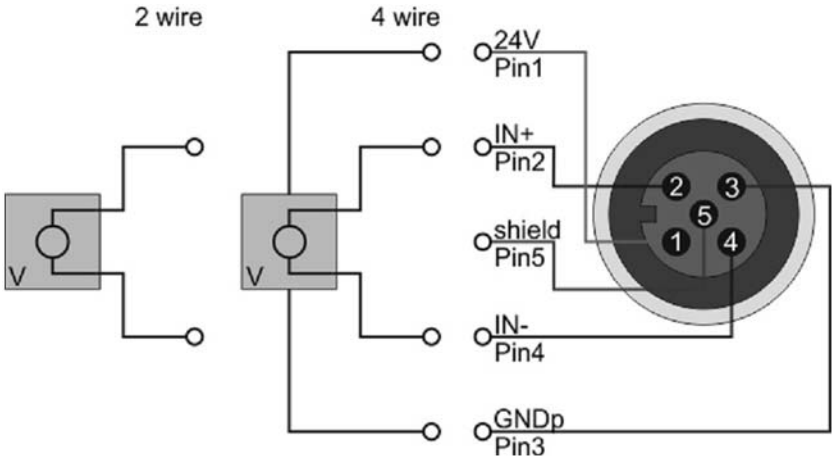
This table provides signal information for the analog connectors on the IOLB-7014.



Pin	Description
1	Power supply 2L+
2	Input +
3	Ground 2M
4	Input -
5	Shield

Signal Connection - Analog Voltage Input

The signal is measured using a differential input (Pin 2 and Pin 4). Either a 4-wire or 2-wire voltage device can be connected. The voltage range is set through parameters.

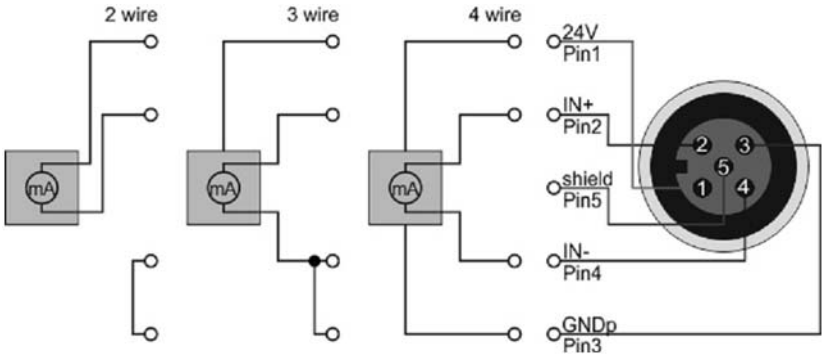


Note: *The device is functioning correctly if the Run LED is lit and the Error LED is not lit.*

Connector	LED 	Display	Meaning
M12 Socket 1 -4	R Left	Off	No data transmission to A/ D converter.
		Green	Data transmission to A/D converter.
	E Right	Off	Correct operation.
		Red	Error: wire breakage or measured value out of range.

Signal Connections - Current Inputs

The signal is measured using a differential signal (Pin 2 and Pin 4). A 4-wire, 3-wire, or 2-wire current device can be connected.

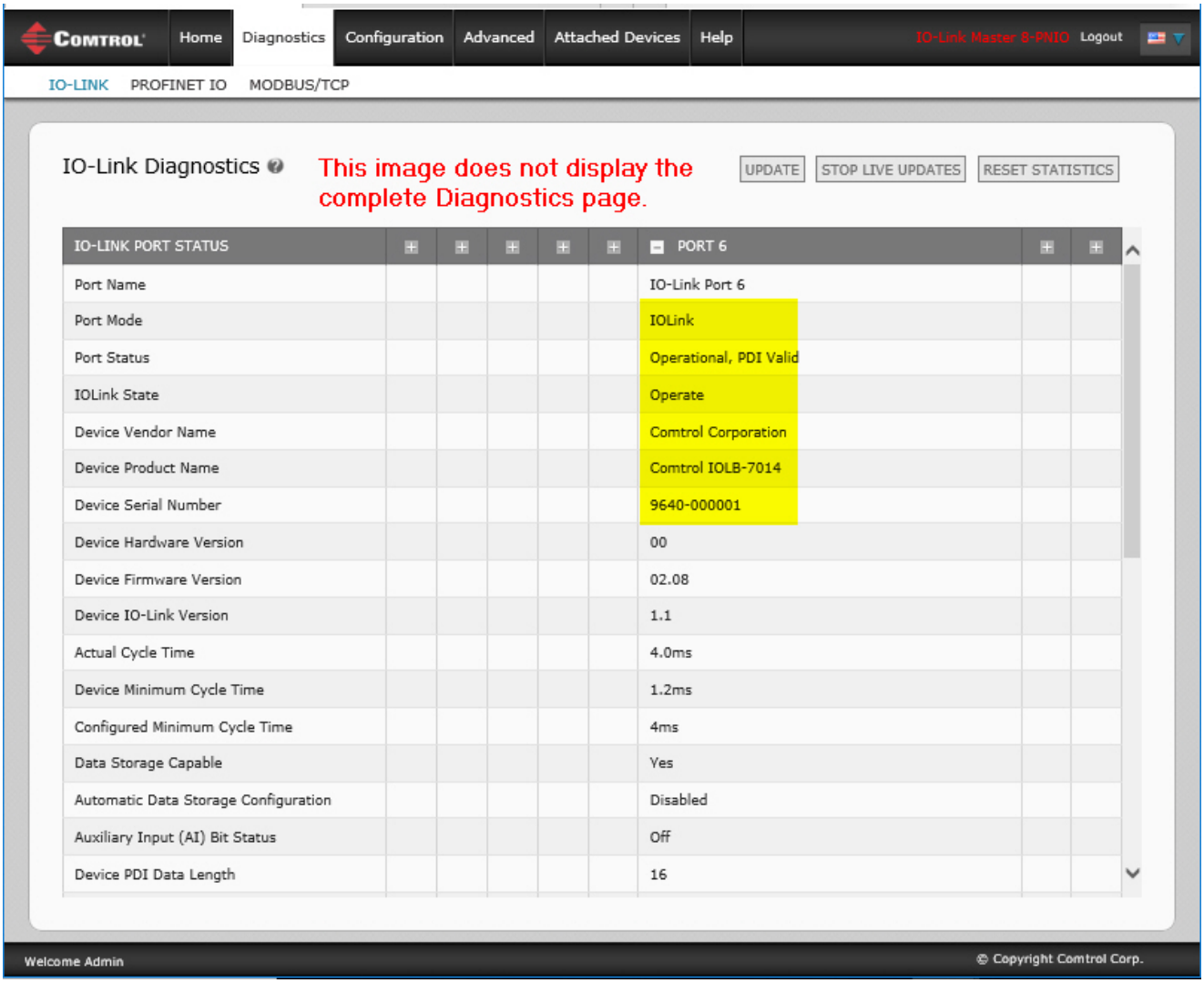


Connector	LED 	Display	Meaning
M12 Socket 1 - 4	R	Off	No data transmission to A/ D converter
	left	Green	Data transmission to A/D converter
	E	Off	Correct operation
	right	Rot	Error: wire breakage or measured value out of range

Comtrol IO-Link Master Diagnostic Page

You can also verify the IOLB-7014 operation by viewing the Comtrol IO-Link Master IO-Link Diagnostics page.

1. Log into the Comtrol IO-Link Master using the IP address.
2. Click **Diagnostics | IO-Link**.



Configuring the IOLB-7014

This section discusses loading the IODD on the Comtrol IO-Link Master.

Locating the IOLB-7014 IODD Files

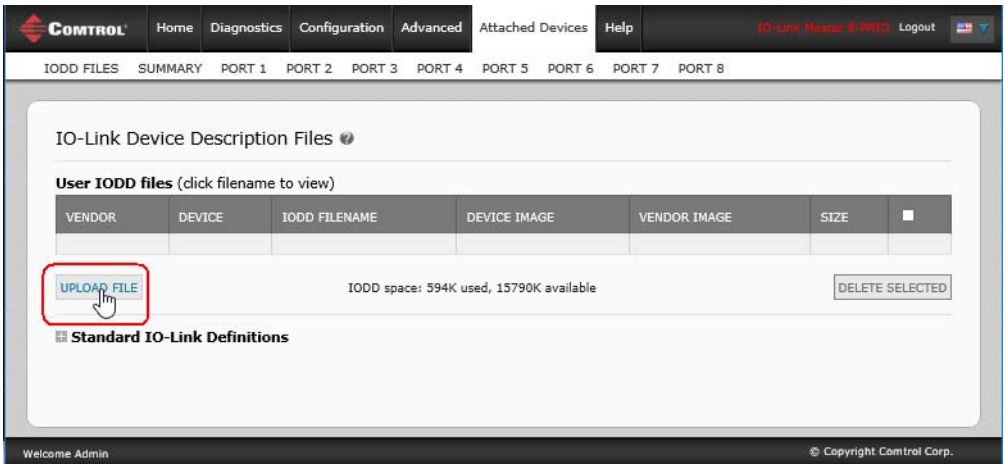
The IOLB-7014 IODD files are located on the Comtrol download site using one of these addresses:

- http: //downloads.comtrol.com/IO_Link_Block/IOLB-7014/IODD/
- ftp://ftp.comtrol.com/IO_Link_Block/IOLB-7014/IODD/

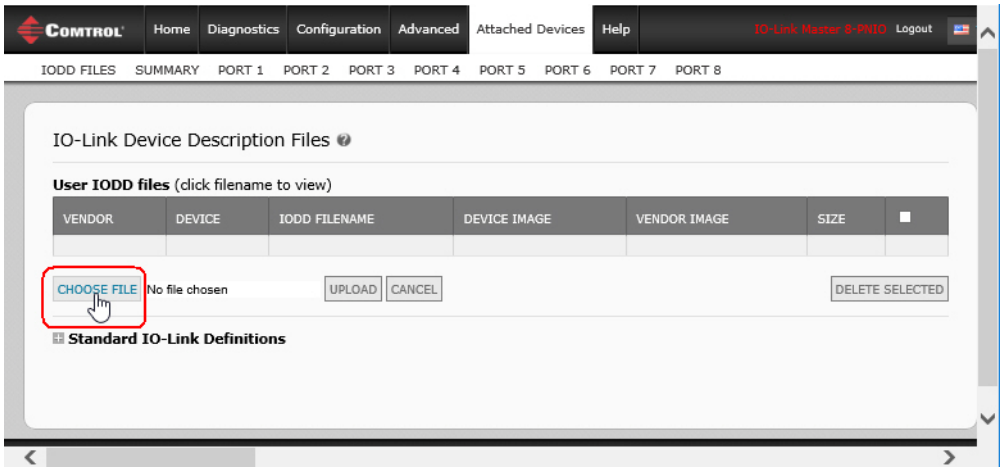
Loading the IODD Files Onto the Comtrol IO-Link Master

Use the following procedure to load the IOLB-7014 IODD file.

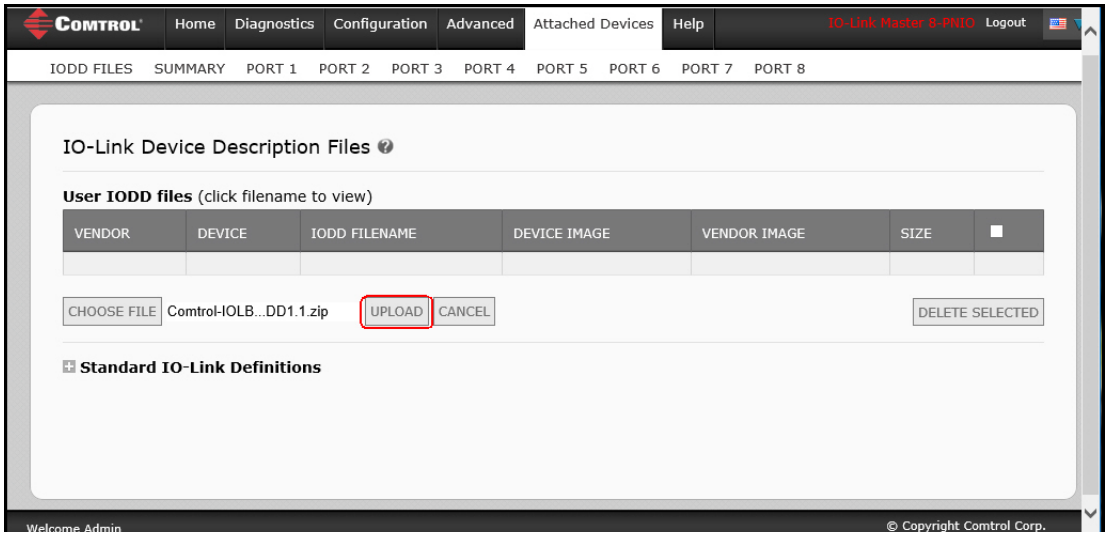
1. If necessary, download the IOLB-7014 IODD files.
2. Log into the Comtrol IO-Link Master using the IP address.
3. Click **Attached Devices**.
4. Click the **UPLOAD FILE** button.



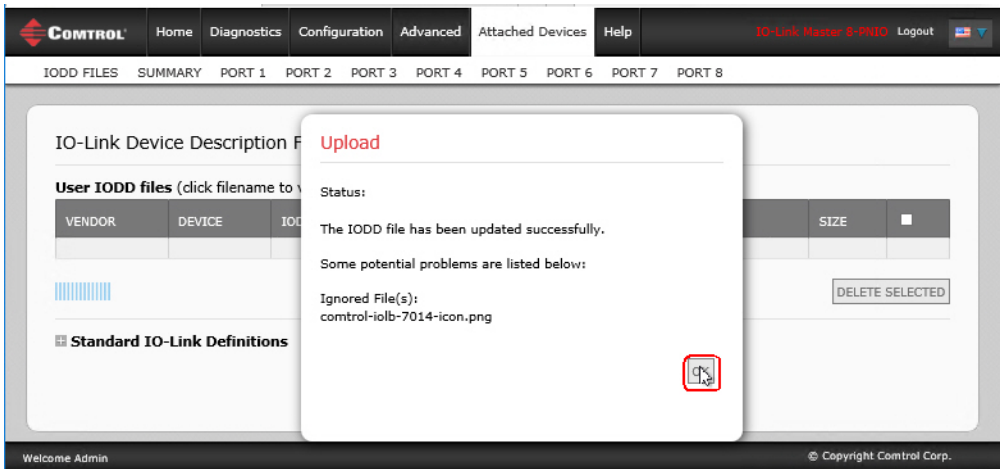
5. Click the **CHOOSE FILE** button.



6. Browse to and select the **Comtrol-IOLB-7014-20180301-IODD1.1.zip** file.
7. Click the **UPLOAD** button.

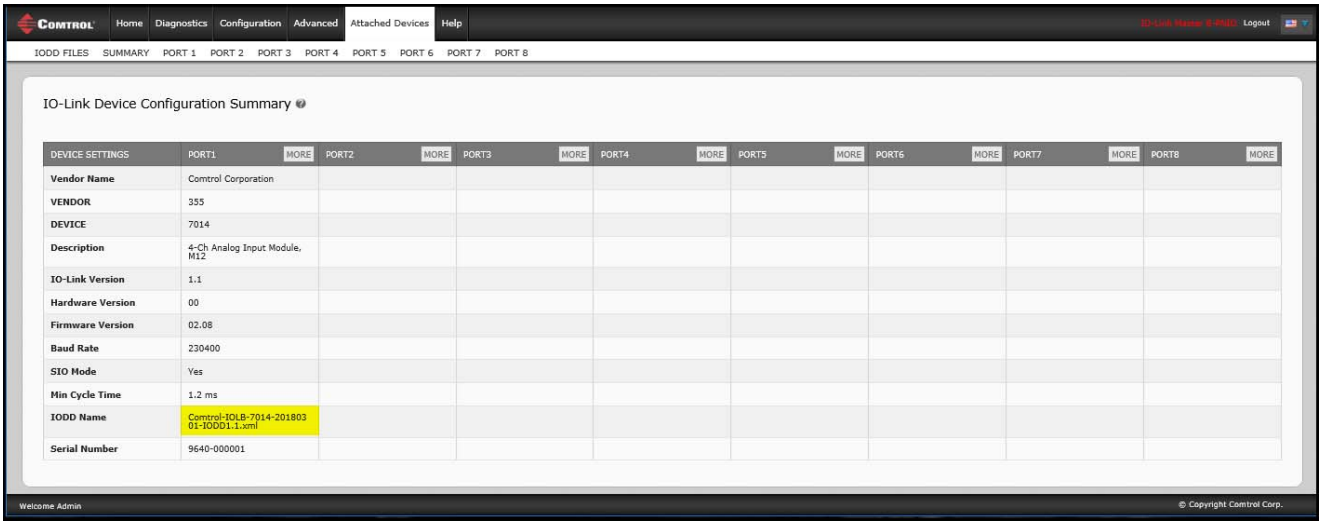


8. Click the **Ok** button.



Note: *The above message is expected behavior because the .icon file is not required by the XML file.*

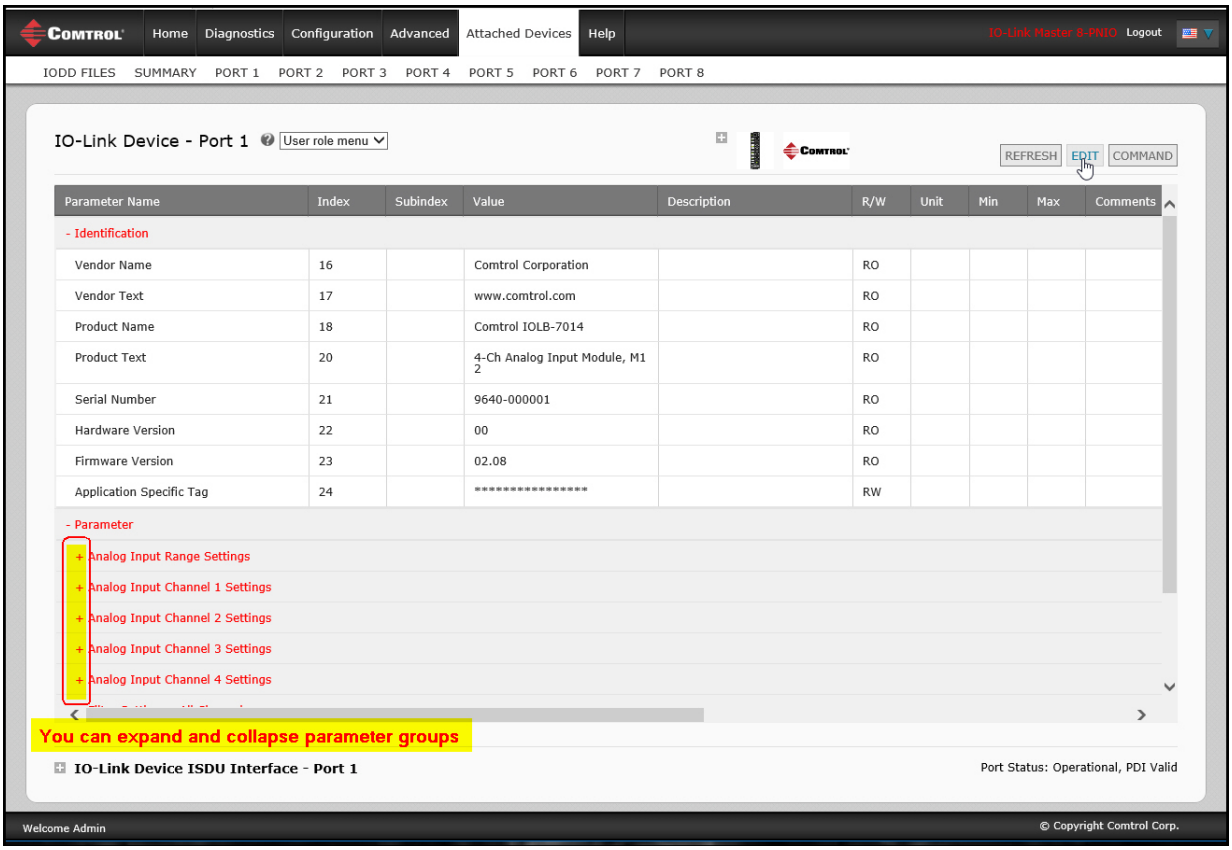
9. Click the **SUMMARY** link to verify that the correct IODD file loaded.



Configuring the IOLB-7014

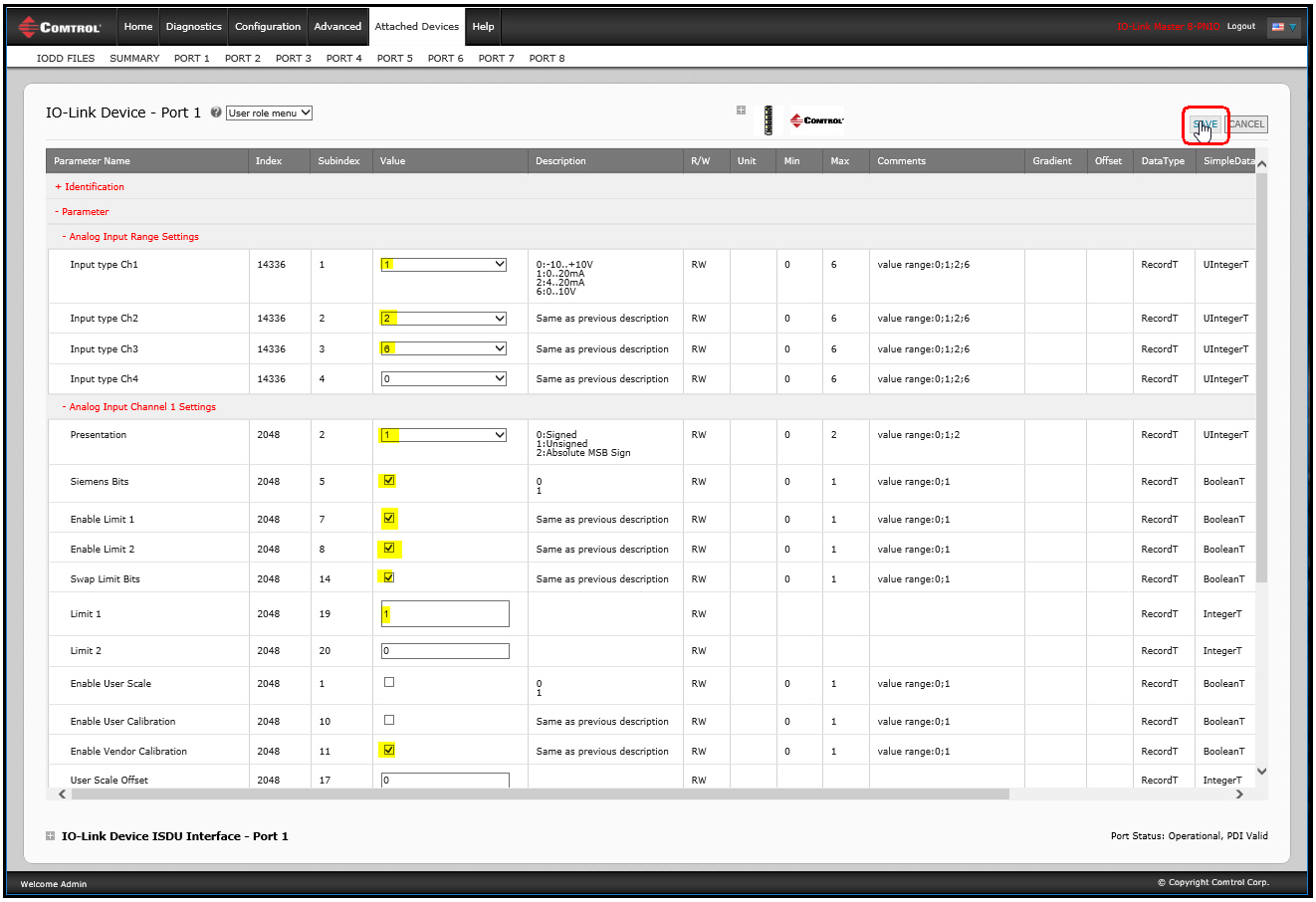
After loading the IODD file, you are ready to configure the channels on the IOLB-7014.

1. If necessary, log into the Comtrol IO-Link Master.
2. Click **Attached Devices | Port x,** where x is the IO-Link port that you have attached the IOLB-7014.
3. Click the **EDIT** button.



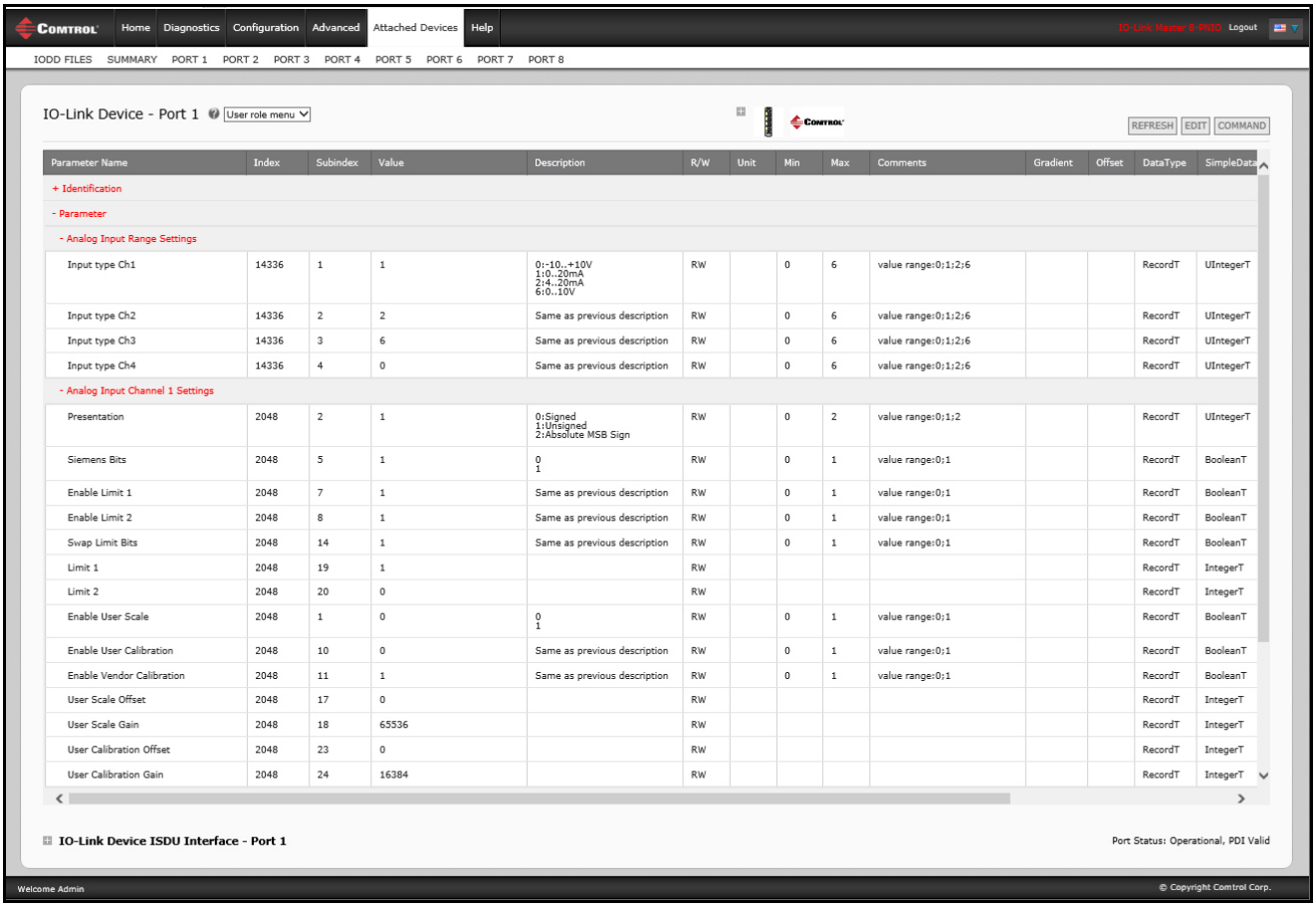
Note: *For information about using the Comtrol IO-Link Master, refer to the help system or appropriate User Guide for the model.*

4. Make the necessary changes to reflect the analog devices that you intend on connecting and click the **SAVE** button.



Note: *See Filters (Common to All Input Channels) on Page 30 and IOLB-7014 Parameters on Page 41 for more information.*

After the page is saved, note that the changes have been implemented.



Parameter Name	Index	Subindex	Value	Description	R/W	Unit	Min	Max	Comments	Gradient	Offset	DataType	SimpleData
+ Identification													
- Parameter													
- Analog Input Range Settings													
Input type Ch1	14336	1	1	0:-10..+10V 1:0..20mA 2:4..20mA 6:0..10V	RW		0	6	value range:0;1;2;6			RecordT	UIntegerT
Input type Ch2	14336	2	2	Same as previous description	RW		0	6	value range:0;1;2;6			RecordT	UIntegerT
Input type Ch3	14336	3	6	Same as previous description	RW		0	6	value range:0;1;2;6			RecordT	UIntegerT
Input type Ch4	14336	4	0	Same as previous description	RW		0	6	value range:0;1;2;6			RecordT	UIntegerT
- Analog Input Channel 1 Settings													
Presentation	2048	2	1	0:Signed 1:Unsigned 2:Absolute MSB Sign	RW		0	2	value range:0;1;2			RecordT	UIntegerT
Siemens Bits	2048	5	1	0 1	RW		0	1	value range:0;1			RecordT	BooleanT
Enable Limit 1	2048	7	1	Same as previous description	RW		0	1	value range:0;1			RecordT	BooleanT
Enable Limit 2	2048	8	1	Same as previous description	RW		0	1	value range:0;1			RecordT	BooleanT
Swap Limit Bits	2048	14	1	Same as previous description	RW		0	1	value range:0;1			RecordT	BooleanT
Limit 1	2048	19	1		RW							RecordT	IntegerT
Limit 2	2048	20	0		RW							RecordT	IntegerT
Enable User Scale	2048	1	0	0 1	RW		0	1	value range:0;1			RecordT	BooleanT
Enable User Calibration	2048	10	0	Same as previous description	RW		0	1	value range:0;1			RecordT	BooleanT
Enable Vendor Calibration	2048	11	1	Same as previous description	RW		0	1	value range:0;1			RecordT	BooleanT
User Scale Offset	2048	17	0		RW							RecordT	IntegerT
User Scale Gain	2048	18	65536		RW							RecordT	IntegerT
User Calibration Offset	2048	23	0		RW							RecordT	IntegerT
User Calibration Gain	2048	24	16384		RW							RecordT	IntegerT

Technical Data Overview

This section provides supporting information for the IOLB-7014:

Note: *Refer to Object Descriptions on Page 41 for more information.*

Analog Input Range Settings (Index 14336)

Use Index 14336 (Sub-indexes 1-4) to set the appropriate voltage or current range for each channel.

Analog Input Channel Parameters (Common)

The following subsections provide detailed channel parameter information that you may need.

The following subsections discuss common sub-indexes for the these channel parameter Indexes.

Analog Input Channel	Index
1	2048
2	2064
3	2080
4	2096

Note: *See Filters (Common to All Input Channels) on Page 30 for information about filtering.*

Presentation (Sub-Index 02)

Measured value can be output in the following formats: Signed integer (default) and Unsigned integer (absolute value) in two's complement format (signed integer).

- **Signed Integer Representation:** The negative output value is represented in two's complement (negated + 1). Maximum representation range for 16 bits = -32768 to +32767dec.

Input signal				Value	
+/- 10 V	**0 - 20 mA**	**4 - 20 mA**	**0 - 10 V**	**Decimal**	**Hexadecimal**
10 V	20 mA	20 mA	10 V	32767	0x7FFF
5 V	10 mA	12 mA	5 V	16383	0x3FFF
0 V	0 mA	4 mA	0 V	0	0x0000
-5 V	-	-	-	-16383	0xC001
-10 V	-	-	-	-32767	0x8000

- **Unsigned Integer Representation**: The output value is represented with 15-bit resolution without sign, therefore polarity detection is no longer possible. Maximum representation range for 16 bits = 0 to +32767dec.
- **Absolute Value With MSB**: The output value is displayed in magnitude-sign format: MSB=1 (highest bit) in the case of negative values. Maximum representation range for 16 bits = -32768 to +32767dec.

Input values (+/- 10 V)	Representation (values dec. / values hex.)	
	unsigned integer	absolute value with MSB as sign
10	32767 / 0x7FFF	32767 / 0x7FFF
5 V	16383 / 0x3FFF	16383 / 0x3FFF
0 V	0 / 0x0000	0 / 0x0000
-5	16384 / 0x4000	[-16384] / 0xC000
-10	32767 / 0x7FFF	[-32767] / 0xFFFF

Siemens Bits (Sub-Index 05)

When set to 1, the status displays are superimposed on the lowest three bits of the process data input. In the event that an **overrange** or **underrange** occurs, Bit 0 is set. See *Data Flow and Correction Calculation* on Page 35 and *PDI (Process Data Input) Channel Information* on Page 38 for more information.

Enable Limit 1 | Enable Limit 2 (Sub-Indexes 7 and 8)

Sub-index 7 or 8 respectively serve to enable the Limit 1 and Limit 2 value monitoring.

Swap Limit Bits (Sub-Index 14)

When set to 1, the limits are inverted. See *Limit 1 | Limit 2 (Sub-Indexes 19 and 20)* on Page 29.

Limit 1 | Limit 2 (Sub-Indexes 19 and 20)

When the analog value (Y_S) exceeds or falls below the value entered in Limit 1 and Limit 2, then the Limit bits in the PDI are set according to the table below. See *PDI (Process Data Input) Channel Information* on Page 38.

Limit Swap (Sub-Index 14)	Limit Bits (2 Bits) Value
FALSE (default)	0: not active
	1: value <limit
	2: value> limit
	3: value = limit value
TRUE	0: not active
	1: value> limit
	2: value <limit
	3: value = limit value

Note: *The limit evaluation is based on a Signed representation. The conversion to the desired presentation (Sub-Index 02) takes place only after the limit evaluation.*

Limit Analysis Example:

Port1, channel 1; Limit 1 and Limit 2 enabled, limit 1 = 2.8 V, limit 2 = 7.4 V, presentation: signed integer, swap = false.

Input Channel 1	Limit 1 Bits	Limit 2 Bits
1.8 V	0x01hex	0x01hex
2.8 V	0x03hex	0x01hex
4.2 V	0x02hex	0x01hex
8.5 V	0x02hex	0x02hex

Enable Vendor Calibration (Sub-Index 11)

When vendor calibration is enabled, the factor calibration (offset and gain) is applied to the raw input signal. Vendor calibration parameters cannot be changed. The following tables provide information about vendor calibration values, which is displayed under the Observation group for each channel.

Channel	Index
1	2063
2	2079
3	2095
4	2111

Sub-Index	Description
01	R0 offset (vendor compensation)
02	R0 gain (vendor compensation)
03	R1 offset (vendor compensation)
04	R1 gain (vendor compensation)
05	R2 offset (vendor compensation)
06	R2 gain (vendor compensation)

Enable User Scale (Sub-Index 1)

User scaling is enabled using Sub-Index 1. User scale provides offset and gain as discussed in the next two subsections.

Refer to *Data Flow* on Page 35 for related information.

User Scale Offset (Sub-Index 17)

When User Scale is enabled using Sub-Index 1, use Sub-index 17 to configure the offset.

User Scale Gain (Sub-Index 18)

When User Scale is enabled using Sub-Index 1, use Sub-index 18 to configure the gain.

Enable User Calibration (Sub-Index 10)

User calibration is enabled using Sub-Index 10. User calibration provides offset and gain as discussed in the next two subsections.

Refer to *Data Flow* on Page 35 for related information.

User Calibration Offset Sub-Index 23)

When user calibration is enable using Sub-Index 10, use Sub-index 23 to configure the offset.

User Calibration Gain (Sub-Index 24)

When user calibration is enable using Sub-Index 10, use Sub-index 24 to configure the gain.

Filters (Common to All Input Channels)

This subsection provides the following information:

Filter Enable (Index 2048 | Sub-Index 6)

When the filter is enabled, the filter settings are applied to all input channels.

Filter Setting (Index 2048 | Sub-Index 21)

The IOLB-7014 incorporates a digital filter which, depending on the selected setting, can adopt the characteristics of a Finite Impulse Response filter (FIR filter), or an Infinite Impulse Response filter (IIR filter). The filter can also be deactivated (default).

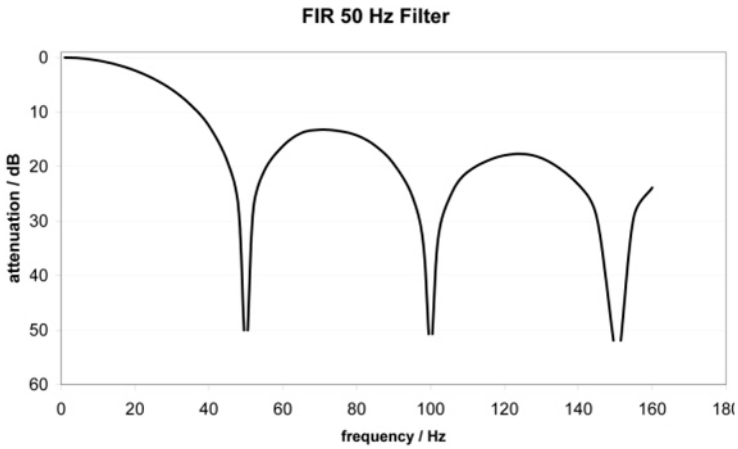
Note: *The filter frequencies are set for all channels of the IOLB-7014.*

FIR Filter

The filter performs a notch filter function and determines the conversion time of the module. The higher the filter frequency, the faster the conversion time. A 50 Hz and a 60 Hz filter are available.

Notch filter means that the filter has zeros (notches) in the frequency response at the filter frequency and multiples thereof, that is, it attenuates the amplitude at these frequencies.

The FIR filter functions as a non-recursive filter.



Note: *Typical attenuation curve of notch filter at 50 Hz*

Filter characteristics FIR filter (Channels 1- 4)			
Filter	Attenuation	Limit frequency (-3 dB)	Conversion time
50 Hz FIR	> 50 dB	22 Hz	625 µs
60 Hz FIR	> 40 dB	26 Hz	521 µs

IIR Filter

The filter with IIR characteristics is a discrete time, linear, time invariant filter that can be set to eight levels (level 1 = weak recursive filter, up to level 8 = strong recursive filter).

The IIR can be understood to be a moving average value calculation after a low-pass filter.

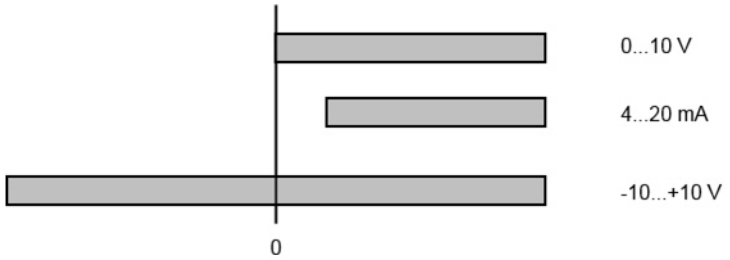
IIR Filter	-3 dB Limit Frequency (50 µs Sample Time)
IIR 1	400 Hz
IIR 2	220 Hz
IIR 3	100 Hz
IIR 4	50 Hz
IIR 5	24 Hz
IIR 6	12 Hz
IIR 7	6,2 Hz
IIR 8	3,0 Hz

Analog Specifications

This subsection contains the following information:

Full Scale Value

An I/O device with an analog input measures over a nominal measuring range that is limited by an upper and a lower limit (initial value and end value); these can usually be taken from the IOLB-7014 designation. The range between the two limits is called the measuring span and corresponds to the equation (end value - initial value). Analogous to pointing devices this is the measuring scale (see IEC 61131) or also the dynamic range.



For the above examples this means:

- Measuring range 0 to 10V: asymmetric unipolar, full scale value = 10V, measuring span = 10V
- Measuring range 4 to 20mA: asymmetric unipolar, full scale value = 20mA, measuring span = 16mA
- Measuring range -10 to +10V: symmetric bipolar, full scale value = 10V, measuring span = 20V

± Measuring Error [% of the Full Scale Value] (Also: Measurement Error)

The relative measuring error is referenced to the full scale value and is calculated as the quotient of the largest numerical deviation from the true value (**measuring error**) referenced to the full scale value.

Measurement Error = Maximum Deviation/Full Scale Value

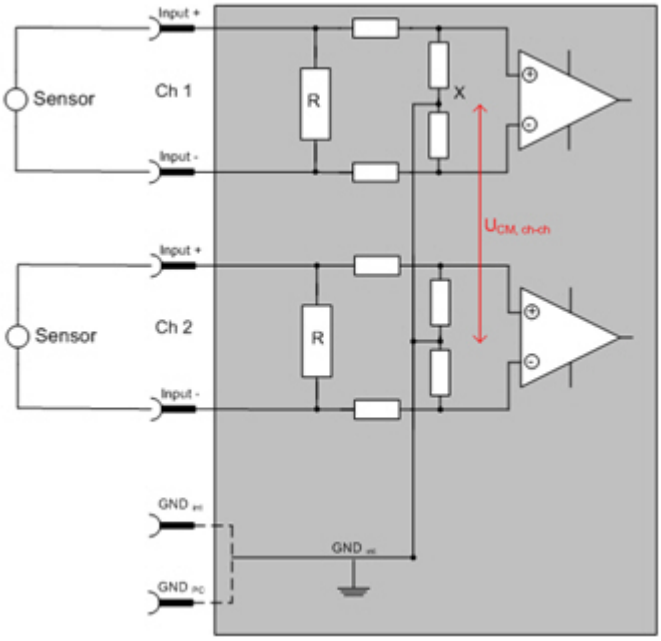
The measuring error is generally valid for the entire permitted operating temperature range, also called the *usage error limit* and contains random and systematic portions of the referred device (that is, all influences such as temperature, inherent noise, aging, etc.).

It is always to be regarded as a positive/negative span with ±, even if it is specified without ± in some cases. The maximum deviation can also be specified directly.

Example: Measuring range 0 to 10 V and measuring error < ± 0.3 % full scale value - maximum deviation ±30mV in the permissible operating temperature range.

Differential Typification

This diagram shows the DIFF module.



Note: *Dashed lines indicate that the respective connection may not necessarily be present in each DIFF module.*

The basic rule:

- Analog measurements always take the form of voltage measurements between two potential points. For voltage measurements a large R is used, in order to ensure a high impedance. For current measurements a small R is used as shunt. If the purpose is resistance measurement, corresponding considerations are applied.
  - Comtrol generally refers to these two points as input+/signal potential and input-/reference potential.
  - For measurements between two potential points two potentials have to be supplied.
  - Regarding the terms *single-wire connection* or *three-wire connection*, please note the following for pure analog measurements: three- or four-wire connections can be used for a sensor supply, but are not involved in the actual analog measurement, which always takes place between two potentials/wires.
- The term *electrical isolation* should be clarified in advance with regard to the channel connection a distinction is made in terms of how the channels:
  - Within a module relate to each other, or
  - Of several modules relate to each other.

The property of electrical isolation indicates whether the channels are directly connected to each other.

- The IOLB-7014 features electrical isolation between the field/analog side and the IO-Link side.
- Differential channels are not electrically isolated channel to channel.
- Analog measuring channels are subject to technical limits, both in terms of the recommended operating range (continuous operation) and the destruction limit. Refer to *IOLB-7014 Technical Specifications* on Page 7 for information about channel limits.

Differential Explanation

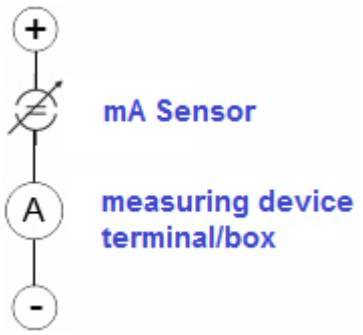
- Differential measurements provide the most flexibility. You can choose both connection points, input+/ signal potential and input-/reference potential, within the framework of the technical specification.
- Since a differential input is configured symmetrically internally (see diagram), there will be a mid-potential (X) between the two supplied potentials that is the same as the internal ground/reference ground for this channel. The technical property VCM (common-mode voltage) indicates the degree to which the mean voltage of the channels may differ.

- The internal reference ground may be accessible as connection point at the IOLB-7014, in order to stabilize a defined GND potential in the IOLB-7014. In this case it is particularly important to pay attention to the quality of this potential (noiselessness, voltage stability). At this GND point a wire may be connected to make sure that $V_{CM\ max}$ is not exceeded in the differential sensor cable. If differential channels are not electrically isolated, usually only one $V_{CM\ max}$ is permitted.
- Differential measurement in combination with correct sensor wiring has the special advantage that any interference affecting the sensor cable (ideally the feed and return line are arranged side by side, so that interference signals have the same effect on both wires) has very little effect on the measurement, since the potential of both lines varies jointly (hence the term common mode). In simple terms: Common-mode interference has the same effect on both wires in terms of amplitude and phasing.
- Nevertheless, the suppression of common-mode interference within a channel or between channels is subject to technical limits, which are specified in the *IOLB-7014 Technical Specifications* on Page 7.

Typification of the 2/3/4-Wire Connection of Current Sensors

Current transducers/sensors/field devices (referred to in the following simply as *sensor*) with the industrial 0/4-20mA interface typically have internal transformation electronics for the physical measured variable (temperature, current, etc.) at the current control output. These internal electronics must be supplied with energy (voltage, current). Thus separates the sensors into self-supplied (2-wire) or externally supplied sensors (3-wire or 4-wire):

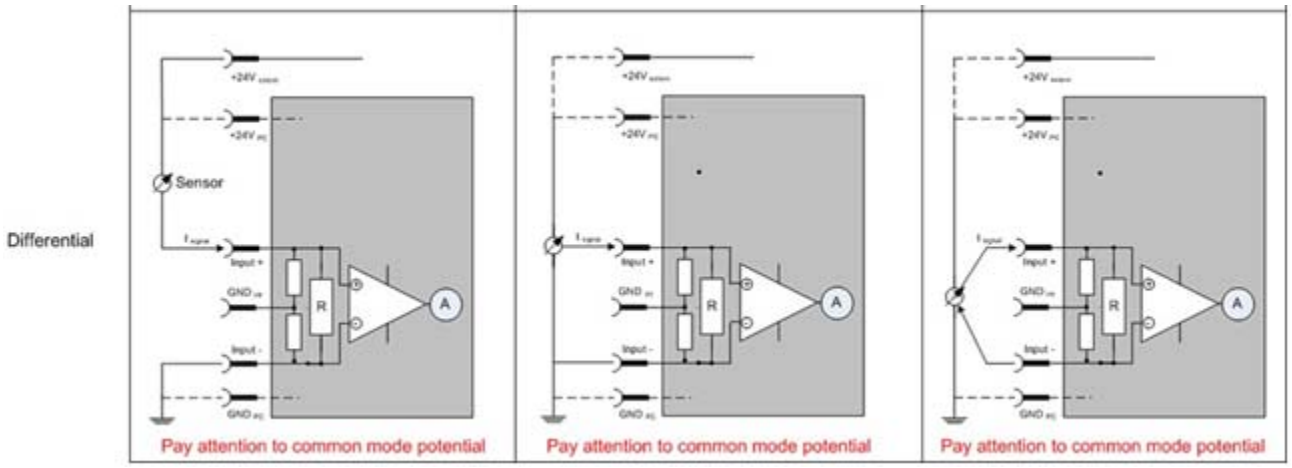
- Self-supplied sensors
  - The sensor draws the energy for its own operation via the sensor/signal wires + and -. So that enough energy is always available for the sensor's own operation and open-circuit detection is possible, a lower limit of 4mA has been specified for the 4-20mA interface; i.e. the sensor allows a minimum current of 4mA and a maximum current of 20mA to pass.
  - For a 2-wire connection; see IEC60381-1
  - Such current transducers generally represent a current sink and thus like to sit between + and – as a *variable load*. Refer also to the sensor manufacturer's information.



Therefore, they are to be connected accordingly:

- The sensor draws the energy/operating voltage for its own operation from two supply wires of its own. One or two further sensor wires are used for the signal transmission of the current loop:
- Sensor cable: according to the terminology such sensors are to be connected to *single- ended* inputs in 3 wires with +/-/Signal lines and if necessary a cable shield
- Sensor cables: In the case of sensors with 4-wire connection according to +-/+Signal/-Signal, you must check whether +Signal may be connected to +Supply or –Signal to –Supply.
  - Yes: then you can connect accordingly to a Comtrol *single-ended input*.
  - The *differential input* for +Signal and –Signal is to be selected; +Supply and –Supply are to be connected via additional wires.

Note: *Expert organizations such as NAMUR demand a usable measuring range <4mA / >20mA for error detection and adjustment, see also NAMUR NE043.*

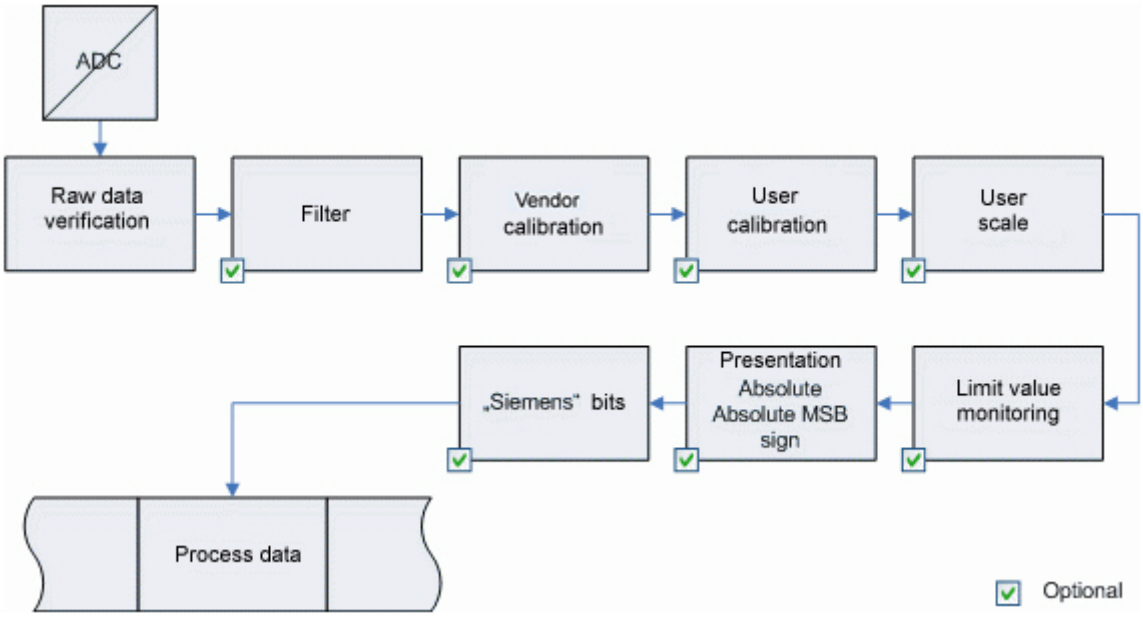


Data Flow and Correction Calculation

This subsection contains the following topics:

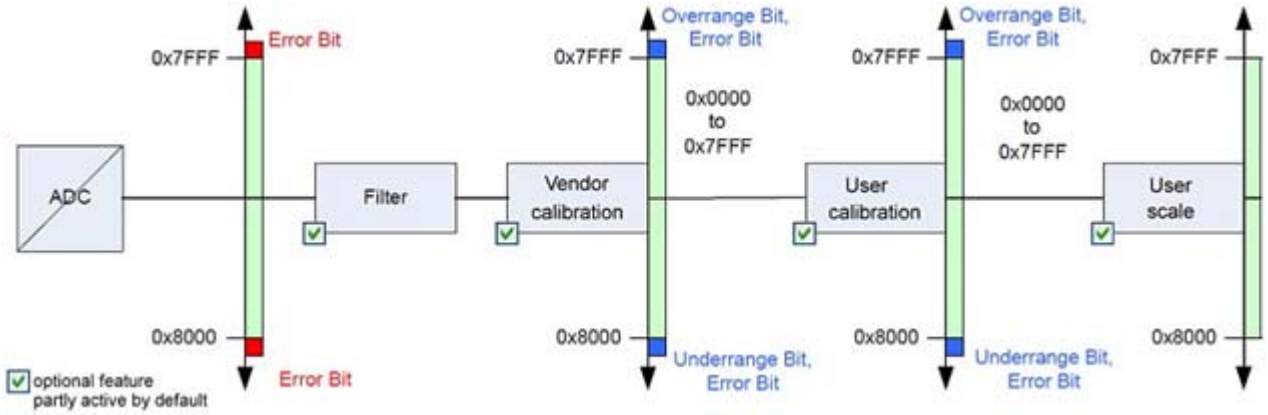
Data Flow

The flowchart below shows demonstrative the data flow of the IOLB-7014 (processing of the raw data).



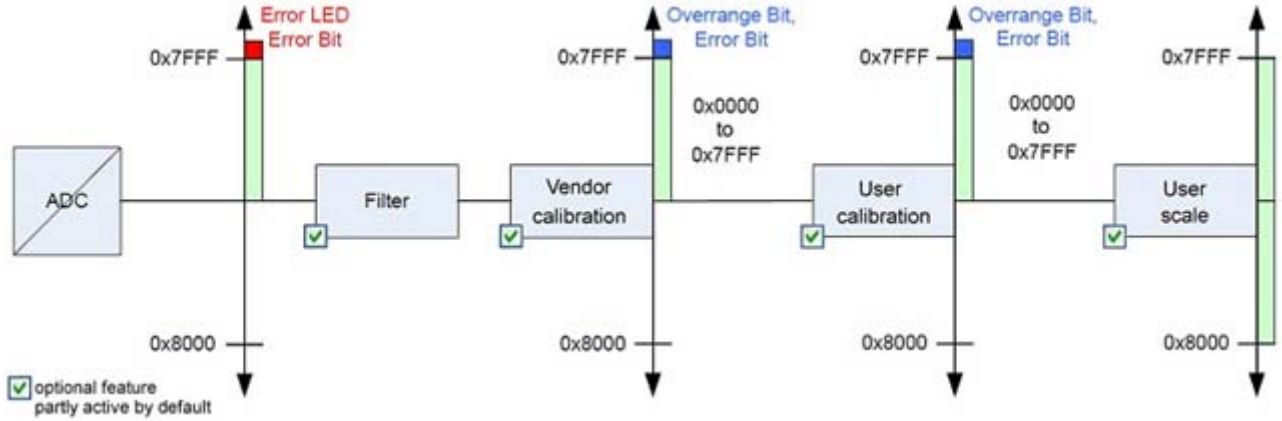
Correction Calculation (+/- 10V)

This figure shows the correcting calculation of the raw values to the output values if the range is over- or undershot.



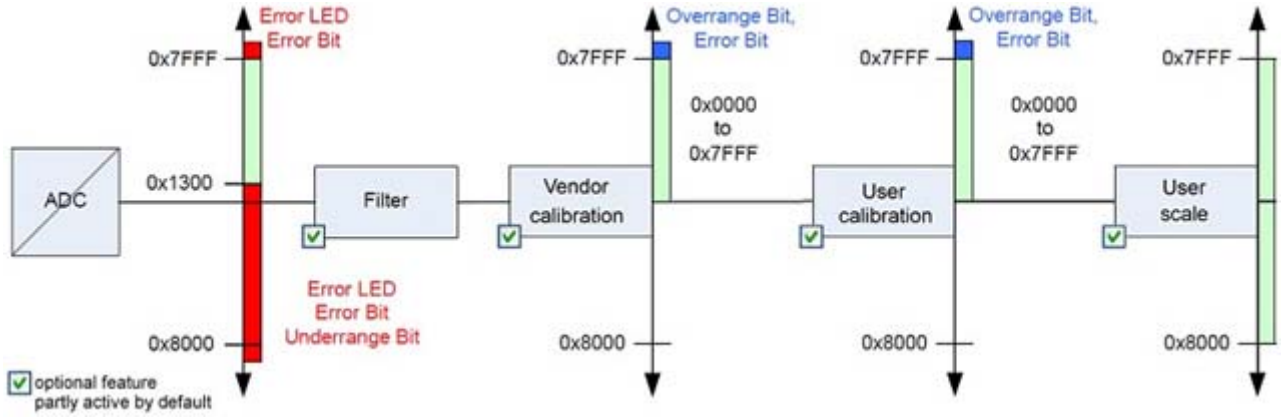
Correction Calculation (0 to 20mA)

This figure shows the correcting calculation of the raw values to the output values if the range is over- or undershot.



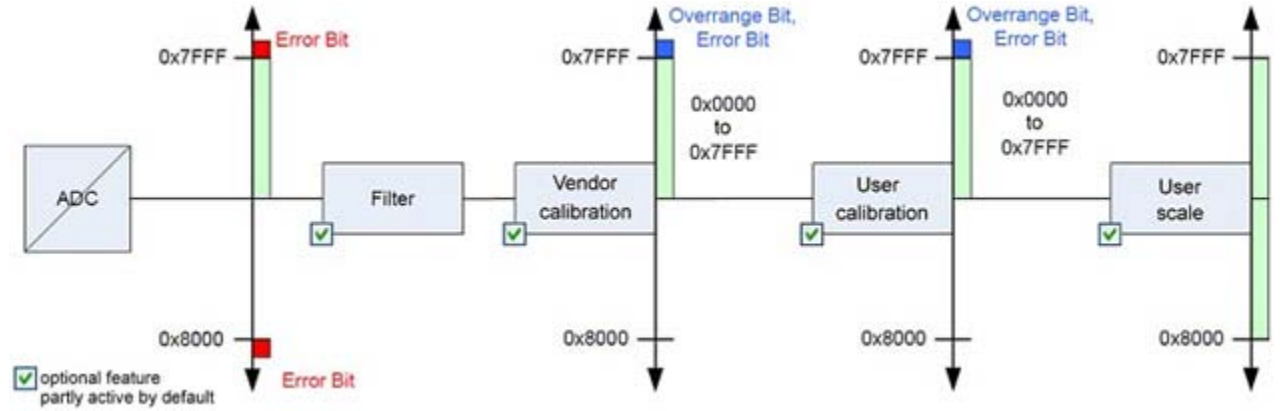
Correction Calculation (4 to 20mA)

This figure shows the correcting calculation of the raw values to the output values if the range is over- or undershot.



Correction Calculation (0 to 10V)

This figure shows the correcting calculation of the raw values to the output values if the range is over- or undershot.



Process Data Calculations

The IOLB-7014 records measured values continuously and places the raw value of its A/D converter into the ADC raw value objects 2062, 2078, 2094, and 2110. The calculation of the correction with the vendors calibration values takes place after each acquisition of the analog signal. User scaling then follows (optionally):

$Y_H = (X_{ADC} - B_H) * A_H$

Measured value following vendor calibration ($Y_H = X_{ADC}$), if vendor calibration is disabled.

$Y_A = (Y_H - B_A) * A_A$

Measured value following user calibration ($Y_A = Y_H$), if user calibration is disabled.

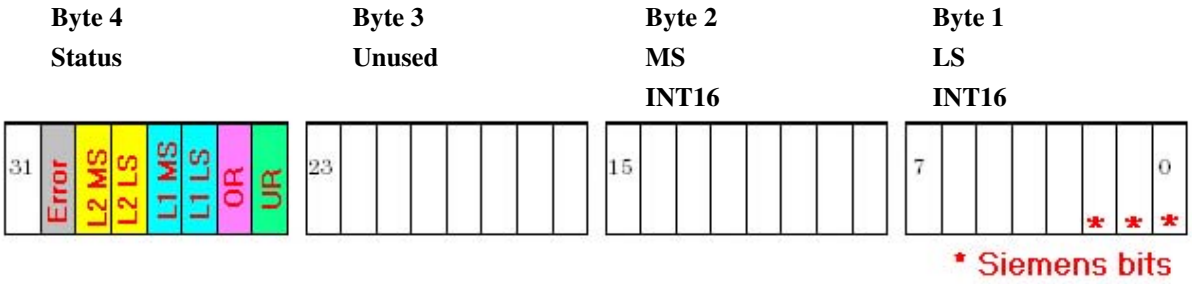
$Y_S = Y_A * A_S * 22\text{-}16 + B_S$

Measured value following user scale $Y_S = Y_A$, if user scale is disabled.

Name	Designation	Index	Sub-Index
X_{ADC}	Output value of the A/D converter	2062, 2078, 2094, 2110	01
B_H	Vendor calibration offset (only changeable if Indexes 2048, 2064, 2080, or 2096; Sub-index 11 is set)	2063, 2079, 2095, 2111	01, 03, 05
A_H	Vendor calibration gain (only changeable if Indexes 2048, 2064, 2080, or 2096; Sub-index 11 is set)	2063, 2079, 2095, 2111	02, 04, 06
Y_H	Measuring value after manufacturer calibration	-	
B_A	User calibration offset	2048, 2064, 2080, 2096	23
A_A	User calibration gain	2048, 2064, 2080, 2096	24
Y_A	Measuring value after user calibration	-	
B_S	User scaling offset (can be activated via indexes 2048, 2064, 2080, or 2096 Sub-index: 1)	2048, 2064, 2080, 2096	14
A_S	User scaling gain (can be activated via indexes 2048, 2064, 2080, or 2096 Sub-index: 1)	2048, 2064, 2080, 2096	18
Y_S	Process data for controller, measuring value after user scale	-	

PDI (Process Data Input) Channel Information

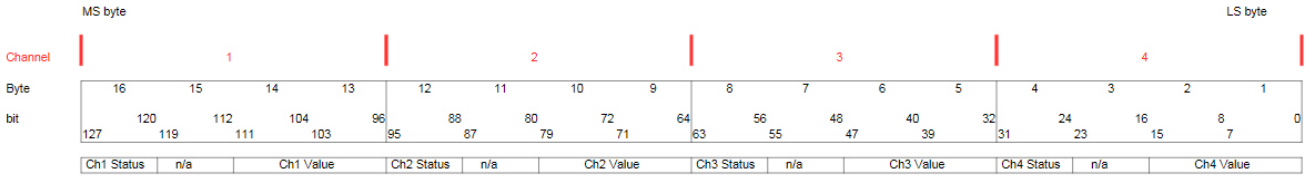
This image illustrates the PDI channel data for one channel on the IOLB-7014.



Where:

- **UR** is Under-range
- **OR** is Over-range
- **L1LS** is Limit 1 LS
- **L1MS** is Limit 1 MS
- **L2LS** is Limit 2 LS
- **L2MS** is Limit 2 MS
- Siemens bits are superimposed over 3 bits of PDI

This image illustrates all 16 PDI data bytes from the IOLB-7014.



Object Descriptions

This section provides supporting information for the IOLB-7014 object descriptions.

IOLB-7014 Parameters

Note: *The Index and Sub-indexes are displayed as decimal numbers, which match the Comtrol IO-Link Master.*

Index	Subindex	Name	Meaning	Data type	Flags	Default
IDENTIFICATION						
16		Vendor Name	Comtrol Corporation	StringT64	RO	N/A
17		Vendor Text	www.comtrol.com	StringT64	RO	N/A
18		Product Name	Comtrol IOLB-7014	StringT64	RO	N/A
20		Product Text	4-Ch Analog Input Module, M12	StringT64	RO	N/A
21		Serial Number	9640-XXXXXX	StringT16	RO	N/A
22		Hardware Version	00	StringT64	RO	N/A
23		Firmware Version	02.08	StringT64	RO	N/A
24		Application Specific Tag	**********	StringT32	RO	N/A
ANALOG INPUT RANGE SETTINGS						
14336	01	Input type Ch1	Input signal range for Channels 0 -10 to +10 V 1 0 to 20 mA 2 4 to 20 mA 6 0 to 10 V	UINT16	RW	0x0000 (0dec)
14336	02	Input type Ch2	Input signal range for Channel 2 (values see Channel 1)	UINT16	RW	0x0000 (0dec)
14336	03	Input type Ch3	Input signal range for Channel 3 (values see Channel 1)	UINT16	RW	0x0000 (0dec)
14336	04	Input type Ch4	Input signal range for Channel 4 (values see Channel 1)	UINT16	RW	0x0000 (0dec)

Index	Subindex	Name	Meaning		Data type	Flags	Default
ANALOG INPUT CHANNEL 1 SETTINGS							
2048	01	Enable user scale	1	User scale is enabled	BOOLEAN	RW	0x00 (0dec)
2048	02	**Presentation**	0	Signed presentation	BIT3	RW	0x00 (0dec)
2048			1	Unsigned presentation			
2048			2	Absolute value with MSB as sign			
2048	05	**Siemens bits**	1	Status displays are superimposed on the lowest three bits in the status word.	BOOLEAN	RW	0x00 (0dec)
2048	07	Enable limit 1	1	Enable Limit 1	BOOLEAN	RW	0x00 (0dec)
2048	08	Enable limit 2	1	Enable Limit 2	BOOLEAN	RW	0x00 (0dec)
2048	10	Enable user calibration	1	User calibration is enabled	BOOLEAN	RW	0x00 (0dec)
2048	11	Enable vendor calibration	1	Vendor calibration is enabled	BOOLEAN	RW	0x01 (1dec)
2048	14	Swap limit bits	1	Swaps the two limit bits to be compatible to older hardware versions.	BOOLEAN	RW	0x00 (0dec)
2048	17	User scale offset	User scale offset		INT16	RW	0x0000 (0dec)
2048	18	User scale gain	The gain is represented in fixed-point format, with the factor 2-16. A value of 1 for the gain factor therefore corresponds to 65535dec (0x00010000hex) and is limited to 0x7FFFF.		INT32	RW	0x00010000 (65536dec)
2048	19	Limit 1	First limit value for setting the status bits		INT16	RW	0x0000 (0dec)
2048	20	Limit 2	Second limit value for setting the status bits		INT16	RW	0x0000 (0dec)
2048	23	User calibration offset	User calibration offset		INT16	RW	0x0000 (0dec)
2048	24	User calibration gain	User calibration gain		INT16	RW	0x4000 (16384dec)

Index	Subindex	Name	Meaning		Data type	Flags	Default
ANALOG INPUT CHANNEL 2 SETTINGS							
2064	01	Enable user scale	1	User scale is enabled	BOOLEAN	RW	0x00 (0dec)
2064	02	Presentation	0	Signed presentation	BIT3	RW	0x00 (0dec)
2064			1	Unsigned presentation			
2064			2	Absolute value with MSB as sign			
2064	05	Siemens bits	1	Status displays are superimposed on the lowest three bits in the status word.	BOOLEAN	RW	0x00 (0dec)
2064	07	Enable limit 1	1	Enable Limit 1	BOOLEAN	RW	0x00 (0dec)
2064	08	Enable limit 2	1	Enable Limit 2	BOOLEAN	RW	0x00 (0dec)
2064	10	Enable user calibration	1	User calibration is enabled	BOOLEAN	RW	0x00 (0dec)
2064	11	Enable vendor calibration	1	Vendor calibration is enabled	BOOLEAN	RW	0x01 (1dec)
2064	14	Swap limit bits	1	Swaps the two limit-bits to be compatible to older hardware versions.	BOOLEAN	RW	0x00 (0dec)
2064	17	User scale offset	User scale offset		INT16	RW	0x0000 (0dec)
2064	18	User scale gain	The gain is represented in fixed-point format, with the factor 2-16. A value of 1 for the gain factor therefore corresponds to 65535dec (0x00010000hex) and is limited to 0x7FFFF.		INT32	RW	0x00010000 (65536dec)
2064	19	Limit 1	First limit value for setting the sta- tus bits		INT16	RW	0x0000 (0dec)
2064	20	Limit 2	Second limit value for setting the status bits		INT16	RW	0x0000 (0dec)
2064	23	User calibration offset	User calibration offset		INT16	RW	0x0000 (0dec)
2064	24	User calibration gain	User calibration gain		INT16	RW	0x4000 (16384dec)

Index	Subindex	Name	Meaning		Data type	Flags	Default
ANALOG INPUT CHANNEL 3							
2080	01	Enable user scale	1	User scale is enabled	BOOLEAN	RW	0x00 (0dec)
2080	02	Presentation	0	Signed presentation	BIT3	RW	0x00 (0dec)
2080			1	Unsigned presentation			
2080			2	Absolute value with MSB as sign			
2080	05	Siemens bits	1	Status displays are superimposed on the lowest three bits in the status word.	BOOLEAN	RW	0x00 (0dec)
2080	07	Enable limit 1	1	Enable Limit 1	BOOLEAN	RW	0x00 (0dec)
2080	08	Enable limit 2	1	Enable Limit 2	BOOLEAN	RW	0x00 (0dec)
2080	10	Enable user calibration	1	User calibration is enabled	BOOLEAN	RW	0x00 (0dec)
2080	11	Enable vendor calibration	1	Vendor calibration is enabled	BOOLEAN	RW	0x01 (1dec)
2080	14	Swap limit bits	1	Swaps the two limit-bits to be compatible to older hardware versions.	BOOLEAN	RW	0x00 (0dec)
2080	17	User scale offset	User scale offset		INT16	RW	0x0000 (0dec)
2080	18	User scale gain	The gain is represented in fixed-point format, with the factor 2-16. A value of 1 for the gain factor therefore corresponds to 65535dec (0x00010000hex) and is limited to 0x7FFFF.		INT32	RW	0x00010000 (65536dec)
2080	19	Limit 1	First limit value for setting the status bits		INT16	RW	0x0000 (0dec)
2080	20	Limit 2	Second limit value for setting the status bits		INT16	RW	0x0000 (0dec)
2080	23	User calibration offset	User calibration offset		INT16	RW	0x0000 (0dec)
2080	24	User calibration gain	User calibration gain		INT16	RW	0x4000 (16384dec)

Index	Subindex	Name	Meaning		Data type	Flags	Default
ANALOG INPUT CHANNEL 4 SETTINGS							
2096	01	Enable user scale	1	User scale is enabled	BOOLEAN	RW	0x00 (0dec)
2096	02	Presentation	0	Signed presentation	BIT3	RW	0x00 (0dec)
2096			1	Unsigned presentation			
2096			2	Absolute value with MSB as sign			
2096	05	Siemens bits	1	Status displays are superimposed on the lowest three bits in the status word.	BOOLEAN	RW	0x00 (0dec)
2096	06	Enable filter	1	Filter enabled, the cycle-synchronous data exchange is not applied	BOOLEAN	RW	0x01 (1dec)
2096	07	Enable limit 1	1	Enable Limit 1	BOOLEAN	RW	0x00 (0dec)
2096	08	Enable limit 2	1	Enable Limit 2	BOOLEAN	RW	0x00 (0dec)
2096	10	Enable user calibration	1	User calibration is enabled	BOOLEAN	RW	0x00 (0dec)
2096	11	Enable vendor calibration	1	Vendor calibration is enabled	BOOLEAN	RW	0x01 (1dec)
2096	14	Swap limit bits	1	Swaps the two limit-bits to be compatible to older hardware versions.	BOOLEAN	RW	0x00 (0dec)
2096	17	User scale offset	User scale offset		INT16	RW	0x0000 (0dec)
2096	18	User scale gain	The gain is represented in fixed-point format, with the factor 2-16. A value of 1 for the gain factor therefore corresponds to 65535dec (0x00010000hex) and is limited to 0x7FFFF.		INT32	RW	0x00010000 (65536dec)
2096	19	Limit 1	First limit value for setting the status bits		INT16	RW	0x0000 (0dec)
2096	20	Limit 2	Second limit value for setting the status bits		INT16	RW	0x0000 (0dec)
2096	23	User calibration offset	User calibration offset		INT16	RW	0x0000 (0dec)
2096	24	User calibration gain	User calibration gain		INT16	RW	0x4000 (16384dec)

Index	Subindex	Name	Meaning		Data type	Flags	Default
FILTER SETTINGS - ALL CHANNELS (See *Filters (Common to All Input Channels)* on Page 30 for more information)							
2048	06	Enable filter	1	Filter enabled, the cycle-synchronous data exchange is not applied	BOOLEAN	RW	0x00 (0dec)
2048:	21	Filter settings	This object defines the digital filter settings of all the modules channels, if it is activated with index 2048:06. The possible settings are numbered consecutively. 0 50 Hz FIR 1 60 Hz FIR 2 IIR 1 3 IIR 2 4 IIR 3 5IIR 1 IIR 4 6IIR 1 IIR 5 7 IIR 6 8 IIR 7 9 IIR 8		UINT16	RW	0x0000 (0dec)
MISCELLANEOUS SETTINGS							
2		Standard Command	130 - Restore factory defaults		UINT8	WO	0x0000 (0dec)
12	02	Data Storage Lock			BOOLEAN	RW	0x0000 (0dec)

Observation Parameters

Index	Subindex	Name	Meaning	Data type	Flags	Default
ANALOG INPUT CHANNEL 1						
2062	01	ADC raw value	Raw value of the analog/digital converter	INT16	RO	0x0000 (0dec)
2063	01	R0 offset	offset (vendor calibration)	INT16	RW	0x0000 (0dec)
2063	02	R0 gain	gain (vendor calibration)	INT16	RW	0x4000 (16384dec)
2063	03	R1 offset	offset (vendor calibration)	INT16	RW	0x0000 (0dec)
2063	04	R1 gain	gain (vendor calibration)	INT16	RW	0x4000 (16384dec)
2063	05	R2 offset	offset (vendor calibration)	INT16	RW	0x0000 (0dec)
2063	06	R2 gain	gain (vendor calibration)	INT16	RW	0x4000 (16384dec)
ANALOG INPUT CHANNEL 2						
2078	01	ADC raw value	Raw value of the analog/digital converter	INT16	RO	0x0000 (0dec)
2079	01	R0 offset	offset (vendor calibration)	INT16	RW	0x0000 (0dec)
2079	02	R0 gain	gain (vendor calibration)	INT16	RW	0x4000 (16384dec)
2079	03	R1 offset	offset (vendor calibration)	INT16	RW	0x0000 (0dec)
2079	04	R1 gain	gain (vendor calibration)	INT16	RW	0x4000 (16384dec)
2079	05	R2 offset	offset (vendor calibration)	INT16	RW	0x0000 (0dec)
2079	06	R2 gain	gain (vendor calibration)	INT16	RW	0x4000 (16384dec)

Index	Subindex	Name	Meaning	Data type	Flags	Default
ANALOG INPUT CHANNEL 3						
2094	01	ADC raw value	Raw value of the analog/digital converter	INT16	RO	0x0000 (0dec)
2095	01	R0 offset	offset (vendor calibration)	INT16	RW	0x0000 (0dec)
2095	02	R0 gain	gain (vendor calibration)	INT16	RW	0x4000 (16384dec)
2095	03	R1 offset	offset (vendor calibration)	INT16	RW	0x0000 (0dec)
2095	04	R1 gain	gain (vendor calibration)	INT16	RW	0x4000 (16384dec)
2095	05	R2 offset	offset (vendor calibration)	INT16	RW	0x0000 (0dec)
2095	06	R2 gain	gain (vendor calibration)	INT16	RW	0x4000 (16384dec)
ANALOG INPUT CHANNEL 4						
2110	01	ADC raw value	Raw value of the analog/digital converter	INT16	RO	0x0000 (0dec)
2111	01	R0 offset	offset (vendor calibration)	INT16	RW	0x0000 (0dec)
2111	02	R0 gain	gain (vendor calibration)	INT16	RW	0x4000 (16384dec)
2111	03	R1 offset	offset (vendor calibration)	INT16	RW	0x0000 (0dec)
2111	04	R1 gain	gain (vendor calibration)	INT16	RW	0x4000 (16384dec)
2111	05	R2 offset	offset (vendor calibration)	INT16	RW	0x0000 (0dec)
2111	06	R2 gain	gain (vendor calibration)	INT16	RW	0x4000 (16384dec)