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# **iqMAXREFDES42 Documentation**

*Release 1.3.3*

**IQ2 Development GmbH**

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## Introduction

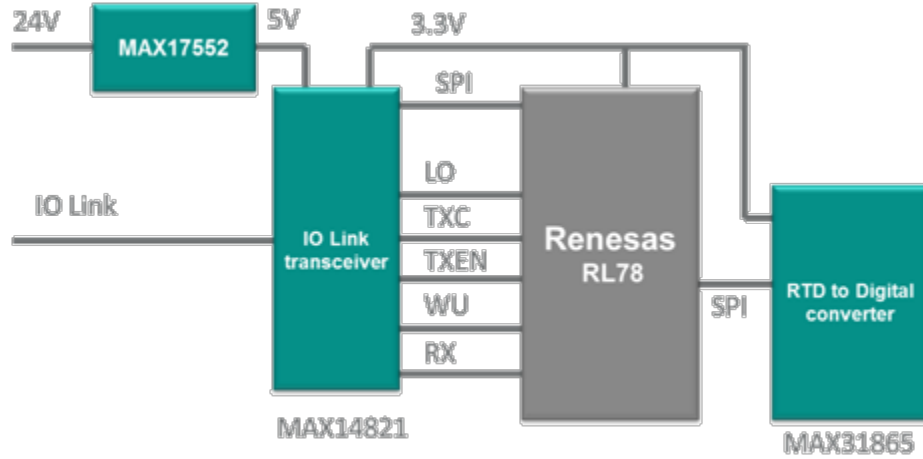


Maxim's Mojave (MAXREFDES42#) reference design features a resistance to digital temperature sensor which can also detect multiple faults. The IO-Link communication protocol enables quick sensor configuration and reduces cabling while featuring a robust, medium speed, communication protocol with power, enabling higher powered sensors than a 4-20mA loop.

## 1.1 Board Specification

Item	Specification
Oscillator Frequency	18.432MHz
Microcontroller	Renesas RL78/G1A (R5F10E8EALA)
DC Power	24V via M12 Connector
LEDs	<ul style="list-style-type: none"> <li>• Power indicator: Green x1</li> <li>• IO-Link indicator: Amber x1</li> <li>• Digital output indicator: Red x1</li> </ul>
IO-link Connector	Male M12 4-pole A-coded
IO-Link PHY	Maxim MAX14821EWA+
RTD-to-Digital Converter	MAX31865ATP+
SPI 3.3V/5V Level Shifter	MAX1841EUB
Dot Addressable Display	SCE5744 Z

## 1.2 Project Goal



The purpose of this project is by giving the user a strong basis to start develop production-ready IO-Link® application based on Maxim Integrated IO-Link device transceiver (MAX14821), a Renesas ultra-low-power, 16-bit microcontroller (RL78) and iqStack® IO-Link Device Stack.

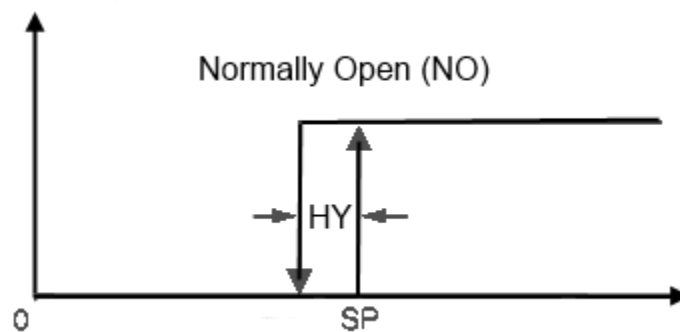


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## Sensor Logic

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In iqMAXREFDES42 have been implemented simple switch-point hysteresis logic and additionally can be configured as normally open (NO) or normally closed (NC).



By default ambient temperature switch-point settings (32767 is the maximal value):

What	SP (Level)	Hysteresis	Mode
Ambient temperature	9148 (0x23BC, 30°C/86°F)	32 (0x20, 1°C/1.8°F)	Normally Open (NO)

**Note:** Ambient temperature switch-point flag always indicated on digital output channel (red LED).

**Note:** Ambient temperature switch-point level can be calculated via IO-Link Tech-in command (160, 0xA0) automatically.

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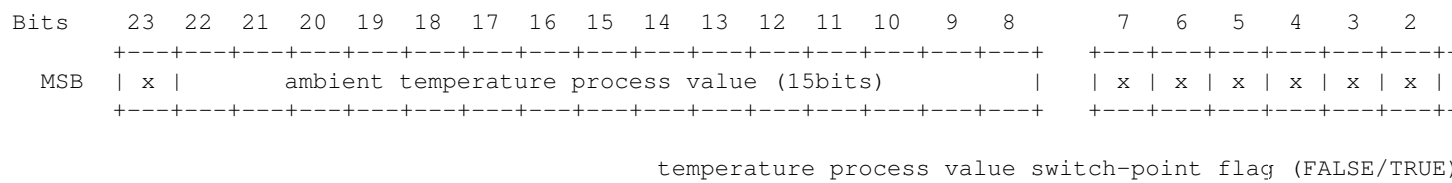
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## IO-Link Application

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iqMAXREFDES42 communicates with an IO-Link Master on COM3 transmission rate (230,4kbit/s).

### 3.1 Process Data In



### 3.2 Process Data Out

Be absent.

### 3.3 Commands

Can be run by IO-Link Index 0x0002:

Value	Description
128 (0x80)	Device Reset
160 (0xA0)	Tech-in ambient temperature switch-point level (see IO-Link index 0x0100 below)

### 3.4 Parameters

IO-Link index	Mode	Description	Default value
16 (0x0010)	read-only	Vendor Name	Maxim Integrated
17 (0x0011)	read-only	Vendor Text	The world leader in analog integration
18 (0x0012)	read-only	Product Name	Mojave (MAXREFDES42#)
19 (0x0013)	read-only	Product ID	MAXREFDES42
20 (0x0014)	read-only	Product Text	IO-Link RTD Temp Sensor
23 (0x0017)	read-only	Firmware Revision	v 1.3.3
256 (0x0100)	read/write	Ambient temperature switch-point level	9148 (0x23BC)
257 (0x0101)	read/write	Ambient temperature switch-point hysteresis	32 (0x20)
258 (0x0102)	read/write	Display's temperature scale (0 - °F, 1 - °C)	1 (0x01)
259 (0x0103)	read/write	N-wire type connection (2, 3, 4)	2
260 (0x0104)	read/write	MAX31865ATP+ Configuration register	0xCO (2-wire or 4-wire auto conversion mode)
261 (0x0105)	read-only	MAX31865ATP+ RTD (2 bytes)	0
262 (0x0106)	read/write	MAX31865ATP+ High Fault Threshold (2 bytes)	0xFFFF
263 (0x0107)	read/write	MAX31865ATP+ Low Fault Threshold (2 bytes)	0
264 (0x0108)	read-only	MAX31865ATP+ Fault Status register	0x00
265 (0x0109)	read/write	Reference resistance (3 bytes)	400_000mΩ (PT100)
266 (0x010A)	read/write	Nominal resistance at 0°C (3 bytes)	100_000mΩ (PT100)
267 (0x010B)	read-only	Ambient temperature (in °F)	-412.3768°F
268 (0x010C)	read-only	Ambient temperature (in °C)	-246.876°C
269 (0x010D)	read-only	Ambient temperature SP level (in °F)	86.0°F
270 (0x010E)	read-only	Ambient temperature SP level (in °C)	30.0°C
271 (0x010F)	read-only	Ambient temperature SP hysteresis (in °F)	1.8°F
272 (0x0110)	read-only	Ambient temperature SP hysteresis (in °C)	1.0°C

## 3.5 Events

Event code	Description
0x4210	Device temperature over-run
0x5000	Device hardware fault
0x5111	Primary supply voltage under-run
0x6000	Device software fault
0x7710	Short circuit



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## Installation Details

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There are two ways to experiment with MAXREFDES42#:

- Upload Firmware HEX-file, connect a device to IO-Link Master and play around.
- Clone the source code from Bitbucket repository, go throw and try to debug.

### 4.1 Firmware

Firmware HEX-file, IODDs data and this document in PDF format can be downloaded from the [Bitbucket repository](#) absolutely free without registration.

To upload HEX-file into MAXREFDES23 have to get [Renesas E1 emulator](#) and also [Renesas Flash Programmer](#).

### 4.2 Source Code

The project source code can be cloned from the [Bitbucket repository](#) freely without registration.

Download a trial version of [IAR RL78 Embedded Workbench IDE](#) in order to compile it and also take a look for [Renesas Application Leading Tool \(Applilet\)](#).

Also the [Renesas E1 emulator](#) and [Renesas Flash Programmer](#) needed to start debug session with a device.





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## Troubleshooting

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If during power-on self-test (POST) hardware fails were occurred, then the main sensor application will not started and instead a first appeared hardware fail number was blinked on digital output red-indicator channel continuously and also was displayed on LCD.

Blinks Count	Fail Description
1	Renesas RL78 Illegal memory access (a firmware error, contact with developers)
2	Renesas RL78 RAM parity check (a firmware error, contact with developers)
3	Renesas RL78 Illegal instruction (a firmware error, contact with developers)
4	Maxim MAX14821EWA+ selfcheck (the chip is possibly corrupt, try to restart the device)
5	Maxim MAX31865ATP+ selfcheck (the chip is possibly corrupt, try to restart the device)



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**Changelog**

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**6.1 v1.3.3 (2015-03-03)**

- Improvements:
  - (#16) Introduce startup delay (100-300 msec)

**6.2 v1.3.2 (2014-11-18)**

- Improvements:
  - (#15) Restarting the ADC after a fault RTD-to-Digital Converter (MAX31865) detection cycle

**6.3 v1.3.1 (2014-09-30)**

- Improvements:
  - (#14) Please don't make display go “—” when fault is detected

**6.4 v1.3 (2014-08-24)**

- Improvements:
  - (#12) Temperature readback value in oC does not match display after calibrating Ro
  - (#13) Use '0.xxxx' format for temperature readback values

**6.5 v1.2 (2014-08-08)**

- Improvements:
  - (#9) PT100 & PT1000 & Custom Ro

## 6.6 v1.1.1 (2014-07-28)

- Improvements:
  - (#4) Callendar-Van Dusen equation

## 6.7 v1.1 (2014-06-07)

- **Breaking changes:**
  - (#3) MAX31865ATP+ RTD-to-Digital Converter registers are available as IO-Link parameters
  - (#6) Switch N-wire connection type via an IO-Link parameter
- Improvements:
  - (#5) IODD picture and icon was added

## 6.8 v1.0 (2014-05-17)

- New features:
  - Hardware setups:
    - \* Renesas RL78/G1A (R5F10E8EALA) microcontroller (with Applilet3 support, see 'src\applilet3\_src')
    - \* MAX14821EWA+ IO-Link Device Transceiver (SPI/UART, see 'src\hw\_drivers\c\_max1482x.\*')
    - \* MAX31865ATP+ RTD-to-Digital Converter (SPI, see 'src\hw\_drivers\c\_max31865.\*')
    - \* SCE574x 4-Character 5x7 Dot Matrix Serial Input Dot Addressable Display (SPI, see 'src\hw\_drivers\c\_sce574x.\*')
  - Porting IO-Link iqStack(R) Device and set up the IO-Link communication (see 'src\applilet3\_src\r\_main.c')
  - Write a simple IO-Link *resistor temperature detector* Application (with appropriate IODDs, see 'src\sensor\_appl.c')

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**Glossary**

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**RTD** Short for *resistor temperature detector*.

**PV** Short for *process value*.

**resistor temperature detector** Temperature sensor that operates on the measurement principle that a material's electrical resistance changes with temperature.

**process value** Internal unsigned numeric number, must be converted in order to display a required physical value.



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**License**

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## P

process value, [17](#)

PV, [17](#)

## R

resistor temperature detector, [17](#)

RTD, [17](#)