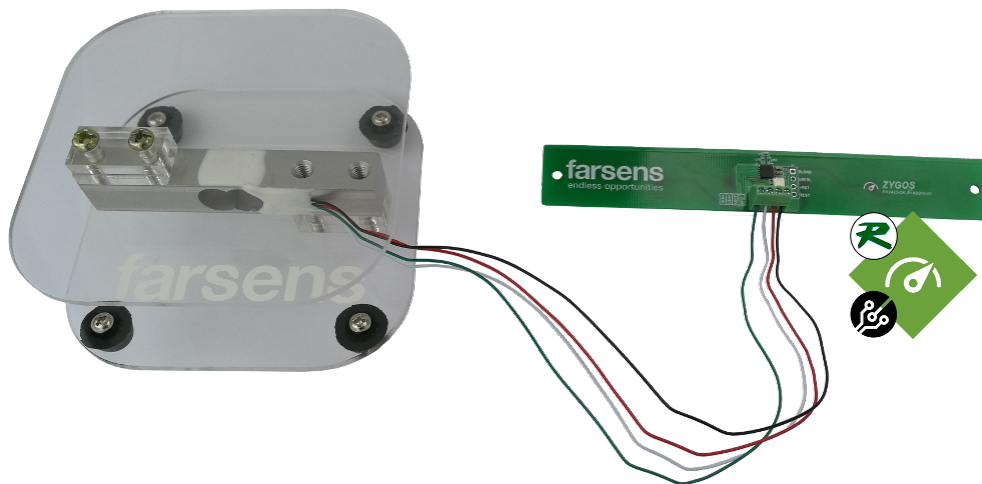


## EPC C1G2 BATTERYLESS LOAD SENSOR

Check for samples: [EVAL01-ZYGOS-RM](#)



## FEATURES

- EPC C1G2 compliant
- ISO 18000-6 Type C compliant
- 160-bit EPC Bank: Up to 128-bit EPC
- 96-bit TID Bank: Up to 48-bit Serial Number
- Available User Memory: Up to 1008-bit Non Volatile User Data
- Long range in passive mode: 5m
- Extended range in battery assisted passive mode: 20m
- Load sensor
  - Load range: 5 kg
  - Load accuracy:  $\pm 50$  g
- Pick to light indicator for visual identification

## DESCRIPTION

ZYGOS-RM is an EPC Class-1 Generation-2 (C1G2) RFID tag based on Farsens' batteryless sensor

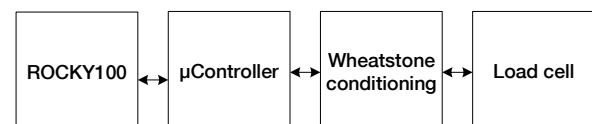
technology. Built in a compact PCB format, the tag includes a load cell sensor mounted on a scale.

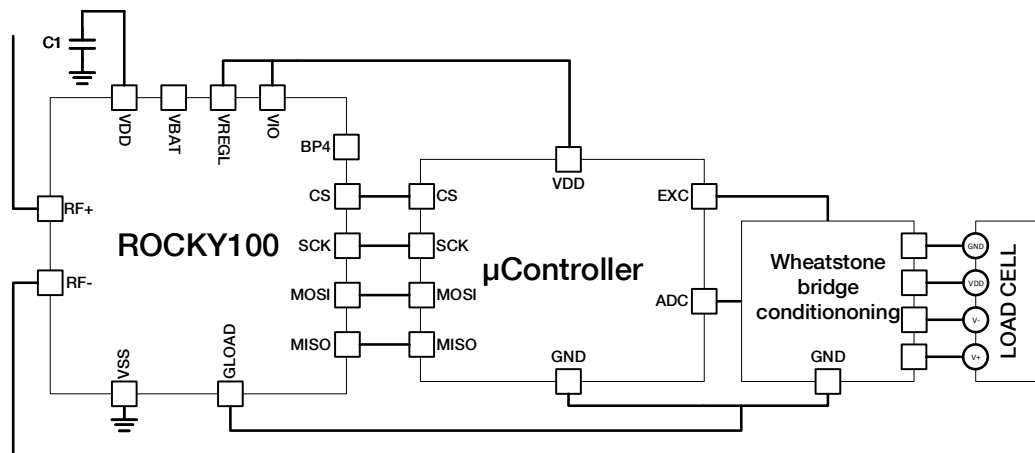
These RFID sensor tags are compatible with commercial UHF RFID readers (EPC C1G2). With a 2W ERP setup the battery-less light sensor can communicate to over 5 meters - 16 feet.

The ZYGOS-RM can be customized with different antenna design and sizes, depending on the specific application. It can be encapsulated in an IP67 or IP68 casing for usage in harsh environments. It may also be possible to customize the specifications of the sensor upon request.

## BLOCK DIAGRAM

The ZYGOS-RM tag consists of a ROCKY100 IC for energy harvesting and wireless communication, a microcontroller, a Wheatstone bridge sensing circuitry and a load cell.





The ROCKY100 IC includes the RF frontend for UHF RFID power harvesting and communication, a power supply module to generate the required voltage levels, and an EPC C1G2/ISO18000-6C digital processor including a SPI bridge. The SPI bridge can be controlled via EPC C1G2 standard memory access commands.

The operation of measuring load is controlled with a microcontroller. Besides the CPU and the memory, the microcontroller includes an ADC.

A Wheatstone bridge conditioning circuitry including an operational amplifier provides an analog signal proportional to the sensed load. This signal is digitized by the integrated ADC.

The microcontroller is configured in such way that it updates the measurement of the load. The capacitor C1 is included in the device in order to support the current peaks during measurements. Upon receiving a SPI directed read request from the UHF RFID reader, the ROCKY100 SPI bridge requests the value of the last measurement to the microcontroller, and includes it in the answer towards the reader.

## CHARACTERISTICS

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT
<b>RFID</b>					
$r_{operation}$	Operation range full passive		5		m
	Operation range BAP		15		m
	Operation range EBAP		20		m
<b>OPERATING CONDITIONS</b>					
$T_{OP\_TOP}$	Operating temperature range	-40		85	°C
<b>LOAD</b>					
$L_{range}$	Load range	0		5	kg
$L_{acc}$	Load accuracy		±50		g
$L_{res}$	Load resolution		5		g

## OPERATION

### EPC READING

In order to read the EPC of the tag, commercial EPC C1G2 readers can be used. However, some considerations have to be taken into account.

As the tag has a significant supply capacitor connected to VDD, the power-up of the system will be slow. It can last several seconds. In order to speed up the charge process, the reader shall be configured to send power as continuously as possible.

Once the supply capacitor is charged, the tag will respond with its EPC. From this point on, memory access commands can be used to control additional functionalities via the SPI bridge.

### LOAD READING

The sensed load can be read using standard EPC read commands. The answer to such command will include the values of the latter measurements of the device.

**Read Load**                      Operation: Read  
    Memory bank: User Memory  
    Word Pointer: 0x100  
    Word Count: 3

The answer from the tag to such a request will contain 6 bytes of data. Assuming that the reader returns the received data in the buffer of bytes *rawdata*, the content of the answer is defined as follows:

rawdata	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
content	HEADER	FW_VER	LOAD	0x00	QOS	

- **HEADER** (uint8): datagram header '0xAA'. The header will be set once the micro-controller has taken the first measurement. If header is not set, the following fields have to be discarded.
- **FW\_VER** (uint8): firmware version included in the micro-controller.
- **LOAD** (int16): sensed load value in signed integer format (Little Endian). Value is given in *g*.
- **QOS** (uint8): Quality Of Service provided by ROCKY100. Refer DS-ROCKY100 for further details on this parameter.

QOS	Meaning
0xFF	Sensor working in best conditions
0xEE	Sensor working in good conditions
0xCC	Sensor switched off
0x88	Sensor switched off

## EXAMPLE OPERATION LOG

```
[10/07/2017 14:32:08] Start inventory... OK
[10/07/2017 14:32:09] Stop continuous inventory... OK
[10/07/2017 14:32:09] Read comamnd. Bank = User WordPtr = 0x00000100 WordCount = 3
                        Data Read = 0x0000000000CC
[10/07/2017 14:32:09] QoS byte : 0xCC, Interpretation: VtagAboveVtagon
[10/07/2017 14:32:09] Invalid data header (received 0x00, expected 0xAA).
                        Discard received data
[10/07/2017 14:32:09] Start inventory... OK
[10/07/2017 14:32:10] Stop continuous inventory... OK
[10/07/2017 14:32:10] Read comamnd. Bank = User WordPtr = 0x00000100 WordCount = 3
                        Data Read = 0xAA01DA0300FF
[10/07/2017 14:32:10] QoS byte : 0xFF, Interpretation: VloadAboveVloadon
[10/07/2017 14:32:10] Valid data header (0xAA). Process received data
[10/07/2017 14:32:10] Firmware revision = 0x01
[10/07/2017 14:32:10] Extract load value. Binary representation : 0xDA03
                        Interpreted value (unsigned integer) : 986
```

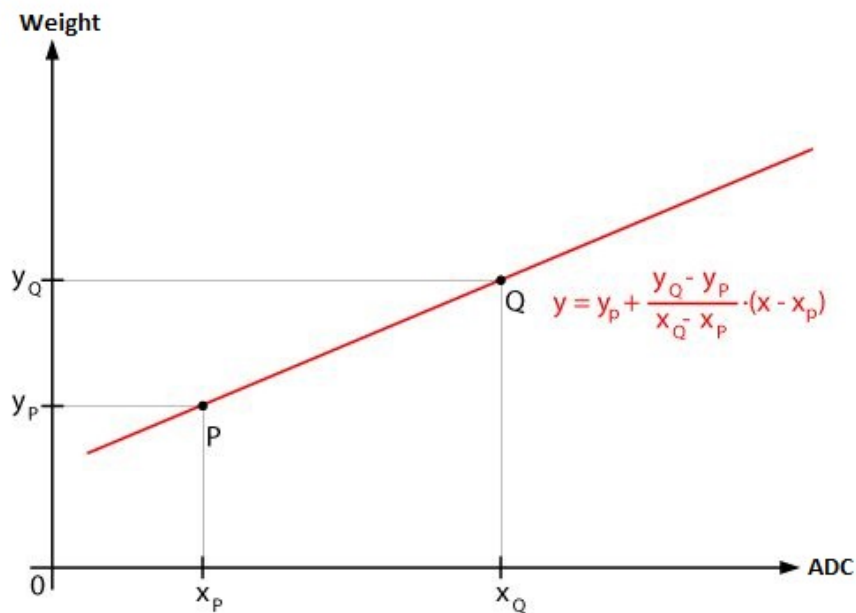
In this example operation, continuous inventory is triggered by default to send power over the air. Every second, the continuous inventory is stopped, a sensor read command is sent and the response is interpreted. When done, the continuous inventory is triggered again to keep on sending power over the air so that ZYGOS-RM is energized.

In this example, the first reading returns an invalid header, which means that the measurement buffer is still empty. The second measurement returns a valid header, and the following fields are interpreted in order to get the measured load value.

## CALIBRATING THE SENSOR

Due to the ADC output variation between different load cell sensors, the tag can be manually calibrated for the connected load cell. The sensor calibration involves determining a slope and offset for the entered weight so the ADC output value from the Wheatstone bridge can be properly converted to weight.

The slope and offset are automatically calculated by the microcontroller, the values are calculated based on two known weights and their respective ADC value. To calibrate the sensor it is then needed to specify those two known weights via EPC read commands.



To specify each point it is needed to:

1. Specify a known weight in grams to the microcontroller (Y)
2. The microcontroller measures that weight (X)

Once the two points have properly been specified, a final command is sent to the microcontroller to calculate the offset and slope. Once the calibrate command has been sent, subsequent reads to the sensor load will reflect the new slope and offset.

To perform the calibration with EPC read commands, the commands and included byte data (if any) should be added to the read address with the following format:

**Calibration Command**    Operation: Read  
                                  Memory bank: User Memory  
                                  Word Pointer: command + data  
                                  Word Count: 3

Where the available commands are the following:

Command	Description
0x200	Set $Y_P$ LSB
0x300	Set $Y_P$ MSB
0x400	Set $Y_Q$ LSB
0x500	Set $Y_Q$ MSB
0x600	Measure $X_P$
0x700	Measure $X_Q$
0x800	Calibrate
0x900	Set ADC

Note that sending the MSB of  $Y_P$  and  $Y_Q$  is optional but it should only be set after having set its LSB.

For testing purposes, it is also possible to see the raw ADC output by sending the "Set ADC" command, which will set the slope to 1 and offset to 0.

## PICK TO LIGHT INDICATOR

The pick to light indicator of ZYGOS-RM can be triggered using standard EPC read commands. The PWM module of the ROCKY100 is used to control an LED. Upon receiving a not-null value write command directed to the PWM trigger register, ZYGOS-RM will generate the PWM signalling which will make the LED of the device blink according to the active configuration. By default, the device will generate 3 short blinks.

### Trigger blink

Operation: Write  
Memory bank: User Memory  
Word Pointer: 0x91  
Data: 0x01

## DEMO SOFTWARE

Demonstration software to read and control the ZYGOS-RM is available in the web. Download the latest software and user guide at: <http://www.farsens.com/software.php>. Check the website for updated reader compatibility list. Up to the date of writing this document, this is the status of the compatibility list:

Fixed readers			
Manufacturer	Model	Tested HW rev.	Tested FW rev.
Impinj	R420	HLA: 1.00   PCBA: 4.00	5.12.1
Impinj	R220	-	-
Impinj	R120	-	-
Nordic ID	Sampo	PWM00282	5.4 A
Nordic ID	Stix	PWM00226	5.10 A
Alien	ALR9900	-	14.07.01.00
ThingMagic	Mercury6	1.0	4.19.3.2
Zebra	FX9500	-	1.5.4.348

Handheld readers				
Manufacturer	Model	OS	Tested HW rev.	Tested FW rev.
Nordic ID	Merlin	Windows CE 6.0	PWM00193	3.7.0
Zebra	MC9090G	Windows CE	x.xx	x.xx



## REFERENCES

The next table shows the available references of the ZYGOS-RM.

Ref.	Name	Description
41602	EVAL01-ZYGOS-RM-DKWB	ZYGOS-RM, dipole wideband antenna, PCB format

For custom references with other antennas and housings, please contact us at [sales@farsens.com](mailto:sales@farsens.com).

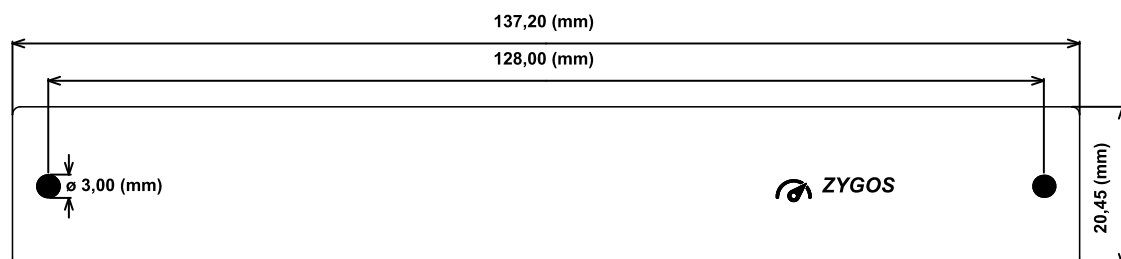
## MECHANICAL DIMENSIONS

All dimensions are in millimeters.

Valid for reference(s): 41602

### DKWB

#### 2D VIEW



Maximum height: 10mm

#### 3D VIEW



## SCALE

### 2D VIEW

