100 years Since 1925 SIAP+MICROS Environmental Monitoring Solutions

T064A–TLR35–IS12

W–band RADAR water level sensor

User and maintenance manual

Firmware version 1.1.0

Siap+Micros S.p.A.
Via del Lavoro, 1
31020 - San Fior (TV) - ITALY

tel.: +39 0438 491411 - fax: +39 0438 401547
e-mail: info@siapmicros.com
www.siapmicros.com

Summary

1. Introduction 4
1.1 Purpose and target audience of the manual 4
1.2 Contact and support information 4
1.3 Conventions and symbols used 5
2. Precautions and safety measures 6
2.1 Intended use 6
2.2 Warnings 6
2.3 Moving 6
2.4 Removing the packaging 6
2.5 Powering up 7
2.6 During operation 7
2.7 Storage 7
2.8 Maintenance 8
2.8.1 Cleaning the instrument 8
2.8.2 Power line protection 8
2.9 Disposal 8
3. Hardware and connections 9
3.1 TLR35 overview 9
3.2 Electrical connections 10
3.3 Electrical characteristics 11
3.3.1 Power supply 11
3.3.2 RS – 485 12
3.3.3 SDI – 12 12
3.3.4 4 – 20mA analogue output 13
3.4 Identification label 14
4. Installation and commissioning 15
5. Operation 16
5.1 Operating principle 16
5.2 Acquisition and measurements 17
5.3 Communication protocols 18
5.3.1 MODBUS protocol 18
5.3.2 SDI – 12 protocol 20
5.3.2.1 Sensor test <a>! 20

5.3.2.2 Send identifier <a>I! 20
5.3.2.3 Change address <a>A<b>! 21
5.3.2.4 Current address request ?! 21
5.3.2.5 Commands and procedures for reading measurements 21
5.4 Analogue output 4 – 20mA 25
6. Revision history 26
7. Reference directives 27
8. Annex A: Radio astronomy stations 28

1. Introduction

This manual contains important information for the use and maintenance of the RADAR T064A–TLR35–IS12 water level sensor. Always consult the manual before performing any operation on the instrument.

1.1 Purpose and target audience of the manual

The manual provides:

- Safety information on the T064A–TLR35–IS12 product
- Information on the device's hardware and connections
- Information on installation, use, maintenance and disposal of the device

The manual is primarily intended for technical personnel such as:

- Monitoring network designers
- Monitoring network operators
- Installers
- Technical operators
- Maintenance personnel

Keep the manual in a safe place and always have a copy available for operators.

1.2 Contact and support information

For technical and commercial information and support, please refer to the manufacturer's contact details.

SIAP+MICROS S.p.A.

Via del Lavoro 1,

31020 – San Fior (TV) - Italy

https://www.siapmicros.com/en/

https://www.siapmicros.com/en/contatti/

For detailed technical documentation, please refer to the product page.

https://www.siapmicros.com/en/sistemi-di-misura/hydrometric-level/

1.3 Conventions and symbols used

The following symbols may be used in the text, with their meanings explained below.

 General warning/danger symbol. It indicates a potential risk that may cause damage to persons or property. Pay particular attention when you see this symbol.

 Disposal. The product must NOT be disposed of as municipal waste but rather in accordance with the European Directive on Waste Electrical and Electronic Equipment (WEEE) 2012/19/EU.

⎓ Direct voltage and direct current symbol.

Important text Pay particular attention when you see text framed in red.

Risky operation White text on a red background indicates a potentially hazardous operation for the equipment, such as:

- Loss of measurement configuration
- Loss of functionality
- Degradation of measurement performance
- Damage to the equipment

For operator safety, it is necessary to follow the procedures described in this manual and read all the notes carefully.

Hereinafter, the terms "TLR35–IS12", "TLR35", "sensor", "device", "RADAR", "instrument" and "product" will be used interchangeably to refer to the RADAR T064A–TLR35–IS12 product.

2. Precautions and safety measures

2.1 Intended use

The instrument is a W–band RADAR (80GHz), designed to measure water levels up to a full scale of 35 meters. It can generally be used to measure the distance from objects with a dielectric permittivity greater than 1.9.

2.2 Warnings

The manufacturer declines any responsibility in the event of faults due to failure to follow the instructions, tampering, use not covered by this manual, improper use of the device, or use by untrained operators. Only authorized and trained personnel should have access to the work area for normal use and maintenance operations.

General safety rules

- Only handle the instrument with perfectly dry hands.
- The instrument must not be operated in the presence of flammable gases, fumes or in any environment where there is a risk of explosion.
- Do not remove, replace or modify any electrical or mechanical parts.
- Maintenance operations, component replacement and work inside the device must only be carried out by SIAP+MICROS technical personnel or personnel trained by SIAP+MICROS.
- Pay attention to any warning labels against potentially dangerous procedures.

2.3 Moving

To avoid damage to the equipment, take care during transport. Avoid impacts. Transport the TLR35 in suitable protective packaging.

2.4 Removing the packaging

Before removing the packaging and installing the instrument, ensure that you have taken the following precautions:

- Wear suitable gloves to protect yourself against abrasion, etc.
- If any damage caused during transport by the supplier is found, return the instrument to the supplier.
- Once removed from the packaging, place the instrument and its components on a flat surface.

- Pay attention to the connectors on the side of the instrument container during this operation.

Before installing the instrument, check that:

- The mains voltage in the installation area complies with the operating conditions of the instrument.

2.5 Powering up

To switch on the instrument, simply insert the 7–pin connection cable with the power supply voltage present at pins 6 (positive) and 7 (ground). The connection diagram is shown in detail in chapter three.

Do not exceed the maximum supply voltage of 30V ⎓

Pay particular attention when connecting the 7–pin connection cable: first ensure that all other signals on the connector, RS-485, SDI-12 and analogue output, are correctly connected on the data logger side/acquisition instrumentation side or suitably isolated.

2.6 During operation

During operation, avoid tampering with electrical connections: completely disconnect the power supply before performing any operation.

2.7 Storage

If you do not plan to use the equipment for an extended period (at least one year):

- Disconnect all cables from the device, place it in a transparent plastic bag together with a bag of desiccant salts and seal the bag with adhesive tape. Label the bag with the contents and weight of the equipment, adding the words

HANDLE WITH CARE

- Store the instrument in an environment with a temperature between 0 and 60 degrees Celsius and humidity not exceeding 80%.
- Ensure that the instrument is stored in a stable position and that it cannot be damaged or moved due to carelessness or distraction.
- Do not stack other instruments or weights on top of it. Do not stack the instrument on top of other instruments and, in any case, ensure that the support underneath is solid and stable.

2.8 Maintenance

The sensor does not require any maintenance. For correct and consistent measurement, ensure that the area below the sensor inside the measurement cone (8°) is kept clean and free from obstacles, even temporary ones.

However, it is advisable to periodically check the proper functioning of the instrument, for example annually, by comparing it with reference instruments.

2.8.1 Cleaning the instrument

Before cleaning the instrument, disconnect all connection cables. Use soft, dry cloth for cleaning. Never use damp clothes, solvents, water or other liquids. Compressed air can be used to remove any dust residues.

2.8.2 Power line protection

The product is equipped with protection devices against overvoltage, overcurrent and electrostatic discharge. The power supplies are also equipped with reverse polarity protection circuitry. Always pay particular attention to the connections and always refer to the technical specifications of the instrument available at https://www.siapmicros.com/en/sistemi-di-misura/hydrometric-level/ for applicability limits. See chapter three for more details.

2.9 Disposal

In accordance with European Union Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), this product must be disposed of at a designated collection point for the recycling of electrical and electronic equipment.

For further information on your nearest recycling center, please contact your local authority.

3. Hardware and connections

3.1 TLR35 overview

The TLR35 is a W–band RADAR sensor for measuring water levels up to a maximum of 35 meters full scale. For details on the measurement cycle and available electrical quantities, refer to chapter five on device operation. The components of the TLR35 are shown in the following figure.

Figure1: TLR35 RADAR

- **7–pin interface connector**

  This connector provides:

  - Power supply to the sensor.
  - RS–485 bus.
  - SDI–12 bus.
  - 4 – 20mA analogue current output

- **Vent**

  Ensures pressure compensation and preserves the container seal.

- **Mounting bracket**

  Allow installation on different types of connections. The following figure 2 shows the dimensions, in mm, and overall dimensions of the sensor. On the bracket, next to the SIAP+MICROS logo, there is an engraving of the emission cone indicating the direction of the RADAR output signal: the signal exits from the bottom of the sensor (opposite side to the label).

The following figure shows the dimensions of the TLR35.

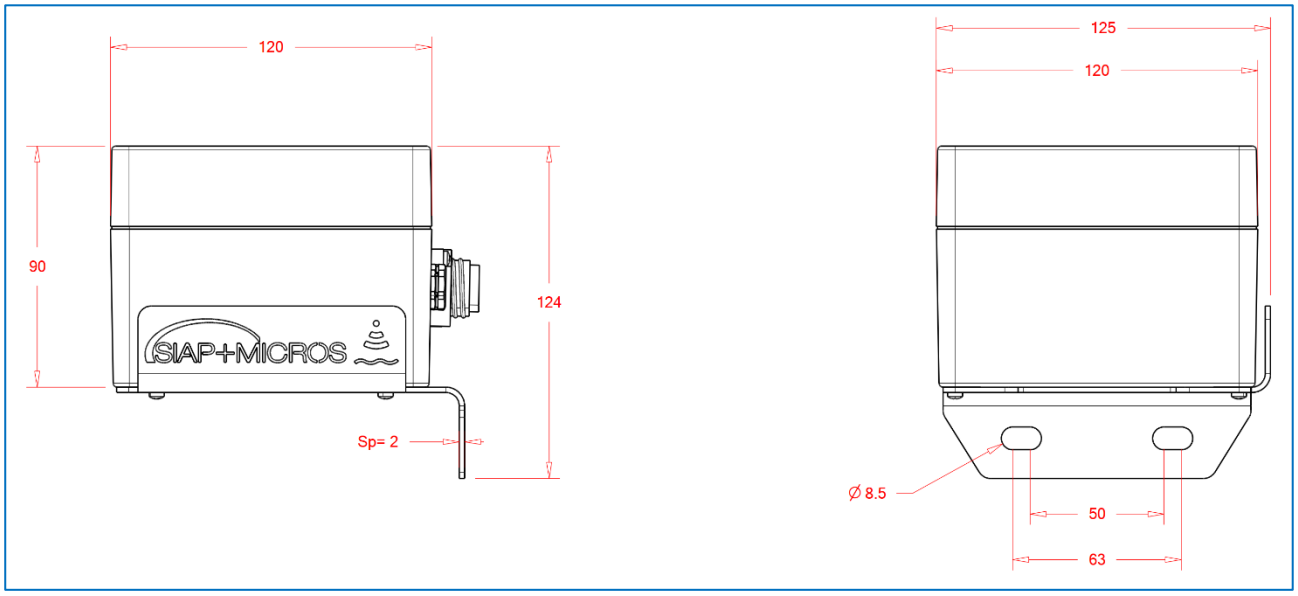
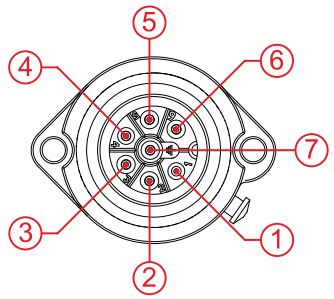


Figure2: TLR35 dimensions

The sensor is compact and has no exposed parts. The polycarbonate housing, for outdoor applications, is transparent to the electromagnetic signal emitted during measurement and the instrument's antenna is conveniently housed inside it. The measurement plane is calibrated to coincide with the bottom of the housing.

3.2 Electrical connections

The electrical connections are shown on a 7 – pin Amphenol C016 30C006 100 12 connector.



Pin	Signal
1	A – RS485
2	B – RS485
3	SDI – 12
4	+(4 – 20mA)
5	–(4 – 20mA)
6	+Power supply
7	GND

Figure3: Electrical connections with 4 – 20mA output

The color of the rows in the "Signal" column of the table reflects the color of the wires in the standard connection cable that can be supplied by SIAP+MICROS.

With reference to the connector shown in Figure 3:

1. Pin 1: **A – RS485**, positive of RS – 485, referring to the GND ground of pin 7.
2. Pin 2: **B – RS485**, negative of RS – 485, referring to the GND ground of pin 7.
3. Pin 3: **SDI – 12**, data line for the SDI – 12 protocol, referring to the GND ground of pin 7.
4. Pin 4: **+(4 – 20mA)**, positive of the 4 – 20mA current output.
5. Pin 5: **–(4 – 20mA)**, negative of the 4 – 20mA current output.
6. Pin 6: **+Power supply**, positive power supply (continuous voltage range 7V to 30V ⎓)
7. Pin 7: **GND**, negative power supply and voltage reference for electrical levels at pins 1, 2, 3.

3.3 Electrical characteristics

This section describes the electrical characteristics of the signals at the seven-pin connector with reference to electrical limits, filtering, protection against polarity reversal, overvoltage, overcurrent, and electrostatic discharge. The description is divided into the following sections:

- Power supply
- RS-485 bus
- SDI-12 bus
- 4 – 20mA analogue output

3.3.1 Power supply

The power supply is connected to pins 6 (positive) and 7 (negative) of the seven – pin connector.

- Operating voltage range 7V ÷ 30V ⎓ .
- Average consumption in MODBUS at 9600bps less than 10mA for 12V power supply ⎓ .
- Average consumption in SDI – 12 less than 10mA for 12V power supply ⎓ .
- Average consumption in 4 – 20mA less than 30mA at 12V ⎓ .
- Maximum peak consumption during measurement: 100mA for 12V power supply ⎓ .

The power supply is equipped with a three – stage protection circuit, gas discharge tube, varistor and TVS, for protection against overcurrents, overvoltages and electrostatic discharges. Protection characteristics:

- Nominal DC trigger voltage: 75V.
- DC impulse triggering voltage: < 400V @ 100 V/µs, < 700V @ 1 kV/µs.
- Overcurrent protection: 3kA (8/20 µs and 10 protection operations), 3.5kA maximum (1 operation 8/20 µs).

- Electrostatic discharge protection: up to 18 kV; IEC 61000-4-2 level 4, IEC 61000-4-5 (surge) IPP = 3A (8/20 µs).
- Protection fuse: resettable PTC technology, holding current 0.5 A and trigger current 1 A. Trigger time: 150 ms at an overcurrent of 8 A.

The power supply is also equipped with a polarity reversal protection circuit.

3.3.2 RS – 485

The RS – 485 is present at pins 1 (positive) and 2 (negative) of the seven – pin connector.

- The positive line, pin 1, has a pull – up to the internal 3.3V of the TLR35. This pull – up is located between the RS – 485 transceiver and all line protections before the connector.
- The negative line, pin 2, has a pull – down to the internal ground of the TLR35. This pull – down is located between the RS – 485 transceiver and all line protections before the connector.
- There is a line low – pass filter with a 3dB cut – off frequency of approximately 7MHz.

Each line is equipped with a three – stage protection circuit, gas discharge tube, varistor and TVS, for protection against overcurrents, overvoltages and electrostatic discharges. Protection characteristics:

- Nominal DC trigger voltage: 75V.
- DC impulse triggering voltage: < 400V @ 100 V/µs, < 700V @ 1 kV/µs.
- Overcurrent protection: 3kA (8/20 µs and 10 protection operations), 3.5kA maximum (1 operation 8/20 µs).
- Electrostatic discharge protection: ESD: IEC 61000-4-2, ±30kV for contact discharge, ±30kV for air discharge. EFT: IEC 61000-4-4, 50A (5/50ns). Lightning strike: IEC 61000- 4-5, 19 A (8/20 µs).
- Protective fuse: resettable PTC technology, holding current 0.12 A and tripping current 0.3 A. Tripping time: 100ms at an overcurrent of 1 A.

3.3.3 SDI – 12

The SDI – 12 data line is present at pin 3 of the seven – pin connector.

The impedance on the line follows the specifications recommended by the SDI – 12 standards:

- 220kΩ pull – down resistance.
- Capacitor between line and ground: 2.2 nF.
- Series resistors on the line, before and after the filter, 560Ω.

The line therefore has a low – pass filter with a 3dB cut – off frequency of approximately 130kHz.

The line is equipped with a three – stage protection circuit, gas discharge tube, varistor and TVS, for protection against overcurrents, overvoltages and electrostatic discharges. Protection characteristics:

- Nominal DC trigger voltage: 75V.
- DC impulse triggering voltage: < 400V @ 100 V/µs, < 700V @ 1 kV/µs.
- Overcurrent protection: 3kA (8/20 µs and 10 protection operations), 3.5kA maximum (1 operation 8/20 µs).
- Electrostatic discharge protection: IEC 61000-4-2, ±30kV for contact discharge, ±30kV for air discharge.
- Protection fuse: resettable PTC technology, holding current 0.12 A and tripping current 0.3 A. Tripping time: 100ms at an overcurrent of 1 A.

3.3.4 4 – 20mA analogue output

The 4 – 20mA analogue output is present at pins 4 (positive) and 5 (negative) of the seven – pin connector.

The voltage present on the line is equal to the RADAR supply voltage, while the current is proportional to the measured signal, as explained in chapter five.

The maximum load depends on the sensor supply voltage:

- 250 Ω @ Valim > 11V ⎓
- 200 Ω @ 10V < Valim ≤ 11V ⎓
- 150 Ω @ Valim ≤ 10V ⎓

The output is equipped with a three – stage protection circuit, gas discharge tube, varistor and TVS, for protection against overcurrents, overvoltages and electrostatic discharges. Protection characteristics:

- Nominal DC trigger voltage: 75V.
- DC impulse triggering voltage: < 400V @ 100 V/µs, < 700V @ 1 kV/µs.
- Overcurrent protection: 3kA (8/20 µs and 10 protection operations), 3.5kA maximum (1 operation 8/20 µs).
- Electrostatic discharge protection: up to 18 kV; IEC 61000-4-2 level 4, IEC 61000-4-5 (surge) IPP = 3A (8/20 µs).
- Protection fuse: resettable PTC technology, holding current 0.12 A and tripping current 0.3 A. Tripping time: 100 ms at an overcurrent of 1 A.

3.4 Identification label

The identification label shown in the figure below is located on the top of the sensor.

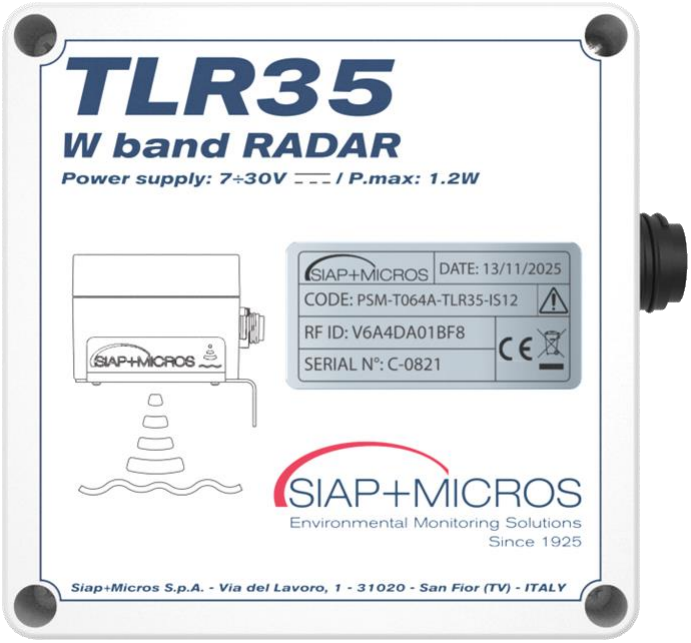


Figure4: TLR35 label

The top part shows the product name, operating band and power requirements. The bottom part shows contact information.

The grey section contains important traceability information, such as the date of manufacture, the serial number and the internal radio frequency element identifier. It also contains hazard and disposal warnings.

4. Installation and commissioning

For correct installation, follow the instructions below.

- Install the TLR35 with its underside parallel to the surface being measured.

  The absence of inclination ensures that the emitted signal can strike the target perpendicularly. Inclinations of the sensor with respect to the measurement surface led to progressive deterioration of the echo signal and possible signal loss.

- Install the RADAR so that there are no obstructions or obstacles along the signal path.

  The TLR35 signal has an emission cone width of 8° at 3dB. The cone therefore "illuminates" a circular area with a diameter of approximately 14cm at a distance of 1m. At 10m, the illuminated area has a diameter of approximately 1.4m and approximately 4.9m at 35m. Take this into account during installation. To minimize interference and false echoes, consider a 28° clearance zone within which there should be no obstacles to the propagation of the electromagnetic signal. The following figure shows the 8° emission cone in red and the 28° clearance zone in green.

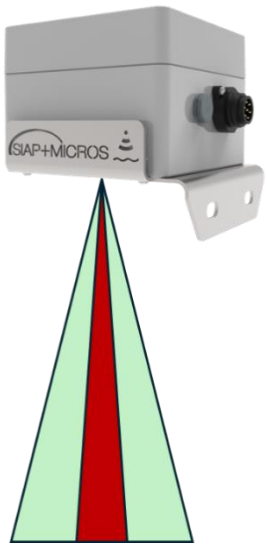


Figure5: emission cone (8°) and clearance cone (28°)

- For free field installations, the installation site must be at **least 4 km** away from the radio astronomy stations listed in Annex **A** of chapter eight, otherwise approval must be obtained from the competent authority. If the device is installed at a distance **between 4 and 40 km** from one of the listed stations, it must not be installed at a height greater than **15 m** above ground level. Refer to ETSI EN 302 729 V2.1.

To start up the sensor, connect the connection cable to the seven – pin connector. The sensor is not equipped with on/off buttons, indicator LEDs or other interfaces.

5. Operation

5.1 Operating principle

The TLR35 RADAR measures the distance to a target using the time – of – flight measurement principle: by knowing the propagation speed of the electromagnetic wave in the air, and measuring the time between the emission of the wave and the return of the echo, it is possible to determine the distance between the sensor and the target that generated the echo.

The RADAR signal, at a carrier frequency of 80GHz, is emitted by the TLR35 according to the FMCW (Frequency Modulated Continuous Wave) principle, in which the radio signal is emitted as a continuous wave whose frequency is modulated over time. The reflected signal arrives at the RADAR at a certain frequency. The difference in frequency between the signal emitted at a given moment and the reflected signal (beat frequency) is directly proportional to the distance between the RADAR and the source of the reflection. The sensor performs a distance measurement every ten seconds, therefore, RADAR emission is active only during the measurement period. The measurement cycle consists of ten samples, each with a time of less than 100ms. The RADAR activity time is therefore less than one second every ten seconds.

The sensor is configured with a blanking zone of 0.5 meters from the bottom of the container, which means that any reflection between zero and 0.5 meters is not measured. The blanking zone allows interference signals in the proximity of the antenna to be suppressed.

As illustrated in chapter four, the emitted signal has a total opening angle of 8° and, in a real installation, it is advisable to maintain a safety cone of 28°.

The reflective surface must have a dielectric permittivity greater than 1.9. Ideal measurement conditions occur with media with high dielectric permittivity, such as water, in non – turbulent surface conditions and in a homogeneous atmosphere (no variation in particulate matter or suspended gases or humidity or similar).

The TLR35 is suitable for measuring the distance of both liquids and solids; however, the actual measurement range depends on the reflection properties of the medium, the installation position and possible reflection interference.

5.2 Acquisition and measurements

The distance measurement is acquired every 10 seconds and, at the same time, is made available in the MODBUS and SDI – 12 communication protocols. The analogue output value is also updated during this phase. In addition to the distance measurement, the sensor acquires a series of diagnostic measurements. Details of the various measurements available are given below.

- **Distance [mm]**

  This is the main measurement of the sensor, expressed in mm, and indicates the distance between the bottom of the TLR35 and the target, for example the surface of a river. Measurement is the result of internal filtering.

- **Signal quality**

  A quality parameter, an integer between 0 and 3, which indicates the quality of the echo signal.

  - 3: excellent echo quality
  - 2: good echo quality
  - 1: low echo quality
  - 0: no echo signal.

- **Board inclination [°]**

  Hereinafter referred to as tilt, this is a measure of the sensor's inclination. In a real installation, ideally, the inclination should be 0° or in any case no greater than 4°.

- **Supply voltage [V]**

  The sensor power supply voltage is expressed in volts and measured at each cycle.

- **Internal temperature [°C]**

  Measurement of the internal temperature of the sensor, expressed in °C.

- **Internal humidity [%]**

  Measurement of the relative humidity inside the sensor, expressed in %.

- **Number of echoes in a single measurement**

  The distance measurement is obtained from a statistical processing of multiple echoes. Ten signals are sent for each measurement, and the relative echoes are measured. Ideally, therefore, the number of echoes in the measurement should be equal to ten. A lower value may be a sign of poor installation, interference on the signal path, or attenuation due, for example, to rain or a surface that is not perfectly reflective, such as stones on the bed of a temporary dry stream.

- **Echoes used in filtering**

  Statistical filtering does not use all echoes but makes a selection for the extraction of the final distance measurement based on internal parameters. This measurement is precisely the number of echoes used. The maximum number that the algorithm plans to use is 6. A lower value may indicate signal dispersion.

5.3 Communication protocols

The sensor makes its measurements available in both MODBUS and SDI – 12 protocols.

5.3.1 MODBUS protocol

The sensor supports the standard MODBUS protocol carried on RS – 485 to pins 1 and 2 of the seven – pin connector, as explained in chapter three. Please refer to the MODBUS standard specifications available on the website https://www.modbus.org/modbus-specifications.

The physical characteristics of the communication port are:

- Speed: 9600 bps
- Data bits: 8
- Stop bits: 1
- Parity check: none

The default MODBUS call address of TLR35 is **21**.

The MODBUS functions supported for reading measurements are:

- Function *0x03 Read Holding Registers*
- Function *0x04 Read Input Registers*

Both functions share the same data table: the content of a Holding Register reading will be identical to the reading of the same Input Register. Both functions are read-only.

Measurements are represented in the IEEE 754 **float** representation standard. Each data is therefore 32 bits wide and will be obtained by reading two consecutive 16bit registers. The byte order, according to the MODBUS standard, is classified as **swapped float**. This means that if a float is represented by the 4byte sequence ABCD, with A being the most significant byte and D the least significant byte, its swapped float representation will be in the order **CDAB**. Since MODBUS registers are 16bit, this means that the least significant byte pair **CD** will be found in the lower index register and the most significant byte pair **AB** in the next register.

Below is the register table with the measurement value map.

Register	# registers – data type	Measurement type	Measurement meaning	Unit of measurement	Recommended decimals
1	2 – Swapped Float	Primary measurement	**Distance**	[mm]	2
3	2 – Swapped Float	Measurement quality	**Signal quality**	---	0
5	2 – Swapped Float	Measurement quality	**Tilt**	[°]	3
7	2 – Swapped Float	Internal use	**DO NOT USE**	---	---
9	2 – Swapped Float	Internal use	**DO NOT USE**	---	---
11	2 – Swapped Float	Internal use	**DO NOT USE**	---	---
13	2 – Swapped Float	Diagnostic	**Power supply voltage**	[V]	2
15	2 – Swapped Float	Diagnostics	**Internal temperature**	[°C]	1
17	2 – Swapped Float	Diagnostics	**Internal humidity**	[%]	1
19	2 – Swapped Float	Diagnostics	**Firmware version**	---	0
21	2 – Swapped Float	Internal use	**DO NOT USE**	---	---
23	2 – Swapped Float	Internal use	**DO NOT USE**	---	---
25	2 – Swapped Float	Internal use	**DO NOT USE**	---	---
27	2 – Swapped Float	Measurement quality	**Number of echoes in measurement**	---	0
29	2 – Swapped Float	Measurement quality	**Number of echoes in filtering**	---	0

5.3.2 SDI – 12 protocol

The sensor supports the standard SDI – 12 protocol specification 1.4 on pin 3 of the seven – pin connector, as explained in chapter three. For more information on the protocol, refer to the SDI – 12 standard specifications available at https://www.sdi-12.org/specification.

The SDI – 12 call address of the TLR35 is **L**, ASCII encoding of the MODBUS address 21. In general, addresses are converted to ASCII using the numbers '0' to '9', the uppercase letters of the alphabet, 'A' to 'Z', followed by the lowercase letters, 'a' to 'z', for a total of 62 possible addresses. This is how the MODBUS address 21 corresponds to the SDI – 12 L address.

In the following, the convention will be used to indicate with:

- <CR> the carriage return character expressed in hexadecimal as 0x0D
- <LF> the line feed character expressed in hexadecimal as 0x0A

Responses to commands end with the sequence <CR><LF>.

In the following, commands are illustrated with the generic address indicated by **<a>**. In practice, this must be replaced with the sensor address L.

5.3.2.1 Sensor test <a>!

The command <**a>!** can be used to check the presence of the sensor on the BUS. The sensor responds to the command with

<a><CR><LF>

5.3.2.2 Send identifier <a>I!

The command <**a>I!** can be used to request a sensor identifier. The sensor responds to the command with

<a>14*SMSpa*TLR35*110 <CR><LF>

The response to the command can be interpreted as follows:

- **<a>**: the sensor address.
- **14**: the SDI – 12 1.4 specification version
- **SMSpa**: identifies the manufacturer SIAP+MICROS S.p.A.
- **TLR35** is the generic name of the product
- **110** is the firmware version 1.1.0

5.3.2.3 Change address <a>A<b>!

The standard provides for the command <a>A<b>! to change the sensor address from <a> to <b>. The response to the command provides the new address.

<b><CR><LF>

It is important to note that the address change also affects the MODBUS protocol. For example, if the address is changed from 'L' to 'A', the MODBUS address changes from 21 ('L') to 10 ('A').

5.3.2.4 Current address request ?!

If you do not know the sensor address, you can use the command ?! to which the sensor responds with its address.

<a><CR><LF>

The command can only be used if there is a single sensor on the SDI – 12 bus.

5.3.2.5 Commands and procedures for reading measurements

The SDI – 12 protocol provides different command types for requesting measurements, for which reference should be made directly to the standard specification. Here, we will describe the grouping of measurements and the sequences of commands required to obtain the measurements themselves.

Since the standard imposes a maximum byte limit on the response, the measurements have been divided into three distinct blocks:

1. **Main block**. This contains the main measurements, namely:
    a. Distance
    b. Signal quality
    c. Tilt
    d. Supply voltage
2. **Diagnostic block**. Contains the main diagnostic measurements:
    a. Internal temperature
    b. Internal humidity
    c. Firmware version
3. **Echo filtering block**. Contains indicative measurements of filtered echoes:
    a. Echoes received in measurement
    b. Echoes used in filtering

Interrogation commands generally involve two distinct phases:

1. Preliminary command to request measurement execution (commands <a>M!, <a>M1!, … <a>M9!, <a>C!, <a>C1!, … <a>C9!, <a>MC!, <a>MC1!, … <a>MC9!, <a>CC!, <a>CC1!, … <a>CC9!).
2. Measured data request command (commands <a>D0! … <a>D9!)

The type of commands that can be used therefore depends heavily on the structure of the measurement blocks within the sensor. For TLR35, with the blocks seen above, there are essentially three different methods for reading the measured values.

SINGLE START MEASUREMENT COMMAND AND SEQUENTIAL RETRIEVAL OF MEASUREMENTS

This mode involves sending a single start measurement command, which can be followed by three separate block retrieval commands, as illustrated below.

- Measurement start command **<a>M!** or alternatively **<a>C!** to which the sensor always responds with:

  <a>0009<CR><LF>

  indicating that a total of nine measurements is immediately available.
- First block retrieval command **<a>D0!** to which the sensor always responds with:

  <a><distance><quality><tilt><power supply><CR><LF>
- Second block retrieval command **<a>D1!** to which the sensor always responds with:

  <a><temperature><humidity><firmware><CR><LF>
- Third block retrieval command **<a>D2!** to which the sensor always responds with:

  <a><measurement echoes><filtering echoes><CR><LF>

To include a CRC control, send the start measurement commands **<a>MC!** or **<a>CC!**.

Here is an example sequence:

➔ <a>M!

🡐 <a>0009<CR><LF>

➔ <a>D0!

🡐 <a><distance><quality><tilt><power supply><CR><LF>

➔ <a>D1!

🡐 <a><temperature><humidity><firmware><CR><LF>

➔ <a>D2!

🡐 <a><measurement echoes><filtering echoes><CR><LF>

<a>M! was used, but the same applies to <a>C!, <a>MC! , <a>CC!.

COMMANDS TO START AND RETRIEVE MEASUREMENTS PER BLOCK

Measurement blocks can also be requested using pairs of specific commands to request a single block. The following commands are supported.

- Retrieval of the first block with the start measurement command **<a>M1!** or alternatively **<a>C1!** to which the sensor always responds with:

  <a>0004<CR><LF>

  indicating four total measurements available immediately (the first block). To request the data from the first block, send the command with **<a>D0!** to which the sensor will respond with:

  <a><distance><quality><tilt><power supply><CR><LF>

- Retrieve the second block with the start measurement command **<a>M2!** or alternatively **<a>C2!** to which the sensor always responds with:

  <a>0003<CR><LF>

  indicating three total measurements available immediately (the second block). To request the data from the second block, send the command **<a>D0!** to which the sensor will respond with:

  <a><temperature><humidity><firmware><CR><LF>

- Retrie the third block with the start measurement command **<a>M3!** or alternatively **<a>C3!** to which the sensor always responds with:

  <a>0002<CR><LF>

  indicating two total measurements available immediately (the third block). To request the data from the third block, send the command **<a>D0!** to which the sensor will respond with:

  <a><measurement echoes><filtering echoes><CR><LF>

To include a CRC control, send the measurement start commands <a>MC1!, <a>MC2!, <a>MC3! or <a>CC1!, <a>CC2!, <a>CC3!.

Here is an example sequence:

➔ <a>M1!

🡐 <a>0004<CR><LF>

➔ <a>D0!

🡐 <a><distance><quality><tilt><power supply><CR><LF>

➔ <a>M2!

← <a>0003<CR><LF>

→ <a>D0!

← <a><temperature><humidity><firmware><CR><LF>

→ <a>M3!

← <a>0002<CR><LF>

→ <a>D0!

← <a><measurement echoes><filtering echoes><CR><LF>

MEASUREMENT RETRIEVAL COMMANDS WITHOUT START MEASUREMENT COMMAND

Measurement blocks can also be requested with single commands in a single step.

- Retrieve the first block with command **<a>R0!** to which the sensor responds with:

  <a><distance><quality><tilt><power supply><CR><LF>
- Retrieve the second block with command **<a>R1!** to which the sensor responds with:

  <a><temperature><humidity><firmware><CR><LF>
- Retrieve the third block with command **<a>R2!** to which the sensor responds with:

  <a><measurement echoes><filtering echoes><CR><LF>

To include a CRC control, send the commands <a>RC0!, <a>RC1!, <a>RC2!.

Here is an example sequence:

→ <a>R0!

← <a><distance><quality><tilt><power supply><CR><LF>

→ <a>R1!

← <a><temperature><humidity><firmware><CR><LF>

→ <a>R2!

← <a><measurement echoes><filtering echoes><CR><LF>

As required by the SDI – 12 standards, within each block, measurements are separated by their sign. There are no other separator characters.

5.4 Analogue output 4 – 20mA

The analogue current output of the TLR35 reports only the distance measurement in analogue form with the following correspondence:

4mA ➔0mm

20mA ➔35000mm

The analogue output is 14 bits on 25mA full scale, which translates into an output resolution of approximately 3.3mm on the distance measurement data.

If, for any reason, the measured distance value is less than the physical minimum of 0mm, the output will assume a value of 4mA.

If, for any reason, the measured distance value exceeds the physical maximum of 35000mm, the output would assume a value of 20mA.

In the event of a measurement error, the current output will assume a value of 22mA to signal the anomaly.

6. Revision history

The following table lists the changes made to this document.

Version	Date	Updates
1	*02/02/2026*	*First version of the document.*

All information contained in this document is current at the time of printing. SIAP+MICROS S.p.A. reserves the right to change it without prior notice.

7. Reference directives

The reference directives for the TLR35–IS12 are:

- 2014/30/EU The Electromagnetic Compatibility Directive (EMC)
- 2014/53/EU The Radio Equipment Directive (RED)
- 2014/35/EU The Low Voltage Directive (LVD)
- 2011/65/EU The Restriction of Hazardous Substances Directive (RoHS)

EU Declaration of Conformity (DoC)

Manufacturer: SIAP+MICROS S.p.A.
Via del Lavoro, 1 – 31020 S. Fior (TV) – Italy
https://www.siapmicros.com/en/

This declaration of conformity is issued under the sole responsibility of the manufacturer.

Object of the declaration:

Model / Description	Product Code / Model
TLR35–IS12 RADAR sensor for distance measurement, range 0÷35m, MODBUS, SDI – 12 and analogue current output	PSM-T064A-TLR35-IS12

The object of the declaration described above is in conformity with the relevant Union harmonization legislation:

- **2014/30/EU The** Electromagnetic Compatibility Directive (EMC)
- **2014/53/EU The** Radio Equipment Directive (RED)
- **2014/35/EU The** Low Voltage Directive (LVD)
- **2011/65/EU The** Restriction of Hazardous Substances Directive (RoHSD)

The following harmonized standards and technical specifications have been applied:

ELECTROMAGNETIC COMPATIBILITY (Article 3.1b)**:**

EN 61326-1	Electrical equipment for measurement, control and laboratory use - EMC requirements - General requirements

EFFECTIVE AND EFFICIENT USE OF RADIO SPECTRUM (Article 3.2):

ETSI EN 302 729 V2.1.1:2016	Short Range Devices (SRD); Level Probing Radar (LPR) equipment operating in the frequency ranges 6 GHz to 8,5 GHz, 24,05 GHz to 26,5 GHz, 57 GHz to 64 GHz, 75 GHz to 85 GHz; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU

HEALTH & SAFETY (Article 3.1a):

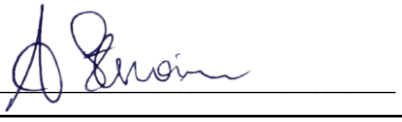
EN 61010-1:2010	Safety requirements for electrical equipment for measurement, control, and laboratory use; Part 1: General requirements
EN IEC 62311	Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz to 300 GHz)

RoHS:

EN IEC 63000	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

Date
02/02/2026

CEO
Alex Stevanin



8. Annex A: Radio astronomy stations

The following table lists the coordinates of radio astronomy stations which, in accordance with the requirements of ETSI EN 302 729 V2.1, impose restrictions on installation in their proximity. For details of these restrictions, please refer to chapter four on installation and commissioning.

Country	Station name	Latitude	Longitude
Germany	Effelsberg	50°31'32" N	06°53'00" E
Finland	Metsähovi	60°13'04" N	24°23'37" E
	Tuorla	60°24'56" N	24°26'31" E
France	Plateau de Bure	44°38'01" N	05°54'26" E
	Floirac	44°50'10" N	00°31'37" W
Italy	Medicina	44°31'14" N	11°38'49" E
	Noto	36°52'34" N	14°59'21" E
	Sardinia	39°29'50" N	09°14'40" E
Poland	Krakow Fort Skala	50°03'18" N	19°49'36" E
United Kingdom	Cambridge	52°09'59" N	00°02'20" E
	Damhall	53°09'22" N	02°32'03" W
	Jodrell Bank	53°14'10" N	02°18'26" W
	Knockin	52°47'24" N	02°59'45" W
	Pickmere	53°17'18" N	02°26'38" W
Russia	Dmitrov	56°26'00" N	37°27'00" E
	Kalyazin	57°13'22" N	37°54'01" E
	Pushchino	54°49'00" N	37°40'00" E
	Zelenchukskaya	43°49'53" N	41°35'32" E
Sweden	Onsala	57°23'45" N	11°55'35" E
Switzerland	Bleien	47°20'26" N	08°06'44" E
Spain	Yebes	40°31'27" N	03°05'22" W
	Robledo	40°25'38" N	04°14'57" W
Hungary	Penc	47°47'22" N	19°16'53" E

Please refer to https://www.craf.eu/ for up – to – date information on the list of radio astronomy stations.