

the sensor people

## RFU - UHF Series

Stationary RFID Read/Write Systems, Transponders,  
Connector Units



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## 1 General information

### 1.1 Explanation of symbols

The symbols used in this operating manual are explained below.



**Attention!**

*This symbol precedes text messages which must strictly be observed. Failure to comply with this information results in injuries to personnel or damage to the equipment.*



**Notice!**

*This symbol indicates text passages containing important information.*

### 1.2 Declaration of conformity

The devices of the RFU (UHF RFID) series, including corresponding IMRFU connector units and TFU transponders, were developed and manufactured in accordance with the applicable European standards and directives.



**Notice!**

*The Declarations of Conformity for the devices are available for download at [www.leuze.com](http://www.leuze.com).*

The manufacturer of the product, Leuze electronic GmbH + Co. KG in D-73277 Owen, possesses a certified quality assurance system in accordance with ISO 9001.



### 1.3 Definition of terms / abbreviations

For better understanding of the explanations provided in this document, a definition of terms and explanations of the abbreviations follows below:

- **EPC:**  
**Electronic Product Code** = International standard for a unique identification number that can be used worldwide to uniquely label and identify both products as well as logistical units (e.g., outer packaging, transport pallets, etc.). The memory area provided for this purpose in the transponder is also called the EPC bank.
- **ERP:**  
**Effective Radiated Power** = Effective radiated power of the antenna in watts.
- **RFID:**  
**Radio Frequency Identification** – umbrella term for the contactless identification of objects equipped with transponders by means of radio waves.
- **TID:**  
**Tag Identifier** - transponder identification code = Serial number.
- **UHF:**  
**Ultra High Frequency** – radio-frequency band in which data transmission between the read/write system and transponder occurs. Data transmission occurs according to ISO/IEC 18000-6:2010 type C within the EU in the range from 865 ... 868MHz.

## 2 Safety notices

### 2.1 General safety notices

#### **Documentation**

All entries in this technical description must be heeded, in particular those in section "Safety notices". Keep this technical description in a safe place. It should be available at all times.

#### **Safety regulations**

Observe the locally applicable legal regulations and the rules of the employer's liability insurance association.

#### **Repair**

Repairs must only be carried out by the manufacturer or an authorized representative.

### 2.2 Safety standards

The devices of the series RFU - UHF RFID Series were developed, manufactured and tested in accordance with the applicable safety standards. They correspond to the state of the art.

### 2.3 Intended use



#### **Attention!**

*The protection of personnel and the device is guaranteed only if the device is operated in a manner corresponding to its intended use.*

The RFU 61/81 SL 100-EU model read/write systems with the IMRFU-1 connector unit based on radio frequency identification (RFID) are electronic devices for inductive data transmission from/to compatible code and data carriers, so-called transponders. The systems are used primarily for automatic object detection and material flow control. The IMRFU-1 and MA 2xx connector units simplify the electrical connection of the RFU 61/81... read/write systems and facilitate the connection to various interfaces and fieldbus systems. In particular, unauthorized uses include

- Use in rooms with explosive atmospheres
- For medicinal purposes

### ***Typical areas of application***

The RFU 61/81 SL 100-EU model read/write systems with the IMRFU-1 connector unit are especially designed for the following areas of application:

- Object recognition in handling and warehousing systems
- Commissioning systems in dispatch centers
- Flexible material flow control in assembly lines and daisy-chained manufacturing cells
- Acquisition of operational data
- Loading-gate detection with high-lift trucks

## **2.4 Working safely**



### ***Attention!***

*Access to or changes on the devices, except where expressly described in this operating manual, are not authorized.*

### ***Safety regulations***

Observe the locally applicable legal regulations and the rules of the employer's liability insurance association.

### ***Qualified personnel***

Mounting, commissioning and maintenance of the device must only be carried out by qualified personnel.

Electrical work must be carried out by a certified electrician.



### 3 Device description RFU - UHF RFID Series

#### 3.1 Information on the RFID read/write systems of the RFU series

The read/write systems of the RFU series are RFID devices suitable for industrial use that operate in the UHF band between 865MHz and 868MHz. They are equipped with an integrated decoder for the identification of common transponders (data carriers) acc. to EPC1 Gen2, such as NXP G2XM, Alien Higgs3, Impinj.

The RFID devices of the RFU series are available with various antenna sizes and operating ranges.

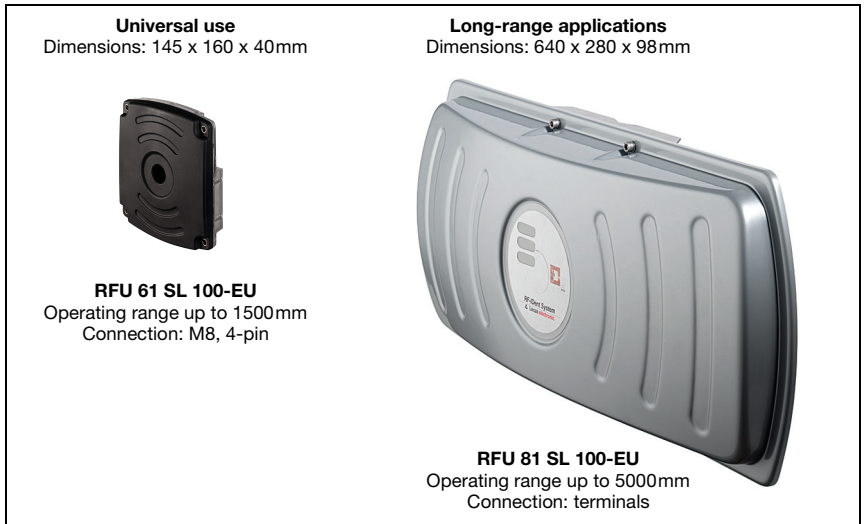


Figure 4.1: RFU device series

In general, the RFID devices of the RFU series are designed for handling and warehousing systems with medium to long operating ranges.

Extensive device configuration possibilities by means of the **RF-Config** software allow the system to be adapted to a number of reading tasks. The optimized reading distance, combined with a very homogeneous field structure and a compact design, enables optimum use in container and pallet transport systems.

On the mandatory IMRFU-1 connector unit, the devices are equipped with an RS 232 interface for direct connection of the host.

With the help the various possibilities of the **MA...** modular connector units, the devices can be networked and coupled to typical fieldbus systems such as PROFIBUS DP, PROFINET, EtherNet, DeviceNet, etc.

### 3.2 Characteristics of the RFID read/write systems of the RFU series

#### 3.2.1 Performance characteristics

- Large opening angle (65°/120°) and, thus, large reading field width
- Compact construction, optimized for the operating range
- Reliable detection of moving transponder though activation (trigger)
- Configurable functions following a trigger: read with preset byte range, write
- Online commands for customized, fast access to data
- Pre-transmission of write data to the RFU device (Precharge function)
- Support of the transponder-specific commands and functions
- Visualization of the most important operating states by means of bright LEDs
- Switching input for triggering a read process/write process
- Switching output for signaling states
- RS 232 serial interface
- Industrial design in protection class IP 65/IP 67
- Easy-to-use RF-Config configuration software available via free download

#### 3.2.2 Typical reading behavior



**Attention!**

The values specified may deviate as a result of temperature influences, installation site, read angle, etc.

The read field of the UHF device is a cone with various opening angles (see chapter 4.1 "General specifications of the RFU read/write systems") between 65° ... 120°.

Reflections may result in overshooting. Align the reader so that the transponder is always moved in the cone of the reader. Multiple readings can only be excluded if the transponders are clearly separated from one another (sufficient spacing between the transponders).

#### Maximum recommended transponder speed

Transponder	Part no.	Read/write distance					
		250mm	500mm	750mm	1000mm	1500mm	2000mm
TFU 03 2201.308	50114086	3m/s	2m/s	2m/s	1.5m/s	_ 1)	_ 1)
TFU 05 1101.308	50114995	1.5m/s	1.5m/s	1.5m/s	0.5m/s	_ 1)	_ 1)
TFU 05 2101.308	50112257	1m/s	1.5m/s	1.5m/s	2m/s	2m/s	_ 1)
TFU 08 2101.308	50112913	2m/s	2m/s	2m/s	1.5m/s	_ 1)	_ 1)
TFU 10 2201.308	50112443	1.5m/s	1.5m/s	2m/s	3.5m/s	3.5m/s	3m/s

1) No function

Table 3.1: Maximum recommended transponder speed

**Recommended maximum read/write distances**

Transponder	Part no.	Read/write device ERP transmitting power (effective radiated power)			
		RFU 61 / 0.1W	RFU 61 / 0.3W	RFU 81 / 1.0W	RFU 81 / 2.0W
TFU 03 2201.308	50114086	<b>380mm</b> max. 550mm	<b>850mm</b> max. 1000mm	<b>850mm</b> max. 1000mm	_ 1)
TFU 05 1101.308	50114995	<b>380mm</b> max. 550mm	<b>850mm</b> max. 1000mm	<b>850mm</b> max. 1000mm	_ 1)
TFU 05 2101.308	50112257	<b>180mm</b> max. 200mm	<b>350mm</b> max. 400mm	<b>600mm</b> max. 700mm	<b>1000mm</b> max. 1200mm
TFU 05 2101.308 on metal		<b>350mm</b> max. 400mm	<b>550mm</b> max. 700mm	<b>1300mm</b> max. 1500mm	<b>1700mm</b> max. 2000mm
TFU 08 2101.308	50112913	<b>180mm</b> max. 200mm	<b>500mm</b> max. 600mm	<b>750mm</b> max. 1200mm	<b>1200mm</b> max. 1700mm
TFU 10 2201.308	50112443	<b>680mm</b> max. 750mm	<b>1500mm</b> max. 1600mm	<b>1500mm</b> max. 2200mm	<b>3000mm</b> max. 4000mm

1) No function

Table 3.2: Recommended maximum read/write distances

**3.2.3 Device construction**

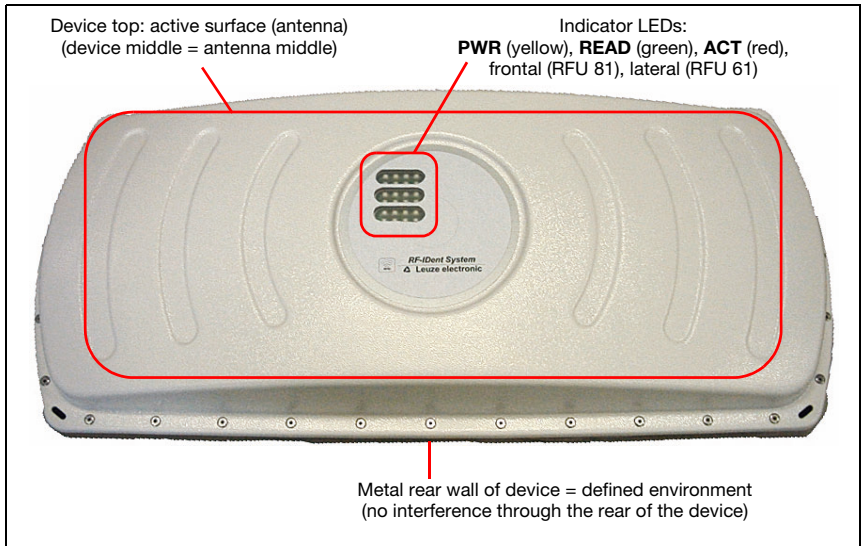


Figure 3.1: Device construction using the RFU 81 as an example

### 3.3 Read and write techniques

RFID devices in the frequency range 865 ... 868MHz (UHF) form a cone-shaped electromagnetic field with an opening angle of approx.  $65^\circ$  above the antenna. The operating range varies depending on the device type. The transponder that is used (antenna geometry) also has a significant influence. For exact data, please refer to the specifications of the read/write systems (see also table 3.2 "Recommended maximum read/write distances" on page 9).

The front of the device (black or silver) is the active side (equipped with LEDs, depends on model) and must not be enclosed by metal. A metal surface in the read field will likewise reduce the operating range through reflection. Even a smooth glass pane can cause reflections and reduce the operating range.



#### **Notice!**

*Due to the physical field propagation, an angle of the read/write system to the transport direction of approx.  $15^\circ$  ...  $20^\circ$  and an inclination of the antenna by  $20^\circ$  ...  $45^\circ$  is helpful for avoiding reflections and field gaps.*

#### **Areas of application**

- Object recognition in handling and warehousing systems
- Commissioning systems in dispatch centers
- Flexible material flow control in assembly lines and daisy-chained manufacturing cells
- Acquisition of operational data

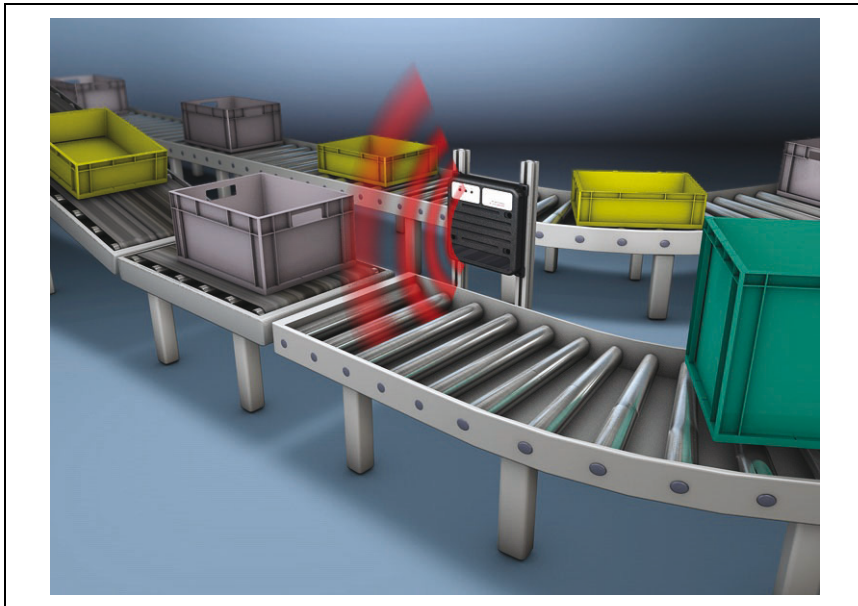


Figure 3.2: Lateral reading (containers)

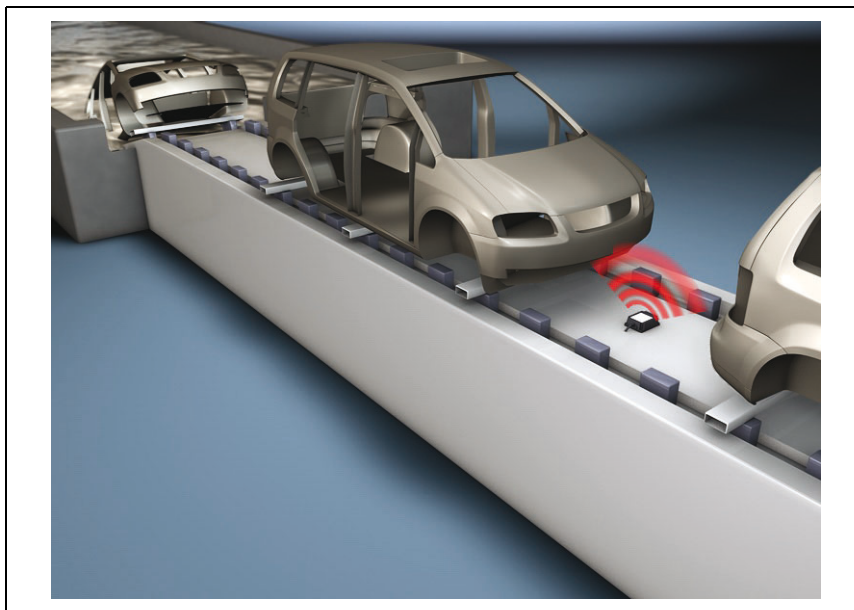


Figure 3.3: Reading from below (skid)

### 3.4 Standalone connection

The RFID devices of the RFU family can be operated as a "standalone" single station with the IMRFU-1 connection and evaluation unit. A ready-made cable with M8 socket (K-D M8A-4p-...) can be used for the electrical connection of the RFU 61. A screened signal line (4 x 0.5mm<sup>2</sup>) to the IMRFU-1 is to be provided on-site for the electrical connection of the RFU 81 with terminals. Terminals are provided on the IMRFU-1 for connecting the RS 232 host interface.

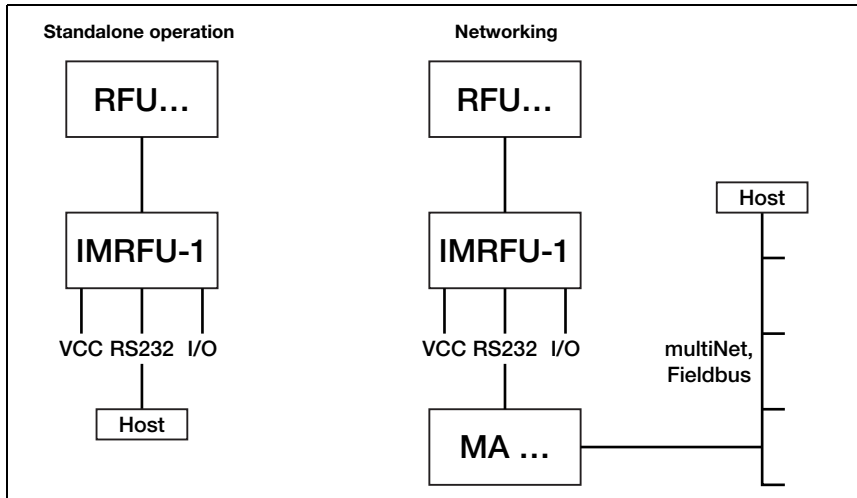


Figure 3.4: Standalone connection / networking

### 3.5 Networking - Leuze multiNet plus

Up to 30 RFU read/write systems with IMRFU-1 and MA 21 100.2 can be networked via one MA 31 network master. For this purpose, an MA 21 100.2 with unique station address is connected to each IMRFU-1. Networking is via a parallel connection of the individual RS 485 interfaces of the respective MA 21 100.2 units.

#### **Leuze multiNet plus**

In Leuze's proprietary **multiNet plus** network, the individual network devices transmit their data upon request through the MA 31 network master in sequence. In addition, each network device (MA 21 100.2) declared as a slave receives a device address which is set with the aid of the rotary switch on the MA 21 100.2.

The master then transmits the data of all network devices to a primary PLC or a computer via its host interface, i.e., it "collects" the data in the network and transmits it via an interface to the host computer. This reduces interface costs (CPs) and time spent programming the software.

### ***Two-wire RS 485***

The Leuze **multiNet plus** is optimized for fast transmission of scanner data to a primary host computer. Physically, it consists of a two-wire RS 485 interface that is controlled by a software protocol, the Leuze **multiNet plus** protocol. As a result, wiring of the network is simple and economical, since the network connection is simply looped from one slave to the next.

For the Leuze **multiNet plus**, a shielded, double-strand cable with twisted strands should be used. This makes possible a total network length of up to 1200m. The M12 connection technology simplifies wiring here.

## **3.6 Leuze multiScan**

The multiScan operation mode is based on the Leuze **multiNet plus** and links individual readings from multiple RFID devices into a single read result. This is used, for example, on a packet conveyor system on which the transponder can be affixed on the right side, on the left side or on top, thereby requiring three read stations. So that the host does not need to process one decoding result and two "No Reads", i.e. three readings for each package, a **multiScan** arrangement is used to ensure that the **multiScan** master passes only one reading from the three read stations to the host. As a result, the read/write system network looks like just one RFID device to the host on the outside!

For this purpose, a **multiScan** master and one or more **multiScan** slaves are connected together via the RS 485 interface. The **multiScan** function on the RS 485 interface is possible for a minimum of 2 and a maximum of 30 devices.

The protocol set on the RS 485 interface is the **multiNet** protocol. As a result, during **multi-Scan** operation on the RS 485 interface, the **multiNet** master also becomes a **multiScan** master and the **multiNet** slaves become **multiScan** slaves (all **multiNet** slaves are, thus, integrated in **multiScan** operation).

### 3.7 Fieldbus systems

Various **MA...** modular connector units are available for connecting to a range of different fieldbus systems, such as PROFIBUS DP, ProfiNet, EtherNet, etc.

For simple electrical connection of the IMRFU-1 to the MA..., the **KB JST-3000** cable (3m long, optional accessory, Part no. 50115044) with the system plug on one cable end can be directly plugged into the MA. For the connection to the IMRFU-1, the cable is equipped with open ends on the other end.

Description	Designation	Part no.
RS232 to Leuze Multinet (slave), device connection with system plug, service interface in the MA... for device configuration	MA 21 100.2	50103125
RS232 to RS485 converter, device connection with terminals, service interface in the MA... for device configuration	MA 21 100	50030481
RS232 to RS422 converter, device connection with terminals, service interface in the MA... for device configuration	MA 21 130	50030484
RS232 to RS232 protocol converter with elect. isolation, device connection with terminals, service interface in the MA... for device configuration	MA 21 110	50030482
RS232 gateway to Profibus DP, device connection with system plug, service interface in the MA... for device configuration	MA 204i	50112893
RS232 gateway to Ethernet TCP / IP, device connection with system plug, service interface in the MA... for device configuration	MA 208i	50112892
RS232 gateway to CANopen, device connection with system plug, service interface in the MA... for device configuration	MA 235i	50114154
RS232 gateway to EtherCAT, device connection with system plug, service interface in the MA... for device configuration	MA 238i	50114155
RS232 gateway to PROFINET IO RT, device connection with system plug, service interface in the MA... for device configuration	MA 248i	50112891
RS232 gateway to DeviceNet, device connection with system plug, service interface in the MA... for device configuration	MA 255i	50114156
RS232 gateway to EtherNet/IP, device connection with system plug, service interface in the MA... for device configuration	MA 258i	50114157



## 4 Specifications

### 4.1 General specifications of the RFU read/write systems

<b>General specifications</b>	<b>RFU 61 SL 100-EU</b>	<b>RFU 81 SL 100-EU</b>
Working frequency	865 ... 868MHz (EU)	
Reading range <sup>1)</sup>	≤ 1.5m	≤ 5m
Writing range <sup>1)</sup>	≤ 1.0m	≤ 4m
Transponder speed <sup>1)</sup>	transponder-dependent, see table 3.1 on page 8	
Detection range	opening angle approx. 65°	opening angle approx. 65°/ 130°
Data protocol	EPC class 1 Gen 2 (NXP, Impinji, Alien)	
Output power <sup>2)</sup>	0.01 ... 0.4W ERP (factory setting: 0.4W ERP)	0.1 ... 2W ERP (factory setting: 2W ERP)
<b>Electrical data</b>		
Operating voltage U <sub>B</sub>	18 ... 30VDC (incl. residual ripple)	
Residual ripple	≤ 10% of U <sub>B</sub>	
Power consumption	≤ 7W, in standby approx. 2.5W	≤ 10W, in standby approx. 2.5W
Interface to IMRFU-1	RS485, system-specific protocol	
Inputs	1 (to IMRFU-1)	
Outputs	1, relay change-over contact (to IMRFU-1)	
<b>Indicators</b>		
Green LED PWR	ready for operation	
Red LED ACT	activation	
Green LED READ	read state	
<b>Mechanical data</b>		
Housing	plastic (PA6/PMMA)	
Color	black/gray	silver gray
Fastening	through-holes 4 x dia. 6mm	integrated holder for horizontal/ vertical mast mounting
Weight	approx. 500g	approx. 2,500g
Connection type	M8 connector, 4-pin	terminals
<b>Environmental data</b>		
Ambient temp. (operation/storage)	-25°C ... +60°C/-40°C ... +80°C	
Protection class	IP 65	
Standards applied	EN 301489-3 EN 302208-1 EN 50364	

1) Dependent on the transponder and environment

2) Dependent on the nationally admissible powers (see Safety Notices and Certification)

## 4.2 General specifications of the IMRFU-1 connector unit

### Electrical data

Operating voltage $U_B$	18 ... 30VDC (incl. residual ripple)
Residual ripple	$\leq 10\%$ of $U_B$
Power consumption	$\leq 2W$
Interface to RFU...	RS485, system-specific protocol
Host interface	RS232 (factory setting: 9600 baud, 8, N, 1)
Inputs	1
Outputs	1, relay change-over contact

### Indicators

Blue LED  PWR	ready for operation
Red LED  ACT	activation
Green LED  READ	read state

### Mechanical data

Housing	plastic (ABS)
Color	light gray
Fastening	top hat rail mounting in accordance with EN 50022
Dimensions	105mm x 72mm x 72mm (HxWxD)
Weight	approx. 300g
Connection type	terminals (removable)

### Environmental data

Ambient temp. (operation/storage)	-25°C ... +60°C/-40°C ... +80°C
Protection class	IP 54
Standards applied	EN 55022 EN 55024

## 4.3 General specifications of the TFU transponders

### General specifications

Working frequency	868MHz (UHF)
Read distance	see diagrams
Data carrier speed	max. 7.5m/s, dependent on transponder (see table 3.1)
Data storage	12 byte or 60 byte
Block size	always 2 bytes
Memory access	reading/writing - approx. 15ms typical, 2 byte-by-byte min. 100,000 write cycles, 10 years of data retention
Material	self-adhesive transponder: paper with pressure-sensitive adhesive disc transponder: Royalplast/PU card transponder: PVC
Color	self-adhesive transponder: white disc transponder: gray/black card transponder: white

### 4.4 Dimensioned drawings

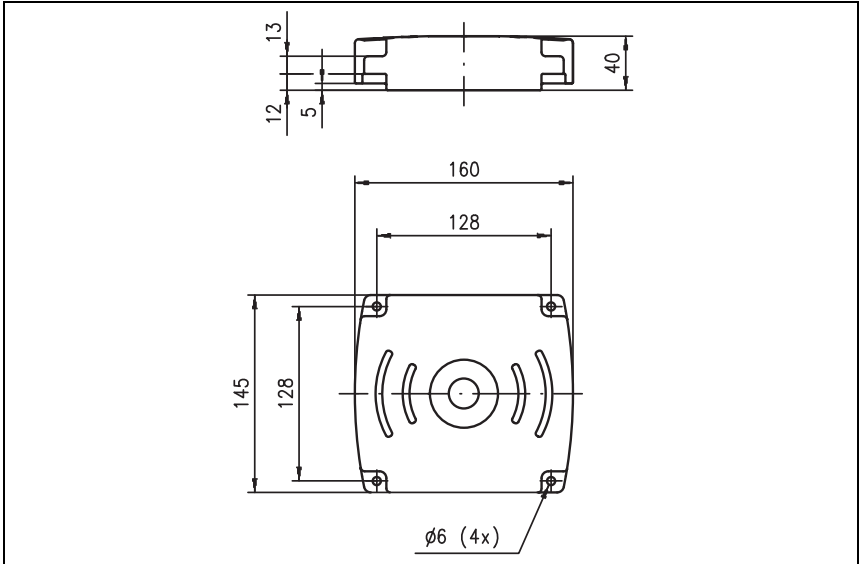


Figure 4.1: Dimensioned drawing of the RFU 61 SL 100-EU read/write system

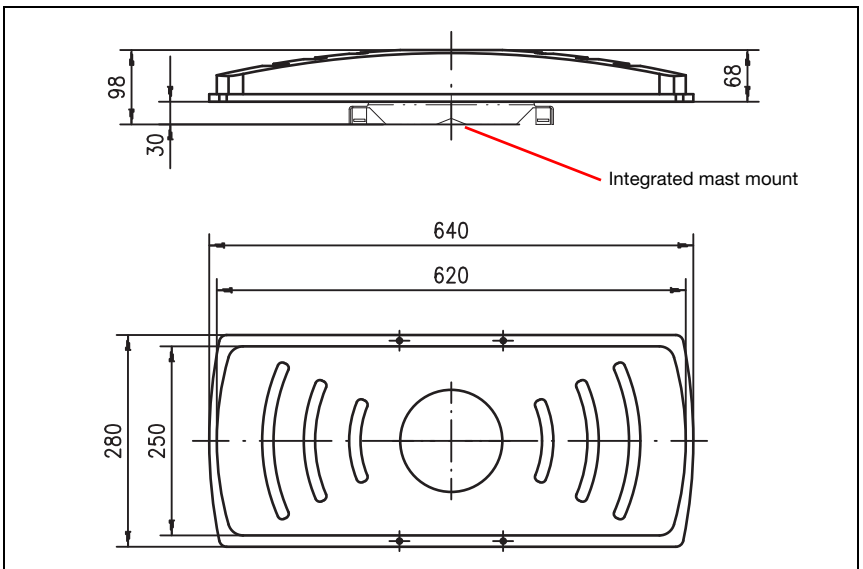


Figure 4.2: Dimensioned drawing of the RFU 81 SL 100-EU read/write system

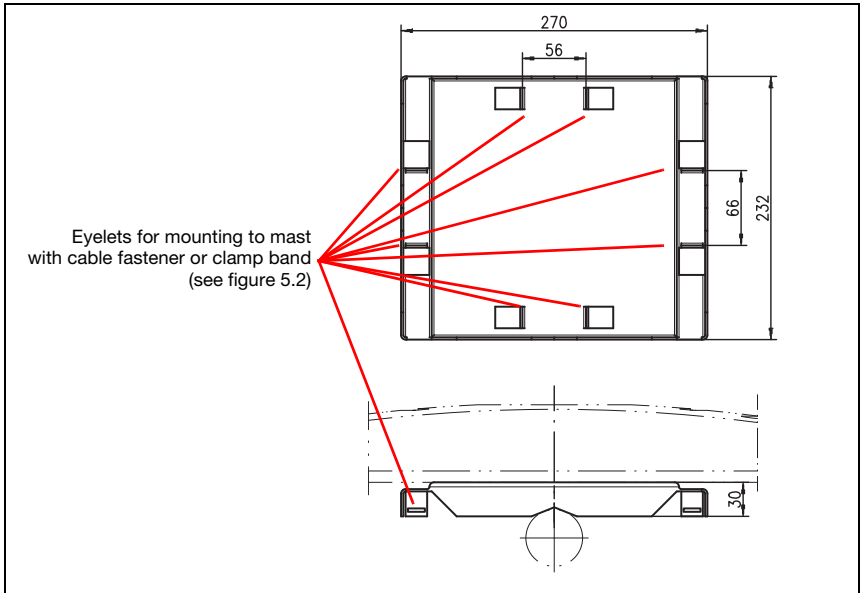


Figure 4.3: Dimensioned drawing of the RFU 81 SL 100-EU integrated mast mount

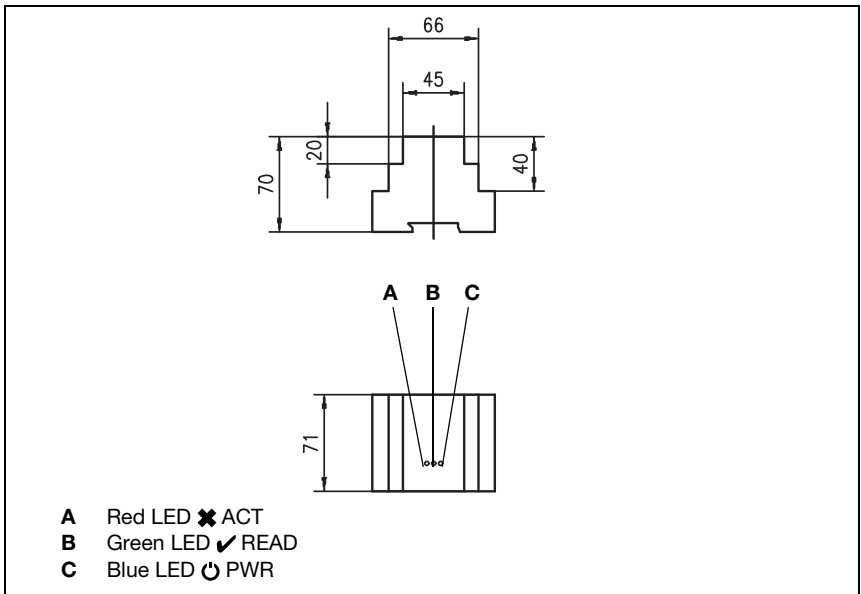


Figure 4.4: Dimensioned drawing of the IMRFU-1 connector unit

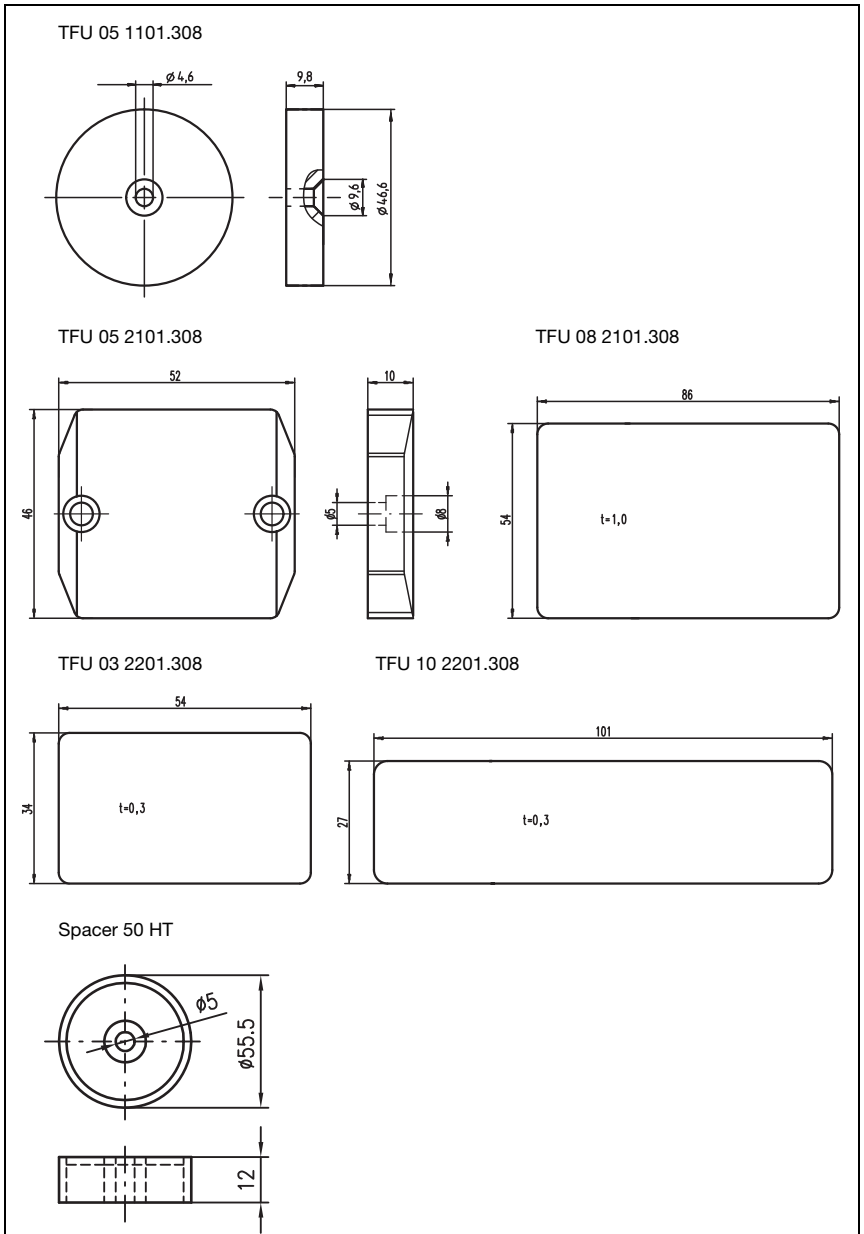


Figure 4.5: Dimensioned drawing of the TFU... transponders

## 5 Installation and mounting

### 5.1 Unpacking

✎ Check the packaging for any damage. If damage is found, notify the post office or shipping agent as well as the supplier.

✎ Check the delivery contents using your order and the delivery papers:

- Delivered quantity
- Device type and model as indicated on the nameplate
- Brief manual

The name plates provide information about the given device type. For specific information, please refer to the package insert or chapter 9.1.

✎ Save the original packaging for later storage or shipping.

If you have any questions concerning your shipment, please contact your supplier or your local Leuze electronic sales office.

✎ Observe the applicable local regulations when disposing of the packaging materials.

### 5.2 Mounting the RFU read/write systems

The UHF RFID read/write systems are mounted in various ways:

- **RFU 61:**  
via four fastening holes in the device with 4 M5 screws
- **RFU 81:**  
Mast mounting by means of the mast mount integrated in the rear wall of the device.

#### **RFU 61 fastening via four fastening holes**

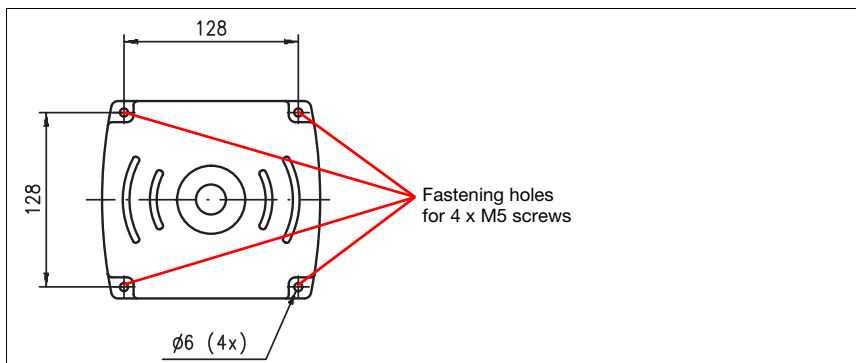


Figure 5.1: RFU 61 fastening holes

***Mast mounting - RFU 81 SL 100-EU***

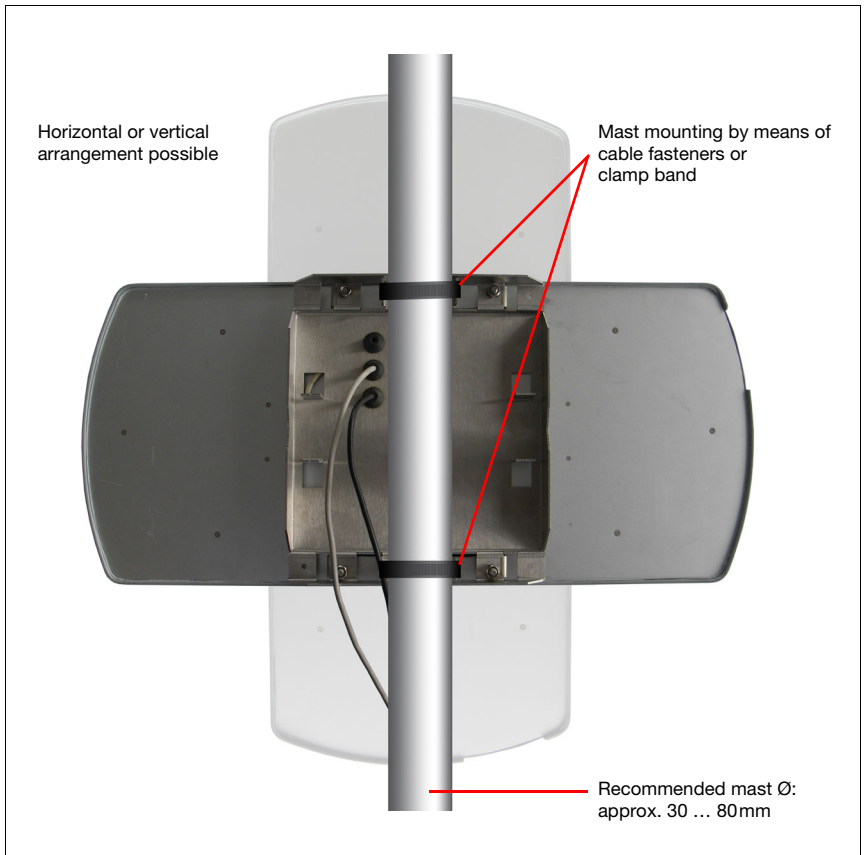


Figure 5.2: Mast mounting - RFU 81

## 5.3 Device arrangement

### 5.3.1 Selecting a mounting location

In order to select the right mounting location, several factors must be considered:

- Size, alignment and position tolerance of the transponder with respect to the object to be detected.
- The minimum and maximum reading distances determined from the read field of the devices (see read field curves) are also transponder dependent.
- If possible, the reading location should be positioned at a defined distance to the metal; if necessary, detection range to the side or downward at an angle to the metal in order to prevent reflections (approx. 15-25/45°).
- The reader should never be pointed directly at smooth (metal) surfaces, but rather at angles of 15-20°.
- The transponder temperature at the reading location is within the operating temperature range.
- Spacing (twice the max. operating range) between devices in order to prevent interference; channel preselection possible.
- Writing/reading **must** occur while the transponder is in motion, not at a standstill!
- The distance between the RFU / MA and the host system with respect to interface.

The best read results are achieved if

- the transponder is moved past the center of the antenna (middle of the device) with a skew of less than +/- 45
- the temperature of the transponder at the reading location is less than 60° and the reading location is not wet
- the reader is at an angle of 15-20° to the transport direction
- the reading distance is in the middle part of the read field
- no reflections affect the reading; reader at an angle of 15° downward
- the transponders pass by the device individually.



### 5.3.2 Arrangement on the transport system

**Attention!**

*Writing/reading must occur while the transponder is in motion, not at a standstill!*

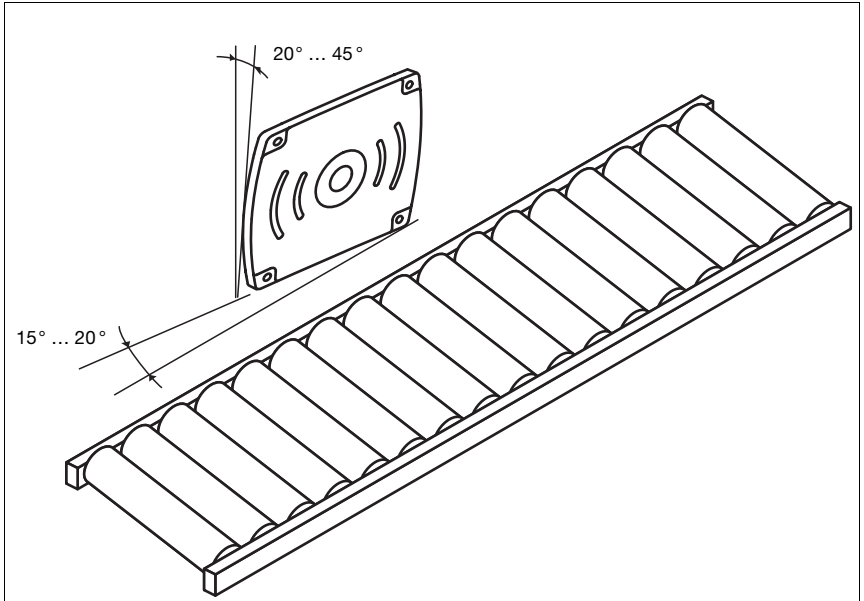


Figure 5.3: Arrangement of the read/write systems on the transport system

### 5.4 Cleaning

👉 *Clean the housing of the RFU - UHF RFID Series with a soft cloth after mounting. Remove all packaging remains, e.g., carton fibers or Styrofoam balls.*

**Attention!**

*Do not use aggressive cleaning agents such as thinner or acetone for cleaning the device.*

## 6 Electrical connection

The RFU 61/RFU 81 RFID devices must be connected via the IMRFU-1 connector unit. Configuration is performed via the RS232 interface.



**Notice!**

The corresponding mating connectors and ready-made cables are available as accessories for all cables. For further information, see chapter 9 "Type overview and accessories".

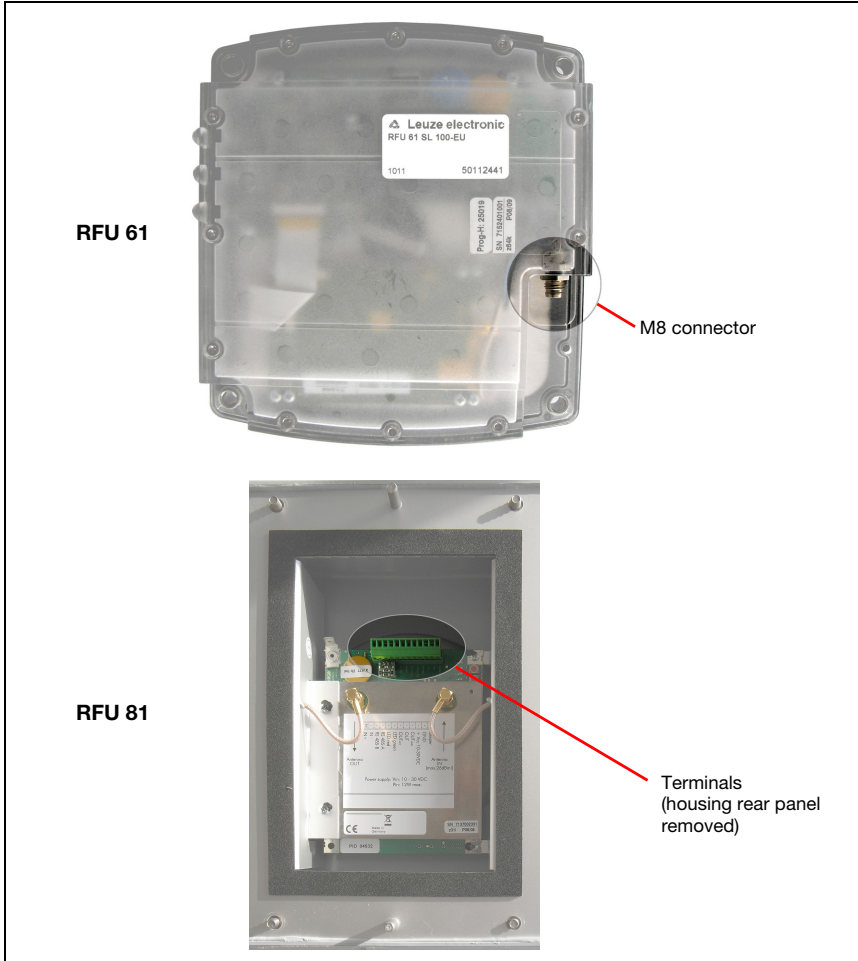


Figure 6.1: Location of the electrical connections on the housing rear

## 6.1 Safety notices for the electrical connection

**Attention!**

*Before connecting the device, be sure that the supply voltage agrees with the value printed on the name plate.*

*Connection of the devices and cleaning must only be carried out by a qualified electrician. Ensure that the functional earth (FE) is connected correctly. Unimpaired operation is only guaranteed when the functional earth is connected properly.*

*If faults cannot be corrected, the device should be removed from operation and protected against possible use.*

**Attention!**

*For UL applications, use is permitted exclusively in Class 2 circuits according to NEC (National Electric Code).*



*The IMRFU-1 and MA... connector units are designed in accordance with safety class III for supply by PELV (Protective Extra Low Voltage).*

**Notice!**

*Protection class IP65 is achieved only if the connectors and terminal chamber are screwed into place!*

## 6.2 Pin assignment


RFU 61 - M8 male 4-pole			RFU 81 - Terminals					
								
PIN	Color	Signal	PIN	Signal	PIN	Signal	PIN	Signal
1	br/BN	VCC	1	n.c.	5	n.c.	9	RS485 A
2	ws/WH	RS485 A	2	GND	6	n.c.	10	RS485 B
3	bl/BU	GND	3	VCC	7	n.c.	11	n.c.
4	sw/BK	RS486 B	4	n.c.	8	n.c.	12	n.c.

Figure 6.2: RFU 61/RFU 81 read/write system connections



IMRFU 1 - Terminals					
Connector IN	PIN	Signal	Connector READER	PIN	Signal
	1	IN1		1	VCC
	2	GND		2	GND
	3	n.c.		3	RS485 A
Connector OUT	PIN	Signal	Connector CONTROLLER	PIN	Signal
	4	n.c.		4	RS485 B
	1	VCC		1	n.c.
	2	GND		2	GND
	3			3	VCC
4		4		n.c.	
5		5		n.c.	
Connector RS232	PIN	Signal		6	n.c.
	1	TX		7	n.c.
2	RX	8		n.c.	
		9	n.c.		
		10	n.c.		

Figure 6.3: IMRFU-1 connector unit connections

### 6.3 Cable lengths and shield

↳ Observe the following maximum cable lengths and shield types:

Connection	Interface	Max. cable length	Shield
<b>RFU 61 – IMRFU-1</b>	RS 485	10m	recommended
		50m	mandatory, core cross section > 0.25 mm <sup>2</sup>
<b>RFU 81 – IMRFU-1</b>	RS 485	10m	mandatory
		50m	mandatory, core cross section > 0.25 mm <sup>2</sup>
<b>IMRFU-1 – host/ fieldbus gateway</b>	RS 232	10m	mandatory

Table 6.1: Cable lengths and shield

### 6.4 Network/fieldbus connection via MA... connector units

Various modular MA... connector units are available for connecting the read/write system to a network or fieldbus. A separate MA... connector unit is required for each station (in addition to the IMRFU-1). Each telegram is represented in the standard Leuze data frame. ASCII characters are transmitted.

**Network/fieldbus**

**Connector unit MA...**

RS485 network  
RS422 network  
Leuze multiNet

**MA 21 100** + on-site 3/5-pin connection cable to IMRFU-1  
**MA 21 130** + on-site 3/5-pin connection cable to IMRFU-1  
**MA 21 100.2** + KB JST-3000 to IMRFU-1

PROFIBUS  
EtherNet TCP/IP  
CANopen  
EtherCAT  
PROFINET  
DeviceNet  
EtherNet/IP

**MA 204i** + KB JST-3000 to IMRFU-1  
**MA 208i** + KB JST-3000 to IMRFU-1  
**MA 235i** + KB JST-3000 to IMRFU-1  
**MA 238i** + KB JST-3000 to IMRFU-1  
**MA 248i** + KB JST-3000 to IMRFU-1  
**MA 255i** + KB JST-3000 to IMRFU-1  
**MA 258i** + KB JST-3000 to IMRFU-1

Each connector unit makes available a separate RS 232 service interface that enables configuration of the RFU read/write system with the **RF-Config** software via a null modem cable from a PC/notebook.

## 7 Commissioning and configuration

With the Leuze **RF-Config** software program, a Windows-based graphical user interface is available for configuring the RFID devices of the RFU series. Operating systems: Windows 2000, Windows XP, Windows Vista, Windows 7.

You can download the RF-Config software program from the Leuze website at  
 -> **Download** -> **identify** -> **Stationary RFID read/write systems**.

### 7.1 Configuration via the service interface of the MA...

Device configuration using the service interface of the MA... connector unit (9-pin, Sub-D connector) simplifies the configuration.

To configure, the PC with installed RF-Config software (administrator permissions not required) is simply connected to the 9-pin, Sub-D plug connection of the MA... service interface using a null modem cable (cross-wired cable with Sub-D connectors).

Configuration can also be performed by means of appropriate ASCII commands via the serial process interface (host interface). These devices also use the process interface as a service interface. It may be necessary to adjust the baud rate for downstream devices or for service access!

### 7.2 Commands and messages of the devices

The factory settings of the serial interface correspond to those of the other Leuze electronic RFID devices.

The interface parameters are: **9600 baud, 8 data bits, no parity, 1 stop bit**.

**Standard telegram structure:**

STX	Command	CR LF
0x02	HEX character	0x0D 0x0A



**Notice!**

The baud rate can be set for the RFU devices; it is, however, recommended that a change be made **ONLY** during standalone operation.

The following commands (in the standard telegram structure specified above) can be used to address the device via the interface.



**Notice!**

When reading out areas of the transponder, "02" is transmitted in the telegram for the TID, "01" is transmitted for the EPC, and "03" is transmitted for the user area; the **block number** is transmitted in the telegram as well.

The factory setting enables immediate function after connection of the supply voltage.

**Factory settings (read with trigger, 1 transponder in the field):**

The following settings are activated by factory settings:

- **Data:** UHF transponders have up to three 3 memory banks. The basic setting is the EPC bank of the transponder. Transmitted in the telegram when reading out transponder areas are "01" for the EPC and the **block number**.
- **Trigger:** After connection of a trigger signal to the IMRFU-1 or after a software trigger (command '+'), the device reads the EPC no. of the transponder.
- **Output good read:** If the read is successful, the device supplies a 300ms high pulse at the output.
- **ERP:** The reader generates an electromagnetic field with 400mW of power.
- **Output format:** The output contains the transponder type, the memory bank, the start block in the bank and the EPC no.

**Short commands without data**

The following commands can be used to carry out direct actions:

- **Command '+'** (0x2B) activates a read process.  
 Command syntax: **<STX>+<CR><LF>**  
 Answer: **<STX>BankBlocknoTagtypeEPC<CR><LF>**  
**Bank/Blockno** stands for memory bank and block:  
**01/0000** = Memory bank **01**, block **0000**  
**Tagtype** stands for transponder type: **000000** = EPC 1 Gen 2
- **Command '-'** (0x2D) terminates the read process without a response.  
 If no transponder was read, a NO READ (0x18) is output.
- **Command 'V'** (0x5630) returns the software version of the IMRFU-1 or the RFU.  
 Command syntax: **<STX>Vx<CR><LF>** (x = 0: IMRFU; x = 1: RFU)  
 Answer: **<STX>y1y0m1m0d1d0t3t2t1t0Name<CR><LF>**  
 Where **y** = Year(2); **m** = Month(2); **d** = Day(2); **t** = Tag number(4)  
 and **Name** for IMRFU = **IMRFU** and for RFU = **01230102 FW/ HWversion**
- **Command 'R'** (0x5230) executes a restart and resets the device to factory settings.  
 Command syntax: **<STX>Rx<CR><LF>** (x = 0: IMRFU; x = 1: RFU)  
 Answer: **<STX>Q2<CR><LF>** and then **<STX>S<CR><LF>**  
 Where **Q2** = Action carried out and **S** = Ready for operation

### Further commands

The commands for writing and reading access the EPC area of the memory (factory setting). The start address of this area is bank **0x01**, block **0x00**.

Additional areas are available depending on the transponder:

- Serial number (TID): Bank 0x02
- User memory: Bank 0x03

Reference is, however, the EPC number.

- **Command 'N' (0x4E)** Read block.  
 Command syntax **<STX>N0100000002000000<CR><LF>** where  
**01** = Bank number (01, EPC area)  
**0000** = Start block number (00)  
**0002** = Number of bytes to be read (02 ... 20)  
**000000** = Tag type, all EPC 1 Gen 2 transponders  
 Answer: Read data, e.g.  
**<STX>00100000002006004304C<CR><LF>**  
 (see chapter 7.4)
- **Command 'W' (0x57)** Write block.  
 Command syntax **<STX>W0100040002000000xxxx<CR><LF>** where  
**01** = Bank number (01, EPC area)  
**0004** = Start block number (00, EPC beginning with 04)  
**0002** = Number of bytes to be written (2-C, EPC)  
 (user bank area 2-10), dependent on chip type  
**000000** = Tag type, all EPC 1 Gen 2 transponders  
**xxxx** = Data (hexadecimal)  
 Answer: **<STX>yy<CR><LF>** where  
 yy = **Q4**: Command understood (if precharge activated!)  
 yy = **Q5**: Write operation successful (after trigger)  
 yy = **Q0**: Write operation failed (see chapter 7.4)
- **Command 'B' (0x42)** Lock block.  
 Command syntax **<STX>B0x<CR><LF>** where  
**x = 1**: Lock EPC bank  
**x = 2**: Lock TID bank  
**x = 3**: Lock user bank  
 Answer: **<STX>Q2<CR><LF>** (see chapter 7.4)



#### Attention!

**The locking of a bank CAN NOT BE REVERSED.**

**The processes is irreversible!**



- **Command 'D'**  
**(0x44)**      Diagnostics - call up information on the read quality.  
The device executes the specified number of read operations and returns the number of valid read results as the answer.  
Command syntax **<STX>Dxx<CR><LF>** where  
**xx = 0x19:** 25 read attempts (time overhead approx. 3s)  
**xx = 0x32:** 50 read attempts  
**xx = 0x64:** 100 read attempts  
 Answer:                    **<STX>yy<CR><LF>** where  
**yy =** Number of valid read results
  
- **Command 'F'**  
**(0x46)**      Antenna (electromagnetic field) ON/OFF.  
Command syntax **<STX>Fx<CR><LF>** where  
**x = 0x01:** Field ON  
**x = 0x02:** Field OFF  
**x = 0x03:** RESET field  
 Answer:                    **<STX>Q2<CR><LF>** (see chapter 7.4)

**Notice!**

*The device field is generally off; only following activation is it switched on.*

- **Command 'A'**  
**(0x41)**      Set output.  
This command permanently sets the output; it is not acknowledged!  
Command syntax **<STX>A0xx<CR><LF>** where  
**xx = 0xFF:** Output activated  
**xx = 0x00:** Output not activated  
 Answer:                    none

**Attention!**

*This command can only be executed if the switching output is not automatically activated via the configuration!*

### 7.3 Configuring the RFID reader using the RF-Config software

The devices can be configured with the RF-Config software from Leuze electronic transparently and easily with a mouse click. All parameters and functions can be set via the user interface using menus.

Should direct access be necessary via a PLC or without the software tool, a standard terminal program can likewise be used with the information and commands described here. In this case, always observe the described command syntax.

- **Command 'G' (0x47)**      Read configuration.  
 Command syntax **<STX>Gxxxx<CR><LF>** where  
**xxxx** = 0xFF 0x00: Completely read out configuration  
 Answer:            **<STX>00yyyyyyyy<CR><LF>**
- **Command 'C' (0x43)**      Write configuration data.  
 Command syntax **<STX>Cxyyyzz<CR><LF>** where  
**xx** = Number of data bytes  
**yy** = Register address  
**zz** = Configuration data  
 Answer:            **<STX>Q1<CR><LF>** (see chapter 7.4)



**Notice!**

*The data is always hexadecimal encoded. Since only complete blocks (2 bytes) can be transmitted, the block data must always be filled in even numbers.*

*The complete description of the instruction set and configuration is included with the configuration software or can be downloaded separately from [www.leuze.com](http://www.leuze.com).*

To simplify the setting of parameters, corresponding menus are provided in the "RF-Config" configuration tool.



**Notice!**

*You can find the program on the Internet at [www.leuze.com](http://www.leuze.com) -> Download -> identify -> Stationary RFID read/write systems.*

After downloading the file to your computer, simply start the installation routine to set up the program. No special permissions are necessary for this purpose (e.g., administrator permissions). After installing, double-click the desktop icon to start the program.

You can use RF-Config to configure and parameterize all RFID devices from the Leuze electronic product line. The various device types with their parameter sets are available for selection via a device list.

After starting the program, first select the connected device from the left side of the user interface in the device bar.

Its factory configuration (parameter set) is displayed on the right side of the user interface in four tabs.



**Notice!**

In the **Help** menu, you will find the documentation for the selected device type:

- Technical description
- Instruction set and configuration structure
- Commissioning tips
- Data sheet for the standard UHF transponders available from Leuze

**Transponder tab**

In this tab, you can select from the available transponder types. The various types have different memory sizes and memory areas; please take note. The basic setting is release for all EPC 1 Gen 2 transponders.

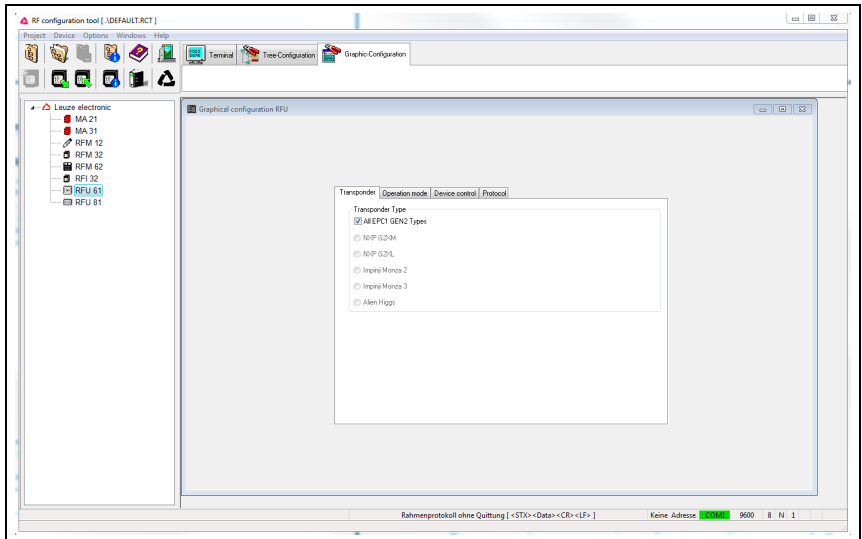


Figure 7.1: RF-Config – Transponder tab



**Attention!**

**Any settings that are made do not take effect until transferred to the device!**

### Operation mode tab

The operation mode setting is important for automatic operation of the device. Here, you set the function after activation/trigger (operation mode) and memory access (memory bank, block number).

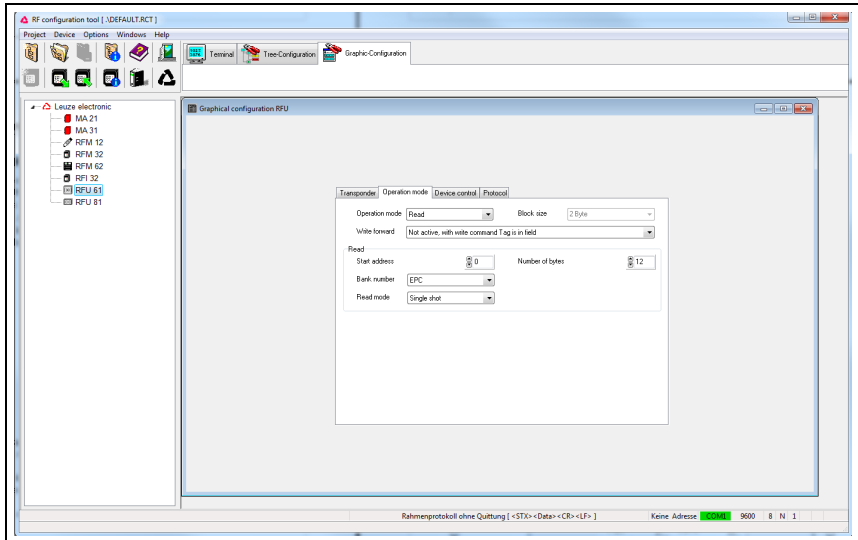


Figure 7.2: RF-Config – Operation mode tab

In any case, the EPC 1 Gen 2 transponders have an EPC area with at least 12 bytes. Other memory banks are chip-dependent, but are supported with the basic setting. If selected but not present, an error message is output.

For the "Write" online command, the **Precharge** function can also be set. In this case, the write data are transferred to the read/write system before the transponder to be written is located in the field. When the transponder does enter the field, it is automatically written with the precharged data.

**Device control tab**

Grouped together on this tab are the options for controlling the device.

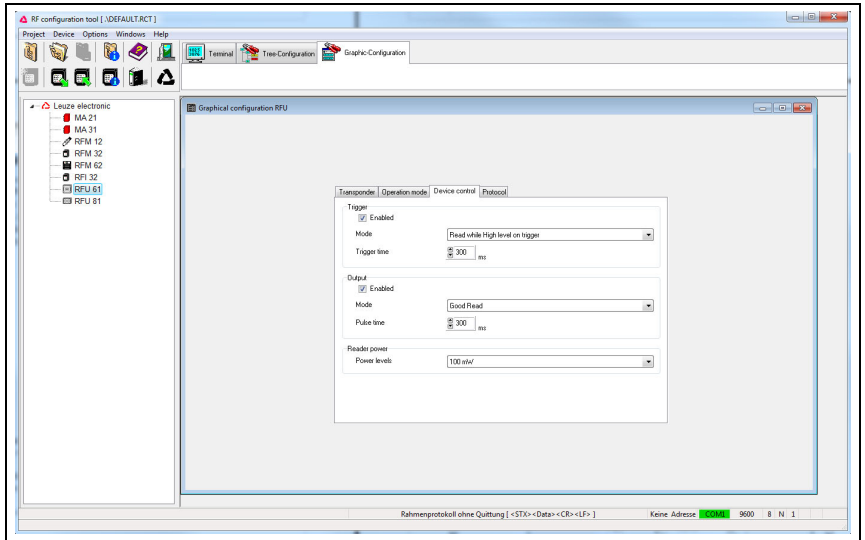


Figure 7.3: RF-Config – Device control tab

The configuration options range from activation or type of activation to the function of the switching output to the setting of the output power of the reader (device dependent).

### Protocol tab

Due to the open design of the EPC 1 Gen 2 standard, addressing on the transponder is more comprehensive. As a result, the telegram ('N', 'W' commands) is longer. If using a single transponder type and always the same memory access, the telegram can be shortened with the settings on this tab.

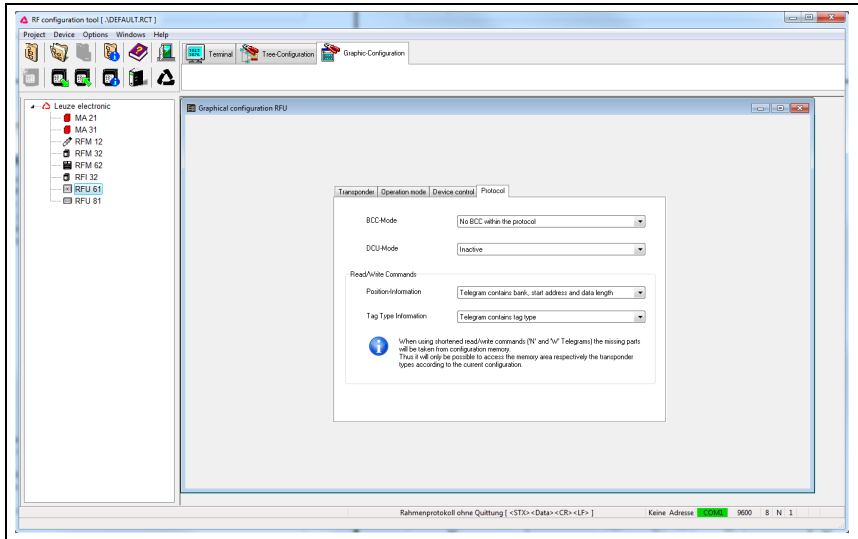


Figure 7.4: RF-Config – Protocol tab

Activation of an additional bit for increasing the security of data transmission (CRC - Character Redundancy Check) can be set here.



### Attention!

*Some parameters and functions are dependent on others, others are mutually exclusive.*

Listed below are some of the most important configuration constellations for which such dependencies exist:

- If the **Precharge** function = "Active" (address 01, bit 6), **Trigger** must also = "Active" (address 01, bit 4).
- If **Permanent reading** is set as read type/read mode (address 01, bit 5), **Trigger** must = "Not active" (address 01, bit 4) and **Precharge** must = "Not active" (address 01, bit 6).

If these dependencies are not observed either in whole or in part, the "**E10**" error message is returned by the device without any changes having been made to the device configuration.

## 7.4 Acknowledgments and error codes

To receive acknowledgment to specific commands and to recognize transmission errors, several acknowledgment and error codes are defined.

### Acknowledgments

Code	Meaning
<b>Q0</b>	Command could not be carried out
<b>Q1</b>	Configuration change carried out
<b>Q2</b>	Action carried out
<b>Q4</b>	Write command understood (only for the <b>Precharge</b> function)
<b>Q5</b>	Data successfully written (including control reading)

Table 7.1: Possible command acknowledgments



### Attention!

Not all available and readable transponders have the memory listed in chapter 7.6; some are missing **USERBank** and/or **TID** (serial number)! Operations on non-available memory areas are acknowledged with "**Q0**"!

### Error codes

An error occurs if a command or transmitted command parameters are transmitted incompletely or with faulty characters.

Code	Meaning
<b>E01</b>	Invalid command
<b>E02</b>	Invalid parameter
<b>E04</b>	Framing error (transmission)
<b>E08</b>	CRC checksum error
<b>E10</b>	Contradictory settings activated (e.g., permanent reading and trigger)

Table 7.2: Possible error codes



### Notice!

If error code "**E08**" occurs, a CRC check was most likely accidentally activated. To reset, please send commands "**RO**" and "0xD2" via the interface.

## 7.5 LED indicators







LED	State		Meaning
PWR		Off	Device OFF - No supply voltage
READ		Green, flashing	Device OK, initialization phase - Self test running
ACT		Red, flashing	
PWR		Green, continuous light	Device ready
ACT		Red, continuous light	Device (antenna) activated - Reading gate open/precharged for writing - Transponder is expected
READ		Green, flashing	Transponder has been detected - Data output via interface

Table 7.3: LED indicators and their meaning

## 7.6 Transponder memory organization



**Attention!**

*Not all available and readable transponders have all memory areas!  
Operations on non-available memory areas are acknowledged with Q0!*

Chip type		Manufacturer ID (MDID) <sup>1)</sup>	Model no. <sup>1)</sup>	Memory banks / size			
Transponder	Part no.			EPC 96 bits	240 bits	TID 64 bits	USER 240 bits
<b>NXP G2XM</b>							
TFU 05 2101.308	50112257	0x006	0x003		●	●	●
<b>NXP G2XL</b>							
TFU 03 2201.308	50114086	0x006	0x004				
TFU 10 2201.308	50112443	0x006	0x004		●	●	-
TFU 08 2101.308	50112913	0x006	0x004				
<b>Impinj Monza 3</b>							
TFU 05 1101.308	50114995	0x001	0x093	●		●	-

1) Part of the TID

Table 7.4: Chip types / memory organization of UHF transponders

The exact memory area can be selected and addressed via the start address, always in even steps (2, 4, 6, ...) since the smallest unit is 2 bytes in size.



## 8 Diagnostics and troubleshooting

### 8.1 General causes of errors

Error	Possible cause of error	Remedial measures
Status LED <b>PWR</b> off	<ul style="list-style-type: none"> <li>No supply voltage connected to the device.</li> <li>Hardware error.</li> </ul>	<ul style="list-style-type: none"> <li>Check supply voltage.</li> <li>Send device to customer service.</li> </ul>
Status LED <b>ACT</b> red continuous light <b>and</b> Status LED <b>READ</b> green continuous light	<ul style="list-style-type: none"> <li>Error during initialization.</li> </ul>	<ul style="list-style-type: none"> <li>Switch the supply voltage off and on again.</li> <li>Send device to customer service.</li> </ul>
Status LED <b>ACT</b> red continuous light	<ul style="list-style-type: none"> <li>Device deactivated or device activated, but no transponder detected.</li> </ul>	<ul style="list-style-type: none"> <li>Check wiring of trigger.</li> </ul>
After activation and with transponder in read field:  Status LED <b>READ</b> not flashing green	<ul style="list-style-type: none"> <li>Device activated, but no transponder detected.</li> </ul>	<ul style="list-style-type: none"> <li>Check enable of the transponder type in the configuration.</li> </ul>

### 8.2 Interface error

Error	Possible cause of error	Remedial measures
No communication via RS232 / RS 422 / RS485	<ul style="list-style-type: none"> <li>Wiring not correct.</li> </ul>	<ul style="list-style-type: none"> <li>Check wiring.</li> </ul>
Sporadic error on the RS232 interface	<ul style="list-style-type: none"> <li>Influences from electromagnetic interference (EMC).</li> </ul>	<ul style="list-style-type: none"> <li>Check shield (shield overlap up to the clamping point!).</li> <li>Avoid electromagnetic interference from high-voltage power lines running parallel.</li> </ul>

**Notice!**

Please use **chapter 8 as a master copy** should servicing be required.

Cross the items in the "Measures" column which you have already examined, fill out the following address field and fax the pages together with your service contract to the fax

number listed below.

**Customer data (please complete)**

<b>Device type:</b>	
<b>Company:</b>	
<b>Contact partner / department:</b>	
<b>Phone (direct):</b>	
<b>Fax:</b>	
<b>Street / No:</b>	
<b>ZIP code/City:</b>	
<b>Country:</b>	

**Leuze Service fax number:**

**+49 7021 573 - 199**

## 9 Type overview and accessories

### 9.1 Model overview of the RFU series

Type designation	Description	Part no.
RFU 61 SL 100-EU	Stationary, universal read/write system, operating range up to 1500 mm	50112441
RFU 81 SL 100-EU	Stationary, long-range read/write system, operating range up to 5000 mm	50112442
IMRFU-1	Connector unit / interface module for 1 RFU read/write system (mandatory)	50112439

Table 9.1: Model overview of the RFU series

### 9.2 Model overview of connector units / networking

Type designation	Description	Part no.
MA 21 100.2	Leuze multiNet plus connector unit (slave)	50103125
MA 21 100	Connector unit/interface converter RS 232 – RS 485 (electrically insulated)	50030481
MA 21 130	Connector unit/interface converter RS 232 – RS 422 (electrically insulated)	50030484
MA 21 110	Connector unit/interface converter RS 232 – RS 232 (electrically insulated)	50030482
MA 204i	PROFIBUS DP gateway	50112893
MA 208i	EtherNet TCP/IP gateway	50112892
MA 235i	CANopen gateway	50114154
MA 238i	EtherCAT gateway	50114155
MA 248i	PROFINET-IO RT gateway	50112891
MA 255i	DeviceNet gateway	50114156
MA 258i	EtherNet/IP gateway	50114157

Table 9.2: Model overview of connector units / networking

### 9.3 Accessories: Ready-made cables

Type designation	Description	Part no.
K-D M8A-4P-5m-PVC	Connection cable RFU 61 to IMRFU-1, length 5m, PVC sheathing	50104526
K-D M8A-4P-10m-PVC	Connection cable RFU 61 to IMRFU-1, length 10m, PVC sheathing	50104528
KB JST-3000	Connection cable between IMRFU-1 and MA 21 100.2/MA 2xxi, length 3m	50115044

Table 9.3: Accessories: Ready-made cables

### 9.4 Model overview of TFU UHF transponders

Type designation	Description	Part no.
<b>Disc transponder</b>		
TFU 05 1101.308	∅ 47x10mm, 12 byte memory, IP 67, PU	50114995
TFU 05 2101.308	46x52x11 mm, 30+30 byte memory, IP 68, PU	50112257
<b>Self-adhesive transponder</b>		
TFU 03 2201.308	54x34x0.3mm, 30 byte memory, paper	50114086
TFU 10 2201.308	97x27x0.3mm, 30 byte memory, paper	50112443
<b>Card transponder</b>		
TFU 08 2101.308	86x54x1 mm, 12 byte memory, IP 68, PVC	50112913

Table 9.4: Model overview of TFU UHF transponders

## 10 Maintenance

### 10.1 General maintenance information

The RFID devices of the RFU series require no maintenance by the operator.

If a film forms, the devices can be cleaned with a cloth; function is influenced only by metal dust or liquid present on the device.



**Attention!**

*Do not use solvents or cleaning agents containing acetone.*

*Use of improper cleaning agents can damage the housing.*

### 10.2 Repairs and servicing

Repairs to the device must only be carried out by the manufacturer.

 *Contact your Leuze distributor or service organization should repairs be required.*

*The addresses can be found on the inside of the cover and on the back.*



**Notice!**

*When sending devices to Leuze electronic for repair, please provide an accurate description of the error.*

### 10.3 Disassembling, packing, disposing

**Repacking**

For later reuse, the device is to be packed so that it is protected.



**Notice!**

*Electrical scrap is a special waste product! Observe the locally applicable regulations regarding disposal of the product.*

**11 Appendix**

**11.1 ASCII table**

ASCII	Dec.	Hex.	Oct.	Designation	Meaning
NUL	0	00	0	NULL	Null
SOH	1	01	1	START OF HEADING	Start of heading
STX	2	02	2	START OF TEXT	Start of text characters
ETX	3	03	3	END OF TEXT	Last character of text
EOT	4	04	4	END OF TRANSMISSION	End of transmission
ENQ	5	05	5	ENQUIRY	Request for data transmission
ACK	6	06	6	ACKNOWLEDGE	Positive acknowledgment
BEL	7	07	7	BELL	Bell signal
BS	8	08	10	BACKSPACE	Backspace
HT	9	09	11	HORIZONTAL TABULATOR	Horizontal tabulator
LF	10	0A	12	LINE FEED	Line feed
VT	11	0B	13	VERTICAL TABULATOR	Vertical tabulator
FF	12	0C	14	FORM FEED	Form feed
CR	13	0D	15	CARRIAGE RETURN	Carriage return
SO	14	0E	16	SHIFT OUT	Shift out
SI	15	0F	17	SHIFT IN	Shift in
DLE	16	10	20	DATA LINK ESCAPE	Data link escape
DC1	17	11	21	DEVICE CONTROL 1 (X-ON)	Device control character 1
DC2	18	12	22	DEVICE CONTROL 2 (TAPE)	Device control character 2
DC3	19	13	23	DEVICE CONTROL 3 (X-OFF)	Device control character 3
DC4	20	14	24	DEVICE CONTROL 4	Device control character 4
NAK	21	15	25	NEGATIVE ACKNOWLEDGE	Negative acknowledge
SYN	22	16	26	SYNCHRONOUS IDLE	Synchronization
ETB	23	17	27	END OF TRANSMISSION BLOCK	End of data transmission block
CAN	24	18	30	CANCEL	Invalid
EM	25	19	31	END OF MEDIUM	End of medium
SUB	26	1A	32	SUBSTITUTE	Substitution
ESC	27	1B	33	ESCAPE	Escape
FS	28	1C	34	FILE SEPARATOR	File separator
GS	29	1D	35	GROUP SEPARATOR	Group separator
RS	30	1E	36	RECORD SEPARATOR	Record separator
US	31	1F	37	UNIT SEPARATOR	Unit separator
SP	32	20	40	SPACE	Space
!	33	21	41	EXCLAMATION POINT	Exclamation point
"	34	22	42	QUOTATION MARK	Quotation mark
#	35	23	43	NUMBER SIGN	Number sign
\$	36	24	44	DOLLAR SIGN	Dollar sign
%	37	25	45	PERCENT SIGN	Percent sign
&	38	26	46	AMPERSAND	Ampersand
'	39	27	47	APOSTROPHE	Apostrophe
(	40	28	50	OPENING PARENTHESIS	Opening parenthesis

Table 11.1: ASCII table

ASCII	Dec.	Hex.	Oct.	Designation	Meaning
)	41	29	51	CLOSING PARENTHESIS	Closing parenthesis
*	42	2A	52	ASTERISK	Asterisk
+	43	2B	53	PLUS	Plus sign
,	44	2C	54	COMMA	Comma
-	45	2D	55	HYPHEN (MINUS)	Hyphen (minus)
.	46	2E	56	PERIOD (DECIMAL)	Period (decimal)
/	47	2F	57	SLANT	Slant
0	48	30	60	0	Number
1	49	31	61	1	Number
2	50	32	62	2	Number
3	51	33	63	3	Number
4	52	34	64	4	Number
5	53	35	65	5	Number
6	54	36	66	6	Number
7	55	37	67	7	Number
8	56	38	70	8	Number
9	57	39	71	9	Number
:	58	3A	72	COLON	Colon
;	59	3B	73	SEMICOLON	Semicolon
<	60	3C	74	LESS THAN	Less than
=	61	3D	75	EQUALS	Equals
>	62	3E	76	GREATER THAN	Greater than
?	63	3F	77	QUESTION MARK	Question mark
@	64	40	100	COMMERCIAL AT	Commercial AT
A	65	41	101	A	Uppercase letter
B	66	42	102	B	Uppercase letter
C	67	43	103	C	Uppercase letter
D	68	44	104	D	Uppercase letter
E	69	45	105	E	Uppercase letter
F	70	46	106	F	Uppercase letter
G	71	47	107	G	Uppercase letter
H	72	48	110	H	Uppercase letter
I	73	49	111	I	Uppercase letter
J	74	4A	112	J	Uppercase letter
K	75	4B	113	K	Uppercase letter
L	76	4C	114	L	Uppercase letter
M	77	4D	115	M	Uppercase letter
N	78	4E	116	N	Uppercase letter
O	79	4F	117	O	Uppercase letter
P	80	50	120	P	Uppercase letter
Q	81	51	121	Q	Uppercase letter
R	82	52	122	R	Uppercase letter
S	83	53	123	S	Uppercase letter
T	84	54	124	T	Uppercase letter
U	85	55	125	U	Uppercase letter

Table 11.1: ASCII table

ASCII	Dec.	Hex.	Oct.	Designation	Meaning
V	86	56	126	V	Uppercase letter
W	87	57	127	W	Uppercase letter
X	88	58	130	X	Uppercase letter
Y	89	59	131	Y	Uppercase letter
Z	90	5A	132	Z	Uppercase letter
[	91	5B	133	OPENING BRACKET	Opening bracket
\	92	5C	134	REVERSE SLANT	Reverse slant
]	93	5D	135	CLOSING BRACKET	Closing bracket
^	94	5E	136	CIRCUMFLEX	Circumflex
_	95	5F	137	UNDERSCORE	Underscore
`	96	60	140	GRAVE ACCENT	Grave accent
a	97	61	141	a	Lowercase letter
b	98	62	142	b	Lowercase letter
c	99	63	143	c	Lowercase letter
d	100	64	144	d	Lowercase letter
e	101	65	145	e	Lowercase letter
f	102	66	146	f	Lowercase letter
g	103	67	147	g	Lowercase letter
h	104	68	150	h	Lowercase letter
i	105	69	151	i	Lowercase letter
j	106	6A	152	j	Lowercase letter
k	107	6B	153	k	Lowercase letter
l	108	6C	154	l	Lowercase letter
m	109	6D	155	m	Lowercase letter
n	110	6E	156	n	Lowercase letter
o	111	6F	157	o	Lowercase letter
p	112	70	160	p	Lowercase letter
q	113	71	161	q	Lowercase letter
r	114	72	162	r	Lowercase letter
s	115	73	163	s	Lowercase letter
t	116	74	164	t	Lowercase letter
u	117	75	165	u	Lowercase letter
v	118	76	166	v	Lowercase letter
w	119	77	167	w	Lowercase letter
x	120	78	170	x	Lowercase letter
y	121	79	171	y	Lowercase letter
z	122	7A	172	z	Lowercase letter
{	123	7B	173	OPENING BRACE	Opening brace
	124	7C	174	VERTICAL LINE	Vertical line
}	125	7D	175	CLOSING BRACE	Closing brace
~	126	7E	176	TILDE	Tilde
DEL	127	7F	177	DELETE (RUBOUT)	Delete

Table 11.1: ASCII table

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