logic IO
The M2M Enabler

RTCU LX2 pro

Advanced Industrial M2M/IoT Gateway

Technical Manual

Version 1.00

Introduction

The **RTCU LX2 pro** is a powerful successor to the **RTCU MX2 turbo** with significant features, capacity, power and security improvements. The **RTCU LX2 pro** is based on the latest LX hardware architecture, offering an unprecedented balance between price and performance

The **RTCU LX2 pro** is positioned for a broad range of professional Automotive Internet of Things applications. With onboard **Worldwide LTE Cat. 4**, **Dual-band GNSS**, and **BLE 5.3**, the **RTCU LX2 pro** device is ready for tomorrow's advanced IoT applications.

The device rests on the **NX32L** (NX32 for Linux) architecture that embraces many new technologies and, at the same time, maintains full backward compatibility, which ensures that already implemented and tested **NX32** applications can execute without changes.

The **RTCU LX2 pro** device has been designed to meet the ever-increasing security challenges. It offers full TLS on all major protocols and includes a hardened protected execution environment with dual-boot and automatic fallback and recovery.

The **RTCU LX2 pro** has an onboard **Dual-band Multi-constellation GNSS** positioning engine that supports the concurrent reception of all four global GNSS systems. The Dual-band receiver tracks not only L1 but also L5, significantly mitigating the multipath effect in an urban environment - ultimately improving positioning accuracy substantially. The **RTCU LX2 pro** is also available in versions with Dead-Reckoning and RTK.

This manual contains technical documentation covering the installation and usage of the **RTCU LX2 pro** device. For detailed information on the product's programming and software configuration, please refer to the RTCU IDE documentation.

For detailed information on the powerful RTCU M2M Platform, please refer to the ***RTCU M2M Platform datasheet***.

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Important Information

Thank you very much for using a product from Logic IO Aps. Our products are designed for professional use; therefore, this manual assumes technical knowledge and practice working with such products.

This documentation does not entail any guarantee on the part of Logic IO Aps with respect to technical processes described in the manual or any product characteristics set out in the manual. We do not accept any liability for any printing errors or other inaccuracies in the manual, unless it can be proven that we are aware of such errors or inaccuracies, or that we are unaware of these as a result of gross negligence and Logic IO Aps has failed to eliminate these errors or inaccuracies for this reason.

This product is a complex and sensitive electronic product. Please act carefully and ensure that only qualified personnel will handle and use the device. In the event of damage to the device caused by failure to observe the information in this manual and on the device, Logic IO Aps shall not be required to honor a warranty claim even during the warranty period and shall be exempted from the statutory accident liability obligation. Any attempts to repair or modify the product also voids all warranty claims. Only open the device to access the internal SIM card reader. There is no user-serviceable part inside.

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Differences between the RTCU MX2 turbo and the RTCU LX2 pro

The table below lists the differences between the **RTCU LX2 pro** and the **RTCU MX2 turbo LTE:**

Feature	RTCU LX2 pro	RTCU MX2 turbo LTE
Cellular Engine	LTE Cat. 4 (Worldwide)	LTE Cat. 1 (EMEA)
Bluetooth LE	√	X
GNSS	Dual-Band (L1 C/A and L5)	Single-band (L1 C/A)
Digital Inputs	6	5
Analog Inputs	0..10V / 0-30V	0-10V
DC-Out	5V	3.3V
XVoice	X	√
Headset	X	√
CAN-Bus	2	1
Motion Sensor	Accelerometer/Gyroscope	Accelerometer
Service/Programming Port	USB	RS232
Configuration	DIP-switch	Jumper
Storage	eMMC VFRAM	SD-card FRAM
6-pin connector (X4)	RD 4 1 TD GND 5 2 CAN2-H GND 6 3 CAN2-L	RD 4 1 TD GND 5 2 RS-Detect GND 6 3 DC-Out
12-pin connector (X2)	1W-LED 7 1 1-Wire GND 8 2 GND CAN1-L 9 3 CAN1-H GND 10 4 DIN6 GND 11 5 RS485A DC-Out 12 6 RS485B	1W-LED 7 1 1-Wire GND 8 2 GND CAN-L 9 3 CAN-H GND 10 4 XVoice GND 11 5 RS485A DC-Out 12 6 RS485B

Technical Highlights

Platform:

- Based on the RTCU M2M Platform.
- NX32L (NX32 for Linux) execution architecture.
  - RTCU IDE development tool.
  - Operates under a full and highly optimized Linux variant.
  - Open and extendable with Platform SDK.

LX Hardware Core:

- Cortex-A7 32-bit ARM processor operating at up to 1 GHz.
- Cortex-M4 32-bit co-processor for advanced power management.
- Hardware floating-point and DSP instructions.
- 128 MByte RAM.
- Up-to 512 MByte NAND Flash (system boot, persistent memory, and file-systems).
- Real-time clock with a dedicated backup battery.

Security:

- Embedded firewall.
- TLS/SSL support with full certificate management.
- TLS/SSL supporting all significant TCP protocols, such as RCH, FTP, SMTP, MQTT, and sockets.
- Hardware-assisted encryption/authentication: AES-128, AES-192, AES-256, DES, TripleDES, HASH, RND and RSA signature.

Wireless Communication:

- LTE Cat. 4 Worldwide Multi-Band Cellular Engine.
- Dual SIM-card readers with support for eSIM.
- Dual-Band, Multi-constellation GNSS positioning engine.
- Bluetooth LE 5.3.

Wired Communication:

- 2 x Full CAN 2.0B channels with hardware filtering and multi-speed support.
- 1-Wire bus for accessories such as ID-button reader, temperature sensors, etc.
- 2 x RS232 interface with handshake support.
- 1 x RS485 interface.

I/O Interfaces:

- 6 x digital inputs.
- 4 x high-power solid-state digital outputs.
- 2 x analog inputs with 0..10 volt / 0..30 volt.
- Expandable I/O with standard Modbus modules.

Sensors:

- 3-axis Accelerometer with 16g scale.
- 3-axis Gyroscope with 2000 dps scale.
- Temperature sensor.

User Interaction:

- 4 x bi-color LED.
- Dual user DIP-switches.
- Reset/recovery switch.
- High-speed Mini-USB service-port connector.

Audio:

- Fully digitized audio system.
- Digitized cellular audio.
- DTMF support for Interactive Voice Response applications.

Storage:

- Internal eMMC flash drive with 4 GB capacity.
- Persistent memory and circular datalogger.

Power and Battery:

- Operating voltage from 8 to 36VDC.
- On-board 2 Ah Li-Ion battery with intelligent charging.

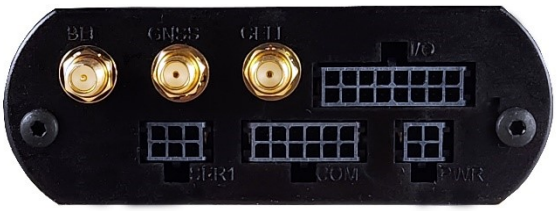
Encapsulation:

- Housed in durable aluminum encapsulation.

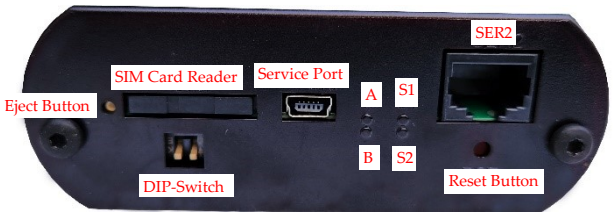
Regulatory Approvals:

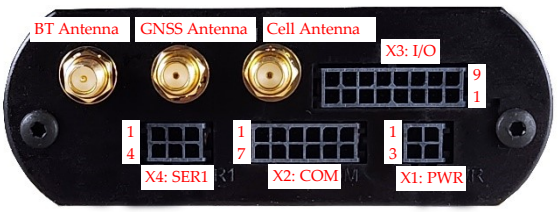
- 2007/46/EC UN ECE R10 Rev. 06 (E1).
- Radio Equipment Directive, RED 2014/53/EU.
- EMC Directive, 2014/30/EU.
- 2011/65/EU RoHS Directive.

Graphical Overview



A graphical overview of the front- and back are shown below:





External Connections

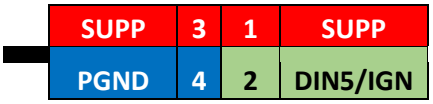
Connections to external equipment are made via the connectors located on the back and front of the RTCU LX2 pro.

The front panel is equipped with connectors commonly accessed by the user: SIM-Card, DIP-switch, Service/programming port, LED's, RS232 and the reset button. Additionally, the configuration DIP-switches are placed directly behind the front panel.

The back panel holds all connectors necessary for installation: 4-pin (X1) power and ignition, 6-pin (X4) for RS232 and CAN, 12-pin (X2) for different communication interfaces and a 16-pin (X3) for analog and digital I/O. Connection to the cellular antenna is via an SMA(F), connection to a 3V active GNSS antenna via an SMA(F), and connection to the Bluetooth antenna via an RP-SMA(F) connector.

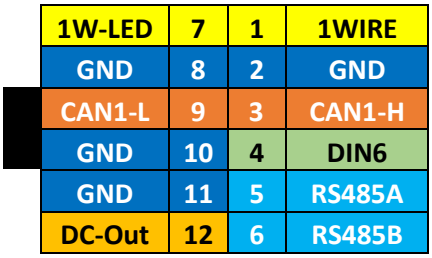
Overview

Connector X1: 4 pin PWR connector



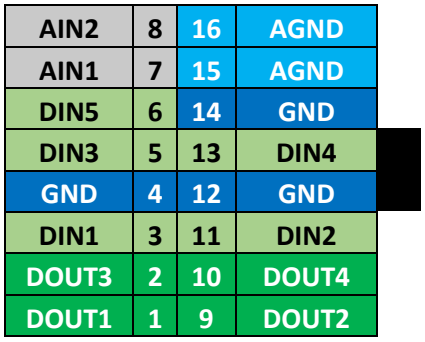
Pin	Name	Description
1	SUPP	Power supply, positive (+) connection
2	DI5/IGN	Digital input 5 / Ignition input (Shared with X3)
3	SUPP	Power supply, positive (+) connection
4	PGND	Power Ground

Connector X2: 12 pin COM connector



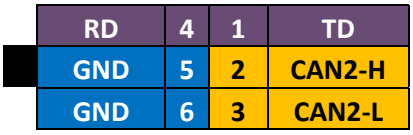
Pin	Name	Description
1	1WIRE	1-Wire bus
2	GND	Signal Ground
3	CAN1-H	CAN-bus 1 H-signal
4	DIN6	Digital input 6
5	RS485A	RS485 non-inverting signal
6	RS485B	RS485 inverting signal
7	1W-LED	1-Wire ID-Button LED
8	GND	Signal Ground
9	CAN1-L	CAN-bus 1 L-signal
10	GND	Signal Ground
11	GND	Signal Ground
12	DC-Out	5V/300mA DC-Out for external equipment.

Connector X3: 16 pin I/O connector



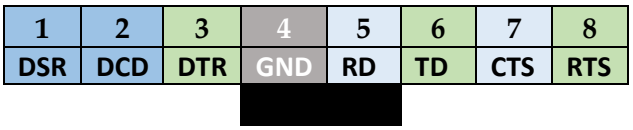
Pin	Name	Description
1	DOUT 1	Digital output 1
2	DOUT 3	Digital output 3
3	DIN 1	Digital input 1
4	GND	Signal Ground
5	DIN 3	Digital input 3
6	DIN 5/IGN	Digital input 5 / Ignition input (Shared with X1)
7	AIN 1	Analog input 1
8	AIN 2	Analog input 2
9	DOUT 2	Digital output 2
10	DOUT 4	Digital output 4
11	DIN 2	Digital input 2
12	GND	Signal Ground
13	DIN 4	Digital input 4
14	GND	Signal Ground
15	AGND	Analog Ground
16	AGND	Analog Ground

Connector X4: 6 pin SER1 connector



Pin	Name	Description
1	TD	Transmit Data from serial port 1, RS232 compatible
2	CAN2-H	CAN-bus 2 H-signal
3	CAN2-L	CAN-bus 2 L-signal
4	RD	Receive Data for serial port 1, RS232 compatible
5	GND	Signal Ground
6	GND	Signal Ground

Connector SER2: RJ45 (RS232) connector



Pin	Name	Description
1	DSR	Data Set Ready, RS232 compatible
2	DCD	Data Carrier Detect, RS232 compatible
3	DTR	Data Terminal Ready, RS232 compatible
4	GND	Signal Ground
5	RD	Receive Data for serial port 2, RS232 compatible
6	TD	Transmit Data from serial port 2, RS232 compatible
7	CTS	Clear To Send, RS232 compatible
8	RTS	Request To Send, RS232 compatible

Mini USB-B Connector

This USB port is for programming and communication with the RTCU IDE or other RACP-compliant applications. A standard USB cable can be used between the device and the PC.

Power Supply

The RTCU LX2 pro device must be supplied with 8..36 VDC from an external DC power source connected to the X1 connector. Positive power is applied to the SUPP pin, and the ground is connected to the PGND pin.

The connector has two "SUPP" supply pins, which also supply power to the digital outputs. If the total current consumption on the digital outputs exceeds 5A, then power must be applied to both pins. Otherwise, one pin is sufficient.

There are three different labels for the ground connections:

- Power Ground (PGND)
- Signal Ground (GND)
- Analog Ground (AGND)

The signal and analog grounds are filtered from the power ground. Power ground must only be used as a power supply return path. The signal ground is used as a ground reference for digital I/O's and serial interfaces. The analog ground is a low-noise ground reference for the analog inputs.

The RTCU is protected against wrong polarity. For example, if a chassis or system ground is connected to either SGND or AGND, a wrong polarity on the supply lines will destroy the internal GND connection. A fuse can be installed on the positive supply to avoid such a scenario.

The RTCU also contains an internal high-capacity backup battery, which will supply the RTCU if the external power supply fails or is disconnected. By default, the RTCU is powered down when a power failure occurs. This setting, however, can be changed. Please consult the RTCU IDE online help for more information.

Disabling the external DC power from the application interface and forcing the device to operate on the internal backup battery is supported. Please consult the RTCU IDE documentation for additional information.

When the ignition input is activated with a logical high, the RTCU unit will wake up if it is in power-down mode. The ignition input (digital input 5) is available on the power connector to minimize the need for connectors in minimal installations, but it is also available on the X3 connector (digital I/O and analog Inputs) - only one should be used at a time.

X1: 4 pin PWR connector overview

Pin	Name	Description
1	SUPP	Power supply, positive (+) connection
2	DI5/IGN	Digital input 5 / Ignition input (Shared with X3)
3	SUPP	Power supply, positive (+) connection
4	PGND	Power Ground

Digital Outputs

The digital outputs control four "high-side" switches. They function like contacts, where one side is connected to the positive supply of the RTCU unit, and the other side is to the output. The switches are protected against short circuits, ESD, and electronic kickback from inductive loads such as a relay. The maximum switchable inductance is 20mH and must not be exceeded.

The digital outputs are supplied through the X1 power connector that also supplies the rest of the RTCU unit. As the power is also the RTCU LX2 pro main power, a power fail would also affect the digital outputs.

The RTCU unit offers advanced power management that can enable one or more outputs while the RTCU is in low-power mode. Please consult the RTCU IDE documentation for additional information.

X3: 16 pin I/O connector overview

Pin	Name	Description
1	DOUT 1	Digital output 1
9	DOUT 2	Digital output 2
2	DOUT 3	Digital output 3
10	DOUT 4	Digital output 4

Specification for each digital output

Type	Max.	Unit	
Solid state	36 1.5	VDC A	Short-circuit, ESD, Inductive kickback protected up to 20mH.

Please note: Special attention to wiring must be taken; if the total current consumption of the digital outputs exceeds 1.5A, then PGND must be used as a return path for the output(s).

If the total current consumption of the digital outputs exceeds 5A, the two SUPP pins must be used for supply.

Digital Inputs / Ignition Input

The digital inputs are all low-pass filtered and transient-protected. To activate the inputs, connect a positive voltage between the input and the GND connector.

Please note: The DIN 5/IGN input is special as it also functions as the ignition input. If the ignition input is activated with a logical high or low (Wait For Event mode only), it will wake up the unit when the RTCU is in low power mode. A power apply will also wake up the unit, if it is in power-down mode or WaitForEvent mode with power apply and/or ignition selected for wake-up.
The DIN 5/IGN input is available on both the X1 power connector and the X3 connector together with the other digital inputs – only one should be used at a time.

The power management allows the possibility to configure a wake-up on one or more digital inputs with individually configured falling- or rising edge detection. Please consult the RTCU IDE documentation for additional information.

X3: 16 pin I/O connector overview

Pin	Name	Description
3	DIN 1	Digital input 1
11	DIN 2	Digital input 2
5	DIN 3	Digital input 3
13	DIN 4	Digital input 4
6	DIN5/IGN	Digital input 5 / Ignition input. (Shared with X1)
4	GND	Signal Ground
10	GND	Signal Ground
14	GND	Signal Ground

X2: 12 pin I/O connector overview

Pin	Name	Description
4	DIN6	Digital input 6
10	GND	Signal Ground

Specification for each digital input

	Min.	Typ.	Max.	Unit	
Logic "High"	8	12	40	VDC	Protected against transients and low-pass filtered
Logic "Low"	-5	-	3	VDC	
Cut-off frequency	-	25	-	kHz	
Input impedance	-	13	-	kΩ	

Analog Inputs / Flex Inputs

The RTCU LX2 pro has two analog inputs. The analog inputs are voltage inputs specified with an operating range of 0V to 30V DC. The conversion resolution is up to 12 bit(0..4095).

By default, the analog voltage is converted to a digital value with a resolution of 10-bit before being presented to the application (0..1023). The application can change the resolution to the full 12 bit (0..4095). Please consult the RTCU IDE documentation for further details.

The input signal is connected between AINx and AGND. Therefore, AGND must be connected to the reference of the connected equipment. Please be aware that deviations may occur, as the system is very noise-sensitive. Avoid long unshielded wires and significant fast-changing signals routed parallel to the analog signals.

The inputs are low-pass filtered, ESD- and transient protected.

X3: 16 pin I/O connector overview

Pin	Name	Description
7	AIN 1	Analog input 1 / Flex input 1
8	AIN 2	Analog input 2 / Flex input 2
15	AGND	Analog Ground
16	AGND	Analog Ground

Specification for each analog input when used as analog input:

	Min.	Typ.	Max.	Unit	
Voltage	0	-	10	VDC	Protected against transients and
Resolution	-	-	12	Bit	low-pass filtered
Precision	-	0.3	0.5	%FSR	Precision is based on
Cut-off frequency	-	4.5	-	kHz	measurements @ 25 ˚C
Input impedance	-	30	-	kΩ	

Specification for each analog input when used as flex input:

	Min.	Typ.	Max.	Unit	
Voltage	0	-	30	VDC	Protected against transients and
Resolution	-	-	12	Bit	low-pass filtered
Precision	-	0.2	0.3	%FSR	Precision is based on
Cut-off frequency	-	4.5	-	kHz	measurements @ 25 ˚C
Input impedance	-	30	-	kΩ	

The analog inputs are made available at the same time as both normal analog inputs with an operating voltage range of 0-10V DC, and as flex inputs.
When used as flex inputs, the inputs are multi-mode inputs that can be configured to operate as either analog or digital inputs. When operating as a Flex input the operating range is from 0V to 30V DC and is configurable as digital inputs with customized threshold values.
The flex inputs can also be used as digital inputs, behaving the same way as the normal digital inputs with the same threshold values or using different threshold values for more advanced features.
The same flex input can be used for multiple digital inputs with different settings, e.g., different threshold values or debounce timing.
Configuring the flex input for band matching allows triggering the digital inputs at specific values, making it possible to connect circuits that generate different voltages for different states and then read the state directly.
See the RTCU IDE documentation for more details about configuring the flex inputs as digital inputs.

CAN Communication Port

The RTCU provides the physical layer for the CAN (Controller Area Network) serial communication interface in accordance with the ISO 11898 standard. The CAN bus is designed for high-speed (up to 1Mbit) robust communication in especially harsh environments like those found in the automotive industry.

The CAN interface can be connected to an existing CAN network with a common protocol, such as the J1939 standard, to retrieve information for surveillance or information purposes. The interface can also be used as a robust serial data link with a non-standard protocol. Please consult the RTCU IDE documentation for more information.

The physical layer consists of a two-wire (CAN-H and CAN-L) differential bus and a signal ground for reference.

If the RTCU is connected to a "non-existing" network, a 120 ohm resistor must be connected between CAN-H and CAN-L on each end of the transmission line in order to terminate it and avoid signal reflections. This resistor can be connected on CAN bus 2 by activating configuration DIP-Switch 3, which is located on the front-side, behind the front end-cap.

Be aware that connecting the RTCU to a CAN network can be dangerous. If the RTCU is not configured with the correct network parameters, it will lead to network corruption and may interfere with other connected equipment on the bus. Especially in vehicles, great precautions must be observed to prevent communication interruptions.

By default, the write capability on the CAN bus is disabled. However, this can be enabled using configuration DIP-switch 1 and 2 (located on the front, behind the end-cap) for the corresponding CAN bus.

A wide range of software functions is available for easy access to the network. Please consult the RTCU IDE documentation for further information.

X2: 12 pin COM connector overview

Pin	Name	Description
3	CAN1-H	CAN-bus H-signal
9	CAN1-L	CAN-bus L-signal
8	GND	Signal Ground

X4: 6 pin COM connector overview

Pin	Name	Description
2	CAN2-H	CAN-bus H-signal
3	CAN2-L	CAN-bus L-signal
6	GND	Signal Ground

RS232 Port 1

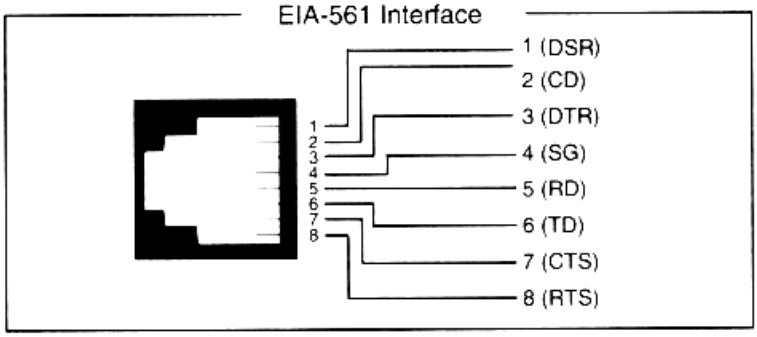
This port can be used as a general-purpose RS232 serial port without hardware handshake signals.

X4: 6 pin SER1 connector overview

Pin	Name	Description
1	TD	Transmit Data from serial port 1, RS232 compatible
4	RD	Receive Data for serial port 1, RS232 compatible
5	GND	Signal Ground

RS232 Port 2

The port is a general-purpose RS232 port with all control signals, according to EIA-561 that defines RS232 on a modular connector.



The signals are available on the RJ-45 connector located on the front panel of the RTCU.

Connector SER2: RJ-45 connector overview, fully RS232 compatible

Pin	Name	Description
1	DSR	Data Set Ready
2	DCD	Data Carrier Detect
3	DTR	Data Terminal Ready
4	GND	Signal Ground
5	RD	Receive Data for serial port 2
6	TD	Transmit Data from serial port 2
7	CTS	Clear To Send
8	RTS	Request To Send

RS485 Port

RS485 is a multi-drop network with a maximum of 32 nodes connected simultaneously to the bus. Each RS485 bus contains an RSA, an RSB signal, and a signal ground, which must always be connected to the common signal ground for all nodes connected to the RS485 bus!

The maximum cable length for the RS485 bus is according to the EIA/TIA-485-A standard (max. 1000m @ <100kbit); this limit is highly influenced by the quality of the cable, signaling rate, noise etc.

At longer cable lengths, noisy environments, or high communication speeds, it might be necessary to terminate the transmission line with a 120[1] ohm resistor at each end of the transmission line to terminate it and avoid signal reflections. If the RTCU LX2 pro is used as an endpoint node, the RS485 communication lines can be terminated with 120Ω by using configuration DIP-switch 4, located on the front, behind the end-cap. By default, the RS485 communication lines are not terminated.

Please note: For best performance, protection, and noise immunity, it is advised to use a shielded cable to connect the device to the RS485 communications bus.

X2: 12 pin COM connector overview

Pin	Name	Description
5	RS485A	RS485 non-inverting signal (A)
6	RS485B	RS485 inverting signal (B)
11	GND	Signal Ground

1 Assuming use of a CAT5 twisted pair cable

1-Wire Bus

The 1-Wire bus is available on the X2 connector. All 1-Wire communication goes through a single connection, and all 1-Wire devices connected can retrieve power directly from the bus (called parasitic power). Only two wires are needed – the 1-wire signal and the ground reference – allowing minimal cable installations.

For 1-Wire ID-Button readers, which include a built-in LED, a dedicated output is available for this purpose. Please consult the RTCU IDE documentation for further information.

X2: 12 pin COM connector overview

Pin	Name	Description
1	1Wire	1-Wire bus
7	1W-LED	1-Wire ID-Button LED
2	SGND	Signal Ground

Specification of the 1-Wire bus:

	Max.	Unit
Total weight[1]	65	m

DC-Out – 5 Volt

A 5V DC output is available on the X2 connector. It is possible to control the output to save power. The output is short circuit- (to ground), ESD- and transient protected. Make sure not to exceed the current specification of the output, and be aware that inrush currents of the external equipment may exceed the specifications. It is recommended to install a fuse to protect the output.

This output must be enabled from the application. Please consult the RTCU IDE online manual for more information.

X2: 12 pin COM connector overview

Pin	Name	Description
12	DC-Out	+5V/300mA DC-Out for external equipment.
11	GND	Signal Ground

1 The term of weight has been described in "Modular 1-wire concept – Technical Manual" document.

3D Movement Sensor

The RTCU LX2 pro unit contains a 3-axis accelerometer and 3-axis gyroscope in order to detect both vibration and motion. This sophisticated range of movement sensors allows for detecting movement and position change in 3 directions, X-Y-Z with force as high as 16g in acceleration, 2000 dps in rotation. The most straightforward use is with the power management detecting when the vehicle is moved and the most advanced analytical applications such as driving behavior/eco-driving.
Please consult the RTCU IDE documentation for more detailed information.

The positions of the 3-axis are as follows:

Specification:

			Unit	
Resolution	Accelerometer	±16	g	The acceleration can be set as relative to motion, or relative to Earth's gravity
	Gyroscope	±2000	dps	

LED Indicators

Four bi-colored (red and green) LED indicators are present on the front of the unit (see the graphical overview).

Two bi-colored LED (A and B) are available to the user, and the remaining two LEDs (S1 and S2) signal the status and possible errors of the RTCU device.

User LED A and B

LED A and B is composed of two individually controllable LEDs:

- LED named A on the front consists of LED 1 (green) and LED 2 (red).
- LED named B on the front consists of LED 3 (green) and LED 4 (red).

The LEDs are easily accessed from within the application program, and it is possible to mix the LEDs to obtain a third color: yellow. Please consult the RTCU IDE documentation for more information.

System LED S1 and S2

The RTCU is equipped with two system LEDs, which show the status and possible errors of the RTCU device.

The different patterns are listed in the table below. If the color of the system LED S1 is yellow, the device actively communicates with the RTCU IDE (or another program supporting the RTCU RACP protocol).

The LED S2 signifies either the cellular engine activity or all other LEDs are off, that the RTCU is in the "wait for event" low power state.

S1: System LED1 pattern overview

Pattern	Description
Fastest blinking, green	The device is initializing, preparing to start the application.
Fast blinking, green S2 On, green	The device is installing an update. Depending on the kind of update, it may take some time. The progress can also be observed on the display.
Fast blinking, green[1]	The device has been forced into recovery mode with the use of the system switch. The application is not executing.
500ms On / 500ms Off green[1]	The device is executing the application program
1.5s On / 0.5s Off. green[1]	The device is executing the application program, while charging the internal backup battery.
Fast blinking, red[1]	A runtime error has been detected in the program. Use the RTCU IDE to obtain the fault log.
Alternating Fast/Slow, red[1]	The device has lost its firmware. This can only happen if, during a firmware upgrade, the RTCU device loses power or the communication is lost completely. In this case, simply upload the firmware to the device again.
75ms On / 925ms Off, green	Execution speed is different from full-speed.
On yellow (All other Leds OFF)	The device is booting, initializing the system

S2: System LED2 pattern overview (Cellular activity and Power saving mode)

Pattern	Operating Status
Off	The cellular engine is turned off
600 ms On / 600 ms Off	Missing SIM card or PIN code. Network search and logon in progress.
75 ms On / 3 s Off	Logged on to the network.
75 ms On / 75 ms Off / 75 ms On / 3 s OFF	A data session is active.
Flashing	Indicates a data transfer.
On	A voice session is active.
On (and all other LEDs OFF)	The system is booting.
8 s OFF / 10 ms ON (and all other LEDs OFF)	The RTCU unit is in low-power "Wait For Event" state
10 s OFF / 50 ms ON	The RTCU device is in a low-power power saving mode.

1 Or yellow when communicating with the RTCU IDE or another program, supporting the RTCU RACP protocol).

Switches

User DIP-Switch

The RTCU LX2 pro unit contains a user-accessible DIP switch with two switches. The DIP-switch is located on the front panel for easy user access (see the graphical view).

System Switch (RST)

The RTCU LX2 pro device contains a combined reset/diagnostic switch. This switch is accessible from the front of the unit (see the graphical overview). It is necessary to use a small thin object with a diameter of approx. 2 mm, for example, a straightened-out paper clip for this purpose.

The RTCU device will perform a full reset by activating the switch shortly.

If the reset switch is held down for approx. 3 seconds[1], the device will instead enter recovery mode[2] , and the application will not be started. The system will automatically turn on the cellular engine in recovery mode to connect to the network and RTCU Communication Hub (if configured).

Pressing reset will also activate the device when in power-down mode. If external power is removed and the backup battery is disabled, the reset switch can still be used to boot into recovery mode as long as enough power is left on the battery.

1 System LED S2 will flash green three times when this state is entered.

2 System LED S1 will indicates this state by fast blinking green or yellow.

Internal Li-Ion Backup Battery

The RTCU contains an internal Li-Ion battery for operation even when the external power is absent, making it possible to report power loss etc. Please note, that when external power is removed, the device will be powered down by default. This setting can be changed as documented in the RTCU IDE documentation.

The digital outputs will be disabled when a power failure occurs, as the internal battery can not provide the supply voltage needed.

The battery charging is entirely automated and handled internally by the RTCU device – leaving no need for user interaction. Different functions (Battery low, Charger enable, charging status, etc.) are available to the user application.

The charge current is relatively high, for a shorter charge time, as specified in the technical specification. Make sure both the power supply and cables can handle the high current.

Whenever a power failure occurs, the battery will be charged to establish the capacity, thus making the battery ready for the next power failure.

By default, the battery cannot be charged above 45°C or below 0°C. The RTCU offers to charge down to -10 °C using a specialized algorithm to protect the battery.

If the temperature is above 45°C, the charging will not start and will be postponed until it is below this threshold.

The temperature has a strong influence on the battery capacity. At 0°C the capacity has dropped to 60% of the initial capacity, and it falls dramatically at lower temperatures.

The battery cycle (numbers of charges and discharges) also influences the capacity. After 300 cycles, the capacity has dropped to approximately 80% of the initial capacity.

Warning
Misusing the RTCU device may cause the built-in battery security circuit to be damaged.

- *Do not place the RTCU device in high-temperature locations such as in direct sunlight or near engines. Using the RTCU device in this environment may result in a loss of battery performance and a shortened life expectancy.*
- *Do not expose the device to water, saltwater or allow the battery to get wet.*
- *Avoid strong impacts and shocks.*

Wireless Communication

Worldwide LTE Cat. 4 Cellular Engine

The RTCU LX2 pro uses an LTE/UMTS/HSPA engine with the following features:

- Max. 150Mbps down / 50Mbps upload (Cat 4)
- LTE-FDD: B1/ B2/ B3/ B4/ B5/ B7/ B8/ B12/ B13/ B18/ B19/ B20/ B25/ B26/ B28.
- LTE-TDD: B38/ B39/ B40/ B41
- WCDMA: B1/ B2/ B4/ B5/ B6/ B8/ B19
- GSM: 850/900/1800/1900 MHz
- SMS (Text and PDU)
- UMTS release 7, max. 42Mbps down / 5.76Mbps upload, (Cat 6)
- Digitized audio / DTMF capability.

The Cellular Engine is designed for Worldwide deployment.

Bluetooth LE

The RTCU LX2 pro has an on-board Bluetooth LE 5.3 radio operating at the standard 2.4 GHz spectrum. Please consult the RTCU IDE for details on the application usage.

Multi GNSS Receiver

The RTCU LX2 pro uses an **Airoha AG3335** single-chip GNSS receiver.

This dual-band L1/L5, multi-constellation GNSS receiver supports the concurrent reception of all four global GNSS constellations: GPS, BDS, Galileo, and GLONASS.

Compared to GNSS receivers that track only L1 signals, the AG3355 receives and tracks more visible satellites in multi-bands, significantly mitigating the multipath effect in deep urban canyons and improving positioning accuracy. Featuring dual frequency support, the chipset delivers CEP accuracy values of 1 m in autonomous mode and centimeter levels in the RTK-capable variants. In addition, the optional DR function ensures superior positioning performance even in weak signal areas or when GNSS signals are not available.

Multi-GNSS receiver	• Concurrent L1 and L5 dual-band GNSS receiver • Multi-Constellation GPS / GLONASS / Galileo / BDS / QZSS receiver. • SBAS: WAAS / EGNOS / MSAS / GAGAN. • AGNSS support
RTCM ready	V2.3 and V3.3.
Update Frequency	Up to 4 Hz.
Position Accuracy	< 1m CEP (Autonomous)
Horizontal Accuracy	< 1m CEP (Autonomous)
Velocity Accuracy	0.03 m/s (Autonomous)
Time-to-First Fix (without AGNSS)	• Cold start: 26 sec. • Warm start: 16 sec. • Hot start: 1 sec.
Sensitivity	• Acquisition: -147 dBm. • Reacquisition: -159 dBm. • Tracking: -165 dBm.

The RTCU LX2 pro is available in variants with DR and RTK.

SIM-Card Readers

Internal / External SIM-Card Readers

The RTCU LX2 pro contains an internal and an external standard mini-SIM card reader.

The external reader is located on the front panel (please see the graphical view) and is easily accessed. The internal reader is located on the top side of the baseboard. Installing a SIM card in both readers simultaneously and switching programmatically between them from the application is possible. The RTCU LX2 pro is also prepared for an M2M chip internally, which shares the SIM card signals with the internal SIM-card reader. Please contact Logic IO for information on this option.

Installing the External SIM-card

The SIM card reader has a tray to insert the SIM card into, which is then pushed into the SIM card reader, until it is locked securely in place.

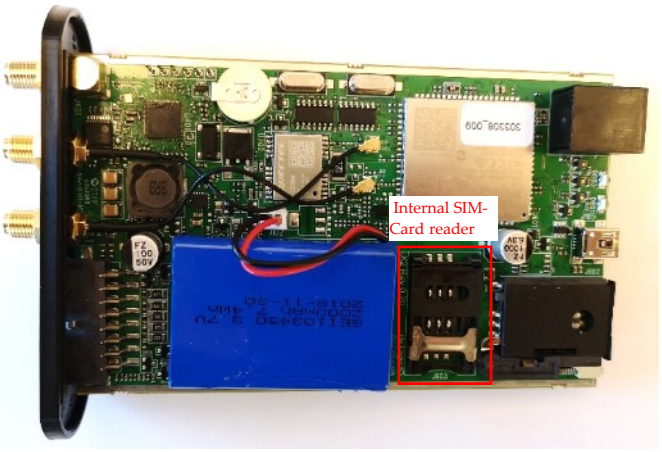
Below is the SIM-card inserted in the tray:

SIM-card orientation in the tray

To remove the card, push the ejection lever inside the hole next to the SIM card with a paper clip or other small tool until the tip of the tray is outside the front end-cap. The tray can then be pulled out without much resistance.

Installing the Internal SIM-card

In order to gain access to the internal SIM-card reader, it is necessary to disassemble the device, as described in Appendix A.

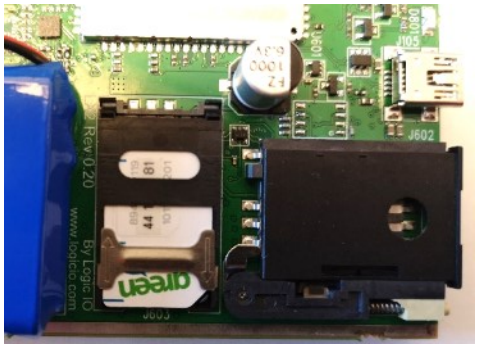


The SIM card reader is lid-based with a mechanical lock to secure a safe installation.

1. Open the hinged lid of the reader and orientate the SIM card as shown below.
2. Insert the SIM card into the lid of the card reader.
3. Close the lid and slide the metal locking mechanism into the locked position
4. Assemble the unit again.

To remove the card, slide the metal locking mechanism to the unlocked position, as shown with an arrow and text on the lid, and open the lid. The SIM-card can now be removed.

SIM-card orientation



SIM inserted and locked

Antennas

Cellular Antenna

The RTCU LX2 pro device contains an SMA female connector for connecting a suitable LTE-compliant antenna. When installing the antenna, please ensure that the antenna is not close to metallic parts or anything else which can influence the antenna's efficiency.
Please consult the installation guide that follows the antenna.

GNSS Antenna

The RTCU LX2 requires a suitable GNSS antenna to be used. The connection is with an SMA female connector, and the GNSS antenna must be a 3V active antenna with an SMA male connector.
For the best performance it is recommended to use an antenna that supports both the L1 and the L5 bands.

When installing the antenna, please ensure it has a good view of the sky so that it can receive weak signals from the satellites. Please also consult the installation guide that follows the antenna.

Bluetooth Antenna

The RTCU LX2 device contains an RP-SMA female connector for connecting a suitable Bluetooth antenna.

When installing the antenna, please make sure that the antenna is not in close proximity to metallic parts or anything else which can influence the antenna's efficiency. Please consult the installation guide that follows the antenna.

Product Identification Label with Barcode

The RTCU LX2 pro product identification on the device's exterior contains a unique serial number in readable form and a barcode.

The first three digits in the serial number identify the device type, and for the RTCU LX2 pro evaluation device, this unique code is **376** or **377**.

Barcode format used: 2/5 Interleaved with check-digit.

Power Consumption

The table below shows detailed information about the RTCU LX2 pro device's typical power consumption while operating.

Typical power consumption: Device operating in normal mode

	12V	24V	BAT		
Device active	50	27	130	mA	
Device active with Cellular on*	55	30	135	mA	idle @ -51dBm* 4G)
Device active with a data session*	125	85	465	mA	@ -51dBm, Battery not charging*
Device active with GNSS on	65	35	165	mA	Mode 3
Device active while charging	650	350	-	mA	Fully discharged battery

Note: Values marked with (*) are averaged and should be considered guidelines as they may vary depending on the cellular signal strength.
Note: Power consumption from the battery @ 3.8V

The table below shows detailed information about the RTCU LX2 pro device's typical power consumption in power-saving modes.

The following power-saving modes are used:

➢ Mode 1: LED blinks every ~10 s, resumes the application when it is awoken.

➢ Mode 3: Does not blink, resets the device when it is awoken.

See the RTCU IDE online manual for information about how to use the power-saving modes.

	Mode 1			Mode 3			
Wake-up source	**12V**	**24V**	**BAT**	**12V**	**24V**	**BAT**	
Cellular*	3.5	1.6	5	-	-	-	mA
RS232 1	0.7	0.4	1.9	-	-	-	mA
RS232 2	0.7	0.4	1.9	0.22	0.15	0.7	mA
RS485	0.72	0.41	2	-	-	-	mA
Din 1-5/Ignition	0.7	0.4	1.9	0.22	0.15	0.7	mA
Power Failure / Apply	0.7	0.4	1.9	0.22	0.15	0.7	mA
CAN *Write disabled*	6.5	3.5	17	-	-	-	mA
CAN *Write enabled*	8	4	21	-	-	-	mA
Vibration	0.8	0.5	2.5	0.3	0.18	0.9	mA
Time	0.7	0.4	1.9	0.22	0.15	0.7	mA

Note: Power consumption from the battery @ 3.8V

Note: Values marked with (*) are averaged and should be considered guidelines, as they vary, depending on the signal strength.

Note: The RS232/RS458 ports are configured to wake on any change.
Note: It may take up to 1 minute before the consumption is stabilized.

Appendices

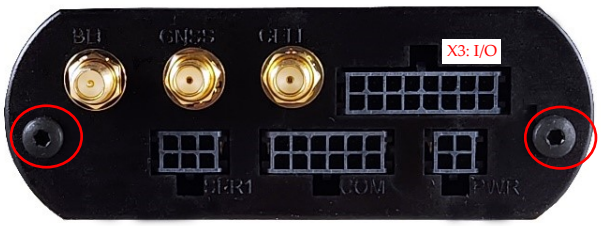
Appendix A – Opening the Device

We recommend not disassembling the RTCU LX2 pro device, and the only situation where this is required is to gain access to the internal SIM card reader.

The following steps describe the process.

ATTENTION: The device's internal electronics are sensitive to Electro Static Discharge (ESD) and must be handled only in an ESD-safe environment.
Avoid touching the electronic components and parts.

1. Remove the back panel. Use a Torx TX10 screwdriver to remove the two screws.



2. Gently pull out the board.
   Hint: Use a finger to push on the RJ45 connecter on the opposite end of the device.

For assembling, please follow the above steps backward. In any case, DO NOT USE FORCE. When assembling the circuit board, be careful with the RJ45 connector, the mini-USB connector, and the external SIM-card tray. Loosening the front panel to align the connectors and readers on the front side may be necessary.

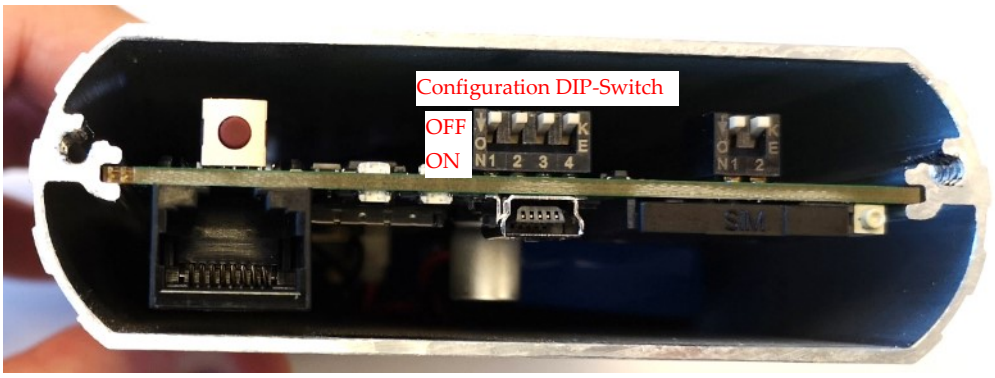
Be careful not to tighten the screws too much, damaging the aluminum case.

Appendix B – Configuration DIP-switches

The configuration jumper DIP-switch is located near the front side of the board, behind the front panel. To gain access it is necessary to remove the front end-cap using a Torx TX10 screwdriver.

The DIP switch enabled the following configuration options:

DIP-switch	Function	Configuration
1	CAN bus 1 write enable	ON: write enabled
2	CAN bus 2 write enable	ON: write enabled
3	CAN bus 2 line termination	ON: 120 ohm line termination enabled
4	RS485 port line termination	ON: 120 ohm line termination enabled



The DIP-switches can be accessed by removing the front end-cap. It is, however, not necessary to remove the board from the encapsulation.

Appendix C - Open Source Disclaimer

The RTCU LX2 pro products include several open-source software tools. This open-source software is governed by the terms and conditions of the applicable open-source license. You are bound by the terms and conditions of the appropriate open-source license in connection with your use and distribution of the open-source software in this product.

Please refer to the separate document "**RTCU Open Source Licenses.pdf**" for detailed information about the packages used.

RTCU LX2 pro Specifications

RTCU M2M Platform
- NX32L Execution Architecture.
- Fully NX32 compatible.
- Open and user-extendable API.
- RTCU M2M Platform SDK.

LX Hardware Core
- Powerful 32-bit ARM processor.
- Hardware floating point and DSP.
- 128 Mbyte RAM.
- Up-to 512 Mbyte NAND flash.
- Real-time clock with battery-backup.

Storage
- 4 GB Internal flash drive.
- Persistent data flash.
- Multiple circular dataloggers.

Cellular Engine
- **LTE Cat.4 Engine (Worldwide).**
  Max 150 Mbps(DL)/Max 50 Mbps(UL).
  LTE FDD: 15 bands.
  LTE-TDD: 4 bands.
  WCDMA: 7 bands.
  GSM: Quad-band.
- DTMF decoding / transmission.
- Digitized voice playback / IVR.
- Dual SIM card reader (int/ext).
- Mini-SIM 1.8/3 volt
- Application controlled SIM card.
- Optional eSIM.

Audio
- Fully digitized audio system.
- Transfer, store and play audio.
- Digitized cellular audio.

Bluetooth
- Bluetooth Low Energy 5.3.
- IEEE 802.15.4-2011 PHY
- Optional: Zigbee and OpenThread.

GNSS
- Multi-constellation.
- Dual-Band using L1 / L5 bands.
- GPS, Galileo, GLONASS, BeiDou, and QZSS.
- SBAS: WAAS, EGNOS, MSAS, and GAGAN.
- AGPS capable.
- RTCM v2.3 and v3.3.
- Accuracy: < 1m CEP (@-130 dBm).
- Anti-jamming, Noise cancellation.
- Active 3 volt GNSS antenna.
- RTK (optional) with sub-centimeter accuracy.
- Dead Reckoning with IMU (optional).
- Optional dual GNSS receiver.

Sensors
- Temperature sensor.
- 3-axis Accelerometer. ±16g@16b.
- 3-axis Gyroscope. ±2000dps @16b.

Wired Communication
- 2 x Full CAN2.0B with hardware filtering and multi-speed support.
- 1 x RS232 with control signals.
- 1 x RS232 with RX/TX.
- 1 x RS485 with Modbus support.
- 1-Wire bus.
- USB service/programming port.

I/O Interface
- 4 x digital solid-state digital output.
  Max. 36 volt / 1.5 A per. channel.
  Short-circuit, ESD, Inductive kick-back protected up to 20 mH.
- 6 x digital inputs with ignition.
  Logic high: 8 to 40 VDC.
  Logic low: -5 to 3 VDC.
  Impedance: 13 kohm @ 12V.
- 2 x analog inputs.
  Range is 0..10VDC or 0..30VDC.
  Resolution: 12 bit
  Accuracy: Typ. ±0.3% FSR @ 25°C.
  Impedance: 40 kohm.
- Protected against transients and low-pass filtered.

User Interaction
- 4 x bi-colour LED.
- 2 x DIP-switches.
- Switches for RS485 /CAN termination.
- CAN write enable switch.
- Reset / recovery switch.

External Interfaces

- Plug-compatible with the MX2 turbo and the RTCU NX-200.
- SIM-card slot for a mini-SIM card
- SIM card tray presence detection.
- 4 x LED indicators and 2 x DIP switches.
- Reset/recovery switch.
- RJ45 for RS232 with full control signals.
- Dip-switch under frontplate:
  - CAN/RS485 termination.
  - CAN write enable.
- SMA Female connector for cellular.
- SMA-RP Female connector for BT.
- SMA Female connector for GNSS.
- USB 2.0 service port mini-USB.
- TE-Connectivity "Mate'n'Lok':
  - Power
  - I/O.
  - RS232 / RS485
  - CAN
  - 1-wire

Electrical

- Operating voltage: 8 to 36 VDC.
- Short and reverse power protected.
- 5 VDC-out @ 500 mA.

Battery and Charger

- On-board 2 Ah (nominal) Li-Ion battery.
- Intelligent charger with temperature throttle and sub-zero degrees support.

Power Management

- Low-power modes.
- Wait for Event:
  Timer, Digital input, Accelerometer, RS232, RS485, CAN, Cellular, and Power change state.
- Wait for event, from: 0.4 mA@12V.
- Supervision of supply voltage / type.

Physical Characteristics

- Encapsulation: Aluminium profile.
- Colour: Anodized natural grey.
- Material: Aluminum and plastic.
- Approx. 300 gram without accessories.
- W 97 x H 35 x D 132 mm.
  (without connectors).
- Optional mounting bracket

Environmental Specification

- Operating temperature: -40 to 65°C.
- Battery charge temperature:
  -10 to 45 °C.
- Recommended storage temperature:
  0 to 45°C.
- Humidity: 5..90% (non condensing).
- Ingress Protection: IP20 .

Approvals

- 2007/46/EC UN ECE R10 Rev. 06 (E1).
- 2014/53/EU Radio Equipment Directive.
- 2011/65/EU RoHS Directive.
- Cellular:
  GCF/CE/FCC/PTCRB/IC/Anatel/SRRC/NAL/CCC/KC/NCC/JATE/TELEC/RCM/IFETEL/FAC/NBTC/ICASA.

Warranty

- Two-years return to factory parts and labor.
- Optional warranty up to 5 years. (restrictions apply).

**** END OF DOCUMENT ****