Low Power Radio Solutions Ltd
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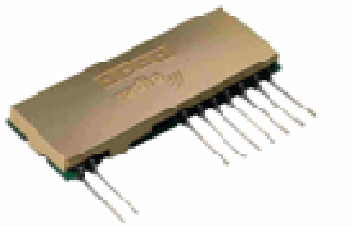
easyRadio Advanced

User Guide

Modules Included:

- **ERA900TRS**
  - 804MHz – 940MHz

  FCC ID: SLW-ERA9TRS



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Changes to this document

This data sheet has been updated to reflect firmware changes throughout the range of modules. Specific alterations are recorded in the documentation history later in the document.

Terms and Conditions of Use

Low Power Radio Solutions Ltd has an on-going policy to improve the performance and reliability of their products; we therefore reserve the right to make changes without notice. The information contained in this data sheet is believed to be accurate however we do not assume any responsibility for errors or any liability arising from the application or use of any product or circuit described herein. This data sheet neither states nor implies warranty of any kind, including fitness for any particular application.

easyRadio modules are a component part of an end system product and should be treated as such. Testing to fitness is the sole responsibility of the manufacturer of the device into which easyRadio products are fitted, and is expected BEFORE deployment into the field.

Any liability from defect or malfunction is limited to the replacement of product ONLY, and does not include labour or other incurred corrective expenses.

Using or continuing to use these devices hereby binds the user to these terms.

FCC Warning Statement:

- This device complies with Part 15 of the FCC Rules.
  Operation is subject to the following two conditions:
  (1) This device may not cause harmful interference, and
  (2) This device must accept any interference received, including interference that may cause undesired operation.
- This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance. This transmitter must not be co-located or operated in conjunction with any other antenna or transmitter. This device should not be used with antennas other than those specified below or those of less or equal gain to the maximum gain used in the table below.
- Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.
- Pin 1. Not suitable for use for FCC compliance. For FCC compliance, this pin MUST be cut off prior to installation

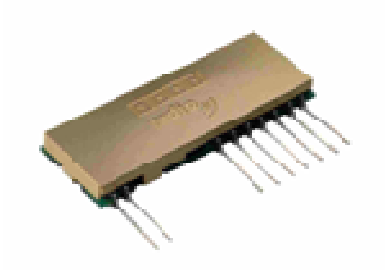
Antennas Approved to use with ERA900TRS

Supplier	Part Number	Gain
LPRS	ANT900MS	3dBi
LPRS	ANT-WP915SMA-Y	2.5dBi
LPRS	ANT-RP915SMA-Y	2dBi

Antennas must be used in conjunction with UFL cable or equivalent:

LPRS Part#: ARW-CAB-SMA-UFL-10

Introduction to easyRadio Advanced



easyRadio Advanced (ERA) modules extend on the simplicity of previous easyRadio(02) modules by incorporating truly innovative features, including the ability to change bandwidth of the radio from 150KHz down to 12.5KHz, which means narrow-band performance on a wide-band budget.
Internal temperature measurement ensures less than 1.5KHz frequency drift from ambient 20°C, over a range of -40°C to +85°C, as well as providing a usable thermometer for the connected application accurate to within 1°C.

Modes of transmission include an enhanced easyRadio protocol with 16-bit encryption and anti-cross talk software, plus raw data modes where users can now use self-coding system which can be set to interface to any other raw data module on ISM bands in both FSK (FM) and ASK (AM) modulation.

With the addition of three (total 4) separate data buffers, data throughput has been massively improved by around 25% (Using equivalent BAUD rate).

Features:

- A digital RSSI (Received Signal Strength Indication) now reduces the requirement for the host to handle A-D measurement and can be called via a simple command for either the current RSSI level or the signal strength of the last received data packet. This value can also be delivered as the first BYTE in the delivered packet.
- Temporary channel/power level selection: This command allows the user to scan other channels on the fly without storing the settings in internal EEPROM, therefore not reducing the life of the EEPROM through repetitive modification.
- Free flash firmware upgrades. Using the tools from LPRS, new updates/features can be quickly programmed making a truly future proof solution. Custom firmware can also be used (Contact LPRS for details)
- Back compatibility with easyRadio 02 series modules.
- Temperature compensation plus crystal controlled synthesiser for frequency accuracy less than +/- 1KHz over full temperature range
- Temperature sensor usable by host

Basic Specifications

High sensitivity receiver
-107dBm @ 19.2 Kbps
-112dBm @ 4.8 Kbps
-117dBm @ 2.4 Kbps
Current
Receiver: 21mA (Max)
Transmitter: 32mA (Max)
User Programmable:
Frequency (Up to 132 channels)
Bandwidth (Down to 12.5KHz)
RS232 Data Rate 2.4Kbps – 115.2Kbps
Output Power (Up to 10dBm)
10mW (ERA400TRS & ERA400TS)
5mW (ERA900TRS & ERA900TS)

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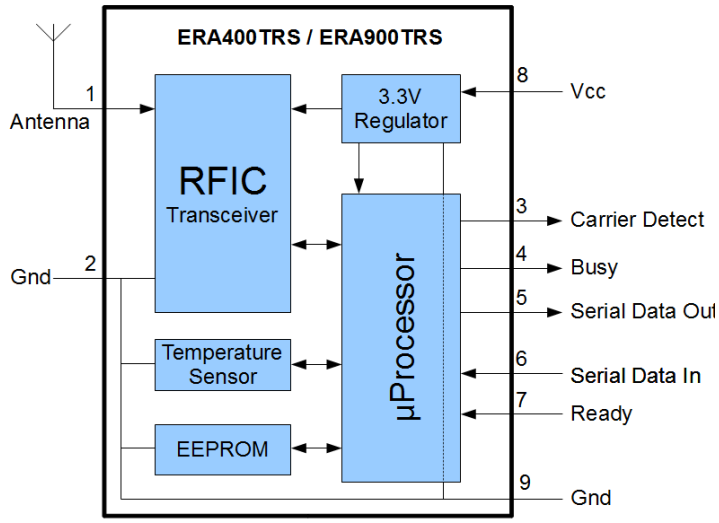
ERA900TRS Transceiver Description

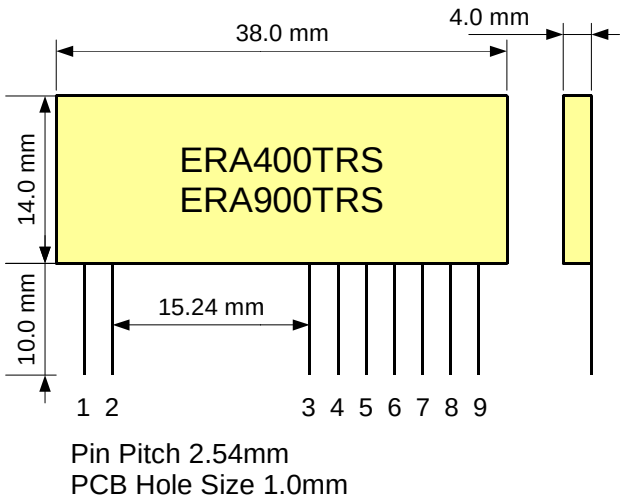
The easyRadio Transceiver is a complete sub-system that combines a high performance very low power RF transceiver, a microcontroller and a voltage regulator.

The Serial Data Input and Serial Data Output operate at the standard 19,200 Baud and the two handshake lines provide optional flow control to and from the host. The easyRadio Transceiver can accept and transmit up to 180 bytes of data, which it buffers internally before transmitting in an efficient over-air code format.
Any other easyRadio Transceiver within range and on the same channel that 'hears' the transmission will decode the message and place the recovered data within a receive buffer that can then be downloaded to the receiving host for processing and interpretation. Radio transmission and reception is bi-directional (half duplex) i.e. transmit OR receive but not simultaneously.
Increased internal buffers however, allow the user to upload while a download is in progress giving an appearance of fully duplex data flow.

easyRadio Transceiver



Block Diagram



Physical Dimensions

Pin Description (easyRadio mode)

Pin No	Name	Description	Notes
1	Antenna	50Ω RF input/output. Connect to suitable antenna. For non USA ONLY. See notes.	Not suitable for use for FCC compliance. For FCC comliance, this pin MUST be cut off prior to installation
2	RF Ground	RF ground. Connect to antenna ground (coaxial cable screen braid) and local ground plane. Internally connected to other Ground pins.	
3	CD	Carrier Detect	From V3.6.24
4	Busy Output	Digital Output to indicate that transceiver is ready to receive serial data from host.	CTS function
5	Serial Data Out	Digital output for received data to host	
6	Serial Data In	Digital input for serial data to be transmitted	
7	Host Ready Input	Digital Input to indicate that Host is Ready to receive serial data from transceiver	RTS function
8	Vcc	Positive supply pin. +2.5 to +5.5 Volts. This should be a 'clean' noise free supply with less than 25mV of ripple.	
9	Ground	Connect to supply 0 Volt and ground plane	

Checklist

- The module operates internally from an on board 3.3 Volt low drop regulator. The logic levels of the input/output pins are therefore between 0 Volt and 3.3 Volts. (See specifications/performance data).
- The serial inputs and outputs are intended for connection to a UART or similar low voltage logic device. Do not connect any of the inputs or outputs directly to an RS232 port. The transceiver module may be permanently damaged by the voltages (+/- 12V) present on RS232 signal lines. See Application Circuit (Figure 11) for typical connection to an RS232 port via MAX232 interface IC.
- The 'Host Ready Input' should be tied to 0 Volt (Ground) if not used, only when handshaking is enabled.
- Outputs will drive logic operating at 3.3 Volts and inputs will be correctly driven by logic operating at 5 Volts.
- Fit 1K resistors in series with data lines if connecting to 5V logic.

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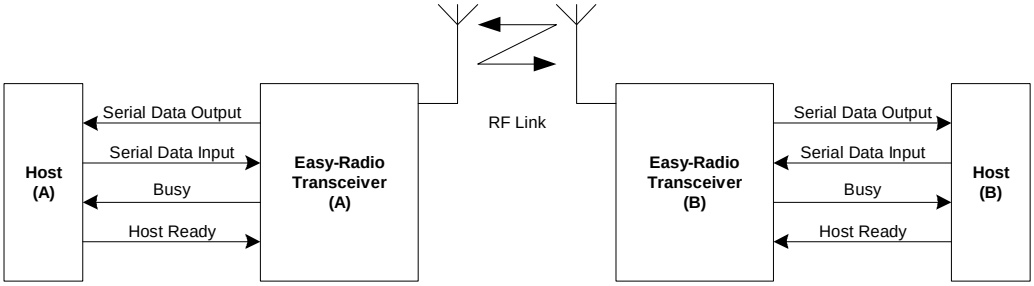
Application & Operation of a transceiver: ERAx00TRS

The diagram below shows a typical system block diagram comprising hosts (user's application) connected to easyRadio Transceivers. The hosts (A & B) will be monitoring (collecting data) and/or controlling (sending data) to some real world application.



Typical System Block Diagram

The hosts provide serial data input and output lines and two 'handshaking' lines that control the flow of data to and from the easyRadio Transceivers. The 'Busy' output line, when active, indicates that the transceiver is undertaking an internal task and is not ready to receive serial data. The 'Host Ready' input is used to indicate that the host is ready to receive the data held in the buffer of the easyRadio Transceiver.

The host should check before sending data that the 'Busy' line is not high, as this would indicate that the transceiver is unable to reliably receive further data. It should also pull the 'Host Ready' line low and check that no data appears on the Serial Data Output line.

The busy output is active all the time regardless of handshaking setting. The host ready is enabled by the handshaking setting.

Absolute Maximum Ratings

Operating Temperature Range	-40° C to +85° C
Storage Temperature Range	-40° C to +85° C
Vcc	- 0.3 to + 6 Volts
All Other Pins (N.B.)	- 0.3 to 3.3 Volts
Antenna	50V p-p @ < 10MHz Must be insulated to prevent damage from ESD

Performance Data: ERAxxxTRS Supply +5.0 Volt ± 5%, Temperature 20° C

DC Parameters	Pin	Min	Typical	Max	Units	Notes
Supply Voltage (Vcc)	8	2.5	3.3-5.0	5.5	Volts	
Transmit supply current	8		32	33	mA	
Receive supply current	8		21		mA	
Sleep Mode current	8		800		µA	4

Interface Levels		Min	Typical	Max	Units	Notes
Data Output Logic 1			3.1		Volts	10k load to +Vcc supply
Data Output Logic 0			0.1		Volts	10k load to +Vcc supply
Logic Output Current				25	mA	
Data Input Logic 1		2.0		3.6	Volts	
Data Input Logic 0				0.2	Volts	
Input Pull-ups			100		KΩ	1
RF Parameters	Pin	Min	Typical	Max	Units	Notes
Antenna Impedance	1		50		Ohms	
RF Frequency		868 904	869.85 915	870 926	MHz MHz	See ER Configuration Command set

Transmitter	Pin	Min	Typical	Max	Units	Notes
RF Power Output	1	-5 -5	+5 -3	+5 -3	dBm (869MHz) dBm (915MHz)	50Ω load Depends on Frequency
Frequency accuracy			±2		ppm	Overall
FM deviation (FSK/GFSK)			9.9 2.4 2.025		Khz Khz Khz	100KHz Spacing 25KHz Spacing 12.5KHz Spacing
Harmonics/ Spurious Emissions			-47	< -36	dBm	Meets EN 300 220-3
Over Air Data rate		1200	19200	38400	bps	Manchester Encoded

Receiver		Min	Typical	Max	Units	Notes
Receive Sensitivity			-107 -117		dBm dBm	At 100KHz Channel Spacing At 12.5KHz Channel Spacing
Serial Data Rate		2.4	19.2	115.2	Kbps	Host interface. 6

Logic Timing	Pin	Min	Typical	Max	Units	Notes
Initial Power Up Time			5	75	mS	2,3

Mechanical						
Size			38 x 14 x 2.75		mm	
Pin Pitch			2.54		mm	(Standard 0.1 Inches)
Weight			3.5		grams	

Notes:

1. The 'Host Ready Input' and the 'Serial Data Input' have 'weak' internal pull-ups enabled.
2. When power is first applied to the module the processor retrieves 'calibration' data for the RF section that compensates for temperature and power supply voltage variations. The transceiver will then be ready to receive (default) or transmit. It would normally be left in this powered state ready to receive data.
3. During power up the Busy Output line goes high and goes low once ready.
4. Applies to RAW data mode of transceiver when in idle state.

ERA900TRS Channel Frequencies vs Bandwidth Settings

Each channel frequency is calculated relative to the channel number, the channel width, and the start frequency of the channel. Three commands control the settings of each of these parameters:

Channel command: ER_CMD#Cn - Where n is channel number (See command table)

Bandwidth Command: ER_CMD#Bn - Where n is the Channel spacing

Band Plan Command: ER_CMD#bn - Where n is the START frequency of the band plan being used

The centre frequency of each channel is calculated using the formula:

Centre Frequency $(\mathrm{f}) = \mathrm{b} + \mathrm{cs} + \frac{s}{2}$

Where b = band plan start frequency

c = channel number

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s = channel spacing

easyRadio Configuration Command Set

The programming software sends 'Text Commands' to the modules and this action can be performed by terminal software or the host's Microcontroller using the following list of commands:

RS232 Communication Settings **Command**						
ER_CMD#U1	2400					
ER_CMD#U2	4800					
ER_CMD#U3	9600					
ER_CMD#U4	19200					
ER_CMD#U5	38400					
ER_CMD#U6	31250					
ER_CMD#U7	76800					
ER_CMD#U8	115200					
ER_CMD#U?	Get UART Value				The module replies echos with the UART value. Eg: ER_CMD#U2 No ACK is required.	
ER_CMD#A70	PARITY DISABLE		DISABLED BY DEFAULT When enabled data = 1 Start, 8 Data, 1 Parity, 1 Stop			
ER_CMD#A71	EVEN PARITY					
ER_CMD#A72	ODD PARITY					
ER_CMD#A41	FAST ACK Enable		OFF		OFF	(Upper case i) See notes on "FAST ACK" below.
ER_CMD#A40	FAST ACK Disable					
			CE 869MHz		**ER900 Series (FCC)**	
ER_CMD#P0~9	RF Power Output		**TRS**		**TRS**	
		P0	-1		-10	dBm
		P1	0		-4	dBm (default FCC)
		P2	1		0	dBm
		P3	2		2	dBm
		P4	3		3	dBm
		P5	4		4	dBm
		P6	5		5	dBm
		P7	6		6	dBm
		P8	6.5		6.5	dBm
		P9	7		7	dBm
ER_CMD#p0~9	Temporary RF Power adjustment.				Lowercase 'p' allows power adjustment without modifying the value for a Power reset.	

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ER_CMD#P?	Get Power Value		The module replies with the power value. eg: ER_CMD#P9 No ACK is required.

RF Channel Settings				
ER_CMD#Cx	Where x = Channel Number in Decimal		Eg Channel 5: ER_CMD#C5 or ER_CMD#C05 or ER_CMD#C005 Uppercase 'C' stores settings in EEPROM	
ER_CMD#cx	As Upper case C		Lowercase 'c' does not store in EEPROM	
ER_CMD#C?	Get Channel Value		The module replies echoes with the current channel. Eg: ER_CMD#C9 No ACK is required.	
Bandwidth				
ER_CMD#Bx	X = 0 1 2 3 6	12.5KHz 25KHz 50KHz 100KHz 150KHz	2400bps 4800bps 9600bps 19200bps 02 Compatibility	After this command, the Channel number will set to Channel 0.
Band Plan			**ERA900**	
ER_CMD#bx	Default = 0 1 2 3		869.7MHz 902MHz 863MHz	This setting chooses the start frequency of Channel 0
Miscellaneous				
ER_CMD#R0	Reset module (POR)			Power reset
ER_CMD#A00	DCS OFF (default)	Used for 02 compatibility ONLY See 02 Series documentation		
ER_CMD#A01	DCS ON			
ER_CMD#A10	Encryption OFF (default)	Encryption algorithm is created and owned solely by LPRS. It uses a 16-bit seed that can be set by the developer.		
ER_CMD#A11	Encryption ON			
ER_CMD#A20/21	CRC16 OFF/ON ON = default	The CRC16 routines are more efficient and secure than the old CRC8. For new applications it is recommended. All new Bandwidth settings use CRC16. This setting only applies to 02 compatibility mode.		
ER_CMD#A30/31	Repeater OFF/ON	NOT YET IMPLEMENTED		
ER_CMD#A40/41	Fast ACK OFF/ON			
ER_CMD#A50/51	Handshaking OFF/ON			
ER_CMD#A70 ER_CMD#A71 ER_CMD#A72	Parity Disable Parity Even Parity Odd	NOT YET IMPLEMENTED		

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ER_CMD#a00/01	RSSI In Packet a00 = OFF; a01 = ON	When enabled each packet is preceded by the 8 bit RSSI value of the received packet
ER_CMD#a1pxx	Programmable Carrier Detect	p = polarity: 0 = rest at 0 (1 when carrier detect) 1 = idle high, (0 when carrier detect) xx = RSSI value in ASCII HEX To disable, set xx = FF Choose RSSI values in conjunction with RSSI graphs later in this document

Test Modes		
ER_CMD#T0	Upper FSK Carrier	Test Mode 0
ER_CMD#T1	Modulated Carrier	Test Mode 1 With Temperature compensation
ER_CMD#T2	Lower FSK Carrier	Test Mode 2
ER_CMD#T3	Get Firmware Revision	Returns Firmware String: eg ERA400TRS V3.6.23
ER_CMD#T4	RAW Data Test	Out of CTS pin
ER_CMD#T5	Modulated Carrier	Without Temperature compensation
ER_CMD#T7	Temperature Sensor	Reply example: -15'C or 23.7'C
ER_CMD#T8	Last Packet RSSI	Returns the HEX value of the RSSI register measured on the last valid packet.
ER_CMD#T9	Current RSSI	Live RSSI Value

To successfully send commands do the following:

1. Send Command from host: e.g. ER_CMD#U5 (Set UART BAUD to 38400)
2. In the case of a TRS/RS:
    - Wait for echo of command from module. e.g. ER_CMD#U5
3. Send the ASCII string from the host: ACK

The commands should be sent exactly as shown (case sensitive) with no spaces between characters. The ACK command is sent as three ASCII characters, ACK in sequence. ‘A’’C’’K’ .

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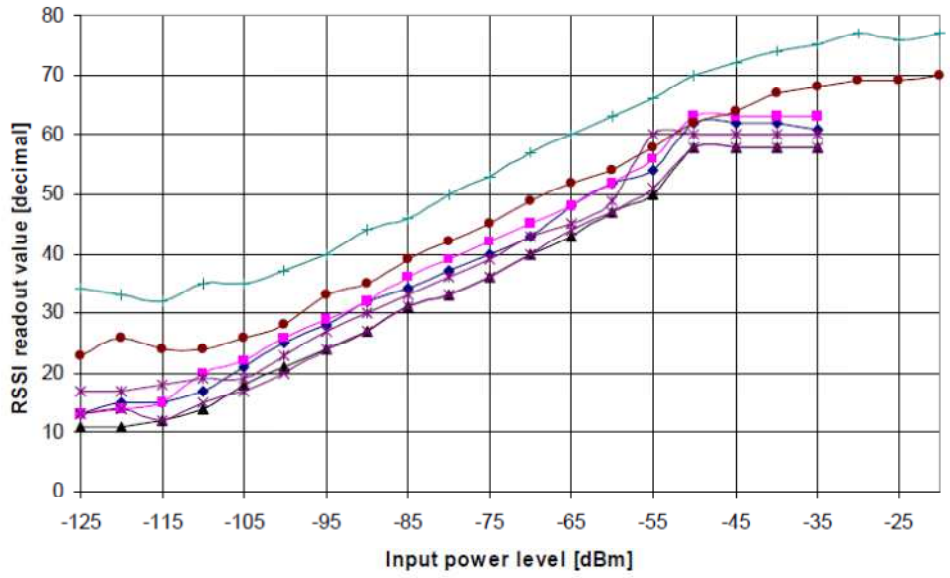
RSSI

The Receiver/Transceiver has a built in RSSI (Received Signal Strength Indicator) that provides a digital value relating to the power at the input. This value can be read back using the ER command “ER_CMD#T8” or can be set to deliver the value as the first byte of each packet.

This value will be different, depending on the bandwidth currently in use. The graph below explains how to interpret the values:



RSSI Levels (804MHz – 940MHz)

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PCB Layout

The Ground (0 Volt) pins of the receiver should be connected to a substantial ground plane (large area of PCB copper) connected to 0 Volt. It is suggested that a double sided PCB be used with one layer being the ground plane.

Power Supply

The supply used to power the receiver should be 'clean' and free from ripple and noise (<20mV p-p total). It is suggested that 100nF ceramic capacitors be used to de-couple the supply close to the power pins of the receiver. The use of 'switch mode' power supplies should be avoided as they can generate both conducted and radiated high frequency noise that can be very difficult to eliminate. This noise may considerably reduce the performance of any radio device that is connected or adjacent to the supply.

Antennas

The transceiver can be used with antenna that match 50Ω RF Input/Output with a gain no greater than 3dBi.

Monopole antennas are resonant with a length corresponding to one quarter of the electrical wavelength (λ/4). They are very easy to implement and can simply be a 'piece of wire' or PCB track which at 434MHz should be 16.4cms in length. This should be straight, in 'free space' (kept well away from all other circuitry) and should be connected directly to the Antenna pin of the receiver. If the antenna is remote it should be connected via a 50Ω coaxial feeder cable or transmission line. A 50Ω transmission line can be constructed on FR4 board material by using a 3mm wide PCB track over a ground plane. This should be kept as short as possible.

Helical antennas are also resonant and generally chosen for their more compact dimensions. They are more difficult to optimise than monopole antennas and are critical with regard to surrounding objects that can easily 'de-tune' them. They operate most efficiently when there is a substantial ground plane for them to radiate against.

Wire or PCB Loop antennas are the most compact antennas but are less effective than the other types. They are also more difficult to design and must be carefully 'tuned' for best performance.

The Internet can provide much useful information on the design of Short Range Device (SRD) Antennas.

Product Order Codes

Name	Description	Order Code
ERA900TRS	Europe/US FCC Certified-Transceiver Module 869/915MHZ	ERA900TRS

Please contact the sales office for availability and other variants of the standard product. The software interface can be customised to specific requirements for high volume applications.

easy-Radio Advanced Module Firmware Version

Version	Date	Revision	Known Issues
3.10.1	October 2013	Initial Release	None at time of print.

Document History

Issue	Date	Revision
Initial User Guide	Nov 2013	1.0

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Contact Information

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