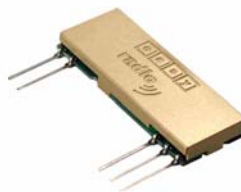# Low Power Radio Solutions Ltd

"ERx00-02 Series Data Sheet (Rev 2.4).pdf"

Modules Included:

- **ER400TS-02**

- **ER400RS-02**

- **ER400TRS-02**

- **ER900TS-02**

- **ER900RS-02**

- **ER900TRS-02**

Contents

<u>Disclaimer</u>

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 <u>we do not assume any responsibility for errors or any liability arising from the application or use of any product or circuit described herein</u>. 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, as is also the 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.

Introduction to easyRadio

The easyRadio (ER) ERx00TS Transmitter, ERx00RS Receiver and ERx00TRS transceiver incorporate 'easyRadio' technology to provide high performance, simple to use radio devices that can transfer data over a range of up to 250 metres Line Of Sight (LOS). Furthermore 'Easy-Radio' technology allows frequency, data rate and power output to be optimised for customer specific applications. The embedded software reduces design and development time significantly.

ER modules are available in two frequency versions: ER400 series (433-434MHz) & ER900 series (869.85MHz & 902-928MHz). For purposes in this document they will be referred to as ERx00.

2nd Generation Modules (please READ)

This Data Sheet covers the new hardware/firmware revisions of the Easy Radio TS, RS & TRS modules. Their Part numbers are the same as before with the addition of "-02" (eg. ER400TRS-02).

The "02" modules address issues that have been identified in previous hardware. The primary objectives for its development was to solve two main issues:

- Unintentional Loss of user configured settings:
  o The previously used micro-controller (µC) was susceptible to EEPROM corruption when a 'brown-out' condition occurred. Particularly when power cycling the module. This had the effect of triggering the automatic *Reset to Default* behaviour of the module.
- Frequency Stability:
  o Previous data sheets clearly show a frequency tolerance of +-50ppm. Despite operating within this specification, over some batches of product this has caused some unreliable communication to occur, as frequencies have been too far away from each other. If you are having issues in this area, please contact us.
- Back Compatibility:
  o New Modules can be set to be compatible with any frequency variations in the past. Please contact technical for details or consult evaluation software help file.

What improvements are there in '**02**'?

1. The µC has now been changed to one which also has a low-voltage brown-out-detect (BOD) circuit built in. Extensive testing has been done on this, and therefore power cycling techniques to conserve power are now easily achieved without the loss of programmed settings. The new µC also benefits from greater ROM size and peripheral features which means more functionality is being packed into the Easy Radio Modules.
2. The Crystal that controls the RF is now as low as +-10ppm, which guarantees consistent frequency stability over batches and over an extended temperature range of −40°C to +85°C.

Of course some specifications have been effected to allow these hardware changes, but we feel it has been a necessary move to improve the product. LPRS are committed to the continued development and enhancement of Easy Radio and enhancements may be made without prior notice. A list of development hardware and software known issues and changes are listed at the end of this document. Please always make sure you are reading the latest document for update information.

This data sheet describes the electrical and physical characteristics of the device. Operation of the Easy Radio software and Timing Specifications are described later in this document.

General Features

Crystal controlled synthesiser for frequency accuracy
High sensitivity receiver – typically –103dBm @ 19.2 Kbps
Up to 10mW Transmit Power (at 434MHz)
Low operating Voltage – 2.5-5.5 Volts – Single Lithium Cell
Low power consumption: Receiver - 21mA
                          Transmitter - 25mA
                          Sleep – 120µA (V2.01.6 + later)
User programmable: Frequency of operation
                      Data Rate
                      Output Power

Applications

Handheld Terminals
Environmental Sense & Control
Vehicle to Base Station Data Transfer
Remote Data Acquisition
Electronic Point of Sale equipment
Etc

New '02' Added Features

- User Customisable RS232 BAUD rate
  - Literally add any required BAUD rate in the new Easy Radio Evaluation Software and select your new BAUD using the new ER_CMD#U**0** command. *
- RS232 Parity **
  - Odd/even parity is supported**
- FAST ACK feature
  - Reduce the time to issue 'ER' commands, using the HEX06 ASCII ACK character.
- Default Power Settings
  - Set your own power defaults for each channel using lowercase 'p' command.
- Customisable Data ID **
  - Set a 16-bit ID to prevent communication with other Easy Radio Users.
- Programmable Encryption **
  - Secure your data with a user defined 16-bit seed.
- User programmable frequencies
  - Change the channel frequencies to personalised settings. (Via PC Software)
- DCS (Digital Channel Selection)
  - Prevent crosstalk between adjacent channels
- Repeater Mode **
  - Extend transmission range
- 16-bit CRC **
  - Increased error checking

*   Note some BAUD rates may require two stop bits. (See Evaluation Software for details on specific BAUD)
**   Available on firmware versions 2.01.6 and above
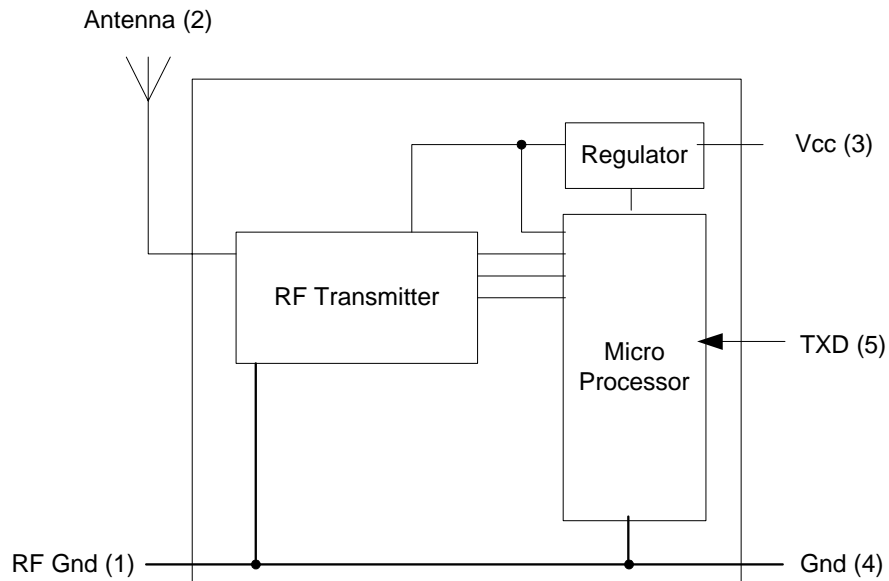
ERx00TS-02 Transmitter
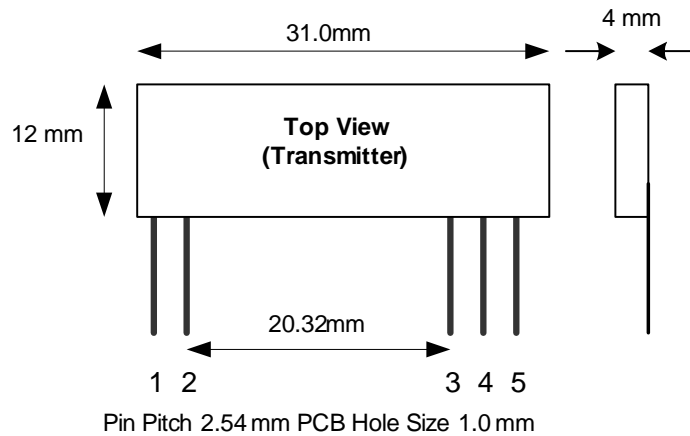

Figure 1 Block Diagram


Figure 2 Physical Dimensions

Pin Description

Pin No	Name	Description	Notes
1	RF Gnd	RF ground. Connect to antenna ground (coaxial cable screen braid) and local ground plane. Internally connected to Pin 4	
2	RF Out	50Ω RF output. Connect to suitable antenna	
3	Vcc	Positive supply pin. +2.5 to +5.5 Volts. This should be a 'clean' noise free supply with less than 25mV of ripple	
4	Gnd	Supply 0 Volt and Ground Plane	
5	TXD	Transmit Data Digital Input (SDI)	

Notes

1. The module operates internally from an on board 3.3 Volt low drop regulator.
2. TXD input will be correctly driven by logic operating at 5 Volts (CMOS & TTL logic levels). Input should not be driven by an analogue source.

ERx00RS Receiver

The ERx00RS-02 Receiver is a complete sub-system that combines a high performance low power RF receiver, a 'flash' programmable microcontroller and a voltage regulator (Figure 3). The microcontroller programmes the functions of the RF receiver and provides the interface to the host system via a data output. It also contains programmable EEPROM memory that holds configuration data for the various receiver-operating modes. The microcontroller also relieves the host from the intensive demands of searching for signals within the noise, recovering the received data and then presenting it to the host. A Received Signal Strength Indicator output can be optionally used to measure received signal levels. The module connects to a 50Ω antenna such as a whip, helical or PCB loop.
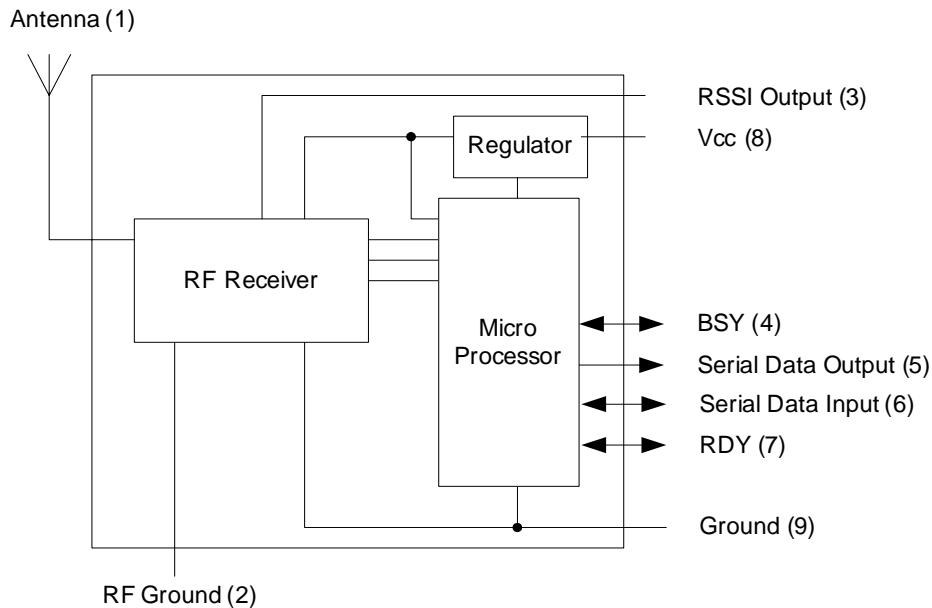
Figure 3 Easy-Radio Receiver Block Diagram

The ERx00RS-02 will receive and decode any Easy-Radio transmission within range and on the same frequency and deliver clean RS232 data to the host system for further processing.

The Serial Data Output operates at programmable standard Baud Rates (default/typical 19,200Baud).

Key parameters (frequency, power output, serial baud rate etc.) of the module may be programmed using the Easy-Radio PC Software via SDI pin 6. (Easy Radio Configuration Command Set, later in this document)

Pin Out
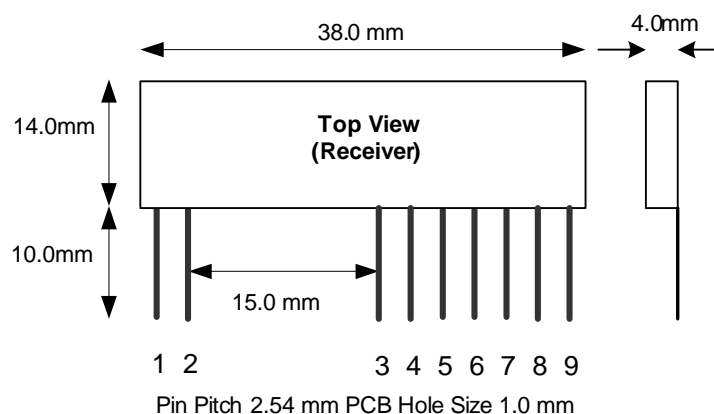
Figure 4 Physical Dimensions

Pin Description

Pin No	Name	Description	Notes
1	Antenna	50Ω RF input/output. Connect to suitable antenna.	
2	RF Ground	RF ground. Connect to antenna ground (coaxial cable screen braid) and local ground plane. Internally connected to other Ground pins.	
3	RSSI	Received Signal Strength Indication - Analogue	
4	BSY	Output (Low - Ready for data from Host) (High - Not Ready)	CTS function
5	Data Out	Received Data Output	SDO
6	Data In	ER command Input	SDI
7	RDY	Input (Low – Host Ready to receive data) (High – Not Ready)	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

1. 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 RS Performance Data).

2. All digital inputs and outputs are intended for connection to low voltage logic devices. Do not connect any of the inputs or outputs directly to an RS232 port. The receiver 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.

3. Outputs will drive logic operating at 5 Volts provided the switching levels are less than 3V.

4. If in handshaking mode, pin (7) of the ERx00RS-02 module should be 0V for data to be delivered.

Application & Operation ERx00TS-02 & RS-02

Figure 5 shows a typical system block diagram comprising hosts (user's application) connected to Easy-Radio Transmitters and Receivers. Host (A) will be monitoring (collecting data) and Host (B) will be receiving and processing this data.
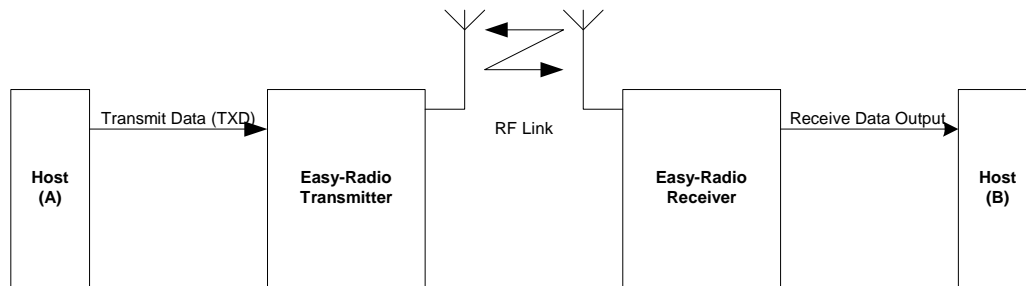

Figure 5 Typical System Block Diagram

The Host (A) should provide the serial data input (up to a maximum 180 characters per packet) to the Easy-Radio transmitter. The data should be sent in 'bursts' therefore allowing adequate time for transmission and reception over the RF link (See Figure 6). The receiver, upon reception and decoding of the RF transmission immediately sends serial data to the Host B.

Data is sent and received in standard 'RS232' serial format (logic level only) and there is no restriction on the characters that may be sent. (HEX 00 – FF)

A. Host (A) sends serial data to the Easy-Radio Transmitter (A). The data must be continuously streamed at the selected baud rate and it loads an internal transmit buffer until either it is full or a gap of two bytes is detected.
B. After detecting either the 'End of Data' gap or the 'Buffer Full' condition the controller enables RF transmit and sends the data in the buffer using Manchester coding for efficient transmission across the RF link. Any Easy-Radio receivers within range that 'hear' the transmission will simultaneously decode the data and place it into their receive buffers.
C. After checking the data for integrity, the Data within the receive buffer of Easy-Radio Receiver (B) is then sent continuously to the host at the selected baud rate.

There is no 'RF handshaking' provided at either the transmitter or receiver. The user should therefore ensure that sufficient time is allowed for the completion of transmission and reception of data. The Timing Specifications detail these requirements (see page 9). Transmitter Host (A) must allow time for the 'Over Air' transmission and for the receiving Host (B) to unload (and process) the data before sending any more new data. The receiver Host (B) must always be 'ready and waiting' for data to arrive. It should be possible to use fast response 'interrupts' without any loss of data.

With such a 'one-way' (simplex) system there is no confirmation of the satisfactory reception of the data and for added reliability it is recommended that the data be sent, perhaps, repetitively several times. For increased reliability the use of transceivers (which can acknowledge packet reception) is recommended. Easy-Radio services do not provide automatic acknowledgement (or re-tries) but these can be provided by the users application.
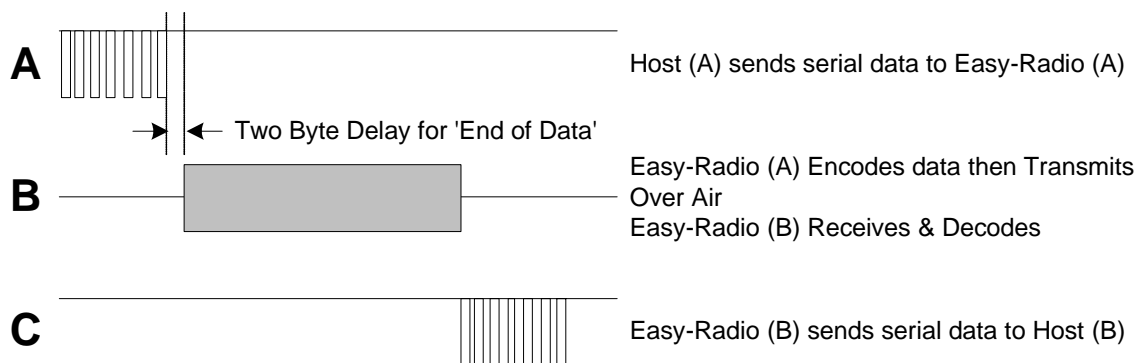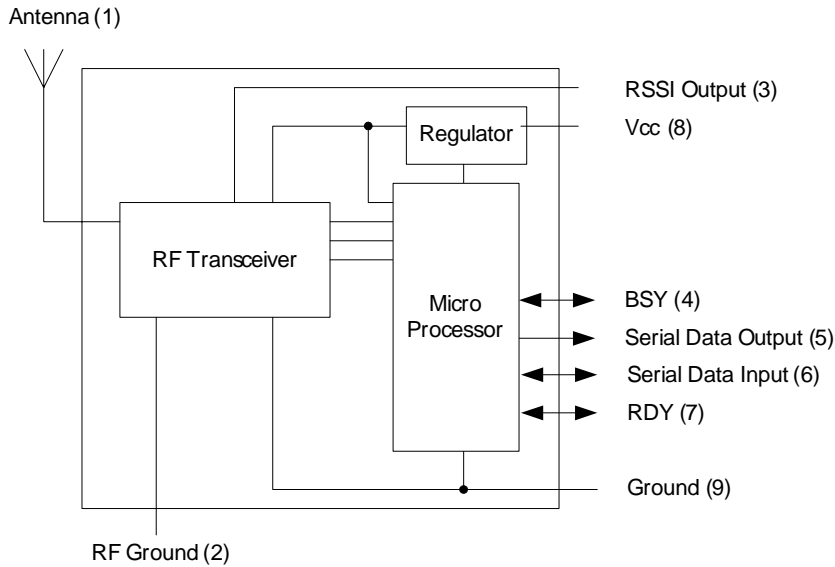

Figure 6 Serial Data

## ERx00TRS-02 Transceiver Description

The Easy-Radio Transceiver is a complete sub-system that combines a high performance very low power RF transceiver, a microcontroller and a voltage regulator (Figure 7).

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Figure 7 **Easy-Radio Transceiver Block Diagram**

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 Easy-Radio 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 Easy-Radio Transceiver within range that 'hears' the transmission will decode the message and place the recovered data within a receive buffer that can then be unloaded to the receiving host for processing and interpretation. Transmission and reception are bi-directional half duplex i.e. transmit OR receive but not simultaneously.
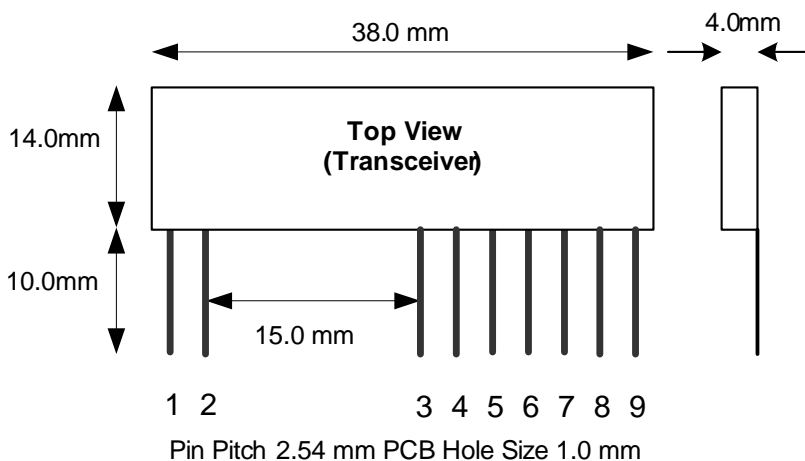
**Figure 8 Physical Dimensions**

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Pin Description

Pin No	Name	Description	Notes
1	Antenna	50Ω RF input/output. Connect to suitable antenna.	
2	RF Ground	RF ground. Connect to antenna ground (coaxial cable screen braid) and local ground plane. Internally connected to other Ground pins.	
3	RSSI	Received Signal Strength Indication	
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

1. 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).
2. 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.
3. The 'Host Ready Input' should be tied to 0 Volt (Ground) if not used, when handshaking is enabled.
4. The 'Serial Data In' should be tied to Vcc if not used. (Receive mode only).
5. Outputs will drive logic operating at 5 Volts and inputs will be correctly driven by logic operating at 5 Volts (CMOS & TTL logic levels).

Application & Operation ERx00TRS-02

Figure 9 shows a typical system block diagram comprising hosts (user's application) connected to Easy-Radio Transceivers. The hosts (A & B) will be monitoring (collecting data) and/or controlling (sending data) to some real world application.
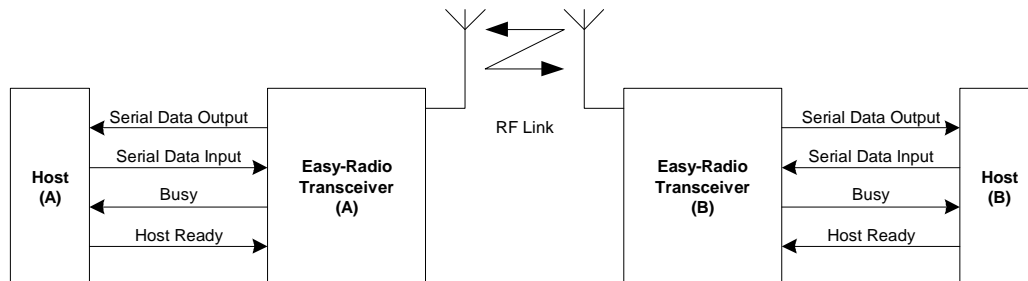
Figure 9 Typical System Block Diagram

The hosts provide serial data input and output lines and two 'handshaking' lines that control the flow of data to and from the Easy-Radio 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 Easy-Radio Transceiver.

The host should check before sending data that the 'Busy' line is not high, as this would indicate that the transceiver is either transmitting or receiving data over the radio link. It should also pull the 'Host Ready' line low and check that no data appears on the Serial Data Output line.

Timing Specifications – Applies to all Easy-Radio Modules.

Parameters	Min	Units	Notes
Host Serial Input/Output	2400, 4800, 9600, 19200, 38400 + Custom	baud	1
Host Character Format	1 Start, 8 Data, No Parity, 1 Stop	Bits	2 &2a
End of Data Delay	2 x BAUD BYTE Duration	mS	3
RF Transmit	13.2 + (n Bytes X 0.8)	mS	4
Buffer Size	1-180	Bytes	5

Notes

1. Data is inverted i.e. Start Bit is logic low. The inputs are intended for direct connection to a microcontroller UART or to RS232 inputs and outputs via an RS232 Level translator such as a Maxim MAX232, which invert the logic of the RS232 signals. This allows direct connection to, for example a Microcontroller UART. The data rate is user programmable (Default 19200 baud) and may differ between individual units within a system. (See Application Circuit diagram for logic level to RS232 interface figure 11).
2. 1 start, 8 data, 1 stop = 10 bits @ 104uS/bit = 0.52mS/character at 19200 Baud. (Default)
    a. Some Custom BAUD rates require 2 stop bits, otherwise some characters may be lost.
    b. If parity is used, substitute in the above calculation using 11 bits.
3. The 'End of Data' delay is fixed at twice the character time.
4. A fixed package overhead of 13.2mS is added to all packets.
5. The buffer size is limited to 180 bytes. Sending more than 180 bytes will cause loss of data.
    a. CTS pin will go high 2 bytes before the buffer is full. This allows characters already sent to be accepted by the ER module.

Absolute Maximum Ratings ERx00TS-02, ERx00RS-02 and ERx00TRS-02

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

Performance Data: ERx00TS-02 Transmitter Supply +5.0 Volt ± 5%, Temperature 20° C

DC Parameters	Pin	Min	Typical	Max	Units	Notes
Supply Voltage (Vcc)	3	2.5	5.0	5.5	Volts	
Supply current	3		23		mA	1
Interface Levels						
Data Input Logic 1		2.0		4	Volts	
Data Input Logic 0				0.2	Volts	
Input Impedance			100		KΩ	
RF Parameters	**Pin**	**Min**	**Typical**	**Max**	**Units**	**Notes**
Antenna Impedance	2		50		Ohms	
RF Frequency		433 868 902	434 869.85 915	434 870 928	MHz MHz MHz	See ER Configuration Command set
RF Power Output	2	-5 -5	+10 +7	+10 +7	dBm (434MHz) dBm (869MHz)	50Ω load (depends on frequency)
Frequency accuracy			±10		ppm	Overall
FM deviation			64		KHz	
Harmonics		-43			dBc	Below fundamental
Data Rate		2.4	19.2 (Default)	38.4	Kbps	Custom Over Air BAUD rates can be set via software
Logic Timing	**Pin**	**Min**	**Typical**	**Max**	**Units**	**Notes**
Power Up Time			13	35	mS	2
Mechanical						
Size			31 x 12 x 4		mm	
Pin Pitch			2.54		mm	Standard 0.1 Inch
Weight			2.5		gms	

Notes

1. Measured on full RF power. Current will reduce as power decreases.
2. Time required to 'lock' synthesiser from power up. If not previously calibrated or after a channel change, power up time is increased to 35mS.

Performance Data: ERx00RS-02 Receiver Supply +5.0 Volt ± 5%, Temperature 20° C

DC Parameters	Pin	Min	Typical	Max	Units	Notes
Supply Voltage (Vcc)	8	2.5	5.0	5.5	Volts	
Receive supply current	8		19.5		MA	
Sleep Mode current	8		120		µA	
Interface Levels						
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	
Antenna Impedance	1		50		Ohms	
RF Frequency		433	434	434	MHz	See ER Configuration
		868	869.85	870	MHz	Command set
		902	915	928	MHz	
Receiver						
Receive Sensitivity		-99	-102	-105	dBm	BER = 10^{-3}
LO leakage			< -60		dBm	Meets EN 300 220-3
Data Rate		2.4	19.2	38.4	Kbps	
RSSI Output	3	0		1.2	Volt	See Figure 10
Logic Timing	**Pin**	**Min**	**Typical**	**Max**	**Units**	**Notes**
Initial Power Up Time			14	75	mS	1
Mechanical						
Size			38 x 14 x 4	Mm		
Pin Pitch			2.54		mm	Standard 0.1 Inches
Weight			3.5		gms	

Notes

1. 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 receiver will then be ready to receive. It would normally be left in this powered state ready to receive data.

Performance Data: ERx00TRS transceiver Supply +5.0 Volt ± 5%, Temperature 20° C

DC Parameters	Pin	Min	Typical	Max	Units	Notes
Supply Voltage (Vcc)	8	2.5	5.0	5.5	Volts	
Transmit supply current	8		25		mA	
Receive supply current	8		21		mA	
Sleep Mode current	8		120		µA	
Interface Levels						
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		433	434	434	MHz	See ER Configuration
		868	869.85	870	MHz	Command set
		902	915	928	MHz	
Transmitter						
RF Power Output	1	-5	+10	+10	dBm (434MHz)	50Ω load
		-5	+5	+5	dBm (869MHz)	Depends on Frequency
Frequency accuracy			±10		ppm	Overall
FM deviation			64		kHz	
Harmonics			-25		dBc	
Over Air Data rate		2400	19200	38400	bps	Manchester Encoded
Receiver						
Receive Sensitivity		-99	-102	-105	dBm	BER = 10⁻³
LO leakage			< -60		dBm	Meets EN 300 220-3
Serial Data Rate		0.3	19.2	38.4	Kbps	Host interface. 6
RSSI Output	3	0		1.2	Volt	See Figure 10
Logic Timing	**Pin**	**Min**	**Typical**	**Max**	**Units**	**Notes**
Initial Power Up Time			13	75	mS	2,3
Mechanical						
Size			38 x 14 x 4	Mm		
Pin Pitch			2.54		mm	Standard 0.1 Inches
Weight			3.5		gms	

Notes

1. The 'Host Ready Input' and the 'Serial Data Input' have 'weak' internal pull-ups enabled. These inputs should not however be left 'floating' but should be tied to either Vcc via a resistor for the Serial input or Ground 0 Volts for the Host Ready Input.
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.

Easy-Radio 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:
Note that shaded items are new **02** commands only.

Command	Function	ER400	ER900	Notes
RS232 Communication Settings				
ER_CMD#U0	Custom BAUD rate	300	300	Programmable via ER Windows Software (ii)
ER_CMD#U1	UART Data Rate	2400	2400	
ER_CMD#U2		4800	4800	
ER_CMD#U3		9600	9600	
ER_CMD#U4		19200	19200	
ER_CMD#U5		38400	38400	
ER_CMD#U?	Get UART Value			The module replies echos with the UART value. Eg: ER_CMD#U2 No ACK is required.
ER_CMD#H1	Handshaking ON	OFF	OFF	Only effects RTS Pin.
ER_CMD#H2	Handshaking OFF			
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#I7	FAST ACK Enable	OFF	OFF	(Upper case i) See notes on "FAST ACK" below.
ER_CMD#I8	FAST ACK Disable			
RF POWER Settings				
		ER400Series	ER900 Series	
ER_CMD#P0	RF Power Output Sets output power on a channel. Warning! This level will be set to the default setting when the frequency is changed or reset via a Channel command.	1mW	0.0625mW (TS)	0.0625mW (TRS)
ER_CMD#P1		2mW	0.125mW (TS)	0.125mW (TRS)
ER_CMD#P2		3mW	0.25mW (TS)	0.25mW (TRS)
ER_CMD#P3		4mW	0.5mW (TS)	0.5mW (TRS)
ER_CMD#P4		5mW	1.2mW (TS)	1mW (TRS)
ER_CMD#P5		6mW	1.5mW (TS)	1.2mW (TRS)
ER_CMD#P6		7mW	2mW (TS)	1.5mW (TRS)
ER_CMD#P7		8mW	3.1mW (TS)	2mW (TRS)
ER_CMD#P8		9mW	4mW (TS)	2.5mW (TRS)
ER_CMD#P9		10mW	5mW (TS)	3.1mW (TRS)
ER_CMD#P?	Get Power Value			The module replies with the power value. eg: ER_CMD#P9 No ACK is required.
ER_CMD#p0	Set **Default** RF Power Output. This allows the host to set each channel to a different default	1mW	0.0625mW	NOTE lower case 'p'
ER_CMD#p1		2mW	0.125mW	
ER_CMD#p2		3mW	0.25mW	
ER_CMD#p3		4mW	0.5mW	
ER_CMD#p4		5mW	0mW	

ER_CMD#p5	power setting. (Ideal for automatic selection between bands like 869 & 914 etc.)	6mW	1mW	
ER_CMD#p6		7mW	2mW	
ER_CMD#p7		8mW	3mW	
ER_CMD#p8		9mW	4mW	
ER_CMD#p9		10mW	5mW	

RF Channel Settings

ER_CMD#C0	Channel 0	433.23 MHz	869.9MHz	All channels can now be chosen in software. Custom frequencies can only be set using software available from LPRS.
ER_CMD#C1	Channel 1	433.30 MHz	914.65MHz	
ER_CMD#C2	Channel 2	433.45 MHz	Not Set	
ER_CMD#C3	Channel 3	433.55 MHz	Not Set	
ER_CMD#C4	Channel 4	433.68 MHz	869.85MHz[i]	
ER_CMD#C5	Channel 5	433.83 MHz	Not Set	
ER_CMD#C6	Channel 6	433.88 MHz	Not Set	
ER_CMD#C7	Channel 7	434.00 MHz	Not Set	
ER_CMD#C8	Channel 8	434.15 MHz	Not Set	
ER_CMD#C9	Channel 9	434.35 MHz	Not Set	
ER_CMD#C?	Get Channel Value			The module replies echos with the power value. Eg: ER_CMD#C9 No ACK is required.
ER_CMD#C**:**	TS ONLY Set Frequency Bank 1			**:** = colon
ER_CMD#C**;**	TS ONLY Set Frequency Bank 2			**;** = semi-colon

MISCELLANEOUS COMMANDS

ER_CMD#R1	Reset to Default Settings	U4, P9, C7	U4, P9, C0	Factory Default
ER_CMD#L0	Sleep	This command shuts down the transceiver completely by halting the oscillator and dropping the microprocessor down to a slow clock speed. Toggle the RTS pin to wake up. (Allow start-up Time)		
ER_CMD#A00	DCS OFF (default)	Recommended ON for new designs where back compatibility to older devices is not required		
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	CRC16 OFF (default)	The CRC16 routines are more efficient and secure than the old CRC8. For new applications it is recommended.		
ER_CMD#A21	CRC16 ON			
ER_CMD#A30	Repeater Mode OFF (default)	When enabled, this mode will simply echo EVERY message is hears. Therefore no more than 1 repeater should be used UNLESS specific rules are followed. An application note will be available shortly to explain this further.		
ER_CMD#A31	Repeater Mode ON			
ER_CMD#Fds	FREQUENCY SWAP 'd' = destination 's' = source	This feature allows you to transmit on a different channel frequency to the receive frequency. e.g. ER_CMD#F07 After reselecting channel 0, the module will listen on CH0 but transmit on CH7. To reset the module to its default, send the same source channel number to the destination: e.g. ER_CMD#F00 **Warning DCS should be disabled to use this feature.**		

TEST MODES				
ER_CMD#T0	Upper FSK Carrier			Test Mode 0
ER_CMD#T1	Modulated Carrier			Test Mode 1
ER_CMD#T2	Lower FSK Carrier			Test Mode 2
ER_CMD#T3	Get Firmware Revision			Returns Firmware String: eg ER400TRS-02V2.01.5
ER_CMD#T4	RAW Data Test			Out of CTS pin

    i)   Recommended setting for EN300-220 compliance This setting is effective on ALL ER900TRS/RS/TS despatched on or after 5th September 2005.

    ii)   Use the custom BAUD settings with extreme caution especially on versions up to V2.0.1.7. If the custom BAUD rate has been set to a speed that is not compatible with a PC, it can only be reset using a microcontroller set to the same BAUD. From firmware V2.01.8, a start-up reset to 19200 can be set by grounding the pin on the reverse of the module on power up. This mode is temporary and allows the user to recover the module, using ER commands at 19200.(See picture Below)
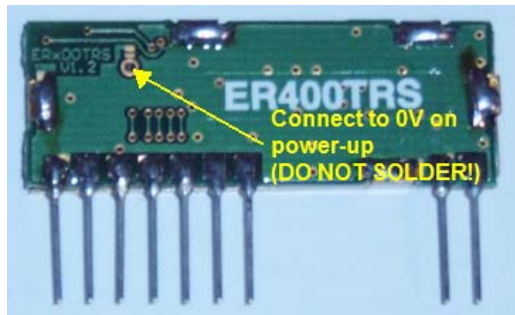
To successfully send a command do the following:
1. Send Command from host: e.g.   ER_CMD#U5   (Set UART BAUD to 38400)
2. In the case of a TRS/RS:
    o   Wait for echo of command from module.   e.g. ER_CMD#U5
    In the case of a TS:
    o   Wait 20mS
3. Send the ASCII string from the host: ACK

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' .
Note that the TS (transmitter) devices send data 'over air' as they are not equipped with a serial data out or handshake pins. This takes approximately 20mS and time should be taken in to account before sending the 'ACK' sequence

"FAST ACK"

In this mode the procedure to update settings is made much faster. In response to an ER_CMD#x string the TRS/RS module will reply with a single HEX 6 (0x06) which is the ASCII ACK value. The host will then issue the same single byte 0x06 in replacement of the Txt version of "ACK".

Notes:
RSSI Output

The Receiver/Transceiver has a built in RSSI (Received Signal Strength Indicator) that provides an analogue output voltage that is inversely proportional to the RF energy present within the pass band of the receiver. It ranges from 0 Volt (maximum signal, –65dBm) to 1 Volt (minimum signal, -115bBm) and has a slope of approximately 50dB/Volt. This analogue output signal should only be connected to a high impedance load (>100kΩs) and can be used to provide a measure of the signal strength and any interfering signals (noise) within band during the installation and operation of systems.

Figure 10 RSSI Output
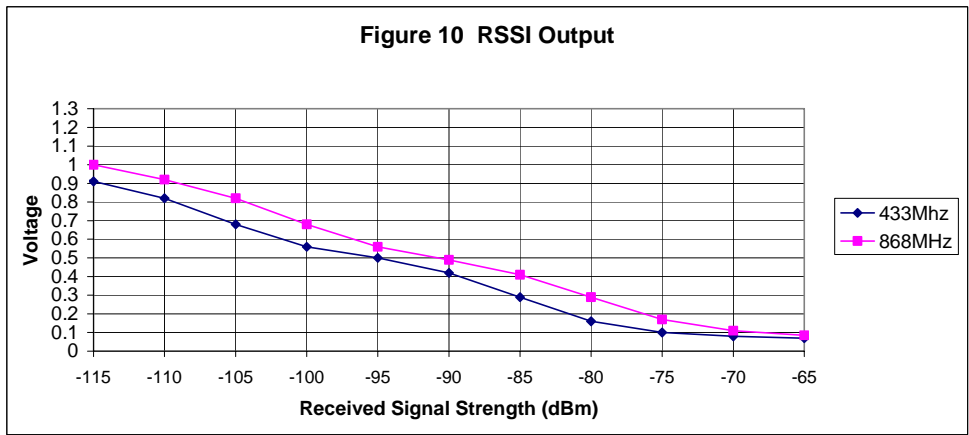
Application Notes

MAX232 Application
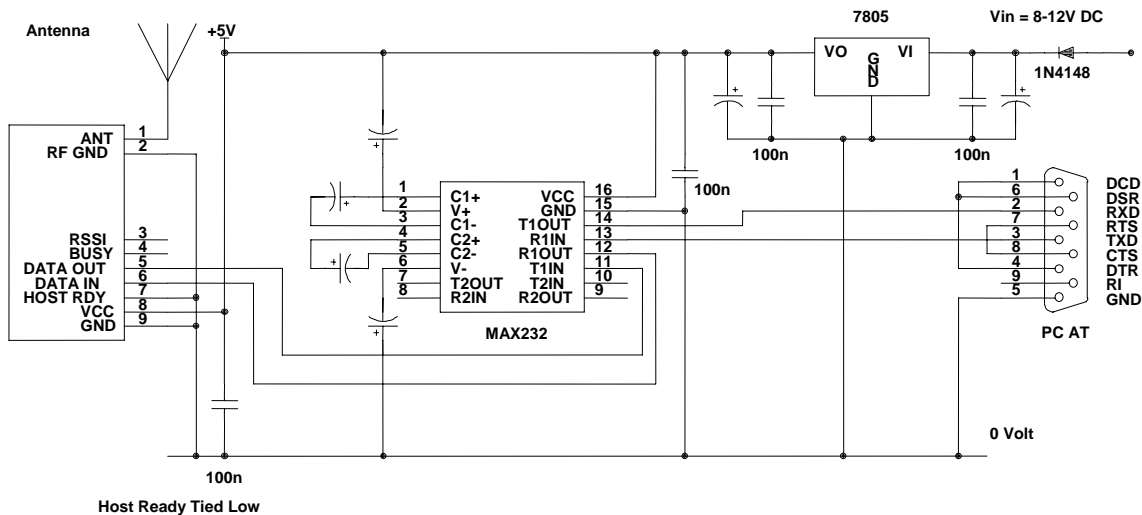
Figure 11 MAX232 Application Circuit

Compatibility

The ERx00TS, ERx00RS & ERx00TRS use crystal controlled synthesisers to accurately define transmit and receive frequencies incorporating RS232 protocols, and so should not be used in connection with Non-Easy Radio RF modules unless the firmware allows.

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 receiver can be used with the various common types of antenna that match the 50Ω RF Input/Output such as a monopole (whip), helical or PCB/Wire loop antennas.

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.

Technical Characteristics

ER900TRS: Power vs Temperature (868Mhz @ 5V)
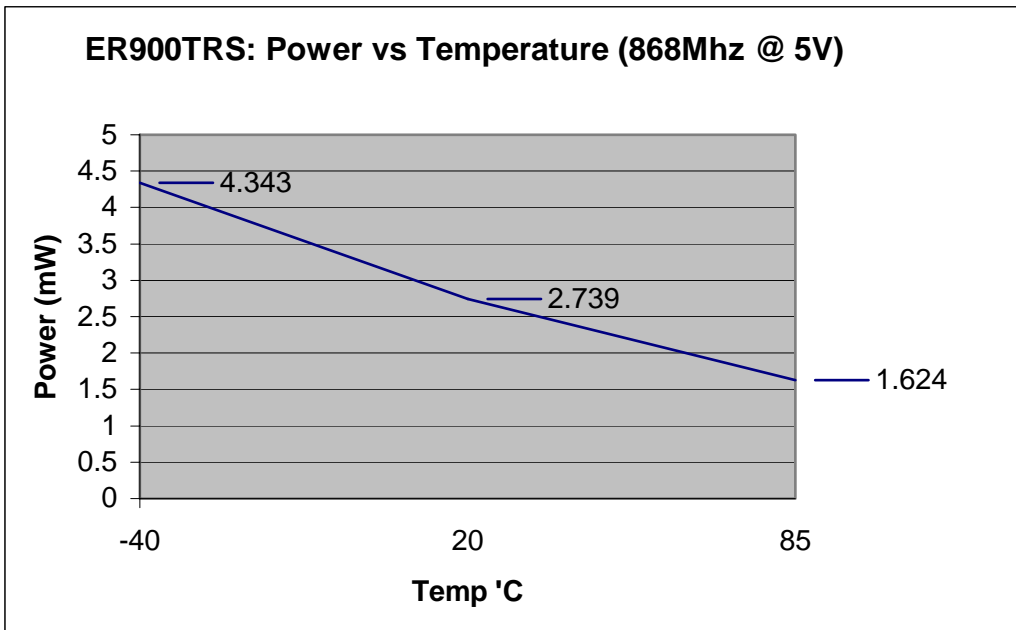
easyRadio errata notes:

ISSUE1

(LPRS ERRATA-001.pdf)
This Errata sheet applies to all ER400TRS-02 & ER400RS-02 modules shipped prior to 4th May 2005.

ISSUE:
Frequency Channels 1, 4 & 9 may have poor or no communication.

DESCRIPTION:
The receiving frequency channels 1, 4 & 9 which can be selected using the easyRadio command structure, ("ER_CMD#Cx" where x is the channel number) as set by the factory may be sufficiently off frequency to cause poor communication and in worst cases none at all on these channels.
All other channels are unaffected.
This has been caused during production where incorrect values have been set in the EEPROM locations that control each channel frequency.
This is NOT a software bug, but rather a setting used by the firmware. A couple of workarounds can be suggested if this poses an issue, when frequencies other than the defaults are used.

Work Around:
i)   Do not use channels 1,4, or 9.
ii)   Update module settings.

The latest easyRadio Evaluation software (Version 2 and above) incorporates the necessary settings to update the module and is available for download via http://www.lprs.co.uk
As this is NOT a firmware update, the firmware version will remain unaffected.

ISSUE2

(LPRS ERRATA-002.pdf)
This Errata sheet applies to all ER400TRS-02 & ER400RS-02 modules with firmware up to V2.01.5

ISSUE:
RTS (Host Ready) input, does not allow restart of data flow when set low after being held high.

DESCRIPTION:
When Handshaking it enabled, the data received over air will only be delivered if the RTS pin is held low continually.
Any break in the sequence (ie. RTS being set) will prevent remaining data being streamed.
The module may also reset, causing a recalibration to take place.
No settings will be lost and reception will carry on transparent to the host.

Work Around:
1. Do not enable the handshaking mode, then:
2. Use the CTS to prepare the system for data and dedicate time to receive the data.

This issue will be resolved in the next firmware revision (V2.01.6 & above)

ISSUE 3

(LPRS ERRATA-003.pdf)
This Errata sheet applies to all ER4/900TRS-02 modules up to and including firmware V2.01.5

ISSUE:
Radio appears to stop responding after an undefined period.

DESCRIPTION:
When a host device is dependant on receiving a signal from another remote unit before transmitting and usually when a lot of data is being exchanged (ie multiple transmissions & receptions per second over long periods), occasionally the PLL may not lock in frequency when returning to RX mode after a transmission. In our tests this may only happen after thousands of exchanges, typically above 5000, although this number is not definitive.

Work Around:
1)   Test for a lock condition:
Send the command:
        ER_CMD#L30D?
After the final "ACK" the module will return a two-byte ASCII number. E.g. 83.
The '3' is the important number. Any other number will show the PLL is not locked and needs to be reset.
Either:
   i.   Send a 'Dummy' transmission. This will force the RX to reset again after the transmission.
   ii. Send a channel update (eg. ER_CMD#C7 etc)
   iii. Reset Module through a power on reset

2)   If you do not wish to test for a lock condition, you may be able to detect (through timeouts in your own software etc) that a problem has occurred, and perform one of the resolutions as described in 1).

This issue will be resolved in the next firmware revision (V2.01.6 & above)

ISSUE 4

This Errata applies to all ER4/900TRS-02 modules with firmware V2.01.7

ISSUE:
Data is not delivered correctly with handshaking turned on.

DESCRIPTION:
When handshaking is turned ON, the RTS pin is used to control the flow of data from the module. When the RTS pin is held high, instead of stalling the flow of data from the received buffer the data is dumped and the module reset.

Work Around:
There is no workaround for this, other than to not use the feature.
This issue has been rectified in firmware version V2.01.8

Product Order Codes

Name	Description	Order Code
Easy-Radio 400 Transmitter	UK/European Transmitter Module on 433 MHz	ER400TS-02
Easy-Radio 400 Receiver	UK/European Receiver Module on 433 MHz	ER400RS-02
Easy-Radio 400 Transceiver	UK/European Transceiver Module on 433 MHz	ER400TRS-02
Easy-Radio 900 Transmitter	Europe/US Transmitter Module 869/915MHZ	ER900TS-02
Easy-Radio 900 Receiver	Europe/US Receiver Module 869/915MHZ	ER900RS-02
Easy-Radio 900 Transceiver	Europe/US Transceiver Module 869/915MHZ	ER900TRS-02

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 Module Firmware Version

Version	Date	Revision	Known Issues
2.01.8	Feb 2006	**Fixes:** 2.01.7 Issues resolved. **Features added:** RS232 override (see Page 18 note ii)	None at time of print.
2.01.7	Sept 2005	**Fixes:** Busy pin sets when waking from sleep	1) ER_CMD#R1 "Reset to Default" does not work. 2) If HS enabled, delivery of data may stop if interrupted by asserting RTS.
2.01.6	Sept 2005	**Fixes:** (See errata for published issues) RTS issue Frequency lock issue. Frequency settings updated. **Features added:** Encryption, 16-Bit CRC, Repeater, RS232 Parity, Sleep mode	Busy will not set while waking from sleep. Workaround: wait 14mS before sending data after waking from sleep.
2.01.5	March 2005	Fixed 2.01.4 Issue Added Default Power settings using lowercase 'p' (See Command Table)	See errata sheets 001-003
2.01.4	Feb 2005	Fixed RSSI. (Previous Releases did not work correctly)	ER_CMD#R1 Reset to defaults sets UART/POWER/CHANNEL all to 0
2.01.3	Jan 2005	Initial Release	

Document History

Issue	Date	Revision
2.4	March 2006	Removed references to 'Software guide'. Added items in command list. Updates some specification values.
2.3	September 2005	Corrected Voltage and other minor Specifications. Added Temperature Characteristic table, Contents, Command list items, errata.
2.2	March 2005	Removed Provisional status. Updated commands & feature lists.
2.1	Feb 2005	First Provisional Datasheet for '02' series modules

Copyright

Certificates of Conformance to EN300-220 Part3

The following pages contain the certificates of conformance to the regulations as set out in the ETSI documentation for EN300-220, and the essential requirements, as laid out within part 3.

You may add these certificates to your own technical construction file under the provisions provided within article 3 of the Directive 1999/5/EC.

However, during design, care must be taken so that there is no amplification made to the module, either by use of an antenna with gain or an external RF amplifier. Any such changes or modifications will make these certificates invalid, and further testing will remain the responsibility of the final product.

ER400TS-02   and   ER900TS-02

Low Power Radio Solutions Ltd
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Certificate of Conformance

Date: 8th July 2005

Module Family: easy-Radio

Type: ER400TS-02   and   ER900TS-02

Frequency: 433.23 – 434.35MHz   (ER400TS-02)
                                                              869.7MHz – 870MHz   (ER900TS-02)

Description: Low Power Radio Transmitter

Intended Purpose: RF Short Range Devices

Equipment Class: Class 3 Radio Communications Equipment

We hereby declare the above listed product complies with the essential requirements of article 3 and other relevant provisions of the Directive 1999/5/EC when used for its intended purpose, as self-certified and tested internally by LPRS Ltd under the provisions provided within article 3 of the Directive 1999/5/EC.

Measure for the efficient use of the radio frequency spectrum pursuant to Article 3.2

Standards applied: ETS 300 220-3 09/2000

This certificate does not cover safety, fitness for any purpose or any requirements other than those stated

Signed for and on behalf of
Low Power Radio Solutions Ltd

…………………………………..

ER400RS-02 and ER900RS-02

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UK

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Certificate of Conformance

Date: 8th July 2005

Module Family: easy-Radio

Type: ER400RS-02   and ER900RS-02

Frequency: 433.23 – 434.35MHz   (ER400RS-02)
                                            869.7MHz – 870MHz   (ER900RS-02)

Description: Low Power Radio Receiver

Intended Purpose: RF Short Range Devices

Equipment Class: Class 3 Radio Communications Equipment

We hereby declare the above listed product complies with the essential requirements of article 3 and other relevant provisions of the Directive 1999/5/EC when used for its intended purpose, as self-certified and tested internally by LPRS Ltd under the provisions provided within article 3 of the Directive 1999/5/EC.

Measure for the efficient use of the radio frequency spectrum pursuant to Article 3.2

Standards applied: ETS 300 220-3 09/2000

This certificate does not cover safety, fitness for any purpose or any requirements other than those stated

Signed for and on behalf of
Low Power Radio Solutions Ltd

…………………………………..

ER400TRS-02 and ER900TRS-02

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Certificate of Conformance

Date: 6th July 2005

Module Family: easy-Radio

Type: ER400TRS-02   and   ER900TRS-02

Frequency: 433.23 – 434.35MHz   (ER400TRS-02)
                              869.7MHz – 870MHz   (ER900TRS-02)

Description: Low Power Radio Transceiver

Intended Purpose: RF Short Range Devices

Equipment Class: Class 3 Radio Communications Equipment

We hereby declare the above listed product complies with the essential requirements of article 3 and other relevant provisions of the Directive 1999/5/EC when used for its intended purpose, as self-certified and tested internally by LPRS Ltd under the provisions provided within article 3 of the Directive 1999/5/EC.

Measure for the efficient use of the radio frequency spectrum pursuant to Article 3.2

Standards applied: ETS 300 220-3 09/2000

This certificate does not cover safety, fitness for any purpose or any requirements other than those stated

Signed for and on behalf of
Low Power Radio Solutions Ltd

…………………………………..

Disclaimer

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 <u>we do not assume any responsibility for errors or any liability arising from the application or use of any product or circuit described herein</u>. 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, as is also the 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.

CONTACT INFORMATION

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The above address is a dedicated web site for Easy-Radio