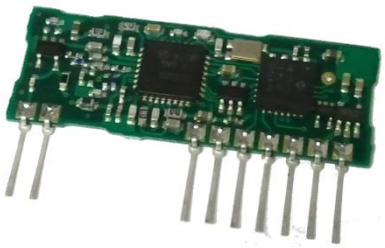
Low Power Radio Solutions Ltd

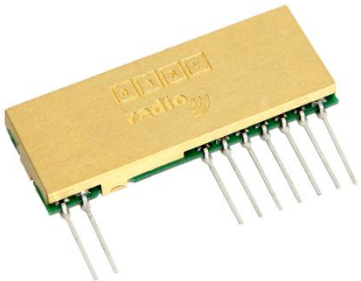
Data Sheet

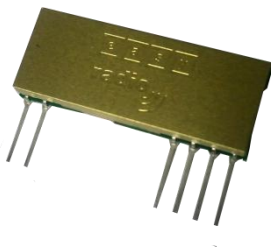
easyRadio Advanced ISM radio modules

Modules Included:

- ERA400TRS
- ERA900TRS
- ERA400TS
- ERA900TS







Contents

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.

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

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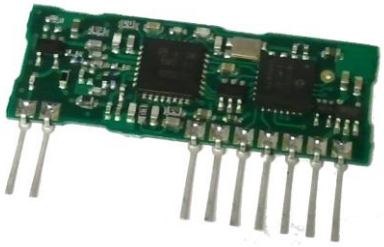
Introduction to easyRadio Advanced



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 19.2KHz 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%*.

New features:

- A new 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 new command allows the user to scan other channels 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 02 modules.
- Temperature compensation plus crystal controlled synthesiser for frequency accuracy less than +/- 1KHz over full temperature range
- Temperature sensor usable by host

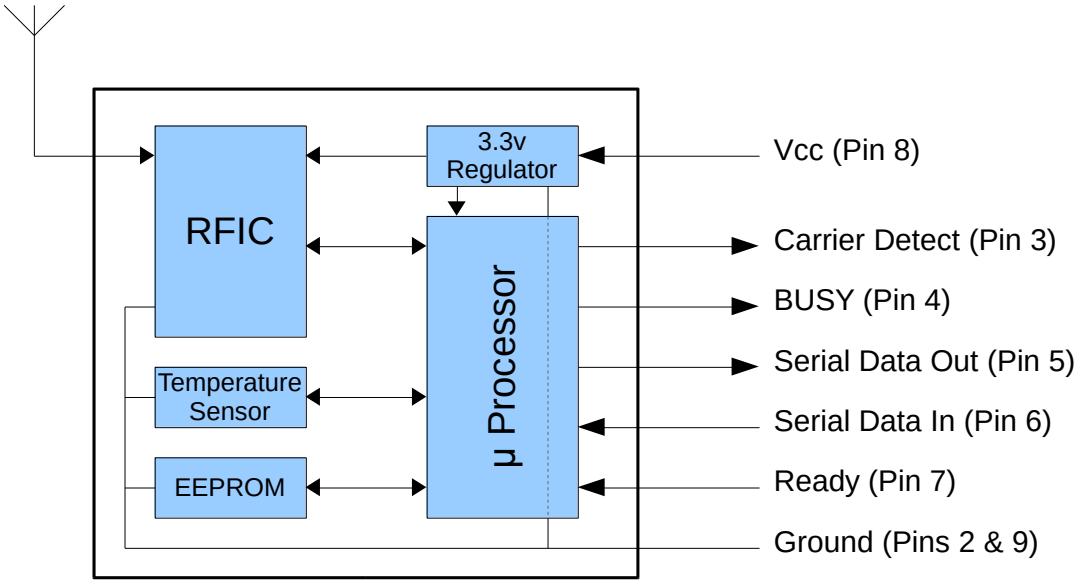
Basic Specifications

- 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
  Output Power (Up to 10dBm)
  10mW @ 434MHz
  5mW @ 869.85MHz

ERA400TRS/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:

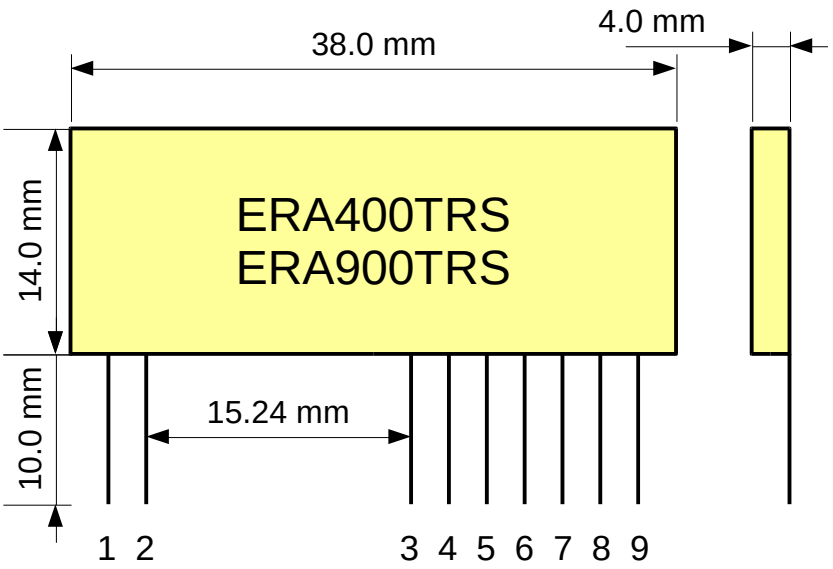
easyRadio Transceiver Block Diagram



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 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.

Physical Dimensions



Pin Pitch 2.54mm
PCB Hole Size 1.0mm

Pin Description (easyRadio mode)

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	CD	Carrier Detect	
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	

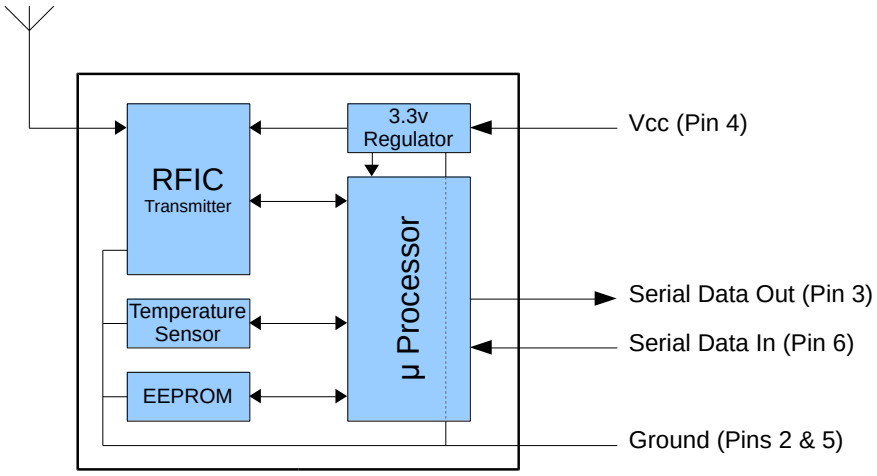
Checklist

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, only when handshaking is enabled.
4. Outputs will drive logic operating at 3.3 Volts and inputs will be correctly driven by logic operating at 5 Volts.
5. Fit 1K resistors in series with data lines if connecting to 5V logic.

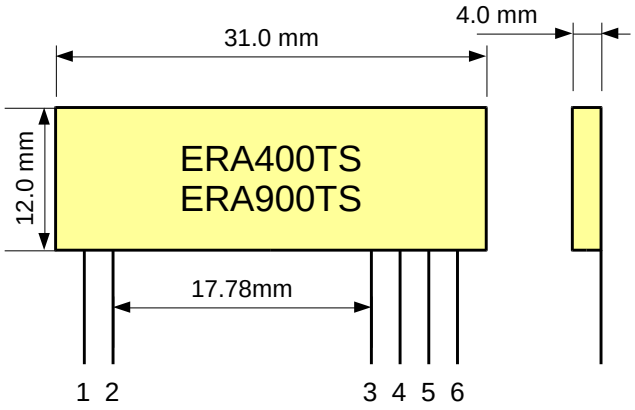
Pin Description (RAW RF Data mode)

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	CD/Config	Carrier Detect	Carrier Detect/Config mode select pin
4	RX Select	RX mode select pin	Active Low
5	RX Data	Raw RF data output	
6	TS Data	Raw RF data Input (Toggling this pin modulates the carrier)	
7	TX Select	Enables the transmitter carrier.	Active Low
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	

ERAx00TS Transmitter



Block Diagram



Pin Pitch 2.54mm
PCB Hole Size 1.0mm

Physical Dimensions

Pin Description

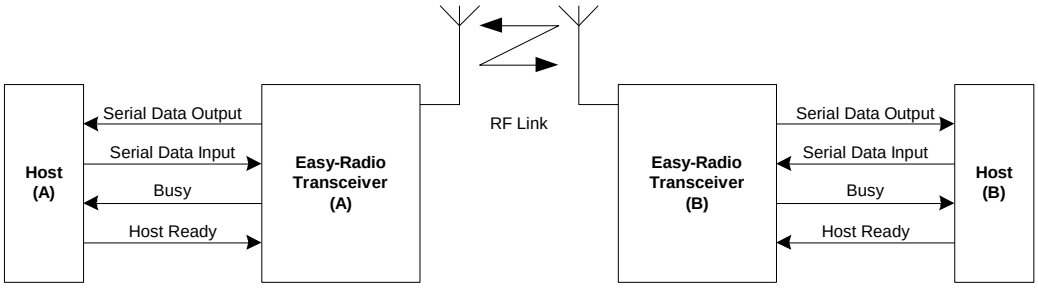
1	RF Gnd	RF ground. Connect to antenna ground (coaxial cable screen braid) and local ground plane. Internally connected to Pin 5	
2	RF Out	50Ω RF output. Connect to suitable antenna	
3	Serial Data Out	RS232 Output for Command use (SDO)	
4	Vcc	Positive supply pin. +2.5 to +5.5 Volts. This should be a 'clean' noise free supply with less than 25mV of ripple	
5	Gnd	Supply 0 Volt and Ground Plane	
6	TXD	RS232 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 2.5 - 5 Volts. Input should not be driven by an analogue source.

Application & Operation ERx00TRS-03

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 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 easyRadio Advanced Modules.

Host Serial Input/Output	2400, 4800, 9600, 19200, 38400, 31250 (MIDI), 76800 & 115200	baud	1
Host Character Format	1 Start, 8 Data, No Parity, 1 Stop	Bits	2
End of Data Delay	2 x BAUD BYTE Duration	mS	3
RF Transmit	Depends on Bandwidth	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)
3. The 'End of Data' delay is fixed at twice the character time.
4. A fixed package overhead of xx 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 ERA400TRS & ERA900TRS

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	
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		402 868 902	434 869.85 915	470 870 928	MHz MHz MHz	See ER Configuration Command set
Transmitter						
RF Power Output	1	-5 -5	+9 +5	+10 +5	dBm (434MHz) dBm (869MHz)	50Ω load Depends on Frequency
Frequency accuracy			±2		ppm	Overall
FM deviation			9.9 2.4 2.025		Khz Khz KHz	100KHz Spacing 25KHz Spacing 12.5KHz Spacing
Harmonics/ Spurious Emmissions			-47	< -36	dBm	Meets EN 300 220-3
Over Air Data rate		1200	19200	38400	bps	Manchester Encoded
Receiver						
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 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.
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.

ERA400TRS 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
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:
Note that shaded items are either new **03** commands or changes from **02** modules.

RS232 Communication Settings				
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#U6	31250	31250		
ER_CMD#U7	76800	76800		
ER_CMD#U8	115200	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			

RF POWER Settings				
		ER400Series	**ER900 Series**	
ER_CMD#P0~9	RF Power Output			
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		**ERA400**	**ERA900**	
ER_CMD#bx	Default = 0 1 2 3	433.1 MHz 433.1125 MHz 458.5125 MHz 433.0 MHz	869.7MHz 902MHz 863MHz	This setting chooses the start frequency of Channel 0
MISCELLANEOUS COMMANDS				
ER_CMD#R0	Reset module (POR)			Power reset
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	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#A21	CRC16 ON(default)			
ER_CMD#A30/1	Repeater OFF/ON	NOT YET IMPLEMENTED		
ER_CMD#A40/1	Fast ACK OFF/ON			
ER_CMD#A50/1	Handshaking OFF/ON			
ER_CMD#A70 ER_CMD#A71 ER_CMD#A72	Parity Disable Parity Even Parity Odd			
ER_CMD#a0/1	RSSI In Packet	When enabled each packet is preceded by the 8 bit RSSI value of the received packet		

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
1. 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' .

RAW Data Mode (TRS Only at time of print)

easyRadio Advanced modules have the added versatility of being used without the proprietary protocols from easyRadio and yet still being used as a multi-channel, multi-bandwidth module.

This allows the user to set precise frequencies to replace other raw data devices on exact frequencies.

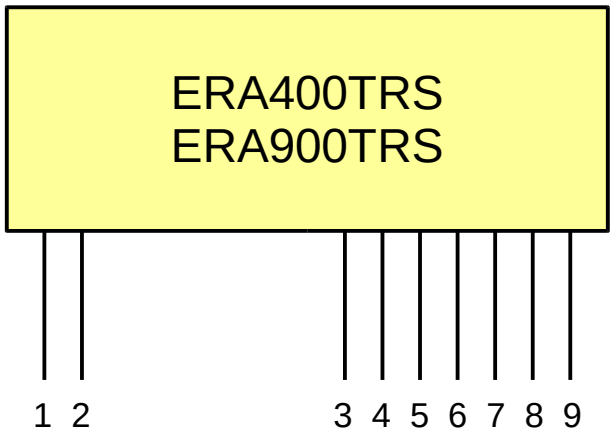
Both FSK (FM) and ASK (AM) modes are supported, and with the integration of a configuration mode, AM/FM modes, power levels, channels and bandwidth settings, can be changed on the fly with a very efficient command structure.

Enable RAW data mode:

1) When in easyRadio mode send the command ER_CMD#L40202
2) Perform a power reset with Pin 3 left either floating or held high

Return to easyRadio mode:

1) Hold Pin 3 low while providing power (This will not change the default POR setting)
2) Once powered, send the command ER_CMD#L40200. This will reset the default POR setting to easyRadio Mode



Pin 1 Antenna
Pin 2 RF Ground
Pin 3 Carrier Detect/Config Mode Pin
Pin 4 RX Select (Active Low)
Pin 5 RF RX Data Output
Pin 6 TX Data Input
Pin 7 TX Select (Active Low)
Pin 8 VCC
Pin 9 Data Ground

Mode Selection 1 = +V, 0 = 0V, x = Don't Care			
Pin 3	Pin 4	Pin 7	Mode
x	1	1	Sleep
x	0	1	RX Enabled (Output on Pin 5)
x	1	0	TX Enabled (Input Modulation on Pin 6)
1	0	0	Module asleep but higher current (Not recommended)
0	0	0	Configure mode

Once in configure mode, Pins 5 & 6 return to functional UART pins at the stored module BAUD rate (default 19200).
The configuration command set ALL setting in one command which is 5 bytes long:

BYTE 1	BYTE 2	BYTE 3	BYTE 4	BYTE 5
Bandwidth/AM-FM	Band Plan	Channel	Power Level	CSUM

Each byte uses Hex values in 8-bit format and corresponds to the settings used when selecting parameters in normal ER commands. Bit 7 of BYTE 1 is used to switch between AM/FM modes. 0 = FM, 1 = AM.
Therefore, to set an FM channel 10 at 12.5KHz Spacing on Band-plan 0 and power level 9:
The configuration word would be: 01 00 0A 09 14 (Note CSUM at BYTE 5)

The module will ALWAYS respond with an ERROR Status Byte:

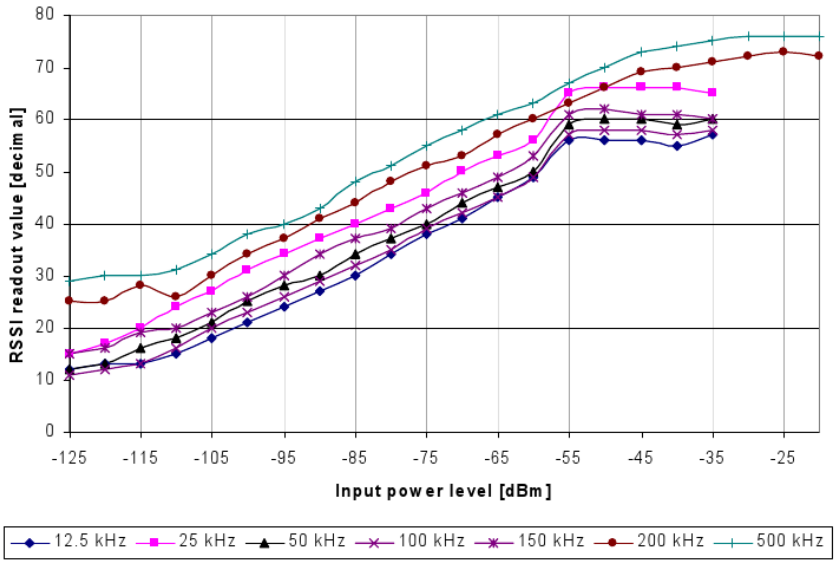
7	6	5	4	3	2	1	0
X	X	PLL	BW	BP	C	P	CSUM

A high in ANY of these positions indicates a failure in the Values used.
Bit 5 (PLL) indicates a failure to lock frequency using the settings requested and returns the module to the previously set mode.
Exit Configuration Mode:
Simply return Pin 3 to the High State and once all operations are completed (After delivery of ERROR Status BYTE) the Radio will return to RAW Data Mode with the new settings.

Notes:

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:



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 (¤/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
ERA400TS	UK/European Transmitter Module on 433 MHz	ERA400TS
ERA400TRS	UK/European Transceiver Module on 433 MHz	ERA400TRS
ERA900TS	Europe/US Transmitter Module 869/915MHZ	ERA900TS
ERA900TRS	Europe/US 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.

easyRadio Advanced Module Firmware Version

Version	Date	Revision	Known Issues
3.6.9	January 2010	Initial Release	None at time of print.
3.6.17	October 2010	Improved Calibration.	
3.6.23	March 2011	Numerous feature additions	RS232 Parity not yet working.

Document History

Issue	Date	Revision
3.1	January 2010	First Provisional Datasheet for '03' series modules
3.4	April 2011	Module rebranded as ERA. Numerous corrections/additions

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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.

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