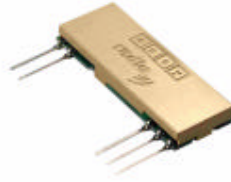




RS & TRS



TS



The Easy-Radio ER400TS Transmitter, ER400RS Receiver and ER400TRS transceiver incorporate 'Easy-Radio' 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.

The modules operate on the Pan-European 433 to 434MHz frequency band from a 3.6V supply and are housed in space saving Single-In-Line (SIL) packages.

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. Further information is available in the 'Easy-Radio Demonstration Kit & Programming Software' guide, which should be read in conjunction with this data sheet.

**Features**

- Crystal controlled synthesiser for frequency accuracy
- High sensitivity receiver – typically -105dBm @ 38.4 Kbps
- 10mW Transmit Power
- Low operating Voltage - 3.6 Volts – Single Lithium Cell
- Low power consumption: Receiver – 13mA  
Transmitter – 23mA
- 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

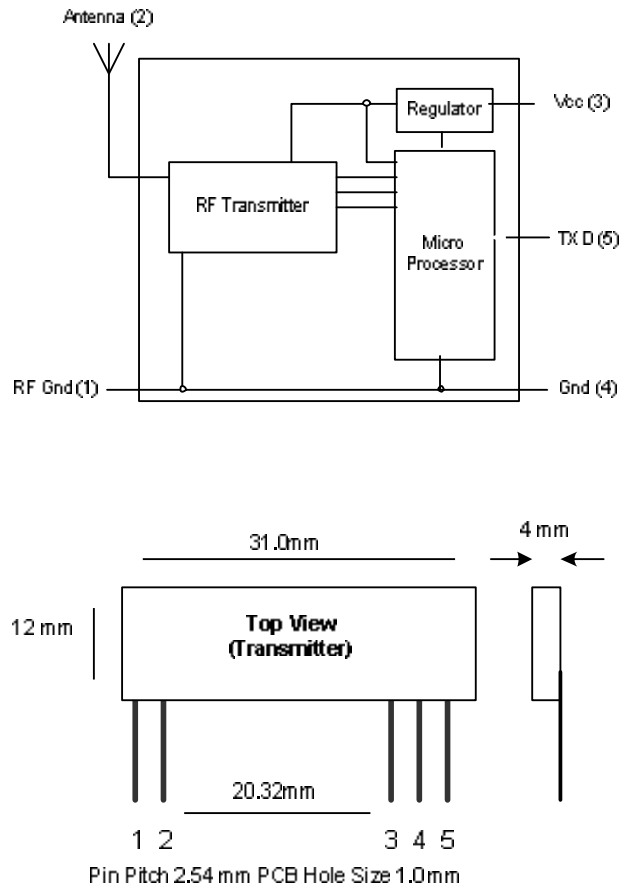
**Description**

The Easy-Radio ER400TS Transmitter, ER400RS Receiver and ER400TRS Transceiver utilise modern high performance FM (FSK) transmitter and receiver ICs combined with a 'flash' programmable microprocessor and an internal voltage regulator. They are suited for general-purpose remote control and data telemetry applications within the European 433MHz ISM band.

The receiver is provided with a Received Signal Strength Indicator (RSSI) output that can be optionally used to measure received signal levels.

The modules connect to any 50-Ohm antenna such as a whip, helical or PCB loop.

**ER400TS Transmitter**



**Figure 2 Physical Dimensions**

**Pin Description**

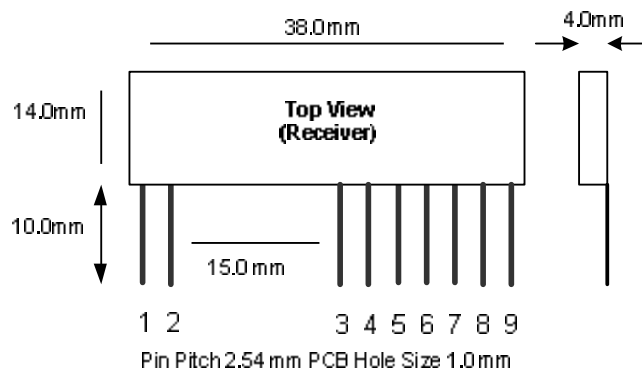
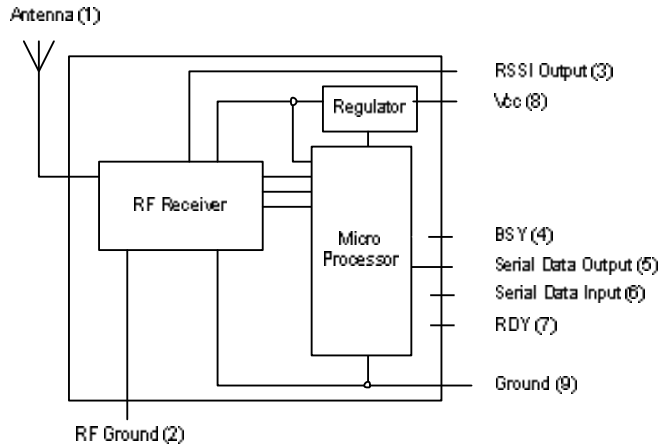
Pin No	Name	Description	Notes
1	RF Gnd	RF ground. Connect to antenna ground (coaxial cable screen braid) and local ground plane. Internally connected to Pin 4	
2	RF Out	50 Ohm RF output. Connect to suitable antenna	See Note
3	Vcc	Positive supply pin. +3.6 to +6.0 Volts. This should be a 'clean' noise free supply with less than 25mV of ripple	
4	Gnd	Supply 0 Volt and Ground Plane	
5	TXD	Transmit Data Digital Input (SDI)	2

**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 output.

**ER400RS Receiver**

The Easy-Radio 400 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 50 Ohm antenna such as a whip, helical or PCB loop.



**Figure 4 Physical Dimensions**

**Pin Description**

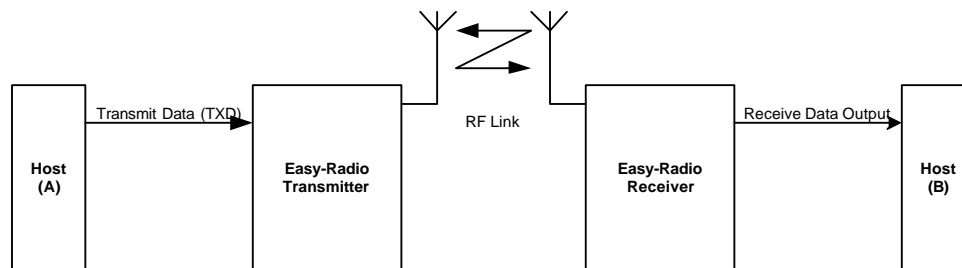
Pin No	Name	Description	Notes
1	Antenna	50 Ohm RF input/output. Connect to suitable antenna.	See Note
2	RF Ground	RF ground. Connect to antenna ground (coaxial cable screen braid) and local ground plane. Internally connected to other Ground pins.	
3	RSSI	Received Signal Strength Indication - Analogue	See Note
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. +3.6 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.
4. If in handshaking mode, pin (7) of the ER400RS module should be connected directly to GND for data to be delivered.

**Application & Operation ER400TS & RS**

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 128 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.

- 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 fills an internal transmit buffer until either 128 bytes have been received 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 a fixed 10mS preamble followed by the data in the buffer which is Manchester encoded at 19,200 Baud for efficient transmission across the RF link. Any Easy-Radio receivers within range that 'hear' the transmission will simultaneously lock onto the preamble, 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 '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 8). 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.

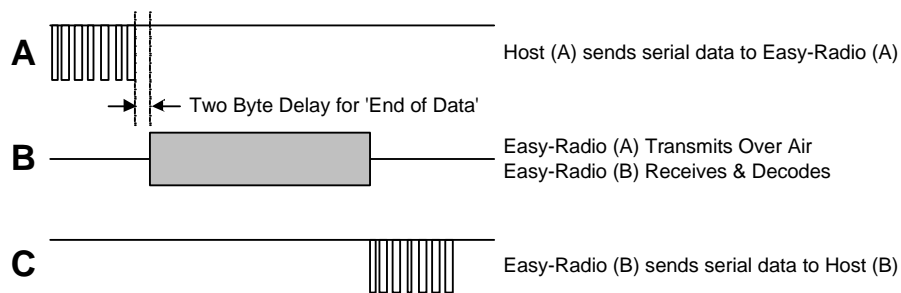
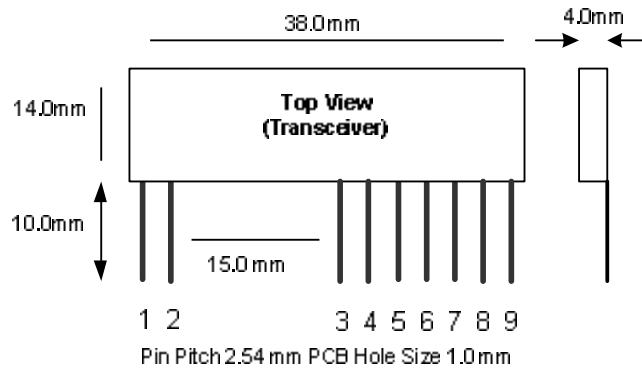
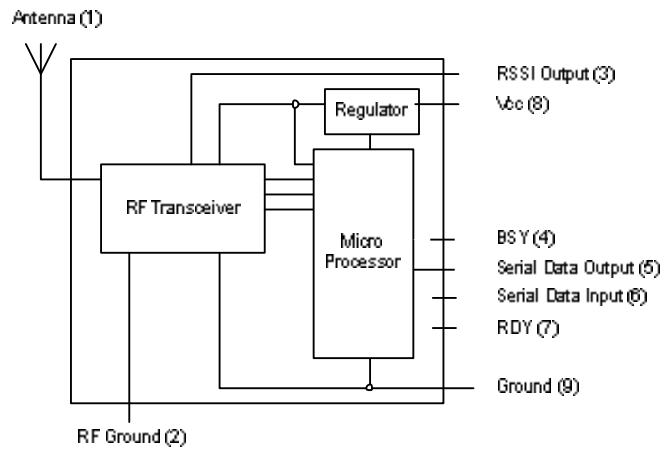


Figure 6 Serial Data

### ER400TRS Transceiver Description

The Easy-Radio 400 Transceiver is a complete sub-system that combines a high performance very low power RF transceiver, a microcontroller and a voltage regulator (Figure 7).



**Figure 8 Physical Dimensions**

**Pin Description**

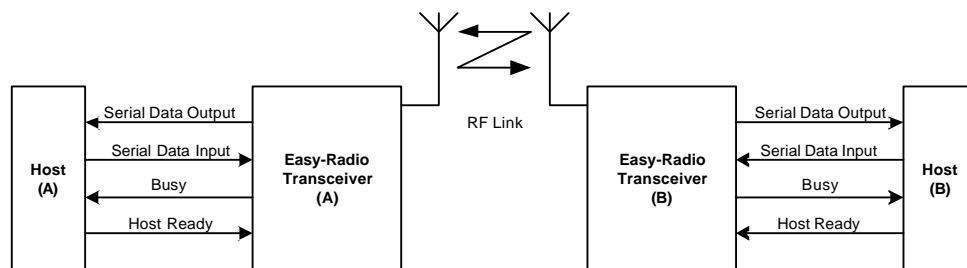
Pin No	Name	Description	Notes
1	Antenna	50 Ohm RF input/output. Connect to suitable antenna.	See Note
2	RF Ground	RF ground. Connect to antenna ground (coaxial cable screen braid) and local ground plane. Internally connected to other Ground pins.	
3	RSSI	Received Signal Strength Indication	See Note
4	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. +3.6 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.
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 ER400TRS**

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.

Detailed operation of interfacing, handshaking (including timing) is described in the 'Easy-Radio Software Guide'.

**Timing Specifications** – Applies to all Easy-Radio Modules.

<b>Parameters</b>	<b>Min</b>	<b>Units</b>	<b>Notes</b>
Host Serial Input/Output	2400, 4800, 9600, 19200, 38400	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	13.2 + (n Bytes X 0.8)	mS	4
Buffer Size	1-128	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 PIC 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, page 13).
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 13.2mS is added to all packets.
5. The buffer size is limited to 128 bytes. Sending more than 128 bytes will cause loss of data.



**Absolute Maximum Ratings ER400TS, ER400RS and ER400TRS**

Operating Temperature Range	-20° C to +65° C (Commercial)
Storage Temperature Range	-20° C to +75° C
Vcc	- 0.3 to + 6.0 Volts
All Other Pins (N.B.)	- 0.3 to 3.3 Volts
Antenna	50V p-p @ < 10MHz

**Performance Data: ER400TS Transmitter** Supply +5.0 Volt ± 5%, Temperature 20° C

DC Parameters	Pin	Min	Typical	Max	Units	Notes
Supply Voltage (Vcc)	3	3.6	5.0	5.5	Volts	
Supply current	3		23		mA	1
Interface Levels						
Data Input Logic 1		2.0			Volts	
Data Input Logic 0				0.2	Volts	
Input Impedance			100		K Ohm	
RF Parameters	Pin	Min	Typical	Max	Units	Notes
Antenna Impedance	2		50		Ohms	
RF Frequency			433-4		MHz	See ER Configuration Command set Page 12
RF Power Output	2		+10		dBm	50 Ohm load
Frequency accuracy			±50		ppm	Overall
FM deviation			64		kHz	
Harmonics		-43			dB	Below fundamental
Data Rate		2.4	19.2 (Default)	38.4	Kbps	76.8k available on request
Logic Timing	Pin	Min	Typical	Max	Units	Notes
Power Up Time			7		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. Contact the Sales Office for details of special low power variants. RF power output can be programmed at the factory.
2. Time required to 'lock' synthesiser from power up.

**Performance Data: ER400RS Receiver** Supply +5.0 Volt  $\pm$  5%, Temperature 20° C

DC Parameters	Pin	Min	Typical	Max	Units	Notes
Supply Voltage (Vcc)	8	3.6	5.0	5.5	Volts	
Receive supply current	8		12.5		mA	
Quiescent supply current	8		2		mA	1
<b>Interface Levels</b>						
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		K Ohm	
<b>Antenna</b>						
Antenna Impedance	1		50		Ohms	
RF Frequency			433-4		MHz	See ER Configuration Command set Page 12
<b>Receiver</b>						
Receive Sensitivity			-105		dBm	BER = 10 <sup>-3</sup>
LO leakage			-60		dBm	Meets EN 300 220-3
Data Rate		2.4	19.2	38.4	Kbps	76.8 on Request
RSSI Output	3	0		1.2	Volt	See Figure 10
<b>Logic Timing</b>						
Initial Power Up Time			7.5		mS	2,3
<b>Mechanical</b>						
Size		38 x 14 x 4		mm		
Pin Pitch			2.54		mm	Standard 0.1 Inches
Weight			3.5		gms	

**Notes**

1. Processor running at full speed. Contact the Sales Office for details of special low power variants.
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 receiver will then be ready to receive. It would normally be left in this powered state ready to receive data.
3. Contact the Sales Office for special 'fast' versions that can incorporate internal 'duty cycling' to further reduce quiescent power consumption for battery powered applications. Also for variants in frequency etc.

**Performance Data: ER400TRS transceiver** Supply +5.0 Volt  $\pm$  5%, Temperature 20° C

DC Parameters	Pin	Min	Typical	Max	Units	Notes
Supply Voltage (Vcc)	8	3.6	5.0	5.5	Volts	
Transmit supply current	8		23		mA	
Receive supply current	8		17.0		mA	
Quiescent supply current	8		2		mA	1
<b>Interface Levels</b>						
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				10	mA	
Data Input Logic 1		2.0			Volts	
Data Input Logic 0				0.2	Volts	
Input Pull-ups			100		K Ohm	2
RF Parameters	Pin	Min	Typical	Max	Units	Notes
Antenna Impedance	1		50		Ohms	
RF Frequency			433-4		MHz	See ER Configuration Command set Page 12
<b>Transmitter</b>						
RF Power Output	1		+10		dBm	50 Ohm load
Frequency accuracy			$\pm$ 50		ppm	Overall
FM deviation			-30		kHz	
Harmonics			-25		dBc	
Over Air Data rate			19200		bps	Manchester Encoded
<b>Receiver</b>						
Receive Sensitivity			-105		dBm	BER = $10^{-3}$
LO leakage			-60		dBm	Meets EN 300 220-3
Serial Data Rate		4.8	19.2	38.4	Kbps	Host interface. 6
RSSI Output	3	0		1.2	Volt	See Figure 10
<b>Logic Timing</b>						
Logic Timing	Pin	Min	Typical	Max	Units	Notes
Initial Power Up Time			7.5		mS	3,4
Standby Power Up Time			TBA			5
<b>Mechanical</b>						
Size		38 x 14 x 4		mm		
Pin Pitch			2.54		mm	Standard 0.1 Inches
Weight			3.5		gms	

## Notes

1. Processor running at full speed. Contact the Sales Office for details of special low power variants.
2. 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 or Ground 0 Volts.
3. 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.
4. During power up the Busy Output line goes high.
5. Contact the Sales Office for special 'fast' versions that can incorporate internal 'duty cycling' to further reduce quiescent power consumption for battery powered applications.
6. Serial data rate up to 38.4k standard but 76.8k available on request.

### Easy-Radio Configuration Command Set

The programming software sends 'text messages' to the modules and this action can be performed by the terminal software or User's own PIC using the following list of commands:

Command	Function	Value	Notes
ER_CMD#U1	UART Data Rate	2400	
ER_CMD#U2		4800	
ER_CMD#U3		9600	
ER_CMD#U4		19200	
ER_CMD#U5		38400	
ER_CMD#P0	RF Power Output	1mW	
ER_CMD#P1		2mW	
ER_CMD#P2		3mW	
ER_CMD#P3		4mW	
ER_CMD#P4		5mW	
ER_CMD#P5		6mW	
ER_CMD#P6		7mW	
ER_CMD#P7		8mW	
ER_CMD#P8		9mW	
ER_CMD#P9		10mW	
ER_CMD#C0	Channel 0	433.23	MHz
ER_CMD#C1	Channel 1	433.30	MHz
ER_CMD#C2	Channel 2	433.45	MHz
ER_CMD#C3	Channel 3	433.55	MHz
ER_CMD#C4	Channel 4	433.68	MHz
ER_CMD#C5	Channel 5	433.83	MHz
ER_CMD#C6	Channel 6	433.88	MHz
ER_CMD#C7	Channel 7	434.00	MHz
ER_CMD#C8	Channel 8	434.15	MHz
ER_CMD#C9	Channel 9	434.35	MHz
ER_CMD#R1	Default Settings		Factory Default
ER_CMD#T1	Carrier Only	XX	Test Mode 1
ER_CMD#T2	Constant Preamble	XX	Test Mode 2
ER_ERR#01	Invalid Command Parameter		Error command
ER_ERR#02	EEPROM is reset to defaults		

### Notes

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

**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, -50dBm) to 1.2 Volts (minimum signal, -105dBm) and has a slope of approximately 50dB/Volt. This analogue output signal should only be connected to a high impedance load (>100k Ohms) 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.

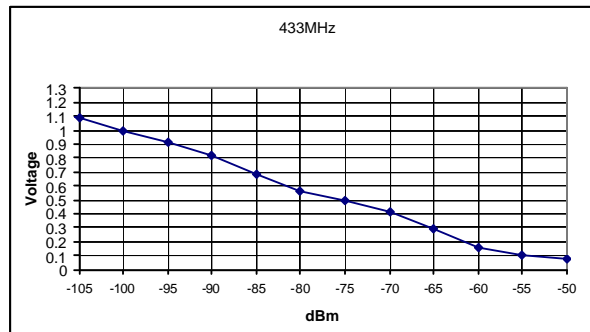


Figure 10 RSSI Output

**Application Notes**

**MAX232 Application**

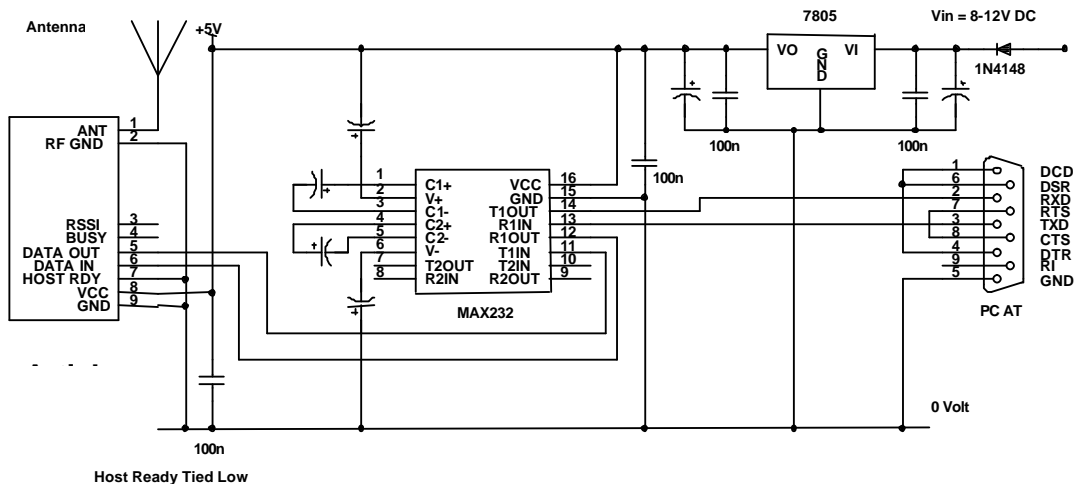


Figure 11 MAX232 Application Circuit

**Compatibility**

The ER400TS, ER400RS & ER400TRS 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.

**Encoding/Decoding**

Easy-Radio technology allows the transport of simple encoder/decoder code formats or more sophisticated schemes. Please contact sales/applications for further technical advice.

### **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 50 Ohm 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 ( $\lambda/4$ ). They are very easy to implement and can simply be a 'piece of wire' or PCB track which at 434MHz should be 16.4 cms 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 50 Ohm coaxial feeder cable or transmission line. A 50 Ohm 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
Easy-Radio 400 Transmitter	UK/European Transmitter Module on 433 MHz	ER400TS
Easy-Radio 400 Receiver	UK/European Receiver Module on 433 MHz	ER400RS
Easy-Radio 400 Transceiver	UK/European Transceiver Module on 433 MHz	ER400TRS

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
1.02	March 2003	

**Document History**

Issue	Date	Revision
1.1	March 2004	

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Web: <http://www.easy-radio.co.uk>

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

**End of Data Sheet**