# ETRX357DVK – TELEGESIS DEVELOPMENT KIT FOR ZIGBEE® TECHNOLOGY

# PRODUCT MANUAL

# 1 ETRX357DVK – Development Kit Functional Summary

## Devkit Features

- ZigBee Networking “Out-of-the-Box”
- Low cost evaluation platform for ZigBee wireless mesh networking
- Designed to set up a ZigBee mesh network in only a few minutes without the need for any embedded software
- The freely downloadable Telegesis Terminal Software application offers an easy to use interface to the modules on the development boards.
- Also works with 3rd party terminal software like HyperTerminal.
- Broad selection of modules allows range testing of any possible module/antenna combination.
- Seamlessly Integrates into the Silicon Labs InSight Toolchain
- Development boards can be used as hardware platform for trials
- Battery option allows easy prototyping of end devices
- USB Drivers available for Windows from www.telegesis.com

## Module Features

- Based on the Silicon Labs EM357 single chip ZigBee/ IEEE802.15.4 solutions
- 2.4GHz ISM Band
- Industry’s first ARM® Cortex-M3 based family of ZigBee modules
- 192kB flash and 12kB of RAM
- 24 general-purpose I/O lines including analogue inputs (all GPIOs of the EM357 are accessible)
- Lowest Deep Sleep Current of sub 1µA and multiple sleep modes

The Telegesis ETRX357-DVK development kit is an ideal starting point for development and evaluation of the ETRX357 series low power 2.4GHz ZigBee modules.

The ETRX357 modules are based on the third generation Silicon Labs EM357 chipset offering the industry’s highest wireless networking performance and application code space at the lowest power consumption.

The modules’ unique AT-style command line interface allows designers to quickly integrate ZigBee technology without complex software engineering. For custom application development the ETRX357 development kits integrate with ease into Silicon Labs’ InSight development environment.

## Development Kit Contents

- 3 x USB Development Boards
- 3 x USB Cable
- 2 x ETRX357 on Carrier-Board
- 2 x ETRX357HR on Carrier-Board
- 2 x ETRX357-LRS on Carrier-Board
- 2 x ETRX357HR-LRS on Carrier-Board
- 1 x ETRX3USB stick
- 2 x ½-wave Antenna
- 2 x ¼-wave Stubby Antenna

## Development Board Features

- Power can be supplied via USB, Power Jack or on board battery holder (2xAAA)
- Access to the Silicon Labs InSight Port
- Light and Temperature sensor
- 4 x Buttons, 2 x LEDs, 1 x Buzzer
- Reset and Bootload Button
- USB to Serial converter
- Breakout of all GPIO pins

## Example AT-Style Commands

| | |
|---|---|
| AT+BCAST | Sends a Broadcast |
| AT+UCAST:<address> | Sends a Unicast |
| AT+EN | Establish PAN network |
| AT+JN | Join PAN |

# Table of Contents

# 2 Absolute Maximum Ratings of the Devboard

| Parameter | Min. | Max. | Units | Condition |
|---|---|---|---|---|
| Supply Voltage $V_{DD}$ | -0.3 | 9 | V | |
| Voltage on any I/O pin | -0.3 | 3.3 | V | |
| Storage Temperature range | -50 | 85 | °C | Without batteries inserted |

**Table 1: Absolute Maximum Ratings**

The absolute maximum ratings given above should under no circumstances be violated. Stress exceeding one or more of the limiting values may cause permanent damage to the device.

Caution! ESD sensitive devices. Precautions should be used when handling the device in order to prevent permanent damage.

# 3 Operating Conditions of the Devboard

Typical values at 5V 25°C.

| Parameter | Min. | Typ. | Max. | Units | Condition |
|---|---|---|---|---|---|
| Supply Voltage, $V_{DD}$ | 4 | 5 | 6 | V | |
| Supply Current | | | 150 | mA | TX with LRS-Module |
| Operating ambient temperature range | -20 | 25 | 40 | °C | Range may be more limited when batteries are inserted. Consult datasheets applicable to your batteries |

**Table 2. Operating Conditions**

The voltage regulators used are protected against overtemperature and overcurrent.

# 4 Electrical Specifications

## 4.1 Power supplies

Only use a mains adaptor that has been certified as a low power source according to IEC60950-1.

The power from the USB connection should be restricted in line with the requirements of IEC 60950-1. PCs approved to IEC 60950-1 will meet this requirement.

Only good quality (vented) alkaline batteries should be used. Ensure they are inserted with the correct polarity. Note that they may restrict the working temperature range of the equipment.

## 4.2 ZigBee modules

See ETRX357 and ETRX357-LRS Product Manuals

## 5 Interoperability

Unless otherwise specified the Development kits ships with Telegesis R3xx firmware based on EmberZNet4.x. Please note that the R3xx Telegesis AT-Command line interpreter is based on ZigBee PRO, but most of the functionality is implemented as a private application profile. Interoperability with wireless mesh networking solutions from other manufacturers is only possible when knowing the application profile specification of this device and using the provided transparent commands. If this is a concern please contact us for advice. Telegesis also offer separate firmware specifically developed for Home Automation and Smart Energy applications.

## 6 Overview

The ETRX357DVK development kit has been designed to allow quick evaluation and prototyping using the ETRX357 ZigBee modules.

This document is intended to describe the hardware and accompanying software of the development kits. To learn more about the usage of the ETRX357 module please refer to the following documents:

- TG-ETRX357-PM-010-xxx: ETRX357 Product manual
- TG-ETRX357-LRS-PM-015-xxx: ETRX357-LRS (long range) Product manual
- TG-ETRX357USB-PM-014-xxx: ETRX3 USB stick Product manual
- TG-ETRXn-R3xx-Commands: AT Style command dictionary for firmware R3xx

All our documents can be found at http://www.telegesis.com/support/document_centre.htm.

The ETRX357 module is available in four variants:

- ETRX357 – with on-board ceramic antenna and 8dBm output power
- ETRX357HR – with Hirose coaxial connector and 8dBm output power
- ETRX357-LRS – with on-board ceramic antenna, LNA and 19dBm output power
- ETRX357HR-LRS – with Hirose coaxial connector, LNA and 19dBm output power

## 6.1 The Development Board

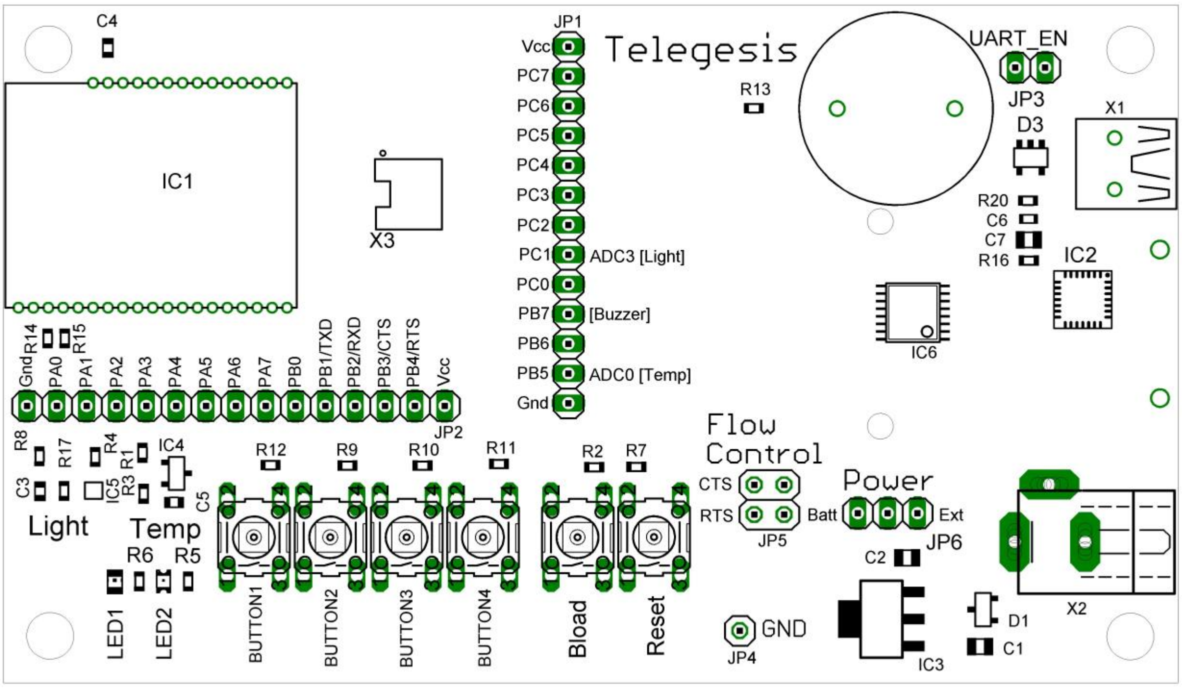


**Figure 1. The development board**

The development board which is part of the development kit hosts a USB to serial bridge as well as voltage regulation circuitry. Furthermore it hosts a reset switch, a bootloader switch, 4 buttons, 2 LEDs and a beeper, all of are connected to the I/Os of the module as described later in this document.

## 6.2 The carrier board

The carrier board has an ETRX357 module plus two LEDs, and a connector to attach to a Silicon Labs InSight Adaptor for reflashing the firmware. It plugs on to the development board.

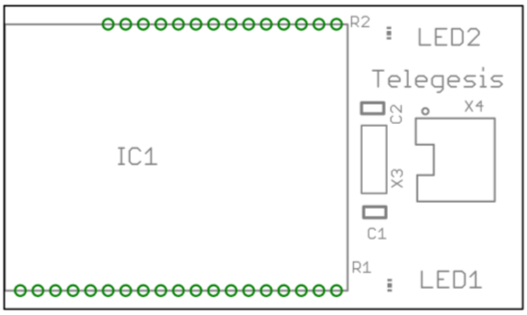


**Figure 2. The carrier board**

## 6.3 What's in the ETRX357DVK box?

- 3 x ETRX357DV Development Boards
- 3 x USB cables
- 2 x ETRX357 on carrier boards
- 2 x ETRX357HR on carrier boards
- 2 x ETRX357-LRS on carrier boards
- 2 x ETRX357HR-LRS on carrier boards
- 1 x ETRX3USB USB stick
- 2 x ½-wave antennae
- 2 x ¼-wave antennae

These packages contain everything you need to immediately set up an ETRX357 development platform using the enclosed modules. The ETRX357DVK currently includes an ETRX3USB stick built around an ETRX357 module; earlier kits included the ETRX2USB stick, but the USB drivers and the command set are the same.

## 7 Setting up the Hardware

In the development kits are all four versions of the module. They can be powered from either a USB hub, the mains (via a suitable power supply) or batteries.

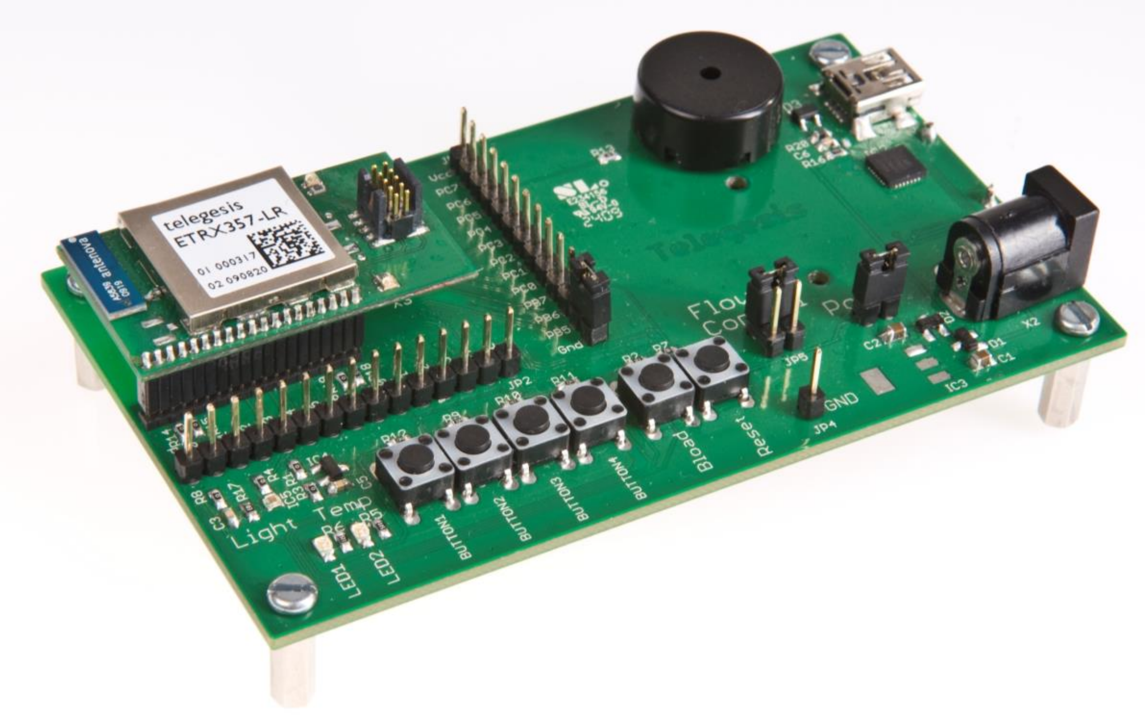


Figure 3. ETRX357-LR Module on Carrierboard plugged on to Devboard

## 8 ETRX357 pinout

The functions of each of the ETRX357 pins depend on the firmware. When using the Telegesis AT command-based firmware the S-register settings control the configuration of the I/Os. Some of them have a main function and an alternate function, as determined by the value of register S15. Holding pad PA5 low when powering up or resetting the module will cause it to enter the bootloader mode; this operation lies outside the normal firmware so it is independent of the value of S15. As the functions are firmware-dependent and may change between versions, Table 3 should be read in conjunction with the latest R3xx AT Command Manual.

**Notes on Table 3 headings**

**Name** is the designation of both the ETRX357 pad and the EM357 chip pin.

**Index** can be used to reference the individual pin in various S-registers (see the R3xx AT Command Manual)

**Pad** is the module's pad numbering

**Default direction** indicates whether the pad is normally an input or output

**Main function** and **Alternate function** indicate the purpose and connection of the pad

**Default alt fn setting** indicates whether the default firmware setting chooses the main or alternate function

| Name | Index | Pad | Default direction S17= 0142CC | Main function | Alternate function | Default alt fn setting S15= 00000600 |
|---|---|---|---|---|---|---|
| PC7 | 17 | 4 | In | | | |
| PC6 | 16 | 3 | In | | | |
| PC5 | 15 | 2 | In | | Enable TX_active on ETRX357 {4} | |
| PC4 | 14 | 24 | In | | | |
| PC3 | 13 | 23 | In | | | |
| PC2 | 12 | 22 | In | | | |
| PC1 | 11 | 26 | In | | ADC3 (light sensor) {2} | |
| PC0 | 10 | 27 | Out | LED | | |
| PB7 | F | 28 | In | | ADC2, PWM {2} | |
| PB6 | E | 29 | Out | LED, Button 4, IRQ3 {1} | ADC1 {2} | |
| PB5 | D | 30 | In | | ADC0 (temp sensor) {2} | |
| PB4 | C | 8 | In | | | |
| PB3 | B | 6 | In | | | |
| PB2 | A | 18 | In | | RXD | Enabled |
| PB1 | 9 | 17 | Out | | TXD | Enabled |
| PB0 | 8 | 25 | In | Button 3, IRQ2 {1} | | |
| PA7 | 7 | 5 | Out | LED | | |
| PA6 | 6 | 16 | Out | LED | | |
| PA5 | 5 | 15 | In | (Bootload) | | |
| PA4 | 4 | 14 | In | | | |
| PA3 | 3 | 12 | Out | Sensor supply {3} | | |
| PA2 | 2 | 11 | Out | Sensor supply {3} | | |
| PA1 | 1 | 10 | In | Button 2, IRQ1 {1} | | |
| PA0 | 0 | 9 | In | Button 1, IRQ0 {1} | | |

**Table 3. Module pads and functions**

## Notes

{1} The IRQS are always enabled; it is not necessary to activate the alternate function. PB0 is not available for use on an ETRX357-LRS module as it is used internally to control the RF front-end module

{2} The ADCs are normally disabled; it is necessary to activate the alternate function

{3} In a development kit, the sensor supply outputs PA2 and PA3 must be high for the sensors to function

{4} On the ETRX357 TX_active is an output which indicates that the RF circuit is transmitting. On the ETRX357-LRS TX_active is always selected, and is not available as an ordinary I/O because it is connected internally to RF components.

# 9 The Development Board

## 9.1 Development Board Interface Description

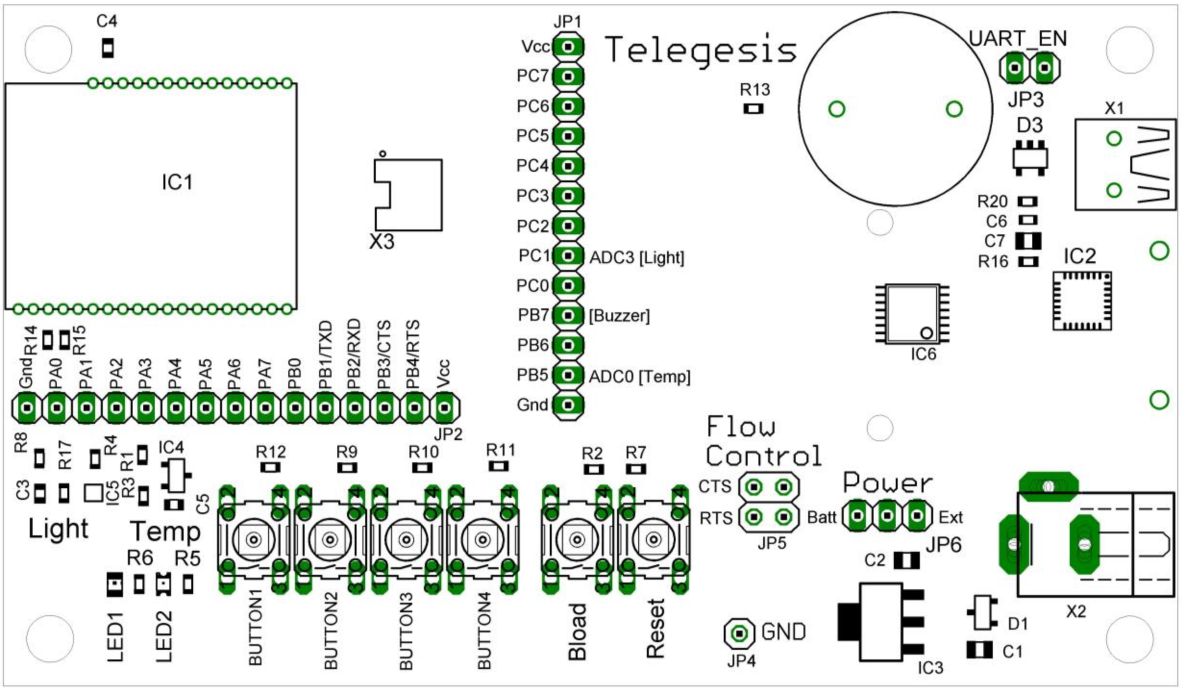


**Figure 4. The development board**

Figure 4 shows the location of the connectors described below.

**Programming Connector:** The 10-way programming connector X3 is used to program the ETRX357 module from a Silicon Labs InSight Adaptor. It is duplicated on the carrier board, and will not normally be fitted in the Development Board.

**USB Port:** The USB serial port allows connectivity to a PC. This provides access to the command line interface and the bootloader for firmware upgrades, and supplies DC power to the board.

**I/O connection:** JP1 and JP2 can be used to connect the I/O pins as shown in Table 4.

**Reference Ground:** JP4 is connected to the devboard’s ground plane. It can be used as a reference point when making measurements on the devboard.

**I/O breakout:**

JP1 and JP2 give access to the I/O on the ETRX357 module. The individual pins are labelled on the circuit board, and the pin numbering (PA0, PB1 etc) matches that of the EM357 chip inside the module.

| Pin | Devboard functionality |
|---|---|
| PA0 | Button1 |
| PA1 | Button2 |
| PA2 | Temp sensor supply |
| PA3 | Light sensor supply |
| PA5 | Bootloader button |
| PB0 | Button3 |
| PB1 | TXD |
| PB2 | RXD |
| PB3 | CTS |
| PB4 | RTS |
| PB5 | ADC0 (Temp sensor reading) |
| PB6 | Button4 |
| PB6 | LED1 |
| PB7 | Buzzer |
| PC0 | LED2 |
| PC1 | ADC3 (Light sensor reading) |

**Table 4. I/O Connectivity on development board**

**Flow Control Selection:** JP5 is used to connect the RTS and CTS lines used for the flow control to the host. By default flow control is disabled and the corresponding lines of the module are used as standard I/Os (see the AT command dictionary on how to enable flow control), so the default setting of JP5 does not connect those lines to the host as shown in Figure 5. When flow control is enabled JP5 must be set as shown in Figure 6. Please make sure the jumpers are only set to this configuration when flow control is enabled as otherwise I/Os driving against each other (via a protective resistor) will increase the current consumption.

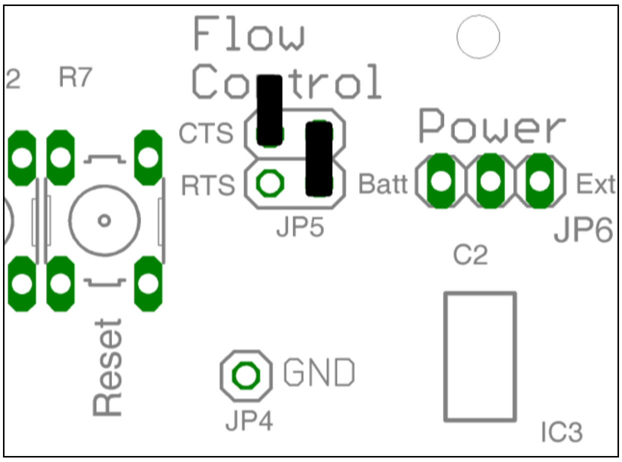


**Figure 5. No Flow Control (default)**

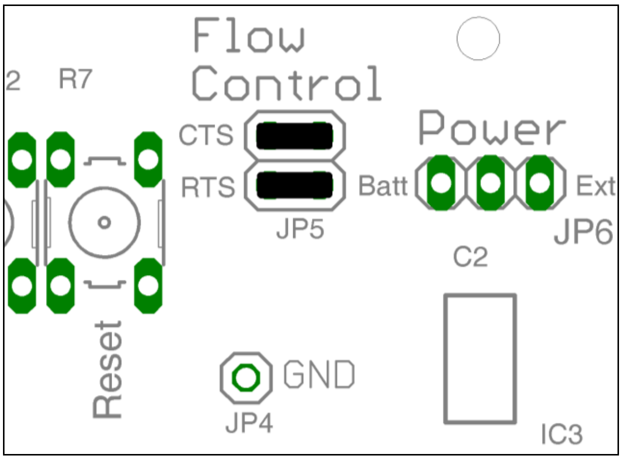


**Figure 6. Flow control enabled**

**Power supply jumpers:** links must be inserted at JP3 and JP6 according to the DC supply feed. JP3 can be left connected at all time, but it disconnects the serial interface lines and prevents power drain through them when the serial (USB) interface is not used. This will minimise the current drain from a battery and produce a more accurate reading of the current consumption.

It permissible to attach a USB connection while the board is powered from a battery or external supply.

There are three options:

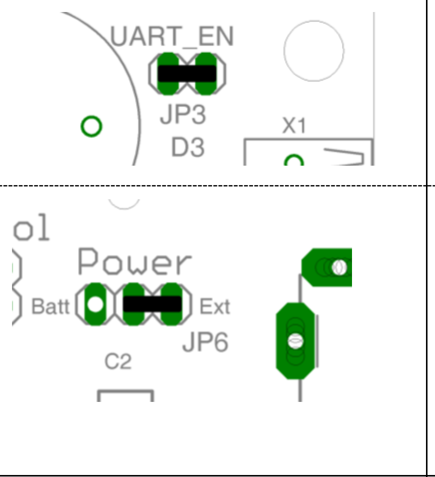
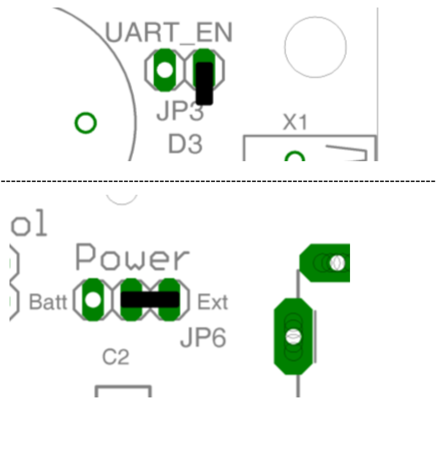
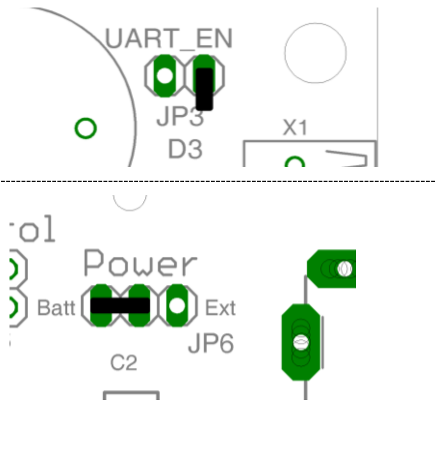
| **USB power** | **External power through the X2 socket** | **Battery power** |
|---|---|---|
|  UART_EN<br>JP3<br>D3<br>X1<br>ol<br>Power<br>Batt<br>Ext<br>JP6<br>C2 |  UART_EN<br>JP3<br>D3<br>X1<br>ol<br>Power<br>Batt<br>Ext<br>JP6<br>C2 |  UART_EN<br>JP3<br>D3<br>X1<br>ol<br>Power<br>Batt<br>Ext<br>JP6<br>C2 |
| Insert JP3. Connect the centre pin of JP6 to 'Ext'. | Optionally, omit JP3. Connect the centre pin of JP6 to 'Ext'. | Optionally, omit JP3. Connect the centre pin of JP6 to 'Batt'. |

**Figure 7. Power feed options**

Instead of a shorting link, a current meter can be inserted at JP6 to monitor the power consumption.

## 9.2 Development Board Sensors

The board's temperature sensor IC4 is a National Semiconductor LM61 which has an offset of 600mV and a sensitivity of 10mV/deg. Hence for example 0°C give 600mV and 20° gives 800mV. The ETRX357's ADCs have a sensitivity of 0.1mV/LSB, so 100 LSB's ≡ 1 degree.

The light sensor IC5 is an Avago APDS 9005; it indicates ambient light level but is not suitable for accurate measurements.

# 10 The Carrier Board

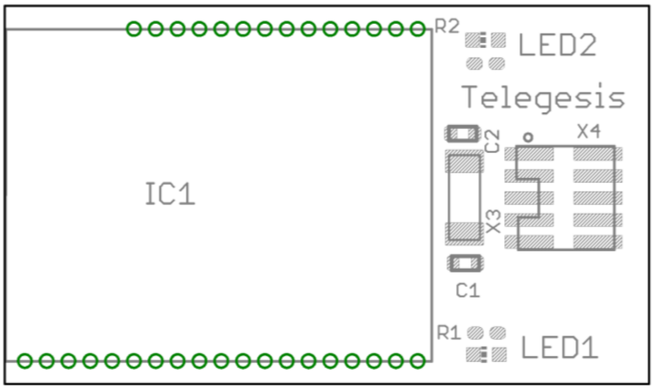


**Figure 8. The carrier board**

The ETRX357 carrier board has two LEDs.

| Pin | Carrier board functionality |
|---|---|
| PA6 | LED1 |
| PA7 | LED2 |

**Table 5. Carrier board LEDs**

**Programming Connector:** The 10-way programming connector X4 is used to program the ETRX357 module from a Silicon Labs InSight Adaptor.

**Watch crystal:** an optional 32kHz crystal and its associated capacitors can be fitted at X3, C1 and C2. In this case, R14 and R15 should be removed from the main development board. The use of this crystal is dependent on the user's firmware and the latest Silicon Labs documentation should be consulted for details of the circuit design.

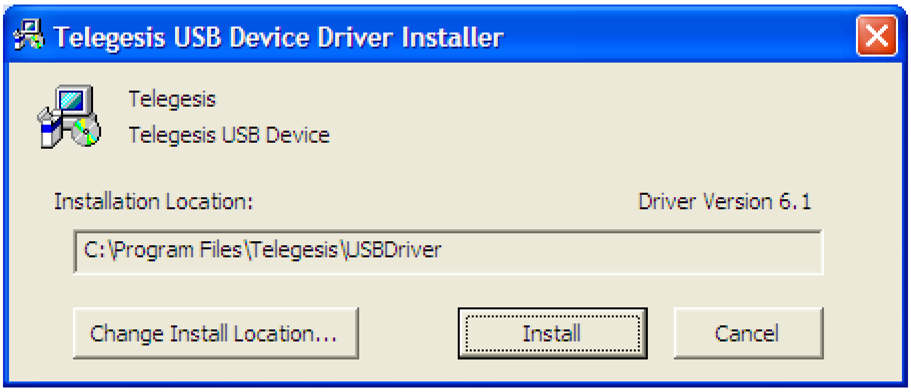
# 11 Driver Installation and Operation

The USB drivers obtainable from www.telegesis.com/telegesis_zigbee_technology_-_technical_support_/software_download.htm will generate a virtual COM port allowing easy access to the serial port of the embedded ETRX357. The ETRX357 development board uses the same USB-to-serial device as the ETRX2USB and ETRX3USB products, so the same USB drivers can be used. The development kit board and the USB stick use the same drivers so you only need to install them once.

## 11.1 Windows 9x/XP/2k Driver Installation

Install the drivers before connecting the development kit using the provided USB cable. The driver package should be unzipped into a local folder. When executing the file 'TGvcpInstaller_x86.exe' or 'TGvcpInstaller_x64.exe' an installer will guide you through the steps required for the driver installation. Note that updates to the driver package may result in the various messages differing from the screen-shots shown here.

The installer will first ask you to confirm the location for the files:


Telegesis USB Device Driver Installer

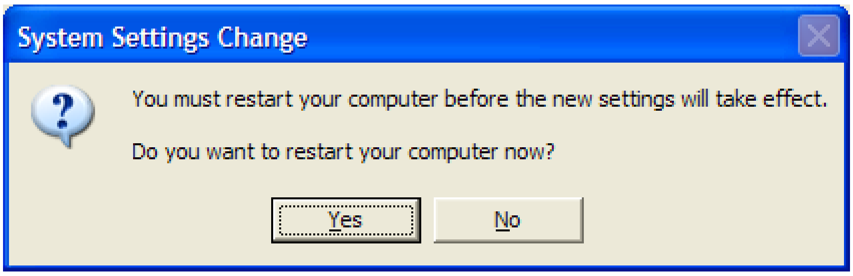
Telegesis
Telegesis USB Device

Installation Location: Driver Version 6.1

C:\Program Files\Telegesis\USBDriver

Figure 9. File location

After the files are installed you may have to restart the computer:

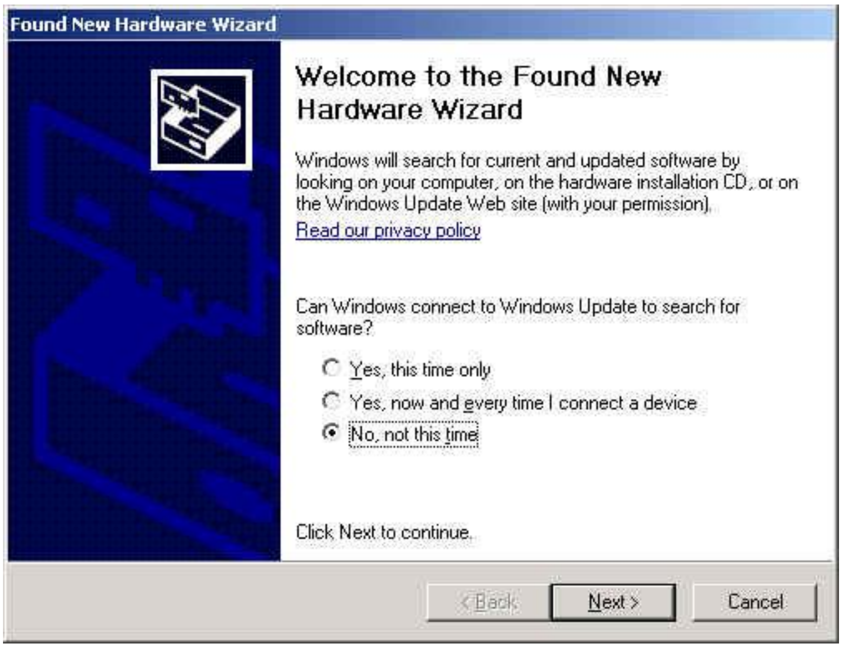

System Settings Change

You must restart your computer before the new settings will take effect.

Do you want to restart your computer now?

Figure 10. Request to restart

After you connect the devboard Windows® will prompt that new hardware has been found. If you have not run ‘TGvcpInstaller_xx.exe’ you will have to manually point to the directory into which you have unzipped the driver. Depending on your PC setup Windows may ask to check the internet for updated drivers, but there is no point in doing this.


Found New Hardware Wizard

Welcome to the Found New Hardware Wizard

Windows will search for current and updated software by looking on your computer, on the hardware installation CD, or on the Windows Update Web site (with your permission).

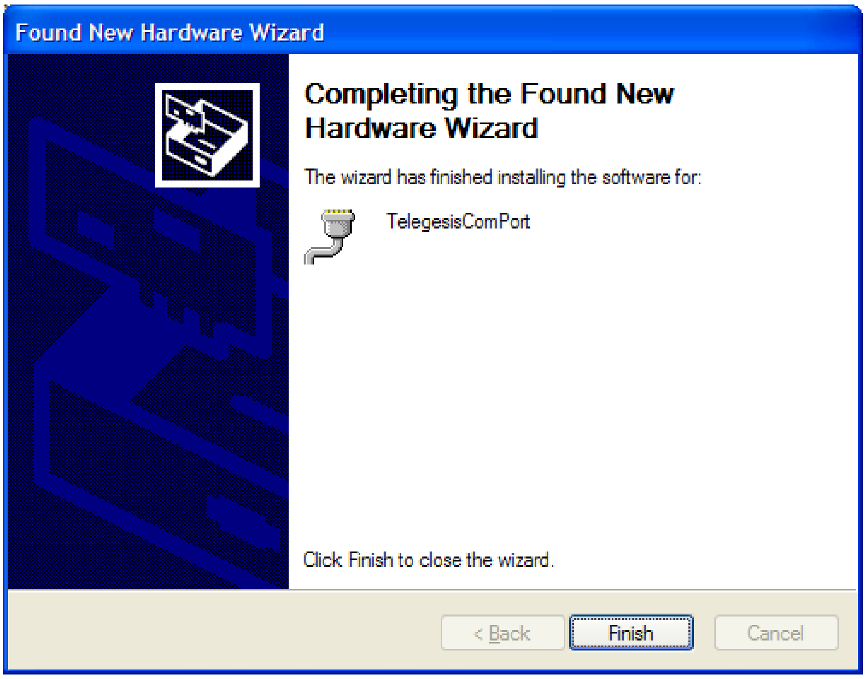
Read our privacy policy

Can Windows connect to Windows Update to search for software?

○ Yes, this time only
○ Yes, now and every time I connect a device
● No, not this time

Click Next to continue.

Figure 11. Found New Hardware Wizard



Found New Hardware Wizard

Completing the Found New Hardware Wizard

The wizard has finished installing the software for:

TelegesisComPort

Click Finish to close the wizard.

**Figure 12. Satisfactory completion**

Please note that each devboard and USB stick has a unique serial number which requires the installation procedure to be repeated with every new unit being attached to the computer. This allows multiple devices to be used on the same computer at any one time. If a USB stick is unplugged and re-inserted the computer recognises it without having to repeat the installation process, and the USB device retains its former COM port number.

In order to find out the identity/number of the virtual COM port the devboard or USB stick has been assigned to, please open the Device Manager under the Windows Computer Management screen (see below) and click on the Ports (COM and LPT) section where you should find the new virtual COM port. By double clicking on the entry of the virtual COM port you can also change the number assigned to the virtual COM port when entering the advanced setup of the device.

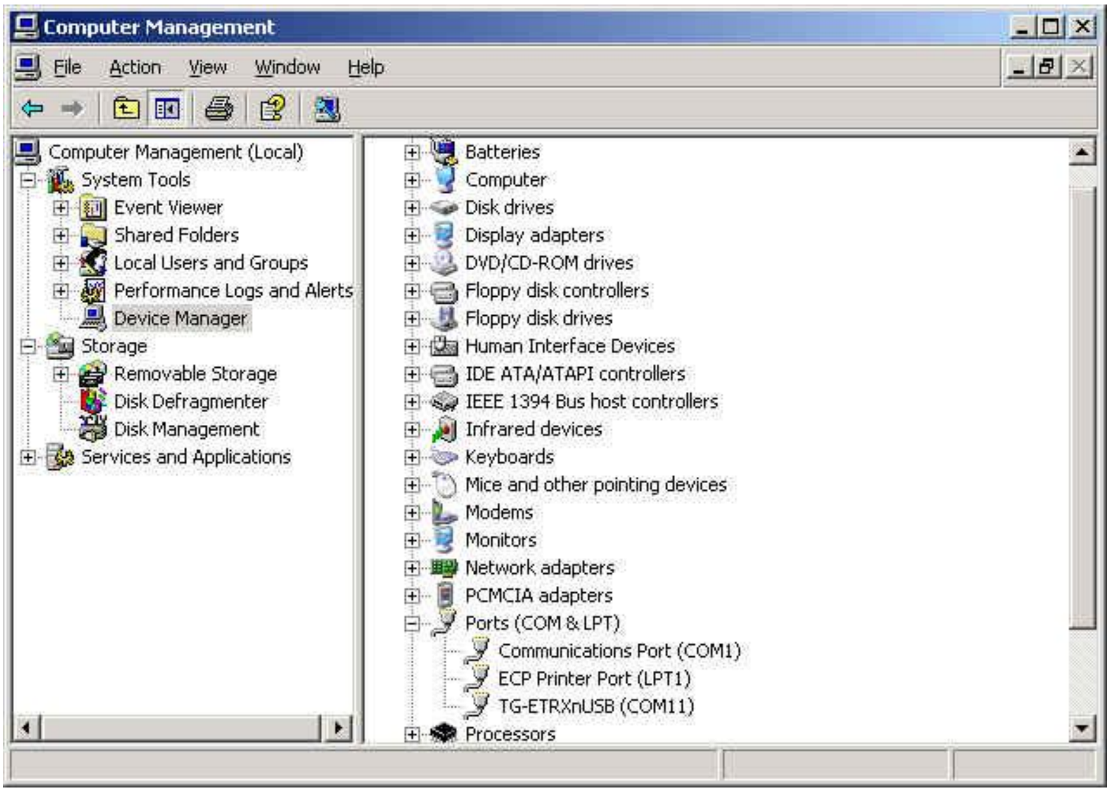
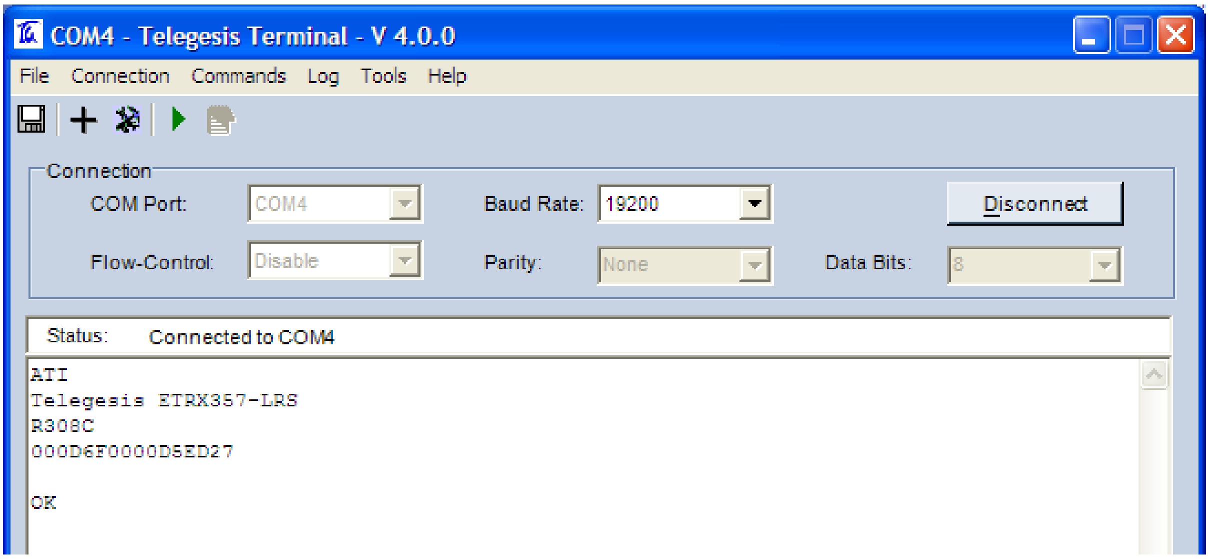


**Figure 13. Device Manager**

Once the correct COM port has been selected, the Telegesis Terminal software can be used to control the devboard as described in chapter 11.


COM4 - Telegesis Terminal - V 4.0.0
File Connection Commands Log Tools Help
Connection
Disconnect

COM Port: COM4

Baud Rate: 19200

Flow-Control: Disable

Parity: None

Data Bits: 8

Status: Connected to COM4

```
ATI
Telegesis ETRX357-LRS
R308C
000D6F0000D5ED27

OK
```

**Figure 14. Telegesis Terminal**

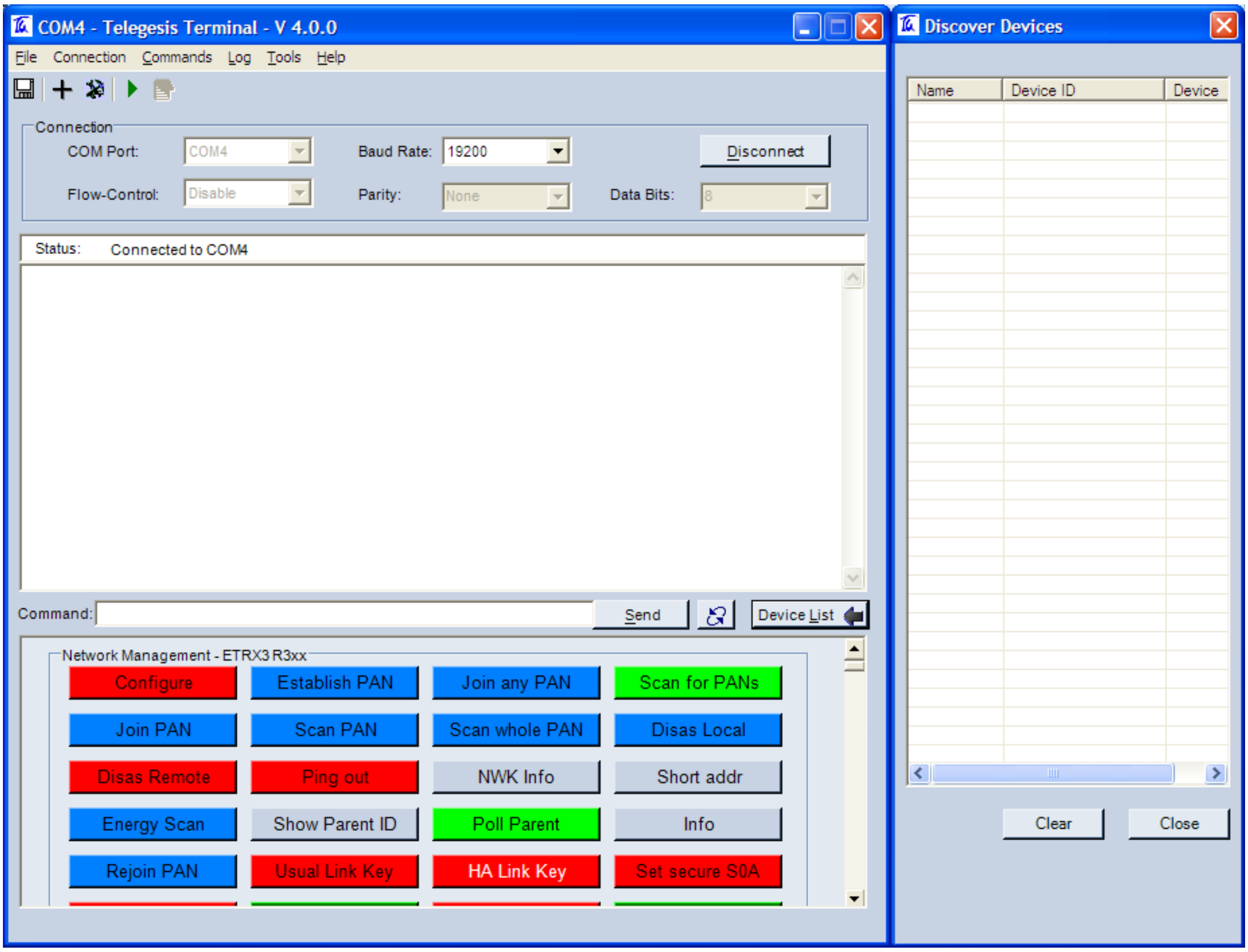
## 12 Application Software

The command line of the ETRX357 can be accessed using any terminal software program such as HyperTerminal®. Simply set up HyperTerminal® to connect to the appropriate COM port at 19200bps, Data bits - 8, Parity - none, Stop bits - 1, Flow Control – none (ETRX357 factory default).

To speed up evaluation Telegesis provides its own Terminal Application Software program which allows enhanced functionality especially suited to the ETRX357 modules. The AT-Style commands can be issued by clicking on customisable 'Command' buttons and all of the 64-bit serial numbers which report are listed in a separate window. This means you will not need to input any of the 64-bit serial numbers.

For instructions on how to use the AT commands read the R3xx AT Command Manual.

Note: Telegesis Terminal does not interpret the AT commands and send instructions to the ETRX357 in a different format. It does not alter the AT commands in any way – the ETRX357 receives them exactly as described here and in the AT Command Manual. Likewise, if you are writing your own terminal application, it should send and receive data as formatted in our manuals.



COM Port: COM4
Baud Rate: 19200
Flow-Control: Disable
Parity: None
Data Bits: 8
Status: Connected to COM4

Figure 15. Appearance of the Telegesis Terminal Application Software

## 12.1 Software Set-up

Telegesis Terminal R4.0 no longer needs .NET Framework Version 1.1 which was required for earlier versions. Download Telegesis Terminal from our website at

www.telegesis.com/telegesis_zigbee_technology_-_technical_support_/telegesis_terminal.htm

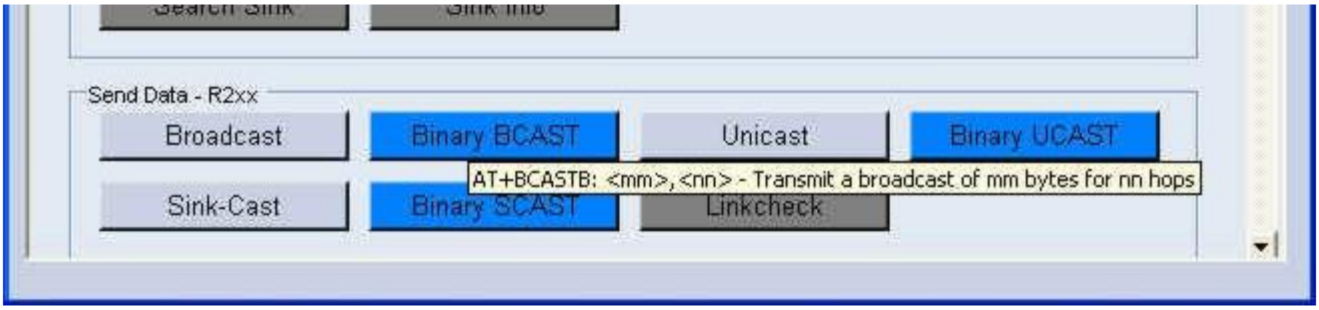
With recent operating systems such as Windows 7, it is advisable to right-click on the Telegesis Terminal setup program and select “Run as administrator”. This avoids problems when you try to save customised button layout files as they are normally stored in the program folders.

After installing and starting the Telegesis Terminal Application program a single command button for the firmware will be shown at the bottom of the window. In order to use the Telegesis Terminal software, first open the correct button layout file for your firmware by selecting File → Open Layout, then select the correct COM port and the connection parameters (ETRX357 default 19200, 8 bits, no parity, no flow control) and press the connect button. These settings are automatically retained each time the software is re-started.

## 12.2 Features of the Telegesis Terminal Application for ETRX357

### 12.2.1 The buttons

To make life easy many of the AT commands have been pre-defined and conveniently grouped at the bottom of the terminal window. Pressing a button (where no parameters are required) causes the corresponding command to be issued instantly. Where a parameter is required the command is shown in the Command bar and the required parameter can be entered manually. In order to issue the command from the command bar simply press the <enter> or the Send button. To see the parameters for a specific command, move and hold the mouse pointer over the chosen command button - Figure 16.



AT+BCASTB: <mm>,<nn> - Transmit a broadcast of mm bytes for nn hops

**Figure 16. Screen tips for parameters**

The application software also allows you to add custom command buttons and edit existing command buttons. New groups of commands can be created and command buttons can be moved between groups.

### 12.2.2 The device window

Every EUI64 number reporting in is listed in a separate window which can be opened or closed by clicking on the button labelled ‘**Device List**’. If a device ID is required as a parameter in the command bar, simply double click on an entry in the device list and its EUI64 will be automatically transferred to the current cursor position of the command bar.

To allow for easier identification, the EUI64 IDs in the device list can be named. When right clicking on any EUI64 ID a name can be associated with the respective ID - Figure 17.

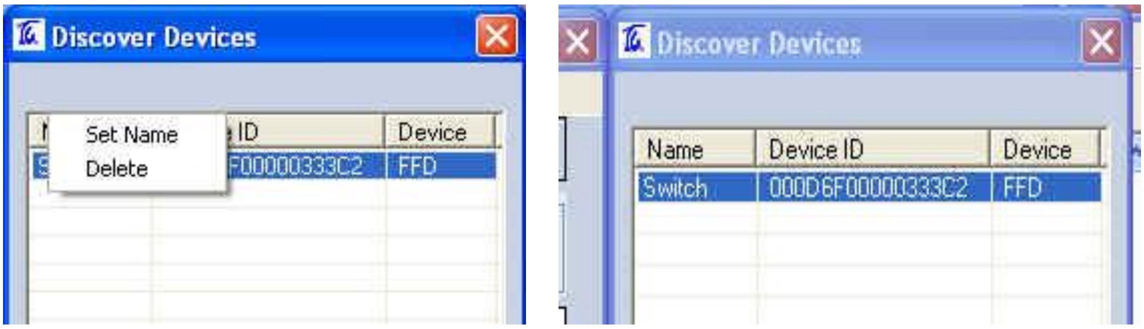


**Figure 17. Device Naming**

### 12.2.3 The menu bar

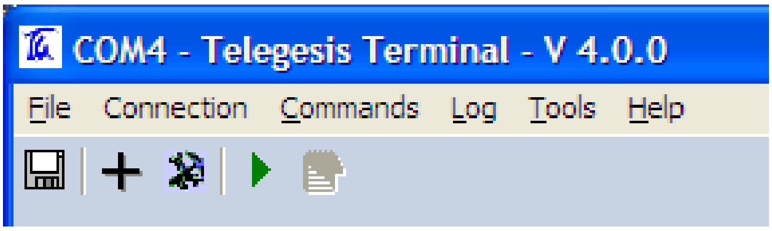


**Figure 18. Telegesis Terminal menu bar**

| | |
|---|---|
| • File | To open and save button layout files |
| • Connection | To switch connection address mode between COM port and IP address |
| • Commands | To open a button layout editor |
| • Log | To save a record of the session |
| • Tools | Refresh COM Ports – update the drop-down list of ports<br>Transfer File – open an XMODEM dialogue window<br>Send Text – import a file into the large dialogue window<br>Show STX ETX – displays <stx> and <etx> characters when the firmware uses them to bracket its output<br>Use Nonprinting Characters – characters can be entered as two hexadecimal characters bracketed by <…>, eg <41> for A or <0D> for carriage return |
| • Help | Shows the software version |

Button layout files are normally found in the folder into which Telegesis Terminal was installed. They are xml files so they can be edited by a text editor or by a tool such as the Microsoft XML Notepad, as well as from within Telegesis Terminal itself. Buttons usually have a single AT command attached to them, but v4 of Telegesis Terminal allows a button to have multiple commands, each terminated by <cr>. When the button is pressed a 100ms delay is inserted after each command.

Connection can be made to a COM port or to an IP address and port number; the latter opens a TCP connection.

XMODEM is generally used when bootloading a new firmware file on to a module.

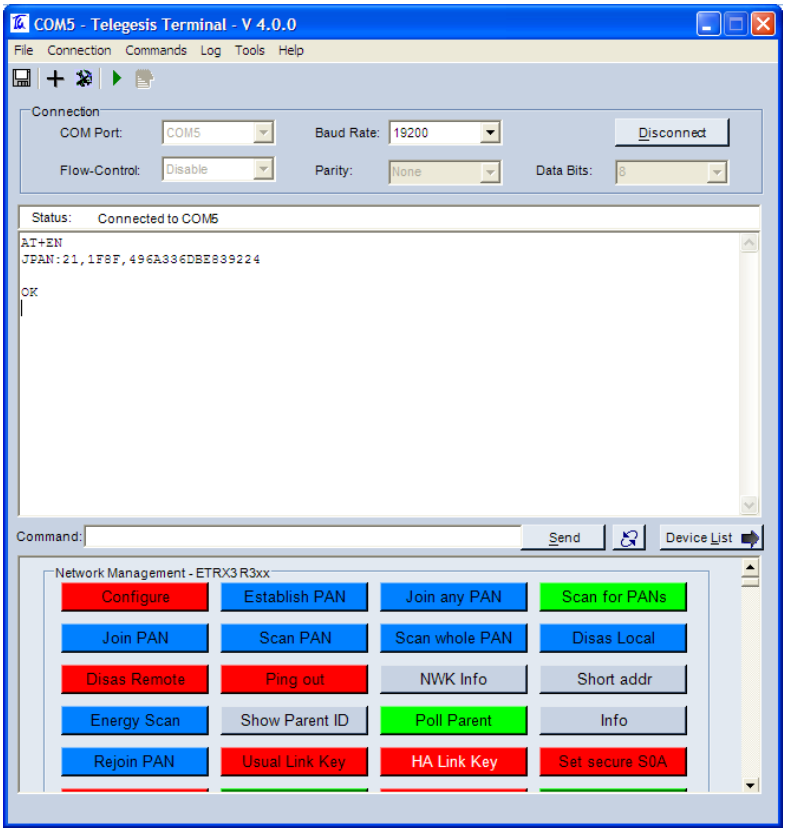
## 12.3 A Quick Start

This section gives you a quick introduction on how to get started. Power up the node connected to the PC and open a connection to the correct device; refresh the list of COM ports if the expected device is not shown. Type **AT** followed by **<enter>**. If the communication to the module is working the module will prompt **OK**, if not check the USB connectivity and driver status and make sure you have connected to the correct COM port with the correct speed. Please note that even when connected to the wrong COM port there may be a reply to AT, for example when you are communicating with your PC's modem or Bluetooth device. To double check you are actually communicating with a Telegesis ZigBee device use the ATI command described below.

### 12.3.1 Select the correct set of buttons

Type **ATI<enter>** to verify your firmware version (eg R308C). Then select File → Open Layout on the menu bar and open the appropriate xml file – usually R3xx.xml. This attaches the correct set of AT commands to the buttons. You can create your own button configurations for different situations and save them as separate files. Telegesis Terminal starts up using the configuration of the previous session.

### 12.3.2 Network Setup



Connection
COM Port: COM5
Baud Rate: 19200
Flow-Control: Disable
Parity: None
Data Bits: 8

Status: Connected to COM5

```
AT+EN
JPAN:21,1F8F,496A336DBE839224

OK
```

Command:

**Figure 19. Command Line Interactions**

To establish a PAN network issue the **AT+EN** command, or alternatively press the '**Establish PAN**' button.

The local unit will now scan all available 16 channels and establish a PAN with a random PAN ID, on the quietest available one. This may take up to 16 seconds and leads to the node becoming the network's coordinator. When successful the module will prompt '**JPAN**' followed by the details of the newly created PAN. If you get an error message instead, it is likely that the module was already part of a PAN, so you will need to issue the **AT+DASSL** command or press the '**Disas Local**' button to leave the PAN before going back to starting a new one. In order to find out about the network status simply issue the **AT+N** command or press the '**NWK Info**' button.

Once the network is established, remote nodes can be powered up ready to join in. If you have serial access to remote nodes simply issue the **AT+JN** command or press the '**Join any PAN**' button, to join the newly established PAN. If you do not have serial access to the remote nodes (as is the case of the two MCBs provided with the previous ETRX2-based DVKA) you will just need to wait for them to join the network automatically. By default, once every minute all nodes (except coordinators) are set up to check whether there are any neighbours on the same PAN nearby, or if they have been orphaned. If no neighbours are found after 5 consecutive tries, the unit will leave the (deserted) PAN and then try to join a new one once every minute.

This initial network set-up can take a few minutes, especially with no serial access to remote nodes, but once the network is set up it will remain set even after power cycles. New nodes joining will cause a prompt '**NEWNODE:**' on the remote side and display the **JPAN** message locally as described above.

The ETRX357 stores its network parameters in non-volatile memory, so if you reset or power-cycle a module there is no need to re-establish or join the PAN again.

If devices do not join the desired PAN automatically, check that they are not already in a network of their own. The command **AT+PANSCAN** will reveal the presence of other networks in the vicinity.

To learn more about setting up and maintaining a PAN please refer to the user guide and the AT Command Dictionary.

### 12.3.3 Mesh networking

A typical ZigBee network is a mesh, where every device can send a message to any other device. If the two devices are in radio range of each other the message passes directly, but if they are too far apart the message is relayed via an intermediate device. The routing is taken care of by the firmware and the user is generally not even aware that it is happening. You can easily discover the basic principles of mesh networking: simply move a Development Board out of range (if you do not have enough space simply turn the transmit power down or put it behind a metal screen) and then add another Development Board between the local node and the remote one. You will find that the network has healed the broken link and all three nodes are accessible again.

### 12.3.4 Node types

A ZigBee node is one of several types:

- Router. If you have started a network as described so far in this manual, all the devices are routers and can communicate directly with each other

- Coordinator. This is merely the device which first established the network. It is also the trust centre which grants permission for other devices to join, so do not disassociate it from your network

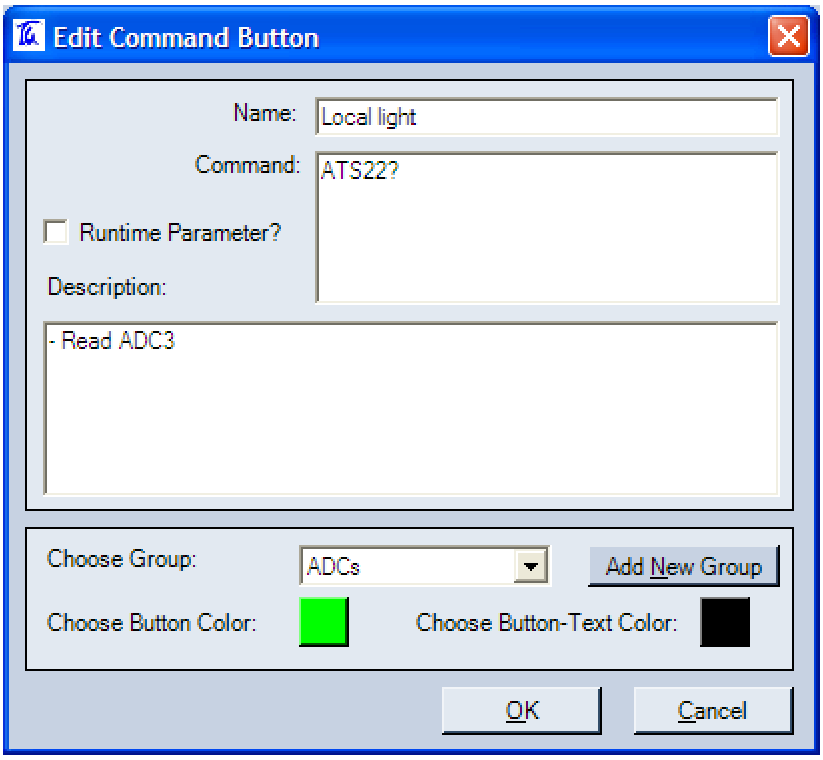
- Sleepy End Device. SEDs do not play any part in the routing so they can be put into a sleep state while they do not need to send or receive messages. To turn a device into an SED disassociate it from your network, set bit E of register S0A with the command **ATS0AE=1;password** then let it join the network. An SED is adopted by a parent router which buffers any messages sent to the SED until it sends a Data Request (or poll) to its parent to indicate it is ready to receive. The power mode is defined in register S39, so refer to the AT command manual for more details

- Mobile End Device. MEDs are like SEDs but they react more quickly when they move of range of their parent and need to find a new one. Set bits E and F of register S0A to create an MED

- ZigBee End Device. ZEDs cannot be put into a sleep state to save power nor do they take part in the routing, so they are of very limited use

## 12.4 Configuring Buttons for your Setup

You can open several copies of Telegesis Terminal on the same PC, so if you have two or more development boards connected to a PC try sending messages between them using the Broadcast or Unicast buttons. This will begin to give you an understanding on how to integrate the ETRX357 into your application. The Telegesis Terminal Application also allows you to create custom command buttons for your individual application, just click on **Commands / Add command button.**



Name: Local light

Command: ATS22?

☐ Runtime Parameter?

Description: - Read ADC3

Choose Group: ADCs

Choose Button Color: 🟩

Choose Button-Text Color: ■

**Figure 20. Button editor**

In this way you can add buttons that are specific to your tests, reduce the number of buttons to a simple layout for demonstrations, or create a sequence of operations for commissioning devices and systems.

The first button on the pre-supplied layouts is Configure. When you click on this, the local device executes the AT+SN command to scan the network for other devices and for each one it adds three new buttons:

LEDS n ON, LEDS n OFF (in the Send Data – R3xx group)

Ident Noden (in the Register Access – R3xx group).

Clicking any of these controls the LEDs on the corresponding dev board, or sounds its buzzer.

For a more detailed description of the AT command interface please refer to the appropriate command manual for your version of firmware R3xx.

Some useful I/O commands for the ETRX357 are given in the next section.

## 12.5 Using LEDs and ADCs on the ETRX357

The LEDs are connected to the ETRX357 in a pull-down arrangement so each output must be set to ‘0’ to turn on its LED. Refer to Table 3 for details of the various connections; since they are distributed across the 16 I/O pins some examples of typical functions are given here for convenience. The four LED pins are configured as outputs by default so they can be used immediately. Before each ADC can be used, its pin must be set to use the alternate function in register S15, but it does not matter whether it is defined as a digital input or output. The temperature and light sensors on the circuit board are powered from two of the ETRX357’s outputs, so these pins must be set high in order for the sensors to function.

| | |
|---|---|
| Turn on local LEDs | ATS18=00000000 |
| Turn off local LEDs | ATS18=000140C0 |
| Turn off LEDs at EUI64 000D6F0000D5ED27 | ATREMS:000D6F0000D5ED27,18=000140C0 |
| Turn off all remote LEDs in the network | ATSALL,FFFF,18=000140C0 |
| Turn on local LEDs and supply power to temperature and light sensors | ATS18=0000000C |
| Enable temperature and light ADCs | ATS15=0002E600 |
| Read local light sensor | ATS22? |

Note that these immediately change the actual values of the registers described but not their default values.

The ADC registers can be read on a local or remote device by using the ATS or ATREMS commands, but they can also be sent automatically to the network sink by using function 0110 or 0130; consult the AT Command Manual for the details, and see section 12.6 here.

## 12.6 Temperature display

The AT command set provides two powerful features:

1. A node can be defined as a “sink”. It broadcasts its address to the rest of the network, so the other devices can use commands and built-in functions that send data to the sink. In this way, an application can be designed without the need to know in advance the address of the sink node, which will be different in each installation.

2. Software timers implemented in the firmware can execute various predefined functions. Simple applications can therefore often be implemented without the need for a host processor to send AT commands to a device.

As an example of both of these features, the following commands demonstrate how to collect temperature information from development kit boards:

1. Define the module on the data-gathering development board as the network sink with the command

   ```
   ATS104=1
   ```

2. Instruct one or more sensor development boards to send their ADC readings to the sink at regular intervals by setting a Timer/Counter on the ETRX357, eg to send every second using Timer/Counter 5 use these commands on each sensor board:

   ```
   ATS33=0004
   ATS34=8130
   ```

3. Activate all four ADCs on each sensor board with the command

   ```
   ATS15=0002E600
   ```

4. Turn on the sensor power on each sensor board with the commands

   ```
   ATS182=1
   ATS183=1
   ```

5. The ADC readings will appear at the sink in the form of a “FN130” prompt, which also contains the digital I/O values and the contents of the S46 counter register. See the AT Command Manual for full details of the prompt and the registers used here. The units are 0.1mV; the sensor has a slope of 10mV/deg with a 600mV offset.

It is usually easiest to set the sensor device’s registers by accessing them via USB, but you can also use the ATREMS command from the sink node.

# 13 Firmware upgrades

If required, the firmware of the ETRX357 modules can be upgraded serially as well as over the air. Over-the-air upgrading is primarily a function of the Silicon Labs bootloader and it is not available with the early bootloader versions. See section 13.2 for more details.

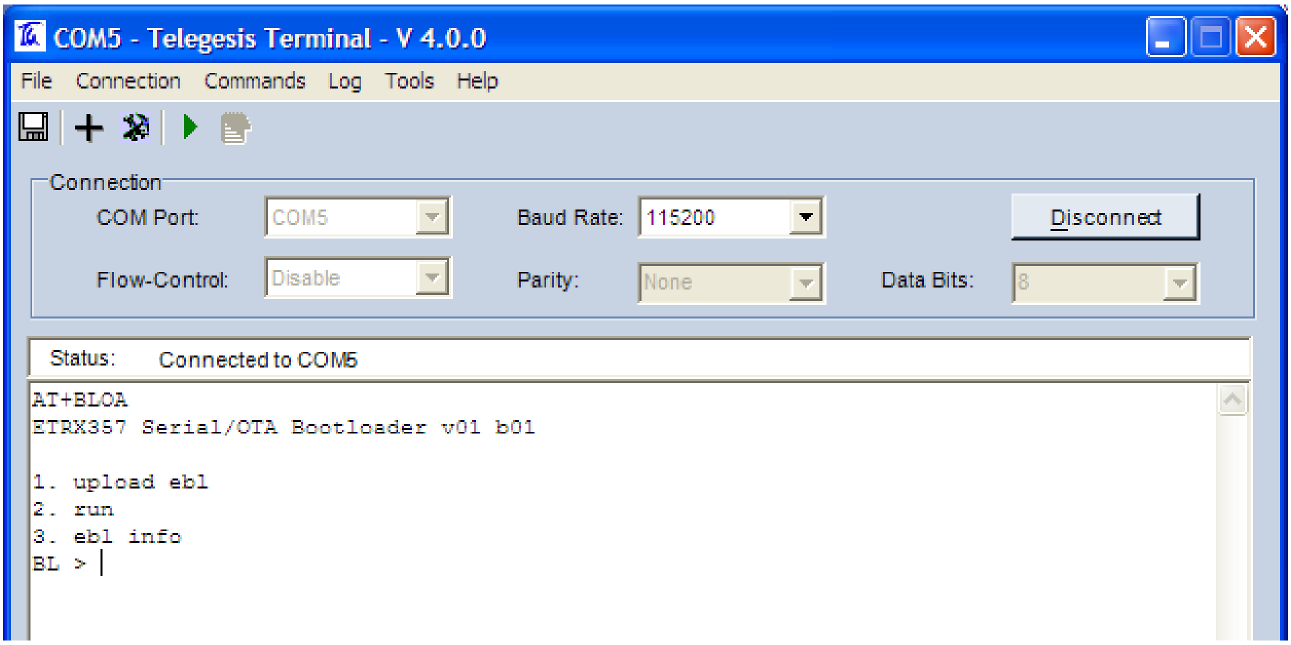
## 13.1 Firmware Upgrades via Serial Port

In order to upgrade the firmware of the ETRX357 module using the serial bootloader, issue the "**AT+BLOAD**" command either by typing it in, or by pressing the respective button in the "**Module Control**" group of the Telegesis Terminal Application.

Alternatively the button labelled "Bload" can be pressed on the development board whilst the reset button is pressed and released.

After entering the bootloader, the connection parameters need to be changed to 115200bps, 8 data bits, 1 stop bit, no parity, no flow control (providing that it is not already set to these values).

After pressing '**Enter**', the bootloader menu will be shown in the terminal window as shown in Figure 21.



Connection

COM Port: COM5

Baud Rate: 115200

Flow-Control: Disable

Parity: None

Data Bits: 8

Status: Connected to COM5

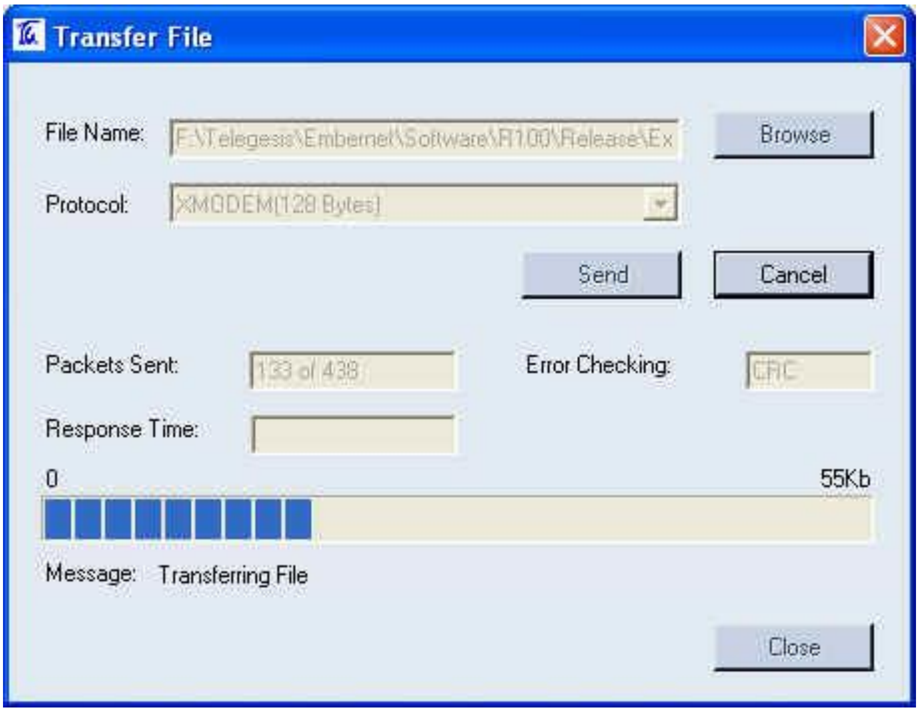
```
AT+BLOA
ETRX357 Serial/OTA Bootloader v01 b01

1. upload ebl
2. run
3. ebl info
BL > |
```

**Figure 21. Bootloader Menu**

Pressing '**1**' initiates the upload of the new firmware and a number of '**C**' characters will indicate that the ETRX357 is ready to receive data. Within 60 seconds, select **Tools** / **Transfer File**… and browse for the new firmware file.

Firmware files for the ETRX357 will be in the format ETRX357_R3xxC.ebl. After checking that the protocol is set to XMODEM (128 Bytes), press the **Send** button and the new firmware will be downloaded as shown in Figure 22.



File Name: F:\Telegesis\Embernet\Software\R100\Release\Ex

Protocol: XMODEM(128 Bytes)

Packets Sent: 133 of 438

Error Checking: CRC

Response Time:

0 55Kb

Message: Transferring File

**Figure 22. File Transfer Window**

When the transfer has been completed successfully, press **Enter** again in order to return to the bootloader menu (shown in Figure 21) and option '**2**' to run the downloaded application software. If the application software has a baudrate other than 115200bps, this will need to be changed to the application baudrate as described above – 19200 baud in the case of R3xx firmware.

## 13.2 Over the Air Firmware Upgrades

### 13.2.1 ETRX2 and ETRX357 features

With the ETRX2, upgrading over the air is possible by cloning a local node's firmware to a remote node, so if new firmware has to be introduced to the network it can be downloaded serially to a master node, which then can clone itself to one node after the other in turn given the target node is only a single hop away. Cloning between some firmware releases may not always be possible, so check the Firmware Revision History for relevant comments.

The ETRX357 uses passthrough OTA bootloading, so the new file is stored in the host processor and loaded on to the target device by transmitting it through the local device. The local device is therefore not required to have the same firmware as the updated target.

The ETRX2 and ETRX357 have different bootloaders and firmware files as well as different modes of transferring the new file. Consequently you cannot upgrade an ETRX357 via an ETRX2 or vice-versa.

### 13.2.2 Passthrough with an ETRX357

You should first verify that the module's bootloaders are sufficiently recent, as this feature was not included in the earliest versions. Start the bootloader with the AT+BLOAD command, enter a <cr> and check the response, then exit the bootloader without altering the firmware by selecting option 2 ('run'). The bootloader needs to be version v42 or higher for passthrough to be possible, or else v01 which is a Telegesis variant of the Silicon Labs bootloader. A new bootloader can only be installed by reflashing the module's memory with a Silicon Labs Insight Adaptor.

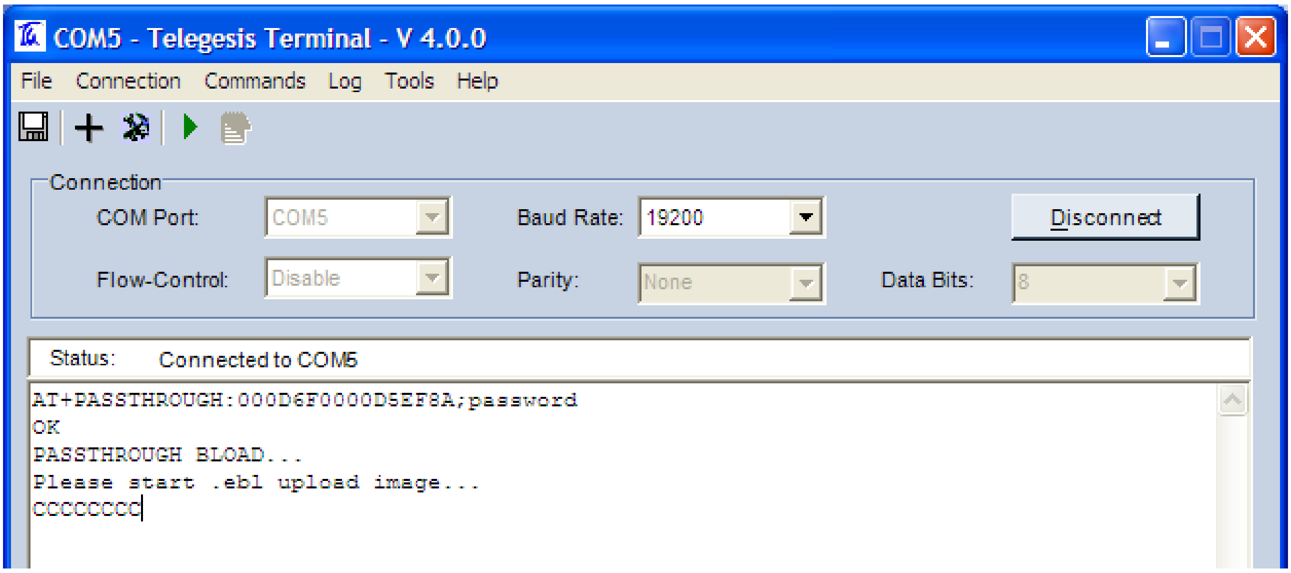
The passthrough process is similar to bootloading a file on to the local device, except that there is no need to change the baud rate. Use the command

**AT+PASSTHROUGH:<EUI64 of the target device>:<Target device's password>**

The device will respond with a prompt and a sequence of 'C' characters. Select **Tools** / **Transfer File**… from the drop-down menu of Telegesis Terminal and browse for the new firmware file.

Firmware files for the ETRX357 will be in the format ETRX357_R3xxC.ebl. After checking that the protocol is set to XMODEM (128 Bytes), press the **Send** button and the new firmware will be downloaded as shown in Figure 22.

Passthrough bootloading on to an End Device or across multiple hops is not possible.



COM Port: COM5
Baud Rate: 19200
Flow-Control: Disable
Parity: None
Data Bits: 8

Status: Connected to COM5

```
AT+PASSTHROUGH:000D6F0000D5EF8A;password
OK
PASSTHROUGH BLOAD...
Please start .ebl upload image...
CCCCCCCC
```

Figure 23. Passthrough bootloading

### 13.2.3 Recovering on the default channel

If the target device is reset or power cycled whilst in the bootloader, the unit will listen for new firmware files on channel 13. It is therefore required to set up a node on channel 13 and repeat the recovery action described in the previous section.

To set up a node on channel 13 use the following commands:

**AT+DASSL** – leave the current network (will show an error if not currently part of a network)
**ATS00=0004** – Only allow channel 13
**AT+EN** – establish new network on channel 13

This will cause the local node to become a coordinator on channel 13.

**AT+RECOVER**

The local node will search for a remote node in bootload mode and clone the local firmware to that remote node.

# 14 Hardware enhancement kit

For users who are developing their own firmware on the Silicon Labs EM3587 chip, Telegesis offer an enhancement pack for the ETRX357 Development Kit or the Silicon Labs EM35x Development Kit that contains EM3587-based modules on carrier boards. This will enable you to download your application to the modules and verify its operation on our development kit boards. In this way you can demonstrate that your firmware is portable on to the ETRX3587, that it functions correctly with the power amplifier of the ETRX3587-LRS, and that it is over-the-air compatible with the ETRX357. Each enhancement pack contains two examples of the following, each on a carrier board:

| Model | Antenna | Max RF power |
|---|---|---|
| ETRX3587 | Antenova Rufa | 8dBm |
| ETRX3587HR | Hirose U.FL connector for external antenna | 8dBm |
| ETRX3587-LRS | Antenova Rufa | 20dBm |
| ETRX3587HR-LRS | Hirose U.FL connector for external antenna | 20dBm |

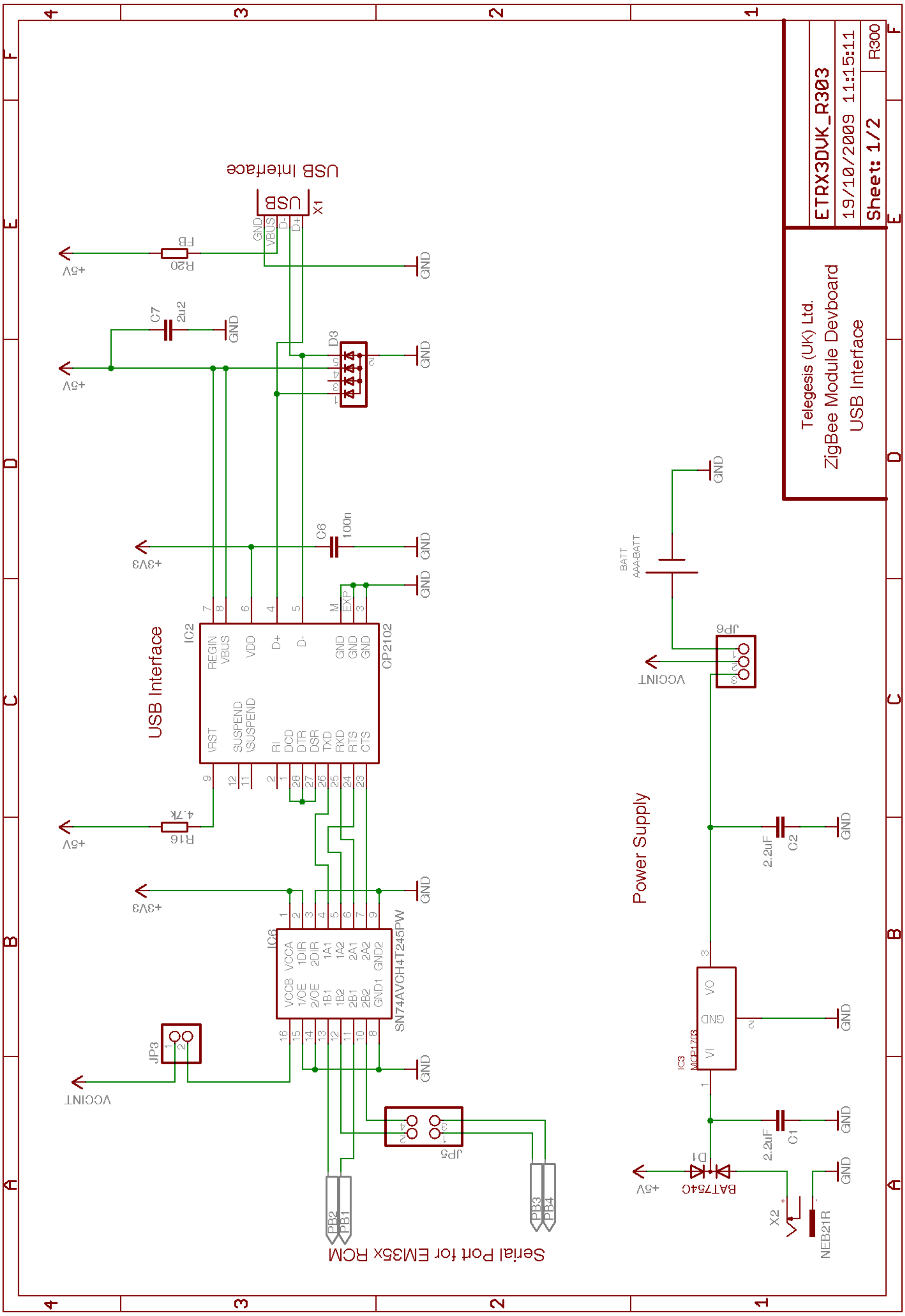
**Table 6. ETRX3587 Enhancement Pack contents**

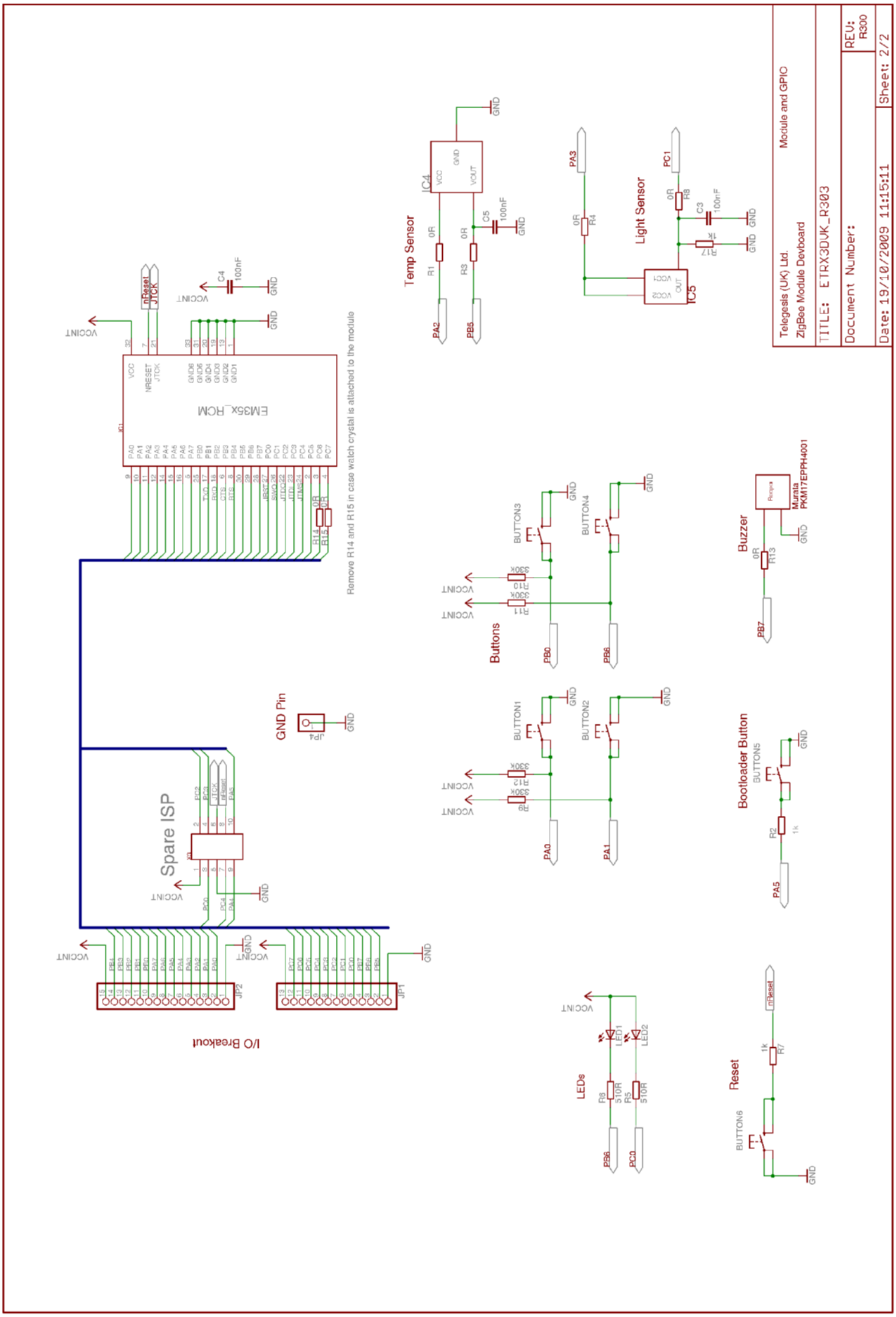
The devices in the enhancement pack will be supplied with the Silicon Labs nodetest firmware. Connect to the COM port of the board at 115200 baud and type *help*, which returns a list of the available commands. There is some information about the commands in the SiLabs application note AN710 *Bringing Up Custom Devices For The Ember® Em35x Soc Platform* at

www.silabs.com/support/pages/document-library.aspx?p=Wireless&f=ZigBee&pn=EM357

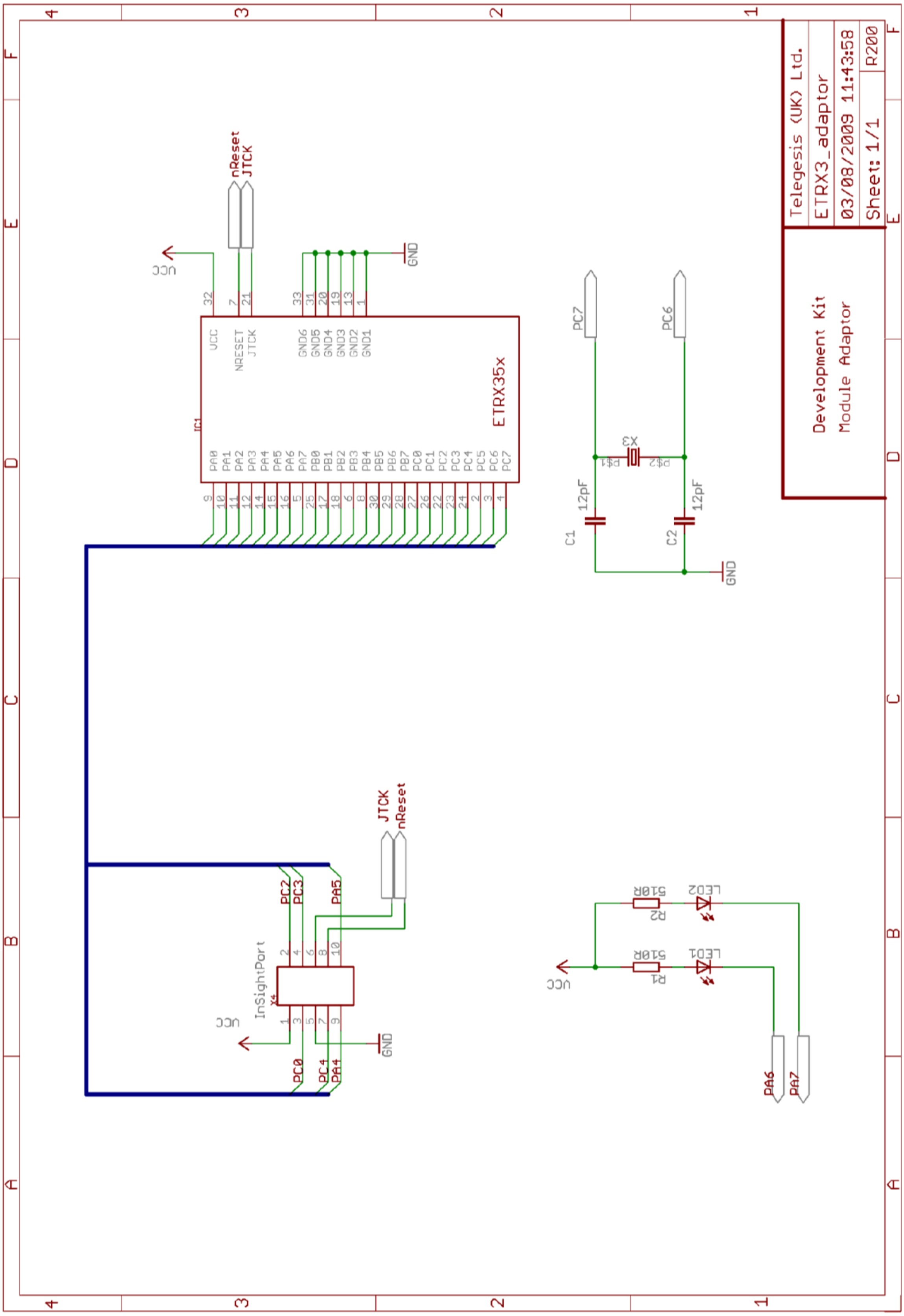
but the command set is otherwise undocumented.

# 15 Devboard Schematic




Temp Sensor
IC4
Light Sensor
IC5
Buttons
BUTTON1
BUTTON2
BUTTON3
BUTTON4
Buzzer
Murata PKM17EPPH4001
GND Pin
JP4
Spare ISP
Bootloader Button
BUTTON5
I/O Breakout
JP1
JP2
LEDs
LED1
LED2
Reset
BUTTON6
EM35x_RCM
Remove R14 and R15 in case watch crystal is attached to the module
VCCINT
GND
nReset
JTCK
100nF
Telegesis (UK) Ltd.
ZigBee Module Devboard
Module and GPIO
TITLE: ETRX3DVK_R303
Document Number:
REV: R300
Date: 19/10/2009 11:15:11
Sheet: 2/2

# 16 Carrier Board Schematic



# 17 ETRX357 Ordering Information

| Ordering/Product Code | Description |
|---|---|
| **ETRX357** | Telegesis Wireless Mesh Networking Module with Silicon Labs ZigBee® Technology:<br>• Telegesis AT Style Command Interpreter based on Silicon Labs' EmberZNet stack<br>• Integrated 2.4GHz Antenna |
| **ETRX357HR** | Telegesis Wireless Mesh Networking Module with Silicon Labs ZigBee® Technology:<br>• Telegesis AT Style Command Interpreter based on Silicon Labs' EmberZNet stack<br>• Hirose U.FL Antenna Connector |
| **ETRX357DVK** | Telegesis Development Kit with:<br>• 3 x ETRX357DV Development Boards<br>• 2 x ETRX357 Modules on Carrier Boards<br>• 2 x ETRX357HR Modules on Carrier Boards<br>• 2 x ETRX357-LRS Modules on Carrier Boards<br>• 2 x ETRX357HR-LRS Modules on Carrier Boards<br>• 1 x ETRX3USB stick<br>• 2 x ½-wave antennae<br>• 2 x ¼-wave antennae<br>• 3 x USB Cables |
| **ETRX3587 Enhancement Pack** | • 2 x ETRX3587 Modules on Carrier Boards<br>• 2 x ETRX3587HR Modules on Carrier Boards<br>• 2 x ETRX3587-LRS Modules on Carrier Boards<br>• 2 x ETRX3587HR-LRS Modules on Carrier Boards |

**Notes:**

- Customers' PO's must state the Ordering/Product Code.
- There is no "blank" version of the ETRX357 Module available. All Modules carry the Telegesis AT style Command Layer based on the EmberZNet Stack. (Where customers wish to add their own firmware they can re-program the flash memory of the embedded EM357).
- Please contact Telegesis if you require additional AT style commands or specific integration assistance.

## 18 Trademarks

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## 19 Disclaimer

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## 20 Contact Information

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## 21 References

| | | |
|---|---|---|
| Telegesis | - | www.telegesis.com |
| Silicon Labs / Ember | - | www.silabs.com/products/wireless/zigbee/Pages/default.aspx |