4 Hardware Description

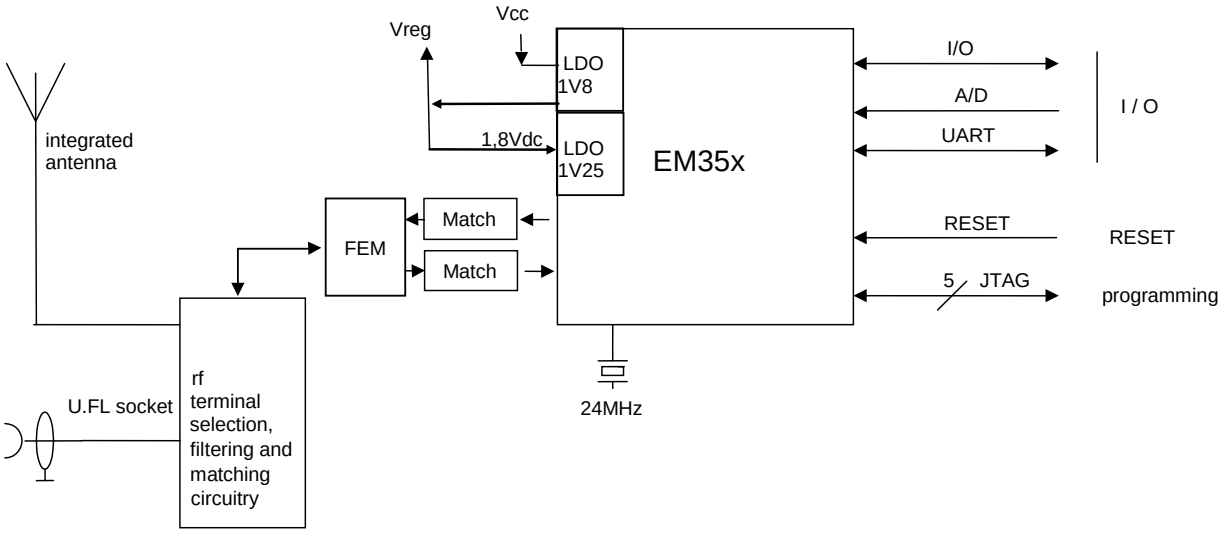

Figure 2: Hardware Diagram

The ETRX351-LRS and ETRX357-LRS are based on the Ember EM351 and EM357 respectively in addition to a frontend module containing a PA, LNA and RF switch in addition to the RF-Frontend. The EM351 and EM357 are fully integrated 2.4GHz ZigBee transceivers with a 32-bit ARM® Cortex M3™ microprocessor, flash and RAM memory, and peripherals.

The industry standard serial wire and JTAG programming and debugging interfaces together with the standard ARM system debug components help to streamline any custom software development.

In addition to this a number of MAC functions are also implemented in hardware to help maintain the strict timing requirements imposed by the ZigBee and IEEE802.15.4 standards.

The new advanced power management features allow faster wakeup from sleep and new power-down modes allow this 3rd generation module to offer a longer battery life than any 2nd generation modules on the market.

The EM35x has fully integrated voltage regulators for both required 1.8V and 1.25V supply voltages. The voltages are monitored (brown-out detection) and the built in power-on-reset circuit eliminates the need for any external monitoring circuitry. A 32.768kHz watch crystal can be connected externally to pads 3 and 4 in case more accurate timing is required.

4.1 Hardware Interface

All GPIO pins of the EM351 or EM357 except PB0 and PC5 are accessible on the module's pads. Whether signals are used as general purpose I/Os, or assigned to a peripheral function like ADC is set by the firmware. When using the Telegesis AT Command-set please refer to the AT Command-set manual for this information and when developing custom firmware please refer to the EM35x datasheet.

5 Firmware Description

The modules will be pre-loaded with a standalone bootloader by Ember, which supports over-the-air bootloading as well as serial bootloading of new firmware.

In order to enter the standalone bootloader using a hardware trigger pull PA5 to ground and power-cycle or reset the module. To avoid entering the standalone bootloader unintentionally make sure not to pull this pin down during boot-up unless the resistance to ground is >10kΩ. A pull-up is not required).

In addition to the standalone bootloader the modules also contain the current release of the Telegesis AT-style command interface as described in the Telegesis AT command dictionary and the Telegesis user guide. Check www.telegesis.com for updates. Each module comes with a unique 64-bit 802.15.4 identifier which is stored in non-volatile memory. The commands and responses pass through the serial port of the ETRX35x-LRS as ASCII text, so a simple terminal application will usually suffice. Telegesis Terminal is provided as a development tool, but it is not an essential feature.

The pre-loaded AT-style command interface firmware is based on the latest EmberZNet meshing stack which implements routers/coordinators as well as (sleepy) end devices. [End devices have no routing responsibility and therefore are allowed to go to sleep, whilst still being able to send and receive messages via a parent router. In addition to a classical (sleepy) end device the module firmware also supports mobile (sleepy) end devices capable of changing their parent quickly whenever they change their position within the network.]

A router is typically a mains powered device whilst a sleepy end device (SED) can be battery powered.

The module is also able to act as a PAN coordinator and Trust Centre through external host control. The AT style command line supplies all the tools required to set up and manage a ZigBee network by allowing easy access to the low-level functionality of the stack.

The Telegesis firmware uses the meshing and self healing EmberZNet PRO stack to overcome many of the limitations of the tree network topology of the ZigBee® 2006 stack by using the ZigBee PRO feature-set.

The Telegesis firmware also allows low-level access to physical parameters such as radio channel and power level. Parameters that define the functionality of the ETRX35x-LRS module and also allow standalone functionality are saved in non-volatile memory organised in so-called S-Registers. The SPI and I2C buses are not supported by the current firmware release, but can be used with custom firmware.

5.1 Custom Firmware

For high volume customers the firmware can be customised on request. Customers can use the ETRX35x-LRS module as hardware only and develop application specific firmware based on the EmberZNet stack. In order to develop custom firmware the Ember Insight tool-chain is required.

5.2 Boost Mode vs. Normal Mode

The Ember EM35x chips support a “boost mode” power setting next to the “normal mode” power setting. The “boost mode” setting increases the sensitivity and output power of the radio transceiver, however with the LRS variants enabling boost mode has no positive effect on neither the output power nor the sensitivity and therefore it is recommended to not use boost mode on this platform. The Telegesis AT Command-set firmware automatically disables boost mode on LRS series modules.

Section 11.2lists the requirements for power settings for use of the LRS family in different countries.

5.3 Software Interface

Using the default firmware the ETRX35x-LR is controlled using a simple AT-style command interface and (mostly) non-volatile S-Registers. In order to get a full listing of all the available AT-Commands, please refer to the AT command dictionary document which corresponds to the firmware revision you intend to use.

In addition to the command dictionary there are user guides explaining the features of the firmware in more detail. If you need to find out which firmware resides on your module simply type “**ATI**” followed by a carriage return and you will be prompted with the module’s manufacturing information.

The Development Kit manual describes how to upgrade the firmware either via a serial link or over the air.

6 Absolute Maximum Ratings

Supply: **3.6V**
Inputs: **-0.3V to Vcc + 0.3V**
Operating temperature: **-40 to 85°C**

No.	Item	Symbol	Absolute Maximum Ratings	Unit
1	Supply voltage	V_{CC}	-0.3 to +3.6	Vdc
2	Voltage on any I/O[11:0] , SIF_CLK, SIF_MISO, SIF_MOSI, SIF_LOADB, RESET	V_{in}	-0.3 to V_{CC} +0.3	Vdc
3	Voltage on any Pad pin (PA4, PA5, PB5, PB6, PB7, PC1), when used as an input to the general purpose ADC with the low voltage range selected	V_{in}	-0.3 to +2.0	Vdc
4	Storage temperature range	T_{stg}	-40 to +105	°C
5	Operating temperature range	T_{op}	-40 to +85	°C
6	Input RF level	P_{max}	15	dBm
7	ESD on any pin {1} except the RF port according to Human Body Model (HBM) circuit description	V_{THHBM}	±1	kV
8	ESD on RF Port	V_{THHBM}	500	V
9	Reflow temperature	T_{Death}	Please refer to chapter 13	°C

Table 4. Absolute Maximum Ratings

Note:

{1} Input must be current limited to the value specified.

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

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

7 Recommended Operating Conditions

No.	Item	Condition / Remark	Symbol	Value			Unit
				Min	Typ	Max	
1	Supply voltage		V_{CC}	2.1	3.0	3.5	Vdc
2	RF Input Frequency		f_C	2405		2480	MHz
3	RF Input Power		p_{IN}			0	dBm
4	Operating temperature range		T_{op}	-40		+85	°C

Table 5. Recommended Operating Conditions

8 DC Electrical Characteristics

V_{CC} = 3.0V, T_{AMB} = 25°C, NORMAL MODE unless otherwise stated

No.	Item	Condition / Remark	Symbol	Value			Unit
				Min	Typ	Max	
1	Module supply voltage		V_{CC}	2.1	3.0	3.6	Vdc
2	Quiescent current, internal RC oscillator disabled		I_{SLEEP}		1		µA
3	Quiescent current, internal RC oscillator enabled		I_{SLEEP}		1.2		µA
4	Quiescent current, including 32.768kHz oscillator		I_{SLEEP}		1.5		µA
5	Transmit current consumption	at +20dBm module output power	I_{TXVCC}		140		mA
7	Transmit current consumption	at min. module output power	I_{TXVCC}		52		mA
8	Receive current consumption	Total, 12MHz clock speed	I_{RX}		30		mA
9	Receive current consumption	Total, 24MHz clock speed	I_{RX}		31.5		mA
12	MCU, RAM and flash, FEM, radio off	12MHz clock speed	I_{MCU}		7		mA
13	MCU, RAM and flash, FEM, radio off	24MHz clock speed	I_{MCU}		8		mA
14	Serial Controller	Max data rate	I_{SC}		0.2		mA
15	Timer	Max clock rate	I_{TMR}		0.25		mA
16	ADC	Max sample rate	I_{ADC}		1.1		mA
17	Wake time from deep sleep	From wakeup event to 1st instruction			100		µs
18	Shutdown time	From last instruction into deep sleep			5		µs

Table 6. DC Electrical Characteristics

Please Note: The average current consumption during operation is dependent on the firmware and the network load, therefore these figures are given in the command dictionary of the respective firmware.