



# EM35x Module Technical Specification

The Ember EM35x Development Kit contains nine modules designed around the EM300 Series. All of these modules are designed and sold (as the ETRX35x Series) by Ember’s partner, Telegesis, Ltd of Marlow, England. The module design allows them to be integrated into any product without the need for RF experience and expertise. Utilizing EmberZNet PRO, Ember’s certified ZigBee PRO network stack, the ETRX35x Series enables a developer to add powerful wireless networking capability to products and quickly bring them to market.

This document provides the technical specification of the EM35x Module on its Ember-specific carrier board. For more information on the other Telegesis modules, contact Telegesis, Ltd directly at [www.telegesis.com](http://www.telegesis.com).

### New in this Revision

‘EM35x Configurations’ section added.

Table 8: Pins 13 and 14 corrected.

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## EM35x Module Definitions

To accommodate the requirements of the different ZigBee markets, Telegesis has developed a series of pin-compatible modules based on Ember's EM357 and EM351 chipset. Table 1 defines the Telegesis and Ember part numbers for each module as well as describes the differences (Power Amplifier (PA), Low Noise Amplifier (LNA), and RF connection) between each module.

Table 1. Ember and Telegesis Part Numbers

Ember P/N	Ember Chip	Telegesis P/N (Module only)	RF Connection	PA / LNA? (Long Range)
110-0720-000	EM357	ETRX357	SMT Antenna	No
110-0721-000	EM357	ETRX357HR	Mini-RF Connector	No
110-0722-000	EM357	ETRX357HR-LR	Mini-RF Connector	Yes
110-0723-000	EM357	ETRX357-LR	SMT Antenna	Yes
110-0724-000	EM351	ETRX351	SMT Antenna	No
110-0725-000	EM351	ETRX351HR	Mini-RF Connector	No
110-0726-000	EM351	ETRX351HR-LR	Mini-RF Connector	Yes
110-0727-000	EM351	ETRX351-LR	SMT Antenna	Yes

All of these modules are available from Telegesis. Ember provides all four EM357-based module types but only one EM351-based module type (ETRX351, Ember P/N: 110-0724-000) with the EM35x Development Kit.

For modules whose RF connection is a mini-RF connector, an RF adapter cable (Tyco/Amp part number 2032440-1) can be used to interface the module to external test equipment. One of these RF adapter cables is included with the EM35x Development Kit.

To connect to the EM35x breakout board (Ember P/N: 130-0680-000), each Telegesis module shown in Table 1 is soldered to a small carrier board. The carrier board connector is discussed later in this document.

## EM35x Module Features

Module features:

- Small form factor, SMT module (25 mm x 19mm)
- Side castellations for easy soldering and inspection
- Industry standard JTAG Programming and real-time network level debugging via the Ember Insight Port (ISP).

- Wide supply voltage range (2.1 to 3.6V)
- Low sleep current (< 1uA)
- Access to all 24 GPIO from the EM35x System-on-Chip (SoC)
- Access to either a U.FL RF Connector or a SMT antenna allows flexibility in antenna selection process
- FCC compliance, FCC modular approval pending
- CE compliance
  - Radio: EN300 328 v1.7.1 (10/2006)
  - EMC: EN301 489-17 v2.1.1 (09/2008)
  - Safety: EN60950-1:2006
- Long Range version with a link budget of up to 124dB

Module with carrier board features:

- Access to 32.768kHz watch crystal for deep sleep timer
- Access to Ember's InSight Port connector (allows for direct connection to Ember's InSight Adapter (ISA3) for programming and debugging)
- Two debug LEDs
- Access to all EM35x GPIO through a robust 0.05" pitch connector

## Performance Characteristics

This section describes the characteristics of the module with carrier board. For more information on the EM35x SoC performance, refer to Ember document 120-035X-000: *EM35x Datasheet*.

Unless specified, the data within each of the tables was gathered at room temperature (25°C) and 3.0V source potential.

Table 2 summarizes the recommended operating conditions for the EM35x module.

Table 2. Recommended Operating Conditions for the EM35x Module

Parameter	Min.	Typ.	Max.	Unit
VDD supply	2.1		3.6	V
RF Input Frequency	2405		2480	MHz
RF Input Power (at RF Port)			0	dBm
Operating Temperature Range	-40		85	°C

Table 3 summarizes the DC characteristics at 25°C and VDD of 3V of the EM35x Module.

Table 3. DC Characteristics of the EM35x Module

Parameter	Min.	Typ.	Max.	Unit
VDD supply	2.1		3.6	V
Sleep Current				
32kHz watch crystal		1.3		uA
RC oscillator		0.4		uA
Active Current (TX)				
TX, Normal Mode, +3 dBm		31		mA
TX, Boost Mode, +8 dBm		39		mA
TX, Normal Mode, 0 dBm		28.5		
Active Current (RX)				
RX, Normal Mode		26		mA
RX, Boost Mode		27		mA
Wake Time from Deep Sleep		100		us
Shutdown Time		5		us

Table 4 summarizes the digital I/Os at VCC = 3V and 25°C of the EM35x Module.

Table 4. Digital I/O Characteristics of the EM35x Module

Parameter	Min.	Typ.	Max.	Unit
Input Logic Threshold				
Schmitt threshold (high to low)	0.42 x VDD		0.5 x VDD	V
Schmitt threshold (low to high)	0.62 x VDD		0.8 x VDD	V
Input Current				
Logic Low			-0.5	uA
Logic High			0.5	uA
Output Voltage				
Logic Low	0		0.18 x VDD	V
Logic High	0.82 x VDD		VDD	V
Output Current				
Source, Standard Pad			4	mA
Sink, Standard Pad			4	mA
Source, High Current Pad			8	mA
Sink, High Current Pad			8	mA
Total Output Current			40	mA

Table 5 summarizes the RF parameters of the EM35x Module.

Table 5. RF Characteristics of the EM35x Module

Parameter	Min.	Typ.	Max.	Unit
Frequency Range	2405		2480	MHz
Channel Spacing		5		MHz
RX Sensitivity (1% PER, 20-byte packet)				
Normal Mode		-100	-94	dBm
Boost Mode		-101	-95	dBm
Adjacent Channel Rejection				
High Side		35		dB
Low Side		35		dB
2 <sup>nd</sup> High Side		43		dB
2 <sup>nd</sup> Low Side		43		dB
All other channels		40		dB
TX Power (Maximum)				
Boost Mode		8		dBm
Normal Mode		3		dBm
Error Vector Magnitude (Offset EVM) (per IEEE 802.15.4-2003)		5	15	%
PSD (3.5MHz from carrier)				
Relative	-20			dB
Absolute	-30			dBm

## EM35x Configurations

The EM35X on the EM35x Module can be set to different RF frequency channels as well as different power levels. When using Ember's RANGETEST test application on the module, the frequency channels and output power levels can be configured through a command line interface (CLI).

In order to configure the output power, the setTXPower command can be used. Table 6 demonstrates the setTXPower command and the power level expected (note there are differences between Boost Mode and Normal Mode).

Table 6: List of TX output powers when using SetTxPower

SetTxPower [signed hexadecimal]	Output Power (Boost Mode, dBm)	Output Power (Normal Mode, dBm)
SetTxPower 9	+3	+3
SetTxPower 8	+8	+3
SetTxPower 7	+7	+3
SetTxPower 6	+6	+3
SetTxPower 5	+5	+3

SetTxPower [signed hexadecimal]	Output Power (Boost Mode, dBm)	Output Power (Normal Mode, dBm)
SetTxPower 4	+4	+3
SetTxPower 3	+3	+3
SetTxPower 2	+2	+2
SetTxPower 1	+1	+1
SetTxPower 0	0	0
SetTxPower -1	-1	-1
SetTxPower -2	-2	-2
SetTxPower -3	-3	-3
SetTxPower -4	-4	-4
SetTxPower -5	-5	-5
SetTxPower -6	-6	-6
SetTxPower -7	-7	-7
SetTxPower -8	-8	-8
SetTxPower -9	-9	-9
SetTxPower -a	-9	-9
SetTxPower -b	-11	-11
SetTxPower -c	-12	-12
SetTxPower -d	-12	-12
SetTxPower -e	-14	-14
SetTxPower -f	-14	-14
SetTxPower -10	-14	-14
SetTxPower -11	-17	-17
SetTxPower -12	-17	-17
SetTxPower -13	-17	-17
SetTxPower -14	-20	-20
SetTxPower -15	-20	-20
SetTxPower -16	-20	-20
SetTxPower -17	-20	-20

To change the channel, the setChannel command can be used (assuming RANGETEST test application is on the device). Table 7 lists the valid parameters to be used with setChannel command.

Table 7: List of setChannel values for EM35x

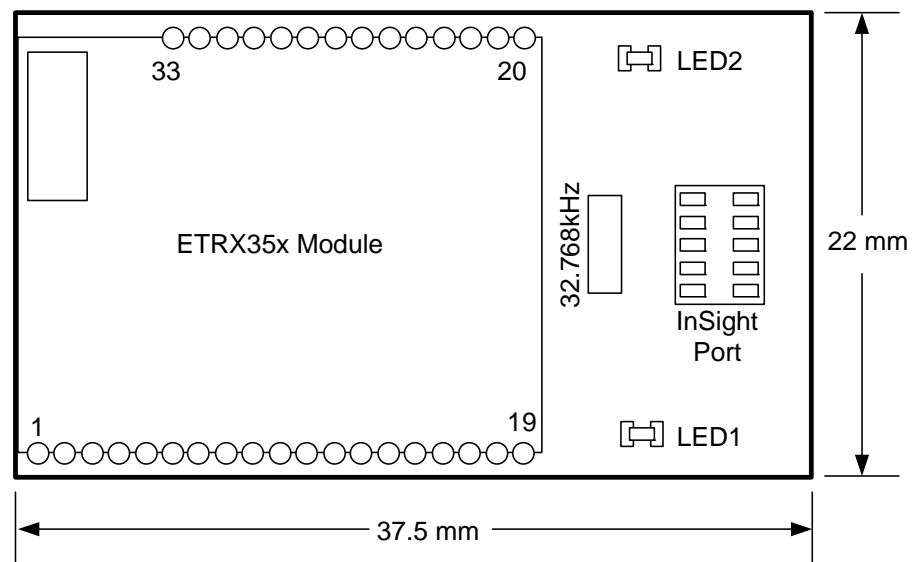
setChannel (decimal)	Center Frequency (GHz)	radioChannel (decimal)	Center Frequency (GHz)
11	2.405	19	2.445
12	2.410	20	2.450
13	2.415	21	2.455
14	2.420	22	2.460

setChannel (decimal)	Center Frequency (GHz)	radioChannel (decimal)	Center Frequency (GHz)
15	2.425	23	2.465
16	2.430	24	2.470
17	2.435	25	2.475
18	2.440	26	2.480

## Mechanical Details

Figure 1 illustrates the EM35x Module on a carrier board.

Figure 1: ETRX357 Module with Carrier Board



### EM35x Module interface connector

Two single-row, 0.05" pitch, connectors make up the EM35x module interface to the EM35x breakout board. In addition, two single-row, guide connectors on the EM35x breakout board assist with connecting the EM35x module to the breakout board. The board-to-board connector scheme allows access to all EM35x GPIO as well as nRESET and the JCLK signals. The connector is illustrated in Figure 2, while the connector dimensions are listed in Figure 3.

Figure 2. Board-to-board connector for the EM35x module (top view)

33	GND
32	VDD_3V_I/MOD
31	GND
30	EM35x_PB5
29	EM35x_PB6
28	EM35x_PB7
27	EM35x_PC0
26	EM35x_PC1
25	EM35x_PB0
24	EM35x_PC4
23	EM35x_PC3
22	EM35x_PC2
21	JCLK
20	GND

1	GND
2	EM35x_PC5
3	EM35x_PC6
4	EM35x_PC7
5	EM35x_PA7
6	EM35x_PB3
7	nRESET
8	EM35x_PB4
9	EM35x_PA0
10	EM35x_PA1
11	EM35x_PA2
12	EM35x_PA3
13	GND
14	EM35x_PA4
15	EM35x_PA5
16	EM35x_PA6
17	EM35x_PB1
18	EM35x_PB2
19	GND

Figure 3. Board-to-board connector dimensions for the EM35x module (top view)

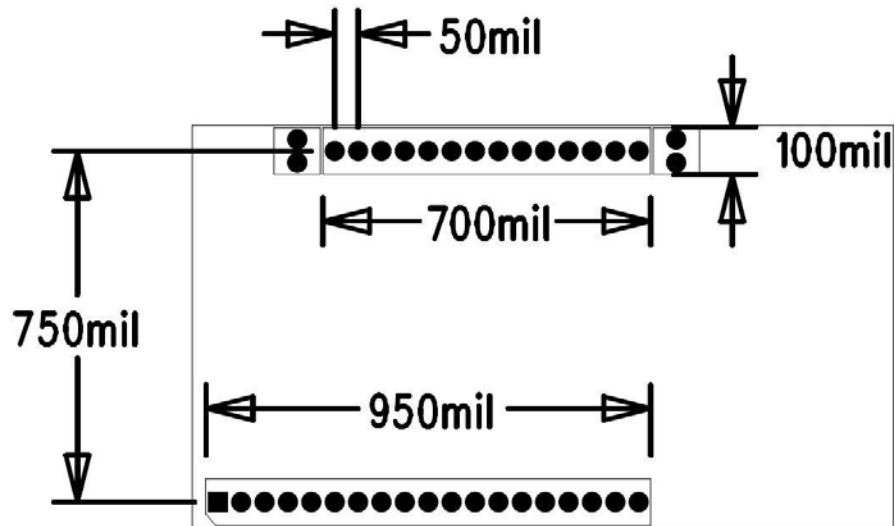


Table 8 describes the pinout and signal names on the connector.

For more information on the alternate functions of the GPIO connector, refer to Ember document 120-035X-000: *EM35x Datasheet*.

Table 8. Pinout and signal names of the interface connector

Pin #	Signal name	Direction <sup>1</sup>	Description
1	GND	Power	Ground Connection
2	PC5	I/O	EM35x GPIO
3	PC6	I/O	EM35x GPIO
4	PC7	I/O	EM35x GPIO
5	PA7	I/O	EM35x GPIO
6	PB3	I/O	EM35x GPIO
7	nRESET	I/O	Active low chip reset (internal pull-up on EM35x)
8	PB4	I/O	EM35x GPIO
9	PA0	I/O	EM35x GPIO
10	PA1	I/O	EM35x GPIO
11	PA2	I/O	EM35x GPIO
12	PA3	I/O	EM35x GPIO
13	GND	Power	Ground Connection
14	PA4	I/O	EM35x GPIO
15	PA5	I/O	EM35x GPIO
16	PA6	I/O	EM35x GPIO
17	PB1	I/O	EM35x GPIO
18	PB2	I/O	EM35x GPIO
19	GND	Power	Ground connection
20	GND	Power	Ground connection
21	JCLK	Input	JTAG interface, serial clock
22	PC2	I/O	EM35x GPIO
23	PC3	I/O	EM35x GPIO
24	PC4	I/O	EM35x GPIO
25	PB0	I/O	EM35x GPIO
26	PC1	I/O	EM35x GPIO
27	PC0	I/O	EM35x GPIO
28	PB7	I/O	EM35x GPIO
29	PB6	I/O	EM35x GPIO
30	PB5	I/O	EM35x GPIO
31	GND	Power	Ground connection
32	VDD	Power	2.1 to 3.6V Module Power Domain
33	GND	Power	Ground connection

<sup>1</sup> with respect to the EM35x Module

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**After Reading This Document**

If you have questions or require assistance with the procedures described in this document, contact Ember Customer Support. The Ember Customer Support portal provides a wide array of hardware and software documentation such as FAQ's, reference designs, user guides, application notes, and the latest software available to download. To obtain support on all Ember products and to gain access to the Ember Customer Support portal, visit [http://www.ember.com/support\\_index.html](http://www.ember.com/support_index.html).

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