EMBER® EM3X MODULE TECHNICAL SPECIFICATION

Silicon Labs' EM3x development kits contain various modules designed around the EM3x family of ICs. All of these modules are designed and sold by Silicon Labs' module partners Telegesis (UK) Limited and California Eastern Laboratories (CEL). The module designs allow them to be integrated into any product without the need for RF experience and expertise. Utilizing stacks such as Silicon Labs' certified ZigBee network stack EmberZNet, these modules enable a developer to add powerful wireless networking capability to products and quickly bring them to market.

This document provides the technical specification of the EM3x modules on its Silicon Labs-specific carrier board. For more information on the other Telegesis modules, contact Telegesis, Ltd directly at www.telegesis.com. For more information on other CEL modules, contact CEL directly at meshconnect.cel.com.

New in This Revision

Added CEL CE compliance information.

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1 EM3x Module Definitions

To accommodate the requirements of the different markets, Telegesis and CEL have developed a series of pin-compatible modules based on the Ember EM341, EM346, EM357, and EM3588 chipsets. Table 1 defines the Telegesis, CEL, and Silicon Labs 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. Silicon Labs and Module Partner Part Numbers

Silicon Labs P/N	Silicon Labs Orderable Part Number (OPN)	EM3x IC	Module Partner	Module Partner P/N (Module only)	RF Connection	PA / LNA? (Long Range)
110-0740-000	EM341-MOD-ANT-C	EM341	CEL	ZICM341SP0-1	Antenna	No
110-0741-000	EM341-MOD-RF-C	EM341	CEL	ZICM341SP0-1C	Connector	No
110-0742-000	EM346-MOD-ANT-C	EM346	CEL	ZICM346SP0-1	Antenna	No
110-0743-000	EM346-MOD-RF-C	EM346	CEL	ZICM346SP0-1C	Connector	No
110-0720-000	EM357-MOD-ANT-T	EM357	Telegesis	ETRX357	SMT Antenna	No
110-0721-000	EM357-MOD-RF-T	EM357	Telegesis	ETRX357HR	Mini-RF Connector	No
110-0722-000	EM357-MOD-LR-RF-T	EM357	Telegesis	ETRX357HR-LRS	Mini-RF Connector	Yes
110-0723-000	EM357-MOD-LR-ANT-T	EM357	Telegesis	ETRX357-LRS	SMT Antenna	Yes
110-0730-000	EM357-MOD-ANT-C	EM357	CEL	ZICM357SP0-1	SMT Antenna	No
110-0731-000	EM357-MOD-RF-C	EM357	CEL	ZICM357SP0-1C	Mini-RF Connector	No
110-0732-000	EM357-MOD-LR-RF-C	EM357	CEL	ZICM357SP2-1C	Mini-RF Connector	Yes
110-0733-000	EM357-MOD-LR-ANT-C	EM357	CEL	ZICM357SP2-1	SMT Antenna	Yes
110-0734-000	EM3588-M-AN-C	EM3588	CEL	ZICM3588SP0-1	SMT Antenna	No
110-0735-000	EM3588-MOD-RF-C	EM3588	CEL	ZICM3588SP0-1C	Mini-RF Connector	No
110-0736-000	EM3588-MLR-RF-C	EM3588	CEL	ZICM3588SP2-1C	Mini-RF Connector	Yes
110-0737-000	EM3588-MLR-AN-C	EM3588	CEL	ZICM3588SP2-1	SMT Antenna	Yes

All of these modules are available from Telegesis and CEL. Silicon Labs provides the CEL EM357 and EM3588 module types with the EM35x Development Kit (part number EM35X-DEV) and the EM341 and EM346 modules with the EM34x Development Kit (part number EM34X-DEV).

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 development kits.

To connect to the EM35x breakout board (Silicon Labs P/N: 130-0680-000), each module shown in Table 1 is soldered to a small carrier board. The carrier board connector is discussed in section 5.1, EM3x Module Interface Connector.

2 EM3x Module Features

Module features:

- Small form factor, SMT module (25 mm x 19 mm)
- Side castellation for easy soldering and inspection
- Industry standard JTAG Programming and real-time network level debugging via the Packet Trace Port.
- Wide supply voltage range (2.1 to 3.6 V)
- Low sleep current (< 1 µA for EM35x and EM34x, < 2 µA for EM3588)
- Access to all EM3x GPIO from the System-on-Chip (SoC)
- Access to either a U.FL RF Connector or a SMT antenna allows flexibility in antenna selection process
- FCC compliance

    Telegesis:

        FCC ID: S4GEM35XA
    CEL:
        FCC ID: W7Z-ZICM357SPO
        FCC ID: W7Z-ZICM357SP2

- CE compliance

    Telegesis:
        Radio: EN300 328 v1.7.1
        EMC: EN301 489-17 v2.1.1
        Safety: EN60950-1
    CEL

        Radio: EN 300 328 V1.8.1 (2006 - 2012)
        EMC: EN 301 489-1 V1.8.1, V1.9.1
                EN 301 489-17 V2.2.1

- Long Range versions with a link budget of up to 124 dB

Module with carrier board features:

- Access to the Packet Trace Port connector (allows for direct connection to the Ember Debug Adapter (ISA3) for programming and debugging)
- Two debug LEDs
- Access to all EM3x GPIO through a robust 0.05" pitch connector

3 Performance Characteristics

This section describes the characteristics of the module with carrier board. For more information on the EM35x and EM34x SoC performance, refer to the EM35x, EM358x, EM341 and EM346 data sheets.

Unless specified, the data within each of the tables was gathered at room temperature (25 °C) and 3.0 V source potential. Table 2 summarizes the recommended operating conditions for the modules.

Table 2. Recommended Operating Conditions for the EM3x 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

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Table 3 summarizes the DC characteristics at 25 °C and VDD of 3 V of the EM3x Module.

Table 3. DC Characteristics of the EM3x Module

Parameter	Min	Typ	Max	Unit
VDD supply	2.1	—	3.6	V
Sleep Current (RC oscillator)	—	0.4	—	µA
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 = 3 V and 25 °C of the EM3x Module.

Table 4. Digital I/O Characteristics of the EM3x 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	µA
Logic High	—	—	0.5	µA
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

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Table 5 summarizes the RF parameters of the EM3x Module.

Table 5. RF Characteristics of the EM3x 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
2nd High Side	—	43	—	dB
2nd 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 (3.5 MHz from carrier)				
Relative	-20	—	—	dB
Absolute	-30	—	—	dBm

4 EM3x Configurations

The IC on the EM3x Module can be set to different RF frequency channels as well as different power levels. When using the nodetest 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 expected power output. Note that these are the typical expected power output levels based on the performance of the EM3x IC and actual results are dependent on the module provider design implementation.

Note: Table 6 refers to the non-PA versions of the modules. For the version with a PA, the output power should be set to -5 dBm in order to achieve +20 dBm output power.

Table 6: List of TX output powers when using SetTxPower

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

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

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

Table 7: List of setChannel values for EM3x

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
15	2.425	23	2.465
16	2.430	24	2.470
17	2.435	25	2.475
18	2.440	26	2.480

5 Mechanical Details

Figure 1 illustrates the ZICM35x Module carrier board from CEL, while Figure 2 illustrates the ETRX35x Module from Telegesis on a carrier board.
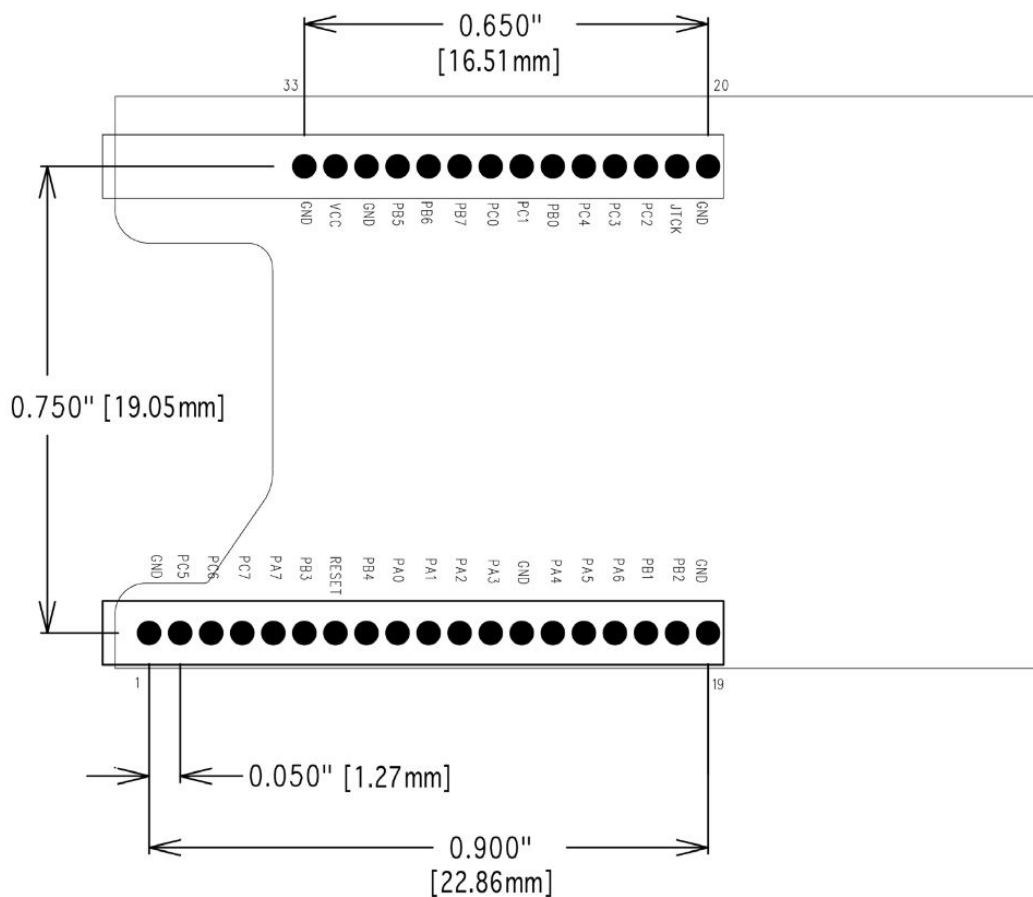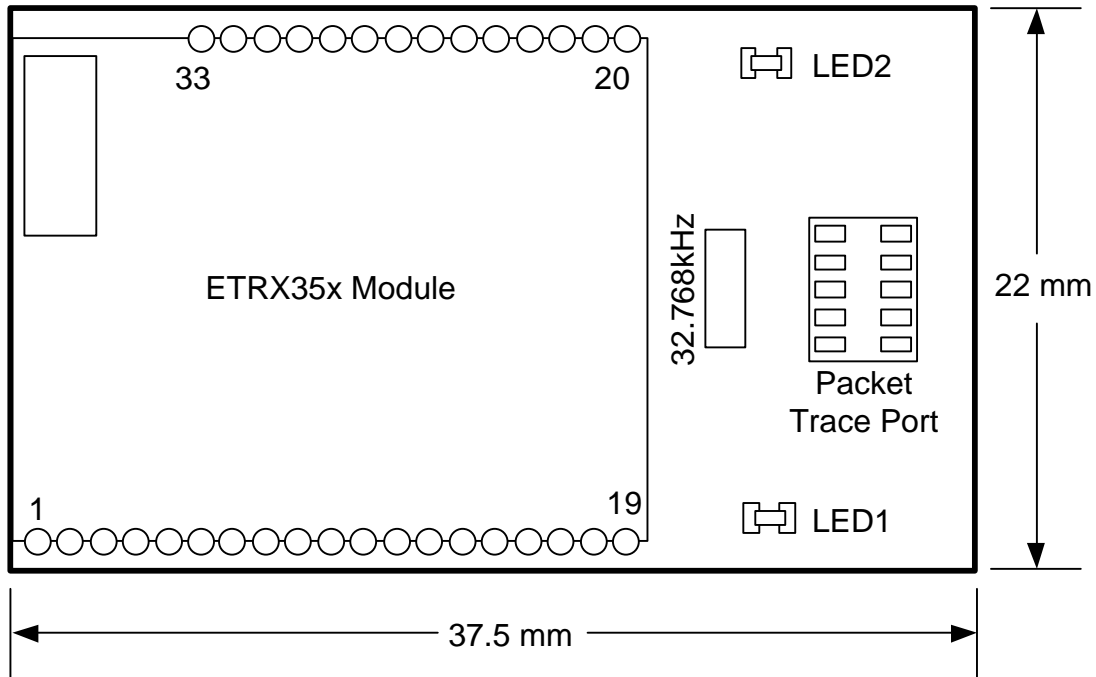

Figure 1. CEL ZICM35x Module Carrier Board

Figure 2. Telegesis ETRX35x Module with Carrier Board

5.1   EM3x Module Interface Connector

Two single-row, 0.05" pitch, connectors make up the EM3x module interface to the EM35x breakout board. In addition, two single-row, guide connectors on the EM35x breakout board assist with connecting the EM3x module to the breakout board. The board-to-board connector scheme allows access to all EM3x GPIO as well as nRESET and the JCLK signals. The connector is illustrated in Figure 3, while the connector dimensions are listed in Figure 4.
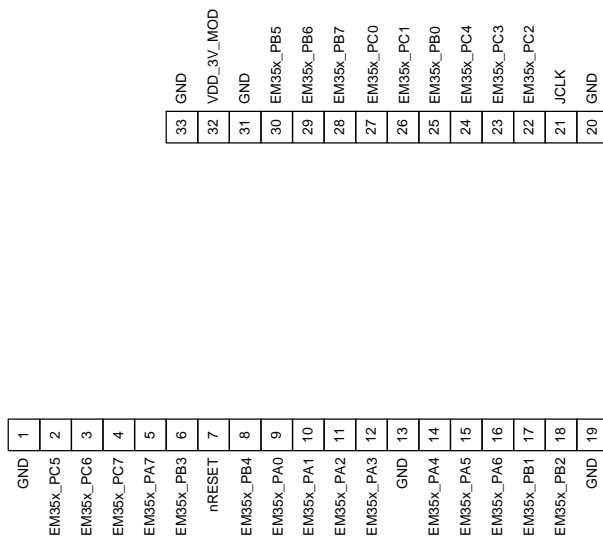

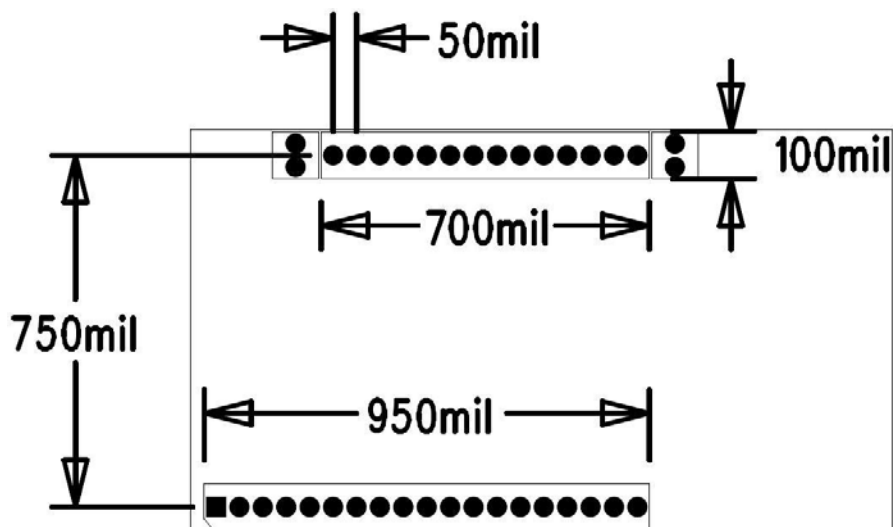**Figure 3. Board-to-board connector for the EM3x module (top view)**

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Figure 4. Board-to-Board Connector Dimensions for the EM3x 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 the *EM35x Data Sheet*.

Table 8. Pinout and Signal Names of the Interface Connector

Pin #	Signal name	Direction[1]	Description
1	GND	Power	Ground Connection
2	PC5	I/O	EM3x GPIO
3	PC6	I/O	EM3x GPIO
4	PC7	I/O	EM3x GPIO
5	PA7	I/O	EM3x GPIO
6	PB3	I/O	EM3x GPIO
7	nRESET	I/O	Active low chip reset (internal pull-up on EM3x)
8	PB4	I/O	EM3x GPIO
9	PA0	I/O	EM3x GPIO
10	PA1	I/O	EM3x GPIO
11	PA2	I/O	EM3x GPIO
12	PA3	I/O	EM3x GPIO
13	GND	Power	Ground Connection
14	PA4	I/O	EM3x GPIO
15	PA5	I/O	EM3x GPIO
16	PA6	I/O	EM3x GPIO (NC on EM346 module)
17	PB1	I/O	EM3x GPIO
18	PB2	I/O	EM3x GPIO
19	GND	Power	Ground connection
20	GND	Power	Ground connection
21	JCLK	Input	JTAG interface, serial clock
22	PC2	I/O	EM3x GPIO
23	PC3	I/O	EM3x GPIO

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Pin #	Signal name	Direction[1]	Description
24	PC4	I/O	EM3x GPIO
25	PB0	I/O	EM3x GPIO
26	PC1	I/O	EM3x GPIO
27	PC0	I/O	EM3x GPIO
28	PB7	I/O	EM3x GPIO (NC on EM346 module)
29	PB6	I/O	EM3x GPIO (NC on EM346 module)
30	PB5	I/O	EM3x GPIO (NC on EM346 module)
31	GND	Power	Ground connection
32	VDD	Power	2.1 to 3.6 V Module Power Domain
33	GND	Power	Ground connection

[1] with respect to the EM3x Module

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