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CEL California Eastern Laboratories

Free Star Pro Series

ZFSM-201-KIT-1
Development Kit
User's Guide

ZFSM-201-1 FreeStar Pro Module

Document # 0006-00-08-00-000

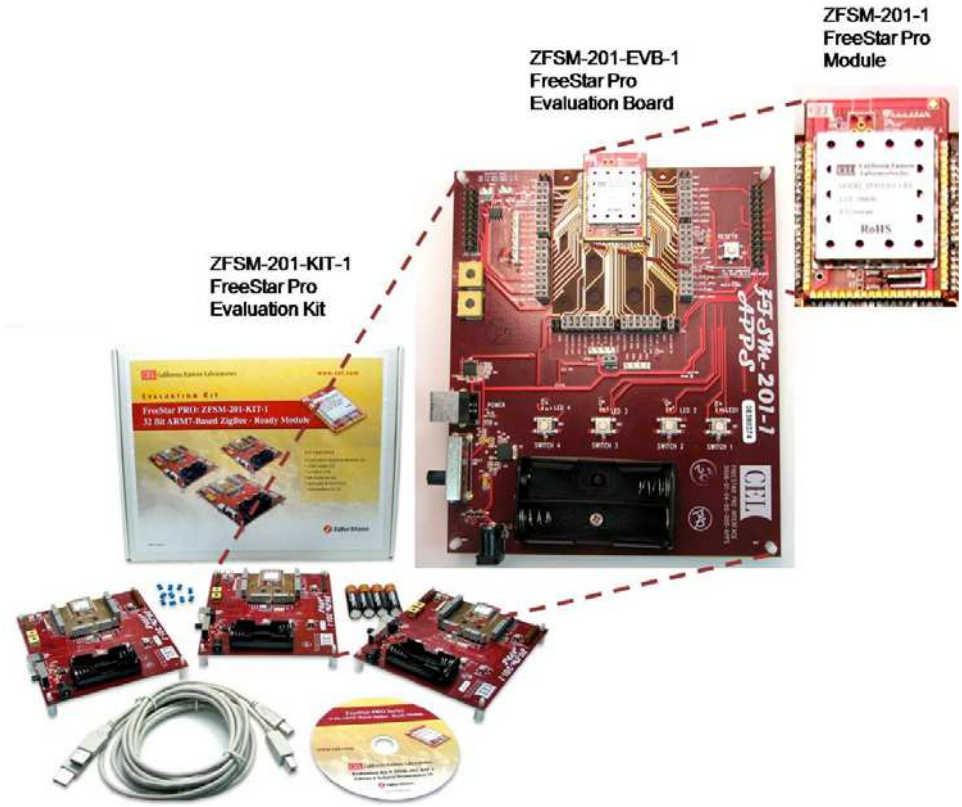
(Rev B)

Table of Contents

1 INTRODUCTION

This document is the user guide for the California Eastern Laboratories (CEL) FreeStar Pro Evaluation Kit, (**ZFSM-201-KIT-1**). The kit is a collection of hardware and software assembled to allow a customer to design a remote sensing, AMR/AMI, home and building automation, industrial control, or security application.

1.1 KIT DESCRIPTION



The main component in the Evaluation Kit is the **ZFSM201-EVB-1** FreeStar Pro Evaluation Board. The board serves as an interface, evaluation and development tool enabling the user to demonstrate, and evaluate the capabilities of the CEL **ZFSM-201-1,** FreeStar Pro Module. At the heart of the CEL **ZFSM-201-1** is the Freescale **MC13224V** Platform-in-Package (PiP) transceiver, a 32-bit ARM-based ZigBee radio module and a third-generation 2.4GHz IEEE® 802.15.4 platform.

The 32-bit ARM7 processor and extensive on-chip memory allows designers to eliminate the peripheral host processors often required by 8- and/or 16-bit transceiver solutions. The high level of integration also helps to reduce component count, lowering power consumption and reducing overall system cost.

The evaluation kit provides the end user the ability to quickly become familiar with both the **ZFSM-201-1** FreeStar Pro module's hardware and software. Each evaluation board comes preloaded with firmware demonstrating a wireless link and communicating with the supplied ***FreeStar Pro Test Tool*** Graphical User Interface (GUI).

Full application source code of the firmware is based on Freescale's SMAC and MAC

codebases for ARM7® are supplied in an IAR Embedded Workbench for ARM project. The source code exercises key features of the MC13224V and provides a good reference or starting point for creating custom applications on the SMAC codebase.

NOTE: The *MACPHY.A* library file has been removed from the pre-programmed Freescale MAC example project. The user will need to install the Freescale BeeKit™ and agree to the Terms and Conditions to receive the *MACPHY.A* library file.

Both applications include the following features:

- RF Evaluation
- Range Test Application
- Packet Error Rate Test (PERT) Application
- Transmitting and receiving on the UART
- Using low power modes
- Reading and writing to Non-Volatile Memory (NVM)
- Reading Analog to Digital Converters
- Using GPIOs

1.2 ZFSM-201-KIT-1 CONTENTS

Qty	Part Number	Description
3	ZFSM-201-EVB-1	FreeStar Pro Evaluation Boards (with firmware loaded)
2	94611-6 2.0 ver. A-B M/M 6'	USB interface cables
4	Any	Type AA Batteries
10	3M 929955-06 (0.1" SHUNT JUMPER)	Shorting Jumpers
1	CEL #0006-03-00-00-000	CEL Informational CD

The CEL Informational CD contains:

- CEL Documentation (See list in Section 1.3)
- Set-up files for the ***FreeStar Pro Test Tool*** program
- Sample Project files
  - A Project File for ***IAR Workbench®***
  - A Solution File for ***BeeKit™***
  - Application Firmware files for the **ZFSM-201-1** Module
- Files for loading theFreescale ***BeeKit™*** and ***Test Tool***

1.2.1 Optional Hardware and Software

Manufacturer/Part Number	Description
Hardware Components	
Manufacturer: Phihong P/N: PSA05R-090-R	9V DC 0.5A Power Supply
Manufacturer: IAR Systems P/N: JLINK ARM	IAR J-Link for ARM Debug Probe (recommended for development)
Software Components	
Manufacturer: IAR Systems Name: ***EWARM***	***IAR Embedded Workbench® IDE*** – Development and Compiler software (required for development)
Manufacturer: Freescale Name: ***BeeKit***	***BeeKit™*** – Freescale Wireless Connectivity Toolkit

1.3 REFERENCED DOCUMENTS

Table 1 contains the documents that have been referenced by this document (or recommended as additional information). Please consult the appropriate website to check for the latest revisions and editions.

Table 1 – Related and Referenced Documents

Document Title	Document Name / Number
Freescale Semiconductor Documents (www.freescale.com)	
BeeKit™ Wireless Connectivity Toolkit Quick Start Guide	BKWCTKQSG
BeeKit™ Wireless Connectivity Toolkit User's Guide	BKWCTKUG
BeeKit™ Wireless Connectivity Toolkit Software Release Notes	BKWCTKRN
MC13224V Datasheet	MC1322x
MC1322x Reference Manual	MC1322xRM
MC1322x Software Driver Reference Manual	22XDRVRRM
MC1322x Simple Media Access Controller (SMAC) Reference Manual	22xSMACRM
802.15.4 Media Access Controller (MAC) MyWirelessApp	802154MWAUG
802.15.4 Media Access Controller (MAC MyStarNetworkApp	802154MSNAUG
802.15.4 MAC PHY Software Reference Manual	802154MPSRM
Simple Media Access Controller (SMAC) User's Guide	SMACRM
Freescale ***Test Tool*** User's Guide	TTUG
Note: The Freescale documents listed above will be loaded to the user's PC when installing the ***BeeKit™*** Toolkit found on the CEL Freestar Pro CD	
CEL Documents (www.cel.com)	
ZFSM-201-1 Datasheet	0006-00-07-00-000
ZFSM-201-KIT-1 Development Kit User Guide	0006-00-08-00-000
ZFSM-201-EVB-1 Evaluation Board Host Serial & RF Protocol Guide	0006-00-08-01-000
ZFSM-201-EVB-1 Evaluation Board SMAC Programmers Guide	0006-00-08-02-000
ZFSM-201-EVB-1 Evaluation Board BeeKit™ Porting Guide	0006-00-08-03-000
ZFSM-201-EVB-1 Evaluation Board MAC Programmers Guide	0006-00-08-05-000
ZFSM-201-KIT-1 Wireless UART Application User Guide	0006-00-08-06-000
ZFSM-201-KIT-1, **ZFSM-201-EVB-1** Erratum	0006-00-08-04-000
Note: The CEL documents listed above are included on the CEL CD.	

2 HARDWARE OVERVIEW

2.1 ZFSM-201-EVB-1 OVERVIEW

The **ZFSM-201-1** FreeStar Pro module is a 2.4GHz IEEE 802.15.4 compliant data transceiver module (based on the Freescale **MC13224V**) with a 100mW power amplifier providing enhanced range performance. Two crystals needed for the clock oscillators are also incorporated into the module. The module also contains an integrated PCB trace antenna and possesses the ability to optionally add an MMCX connector in order to use an external antenna. The procedure for adding the connector is located in APPENDIX 1: USING AN EXTERNAL ANTENNA at the end of this document.

In order to interface with the module, it has been mounted to a PCB to produce a **ZFSM-201-EVB-1** Evaluation Board as pictured in Figure 1.

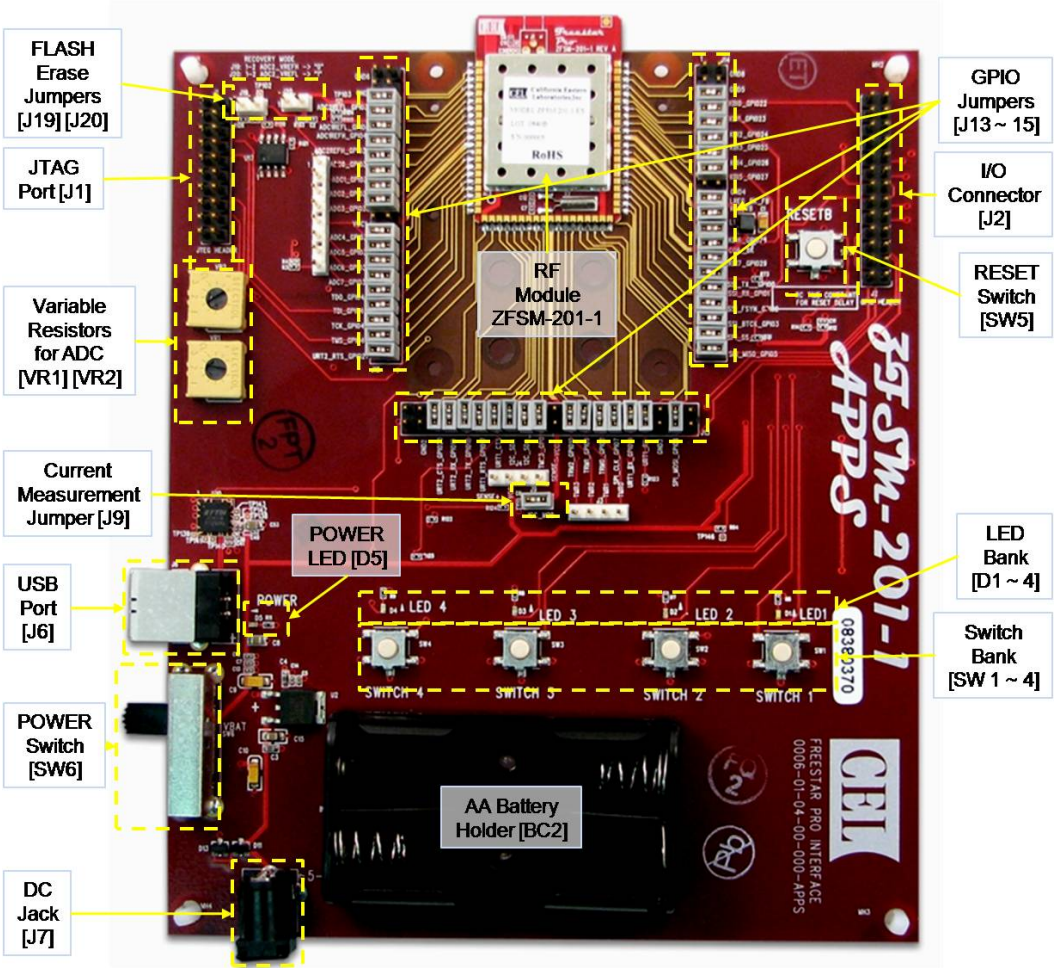


Figure 1 – Photo, ZFSM-201-EVB-1 Evaluation Board (top view)

2.2 DESCRIPTION OF THE MAJOR COMPONENTS – ZFSM-201-EVB-1

2.2.1 Input Power:

The device can be powered using any of three different methods:

- Through the ***USB Port [J6]*** using the supplied USB cable
- Through the ***DC Jack [J7]*** using an optional DC Power Supply
- Through the ***Battery Holder [BC2]*** using two supplied AA batteries

2.2.2 Power Switch [SW6]:

The Power Switch applies power from the chosen power source to the evaluation board. It is a three position switch with the three positions being OFF → '**V BAT**' (ON for battery operation) → ON (for USB or DC Jack connections)

2.2.3 Power LED [D5]

This Red LED is connected to input power bus and will be illuminated when power is applied.

2.2.4 Current Measurement Jumper [J9 2-pin]

The jumper on J9 can be removed and a current meter placed in series to measure current into the module, a useful feature for evaluating low-power modes.

2.2.5 JTAG Port [J1 20-pin]:

The JTAG port is used for debugging applications and loading firmware using the ***IAR Embedded Workbench® IDE*** program.

Table 2 – JTAG Port Connector pins

Description	Pin	Pin	Description
VCC	1	2	VCC
not connected	3	4	GND
TDI	5	6	GND
TMS	7	8	GND
TCK	9	10	GND
RTCK	11	12	GND
TDO	13	14	GND
DBGRQ	15	16	GND
DBGACK	17	18	GND
not connected	19	20	GND

2.2.6 Variable Resistors [VR1 & VR2]:

The onboard potentiometers are connected to the Analog to Digital Converter (ADC) pins on the **MC13224V**. They are used to demonstrate the functionality of the ADC.

2.2.7 FLASH Erase Jumpers [J19 2-pin, J20 2-pin]:

A method for manually erasing the Flash memory using these jumpers is discussed in Section 7.2 of this manual.

2.2.8 Reset Switch [SW5]:

The ability to reset the microcontroller on the FreeStar Pro module is provided by this switch.

2.2.9 GPIO Header Connector [J2 26-pin]

Additional access to selected I/O pins on the **MC13224V** is provided at this connector.

Table 3 – GPIO Header Connector pins

I/O	Pin	Pin	I/O
TMR1	1	2	*not connected*
VCC	3	4	GND
ADC1	5	6	ADC2
ADC3	7	8	ADC4
ADC5	9	10	*not connected*
SSI_TX	11	12	SSI_RX (GPIO1)
SSI_FSYN	13	14	SSI_BITCK
KBI0 (GPIO22)	15	16	KBI4 (GPIO26)
UART2_TX	17	18	UART2_RX
UART2_RTS	19	20	UART2_CTS
I^2C_SCL	21	22	I^2C_SDA
SPI_SCK	23	24	SPI_SS
SPI_MOSI	25	26	SPI_MISO

2.2.10 Application Switches [SW1-SW4]

User inputs for standalone demonstrations or custom applications.

2.2.11 LED's [D1-D4]

User outputs for standalone demonstrations or custom applications.

2.2.12 Timer I/O Connector [J3 4-pin]

The four Timer I/O signals are available on the J3 connector.

Table 4 – Timer I/O Connector pins

Pin 1	Pin 2	Pin 3	Pin 4
TMR0	TMR1	TMR2	TMR3

2.2.13 Supply Voltage Connector [J4 4-pin]

This connector allows powering of the EVB directly (bypassing the regulator) through Pin 3 and allows monitoring of the module's VCC through Pin 4 (SENSE+)

Table 5 – VCC Connector pins

Pin 1	Pin 2	Pin 3	Pin 4
GND (SENSE–)	GND	VCC In	VCC Module (SENSE+)

2.2.14 ADC Input Channel Connector [J5 8-pin]

The eight ADC input channels are available on the J5 connector.

Table 6 – ADC Input Channel Connector pins

Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
ADC0	ADC1	ADC2	ADC3	ADC4	ADC5	ADC6	ADC7

2.2.15 Add on Antenna

The module contains an integrated PCB antenna and possesses the capacity to add an external antenna to the module. A simple procedure for making this change (adding the connector, changing the position of a capacitor) is included in APPENDIX 1: USING AN EXTERNAL ANTENNA located at the end of this document.

2.2.16 GPIO Jumpers [J13 40-pin, J14 40-pin, J15 40-pin]:

Three 40-pin jumper connectors provide access to the I/O pins of the **ZFSM-201-1** FreeStar Pro module and as a result to most of the I/O pins of the Freescale **MC13224V** device.

Table 7 below shows the connections made by each jumper for each of the three connectors J13, J14 and J15 as shown in Figure 2.

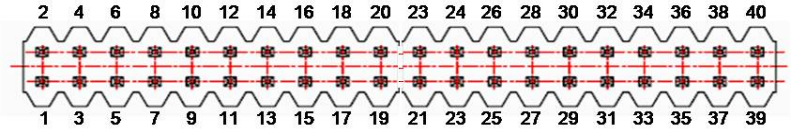


Figure 2 – Pin numbering for the 40-pin Jumper Connectors (J13, J14 and J15)

Table 7 – Jumper Connections Map

Connection to the Module/IC					Connector Pins		Connection on the EVB
Pin #		GPIO	Description	Pin Name			
IC[1]	Mod[2]	#			#	#	*designates Jumper*[3]
Jumper Connections, J14							
86	59	-	Ground	GND8	1	2	both pins hard wired to ground
79	58	-	Ground	GND5	3	4	both pins hard wired to ground
42	57	22	Keyboard Interface Bit 0	KBI0	**5**	**6**	pin 15, J2(GPIO Header)
41	56	23	Keyboard Interface Bit 1	KBI1	**7**	**8**	LED1
40	55	24	Keyboard Interface Bit 2	KBI2	**9**	**10**	LED2
39	54	25	Keyboard Interface Bit 3	KBI3	**11**	**12**	LED3
38	53	26	Keyboard Interface Bit 4	KBI4	**13**	**14**	SW1; pin 16, J2(GPIO Header)
37	52	27	Keyboard Interface Bit 5	KBI5	**15**	**16**	SW2
78	51	-	Ground	GND4	17	18	both pins hard wired to ground
44	50	-	Voltage Input to Onboard Regulators, Buck Regulator Feedback Voltage	LREG_BK_FB	**19**	**20**	connected to pin 26 through an inductor
51	49	-	System Reset Input	RESETB	**21**	**22**	RESET (SW5)
36	48	28	Keyboard Interface Bit 6	KBI6	**23**	**24**	SW3
43	47	-	Buck Converter Coil Drive Output	COIL_BK	**25**	**26**	connected to pin 20 through an inductor
35	46	29	Keyboard Interface Bit 7	KBI7	**27**	**28**	SW4
34	45	0	SSI TX Data Output	SSI_TX	**29**	**30**	pin 11, J2(GPIO Header)
33	44	1	SSI RX Data Input	SSI_RX	**31**	**32**	LED4; pin 12, J2(GPIO Header)
32	43	2	SSI Frame Sync	SSI_FSYN	**33**	**34**	pin 13, J2(GPIO Header)
31	42	3	SSI Bit Clock (bidirectional)	SSI_BITCK	**35**	**36**	pin 14, J2(GPIO Header)
30	41	4	SPI Port Slave Select	SPI_SS	**37**	**38**	pin 24, J2(GPIO Header)
29	40	5	SPI Port Master In Slave Out	SPI_MISO	**39**	**40**	pin 26, J2(GPIO Header)
Jumper Connections, J13							
No Connection					1	2	
28	39	6	SPI Port Master Out Slave In	SPI_MOSI	**3**	**4**	pin 25, J2(GPIO Header)
77	38	-	Ground	GND3	5	6	both pins hard wired to ground
19	37	15	UART1 RX Data Input	UART1_RX	**7**	**8**	pin 30, U10(USB to UART IC) through 1KΩ
20	36	14	UART1 TX Data Output	UART1_TX	**9**	**10**	pin 2, U10(USB to UART IC) through 1KΩ
27	35	7	SPI Port Clock	SPI_SCK	**11**	**12**	pin 23, J2(GPIO Header)
26	34	8	Timer 0 IO Signal	TMR0	**13**	**14**	pin 1, J3(Timers Conn)
25	33	9	Timer 1 IO Signal	TMR1	**15**	**16**	pin 2, J3(Timers Conn)
24	32	10	Timer 2 IO Signal	TMR2	**17**	**18**	pin 3, J3(Timers Conn)
45	31	-	Supply Voltage to Buck Regulator, switching MOSFETS & IO buffers	VCC2	19	20	both pins hard wired to Vcc
23	30	11	Timer 3 IO Signal	TMR3	**21**	**22**	pin 4, J3(Timers Conn)
22	29	12	I^2C Bus Clock	I2C_SCL	**23**	**24**	pin 21, J2(GPIO Header)
21	28	13	I^2C Bus Data	I2C_SDA	**25**	**26**	pin 22, J2(GPIO Header)

[1] The pin number on the Freescale **MC13224V** of the function listed.
[2] The pin number on the CEL **ZFSM-201-1** Free Star Pro Module of the function listed.
[3] The **dark gray** color in the Connector Pins columns designates that a Jumper was in place at this location at shipment and should be in place for normal operation.

Connection to the Module/IC					Connector Pins		Connection on the EVB
Pin #		GPIO	Description	Pin Name			
IC[1]	Mod[2]	#			#	#	*designates Jumper*[3]
18	27	16	UART1 Clear to Send Output	UART1_CTS	**27**	**28**	pin 8, U10(USB to UART) through 1KΩ
17	26	17	UART1 Request to Send Input	UART1_RTS	**29**	**30**	pin 32, U10(USB to UART) through 1KΩ
16	25	18	UART2 Tx Data Output	UART2_TX	**31**	**32**	pin 17, J2(GPIO Header)
15	24	19	UART2 Rx Data Input	UART2_RX	**33**	**34**	pin 18, J2(GPIO Header)
14	23	20	UART2 Clear to Send Output	UART2_CTS	**35**	**36**	pin 20, J2(GPIO Header)
76	22	-	Ground	GND2	37	38	both pins hard wired to ground
	No Connection				39	40	
Jumper Connections, J15							
13	21	21	UART2 Request to Send Input	UART2_RTS	**1**	**2**	pin 19, J2(GPIO)
12	20	46	JTAG Test Mode Select Input	TMS	**3**	**4**	pin 7, J1(JTAG)
11	19	47	JTAG Test Clock Input	TCK	**5**	**6**	pin 9, J1(JTAG)
10	18	48	JTAG Test Data Input	TDI	**7**	**8**	pin 5, J1(JTAG)
9	17	49	JTAG Test Data Output	TDO	**9**	**10**	pin 13, J1(JTAG)
8	16	37	ADC Analog Input Channel 7	ADC7	**11**	**12**	pin 8, J5(ADC)
7	15	36	ADC Analog Input Channel 6	ADC6	**13**	**14**	pin 7, J5(ADC)
6	14	35	ADC Analog Input Channel 5	ADC5	**15**	**16**	pin 6, J5(ADC); pin 9, J2(GPIO)
5	13	34	ADC Analog Input Channel 4	ADC4	**17**	**18**	pin 5, J5(ADC) ; pin 8, J2(GPIO)
45	12	-	Supply Voltage to Buck Regulator, switching MOSFETS & IO buffers	VCC1	19	20	both pins hard wired to VCC
4	11	33	ADC Analog Input Channel 3	ADC3	**21**	**22**	pin 4, J5(ADC) ; pin 7, J2(GPIO)
3	10	32	ADC Analog Input Channel 2	ADC2	**23**	**24**	pin 3, J5(ADC) ; pin 6, J2(GPIO)
2	9	31	ADC Analog Input Channel 1	ADC1	**25**	**26**	pin 2, J5(ADC) ; pin 5, J2(GPIO)
1	8	30	ADC Analog Input Channel 0	ADC0	**27**	**28**	pin 1, J5(ADC)
64	7	38	High Ref Voltage for ADC2	ADC2_VREFH	**29**	**30**	pin 2, J19 (Flash Erase)
63	6	40	High Ref Voltage for ADC1	ADC1_VREFH	**31**	**32**	R105 to GND
62	5	41	Low Ref Voltage for ADC1	ADC1_VREFL	**33**	**34**	pin 8, U17
61	4	39	Low Ref Voltage for ADC2	ADC2_VREFL	**35**	**36**	pin 1, J20 (Flash Erase)
75	3	-	Ground	GND1	37	38	both pins hard wired to ground
84	2	-	Ground	GND6	39	40	both pins hard wired to ground

3 ZFSM-201-EVB-1 STANDALONE DEMONSTRATIONS (w/o PC Connection)

3.1 TRANSMISSION/RANGE DEMONSTRATION

The following demonstration can be performed using two powered **ZFSM-201-EVB-1** Evaluation Boards. No PC is required to perform this test.

1) Power each of the evaluation boards by one of three methods (USB, battery or DC Jack).
2) Switch the Power Switch **'SW6'** so that the Red Power LED (D5) turns on.
3) LED's 1 through 4 should all turn on and then turn off in sequence.

3.1.1 The Transmitter Setup

4) Pressing **'SWITCH 1'** puts the device into **'Transmit Range'** mode where the device will continually send out RF packets. The following parameters are set automatically when the switch is pressed:
   - The ID of the device is set to **'1010'**.
   - The channel is set to **'13'**.
   - The power is set to maximum for the transmitted range message, **'18'** (20dBm).
   - The device transmits a periodic range message (approx 200/min) and blinks LED1 for each transmission.
5) Between transmissions, the device switches to **'Receive Ack'** mode where it waits to receive an RF acknowledgment from the receiver.
6) If a valid acknowledgment response is received, the device will blink LED2 once for each receipt.

3.1.2 The Receiver Setup

7) Pressing **'SWITCH 2'** puts the device into **'Receive Range'** mode where the device continually listens for RF packets on its channel. The following are set automatically when the switch is pressed:
   - The ID of the device is set to **'2020'**.
   - The channel is set to **'13'**.
   - The power is set to maximum for the transmission of the acknowledgment message, **'18'** (20dBm).
   - If a valid message is received, the device will blink LED2 for each receipt of the message.
8) The device then switches to **'Transmit Ack'** mode where it transmits an acknowledgement message back to the source and blinks LED1.

3.1.3 Transmission Indicators

9) If the Transmitter is setup before the Receiver, the Transmit board will blink LED1 only, until the Receiver is setup. It will then blink both LED1 and LED2, as will the Receiver board.
10) If the Receiver is setup first, it will blink LED2 once, and then wait until the Transmitter is setup. Then both boards will blink both LED1 and LED2.

3.1.4 Testing the Range

Testing the range in the standalone mode can be done by separating the two boards until the Receiver board stops blinking. However, more effective range demonstrations are described later on in this document (Section 5.3 and 5.4).

3.2 ADC DEMONSTRATION

This demonstration requires only one powered **ZFSM-201-EVB-1** evaluation board; no PC is required.

1) Locate the two Variable Resistors (VR1 and VR2) on the board.

2) Adjusting VR1 will adjust the brightness of LED2, which will remain illuminated for about 2 seconds after the last adjustment.
3) Adjusting VR2 will adjust the brightness of LED1; it too will remain illuminated for about 2 seconds.

4 *FREESTAR PRO TEST TOOL* SOFTWARE

The ***FreeStar Pro Test Tool*** evaluation software was designed to give the developer the ability to quickly test features built into the **ZFSM-201-1** FreeStar Pro module. The underlying UART communications can also be used to incorporate automated manufacturing tests. The ***FreeStar Pro Test Tool*** evaluation software is described in the following sections.

4.1 SOFTWARE INSTALLATION AND SETUP

4.1.1 Prerequisites to Installation

CEL strongly recommends the disabling of any anti-virus software during the installation of the software. Anti-virus software may be re-enabled once the installation has completed. As certain driver files may change during installation, close all other applications in order to properly install the software.

4.1.2 Installation

Insert the CD into the drive and double-click the **'setup.exe'** file in the directory \ZFSM-201\Tools\FSPTT v1.5\ for the SMAC and/or MAC demo.

1) The installer will launch automatically. Follow the instructions to install the program.
2) When the installation is complete, a shortcut to the program will be created on the desktop. Double click the shortcut to open the ***FreeStar Pro Test Tool*** program. The screen in Figure 3 will appear:

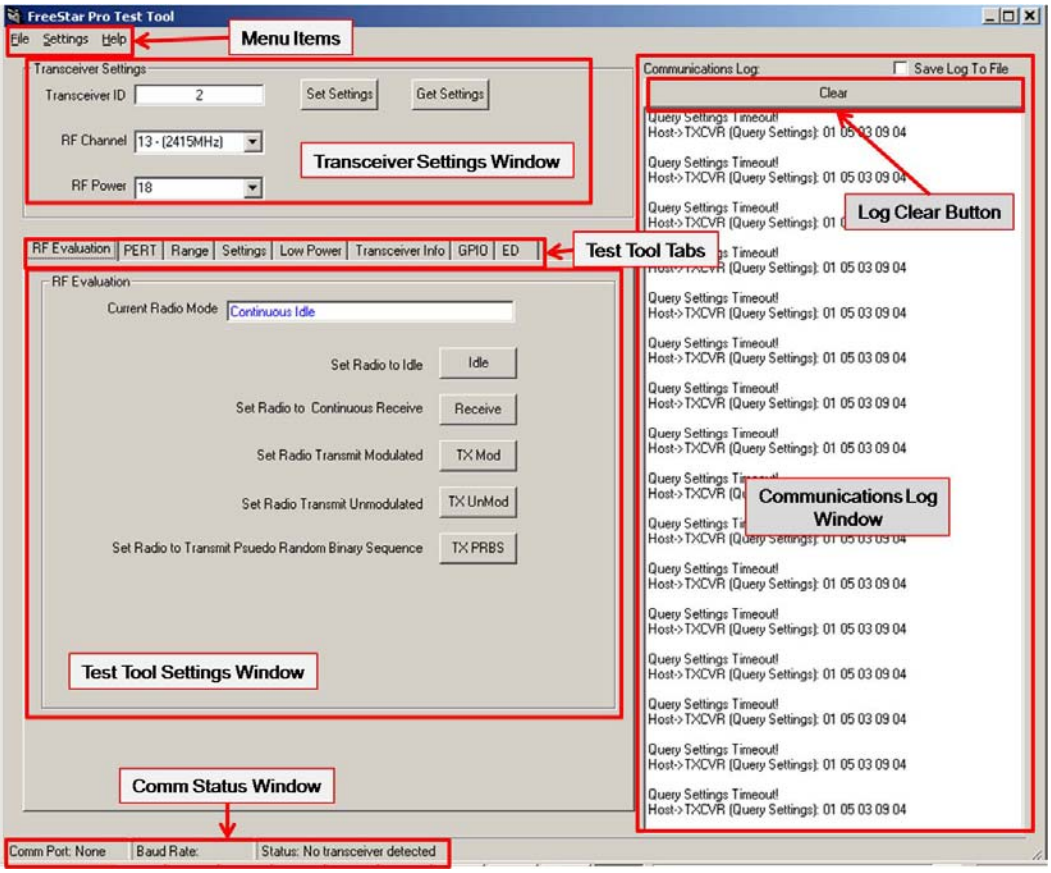


Figure 3 – Screen, *FreeStar Pro Test Tool* (Opening)

4.2 GUI SCREEN DESCRIPTIONS

Please refer to Figure 3 to become familiar with the screen location of each of the following areas, commands, and functions:

4.2.1 Menu Items

The major commands in the header menu bar of the opening screen

- **File**
  - **New**: To create a new file.
  - **Open**: To open an existing file.
  - **Exit**: To exit the program.
- **Settings**
  - **Communications…**: To set up the serial communications link with an evaluation board
- **Help**
  - **About FreeStar Pro Test Tool**: Additional information about the program.

4.2.2 Transceiver Settings Window:

Sets the parameters of the **ZFSM-201-EVB-1** FreeStar Pro evaluation board attached to the PC by a USB cable.

- **Transceiver ID**: Enter the ID of the transmitter (1-65,535)
- **RF Channel**: Enter the RF channel (11: 2405MHz ~ 26: 2480MHz).
- **RF Power**: Adjusts the Power Level of the Device from +5 to +20dBm (settings of 0 ~ 18)
- **Set Settings**: Writes the **'Transceiver ID'**, **'RF Channel'**, and **'RF Power'** to the Flash memory of the module attached to the evaluation board
- **Get Settings**: Reads the **'Transceiver ID'**, **'RF Channel'**, and **'RF Power'** from the Flash memory of the module attached to the evaluation board.

4.2.3 Communications Log Window:

All supported UART messages sent and received by the PC will be displayed.

- See ***"ZFSM-201-EVB-1 Module, Host and RF Protocol Guide"*** (CEL Doc #0006-00-08-01-000) for a detailed list of supported messages and their frame formats.
- Messages are listed with the most current on the top
- Clicking the **'Clear'** button will clear all messages in the log.
- Checking the **'Save to Log'** file will open a New save window. To save the log file, choose the appropriate directory and click '**Save**'.

4.2.4 Test Tool Tabs:

The individual test tools available in the ***FreeStar Pro Test Tool*** software titled:

- **RF Evaluation** (Section 4.4.1): Sets the mode of a single module for RF testing.
- **PERT** (Section 4.4.2): Performs a Packet Error Rate Test on a pair of modules.
- **Range** (Section 4.4.3): Sets up a single or periodic transmission between two modules.
- **Settings** (Section 4.4.4): Queries the reference oscillator capacitor values and the ADC values on the evaluation board.
- **Low Power** (Section 4.4.5): Allows the user to put the evaluation board into various Sleep modes for testing; enables the on-chip Buck Regulator (a hardware change is needed also) See ***"ZFSM-201-KIT-1, ZFSM-201-EVB-1 Errata"*** (CEL Doc #0006-00-08-04-000) for further information on the Buck Regulator.
- **Transceiver Info** (Section 4.4.6): Reads firmware versions and transceiver statistics.
- **GPIO** (Section 4.4.7): Reads or sets selected GPIO Outputs.
- **ED** (Section 4.4.8): Performs an energy scan of the IEEE 802.15.4 2.4GHz channels.

4.2.5 Test Tool Settings Window:

This area changes depending on the **'Test Tool Tab'** selected. Please see individual descriptions in Section 4.4.

4.2.6 Comm Status Window:

The status bar at the bottom of the screen showing:

- **Comm Port**: The PC COM port number through which the evaluation board is connected (or none).
- **Baud Rate**: The speed of the connection from the PC to the evaluation board
- **Status**: The connection status of the evaluation board:
  - **'Status: No transceiver detected'**
  - **'Status: Found FreeStar Pro Module'**

4.3 COMMUNICATIONS SETUP

4.3.1 Virtual Serial Port Setup

1) Attach a USB cable (supplied) between the **ZFSM-201-EVB-1** and the PC.

Note: It is strongly recommended that the USB cable be plugged directly into the PC and not through a USB Hub to avoid COM port conflicts.

The first time a ZFSM-201-EVB-1FreeStar Pro Evaluation Board is connected to a computer, the PC will install virtual serial port drivers and a COM port number will be assigned to the evaluation board. To check which COM port is assigned to the USB connection follow steps 2) through 5):

2) Open the Windows **'System Properties'** window using **'Start'->'Control Panel'** ->**'System'** or right click on **'My Computer'** in the **'Start'** menu and select **'Properties'** from the drop down menu.
3) In the **'System Properties'** window under the **'Hardware'** tab, click the **'Device Manager'** button as indicated in Figure 4.

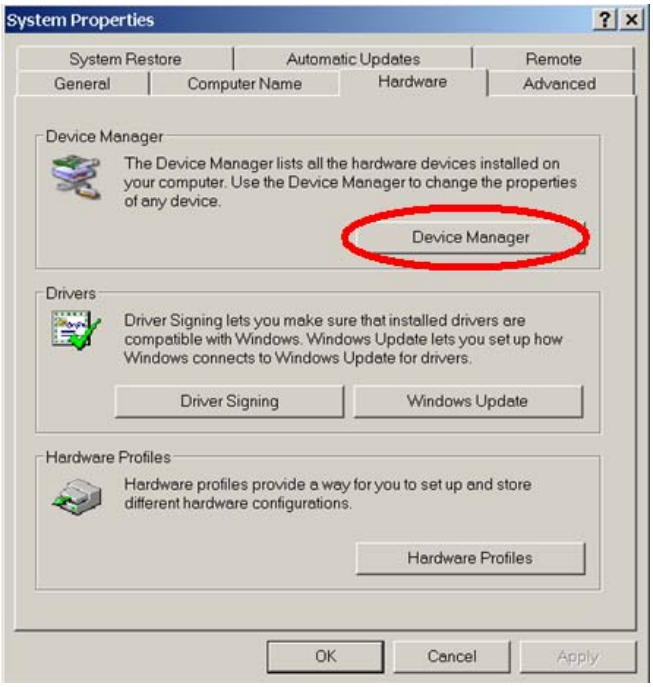


Figure 4 – Screen, Windows System Properties

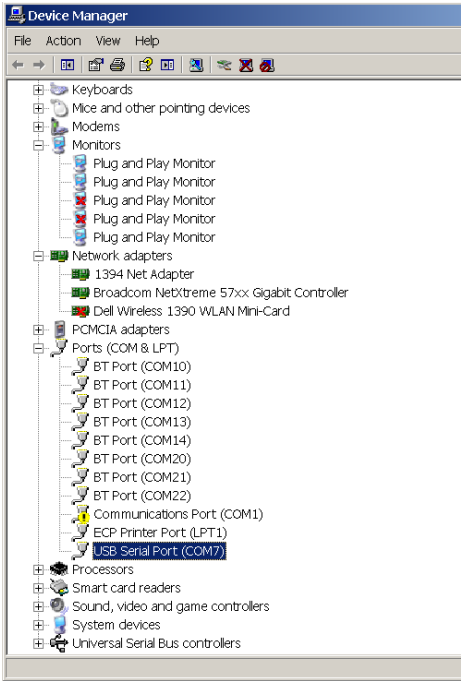


Figure 5 – Screen, Device Manager

4) Click on the '**Ports (COM & LPT)**' label or expand the tree by clicking the '**+**' sign. The COM ports in the system will be displayed as shown in Figure 5.

5) As shown in Figure 5, the COM port chosen by the system is displayed as '**USB Serial Port (COM7)**'.

Only COM ports 1-16 should be used with the ***FreeStar Pro Test Tool***. If a COM port greater than 16 has been selected by the system follow steps 6) through 8):

6) Double click on the '**USB Serial Port**' in the '**Device Manager**' window shown in Figure 5.

7) The window shown in Figure 6 will appear. Select the '**Port Settings**' tab and click the '**Advanced**' button.

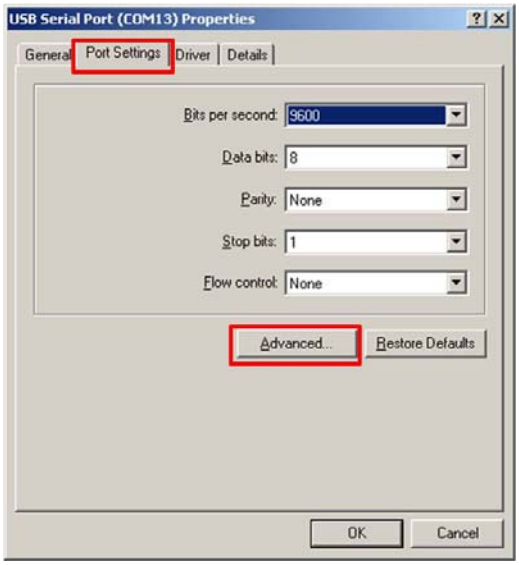


Figure 6 – Screen, Device Manager – Port Settings

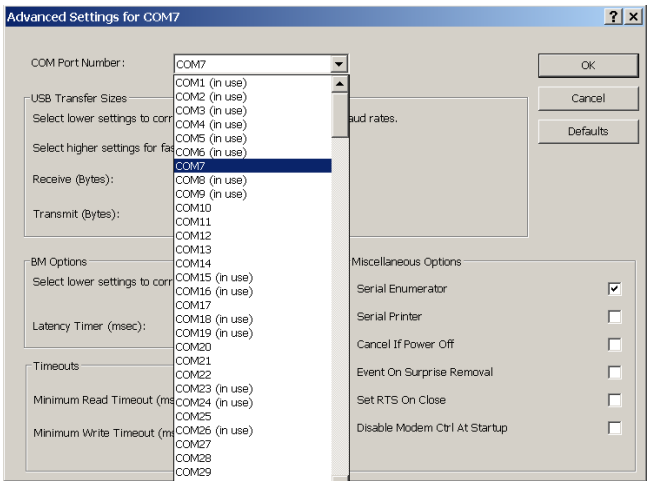


Figure 7 – Screen, Device Manager – COM Port Setting

8) Click the **'COM Port Number'** drop down menu and select a COM Port (not in use) between 1 and 16 as shown in Figure 7.

Note: If all COM Ports between 1 and 16 are shown as **'(in use)'** and one of them is not physically being used, it can be assigned.

4.3.2 Establishing the Connection

If the bottom status bar shows **'Comm Port: None'**, then the test tool was not able to find a FreeStar Pro module on any of the available PC COM ports.

1) Click on the **'Settings'** menu and click the **'Communications'** Pull down entry as shown in Figure 8. The screen shown in Figure 9 will appear.

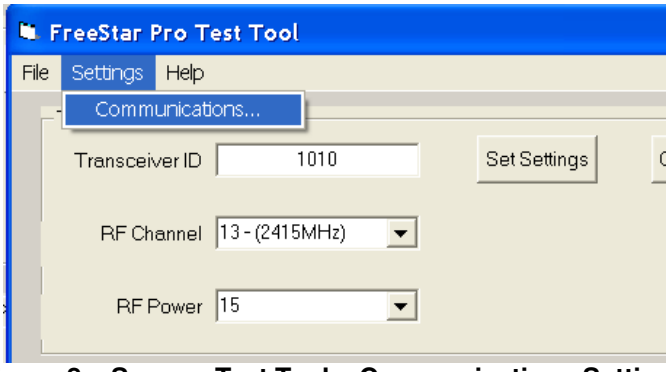


Figure 8 – Screen, Test Tool – Communications Settings

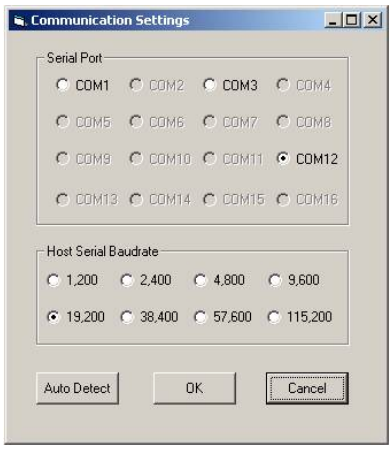


Figure 9 – Screen, Test Tool – Port & Baud Rate Settings

2) The default baud rate should be set correctly at **'19,200'** baud. Check that the correct serial port is identified and click **'OK'**. The status bar should appear as in Figure 10.

When the connection with the module has been successful, the Communications Status Window will show the COM port number, the baud rate, and the **'Status: Found FreeStar Pro Module'** as shown in Figure 10.

Figure 10 – Screen, Test Tool – Comm Status Window (Connected)

If the Comm Status Window displays another message, click on the **'Settings'** menu and click the **'Communications'** Pull down entry.

3) If the COM port in use is not shown or not known, select **'Auto Detect'**. If **'Auto Detect'** is successful the status bar will display a COM port number and a baud rate as in Figure 11 below. Repeat steps 1) and 2) until the correct status (as in Figure 10) is displayed in the **'Comm Status Window'**.

Figure 11 – Screen, Test Tool – Comm Status Window (COM Port Found)

4) If communication with the module is still unsuccessful with correct settings, restart the test tool, and perform the steps outlined above.

When connected to the FreeStar Pro Test Tool program the Indicator LED's 1 through 4 will convey the following information:

- LED4 blinks when UART messages sent from the Host PC are received on the evaluation board.
- LED3 blinks when UART messages are sent from the evaluation board to the Host PC.
- LED2 blinks when the evaluation board receives a message through the RF channel.
- LED1 blinks when the evaluation board transmits a message through the RF channel.

4.4 DESCRIPTIONS OF THE MAC TEST TOOLS

Eight different tools are available in the ***Free Star Pro Test Tool*** program provided on the CEL CD and are shown as Tabs in the program's opening screen.

4.4.1 RF Evaluation Tab

The RF Evaluation Tab is used to set the module to run in different modes for RF Evaluation Tests, commonly used for FCC certification or other RF evaluation.

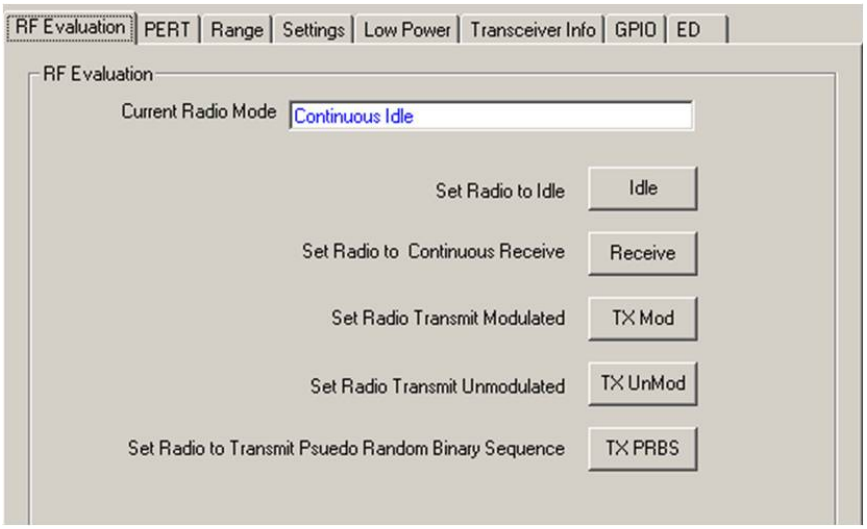


Figure 12 – Screen, Test Tool – RF Evaluation Modes

- **Idle**: Sets the radio to Idle mode where the reference oscillator is operating, but the radio is neither transmitting nor receiving.
- **Receive**: The radio will continually receive RF messages. In this mode any RF messages received will be ignored by the processor.
- **TX Mod**: The radio will continually transmit a Modulated signal.
- **TX UnMod**: The radio will continually transmit an Unmodulated signal.
- **TX PRBS**: The radio will continally transmit a Psuedo Random Binary Sequence.

4.4.2 PERT Tab

The Packet Error Rate Test is conducted between two evaluation boards, one configured as a transmitter and the other as a receiver. It sends a defined number of packets (with a defined message code) from the transmitter to the receiver. The receiver counts the number of packets received with the same message code and displays the statistics. A demonstration of this function is given in Section 5.4 of this document.

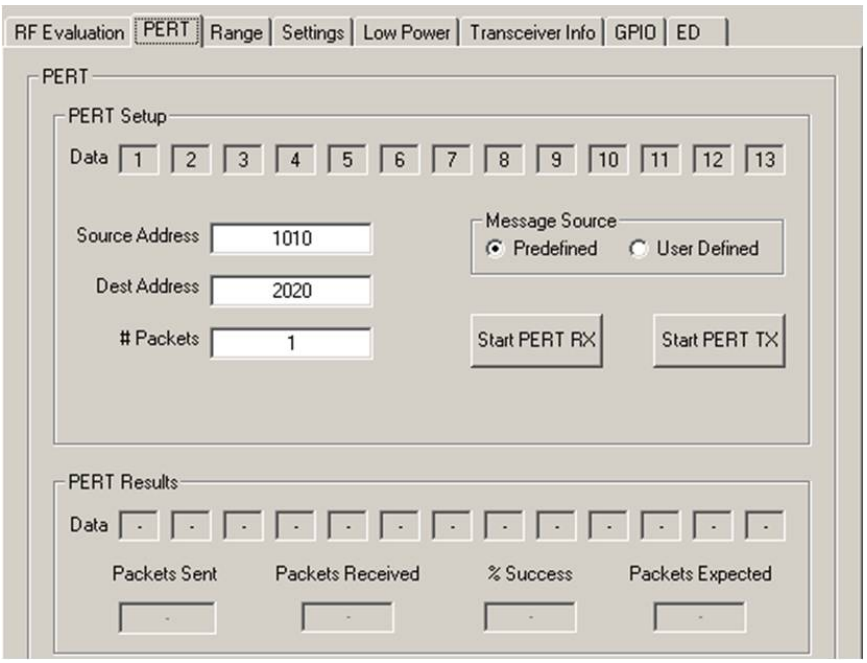


Figure 13 – Screen, Test Tool – PERT Test

4.4.2.1 PERT Setup Section

- **Data**: The message to be sent (thirteen 1-byte fields).
- **Source Address**: The **'Transceiver ID'** of the evaluation board being used as the transmitter.
- **Dest Address**: The **'Transceiver ID'** of the evaluation board being used as the receiver
- **# Packets**: The number of times the packet will be transmitted.
- **Message Source**: Defines the message in the data fields, as follows:
  - **Predefined**: Fills the Data fields with predefined numbers (1 ~ 13).
  - **User Defined**: Allows the user to change any of the data values (0 ~255) in the 13 **'Data'** fields.
- **Start PERT RX**: Sets the receiver into a mode ready to receive packets (if the module connected to this version of the GUI is configured as the receiver); if using a User Defined Message Source, copies the data fields from the **'Transmitter'** area.
- **Start PERT TX**: Starts the transmission of the specified number of packets (if the module connected to this version of the GUI is configured as the transmitter).

4.4.2.2 PERT Results Section

- **Data**: The criteria message for the error rate test (must match the transmitter data).

The next four fields are filled by the test program when it is run. On starting the PERT, Packets Expected will immediately display:

- **Packets Sent**: Total number of packets sent.
- **Packets Received**: Successfully received packets (data received matched the criteria).
- **% Success**: Equal to '**Packets Received**'/'**Packets Sent**'.
- **Packets Expected**: Equals the '**# Packets**' from the Transmitter.

4.4.3 Range Tab

The test under this tab will set up a transmission (single or continuous) between two evaluation boards, and measure the Link Quality Indication parameter for their communications link.

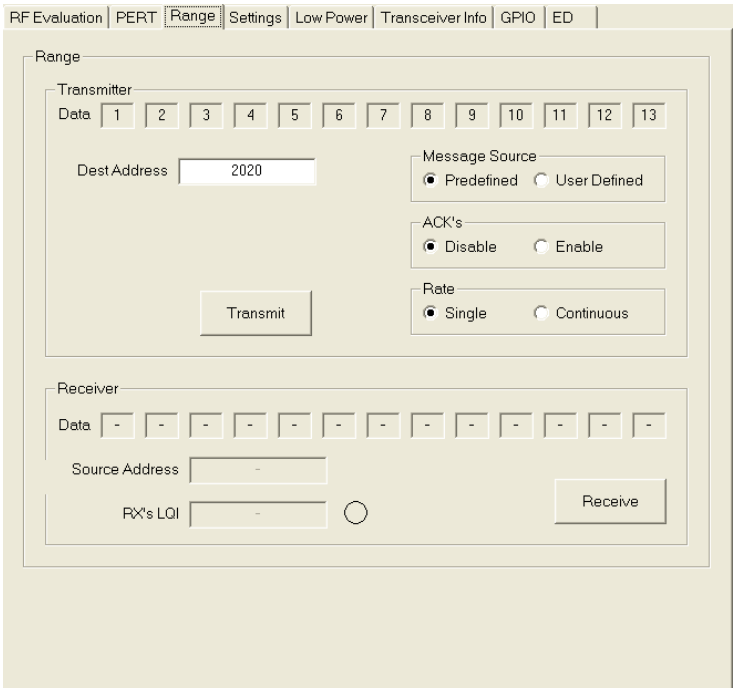


Figure 14 – Screen, Test Tool – Range Test

4.4.3.1 Transmitter Section

- **Data**: The message to be sent (thirteen 1-byte fields).
- **Dest Address**: The **'Transceiver ID'** of the evaluation board being used as the receiver.
- **Message Source**: Defines the message in the data fields, as follows:
  - **Predefined**: Fills the Data fields with predefined numbers (1 ~ 13).
  - **User Defined**: Allows the user to change any of the data values (0 ~255) in the 13 **'Data'** fields.
- **ACK's**: Determines whether the transmitter asks for an acknowledgement of its message, as follows:
  - **Disable**: Turns OFF the acknowledgement request.
  - **Enable**: Turns ON the acknowledgement request.
- **Rate**: Defines the transmission rate, as follows:
  - **Single**: Transmits a single packet.
  - **Continuous**: Transmits the packet repeatedly until stopped manually (i.e. can be stopped with the RESET button).
- **Transmit**: Starts the transmission of packets.

4.4.3.2 Receiver Section

- **Data**: The message being received; it should agree with the Transmit **'Data'**.
- **Source Address**: The **'Transceiver ID'** of the evaluation board being used as the transmitter.
- **RX's LQI**: The Link Quality Indicator as measured by the receiver (with indicator "light")
- **Receive**: Starts the reception of packets.

4.4.4 Settings Tab

The settings tab can be used to query the settings (capacitor values) of the reference oscillator, or to query the Analog to Digital Converters. See Figure 15.

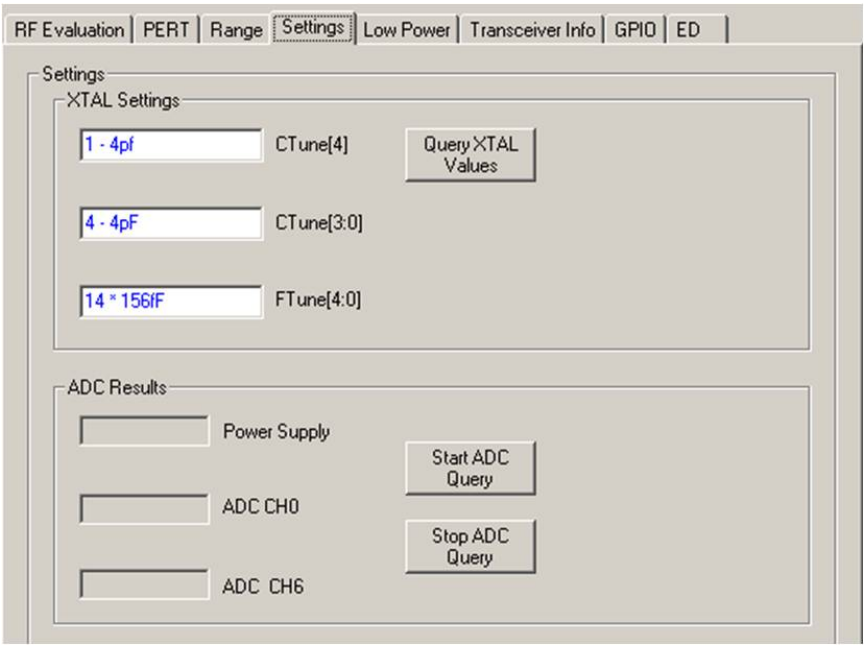


Figure 15 – Screen, Test Tool – Settings

4.4.4.1 XTAL Settings

- The default XTAL settings are hardcoded into the program and are displayed on turn on.
- Clicking the **'Query XTAL Values'** button will read the actual values in the device and display them in the drop down boxes. Packets sent and received can be seen in the Communications Log screen.

4.4.4.2 ADC Results

- By clicking the **'Start ADC Query'** button the ADC's connected to the Potentiometers (See Figure 1) will be continually read (about twice a second). Their values will be updated in the respective boxes in the GUI.
- In addition the **MC13224V** has the ability to monitor its own power supply from an internal voltage reference. This value will also be updated in the ADC query.
- Clicking the **'Stop ADC Query'** button will stop the query.

4.4.5 Low Power Tab

There are a variety of low power and wakeup options available on the **MC13224V**. The GUI allows the user to experiment with low power modes by placing the device into the selected low-power mode for 10 seconds, for a purpose such as to monitor the current into the module (using the current measurement jumper). See Figure 1 for its location.

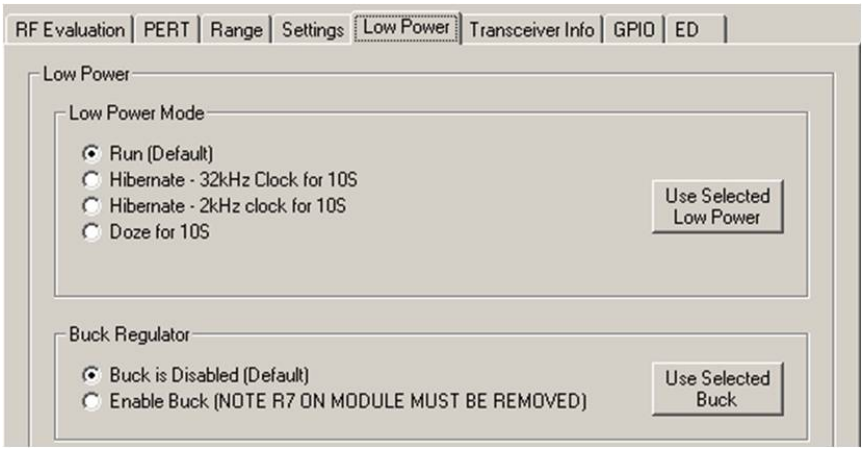


Figure 16 – Screen, Test Tool – Low Power Mode/Buck Regulator

4.4.5.1 Low Power Mode

Note: All of the '**Low Power Mode**' demonstrations require that the transceiver '**Current Radio Mode**' be in '**Idle**' '**Receive**' or '**TXUnMod**' under the '**RF Evaluation**' tab

- In the two Hibernate modes, the Real Time Clock (RTC) is configured as the wakeup source with either the 2 kHz internal clock or the external 32 kHz crystal used as the clock.
- In Doze mode, the reference oscillator (24 MHz) is the wakeup source.
- Run mode is normal operation.

4.4.5.2 Buck Regulator (this function is not supported by current software)

- The **MC13224V** contains an on-board Buck Regulator to further reduce operating current on battery powered devices.
- The evaluation board contains the external components needed to operate the Buck Regulator.

NOTE: FreeStar Pro Module hardware must be modified to enable the Buck Regulator.

- Check the Enable Buck/Disable Buck selection followed clicking the Use Selected Buck button. The buck will stay enabled/disabled until reset.

4.4.6 Transceiver Info Tab

Version and transceiver information can be obtained from this tab as seen in Figure 17.

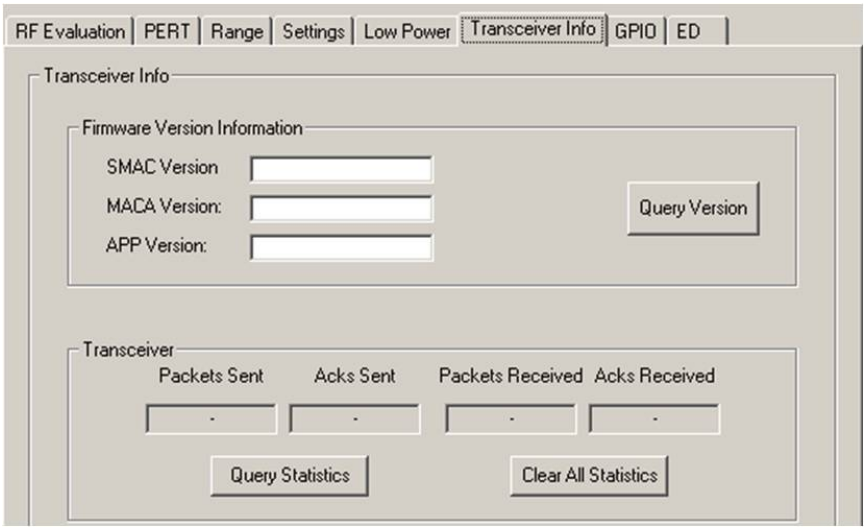


Figure 17 – Screen, Test Tool – Transceiver Info

4.4.6.1 Firmware Version Information

- The version information is updated when the evaluation board is first plugged into the host PC. It can be viewed by clicking **'Query Version'**.

4.4.6.2 Transceiver

Displays the statistics on the connected device accumulated since it was last cleared (Powering OFF or resetting the EVB do NOT clear the statistics.)

- The number of packets sent and received as well as the number of acknowledgement sent and received is tracked.
- Can be used (for example) in conjunction with the Range test to monitor the radio performance over an extended period of time.
- Clicking the **'Clear All Statistics'** button will set all data to zero.
- Clicking the **'Query Statistics'** will display the current data for the connected evaluation board.