PRO-FLEX SERIES
TRANSCEIVER MODULES

User's Guide

Powered By

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Table of Contents

1 Introduction

1.1 Purpose & Scope

The purpose of this document is to provide details regarding the setup and use of the Pro-FLEX series transceiver module development board. This document covers how to use the preinstalled (Ping Pong Test) demo firmware, a description of the development board and its features, and a brief tutorial on how to download customer-specific application firmware.

This document is applicable to hardware revision B of the ModFLEX Development Board.

1.2 Audience

This document is intended to be read by engineers and technical management. A general knowledge of common engineering practices is assumed.

1.3 Applicable Documents

- *Pro-FLEX Datasheet* (LSR)
- *Pro-FLEX Serial Host Protocol* (LSR

1.4 Revision History

Date	Change Description	Revision
	Initial release.	1.0

Table 1 Revision History

2 Quick Start

2.1 Operational Overview

The quick start demonstration presented in this chapter is referred to as the Ping Pong Test. The Ping Pong Test allows an end user to easily verify communication between two transceivers and get a feel for the quality of the link via feedback of the flashing LEDs.

Running the Ping Pong Test requires the use of two (2) development boards. One board will be the master (or transmitter), and the other board will be the slave (or receiver). The master periodically transmits packets to the slave. If the slave receives and verifies the packet, it will flash its LEDs and transmit an acknowledgement to the master. If the master receives and verifies the acknowledgement, it will flash its LEDs.

In normal ping pong mode, LEDs indicate signal strength (two LEDs on indicate high signal strength, one LED indicates low signal strength). If the LEDs do not light, the packet or acknowledgement was not received.

2.2 Software Installation

The included software is an IAR Systems Embedded Workbench for MSP430 (rev. 4.11B) project. As a result, this development environment should be installed on the development PC. Also, the latest version of the TI ZigBee stack should be installed on the development PC. The ZigBee stack is available on the TI web site. It should be noted that the included Pro-FLEX firmware project only uses the 802.15.4 MAC API of the ZigBee stack.

To install the firmware unzip the files to the C:\Texas Instruments\ZStack-2.2.0-1.3.0\Projects directory of the TI ZigBee stack. This is assuming that ZigBee stack was installed into the default directory structure.

Once the firmware is installed, the IAR workspace file should be in C:\Texas Instruments\ZStack-2.2.0-1.3.0\Projects\ProFlex01. The workspace filename is Proflex01.eww.

2.3 Setting up TI Z-Stack

TBD

2.4 Modifying Include Directories

TBD

For additional information relating to the TI Z-Stack, refer to the documentation folder installed with Z-Stack:

Start → All Programs → Texas Instruments → Z-Stack → Documentation

2.5 Hardware Connections

MCU#				MCU#
-	GND	1	GND	-
-	GND	2	GND	-
-	GND	3	GND	-
-	NC	4	NC	-
-	NC	5	NC	-
-	NC	6	NC	-
-	NC	7	NC	-
-	NC	8	NC	-
74	JTAG - TMS	9	SPI - MOSI	56
73	JTAG - TDI	10	SPI - MISO	57
75	JTAG - TCK	11	SPI - CLK	41
72	JTAG - TDO	12	SPI - SS	55
71	JTAG - TEST	13	IIC - SDA	42
76	JTAG - /RESET	14	IIC - SCL	54
9	VREF+	15	GPIO 16	29
10	VERF-	16	GPIO 15	28
77	CMP+	17	GPIO 14	27
78	CMP-	18	GPIO 13	26
79	CMPOUT	19	GPIO 12	25
80	ADC1	20	GPIO 11	18
1	ADC2	21	GPIO 10	17
2	ADC3	22	GPIO 09	8
3	ADC4	23	GPIO 08	7
4	ADC5	24	GPIO 07	60
5	ADC6	25	GPIO 06	61
-	VCC - 3V3DC	26	ND	-

Texas Instruments
MSP430F5437

27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
TMR/PWM 1	TMR/PWM 2	TMR/PWM 3	TMR/PWM 4	TMR/PWM 5	TMR/PWM 6	TMR/PWM 7	TMR/PWM 8	UART - TX	UART - RX	UART - CTS	UART - RTS	GPIO 1	GPIO 2	GPIO 3	GPIO 4	GPIO 5
53	52	48	47	46	45	44	43	39	40	58	59	66	65	64	63	62

Figure 1 Pro-FLEX MCU Interconnects

2.6 PER Test

To run the PER test you will need these items:

- Two Pro-FLEX Development Boards with latest software
- Pro-FLEX Test Tool (PC Software)
- PC running Windows XP
- Two USB cables

2.6.1 Receiver Setup

Setup a board as a receiver with these settings, for example, as shown in Figure 2:

- Short Address: 200
- Pan ID: 111
- RF Channel: 20
- Tx Power: 0

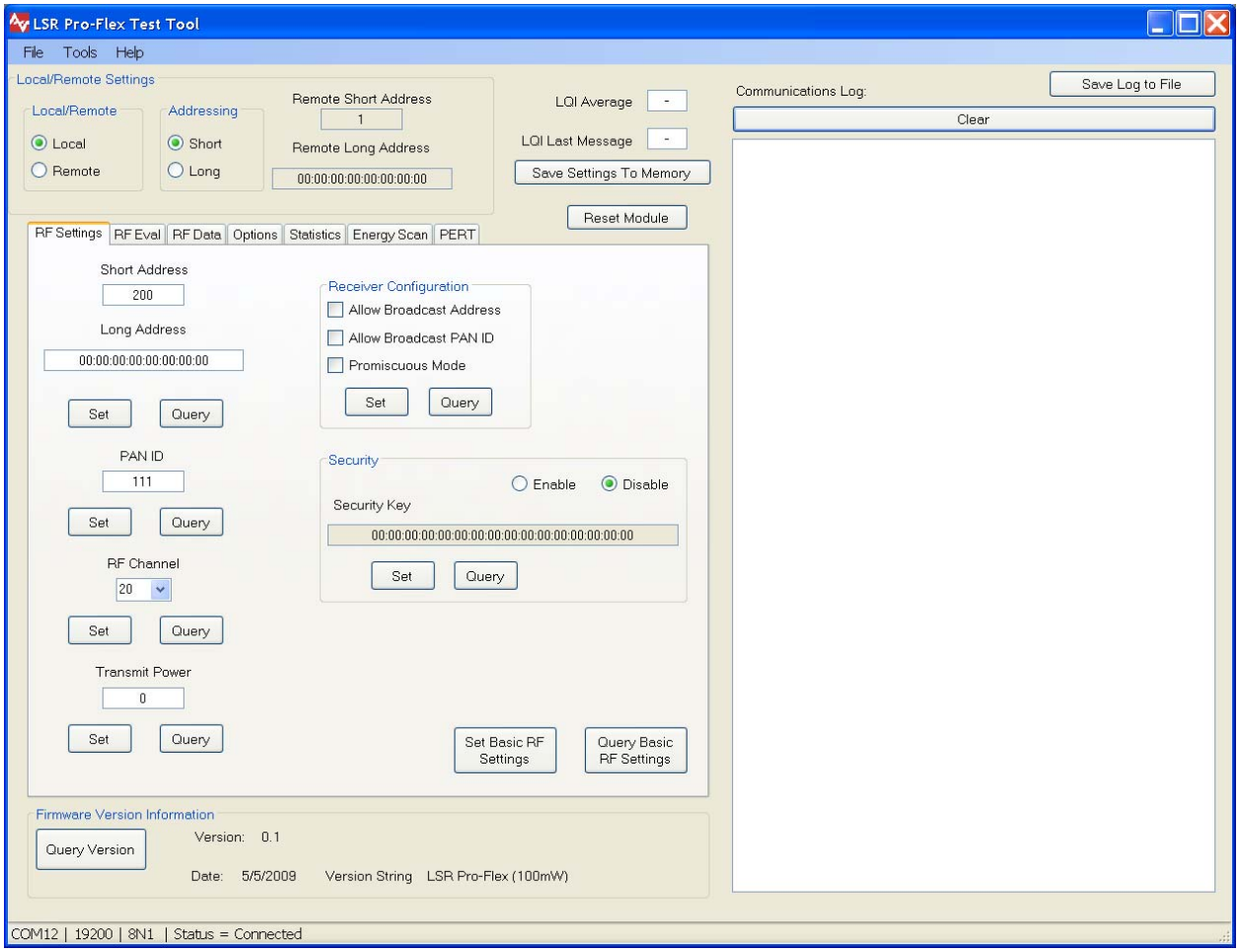

Figure 2 PER Test Receiver RF Settings

Test Mode

- Tx Mode – Board is transmitter
- Rx Mode – Board is receiver

Options

- Send Results after test – results are sent back to host only after test is completed.

- Send Results every second – results are sent back to host on a 1s periodic basis. This is the preferred option for the test tool, because you get instant feedback that the test is working and how well it is working.

OTA Data

- N/A for PERT Rx

Query / Cancel

- Sends out Host Message Type 0x43.
- Used by Host to obtain results of PERT Test
- PERT Test in Rx can end in one of three ways:
  - 100% of packets are received
  - The OTA transmit count = Number of Packets to Receive
  - Host cancel request. Since it cannot be guaranteed that the last packet will be received, it is the responsibility of the host to ensure the test is canceled.
- If cancel is selected it will cancel the current test
- "PERT In-Progress" is filled in based on query results. Red = no test in progress, green = test in progress

Setup Packet Error Rate Test

- Src Transceiver Address: 100 (who to expect message from)
- Number of Packets: 100 (number of RF packets (5-65535). Must match PERT Tx selection.
- Number of Bytes: 30 (number of user bytes in packet. Range is 1-105) Must match PERT Tx selection.

Packet Error Rate Results

- Filled in when results are received based on options above.
- "Number of Received Packets" – keeps count of how many packets were rx'd
- "Total Number of Packets" – configured in UART message above. Used to calculate PERT success.
- LQI Average – the average LQI of Rx'd messages
- PERT Success – The number of rx'd packets / total number of packets. Not valid until end of test.
- Real Time PERT Success – The number of rx'd packets/ number of tx'd packets. The number of Tx'd packets is determined from the count in the OTA data.

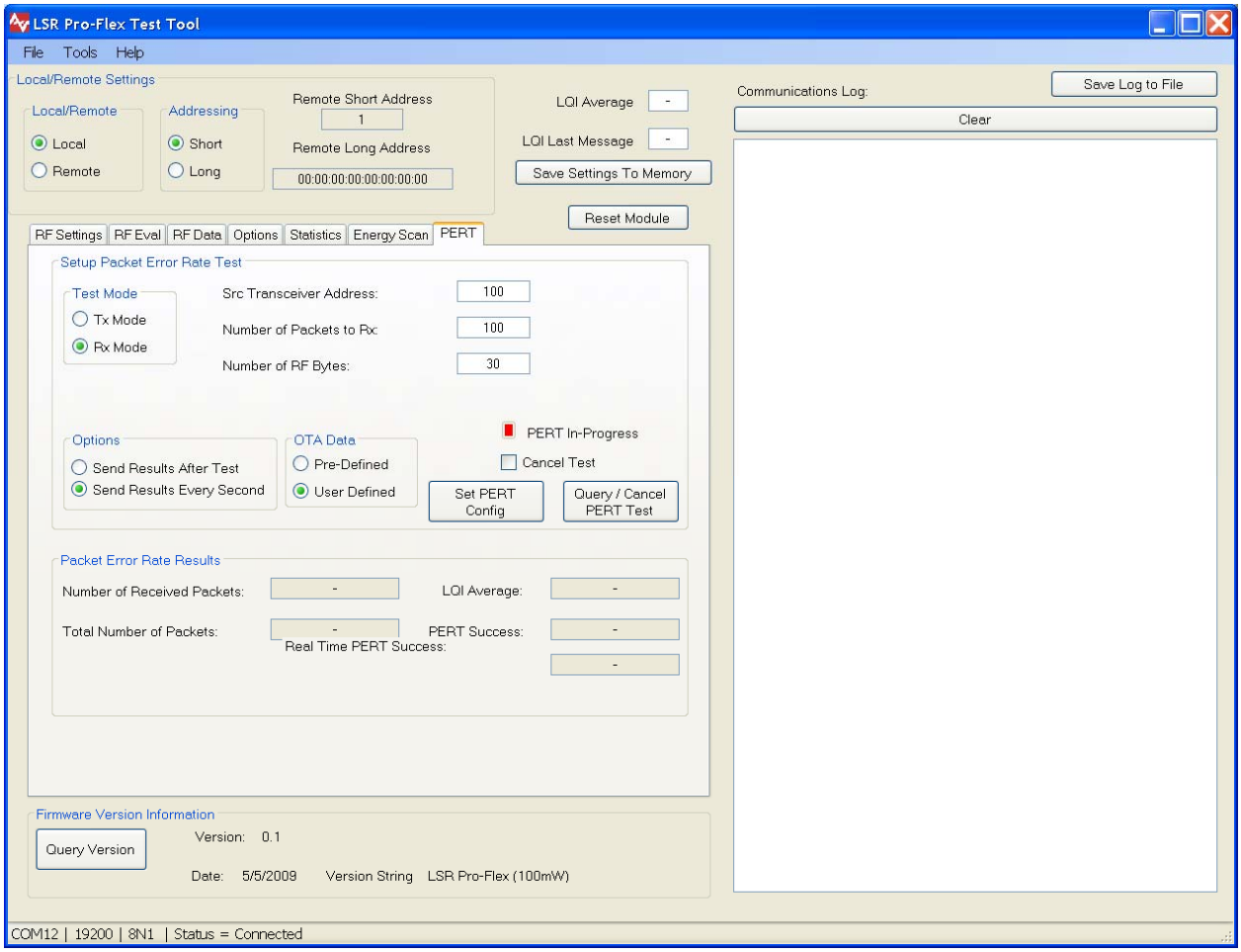

Figure 3 Receiver PERT Tab

2.6.2 Transmitter Setup

Setup a board as a transmitter with these setting, for example, as shown in Figure 4:

- Short Address: 100
- Pan ID: 111
- RF Channel: 20
- Tx Power: 0

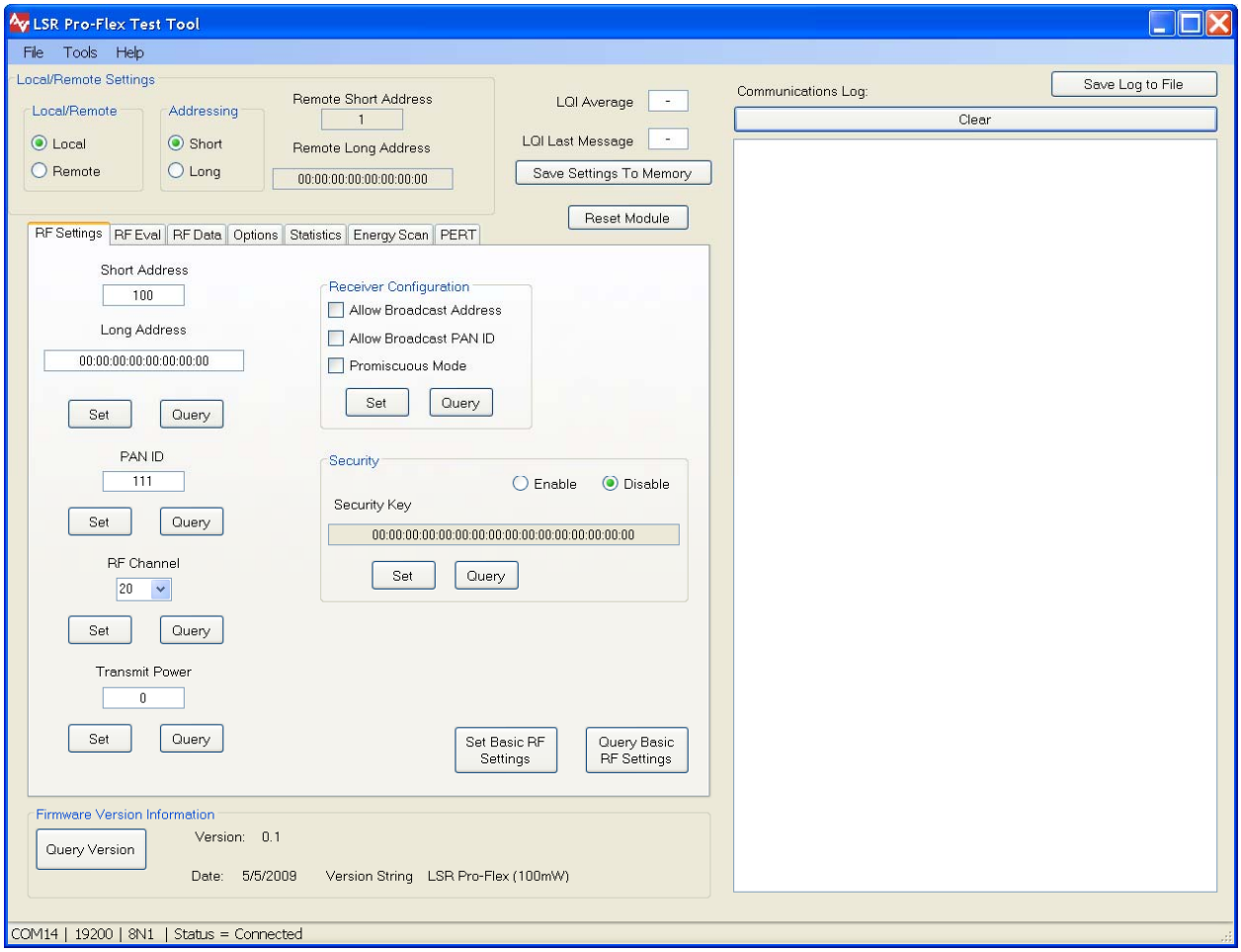

Figure 4 PER Test Transmitter RF Settings

On the PERT tab, configure these test settings, as shown in Figure 5:

Test Mode

- Tx Mode – Board is transmitter
- Rx Mode – Board is receiver

Options

- Send Results after test – results are sent back to host only after test is completed.
- Send Results every second – results are sent back to host on a 1s periodic basis. This is the preferred option for the test tool, because you get instant feedback that the test is working and how well it is working.

OTA Data

- User defined – user can enter ASCII data to be transmitted. When this is selected the "Number of Bytes to Transmit" is hidden. This is not shown below.
- Pre defined – sequential data starting at 1 and ending at Number of Bytes to Transmit is sent.
- In either case the prefix for this data is amended.

- OTA packet type – 0x71 (1 byte)
- Current Message Number (0-65535) two bytes
- Total Number of Messages (0-65535) two bytes

Query / Cancel

- Sends out Host Message Type 0x43.
- PERT Test in Tx will end in one of two ways:
  - 100% of packets are transmitted
  - Host cancel
- If cancel is selected it will cancel the current test
- "PERT In-Progress" is filled in based on query results. Red = no test in progress, green = test in progress

Setup Packet Error Rate Test

- Dest Transceiver Address: 200 (who message is being sent to)
- Number of Packets: 100 (number of RF packets (5-65535)
- Time between Packets: 20 (in terms of 5mS ticks. A selection of 5 would sent out packets every 5x5mS or 25mS). Range is 1-255.
- Number of Bytes: 30 (number of user bytes in packet. Range is 1-105)

Packet Error Rate Results

- Filled in when results are received based on options above
- The PERT Completion uses the number of packets sent/total number of packets to calculate how far into the test we are.
- LQI Average and PERT Success are grayed out because they are N/A on the TX side

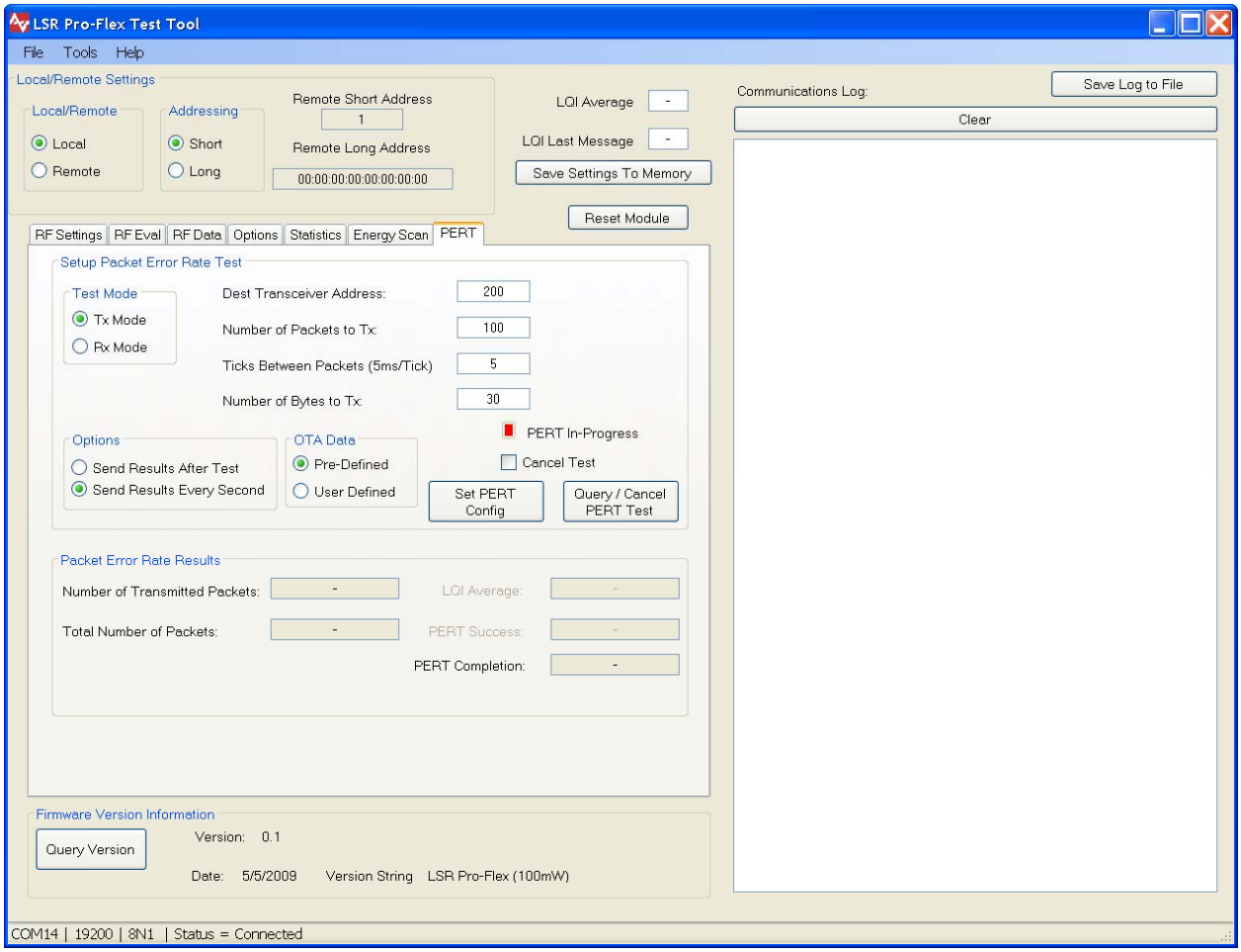

Figure 5 Transmitter PERT Tab

2.7 Ping-Pong Test

To perform the ping-pong test (without the use of the ModFLEX Development Board), the Pro-FLEX module will require external hardware connections. A nominal 3.3 volt DC power supply should be connected to the 3V3DC pin shown in Figure 1. Also, a ground connection is required. Also, 4 LEDs should be connected to pins TMR/PWM1 through TMR/PWM3. The cathode of each LED should be each pin. The anode of each LED should be connected to the 3.3 V power supply through a nominal resistor value of 470 ohms. Each output can sink up to 15 mA to turn on each LED. The outputs are set to high strength mode in the firmware. The TMR/PWM1 output should have a green LED. The TMR/PWM2 output should have a yellow LED.

The TMR/PWM5 pin is configured as an input to initiate the ping-pong test mode. This pin should be connected to ground through a momentary contact normally open (NO) push button switch. This switch is referred to as the user button in the subsequent instructions. Also, the RESET pin should be connected to ground through a momentary contact normally open (NO) push button switch. This switch is referred to as the reset button in the subsequent instructions.

2.7.1 Master / Slave Selection

Master device setup

1. Press the reset button and the user button simultaneously.
2. Release the reset button.
3. Wait until the green LED is lit, then release the user button.

Slave device setup

1. Press the reset button and the user button simultaneously.
2. Release the reset button.
3. Quickly release the user button (Release within 1.5 seconds of performing step 2 above).

2.7.2 Association Mode

In association mode, the red LED will flash rapidly on each board until it has linked with the other device. At this point, the red LED will go out and the green LED will begin to flash rapidly for approximately two seconds. Association mode lasts up to thirty seconds after power up, so the master and slave pair should be powered up at relatively the same time. If the transceivers link, they will enter the ping pong mode after association mode times out. However, if they do not link, they will not communicate and the sequence must be repeated from the point of master/slave selection at power up.

2.7.3 Ping Pong Mode

In ping pong mode, the master and slave boards will flash one or two LEDs with each packet (slave) or acknowledge (master) received, based on message signal strength. Refer to Table 2 below for a description of the LEDs versus signal strength. In case there is a lot of traffic on the default channel, it is possible to change the channel.

Red LED	Green LED	Signal Strength
OFF	OFF	None
ON	OFF	Marginal
OFF	ON	Good
ON	ON	Excellent

Table 2 LED Signal Strength Definitions

2.7.4 Changing RF Channels

Note that this can only be performed if boards have been associated.

While in the ping pong mode, the current channel can be changed to one of four other unique channels (four channels total). This is accomplished by holding the User Button for approximately two seconds, at which point the yellow LED will be lit steady. Once the push button is released, the current channel option number (one through four) is displayed by a series of flashes on the red LED. Each short push button press will increment the channel option number and display it with a given number of flashes on the red LED. To accept the last selected channel, hold the push button until the green LED goes out (approximately two seconds). After again releasing the button, the device will return to the ping pong mode.

Note that both the master and slave devices must be set to the same channel option number for the pair to communicate, and each board must be individually set to that given channel option number.

3 Development Board Overview

Figure 6 shows a ModFLEX development board, which is discussed throughout the remainder of this section.

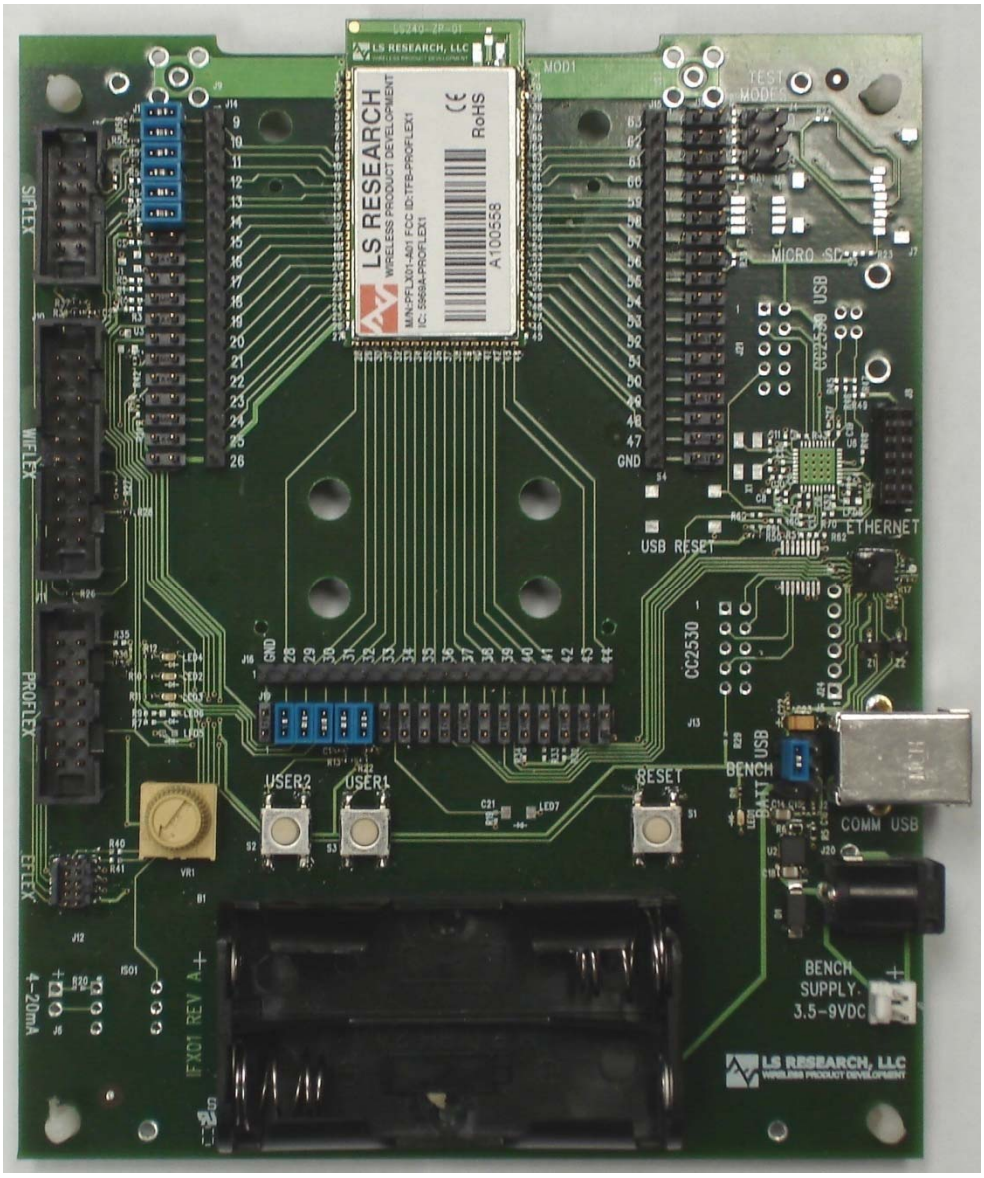

Figure 6 ModFLEX Development Board

3.1 Jumpers

3.1.1 Development Jumper Headers

The three rows of jumper headers on the east, south, and west sides of the installed Pro-FLEX module can be used to control the interconnects of the Pro-FLEX module to

the outside world. For the sake of discussion, Figure 7 will be used to describe the various Pro-FLEX module interconnect jumper settings.

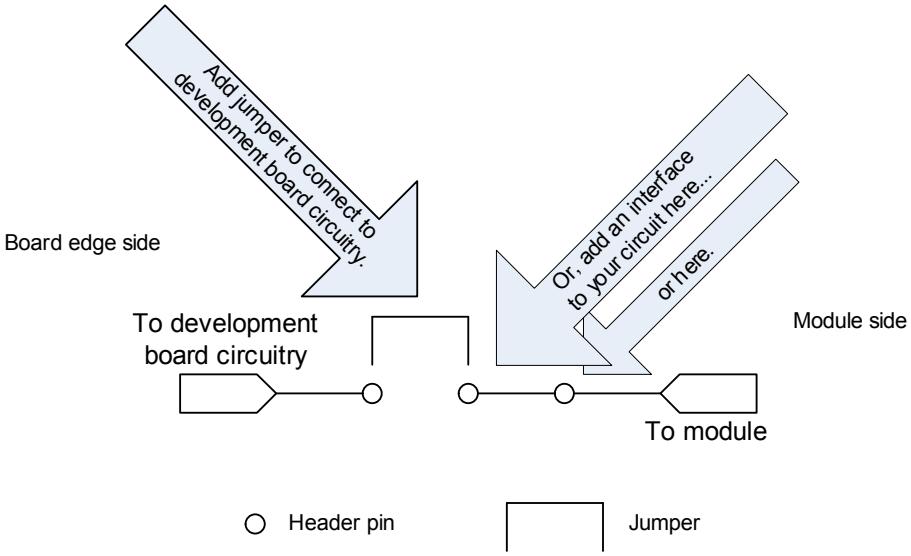

Figure 7 Interface Pins Layout

To connect the Pro-FLEX module pins to their development board periphery circuits the respective pins need to be jumpered together. To isolate the Pro-FLEX module, remove the jumpers. The jumper pins can be used to connect the Pro-FLEX module to an application circuit and/or test/debug equipment, such as a multi-meter or oscilloscope.

In order to program or debug the Pro-FLEX module, the jumpers bridging module pins 9 through 14 will need to be in place.

Additional details regarding Pro-FLEX module pin configurations can be found in the Pro-FLEX datasheet.

3.2 Power Supply Jumpers

3.2.1 Rev. C and Later

TBD

3.2.2 Rev. B and Earlier

Figure 8 shows the power supply jumpers on the Pro-FLEX development board, which are located behind the female USB-B plug.

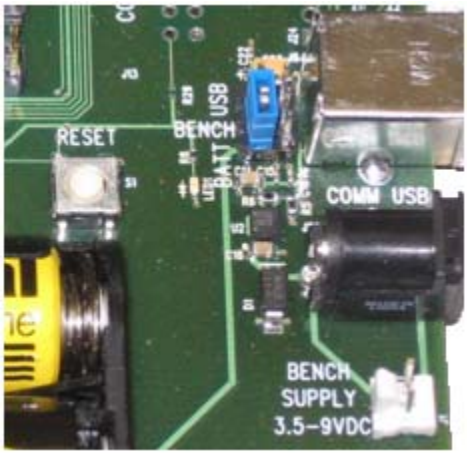

Figure 8 Power Supply Jumpers

Figure 9 Power Supply Jumper Settings

shows the configurations of the power supply jumper settings to select from the various power supply options: USB, Batteries, or Bench Supply / AC Adapter.

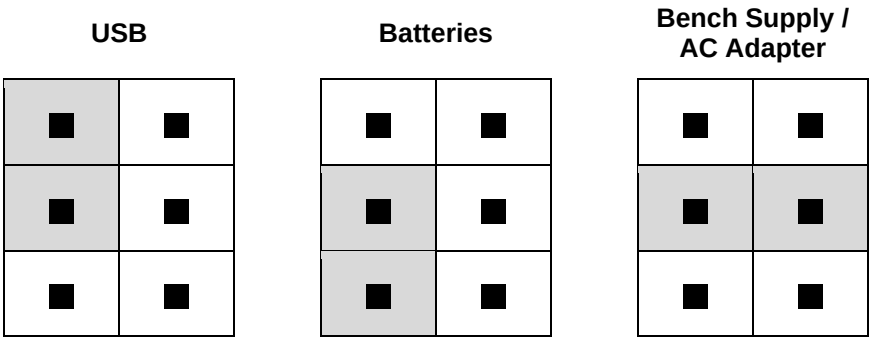

Figure 9 Power Supply Jumper Settings

3.3 Debug Headers

Because the same development board is used for all of the ModFLEX series transceiver modules, the Pro-FLEX development board is populated with debug headers / development ports for the Si-FLEX, Wi-FLEX, and E-FLEX series transceiver modules, in addition to having a debug header for Pro-FLEX modules. Each of these development ports is intended for use only with their respective ModFLEX series transceiver module.

Please note that using the debug headers for purposes other than their intended use is not advised and may void the module warranty.

When developing with the Pro-FLEX transceiver module, be sure to use the Pro-FLEX debugging header described in section 2.5.

4 Hardware Setup

TBD

5 Writing Application Firmware

5.1 Development Tools

Developing custom firmware for the Pro-FLEX series transceiver modules requires the use of the MSP-FET430UIF debugging interface from Texas Instruments and IAR Embedded Workbench from IAR Systems. It is also recommended that you obtain a license for Sensor Network Analyzer from Daintree Networks, as this is a very useful and very powerful 802.15.4 RF sniffer.

5.1.1 Texas Instruments MSP-FET430UIF

Custom firmware development can be done on the Pro-FLEX module using development tools available thought TI. As shown in Figure 10, a MSP-FETUIF USB Interface is required. It plugs directly into the ModFLEX Development Board (see Figure 6), and can easily be adapted to other hardware. See the Texas Instruments website (www.ti.com) for more information and how to order.

Figure 10 MSP-FET430UIF[1]

5.1.2 IAR Systems Embedded Workbench for MSP430

Also required is Embedded Workbench for TI MSP430 from IAR Systems. IAR Embedded Workbench for MSP430 provides extensive support for devices in MSP430 and MSP430X families and generates very compact and efficient code. Built-in plugins for various hardware debug systems and RTOSs are included in the standard edition. KickStart, Evaluation, Baseline, and Full editions are available from IAR Systems. Visit www.iar.com for additional information.

[1] The *MSP-FET430UIF* will be needed to develop firmware for Pro-FLEX series transceiver modules with the Texas Instruments chipset solution. Visit www.ti.com for additional details.

5.1.3 Daintree Networks Sensor Network Analyzer

Figure 11 Daintree Networks Sensor Network Analyzer RF Sniffer

Daintree Network's Sensor Network Analyzer features include a powerful protocol decoder that allows you to drill down to packet, field, and byte level; unique visualization capabilities that allow you to view all network devices and interactions simultaneously; customization options including filtering, labeling and color-coding to make it easy to locate packets of interest; performance measurements for 802.15.4 and ZigBee; and intuitive tools that make it easy to perform complex functions such as multi-node and multi-channel capture and ZigBee commissioning. Visit www.daintree.net for additional information.

5.1.4 Daintree Networks Sensor Network Adapter

While the Daintree Networks Sensor Network Analyzer is compatible with the MSP430F5437, LSR recommends using the Daintree 2400E Sensor Network Adapter in conjunction with Daintree's Sensor Network Analyzer software. The Daintree Networks 2400E Sensor Network Adapter, see Figure 12, is a capture accessory that acts as an observation and control point enabling the use of Daintree's Sensor Network Analyzer (SNA) software in live wireless embedded networks. More than just a capture device, this versatile Adapter can also join live ZigBee networks to actively poll and commission devices. The 2400E Sensor Network Adapter provides both Ethernet and USB interfaces. It is portable and light-weight making it suitable for use in remote locations. A more detailed overview of the 2400E Sensor Network Adapter can be found at http://www.daintree.net/products/adapter.php.

Figure 12 Sensor Network Adapter

5.1.5 TI SmartRF Protocol Packet Sniffer

The TI SmartRF Protocol Packet Sniffer is a free IEEE 802.15.4 packet sniffer, that can be used with any CC24xx or CC25xx development kit from Texas Instruments. The Packet Sniffer is a PC software application used to display and store RF packets captured with a listening RF Device. The RF Device is connected to the PC with an USB cable. Various RF protocols are supported. The Packet Sniffer filters and decodes packets and displays them in a convenient way, with options for filtering and storage to a binary file format.[2]

5.2 Debugging

When your custom firmware is ready for debugging, connect the MSP-FET430UIF to the ModFLEX development board fitted with a Pro-FLEX series transceiver module. From the Project menu, select Debug, or, alternatively, click the Debugger button in the IAR Embedded Workbench toolbar. See the MSP430 IAR Embedded Workbench® IDE User Guide for additional details. This document can be found through the Help menu of Embedded Workbench, after it is installed on your machine.

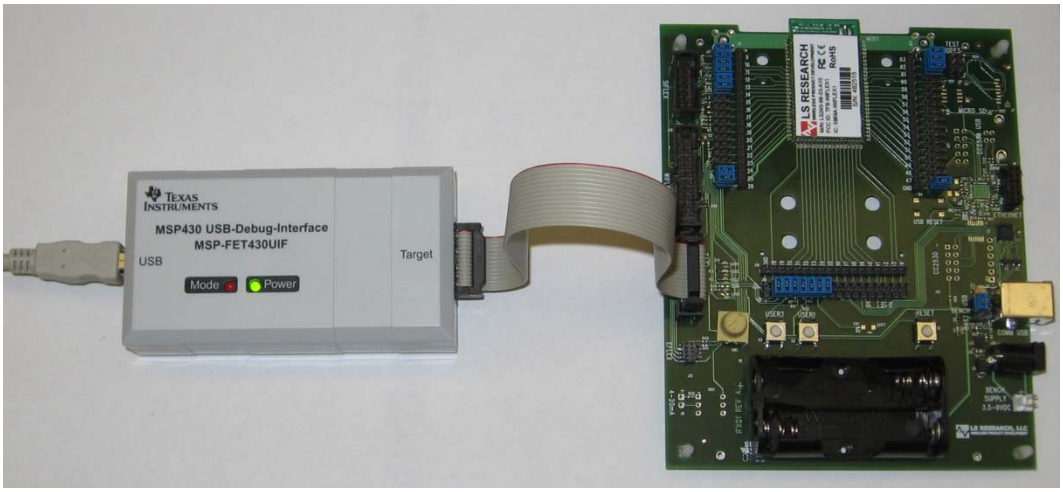

Figure 13 Debugging Pro-FLEX Custom Firmware via MSP-FET430UIF

[2] http://focus.ti.com/docs/toolsw/folders/print/packet-sniffer.html

5.3 In-House Programming

For programming prototypes in-house, either Embedded Workbench for MSP430 from IAR Systems or FET-Pro430 from Elprotronic (www.elprotronic.com) can be used. Detailed instructions for programming your module with Embedded Workbench for MSP430 or FET-Pro430 can be found in their respective User's Guides.

5.4 Production Programming

In place of the MSP-FET430UIF, Texas Instruments recommends using their MSP-GANG430 programmer, see Figure 14, for production programming. This device allows for programming of up to eight devices simultaneously. Additional details regarding the MSP430 Gang Programmer can be found on the Texas Instruments website (www.ti.com).

Figure 14 MSP430 Gang Programmer

6 ModFLEX Development Board

6.1 Schematics

Figure 15 and Figure 16 are the schematics for Rev. C of the ModFLEX development board. Table 3 specifies the No-Pop components.

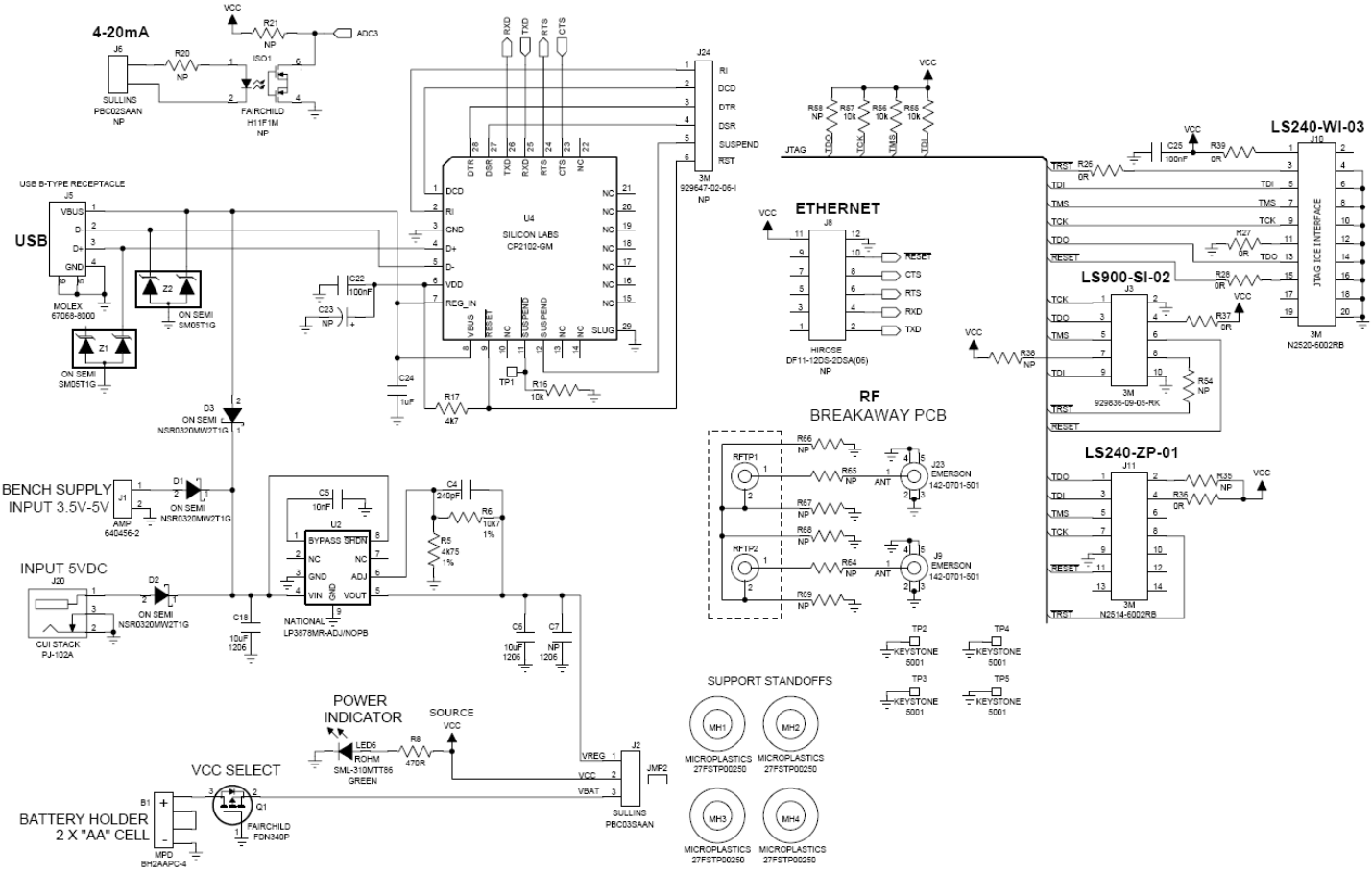

Figure 15 ModFLEX Development Board Schematic Page 1 of 2

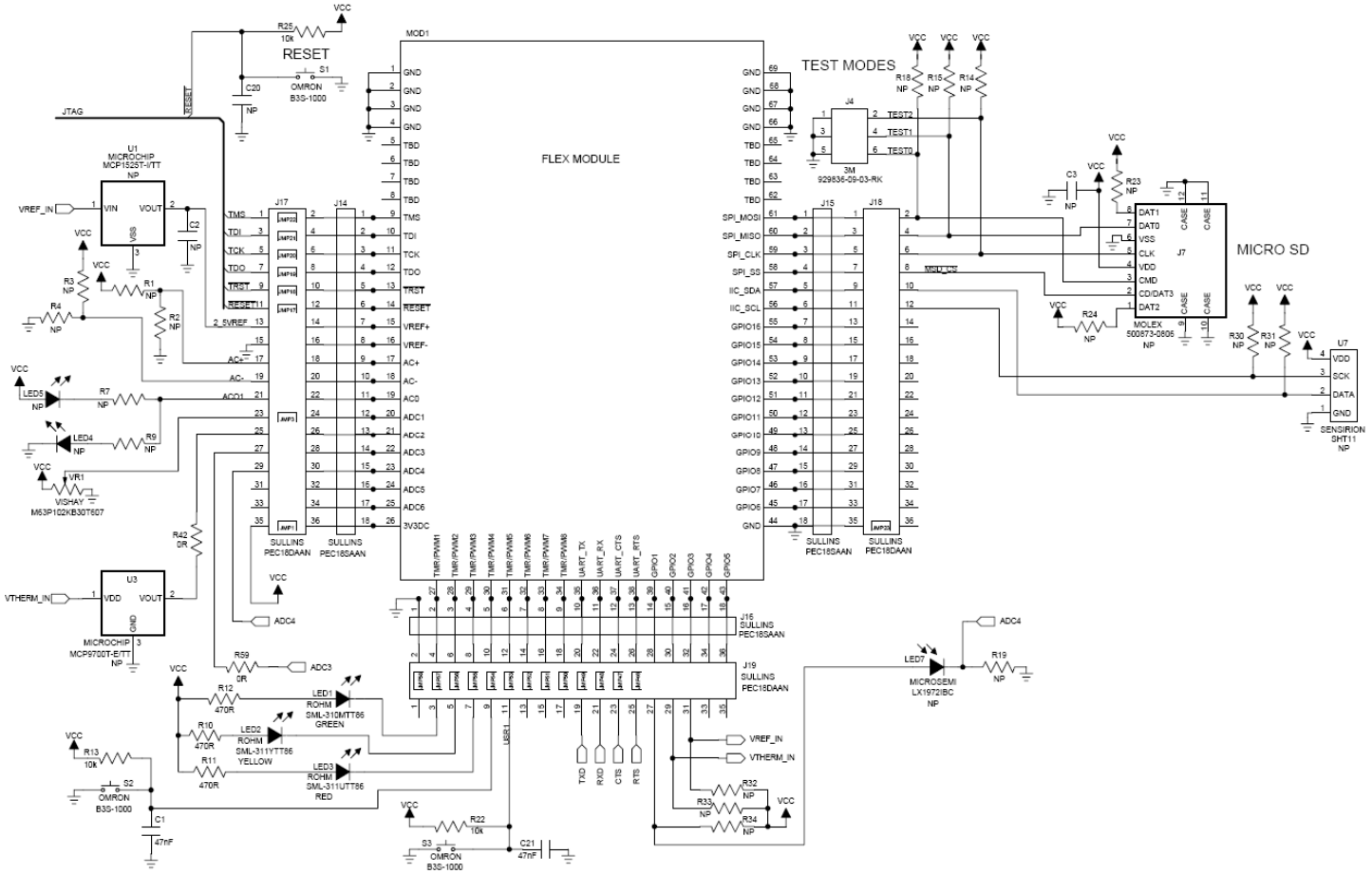

Figure 16 ModFLEX Development Board Schematic Page 2 of 2

Reference	Value	Tol.	Voltage/ Power	Manufacturer	Part Number	Description
C2 C3 C20	NP					0402 SIZE SMT CERAMIC CAPACITOR
C7	NP					1206 SIZE SMT CERAMIC CAPACITOR
C23	NP					SURFACE MOUNT TANT. CAPACITOR 'A' CASE SIZE
ISO1				FAIRCHILD	H11F1M	PHOTOFET OPTOCOUPLER
J6				SULLINS	PBC02SAAN	2 PIN 0.1" HEADER
J7				MOLEX	500873-0806	MICRO SD CARD CONNECTOR, SMT W/PUSH PUSH
J8				HIROSE	DF11-12DS-2DSA(06)	6 POSITION DUAL ROW 2mm SMT RECEPTACLE
J24				3M	929647-02-06-I	6 PIN 0.1" STRIP HEADER
LED4 LED5	RED			ROHM	SML-311UTT86	0603 SIZE SMT RED LED
LED7				MICROSEMI	LX1972IBC	AMBIENT LIGHT DETECTOR
MOD1						FLEX MODULE

Reference	Value	Tol.	Voltage/ Power	Manufacturer	Part Number	Description
R1 R2 R3 R4 R7 R9 R14 R15 R18 R19 R20 R21 R23 R24 R30 R31 R32 R33 R34 R35 R38 R54 R58	NP					THICK FILM 0402 SMT RESISTOR
R64 R65 R66 R67 R68 R69	NP	5%	125mW	Any		0805 SURFACE MOUNT RESISTOR
U1	2.5V	1%		MICROCHIP	MCP1525T-I/TT	2.5V VOLTAGE REFERENCE
U3	2.5V	±4°C		MICROCHIP	MCP9700T-E/TT	LOW POWER LINEAR ACTIVE THERMISTOR
U7				SENSIRION	SHT11	HUMIDITY AND TEMP SENSOR

Table 3 No-Pop Components

6.2 Revision History

6.2.1 Rev. A Schematic Changes

Initial production release.

6.2.2 Rev. B Schematic Changes

Change Description	Change Description Continuation and/or Change Justification
Swap UART TX and RX pins on the Development Board	Right now TX on the silicon labs part is wired to TX on the Module and same for Rx. Tx of the Module s/b going to Rx of the SI Labs part and Rx of the Module to RX of the SI Labs part

Table 4 Rev. B Schematic Changes

6.2.3 Rev. C Schematic Changes

Change Description	Change Description Continuation and/or Change Justification
Rearranged reference designators for LEDs as follows: Was LED4, now LED1 Was LED6, Now LED4 Was LED1, now LED6	More intuitive and easier to read arrangement
Disconnect J20 pin 3 from J1 pin 2.	New supply scheme doesn't use switch isolation
Connect J1 pin 2 to GND net	New supply scheme doesn't use switch isolation
Connect J20 pin 3 to GND net	New supply scheme doesn't use switch isolation
Insert D2 in series between J20 pin 1 (anode) and J1 pin 1/C18 node (cathode)	So the module doesn't burn

Change Description	Change Description Continuation and/or Change Justification
Insert D1 in series between J1 pin 1 (anode) and D2/C18 node (cathode)	So the module doesn't burn
Connect D3 anode to J5 pin 1/Z2 pin 2/C24/U4 pin7/U4 pin 8 node	So the module doesn't burn
Connect D3 cathode to D1/D2/C18 node	So the module doesn't burn
Connect U2 as described below: Connect C5 between U2 pin 1 and GND net Connect U3 pin 3 to GND net Connect U2 pin 4 and U2 pin 8 to D1/D2/D3/C18 node Connect R6 between U2 pin 5 and U2 pin 6 Connect C4 in parallel with R6 Connect R5 between U2 pin 6/R6/C4 node and GND net	Higher input Voltage and safety features with new regulator circuit
Connect C6 between U2 pin 5/R6/C4 node and GND net	Higher input Voltage and safety features with new regulator circuit
Connect C7 between U2 pin 5/R6/C4/C6 node and GND net	Higher input Voltage and safety features with new regulator circuit
Connect J2 pin 1 to U2 pin 5/R6/C4/C6/C7 node. Label node as VREG net	New voltage source selection scheme
Connect J2 pin 2 to VCC net	New voltage source selection scheme
Connect Q1 as described below: Connect Q1 pin 1 to GND net Connect Q1 pin 2 to J2 pin 3. Label net as VBAT Connect Q1 pin 3 to B1 pin 1	Reverse battery protection

Table 5 Rev. C Schematic Changes

7 Agency Statements

Federal Communication Commission Interference Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.

- Increase the separation between the equipment and receiver.

- Connect the equipment into an outlet on a circuit different from that

  to which the receiver is connected.

- Consult the dealer or an experienced radio/TV technician for help.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC/IC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

OEM Responsibility to the FCC Rules and Regulations

The **Pro-FLEX** Module has been certified per FCC Part 15 and IC RSS-GEN (2007) rules for integration into products without further testing or certification. To fulfill the FCC and IC certification requirements the OEM of the **Pro-FLEX** Module must ensure that the information provided on the **Pro-FLEX** Label is placed on the outside of the final product.

The **Pro-FLEX** Module is labeled with its own FCC ID and IC Number. If the FCC ID and IC Number are not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. The final end product must be labeled in a visible area with the following:

"**Contains Transmitter Module FCC ID: TFB-PROFLEX1"**

"**Contains Transmitter Module IC: 5969A-PROFLEX1"**

or

"**Contains FCC ID: TFB-PROFLEX1"**

"**Contains IC: 5969A-PROFLEX1"**

The OEM of the **Pro-FLEX** Module must only use the approved antenna(s), which have been certified with this module.

The OEM of the **Pro-FLEX** Module must test their final product configuration to comply with Unintentional Radiator Limits before declaring FCC compliance per Part 15 of the FCC rules and RSS-GEN (2007) of Industry Canada's rules.

This transmitter module is authorized to be used in other devices only by OEM integrators under the following conditions:

1. The antenna(s) must be installed such that a minimum separation distance of 20cm is maintained between the radiator (antenna) and all persons at all times.
2. The transmitter module must not be co-located or operating in conjunction with any other antenna or transmitter.

As long as the two conditions above are met, further transmitter testing will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

IMPORTANT NOTE: In the event that these conditions cannot be met (for certain configurations or co-location with another transmitter), then the FCC and IC authorizations are no longer considered valid and the FCC and IC # cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC and IC authorization.

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module or change RF related parameters in the user manual of the end product.

The user manual for the end product must include the following information in a prominent location:

"To comply with FCC RF radiation exposure requirements, the antenna(s) used for this transmitter must be installed such that a minimum separation distance of 20cm is maintained between the radiator (antenna) & user's/nearby people's bodies at all times and must not be co-located or operating in conjunction with any other antenna or transmitter."

INDUSTRY CANADA STATEMENTS

Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication.

This device has been designed to operate with the antennas listed below, and having a maximum gain of 2.0 dBi. Antennas not included in this list or having a gain greater than 2.0 dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

Approved Antennas

Nearson DiPole # S131CL-L-PX-2450S

Inverted F Trace

To comply with IC RF exposure limits for general population/uncontrolled exposure, the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be collocated or operating in conjunction with any other antenna or transmitter.

8 Contacting LS Research

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