

Si1000/Si1010 WIRELESS MCU QUICK-START GUIDE

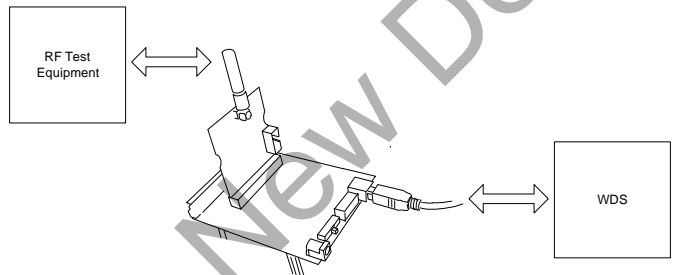
1. Introduction

This application note will help you get a quick start on demonstration, evaluation, or code development with the Si10xx products.

1.1. Choose between Evaluation, Demonstration, or Code Development

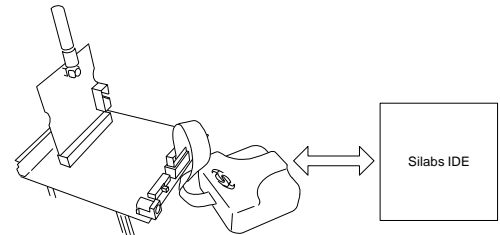
■ **Evaluate the radio performance or experiment with register settings:**

1. Get one Si1000/10 radio card and one Si1000-MB motherboard.
2. Download the demonstration host firmware to the Si1000/10 MCU.
3. Install WDS and connect.
4. Skip to "1.2. WDS" on page 2.



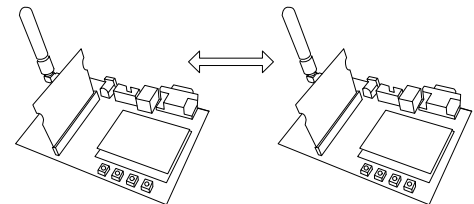
■ **Compile and Download RF demonstration firmware:**

1. Get one Si1000/10 radio card and one Si1000-MB motherboard.
2. Install the Silicon Labs Integrated Development Environment (IDE).
3. Install an evaluation version of a C compiler.
4. Connect the Si1000/10 to the Si1000 MB.
5. Open→modify→build→download→go.
6. Skip to "1.3. Code Development" on page 7.



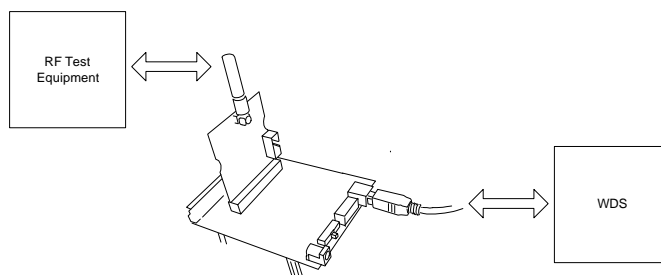
■ **Demonstrate a wireless link between two nodes:**

1. Get two Si1000/10 radio cards and two Software Development Boards.
2. Download bypass code to the Si1000/10's onboard MCU.
3. Configure the radio via the onboard LCD.
4. Skip to "1.4. Portable Demo Quick Start" on page 13.



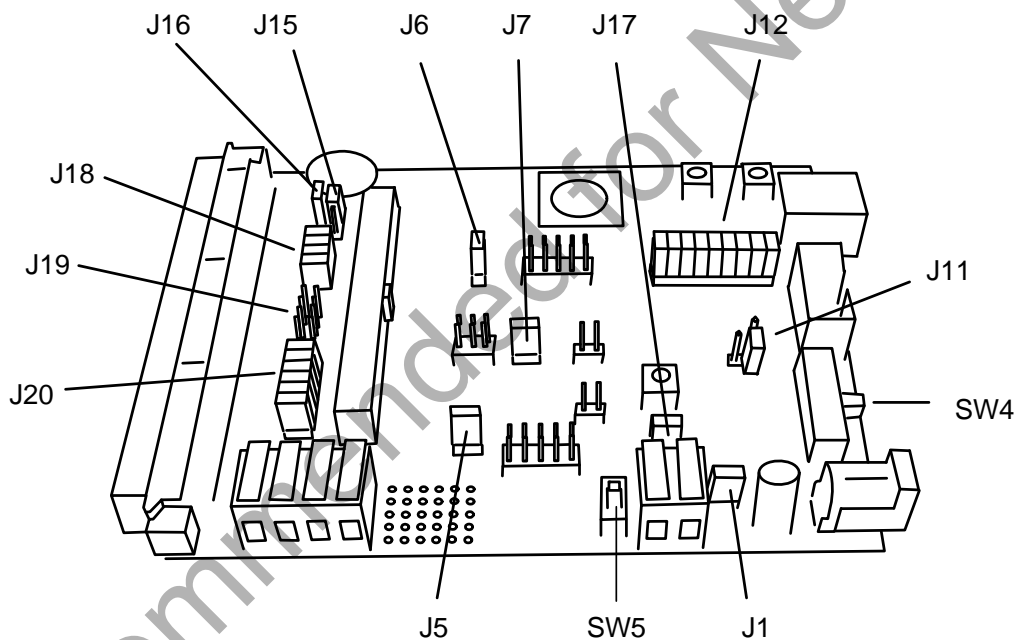
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1.2. WDS



Using the WDS Chip Configurator software is the best way to evaluate the RF performance in the lab with a PC in various configurations. The WDS GUI provides a convenient way to run configuration scripts and to change the radio settings bit-by-bit.

1. Install the WDS Chip Configurator either from the supplied CD or from www.silabs.com
2. Connect an Si10xx or Si101x RF card to the Si1000-MB motherboard.
3. Ensure jumpers/ switches are in the correct position:

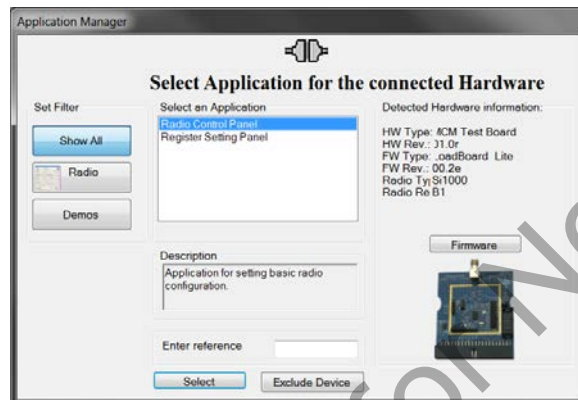


- SW4 in "2 CELL"
- J11 in WALL_PWR
- Jumpers shorted:
 - J1
 - J5
 - J6
 - J7
 - J12 (all)
 - J15
 - J16
 - J17
 - J18 (all, if using Si1000, 1, 2, 3, 4, or 5)
 - J19 (all, if using Si1010, 1, 2, 3, 4, or 5)
 - J20 (all)

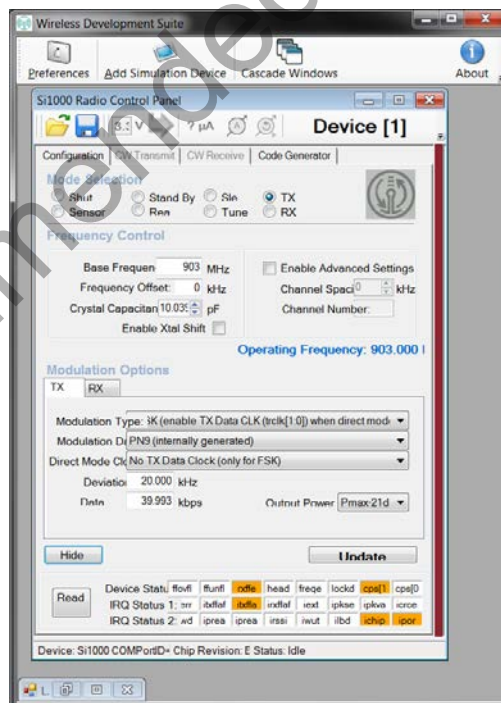
4. Connect the USB cable (which will supply power and USB communications).
5. Turn on power: SW5 → ON
6. Download the LoadBoard Light code to each. (See "3. Silicon Laboratories IDE Code Download" on page 16).
File location: C:\SiLabs\MCU\Examples\Si100x\EZRadioPRO\WDS_Support\lb_light.hex (Si100x) or
C:\SiLabs\MCU\Examples\Si101x\EZRadioPRO\WDS_Support\lb_light.hex (Si101x)
(Files installed automatically with the Silicon Labs IDE)

Note that the red LED, DS3, blinks when the LoadBoard Light firmware is running.

7. Launch the WDS Chip Configurator application on your PC (Start → Silicon Laboratories → WDS3)
8. WDS should automatically detect the Si1000 connected via USB. The following screen will appear:



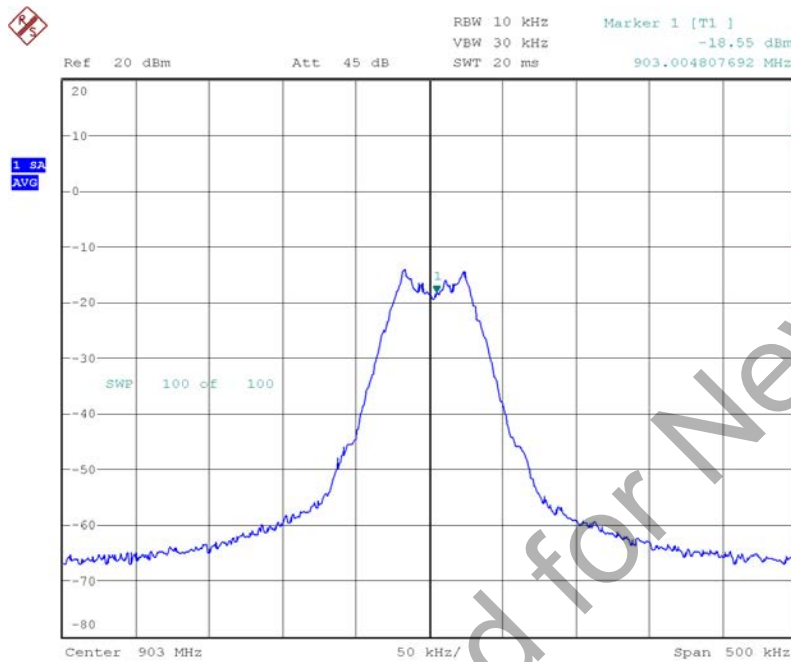
9. Click Radio Control Panel and Select.
10. Configure the radio to transmit a GFSK-modulated PN9 test message:



- a. Select the TX state by clicking the TX button,.
- b. Set the frequency (903 MHz shown).
- c. Set the crystal load capacitance to 10.039 pF.

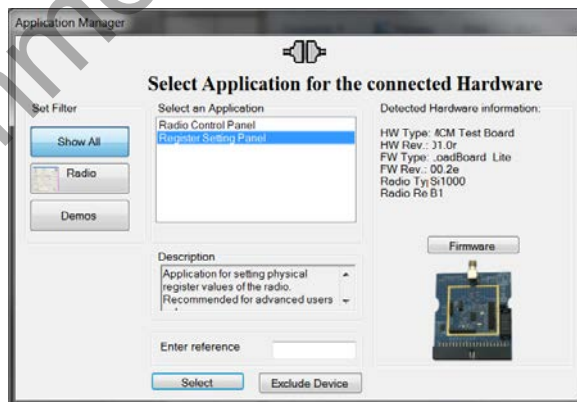
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- d. Select GFSK from Modulation Type.
 - e. Select PN9 from Modulation Data.
 - f. Click Update to write these values to the radio.
11. Connect a spectrum analyzer to the antenna output:
You should see a GFSK-modulated test signal at 903 MHz.

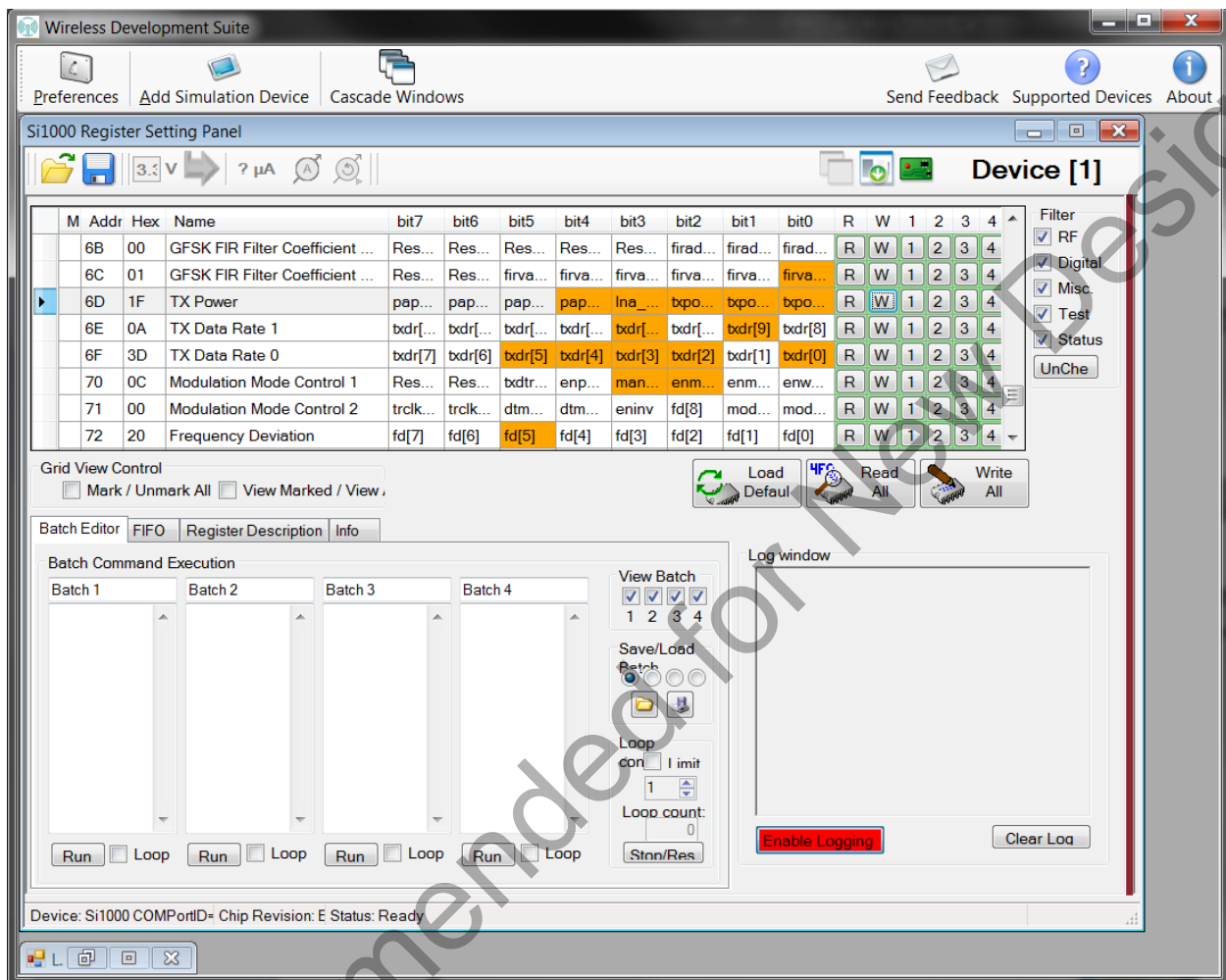


Date: 25.AUG.2010 17:17:36

12. Use the Register Setting panel to adjust the Transmit Power register:
Close the Radio Control panel. The Application Select panel will open:

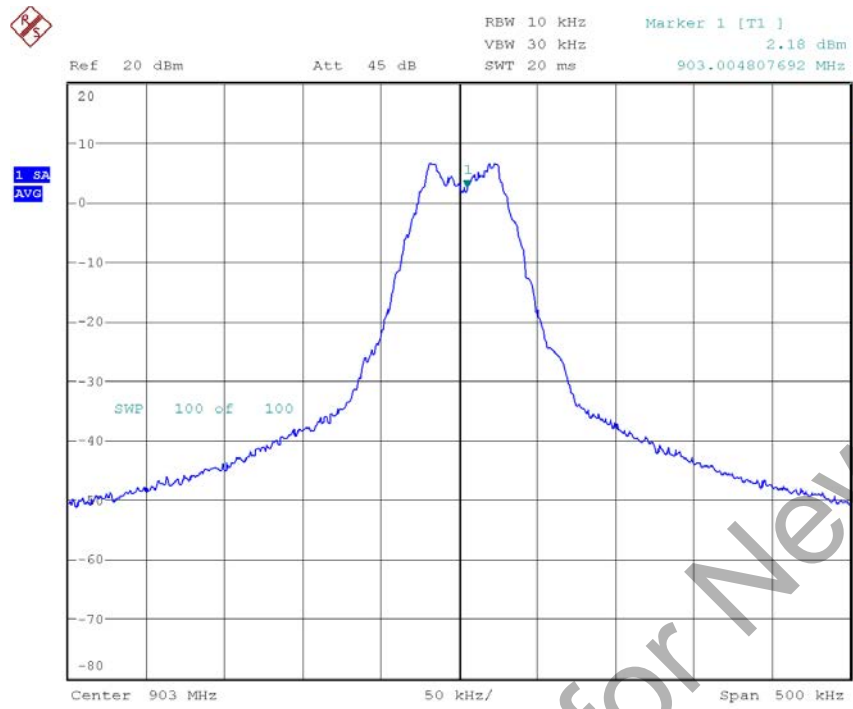


- Choose Register Setting Panel and Select.
- Scroll down to register 6D, the TX Power register. Set bits TXPOW[2:0] to 1. Click the W icon to write this register.



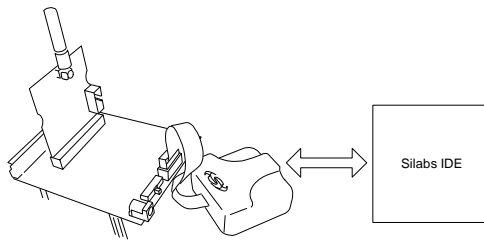
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c. Verify that the transmitter power has increased by checking the spectrum analyzer:



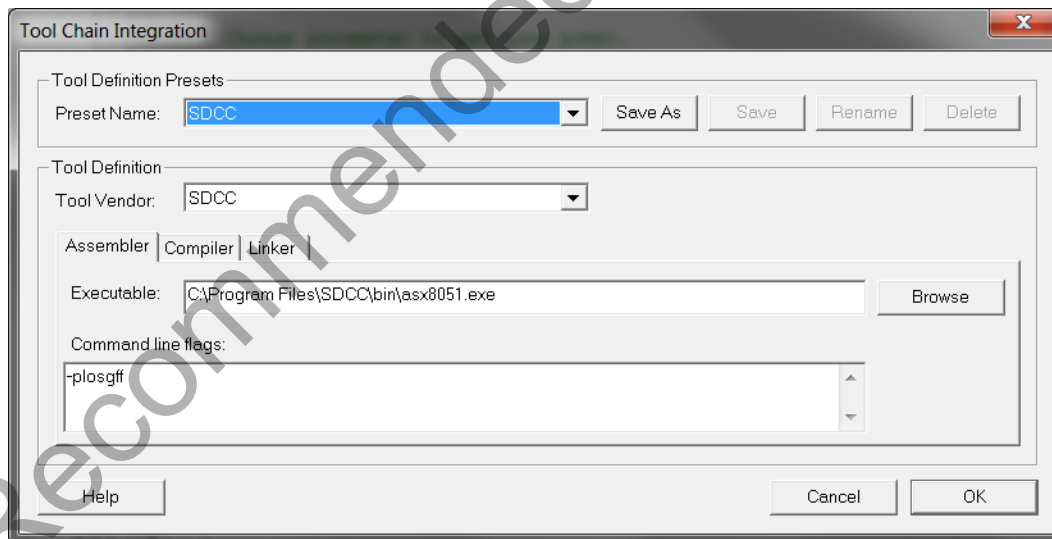
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1.3. Code Development



A number of RF programming examples are included with the standard Silicon Laboratories IDE installation. This section will get you started building and running one of those examples.

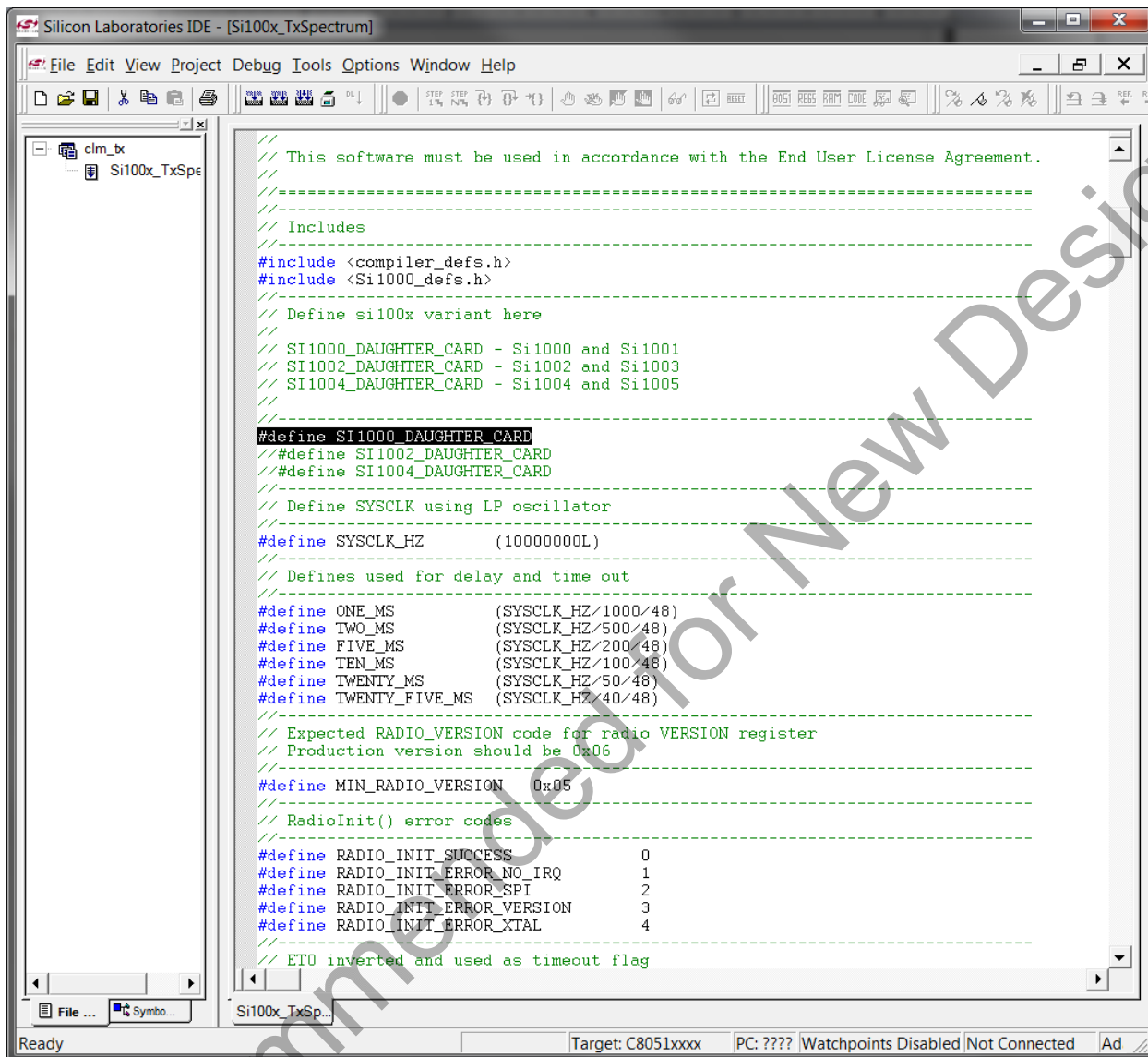
1. Install the Silicon Labs IDE software. Use the included CD or download from www.silabs.com.
2. Install a C compiler. This example uses SDCC. A list of compiler links is at <http://www.silabs.com/products/mcu/Pages/DevelopmentTools.aspx>
3. Connect the USB Programming Adapter to your computer.
4. Plug a Si1000 915 MHz radio card in to the Software Development Board or Si1000-MB.
5. Connect power.
6. Connect the USB Programming Adapter ribbon cable to J1 on the radio card.
7. Launch the Silicon Labs IDE software: All Programs → Silicon Laboratories → Silicon Laboratories IDE
8. Select the SDCC compiler.
 - a. Project → Tool Chain Integration ...
 - b. Select the SDCC preset.
 - c. Click OK.



9. Establish a connection to the Si1000 device: Debug → Connect
10. Open the Si100x_TxSpectrum.c file
(path: C:\SiLabs\MCU\Examples\Si100x\EZRadioPRO\TxSpectrum Si100x_TxSpectrum.c)

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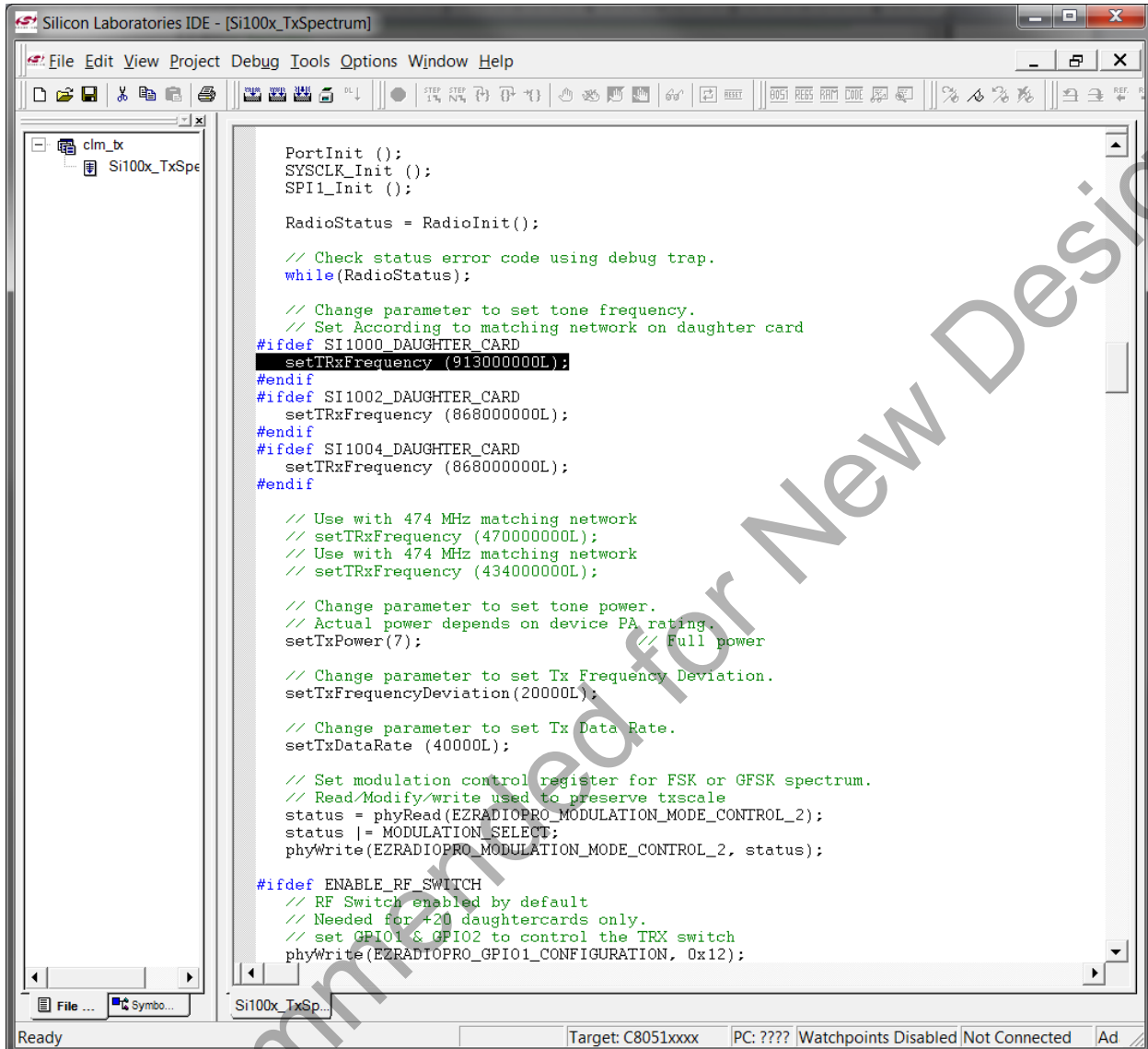
11. Ensure the Si1000 EVB is selected as a target:



```
Silicon Laboratories IDE - [Si100x_TxSpectrum]
File Edit View Project Debug Tools Options Window Help
// This software must be used in accordance with the End User License Agreement.
//-----
// Includes
//-----
#include <compiler_defs.h>
#include <Si1000_defs.h>
//-----
// Define si100x variant here
// SI1000_DAUGHTER_CARD - Si1000 and Si1001
// SI1002_DAUGHTER_CARD - Si1002 and Si1003
// SI1004_DAUGHTER_CARD - Si1004 and Si1005
//-----
#define SI1000_DAUGHTER_CARD
// #define SI1002_DAUGHTER_CARD
// #define SI1004_DAUGHTER_CARD
//-----
// Define SYSCLK using LP oscillator
#define SYSCLK_HZ (100000000L)
//-----
// Defines used for delay and time out
//-----
#define ONE_MS (SYSCLK_HZ/1000/48)
#define TWO_MS (SYSCLK_HZ/500/48)
#define FIVE_MS (SYSCLK_HZ/200/48)
#define TEN_MS (SYSCLK_HZ/100/48)
#define TWENTY_MS (SYSCLK_HZ/50/48)
#define TWENTY_FIVE_MS (SYSCLK_HZ/40/48)
//-----
// Expected RADIO_VERSION code for radio VERSION register
// Production version should be 0x06
//-----
#define MIN_RADIO_VERSION 0x05
//-----
// RadioInit() error codes
//-----
#define RADIO_INIT_SUCCESS 0
#define RADIO_INIT_ERROR_NO_IRQ 1
#define RADIO_INIT_ERROR_SPI 2
#define RADIO_INIT_ERROR_VERSION 3
#define RADIO_INIT_ERROR_XTAL 4
//-----
// ETO inverted and used as timeout flag
```

Ready Target: C8051xxx PC: ??? Watchpoints Disabled Not Connected Ad

12. Change the frequency to 913 MHz:



```
Silicon Laboratories IDE - [Si100x_TxSpectrum]
File Edit View Project Debug Tools Options Window Help
PortInit ();
SYSCLK_Init ();
SPI1_Init ();

RadioStatus = RadioInit();

// Check status error code using debug trap.
while(RadioStatus);

// Change parameter to set tone frequency.
// Set According to matching network on daughter card
#ifdef SI1000_DAUGHTER_CARD
setTRxFrequency (913000000L);
#endif
#ifdef SI1002_DAUGHTER_CARD
setTRxFrequency (868000000L);
#endif
#ifdef SI1004_DAUGHTER_CARD
setTRxFrequency (868000000L);
#endif

// Use with 474 MHz matching network
// setTRxFrequency (470000000L);
// Use with 474 MHz matching network
// setTRxFrequency (434000000L);

// Change parameter to set tone power.
// Actual power depends on device PA rating.
setTxPower(7); // Full power

// Change parameter to set Tx Frequency Deviation.
setTxFrequencyDeviation(20000L);

// Change parameter to set Tx Data Rate.
setTxDataRate (40000L);

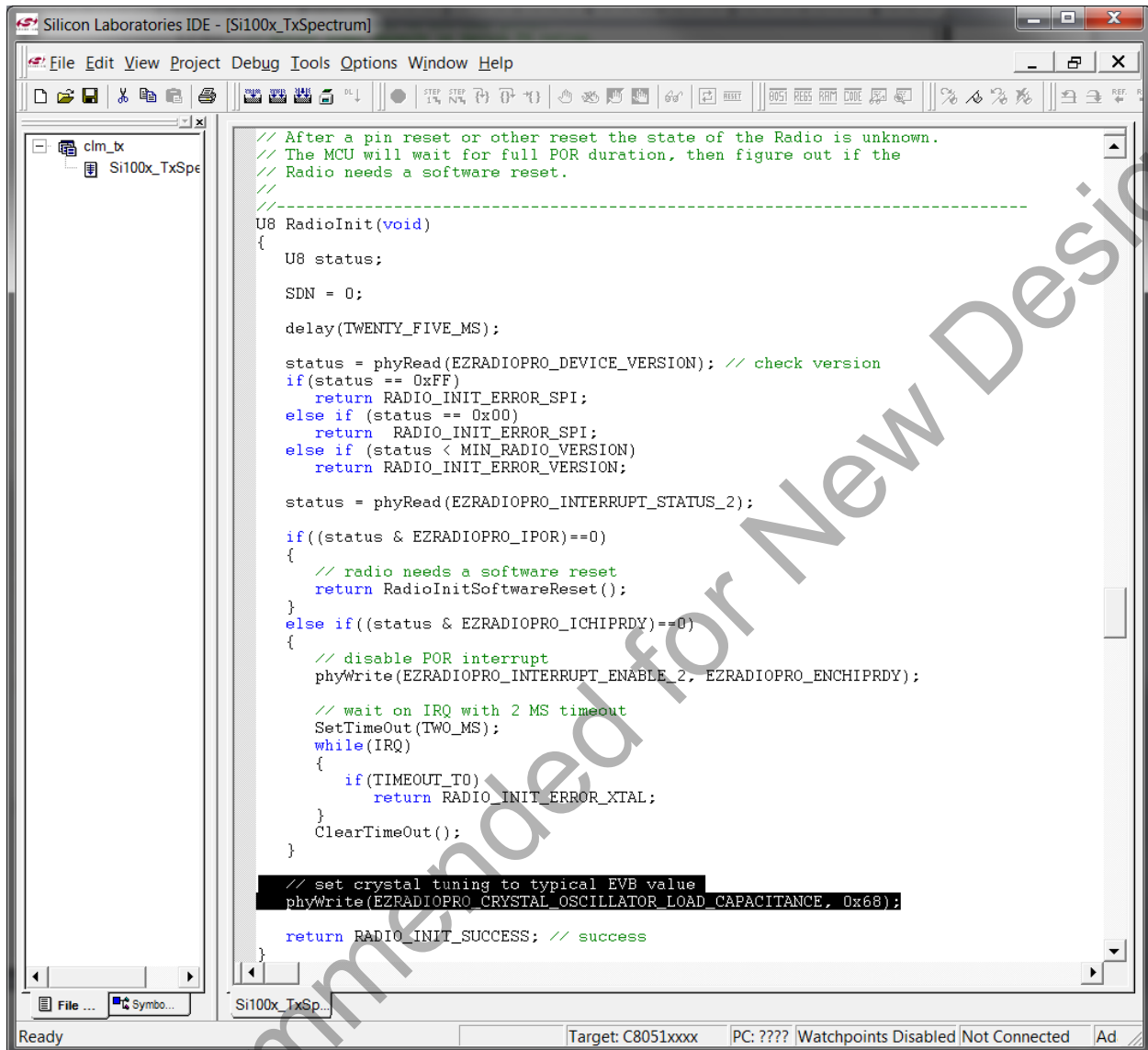
// Set modulation control register for FSK or GFSK spectrum.
// Read/Modify/write used to preserve txscale
status = phyRead(EZRADIOPRO_MODULATION_MODE_CONTROL_2);
status |= MODULATION_SELECT;
phyWrite(EZRADIOPRO_MODULATION_MODE_CONTROL_2, status);

#ifdef ENABLE_RF_SWITCH
// RF Switch enabled by default
// Needed for +20 daughtercards only.
// set GPIO1 & GPIO2 to control the TRX switch
phyWrite(EZRADIOPRO_GPIO1_CONFIGURATION, 0x12);
#endif

Ready Target: C8051xxx PC: ??? Watchpoints Disabled Not Connected Ad
```

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13. Fine-tune the EVB's crystal frequency. Scroll down to the RadioInit function and add a phyWrite command:



```
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Silicon Laboratories IDE - [Si100x_TxSpectrum]
File Edit View Project Debug Tools Options Window Help
clm_bx
Si100x_TxSpe

// After a pin reset or other reset the state of the Radio is unknown.
// The MCU will wait for full POR duration, then figure out if the
// Radio needs a software reset.
//-----
U8 RadioInit(void)
{
    U8 status;

    SDN = 0;

    delay(TWENTY_FIVE_MS);

    status = phyRead(EZRADIOPRO_DEVICE_VERSION); // check version
    if(status == 0xFF)
        return RADIO_INIT_ERROR_SPI;
    else if (status == 0x00)
        return RADIO_INIT_ERROR_SPI;
    else if (status < MIN_RADIO_VERSION)
        return RADIO_INIT_ERROR_VERSION;

    status = phyRead(EZRADIOPRO_INTERRUPT_STATUS_2);

    if((status & EZRADIOPRO_IPOR)==0)
    {
        // radio needs a software reset
        return RadioInitSoftwareReset();
    }
    else if((status & EZRADIOPRO_ICHIPRDY)==0)
    {
        // disable POR interrupt
        phyWrite(EZRADIOPRO_INTERRUPT_ENABLE_2, EZRADIOPRO_ENCHIPRDY);

        // wait on IRQ with 2 MS timeout
        SetTimeOut(TWO_MS);
        while(IRQ)
        {
            if(TIMEOUT_T0)
                return RADIO_INIT_ERROR_XTAL;
        }
        ClearTimeOut();
    }

    // set crystal tuning to typical EVB value
    phyWrite(EZRADIOPRO_CRYSTAL_OSCILLATOR_LOAD_CAPACITANCE, 0x68);

    return RADIO_INIT_SUCCESS; // success
}

Ready Target: C8051xxx PC: ??? Watchpoints Disabled Not Connected Ad
```

14. Build project and download the project

- Press ctrl-shift-F7 to compile and build.
- Press the [DL↓] icon to download.
- Ensure Download Successful appears in the Output Window.

The screenshot shows the Silicon Laboratories IDE interface. The main editor window displays the source code for `Si100x_TxSpectrum.c`. The code includes a copyright notice for Silicon Laboratories, Inc. (2010) and a detailed C file description. The description explains that the code is a simple example for generating an FSK or GFSK spectrum, provides runtime support for setting TX frequency, deviation, and data rate, and includes a `RadioInit()` function for debug support. It also provides instructions on how to use the code, including connecting the SDN pin, the IRQ pin, and the LED, and how to connect a spectrum analyzer to measure the RF amplitude.

The output window at the bottom shows the following text:

```
Link in progress...
C:\Program Files\SDCC\bin\sdcc.exe --debug --use-stdout -V -I"C:\SiLabs\MCU\Examples\Si100x\EZRadioPRO\TxSpectrum" -o"C:\SiLabs\MCU\Examples\Si100x\EZRadioPRO\TxSpectrum\clm_tx.hex" "C:\SiLabs\MCU\Examples\Si100x\EZRadioPRO\TxSpectrum\Si100x_TxSpectrum.rel"

+ C:\PROGRA~1\SDCC\bin\sdld.exe -nf "C:\SiLabs\MCU\Examples\Si100x\EZRadioPRO\TxSpectrum\clm_tx.lnk"

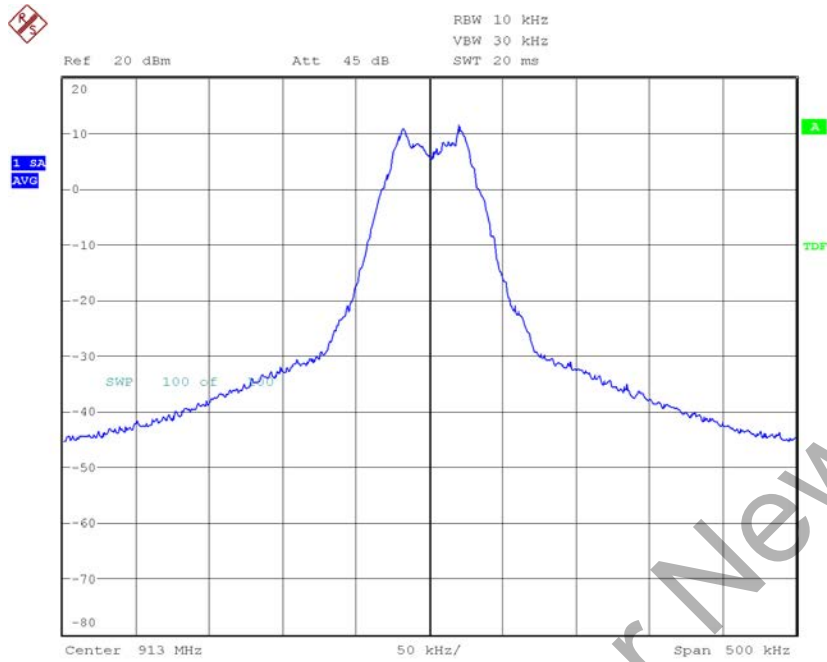
Downloading: C:\SiLabs\MCU\Examples\Si100x\EZRadioPRO\TxSpectrum\clm_tx
Checksum:0xcacd
Download successful
```

The status bar at the bottom of the IDE shows "Ready", "Target: Si1000", "PC: 0000 Watchpoints Disabled Halted", and "Ad".

15. Run: F5

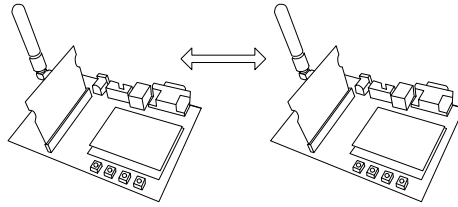
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16. Connect spectrum analyzer to antenna port and verify modulated spectrum.



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1.4. Portable Demo Quick Start



Note: This demo available with Software Development Board firmware v3.74 and later.

This demo will configure two Si10xx devices to ping-pong a message back and forth. One node will send a packet to the second. If the second receives it, it will reply with an ACKnowledgement. The transmitting node will compute the packet error ratio (PER) as the ratio of packets sent and acknowledged to the total number of packets sent.

1. Connect the two Si1000 wireless MCU daughtercards to their respective software development boards.
2. Connect power to each.
3. Download the SPI_PassThrough code to each. (See "3. Silicon Laboratories IDE Code Download" on page 16).

File location: C:\SiLabs\MCU\Examples\Si100x\EZRadioPRO\SPI_PassThrough.
(Installed automatically with the Silicon Labs IDE)

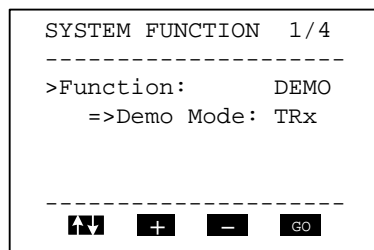
Select the appropriate version:

- SPI_PassThrough_Si101x.hex: For all Si101x devices
- SPI_PassThrough_Si1000.hex: For Si1000
- SPI_PassThrough_Si1004.hex: For Si1004

4. Press reset on each node; the Welcome message should appear:



5. On menu page 1/4, Select the DEMO function, TRx mode, press GO.



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6. On page 2/4, select 2.4 kbps, GFSK, 903.0 MHz, and GO:

```
RF  PARAMETERS  2/4
-----
>Data Rate:  2.4kpbs
Modulation:  GFSK
Frequency:   903.00MHz
-----
[↑↓] [ + ] [ - ] [ GO ]
```

7. On page 3/4, select output power +8 dBm and GO:

```
RF  PARAMETERS  3/4
-----
>Output power: +8dBm
-----
[↑↓] [ + ] [ - ] [ GO ]
```

8. On page 4/4, change ID: Destination to match the other card's ID: Self:

- Choose Packet length =5 and Max. Packets: 1000
- Select GO

Node 1:

```
NODE PARAMETERS  4/4
-----
ID: Self:         111
>ID: Destination: 176
Packet length:    5
Max. Packets:    1000
-----
[↑↓] [ + ] [ - ] [ GO ]
```

Node 2:

```
NODE PARAMETERS  4/4
-----
ID: Self:         176
>ID: Destination: 111
Packet length:    5
Max. Packets:    1000
-----
[↑↓] [ + ] [ - ] [ GO ]
```

9. Press TXON on Node 1.

- This will send a packet to Node 2.
- Node 2 will reply with an ACK.
- Node 1 will update its PER count (a missed ACK counts as an error).
- Repeat sending a packet to Node 2.

Node 1:

```
[ TX ] [ RX ] [ Y1 ]
-----
Si4432 GFSK 176-111
2.4k/903.0M TX/RX-SW
0025/0025 PER 0.00%
ACK RECEIVED!
-----
[ TX ON ] [ SETTINGS ]
```

Node 2:

```
[ TX ] [ RX ] [ Y1 ]
-----
Si4432 GFSK 111-176
2.4k/903.0M TX/RX-SW
ACK SENT
-----
[ TX ON ] [ SETTINGS ]
```

2. For More Information

Device data sheets

- Si1000
- Si1010

Evaluation board information

- Si10xx-DK User's Guide
- SDBC-DK3 User Guide Revision 0.4
- RF card schematics and PCB layout (www.silabs.com)

Register information, programming guides, and examples

- AN440: Si4430/31/32 Register Descriptions
- AN474: Si1000 Code Examples
- AN415: EZRadioPRO® Programming Guide
- AN417: Si4x3x Family Crystal Oscillators
- Si1000/Si1010 MCU Example Code (included as part of the IDE installer)

Lab testing and evaluation

- AN439: EZRadioPRO® RF Testing Quick-Start Guide
- AN437: Si4432 RF Performance and FCC Compliance Test Results
- AN445: Si4431 RF Performance and ETSI Compliance Test Results
- AN459: Measurement Results for Si4430-B and 950 MHz ARIB STD-T96 Compliance

Design

- AN435: Si4032/4432 PA Matching
- AN436: Si4030/4031/4430/4431 PA Matching
- AN463: Raw Data Mode with EZRadioPRO®

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3. Silicon Laboratories IDE Code Download

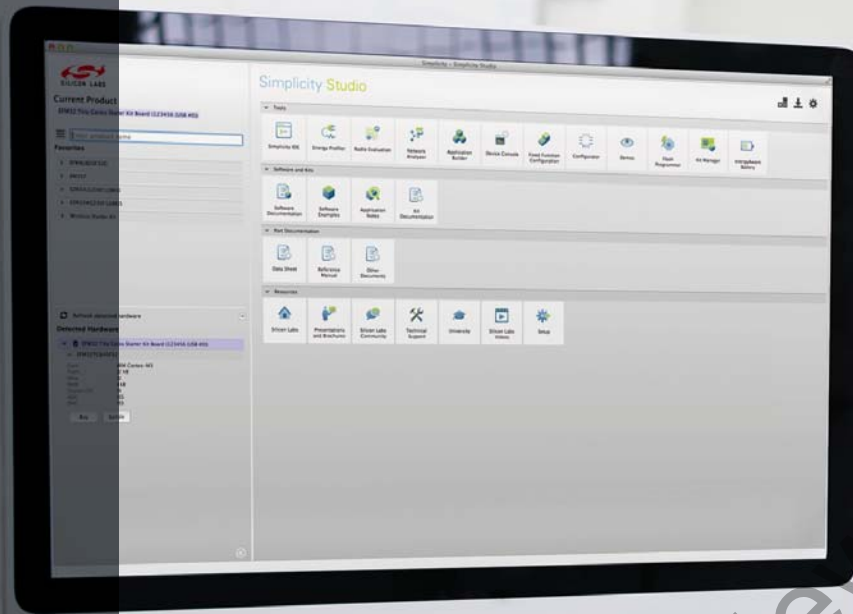
1. Install the Silicon Labs IDE software. Use the included CD or download from www.silabs.com.
2. Connect the USB Programming Adapter to your computer.
3. Plug the radio card in to the Software Development Board or Si1000-MB.
4. Connect power
5. Connect the USB Programming Adapter ribbon cable to J1 on the radio card.
6. Launch the Silicon Labs IDE software: All Programs→ Silicon Laboratories → Silicon Laboratories IDE
7. Establish a connection to the Si1000 device: Debug → Connect
8. Select the hex file to download: Debug → Download Object File. Choose the file, then select Download to initiate the programming.
9. Verify the successful download.
10. Disconnect the connection from IDE to Si1000 device: Debug → Disconnect
11. Disconnect the USB Programming Adapter ribbon cable.
12. Reset by cycling the power.

4. Contact Information

Please visit the Silicon Labs Technical Support web page:

<https://www.silabs.com/support/pages/contacttechnicalsupport.aspx>

and register to submit a technical support request.



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SILICON LABS

Silicon Laboratories Inc.
400 West Cesar Chavez
Austin, TX 78701
USA

<http://www.silabs.com>