Freescale Semiconductor
Application Note

AN2777
Rev. 1, 6/2005

Tango3 Monitor for the MC9S08RG60 MCU

by: John Logan
8/16-bit Division
East Kilbride

Introduction

This application note describes how to use the Tango3 Monitor program to evaluate the performance of the MC33493 RF transmitter IC (Tango3). It shows the hardware setup required, describes how to set up the monitor, lists all available commands, and gives some examples of usage.

The reader should be familiar with the Tango3 device data sheet and the RF data formats described in the MC33591 RF receiver (Romeo2) data sheet.

Description

The Tango3 Monitor is a software program that runs on Freescale's MC9S08RG60 Demo Board. The MC9S08RG60 Demo Board is connected to a Tango3 RF module, and to a PC via a serial port. The PC runs a terminal emulation program, for example, Hyperterminal. Figure 1 is a screenshot of Hyperterminal showing the monitor program. Figure 2 and Figure 3 show the hardware setup required to use the monitor program.

Description

The pins of the Tango3 RF module can be controlled by typing simple commands into the PC. The user can also trigger transmission of data messages from Tango3 by typing them into the PC.

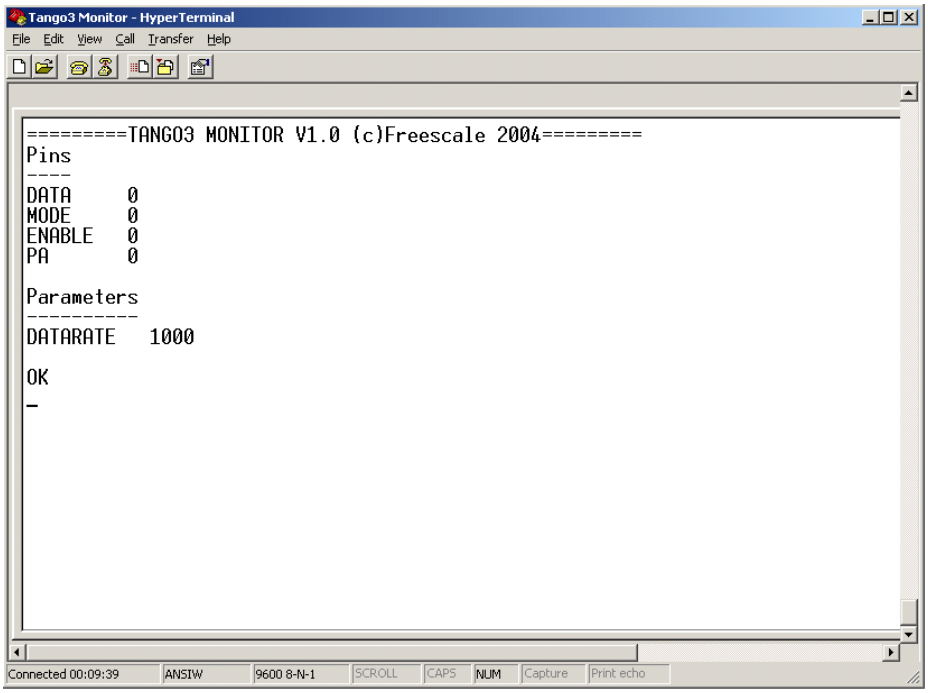

Figure 1. Tango3 Monitor Communicating with Hyperterminal

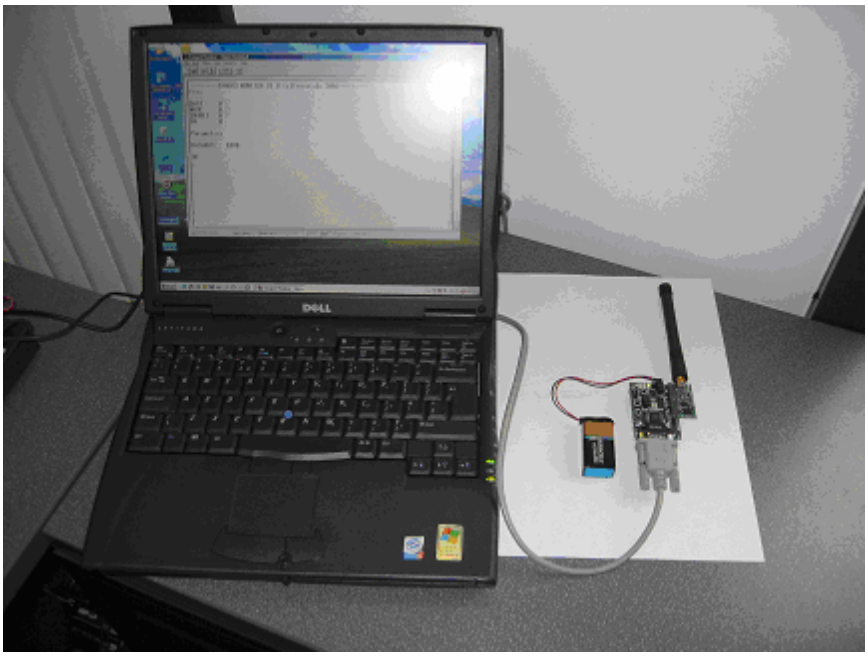

Figure 2. Tango3 Monitor Setup

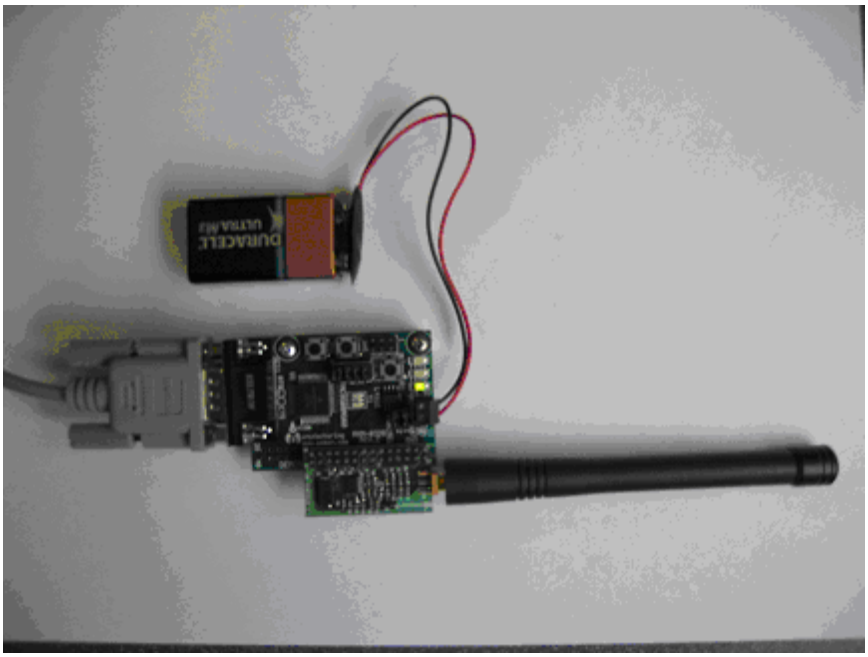

Figure 3. Close-up of MC9S08RG60 Demo Board and Tango3 RF Module

Requirements

To use the software, you must have the following hardware and software.

- MC9S08RG60 Demo Board (part number: DEMO9S08RG60)
- Tango RF module (part number: MC33493MOD315 or MC33493MOD434 — others may be available)
- MetroWerks CodeWarrior version 3.0 or later
- 'AN2777SW.zip', which contains the software files
- A PC running Hyperterminal, or any other terminal program

Full source code for the Tango3 monitor is available; this allows the monitor to be extended or modified, if required.

Programming Tango3 Monitor into the MC9S08RG60 MCU Using MC9S08RG60 Serial Monitor

The Tango3 monitor program must be programmed into the FLASH memory of the MC9S08RG60 Demo Board before it can be used. There are several programming tools available for the HC(S)08 MCU families that can be used for this purpose. This application note describes how to program the MC9S08RG60 using a free evaluation copy of the CodeWarrior development environment and the MC9S08RG60 Demo Board's built-in serial monitor.

To do this:

1. Install power select (PWR_SEL) jumpers 1 and 2 on the MC9S08RG60 Demo Board. Both jumpers must be installed.
2. Install all USER jumpers.
3. Connect the serial port connector on the MC9S08RG60 Demo Board to a PC comm. port using a 9-pin straight-through serial cable.
4. Connect a 9V power supply or battery tothe power connector on the MC9S08RG60 Demo Board.
5. Install CodeWarrior.

NOTE

You must have a copy of the CodeWarrior development tool for HC(S)08 installed. A copy of CodeWarrior is supplied with the MC9S08RG60 Demo Board. Please follow the instructions supplied with the demo board.

6. Unzip file Tango3RG60MonSource.zip (contained within AN2777SW.zip). This unzips a CodeWarrior project containing the programming file for the monitor.

NOTE

This project does not contain any source code. If you wish to read or modify the Tango3 monitor source code, you should unzip file Tango3RG60MonProg.zip, contained in AN2777SW.zip. To modify this

code, you require a full license for CodeWarrior, which can be purchased from www.metrowerks.com, or your local Freescale or MetroWerks. representative.

7. Start CodeWarrior (Start menu->MetroWerks->CodeWarrior->CodeWarrior IDE).
8. Select File->Open and open the file Tango3MonitorProgrammingFile.mcp. This opens a CodeWarrior project.
9. Press and hold the reset and SW1 switches on the MC9S08RG60 Demo Board. Release the reset switch while continuing to hold SW1. Then release SW1. This puts the demo board into 'serial monitor mode', ready to receive data from CodeWarrior.
10. In CodeWarrior, click on file 'Tango3MonProg' in the Target window. Then press key F5, or select Project->Debug from the menu bar. This launches a debugger, which communicates with the MC9S08RG60 Demo Board and attempts to burn the Tango3 monitor program into FLASH memory on the MCU.
11. If the MCU's FLASH memory is blank, the debugger will program the Tango3 monitor into memory. You should see the screen shown in Figure 4 when programming is complete. Go to step 15.
12. If the MCU's FLASH memory is not blank, the debugger will report an error. Click OK in any error windows that appear, then select MONITOR-HCS08->Erase FLASH from the menu bar.
13. Now select MONITOR-HCS08->Load from the menu bar. Select file 'Tango3RG60MonProg.abs' from the project directory.
14. The debugger will program the monitor into the MCU's FLASH memory. You should see screenshot shown in Figure 4 when programming is complete.
15. The monitor program has now been programmed into the MC9S08RG60 Demo Board. CodeWarrior is no longer required. Shut down all CodeWarrior windows and exit the program.

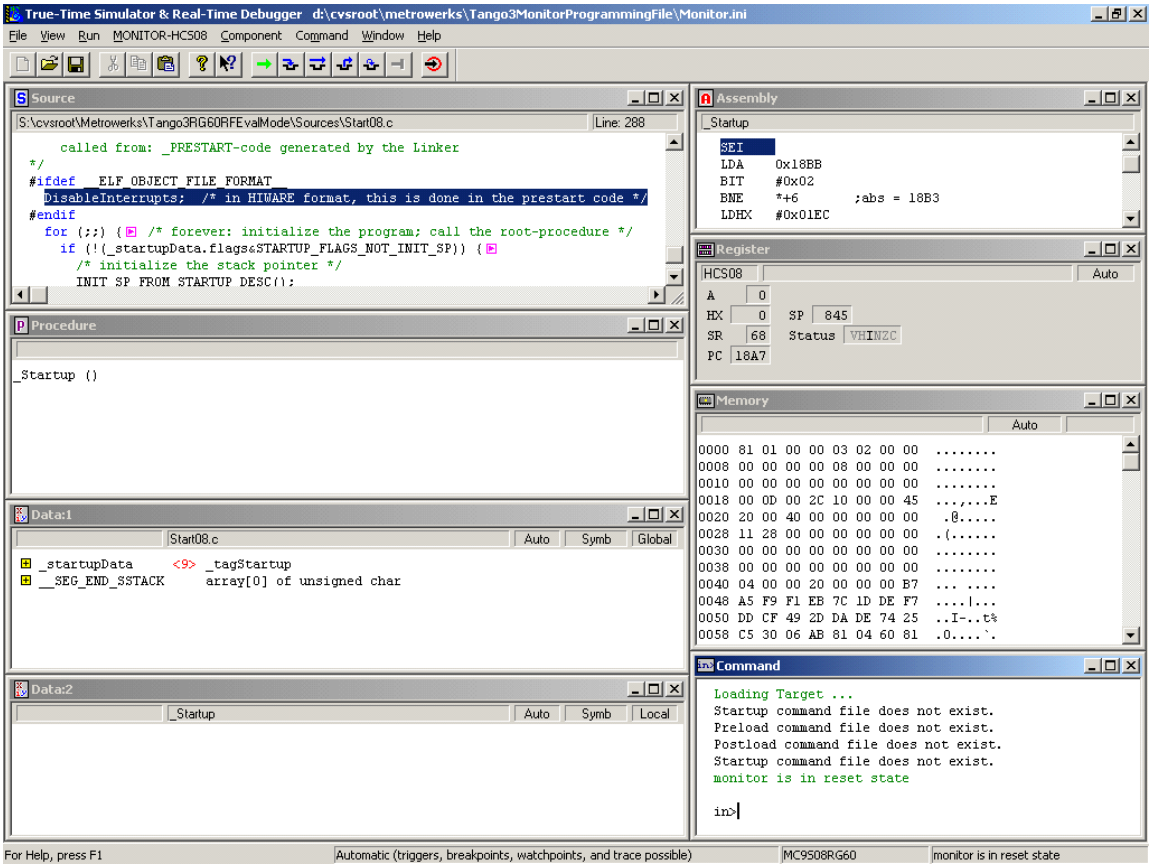

Figure 4. CodeWarrior debugger after successful programming

NOTE

The MC9S08RG60 serial monitor is co-resident in the MC9S08RG60's FLASH memory after this operation, so the user can reprogram the board with new programs at a later stage.

Using the Software

To use the software, connect the MC9S08RG60 Demo Board to a PC comm. port using a straight-through 9-pin serial cable. The MCU board will communicate with a terminal emulation program on the PC. Hyperterminal is a common terminal program, which is supplied with the Windows operating system. It should be configured for 9600 baud, eight data bits, no parity, one stop bit, no flow control. (See Figure 5.)

A setup file (Tango3Monitor.ht) for Hyperterminal is supplied in the software package for this application note (AN2777SW.zip), which can be downloaded from www.freescale.com.

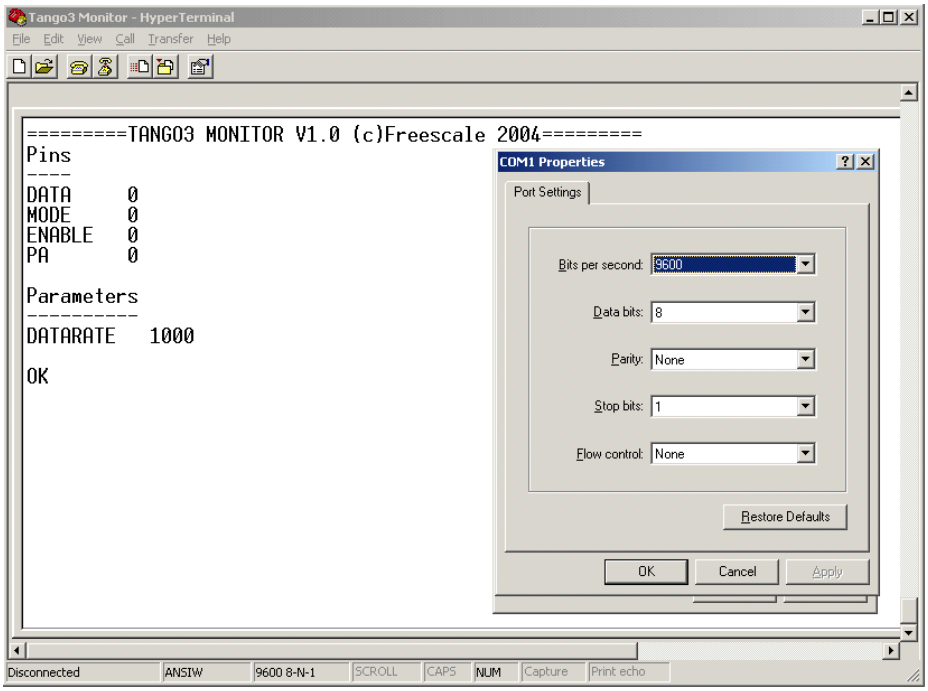

Figure 5. Terminal Program Configuration

To start the monitor:

1. Connect the Tango3 RF Module to connector J1 on the Mc9S08RG60 Demo Board. Pin 1 on each board should be aligned.
2. Connect an antenna to the Tango3 RF module.

NOTE

Tango3 RF modules are available in a range of frequencies; each is supplied with an appropriate antenna.

3. Install power select (PWR_SEL) jumpers 1 and 2 on the MC9S08RG60 Demo Board. Both jumpers must be installed.
4. Connect the serial port connector on the MC9S08RG60 Demo Board to a PC comm. port using a 9-pin straight-through serial cable.
5. Connect a 9V power supply or battery to the power connector on the MC9S08RG60 Demo Board. (See Figure 3 for a reference setup.)
6. Configure the terminal program for 9600 baud, eight data bits, no parity, one stop bit, no flow control. (If using Hyperterminal, use the Tango3Monitor.ht setup file.)
7. Connect the MC9S08RG60 Demo Board to the PC comm. port using the 9-pin D connector.
8. Start the terminal program. (In Hyperterminal, click the 'Connect' icon on the toolbar at the top of the screen.)
9. Connect power to the MC9S08RG60 Demo Board.

You should now see the screen shown in Figure 1. If not, press the reset switch on the MC9S08RG60 Demo Board.

This screen shows the state of various pins that connect between theTango3 RF module and the MC9S08RG60 Demo Board. It also shows the currently selected data rate for RF transmission.

NOTE

Each Tango3 RF module is hard-wired to a specific carrier frequency — 315 MHz, 434 MHz, 838 MHz, or 915 MHz. The monitor does not allow the user to change the carrier frequency.

The user can type commands in the terminal program window. Type HELP <return> for a complete list of commands, as shown in Figure 6.

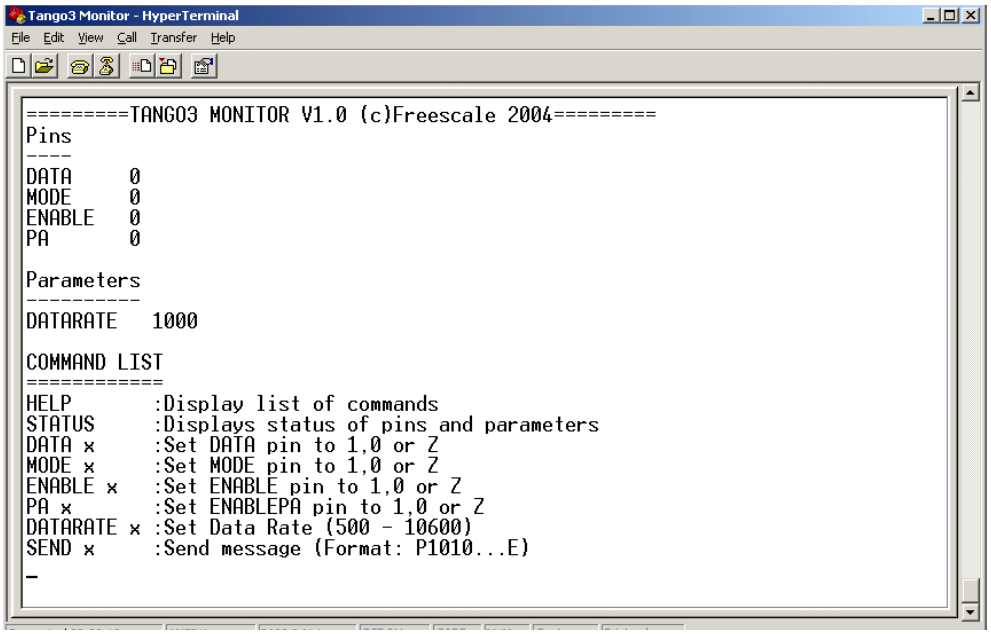

Figure 6. List of Commands

Command List

The Tango3 monitor supports the following commands.

HELP

Description: Help displays a list of all available commands with a short description of each command.

STATUS

Description: Displays the current status of Tango3 RF module pins and parameters.

DATA

Description: DATA allows the user to configure the DATA pin connection to Tango3. The pin can be set to an output at logic 1 or logic 0, or set to an input (high impedance state).

DATA 1 <return> — Set Data pin to output logic 1

DATA 0 <return> — Set Data pin to output logic 0

DATA Z <return> — Set pin to input, high impedance

MODE

Description: MODE allows the user to configure the MODE pin connection to Tango3. The pin can be set to an output at logic 1 or logic 0, or set to an input (high impedance state).

MODE 1 <return> — Set Mode pin to output logic 1

MODE 0 <return> — Set Mode pin to output logic 0

MODE Z <return> — Set pin to input, high impedance

ENABLE

Description: ENABLE allows the user to configure the ENABLE pin connection to Tango3. The pin can be set to an output at logic 1 or logic 0, or set to an input (high impedance state).

ENABLE 1 <return> — Set Enable pin to logic 1

ENABLE 0 <return> — Set Enable pin to logic 0

ENABLE Z <return> — Set pin to input, high impedance

PA

Description: PA allows the user to configure the power amplifier PA pin connection to the Tango3 RF module. The pin can be set to an output at logic 1 or logic 0, or set to an input (high impedance state).

PA 1 <return> — Enable power amplifier

PA 0 <return> — Disable power amplifier

PA Z <return> — Set pin to input, high impedance

DATARATE

Description: DATARATE allows the user to set the data rate for RF transmissions. This can be set to any value with the range 500 bps to 10600 bps.

DATARATE value <return> — Set data rate to 'value'

SEND

Description: SEND allows the user to transmit an RF data packet from Tango3.

Data packets can be constructed from the following fields.

P — Preamble. The Preamble is a fixed format field that allows Romeo to detect the start of a message. See the Romeo2 data sheet for details.

1 — sends a logic 1 Manchester encoded.

0 — sends a logic 0 Manchester encoded.

H — sends a logic 1 for one bit time (no Manchester encoding).

L — sends a logic 0 for one bit time (no Manchester encoding).

E — sends an End Of Message. This is a fixed format field that indicates the end of a message.

These fields follow the format defined in the Romeo2 data sheet. These fields can be sent in any combination up to a maximum of 128 fields.

The P, 1, 0, and E fields follow the format defined in the Romeo2 data sheet.

SEND Command Examples

P1111111101010101E — Sends single message.

P1111111101010101EP1111111101010101E — Sends two back-to-back messages.

The H and L fields allow the user to send messages without Manchester encoding, or can be mixed with Manchester encoded messages.

NOTE

After a SEND command, the DATA pin is configured as an output pin set to logic 0. This is intended to prevent spurious signals from occuring on the data pin at the end of a message.

VERBOSE

Description: The VERBOSE command determines the amount of information displayed by the Tango monitor. By default, VERBOSE is set to ON, resulting in the detailed display shown in Figure 1. Setting VERBOSE to OFF reduces the amount of information shown (see Figure 7).

VERBOSE ON <return> — Full screen display (Figure 1)

VERBOSE OFF <return> — Reduced screen display (Figure 7)

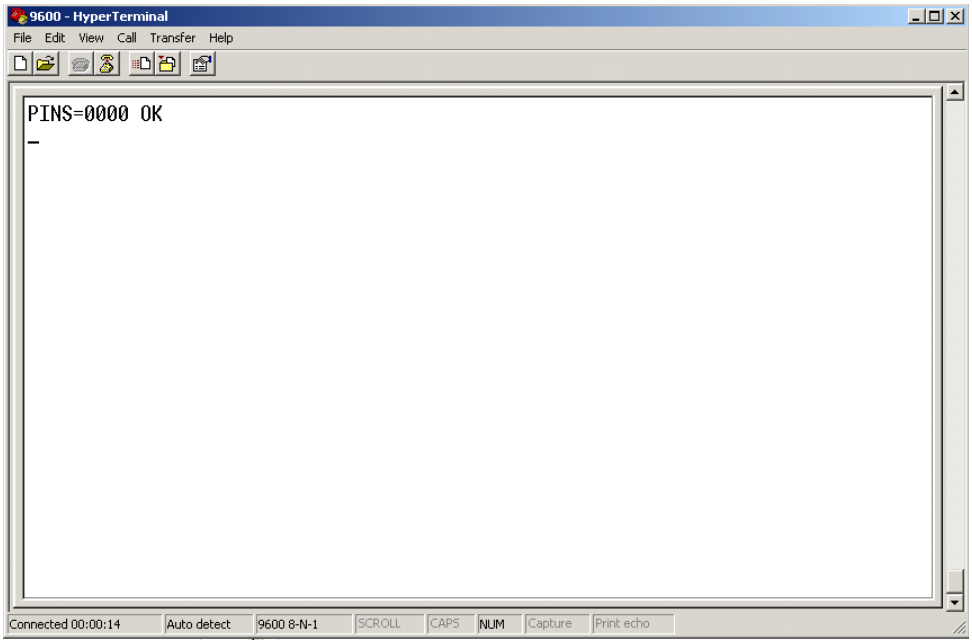

Figure 7. Reduced Screen Display

BAUD

Description: The BAUD command allows the user to change the baud rate for communications between the monitor and the PC. By default, the baud rate is set to 9600. It can be changed to 19200 or 38400 if desired. On reset and startup, the baud rate is always set to 9600.

BAUD 9600 — Select 9600 baud

BAUD 19200 — Select 19200 baud

BAUD 38400 — Select 38400 baud

RF Message Formats

The Tango3 monitor allows the user to transmit messages using the data formats defined in the Romeo2 data sheet. There are two basic formats: messages with a header field and messages without a header field. Figure 8 shows some basic messages following these formats.

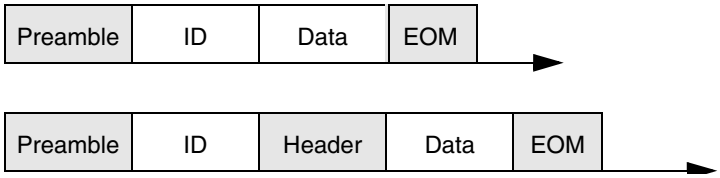

Figure 8. Basic Message Formats

The various fields in the messages are described below.

Preamble — The Preamble is a fixed format field that allows Romeo to detect the start of a message. The Tango3 monitor can transmit Preambles with the correct format using the 'P' field.

ID — Each Romeo device can be assigned an 8-bit ID number. It will receive messages with this ID only. This allows each Romeo device in an RF network to have a unique ID.

The Tango3 monitor can construct and send any ID byte using the '1' and '0' fields.

NOTE

Romeo2 can also accept messages with TONE based IDs. A TONE is an ID field consisting entirely of 1's or 0's. Refer to the Romeo2 data sheet for more information.

Header — The header field is a 4-bit fixed format field. It notifies Romeo that message data is next. The field has values '0110' or '1001'.

The Tango3 monitor can construct and send headers using the '1' and '0' fields.

Data — Data can be any length and consists of Manchester encoded 1's and 0's. The Tango3 monitor can construct any data pattern required.

EOM — End of Message. This is a fixed format field that indicates the end of a message. The Tango3 monitor can transmit EOMs with the correct format using the 'E' field.

The ID, header and data fields are constructed from Manchester encoded 1's and 0's. A Manchester encoded bit is represented by a sequence of two opposite logic levels. A '0' bit of data is encoded as sequence '01', a '1' bit of data is encoded as sequence '10'. Figure 9 shows what will be seen on Tango3's DATA pin when transmitting the data sequence '11001' using Manchester encoding.

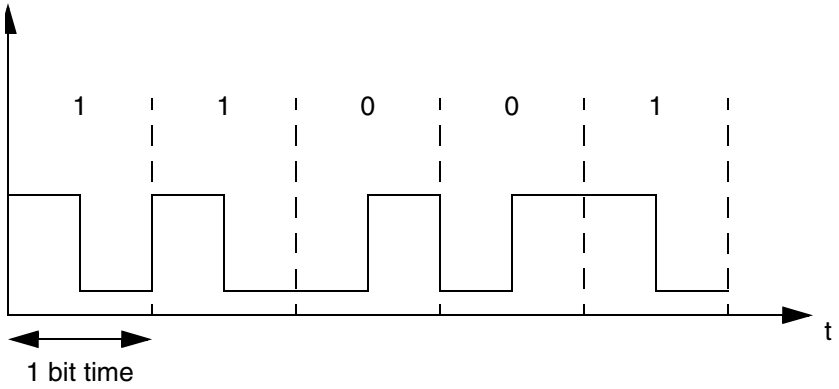

Figure 9. Manchester Encoding Of Data

The Tango3 monitor also can also construct RF messages without Manchester encoding using the H and L fields. Figure 10 shows an example.

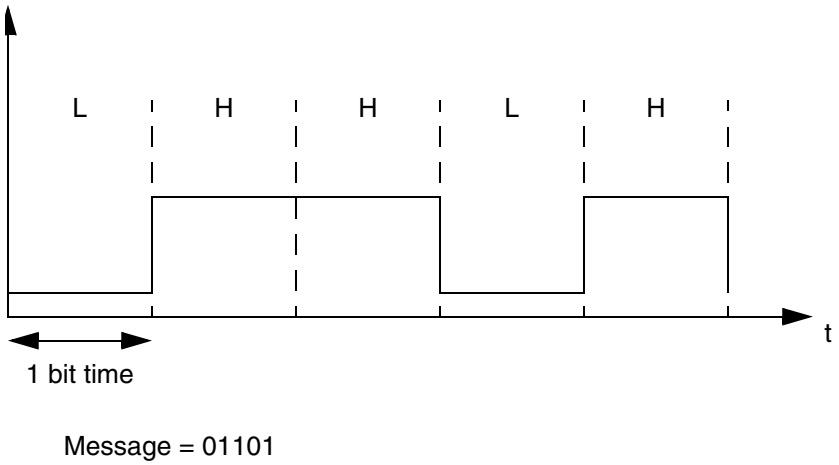

Figure 10. Data Encoding Using the H and L Fields

Examples

Transmitting an OOK Message Without Header

Below is an example of sending an OOK modulated message consisting of a Preamble, ID byte, eight bits of data, and an EOM. The data rate is 2400 bits per second.

To send an OOK data frame with ID 0x2a (00101010 binary), one data byte of 0xf0 (11110000 binary):

1. Set required baud rate with data rate DATARATE 2400 <return>.
2. To select OOK modulation, set the MODE pin to 0 using command MODE 0 <return>.
3. To enable the Tango3 IC, set the Enable pin to 1 with command ENABLE 1 <return>.

4. Use command SEND P0010101011110000E <return>.
5. To repeat SEND command, press return repeatedly.

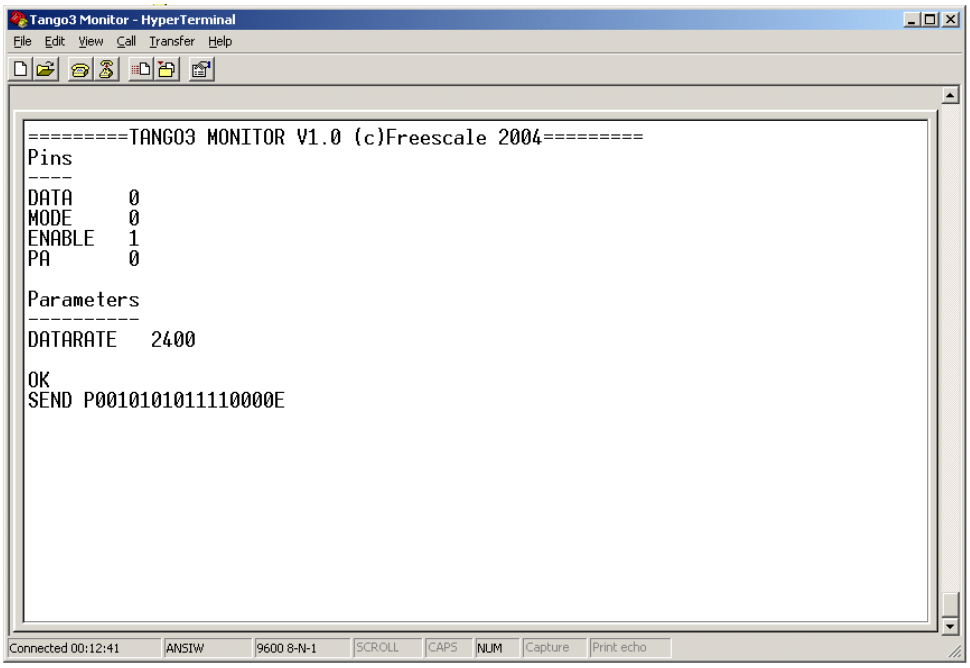

Figure 11. Transmitting an OOK Message Without Header

If the power amplifier is required to increase output power, set PA to 1 using command PA 1 <return>.

Transmitting an FSK message Without Header

Below is an example of sending an FSK modulated message consisting of a Preamble, an ID byte, eight bits of data, and an EOM. The data rate is 1000 bits per second.

To send an FSK data frame with ID 0xA5 (10100101 binary), one data byte of 0xff (11111111 binary):

1. Set required baud rate with data rate DATARATE 1000 <return>.
2. To select FSK modulation, set the MODE pin to 1 using command MODE 1 <return>.
3. To enable the Tango3 IC, set the Enable pin to 1 with command ENABLE 1 <return>.
4. Use command SEND P1010010111111111E <return>.
5. To repeat the SEND command, press return repeatedly.

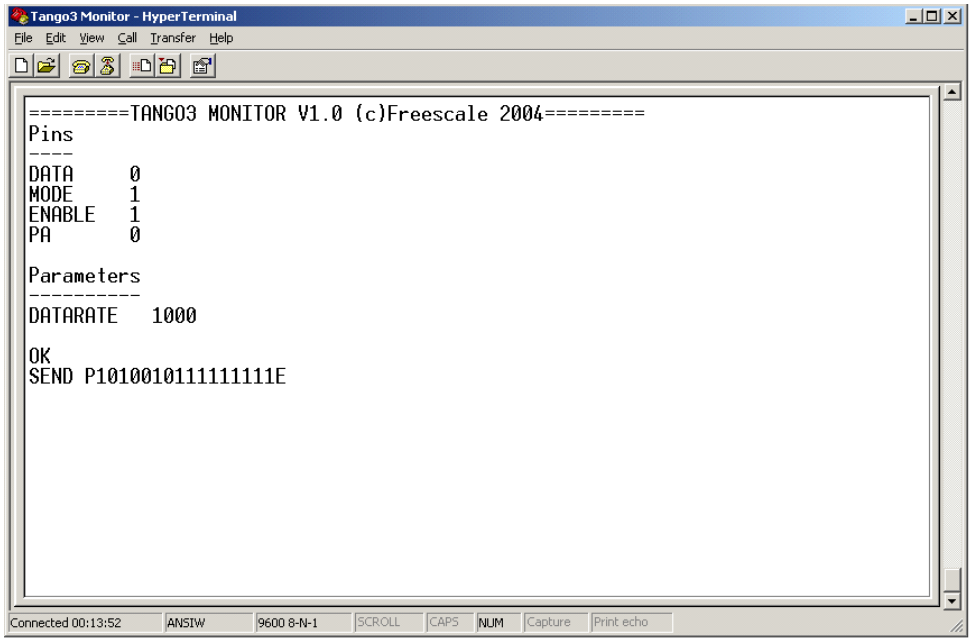

Figure 12. Transmitting an FSK Message Without Header

Transmitting Messages With Header Field

Sending a message with a header field can easily be done. Simply place the sequence '0110' in the message at the required position.

For example, to send a message with an ID of 0x55 (01010101 binary), data byte 0xff (11111111 binary), and a header field (0110 binary), at data rate of 1000 bps with OOK modulation:

1. Set required baud rate with DATARATE 1000 <return>.
2. To select OOK modulation, set the MODE pin to 0 using command MODE 0 <return>.
3. To enable the Tango3 IC, set the Enable pin to 1 with command ENABLE 1 <return>.
4. Use command SEND P01010101011011111111E <return>.
5. To repeat the SEND command, press return repeatedly.

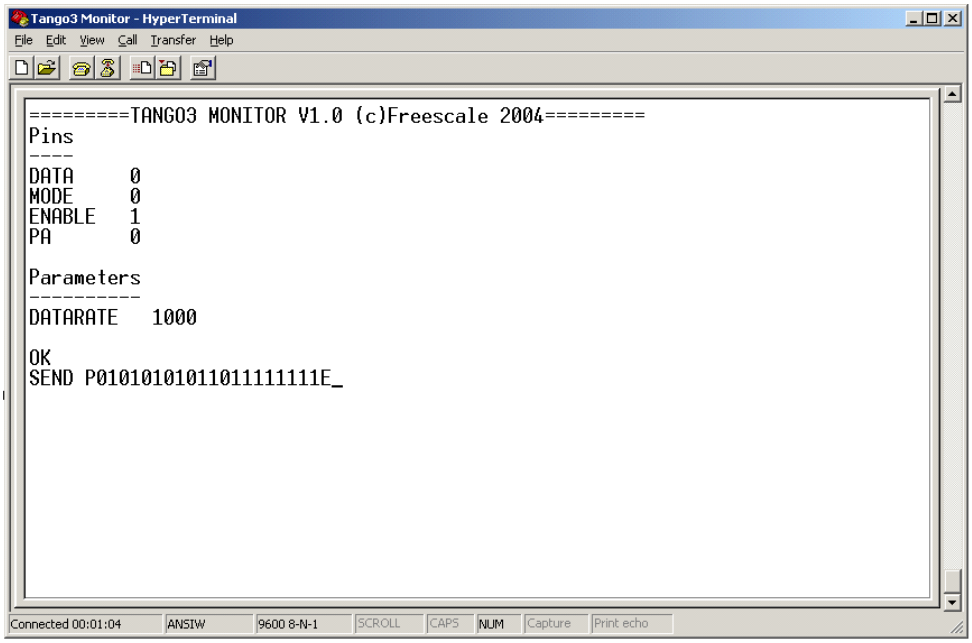

Figure 13. Transmitting Message With Header

Transmitting a Continuous Logic 1 or 0 (No Manchester Encoding)

To set Tango3 to continuously output a logic 1 signal:

1. Set DATA pin to the required level using DATA command.
2. Enable Tango3 using the command ENABLE 1 <return>.

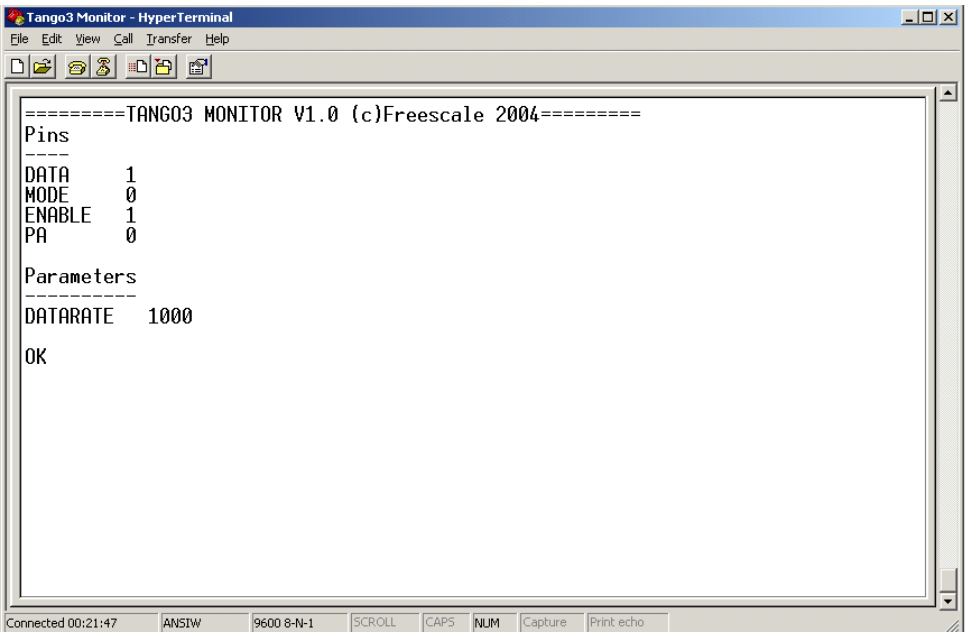

Figure 14. Transmitting a Logic 1 (No Manchester Encoding)

Troubleshooting

Monitor Resets to Initial State Randomly

If you have enabled the Tango3 module power amplifier (PA = 1) and are using long cables to provide power to the MC9S08RG60 board, the RF transmission may couple onto the power supply cables and cause problems for the MCU. You should use short power supply cables, or place ferrite filters on the power supply cables, if this problem occurs.

Tango3 Monitor Source Code

The Tango3 monitor was written using the C programming language. Full source code is supplied in file AN2777SW.zip, which can be downloaded from www.freescale.com.

Modifying Tango3 Monitor

The Tango3 monitor program has a simple structure. It has been written to allow easy porting to other MCUs. The code is liberally commented and should be easy to understand.

Decoding of commands typed into the PC terminal program is done in the SCIRx() routine. This routine is called each time the MCU receives a character from the PC keyboard. It stores characters in a buffer until a carriage return is detected. It then decodes the buffer and performs the required function for each message.

When the SEND command is used, the monitor uses the MCU's 16-bit timer to generate the Manchester encoded data on the timer channel 1 output pin.

The monitor uses the following MCU resources.

- Timer 1
- SCI 1
- FLASH
- RAM

It should be possible to port the code to another MCU by changing the register definitions and some other definitions at the beginning of the code.

References

1. MC33493 RF Transmitter IC (Tango3) data sheet
2. MC33591 RF Receiver (Romeo2) data sheet

Trademarks

How to Reach Us:

USA/Europe/Locations not listed:
Freescale Semiconductor Literature Distribution
P.O. Box 5405, Denver, Colorado 80217
1-800-521-6274 or 480-768-2130

Japan:
Freescale Semiconductor Japan Ltd.
SPS, Technical Information Center
3-20-1, Minami-Azabu
Minato-ku
Tokyo 106-8573, Japan
81-3-3440-3569

Asia/Pacific:
Freescale Semiconductor H.K. Ltd.
2 Dai King Street
Tai Po Industrial Estate
Tai Po, N.T. Hong Kong
852-26668334

Learn More:
For more information about Freescale Semiconductor products, please visit
http://www.freescale.com

AN2777
Rev. 1, 6/2005

freescale™
semiconductor