Freescale Semiconductor
Application Note

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Romeo2 Monitor for the MC68HC908GZ60 MCU

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Introduction

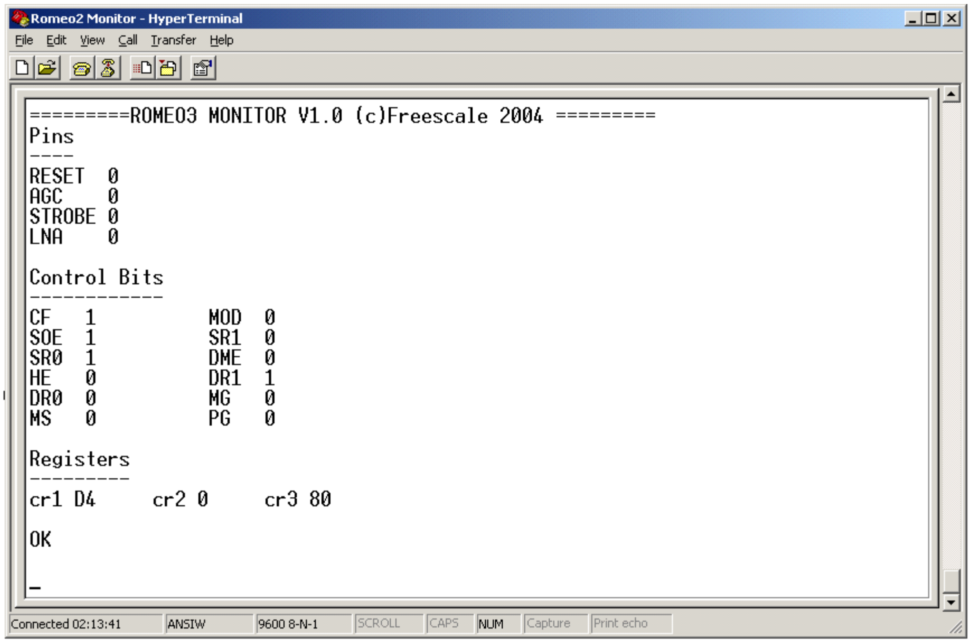
This application note describes how to use the Romeo2 Monitor program to evaluate the performance of the MC33591/2/3/4 family of RF receiver ICs (Romeo2). It shows the hardware setup required, describes how to set up the monitor, lists all available commands, and gives some examples of usage.

The reader should be familiar with the Romeo2 device data sheet and with the RF data formats described in the data sheet.

Description

The Romeo2 Monitor is a software program that runs on Freescale's MC68HC908GZ60 Demo Board. The MC68HC908GZ60 Demo Board is connected to a Romeo2 RF module and also 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.

The user can control the pins of the Romeo2 RF module by typing simple commands into the PC. The user can also configure any of Romeo2's internal registers and enable reception of messages.


Romeo2 Monitor - HyperTerminal
File Edit View Call Transfer Help
Connected 02:13:41
ANSIW
9600 8-N-1
SCROLL
CAPS
NUM
Capture
Print echo

```
=========ROMEO3 MONITOR V1.0 (c)Freescale 2004 =========
Pins
----
RESET  0
AGC    0
STROBE 0
LNA    0

Control Bits
------------
CF   1          MOD  0
SOE  1          SR1  0
SR0  1          DME  0
HE   0          DR1  1
DR0  0          MG   0
MS   0          PG   0

Registers
---------
cr1 D4     cr2 0     cr3 80

OK

_
```

Figure 1. Romeo2 Monitor Communicating with Hyperterminal

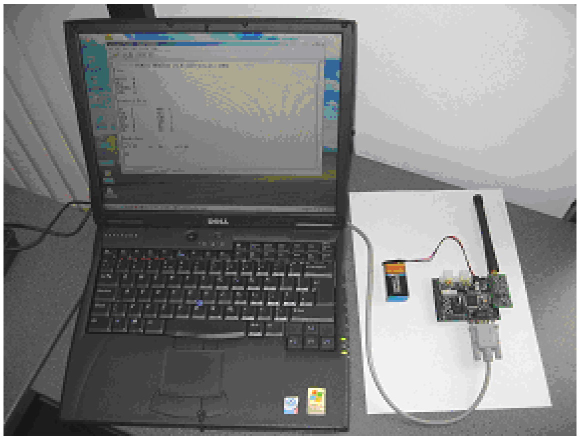


Figure 2. Romeo2 Monitor Setup

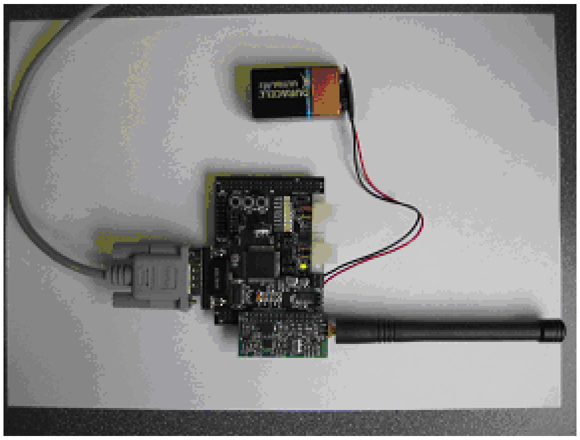


Figure 3. Close-up of MC68HC908GZ60 Demo Board and Romeo2 RF Module

Requirements

To use the software, you will need the following hardware and software.

- MC68HC908GZ60 Demo Board (part number: xxxxx)
- Romeo2 RF module (part number: xxxx)
- Metrowerks Codewarrior version 3.0 or later
- 'xxxxx.zip', which contains the software files
- A PC running Hyperterminal, or any other terminal program

Full source code for the Romeo2 monitor is available; this allows the monitor to be extended or tailored, if required.

Hardware Setup

Set up the hardware as follows.

1. Connect the Romeo2 RF Module to connector J1 on the MC68HC908GZ60 demo board. (Pin 1 on each board must be aligned.)
2. Connect an antenna to the Romeo2 RF module. (Note: Romeo2 RF modules are available in a range of frequencies; each is supplied with appropriate antenna.)
3. Install power select (PWR_SEL) jumpers 1 and 2 on the MC68HC908GZ60 demo board. (Both jumpers must be installed.)
4. Install the 2 COM_SEL jumpers on pins 1 and 2 of the COM_SEL header.
5. Remove jumper J3.

6. Connect the serial port connector on the MC68HC908GZ60 Demo Board to a PC comm port using a 9-pin straight-through serial cable.
7. Connect a 9V power supply or battery to the power connector on MC68HC908GZ60 board.

See Figure 3 for a reference setup.

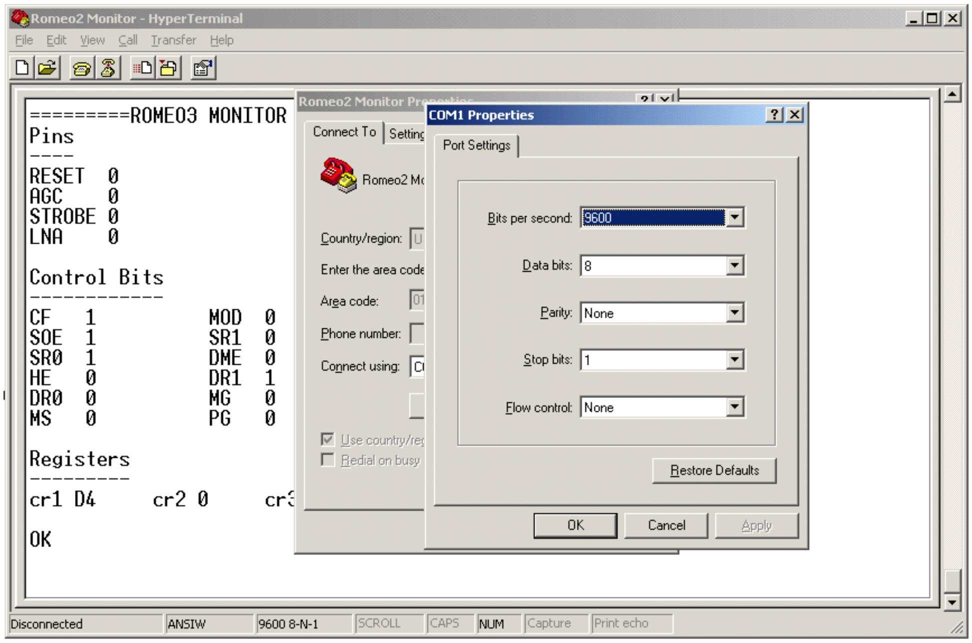
If the Romeo2 monitor program has already been programmed into the MC68HC908GZ60 demo board, you can start to use the monitor immediately (see Using the Software); otherwise, you must follow the programming procedure described below.

Programming Romeo2 Monitor into the MC68HC908GZ60 MCU

Need rev b board from Nathan to confirm. Leave some space here …..

Using the Software

To use the software, connect the MC68HC908GZ60 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, 8 data bits, no parity, 1 stop bit, no flow control. See Figure 4. A setup file (Romeo2Monitor.ht) for Hyperterminal is supplied in the software package for this Application Note and can be downloaded from wwwxxxx.yyyy.



Romeo2 Monitor - HyperTerminal

```
=========ROME03 MONITOR
Pins
----
RESET  0
AGC    0
STROBE 0
LNA    0

Control Bits
------------
CF   1          MOD  0
SOE  1          SR1  0
SR0  1          DME  0
HE   0          DR1  1
DR0  0          MG   0
MS   0          PG   0

Registers
---------
cr1 D4      cr2 0      cr3

OK
```

COM1 Properties — Port Settings

- Bits per second: 9600
- Data bits: 8
- Parity: None
- Stop bits: 1
- Flow control: None

Figure 4. Terminal Program Configuration

To start the monitor:

1. Configure the terminal program for 9600 baud, 8 data bits, no parity, 1 stop bit, no flow control (if using Hyperterminal, use the Romeo2Monitor.ht setup file)
2. Connect the MC68HC908GZ60 demo board to the PC comm port using the 9-pin D connector.
3. Start the terminal program (in Hyperterminal, click the 'Connect' icon on the toolbar at the top of screen)
4. Connect power to the MC68HC908GZ60 demo board.

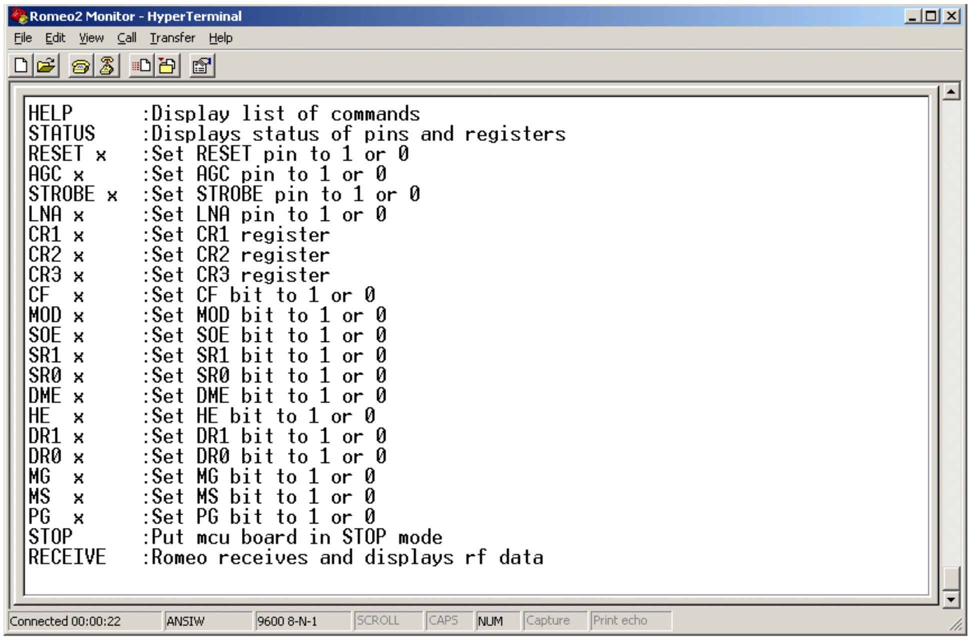
You should now see the screen shown in Figure 1. If not, press the Reset switch on the MC68HC908GZ60 demo board.

This screen shows the state of various pins that connect between the Romeo2 RF module and the MC68HC908GZ60 demo board. It also displays the contents of Romeo2's internal registers and displays the state of each bit in these registers.

NOTE

Each Romeo2 RF module is hard-wired to a specific carrier frequency — 315 MHz, 434 MHz, 838 MHz, or 915 MHz. Ensure that you program the CF bit in register CR1 to the correct value for your RF module.

The user can type commands in the terminal program window. Type HELP <return> for a complete list of commands, as shown in Figure 5.


Romeo2 Monitor - HyperTerminal
File Edit View Call Transfer Help
Connected 00:00:22
ANSIW
9600 8-N-1
SCROLL
CAPS
NUM
Capture
Print echo

```
HELP       :Display list of commands
STATUS     :Displays status of pins and registers
RESET x    :Set RESET pin to 1 or 0
AGC x      :Set AGC pin to 1 or 0
STROBE x   :Set STROBE pin to 1 or 0
LNA x      :Set LNA pin to 1 or 0
CR1 x      :Set CR1 register
CR2 x      :Set CR2 register
CR3 x      :Set CR3 register
CF  x      :Set CF bit to 1 or 0
MOD x      :Set MOD bit to 1 or 0
SOE x      :Set SOE bit to 1 or 0
SR1 x      :Set SR1 bit to 1 or 0
SR0 x      :Set SR0 bit to 1 or 0
DME x      :Set DME bit to 1 or 0
HE  x      :Set HE bit to 1 or 0
DR1 x      :Set DR1 bit to 1 or 0
DR0 x      :Set DR0 bit to 1 or 0
MG  x      :Set MG bit to 1 or 0
MS  x      :Set MS bit to 1 or 0
PG  x      :Set PG bit to 1 or 0
STOP       :Put mcu board in STOP mode
RECEIVE    :Romeo receives and displays rf data
```

Figure 5. Command List

Command List

Below is a list of the commands supported by the Romeo2 monitor.

HELP

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

STATUS

Description: Displays current values of Romeo2 RF module pins and internal register values

RESET

Description: RESET allows the user to set the level of the RESET pin on Romeo2 . The pins can be set to logic 1 or logic 0

RESET 1 <return> — Set Reset pin to logic 1

RESET 0 <return> — Set Reset pin to logic 0

AGC

Description: AGC allows the user to set the level of the Automatic Gain Control (AGC) pin on Romeo2 . The pins can be set to logic 1 or logic 0

AGC 1 <return> — Set AGC pin to logic 1

AGC 0 <return> — Set AGC pin to logic 0

STROBE

Description: STROBE allows the user to set the level of the STROBE oscillator pin on Romeo2 . The pins can be set to logic 1 or logic 0.

STROBE 1 <return> — Set STROBE pin to logic 1

STROBE 0 <return> — Set STROBE pin to logic 0

LNA

Description: LNA allows the user to set the level of the Low Noise Amplifier LNA pin on Romeo2 . The pins can be set to logic 1 or logic 0

LNA 1 <return> — Set LNA pin to logic 1

LNA 0 <return> — Set LNA pin to logic 0

CR1

Description: CR1 allows the user to set the value of the CR1 register on Romeo2 . The register can have any value in range 0x00 - 0xff.

CR1 value <return>

CR2

Description: CR2 allows the user to set the value of the CR2 register on Romeo2 . The register can have any value in range 0x00 - 0xff. CR2 holds the ID value for Romeo2.

CR2 value <return>

CR3

Description: CR3 allows the user to set the value of the CR3 register on Romeo2 . The register can have any value in range 0x00 - 0xff.

CR3 value <return>

CF

Description: CF allows the user to set the value of the Carrier Frequency (CR) bit in register CR1 on Romeo2 . The bit can be set to logic 1 or logic 0.

CF 1 <return> — Set CF bit to logic 1

CF 0 <return> — Set CF bit to logic 0

MOD

Description: MOD allows the user to set the value of the Modulation type (MOD) bit in register CR1 on Romeo2 . The bit can be set to logic 1 or logic 0.

MOD 1 <return> — Set MOD bit to logic 1

MOD 0 <return> — Set MOD bit to logic 0

SOE

Description: SOE allows the user to set the value of the Strobe Oscillator Enable (SOE) bit in register CR1 on Romeo2 . The bit can be set to logic 1 or logic 0.

SOE 1 <return> — Set SOE bit to logic 1

SOE 0 <return> — Set SOE bit to logic 0

SR1

Description: SR1 allows the user to set the value of the Strobe Ratio 1 (SR1) bit in register CR1 on Romeo2 . The bit can be set to logic 1 or logic 0.

SR1 1 <return> — Set SR1 bit to logic 1

SR1 0 <return> — Set SR1 bit to logic 0

SR0

Description: SR0 allows the user to set the value of the Strobe Ratio 0 (SR0) bit in register CR1 on Romeo2 . The bit can be set to logic 1 or logic 0.

SR0 1 <return> — Set SR0 bit to logic 1

SR0 0 <return> — Set SR0 bit to logic 0

DME

Description: DME allows the user to set the value of the DATA Manager Enable (DME) bit in register CR1 on Romeo2 . The bit can be set to logic 1 or logic 0.

DME 1 <return> — Set DME bit to logic 1

DME 0 <return> — Set DME bit to logic 0

HE

Description: HE allows the user to set the value of the Header Enable (HE) bit in register CR1 on Romeo2 . The bit can be set to logic 1 or logic 0.

HE 1 <return> — Set HE bit to logic 1

HE 0 <return> — Set HE bit to logic 0

DR1

Description: DR1 allows the user to set the value of the Data Rate 1 (DR1) bit in register CR3 on Romeo2 . The bit can be set to logic 1 or logic 0.

DR1 1 <return> — Set DR1 bit to logic 1

DR1 0 <return> — Set DR1 bit to logic 0

DR0

Description: DR0 allows the user to set the value of the Data Rate 0 (DR0) bit in register CR3 on Romeo2. The bit can be set to logic 1 or logic 0.

DR0 1 <return> — Set DR0 bit to logic 1

DR0 0 <return> — Set DR0 bit to logic 0

MG

Description: MG allows the user to set the value of the Mixer gain (MG) bit in register CR3 on Romeo2 . The bit can be set to logic 1 or logic 0.

MG 1 <return> — Set MG bit to logic 1

MG 0 <return> — Set MG bit to logic 0

MS

Description: MS allows the user to set the value of the Mixout pin select (MS) bit in register CR3 on Romeo2 . The bit can be set to logic 1 or logic 0.

MS 1 <return> — Set MS bit to logic 1

MS 0 <return> — Set MS bit to logic 0

PG

Description: PG allows the user to set the value of the Phase Comparator Gain (PG) bit in register CR3 on Romeo2 . The bit can be set to logic 1 or logic 0.

PG 1 <return> — Set PG bit to logic 1

PG 0 <return> — Set PG bit to logic 0

STOP

Description: STOP puts the MC68HC908GZ60 MCU into its low power STOP mode. This allows the user to make current measurements of the system. To restart the MCU, press the Reset button on the MC68HC908GZ60 demo board.

RECEIVE

Description: RECEIVE configures the system to receive and display RF messages. The RESET pin on the Romeo2 RF module is set to logic 1. If Romeo2 receives RF data using any of the data format listed in the Romeo2 data sheet, these will be passed to the MC68HC908GZ60 via Romeo2's SPI interface.

The GZ60 will pass these messages to the terminal program via its serial port. Examples of the RECEIVE command usage are given in the following sections.

RF Message Formats

The Romeo2 monitor allows the user to receive messages using the data formats defined in the Romeo2 data sheet. There are 2 basic formats - messages with a header field and messages without a header field. Figure 6 shows some basic messages following these formats

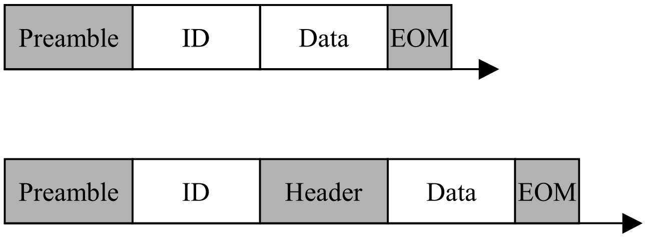


Figure 6. Basic Message Formats

The various fields in the messages are described below.

Preamble — The preamble is a fixed format field that allows Romeo2 to detect the start of a message. The Tango3 monitor can transmit Preambles with the correct format using the 'P' field.

ID — Each Romeo2 device can be assigned an 8 bit ID number. It will only receive messages with this particular ID. This allows each Romeo2 device in an RF network to have a unique ID.

The Romeo2 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 Romeo2 documentation for more details.

Header — The header field is a 4-bit fixed format field. It notifies Romeo2 that message data is next. The field has values '0110' or '1001'.

The Romeo2 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 Romeo2 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 7 shows the data sequence '11001' using Manchester encoding.

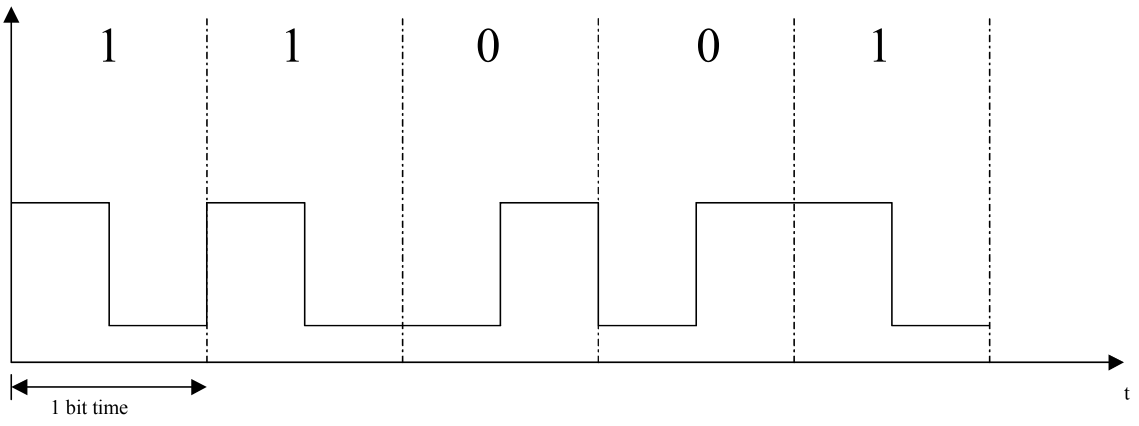


Figure 7. Manchester Encoding of Data

Examples

Receiving an OOK Message Without Header

Below is an example of receiving an OOK modulated message without a header. The message ID is 0x2a. The data rate is 2400 bits per second, carrier frequency 434 MHz.

To configure system to receive an OOK data frame with ID 0x2a at 434 Mhz, no header:

1. Set CR1 register to value 0xDA using command CR1 DA <return>.

This configures the following bits.

- CF = 1 (434 MHz carrier frequency)
- MOD = 0 (OOK modulation)
- SOE = 1 (strobe oscillator enabled)
- SR0/1 = 10 (strobe osc ration - value not important)
- DME = 1 (Data Manager Enabled)
- HE = 0 (No header in message)

2. Set CR2 (ID register) to 0x2a using command CR2 2a <return>
3. Set CR3 register to value 0x48 using command CR3 48 <return>

This configures the following bits.

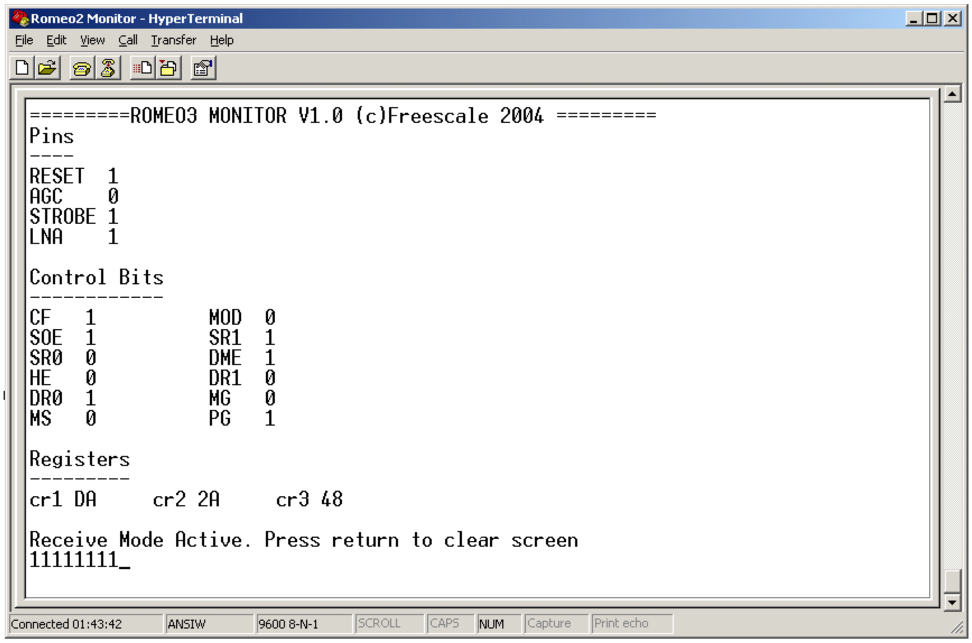
- DR1/0 = 01 (2 -2.7kBd data rate range)
- MG = 0 (normal mixer gain)
- MS = 0 (mixout pin set to mixer output)
- PG = 1 (phase comparator gain = low gain mode)

4. Set LNA pin to logic 1 using command LNA 1 <return>
5. Set STROBE pin to logic 1 using command STROBE 1 <return>
6. Enable reception of messages using command RECEIVE. This sets the RESET pin to logic 1 and the Romeo2 monitor will display any received data

Figure 8 shows the above setup after reception of a message containing 1 byte of data with value 0xff (11111111 binary)

NOTE

When receiving messages where the number of sdata bits is an exact multiple of 8, Romeo2 may add an extra byte to the end of the message.


Romeo2 Monitor - HyperTerminal
File Edit View Call Transfer Help
Connected 01:43:42
ANSIW
9600 8-N-1
SCROLL
CAPS
NUM
Capture
Print echo

```
=========ROMEO3 MONITOR V1.0 (c)Freescale 2004 =========
Pins
----
RESET  1
AGC    0
STROBE 1
LNA    1

Control Bits
------------
CF   1          MOD  0
SOE  1          SR1  1
SR0  0          DME  1
HE   0          DR1  0
DR0  1          MG   0
MS   0          PG   1

Registers
---------
cr1 DA     cr2 2A     cr3 48

Receive Mode Active. Press return to clear screen
11111111_
```

Figure 8. Receiving OOK Message Without Header

Receiving an FSK message Without Header

Below shows an example of receiving an FSK modulated message. The message ID is 0xA5. The data rate is 1000 bits per second, carrier frequency 434 MHz

1. Set CR1 register to value 0xFA using command CR1 FA <return>

This configures the following bits.

- CF = 1 (434 MHz carrier frequency)
- MOD = 1 (FSK modulation)
- SOE = 1 (strobe oscillator enabled)
- SR0/1 = 10 (strobe osc ration - value not important)
- DME = 1 (Data Manager Enabled)
- HE = 0 (No header in message)

2. Set CR2 (ID register) to 0xa5 using command CR2 a5 <return>
3. Set CR3 register to value 0x48 using command CR3 48 <return>

This configures the following bits.

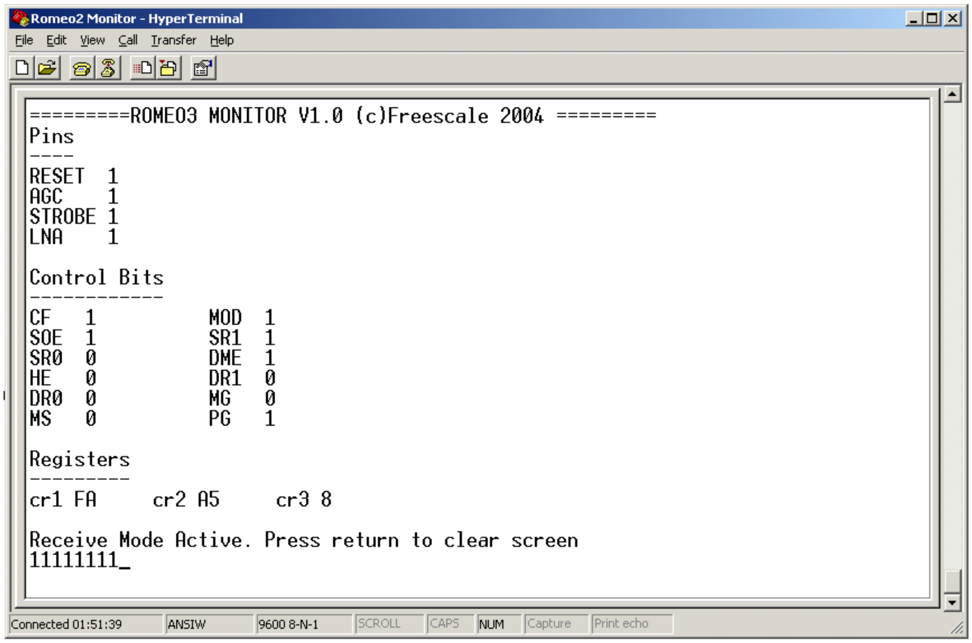
- DR1/0 = 00 (1 -1.4kBd data rate range)
- MG = 0 (normal mixer gain)
- MS = 0 (mixout pin set to mixer output)
- PG = 1 (phase comparator gain = low gain mode)

4. Set LNA pin to logic 1 using command LNA 1 <return>
5. Set STROBE pin to logic 1 using command STROBE 1 <return>
6. Set AGC pin to logic 1 using command AGC 1 <return>
7. Enable reception of messages using command RECEIVE. This sets the RESET pin to logic 1 and the Romeo2 monitor will display any received data

Figure 9 shows the above setup after reception of a message containing one byte of data with value 0xff (11111111 binary).

NOTE

When receiving messages where the number of sdata bits is an exact multiple of 8, Romeo2 may add an extra byte to the end of the message.


Romeo2 Monitor - HyperTerminal
File Edit View Call Transfer Help
Connected 01:51:39
ANSIW
9600 8-N-1
SCROLL
CAPS
NUM
Capture
Print echo

```
=========ROMEO3 MONITOR V1.0 (c)Freescale 2004 =========
Pins
----
RESET  1
AGC    1
STROBE 1
LNA    1

Control Bits
------------
CF   1          MOD  1
SOE  1          SR1  1
SR0  0          DME  1
HE   0          DR1  0
DR0  0          MG   0
MS   0          PG   1

Registers
---------
cr1 FA     cr2 A5     cr3 8

Receive Mode Active. Press return to clear screen
11111111_
```

Figure 9. Receiving FSK Message Without Header

Receiving Messages With Header Field

To receive a message with an ID of 0x55 (01010101 binary) with a header field (0110 binary) at data rate of 1000 bps, OOK modulation, 434 MHz carrier frequency:

1. Set CR1 register to value 0xDB using command CR1 DB <return>

This configures the following bits.

- CF = 1 (434 MHz carrier frequency)
- MOD = 0 (OOK modulation)
- SOE = 1 (strobe oscillator enabled)
- SR0/1 = 10 (strobe osc ration - value not important)
- DME = 1 (Data Manager Enabled)
- HE = 1 (Header enabled)

2. Set CR2 (ID register) to 0x55 using command CR2 55 <return>
3. Set CR3 register to value 0x08 using command CR3 08 <return>

This configures the following bits.

- DR1/0 = 00 (2 -2.7kBd data rate range)
- MG = 0 (normal mixer gain)

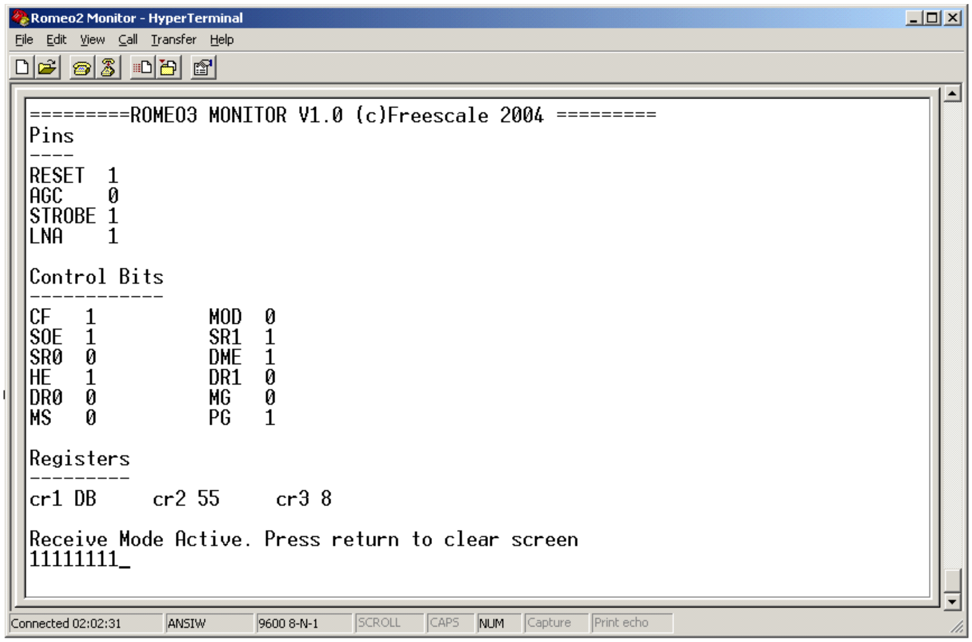
- MS = 0 (mixout pin set to mixer output)
- PG = 1 (phase comparator gain = low gain mode)

4. Set LNA pin to logic 1 using command LNA 1 <return>
5. Set STROBE pin to logic 1 using command STROBE 1 <return>
6. Enable reception of messages using command RECEIVE. This sets the RESET pin to logic 1 and the Romeo2 monitor will display any received data.

Figure 10 shows the above setup after reception of a message containing one byte of data with value 0xff (11111111 binary).

NOTE

When receiving messages where the number of data bits is an exact multiple of 8, Romeo2 may add an extra byte to the end of the message.


Romeo2 Monitor - HyperTerminal
File Edit View Call Transfer Help
Connected 02:02:31
ANSIW
9600 8-N-1
SCROLL
CAPS
NUM
Capture
Print echo

```
=========ROMEO3 MONITOR V1.0 (c)Freescale 2004 =========
Pins
----
RESET  1
AGC    0
STROBE 1
LNA    1

Control Bits
------------
CF   1          MOD  0
SOE  1          SR1  1
SR0  0          DME  1
HE   1          DR1  0
DR0  0          MG   0
MS   0          PG   1

Registers
---------
cr1 DB     cr2 55     cr3 8

Receive Mode Active. Press return to clear screen
11111111_
```

Figure 10. Receiving Message With Header FIeld

Receiving Data Without Manchester Encoding

The Romeo2 monitor can be used to configure Romeo2 to receive RF data not encoded using Manchester encoding. To do this, Romeo2's Data Manager should be disabled (set DME bit to logic 0) However, this data will not be displayed correctly on the terminal screen. The user should use an oscilloscope on Romeo2's MOSI pin to monitor the data.

For example, to receive data in different encoding formats at 434 Mhz, OOK modulation:

1. Set CR1 register to value 0xD8 using command CR1 DA <return>.

This configures the following bits.

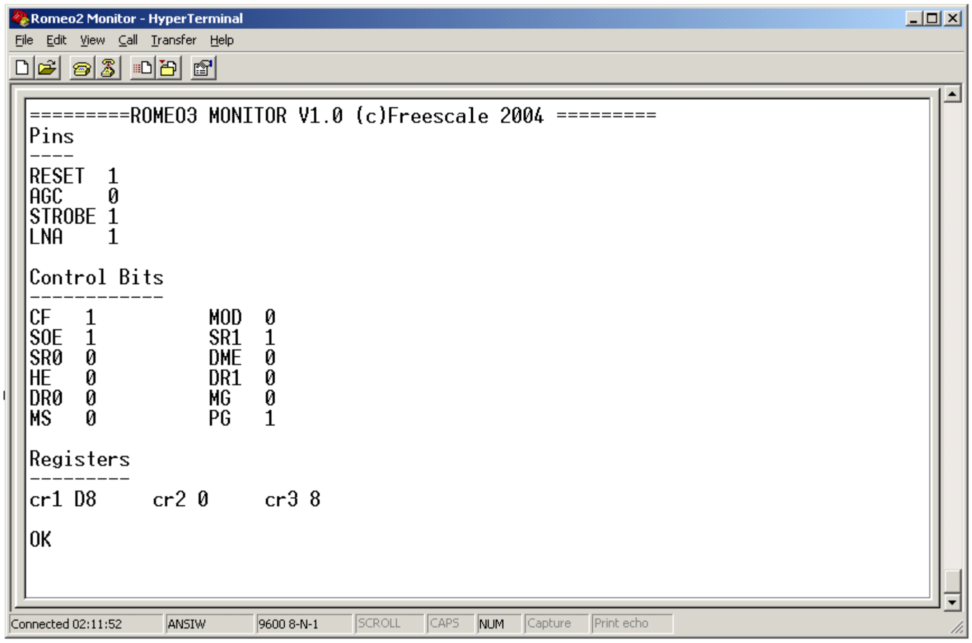
- CF = 1 (434 MHz carrier frequency)
- MOD = 0 (OOK modulation)
- SOE = 1 (strobe oscillator enabled)
- SR0/1 = 10 (strobe osc ration - value not important)
- DME = 0 (Data Manager Enabled)
- HE = 0 (No header in message)

2. Set CR3 register to value 0x48 using command CR3 48 <return>

This configures the following bits

- DR1/0 = 01 (2 to 2.7 kBd data rate range)
- MG = 0 (normal mixer gain)
- MS = 0 (mixout pin set to mixer output)
- PG = 1 (phase comparator gain = low gain mode)

3. Set LNA pin to logic 1 using command LNA 1 <return>
4. Set STROBE pin to logic 1 using command STROBE 1 <return>
5. Set RESET pin to logic 1 using command RESET 1 <return>


Romeo2 Monitor - HyperTerminal
File Edit View Call Transfer Help
Connected 02:11:52
ANSIW
9600 8-N-1
SCROLL
CAPS
NUM
Capture
Print echo

```
=========ROMEO3 MONITOR V1.0 (c)Freescale 2004 =========
Pins
----
RESET  1
AGC    0
STROBE 1
LNA    1

Control Bits
------------
CF   1          MOD  0
SOE  1          SR1  1
SR0  0          DME  0
HE   0          DR1  0
DR0  0          MG   0
MS   0          PG   1

Registers
---------
cr1 D8     cr2 0     cr3 8

OK
```

Figure 11. Receiving Data Without Manchester Encoding

Romeo2 Monitor Source Code

The Romeo2 monitor was written using the C programming language. Full source code is supplied in file xxxxx.zip which can be downloaded from www.xxxxx.

Modifying Romeo2 Monitor

The Romeo2 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 configuring the internal registers on Romeo2, the monitor uses the MCU's SPI peripheral. It also uses the SPI when the RECEIVE command is used to receive data from Romeo2.

The monitor uses the following MCU resources.

- SPI 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 start of the code.