

Introduction

The Holt HI-6140BC Application Development Kit demonstrates the broad featureset of Holt’s Enhanced Bit Rate (EBR), MIL-STD-1553B protocol device; the HI-6140. The HI-6140 is combined with a Complex Programmable Logic Device(CPLD)Logical Hub and HI-4853 RS485 transceivers, to produce a complete 10Mbps Bus Controller. The board can be used to develop MMSI systems complying withSAE specification AS5652, this specification uses standard MIL-STD-1553B protocol and Manchester coding, but has an enhanced bit rate of 10Mbps RS485 bus interface. All three ‘Logical Hub’ modes: SWITCH, LINK and SPEC are supported.

Each kit containstwo boards, a lower microcontroller board and the upper HI-6140 with a BC Logical Hub; see picture below.

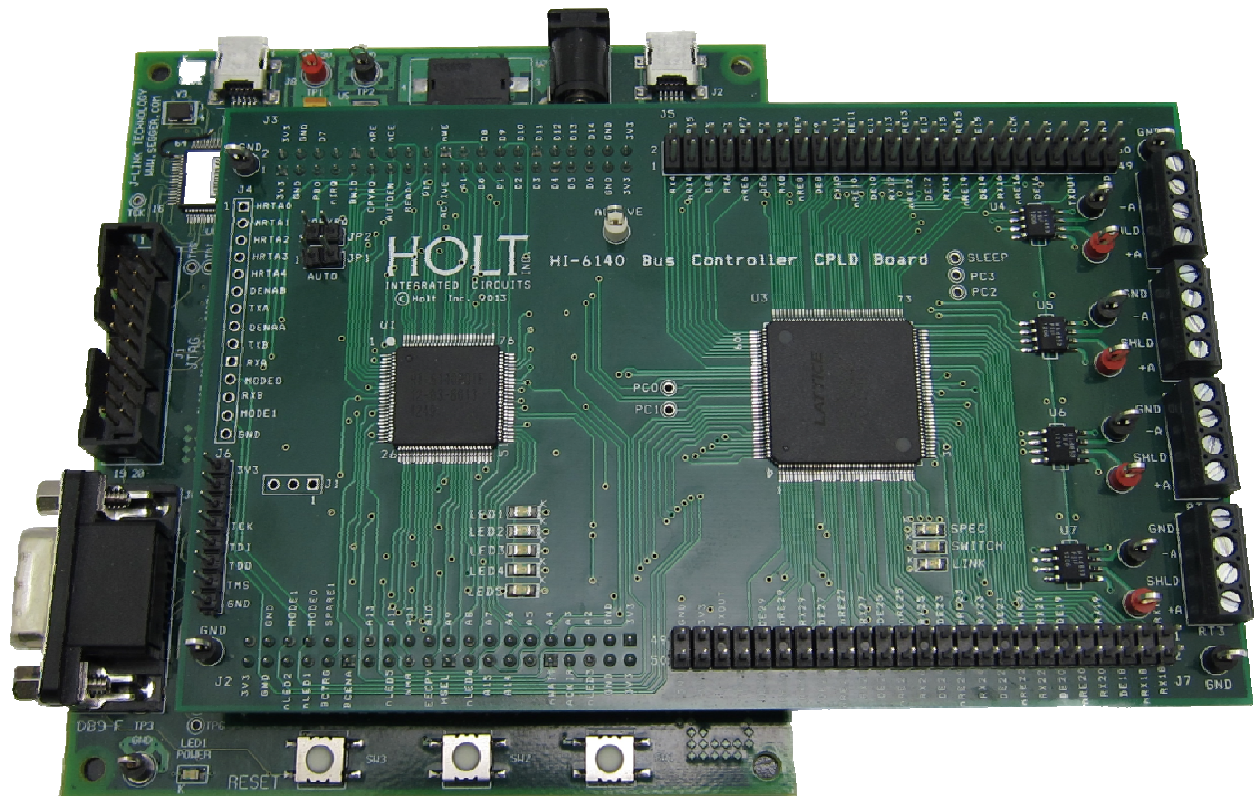


Figure 1 – HI-6140 board assembled on microcontroller board

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This development kit is solely for Bus Controller development, if a Remote Terminal evaluation kit is required; please order the separate HI-6140 RT evaluation kit.

A C language reference project is provided that is ready-to-run on the ARM Cortex M3 evaluation platform, demonstrating concurrent operation for a Bus Controller only. It supports the three 'Logical Hub' modes: SWITCH, LINK and SPEC. For demonstration purposes, only four RS485 ports of a possible 31 RS485 interfaces are provided, however the control signals can be output from the CPLD for all 31 RT ports. For convenience, this kit includes IAR Systems Embedded Workbench® for ARM, and a fully integrated debug interface for the ARM Cortex M3 microcontroller.

This guide describes how to set up and run the board. Additional support material and all required project software are found in the included Holt CD-ROM. A version of the demonstration software is already programmed into the microcontroller flash; the board is operational right out of the box without installing or running the provided software development tools.

EvaluationKit Contents

- This User Guide.
- Holt HI-6140 Project Software and Documentation CD.
- Installation CD for IAR Systems Embedded Workbench® for ARM (32KB KickStart.).
- Plug-in DC power supply.
- USB debug interface cable.
- RS-232 serial cable, DB-9M to DB-9F for console I/O using a connected computer.
- 2-board assembly comprised of
 - Upper HI-6140 and logical hub board with four RS485 hub-RT links.
 - Lower MCU board with ARM Cortex M3 16-/32-bit microprocessor, debug interface and regulated 3.3VDC power supply.

Hardware Design Overview

Refer to the CD for separate schematic diagrams and bills of material for the upper and lower circuit boards.

The HI-6140 board can be separated from the provided MCU board for connection to a user-supplied alternate microprocessor or FPGA board. The inter-board headers are located on 0.1" (2.54 mm) grid for compatibility with generic prototyping boards. All host interface signals go through the inter-board headers.

The lower ARM Cortex M3 board is based on the flash-programmable Atmel AT91SAM3U-EK microprocessor. A UART-based serial port provides RS-232 console I/O (optional). An uncommitted USB 2.0 port is available for future

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expansion. Two pushbuttons are available for software interaction. A RESET pushbutton resets the ARM microprocessor, which in turn controls the HI-6140 Master Reset signal.

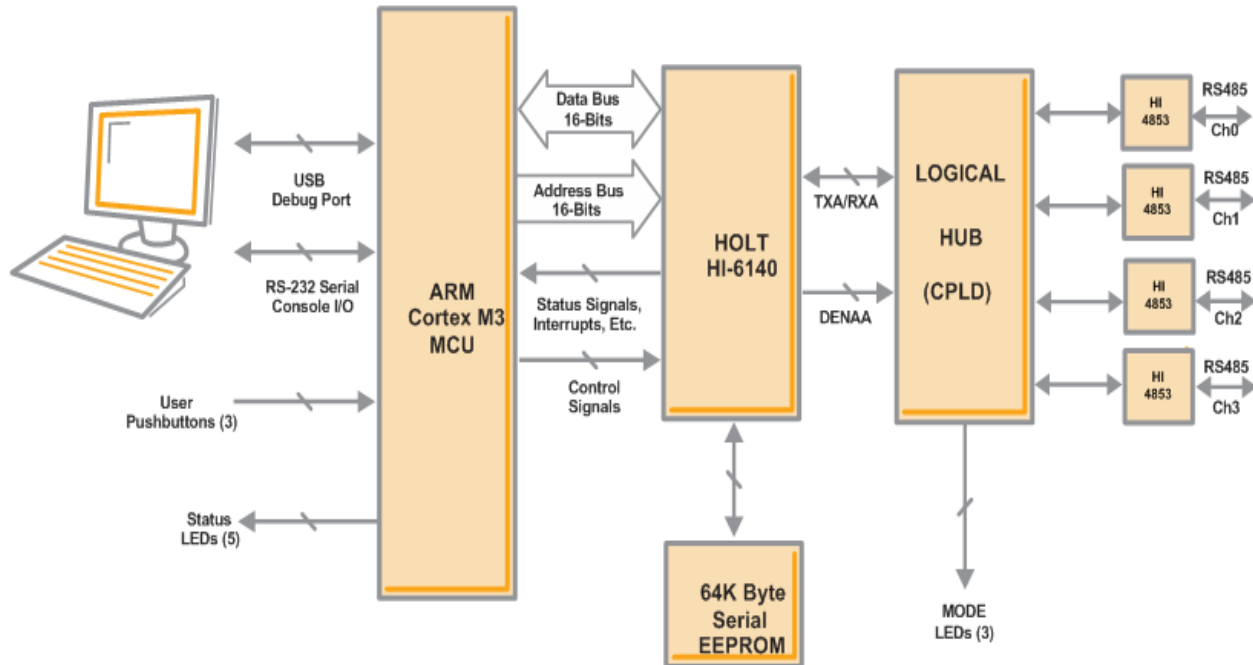


Figure 2 - Evaluation Board Block Diagram

The ARM Cortex M3 board includes “J-Link On Board” debug interface, licensed from www.segger.com, providing out-of-box readiness without having to buy a costly JTAG debug cable. The kit includes a simple USB cable for connecting the board’s debug interface to your computer. (For users already owning an ARM debug interface with ribbon-cable connector, an ARM-standard 2x10 debug connector provides debug connectivity. In this case, jumper JP2 on the bottom of the lower board should be soldered closed to disable “J-Link On Board”).

As shown in figure 2, the upper board contains an HI-6140 with a logical hub and four RS485 transceivers. The logical hub operation changes depending on which EBR mode is selected. In SWITCH and LINK mode the hub switches the TXA signal from the HI-6140 to the addressed RT only (the other RTs do not receive a signal). This is true of all addresses except address 31; this ‘broadcast’ mode is transmitted to all RTs in the system. The 3 HUB modes are selected by pressing SW2, on the lower board, an LED is illuminated to indicate if SPEC, SWITCH or LINK mode has been selected.

In SPEC mode the hub data steering capability is not used, instead the data is transmitted to all RTs in the system, only the RT being addressed will respond. An EBR register setting of 0x00 is used, this is the setting the board powers up in. Data is passed to the RS485 transceivers for transmission over 120 ohm screen twisted pairs at 10Mbps.

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In SWITCH and LINK modes the data is steered by the logical hub to the correct RT using the HRTA pins on the HI-6140, the only difference between these two modes is that LINK mode always contains RT address '0' embedded in the message whatever RT is addressed; the only exception is broadcast mode (address 31).

For system testing, a remote terminal card (RT) is required. A HOLT HI-6140 RT evaluation card (not included) can be used for this purpose.

The figure below shows the top level view of the board.

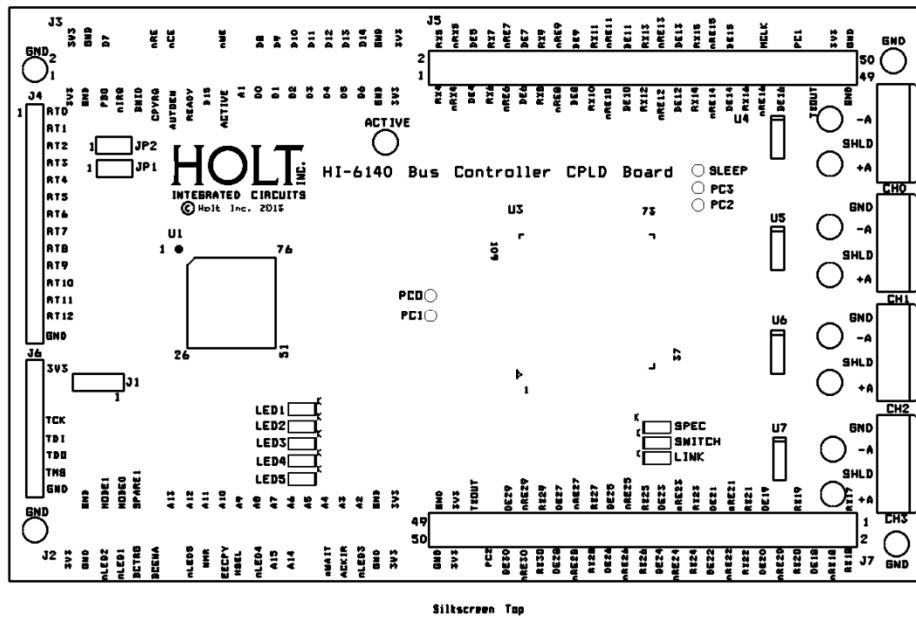


Figure 3 - Evaluation Board Top Level View

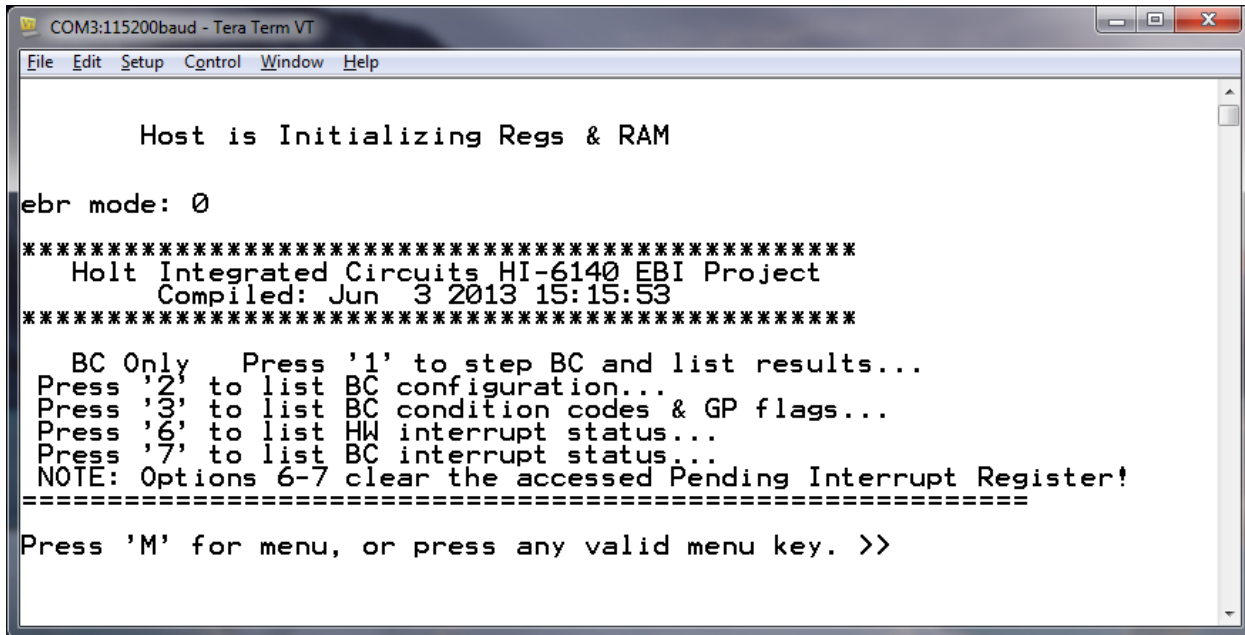
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Demonstration using the preprogrammed instructions

The Holt HI-6140BC Card pre-programmed to operate as a Bus Controller. By default the board is set to operate in SPEC mode, to change modes to SWITCH or LINK press SW2 until the correct LED illuminates.

Assuming the board is in the default SPEC mode; follow the instructions below to generate data commands on the RS485 I/O. SPEC mode transmits on all the available hub-RT links.

1. Using the provided DB-9 serial cable, connect the MCU board to the serial port on the Windows computer; if there is no serial port then use a USB-Serial dongle. Plug-in the provided 5V DC power supply and connect the cable to the power input jack on the lower circuit board.
2. The preprogrammed demonstration provides console I/O between the MCU board serial port and a Windows computer running a terminal emulation program. If using Vista or Windows 7, install TeraTerm (see page 5) and run it. If using XP or Windows 2000, you may instead open HyperTerminal from the Windows "Accessories" program group, although TeraTerm is recommended. Configure the TeraTerm program for serial port (not TCP I/P), 115,200 baud, no parity, 8 data bits, 1 stop bit, flow control off. If configured correctly, a text header appears when power is applied, or when the RESET pushbutton is pressed, as shown below:



```
COM3:115200baud - Tera Term VT
File Edit Setup Control Window Help

Host is Initializing Regs & RAM

ebr mode: 0

*****
Holt Integrated Circuits HI-6140 EBI Project
Compiled: Jun 3 2013 15:15:53
*****

BC Only Press '1' to step BC and list results...
Press '2' to list BC configuration...
Press '3' to list BC condition codes & GP flags...
Press '6' to list HW interrupt status...
Press '7' to list BC interrupt status...
NOTE: Options 6-7 clear the accessed Pending Interrupt Register!
=====
Press 'M' for menu, or press any valid menu key. >>
```

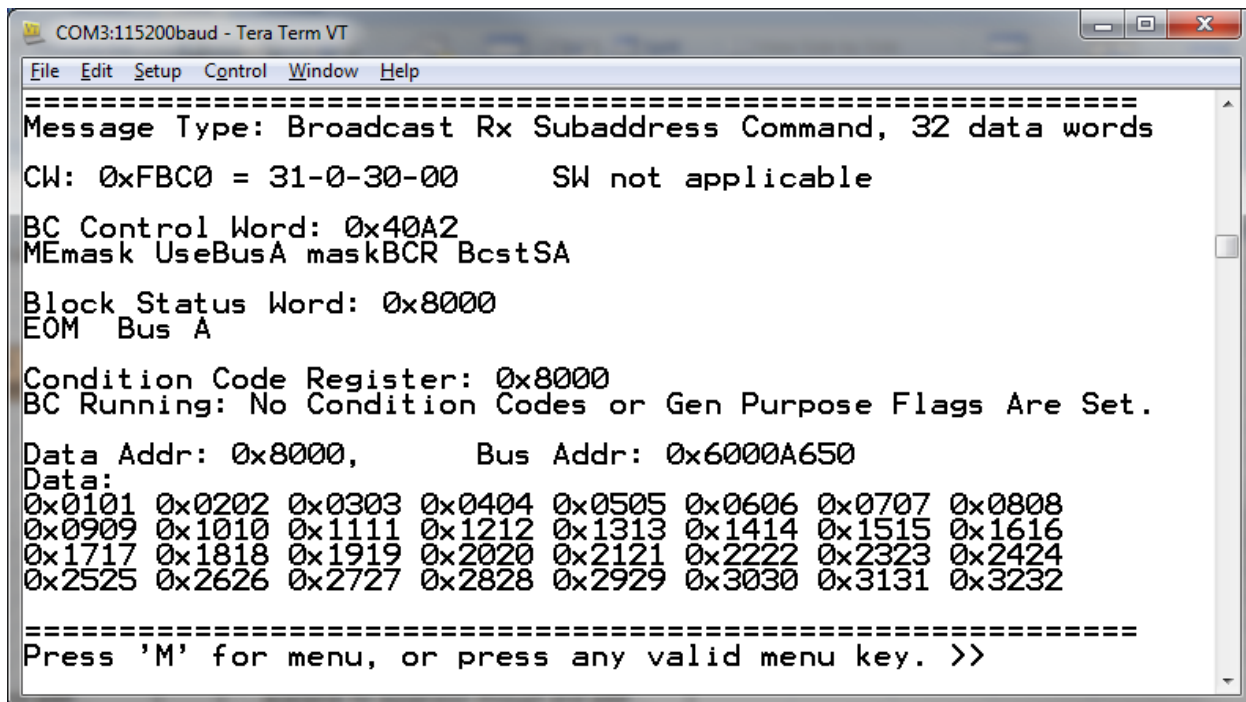
3. Note in the top left the 'EBR' mode' is listed as 0. This shows the contents of the HI-6140 EBR register (0x004D) EBR bits. The EBR bits setting can be changed by pressing SW2 on the ARM board, it then toggles through the three options available:
 - a. EBR = 0 This the default 'SPEC' mode

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- b. EBR = 0x08 This is the setting for SWITCH mode
- c. EBR = 0x18 This is the setting for LINK mode

Note that the LEDs on the board indicate which mode is selected.

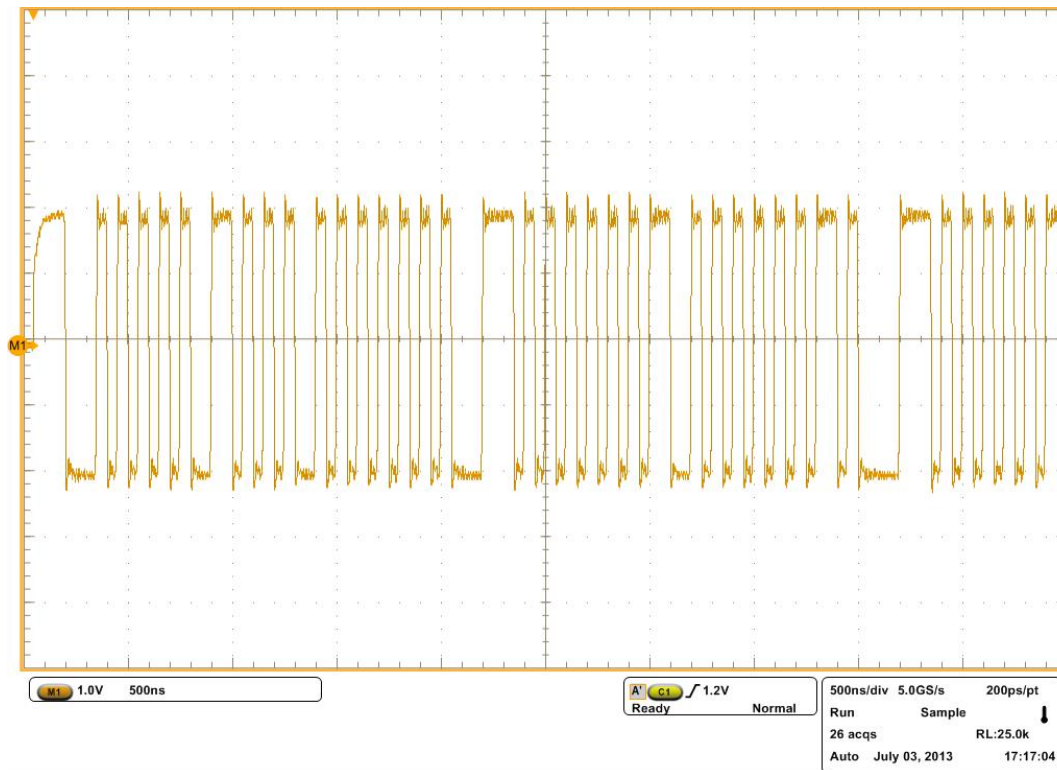
4. The Bus Controller is programmed with a set of Messages, listed in table below. Each bus command is preceded by a BC "Wait for Trigger" op code. The MCU is preprogrammed to issue a trigger pulse to the BC each time the numeric "1" key is pressed on the computer keyboard. The messages can also be sequenced by pressing the SW1 button on the MCU board. Below shows the first message as displayed on the terminal.



```
COM3:115200baud - Tera Term VT
File Edit Setup Control Window Help
=====
Message Type: Broadcast Rx Subaddress Command, 32 data words
CW: 0xFBC0 = 31-0-30-00      SW not applicable
BC Control Word: 0x40A2
MEMask UseBusA maskBCR BcstSA
Block Status Word: 0x8000
EOM Bus A
Condition Code Register: 0x8000
BC Running: No Condition Codes or Gen Purpose Flags Are Set.
Data Addr: 0x8000,      Bus Addr: 0x6000A650
Data:
0x0101 0x0202 0x0303 0x0404 0x0505 0x0606 0x0707 0x0808
0x0909 0x1010 0x1111 0x1212 0x1313 0x1414 0x1515 0x1616
0x1717 0x1818 0x1919 0x2020 0x2121 0x2222 0x2323 0x2424
0x2525 0x2626 0x2727 0x2828 0x2929 0x3030 0x3131 0x3232
=====
Press 'M' for menu, or press any valid menu key. >>
```

5. To observe bus activity, connect an oscilloscope to the Ch0, red test point +A. The test point labeled ACTIVE goes high when the HI-6140 is processing a message; this can be used as a convenient trigger point for the oscilloscope. A waveform similar to the one below, showing the initial part of message 1 (a broadcast command), should be observed.

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6. For a system test, at least one RT should be connected to the BC card. Connect a screen twisted pair cable from the BC terminals to the RT terminals, for short range testing, clip on leads will suffice, however check that both sides of the cable are equal lengths.
7. A list of the demonstration messages contained in the software is shown in the table below. Message1 is a broadcast command and it sends data to all the RTs in the system. This data is stored for loopback (called data wrap around) from subaddress 30. Messages 2-5 are mode code 2 commands, requesting status for each of the four RT's. Messages 6-9 loopback the data sent to all RT's in message 1, again each RT is individually polled.

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Message #	Type	RT Address	Sub Addr	Data Words	Comment
1	Rx	31	30	32	Broadcasts 0101-3232 pattern to all RTs.
2	Tx	0	31	0	Mode code 2 command: Txstatus
3	Tx	1	31	0	Mode code 2 command:Tx status
4	Tx	2	31	0	Mode code 2 command: Tx status
5	Tx	3	31	0	Mode code 2 command : Tx status
6	Tx	0	30	32	Data wrap around (loopback) from subaddress 30
7	Tx	1	30	32	Data wrap around (loopback) from subaddress 30
8	Tx	2	30	32	Data wrap around (loopback) from subaddress 30
9	Tx	3	30	32	Data wrap around (loopback) from subaddress 30

8. Once an RT is connected, it should respond to the commands sent to it. Make sure the address and parity bits are set correctly on the RT. Below is shown the terminal response to message 2, the status word is show:

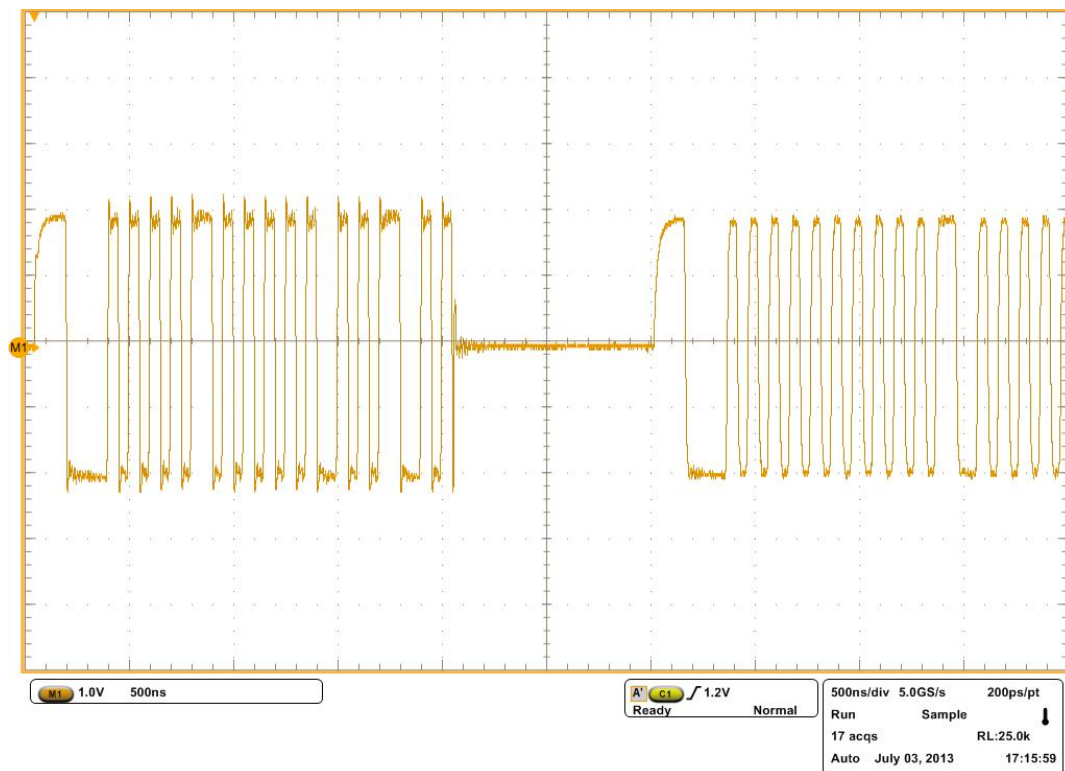
SW: 0x0010 = RT00 BCR. (RT number and Broadcast Command Received)

This indicates that the RT has received the command and returned a status word with the broadcast command received bit set. This is correct as message 1 previously sent, was a broadcast command.

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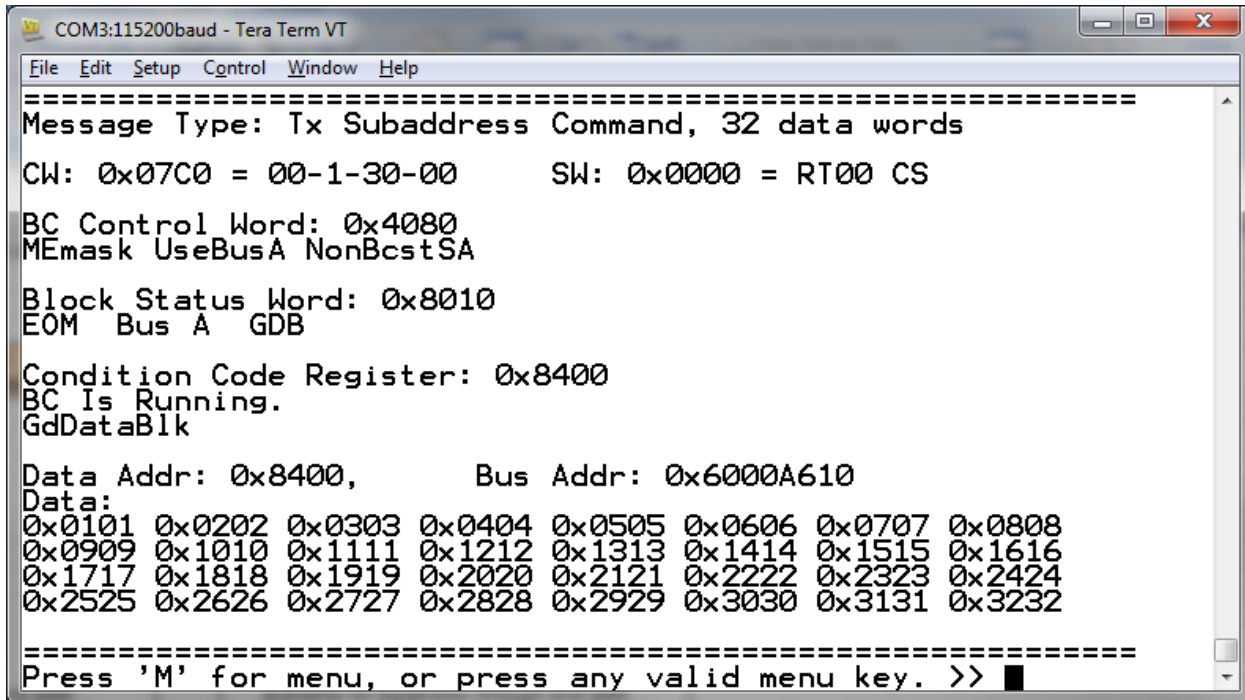
```
COM3:115200baud - Tera Term VT
File Edit Setup Control Window Help
=====
Press 'M' for menu, or press any valid menu key. >>
Results From Last Message Issued by BC
=====
Message Type: Tx Mode Code 02 w/o Data
CW: 0x07E2 = 00-1-31-02      SW: 0x0010 = RT00 BCR
BC Control Word: 0x40A4
MEmask UseBusA maskBCR MC
Block Status Word: 0x8000
EOM Bus A
Condition Code Register: 0x8000
BC Running: No Condition Codes or Gen Purpose Flags Are Set.
Data Addr: 0x8000,      Bus Addr: 0x6000A610
Data:
=====
Press 'M' for menu, or press any valid menu key. >>
```

9. Below shows a plot of the RS485 positive line with an RT responding to message 2 with the status word (the second word on the plot).



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10. Messages 6-9 are data wraparoundTx commands. Here the RT sent back the data from subaddress 30 that was received in the broadcast command (message 1). The data read back is shown in the terminal screen below the control data, see response to message 5 below:



```
COM3:115200baud - Tera Term VT
File Edit Setup Control Window Help
=====
Message Type: Tx Subaddress Command, 32 data words
CW: 0x07C0 = 00-1-30-00      SW: 0x0000 = RT00 CS
BC Control Word: 0x4080
MEmask UseBusA NonBcstSA
Block Status Word: 0x8010
EOM Bus A GDB
Condition Code Register: 0x8400
BC Is Running.
GdDataBlk
Data Addr: 0x8400,      Bus Addr: 0x6000A610
Data:
0x0101 0x0202 0x0303 0x0404 0x0505 0x0606 0x0707 0x0808
0x0909 0x1010 0x1111 0x1212 0x1313 0x1414 0x1515 0x1616
0x1717 0x1818 0x1919 0x2020 0x2121 0x2222 0x2323 0x2424
0x2525 0x2626 0x2727 0x2828 0x2929 0x3030 0x3131 0x3232
=====
Press 'M' for menu, or press any valid menu key. >> █
```

Note that the data shown in the lower section is the same as that sent out in the broadcast command of message 1.

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Bill of Materials			HI-6140 Bus Controller Evaluation Board	Revised: 08/02/13	
Item	Qty	Description	Reference	DigiKey	Mfr P/N
1	1	PCB, Bare, Eval Board	N/A	-----	Jet Tech # 35167
2	25	Capacitor, Cer 0.1uF 20% 50V Z5U 0805	C1,C2,C5,C6,C7,C9,C10,C12,C13,C23,C27,C30,C32,	399-1176-1-ND	Kemet C0805C104M5UACTU
3	1	Capacitor, Cer 4.7uF 10% 6.3V X5R 0805	C4	399-3134-1-ND	Kemet C0805C475K9PACTU
4	10	Capacitor, Cer 10uF 10% 6.3V X5R 0805	C8,C11,C14,C24,C25,C26,C28C29,C31,C37	399-3138-1-ND	Kemet C0805C106K9PACTU
5	1	Capacitor 68uF 10% 6.3V Tant 400 mOhm SMD EIA 6032-28	C3	495-1507-1-ND	T495C686K006ZTE400
6	4	Terminal Block 3.5MM 4Pos PCB Mounted	J8,J10,J12,J14	ED1516-ND	On Shore Tech ED555/4DS
7	2	Header, Male 2x20 0.1" Pitch, 0.230" Pins, 0.120" Tail	J2,J3	S2012E-20-ND	Sullins PEC36DAAN
8	2	Header, Male 2x25 0.1" Pitch, 0.230" Pins, 0.120" Tail	J5,J7	S2012E-25-ND	Sullins PEC25DAAN
9	1	Header, 1x3, 0.1" pitch	J1	DO NOT STUFF	
10	1	Header, 1x13, 0.1" pitch	J4	DO NOT STUFF	
11	6	Solder Jumper	JP1,JP2,J9,J11,J13,J15	DO NOT STUFF	
12	2	Header, 1x2, 0.1" pitch	JP1,JP2		PEC36SAAN
13	2	Shunt jumper	JP1,JP2	A26228-ND	TE Connectivity 382811-8
14	1	Header, 1x8, 0.1" pitch	J6		PEC36SAAN
15	8	LED Green 0805	LED1,LED2,LED3,LED4,LED5,LED6,LED7,LED8	160-1179-1-ND	LiteOn LTST-C170GKT
16	1	Osc, 50MHz 25ppm 3.3V SMD 5x7mm	OSC1	535-10087-1-ND	Abrakon ASV-50.000MHZ-E-T
17	4	Resistor, 120 Ohm 5% 1/8W 0805	R22,R23,R24,R25	P120ECT-ND	Panasonic ERJ-8GEYJ121V
18	3	Resistor, 0 5% 1/8W 0805	R1,R2,R3	P0.0ACT-ND	Panasonic ERJ-6GEY0R00V
19	6	Resistor, 0 5% 1/8W 0805	R4,R5,R6,R7,R9,R11	DO NOT STUFF	
20	8	Resistor, 150 5% 1/8W 0805	R13,R14,R15,R16,R17,R18,R19,	P150ACT-ND	Panasonic ERJ-6GEYJ151V
21	1	Resistor, 1.0K 5% 1/8W 0805	R8	P1.0KACT-ND	Panasonic ERJ-6GEYJ102V
22	1	Resistor, 10K 5% 1/8W 0805	R10	P10KACT-ND	Panasonic ERJ-6GEYJ103V
23	1	Resistor, 47K 5% 1/8W 0805	R12	P47KACT-ND	Panasonic ERJ-6GEYJ473V
25	4	Test Point, Gnd, Black Insulator, 0.062" hole	GND	5011K-ND	Keystone 5011
26	4	Test Point, Black Insulator, 0.062" hole	BUS A Negative	5011K-ND	Keystone 5011
27	4	Test Point, Red Insulator, 0.062" hole	BUS A Positive	5010K-ND	Keystone 5010
28	1	Test Point, Active White Insulator, 0.062" hole	Active	5012K-ND	Keystone 5012
29	1	IC HI-6140 100-PQFP	U1	Holt IC	Holt HI-6140
30	4	IC HI-4853 8-SOIC	U4,U5,U6,U7	Holt IC	Holt HI-4853
31	1	IC PLD 1200LUTS 113I/O 144-TQFP	U3	220-1178-ND	LCMXO1200C-3TN144C
32	1	IC, Serial EEPROM 512Kbit 20MHz SPI 8-SOIC, Microchip	U4	25LC512-I/SN-ND	Microchip 25LC512-I/SN

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REVISION HISTORY

Revision	Date	Description of Change
QSG-6140BC, Rev. New	7-16-13	Initial Release
QSG-6140BC, Rev. A	8-12-13	Added BOM