HI-3593 ARINC 429 3.3V Dual Receiver, Single Transmitter with SPI Evaluation Board
Users Guide
June 14, 2012
INTRODUCTION

The Holt HI-3593 ARINC 429 Evaluation Board can be used to evaluate most of the features of the HI-3593 ARINC Dual Receiver and Single Transmitter IC. The HI-3593 features an on-chip DC-DC converter which generates both +5V and -5V to supply the bipolar differential voltage levels needed to meet the ARINC 429 Bus levels from a single 3.3V supply voltage. The main board “General Purpose SPI Evaluation Board” includes switches, pushbutton switches and LEDs to help navigate the operating modes and confirm data and status information. A Freescale MC9S12XDT512 microcontroller on the main board communicates with the HI-3593 through the SPI interface. A Serial UART port is provided which enables viewing messages and status information or entering of optional commands using any terminal program such as Hyper-Terminal. The HI-3593 Evaluation Board is a daughter card that plugs on to the General Purpose SPI board via two 26 pin connectors.

This Users Manual provides a more detailed description of the evaluation board and demo program than in the Quick Start Guide.

Kit Contents

- Quick Start Guide.
- General Purpose SPI Evaluation board and schematic.
- HI-3593 Evaluation Board (daughter card) and schematic.
- HI-3593 Data Sheet.
- RS-232 9 Pin Serial Cable.
- Demo Project compatible with Freescale™ CodeWarrior™.
- This HI-3593 Users Guide.
- HI-3593 Application Note.
Demo board software features

- Transmission and Reception of ARINC low speed and high speed messages.
- Selectable ODD or EVEN parity.
- Self Test mode (Internal digital loop back).
- 256 receiver labels.
- Receiver label reverse bit order.
- Transmitter label reverse bit order.
- Receiver Priority Label Mailboxes.
- Receiver filter on SD9 or SD10.
- ARINC ACLK programmable divider.

General Purpose SPI Board

The bottom main board is a general purpose board used to demonstrate a variety Holt devices.

The schematic of this board will have slightly different references for some of the Dip switches. For this application BITRATE1 is used for Receiver-1 Parity Checking and BITRATE2 is used for Receiver-2 Parity Checking. If in doubt refer to the HI-3593 Quick Start Guide and Users Guide for the proper use of these dip switches. IC U3 on this main board is not populated so that the HI-3593 daughter card has full access to the SPI interface. For this application the 9-pin D connector J2 is Not Used.
Evaluation Board Block Diagram

- USB Debug Port
- RS-232 Console
- LEDS (10)
- User Push Button Switches (4)
- RESET Button
- MC9S12XD 16 Bit MCU
- SPI (4)
- R1INT, R2INT, MB1-1, MB2-1
- Transmitter
- Receiver-1
- Receiver-2
- ARINC TX BUS
- ARINC RX BUS
- Expansion Headers (2x14) x 2
- +3.3V
- Single Supply +3.3V
- 4MHz OSC
- Dip SWs (4)
- Dip SWs (6)
- DC / DC Converter
- +3.3V
- MR
- Dip SWs (6)
Initial Board Set up

1. Connect a +3.3V power supply to TP1 and ground to TP6. The HI-3593 uses +3.3V and this is the only power supply needed by this demo since the HI-3593 includes an on-chip DC-DC converter which generates the +5V and -5V for the ARINC transmit levels.

2. Connect the RS-232 cable to the board and the PC. Some features are only available using Console commands entered through the serial port. To view ARINC messages, Control and Status registers and enter optional commands, use a terminal program such as HyperTerminal. Configure the communication for 115200 Baud, 8 bits, No Parity, No handshaking.

3. HI-3593 daughter card factory default jumper settings:

   JPR3 – shorted. Removing this jumper opens the VDD path only to the HI-3593. This jumper provides a way to measure the HI-3593 power supply current ICC.
J2 1-2 – This configures the ACLK signal to come from the on-board OSC U16. To use an external clock source remove this jumper and connect an external clock source to J2 – 2.

Main Board Jumpers

Power On Reset

For normal operation ensure SW2 – 4 (MRST) is in the open position otherwise the MCU will be held in the reset state. The purpose of this MRST Dip switch is to allow easy interfacing of an external MCU to the HI-3593 (the SPI signals from the Freescale MCU will be forced into high impedance so as not to conflict with an external MCU). For normal operation keep this switch open and use the RESET button to reset the MCU during testing.

Some jumpers do not apply to the HI-3593 so they will typically be shown as NA.

- JP1 - NA
- JP2 - NA
- JP3 - VDD jumper to J5 VLOGIC. Removing JP3 can be used to measure ICC.
- JP4 - NA
- JP5 - NA
- JP7 - NA.

Mode Selection

<table>
<thead>
<tr>
<th>Mode-2</th>
<th>Mode-1</th>
<th>Mode-0</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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<td>0</td>
<td>Board Test</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>Transmit Messages with Labels</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>Transmit Messages with Labels SELF-TEST</td>
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<td>0</td>
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<td>HI3593 Explorer Mode</td>
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<tr>
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<td>0</td>
<td>HI3593 Explorer SELF-TEST Mode</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>Serial Console Commands</td>
</tr>
</tbody>
</table>

OPT1 switch Transmitter Party Enable

Open = Transmit Parity Enabled.
OPT2 switch  Receiver Label, Priority Label Enable
   Open=Enables label recognition. This includes the 256 possible labels and also the three Priority Label Mail Boxes in both Receiver-1 and Receiver-2.

BITRATE0 switch  ARINC High or Low Speed selection
   Open = Low Speed.
   Closed = High Speed.
   This program configures the Transmitter, Receiver-1 and Receiver-2 to High or Low speed according to this switch setting.

BITRATE1 switch  Receiver-1 Parity Checking
   Open = Receiver-1 parity checking Enabled.
   Closed = Receiver-1 Parity checking Disabled.

BITRATE2 switch  Receiver-2 Parity Checking
   Open = Receiver-2 parity checking Enabled.
   Closed = Receiver-2 Parity checking Disabled.

Push Buttons SW1-SW4

   Depending on selected mode, these buttons perform specific tasks.

LED Indicators

LEDs 1-8 show the program revision after a reset and also status information during the demo execution. The format for the program revision is

   LED8 – LED5 = digit, LED4-LED1 = sub digit

For program revision 1.0, LED5 will be turned on for two seconds before the program continues. The program also displays the program revision on the Console.

The red LED8 is used to show a fault if the program cannot initialize the HI-3593. After performing a MR the program checks the transmit status register for the default value 0x01. If this value is not read the program turns on the red LED and enters a dead loop.

LED7 will usually flash at a one second interval to show the program is running. For Mode-1 and Mode-2, LEDs 5-7 are reconfigured to blink when a Priority Label is received by either Receiver-1 or Receiver-2:
Priority Label-1 = LED5
Priority Label-2 = LED6
Priority Label-3 = LED7

LEDs 1-4 show the last upper nibble of the transmitted LSB byte.

**Mode Descriptions**

There are six valid demo modes selectable by the Mode-0, Mode-1 and Mode-2 Dip switches. Set the switches according to the desired mode, ARINC speed and Receiver Parity checking and power cycle the board or press the RESET button on the main board.

**Mode-0 Board Test:**

This is a simple test program that cycles the LEDs 1 - 8 on briefly to verify operation. LED7 will flash every second independently in addition to the normal flash. Pressing down SW-1 will stop the sequence and turn on LED1. Pressing SW 2-4 will turn on LEDs 2-4 respectively. This is a way to verify that the push button switches work.

The output on the console will be similar to:

```
Holt HI-3593 Demonstration Software Revision: X.X
Board Test
```

**Mode-1 Transmit Messages with Labels**

This mode demonstrates most of the capabilities in the HI-3593. It first checks the dip switches and configures the Transmitter and both Receiver control registers for Transmit Parity, Label enable/disable, ARINC low/ high speed. Both receivers are also configured depending on the switch settings. The initial console screen looks similar to this, depending on the switch settings:

```
Holt HI-3593 Demonstration Software Revision: X.X
Transmit & Receive With Labels Mode
Fast Speed
Receiver-1 Parity is Enabled
Receiver-2 Parity is Disabled
All labels are Disabled
Press Button-1 to start initially
```
--- Button Commands ---
SW-1 or Space Bar to Display Status and Control Registers
SW-2 to Pause
SW-3 to Display Label Memory

--- Console Commands Help ---
P = Parity Toggle on/off
T = TFLIP Toggle on/off
R = RFLIP Toggle on/off
S = SDON, SD9, SD10 Toggle on/off
H = This Help Page
Space Bar = Display Status and Control regs
I = Increment Message and Transmit. Explorer Mode - ONLY!
M = Enter Custom Message. Explorer Mode - ONLY!
ENTER= Transmit next message. Explorer Mode - ONLY!

Pressing SW-1 will start the program to begin transmitting messages with incrementing data. The console output shows the TX message and three data bytes and the Label byte as shown below. These data values are in hex format by default. This demo mode copies the LSB byte to the Label byte in the transmit buffer before transmitting the message to allow testing Label reception. Label reception is enabled if the OPT2 switch is in the open position.

Transmitting
>
>TX Data:00 00 00 Label:30
>TX Data:00 00 01 Label:01
>TX Data:00 00 02 Label:02

Pressing SW-1, SW-2 or SW-3 causes the program to pause and print out status information on the Console. For example, pressing SW-1 or optionally pressing the Space Bar on the console pauses the transmissions and prints out the contents of the HI-3593 control and status registers as follows.

HI-3593 Status, Control Registers

<table>
<thead>
<tr>
<th>Register</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>REC1 Status Reg</td>
<td>0x01</td>
</tr>
<tr>
<td>REC1 Control Reg</td>
<td>0x86</td>
</tr>
<tr>
<td>REC2 Status Reg</td>
<td>0x01</td>
</tr>
<tr>
<td>REC2 Control Reg</td>
<td>0x86</td>
</tr>
<tr>
<td>Transmit Status Reg</td>
<td>0x01</td>
</tr>
<tr>
<td>Transmit Control Reg</td>
<td>0x60</td>
</tr>
<tr>
<td>FLAG Int Assig</td>
<td>0x00</td>
</tr>
<tr>
<td>ACLK Divisor</td>
<td>0x08</td>
</tr>
<tr>
<td>PL1 Match 1 Reg</td>
<td>0x20</td>
</tr>
<tr>
<td>PL1 Match 2 Reg</td>
<td>0x40</td>
</tr>
<tr>
<td>PL1 Match 3 Reg</td>
<td>0x7F</td>
</tr>
</tbody>
</table>
Pressing SW-3 displays the contents of the Label memory for both receivers as shown:

Receiver 1 Labels
Labels 0 - 63: 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF
Labels 64-127: 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF
Labels 128-191: 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
Labels 192-255: 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00

Receiver 2 Labels
Labels 0 - 63: 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
Labels 64-127: 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
Labels 128-191: 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF
Labels 192-255: 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF 0xFF

Press Button-4 to Resume

On-The-Fly Console Commands

While transmitting, Console commands are available by pressing the upper or lower case letter of the Console command. Entering these commands on-the-fly alters the transmission characteristics such as enabling or disabling Parity, reversing the label field bit order of either the transmitter or the receiver, or enabling the SDON feature. The SDON feature allows filtering on the receiver data bits 9 and 10 based on the Receiver Control Register setting of SD9 and SD10. A short message on the Console shows the new status of any new command entered.

Using the on-the-fly Console commands while viewing the transmitter signal on an oscilloscope provides an easy way to learn how the control register configuration bits affects the data pattern. Keep in mind the OPT1 and OTP2 switches for Transmit Parity and Label recognition are only sampled immediately after a reset. To change these settings first make the change and then press the RESET button.

While transmitting, it is possible to press the H key on the Console to display the help screen.

Console Commands Help Screen:

--- Console Commands Help ---
P = Parity Toggle on/off
T = TFLIP Toggle on/off
R = RFLIP  Toggle on/off  
S = SDON, SD9, SD10 Toggle on/off  
H = This Help Page  
Space Bar = Display Status and Control regs 
I = Increment Message and Transmit. Explorer Mode - ONLY!  
M = Enter Custom Message. Explorer Mode – ONLY!  
ENTER= Transmit next message. Explorer Mode – ONLY! 

Press Space Bar or Button-4 to resume.

The last three Console commands listed on the help screen (I, M and ENTER) are not available in this mode. Those commands will be discussed in the Mode-3 and Mode-4 sections later.

By connecting an external ARINC source to one of the receiver inputs the program will also display received ARINC messages. Demonstrate this by connecting the on-board transmitter output to one of the receiver inputs using two clip leads. Connect the transmitter to the Receiver-2 input as follows:

J9-5 to J8-5   (TXAOUT to RIN2A)  
J9-4 to J8-4   (TXBOUT to RIN2B)  

This output shows a case where a Priority Label was received in addition to the regular message:

>TX Data:00 0F B0 Label:B0  
>Rec-2 Data:00 0F B0 Label:B0  
>PL2-1 Data:00 0F B0 Match:B0 (Priority Label 1 from Receiver-2)  

**Mode-2   Transmit Messages with Labels  SELF-TEST**

Mode-2 is almost identical to Mode-1 with the exception that the SELFTEST bit in the transmit control register is set. This enables an internal digital loop back feature. In this mode no external transmitter data will be outputted. Also, the normal data from the transmitter will be received on Receiver-1 and an inverted copy will be received on Receiver-2 automatically. SELF-TEST or digital loop back is very useful when bringing up new hardware. Using the SELF-TEST provides a means of testing the device at the local level by enabling transmitter data to be routed internally to the receive FIFO so that software can be tested without actually having an external ARINC source.

The header on the console displays this additional message:

SELF-TEST, Internal Digital Loop-back, No data is transmitted externally

The first few messages on the console will appear similar to this:
Transmitting
>
>TX  Data:00 00 00 Label:30  (initial Label is 0x30)
>Rec-1 Data:00 00 00 Label:30
>Rec-2 Data:FF FF FF Label:CF
>
>TX  Data:00 00 01 Label:01  (Label changes to LSB)
>Rec-1 Data:00 00 01 Label:01
>Rec-2 Data:FF FF FE Label:FE
>
>TX  Data:00 00 02 Label:02
>Rec-1 Data:00 00 02 Label:02
>Rec-2 Data:FF FF FD Label:FD

Mode-3     HI3593 Explorer Mode

The HI 3593 Explorer Mode-3 allows greater control over the transmitted and received messages. Mode-3 shares much of the same functionality of Mode-1 and Mode-2. The Dip switches are defined the same as Mode-1 and Mode-2 and most of the SW buttons and Console commands are the same. The valid commands are listed on the Console output after a reset.

Both receivers are enabled and are configured according to the Dip switches. In addition some of the receiver and transmitter options can be altered by entering Console commands. The transmitter transmits a single message at a time by pressing SW-2 or by pressing the ENTER key on the Console. Between the dip switch settings and the on-the-fly Console commands, a wide variety of message types can be exercised to learn how the HI-3593 works.

For this Demo, configure the following:

Enable Labels by setting the OPT2 switch to the open position.

Connect the transmitter to the Receiver-2 input pins on the connectors as follows:

J9-5 to J8-5     (TXAOUT to RIN2A)
J9-4 to J8-4     (TXBOUT to RIN2B)

Press the RESET button. A similar header screen will be shown on the Console

Holt HI-3593 Demonstration Software Revision: 1.00

Explorer Mode
Fast Speed
Receiver-1 Parity is Enabled
Receiver-2 Parity is Disabled
All labels are Enabled

--- Button Commands ---
SW-1 or spacebar to Display Status and Control Registers
SW-3 to Display Label Memory

--- Console Commands Help ---
P = Parity Toggle on/off
T = TFLIP  Toggle on/off
R = RFLIP  Toggle on/off
S = SDON, SD9, SD10 Toggle on/off
H = This Help Page
Space Bar = Display Status and Control regs
I = Increment Message and Transmit. Explorer Mode - ONLY!
M = Enter Custom Message. Explorer Mode - ONLY!
ENTER= Transmit next message. Explorer Mode - ONLY!

Press ENTER to Transmit or use the (T) command to enter a custom message

Press the ENTER key on the Console or press SW-2 to transmit the message currently in the transmit buffer. The default message in the transmit buffer will be: 00 00 00 30 and this default message will be transmitted each time the ENTER key or SW-2 is pressed. There are two ways to alter the contents of the transmit buffer. One is to use the Increment data Console command “I” and the other way is to use the Custom Message Console command “M”.

Press the M key to get this command prompt:

>Command M
To Transmit, enter 3 bytes followed by a label byte followed by ENTER
Format: Bits32-25, Bits24-17, Bits16-9, LABEL
:Example: 01 23 45 67 ENTER

Enter 8 valid hex digits (0-F). The program displays each digit as it is pressed then a “Press ENTER” prompt will be displayed. Press the ENTER key to transmit this new message.

:12 34 56 78 Press RETURN Transmitted..
This transmits the message 0x12, 0x34, 0x56 with Label 0x78. The actual data on the SPI interface will be 0xC (Opcode), 0x12, 0x34, 0x56, 0x78 and follows the same order shown on the HI-3593 data sheet figure 1, example 1. This new message will also be copied to the transmit buffer. Pressing the ENTER key or pressing SW-2 retransmits this new message from now on.

Notice that although there was a TX message transmitted, there was no message received by either receiver. This is because labels were enabled by OTP2 in the open position. Enter message 12 34 56 80 using the M Console command. Receiver-2 should have received the message now. This is because the label memory in this program is configured so labels 0-127 (0x00-0x7F) are set for Receiver-1 and labels 128-255 (0x80-0xFF) are set for Receiver-2. This message with label 80h is now enabled to be received because the label 128(Decimal) is set in the label memory.

Enter the R Console command to toggle the RFLIP bit and transmit a message using the ENTER command. Notice the label value changed from 0x80 to 0x01. By viewing the actual data on an oscilloscope, you can also see the effect of changing the Parity, TFLIP, RFLIP and DSON bits by using the Console commands to alter these bits and then re transmitting the new message. These commands toggle the corresponding bits on or off, depending on the previous state.

The I Console command is very simple; it just increments the current value in the transmit buffer and transmits that message.

Mode- 4 – HI3593 Explorer Mode SELF-TEST

Mode- 4 is identical to Mode- 3 except it sets the SELF-TEST bit.
**Mode-7 (Serial Commands)**

Setting all the Mode switches to the open position enables Mode-7. These are simple optional test functions which could be easily expanded to perform other customized tests. A few simple examples are provided:

```
****** HOLT HI-3593 Serial Console Commands ******

Input String Demo                0
Reset HI-3593 using the MR pin   1
Control and Status Register Dump 2
Initialize TCR, RCR1 and RCR2    3

Enter Selection:
```

**HI-3593 Daughter Card standalone use:**

To use the Daughter Card in standalone mode without connection to the Holt General Purpose SPI main board a 10 pin connector J10 is provided with most of the signals needed to connect to an external MCU. Connectors J5 and J6 can provide some of the signals not preset on J10.
**HI-3593 demo CodeWarrior™ Software Project**

The software project is built with Freescale’s CodeWarrior version 5.9.0 using the free limited 32K version. The current code size of the demo is approximately 16K. The main functions are in main.c and the low level HI-3593 drivers are in the 3593Driver.c file. The software project “HI-3593 Demo” will normally be distributed in a zip file on a CD-ROM with the same name. **To develop, debug and download this software into the board a debug cable is necessary. It is not provided in this kit.** To purchase this cable, go to the PE Micro website or purchase it from Digi-Key.

**Project Files**

**Source Files**
- main.c: Main code
- 3593Driver.C: SPI low-level drivers for the HI-3593
- Peripherals.c: GPIO, PLL frequency setup and SPI configuration
- BoardTest.c: Board Test functions
- Uart.c: Low-level UART drivers
- datapage.c: Freescale™ IDE support file

**Include Files**
- Main.h
- 3593Driver.h: HI-3593 header
- Peripherals.h
- BoardTest.H
- Uart.h
- Common.h: Common defines for the project
- Derivative.h: Freescale™ IDE support file
- Mc9s12xdt512.h: Freescale™ IDE target part support file
CodeWarrior™ and Software Project Setup:

1. Download and install the CodeWarrior™ IDE from the Freescale website. The download links are provided below.

2. Unzip the HI-3593 zip file into the directory you plan to use for your project.

3. Navigate to the HI-3593 project folder and double click the HI-3593 Demo.mcp project file to launch this project with CodeWarrior. The IDE should open with the project files on the left side of the window.

4. Click Make from the Project menu to rebuild the project. The project should build without errors. You may receive a dead assignment warning if for example some defines are set to a zero value.

5. Install the PE Micro USB Multilink Interface cable per the instructions.

6. Plug the USB Multilink 6-pin debug cable into the J9 debug connector and power up the board with 3.3V.

7. Download the program by clicking Debug from the Project menu. The first time the program is downloaded the debugger will need to be configured for the USB Multilink cable. After downloading is complete, the debugger window should be displayed with the first line in main.c highlighted. Press the green arrow button to run the program. Since the program has been loaded, you can power down the board and re-power the board and the program should run automatically without the debugger.
Holt HI-3593 project loaded into CodeWarrior™ 5.9.0

Freescale™ MC9S12XDT512xxx Development Tools

The Freescale™ microcontroller data sheet and other documentation can be found at this link:


If these links become out of date go to: http://www.freescale.com/

and search for information on “S12XD: 16-Bit Automotive Microcontroller”.

A Free 32K limited version of the CodeWarrior™ IDE from Freescale™ is available:
The US Multilink debugger cable used for this project is:


http://search.digikey.com/scripts/DkSearch/dksus.dll?Detail&name=USBMULTILINKBDME-ND

References:

http://www.holtic.com/
# BILL OF MATERIALS

**Bill of Materials**

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<thead>
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<th>Item</th>
<th>Qty</th>
<th>Description</th>
<th>Reference</th>
<th>DigiKey</th>
<th>Mfr P/N</th>
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<td>Holt</td>
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<td>Header, Female 2X14 0.1&quot; Pitch</td>
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<td>7</td>
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<td>Test Point, Black Insulator, 0.062&quot; hole</td>
<td>TP1, TP3</td>
<td>5011K-KD</td>
<td>Keystone 5011</td>
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<tr>
<td>8</td>
<td>2</td>
<td>Test Point, Red Insulator, 0.062&quot; hole</td>
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<td>5010K-ND</td>
<td>Keystone 5010</td>
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<td>9</td>
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<td>Header, Male 1x2, 0.1&quot; Pitch</td>
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<td></td>
</tr>
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<td>1</td>
<td>Header, Male 1x3, 0.1&quot; Pitch</td>
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<td>Capacitor, Ceramic 10nF 10% 50V X7R 0805</td>
<td>C9, C10</td>
<td>399-1158-1-ND</td>
<td>Kemet C0805C103K5RACTU</td>
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<td>C2, C5</td>
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<td>Capacitor, Tant 47uF 16V 20% SMD 2917</td>
<td>C7</td>
<td>495-2251-6-ND</td>
<td>Kemet B45196H3476M409</td>
</tr>
<tr>
<td>16</td>
<td>2</td>
<td>Capacitor, CER 47uF 10V 20% <strong>Low ESR</strong>, SMT 1210</td>
<td>C3, C4</td>
<td>587-2783-1-ND</td>
<td>Yaiyo Yuden EMK325B7476MM-T</td>
</tr>
<tr>
<td>17</td>
<td>4</td>
<td>Resistor, 40.2K 1%, SMT 0805</td>
<td>R6, R7, R8, R9</td>
<td>P40.2KCCT-ND</td>
<td>ERJ-6ENF4022V</td>
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<tr>
<td>18</td>
<td>2</td>
<td>Resistor, 31.6 ohm, 1%, SMT 0805</td>
<td>R16, R17</td>
<td>P31.6CCT-ND</td>
<td>ERJ-6ENF31R6V</td>
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## Bill of Materials

### General Purpose SPI

<table>
<thead>
<tr>
<th>Item</th>
<th>Qty</th>
<th>Description</th>
<th>Reference</th>
<th>DigiKey</th>
<th>Mfr P/N</th>
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<tr>
<td>1</td>
<td>1</td>
<td>PCB, Bare, Evaluation Board</td>
<td>N/A</td>
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<td>3</td>
<td>1</td>
<td>RS-232 Serial Cable</td>
<td>AE1379-ND</td>
<td>AK131-2-R</td>
<td>C0805C100J5G</td>
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<td>4</td>
<td>4</td>
<td>Capacitor, Cer 10pF 50V 5% NP0 0805</td>
<td>C11,C12,C15,C19</td>
<td>ACTU</td>
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<tr>
<td>5</td>
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<td>Capacitor, Cer 470pF 50V 5% X7R 0805</td>
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<td>ACTU</td>
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<td>6</td>
<td>6</td>
<td>Capacitor, Cer 220nF 10% 50V X7R 0805</td>
<td>C13,C14,C23,C25,C26,C27</td>
<td>ACTU</td>
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<tr>
<td>1</td>
<td>1</td>
<td>1uF 6.3V MLCC</td>
<td>C5</td>
<td>490-4354-1-ND</td>
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<td>3</td>
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<td>4.7uF 10% 6.3V Low ESL</td>
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<td>8</td>
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<td>Capacitor, Cer 1nF 20% 50V X7R 0805</td>
<td>C9,C18</td>
<td>399-1146-1-ND</td>
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<td>9</td>
<td>3</td>
<td>Capacitor, Cer 0.01uF 20% 50V X7R 0805</td>
<td>C8,C17,C24</td>
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<td>10</td>
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<td>Capacitor, Cer 0.1uF 10% 10V 1206</td>
<td>C2,C4,C7,C10,C16,C20,C28,C29,C30,C31,C32,C33,C34</td>
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<td>11</td>
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<td>Ferrite Bead</td>
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<tr>
<td>12</td>
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<td>Connector DB9F, RA PCB, 315&quot;</td>
<td>J2,J10</td>
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<tr>
<td>13</td>
<td>1</td>
<td>Res 220K, 1/8W 5% 0805 SMD</td>
<td>R34</td>
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<tr>
<td>14</td>
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<td>Header, Male 2X14, 0.1&quot; Pitch</td>
<td>J5,J6</td>
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<tr>
<td>18</td>
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<td>Header, Male 0.1&quot;, Right Angle 2 x 3</td>
<td>J9</td>
<td>495-2254-1-ND</td>
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<tr>
<td>19</td>
<td>6</td>
<td>Header, Male 1x2, 0.1&quot; Pitch</td>
<td>JP1-JP5,JP7</td>
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<tr>
<td>20</td>
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<td>LED Green 0805</td>
<td>LED1-LED7,LED10,LED11</td>
<td>160-1179-1-ND</td>
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<td>21</td>
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<td>LED Yellow 0805</td>
<td>LED9</td>
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<td>22</td>
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<td>LED Red 0805</td>
<td>LED8</td>
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<td>23</td>
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<td>Res 1M, 1/8W 5% 0805 SMD</td>
<td>R40</td>
<td>RHM1.0MARCT-ND</td>
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<tr>
<td>24</td>
<td>17</td>
<td>Res 3.3K, 1/8W 5% 0805 SMD</td>
<td>R17,R18,R20-R22,R24-R26,R29-R33,R35-R38</td>
<td>160-1179-1-ND</td>
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**13-Jun-12**
<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Value</th>
<th>Part Number</th>
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<tr>
<td>11</td>
<td>Res 680, 1/8W 5%</td>
<td>R1-R6,R8,R11,R12,R14,R16</td>
<td>RHM680ARCT-ND MCR10EZPJ681</td>
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<tr>
<td>12</td>
<td>0805 SMD</td>
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<tr>
<td>29</td>
<td>Res, 4.02 OHM 1%</td>
<td>R9,R10</td>
<td>311-4.02CRCT-ND RC0805FR-074R02L</td>
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<td>30</td>
<td>1/8W 0805</td>
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<tr>
<td>31</td>
<td>Res 60.4 Ohm 1/4W 1% 1210 SMD</td>
<td>R15,R19</td>
<td>RHM60.4BDCT-ND MCR25JZH60R4</td>
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<tr>
<td>32</td>
<td>0805 SMD</td>
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<tr>
<td>33</td>
<td>Res 0 ohm, 1/8W 5% 0805 SMD</td>
<td>R7</td>
<td>RHM0.0ARCT-ND MCR10EZPJ000</td>
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<tr>
<td>34</td>
<td>Res 1.5M, 1/8W 5% 0805 SMD</td>
<td>R39</td>
<td>RHM1.5MARCT-ND RHM1.5MARCT-ND MCR10EZPF470</td>
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<tr>
<td>35</td>
<td>0805 SMD</td>
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<td>36</td>
<td>Res 4.7K, 1/8W 1% 0805 SMD</td>
<td>R28</td>
<td>RHM4.70KCRCT-ND MCR10EZPF470</td>
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<tr>
<td>37</td>
<td>Dip Switch 4-Pos Slide SMD</td>
<td>SW2</td>
<td>CT2194LPST-ND CTS 219-4LPST</td>
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<tr>
<td>38</td>
<td>Dip Switch 6-Pos Slide SMD</td>
<td>SW1</td>
<td>CT2196LPST-ND CTS 2196LPST</td>
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<tr>
<td>39</td>
<td>Switch Tactile SPST-NO 0.05A 32V</td>
<td>S1,S2,S3,S4,RESET BUTTON</td>
<td>CKN9195CT-ND KSC222J LFS</td>
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<td>40</td>
<td>Polyzen 5.6V PPTC Zener SMD</td>
<td>U2</td>
<td>ZEN056V130A24 LSCT-ND ZEN056V130A24 LSCT-ND</td>
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<tr>
<td>41</td>
<td>Test Point, Red Insulator, 0.062&quot; hole</td>
<td>TP1, TP9</td>
<td>5010K-NDS 4LS</td>
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<td>42</td>
<td>Test Point, Black Insulator, 0.062&quot; hole</td>
<td>TP5,TP6,TP8</td>
<td>5011K-KD Keystone 5011</td>
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<td>43</td>
<td>Test Point White Insulator, 0.062&quot; hole</td>
<td>TP2</td>
<td>5012K-NDS Keystone 5012</td>
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<td>44</td>
<td>Test Point Orange Insulator, 0.062&quot; hole</td>
<td>TP3,TP4</td>
<td>5013K-NDS Keystone 5013</td>
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<tr>
<td>45</td>
<td>IC, MC9S12XDT512CAA 80 QFP 16-Bit MCU, 512K Flash 0-70C</td>
<td>U1</td>
<td>MC9S12XDT512CAA-ND MC9S12XDT512CAA-ND</td>
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<td>46</td>
<td>IC, MAX3232CSE Narrow 16- SOIC</td>
<td>U4</td>
<td>MAX232CSE+-ND MAX232CSE+-ND Texas Inst</td>
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<tr>
<td>47</td>
<td>Crystal 24MHz, SMD, 50ppm 20pF load</td>
<td>Y1</td>
<td>631-1020-1-ND FOXSDFL/240F-20</td>
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<tr>
<td>48</td>
<td>Crystal 4.00MHz, SMD, 50ppm 20pF load</td>
<td>Y2</td>
<td>631-1005-1-ND FOXSDFL/040</td>
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<tr>
<td>49</td>
<td>OSC 24MHz, 5.0V, 1/2 SIZE</td>
<td>OSC1 (Do Not Install)</td>
<td>XC275-NDS ECS-2200B-240</td>
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<tr>
<td>50</td>
<td>3M Bumpon</td>
<td>Install at four corners and center.</td>
<td>SJ5746-0-ND 3M: SJ61A1</td>
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## REVISION HISTORY

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date</th>
<th>Description of Change</th>
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</thead>
<tbody>
<tr>
<td>AN-160, Rev. New</td>
<td>2-11-11</td>
<td>Initial Release</td>
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<tr>
<td>AN-160, Rev. A</td>
<td>3-4-11</td>
<td>Updated revision number text on screen console example</td>
</tr>
<tr>
<td>AN-160, Rev. B</td>
<td>4-2-12</td>
<td>Update daughter card schematic/BOM C3, C4 capacitors to 125C and remove power resistors and replace with jumpers.</td>
</tr>
<tr>
<td>AN-160, Rev. C</td>
<td>6-14-12</td>
<td>Update daughter card photo and BOM for SPI demo board.</td>
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