

# HI-3593 ARINC 429 3.3V Dual Receiver, Single Transmitter with SPI Evaluation Board Users Guide April 2, 2012

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## 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

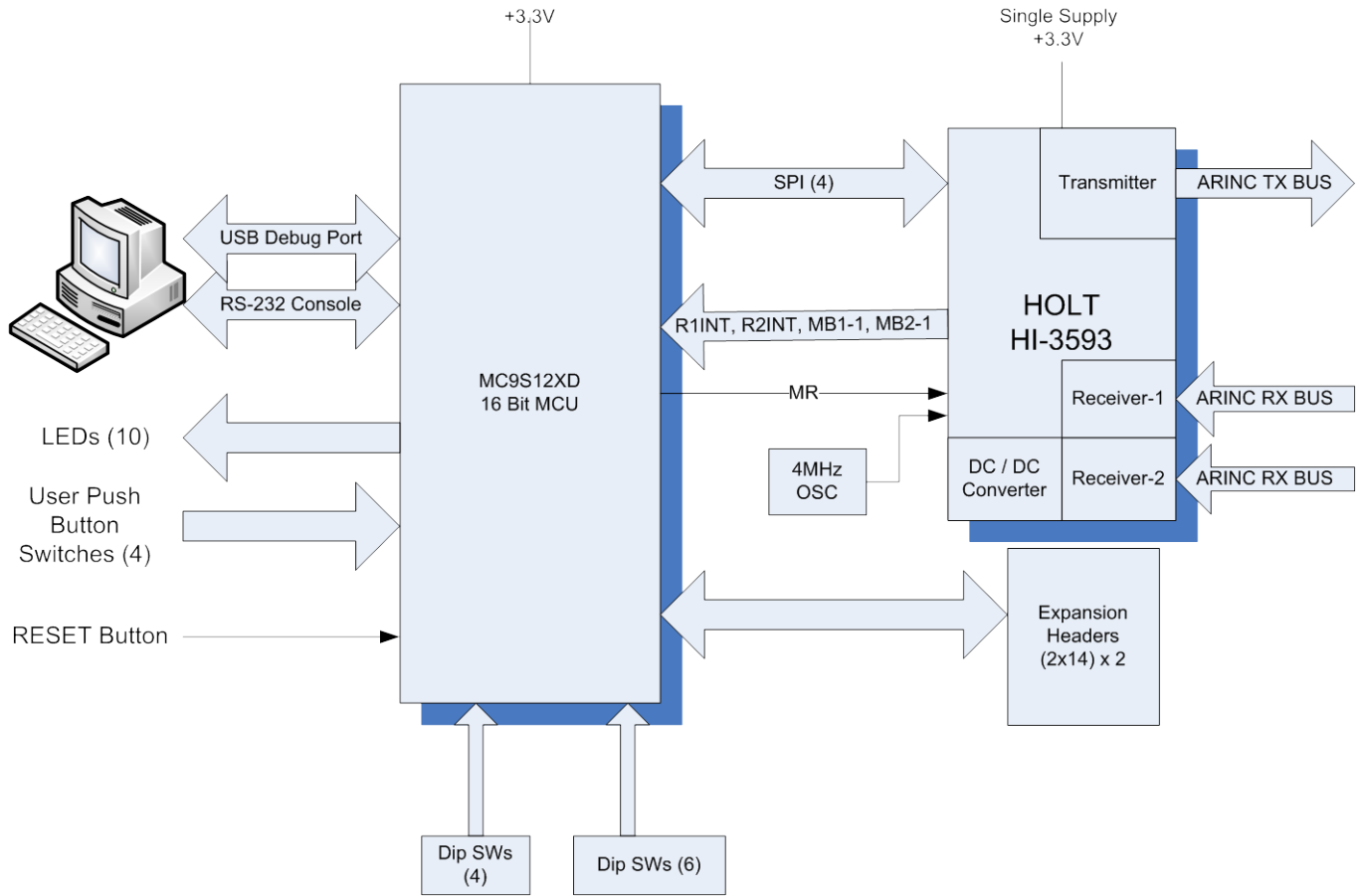
- Transmission and Reception of ARINC low speed and high speed messages.
- Selectable ODD or EVEN parity.
- Self Test mode (Internal digital loop back).
- 256 receiver labels.
- Receiver label reverse bit order.
- Transmitter label reverse bit order.
- Receiver Priority Label Mailboxes.
- Receiver filter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





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

Mode-2	Mode-1	Mode-0	Mode
0	0	0	Board Test
0	0	1	Transmit Messages with Labels
0	1	0	Transmit Messages with Labels SELF-TEST
0	1	1	HI3593 Explorer Mode
1	0	0	HI3593 Explorer SELF-TEST Mode
1	1	1	Serial Console Commands

### OPT1 switch Transmitter Parity 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

REC1 Status Reg      0x01
REC1 Control Reg     0x86
REC2 Status Reg      0x01
REC2 Control Reg     0x86
Transmit Status Reg  0x01
Transmit Control Reg 0x60
FLAG Int Assig       0x00
ACLK Divisor         0x08
PL1 Match 1 Reg      0x20
PL1 Match 2 Reg      0x40
PL1 Match 3 Reg      0x7F

```

```

PL2 Match 1 Reg      0xB0
PL2 Match 2 Reg      0xD0
PL2 Match 3 Reg      0xFF
Press SW4 or spacebar to continue

```

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 OPT2 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 re 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..

>

```
>TX    Data:12 34 56 Label:78
```

This transmits the message 0x12, 0x34, 0x56 with Label 0x78. The actual data on the SPI interface will be 0x0C (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.

```
>TX    Data:12 34 56 Label:80
>Rec-2 Data:12 34 56 Label:80    (label 80 was received)
```

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

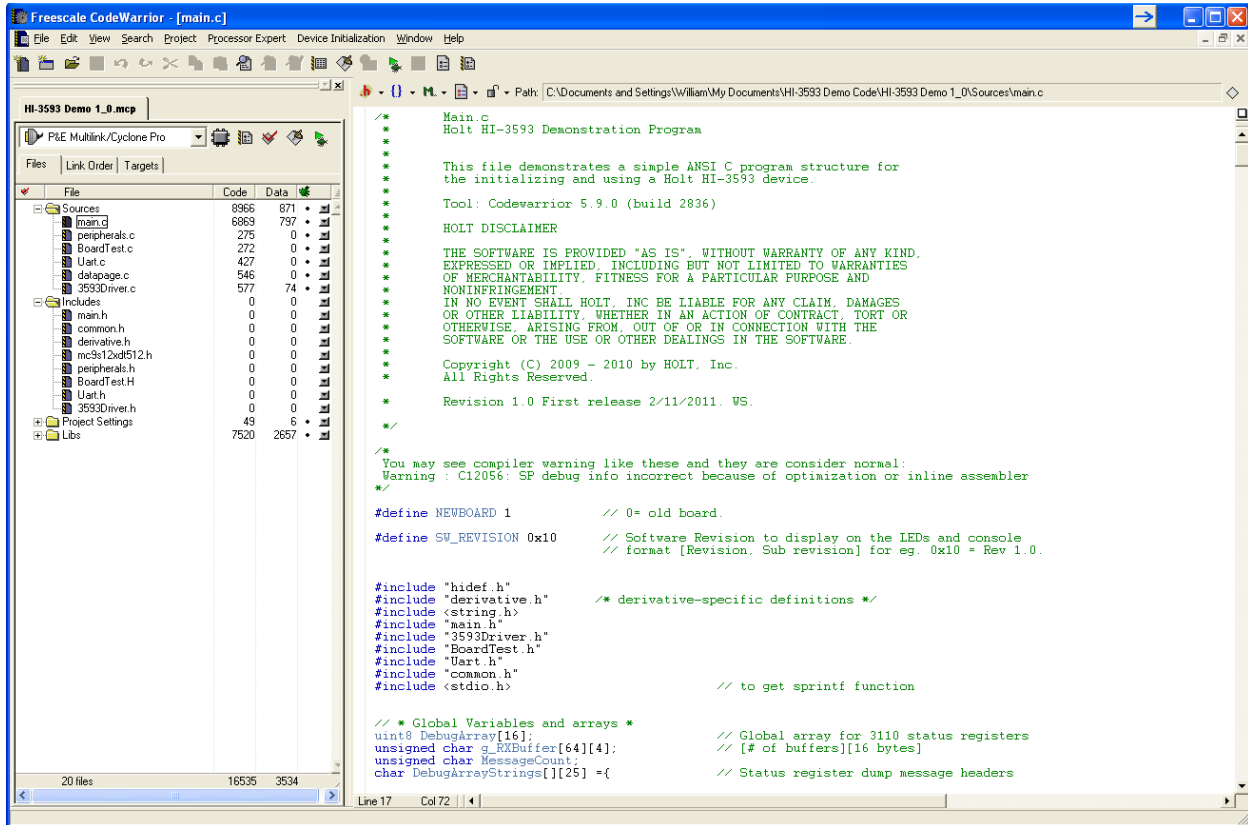
#### Include Files

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:

[http://www.freescale.com/webapp/sps/site/prod\\_summary.jsp?code=S12XD&tid=16bhp](http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=S12XD&tid=16bhp)

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:

[http://www.freescale.com/webapp/sps/site/prod\\_summary.jsp?code=CW-HCS12X&fsrch=1](http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=CW-HCS12X&fsrch=1)

The US Multilink debugger cable used for this project is:

[http://www.freescale.com/webapp/sps/site/prod\\_summary.jsp?code=USBMULTILINKBDM&parentCode=S12XD&fsp=1](http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=USBMULTILINKBDM&parentCode=S12XD&fsp=1)

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

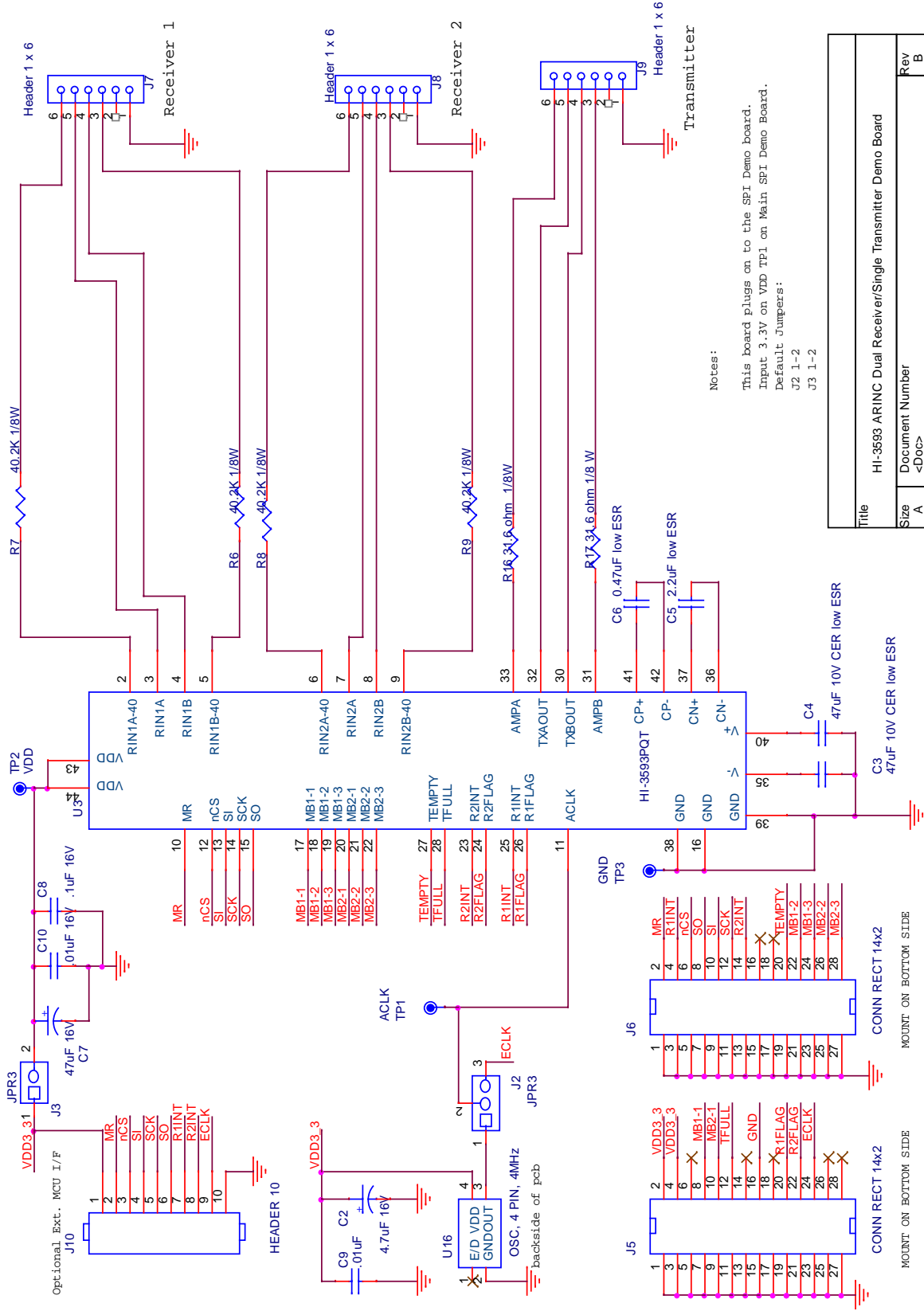


### References:

<http://www.holtic.com/>

## BILL OF MATERIALS

Bill of Materials		HI-3593 Daughter Card rev B		Revised: 2/28/2012	
Item	Qty	Description	Reference	DigiKey	Mfr P/N
1	1	PCB, Bare, Evaluation Board	N/A	-----	
2	1	HI-3593PQT	U3		Holt
3	1	4Mhz OSC, 6-SMD	OSC1	631-1194-1-ND	FOX: FX0-HC736R-4
4	2	Header, Female 2X14 0.1" Pitch	J5, J6	S7082-ND	Sullins
5	3	Header, Male 1x6, 0.1" Pitch	J7,J8,J9	S2012E-36-ND	Sullins
6	1	Header, Male 1x10, 0.1" Pitch	J10	S2012E-36-ND	Sullins
7	1	Test Point, Black Insulator, 0.062" hole	TP1, TP3	5011K-KD	Keystone 5011
8	2	Test Point, Red Insulator, 0.062" hole	TP2	5010K-ND	Keystone 5010
9	1	Header, Male 1x2, 0.1" Pitch	J3		
10	1	Header, Male 1x3, 0.1" Pitch	J2		
11	2	Capacitor, Ceramic 10nF 10% 50V X7R 0805	C9, C10	399-1158-1-ND	Kemet C0805C103K5RACTU
12	1	Capacitor, Ceramic 0.1uF 20% 50V Z5U 0805	C8	399-1176-1-ND	Kemet C0805C104M5UACTU
13	2	Capacitor, CER 2.2uF 16V SMD 0805, <b>Low ESR</b>	C2, C5	587-1431-1-ND	Yaiyo Yuden EMK212B7225KG-T
13	1	Capacitor, CER 0.47uF 16V SMD 0805, <b>Low ESR</b>	C6	587-1282-1-ND	Yaiyo Yuden EMK212B7474KD-T
14	1	Capacitor, Tant 47uF 16V 20% SMD 2917	C7	495-2251-6-ND	Kemet B45196H3476M409
	2	Capacitor, CER 47uF 10V 20% <b>Low ESR</b> , SMT 1210	C3, C4	587-2783-1-ND	Yaiyo Yuden EMK325B7476MM-T
15	4	Resistor, 40.2K 1%, SMT 0805	R6, R7, R8, R9	P40.2KCCT-ND	ERJ-6ENF4022V
16	2	Resistor, 31.6 ohm, 1%, SMT 0805	R16, R17	P31.6CCT-ND	ERJ-6ENF31R6V



Notes:  
 This board plugs on to the SPI Demo board.  
 Input 3.3V on VDD TP1 on Main SPI Demo Board.  
 Default Jumpers:  
 J2 1-2  
 J3 1-2

Title		HI-3593 ARINC Dual Receiver/Single Transmitter Demo Board	
Size	A	Document Number	<Doc>
Rev	B	Date:	Tuesday, March 27, 2012
		Sheet	1 of 1

Bill of Material		General Purpose SPI evaluation board		Revised: 2/11/2011	
Item	Qty	Description	Reference	DigiKey	Mfr P/N
1	1	PCB, Bare, Evaluation Board	N/A	-----	
2	1	RS-232 Serial Cable		AE1379-ND	AK131-2-R
3	4	Capacitor, Ceramic 10pF 5% NPO 50V 1206	C11,C12,C15,C19	311-1150-1-ND	YaegoCC1206JRNPO9BN100
4	1	Capacitor, Ceramic 470pF 10% NPO 50V 1206	C22	311-1167-1-ND	Yaego CC1206KRX7R9BB471
5	6	Capacitor, Ceramic 220nF 10% 50V X7R 0805	C13,C14,C23,C25,C26,C27	399-3491-1-ND	Kemet C0805C224K5RACTU
6	2	Capacitor, Ceramic 0.001uF 20% 50V 7XR 0805	C9,C18	399-1146-1-ND	Kemet C0805C102M5RACTU
7	3	Capacitor, Ceramic 0.01uF 20% 50V 7XR 0805	C8,C17,C24	399-1160-1-ND	Kemet C0805C103M5RACTU
8	13	Capacitor, Ceramic 0.1uF 10% 100V X7R 0805	C2,C4,C7,C10,C16,C20,C28,C29,C30,C31,C32,C33,C34	399-5333-1-ND	Kemet C0805X104K1RACTU
9	1	Capacitor 10uF 10% 10V 1206	C3	399-3684-1-ND	Kemet T491A106K010AT. Alternate: 718-1121-1-ND
10	2	Capacitor 68uF ,20%, 16V Tantalum SMD Kemet	C1,C21	495-2254-1-ND	Kemet b45196h3686m409
11	2	Connector DB9F, RT-Angle PCB Short Body	J2,J10	A35109-ND	NorComp 182-009-213R161
12	1	Resistor, 220k 5%	R34	P220KACT-ND	Panasonic ERJ-6GEYJ224V
13	2	Header, Male 1x8, 0.1" Pitch	J1,J7	S2012-18-ND	Sullins
14	2	Header, Male 2X14, 0.1" Pitch	J5,J6	S1012-12-ND	Sullins
15	0	Header, Male 1x18, 0.1" Pitch	J8	DO NOT STUFF	Sullins
16	1	Header, Male 0.1" Right Angle 2 x 3	J9	S2312E-ND	Sullins
17	9	LED Green 0805	LED1,LED2,LED3,LED4,LED5,LED6,LED7,LED10,LED11	160-1179-1-ND	LiteOn LTST-C170GKT
18	1	LED Yellow 0805	LED9	160-1175-1-ND	LiteOn LTST-C170YKT
19	1	LED Red 0805	LED8	160-1176-1-ND	LiteOn LTST-C170CKT
20	1	Resistor , 1 meg 5% 0805	R40	P1.0MACT-ND	Panasonic ECG ERJ-6GEYJ105V
21	17	Resistor, 3.3K Ohm 5% 1/8W 0805	R17,R18,R20,R21,R22,R24,R25,R26,R29,R30,R31,R32,R33,R35,R36,R37,R38	311-3.3KARCT-ND	Alternate: 541-3.3KACT-ND
22	11	Resistor, 680 5% 1/8W 0805	R1,R2,R3,R4,R5,R6,R8,R11,R12,R14,R16	311-680ARCT-ND	Any
23	2	Resistor, 4.02 OHM 1% 1/8W 0805	R9,R10	541-4.02CCT-ND	CRCW08054R02FNEA OR OTHER
24	2	Resistor, 60.4 1% .5W	R15,R19	P60.4AACT-ND	Panasonic ERJ-14NF60R4U
25	2	Resistor, 0 ohm 5% 1/8W 0805	R7,R13	311-0.0ACT-ND	Any
26	1	Resistor, 1.5 meg 5%	R39	P1.5MACT-ND	Panasonic ECG ERJ-6GEYJ155V
27	1	Resistor, 4.7k 1% 1/10 W SMD	R28	RMCF1/104.7KFRCT-ND	Stackpole Electronics or other
28	1	DIP Switch 4-Pos Slide SMD	SW2	CT2194LPST-ND	CTS 219-4LPST
29	1	DIP Switch 6-Pos Slide SMD	SW1	CT2196LPST-ND	CTS 2196LPST. Alternate: CKN6121ND
30	5	Push Button Switch	S1,S2,S3,S4,RESET BUTTON	P12948SCT-ND	Panasonic EVQ-Q2P02W
31		TVS 5.6V Diode	U2	Mouser: 650-ZEN056V130A24LS	Tyco ZEN056V130A24LS
32	2	Test Point, Red Insulator, 0.062" hole	TP1, TP9	5010K-ND	Keystone 5010
33	7	Test Point, Black Insulator, 0.062" hole	TP3,TP4,TP5,TP6,TP7,TP8,TP10	5011K-KD	Keystone 5011
34	1	IC, MC9S12XDT512CAA 80 QFP 16-Bit MCU, 512K Flash 0-70C	U1	Digikey: MC9S12XDT512CAA-ND	
35	42	IC, MAX3232CSE Narrow 16-SOIC	U4	MAX232CSE+-ND	Texas Inst MAX3232CDR Maxim MAX3232CSE+-ND
44					
45	1	Crystal 24.00MHz, SMD, 50ppm 20pF load cap	Y1	631-1020-1-ND	FOXSDLF/240F-20
46	1	Crystal 4.00MHz, SMD, 50ppm 20pF	Y2	XC564CT-ND	DIGIKEY
47	1	Crystal 24MHz,OSC MODULE - OPTIONAL DO NOT INSTALL	OSC1	DO NOT STUFF - ESCP85-AN-ND 24MHz	MFG: ECS ESCP85-AN-ND
47	4	Stand-off, #4-40 Female Thread, 1" long	----	3482K-ND	
48	4	Machine Screw, #4-40 x 1/4"	----	H343-ND	
49	4	Lock Washer, Int. Tooth #4-40	----	H729-ND	
50	1	Ferrite Bead	L1	490-5221-1-ND	
51	1	1uF 6.3V MLCC	C5	490-4354-1-ND	Murata: LLL219R70J105MA01 (do not sub)
52	1	4.7uF 10% 6.3V Low ESL	C6	587-1237-1-ND	Taiyo Yuden JWK212C6475KD-ND
53	1	LC Filter 2200pF 1206	LCF1	490-2547-1-ND	Murata NFE31PT222
54	4	3M Bumpom		SJ5746-0-ND	3M: SJ61A1



## REVISION HISTORY

Revision	Date	Description of Change
AN-160, Rev. New	2-11-11	Initial Release
AN-160, Rev. A	3-4-11	Updated revision number text on screen console example
AN-160, Rev. B	4-2-12	Update daughter card schematic/BOM C3, C4 capacitors to 125C and remove power resistors and replace with jumpers.