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HI-8435 32 Sensor Array with Ground/Open or Supply/Open Sensors and SPI interface. Evaluation Board

User Guide
March 2, 2015

INTRODUCTION

The Holt HI-8435 Evaluation Board demonstrates the features of the HI-8435 32 Sensor IC. The board and the HI-8435 run from a single 3.3V+/- 5% supply voltage. The sensor input thresholds are programmable from 2V to 26V. The EVM (Evaluation Module) plugs into a Holt 'General Purpose SPI Evaluation Board, based on a 16 bit, Freescale MC9S12XDT512 microcontroller motherboard. The Holt CD, included with the evaluation kit, contains example source code, allowing the customer an easy path to developing their own control software. The mother board MCU uses an SPI interface to communicate with the HI-8435. Switches and LEDs help navigate the operating modes and confirm data and status information. A Serial UART output from the MCU provides debug and data messages to be sent to a PC using any terminal emulation program such as HyperTerminal. The HI-8435 Evaluation Board plugs into to the Holt General Purpose SPI board through a 26 pin connector, as shown in the diagram below:

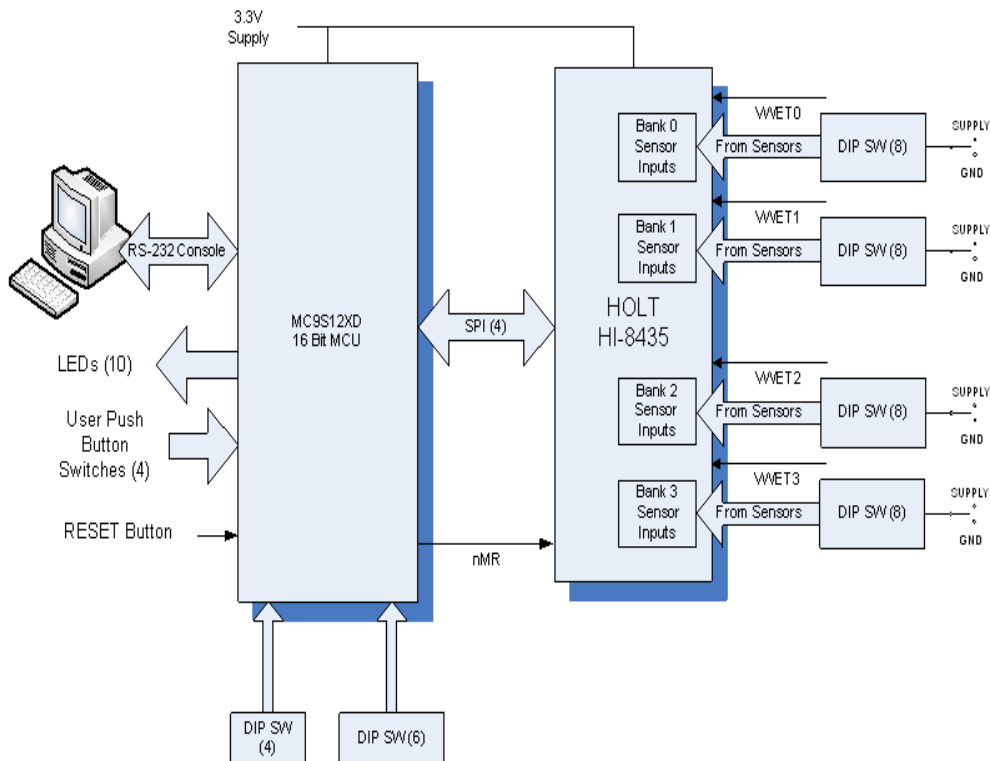


This guide summarizes how to get set up and running quickly. Additional support material is provided on CD-ROM.

KIT CONTENTS

- This User Guide.
- General Purpose SPI Evaluation board.
- HI-8435 Evaluation Board (daughter card).
- CD with HI-8435 Users Guide and example source code.
- RS-232 9 Pin Serial Cable.

Demonstration Set-up



Default Jumper and Switch Settings

HI-8435 Board

JUMPER	POSITION	DESCRIPTION
J8	ON	GND Link for HI-8435 supply
J9	ON	VDD Link for LED supply current (disconnect to measure HI-8435 supply current at TP13)
J5	3	Bank 0 = Left Supply/Open, Right = GND/Open
J6	3	Bank 1 = Left Supply/Open, Right = GND/Open
J7	3	Bank 2 = Right Supply/Open, Left = GND/Open
J10	3	Bank 3 = Right Supply/Open, Left = GND/Open
J9	ON	VDD Link FOR HI-8435 and LED supply current (disconnect and use ammeter to measure HI-8435 supply current, after removing LED jumper)

SW1	POSITION	DESCRIPTION
1-8	All ON	Sensor input for Bank0, Sensors 0-7
SW2	POSITION	DESCRIPTION
1-8	All ON	Sensor input for Bank1, Sensors 8-15
SW3	POSITION	DESCRIPTION
1-8	All ON	Sensor input for Bank2, Sensors 16-23
SW4	POSITION	DESCRIPTION
1-8	All ON	Sensor input for Bank3, Sensors 24-31

SPI Board

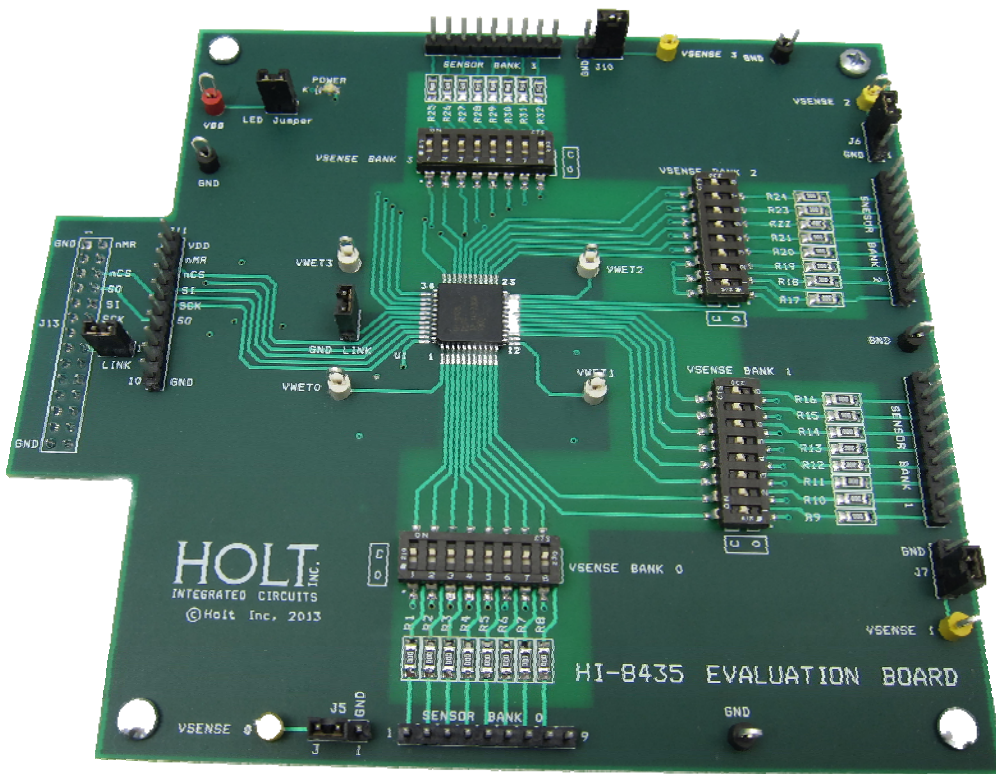
JP	POSITION	DESCRIPTION
1	Open	
2	Open	
3	ON	
4	Open	
5	Open	
6	Open	
7	Open	

SW1	POSITION	DESCRIPTION
1	ON	BITR0
2	ON	BITR1
3	ON	BITR2
4	Open	Mode0
5	Open	Mode1
6	Open	Mode2

SW2	POSITION	DESCRIPTION
1	ON	Opt1
2	ON	Opt2
3	ON	
4	Open	Master Reset

Initial Board Set up

1. Make sure the daughter board jumpers and switch positions are in the positions shown in the picture below. J12 (VDD LINK) and J8 (GND LINK) connect VDD and GND to the HI-8435 and can be used to measure the device supply current. The 'LED Jumper' disconnects the LED so an accurate current measurement can be made.



2. For normal operation, ensure SW2 position 4 (MRST) is in the open position, otherwise the MCU will be held in the reset state. This MRST DIP switch allows easy interface of an external MCU to the HI-8435. Closing SW2 position 4 keeps the RESET pin low, forcing the Freescale MCU GPIOs into a high impedance state. For normal operation, keep this switch open and use the RESET button to reset the MCU during testing.

3. Connect a +3.3V power supply to TP1 (RED) and ground to TP6 (BLK) of the Motherboard. This also supplies the HI-8435 daughter board with the same voltage. This is the only power supply needed by this demo.
4. After a power-on reset, the program switches all LEDs on for 3 seconds; the software revision is then displayed on the LEDs for two seconds in binary format, where LED1 is the LSB. After two seconds, the LEDs are turned off.

A text message is also sent to the Console Port.

5. All control of the HI-8435 is done through the 'Control Console'. This requires use of a terminal emulator for communication, such as HyperTerminal or Tera Term.

Windows versions earlier than Windows Vista

Open HyperTerminal by clicking **Start** then **All Programs**; click the Windows **Accessories** then **Communications** program group. Double-click HyperTerminal to run it.

Windows versions Vista or later

Then HyperTerminal is not available, use the Tera Term, supplied on the CD. Run teraterm-4.71.exe installer program from the Holt CD. Accept the license agreement stating redistribution is permitted provided that copyright notice is retained. The notice can be displayed from the Tera Term window by clicking **Help** then clicking **About Tera Term**. Continuing to install...

- Accept the default install destination and click **Next**.
- At the Select Components screen, unselect all options except Additional Plugin = TTXResizeMenu and click **Next**.
- Select the installed language, then click **Next**.
- Accept the default Start Menu folder, then click **Next**.
- Select any desired shortcuts, then click **Next**.
- At the Ready to Install screen, click **Install**.

Run the Tera Term program. At the **New Connection** screen, select **(x)Serial** and choose the selected COM port, find the correct COM port using **Device Manager**.

6. Click **Setup** then **Serial Port** to open the serial port setup window.

Choose these settings: Baud Rate: 115200, Data: 8 bits, Parity: none, Stop: 1 bit, Flow Control: none

If your PC has a serial port, using the DB-9 serial cable provided, connect the MCU board to the computer serial (COM) port. If your PC only has USB connectors then use a USB to serial converter (dongle) to connect (not provided).

7. The evaluation software is installed in the Motherboard microcontroller; this has been pre-loaded at the Holt Applications Support Center. On power up, the software displays a message on the monitor, as shown below.
8. Note: If under any circumstances, this software locks up, use the 'RESET' key on the SPI board to recover.

```

COM3:115200baud - Tera Term VT
File Edit Setup Control Window Help
Holt HI-8435 Demonstration Software Revision: 0.6

***** HOLT HI-8435 Serial Console Commands *****

Read HI-8435 all registers                0
Reset HI-8435 using the MRB pin          1
Program Sense Banks                      2
Set Input Test Mode                      3
GND/OPEN Threshold and Hysteresis       4
SUPPLY/OPEN Threshold and Hysteresis    5
Write to a register 1 byte               6
Read a register. 1 byte                  7
Monitor a sensor Bank on LEDs1-8 & PA7  8
Set Test Mode                            9
Monitor Sensors (hit any key to exit)   10
Set Preset Threshold and Hysteresis     11
Soft Reset                              12
Self Test digital section                13

Enter Selection: █

```

9. Press key '1' to perform a Hardware Reset. Then press key '0' to read and display values of all read registers, it shows the default state as shown below:


```

COM3:115200baud - Tera Term VT
File Edit Setup Control Window Help
0
HI-8435 Read all Registers
Control Reg                                0x00
Sense Bank Control Reg                     0x00
GND/OPEN Hysteresis      Reg BA.1         0x00
GND/OPEN Threshold      Reg BA.0         0x00
Supply/OPEN Hysteresis   Reg BC.1         0x00
Supply/OPEN Threshold   Reg BC.0         0x00
Test Mode Reg            0x00
Sensor Bank 0            0x00
Sensor Bank 1            0x00
Sensor Bank 2            0x00
Sensor Bank 3            0x00

Sensors - All Banks      0x00
                          0x00
                          0x00
                          0x00

Press any key to return to main menu

```

10. DIP switches SW1-4 set a voltage level on the sensors inputs; there is one set of switches for each bank of sensors. The voltage source to the switches is selected using jumpers J4-7, with the jumper in the inner position the source is ground. When jumpers J4-7; are in position 3 the test point adjacent to the jumper is used to connect a sensor supply.

11. Initially it is easier to test the Supply/Open sense mode as no VWET current is required. To do this, ensure all switches and jumpers are in the default positions as shown at the beginning of this guide.

With software displaying the Main Menu, screen press key 2. This brings up the Program Sense Menu as shown below:

```
COM3:115200baud - Tera Term VT
File Edit Setup Control Window Help
2
Program Sense Bank
0 = Program All Sensors GND/Open
1 = Program All Sensors Supply/Open
2 = Program Even Bank Supply/Open
3 = Program Odd Bank Supply/Open
4 = Program Register directly
Q = Return to main menu
Enter Test Mode number
█
```

Select 'Program All Sensors Supply/ Open' by pressing key '1', then 'q' to return to Main Menu. Press '0' again to read registers and verify that the Sense Bank Control reads 0x0F, see below. All 32 sensors are now set to detect the Supply/Open states.

```

COM3:115200baud - Tera Term VT
File Edit Setup Control Window Help
0
HI-8435 Read all Registers
Read Control Reg                0x00
Sense Bank Control Reg          0x0F
GND/OPEN Hysteresis             Reg BA.1 0x00
GND/OPEN Threshold              Reg BA.0 0x00
Supply/OPEN Hysteresis          Reg BC.1 0x00
Supply/OPEN Threshold           Reg BC.0 0x00
Test Mode Reg                   0x00
Sensor Bank 0                   0xFF
Sensor Bank 1                   0xFF
Sensor Bank 2                   0xFF
Sensor Bank 3                   0xFF
Sensor Bank All Banks           0xFF
                                0xFF
                                0xFF
                                0xFF

Press any key to return to main menu

```

12. Return to the main menu. The thresholds now need to be set. There are two ways to do this:

- 1: Preset software settings, key 'P'.
- 2: Manual threshold selection, keys '4' and '5'

If using the preset method, a screen like that shown below is displayed. Select the preset that fits your usage; for example key '1', Airbus. This sets the VTHL and VTHH thresholds as shown below:

GND/Open

$$VTLO \text{ is } (7.5 - 6/2) = 4.5V$$

$$VTHI \text{ is } (7.5 + 6/2) = 10.5V$$

Supply/Open

$$VTLO \text{ is } (9 - 6/2) = 6V$$

$$VTHI \text{ is } (9 + 6/2) = 12V$$

```

COM3:115200baud - Tera Term VT
File Edit Setup Control Window Help
Monitor a sensor Bank on LEDs1-8 & PA7 9
Set Test Mode t
Monitor Sensors (hit any key to exit) e
Set Preset Threshold and Hysteresis m
Soft Reset r
Self Test digital section s

Enter Selection: p

Stored Settings

0 = Minimum (Thresh = 2.5V, Hyst = 1V)
1 = Airbus (GND/Open Thresh = 7.5V, Hyst = 6V)
   (Supply/Open Thresh = 9V, Hyst = 6V)
2 = Maximum (Thresh = 20.5V, Hyst = 1V)
Q = Return to main menu

Enter preset number, one digit

```

13. If preferred, use the second option; manually setting thresholds and hysteresis, using keys 4 and 5. See screen below:

```

COM3:115200baud - Tera Term VT
File Edit Setup Control Window Help
GND/OPEN Threshold and Hysteresis 4
SUPPLY/OPEN Threshold and Hysteresis 5
Write to a register 0 byte 6
Write to a register 1 byte 7
Read a register. 1 byte 8
Monitor a sensor Bank on LEDs1-8 & PA7 9
Set Test Mode t
Monitor Sensors (hit any key to exit) e
Set Preset Threshold and Hysteresis m
Soft Reset r
Self Test digital section s

Enter Selection: 4

HI-8435 Set GND/Open Threshold/Hysteresis Register

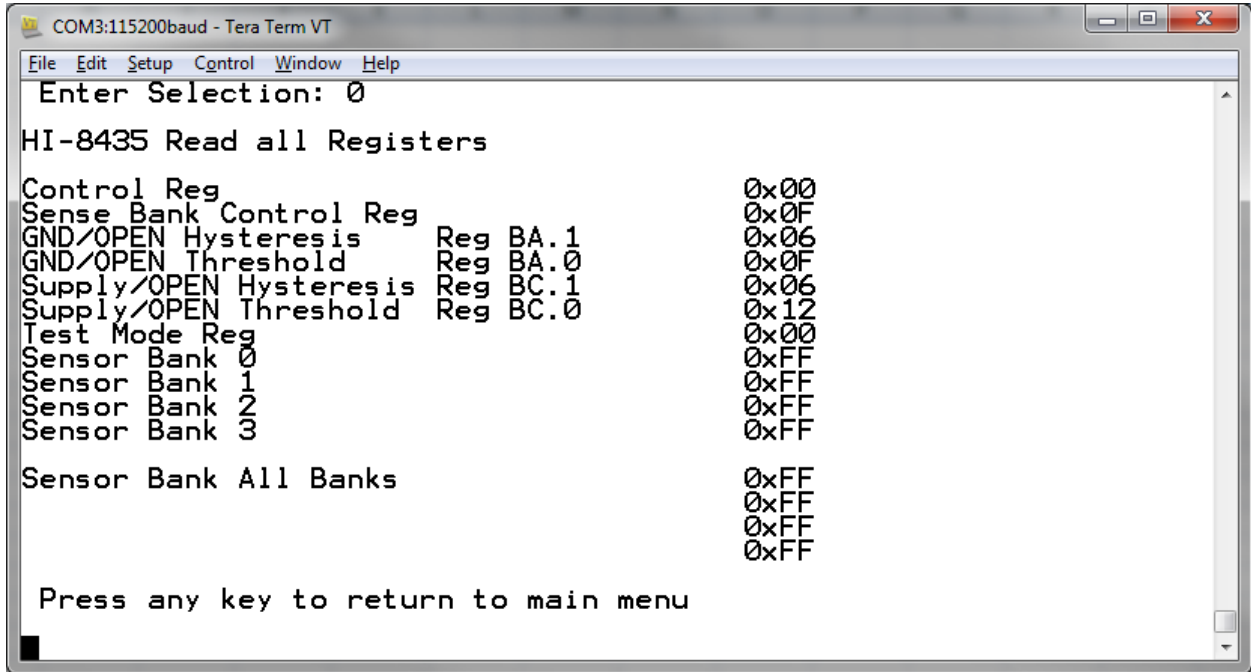
Hysteresis is set at = 0x06
Threshold is set at = 0x12

Enter Hysteresis value (two Hex digits) or q/Q to quit
Enter number : █

```

Enter the hysteresis value as two hex digits, (06) then threshold (0F), press Q, then 5 and set Supply/Open thresholds, 06, 12.

14. Press 'q' to return to the main menu. Do a register read again to verify that register values were set correctly, see screen below:



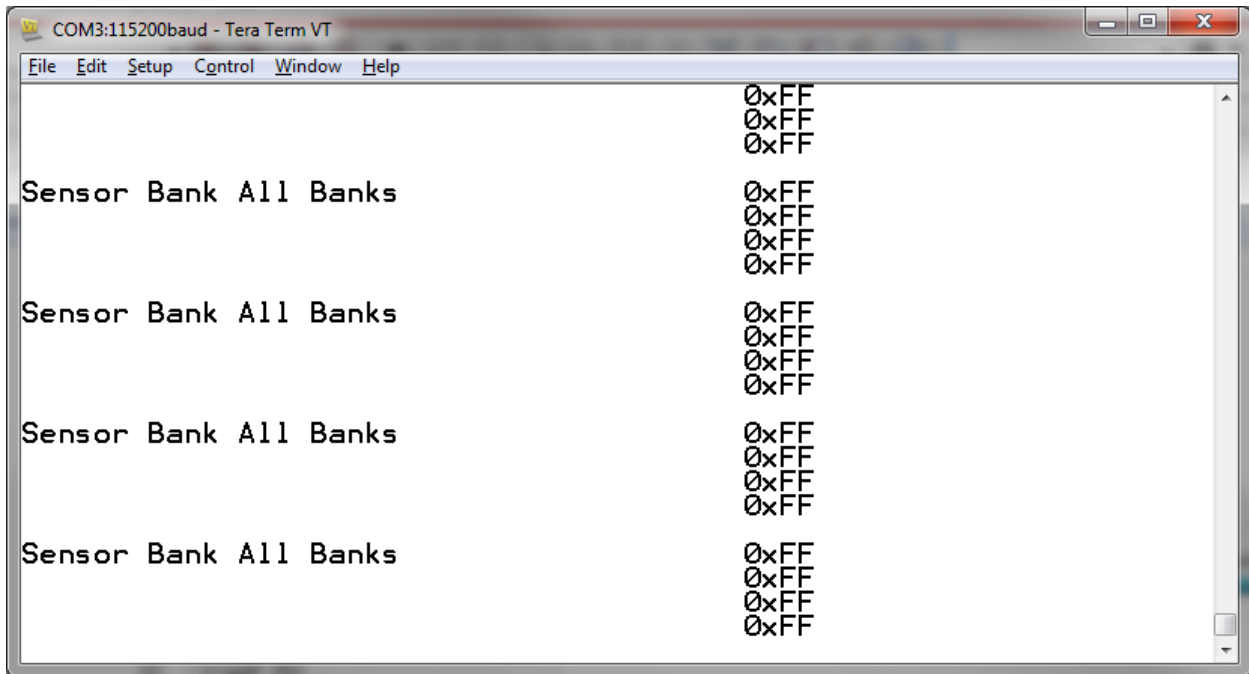
```
COM3:115200baud - Tera Term VT
File Edit Setup Control Window Help
Enter Selection: 0
HI-8435 Read all Registers
Control Reg                                0x00
Sense Bank Control Reg                     0x0F
GND/OPEN Hysteresis Reg BA.1              0x06
GND/OPEN Threshold Reg BA.0              0x0F
Supply/OPEN Hysteresis Reg BC.1          0x06
Supply/OPEN Threshold Reg BC.0          0x12
Test Mode Reg                              0x00
Sensor Bank 0                              0xFF
Sensor Bank 1                              0xFF
Sensor Bank 2                              0xFF
Sensor Bank 3                              0xFF

Sensor Bank All Banks                      0xFF
                                           0xFF
                                           0xFF
                                           0xFF

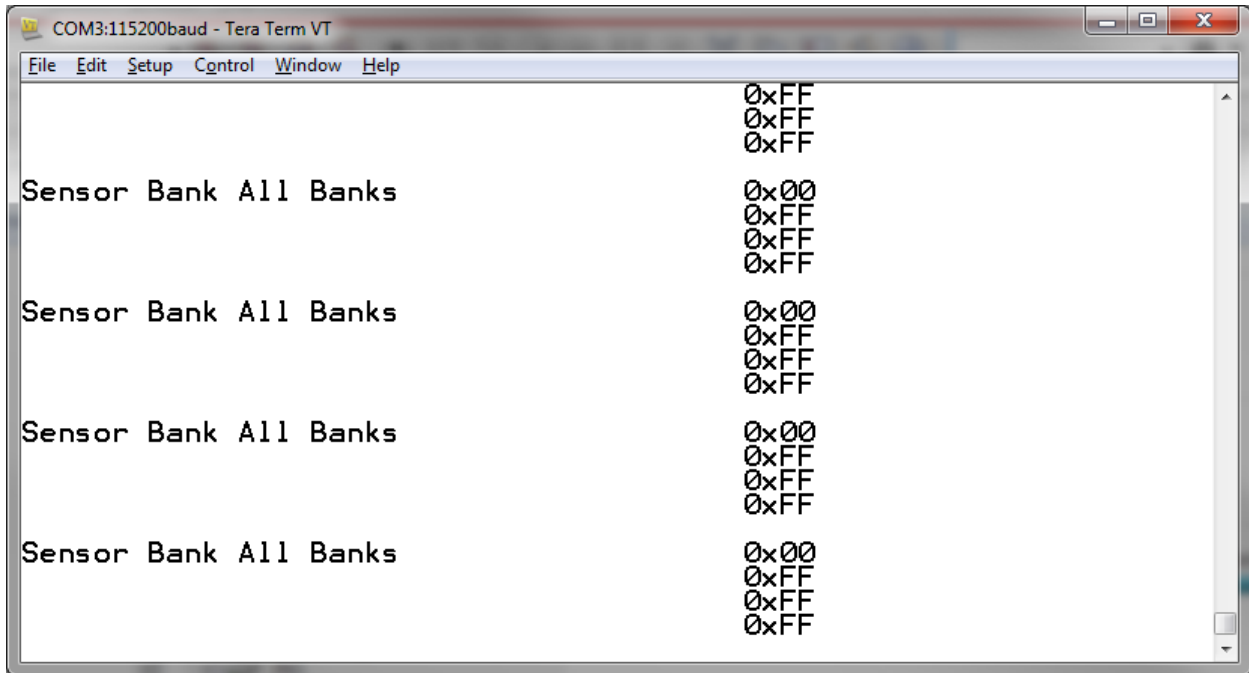
Press any key to return to main menu
```

15. If you used the example values, a threshold of 9V is set with a hysteresis of 6V for the Supply/Open mode, this results in $V_{THL} = 6V$ and $V_{THH} = 12V$. This can be tested by connecting a voltage source to the test point on VSENSE0. Make sure all DIP switches are in the default position.

Return to the main menu then select the monitor mode by pressing button 'm'. This displays a screen that continually monitors the sensor banks. A screen like the one below will appear.



16. The screen above is monitoring the four register banks. 0xFF means all 8 sensor bits are at a '1' state. In Supply/Open, this means Opens are detected. Now connect a 0V source to the VSENSE0 test point. Increase the voltage up to +12V. Approaching 12V, Bank0 should start reading 0x00, indicating a closed switch has been detected, as shown in the screen below.



17. Now slowly reduce the voltage. Approaching 6V, Bank 0 should start reading 0xFF again. This verifies the threshold levels.
18. Return to the main menu by pressing any key. The GND/Open mode will be evaluated next. Press key '2' and then key '0'. Then press 'q' to return to Main Menu. Press '0' again to read registers and check that the 'Sense Bank Control Reg' reads 0x00, see below. All 32 sensors are now set to detect the GND/Open states.

```

COM3:115200baud - Tera Term VT
File Edit Setup Control Window Help
Enter Selection: 0
HI-8435 Read all Registers
Control Reg                                0x00
Sense Bank Control Reg                    0x00
GND/OPEN Hysteresis      Reg BA.1         0x06
GND/OPEN Threshold      Reg BA.0         0x0F
Supply/OPEN Hysteresis  Reg BC.1         0x06
Supply/OPEN Threshold   Reg BC.0         0x12
Test Mode Reg          0x00
Sensor Bank 0          0xFF
Sensor Bank 1          0xFF
Sensor Bank 2          0xFF
Sensor Bank 3          0xFF
Sensor Bank All Banks 0xFF
                          0xFF
                          0xFF
                          0xFF
Press any key to return to main menu

```

19. If threshold are using the example values, threshold = 0F and hysteresis = 06 gives a center threshold of 7.5V and a hysteresis of 6V, corresponding to a VTHL = 4.5V and VTHH = 10.5V.
20. A sensor bank or an individual sensor can also be monitored using the '9' key. For example press key '9', then key 0, to select Bank 0. You then have a choice of selecting all sensors from that Bank, or selecting just one. Press key '1'. The selected the sensor outputs are shown on LEDs 1-8, corresponding to sensors 0-7 of that bank

```

COM3:115200baud - Tera Term VT
File Edit Setup Control Window Help
Read a register. 1 byte
Monitor a sensor Bank on LEDs1-8 & PA7
Set Test Mode
Monitor Sensors (hit any key to exit)
Set Preset Threshold and Hysteresis
Soft Reset
Self Test digital section
8
9
t
m
d
r
s
S

Enter Selection: 9
HI-8435 Read a register

Enter Sensor Bank to monitor (one digit 0-3)
Enter number : 0

Enter Sensor # to monitor (one digit 0-7), A for All
Enter number : 1
Press any key to stop █

```

21. To test sensor 1, bank 0 connect a voltage source to test point VSENSE0, all SW1 switches should be in the 'OFF' position, except switch 2 should be 'ON'. With 0V, LED2 should be lit. Ramp up the voltage on VSENSE; at around 10.5V the LED should go off, indicating the sensor has detected an OPEN. Slowly reduce voltage at around 4.5V the LED should come back on, indicating the sensor has detected a CLOSED.
22. In this monitor mode, the sensor state can also be monitored on pin PA7 of the SPI mother board, when the sensor changes state so does the level on PA7. This output can be used to trigger an oscilloscope or a data logger to capture the threshold trigger point.

Connecting external sensors

To connect an external sensor, first make sure the corresponding DIP switch on switches SW1-4 is in the 'OPEN' state. The sensor wires can be connected to the board on the pin headers J1 to J4, see table below.

When using GND/Open sensors, the VWET terminal must be used to pull up the sensors to the higher VWET voltage. With VWET at 28V and VLOGIC at 3.3V, the wetting current will be approximately 0.88mA. If additional wetting current is required, connect an external resistor from VWET to the sense line. There are four VWET terminals, one for each bank of sensors, so the voltage should be applied to the corresponding VWET terminal on the board for that bank. See datasheet for more guidance on wetting current tables and adjustment.

Pin Number	Sensor Number			
	J1	J2	J3	J4
1	0	8	16	24
2	1	9	17	25
3	2	10	18	26
4	3	11	19	27
5	4	12	20	28
6	5	13	21	29
7	6	14	22	30
8	7	15	23	31
9	GND	GND	GND	GND

Connection pins for external sensors

Stand Alone Operation

The evaluation board can be used in a standalone mode (without the lower MCU board). It requires the customer to have access to a SPI interface. Power should be connected between the VDD terminal and ground. The SPI controller should then be connected to J11, using the following pin connections:

Pin Number	Label	Description
1	VDD	VDD, 3.3V Supply
2	nMR	Master Reset
3	CSn	Chip Select
4	SI	Serial Input to HI-8435
5	SCK	Serial Clock Input (up to 20MHz)
6	SO	Serial Output from HI-8435
7	-	Not Used
8	-	Not Used
9	-	Not Used
10	Supply Ground (0V)	GND

J11 connection pins, for external SPI

Other Modes

An internal test mode is present on the HI-8435. This can be selected up by hitting key 't' from the main menu. Hit key '3'. Another screen will appear allowing the HI-8435 to internally set the sensor inputs. This test mode can set the internal sensors input to:

- a) All Inputs Set Low (GND)
- b) All Inputs Set High (VDD)
- c) Odd Inputs Set Low (GND)
- d) Odd Inputs Set High (VDD)

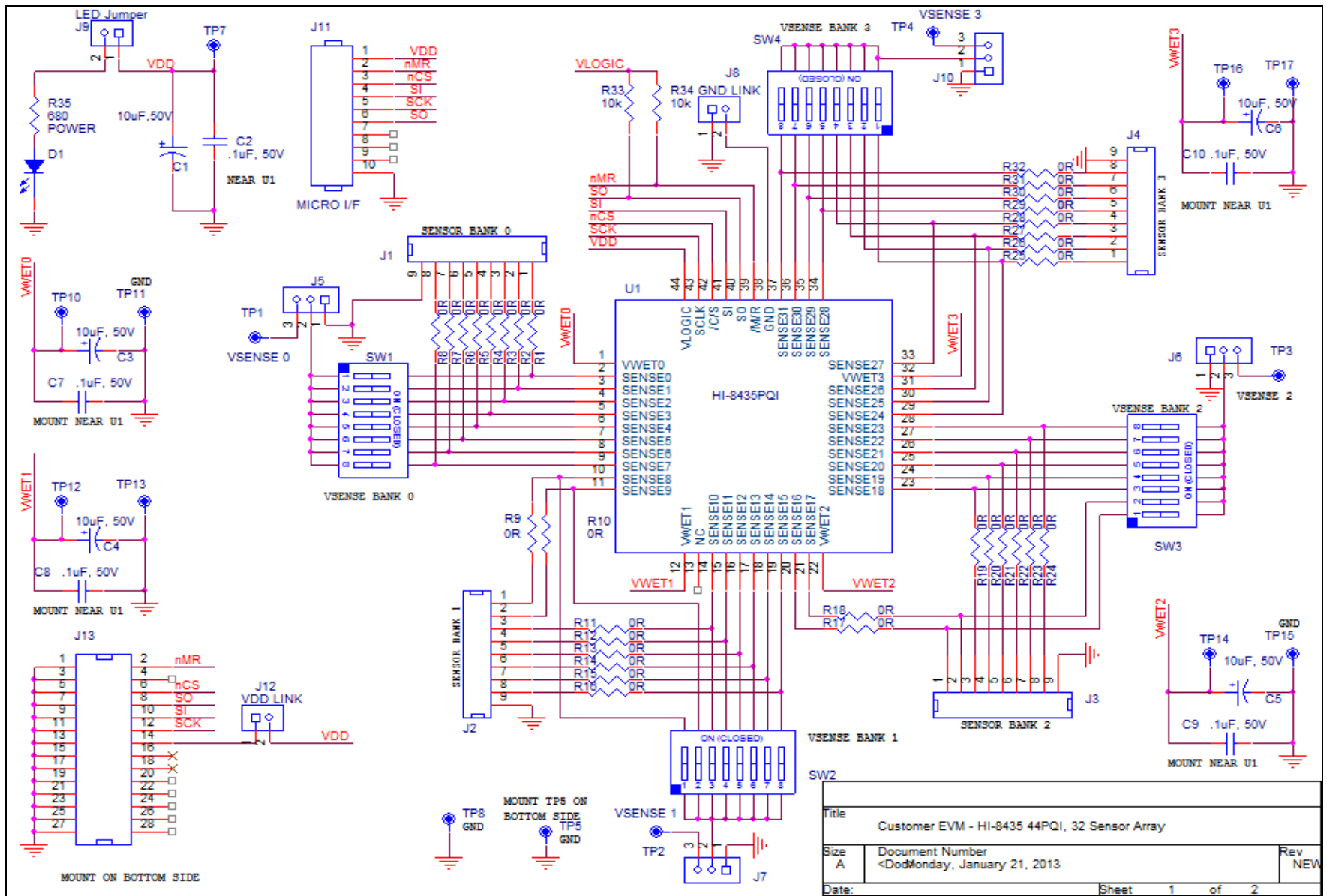
After setting the inputs and the sensors bits, use the key '0' command to read back the sensor data to verify correct operation. To exit test mode, a Hardware or Software reset should be used. Note that before using the test mode the minimum thresholds should be set, otherwise false failures could occur.

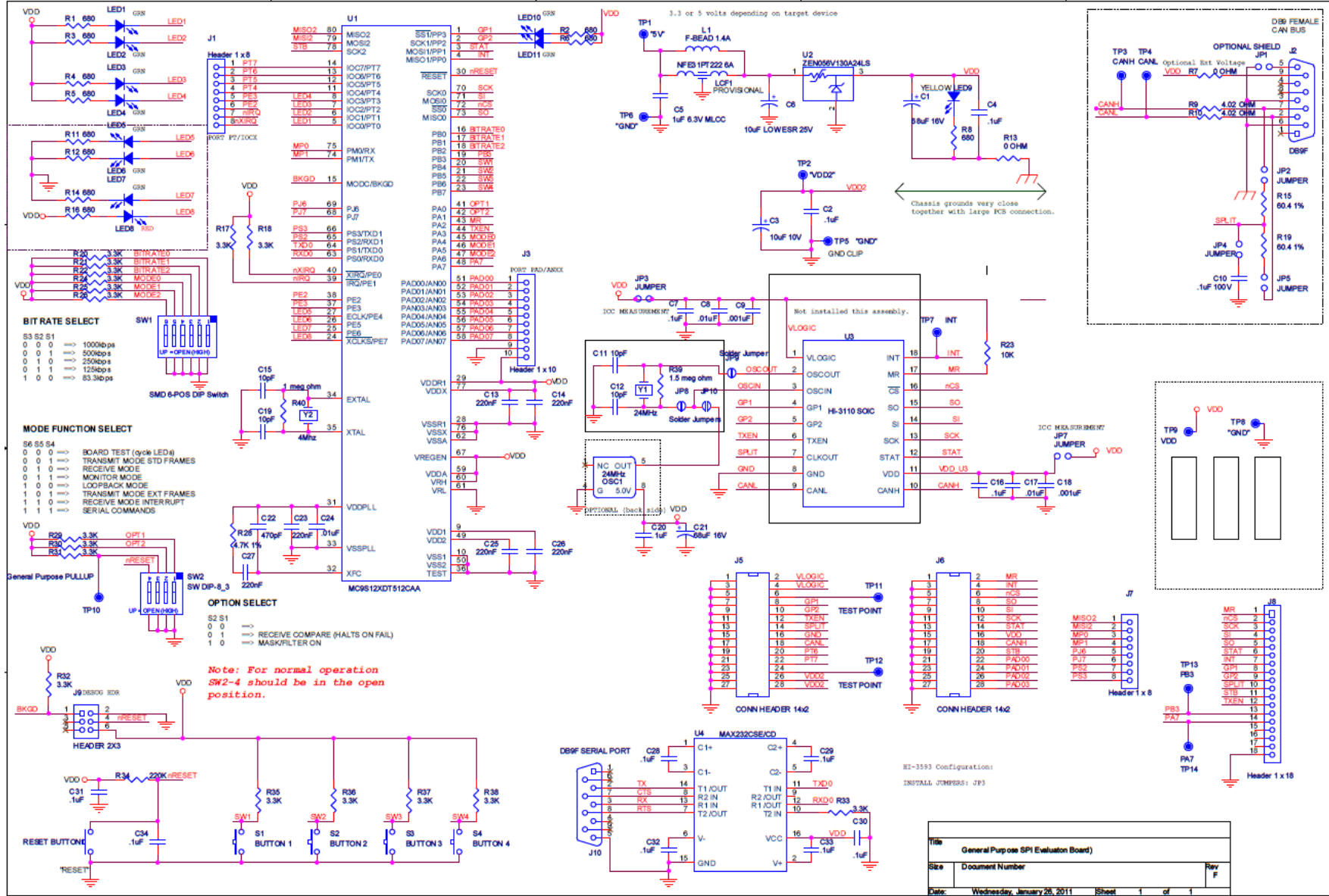
Self Test

The self test feature (key 'S' in the menu) runs through the internal test modes; testing the only the digital section of the device. If a register fails this will be reported or if a sensor fails, the Bank and pattern that failed will be shown on the screen.

Soft Reset

This resets all registers to the default state.





Appendix 1 Lightning Protection

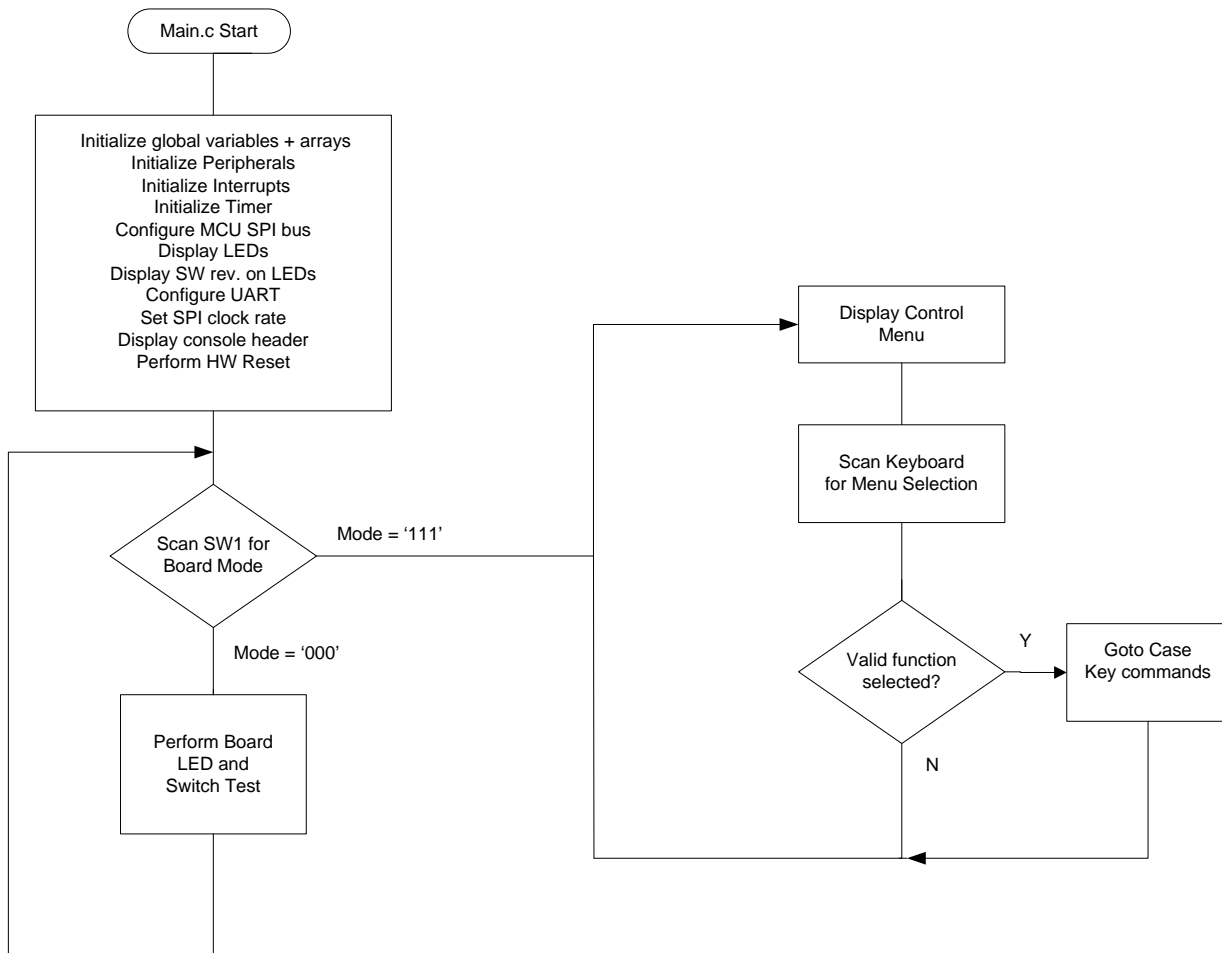
All sense inputs are protected to RTCA/DO-160G, Section 22, Categories AZ and BZ, Waveforms 3, 4, 5A, with no external components. In addition, all inputs are also protected to ZZ, Waveforms 3 and 5B, to provide more robustness in composite airframe applications. For details of the Z levels please see the latest datasheet.

The level of lightning protection can be increased by adding a resistor in series with the sensor input. On the Evaluation Board these resistors, R1-32, are populated with 0 ohm links, the value of R1 to R32 can be changed, refer to Application Note AN-305, available from the Holt website.

The layout of a HI-8435 board should always have low conductivity paths from the device power/ground pin to the relevant power or ground origin. These paths should avoid proximity to sense or other signal traces; this applies to above and below as well as horizontally. It is good practice to have a power and ground 'moat' beneath the sense line to prevent disturbance on these lines during a 'lightning' event.

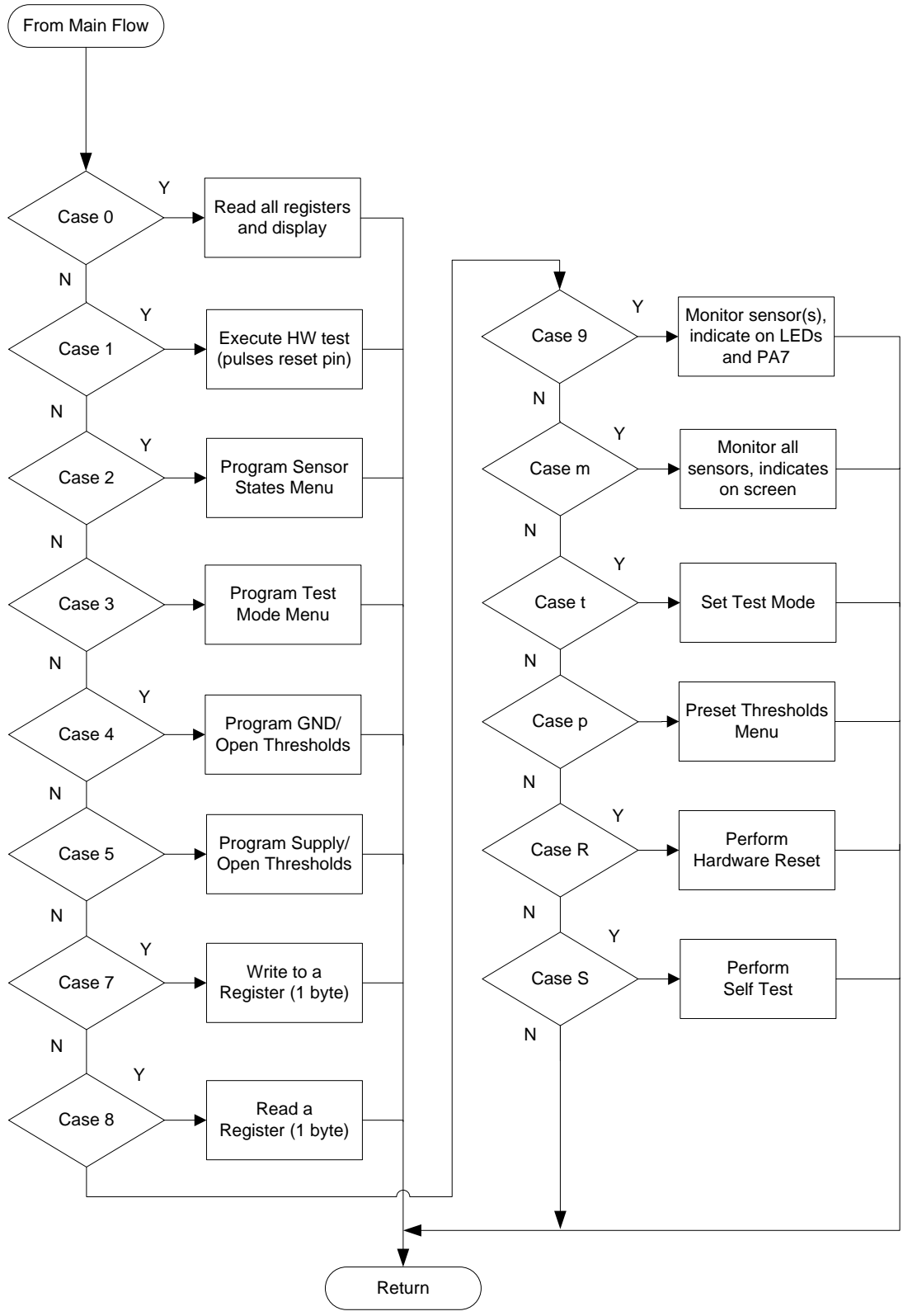
Appendix 2 Demo software overview

This overview flow chart shows the demo program at a glance.



At reset the program can enter either of two modes, Board Test mode or Serial Command mode, this is selected by the three mode switches. To restart in a different mode, reconfigure the mode switches and reset the board. Board test mode is just used to test some basic functions on the main SPI board, such as switches and LEDs.

Serial Command mode is used for the demonstration of the HI-8435.



MCU Clock and SPI Frequencies

The Freescale MC9S12XDT512 (MCU) on the main board uses a 4MHz crystal for operation and the built-in PLL multiplies this by 20 to achieve an 80MHz system clock. This system clock is divided by two for a 40MHz Bus Clock, used internally for the MCU peripherals.

The PLL is programmed to multiply by 20 by this line of code in the Peripherals.c module:

```
SYNR = 9;                // 80MHz PLL system clock
```

The SPI frequency is set by this code in the main.c module:

```
    if(!SW4)                // Set SPI to 10Mhz if SW4 pressed at power up
    {
        SPI0BR = 0x01;        // 10MHz SPI
        xprint("SPI = 10MHz ");
    } else
        SPI0BR = 0x00;        // 20MHz SPI

if(!SW3) {

    SPI0BR = 0x02;            // 5MHz SPI
    xprint("SPI = 5MHz ");
}
```

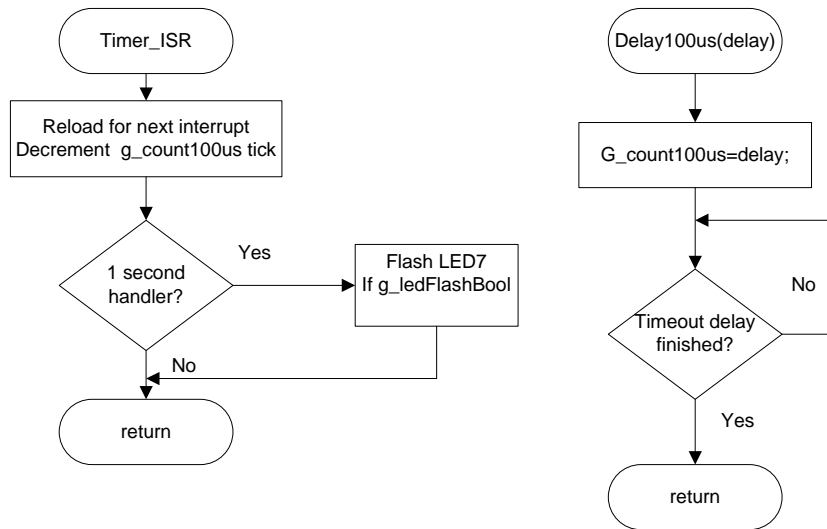
The maximum SPI frequency for the HI-8435 is 20MHz and is set by default. By pressing SW4 during reset a 10MHz clock can be set. Similarly a 5MHz clock can be set by pressing SW3.

Timing and Delay Functions

These functions provide the basic timing for the program. The Delay100us() can be used anywhere an accurate delay is needed in the program .

The global g_count100us variable is decremented at the 100us timer rate. This variable is used by a general delay function which can be called with a specified number of delay intervals. The g_count100us variable is a 16-bit integer so the delay ranges from 100us to 6.5536 seconds.

```
// -----
// General timer tick 100us for delays
// -----
void Delay100us(unsigned int delay){
    g_count100us=delay;
    while(g_count100us);
}
}
```



A number of predefined constants are defined which can be used by calling the function with these constants.

```

#define K_1MS 10 // 1ms
#define K_10MS 100 // 10ms
#define K_100MS 1000 // 100ms
#define K_1SEC 10000 // 1 second

```

Usage: Delay100us(K_1SEC); // delay for one second

A one second interrupt handler in the TIMER_ISR is provided. Any code placed here automatically executes every second.

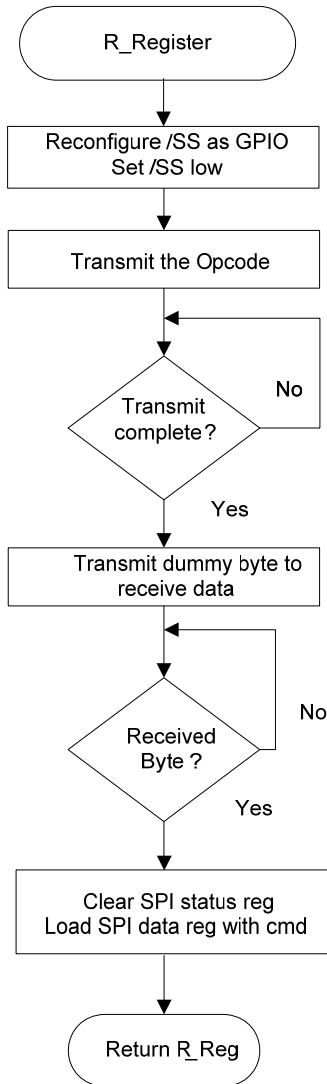
```

if(!count100us)
{
    count100us = K_1SEC; // 1 second scheduler
    if(ON==g_ledFlashBool) // Flash the LED7 if enabled
        LED7 ^= TOGGLE;
}

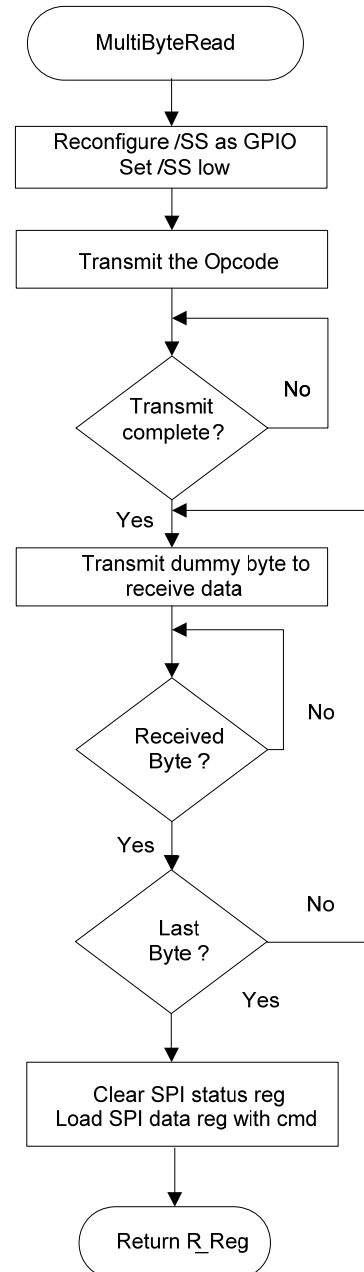
```

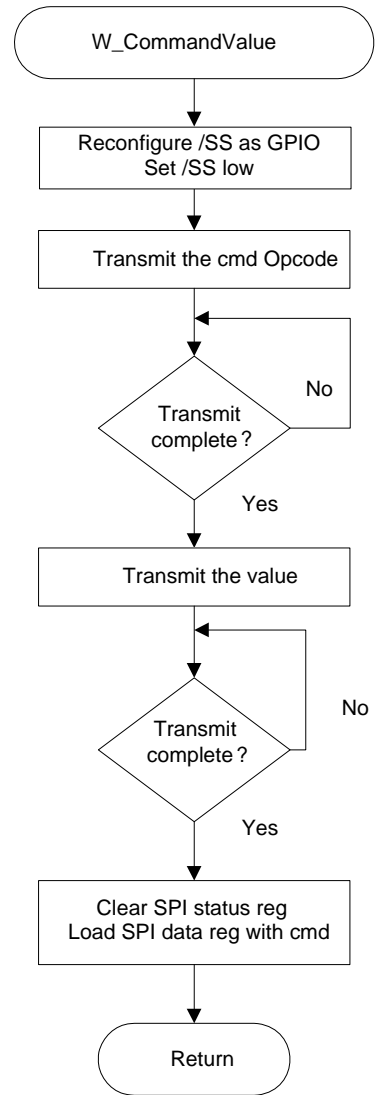
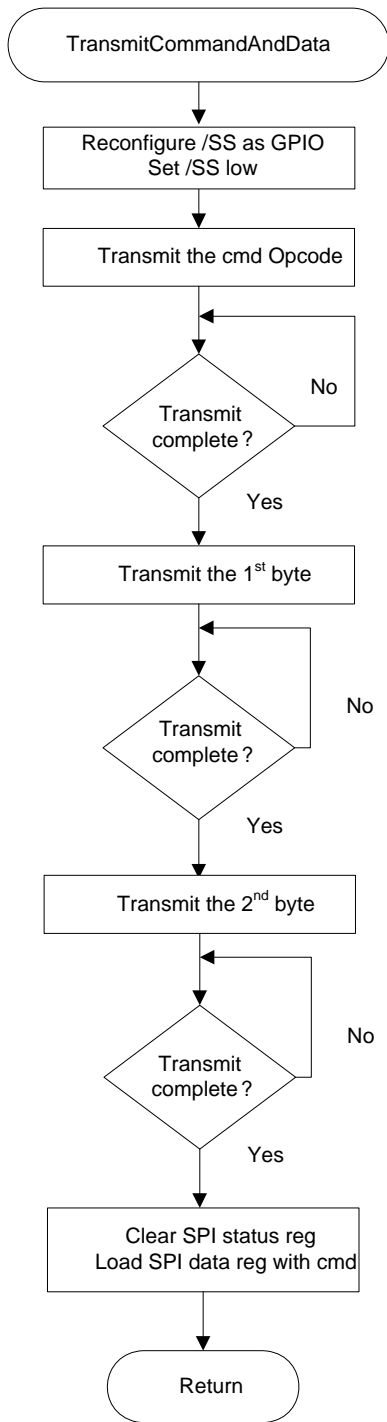
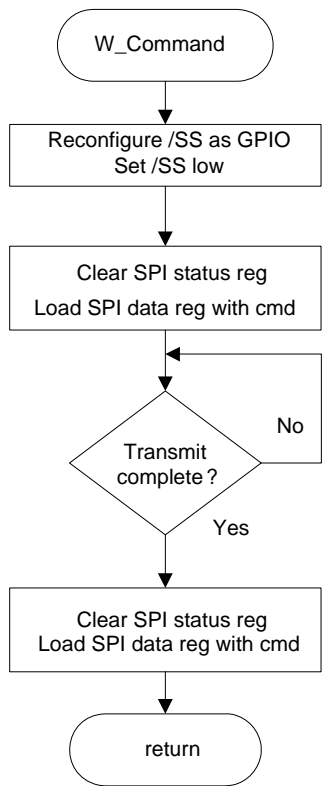
SPI Driver Functions

There are five SPI functions used in the program, these primitive SPI functions make up the basic read and write functions to access the SPI interface of the HI-8435. More complicated functions perform multi-byte reads or writes; these are basically derivatives of the simpler single-byte functions. All HI-8435 SPI driver functions are included in the 8435Driver.c module and its 8435Driver.h header file. The MCU /SS pin is connected to the HI-8435 /CS pin.



SPI Read Functions



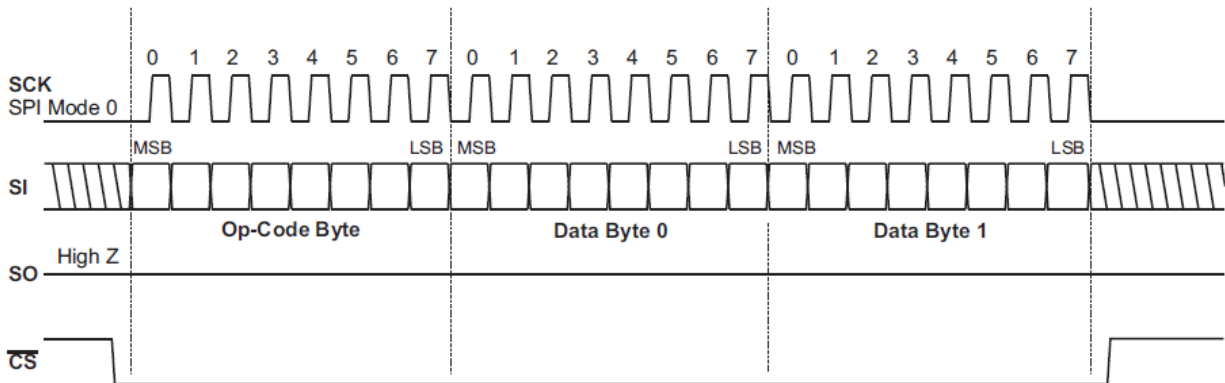


SPI Write Functions

Special handling of the /SS SPI signal:

All HI-8435 SPI Op-Codes require the /CS to remain low for the complete duration of the data transfer including multi-byte reads and writes. Refer to figures 5, 6 and 7 of the data sheet for timing diagram examples.

To achieve this, the default SPI slave select line /SS in the Freescale MCU must be reconfigured as a GPIO and controlled by software. This technique is common for devices requiring the /CS line to remain low during multi-byte transfers. All SPI accesses will consist of an integer number of 8-bit segments, either an opcode or data. The first positive SCK edge must occur after /CS is asserted low; the last falling SCK edge must occur before the /CS is negated high as shown in the following diagram:



Uart.c Serial Port (RS-232)

The drivers supporting the serial port (console) are contained in this module. Some function drivers allow messages to be sent and received on the UART. This is useful to log status or data messages on HyperTerminal or any other terminal program. It currently uses polling to determine when the data receive or transmit registers can be read or written.

LEDs

LED1-LED8

These LEDs are controlled by a function in the program. LED1-LED4s and LED8 are low true logic and LED5-LED7s are high true logic. Using this support function allows a universal way to turn the LEDs on and off from the program. The Freescale MC9S12DT part uses the pins PE5, PE6, PE7 for configuration sense pins during reset, so the logic on these three pins need to be reversed so the MCU sees a low at reset time.

```

// Control LED1 - LED8
// ledNumber: LED_1,LED_2,LED_3,LED_4...LED_8 [1-8]
// OnOff: 1=ON, 0=OFF
// -----
void LED_CTL(uint8 ledNumber, uint8 OnOff){
#if NEWBOARD
    if(ledNumber>4 && ledNumber<8)// LEDs 5-7 have reversed HW logic so invert
                                     these 3
#else
    if(ledNumber>4)                // Old board.
#endif

    OnOff = ~OnOff;
    switch (ledNumber){
        case 1: LED1=OnOff; break;
        case 2: LED2=OnOff; break;
        case 3: LED3=OnOff; break;
        case 4: LED4=OnOff; break;
        case 5: LED5=OnOff; break;
        case 6: LED6=OnOff; break;
        case 7: LED7=OnOff; break;
        case 8: LED8=OnOff; break;
        default: break;
    }
}

```

Usage examples:

```

LED_CTL(LED_1,OFF);           // turns off LED1
LED_CTL(LED_1,ON);           // turns on LED1

```

A similar function, LED_BYTE(uint8 LEDByte), sends a byte to control LED1 though LED8, with a '1' powering up the LED and a '0' turning it off. LED1-LED8 map to bits 0 to 7.

LED 9

When illuminated this indicates the VDD supply is present.

LED 10, 11

These are not used in this program.

HI-8435 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-8435 drivers are in the 8435Driver.c file. The software project "HI-8435 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 PE Micro "USB Multilink Interface" 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. See the links at the end of this document.

Project Files

Source Files

main.c	Main code
8435Driver.C	SPI low-level drivers for the HI-8435
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

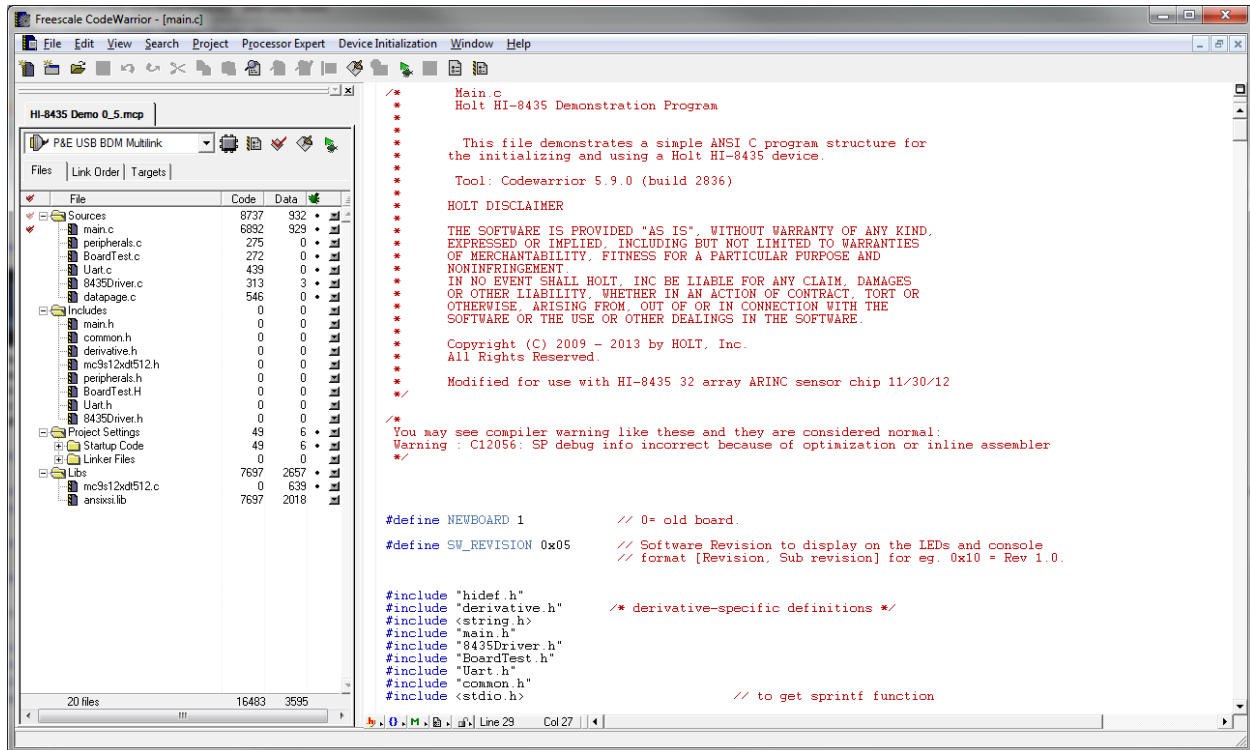
Include Files

Main.h	
8435Driver.h	HI-8435 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 Installation:

1. Download and install the CodeWarrior IDE from the Freescale website. The download links are provided below.
2. Unzip the HI-8435 zip file into the directory you plan to use for your project.
3. Navigate to the HI-8435 project folder and double click the HI-8435 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 you download you may need to configure the debugger 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-8435 project loaded with 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

If these links become out of date go to: <http://www.freescale.com/>, then search for information on "S12XD: 16-Bit Automotive Microcontroller".

A Free 32K limited version of the Code Warrior IDE from Freescale is available:

http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=CW-HCS12X&tid=CWH#

The US Multilink debugger cable used for this project is:

http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=USBMULTILINKBDM&parentCode=S12XD&fpssp=1

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



References:

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

Bill of Materials: 8435 Evaluation Board

Item	Qty	Description	Reference	DigiKey	Mfr P/N
1	1	PCB, Bare, Eval Board	N/A	-----	JetTech 34539
2	5	Capacitor, Cer 0.1uF 20% 50V Z5U 0805	C2,C7,C8,C9,C10	399-1176-1-ND	Kemet C0805C104M5UACTU
3	5	Cap Alum 10uF 50V 20% SMD	C1,C3,C4,C5,C6	493-6255-1-ND	Nichicon UUT1H100MCL1GS
4	4	Header, Male 1x9, .1" Pitch	J1,J2,J3,J4	S1012E-09-ND	Sullins S1012E-09-ND
5	4	Header, Male 1x3, .1" Pitch	J4,J5,J6,J10	S1012E-03-ND	Sullins S1012E-03-ND
6	3	Header, Male 1x2, .1" Pitch	J8,J9,J12	S1012E-02-ND	Sullins S1012E-02-ND
7	1	Header, Male 1x10, .1" Pitch	J11	S1012E-10-ND	Sullins S1012E-10-ND
8	1	Header, Female 2x14, .1" Pitch	J13	S7082-ND	Sullins PPTC142LFBN-RC
9	1	LED Green 0805	D1	160-1179-1-ND	LiteOn LTST-C170GKT
10	32	Resistor, 0 5% 1/4W 1206	R1- R32	P0.0ECT-ND	Panasonic ERJ-8GEY0R00V
11	1	Resistor, 680 5% 1/4W 1206	R35	P680ECT-ND	Panasonic ERJ-8GEYJ681V
12	2	Resistor, 10K 5% 1/4W 1206	R33,R34	P10KECT-ND	Panasonic ERJ-8GEYJ103V
13	4	Switch Tape Seal 8Pos SMD	SW1,SW2,SW3, SW4	CT2198MST-ND	CTS 219-8MST
14	1	Test Point, Red Insulator, 0.062" hole	TP7	5010K-ND	Keystone 5010
15	6	Test Point, Black Insulator, 0.062" hole	TP11,TP13,TP8, TP5,TP15,TP17	5011K-ND	Keystone 5011
16	4	Test Point, White Insulator, 0.062" hole	TP10,TP12,TP14, TP16	5012K-ND	Keystone 5012
17	4	Test Point, Orange Insulator, 0.062" hole	TP1,TP2,TP3,TP4	5013K-ND	Keystone 5013
18	1	HI-8435PQI - 44PQFP	U1	HOLT IC	Holt IC
19	4	Stand-off, Threaded #4-40F, 3/4" Long Round	Any	3481K-ND	Keystone 3481
20	4	Machine Screw, #4-40 x 1/4"	Any	H343-ND	PMS 440 0031 PH
21	4	Lock Washer, Int.Tooth #4-40	Any	H236-ND	B&F Intlwz 004

Bill of Materials: GPSPi

Item	Qty	Description	Reference	DigiKey	Mfr P/N
1	1	PCB, Bare, Evaluation Board	N/A	-----	
2	1	RS-232 Serial Cable	Separated ordering	AE1379-ND	AK131-2-R
3	4	Capacitor, Cer 10pF 50V 5% NP0 0805	C11, C12, C15, C19	399-1108-1-ND	C0805C100J5GACTU
4	1	Capacitor, Cer 470pF 50V 5% X7R 0805	C22	399-1133-1-ND	C0805C471J5GACTU
5	6	Capacitor, Cer 220nF 10% 50V X7R 0805	C13, C14, C23, C25, C26, C27	399-3491-1-ND	Kemet C0805C224K5RACTU
6	1	1uF 6.3V MLCC	C5	490-4354-1-ND	Murata: LLL219R70J105MA01 (do not sub)
7	1	4.7uF 10% 6.3V Low ESL	C6	587-1237-1-ND	JWK212C6475KD-T
8	2	Capacitor, Cer 1nF 20% 50V 7XR 0805	C9, C18	399-1146-1-ND	Kemet C0805C102M5RACTU
9	3	Capacitor, Cer 0.01uF 20% 50V 7XR 0805	C8, C17, C24	399-1160-1-ND	Kemet C0805C103M5RACTU
10	13	Capacitor, Cer 0.1uF 10% 25V X7R 0805	C2,C4,C7,C10,C16,C20,C28,C29,C30,C31,C32,C33,C34	399-1168-1-ND	Kemet C0805C104K3RACTU
11	1	Capacitor 10uF 10% 10V 1206	C3	399-3684-1-ND	Kemet T491A106K010AT
12	2	Capacitor 68uF,20%, 16V Tant SMD	C1, C21	495-2254-1-ND	T491D686M016ZT
13	1	Ferrite Bead	L1	490-5221-1-ND	BLM18PG221SN1D
14	1	LC Filter 2200pF 1206	LCF1 (Do Not Install)	490-2547-1-ND	Murata NFE31PT222
15	2	Connector DB9F, RA PCB, .315"	J2, J10	A35107-ND	Amp 1734354-1
16	1	Res 220K, 1/8W 5% 0805 SMD	R34	RHM220KACT-ND	MCR10EZJ224
17	2	Header, Male 1x8, 0.1" Pitch	J1, J7 (Do Not Install)		
18	2	Header, Male 2X14, 0.1" Pitch	J5, J6	S2012E-36-ND	Sullins PEC36DAAN
19	0	Header, Male 1x18, 0.1" Pitch	J8 (Do Not Install)		
20	1	Header, Male 0.1", Right Angle 2 x 3	J9	S2312E-36-ND	Sullins PEC36DAAN
21	6	Header, Male 1x2, 0.1" Pitch	JP1-JP5, JP7	S1012E-36-ND	Sullins PEC36SAAN
22	9	LED Green 0805	LED1-LED7, LED10, LED11	160-1179-1-ND	LiteOn LTST-C170GKT
23	1	LED Yellow 0805	LED9	160-1175-1-ND	LiteOn LTST-C170YKT
24	1	LED Red 0805	LED8	160-1176-1-ND	LiteOn LTST-C170CKT
25	1	Res 1M, 1/8W 5% 0805 SMD	R40	RHM1.0MARCT-ND	Panasonic ECG ERJ-6GEYJ105V

Bill of Materials (cont.): GPSPI

Item	Qty	Description	Reference	DigiKey	Mfr P/N
26	17	Res 3.3K, 1/8W 5% 0805 SMD	R17, R18, R20-R22, R24-R26, R29-R33, R35-R38	RHM3.3KACT-ND	MCR10EZHJ332
27	11	Res 680, 1/8W 5% 0805 SMD	R1-R6, R8, R11, R12, R14, R16	RHM680ARCT-ND	MCR10EZPJ681
28	2	Res, 4.02 OHM 1% 1/8W 0805	R9, R10	311-4.02CRCT-ND	RC0805FR-074R02L
29	2	Res 60.4 Ohm 1/4W 1% 1210 SMD	R15, R19	RHM60.4BDCT-ND	MCR25JZHf60R4
30	1	Res 0 ohm, 1/8W 5% 0805 SMD	R7	RHM0.0ARCT-ND	MCR10EZPJ000
31	1	Res 1.5M, 1/8W 5% 0805 SMD	R39	RHM1.5MARCT-ND	RHM1.5MARCT-ND
32	1	Res 4.7K, 1/8W 1% 0805 SMD	R28	RHM4.70KCRCT-ND	MCR10EZPF4701
33	1	DIP Switch 4-Pos Slide SMD	SW2	CT2194LPST-ND	CTS 219-4LPST
34	1	DIP Switch 6-Pos Slide SMD	SW1	CT2196LPST-ND	CTS 2196LPST
35	5	Switch Tactile SPST-NO 0.05A 32V	S1, S2, S3, S4, RESET BUTTON	CKN9195CT-ND	KSC222J LFS
36	1	Polyzen 5.6V PPTC Zener SMD	U2	ZEN056V130A24L SCT-ND	Teconn ZEN056V130A24LS
37	2	Test Point, Red Insulator, hole	0.062" TP1, TP9	5010K-ND	Keystone 5010
38	3	Test Point, Black Insulator, hole	0.062" TP5, TP6, TP8	5011K-KD	Keystone 5011
39	1	Test Point White Insulator, hole	0.062" TP2	5012K-ND	Keystone 5012
40	2	Test Point Orange Insulator, hole	0.062" TP3, TP4	5013K-ND	Keystone 5013
41	1	IC, MC9S12XDT512CAA 80 QFP Bit MCU, 512K Flash 0-70C	16- U1	MC9S12XDT512CA A-ND	MC9S12XDT512CAA-ND
42	1	IC, HI-3110 18-SOIC WB PKG	U2	Holt IC	HOLT HI-3110PSI
43	1	IC, MAX3232CSE Narrow 16-SOIC	U4	MAX232CSE+-ND	Texas Inst MAX3232CDR
44	1	Crystal 24MHz, SMD, 50ppm 20pF load	Y1	631-1020-1-ND	FOXSDLF/240F-20
45	1	Crystal 4.00MHz, SMD, 50ppm 20pF load	Y2	631-1005-1-ND	FOXSDLF/040
46	1	OSC 24MHz, 5.0V, 1/2 SIZE	OSC1 (Do Not Install)	XC275-ND	ECS-2200B-240
47	5	3M Bumpon	Install at four corners and center.	SJ5746-0-ND	3M: SJ61A1

REVISION HISTORY

Revision	Date	Description of Change
AN-8435, Rev. New	2-5-13	New
AN-8435, Rev. A	2-12-13	Software Appendix Added
AN-8435, Rev. B	3-2-15	Add BOMs. Update board image