Application Note

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HC908EY16 LIN Monitor

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Introduction

With the continued increase in communications within the Automotive environment, car manufacturers are resorting more and more to serial multiplex bus systems. Controller Area Networks (CAN) continue to dominate, but many applications are now being designed around the Local Interconnect Network (LIN, reference 1).

To support this requirement, Freescale have designed a range of devices, development boards and software applications to facilitate the migration to LIN.

This application note will focus on the following:

1. Hardware: HC908EY16 Sample Evaluation board
   - A pcb designed to ease new application development when using the HC908EY16.
   - LIN Physical Interface
   - On board Programming
2. Software: Demonstration of LIN functionality
   - Use of the Metrowerks LIN Software Drivers
   - Monitoring LIN activity
   - Interfacing a LCD display with the Sample Evaluation Board

Hardware: HC908EY16 Sample Evaluation board

General Overview

The HC908EY16 Sample board has been designed to allow the user an easy development path with the EY family of parts.

Central to the board is the 44 pin HC908EY16. Each of the user pins (Ports A through E) is brought out to Single In Line Headers (P3 & P5). This is to allow the user to easily interface with much of the functionality of the EY16.

On board LEDs (on Ports A & D) are provided for general application use.

Clock, Reset & IRQ Options

The EY16 is capable of running from a variety of clock sources: internally from the Internal Clock Generator (ICG), externally from a crystal source (from 32KHz up to 8MHz), or from an external oscillator module. This board allows the user to develop applications using any of the three options.

When using the on board crystal, it is necessary to make the link from pin 11 to pin 13 on P4 and also from J2 pin 1 to pin 2. If using a clock source such as the on board 9.8304MHz canned oscillator, these links should be removed. This allows easy clock selection between the different sources.

Power on reset is provided on the board, as well as a reset switch (S2).

The IRQ pin is used on all Freescale HC08s to select between Monitor mode and User mode. Link J1 allows the user to select the required mode. Its default position is from pin 1 to 2. If using the Cyclone (see later text), this link should be removed.

Power and LIN functionality

Power can be provided in two ways: either 12V through the Battery Input Connector (B1) or 12V through the LIN Interface Connector (P2).

This LIN Connector is a three pin header, which is the requirement for connection with a LIN Communication network (two power lines & single LIN communication wire).

Whilst the HC908EY16 is designed as a general multi-purpose MCU, it does have several features to simplify LIN interaction. These include an Enhanced SCI module (with a special timer functionality for break detection & generation) and the ICG (no external crystal required).

With these LIN features in mind, a LIN Physical Interface (MC33399) has been included on the pcb. It is enabled by a port pin (PTB5 high) and can be configured as either a Master or Slave node. If D1 & R4 are fitted, then the node will act as a LIN master; if D1/R4 are omitted, the node defaults to slave status. This behaviour is more fully described in the LIN specification (reference 1).

NOTE: *This option configures the hardware as a Master or Slave. For complete master or Slave status it is still necessary to configure the software appropriately.*

On board programming

The HC908EY16 Flash device can be quickly programmed on this Sample board from two sources: the RS232 connector & the Cyclone Header.

If using the RS232 connector (P1), the following steps are recommended:

1. Power down the board
2. Ensure that the Cyclone is disconnected
3. Remove the P4 pin 11 – P4 pin 13 connection
4. The canned oscillator should be fitted
5. Connect a serial cable from P1 to the serial port on the PC
6. Connect J1 pin 2 to pin 3 (connects high voltage to IRQ)
7. Power the board (via switch S1)
8. Launch CodeWarrior and follow the on screen guide (reference 2)

Once the Flash is programmed, code can be executed and debugged using the CodeWarrior environment or the user may choose to disconnect the debugger and run from Flash. Please be sure to select the correct crystal option and IRQ configuration (typically J1 pin 1 – pin 2 connected) in either case.

If programming using the Cyclone (reference 3):

1. Power down the board
2. Remove the P4 pin 11 – P4 pin 13 connection
3. The canned oscillator should be removed
4. Connect J1 pin 1 to pin 2 (connects Vdd to IRQ – Cyclone will override as appropriate)
5. Connect the Cyclone to the 16 pin header (P4)
6. Connect the Cyclone to the PC as per the User guide (reference 3)
7. Power the board (via switch S1)
8. Launch CodeWarrior and follow the on screen guide (reference 2)

Again, code can be executed and debugged using the CodeWarrior environment or the user may choose to disconnect the debugger and run from Flash. If the Cyclone is used, it should be configured to provide the on board clock.

Software: Demonstration of LIN functionality

General Overview

The application developed on the HC908EY16 Sample board makes extensive use of the Metrowerks LIN drivers (reference 4). These drivers take care of the interfacing between the Enhanced SCI module of the EY16 with the LIN bus.

Use of the Metrowerks LIN Software Drivers

LIN drivers have been developed for many Freescale MCUs by Metrowerks and these drivers are available to customers. The LIN drivers used with this HC908EY16 application are currently in the testing stage of the Software Life cycle: the final production version should be sought when developing future applications.

When installing the LIN drivers, they automatically create a sample LIN project which may then be either cloned or edited. Once these drivers are included as part of the project, many functions are available to the user, but this application only makes use of the following:

LIN_Init	Software initialisation of driver (eg resets counters) Hardware initialisation of the ESCI (Baud rate, Tx pin, etc)
LIN_GetMsg	The LIN drivers utilise the ESCI to automatically update various data buffers if activity has occurred on the LIN bus. This routine is used to extract that data from these registers.
LIN_PutMsg	Not used in this application, but allows data to be written to the LIN bus when prompted by the Master.
LIN_DriverStatus & *LIN_IdleClock*	These two functions are used together to determine the length of inactivity on the bus. Particularly useful in low power applications where the application may need to go to ‘sleep’ after particular timeout periods.

Monitoring LIN activity

The main software loop of this application constantly monitors the LIN bus for activity. If no activity has been detected for greater than a timeout period (LIN_IDLETIMEOUT is specified in the LIN header file slave.cfg by the user), then a simple ‘No Messages’ is written to the LCD display.

If activity is detected, Port C bit 2 is monitored to determine which message id will be processed. This application only looks for two messages (Id 0x20 & Id 0x30), depending on the level on Port C bit 2.

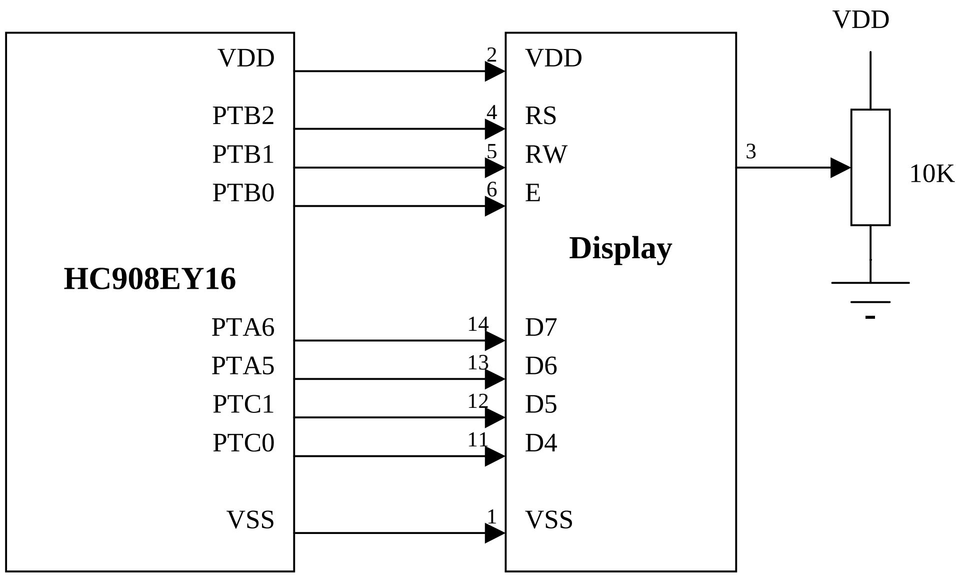
With very little effort, it would be straightforward to extend this further.

Once the id has been determined, LIN_GetMsg is used to retrieve the last message data received on the bus.

This data is written onto the display, along with the appropriate message id.

Interfacing a LCD display with the Sample Evaluation Board

A simplified block diagram of the MCU interfacing with the display would be:



As can seen from the diagram, only four lines are being used as the data bus between the EY16 & the display. This complicates the software slightly, since any data writes / reads take place over two cycles rather than one. However, this makes the hardware interface much more straightforward, minimising the lines required to drive the display.

During initial power on, the display defaults to 8 bit mode. Hence one of the essential events in the display initialisation routine changes this default into 4 bit mode.

All display actions should be preceded by examining the busy flag, which is the MSB of a two byte register read.

The majority of the software routines are very simple and self-explanatory: please see the attached software listings with comments.

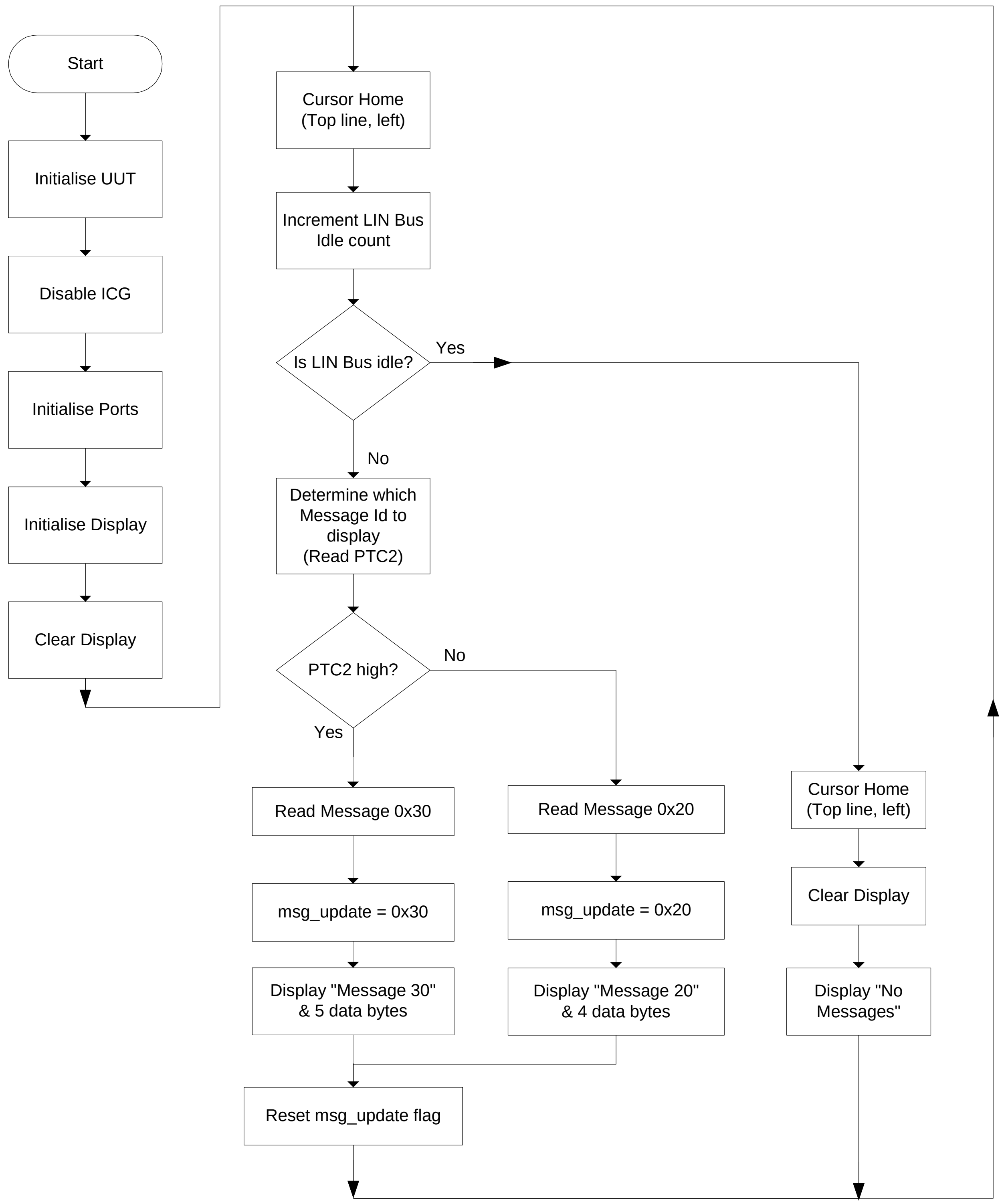
References

1. LIN Protocol Specification, Version 1.2, 17th November 2000
2. Metrowerks CodeWarrior, www.metrowerks.com
3. MON08 Cyclone, www.pemicro.com!
4. Metrowerks LIN Drivers, www.metrowerks.com

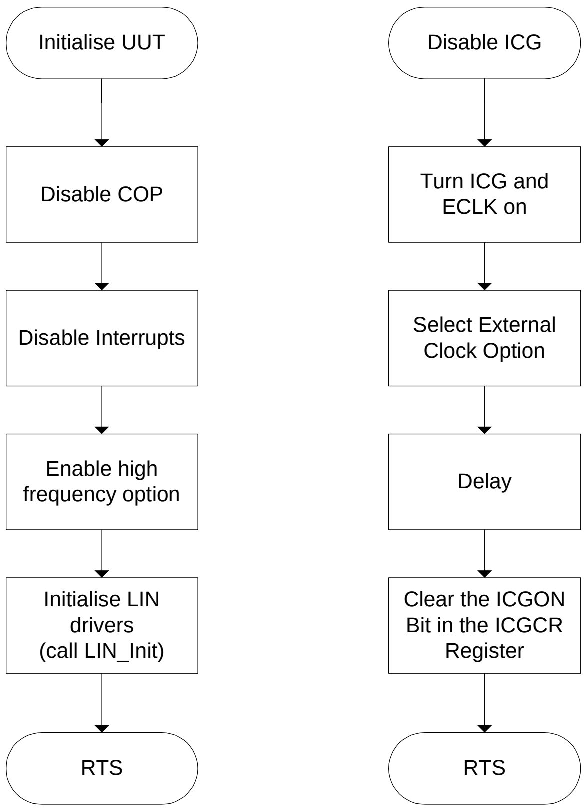
Acronyms

UUT	Unit Under Test
LIN	Local Interconnect Network
CAN	Controller Area Network

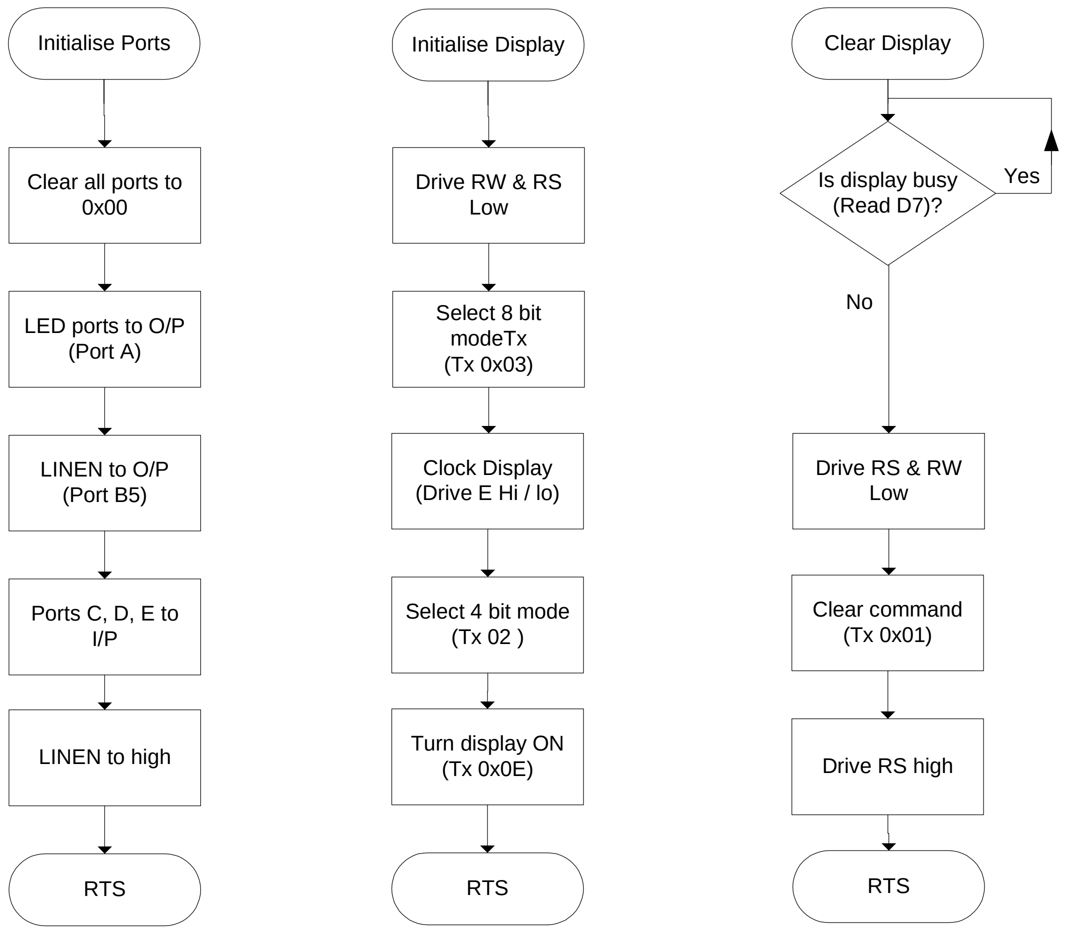
Appendix A: Software Flowchart – Main Control loop



Appendix A: Software Flowchart – Initialisation Functions (1)


Initialise UUT
Disable COP
Disable Interrupts
Enable high frequency option
Initialise LIN drivers (call LIN_Init)
RTS
Disable ICG
Turn ICG and ECLK on
Select External Clock Option
Delay
Clear the ICGON Bit in the ICGCR Register
RTS

Appendix A: Software Flowchart – Initialisation Functions (2)



Appendix B – Source Files

ey16 giveaway.c

```
/*******************************************************************************
                                    Copyright (c)  2002
File Name           :           ey16 giveaway.c
Originator          :           C. Culshaw
Location            :           EKB
Date Created        :           8/3/02
Current Revision    :           1.0
Function            :           Demonstrate LIN functionality using the EY16 Sample board
Notes               :           Utilises the HC908EY16 as a LIN monitor.
                                Software requires companion hardware,
                                'EY16 SAMPLE BOARD, BEAPP038' & a hitachi LCD display

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******************************************************************************/

#pragma DATA_SEG SHORT _DATA_ZEROPAGE

// Prototypes for functions
#include "ey16port.h"
#include "ey16config.h"
#include "ey16icg.h"
#include "linapi.h"          // Include the Freescale EY16 LIN drivers as part of the project


// Global register definition

#define EY16PORT (* ((tEY16PORT *)0x00))               //Register block definition
#define EY16SI (* ((tEY16SI *)0x0D))                   //Serial ports
#define EY16CONFIG (* ((tEY16CONFIG *)0x1E))           //Configuration registers
#define EY16TIMER (* ((tEY16TIMER *)0x20))             //ECT registers
#define EY16ICG (* ((tEY16ICG *)0x36))                 //ICG registers
#define EY16ATD (* ((tEY16ATD *)0x3C))                 //ATD registers
```

```
void Initialise_UUT(void);
void Disable_ICG(void);
void Initialise_Ports(void);
void Initialise_Display(void);

void Delay(unsigned long);
void Clock_Display(void);
void Display_Port(unsigned char);
void Display_Data(unsigned char, unsigned char);
void Clear_Display(void);
unsigned char Busy_Status(void);
void Cursor_Home(void);
void Write_Line2(unsigned char);
void DisplayChar(char, unsigned char, unsigned char);


// Global variable definition
unsigned char No_messages[] = "No messages";
unsigned char Message[] = "Message ";

unsigned char Message_20[4];                           // Used to store LIN received message data
unsigned char Message_30[8];                           //


/****************************************************************************
 * Function       :         LIN_Command
 *
 * Description    :         User call-back.
 *                          Called by the driver after successful transmission or receiving
 *                          of the Master Request Command Frame (ID Field value '0x3C').
 *
 * Returns        :         never return
 *
 * Notes:
 ****************************************************************************/
void LIN_Command()
{
         while(1)
         {
         }
}

/****************************************************************************
Function Name     :         Initialise_UUT
Engineer          :         C. Culshaw
Date              :         06/09/02
Parameters        :         None
Returns           :         None
Notes             :         Initialise micro to default conditions
****************************************************************************/
void Initialise_UUT(void)
{
         EY16CONFIG.ey16config1.byte = 0x01;           // Disable COP watchdog
         asm sei;                                      // Disable interrupts
         EY16CONFIG.ey16config2.byte = 0x29;           // Configure part for high frequency
                                                       // external crystal, ssb pull up resistor disabled
         LIN_Init();                                   // Initialise SCI / LIN registers
}


/****************************************************************************
```

```
Function Name     :         Disable_ICG
Engineer          :         C. Culshaw
Date              :         06/09/02
Parameters        :         None
Returns           :         None
Notes             :         The EY16 defaults to its internal clock generator (ICG).
                  :         For this application, disable the ICG & select the
                  :         external crystal
*****************************************************************************/
void Disable_ICG(void)
{
         unsigned short delay1 = 0;
         EY16ICG.icgcr.byte = 0x0A;                    // ICG and ECLK ON
         EY16ICG.icgcr.byte = 0x1A;                    // set CS
         while (delay1++ != 100);
         EY16ICG.icgcr.byte = 0x12;                    // now put ICG OFF

         while (!(EY16ICG.icgcr.byte & 0x13))
         {
                  EY16ICG.icgcr.byte = 0x12;           // CS = ECLK, Ext clk ON and ICG off
         }
}


/*****************************************************************************
Function Name     :         Initialise_Ports
Engineer          :         C. Culshaw
Date              :         06/09/02
Parameters        :         None
Returns           :         None
Notes             :         For this LIN application, Port B bit 5 is used to enable
                  :         the LIN Physical Interface
                  :         General purpose LEDs are connected to port A bits 4,5,6
                  :         & port D bits 0 & 1
*****************************************************************************/
void Initialise_Ports(void)
{
         EY16PORT.pta.byte = 0x00;                     // Ensure all port registers
         EY16PORT.ptb.byte = 0x00;                     // 'cleared' to default
         EY16PORT.ptc.byte = 0x00;
         EY16PORT.ptd.byte = 0x00;
         EY16PORT.pte.byte = 0x00;

         EY16PORT.ddra.byte = 0x70;                    // Set port A bits 4,5,6 (LEDs) to O/P, rest input
         EY16PORT.ddrb.byte = 0x20;                    // Set port B bit 5 (LINEN) to O/P, rest input
         EY16PORT.ddrc.byte = 0x00;                    // Set port C to input & do not output MCLK
         EY16PORT.ddrd.byte = 0x00;                    // Set port D to input
         EY16PORT.ddre.byte = 0x00;                    // Set port E to input

         EY16PORT.ptb.byte = 0x20;                     // LIN enabled
}


/*****************************************************************************
Following display routines are to be used in conjunction with a Hitachi LCD
display.
This application only uses a 7 line interface, connected as follows:
Display   D7 D6 D5 D4 RS RW E
EY16 Port C1 C0 A6 A5 B2 B1 B0

The interface will be initialised into four bit mode, where each byte transfer is completed
```

```
using a two nibble write
******************************************************************************/

/******************************************************************************
Function Name     :          Clock_Display
Engineer          :          C. Culshaw
Date              :          06/09/02
Parameters        :          None
Returns           :          None
Notes             :          Drive the Display E line high / low to clock data
******************************************************************************/
void Clock_Display(void)
{
         EY16PORT.ddrb.byte |= 0x01;                    // Set port B bit 0 (Display E) to O/P
         EY16PORT.ptb.byte |= 0x01;                     // Display E high
         EY16PORT.ptb.byte &= ~(0x01);                  // Display E low
}


/******************************************************************************
Function Name     :          Busy_Status
Engineer          :          C. Culshaw
Date              :          06/09/02
Parameters        :          None
Returns           :          busy_state - if set indicates display busy
Notes             :          Read the busy state of the display and return status to
                  :          calling routine.
                  :          Bits manipulated one at a time, otherwise display
                  :          timing requirements will be violated
******************************************************************************/
unsigned char Busy_Status(void)
{
         unsigned char busy_state;
         EY16PORT.ddra.byte &= ~(0x60);                 // Set port A bits 5,6 (Display D4 & D5) to I/P
         EY16PORT.ddrc.byte &= ~(0x03);                 // Set port C bits 0,1 (Display D6 & D7) to I/P

         EY16PORT.ptb.byte &= ~(0x04);                  // Display RS low
         EY16PORT.ptb.byte |= 0x02;                     // Display RW high
         EY16PORT.ptb.byte |= 0x01;                     // Display E high
         busy_state = (EY16PORT.ptc.bit.ptc1 & 0x01);   // Check display status
         EY16PORT.ptb.byte &= ~(0x01);                  // Display E low
         EY16PORT.ptb.byte &= ~(0x02);                  // Display RW low
         Delay(1);
         return(busy_state);
}


/******************************************************************************
Function Name     :          Display_Data
Engineer          :          C. Culshaw
Date              :          06/09/02
Parameters        :          data - byte to be written to display
                  :          regsel -  used to drive Register Select Line
                  :          (0 = Command mode, 1 = data mode)
Returns           :          None
Notes             :          'data' will be written as two nibbles,
******************************************************************************/
void Display_Data(unsigned char data, unsigned char regsel)
{
         EY16PORT.ddrb.byte |= 0x07;                    // Set port B bits 0,1,2 (Display RS, R/W, E) to O/P
         while (Busy_Status() == 0x01);                 // Read busy status (Display D7)

         if (regsel == 1)
                  {
                           EY16PORT.ptb.byte |= 0x04;      // Display RS high
                  }
         else
                  {
                           EY16PORT.ptb.byte &= ~(0x04);   // Display RS low
                  }

         // shift data to allow high nibble to be written to display
         Display_Port(data/16);
         Clock_Display();                               // Display E Hi / Lo

         // mask & transmit low nibble
         Display_Port(data & 0x0F);
         Clock_Display();                               // Display E Hi / Lo
         asm NOP;                                       // Convenient Break point setting!
}


/****************************************************************************
Function Name      :         Write_Line2
Engineer           :         C. Culshaw
Date               :         06/09/02
Parameters         :         msg_id - id of message to be displayed
Returns            :         None
Notes              :         Update second line of display with the received message
                   :         data bytes
                   :         Currently set up to act on ids 0x20 & 0x30 only
****************************************************************************/
void Write_Line2(unsigned char msg_id)
{
         char nibble_pos = 0x00, byte;
         unsigned char hi_nibble, lo_nibble;

         switch (msg_id)
         {
                  case 0x20:
                           for(byte = 0; byte < 4; byte++)
                           {
                                  // Extract high nibble, then add ascii offset
                                  hi_nibble = (Message_20[byte]/16) + 0x30;
                                  // Extract low nibble, then add ascii offset
                                  lo_nibble = (Message_20[byte]&0x0F) + 0x30;
                                  // if either nibble between A & F, additional ascii offset required
                                  if (hi_nibble > 0x39)
                                                    hi_nibble+=0x07;
                                  if (lo_nibble >= 0x39)
                                                    lo_nibble+=0x07;
                                  DisplayChar(2, nibble_pos++, hi_nibble);
                                  DisplayChar(2, nibble_pos++, lo_nibble);
                                  nibble_pos++;
                           }
                           break;
                           // Message 0x30 is a 8 byte message, but because of display size
                           // & since only the first 5 bytes are being used in this
                           // application, then only display these 5 bytes.
                  case 0x30:
                           for(byte = 0; byte < 5; byte++)
```

```
                                        {
                                                hi_nibble = (Message_30[byte]/16) + 0x30;
                                                lo_nibble = (Message_30[byte]&0x0F) + 0x30;
                                                if (hi_nibble > 0x39)
                                                                        hi_nibble+=0x07;
                                                if (lo_nibble >= 0x39)
                                                                        lo_nibble+=0x07;
                                                DisplayChar(2, nibble_pos++, hi_nibble);
                                                DisplayChar(2, nibble_pos++, lo_nibble);
                                                nibble_pos++;
                                        }
                                        break;
                        default:
                                        break;

                }

                // Clear last two bytes of display
                DisplayChar(2, nibble_pos++, ' ');
                DisplayChar(2, nibble_pos, ' ');

}

/*******************************************************************************
Function Name           :               DisplayChar
Engineer                :               S. McAslan
Date                    :               16/08/01

Parameters              :               line - line of display; pos - position on line;
                                        character - char to display
Returns                 :               None
Notes                   :               Display character at pos on line.
*******************************************************************************/
void DisplayChar(char line, unsigned char pos, unsigned char character)
{
                unsigned char value;

                while (Busy_Status() == 0x01);                  // Read busy status (Display D7)

                value = pos & 0x1F;
                if (line == 1)
                {
                                value += 0x80;
                }
                else
                {
                                value += 0xC0;
                }

                EY16PORT.ddrb.byte |= 0x06;                     // Set port B bits 1&2 (Display RS & R/W) to O/P
                EY16PORT.ptb.byte &= ~(0x04);                   // Display RS low
                EY16PORT.ptb.byte &= ~(0x02);                   // Display RW low
                Display_Data(value, 0x00);                      // Select DD RAM / cursor location

                while (Busy_Status() == 0x01);                  // Read busy status (Display D7)

                EY16PORT.ptb.byte |= 0x04;                      // Display RS high

                Display_Data(character, 0x01);
}
```

```
/****************************************************************************
Function Name      :          Initialise_Display
Engineer           :          C. Culshaw
Date               :          06/09/02
Parameters         :          None
Returns            :          None
Notes              :          Display defaults to 8 bit data bus mode
                   :          First part of routine will change display to be 4 bit
                   :          Once 4 bit is selected, data is transmitted to the
                   :          display in two 4 bit nibbles
****************************************************************************/
void Initialise_Display(void)
{

         EY16PORT.ddrb.byte |= 0x06;                    // Set port B bits 1&2 (Display RS & R/W) to O/P
         EY16PORT.ptb.byte &= ~(0x06);                  // Display RW & RS low

         Display_Port(0x03);                            // Function set (initially DL =1 = 8 bit mode)
         Clock_Display();                               // Display E Hi / Lo
         Delay(100);

         Clock_Display();                               // Display E Hi / Lo
         Delay(100);

         Clock_Display();                               // Display E Hi / Lo
         Delay(100);

         Display_Port(0x02);                            / Function set, with DL = 0 to 4 bit mode
         Clock_Display();                               // Display E Hi / Lo
         Delay(100);

         Display_Data(0x28, 0x00);                      // 4 bit mode, N=1 (2 line display)
         Display_Data(0x08, 0x00);                      // Display OFF
         Display_Data(0x0E, 0x00);                      // Display ON

         Display_Data(0x80, 0x00);                      // DD RAM selected

         EY16PORT.ptb.byte |= 0x04;                     // Display RS high
}

/****************************************************************************
Function Name      :          Clear_Display
Engineer           :          C. Culshaw
Date               :          06/09/02
Parameters         :          None
Returns            :          None
Notes              :          Clear display contents
****************************************************************************/
void Clear_Display(void)
{
         while (Busy_Status() == 0x01);                 // Read busy status (Display D7)
         EY16PORT.ddrb.byte |= 0x06;                    // Set port B bits 1&2 (Display RS & R/W) to O/P
         EY16PORT.ptb.byte &= ~(0x04);                  // Display RS low
         EY16PORT.ptb.byte &= ~(0x02);                  // Display RW low
         Display_Data(0x01, 0x00);                      // Clear display command
         EY16PORT.ptb.byte |= 0x04;                     // Display RS high
}

/****************************************************************************
Function Name      :          Cursor_Home
Engineer           :          C. Culshaw
```

```
Date               :         06/09/02
Parameters         :         None
Returns            :         None
Notes              :         Return cursor to home position (top line, left)
*****************************************************************************/
void Cursor_Home(void)
{
         while (Busy_Status() == 0x01);                // Read busy status (Display D7)
         EY16PORT.ddrb.byte |= 0x06;                   // Set port B bits 1&2 (Display RS & R/W) to O/P
         EY16PORT.ptb.byte &= ~(0x04);                 // Display RS low
         EY16PORT.ptb.byte &= ~(0x02);                 // Display RW low
         Display_Data(0x02, 0x00);                     // Cursor home command
         EY16PORT.ptb.byte |= 0x04;                    // Display RS high
}


/****************************************************************************
Function Name      :         Display_Port
Engineer           :         C. Culshaw
Date               :         06/09/02
Parameters         :         data - output onto display lines
Returns            :         None
Notes              :         Place data onto the four display lines, D4,5,6,7
*****************************************************************************/
void Display_Port(unsigned char data)
{
         EY16PORT.ddra.byte |= 0x60;                   // Set port A bits 5,6 (Display D4 & D5) to O/P
         EY16PORT.ddrc.byte |= 0x03;                   // Set port C bits 0,1 (Display D6 & D7) to O/P

         switch (data)
         {
                  case 0x00:
                           EY16PORT.ptc.bit.ptc1 = 0x00;   // Display D7 low
                           EY16PORT.ptc.bit.ptc0 = 0x00;   // Display D6 low
                           EY16PORT.pta.bit.pta6 = 0x00;   // Display D5 low
                           EY16PORT.pta.bit.pta5 = 0x00;   // Display D4 low
                           break;
                  case 0x01:
                           EY16PORT.ptc.bit.ptc1 = 0x00;   // Display D7
                           EY16PORT.ptc.bit.ptc0 = 0x00;   // Display D6
                           EY16PORT.pta.bit.pta6 = 0x00;   // Display D5
                           EY16PORT.pta.bit.pta5 = 0x01;   // Display D4
                           break;
                  case 0x02:
                           EY16PORT.ptc.bit.ptc1 = 0x00;   // Display D7
                           EY16PORT.ptc.bit.ptc0 = 0x00;   // Display D6
                           EY16PORT.pta.bit.pta6 = 0x01;   // Display D5
                           EY16PORT.pta.bit.pta5 = 0x00;   // Display D4
                           break;
                  case 0x03:
                           EY16PORT.ptc.bit.ptc1 = 0x00;   // Display D7
                           EY16PORT.ptc.bit.ptc0 = 0x00;   // Display D6
                           EY16PORT.pta.bit.pta6 = 0x01;   // Display D5
                           EY16PORT.pta.bit.pta5 = 0x01;   // Display D4
                           break;
                  case 0x04:
                           EY16PORT.ptc.bit.ptc1 = 0x00;   // Display D7
                           EY16PORT.ptc.bit.ptc0 = 0x01;   // Display D6
                           EY16PORT.pta.bit.pta6 = 0x00;   // Display D5
                           EY16PORT.pta.bit.pta5 = 0x00;   // Display D4
                           break;
```

```
case 0x05:
          EY16PORT.ptc.bit.ptc1 = 0x00;   // Display D7
          EY16PORT.ptc.bit.ptc0 = 0x01;   // Display D6
          EY16PORT.pta.bit.pta6 = 0x00;   // Display D5
          EY16PORT.pta.bit.pta5 = 0x01;   // Display D4
          break;
case 0x06:
          EY16PORT.ptc.bit.ptc1 = 0x00;   // Display D7
          EY16PORT.ptc.bit.ptc0 = 0x01;   // Display D6
          EY16PORT.pta.bit.pta6 = 0x01;   // Display D5
          EY16PORT.pta.bit.pta5 = 0x00;   // Display D4
          break;
case 0x07:
          EY16PORT.ptc.bit.ptc1 = 0x00;   // Display D7
          EY16PORT.ptc.bit.ptc0 = 0x01;   // Display D6
          EY16PORT.pta.bit.pta6 = 0x01;   // Display D5
          EY16PORT.pta.bit.pta5 = 0x01;   // Display D4
          break;
case 0x08:
          EY16PORT.ptc.bit.ptc1 = 0x01;   // Display D7
          EY16PORT.ptc.bit.ptc0 = 0x00;   // Display D6
          EY16PORT.pta.bit.pta6 = 0x00;   // Display D5
          EY16PORT.pta.bit.pta5 = 0x00;   // Display D4
          break;
case 0x09:
          EY16PORT.ptc.bit.ptc1 = 0x01;   // Display D7
          EY16PORT.ptc.bit.ptc0 = 0x00;   // Display D6
          EY16PORT.pta.bit.pta6 = 0x00;   // Display D5
          EY16PORT.pta.bit.pta5 = 0x01;   // Display D4
          break;
case 0x0A:
          EY16PORT.ptc.bit.ptc1 = 0x01;   // Display D7
          EY16PORT.ptc.bit.ptc0 = 0x00;   // Display D6
          EY16PORT.pta.bit.pta6 = 0x01;   // Display D5
          EY16PORT.pta.bit.pta5 = 0x00;   // Display D4
          break;
case 0x0B:
          EY16PORT.ptc.bit.ptc1 = 0x01;   // Display D7
          EY16PORT.ptc.bit.ptc0 = 0x00;   // Display D6
          EY16PORT.pta.bit.pta6 = 0x01;   // Display D5
          EY16PORT.pta.bit.pta5 = 0x01;   // Display D4
          break;
case 0x0C:
          EY16PORT.ptc.bit.ptc1 = 0x01;   // Display D7
          EY16PORT.ptc.bit.ptc0 = 0x01;   // Display D6
          EY16PORT.pta.bit.pta6 = 0x00;   // Display D5
          EY16PORT.pta.bit.pta5 = 0x00;   // Display D4
          break;
case 0x0D:
          EY16PORT.ptc.bit.ptc1 = 0x01;   // Display D7
          EY16PORT.ptc.bit.ptc0 = 0x01;   // Display D6
          EY16PORT.pta.bit.pta6 = 0x00;   // Display D5
          EY16PORT.pta.bit.pta5 = 0x01;   // Display D4
          break;
case 0x0E:
          EY16PORT.ptc.bit.ptc1 = 0x01;   // Display D7
          EY16PORT.ptc.bit.ptc0 = 0x01;   // Display D6
          EY16PORT.pta.bit.pta6 = 0x01;   // Display D5
          EY16PORT.pta.bit.pta5 = 0x00;   // Display D4
          break;
case 0x0F:
```

```
                            EY16PORT.ptc.bit.ptc1 = 0x01;   // Display D7
                            EY16PORT.ptc.bit.ptc0 = 0x01;   // Display D6
                            EY16PORT.pta.bit.pta6 = 0x01;   // Display D5
                            EY16PORT.pta.bit.pta5 = 0x01;   // Display D4
                            break;
         }
}

/****************************************************************************
Function Name       :           Delay
Engineer            :           C. Culshaw
Date                :           06/09/02
Parameters          :           delay_var - varies length of delay loop
Returns             :           None
Notes               :           Requires rewriting to make use of timer module
****************************************************************************/
void Delay(unsigned long delay_var)
         {
         char countloop = 0;
         unsigned long mainloop = 0;

         while (mainloop++ < delay_var)
                  while (countloop++ < 200);
         }


/****************************************************************************
Function Name       :           main
Engineer            :           C. Culshaw
Date                :           06/09/02
Parameters          :           None
Returns             :           None
Notes               :           Continuously update the display with the latest data read
                    :           from the LIN bus.
                    :           Displays the id selected by PortC bit 2 (high = id 0x30,
                    :           low = id 0x20)
****************************************************************************/
void main(void)
         {
         LINDriverStatusType driver = LIN_STATUS_IDLE;
         unsigned char count = 0x00, msg_update = 0x00, msg_sel;

         Initialise_UUT();                         // Put pcb & micro into default conditions//
         Disable_ICG();
         Initialise_Ports();
         Initialise_Display();

         asm cli;                                  // Enable interrupts

         Clear_Display();

         while(1)

                  {

                            // Prepare display
                            Cursor_Home();
                            // Display "Message ";
                            for (count = 0; count < 8; count++)
                            {
                                   Display_Data(Message[count], 0x01);
                    }

                    LIN_IdleClock();           // Increment bus activity counter

                    // Determine if bus is active.
    if ((driver = LIN_DriverStatus()) != LIN_STATUS_IDLE)
    {
         // Determine which message Id will be displayed
         // Tie Port C2 high or low to select message 20 or 30
                        msg_sel = (EY16PORT.ptc.bit.ptc2);

         // Read LIN message buffer
         if (msg_sel)
         {
                    LIN_GetMsg (0x30, Message_30);
                                msg_update = 0x30;
                        }
                        else
         {
                                LIN_GetMsg (0x20, Message_20);
                                msg_update = 0x20;
         }

         switch (msg_update)
         {
                    case 0x20:
                                DisplayChar(1, 9, '2');// Write '20' to line 1
                                DisplayChar(1, 10, '0');
                        Write_Line2(0x20);          // Write Rx data to line 2
                        break;
                    case 0x30:
                                DisplayChar(1, 9, '3');// Write '30' to line 1
                                DisplayChar(1, 10, '0');
                        Write_Line2(0x30);          // Write Rx data to line 2
                        break;
         }
         msg_update = 0;

                        asm NOP;
                    }
                    else
                    {
         // No message has been seen on bus for > LIN_IDLETIMEOUT
         // Display No messages
                        Clear_Display();
                        Cursor_Home();
                        for (count = 0; count < 11; count++)
                        {
                                Display_Data(No_messages[count], 0x01);
                        }
                        for (count = 0; count <16; count++)
                        {
                                DisplayChar(2, count, '.');
                                DisplayChar(2, count+1, '.');
                                DisplayChar(2, count, ' ');
                        }
                    }

         }
    }
```

vector.c

```
#define VECTOR_C
/******************************************************************************
*
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*
*       The code is the property of Freescale GSG St.Petersburg
*       Software Development
*
*
*       The copyright notice above does not evidence any
*       actual or intended publication of such source code.
*
* Filename:     $Source: /net/sdt/vault-rte/cvsroot/lin/release/hc08/hc08/vector.c,v $
* Author:       $Author: kam $
* Locker:       $Locker:  $
* State:        $State: Exp $
* Revision:     $Revision: 1.17 $
*
* Functions:    Vectors table for LIN08 Drivers with Freescale API
*
* History:      Use the CVS command log to display revision history
*               information.
*
* Description:  Vector table and node's startup for HC08.
*               The users can add their own vectors into the table,
*               but they should not replace LIN Drivers vectors.
*
* Notes:
*
******************************************************************************/

#if defined(HC08)                       /* for HC08 */

#if defined(HC08AZ32)
extern void LIN_ISR_SCI_Receive();      /* SCI receive ISR       */
extern void LIN_ISR_SCI_Error();        /* SCI error ISR         */
// extern void BREAK_Command();        /* SWI ISR         */

#if defined MASTER                      /* (used for Master node only) */
extern void LIN_ISR_SCI_Transmit();     /* SCI transmit ISR      */
extern void LIN_ISR_Timer0();           /* Timer Interface Module Channel 0 ISR */
#endif /* defined MASTER */
#endif /* defined(HC08AZ32) */


#if defined(HC08EY16)
extern void LIN_ISR_SCI_Receive();      /* ESCI receive ISR       */
extern void LIN_ISR_SCI_Error();        /* ESCI error ISR         */
// extern void BREAK_Command();        /* SWI ISR               */

#if defined MASTER                      /* (used for Master node only)           */
extern void LIN_ISR_SCI_Transmit();     /* ESCI transmit ISR                     */
extern void LIN_ISR_Timer0();           /* Timer Interface Module Channel 0 ISR  */
#endif /* defined MASTER */
#endif /* defined(HC08EY16) */
```

```
/******************************************************************************
    NODE STARTUP
    By default compiler startup routine is called.
    User is able to replace this by any other routine.
******************************************************************************/

#if defined(HICROSS08)
#define Node_Startup    _Startup
extern void _Startup();                 /* HiCross compiler startup routine declaration */
#endif  /* defined(HICROSS08) */

#if defined(COSMIC08)
#define Node_Startup    _stext
extern void _stext();                   /* Cosmic compiler startup routine declaration  */
#endif  /* defined(COSMIC08) */


/******************************************************************************
    INTERRUPT VECTORS TABLE
    User is able to add another ISR into this table instead NULL pointer.
******************************************************************************/

#if !defined(NULL)
#define NULL    (0)
#endif /* !defined(NULL) */

#undef  LIN_VECTF

#if defined(HICROSS08)
#define LIN_VECTF ( void ( *const ) ( ) )
#pragma CONST_SEG VECTORS_DATA              /* vectors segment declaration */
void (* const _vectab[])( ) =
#endif  /* defined(HICROSS08) */

#if defined(COSMIC08)
#define LIN_VECTF (void *const)
void *const _vectab[] =
#endif  /* defined(COSMIC08)  */

#if defined(HC08AZ32)

/*****************************************************************************/
/*      HC08AZ32                                                             */
/*****************************************************************************/

{
    LIN_VECTF NULL,          e             /* 0xFFD0   ADC               */
    LIN_VECTF NULL,                        /* 0xFFD2   IRQ2/Keypad       */
#if defined(MASTER)                        /* (used for Master node only)*/
    LIN_VECTF LIN_ISR_SCI_Transmit,        /* 0xFFD4   SCI transmit      */
#endif /* defined(MASTER) */
#if defined(SLAVE)
    LIN_VECTF NULL,                        /* 0xFFD4   SCI transmit      */
#endif /* defined(SLAVE) */
    LIN_VECTF LIN_ISR_SCI_Receive,         /* 0xFFD6   SCI receive       */
    LIN_VECTF LIN_ISR_SCI_Error,           /* 0xFFD8   SCI error         */
    LIN_VECTF NULL,                        /* 0xFFDA   MSCAN Wakeup      */
    LIN_VECTF NULL,                        /* 0xFFDC   MSCAN Error       */
    LIN_VECTF NULL,                        /* 0xFFDE   MSCAN Receive     */
    LIN_VECTF NULL,                        /* 0xFFE0   MSCAN Transmit    */
    LIN_VECTF NULL,                        /* 0xFFE2   SPI transmit      */
    LIN_VECTF NULL,                        /* 0xFFE4   SPI receive       */
    LIN_VECTF NULL,                        /* 0xFFE6   TIMER B overflow  */
    LIN_VECTF NULL,                        /* 0xFFE8   TIMER B channel 1 */
    LIN_VECTF NULL,                        /* 0xFFEA   TIMER B channel 0 */
    LIN_VECTF NULL,                        /* 0xFFEC   TIMER A overflow  */
    LIN_VECTF NULL,                        /* 0xFFEE   TIMER A channel 3 */
    LIN_VECTF NULL,                        /* 0xFFF0   TIMER A channel 2 */
    LIN_VECTF NULL,                        /* 0xFFF2   TIMER A channel 1 */
#if defined(MASTER)                        /* (used for Master node only)*/
    LIN_VECTF LIN_ISR_Timer0,              /* 0xFFF4   TIMER A channel 0 */
#endif /* defined(MASTER) */
#if defined(SLAVE)
    LIN_VECTF NULL,                        /* 0xFFF4   TIMER A channel 0 */
#endif /* defined(SLAVE) */
    LIN_VECTF NULL,                        /* 0xFFF6   PIT               */
    LIN_VECTF NULL,                        /* 0xFFF8   PLL               */
    LIN_VECTF NULL,                        /* 0xFFFA   IRQ1              */
//  LIN_VECTF BREAK_Command,               /* 0xFFFC   SWI               */
    LIN_VECTF NULL,                        /* 0xFFFC   SWI               */
    LIN_VECTF Node_Startup                 /* 0xFFFE   RESET             */
};

#endif  /* defined(HC08AZ32) */


#if defined(HC08EY16)

/***************************************************************************/
/*      HC08EY16                                                         */
/***************************************************************************/

{
    LIN_VECTF NULL,                        /* 0xFFDC   Timebase          */
    LIN_VECTF NULL,                        /* 0xFFDE   SPI transmit      */
    LIN_VECTF NULL,                        /* 0xFFE0   SPI receive       */
    LIN_VECTF NULL,                        /* 0xFFE2   ADC               */
    LIN_VECTF NULL,                        /* 0xFFE4   Keyboard          */
    LIN_VECTF LIN_ISR_SCI_Error,           /* 0xFFE6   ESCI error        */
#if defined(MASTER)                        /* (used for Master node only)*/
    LIN_VECTF LIN_ISR_SCI_Transmit,        /* 0xFFE8   ESCI transmit     */
#endif /* defined(MASTER) */
#if defined(SLAVE)
    LIN_VECTF NULL,                        /* 0xFFE8   ESCI transmit     */
#endif /* defined(SLAVE) */
    LIN_VECTF LIN_ISR_SCI_Receive,         /* 0xFFEA   ESCI receive      */
    LIN_VECTF NULL,                        /* 0xFFEC   TIMER B overflow  */
    LIN_VECTF NULL,                        /* 0xFFEE   TIMER B channel 1 */
    LIN_VECTF NULL,                        /* 0xFFF0   TIMER B channel 0 */
    LIN_VECTF NULL,                        /* 0xFFF2   TIMER A overflow  */
    LIN_VECTF NULL,                        /* 0xFFF4   TIMER A channel 1 */
#if defined(MASTER)                        /* (used for Master node only)*/
    LIN_VECTF LIN_ISR_Timer0,              /* 0xFFF6   TIMER A channel 0 */
#endif /* defined(MASTER) */
#if defined(SLAVE)
    LIN_VECTF NULL,                        /* 0xFFF6   TIMER A channel 0 */
#endif /* defined(SLAVE) */
    LIN_VECTF NULL,                        /* 0xFFF8   CMIREQ            */
    LIN_VECTF NULL,                        /* 0xFFFA   IRQ               */
//  LIN_VECTF BREAK_Command,               /* 0xFFFC   SWI               */
    LIN_VECTF NULL,                        /* 0xFFFC   SWI               */
    LIN_VECTF Node_Startup                 /* 0xFFFE   RESET             */
```

```
};

#endif  /* defined(HC08EY16) */


#if defined(HICROSS08)
#pragma CONST_SEG DEFAULT
#endif  /* defined(HICROSS08) */

#endif  /* defined(HC08) */
```

slave.cfg

```
#ifndef LINCFG_H
#define LINCFG_H

/*******************************************************************************
*
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*
* Filename:     $Source: /net/sdt/vault-rte/cvsroot/lin/release/hc08/sample/slave/slave.cfg,v $
* Author:       $Author: kam $
* Locker:       $Locker:  $
* State:        $State: Exp $
* Revision:     $Revision: 1.12 $
*
* Functions:    LIN Driver static configuration file for LIN08 Slave sample
*               with Freescale API
*
* History:      Use the CVS command log to display revision history
*               information.
*
* Description:It is allowed to modify by the user.
*
* Notes:
*
*******************************************************************************/

#if defined (HC08)

/* External MCU frequency = 16MHz      */
/* SCI Baud rate          = 15.6K      */

/* External MCU frequency = 8MHz      */
/* SCI Baud rate          = 19K2      */

/*
    This definition configures the LIN bus baud rate.
    This value shall be set according to target MCU
    SCI register usage.
    HC908EY16: the 8-bit value will be masked by 0x37
    and put into SCBR register.
*/
/* Selects 9600 baud rate if using a 9.8304MHz crystal */
/*#define LIN_BAUDRATE            0x04u*/

/* Selects 9600 baud rate if using a 8MHz crystal */
#define LIN_BAUDRATE            0x30u

/*
    This definition set the number of user-defined time clocks
    (LIN_IdleClock service calls), recognized as "no-bus-activity"
    condition.
    T|his number shall not be greater than 0xFFFF.
*/
#define LIN_IDLETIMEOUT         400u

#endif /* defined (HC08) */

#endif /* !define (LINCFG_H) */
```

slave.id

```
#ifndef LINMSGID_H
#define LINMSGID_H
/******************************************************************************
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*
* Filename:     $Source: /net/sdt/vault-rte/cvsroot/lin/release/hc08/sample/slave/slave.id,v $
* Author:       $Author: snl $
* Locker:       $Locker:  $
* State:        $State: Exp $
* Revision:     $Revision: 1.8 $
*
* Functions:    Message Identifier configuration for LIN08 Slave sample
*               with Freescale API
*
* History:      Use the CVS command log to display revision history
*               information.
*
* Description:
*
* Notes:
*
******************************************************************************/

/* In this application the LIN 'monitor' software is only monitoing network
activity, hence all messages are LIN_RECEIVE only.
Change to LIN_SEND if the LIN node is required to transmit
*/

#define LIN_MSG_09  LIN_RECEIVE
#define LIN_MSG_0A  LIN_RECEIVE
#define LIN_MSG_20  LIN_RECEIVE
#define LIN_MSG_21  LIN_RECEIVE
#define LIN_MSG_30  LIN_RECEIVE

/* this string is not necessary - just as an example */
#define LIN_MSG_20_LEN4       /* standard length */
#define LIN_MSG_09_LEN2       /* standard length */
#define LIN_MSG_0A_LEN2       /* standard length */
#define LIN_MSG_21_LEN  4       /* standard length */
#define LIN_MSG_30_LEN  8       /* standard length */

#endif /* defined(LINMSGID_H)*/
```

hc08ey16.prm

```
LINK slave.abs

NAMES
  ansi.lib
         ..\..\..\lib\hicross08\lin08EYs.lib
  /* other object files to link are passed from the IDF with the linker -Add option */
END

SECTIONS
    LIN_ZRAM    = READ_WRITE 0x0040 TO 0x00FF;          /* zero page*/
    LIN_RAM     = READ_WRITE 0x0100 TO 0x01FF;          /* program data */
    LIN_STACK   = READ_WRITE 0x0200 TO 0x023F;          /* stack*/
    LIN_ROM     = READ_ONLY  0xC000 TO 0xFDFF;          /* program code & constants */
    LIN_VECTORS = READ_ONLY  0xFFDC TO 0xFFFF;          /* interrupt vectors (use your vector.obj) */
END

PLACEMENT
    ZeroSeg, _DATA_ZEROPAGE INTO LIN_ZRAM;
    DEFAULT_ROM, ROM_VAR    INTO LIN_ROM;
    DEFAULT_RAM             INTO LIN_RAM;
    SSTACK                  INTO LIN_STACK;
    VECTORS_DATA            INTO LIN_VECTORS;
END

STACKSIZE 0x0040

ENTRIES
 _vectab
END
INIT              _Startup   /* contains line replacing default _PRESTART*/
MAPFILE ON
```

Appendix C – Header Files

ey16port.h

```
/****

Filename : EY16port.h

Defines the port block as a datastructure

Datastructure base address (out of reset) -

EY16       : 0x0000

Written by Ross McLuckie (R38917)

Revision history -

7/2/00   - Initial coding
8/1/02   - Modified for the HC908EY16 (TMcH)

****/

#ifndef EY16PORT_H           //prevent duplicate includes
#define EY16PORT_H

#ifndef COMMON_H  //prevent duplicate includes
#include <common.h>
#endif

typedef union uPTA
  {
  tU08   byte;
  struct
    {
    tU08 pta0     :1;        //i/o port pins
    tU08 pta1     :1;
    tU08 pta2     :1;
    tU08 pta3     :1;
    tU08 pta4     :1;
    tU08 pta5     :1;
    tU08 pta6     :1;
    tU08          :1;        //not used
    }bit;
  }tPTA;

#define PTA0      0x01       //bit masks
#define PTA1      0x02
#define PTA2      0x04
#define PTA3      0x08
#define PTA4      0x10
#define PTA5      0x20
#define PTA6      0x40

typedef union uPTB
  {
```

```
  tU08   byte;
  struct
    {
    tU08 ptb0     :1;        //i/o port pins
    tU08 ptb1     :1;
    tU08 ptb2     :1;
    tU08 ptb3     :1;
    tU08 ptb4     :1;
    tU08 ptb5     :1;
    tU08 ptb6     :1;
    tU08 ptb7     :1;
    }bit;
  }tPTB;

#define PTB00x01  //bit masks
#define PTB1      0x02
#define PTB2      0x04
#define PTB3      0x08
#define PTB4      0x10
#define PTB5      0x20
#define PTB6      0x40
#define PTB7      0x80

typedef union uPTC
  {
  tU08   byte;
  struct
    {
    tU08 ptc0     :1;        //i/o port pins
    tU08 ptc1     :1;
    tU08 ptc2     :1;
    tU08 ptc3     :1;
    tU08 ptc4     :1;
    tU08          :3;        //not used
    }bit;
  }tPTC;

#define PTC00x01  //bit masks
#define PTC1      0x02
#define PTC2      0x04
#define PTC3      0x08
#define PTC4      0x10

typedef union uPTD
  {
  tU08   byte;
  struct
    {
    tU08 ptd0     :1;        //i/o port pins
    tU08 ptd1     :1;
    tU08          :6;        //not used
    }bit;
  }tPTD;

#define PTD0      0x01       //bit masks
#define PTD1      0x02


typedef union uDDRA
  {
  tU08   byte;
  struct
    {
    tU08 ddra0    :1;        //data direction bits (0:input;1:output)
    tU08 ddra1    :1;
    tU08 ddra2    :1;
    tU08 ddra3    :1;
    tU08 ddra4    :1;
    tU08 ddra5    :1;
    tU08 ddra6    :1;
    tU08          :1;        //not used
    }bit;
  }tDDRA;

#define DDRA0     0x01       //bit masks
#define DDRA1     0x02
#define DDRA2     0x04
#define DDRA3     0x08
#define DDRA4     0x10
#define DDRA5     0x20
#define DDRA6     0x40

typedef union uDDRB
  {
  tU08   byte;
  struct
    {
    tU08 ddrb0    :1;        //data direction bits (0:input;1:output)
    tU08 ddrb1    :1;
    tU08 ddrb2    :1;
    tU08 ddrb3    :1;
    tU08 ddrb4    :1;
    tU08 ddrb5    :1;
    tU08 ddrb6    :1;
    tU08 ddrb7    :1;
    }bit;
  }tDDRB;

#define DDRB0     0x01       //bit masks
#define DDRB1     0x02
#define DDRB2     0x04
#define DDRB3     0x08
#define DDRB4     0x10
#define DDRB5     0x20
#define DDRB6     0x40
#define DDRB7     0x80

typedef union uDDRC
  {
  tU08   byte;
  struct
    {
    tU08 ddrc0    :1;        //data direction bits (0:input;1:output)
    tU08 ddrc1    :1;
    tU08 ddrc2    :1;
    tU08 ddrc3    :1;
    tU08 ddrc4    :1;
    tU08          :2;        //not used
    tU08 mclken:1;
    }bit;
  }tDDRC;
```

```
#define DDRC0     0x01       //bit masks
#define DDRC1     0x02
#define DDRC2     0x04
#define DDRC3     0x08
#define DDRC4     0x10
#define MCLKEN    0x80

typedef union uDDRD
  {
  tU08   byte;
  struct
    {
    tU08 ddrd0    :1;        //data direction bits (0:input;1:output)
    tU08 ddrd1    :1;
    tU08          :6;        //not used
    }bit;
  }tDDRD;

#define DDRD0     0x01       //bit masks
#define DDRD1     0x02
#define DDRD2     0x04
#define DDRD3     0x08
#define DDRD4     0x10
#define DDRD5     0x20
#define DDRD6     0x40
#define DDRD7     0x80

typedef union uPTE
  {
  tU08   byte;
  struct
    {
    tU08 pte0     :1;        //i/o port pins
    tU08 pte1     :1;
    tU08          :6;        //not used
    }bit;
  }tPTE;

#define PTE0      0x01       //bit masks
#define PTE1      0x02



typedef union uDDRE
  {
  tU08   byte;
  struct
    {
    tU08 ddre0    :1;        //data direction bits (0:input;1:output)
    tU08 ddre1    :1;
    tU08          :6;        //not used
    }bit;
  }tDDRE;

#define DDRE0     0x01       //bit masks
#define DDRE1     0x02


typedef struct               //port control
  {
  volatile tPTA   pta;       //port A data register
  volatile tPTB   ptb;      //port B data register
  volatile tPTC   ptc;      //port C data register
  volatile tPTD   ptd;      //port D data register
           tDDRA  ddra;     //port A data direction register
           tDDRB  ddrb;     //port B data direction register
           tDDRC  ddrc;     //port C data direction register
           tDDRD  ddrd;     //port D data direction register
  volatile tPTE   pte;      //port E data register
           tU08   rsv;      //maintaining memory map
           tDDRE  ddre;     //port E data direction register
  }tEY16PORT;

#endif //EY16PORT_H
```

ey16icg.h

```
/****

Filename : EY16icg.h

Defines the serial internal clock generation register block as a datastructure

ICG datastructure base address (out of reset) -

EY16       : 0x0036

Written by Ross McLuckie (R38917)

Revision history -

7/5/02   - Initial coding


****/

#ifndef EY16ICG_H            //prevent duplicated includes
#define EY16ICG_H

#ifndef COMMON_H             //prevent duplicated includes
#include <common.h>
#endif

typedef union uICGCR
  {
  tU08   byte;
  struct
    {
    tU08 ecgs      :1;       //transmit interrupt enable
    tU08 ecgon     :1;       //spi enable
    tU08 icgs      :1;       //wired-OR mode
    tU08 icgon     :1;       //clock phase
    tU08 cs        :1;       //clock polarity
    tU08 cmon      :1;       //master mode (1), slave mode (0)
    tU08 cmf       :1;       //not used
    tU08 cmie      :1;       //receiver interrupt enable
    }bit;
  }tICGCR;

#define ECGS      0x01       //bit masks
#define ECGON     0x02
#define ICGS      0x04
#define ICGON     0x08
#define CS        0x10
#define CMON      0x20
#define CMF       0x40
#define CMIE      0x80

typedef union uICGMR
  {
  tU08   byte;
  struct
    {
    tU08 n0        :1;       //spi baud rate bits
    tU08 n1        :1;       //mode fault enable
    tU08 n2       :1;       //transmitter empty flag
    tU08 n3       :1;       //mode fault flag
    tU08 n4       :1;       //receiver overflow flag
    tU08 n5       :1;       //error interrupt enable
    tU08 n6       :1;       //receiver full flag
    tU08          :1;       //not used
    }bit;
  }tICGMR;

#define N0        0x01      //bit masks
#define N1        0x02
#define N2        0x04
#define N3        0x08
#define N4        0x10
#define N5        0x20
#define N6        0x40


typedef union uICGTR
  {
  tU08   byte;
  struct
    {
    tU08 trim0    :1;
    tU08 trim1    :1;
    tU08 trim2    :1;
    tU08 trim3    :1;
    tU08 trim4    :1;
    tU08 trim5    :1;
    tU08 trim6    :1;
    tU08 trim7    :1;
    }bit;
  }tICGTR;

#define TRIM0     0x01      //bit masks
#define TRIM1     0x02
#define TRIM2     0x04
#define TRIM3     0x08
#define TRIM4     0x10
#define TRIM5     0x20
#define TRIM6     0x40
#define TRIM7     0x80


typedef union uICGDVR
  {
  tU08   byte;
  struct
    {
    tU08 ddiv0    :1;       //parity type
    tU08 ddiv1    :1;       //parity enable
    tU08 ddiv2    :1;       //idle line type
    tU08 ddiv3    :1;       //wake up by address mark/idle
    tU08          :4;       //not used
    }bit;
  }tICGDVR;

#define DDIV0     0x01      //bit masks
#define DDIV1     0x02
#define DDIV2     0x04
#define DDIV3     0x08
```

```
typedef union uICGDSR
  {
  tU08   byte;
  struct
    {
    tU08 dstg0    :1;       //send break character
    tU08 dstg1    :1;       //receiver wake-up control
    tU08 dstg2    :1;       //receiver enable
    tU08 dstg3    :1;       //transmitter enable
    tU08 dstg4    :1;       //idle line interrupt enable
    tU08 dstg5    :1;       //receiver interrupt enable
    tU08 dstg6    :1;       //transmit complete interrupt enable
    tU08 dstg7    :1;       //transmit interrupt enable
    }bit;
  }tICGDSR;

#define DSTG0     0x01      //bit masks
#define DSTG1     0x02
#define DSTG2     0x04
#define DSTG3     0x08
#define DSTG4     0x10
#define DSTG5     0x20
#define DSTG6     0x40
#define DSTG7     0x80


typedef struct
 {
  volatile tICGCR           icgcr;  //icg control register
  volatile tICGMR           icgmr;  //icg multiplier register
  volatile tICGTR           icgtr;  //icg trim register
  volatile tICGDVR          icgdvr; //icg divider control register
  volatile tICGDSR          icgdsr; //icg dco stage control register
  }tEY16ICG;

#endif //EY16ICG_H
```

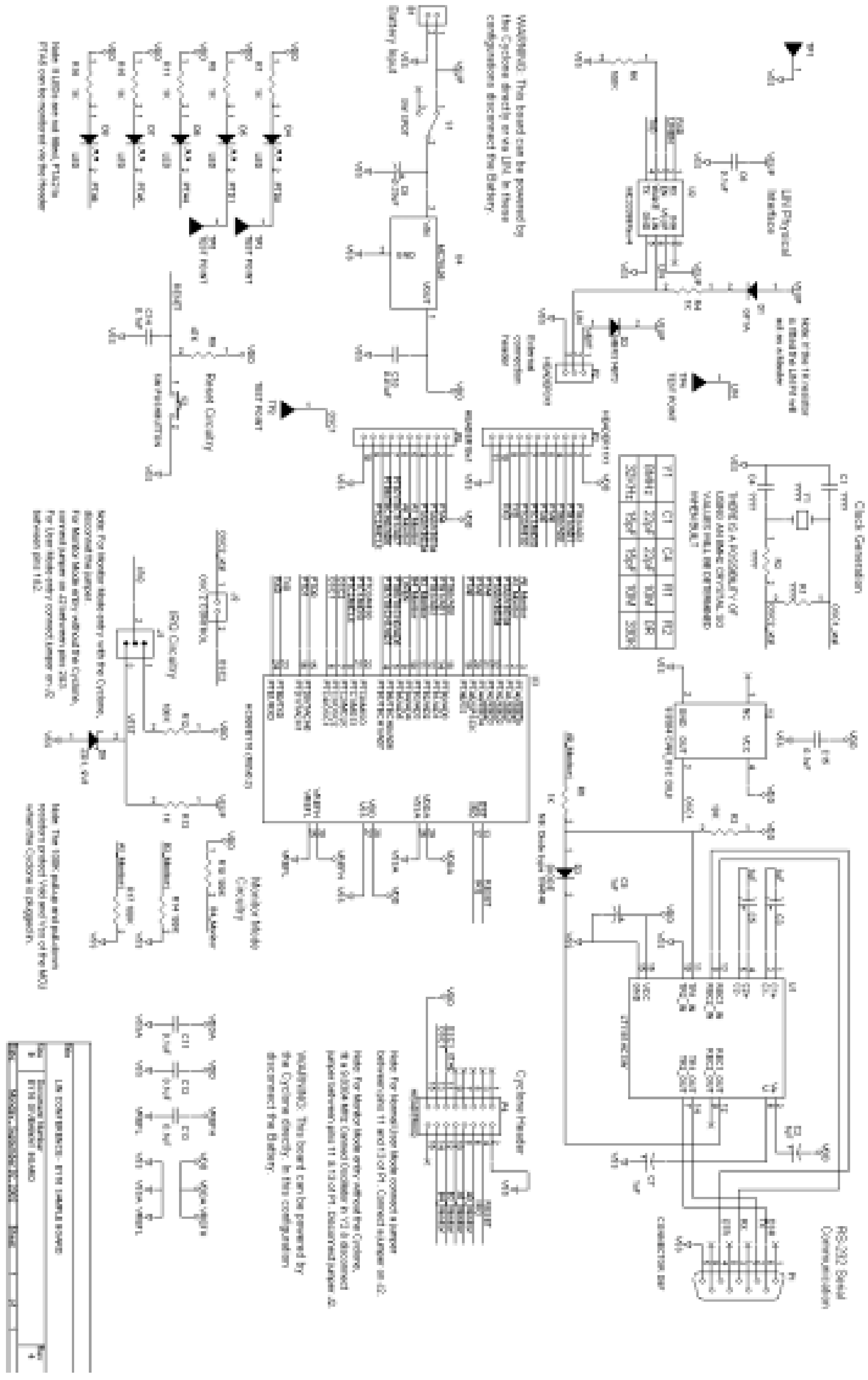
ey16config.h

```
/****

Filename : ey16config.h

Defines the config registers as a datastructure

base address (out of reset) -

EY16      : 0x001E

Written by Ross McLuckie (R38917)

Revision history -

8/2/00   - Initial coding

****/

#ifndef EY16CONFIG_H        //prevent duplicated includes
#define EY16CONFIG_H

#ifndef COMMON_H            //prevent duplicated includes
#include <common.h>
#endif

typedef union uEY16CONFIG2
  {
  tU08   byte;
  struct
    {
    tU08          ssbpuenb         :1;                //ssb pull up enable bit
    tU08          oscennstop       :1;                //oscillator enable in stop mode bit
    tU08          tmbclksel        :1;                //cop long timeout bit
    tU08          extclken         :1;                //short stop recovery bit
    tU08          extslow          :1;                //lvi power enable bit
    tU08          extxtalen        :1;                //lvi reset bit
    tU08                           :2;                //not used
    }bit;
  }tEY16CONFIG2;

#define           SSBPUENB         0x01
#define           OSCENNSTOP       0x02
#define           TMBCLKSEL        0x04
#define           EXTCLKEN         0x08
#define           EXTSLOW          0x10
#define           EXTXTALEN        0x20


typedef union uEY16CONFIG1
  {
  tU08   byte;
  struct
    {
    tU08          copd             :1;                //cop disable bit
    tU08          stop             :1;                //stop enable bit
    tU08          ssrec            :1;                //short stop recovery bit
    tU08          lvi5or3          :1;                //lvi 5-v or 3-v operating mode bit
    tU08          lvipwrd          :1;                //lvi power disable bit
    tU08          lvirstd          :1;                 //lvi reset disable bit
    tU08          lvistop          :1;                 //lvi enable in stop mode bit
    tU08          coprs            :1;                 //cop rate select bit
    }bit;
  }tEY16CONFIG1;

#define           COPD             0x01
#define           STOP             0x02
#define           SSREC            0x04
#define           LVI5OR3          0x08
#define           LVIPWRD          0x10
#define           LVIRSTD          0x20
#define           LVISTOP          0x40
#define           COPRS            0x80


typedef struct
  {
         tEY16CONFIG2       ey16config2;               //timer count registers
         tEY16CONFIG1       ey16config1;               //timer modulo registers
  }tEY16CONFIG;

#endif //EY16CONFIG_H
```

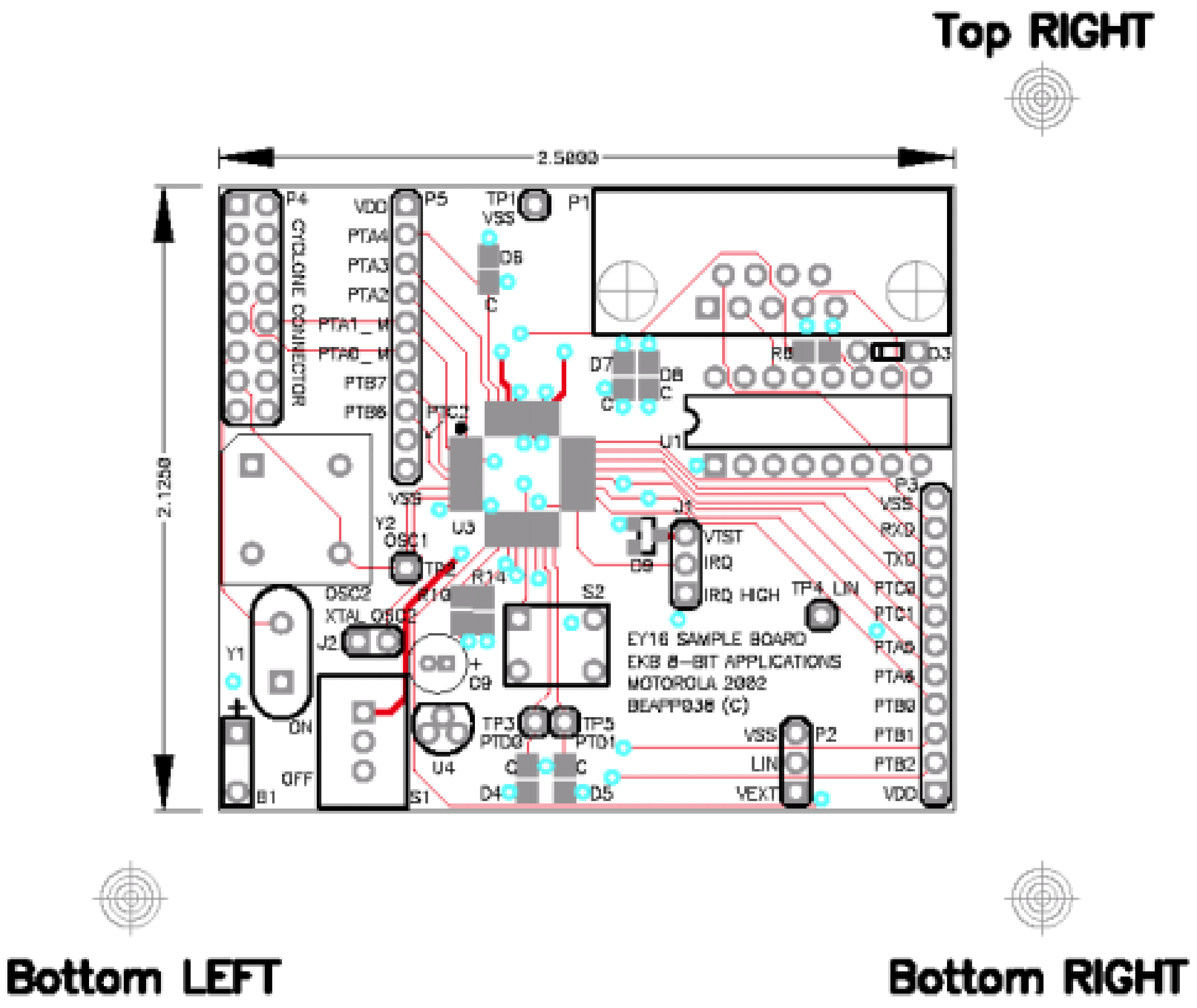
hc908ey16.h

```
/******************************************************
  HC08EY16.H
  Register and bit defiitions for the 908EY16

  T. McHenry                                  08-01-02
******************************************************/



#define           CONFIG1          *((volatile unsigned char *)0x001F)
#define           CONFIG2          *((volatile unsigned char *)0x001E)

#define           ICGCR            *((volatile unsigned char *)0x0036)
```

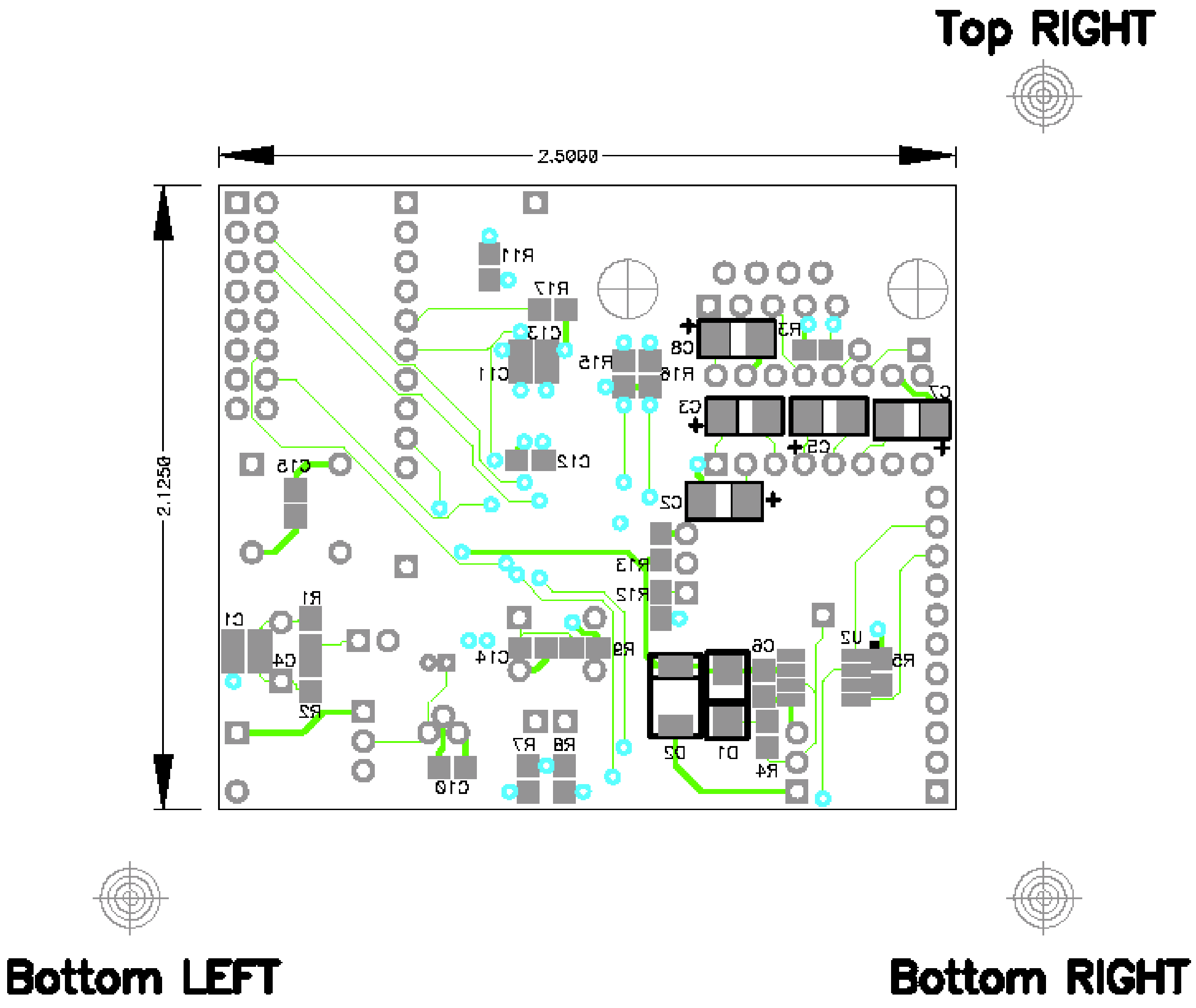
Appendix D – HC908EY16 Sample Board Schematic



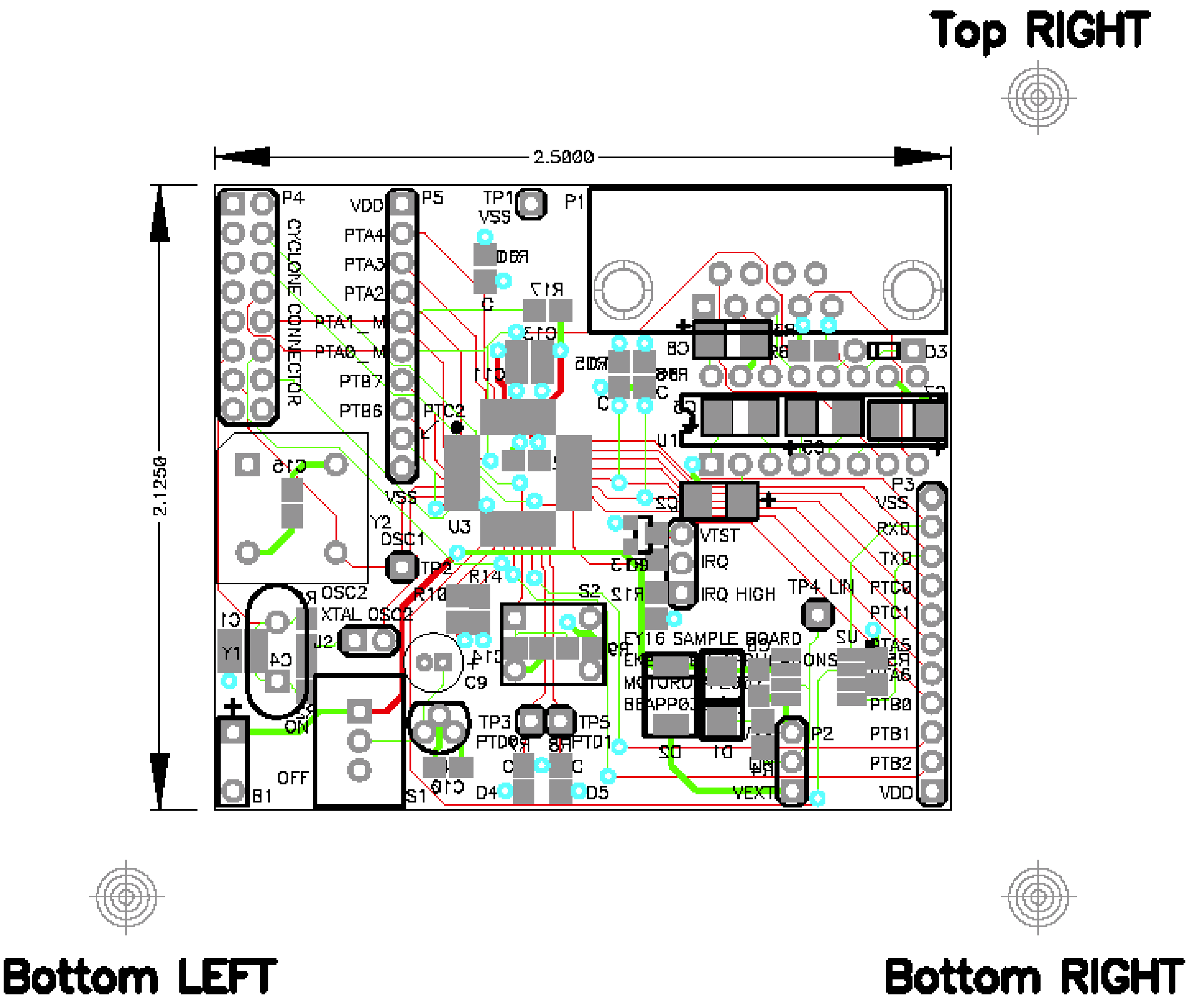
Appendix E – Layout Top View



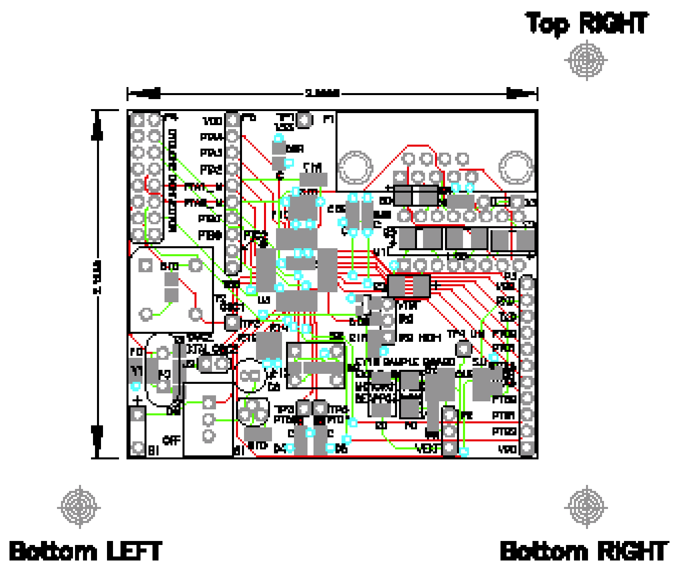
Appendix E – Layout Bottom view



Appendix E – Layout Combined



Appendix E – Layout Specification



SPECIFICATIONS:

1. DRILL FROM TOP SIDE.
2. HOLE DIAMETERS ARE AFTER PLATING.
3. ALL DIMENSIONS ARE IN INCHES AND ARE +/- .010 UNLESS NOTED.
4. ALL HOLES TO BE PLATED THRU UNLESS OTHERWISE NOTED.

MATERIAL:

1. BOARD THICKNESS: .062 INCHES.
2. FR4

FINISH:

1. 1 OUNCE COPPER.
2. SOLDER COAT.

Drill Symbol Table		
Hole Dia (Inch)	Symbol	Quantity
0.018	+	43
0.038	╳	85
0.124	Y	2

DESIGN RULES	
MINIMUM TRACK WIDTH	8
PAD TO PAD CLEARANCE	8
PAD TO TRACK CLEARANCE	8
TRACK TO TRACK CLEARANCE	8

LAYER: [illegible]MASK

NOTE: ALL LAYERS OF THIS ARTWORK ARE VIEWED FROM THE TOP SIDE

MOTOROLA TSPG 8 BIT APPLICATIONS EKB	
PROJECT: LIN CONFERENCES – EY16 SAMPLE BOARD	
SCHEMATIC REVISION: 4	PCB REVISION: 0
SCHEMATIC FORMAT: ORCAD PCB LAYOUT FORMAT: TANGO	DATE: 03 SEPTEMBER 2002

NOTE: IF MANUFACTURERS MARKINGS ARE USED THEY MUST BE PLACED ON SOLDER SIDE IN COPPER COVERED BY THE SOLDER MASK

[redacted]

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