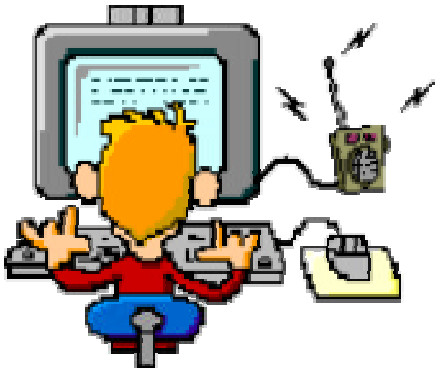
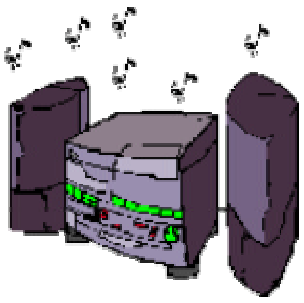
@Home Radio

FM Audio Link





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Service Manual

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1. Introduction

Welcome to the @Home Radio Audio Link Service Manual. This document is created to explain, to a user with a background in computers and electronics, how the system operates and how to repair the system should it fail. In the following pages we will discuss both hardware and software aspects of the system.

As described in the user's manual, @Home Radio is designed to transmit any stereo or audio signal inputted to the device through its RCA-compatible jack, located on the rear side of the system box. Any output frequency between 87.9 and 107.9 MHz can be selected (in 100 kHz increments). Since all commercial stations broadcast on the "odd" tenths (example: 97.9 or 102.3), we have included the option of transmitting on the "even" tenths (example: 88.8), doubling the number of output frequency levels. This permits the user to better use small areas of open bandwidth. The current output frequency is displayed on the four seven-segment displays on the front of the transmitter box.

The frequency can be controlled two ways – "on the box," and through the use of a PC with the packaged software. The transmitter box has buttons labeled "Up" and "Down." These buttons, as expected, raise and lower the frequency. By pressing and releasing one of these buttons, the frequency is either incremented or decremented 100 kHz. The second method of controlling the frequency is with the packaged @Home Radio software, which operates on any Windows platform. The PC will be connected to the transmitter box through the serial cable provided with the system. The PC and transmitter communicated via the RS-232 standard of operation. One convenient aspect of the system is that when the PC is attached, the box buttons can still be used at the user's convenience; they frequency shown on the PC will be updated when the buttons are pressed.

Just like the frequency, the Stereo / Mono and Mute states of transmission can be controlled both on the box and through the PC Software. Pressing and releasing the button marked "Stereo" on the box toggles between stereo and monaural modes of transmission. In the same manner, pressing and releasing the mute button toggles the mute state of transmission (a dead carrier signal is outputted) on and off.

A simple audio player is packaged with the frequency control software for the user's convenience. If a user does not have or wish to use WinAmp or Microsoft's Windows audio software, then the @Home Radio software will easily suffice. It supports .wav, CD, and .mp3 playback formats, which the user selects when loading a given file. While the file is playing, a counter is displayed that counts the number of seconds the song has been playing.

One of the great advantages of the @Home Radio system is its high portability. It accepts a standard 12 V DC input for power; the packaged AC adapter plugs into any home wall jack, and the cigarette lighter permits use of the product in a car. As stated in the User's Manual, a PC is **not** required for system operation. For example, a user can attach the system to a discman in the front seat of his or her car, power up the system with the cigarette lighter adapter, and listen to compact discs on the car's FM radio.

2a. PC Software

The code described in this section is listed in section 3d of this Service Manual. The following steps through the code function by function providing explicit detail that cannot be obtained from the comments in the code.

Splash Screen Interface

The splash screen serves no purpose other than for aesthetics. When the @Home Radio GUI is loaded, it appears on the screen; after 1.5 seconds or any key press, it disappears and the main window appears. This is accomplished through the following functions:

- *Form_KeyPress(KeyAscii As Integer)* – closes the Splash Screen Interface window when any key is pressed.
- *Form_Load()* – sets up the version label text box.
- *Frame1_Click()* – closes the splash screen when the mouse clicks the within the frame.
- *Timer1_Timer* – after 1500 milliseconds, it closes the Splash Screen Interface window.

Main Interface

All of the functionality that the GUI provides can be accessed from this window. It is both menu and command button driven. The following is a detailed list of the functions provided by the main form:

- *Form_Load()* – loads the Splash Screen Interface window; selects communication port 1; sets port one for 2400 baud, no parity, 8 data, and 1 stop bit; sets the communications port control to read the entire buffer on input; opens port 1; initializes *testcomvar* which is used to test communications with the transmitter.
- *OpenPlayerCommand_Click()* – loads the Audio Player Interface window.
- *ExitCommand_Click()* – closes the GUI
- *MuteMenu_Click()* – sends a message to transmitter to change mode of operation; changes the display on the tool bar to fit the current state of the transmitter; changes the description of the function on the drop down menus to fit the current state of the transmitter; loads the Dialog Interface window with the appropriate message.

- *SetFrequencyMenu_Click()* – loads the Set Frequency Interface window.
- *MonoStereoMenu_Click()* – sends a message to transmitter to change mode of operation; changes the display on the tool bar to fit the current state of the transmitter; changes the description of the function on the drop down menus to fit the current state of the transmitter; loads the Dialog Interface window with the appropriate message.
- *TestCMenu_Click()* – sends a message to the transmitter signaling a communications test; loads the Communications Test Interface window.
- *AboutCommand_Click()* – loads the Version Information Interface window.
- *SupportCommand_Click()* – loads the User Help Interface window.
- *OpenPlayerButton_Click()* – loads the Audio Player Interface window.
- *ChangeFreqButton_Click()* – loads the Set Frequency Interface window.
- *UpIncrementButton_Click()* – adds 1 kHz to the current broadcast frequency (if 107.9, changes the value to 87.9); calls the private sub function *TxFreq*.
- *DnIncrementButton_Click()* – subtracts 1 kHz from the current broadcast frequency (if 87.9, changes the value to 107.9); calls the private sub function *TxFreq*.
- *MuteButton_Click()* – sends a message to transmitter to change mode of operation; changes the display on the tool bar to fit the current state of the transmitter; changes the description of the function on the drop down menus to fit the current state of the transmitter; loads the Dialog Interface window with the appropriate message.
- *MonoStereo_Click()* – sends a message to transmitter to change mode of operation; changes the display on the tool bar to fit the current state of the transmitter; changes the description of the function on the drop down menus to fit the current state of the transmitter; loads the Dialog Interface window with the appropriate message.
- *TestComm_Click()* - sends a message to the transmitter signaling a communications test; loads the Communications Test Interface window.
- *HelpButton_Click()* - loads the User Help Interface window.
- *MSComm1_OnComm()* – receives input from the communications port control; dissects input to determine whether to change frequency or change mode of operation (i.e. mute the

transmitter); according to the message, carries out appropriate function using the same methods as described in the above functions (i.e. to change from mono to stereo).

Set Frequency Interface

This interface allows the user to manually type in a new frequency. It checks for errors (It will not accept alphabetic characters or numeric characters smaller than 87.9 or larger than 107.9.). Once a valid new frequency is received, it sends a message to the transmitter notifying it of the change and displays the new frequency on Main Interface window. The following is the list of functions used to accomplish these tasks:

- *cmdCancel_Click()* – closes the Set Frequency Interface window and returns control to the Main Interface window without making any changes or sending any messages to the transmitter.
- *cmdOK_Click()* – checks the user entered date for alphabetic or numeric characters outside the desired range; if data is acceptable, changes the display on the Main Interface window and sends a message to the transmitter notifying it of the change; if data is not acceptable, loads the Error Interface window.

Error Interface

The Error Interface is used to alert the user of invalid data that was entered in the Set Frequency Interface window. It is simply a dialog box that once closed, resets the entry blank on the Set Frequency Interface window so that the data can be reentered. Below is the function used to accomplish this task:

- *cmdOK_Click()* – resets the entry blank on the Set Frequency Interface Window; closes the Error Interface window.

User Help Interface

The User Help Interface is used to act as a quick reference guide to the novice user of the @Home Radio system. It has a list of assumed typical questions that the user may have. By clicking on the question, the user is given a brief answer. The user can view the different questions and answers and many times as necessary without reopening the window. The functions listed below are used to accomplish these tasks:

- *Form_Load()* – initializes variables used to keep track of the two display modes.

- *Command1_Click()* – changes the display from an answer back to the main list of questions; retains the last answer displayed.
- *Command2_Click()* – changes the display from the main list of questions to the last answer displayed.
- *Command3_Click()* – closes the User Help Interface and returns control to the Main Interface window
- *List1_Click()* – according to the question clicked on by the user, displays the answer.

Communications Test Interface

The Communications Test Interface is used to carry out the communications test between the GUI and the transmitter. A signal is sent out serially by the GUI. The transmitter is then given 3000 milliseconds to respond. If it does not by the given time, an alert dialog appears and reports the test failed. Otherwise, an alert dialog appears and reports the success of the test. The functions described below are used to carry out these tasks:

- *Timer1_Timer()* – waits to receive a signal from the transmitter for 3000 milliseconds; if nothing is received or if communication was verified, displays the correct message.
- *CancelButton_Click()* – closes the Communications Test Interface and the entire GUI.
- *OKButton_Click()* – only enabled after a test has succeeded or failed; upon test failure, runs the test again; upon test success, closes Communications Test Interface and returns control to the Main Interface window.

Dialog Interface

The Dialog Interface is used to display alert messages to the user upon the transmitter changing modes (i.e. changing from mono to stereo). It serves no other purpose and closes after 2500 milliseconds. This is done using the following function:

- *Timer1_Timer()* – after 2500 milliseconds, closes the Dialog Interface and returns control to the Main Interface window.

Version Information Interface

The Version Information Interface is used to display the current version information of the @Home Radio GUI. It serves no other purpose and after it is close, it returns control to the Main Interface window. This task is done using the following function:

- *cmdOK_Click()* – closes the Version Information Interface and returns control to the Main Interface window.

Audio Player Interface

The Audio Player Interface is used to play audio files located on the PC. It is capable of playing three file types: *.wav, *.mp3, and *.cda. If the device selected is the CD player, then it can advance between tracks; otherwise, each song must be individually opened. This is done using the following functions:

- *Form_Load()* – initialize a variable that keeps track of the opened device; initializes the devices to be used; initializes the variables used to display the music timer.
- *Mode_Click()* – loads the Audio Selection Interface.
- *Open_Click()* – when enabled (disabled when the selected device is a CD-ROM), loads a common dialog box that opens files of the desired type (*.wav or *.mp3).
- *Timer1_Timer()* – loads the correct .bmp file according to how much time has passed since the audio player was started (operates the music timer).
- *Prev_Click()* – "rewinds" the current track; if the track is "rewound", plays the previous track; resets music timer.
- *Play_Click()* – plays the currently loaded track or file; signals the music timer to begin.
- *Pause_Click()* – stops the play of the currently loaded track or file; disables the music timer (keeps the display the same).
- *Stop_Click()* – stops the play of the currently loaded track or file and "rewinds" it; disables the music timer (resets the display).
- *Next_Click()* – plays the next track on the CD.

Audio Selection Interface

The Audio Selection Interface is used to open up a single audio device (i.e. CD–ROM). Once the user selects to play one of the three supported file types, the interface is closed giving control to the Audio Player Interface. This is done using the following functions:

- *List1_Click()* – stores the user's choice of audio source; closes the Audio Selection Interface and give control to the Audio Player Interface.

2b. PIC Subsystem

The 330 W resistor packs, 7447 BCD decoders, and PIC microcontroller are all placed into sockets. The various capacitors, resistors, the oscillator, and the voltage regulator are also placed in sockets for easy replacement. There are only a few items not placed in sockets – the diode needed for the voltage regulator circuit is soldered directly to the +12 volt input and the 330 ? resistors needed for the power indicator, stereo, and mute LED's are soldered directly to the jumpers for those respective lights. All socket pin connections are made with wire-wrap except for the PIC's socket, which is soldered.

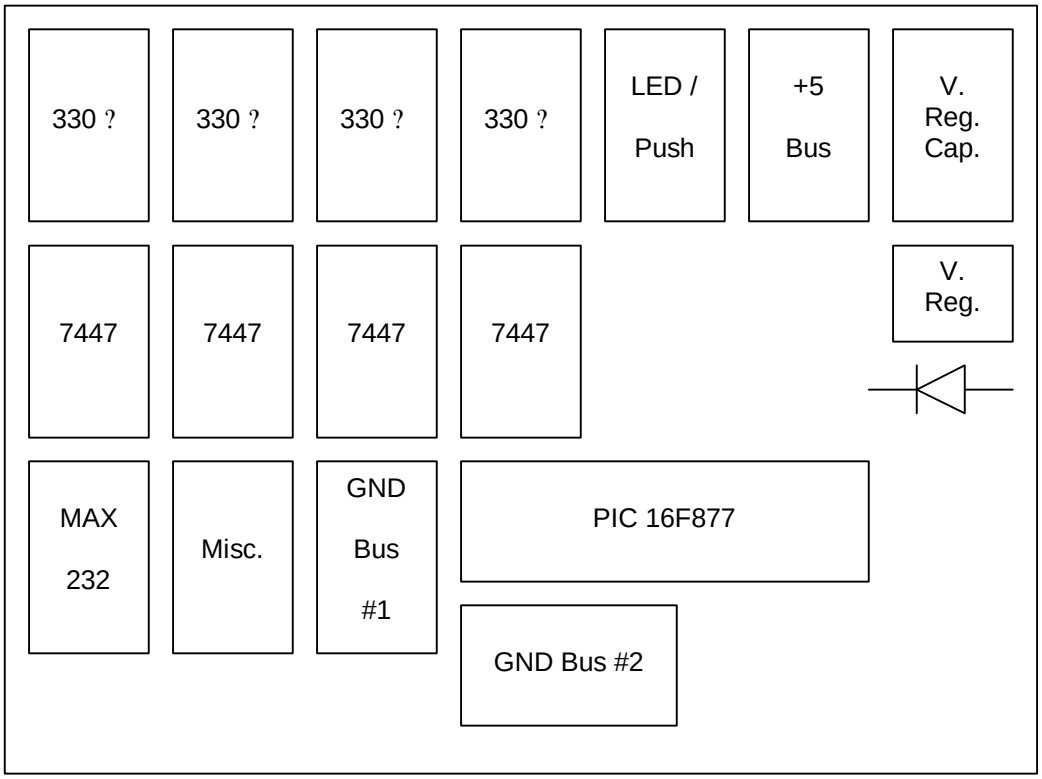

Figure 3. PIC System Board (Top)

Ground Bus #1

This socket creates a bus by simply connecting the pins on the left side to those on the right with small wire jumpers; that is, port 1 is connected to port 16, port 2 is attached to port 15, and so on. Ground pins on the 7447 chips, PIC microcontroller, and MAX 232 chip are connected to this bus. The bus itself gets its ground from the voltage regulator circuit.

Ground Bus #2

This socket is quite different from the first. The eight pins facing the middle of the board are tied to ground, but the others are not connected. The grounds for all of the LED's and pushbuttons on the front of the box as well as the serial cable's ground pin are connected here by pushing the jumpers down into the socket.

+5 Bus

This bus is similar to Ground Bus in that all the pins on the left side are connected to those on the right side with jumpers, except for pins 1 and 20. These two pins are connected with a 330 ? resistor, and one end is tied to ground, rather than +5 volts. The other end is connected to pin 5 on the socket that connects to the ones LED; this lights up the decimal point. All power connections for the system are connected to this bus, which gets is connected directly to the output of the voltage regulator circuit.

Voltage Regulator Socket

The voltage regulator is placed in pins 6, 7, and 8, facing the middle of the board. Nothing else is placed in this socket.

Voltage Regulator Capacitors Socket

The large 1000 ?F capacitor is placed in pins 1 and 3 (the positive end being in pin 1), and the 47 ?F capacitor is placed in pins 9 and 10, with the positive leg placed in pin 10. No other connections are made into this socket.

Voltage Regulator Circuit

The following diagram illustrates the setup of the +12 to +5 volt converter. The diode input is soldered to the +12 volt input plug that connects to the wall jack (or cigarette lighter adapter). The five volt output connects to the power bus.

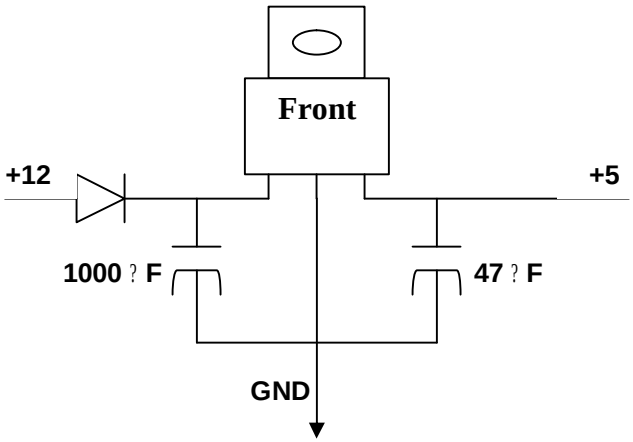

Figure 2. Voltage Regulator Circuit

Miscellaneous Socket

This socket contains several items with varying functions. The top ten pins (1 through 5 and 16 to 20) contain the 5 capacitors needed to operate the MAX 232 chip. The positive capacitor side is the right side of the socket, and the negative the left side. The bottom four pins (9 to 12) hold the two capacitors connected to the PIC's oscillator. The two pins directly above them – 8 and 13 – hold the capacitor itself. Pins 7 and 14 hold the 1 k? resistor needed to connect PIC pin 1 (MCLR) to +5 volts; pin 7 is connected to the PIC, and pin 14 connected to the power bus. This leaves pins 6 and 15, which are not connected.

PIC 16F877 Socket

Unlike the other sockets, all connections to this circuit are soldered. The PIC connects to the various other components in the circuit as shown in the circuit diagram in Chapter 3.

MAX 232 Socket

This socket and chip connect to the other circuit components as diagrammed in Chapter 3.

7447 BCD Decoder Sockets

The inputs to these sockets connect to the PIC, and the outputs are tied to the 330 W resistor packs. Power and ground, as with the other chips, are drawn from the power and ground buses.

330 W Resistor Packs

The resistors connect the pins on the left side to the pins directly across from them on the right side. Only the 7447 decoders and seven segment displays are connected to these sockets.

Seven Segment Displays

These sockets are not "stuck" in the perf board; rather, they are simply wired to the resistor packs and "hang" from the board. This permits ease of connection to the actual displays, which are glued to the transmitter box itself.

LED / Pushbutton I/0 Socket

Only pins 1 through 6 are used in this socket. The frequency up button plugs into pin 1, and the frequency down button is plugged into pin 2. Toggle stereo / mono plugs into pin 3, while toggle mute is placed into pin 4. The positive end of the stereo / mono LED connects to pin 5 of this socket, leaving pin 6, which connects to the mute LED. On the underside of the perf board, these pins are tied to the PIC as specified in the circuit diagram.

2c. PIC Software

The code described in this section is listed in section 3d of this Service Manual. The following information steps through the code function by function, giving an more in-depth explanation than can be realized from simply reading the commenting in the file.

Processor Declarations

Since we are using a PIC16F877, we select it and the corresponding include file here.

Register Usage

Dlay refers to a delay used to debounce the pushbuttons. Freq, count, and oldfrq are simple register variables used to store a single byte of data each. The #define freq declarations assign a name to represent each bit of the stored frequency value. This allows for easy bit checking. The following six #define statements assign a name to the frequency up button, frequency down button, stereo button, mute button, stereo LED, and mute LED for easy checking and setting.

Code Origin

The org call starts the code at location 0, the first available spot.

Port Setup

At register page 0, all five I/O ports are cleared for initialization. Then, at register page 1, Analog to Digital conversion for port A is disabled, port A is set to output, port B is set up for input at bits 0 through 5 and output at bits 6 and 7, and ports C, D, and E are set for output. The serial transmit and receive pins on port C are activated and set to asynchronous transmission at a baud rate of 2400. Receive is finally enabled at register page 0.

Run Once at Start

This section initializes the frequency to 87.9 MHz and enables stereo transmission while disabling the mute setting. It also sends this frequency setting to the PC.

Main Code

The main code section is actually very short. First, the receive register is checked to see if the frequency has been changed on the PC. If it has, it jumps to the check frequency section. If not, it checks all four of the input buttons on the box in sequence. If none of the buttons have been pressed, then the main code restarts. If a button has been pressed, the code jumps to a debounce routine for the particular pushbutton that was activated.

Check Input

Here, the upper nibble of the input from the PC is checked to see if it is 1111. If it is, then this designates a special opcode from the PC has been sent rather than a new frequency. If bit 2 is set, then the PC is asking for a communication test; we jump to a section in the code that sends back exactly what the PC transmitted – 11110100. Bit 1 is then checked. If bit 1 is set, then a mute setting has been received. If it is clear, a stereo / mono setting has been inputted. The code then jumps to a section for either a mute or stereo setting, depending on this bit.

Test Communication

Here, a hexadecimal F4 is sent in response to the PC's call for a communication test. Transmission is enabled, hex F4 is loaded, then it is sent via the transmit register. A loop then repeatedly checks the transmit buffer to see if it is empty; if it is not, a small delay routine is called. Once the buffer is emptied and transmission is finished, transmission is disabled. The program then returns to the main code.

PC Set Stereo

This function changes the stereo setting based on input from the PC. Bit 0 of the data sent from the PC is checked. If the bit is set, stereo is turned on, if it is clear, the stereo LED is turned off.

PC Set Mute

This function changes the mute setting based on input from the PC. Bit 0 of the data sent from the PC is checked. If the bit is set, mute is turned on, if it is clear, the mute LED is turned off.

Restore Frequency

This function is called from either test communication, PC set stereo, or PC set mute, since an opcode was sent rather than a new frequency. The previous frequency, which was stored in the variable oldfrq, is loaded back into the variable freq, resetting the frequency back to what it was before the PC data was received. We jump back to the main code.

Decrement Frequency

Within this function, the down button is debounced and the frequency decremented before jumping to a transmit frequency to PC function. The down button is checked to see if it is still set (pressed). If it is clear, it's checked a second time to ensure the debounce has completed. If it is not clear, a small 20-millisecond delay is called. Once this debounce routine has finished, each bit of the frequency is checked to see if it is the minimum value (all eight bits of the variable freq zeroes), or 87.9 MHz. If it is at this minimum value, the variable freq is set to 11001000, or 107.9 MHz; otherwise, freq is decremented, moving the output frequency down 100 kHz.

Increment Frequency

Within this function, the up button is debounced and the frequency incremented before jumping to a transmit frequency to PC function. The up button is checked to see if it is still set (pressed). If it is clear, it's checked a second time to ensure the debounce has completed. If it is not clear, a small 20-millisecond delay is called. Once this debounce routine has finished, each bit of the frequency is checked to see if it is the maximum value (freq is equal to 11001000), or 107.9 MHz. If it is at this maximum value, the variable freq is set to all zeroes, or 87.9 MHz; otherwise, freq is incremented, moving the output frequency up 100 kHz.

Toggle Stereo

Within this function, the stereo / mono button is debounced and LED toggled before jumping to a transmit stereo setting to PC function. The stereo / mono button is checked to see if it is still set (pressed). If it is clear, it's checked a second time to ensure the debounce has completed. If it is not clear, a small 20-

millisecond delay is called. Once this debounce routine has finished, the stereo LED is checked. If it is set (on), the LED is turned off for mono transmission. Otherwise, it is turned on, indicating a stereo transmission.

Toggle Mute

Within this function, the mute button is debounced and LED toggled before jumping to a transmit mute setting to PC function. The mute button is checked to see if it is still set (pressed). If it is clear, it's checked a second time to ensure the debounce has completed. If it is not clear, a small 20-millisecond delay is called. Once this debounce routine has finished, the mute LED is checked. If it is set (on), the LED is turned off for normal transmission. Otherwise, it is turned on, indicating a muted transmission.

Display Frequency

This function sets ports D and E to correctly display the frequency setting. Port D displays the decimals and ones, while port E contains the tens and hundreds data. Initially, the high byte of the decimals and ones table location is loaded into the program counter. Then the table is called, which returns a value a number of steps down the table based in the value stored in the variable freq. That is, if freq is all zeroes, it returns the first value in the table, the data needed to display the seven and nine in 87.9. If it is 00000010, it returns the third value, which contains the data needed to display 88.1, and so on. The returned value for the decimals and ones is then sent to port D, as stated above. The tens and hundreds values are displayed in the same manner – the high value of the table is loaded, the code jumps the same number of values down in this table as it did in the previous one, and the returned value is moved to port E, displaying the correct tens and hundreds digits. The code now returns to main.

Transmit Frequency

The data stored in the variable freq is sent to the PC through this function, which then jumps to a display routine. Transmission is enabled, and the freq is loaded into the transmit register. A loop then repeatedly checks the transmit buffer to see if it is empty; if it is not, a small delay routine is called. Once

the buffer is emptied and transmission is finished, transmission is disabled. The program then jumps to the aforementioned display code.

Transmit Stereo Setting

This function sends the stereo / mono state serially to the PC. Transmission is enabled, and the stereo LED is checked. If it is on, hexadecimal F1, the opcode for set stereo, is loaded to the transmit register. Otherwise, hexadecimal F0, the opcode for mono transmission, is loaded to the transmit buffer. As in all of the other serial transmission functions, a loop repeatedly checks the transmit buffer. A delay is called until the buffer is empty, at which point the transmission is disabled since it is finished. We then jump back to the main code.

Transmit Mute Setting

This function sends the mute state serially to the PC. Transmission is enabled, and the mute LED is checked. If it is on, hexadecimal F2, the opcode for set mute, is loaded to the transmit register. Otherwise, hexadecimal F3, the opcode for normal transmission, is loaded to the transmit buffer. Again, a loop repeatedly checks the transmit buffer. A delay is called until the buffer is empty, at which point the transmission is disabled since it is finished. We then jump back to the main code.

Delay

This is called by all of the transmit routines. Hexadecimal FF is loaded into a counter variable, and it is repeatedly decremented though a loop until it is equal to zero. The program then returns to its previous location

Data Read

This function is not currently used.

Data Write

This function is not currently used.

Decimals and Ones

This table begins at register address 300 to avoid paging errors in the high byte of the program counter. It returns a value that will display the correct decimals and ones values through the use of BCD decoders.

Tens and Hundreds

This table begins at register address 600 to avoid paging errors in the high byte of the program counter. It returns a value that will display the correct tens and hundreds values through the use of BCD decoders.

2d. Transmitter Subsystem

The transmitter portion of the @Home Radio is laid out on a printed circuit board. The peripheral connections are power, ground, lines to the PIC microprocessor, and RF output to the antenna. The complete schematic for the transmitter subsystem can be seen in section 3d of this service manual. Nonstandard components (resistors, capacitors, crystals, etc.) are listed below.

Description	Manufacturer	Part #
Darlington Transistor	ROHM	2SC2062S
Varactor Diode	TOKO	KV1471E
Band Pass Filter	SOSHIN	GFWB3
Variable Inductor	SUMIDA	FEM10C-3F6
Stereo Modulator – RF generator	ROHM	BH1415F
RF Amplifier	RF Micro Devices	RF2334

Audio Input

The audio input is done through standard RCA Jacks. One being a left channel and the other the right channel. This input is filtered by the BH1415F chip with a low pass filter before being added (L+R) and subtracted (L-R) by the chip. The multiplexed stereo (or mono when mono is on) output is observed at pin 5 of the BH1415F. This is connected to a potentiometer for desired attenuation, and fed to the rest of the circuit.

Phase Lock Loop (PLL)

The BH1415F chip implements a phase lock loop system that contains some components that are off-chip. The goal of the PLL is to allow the user to serially select the operating frequency, and to adjust the RF output frequency accordingly. The serial data is input via pins 15, 16, and 17 on the BH1415F. For specifics on programming the serial input please refer to the BH1415F data sheet included with this manual.

Voltage Controlled Oscillator

The voltage controlled oscillator (VCO) portion that is contained outside of the BH1415F consists of the parallel network with the varactor diode and variable inductor. The inductor can be adjusted with a tuning want to vary the resonant frequency of the VCO. This can be used to calibrate the digital frequency settings.

RF Output Stage

The RF output is seen at pin 11 of the BH1415F and passes through a resistor network that attenuates the signal. This is then passed to the Soshin GFWB6 band pass filter. This assures that transmission does not exceed the desired FM band. In case of Faulty operation, the GFWB6 can be replaced with any band pass filters out all but 88-108 MHz. The final portion of the RF output is the RF2334 RF amplifier. This amplifier operates in the DC-4000 MHz range, and could be replaced with and any amplifier that accepts 88-108 MHz.

Voltage Test Point

The voltage between the two 3.3K resistors is the control voltage for the VCO. This voltage can be observed to determine if the phase lock loop system (PLL) is operating properly. When the PLL is not locked (occurs on power up, or when a new frequency has been selected), the test voltage should either raise from a low voltage to +5 or lower from +5 to close to zero volts. This is when the PLL is searching for the frequency to lock on. Once the PLL finds the correct frequency the control voltage should stabilize and no longer vary.

3a. PC Code

This section contains code for both the audio player and the PC's transmitter control. It should be compiled with Microsoft Visual Basic 6.0, which can be found in the Microsoft Visual Studio software package.

```
''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''

' About Form Code

Private Sub cmdOK_Click()
 Unload AboutForm
End Sub


' Audio Player Form Code

Private Sub Form_Load()
' Initialize Device Type (Error Chex)
    DeviceType = -1

' Initialize Clock Variables
    AudioPlayer.Counter = 0
    AudioPlayer.Clock_Tens = 0
    AudioPlayer.Clock_Minutes = 0
    AudioPlayer.Clock_Hours = 0


AudioSelection.Show (1)

' Use MMControl for CD Audio

    MMControl1.Notify = False
    MMControl1.Wait = True
    MMControl1.Shareable = False
    MMControl1.DeviceType = "CDAudio"
    MMControl1.Command = "Open"

End Sub

Private Sub Mode_Click()

AudioSelection.Show (1)
End Sub

Private Sub Next_Click()
    Hours.Picture = LoadPicture("A:\0.bmp")
    Minutes.Picture = LoadPicture("A:\0.bmp")
    Tens.Picture = LoadPicture("A:\0.bmp")
    Ones.Picture = LoadPicture("A:\0.bmp")
            AudioPlayer.Counter = 0
        AudioPlayer.Clock_Tens = 0
        AudioPlayer.Clock_Minutes = 0
        AudioPlayer.Clock_Hours = 0

' Be sure device has been selected.
    If DeviceType = -1 Then
        AudioSelection.Show (1)
    End If

' Select Correct Device
    If AudioPlayer.DeviceType = 0 Then
        ' Do Nothing!
```

```
   Else
      MMControl1.Command = "Next"
   End If
End Sub

Private Sub Open_Click()
   Select Case AudioPlayer.DeviceType
      Case 0
         CommonDialog1.Filter = "*.mp3|*.mp3"
         CommonDialog1.ShowOpen
         If CommonDialog1.FileName <> "" Then
            AP.FileName = CommonDialog1.FileName
            AP.Play

         End If
      Case 1
         CommonDialog1.Filter = "*.cda|*.cda"
         CommonDialog1.ShowOpen
         If CommonDialog1.FileName <> "" Then
            MMControl1.FileName = CommonDialog1.FileName
            MMControl1.Command = "Play"
         End If
      Case 2
         CommonDialog1.Filter = "*.wav|*.wav"
         CommonDialog1.ShowOpen
         If CommonDialog1.FileName <> "" Then
            AP.FileName = CommonDialog1.FileName
            AP.Play
         End If
   End Select
   If CommonDialog1.FileName <> "" Then
   Hours.Picture = LoadPicture("A:\0.bmp")
   Minutes.Picture = LoadPicture("A:\0.bmp")
   Tens.Picture = LoadPicture("A:\0.bmp")
   Ones.Picture = LoadPicture("A:\0.bmp")
   Timer1.Enabled = True
   End If
End Sub

Private Sub Pause_Click()
Timer1.Enabled = False
' Be sure device has been selected.
   If DeviceType = -1 Then
      AudioSelection.Show (1)
   End If

' Select Correct Device
   If AudioPlayer.DeviceType = 0 Then
      AP.Pause
   Else
      MMControl1.Command = "Pause"
   End If
End Sub

Private Sub Play_Click()
' Be sure device has been selected.
   If DeviceType = -1 Then
      AudioSelection.Show (1)
   End If

' Select Correct Device
   If AudioPlayer.DeviceType = 0 Then
      If AP.FileName <> "" Then
         AP.Play
         If AudioPlayer.Counter = 0 Then
            Hours.Picture = LoadPicture("A:\0.bmp")
            Minutes.Picture = LoadPicture("A:\0.bmp")
            Tens.Picture = LoadPicture("A:\0.bmp")
            Ones.Picture = LoadPicture("A:\0.bmp")
         End If
```

```
        Timer1.Enabled = True

      End If
   Else
      If 1 Then
         MMControl1.Command = "Play"


      If AudioPlayer.Counter = 0 Then
         Hours.Picture = LoadPicture("A:\0.bmp")
         Minutes.Picture = LoadPicture("A:\0.bmp")
         Tens.Picture = LoadPicture("A:\0.bmp")
         Ones.Picture = LoadPicture("A:\0.bmp")
      End If
      Timer1.Enabled = True

      End If

   End If
End Sub

Private Sub Prev_Click()
   Hours.Picture = LoadPicture("A:\0.bmp")
   Minutes.Picture = LoadPicture("A:\0.bmp")
   Tens.Picture = LoadPicture("A:\0.bmp")
   Ones.Picture = LoadPicture("A:\0.bmp")
         AudioPlayer.Counter = 0
      AudioPlayer.Clock_Tens = 0
      AudioPlayer.Clock_Minutes = 0
      AudioPlayer.Clock_Hours = 0

' Be sure device has been selected.
   If DeviceType = -1 Then
      AudioSelection.Show (1)
   End If

' Select Correct Device
   If AudioPlayer.DeviceType = 0 Then
      ' Do Nothing!
   Else
      MMControl1.Command = "Prev"
   End If
End Sub

Private Sub Stop_Click()
Timer1.Enabled = False

' Be sure device has been selected.
   If DeviceType = -1 Then
      AudioSelection.Show (1)
   End If

' Select Correct Device
   If AudioPlayer.DeviceType = 0 Then
      AP.Stop
      AudioPlayer.Counter = 0
      AudioPlayer.Clock_Tens = 0
      AudioPlayer.Clock_Minutes = 0
      AudioPlayer.Clock_Hours = 0

   Else
      MMControl1.Command = "Stop"
      MMControl1.Command = "Prev"
      AudioPlayer.Counter = 0
      AudioPlayer.Clock_Tens = 0
      AudioPlayer.Clock_Minutes = 0
      AudioPlayer.Clock_Hours = 0
   End If
```

```
End Sub

Private Sub Timer1_Timer()
' Increment Counter
   AudioPlayer.Counter = AudioPlayer.Counter + 1

If AudioPlayer.Counter < 10 Then

   Select Case AudioPlayer.Counter

      Case 0
         Ones.Picture = LoadPicture("A:\0.bmp")
      Case 1
         Ones.Picture = LoadPicture("A:\1.bmp")
      Case 2
         Ones.Picture = LoadPicture("A:\2.bmp")
      Case 3
         Ones.Picture = LoadPicture("A:\3.bmp")
      Case 4
         Ones.Picture = LoadPicture("A:\4.bmp")
      Case 5
         Ones.Picture = LoadPicture("A:\5.bmp")
      Case 6
         Ones.Picture = LoadPicture("A:\6.bmp")
      Case 7
         Ones.Picture = LoadPicture("A:\7.bmp")
      Case 8
         Ones.Picture = LoadPicture("A:\8.bmp")
      Case 9
         Ones.Picture = LoadPicture("A:\9.bmp")
   End Select

Else

   AudioPlayer.Counter = 0
   Ones.Picture = LoadPicture("A:\0.bmp")
   AudioPlayer.Clock_Tens = AudioPlayer.Clock_Tens + 1

   If AudioPlayer.Clock_Tens < 6 Then

      Select Case AudioPlayer.Clock_Tens

         Case 0
            Tens.Picture = LoadPicture("A:\0.bmp")
         Case 1
            Tens.Picture = LoadPicture("A:\1.bmp")
         Case 2
            Tens.Picture = LoadPicture("A:\2.bmp")
         Case 3
            Tens.Picture = LoadPicture("A:\3.bmp")
         Case 4
            Tens.Picture = LoadPicture("A:\4.bmp")
         Case 5
            Tens.Picture = LoadPicture("A:\5.bmp")

      End Select

   Else

      AudioPlayer.Clock_Tens = 0
      Tens.Picture = LoadPicture("A:\0.bmp")
      AudioPlayer.Clock_Minutes = AudioPlayer.Clock_Minutes + 1

      If AudioPlayer.Clock_Minutes < 10 Then

         Select Case AudioPlayer.Clock_Minutes

               Case 0
                  Minutes.Picture = LoadPicture("A:\0.bmp")
```

```
          Case 1
             Minutes.Picture = LoadPicture("A:\1.bmp")
          Case 2
             Minutes.Picture = LoadPicture("A:\2.bmp")
          Case 3
             Minutes.Picture = LoadPicture("A:\3.bmp")
          Case 4
             Minutes.Picture = LoadPicture("A:\4.bmp")
          Case 5
             Minutes.Picture = LoadPicture("A:\5.bmp")
          Case 6
             Minutes.Picture = LoadPicture("A:\6.bmp")
          Case 7
             Minutes.Picture = LoadPicture("A:\7.bmp")
          Case 8
             Minutes.Picture = LoadPicture("A:\8.bmp")
          Case 9
             Minutes.Picture = LoadPicture("A:\9.bmp")

      End Select

   Else

      AudioPlayer.Clock_Minutes = 0
      Minutes.Picture = LoadPicture("A:\0.bmp")
      AudioPlayer.Clock_Hours = AudioPlayer.Clock_Hours + 1

      If AudioPlayer.Clock_Hours < 6 Then

         Select Case AudioPlayer.Clock_Hours

         Case 0
            Hours.Picture = LoadPicture("A:\0.bmp")
         Case 1
            Hours.Picture = LoadPicture("A:\1.bmp")
         Case 2
            Hours.Picture = LoadPicture("A:\2.bmp")
         Case 3
            Hours.Picture = LoadPicture("A:\3.bmp")
         Case 4
            Hours.Picture = LoadPicture("A:\4.bmp")
         Case 5
            Hours.Picture = LoadPicture("A:\5.bmp")

         End Select
      Else

         AudioPlayer.Clock_Hours = 0
         Hours.Picture = LoadPicture("A:\0.bmp")

      End If

   End If

 End If

End If
End Sub

''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
' Audio Selection Code

Private Sub List1_Click()
 Select Case List1.ListIndex

   Case 0
      AudioPlayer.DeviceType = 1
      AudioPlayer.Open.Enabled = False
      AudioPlayer.Prev.Enabled = True
      AudioPlayer.Next.Enabled = True
```

```
    Case 1
      AudioPlayer.DeviceType = 0
      AudioPlayer.Open.Enabled = True
      AudioPlayer.Prev.Enabled = False
      AudioPlayer.Next.Enabled = False
    Case 2
      AudioPlayer.DeviceType = 2
      AudioPlayer.Open.Enabled = True
      AudioPlayer.Prev.Enabled = False
      AudioPlayer.Next.Enabled = False
  End Select
  Me.Hide
End Sub

''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
' Test Communication Code

Private Sub OKButton_Click()
Unload Dialog
If Form1.testcomvar = False Then
        Form1.MSComm1.Output = Chr(244)
        Dialog.Show (1)
Else
        Form1.testcomvar = False
End If
End Sub

Private Sub Timer1_Timer()
If Form1.testcomvar = True Then
        TestBar.Value = 100
        CancelButton.Enabled = False
        TestBar.Visible = False
        Label1.Visible = False
        Label2.Visible = False
        Label4.Visible = True
        OKButton.Enabled = True
Else
        Label1.Visible = True
        TestBar.Visible = True
        If TestBar.Value < 100 Then
                TestBar.Value = TestBar.Value + 10
        ElseIf TestBar.Value = 100 Then
                OKButton.Enabled = True
                Label1.Visible = False
                TestBar.Visible = False
                Label2.Visible = True
                Image1.Visible = False
                Image2.Visible = True
        End If
End If
End Sub

''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
' Mute/Mono/Stereo Form Code

Private Sub Timer1_Timer()
If Form1.tmpfreq2 <> 244 Then
        Me.Hide
End If
End Sub

''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
' Main Window Code

Public testcomvar As Boolean
Public tmpfreq2 As Variant


Private Sub AboutCommand_Click()
AboutForm.Show (1)
```

```
End Sub

Private Sub ChangeFreqButton_Click()
Form2.Show (1)
End Sub

Private Sub Command1_Click()
Dialog.Hide
MSComm1.Output = Chr(244)
Dialog.Show (1)
End Sub

Private Sub ContentsCommand_Click()
helpwin.Show (1)
End Sub

Private Sub Command2_Click()
Form4.Show (1)
End Sub

Private Sub DnIncrementButton_Click()
If FreqText.Text > 87.9 Then
FreqText.Text = FreqText.Text - 0.1
If (FreqText.Text - Int(FreqText.Text)) = 0 Then
Tmp = FreqText.Text & ".0"
FreqText.Text = Tmp
End If
Else
FreqText.Text = 107.9
End If
TxFreq
End Sub

Private Sub ExitCommand_Click()
Unload Form1
End Sub

Private Sub Form_Load()
testcomvar = False
frmSplash.Show (1)
' Use COM1.
   MSComm1.CommPort = 1
   ' 2400 baud, no parity, 8 data, and 1 stop bit.
   MSComm1.Settings = "2400,N,8,1"
   ' Tell the control to read entire buffer when Input
   ' is used.
   MSComm1.InputLen = 1
   MSComm1.RThreshold = 1
   ' Open the port.
   MSComm1.PortOpen = True
   ' Send the attention command to the modem.

End Sub

Private Sub MonoStereo_Click()
If MonoStereo.Picture = MonoStereo.DisabledPicture Then
MonoStereo.Picture = MonoStereo.DownPicture
MonoStereoMenu.Caption = "Ch&ange to Mono Transmission"
Dialog1.Caption = "@Home Radio - Mono / Stereo Select"
Dialog1.Label1.Visible = False
Dialog1.Label2.Caption = "The transmitter is now broadcasting a Stereo audio signal."
Dialog1.Label2.Visible = True
Dialog1.Show (1)
MSComm1.Output = Chr(241)
Else
MonoStereo.Picture = MonoStereo.DisabledPicture
MonoStereoMenu.Caption = "Ch&ange to Stereo Transmission"
Dialog1.Caption = "@Home Radio - Mono / Stereo Select"
Dialog1.Label1.Visible = False
Dialog1.Label2.Caption = "The transmitter is now broadcasting a Mono audio signal."
```

```
Dialog1.Label2.Visible = True
Dialog1.Show (1)
MSComm1.Output = Chr(240)
End If
End Sub

Private Sub MonoStereoMenu_Click()
If MonoStereo.Picture = MonoStereo.DisabledPicture Then
MonoStereo.Picture = MonoStereo.DownPicture
MonoStereoMenu.Caption = "Ch&ange to Mono Transmission"
Dialog1.Caption = "@Home Radio - Mono / Stereo Select"
Dialog1.Label1.Visible = False
Dialog1.Label2.Caption = "The transmitter is now broadcasting a Stereo audio signal."
Dialog1.Label2.Visible = True
Dialog1.Show (1)
MSComm1.Output = Chr(241)
Else
MonoStereo.Picture = MonoStereo.DisabledPicture
MonoStereoMenu.Caption = "Ch&ange to Stereo Transmission"
Dialog1.Caption = "@Home Radio - Mono / Stereo Select"
Dialog1.Label1.Visible = False
Dialog1.Label2.Caption = "The transmitter is now broadcasting a Mono audio signal."
Dialog1.Label2.Visible = True
Dialog1.Show (1)
MSComm1.Output = Chr(240)
End If
End Sub

Private Sub MSComm1_OnComm()
Dim tmpfreq As Variant

Select Case MSComm1.CommEvent

' Errors
   Case comEventBreak      ' A break was received
   Case comEventFrame      ' Framing Error
   Case comEventOverrun    ' Data Lost
   Case comEventRxOver     ' Receive buffer overflow
   Case comEventRxParity   ' Parity Error
   Case comEventTxFull     ' Transmit buffer full
   Case comEventDCB        ' Unexpected error retrieving DCB

' Events
   Case comEvCD        ' Change in the CD line.
   Case comEvCTS       ' Change in the CTS line.
   Case comEvDSR       ' Change in the DSR line.
   Case comEvRing      ' Change in the Ring Indicator.
   Case comEvReceive   ' Received RThreshold # of chars.
      tmpfreq = Asc(MSComm1.Input)
      tmpfreq2 = tmpfreq
      If tmpfreq < 201 Then
         tmpfreq = (tmpfreq + 879) / 10
         If (tmpfreq - Int(tmpfreq)) = 0 Then
            tmpfreq = tmpfreq & ".0"
         End If

      FreqText.Text = tmpfreq
      tmpfreq2 = tmpfreq

      Else
         If tmpfreq <> 244 Then
         Dialog1.Hide
         End If
         Select Case tmpfreq

            Case 244       'Test Comm
               testcomvar = True
            Case 240       'Set Mono
               MonoStereo.Picture = MonoStereo.DisabledPicture
               MonoStereoMenu.Caption = "Ch&ange to Stereo Transmission"
```

```
            Dialog1.Caption = "@Home Radio - Mono / Stereo Select"
            Dialog1.Label1.Visible = False
            Dialog1.Label2.Caption = "The transmitter is now broadcasting a Mono audio signal."
            Dialog1.Label2.Visible = True
            Dialog1.Show (1)
        Case 241        'Set Stereo
            MonoStereo.Picture = MonoStereo.DownPicture
            MonoStereoMenu.Caption = "Ch&ange to Mono Transmission"
            Dialog1.Caption = "@Home Radio - Mono / Stereo Select"
            Dialog1.Label1.Visible = False
            Dialog1.Label2.Caption = "The transmitter is now broadcasting a Stereo audio signal."
            Dialog1.Label2.Visible = True
            Dialog1.Show (1)
        Case 242        'Mute Transmitter
            formclose = True
            MuteButton.Picture = MuteButton.DisabledPicture
            Dialog1.Caption = "@Home Radio - Mute Transmission"
            Dialog1.Label1.Visible = True
            Dialog1.Label2.Visible = False
            Dialog1.Show (1)
            MuteMenu.Caption = "Sou&nd Transmitter"
        Case 243        'Sound Transmitter
            MuteButton.Picture = MuteButton.DownPicture
            MuteMenu.Caption = "M&ute Transmitter"

      End Select
    End If

  Case comEvSend     ' There are SThreshold number of characters in the transmit buffer.
  Case comEvEOF      ' An EOF charater was found in the input stream

End Select
End Sub

Private Sub MuteButton_Click()
If MuteButton.Picture = MuteButton.DisabledPicture Then
MuteButton.Picture = MuteButton.DownPicture
MuteMenu.Caption = "M&ute Transmitter"
MSComm1.Output = Chr(243)
Else
MuteButton.Picture = MuteButton.DisabledPicture
Dialog1.Caption = "@Home Radio - Mute Transmission"
Dialog1.Label1.Visible = True
Dialog1.Label2.Visible = False
Dialog1.Show (1)
MuteMenu.Caption = "Sou&nd Transmitter"
MSComm1.Output = Chr(242)
End If
End Sub

Private Sub MuteMenu_Click()
If MuteButton.Picture = MuteButton.DisabledPicture Then
MuteButton.Picture = MuteButton.DownPicture
MuteMenu.Caption = "M&ute Transmitter"
MSComm1.Output = Chr(243)
Else
MuteButton.Picture = MuteButton.DisabledPicture
MuteMenu.Caption = "Sou&nd Transmitter"
Dialog1.Caption = "@Home Radio - Mute Transmission"
Dialog1.Label1.Visible = True
Dialog1.Label2.Visible = False
Dialog1.Show (1)
MSComm1.Output = Chr(242)
End If
End Sub

Private Sub OpenPlayerButton_Click()
AudioPlayer.Show (1)
End Sub
```

```
Private Sub OpenPlayerCommand_Click()
AudioPlayer.Show (1)
End Sub

Private Sub SetFrequencyMenu_Click()
Form2.Show (1)
End Sub

Private Sub Timer1_Timer()
Unload frmSplash
End Sub

Private Sub SplashScreenOption_Click()
If SplashScreenOption.Checked = True Then
SplashScreenOption.Checked = False
Else
SplashScreenOption.Checked = True
End If
End Sub

Private Sub SupportCommand_Click()
Form4.Show (1)
End Sub

Private Sub TestCMenu_Click()
MSComm1.Output = Chr(244)
Dialog.Show (1)
End Sub

Private Sub UpIncrementButton_Click()
If FreqText.Text < 107.9 Then
FreqText.Text = FreqText.Text + 0.1
If (FreqText.Text - Int(FreqText.Text)) = 0 Then
Tmp = FreqText.Text & ".0"
FreqText.Text = Tmp
End If
Else
FreqText.Text = 87.9
End If
TxFreq
End Sub

Private Sub WindowOption_Click()
If WindowOption.Checked = True Then
WindowOption.Checked = False
Else
WindowOption.Checked = True
End If
End Sub

Public Sub TxFreq()
Dim freq As Variant
freq = FreqText.Text
freq = (freq * 10) - 879
MSComm1.Output = Chr(freq)
End Sub

''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
' Set Frequency Form Code

Private Sub cmdCancel_Click()
Me.Hide
End Sub

Private Sub cmdOK_Click()
If (SetFreqText.Text >= "A") And (SetFreqText.Text <= "z") Then
Form3.Show (1)
ElseIf SetFreqText.Text = "" Then
Form3.Show (1)
Else
```

```
If (SetFreqText.Text >= 87.9) And (SetFreqText.Text <= 107.9) Then
If (SetFreqText.Text - Int(SetFreqText.Text)) = 0 Then
   SetFreqText.Text = SetFreqText.Text & ".0"
End If
Form1.FreqText.Text = SetFreqText.Text
Else
Form3.Show (1)
End If
End If
Form1.TxFreq
Me.Hide
End Sub

''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
' Error Form Code

Private Sub cmdOK_Click()
Form2.SetFreqText.Text = ""
Unload Form3
Unload Form2
Form2.Show (1)
End Sub

''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
' Help Form Window

Public fwd As Integer
Public textwindow As Integer

Private Sub Command1_Click()
      If textwindow > 0 Then
         List1.Visible = True
         Select Case textwindow
            Case 1
               Text1.Visible = False
               fwd = 1
            Case 2
               Text2.Visible = False
               fwd = 2
            Case 3
               Text3.Visible = False
               fwd = 3
            Case 4
               Text4.Visible = False
               fwd = 4
            Case 5
               Text5.Visible = False
               fwd = 5
            Case 7
               Text6.Visible = False
               fwd = 7
            Case 8
               Text7.Visible = False
               fwd = 8
            Case 9
               Text8.Visible = False
               fwd = 9
         End Select
         textwindow = 0
      End If
End Sub

Private Sub Command2_Click()
   If fwd > 0 Then
      List1.Visible = False
      Select Case fwd
         Case 1
            Text1.Visible = True
            textwindow = 1
         Case 2
```

```
            Text2.Visible = True
            textwindow = 2
         Case 3
            Text3.Visible = True
            textwindow = 3
         Case 4
            Text4.Visible = True
            textwindow = 4
         Case 5
            Text5.Visible = True
            textwindow = 5
         Case 7
            Text6.Visible = True
            textwindow = 7
         Case 8
            Text7.Visible = True
            textwindow = 8
         Case 9
            Text8.Visible = True
            textwindow = 9
      End Select
   End If
End Sub

Private Sub Command3_Click()
Me.Hide
End Sub

Private Sub Form_Load()
fwd = 0
textwindow = 0
End Sub

Private Sub List1_Click()
Select Case List1.ListIndex
   Case 0, 6
      fwd = 0
      textwindow = 0
   Case 1
      List1.Visible = False
      Text1.Visible = True
      textwindow = 1
   Case 2
      List1.Visible = False
      Text2.Visible = True
      textwindow = 2
   Case 3
      List1.Visible = False
      Text3.Visible = True
      textwindow = 3
   Case 4
      List1.Visible = False
      Text4.Visible = True
      textwindow = 4
   Case 5
      List1.Visible = False
      Text5.Visible = True
      textwindow = 5
   Case 7
      List1.Visible = False
      Text6.Visible = True
      textwindow = 7
   Case 8
      List1.Visible = False
      Text7.Visible = True
      textwindow = 8
   Case 9
      List1.Visible = False
      Text8.Visible = True
      textwindow = 9
```

```
End Select
End Sub

''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
' Splash Screen Form Code

Private Sub Form_KeyPress(KeyAscii As Integer)
   Unload Me
End Sub

Private Sub Form_Load()
   lblVersion.Caption = "Version " & App.Major & "." & App.Minor & "." & App.Revision
End Sub

Private Sub Frame1_Click()
Unload Me
End Sub

Private Sub lblLicenseTo_Click()

End Sub

Private Sub Timer1_Timer()
Unload frmSplash
End Sub
```

3b. PIC Subsystem Schematics

This section contains four schematics that display all the connections within the PIC subsystem. The first details the PIC's power and ground connections, the second lists connections that need to be made to the PC and the transmitter subsystem, the third displays how the PIC is connected to the four 7447 BCD decoders, and the final one shows how all the connections are made between the 7447's and seven segment displays (the same four all four sets).

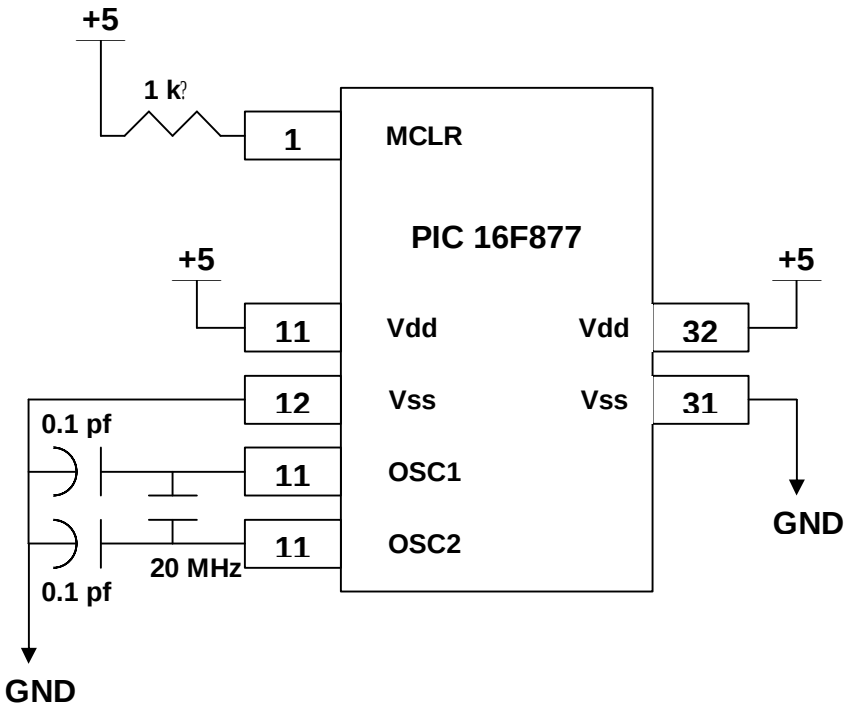

Figure 1. PIC Power and Ground Connections

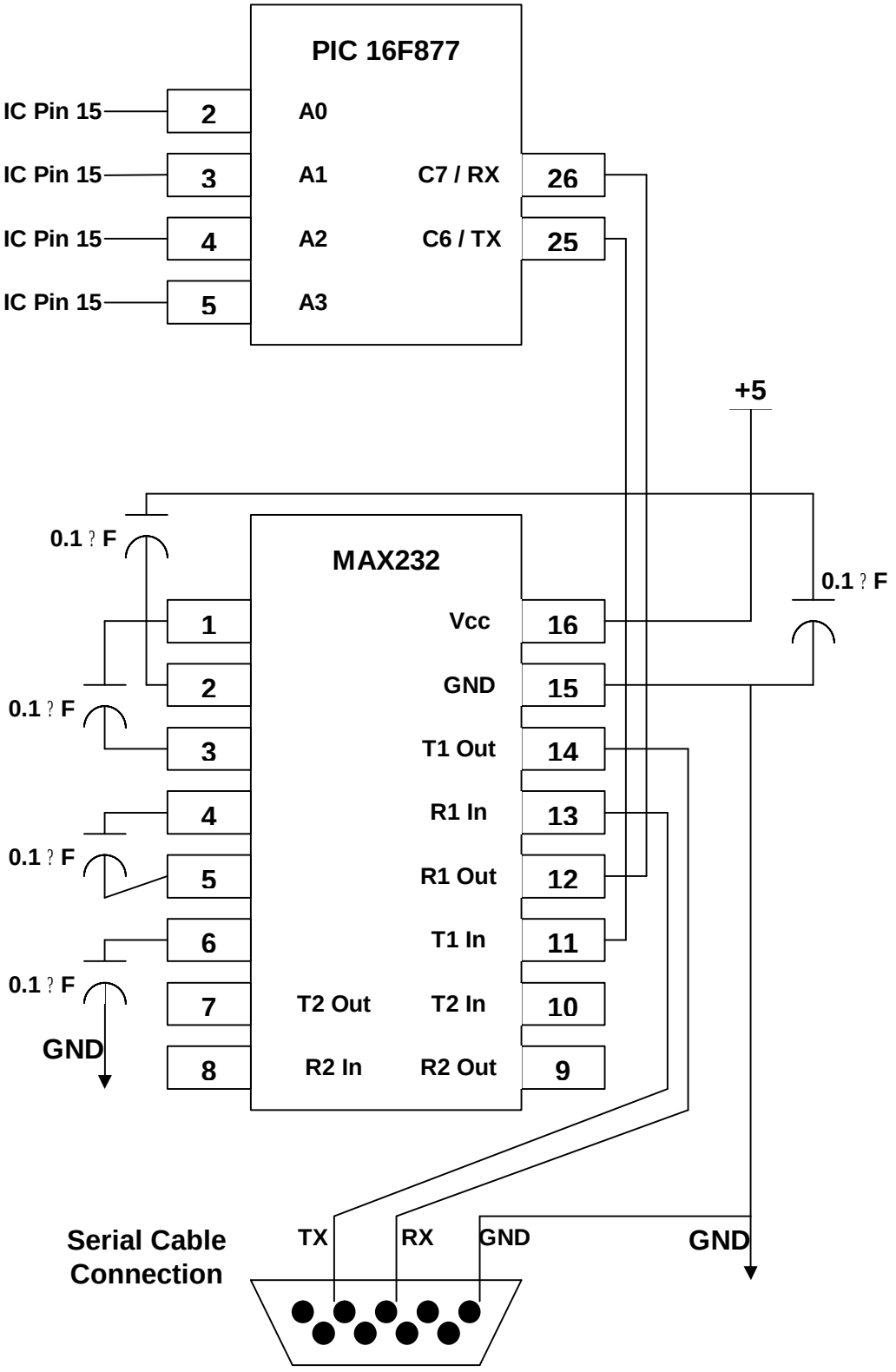

Figure 2. PIC Connections to PC and Transmitter

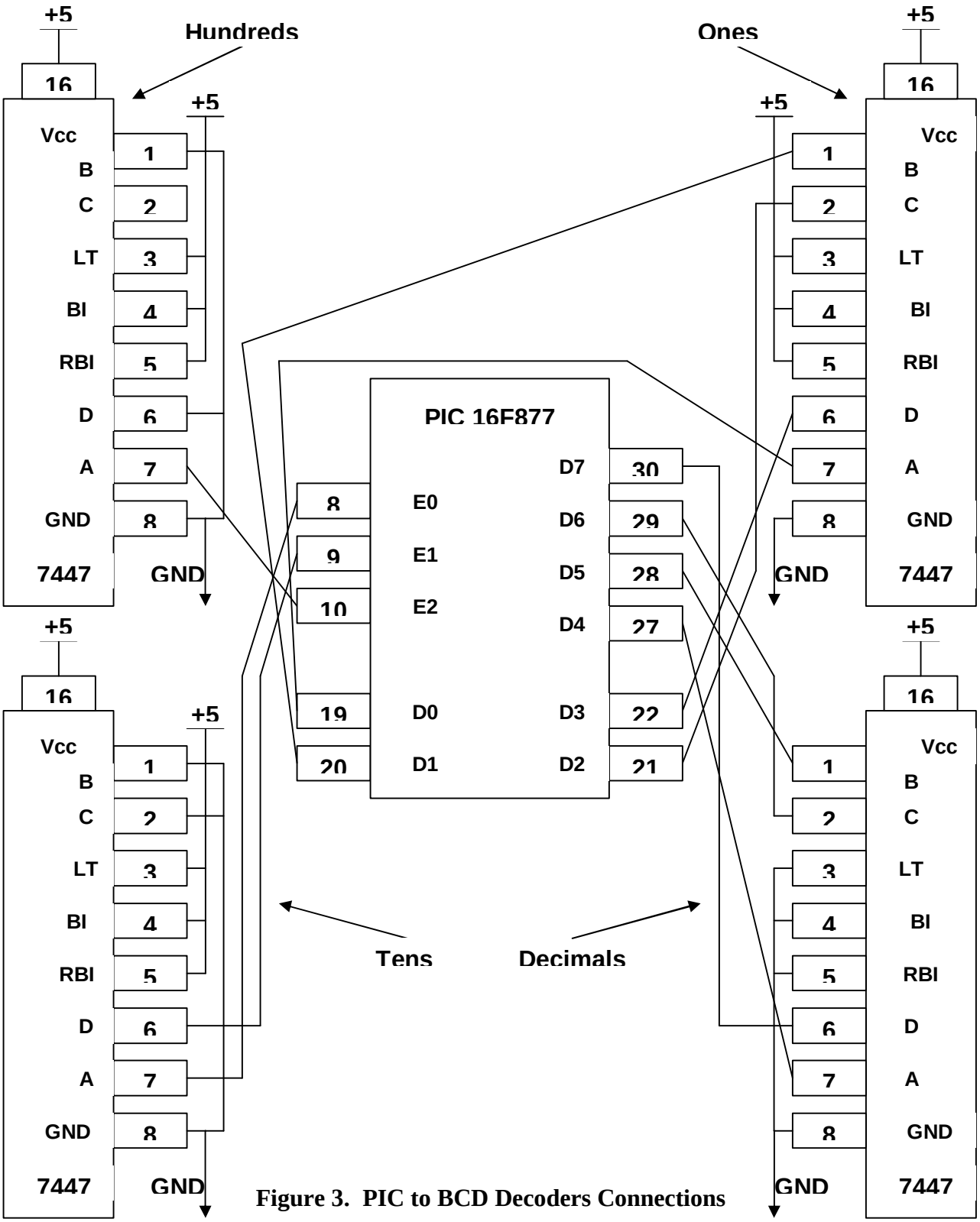

Figure 3. PIC to BCD Decoders Connections

All of the four seven segment display / resistor / 7447 BCD Decoder displays are exactly the same with one exception – pin 9 on the ones display should be tied to ground through a 330 ? resistor to activate the decimal point.

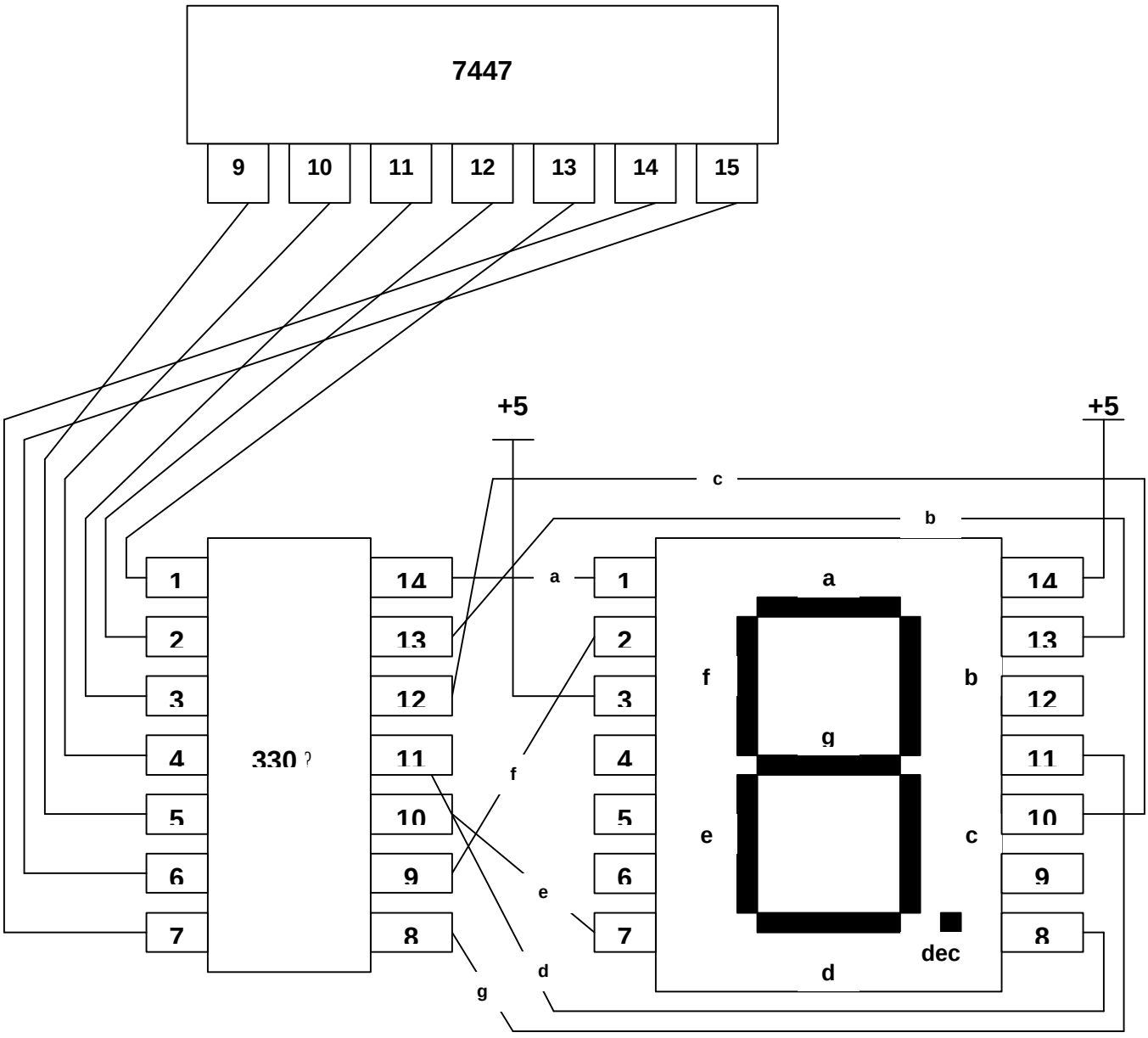

Figure 4. BCD Decoder to Seven Segment Display Connections

3c. PIC Subsystem Code

This code should be compiled using Microchip's MPLAB software. It can be downloaded at Microchip's website – http://www.microchip.com/. The generated .hex file can be burned to the PIC using the PICStartPlus software attached to MPLAB or with the EPIC PIC programming software – http://www.melabs.com/products/epic.htm.

```
;------------------------;
;  PIC Subsystem  ;
;------------------------;


;------------------------;
;  Processor Decs  ;
;------------------------;

            LIST      p=16f877
            include   "c:\Progra~1\MPLAB\p16f877.INC"


;------------------------;
;  Register Usage  ;
;------------------------;

            CBLOCK 0x00C                  ;Start registers at end of the values
Dlay                                      ;High byte of delay variable
            ENDC

freq        equ       0x020               ;Holds frequency value
count       equ       0x021               ;Holds counter for delay
oldfrq      equ       0x022               ;Holds previous frequency value
addr        equ       0x030               ;Holds eeprom data address – not currently used


#define     Freq0     freq,     0
#define     Freq1     freq,     1
#define     Freq2     freq,     2
#define     Freq3     freq,     3
#define     Freq4     freq,     4
#define     Freq5     freq,     5
#define     Freq6     freq,     6
#define     Freq7     freq,     7


#define     DownB     PORTB,    0
#define     UpB       PORTB,    1

#define     SterB     PORTB,    2
#define     MuteB     PORTB,    3

#define     SterL     PORTB,    6
#define     MuteL     PORTB,    7


;---------------------;
;   Code Origin   ;
;---------------------;

            org       0
            goto      start
```

```
;--------------------;
;   Port Setup   ;
;--------------------;

start   bcf     STATUS, 5               ;Register Page 0
        bcf     STATUS, 6

        clrf    PORTA                   ;Initialize data ports
        clrf    PORTB
        clrf    PORTC
        clrf    PORTD
        clrf    PORTE

        bsf     STATUS, 5               ;Register Page 1
        bcf     STATUS, 6

        movlw   0x06                    ;Disable A/D
        movwf   ADCON1 ^        0x080

        movlw   0x00                    ;Port A Output
        movwf   TRISA   ^       0x080

        movlw   0x3F                    ;PortB I/O, Pullups Enabled
        movwf   TRISB   ^       0x080
        movlw   0x7F                    ;Enable pull-ups
        movwf   OPTION_REG      ^       0x080

        movlw   0xFE                    ;PortC Serial PC Communication
        movwf   TRISC   ^       0x080

        movlw   0x00                    ;PortD Output
        movwf   TRISD   ^       0x080

        movlw   0x00                    ;PortE Output
        movwf   TRISE   ^       0x080

        movlw   #081h                   ;Set baud rate to 2400
        movwf   SPBRG   ^       0x080

        bcf     TXSTA,  4               ;Asynchronous

        bcf     STATUS, 5               ;Register Page 0
        bsf     RCSTA,  7               ;Asynchronous
        bsf     RCSTA,  4               ;Enable reception

        goto    run1


;-------------------------;
;Run Once at Start ;
;-------------------------;

run1    ;call   rdata                   ;Load previous frequency
        movlw   b'00000000'
        movwf   freq                    ;Store previous frequency

        bsf     SterL                   ;Load previous stereo / mono setting
        bcf     MuteL                   ;Load previous mute setting

        goto    trans                   ;Transmit previous frequency to PC


;---------------------;
;    Main Code    ;
;---------------------;

main    movfw   freq                    ;Save old frequency
```

```
            movwf   oldfrq

            btfss   PIR1,   5           ;Check for reception
            goto    chkdn               ;Nothing recieved, check buttons

            movfw   RCREG               ;Get pc data
            movwf   freq                ;Store data

            tstf    freq                ;Update flags

            goto    chkin               ;Check input

chkdn       btfss   DownB               ;Check to see if down button has been pressed
            goto    freqd               ;Down button pressed, jump to frequency decrement sequence

chkup       btfss   UpB                 ;Check to see if up button has been pressed
            goto    frequ               ;Up button pressed, jump to frequency increment sequence

chkst       btfss   SterB               ;Check to see if stereo / mono button has been pressed
            goto    togst               ;Stereo / mono button pressed, jump to toggle stereo sequence

chkmu       btfss   MuteB               ;Check to see if mute button has been pressed
            goto    togmu               ;Mute button pressed, jump to toggle mute sequence

            goto    main


;---------------------;
;   Check Input   ;
;---------------------;

chkin       btfss   Freq7               ;Check for 1111 as the first nibble
            goto    dispf               ;Not 1111, display new frequency
            btfss   Freq6               ;Check for 1111 as the first nibble
            goto    dispf               ;Not 1111, display new frequency
            btfss   Freq5               ;Check for 1111 as the first nibble
            goto    dispf               ;Not 1111, display new frequency
            btfss   Freq4               ;Check for 1111 as the first nibble
            goto    dispf               ;Not 1111, display new frequency

            btfsc   Freq2               ;Check bit 2
            goto    tscom               ;Test PC communication

            btfsc   Freq1               ;Check bit 1
            goto    pcmute              ;Mute setting, check it
            goto    pcster              ;Stereo / mono setting, check it


;---------------------;
;   Test Comm     ;
;---------------------;

tscom       bsf     STATUS, 5           ;Register Page 1
            bsf     TXSTA,  5           ;Enable transmission
            bcf     STATUS, 5           ;Register Page 0

            movlw   0xF4                ;Load test value for transmission
            movwf   TXREG               ;Send test value

            bsf     STATUS, 5           ;Register Page 1
tscom2      btfss   TXSTA,  1           ;Wait until transmit buffer is empty
            goto    tscom2
            bcf     STATUS, 5           ;Register Page 0

            call    delay

            bsf     STATUS, 5           ;Register Page 1
            bcf     TXSTA,  5           ;Disable transmission
            bcf     STATUS, 5           ;Register Page 0
```

```
            goto    main                    ;Restart loop


;----------------------;
;  PC Set Stereo  ;
;----------------------;

pcster      btfss   Freq0                  ;Is it set to stereo or mono?
            goto    setmon                  ;Mono, turn off LED

setstr      bsf     SterL                   ;Stereo, turn on mono / stereo LED
            goto    restf                   ;Restore frequency

setmon      bcf     SterL                   ;Turn off mono / stereo LED
            goto    restf                   ;Restore frequency


;----------------------;
;  PC Set Mute    ;
;----------------------;

pcmute      btfss   Freq0                   ;Is mute on or off??
            goto    setmun                  ;Mute, turn on LED

setmuf      bcf     MuteL                   ;Mute off, turn off LED
            goto    restf                   ;Restore frequency

setmun      bsf     MuteL                   ;Turn on mute LED
            goto    restf                   ;Restore frequency


;----------------------;
;  Restore Freq   ;
;----------------------;

restf       movfw   oldfrq                  ;Load old frequency
            movwf   freq                    ;Restore since it was not actually changed
            goto    main                    ;Restart loop


;------------------------;
;  Decrement Freq  ;
;------------------------;

freqd       btfss   DownB                   ;Is the down button still pressed?
            goto    $ - 1                   ;Yes, go back

            movlw   0x00C                   ;Wait for debounce
            movwf   Dlay                    ;Delay 20 msecs
            movlw   0x0D7

            btfss   DownB                   ;Is the down button still pressed?
            goto    $ - 6                   ;Yes, go back again

            ifndef  Debug                   ;Skip small loop if Debug is defined
                    addlw   1               ;Increment the delay count
                    btfsc   STATUS, Z       ;If low byte in w is not equal to zero, then loop
                    decfsz  Dlay
                    goto    $ - 5
            else
                    decfsz  Dlay            ;Else, short loop
                    goto    $ - 3
            endif

            btfsc   Freq0                   ;Check frequency to ensure it is not already at min value
            goto    freqd2
            btfsc   Freq1
            goto    freqd2
            btfsc   Freq2
            goto    freqd2
```

```
        btfsc   Freq3
        goto    freqd2
        btfsc   Freq4
        goto    freqd2
        btfsc   Freq5
        goto    freqd2
        btfsc   Freq6
        goto    freqd2
        btfsc   Freq7
        goto    freqd2

        movlw   b'11001000'             ;Min value, wrap back around to max value
        movwf   freq
        goto    trans                   ;Transmit new frequency

freqd2  decf    freq                    ;Done debouncing, decrement frequency
        goto    trans                   ;Transmit new frequency


;-----------------------;
;  Increment Freq  ;
;-----------------------;

frequ   btfss   UpB                     ;Is the up button still pressed?
        goto    $ - 1                   ;Yes, go back

        movlw   0x00C                   ;Wait for debounce
        movwf   Dlay                    ;Delay 20 msecs
        movlw   0x0D7

        btfss   UpB                     ;Is the up button still pressed?
        goto    $ - 6                   ;Yes, go back again

        ifndef  Debug                   ;Skip small loop if Debug is defined
                addlw   1               ;Increment the delay count
                btfsc   STATUS, Z       ;If low byte in w is not equal to zero, then loop
                decfsz  Dlay
                goto    $ - 5
        else
                decfsz  Dlay            ;Else, short loop
                goto    $ - 3
        endif

        btfsc   Freq0                   ;Check frequency to ensure it is not already at min value
        goto    frequ2
        btfsc   Freq1
        goto    frequ2
        btfsc   Freq2
        goto    frequ2
        btfss   Freq3
        goto    frequ2
        btfsc   Freq4
        goto    frequ2
        btfsc   Freq5
        goto    frequ2
        btfss   Freq6
        goto    frequ2
        btfss   Freq7
        goto    frequ2

        movlw   b'00000000'             ;Max value, wrap back around to min value
        movwf   freq
        goto    trans                   ;Transmit new frequency

frequ2  incf    freq
        goto    trans                   ;Transmit new frequency


;-----------------------;
;  Toggle Stereo  ;
```

```
;----------------------;

togst   btfss   SterB                   ;Is the stereo / mono button still pressed?
        goto    $ - 1                   ;Yes, go back

        movlw   0x00C                   ;Wait for debounce
        movwf   Dlay                    ;Delay 20 msecs
        movlw   0x0D7

        btfss   SterB                   ;Is the stereo / mono button still pressed?
        goto    $ - 6                   ;Yes, go back again

        ifndef  Debug                   ;Skip small loop if Debug is defined
                addlw   1               ;Increment the delay count
                btfsc   STATUS, Z       ;If low byte in w is not equal to zero, then loop
                decfsz  Dlay
                goto    $ - 5
        else
                decfsz  Dlay            ;Else, short loop
                goto    $ - 3
        endif

        btfss   SterL                   ;Is stereo already selected?
        goto    ston                    ;No, change from mono to stereo

stoff   bcf     SterL                   ;Yes, turn stereo LED off
        goto    txst

ston    bsf     SterL                   ;Turn stereo LED on
        goto    txst



;----------------------;
;   Toggle Mute    ;
;----------------------;

togmu   btfss   MuteB                   ;Is the stereo / mono button still pressed?
        goto    $ - 1                   ;Yes, go back

        movlw   0x00C                   ;Wait for debounce
        movwf   Dlay                    ;Delay 20 msecs
        movlw   0x0D7

        btfss   MuteB                   ;Is the stereo / mono button still pressed?
        goto    $ - 6                   ;Yes, go back again

        ifndef  Debug                   ;Skip small loop if Debug is defined
                addlw   1               ;Increment the delay count
                btfsc   STATUS, Z       ;If low byte in w is not equal to zero, then loop
                decfsz  Dlay
                goto    $ - 5
        else
                decfsz  Dlay            ;Else, short loop
                goto    $ - 3
        endif

        btfss   MuteL                   ;Is mute already selected?
        goto    muton                   ;No, mute transmission

mutoff  bcf     MuteL                   ;Yes, turn mute LED off
        goto    txmut

muton   bsf     MuteL                   ;Turn mute LED on
        goto    txmut
```

```
;---------------------;
;  Display Freq  ;
;---------------------;

dispf   movlw   HIGH    decone          ;Set counter to correct table address
        movwf   PCLATH
        movfw   freq

        call    decone                  ;Call table for decimals and ones display
        movwf   PORTD                   ;Display decimals and ones values

        movlw   HIGH    tenhun          ;Set counter to correct table address
        movwf   PCLATH
        movfw   freq

        call    tenhun                  ;Call table for tens and hundreds display
        movwf   PORTE

        ;call   wdata                   ;Store frequency in eeprom – not used

        goto    main                    ;Transmit new frequency to PC


;---------------------;
;  Transmit Freq  ;
;---------------------;

trans   bsf     STATUS, 5               ;Register Page 1
        bsf     TXSTA,  5               ;Enable transmission
        bcf     STATUS, 5               ;Register Page 0

        movfw   freq                    ;Load frequency for transmission
        movwf   TXREG                   ;Send the frequency

        bsf     STATUS, 5               ;Register Page 1
trans2  btfss   TXSTA,  1               ;Wait until transmit buffer is empty
        goto    trans2
        bcf     STATUS, 5               ;Register Page 0

        call    delay

        bsf     STATUS, 5               ;Register Page 1
        bcf     TXSTA,  5               ;Disable transmission
        bcf     STATUS, 5               ;Register Page 0

        goto    dispf


;-----------------------;
; Transmit Stereo  ;
;-----------------------;

txst    bsf     STATUS, 5               ;Register Page 1
        bsf     TXSTA,  5               ;Enable transmission
        bcf     STATUS, 5               ;Register Page 0

        btfss   SterL                   ;Is stereo on?
        goto    txst2

txst1   movlw   0xF1                    ;Yes, send F1
        goto    txst3

txst2   movlw   0xF0                    ;No, send F0

txst3   movwf   TXREG                   ;Send the state

        bsf     STATUS, 5               ;Register Page 1
txst4   btfss   TXSTA,  1               ;Wait until transmit buffer is empty
        goto    txst4
        bcf     STATUS, 5               ;Register Page 0
```

```
            call    delay

            bsf     STATUS, 5           ;Register Page 1
            bcf     TXSTA,  5           ;Disable transmission
            bcf     STATUS, 5           ;Register Page 0

            goto    main


;---------------------;
;  Transmit Mute   ;
;---------------------;

txmut       bsf     STATUS, 5           ;Register Page 1
            bsf     TXSTA,  5           ;Enable transmission
            bcf     STATUS, 5           ;Register Page 0

            btfss   MuteL               ;Is mute on?
            goto    txmut2

txmut1      movlw   0xF2                ;Yes, send F2
            goto    txmut3

txmut2      movlw   0xF3                ;No, send F3

txmut3      movwf   TXREG               ;Send the state

            bsf     STATUS, 5           ;Register Page 1
txmut4      btfss   TXSTA,  1           ;Wait until transmit buffer is empty
            goto    txmut4
            bcf     STATUS, 5           ;Register Page 0

            call    delay

            bsf     STATUS, 5           ;Register Page 1
            bcf     TXSTA,  5           ;Disable transmission
            bcf     STATUS, 5           ;Register Page 0

            goto    main


;------------------;
;     Delay      ;
;------------------;

delay       movlw   #0FFh
            movwf   count

delay2      decfsz  count
            goto    delay2

            return


;---------------------;
;   Data Read     ;
;---------------------;

;This feature is not currently in use

rdata       bsf     STATUS, RP1         ;Register page 2
            bcf     STATUS, RP0

            movf    addr,       w       ;Write address to read from
            movwf   EEADR

            bsf     STATUS, RP0         ;Register page 3

            bcf     EECON1, EEPGD       ;Point to data memory
```

```
        bsf     EECON1, RD              ;Start read operation

        bcf     STATUS, RP0             ;Register page 2

        movf    EEDATA, w               ;Read in data
        movwf   freq                    ;Store frequency data

        bcf     STATUS, 5               ;Register page 0
        bcf     STATUS, 6

        return                          ;Return to previous position in code


;--------------------;
;   Data Write    ;
;--------------------;

;This feature is not currently in use

wdata   bsf     STATUS, RP1             ;Register page 3
        bsf     STATUS, RP0

        btfsc   EECON1, WR              ;Wait for write to finish
        goto    $ - 1

        bcf     STATUS, RP0             ;Register page 2

        movf    addr,       w           ;Address to write to
        movwf   EEADR

        movf    freq,       w           ;Load frequency data to write
        movwf   EEDATA

        bsf     STATUS, RP0             ;Register page 3

        bcf     EECON1, EEPGD           ;Point to data memory
        bsf     EECON1, WREN            ;Enable writes

        movlw   0x55                    ;Write 55h to EECON2
        movwf   EECON2

        movlw   0xAA                    ;Write AAh to EECON2
        movwf   EECON2

        bsf     EECON1, WR              ;Start write operation
        bcf     EECON1, WREN            ;Disable writes

        bcf     STATUS, 5               ;Register page 0
        bcf     STATUS, 6

        return


;------------------------;
;  Dec's and Ones  ;
;------------------------;

        org     0x300

decone  addwf   PCL,        F
        retlw   b'01111001'             ;Ones = 7, Decimals = 9
        retlw   b'10000000'             ;Ones = 8, Decimals = 0
        retlw   b'10000001'             ;Ones = 8, Decimals = 1
        retlw   b'10000010'             ;Ones = 8, Decimals = 2
        retlw   b'10000011'             ;Ones = 8, Decimals = 3
        retlw   b'10000100'             ;Ones = 8, Decimals = 4
        retlw   b'10000101'             ;Ones = 8, Decimals = 5
        retlw   b'10000110'             ;Ones = 8, Decimals = 6
        retlw   b'10000111'             ;Ones = 8, Decimals = 7
        retlw   b'10001000'             ;Ones = 8, Decimals = 8
```

```
retlw   b'10001001'     ;Ones = 8, Decimals = 9
retlw   b'10010000'     ;Ones = 9, Decimals = 0
retlw   b'10010001'     ;Ones = 9, Decimals = 1
retlw   b'10010010'     ;Ones = 9, Decimals = 2
retlw   b'10010011'     ;Ones = 9, Decimals = 3
retlw   b'10010100'     ;Ones = 9, Decimals = 4
retlw   b'10010101'     ;Ones = 9, Decimals = 5
retlw   b'10010110'     ;Ones = 9, Decimals = 6
retlw   b'10010111'     ;Ones = 9, Decimals = 7
retlw   b'10011000'     ;Ones = 9, Decimals = 8
retlw   b'10011001'     ;Ones = 9, Decimals = 9
retlw   b'00000000'     ;Ones = 0, Decimals = 0
retlw   b'00000001'     ;Ones = 0, Decimals = 1
retlw   b'00000010'     ;Ones = 0, Decimals = 2
retlw   b'00000011'     ;Ones = 0, Decimals = 3
retlw   b'00000100'     ;Ones = 0, Decimals = 4
retlw   b'00000101'     ;Ones = 0, Decimals = 5
retlw   b'00000110'     ;Ones = 0, Decimals = 6
retlw   b'00000111'     ;Ones = 0, Decimals = 7
retlw   b'00001000'     ;Ones = 0, Decimals = 8
retlw   b'00001001'     ;Ones = 0, Decimals = 9
retlw   b'00010000'     ;Ones = 1, Decimals = 0
retlw   b'00010001'     ;Ones = 1, Decimals = 1
retlw   b'00010010'     ;Ones = 1, Decimals = 2
retlw   b'00010011'     ;Ones = 1, Decimals = 3
retlw   b'00010100'     ;Ones = 1, Decimals = 4
retlw   b'00010101'     ;Ones = 1, Decimals = 5
retlw   b'00010110'     ;Ones = 1, Decimals = 6
retlw   b'00010111'     ;Ones = 1, Decimals = 7
retlw   b'00011000'     ;Ones = 1, Decimals = 8
retlw   b'00011001'     ;Ones = 1, Decimals = 9
retlw   b'00100000'     ;Ones = 2, Decimals = 0
retlw   b'00100001'     ;Ones = 2, Decimals = 1
retlw   b'00100010'     ;Ones = 2, Decimals = 2
retlw   b'00100011'     ;Ones = 2, Decimals = 3
retlw   b'00100100'     ;Ones = 2, Decimals = 4
retlw   b'00100101'     ;Ones = 2, Decimals = 5
retlw   b'00100110'     ;Ones = 2, Decimals = 6
retlw   b'00100111'     ;Ones = 2, Decimals = 7
retlw   b'00101000'     ;Ones = 2, Decimals = 8
retlw   b'00101001'     ;Ones = 2, Decimals = 9
retlw   b'00110000'     ;Ones = 3, Decimals = 0
retlw   b'00110001'     ;Ones = 3, Decimals = 1
retlw   b'00110010'     ;Ones = 3, Decimals = 2
retlw   b'00110011'     ;Ones = 3, Decimals = 3
retlw   b'00110100'     ;Ones = 3, Decimals = 4
retlw   b'00110101'     ;Ones = 3, Decimals = 5
retlw   b'00110110'     ;Ones = 3, Decimals = 6
retlw   b'00110111'     ;Ones = 3, Decimals = 7
retlw   b'00111000'     ;Ones = 3, Decimals = 8
retlw   b'00111001'     ;Ones = 3, Decimals = 9
retlw   b'01000000'     ;Ones = 4, Decimals = 0
retlw   b'01000001'     ;Ones = 4, Decimals = 1
retlw   b'01000010'     ;Ones = 4, Decimals = 2
retlw   b'01000011'     ;Ones = 4, Decimals = 3
retlw   b'01000100'     ;Ones = 4, Decimals = 4
retlw   b'01000101'     ;Ones = 4, Decimals = 5
retlw   b'01000110'     ;Ones = 4, Decimals = 6
retlw   b'01000111'     ;Ones = 4, Decimals = 7
retlw   b'01001000'     ;Ones = 4, Decimals = 8
retlw   b'01001001'     ;Ones = 4, Decimals = 9
retlw   b'01010000'     ;Ones = 5, Decimals = 0
retlw   b'01010001'     ;Ones = 5, Decimals = 1
retlw   b'01010010'     ;Ones = 5, Decimals = 2
retlw   b'01010011'     ;Ones = 5, Decimals = 3
retlw   b'01010100'     ;Ones = 5, Decimals = 4
retlw   b'01010101'     ;Ones = 5, Decimals = 5
retlw   b'01010110'     ;Ones = 5, Decimals = 6
retlw   b'01010111'     ;Ones = 5, Decimals = 7
retlw   b'01011000'     ;Ones = 5, Decimals = 8
```

```
retlw   b'01011001'     ;Ones = 5, Decimals = 9
retlw   b'01100000'     ;Ones = 6, Decimals = 0
retlw   b'01100001'     ;Ones = 6, Decimals = 1
retlw   b'01100010'     ;Ones = 6, Decimals = 2
retlw   b'01100011'     ;Ones = 6, Decimals = 3
retlw   b'01100100'     ;Ones = 6, Decimals = 4
retlw   b'01100101'     ;Ones = 6, Decimals = 5
retlw   b'01100110'     ;Ones = 6, Decimals = 6
retlw   b'01100111'     ;Ones = 6, Decimals = 7
retlw   b'01101000'     ;Ones = 6, Decimals = 8
retlw   b'01101001'     ;Ones = 6, Decimals = 9
retlw   b'01110000'     ;Ones = 7, Decimals = 0
retlw   b'01110001'     ;Ones = 7, Decimals = 1
retlw   b'01110010'     ;Ones = 7, Decimals = 2
retlw   b'01110011'     ;Ones = 7, Decimals = 3
retlw   b'01110100'     ;Ones = 7, Decimals = 4
retlw   b'01110101'     ;Ones = 7, Decimals = 5
retlw   b'01110110'     ;Ones = 7, Decimals = 6
retlw   b'01110111'     ;Ones = 7, Decimals = 7
retlw   b'01111000'     ;Ones = 7, Decimals = 8
retlw   b'01111001'     ;Ones = 7, Decimals = 9
retlw   b'10000000'     ;Ones = 8, Decimals = 0
retlw   b'10000001'     ;Ones = 8, Decimals = 1
retlw   b'10000010'     ;Ones = 8, Decimals = 2
retlw   b'10000011'     ;Ones = 8, Decimals = 3
retlw   b'10000100'     ;Ones = 8, Decimals = 4
retlw   b'10000101'     ;Ones = 8, Decimals = 5
retlw   b'10000110'     ;Ones = 8, Decimals = 6
retlw   b'10000111'     ;Ones = 8, Decimals = 7
retlw   b'10001000'     ;Ones = 8, Decimals = 8
retlw   b'10001001'     ;Ones = 8, Decimals = 9
retlw   b'10010000'     ;Ones = 9, Decimals = 0
retlw   b'10010001'     ;Ones = 9, Decimals = 1
retlw   b'10010010'     ;Ones = 9, Decimals = 2
retlw   b'10010011'     ;Ones = 9, Decimals = 3
retlw   b'10010100'     ;Ones = 9, Decimals = 4
retlw   b'10010101'     ;Ones = 9, Decimals = 5
retlw   b'10010110'     ;Ones = 9, Decimals = 6
retlw   b'10010111'     ;Ones = 9, Decimals = 7
retlw   b'10011000'     ;Ones = 9, Decimals = 8
retlw   b'10011001'     ;Ones = 9, Decimals = 9
retlw   b'00000000'     ;Ones = 0, Decimals = 0
retlw   b'00000001'     ;Ones = 0, Decimals = 1
retlw   b'00000010'     ;Ones = 0, Decimals = 2
retlw   b'00000011'     ;Ones = 0, Decimals = 3
retlw   b'00000100'     ;Ones = 0, Decimals = 4
retlw   b'00000101'     ;Ones = 0, Decimals = 5
retlw   b'00000110'     ;Ones = 0, Decimals = 6
retlw   b'00000111'     ;Ones = 0, Decimals = 7
retlw   b'00001000'     ;Ones = 0, Decimals = 8
retlw   b'00001001'     ;Ones = 0, Decimals = 9
retlw   b'00010000'     ;Ones = 1, Decimals = 0
retlw   b'00010001'     ;Ones = 1, Decimals = 1
retlw   b'00010010'     ;Ones = 1, Decimals = 2
retlw   b'00010011'     ;Ones = 1, Decimals = 3
retlw   b'00010100'     ;Ones = 1, Decimals = 4
retlw   b'00010101'     ;Ones = 1, Decimals = 5
retlw   b'00010110'     ;Ones = 1, Decimals = 6
retlw   b'00010111'     ;Ones = 1, Decimals = 7
retlw   b'00011000'     ;Ones = 1, Decimals = 8
retlw   b'00011001'     ;Ones = 1, Decimals = 9
retlw   b'00100000'     ;Ones = 2, Decimals = 0
retlw   b'00100001'     ;Ones = 2, Decimals = 1
retlw   b'00100010'     ;Ones = 2, Decimals = 2
retlw   b'00100011'     ;Ones = 2, Decimals = 3
retlw   b'00100100'     ;Ones = 2, Decimals = 4
retlw   b'00100101'     ;Ones = 2, Decimals = 5
retlw   b'00100110'     ;Ones = 2, Decimals = 6
retlw   b'00100111'     ;Ones = 2, Decimals = 7
retlw   b'00101000'     ;Ones = 2, Decimals = 8
```

```
        retlw   b'00101001'             ;Ones = 2, Decimals = 9
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3d. Transmitter Subsystem Schematic

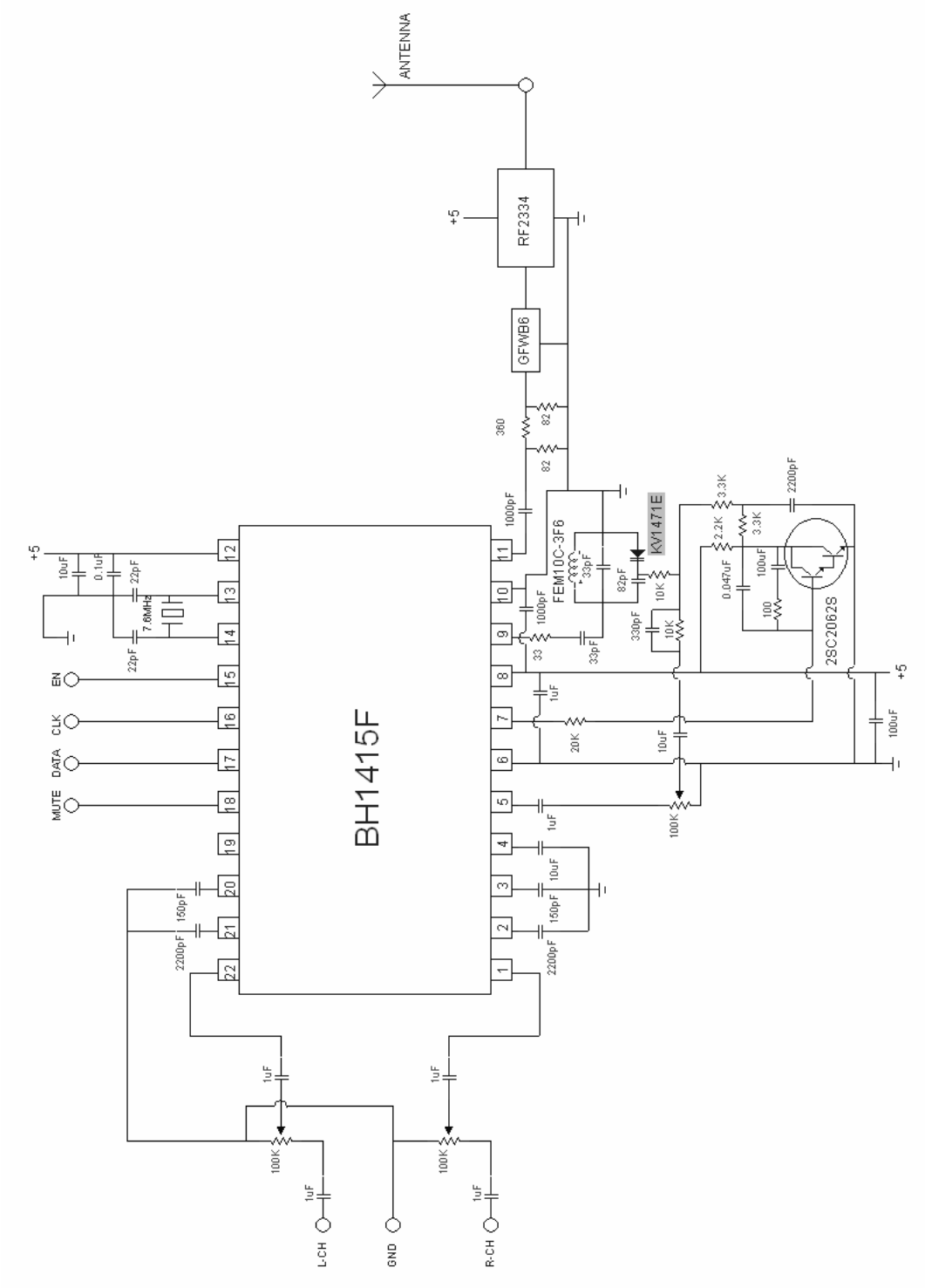

Figure 5. Transmitter Subsystem Schematic

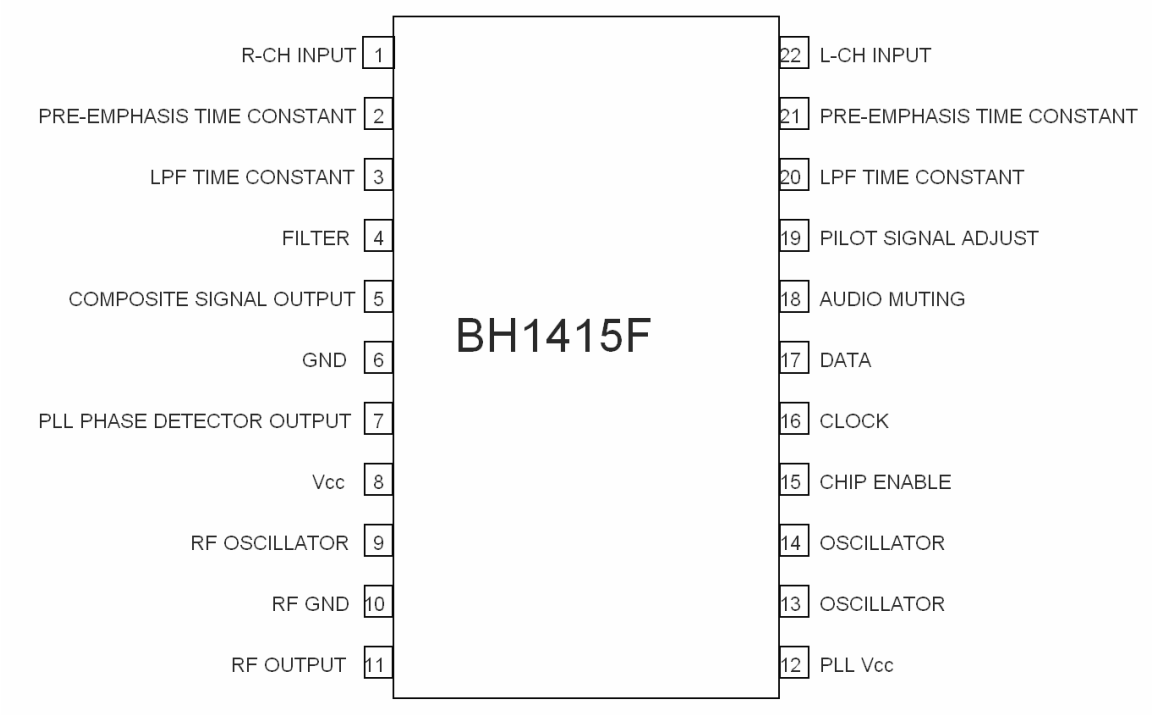

Figure 6. Pin Descriptions for BH1415F

3e. Parts List

Transmitter Components

Quantity	Value	Type
2	3.3K	Resistor
2	10K	
1	33	
1	20K	
1	100	
1	2.2K	
2	82	
1	360	
3	2200pF	Capacitor
2	150pF	
2	1000pF	
2	100uF	
1	82pF	
1	0.1uF	
1	0.047uF	
2	33pF	
1	0.01uF	
3	10uF	
5	1uF	
2	22pF	
2	100K	Potentiometer
1	10K	
1	BH1415F (ROHM)	Stereo Modulation IC
1	FEM10C-3F6 (SUMIDA)	Variable Inductor
1	KV1714E (TOKO)	Varactor Diode
1	2SC2062S (ROHM)	Darlington Transistor
1	GFWB6 (SOSHIN)	Band Pass Filter
1	7.6 MHz	Crystal Oscillator
2	-	RCA Jack
1	-	BNC Whip Antenna
1	RF2334(RF MICRO DEVICES)	RF Amplifier
1	-	Male SMA Connector
1	-	Male SMA to Male BNC Adapter
1	-	Printed Circuit Board

Onboard Display and Communication Components

Quantity	Value	Type
1		Perf Board
1	PIC16F877(MICROCHIP)	Microprocessor
4	330 ?	Resistor Pack (7)
4	7447	BCD Decoder
4	-	7 Segment Display
1	MAX232(MAXIM)	RS232 Voltage Converter
1	-	40 pin socket
2	-	20 pin socket
8	-	14 pin socket
7	-	16 pin socket
1	-	8 pin socket
1	-	Project Box
2	-	Red LED
2	-	Green LED
1	-	Power Jack
1	-	AC Adapter
1	-	Cigarette Lighter Adapter
4	-	Pushbuttons
1	20 MHz	Crystal Oscillator
2	22pF	Capacitor
5	0.1uF	
1	1000uF	
1	47uF	
4	330?	Resistor
1	7805	Voltage Regulator
1	-	Diode
1	-	Serial Cable
1	-	Female DB9 serial connector

4a. Transmitter Subsystem Potentiometers

The potentiometers seen in Figure 5 are used to attenuate the audio signal before modulating it onto the carrier frequency generated by the BH1415F. The 100K potentiometers connected to the right and left channels function exactly the same, and are used to attenuate the audio input such that information is not lost when passed through the audio limiter circuit that is inside the BH1415F. If the audio input level is too high then the signal will be clipped by the BH1415F, causing a loss of information.

The 10K potentiometer connected to pin 5 of the BH1415F is designed to allow attenuation of the multiplexed stereo (or mono) signal that is generated by the BH1415F. This can be adjusted to affect the modulation of the signal onto the carrier frequency.

4b. Transmitter Subsystem Inductor

The FEM10C-3F6, manufactured by Sumida Corporation, is used in the voltage controlled oscillator that is a necessary for successful operation of the Bh1415F. This inductor should only be tuned with a proper tuning wand, and can be varied to change the oscillation frequency of the VCO. This can be used to calibrate the frequency such that it matches the serially selected frequency.

5. Troubleshooting

Troubleshooting the Transmitter

Output Frequency is not correct

Check to make sure that the serial data is being sent properly. Refer to the BH1415F data sheet for timing diagrams and specifications relating to the serial data.

Verify that the phase lock loop system is working by measuring the control voltage of the VCO. This is between the two 3.3K resistors shown in Figure 5 in section 3d. This voltage should lower and raise between 0-5 volts searching for the correct frequency. It should then stabilize when the frequency is found, and the frequency becomes stable.

Verify that the connections to the RF output are correct, and that there are no shorts to ground.

Verify that the oscillator connected to pins 13 and 14 of the BH1415F is actually oscillating. If not, replace the oscillator.

Audio is distorted

Measure the composite output at pin 5 of the BH1415F to verify that the audio signal is not being clipped by the audio limiter built into the BH1415F. If it is being clipped adjust the 100K potentiometer connected to the right and left channels such that the output of pin 5 is no longer clipped.

Audio is being played, but no signal is heard

Verify that the mute, pin 18 of the BH1415F, is low.

Check the composite signal output (pin 5) to verify that audio is propagating through the chip. If there is no AC signal try adjusting the right and left channel potentiometers. It is possible that they are set such that all the audio is being attenuated.

Verify that the audio source is actually supplying audio to the BH1415F by looking at pins 1 and 2.

Troubleshooting the PIC System

Displayed frequency on box does not match the one displayed by the PC or is garbage.

Turn off the power to the @Home Radio system and close the program on the PC. Restart the program, and then turn the power on to the transmitter. This should reset everything to 87.9 MHz.

Same as above, but restart the PC before restarting the program and turning on the transmitter. This may fix problems caused by an unreliable serial port.

Make sure the sockets attached to the back of the seven segment displays are attached correctly.

Verify that wire wrap connections from the sockets to the resistor packs are good.

Verify the connections from the resistor packs to the BCD decoders.

Verify the connections from the BCD decoders to the PIC.

Touch the problematic BCD decoder(s) and the PIC after the system has been turned on for a few seconds. Are they hot? If so, the problematic component will likely need to be replaced.

My PIC went bad, and I'm can't get the new one to program correctly.

Make sure the watchdog timer is turned off when you program.

Ensure that low voltage program enable is disabled.

Be sure code protect is turned off; if this is not the case, you've wasted another PIC.

Pushbuttons don't always work.

Verify that the solder connections on the problematic pushbutton have not broken.

Ensure the wires on the pushbutton are pressed fully into the target socket.

Verify the connection from the socket to the PIC is wire wrapped correctly on the socket side and has a good solder connection on the PIC side.

System won't turn on.

Make sure the oscillator is fully pressed into the socket. Verify its connections to the PIC.

Verify solder connections from power jack to voltage regulator circuit.

Ensure the capacitors for the voltage regulator circuit have the correct polarization.

Check the solder connections on the diode.

Ensure front of voltage regulator faces the center of the board; if it does not, the voltage regulator may have burned up and will need to be replaced.

Make sure the PIC is plugged into the system correctly. Touch it when the system is plugged in for a few seconds – is it hot? If so, it has most likely burned up and will need to be replaced.

Serial connection with PC fails even though everything is plugged in correctly.

Verify solder connections on the inside of the box from the jack to the system.

Ensure the 5 capacitors for the MAX 232 chip are plugged fully into the socket and in the correct places.

Ensure pins 25 and 26 on the PIC as well as pins 11 and 12 have 5 volts across them.

Ensure pins 13 and 14 on the MAX 232 chip have negative voltages between –5 and –25 volts.

Using an oscilloscope, verify transmission on the above pins.

If none of the above has worked, try replacing the MAX 232 chip. If that doesn't work, verify connections and possibly try a new PIC.

Troubleshooting the PC software

To troubleshoot any problem with the @Home Radio software, open the file "cpe481_prj.vbp" in Microsoft Visual Basic 6.0. On the drop down menu, click "Run" and then "Start." The program will then run just like an executable. Repeat the steps taken before the error originally appeared and try to reproduce it. If the program encounters a bug, it will alert the user of a problem and highlight the section of code that is wrong. From there, the user can access the MSDN help files to solve the problem.