AN657

Decoding Infrared Remote Controls Using a PIC16C5X Microcontroller

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INTRODUCTION

For many years the consumer electronics industry has been employing infrared remote controls for the control of televisions, VCR's, and cable boxes. This same technology has recently started to appear in industrial applications to eliminate keypads.

Decoding most of the infrared signals can be easily handled by PIC16C5X microcontrollers. This application note describes how this decoding may be done.

The only mandatory hardware for decoding IR signals is an infrared receiver. The use of two types is described here. Both are modular types used often by the consumer electronics industry. The first type responds to infrared signals modulated at about 40 kHz. The second responds to non-modulated infrared pulses and has a restricted range. The hardware costs of each approach will be less than two dollars.

Three PIC16C5X application programs are described, and instructions on how they can be used to create an algorithm that can decode just about any remote control signal. Each PIC16C5X application program represents a step in mapping out a pre-existing infrared format. The final application is a fully implemented example of decoding and interpreting the infrared signals of a type of Teknika TV remote.

THE THREE LAYERS OF AN INFRARED SIGNAL

The typical infrared signal used by remote controls has three layers. The names used for these layers has not been standardized. In this application note they are called the infrared, the modulation, and the serial data.

The infrared layer is the means of transmission. Infrared is light whose wavelength is too long to see. Although you cannot see the infrared beam, it behaves the same as light, so if you cannot see the target device, you cannot control it with an infrared signal. To control around corners or through opaque materials, RF, usually UHF signals are used. Although this application note does not further mention RF, much of what is presented here can be used with an RF transmission medium.

The modulation layer refers to the fact that each burst of infrared signal is often modulated at a frequency between 32.75 kHz and 56.8 kHz. This is done to diminish the effects of ambient light. This layer, however, is optional. Some infrared formats do not modulate their outputs, sending pulses of unmodulated infrared light instead. This is done to extend the remote control's battery life and to reduce the cost of the remote control device.

The serial data layer has the information containing a command. This is typically coded in the lengths of infrared bursts or in the lengths of gaps between infrared bursts. A long gap or burst is interpreted as a '1', a short gap or burst is interpreted as a '0'.

HARDWARE DESCRIPTION

The schematic in Figure 1 shows a tool that can be made to aid development of infrared receiver code. The schematic consists of a PIC16C57 connected to one of two available infrared receivers. One receiver is for non-modulated signals, the other for modulated signals. Modulated receivers are available from Sharp and LiteOn, part numbers GP1U521Y and LT-1060 respectively. The non-modulated type is available from Quality Technologies part number QSE157QT.

The choice of the PIC16C57 is not indicative of the processing power required for decoding. Typical IR receiver code can fit into less than half the ROM space available in a PIC16C54, and uses four RAM locations. The choice of a PIC16C57 in this case was driven by the need to store a lot of signal lengths for later reading.

A ceramic resonator clocks the PIC16C57. It will give adequate frequency accuracy to determine pulse and gap lengths. A RC network does not usually have adequate accuracy.

A button is available for resetting the PIC16C57, and four jumpers are provided to control the application start-up. The two digit display is multiplexed and driven through Q1 and Q2.

Three octal switches are used as inputs to control the OPTION register and which file is displayed.

The whole circuit derives its power from a 9V, 200 mA wall mounted supply. U1 regulates the 9V down to 5V for the PIC16C57 and associated circuitry.

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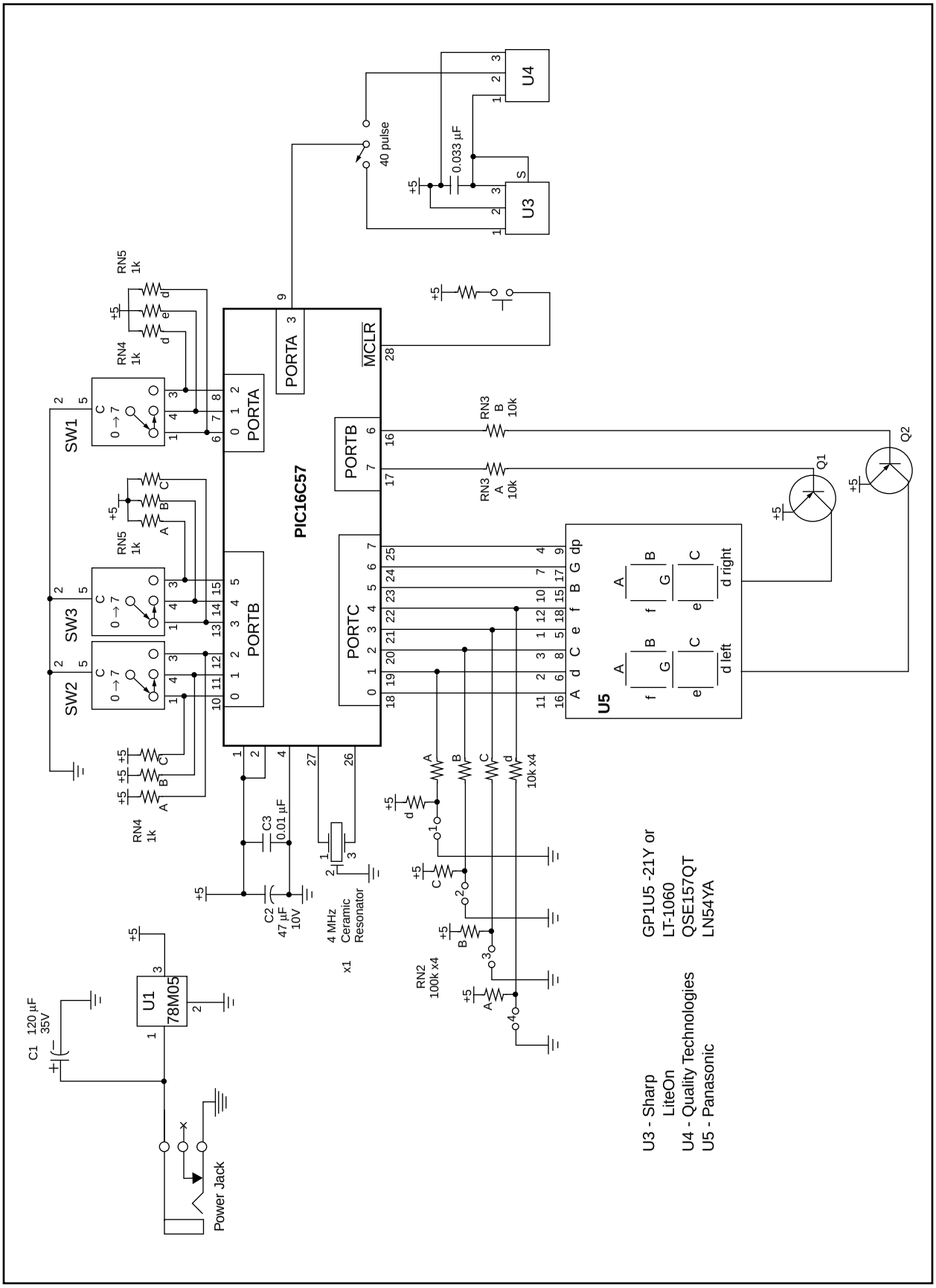
FIGURE 1: IR RECEIVER SCHEMATIC



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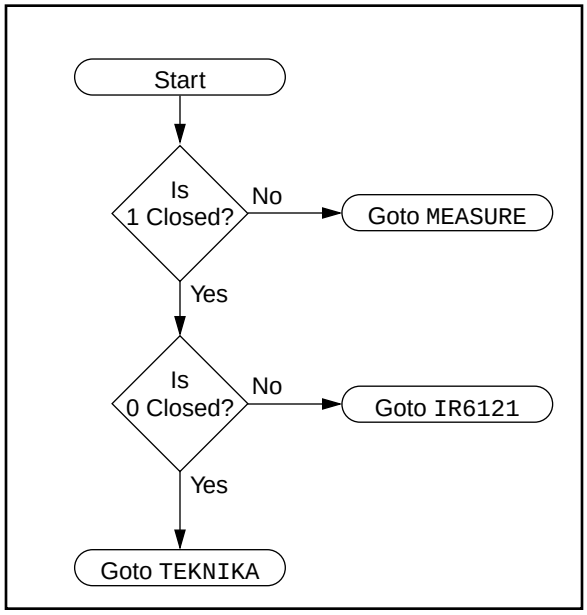
DESCRIPTION OF SOFTWARE TO AID DEVELOPMENT

This application uses four different firmware files. IRMAIN.ASM controls the selection of the three application files. The first file is MEASURE.ASM which stores the infrared burst and gap lengths into memory and allows playback of that information. IR6121.ASM decodes NEC6121 infrared format and displays the received codes on the LED display. The final file, TECNICKA.ASM, shows the final firmware for decoding the infrared format for a Teknika Television.

IRMAIN.ASM

The firmware listed includes three applications that will aid in designing an infrared control system. IRMAIN.ASM reads jumpers 1 and 2 and directs program flow after reset to one of the three applications. Having no jumper in 2 will direct program flow to MEASURE.ASM. A jumper in 2 only will direct program flow to IR6121.ASM. Jumpers in both 1 and 2 will direct program flow to TEKNIKA.ASM. Jumpers 3 and 4 are not used.

FIGURE 2: IRMAIN FLOWCHART



MEASURE.ASM

This is the most basic and most useful of the three applications. This program stores the infrared burst and gap lengths into memory, allowing playback of the measurements through the two digit display. It allows external control of the OPTION register also, through SW1. The setting of SW1 is read directly into the OPTION register prescaler value for TMR0. If SW1 is changed during program operation, the PIC16C57 resets.

Upon start-up a “hyphen” will be displayed in the left digit space until the infrared input settles to the dark logic indicating that the unit is ready to receive an infrared signal.

As an infrared signal comes in, the lengths of bursts of infrared, and the lengths of gaps between burst are stored in consecutive file locations until all four pages of the PIC16C57’s memory files are filled. If a jumper had been in 1, the program throws away the first 32 pulse and gap lengths and starts storing pulse and gap lengths with the thirty third pulse length. This allows the decoding of very long formats.

When all four pages of file memory are filled with pulse and gap lengths, a number and decimal point are displayed. The decimal point indicates that the unit is done reading. The number is a gap or pulse length. SW2 and SW3 control the time sequence of the pulse or gap length displayed. These are in octal with SW3 being the more significant digit.

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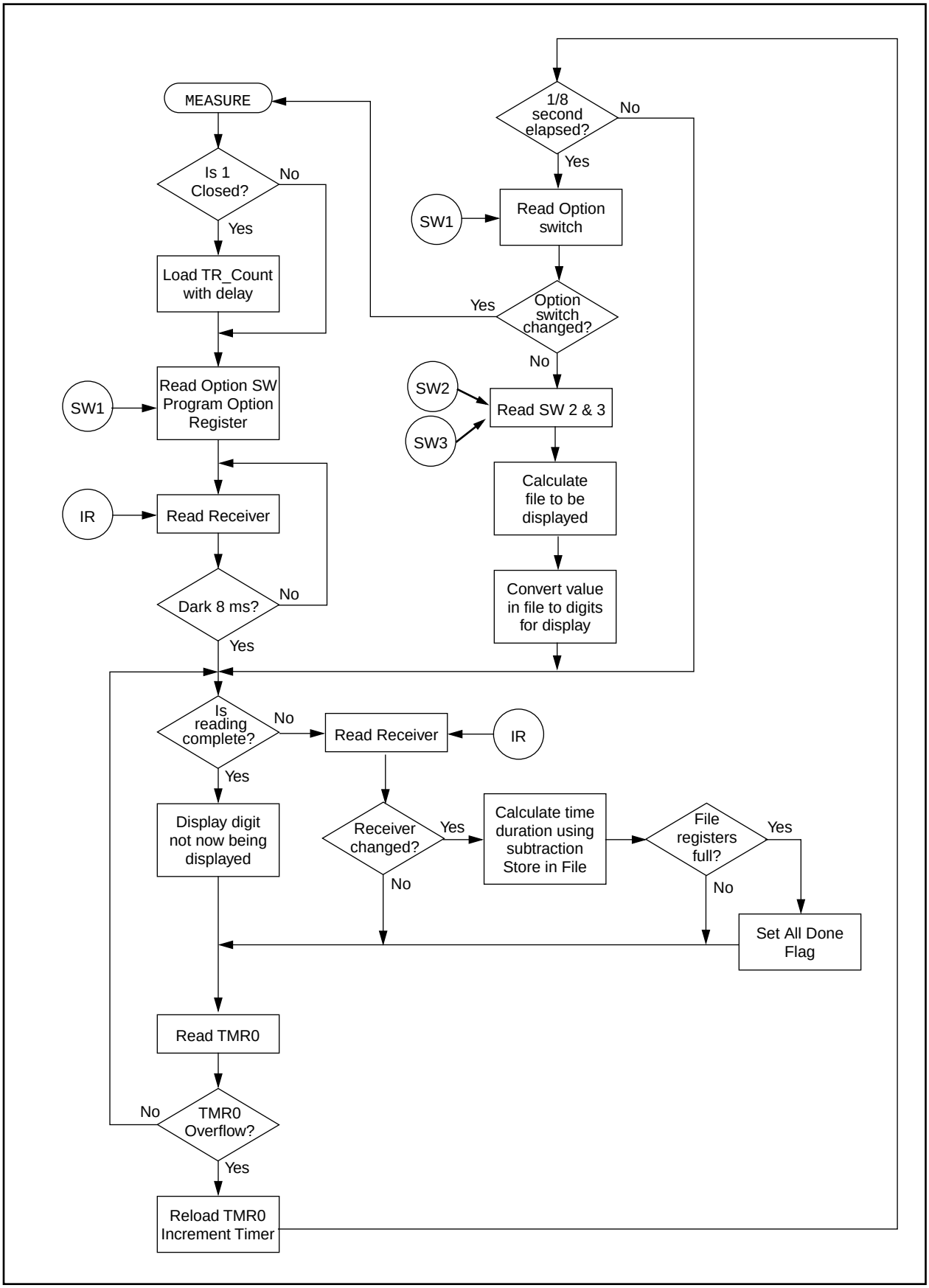
FIGURE 3: MEASURE.ASM FLOWCHART



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IR6121.ASM

This is an example of the next stage in development. It uses the IR receiver, PIC16C57 clock frequency, OPTION prescaler value and characteristic time length constants that were found after using MEASURE.ASM with an infrared remote control based on the NEC6121 infrared controller[1]. The resulting algorithm is able to decode the infrared bit stream and display it as four bytes on the two digit display. The bytes are switched using SW1 (changing it will not cause this application to reset). From it, or such a program customized to your particular remote control, a list can be made of how each button on a remote control resolves to a set of bytes in memory. This allows the creation of a button lookup table.

FIGURE 4: 1/4 SECOND CHORES

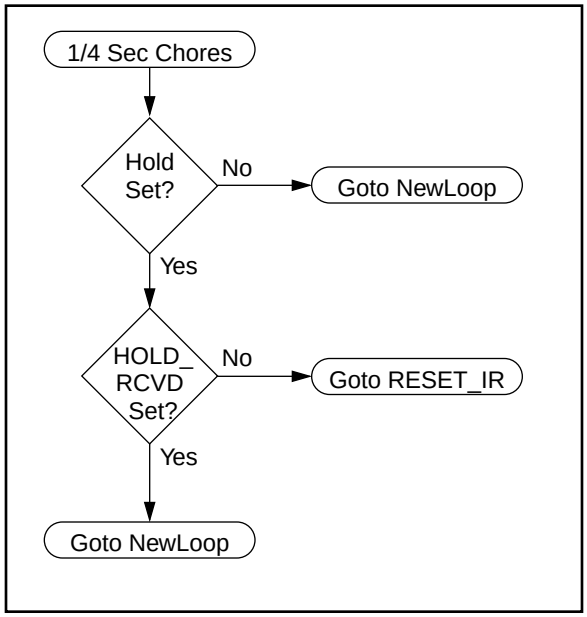
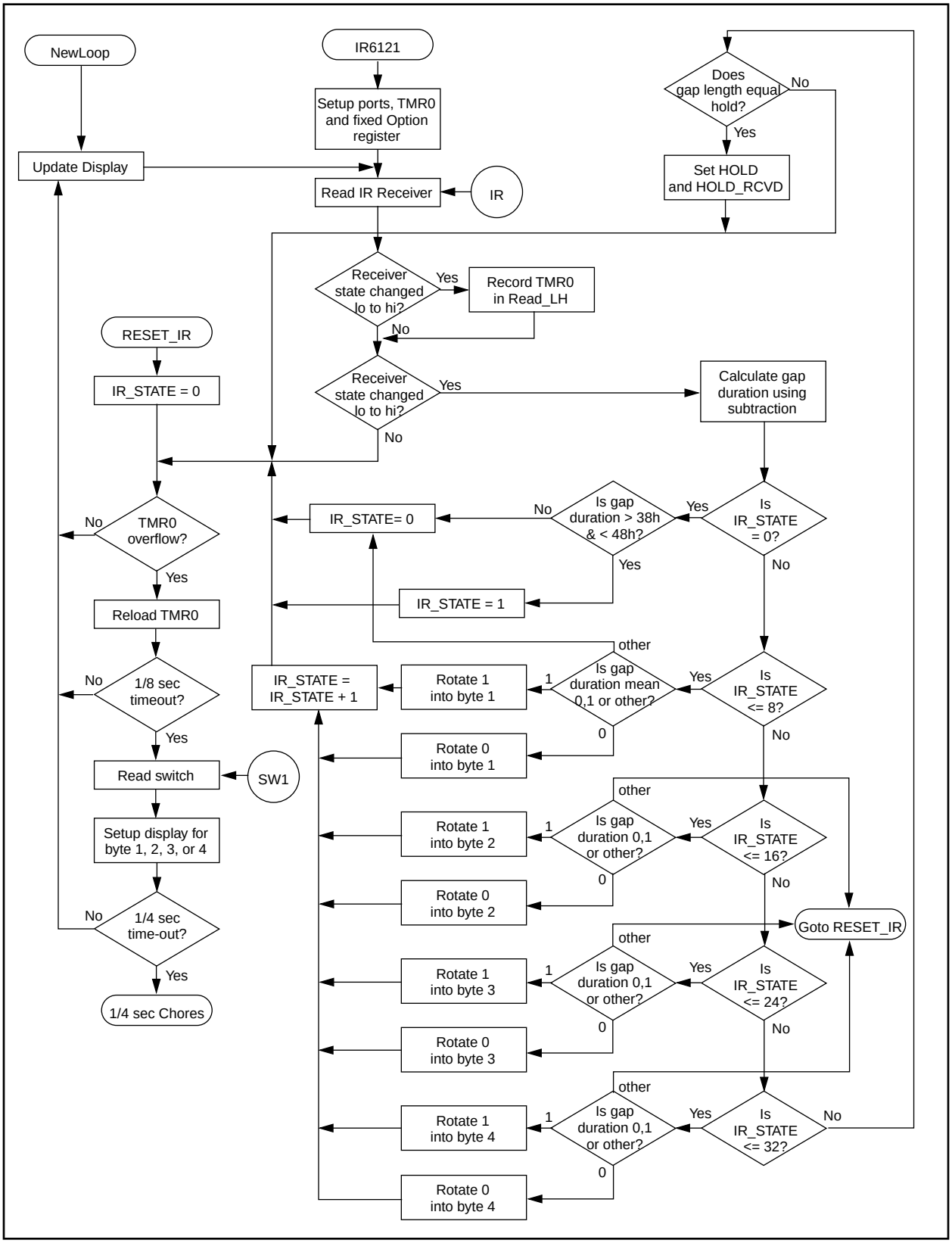


FIGURE 5: IR6121.ASM FLOWCHART



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TEKNIKA.ASM

This is an example of a finished product. This program fully decodes the infrared format of a Teknika Television. When a number is pressed on the remote control it is displayed on the display. When channel up or channel down is pressed, the displayed number increases or decreases.

It incorporates the final step in implementing a remote control decoder, that of cross referencing codes to button numbers. The algorithm will only respond if the first two bytes are 14h and EBh, the characteristic of this type of Teknika television. Byte 3 and byte 4 are checked to see if they are complements. If so, byte 3 is sent through a lookup table to determine which button the received byte corresponds to, then the appropriate action is taken. The lookup table was made by using IR6121 and recording byte 3 with the button pressed. Similar tables can be made using other remote controls.

FIGURE 6: TEKNIKA.ASM FLOWCHART

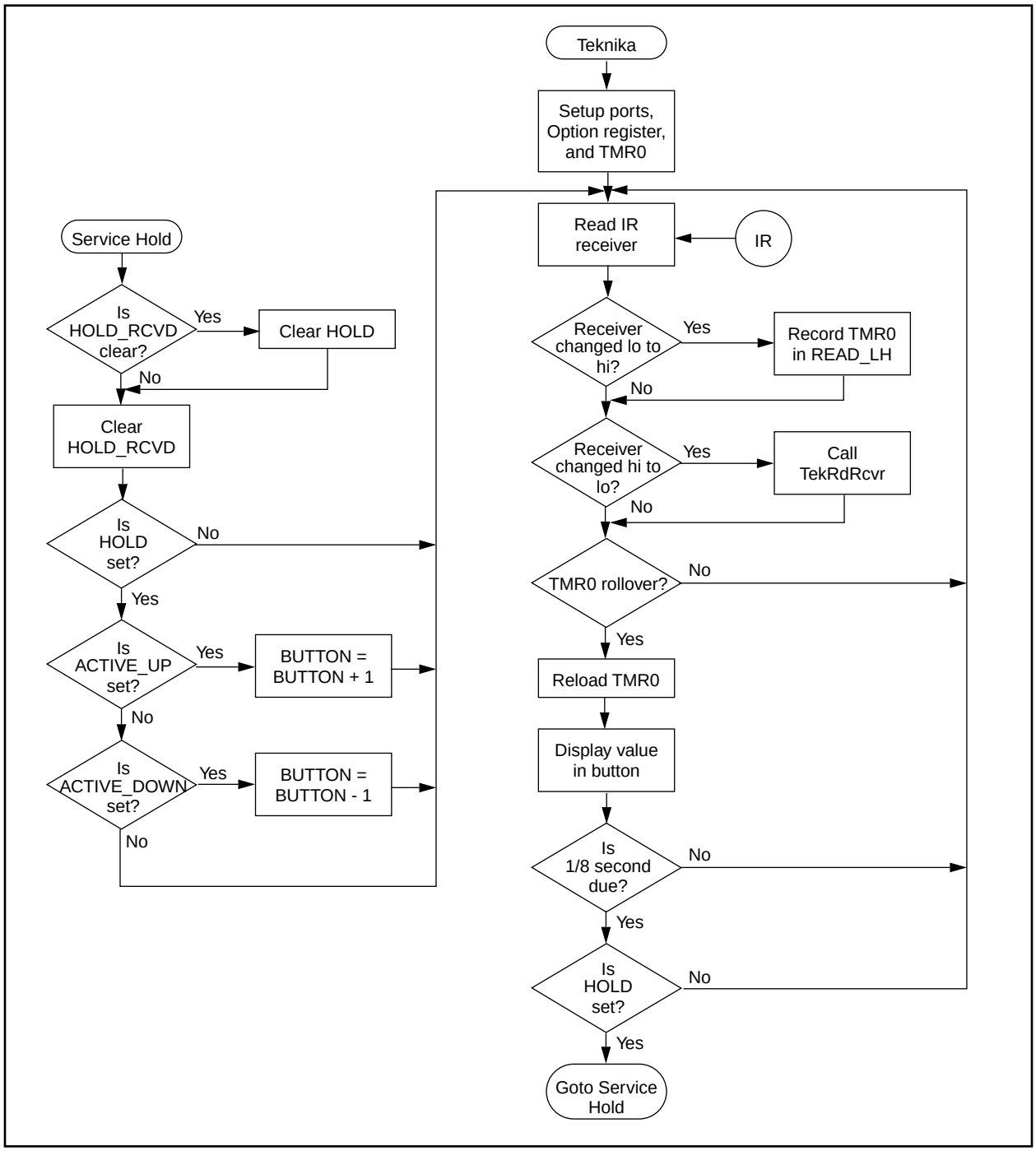

FIGURE 7: TEKRDRCVR, TEKIRRESET, TEKRDADDR FLOWCHART

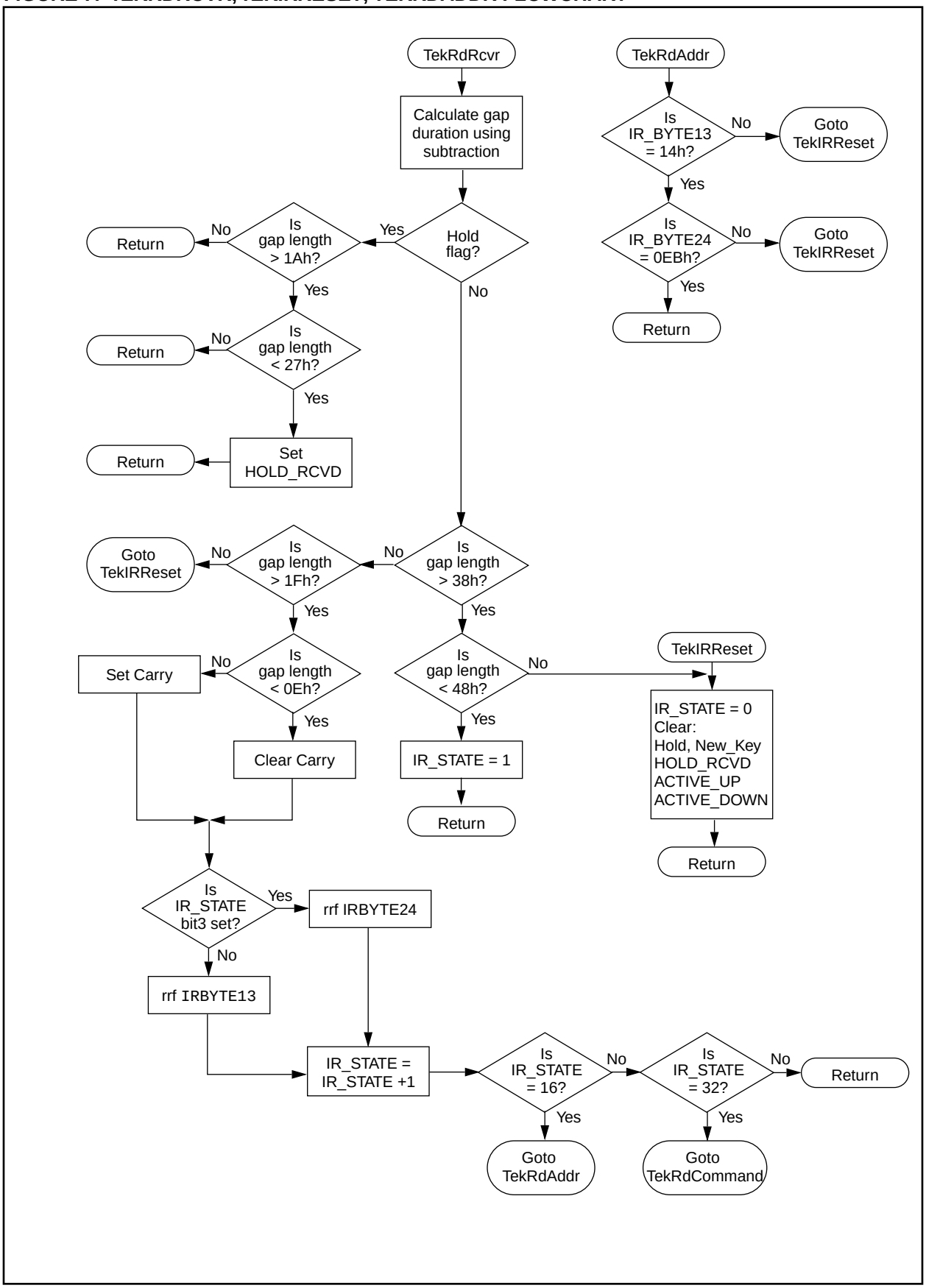

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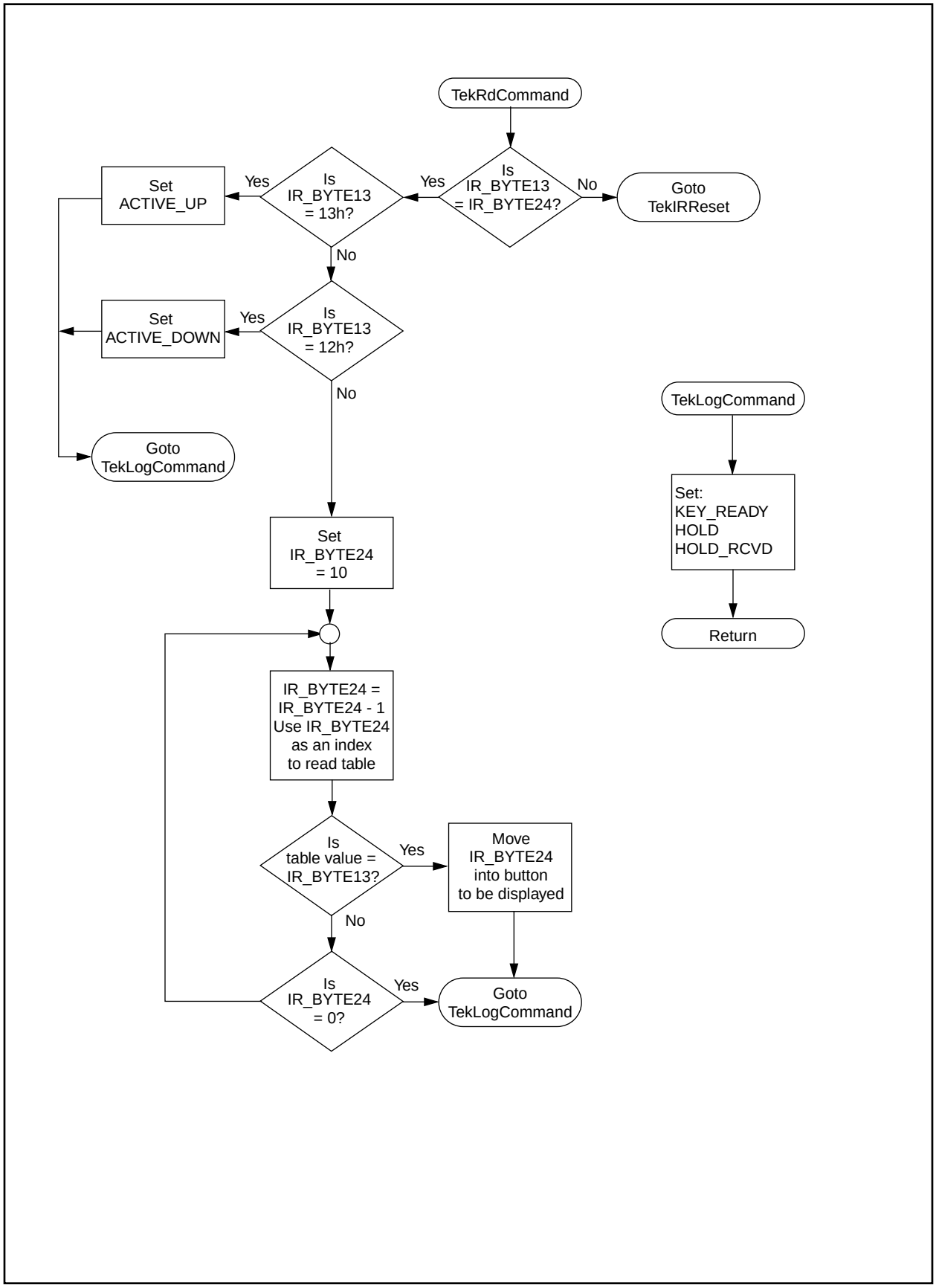
FIGURE 8: TEKCOMMAND FLOWCHART



INSTRUCTIONS ON WRITING AN ALGORITHM TO DECODE IR REMOTES

1. To design a system that uses an infrared remote control, the first step is to choose a remote control. Self designed or off the shelf, modulated or unmodulated are the primary technical decisions.
2. Once a remote control has been chosen or designed, its modulation frequency, if it has one, must be determined. This controls the kind of hardware used to receive the infrared signal.
3. The next step is to determine the time-base of the data, that is, if the pulses and gaps are short or long in reference to the PIC16C57 clock. The OPTION switch, SW1, is used to get optimum length pulse and gap counts from TMR0. This defines the value of the OPTION prescaler.
4. Fourth, definition is made as to what, in the format, defines a '1', and what, in the format, defines a '0'. This could be gap counts, pulse counts, or a combination of both.
5. Fifth, determination is made of the full length of commands. This enables the determination as to whether a button is being held down or if a new command of the same type as previous is being issued.
6. The sixth step requires the writing of code. The code will resolve the gap and pulse lengths and command lengths into bits and bytes. Each button on the remote will decode to a unique series of bits.
7. The seventh and final step takes these codes that are received and converts them to button numbers or commands, using a lookup table.

Step 1: Choosing a remote control

Depending on your application, you may choose to have an off the shelf remote control or design one yourself. Typically they have small 4-bit microcontrollers in them, preprogrammed for a serial format. Some companies such as General Instrument sell them as complete units, others such as NEC sell the main component which can be customized by external diodes to not interfere with other applications. It is also possible to program a PIC16C57 to generate a signal that can be sent to an infrared LED for transmission. Yet another approach is to use a programmable remote control to generate any number of infrared formats and use them right off the shelf to control the target device.

Step 2: Determining a modulation frequency

For this and the next step the MEASURE.ASM program will be used. To start out, use the non-modulated receiver and a PIC16C57 running the MEASURE.ASM application. Select 1 on the option selector. Press a button until the decimal point comes on. Using the jumpers switch through the memorized pulse durations that the PIC16C57 will have stored in its memory.

If all of the reading except the first are below 40h, the infrared format is a modulating one. If half or more of the values show up as 0FFh, then the remote is non-modulating.

Step 3: Determine time-base

If the remote control is modulated, switch to a demodulating IR receiver. With the option selector still at 1, press a button on the remote control again until the decimal point comes on. The series of memorized pulse durations will now probably include a lot of FFh values. If so, move the Option selector up until the values are in the 7h to 1Fh range. The Option selector has the optimum value for the option divisor to be used in the TMR0 register.

To optimize range and reliability, several demodulating receivers may be tried. These are available from Sharp or LiteOn. The modulating frequencies that are presently used are 32.75 kHz, 35.0 kHz, 36.0 kHz, 36.7 kHz, 38 kHz, 39 kHz, 40 kHz, 41.7 kHz, 48 kHz, and 56.8 kHz[2]. The most common are round 40 kHz. The best match for your remote control will give the longest range and most consistent results.

Step 4: Decoding ones and zeros

The next step is to map out the characteristic pulse and gap lengths that represent ones and zeros. By pressing the same button on the remote, write down the series of numbers read by the PIC16C57 running the `MEASURE.ASM` program. Each odd numbered entry is the duration of a burst of IR from the remote control. Each even numbered entry is the duration of a gap between bursts of infrared. The lengths of these gaps and bursts define ones and zeros. Their order will depend on which button is pressed. Once the characteristic lengths have been discovered for a one and a zero, an algorithm can then be created with a counter to translate the lengths into ones and zeros.

Step 5: Finding the Command Length

Press the same button again. The command duration can also be found. This is necessary to determine if a button is being held down or a new command of the same type is being issued. Most remote controls repeat the command as long as the button is held down, the repetitions separated by a long dark time, usually 0FFh on an even numbered transition. If no long even numbered counts can be found, consider that some commands can be longer than 64 transitions. The option to delay counting is available for this reason. Insert jumper 1 and `MEASURE.ASM` will only start storing transition times after the 32nd transition.

Step 6: Translating lengths to bits

Once the characteristic lengths of ones and zeros have been found and the length of the typical command has been found, a program can then be written to decode

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these lengths to ones and zeros and display them on the two digit display. Also a HOLD flag can be created which will be true as long as the button is being held down. Usually 1/8 second between commands indicates a new command. Use this value to time out HOLD times and times between commands. IR6121.ASM is an example of a program that translates the gap lengths of the NEC6121 format to the four bytes that make up the information in each command.

Step 7: Create a button to code cross reference table

TEKNIKA.ASM implements a lookup table to translate the codes received to the actual button pressed. A counter is loaded with the highest number button that can be pressed, and the code is then looked up and compared with the code that was received. If no match, the counter is decremented until a match is found. When found, the counter then has the button number that was pressed.

Note too, that more checking may be done at this level on some formats, such as having an address, a complement of the code following the code itself for checking.

The result from all of the steps in decoding is that if a button is pressed on a remote control, that button number appears in a PIC16C57 file location. A command such as channel up or channel down will appear as two set flags, one to indicate the command, the other to indicate that it is active, HOLD. From this point the application can access these flags and files to respond appropriately.

REFERENCES

[1] Infrared Remote Controls ICs; NEC Electronics. August 1991. Literature available 1-800-632-3531.

[2] Sharp Optoelectronics Data Book, 1991/1992, page 961.

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Please check the Microchip BBS for the latest version of the source code. Microchip's Worldwide Web Address: www.microchip.com; Bulletin Board Support: MCHIPBBS using CompuServe® (CompuServe membership not required).

APPENDIX A: IRMAIN.ASM

```
MPASM 01.40 Released           IRMAIN.ASM   10-2-1996  10:24:32         PAGE  1


LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

           00001 TITLE        "IR Receiver Ap-Note Program Selector V0.02"
           00002 ;
           00003 ;*****************************************************************
           00004 ; File Name :      IRMAIN.ASM
           00005 ;*****************************************************************
           00006 ;      Author:    William G. Grimm
           00007 ;      Company:   Microchip Technology
           00008 ;      Revision:  V0.02
           00009 ;      Date:      March 28, 1996
           00010 ;      Assembler: MPASM version 1.21
           00011 ;
           00012 ;*****************************************************************
           00013 ;   Revision History:
           00014 ;
           00015 ;
           00016 ;   V0.01    Original  March 28, 1996
           00017 ;
           00018 ;   V0.02    Added the Technika routine March 28, 1996
           00019 ;
           00020 ;
           00021 ;*****************************************************************
           00022 ; Assembly options
           00023           LIST     P=16C57,r=hex,N=75,C=120,T=ON
           00024 ;
           00025 ;*****************************************************************
           00026 ;   Required modules:
           00027 ;
           00028 ;       picreg.equ
           00029 ;       irundef.asm           ; undefines constants for include files
           00030 ;       measure.asm           ; decodes all remotes
           00031 ;       ir6121.asm            ; decodes all 6121 format remotes
           00032         include     "p16c5x.inc"
           00001         LIST
           00002 ; P16C5X.INC  Standard Header File, Version 3.30 Microchip Tech, Inc.
           00224         LIST
           00033 ;
           00034 ;*****************************************************************
           00035 ;
           00036 ;
           00037 ;
           00038 ;*****************************************************************
           00039 ; Ceramic resonator or Crystal, 4.000Mhz. If a Prescaler of
           00040 ; 64 (5 in the option register) is used, TMR0 will increment every
           00041 ; 64.00 microseconds.
           00042 ; If TMR0 is initially loaded with 131, TMR0 will overflow to 0
           00043 ; in 8.000 milliseconds.
00000083   00044 MSEC8         EQU    D'131'
           00045 ;*****************************************************************
           00046 ;
           00047 ;
           00048 ;^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
           00049         SUBTITL "File and Flag definitions."
           00050 ;*****************************************************************
           00051 ; file memory location definitions
```


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```
           00052 ;***********************************************************************
           00053 ;
           00054 ; full byte file memory locations
           00055 ;
0000000E   00056 LEFT_DIGIT    EQU   0E        ; code to be displayed on left digit
0000000F   00057 RIGHT_DIGIT   EQU   0F     ; code to be displayed on right digit
           00058
           00059 ;
           00060 ;^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
           00061         SUBTITL "Constant definitions."
           00062 ; ***********************************************************************
           00063 ; Definition of program constants
           00064         SUBTITL "Constant definitions."
           00065 ; ***********************************************************************
           00066 ; Definitions of constants used to configure the ports
0000000F   00067 A_CONFIG  EQU  0f          ; IR input and option dial all inputs
           00068 ;
0000003F   00069 B_CONFIG  EQU  03f         ; PORTB has outputs on bits 6 and 7 for
           00070                            ; the display, bits 0 to 5 are inputs for
           00071                            ; the dials
           00072 ;
0000001E   00073 C_CONFIG1 EQU  01e         ; lines 1,2,3, and 4 are input during selection
00000000   00074 C_CONFIG2 EQU  0           ; all lines are outputs normally
           00075 ;
           00076 ;***********************************************************************
           00077 ; Definition of program constants
           00078 ;
000000BF   00079 HIPHEN   EQU B'10111111'          ; -  for display
           00080 ;
           00081 ;
           00082 ;DEFINE PORT_A REG FUNCTION:
           00083 ;       BIT # 7|6|5|4|3|2|1|0|
           00084 ;--------------|-|-|-|-|-|-|-|
           00085 ;              | | | | | | |Y| --> OPTION dial bit 0
           00086 ;              | | | | | |Y| | --> OPTION dial bit 1
           00087 ;              | | | | |Y| | | --> OPTION dial bit 2
           00088 ;              | | | |Y| | | | --> IR input
           00089 ;              | | |O| | | | | --> Unavailable
           00090 ;              | |O| | | | | | --> Unavailable
           00091 ;              |O| | | | | | | --> Unavailable
           00092 ;             O| | | | | | | | --> Unavailable
           00093 ;
00000003   00094 IR            EQU  3              ; IR  receiver
           00095 ;
           00096 ;DEFINE PORT_B REG FUNCTION:
           00097 ;       BIT # 7|6|5|4|3|2|1|0|
           00098 ;--------------|-|-|-|-|-|-|-|
           00099 ;              | | | | | | |Y| --> Right dial bit 0
           00100 ;              | | | | | |Y| | --> Right dial bit 1
           00101 ;              | | | | |Y| | | --> Right dial bit 2
           00102 ;              | | | |Y| | | | --> Left dial bit 0
           00103 ;              | | |Y| | | | | --> Left dial bit 1
           00104 ;              | |Y| | | | | | --> Left dial bit 2
           00105 ;              |Y| | | | | | | --> controls right digit, LOW is on
           00106 ;             Y| | | | | | | | --> controls left digit, LOW is on
           00107 ; Y = DEFINED AS SHOWN (0/1)
           00108 ;
00000006   00109 RIGHT_OFF     EQU  6
00000007   00110 LEFT_OFF      EQU  7
           00111 ;
           00112 ;DEFINE PORT_C REG FUNCTION:
           00113 ;       BIT # 7|6|5|4|3|2|1|0|
           00114 ;--------------|-|-|-|-|-|-|-|     0 turns element on
           00115 ;              | | | | | | |Y| --> A
           00116 ;              | | | | | |Y| | --> D  SW1
           00117 ;              | | | | |Y| | | --> C  SW2
```

```
           00118 ;              | | | |Y| | | | --> E
           00119 ;              | | |Y| | | | | --> F
           00120 ;              | |Y| | | | | | --> B
           00121 ;              |Y| | | | | | | --> G
           00122 ;             Y| | | | | | | | --> dp
           00123 ; Y = DEFINED AS SHOWN (0/1)
           00124 ;
00000001   00125 SW1           EQU  1
00000002   00126 SW2           EQU  2
00000007   00127 DP            EQU  7
           00128 ;
           00129 ;^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
           00130         SUBTITL "Display."
           00131 ; ************************************************************************
           00132 ; Display handling routines
           00133 ;
           00134 ;------------------------------------------------------------------------
           00135 ; LookUpDigit
           00136 ;  Inputs a number, outputs the bit pattern to display that number
           00137 ;------------------------------------------------------------------------
0000       00138 LookUpDigit
0000 0E0F  00139      andlw  0F                  ; mask off any higher order bits
0001 01E2  00140      addwf  PCL,F               ; add to create a jump to a return
           00141 ;         76543210              ; PORTC line
           00142 ;          GBFECDA              ; element assignment
0002 08C0  00143      retlw  B'11000000'         ; Zero
0003 08DB  00144      retlw  B'11011011'         ; 1
0004 0894  00145      retlw  B'10010100'         ; 2
0005 0898  00146      retlw  B'10011000'         ; 3
0006 088B  00147      retlw  B'10001011'         ; 4
0007 08A8  00148      retlw  B'10101000'         ; 5
0008 08A0  00149      retlw  B'10100000'         ; 6
0009 08DA  00150      retlw  B'11011010'         ; 7
000A 0880  00151      retlw  B'10000000'         ; 8
000B 0888  00152      retlw  B'10001000'         ; 9
000C 0882  00153      retlw  B'10000010'         ; A
000D 08A1  00154      retlw  B'10100001'         ; b
000E 08B5  00155      retlw  B'10110101'         ; c
000F 0891  00156      retlw  B'10010001'         ; d
0010 08A4  00157      retlw  B'10100100'         ; E
0011 08A6  00158      retlw  B'10100110'         ; F
           00159 ;
           00160 ;------------------------------------------------------------------------
           00161 ; UpdateDisplay
           00162 ;  Rotates power to each of the three display digits.
           00163 ;------------------------------------------------------------------------
0012       00164 UpdateDisplay
0012 07C6  00165      btfss  PORTB,RIGHT_OFF     ; Check the right digit
0013 0A19  00166      goto   RightOn             ; right digit is on now
           00167 ;
0014 091E  00168      call   DisplayOff          ; turn off all displays, and read PORTC
           00169                                 ; inputs if active
0015 020F  00170      movf   RIGHT_DIGIT,W       ; Left digit is on, turn on right digit
0016 0027  00171      movwf  PORTC               ; send right digit out to the port
0017 04C6  00172      bcf    PORTB,RIGHT_OFF     ; turn on the right digit
0018 0800  00173      retlw  0
0019       00174 RightOn
0019 091E  00175      call   DisplayOff          ; turn off all displays, and read PORTC
           00176                                 ; inputs if active
001A 020E  00177      movf   LEFT_DIGIT,W        ; Right digit is on, turn on left digit
001B 0027  00178      movwf  PORTC               ; send left digit out to the port
001C 04E6  00179      bcf    PORTB,LEFT_OFF      ; turn on the left digit
001D 0800  00180      retlw  0
           00181 ;
           00182 ;------------------------------------------------------------------------
           00183 ; DisplayOff
```


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```
           00184 ;  Turns off the display at the three transistors
           00185 ;-----------------------------------------------------------------------
001E       00186 DisplayOff
001E 05E6  00187      bsf    PORTB,LEFT_OFF       ; turn off the left digit
001F 05C6  00188      bsf    PORTB,RIGHT_OFF      ; turn off the right digit
0020 0800  00189      retlw  0
           00190 ;
           00191 ;*******************************************************************
           00192 ;  include files
0200       00193      org            200
0200       00194 BeginMeasure
           00195      include        "measure.asm"
           00001            TITLE        "IR Receiver output measurement routine V0.07"
           00002 ;
           00003 ;*******************************************************************
           00004 ; File Name :      MEASURE.ASM
           00005 ;*******************************************************************
           00006 ;      Author:    William G. Grimm
           00007 ;      Company:   Microchip Technology
           00008 ;      Revision:  V0.07
           00009 ;      Date:      March 31, 1996
           00010 ;      Assembler: MPASM version 1.21
           00011 ;
           00012 ;*******************************************************************
           00013 ;   Revision History:
           00014 ;
           00015 ;
           00016 ;   V0.01    Original  January 9, 1995
           00017 ;
           00018 ;   V0.02    Added overflow indication January 12, 1996
           00019 ;
           00020 ;   V0.03    Modified to conform to Microchip specifications
           00021 ;            February 17, 1996
           00022 ;
           00023 ;   V0.04    Modified for new hardware March 19, 1996
           00024 ;
           00025 ;   V0.05    Changable option register and delay added
           00026 ;            March 20, 1996
           00027 ;
           00028 ;   V0.06    Added code that creates 1/8 second time out
           00029 ;            for all options 1 to 7, 0 gets a 1/16 second time out.
           00030 ;            March 26, 1996
           00031 ;
           00032 ;   V0.07    Improved roll over detection for long gaps and pulses
           00033 ;            March 27, 1996
           00034 ;
           00035 ;   V0.08    Changed to header file March 31, 1996
           00036 ;
           00037 ;   V0.09    Fixed bug that kept jumper 1 from being read
           00038 ;
           00039 ;
           00040 ;*******************************************************************
           00041 ; Assembly options
           00042           LIST     P=16C57,r=hex,N=75,C=120,T=ON
           00043 ;
           00044 ;*******************************************************************
           00045 ;
           00046 ;
           00047 ;
           00048 ;*******************************************************************
           00049 ;*******************************************************************
           00050 ;
           00051 ;^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
           00052         SUBTITL "RAM and Flag definitions."
           00053 ;*******************************************************************
           00054 ; file memory location definitions
```

```
          00055 ;***********************************************************************
          00056 ;
          00057 ;  full byte file memory locations
          00058 ;
00000008  00059 START_COUNT   EQU   08        ; TMR0 value at previous IR rcvr transition
00000009  00060 TR_COUNT      EQU   09        ; transition being read
          00061
0000000B  00062 TIMERM        EQU   0b        ; Bit5 = 1/4 sec, Bit1 = 16 millisecs.
0000000C  00063 FLAG          EQU   0c        ; program flags
0000000D  00064 SCALE_RECORD  EQU   0d        ; prescaler value is stored here
          00065 ;    LEFT_DIGIT    EQU   0E   ; defined in main routine
          00066 ;    RIGHT_DIGIT   EQU   0F
          00067                               ; Files 10h-1fh,30h-3fh,50h-5fh,70h-7fh
          00068                               ; are used to store IR pulse and gap lengths.
          00069 ;
          00070 ;
          00071 ;
          00072 ;
          00073 ;DEFINE FLAG REG FUNCTION:
          00074 ;       BIT # 7|6|5|4|3|2|1|0|
          00075 ;--------------|-|-|-|-|-|-|-|
          00076 ;              | | | | | | |Y| -->
          00077 ;              | | | | | |Y| | --> Eighth second flag.
          00078 ;              | | | | |Y| | | --> used for math, TMR0 overdue for reload
          00079 ;              | | | |Y| | | | --> the Value START_COUNT is new
          00080 ;              | | |Y| | | | | --> measurement has overflowed
          00081 ;              | |Y| | | | | | --> Value of last IR  bit received.
          00082 ;              |Y| | | | | | | --> if set memory is full, stop reading
          00083 ;             Y| | | | | | | -->
          00084 ;
00000001  00085 _8TH_SEC          EQU 1
00000002  00086 OVERDUE           EQU 2
00000003  00087 NEW_START_COUNT   EQU 3
00000004  00088 OVERFLOW          EQU 4
00000005  00089 LAST_IR           EQU 5
00000006  00090 ALL_DONE          EQU 6
          00091 ;
          00092 ;
          00093 ;^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
          00094         SUBTITL "Constant definitions."
          00095 ; ***********************************************************************
          00096 ; Definition of program constants
          00097 ;
00000020  00098 SKIP_NUM EQU d'32'               ; readings to skip before filing them
00000000  00099 OPTION_MASK   EQU    B'00000000'  ; SET UP PRESCALER, WDT on 18msec.
          00100                                 ; lowest three bits must be zero to not
          00101                                 ; overwrite the prescaler dialed in
          00102                                 ; externally
          00103 ;
          00104 ;^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
          00105         SUBTITL "Timer routines."
          00106 ; ***********************************************************************
          00107 ; Timer servicing routine
          00108 ;    Called every 1.6 to 8 milliseconds this clears the
          00109 ;    watch dog, reloads TMR0
          00110 ;    and keeps track of relative time.
          00111 ;
0200      00112 ServiceTimerM
0200 0C83 00113      movlw   MSEC8               ;TMR0 = 8 milliseconds.
0201 01C1 00114      addwf   TMR0,W              ; Add overflow amount.
0202 0021 00115      movwf   TMR0                ;       /
0203 0004 00116      clrwdt
0204 076C 00117      btfss   FLAG,NEW_START_COUNT ; find if measured length is too long
0205 058C 00118      bsf     FLAG,OVERFLOW       ; length is too long to measure
0206 046C 00119      bcf     FLAG,NEW_START_COUNT ; set the flag indicating the reload
0207 02AB 00120      incf    TIMERM,F            ; increment the timer
```


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```
0208 090F  00121      call    TimerLookup          ; get the maximum count
0209 018B  00122      xorwf   TIMERM,W             ; see if maximum count is here
020A 0743  00123      btfss   STATUS,Z             ; Is maximum count there?
020B 0800  00124      retlw   0                    ; not there return
020C 006B  00125      clrf    TIMERM               ; reset the timer
020D 052C  00126      bsf     FLAG,_8TH_SEC        ; Set the 1/8 sec flag.
020E 0800  00127      retlw   0                    ; reset and ready for 1/8 sec chores
           00128 ;
020F       00129 TimerLookup
020F 020D  00130      movf    SCALE_RECORD,W       ; bring in the record of the option
0210 0E07  00131      andlw   7                    ; ensure lookup table is not overjumped
0211 01E2  00132      addwf   PCL,F                ; look up the proper timer overflow
0212 0800  00133      retlw   0                    ; this will only get 1/16 sec time out
0213 0800  00134      retlw   0                    ; option = 1
0214 0880  00135      retlw   b'10000000'          ; option = 2
0215 0840  00136      retlw   b'01000000'          ; option = 3
0216 0820  00137      retlw   b'00100000'          ; option = 4
0217 0810  00138      retlw   b'00010000'          ; option = 5
0218 0808  00139      retlw   b'00001000'          ; option = 6
0219 0804  00140      retlw   b'00000100'          ; option = 7
           00141 ;
           00142 ;
           00143 ;^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
           00144         SUBTITL "IR  counter."
           00145 ;
           00146 ;
           00147 ; ************************************************************************
           00148 ; IR  Receiver routines
           00149 ;
           00150 ;------------------------------------------------------------------------
           00151 ; ReadReceiver
           00152 ;  Second part of the IR receiver.  It takes the present count of the
           00153 ;  TMR0 and subtracts the count recorded when the receiver output
           00154 ;  went high (START_COUNT) to find the dark pulse duration.  In that duration
           00155 ;  will be encoded the 1, 0, HOLD, or attention.
           00156 ;------------------------------------------------------------------------
021A       00157 ReadReceiverHi
021A 05AC  00158      bsf      FLAG,LAST_IR        ; record the IR receiver state
021B 02A9  00159      incf     TR_COUNT,F
021C 0509  00160      bsf      TR_COUNT,0          ; Times when IR rcvr is Lo are recorded
           00161                                  ; in odd numbered locations
021D 0C3F  00162      movlw    3fh                 ; bring in highest valid address in
021E 0189  00163      xorwf    TR_COUNT,W          ; TR_count see if highest count is in
021F 0643  00164      btfsc    STATUS,Z            ; skip if not highest address
0220 05CC  00165      bsf      FLAG,ALL_DONE
           00166                                  ; set all done flag to stop reading
0221 0A25  00167      goto     TimeIRReceiver
           00168 ;
0222       00169 ReadReceiverLo
0222 04AC  00170      bcf      FLAG,LAST_IR        ; record the IR value
0223 02A9  00171      incf     TR_COUNT,F
0224 0409  00172      bcf      TR_COUNT,0          ; Times when IR rcvr is Hi are recorded
           00173                                  ; in even numbered locations
           00174 ;
           00175                                  ; Calc the length of the dark pulse,
           00176                                  ; length of time receiver was high.
           00177                                  ; (placed in START_COUNT)
0225       00178 TimeIRReceiver
0225 0208  00179      movf     START_COUNT,W       ; bring in the start measurement
0226 0081  00180      subwf    TMR0,W              ; subtract the final from the start
0227 0028  00181      movwf    START_COUNT         ; gap or pulse length is now in
           00182                                  ; START_COUNT, must be checked
0228 0C83  00183      movlw    MSEC8               ; Base number of TMR0 count.
0229 0088  00184      subwf    START_COUNT,W       ; Subtract the base count of TMR0
022A 0603  00185      btfsc    STATUS,C            ; skip the store and toss value if neg.
022B 0028  00186      movwf    START_COUNT         ; value was positive, store
```

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```
          00187 ;
022C      00188 MathDone
022C 06E9 00189      btfsc    TR_COUNT,7          ; check to see if in delay
022D 0A3A 00190      goto     DoNotStore          ; do not store the value if in delay
          00191 ;
          00192                                    ; format for FSR
022E 0209 00193      movf     TR_COUNT,W          ; Setup place the count will be stored
022F 0E0F 00194      andlw    0f                  ; reduce to file location
0230 0024 00195      movwf    FSR                 ; place file address in FSR
0231 0584 00196      bsf      FSR,4               ; set to place in upper file group
0232 0689 00197      btfsc    TR_COUNT,4          ; set bank bit 0
0233 05A4 00198      bsf      FSR,5               ; /
0234 06A9 00199      btfsc    TR_COUNT,5          ; set bank bit 1
0235 05C4 00200      bsf      FSR,6               ; /
          00201 ;
0236 0CFF 00202      movlw    0ffh                ; bring in the overflow indication
0237 078C 00203      btfss    FLAG,OVERFLOW       ; skip loading of result if overflowed
0238 0208 00204      movf     START_COUNT,W       ; bring in the measurement
0239 0020 00205      movwf    INDF                ; store it for display using
          00206                                    ; indirect addressing
023A      00207 DoNotStore
023A 0201 00208      movf     TMR0,W              ; bring in the count now
023B 0028 00209      movwf    START_COUNT         ; store it for next time
023C 056C 00210      bsf      FLAG,NEW_START_COUNT
          00211                                    ; set ind flag that START_COUNT is new.
          00212                                    ; this flag is used to determine if the
          00213                                    ; pulse has gone on too long to measure
023D 048C 00214      bcf      FLAG,OVERFLOW       ; clear any overflow indication
          00215 ;
023E 0800 00216      retlw    0
          00217 ;
          00218 ;
          00219 ;*****************************************************************************
          00220 ; The following code segments are called by the executive
          00221 ; every 1/8 second and every two seconds
          00222 ;
023F      00223 EighthSecondChores                 ; all that needs doing every 1/8 sec
          00224                                    ; can be placed in this subroutine
023F 042C 00225      bcf      FLAG,_8TH_SEC       ; clear the time out flag
          00226 ;
0240 0246 00227      comf     PORTB,W             ; read the dial settings
          00228                                    ; the requested memory location is in W
0241 0024 00229      movwf    FSR
          00230                                    ; Following formats the FSR to point to
          00231                                    ; the selected file w/ the IR pulse
0242 04C4 00232      bcf      FSR,6               ; or gap length
0243 06A4 00233      btfsc    FSR,5               ; move bit 5 to 6
0244 05C4 00234      bsf      FSR,6               ; if 5 was 1, set 6
0245 04A4 00235      bcf      FSR,5
0246 0684 00236      btfsc    FSR,4               ; move bit 4 to 5
0247 05A4 00237      bsf      FSR,5               ; if 4 was high, set bit 5 of fsr
0248 0584 00238      bsf      FSR,4               ; Format for FSR, upper bank of bytes
          00239 ;
0249 04A3 00240      bcf      STATUS,PA0          ; get ready to call from page 1
024A 04C3 00241      bcf      STATUS,PA1          ;  /
          00242 ;
024B 0380 00243      swapf    INDF,W              ; bring in IR measurement to be disp'd
024C 0900 00244      call     LookUpDigit
024D 002E 00245      movwf    LEFT_DIGIT          ; display more significant digit
          00246 ;
024E 0200 00247      movf     INDF,W              ; bring in IR measurement to be disp'd
024F 0900 00248      call     LookUpDigit
0250 002F 00249      movwf    RIGHT_DIGIT         ; display less significant digit
          00250 ;
          00251  if BeginMeasure==200             ; return the bits to this page
0251 05A3 00252      bsf      STATUS,PA0          ; page 1
```


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```
0252 04C3  00253      bcf      STATUS,PA1          ; /
           00254  endif
           00255  if BeginMeasure==400
           00256      bcf      STATUS,PA0          ; page 2
           00257      bsf      STATUS,PA1          ; /
           00258  endif
           00259  if BeginMeasure==600
           00260      bsf      STATUS,PA0          ; page 3
           00261      bsf      STATUS,PA1          ; /
           00262  endif
           00263 ;
0253 0245  00264      comf     PORTA,W             ; bring in the req'd prescale value
           00265                                  ; from the dial, reverse sense
0254 0E07  00266      andlw    7                   ; AND w/ highest possible prescale value
0255 018D  00267      xorwf    SCALE_RECORD,W      ; compare the prescale dial setting
           00268                                  ; with the original one
0256 0743  00269      btfss    STATUS,Z            ; skip if the same
0257 0A61  00270      goto     StartMeasure        ; restart the application if different
0258 0AAD  00271      goto     DoneEighthSecondChores
           00272 ;
           00273 ;
0259       00274 ClearRam                         ; clears memory at reset
0259 0024  00275      movwf    FSR                 ; place in fsr for indirect addressing.
025A 003F  00276      movwf    1fh                 ; when zero, memory init is done.
025B       00277 MemoryInitLoop
025B 02A4  00278      incf     FSR,F               ; increment to the next memory location
           00279                                  ; to be initialized.
025C 0060  00280      clrf     INDF                ; clear memory location.
025D 021F  00281      movf      1fh,w              ; Has top memory location zeroed yet?
025E 0743  00282      btfss    STATUS,Z            ;    /
025F 0A5B  00283      goto     MemoryInitLoop      ; /
0260 0800  00284      retlw    0
           00285 ;
           00286 ;
           00287 ;*************************************************************************
           00288 ;         Start HERE.
           00289 ;*************************************************************************
0261       00290 StartMeasure
0261 006C  00291      clrf     FLAG                ; Clear out flag bank 1.
           00292 ;
0262 006B  00293      clrf     TIMERM              ; restart the TIMERM at 0
           00294 ;
0263 0069  00295      clrf     TR_COUNT            ; initialize memory counter
           00296 ;
0264 0C0F  00297      movlw    0f                  ; start zeroing at memory location 10h
0265 0959  00298      call     ClearRam            ; clear the first bank of memory
           00299 ;
0266 0C2F  00300      movlw    2f                  ; start zeroing at memory location 10h.
0267 0959  00301      call     ClearRam            ; clear the second bank of memory
           00302 ;
0268 0C4F  00303      movlw    4f                  ; start zeroing at memory location 10h
0269 0959  00304      call     ClearRam            ; clear the third bank of memory
           00305 ;
026A 0C6F  00306      movlw    6f                  ; start zeroing at memory location 10h
026B 0959  00307      call     ClearRam            ; clear the fourth bank of memory
           00308 ;
026C 0C0F  00309      movlw    A_CONFIG            ; setup for PORTA, in loop so
           00310                                  ; micocontroller will never forget
026D 0005  00311      tris     PORTA               ; inputs on bit 0.
026E 0C3F  00312      movlw    B_CONFIG
026F 0006  00313      tris     PORTB               ; PORTB has outputs on bits 0,6,7;
           00314                                  ; inputs on bits 1, 2, 3, 4, and 5.
           00315 ;
0270 05E6  00316      bsf      PORTB,LEFT_OFF      ; turn off both digits to read jumpers
0271 05C6  00317      bsf      PORTB,RIGHT_OFF     ; /
0272 0C1E  00318      movlw    C_CONFIG1           ; configuration to read from PORTC
```

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```
0273 0007  00319      tris     PORTC               ; configure PORTC to read the bits
0274 0CE0  00320      movlw    -(SKIP_NUM)         ; let inputs settle, bring in skip numb
0275 0727  00321      btfss    PORTC,SW1           ; skip if jumper 1 is not installed
0276 0029  00322      movwf    TR_COUNT            ; move the skip number to file pointer
           00323 ;
0277 0C00  00324      movlw    C_CONFIG2           ; bring in config to use PORTC for disp
0278 0007  00325      tris     PORTC               ; PORTC is normally all outputs
           00326 ;
0279 0245  00327      comf     PORTA,W             ; bring in the requested prescale
           00328                                  ; value from the dial, reverse sense
027A 0E07  00329      andlw    7                   ; AND w/ highest possible prescale value
027B 002D  00330      movwf    SCALE_RECORD        ; record the value of the prescaler
027C 0D00  00331      iorlw    OPTION_MASK         ; Setup prescaler for TMR0, WDT on 18ms.
027D 0002  00332      option                       ; /
           00333 ;
           00334 ;
027E 0CBF  00335      movlw    HIPHEN              ; Disp that unit waiting for dark cond's
027F 0027  00336      movwf    PORTC               ; put the Hiphen on right digit
0280 05E6  00337      bsf      PORTB,LEFT_OFF      ; turn off left digit
0281 04C6  00338      bcf      PORTB,RIGHT_OFF     ; turn ON right digit
           00339 ;
0282 0C83  00340      movlw    MSEC8               ;TMR0 = 8 mSEC
0283 0021  00341      movwf    TMR0                ;       /
           00342 ;
0284       00343 SettlingLoop
0284 0C83  00344      movlw    MSEC8               ; Check for overflow.
0285 0081  00345      subwf    TMR0,W              ; SEE IF TMR0 < MSEC8,
0286 0603  00346      btfsc    STATUS,C            ; If TMR0 < MSEC8, Overflow.
0287 0A84  00347      goto     SettlingLoop        ; No overflow, no carry, loop.
0288 0900  00348      call     ServiceTimerM       ; Keep time and reload time keeper.
0289 0765  00349      btfss    PORTA,IR            ; IR receiver quiet?
028A 006B  00350      clrf     TIMERM              ; not quiet, reset timer
028B 072C  00351      btfss    FLAG,_8TH_SEC       ; Allow out of loop if quiet for 1/8sec
028C 0A84  00352      goto     SettlingLoop        ; not quiet long enough yet
028D 006C  00353      clrf     FLAG                ; re-clear all of the flags
028E 05AC  00354      bsf      FLAG,LAST_IR        ; set the flag, receiver is now hi
           00355 ;
           00356 ;
028F 0CBF  00357      movlw    HIPHEN              ; Display that unit is ready to receive
0290 0027  00358      movwf    PORTC               ; put the Hiphen on right digit
0291 04E6  00359      bcf      PORTB,LEFT_OFF      ; turn on left digit
0292 05C6  00360      bsf      PORTB,RIGHT_OFF     ; turn OFF right digit
           00361 ;
0293 093A  00362      call     DoNotStore          ; setup timer last read for first read
           00363 ;
           00364 ;************ Main loop Starts here. *************
0294       00365 Main
           00366 ;
           00367 ;
0294       00368 InnerLoop
0294 07CC  00369      btfss    FLAG,ALL_DONE       ; update display only if memory is full
0295 0A9E  00370      goto     CheckIr             ; not full, keep reading the IR rcvr
0296 04A3  00371      bcf      STATUS,PA0          ; get ready to call from page 1
0297 04C3  00372      bcf      STATUS,PA1          ;  /
0298 0912  00373      call     UpdateDisplay       ; rotate power to the next display digit
           00374 ;
           00375  if BeginMeasure==200            ; return the bits to this page
0299 05A3  00376      bsf      STATUS,PA0          ; page 1
029A 04C3  00377      bcf      STATUS,PA1          ; /
           00378  endif
           00379  if BeginMeasure==400
           00380      bcf      STATUS,PA0          ; page 2
           00381      bsf      STATUS,PA1          ; /
           00382  endif
           00383  if BeginMeasure==600
           00384      bsf      STATUS,PA0          ; page 3
```


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```
           00385      bsf      STATUS,PA1          ; /
           00386  endif
029B 07C6  00387      btfss    PORTB,RIGHT_OFF     ; skip if the right digit is off
029C 04E7  00388      bcf      PORTC,DP            ; lite the decimal to show read taken
029D 0AA6  00389      goto     ReadDone            ; memory is full, done reading receiver
           00390 ;
029E       00391 CheckIr
029E 0665  00392      btfsc    PORTA,IR            ; ?IR receiver not recv'g an IR burst?
029F 06AC  00393      btfsc    FLAG,LAST_IR        ; was it receiving a burst last time?
02A0 02A2  00394      incf     PCL,F               ; Not either, skip next instruction
02A1 091A  00395      call     ReadReceiverHi      ; Record TMR0 value when the lo to hi
           00396                                  ; transition came from the receiver
           00397 ;
02A2 0765  00398      btfss    PORTA,IR            ; ?IR receiver receiving an IR burst?
02A3 07AC  00399      btfss    FLAG,LAST_IR        ; was it not receiving burst last time?
02A4 02A2  00400      incf     PCL,F               ; Not either skip next instruction
02A5 0922  00401      call     ReadReceiverLo      ; read the new information
           00402 ;
02A6       00403 ReadDone
           00404 ;
02A6 0C83  00405      movlw    MSEC8               ; Check for overflow.
02A7 0081  00406      subwf    TMR0,W              ; SEE IF TMR0 < MSEC8,
02A8 0603  00407      btfsc    STATUS,C            ; If TMR0 < MSEC8, Overflow.
02A9 0A94  00408      goto     InnerLoop           ; No overflow, no carry, loop.
02AA 0900  00409      call     ServiceTimerM       ; Keep time and reload time keeper.
           00410 ;
02AB 062C  00411      btfsc    FLAG,_8TH_SEC       ; check for 1/8 second time out
02AC 0A3F  00412      goto     EighthSecondChores
           00413                                  ; anything that needs doing every 1/8sec
           00414                                  ; can go in this subroutine
02AD       00415 DoneEighthSecondChores
           00416 ;
02AD 0A94  00417      goto     Main
           00418 ;
           00419 ;
           00420
0400       00196      org            400
0400       00197 BeginIr6121
           00198      include        "ir6121.asm"
           00001           TITLE        "IR-NEC6121 format Remote Control Detector V0.02"
           00002           SUBTITL      "Comments documentation and history"
           00003 ;
           00004 ;***************************************************************************
           00005 ; File Name :      IR6121.ASM
           00006 ;***************************************************************************
           00007 ;      Author:    William G. Grimm
           00008 ;      Company:   Microchip Technology
           00009 ;      Revision:  V0.02
           00010 ;      Date:      February 27, 1996
           00011 ;      Assembler: MPASM version 1.21
           00012 ;
           00013 ;***************************************************************************
           00014 ;   Revision History:
           00015 ;
           00016 ;
           00017 ;   V0.01    Original  February 27, 1996
           00018 ;
           00019 ;   V0.02    Converted to Ap-note format and made into a header
           00020 ;            file March 28, 1996
           00021 ;***************************************************************************
00000005   00022 OPTION_CODE   EQU    B'00000101'     ;SET UP PRESCALER, WDT on 18msec.
           00023 ;***************************************************************************
           00024 ;
           00025 ;***************************************************************************
           00026 ; file memory location definitions
           00027 ;***************************************************************************
```

```
          00028 ;
          00029 ;  full byte file memory locations
          00030 ;
0000000B  00031 TIMER         EQU   0b        ; Bit 5 = 1/4 second, Bit 1 = 16 millisecs.
0000000C  00032 TEMP          EQU   0c        ; temporary file storage
          00033 ;
          00034 ;    LEFT_DIGIT    EQU   0e   ; defined in irmain
          00035 ;    RIGHT_DIGIT   EQU   0f   ; defined in irmain
00000011  00036 READ_LH       EQU   11        ; Low to high reading is stored here.
00000012  00037 IR_STATE      EQU   12        ; Which bit is coming in.
00000013  00038 IR_BYTE13     EQU   13        ; First byte for collecting inputs.
00000014  00039 IR_BYTE24     EQU   14        ; Second byte for collecting inputs.
          00040 ;
00000018  00041 FLAG2         EQU   18        ; flag bank 2
00000019  00042 FLAG3         EQU   19        ; flag bank 3
0000001A  00043 C_BYTE_1      EQU   1A        ; Memory location def's for storing inputs
0000001B  00044 C_BYTE_2      EQU   1B
0000001C  00045 BYTE_1        EQU   1C
0000001D  00046 BYTE_2        EQU   1D
0000001E  00047 BYTE_3        EQU   1E
0000001F  00048 BYTE_4        EQU   1F
          00049 ;
          00050 ;DEFINE FLAG2 REG FUNCTION:
          00051 ;       BIT # 7|6|5|4|3|2|1|0|
          00052 ;--------------|-|-|-|-|-|-|-|
          00053 ;              | | | | | | |Y| --> Command Ready.
          00054 ;              | | | | | |Y| | --> Command in process.
          00055 ;              | | | | |Y| | | --> Most Significant bit of time stamp.
          00056 ;              | | | |Y| | | | --> HOLD is active
          00057 ;              | | |Y| | | | | --> Four bytes have been recv'd ok
          00058 ;              | |Y| | | | | | --> Value of last IR bit received.
          00059 ;              |Y| | | | | | | --> A Valid hold received < 1/4 sec ago.
          00060 ;             Y| | | | | | | -->
          00061 ; Y = DEFINED AS SHOWN (0/1)
          00062 ;
00000006  00063 HOLD_RCVD          EQU 6
00000005  00064 LAST_IR_STATE      EQU 5
00000004  00065 KEY_READY          EQU 4
00000003  00066 HOLD               EQU 3
00000002  00067 STAMP_MSB          EQU 2
00000001  00068 CMD_PEND           EQU 1  ; A channel command is pending.
00000000  00069 CMD_RDY            EQU 0  ; A channel command is ready.
          00070 ;
          00071 ;DEFINE FLAG3 REG FUNCTION:
          00072 ;       BIT # 7|6|5|4|3|2|1|0|
          00073 ;--------------|-|-|-|-|-|-|-|
          00074 ;              | | | | | | |Y| --> Quarter second flag.
          00075 ;              | | | | | |Y| | --> Eighth second flag.
          00076 ;              | | | | |Y| | | --> Two second flag.
          00077 ;              | | | |Y| | | | -->
          00078 ;              | | |Y| | | | | -->
          00079 ;              | |Y| | | | | | -->
          00080 ;              |Y| | | | | | | -->
          00081 ;             Y| | | | | | | | -->
          00082 ; Y = DEFINED AS SHOWN (0/1)
          00083 ;
          00084 ;
00000000  00085 _4TH_SEC       EQU 0
00000001  00086 EIGTH_SEC      EQU 1
00000002  00087 TWO_SEC        EQU 2
          00088 ;
          00089 ;^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
          00090         SUBTITL "Constant definitions."
          00091 ;*****************************************************************
          00092 ; Gap length IR decoding time constants.  Values were derived from
          00093 ; successive readings made with MEASURE.ASM
```


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```
                00094 ;
0000001A        00095 HOLD_MIN      EQU  1a         ; Changed from 1e to minimize intermittency.
00000027        00096 HOLD_MAX      EQU  27         ; Changed from 23 to minimize intermittency.
00000038        00097 HEAD_MIN      EQU  38
00000048        00098 HEAD_MAX      EQU  48
0000001F        00099 ONE_MAX       EQU  1f
0000000E        00100 ZERO_MAX      EQU  0e
                00101 ;
                00102 ;
                00103 ;
                00104 ;^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
                00105         SUBTITL "Timer Routines."
                00106 ;*************************************************************************
                00107 ; Timer servicing routine
                00108 ;    Called every 8 milliseconds this clears the
                00109 ;    watch dog, reloads the real time clock counter
                00110 ;    and keeps track of relative time.
                00111 ;
0400            00112 SvcTimer
0400 0C83       00113      movlw    MSEC8               ;TMR0 = 8 milliseconds.
0401 01C1       00114      addwf    TMR0,W              ; Add overflow amount.
0402 0021       00115      movwf    TMR0                ;       /
0403 0004       00116      clrwdt
0404 03EB       00117      incfsz   TIMER,F             ; Increment the timer, Skip to two sec
                00118                                   ; set up if it rolls over.
0405 0A08       00119      goto     CheckMatch          ; Go to other possible set ups.
0406 0559       00120      bsf      FLAG3,TWO_SEC       ; Set the 2 second flag.
                00121 ;
0407 0800       00122      retlw    0                   ; sync serviced.
0408            00123 CheckMatch                        ; 1/8 and 1/4 sec flags are staggered
                00124                                   ; for more eff use of processor time.
0408 020B       00125      movf     TIMER,W             ; Bring in the timer.
0409 0E0F       00126      andlw    b'00001111'         ; Check lower bits.
040A 0F02       00127      xorlw    d'2'                ; 1/8sec chores called when lo nibble=2.
040B 0643       00128      btfsc    STATUS,Z            ; Was the low nibble not 2?
040C 0539       00129      bsf      FLAG3,EIGTH_SEC     ; No! it was 2, Set the 1/8 sec flag.
040D 020B       00130      movf     TIMER,W             ; Bring in the timer.
040E 0E1F       00131      andlw    b'00011111'         ; Check five lower bits.
040F 0F19       00132      xorlw    0x19                ; 1/4 second chores called every 0x19.
0410 0643       00133      btfsc    STATUS,Z            ; Was the low five bits not 0x19?
0411 0519       00134      bsf      FLAG3,_4TH_SEC      ; No! it was 0x19, Set the 1/4sec flag.
0412 0800       00135      retlw    0                   ; matches checked, return.
                00136 ;
                00137 ;
                00138 ;
                00139 ;^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
                00140         SUBTITL "6121 type IR remote control reader."
                00141 ; ************************************************************************
                00142 ; The following reads the IR transmitter.
                00143 ; When the IR transmitter is being read,
                00144 ; This routine takes control of the clocks
                00145 ; and suspends all other functions.
                00146 ;
                00147 ; ************************************************************************
                00148 ; IR Receiver routine
                00149 ;
                00150 ;
                00151 ;-------------------------------------------------------------------------
                00152 ; ReadAddr
                00153 ;   This routine places the first two bytes received in temporary
                00154 ;   locations.  Normally this routine would be configured to detect
                00155 ;   weather or not the received command was ment for this equipment
                00156 ;-------------------------------------------------------------------------
0413            00157 ReadAddr
0413 0213       00158      movf     IR_BYTE13,W         ; bring in the first complete byte read
0414 003A       00159      movwf    C_BYTE_1            ; store it in the contingent first byte
```

```
0415 0214  00160      movf     IR_BYTE24,W         ; bring in the second complete byte read
0416 003B  00161      movwf    C_BYTE_2            ; store it in the contingent second byte
0417 0800  00162      retlw    0                   ; command.
           00163 ;
           00164 ;-------------------------------------------------------------------------
           00165 ; ReadCommand
           00166 ;   This routine places the third and fourth bytes in memory locations
           00167 ;   so they can be displayed.  The first two bytes are transferred from
           00168 ;   their trmporary locations to locations where they too can be
           00169 ;   displayed.  Normally this routine would be configured to decode
           00170 ;   the appropriate action from the received number.  the third and fourth
           00171 ;   bytes are always complements of each other in this format.  Typically
           00172 ;   a complementary check of these two bytes is done at this point in the IR
           00173 ;   reception
           00174 ;-------------------------------------------------------------------------
0418       00175 ReadCommand
0418 021A  00176      movf     C_BYTE_1,W      ; bring in the first complete byte read
0419 003C  00177      movwf    BYTE_1          ; store it to be disp'd as actual first byte
041A 021B  00178      movf     C_BYTE_2,W      ; bring in the first complete byte read
041B 003D  00179      movwf    BYTE_2          ; store it to be disp'd as actual 2nd byte
041C 0213  00180      movf     IR_BYTE13,W     ; bring in the third complete byte read
041D 003E  00181      movwf    BYTE_3          ; store it to be displayed as the 3rd byte
041E 0214  00182      movf     IR_BYTE24,W     ; bring in the fourth complete byte read
041F 003F  00183      movwf    BYTE_4          ; store it to be displayed as the 4th byte
0420 0598  00184      bsf      FLAG2,KEY_READY ; Good set received
0421 0A48  00185      goto     LogHold         ; Activate the hold for the first pass.
           00186 ;
           00187 ;
           00188 ;-------------------------------------------------------------------------
           00189 ; ReadReceiver
           00190 ;  Second part of the IR receier.  It takes the present count of the
           00191 ;  RTCC and subtracts the count recorded when the receiver output
           00192 ;  went high (READ_LH) to find the dark pulse duration.  In that duration
           00193 ;  will be encoded the 1, 0, HOLD, or attention.
           00194 ;-------------------------------------------------------------------------
0422       00195 ReadReceiver
0422 04B8  00196      bcf      FLAG2,LAST_IR_STATE ; Record that the IR receiver output
           00197                                   ; is now high
           00198                                   ; Calc the length of the dark pulse,
           00199                                   ; length of time receiver was high.
           00200                                   ; (placed in READ_LH)
0423 0211  00201      movf     READ_LH,W           ; bring in the start measurement
0424 0081  00202      subwf    TMR0,W              ; subtract the final from the start
0425 0031  00203      movwf    READ_LH             ; gap or pulse length is now in
           00204                                   ; READ_LH, must be checked
0426 0C83  00205      movlw    MSEC8               ; Base number of TMR0 count.
0427 0091  00206      subwf    READ_LH,W           ; Subtract the base count of TMR0
0428 0603  00207      btfsc    STATUS,C            ; skip the store and toss value if neg
0429 0031  00208      movwf    READ_LH             ; value was positive, store
           00209 ;
042A       00210 Ir6121MathDone
           00211 ;
042A 0678  00212      btfsc    FLAG2,HOLD          ; is it now looking for holds?
042B 0A40  00213      goto     LookForHold         ; look for HOLD
           00214 ;
042C 094B  00215      call     LookForAttentionGap ; look for an attention dark pulse
042D 01E2  00216      addwf    PCL,F               ; skip if a 1 was ret'd, no atten pulse
042E 0800  00217      retlw    0                   ; a 0 ret'd, ATTEN pulse found, return
           00218 ;
042F 0C1F  00219      movlw    ONE_MAX          ; Test for the max length of one.
0430 0091  00220      subwf    READ_LH,W        ; If no carry gen'd, A valid 1 is found
0431 0603  00221      btfsc    STATUS,C         ; No carry means the reading is below max
0432 0A5E  00222      goto     ResetIR          ; IR no good, Above maximum is invalid.
           00223 ;
0433 0C0E  00224      movlw    ZERO_MAX         ; Test for the max length of Zero.
0434 0091  00225      subwf    READ_LH,W        ; If no carry gen'd, A valid 0 is found.
```


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```
                00226                               ; the carry now has the newly received bit
                00227                               ; shift the bit into the proper location
                00228 ;
0435 0772       00229       btfss   IR_STATE,3      ; Every 8 states result in dest changes
0436 0333       00230       rrf     IR_BYTE13,F     ; this bit is a part of IR byte 1 or 3
0437 0672       00231       btfsc   IR_STATE,3      ;   /
0438 0334       00232       rrf     IR_BYTE24,F     ; this bit is a part of ir byte 2 or 4
                00233 ;
0439 0C01       00234       movlw   1               ; Get ready to add one to the IR STATE
043A 01F2       00235       addwf   IR_STATE,F      ; inc the state setting half carry bits
043B 0723       00236       btfss   STATUS,DC       ; skip if digit carry generated
043C 0800       00237       retlw   0               ; all done reading for now
043D 07B2       00238       btfss   IR_STATE,5      ; check to determine if the 1st and 2nd
                00239                               ; bytes or 3rd and 4th bytes are now ready
043E 0A13       00240       goto    ReadAddr        ; First and second byte ready.
043F 0A18       00241       goto    ReadCommand     ; Third and fourth byte ready.
                00242 ;
                00243 ;-------------------------------------------------------------------------
                00244 ; LookForHold
                00245 ;  Reads the length of the received dark pulse and determines if
                00246 ;  a valid HOLD pulse has been received
                00247 ;-------------------------------------------------------------------------
0440            00248 LookForHold
0440 0C1A       00249       movlw   HOLD_MIN        ; Find if between hold and one.
0441 0091       00250       subwf   READ_LH,W       ; IF no carry is gen'd, The read is between
0442 0703       00251       btfss   STATUS,C        ; HOLD and one and as such, invalid.
0443 0800       00252       retlw   0               ; Return to main routine from invalid read
0444 0C27       00253       movlw   HOLD_MAX        ; Test for the max length of HOLD.
0445 0091       00254       subwf   READ_LH,W       ; If no carry is gen'd, get a valid hold
0446 0603       00255       btfsc   STATUS,C        ;
0447 0800       00256       retlw   0
0448            00257 LogHold
0448 0578       00258       bsf     FLAG2,HOLD      ; valid HOLD received
0449 05D8       00259       bsf     FLAG2,HOLD_RCVD ; clear bit for the next hold condition
044A 0800       00260       retlw   0
                00261 ;
                00262 ;-------------------------------------------------------------------------
                00263 ; LookForAttentionGap
                00264 ;  Reads the length of the received dark pulse and determines if
                00265 ;  a valid attention pulse has been received
                00266 ;-------------------------------------------------------------------------
044B            00267 LookForAttentionGap           ; look for attention dark pulse
044B 0C38       00268       movlw   HEAD_MIN        ; Find if between head and one.
044C 0091       00269       subwf   READ_LH,W       ; IF no carry is gen'd, reading is between
044D 0703       00270       btfss   STATUS,C        ; HOLD and HEAD and as such, invalid.
044E 0A55       00271       goto    CheckIRState    ; continue, no attention gap.
044F 0C48       00272       movlw   HEAD_MAX        ; Test for the max length of HEAD.
0450 0091       00273       subwf   READ_LH,W       ; If no carry is gen'd, get a valid head.
0451 0603       00274       btfsc   STATUS,C        ; A carry = a too long gap and is invalid.
0452 0A55       00275       goto    CheckIRState    ; continue, no attention gap
0453 0072       00276       clrf    IR_STATE        ; Valid Attention dark pulse.  This command
                00277                               ; starts the state machine looking for bits
0454 0800       00278       retlw   0               ; return to main routine, ATTEN found
0455            00279 CheckIRState
0455 0CE0       00280       movlw   0e0             ; load A mask to mask all counting states
0456 0152       00281       andwf   IR_STATE,W      ; compare with present state
0457 0743       00282       btfss   STATUS,Z
0458 0800       00283       retlw   0               ; not a count state, return to main routine
0459 0801       00284       retlw   01              ; counting state, look for 1's and 0's
                00285 ;
                00286 ;-------------------------------------------------------------------------
                00287 ; RecordRTCCatLowToHiTransition
                00288 ;  First part of the IR receier.  It records the time when the
                00289 ;  output of the IR receiver went from low to high.  this creates the
                00290 ;  starting time for timing an IR pulse.
                00291 ;-------------------------------------------------------------------------
```

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```
045A       00292 RecordRTCC_atLowToHiTransition
045A 05B8  00293      bsf      FLAG2,LAST_IR_STATE ; record that IR was last in dark pulse
045B 0201  00294      movf     TMR0,W              ; bring in the clock time
045C 0031  00295      movwf    READ_LH             ; record for when it goes back low
045D 0800  00296      retlw    0
           00297 ;--------------------------------------------------------------------
           00298 ; ResetIR
           00299 ;  Resets the IR state machine to ready it for receiving IR messages.
           00300 ;--------------------------------------------------------------------
045E       00301 ResetIR
045E 0478  00302      bcf      FLAG2,HOLD          ; not seen clear the hold
045F 04D8  00303      bcf      FLAG2,HOLD_RCVD     ; clear the bit for next hold condition
0460 0072  00304      clrf     IR_STATE            ; preset IR_STATE to -1
0461 0272  00305      comf     IR_STATE,F          ;  /
0462 0800  00306      retlw    0
           00307 ;
           00308 ;********************************************************************
           00309 ; The following subroutines are called by the executive
           00310 ; every 1/8 second, every 1/4 second, and every two seconds
           00311 ;
0463       00312 EigthSecChores                     ; all that needs doing every 1/8 sec
           00313                                    ; can be placed in this subroutine
0463 0439  00314      bcf      FLAG3,EIGTH_SEC     ; clear the time out flag
           00315 ;
0464 0245  00316      comf     PORTA,W             ; bring in the requested prescale value
           00317                                    ; from the dial, reverse sense
0465 0E07  00318      andlw    7                   ; AND w/ highest possible prescale value
0466 0643  00319      btfsc    STATUS,Z            ; if zero, display hiphens
0467 0A7A  00320      goto     DisplayHiphens      ; was zero, display hiphens
0468 002C  00321      movwf    TEMP                ; place in temporary storage
0469 00EC  00322      decf     TEMP,F              ; dec, dial settings 1 to 4 are valid
046A 064C  00323      btfsc    TEMP,2              ; if bit2 is set dial is 5 or higher
046B 0A7A  00324      goto     DisplayHiphens      ; dial is above 5, display hiphens
046C 0C1C  00325      movlw    BYTE_1
046D 01CC  00326      addwf    TEMP,W              ; add in dial setting (between 0 and 3)
046E 0024  00327      movwf    FSR                 ; place in pointer register.
           00328                                    ; NOTE! FSR bits5,6 = clear, File page1
           00329 ;
046F 04A3  00330      bcf      STATUS,PA0          ; get ready to call from page 1
0470 04C3  00331      bcf      STATUS,PA1          ;  /
           00332 ;
0471 0380  00333      swapf    INDF,W              ; bring in IR measurement to be disp'd
0472 0900  00334      call     LookUpDigit
0473 002E  00335      movwf    LEFT_DIGIT          ; display more significant digit
           00336 ;
0474 0200  00337      movf     INDF,W              ; bring in IR measurement to be disp'd
0475 0900  00338      call     LookUpDigit
0476 002F  00339      movwf    RIGHT_DIGIT         ; display less significant digit
           00340 ;
           00341  if BeginIr6121==200               ; return the bits to this page
           00342      bsf      STATUS,PA0          ; page 1
           00343      bcf      STATUS,PA1          ; /
           00344  endif
           00345  if BeginIr6121==400
0477 04A3  00346      bcf      STATUS,PA0          ; page 2
0478 05C3  00347      bsf      STATUS,PA1          ; /
           00348  endif
           00349  if BeginIr6121==600
           00350      bsf      STATUS,PA0          ; page 3
           00351      bsf      STATUS,PA1          ; /
           00352  endif
           00353 ;
0479 0800  00354      retlw    0
047A       00355 DisplayHiphens
047A 0CBF  00356      movlw    HIPHEN              ; dial not in range, display hiphens
047B 002E  00357      movwf    LEFT_DIGIT          ; / Hiphen in left digit
```


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```
047C 002F  00358      movwf    RIGHT_DIGIT         ; / Hiphen in right digit
047D 0800  00359      retlw    0
           00360 ;
047E       00361 QuarterSecChores                  ; all that needs doing every 1/4 second
           00362                                   ; can be placed in this subroutine
047E 0678  00363      btfsc    FLAG2,HOLD          ; Check for HOLD condition still valid
047F 06D8  00364      btfsc    FLAG2,HOLD_RCVD     ; Check to see if a hold pulse has been
           00365                                   ; seen in the last 1/4 second
0480 02A2  00366      incf     PCL,F
0481 095E  00367      call     ResetIR             ; reset the IR state machine and get
           00368                                   ; ready for next
0482 04D8  00369      bcf      FLAG2,HOLD_RCVD     ; Clear the hold received flag, it is
           00370                                   ; to be set by IR controller
           00371 ;
0483 0419  00372      bcf      FLAG3,_4TH_SEC      ; clear the 1/4 second time out
0484 0800  00373      retlw    0
           00374 ;
0485       00375 TwoSecChores                      ; things done every two seconds
0485 0C0F  00376      movlw    A_CONFIG            ; setup for PORTA, in loop so
           00377                                   ; microcontroller will never forget
0486 0005  00378      tris     PORTA               ; inputs are on bits 0,1, and 2.
0487 0C3F  00379      movlw    B_CONFIG            ; PORTB inputs are not used,
0488 0006  00380      tris     PORTB               ; PORTB outputs control digit drives
0489 0C00  00381      movlw    C_CONFIG2
048A 0007  00382      tris     PORTC               ; PORTC is all outputs
048B 0498  00383      bcf      FLAG2,KEY_READY     ; Routine that would interpret the key
           00384                                   ; will clear the flag that says it is
           00385                                   ; ready
048C 0459  00386      bcf      FLAG3,TWO_SEC       ; clear the two second time out
048D 0800  00387      retlw    0
           00388 ;
           00389 ;
           00390 ;*************************************************************************
           00391 ;         Start HERE.
           00392 ;*************************************************************************
048E       00393 StartIr6121
048E 0985  00394      call     TwoSecChores        ; re-setup ports A, B, and C
           00395 ;
048F 0C05  00396      movlw    OPTION_CODE         ;SET UP PRESCALER, WDT on 18msec.
0490 0002  00397      option                       ;Clock TMR0 every 64 instruc cycles.
           00398 ;
0491 0078  00399      clrf     FLAG2               ; Clear out flag bank 2.
0492 0079  00400      clrf     FLAG3               ; Clear out flag bank 3.
           00401 ;
0493 0CFF  00402      movlw    0ff                 ; Display FF at start up
0494 003C  00403      movwf    BYTE_1              ; first byte = FF
0495 003D  00404      movwf    BYTE_2              ; second = FF
0496 003E  00405      movwf    BYTE_3              ; third = FF
0497 003F  00406      movwf    BYTE_4              ; fourth byte = FF
           00407 ;
0498 0C83  00408      movlw    MSEC8               ;TMR0 = 8 mSEC
0499 0021  00409      movwf    TMR0                ;       /
           00410 ;
049A 095E  00411      call     ResetIR             ; get the IR ready to receive
049B 05B8  00412      bsf      FLAG2,LAST_IR_STATE ; preset the IR flag for a
           00413                                   ; RecordRTCCatLowToHiTransition
049C 04A4  00414      bcf      FSR,5               ; File page 1
049D 04C4  00415      bcf      FSR,6               ; /
           00416 ;
           00417 ;************ Main loop Starts here. *************
049E       00418 IRMain
           00419 ;
           00420 ;
049E       00421 IRInnerLoop
049E 0665  00422      btfsc    PORTA,IR            ; ?IR rcvr not receiving an IR burst?
049F 06B8  00423      btfsc    FLAG2,LAST_IR_STATE ; was it receiving a burst last time?
```

```
04A0 02A2  00424      incf     PCL,F               ; Not either
04A1 095A  00425      call     RecordRTCC_atLowToHiTransition
           00426                                   ; Record the TMR0 value when the lo to
           00427                                   ; hi transition came from the receiver
           00428 ;
04A2 0765  00429      btfss    PORTA,IR            ; ?IR receiver receiving an IR burst?
04A3 07B8  00430      btfss    FLAG2,LAST_IR_STATE ; was it not rcv'g a burst last time?
04A4 02A2  00431      incf     PCL,f               ; Not either
04A5 0922  00432      call     ReadReceiver        ; read the new information
           00433
04A6 0C83  00434      movlw    MSEC8               ; Check for overflow.
04A7 0081  00435      subwf    TMR0,W              ; SEE IF TMR0 < MSEC8,
04A8 0603  00436      btfsc    STATUS,C            ; If TMR0 < MSEC8, Overflow.
04A9 0A9E  00437      goto     IRInnerLoop         ; No overflow, no carry, loop.
04AA 0900  00438      call     SvcTimer            ; Keep time and reload time keeper.
           00439 ;
04AB 04A3  00440      bcf      STATUS,PA0          ; get ready to call from page 1
04AC 04C3  00441      bcf      STATUS,PA1          ;  /
04AD 0912  00442      call     UpdateDisplay       ; rotate power to next display digit
           00443 ;
           00444  if BeginIr6121==200             ; return the bits to this page
           00445      bsf      STATUS,PA0          ; page 1
           00446      bcf      STATUS,PA1          ; /
           00447  endif
           00448  if BeginIr6121==400
04AE 04A3  00449      bcf      STATUS,PA0          ; page 2
04AF 05C3  00450      bsf      STATUS,PA1          ; /
           00451  endif
           00452  if BeginIr6121==600
           00453      bsf      STATUS,PA0          ; page 3
           00454      bsf      STATUS,PA1          ; /
           00455  endif
           00456 ;
04B0 07C6  00457      btfss     PORTB,RIGHT_OFF    ; Is display ready to display HOLD?
04B1 0778  00458      btfss     FLAG2,HOLD         ; IS the hold active?
04B2 0AB4  00459      goto      NotHold            ; do not turn on lite for HOLD indicate
04B3 04E7  00460      bcf       PORTC,DP           ; TURN on LED flag, show HOLD is active
04B4       00461 NotHold
           00462 ;
04B4 0639  00463      btfsc     FLAG3,EIGTH_SEC    ; check for 1/8 second time out
04B5 0963  00464      call      EigthSecChores     ; all that needs doing every 1/8 second
           00465                                  ; can go in this subroutine
           00466 ;
04B6 0619  00467      btfsc     FLAG3,_4TH_SEC     ; check for 1/4 second time out
04B7 097E  00468      call      QuarterSecChores   ; all that needs doing every 1/4sec
           00469                                  ; can go in this subroutine
           00470 ;
04B8 0659  00471      btfsc     FLAG3,TWO_SEC      ; check for two second time out
04B9 0985  00472      call      TwoSecChores       ; all that needs doing every two secs
           00473                                  ; can go in this subroutine
           00474
04BA 0A9E  00475      goto      IRMain
           00476 ;
0600       00199      org       600
0600       00200 BeginTeknika
           00201      include        "teknika.asm"
           00001           TITLE        "IR-Technica TV format Remote Control Detector V0.01"
           00002           SUBTITL      "Comments documentation and history"
           00003 ;
           00004 ;*****************************************************************
           00005 ; File Name :      TEKNIKA.ASM
           00006 ;*****************************************************************
           00007 ;      Author:    William G. Grimm
           00008 ;      Company:   Microchip Technology
           00009 ;      Revision:  V0.01
           00010 ;      Date:      March 31, 1996
```


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00011 ;      Assembler: MPASM version 1.21
00012 ;
00013 ;***************************************************************************
00014 ;   Revision History:
00015 ;
00016 ;
00017 ;   V0.01    Original  March 28, 1996
00018 ;
00019 ;   V0.02    repaired bug that kept HOLD from operating
00020 ;            March 31, 1996
00021 ;
00022 ;   V0.03    modified gpa and pulse length subtraction
00023 ;            March 31, 1996
00024 ;
00025 ;***************************************************************************
00026 ;   OPTION_CODE   EQU    B'00000101'     ;SET UP PRESCALER, WDT on 18msec.
00027 ;              Same as IR6121
00028 ;***************************************************************************
00029 ;
00030 ;***************************************************************************
00031 ; file memory location definitions
00032 ;***************************************************************************
00033 ;
00034 ;  full byte file memory locations
00035 ;            (those commented out are defined in IR6121 or IRMAIN)
00036 ;
00037 ;    TIMER         EQU   0b    ; Bit5 = 1/4 second, Bit1 = 16 millisecs.
0000000C 00038      BUTTON        EQU   0c    ; holds last value of last button pressed
00039 ;
00040
00041 ;    RIGHT_DIGIT   EQU   0f        ; defined in irmain
00042 ;    READ_LH       EQU   11        ; Low to high reading is stored here.
00043 ;    IR_STATE      EQU   12        ; Which bit is coming in.
00044 ;    IR_BYTE13     EQU   13        ; First byte for collecting inputs.
00045 ;    IR_BYTE24     EQU   14        ; Second byte for collecting inputs.
00046 ;
00047 ;    FLAG2         EQU   18        ; flag bank 2
00048 ;    FLAG3         EQU   19        ; flag bank 3
00049 ;
00050 ;DEFINE FLAG2 REG FUNCTION:
00051 ;       BIT # 7|6|5|4|3|2|1|0|
00052 ;--------------|-|-|-|-|-|-|-|-|
00053 ;              | | | | | | |Y| --> Command Ready.
00054 ;              | | | | | |Y| | --> Command in process.
00055 ;              | | | | |Y| | | --> Most Significant bit of time stamp.
00056 ;              | | | |Y| | | | --> HOLD is active
00057 ;              | | |Y| | | | | --> 4 bytes have been rcv'd successfully
00058 ;              | |Y| | | | | | --> Value of last IR bit received.
00059 ;              |Y| | | | | | | --> A Valid hold received < 1/4 sec ago.
00060 ;             Y| | | | | | | | -->
00061 ; Y = DEFINED AS SHOWN (0/1)
00062 ;   (commented definitions are defined elsewhere)
00063 ;HOLD_RCVD     EQU 6
00064 ;LAST_IR_STATE EQU 5
00065 ;KEY_READY     EQU 4
00066 ;HOLD          EQU 3
00067 ;STAMP_MSB     EQU 2
00068 ;CMD_PEND      EQU 1               ; A channel command is pending.
00069 ;CMD_RDY       EQU 0               ; A channel command is ready.
00070 ;
00071 ;DEFINE FLAG3 REG FUNCTION:
00072 ;       BIT # 7|6|5|4|3|2|1|0|
00073 ;--------------|-|-|-|-|-|-|-|-|
00074 ;              | | | | | | |Y| --> Quarter second flag.
00075 ;              | | | | | |Y| | --> Eighth second flag.
00076 ;              | | | | |Y| | | --> Two second flag.
```

```
           00077 ;              | | | |Y| | | | --> A channel up has been received
           00078 ;              | | |Y| | | | | --> A Channel Down has been received
           00079 ;              | |Y| | | | | | -->
           00080 ;              |Y| | | | | | | -->
           00081 ;             Y| | | | | | | | -->
           00082 ; Y = DEFINED AS SHOWN (0/1)
           00083 ;   (commented definitions are defined elsewhere)
           00084 ;
           00085 ;_4TH_SEC      EQU 0
           00086 ;EIGTH_SEC     EQU 1
           00087 ;TWO_SEC       EQU 2
00000003   00088 ACTIVE_UP      EQU 3
00000004   00089 ACTIVE_DOWN    EQU 4
           00090 ;
           00091 ;^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
           00092         SUBTITL "Constant definitions."
           00093 ;*************************************************************************
           00094 ; Gap length IR decoding time constants.  Values were derived from
           00095 ; successive readings made with MEASURE.ASM
           00096 ;  (commented defines are characterisitic of all 6121 remotes
           00097 ;   and are defined in IR6121)
           00098 ;HOLD_MIN     EQU  1a        ; Changed from 1e to minimize intermittency.
           00099 ;HOLD_MAX     EQU  27        ; Changed from 23 to minimize intermittency.
           00100 ;HEAD_MIN     EQU  38
           00101 ;HEAD_MAX     EQU  48
           00102 ;ONE_MAX      EQU  1f
           00103 ;ZERO_MAX     EQU  0e
           00104 ;
           00105 ;
           00106 ;  Definitions characteristic of Teknika TV remote controls
00000014   00107 ID_BYTE_1     EQU  14              ; Teknika signature byte 1
000000EB   00108 ID_BYTE_2     EQU  0eb             ; Teknika signature byte 2
           00109 ;
00000000   00110 TEK_ZERO      EQU  000             ; #0
00000001   00111 TEK_ONE       EQU  001             ; #1
00000002   00112 TEK_TWO       EQU  002             ; #2
00000003   00113 TEK_THREE     EQU  003             ; #3
00000008   00114 TEK_FOUR      EQU  008             ; #4
00000009   00115 TEK_FIVE      EQU  009             ; #5
0000000A   00116 TEK_SIX       EQU  00a             ; #6
0000000B   00117 TEK_SEVEN     EQU  00b             ; #7
00000010   00118 TEK_EIGHT     EQU  010             ; #8
00000011   00119 TEK_NINE      EQU  011             ; #9
0000001B   00120 TEK_ON_OFF    EQU  01b             ; ON/OFF
0000001A   00121 TEK_MUTE      EQU  01a             ; Mute button
00000013   00122 TEK_CHUP      EQU  013             ; CHUP Clockwise
00000012   00123 TEK_CHDN      EQU  012             ; CHDN Counter Clockwise
           00124 ;
           00125 ;^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
           00126         SUBTITL "Timer Routines."
           00127 ;*************************************************************************
           00128 ; Timer servicing routine
           00129 ;    Called every 8 milliseconds, this clears the
           00130 ;    watch dog, reloads TMR0
           00131 ;    and keeps track of relative time.
           00132 ;
0600       00133 TekServiceTimer
0600 0C83  00134      movlw    MSEC8             ;TMR0 = 8 milliseconds.
0601 01C1  00135      addwf    TMR0,W            ; Add overflow amount.
0602 0021  00136      movwf    TMR0              ;       /
0603 0004  00137      clrwdt
0604 03EB  00138      incfsz   TIMER,F           ; Increment the timer, Skip to two second
           00139                                 ; set up if it rolls over.
0605 0A08  00140      goto     TekCheckMatch     ; Go to other possible setups.
0606 0559  00141      bsf      FLAG3,TWO_SEC     ; Set the two second flag.
           00142 ;
```


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```
0607 0800        retlw    0                  ; sync serviced.
0608       TekCheckMatch                     ; 1/8 and 1/4 second flags are staggered
                                             ; make more efficient use of processor time
0608 020B        movf     TIMER,W            ; Bring in the timer.
0609 0E0F        andlw    b'00001111'        ; Check lower bits.
060A 0F02        xorlw    d'2'               ; 1/8sec chores called when low nibble=2.
060B 0643        btfsc    STATUS,Z           ; Was the low nibble not 2?
060C 0539        bsf      FLAG3,EIGTH_SEC    ; No! it was 2, Set the 1/8 sec flag.
060D 020B        movf     TIMER,W            ; Bring in the timer.
060E 0E1F        andlw    b'00011111'        ; Check five lower bits.
060F 0F19        xorlw    0x19               ; 1/4 second chores called every 0x19.
0610 0643        btfsc    STATUS,Z           ; Was the low five bits not 0x19?
0611 0519        bsf      FLAG3,_4TH_SEC     ; No! it was 0x19, Set the 1/4 sec flag.
0612 0800        retlw    0                  ; matches checked, return.
           ;
           ;
           ;
           ;^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
                  SUBTITL "6121 type IR remote control reader."
           ; *******************************************
           ; The following reads the IR transmitter.
           ; When the IR transmitter is being read,
           ; this routine takes control of the clocks
           ; and suspends all other functions.
           ;
           ; ********************************************
           ; IR Receiver routine
           ;
           ;
           ;---------------------------------------------------------------------------
           ; TekRdAddr
           ;   This routine determines whether a Teknika remote control is
           ;   sending the command.
           ;---------------------------------------------------------------------------
0613       TekRdAddr
0613 0C14        movlw    ID_BYTE_1      ; bring in what would be the first byte
0614 0193        xorwf    IR_BYTE13,W    ; compare with the byte that came in first
0615 0743        btfss    STATUS,Z       ; if the same, the zero bit is set
0616 0A82        goto     TekIRReset     ; wrong ID, reset the IR state
0617 0CEB        movlw    ID_BYTE_2      ; bring in what would be the second byte
0618 0194        xorwf    IR_BYTE24,W    ; compare with the byte that came in 2nd
0619 0743        btfss    STATUS,Z       ; if the same, the zero bit is set
061A 0A82        goto     TekIRReset     ; wrong ID, reset the IR state
061B 0800        retlw    0              ; Success! A Teknika remote sent the command
           ;
           ;---------------------------------------------------------------------------
           ; RD_COMMAND
           ;   This routine determines what kind of command was sent, and places
           ;   the result in BUTTON or one of the channel up or down flags.
           ;---------------------------------------------------------------------------
061C       TekRdCommand
061C 0253        comf     IR_BYTE13,W         ; Byte3 must be the complement of Byte4
061D 0194        xorwf    IR_BYTE24,W         ; For a valid command.
061E 0743        btfss    STATUS,Z            ; If the same, skip to continue.
061F 0A82        goto     TekIRReset          ; not complements, not valid.
           ;
0620 0C13        movlw    TEK_CHUP            ; check for a channel up command
0621 0193        xorwf    IR_BYTE13,W         ; compare with byte 3
0622 0643        btfsc    STATUS,Z            ; skip if no match
0623 0579        bsf      FLAG3,ACTIVE_UP     ; active channel up
0624 0643        btfsc    STATUS,Z            ; skip again if no active channel up
0625 0A39        goto     TekLogCommand
           ;
0626 0C12        movlw    TEK_CHDN            ; check for a channel down command
0627 0193        xorwf    IR_BYTE13,W         ; compare with byte 3
0628 0643        btfsc    STATUS,Z            ; skip if no match
```

```
0629 0599  00209      bsf      FLAG3,ACTIVE_DOWN   ; active channel down
062A 0643  00210      btfsc    STATUS,Z            ; skip again if no active channel down
062B 0A39  00211      goto     TekLogCommand
           00212 ;
062C 0C0A  00213      movlw    d'10'               ; Look for ten possible buttons.
062D 0034  00214      movwf    IR_BYTE24           ; IR_BYTE24 is converted for use as
           00215                                  ; a counter.
062E       00216 GuessLoop
062E 00F4  00217      decf     IR_BYTE24,F         ; decrement to next button to look for
062F 0254  00218      comf     IR_BYTE24,W         ; See if it rolled over to FF
0630 0643  00219      btfsc    STATUS,Z            ; If rollover, this not a valid command.
0631 0A39  00220      goto     TekLogCommand       ; not a listed button return.
0632 0214  00221      movf     IR_BYTE24,W         ; Bring in the counter, which is a
           00222                                  ; guess as to what the button is.
0633 093B  00223      call     TekTable            ; NO! Get the code for guessed value
0634       00224 CheckGuess                       ; for dog biscuit
0634 0193  00225      xorwf    IR_BYTE13,W         ; look for a match with the guess and
           00226                                  ; actual value which is in IR_BYTE13.
0635 0743  00227      btfss    STATUS,Z            ; If it matchs skip and stop looping.
0636 0A2E  00228      goto     GuessLoop           ; No match.  Guess again.
0637       00229 TekLogButton
0637 0214  00230      movf     IR_BYTE24,W         ; bring in the count
0638 002C  00231      movwf    BUTTON              ; it has the new button number
0639       00232 TekLogCommand
0639 0598  00233      bsf      FLAG2,KEY_READY     ; Good set received
063A 0A6C  00234      goto     TekLogHold          ; Activate the hold for the first pass.
           00235 ;
063B       00236 TekTable
063B 01E2  00237      addwf    PCL,F               ; Computed jump for look-up table.
063C 0800  00238      retlw    TEK_ZERO            ; #0
063D 0801  00239      retlw    TEK_ONE             ; #1
063E 0802  00240      retlw    TEK_TWO             ; #2
063F 0803  00241      retlw    TEK_THREE           ; #3
0640 0808  00242      retlw    TEK_FOUR            ; #4
0641 0809  00243      retlw    TEK_FIVE            ; #5
0642 080A  00244      retlw    TEK_SIX             ; #6
0643 080B  00245      retlw    TEK_SEVEN           ; #7
0644 0810  00246      retlw    TEK_EIGHT           ; #8
0645 0811  00247      retlw    TEK_NINE            ; #9
           00248 ;
           00249 ;
           00250 ;--------------------------------------------------------------------------
           00251 ; TekRdRcvr
           00252 ;  Second part of the IR receiver.  It takes the present count of
           00253 ;  TMR0 and subtracts the count recorded when the receiver output
           00254 ;  went high (READ_LH) to find the dark pulse duration.  In that duration
           00255 ;  will be encoded the 1, 0, HOLD, or attention.
           00256 ;--------------------------------------------------------------------------
0646       00257 TekRdRcvr
0646 04B8  00258      bcf      FLAG2,LAST_IR_STATE ; Record that the IR rcvr output
           00259                                  ; is now high
           00260                                  ; Calculate length of the dark pulse,
           00261                                  ; length of time receiver was high.
           00262                                  ; (placed in READ_LH)
0647 0211  00263      movf     READ_LH,W           ; bring in the start measurement
0648 0081  00264      subwf    TMR0,W              ; subtract the final from the start
0649 0031  00265      movwf    READ_LH             ; gap or pulse length is now in
           00266                                  ; READ_LH, must be checked
064A 0C83  00267      movlw    MSEC8               ; Base number of TMR0 count.
064B 0091  00268      subwf    READ_LH,W           ; Subtract the base count of TMR0
064C 0603  00269      btfsc    STATUS,C            ; skip the store and toss value if neg
064D 0031  00270      movwf    READ_LH             ; value was positive, store
           00271 ;
064E       00272 TekMathDone
           00273 ;
064E 0678  00274      btfsc    FLAG2,HOLD          ; is it now looking for holds?
```


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```
064F 0A64  00275      goto     TekLookHold         ; look for HOLD
           00276 ;
0650 096F  00277      call     TekLookAtten        ; look for an attention dark pulse
0651 01E2  00278      addwf    PCL,F               ; skip if 1 was ret'd, no atten pulse
0652 0800  00279      retlw    0                   ; a 0 ret'd, ATTEN pulse found, return
           00280 ;
0653 0C1F  00281      movlw    ONE_MAX             ; Test for the max length of one.
0654 0091  00282      subwf    READ_LH,W           ; If no carry is gen'd, get a valid one
0655 0603  00283      btfsc    STATUS,C            ; No carry means the read is below max
0656 0A82  00284      goto     TekIRReset          ; IR no good, Above maximum is invalid.
           00285 ;
0657 0C0E  00286      movlw    ZERO_MAX            ; Test for the max length of Zero.
0658 0091  00287      subwf    READ_LH,W           ; If no carry is gen'd, get a valid 0.
           00288                                  ; the carry now has the newly rcv'd bit
           00289                                  ; shift the bit into the proper location
           00290 ;
0659 0772  00291      btfss    IR_STATE,3          ; Every 8 states gives dest changes
065A 0333  00292      rrf      IR_BYTE13,F         ; this bit is a part of IR byte 1 or 3
065B 0672  00293      btfsc    IR_STATE,3          ;   /
065C 0334  00294      rrf      IR_BYTE24,F         ; this bit is a part of ir byte 2 or 4
           00295 ;
065D 0C01  00296      movlw    1                   ; Get ready to add one to the IR STATE
065E 01F2  00297      addwf    IR_STATE,F          ; inc the state setting half carry bits
065F 0723  00298      btfss    STATUS,DC           ; skip if digit carry generated
0660 0800  00299      retlw    0                   ; all done reading for now
0661 07B2  00300      btfss    IR_STATE,5          ; check to determine if the 1st and 2nd
           00301                                  ; bytes or 3rd and 4th bytes now ready
0662 0A13  00302      goto     TekRdAddr           ; First and second byte ready.
0663 0A1C  00303      goto     TekRdCommand        ; Third and fourth byte ready.
           00304 ;
           00305 ;--------------------------------------------------------------------
           00306 ; LOOK_HOLD
           00307 ;  Reads the length of the received dark pulse and determines if
           00308 ;  a valid HOLD pulse has been received
           00309 ;--------------------------------------------------------------------
0664       00310 TekLookHold
0664 0C1A  00311      movlw    HOLD_MIN          ; Find if between hold and one.
0665 0091  00312      subwf    READ_LH,W         ; IF no carry is gen'd, The read is between
0666 0703  00313      btfss    STATUS,C          ; HOLD and one and as such, invalid.
0667 0800  00314      retlw    0                 ; Ret to main routine from invalid read.
0668 0C27  00315      movlw    HOLD_MAX          ; Test for the max length of HOLD.
0669 0091  00316      subwf    READ_LH,W         ; If no carry is gen'd, get a valid hold.
066A 0603  00317      btfsc    STATUS,C          ;
066B 0800  00318      retlw    0
066C       00319 TekLogHold
066C 0578  00320      bsf      FLAG2,HOLD        ; valid HOLD received
066D 05D8  00321      bsf      FLAG2,HOLD_RCVD   ; clear bit for the next hold condition
066E 0800  00322      retlw    0
           00323 ;
           00324 ;--------------------------------------------------------------------
           00325 ; LOOK_ATTEN
           00326 ;  Reads the length of the received dark pulse and determines if
           00327 ;  a valid attention pulse has been received
           00328 ;--------------------------------------------------------------------
066F       00329 TekLookAtten                     ; look for attention dark pulse
066F 0C38  00330      movlw    HEAD_MIN          ; Find if between head and one.
0670 0091  00331      subwf    READ_LH,W         ; IF no carry is gen'd, Reading between
0671 0703  00332      btfss    STATUS,C          ; HOLD and HEAD and as such, invalid.
0672 0A79  00333      goto     TekCheckState     ; continue, no attention gap.
0673 0C48  00334      movlw    HEAD_MAX          ; Test for the max length of HEAD.
0674 0091  00335      subwf    READ_LH,W         ; If no carry is gen'd, get a valid head
0675 0603  00336      btfsc    STATUS,C          ; A carry = a too long gap = invalid.
0676 0A79  00337      goto     TekCheckState     ; continue, no attention gap
0677 0072  00338      clrf     IR_STATE          ; Valid Atten dark pulse. Command starts
           00339                                  ; the state machine looking for bits.
0678 0800  00340      retlw    0                 ; return to main routine, ATTEN found
```

```
0679       00341 TekCheckState
0679 0CE0  00342      movlw    0e0                ; load A mask to mask all count states
067A 0152  00343      andwf    IR_STATE,W         ; compare with present state
067B 0743  00344      btfss    STATUS,Z
067C 0800  00345      retlw    0                  ; not a count state, ret to main routine
067D 0801  00346      retlw    01                 ; counting state, look for 1's and 0's
           00347 ;
           00348 ;-------------------------------------------------------------------
           00349 ; RECORD_LH
           00350 ;  First part of the IR receiver.  It records the time when the
           00351 ;  output of the IR receiver went from low to high.  this creates the
           00352 ;  starting time for timing an IR pulse.
           00353 ;-------------------------------------------------------------------
067E       00354 TekRecordLH
067E 05B8  00355      bsf      FLAG2,LAST_IR_STATE ; record that IR was last in dark pulse
067F 0201  00356      movf     TMR0,W              ; bring in the clock time
0680 0031  00357      movwf    READ_LH             ; record for when it goes back low
0681 0800  00358      retlw    0
           00359 ;-------------------------------------------------------------------
           00360 ; TekIRReset
           00361 ;  Resets the IR state machine to ready it for receiving IR messages.
           00362 ;-------------------------------------------------------------------
0682       00363 TekIRReset
0682 0478  00364      bcf      FLAG2,HOLD          ; not seen clear the hold
0683 04D8  00365      bcf      FLAG2,HOLD_RCVD     ; clear bit for the next hold condition
0684 0479  00366      bcf      FLAG3,ACTIVE_UP     ; clear channel up if present
0685 0499  00367      bcf      FLAG3,ACTIVE_DOWN   ; clear channel down if present
0686 0072  00368      clrf     IR_STATE            ; preset IR_STATE to -1
0687 0272  00369      comf     IR_STATE,F          ;  /
0688 0800  00370      retlw    0
           00371 ;
           00372 ;-------------------------------------------------------------------
           00373 ; TekSvcHold
           00374 ;  Uses the HOLD to increment or decrement the BUTTON number.
           00375 ;-------------------------------------------------------------------
0689       00376 TekSvcHold
0689 0679  00377      btfsc    FLAG3,ACTIVE_UP     ; is Channel up now present?
068A 0A8E  00378      goto     IncButton           ; Yes, increment button
068B 0699  00379      btfsc    FLAG3,ACTIVE_DOWN   ; is Channel Down now present?
068C 0A94  00380      goto     DecButton           ; Yes, Decrement button
068D 0800  00381      retlw    0                   ; neither now active
068E       00382 IncButton
068E 02AC  00383      incf     BUTTON,F            ; increment button
068F 0C0A  00384      movlw    d'10'               ;
0690 008C  00385      subwf    BUTTON,W            ; Compare with 10
0691 0603  00386      btfsc    STATUS,C            ; is BUTTON < 10?
0692 006C  00387      clrf     BUTTON              ; No recycle
0693 0800  00388      retlw    0
0694       00389 DecButton
0694 00EC  00390      decf     BUTTON,F            ; Decrement button
0695 024C  00391      comf     BUTTON,W            ; Roll to FF?
0696 0743  00392      btfss    STATUS,Z            ; ship if roll over
0697 0800  00393      retlw    0
0698 0C09  00394      movlw    d'9'                ; recycle on zero
0699 002C  00395      movwf    BUTTON              ;  /
069A 0800  00396      retlw    0
           00397 ;
           00398 ;*******************************************************************
           00399 ; The following subroutines are called by the executive
           00400 ; every 1/8 second, every 1/4 second, and every two seconds
           00401 ;
069B       00402 TekEigthSec                      ; all that needs doing every 1/8 sec
           00403                                  ; can be placed in this subroutine
069B 0439  00404      bcf      FLAG3,EIGTH_SEC     ; clear the time out flag
           00405 ;
069C 0800  00406      retlw    0
```


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```
          00407 ;
069D      00408 TekQuarterSec                    ; all that needs doing every 1/4 second
          00409                                  ; can be placed in this subroutine
069D 0678 00410      btfsc    FLAG2,HOLD         ; Check for HOLD condition still valid
069E 06D8 00411      btfsc    FLAG2,HOLD_RCVD    ; Check to see if a hold pulse has been
          00412                                  ; seen in the last 1/4 second
069F 02A2 00413      incf     PCL,F
06A0 0982 00414      call     TekIRReset         ; reset the IR state machine and get
          00415                                  ; ready for next
06A1 04D8 00416      bcf      FLAG2,HOLD_RCVD    ; Clear the hold received flag, it is
          00417                                  ; to be set by IR controller
06A2 0678 00418      btfsc    FLAG2,HOLD         ; check for active hold
06A3 0989 00419      call     TekSvcHold         ; service the hold function
          00420 ;
06A4 0419 00421      bcf      FLAG3,_4TH_SEC     ; clear the 1/4 second time-out
06A5 0800 00422      retlw    0
          00423 ;
06A6      00424 TekTwoSec                        ; things done every two seconds
06A6 0C0F 00425      movlw    A_CONFIG           ; setup for PORTA in loop, so
          00426                                  ; microcontroller will never forget
06A7 0005 00427      tris     PORTA              ; inputs are on bits 0,1, and 2.
06A8 0C3F 00428      movlw    B_CONFIG           ; PORTB inputs are not used,
06A9 0006 00429      tris     PORTB              ; PORTB outputs control digit drives
06AA 0C00 00430      movlw    C_CONFIG2
06AB 0007 00431      tris     PORTC              ; PORTC is all outputs
06AC 0498 00432      bcf      FLAG2,KEY_READY    ; Routine that would interpret the key
          00433                                  ; will clear the flag that says it is
          00434                                  ; ready
06AD 0459 00435      bcf      FLAG3,TWO_SEC      ; clear the two second time-out
06AE 0800 00436      retlw    0
          00437 ;
          00438 ;
          00439 ;*************************************************************************
          00440 ;         Start HERE.
          00441 ;*************************************************************************
06AF      00442 StartTek
06AF 09A6 00443      call     TekTwoSec          ; re-setup ports A and B
          00444 ;
06B0 0C05 00445      movlw    OPTION_CODE        ;SET UP PRESCALER, WDT on 18msec.
06B1 0002 00446      option                      ;Clock TMR0 every 64 inst cycles.
          00447 ;
06B2 0078 00448      clrf     FLAG2              ; Clear out flag bank 2.
06B3 0079 00449      clrf     FLAG3              ; Clear out flag bank 3.
06B4 006C 00450      clrf     BUTTON             ; Displays Zero on reset
          00451 ;
          00452 ;
06B5 0C83 00453      movlw    MSEC8              ;TMR0 = 8 mSEC
06B6 0021 00454      movwf    TMR0               ;       /
          00455 ;
06B7 0982 00456      call     TekIRReset         ; get the IR ready to receive
06B8 05B8 00457      bsf      FLAG2,LAST_IR_STATE ; preset the IR flag for a RECORD_LH
          00458 ;
06B9 04A4 00459      bcf      FSR,5              ; File page 1
06BA 04C4 00460      bcf      FSR,6              ; /
          00461 ;
          00462 ;************ Main loop Starts here. *************
06BB      00463 TekMain
          00464 ;
          00465 ;
06BB      00466 TekInnerLoop
06BB 0665 00467      btfsc    PORTA,IR           ; ?IR receiver not rcv'g an IR burst?
06BC 06B8 00468      btfsc    FLAG2,LAST_IR_STATE ; was it receiving a burst last time?
06BD 02A2 00469      incf     PCL,F              ; Not either
06BE 097E 00470      call     TekRecordLH        ; Record the TMR0 value when the lo to
          00471                                  ; hi transition came from the receiver
          00472 ;
```

```
06BF 0765  00473      btfss    PORTA,IR            ; ?IR receiver receiving an IR burst?
06C0 07B8  00474      btfss    FLAG2,LAST_IR_STATE ; was it not rcv'g a burst last time?
06C1 02A2  00475      incf     PCL,F               ; Not either
06C2 0946  00476      call     TekRdRcvr           ; read the new information
           00477
06C3 0C83  00478      movlw    MSEC8               ; Check for overflow.
06C4 0081  00479      subwf    TMR0,W              ; SEE IF TMR0 < MSEC8,
06C5 0603  00480      btfsc    STATUS,C            ; If TMR0 < MSEC8, Overflow.
06C6 0ABB  00481      goto     TekInnerLoop        ; No overflow, no carry, loop.
06C7 0900  00482      call     TekServiceTimer     ; Keep time and reload time keeper.
           00483 ;
06C8 04A3  00484      bcf      STATUS,PA0          ; get ready to call from page 1
06C9 04C3  00485      bcf      STATUS,PA1          ;  /
           00486 ;
06CA 020C  00487      movf     BUTTON,W            ; get the IR measurement to be disp'd
06CB 0900  00488      call     LookUpDigit
06CC 0027  00489      movwf    PORTC               ; display on Right digit
           00490 ;
           00491  if BeginTeknika==200            ; return the bits to this page
           00492      bsf      STATUS,PA0          ; page 1
           00493      bcf      STATUS,PA1          ; /
           00494  endif
           00495  if BeginTeknika==400
           00496      bcf      STATUS,PA0          ; page 2
           00497      bsf      STATUS,PA1          ; /
           00498  endif
           00499  if BeginTeknika==600
06CD 05A3  00500      bsf      STATUS,PA0          ; page 3
06CE 05C3  00501      bsf      STATUS,PA1          ; /
           00502  endif
           00503 ;
06CF 0678  00504      btfsc    FLAG2,HOLD          ; IS the hold active?
06D0 04E7  00505      bcf      PORTC,DP            ; TURN on LED flag to show HOLD active
           00506 ;
06D1 05E6  00507      bsf      PORTB,LEFT_OFF      ; turn off the left digit
06D2 04C6  00508      bcf      PORTB,RIGHT_OFF     ; turn on the right digit
           00509 ;
06D3 0639  00510      btfsc    FLAG3,EIGTH_SEC     ; check for 1/8 second time-out
06D4 099B  00511      call     TekEigthSec         ; all that needs doing every 1/8 sec
           00512                                  ; can go in this subroutine
           00513 ;
06D5 0619  00514      btfsc    FLAG3,_4TH_SEC      ; check for 1/4 second time-out
06D6 099D  00515      call     TekQuarterSec       ; all that needs doing every 1/4 sec
           00516                                  ; can go in this subroutine
           00517 ;
06D7 0659  00518      btfsc    FLAG3,TWO_SEC       ; check for two second time-out
06D8 09A6  00519      call     TekTwoSec           ; all that needs doing every two sec
           00520                                  ; can go in this subroutine
           00521
06D9 0ABB  00522       goto    TekMain
           00523 ;
0100       00202      org            100
           00203 ;
           00204 ;^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
           00205         SUBTITL "Start"
           00206 ;
           00207 ;*************************************************************************
           00208 ;         Start HERE.
           00209 ;*************************************************************************
0100       00210 StartAll
0100 0C1E  00211      movlw    C_CONFIG1           ; configuration to read from PORTC
0101 0007  00212      tris     PORTC               ; configure PORTC to read the bits
0102 0000  00213      nop                          ; allow time for the inputs to settle
0103 0747  00214      btfss    PORTC,SW2           ; check to see if jumper is in #2
0104 0B08  00215      goto     TekOr6121           ; Indicates IR6121 or TEK is requested
           00216  if BeginMeasure==200
```


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```
0105 05A3  00217      bsf      STATUS,PA0          ; page 1
0106 04C3  00218      bcf      STATUS,PA1          ; /
           00219  endif
           00220  if BeginMeasure==400
           00221      bcf      STATUS,PA0          ; page 2
           00222      bsf      STATUS,PA1          ; /
           00223  endif
           00224  if BeginMeasure==600
           00225      bsf      STATUS,PA0          ; page 3
           00226      bsf      STATUS,PA1          ; /
           00227  endif
0107 0A61  00228      goto     StartMeasure        ; Start the IR measurement routine
0108       00229 TekOr6121
0108 0727  00230      btfss    PORTC,SW1           ; check SW1 to determine if Tek or 6121
0109 0B0D  00231      goto     Teknika             ; jumper in, Teknika
           00232  if BeginIr6121==200
           00233      bsf      STATUS,PA0          ; page 1
           00234      bcf      STATUS,PA1          ; /
           00235  endif
           00236  if BeginIr6121==400
010A 04A3  00237      bcf      STATUS,PA0          ; page 2
010B 05C3  00238      bsf      STATUS,PA1          ; /
           00239  endif
           00240  if BeginIr6121==600
           00241      bsf      STATUS,PA0          ; page 3
           00242      bsf      STATUS,PA1          ; /
           00243  endif
010C 0A8E  00244      goto     StartIr6121         ; Start the 6121 IR format decoder
010D       00245 Teknika
           00246  if BeginTeknika==200
           00247      bsf      STATUS,PA0          ; page 1
           00248      bcf      STATUS,PA1          ; /
           00249  endif
           00250  if BeginTeknika==400
           00251      bcf      STATUS,PA0          ; page 2
           00252      bsf      STATUS,PA1          ; /
           00253  endif
           00254  if BeginTeknika==600
010D 05A3  00255      bsf      STATUS,PA0          ; page 3
010E 05C3  00256      bsf      STATUS,PA1          ; /
           00257  endif
010F 0AAF  00258      goto     StartTek            ; Start the Technika Remote decoder
           00259 ;
           00260 ;  START Vector
07FF       00261      org      0x07ff
07FF 0B00  00262      goto     StartAll            ; start vector
           00263 ;
           00264      END
```

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```
MEMORY USAGE MAP ('X' = Used,  '-' = Unused)

0000 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX X--------------- ----------------
0100 : XXXXXXXXXXXXXXXX ---------------- ---------------- ----------------
0200 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0240 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0280 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXX-- ----------------
0400 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0440 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0480 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXX-----
0600 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0640 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0680 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
06C0 : XXXXXXXXXXXXXXXX XXXXXXXXX------ ---------------- ----------------
07C0 : ---------------- ---------------- ---------------- ---------------X
All other memory blocks unused.
Program Memory Words Used:   629
Program Memory Words Free:  1419
Errors   :     0
Warnings :     0 reported,     0 suppressed
Messages :     0 reported,     0 suppressed
```


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