FM Tuner Controller for Portable and Car Radios

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APPLICATION OPERATION

The design is for FM tuner applications. It is a simple circuit that can be easily attached to any FM tuner so that pushbutton tuning is achieved and at the same time provides a few memories to store and recall your favorite channels on FM broadcast band. There are pushbuttons for user control The functions are explained in Table 1.

The keyboard is very easy to operate. Stations can be tuned by momentarily pressing the up or down tuning button. The receiver locks in to the next station. If any of these buttons are pressed continuously, then continuous tuning is achieved. Similarly stored stations can be recalled at any time by just pressing the required memory button. The heart of the circuit is the PICmicro™ microcontroller which does two major functions:

- Generating PWM
- Keyboard scanning

Upon power-up, the PICmicro™ microcontroller loads with the PWM default value from ROM and produces a PWM wave at the output. Even though a high frequency PWM is preferred, this program generates PWM with a period of 255 ms. This PWM is converted into DC voltage by integrating. A simple RC integrator will be sufficient for this purpose.The upper cut-off frequency is set to a few Hz . The PWM wave is buffered and level converted by the NPN transistor, t1. It is a general-purpose NPN transistor such as BC547 or 2N2222, etc. Receiver tuning is achieved by giving this voltage to the local oscillator. The local oscillator should be a VCO-type. Tuning voltage varies the junction capacitance of the varactor diode in the oscillator tank circuit and, hence, the frequency. By varying the Pulse width of the PWM wave form, the tuning voltage varies and hence tuning. It is important to note that in low-cost receivers, the front end RF amplifier is of wide band type, avoiding any tuning needed. But, in high sensitive receivers, the front end must also be tuned in accordance with the Local Oscillator (LO). This can be achieved by making the front end also varector tuned. Receiver front tuning can thus be done by deriving the control voltage from tuning voltage to LO. This arrangement is not shown in the schematic.

A feedback from the receiver is given to GP3 of the PICmicro™. This input goes high when a station of sufficient strength is tuned. Carrier detect is a logic signal derived from the AGC voltage developed in the receiver IF stage. A simple comparator, as shown in the Block Diagram on page 2, can be used to get the carrier detect signal. The carrier threshold or signal strength can be adjusted by the potentiometer (P1). During tuning, if a carrier detect signal is received by the PICmicro™, the present value in the PWM register is held constant and, thereby, maintains a constant DC voltage as the tuning voltage. An automatic frequency control loop in the receiver circuitry fine tunes the LO to receive the station. Now the PWM value is changed again only if tuning button connected to PICmicro™ microcontroller is activated again. PWM values corresponding to any station can be stored and recalled by appropriate action of the memory switches. In this circuit three memories are shown, which is sufficient for most purposes. More memories can added if desired. For interfacing the function switches (all are non-locking pushbuttons) a diode matrix is used. The advantages are low power consumption, low cost, and less space needed for PCB.With four lines to the PICmicro™ from the matrix, it can have a maximums 15 switches. Here we use only 6.

TABLE 1: PUSH-BUTTON FUNCTIONS

Name	Function
UP TUNE	When pressed, the receiver tunes to the next higher frequency. side station.
DOWN TUNE	When pressed, receiver tunes to the next lower frequency station.
STORE	press this button to store the current tuned frequency to memory specified by the next button to be pressed.

TABLE 1: PUSH-BUTTON FUNCTIONS

M1, M2, M3	These are the memory buttons Stations can be memorized in any of these by pressing the store button followed by theM1, M2, and M3.

Generating PWM

The most complex part of the program is the generation of the PWM waveform. The waveform should be accurate to produce good results. The clock does not need to be very stable, as the AFC loop in the receiver always takes care of the small drift in the LO frequency due to instability of the PICmicro clock or parameter change of the frequency determining elements in the local oscillator circuit. Hence, the internal RC oscillator will be sufficient.

The TMR0 is used to generate a fairly good PWM wave, without sacrificing other routines needed for the software.

BLOCK DIAGRAM

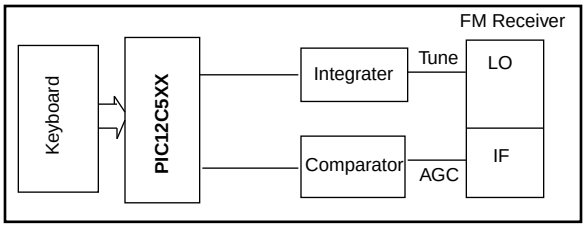
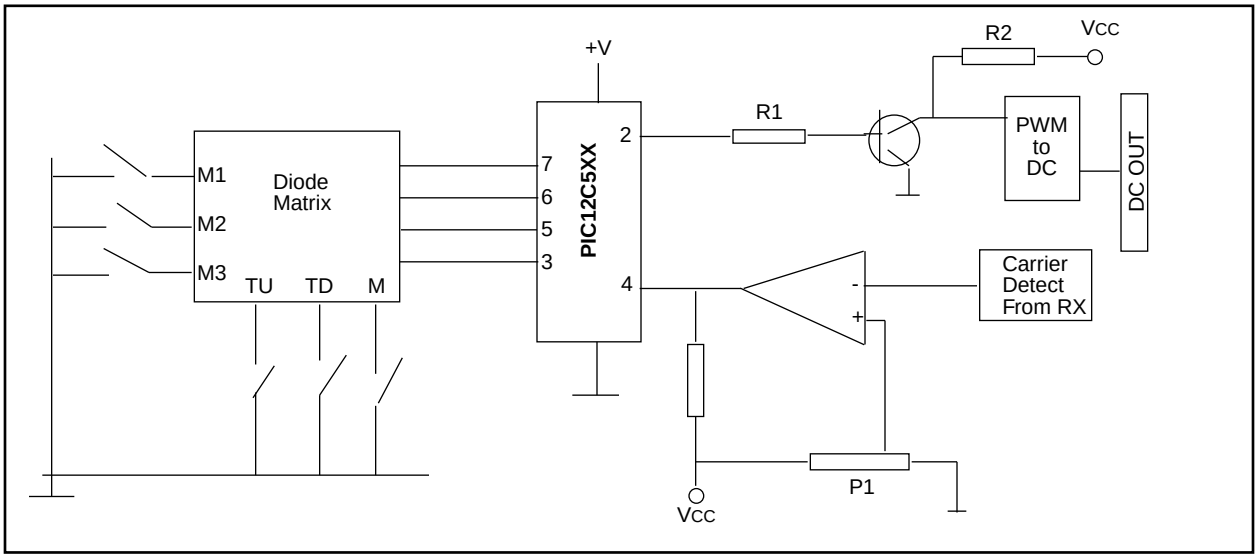


TABLE 2: KEY BOARD MAPPING

Keys	Address Read By PICmicro™ Microcontroller
Tune Up	X1110
Tune Down	X1101
Store	X1100
M1	X1011
M2	X0111
M3	X0011

FIGURE 1: CIRCUIT DIAGRAM OF PIC12C5XX BASED FM TUNER CONTROLLER



SOFTWARE LISTING

```
;-----------------------------------------------------
;This program runs on PIC12C5XX
;This program is written as control program
;for FM tuner
;WRITTEN BY MANI.T.K(VU2ITI)
;
;
;
;;-----------------------------------------------------
register equ     0x07
M1             equ     register+0
M2             equ     register+1
M3             equ     register+2
PWM           EQU            register+3
DELAY         EQU            register+4
STATUS        equ            0x03
output        equ            05
w              equ     0
f              equ            1
GPIO          EQU            06
TMR0          EQU            01
;
        org     0       ;start address 0
;
start
              movlw          0x81              ;Initialise timer 0
              option
              movlw          0x1f
              tris           GPIO              ; configure the input and output
              movlw          0x7f
              movwf          TMR0
              BSF            GPIO,output       ;set output
;
BIGIN
              MOVF           TMR0,f
              BTFSC          STATUS,02         ;check for timeout
;
TIMOUT
              CALL           UPDATE            ;If timout, call update
              MOVF           GPIO,w            ;read input
              ANDLW          0X0C              ;check for m3
              BTFSC          STATUS,02
              GOTO           M3TOPWM           ;if m3,  m3 to pwm
              MOVF           TMR0,f
              BTFSC          STATUS,02         ;check for timeout
;
              CALL           UPDATE            ;If timout, call update
              MOVF           GPIO,w            ;read input
              ANDLW          0X08              ;check for m2
              BTFSC          STATUS,02
              GOTO           M2TOPWM           ;if m2,  m2 to pwm
;
              MOVF           TMR0,f
              BTFSC          STATUS,02         ;check for timeout
              CALL           UPDATE            ;If timout, call update
              MOVF           GPIO,w            ;read input
              ANDLW          0x04              ;check for m1
              BTFSC          STATUS,02
              GOTO           M1TOPWM           ;if m1,  m1 to pwm
;STORE
              MOVF           GPIO,W
              ANDLW          0x13              ;Check is store button is pressed
              BTFSC          STATUS,02
              GOTO           STORE             ;if store, goto STORE
```

```
            ;
TUNE        ;Tuning rutine.
            MOVF        GPIO,w          ;read input
            ANDLW       0x01            ; if tune up, inc pwm
            BTFSC       STATUS,02
            INCF        PWM,F           ; if tune up, inc pwm
            MOVF        GPIO,w          ;read input
            ANDLW       02
            BTFSC       STATUS,02
            DECF        PWM,F           ;if tune down dec pwm
            MOVF        PWM,W
            MOVWF       TMR0
            MOVF        TMR0,f
            BTFSC       STATUS,02       ;check for timeout
            CALL        UPDATE          ;If timout, call update
            BTFSC       GPIO,05         ;Check for carrier detect
            GOTO        TUNE            ; If no carrier, Continue tuning
            GOTO BIGIN
;-------------------------UPDATE SOUBROUTINE----------------------------
UPDATE
            COMF        GPIO,f
            ;           compliment output
            MOVF        PWM,w
            MOVWF       TMR0            ;pwm to TMR0 And compliment
            RETLW       0x00            ;return from subroutine
;*********************************************************************
; routines for recalling memory1
M1TOPWM
            MOVF        M1,W
            MOVWF       PWM
            GOTO        BIGIN
; end for m1 to pwm

; routines for recalling memory2
M2TOPWM
            MOVF        M2,W
            MOVWF       PWM
            GOTO        BIGIN
; end for m2 to pwm
; routines for recalling memory
M3TOPWM
            MOVF        M3,W
            MOVWF       PWM
            GOTO        BIGIN
; end for m3 to pwm
;this can be exetended further for more memories.
;
;*********************************store routine***********************
STORE
            MOVLW       0XFF
            MOVWF       DELAY
LOOP

            MOVF        GPIO,w          ;read input
            ANDLW       0x0C            ;check for m3
            BTFSC       STATUS,02
            GOTO        PWMTOM3         ;if m3,  pwm  to m3
            movf        TMR0,f
            BTFSC       STATUS,02       ;check for timeout
;
            CALL        UPDATE          ;If timout, call update
            MOVF        GPIO,w          ;read input
            ANDLW       0x08            ;check for m2
            BTFSC       STATUS,02
            GOTO        PWMTOM2         ;if m2, pwm to M2
```

```
;
             MOVF          TMR0,f
             BTFSC         STATUS,02          ;check for timeout
             CALL          UPDATE             ;If timout, call update
             MOVF          GPIO,w             ;read input
             ANDLW         0x04               ;check for m1
             BTFSC         STATUS,02
             GOTO          PWMTOM1            ;if m1, pwm TO M1
             DECFSZ        DELAY,F
             GOTO          LOOP
             GOTO          BIGIN

;routines for storing memory
PWMTOM1
             MOVF          PWM,W
             MOVWF         M1
             GOTO          BIGIN
PWMTOM2
             MOVF          PWM,W
             MOVWF         M2
             GOTO          BIGIN
PWMTOM3
             MOVF          PWM,W
             MOVWF         M3
             GOTO          BIGIN

             END
```

NOTES: