Tuners Using the Motorola® MC44817D Phase-Locked Loop

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OVERVIEW

This Application Note covers VTSH-series tuners which utilize the Motorola® MC44817D Phase-Locked-Loop (PLL) Integrated Circuits (ICs). All of the Sharp products covered here are useful for Television, Video Cassette Recorders, Multimedia, or other similar applications that require a first-conversion stage.

INTRODUCTION

SHARP's VTSH series of tuners use the same Motorola PLL IC for a variety of tuner application types. These tuners operate in similar manner, with variations dependent on the destination country. All the PLL devices are programmed in a similar manner, with the frequency step dependent on the application.

VTSH Series

Table 1. PLL Specifications

TUNER PART NUMBER	TYPE	CRYSTAL REFERENCE FREQUENCY	STEP SIZE
VTSH6UZ60	NTSC	4 MHz	62.5 kHz
VTSH7UZ50	NTSC	4 MHz	62.5 kHz
VTSH6HZF1	PAL 5.5	3.2 MHz	50 kHz
VTSH7UF56	NTSC	4 MHz	62.5 kHz

The VTSH series of tuners are PLL-tuned and cover the VHF and UHF frequency bands. A total of 181 standard North American NTSC-M channels are within the 55.25 MHz to 801.25 MHz tune range of the VTSH6UZ60, VTSH7UZ50, and VTSH7UF56 models. The VTSH7UF56 has an F-connector input instead of the standard RCA connector. Channels in the Standard, HRC, and IRC frequency plans can be tuned with these products. The VTSH6HZF1 has an RCA input and is appropriate for reception of signals modulated in the PAL formats that use a 5.5 MHz intercarrier. It covers the 48.25 MHz to 855.25 MHz range. Other variations of PLL tuners and off-air non-PLL tuners are available for a variety of destination countries.

MC44817D

The MC44817D is a surface mount version of the MC44807P (DIP) PLL IC. It uses an 18-bit serial data string for configuring the PLL. The specification defines a variety of possible operating configurations; however, the specific conditions for these tuners will be discussed.

The computation for the required N-count to load the PLL is very simple.

$$N = F_{OSC} / \text{Step Size} \quad (1)$$

As indicated in Table 1, the step size is predetermined for each application and is a constant in the equation. The (1) indicates that it is equation 1 in this document. The Voltage Controlled Oscillator (VCO) output frequency term F_{OSC} is determined by the output from the PLL IC. F_{OSC} is determined by:

$$F_{OSC} = F_{CHANNEL} + F_{IF} \quad (2)$$

where $F_{CHANNEL}$ is the channel to which you want to tune, and F_{IF} is the standard 45.75 MHz inverted IF as referenced to the video carrier. As an example of the above expression, we will tune to Channel 2, with the video carrier at 55.25 MHz.

$$F_{OSC} = 55.25 \text{ MHz} + 45.75 \text{ MHz} = 101 \text{ MHz} \quad (3)$$

The required VCO frequency to tune NTSC-M Channel 2, which is at 55.25 MHz, referenced to the video carrier, is 101 MHz. The Intermediate Frequency (IF) output for the NTSC tuners is 45.75 MHz. As part of the conversion process, the VCO is the conversion Local Oscillator (LO), and is tuned above the desired frequency by an amount equal to the IF. Thus 101 MHz – 55.25 MHz = 45.75 MHz produces the desired IF output frequency. For a given channel frequency, add 45.75 MHz, and the required VCO frequency will result.

Determine the N-count for the above channel by:

$$N = F_{OSC} / \text{Step Size} \quad (1)$$

$$N = 101 \text{ MHz} / 62.5 \text{ kHz} = 1616 \quad (4)$$

The derived value of 1616 is the decimal value that will be loaded into the PLL to set F_{OSC} at 101 MHz. The maximum N-count allowed is 16,363 and a minimum count of 17.

For the VTSH6HZF1, the same process is used to tune to the lowest channel at 48.25 MHz, with the standard IF placed at 38.9 MHz. Repeating from equations (2) and (1):

$$F_{OSC} = F_{CHANNEL} + F_{IF} \quad (2)$$

$$F_{OSC} = 48.25\ MHz + 38.9\ MHz = 87.15\ MHz \quad (5)$$

$$N = F_{OSC} / \text{Step Size} \quad (1)$$

$$N = 87.15\ MHz / 50\ kHz = 1743 \quad (6)$$

To send this information to the PLL IC, it is combined with 4 bits of Band Switch data. The PLL IC automatically controls the three different tuning bands VHF Low, VHF High, and UHF by responding to the Band Switch bits in the serial data string. The Band bits are referenced in the separate tuning tables for each tuned channel and are provided in each tuner specification.

To convert the N value to the serial data string, the Band bits occupy bits 1 through 4, and the N-value occupies the 14 remaining bits of the serial string. For the example of the NTSC tuner, the derived value from equation (4) of 1616 decimal must be converted to 14 binary bits. The decimal value converts to a binary value: 00011001010000. Please note that the leading 00 have been added to complete the full 14-bit string. It is essential to make sure that the entire fourteen bits are configured correctly.

The Band Switch bit configuration for channel 2 is 0001. This value is added to the Most Significant Bit (MSB) end of the data string. In table form the process looks like:

DECIMAL		BINARY
N-value	1616	011001010000
Add 2 bits	0	00011001010000
Band bits (4)	0001	000100011001010000

For the of the PAL tuner, the derived value from equation (6) of 1743 decimal must be converted to 14 binary bits. The decimal value converts to a binary value: 00011011001111. Please note that the leading 00 have been added to complete the full 14-bit string. It is essential to make sure that the entire fourteen bits are configured correctly.

The Band Switch bit configuration for this channel is 0001. This value is added to the Most Significant Bit (MSB) end of the data string. In table form the process looks like:

DECIMAL		BINARY
N-value	1743	011011001111
Add 2 bits	0	00011011001111
Band bits (4)	0001	000100011011001111

Programming Note

Care should be taken to ensure that extra clock pulses are not present on the clock line prior to disabling the Load Enable line on the PLL. Extraneous clock pulses will create the appearance of the tuner not operating correctly, as it will tune erratically. This is due to the data stream being shifted by one or more additional bits, providing a division of all register values, and incorrect band switching control bits being asserted.

Programming errors will create a wide variety of problems that generate symptoms that are misleading. If the circuit design appears to be correct in all respects, and difficulties are experienced, examine the timing of the clock, data, and load enable lines carefully. In addition, insure that the correct data bits are being sent to the PLL for your desired channel.

Band-Switching

The PLL IC provides four pins for control of band-switching in electronic tuners. Different sections of the tuner are used for the VHF and UHF reception bands. In this manner, one section of the tuner is enabled and another section disabled for the specified tuning range. This function is automatically controlled from the PLL IC directly, as decoded by the PLL from the serial tuning data string.

This function is transparent to the operator of the tuner module. The first four bits of the serial data string indicate which band is to be selected for operation. Each tuner specification will indicate which band selection is required for each channel in its tuning range. The band switch range and associated bits are shown in the following table. Band bit 3 activates the EIA IS-31 filter and does not affect the tuning performance. Bit 3 may be asserted at the same time as any of the other three band bits. For example:

CHANNELS	FREQUENCIES, MHZ	BIT PATTERN
2 – G	55.25 – 157.25	0001
H – W + 11	163.25 – 361.262	0010
W + 12 – W + 83	367.262 – 793.25	1000

TUNING TABLES

Tables with tuning values for N based on nominal VCO frequencies are available on request. Standard tuning frequencies are provided in most tuner specifications.

REFERENCES

VTSH6UZ60, SHARP Electronics Corporation.

VTSH7UZ50, SHARP Electronics Corporation.

VTSH6HZF1, SHARP Electronics Corporation.

VTSH7UF56, SHARP Electronics Corporation.