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APPLICATION NOTE

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LOW COST LOW VOLTAGE ACTIVE FILTER FOR MC68HC05F2 DTMF OUTPUT

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Introduction

The MC68HC05F2 is a fully static single chip CMOS Microcomputer. It has 256 Bytes RAM , 2048 Bytes ROM, an DTMF Generator and 4 High Current Output Pins (10mA) for LED direct drive.

This application note illustrates a simple hardware implementation for a low voltage low pass filter for F2 DTMF output.

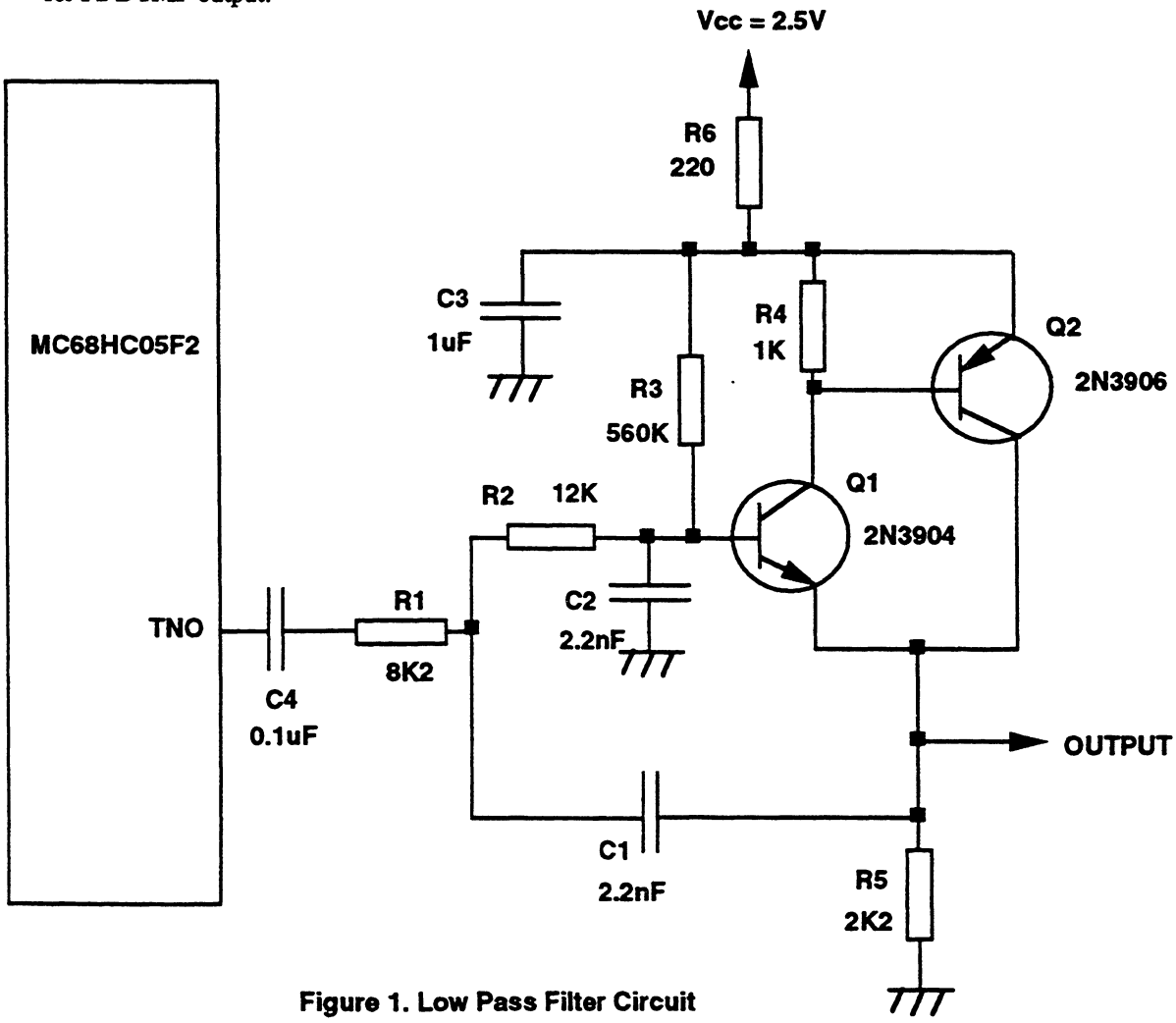

Figure 1. Low Pass Filter Circuit

Circuit Description

The circuit in figure 1 is a second order low pass Butterworth filter with cut off frequency around 6.4KHz. The transistor pairs Q1 and Q2 form a series feedback pair. The transistors form a unity gain amplifier with input at the base of Q1 and output at the emitter of Q1. The Q2 forms negative feedback from the collector signal of Q1 to the emitter of Q1. The feedback improves the linearity and stability.

One can adjust the quiescent current of the circuit by altering R_4. However, large value of R_4 will limit the upper swing of the signal.

For the circuit shown in fig.1, the quiescent current consumption is below 0.8mA at Vcc = 2.2V. The measured quiescent current consumption is 0.3mA.

Low Pass Filter

The filter implement is a second order low pass Butterworth filter with transfer function as:-

$$H(s) = \frac{Wo^2}{S^2 + \sqrt{2}\,Wo\,S + Wo^2} = \frac{\frac{1}{R_1C_1R_2C_2}}{S^2 + \left(\frac{1}{R_1C_1} + \frac{1}{R_2C_1}\right)S + \frac{1}{R_1C_1R_2C_2}}$$

$$Wo = 2\pi\,6.4KHz$$

$$\frac{1}{R_1C_1R_2C_2} = (2\pi\,6.4\,KHz)^2$$

$$\frac{1}{R_1C_1} + \frac{1}{R_2C_1} = (2\pi\,6.4\,KHz)\sqrt{2}$$

Take $C_1 = C_2$

By solving the above equations, the result is

$R_1 = 7.9K\Omega$
$R_2 = 12.65K\Omega$
$C_1 = 2.486nF$
$C_2 = 2.486nF$

The circuit using nearest preferred values are shown in fig. 1. The cutoff frequncy is shifting slightly higher. Ihe typical spectral energy spectrum of the filter output is shown in fig.2 susing circuit in fig.1.

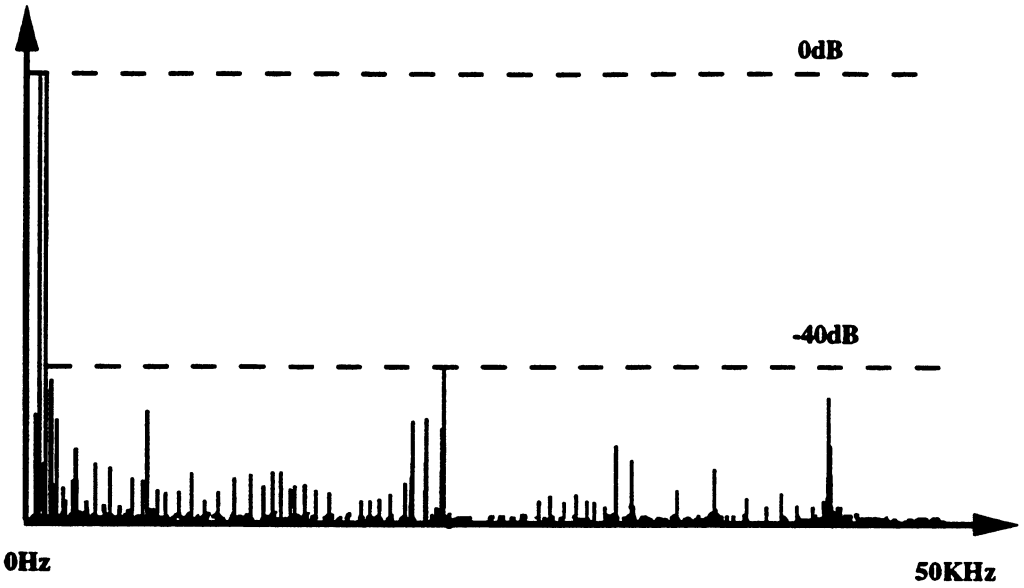

Fig. 2 Typical Energy Spectrum of the DTMF frequency pairs and the corresponding response of their harmonics at the filter ouput measured at Vcc=2.2V

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