

DUAL TONE GENERATION

To generate dual tone we use lookup table method as it gives nice result. To do this first we should generate two single tones and add these two tones together and then if necessary scale the result.

Let us generate a dual tone having 2 frequency contents $f_1=800\text{Hz}$ and $f_2=1100\text{Hz}$ being sampled regularly with sampling frequency 8000Hz .

For tone1: $wT=2*\pi*f_1*T$

$$=2*3.14*800*1/8000$$

$$=0.62832$$

For tone2: $wT=2*\pi*f_2*T$

$$=2*3.14*1100*1/8000$$

$$=0.8639$$

To get Wavetable for the tone1 substitute the value of $wT=0.62832$ in Turbo-c program TONE.C and run the program.

Obtained wave table is,

tone1=[97,97,79,49,20,2,2,20,50,79,97,97,79,49,20,2,2,20,50,79,97]

To get Wavetable for the tone2, substitute the value of $wT=0.8639$ in Turbo-c program

TONE.C. Obtained Wavetable is,

tone2=[99,76,34,3,5,38,79,99,85,46,9,1,27,69,97,92,57,17,0,17,57]

Both above tones can be checked for its shape and frequency contents as we have done in explaining Wavetable method. Here we will not do this, as it would be mere repetition of what we have done earlier.

To get dual tone add tone1 and tone2 wave tables. The resultant dual tone table is,

tone1+tone2=[196,173,113,52,25,40,81,119,135,125,106,98,106,118,117,94,59,37,50,96,154]

This dual tone table as it is will not deliver satisfactory result. It is because; remember that tone1 and tone2 are added with same fixed DC level. When you add tone1 and tone2 this DC level also gets added up. Because of this reason the value reaches to either saturation or cutoff level and hence we will end up with a square wave instead of sine wave.

To overcome the problems divide the each data of the dual tone table by 2. The resultant table is,

tone1+tone2/2=Dual tone

=[98,87,57,26,13,20,41,60,68,63,53,49,53,59,59,47,30,19,25,48,77]

In this computation, we get fractional part. These fractions are rounded to nearest integer.

To see how this dual tone looks like, use MS-Excel as mentioned earlier. Thus the plotted graph for dual tone table is as shown in Figure (4).

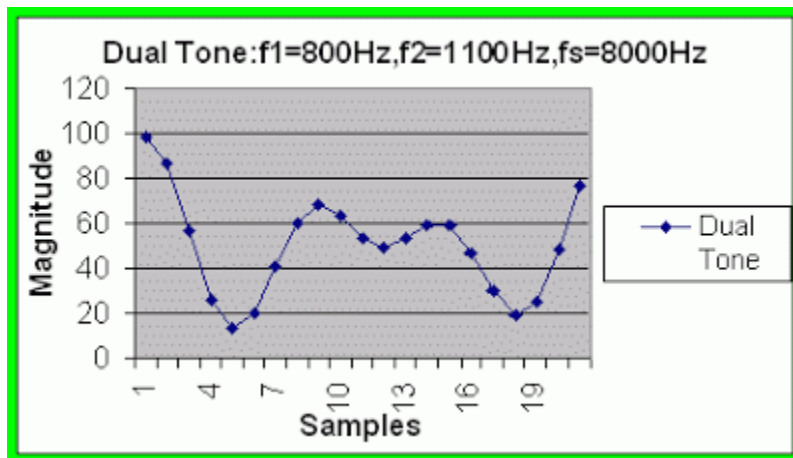


Figure (4)

Using dtmf.m program we can find out the frequency spectrum of the dual tone. For this replace the value of y by dual tone table given above and change the title to 'Dual Tone Spectrum: f1=800Hz & f2=1100Hz'. Thus observed frequency spectrum is as shown in Figure (5).

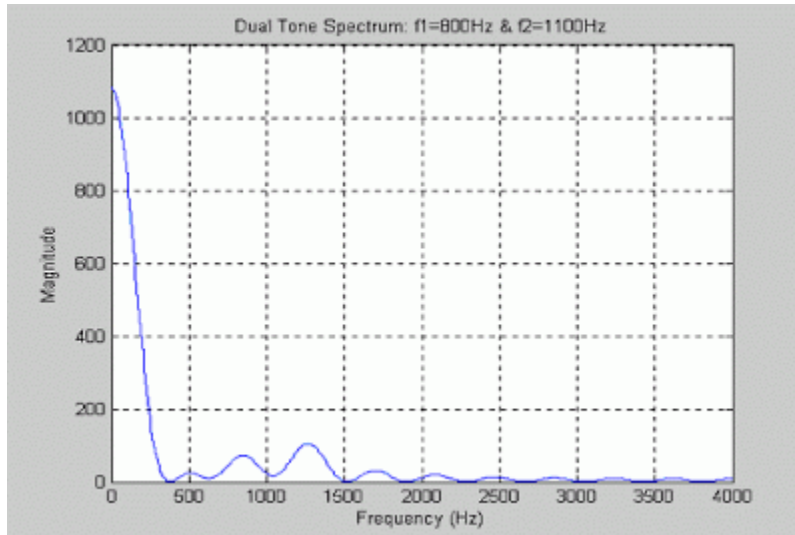


Figure (5)

From the frequency spectrum, we can observe 3 peaks: one corresponding to DC level (0Hz), other one is for 800Hz and another one is for 1100Hz. But these peaks are not exactly located over 800Hz and 1100Hz. There is a slight shift of these frequencies over frequency range. This happened due to the error introduced when we have performed truncation and scaling of the Wavetable data.

To implement the dual tone on hardware, substitute dual tone table as a[i] in program tone1.c and program the tone1.hex file to PIC16F877 IC.

The observed dual tone on CRO exactly resembles the waveform that we have got with MS Excel plot.

In the above program delay is adjusted to get a sampling time of $125\mu\text{s}$ (i.e. sampling frequency 8000Hz)

For the low pass filter, design is as follows:

Let $f = 2200\text{Hz}$,

$R = 1.5\text{K}\Omega$

Therefore, $C = 1/2\pi fR = 1/(2 \times 3.14 \times 2200 \times 1.5 \times 10^3)$

= 4.82532 μ F

In the program tone1.c without any delay loops minimum sampling time achievable (for PIC MCUs with clock frequency 4mHz) is 25 μ s i.e. maximum sampling frequency is $1/25\mu\text{s}=40\text{KHz}$. This means that we can generate a dual tone, which can contain a tone of around maximum 10 KHz frequency.

The extended part of the dual tone generation is the generation of “Dual Tone Multi Frequency (DTMF)” signal, which are widely used in modern telecommunication field.

Applications of Dual Tone

Tone generation is required in many applications. It can be used in applications involving secure off-site control, where commands or data in the format of tones are transmitted over a telephone tone. The tone generation finds application involving signal modulation as well. The routine can be used to generate audible tones and output for speaker connected to an I/O port or a PWM channel. Dual tones are heavily used in DTMF signal generation.

Source : <http://asic-soc.blogspot.in/2007/12/digital-dual-tone-generation-using.html>