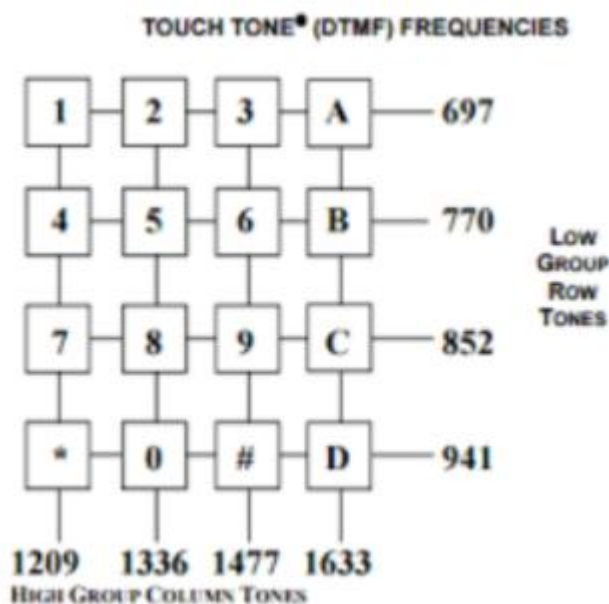


### DTMF decoder:

Analog DTMF telephone signalling is based on encoding standard telephone Keypad digits and symbols in two audible sinusoidal signals of frequencies FL and FH. Thus, the scheme gets its name as dual tone multi frequency (DTMF).

Each digit or symbol represented in figure 1 has 2 distinct high and low frequency components. Thus, each high-low frequency pair uniquely identifies the corresponding telephone keypad digit or symbol. Each key pressed can be represented as a discrete time signal.

Typically, in the sampling frequency used is 8khz. Thus, if the two-individual frequency components of the signal can be identified then the number dialled can be decoded.



(DTMF frequencies)

### Implementation of DTMF Decoder:

The input to the decoder is a vector containing DTMF tones that are encoded by the encoder (code provided in Touch Tone Dialler). Our objective is to accurately determine (in a range of appropriate Signal To Noise Ratio (SNR) ) the key that was pressed on the dialler which generated the tones. This can be further

used to decode a complete telephone number from a single signal.  
(Touch Tone decoder)

Next, we computed the encoded signal FFT and normalized it into the range (0 to 1477Hz). Next, we Separated the Row and Column Frequencies. The peak observed determines the digit which was pressed as input. A good Signal to Noise Ratio range for working of this decoder accurately is greater than 15, ideally 20.

#### Challenges faced:

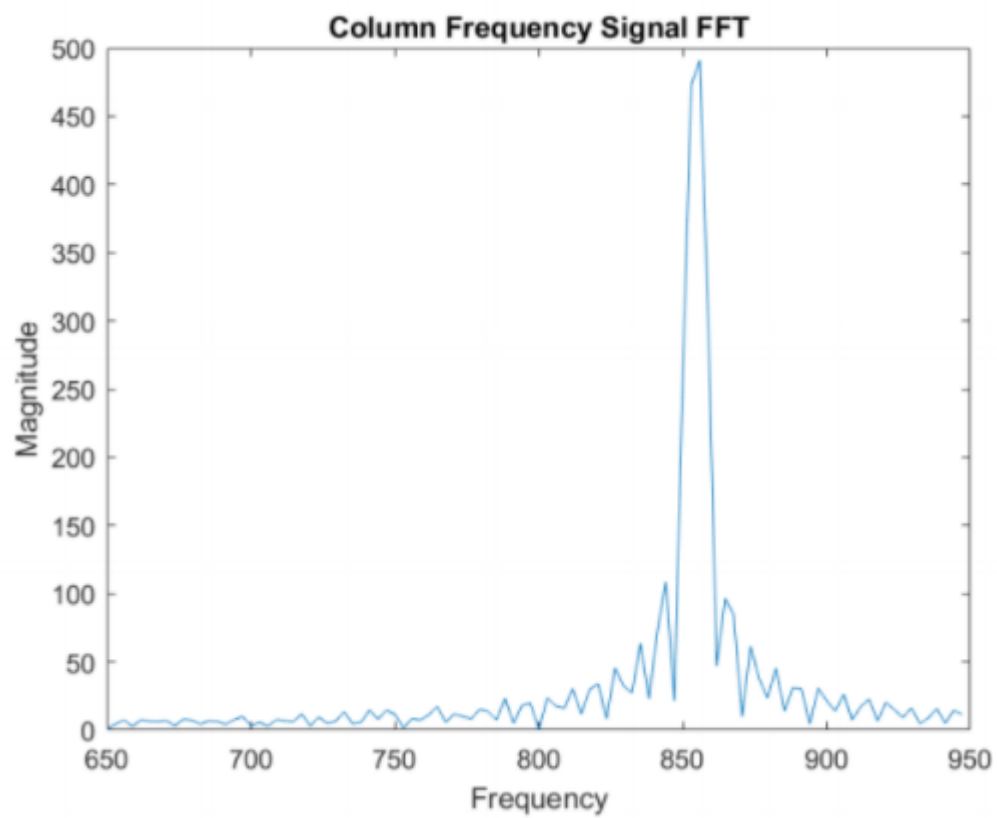
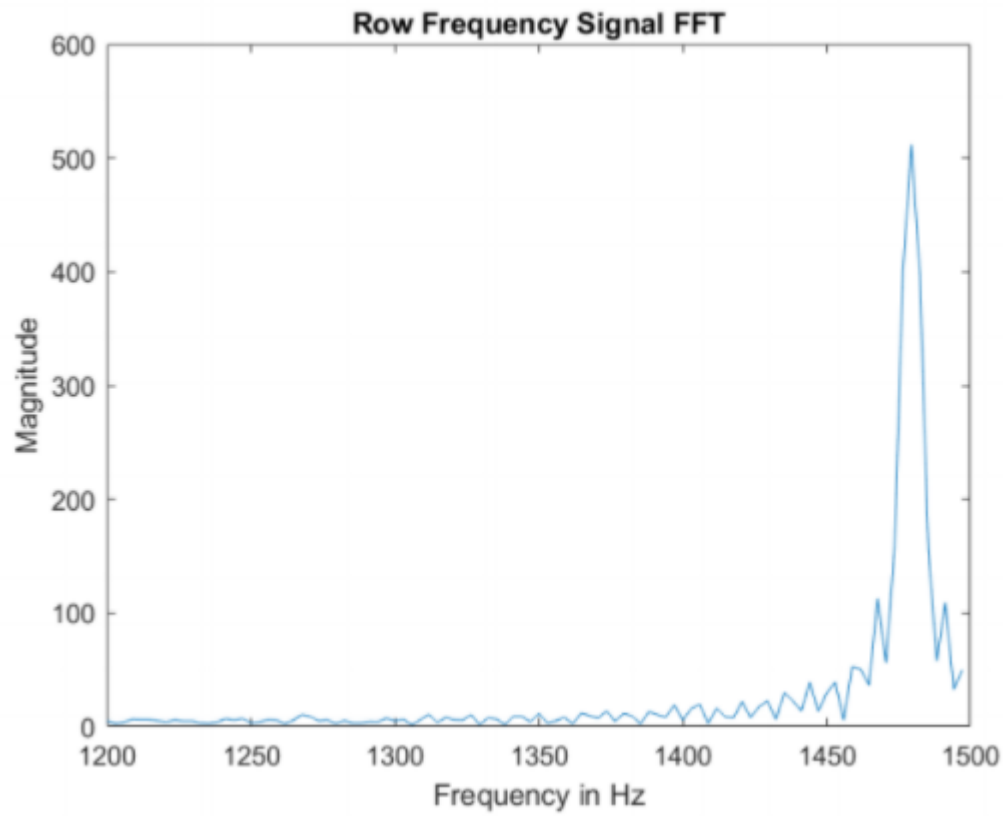
We had to reduce and separate the FFT components for the DTMF decoder. For touch tone dialler, the major problem is that the number of telephone digits is unknown so how to estimate that. The signal on average has about 2,000 components so dividing the length by 2000 gives us the number of digits. And then we simply implement a loop for the number of digits and run DTMF decoder for that many iterations which gives us the decoding of a complete telephone number.

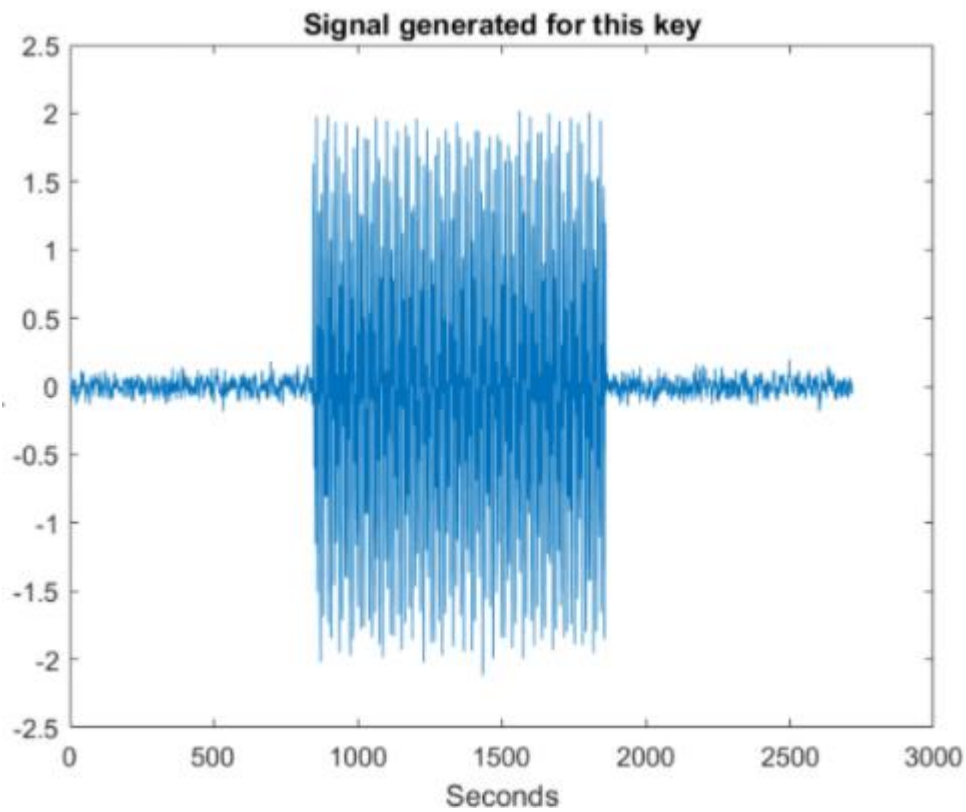
#### Results/Conclusions:

DTMF decoder: The input is the digit '9' at SNR level '20' to the encoder and the resulting signal is fed to the dtmf decoder. It accurately shows the peak at 9's frequencies and estimates the digit to be 9.

Touch Tone decoder: The input is the digit '93245' at SNR level '20' to the encoder and the resulting signal are fed to the touch tone decoder. It accurately estimates the keys to be 93245.

(Below) Row, Column Frequency signal FFT and the signal generated for digit '9':





(Below) Row, Column Frequency signal FFT and the signal generated for digits '93245':

