

## Precise Frequency Detector Modification and Special Tone Generation

The Teridian 73M2901CE integrated circuit modem provides all the microprocessor control, modulation, and demodulation functions required to implement a V.22 *bis* 2400 bps modem. There are some ways to make the 73M2901CE do functions that it was not originally intended to do, for instance detecting and generating tones that are not normally used for normal modem functions.

Although all the 73M2901CE is preprogrammed for most normal dial-up low speed modem applications, in some cases it may be desirable to detect and/or generate frequencies that are not part of its default set. The 73M2901CE can be programmed to detect and generate other frequencies beside the ones normally used. This application notes describes the procedure for modifying the detect frequencies of the precise call progress filters of the 73M2901CE.

### Customizing the Tone Detection Frequencies

The Precise Call Progress Detection (CPD) feature comprises 4 different frequencies by default: 350Hz, 440Hz, 480Hz and 620Hz. A detect frequency is characterized by its coefficient. The detect coefficients for the default precise call progress tones are stored in RAM memory and can be modified by the user. To select a different tone a special AT command is used modify the coefficient. This operation will need to be redone after each reset of the part or modem session.

### Locations and Settings for Default Precise CPD Frequencies

Frequency Position	Default Frequency Selected	RAM Location (address)	Value (in HEX)
1	350Hz	A2.\$E6	\$7A.\$13
2	440Hz	A2.\$EA	\$76.\$AE
3	480Hz	A2.\$EE	\$74.\$EF
4	620Hz	A2.\$F2	\$6D.\$B8

Three steps are needed in order to modify any of the default frequencies.

### Calculating Frequency Coefficient

The equation for calculating a detect frequency coefficient is:

$$\text{Detect coefficient} = 32768 \times \cos( (2 \times \pi \times f) / 7200 )$$

where *f* is the desired detect frequency (this operation must be done in radians).

The resulting coefficient must then be translated into HEX (\$xx.\$yy format) prior to updating the RAM memory. It is suggested that you try this on one of the default frequencies to see that the correct value is calculated. Once you are able to properly calculate the default frequency HEX values, you should also be able to do the same with the frequency you are interested in detecting.

### Modifying the Specific RAM Value

The memory location for each of the four default frequencies is shown in the tone table. The write to RAM needs to occur after any reset phase of the chip and after any modification to the country configuration default value in register S99 (modification of the country configuration overwrites the RAM default values).

Assuming the coefficient is formatted as \$xx\$yy, the AT commands required are as follows:

Frequency 1:	AT@A2.\$E6=\$xx.\$yy
Frequency 2:	AT@A2.\$EA=\$aa.\$bb
Frequency 3:	AT@A2.\$EE=\$cc.\$dd
Frequency 4:	AT@A2.\$F2=\$ee.\$ff

### Enabling Precise CPD

If the frequencies are used in place of the normal call progress frequencies during the call progress portion of the connection, the new coefficients have to be entered in the RAM memory. The precise call progress function has to be enabled and configured for level and timing. This is done through registers S19, S20, S63, S77 and S78 (See the User Guide for details).

ATS20=34 enables detection of all precise tones only.

#### Example:

Modification of the frequency 1 to detect a 250Hz frequency.

1. Detect coefficient =  $32768 \times \cos \left( \frac{2 \times \pi \times 250}{7200} \right) = 31991$
2. Coefficient converted to signed HEX = \$7CF7
3. RAM modification for frequency 1: AT@A2.\$E6=\$7C.\$F7
4. Enable precise tone detection: ATS20=34

The first 3 steps need to be repeated for each frequency that has to be modified.

#### For use other than during the handshake:

If the new tone is to be used for purposes other than in the idle or call progress state, such as for detecting a special tone when not operating as a modem, the status of the tone detectors can be read using the S63 register. To do this the modem must be in call progress mode (off hook). To determine whether a tone is detected the register must be read at a rate that is appropriate for the duration the tone will be present, i.e., it should be over sampled at a rate that is shorter than the duration of the tone. By turning the AT command delay off (ATS73-32) and using a 9600 bps DTE rate the process can be sped up so a register can be polled as fast as every 60 mS or so. Also use the A/ command instead of ATS63? after the first time to make polling faster.

It is also important that the modem be in the correct operating mode. Since this app note only covers using the CPD filters, the modem should be configured for the originate mode. The same would be true if the tone modified were normally used in the answer mode. The modem mode can be selected through the S14 register bit 7 (the default is 1 for originate mode). Consult the factory for RAM locations other than for CPD.

Although the 73M2901CE was not originally intended for general tone detection tasks, it does have some flexibility that will allow them to be used for these as well. Care should be taken to make sure detection is suitable for the application, but for many general-purpose tone detection applications the 73M2901CE should be adequate.

### Using the 73M2901CE for Special Tone Generation

The tone generators can also be used to generate various tones and even dual tones such as dial tone. This is also done by modifying coefficients in a similar way to what has been discussed for tone detection. Tone generation is even easier to do than the detection since the math is somewhat simpler. The tones are generated by directly modifying the tone generator parameters. Both the tone frequency and amplitude must be set in the tone generator. Since the tone generator can generate two tones at once, there are two locations for the tone frequencies and two locations for the tone amplitudes. If only one tone is needed, only one frequency and amplitude should be programmed. If the amplitude is set to zero, the corresponding tone will be off.

Tone	Frequency Coeff. Location	Amplitude Location
ToneGen 1	B1.\$5F	A0.\$BE
ToneGen 2	B1.\$61	A0.\$CE

An example of the commands to generate 350Hz and 440Hz tones are shown below:

```

ATH1                               Go off hook
AT@B1.$5F=$0C.$71   Frequency for ToneGen 1 = 350Hz
AT@A0.$BE=60        Amplitude for ToneGen 1, turns on tone 1
AT@B1.$61=$0F.$A4   Frequency for ToneGen 2 = 440Hz
AT@A0.$CE=60        Amplitude for ToneGen 2, turns on tone 2

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The frequency numbers are calculated as  $(\text{Freq} * 65536 / 7200)$ . To turn a tone off, set the amplitude values to zero. The amplitude values shown give a transmit level of approximately  $-13\text{dBm}$ .

### Transmitting and Receiving FSK Data with Different Transmit Frequencies

It may be desirable to change the transmit and receive frequencies for FSK. This can also be done quite easily using a similar process to what has already been discussed. The memory locations for the FSK tones is different than for the CPD tones and the values need to be modified after the modem handshake when the tones are being sent.

The memory locations of the tones are:

```

For the FSK Modulator (Tx):   Mark frequency: AT@B1.$47=HH.LL
                               Space frequency: AT@B1.$49=HH.LL
For the FSK Demodulator (Rx): Center frequency: AT@B1.$39=HH.LL

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For the transmit frequencies HH.LL are calculated as  $(65536 * \text{Freq} / 14400)$  as a 16 bit number. This varies from the CPD filters because of the 14.4KHz interpolation of the carrier transmit samples.

For the receive center frequency HH.LL is calculated  $(65536 * \text{Freq} / 7200)$  as a 16 bit number. It is suggested that the modulation mode closest to the one being used be the starting mode before the memory is modified. This make it easier to transition to the new frequencies and insures the receive filters are more likely to be compatible with the new frequencies that are being used. If the transmit and receive channels are switched off or swapped, the locations will need to be reprogrammed after the carriers are re-enabled.

An example of this process and the steps required to set this up are as follows. This is an example that is used to allow the use of the 73M2901CE in an application main channel V.23 transceiver. Many customers used this part with a 3.58 MHz color burst crystal instead of the normal 3.18 MHz crystal. This made the transmit and receive frequencies 11% higher than normal. To compensate the frequencies for the 72M2901CE are shifted up 11% so the part can be used in applications where the crystal frequency was altered from the normal. The receive filters are still compatible with the new frequencies.

1. The following signals are used to control the modem for half duplex operation.
  - a. RTS\ controls the transmit on (low) and off (high).
  - b. CTS\ indicates it is OK to transmit data (low true).
  - c. DCD\ indicates there is a carrier being received (this will also go low if you are transmitting and the TXA and RXA are connected together).
  - d. TXD is where you send commands and data.
  - e. RXD is where you receive data.
2. If this is a non-dial up connection initialize the modem with ATX1Y0B10C2S10=255<CR><LF> (X1 is so it will not try to look for dial tone).
3. On the receiving side set RTS\ high so it will not transmit its carrier and initialized with the same dial string.
4. To start the modems, send ATD<CR><LF> to the one that is receiving data and ATA<CR><LF> to the other sending data.
5. After both modems send their "connect" message on RXD, go into the on line command mode by sending "+++"
6. On the receiving modem, send the command AT@B1.\$39=\$43.\$17O<CR><LF>. The modem will go back on line with a new receiver center frequency.
7. On the transmitting side, send AT@B1.\$47=\$19.\$A7@B1.\$49=\$29.\$70O<CR><LF>. The modem will go back on line and start sending the new carrier.
8. Send your data at 1200 bps.
9. If the carrier is turned off or the connection turned around, the transmit side will need to resend the carrier frequency command again. The same is true if the receive side is used to transmit and then set back to receive.

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