

Introduction

The Teridian 73M2901CE integrated circuit modem provides all the microprocessor control, modulation, and demodulation functions required to implement a ITU-T V.22 *bis* 2400 bps modem. This application note explains how to modify the 73M2901CE Imprecise Call Progress Monitor filter as a more general purpose signal detection mechanism. This supports the detection of signal frequencies that are not included in the device default set.

The 73M2901CE provides a set of precise and imprecise filters. The difference being that signals to be detected by the precise filter set use the exact frequencies in the detection process, whereas for the imprecise filter set, frequencies in a specific bandwidth are monitored. The method described in this application note is intended to provide insight into how the imprecise detector maybe programmed to detect custom frequencies.

Call Progress Monitor Registers

Tones fall into two categories:

- Pre-dial call progress tones: tones that would be detected before a number is dialed (specifically a dial tone).
- Post-dial call progress tones: tones such as a ringback tone (the tone you hear when the called telephone is ringing) or a busy tone.

Pre and post dialing is controlled by Register S20. The specific frequencies or the bandwidth of the imprecise detectors can be selected. Register S88 selects the imprecise bandwidth to be used. Register S88 has a "USER DEFINED" setting that is used for user programmed bandwidths. The detector results can be read back in Register S63 (Bit 7 is the imprecise detector monitor).

Calculating the Imprecise Call Progress Detector Filter Taps

The imprecise detector uses an 80-tap FIR digital filter operating at a sample rate of 7200 Hz. The taps are signed eight-bit two's complement. The filter gain should be set to unity gain. Not all 80 taps need to be used, but unused filter taps must be set to zero.

Third party programs are available that can provide the filter tap values for a given design. ScopeFIR™ is one of many possible programs and is available from www.iowegian.com. The results obtained using this particular program agreed closely with those obtained by the proprietary methods used by Teridian.

The ScopeFIR program is simple and fast. Use the “Simple Parks-McClellan” filter template.

1. Set the sample rate to 7.2 kHz (which is what is used in the 73M2901CE).
2. Enter the units (kHz, ms) into the appropriate places in the pop-up.
3. Enter 80 into the Number of Taps.
4. Select Bandpass as the filter type.
5. Set the desired Passband at the top and bottom, ripple, stopband attenuation, and the center frequency in the appropriate places.
6. Press the “Design” button to calculate the tap data.

When the design is complete, 80 numbers, as well as the filter shape, and impulse response plot will be displayed. There are a number of dots on the impulse response plot that correspond to the taps you are generating (80 dots = 80 taps; the scale on the left indicates the same values as the taps that are created). Changing the input parameters will result in a corresponding change to the filter and impulse response.

You may find that the actual filter range is not exactly what was specified in the filter design program. Teridian has found that they tend to be slightly narrower than what was specified, so test the detector and make adjustments to get exactly what is required. Teridian recommends setting the stopband to 40 or 50 dB and the ripple from 1 to 3 dB to start. Also remember the stopband frequency range must be wider than the passband range.

Writing the Filter Coefficients to 73M2901CE Memory

The data for the filter is most easily entered into the memory in two’s compliment decimal notation but if two’s compliment decimal is not one of the data formats that is available for output, Excel® can be used to do the conversion (it can also be entered in HEX). Use the Excel Bin2Dec function to do the conversion as described below.

1. In ScopeFIR, convert the output to binary (it is actually two’s compliment binary): Right click in the data field and select “Select Filter and data format”, “Text:Binary”, and for options, 8-bit data.
All of the numbers for the taps are small, ranging from approximately – 20 to +20. Remember, negative numbers have the MSB set to one, so they will look a little odd (e.g., 11111111 is actually -1).
2. Select all the data in the coefficient editor pane and copy it to Excel in the first column, remembering it is 80 rows.
3. Select the bin2dec function in Excel (this will be found in different places in different versions of Excel. Some versions may require loading this function from the installation disk).

The output will now be in decimal with negative numbers looking large again as with the binary (see [Table 1](#)). This is exactly what should be load into the 72M2901CE.

If Hex data is used instead of two’s compliment decimal, make sure all the data has a “\$” preceding it (e.g. \$FE).

Table 1: Portion of the ScopeFIR Output Copied to Excel and Converted to Decimal

| TEXT: bin, 8-bit | 800-1400 Hz Detector Filter |
|--------------------------|-----------------------------|
| BIN Output from ScopeFIR | bin2dec |
| 0 | 0 |
| 0 | 0 |
| 0 | 0 |
| 0 | 0 |
| 0 | 0 |
| 0 | 0 |
| 11111111 | 255 |
| 11111111 | 255 |
| 11111111 | 255 |
| 1 | 1 |
| 10 | 2 |
| 10 | 2 |
| 11111111 | 255 |
| 11111101 | 253 |
| 11111101 | 253 |

Once the tap data is in the proper format, it is simple to copy and paste it into a text editor and format it into the command data. The following example shows the commands to write 16 taps at a time into the 73M2901 memory. Since there are 16 taps per line, it takes 5 memory writes to load all 80 taps. This example also shows where the data is to be written (at memory addresses A2.\$30 to A2.\$70+15). When a number of successive locations are written, they can be strung together in the command with a period in between as shown below. Also note that the first 40 values are mirrored in the last forty values.

```
AT@A2.$30=1.1.1.254.255.0.0.1.0.0.0.0.0.255.255.0
AT@A2.$40=2.2.1.254.253.255.1.1.0.0.1.2.0.252.250.253
AT@A2.$50=6.11.7.251.242.245.2.14.14.2.245.242.251.7.11.6
AT@A2.$60=253.250.252.0.2.1.0.0.1.1.255.253.254.1.2.2.0
AT@A2.$70=0.255.255.0.0.0.0.0.1.0.0.255.254.1.1.1
```

One more memory write may be necessary if the detector will need to operate for frequencies above 1 kHz. Normally there is a filter to prevent energy outside the normal call progress band from interfering with the detectors, and this must be disabled to detect frequencies above 1 kHz. The command to do this is:

```
AT@A2.$2C=$00.$7F.$00
```

Note that this command uses 8-bit Hex notation.

Refer to the *73M2901CE Data Sheet* and the *73M2901CE AT Command User Guide* for additional information on writing to the 73M2901CE memory.

Additional Considerations for Programming and Using the 73M2901CE Registers

Register S88 can be written to at any time before going off hook (remember there is a pre-dial and post dial mode that can be selected). All other registers should be written to after the 73M2901CE has been taken off hook. The user defined filter is selected by setting the value for Register S88 to \$F for the mode required. To select them both for convenience, set S88 to \$FF.

To actually use the detector, it is necessary to poll the S63 register to see if the detector bit is on. If the filter is detecting energy in the band, it will read 128 (sometimes a precise detector could also come on if it's tone is present, but the MSB is the one of interest). The fastest way to poll the register is to send the "ATS63?" command the first time, and then "A" to repeat the last command. Clearing S73 bit 5 will speed up execution (disable the delay between commands) as will sending commands at 9600 bps. If the results are not as expected, make sure the register programming is done in the exact order outlined above.

Related Documentation

The following 73M2901CE related documents are available from Teridian Semiconductor Corporation:

73M2901CE Data Sheet

73M2901CE AT Command User Guide

Revision History

| Revision | Date | Description |
|----------|----------------|--------------------|
| 1.0 | March 13, 2009 | First publication. |

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