

Additional Resources	PE0002 scripts – Download from the CML website using the link that accompanied this document on the Application Notes download page
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## 1 Introduction

Vector quantisation, as a compression method, is sensitive to distortion products in the input signal and the perceived voice quality of the decoded signal rapidly deteriorates as the input signal level begins to clip when the ADC runs out headroom. The input level may be managed using a number of techniques depending on the application. This application note explores some of these techniques and how they might be applied to obtain best performance from the Vocoder. The EV6180 or EV6380, Vocoder Evaluation Kit, and the PE0002, Evaluation Kit Interface Card, have been used to evaluate the algorithms derived. The Scripts are available to download from the CML website using the link provided.

The relevant device data sheets should be used in conjunction with this Application Note.

## 2 History

Version	Changes	Date
1.0	First release	02-08-08

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## 4 CMX6x8 Peak Level Measurement Function

The CMX6x8 includes a peak level measurement function that can be used to determine when the input signal is approaching the threshold at which clipping occurs. Using the gain blocks in the Analogue Input Gain Control register allows the input signal to be pre-conditioned under software control to obtain optimum performance from the CMX6x8.

### 4.1 Measured peak level response

Figure 1 shows the peak level response measured for two input signal levels. The input is configured as recommended in the data sheet for an unbalanced connection and uses a 500Hz, amplitude modulated sinewave for characterisation. It can be seen that a peak value around 17000 is indicative of the point at which clipping occurs.

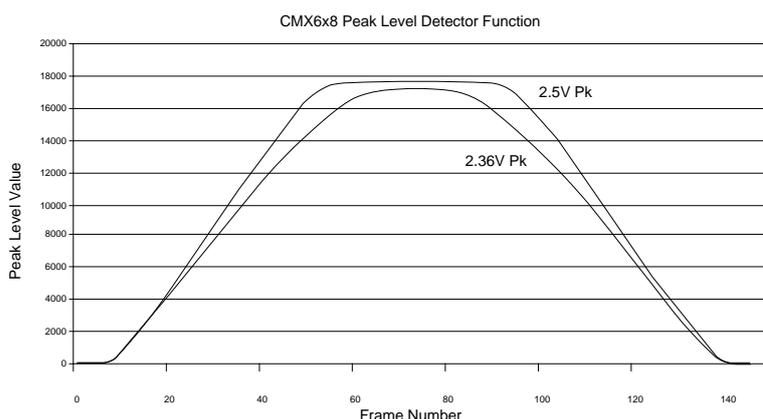


Figure 1. The peak level detector response of the CMX6x8

### 4.2 Peak Level transient response

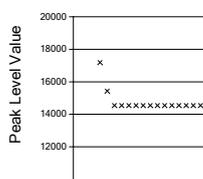
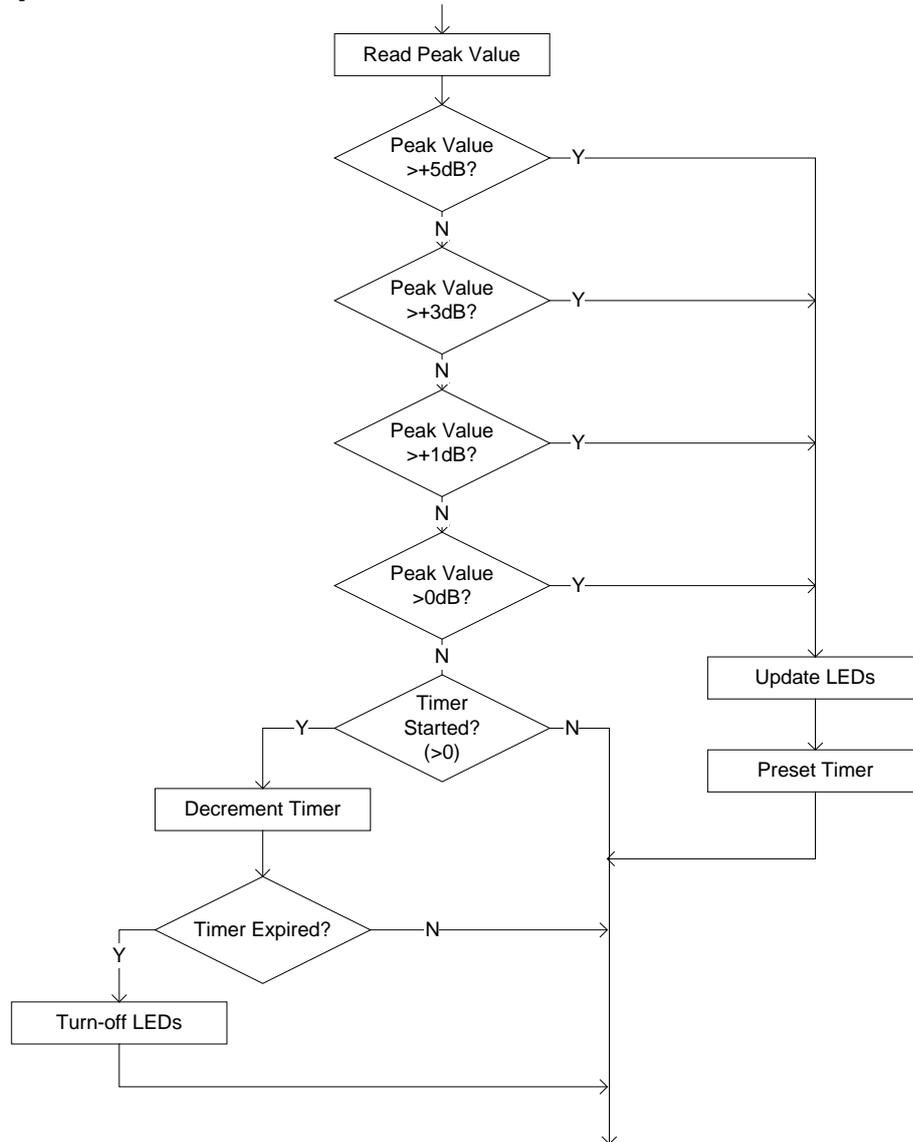


Figure 2. Transient response of the input circuit. The first and second frame give a higher than expected peak level.

The peak level value was noted to be higher than expected on the first, and occasionally the second, frame, regardless of the packet size. Figure 2 shows the peak response to a large, step change in the amplitude of the input signal. It is an expanded portion of a plot using the same format as Figure 1. The first and second frame's peak value have overshoot the steady state value for all subsequent frames. Software using the peak level value to control the input gain may need to take account of this overshoot although it can most likely be ignored.

A simple method to set the gain for record purposes is to construct a bargraph VU meter. The meter is used to set the input level manually by looking for repetitive, high level peaks indicated by the duration when all the LEDs are illuminated. LED indications corresponding to the lower peak values are acceptable provided they are not constant. The highest-level indication should be only brief and intermittent, or not at all.

## 5 Bargraph VU Meter



**Figure 3. A VU meter function**

Normally, a VU meter signals from around the noise floor to the maximum, undistorted level, which is set at 0dB. Because transients are normally tolerable in audio systems, the scale will continue upward to either +3dB or +5dB. The VU meter response is normally damped to make it easier to read.

The PE0002 is fitted with 4 LEDs, mounted adjacent to each other and can be controlled by script commands. They are ideal for a small bargraph using a partial scale. In this example each LED is assigned a value corresponding to peak level set-points of 0, +1, +3 and +5 dB, assuming a baseline of 10000 corresponds to 0dB. These set-points were derived through experimentation and may not be optimum for signal inputs with a different dynamic range.

Script, "Encode with VU.pes" is the encode process with a VU function added. The VU function is charted in Figure 3. The vocoder's Codemethod and the number of frames in a packet are controlled from an external configuration file, "CodecSetup.txt". This is opened in the configuration section of the script and

the values assigned to variables. The number of packets encoded is set by the constant, PacketCount which should be set to a useful value.

The VU meter function is very simple but effective. The ADC block digitises speech in 20ms slices and passes these, as a packet, to the peak level measurement function. The speech packet is then sent to the encoder. Thus, the VU function is placed in the script before the encoded packet is read from the vocoder. VU signal processing is managed during delay of the encode process. An interrupt and the PLV flag signal that a peak value is ready.

The LEDs are mapped to the peak level set-points so that the LEDs are turned on successively with increasing peak value. On a PLV interrupt, the peak value is read and then compared against the four set-points in descending magnitude. If one of the set-points has been exceeded, all the LEDs corresponding to that set-point and below, are illuminated and a counter is started. If none of the set-points are exceeded, then the counter is decremented and, when it reaches zero, all the LEDs are extinguished.

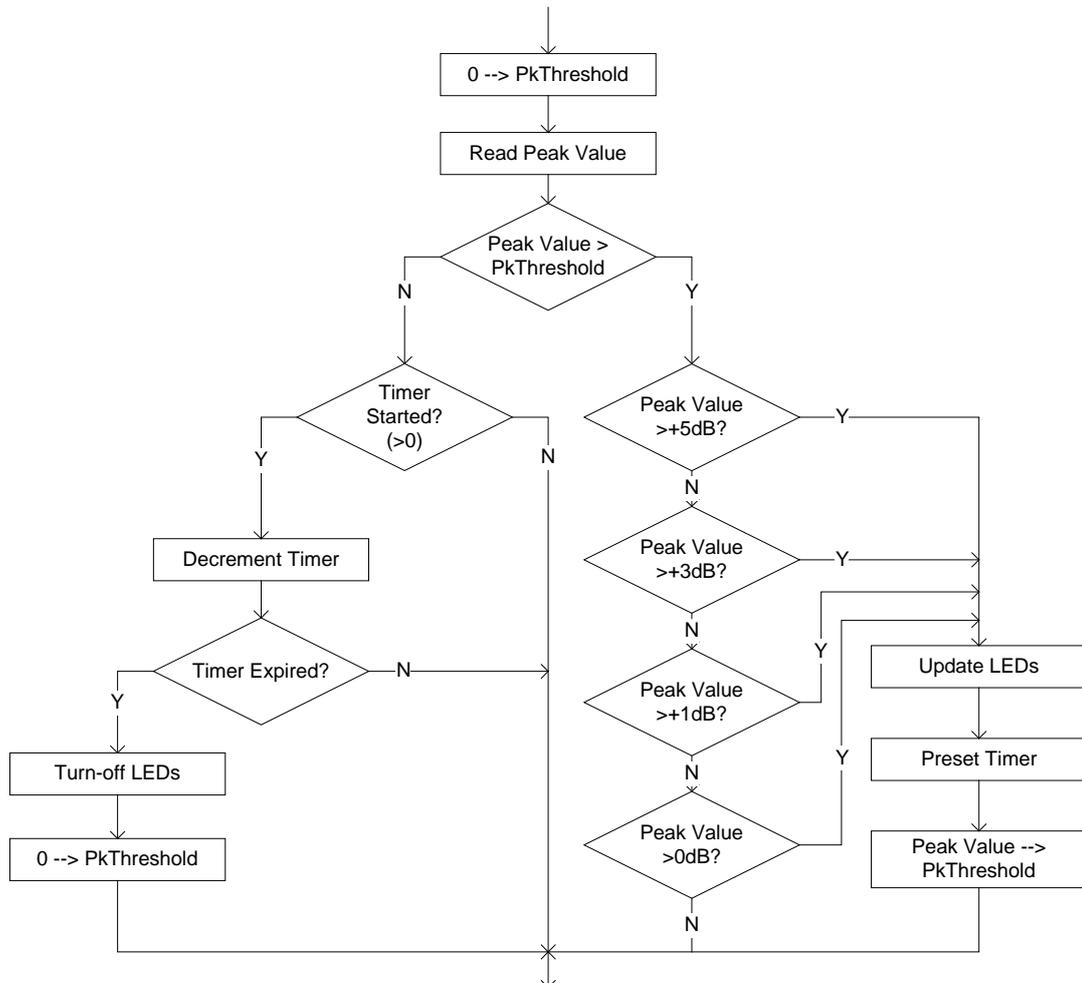
The counter provides a timer function that keeps the LEDs illuminated for a short period if no further peaks are detected. This ensures that single peak level events are captured although a value of 1, a 20ms period, was found to be adequate. Damping can be added if required, by averaging the peak levels detected within the counter's window.

In use, the standard and damped VU meters are best used with compressed speech, where compressed in this instance means an AGC or similar function has been applied. Compressed speech may contain amplitude peaks but they are likely to be transient and amplitude limited. Original, low level signals will have been amplified. The dynamic range of compressed speech is thus much lower than the original. Run the speech samples and the script. Examine the LEDs. Brief and intermittent illumination is okay but if the +5dB LED illuminates, back the gain off one step. Back the gain off if persistent illumination of any LEDs occurs. If the lowest gain setting is reached and the signal level is still too high, then attenuate the signal before the Vocoder's input. The gain is preset by the constant InGain.

For convenience, the peak level value of each frame is displayed in the log window in hex and decimal.

For uncompressed speech, a peak detector is often employed to indicate when the signal is close to the saturation point of the equipment or recording media. A peak detector gives an indication only when a set-point is exceeded, then holds this state for a short time. This function is occasionally used as an indicator to set input signal level on low-cost equipment. Both functions are normally combined in one meter in studio grade equipment to detect fast transients that may be missed with a damped VU function. A few simple script changes will allow the VU meter to function as a peak detector.

## 6 Bargraph Peak Detector



**Figure 4. The VU function modified for peak detection**

“Encode with peak det.pes” is the PE0002 script to demonstrate this function. The modifications to the VU function are clearly seen in Figure 4. The peak value is again compared against the four set-points but entry to the comparison is controlled by a test. When a set-point is exceeded the corresponding LED lights, a counter is preset and the peak value copied to the variable PkThreshold. This variable is ‘sticky’ or persistent, in that its value is only held for a timed period. As each peak value is read, it is compared against PkThreshold. If higher, the set-point comparisons are tested – the test mentioned earlier. If lower, the counter is decremented until zero is reached, when the lit LED is extinguished.

In use, the peak detect meter is best applied to signals with a wide dynamic range such as uncompressed speech. Run the speech samples and the script. Examine the LEDs. If the +5dB LED illuminates, back the gain off at least one step. If persistent illumination of any LED occurs, back the gain off 1 step. If the lowest gain setting is reached and the signal level is still too high, then attenuate the signal before the Vocoder’s input. The gain is preset by the constant InGain.



Peak Value	Gain Reduction (dB)
>17000	4.5
>15000	3
>11000	1.5

**Table 1. Gain Reduction corresponding to a measured peak value**

The previous two examples assumed the MIC Amp was disabled. In this example, the MIC Amp is included in the gain control loop since the automatic control of gain is most applicable to applications that use microphones and have no manual gain control.

For convenience, every time a gain adjustment is made, the corresponding frame number that caused the adjustment and the resulting gain, are output to the log window. If the MIC Amp is disabled, a message will be displayed. If the lowest gain setting is reached and the signal level is still too high, then a message will be displayed, the lowest gain setting retained and the recording process will continue.

## 8 Trialling The Encode/Decode Path

To allow the full encoder through decoder path, a generic script has been written for the decode process, "Decode.pes" This accesses the same configuration file as the encoder scripts, thereby ensuring both encode and decode processes match. The decoder also tests encoded data is available then tracks usage, so that it will terminate correctly when the encode data is exhausted.

In use, run any of the encode processes for the required time length. There is no restriction on the length of the recording except the file length restriction of the OS. The configuration file, "CodecSetup.txt" can be easily edited for different codec configurations. An extract from the configuration file follows:

```
;2400bps, 1x20ms, no FEC  
05  
06
```

```
2400bps, 2x20ms, no FEC  
;06  
;0C
```

Each paragraph comprises a text line that describes a possible vocoder configuration. The following two lines are the configuration information. If the vocoder configuration for 2400bps, 1x20ms, no FEC is examined it will be seen that configuration information is 05 and 06 with no leading semicolons. Each of the encode scripts parse the 'CodecSetup.txt' file and extract the two incidences without preceding semicolons. To change the configuration, remove the semicolons from the desired configuration and replace them in the unwanted configuration. The previous extract is modified to set the configuration to 2400bps, 2x20ms frames per packet and no FEC.

```
;2400bps, 1x20ms, no FEC  
;05  
;06
```

```
2400bps, 2x20ms, no FEC  
06  
0C
```

Any of the supplied scripts can be modified but both the relevant Vocoder Data Sheet and the Script Reference should be read and understood first.

## 9 Conclusion

The ideas presented here and the scripts resulting from them should not be relied on for final design but should be tested thoroughly to ensure that they meet the expected design requirements. The output gain control has been fixed at -14dB, which is the default after reset. Improvements may be made to the voice quality by carefully adjusting the input gain settings and optimising the output gain control.

The ideas presented here can be used

- In the preparation of preset recordings,
- to determine initial hardware set-up,
- to evaluate a prototype system,
- to provide a digital gain control with user feedback,
- to provide a software limiting function.

By extending the concepts, it is possible to develop a software AGC function or to extend gain control to external hardware.

## 10 Audio Source

ITU Series P, Exp2\original\e

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<b>Tel:</b> +44 (0)1621 875500 <b>Fax:</b> +44 (0)1621 875600 <b>Sales:</b> sales@cmlmicro.com <b>Tech Support:</b> techsupport@cmlmicro.com	<b>Tel:</b> +1 336 744 5050 800 638 5577 <b>Fax:</b> +1 336 744 5054 <b>Sales:</b> us.sales@cmlmicro.com <b>Tech Support:</b> us.techsupport@cmlmicro.com	<b>Tel:</b> +65 67450426 <b>Fax:</b> +65 67452917 <b>Sales:</b> sg.sales@cmlmicro.com <b>Tech Support:</b> sg.techsupport@cmlmicro.com	<b>Tel:</b> +86 21 6317 4107 +86 21 6317 8916 <b>Fax:</b> +86 21 6317 0243 <b>Sales:</b> cn.sales@cmlmicro.com.cn <b>Tech Support:</b> sg.techsupport@cmlmicro.com
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