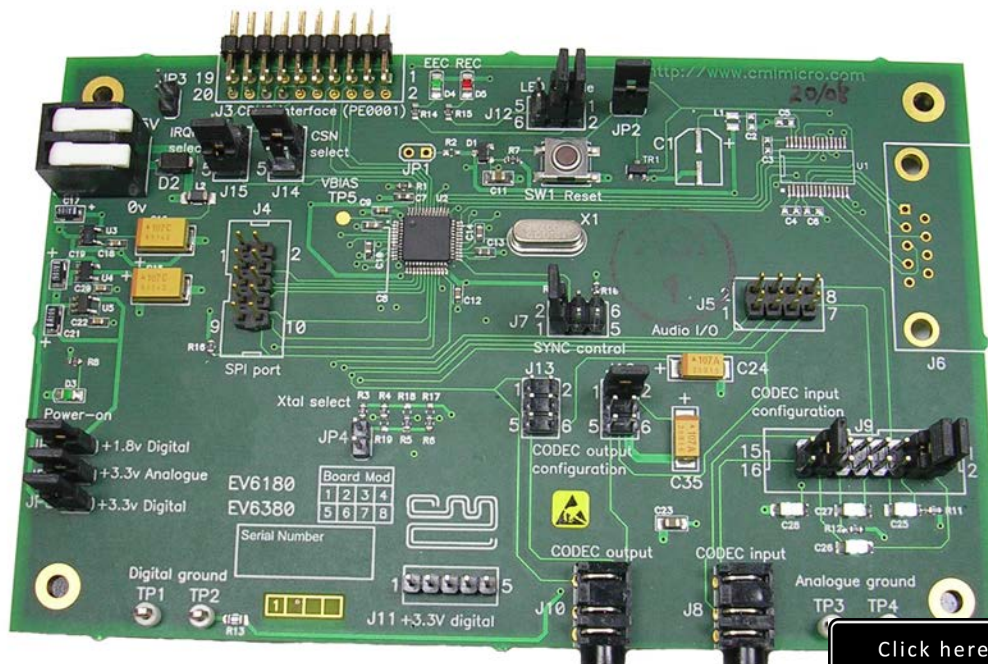


UM6180/5 September 2016

Features

- Evaluation platform for CMX608, CMX618 and CMX638 RALCWI Vocoder ICs
- 3.5mm stereo jack socket microphone connections to integral audio CODEC
- Single-ended or differential audio CODEC I/O
- Requires a single, external +5Vdc power supply
- EV6180: For CMX608 and CMX618
- Header connections to the SPI interface: for use with external 3rd party CODECs
- Header connections to the C-BUS interface: for PE0003 Evaluation Kit Interface Card or 3rd party microcontroller (not supplied)
- EV6380: For CMX638



Click here for:

- Latest Datasheet
- Product Data Resource

1. Brief Description

This document details the use of two Evaluation Kits: EV6180 for CMX608 and CMX618, EV6380 for CMX638. The EV6180 and EV6380 Evaluation Kits each provide the means to demonstrate and evaluate the operation of CMX6x8 RALCWI Vocoder ICs. The boards are operated from a single, external +5Vdc power supply. On-board voltage regulators provide the required analogue and digital supply voltages.

Each board can be controlled with a PE0003 Evaluation Kit Interface Card and ES0003 GUI software. To use this software, a host PC and PE0003 Evaluation Kit Interface Card are required. Additionally, an external audio CODEC is required to demonstrate the CMX608 option (EV6180).

Connectors are provided to allow direct interfacing to the C-BUS and SPI interfaces on the CMX6x8 devices. The on-chip audio CODEC (CMX618/638 devices only) is accessible through two 3.5mm stereo jack sockets. The audio CODEC signal paths can be configured as single-ended or differential.

CONTENTS

<u>Section</u>	<u>Page</u>
1. Brief Description	1
2. Preliminary Information	5
2.1. Laboratory Equipment	5
2.1.1. Power Supply	5
2.1.2. EvKit Interface Card – PE0003	5
2.1.3. External CODEC	5
2.1.4. External Microphone	5
2.1.5. External Loudspeaker(s)	5
2.1.6. Host PC	6
2.1.7. Cables	6
2.2. Handling Precautions	6
2.2.1. Static Protection	6
2.2.2. Contents - Unpacking	6
2.3. Approvals	6
3. Quick Start	7
3.1. Setting-Up the EV6180/6380 with the PE0003	7
3.2. Adjustments	7
3.3. Operation	7
4. Signal Lists	8
5. Circuit Schematics and Board Layouts	11
6. Detailed Description	12
6.1. Hardware Description	12
6.1.1. Voltage Requirements	12
6.1.2. Clocking	12
6.1.3. Device Reset	12
6.1.4. LED State Indication	12
6.1.5. CODEC Selection	12
6.1.6. Connectors and Jumpers	12
6.2. Full-duplex Demonstration	14
7. Performance Specification	17
7.1. Electrical Performance	17
7.1.1. Absolute Maximum Ratings	17
7.1.2. Operating Limits	17
7.1.3. Operating Characteristics	18

<u>Table</u>	<u>Page</u>
Table 1 – Signal List.....	9
Table 2 – Test Points	9
Table 3 – Default jumper tab settings	10
Table 4 – Configuration Options for Voice CODEC I/O	13

<u>Figure</u>	<u>Page</u>
Figure 1 – Evaluation Layout Diagram	4
Figure 2 – PCB Layout: top	11
Figure 3 – PCB Layout: bottom	11
Figure 4 – ‘Import Raw Data’ Dialog Box	15

It is always recommended that you check for the latest product datasheet version from the Datasheets page of the CML website: [www.cmlmicro.com].

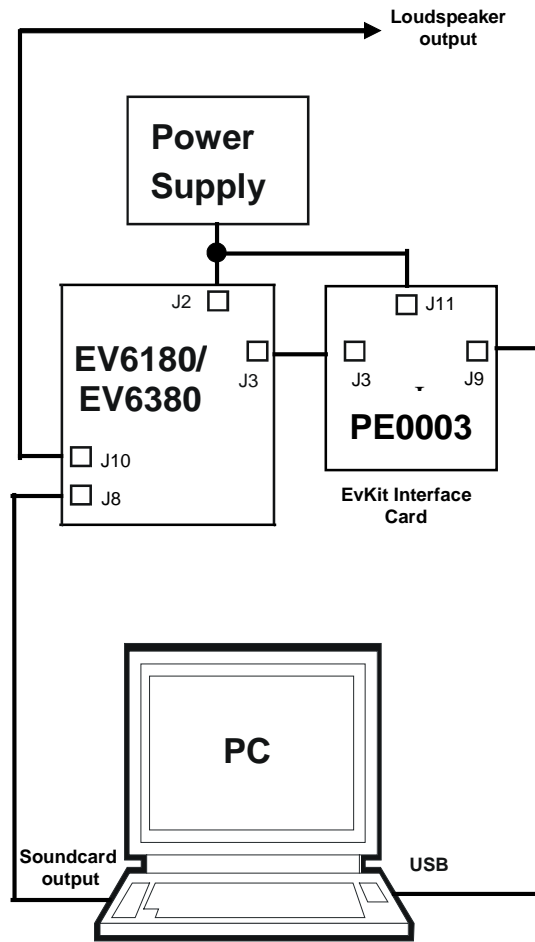


Figure 1 – Evaluation Layout Diagram

2. Preliminary Information

2.1. Laboratory Equipment

The following laboratory equipment will be useful for demonstrating the EV6180/6380:

2.1.1. Power Supply

A bench power supply with a regulated +5Vdc output.

2.1.2. EvKit Interface Card – PE0003

The ES0003 software application requires the use of a PE0003 Evaluation Kit Interface Card, which connects the PE0003 interface connector J3 to the C-BUS interface connector J3 on the EV6180/6380. The ES0003 application is part of the PE0003 support package, which is available from <http://www.cmlmicro.com/>. The PE0003 is not supplied with this kit, but can be ordered separately.

2.1.3. External CODEC

An external voice CODEC is required for demonstrating the CMX608 functionality. This connects to the SPI port connector (J4) on the EV6180. The CMX608/618/638 datasheet contains a section documenting external voice CODEC support. The external CODEC must be supplied by the customer.

2.1.4. External Microphone

It is recommended that an electret type of microphone is used for the demonstration. The power for this is supplied from the EV6180/6380 kit.

2.1.5. External Loudspeaker(s)

It is recommended that an external loudspeaker(s) with additional amplification is used to connect to the CODEC output socket. However, a 32ohm impedance loudspeaker can be connected directly without additional amplification.

2.1.6. Host PC

A PC with the following minimum specification:

- 1GHz Pentium processor or equivalent
- 1 USB port
- 256MByte RAM
- 10MByte of hard drive space available
- Windows 2000 or XP installed
- Software application ES0003xx installed
- A Sound Editor application such as Audacity installed
- Windows supported soundcard

2.1.7. Cables

USB type A male to mini B male cable.

2 x 3.5mm jack plug to 3.5mm jack plug (mono or stereo).

2.2. Handling Precautions

Like most evaluation kits, this product is designed for use in office and laboratory environments. The following practices will help ensure its proper operation.

2.2.1. Static Protection

This product uses low power CMOS circuits that can be damaged by electrostatic discharge. Partially damaged circuits can function erroneously, leading to misleading results. Observe ESD precautions at all times when handling this product.

2.2.2. Contents - Unpacking

Please ensure that you have received all of the items on the separate information sheet (EK6380) and notify CML within 7 working days if the delivery is incomplete.

2.3. Approvals

There are no approvals for this product.

3. Quick Start

This section provides instructions for users who wish to experiment immediately with the evaluation kit. A full description of the kit hardware and software is contained in section 6 of this document.

3.1. Setting-Up the EV6180/6380 with the PE0003

Before commencing with setting up the hardware and software please refer to section 4 of this document and ensure that the jumper tab settings on the board are the same as the default positions listed in Table 3.

Extract the PE0003 support package to a directory on the host PC.

Plug the right-angled connector J3 on the EV6180/6380 board directly into right-angled connector J3 on the PE0003. Connect the output of a regulated DC power supply to J2 on the EV6180/6380 and J11 on the PE0003. The supply voltage should be set at +5V.

Attach the USB cable between connector J9 on the PE0003 and the relevant USB port on the host PC. Apply voltage to both cards. D8 will illuminate on the PE0003 and D3 will illuminate on the EV6180/6380.

After power is applied to the EV6180/6380 and PE0003 a request will be displayed on the PC monitor to install the USB driver. The driver will be located in the directory into which the support package has been extracted, under the 'Driver' sub-directory. Note that during driver installation a message box may be displayed containing a message that the software being installed does not pass Windows Logo testing. Click on the 'Continue Anyway' button.

Once installation is complete the ES0003xx application can be started. When prompted press the reset switch SW1 on the PE0003 and click the 'OK' button on the GUI. The kit is now ready to use.

3.2. Adjustments

None.

3.3. Operation

Refer to section 6.

4. Signal Lists

CONNECTOR PINOUT				
Connector Ref.	Connector Pin No.	Signal Name	Signal Type	Description
J2	1	+5V	PWR	+5V external supply voltage
	2	GNDD	PWR	External supply ground
J3	5, 13, 14, 15, 17, 18,	N/C		
	1, 2, 3	CSN	I/P	C-BUS chip select
	4	CDATA	I/P	C-BUS command data
	6	CLK	I/P	C-BUS serial clock
	8	RDATA	O/P	C-BUS reply data
	7, 9, 10	IRQN	O/P	C-BUS interrupt request
	11, 12	GNDD	PWR	Digital ground
	16	SOFT_RESET	I/P	Reset control line for CMX6x8
	19, 20	+3V3D	PWR	+3.3V digital supply voltage
J4	1	N/C		
	2	+3V3D	PWR	+3.3V digital supply voltage
	3	STRB	I/P	SSP port serial strobe input
	4	SDI	I/P	SSP port serial data input
	5	GNDD	PWR	Digital ground
	6	SCLK	I/P	SSP port serial clock input
	7	EEC	O/P	Enable external CODEC
	8	SDO	O/P	SSP port serial data output
	9	REC	O/P	Reset external CODEC
	10	CSEL	I/P	External/internal CODEC select
J5	1	INPUTP	I/P	Positive audio CODEC input
	3	INPUTN	I/P	Negative audio CODEC input
	5	OUTP	O/P	Positive audio CODEC output
	7	OUTN	O/P	Negative audio CODEC output
	2, 4, 6, 8	GNDA	PWR	Analogue ground

Table continued on next page....

CONNECTOR PINOUT				
Connector Ref.	Connector Pin No.	Signal Name	Signal Type	Description
J8	Sleeve	GNDA	PWR	Analogue ground
	Tip	SOCKETP	I/P	Positive external audio input
	Ring	SOCKETN	I/P	Negative external audio input
J10	Sleeve	GNDA	PWR	Analogue ground
	Tip	OUTP	O/P	Positive external audio output
	Ring	OUTN	O/P	Negative external audio output
J11	1, 3	+3V3D	PWR	+3.3V digital supply voltage
	2, 4	GNDD	PWR	Digital ground
	5	N/C		

Table 1 – Signal List

TEST POINTS		
Test Point Ref.	Default Measurement	Description
TP1, TP2		Digital ground
TP3, TP4		Analogue ground
TP5	+1.65V	Analogue bias output

Table 2 – Test Points

JUMPERS			
Link Ref.	Positions	Default Position	Description
JP2	1 – 2	Open	Software reset connection disabled
JP3	1 – 2	Open	+3.3V digital supply rail disconnected from connector J3
JP4	1 – 2	Open	Crystal oscillator enabled
JP5	1 – 2	Short	Current measurement connection for +3.3V digital rail
JP6	1 – 2	Short	Current measurement connection for +1.8V digital rail
JP7	1 – 2	Short	Current measurement connection for +3.3V analogue rail
J7	1 – 2	Short	SYNC control pulled high to +3.3V
	3 – 4	Open	
	5 – 6	Open	
J9	1 – 2	Short	Audio CODEC input configured as single ended
	3 – 4	Short	
	5 – 6	Open	
	7 – 8	Open	
	9 – 10	Open	
	11 – 12	Open	
	13 – 14	Short	
	15 – 16	Open	
J12	1 – 2	Short	D4 and D5 drive enabled, internal CODEC selected
	3 – 4	Short	
	5 – 6	Open	
J13	1 – 2	Open	Audio CODEC output configured as single ended
	3 – 4	Open	
	5 – 6	Open	
J16	1 – 2	Short	
	3 – 4	Open	
	5 – 6	Open	
J14	1 – 2	Open	CSN drive select pin
	3 – 4	Short	
	5 – 6	Open	
J15	1 – 2	Open	IRQN drive select pin
	3 – 4	Open	
	5 – 6	Short	

Table 3 – Default jumper tab settings

Notes: I/P = Input
O/P = Output
PWR = Power

5. Circuit Schematics and Board Layouts

For clarity, circuit schematics are available as separate high-resolution files. These can be obtained via the CML website. The layout on each side of the PCB is shown in figures 2 and 3 shown below.

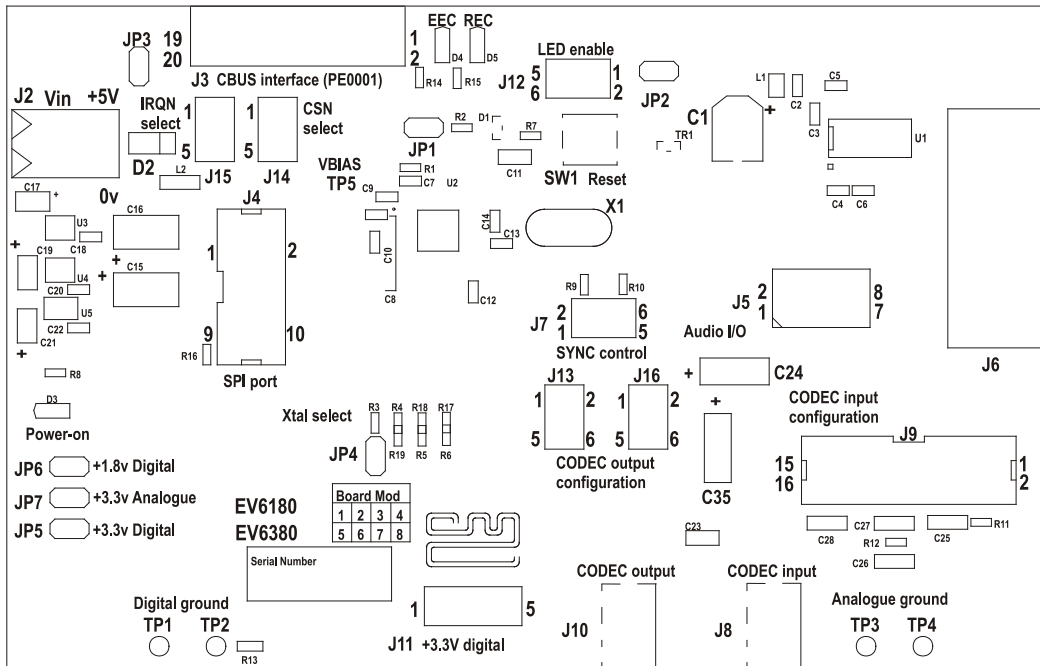


Figure 2 – PCB Layout: top

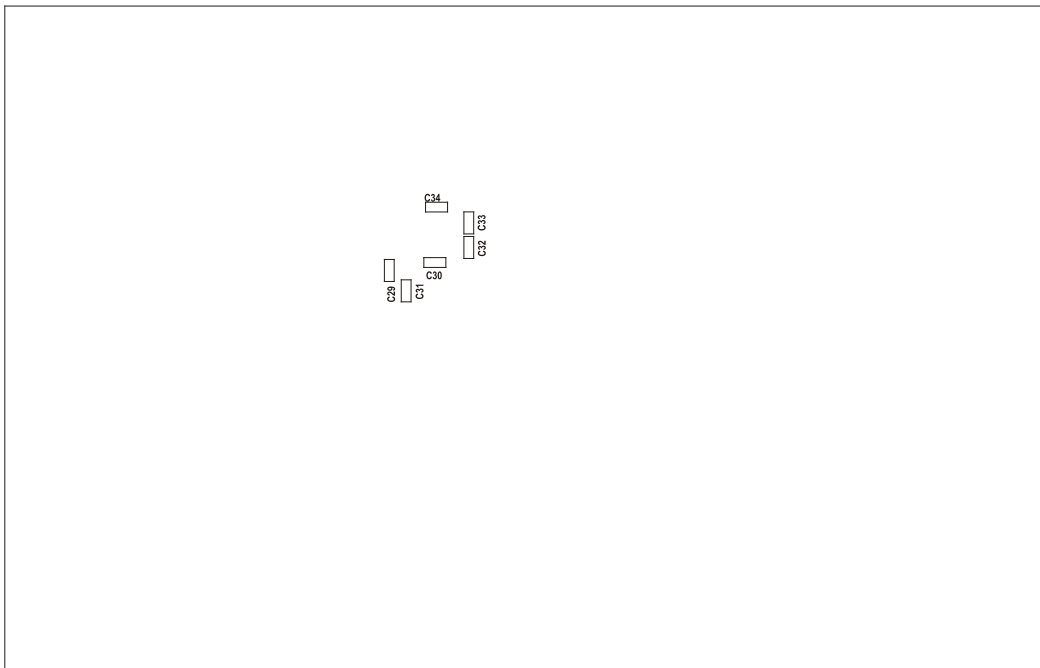


Figure 3 – PCB Layout: bottom

6. Detailed Description

6.1. Hardware Description

6.1.1. Voltage Requirements

The board is equipped with three voltage regulators, which provide +3.3V digital, +3.3V analogue and +1.8V digital supply voltages. The input to these regulators is provided by an external +5V power supply. Component D3 illuminates when the +3.3V digital voltage is present on the board.

To measure the current consumption of each supply rail remove the jumper tab from the relevant 2-pin header (JP5 for +3.3V digital, JP6 for +1.8V digital, JP7 for +3.3V analogue) and connect an ammeter to the header.

6.1.2. Clocking

The frequency of crystal X1, as supplied with the kit, is 12MHz. The crystal oscillator is disabled when a jumper tab is fitted to JP4 and enabled when removed.

6.1.3. Device Reset

The CMX6x8 can be reset in one of three ways:

- Pressing switch SW1
- Issuing a C-BUS reset command via the PE0003
- Driving pin 16 of connector J3 high, via the PE0003 (jumper tab must be fitted to JP2)

6.1.4. LED State Indication

LEDs D4 and D5 can be optionally connected to or disconnected from pins 19 and 20 respectively of the CMX6x8 device. The jumper tab settings on connector J12 determine whether the LEDs are in-circuit or not. By default both LEDs are connected in-circuit. The state of pins 19 and 20 is controlled by the C-BUS register EXCODECCONT (\$0B) and writing specific values to this register controls the illuminated state of the LEDs when they are in-circuit. For a description of this register refer to the CMX608/618/638 datasheet.

6.1.5. CODEC Selection

The setting of pins 5 and 6 of J12 selects an external CODEC or the internal (CMX618/638 only) CODEC. Fitting a jumper tab to these pins will select the external CODEC option and removing the jumper tab will select the internal CODEC option.

6.1.6. Connectors and Jumpers

The C-BUS signals from the CMX6x8 are terminated at connector J3. This is a 20-pin, right-angled male header, which will mate with the corresponding female socket (J3 or J7) on the PE0003 Evaluation Kit Interface Card. This allows the CMX6x8 C-BUS to be driven directly by the PE0003.

J3 also has +3.3V digital supply and ground connections. The +3.3V supply can be connected to pins 19 and 20 on connector J3 by fitting the jumper tab on JP3.

The C-BUS signals CSN and IRQN can each be connected to one of three pins on J3. The pin to which each of them is connected is determined by the jumper tab settings on connectors J14 and J15 (J14 for CSN, J15 for IRQN). The default setting is to connect CSN to pin 2 and IRQN to pin 10. This corresponds to the pin configuration for interfacing to the PE0003.

J4 is a double row 5-pin header and provides access to the SPI port signals on the CMX6x8. It also has +3.3V digital supply and ground connections.

J7 is used in conjunction with the SYNCCTRL register (address \$04) on the CMX6x8. This register controls Vocoder synchronisation with the controlling host. J7 can be used to pull up or pull down the SYNC pin on the CMX6x8 and to access the internal synchronisation signal. Additionally, an external synchronisation signal can be applied to the SYNC pin of the CMX6x8 via this connector.

The voice CODEC input and output pins on the CMX6x8 are directly accessible via connector J5. Alternative access to the voice CODEC I/O is through connectors J8 and J10, which are stereo, 3.5mm jack sockets. Signals applied to the board via these sockets can be routed into and out of the voice CODEC in single ended and differential configurations. The jumper tab settings of J9, J13 and J16 determine what configuration is used. Table 4 lists some suggested jumper tab settings for these connectors.

Configuration	Socket	J9 setting	J13 setting	J16 setting
Single ended input	J8	1 – 2 short 3 – 4 short 5 – 6 open 7 – 8 open 9 – 10 open 11 –12 open 13 –1 4 short 15 – 16 open	-	-
Differential input	J8	1 – 2 open 3 – 4 open 5 – 6 short 7 – 8 short 9 – 10 short 11 –12 short 13 –1 4 open 15 – 16 open	-	-
Single ended output	J10	-	1 – 2 open 3 – 4 open 5 – 6 open	1 – 2 short 3 – 4 open 5 – 6 open
Differential output	J10	-	1 – 2 open 3 – 4 short 5 – 6 open	1 – 2 open 3 – 4 open 5 – 6 open

Table 4 – Configuration Options for Voice CODEC I/O

Test points TP1, TP2, TP3 and TP4 are attachment points to the digital and analogue ground planes. These can be used to ground test and measurement equipment. Test point TP5 connects to the bias pin of the CMX6x8 and can be used to monitor the state of the bias voltage (1.65V).

J11 is an attachment point for the regulated +3.3V digital voltage.

6.2. Full-duplex Demonstration

This section contains an example script that can be executed using the Script Handler tab, which is part of the ES0003 software application. The script is available as part of the EV6380 support package, which is available from <http://www.cmlmicro.com/>. For a full description of the Script Handler command syntax refer to the Script Language Reference (publication SD/PE0003/script/2 or later) and the PE0003 User Manual (publication UM0003/2 or later). For a full description of the CMX638 device refer to the CMX608/618/638 datasheet.

The example script will set up the CMX638 for full-duplex operation at 2400bps. Using a software sound editor such as Audacity, installed on the host PC, PCM samples can be output from the PC sound card and fed into the CODEC input socket on the EV6180/6380. The PCM sample data will be encoded, decoded and the resultant output from the CODEC output socket of the EV6180/6380 can be played back through the sound card on the host PC.

```

;FullDuplexDemo.txt
value buffer 27                                ;Declare an array 'value' of size 27 x 16-bit.

register #1, #$09, #1                            ;Set Powersave register length to 8 bits
register #1, #$07, #1                            ;Set Vocoder configuration register length to 8 bits
register #1, #$2E, #1                            ;Set Service Acknowledgement reg. length to 8 bits
register #1, #$10, #1                            ;Set Decoder Frame register length to 8 bits
register #1, #$30, #1                            ;Set Encoder Frame register length to 8 bits
register #1, #$06, #1                            ;Set Analogue Output Gain register length to 8 bits
register #1, #$05, #1                            ;Set analogue Input gain register length to 8 bits
register #1, #$0A, #1                            ;Set DTMF Attenuation register length to 8 bits

device #1                                       ;Select device 1 (connect EV6380 to J3 PE0003)
copy #1, *$01                                   ;Reset CMX638
copy #0, value

while value == #0                               ;Wait for RDY flag (Status reg. bit 15) to be set
    copy *$40, value
    and #$8000, value
endwhile

copy #$00, *$05                                ;Set analogue input gain to 0dB
copy #$08, *$06                                ;Set analogue output gain to +2dB
copy #$8107, *$1F                              ;Enable interrupts
copy #$0006, *$1D                              ;Select fast clock speed for full-duplex mode
copy #$00, *$0A
copy #$03, *$09                                ;Turn on analogue BIAS and CODEC master clock
delay #100                                     ;Allow 100ms to allow bias to reach its final value
copy #$37, *$07                                ;Set FEC, HDD, 2400bps and 3 x 20ms frames
copy #0, value

while value == #0                               ;Wait for RDY flag to be set
    copy *$40, value
    and #$8000, value
endwhile

copy *$2E, value                               ;Check that device has accepted configuration
and #$0001, value
jmpc value == #$0001 device_configured
disp "Device not configured"
stop

device_configured
disp "Device configured"
copy #$0003, *$11                              ;Enable encoder and decoder
copy #0, value

while value == #0                               ;Wait for RDY flag to be set
    copy *$40, value
    and #$8000, value
endwhile

copy *$2E, value                               ;Check that device has accepted control command
and #$0001, value
jmpc value == #$0001 device_ready

```

```

        disp "Device not ready"
        stop
device_ready
        disp "Device ready"
        jmp encode_frames           ;Start processing frames

encode_frames
        copy *$40, value           ;Clear any pending interrupt
        copy #0, value
        jsr wait_for_interrupt     ;Wait for Vocoder Data Available flag to be set
        read *$30, value[0], #27  ;Read encoded frame (27 bytes) from device
        jmp decode_frames         ;Decode the encoded frame

decode_frames
        write value[0], *$10, #27 ;Write encoded frame to Decoder Frame register
        jmp encode_frames         ;Process the next frame

wait_for_interrupt
        while value == #0
            copy *$40, value
            and #$0001, value
        endwhile

        return

```

There are numerous software based sound editors currently available, both open source and proprietary. Audacity is an open source application and is freeware. It is available for download from <http://audacity.sourceforge.net/>. A short guide to using Audacity with the demonstration is described below. Before running through the demonstration it is assumed that the following has been carried out:

- The EV6180/6380 has been connected to the PE0003 and both boards powered up
- The ES0003 application is running
- The PC soundcard output is connected to the CODEC input socket and the CODEC output socket is connected to the PC soundcard input
- A loudspeaker or headphones have been connected to the audio output of the PC soundcard

1. Start the Audacity application.
2. From the 'Project' menu select the 'Import Raw Data' option.
3. Select a file that holds PCM encoded speech and click on the 'Open' button. The format of the encoded speech must be signed, 16-bit PCM, with a sampling frequency of 8kHz.
4. Set the options on the 'Import Raw Data' dialog box to the same settings shown in Figure 4. The raw data once imported will be displayed on an audio track within the editor window.

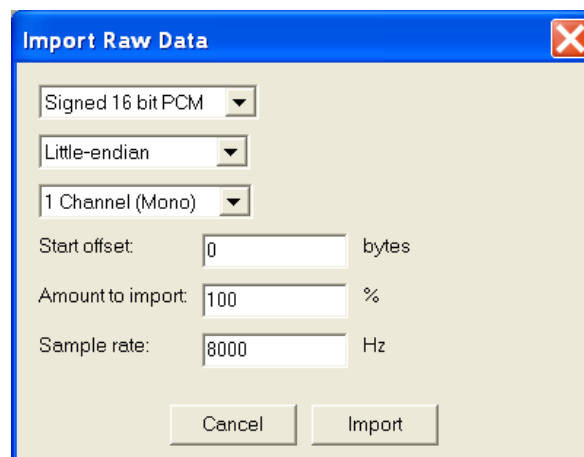


Figure 4 – 'Import Raw Data' Dialog Box

5. Press the 'Select Script' button on the Script Handler tab within the ES0003 application. Using the displayed dialog box navigate to the directory on the host PC where the example script has been extracted and select it. Once the script has been loaded press the 'Run' button to run the script.
6. Using the opened Audacity editor window, begin playback of the imported audio track by pressing the play button. The play button is displayed within the Control toolbar, which by default is located at the top right corner of the Audacity editor window. For continual looped playback of the audio track hold down the shift key whilst pressing the play button.

7. Performance Specification

7.1. Electrical Performance

7.1.1. Absolute Maximum Ratings

Exceeding these maximum ratings can result in damage to the Evaluation Kit.

	Min.	Max.	Units
Supply ($V_{IN} - V_{SS}$)	-0.3	16.0	V
Voltage on any connector pin to V_{SS}	-0.3	$V_{DD} + 0.3$	V
Current into or out of OUTP, OUTN, V_{IN} and V_{SS} pins	0	+1.5	A
Current into or out of any other connector pin	-20	+20	mA

7.1.2. Operating Limits

Correct operation of the Evaluation Kit outside these limits is not implied.

	Notes	Min.	Max.	Units
Supply ($V_{IN} - V_{SS}$)		4.0	16.0	V
Xtal/External Clock Frequency	1	9.6	24.0	MHz

Notes: 1. Allowable maximum crystal frequency is 12MHz. Frequencies above 12MHz should be generated by an external clock source.

7.1.3. Operating Characteristics

For the following conditions unless otherwise specified:

Xtal Freq. = 12.0MHz \pm 100ppm, $V_{DDPA} = AV_{DD} = IOV_{DD} = 3.0V$ to 3.6V; $V_{DD} = 1.7V$ to 1.9V; $T_{amb} = 25^{\circ}C$.

	Notes	Min.	Typ.	Max.	Units
DC Parameters					
I_{DD} (total, when operating)	1		50.0	–	mA
AC Parameters					
CODEC					
Input Impedance (INPUT P or INPUT N)		1	–	–	M Ω
Input Voltage Range (INPUT P or INPUT N)		–	–	20 to 80	% V_{DD}
Differential Input Voltage		–	–	100	% V_{DD}
Output Load Impedance (OUT P or OUT N)	3	32	–	–	Ω
Output Voltage Range (OUT P or OUT N)	2	–	–	10 to 90	% V_{DDPA}
Differential Output Voltage	2	–	–	160	% V_{DDPA}
Differential Output Power	2	–	120	–	mW
Xtal/Clock Input (for an external clock)					
'High' pulse width		15			ns
'Low' pulse width		15			ns
Input logic "1" level		70%			V_{DD}
Input logic "0" level				30%	V_{DD}
μC Interface					
Input logic "1" level		80%			V_{DD}
Input logic "0" level				20%	V_{DD}
Output logic "1" level ($I_{OH} = 120\mu A$)		90%			V_{DD}
Output logic "0" level ($I_{OL} = 360\mu A$)				10%	V_{DD}

- Notes:**
1. PCB current consumption, including current consumption of the CMX6x8, with no external loads.
 2. Measured whilst driving a 32 Ω resistive load between OUTP and OUTN pins.
 3. Care should be taken to avoid shorting the OUTP and OUTN pins together, or to V_{DD} or V_{SS} .

Operating Characteristics - Timing Diagrams

Please refer to CMX608/618/638 Datasheet for details.

CML does not assume any responsibility for the use of any circuitry described. No IPR or circuit patent licences are implied. CML reserves the right at any time without notice to change the said circuitry and any part of this product specification. Evaluation kits and demonstration boards are supplied for the sole purpose of demonstrating the operation of CML products and are supplied without warranty. They are intended for use in a laboratory environment only and are not for re-sale, end-use or incorporation into other equipments. Operation of these kits and boards outside a laboratory environment is not permitted within the European Community. All software/firmware is supplied "as is" and is without warranty. It forms part of the product supplied and is licensed for use only with this product, for the purpose of demonstrating the operation of CML products. Whilst all reasonable efforts are made to ensure that software/firmware contained in this product is virus free, CML accepts no responsibility whatsoever for any contamination which results from using this product and the onus for checking that the software/firmware is virus free is placed on the purchaser of this evaluation kit or development board.

 CML Microcircuits (UK) Ltd <small>COMMUNICATION SEMICONDUCTORS</small>	 CML Microcircuits (USA) Inc. <small>COMMUNICATION SEMICONDUCTORS</small>	 CML Microcircuits (Singapore) Pte Ltd <small>COMMUNICATION SEMICONDUCTORS</small>
Tel: +44 (0)1621 875500 Fax: +44 (0)1621 875600 Sales: sales@cmlmicro.com Tech Support: techsupport@cmlmicro.com	Tel: +1 336 744 5050 800 638 5577 Fax: +1 336 744 5054 Sales: us.sales@cmlmicro.com Tech Support: us.techsupport@cmlmicro.com	Tel: +65 62 888129 Fax: +65 62 888230 Sales: sg.sales@cmlmicro.com Tech Support: sg.techsupport@cmlmicro.com
- www.cmlmicro.com -		