

## FEATURES

- Up to 192kHz sampling frequency
- Up to 24 bits resolution
- USB 2.0 device
- Bit-perfect, asynchronous transfer
- Low jitter on-board oscillators
- Kernel streaming and direct sound operation
- Compatible with Windows XP, Vista and 7 (32 and 64 bits)
- Compatible with MacOS (Intel and PowerPC platforms)
- Accepts all common high-quality files' sampling frequencies: 44.1, 48, 88.2, 96, 176.4 and 192kHz
- LVCMOS I<sup>2</sup>S output
- 5V or 3.3V/1.8V supply
- 5V bus supply option
- Small form factor (55.9 x 36.2 mm)

## APPLICATIONS

- High performance audio USB input for DAC's, streaming players, class-D amplifiers
- USB-to-S/PDIF or USB-to AES-EBU adaptors

## DESCRIPTION

M2TOEM-01 is a high performance USB-to I<sup>2</sup>S converter which allows for asynchronous audio transfer from a computer provided with an USB 2.0 port to a digital audio device or equipment provided with I<sup>2</sup>S interface.

Thanks to proprietary drivers (included in the package), M2TOEM-01 overcomes all the problems and limitations of various off-the-shelf IC's which operation is generally limited to direct sound 48kHz, 16 bits or, using ASIO or WASAPI drivers, to 96kHz, 24 bits.

M2TOEM-01 operates up to 192kHz, 24 bits in kernel streaming mode.

No specific programming skills are required to integrate M2TOEM-01 in an existing or new design. All the software, firmware and microcode is provided either in the IC's used on the board or as drivers.

Two strip connectors carry all I<sup>2</sup>S, supply and control signals for an easy integration on a motherboard.

Various supply options allow for different layouts: M2TOEM-01 can be directly powered by the USB bus itself or various external supply layouts can be implemented.

Control signals carry information about interface status, base clock selection and multiplication factor (x1, x2 and x4). Also, mute and reset signals are available.

Low-capacity high speed protection on USB bus lines allow for easy CE marking. USB connector chassis can be earthed or grounded by means of a metallized hole on the PCB.



## ORDERING INFORMATION<sup>(1)</sup>

T <sub>i</sub>	SUPPLY OPTION	PART NUMBER
0-70°C	Bus powered	M2TOEM-01-1
	External 5V / Filtered bus power	M2TOEM-01-2
	External 3.3V + 1.8V	M2TOEM-01-3
	External 3.3V + 1.8V / Filtered oscillators power	M2TOEM-01-4

(1) All versions are RoHS compatible.

### ABSOLUTE MAXIMUM RATINGS <sup>(1)</sup>

over operating free-air temperature range (unless otherwise noted)

		UNIT
Supply voltage range (with respect to GND)	5V <sub>IN</sub>	5.5V
	3.3V <sub>IN</sub>	4.0V
	1.8V <sub>IN</sub>	2.0V
Output current	any output pin	10mA
T <sub>A</sub>	Operating free-air temperature range	0°C to 60°C
T <sub>j</sub>	Junction temperature range	0°C to 70°C
T <sub>stg</sub>	Storage temperature	-40°C to 125°C

(1) Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the devices on the board. These are stress ratings only, and functional operation of the devices on the board at these or any other conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect board reliability.

### RECOMMENDED OPERATING CONDITIONS

	MIN	NOM	MAX	UNIT
5V <sub>IN</sub> (M2TOEM-01-2)	4.5	5	5.5	V
3.3V <sub>IN</sub> (M2TOEM-01-3 and M2TOEM-01-4)	3.0	3.3	3.6	V
1.8V <sub>IN</sub> (M2TOEM-01-3 and M2TOEM-01-4)	1.6	1.8	1.9	V
OSCV <sub>IN</sub> (M2TOEM-01-4)	3.0	3.3	3.6	V
Operating junction temperature range, T <sub>j</sub>	0		70	°C

### ELECTRICAL CHARACTERISTICS

T<sub>j</sub> = 0°C to 60°C and recommended supply voltage range (unless otherwise stated)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
I <sub>CC</sub>	M2TOEM-01-2 Bus connected			85	mA
I <sub>CC</sub>	M2TOEM-01-2 No bus			25	mA
I <sub>CC33</sub>	M2TOEM-01-3 Bus connected			120	mA
I <sub>CC33</sub>	M2TOEM-01-3 No bus			32	mA
I <sub>CC33</sub>	M2TOEM-01-4 Bus connected			87	mA
I <sub>CC33</sub>	M2TOEM-01-4 No bus			3	mA
I <sub>CC18</sub>	M2TOEM-01-3/4			2.5	mA
I <sub>CCOSC</sub>	M2TOEM-01-4			30	mA
V <sub>OH</sub>	I <sup>2</sup> S, MCLK pins	2.9			V
	All pins except I <sup>2</sup> S, MCLK, I <sub>OUT</sub> =4mA	2.4			V
V <sub>OL</sub>				0.4	V
MCLK		22.5972		24.576	MHz
SCLK		2.8224		12.288	MHz
LRCK		44.1		192	kHz

### J2 PIN DESCRIPTION

PIN	TYPE	NAME	FUNCTION
1, 3, 5, 7	Power	GND	Ground return for high speed signals
2	Output	MCLK	Master clock from on-board low-jitter oscillators
4	Output	SCLK	I <sup>2</sup> S Bit clock
6	Output	LRCK	I <sup>2</sup> S Sampling frequency
8	Output	SDATA	I <sup>2</sup> S Serial Data

### J4 PIN DESCRIPTION

PIN	TYPE	NAME	FUNCTION
3, 5, 11, 14	Power	GND	Ground return for supply and low speed signals
1	Power	5V <sub>BUS</sub>	Bus 5V output
2	Power	5V <sub>IN</sub>	External 5V input <sup>(1)</sup>
4	Power	3.3V <sub>IN</sub>	External 3.3V input <sup>(1)(2)</sup>
6	Output	MUTE	Mute/no data signal, active high
7	Output	CLKSEL1	MCLK/LRCK ratio indicator
8	Output	CLKSEL0	
9	Output	#RESET	Reset signal for external devices, active low
10	Output	24/22	Indicates which oscillator is selected
12	Power	1.8V <sub>IN</sub>	External 1.8V input <sup>(1)(2)</sup>
13	Power	OSCV <sub>IN</sub>	External oscillator power input <sup>(1)(2)(3)</sup>

(1) Leave unconnected on M2TOEM-01-1.

(2) Leave unconnected on M2TOEM-01-2.

(3) Leave unconnected on M2TOEM-01-3.

TYPICAL APPLICATION CIRCUITS

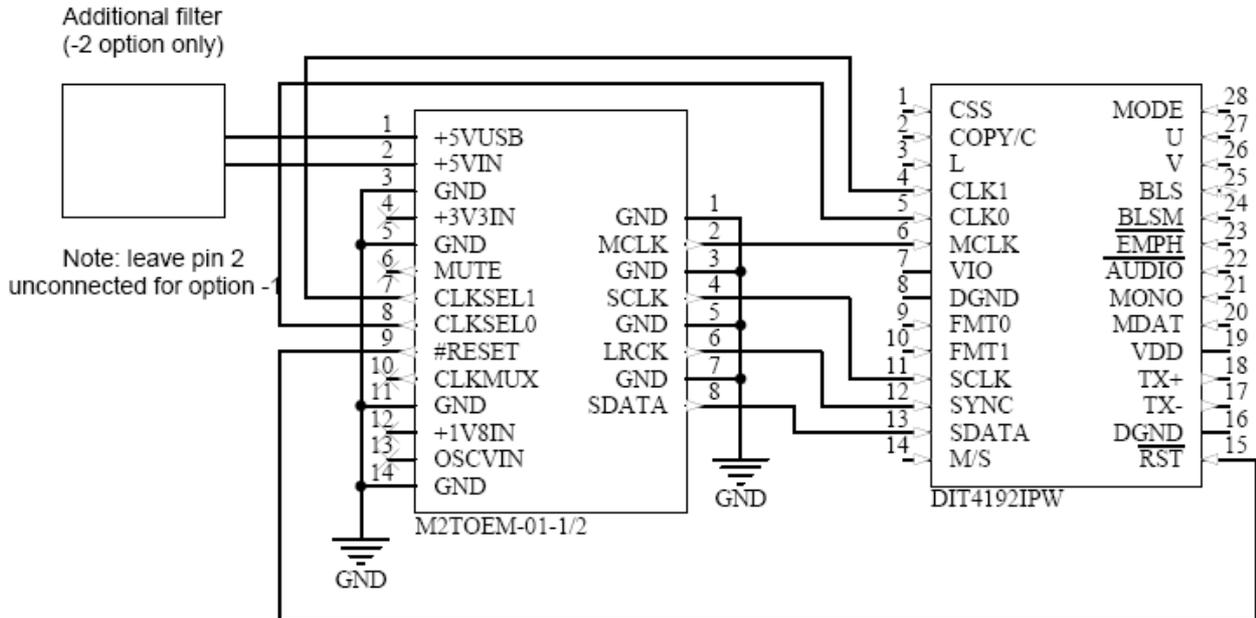


Figure 1. Standalone USB-S/PDIF adaptor

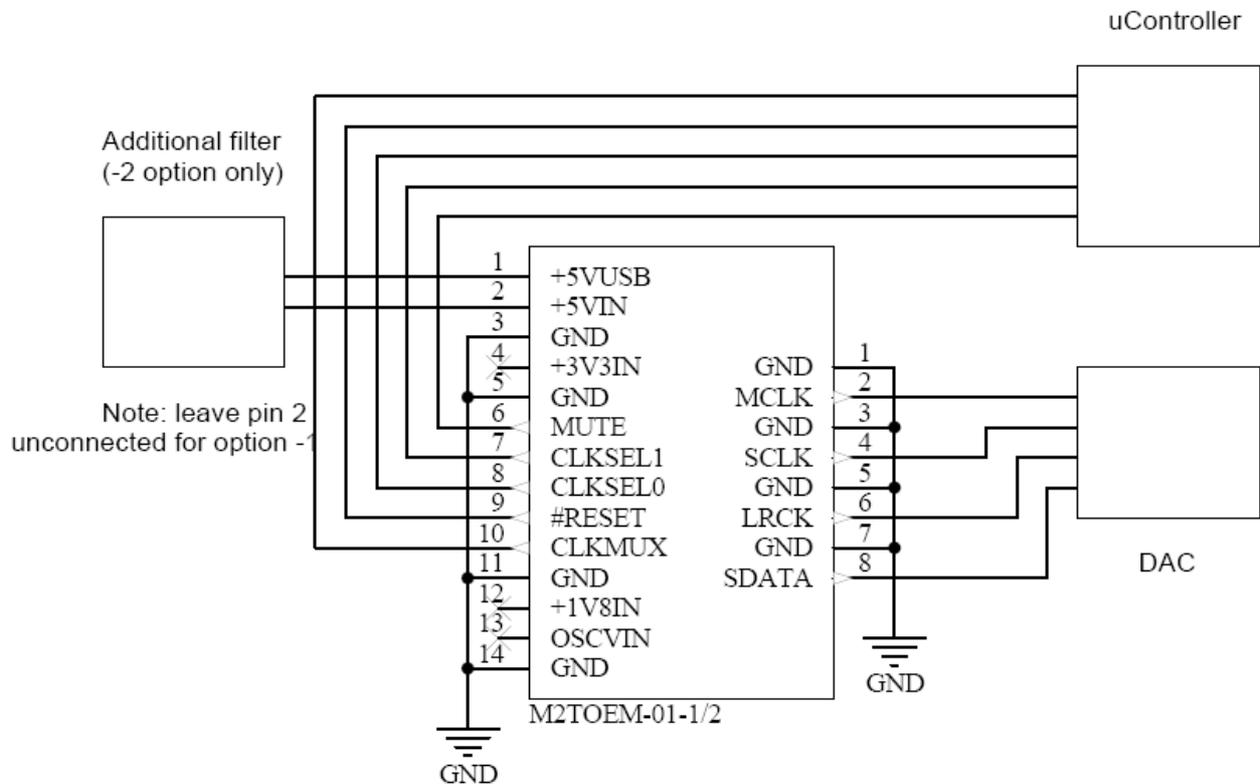


Figure 2. Bus powered USB interface for D-to-A converter

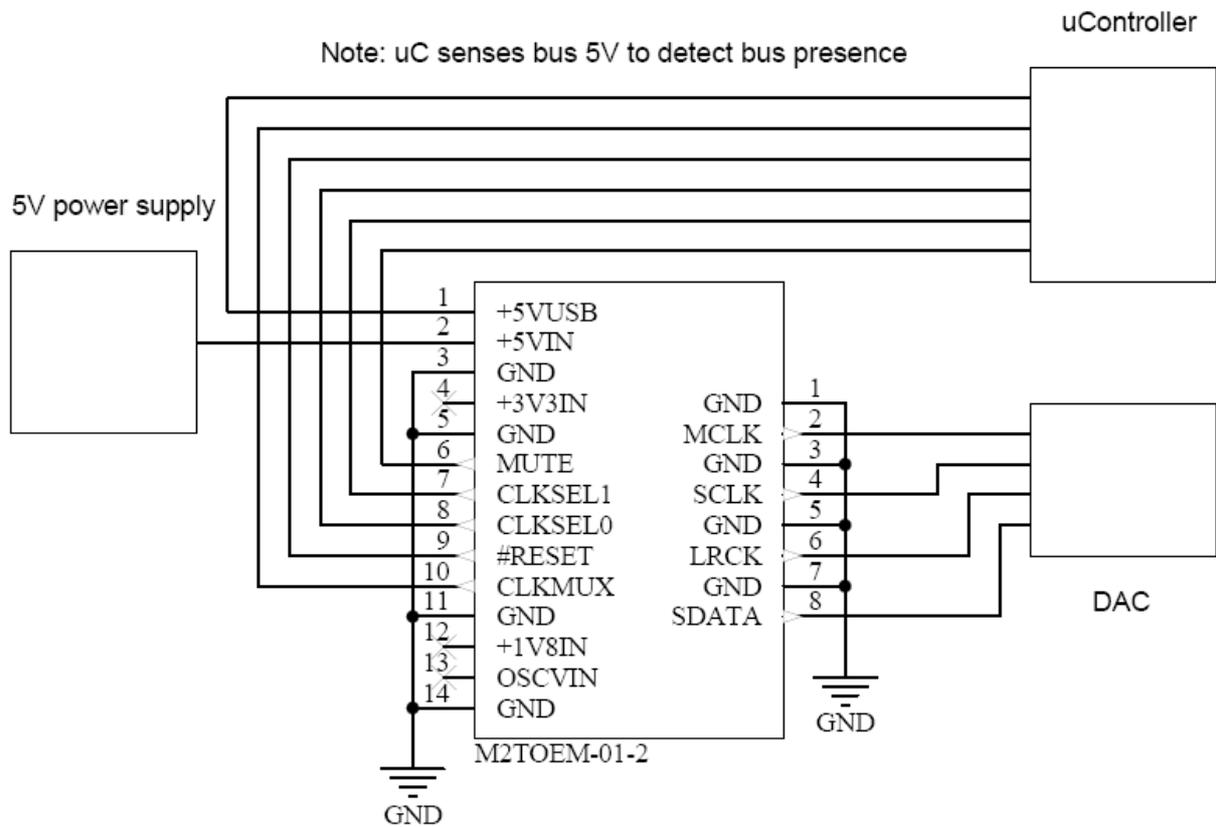


Figure 3. 5V-powered USB interface for D-to-A converter (3.3V LVCMOS outputs)

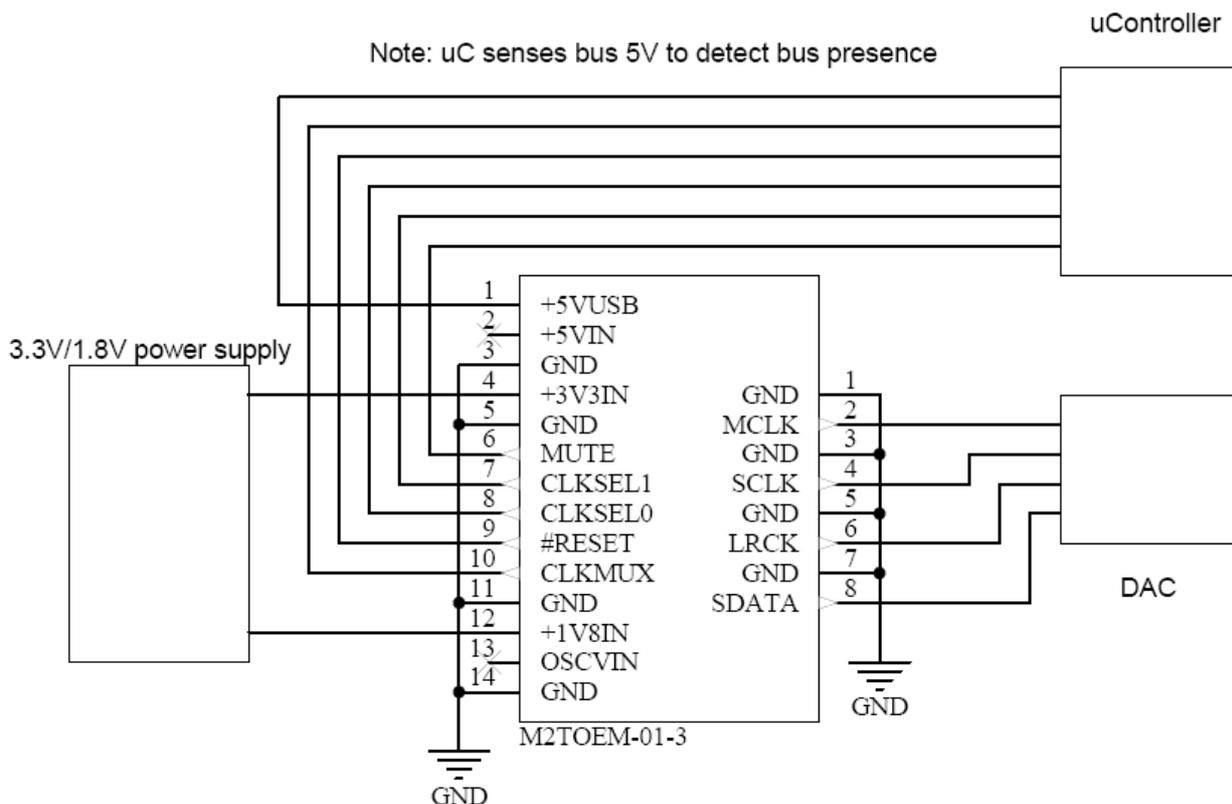
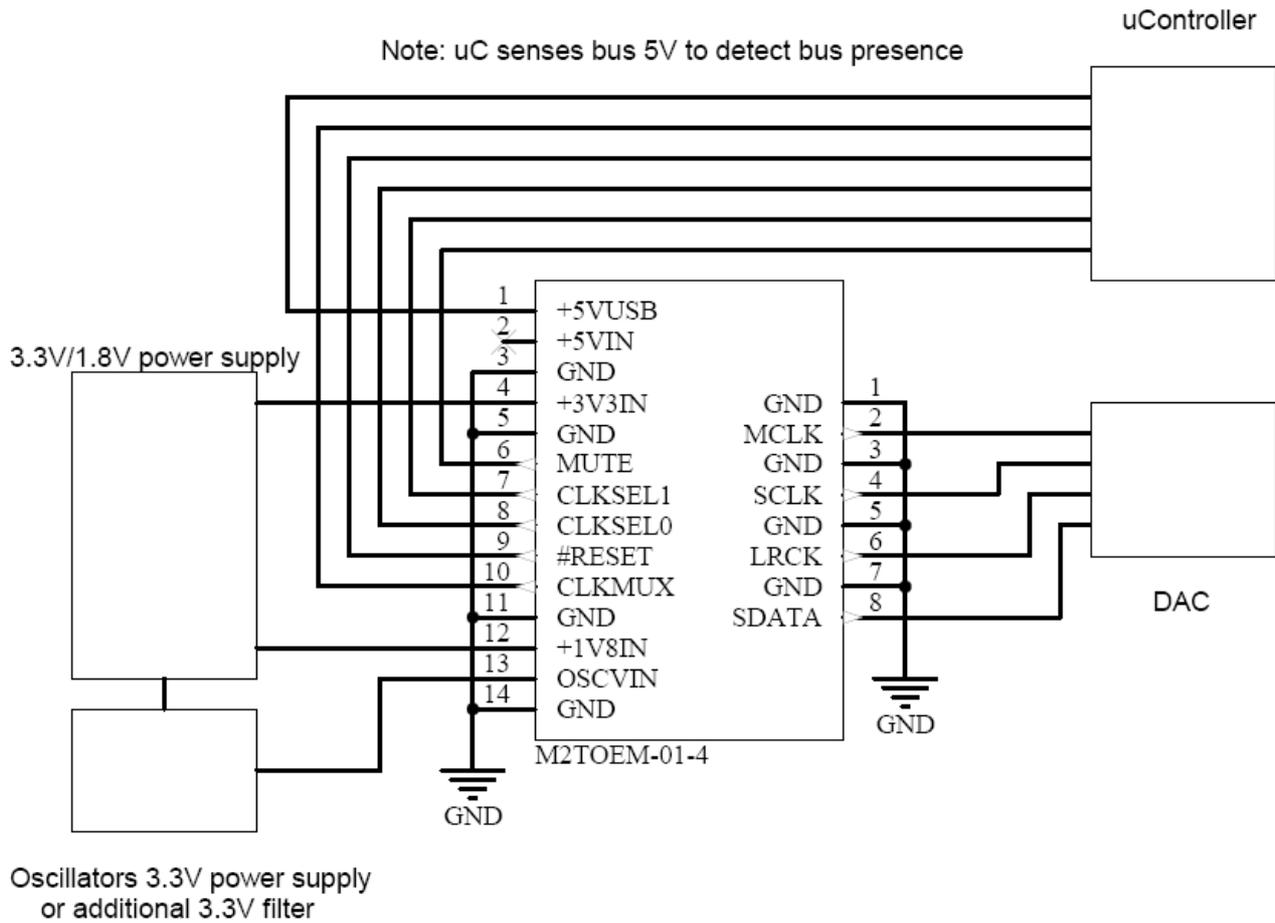


Figure 4. 3.3V/1.8V-powered USB interface for D-to-A converter



**Figure 5. 3.3V/1.8V-powered USB interface with filter or separate supply for oscillators**

## APPLICATION INFORMATION

The I<sup>2</sup>S output of M2TOEM-01 is always active, regardless of the state of the bus (connected or not connected). Upon reset, the output interface sets for 192kHz. Subsequent playback of files with different sampling frequency causes the interface parameters to change accordingly. Frequency settings (and indicator pins status) only change when MUTE pin is high.

### CLKSEL[1..0] indicators and MCLK/LRCK ratio

The relationship between MCLK and LRCK is indicated by CLKSEL[1..0] as reported by the following table (format is compatible with TI digital audio transmitter DIT4192 settings):

CLKSEL[1..0]	MCLK/LRCK ratio
00	128
01	256
10	invalid
11	512

**Table 1. Clock multiplication ratios**

Example: when a 44.1kHz file is played back, CLKSEL[1..0] are 11, because MCLK frequency is 22.5792MHz ( $22579.2/44.1=512$ ).

CLKSEL[1..0] can be used to indicate to a DAC or a uController which frequency is used at the moment, or to drive a multiplexer/divider should MCLK be too high at low sampling rates.

### CLKMUX indicator and oscillator selection

Two high precision, low jitter oscillators are used on M2TOEM-01. Depending on the sampling frequency of the file to be played back, one of the two oscillators must be selected. The selection is performed automatically and is indicated by CLKMUX output as reported in the following table:

CLKMUX	MCLK
0	22.5792MHz
1	24.576MHz

**Table 2. Clock selection**

### Supply options

Depending on the option selected, M2TOEM-01 can be powered in different ways. Option -1 is for standalone applications, such as USB-to-S/PDIF or USB-to-AES-EBU adaptors. It gets power directly from USB bus. Option -2 allows for external 5V supply, but can also be used for standalone application when extra filtering of USB supply is required. Options -3 and -4 are best suited to applications in which a good, clean supply is available. Option -3 requires 3.3V and 1.8 from a motherboard or an external supply board. Option -4 allows for extra filtering of oscillator 3.3V supply to further reduce jitter.

### Galvanic isolation of M2TOEM-01

In certain applications it is desirable to galvanically isolate the module from the downstream circuit. This can be easily accomplished using specific IC's, like those in Analog Devices' ADuM140x and ADuM540x series, to translate high speed signals. The latter (which also include an isolated DC/DC converter) is particularly suitable to M2TOEM-01-2/3/4 which require an isolated supply. Check the power capability of ADuM540x modules before using them: when needed, it's possible

to synchronize more than one module to obtain more power. Please visit ADI website for more details. Slow signals (CLKSEL[1..0], CLKMUX, MUTE, #RESET) may also be decoupled using photocouplers.

M2TOEM-01-1 is self-powered from the bus, thus it doesn't require an isolated supply. In this case, either an ADuM140x or totem-pole output logic photocouplers can be used for MCLK and I2S signals.

## MECHANICAL DATA

(TBD)

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