THCAD2 MANUAL

Version 1.5

WARNING

The THCAD2 card may have potentially deadly input voltages. There are direct hazards from coming into contact with the input or A-D side of the THCAD2, and indirect hazards caused by inadvertent loss of isolation.

1. Do not touch card when system power is applied.

2. Do not operate in a location where the THCAD2 card may become wet or contaminated with conductive materials.

3. Always ground THCAD2 power ground to system ground.

Table of Contents

THCAD

GENERAL

The THCAD2 is a frequency to voltage converter type A-D designed for high noise environments like plasma voltage monitoring for torch height controls. The THCAD2 has selecable 0 to 5V and 0 to 10V ranges. When used for direct plasma voltage monitoring, the THCAD2 requires an external high voltage resistor.

The THCAD2 has a frequency output range of approximately 100 KHz to 1 MHz. This can be counted directly by our FPGA cards or uControllers for conversion to digital voltage value. The frequency output can optionally be divided by 32, 64 or 128 if the output must be counted in software.

Frequency and reference frequency outputs are available. Both outputs are differential for high noise immunity, but can be used single-ended (TTL) if desired. The A-D has galvanically isolated inputs (2500V common mode isolation). The THCAD2 can withstand a 500V input overload indefinitely.

Being a frequency to voltage type A-D, resolution is sample rate dependent and approximately 10 bits at a 1 KHz sample rate and 12 bits at a 250 Hz sample rate. The THCAD2 requires 5V at 100 mA for operation. Pluggable screw terminal blocks are provided for all connections.

HARDWARE CONFIGURATION

GENERAL

The THCAD2 has 2 hardware settable options. These options are 5V/10V full scale input select and output frequency select. Hardware options are determined by moving sets of jumpers to different positions. The jumper positions assume that the THCAD2 card is right-side up, that is the THCAD2 silkscreen text is right-side up.

5V/10V FULL SCALE SELECTION

The THCAD2 has a selectable 5V or 10V full scale input range. When W1 is in the "UP" position the 10V range is selected. When W1 is in the "DOWN" position, the 5V range is selected.

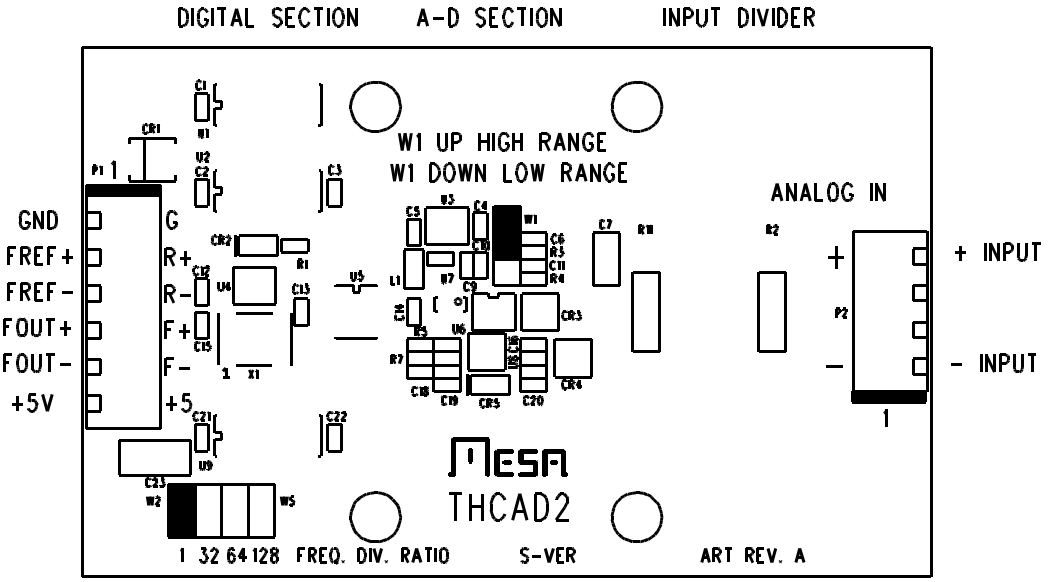
W1	**MODE**
UP	10V FULL SCALE
DOWN	5V FULL SCALE

OUTPUT FREQUENCY

The THCAD2's frequency output can be optionally divided by 32, 64, or 128 for applications where the frequency is counted by software. Output frequency is selected by placing a shorting jumper on one of 4 sets of pins. Default mode is divide by one. The calibration data on the THCAD is recorded in the divide by one mode.

W2	**W3**	**W4**	**W5**	**MODE**
IN	OUT	OUT	OUT	F/1
OUT	IN	OUT	OUT	F/32
OUT	OUT	IN	OUT	F/64
OUT	OUT	OUT	IN	F/128

CONNECTORS AND DEFAULT JUMPER LOCATIONS



CONNECTORS

P1 POWER AND DIGITAL OUT

Connector P1 on the left side of the THCAD2 card is the power and digital output connector. P1 is a six pin 3.5 MM header with a matching plug-in screw terminal block (supplied with THCAD2). P1 pinout is as follows:

PIN	SIGNAL	FUNCTION
1	GND	Power/signal ground
2	FREF+	Reference frequency+
3	FREF-	Reference frequency-
4	FOUT+	Frequency out+
5	FOUT-	Frequency out-
6	+5V power	Supplies THCAD2 operating power

P2 ANALOG IN

Connector P2 on the right side of the THCAD2 card is the analog input connector. P2 is a four pin 3.5 MM header. A matching plug-in screw terminal block is supplied with THCAD2. P2 pinout is as follows:

PIN	SIGNAL	FUNCTION
1	IN-	Analog in -
2	XX	Not used
3	XX	Not used
4	IN+	Analog in +

OPERATION

CALIBRATION

The THCAD2 has a calibration sticker on its reverse side. This calibration data gives the output frequency for 0V input (FZERO), and the output frequency for full scale input (FFS). Measured input voltage V can be calculated from the THCAD2s output frequency using the following formula:

V= VFS * (FOUT - FZERO) / (FFS - FZERO)

Where FOUT is the output frequency of the THCAD, VFS is the full scale range 5V, 10V, or custom value determined by external resistors. FFS is the full scale output frequency on the calibration sticker, and FZERO is the 0V input output frequency on the calibration sticker.

DEFAULT CALIBRATION

The THCAD2 initial calibration is guaranteed to have less than +-1% offset and full scale range errors, so for applications that do not need better than 1% accuracy, the calibration sticker numbers can be ignored and the design center values of 100 KHz at 0V (FZERO) and 900 KHz at full scale (FFS) can be used.

EXTENDING INPUT RANGE

The THCAD2 can have its input range extended by adding series resistance to its inputs. The input circuitry of the THCAD2 consists of a current to voltage converter with a 50 uA full scale range when in 5V mode and a 100 uA full scale range when in 10V mode. The THCAD2 has 100K of total input resistance in their input divider section giving it full scale input ranges of 100K*50uA = 5V in 5V mode and 100K*100uA = 10V in 10V mode. When an external series resistor is used to extend the input voltage range, the required resistance value is:

REXT = (VFS - 5V)/50 uA (5V mode)

REXT = (VFS - 10V)/100 uA (10V mode)

Where VFS is the new full scale input voltage and REXT is the new external series resistor. For example, to extend the THCAD2s input range to a 300V a (300-10)/100uA = 2.9M resistor would be required if the THCAD2 was set to 10V mode. For typical plasma voltage reading applications, the external resistor should be added to the - analog input.

OPERATION

EXTERNAL DIVIDERS

When external voltage dividers are used, the division ratio must be adjusted based on the external divider output resistance and the load the THCAD2 represents. The divider output resistance can be measured with a DVM at the divider output with the plasma source turned off and the divider output disconnected from the THCAD2. The actual division ratio will be higher than the stated ratio and can be calculated with this formula:

ACTUAL_RATIO=DIVISION_RATIO*(R_DIVIDER+100K)/100K

For example, if a 50:1 divider has an output resistance of 6K Ohms, the actual division ratio will be:

50*(100K+6K)/100K or 53.

FREQUENCY OUTPUT

The THCAD2s frequency output is available on the FOUT+ and FOUT- pins. These pins comprise a differential pair. (That is, one output is always just an inverted copy of the other). For best noise immunity the differential outputs of the THCAD2 should drive a terminated RS-422 receiver. If differential mode is not required, either FOUT+ or FOUT- may be used as TTL level signals.

REFERENCE FREQUENCY

The THCAD2 outputs a 1 MHz reference frequency that is synchronous with the output pulse train. This may be used as a frequency counters gate reference source. The advantage of using the THCAD2s reference frequency as a gate source rather than a local crystal clock is that it is synchronous with THCAD2s frequency output and therefore eliminates the +- 1 count uncertainty that comes from using a asynchronous gate. In most cases this extra resolution is not needed so the reference frequency outputs can be ignored. The reference frequency is output as a differential pair, FREF+ and FREF- if differential mode is not required, either FREF+ or FREF- may be used as TTL level signals.

READOUT AND RESOLUTION

Since the THCAD2 outputs a frequency signal proportional to the input signal, the most straightforward way to recover the voltage reading is with a frequency counter. That is a device that measures the number of rising or falling edges for a fixed "gate" time. Note that period measurements of the 1X output frequency will not yield accurate results, this is because the V-F converter used in the THCAD2 is a *synchronous* type V-F device. Period measurements of the divided outputs can be used with a period measureing device because the divider averages the output periods.

OPERATION

READOUT AND RESOLUTION

For frequency counter mode readout, the resolution is the number of counts per gate time for a full scale input minus the number of counts for a zero input. This number is typically 800,000. So the count resolution with a 1 ms gate time would be about 800 counts(about 9.5 bits). With a 10 mS gate time, the resolution would be around 8000 counts (about 13 bits of resolution). Longer gate times will result in better resolution but the linearity of the THCAD2 is about 12 bits (1 part in 4000) so little is gained with gate time greater than about 10 mS.

READOUT VIA ENCODER COUNTER (LINUXCNC)

The HostMot2 encoder counter firmware is capable of measuring input frequency. The HostMot2 drivers velocity output is proportional to the input frequency and can be used to read out the THCAD2s analog input voltage. To do this, the encoder counter must be set to up/down mode, and the count input (A) connected to the THCAD2s frequency output. The velocity output must be offset and scaled to get a direct voltage number.

ISOLATION

The analog inputs on the THCAD2 are full floating with a 2500V RMS test rating (1 minute). This is a common mode rating. This is also specified as a 425V continuous peak rating with 50 year life.

INPUT BANDWIDTH

Input RFI filters limit the analog signal with a 3 dB point of approximately 2.5 KHz. Effective input bandwidth is further reduced by the sampling rate (frequency counter gate time)

LEDS

The THCAD2 has a yellow LED (CR2) that monitors the output frequency and a yellow LED (CR5) that monitors isolated input side 5V power. These LEDS can be used as a crude indication of THCAD2 operation. In normal operation, LED CR5 should glow steadily, while LED CR2 should blink. The blink rate is output frequency/262144, or roughly 0.5 Hz at 0 input and 3.3 Hz at full scale input.

REFERENCE

SPECIFICATIONS

	MIN	**MAX**	**NOTES**:
POWER SUPPLY	4.75V	5.25V	5V 5%
POWER CONSUMPTION: A REV	----	200 mA	Typ=150 mA
POWER CONSUMPTION: C REV	----	100 mA	Typ=65 mA
ACCURACY	-.5%	+.5%	Over full operating temperature using supplied calibration data.
LINEARITY	-.05%	+.05%	Typically .025%
UNCALIBRATED ACCURACY	-1%	+1%	Card to card deviation from design center values.
INPUT IMPEDANCE	100K	100K	Ohms 0.1%
WORKING ISOLATION VOLTAGE	—	425 V	Peak continuous
TEST ISOLATION VOLTAGE	—	2500V	RMS 1 Min max
OPERATING TEMP.	0°C	+70°C	
OPERATING TEMP. (-I version)	-40°C	+85°C	
OPERATION HUMIDITY	0	95%	NON-CONDENSING

REFERENCE

MECHANICAL DRAWING