THCAD MANUAL

Version 1.1

WARNING

The THCAD card may have potentially deadly input voltages. There are direct hazards from coming into contact with the input or A-D side of the THCAD, 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 THCAD card may become wet or contaminated with conductive materials.

3. Always ground THCAD power ground to system ground.

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THCAD

GENERAL

The THCAD is a frequency to voltage converter type A-D designed for high noise environments like plasma voltage monitoring for torch height controls. The THCAD is available in two voltage ranges, 0-10V and 0-300V. When used for plasma voltage monitoring, the 10V version requires an external high voltage resistor. The advantage of the 10V THCAD and external resistor is that the resistor can be selected to work with high-frequency start torches. The 300V version of the THCAD has all input divider resistor on board and can connect directly to the plasma voltage of touch start type torches only.

The THCAD 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 10V model can withstand a 500V input overload indefinitely. The 300V model can withstand a 2500V 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 THCAD is normally used in unipolar mode but can be jumpered for bipolar mode for non-plasma applications. The THCAD requires 5V at 150 mA for operation. Pluggable screw terminal blocks are provided for all connections.

HARDWARE CONFIGURATION

GENERAL

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

UNIPOLAR / BIPOLAR MODE

The THCAD has can have a unipolar or bipolar input range. The THCAD-10 has a 0 to 10V input range in unipolar mode and a -5 to + 5 input range in bipolar mode. The THCAD-300 has a 0 to 300V input range in unipolar mode and a -150 to +150 V input range in bipolar mode. Selection of unipolar vs bipolar mode is done with jumper

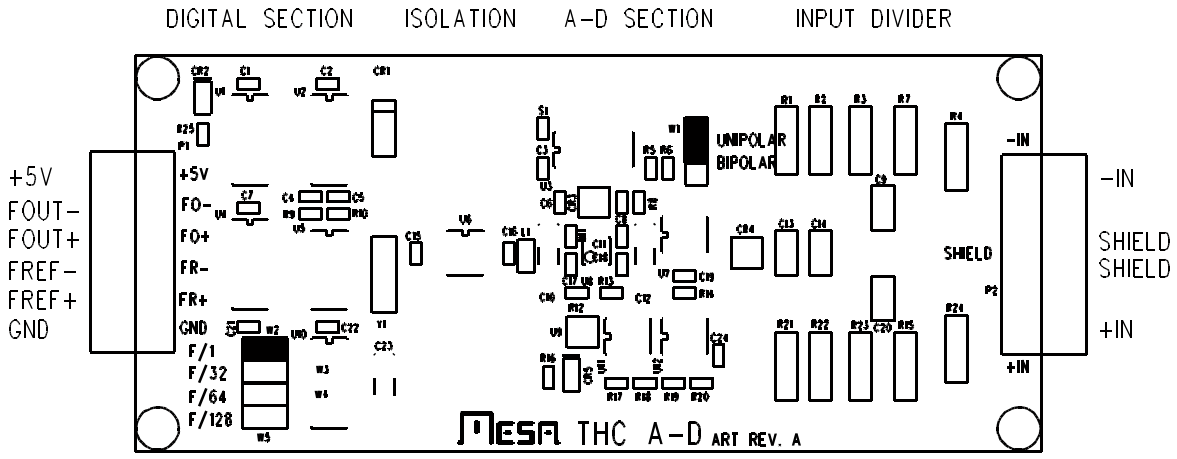
W1	**MODE**
DOWN	UNIPOLAR
UP	BIPOLAR

OUTPUT FREQUENCY

The THCAD'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



P1 --> DIGITAL OUT AND POWER

P2 --> ISOLATED ANALOG IN

CONNECTORS

P1 POWER AND DIGITAL OUT

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

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

P2 ANALOG IN

Connector P2 on the right side of the THCAD card is the analog input connector. P2 is a six pin 3.5 MM right angle header with pins 2 and 5 removed to allow a long creepage path for high voltage. A matching plug-in screw terminal block issupplied with THCAD). P2 pinout is as follows:

PIN	SIGNAL	FUNCTION
1	IN+	Analog in +
2	XX	Not used
3	SHIELD	Shield gnd
4	SHIELD	Shield gnd
5	XX	Not used
6	IN-	Analog in -

OPERATION

CALIBRATION

The THCAD 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 unipolar input (FFS). Measured input voltage can be calculated from the THCADs output frequency using the following formula:

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

Where FOUT is the output frequency of the THCAD, VFS is the unipolar full scale range 10V or 300V 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.

EXTENDING INPUT RANGE

The THCAD-10 can have its input range extended by adding series resistance to its inputs. The input circuitry of the THCAD-10 consists of a current to voltage converter with a 100 uA full scale range. The THCAD-10 has 100K of total input resistance in its input divider section giving it a full scale input range of 100K*100uA = 10V. When external series resistors are used to extend the input voltage range, the required resistance value is:

(VFS - 10V)/100 uA

Where VFS is the new full scale input voltage and REXT is the new external series resistor. For example, to extend the THCAD-10s input range to a 500V a (500-10)/100uA = 4.9M resistor would be required.

BIPOLAR MODE

The THCAD is normally used for measuring unipolar signals but does have the option to offset its input circuit ½ way up in order to measure bipolar signals. Calibration of the ½ offset has a tolerance of 2%. ½ offset point calibration data is include with the THCAD. Whaen set for bipolar mode, the THCAD-10 has an input range of +5V to -5V and the THCAD-300 has an input range of -150V to +150V.

OPERATION

FREQUENCY OUTPUT

The THCADs 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 THCAD 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 THCAD 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 THCADs reference frequency as a gate source rather than a local crystal clock is that it is synchronous with THCADs 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 THCAD 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 THCAD 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.

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 THCAD is about 12 bits (1 part in 4000) so little is gained with gate time greater than about 10 mS.

READOUT VIA ENCODER COUNTER (EMC)

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 THCADs analog input voltage. To do this, the encoder counter must be set to up/down mode, and the count input (A) connected to the THCADs frequency output. The velocity output must be offset and scaled to get a direct voltage number.

OPERATION

ISOLATION

The analog inputs on the THCAD 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 SHIELD

The THCAD has an input shield that should be connected to frame ground on most systems. The input shield is the ground signal to a common mode RFI filter on the THCAD inputs

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 THCAD has a yellow LED (CR2) that monitors the output frequency and a green LED (CR5) that monitors isolated input side 5V power, These LEDS can be used a a crude indication of THCAD operation. In normal operation, the green LED should glow steadily, while the yellow LED 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:	----	250 mA	Typ=150 mA
UNIPOLAR MODE ACCURACY	-.7%	+.7%	Over full operating temperature using supplied calibration data = +-100 PPM/C
LINEARITY	-.05%	+.05%	Typically .025%
UNCALIBRATED ACCURACY	-5%	+5%	Card to card deviation from design center values
INPUT IMPEDANCE THCAD-10	100K	100K	Ohms 2%
INPUT IMPEDANCE THCAD-300	3M	3M	Ohms 2%
WORKING ISOLATION VOLTAGE	—	425 V	Peak continuous
TEST ISOLATION VOLTAGE	—	2500V	RMS 1 Min max
OPERATING TEMP.	0^oC	$+70^oC$	
OPERATING TEMP. (-I version)	-40^oC	$+85^oC$	
OPERATION HUMIDITY	0	95%	NON-CONDENSING

REFERENCE

MECHANICAL DRAWING