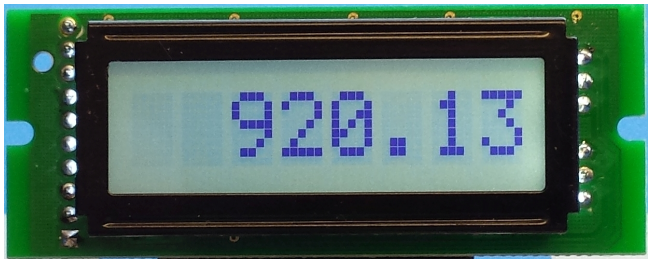
Locus Engineering Inc. E2063

Chromatic Tuner & Frequency Counter



FEATURES

- C0 (16.35 Hz) to G#8 (6644 Hz)
- 0.04 Hz to 99,999 Hz range
- sine, ramp, square fundamental signal input
- music note or frequency display select
- music note error indication +/- 1 to 5 from fundamental note
- equal tempered scale A4=440 Hz
- inverse period fractional frequency measurement
- 0.01 Hz resolution to ~1,500 Hz
- 0.1 Hz resolution to ~15,000 Hz
- selectable 1.8V internal comparator reference or user defined external reference
- ESD protected inputs
- <20ppm measurement error
- serial output (115,200 baud) every measurement
- easily mountable 1.1" by 2.75" package
- 4V to 17V input power
- backlit display with 0.3" high characters

DESCRIPTION

The E2063 Chromatic Tuner & Frequency Counter is a compact module providing a fast and accurate measurement over a wide range of musical notes or frequencies. The module uses a multi-cycle period measurement algorithm accurate to 20ppm followed by a 64 bit division to provide exceptional resolution. The music note or frequency measurement mode is selectable with either a switch or logic input. A comparator input allows any fundamental waveform for the signal input. The comparator reference is selectable between an internal 1.8V or an external user defined reference voltage. A serial output is also provided every measurement at 115,200 baud.

APPLICATIONS

- sound studio instrumentation
- electronic music synthesis control panels
- calibration and test equipment

Table 1. Absolute Maximum Ratings

Parameter	Rating
V_{dd} to GND	-0.3 to +18V
Digital input voltage to GND	-0.3 to +4.0V
Operating temperature range	-40 to +85°C
Storage temperature range	-65 to +150°C
Maximum output current from module pin	100mA

Table 2. Electrical Characteristics

Test Conditions: Supply Voltage V_{dd} = +5.0V, $T_{ambient}$ = 25° C, unless otherwise specified

Symbol	Parameter	Min.	Typ.	Max.	Unit
I_{dd}	Supply current, no backlight		8.0		mA
I_{dd}	Supply current with backlight		41		mA
V_{IH}	Digital high input voltage	2.0	3.0	3.3	V
V_{IL}	Digital low input voltage	0.0	0.1	0.8	V
	Update rate	0.128		23	sec
Fmin Fmax	Frequency Display Range	0.04		99,999	Hz
	Music Note Display Range	C0 16.35 Hz		G#8 6,644 Hz	
	Frequency Error	0.00011 Hz @16.35 Hz	0.044 Hz @6,644 Hz	0.67 Hz @99,999 Hz	

General Precautions

Charged devices and circuit boards can discharge without warning. Proper ESD precautions should be followed to avoid failure.

This device is not authorized for use in any product where the failure or malfunction of the product can reasonably be expected to cause failure in a life support system or to significantly affect its operation.

Locus Engineering Inc. reserves the right to make changes at any time without notice to improve product features or reliability.

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Table 3. Pin Descriptions

Pin#	Name	Function
1	V+	Power input, +4V to +17V
2	0V	Power return or ground
3	RX	not used
4	0V	Power return or ground
5	TX	Serial output 115,200 baud 3.3V logic level
6	AI	Fundamental frequency input between 0.25V and <3.3V, sine, ramp, square wave
7	0V	Signal return or ground
8	AG	External comparator reference between 0.0V and 3.3V (optional)
9	VR	not used
10	LD	Single cycle measurement status, active low
11	0V	Signal return or ground
12	EN	Display mode select; ground = frequency display, open = music note display
13	0V	Signal return or ground
14	SL	Comparator reference select; ground= external user supplied reference 0V to 3.3V, open=internal 1.8V

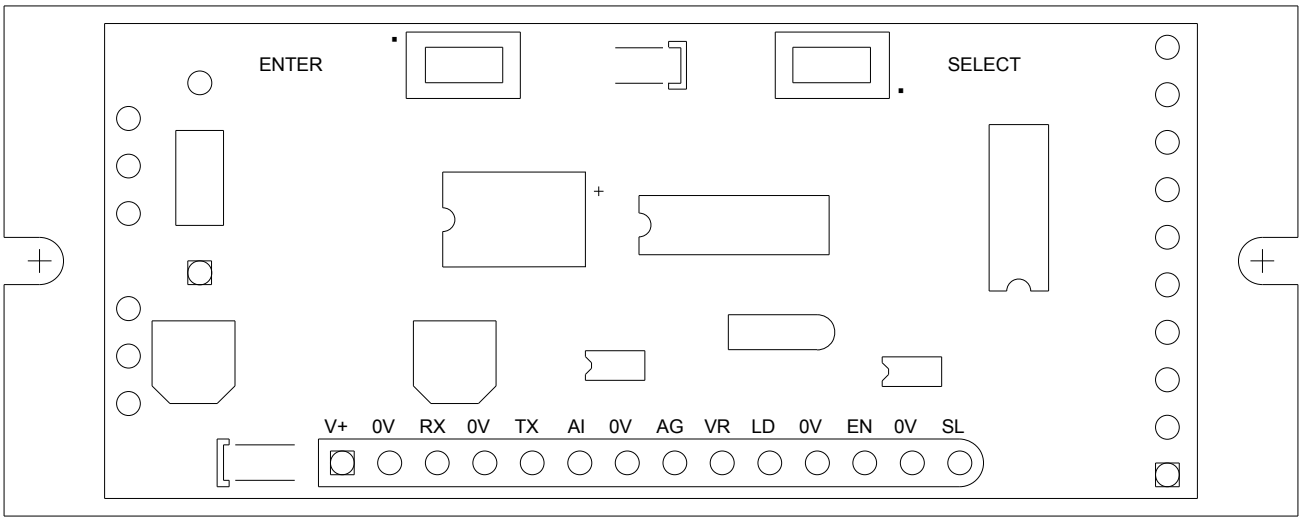

Figure 1. Pinout Diagram

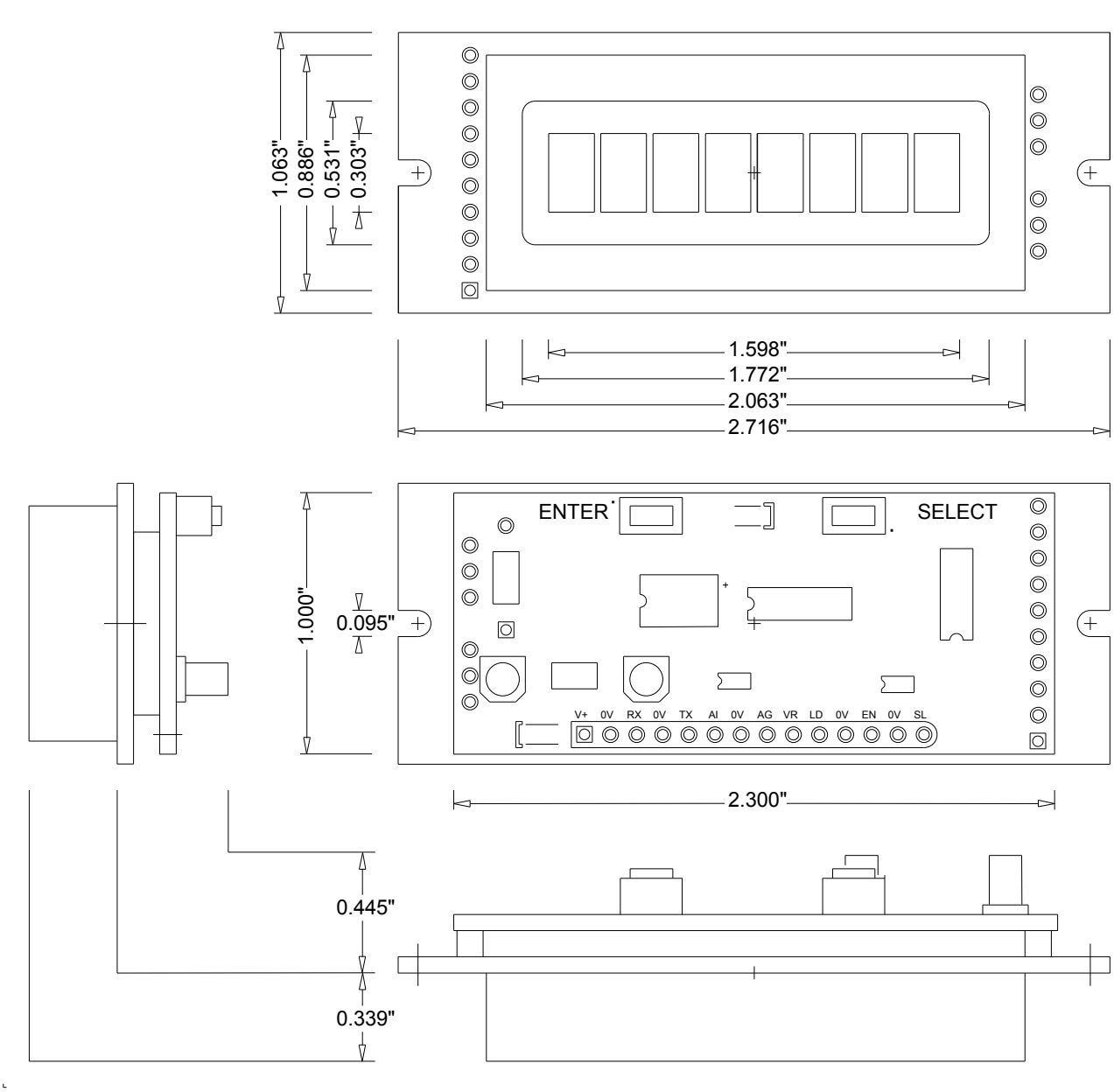

Figure 2. Module Dimensions

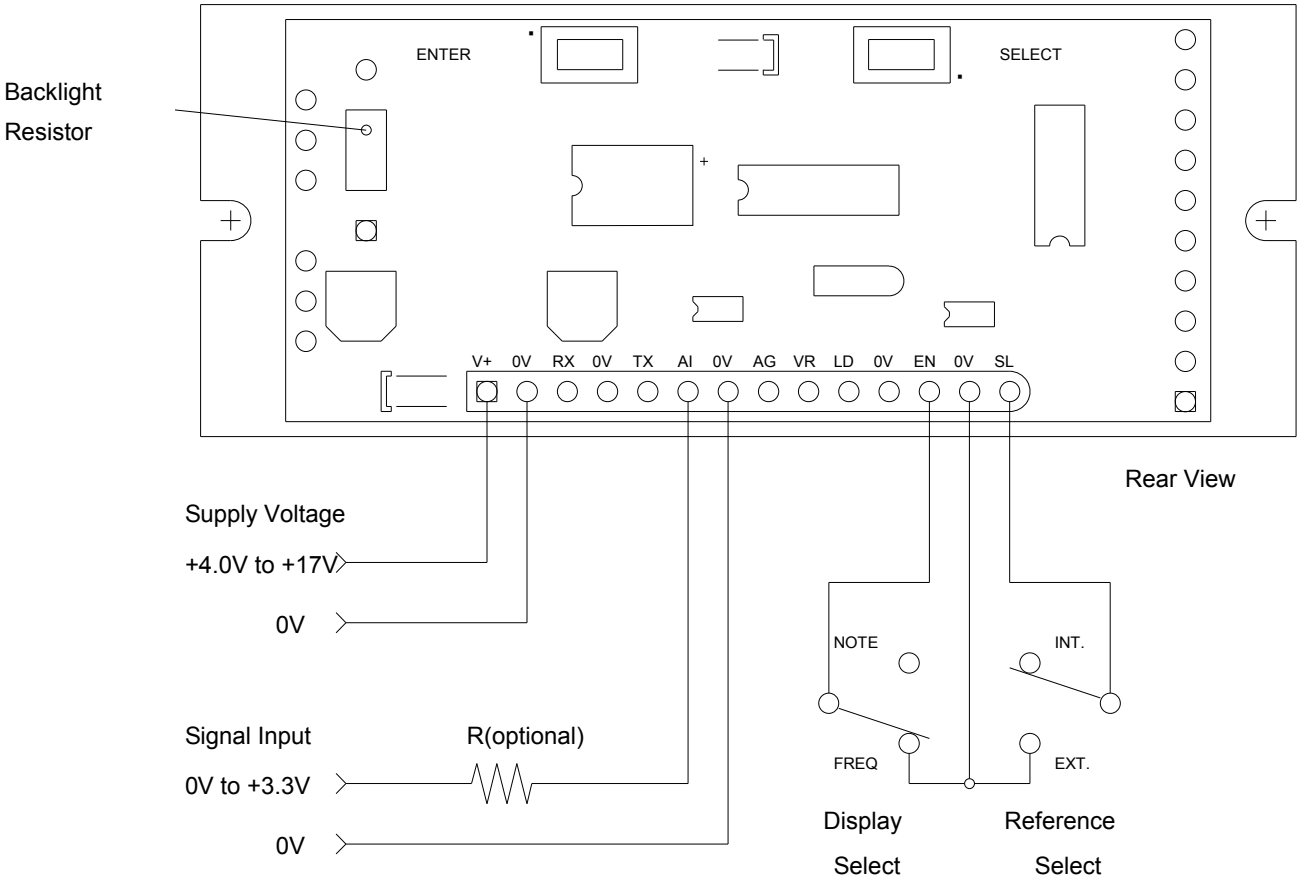

Figure 3. General Application Circuit

Power Supply

The E2063 module requires a voltage between +4.0V and +17V to operate the module. The module consumes approximately 41 mA although most of this is due to the backlight. For lower power operation, the backlight resistor can be disconnected or replaced with a higher value. To calculate the backlight resistor for another current,

R(ohms) = (Vin – 3.0V)/backlight current where backlight current <30mA and Vin<17V.

e.g. R(ohms) = (12-3)/0.005 = 1.8 KΩ for 5mA backlight current and 12V supply voltage.

All ground pins (0V) are connected internally on the module. A series diode at the V+ power input provides reverse polarity protection.

Signal Input

The signal input can be any waveform such as sine, ramp, or square wave between 0.25V and <3.3V referenced to ground. AC signals can be used but need a series resistor as described in the Input Protection section below. Any waveform which steadily increases then steadily decreases for one period is acceptable. A comparator is used to trigger the measurement on the rising edge of the signal relative to a voltage reference. When the signal increases more than the comparator reference, the comparator output is triggered. The comparator provides 5mV of hysterisis to ensure consistent triggering, even for slow signal rise times. The comparator reference must be within the input signal voltage range for the comparator to trigger the period measurement. For AC signals, it is recommended to level shift the signal to the comparator reference voltage.

The default internally provided voltage reference is 1.8V, however for smaller signals, an external reference voltage between 0.0V and 3.3V can be supplied to pin 8 (AG). Ideally the external reference should be centered to the input signal being measured. The external reference voltage is selected by grounding Pin 14 (SL); if the pin is left floating, the internal 1.8V reference is selected. Open drain or open collector logic can also drive this pin to control the reference selection, so no pullup resistor is necessary. The comparator reference selection is sampled every measurement cycle.

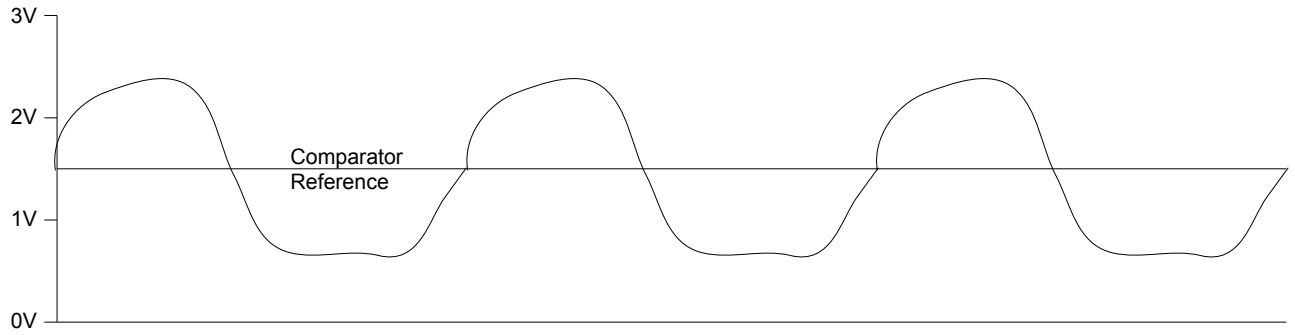

Figure 4. Input Signal with Comparator Reference

Input Protection

All signal inputs are protected with 3.3V transient protection clamping diodes. For signal inputs larger than 3.3V, a current limiting resistor is needed, 1KΩ per additional volt is recommended. For example, if a 15V signal is used, put a 12KΩ resistor in series between the source and the module.

e.g. Rin = (Vsig – 3.3V) x 1KΩ/volt = (15-3.3) x 1KΩ/volt = 11.7KΩ or 12KΩ

If AC signals are used referenced to ground, a resistor should also be used to limit the current since the transient protection diode will conduct when the signal voltage is negative. 1KΩ per volt is recommended as a series resistor for AC signals.

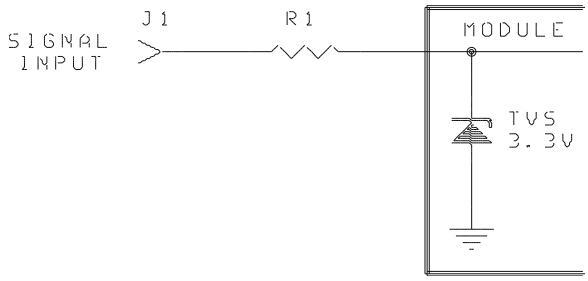

Figure 5. Input Protection Diode and Current Limiting Resistor

Music Note/Frequency Mode

Pin 12 is the display mode pin (labeled EN on the module) which selects between music note display or frequency display. Grounding this pin selects the frequency display, and leaving it open selects the music note display. Open drain or open collector logic can also drive this pin to control the display mode and no pullup resistor is necessary. The display mode pin is sampled every measurement cycle.

Display

The display update rate depends on the input frequency being measured. Higher signal frequencies update the display up to 8 Hz while very low signal frequencies update the display every period, which in the case of the lower limit of 0.04 Hz is about every 23 seconds.

The module measures the input signal period in either multi-cycle or single cycle mode. For signals above 4 Hz, the module measures multiple cycles, while below 3 Hz the module measures single cycles. When the input signal frequency drops below 3 Hz or if the signal input is disconnected, the display will indicate " Fin<3Hz" in frequency mode until the next signal edge occurs, at which point the frequency will be displayed. This message will only occur once and is a comfort message to indicate the measurement is active. The single cycle status pin 10 will also go low and the LED will light. The single cycle measurement mode ends for frequency inputs greater or equal to 4 Hz. For signal frequencies below 0.04 Hz or if there is no signal, the display will indicate "--------" after 23 seconds.

The display has a leading zero suppression feature for frequencies below 100,000 Hz. For frequencies 100,000 Hz and above, leading zeroes are displayed, and the display will continue to indicate correctly except the hundred thousand digit is not displayed.

In note mode, the display will indicate "Infra" for notes below C0 -5 or "Supra" for notes above G8 +5.

Music Note Error

The error range between notes is near linear, so it is divided into tenths and interpreted as -5 to +5 about the exact note.

e.g. C#8 +1 +2 +3 +4 +5 -5 -4 -3 -2 -1 D8 +1 +2 +3 +4 +5 -5 -4 -3 -2 -1 D#8

Serial Port

Serial data is available on pin 5 (Tx) at 115,200 baud with 3.3V levels. The output has the format every measurement cycle:

FRQ 000442.34, A4 +1

For frequencies below about 3Hz, the serial port will send once:

Fin<3Hz

For frequencies below 0.04Hz (i.e. after ~23 seconds) or in the event of loss of signal, the serial port will send :

FRQ --------, --- --

A Carriage Return and Line Feed characters precede each transmission. These are represented by the hexadecimal characters 0D and 0A respectively.

Connections

Several options are available to connect the module. 24AWG stranded wire can be used as it is flexible, and is easy to remove. Make a small loop in each wire to isolate against vibration and uneven wire lengths, and secure the cable to minimize wire breakage at the module. A 14 pin right angle male or female header can also be soldered to allow the module to be plugged in.

Mounting

The module is typically mounted from behind a panel using 2mm screws and plastic spacers. Plastic spacers are needed to prevent contact between the PCB traces on the display board and the front panel, and also set the distance between the module and the panel. For a flush mounted display, the spacer length is calculated as panel thickness + 0.339". The display board holes can be enlargened with an 1/8"diameter round file to accomodate #4-40 hardware. The panel cutout dimensions below allow for 0.01" clearance around the module.

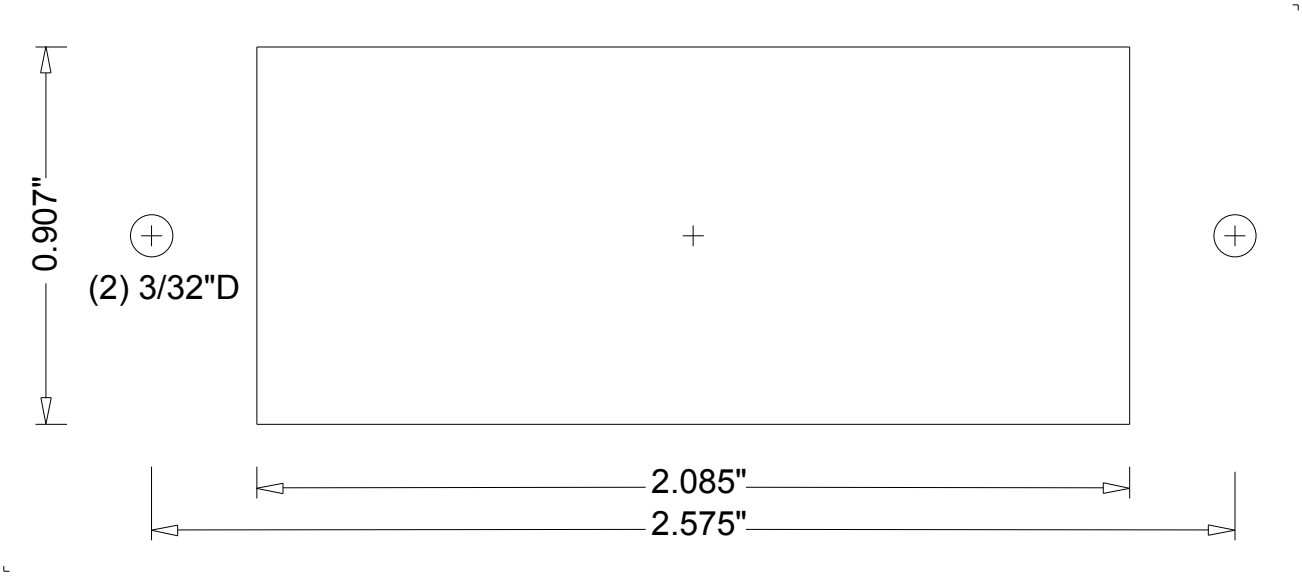

Figure 6. Panel Cutout Detail