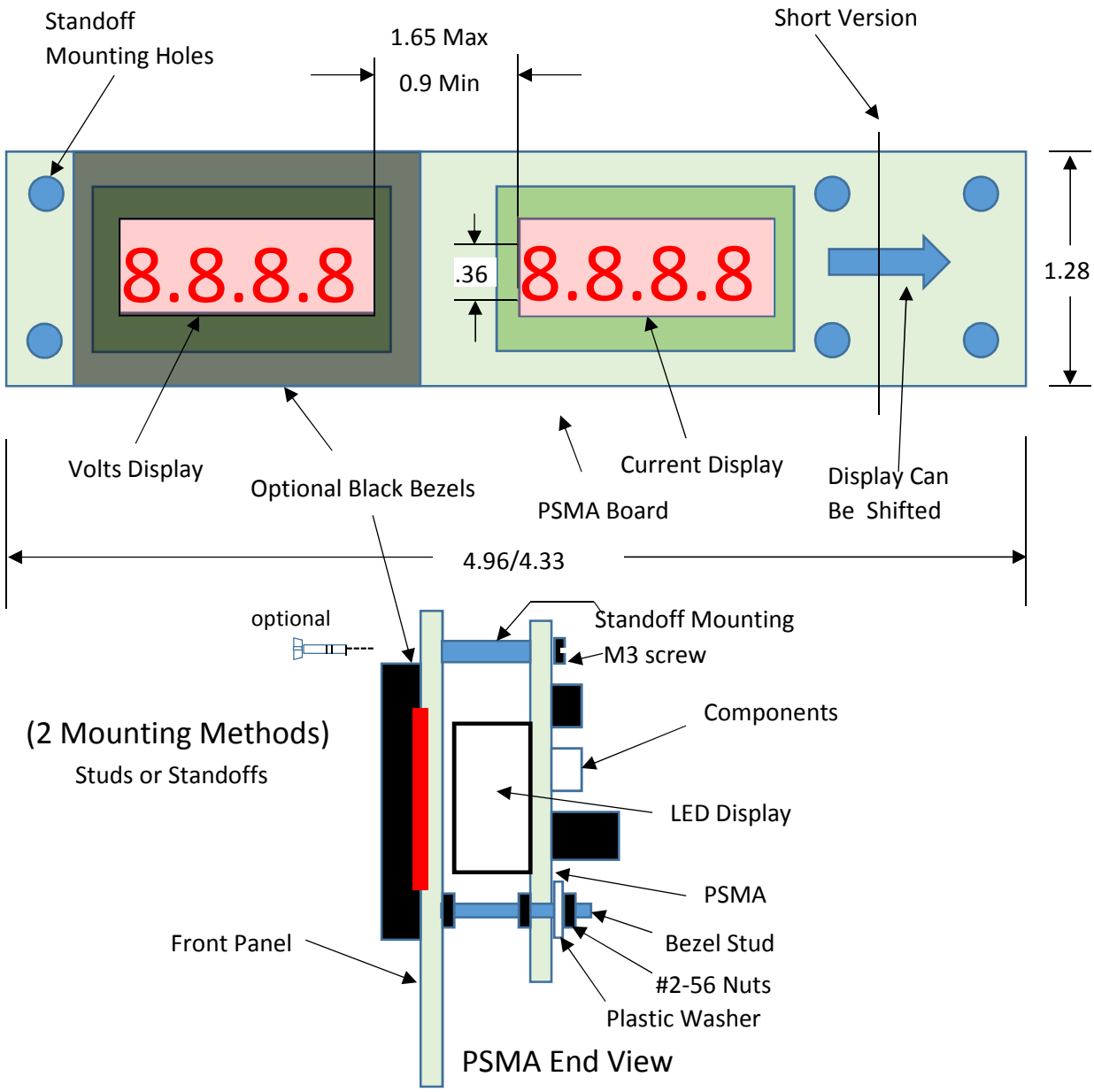
Precision Power Supply Meter Assembly Revised 1/16/22

The precision power supply meter assembly (PSMA) provides two 4-digit meters for the 'red-board' power supply kit sourced from eBay/China. The left one is a volt meter which is pre-calibrated and to show 0.00 to 30.00 volts and the right one is a current meter which shows 0.000 Amps to 3.000 amps. The meters will accurately display any ranges less than these maximums. The volt meter is mounted in a fixed position while the current meter can be mounted in its 'home' position closest to the voltmeter or shifted right for additional meter separation (¼" increments).



As shown above the PSMA can be mounted to a panel using standoffs, or can attach to the same studs that hold the optional bezels in place -- for shorter widths.

The (left) volt meter uses a differential measurement (because the supply output is not ground-referenced). 12-bit measurements are made, averaged for stability* and displayed. It is factory precalibrated to better than +/- 0.5% full scale. The current meter measures the voltage across the supply's 0.47 ohm 5% sense resistor. It is also factory precalibrated however because of the resistor tolerance, the measurement can have 5% error. It can be made more accurate by calibrating for the installed 0.47 ohm resistor. A calibration procedure is included later in this description to improve the 5% current accuracy.

Mounting Descriptions:

There are three mounting methods as shown in the previous diagram. Detailed instructions for each are appended to this manual. The shortest overall length of the PSMA (-M model) is achieved using the bezel-stud method (2). Refer to https://www.versalent.biz/psma.htm

1) Mount the PSMA on the inside of your panel using the two M3 threaded standoffs either screwed to your panel (screws visible from front), or with the standoffs permanently glued ** to the inside of your panel so no attachment screws penetrate the front. (Diagonal standoffs provide the best support). The 1/16" thick plastic red filter can be clear-glued or screwed to the front of your panel. The black flat-head screws can be hidden behind the red plastic filter with the filter glued to the panel , or can penetrate the filter to hold it in place as well as the standoff.
2) Do NOT use the standoffs .. instead mount the assembly on the long studs provided with the optional black plastic bezels (purchased separately). Using this method no screws are visible from the front. The bezels contain red filters so no separate filter is used. See detailed mounting instructions below.
3) This combines #1 and #2 above. The bezels are mounted to the front panel using the ¼" long screws (long studs not used). Then the PSMA is independently mounted to the panel behind the bezels using glued/screwed standoffs. The bezels contain red filters so no separate filter is used.

The full size assembly is 4.96" wide (see diagram above). The current meter can be mounted with an inter-digit space of 0.9", 1.15", 1.40" or 1.65". The -S 'short' version assembly is 4.33" wide and the inter-digit space is 0.9" for standoff mount (or 0.9"/1.15" with bezel-mount). The –M 'mini' version is 3.8" wide with inter-digit space of 0.9" and mounts on bezel studs only.

* 64- readings averaged over 1/2 second provide similar noise cancellation to the continuous averaging that dual-slope integrating converters provide.

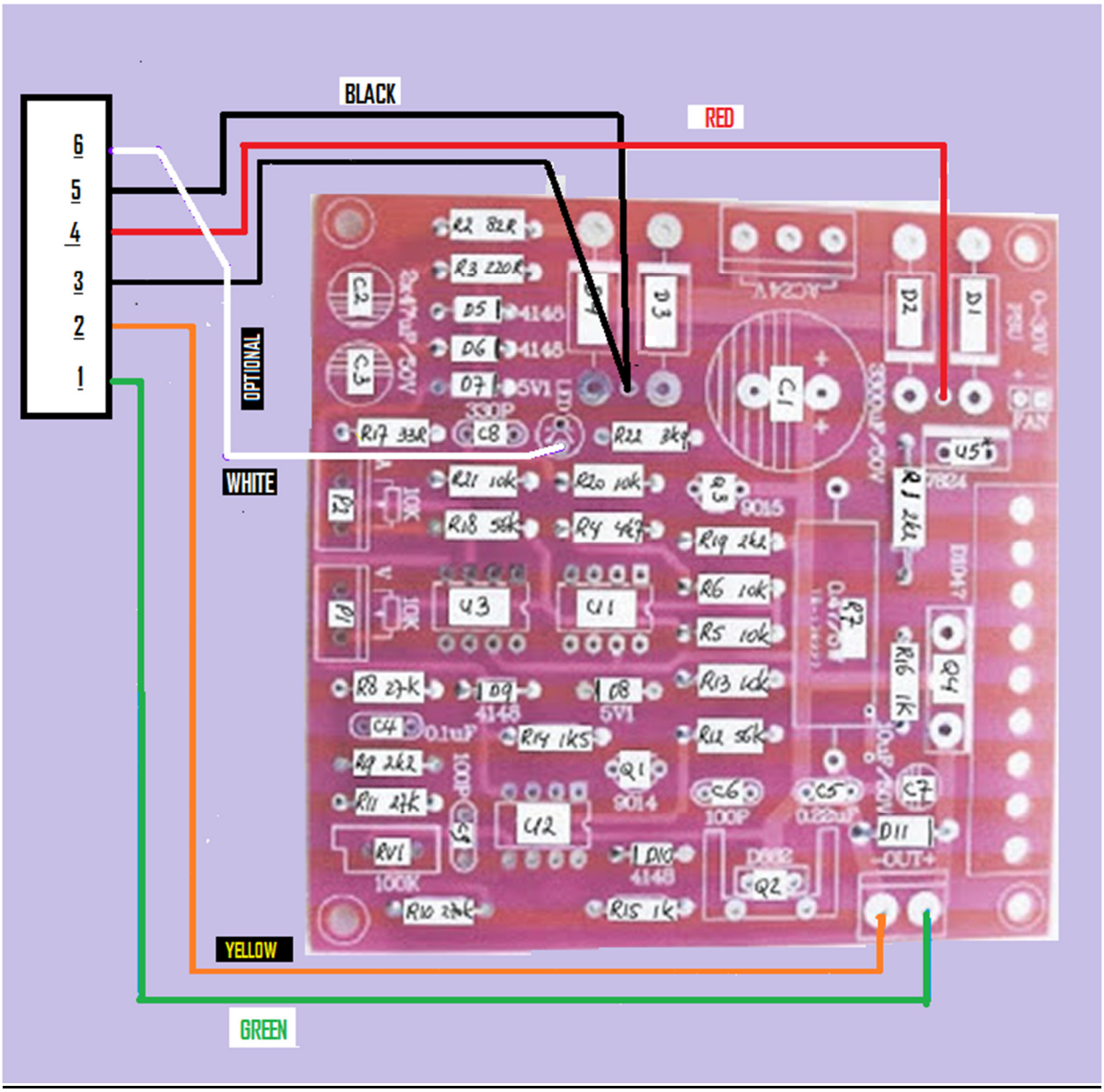
** Suitable hard glues like Gorilla Glue, JB Weld, and most 5-minute epoxies work well. Tougher more flexible glues like Goop, E6000 are also good. Use any glue that adheres to the aluminum standoffs as well as your panel material.

Detailed Mounting Instructions (Mounting method #2 on Bezel Studs) **:**

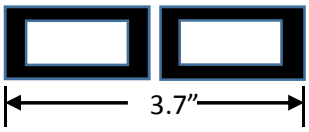
1) Cut out and drill panel per dimensions below.
2) Screw the (4) #2-56 X .8" studs into the bezel with firm finger pressure.
3) Refer to the PSMA end-view drawing above. Mount the bezels to the panel passing the studs through the panel holes, and attach bezels to the panel with (4) #2-56 nuts.
4) Screw 4 more nuts onto the studs down to within about ¼" of the bezel-mount nuts.
5) Place the PSMA onto the studs (decimal points down) and gently push until the face of the white LED blocks touch the bezel red plastic filters.
6) Unscrew the nuts from (4) above until they just contact the PSMA circuit board, then continue to unscrew another 1 turn.
7) Place a nylon flat washer and nut on each stud and lightly tighten to hold the PSMA into place on the studs.

Wiring Description:

The 6-pin white polarized connector (5 pins required, one optional) must be wired to the power supply board. Once connected, it is plugged into its 6-pin white mate on the PSMA. The red circuit board does not provide terminals for all the signals needed, so some must be soldered to the points shown in the diagram. The two ground wires are used to keep the measurements accurate and should be wired as shown with both black wires extending to the circuit board. (D3 and D4 leads adjacent to the connection point shown are also valid ground connection points if both black wires do not fit in the hole). If Pin6 is connected as shown, the current display's decimal point which is normally ON solidly, will flash very quickly when current limiting is active. This feature can be used instead of, or in addition to, installing the separate current-limit LED provided with the supply kit. If you do not want to use this feature, do not connect pin6.


6
5
4
3
2
1
BLACK
RED
OPTIONAL
WHITE
YELLOW
GREEN

Models Available:

Model	Description
PSMA	Standard 4.96” width. Meter digits can be separated by 0.9” to 1.65”. Can mount on optional Black bezel studs or standoffs. Overall bezel widths: 3.7”, 3.95”, 4.2”, 4.45”
PSMA-S	Short Version 4.33” width. Meter digits separated by 0.9” only. Can mount on optional Bezel studs or standoffs. Overall bezel widths: 3.7”, 3.95”
PSMA-M	Mini Version 3.8” wide. Mounts ONLY on Bezel studs (no standoffs). Meter digits separated by 0.9” only with Bezel separation of .060”. Overall bezel width = 3.7” 

Optional Calibration:

Calibration is digital (no onboard pots) and there are several calibrations which can be performed using the two onboard push button switches. Note that all items are ***factory calibrated***, however because each power supply board will vary slightly, the calibrations below are provided. The Mode button selects which function to calibrate and in which direction (increase/decrease) and the Bump button provides an incremental change to the selected. Press Mode until the desired function appears on the left display (ie ‘CAL1’). Then press Bump until the value on the right display shows the corrected value. Note that calibration factors are finely tuned and it may take several Bump presses to cause a PSMA digit change. The Mode and Bump switches are labeled on the circuit board (Mode is the lower one closest to the display decimal points).

To SAVE the changed values and return the PSMA to normal operation after a calibration, advance the Mode one press beyond CAL9 . The calibrations are immediately in effect and the PSMA will subsequently power up with these calibrations.

Mode	Description
Normal	Normal Operation. Voltage and Current Meters show supply values
CAL1	Calibrate Current Meter (Adjust UP)
CAL2	Calibrate Current Meter (Adjust DOWN)
CAL3	Set Display Brightness(Adjust UP only, from max return to minimum)
CAL4	Calibrate Volt Meter (Adjust UP)
CAL5	Calibrate Volt Meter (Adjust DOWN)
CAL6	Calibrate Volt Meter Differential (Adjust UP)
CAL7	Calibrate Volt Meter Differential (Adjust DOWN)
CAL8	Calibrate Current Meter Zero Offset (Adjust UP)
CAL9	Calibrate Current Meter Zero Offset (Adjust DOWN)

Calibration Procedures:

CAL1/CAL2 To **calibrate the PSMA current meter** an external current meter is required. This calibration is interactive with the zero-current calibration so that should be done first. (see CAL8/9). It is best to calibrate near the full scale current value for best results. Set to CAL1 mode as above, connect a load resistor to the supply, and increase the supply output voltage until the external meter reads close to the meter's full scale current. If the PSMA (right) display value is LOW press the Bump switch repeatedly until the PSMA current display agrees with the external current meter. If the PSMA display is HIGH press the Mode switch to move to CAL2, then press Bump until the PSMA display is correct. Because the adjustment resolution is very fine it may take multiple Bump presses to change the display by one digit increment . Calibration is complete. Advance the Mode one press past CAL9 to save this setting and return to normal operation.

CAL3 To **set the display brightness** set to CAL3 as above. Then press the Bump switch to increase the brightness by one increment (eight brightness levels 0-7). The brightness level is displayed on the right meter. The value rolls from 0 to 7 to 0 so to decrease brightness, advance beyond 7. LED brightness is very nonlinear as are our eyes so it is sometimes difficult to see a brightness change between adjacent levels. LED life is longest at lower than maximum brightness levels. Advance the Mode one press past CAL9 to save this setting and return to normal operation.

CAL4/CAL5 To **calibrate the PSMA voltage meter** requires an external volt meter monitoring the supply output. Factory calibration is better than 0.5% so there is usually no need to calibrate. Remove any load from the supply so there will be no current output. Set the Mode to CAL4. Turn up the supply voltage until the external meter is near full scale. The right PSMA meter shows voltage during this calibration. If the PSMA reading is LOW, press Bump repeatedly until the PSMA meter increases to the correct value. If the PSMA reading is HIGH, advance the Mode to CAL5, and press Bump until the meter decreases to the correct value. Because the adjustment resolution is very fine it may take multiple Bump presses to change the display by one digit increment. Advance the Mode one press past CAL9 to save this setting and return to normal operation.

CAL6/CAL7 If **PSMA voltage** is re-calibrated, the associated **differential measurement** should be recalibrated. An external meter is NOT required for this calibration. You will need a load resistor that draws 10-20% less than full scale current at near full scale voltage. Set mode to CAL6 and turn the supply's current limit control to maximum. With NO load on the supply (no load current) , turn up the PSMA output voltage until the (right) display shows at or near full scale voltage. Note the exact voltage displayed. Now apply the load resistor. The voltage display should not change. If the PSMA voltage increased, press Bump until the display returns to its no-load value. If the PSMA voltage had decreased with the application of the load, change the Mode to CAL7 and press Bump the bring the display back to its no-load value. Advance the Mode one press past CAL9 to save this setting and return to normal operation.

CAL8/CAL9 **Calibrate the zero-current measurement.** Typically power supply circuits that use a ground-sense resistor drain a small amount of 'bias' current (2-5 mA) through the sense resistor even at zero load current. Since the PSMA measures/displays current with a resolution of 1mA this bias current appears as a zero-error . To compensate for this, the PSMA provides a zero-current-offset adjustment. This offset is factory adjusted to zero for a typical 'red-board' power supply, however yours may differ. An external current meter is required for this adjustment. To calibrate, connect a load resistor of 1k-5k and set the output voltage to a value that delivers 2.00mA. If the PSMA reads less than 2mA advance the mode to CAL8 and press Bump until the right meter displays 0.002. If the current meter reads more than 2mA, advance the Mode to CAL9 and press Bump until the meter reads 0.002. Advance the Mode one press past CAL9 to save this setting and return to normal operation. Disconnect the load resistor and confirm that the current reads 0.000 .

Specifications:

2 four-digit .36" high LED displays

Power required: 20VDC – 40VDC MAX @ 45mA

Maximum size: 4.96" X 1.28" X 1" (Not including optional Bezels)

Minimum Size: 3.78" X 1.28" X 1" (Not including optional Bezels)

A/D conversion method: Successive Approximation (64 samples averaged over 0.5 sec interval)

Measurement resolution: 12-bits

3 measurement channels (ch1 and ch2 form a differential pair)

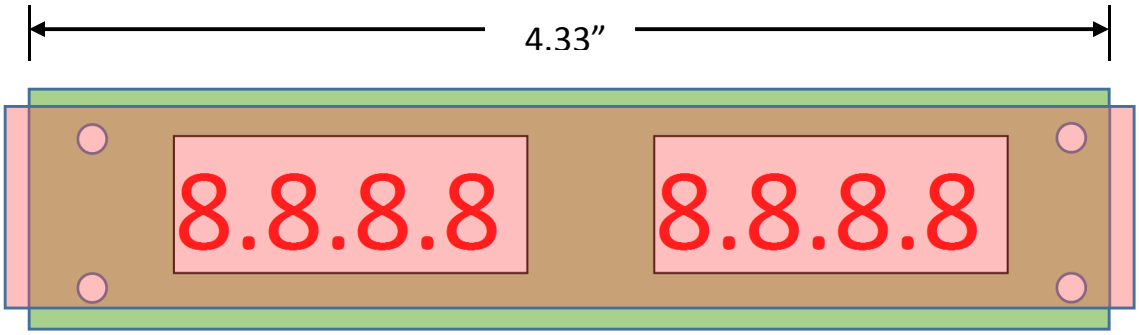
Voltage Measurement Accuracy: +/- 0.5% +/- 1 count with factory calibration

Voltage Channel Input Impedance: 170k ohms

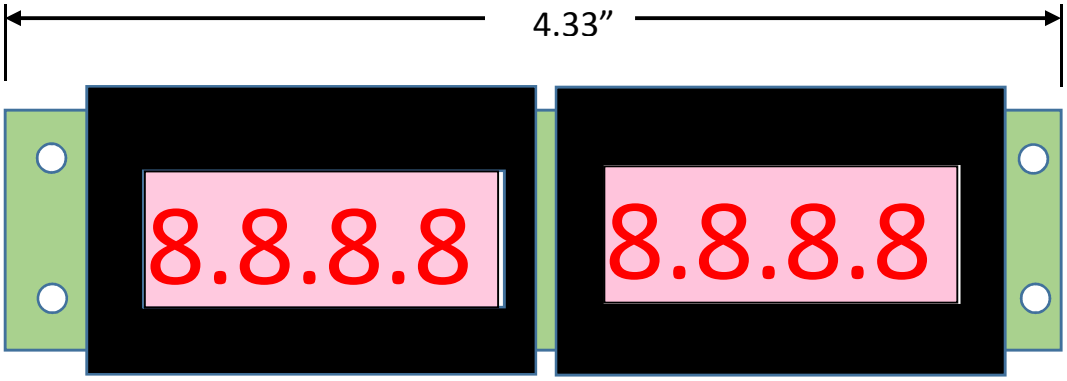
Current Measurement Accuracy: +/- 5% +/- 1 count with factory calibration

Current Channel Input Resistance: 30k ohms

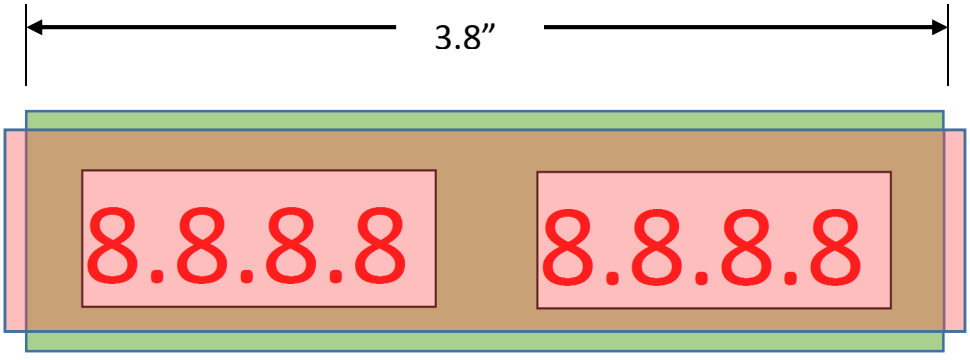
Display Refresh Rate: ½ second



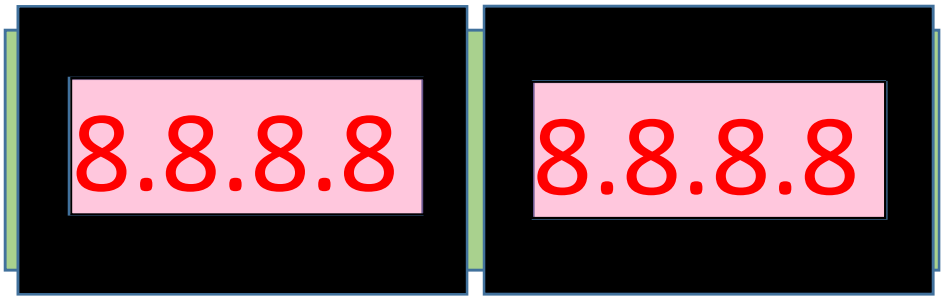
PSMA-S (Short 4.33”) w/Flat Red Plastic Filter



PSMA-S (Short 4.33”) w/Bezels



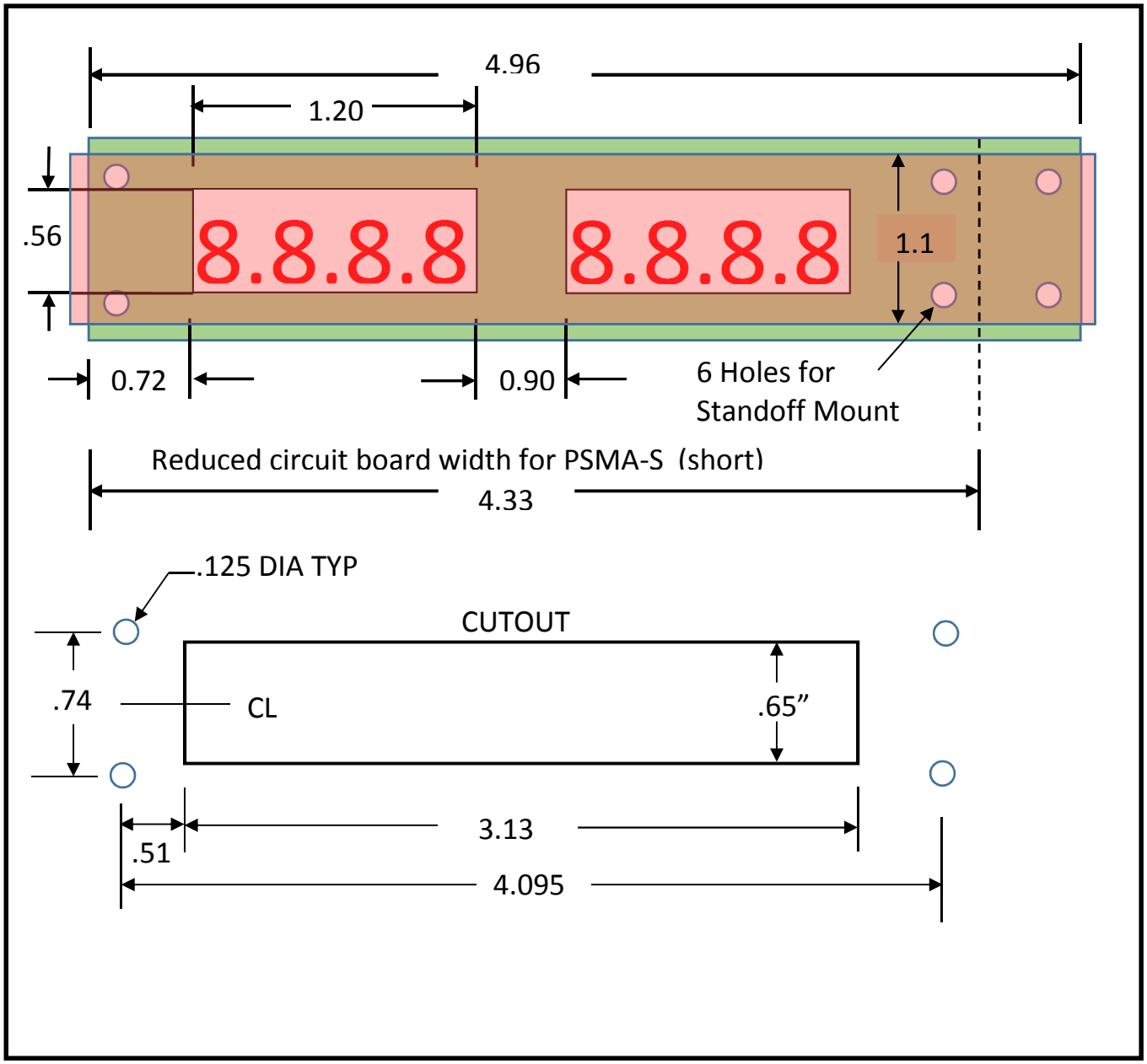
PSMA-M (Mini 3.8”) w/Flat Red Plastic Filter



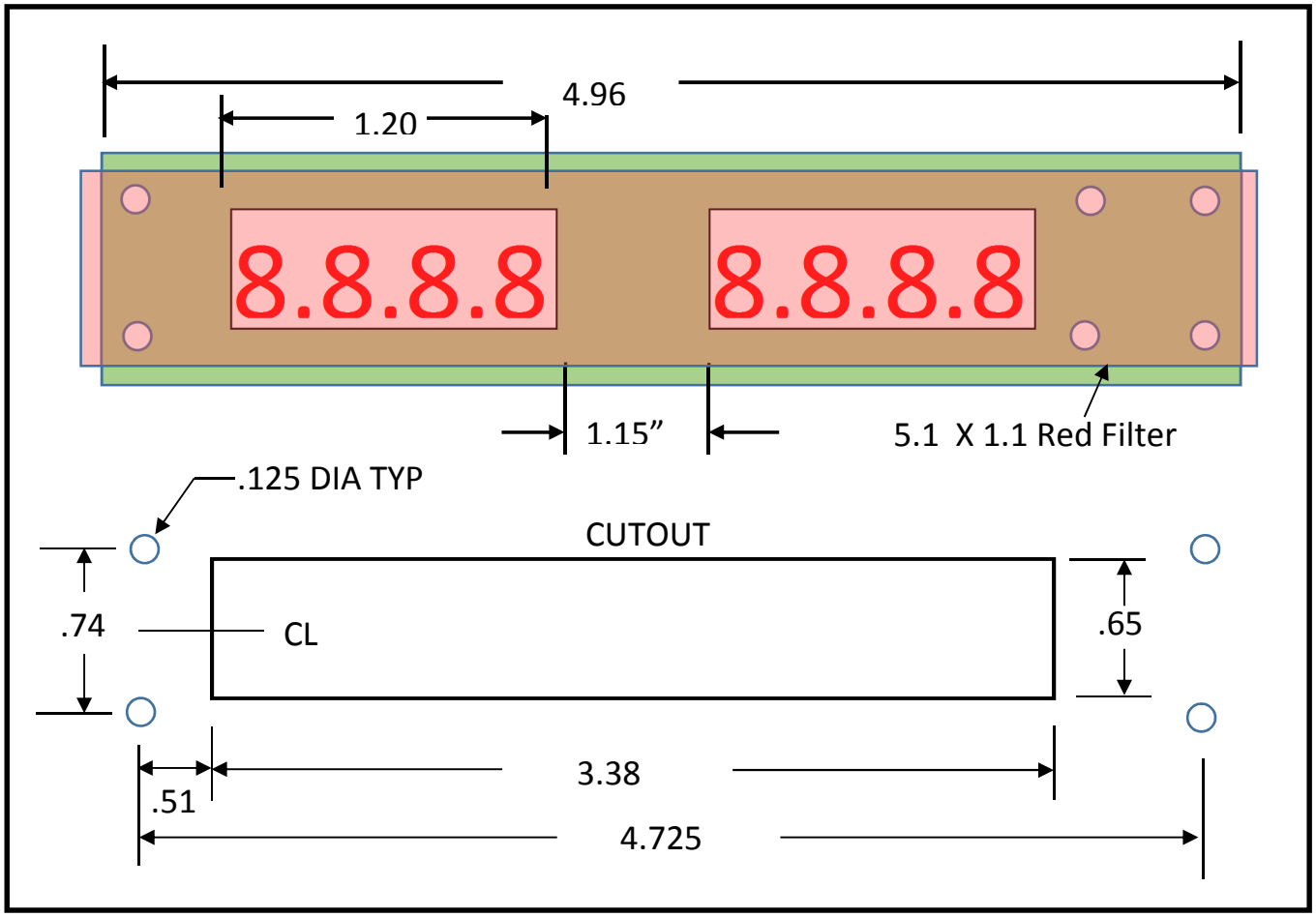
PSMA-M (Mini 3.8”) w/Black Bezels

Must Mount on Bezel Studs

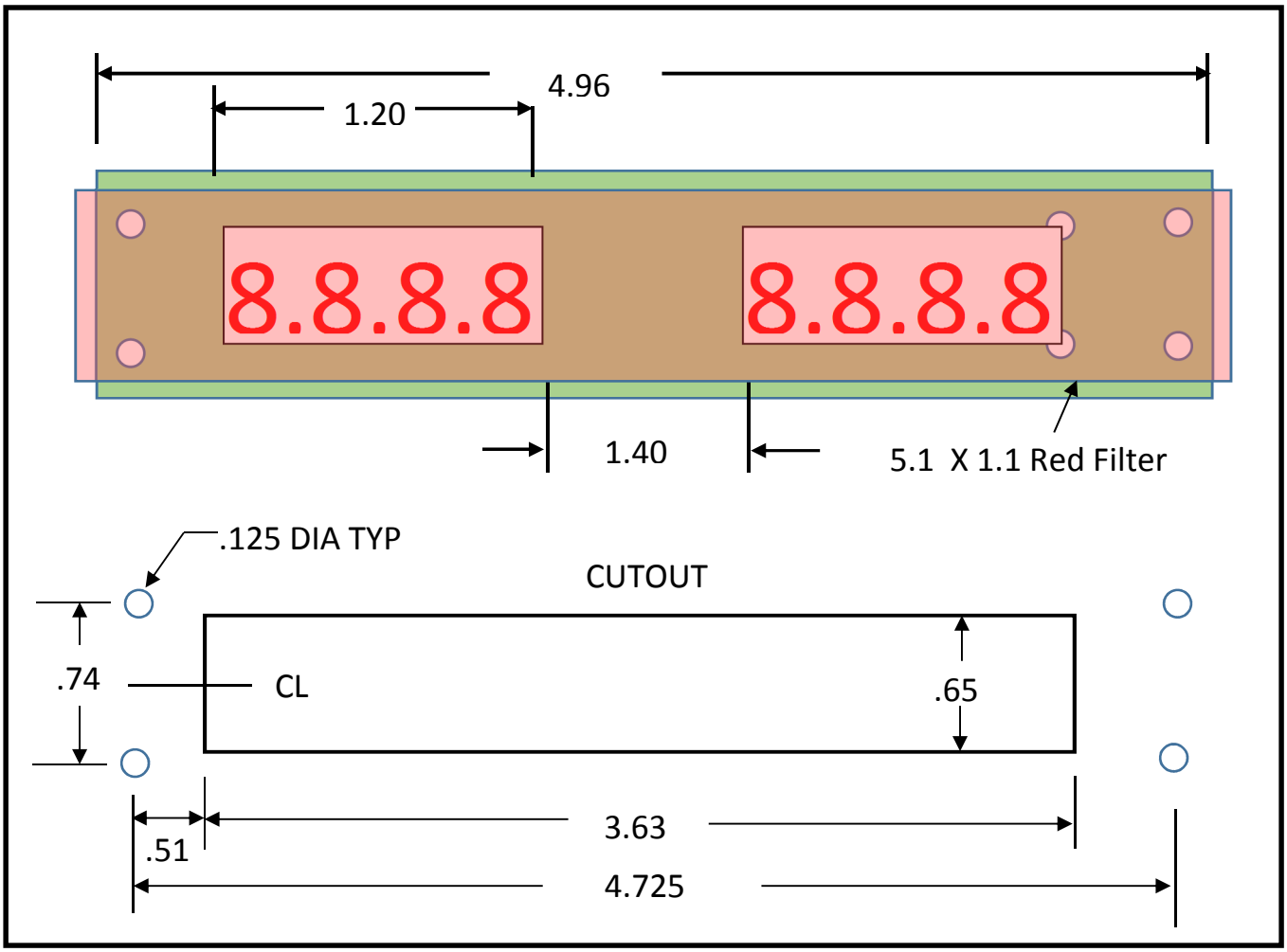
PSMA & PSMA-S, STANDOFF MOUNT, 0.9 Inter-digit SPACING (Dims in inches)



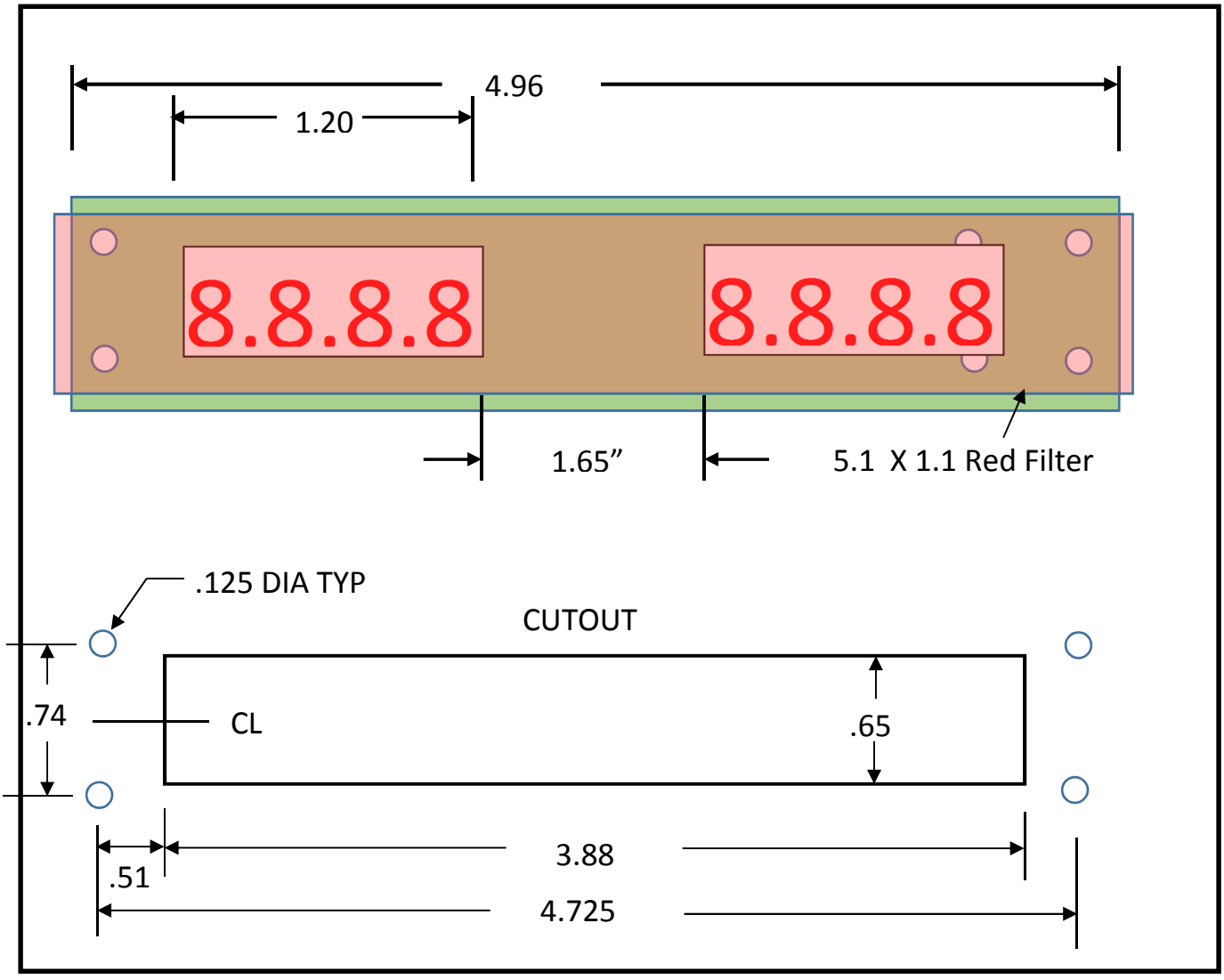
STD WIDTH PSMA, STANDOFF MOUNT, 1.15 Inter-digit SPACING



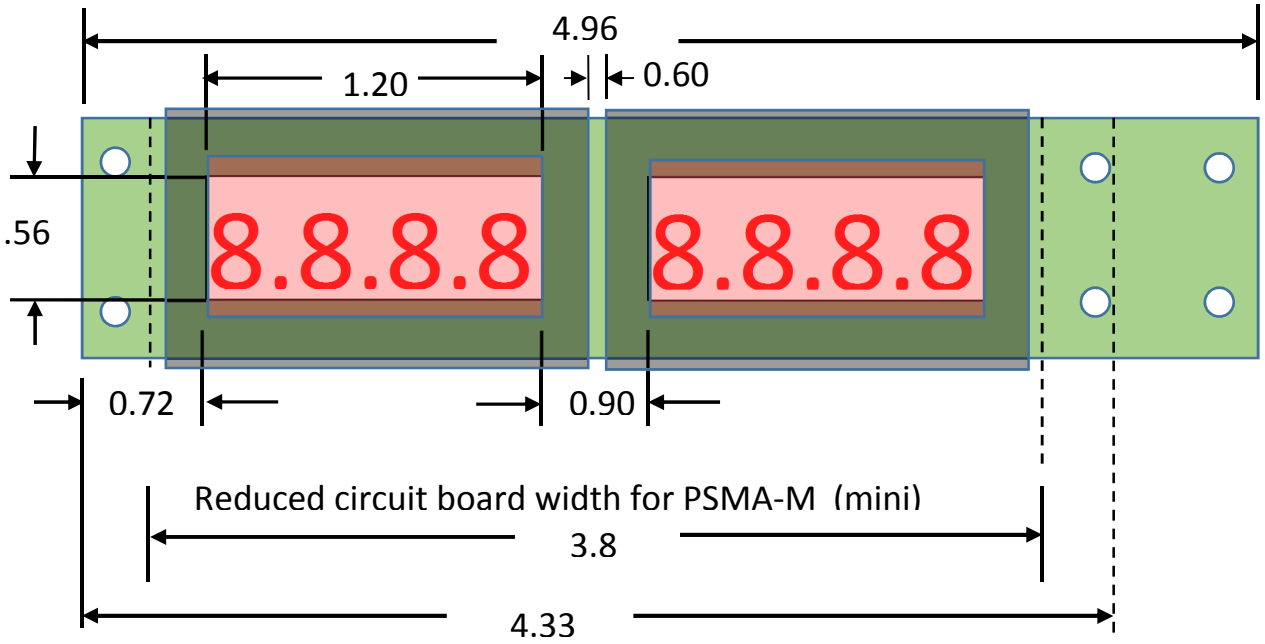
STD WIDTH PSMA, STANDOFF MOUNT, 1.4 Inter-digit SPACING

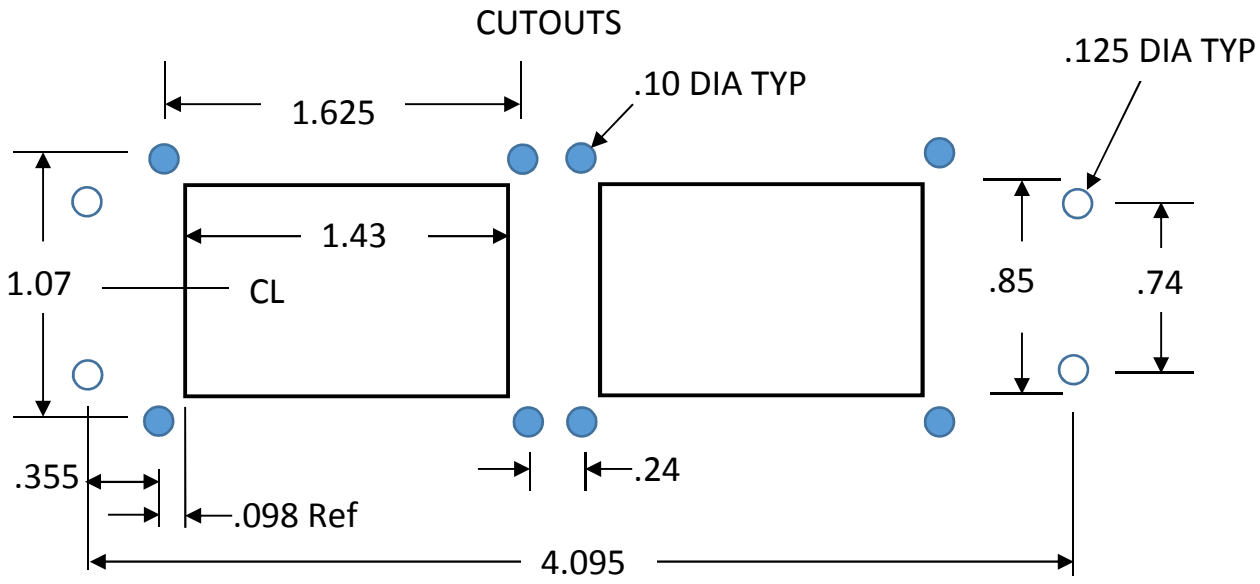


STD WIDTH PSMA, STANDOFF MOUNT, 1.65 Inter-digit SPACING



PSMA , PSMA-M, PSMA-S BEZEL MOUNT or STANDOFF MOUNT





Right Bezel and cutout can shift right on 0 .25” increments for alternate meter spacings.

A Few Notes About the 'Red-Board' Supply:

The (red/China) power supply board uses a well known circuit with low-side current sense. Its output is stable with all loads and the current limiting is crisp. However it does has a several deficiencies and some are severe.

1) **It will not deliver 30V as advertised. Severity MODERATE.** The maximum rectified voltage with a 24V transformer is about 32V, and the TL081's I received are apparently non-authentic – their output only goes to about 24 volts so the maximum output is approximately 23 volts. Even with a good TL081 the op amp output will only go to within 3 volts of the + rail and the maximum output would then be 28V at very low output current.

2) **The Current Limit LED does not turn off. Severity HIGH.** Again because of the lousy TL081 whose output does not approach the + rail, the LED circuit cannot turn the LED off.

3) **It will not deliver 3A at its higher output voltages**. **Severity Moderate**. The filter capacitor of 3300uF is not large enough. With a 3A load the 120Hz ripple on this capacitor is in the range of 2V. Adding to that is the typical +/-20% capacitor tolerance on large caps, and capacitor aging and the supply can easily go in and out of regulation when delivering even 25V at 3A.

4) **The TL081 is a 36V max op amp which is exceeded. Severity HIGH**. With the +rail at about 32V and the –rail at -5V, U2 and U3 are subjected to 37V or slightly more. This could result in in a snap/smoke failure at any time.

FIXES For These Issues:

A good fix for #1 –replace TL081-fake U2 with an authentic one, and limit the output voltage to 25V.

A fix for #1 that does not require a new TL081 : limit the output voltage to 20V. See diagrams below.

A good fix for #2 – replace TL081-fake U3 with an authentic one, and replace 10k R20 with 20k for more reliable operation.

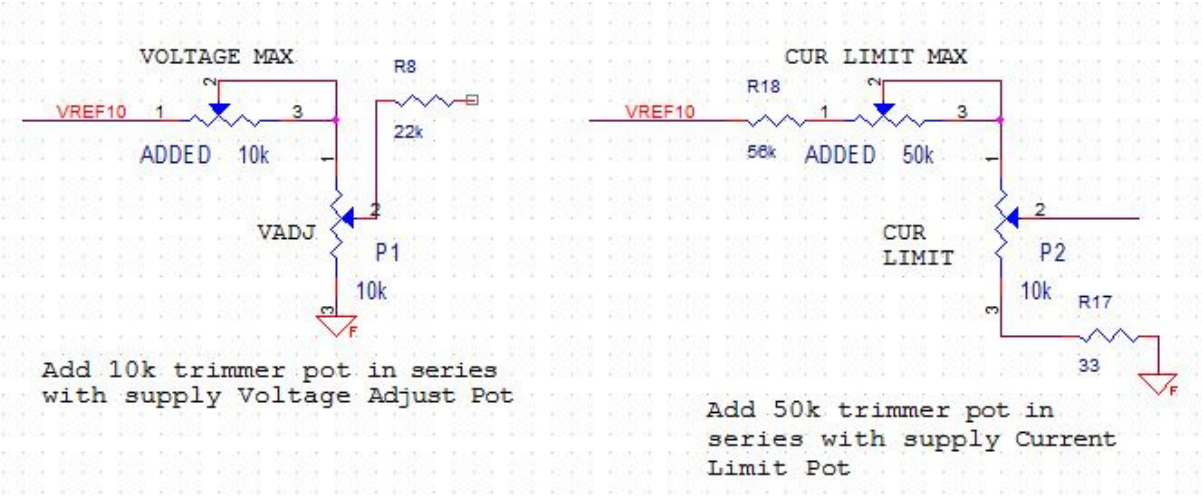
A fix for #2 that does not require a new TL081: replace R20 with a 56k resistor so the LED works with even a lousy op amp.

A good fix for #3 would be to install a filter capacitor 2X or 3X larger than the current one but this is probably impossible to do on-board.

A fix for #3 that does not require replacing the capacitor: limit the output current to 2A (or 1A), and reduce the maximum output voltage to 20V (or 25V) so that the ripple does not cause loss of regulation.

A good fix for #4 would be to replace U2 and U3 with 40V rated op amps however those with a matching package/pinout are typically expensive. A reasonable fix is to reduce the (D7) 5V Zener to a 3.5V Zener and increase R13 to 15k so the TL081 max supply voltage is not exceeded.

Overall I rate this supply board a D- as delivered, and a B if it is used at reduced current and voltage, the TL081's are replaced with authentic, additional pots are placed inline with the voltage and current adjustment pots to limit/adjust values as above, and D7 zener voltage is reduced. The circuit diagram below shows how to add pots to limit the output voltage to 20V/25V and output current to 2A.



These added pots can be attached/glued to the body of the panel pots provided.