TIU 2 or 4 Port Signal Indicator Board- User Notes R1a 02-03-22

This project is adapted from the great little portable TIU port tester that Adrian designed, many contributed good ideas, and finally gunrunnerjohn did the board design for. It was developed in an OGR forum topic called "$10-20 DCS-TIU Port Tester Tool"; and it is being distributed by rtr12. It is inexpensive and works quite well. Thanks to Adrian, Stan, grj, and others, and rtr12 for doing all the work to make this kit available!

When I reread the thread I was reminded that early on someone suggested visual indication would be a nice feature to have, by adding an LED to the output of each TIU channel to indicate the presence of DCS output pulses. This would function like the red LED on Legacy and TMCC bases, which is a very handy tool for troubleshooting. The result is this board, which can be mounted neatly ***inside*** the TIU case, with just the indicator LEDs sticking out through the cover, one at each TIU channel output. A 2 port board is used if you are only using one or two fixed DCS outputs say. If instead you are using all 4 TIU outputs, you can install 2 modules and cover all 4. Optionally if your TIU is out of sight under the layout, the board(s) can be mounted in small project boxes (say 85 x 50 x 20mm; one available size) and put right on the control panel.

The portable tester uses 2 channels of a CD74HCT123E chip; one for the red led and the second for the green led. But we can use these same two channels to provide basic go-no go DCS signal indication for two separate TIU ports instead. And it is convenient to have the LEDs board mounted so as to make installation in the TIU simple.

There are only two internal connections needed per channel, to the respective port output posts inside the TIU. Channel output powers the board, just like with the tester kit. The basic design is through-hole assembly, like the portable tester, so anyone can build it. The costs should be about the same as the portable tester kit.

Unlike the tester, only a single led is used per channel with the threshold signal level set at about 7-8 volts. That way any TIU kicking out the normal 10-12 volts or more DCS signal will show an LED hit with every data packet. Ports with an output much less than 8 volts won't activate the LED at all. Adjustable trim pots provide the signal splitting to adjust the trigger sensitivity level for each port. This allows setting the threshold voltage as desired. If you are monitoring 2 or more ports of your TIU, and suddenly one is not indicating when the rest are, you immediately know that channel may have a DCS signal problem.

Inspection revealed that there is adequate space inside the TIU near the output ports for installation of one or two small pcbs. If using only one, it can straddle the two center fixed outputs. If using two, each will straddle one variable and one fixed output mounted end to end. A single 4 port board may also be offered with a full length of about 183 mm. (Whether this version gets built or not will depend on the level of interest shown)

The pairs of TIU output posts are spaced about 56 mm, so the two leds (one per channel) are set about 10 mm inboard from the ends of the pcb; 56mm C-C apart.

The board includes a 3 pin header to allow selecting either TIU channel for power. This allows versatility of hookup regardless of how many, and which, TIU channels are being used.

Note that because of the nature of the HCT123M IC, the black commons of all TIU channels connected to any indicator board will be electrically tied together. Normally this does not cause any problem, but for a layout installation that requires TIU output black commons to be electrically isolated, you will not be able to use this board with more than one channel.

Board Assembly (Refer to the specific board version notes for further information)

The two port board is simple construction using only 25 components, many of which are generic two hole non-polar passive devices like resistors and ceramic capacitors. The 4 port board uses 44 total similar components. Both boards use a regulated 5 VDC power supply to supply power for all channels.

Board assembly is easy thru-hole using a standard 50-70 watt soldering station. The only exception is the SOIC-16 CD74HCT123M chip which is SMD with lead pitch of 1.27mm. This will require a fine point tip and 0.020” 63/37 solder and a steady hand so as to avoid bridging any leads. One of these chips is used on the 2 port board; two are used on the 4 port board.

The CD74HCT123 chip is a CMOS device and hence ESD sensitive. It would be prudent to do all the simple thru-hole stuff first, then mount the chip last, using at least basic ESD precautionary measures. Note that most components mount on the top of the board, and will fit within the 7mm spacing between the board and the TIU case cover that is created by the cover strengthening ribs. All except the 220 uF filter cap C7 that is, which mounts underneath the board due to its size. Its location on the board is such that there should be no conflict with other TIU components.

Suggested order of assembly:

-diodes (3); observe polarity
-resistors (7) and L1 inductor (1); non-polar
-0.1uF ceramic caps (6); non-polar
-trim pots (2)
-LM78L05 Vreg; align pin 1
-LEDs (3); observe polarity
-U2 16 pin IC; align pin 1
-220uF aluminum cap; observe polarity
-power jumper J3
-install board lead wires

Optionally the two trim pots can also be installed on the underside of the board, as explained a little later. The TO-92 LM78L05 voltage regulator should be mounted on the top of the board, and bent over 90 degrees so it lies flush to the top of the board. This will provide clearance from the case cover.

No components should be mounted on the bottom of the board within the designated "Keep Out Zone". These zones are located immediately above two large rectangular relays on the TIU board, and any components mounted in these zones might cause interference.

The two red 3mm port indicator LEDs should stand off the board by about 4-5mm so they will project 2-3 mm above the case cover when the board is mounted. 5mm LEDs should be flush, or up to perhaps 3mm stand off. The blue power LED can be flush mounted to the board, so that it is below the case cover, visible through its access hole. Or it can also project through the case cover at the user's option. 3mm red LEDs are recommended but you can also use 5mm if desired. Use whatever colors you prefer.

Select which port will be used for power for the board and jumper the 3 way header J3 accordingly. Finally install two pairs of short (4") light gauge (22-26 AWG) stranded jumper wires to the J1 and J2 jumper blocks for connection inside the TIU later. Observe polarity. "R" on the board header goes to the red TIU port connector, and "B" goes to black. Easy!

## Board Installation Inside the TIU

If you are using only one or two fixed TIU channels you need only install one two port indicator board. If you are using all 4 TIU channels for DCS operation you can use either two two-port boards, or one 4 port board, whichever is convenient.

If you initially install a single 2 port board center mounted, then later decide to use all 4 TIU ports, you can re-locate the original 2 port board and add a second 2 port board to monitor all 4 TIU channels. There will be no wasted boards or led holes doing this.

Note that to use the two "variable" TIU ports for DCS operation you must first set them to "fixed mode" using the DCS handheld. Refer to the DCS manual for instructions. Note also that power for each TIU channel must be a true sine wave power source, and not "chopped" sine wave. This means you should not use a Z-1000 or CW-80 or similar (with its controller) for power. You can use any PW Lionel or MRC transformer, MTH Z-4000, or any power "brick" alone; *without* it's adjustable controller. Inadvertent use of chopped sine wave power will likely produce only a steady red output from the respective indicator LED (because the chip is constantly re-triggering), though it won't cause any damage to the board or TIU.

Print the appropriate hole drilling template png file in full size. Check the key dimensions on the template with a ruler to insure the print scaling is accurate. The most critical dimension is the 56 mm C-C between LEDs. Landscape orientation is recommended. Depending on your printer you may find that "Print Full Size" works better than "Fit to

Page” or similar. As a last resort you can photocopy the printed page using a reduce/enlarge scaling factor that produces the correct size copy.

On the top of the TIU case cover measure 20 mm from the near edge of the outermost cooling louvres towards the output side of the TIU, at each end. Draw a pencil line between these marks. This is the centerline of the red LEDs when installed. See Pic 1.

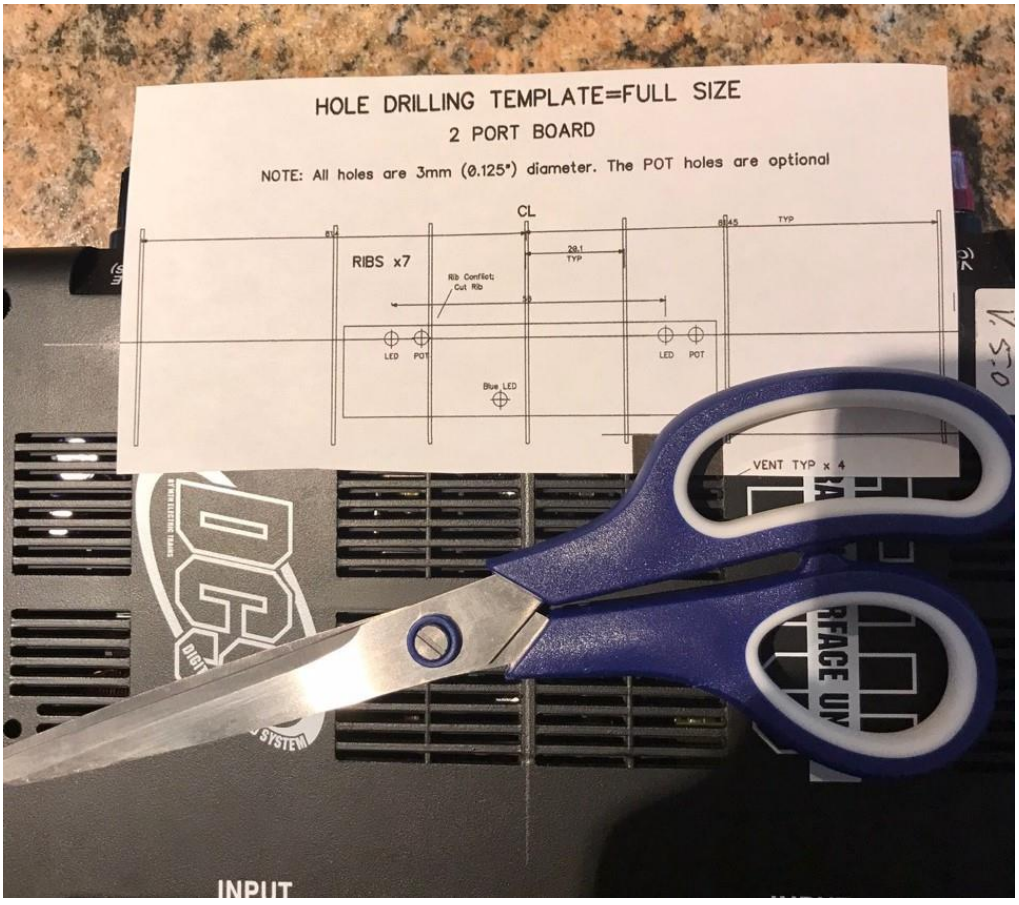

PIC 1; Draw a horizontal LED hole centerline 20mm away from the vents

Now measure and draw a vertical pencil line running along the TIU centerline between the two sets of fixed outputs, towards the fixed inputs, running down the middle between the four sets of central cooling vents. This is the line that the board will be horizontally centered on. See Pic 2

Now trim the drilling template and align the “CL of LEDs” line with the horizontal pencil line on the case cover. Also align the middle rib on the template with the vertical pencil centerline on the case. Tape the template in place. See Pic 3

Refer to the specific board version notes for further information.


PIC 2; Draw a vertical case centerline




PIC 3; Align and tape the drill template in position

Next use a sharp object like an awl to mark through the center of the LED holes into the case cover. Don't forget the blue power LED opening. Optionally you can also mark and drill the POT adjustment holes, though this is not strictly necessary. Only do this if you wish to be able to adjust the port sensitivity from outside the case after board installation. If you set the pots initially at about ¾ turn CW you should get satisfactory operation with any healthy TIU port. (This should give about 250 ohms between pins 2 and 3 of the pot)

Optionally you can mount the pots underneath the board; there should be no conflict with any other parts. If you mount them this way the rotation is *reversed*, so turning *CCW* increases sensitivity. The initial setting should be ¾ of a turn CCW. This mounting avoids drilling case holes for the pots as well as rib modification to relieve pot conflicts, and they can still be adjusted easily *with the TIU cover removed.*

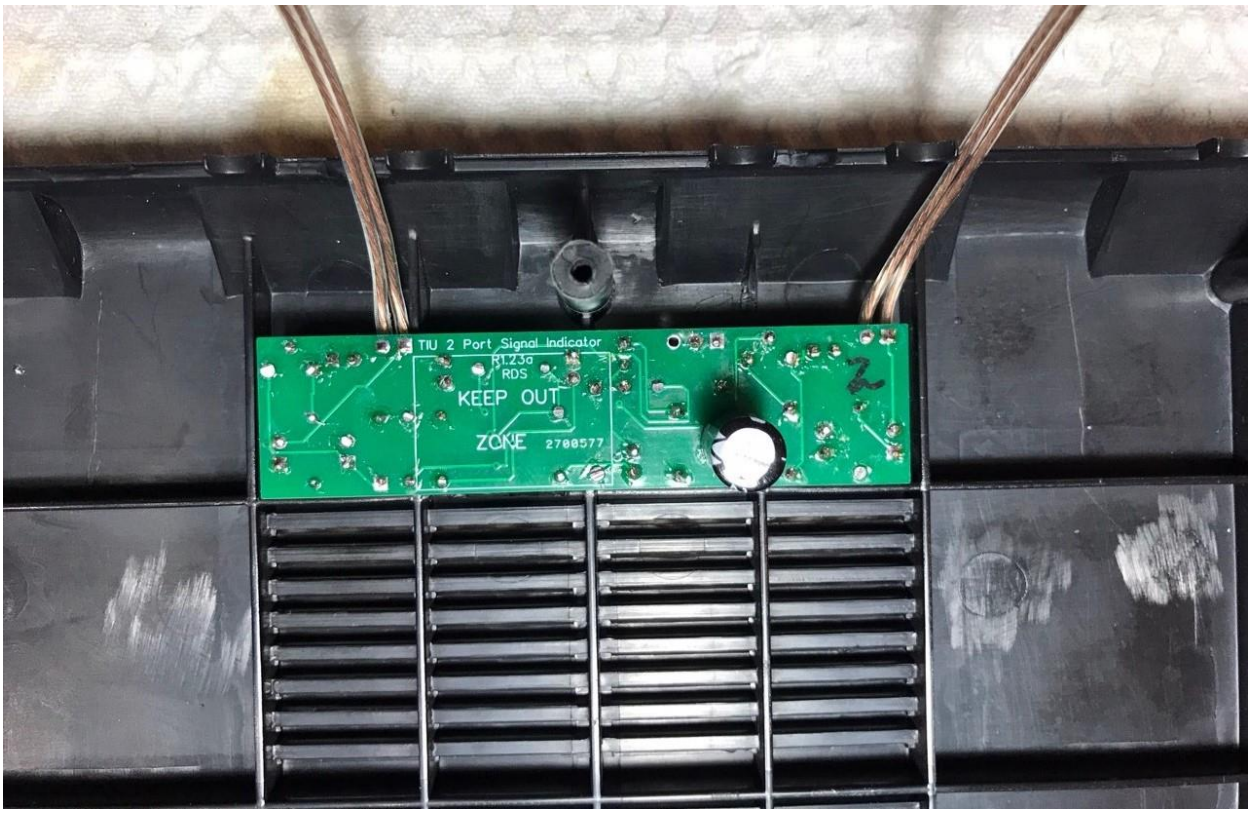
Remove the template and carefully drill the marked hole centers. A step drill bit is recommended; otherwise start with your smallest bit. The best hole size is 3mm (0.125") for 3mm LEDs, or 5mm (13/64") for 5 mm LEDs. The POT adjust holes need only be 4 mm (5/32") in any case.

Note the rib area on the template marked "rib conflict", when the pots are top mounted. You will need to remove about ½" section of the rib on the inside of the cover in this area for pot clearance. Simply break off a rib section as needed with a pair of pliers. You will find that the case plastic is brittle and the ribs break easily. Trim any uneven flash flush to the cover surface. It does not have to be pretty! (You can also trim other ribs a little as needed to alleviate conflicts with other smaller board components such as resistors and capacitors)

Before installation you may wish to bench test the completed board; refer to Testing below. (Jumper the board input wires to the TIU outputs for this test.)

Then test fit the board by aligning the LEDs with the respective holes in the cover. It should fit up fairly flush with the bottom of the ribs, with the red LEDs sticking through the cover. Make any adjustments necessary so the board clears the ribs and fits properly. You can re-solder the LEDs to adjust for more or less projection through the case as desired. Basically no components should extend above the tops of the trim pots, including the TO-92 regulator.

Now secure the board to the inside of the cover either by applying a small dab or two glue where the board contacts the bottom of the ribs, or simply tape it into position using masking tape. See PIC 4.




PIC 4; Board fitted into cover, almost ready for closeup

Before closeup do a test fit of the cover to the TIU body to make sure there is no interference. Fix any problem areas. Finish up by applying electrical tape (or masking tape) to the bottom of the board so as to cover the bare solder joints. Then connect the wires from the board to the respective TIU port output connections (R to red, B to black) using solder, or ring crimp connectors under the post nuts. Tuck the wires in carefully and close up the TIU.

Testing and Operation

You can bench test the modified TIU by simply applying 12-18 VAC power to the input port you selected for board power. The blue LED should immediately light, and the TIU startup burst should run for a second or so. This will be immediately followed by the watchdog signal which is a sequence of short bursts lasting a couple of seconds. These signals should produce very pronounced red flashes on all monitored TIU channels, powered or not.

If the board test is good re-connect the TIU to the layout wiring and power supplies. Note that the indicator board will not power up (blue LED) until track power is applied to the port you selected for board power, regardless of how the TIU itself is powered.

In normal operation you should see a short LED flash or two whenever an engine command is sent using the DCS handheld; *on all board channels that monitor a powered TIU port*. (An unpowered channel will send out the watchdog signal at powerup, but will not send routine DCS commands thereafter)

There will also be sporadic flashes in a random pattern as trains are running, which occur whenever the TIU interrogates an engine. Running the chronometer or odometer checks creates an intense amount of back and forth communication between the TIU and the engine; as does the “Read” command while searching for engines.

If one or more engines lose control with normal DCS commands, the signal indicator board will provide a quick diagnostic as to whether the TIU is operating normally and sending out DCS data packets on any or all channels, especially when the watchdog signal runs at TIU power up. Any powered TIU channel whose indicator does not show the watchdog signal on startup, or a flash or two with any handheld command, is suspect, and should be further tested for correct operation.