

# Centnet DSM Electronics Box Interface Panels:

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## Document Description:

### **File Reference:**

MS Word Document: /net/isf/isff/doc/centnet/Centnet\_InterfacePanels.doc/.pdf

### **DSM vs NDAQ:**

This document includes information regarding the ‘Centnet’ version ISFS DSM interface panels, cabling and some associated equipment, including the long range BlueTooth radio WT41 interface that is used to communicate with external devices.

The older version ISFS Electronics Box and Data System was referred to as ‘NDAQ’ whereas ISFS now uses the term common with RAF’s use of the PC104 system as “DSM” which stands for Data System Manager. The PC104 hardware with NDAQ centered around the Viper CPU boards, whereas the DSM hardware interfacing system described here is for the Titan boards. The NDAQ box panels had different interfaces with these differences:

- Power Distribution connectors 2-pin      DSM has 6pin
- No Isolated Working Ground              DSM has ‘brick’ isolation between working and earth.
- DCDC distribution was different          DSM has easier implementation and more ports for this

## Related Documents

[ISFS Sensor Cables.docx](#)      Information about cables and sensor connectors that was previously in this doc.

## Design Guidelines:

<i>Item</i>	<i>Rating</i>	<i>NDAQ?</i>	<i>Comment</i>
Power:	5A	Same	Max.
DC Input – Nominal	12V	Same	Supply. Feasible to run PV system at 24 but convert to 12 for DSM
Board Connectors	15A 8A	Same	5mm Black 2-pin Molex (wm5872-nd, wm5862-nd) 3.5mm Black 2-pin Molex (wm5624-nd, wm5605-nd)
On/Off Switch	SPST toggle	Different	Was Push-Button with NDAQ, and access was outside the box. SPST is on the Power Panel accessed inside.
Input Fusing	Car Fuse	Different	5A
Port Fuses	Car Fuse	Different	Huge size, but significant advantages, cost, availability. Flavors=1A,2A,3A, etc. Automotive Mini ATO. Old NDAQ used expensive smt OmniBlock fuses
Output:	To Bulgins		
DC Output	1.5A		Continuous
	~3.0A		Peak (for Licor). Worst case heating of fet = $I^2R_{ds} = 9 * \sim .1$ ohm Need to check thermal/junc. characteristics
	12V		Nominal, or see above up to 24
	24V		Option: from DC-DC subpanel jumpered to Pin-2 (shield, where jumper to ground is)
	DC-DC Sub-Panel	Different	DCDC power for Eth1, ttyS2 and ttyS4 is jumper option on 5-pin JPx.2; see note below. Old NDAQ 4-pin header for Ethernet1 and Com5 (485) is gone
Power FET	All Ports Switched	Same	
	5-pin Jumper	Different	<i>The old version had a 4-pin jumper to enable port power with either the fet output or +12. Centnet Titan/Emerald panels have a 5-pin jumper so we can select either +12 or output from the DC-DC converter for port supply.</i>
	Component	Pin Compat.	Old Version IPS521 has a replacement part P-chan MOSFET IPS6041
Protection	GasTube	New	Add for power/io lines, small enough to fit but obviously reduced capacity just like ESD/EFT
	TVS	Similar	Lower working/breakdown voltage components
	power choke	Different	Ferrites are now used instead of coils.
	Series resistor	New	Small resistor ( $\leq 10$ ohms) used to help voltage trigger tvs/gastube
GPS	SCL – I2C SDA – I2C	Not Used per G.M.	Titan J3 – Pin1; J-GPS Pin12 2mm header Titan J3 – Pin2; J-GPS Pin14
	PPS-TtyS3	Same as with mapper	Titan J1 – Pin21 COM4 (ttyS3) DCD4 This is also on J-GPS Pin6 to DCD4 for the internal GPS option
	Rx Tx		J1 – Pin23 COM4-Rx, Output from GPS to Titan, J-GPS Pin10 J1 – Pin25 COM4-Tx, J-GPS Pin8

# Power Distribution:

**Board Layouts:** are covered in: [PCB Design / Manufacturing section...](#)

**Connections:** Power: 5mm 15-Amp rated Molex to secondary boards

Power: 3.5mm 8-Amp rated Molex to stack. Power-In: AMP connector labeled “MAIN”, through a TVS array, Choke and filter.

High current ferrite-beads are used as common-mode chokes on both ground and +Vout to suppress noise and assist the TVS protection.

**Ground Bonding:** The ground plane of the boards is isolated. The Bottom/Signal layer has a plane-fill that is bonded to the metal front panel via the mounting screws which will be connected to Earth.

## **Component Current / Power Capacity:**

**Current capacity** depends on board and component temperature. *In general current capacity goes down with higher temperature for lams/wire, but improves for components that are limited on internal junction temp/heat sinking.* See also [PCB Board Design / Manufacturing](#)

## **Component Current Handling Capacities**

<b>Component</b>	<b>Rating</b>	<b>Comment</b>
AMP Pins	13A? per pin *2	Mentioned on one note in digikey catalog
Bulgin Pins	5A	Max for Pins/Sockets (p/n 3347 and 3348), 22AWG
	1.3A	Max, 26AWG wire
16AWG Wire for +/- to board from Power Panel	13A per wire	Note temp./insulation deratings reduce these
22AWG Wire for +/- to Sensors	5A	Absolute max derated by .004degC and inside jacketing
Board Connectors	15A	5mm Black 2-pin Molex (wm5872-nd, wm5862-nd)
	8A	3.5mm Black 2-pin Molex (wm5624-nd, wm5605-nd)
PCB Total		Measured once at room temp but should redo at cold (lower capacity). Board has internal power/ground planes, so ‘really big lan’.
Board LANs	~0.7A@-10degC ~1.5A@0degC ~2.0A@10degC ~4.0A@45degC	.080” x 1.25 Oz./ft^2 copper trace through coil, fuse to Bulgin connector. CHECK THIS/FUSING CURRENTS
Power Switch	8A	Rated
FET for Aux1	1.4A @ 125degF 2.0A @ 75degF 2.6A @ 25degF 10A peak	IRL IPS6041G part. Max continuous current is dictated by Junction Temperatures. These improve with lower ambient temps. and better heat sinking on chip or lan. The board was not designed with any special heat sinking capabilities.
DC-DC converter	1.8A	For providing +15VDC to board, used for Ethernet on viper in particular. (20W module)
Ferrite, power choke.	6A	
Pin on +12 Distrib to dc-dc submodule.	3A	Sullens .1” breakaway (s1011-35-nd)
Shunts on PowerPin	3A	Sullens .1” (s9000-nd)

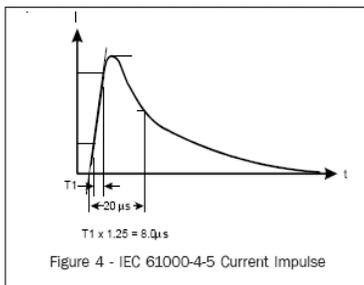
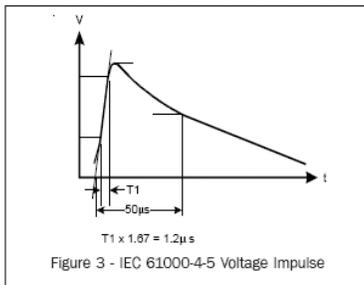
## ESD / Lightning Protection:

Threats are from roughly 3 sources: ESD, CableDischarge, Lightning

**ESD:** Mostly from human contact and can either be a direct or air-discharge event. Durations are very fast, in nS range. International standard IEC61000-4-2 is used commonly by manuf. and is much more stringent than JEDEC/Mil-Std883. However, testing can be done at different levels. Best is level-4 at 15kV air / 8kV direct with currents up to 30A (vs 5.3 for 883) for discharge lasting 30-60nS (initial peak happens roughly 1nS). Testing is done discharging a 150pf cap through a resistor.

**Cable-Discharge (CDE):** This threat occurs particularly in vulnerable Ethernet cabling. Cables have capacitance that can become charged by inductive or triboelectric (contact between materials, rubbing, etc) means. CAT5/6 cables have low-leakage so the charge may remain high until discharge occurs when cables get plugged in. It is essentially an ESD event.

**Lightning:** Electromagnetically coupled surge transients are 'slow' lasting from microseconds to seconds. It can be modeled wither as a voltage or current even. IEC61000-4-5 specifies 25A, rise time 8microSec and 50% discharge at 20microSec. (8x20uS)



**Protection Devices - GasTubes:** Essentially high capacity devices for slow surge (lightning) events. They have almost no loading capacitance (~1-2pf). They can handle large currents but must be 'hybridized' with fast TVS diodes to make sure the fast rising surge is clipped before getting into components. Once triggered by breakdown voltage they act as shorts and continue to shunt current including below the breakdown voltage. This follow-on current must sufficiently diminish before they turn off. It is possible a loaded power line may feed through it after the surge is gone however the fuse on the interface should prevent this problem. The hold-over voltage is generally above operating voltage level. **TVS:** Silicon based fast response to clip initial pulse but typically do not handle large currents, although this depends upon the 'amount of silicon' and thus component size. For PCB panels with limited space this is an issue. TVS's also have more limited cycle life, with high current avalanch varieties (not used) can take only a few hits. The VS10P12C's are socketed devices for easy replacement.

The Titan and Emerald Interface Panels use Fuse, TVS and GasTube devices to protect for 'cable,' 'lightning' and 'over-load/short' conditions.

Port	TVS Component		Vw	Vb	Vc	8/20 A	leak $\mu$ A	Cap pf	#lines	8/20 Watts
COM1-4	VS10P12C = Bidirectional	VSIP-10	12	13.3	19.5	24	1	150	8	800
COM5 RS485	Protek – <a href="#">PSM712.pdf</a>	SOT23 Uni	7 12	7.5 13.3	17 30	34 30	20 1	75 75	2?	600
Ethernet	SLVDA2.8LC	SO8	2.8	3	21	30	1	5	4	600
USB	Bournes <a href="#">CD143A-SR05</a>	SOT-143	5	6	9.8	30	5	10	2	500
	<b>GAS Tube:</b>									
All-Ports	LittleFuse SG75	SMT		75		2000				

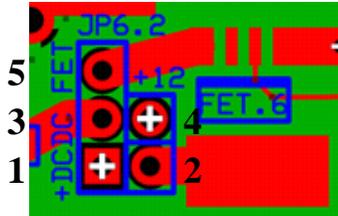
### **Titan's on-board ESD Protection:**

The data sheet mentions “15kV” testing for interface parts on the board but does not say to what standard it complies.

Interface	ESD “quoted” in Titan Manual	
COM1/ttyS0 – RS232	+/-15kV ESD	UART in PXA270 Full handshaking/modem
COM2/ttyS1 – RS232	+/-15kV ESD	BlueTooth UART in PXA270, Full handshaking/modem
COM3/ttyS2 – RS232	+/-15kV ESD	Standard UART in PXA270 Full handshaking/modem
COM4/ttyS3 – RS232 (gps)	+/-15kV ESD	XR16C2850 Rx/Tx
COM2/ttyS4 – RS485/422	+/-15kV ESD	XR16C2850, GPIO81=0=RS485;1=422
USB	NO mention of built-in ESD protection Has short-circuit protection	
Ethernet IEEE802.3 10/100-BaseTx	NO mention of built-in ESD protection in the Titan Manual.	Davicom DM9000A Ethernet Controller 3.3V with 5V tolerance Transformer noted is on the Titan board= Pulse H1102NL 10/100Base-T single port transformer. Turns: 1:1,1:1
Switching Regulator	LTC3412 3-5, 2.5A	

## Power Jumper Settings / Switching FETs:

**Titan Panel Port Power Selection (& Emerald ttyS9-12):** Unlike the ‘Viper’ interface panel, the CentNet version uses a 5-pin jumper to choose which supply is distributed to the Bulgin connector. This was done so that there is now an option to provide both +12 (main power supply) and +DC-DC (converter supply) to any port. This requires 2 jumpers for FET controlled output and 1 jumper for uncontrolled raw voltage output. These are enabled by jumper Pads JPx.2.



JPx.2 Pin Layout  
(Top View looking  
down into DSM box)

### FET Controlled Output Options:

3-5= +FET Output to Bulgin

Then either:

2-4= Main +12 Power or

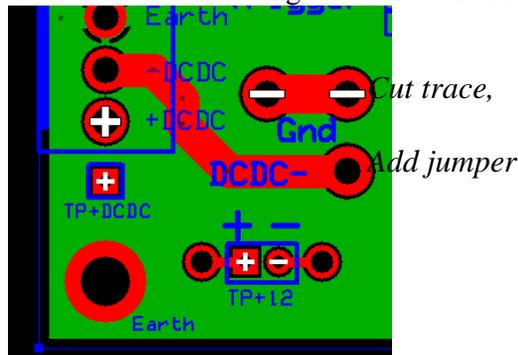
1-2= DC-DC+ Power

### Output Always ON Options:

3-4= Main +12 Power or

1-3= DC-DC+ Power

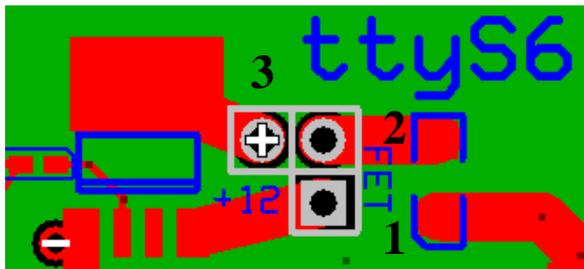
**Titan Board DC-DC Isolated Supply Option:** Ports ttyS2, ttyS4, Ethernet have the option of distributing DC-DC voltage to the output ports with isolated –DC. This requires modification of the interface panel, by cutting the large GND trace near the top left of the board adjacent to the ‘Power Panel’ connector. Then soldering a new jumper to DCDC- from the open hole. See the panel layout inner ground plane layer. If you do this then jumpers JP6.2 (Ethernet), JP3.2 (ttyS2) and JP5.2 (ttyS4) for the +voltage should be for DCDC+. The traces are located adjacent to the Power Distribution Connector J1 in the ‘upper-left’ side of the board looking down into a DSM box:



**V2 Emerald Panel Port Power Selection:** The Emerald panel has 4 ports setup like the Titan for either FET controlled or direct +12 or +DCDC (ttyS9-ttyS12 located on the right side of the board when looking down into the DSM box).

These are jumpered the same as JPx.2 noted above.

Another 4 ports (ttyS5-ttyS8 on the left) have a 3-pin jumper for +12/Main options only.



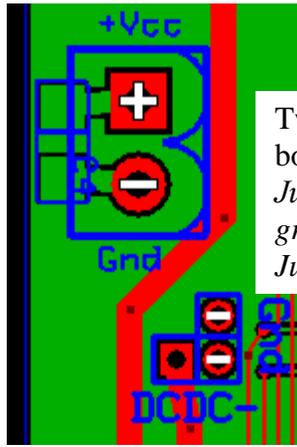
### FET Controlled Output Option:

1-2= +12 through FET Output to Bulgin

Output Always ON Option:

2-3= Main +12 Power

**V2 Emerald Board DC-DC Isolated Supply Option:** Ports ttyS11 and ttyS12 can provide isolated DC-DC outputs. Both ports require a jumper to select either ‘main’ or DCDC- ‘ground.’



Two 3-Pin headers on the right side of board near power input connectors.  
*Jumper 'Gnd-Gnd' for main supply ground.*  
*Jumper DCDC- for isolated ground*

**FET Gate Drive Considerations:** +5 Drive signals are provided by the Titan GPIO on J3 (Maxim MAX7313). *Each Titan GPIOx line should be configured for the “open-drain current-sinking output (50mA) with the 10kΩ pull-up resistor to guarantee that proper FET turn-on is achieved.* REDBOOT said controls OUT0-2 come up as logic ‘0’

NOTE: The J3 ribbon cable from the Titan is routed first to the ‘Titan Panel’ and then a sub-ribbon with only pins 11-20 are routed to the power panel.

<b><i>Titan Board:</i></b>	<b><i>J3 GPIO Connector</i></b>	
ttyS0	Pin-9, P6, MAX7313 GPIOxx	Bootup Default = ?
ttyS1	Pin-6, P3, MAX7313 GPIO	Bootup Default =
ttyS2	Pin-5, P2, MAX7313 GPIO	Bootup Default =
ttyS3	Pin-4, P1, MAX7313 GPIO	Bootup Default =
ttyS4	Pin-3, P0, MAX7313 GPIO	Bootup Default =
Optional DC/DC control on sub-module	Pin-20, P15, MAX7313 GPIO (Control line to shut off DC/DC module itself. Not normally available on the parts we buy)	Bootup Default =
DC/DC FET on power panel for AUX1	Pin-16, P11, MAX7313 GPIO (Control line turns on/off the fet routing power from dc/dc to the AUX1 connector on the power panel.	Bootup Default =
+5V-FET for Vinfinty 7805 on pwr panel	Pin-18, P13, MAX7313 GPIO (Control line turns on/off the fet on the power panel for +5V to the ‘cell-modem’ ,etc	Bootup Default =
<b><i>Viper Board:</i></b>	<b><i>PL9 GPIO Connector</i></b>	
ttyS0	Pin-11, OUT-0, PXA255 GPIO20	Bootup Default = OFF
ttyS1	Pin-18, OUT-5, PXA255 GPIO21	Bootup Default = On
ttyS2	Pin-20, OUT-7, PXA255 GPIO22	Bootup Default = On
ttyS3	Pin-16, OUT-3, PXA255 GPIO23	Bootup Default = On
ttyS4	Pin-14, OUT-1, PXA255 GPIO24	Bootup Default = OFF
USB	Pin-15, OUT-2, PXA255 GPIO25	Bootup Default = OFF
Ethernet-1	Pin-19, OUT-6, PXA255 GPIO26	Bootup Default = On
Ethernet-2	Pin-17, OUT-4, PXA255 GPIO27	Bootup Default = On

**FET Info:**

The IPS6041 is used on Centnet interface panels whereas the older IPS521 was on the NDAQ panels but is no longer available. NOTE: The IPS6041 can only be ordered from International Rectifier IRL.com. There are some other pin compatible options, IPS7091, etc.

<i>Basic Specs:</i>	<b>IPS6041</b>	<b>IPS521</b>	
	SO8	SO8	
Max. Continuous Current (At 75degC Ambient)	(1.7A)	1.6A	Most sensors will operate at 1A
High-Level, ie turn-on voltage	4.0-5.5V	4.0-5.5V	
Low-Level, ie. turn-off voltage	0.0-0.9V	-0.3-0.9V	
Typ. On/Off voltages	2.5 on, 2.0 off		
Vcc Operating Range	6-28V		
Pd Max (power dissip.)			
Rds, on state resistance	110-190mOhm		
Rds, Tj=150C			
RjaThermal Resistance Junc-Amb.	100C/W		
Tj Max Allowable	150C		Min. value to trip protection
Leakage:	1uA (G-S)		
<i>Measured Values</i>			
Actual Turn-On Voltage		2.4V	
No-Load Leakage Current w/+5 10K pullup, ie 'On'		.83mA @ 12.v = 10mW	
Leakage with floating input		.016mA = .1mW	
Leakage with +12 source disconnected		.06mA = .7mW	
+5V current when 'On'		.055mA = .3mW	



## Commands for checking / using 'Emerald' boards:

- eio x 1/0* Controls FET power (if jumper enabled) port-x 0=off, 1=on  
Note this is actually a convenient script in /usr/local/isff/scripts/. The actual executable program is called 'emerald\_dio'.
- emode x mode* Sets (or "emode x" reports) port operating mode for a newer Emerald Version EMM-8P (which we're trying to migrate fully toward). Doesn't work for older version EMM-8M which requires jumper settings; yuck.  
mode: 232, 422, 485, 485nd (ne=no echo)  
Note this is actually a convenient script in /usr/local/isff/scripts/. The actual executable program is called 'set\_emerald'. The executable requires an explicit reference to a specific board '/dev/emerald0' for ex.  
Note Specific project startup scripts usually found in /usr/local/isff/projects/NAME/ISFF/scripts/dsm/ and may be named 'other.sh' often are used to automatically setup port modes.  
Note Don't change emode on an open port, can hang the system.
- set\_emerald /dev/emeraldx* Checks whether an emerald x (0=5-12, 1=13-20) is responding and on the right ioport address.
- setserial -a /dev/ttySx* Queries the device driver for port x to see if it's responding.
- more /proc/tty/driver/serial* Queries serial drivers and reports their status for both Titan/Viper ports and Emerald ports, showing i/o activity and whether there are fe-framing errors, etc.

## Bootup of Emerald:

- /etc/init.d/emerald* This is the bootup script that configures the serial ports on each card. The ioport addresses are mapped depending upon the Linux kernel version to 0xf1000xxx for example.
- bootup config. report* The ports are booted up towards the end of bootup. There will be messages such as for each port:  
/dev/ttyS5 at 0xf1000100 (irq = 3) is a 16654  
/dev/ttyS6 at 0xf1000108 (irq = 3) is a 16654

## Networking

- /etc/network/* Primary directory where you can setup dhcp, static
- > *ifconfig* Displays the ethernet address. located in /sbin/ifconfig
- > *ifdown eth0* Script stops the ethernet driver interface
- > *ifup eth0* Script re/starts the Ethernet interface.
- interfaces* File in /etc/network used to declare dhcp,static.  
# /etc/network/interfaces -- configuration file for ifup(8), ifdown(8)  
# interfaces to bring up automatically  
auto lo eth0  
# The loopback interface  
iface lo inet loopback  
# DHCP on the first ethernet device  
# iface eth0 inet dhcp **Uncomment this line to have DHCP enabled and comment out 'static stuff'**

```
# Static interface for the first ethernet interface, comment out the
# above and uncomment this
iface eth0 inet static
    address 192.168.0.126
    netmask 255.255.255.0
    broadcast 192.168.0.255
    gateway 192.168.0.1
```

**PPP See wiki: <http://wiki.eol.ucar.edu/sew/ISFF/PPP>**

## **Project Configuration**

```
/usr/local/isff/current_project      Edit to change the $PROJECT
/usr/local/isff/projects/-name-/ISFF/...
    /config
    /cal_files
    /scripts
    /scripts/dsm  This has some of the environment startup scripts the nidus uses; port settings, etc.
/usr/local/isff/projects/$PROJECT/scripts/adam/adam_env.sh
Among other things this holds
Project
Config_xml: file name of the xml file, which
    could be keyed to adam-name, project, etc.
    export CONFIG_XML=grove1.xml
    #export CONFIG_XML=`hostname`.xml
DataMnt:  device for storage
    #export DATAMNT=/cf
    export DATAMNT=/media/usbdisk
```

## **Log Files**

```
/var/log          Top directory for system logs
/var/log/isfs/    dsm.log, messages and kernel logs
                  Old boot logs are shown "name.0" and "name.x.gz" etc.  These are created by a 'logrotate' cron
>tail -f /var/log/isfs/messages Monitors the system messages log until you exit via Ctrl-C
>tail /var/log/isfs/dsm.log      Good place to look for dsm data acq. problems, or normal behavior
```

## **Scripts**

```
/usr/local/scripts
    net_check.sh    Looks at network connections and restarts if necessary.....used in crontab
                    processes. Note that shown below with crontab is one that has a hard address set
                    on the eth0 ethernet interface. If we have static addressing and that's it, OK, but
                    otherwise...
```

## **CronTab -l**

Crontab list shows what's running periodically. Primarily rotation of the log file, and regular tests/restarts for the network connections whether ethernet/wifi or bluetooth

```
5 * * * * /etc/cron.daily/logrotate
#
```

```
# Only run router_check.sh if net_check.sh succeeds to avoid power cycling modem if the problem is with the ethernet connection
# old 5,35 * * * * net_check.sh eth0 192.168.0 192.168.0.1 && router_check.sh 7 www.eol.ucar.edu www.google.com
* /10 * * * * blue_check.sh
* /30 * * * * net_check.sh
```

## DataStorage

```
mount /dev/sda1 /media/usbdisk           Should be done automatically
/media/usbdisk/projects/DEEPWAVE/raw_data
```

## Checking Data

```
data_stats >ds (ds is an alias)
Counts ingest data and when Ctrl-C escape from it, a presentation shows what ports are receiving
data and what the message rate is. Note 'Motes' get combined and shown under ttyS5 instead of
split between that and ttyS9 (don't ask...). Below is ex. where trh,rg,baro are missing.
sensor      dsm sampid  nsamps |----- start -----| |----- end -----| rate minMaxDT(sec) minMaxLen
issmet:/var/tmp/gps_pty0 1 10 22 2014 02 10 20:28:05.316 02 10 20:28:15.466 2.07 0.150 0.870 72 73
issmet:/dev/ttyS4 1 40 12 2014 02 10 20:28:05.353 02 10 20:28:16.343 1.00 0.990 1.003 33 33
issmet:/dev/ttyS5 1 32768 4 2014 02 10 20:28:05.362 02 10 20:28:15.371 0.30 2.320 5.000 21 26

data_dump >data_dump -i 1,xx -p(processed data output)
>data_dump -i 1,xx (raw output, can be messy if non-printable messages but show hex values)
See the table above for what 'id' to use for specific sensors. The ids are declared in the xml

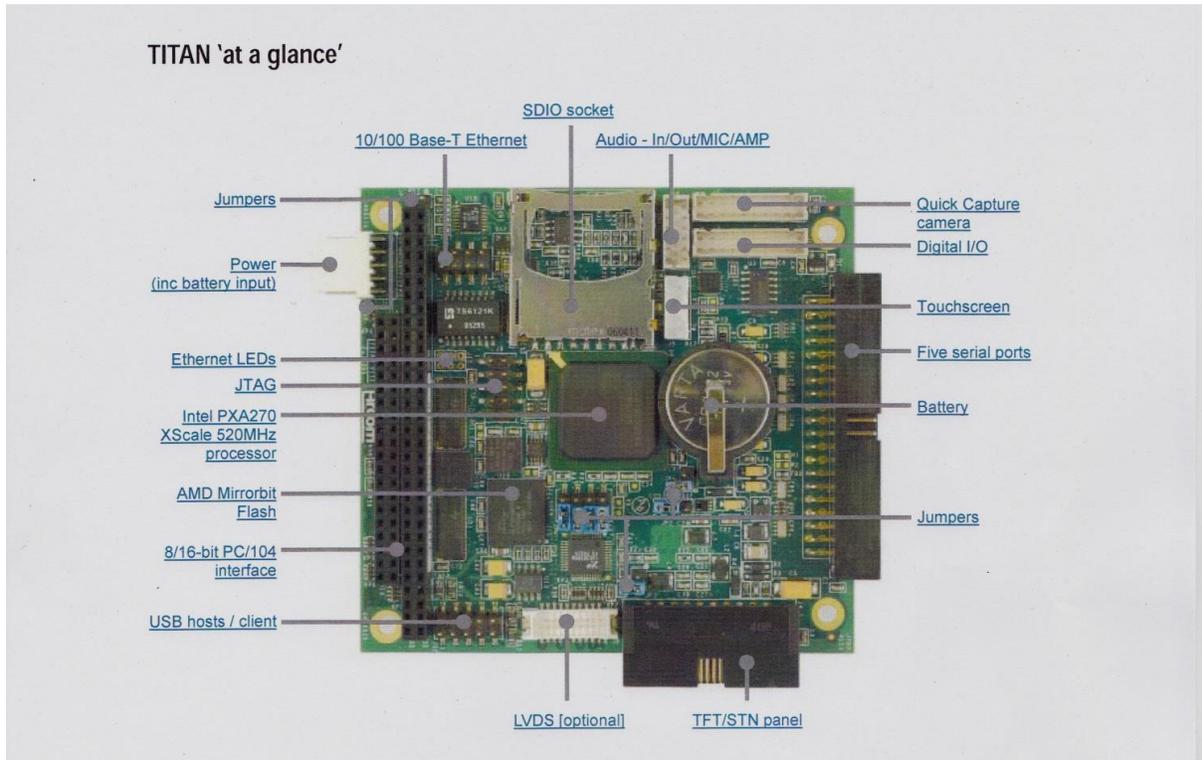
mote_dump >mote_dump -i 1 (shows output from all motes in raw hex 'wisard-message' values)
>mote_dump -i 1,9

rserial >rs x (rs is an alias)
To talk to sensors. 'x' is the port number of the sensor you want to talk to ie 'rs 4' talks to the
Gill.

disk use >df You should see /media/usbdisk which is your local storage archive.
data files >ls -l /media/usbdisk/projects/DEEPWAVE/raw_data/issmet_yyyymmdd_hhmmss.dat
Do this a couple times to make sure the current file is not only there, but growing. Files
normally hold 8 hours of data, ie hhmmss = 000000 or 080000 or 160000
```

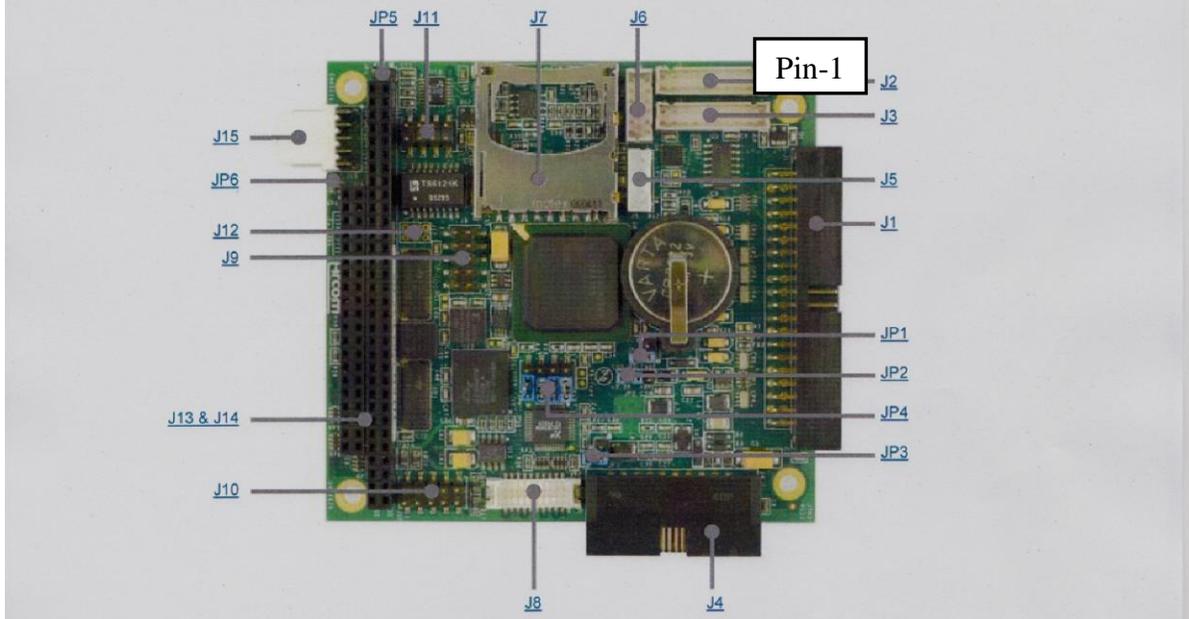
# Titan PC104 Board / Interface:

ISFS replaced the Data System CPU from Viper to Titan for Centnet. From the point of view of the Interfacing, they are largely similar, however a new interface panel was built to improve cabling and circuit protection. The **Titan PC104 board:**



## Connectors, LEDs and jumpers

The following diagram shows the location of the connectors, LEDs and jumpers on the TITAN:



## Titan COM-Port Summary:

There are 5 COM ports available on a 40-pin , .1” IDC header, connector Titan-J1 (same as PL4 on Viper).

### Port Protection:

All ports have  $\pm 15\text{kV}$  ESD on the Titan board itself. On the interface panel, signal lines are protected with Protek VS10P12C TVS arrays with 12vdc stand-off voltage, 13.3 breakdown and 19.5 clamping voltage, 25kV ESD, 24A 8/20us surge, 40A 5/50ns EFT capacity. Protection for sustained big hits also includes LittleFuse SG75 gastubes with 75V breakdown upto 2kA.

### FET Power Control:

Power can be jumpered always on, or FET controlled through 20-pin 2mm IDC header Titan-J3. These I/O lines are controlled via a MAX7313 chip on the Titan and Nidas software Command: “tio -a x 1/0”. Gordon has also enabled a DIO mapping to make control easier, and by ttyS number.

See [ttyS0-ttyS4 and Ethernet Port Power Selection](#): jumper settings below.

Port	Titan-J3 DIO control line	Software Command
COM1 – ttyS0	Pin-9, P6	“tio 0 1/0” or “tio -a 6 1/0”
COM2 – ttyS1	Pin-6, P3	“tio 1 1/0” or “tio -a 3 1/0”
COM3 – ttyS2	Pin-5, P2	“tio 2 1/0” or “tio -a 2 1/0”
COM4 – ttyS3	Pin-4, P1	“tio 3 1/0” or “tio -a 1 1/0”
COM5 – ttyS4	Pin-3, P0	“tio 4 1/0” or “tio -a 3 1/0”
Ethernet	Pin-7, P4	“tio 5 1/0” or “tio -a 7 1/0”

### Power on ttyS0 port:

The original Titan interface boards (ordered 053112) did not have resistor R1.1 installed, thus leaving its Bulgin power pin-1 open and unavailable without going back and actually installing R1.1. The part was a current shunt monitor that was a relic-idea from prototypes but was not used in practise. It is a 1206-wide component, Digikey #RHM1227CT-ND, .01, 1W, or else a second ferrite could be used to span the gap.

### Serial DTR Signal:

Data Terminal Ready, DTR, is sometimes used to indicate that a computer (DSM/DTE) is ready to receive data from a DCE device, often a modem. Occassionally there may be a sensor that uses this signal for either power or to indicate the computer is online and ready for its data.

The DTR line cannot be used simultaneously with ‘DSM-Tx’ to the sensor. DTR is available on Titan ports COM1 (ttyS0) and COM4 (ttyS3). It is also available on all Emerald ports.

### I2C:

The Titan has an I2C bus support provided on J1. On the interface panel it is routed to 2x10, 2mm connector “J-GPS.” The additional connector is available for custom stacking boards the initial version of which supports a Ublox GPS like used on the Wisard Version3. In addition, COM4/ttyS3 serial connectors are routed to this connector for alternative uses.

Limitations:

- 1) I2C Supply Current. Need to compare the current restrictions of the Titan supply versus max loads possible with GPS, etc.
- 2) Signal levels. The Titan operates with TTL (+5) levels. Any stacking board needing to communicate with the Titan may need level translators.

**Titan COM-Port Wiring (green-jacket cable):**

Cable-Wire	Bulgin	Titan J1 Pin/Signal	Interface
<b>ttyS0 - COM1 - PXA270 Console: RTS/CTS/DTR</b>			
A = Red	1 (Power +Vcc)		
B = Bare	2 (Shield)		Jumper connects it Ground or left open
C = White	5 (Titan Input)	33 – Rx1	DTE Tx to Titan (DCE) Rx
D = Black	4 (Titan Input)	34 – RTS1	DTE RTS output to Titan: ready to recv
F = Orange	6 (Titan Output)	35 – Tx1	
E = Brown	3 (Titan Output)	36 – CTS1	
G = Yellow	7	37 – DTR1	
H = Black	8 (Ground)	39 - Gnd	Direct connection to Ground Plane
<b>ttyS1 - COM2 – PXA270 BlueTooth UART, full handshake: RTS/CTS</b>			
A = Red	1 (Power +Vcc)		TVS SMC, RLC Choke/Filter -Gnd
B = Bare	2 (Shield)		Jumper connects it Ground or left open
H = Black	8 (Ground)		Direct connection to Ground Plane
C = White	5	13 – Rx2	
D = Black	4	14 – RTS2	
F = Orange	6	15 – Tx2	
E = Brown	3	16 - CTS2	
G = Yellow	7 (SigGnd)		(n/c)
<b>ttyS2- COM3 – PXA270 standard UART: Tx/Rx Only</b>			
A = Red	1 (Power +Vcc)		TVS SMC, RLC Choke/Filter -Gnd
B = Bare	2 (Shield)		Jumper connects it Ground or left open
H = Black	8 (Ground)	10 - Gnd	Direct connection to Ground Plane
F = Orange	6	11 – Tx3	
C = White	5	12 – Rx3	
D = Black	4 (n/c)		
E = Brown	3 (n/c)		
G = Yellow	7 (SigGnd)		(n/c)
<b>ttyS3 - COM4 – XR16C2850, full handshake: RTS/CTS/DTR, GPS Port</b>			
A = Red	1 (Power +Vcc)		TVS SMC, RLC Choke/Filter -Gnd
B = Bare	2 (Shield)		Jumper connects it Ground or left open
C = White	5	23 –Rx4	
D = Black	4	24 – RTS4	
F = Orange	6	25 – Tx4	
E = Brown	3	21 – DCD4	PPS Signal from GPS
G = Yellow	7	27 – DTR4	
H = Black	8 (Ground)	29 - Gnd	Direct connection to Ground Plane
<b>ttys4 - COM5 – XR16C2850 RS422/RS485 (half-duplex)</b>			
A = Red	1 (Power +Vcc)		GasTube, TVS SMC -Gnd
B = Bare	2 (Shield)		Connected to Ground. NOTE: Manual says SHIELD MUST BE CONNECTED TO GROUND or else damage to the transceiver may occur.
H = Black	8 (Ground)	9 - Gnd	Direct connection to Ground Plane
C = White	5	5 = Tx+ (422), Tx+/Rx+ (485)	
D = Black	4	6 = Tx- (422), Tx-/Rx- (485)	
F = Orange	6	7 = Rx+ (422)	
E = Brown	3	8 = Rx- (422)	
G = Yellow	7 (SigGnd)		(n/c)
<b>Other J1 Connections</b>			
		1 – Scl (I2C)	
		2– Sda (I2C)	
		3 – Gnd (I2C)	
		4 – 3.3 (I2C)	
		18,19 - Gnd	
		20,40 – N.C.	(n/c)

## COM-4: Garmin GPS – With PPS

4800bps for standard NMEA messages.

GPS Signal	Bulgin Pin	Garmin Cable-Wire Color	Titan – J1 COM4
+12 VDC	1	Red	
Shield	2	Bare Shield	
PPS signal	3	Gray	21 – DCD
TxDData from GPS to PC	5	White	23 – Rx
Receive Commands	6	Blue	25 - Tx
	4,7	n/c	
Ground	8	Black	

minicom gps0 allows checking of the gps when dsm is not running, provided tee\_tty is running

### Starting at Bootup

/etc/init.d/gps Script file

/usr/sbin/garmin executable for the gps unit

### Startup Delay

Defaults to 10-minutes to obtain lock 'A'

For lab testing, just remove the gps and nidas will bypass this, otherwise if it gets 'V' it knows gps is attached and will wait for 'A'

Program Running the Time Sync: /usr/bin/gps\_nmea\_sysclock

Usage: /usr/bin/gps\_nmea\_sysclock[-b baud] [-d data\_timeout] [-l lock\_timeout] device

-b baud: baud rate, default=4800

-d data\_timeout: seconds to wait for \$GPRMC data from device (default=30)

-l lock\_timeout: seconds to wait until receipt of a valid 'A' \$GPRMC record(default=600)

device: Name of serial device or pseudo-terminal, e.g. /dev/gps0

### NTP Notes:

/etc/ntp.conf Configuration File

/etc/ntpdate -d 128.117.64.12 Application to display/update from server

"ntpq -p" Check for ntp syncing. The output "\*" indicates it's active for syncing. Offset is in mS.

"more /etc/ntp.drift" Log File

The ntp daemon is conservative it won't adjust the system clock by more than 1/2 hour.

Before the ntp daemon starts a program (gps\_nmea\_sysclock) sets the clock from the gps 'A' records and then starts the ntp daemon. So if you don't get at least close first, ntp will never change the clock.

....ie if you don't start out in sync, you may want to reboot after 'A' is acquired.

ntp log files: These are started up via the ntp's: /etc/ntp.conf file

remember to setup for the directory:

statsdir /var/log/isfs/

/var/log/isfs/clockstats:

/var/log/isfs/loopstats: julian-time time\_offset freq\_offset\_itter allan\_dev\_ppm clock\_disc\_time\_const

### PPS Usage:

"ppstest /dev/ttyS3" Test program to check for it, output looks like...

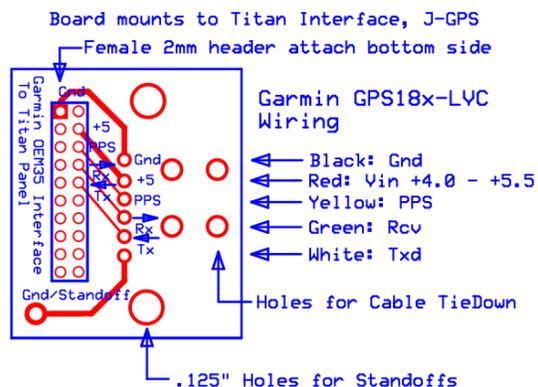
trying PPS source "/dev/ttyS3"

found PPS source #3 "serial3" on "/dev/ttyS3"

ok, found 1 source(s), now start fetching data...

## Garmin GPS to Titan Interface:

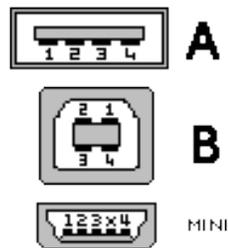
The Titan interface connector J-GPS is a 2x10 2mm header for attaching auxiliary I/O inside of the data system box. The Titan I2C and ttyS3 serial lines are routed to this connection. Power is provided by a V-Infinity DC-DC +5V module on the Titan board. A +5V Garmin GPS18LVC can be interfaced to it with the this plug-in adaptor. Two ¼" nylon standoffs are used as spacers. The GPS cable is tied down through 4 holes with small cable ties.



## USB-1, USB-2 Cabling:

The Titan has 2 USB ports. Both are routed to the interface panel USB jacks only; neither are routed outside, nor is there any fuse/power. Steering Diode/TVS is provided for each with a Bournes CD143A-SR05 chip, providing modest ESD/EFT protection only.

Ribbon-10 - Titan J10	On-Board USB Type-A Conn.
1 = VBUS-1	USB-1, Pin-1
2 = VBUS-2	USB-2, Pin-1
3 = DNEG-1	USB-1, Pin-2
4 = DNEG-2	USB-2, Pin-2
5 = DPOS-1	USB-1, Pin-3
6 = DPOS-2	USB-2, Pin-3
7 = Gnd	USB-1, Pin-4
8 = Gnd	USB-2, Pin-4
9,10 = Shield	



cable plug connector at the peripherals

jack connector at the controller

USB 1.x/2.0 Standard pinout			
Pin	Name	Cable color	Description
1	VBUS	Red	+5 V
2	D-	White	Data -
3	D+	Green	Data +
4	GND	Black	Ground

USB 1.x/2.0 Mini/Micro pinout			
Pin	Name	Cable color	Description
1	VBUS	Red	+5 V
2	D-	White	Data -
3	D+	Green	Data +
4	ID	None	Permits distinction of host connection from slave connection. * host: connected to Signal ground * slave: not connected
5	GND	Black	Signal ground

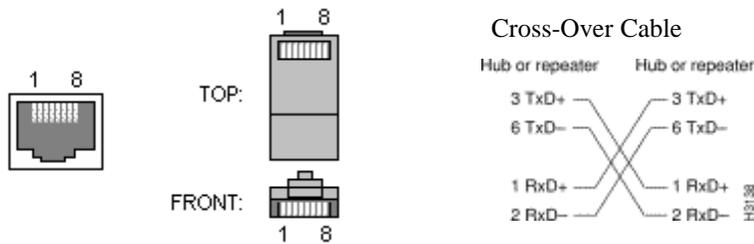
## Ethernet

TVS Array	FET Power Control	Shielded Pair 4,5 – C,D	Shielded Triad 3,6,7 – E,F,G
SLVDA2.8-4	OUT-6 (Viper PL9-19)	Tx+/-	Rx+/-,LANGnd
Sensor Power Option	Jumpering		
Vcc	CONS: 1-2 JP2: 2-3	FET disabled	JP4 Out
FET	CONS: 1-2 JP2: 1-2, 3-4 JP2: 1-2	FET enabled	JP4 In
+15SubModule	JP2: 2-3	FET disabled	JP4 Out
None	JP2: all removed	FET disabled	JP4 Out

Cable-Wire 'GreenJacket'	Bulgin to External	Ribbon-8 - Titan J11 (Viper PL1)	Protection / Interface	On-Board Eth. Modular Jack
A = Red	1 (Power +Vcc)		F1, TVS SMC, RLC Choke/Filter - Gnd	
B = Bare	2 (Shield: jumper to gnd)		JP1, Thermal Pad to Ground Plane	
H = Black	8 Ground Plane		Thermal Pad to Ground Plane	
C = White	5	1 = Tx+	TVS/Diode array1	ETH1, Pin-1
D = Black	4	2 = Tx-	TVS/Diode array2	ETH1, Pin-2
E = Brown	3	3 = Rx+	TVS/Diode array-1	ETH1, Pin-3
		4 = RJ-2		
		5 = RJ-2		
F = Orange	6	6 = Rx-	TVS/Diode array-2	ETH1, Pin-6
G = Yellow	7 (JP6 jump to Gnd)	8 = LANGnd		

Twisted-pair Ethernet (10BASE-T, 100BASE-T, or 1000BASE-T) uses an RJ-45 connector, which is an eight-pin modular connector

- 1 = Tx+
- 2 = Tx-
- 3 = Rx+
- 4 = (n/c)
- 5 = (n/c)
- 6 = Rx-
- 7 = (n/c)
- 8 = (n/c)



## Interface Board File Locations for Schematic/Layout/Mounting Panel:

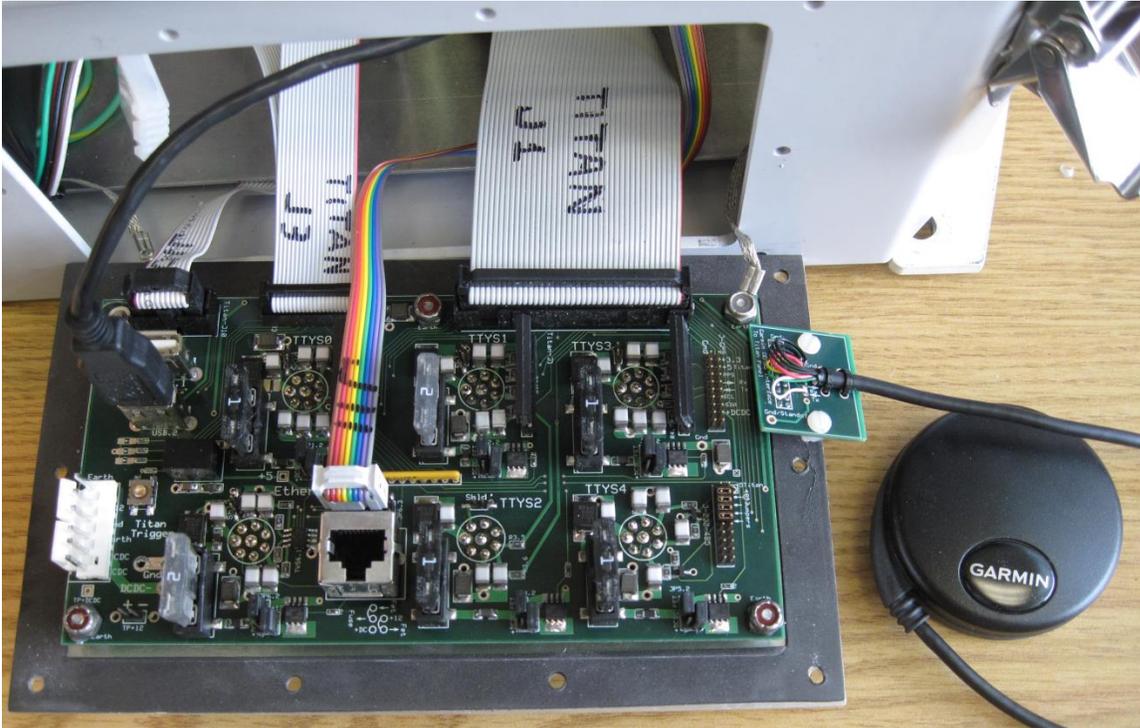
Schematics for both the Titan and Power Interface Boards for Centnet were in a single file:  
/net/isf/isff/doc/ExpressPCB/CentNet\_InterfacePanel/Release\_InterfacePanels\_Adjusted2014.sch. The layout is

/net/isf/isff/doc/ExpressPCB/CentNet\_InterfacePanel/Release TitanPanel-2\_AdjustedJan2014.pcb

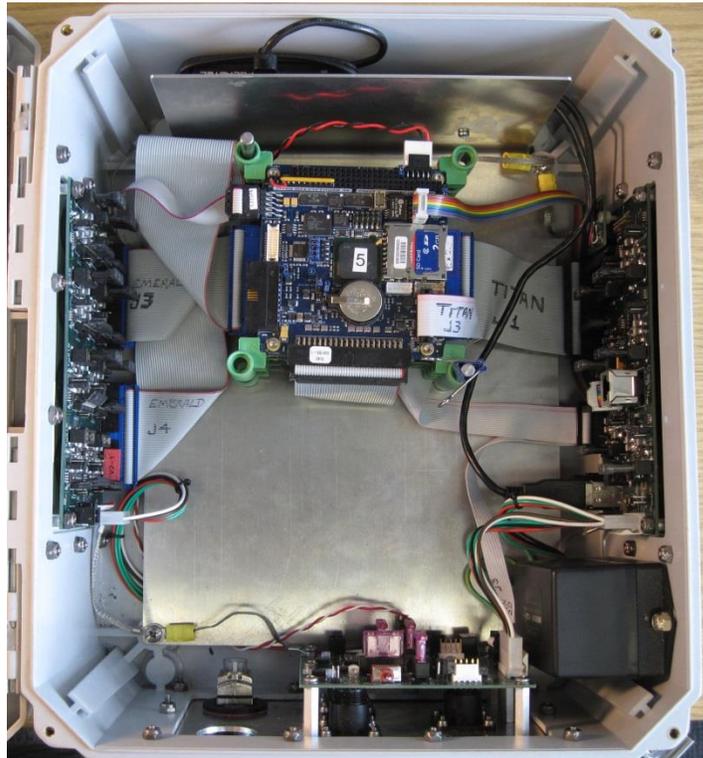
The metal mouting front panel is in

/net/isf/isff/doc/ExpressPCB/CentNet\_InterfacePanels/FrontPanelExpress/Layouts/

[Bill Of Materials:](#) /net/isf/isff/doc/ExpressPCB/CentNet\_InterfacePanels/Titan\_Panel\_BOM.xlsx



Version1 Titan Interface Panel.



### ***Titan Interface Assembly Notes:***

The boards have several through-hole parts which require hand or wave soldering. Surface mount parts can be hand or paste soldered onto the board. The Bulgin connectors are a special case and it is possible to solder them on before cleaning and mounting to the metal DSM box plate. Otherwise it may be better to attach everything else first, clean the board thoroughly, then mount the board to the metal panel using the stand-offs while installing the Bulgins at the same time and then soldering the connectors in place. Afterwards a second cleaning is needed but the metal plate gasket cannot be washed. It is also possible to solder the Bulgin connectors on first which may be more convenient for cleaning, however you may get some flexing of the board as it's screwed down.

- 1) Surface Mount parts first: Hand or Wave Soldering, otherwise use board assembly company.  
Make sure solder paste is <1year old (ie fresh), and/or solder is.  
Solder:
- 2) Through-Hole parts next, except perhaps Bulgins Connectors
- 3) Clean Board in parts washer, scrub and get all flux residue, and solder splashes off.
- 4) Attach Bulgin connectors to metal panel.
- 5) Attach PCB to metal panel using standoffs, flat washer, screws with internal lock washers & nylock nuts. The ground strap is put on the PCB "earth" hole that is adjacent to the 40-pin J4 connector using the 3/4" screw. The other screws are 5/8"
- 6) Solder on Bulgin connectors.
- 7) 2<sup>nd</sup> board cleaning (without the gasket stuck on)
- 8) Test Board: basic continuity, etc.
- 9) Install Jumpers...See Below
- 10) Install Fuses. (nominally 1A)
- 11) Install TVS diode arrays
- 12) Optional: Functionality Test before Box assembly. This requires cabling from the PC104 stack Titan board J3, J10, J11, and power connections.

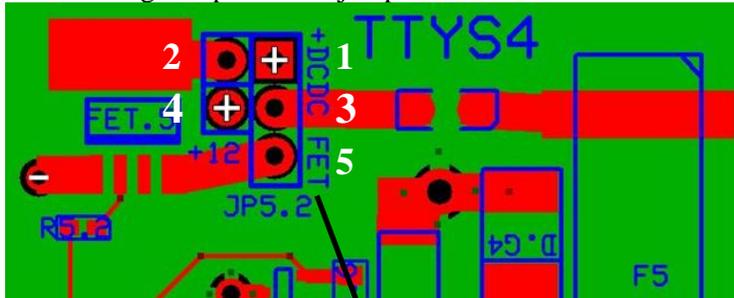
#### Box Assembly:

- 1) Install gasket on mounting panel and attach to DSM box with 1/2" screws, and black neoprene washers.
- 2) Attach ground strap to DSM box internal metal mounting plate that has the PC104 stack, etc.
- 3) Build DSM cables: 6-Pin distribution from Power Panel. Ribbons to PC104 board.
- 4) Final functionality test.

## Titan Interface Jumper Settings:

### ttyS0-ttyS4 and Ethernet Port Power Selection:

A 5-pin header, JPx.2, selects which supply is distributed to the Bulgin connector. Either +12 (main power supply) or +DC-DC (converter supply) can run these ports. Two jumpers are needed for FET control but only 1 jumper for uncontrolled voltage output. The jumpers are located above their respective Bulgin connectors and next to their FET.



#### FET Controlled Output Options:

3-5= +FET Output to Bulgin

Then either:

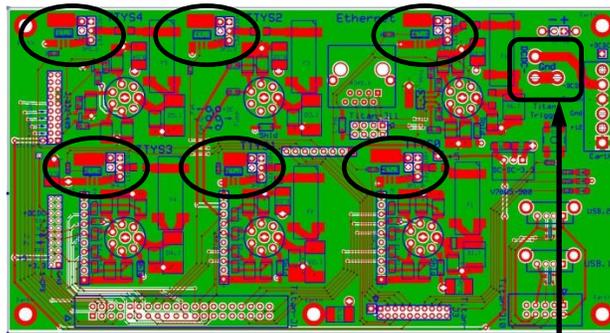
2-4= Main +12 Power or

1-2= DC-DC+ Power

#### Output Always ON Options:

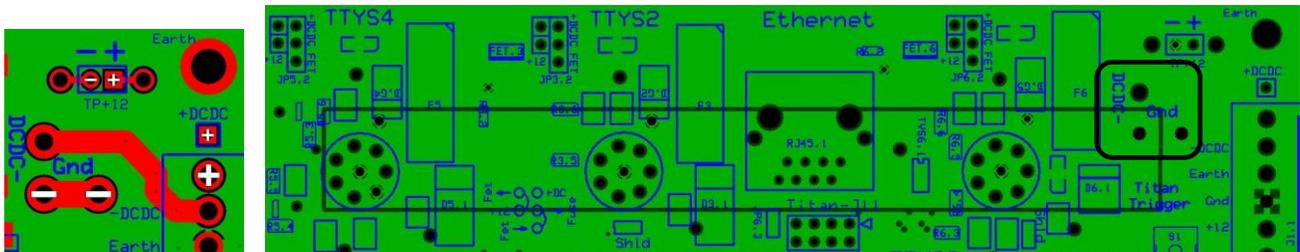
3-4= Main +12 Power or

1-3= DC-DC+ Power



### Titan ttyS2,ttyS4,Ethernet DC-DC Isolated Supply:

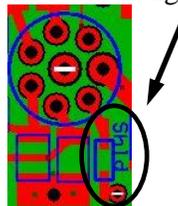
*By Default these ports are non-Isolated.* If for some reason an isolated supply is needed it can be provided for these ports by using the add-on stacking DC-DC module located on the Power Panel, and by the radical method of cutting the 3-pin jumper 'Gnd' located next to the power input connector, and adding a shorting wiring between "DCDC- and Gnd. (NOTE all 3 ports have the same ground, ie all or none can be isolated)



Here is an image of the inner ground plane that provides this connection:

### Shield Jumpers:

All ports except ttyS4 can have their shields jumpered to ground if desired. By default they are normally left open. The jumpers require a 2mm shunt to be installed adjacent to the Bulgin connection.



## Test Procedure / Titan Interface:

### 1) Basic Continuity test with Ohmmeter:

**NOTE:** Do this procedure on a new board, or one that has known or suspected problems but generally not others. Best done with the board removed from the DSM box.

Before Assembly: Check blank boards for shorts between +, ground, earth and signals.

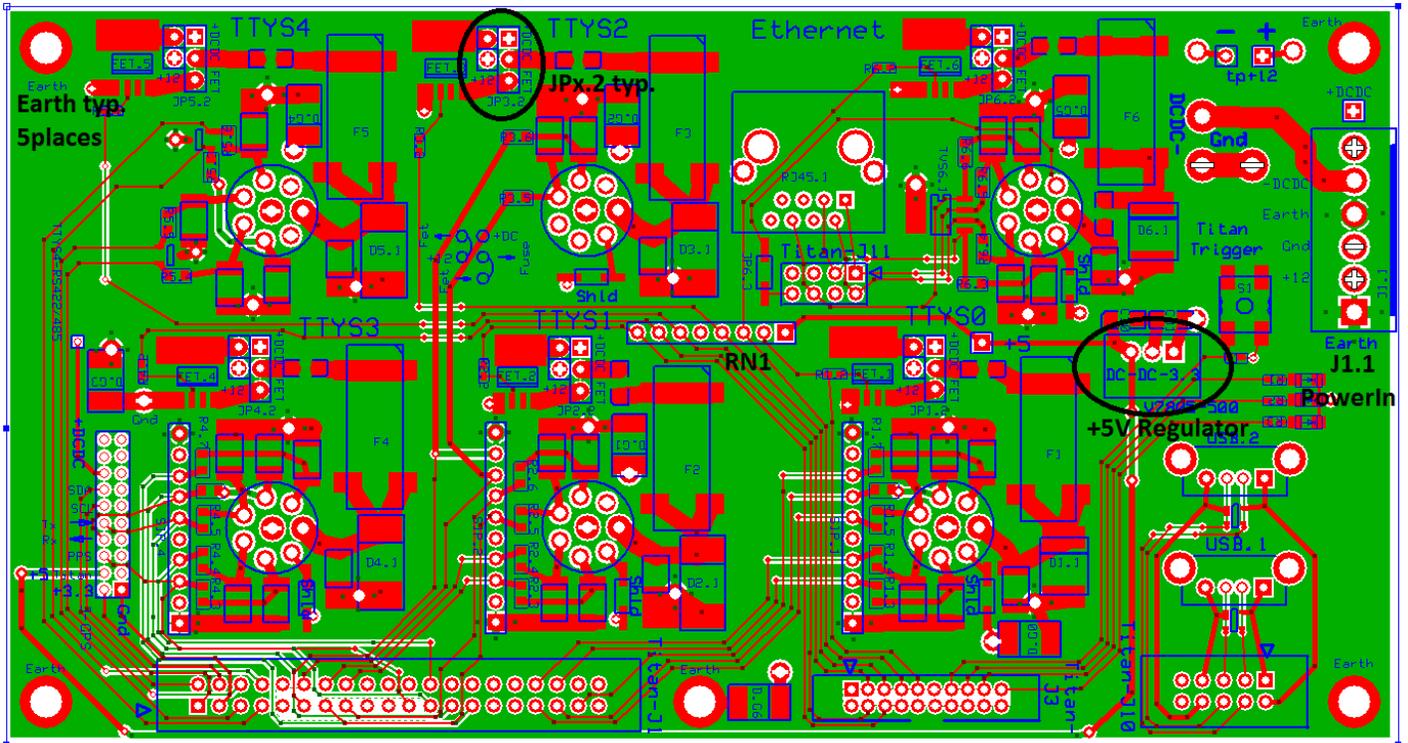
After Assembly: Check for shorts between +, ground and signals.

Continuity between earth and ground exists through the TVS diodes.

#### 6-Pin Input Power Connector J1

**Orientation:** Pin-1 (Earth) is toward the bottom of the DSM box, Pin-6 (DCDC+) is toward the top next to the mounting screw and TP+DCDC.

- DC-DC Negative, J1-5: Check for continuity to “DCDC-“ on Gnd option pad. This is the large trace: no brainer.
- Gnd, J1-3: Check for continuity to Bulgin pin 8 on all ports.
- DC-DC Positive, J1-6; Check for continuity to ‘TP+DCDC’ and to all 6 FET jumper pads JP2.x pin 1 (labeled) for ports ttyS0-4 and Ethernet
- +12, J1-2: Check for continuity to FET jumper pads JPx.2 pin 4 (or on the FET input if the shunt is installed between pins 2,4) on all 6 ports ttyS0-4, Ethernet.
- Earth, J1-4,1: Check for continuity to the board mounting holes and to the gas tubes and TVS’s ‘low side’.



**NOTE: TVS/G.T.:** Disconnect Ground Transient suppression brick if testing inside the DSM box. Otherwise the 'tvs/g.t.' will be shorted from working ground to earth. The brick is an inductor array used for lightning protection from an earth surge

**2) TVS Diodes:** This testing simply confirms the diodes "are there" and still ok. Individual breakdown voltages for these diodes are not listed here.

D1.1-D6.1 These are large TVS's on the output of the +12 fuse. Meter on 'diode';

- probe- on 'earth' probe+ on fuse: should be open.
  - probe- on fuse probe+ on 'earth': should see ~1.1 volt forward drop.
- Note: these diodes are isolated between one another since they go between each port's +12 and 'earth'

D.G1-D.G6: These are TVS's between working ground and 'earth.' Meter on 'diode';

- probe- on 'earth' probe+ on 'ground': should be open
  - probe- on 'ground' probe+ on 'earth': should see ~.5-6v forward drop
- Note: because these connections are common between all of the ports, you cannot easily isolate each of the 7 components: ie. earth and ground are common throughout. So you really can only check one of the parallel set of these diodes.

SIP.1,2,4 These are Protek VS10P12C TVS diode arrays that protect the serial input lines, Bulgin pins 3,4,5,6. They are bi-directional devices so you can't really test forward voltage drop. Specified capacitance is 150pF, and you can check between the earth and conductor pins with a good capacitance meter, but there is also a gas tube in parallel to earth. Checking the pins directly on the package if it is suspect may be best: any of the center conductors to either of the 2 end pins should appear 'open' and have roughly 150pF. Also, there are 10 ohm resistors in line between the bulgin/gas-tube entry points and the SIP. They can be metered directly, but the best test may be to simply try the serial-throughput and i/o methods to confirm they're ok.

Note: Alternate testing for breakdown voltages could be done using the ISFS Cami HiPot test system and creating a 'cable/test' that sets the high-voltage slightly above/below the specified breakdowns, however, as of 1/2015 that has not been done. It's also possible to do 'zap' tests mentioned below.

**3) TVS GasTubes:** Similarly, these cannot be easily tested because they appear as opens and have a high working and breakdown voltage. Best just to check that they appear 'open' with a meter and haven't failed 'shorted' which is less likely than failing 'open.' Their specified capacitance is <1pF, which is also tricky to measure.

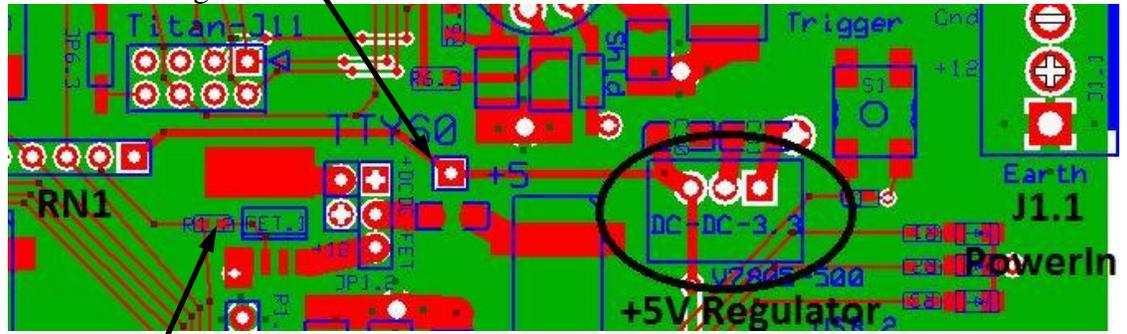
- Validation testing for recovery could be done by pulsing with a voltage above their breakdown of 75V, making sure to limit the continuous current well below 2A, which is their nominal discharge current.
- Off-Line it may be best is to use the 'ESD' gun and set it to test for high peak impulses, many kV, with short duration within the device specs of 2kA for the standard 8/20µSec, or 10A for 10/1000µSec profile.

Note: "zap tests are preferred on a 'sacrificial board' rather than cycling operational components and reducing their lifetime/effectiveness. The basic check can be used on suspect boards that have returned from the field; and then possibly the more stressful high-voltage checks too if in real doubt.

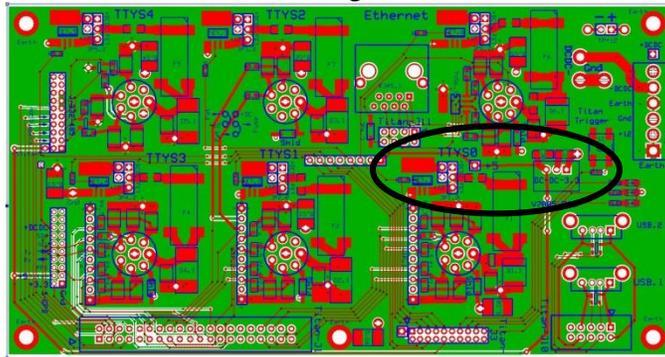
**4) +5V Regulator for FET Pull-Ups:**

The Regulator DC-DC-Board+5, is a 500mA V7805-500 3-pin device that accepts up to 36V input max. It provides the default pull-up voltage to bias the FET power controls to be normally ON. It is over-kill for this purpose, however it is used throughout 'Centnet' and has good maximum input and performance. It is located near the Titan trigger button switch and Power Input connector J1.

- Confirm +5V: Apply 12VDC to the board. Check the output of the +5V regulator:



- Meter FET.1-6 Input Controls: ~4V+ at between Rx.2 and FET.x pin-2. R1/RN1 is a voltage divider of the 5v that biases the FET.



**5) Functionality Tests using DSM electronics box**

Supplies:

- working Titan DSM box
- Power Supply and cable for DSM
- 6-pin Power Distribution Cable/Extension
- 40-pin Titan J1 Comms Cable/Extension
- 10-pin Titan J10 USB Cable/Extension
- 8-pin Titan J11 Ethernet Cable/Extension
- 20-pin Titan J3 DIO Cable/Extension
- DSM console cable
- BulginMale-BulginMale Null Modem/Cross Over cable

	Bulgin-1	Bulgin-2	
Rx	6	5	Tx
Tx	5	6	Rx
Gnd	8	8	Gnd
RTS	3	4	CTS
CTS	4	3	RTS

- normal Bulgin male-female Sensor I/O cable
- Bulgin Serial Port V/I Power test box
- Sensors: TRH, CSAT, Sonic, Gill-2D, etc
- Serial Port V/I Power test box (Bulgin)
- Titan-J3 DIO LED Test board.

Testing of the Titan Panel needs to be done with a functioning DSM box and PC104 stack with Nidas software running.

NOTE: You may need Gordon to setup the Nidas/DSM especially for the networking aspects.

It's best to have the Titan interface installed in the DSM box it's ultimately going into so that the cabling and PC104 board is also tested, but it may be more convenient to use a test DSM setup with long cables so the board can sit outside.

See also [http://wiki.eol.ucar.edu/sew/ISFS/DataSystemNotes#Serial\\_Throughput\\_Tests](http://wiki.eol.ucar.edu/sew/ISFS/DataSystemNotes#Serial_Throughput_Tests) (DSM I/O Tests under DataSystemNotes Wiki Page) for a detailed and up-to-date description of testing procedures and tools Gordon has.

#### *DSM Connections:*

- Attach power extender cable from DSM box to board.
- Attach 40pin .1" ribbon cable to Titan-J1: Serial Comms.
- Attach 20pin 2mm ribbon cable to Titan-J3: DIO / FET control
- Connect USB: Titan-J10 (10-pin .1" header. On the titan board it faces opposite side from the titan interface panel.)  
Insert a USB media disk (pocketec or stick) in one of the USB ports.
- Attach 8pin .1" ribbon cable to Titan-J11: Ethernet  
Connect a CAT5/6 cable to the RJ45 jack and to either the 'FL-Guest-network' or a switch/local PC that will serve a DHCP address to the Titan or as a Statically assigned network node. See Gordon if in doubt.
- Attach Garmin GPS via the J-GPS port/mapper board.
- Jumper ports 0-4 and ethernet for FET power control.
- Attach PC to Console and make sure PC's booted, running a terminal program at 115kbps (procomm/minicom/secureCRT, etc.)
- Boot up DSM with 'console cable' or 'ethernet' to monitor ops.
  - *watch console output for normal/abnormal bootup messages*
- Open 2 login windows to the DSM. Best to login using the network/ssh. If need be use minicom from your PC to the system console, ttyS0, and use 'ifconfig' to see what the ethernet address is to login using 'ssh root@xxx.'
- Because you may not know how the ports are configured:
  - "ddn" Shut Down Nidas (also "adn").
  - "ps -ef" Confirm it's down.

#### *5a) Updating NIDAS/Software*

General procedure is not described here. May be good idea to get Gordon's help, but there should be a utility script on the SD card (where nidas code and such lives) called:

- "*swupdate porter.eol.ucar.edu*"

This utility updates nidas but relies on the machine 'porter' (devel/nidas host) to be available and on-line.

#### *5b) "GPS / ttyS3 Test"*

The GPS is enabled during bootup and Nidas looks for a valid position/time message. You should see:

```
 "$PGRMC,A,00168.5,100,0000000.000,000.000000000,0000,0000,0000,A,3,1,2,04,30.0*77\r\n
```

PPS currently enabled, width=100 msec

enablePPS:

Running gps\_nmea\_sysclock to set clock

Reading /dev/ttyS3 for \$GPRMC 'A' record.

Timeouts: data=30, lock (\$GPRMC 'A')=600 secs. Baud=4800 bps

\$GPRMC status 'A' received

Sys time: 2000 Jan 01 00:00:46.559 GMT

Gps time: 2014 Jul 30 15:15:25.500 GMT

Gps-Sys: 460048478941 millisec

done

Running ntpdate to synchronize clockError resolving base:"

This indicates port 3 is up and acquired GPS lock: ie good.

To verify later login and try:

“rs G” Confirm message coming in at 4800bps

“tio 3 0” Does not effect an internally mounted gps. It is powered by 3.3V provided on Titan J1 comms connector, not from the FET circuit. If the gps is external, “tio 3 0/1” does work to turn it off/on.

#### 5c) “Ethernet Test”

The ethernet is enabled during bootup as well, provided there is a connection; ie thus the ‘guest network/local’ cable. You should see: Configuring network interfaces...eth0: link up, 100Mbps, full-duplex, lpa ... eth0: link up, 100Mbps, full-duplex, lpa 0xC9E1

With the hard-wired ethernet cabled in, if the port is setup for DHCP, the guest network should have assigned an address:

Login and check network:

“ifconfig” If it is up you should see something like:

```
eth0  Link encap:Ethernet HWaddr 00:80:66:06:0A:66
      inet addr:128.117.47.196 Bcast:128.117.47.255 Mask:255.255.255.0
      UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
      RX packets:75833 errors:0 dropped:0 overruns:0 frame:0
      TX packets:368 errors:0 dropped:0 overruns:0 carrier:0
      collisions:0 txqueuelen:1000
      RX bytes:10461435 (9.9 MiB) TX bytes:80144 (78.2 KiB)
      Interrupt:126 Base address:0x4000
```

If the Nidas is setup as ‘static’ check the file:

“more /etc/network/interface”

and notice whether DHCP (this example it is) or the static address:

```
# DHCP on the first ethernet device
```

```
iface eth0 inet dhcp
```

```
# Static interface for the first ethernet interface, comment out the
```

```
# above and uncomment this
```

```
#iface eth0 inet static
```

```
# address 192.168.0.125
```

```
# netmask 255.255.255.0
```

```
# broadcast 192.168.0.255
```

```
# gateway 192.168.0.5
```

If the network is connected and not yet running or you need to restart:

“ifdown eth0” “ifup eth0”

With the network running confirm you can do a ping test for throughput and login, or data transfers:

“ping -t -l 2048 hostip”, “ssh user@hostip”, “sftp user@hostip”

#### 5d) “USB Test”

With the USB media connected, everything should be working if Nidas is able to mount and see the device.

- “mount” Should see  
/dev/sda1 on /media/usbdisk type ext3
- “ls /media” Should see usbdisk

- “ls /media/usbdisk” Should see some files
- watch /var/log/isfs/messages as you connect the usb stick for both USB-0 and USB-1 jacks. Log file shows device/driver install/removal

5e) *FET Power control tests*

Make sure all ports 0-4 and ethernet are jumpered for FET power control. Plug Bulgin Serial Port V/I Power test box into each port or use a meter to monitor the +12 output. Pullups should enable power on the port at bootup. Toggle the power off/on for each (ttyS0-ttyS4 and Ethernet) with the ‘tio’ command.

Note: sio port FET power tests can also be done using the TRH test below.

Note: Ethernet test doesn’t disable the net, only the Bulgin power output to the interface panel where an external router, AP24, etc would be plugged in.

- “tio x 0” x=0-4; Confirm ttySx +12V is off. “tio x 1” and on.
- “tio 5 0” Confirm Ethernet +12V goes off. “tio 5 1” and on.
- If these fail, refer to the titan interface schematic and confirm that the Titan-J3 control line is toggling off/on. Remove the ribbon cable and then either:
  - Insert pin to observe the voltage on pins 9 (ttyS0), 6 (ttyS1), 5 (2), 4 (3), 3 (4), and 7 (Ethernet) to see if they’re toggling with the above commands or not.
  - Or use the Titan-J3 DIO LED Test board for visual checking these lines.
  - If the ‘tio’ line doesn’t toggle, you probably have a bad ribbon cable (unplugged?), etc. and should try a substitute to confirm that.

5f) *“LED” Test*

The leds on the Interface Panel may or may not be installed. By default, if installed, they may be lit. Toggle the fets:

“tio -a x 1/0” x: 10=red, 12=green, 14=blue

5g) *“RS232/TRH” Tests*

This is the simplest and quickest way of testing RS232 ports 0-2

*Note:* Port 4 is RS422/485 only (see Gill RS422 test below).

*Note:* Port 3 is normally for the GPS. If you try the trh on it, first remove the gps interface board; or else simply minicom to it at 4800bps

*Note:* Use the ‘sing test’ for high-speed i/o.

- **For each port ttyS0-3: ‘x’ below = 0,1,2,3**
  - connect TRH to it. Fan should come on.
  - “minicom ttySx” Set baud to 9600: Ctrl-a, ‘P’, ‘E’
  - Messages: TRH44 23.32 12.68 29 0 1577 36 90
  - Ctrl-U Brings up trh menu: rcv is ok.
  - CUR Reports fan Current limit setting
  - EXT Gets out of TRH commands
  - Ctrl-A x Exit minicom
  - “tio x 0” Fan off.
  - “tio x 1” Fan on.

5h,i) *DSM “Sing” RS232 Throughput Port-Port Tests*

- **Valid for port pairs ttyS0,1; ttyS1,2; and ttyS1,3 (if gps disconnected from 3):**

5h) RS232 TX/RX Test

- Connect bulgin cable from ttyS1 to the port you want to test, for example /dev/ttyS2: In one window:

- `sing /dev/ttyS1`

In another window run sing in echo mode:

- `sing -e /dev/ttyS2`

You should see incrementing values for "sent#" and "rcvd#". "n/10" and "N/100" should increment up to 10/10 and 100/100:

```
sent#: 134 rcvd#: 132, 10/10, 100/100, out:0.4776 kB/sec, in:0.3605
kB/sec, dT:73 msec
sent#: 135 rcvd#: 133, 10/10, 100/100, out:0.4776 kB/sec, in:0.4776
kB/sec, dT:73 msec
```

On the echo side, you should see scrolling output like:

```
rcvd#: 132, 10/10, 100/100, in:0.4788 kB/sec
rcvd#: 133, 10/10, 100/100, in:0.4776 kB/sec
```

Ctrl-c the second sing process. Move test cable to next port. Start echo sing process on that port:

- `sing -e /dev/ttyS3`

#### 5i) CTS/RTS test **Valid for port pairs ttyS0,1; and ttyS1,3 (not ttyS2):**

- As above, connect cable from the test box to the port you want to test. In one window start sing with "-m" option to test modem lines:

- `sing -m /dev/ttyS1`

In second window start sing in echo modem lines mode:

- `sing -e -m /dev/ttyS3`

sing on ttyS1 will toggle DTR and RTS. CTS will remain asserted:

- setting modem lines: DTR RTS
  - current modem lines: DTR RTS CTS
  - setting modem lines:
  - current modem lines: CTS

sing on ttyS3 should report that CTS is toggling. DTR and RTS will not change:

- current modem lines: DTR RTS CTS
  - current modem lines: DTR RTS

NOTE: "Sing" parameter adjustments;

The sing program defaults to 9600n81, but has many settings not mentioned here: message rates, sizes, sio protocol, etc. Type "sing"<CR> for help info. and how to change options.

Example: `sing -e -o 57600n81mhr /dev/ttySx`

57600bps with (m)odem carrier detect monitoring, (h)ardware flow control and (r)aw binary data/no translation.

#### 5j) "Gill RS422" Port ttyS4 Test:

The sing program can't be used to test the RS422/485 port ttyS4. A known 422 device, Gill 2D Sonic, is best to test this. Make sure the port is setup for 422 using:

"tp4 q" query settings

"tp4 422 t ns" This should be the default established in  
/usr/local/isff/\$PROJECT/ISFF/scripts/dsm/other.sh

- connect GillSonic to ttyS4.

- "tio 4 I" Power should already be on.

- "minicom ttyS4" Set baud to 9600: Ctrl-a, 'E'

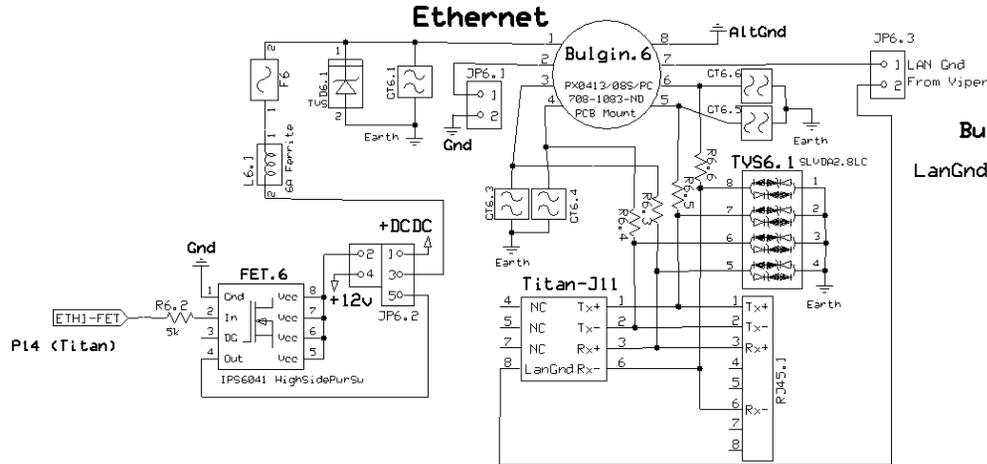
Messages: .A, 247, 000.12, M, 60, .0A

*	Brings up command prompt.
Q	Returns to sampling mode
Ctrl-A x	Exit minicom

Note: If for some reason you're using an old Viper, then you must setup for either RS422 or Half-Duplex RS485

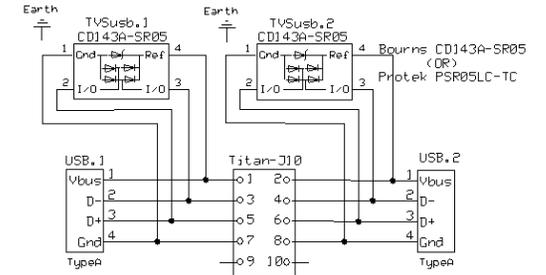
*Viper Jumper selections:* LK6,LK7 to position A=RS485, to position B=RS422

## Titan Interface Schematic:



**Bulgin Pin-7 Use**  
LanGnd jumper JP6.3: Eth0

## Titan Ribbon to USB-TypeA



## Errata about ttyS0:

If we want a future Bluetooth Console, this board would need to be changed or add a dongle outside.

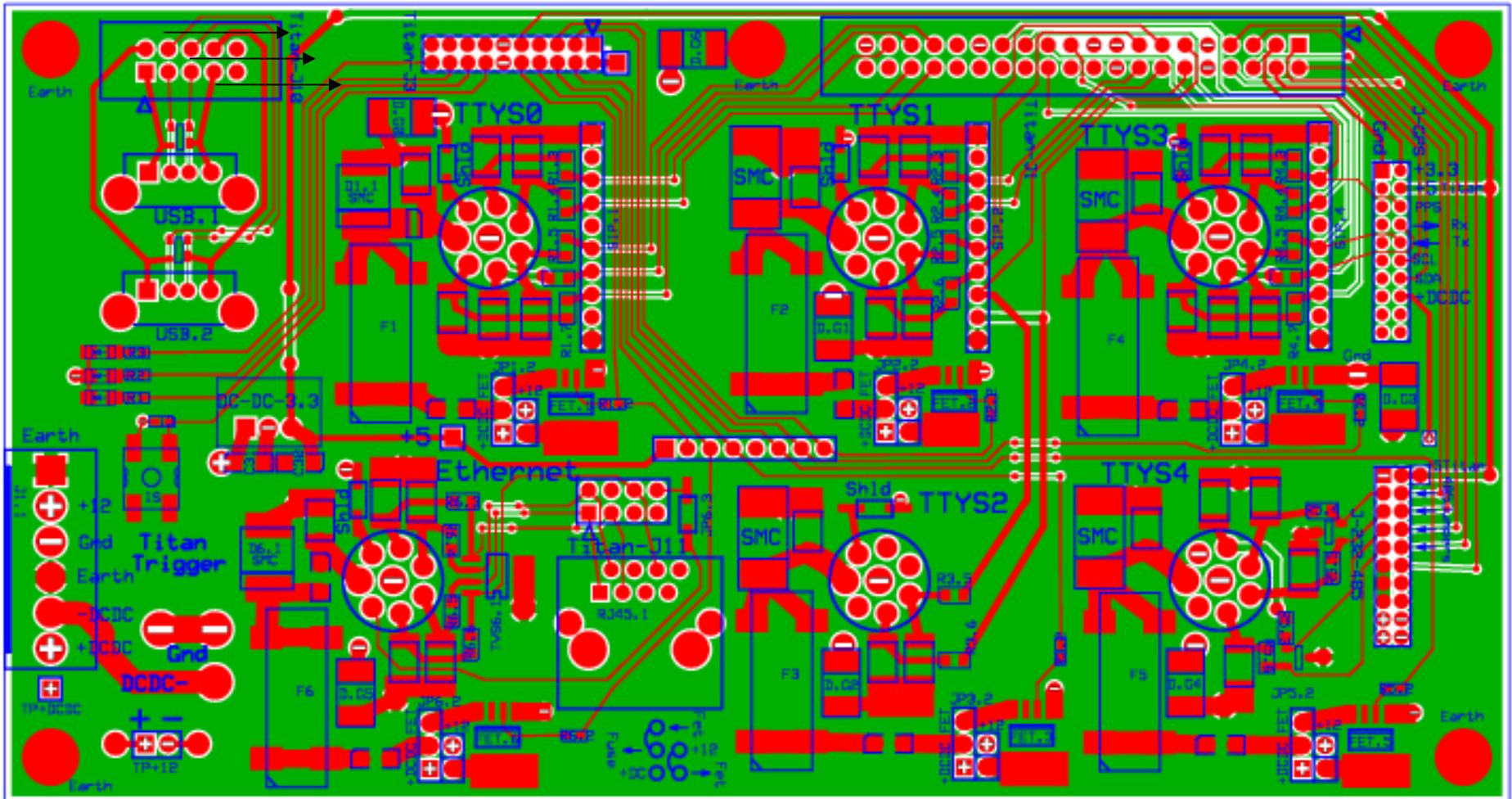
Power +12v to Bulgin1 is connected  
Earlier versions (ordered 5/31/12) had a relic, current shunt resistor R1.1 on the layout  
It was never installed so those old panels (15+) cannot provide power without having that part installed.

NCAR / EOL / [SF / [SFS		
CentNet: Titan Interface Eth/USB		
Miltzer	Rev 1.0 Apr, 2012	Pg 3/3



Titan Layout - Rev1.0 "Ordered 053112" : 1<sup>st</sup> 16 boards built have "J-232-485":

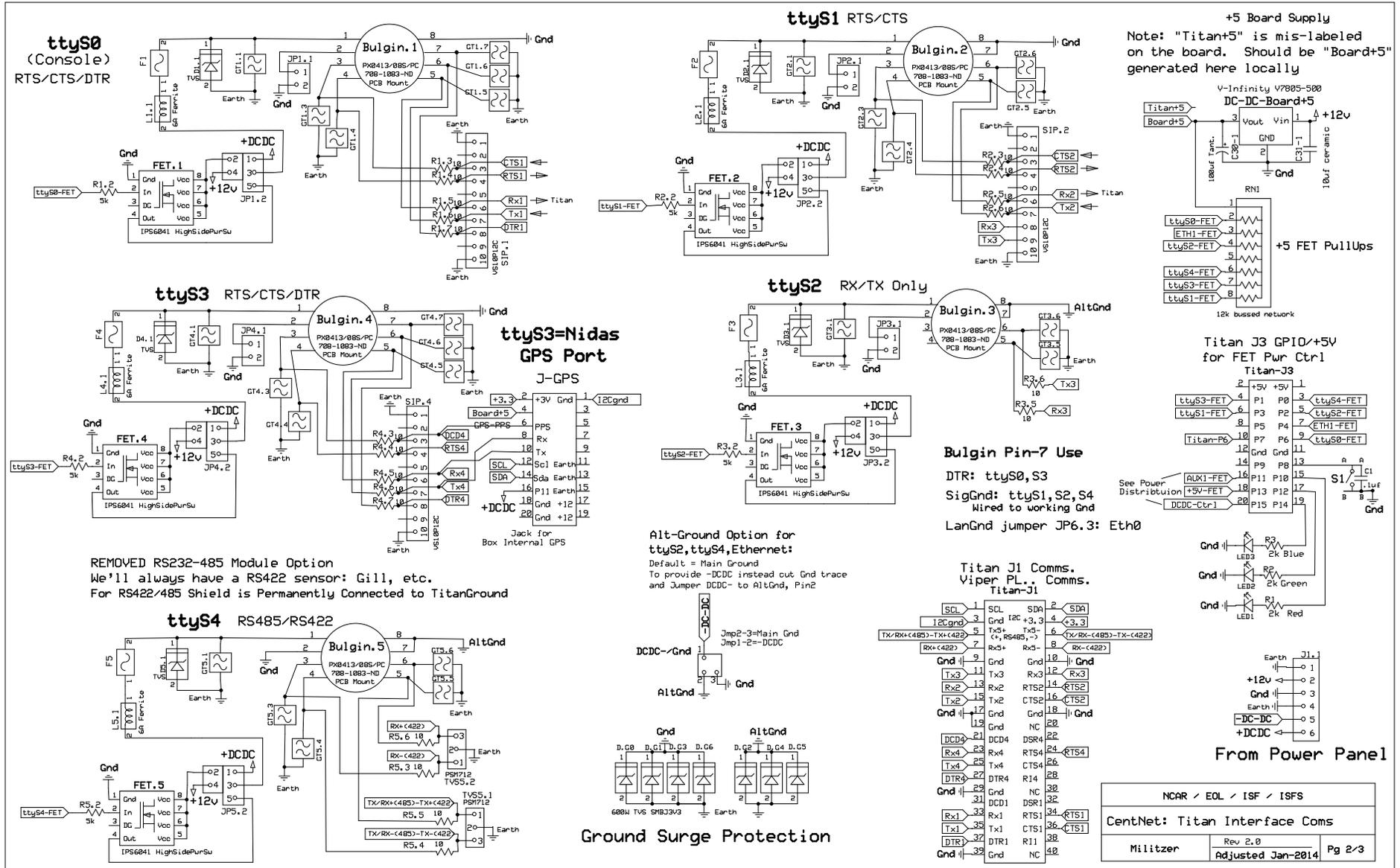
## Bottom of electronics box



*This is a view of the Rev1 Titan Interface Panel. There have been 16 of these boards built. Rev2 is similar except the J-232-485 jumper/header is removed and the labels are reversed to match the newer Emerald Panel orientation. As of 2014, no V2 boards have been built.*

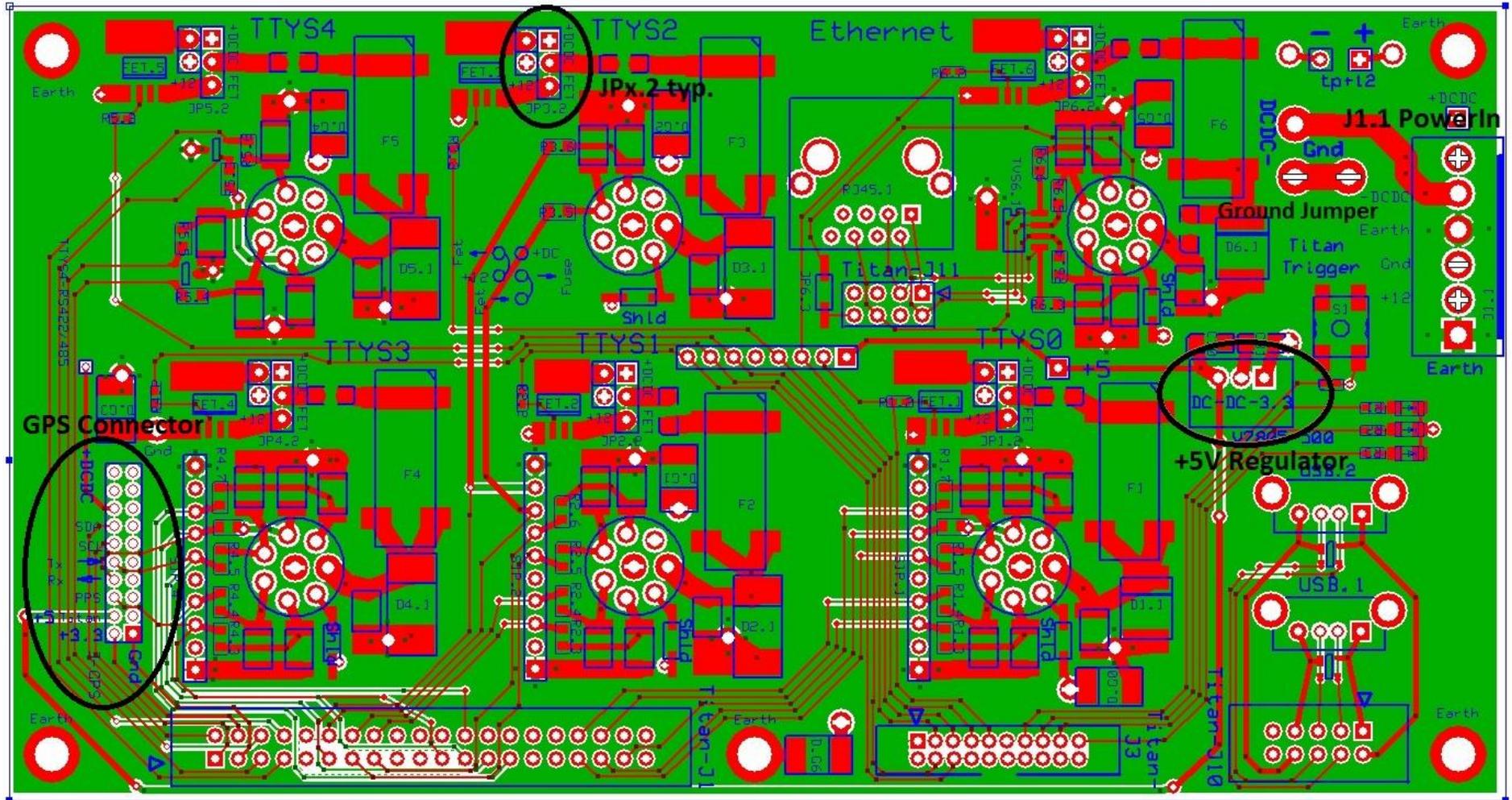
Looking from the top, down into an electronics box:

# Titan Schematic / Comm Ports - Rev2 without "J-232-485" for subsequent builds:



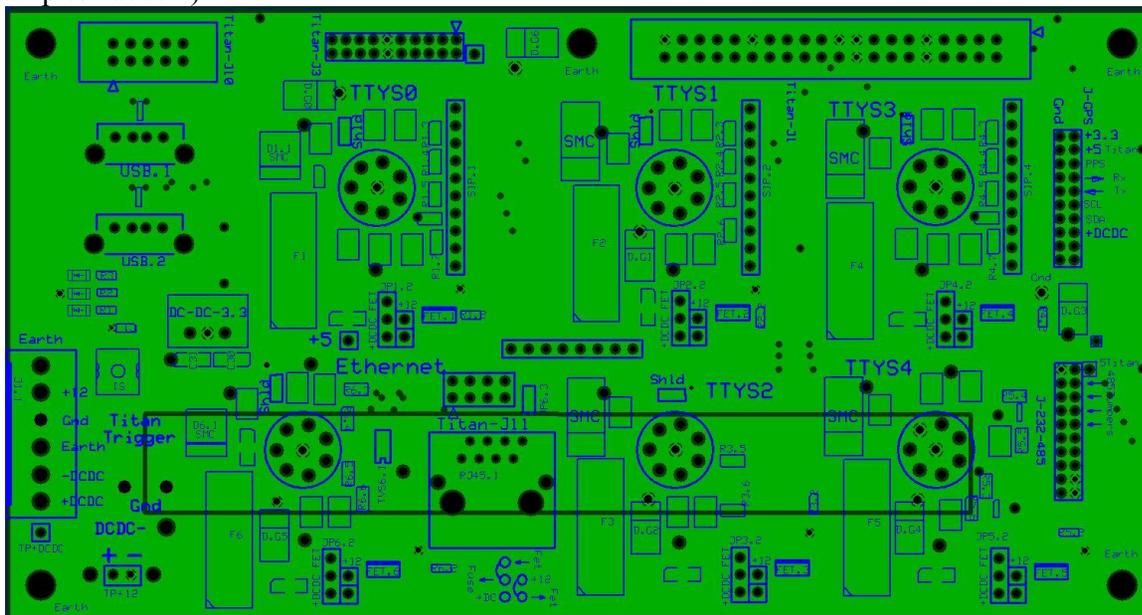
NCAR / EOL / ISF / ISFS	
CentNet: Titan Interface Coms	
Miltizer	Rev 2.0
	Adjusted Jan-2014
	Pg 2/3

Titan Schematic / Comm Ports - Rev2 without “J-232-485” for subsequent builds:  
 Looking from the top, down into an electronics box:

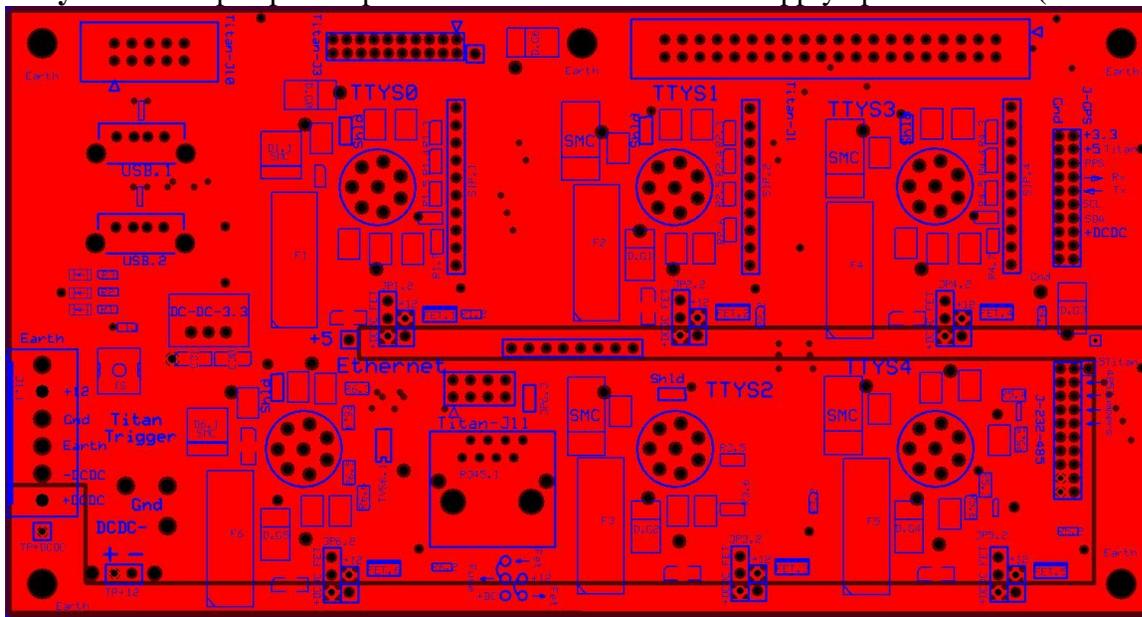


*This is a view of the Rev2 Titan Interface Panel; similar to 1.0 except J-232-485 jumper/header is gone and labels reversed. As of 2014, no V2 boards have been built.*

**Titan Layout: Inner Ground Layer** – Note split-plane option for Isolated Ground using DC-DC- (Negative) jumper (defltn=normal ground, cut trace on top layer and wire jump to ‘dcdc-‘)



**Titan Layout: Inner Power Layer** – Note split-plane option for DC-DC+ versus +12 supply option on JP.x (for each ttySx)

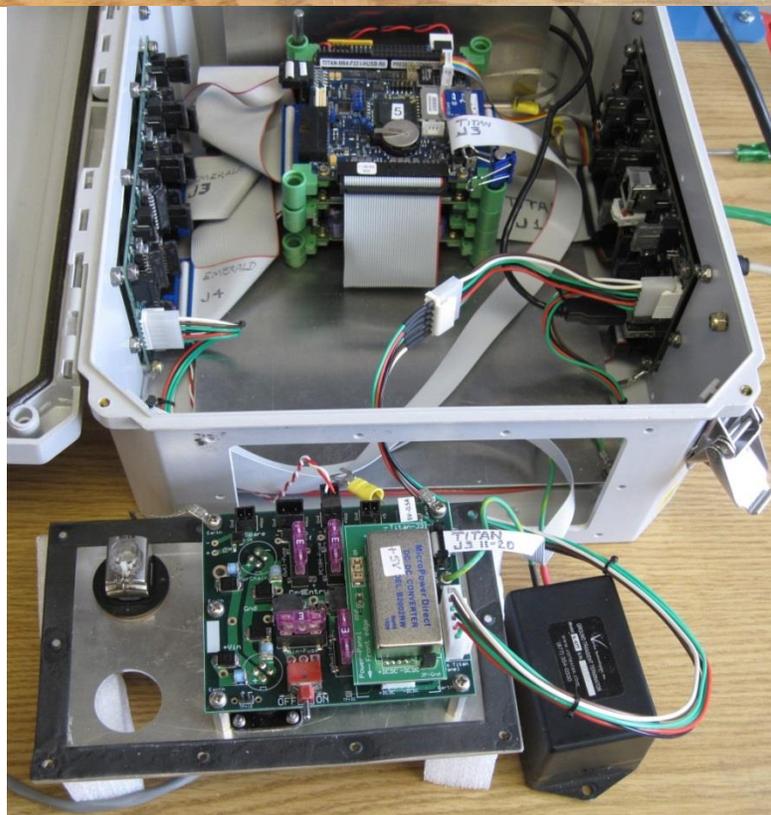


# Power Interface Panel:

File Locations for Schematic, Layouts, and Metal Mounting Panel:

/net/isf/isff/doc/ExpressPCB/CentNet\_InterfacePanels/EmeraldPanel\_Ordered010813.sch and .pcb, and subdirectory 'FrontPanelExpress'

Bill Of Materials: /net/isf/isff/doc/ExpressPCB/CentNet\_InterfacePanels/Emerald\_Panel\_BOM.xlsx



## **Assembly Notes:**

The boards have several through-hole parts which require hand or wave soldering. See [Bill Of Materials](#) Surface mount parts can be hand or paste soldered onto the board. There are no components on the bottom except Amp connectors, however several through-hole components need to be soldered from underneath.

The Amp connectors are unique. It may be challenging to solder them on before cleaning and attaching the board to the metal DSM mounting panel. Maintaining the required spacing between the board and front-panel is important. It may be better to attach everything else first, clean the board thoroughly, then mount the Amp connectors and board to the metal panel using the stand-offs before soldering them in place. Next solder the ground-isolation 'brick' black-wire to the "earth-Gnd" hole next to the power distribution connector J1. Afterwards clean these connections by hand. The metal panel's mounting gasket cannot be washed.

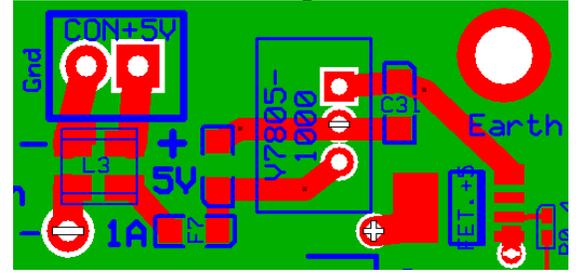
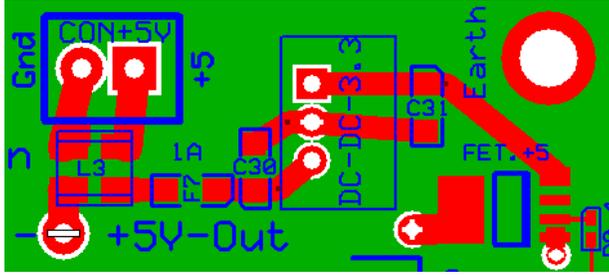
- 1) Surface Mount parts first: Hand or Wave Soldering, otherwise use board assembly company.
- 2) Through-Hole parts next, except Amp Connectors
- 3) Clean Board in parts washer or by hand, scrub and get all flux residue, and solder splashes off.
- 4) Attach Amp connectors to metal panel; tighten. Make sure orientation of pin1 is correct.
- 5) Attach standoffs to metal panel (or PCB), then attach PCB to metal panel feeding the posted Amp pins through the board. Two ground straps are placed under the corner 'earth' screws on the lower side adjacent to the 2pin CON1-4 connectors. Tighten all hardware.
- 6) Solder on Amp connectors.
- 7) Solder on Ground Isolation Brick wire.
- 7) 2<sup>nd</sup> board cleaning (without the gasket stuck on)
- 8) Test Board: basic continuity, etc.
- 9) Install Jumpers...See Below
- 10) Install Fuses. Nominally 3A, but if higher loads expected, 5A. Use 1A for "PC104"/Titan distribution.
- 11) Install +5V-Out 3-pin converter (be careful about orientation)
- 12) Optional: Functionality Test before Box assembly. This requires cabling from the PC104 stack Titan J3, board, and power connections.

### **Box Assembly:**

- 1) Install gasket on mounting panel and attach to DSM box with ½" screws, and black neoprene washers.
- 2) Attach ground straps and Isolation Brick's red-wire to DSM box internal metal mounting plate.
- 3) Install Ground Isolation Brick on DSM box.
- 3) Build DSM cables: 6-Pin Power distribution, Titan stack power (Red+, White-) to CON2, Titan DIO 10pin ribbon split off J3 20pin ribbon cable on Titan Interface Panel for pins 11-20.
- 4) Final functionality test.



**NOTE Critical Difference V1 vs V2 Boards for Switchable “+5V” Output Module!**



**Version1 Layout SilkScreen V780x-500:**

**Version2 Layout SilkScreen V780x-1000:**

NOTE: Different orientation of these two packages that look exactly the same. MAKE SURE you put the correct part in, or else reverse the orientation between the 2 versions: V780x-500 (ie.5A) vs V780x-1000 (ie 1A)!

**DCDC Stacking SubPanel**

**Options:** The DCDC subpanel is normally used to provide +15V output to either:

- ‘Aux1’ (see above) and/or
- Emerald Ports 9-12 (17-21) and/or
- Titan Ports 0-4

through connector J1.0 (To Titan Panel). Depending upon which switching dc-dc converter is installed it can also provide +5, etc. to these ports. Sometimes it is used for powering the Etherant wifi antennas.

*Isolated versus non-isolated ground jumper “JP-Gnd” on the subpanel determines whether the negative supplied to Emerald ports 11,12 (17,18) and/or Titan ports 2,4,Ethernet is normal working ground, or DCDC- from the converter.*

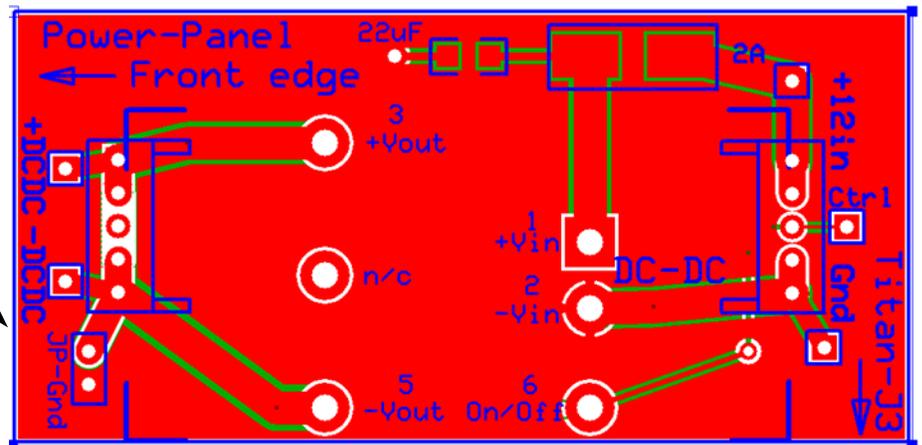
See Also:

Emerald DC-DC/Gnd option jumpers JP4.7 (ttyS11) and JP4.8 (ttyS12) and Titan DCDC-/Gnd “jumper” (Note there isn’t a header on this section located near the power-input connector. By default normal, non-isolated ground is enabled. In order to use isolated grounds: cut the ‘Gnd’ trace and install a jumper or wire across DCDC-.

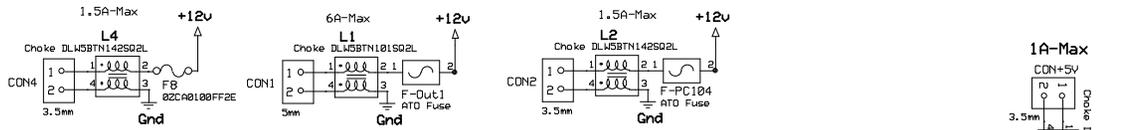
**Note the Version2 subpanel is NOT PIN COMPATIBLE with the NDAQ version1.**

*Non-Isolated / Common Ground: Install “JP-Gnd”*

*Isolated Ground: Remove “JP-Gnd”*



# Schematic:



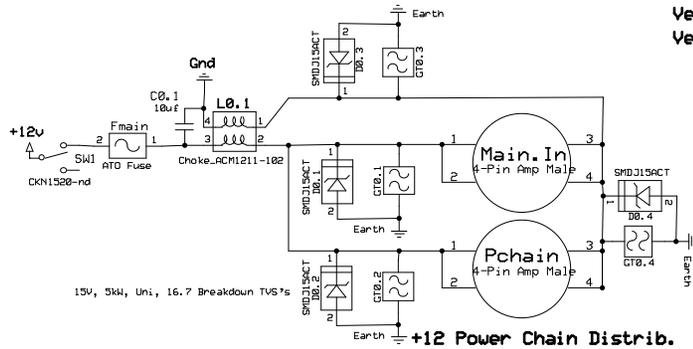
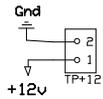
Spare

SioBoard

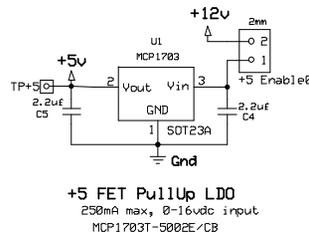
TitanStack

Switchable +5VDC

## Board Edge Connectors



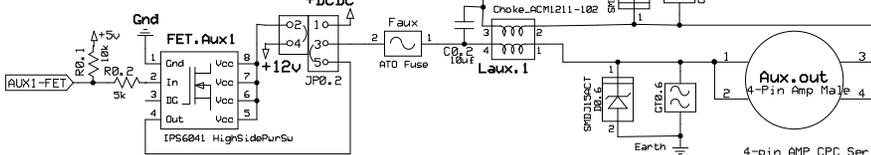
**BEWARE: V780x-1000 has opposite pin orient than...  
V780x-500 Used on Version1 Power\_Panel..  
Version1 Silkscreen: "DC-DC 3.3"  
Version2 Silkscreen: "V780x-1000"**



+5 FET PullUp LDO  
250mA max, 0-16vdc input  
MCP1703T-5002E/CB

## V-DC-DC Power Option for AUX.1 3A max limit with shunts

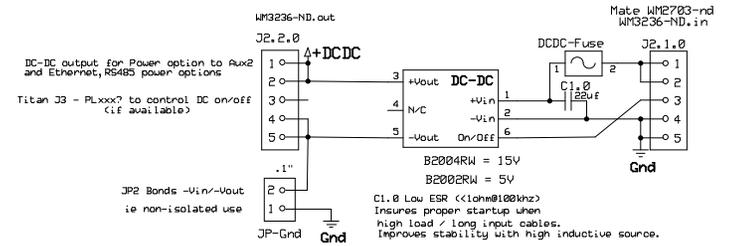
### Switchable Power for AUX.1



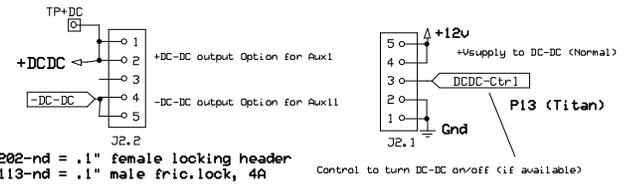
Jumper 1-2,3-4 to Enable Switched Power thru FET to Aux2  
Jumper 2-3 for always on Main to Aux2

4-pin AMP CPC Series1 (206061-2) Recepticle for Male Pins

## Stacking DC-DC SubPanel - Centnet Version



## Board Connection to DC-DC SubPanel



## 20pin header on Titan Panel to 10pin header header on this board



Titan J3 Extension - Ctrl

Power to TitanPanel  
.156" Header

## MISC Notes:

- Separate EARTH from working ground
- Vortex Iso-Line Ground Transient Terminator
- Protects from Lightning Earth-Surges
- No Reverse Polarity Protection

NCR / EOL / ISF / ISFS		
CentNet: Power Distribution Panel		
Miltzer	Apr, 2012	Pg 1/3

## Test Procedure / Power Panel:

### 1) Basic Continuity test with Ohmmeter:

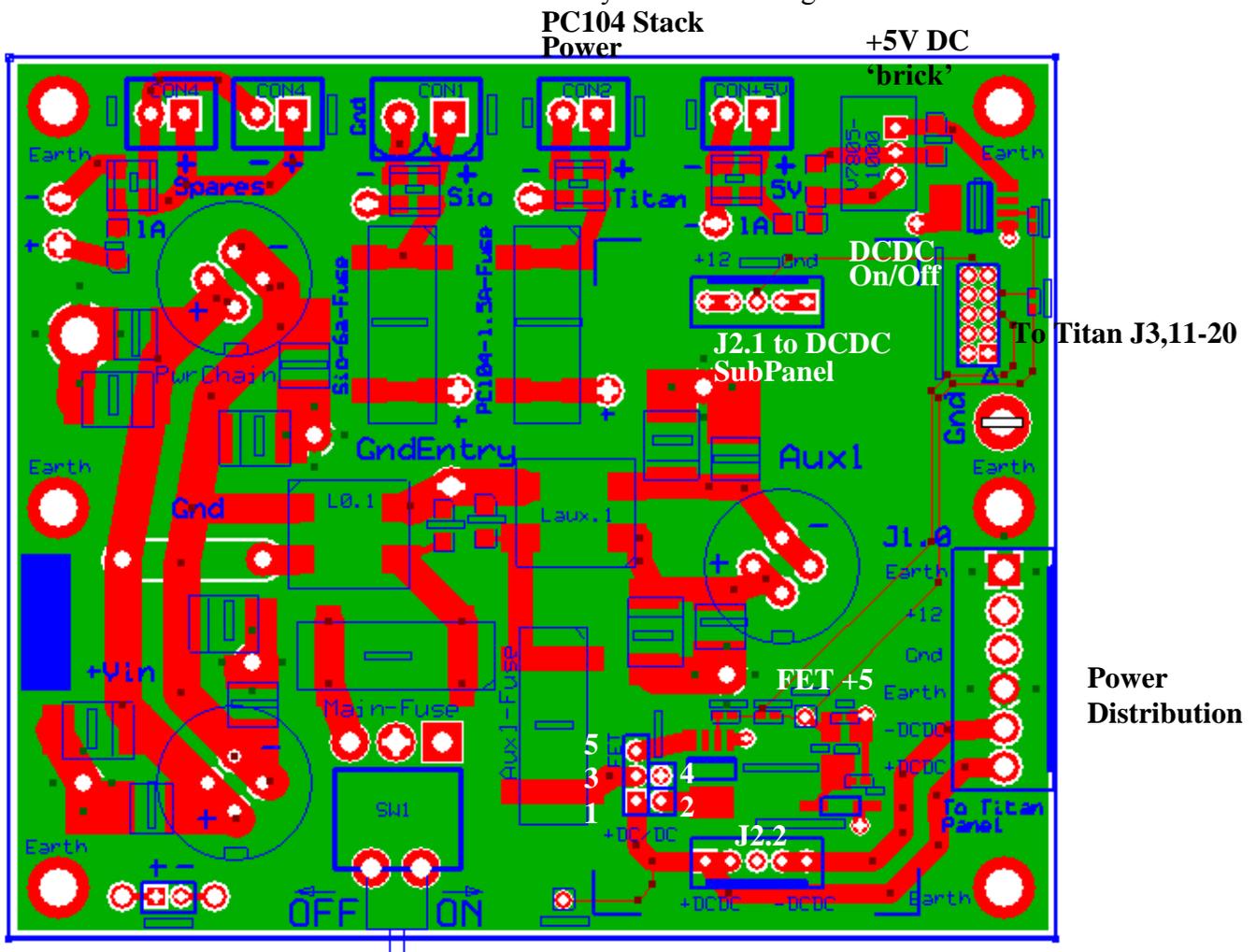
Before Assembly: Check blank boards for shorts between +, ground, earth and signals.

After Assembly: Check for shorts between +, ground and signals.

Continuity between earth and ground exists through the TVS diodes.

#### 6-Pin Input Power Connector J1

- DC-DC Negative: Check for continuity from J1.0 pin-5 (-DCDC) to 5pin J2.2 pins-4,5. Connection to SubPanel where DCDC- is 'generated.'
- Gnd: Check for continuity from J1.0 pin-3 to Amp pins 3,4 on Aux1, In, Spare and J2.1 pins-1,2. Also check pin2 on CON1-4,+5 (which go through the coils to ground). Verify no shorts to +power.
- DC-DC Positive: Check for continuity from J1.0 pin-6 (+DCDC) to 5pin J2.2 pins-1,2; and to FET jumper pad JP0 pin 1 (labeled) on ports ttyS9,10,11,12
- +12 Vin: Check for continuity from +Vin to Spare pins 1,2 and to Switch pin (left side). Turn Switch On and check +Vin to pin1 on CON1-4; FET jumper pad JP02 pin 4 (or on FET input if the short between pins 2,4 is installed); and +5V-FET pins 5-8; and JP2.1 pins 4,5
- Earth: Check for continuity from J1.0-1,4 and the board mounting holes. You can also see continuity to earth on the gas tubes and TVS's 'low side'.



**NOTE: TVS/G.T.:** Disconnect Ground Transient suppression brick if testing inside the DSM box. Otherwise the 'tvs/g.t.' will be shorted from working ground to earth. The brick is an inductor array used for lightning protection from an earth surge

**2) TVS Diodes:** This testing simply confirms the diodes "are there" and still ok. Individual breakdown voltages for these diodes are not listed here.

D0.1-2,6 These are the large TVS's on the output of the +12 fuse. Meter on 'diode';

- probe- on 'earth' probe+ on fuse: should be open.
- probe- on fuse probe+ on 'earth': should see ~1.1 volt forward drop.

Note: these diodes are isolated between one another since they go between each port's +12 and 'earth'

D0.3-5: These are the TVS's between working ground and 'earth.' Meter on 'diode';

- probe- on 'earth' probe+ on 'ground': should be open
- probe- on 'ground' probe+ on 'earth': should see ~.6v forward drop

Note: because these connections are common between all of the ports, you cannot easily isolate each of the 8 components: ie. earth and ground are common throughout. So you really can only check one of the parallel set of these diodes.

Note: Alternate testing for breakdown voltages could be done using the ISFS Cami HiPot test system and creating a 'cable/test' that sets the high-voltage slightly above/below the specified breakdowns, however, as of 1/2015 that has not been done. It's also possible to do 'zap' tests mentioned below.

**3) TVS GasTubes:** Cannot be easily tested because they appear as opens and have a high working and breakdown voltage. Their specified capacitance is <1pF, which is also tricky to measure.

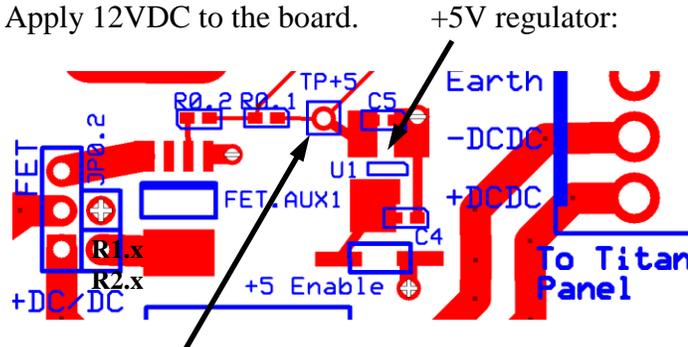
- Quick test with DVM to check that they appear 'open' and haven't failed 'shorted' (less likely than failing 'open.')
- *Non-Standard Test:* Validating for 'zap recovery' could be done by pulsing with a voltage above their breakdown of 75V, making sure to limit the continuous current well below 2A, which their nominal discharge current.
- *Non-Standard Test:* Off-Line it is possible/best to use the 'ESD' gun set for high peak impulses, many kV, with short duration within the device specs of 2kA for the standard 8/20µSec, or 10A for 10/1000µSec profile.

Note: "zap tests are preferred on a 'sacrificial board' rather than cycling operational components and reducing their lifetime/effectiveness. The basic check can be used on suspect boards that have returned from the field; and then possibly the more stressful high-voltage checks too if in real doubt.

#### 4) +5V Regulator for FET Pull-Ups:

The Regulator provides a pull-up voltage to bias the FET power controls for Aux1 and +5Voutput connector to be ON by default. It is U1, a 250mA MCP1703 3-pin SOT23 device that is near J1.0, and the Aux1 connector. To Confirm +5V:

- Install 2mm jumper “+5 enable”
- Apply 12VDC to the board.



- Confirm +5V at “TP+5” to Gnd. (note: ~3.0-3.6V at R0.2 and FET. R0.1/R0.2 is a voltage divider of the 5v that biases the FET.)

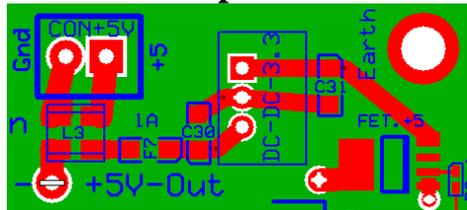
#### 5) Functionality Tests off-line WithOut using DSM electronics box

Supplies: - DCDC Stacking SubPanel module (either +5 or +15 is ok)  
 - 3-pin 5V DC module (V7805-0500 or V7804-1000)

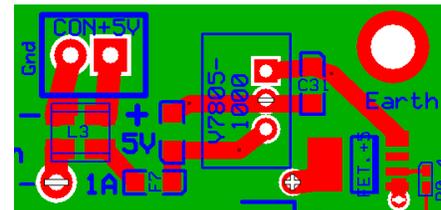
*Power Supply:* Basic checks to see if the board is active.

- Turn Switch Off.
- Install Aux1 FET jumpers 2-4 (+12 supply) and 3-5 (FET controlled output)
- Install a “+5V DC-DC converter module near “+5V-Out” at bottom of board...

**NOTE Critical Difference V1 vs V2 Boards for Switchable “+5V” Output Module!** As of Jan2015 no V2 boards have been built



*Version1 Layout SilkScreen V780x-500:*



*Version2 Layout SilkScreen V780x-1000:*

NOTE: Different orientation of these packages that look exactly the same. MAKE SURE you put the correct part in, or else reverse the orientation between the 2 versions: V780x-500 (ie.5A) vs V780x-1000 (ie 1A)!

- Attach Main.In to a “+12” power supply with an Amp 4pin cable.
  - a) Confirm +12 on switch and secondary “PwrChain” connector.
- Turn Switch On.
  - b) Confirm +5V at 2pin “+5V-Out” connector (FET pull-up is working).
  - c) Confirm +12 Aux1 (FET and pull-up working)
  - d) Confirm +12 at Connectors “Spare”, “Sio” and “Titan”

#### 6) DC-DC SubModule Functionality

Tests for isolated vs non-isolated operation

- a) Confirm +12 at J2.1, pins1-2(+) pins4-5(-). J2.1 is the 5-pin white posted pin connector near “+5V-Out” used for the DCDC submodule
- Turn Switch Off.

- Install DCDC SubPanel. Remove its JP-Gnd. Turn Switch On.
- b) Confirm DCDC+ at output to J1.0 pin 6 to pin 5 DCDC- but shouldn't see it to main Gnd. This checks 'isolated' option
- Turn Switch Off. Install JP-Gnd. Turn Switch On.
- c) Confirm DCDC+ to Gnd and J1.0 pin 6, and at Aux1 FET pin#1.
- Turn Switch Off

## 7) Functionality Tests Using DSM electronics box – FET On/Off control

- Supplies:
- working Titan DSM box
  - 2-pin PC104 Power Cable/Extension
  - 6-pin Power Distribution Cable/Extension
  - 10-pin Ribbon Cable/Extension to Titan J3,11-20 split off from Titan Interface panel
  - (used above) DCDC Stacking SubPanel
  - (used above) 3-pin 5V DC brick (V7805-0500 or V7804-1000)

*DSM Connections:* The DSM is going to be connected and operated by the Power Panel under test.

- Attach Power Distribution Cable/Extension (6-pin white wire plug to Power Output connector J1.0. This cable goes to the Titan Interface Panel where it tees off to run the Emerald panel also.
- Attach 10pin ribbon cable extension of Titan J3 pins 11-20 from where it splits on the Titan Interface Panel to the 2x5 2mm Ribbon Header near the power input J1.0. Note orientation for pin-11,
- Attach 2-pin "red/white" extension cable from "Titan 1.5A" connector to PC104 stack power supply.. Red=+ White=- (confirm). This is the supply to the PC104 stack Jupiter Power Supply board.
- Attach PC to Console and make sure PC's booted, running a terminal program at 115kbps (procomm/minicom/secureCRT, etc.)

*"DSM" Test* Here we test the FET and DCDC module controls via operator commands.

- Turn Switch On. The DSM should boot. Wait for login.
  - "tio -a 11 0" Confirm "Aux1+" goes off. "tio 11 1" turns it back on.
  - "tio -a 13 0" Confirm "+5V-Out" goes off. "tio 13 1" turns it back on.
  - "tio -a 15 0" Confirm DCDC control goes off. "tio 15 1" turns back on.
- NOTE: some DCDC SubPanels do not have on/off capability. It may be better to remove the module and measure the control line from J2.1 (middle pin) directly.
- If any of these fail, confirm that the control line itself from Titan-J3,11-20 is getting pulled to ground: Remove the ribbon cable. Insert pin to observe the voltage on pins 6 (11), 8 (13) and 10 (15) to see if they're toggling with the above commands or not. If not the ribbon cable/connection from the Titan is bad (unplugged?), etc.
  - Turn Switch/DSM off
  - Maybe, remove DCDC submodule and 3-pin 5V DC module if not needed for operations.

*Test Done* Alternative tests could involve putting a load on the CON1-4,+5V-Out (<.5A) etc to confirm they can handle it but that shouldn't be needed.

**8) Log Results:** Enter initials, date, and test notes/results in Excel spreadsheet:

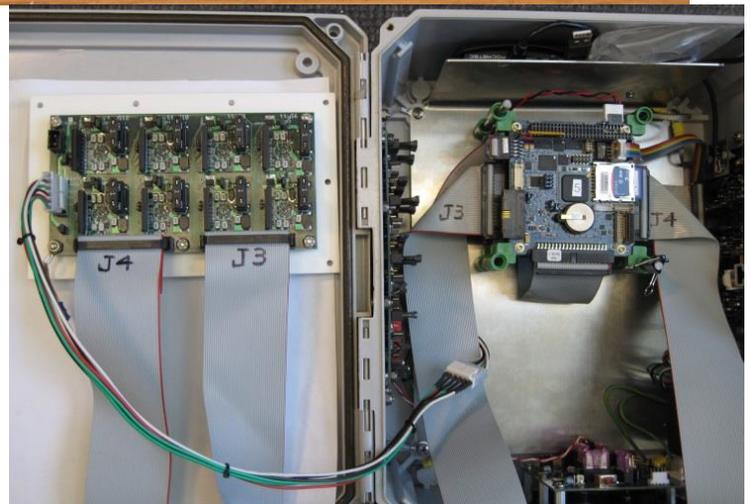
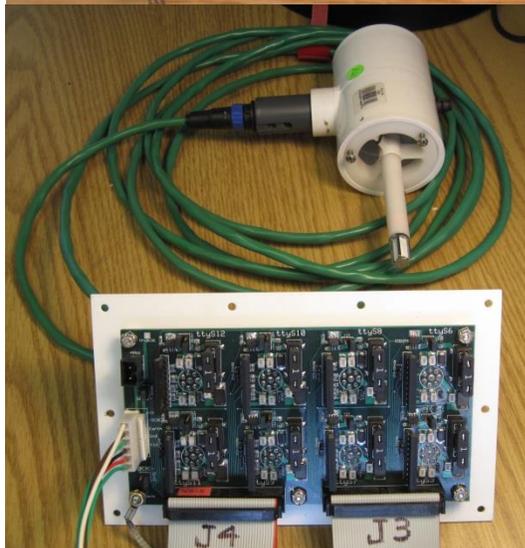
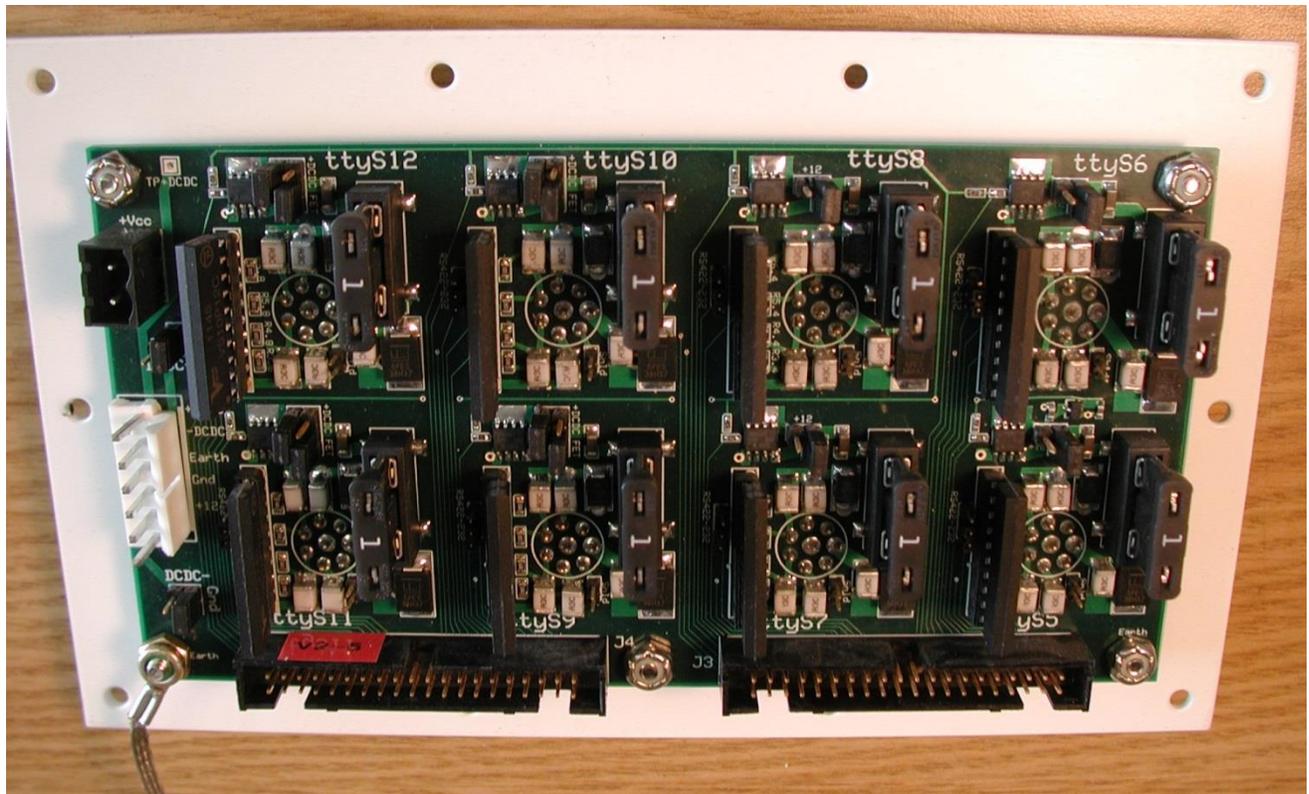
[DSM Test Log.xlsx](#)

# Emerald PC104 Board / Interface:

## Interface Board File Locations for Schematic/Layout/Mounting Panel:

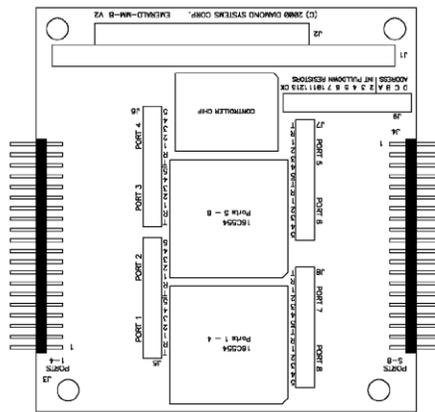
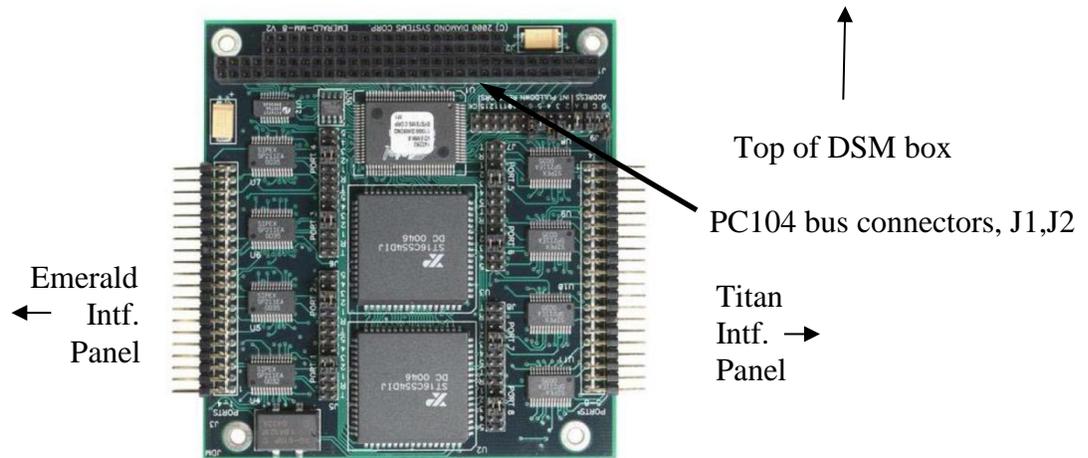
/net/isf/isff/doc/ExpressPCB/CentNet\_InterfacePanels/EmeraldPanel\_Ordered010813.sch and .pcb, and subdirectory 'FrontPanelExpress'

[Bill Of Materials:](#) /net/isf/isff/doc/ExpressPCB/CentNet\_InterfacePanels/Emerald\_Panel\_BOM.xlsx



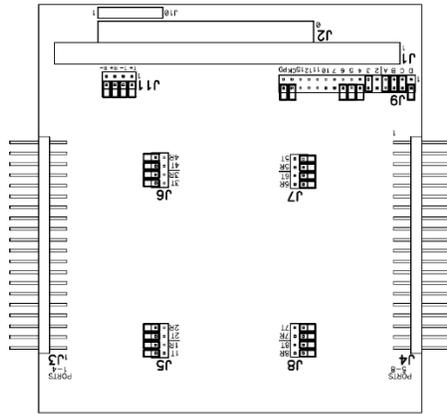
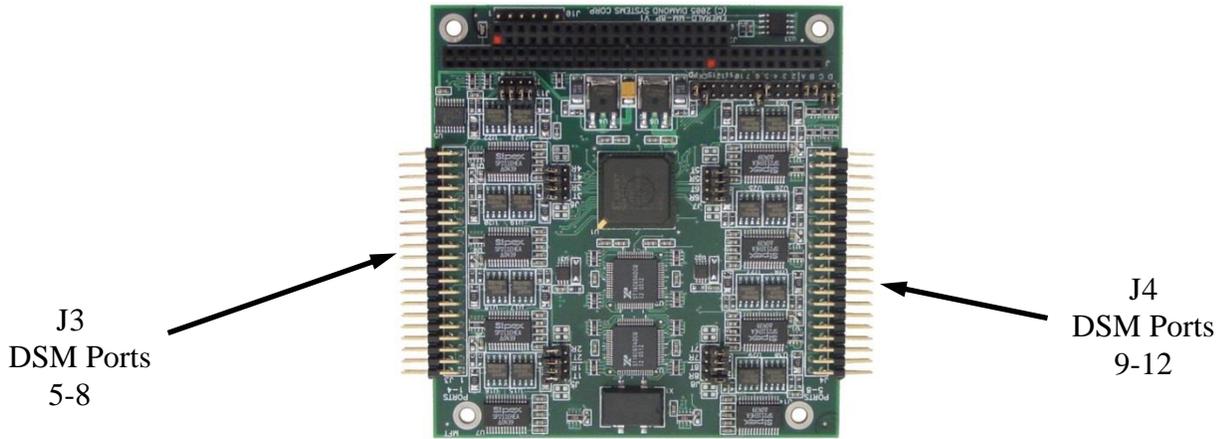
**Emerald Versions:** ISFS uses two types of 8-port Emerald PC104 boards: The older version EMM8 (jumper settings) and EMM-8P (software programmable port settings). **NOTE: The board(s) are in the PC104 stack underneath the Titan board.**

**EMM8 the original version with jumper pads for port settings:**



- J1: PC/104 bus 8-bit connector
- J2: PC/104 bus 16-bit connector
- J3: I/O header for ports 1 – 4 (2x20 pins) + 4 DIO
- J4: I/O header for ports 5 – 8 (2x20 pins) + 4 DIO
- J5 – J8: Protocol configuration jumper blocks, two ports per block
- J9: Board address, interrupt pulldown resistor, and clock configuration

**EMM-8P: NEW VERSION with software port setups:**



- J1: PC/104 bus 8-bit connector
- J2: PC/104 bus 16-bit connector
- J3: I/O header for ports 1 – 4 (2x20 pins) + 4 DIO
- J4: I/O header for ports 5 – 8 (2x20 pins) + 4 DIO
- J5 – J8: Termination jumper blocks, two ports per block
- J9: Board address and interrupt pull-down resistor configuration
- J10: JTAG Programming Connector
- J11: Bias Resistor Enable Jumper Block for Port 4

### ***Emerald Interface Assembly Notes:***

The boards have several through-hole parts which require hand or wave soldering. See [Bill Of Materials](#)  
Surface mount parts can be hand or paste soldered onto the board. There are only 2 components on the bottom side: C1 and C4, otherwise everything else is on the top/silk-screen side. The Bulgin connectors are a special case and it is possible to solder them on before cleaning and mounting to the metal DSM box plate. Otherwise it may be better to attach everything else first, clean the board thoroughly, then mount the board to the metal panel using the stand-offs while installing the Bulgins at the same time and then soldering the connectors in place. Afterwards a second cleaning is needed but the metal plate gasket cannot be washed. It is also possible to solder the Bulgin connectors on first which may be more convenient for cleaning purposes, however you may get some flexing of the board as it's screwed down.

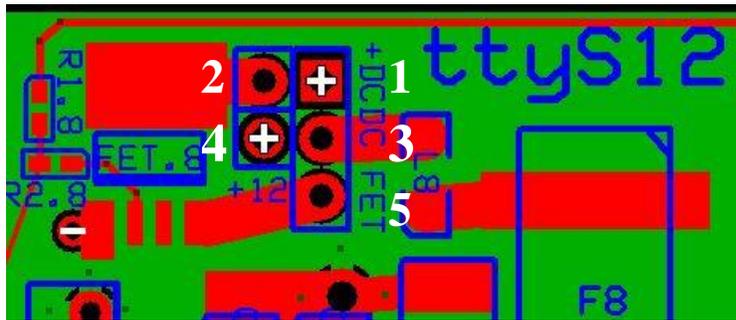
- 1) Surface Mount parts first: Hand or Wave Soldering, otherwise use board assembly company.  
Make sure solder paste is <1 year old (ie fresh), and/or solder is.  
Solder:
- 2) Through-Hole parts next, except perhaps Bulgins Connectors
- 3) Clean Board in parts washer, scrub and get all flux residue, and solder splashes off.
- 4) Attach Bulgin connectors to metal panel.
- 5) Attach PCB to metal panel using standoffs, flat washer, screws with internal lock washers & nylock nuts. The ground strap is put on the PCB "earth" hole that is adjacent to the 40-pin J4 connector using the 3/4" screw. The other screws are 5/8"
- 6) Solder on Bulgin connectors.
- 7) 2<sup>nd</sup> board cleaning (without the gasket stuck on)
- 8) Test Board: basic continuity, etc.
- 9) Install Jumpers...See Below
- 10) Install Fuses. (nominally 1A)
- 11) Install TVS diode arrays
- 12) Optional: Functionality Test before Box assembly. This requires cabling from the PC104 stack Emerald board, and power connections.

#### Box Assembly:

- 1) Install gasket on mounting panel and attach to DSM box with 1/2" screws, and black neoprene washers.
- 2) Attach ground strap to DSM box internal metal mounting plate that has the PC104 stack, etc.
- 3) Build DSM cables: 6-Pin distribution from Power Panel. Ribbons to Emerald pc104 board.
- 4) Final functionality test.

## **Emerald Interface Jumper Settings:**

**V2 Emerald ttyS9-ttyS12 Port Power Selection:** A 5-pin header, JPx.2, selects which supply is distributed to the Bulgin connector. Either +12 (main power supply) or +DC-DC (converter supply) can run these ports. Two jumpers are needed for FET control but only 1 jumper for uncontrolled voltage output. These ports are located on the left side of the board when looking down into the DSM box. The jumpers are located above their respective Bulgin connectors and next to their FET.



*FET Controlled Output Options:*

3-5= +FET Output to Bulgin

Then either:

2-4= Main +12 Power or

1-2= DC-DC+ Power

*Output Always ON Options:*

3-4= Main +12 Power or

1-3= DC-DC+ Power

## **V2 Emerald ttyS5-ttyS8 Port Power Selection:**

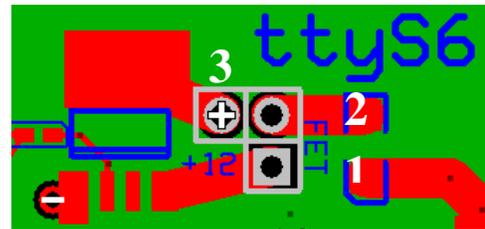
These ports are located on the right side of the board (when looking down into the DSM box). They have a 3-pin jumper to provide FET controlled, or uncontrolled +12/Main only.

*FET Controlled Output Option:*

1-2= +12 through FET Output to Bulgin

*Output Always ON Option:*

2-3= Main +12 Power



## **V2 Emerald ttyS11,ttyS12 DC-DC Isolated Supply:**

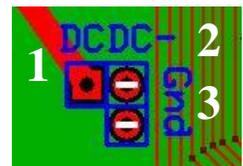
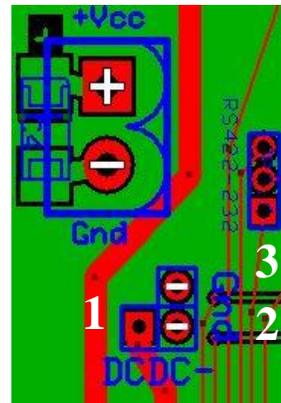
**NOTE: these ports require a jumper to select either 'main' or DCDC- 'ground.'**

Two 3-Pin headers on the left side of board near power input connectors.

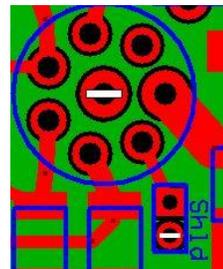
*Jumper 'Gnd-Gnd' for main supply ground. Pins 2-3*

*Jumper DCDC- for isolated ground Pins 1-2*

**NOTE: You Must Set One!**



**Shield Jumpers:** All ports can have their shields jumpered to ground if desired. Normally left open. These are located below the Bulgin connection.



**Serial DTR Signal Note:** Data Terminal Ready, DTR, is sometimes used to indicate that a computer (DSM/DTE) is ready to receive data from a DCE device, often a modem. Rarely but sometimes there are sensors that require this signal to be provided for either powering the device/circuit or to indicate the computer is online and ready for its data.

The DTR line cannot be used simultaneously with ‘DSM-Tx’ to the sensor. This is because of shared use of pins with 422 in the Emerald ribbon cable and decisions made in the interface/cable design process. It has rarely if ever been a problem. However, full DTR use is available on Titan ports COM1 (ttyS0) and COM4 (ttyS3). DTR is also available on the Emerald along with ‘DSM-Rx’ from the sensor as noted here:

**Serial RS232/RS422 Jumpers:** All ports can be configured for either RS232 or RS422.

Two steps are necessary:

- 1) For each port set the 2mm Jumper: RS232=Pins1-2 or for RS422=Pins2-3

This routes the DSM/Emerald’s Tx signal to the sensor.

Rx from the sensor to the DSM/Emerald is hard-wired.

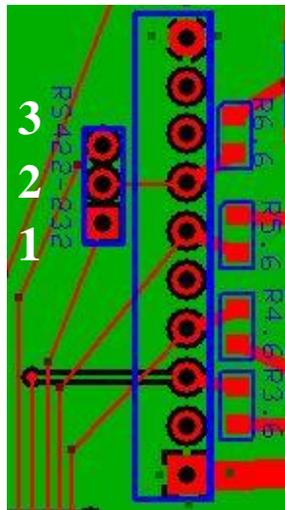
DTR: If needed, it can be provided by setting this jumper ‘422’ but at the expense of losing Tx communication from the Emerald to the sensor.

- 2) Change the DSM’s port setup. The default setup is RS232

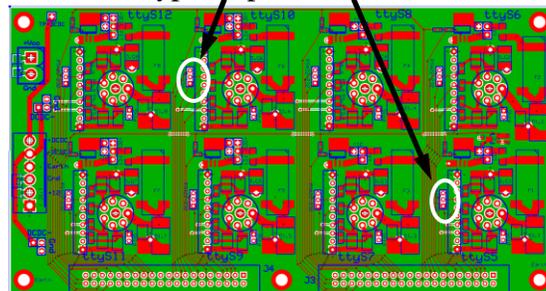
This can be done manually but is normally done in a configuration Script

‘scripts/dsm/other.sh’

“emode x 422” To put port “x” in RS422. X can be 5-12.



Typ. ea. port, 8 Places:



## Test Procedure / Emerald Interface:

### 1) Basic Continuity test with Ohmmeter:

**NOTE:** Do this procedure on a new board, or one that has known or suspected problems but generally not others. Best done with the board removed from the DSM box.

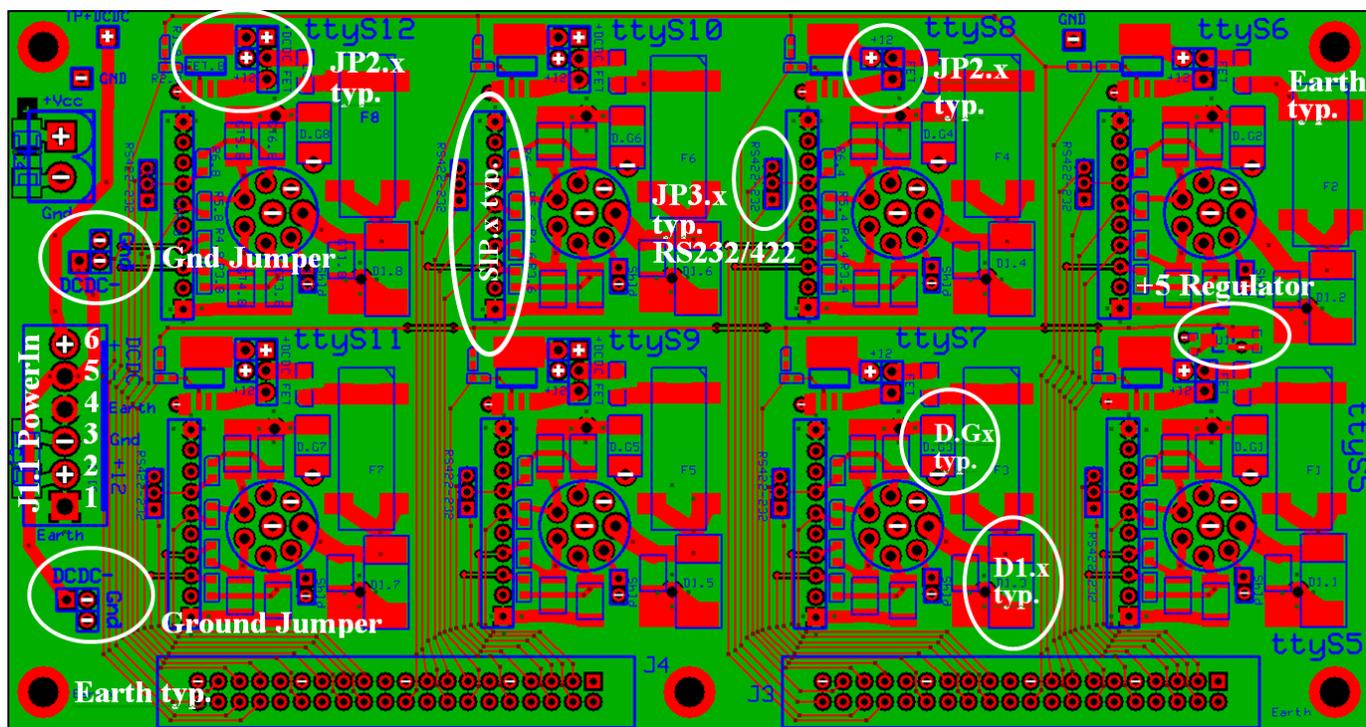
Before Assembly: Check blank boards for shorts between +, ground, earth and signals.

After Assembly: Check for shorts between +, ground and signals.

Continuity between earth and ground exists through the TVS diodes.

#### 6-Pin Input Power Connector J1

- DC-DC Negative: Ground Jumpers across DCDC-. Check for continuity from J1 pin-5 (-DCDC) to Bulgin pin 8 on ports ttyS11, ttyS12.
- Gnd: Move Ground Jumpers across "Gnd". Check for continuity from J1 pin-3 to Bulgin pin 8 on all ports.
- DC-DC Positive: Check for continuity from J1 pin-6 (+DCDC) to FET jumper pads JP2.x pin 1 (labeled) on ports ttyS9,10,11,12
- +12: Check for continuity from J1 pin-2 (+12) to FET jumper pads JP2.x pin 4 (or on the FET input if the short between pins 2,4 is installed) on ports ttyS9,10,11,12; and JP2.x pin 2 also on FET jumper pads for ports ttyS5,6,7,8.
- Earth: Check for continuity from J1 pins-1,4 and the board mounting holes. You can also see continuity to earth on the gas tubes and TVS's 'low side'.



**NOTE: TVS/G.T.:** Disconnect Ground Transient suppression brick if testing inside the DSM box. Otherwise the 'tvs/g.t.' will be shorted from working ground to earth. The brick is an inductor array used for lightning protection from an earth surge

**2) TVS Diodes:** This testing simply confirms the diodes "are there" and still ok. Individual breakdown voltages for these diodes are not listed here.

D1.1-D1.8 These are the large TVS's on the output of the +12 fuse. Meter on 'diode';

- probe- on 'earth' probe+ on fuse: should be open.
- probe- on fuse probe+ on 'earth': should see ~1.1volt forward drop.

Note: these diodes are isolated between one another since they go between each port's +12 and 'earth'

D.G1-D.G8: These are the TVS's between working ground and 'earth.' Meter on 'diode';

- probe- on 'earth' probe+ on 'ground': should be open
- probe- on 'ground' probe+ on 'earth': should see ~.6v forward drop

Note: because these connections are common between all of the ports, you cannot easily isolate each of the 8 components: ie. earth and ground are common throughout. So you really only check one of the parallel set of these diodes.

SIP.1-SIP.8 Check these only if you suspect a problem.  
They are Protek VS10P12C TVS bidirectional diode arrays that protect the serial input lines, Bulgin pins 3,4,5,6; so you can't really test forward voltage drop. Specified capacitance is 150pF. It's possible to check between the earth and conductor pins with a good capacitance meter, but there is also a gas tube in parallel to earth. Checking the pins directly on the package if it is suspect is best: any of the center conductors to either of the 2 end pins should appear 'open' and have roughly 150pF.  
NOTE: There are also 10 ohm resistors between on signal lines between the bulgin/gas-tube entry points and the SIP. They can be metered directly if you have problems with serial-i/o to confirm they're ok.

Note: Alternate testing for breakdown voltages could be done using the ISFS Cami HiPot test system and creating a 'cable/test' that sets the high-voltage slightly above/below the specified breakdowns, however, as of 1/2015 that has not been done. It's also possible to do 'zap' tests mentioned below.

**3) TVS GasTubes:** Cannot be easily tested because they appear as opens and have a high working and breakdown voltage. Their specified capacitance is <1pF, which is also tricky to measure.

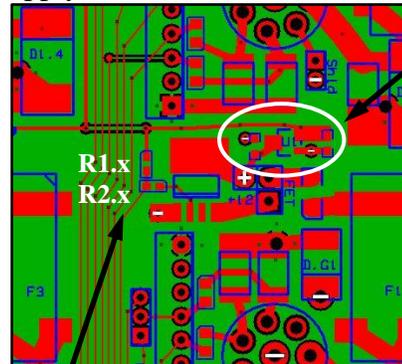
- Quick test with DVM to check that they appear 'open' and haven't failed 'shorted' (less likely than failing 'open.')
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- *Non-Standard Test:* Off-Line it is possible/best to use the 'ESD' gun set for high peak impulses, many kV, with short duration within the device specs of 2kA for the standard 8/20μSec, or 10A for 10/1000μSec profile.

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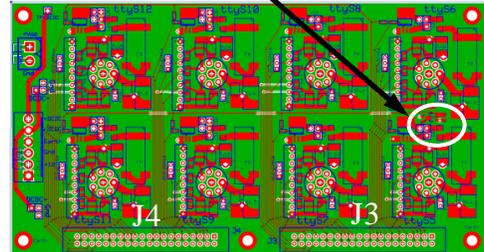
#### 4) +5V Regulator for FET Pull-Ups:

The Regulator provides a pull-up voltage to bias the FET power controls for ttyS6-ttyS12 output connector to be ON by default. It is U1, a 250mA MCP1703 3-pin SOT23 device. It is difficult to see located between ports ttyS5 and ttyS6, opposite the power input connector toward the right hand side of the board. To Confirm +5V:

- Apply 12VDC to the board.



+5V regulator:



- Meter FET Input Controls: ~3.0-3.6V at between R2.x and FET.x. R1.x/R2.x is a voltage divider of the 5v that biases the FET.

#### 5) Functionality Tests using DSM electronics box - FET and I/O confirmation for each port

Supplies:

- working Titan DSM box
- Power Supply and cable for DSM
- 6-pin Power Distribution Cable/Extension
- 40-pin Emerald I/O Cable/Extension for both J3 and J4
- DSM console cable
- BulginMale-BulginMale Null Modem/Cross Over cable

	Bulgin-1	Bulgin-2	
Rx	6	5	Tx
Tx	5	6	Rx
Gnd	8	8	Gnd
RTS	3	4	CTS
CTS	4	3	RTS

- Bulgin male-female Sensor I/O cable
- Bulgin Serial Port V/I Power test box
- Sensors: TRH, CSAT, Sonic, Gill-2D, etc

Note: Make certain the DSM has an Emerald card. For new interface panels, make sure the Emerald PC104 board is fully functional, ie no dead ports! For an interface installed in the box it'll be/was deployed in, the tests will confirm if all ports on both the panel and the PC104 boards are working. It may be more convenient to use long extension cables so the board can sit outside.

NOTE: See [http://wiki.eol.ucar.edu/sew/ISFS/DataSystemNotes#Serial\\_Throughput\\_Tests](http://wiki.eol.ucar.edu/sew/ISFS/DataSystemNotes#Serial_Throughput_Tests) for a detailed and up-to-date description of testing procedures and tools Gordon has documented on the Wiki. The following descriptions are based on or copies of his notes.

*DSM Connections:* Attach Power Distribution Cable/Extension (6-pin white wire plug to Power Output connector J1.0.

- Attach 40pin ribbon cables to Emerald card: J3-Emerald (closest to Titan Interface panel), J4-Emerald (closest to Emerald Interface panel)

- Attach PC to Console and make sure PC's booted, running a terminal program at 115kbps (procomm/minicom/secureCRT, etc.)
- On Interface Panel: jumper all ports i/o to "RS232". JP3.x is the small 2mm pad next to SIP.
- On Interface Panel: jumper all ports output power to "FET"; JP2.x pins 1-3, and for ttyS9-12 pins 2-4 also to provide +12 supply for the FET.
- (optional) Connect bulgin cable to serial port test box and test box to port under test.
- Boot up DSM with 'console cable' or 'ethernet' to monitor ops.
  - "ddn" Shut Down Nidas (also "adn").
  - "ps -ef" Confirm it's down.
- Open 2 login windows to the DSM. Best to login using the network/ssh. If need be use minicom from your PC to the system console, ttyS0, and use 'ifconfig' to see what the ethernet address is to login using 'ssh root@xxx'.

#### 5a) "TRH" Test

This is the simplest and quick way of testing all ports for power switching and basic serial communications. It does not validate RS422, or high-speed i/o.

- **For each port ttyS5-12:** 'x' below = 5,6,7,8,9,10,11,12
  - connect TRH to it. Fan should come on.
    - "emode x" Confirm it's rs232
    - "eio x 0" Fan off.
    - "eio x 1" Fan on.
    - "minicom ttySx" Set baud to 9600: Ctrl-a, 'P', 'E'
- Messages: TRH44 23.32 12.68 29 0 1577 36 90  
 Ctrl-U Brings up trh menu: rcv is ok.  
 CUR Command reports fan Current limit setting  
 EXT Exit TRH command mode  
 Ctrl-A x Exit minicom
- Note If you don't see anything coming in using minicom check the port's operating mode is rs232 "emode x" as described below, 'handy commands'

#### 5b,c) DSM "Sing" RS232 Throughput Port-Port Test

- **For each port ttyS5-12:** 'x' below = 5,6,7,8,9,10,11,12

#### 5b) RS232 TX/RX Test

- Connect male-male Null-Modem cable to ttyS1 and to bulgin cable
- Connect bulgin cable to the port you want to test, for example /dev/ttyS2: In one window:
  - "sing /dev/ttyS1"
- In another window run sing in echo mode:
  - "sing -e /dev/ttySx"

You should see incrementing values for "sent#" and "rcvd#". "n/10" and "N/100" should increment up to 10/10 and 100/100:

```
sent#: 134 rcvd#: 132, 10/10, 100/100, out:0.4776 kB/sec, in:0.3605 kB/sec, dT:73 msec
sent#: 135 rcvd#: 133, 10/10, 100/100, out:0.4776 kB/sec, in:0.4776 kB/sec, dT:73 msec
```

On the echo side, you should see scrolling output like:

```
rcvd#: 132, 10/10, 100/100, in:0.4788 kB/sec
rcvd#: 133, 10/10, 100/100, in:0.4776 kB/sec
```

Ctrl-c the second sing process. Move test box cable to next port. Start echo sing process on that port:

- "sing -e /dev/ttySy"

### 5c) CTS/RTS test

- As above, connect cable to the port you want to test. In one window start sing with "-m" option to test modem lines:

- "sing -m /dev/ttyS1"

In second window start sing in echo modem lines mode:

- "sing -e -m /dev/ttyS5"

sing on ttyS1 will toggle DTR and RTS. CTS will remain asserted:

- setting modem lines: DTR RTS
- current modem lines: DTR RTS CTS
- setting modem lines:
- current modem lines: CTS

sing on ttyS5 should report that CTS is toggling. DTR and RTS will not change:

- current modem lines: DTR RTS CTS
- current modem lines: DTR RTS

NOTE: "Sing" parameter adjustments;

The sing program defaults to 9600n81, but has many settings not mentioned here: message rates, sizes, sio protocol, etc. Type "sing"<CR> for help info. and how to change options.

Example: `sing -e -o 57600n81mhr /dev/ttySx`

57600bps with (m)odem carrier detect monitoring, (h)ardware flow control and (r)aw binary data/no translation.

5d) "Gill RS422" Test The sing program can't be used to test the RS422/485 functionality.

The simplest way is to connect a known RS422 device to each port. The Gill 2D Sonic is convenient. In reality, with the 'rts/cts' and '232' tests above the interface board should be good and RS422 testing will then really be to determined whether the Emerald PC104 board itself is running properly.

- On Interface Panel: jumper all ports i/o to "RS422". JP3.x is the small 2mm pad next to SIP.
- **For each port ttyS5-12:**
  - connect GillSonic to it.
  - "emode x 422" Confirm it's rs422
  - "eio x 1" Power should already be on.
  - "minicom ttySx" Set baud to 9600: Ctrl-a, 'E'  
Messages: .A,247,000.12,M,60,.0A  
\* Brings up command prompt.  
Q Returns to sampling mode  
Ctrl-A x Exit minicom
- Jumper all ports i/o back to "RS232". Normal usage.

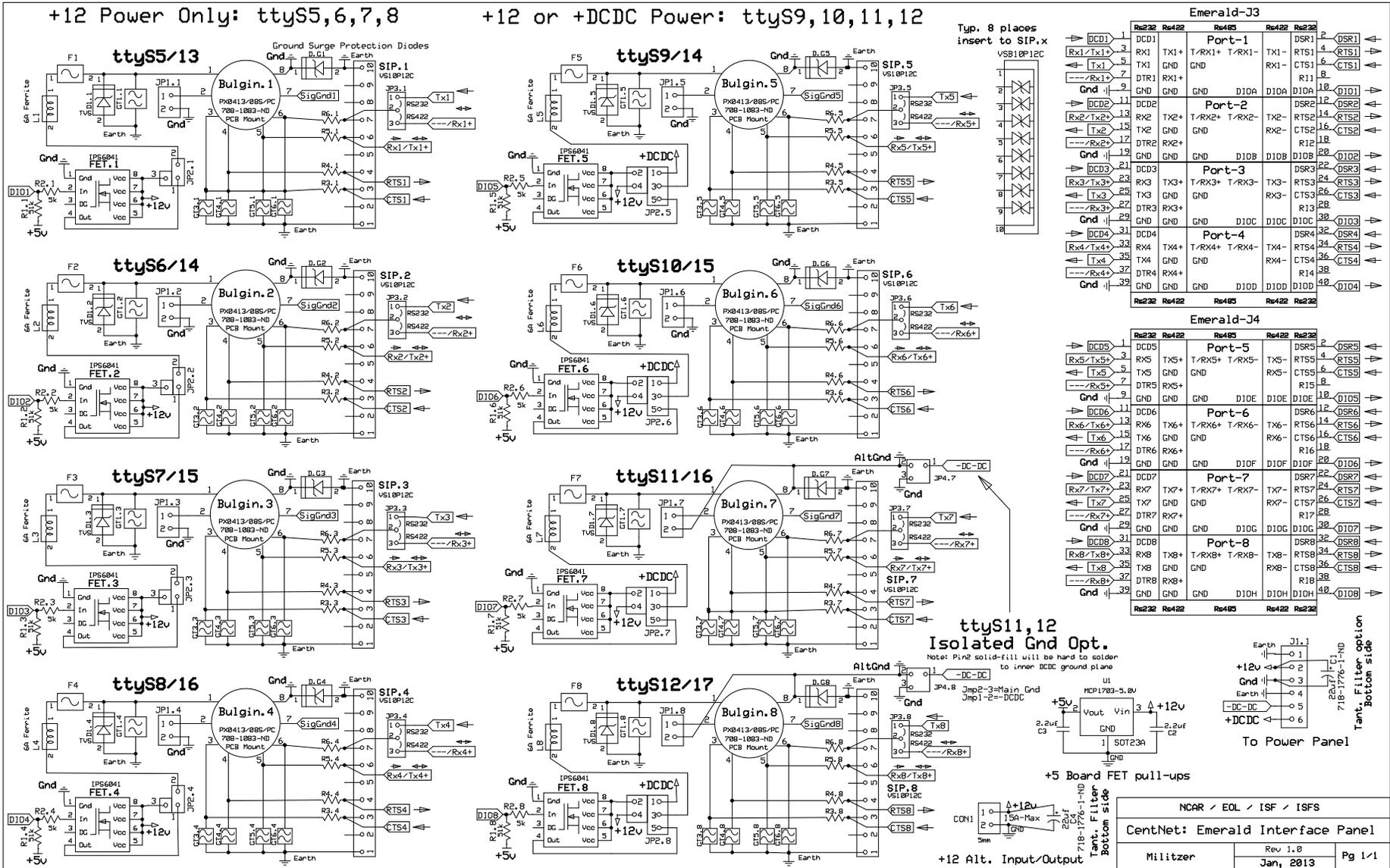
## 6) Log Results:

Enter initials, date, and test notes/results in Excel spreadsheet:

[DSM Test Log.xlsx](#)

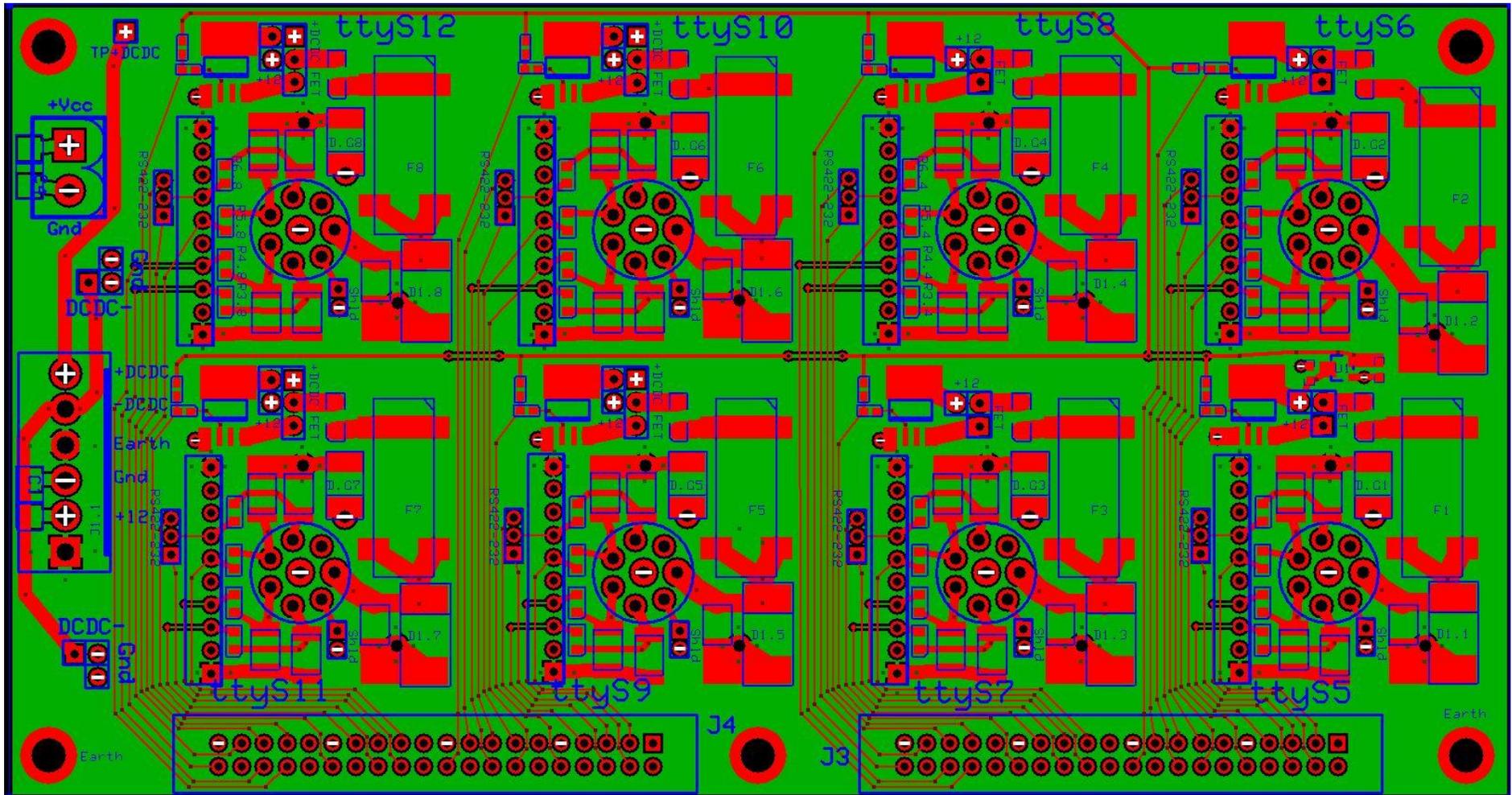
# Emerald Interface Schematic:

**Emerald Schematic:** All ports are configured the same: TVS+gastube+fuses. Each have shunt for shield to gnd. Pull-ups to +5v are provided for the fet control lines to keep power on even when the Emerald DIO lines reboot with default='off'.



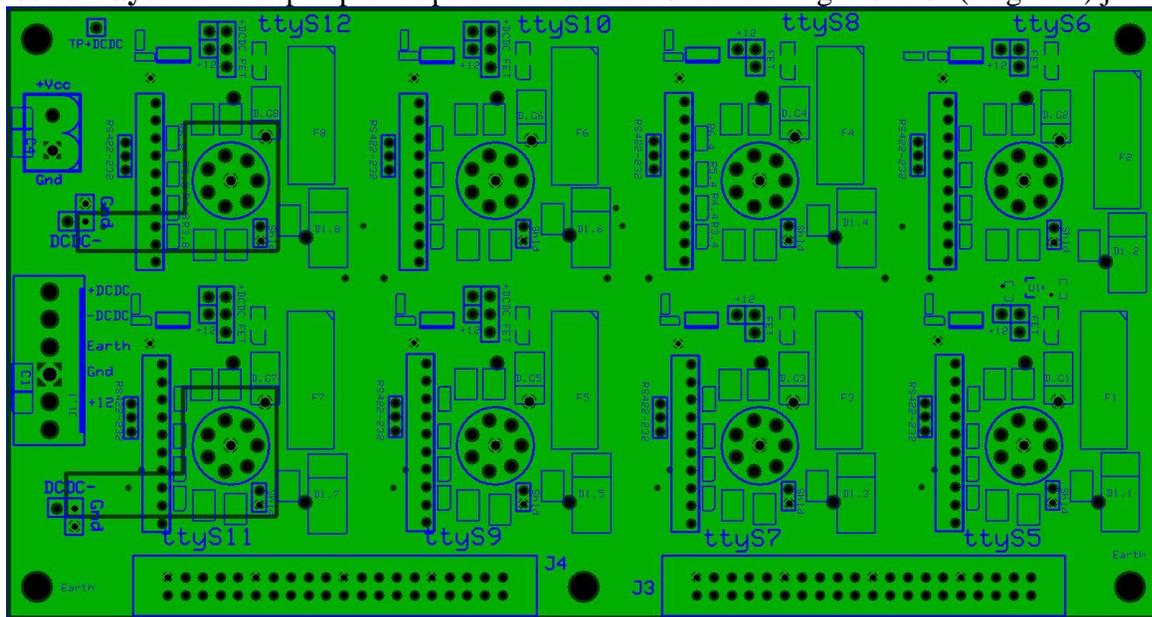
### ***Emerald Interface Layout:***

NOTE This layout allows Power Input from either the 2-Pin jack on the left so that it can be used with the old power/viper panels or from the 6-Pin J1 jack with the Titan Interface Panel. It also allows Isolated DC-DC +v/gnd for port ttyS11 and 12. This is the original build version V1.

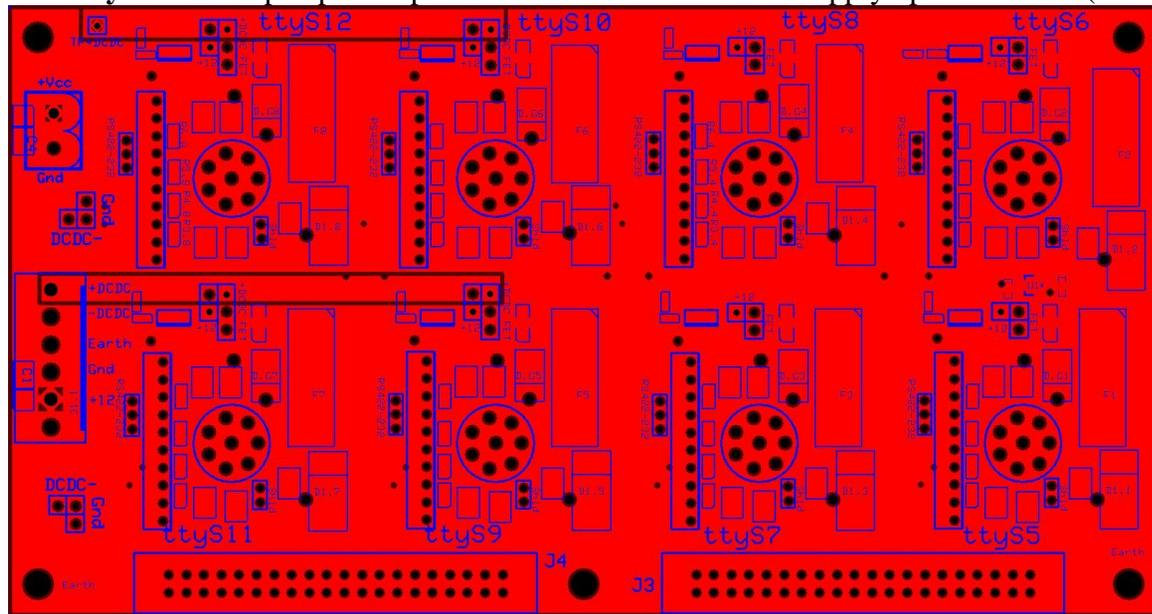


**Bottom of electronics box**

**Emerald Layout: Inner Ground Layer** – Note split-plane option for Isolated Ground using DC-DC- (Negative) jumpers for ttyS11,12 Only



**Emerald Layout: Inner Power Layer** – Note split-plane option for DC-DC+ versus +12 supply option on JP.x (for Only ttyS9,10,11,12)

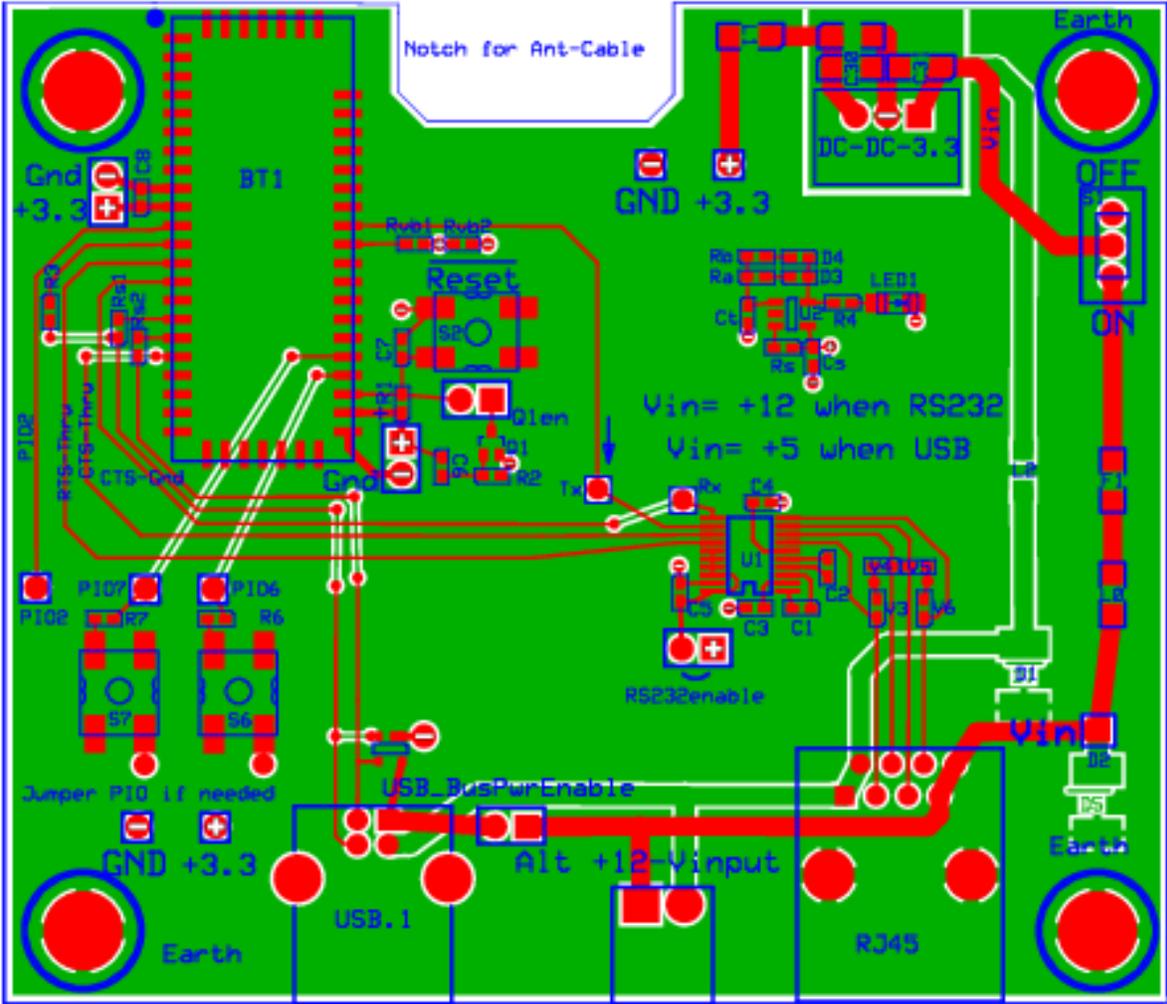


# BlueGiga WT41 BlueTooth Interface:

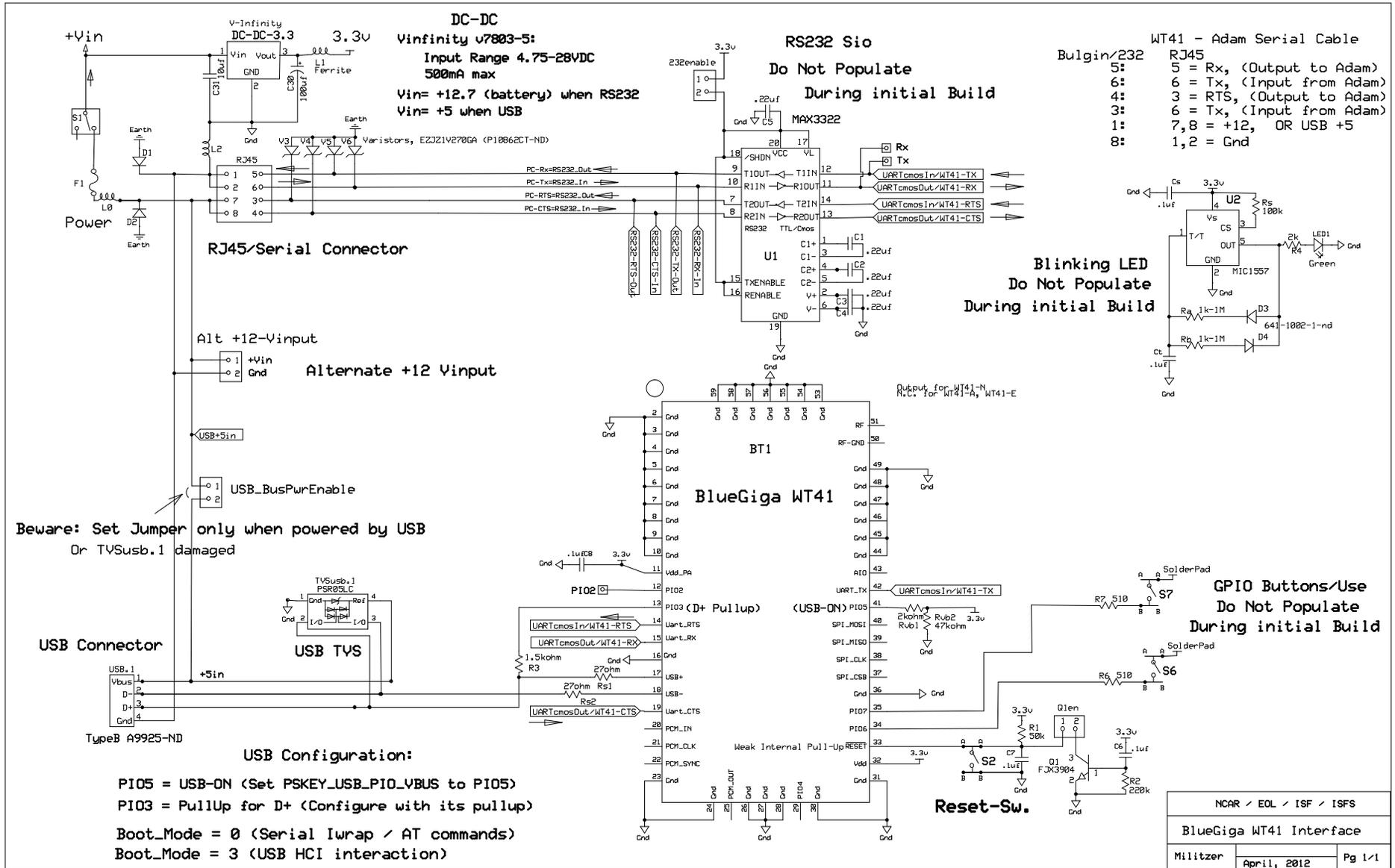
The WT41 is a long range blue tooth module capable of 1km telemetry and beyond with good line of sight.

Board Notes: The WT41 can be cleaned in a parts washer safely.

### Layout:



# BlueGiga WT41 Interface Schematic:



# PCB Board Design

## **Board Design / Layout Software:**

Schematics, Layouts and Board Manufacturing have been done using [www.ExpressPCB.com](http://www.ExpressPCB.com)

Boards are: 4-layer, 1.25oz copper.= Copper Thickness .0017"  
.062" Laminate: FR-4 Epoxy glass: Dielectric Constant = 4.2-5.0  
Stacking: TopSignal/Silkscreen, Ground, Power, BottomSignal  
Assuming equidistant: ~.020" between layers

Milling: Board perimeters are cut to shape using a 0.093" router bit. Slots in the perimeter must be 0.100" or wider. Narrower slots will not be milled correctly. Routing slots or holes in the interior of the board are not offered.

Board Edge Clearance: .020" The edges of the board are cut with an accuracy of  $\pm 0.015$ ". A minimum of 0.020" blank space is recommended between the perimeter and all features on the board. Traces placed closer than 0.015" to the board's edge may be routed off.

## **PCB Component Stuffing and Assembly**

Gerber Files: Assembly companies normally need: Gerber Files, XYRS and Panelized Paste Files; plug BOM and assembly notes.

The Bill Of Materials (BOM) can begin using output from most Schematic capture programs including expresspcb; however the generated files are far from adequate and need to include component identifications, packaging, ordering information and any *special assembly notes such as 'Ublox is no-wash part.'*

Stencils: High-end, quantity manufacturing requires Stencils to apply paste to the PCB before components are automatically picked and placed for oven curing. Using expressPCB these cannot be made directly without the XYRS and Paste files.

The files needed to create stencils can be generated for a cost by most assembly houses for an additional cost. Otherwise, higher end Schematic Capture / Layout programs such as Altium and Eagle have the capability to generate these files.

AAPCB This company has been used for low quantity builds by 'DropSonde' group. They can make their own component templates for automated pick-n-place without needing tape and reels which are typical of large builds but impractical for small runs. Instead they can handle either 'Cut-Tape' (and prefer it), or loose parts.

Advanced Assembly  
20100 East 32nd Parkway, Suite 225, Aurora, CO 80011  
aapcb.com

ExpressPCB only provides Gerber files and only after boards have been manufactured by them. After that you can order them and actually have boards made elsewhere (maybe). They say: We can not generate solder paste, stencil or Centroid files. Typically what our customers do is order gerber files from us which can be edited into other formats. I recommend that you speak with your board assembly house (or the company making your solder paste screens) to verify that they can work with these files.

You can order gerber files by email for PCBs that we have previously manufactured. The cost of these files is \$60. This fee will be billed to the credit card number used in the original order for the boards. You will receive these gerber files in RS-274X format:

- + Top silkscreen layer
- + Top soldermask layer
- + Top copper layer
- + Bottom copper layer
- + Bottom soldermask layer
- + Drill file
- + 4 layer designs also include the 2 inner layers

To order the files, send email to [support@expresspcb.com](mailto:support@expresspcb.com) with this exact information:

- 1) Write a note indicating that you would like to purchase gerber files.
- 2) Acknowledge in your email that you understand there is a \$60 fee for each set of gerber files that you order, and that the fee will be billed to your credit card.
- 3) Specify the order number of the previously manufactured design by noting our original 8 or 9 character order number. Our order numbers have the form ABCD-1234-E.

We will generate the gerber files using the original PCB design file associated with your order number. We will then email the gerber files back to you as an attachment. The email will also include a receipt for the \$60 fee marked "Paid in full". Typically it takes one 24 hour business day to fulfill the order.

### ***Thermal Considerations in PCB Board Design and Layout:***

Care must be taken to provide adequate component cooling under load for power components especially LDO's and other dc-dc devices. Manufacturer's typically specify *junction temperature* in addition to *output current capacity*. Care must be taken to avoid heat-dissipation causing temperature rise above specified limits to avoid damaging the part, and perhaps worse, having their internal safety-monitor shutting them off disconnecting your circuit or even worse: component total failure.

Adequate PCB area must be provided for the anticipated operating temperatures to provide this cooling, or other heat sink techniques in 'big-part' situations. Often we simply provide an area that 'looks good and fits' without doing a specific calculation. However a second factor is what can happen when attaching the part. If the area is too large then *when hand-soldering the component can also be over-heated* and be damaged or just as likely not have a good joint. Manufacturer's generally suggest controlled 'Re-Flow-Soldering' (ie oven) over hand-attachment.

The following sheets provide an accurate calculation of PCB thermal pad area sizing: See:  
PCB\_Thermal\_Copper\_Area\_3\_ [CalculatorforThermalMgmt.xls](#)  
LDO\_ [PowerDissipationCalculator\\_Limits.xls](#)

### ***Soldering Considerations:***

Soldering supplies and a good source for technical support is available from:  
Stellar Technical Products  
Quality Soldering & Production Supplies  
Gardena, CA, 310-660-0140  
888-765-3371

Experience has shown that sometimes water-soluble solder has caused corrosion on pins. Lead free solder has shown deterioration as well with microscopic ‘whiskers’ forming that threaten shorts between conductors. Stellar Technical personnel relate that the whiskers are caused by residues remaining on the board that are reactive. If the boards are cleaned thoroughly these problems should not occur.

Cleaning of boards with alcohol is required for non-water soluble flux cores, and water otherwise. Alcohol cleaning for water-soluble may be inadequate. Beware of ‘no-wash’ parts such as Ublox GPS receivers before bathing them.

Some solders are ‘No-Clean’ where some non-reactive clear ‘coat’ flux residue remains on the board. This could be considered as a protective coating but is clearly (ahem) not comprehensive across the entire board. However, we need to be aware of the full exposure range of solders we use. No-Clean creates a very hard coating that makes rework more difficult and cleaning it off can take a long time. Cirris Solutions (cable test co) reports sometimes these solders can cause failures and the flux may not be visible (but is under uv).

Liquid Flux applied to pads before soldering or reworking parts improves connections. Alpha NR205 Write flux is used and is available in either gallon containers or more convenient ‘NR205 no clean flux pens’ item 70-205-00.

ie Method for Wire Soldering: Apply flux before soldering or reworking.

Some recommended products include:

NR205 no clean flux pen item 70-205-00	No Clean		Alpha Metals' NR205 No-Clean Flux
Telcore 63/37 Item 63-025-51 .025”	No Clean	63% Tin / 37% Lead	J-STD-004 RO-L0. Leaves minimal, optically clear, completely inert residue. Contains 63% Tin /37% Lead and 2% flux core
Telcore 63/37 Item 63-015-51 .015”			
Telcore SACX0307 HF-850 Item 96-420-52 .020”	No Clean	Lead Free	HF-850 residue is safe to leave on electronic assemblies or can be cleaned off with solvents if desired.
Cookson Electronics Alpha Pure Core; Item 110335 63/37 .015”	Water Soluble	63% Tin / 37% Lead	ANSI-J-STD-004ORM1
Kester “44” Resin Core, 63/37 .015”	Req. Clean	63% Tin / 37% Lead	ANSI-J-STD-006A

Solder and flux do have expiration dates. How these effect quality is TBD.

## **Coating PCB Boards:**

There are significant differences between types of coating materials and depending upon application, one may work better than others:

1) Epoxy – Heavy Duty, UV, Good for durable, out-door applications. This is the material we have been using for the Wisard Sensor boards, soils and such that will be exposed to water and abrasion.

Supply: White Rapid Coat Aircraft Paint. Jeff Bobka supplies this stuff. It has a shelf life and cannot be stored for long term.

Mix: 1 to 1. This is critical for good results

Stir / Rest for 15-Minutes. You'll probably see some bubbles.

Stir – Dip Boards

NOTE: if you're going to spray the paint on instead of dipping the 'Rest for 10-Minutes not 15'.

All Other Coatings below are 'Light Duty' and 'Non-UV'

2) Acrylic Do not used for exposed boards. Light duty for protected locations. This coats well and doesn't bubble. It is good for use inside sensor 'clam shells.'

Chemtronics – KonForm spray.

3) Urethane Similar to Acrylic, but hard to coat with this and it bubbles easily...so don't use it for the most part. For this one you must have the board extremely clean

4) Silicone Good for temporary light duty use. It is the only one that can be cleaned off if needed

## **Nominal Current Capacity for PCB trace sizes.**

Current capacity depends on board and component temperature. In general current capacity goes down with higher temperature for lams/wire, but improves for components that are limited on internal junction temp/heat sinking.

For 1.25-Oz copper traces (=1.68 mil thickness, used by ExpressPCB) the approximate current capacity is shown (for ~20degC temperature rise). Elevated temperatures reduce trace capacity.

Trace Width	Sq.Mils(1.25Oz)	20degC temp Rise
.010"	0.17	0.3 Amps
.015"	0.25	0.4A
.020"	0.34	0.7A
.025"	0.42	1.0A
.050"	0.84	2.0A
.080"	1.35	3.2A
.100"	1.68	4.0A
.150"	2.53	6.0A

# Chart of PCB Current Capacities vs Temperatures

(For use in determining current carrying capacity and sizes of etched copper conductors for various temperature rises above ambient.)

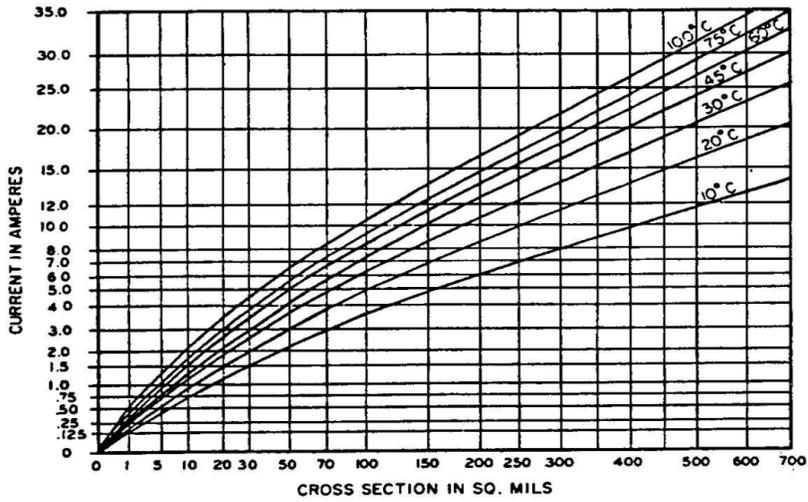


Figure A External Conductors

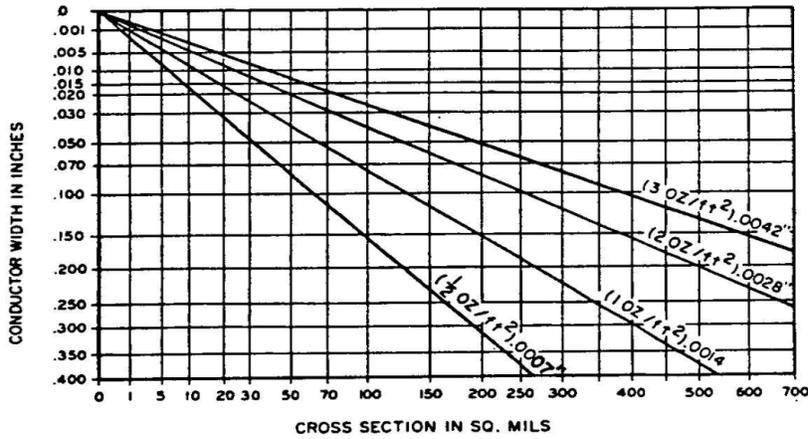


Figure B Conductor width to cross-section relationship

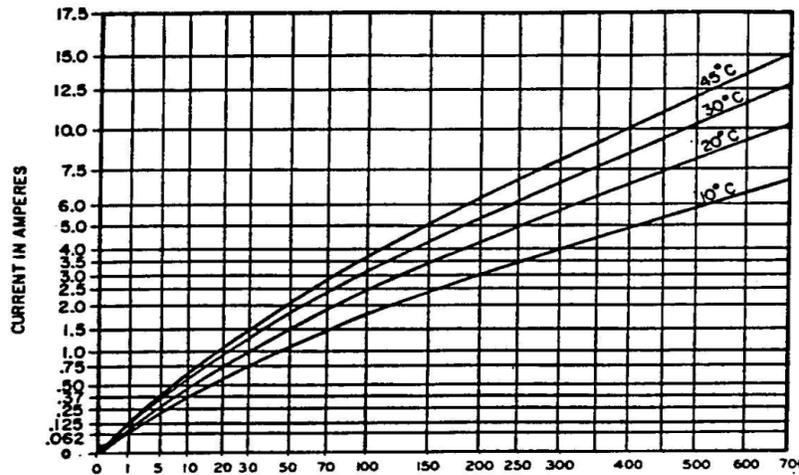


Figure C Internal Conductors

Figure 6-4 Conductor thickness and width for internal and external layers

N  
1.  
2  
3  
4  
5  
6  
7

# Manufacturing Issues

## ***Electronics Box Enclosure / Construction:***

Manufacturer of Gray Box: [www.stahlin.com](http://www.stahlin.com) Model:

Ground Isolator: Iso-Line Ground Transient Terminator  
Manufactured by Vortex Technologies Inc.; vortextek.com  
Model: IL-GTT, ~\$150,

This is the device used to protect the electronics from nearby common mode ground surges that raise the potential of the earth itself. It consists basically of a fancy inductive array that delays and defuses (hopefully) the surge.  
Assembly and Wiring is associated with the Power Interface Panel but it is physically mounted to the electronics box adjacent to the panel.