

**Production
ICC (Slow Controls) Board
Version: PROD_ICC_BOARD_REV3.1 & 3.2
Checkout Procedure**

**Todd Moore
Dark Energy Survey/University of Illinois, Urbana-Champaign**



SERIAL # _____.

CHECKOUT DATE: _____.

CHECKED BY: _____.



Checklist For Version: PROD ICC BOARD REV3.1 & 3.2

- I. INSTALL SERIAL #: _____
- II. CHECK FOR SHORTS ON POWER RAILS: _____
- III. CHECK VOLTAGES: _____
- IV. CHECK OVER VOLTAGE CIRCUIT: _____
 - a. CHECK INSTR. AMPS: _____
 - b. CHECK OV ICs: _____
 - c. CHECK VOLTS GOOD SIG: _____
- V. CHECK TEMP SENSOR: _____
- VI. CHECK HUMIDITY SENSOR: _____
- VII. CHECK FAN RPM ALERT CIRCUIT: _____
 - a. CHECK FAN RPM ALERTS: _____
 - b. CHECK FAN CLEARS: _____
- VIII. CHECK VICOR FAN ALERT CIRCUIT: _____
- IX. INSTALL FIRMWARE: _____
- X. CHECK SPI COMMs: _____
 - a. 1 ICC BOARD: _____
 - b. 4 ICC BOARDS: _____
- XI. INSTALL INTO MOUNT: _____
- XII. CHECK NO_FAULTS SIG: _____
- XIII. CHECK GEN_SHUTDOWN SIG/LED: _____
- XIV. CHECK VOLTS_GOOD SIG/LED _____
- XV. CHECK POWER-UP/DOWN SEQ: _____
- XVI. CHECK OK_PWR_UP SIG/LED: _____
- XVII. CHECK VOLTS_GOOD: _____
- XVIII. CHECK MEMORY: _____
 - a. CHECK DATA SAVED TO MEMORY: _____
 - b. CHECK CLEARING MEMORY: _____
- XIX. CHECK OV LEDs: _____
- XX. CHECK MECH. TEMP SWITCHES: _____
- XXI. CALIBRATE VOLTAGES: _____
- XXII. CHECK AS DAQ & HEATER CRATE
 - a. CHECK SW401 (OV CIRCUIT) _____
 - b. CHECK SW700 (FIRMWARE SW) _____
- XXIII. INSTALL LABELS: _____
- XXIV. INSTALL SILICONE: _____
- XXV. INSTALL MOUNTING NUTS: _____
 - a. ICC BOARD: _____
 - b. DB CONNECTORS: _____
- XXVI. INSTALL COVER/TEMP. SW. _____



Version: 4.0
Modified: 10/25/10

This document outlines the steps used to test the Internal Crate Controller (Slow Controls) printed circuit board, production version: PROD_ICC_BOARD_REV2.1, for functionality. This document is organized in two sections: Hardware Tests & Firmware Tests. Hardware testing starts testing on the bare pcb before any components are installed and continues up through the stuffed pcb with components installed and power applied. Firmware testing tests the ICCMain.c firmware written for the ICC pcb using Microchip's ICD2 IDE programmer and debugger, and MPLAB Version 8.30. Firmware is written as a state machine in the c programming language. The firmware has to be compiled and programmed using Microchip's MPLAB Version 8.30 (or newer) and the ICD2 programmer connected to the ICC board.

I. HARDWARE TESTS:

I.I. Initial Setup/Electrical Shorts Tests:

I.I.I. Prior to component assembly:

1. Check for short between pins 1(+12v) & 2(RTN) on P103.
2. Check for short between pins 4(-12v) & 3(RTN) on P103.
3. Check for short between pins 1(+12v) & 4(-12v) on P103.
4. Check for short between pin 1(+12v) on F501 & pin 2(RTN) on P103.
5. Check for short between pin 2(+12v fused) on F501 & pin 2(RTN) on P103.
6. Check for short between pin 1(-12v) on F502 & pin 3(RTN) on P103.
7. Check for short between pin 2(-12v fused) on F501 & pin 3(RTN) on P103.
8. Check for short between pins 1(+12v) & 2(RTN) on U501.
9. Check for short between pins 3 (+3.3v) & 2(RTN) on U501.
10. Check for shorts between pins 1(+12v) & 3 (+3.3v) on U501.
11. Check for short between pins 1(+12v) & 2(RTN) on U502.
12. Check for short between pins 3 (+5v) & 2(RTN) on U502.
13. Check for shorts between pins 1(+12v) & 3 (+5v) on U502.

Any Shorts?_____.

I.I.II. Put fuses in & connect +/-12v power cables to P103:

1. Insert a 1 amp fuse into F501 and a .500 amp fuse into F502.
2. Set +/-12v power supplies to +/-12.00 volts. Turn on +/-12v power supplies.
3. Measure +12 volts voltage using DMM between pins 1 (+12v) on F501 & T2 (RTN).
4. Measure -12 volts voltage using DMM between pins 1 (-12v) on F502 & T2 (RTN).
5. Measure +3.3 volts voltage using DMM between pins 3 (+3.3v) & 2 (RTN) on U501.
6. Measure +5 volts voltage using DMM between pins 3 (+5v) & 2(RTN) on U502.
7. Get +12 volts current measurement from +12 volts power supply meter.
8. Get -12 volts current measurement from -12 volts power supply meter.
9. Turn off +/-12v power supplies.

Measured +3.3v Voltage:_____.

Measured +5v Voltage:_____.

Measured +12v Voltage:_____.



Measured -12v Voltage: _____.
 Measured +12v Current: _____.
 Measured -12v Current: _____.

I.II. Over-Voltage Circuit Tests:

I.II.I. Check over-voltage isolation circuit:

1. Set voltages on over-voltage power supplies to nominal voltages.
2. Connect over-voltage power supply cables to voltage divider board.
3. Connect output cable of voltage divider board to P101.
4. Turn on +/-12v power supplies.
5. Turn on over-voltage power supplies.
6. Measure input voltage between pins 2(input voltages/rtns) & 3(input voltages/rtns) of U201-U215.
7. Measure isolated voltage between pins 6(Outputs) & T1(Isolated RTN) on U201-U215.
8. Calculate gain of U201-U215.
 1. Voltage gain should be unity (1.000) for +5VD, +3.3VD, +5VA, & -5VA.
 2. Voltage gain should be 2 for +15VA, -15VA, -28VA, & +48VA
 3. Gain = measured output voltage/measured input voltage.

	+5VD	+5VA	+15VA	-28VA	+3.3VD	-5VA	-15VA	+48VA
	U201	U202	U203	U204	U205	U206	U207	U208
Measured Input Voltages in Step 6 (Pin2 & Pin3):								
Measured Output Voltages in Step 7 (Pin6 & T1):								
Calculated gain of U201-U215 in Step 8:								

I.II.II. Check over-voltage detection circuits:

1. Check U409 (NOR IC) signal:
 1. Connect DMM probe to pin 13 (VOLTS_GOOD) on U409 & RTN Test Point.
 2. Make sure all over-voltage power supply voltages are adjusted to their nominal levels.
 1. +3.40 volts for +3.3vd.
 2. +5.10 volts for +5vd.
 3. +5.10 volts for +5va.
 4. -5.10 volts for -5va.
 5. +15.10 volts for +15va.
 6. -15.10 volts for -15va.
 7. -28.10 volts for -28va.
 8. +48.10 volts for +48va.
 3. Adjust each over-voltage power supply voltage up through the trip point & take measurement of U409, pin 13 with the DMM.
 1. DMM probe should show a low signal (0v,) when any input voltage is above trip point & a high signal (+5.0v) when all input voltages are below the trip point.
 4. After each over-voltage is tested, adjust all over-voltage power supply voltages below the trip point.



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NOTE: Turn pot adjustment screws clockwise to send an Alert at a lower voltage.

Slot # on Vicor Supply:	#2	#1	#8	#7	#6	#5	#4	#3
	+3.3VD	+5VD	+5VA	-5VA	+15VA	-15VA	-28VA	+48VA
TO CHECK:	U401/ U205	U402/ U201	U403/ U202	U404/ U206	U405/ U203	U406/ U207	U407/ U204	U408/ U208
USE U409	PIN 4	PIN 3	PIN 9	PIN 12	PIN 2	PIN 5	PIN 11	PIN 10
Over-Voltage Trip Voltage:								
Under-Voltage Trip Voltage:								

2. Check U102, over-voltage relay circuit or 'Volts_Good' signal (ICC schematic page 1):
 1. Connect DMM to pin 1 of U102 (Volts_Good) & RTN Test Point.
 2. Adjust one of the voltages on the over-voltage power supply to cause an over-voltage fault.
 3. Measure voltage at pin 1 of U102.
 1. Voltage should be around 1.115 volts when the relay is on (or there is **NOT** an over-voltage Condition).

U102 is working?: _____

I.III. Temperature Sensor Test:

I.III.I. Check ICC temperature sensor circuit :

1. Measure ambient air temperature.
2. Use DMM to measure output voltage on pin 2 of U801.
 1. Where $V_{out} = (10\text{mv}/^{\circ}\text{C}) + 500\text{mv}$ or $T_{out} = (V_{out} - 500\text{mv})/(10\text{mv})$.
 2. Voltage should be around 750mv @ 25°C.

Ambient air temperature: _____ °C Measured Vout: _____.

Calculated air temperature(Ct): where, $Ct = (V_{out} - 500\text{mv})/(10\text{mv})$ °C

U801 working properly?: _____.

I.IV. Humidity Sensor Test:

I.IV.I. Check ICC humidity sensor circuit:

1. Measure relative humidity of ambient air.
2. Connect DMM to pin 1 of H1.
3. Measure voltage
 1. @ 25°C, where 100%RH = 1000mv or 1%RH = 10mv, So use formula:
 $RH(\%) = (V_{out})/(10\text{mv})$.
 2. Example: $V_{out}=265\text{mv}$; $V_{out}/10\text{mv} = 26.5\%$ RH.
4. Compare RH in air vs. measured RH of H101.

Relative humidity in air: _____ % Measured Vout: _____.

Calculated % Relative Humidity(RH): where, $RH = (V_{out})/10\text{mv}$ %
 _____ % H101 working properly: _____.



I.V. Cooling Fans RPM OK Circuit Tests:

I.V.I. Check ICC Crate cooling fan monitor circuits:

1. Check Fans #1-#4:

1. Set fan power supply to +12.0 volts, then set to standby/off.
2. Connect fan power supply to Fan RPM Test Board.
3. Connect Fan RPM Test Board signals to ICC Board Fan RPM OK signals for fans #1-4.
4. Check FAN #1 signal:
 1. Connect Fan #1 to Fan RPM Test Board.
 2. Connect DMM probe to FAN1-OK & RTN Test Points.
 3. Turn on fan power supply.
 1. Fan should start rotating.
 4. Turn on ICC power supply.
 1. DMM probe signal should be **high** (+3.3v) during normal fan operation indicating **NO** Fan#1 RPM Fault is present.
 5. Slow test fan manually until probe signal goes low.
 6. Use DMM connected to VLTS/RTN Test Points to check that voltage is approx. 2.4V.
5. Check FAN #2 signal:
 1. Connect Fan #2 to Fan RPM Test Board.
 2. Connect DMM probe to FAN2-OK & RTN Test Points.
 3. Turn on fan power supply.
 1. Fan should start rotating.
 4. Turn on ICC power supply.
 1. DMM probe signal should be high during normal fan operation.
 5. Slow test fan manually until probe signal goes low.
 6. Use DMM connected to VLTS/RTN Test Points to check that voltage is approx. 2.4V.
6. Check FAN #3 signal:
 1. Connect Fan #3 to Fan RPM Test Board.
 2. Connect DMM probe to FAN3-OK & RTN Test Points.
 3. Turn on fan power supply.
 1. Fan should start rotating.
 4. Turn on ICC power supply.
 1. DMM probe signal should be high during normal fan operation.
 5. Slow test fan manually until probe signal goes low.
 6. Use DMM connected to VLTS/RTN Test Points to check that voltage is approx. 2.4V.
7. Check FAN #4 signal:
 1. Connect Fan #4 to Fan RPM Test Board.
 2. Connect DMM probe to FAN4-OK & RTN Test Points.
 3. Turn on fan power supply.
 1. Fan should start rotating.
 4. Turn on ICC power supply.
 1. DMM probe signal should be high during normal fan operation.
 5. Slow test fan manually until probe signal goes low.
 6. Use DMM connected to VLTS/RTN Test Points to check that voltage is approx. 2.4V.



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2. Check Fans #5-#8:

1. Set fan power supply to +12.0 volts, then set to standby/off.
2. Connect fan power supply to Fan RPM Test Board.
3. Connect Fan RPM Test Board signals to ICC Board Fan RPM OK signals for fans #5-8.
4. Check FAN #5 signal:
 1. Connect Fan #5 to Fan RPM Test Board.
 2. Connect DMM probe to FAN5-OK & RTN Test Points.
 3. Turn on fan power supply.
 1. Fan should start rotating.
 4. Turn on ICC power supply.
 1. DMM probe signal should be high during normal fan operation indicating No Fan#5 RPM Fault is present.
 5. Slow test fan manually until probe signal goes low.
 6. Use DMM connected to VLTS/RTN Test Points to check that voltage is approx. 2.4V.
5. Check FAN #6 signal:
 1. Connect Fan #6 to Fan RPM Test Board.
 2. Connect DMM probe to FAN6-OK & RTN Test Points.
 3. Turn on fan power supply.
 1. Fan should start rotating.
 4. Turn on ICC power supply.
 1. DMM probe signal should be high during normal fan operation.
 5. Slow test fan manually until probe signal goes low.
 6. Use DMM connected to VLTS/RTN Test Points to check that voltage is approx. 2.4V.
6. Check FAN #7 signal:
 1. Connect Fan #7 to Fan RPM Test Board.
 2. Connect DMM probe to FAN7-OK & RTN Test Points.
 3. Turn on fan power supply.
 1. Fan should start rotating.
 4. Turn on ICC power supply.
 1. DMM probe signal should be high during normal fan operation.
 5. Slow test fan manually until probe signal goes low.
 6. Use DMM connected to VLTS/RTN Test Points to check that voltage is approx. 2.4V.
7. Check FAN #8 signal:
 1. Connect Fan #8 to Fan RPM Test Board.
 2. Connect DMM probe to FAN8-OK & RTN Test Points.
 3. Turn on fan power supply.
 1. Fan should start rotating.
 4. Turn on ICC power supply.
 1. DMM probe signal should be high during normal fan operation.
 5. Slow test fan manually until probe signal goes low.
 6. Use DMM connected to VLTS/RTN Test Points to check that voltage is approx. 2.4V.



I.V.II. Check Vicor Fan RPM OK relay circuit:

1. Check Vicor Fan RPM:

1. Connect Vicor Fan RPM Test Board to P109, ICC Board Vicor Fan RPM OK signals for the Vicor cooling fan.
2. Set SW901 to ON to enable the Vicor Fan RPM OK circuit.
3. Connect DMM probe to V-FAN OK & RTN Test Points.
4. Adjust Vicor fan to an RPM Alert condition.
5. Measure voltage at pin 1 of U104.
 1. Voltage should be around 1.115 volts when the relay is on (or there is **NOT** a Vicor Fan alert condition).
6. Set SW901 to OFF to disable the Vicor Fan RPM OK circuit.
7. Disconnect Vicor Fan RPM Test Board from P109, ICC Board Vicor Fan RPM OK signals for the Vicor cooling fan.
8. . Measure voltage at pin 1 of U104.
 1. Voltage should be around 1.115 volts when the relay is on (or the Fan RPM relay circuit is disabled).

Does SW901 Work? _____

NOTE: Turn POT adjusting screw Counter-Clockwise to cause an alert at a lower RPM.

ICC Board Connector	P110				P111				P109
	Fan#1	Fan#2	Fan#3	Fan#4	Fan#5	Fan#6	Fan#7	Fan#8	Vicor Fan
Fan circuit working?									

II. FUNCTIONAL TESTS USING LABVIEW TEST BENCH CODE:

These tests will test the microprocessor code ‘ICCMain.c’, as well as the circuits directly connected to the microprocessor. Labview project, FPGA_ICC-ICSInterface.lvproj, which is located in folder: Production ICC-ICS Interface V4-6-1 is used for testing.

II.I.I. Install firmware:

1. Build ‘ICCMain.c’ from within the MPLAB IDE environment.
2. Program PIC24FJ128GA010 with the ICD2 programmer.

II.I.II. Check SPI communication:

1. Run Labview testbench code: Production ICC-ICS Interface V4-6-1.
2. Run firmware on ICC board.

Communicate with 1 ICC Board? _____
Communicate with 4 ICC Boards? _____



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II.I.III. Mount ICC board:

ICC Board Mounted? _____

II.I.V. Check DHE_SYS_OK_OUT:

DHE_SYS_OK_OUT OK? _____

II.I.VI. Check NO_FAULTS Signal:

NO_FAULTS OK? _____

II.I.VII. Check GEN_SHUTDOWN Signal:

GEN_SHUTDOWN OK? _____

II.I.VIII. Check Power Up/Down Sequencing:

Power Up/Down Seq. OK? _____

II.I. IX. Check OK_PWR_UP Signal:

OK_PWR_UP OK? _____

II.I.X. Check Volts_Good Signal:

Volts_Good OK? _____

II.I.XI. Check NVRAM Memory :

NVRAM is reading/writing properly? _____

II.I. XII. Check OV LEDs :

Is OV LEDs Working? _____

II.I. XIII. Check Mech. Temp. Switches :

Are Temp Switches Working? _____

II.I. XIV. Check Fan RPM Fault Clearing :

Fan faults cleared OK? _____



II.II. Calculate calibration constant for each measured voltage:

1. For each voltage in ADCValueArray:
 1. Use DMM to measure Vicor power supply voltage.
 2. Use DMM to measure ADC voltage on ICC board.
 3. Set a breakpoint in ICCMain.c to look at the adc value.
 4. Write the adc count value down, then repeat again until the correct adc count value is evaluated.
 5. Calculate calibration constant by dividing the evaluated adc count from the Vicor supply voltage. Ie $5001/2492 = 2.0068$
 6. Insert the new calibration constants into ICCMain.c.

NOTE: The top end of the ADC count is 3296mv.

ADCValueArray	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[9]
Ref. Designator	U206	U205	U202	U203	U208	U204	U207	U201
	-5va	+3.3vd	+5va	+15va	+48va	-28va	-15va	+5vd
Vicor Power Supply Voltage								
ADC Voltage								
ADC Counts								



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II.III. Check Firmware as DAQ & Heater Crate:

II.III.I. Test SW401 (OV DISABLE) & SW700 (FIRM SW):

1. If ICC board is to be used in DAQ Crate:
 1. Set SW700 to CCD DAQ Firmware.
 2. Leave all switches on SW401 turned off to enable all voltage alerts.
 3. No other testing is needed.
2. If ICC board is to be used in Heater Controller Crate:
 1. Set SW700 to Heater Controller Firmware.
 2. Leave switches turned off to enable 4 +/-15 volt power supplies & n_Shutdown signal (+5VA) alerts.
 3. Turn on (close) switches to disable all unused voltage alerts: +5VD, +3.3VD, & -5VA.
 4. Check disabled alert signals going to U409 inputs:
 1. Connect probe to +5VD, +3.3VD, & -5VA alert inputs on U409.
 2. All input signals should remain low.