Project Flight

Hardware Evaluation

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You wanna tempt the wrath of the whatever from high atop the thing?

It is better to be lucky. But I would rather be exact. Then when luck comes, you are ready.

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Contents

Chapter 1

Kestrel Tests

1.1 Sensor Tests

Test Name: **Light - Basic**

DUT: **Kestrel v____**
VEML3328

Equipment Used:

SQ-500-SS, SP-212

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:
Place system level on horizontal surface directly adjacent to sensor for comparison. Make sure uniform light is applied to both test sensor and Kestel board. Do **not** use cover for Kestrel board logger box. Record data using Serial Demo test script.
Note: Estimate solar using $EstimatedSolar = Ambient \times 0.0079[W/m^2]$

Measurements:
Indoor Test:

- **Clear:** __________ $\mu W/cm^2$
- **Red:** __________ $\mu W/cm^2$
- **Green:** __________ $\mu W/cm^2$

- **Blue:** ___________ $\mu W/cm^2$
- **Ambient:** ___________ lx
- **Estimated Solar:** ___________ W/m^2 (N/A if testing indoors)

Meter Readings:

- **SQ-500-SS Output:** ___________ mV
- **SP-212 Output:** ___________ mV

Outdoor Test:

- **Clear:** ___________ $\mu W/cm^2$
- **Red:** ___________ $\mu W/cm^2$
- **Green:** ___________ $\mu W/cm^2$
- **Blue:** ___________ $\mu W/cm^2$
- **Ambient:** ___________ lx
- **Estimated Solar:** ___________ W/m^2 (N/A if testing indoors)

Meter Readings:

- **SQ-500-SS Output:** ___________ mV
- **SP-212 Output:** ___________ mV

Pass: _____ Fail: _____ Initial: ___________ Date: ___/___/_____

Test Name: **Mag - Basic**

DUT: **Kestrel v____**
MMC5633

Equipment Used:

SUUNTO A-30

Conditions:

Tester:

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Procedure:

Place system level on horizontal surface with compass placed parallel to the body of the logger box. Rotate the box through the various general positions, recording simultaneous readings of the MMC5633 with the Serial Demo program and manually viewing the reading from the compass.

Measurements:

- **North:** ___________ °
- **North-East:** ___________ °
- **East:** ___________ °
- **South-East:** ___________ °
- **South:** ___________ °
- **South-West:** ___________ °
- **West:** ___________ °
- **North-West:** ___________ °

Meter Readings:

- **North:** ___________ °
- **North-East:** ___________ °
- **East:** ___________ °
- **South-East:** ___________ °
- **South:** ___________ °

- **South-West:** ___________ °
- **West:** ___________ °
- **North-West:** ___________ °

Result:

- **North Error:** ___________ °
- **North-East Error:** ___________ °
- **East Error:** ___________ °
- **South-East Error:** ___________ °
- **South Error:** ___________ °
- **South-West Error:** ___________ °
- **West Error:** ___________ °
- **North-West Error:** ___________ °

Pass: _____ Fail: _____ Initial: ___________ Date: ___/___/_____

Test Name: **Accel - Basic**

DUT: **Kestrel v____**

MXC6655

Equipment Used:

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Place system level on horizontal surface (measure offset with level), proceed to place logger box on all faces and measure the recorded values of the 3 axis of the accelerometer output using the serial demo interface. All errors should be within 5%.

Measurements:

Offsets X: __________ g Y: __________ g Z: __________ g

Face A X: __________ g Y: __________ g Z: __________ g

Face B X: __________ g Y: __________ g Z: __________ g

Face C X: __________ g Y: __________ g Z: __________ g

Face D X: __________ g Y: __________ g Z: __________ g

Face E X: __________ g Y: __________ g Z: __________ g

Face F X: __________ g Y: __________ g Z: __________ g

Pass: _____ Fail: _____ Initial: __________ Date: ___/___/_____

Test Name: **Atmospheric**

DUT: **Kestrel v____**
SHT40

Equipment Used:

Temtop M2000

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Place system in logger box with top open directly adjacent to the ground truth sensor. Allow both systems to acclimate for 15 minutes before taking measurements using the Serial Demo program.
Use the Temptop M2000 for RH measurements. For temperature measurements - place thermocouple of DMM in contact with die of sensor, record measurement.

Measurements:

- **Temperature:** __________ °C
- **Relative Humidity:** __________ %

Meter Readings:

- **Temperature:** __________ °C
- **Relative Humidity:** __________ %

Result:

- **Temperature Error:** __________ °C, __________ % FSR
- **Relative Humidity Error:** __________ %

Pass: _____ Fail: _____ Initial: __________ Date: ___/___/_____

Test Name: **CSA - Basic**

DUT: **Kestrel v____**

PAC1934

Equipment Used:

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

For voltage measurements, measure between the high side of the current sense resistor in question and the common GND test point. Make internal measurements using the Serial Demo test program, make meter measurements using most accurate DMM available. For current measurements, place the meter in series on the specified port (either battery or solar).
Tests should be performed with nominal solar voltage and current (6.5V, 0.5A) and nominal battery pack connected (3.7V)

Measurements:

Voltage:

- **Bat:** ______________ *V*
- **Sys:** ______________ *V*
- **VBus:** ______________ *V*
- **Solar:** ______________ *V*
- **VBulk:** ______________ *V*
- **3v3 Core:** ______________ *V*
- **3v3 Aux:** ______________ *V*
- **3v3 Bulk:** ______________ *V*

Current:

- **Bat:** ______________ *V*
- **Solar:** ______________ *V*

Meter Readings:

Voltage:

- **Bat:** ______________ *V*

- **Sys:** ________________ V
- **VBus:** ________________ V
- **Solar:** ________________ V
- **VBulk:** ________________ V
- **3v3 Core:** ________________ V
- **3v3 Aux:** ________________ V
- **3v3 Bulk:** ________________ V

Current:

- **Bat:** ________________ mA
- **Solar:** ________________ mA

Result:

Voltage:

- **Bat Error:** ________________ mV, __________ % FSR
- **Sys Error:** ________________ mV, __________ % FSR
- **VBus Error:** ________________ mV, __________ % FSR
- **Solar Error:** ________________ mV, __________ % FSR
- **VBulk Error:** ________________ mV, __________ % FSR
- **3v3 Core Error:** ________________ mV, __________ % FSR
- **3v3 Aux Error:** ________________ mV, __________ % FSR
- **3v3 Bulk Error:** ________________ mV, __________ % FSR

Current:

- **Bat Error:** ________________ mA, __________ % FSR
- **Solar Error:** ________________ mA, __________ % FSR

Pass: _____ Fail: _____ Initial: __________ Date: ___/___/_____

Test Name: **GPS - Location**

DUT: **Kestrel v____**
MAX-M8W

Equipment Used:

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Place system in logger box with antennas attached to mounting plate. Place outside in clear sky with 15 minutes along with comparative sensor. After this time, get measurement info via the Serial Demo interface.

Measurements:

- **Latitude:** ____________________ °
- **Longitude:** ____________________ °
- **SIV:** __________
- **PDOP:** __________ m
- **Time:** ____________________ UTC

Meter Readings:

- **Latitude:** ____________________ °
- **Longitude:** ____________________ °
- **SIV:** __________
- **PDOP:** __________ m
- **Time:** ____________________ UTC

Pass: _____ Fail: _____ Initial: __________ Date: ___/___/_____

Test Name: **GPS - Startup Time**

DUT: **Kestrel v____**
MAX-M8W

Equipment Used:

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

1. Use Kestrel **with GPS backup battery removed**
2. Switch system on in clear sky condition
3. Note start time
4. Poll GPS until Lat/Long is returned (**3D Fix!**)
5. Record time since start up

Repeat procedure with GPS backup battery in place. Record initial startup time with backup battery in place (**cold start**), then switch system off for 60 seconds, turn back on and record time again (**hot start**)

Measurements:

- **Cold Start, No Bat:** TTF (Time) __________ s TTF (2D) __________ s TTF (3D) __________ s
- **Cold Start, With Bat:** TTF (Time) __________ s TTF (2D) __________ s TTF (3D) __________ s
- **Hot Start:** TTF (3D) TTF (Time) __________ s TTF (2D) __________ s TTF (3D) __________ s

Pass: _____ Fail: _____ Initial: __________ Date: ___/___/_____

Test Name: **GPS - Time Base**

DUT: **Kestrel v____**
MAX-M8W

Equipment Used:

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Take measurement of RTC time compared with real computer time, then let the system run for 24 hours running on the backup RTC battery and re-connect to the system and measure the RTC time again using the Serial Demo interface and noting the drift error. Make comparison using time displayed in serial monitor.

Measurements:

- **Time RTC, First Reading:** ____________________ UTC
- **Time Computer, First Reading:** ____________________ UTC
- **Time RTC, Second Reading:** ____________________ UTC
- **Time Computer, Second Reading:** ____________________ UTC

Result:

- **Error, Start:** __________ s
- **Error, End:** __________ s
- **Drift:** __________ s

Pass: _____ Fail: _____ Initial: __________ Date: ___/___/_____

1.2 Power Tests

Test Name: **USB - Charging**

DUT: **Kestrel v____**
BQ25616

Equipment Used:

Conditions:

Tester:

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Procedure:
Connect nominal voltage (3.7V) full capacity (1S3P) battery pack to the battery input on Kestrel. Use on board CSA to measure current in both USB and battery pack. In addition, measure battery current flow manually.
Test using the following USB inputs:

- USB 3.0 Port (Anker USB port, non-charging)
- Charging Pack (Anker iQ)
- Charging Block (Anker iQ)

Confirm charging current is greater than 2A for all charging methods

Measurements:
USB 3.0 Port

- **Voltage USB:** ________________ V
- **Current USB:** ________________ A
- **Voltage Battery:** ________________ V
- **Current Battery:** ________________ A
- **Charger Efficiency:** ________________ %

Charging Pack

- **Voltage USB:** ________________ V
- **Current USB:** ________________ A
- **Voltage Battery:** ________________ V
- **Current Battery:** ________________ A

- **Charger Efficiency:** ________________ %

Charging Block

- **Voltage USB:** ________________ V
- **Current USB:** ________________ A
- **Voltage Battery:** ________________ V
- **Current Battery:** ________________ A
- **Charger Efficiency:** ________________ %

Pass: _____ Fail: _____ Initial: __________ Date: ___/___/_____

Test Name: **Solar - Charging**

DUT: **Kestrel v____**

BQ25616

Equipment Used:

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Connect nominal voltage (3.7V) full capacity (1S3P) battery pack to the battery input on Kestrel. Use on board CSA to measure current in both solar and battery pack. In addition, measure battery current flow manually along with solar voltage and current manually to confirm.

Test using the following solar inputs:

- VSolar = 5.5V, ISolar = 1A (limit)
- VSolar = 6.5V, ISolar = 2A (limit)
- VSolar = 7.5V, ISolar = 2A (limit)

Measurements:

VSolar = 5.5V

- **Voltage Solar:** _______________ V
- **Current Solar:** _______________ A
- **Voltage Battery:** _______________ V
- **Current Battery:** _______________ A
- **Charger Efficiency:** _______________ %

VSolar = 6.5V

- **Voltage Solar:** _______________ V
- **Current Solar:** _______________ A
- **Voltage Battery:** _______________ V
- **Current Battery:** _______________ A
- **Charger Efficiency:** _______________ %

VSolar = 7.5V

- **Voltage Solar:** ________________ V
- **Current Solar:** ________________ A
- **Voltage Battery:** ________________ V
- **Current Battery:** ________________ A
- **Charger Efficiency:** ________________ %

Pass: _____ Fail: _____ Initial: __________ Date: ___/___/_____

Test Name: **DC Input - Charging**

DUT: **Kestrel v____**
BQ25616

Equipment Used:

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:
Connect nominal voltage (3.7V) full capacity (1S3P) battery pack to the battery input on Kestrel. Use on board CSA to measure current in both DC input and battery pack. In addition, measure battery current flow manually along with solar voltage and current manually to confirm.
Test using the following solar inputs:

- DC Input = 12V, 0.5A (limit)
- DC Input = 12V, 1A (limit)

Measurements:
DC Input = 12V, 0.5A limit

- **Voltage DC:** ______________ V
- **Current DC:** ______________ A
- **Voltage Battery:** ______________ V
- **Current Battery:** ______________ A
- **Charger Efficiency:** ______________ %

DC Input = 12V, 1A limit

- **Voltage DC:** ______________ V
- **Current DC:** ______________ A
- **Voltage Battery:** ______________ V
- **Current Battery:** ______________ A
- **Charger Efficiency:** ______________ %

Pass: _____ Fail: _____ Initial: __________ Date: ___/___/_____

Test Name: **Battery Dropout**

DUT: **Kestrel v____**

BQ25616

Equipment Used:

Conditions:

Tester:

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Procedure:

Connect a DC power supply to the battery input of Kestrel with a current limit set to 2A or greater. Proceed with described procedure.
Start the voltage at 3.7V, enable the output of the power supply. Step the voltage down by 0.1V increments, waiting 1 second between each step. Continue this process until the bulk voltage cuts off and record this minimum voltage input.

- Set power supply voltage to 3.7V
- Enable power supply
- Step voltage down in 0.1V increments - waiting at least 1 second between steps
- Continue until bulk voltage cuts off
- Record cutoff voltage
- Set power supply voltage to 2V
- Increase voltage in 0.1V increments - waiting at least 1 second between steps
- Continue until bulk voltage starts up ($\geq$ 3.5V)
- Record startup voltage
- **Cutoff Voltage:** ________________ V
- **Startup Voltage:** ________________ V

Pass: _____ Fail: _____ Initial: ___________ Date: ___/___/_____

Test Name: **Thermal Overload - Charging**

DUT: **Kestrel v____**

BQ25616

Equipment Used:

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Connect nominal voltage (3.7V) full capacity (1S3P) battery pack to the battery input on Kestrel. Use on board CSA to measure current in both DC input and battery pack. In addition, measure battery current flow manually along with solar voltage and current manually to confirm. Place a thermocouple on the bottom of the logger board underneath the charger thermal plane (approximately 2cm in and 3.5cm up from the south-east corner of the board as referenced in the CAD drawings). Connect this with thermal paste and secure in place. Place the logger inside of the standard logger box with all openings sealed appropriately, route the DC connection and thermocouple through the solar cable gland opening in the box and seal as well as possible with butyl rubber to mimic a sealed environment.

Place the entire box in an oven heated to 40°C and wait for the thermocouple to read match this temperature. At this point begin charging at 12V with a 2A current limit. Let this charging proceed for 1 hour and measure temperature, efficiency and operation through out the process at 15 minute intervals. Ensure the device does not enter thermal shutdown during the process.

Ideally, all elements of the system should remain less 85°C, but internal box temperature **must** remain less than 85°C and the thermocouple temperature must remain less than 125°C

Measurements:

Time = 0 min

- **Voltage DC:** ________________ V
- **Current DC:** ________________ A
- **Voltage Battery:** ________________ V
- **Current Battery:** ________________ A
- **Charger Efficiency:** ________________ %
- **Thermocouple Temperature:** ____________ °C
- **Internal Box Temperature:** ____________ °C
- **Oven Temperature:** ____________ °C

Time = 15 min

- **Voltage DC:** ________________ V
- **Current DC:** ________________ A
- **Voltage Battery:** ________________ V
- **Current Battery:** ________________ A
- **Charger Efficiency:** ________________ %
- **Thermocouple Temperature:** ___________ °C
- **Internal Box Temperature:** ___________ °C
- **Oven Temperature:** ___________ °C

Time = 30 min

- **Voltage DC:** ________________ V
- **Current DC:** ________________ A
- **Voltage Battery:** ________________ V
- **Current Battery:** ________________ A
- **Charger Efficiency:** ________________ %
- **Thermocouple Temperature:** ___________ °C
- **Internal Box Temperature:** ___________ °C
- **Oven Temperature:** ___________ °C

Time = 45 min

- **Voltage DC:** ________________ V
- **Current DC:** ________________ A
- **Voltage Battery:** ________________ V
- **Current Battery:** ________________ A
- **Charger Efficiency:** ________________ %
- **Thermocouple Temperature:** ___________ °C
- **Internal Box Temperature:** ___________ °C
- **Oven Temperature:** ___________ °C

Time = 60 min

- **Voltage DC:** ________________ V
- **Current DC:** ________________ A
- **Voltage Battery:** ________________ V
- **Current Battery:** ________________ A
- **Charger Efficiency:** ________________ %

- **Thermocouple Temperature:** ___________ °C
- **Internal Box Temperature:** ___________ °C
- **Oven Temperature:** ___________ °C

Pass: _____ Fail: _____ Initial: ___________ Date: ___/___/_____

Test Name: **Backup Battery**

DUT: **Kestrel v____**

BQ25616

Equipment Used:

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

This test requires the removal of the ORing (`D4` on Kestrel v1.4) and series diode (`D14` on Kestrel v1.4) in various configurations. Then applying a simulated (DC power supply) backup battery voltage to the rail to measure the current draw. In addition, for some tests the system will need to be initialized and placed into sleep mode.
For each test, the same set of data will be measured. This consists of: Battery current with external power enabled (but system in sleep mode), battery current with external power disabled.
For each test, remove the appropriate components and apply a battery backup voltage (3.1V) to the specified voltage rail (**with backup battery removed**) with a DMM in series to measure the current draw. For the final test, replace all components and attach a discharged battery (again with DMM in series) to measure the charge current.
Connect power supply to Kestrel main battery at 3.7V
Take Kestrel with **backup battery removed** and test for the following:

OR and Series Removed (GPS Current):

- Apply 3.1V from a power supply to the `BCKP_GPS` rail, measure current when device in shutdown
- Repeat previous test with main system battery disconnected

OR and Series Removed (RTC Current):

- Apply 3.1V from a power supply to the `BCKP_RTC` rail, measure current when device in shutdown
- Repeat previous test with main system battery disconnected

Series Removed (Combined Current):

- Apply 3.1V from a power supply to the `BCKP_GPS` rail, measure current when device in shutdown
- Repeat previous test with main system battery disconnected

Short the backup battery terminals and measure the max current flow

Connect discharged battery to backup battery terminals and measure the current flow

Measurements:
DC Input = 12V, 0.5A limit

GPS Current

- **Battery Current, with ext bat:** ________________ μA
- **Battery Current, no ext bat:** ________________ μA

RTC Current

- **Battery Current, with ext bat:** ________________ μA
- **Battery Current, no ext bat:** ________________ μA

Combined Current

- **Battery Current, with ext bat:** ________________ μA
- **Battery Current, no ext bat:** ________________ μA

Battery Charge Current

Short Circuit Current: ________________ μA

Battery Starting Voltage: ________________ V

Battery Charge Current: ________________ μA

Pass: _____ Fail: _____ Initial: __________ Date: ___/___/_____

Test Name: **Bulk Rail Switching**

DUT: **Kestrel v____**

Equipment Used:

Conditions:

Tester:

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Procedure:

Connect a DC power supply to the battery input of Kestrel with a current limit set to 2A or greater. Proceed with described procedure.
This test is to ensure the correct and error free switch over for the `3V3_TALON` rail.
During switching, minimum voltage must not fall below 2.805V (15% Error).
Initial Load: 50mA (68Ω)

- Apply load to an output port
- Enable the `3V3_AUX_EN` line to turn on high power output
- Enable output port to load
- Measure voltage at load using scope, set to measure min voltage
- Disable the `3V3_AUX_EN` line to switch the output to use the low power 3.3V rail
- Record minimum voltage
- Enable the `3V3_AUX_EN` line to switch the output to use the high power 3.3V rail
- Record minimum voltage

Repeat process with 125mA (125% of max load, 27Ω)

Measurements:

Normal Load:

- **Output Voltage (`3V3_AUX_EN` ON):** ________________ V
- **Minimum Voltage During Switch (High → Low):** ________________ V
- **Output Voltage (`3V3_AUX_EN` OFF):** ________________ V
- **Minimum Voltage During Switch (Low → High):** ________________ V

Excess Load:

- **Output Voltage (`3V3_AUX_EN` ON):** ________________ V
- **Time To Trip:** ________________ ms

Pass: _____ Fail: _____ Initial: ___________ Date: ___/___/_____

1.3 Talon Interface Tests

Test Name: **Talon Interface - Signal**

DUT: **Kestrel v____**

Equipment Used:

Conditions:

Tester:

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Procedure:

Setup Kestrel powered via USB and running Serial Demo interface. Read output of a given Talon port using oscilloscope (for cross talk) and using logic analyzer (for more general measurement).
Perform the following steps to test the isolation the signal lines of the Talon ports:

- Turn on power to just port being measured
- Set `SELx` pin for given port **HIGH** in order to connect UART to output
- Set `TALONx_GPIOA` and `TALONx_GPIOB` as **OUTPUT** and drive **LOW**
- Send serial message at 115200 baud rate. Ensure correct reception at output (correct conversion by logic analyzer) **- Test ALPHA**
- Set `TALONx_GPIOA` and `TALONx_GPIOB` as **OUTPUT** and drive **HIGH**
- Send serial message at 115200 baud rate. Ensure correct reception at output (correct conversion by logic analyzer) **- Test BETA**
- Set `SELx` pin for given port **LOW** in order to connect GPIO to output
- Set `TALONx_GPIOA` and `TALONx_GPIOB` as **INPUT**
- Send serial message at 115200 baud rate. Measure cross talk from serial lines on output and absolute value of disturbed signal **- Measure 1**
- Set `TALONx_GPIOA` as **OUTPUT**
- Set PWM signal on `TALONx_GPIOA`, confirm output correctness, measure cross talk on GPIOB output and absolute value of disturbed signal **- Test GAMMA**, **Measure 2**
- Set `TALONx_GPIOB` as **OUTPUT**, set `TALONx_GPIOA` as **INPUT**
- Set PWM signal on `TALONx_GPIOB`, confirm output correctness, measure cross talk on GPIOA output and absolute value of disturbed signal **- Test DELTA**, **Measure 3**

- Turn on power to all ports
- Set `SELx` pin for given port **HIGH** in order to connect UART to output
- Set `TALONx_GPIOA` and `TALONx_GPIOB` as **OUTPUT** and drive **LOW**
- Send serial message at 115200 baud rate. Ensure correct reception at output (correct conversion by logic analyzer) **- Test EPSILON**
- Set `TALONx_GPIOA` and `TALONx_GPIOB` as **OUTPUT** and drive **HIGH**
- Send serial message at 115200 baud rate. Ensure correct reception at output (correct conversion by logic analyzer) **- Test ZETA**
- Turn power off on given port, leave on for all other ports
- Set `SELx` pin for given port **HIGH** in order to connect UART to output
- Send serial message at 115200 baud rate. Ensure lack of signal at output, measure output amplitude **- Test ETA**, **Measure 4**
- Connect logic analyzer to different port
- Set `SELx` pin for this new port **HIGH** in order to connect UART to output
- Send serial message at 115200 baud rate. Ensure correct reception at output (correct conversion by logic analyzer) **- Test THETA**

Measurements:

Signal Tests

- **ALPHA -** Pass: ______ Fail: ______
- **BETA -** Pass: ______ Fail: ______
- **GAMMA -** Pass: ______ Fail: ______
- **DELTA -** Pass: ______ Fail: ______
- **EPSILON -** Pass: ______ Fail: ______
- **ZETA -** Pass: ______ Fail: ______
- **ETA -** Pass: ______ Fail: ______
- **THETA -** Pass: ______ Fail: ______

Signal Measures

- **Measure 1:** ______________ dB ______________ mV
- **Measure 2:** ______________ dB ______________ mV
- **Measure 3:** ______________ dB ______________ mV
- **Measure 4:** ______________ mV

Pass: ______ Fail: ______ Initial: __________ Date: ___/___/_____

1.4 General Tests

Test Name: **General Tests - Data Storage**

DUT: **Kestrel v____**

SD,FRAM,RTC(EEPROM)

Equipment Used:

Conditions:

Tester:

Name: ____________	Sign: ____________
Name: ____________	Sign: ____________
Name: ____________	Sign: ____________

Procedure:

Connect Kestrel logger to computer using USB and have no other power source connected (as this is the most volatile anyway.

SD: Using the Serial Demo interface

- Install SD card (SanDisk Ultra 16GB Class 10, A1)
- Write to SD and measure the frequency of `SCK` line
- Power cycle system (by switching USB power on and off) 10 times - turning off power, then waiting 30 seconds, then turning power back on
- Read from SD, verify correct data
- Perform random Read/Write cycle 10 times (no power cycle) and verify results - must be no fails
- Shut off power to SD card by driving `3V3_SD_EN` **LOW**
- Verify state of this pin with DMM
- Read voltage on `3V3_SD` rail, **ensure it is less than 100mV**
- Read card detection switch (verify pin state is **LOW**)
- Push SD card to unlatch the card from the holder, **but do not fully remove the card**! Leave at the partially inserted position.
- Read card detection switch (verify pin state is **HIGH**)
- Remove SD card fully
- Read card detection switch (verify pin state is **HIGH**)

FRAM: Using the Serial Demo interface

- Write test data to FRAM and measure the frequency of `SCL` line

- Power cycle system (by switching USB power on and off) 10 times - turning off power, then waiting 30 seconds, then turning power back on
- Read from FRAM, verify correct data
- Perform random Read/Write cycle 10 times (no power cycle) and verify results - must be no fails

RTC: Using the Serial Demo interface

- Write test data to RTC EEPROM and measure the frequency of `SCL` line
- Power cycle system (by switching USB power on and off) 10 times - turning off power, then waiting 30 seconds, then turning power back on
- Read from EEPROM, verify correct data
- Perform random Read/Write cycle 10 times (no power cycle) and verify results - must be no fails
- Read UUID from EEPROM
- Read RTC Clock frequency - should be 32.768kHz $\pm$ 100ppm at worst

Measurements:

- **SD Write -** Pass: ______ Fail: ______
- **SD High Speed Write -** Pass: ______ Fail: ______
- **SD Read -** Pass: ______ Fail: ______
- **SD R/W Repeat -** Pass: ______ Fail: ______
- **SD Power Off -** Pass: ______ Fail: ______
- **SD Card Detect (inserted) -** Pass: ______ Fail: ______
- **SD Card Detect (semi-removed) -** Pass: ______ Fail: ______
- **SD Card Detect (removed) -** Pass: ______ Fail: ______
- **FRAM Write -** Pass: ______ Fail: ______
- **FRAM High Speed Write -** Pass: ______ Fail: ______
- **FRAM Read -** Pass: ______ Fail: ______
- **FRAM R/W Repeat -** Pass: ______ Fail: ______
- **RTC Mem Write -** Pass: ______ Fail: ______
- **RTC Mem Write Speed -** Pass: ______ Fail: ______
- **RTC Mem Read -** Pass: ______ Fail: ______
- **RTC Mem R/W Repeat -** Pass: ______ Fail: ______
- **RTC UUID Read -** Pass: ______ Fail: ______
- **RTC Clock Freq -** Pass: ______ Fail: ______

Meter Readings:

- **SD SCK Freq:** __________ MHz

- **3V3 SD Off Voltage:** ____________________ mV
- **FRAM SCL Freq:** _____________ MHz
- **RTC Clock Freq:** _____________ kHz **Error:** _____________ ppm

Pass: ______ Fail: ______ Initial: _____________ Date: ___/___/______

Test Name: **General Tests - Human Interface**

DUT: **Kestrel v____**

Equipment Used:

Conditions:

Tester:

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Procedure:

Connect Kestrel logger to computer using USB and have no other power source connected (as this is the most volatile anyway.

Perform the following tasks to confirm the operation of the Safe-Mode circuit as well as the physical button interface

- Reset the logger (depress the reset button for 1 second, then release)
- Place the logger into listening mode (depress the mode button for > 10 seconds, then release)
- Place the logger in safe mode using buttons (depress both **mode** and **reset** buttons, then release **reset** button. Hold **mode** button down until particle light blinks purple, then remove)
- Place the logger into DFU mode using buttons (depress both **mode** and **reset** buttons, then release **reset** button. Hold **mode** button down until particle light blinks yellow, then remove)
- Place the logger into factory reset mode using buttons (depress both **mode** and **reset** buttons, then release **reset** button. Hold **mode** button down until particle light blinks white, then remove)
- Reset the logger using magnetic wand (hold the wand against box until particle light goes out, then remove)
- Place the logger in safe mode using magnetic wand (hold the wand against the box until particle light blinks purple, then remove)
- Place the logger into DFU mode using magnetic wand (hold the wand against the box until particle light blinks yellow, then remove)
- Place the logger into factory reset mode using magnetic wand (hold the wand against the box until particle light blinks white, then remove)

Note: Magnet to be used - 1/4" x 1/16" neodymium disk, McMaster PN: 5862K141

Measurements:

- **Reset, Manual -** Pass: ______ Fail: ______

- **Listening Mode -** Pass: ______ Fail: ______
- **Safe Mode, Manual -** Pass: ______ Fail: ______
- **DFU Mode, Manual -** Pass: ______ Fail: ______
- **Factory Reset, Manual -** Pass: ______ Fail: ______
- **Reset, Wand -** Pass: ______ Fail: ______
- **Safe Mode, Wand -** Pass: ______ Fail: ______
- **DFU Mode, Wand -** Pass: ______ Fail: ______
- **Factory Reset Mode, Wand -** Pass: ______ Fail: ______

Pass: ______ Fail: ______ Initial: __________ Date: ___/___/_____

Test Name: **General Tests - On Board Control**

DUT: **Kestrel v____**

Equipment Used:

Conditions:

Tester:

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Procedure:

Connect Kestrel logger to computer using USB and have no other power source connected (as this is the most volatile anyway).

- Measure period of **PWR** LED blinking and record, ensure it is within specified range
- Measure period of **WDT** pulse, setup to capture time between pulses (use Serial Demo firmware so that `WDT_DONE` is not trigger
- Pulse `WDT_DONE` **HIGH** once every 60 minutes (can also be done using Serial Demo) and ensure that the WDT does not trigger when this is done
- Confirm communication with IO expanders by toggling a pin on each and verifying with manual reading
- Set a given output pin on the IO expanders to be driven **LOW**, then reset the logger and confirm this pin returns to the default **INPUT_PULLUP** state
- Configure IO expander to trigger an interrupt output for a given pin (easiest pins would likely be `SD_CD` and `/FAULTx` for the given expanders. Then cause each of these pins to toggle and manually observe the state change of the interrupt line.
- Record state of voltage rails when reset by WDT. Record the minimum values for these rails to ensure a correct power down

Measurements:

- **PWR LED Period Good -** Pass: ______ Fail: ______
- **WDT Period Good -** Pass: ______ Fail: ______
- **WDT Quiet -** Pass: ______ Fail: ______
- **IO Exp Interface -** Pass: ______ Fail: ______
- **IO Exp Reset -** Pass: ______ Fail: ______

- **IO Exp Interrupt -** Pass: ______ Fail: ______

Meter Readings:

- **PWR LED Period:** __________ s
- **WDT Period:** __________ s

Pass: ______ Fail: ______ Initial: __________ Date: ___/___/_____

Test Name: **General Tests - Power Switch**

DUT: **Kestrel v____**

Equipment Used:

Conditions:

Tester:

Name: ________________________ Sign: ________________________

Name: ________________________ Sign: ________________________

Name: ________________________ Sign: ________________________

Procedure:

Power Kestrel logger via power supply (3.7V) connected to battery port, use this to measure current into the system. Apply 6.5V to solar input to have external power applied as well.

- Place switch in **OFF** position, measure current into logger, confirm system power. Measure all voltage rails
- Place switch in **TEST** position, measure voltage on `TEST` line, confirm system power
- Place switch in **ON** position, measure current into logger, confirm system power

Measurements:

- **System power in OFF state -** Pass: ______ Fail: ______
- **System power in TEST state -** Pass: ______ Fail: ______
- **System power in ON state -** Pass: ______ Fail: ______

Meter Readings:

- **Off Current:** ________________ μA
- **TEST Voltage:** ________________ mV
- **SYS:** ________________ mV
- **BAT_CHG:** ________________ mV
- **VBULK:** ________________ mV
- **3V3_BULK:** ________________ mV
- **3V3_AUX:** ________________ mV

- **3V3_CORE:** ________________ mV
- **VPRIME:** ________________ mV
- **VSOLAR:** ________________ mV

Pass: _____ Fail: _____ Initial: __________ Date: ___/___/_____

Test Name: **Cell Power Limit**

DUT: **Kestrel v____**

Equipment Used:

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Battery Input Test:

Connect a DC power supply to the battery input of Kestrel with a current limit set to 2A or greater. Set voltage to 2.7V, attempt to connect via cellular to cloud. Confirm operation.

USB Input Test:

Connect USB power only (USB 2.0 Port) and attempt to connect via cellular to cloud. Confirm operation.

Result:

- **Battery Input Test -** Pass: _____ Fail: _____
- **USB Input Test -** Pass: _____ Fail: _____

Pass: _____ Fail: _____ Initial: __________ Date: __/__/____

Test Name: **Sleep Current Measure**

DUT: **Kestrel v____**

Equipment Used:

Conditions:

Tester:

Name: ______________________	Sign: ______________________
Name: ______________________	Sign: ______________________
Name: ______________________	Sign: ______________________

Procedure:

Run demo sleep firmware (**make sure to note version which was run**) and record sleep current from battery input (at 3.7V). This current must be less than **1mA** for device to pass.

Configuration State:

- `3V3_AUX_EN` → **LOW**
- All Talon Power → **OFF**
- `3V3_SD_EN` → **LOW**
- `LED_EN` → **LOW**
- `CSA_EN` → **LOW**
- FRAM → **Software Shutdown**
- Accel → **Software Shutdown**
- System Controller → `ULTRA_LOW_POWER`

Result:

- **Sleep Current:** ________________ μA

Pass: _____ Fail: _____ Initial: ___________ Date: ___/___/_____

Chapter 2

Aux Talon Tests

Test Name: **Aux Talon - Analog**

DUT: **Aux Talon v____**

Equipment Used:

Kestrel v____

Conditions:

Tester:

Name: ____________________	Sign: ____________________
Name: ____________________	Sign: ____________________
Name: ____________________	Sign: ____________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.
Configure the ADC to use 2/3 gain value ($\pm 6.144V$) for max range and worst case error. Use default rate of 128 sps for data rate, no averaging.
Connect a controllable power supply to a single analog input on the Aux Talon via a **5m** cable. All manual measurements are to be made at the Talon end of the cable. DMM measurements should be made by short wires soldered to the filter caps.
Process should be repeated for each port
Voltages to apply:

Measure 1 0V

Measure 2 0.1V

Measure 3 0.25V

Measure 4 0.5V

Measure 5 1.0V

Measure 6 2.5V

Measure 7 3V

Measure 8 3.3V

Measure 9 4.5V

Measure 10 5.0V

Perform the following steps to test the analog signal measurement of the Aux Talon:

- Apply a given voltage to the input
- Measure voltage with the DMM, record
- Measure voltage with the Aux Talon interface, record
- Measure on board voltage ref with Aux Talon interface, record

Measurements:

- **Measure # - Samples:** DMM Val [mV], Talon Val [mV], Error [mV], Error [%]
- **Measure 1:** ________ mV ________ mV ________ mV ________ %
- **Measure 2:** ________ mV ________ mV ________ mV ________ %
- **Measure 3:** ________ mV ________ mV ________ mV ________ %
- **Measure 4:** ________ mV ________ mV ________ mV ________ %
- **Measure 5:** ________ mV ________ mV ________ mV ________ %
- **Measure 6:** ________ mV ________ mV ________ mV ________ %
- **Measure 7:** ________ mV ________ mV ________ mV ________ %
- **Measure 8:** ________ mV ________ mV ________ mV ________ %
- **Measure 9:** ________ mV ________ mV ________ mV ________ %
- **Measure 10:** ________ mV ________ mV ________ mV ________ %

Pass: _____ Fail: _____ Initial: __________ Date: ___/___/_____

Test Name: **Aux Talon - Analog with Noise**

DUT: **Aux Talon v____**

Equipment Used:

Kestrel v____

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.
Configure the ADC to use 2/3 gain value ($\pm 6.144V$) for max range and worst case error. Use default rate of 128 sps for data rate, no averaging.
Connect a function generator to a single analog input on the Aux Talon via a **5m** unshielded, 22 AWG cable. All manual measurements are to be made at the Talon end of the cable. DMM measurements should be made at `AIN` point for the given port.
Process should be repeated for each port
Configure function generator for the given voltage plus an addition of 100mV of white noise.
Voltages to apply:

Measure 1 0V

Measure 2 0.1V

Measure 3 0.25V

Measure 4 0.5V

Measure 5 1.0V

Measure 6 2.5V

Measure 7 3V

Measure 8 3.3V

Measure 9 4.5V

Measure 10 5.0V

Perform the following steps to test the analog signal measurement of the Aux Talon:

- Apply a given voltage to the input

- Measure voltage with the DMM, record
- Measure voltage with the Aux Talon interface, record
- Measure on board voltage ref with Aux Talon interface, record

Measurements:

- **Measure # - Samples:** DMM Val [mV], Talon Val [mV], Error [mV], Error [%]
- **Measure 1:** ________ mV ________ mV ________ mV ________ %
- **Measure 2:** ________ mV ________ mV ________ mV ________ %
- **Measure 3:** ________ mV ________ mV ________ mV ________ %
- **Measure 4:** ________ mV ________ mV ________ mV ________ %
- **Measure 5:** ________ mV ________ mV ________ mV ________ %
- **Measure 6:** ________ mV ________ mV ________ mV ________ %
- **Measure 7:** ________ mV ________ mV ________ mV ________ %
- **Measure 8:** ________ mV ________ mV ________ mV ________ %
- **Measure 9:** ________ mV ________ mV ________ mV ________ %
- **Measure 10:** ________ mV ________ mV ________ mV ________ %

Pass: _____ Fail: _____ Initial: __________ Date: ___/___/_____

Test Name: **Aux Talon - Pulse**

DUT: **Aux Talon v____**

Equipment Used:

Kestrel v____

Conditions:

Port Voltage Selected____

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.
Connect the various sensor configurations to the input of a given port on the Aux Talon. Run the test for the given period and measure the ground truth value using a DMM in frequency averaging mode (reset simultaneous to begin of sample).
For tests not using a sensor cable, connection should be made via a **5m** unshielded, 22 AWG cable.
Read values from the Talon via the Serial Demo interface. Use the time stamping in the serial monitor for timing. For each measurement, confirm a good wave form via oscilloscope at the Talon end of the cable.
Wind sensors should be driven via forced airflow to the best approximation of the desired frequency.
For square wave on OD input, use a 2N7002 transistor to drive the open drain line from the function generator input.
Process should be repeated for each port
Measurements must be within 2.5% to pass, except for all signals over 1kHz, these must only be within 5% for a pass.

POD Inputs:

OD1 - Wind Speed, Hall Effect - 25Hz, 5 min

OD2 - Wind Speed, Reed - 25Hz, 5 min

OD3 - Wind Speed, Reed - 0Hz, 5 min (confirm no error pulses)

OD4 - Square Wave (3.3V) - 1kHz, 60 sec

Digital Inputs:

D1 - Square Wave (1.8V) - 100Hz, 5 min

D2 - Square Wave (3.3V) - 100Hz, 5 min

D3 - Square Wave (5V) - 100Hz, 5 min

D4 - Square Wave (3.3V) - 1kHz, 60 sec

Perform the following steps to test the analog signal measurement of the Aux Talon:

- Apply a given signal to the given input
- Restart DMM frequency count
- Restart count with Aux Talon interface
- Wait given time
- Measure frequency from DMM, record
- Measure pulses and delta time from Aux Talon, record
- Calculate Aux Talon frequency and error

Measurements:

- **Measure:** DMM Val [Hz], Talon Val [Count], Talon Val [ms], Talon Val [Hz], Error [%]
- **OD1:** ________ Hz ________ Count ________ ms ________ Hz ________ %
- **OD2:** ________ Hz ________ Count ________ ms ________ Hz ________ %
- **OD3:** ________ Hz ________ Count ________ ms ________ Hz ________ %
- **OD4:** ________ Hz ________ Count ________ ms ________ Hz ________ %
- **D1:** ________ Hz ________ Count ________ ms ________ Hz ________ %
- **D2:** ________ Hz ________ Count ________ ms ________ Hz ________ %
- **D3:** ________ Hz ________ Count ________ ms ________ Hz ________ %
- **D4:** ________ Hz ________ Count ________ ms ________ Hz ________ %

Pass: _____ Fail: _____ Initial: __________ Date: ___/___/_____

Test Name: **Aux Talon - Power Output**

DUT: **Aux Talon v____**

Equipment Used:

Kestrel v____

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.
Connect given load to output port:

- 0mA (open)
- 10mA (3.3V - 330Ω, 5V - 510Ω)
- 50mA (3.3V - 68Ω, 5V - 100Ω)
- 100mA (3.3V - 33Ω, 5V - 47Ω)

Switch given output port on, confirm voltage present at output, record. Switch given output port off, confirm voltage present at output, record.
Test should be done with both 5V and 3.3V configuration!
Output voltages must be within 10% of spec for a pass
Final Test, load all ports with 50mA and enable them to ensure system is able to drive all at reasonable current

Measurements:

3.3V Port Tests:

- **Measure:** Voltage - ON [mV], Voltage - OFF [mV], Error [%]
- **0mA:** __________ mV __________ mV __________ %
- **10mA:** __________ mV __________ mV __________ %
- **50mA:** __________ mV __________ mV __________ %
- **100mA:** __________ mV __________ mV __________ %
- **Measure:** Port1 [mV], Port2 [mV], Port3 [mV], Error - Max [%]
- **50mA, All Ports:** __________ mV __________ mV __________ mV __________ %

5V Port Tests:

- **Measure:** Voltage - ON [mV], Voltage - OFF [mV], Error [%]
- **0mA:** ___________ mV ___________ mV ___________ %
- **10mA:** ___________ mV ___________ mV ___________ %
- **50mA:** ___________ mV ___________ mV ___________ %
- **100mA:** ___________ mV ___________ mV ___________ %
- **Measure:** Port1 [mV], Port2 [mV], Port3 [mV], Error - Max [%]
- **50mA, All Ports:** ___________ mV ___________ mV ___________ mV ___________ %

Pass: _____ Fail: _____ Initial: ___________ Date: ___/___/_____

Test Name: **Aux Talon - Power Fault**

DUT: **Aux Talon v____**

Equipment Used:

Kestrel v____

Conditions:

Tester:

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.
Two failure conditions will be used: Excess load (250mA, 125% of max hold current, 15Ω for 3.3V, 22Ω for 5V) and dead short ($< 0.2\Omega$)
We will apply the following test conditions:

FaultA Port is enabled with load applied

FaultB Load is applied to port already on

Test with both conditions and record the following:

- Confirm output disconnect
- Confirm fault flag indication
- Record time to trip

Test should be done with both 5V and 3.3V configuration!

Measurements:

3.3V Port Tests:

- **Measure:** Output Shutdown [y/n], Fault Flag Indicates [y/n], Time to Trip[ms]
- **FaultA, Excess Load:** ____ y/n ____ y/n __________ ms
- **FaultB, Excess Load:** ____ y/n ____ y/n __________ ms
- **FaultA, Dead Short:** ____ y/n ____ y/n __________ ms
- **FaultB, Dead Short:** ____ y/n ____ y/n __________ ms

5V Port Tests:

- **Measure:** Output Shutdown [y/n], Fault Flag Indicates [y/n], Time to Trip[ms]
- **FaultA, Excess Load:** ______ y/n ______ y/n ____________ ms
- **FaultB, Excess Load:** ______ y/n ______ y/n ____________ ms
- **FaultA, Dead Short:** ______ y/n ______ y/n ____________ ms
- **FaultB, Dead Short:** ______ y/n ______ y/n ____________ ms

Pass: ______ Fail: ______ Initial: ____________ Date: ___/___/_____

Test Name: **Aux Talon - Current Limit Max**

DUT: **Aux Talon v____**

Equipment Used:

Kestrel v____

Conditions:

Tester:

Name: __________________	Sign: __________________
Name: __________________	Sign: __________________
Name: __________________	Sign: __________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.
Apply the max hold current (0.1A) to a single output port and confirm the system does not trip and still functions correctly
Single Port Test: Connect a load resistor (3.3V - 33Ω, 5V - 47Ω) to the port output and enable output, confirm stable output, run for 10 minutes and confirm no thermal overload in that time (output does not drop more more than 10%).
Multi-Port Test: Connect a load resistor (3.3V - 33Ω, 5V - 47Ω) to **each** port output and enable **all** outputs, confirm stable output (record measured output voltage), run for 10 minutes and confirm no thermal overload in that time (output does not drop more more than 10%).

Result:

Single Port Test (3.3V) Output Load Voltage - ____V	Pass: ____	Fail: ____
Single Port Test (5V) Output Load Voltage - ____V	Pass: ____	Fail: ____
Multi-Port Test (3.3V) Output Load Voltage - ____V	Pass: ____	Fail: ____
Multi-Port Test (5V) Output Load Voltage - ____V	Pass: ____	Fail: ____

Pass: ____ Fail: ____ Initial: ________ Date: __/__/____

Test Name: **Aux Talon - Current Consumption**

DUT: **Aux Talon v_____**

Equipment Used:

Kestrel v_____

Conditions:

Port Voltage Selected_____

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.
Connect all 3 ports to digital input lines, this will be the lowest power option. Run all inputs at 25Hz (average wind speed pulse) and record power consumption of the Aux Talon.
Repeat with 5V output disabled.
Must be less than 2.5mA to pass, ideally less than 1mA

Measurements:

Average Current Consumption: _____ mA at 3.3V **Average Current Consumption (w/5V Converter Disabled):** _____ mA at 3.3V

Result:

Pass: _____ Fail: _____ Initial: __________ Date: ___/___/_____

Test Name: **Aux Talon - General Tests**

DUT: **Aux Talon v____**

Equipment Used:

Kestrel v____

Conditions:

Tester:

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.

5V EN Test Toggle `5V_EN` line, confirm 5V line shuts down, record on and off voltage. **Wait 60 seconds for measure**.

Max Digital Frequency Connect oscilloscope to `OUTx` line of given port, apply function generator input to digital input. Set duty cycle to 50% and increase frequency until pulse is not registered on `OUTx` line, record maximum frequency. Must be greater than 1kHz.

Max OD Frequency Connect oscilloscope to `OUTx` line of given port, apply function generator input (using 2N7002 drive circuit and internal pullup) to OD input. Set duty cycle to 50% and increase frequency until pulse is not registered on `OUTx` line, record maximum frequency. Must be greater than 100Hz.

Min Digital Pulse Width Connect oscilloscope to `OUTx` line of given port, apply function generator input to digital input. Set frequency to **1kHz** and pulse width to 500μs (50% duty cycle). Reduce pulse width until pulse is not registered on `OUTx` line, record minim pulse width.

Min OD Pulse Width Connect oscilloscope to `OUTx` line of given port, apply function generator input (using 2N7002 drive circuit and internal pullup) to OD input. Set frequency to **100Hz** and pulse width to 5ms (50% duty cycle). Reduce pulse width until pulse is not registered on `OUTx` line, record minim pulse width.

Pulse Pass Through Configure one of the pulse lines to act as an interrupt input, confirm that a pulse on the input results in triggering of a pulse on the interrupt line.

Overflow Configure one of the overflow lines (`/OVFx`) to act as an interrupt, clear the counters, apply a function generator input (1kHz) and wait for interrupt output. Confirm interrupt output occurs and confirm expected time within 2.5%

Bus Voltage Measurement Measure all bus voltages, confirm with DMM to be within 5% of actual value. Run with 3.3V and 5V selections of ports at the same time.

Multi-port Input Apply a 25Hz pulse input to digital line of a given port for 60 seconds. During this period, pulse an open drain line on a different port about 12 times. Confirm both readings are measured correctly (within 2.5% of expected).

Over Voltage Input Apply a 5V square wave (100Hz) for 60 seconds to a digital input which is configured at 3.3V. Confirm correct pulse count and run test for another 60 seconds with 3.3V pulse and confirm correct count to ensure damage was not done to part of the system.

Reed Switch Input, Slow Drive a reed switch at a cycle of 6 pulses per minute (one pulse every 10 seconds) and confirm correct count (within 2.5%) after 60 seconds

Reed Switch Input, Fast Drive a reed switch at about 25Hz and confirm correct count (within 2.5%) after 60 seconds

EMI Fault Connect 30m of cable with reed switch on end to open drain input of port. Trigger EMI discharge (chair discharge) and confirm no tip event is recorded. Repeat 5 times and ensure no tips are recorded any time. **Discharge should occur at least 1m away from system**.

Measurements:

5V EN Test - Von: ______ mV Voff: ______mV Pass: ______ Fail: ______

Max Digital Frequency - Frequency: ______kHz Pass: ______ Fail: ______

Max OD Frequency - Frequency: ______kHz Pass: ______ Fail: ______

Min Digital Pulse Width - Pulse Width: ______μs Pass: ______ Fail: ______

Min OD Pulse Width - Pulse Width: ______μs Pass: ______ Fail: ______

Pulse Pass Through - Pass: ______ Fail: ______

Overflow - Pass: ______ Fail: ______

Bus Voltage Measurement - Pass: ______ Fail: ______

Multi-port Input - PortA Error: ______ % PortB Error: ______ % Pass: ______ Fail: ______

Over Voltage Input - Pass: ______ Fail: ______

Reed Switch Input, Slow - Pass: ______ Fail: ______

Reed Switch Input, Fast - Pass: ______ Fail: ______

EMI Fault - Pass: ______ Fail: ______

Pass: ______ Fail: ______ Initial: ____________ Date: ___/___/______

Chapter 3

I2C Talon Tests

Test Name: **I2C Talon - Basic Reading**

DUT: **I2C Talon v____**

Equipment Used:

Kestrel v____
Haar Primal v____

Conditions:

Tester:

Name: ____________________	Sign: ____________________
Name: ____________________	Sign: ____________________
Name: ____________________	Sign: ____________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.
Connect a full set of conflicting address sensors to the Talon (use four Haar units) and perform the following operations. Make the connection using **1m cable**.
Use fast mode I2C (400kHz)

Actions:

- Toggle system to internal I2C bus
- Read addresses on internal bus, confirm isolation
- Turn off all data lines for external ports
- Toggle system to external I2C bus

  Case A Leave power on to all ports, toggle data enable line for each port so only one is enabled at a given time

Case B Leave data enable lines high for each port, toggle power enable for each port so only one is enabled at a given time

- Read data, confirm no fault
- Measure voltage on disabled ports, confirm cross talk is less than 50mV

Measurements:

Case A Cross talk, max ________ mV Pass: ______ Fail: ______

Case B Cross talk, max ________ mV Pass: ______ Fail: ______

Pass: ______ Fail: ______ Initial: ___________ Date: __/__/_____

Test Name: **I2C Talon - Bus Reading**

DUT: **I2C Talon v____**

Equipment Used:

Kestrel v_____
Haar Primal v_____
Hedorah NDIR v_____
Hedorah v_____

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.
Connect a set of sensors and perform the following operations. Make the connection using **1m cable**.
Use fast mode I2C (400kHz)

Sensor Set:

- Haar
- Haar, Alt Address
- Hedorah-NDIR
- Hedorah

Actions:

- Connect to all ports
- Read data from each device, confirm no fault, verify waveform on output side
- Measure rise and fall time on bus at sensor (far end of cable)

Measurements:

Rise Time _____ μs

Fall Time _____ μs

Freq _______ kHz

Pass: _____ Fail: _____ Initial: __________ Date: __/__/____

Test Name: **I2C Talon - Bus Fault**

DUT: **I2C Talon v____**

Equipment Used:

Kestrel v_____
Haar Primal v_____

Conditions:

Tester:

Name: ________________________ Sign: ________________________

Name: ________________________ Sign: ________________________

Name: ________________________ Sign: ________________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.

Connect a Haar sensor to an open and enabled port. Take another port on the bus and disable data to it, then apply the following conditions of faults and attempt to communicate with the Haar sensor for each one to ensure no faults occur.

Conditions:

SDA shorted to 3.3V

SCL shorted to 3.3V

SDA shorted to GND

SCL shorted to GND

Pass: _____ Fail: _____ Initial: ___________ Date: ___/___/_____

Test Name: **I2C Talon - Current Limit Fault**

DUT: **I2C Talon v____**

Equipment Used:

Kestrel v_____

Conditions:

Tester:

Name: ____________________	Sign: ____________________
Name: ____________________	Sign: ____________________
Name: ____________________	Sign: ____________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.
Apply a given load to the output and perform the set of actions and ensure all stages are passed

Load Condition:

- Excess Load - 1.25x max load (0.625A, approximately 5Ω for 3.3V bus)
- Dead short - $< 0.1\Omega$

Actions:

- Apply load

  Case A Connect load to disabled port, enable port

  Case B Enable port, connect load

- Measure time to trip
- Confirm output disconnection
- Remove load
- Confirm output latch
- Confirm fault flag

Repeat for fault present at enable and fault applied to line

Measurements:

Excess Load, Case A	Time to Trip ________ μs	Pass: _____	Fail: _____
Excess Load, Case B	Time to Trip ________ μs	Pass: _____	Fail: _____
Dead Short, Case A	Time to Trip ________ μs	Pass: _____	Fail: _____

Dead Short, Case B Time to Trip ________ μs Pass: ______ Fail: ______

Pass: ______ Fail: ______ Initial: ____________ Date: ___/___/______

Test Name: **I2C Talon - Current Limit Max**

DUT: **I2C Talon v_____**

Equipment Used:

Kestrel v_____

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.

Apply the max hold current (0.5A) to a single output port and confirm the system does not trip and still functions correctly

Connect a load resistor (3.3V - 6.8Ω, 12V - 27Ω) to the port output and enable output, confirm stable output, run for 10 minutes and confirm no thermal overload in that time.

Result:

Pass: _____ Fail: _____ Initial: __________ Date: ___/___/_____

Test Name: **I2C Talon - General Tests**

DUT: **I2C Talon v____**

Equipment Used:

Kestrel v_____

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.

EEPROM Write to EEPROM, toggle power 10 times, read from EEPROM and confirm data is correct

Bus Voltage Measurement Measure all bus voltages, confirm with DMM to be within 5% of actual value. Apply load of about $1k\Omega$ to have a reasonable current to measure.

IO Expanders Verify correct I2C address of devices (should be 0x22)

Position Detect Switch Verify switch trips when placed in lower position in box, confirm switch does not trip when in upper position

Sense EN Disable `SENSE_EN` line, confirm `3V3_SENSE` is shutdown. Force enable outputs, confirm power is present at output.

Measurements:

EEPROM - Pass: _____ Fail: _____

Bus Voltage Measurement - Pass: _____ Fail: _____

IO Expanders - Pass: _____ Fail: _____

Position Detect Switch - Pass: _____ Fail: _____

Sense EN - Pass: _____ Fail: _____

Pass: _____ Fail: _____ Initial: __________ Date: ___/___/_____

Chapter 4

SDI-12 Talon Tests

Test Name: **SDI-12 Talon - Apogee Interface Testing**

DUT: **SDI-12 Talon v_____**

Equipment Used:

Kestrel v_____

Conditions:

Tester:

Name: ____________________	Sign: ____________________
Name: ____________________	Sign: ____________________
Name: ____________________	Sign: ____________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.
Fully test out the features of the Apogee specific sensor input

Actions:

- Hard power cycle Talon, confirm `/DATA_EN4` is **HIGH** by default
- Leave `/DATA_EN4` **HIGH** and connect the other ports to data output
- Apply an erroneous signal to the Apogee port input (1kHz, 5V, square wave)
- Measure voltage present on enabled SDI-12 port, ensure this is sufficiently small
- Connect a sensor to an SDI-12 port, communicate with this sensor while erroneous input is connected, ensure there is no fault

- Apply an analog voltage sweep to `DATA_OUT4`, record the manual measure and the system measure along with error

  V0 0V

  V1 0.1V

  V2 0.25V

  V3 0.5V

  V4 1.0V

  V5 2.5V

  V6 3V

  V7 3.3V

  V8 4.5V

  V9 5.0V

- Confirm ability to switch heater power on and off
- Load heater switch with 100mA load (120Ω)
- Turn on heater switch
- Allow to run for 10 minutes and ensure no thermal shutoff

Measurements:

Cross Talk Voltage ________ mV

V0 DMM ________ mV Reported ________ mV Error ________ %

V1 DMM ________ mV Reported ________ mV Error ________ %

V2 DMM ________ mV Reported ________ mV Error ________ %

V3 DMM ________ mV Reported ________ mV Error ________ %

V4 DMM ________ mV Reported ________ mV Error ________ %

V5 DMM ________ mV Reported ________ mV Error ________ %

V6 DMM ________ mV Reported ________ mV Error ________ %

V7 DMM ________ mV Reported ________ mV Error ________ %

V8 DMM ________ mV Reported ________ mV Error ________ %

V9 DMM ________ mV Reported ________ mV Error ________ %

Pass: _____ Fail: _____ Initial: __________ Date: ___/___/_____

Test Name: **SDI-12 Talon - Voltage Rail Testing**

DUT: **SDI-12 Talon v____**

Equipment Used:

Kestrel v____

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.
Test the performance of the switch mode converters on the SDI-12 Talon

Actions:

- Switch on 5V rail
- Measure and record mean voltage and ripple voltage
- Apply 100mA (47Ω resistor) load to the 5V (solder a resistor across capacitor C8)
- Switch on 5V rail
- Measure and record mean voltage and ripple voltage
- Remove resistor load
- Switch on 12V rail
- Measure and record mean voltage and ripple voltage
- Apply 500mA (27Ω resistor) load to 12V output port
- Enable power on given output port
- Measure and record mean voltage and ripple voltage

Measurements:

5V, No Load Mean ________ mV Ripple ________ mV Error ________ %

5V, 100mA Load Mean ________ mV Ripple ________ mV Error ________ %

12V, No Load Mean ________ mV Ripple ________ mV Error ________ %

12V, 500mA Load Mean ________ mV Ripple ________ mV Error ________ %

Pass: _____ Fail: _____ Initial: __________ Date: ___/___/_____

Test Name: **SDI-12 Talon - Bus Reading**

DUT: **SDI-12 Talon v____**

Equipment Used:

Kestrel v____

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.
Connect a set of sensors and perform the following operations.

Isolation Mode:

- Connect 4 sensors (1 Apogee, 3 non-Apogee) to the bus
- Have all sensors configured for **the same address**
- Select each port individually (enable data lines) and read data from device
- Confirm no fault

Bus Mode:

- Connect 4 sensors (1 Apogee, 3 non-Apogee) to the bus
- Have all sensors configured for **different addresses**
- Read from each sensor, while all are connected to the bus
- Confirm no fault

Partial Bus Mode:

- Connect 4 sensors (1 Apogee, 3 non-Apogee) to the bus
- Have all sensors configured for **different addresses**
- Disable a single sensor (disable data line), then read from the rest of the connected sensors (cycling through which one is disconnected)
- Confirm no fault

Bus Fault:

- Connect 3 sensors (1 Apogee, 2 non-Apogee) to the bus

- Have all sensors configured for **different addresses**
- Disable (data enable) the port with the disconnected sensor
- Apply the following faults and confirm data is still able to be read from the remaining sensors
  - Connect data line to GND
  - Connect data line to 5V
  - Connect data line to 12V (also ensure voltage applied to buffer, `DATA_OUT_PROTECx`, does not exceed 5V
- Confirm no fault

Measurements:

Isolation Mode	Pass: ______	Fail: ______
Bus Mode	Pass: ______	Fail: ______
Partial Bus Mode	Pass: ______	Fail: ______
Bus Fault	Pass: ______	Fail: ______

Pass: ______ Fail: ______ Initial: __________ Date: ___/___/_____

Test Name: **SDI-12 Talon - Current Limit Fault**

DUT: **SDI-12 Talon v____**

Equipment Used:

Kestrel v____

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.
Power Kestrel via power supply connected to battery input (3.7V, 3A limit)
Apply a given load to the output and perform the set of actions and ensure all stages are passed
In order to pass, all trip times must be less than **4ms** (minimum trip time for the Kestrel power switch)

Load Condition:

- Excess Load - 1.25x max load (0.625A, approximately 15Ω for 12V bus)
- Dead short - $< 0.1\Omega$

Actions:

- Apply load

  Case A Connect load to disabled port, enable port

  Case B Enable port, connect load
- Measure time to trip
- Confirm output disconnection
- Remove load
- Confirm output latch
- Confirm fault flag

Repeat for fault present at enable and fault applied to line

Measurements:

Excess Load, Case A Time to Trip[1] ________ ms Pass: ______ Fail: ______

[1] These times are software actuated trip times

Excess Load, Case B Time to Trip ________ μs Pass: ______ Fail: ______

Dead Short, Case A Time to Trip[1] ________ ms Pass: ______ Fail: ______

Dead Short, Case B Time to Trip ________ μs Pass: ______ Fail: ______

Pass: ______ Fail: ______ Initial: ____________ Date: ___/___/______

Test Name: **SDI-12 Talon - Current Limit Max**

DUT: **SDI-12 Talon v____**

Equipment Used:

Kestrel v____

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.
Apply the max hold current (0.5A) to a single output port and confirm the system does not trip and still functions correctly
Connect a load resistor (3.3V - 6.8Ω, 12V - 27Ω) to the port output and enable output, confirm stable output, run for 10 minutes and confirm no thermal overload in that time.
Measure voltage applied to load
Repeat process with "half load" as well (3.3V - 13.3Ω, 12V - 47Ω)

Measurements:

Full Load Pass: ____ Fail: ____

Load Voltage, Start - ______V

Load Voltage, End - ______V

Half Load Pass: ____ Fail: ____

Load Voltage, Start - ______V

Load Voltage, End - ______V

Pass: ____ Fail: ____ Initial: ________ Date: __/__/____

Test Name: **SDI-12 Talon - General Tests**

DUT: **SDI-12 Talon v____**

Equipment Used:

Kestrel v____

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.

EEPROM Write to EEPROM, toggle power 10 times, read from EEPROM and confirm data is correct

Bus Voltage Measurement Measure all bus voltages, confirm with DMM to be within 5% of actual value. Apply load of about $1k\Omega$ to have a reasonable current to measure.

IO Expanders Verify correct I2C address of devices (should be 0x22)

Position Detect Switch Verify switch trips when placed in lower position in box, confirm switch does not trip when in upper position

Sense EN Disable `SENSE_EN` line, confirm `3V3_SENSE` is shutdown. Force enable outputs, confirm power is present at output.

Measurements:

EEPROM - Pass: _____ Fail: _____

Bus Voltage Measurement - Pass: _____ Fail: _____

IO Expanders - Pass: _____ Fail: _____

Position Detect Switch - Pass: _____ Fail: _____

Sense EN - Pass: _____ Fail: _____

Pass: _____ Fail: _____ Initial: __________ Date: __/__/____

Chapter 5

Gonk Tests

Test Name: **Gonk - Shutdown/Restart**

DUT: **Gonk 1S3P - Smart v____**

Equipment Used:

Conditions:

Tester:

Name: ______________________	Sign: ______________________
Name: ______________________	Sign: ______________________
Name: ______________________	Sign: ______________________

Procedure:

Take Gonk with batteries removed, connect power supply in place of battery (with 1Ω in series with a 1000μF capacitor).

We will test to obtain: Minimum start up voltage, UVP voltage, OVP voltage, OCD current, and restart conditions

Start Up Voltage:

- Turn power supply off
- Connect DMM to output of Gonk
- Switch Gonk **ON**
- Set power supply for 2.5V
- Turn on power supply
- Press **JUMP** button on Gonk
- Check DMM to verify if output is connected

- Turn off power supply, increment voltage by 0.1V and turn power supply back on
- Repeat process until output is connected, record voltage

UVP Voltage:

- Turn power supply off
- Connect DMM to output of Gonk
- Switch Gonk **ON**
- Set power supply for 3.7V
- Turn on power supply
- Press **JUMP** button on Gonk
- Reduce voltage by increments of 0.1V, delay at least 1 second between each step
- Continue reducing voltage until the output is disconnected, record this voltage

UVP Restart:

- Place the device into UVP mode (see UVP Voltage action items)
- Connect an additional power supply to the external port of Gonk
- Set voltage to 2.5V
- Set DMM to measure voltage on internal battery rail
- Switch power supply on
- Check DMM to see if charge voltage is applied
- Increment charge voltage by 0.1V, delaying at least 1 second between increments
- Repeat until charge voltage is connected to battery rail
- Record UVP restart voltage

OVP Voltage:

- Connect secondary power supply to input of Gonk
- Connect DMM to artificial Gonk battery input
- Switch Gonk **ON**
- Set battery power supply for 3.7V
- Turn on power supply
- Set input power supply for 3.7V
- Turn on power supply
- Increase input voltage by increments of 50mV, delay at least 1 second between each step
- Continue increasing voltage until the input is disconnected disconnected from the battery, record this voltage

OCD Current:

- For this step, remove the series resistor to the power supply

- Connect DMM in series measuring current
- Set DMM for min/max mode
- Set battery power supply to 3.7V with a current limit max > 5A
- Connect load resistor
- Increase load current until output disconnects
- Record maximum current measured

OCD Restart:

- Place the device into OCD mode (see OCD Current action items)
- Remove load from output
- Leave battery power supply at 3.7V
- Test that output did **not** restore connection as a result of this
- Connect an additional power supply to the external port of Gonk
- Set voltage to 2.5V
- Set DMM to measure voltage on internal battery rail
- Switch power supply on
- Check DMM to see if charge voltage is applied
- Increment charge voltage by 0.1V, delaying at least 1 second between increments
- Repeat until charge voltage is connected to battery rail
- Record OCD restart voltage

Measurements:

Minimum Start Up Voltage ________ V

UVP Voltage ________ V

UVP Restart Voltage ________ V

OVP Voltage ________ V

OCD Current ________ A

OCD Restart Voltage ________ V

Pass: _____ Fail: _____ Initial: __________ Date: __/__/____

Test Name: **Gonk - General Tests**

DUT: **Gonk 1S3P - Smart v____**

Equipment Used:

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Current Measure:

- Connect power supply in place
- Place DMM in series to measure current (μA mode)
- Set power supply to 3.7V
- Turn on power supply
- Press **JUMP** button
- Switch Gonk **ON**
- Measure and record (**mean**) quiescent current
- Switch Gonk **OFF**
- Press and hold **SLEEP** button until power is reduced
- Measure and record sleep current

Pass/Fail Tests:

- Switch Test
  - Place internal switch into **OFF** state
  - Ensure output power is off
  - Place external switch into **ON** state
  - Ensure output power is on
- External Switch Test
  - Place external and internal switch in positions specified in Table 5.1
  - Ensure specified output is true for each position combination

Ext Pos / OB Pos	**ON**	**MID**	**OFF**
ON	ON	ON	OFF
OFF	ON	OFF	OFF

Table 5.1: Switch positions and expected output

- LED Output Configure
  - Configure LED bar graph to display SoC only when button is pressed
  - Switch output off (to confirm this works even when power is off)
  - Press button, confirm graph is displayed
  - Release button, confirm graph is removed

Measurements:

Quiescent Current ________ μA

Sleep Current ________ μA

Result:

Switch Test Pass: ______ Fail: ______

External Switch Test Pass: ______ Fail: ______

LED Bar Graph Output Pass: ______ Fail: ______

Pass: ______ Fail: ______ Initial: ____________ Date: ___/___/______

Chapter 6

Addendum: Replacement IO Expander Tests

Test Name: **Kestrel - On Board Control**

DUT: **Kestrel v____**

Equipment Used:

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Connect Kestrel logger to computer using USB and have no other power source connected (as this is the most volatile anyway).

- Confirm communication with IO expanders by toggling a pin on each and verifying with manual reading
- Configure IO expander to trigger an interrupt output for a given pin (easiest pins would likely be `SD_CD` and `/FAULTx` for the given expanders. Then cause each of these pins to toggle and manually observe the state change of the interrupt line.

Measurements:

- **IO Exp Interface -** Pass: ______ Fail: ______
- **IO Exp Interrupt -** Pass: ______ Fail: ______

Pass: ______ Fail: ______ Initial: ____________ Date: ___/___/______

Test Name: **Kestrel - Sleep Current Measure**

DUT: **Kestrel v____**

Equipment Used:

Conditions:

Tester:

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Procedure:

Run demo sleep firmware (**make sure to note version which was run**) and record sleep current from battery input (at 3.7V). This current must be less than **1mA** for device to pass.

Configuration State:

- `3V3_AUX_EN` → **LOW**
- All Talon Power → **OFF**
- `3V3_SD_EN` → **LOW**
- `LED_EN` → **LOW**
- `CSA_EN` → **LOW**
- FRAM → **Software Shutdown**
- Accel → **Software Shutdown**
- System Controller → `ULTRA_LOW_POWER`

Result:

- **Sleep Current:** ________________ μA

Pass: _____ Fail: _____ Initial: __________ Date: ___/___/_____

Test Name: **Aux Talon - Analog**

DUT: **Aux Talon v____**

Equipment Used:

Kestrel v____

Conditions:

Tester:

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.
Configure the ADC to use 2/3 gain value ($\pm 6.144V$) for max range and worst case error. Use default rate of 128 sps for data rate, no averaging.
Connect a controllable power supply to a single analog input on the Aux Talon via a **5m** cable. Place a specified resistor in series with the power supply output to provide the desired input impedance. All manual measurements are to be made at the Talon end of the cable. DMM measurements should be made by short wires soldered to the filter caps.
For each voltage tested, apply the following conditions:

- Floating - Discharge MOSFET is switched off
- Discharged - Discharge MOSFET is switched on for 250ms, then switched off for 1ms before reading
- Loaded - Discharge MOSFET is switched on during measurement

This process should be repeated for input impedances: 0Ω, $1k\Omega$, $10k\Omega$, $100k\Omega$
Voltages to apply:

Measure 1 0V

Measure 2 0.25V

Measure 3 2.5V

Measure 4 5.0V

Perform the following steps to test the analog signal measurement of the Aux Talon:

- Apply a given voltage to the input
- Measure voltage with the DMM, record
- Measure voltage with the Aux Talon interface, record
- Measure on board voltage ref with Aux Talon interface, record

Measurements:

Source Impedance = 0Ω, input mode = Floating

- **Measure # - Samples:** DMM Val [mV], Talon Val [mV], Error [mV], Error [%]
- **Measure 1:** ________ mV ________ mV ________ mV ________ %
- **Measure 2:** ________ mV ________ mV ________ mV ________ %
- **Measure 3:** ________ mV ________ mV ________ mV ________ %
- **Measure 4:** ________ mV ________ mV ________ mV ________ %

Source Impedance = $1k\Omega$, input mode = Floating

- **Measure # - Samples:** DMM Val [mV], Talon Val [mV], Error [mV], Error [%]
- **Measure 1:** ________ mV ________ mV ________ mV ________ %
- **Measure 2:** ________ mV ________ mV ________ mV ________ %
- **Measure 3:** ________ mV ________ mV ________ mV ________ %
- **Measure 4:** ________ mV ________ mV ________ mV ________ %

Source Impedance = $10k\Omega$, input mode = Floating

- **Measure # - Samples:** DMM Val [mV], Talon Val [mV], Error [mV], Error [%]
- **Measure 1:** ________ mV ________ mV ________ mV ________ %
- **Measure 2:** ________ mV ________ mV ________ mV ________ %
- **Measure 3:** ________ mV ________ mV ________ mV ________ %
- **Measure 4:** ________ mV ________ mV ________ mV ________ %

Source Impedance = $100k\Omega$, input mode = Floating

- **Measure # - Samples:** DMM Val [mV], Talon Val [mV], Error [mV], Error [%]
- **Measure 1:** ________ mV ________ mV ________ mV ________ %
- **Measure 2:** ________ mV ________ mV ________ mV ________ %
- **Measure 3:** ________ mV ________ mV ________ mV ________ %
- **Measure 4:** ________ mV ________ mV ________ mV ________ %

Source Impedance = 0Ω

- **Measure # - Samples:** Floating [mV], Discharged [mV], Loaded [mV]
- **Measure 1:** ________ mV ________ mV ________ mV %
- **Measure 2:** ________ mV ________ mV ________ mV %
- **Measure 3:** ________ mV ________ mV ________ mV %
- **Measure 4:** ________ mV ________ mV ________ mV %

Source Impedance = $1k\Omega$

- **Measure # - Samples:** Floating [mV], Discharged [mV], Loaded [mV]
- **Measure 1:** ________ mV ________ mV ________ mV %

- **Measure 2:** ________ mV ________ mV ________ mV %
- **Measure 3:** ________ mV ________ mV ________ mV %
- **Measure 4:** ________ mV ________ mV ________ mV %

Source Impedance = $10k\Omega$

- **Measure # - Samples:** Floating [mV], Discharged [mV], Loaded [mV]
- **Measure 1:** ________ mV ________ mV ________ mV %
- **Measure 2:** ________ mV ________ mV ________ mV %
- **Measure 3:** ________ mV ________ mV ________ mV %
- **Measure 4:** ________ mV ________ mV ________ mV %

Source Impedance = $100k\Omega$

- **Measure # - Samples:** Floating [mV], Discharged [mV], Loaded [mV]
- **Measure 1:** ________ mV ________ mV ________ mV %
- **Measure 2:** ________ mV ________ mV ________ mV %
- **Measure 3:** ________ mV ________ mV ________ mV %
- **Measure 4:** ________ mV ________ mV ________ mV %

Pass: ______ Fail: ______ Initial: ____________ Date: ___/___/_____

Test Name: **Aux Talon - Pulse**

DUT: **Aux Talon v____**

Equipment Used:

Kestrel v____

Conditions:

Port Voltage Selected____

Tester:

Name: ____________________	Sign: ____________________
Name: ____________________	Sign: ____________________
Name: ____________________	Sign: ____________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface. **Ensure both `Dx_SENSE` and `ODx` lines are configured as inputs**.
Connect the various sensor configurations to the input of a given port on the Aux Talon. Run the test for the given period and measure the ground truth value using a DMM in frequency averaging mode (reset simultaneous to begin of sample).
For tests not using a sensor cable, connection should be made via a **5m** unshielded, 22 AWG cable.
Read values from the Talon via the Serial Demo interface. Use the time stamping in the serial monitor for timing. For each measurement, confirm a good wave form via oscilloscope at the Talon end of the cable.
Wind sensors should be driven via forced airflow to the best approximation of the desired frequency.
For square wave on OD input, use a 2N7002 transistor to drive the open drain line from the function generator input.
Process should be repeated for each port
Measurements must be within 2.5% to pass, except for all signals over 1kHz, these must only be within 5% for a pass.

POD Inputs:

OD1 - Wind Speed, Hall Effect - 25Hz, 5 min

OD2 - Wind Speed, Reed - 25Hz, 5 min

OD3 - Wind Speed, Reed - 0Hz, 5 min (confirm no error pulses)

OD4 - Square Wave (3.3V) - 1kHz, 60 sec

Digital Inputs:

D1 - Square Wave (1.8V) - 100Hz, 5 min

D2 - Square Wave (3.3V) - 100Hz, 5 min

D3 - Square Wave (5V) - 100Hz, 5 min

D4 - Square Wave (3.3V) - 1kHz, 60 sec

Perform the following steps to test the analog signal measurement of the Aux Talon:

- Apply a given signal to the given input
- Restart DMM frequency count
- Restart count with Aux Talon interface
- Wait given time
- Measure frequency from DMM, record
- Measure pulses and delta time from Aux Talon, record
- Calculate Aux Talon frequency and error

Measurements:

- **Measure:** DMM Val [Hz], Talon Val [Count], Talon Val [ms], Talon Val [Hz], Error [%]
- **OD1:** ________ Hz ________ Count ________ ms ________ Hz ________ %
- **OD2:** ________ Hz ________ Count ________ ms ________ Hz ________ %
- **OD3:** ________ Hz ________ Count ________ ms ________ Hz ________ %
- **OD4:** ________ Hz ________ Count ________ ms ________ Hz ________ %
- **D1:** ________ Hz ________ Count ________ ms ________ Hz ________ %
- **D2:** ________ Hz ________ Count ________ ms ________ Hz ________ %
- **D3:** ________ Hz ________ Count ________ ms ________ Hz ________ %
- **D4:** ________ Hz ________ Count ________ ms ________ Hz ________ %

Pass: _____ Fail: _____ Initial: __________ Date: ___/___/_____

Test Name: **Aux Talon - General Tests**

DUT: **Aux Talon v____**

Equipment Used:

Kestrel v____

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.

Pulse Pass Through Configure one of the pulse lines to act as an interrupt input, confirm that a pulse on the input results in triggering of a pulse on the interrupt line.

Overflow Configure one of the overflow lines (`/OVFx`) to act as an interrupt, clear the counters, apply a function generator input (1kHz) and wait for interrupt output. Confirm interrupt output occurs and confirm expected time within 2.5%

Bus Voltage Measurement Measure all bus voltages, confirm with DMM to be within 5% of actual value. Run with 3.3V and 5V selections of ports at the same time.

Multi-port Input Apply a 25Hz pulse input to digital line of a given port for 60 seconds. During this period, pulse an open drain line on a different port about 12 times. Confirm both readings are measured correctly (within 2.5% of expected).

Over Voltage Input Apply a 5V square wave (100Hz) for 60 seconds to a digital input which is configured at 3.3V. Confirm correct pulse count and run test for another 60 seconds with 3.3V pulse and confirm correct count to ensure damage was not done to part of the system.

Reed Switch Input, Slow Drive a reed switch at a cycle of 6 pulses per minute (one pulse every 10 seconds) and confirm correct count (within 2.5%) after 60 seconds

EMI Fault Connect 30m of cable with reed switch on end to open drain input of port. Trigger EMI discharge (chair discharge) and confirm no tip event is recorded. Repeat 5 times and ensure no tips are recorded any time. **Discharge should occur at least 1m away from system**.

Measurements:

Pulse Pass Through - Pass: _____ Fail: _____

Overflow - Pass: _____ Fail: _____

Bus Voltage Measurement - Pass: ______ Fail: ______

Multi-port Input - PortA Error: ______ % PortB Error: ______ % Pass: ______ Fail: ______

Over Voltage Input - Pass: ______ Fail: ______

Reed Switch Input, Slow - Pass: ______ Fail: ______

EMI Fault - Pass: ______ Fail: ______

Pass: ______ Fail: ______ Initial: __________ Date: ___/___/______

Test Name: **I2C Talon - Bus Reading**

DUT: **I2C Talon v____**

Equipment Used:

Kestrel v_____
Haar Primal v_____
Hedorah NDIR v_____
Hedorah v_____

Conditions:

Tester:

Name: ____________________ Sign: ____________________
Name: ____________________ Sign: ____________________
Name: ____________________ Sign: ____________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.
Connect a set of sensors and perform the following operations. Make the connection using **1m cable**.
Use fast mode I2C (400kHz)

Sensor Set:

- Haar
- Haar, Alt Address
- Hedorah-NDIR
- Hedorah

Actions:

- Connect to all ports
- Read data from each device, confirm no fault, verify waveform on output side
- Measure rise and fall time on bus at sensor (far end of cable)

Measurements:

Rise Time _____ μs

Fall Time _____ μs

Freq _______ kHz

Pass: _____ Fail: _____ Initial: __________ Date: __/__/____

Test Name: **I2C Talon - General Tests**

DUT: **I2C Talon v____**

Equipment Used:

Kestrel v____

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.

Bus Voltage Measurement Measure all bus voltages, confirm with DMM to be within 5% of actual value. Apply load of about $1k\Omega$ to have a reasonable current to measure.

IO Expanders Verify correct I2C address of devices (should be 0x22)

Position Detect Switch Verify switch trips when placed in lower position in box, confirm switch does not trip when in upper position

Measurements:

Bus Voltage Measurement - Pass: _____ Fail: _____

IO Expanders - Pass: _____ Fail: _____

Position Detect Switch - Pass: _____ Fail: _____

Pass: _____ Fail: _____ Initial: __________ Date: ___/___/_____

Test Name: **I2C Talon - Loopback Test**

DUT: **I2C Talon v____**

Equipment Used:

Kestrel v____
Haar Primal v____

Conditions:

Tester:

Name: ________________	Sign: ________________
Name: ________________	Sign: ________________
Name: ________________	Sign: ________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.
Connect a Haar sensor to an open and enabled port. First perform a test with all other ports open circuit with and without loopback enabled. Then apply the following conditions of faults to an enabled port and attempt to communicate with loopback enabled and disabled.

Conditions:

SDA shorted to 3.3V

SCL shorted to 3.3V

SDA shorted to GND

SCL shorted to GND

Results:

Floating Ports

Loopback Enabled -	0x22: ____	0x44: ____
Loopback Disabled -	0x22: ____	0x44: ____

Loopback Enabled

SDA shorted to 3.3V -	0x22: ____	0x44: ____
SCL shorted to 3.3V -	0x22: ____	0x44: ____
SDA shorted to GND -	0x22: ____	0x44: ____
SCL shorted to GND -	0x22: ____	0x44: ____

Loopback Disabled

SDA shorted to 3.3V -	0x22: ____	0x44: ____

SCL shorted to 3.3V - 0x22: ______ 0x44: ______

SDA shorted to GND - 0x22: ______ 0x44: ______

SCL shorted to GND - 0x22: ______ 0x44: ______

Pass: ______ Fail: ______ Initial: ____________ Date: ___/___/______

Test Name: **I2C Talon - Current Limit Fault**

DUT: **I2C Talon v____**

Equipment Used:

Kestrel v____

Conditions:

Tester:

Name: ____________________	Sign: ____________________
Name: ____________________	Sign: ____________________
Name: ____________________	Sign: ____________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.
Apply a given load to the output and perform the set of actions and ensure all stages are passed

Load Condition:

- Excess Load - 1.25x max load (0.625A, approximately 5Ω for 3.3V bus)
- Dead short - $< 0.1\Omega$

Actions:

- Apply load

  Case A Connect load to disabled port, enable port

  Case B Enable port, connect load

- Measure time to trip
- Confirm output disconnection
- Remove load
- Confirm output latch
- Confirm fault flag

Repeat for fault present at enable and fault applied to line

Measurements:

Excess Load, Case A	Time to Trip ________ μs	Pass: ______	Fail: ______
Excess Load, Case B	Time to Trip ________ μs	Pass: ______	Fail: ______
Dead Short, Case A	Time to Trip ________ μs	Pass: ______	Fail: ______

Dead Short, Case B Time to Trip ________ μs Pass: ______ Fail: ______

Pass: ______ Fail: ______ Initial: ____________ Date: ___/___/_____

Test Name: **SDI-12 Talon - Bus Reading**

DUT: **SDI-12 Talon v____**

Equipment Used:

Kestrel v_____

Conditions:

Tester:

Name: ________________________ Sign: ________________________

Name: ________________________ Sign: ________________________

Name: ________________________ Sign: ________________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.
Connect a set of sensors and perform the following operations.

Bus Mode:

- Connect 4 sensors (1 Apogee, 3 non-Apogee) to the bus
- Have all sensors configured for **different addresses**
- Read from each sensor, while all are connected to the bus
- Confirm no fault

Loopback Mode:

- Connect 3 sensors (1 Apogee, 2 non-Apogee) to the bus
- Have all sensors configured for **different addresses**
- Read from each sensor, while all are connected to the bus
- Confirm no fault
- Enable loopback, read result
- Disable loopback
- Fault extra port (short data to GND)
- Read from each sensor, while all are connected to the bus (confirm expected fault)
- Enable loopback, read result (confirm loopback still reads)

Measurements:

Bus Mode Pass: ______ Fail: ______

Loopback Mode Pass: ______ Fail: ______

Pass: ______ Fail: ______ Initial: ____________ Date: ___/___/______

Test Name: **SDI-12 Talon - Current Limit Fault**

DUT: **SDI-12 Talon v____**

Equipment Used:

Kestrel v____

Conditions:

Tester:

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Name: ____________________ Sign: ____________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.
Power Kestrel via power supply connected to battery input (3.7V, 3A limit)
Apply a given load to the output and perform the set of actions and ensure all stages are passed
In order to pass, all trip times must be less than **4ms** (minimum trip time for the Kestrel power switch)

Load Condition:

- Excess Load - 1.25x max load (0.625A, approximately 15Ω for 12V bus)
- Dead short - $< 0.1\Omega$

Actions:

- Apply load

  Case A Connect load to disabled port, enable port

  Case B Enable port, connect load

- Measure time to trip
- Confirm output disconnection
- Remove load
- Confirm output latch
- Confirm fault flag

Repeat for fault present at enable and fault applied to line

Measurements:

Excess Load, Case A Time to Trip[1] ________ ms Pass: _____ Fail: _____

[1] These times are software actuated trip times

Excess Load, Case B Time to Trip ________ μs Pass: ______ Fail: ______

Dead Short, Case A Time to Trip[1] ________ ms Pass: ______ Fail: ______

Dead Short, Case B Time to Trip ________ μs Pass: ______ Fail: ______

Pass: ______ Fail: ______ Initial: __________ Date: ___/___/_____

Test Name: **SDI-12 Talon - General Tests**

DUT: **SDI-12 Talon v_____**

Equipment Used:

Kestrel v_____

Conditions:

Tester:

Name: ________________________ Sign: ________________________

Name: ________________________ Sign: ________________________

Name: ________________________ Sign: ________________________

Procedure:

Connect Talon to Kestrel, all power and communication will be done through this connection. Enable given port on Kestrel and make measurements using the Serial Demo interface.

Bus Voltage Measurement Measure all bus voltages, confirm with DMM to be within 5% of actual value. Apply load of about $1k\Omega$ to have a reasonable current to measure.

IO Expanders Verify correct I2C address of devices (should be 0x22)

Position Detect Switch Verify switch trips when placed in lower position in box, confirm switch does not trip when in upper position

Measurements:

Bus Voltage Measurement - Pass: ______ Fail: ______

IO Expanders - Pass: ______ Fail: ______

Position Detect Switch - Pass: ______ Fail: ______

Pass: ______ Fail: ______ Initial: ____________ Date: ___/___/_____

Chapter 7

Addendum: Startup Sequence Tests

Test Name: **Kestrel - Startup**

DUT: **Kestrel v____**

Equipment Used:

Conditions:

Tester:

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Name: ______________________ Sign: ______________________

Procedure:

Connect Kestrel to the following power supply combination, ensure that for each connection the logger powers up correctly (`3V3_CORE` rail starts up immediately). This must be true both when power is applied with the switch in the ON state, and when power is applied and the switch is toggled into the ON state.

Test ID	Battery	USB	Solar	Charge Enable ($\overline{\text{CE}}$)
Alpha	Open	Active	Open	LOW
Beta	Open	Active	Open	HIGH
Gamma	Active (nominal[a])	Open	Open	LOW
Delta	Active (nominal)	Open	Open	HIGH
Epsilon	Active (cutoff[b])	Active	Open	LOW
Zeta	Active (cutoff)	Active	Open	HIGH
Eta	Active (cutoff)	Open	Active	LOW
Theta	Active (cutoff)	Open	Active	HIGH
Iota	Open	Open	Active	LOW
Kappa	Open	Open	Active	HIGH
Lambda	Open	Active	Active (cutoff[c])	LOW
Mu	Open	Active	Active (cutoff)	HIGH

[a]Battery nominal Voltage = 3.7V
[b]Battery cutoff Voltage = 2V
[c]Solar cutoff Voltage = 3V

Measurements:

Alpha	Pass: ______	Fail: ______
Beta	Pass: ______	Fail: ______
Gamma	Pass: ______	Fail: ______
Delta	Pass: ______	Fail: ______
Epsilon	Pass: ______	Fail: ______
Zeta	Pass: ______	Fail: ______
Eta	Pass: ______	Fail: ______
Theta	Pass: ______	Fail: ______
Iota	Pass: ______	Fail: ______
Kappa	Pass: ______	Fail: ______
Lambda	Pass: ______	Fail: ______
Mu	Pass: ______	Fail: ______

Pass: ______ Fail: ______ Initial: ____________ Date: ___/___/______