Factory Scorpius Char Test Plan for J307

Module: Scorpius
Station: Scorpius Char (DEV40)
Build: P1B
Release Date: 21 February 2020

This Document Covers the Following Products:J307
Revision: P1B_V2.0
Radar: <rdar://problem/51782237> J307 Scorpius factory ERS

[Note: Anything in brackets is expected to be updated / deleted for the official document]

Table of Contents

1. Revision 3
2. Purpose 4
3. Scope 4
4. References 4
5. Glossary & Definitions 4
6. Critical and Frequently Used Commands 5
    6.1. Quiesce Test Mode 5
7. Overview 6
    7.1. Summary of Test Coverage 6
    7.2. Fixture Coupling specs 6
8. Test Coverage @ Scorpius Char Station 7
    8.1. Load Tx FW & Read Version 7
    8.2. Rx FW Version 7
    8.3. Initial MTP Sector Check Before Tests. 8
    8.4. Low Power Ping (LPP) 10
    8.5. Digital Ping Level Tests 11
    8.6. Power, Efficiency & Ping Pong Tests 12
    8.7. Final MTP Sector Check After Tests. 15
A. Appendix - B332 Dev Board UART Baud rate ----16
B. Feature DRI Comments for Changes to this Document ----17

1. Revision

Build Type	Version	Date	Notes	Author
Please refer to last section of this document for Details/Comments on change to this document				
P0	1.0	2 September 2019	Initial release for J307 P0 Build.	Bhushan Koli
	1.1	14 September 2019	Updated coil fixture specifications and Power flow Efficiency test for setup and Rx commands	Bhushan Koli
	1.2	17 September 2019	Updated Power Efficiency section to swap the sequence of Enable Boost and Full Bridge Enable.	Bhushan Koli
	1.3	20 September 2019	Updated the test limits for all parameters.	Bhushan Koli
	1.4	26 September 2019	Correted LPP & Power efficiency Limits	Bhushan Koli
P1	1.5	26 November 2019	Updated Location of words in MTP and few commands	Bhushan Koli
	1.6	5 December 2019	Added Digital Ping test at 0.1C loading condition	Bhushan Koli/Mikhal
	1.7	16 December 2019	Updated MTP Read Section and limits	Bhushan Koli/Selestino
	1.8	18 December 2019	Updated Calculation in LLP section	Bhushan Koli
	1.9	14 January 2020	Updated limits based on Factory data	Bhushan Koli
P1B	2.0	21 February 2020	Updated Minimum Vboost requirement from 6V to 6.1V	Bhushan Koli/Mikhal

2. Purpose

This document describes the FATP Scorpius Char test plan for the J307 inductive charging Tx module for P0.

3. Scope

The scope of this document is the Scorpius only module of the J307 products. It covers FATP tests of the following high level features:

Test	Scorpius Test
LPP ping and delta calculation	✓
Power Flow & Efficiency	✓
Comms - PingPong	✓

4. References

<rdar://problem/47434171> J4xx Scorpius factory ERS
<rdar://problem/48910417> Dotara Data-sheet
<rdar://problem/48964978> Dotara Block initializations
<rdar://problem/49391712> J307 FW specifications
<rdar://problem/54853341> Radar for Scorpius Factory FW releases
J307 Schematic

5. Glossary & Definitions

Acronym	Term	Description
AMPL	Amplitude	-
ASK	Amplitude shift keying	-
Ballast	Ballast Load	Internal load within Aculeus/Iktara that maintains a constant current load.
CAL	Calibratied	These are after calibration values.
COMM's	Communications	Referring to ASK and FSK communications
CPLG	Coupling	-
CTX	-	Series resonant capacitance.
DC	Duty Cycle	-
DSBL	Disable	-
ENBL	Enable	-
FOD	Foreign Object Detection	Detection mechanism for metallic objects near the inductive power link
FREQ	Frequency	-
FSK	Frequency shift keying	-
FXST	Fixture Setup	-
Kmax	-	Maximum Coupling Coefficient
Kmin	-	Minimum Coupling Coefficient
LPP	Low Power Ping	Object/Rx detection system
MPE	Maximum Permissible Exposure	Protection scheme to limit the maximum leakage H-field when Scorpius is charging
Rx	Receiver	Wireless Power Receiver. Also referred to as PRx
SCRP	Scorpius	Reference for searching Scorpius Module related Data in Insight.
Tx	Transmitter	Wireless Power Transmitter. Also referred to as PTx(J307 MLB)
VCTX	-	Voltage across Tx coil
VBoost	-	Voltage across Boost output
VRect	-	Voltage across Rx Rectifier

6. Critical and Frequently Used Commands

6.1. Quiesce Test Mode

After programming the Tx defaults to NominalMode (LPP > Digital Ping > Power negotiation > Closed loop).
The following command needs to be sent to the Tx to enable QuiesceMode whereby certain test commands are then enabled.

A power cycle will mean the unit needs to be re-programmed as the firmware application is run from SRAM.

This is the test mode whereby additional commands for test/validation are active.This command will disable everything except the MCU i.e. Boost, Bridge, LPP switch will be disabled.

smokey ScorpiusHid --run --test "Set" --args "ReportID=0x09, ReportPayload={0x01}"

Resets into the quiesce mode with the bridge disabled.

> ***Note:*** *This command i.e. Quiesce Mode needs to be set once at beginning of testing i.e. from* ***Section 8.1. Load FW*** *or unless unit is reset or power cycled or Nominal Mode has been set.* ***If the unit is power cycled you will need to load fw again.*** *Nominal Mode*

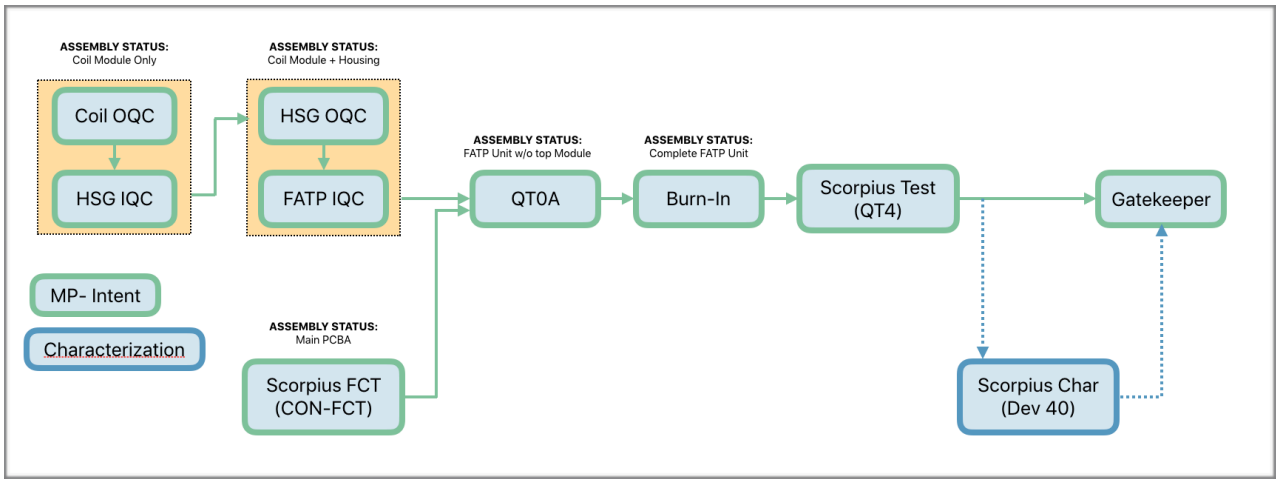
This is the normal runtime mode. Here, a subset of commands used for test/validation are deactivated.

smokey ScorpiusHid --run --test "Set" --args "ReportID=0x09, ReportPayload={0x00}"

Resets into the nominal mode where it will start the LPP -> Digital Ping -> Power negotiation -> Closed loop sequence.

7. Overview

The block diagram below shows the overall end-end test coverage for the inductive Scorpius module. This document covers Scorpius Char Station.



7.1. Summary of Test Coverage

	Kmax	Knom	Kmin
LPP	no load	no load	no load
Open Loop + Ping Pong	0.1C, 3C, 10C	0.1C, 3C, 10C	0.1C, 3C, 10C

7.2. Fixture Coupling specs

Throughout this document various tests will have different limits depending on the offset position i.e. coupling. Ensure close attention is paid to the tables shown for the different coupling positions, loads and limits.

All = all possible positions (MaxK, NomK,MinK)

InSight Keys Recorded	Position (mm)	K Spec	Measured Results (averaged after 5 readings)
KMax	0, 0.83, 0	0.656 - 0.672 (0.664±0.008)	Limits investigation on going, limits to be used need to be same as IQC_coupling station. FYI only. To be updated.
KNom	D1.1, 0.88, L1.1	0.644	
KMin	D1.5, 0.93, L1.5	0.490 - 0.531 (0.516±0.015)	

8. Test Coverage @ Scorpius Char Station

8.1. Load Tx FW & Read Version

Description:-Load Tx FW. Dotara has no NVRAM and therefore will lose all the memory/setting after power cycling or load fw. Dotara will need to load the fw after each power cycling.
Failure Mode(s) Captured:TBD
Test Setup and Procedure:

Step	Description	Interface	Command / Notes
Note: *This command i.e. Quiesce Mode needs to be set once at beginning of testing i.e. from* ***Section 8.1. Load FW*** *or unless unit is reset or power cycled or Nominal Mode has been set.* ***If the unit is power cycled you will need to load fw again.***			
A	**Tell Tx to get out of standalone mode.**	**TX HID (Diags)**	**i2c -w 5 0x39 6** **Note:-Send this command 2x times with 1s delay. There may be I2C error reported with this command, but can be ignored.**
B	**Tell Tx to enter Quiesce Mode**	**TX HID**	**Note: Need to send the below command after every 2nd time of the above command within 3sec or with minimum or no delay as possible of above command. You cannot enter Quiesce mode without exiting the standalone mode.** **smokey ScorpiusHid --run --test "Set" --args "ReportID=0x09, ReportPayload={0x01}"**
1	Set Vin 3.6V. Or Preparation to pull high: PMU_TO_DOTARA_EN_EXT	Fixture	socgpio --port 1 --pin 46 --output 1 **Note: 3.6V ±1% must be met.**
2	Tell Tx to get out of standalone mode.	TX HID (Diags)	i2c -w 5 0x39 6 **Note:-Send this command 2x times with 1s delay. There may be I2C error reported with this command, but can be ignored.**
3	Load Tx FW	Tx HID	**Note**: Need to send this command every time within **3sec** of above command. You cannot enter Load FW without exiting the standalone mode. ***Path for FW might change.*** smokey ScorpiusHid --run --test "FwLoad" --args "PathToFwLoad='nandfs:\\AppleInternal\\Diags\\Scorpius\\J307\\ScorpiusTx-dotara.bin'"
4	Tell Tx to get out of standalone mode.	TX HID (Diags)	i2c -w 5 0x39 6 **Note:-Send this command 2x times with 1s delay. There may be I2C error reported with this command, but can be ignored.**
5	Tell Tx to enter Quiesce Mode	TX HID	**Note**: Need to send the below command after every 2nd time of the above command within **3sec** or with minimum or no delay as possible of above command. You cannot enter Quiesce mode without exiting the standalone mode. smokey ScorpiusHid --run --test "Set" --args "ReportID=0x09, ReportPayload={0x01}"
6	Read Status (Version)	Tx HID	smokey ScorpiusHid --run --test "Get" --args "ReportID=0xBB"

Command to read Tx FW version:
smokey ScorpiusHid --run --test "Get" --args "ReportID=0xBB"
Example:-This reads back 4 bytes: 0x01 0x00 0x02 0x05
Main FW Type (byte1&2): 0x0001
Main FW Version (byte3&4): 0x0502

Test Parameter	Insight Keys Recorded	Notes
Tx Fw Version	**SCRP_Tx_Version**	

8.2. Rx FW Version

Ginger SN: diags get mlbsn
Eload SN: diags get eloadsn
Versions: get versions ——> application: 2.6.19, this line is the Ginger FW version
B332 Dev Board Command to read Rx FW version:
i2c lock charger
i2c rawwrite charger 0x10 0x00 0x02 0x00 0x00 0x00
i2c rawread charger 04
i2c unlock charger
Read 4 byte packet: x x x x
Last 3 bytes will determine Rx version:

8.3. Initial MTP Sector Check Before Tests.

Description: Make sure FW is in a good state at the Before of the test. [TBD]
Failure Mode(s) Captured: TBD
Test Setup and Procedure: Refer below

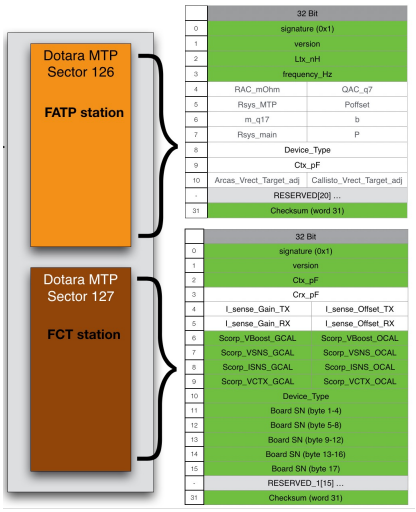


Figure 1 : MTP Word Locations

Step	Description	Interface	Command / Notes
Note: *This command i.e. Quiesce Mode needs to be set once at beginning of testing i.e. from Section 8.3 MTP Sector Check or unless unit is rest/power cycled or Nominal Mode has been set. If the unit is power cycled you will need to load fw again.*			
1	Tell Tx to get out of standalone mode.	TX HID (Diags)	i2c -w 5 0x39 6 **Note:-Send this command 2x times.**There may be I2C error reported with this command, but can be ignored.
2	Tell Tx to enter Quiesce Mode	TX HID	**Note:** Need to send the below command after every 2nd time of the above command within 3sec or with minimum or no delay as possible of above command. You cannot enter Quiesce mode without exiting the standalone mode. smokey ScorpiusHid --run --test "Set" --args "ReportID=0x09, ReportPayload={0x01}"
Skip the above 2 steps if the unit is already in Quiesce Mode			
3	Read MTP Sector 127	Tx HID	smokey ScorpiusHid --run --test "Print_Sector" --args "MTP_sector=127" **Example:-Overlay will read Words that are printed:-** **Word 0 : 0x00000001** / **Word 1 : 0x000000002** / **Word 2 : 0x00030570** / Word 3 : 0x00023F00 Word 4 : 0x00000000 / Word 5 : 0x00000000 / **Word 6 : 0x0A0A0A0A** / **Word 7 : 0x0B0B0B0B** **Word 8 : 0x0C0C0C0C** / **Word 9 : 0x0D0D0D0D** / **Word 10 : 0x03070001** / **Word 11 : 0x00000000** **Word 12 : 0x00000000** / **Word 13 : 0x00000000** / **Word 14 : 0x00000000** / **Word 15 : 0x00000000** Word 16 : 0x00000000 / Word 17 : 0x00000000 / Word 18 : 0x00000000 / Word 19 : 0x00000000 Word 20 : 0x00000000 / Word 21 : 0x00000000 / Word 22 : 0x00000000 / Word 23 : 0x00000000 Word 24 : 0x00000000 / Word 25 : 0x00000000 / Word 26 : 0x00000000 / Word 27 : 0x00000000 Word 28 : 0x00000000 / Word 29 : 0x00000000 / Word 30 : 0x00000000 / **Word 31 : 0xF29D9024**
4	Read MTP Sector 126	Tx HID	smokey ScorpiusHid --run --test "Print_Sector" --args "MTP_sector=126" **Example:-Overlay will read Words that are printed:-** **Word 0 : 0x0000001** / **Word 1 : 0x00000002** / **Word 2 : 0x0E0E0E0E** / **Word 3 : 0x0F0F0F0F** Word 4 : 0x0000000 / Word 5 : 0x0000000 / Word 6 : 0x0000000 / Word 7 : 0x0000000 Word 8 : 0x0000000 / Word 9 : 0x0000000 / Word 10 : 0x0000000 / Word 11 : 0x0000000 Word 12 : 0x0000000 / Word 13 : 0x0000000 / Word 14 : 0x0000000 / Word 15 : 0x0000000 Word 16 : 0x0000000 / Word 17 : 0x0000000 / Word 18 : 0x0000000 / Word 19 : 0x0000000 Word 20 : 0x0000000 / Word 21 : 0x0000000 / Word 22 : 0x0000000 / Word 23 : 0x0000000 Word 24 : 0x0000000 / Word 25 : 0x0000000 / Word 26 : 0x0000000 / Word 27 : 0x0000000 Word 28 : 0x0000000 / Word 29 : 0x0000000 / Word 30 : 0x0000000 / **Word 31 : 0xDDD9E0E1**
5	Location of Calibrated values of VBoost, Vsense, Isense, LFOD & CTx into MTP and other values into MTP :- Signature, Version,HWID, MLB SN, Checksum Follow Figure 1 Bellow for Reference	Test Overlay	Sector 127 :-Word 0(Signature = 0x01); Word 1(Version = 0x02); Word 2(CTx); Word 6(VBoost); Word 7(Vsense); Word 8(Isense); Word 9(LFOD); Word 10(HWID); Word 11 - 15(MLB SN - 17 byte), Word 31(Checksum)
6	Location to store Calibrated values of Inductance (Ltx_nH) & frequency_Hz into MTP and also Signature and version.	Test Overlay	Sector 126 :- Word 0(Signature = 0x01); Word 1(Version = 0x02); Word 2(Ltx_nH); Word 3(frequency_Hz)

Test Parameter	Insight Keys Recorded	Comments/Notes
Check Sum - Sector 127	**SCRP_Check Sum__S127_MTP_BEFORE**	
Check Sum - Sector 126	**SCRP_Check Sum_S126_MTP_BEFORE**	

Test Parameter	Insight Keys Recorded	Comments/Notes
LPP Inductance_MTP	**SCRP_LPP_L_MTP_BEFORE**	Will need this Values to be compared against MTP Check after test **Section 8.5.**
LPP Frequency_MTP	**SCRP_LPP_FREQ_MTP_BEFORE**	
Tx HWID_MTP	**SCRP_TX_HWID_MTP_BEFORE**	
Ctx_MTP	**SCRP_CTx_MTP_127_BEFORE**	
VBoost_MTP	**SCRP_VBoost_MTP_BEFORE**	
VSense_MTP	**SCRP_VSense_MTP_BEFORE**	
ISense_MTP	**SCRP_IBoost_MTP_BEFORE**	
LFOD_MTP	**SCRP_LFOD_MTP_BEFORE**	
Version	**SCRP_Version_MTP_BEFORE**	
Signature	**SCRP_Signature_MTP_BEFORE**	

8.4. Low Power Ping (LPP)

Description: Check the frequency and inductance for LPP at free air vs nominal position coupling.
Failure Mode(s) Captured: Poorly assembled / manufactured coils
Test Setup and Procedure:

Step	Description	Interface	Command / Notes
1	Connect coils at nominal position	Fixture	
2	Send 1.4uS LPP pulse	Tx HID	smokey ScorpiusHid --run --test"Set" --args"ReportID=0x05, ReportPayload={0x00, 0x46, 0x88, 0x13}" Note: 0x46 gives 70 * 20ns = 1.4uS is the duration of the pulse.
3	Delay 15mS before proceeding	Fixture	
4	Read output parameters of F and L and raw ADC data	Tx HID	To read Frequency, Inductance and Raw ADC data: smokey ScorpiusHid --run --test"Get" --args"ReportID=0x05" **Response: (Received LSB First, Length should be 23bytes)** Byte0: ReportId (should equal 0x05) Byte1: Error code (0x00-> no error) Byte2: Sub-cmd (should be 0x00) bytes3-6: Floating point value of frequency Bytes7-10: Floating point value of inductance Bytes19-22: Buffer address of raw ADC data Bytes23-26: Number of raw ADC data elements (of size uint16_t)
5	Collect raw ADC samples and upload to Insight	Tx HID & Fixture	Collect Pointer to raw LPP data by sending the following command from bytes19-22 in the above response.Use the above info to read the raw data and upload to insight. Use the command Below to read the raw ADC buffered data smokey ScorpiusHid --run --test "Mem16" --args "Address=<*address*>, Length=<number of bytes to read>" smokey ScorpiusHid --run --test "Mem16" --args "Address=<buffer address>, Length=220" The LPP data is 660 bytes. Therefore 3 loops of above should finished reading all the LPP data
6	Repeat steps 2 - 5 x 100 times	Fixture & Tx HID	Save all of the data as a single log file for each unit and upload to InSight.
7	Calculate Free Air Δ Tx Frequency & Δ Tx Inductance Averaged over 100 repeats vs MTP sector Value	Tx HID & Fixture	Δ Tx Frequency = SCRP_LPP_FREQ_MTP_BEFORE (From Section 8.3) - **Kxx_LPP_Frequency_100_avg** Δ Tx Inductance = **Kxx_LPP_Inductance_100_avg** - SCRP_LPP_L_MTP_BEFORE (From Section 8.3)
8	Record parameters as per the table below	Fixture	Apply limits accordingly
9	Repeat steps 2 - 8 at all coupling position	Fixture & Tx HID	Coupling Position :- KMax, KNom & KMin

Physical Parameter	InSight Keys Recorded	LL	UL	Unit	Offset Positions
LPP Frequency	**KMax_LPP_Frequency**	53.89	57.97	kHz	Kmax
	KNom_LPP_Frequency	55.95	60.19		Knom
	KMin_LPP_Frequency	57.5	61.88		Kmin
	KMax_LPP_Frequency_avg	53.89	57.97		Kmax
	KNom_LPP_Frequency_avg	55.95	60.19		Knom
	KMin_LPP_Frequency_avg	57.5	61.88		Kmin
LPP Inductance	**KMax_LPP_Inductance**	21.17	23.66	µH	Kmax
	KNom_LPP_Inductance	19.64	21.94		Knom
	KMin_LPP_Inductance	18.56	20.80		Kmin
	KMax_LPP_Inductance_avg	21.17	23.66		Kmax
	KNom_LPP_Inductance_avg	19.64	21.94		Knom
	KMin_LPP_Inductance_avg	18.56	20.80		Kmin
Δ Tx Frequency	**KMax_LPP_Frequency_FA_delta**	13.26	15.34	kHz	All
	KNom_LPP_Frequency_FA_delta	10.81	13.23		
	KMin_LPP_Frequency_FA_delta	9.13	11.55		
Δ Tx Inductance	**KMax_LPP_Inductance_FA_delta**	7.07	9.12	µH	
	KNom_LPP_Inductance_FA_delta	5.46	7.32		
	KMin_LPP_Inductance_FA_delta	4.44	6.09		
LPP Frequency STD	**LPP_Frequency_STDEV**	-	0.4	-	All
LPP Inductance STD	**LPP_Inductance_STDEV**	-	0.4	-	All
LPP_repeatability		100	100	-	All

8.5. Digital Ping Level Tests

Description: This test required ginger/B332 dev board, both Tx and Rx coil. Test digital ping level (6Vboost and 100deg bridge phase) at 0.1C charge rate at various positions and Vrect and Ping Pong Tests. Ping Pong test is performed to check In-band comms by sending a train of bits as ASK (ginger board/B332 Dev Board).

Failure Mode(s) Captured:

1. Vrect: - Ginger/B332 reach UVP or OVP at the digital ping level
2. Ping Pong :-Test Dotara's Internal ASK/FSK Communication.

Test Setup and Procedure:

Order of load ramping as follows:

- Set VBOOST to **6.1V**
- Adjust bridge phase from **100 degrees**
- Set loading to 40mA ballast (No Eload i.e. turn Eload off/Set Eload to 0A)

Description	Interface	Command
Set coupling position	Fixture	Loads @ all Couplings

Step	Description	Interface	Command
	Digital Ping Testing		
	For DP @ 0.1C		
1	Set boost to meet the load conditions. **Note:** Minimum Vboost is 6100mV, Don't set Vboost < 6100mV.	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0xD4; 0x17; 0x88; 0x13}" **Payload: ——>** Byte0-1: Boost voltage (eg. 0x17D4 = 6100mV)
2	Set the Bridge phase **100deg**	Tx HID	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x04, ReportPayload={0x1C; 0xF3; 0x01; 0x00; 0x10; 0x27; 0x50; 0x46}" **Eg 0x2710:** 10000cdeg = 100deg phase
3	Command for following variables: Rx:- Vrect	Tx HID/Rx I2C	Vrect:- scorpius get vrect
4	Tell Rx to go into static mode	Rx I2C	Write I2C packet: (39) c0 ae 80 80 1e 09 02 01 AE Ginger command: set mode none Ginger command: set mode rx Ginger command: ikt write 0xF0000B80 0xAE010209 Read one byte: Should be 0x60 B332 DevBoard: i2c rawwrite charger 0x0f 0x00 0x2E 0x09 0x01 0x01//set Aculeus to static closed loop mode
5	Choose Comm1	Rx I2C	Write I2C packet: (39) c0 ae 80 80 1e 01 00 05 AD Ginger command: ikt write 0x0xF0000B80 0xAD050001 B332 DevBoard : i2c rawwrite charger 0x0F 0x00 0x2d 0x01 0x00 0x05 //Select Comm cap1 - For IpadTx
6	Tell Tx to initiate ping pong with the Rx i.e. 10 packets, 100ms packet delay	Tx HID	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x02, ReportPayload={0x0A; 0x00; 0x64; 0x00}" Payload:——> byte0-1: Number of packets to send: 10 byte2-3: Delay between packets: 100ms
7	Wait 3 second for RX to send packets before reading buffer	Fixture	Wait 3 second
8	Read back data that was captured from the Tx.	Tx HID	smokey ScorpiusHid --run --test "Get" --args "ReportID=0x02" Response: byte0: ID *(PingPongID = 0x02)* byte1: Status *(eg. 0x00 = complete)* [0 = Complete; 1 = In-Progress] byte2-3: Pings Sent *(eg. 0x000A = 10 pings sent)* byte4-5: Pongs Received *(eg. 0x000A = 10 pongs received)* byte6: Last error *(e.g. 0x00 = no errors)* ***Note:-*** *If byte1:Status is in process then repeat the step*
9	Repeat step 2 to 8 with All coupling positions		

Acceptance criteria:

Test Parameter	Insight Keys Recorded	LL	UL	Units	Comments/Notes
Vrect_FXST @ DP0.1C	**Kmax_SCRP_Vrect@DP0.1C**	7769	8257	mV	
	Kmin_SCRP_Vrect@DP0.1C	6347	7155	mV	
Number of Pings Sent @ DP	**SCRP_Pings_Sent@DP**	10	10	-	
Number of Pongs Received @ DP	**SCRP_Pongs_Recieved@DP**	10	10	-	

8.6. Power, Efficiency & Ping Pong Tests

Description: This test required ginger/B332 dev board, both Tx and Rx coil. Transferring power at various loads / charge rates (0.1C, 3C, 10C) at various positions and measuring power and efficiency and Ping Pong Tests. Ping Pong test is performed to check In-band comms by sending a train of bits as ASK (ginger board/B332 Dev Board).

Failure Mode(s) Captured:

1. Power & efficiency:-Unit is not able to transfer required power at different load conditions at required efficiency
2. Ping Pong :-Test Dotara's Internal ASK/FSK Communication.

Test Setup and Procedure:

Order of load ramping as follows:

- Adjust bridge phase from 0 - 180 degrees to reach target Vrect at desired load.
- If target Vrect still cannot be achieved with a phase shift of 180 degrees?
- Start increasing VBoost.
- VBoost should only be adjusted when phase = 180 degrees.
- To reach the desired Vrect start ramping the boost voltage.
- To reach the 10C load step the load with 50mA to avoid OVP.

Charge Rate	0.1C @ 6.5V Vrect	3C @ 8V Vrect	10C @ 14V Vrect
Loading	40mA ballast No Eload i.e. turn Eload off/Set Eload to 0A	~0.9W Set Eload to~112.5mA	3W Set Eload to ~214mA

Step	Description	Interface	Command
Set load and coupling position		Fixture	Repeat all below tests for the following conditions Loads @ all Couplings: **0.1C; 3C & 10C**
			Power & Efficiency Testing
			For 0.1C & 3C
1	Set boost to meet the load conditions. **Note:** Minimum Vboost is 6100mV, Don't set Vboost < 6100mV.	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0xD4; 0x17; 0x88; 0x13}" **Payload: ——>** Byte0-1: Boost voltage (eg. 0x17D4 = 6100mV)
2	Set the Bridge phase to meet the load condition (Set Bridge phase to 0-180)	Tx HID	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x04, ReportPayload={0x1C; 0xF3; 0x01; 0x00; 0x50; 0x46; 0x50; 0x46}" **Eg 0x4650:** 18000cdeg = 180deg phase
			For 10C
1	Set the Full phase to meet the load condition (Set Bridge phase to 180)	Tx HID	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x04, ReportPayload={0x1C; 0xF3; 0x01; 0x00; 0x50; 0x46; 0x50; 0x46}" **Eg 0x4650:** 18000cdeg = 180deg phase
2	Set boost to meet the load conditions. **Note:** Minimum Vboost is 6100mV, Don't set Vboost < 6100mV.	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0xD4; 0x17; 0x88; 0x13}" **Payload: ——>** Byte0-1: Boost voltage (eg. 0x17D4 = 6100mV)
3	Command for following variables: Tx:- Vsense, Isense, LFOD (VCTx) Rx:- Vrect, Irect	Tx HID	Note: Here, a "set" report command is first sent followed by a "get" report to return the requested data. **VSense:** smokey ScorpiusHid --run --test "Set" --args "ReportID=0x31, ReportPayload={0x00; 0x00; 0x0F}" **———> Fixture wait 2 sec <———** smokey ScorpiusHid --run --test "Get" --args "ReportID=0x31" **Response —>** bytes1-4 = Floating point value from ADC **—> VSense_CAL_MCU** **ISense:** smokey ScorpiusHid --run --test "Set" --args "ReportID=0x31, ReportPayload={0x12; 0x00; 0x0F}" **———> Fixture wait 2 sec <———** smokey ScorpiusHid --run --test "Get" --args "ReportID=0x31" **Response —>** bytes1-4 = Floating point value from ADC **—> ISense_CAL_MCU** **LFOD(VCTx)**: smokey ScorpiusHid --run --test "Set" --args "ReportID=0x0B, ReportPayload={0x18; 0x03}" **———> Fixture wait 2 sec <———** smokey ScorpiusHid --run --test "Get" --args "ReportID=0x0B" **Response—>** byte0 = report id byte20-23 = [float] Read avgd ictx peak value in mA (based on Vendor calibration) byte24-27 = [float] Read avgd ictx peak value in mA (based on factory calibration) byte28-31 = [u32] Accumulated ADC raw averaged sampling value **B332 ————>** **Vrect:-** scorpius get vrect **Irect:-** scorpius get irect **Ginger ————>** **Vrect/Irect:-** ikt adc
			Ping Pong Testing

Step	Description	Interface	Command
4	Tell Rx to go into static mode	Rx I2C	Write I2C packet: (39) c0 ae 80 80 1e 09 02 01 AE Ginger command: set mode none Ginger command: set mode rx Ginger command: ikt write 0xF0000B80 0xAE010209 Read one byte: Should be 0x60 **B332 DevBoard: i2c rawwrite charger 0x0f 0x00 0x2E 0x09 0x01 0x01 //set Aculeus to static closed loop mode**
5	Choose Comm1	Rx I2C	Write I2C packet: (39) c0 ae 80 80 1e 01 00 05 AD Ginger command: ikt write 0x0xF0000B80 0xAD050001 **B332 DevBoard : i2c rawwrite charger 0x0F 0x00 0x2d 0x01 0x00 0x05 //Select Comm cap1 - For IpadTx**
6	Tell Tx to initiate ping pong with the Rx i.e. 10 packets, 100ms packet delay	Tx HID	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x02, ReportPayload={0x0A; 0x00; 0x64; 0x00}" **Payload:——>** byte0-1: Number of packets to send: 10 byte2-3: Delay between packets: 100ms
7	Wait 1 second for RX to send packets before reading buffer	Fixture	Wait 1 second
8	Read back data that was captured from the Tx.	Tx HID	smokey ScorpiusHid --run --test "Get" --args "ReportID=0x02" **Response:** byte0: ID *(PingPongID = 0x02)* byte1: Status *(eg. 0x00 = complete)* [0 = Complete; 1 = In-Progress] byte2-3: Pings Sent *(eg. 0x000A = 10 pings sent)* byte4-5: Pongs Received *(eg. 0x000A = 10 pongs received)* byte6: Last error *(e.g. 0x00 = no errors)* ***Note:-*** *If byte1:Status is in process then repeat the step*
9	Repeat step 2 to 8 with All loading and coupling positions		

Acceptance criteria:

Test Parameter	Insight Keys Recorded	LL	UL	Units	Comments/Notes
Load 0.1C					
Vsense @ 0.1C	**KMax_Vsense@0.1C**	5897	6107	mV	
	KNom_Vsense@0.1C	5889	6128		
	KMin_Vsense@0.1C	5889	6122		
Isense @ 0.1C	**KMax_Isense@0.1C**	70.46	80.56	mA	
	KNom_Isense@0.1C	75.38	85.98		
	KMin_Isense@0.1C	80.66	93.19		
Vctx_IPeak @ 0.1C	**KMax_VCtx_IctxPeakFactory@0.1C**	181	728	mA	
	KNom_VCtx_IctxPeakFactory@0.1C	194	785		
	KMin_VCtx_IctxPeakFactory@0.1C	224	839		
Vrect_FXST @ 0.1C	**KMax_Vrect_FXST@0.1C**	6346	6670	mV	Fixture Cmd: Vrect Target = 6.5V ±2% Use Filtered Vrect Value from 'Ikt Adc' command
	KNom_Vrect_FXST@0.1C	6367	6661		
	KMin_Vrect_FXST@0.1C	6391	6638		
Irect_FXST @ 0.1C	**KMax_Irect_FXST@0.1C**	40	46	mA	Iktara ballast load = 40mA. **No fixture load required.**
	KNom_Irect_FXST@0.1C				
	KMin_Irect_FXST@0.1C				
Rx_Loading_Power @ 0.1C	**KMax_Rx_Loading_Power@0.1C**	241.00	318.20	mW	Vrect * Irect
	KNom_Rx_Loading_Power@0.1C	247.20	317.20		
	KMin_Rx_Loading_Power@0.1C	240.00	320.50		
Efficiency @ 0.1C	**KMax_Efficiency@0.1C**	52.65	70.75	%	Rx_Power / (Vsense * Isense)
	KNom_Efficiency@0.1C	50.11	66.35		
	KMin_Efficiency@0.1C	45.75	61.60		
Number of Pings Sent @ 0.1C	**SCRP_Pings_Sent@0.1C**	10	10	-	
Number of Pongs Received @ 0.1C	**SCRP_Pongs_Recieved@0.1C**	10	10	-	
Load 3C					
Vsense @ 3C	**KMax_Vsense@3C**	5900	6108	mV	
	KNom_Vsense@3C	5900	6120		

Test Parameter	Insight Keys Recorded	LL	UL	Units	Comments/Notes
	KMin_Vsense@3C	5900	6411		
Isense @ 3C	**KMax_Isense@3C**	213.72	225.4	mA	
	KNom_Isense@3C	219.66	241.42		
	KMin_Isense@3C	237.45	250.28		
Vctx_IPeak_ @ 3C	**KMax_VCtx_IctxPeakFactory@3C**	417	618	mA	
	KNom_VCtx_IctxPeakFactory@3C	427	710		
	KMin_VCtx_IctxPeakFactory@3C	528	877		
Vrect_FXST @ 3C	**KMax_Vrect_FXST@3C**	7957	8105	mV	Fixture Cmd: Vrect Target = 8V ±2%
	KNom_Vrect_FXST@3C	7879	8200		
	KMin_Vrect_FXST@3C	7770	8232		
Irect_FXST @ 3C	**KMax_Irect_FXST@3C**	114	122.25	mA	Fixture Cmd: Irect Target = 113mA +iktara load(~0 to 15mA)
	KNom_Irect_FXST@3C	114.8	121.2		
	KMin_Irect_FXST@3C	114.8	121.2		
Rx_Loading_Power @ 3C	**KMax_Rx_Loading_Power@3C**	914.00	984.50	mW	Vrect * Irect
	KNom_Rx_Loading_Power@3C	919.65	976.40		
	KMin_Rx_Loading_Power@3C	905.50	982.60		
Efficiency @ 3C	**KMax_Efficiency@3C**	69.06	75.07	%	Rx_Power / (Vsense * Isense)
	KNom_Efficiency@3C	65.10	72.00		
	KMin_Efficiency@3C	59.70	68.20		
Number of Packets Sent @ 3C	**SCRP_Packets_Sent@3C**	10	10	-	
Number of Packets Received @ 3C	**SCRP_Packets_Recieved@3C**	10	10	-	
Load 10C					
Vsense @ 10C	**KMax_Vsense@10C**	9217	9903	mV	
	KNom_Vsense@10C	9685	10542		
	KMin_Vsense@10C	10165	11295		
Isense @ 10C	**KMax_Isense@10C**	447.29	462.45	mA	
	KNom_Isense@10C	443.2	460.02		
	KMin_Isense@10C	439.9	461.55		
Vctx_IPeak_ @ 10C	**KMax_VCtx_IctxPeakFactory@10C**	657	1041	mA	
	KNom_VCtx_IctxPeakFactory@10C	732	1345		
	KMin_VCtx_IctxPeakFactory@10C	887	1575		
Vrect_FXST @ 10C	**KMax_Vrect_FXST@10C**	13436	14587	mV	Fixture Cmd: Vrect Target = 14v
	KNom_Vrect_FXST@10C	13503	14471		
	KMin_Vrect_FXST@10C	13619	14380		
Irect_FXST @ 10C	**KMax_Irect_FXST@10C**	218.48	221.62	mA	Fixture Cmd: Irect Target = 214mA
	KNom_Irect_FXST@10C	217.56	222.72		
	KMin_Irect_FXST@10C	217.28	223.08		
Rx_Loading_Power @ 10C	**KMax_Rx_Loading_Power@10C**	2935.50	3232.77	mW	Vrect * Irect
	KNom_Rx_Loading_Power@10C	2969.00	3190.00		
	KMin_Rx_Loading_Power@10C	2986.00	3178.00		
Efficiency @ 10C	**KMax_Efficiency@10C**	69.25	72.53	%	Rx_Power / (Vsense * Isense)
	KNom_Efficiency@10C	65.13	69.72		
	KMin_Efficiency@10C	60.69	66.76		
Number of Packets Sent @ 10C	**SCRP_Packets_Sent@10C**	10	10	-	
Number of Packets Received @ 10C	**SCRP_Packets_Recieved@10C**	10	10	-	

8.7. Final MTP Sector Check After Tests.

Description: Make sure FW is in a good state at the end of the test. [TBD]
Failure Mode(s) Captured: TBD
Test Setup and Procedure: Refer below

Step	Description	Interface	Command / Notes
1	Pull Low test pin **TP93EF** i.e. **"AOP_TO_DOTARA_RESET_L"** to reset Scorpius	Tx Diags	socgpio --port 1 --pin 46 --output 0
	Wait 500ms	Fixture	
	Pull High test pin **TP93EF** i.e. **"AOP_TO_DOTARA_RESET_L "**	Tx Diags	socgpio --port 1 --pin 46 --output 1
2	Wait 1s	Fixture	
3	Preparation	Tx Diags	socgpio --port 1 --pin 46 --output 1
4	Tell Tx to get out of standalone mode.	TX HID (Diags)	i2c -w 5 0x39 6 **Note:-Send this command 2x times.**There may be I2C error reported with this command, but can be ignored.
5	Load Tx FW	Tx HID	**Note**: Need to send this command every time within **3sec** of above command. You cannot enter Load FW without exiting the standalone mode. smokey ScorpiusHid --run --test "FwLoad" --args "PathToFwLoad='nandfs:\\AppleInternal\\Diags\\Scorpius\\J307\\ScorpiusTx-dotara.bin'"
6	Wait 1s	Fixture	Scorpius FW will take less than 1 second to boot
7	Tell Tx to get out of standalone mode.	TX HID (Diags)	i2c -w 5 0x39 6 Note:-Send this command 2x times.There may be I2C error reported with this command, but can be ignored.
8	Tell Tx to enter Quiesce Mode	Tx Diags	**Note:** Need to send the below command after every 2nd time of the above command within 3sec or with minimum or no delay as possible of above command. You cannot enter Quiesce mode without exiting the standalone mode. smokey ScorpiusHid --run --test "Set" --args "ReportID=0x09, ReportPayload={0x01}"
8	Read MTP Sector 127	Tx HID	smokey ScorpiusHid --run --test "Print_Sector" --args "MTP_sector=127" **Example:-Overlay will read Words that are printed:-** **Word 0 : 0x00000001** / Word 1 : 0x00000002 / Word 2 : 0x00030570 / Word 3 : 0x00023F00 Word 4 : 0x00000000 / Word 5 : 0x00000000 / **Word 6 : 0x0A0A0A0A** / **Word 7 : 0x0B0B0B0B** **Word 8 : 0x0C0C0C0C** / **Word 9 : 0x0D0D0D0D** / **Word 10 : 0x03070001** / **Word 11 : 0x00000000** **Word 12 : 0x00000000** / **Word 13 : 0x00000000** / **Word 14 : 0x00000000** / **Word 15 : 0x00000000** Word 16 : 0x00000000 / Word 17 : 0x00000000 / Word 18 : 0x00000000 / Word 19 : 0x00000000 Word 20 : 0x00000000 / Word 21 : 0x00000000 / Word 22 : 0x00000000 / Word 23 : 0x00000000 Word 24 : 0x00000000 / Word 25 : 0x00000000 / Word 26 : 0x00000000 / Word 27 : 0x00000000 Word 28 : 0x00000000 / Word 29 : 0x00000000 / Word 30 : 0x00000000 / **Word 31 : 0xF29D9024**
9	Read MTP Sector 126	Tx HID	smokey ScorpiusHid --run --test "Print_Sector" --args "MTP_sector=126" **Example:-Overlay will read Words that are printed:-** **Word 0 : 0x0000001** / **Word 1 : 0x00000002** / **Word 2 : 0x0E0E0E0E** / **Word 3 : 0x0F0F0F0F** Word 4 : 0x0000000 / Word 5 : 0x0000000 / Word 6 : 0x0000000 / Word 7 : 0x0000000 Word 8 : 0x0000000 / Word 9 : 0x0000000 / Word 10 : 0x0000000 / Word 11 : 0x0000000 Word 12 : 0x0000000 / Word 13 : 0x0000000 / Word 14 : 0x0000000 / Word 15 : 0x0000000 Word 16 : 0x0000000 / Word 17 : 0x0000000 / Word 18 : 0x0000000 / Word 19 : 0x0000000 Word 20 : 0x0000000 / Word 21 : 0x0000000 / Word 22 : 0x0000000 / Word 23 : 0x0000000 Word 24 : 0x0000000 / Word 25 : 0x0000000 / Word 26 : 0x0000000 / Word 27 : 0x0000000 Word 28 : 0x0000000 / Word 29 : 0x0000000 / Word 30 : 0x0000000 / **Word 31 : 0xDDD9E0E1**
10	Pull Low test pin **TP93EF** i.e. **"AOP_TO_DOTARA_RESET_L"** to reset Scorpius	Tx Diags	socgpio --port 1 --pin 46 --output 0
	Wait 500ms	Fixture	
	Pull High test pin **TP93EF** i.e. **"AOP_TO_DOTARA_RESET_L "**	Tx Diags	socgpio --port 1 --pin 46 --output 1

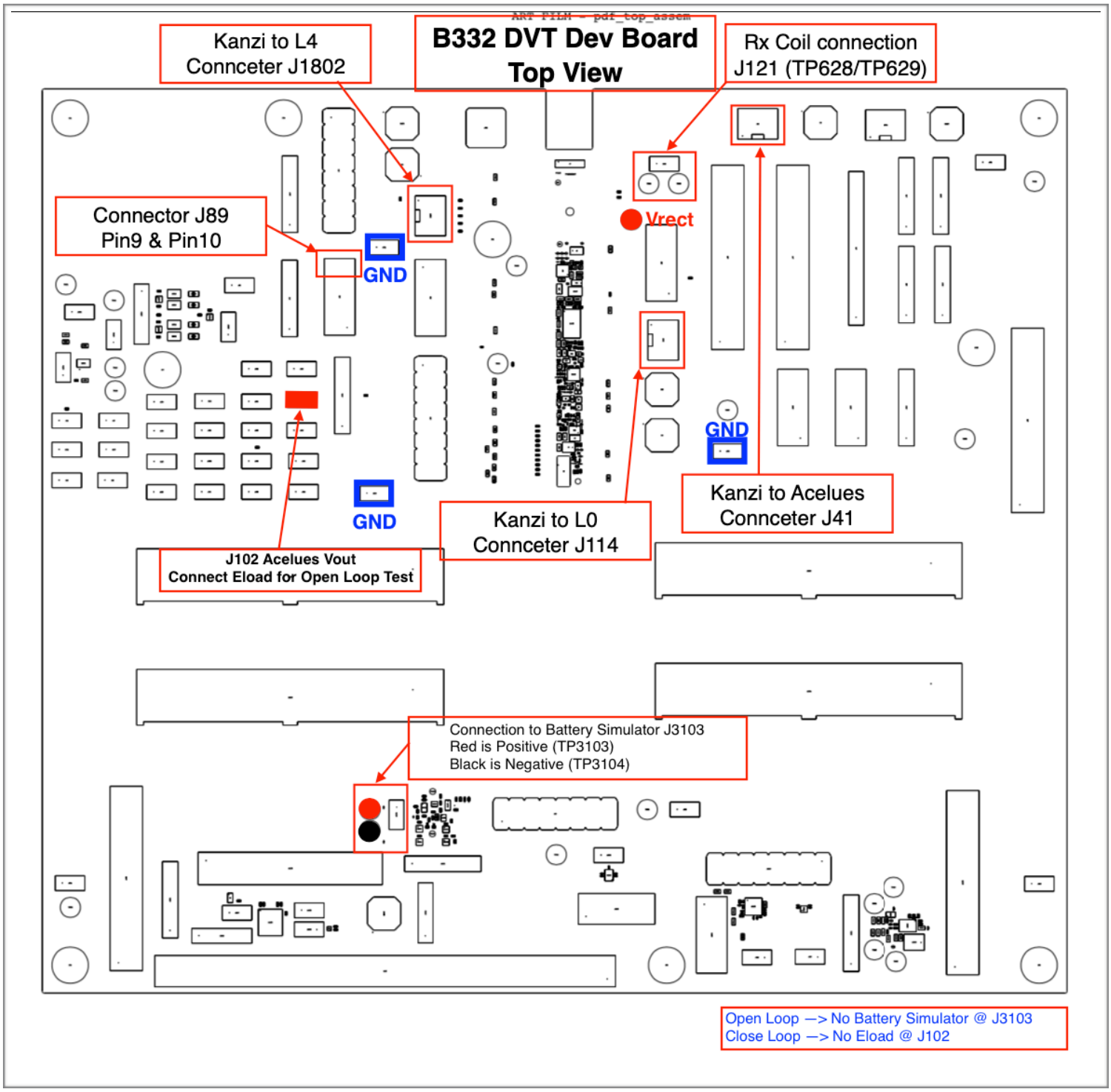
Acceptance:

Test Parameter	Insight Keys Recorded	Comments/Notes
Check Sum - Sector 127	**SCRP_Check Sum__S127_MTP_AFTER**	Pass if this values match with MTP check before test i.e. **Section 8.3**
Check Sum - Sector 126	**SCRP_Check Sum_S126_MTP_AFTER**	
LPP Inductance_MTP	**SCRP_LPP_L_MTP_AFTER**	
LPP Frequency_MTP	**SCRP_LPP_FREQ_MTP_AFTER**	
Tx HWID_MTP	**SCRP_TX_HWID_MTP_AFTER**	
Ctx_MTP	**SCRP_CTx_MTP_127_AFTER**	
VBoost_MTP	**SCRP_VBoost_MTP_AFTER**	
VSense_MTP	**SCRP_VSense_MTP_AFTER**	
ISense_MTP	**SCRP_IBoost_MTP_AFTER**	
LFOD_MTP	**SCRP_LFOD_MTP_AFTER**	
Version	**SCRP_Version_MTP_AFTER**	
Signature	**SCRP_Signature_MTP_AFTER**	

A. Appendix - B332 Dev Board UART Baud rate

The B332 Dev Board is used to send commands to I2C of Aculeus using UART cable. Follow the steps below to open the B332 Dev Board UART.

1. Connect UART (1MBite baudrate, 1.8V) to J89 (Pin9 & Pin 10)
2. Open Terminal
3. nanocom -w 0 -c 1000000,n,8,1
4. Select your Connected UART option.



Note:-Testing with Ginger Rx board is a backup incase factory is not able to get B332 open loop test up and running on time.

B. Feature DRI Comments for Changes to this Document

Feature	DRI	Description/Comments/Reason for Change	Date	Approved and released in Version:
Power, Efficiency & Comms	Bhushan	Replaced Close Loop with Open Loop and Comms with Pingpong as P0 does not support Close Loop.	2 September 2019	
Magnetic - Coil fixture specs	Bhushan/Jin	Updated Coil fixture specification for coupling measurements value to include nominal values + Tolerance limits	14 September 2019	
Power Transfer	Bhushan	Swaped the Sequence of Boost enable & Full Bridge to avoid loading from LPP Boost.	17 September 2019	
General	Bhushan/Mikhal/Jin/ Bernard/Frank	Updated the test limits for all the test parameters based on GBD and Factory data distribution.	20 September 2019	
LPP/Power Transfer	Bhushan	Corrected the LPP and Power Transfer Limits	25 September 2019	
		11/5 KBha: Ensure all limits Vctx, Vboost, IBoost, Vrect and Irect are tailored based on ***actual*** Rx QLC for station. Current limits are based on many Rx QLC corners which will result in missed learnings and CPx >> 2.		
MTP	Bhushan/Samira	Update locations of all the word calibrated/Used from MTP.	26 November 2019	Samira/P1_V1.5
Comms	Bhushan/Mikhal	Added Digital ping test at 0.1C	5 December 2019	Mikhal/P1_V1.6
LPP	Bhushan	Corrected calculation for LLP delta values	18 December 2019	Bhushan/P1_V1.8
Power Transfer	Mikhal	Minimum boost requirement has changed from 6000mV to 6100mV.	21 February 2020	Mikhal/Bhushan/ P1_V2.0