Factory FCT Test Plan for J307

Module: Scorpius
Station: SFCT
Build: EVT
Release Date: 5 August 2020

This Document Covers the Following Products:J307

Revision: EVT_V4.2

<rdar://problem/51782237> J307 Scorpius factory ERS

<rdar://problem/60027625> J3xx&J5xx Scorpius ERS - Foxconn

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

Table of Contents

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	Initial Draft	16 June 2019	Initial release for J307 P0 Build.	Bhushan Koli, Bernard dela Cruz
	1.1	24 July 2019	Review all tests, and test procedure. Finalised the tests on FCT for P0, some adjustment on test steps. Limits and firmware commands are still open, and will finalise once firmware command is ready and validated	Bernard Dela Cruz Lee Zhang And feature DRI
	1.2	30 July 2019	Removed the additional test for the 2 LFOD resistors, because we have coverage in ICT now. Correct the probing inserting point for Current Sense calibration to "PP_DOTARA_VRECT"	Bernard Dela Cruz Lee Zhang And feature DRI
	1.3	12 August 2019	Changing/adding all the smokey commends. Change the Vboost control calibration from linear fitting to making sure the 6V points is closest point to 6V but need to be above 6V. Added all the calibration calculation, address for storages Added a section for Vboost control validation	Bernard Dela Cruz Bhushan Koli Lee Zhang And feature DRI
	1.4	22 August 2019	Updated MTP writing and replaced Critical error check with MTP sector Check. Updated Grape/Kona sync section and LFOD calibration section.	Bhushan Koli, Lee Zhang
	1.5	28 August 2019	Updated MTP writing and Load Tx Fw section. Updated Coil Fixture Specification section for magnetic requirements.	Bhushan Koli, Jin Yu
	1.6	29 August 2019	Updated HWID & CTx word location in MTP Section. And Commands in LPP Section	Bhushan Koli
	1.7	30 August 2019	Add Radar for Scorpius Factory FW releases and smokey Commnads updates and Checksum Calculation update.	Bhushan Koli, Lou Cendana
	1.8	30 August 2019	Added packets details in ping-pong section. For vendor to implement, because vendor use different hardware test platform.	Lee
	1.9	31 August 2019	Added default memory before MTP memory write in and verify MTP section. This is to enable the memory sectors, so the calibrations on the FCT tests are turn on, and will still able to operate without calibrations from stations in the later stage	Lee
	2.0	5 September 2019	Updated Power, Efficiency and Pingpong test procedure to include changing Bridge phase to achieve desired loading conditions and response format of Pingpong test data. Also Updated the Verify calibration test procedure.	Bhushan Koli, Lou Cendana
	2.1	9 September 2019	Updated MTP Sector Write & Read section to include CTx value into Sector 127:Word2	Bhushan Koli, Samira Bakhtiari
	2.2	14 September 2019	Updated Coil Fixture Specification and LPP boost test procedure	Bhushan Koli, Jin Yu, Frank Brooks
	2.3	17 September 2019	Updated the Scorpius throttle Test sequence and Swapped the Sequence of Boost Enable and Full Bridge Enable in Calibration and Power Efficiency section	Bhushan Koli
	2.4	20 September 2019	Reverted back the Scorpius throttle Test sequence back to original one and updated the test limits for all test parameters based unto GBD/Factory data.	Bhushan Koli
P1	2.5	12 November 2019	Updated all the limits based on GBD/Factory built data and updated MTP words location and added Self Heating test in Power & Efficiency part.	All DRIs
	2.6	18 November 2019	Updated all the limits based for coil Specs and Some command for SOC GPIOs and MTP Section	Bhushan/Jin/Selestino
	2.7	25 November 2019	Updated MTP write from single word to all words in one go.	Bhushan/Selestino
	2.8	5 December 2019	Added test for AOP to Scorpius Connectivity check	Bhushan
	2.9	11 December 2019	Updated Isense Calibration test procedure to disable LFOD amplifier	Bhushan/Jin
	3.0	17 December 2019	Updated Limits based on GBD and initial P1 Built data	Bhushan/Jin/Frank/Bernard/ Mikhal
P1B	3.1	19 February 2020	Added LFOD CMR calibration test, Dotara to AOP IRQ functionality. Added Limits to GPIO to Dotara & AOP test. Updated the names of Insight key parameters. Updated Comms-FSK test.	Bhushan/Jin/Frank/Bernard/ Mikhal/Min
	3.2	21 February 2020	Updated Minimum Vboost requirement from 6V to 6.1V	Bhushan/Mikhal
	3.3	10 March 2020	Updated limits for Vsense and Vsense Sampling during calibration, and procedure for Isense Read.	Bhushan/Jin
			Updated command in Garpe to Dotara Sync and AOP to IRQ test	Bhushan/Min
	3.4	13 March 2020	Updated 10C Vsense limits to be +/- 0.6%. Reviewed all Observable limits and highlighted in yellow (Vctx_ipeak, Vsns, Isns)	Daniel Randall
	3.5	31 March 2020	- Added new Digital Filter SOP for fixture to implement it. - Updated command and format for LPP and VCTx - Added reading Sector 129 of MTP for Vendor data.	Bhushan/Jin/Aijun
	3.6	3 April 2020	Updated Dotara Heart Beat Response type Added Rsense estimation before Isense Calibarion. Updated Vsense during calibration and power flow test to Disable LFOD.	Bhushan/Aijun/Jin
Pre-EVT	3.7	17 April 2020	Updated AOP connection test Updated limits for Vsense, Vin & Scorpius Boost	Bhushan/Bernard

Build Type	Version	Date	Notes	Author
Pre-EVT	3.8	22 April 2020	Updated Rsense, Isense calibration and Vsense/Isense Verification procedure. Added Ripple measurement at Scorpius boost test and during power flow test. Update Dotara Inverter Bridge procedure and limits	Bhushan/Bernard
Pre-EVT	3.9	11 May 2020	Updated limits for Ripple measurement at Scorpius boost test and during power flow test. Updated few other limits.	Bhushan/Bernard
EVT	4.0	19 June 2020	Updated Insight key names as per Factory norms/ Test Script. Updated few other limits Updated Gcal & Ocal formulas for Vsense, ISense & LFOD for FW change Removed 3C charging Power Flow test.	Bhushan/Bernard/Jin
	4.1	31 July 2020	Took out the DC measurement test when Boost is Disabled. See Comment section for more details.	Bhushan/Bernard/Jin
	4.2	5 August 2020	Took out the LFOD CMR calibration test as it is not need anymore Added VMID5 (PP20V_DOTARA) measurement before every boost enable/set command to make sure VMID5<1200mV	Bhushan/Rex/Jin/Daniel

2. Purpose

This document describes the SFCT test plan for the J307 Scorpius Inductive Power Tx module for P0.

3. Scope

The scope of this document is the Scorpius only module of the J307 products. Refer Section 8 for test details.

4. References

<rdar://problem/47434171> J4xx Scorpius factory ERS
<rdar://problem/48910417> Dotara Data-sheet
<rdar://problem/48964978> Dotara Block initialization
<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
-	Wireless Power	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

Charge Rate	0.1C @ 6.5V Vrect on Rx	3C @ 8V Vrect on Rx	10C @ 14V Vrect on Rx
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

6. Critical and Frequently Used Commands

6.1. Quiesce Test Mode

After programming the Tx defaults to Nominal Mode (*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 that 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 (i.e.,* ***Section 8.3.6. Writing Calibration Values into MTP****) or power cycled or Nominal Mode has been set.* ***If the unit is power cycled you will need to load fw again.***

6.2. 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

7.1. Coil Fixture Specifications

Throughout this document various tests will have different limits depending on the coupling.
All = all possible positions (minK & maxK)

The table below shows the coil fixture specs for the SFCT. Understanding that K, Q and L cannot be guaranteed simultaneously, we are targeting K as the primary parameter.

Use 128 kHz in measuring all the parameters in below table. All of the following parameters should be measured as part of fixture bring-up and included in the overlay to be uploaded with every individual unit's test results for traceability purposes.

Test Parameters	Insight Keys Recorded	Min	Max	Units	Notes
L_Tx @ Kmin	WirelessPower Coil_Audit-Initial Kmin_Tx_Coil_L	17.00	19.10	µH	This value must be met
Q_Tx @ Kmin	WirelessPower Coil_Audit-Initial Kmin_Tx_Coil_Q	7.50	9.20	N/A	FYI only. Based on P0 data and FEA.
L_Rx @ Kmin	WirelessPower Coil_Audit-Initial Kmin_Rx_Coil_L	99.00	109.50	µH	FYI only. Based on P0 data and FEA.
Q_Rx @ Kmin	WirelessPower Coil_Audit-Initial Kmin_Rx_Coil_Q	9.40	10.60	N/A	FYI only. Based on P0 data and FEA.
Coupling (K) @ Kmin	WirelessPower Coil_Audit-Initial Kmin_Coil_Coupling	0.475	0.490	-	This value must be met
L_Tx @ Kmax	WirelessPower Coil_Audit-Initial Kmax_Tx_Coil_L	20.60	22.70	µH	This value must be met
Q_Tx @ Kmax	WirelessPower Coil_Audit-Initial Kmax_Tx_Coil_Q	9.30	11.50	N/A	FYI only. Based on P0 data and FEA.
L_Rx @ Kmax	WirelessPower Coil_Audit-Initial Kmax_Rx_Coil_L	116.60	128.80	µH	FYI only. Based on P0 data and FEA.
Q_Rx @ Kmax	WirelessPower Coil_Audit-Initial Kmax_Rx_Coil_Q	10.00	12.70	N/A	FYI only. Based on P0 data and FEA.
Coupling (K) @ Kmax	WirelessPower Coil_Audit-Initial Kmax_Coil_Coupling	0.648	0.664	-	This value must be met

8. Test Coverage @ Scorpius FCT Test Station

8.1. Load Tx FW & Read Version

Description:-Load Tx FW on to Dotara as it 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 (i.e.,* ***Section 8.3.6. Writing Calibration Values into MTP****) 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 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 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}"
1	Set Vin 3.6V. Or Preparation to pull high: PMU_TO_DOTARA_EN_EXT	Fixture	pmugpio --pin 3 --pushpull --output 1 socgpio --port 1 --pin 46 --output 1 Note: 3.6V ±1% must be met.
2	Tell Tx to get out of standalone mode.	TX 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 Diags	**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 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 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}"
6	Read Status (Version)	TX Diags	smokey ScorpiusHid --run --test "Get" --args "ReportID=0xBB"

Command to read Tx FW version:

smokey ScorpiusHid --run --test "Get" --args "ReportID=0xBB"

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	WirelessPower Dotara_FWDL-I2C Check_Tx_Version	

8.2. Circuit Functionality Tests - via Pogo Pins

8.2.1.Check PPVCC_Main Supply, 1V8 Supply, 2V95 Supply

Description:-To test the power supply across the Scorpius module.
Failure Mode(s) Captured:TBD
Note: Measure the following test points with respect to GND
Test Setup and Procedure:

Step	Description	Interface	Command / Notes
	PPVCC_Main Supply		
1	Measure the following test point "PPVCC_MAIN"	Fixture	Measure at test point closest to Scorpius Boost IC (U6000)
	1V8 Supply		
2	Measure the following test point "PP1V8_S3"	Fixture	Measure at test point closest to Dotara (U6200)
	2V95 Supply		
3	Measure the following test point "PP2V95_S2_SCORPIUS_FILT"	Fixture	Measure at test point closest to Dotara (U6200)

Acceptance criteria:

Net Name	Insight Keys Recorded	LL	Nominal	UL	Units	Comments
	PPVCC_Main _Supply					
"PPVCC_MAIN"	WirelessPower Voltage_Check-Active PPVCC_MAIN	3564	3600	3636	mV	3.6V± 1%
	1V8 Supply					
"PP1V8_S2"	WirelessPower Voltage_Check-Active PP1V8_S2_SENSORS	1794	1800	1812	mV	Based from volume data
	2V95 Supply					
"PP2V95_S2_SCORPIUS_FILT"	WirelessPower Voltage_Check-Active PP2V95_S2_SCORPIUS_FILT	2947	2950	2975	mV	Based from volume data

8.2.2.Scorpius Boost, LPP Boost + LPP Switch Test

Description:-To test functionality of Scorpius Boost, LPP Boost + LPP Switch.
Failure Mode(s) Captured:TBD
Test procedure:

Step	Description	Interface	Command / Notes
1	Measure the following test points "PP20V_DOTARA"	Fixture	Reference to nearest GND for the respective TPs. NOTE:- Continue with next step if PP20V_DOTARA <1200mV, if not then delay for 1sec and remeasure.
2	Set Boost Voltage to 6.5V±1% (this will turn on LPP_5V_EN automatically)	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0x70; 0x17; 0xF4; 0x01}" **Payload: (LSB-MSB)** ——> Byte0-1: Boost voltage (eg. 0x1770 = 6000mV)
3	Measure the following test points "BOOST_EN" "PP20V_SCORPIUS_BOOST_SW" "PPVBUS_SCORPIUS_BOOSTED" "PP20V_DOTARA" "LPP_5V_EN" "PP5V5_LPP_BOOST_VOUT"	Fixture	"PP5V5_LPP_BOOST_VOUT " needs at least 300uS delay to stabilised
4	Delay at least 300uS to stabilised	Fixture	
5	Set Boost Voltage to 0V (turn off VBoost, and LPP_5V_EN remains on)	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0x00; 0x00; 0xF4; 0x01}" **Payload: (LSB-MSB)** ——> Byte0-1: Boost voltage (eg. 0x0000 = 0mV)
6	Delay at least 300uS to stabilised	Fixture	
7	Measure the following test points "PP20V_DOTARA" & "PP5V5_LPP_BOOST_VOUT"	Fixture	
8	Disable LPP Switch "LPP_5V_EN"	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x01, ReportPayload={0x00}" **Payload: (LSB-MSB)** ——> Byte0: 0 - turn off, 1 - turn on
9	Delay at least 1s to steady state	Fixture	
10	Measure all test points from Step 2, Except "PP20V_SCORPIUS_BOOST_SW" for Amplitude measurement	Fixture	

Acceptance criteria:

Net Name	Insight Keys Recorded	LL	UL	Units	Comments
Before Boost EN is set HIGH					
"PP20V_DOTARA"	WirelessPower Boost_DC_Meas@Scorpius-VCC_MAIN3V6_BEFORE BOOST ENABLED PP20V_DOTARA	0	1200	mV	Record this only if PP20V_Dotara >1200mV
When Boost Enabled (i.e. set to 6.5V)					
"BOOST_EN"	WirelessPower Boost_DC_Meas@Scorpius-VCC_MAIN3V6 BOOST_EN_Enable	1680	1723	mV	Limits are based on Dotara GPIO VOH spec
"PP20V_SCORPIUS_BOOST_SW_Amp"	WirelessPower Boost_DC_Meas@Scorpius-VCC_MAIN3V6 PP20V_SCORPIUS_BOOST_SW_AMPL_Enable	6350	6750	mV	Based from volume data
"PP20V_SCORPIUS_BOOST_SW_Freq"	WirelessPower Boost_DC_Meas@Scorpius-VCC_MAIN3V6 PP20V_SCORPIUS_BOOST_SW_FREQ_Enable	1155	1265	kHz	Based from volume data
"PP20V_SCORPIUS_BOOST_SW_Duty"	WirelessPower Boost_DC_Meas@Scorpius-VCC_MAIN3V6 PP20V_SCORPIUS_BOOST_SW_DC_Enable	54.1	55.5	%	GBD
"PPVBUS_SCORPIUS_BOOSTED"	WirelessPower Boost_DC_Meas@Scorpius-VCC_MAIN3V6 PPVBUS_SCORPIUS_BOOSTED_Enable	6435	6565	mV	6.5V ±1%
"LPP_5V_EN"	WirelessPower Boost_DC_Meas@LPP-VCC_MAIN3V6 LPP_5V_EN_Enable	1776	1795	mV	Limits are based on Dotara GPIO VOH spec
"PP20V_DOTARA"	WirelessPower Boost_DC_Meas@LPP-VCC_MAIN3V6 PP20V_DOTARA_Enable	6445	6620	mV	Limit based from volume data
"PP5V5_LPP_BOOST_VOUT"	WirelessPower Boost_DC_Meas@LPP-VCC_MAIN3V6 PP5V5_LPP_BOOST_VOUT_Enable	5290	5530	mV	GBD
When Boost Disabled (i.e. set to 0V)					
"PP20V_DOTARA"	WirelessPower Boost_DC_Meas@LPP-VCC_MAIN3V6 PP20V_DOTARA_LPP_Enable	5030	5260	mV	GBD
"PP5V5_LPP_BOOST_VOUT"	WirelessPower Boost_DC_Meas@LPP-VCC_MAIN3V6 PP5V5_LPP_BOOST_VOUT_LPP_Enable	5280	5520	mV	GBD
When Boost Disabled (i.e. set to 0V) & "LPP_5V_EN" is Disabled					
"BOOST_EN"	WirelessPower Boost_DC_Meas@Scorpius-VCC_MAIN3V6_Scorpius_DSBL BOOST_EN_Disable	0	10	mV	Based from volume data
~~"PP20V_SCORPIUS_BOOST_SW_Amp"~~	~~WirelessPower Boost_DC_Meas@Scorpius-VCC_MAIN3V6_Scorpius_DSBL PP20V_SCORPIUS_BOOST_SW_AMPL_Disable~~	~~3597~~	~~3605~~	~~mV~~	
"PP20V_SCORPIUS_BOOST_SW_Freq"	WirelessPower Boost_DC_Meas@Scorpius-VCC_MAIN3V6_Scorpius_DSBL PP20V_SCORPIUS_BOOST_SW_FREQ_Disable	0	0	Hz	
"PP20V_SCORPIUS_BOOST_SW_Duty"	WirelessPower Boost_DC_Meas@Scorpius-VCC_MAIN3V6_Scorpius_DSBL PP20V_SCORPIUS_BOOST_SW_DC_Disable	0	0	%	
"LPP_5V_EN"	WirelessPower Boost_DC_Meas@LPP-VCC_MAIN3V6_LPP_DSBL LPP_5V_EN_Disable	0	10	mV	Limits are based on Dotara GPIO VOH spec
"PP20V_DOTARA"	WirelessPower Boost_DC_Meas@LPP-VCC_MAIN3V6_LPP_DSBL PP20V_DOTARA_Disable	0	13	mV	Limit based from volume data
"PP5V5_LPP_BOOST_VOUT"	WirelessPower Boost_DC_Meas@LPP-VCC_MAIN3V6_LPP_DSBL PP5V5_LPP_BOOST_VOUT_LPP_Disable	0	10	mV	SN1909011 provides the true shutdown function and the load is completely disconnected from the input.

8.2.2.1.Scorpius Boost - Ripple Measurements

Description: To test ripple on the output of Scorpius Boost circuit.
Failure Mode(s) Captured: High ripple due to component failure
TestSetup and Procedure: Refer below

Step	Description	Interface	Command / Notes
1	Set PPVCC_MAIN_SCORPIUS voltage to **3.6V**	Fixture	pmugpio --pin **14** --output 1 --pushpull pmugpio --pin **18** --output 1 --pushpull **Note:** 3.6V ±1% must be met.
2	Disable Full Bridge (Bridge is turned off by setting Inverter frequency to 0)	Tx Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x04, ReportPayload={0x00; 0x00; 0x00; 0x00; 0x50; 0x46; 0x50; 0x46}"
3	Measure the following test points "PP20V_DOTARA"	Fixture	Reference to nearest GND for the respective TPs. NOTE:- Continue with next step if PP20V_DOTARA <1200mV, if not then delay for 1sec and remeasure.
4	Set Boost Voltage to 6.1V (this will automatically enable LPP_5V_EN) **Note:** Minimum Vboost is 6100mV, Don't set Vboost < 6100mV.	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0x70; 0x17; 0xF4; 0x01}" **Payload: (LSB-MSB)** ——> Byte0-1: Boost voltage (eg. 0x1770 = 6000mV)
5	Set E-load to 24mA at PP_DOTARA_VRECT	Fixture	Load via pogo pins on TP06IF and TP06IN with reference to GND TPs (TP065Q and TP065K)

Step	Description	Interface	Command / Notes
6	Connect "PPVBUS_SCORPIUS_BOOSTED" test pin to HADC	Fixture	
7	Measure Ripple at 7kHz using HADC	Fixture	
8	Set E-load to 161mA at PP_DOTARA_VRECT	Fixture	Load via pogo pins on TP06IF and TP06IN with reference to GND TPs (TP065Q and TP065K)
9	Measure Ripple at 7kHz using HADC	Fixture	
10	Set Boost Voltage to 12.2V	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0x70; 0x17; 0xF4; 0x01}" **Payload: (LSB-MSB)** ——> Byte0-1: Boost voltage (eg. 0x1770 = 6000mV)
11	Measure Ripple at 7kHz using HADC	Fixture	
12	Set E-load to 450mA at PP_DOTARA_VRECT	Fixture	Load via pogo pins on TP06IF and TP06IN with reference to GND TPs (TP065Q and TP065K)
13	Measure Ripple at 7kHz using HADC	Fixture	
14	Turn off E-load and disconnect "PPVBUS_SCORPIUS_BOOSTED" test pin from HADC	Fixture	
15	Set Boost Voltage to 0V	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0x70; 0x17; 0xF4; 0x01}" **Payload: (LSB-MSB)** ——> Byte0-1: Boost voltage (eg. 0x1770 = 6000mV)

Acceptance criteria:

Net Name	Insight Keys Recorded	LL	UL	Units	Comment
"PP20V_DOTARA"	WirelessPower Boost_Ripple_Meas@SCORP-BEFORE BOOST ENABLED PP20V_DOTARA	0	1200	mV	Record this only if PP20V_Dotara >1200mV
"PPVBUS_SCORPIUS_BOOSTED"	WirelessPower Boost_Ripple_Meas@SCORP-Vboost6V_Eload24mA Get_RIPPLE_7K_VPP	0	15	mV	Based on volume data
	WirelessPower Boost_Ripple_Meas@SCORP-Vboost6V_Eload161mA Get_RIPPLE_7K_VPP	0	15		
	WirelessPower Boost_Ripple_Meas@SCORP-Vboost12V2_Eload161mA Get_RIPPLE_7K_VPP	6	20		
	WirelessPower Boost_Ripple_Meas@SCORP-Vboost12V2_Eload450mA Get_RIPPLE_7K_VPP	13	40		

8.2.3.Scorpius Throttle

Description: Test the Scorpius throttle circuit.
Failure Mode(s) Captured: R6013, R6016, R6015 and U6002 solder (not going to measure resistance)
Test Setup and Procedure: Refer below

Step	Description	Interface	Command / Notes
1	Measure the following test points "PP20V_DOTARA"	Fixture	Reference to nearest GND for the respective TPs. NOTE:- Continue with next step if PP20V_DOTARA <1200mV, if not then delay for 1sec and remeasure.
2	Set boost voltage to 10V.	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0x10; 0x27; 0xF4; 0x01}" **Payload: (LSB-MSB)** ——> Byte0-1: Boost voltage (eg. 0x2710 = 10000mV)
3	Measure BOOST_EN is high	Fixture	
4	Reduce PPVC_MAIN below 2.95V	Fixture	
5	Delay at least 100uS to stabilised	Fixture	
6	Measure BOOST_EN is low	Fixture	

Acceptance criteria:

Net Name	Insight Keys Recorded	LL	UL	Units	Comments
"PP20V_DOTARA"	WirelessPower Boost_Throttle_Test@SCORP-BEFORE BOOST ENABLED PP20V_DOTARA	0	1200	mV	Record this only if PP20V_Dotara >1200mV
"BOOST_EN"	WirelessPower Boost_Throttle_Test@SCORP-VBUS0V BOOST_EN_High	1680	1735	mV	
	WirelessPower Boost_Throttle_Test@SCORP-VBUS0V BOOST_EN_Low	0	13	mV	

8.2.4.Dotara Bridge Inverter Check

Description:-To test the Functionality of Dotara.
Failure Mode(s) Captured: Path to the external coil connector, Tx cap, and connection to the wake up timer.
Test procedure:

Step	Description	Interface	Command / Notes
1	Connect Coil at Kmin position	Fixture	
2	Measure the following test points "PP20V_DOTARA"	Fixture	Reference to nearest GND for the respective TPs. NOTE:- Continue with next step if PP20V_DOTARA <1200mV, if not then delay for 1sec and remeasure.
3	Set Boost Voltage to 6.1V (this will automatically enable LPP_5V_EN) **Note:** Minimum Vboost is 6100mV, Don't set Vboost < 6100mV.	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0x70; 0x17; 0xF4; 0x01}" **Payload: (LSB-MSB)** ——> Byte0-1: Boost voltage (eg. 0x1770 = 6000mV)
4	Enable Full Bridge (Set Inverter)	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x04, ReportPayload={0x1C; 0xF3; 0x01; 0x00; 0x50; 0x46; 0x50; 0x46}" **Eg 0x4650:** 18000cdeg = 180deg phase
5	Measure the following test points "PPVCC_TX_AC1" & "PPVCC_TX_AC2" "PPVCC_TX_COIL_NEG" & "PPVCC_TX_COIL_POS"	Fixture	"PPVCC_TX_COIL_NEG" with-respect-to "PPVCC_TX_COIL_POS":-***Measure using Differential Probe*** Other test points are with respect to GND
6	Disable Full Bridge (Bridge is turned off by setting Inverter frequency to 0)	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x04, ReportPayload={0x00; 0x00; 0x00; 0x00; 0x50; 0x46; 0x50; 0x46}"
7	Disconnect coil from Kmin	Fixture	

Acceptance criteria:

Net Name	Insight Keys Recorded	LL	UL	Units	Comments
"PP20V_DOTARA"	WirelessPower Inverter_Meas-BEFORE BOOST ENABLED PP20V_DOTARA	0	1200	mV	Record this only if PP20V_Dotara >1200mV
"PPVCC_TX_AC1" Frequency	WirelessPower Inverter_Meas-Vboost6V1 PPVCC_TX_AC1_FREQ	127770	127778	Hz	Limit based from volume data
"PPVCC_TX_AC1" Duty cycle	WirelessPower Inverter_Meas-Vboost6V1 PPVCC_TX_AC1_DC	49	50	%	GBD :- Measure at 70% of the pulse
"PPVCC_TX_AC1" Amplitude	WirelessPower Inverter_Meas-Vboost6V1 PPVCC_TX_AC1_AMPL	6410	6670	mV	Limit based from volume data
"PPVCC_TX_AC2" Frequency	WirelessPower Inverter_Meas-Vboost6V1 PPVCC_TX_AC2_FREQ	127770	127778	kHz	Limit based from volume data
"PPVCC_TX_AC2" Duty cycle	WirelessPower Inverter_Meas-Vboost6V1 PPVCC_TX_AC2_DC	49	50	%	GBD :- Measure at 70% of the pulse
"PPVCC_TX_AC2" Amplitude	WirelessPower Inverter_Meas-Vboost6V1 PPVCC_TX_AC2_AMPL	6410	6670	mV	Limit based from volume data
"PPVCC_TX_COIL" Frequency	WirelessPower Inverter_Meas-Vboost6V1 PPVCC_TX_COIL_FREQ	127770	127778	kHz	Limit based from volume data
"PPVCC_TX_COIL" Amplitude	WirelessPower Inverter_Meas-Vboost6V1 PPVCC_TX_COIL_AMPL	16400	21700	mV	Limit based from volume data. Note:- Pk-Pk value

8.2.5.Dotara Heart Beat Connection Check

Description: Test the Dotara heart beat connection to Dotara.
Failure Mode(s) Captured: This is critical for the LPP feature.
Test Setup and Procedure: Refer below

Step	Description	Interface	Command / Notes
1	Pull Test Pin TP064O High (i.e. "DOTAR_WAKE_HEART_BEAT")	Tx Diags	pmugpio --port 1 --pin 43 --output 1
2	Read the this signal from MCU	Tx Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x40, ReportPayload={0x9C; 0x3C; 0x00, 0x40}" **——> Fixture wait 5 msec <——** smokey ScorpiusHid --run --test "Get" --args "ReportID=0x40" **Response—>** **byte 0 = report ID** **byte 1 = error code (0 = no error)** **byte 6, second bit = (0 : low, 1: high)**
3	Pull Test Pin TP064O Low (i.e. "DOTAR_WAKE_HEART_BEAT")	Tx Diags	pmugpio --port 1 --pin 43 --output 0
4	Repeat step 2	Tx Diags	

Acceptance criteria:

Net Name	Insight Keys Recorded	Nominal	Units	
"DOTARA_WAKE_HEART_BEAT"	WirelessPower DOTARA_GPIO_Check HEART_BEAT_HIGH	1	N/A	Note: Convert Hex response to Bin and check the Bit1 . For High —>Bit 1 = 1,For Low —> Bit 1 = 0
	WirelessPower DOTARA_GPIO_Check HEART_BEAT_LOW	0	N/A	

8.2.6.Grape to Dotara Sync Connection Check

Description: Test the connection between SOC and Dotara, for the feature of avoid LPP during touch event.
Failure Mode(s) Captured: Cannot flag the touch event.
Test Setup and Procedure: Refer below

Step	Description	Interface	Command / Notes
1	Enable Touch Display	Tx Diags	--touch --on
2	Pull Test Pin TP934H High (i.e. "GPIO_GRAPE_TO_SCORPIUS_TIME_SYNC_1V8")	Tx Diags	egpio --pick touch:1 --pin 10 --mode output --write 1
3	Read the this signal from MCU	TX Diags	The following command reads directly from the address specified: smokey ScorpiusHid --run --test "Mem32" --args "Address=0x40000C00, Length=4" **Check bit1 is set of the response data (ie GPIO2 pin state)** Example:- When it is high , 40000C00 : 0xxxxxx6, when it is low, 40000C00:0xxxxxx4 **6 (Hex) —-> 0110 (Binary) ===> Bit 1 = 1; 4 (Hex) —-> 0100 (Binary) ===> Bit 1 = 0**
4	Pull Test Pin TP934H Low (i.e. "GPIO_GRAPE_TO_SCORPIUS_TIME_SYNC_1V8")	Tx Diags	egpio --pick touch:1 --pin 10 --mode output --write 0
5	Repeat step 3	TX Diags	
6	Disable Touch Display	Tx Diags	--touch --off

Acceptance criteria:

Net Name	Insight Keys Recorded	Nominal	Units	Comment
"GPIO_GRAPE_TO_DOTARA_TIME_SYNC_1V8"	WirelessPower DOTARA_GPIO_Check GPIO_GRAPE_TO_DOTARA_TIME_SYNC_1V8_High	1	N/A	No need to test the Voltage at this pin as Dotara can detect this signal. **Note: Convert Hex response to Bin and check the Bit1 . For High —>Bit 1 = 1,For Low —> Bit 1 = 0**
	WirelessPower DOTARA_GPIO_Check GPIO_GRAPE_TO_DOTARA_TIME_SYNC_1V8_Low	0	N/A	

8.2.7.AOP to Dotara Connection Check

Description:To test the connection between AOP and Dotara.
Failure Mode(s) Captured: Cannot flag the touch event.
Test Setup and Procedure: Refer below

Step	Description	Interface	Command / Notes
1	Disable SWD for GPIO reading	Tx Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x08; 0x36; 0x00; 0x40; 0x01; 0x00; 0x00; 0x00}"
2	Pull Test Pin TP9347 High (i.e. "DOTARA_SWDIO_1V8" Or "DOTARA_SOC_SWDIO")	Tx Diags	socgpio --port 0 --pin 172 --output 1
3	Pull Test Pin TP9348 High (i.e. "DOTARA_SWCLK_1V8" Or "DOTARA_SOC_SWCLK")	Tx Diags	socgpio --port 0 --pin 21 --output 1
4	Read status of this pin on Dotara	Tx Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x40, ReportPayload={0x00; 0x0C; 0x00: 0x40}" **——> Fixture wait 5 msec <——** smokey ScorpiusHid --run --test "Get" --args "ReportID=0x40" **Response—>** byte 0 = report ID byte 1 = error code (0 = no error) byte 6, bit0-SWDIO = (0 : low, 1: high), bit4-SWDCLK = (0 : low, 1: high)
5	Pull Test Pin TP9347 Low (i.e. "DOTARA_SWDIO_1V8" Or "DOTARA_SOC_SWDIO")	Tx Diags	socgpio --port 0 --pin 172 --output 0
6	Pull Test Pin TP9348 Low (i.e. "DOTARA_SWCLK_1V8" Or "DOTARA_SOC_SWCLK")	Tx Diags	socgpio --port 0 --pin 21 --output 0
7	Repeat step 4	Tx Diags	
8	Enable SWD	Tx Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x08; 0x35; 0x00; 0x40; 0x01; 0x00; 0x00; 0x00}"

Acceptance criteria:

Net Name	Insight Keys Recorded	Nominal	Units	Comments
"DOTARA_SWDIO_1V8"	WirelessPower DOTARA_GPIO_Check DOTARA_SWDIO_1V8_High	1	-	No need to test the Voltage at this pin as Dotara can detect this signal. **Note: Convert Hex response to Bin and check the Bit0 .** **For High —>Bit 0 = 1,For Low —> Bit 0 = 0**
	WirelessPower DOTARA_GPIO_Check DOTARA_SWDIO_1V8_Low	0	-	
"DOTARA_SWCLK_1V8"	WirelessPower DOTARA_GPIO_Check DOTARA_SWCLK_1V8_High	1	-	No need to test the Voltage at this pin as Dotara can detect this signal. **Note: Convert Hex response to Bin and check the Bit4 .** **For High —>Bit 4 = 1,For Low —> Bit 4 = 0**
	WirelessPower DOTARA_GPIO_Check DOTARA_SWCLK_1V8_Low	0	-	

8.2.8.Dotara to AOP IRQ Test

Description: To test the functionality of Dotara to AOP.
Failure Mode(s) Captured:[TBD].
Test Setup and Procedure: Refer below

Step	Description	Interface	Command / Notes
1	Pull Test Pin TP9349 High (i.e. "GPIO_DOTARA_TO_SOC_SCM_INT_1V8" Or "GPIO_DOTARA_TO_SOC_SCM_INT")	Tx Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x6c; 0x35; 0x00; 0x40; 0x01; 0x00; 0x00; 0x00}"
2	Read AOP_FUN18 on AOP side	TX Diags	socgpio --port 1 --pin 31 --get
3	Pull Test Pin TP9349 low (i.e. "GPIO_DOTARA_TO_SOC_SCM_INT_1V8" Or "GPIO_DOTARA_TO_SOC_SCM_INT")	Tx Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x6c; 0x36; 0x00; 0x40; 0x01; 0x00; 0x00; 0x00}"
4	Read AOP_FUN18 on AOP side	TX Diags	socgpio --port 1 --pin 31 --get

Acceptance criteria:

Net Name	Insight Keys Recorded	Nominal	Units
"GPIO_DOTARA_TO_SOC_SCM_INT_1V8"	WirelessPower DOTARA_GPIO_Check GPIO_DOTARA_TO_SOC_SCM_INT_1V8_High	1	N/A
	WirelessPower DOTARA_GPIO_Check GPIO_DOTARA_TO_SOC_SCM_INT_1V8_Low	0	N/A

8.3. Calibration

Linear calibration works by obtaining 2 points [$x1$, $y1$] & [$x2$, $y2$] and models a line between the points as seen in Figure 1 & Figure 2 below. The 2 calibration points would typically be points which give the minimum and maximum expected parameter value.

	VSNS, ISNS	LFOD -VCTx	VBoost_Control(mV)
Meter 1	**y1 (mV or mA)**	**-y1 (-ve sign as we are using the non-inverting path of Op-amp)**	**x1**
Meter 2	**y2 (mV or mA)**	**-y2 (-ve sign as we are using the non-inverting path of Op-amp)**	**x2**
MCU_1	**x1 (ADC)**	**x1 (ADC)**	**y1**
MCU_2	**x2 (ADC)**	**x2 (ADC)**	**y2**

Note: Conversion results for all 4 channels are calibrated in the same way. The resolution of the o*ffset calibration (ocal) is quarter-LSB* and the resolution of the *gain calibration (gcal) is 1/10000 or 0.01%*

A. Equations for *gcal* & o*cal* of Vsense ,Isense & LFOD

For VSNS and ISNS; ocal and gcal are determined as follows:

$$gcal = \left(\frac{Y_2 - Y_1}{(X_2 - X_1) * Nominal\ Gain}\right) \quad \text{(a)}$$

$$ocal = X_1 - \left(\frac{Y_1}{Nominal\ Gain * gcal}\right) \quad \text{(b)}$$

For LFOD; ocal and gcal are determined as follows:

$$gcal = \left(\frac{Y_2 - Y_1}{(\frac{X_2 - X_1}{16}) * Nominal\ Gain}\right) \quad \text{(c)}$$

$$ocal = \frac{X_1}{16.0} - \left(\frac{Y_1}{Nominal\ Gain * gcal}\right) \quad \text{(d)}$$

Rearranging equations for writing values into MTP, we get:

$$gcal_{MTP} = Dec2Hex\left[INT(gcal * 10000.0)\right] \quad \text{(e)}$$

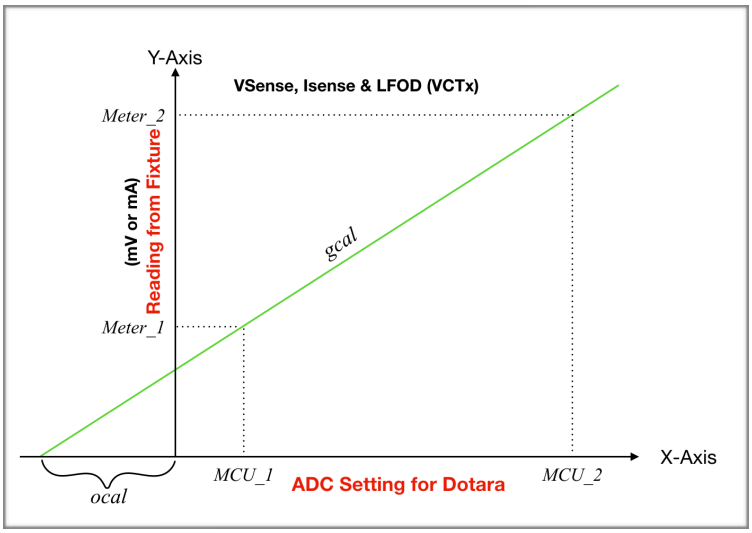
$$ocal_{MTP} = Dec2Hex\left[INT(ocal * 4.0)\right] \quad \text{(f)}$$

The word to be written into MTP is :-val = ocal << 16 | gcal

Note : 0x All values must be converted to **nearest integer** before converting into **hexadecimal** value to be written into MTP. If ***gcal & ocal*** value are negative, then takes 2's compliment of these values to be star into MTP.

Nominal Gain Vsense	**10.2543**
Nominal Gain Isense	**0.3827**
Nominal Gain LFOD (VCTx)	**8.5941**

FIGURE 1 : LINEAR CALIBRATION METHOD FOR VSENSE, ISENSE & LFOD (VCTX)



8.3.1.Vsense Calibration

Description:-To Calibrate Vsense for measurement accuracy.
Failure Mode(s) Captured: TBD
Test Setup and Procedure: Refer below

Step	Description	Interface	Command / Notes
1	Place RX coil aligned with the TX coil in the worst case coupling location.	Fixture	Coupling Position = Kmin 0.475 ~ 0.49
2	Measure the following test points "PP20V_DOTARA"	Fixture	Reference to nearest GND for the respective TPs. NOTE:- Continue with next step if PP20V_DOTARA <1200mV, if not then delay for 1sec and remeasure.
3	Set Boost Voltage to ~6V	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0x70; 0x17; 0xF4; 0x01}" **Payload: (LSB-MSB)** ——> Byte0-1: Boost voltage (eg. 0x1770 = 6000mV)
4	Enable Full Bridge (Set Inverter)	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x04, ReportPayload={0x1C; 0xF3; 0x01; 0x00; 0x50; 0x46; 0x50; 0x46}"
5	Disable LFOD channel	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x98; 0x36; 0x00; 0x40; 0x80; 0x01; 0x00; 0x00}"
	Check if LFOD is disabled	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x40, ReportPayload={0x98; 0x34; 0x00; 0x40}" ——> **Fixture wait 5 msec** <—— smokey ScorpiusHid --run --test "Get" --args "ReportID=0x40" **Response —>** bits 7 & bit 8 = 0 if Disabled, 1 if enabled
	Disable ASK_CR before reading Vsense/Isense	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x58; 0x34; 0x00; 0x40; 0x00; 0x00; 0x00; 0x00}"
6	Measure the voltage from"PP_DOTARA_VRECT" to GND	Fixture	This voltage should be recorded as a 16-bit (2-byte) value **<y1_mV>**. **Note:-** Need this value to be 6V ±1%
7	Trigger sensor sampling.	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x31, ReportPayload={0x00; 0x00; 0x8C}" Comments: Dotara can accumulates 4480 ADC samples and averaging for each reading.
8	Read sensor results ADC Raw Value and record as x1	TX Diags	smokey ScorpiusHid --run --test "Get" --args "ReportID=0x31" **Response: (LSB-MSB)** ——> byte0 = report id bytes1-4 = Floating point value from ADC bytes7-8 = raw ADC value (uint16_t) <x1> 2 bytes of data (16-bit value) are returned and record as x1 <x1>
9	Set Boost Voltage ~12V to Load RX to 10C load conditions (Vrect ~14v & Irect = 214mA i.e. P~3W) are met (note, the load may need be applied in small stages to avoid an over voltage or under voltage event on the RX)	TX Diags & Fixture	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={**<LSB of Boost in mV>; <MSB of Vboost in mV>;** 0xF4; 0x01}" Change the boost voltage by changing payload bytes0-1 below. **Payload: (LSB-MSB)** ——> byte0-1: Boost voltage (eg. 0x34BC = 13500mV)
10	Measure the voltage from"PP_DOTARA_VRECT" to GND	Fixture	This voltage should be recorded as a 16-bit (2-byte) value **<y2_mV>.** **Note:-** Need this value to be 12V ±1%
11	Trigger sensor sampling.	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x31, ReportPayload={0x00; 0x00; 0x8C}" Comments: Dotara can accumulates 4480 ADC samples and averaging for each reading.
12	Read sensor results ADC Raw Value and record as x2	TX Diags	smokey ScorpiusHid --run --test "Get" --args "ReportID=0x31" **Response: (LSB-MSB)** ——> byte0 = report id bytes1-4 = Floating point value from ADC bytes7-8 = raw ADC value (uint16_t) **<x2>** 2 bytes of data (16-bit value) are returned and record as **x2 <x2>**
13	Calculate VSense_CAL_Gain_MTP and VSense_CAL_Offset_MTP	Fixture	Please refer to *Section A* above for gcal and ocal calculation VSense_CAL_Gain_MTP = gcal (LSB 16bits) VSense_CAL_Offset_MTP =ocal (MSB 16bits)
14	Update the memory words VSense_CAL, Sector 127, word 7	Fixture	Note: This part will will done later once we have *gcal* & *ocal* values for other parameters. In Section 8.3.6 Writing calibration value into MTP Word7 = VSense_CAL_Offset_MTP <<16 || VSense_CAL_Gain_MTP Note : 0xValues need to be in HEX
15	Enable LFOD register	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x98; 0x35; 0x00; 0x40; 0x80; 0x01; 0x00; 0x00}"

Acceptance criteria:

Test Parameter	Insight Keys Recorded	LL	UL	Units
"PP20V_DOTARA"	WirelessPower Vsense_CAL-BEFORE BOOST ENABLED PP20V_DOTARA	0	1200	mV
VSense_y1 via fixture	WirelessPower Vsense_CAL-End VSense_y1	5500	7500	mV
VSense_y2 via fixture	WirelessPower Vsense_CAL-End VSense_y2	9500	14500	mV
VSense_x1 via Dotara	WirelessPower Vsense_CAL-End VSense_x1	-	-	16 bit
VSense_x2 via Dotara	WirelessPower Vsense_CAL-End VSense_x2	-	-	16 bit
VSense Calibration Gain Calculated	WirelessPower Vsense_CAL-End VSense_MTP_Gcal	-	-	%
	WirelessPower Vsense_CAL-End VSense_MTP_Gcal_Decimal	9000	11000	Limit is on Decimal value.
VSense Calibration Offset Calculated	WirelessPower Vsense_CAL-End VSense_MTP_Ocal	-	-	mV

8.3.2.Isense Calibration

Description:- To Calibrate Isense for measurement accuracy. We will read x1,y1,x2,y2 first, then calculate gain and offset and save them to MTP (J31x saves x1, y1, x2, y2).

Failure Mode(s) Captured: TBD

Test Setup and Procedure: Refer below

Step	Description	Interface	Command / Notes
			Estimate Rsesne Before Isense
1	Disconnect coil module.	Fixture	
2	Measure the following test points "PP20V_DOTARA"	Fixture	Reference to nearest GND for the respective TPs. NOTE:- Continue with next step if PP20V_DOTARA <1200mV, if not then delay for 1sec and remeasure.
3	Set Boost Voltage to 6.1V	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0xD4; 0x17; 0xF4; 0x01}" **Payload: ——>** Byte0-1: Boost voltage (eg. 0x17D4 = 6100mV)
4	Enable Full Bridge (Set Inverter)	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x04, ReportPayload={0x1C; 0xF3; 0x01; 0x00; 0x50; 0x46; 0x50; 0x46}"
	Check if Full bridge is enabled	TX Diags	smokey ScorpiusHid --run --test "Get" --args "ReportID=0x04"
5	Disable LFOD channel	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x98; 0x36; 0x00; 0x40; 0x80; 0x01; 0x00; 0x00}"
	Check if LFOD is disabled	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x40, ReportPayload={0x98; 0x34; 0x00; 0x40}" **———> Fixture wait 5 msec <———** smokey ScorpiusHid --run --test "Get" --args "ReportID=0x40" **Response —>** bits 7 & bit 8 = 0 if Disabled, 1 if enabled
	Disable ASK_CR before reading Vsense/Isense	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x58; 0x34; 0x00; 0x40; 0x00; 0x00; 0x00; 0x00}"
6	Disable Full Bridge (Bridge is turned off by setting Inverter frequency to 0)	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x04, ReportPayload={0x00; 0x00; 0x00; 0x00; 0x50; 0x46; 0x50; 0x46}"
	Check if Full bridge is disabled	TX Diags	smokey ScorpiusHid --run --test "Get" --args "ReportID=0x04"
7	Connect eload to "PP_Dotara_vrect" and Record it as **I**	Fixture	Step 100mA load from 100mA to 500mA I_1, I_2, I_3, I_4, I_5
8	Measure voltage across Rsense and record it as **V**	Fixture	Measures actual voltage across Rsense V_1, V_2, V_3, V_4, V_5
9	Calculate the leakage current	Overlay	$Il_{n-1} = \left((V_{n-1} * I_n) - (V_n * I_{n-1})\right) / (V_n - V_{n-1})$ $-----> where\ n = 1\ to\ 5$
	Calculate the average(actual) leakage current		$Il = (Il_1 + Il_2 + Il_3 + Il_4)/4$
10	Set eload to 0mA	Fixture	
11	Disconnect eload from "PP_Dotara_vrect"	Fixture	
			Calibrate Isense
12	Set coil module to Kmin position	Fixture	
13	Measure the following test points "PP20V_DOTARA"	Fixture	Reference to nearest GND for the respective TPs. NOTE:- Continue with next step if PP20V_DOTARA <1200mV, if not then delay for 1sec and remeasure.
14	Set Boost Voltage to 6.1V	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0xD4; 0x17; 0xF4; 0x01}" Payload: ——> Byte0-1: Boost voltage (eg. 0x17D4 = 6100mV)
15	Enable Full Bridge (Set Inverter)	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x04, ReportPayload={0x1C; 0xF3; 0x01; 0x00; 0x50; 0x46; 0x50; 0x46}"
	Check if Full bridge is enabled	TX Diags	smokey ScorpiusHid --run --test "Get" --args "ReportID=0x04"
16	Load 0.1C current at RX side	Fixture	Use inductive load to calibrate i.e. **0.1C @ kmin**
17	Wait 0.5 second	Fixture	Give 0.5s margin for the circuit to enter steady state
18	Measure the AVERAGE current.	Fixture	This current should be recorded as **y1 <y1_mA>**
19	Trigger sensor sampling.	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x31, ReportPayload={0x12; 0x00; 0x8C}"
20	Record the value as **x1**	TX Diags	smokey ScorpiusHid --run --test "Get" --args "ReportID=0x31" **Response: (LSB-MSB) ——>** byte0 = report id bytes1-4 = Floating point value from ADC bytes7-8 = raw ADC value (uint16_t) **<x1>** 2 bytes of data (16-bit value) are returned and record as **x1 <x1>**
21	Set Vboost to do Kmin 10C power transfer (~11V)	TX Diags	Target Vrect of 14V and Irect of 214mA smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0xD4; 0x17; 0xF4; 0x01}" **Payload: ——>** Byte0-1: Boost voltage (eg. 0x17D4 = 6100mV)
22	Load 10C current at RX side	Fixture	Use inductive load to calibrate i.e. **10C @ kmin**

Step	Description	Interface	Command / Notes
23	Wait 0.5 second	Fixture	Give 0.5s margin for the circuit to enter steady state
24	Measure the AVERAGE current.	Fixture	This current should be recorded as **y2 <y2_mA>**
25	Trigger sensor sampling.	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x31, ReportPayload={0x12; 0x00; 0x8C}"
26	Record the value as **x2**	TX Diags	smokey ScorpiusHid --run --test "Get" --args "ReportID=0x31" **Response: (LSB-MSB) ——>** byte0 = report id bytes1-4 = Floating point value from ADC bytes7-8 = raw ADC value (uint16_t) **<x2>** 2 bytes of data (16-bit value) are returned and record as **x2 <x2>**
27	Disable Full Bridge (Bridge is turned off by setting Inverter frequency to 0)	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x04, ReportPayload={0x00; 0x00; 0x00; 0x00; 0x50; 0x46; 0x50; 0x46}"
28	Enable LFOD register	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x98; 0x35; 0x00; 0x40; 0x80; 0x01; 0x00; 0x00}"
	Calculate the Isense Gain and Offset		
29	Calculate ISense_CAL_Gain_MTP and ISense_CAL_Offset_MTP	Fixture	Please refer to *Section A* above for gcal and ocal calculation ISense_CAL_Gain_MTP = gcal (LSB 16bits) ISense_CAL_Offset_MTP =ocal (MSB 16bits)
30	Update the memory words: Sector 127, word 8	Fixture	Note: This part will will done later once we have *gcal* & *ocal* values for other parameters. In Section 8.3.6 Writing calibration value into MTP Word8 = ISense_CAL_Offset_MTP <<16 || ISense_CAL_Gain_MTP Note : 0xValues need to be in HEX
31	Measure the following test points "PP20V_DOTARA"	Fixture	Reference to nearest GND for the respective TPs. NOTE:- Continue with next step if PP20V_DOTARA <1200mV, if not then delay for 1sec and remeasure.
32	Disconnect coil module.	Fixture	
33	Set Boost Voltage to 6.1V	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0xD4; 0x17; 0xF4; 0x01}" **Payload: ——>** Byte0-1: Boost voltage (eg. 0x17D4 = 6100mV)
34	Set Bridge to full phase of 180	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x04, ReportPayload={0x1C; 0xF3; 0x01; 0x00; 0x50; 0x46; 0x50; 0x46}" Eg 0x4650: 18000cdeg = 180deg phase
35	Turn Off Dotara Clamp FETs	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x78; 0x36; 0x00; 0x40; 0x00; 0x00; 0x20; 0x00}"
36	Measure I_Bias Current	Fixture	
37	Turn On Dotara Clamp FETs	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x78; 0x35; 0x00; 0x40; 0x00; 0x00; 0x20; 0x00}"
38	Set Boost Voltage to 0V (turn off VBoost, and LPP_5V_EN remains on)	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0x00; 0x00; 0xF4; 0x01}" **Payload: (LSB-MSB) ——>** Byte0-1: Boost voltage (eg. 0x0000 = 0mV)
39	Disable Full Bridge (Bridge is turned off by setting Inverter frequency to 0)	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x04, ReportPayload={0x00; 0x00; 0x00; 0x00; 0x50; 0x46; 0x50; 0x46}"

Acceptance Criteria:

Test Parameter	Insight Keys Recorded	LL	Nominal	UL	Units
"PP20V_DOTARA"	WirelessPower Isense_CAL-BEFORE BOOST ENABLED PP20V_DOTARA	0	-	1200	Record this only if PP20V_Dotara >1200mV
ISense @ Kmin 0.1C	WirelessPower Isense_CAL-End ISense_x1		TBD		16 bit
	WirelessPower Isense_CAL-End ISense_y1		100		mA
ISense @ Kmin 10C	WirelessPower Isense_CAL-End ISense_x2		TBD		16 bit
	WirelessPower Isense_CAL-End ISense_y2		460		mA
ISense Calibration Gain Calculated	WirelessPower Isense_CAL-End ISense_MTP_Gcal		-		%
	WirelessPower Isense_CAL-End ISense_MTP_Gcal_Decimal	9000		11000	Limit is on Decimal value.
ISense Calibration Offset Calculated	WirelessPower Isense_CAL-End ISense_MTP_Ocal		-		mA

8.3.3.LFOD Calibration

8.3.3.1.LFOD Gain & Offset Calibration

Description:-LFOD Calibration for offset and Gain Error value.
Failure Mode(s) Captured: TBD
Test Setup and Procedure: Refer Figure 1 and procedure below

Step	Description	Interface	Command / Notes
1	Disable Full Bridge (Bridge is turned off by setting Inverter frequency to 0)	Tx Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x04, ReportPayload={0x00; 0x00; 0x00; 0x00; 0x50; 0x46; 0x50; 0x46}"
	Check if Full bridge is disabled	TX Diags	smokey ScorpiusHid --run --test "Get" --args "ReportID=0x04"
2	Disconnect the coil.	Fixture	
3	Measure the following test points "PP20V_DOTARA"	Fixture	Reference to nearest GND for the respective TPs. NOTE:- Continue with next step if PP20V_DOTARA <1200mV, if not then delay for 1sec and remeasure.
4	Enable boost at 16V.	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0xB0; 0x3E; 0x88; 0x13} **Payload: (LSB-MSB)** ——> Byte0-1: Boost voltage (eg. 0x3E80 = 16000mV)
5	Pull PPVCC_TX_AC2 to ground.	Fixture	
6	Set PPVCC_TX_AC2_F to 0V.	Fixture	How accurately can fixture set this? Recorded the voltage on PPVCC_TX_AC2_F as **y1** **<y1_mV>**
7	Send VCTx sample command (ADC).	TX Diags	Send the following "set" report to run a VCTx data capture smokey ScorpiusHid --run --test "Set" --args "ReportID=0x0B, ReportPayload={0x18; 0x03}" end the following command to retrieve the sampled data smokey ScorpiusHid --run --test "Get" --args "ReportID=0x0B" **Response: (LSB-MSB)** —> byte0 = report id byte1 = error code (0x00 = no error) bytes18-19 = accumulated ADC raw averaged sampling value Record the 4 bytes of data (32-bit value) that returned ADC raw as **<x1>** Note: Upload this data into Insight.
8	Set PPVCC_TX_AC2_F to 15V.	Fixture	How accurately can fixture set this? Recorded the voltage on PPVCC_TX_AC2_F as **y2** **<y2_mV>**
9	Send VCTx sample command.	TX Diags	Send the following "set" report to run a VCTx data capture smokey ScorpiusHid --run --test "Set" --args "ReportID=0x0B, ReportPayload={0x18; 0x03}" Send the following command to retrieve the sampled data smokey ScorpiusHid --run --test "Get" --args "ReportID=0x0B" **Response: (LSB-MSB)** —> byte0 = report id byte1 = error code (0x00 = no error) bytes18-19 = accumulated ADC raw averaged sampling value Record the 4 bytes of data (32-bit value) that returned ADC raw as **<x2>** Note: Upload this raw data into Insight.
10	Calculate LFOD_CAL_Gain_MTP and LFOD_CAL_Offset_MTP	Fixture	Please refer to *Section B* above for *gcal* and *ocal* calculation LFOD_CAL_Gain_MTP = gcal (LSB 16bits) LFOD_CAL_Offset_MTP =ocal (MSB 16bits)
11	Update the memory words: Sector 127, word 9	Fixture	Note: This part will will done later once we have *gcal* & *ocal* values for other parameters. In Section 8.3.6 Writing calibration value into MTP Word9 = LFOD_OCAL_MTP <<16 || LFOD_GCAL_MTP Note : 0xValues need to be in HEX

Acceptance criteria:

Physical Parameter	Insight Keys Recorded	LL	UL	Units	Comment
"PP20V_DOTARA"	WirelessPower LFOD_CAL-BEFORE BOOST ENABLED PP20V_DOTARA	0	1200	mV	Record this only if PP20V_Dotara >1200mV
LFOD_y1 via fixture	WirelessPower LFOD_CAL-End LFOD_y1			mV	Record these values as negative before using it into Equations of gcal & ocal. Example: if y2 = 15V, then use y2 = -15 in the equations
LFOD_y2 via fixture	WirelessPower LFOD_CAL-End LFOD_y2			mV	
LFOD_x1 via Dotara	WirelessPower LFOD_CAL-End LFOD_x1			16 bit	
LFOD_x2 via Dotara	WirelessPower LFOD_CAL-End LFOD_x2			16 bit	
LFOD Calibration Gain Calculated	WirelessPower LFOD_CAL-End LFOD_MTP_Gcal			-	
	WirelessPower LFOD_CAL-End LFOD_MTP_Gcal_Decimal	10087	12681	-	Limit is on Decimal value.
LFOD Calibration Offset Calculated	WirelessPower LFOD_CAL-End LFOD_MTP_Ocal			mA	

8.3.3.2. ~~LFOD CMR Calibration~~ [Not needed any more]

~~**Description**:Measure the Common Mode Rejection capability of the LFOD channel.~~
~~**Failure Mode(s) Captured**: Low CMR of the LFOD channel~~
~~**Test Setup and Procedure for CMR measurement**: Refer to procedure below~~

Step	Description	Interface	Command / Notes
1	Tie AC2 and AC2_F nodes together.	Fixture	
2	Open TX coil connector and short AC2_F to AC1 node.	Fixture	
3	Disable full bridge inverter	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x04, ReportPayload={0x00; 0x00; 0x00; 0x00; 0x50; 0x46; 0x50; 0x46}"
	Check if Full bridge is disabled	TX Diags	smokey ScorpiusHid --run --test "Get" --args "ReportID=0x04"
4	Set Vboost to 15.5V gradually	TX Diags	Use 3 steps to ramp up: for example 6V, 10V, 15.5V
5	Ground AC2 and AC2_F and measured the fixture voltage as y1	Fixture	Fixture reading should be close to 0 since it's grounded
6	Trigger LFOD channel sampling and record the average value of ADC samples as x1	TX Diags	Send the following "set" report to run a VCTx data capture smokey ScorpiusHid --run --test "Set" --args "ReportID=0x0B, ReportPayload={0x18; 0x03}" end the following command to retrieve the sampled data smokey ScorpiusHid --run --test "Get" --args "ReportID=0x0B" **Response: (LSB-MSB) ---->** byte0 = report id byte1 = error code (0x00 = no error) bytes18-19 = accumulated ADC raw averaged sampling value Record the 4 bytes of data (32-bit value) that returned ADC raw as **<x1>** Note: Upload this data into Insight.
7	Apply 15V to AC2 and AC2_F and measured the fixture voltage as y2	Fixture	
8	Trigger LFOD channel sampling and record the average value of ADC samples as x2	TX Diags	Send the following "set" report to run a VCTx data capture smokey ScorpiusHid --run --test "Set" --args "ReportID=0x0B, ReportPayload={0x18; 0x03}" end the following command to retrieve the sampled data smokey ScorpiusHid --run --test "Get" --args "ReportID=0x0B" **Response: (LSB-MSB) ---->** byte0 = report id byte1 = error code (0x00 = no error) bytes18-19 = accumulated ADC raw averaged sampling value Record the 4 bytes of data (32-bit value) that returned ADC raw as **<x2>** Note: Upload this data into Insight.
9	Calculate CMR	Fixture	$VCM = abs\left(\frac{X2 - X1}{16}\right) * 0.4883 \text{ ------> } CMR = -20 * log_{10}\left(\frac{Y2 - Y1}{VCM}\right)$

Physical Parameter	Insight Keys Recorded	LL	UL	Units	Comment
x1	WirelessPower CMR_CAL-End CMR_Cal_y1				
y1	WirelessPower CMR_CAL-End CMR_Cal_x1	-5	5	mV	
x2	WirelessPower CMR_CAL-End CMR_Cal_y2				
y2	WirelessPower CMR_CAL-End CMR_Cal_x2	14000	16000	mV	
CMR	WirelessPower CMR_CAL-End CMR	-53		dB	

B. Equations for *gcal* & *ocal* of VBoost_Control

For **VBoost_control; ocal and gcal** are determined as follows:

$$gcal = \frac{Y_2 - Y_1}{X_2 - X_1} \quad \text{(g)}$$

$$ocal = X_1 - \left(\frac{Y_1}{gcal}\right) \quad \text{(h)}$$

Rearranging, we get:

$$gcal_{MTP} = Dec2Hex\left[INT\left(gcal * 10000.0\right)\right] \quad \text{(i)}$$

$$ocal_{MTP} = Dec2Hex\left[INT\left(ocal * 4.0\right)\right] \quad \text{(j)}$$

Note : All values must be converted to **nearest integer** before converting into **hexadecimal** value to be written into MTP. If ***ocal*** value is negative, then takes 2's compliment of these values to be store into MTP . Example:- 2'compliment(-2077)= FFFFFFF7E3 ——> F7E3 for MTP

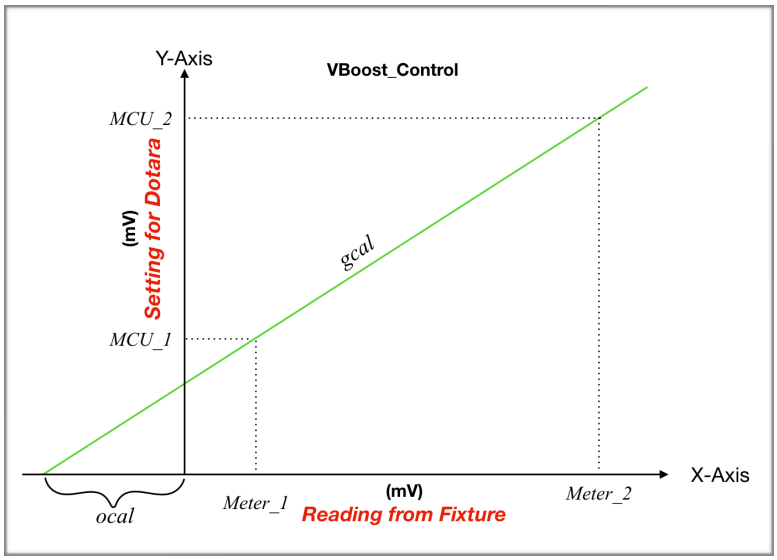


FIGURE 2 : LINEAR CALIBRATION METHOD FOR VBOOST TO SET MIN & MAX VALUES

8.3.4. VBoost Control Calibration

Description :-VBoost Control calibration for setting minimum and Maximum boost voltage.
Failure Mode(s) Captured: If $VBoost_{min}$ < 6.1V and if $VBoost_{max}$ makes Vrect > 14V
Test Setup and Procedure: Refer the Figure 2 and procedure below

Step	Description	Interface	Command / Notes
1	Place RX coil aligned with the TX coil in the worst case coupling location.	Fixture	Coupling Position = Kmin (0.516 ± 0.015)
2	Measure the following test points "PP20V_DOTARA"	Fixture	Reference to nearest GND for the respective TPs. NOTE:- Continue with next step if PP20V_DOTARA <1200mV, if not then delay for 1sec and remeasure.
3	Enable the Boost **@ 4V Vin.**	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={**0x44; 0x16;** 0xF4; 0x01}" **Payload: (LSB-MSB)** ——> Byte0-1: Boost voltage **(eg. 0x1644 = ~5800mV).**
4	Enable Full Bridge (Set Inverter)	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x04, ReportPayload={0x1C; 0xF3; 0x01; 0x00; 0x50; 0x46; 0x50; 0x46}" **Eg 0x4650:** 18000cdeg = 180deg phase**)**
5	Adjust to achieve the Boost Voltage to greater than but closer to 6V.		This voltage should be recorded as a 16-bit (2-byte) value **<y1>.** Change the boost voltage by changing payload bytes0-1 below. smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={**<LSB of Boost in mV>; <MSB of Vboost in mV>**; 0xF4; 0x01}" **Payload: (LSB-MSB)** ——> Byte0-1: Boost voltage setting starts **(eg. 0x1644 = 5800mV)**, with 50mV steps. Keep adjusting this till the fixture reads just >6V (i.e., x1 => 6V in step 4) must meet this value. Steps of 50 mV start from 5800 mV Please refer to the graph above of VBoost calibration for x-y axis readings.
6	Measure the voltage from **"PP_DOTARA_VRECT"** to GND	Fixture	This voltage should be recorded as a 16-bit (2-byte) value **<x1>**. Please refer to the graph above of VBoost calibration for x-y axis readings.

Step	Description	Interface	Command / Notes
7	Set Boost Voltage ~12V to Load RX to 10C load conditions (Vrect ~14v & Irect = 214mA i.e. P~3W) are met (note, the load may need be applied in small stages to avoid an over voltage or under voltage event on the RX)	TX Diags & Fixture	This voltage should be recorded as a 16-bit (2-byte) value **<y2>**. Change the boost voltage by changing payload bytes0-1 below. smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={**<LSB of Boost in mV>; <MSB of Vboost in mV>**; 0xF4; 0x01}" **Payload: (LSB-MSB)** ——> Byte0-1: Boost voltage (eg. 0x32C8 = 13000mV) Keep adjusting this till the fixture reads ~13.5V (i.e. x2 ~ 13.5V in step 6) must meet this value. Steps of 50 mV start from 12400 mV Please refer to the graph above of VBoost calibration for x-y axis readings.
8	Measure the voltage from"PP_DOTARA_VRECT" to GND	Fixture	This voltage should be recorded as a 16-bit (2-byte) value **<x2>** Please refer to the graph above of VBoost calibration for x-y axis readings.
9	Calculate VBoost_Control_Gain_MTP and VBoost_Control_Offset_MTP	Fixture	Please refer to the factor calculation section in the document for gcal and ocal calculation VBoost_Control_Gain_MTP = gcal (LSB 16bits) || VBoost_Control_Offset_MTP =ocal (MSB 16bits)
10	Update the memory words (please refer to the VBoost_Control, Sector 127, word 6	Fixture	Note: This part will will done later once we have *gcal* & *ocal* values for other parameters. In Section 8.3.6 Writing calibration value into MTP Word6 = VBoost_Control_Offset_MTP <<16 || VBoost_Control_Gain_MTP Note : 0xValues need to be in HEX

Acceptance criteria:

Test Parameter	Insight Keys Recorded	LL	Nominal	UL	Units
"PP20V_DOTARA"	WirelessPower Vboost_Control_CAL-BEFORE BOOST ENABLED PP20V_DOTARA	0	-	1200	Record this only if PP20V_Dotara >1200mV
VBoost_y1 via Dotara	WirelessPower Vboost_Control_CAL-End VBoost_y1	5500	6000	7500	mV
VBoost_y2 via Dotara	WirelessPower Vboost_Control_CAL-End VBoost_y2	9500	13500	14500	mV
VBoost_x1 via fixture	WirelessPower Vboost_Control_CAL-End VBoost_x1	-	-	-	mV
VBoost_x1 via fixture	WirelessPower Vboost_Control_CAL-End VBoost_x2	-	-	-	mV
VBoost Control Gain Calculated	WirelessPower Vboost_Control_CAL-End Vboost_Control_MTP_Gcal	-	-	-	%
VBoost Control Offset Calculated	WirelessPower Vboost_Control_CAL-End Vboost_Control_MTP_Ocal	-	-	-	mV

8.3.5.Measure and Record CTx Value

Step	Description	Interface	Command / Notes
		Initialise. Make everything tri-state	
1	Power off Dotara	Fixture	
2	Disconnect Tx coil	Fixture	
3	Force dotara OVP to pull AC2 low	TX Diags	smokey ScorpiusHid --run --test "Mem32" --args "Address=<0x40003518>, WriteData={0x00000010}"
		Measure Ctx	
4	Measure capacitance between PPVCC_TX_AC2 and PPVCC_TX_AC2_F	Fixture	Seems good isolation between Capacitor measurement GND and DUT, fixture ground.
		Ctx Test end, tidy up start	
5	Power on Dotara or Disable Force OVP	TX Diags	smokey ScorpiusHid --run --test "Mem32" --args "Address=<0x40003618>, WriteData={0x00000010}"
6	MCU_value_C = Ctx in pF divided by 1	Fixture	Note: Capacitance: MCU_value_C is 1pF:1 Eg. 198.25nF is equivalent to 198250 MCU_value_C. Use 1pF as unit, not 10pF(J31x)
7	Round MCU_value_C into nearest integer	Fixture	This must be a 2-byte (16-bit) value
8	Update the memory words CTx in Sector 127: Word2	Fixture	Note: This part will will done later once we have *gcal* & *ocal* values for other parameters. In Section 8.3.6 Writing calibration value into MTP Word2 = value from step 7 above on Hex Note : 0xValues need to be in HEX

Acceptance criteria:

Physical Parameter	Insight Keys Recorded	LL	UL	Units	Notes
Tx Resonant Capacitor	WirelessPower Capacitance_Meas-Tx-Sine_10KHz Ctx_value	352.0	373.8	nF	362.9 +/- 3% (2% Component, 1% Fixture tolerance)

8.3.6.Writing calibration values into MTP and verifying.

Description:-Writing the Calibration data from above tests into MTP.
Failure Mode(s) Captured: Calibration data not stored.
Test Setup and Procedure: Refer below
Note:

1. The MTP data should be written in one go using the MTP Sector Write Command. This means the data needs to be prepared in advance in an array of thirty-two (Word0-31) 32bit words with the checksum occupying the last word (word31). Then the sector write command can be executed. Figure 3 below outlines the MTP data that needs to be written for sections 126 and 127.
2. Please use the "READ, MODIFY, WRITE" process when updating MTP. This is to ensure that data is Un-intentionally overwritten with wrong values.

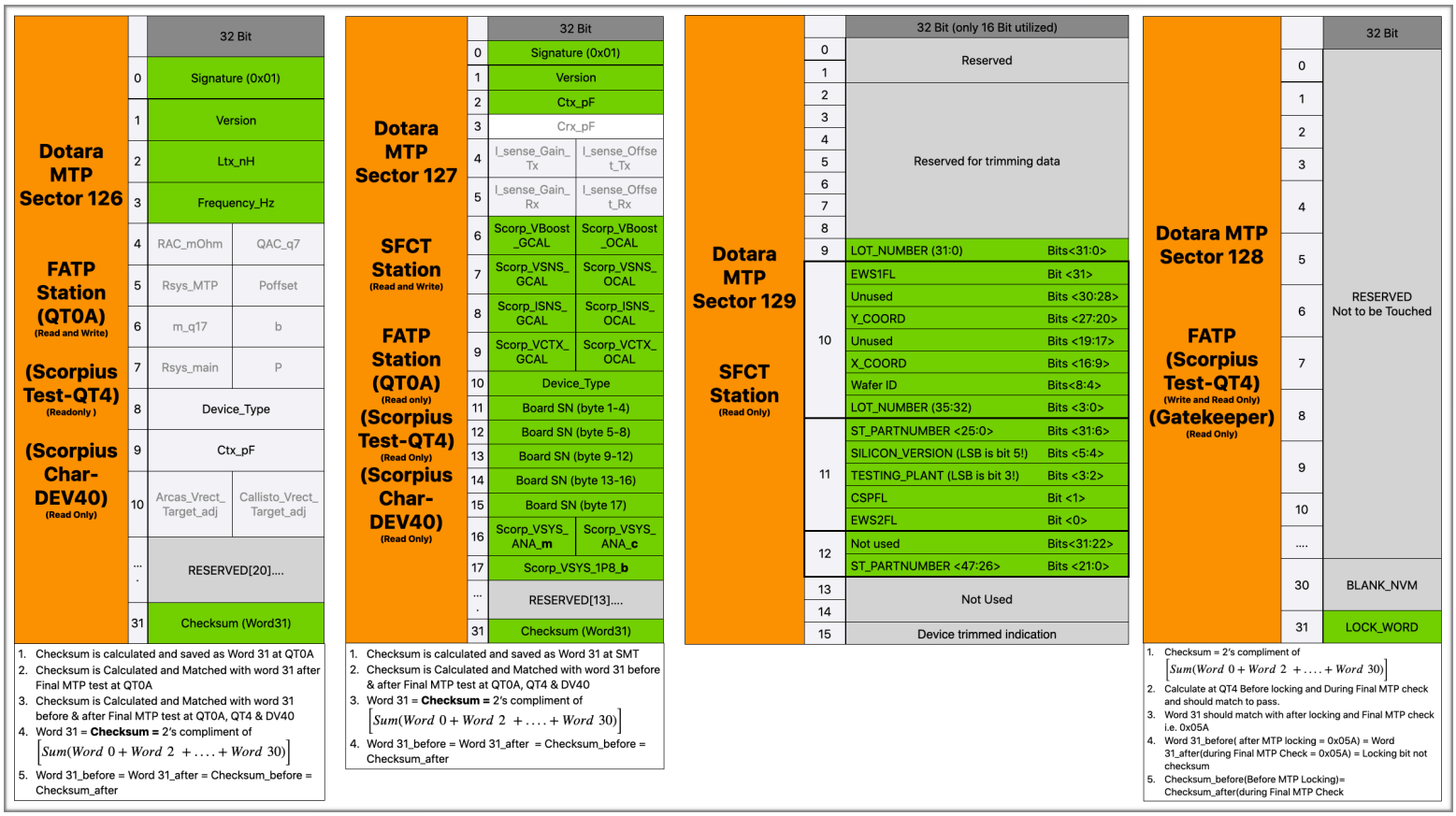


Figure 3 : MTP Word Locations

Step	Description	Interface	Command / Notes
	Write Calibration in memory		
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	pmugpio --pin 3 --pushpull --output 1 socgpio --port 1 --pin 46 --output 1
4	Tell Tx to get out of standalone mode.	TX 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 Diags	**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'"
6	Wait 1s	Fixture	Scorpius FW will take less than 1 second to boot

7	Tell Tx to get out of standalone mode.	TX Diags	i2c -w 5 0x39 6 **Note:-**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 this command every time within **3sec** of above command. You cannot enter Quiesce mode without exiting the standalone mode. smokey ScorpiusHid --run --test "Set" --args "ReportID=0x09, ReportPayload={0x01}"
9	Location to store Calibrated values of VBoost, Vsense, Isense, LFOD & CTx into MTP and other values into MTP :- Signature, Version,HWID, MLB SN, Checksum Follow Figure 3 Bellow for Reference	Test Overlay	Sector 127 :-Word 0(Signature = 0x01); Word 1(Version = 0x02); Word 2(CTx); Word 6(VBoost); Word 7(Sense); Word 8(Isense); Word 9(LFOD); Word 10(HWID); Word 11 - 15(MLB SN - 17 byte), Word 31(Checksum)
10	Read MTP Sector 127	TX Diags	smokey ScorpiusHid --run --test "Print_Sector" --args "MTP_sector=127" Example:-Overlay will read Words that are printed:- **Word 0 : 0x00000000** Word 1 : 0x00000000 **Word 2 : 0x00000000** Word 3 : 0x00000000 Word 4 : 0x00000000 Word 5 : 0x00000000 **Word 6 : 0x00000000** **Word 7 : 0x00000000** **Word 8 : 0x00000000** **Word 9 : 0x00000000** Word 10 : 0x00000000 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 : 0x00000000
11	Measure the following test points "PP20V_DOTARA"	Fixture	Reference to nearest GND for the respective TPs. NOTE:- Continue with next step if PP20V_DOTARA <1200mV, if not then delay for 1sec and remeasure.
12	Set Boost Voltage to 6.1V	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0xD4; 0x17; 0xF4; 0x01}" **Payload: ——>** Byte0-1: Boost voltage (eg. 0x17D4 = 6100mV)
13	Pulling High the Dotara_OTP_WREN pin for writing calibration into MTP.	Tx Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x08; 0x0c; 0x00; 0x40; 0x08; 0x00; 0x00; 0x00}"
14	Calculating Check Sum for writing into MTP. Value of Word 31 is 2's compliment of Sum of all values to be written into MTP	Test Overlay	**Sector 127: Word 31:** 2's Compliment of $\left[Sum(Word\ 0 + Word\ 2\ + ... + Word\ 30)\right]$ **Example: —> Word 31:** 2's Compliment of $(242717C\ 2) = DBD8E\ 83E$
15	Update MTP Sector 127 with Custom/Calibration Data *Note: The default values of unused words need to remain unchanged (Refer to note2 above about using the read/modify/write process).*	Tx Diags	**Command Format to use for Sector Write** smokey ScorpiusHid --run --test "Write_Sector" --args "MTP_sector=127, MTP_Words={word0 [Signature]; word1 [Version]; word2 [CTx]; word3; word4; word5; word6 [VBoost]; word7 [Vsense]; word8 [Isense]; word9 [LFOD]; word10 [HWID]; word11 [MLB SN: bytes0-3; word12 [MLB SN: bytes4-7]; word13 [MLB SN: bytes8-11]; word14 [MLB SN: bytes12-15]; word15 [MLB SN: byte16]; word16; word17; word18; word19; word20; word21; word22; word23; word24; word25; word26; word27; word28; word29; word30; word31 [Checksum]}" ——> Example: Word0: Signature = **0x00000001** Word1: Version = **0x00000002** Word2: Ctx = **0x00030570** Word6: Vboost = **0x0A0A0A0A** Word7: Vsense = **0x0B0B0B0B** Word8: Isense = **0x0C0C0C0C** Word9: LFOD = **0x0D0D0D0D** Word10: HWID = **0x03070001** Words11-15: SerialNum ascii string - "AFEDCBA9876543210" = **0x41464544434241393837363534333231 30** Word31: Checksum = **0xDBD8E83E** Note : Refer to instructions in step 13a below on how to calculate this ——> Example Command to Write Sector: smokey ScorpiusHid --run --test "Write_Sector" --args "MTP_sector=127, MTP_Words={0x00000001; 0x00000002; 0x00030570; 0x00000000; 0x00000000; 0x00000000; 0x0A0A0A0A; 0x0B0B0B0B; 0x0C0C0C0C; 0x0D0D0D0D; 0x03070001; 0x33323130; 0x37363534; 0x42413938; 0x46454443; 0x00000041; 0x00000000; 0x00000000; 0x00000000; 0x00000000; 0x00000000; 0x00000000; 0x00000000; 0x00000000; 0x00000000; 0x00000000; 0x00000000; 0x00000000; 0x00000000; 0x00000000; 0x00000000; 0xDBD8E83E}" ——> Example:-After Writing MTP Sector Values are: Word 0 : 0x00000001 Word 1 : 0x00000002 Word 2 : 0x00030570 Word 3 : 0x00000000 Word 4 : 0x00000000 Word 5 : 0x00000000 Word 6 : 0x0A0A0A0A Word 7 : 0x0B0B0B0B Word 8 : 0x0C0C0C0C Word 9 : 0x0D0D0D0D Word 10 : 0x03070001 Word 11 : 0x33323130 Word 12 : 0x37363534 Word 13 : 0x42413938 Word 14 : 0x46454443 Word 15 : 0x00000041 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 : 0xDBD8E83E
16	Pulling Low the Dotara_OTP_WREN pin after writing calibration into MTP.	Tx Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x0c; 0x0c; 0x00; 0x40; 0x08; 0x00; 0x00; 0x00}"
17	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
18	Wait 1s	Fixture	
19	Preparation		pmugpio --pin 3 --pushpull --output 1 socgpio --port 1 --pin 46 --output 1
18	Tell Tx to get out of standalone mode.	TX 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.
19	Load Tx FW	TX Diags	**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'"
20	Wait 1s	Fixture	Scorpius FW will take less than 1 second to boot

21	Read MTP Sector 127	TX Diags	smokey ScorpiusHid --run --test "Print_Sector" --args "MTP_sector=127" Example:-Overlay will read Words that are printed: This should match what was written in step 14 above. **Word 0 : 0x00000001** **Word 1 : 0x000000002** **Word 2 : 0x00030570** Word 3 : 0x00000000 Word 4 : 0x00000000 Word 5 : 0x00000000 **Word 6 : 0x0A0A0A0A** **Word 7 : 0x0B0B0B0B** **Word 8 : 0x0C0C0C0C** **Word 9 : 0x0D0D0D0D** **Word 10 : 0x03070001** **Word 11 : 0x33323130** **Word 12 : 0x37363534** **Word 13 : 0x42413938** **Word 14 : 0x46454443** **Word 15 : 0x00000041** 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 : 0xDBD8E83E**
22	Read Mlb serial number		**Note:** Before reading the MLB SN, sector signature needs to be set and the unit reset after freshly writing the serial number to mtp for this command to work. smokey ScorpiusHid --run --test "Get" --args "ReportID=0x7C"
	Verifying Calibration		
1	Place RX coil aligned with the TX coil in the worst case coupling location.	Fixture	Coupling Position = Kmin
2	Measure the following test points "PP20V_DOTARA"	Fixture	Reference to nearest GND for the respective TPs. NOTE:- Continue with next step if PP20V_DOTARA <1200mV, if not then delay for 1sec and remeasure.
3	Set Boost Voltage to 6.1V	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0xD4; 0x17; 0xF4; 0x01}" **Payload: ——>** Byte0-1: Boost voltage (eg. 0x17D4 = 6100mV)
4	Enable Full Bridge (Set Inverter)	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x04, ReportPayload={0x1C; 0xF3; 0x01; 0x00; 0x50; 0x46; 0x50; 0x46}"
	Check if Full bridge is enabled	TX Diags	smokey ScorpiusHid --run --test "Get" --args "ReportID=0x04"
5	Disable LFOD channel	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x98; 0x36; 0x00; 0x40; 0x80; 0x01; 0x00; 0x00}"
	Check if LFOD is disabled	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x40, ReportPayload={0x98; 0x34; 0x00; 0x40}" **———> Fixture wait 5 msec <———** smokey ScorpiusHid --run --test "Get" --args "ReportID=0x40" **Response —>** bits 7 & bit 8 = 0 if Disabled, 1 if enabled
	Disable ASK_CR before reading Vsense/Isense	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x58; 0x34; 0x00; 0x40; 0x00; 0x00; 0x00; 0x00}"
6	Command for following variables: Vsense	TX Diags	Note: Here, a "set" report command is first sent followed by a "get" report to return the requested data. smokey ScorpiusHid --run --test "Set" --args "ReportID=0x31, ReportPayload={0x00; 0x00; 0x0F}" **———> Fixture wait 5 msec <———** smokey ScorpiusHid --run --test "Get" --args "ReportID=0x31" **Response —>** bytes1-4 = Floating point value from ADC **—> VSense_CAL_6V_MCU**
7	Measure the voltage from"PP_DOTARA_VRECT" to GND	Fixture	This should match the calculated floating value. Record this As **VSense_CAL_6V_FXST**
8	Disable Full Bridge (Bridge is turned off by setting Inverter frequency to 0)	Tx Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x04, ReportPayload={0x00; 0x00; 0x00; 0x00; 0x50; 0x46; 0x50; 0x46}"
9	Check if Full bridge is disabled	TX Diags	smokey ScorpiusHid --run --test "Get" --args "ReportID=0x04"
10	Enable LFOD register	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x98; 0x35; 0x00; 0x40; 0x80; 0x01; 0x00; 0x00}"
11	Check if LFOD is enabled	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x40, ReportPayload={0x98; 0x34; 0x00; 0x40}" **———> Fixture wait 5 msec <———** smokey ScorpiusHid --run --test "Get" --args "ReportID=0x40" **Response —>** bits 7 & bit 8 = 0 if Disabled, 1 if enabled
	Set Boost Voltage to 6.1V	TX Diags	

Acceptance criteria:

Test Parameter	Insight Keys Recorded	After Calibration value in Hex	Comments
Writing Calibration			
Check Sum - Sector 127	WirelessPower Dotara_MTP_Check-Pre_CAL Read_Sector_127_CheckSum		
Vsense MTP	WirelessPower Dotara_MTP_Check-Pre_CAL Read_Sector_127_Vsense		
Isense MTP	WirelessPower Dotara_MTP_Check-Pre_CAL Read_Sector_127_Isense		
VBoost_Control MTP	WirelessPower Dotara_MTP_Check-Pre_CAL Read_Sector_127_Vboost_Control		
LFOD MTP	WirelessPower Dotara_MTP_Check-Pre_CAL Read_Sector_127_LFOD		
CTx MTP	WirelessPower Dotara_MTP_Check-Pre_CAL Read_Sector_127_CTx		
Tx HWID MTP	WirelessPower Dotara_MTP_Check-Pre_CAL Read_Sector_127_Tx_HWID		
Version	Wireless_Power_Version_MTP_BEFORE		
Signature	Wireless_Power_Signature_MTP_BEFORE		
MLB Serial No. (Word 11 to Word 15 - Bits<1:17>)	Wireless_Power_MLB_SN_MTP_BEFORE		

Test Parameter	Insight Keys Recorded	LL	Nominal	UL	Units
Verifying Calibration					
VSense after calibration	WirelessPower Vsense_Verify Vsense_6V1_MCU	6000	6100	6200	mV
	WirelessPower Vsense_Verify VSense_6V1_FXST	6000	6100	6200	mV
	WirelessPower Vsense_Verify VSense_6V1_ERROR	-0.6	0	0.6	%

8.4. Low Power Ping - LPP

Description:-To Check the frequency and inductance for LPP at minK and maxK coupling.
Failure Mode(s) Captured: TBD
Test Setup and Procedure:

Step	Description	Interface	Command / Notes
1	Connect coils at Kmin	Fixture	Coupling Position = Kmin (0.516 ± 0.015)
2	Send 1.4uS LPP pulse	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x05, ReportPayload={0x00; 0x46}" **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 Diags	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 Diags & 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 Note: Upload this raw data into Insight.
6	Connect coils at Kmax	Fixture	
7	Repeat steps 2 - 7		
8	Record parameters as per below table	Fixture	Apply limits accordingly

Acceptance criteria:-Ignore *Free air response* and *Delta* as there is no free air cal at FCT

Test Parameter	Insight Keys Recorded	LL	UL	Units	Comments
LPP Frequency @ Kmax	WirelessPower LPP_Test@Kmax-Pulse1.4us LPP_Frequency	52.6	57	kHz	These limits are from GBD
LPP Frequency @ Kmin	WirelessPower LPP_Test@Kmin-Pulse1.4us LPP_Frequency	60.7	63.5	kHz	These limits are from GBD
LPP Inductance @ Kmax	WirelessPower LPP_Test@Kmax-Pulse1.4us LPP_Inductance	21.5	25	µH	These limits are from GBD
LPP Inductance @ Kmin	WirelessPower LPP_Test@Kmin-Pulse1.4us LPP_Inductance	17.6	18.7	µH	These limits are from GBD

8.5. Power, Efficiency & Ping Pong Tests

Description: This test requires Xavier/Rx board, both Tx and Rx coil. Transferring power at various loads / charge rates (0.1C, 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).

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 Demodulation circuit

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.**(ramp speed <=500mV/mS)**
- To reach the 10C load step the load with 50mA to avoid OVP.

Step	Description	Interface	Command
Set load and coupling position		Fixture	Repeat all below tests for the following conditions, See section 7.1 for detailed LQK. 1. 0.1C :- @ minK (0.475 - 0.49) & @ maxK (0.648 - 0.664) 2. 10C :- @ minK (0.475 - 0.490) & @ maxK (0.648 - 0.664)
Power & Efficiency Testing			

Step	Description	Interface	Command
			For 0.1C
1	Measure the following test points "PP20V_DOTARA"	Fixture	Reference to nearest GND for the respective TPs. NOTE:- Continue with next step if PP20V_DOTARA <1200mV, if not then delay for 1sec and remeasure.
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; 0xF4; 0x01}" **Payload: ——>** Byte0-1: Boost voltage (eg. 0x17D4 = 6100mV)
3	Set the Bridge phase to meet the load condition (Set Bridge phase to 0-180)	TX Diags	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 Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x04, ReportPayload={0x1C; 0xF3; 0x01; 0x00; 0x50; 0x46; 0x50; 0x46}" **Eg 0x4650:** 18000cdeg = 180deg phase
2	Measure the following test points "PP20V_DOTARA"	Fixture	Reference to nearest GND for the respective TPs. NOTE:- Continue with next step if PP20V_DOTARA <1200mV, if not then delay for 1sec and remeasure.
3	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; 0xF4; 0x01}" **Payload: ——>** Byte0-1: Boost voltage (eg. 0x17D4 = 6100mV)
4	Connect "PPVBUS_SCORPIUS_BOOSTED" test pin to HADC Measure Ripple at Scorpius Switching Frequency using HADC	Fixture	
5	Command for following variables: Vsense, Isense, LFOD (VCTx) **Note :** Disable LFOD & ASK_CR before taking Vsense & Isense Reading and Enable LFOD back before taking LFOD(VCTx) reading.	TX Diags	**Disable LFOD_CFG before reading Isense:** smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x98; 0x36; 0x00; 0x40; 0x80; 0x01; 0x00; 0x00}" Check status of LFOD_CFG smokey ScorpiusHid --run --test "Set" --args "ReportID=0x40, ReportPayload={0x98; 0x34; 0x00; 0x40}" **———> Fixture wait 5 msec <———** smokey ScorpiusHid --run --test "Get" --args "ReportID=0x40" **Response —>** bits 7 & bit 8 = 0 if Disabled, 1 if enabled **Disable ASK_CR before reading Isense:** smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x58; 0x34; 0x00; 0x40; 0x00; 0x00; 0x00; 0x00}" 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; 0x8C}" **———> Fixture Fixture wait 5 msec <———** smokey ScorpiusHid --run --test "Get" --args "ReportID=0x31" **Response —>** bytes1-4 = Floating point value from ADC **—> VSense_kmxx_MCU** **Isense:** smokey ScorpiusHid --run --test "Set" --args "ReportID=0x31, ReportPayload={0x12; 0x00; 0x8C}" **———> Fixture wait 5 msec <———** smokey ScorpiusHid --run --test "Get" --args "ReportID=0x31" **Response —>** bytes1-4 = Floating point value from ADC **—> Isense_kmxx_MCU** **Enabled LFOD after Isense reading:** smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x98; 0x35; 0x00; 0x40; 0x80; 0x01; 0x00; 0x00}" **Wait 1 sec after setting back LFOD before doing next test.** **LFOD(VCTx)**: smokey ScorpiusHid --run --test "Set" --args "ReportID=0x0B, ReportPayload={0x18; 0x03}" **———> Fixture wait 5 msec <———** smokey ScorpiusHid --run --test "Get" --args "ReportID=0x0B" **Response—>** byte0 = report byte16-17 = [u16] Read averaged ictx peak value in mA (based on factory calibrated byte18-19 = [u16] Accumulated ADC raw averaged sampling value Note: Upload this raw data into Insight.
			Ping Pong Testing
5	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
6	Choose Comm1	Rx I2C	Write I2C packet: (39) c0 ae 80 80 1e 01 00 05 AD Ginger command: ikt write 0x0xF0000B80 0xAD050001
7	Tell Tx to initiate ping pong with the Rx i.e. 10 packets, 100ms packet delay	TX Diags	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
8	Wait 1 second for RX to send packets before reading buffer	Fixture	Wait 1 second

Step	Description	Interface	Command
9	Read back data that was captured from the Tx.	TX Diags	smokey ScorpiusHid --run --test "Get" --args "ReportID=0x02" Response: byte0: ID *(PingPongID = 0x02)* byte1: Status *(eg. 0x00 = complete)* [0 = Complete; 1 = In-Progress] byte2: Last error *(e.g. 0x00 = no errors)* byte3-4: Pings Sent *(eg. 0x000A = 10 pings sent)* byte5-6: Pongs Received (*eg. 0x000A = 10 pongs received)* *Note:- If byte1:Status is in process then repeat the step*
10	Measure Dotara (U6200) Temp	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x31, ReportPayload={0x08; 0x00; 0x8C}" **<— Trigger reading of Temp1 (channel 8)** smokey ScorpiusHid --run --test "Set" --args "ReportID=0x31, ReportPayload={0x09; 0x00; 0x8C}" **<—Trigger reading of Temp2 (channel 9)** smokey ScorpiusHid --run --test "Get" --args "ReportID=0x31"

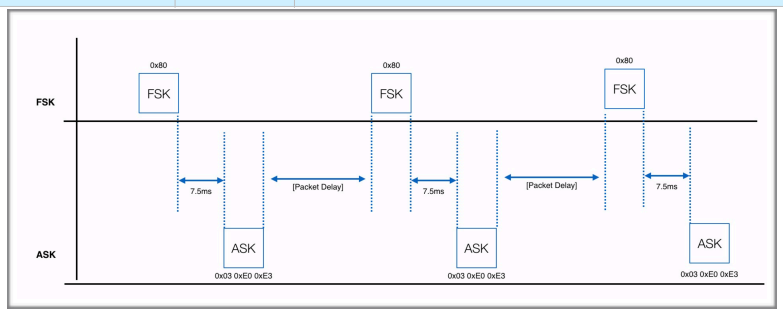


FIGURE 3: PING-PONG PACKET DETAILS

	Preamble											Start	0x03								Parity	Stop	Start	0xE0								Parity	Stop	Start	0xE3								Parity	Stop
	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	1	0	1	0	1	1	0	0	0	1	1	1	0	1

Decimal	Binary								HEX
	0	0	0	0	0	0	1	1	0x03
	1	1	1	0	0	0	0	0	0xE0
(Checksum)	1	1	1	0	0	0	1	1	0xE3

FIGURE 4 : ASK PACKET PREAMBLE AND DATA DETAIL

Acceptance criteria:

Test Parameter	Insight Keys Recorded	LL	UL	Units	Comments/Notes
Load 0.1C					
Isense_Kmax_FXST @ 0.1C	WirelessPower Power_Efficiency@Kmax-0C1 Isense_FXST	71.5	90	mA	Based on volume data
Isense_Kmax_MCU @ 0.1C	WirelessPower Power_Efficiency@Kmax-0C1 Isense_MCU	71.5	90	mA	Based on volume data
Isense_Kmax_Error @ 0.1C	WirelessPower Power_Efficiency@Kmax-0C1 Isense_Error	-3	3	%	
Isense_Kmin_FXST @ 0.1C	WirelessPower Power_Efficiency@Kmin-0C1 Isense_FXST	88	119	mA	Based on volume data
Isense_Kmin_MCU @ 0.1C	WirelessPower Power_Efficiency@Kmin-0C1 Isense_MCU	88	119	mA	Based on volume data
Isense_Kmin_Error @ 0.1C	WirelessPower Power_Efficiency@Kmin-0C1 Isense_Error	-3	3	%	
Vsense_Kmax_FXST @ 0.1C	WirelessPower Power_Efficiency@Kmax-0C1 Vsense_FXST	6020	6180	mV	Based on volume data
Vsense_Kmax_MCU @ 0.1C	WirelessPower Power_Efficiency@Kmax-0C1 Vsense_MCU	6020	6180	mV	Based on volume data
Vsense_Kmax_Error @ 0.1C	WirelessPower Power_Efficiency@Kmax-0C1 Vsense_Error	-1	1	%	
Vsense_Kmax_Ripple@ 0.1C	WirelessPower Power_Efficiency@Kmax-0C1 Get_RIPPLE_254K_VPP	0	40	mV	Based on volume data
Vsense_Kmin_FXST @ 0.1C	WirelessPower Power_Efficiency@Kmin-0C1 Vsense_FXST	6020	6180	mV	Based on volume data
Vsense_Kmin_MCU @ 0.1C	WirelessPower Power_Efficiency@Kmin-0C1 Vsense_MCU	6020	6180	mV	Based on volume data
Vsense_Kmin_Error @ 0.1C	WirelessPower Power_Efficiency@Kmin-0C1 Vsense_Error	-0.6	0.6	%	
Vsense_Kmin_Ripple@ 0.1C	WirelessPower Power_Efficiency@Kmin-0C1 Get_RIPPLE_254K_VPP	0	60	mV	Based on volume data
Vctx_IPeak_Kmax_Fix @ 0.1C	WirelessPower Power_Efficiency@Kmax-0C1 ICTx_Peak_FXST_Digital_Filter	306	528	mA	Digital Filtering
Vctx_IPeak_Kmax_MCU @ 0.1C	WirelessPower Power_Efficiency@Kmax-0C1 ICTx_peak_Factory_MCU	306	528	mA	
Vctx_IPeak_Kmax_Error_MCU @ 0.1C	WirelessPower Power_Efficiency@Kmax-0C1 ICTx_Peak_Digital_Filter_Error	-20	20	%	
Vctx_IPeak_Kmin_Fix @ 0.1C	WirelessPower Power_Efficiency@Kmin-0C1 ICTx_Peak_FXST_Digital_Filter	443	715	mA	Digital Filtering
Vctx_IPeak_Kmin_MCU @ 0.1C	WirelessPower Power_Efficiency@Kmin-0C1 ICTx_peak_Factory_MCU	443	715	mA	

Test Parameter	Insight Keys Recorded	LL	UL	Units	Comments/Notes
Vctx_IPeak_Kmin_Error_MCU @ 0.1C	WirelessPower Power_Efficiency@Kmin-0C1 ICTx_Peak_Factory_Error	-20	20	%	
Vrect_FXST @ 0.1C	WirelessPower Power_Efficiency@Kmax-0C1 Vrect_FXST WirelessPower Power_Efficiency@Kmin-0C1 Vrect_FXST	6420	6565	mV	Vrect Target = 6.5v ±2%
Irect_FXST @ 0.1C	WirelessPower Power_Efficiency@Kmax-0C1 Irect_FXST WirelessPower Power_Efficiency@Kmin-0C1 Irect_FXST	38	42	mA	Iktara ballast load = 40mA ± 2mA. No fixture load required.
Rx_Loading_Power @ 0.1C	WirelessPower Power_Efficiency@Kmax-0C1 Rx_Power_FXST WirelessPower Power_Efficiency@Kmin-0C1 Rx_Power_FXST	243.96	275.73	mW	Vrect * Irect
Efficiency @ 0.1C	WirelessPower Power_Efficiency@Kmax-0C1 Efficiency_FXST WirelessPower Power_Efficiency@Kmax-0C1 Efficiency_MCU	50	62	%	Rx_Power / (Vsense * Isense)
Efficiency @ 0.1C	WirelessPower Power_Efficiency@Kmin-0C1 Efficiency_FXST WirelessPower Power_Efficiency@Kmin-0C1 Efficiency_MCU	30	50	%	
Number of Pings Sent @ 0.1C	WirelessPower Inband_Comms@Kmax-0C1 Packets_Sent_Result WirelessPower Inband_Comms@Kmin-0C1 Packets_Sent_Result	10	10	-	
Number of Pongs Received @ 0.1C	WirelessPower Inband_Comms@Kmax-0C1 Packets_Recieved_Result WirelessPower Inband_Comms@Kmin-0C1 Packets_Recieved_Result	10	10	-	
Dotara Surface Temperature	WirelessPower Power_Efficiency@Kmax-0C1 Temp1_MCU WirelessPower Power_Efficiency@Kmax-0C1 Temp2_MCU WirelessPower Power_Efficiency@Kmin-0C1 Temp1_MCU WirelessPower Power_Efficiency@Kmin-0C1 Temp2_MCU	20	61	℃	Based on P1 data
Load 10C					
Isense_Kmax_FXST @ 10C	WirelessPower Power_Efficiency@Kmax-10C Isense_FXST	420	480	mA	Based on volume data
Isense_Kmax_MCU @ 10C	WirelessPower Power_Efficiency@Kmax-10C Isense_MCU	420	480	mA	Based on volume data
Isense_Kmax_Error @ 10C	WirelessPower Power_Efficiency@Kmax-10C Isense_Error	-1	1	%	
Isense_Kmin_FXST @ 10C	WirelessPower Power_Efficiency@Kmin-10C Isense_FXST	442	500	mA	Based on volume data
Isense_Kmin_MCU @ 10C	WirelessPower Power_Efficiency@Kmin-10C Isense_MCU	442	500	mA	Based on volume data
Isense_Kmin_Error @ 10C	WirelessPower Power_Efficiency@Kmin-10C Isense_Error	-1	1	%	
Vsense_Kmax_FXST @ 10C	WirelessPower Power_Efficiency@Kmax-10C Vsense_FXST	9250	10550	mV	Based on volume data
Vsense_Kmax_MCU @ 10C	WirelessPower Power_Efficiency@Kmax-10C Vsense_MCU	9250	10550	mV	Based on volume data
Vsense_Kmax_Error @ 10C	WirelessPower Power_Efficiency@Kmax-10C Vsense_Error	-1	1	%	
Vsense_Kmax_Ripple@ 10C	WirelessPower Power_Efficiency@Kmax-10C Get_RIPPLE_128kHz_VPP	42	90	mV	Based on volume data
Vsense_Kmin_FXST @ 10C	WirelessPower Power_Efficiency@Kmin-10C Vsense_FXST	10600	12300	mV	Based on volume data
Vsense_Kmin_MCU @ 10C	WirelessPower Power_Efficiency@Kmin-10C Vsense_MCU	10600	12300	mV	Based on volume data
Vsense_Kmin_Error @ 10C	WirelessPower Power_Efficiency@Kmin-10C Vsense_Error	-1	1	%	
Vsense_Kmin_Ripple@ 10C	WirelessPower Power_Efficiency@Kmin-10C Get_RIPPLE_128kHz_VPP	80	210	mV	Based on volume data
Vctx_IPeak_Kmax_Fix @ 10C	WirelessPower Power_Efficiency@Kmax-10C ICTx_Peak_FXST	708	950	mA	Digital Filtering
Vctx_IPeak_Kmax_MCU @ 10C	WirelessPower Power_Efficiency@Kmax-10C ICTx_peak_Factory_MCU	708	950	mA	
Vctx_IPeak_Kmax_Error_MCU @ 10C	WirelessPower Power_Efficiency@Kmax-10C ICTx_Peak_Factory_Error	-5	5	%	Digital Filtering
Vctx_IPeak_Kmin_Fix & 10C	WirelessPower Power_Efficiency@Kmin-10C ICTx_Peak_FXST	1028	1465	mA	Digital Filtering
Vctx_IPeak_Kmin_MCU & 10C	WirelessPower Power_Efficiency@Kmin-10C ICTx_peak_Factory_MCU	1028	1465	mA	
Vctx_IPeak_Kmin_Error_MCU @ 10C	WirelessPower Power_Efficiency@Kmin-10C ICTx_Peak_Factory_Error	-5	5	%	Error after digital filter
Vrect_FXST @ 10C	WirelessPower Power_Efficiency@Kmax-10C Vrect_FXST WirelessPower Power_Efficiency@Kmin-10C Vrect_FXST	13780	14220	mV	Vrect Target = 14v ±2%
Irect_FXST @ 10C	WirelessPower Power_Efficiency@Kmax-10C Irect_FXST WirelessPower Power_Efficiency@Kmin-10C Irect_FXST	213	215	mA	Irect target load = 214mA ±2mA
Rx_Loading_Power @ 10C	WirelessPower Power_Efficiency@Kmax-10C Rx_Power_FXST WirelessPower Power_Efficiency@Kmin-10C Rx_Power_FXST	2935.14	3057.3	mW	Vrect * Irect
Efficiency @ 10C	WirelessPower Power_Efficiency@Kmax-10C Efficiency_FXST WirelessPower Power_Efficiency@Kmax-10C Efficiency_MCU	63.5	72	%	Rx_Power / (Vsense * Isense)
Efficiency @ 10C	WirelessPower Power_Efficiency@Kmin-10C Efficiency_FXST WirelessPower Power_Efficiency@Kmin-10C Efficiency_MCU	52.7	61	%	
Number of Packets Sent @ 10C	WirelessPower Inband_Comms@Kmax-10C Packets_Sent_Result WirelessPower Inband_Comms@Kmin-10C Packets_Sent_Result	9	10	-	

Test Parameter	Insight Keys Recorded	LL	UL	Units	Comments/Notes
Number of Packets Received @ 10C	WirelessPower Inband_Comms@Kmax-10C Packets_Recieved_Result WirelessPower Inband_Comms@Kmin-10C Packets_Recieved_Result	9	10	-	
Dotara Surface Temperature	WirelessPower Power_Efficiency@Kmax-10C Temp1_MCU WirelessPower Power_Efficiency@Kmax-10C Temp2_MCU WirelessPower Power_Efficiency@Kmin-10C Temp1_MCU WirelessPower Power_Efficiency@Kmin-10C Temp2_MCU	20	65	℃	Based on P1 data

8.6. Comms - FSK

Description :- Measure the FSK mod depth at different system frequencies.
Failure Mode(s) Captured: TBD
Test Setup and Procedure:

Note :-This test can be done at all loading condition after doing Power & Efficiency test in above section, so don't need repeat the loading condition again.

Step	Description	Interface	Command / Notes
1	Set load and coupling position	Fixture	Repeat all below tests for the following Load conditions: 1. 0.1C @ minK (0.501 - 0.570) & @ maxK (0.590 - 0.672) 2. 3C @ minK (0.501 - 0.570) & @ maxK (0.590 - 0.672) 3. 10C @ minK (0.501 - 0.570) & @ maxK (0.590 - 0.672)
2	Measure the following test points "PP20V_DOTARA"	Fixture	Reference to nearest GND for the respective TPs. NOTE:- Continue with next step if PP20V_DOTARA <1200mV, if not then delay for 1sec and remeasure.
3	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; 0xF4; 0x01}" **Payload:——>** Byte0-1: Boost voltage (eg. 0x17D4 = 6100mV)
4	Enable Full Bridge with nominal frequency of 127.772kHz	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x04, ReportPayload={0x1C; 0xF3; 0x01; 0x00; **0x50; 0x46;** 0x50; 0x46}"
5	Measure system Frequency f_nom	Fixture	Measure system frequency on fixture Tx side (Default should be **127.772kHz**) Measure AC1 on Tx MLB
6	Change system frequency to f_mod (**126.984kHz**)	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x04, ReportPayload={0x08; 0xF0; 0x01; 0x00; **0x50; 0x46;** 0x50; 0x46}"
7	Delay for 3S to stabilize	Fixture	
8	Measure system Frequency	Fixture	Measure system frequency on fixture Tx side Measure AC1 on Tx MLB Note: No need test AC2.
9	Change system frequency back to default (f_nom)	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x04, ReportPayload={0x1C; 0xF3; 0x01; 0x00; 0x50; 0x46; 0x50; 0x46}" *Note: This command goes back to the base frequency = nominal system frequency of 127.772kHz.*
10	Calculate FSK mod depth	Fixture	f_nom - f_mod
11	Repeat for all coupling and load conditions as outlined in step 3		See test parameters and limits on following page

Acceptance criteria:

Test Parameter/Net Name	Insight Keys Recorded	LL	UL	Units	Notes
F_Nom_Kxxx @ xxC	WirelessPower Inband_Comms@Kmax-0C1 AC1_FSK_Fre_Nom WirelessPower Inband_Comms@Kmin-0C1 AC1_FSK_Fre_Nom	127770	127778	Hz	Base on P0 Volume data Expected:127772.8Hz
F_Mod_Kxxx @ xxC	WirelessPower Inband_Comms@Kmax-0C1 AC1_FSK_Fre_Mod WirelessPower Inband_Comms@Kmin-0C1 AC1_FSK_Fre_Mod	126981	126989	Hz	Base on P0 Volume data Expected: 126984Hz
Mod_Depth_Kxxx @ xxC	WirelessPower Inband_Comms@Kmax-0C1 AC1_FSK_Mod_Depth WirelessPower Inband_Comms@Kmin-0C1 AC1_FSK_Mod_Depth	788	789.5	Hz	Base on P0 Volume data Expected = 788.7Hz

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	

Step	Description	Interface	Command / Notes
3	Preparation	Tx Diags	pmugpio --pin 3 --pushpull --output 1 socgpio --port 1 --pin 46 --output 1
4	Tell Tx to get out of standalone mode.	TX 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 Diags	**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	Read MTP Sector 127	TX Diags	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**
8	Read Mlb serial number	TX Diags	**Note:** Before reading the MLB SN, sector signature needs to be set and the unit reset after freshly writing the serial number to mtp for this command to work. smokey ScorpiusHid --run --test "Get" --args "ReportID=0x7C"
9	Read MTP Sector 129	Tx Diags	smokey ScorpiusHid --run --test "Print_Sector" --args "MTP_sector=129" **Example:-Overlay will read Words that are printed:-** Word 0 : 0x0000043A / Word 1 : 0x000000000 / Word 2 : 0x20000022 / Word 3 : 0x49048382 Word 4 : 0x7602A47F / Word 5 : 0x03000386 / Word 6 : 0x0C11810D / Word 7 : 0x80000090 Word 8 : 0x0001B952 / **Word 9 : 0xC4260101** / **Word 10 : 0x812040A5** / **Word 11 : 0x5206489B** **Word 12 : 0x00239207** / Word 13 : 0x000000000 / Word 14 : 0x000000000 / Word 15 : 0x00000001 Word 16 : 0x0000043A / Word 17 : 0x000000000 / Word 18 : 0x20000022 / Word 19 : 0x49048382 Word 20 : 0x7602A47F / Word 21 : 0x03000386 / Word 22 : 0x0C11810D / Word 23 : 0x80000090 Word 24 : 0x0001B952 / Word 25 : 0xC4260101 / Word 26 : 0x812040A5 / Word 27 : 0x5206489B Word 28 : 0x00239207 / Word 29 : 0x00000000 / Word 30 : 0x00000000 / Word 31 : 0x00000001

Acceptance:

Test Parameter	Insight Keys Recorded	Comments/Notes
Sector 127		
Check Sum (Word 31)	WirelessPower Dotara_MTP_Check-Post_CAL Read_Sector_127_CheckSum	Pass if this values match with MTP Write section i.e. **Section 8.3.6**
Vsense MTP (Word 7)	WirelessPower Dotara_MTP_Check-Post_CAL Read_Sector_127_Vsense	
Isense MTP (Word 8)	WirelessPower Dotara_MTP_Check-Post_CAL Read_Sector_127_Isense	
VBoost_Control MTP (Word 6)	WirelessPower Dotara_MTP_Check-Post_CAL Read_Sector_127_Vboost_Control	
LFOD MTP (Word 9)	WirelessPower Dotara_MTP_Check-Post_CAL Read_Sector_127_LFOD	
CTx MTP (Word 2)	WirelessPower Dotara_MTP_Check-Post_CAL Read_Sector_127_CTx	
Tx HWID_MTP (Word 10):- J307 - 0x03070001	WirelessPower Dotara_MTP_Check-Post_CAL Read_Sector_127_Tx_HWID	
Version (Word 1)	WirelessPower Dotara_MTP_Check-Post_CAL Read_Sector_127_Version	
Signature (Word 0)	WirelessPower Dotara_MTP_Check-Post_CAL Read_Sector_127_Signature	
MLB Serial No. (Word11 to Word 15 - Bits<1:17>)	WirelessPower Dotara_MTP_Check-Post_CAL Read_Sector_127_SN	
Sector 129 (Read Only)		
LOT_NUMBER (31:0 = Word 9 —> BITS<31:0>)	WirelessPower Dotara_MTP_Check-Post_CAL Sector_129_LOT_NUMBER(31:0)	
LOT_NUMBER (35:32 = Word 10 —> BITS<3:0>)	WirelessPower Dotara_MTP_Check-Post_CAL Sector_129_LOT_NUMBER(35:32)	
EWS1FL (Word 10 —> BITS<31>)	WirelessPower Dotara_MTP_Check-Post_CAL Sector_129_EWS1FL	
Y_COORD (Word 10 —> BITS<27:20>)	WirelessPower Dotara_MTP_Check-Post_CAL Sector_129_Y_COORD	
X_COORD (Word 10 —> BITS<16:9>)	WirelessPower Dotara_MTP_Check-Post_CAL Sector_129_X_COORD	
WAFER ID (Word 10 —> BITS<8:4>)	WirelessPower Dotara_MTP_Check-Post_CAL Sector_129_Wafer_ID	
ST_PARTNUMBER (25:0 = Word 11 —> BITS<31:6>)	WirelessPower Dotara_MTP_Check-Post_CAL Sector_129_ST_PARTNUMBER(25:0)	
ST_PARTNUMBER (47:26 = Word 12 —> BITS<21:0>)	WirelessPower Dotara_MTP_Check-Post_CAL Sector_129_ST_PARTNUMBER(47:26)	
SILICON_VERSION (LSB IS BIT 5 = Word 11 ->BITS<5:4>)	WirelessPower Dotara_MTP_Check-Post_CAL Sector_129_SILICON_VERSION	
TESTING_PLANT (LSB IS BIT 3 = Word 11 —>BITS<3:2>)	WirelessPower Dotara_MTP_Check-Post_CAL Sector_129_TESTING_PLANT	
CSPFL (Word 11 —> BITS<1>)	WirelessPower Dotara_MTP_Check-Post_CAL Sector_129_CSPFL	
EWS2FL (Word 11 —> BITS<0>)	WirelessPower Dotara_MTP_Check-Post_CAL Sector_129_EWS2FL	

A. Digital Filtering to be implemented on SFCT fixture

1. Update fixture to sample Vctx waveform by 4MHz speed, collecting continuous 100 PWM cycles in time domain.
2. Continue to calculate Ictx peak current (pk-to-pk/2) averaged by 100 PWM cycles, time 1.022 in the final result.
3. Digital filter coefficients:

   a= [1.000, -2.026, 2.148, -1.159, 0.279]; where a(0)=1.000, a(1)=-2.026, a(2)=2.148, ..., a(5)=0.279;

   b = [0.028, 0.053, 0.071, 0.053, 0.028]; where b(0)=0.028m b(1)=0.053, b(2)=0.053, ..., b(5)=0.028.
4. Calculate the digital filter output using floating point calculation:

   y(n) = b(0)*x(n) + b(1)*x(n-1) + b(2)*x(n-2) + b(3)*x(n-3) + b(4)*x(n-4) - a(1)*y(n-1) - a(2)*y(n-2) - a(3)*y(n-3) - a(4)*y(n-4);

   x(n) is the input Ictx sample.

   Because the first output starts at y(4), it's OK to let y(0)=x(0), y(1)=x(1), y(2)=x(2), y(3)=x(3).

   When finishing calculation, delete the first cycle (32samples) in y.
5. To cross check the results from above calculation, use Matlab built-in functions.

   a= [1.000, -2.026, 2.148, -1.159, 0.279]; b = [0.028, 0.053, 0.071, 0.053, 0.028]. Y =filter(b, a, x).

   Plot Y and y to check if they are matching each other.
6. Please store unfiltered (x) and filtered fixture Ictx samples (y) as fixture raw data.

B. Comments and Feedback for Changes to this Document

This table is for tracking the following:

1. Changes made by DRIs which the factory DRI needs to review before releasing
2. General feedback which should be reviewed and / or incorporated by the factory DRI prior to release

Feature	Updated by	Description/Comments/Reason for Change	Date	Approved and released in Version:
COMMS	Mikhal	Added 3C load at FSK test. Additional Tx measurements on AC1 and AC2 (Duty and phase difference).	10 Jun 2019	
Vsense CAL	Jin	Changed ADC samples to 140 per Aijun's suggestion	10 Jun 2019	
Isense CAL	Jin	Changed ADC samples to 140 per Aijun's suggestion	10 Jun 2019	
2V95 supply	Bernard	Changed PP2V95_S2_THROTTLE to PP2V95_S2_SCORPIUS_FILT . This will enable us to detect the absence of R6013 and C6022	12 Jun 2019	
COMMS	Mikhal	Added Section 8.3.3 LFOD External Resistor Check and take out ASK section as there is no discreet components to test this.	14 Jun 2019	
Circuit Functionality Tests	Steven	Added "Boost Throttle" test	17 Jun 2019	
Circuit Functionality Tests	Steven	Where appropriate, consider including a Dotara ADC read of the power rail.	17 Jun 2019	
Circuit Functionality Tests	Steven	In general, ensure connectivity of all I/Os. Most look like they are indirectly exercised but I couldn't find any tests that exercise this one: DOTARA_GPIO2 (KONA_TO_DOTARA_TIME_SYNC)	17 Jun 2019	
Circuit Functionality Tests	Steven	Test RESET and INT functionality. Can be placeholder until we get FW.	18 Jun 2019	
Calibration	Steven	Do we store any factory calibration factors to Dotara MTP? Would be nice to have single EFI command for this instead of doing it through register writes.	18 Jun 2019	
Resonant Cap Measurement	Bhushan	Added section to Measure the resonance capacitance.	20 Jun 2019	
VCTX CALibraion	Bhushan	VCTX calibration (Writing the actual Measured value to MCU)	21 Jun 2019	
VCTX CALibraion	Bhushan	VCTX calibration taken out as calibration by ST is accurate as suggested by Jin	12 Jul 2019	
VCTX Calibration	Steven	Added VCTX calibration back in, filled in details.	16 Jul 2019	
Boost Vsense Calibration	Bernard	Boost Vsense calibration for triggering the internal comparator	19 Jul 2019	
COMMS	Mikhal	Added Ping-pong test for ASK/FSK test	22 Jul 2019	
LPP	Frank	Merged 5V LPP charge pump probe into section Scorpius Boost + LPP switch test due to LPP_enable required Need to confirm the LPP pulse width later in section LPP test.	22 Jul 2019	
Calibration	Steven	Added "Ictx Sigma Distribution (Data Collection)". Purpose of this test is to gather data on Ictx peak and valley standard deviation. We will need this to implement removal of gross Ictx_peak and Ictx_valley outliers in FW.	23 Jul 2019	
LFOD External Resistance	Bhushan	Took out this section as this resistance measurement can be done at ICT.	30 Jul 2019	
COMMS	Bhushan/Mikhal	Have merged this test with Power & Efficiency test as the setup and test requirements are similar	30 Jul 2019	

Feature	Updated by	Description/Comments/Reason for Change	Date	Approved and released in Version:
Isense Calibration	Steven	Added commands for disabling LFOD amplifier and inverter prior to doing ISNS calibration, to minimize current from VMID to VRECT.	31 Jul 2019	
Calibtraion	Bhushan/Aijun/ Lee	Updated the Calibration procedure for Vsense, Isense, Vboost and LFOD	1 Aug 2019	
Calibration	Steven	Corrected ISNS/VSNS gcal formula, and ocal formula - subtract 2048 from MCU_1/16 Corrected LFOD ocal formula - subtract 2048 from MCU_1/16 as nominal offset is 2048	12 Aug 2019	
Grape/Kona Sync	Bhushan	Replaced external power supply to pull the Kona sync pin high with Diags command. A Diags command can pull this pin to high. And is safer than using external power supply.	21 Aug 2019	
MTP Sector Write and Check	Bhushan	Updated MTP Sector write section and Replaced Critical error Check with MTP Sector check.	22 Aug 2019	
VSense Calibration	Bhushan	Updated the y -axis measurement to include the negative sign before using these values into Equation. As we are using Non- inverting path of OP-Amp we need to add negative sign before taxis reading to be used into gcal & ocal equations.	22 Aug 2019	
Load Tx Fw & Sector Write and Check	Bhushan	Added calculation to get the value of "Check sum" that need to be written as word 0 to initialise writing cal values and added the reset Scorpius section with load Tx Fw. Updated the Load Tx Fw.	28 August 2019	
Magnetic	Jin	Updated Coil fixture specification to include the new limits for LQR	28 August 2019	
MTP	Bhushan	Update HWID & CTx word location in MTP	29 August 2019	
Fw Radar	Lou	Updated fw radar for factory.	30 August 2019	
Power Efficiency	Bhushan	Added Bridge phase changing to get desired Vrect to meet the loading conditions.	5 September 2019	
PingPong	Lou	Updated the PingPong response format	5 September 2019	
MTP Sector Write and Check	Bhushan/Samira	Updated MTP Sector Write & Read section to include CTx value into Sector 127:Word2	9 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	
LPP Boost	Bhushan/Frank	Updated the Procedure to Measure VMID value when Boost is Disabled and LPP boost is enabled	14 September 2019	
Scorpius Throttle	Bhushan	Disabled Scorpius Boost & LPP Boost to correctly measure the Throttle correctly	17 September 2019	
Calibration/Power Transfer	Bhushan	Swaped the Sequence of Boost enable & Full Bridge to avoid loading from LPP Boost.	17 September 2019	
Scorpius Throttle	Bhushan	Reverted back to the original procedure as the test the reported this failure was on Mian MLB FCT and not SFCT where they were testing the wrong output.	20 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	
MTP	Bhushan/Samira	Update locations of all the word calibrated/Used from MTP.	11 November 2019	Samira/P1_V2.5
Power Transfer	Bhushan	Updated Limits for Power Transfer test and added self heating test.	11 November 2019	All DRIs/P1_V2.5
Calibration	Jin	Updated the LFOD calibration verification Part	11 November 2019	Jin/P1_V2.5
Magnetic - Coil fixture specs	Bhushan/Jin	Updated Coil fixture specification for coupling measurements value t based on GBD and Factory data distribution.	11 November 2019	Jin/P1_V2.5
MTP	Bhushan/ Selestino	Updated MTP write from single word to all words in one go.	25 November 2019	Samira/P1_V2.7
AOP Connectivity Check	Bhushan	Added test to check all connectivity between App to Scorpius	5 December 2019	Bhushan/P1_2.8
Calibration	Jin	Updated the Isense calibration verification Part to disable LFOD amplifier	11 December 2019	Jin/P1_V2.9
General	Bhushan	Limits update based on BGD and P1 built data. Changed limits for Ping Pong Test temporarily as it is having high retest issue and slowing down the line UPH. Will update this limits back to original when RX(Xavier) FW PingPong part is fixed.	17 December 2019	Bhushan/Bernard/ Frank/Mikhal/P1_V3.0
LFOD Calibration	Jin Yu	Added LFOD CMR calibration test to reduce Isense error. And took out ICTx Sigma Distribution test	19 February 2020	Bhushan/JIn/Min/ Mikhal/Bernard/ P1B_V3.1
Insight Key Parameters	Bhushan	Updated the names of Insight key parameters to match the Factory key names based o Factory Standards	19 February 2020	
Dotara	Bhushan/Min/ Bernard	Added test for Dotara to AOP IRQ functionality. Added Limits to GPIO to Dotara & AOP test & Dotara temperature During Power Flow	19 February 2020	
Comms	Mikhal	Took out measurement of AC2 and Vrect	19 February 2020	
Power Transfer	Mikhal	Minimum boost requirement has changed from 6000mV to 6100mV.	21 February 2020	Mikhal/Bhushan/ P1B_V3.2
Dotara	Bhushan/Min/ Samira	Update procedure for Grape to Dotara Time sync and Dotara heart beat connection test	10 March 2020	Samira/Ajiun/Stino/ Bhushan/P1B_V3.3

Feature	Updated by	Description/Comments/Reason for Change	Date	Approved and released in Version:
Vsense & Isense	Jin/Bhushan	Updates Vsense Limits for change of minimum boost requirement and Vsense Error. Updated Isense MCU reading procedure to account for LFOD	10 March 2020	Bhushan/Jin/P1B_V3.3
Fixture	Bhushan/Jin	Added Digital filtering procedure for fixture measurement of ICtx	31 March 2020	
LPP	Bhushan/Aijun/ Samira	Updated LPP command and response format for FW520 onwards releases.		
VCTx/ICtx	Bhushan/Aijun/ Samira	Updated ICtx response format for FW520 onwards releases.		
Calibration	Bhushan	Updated Vsense & Isense calibration procedure based on J307 ERS for reading only 1x as compared to 30x.		
Dotara Heart Beat	Bhushan/Samira	Updated Dotara heart beat response to Bit response from byte response	2 April 2020	Bhushan/Samira/ P1B_V3.6
Calibration Verification	Bhushan/Aijun/Jin	Updated test procedure for verification part to take out LFOD measurement and add LFOD Chanel status check before Isense reading		
Calibration	Bhushan/Jin	Added Rsense estimation before Isense Calibration part. Updated Vsense procedure to disable LFOD during calibration.	3 April 2020	
Power Transfer	Bhushan/Jin	Updated procedure to Disable LFOD during Vsense & Isense reading.		
Power Transfer	Bhushan/Bernard	Updated Limits for Vsense	17 April 2020	Bhushan/Bernard/ Pre-EVT_V3.7
Power Supply & Scorpius	Bhushan/Bernard	Updated Limits for Vin and Scorpius Boost to ±1%		
AOP Connectivity Check	Bhushan	Updated procedure which correct command and response format		
Calibration	Jin/Nan/Bhushan	Updated Rsense, Isense calibration and Vsense/Isense Verification procedure.	22 April 2020	Bhushan/Jin/Nan/ Bernard/ Pre-EVT_V3.8
Scorpius Boost	Bhushan/Bernard	Added Ripple measurement at Scorpius boost test and during power flow test.		
ICtx	Jin	Updated limits for Ictx Error in power flow for 10C		
Dotara	Bhushan/Rex	Updated procedure and limits for Dotara Inverter check to implement connecting coil at kmin same as J307		
Scorpius Boost	Bhushan/Bernard	Updated Ripple measurement limits at Scorpius boost test and during power flow test.	11 May 2020	Bhushan/Bernard/ Pre-EVT_V3.9
Insight Key Parameters	Bhushan	Updated the names of Insight key parameters to match the Factory key names based o Factory Standards	19 June 2020	Bhushan/Jin/Nan/ Bernard/Mikhal EVT_V4.0
Vsense & Isense	Jin	Added ASK_CR disable command before all Vsense/Isense ADC readings		
Power Transfer	Bhushan/Mikhal/ Jin/Bernard/Frank	Taken out Power Flow test at 3C charging rate.		
Calibration	Jin/Bhushan	Update Vsense, ISesne & LFOD Gcal & OCal formulas		
Calibration	Jin/Bhushan	Updated few test procedures to reflect the latest changes in Overlay due to DOE,s		
Comms	Mikhal	Updated test to exclude AC 2 measurement.		
Scorpius Boost	Bhushan/Daniel/ Bernard	Took out measurement of WirelessPower Boost_DC_Meas@Scorpius-VCC_MAIN3V6_Scorpius_DSBL PP20V_SCORPIUS_BOOST_SW_AMPL_Disable as a low speed ADC(Mux) was solely used to measure this which was also the major cause to VMID failure and was also cost effective to take this out for MP intent.	31 July 2020	Bhushan/Bernard/ Daniel/Kunal EVT_V4.1
LDOF Calibration	Nan/Bhushan	Took out the LFOD CMR calibration test as it is not need anymore	5 August 2020	Bhushan/Nan/Rex/ Daniel EVT_V4.2
Power Transfer	Bhushan/Jin	Updated Vsense limits to 1% during power flow for DVT		
Dotara	Bhushan/Rex/ Daniel	Added VMID5 (PP20V_DOTARA) measurement before every boost enable/set command to make sure VMID5<1200mV		