



# Factory FATP Test Plan for J5xx

Module: Scorpius

Stations: QT0a + Scorpius Test (QT4)

Build: P1

Release Date: 03 April 2020

This Document Covers the Following Products: J5xx

Revision: P1\_V1.3

[<rdar://problem/56766302> J5xx Scorpius Factory ERS](rdar://problem/56766302)

[<rdar://problem/60027625> J3xx&J5xx Scorpius ERS - Foxconn](rdar://problem/60027625)

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



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# 1. Revision

Build Type	Version	Date	Notes	Author
Please refer to last section of this document for Details/Comments on change to this document				
P1	1.0	19 February 2020	Initial release for J5xx P1 Build based on J307 P1 build.	Bhushan Koli, Rex Haung, Nan Liu
	1.1	21 February 2020	Updated Minimum Vboost requirement from 6V to 6.1V	Bhushan/Mikhal
	1.2	18 March 2020	Updated Limits for LPP at QT0a & QT4. Updated Power flow test procedure to include Flex drop. Added Flex connectivity test at QT0a Added VSYS_1P8 test at both QT0a and Scorpion Test	Bhushan Koli, Rex Haung, Nan Liu, Daniel Randall
	1.3	3 April 2020	Updated Flex Connectivity test at QT0A Updated command and response format of LPP and VCTx respectively Added Dotara Temperature measurement At QT4 Updated Vsense during calibration and power flow test to Disable LFOD.	Bhushan Koli, Rex Haung, Nan Liu



## 2. Purpose

This document describes the FATP test plan for J5xx Scorpius Inductive Power Tx module for P0.

## 3. Scope

The scope of this document is the Scorpius only module of the J5xx products. It covers FATP tests of the following high level features:

Test	Scorpius FATP Station
LPP Free Air Calibration	✓
MTP Sector Check	✓
LPP Test	✓
Power Flow & Efficiency	✓
Comms - PingPong	✓

## 4. References

<[rdar://problem/47434171](#)> J4xx Scorpius factory ERS  
<[rdar://problem/48910417](#)> Dotara Data-sheet  
<[rdar://problem/48964978](#)> Dotara Block initializations  
<[rdar://problem/49391712](#)> J5xx FW specifications  
<[rdar://problem/54853341](#)> Radar for Scorpius Factory FW releases  
J5xx 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	Calibrated	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
SCRIP	Scorpius	Reference for searching Scorpius Module related Data in Insight.
Tx	Transmitter	Wireless Power Transmitter. Also referred to as PTx(J5xx MLB)
VCTX	-	Voltage across Tx coil
VBoost	-	Voltage across Boost output



## 6. Critical and Frequently Used Commands

### 6.1. Quiesce Test Mode

After programming the Tx defaults to NominalMode (LPP → Digital Ping → Power negotiation → Closed loop).

The following command needs to be sent to the Tx to enable QuiesceMode whereby certain test commands are then enabled.

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

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

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

Resets into the quiesce mode with the bridge disabled.

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

### 6.2. Nominal Mode

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

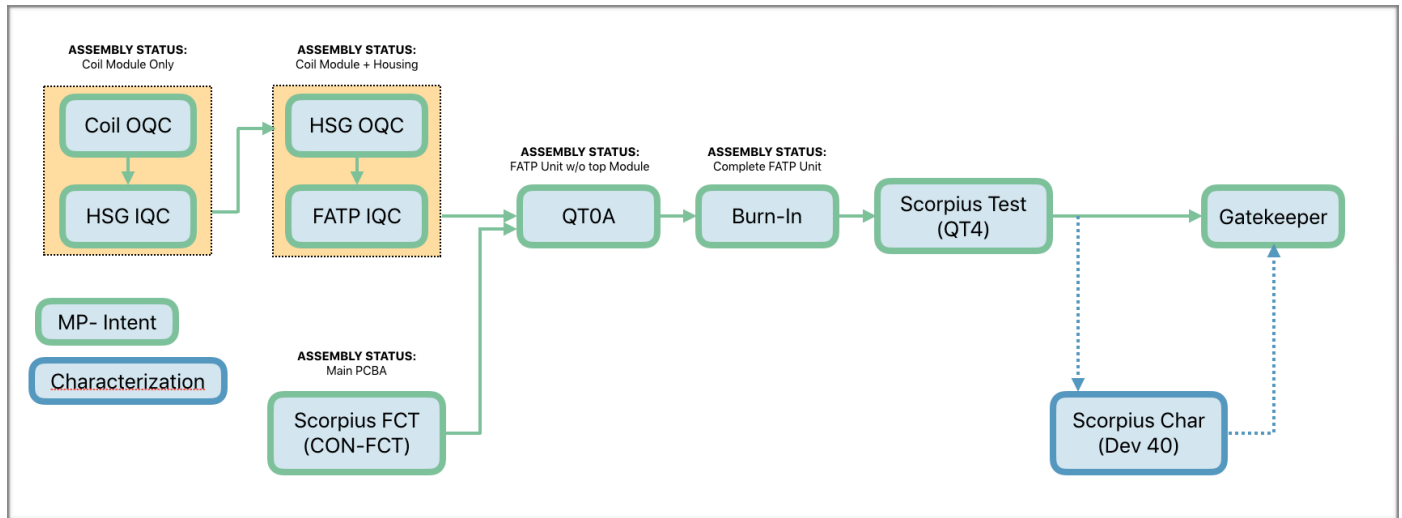
**smokey ScorpiousHid --run --test "Set" --args "ReportID=0x09, ReportPayload={0x00}"**

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



## 7. Overview

The block diagram below shows the overall end-end test coverage for the inductive Scorpius module.



### 7.1. Fixture Coupling specs

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

InSight Keys Recorded	Position (mm)	K Spec	Comments
KMax	0, 0.83, 0	0.535 - 0.610	Coupling for Scorpius Test Station should be between Kmax and Kmin. Ideally should be close to Knom
KNom	D1.1, 0.88, L1.1	TBD	
KMin	D1.5, 0.93, L1.5	0.440 - 0.530	



## 8. Test Coverage @ Scorpius FATP Stations

### 8.1. Load Tx FW & Read Version @ QT0A & QT4

**Description:** -Load Tx FW. Dotara has no NVRAM and therefore will lose all the memory/setting after power cycling or load fw. Dotara will need to load the fw after each power cycling.

**Failure Mode(s) Captured:** TBD

**Test Setup and Procedure:**

Step	Description	Interface	Command / Notes
<b>Note:</b> This command i.e. Quiesce Mode needs to be set once at beginning of testing i.e. from <b>Section 8.1. Load FW</b> or unless unit is reset or power cycled or Nominal Mode has been set. <b>If the unit is power cycled you will need to load fw again.</b>			
A	Tell Tx to get out of standalone mode.	TX HID (Diags)	i2c -w 6 0x39 6 <b>Note:</b> -Send this command 2x times with 1s delay. There may be I2C error reported with this command, but can be ignored.
B	Tell Tx to enter Quiesce Mode	TX HID	<b>Note:</b> 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 14 --output 1 --pushpull
2	Tell Tx to get out of standalone mode.	TX HID (Diags)	i2c -w 6 0x39 6 <b>Note:</b> -Send this command 2x times with 1s delay. There may be I2C error reported with this command, but can be ignored.
3	Load Tx FW	Tx HID	<b>Note:</b> Need to send this command every time within <b>3sec</b> of above command. You cannot enter Load FW without exiting the standalone mode. <b>Path for FW might change.</b> smokey ScorpiusHid --run --test "FWLoad" --args "PathToFwLoad='nandfs:\\AppleInternal\\Diags\\Scorpius\\J517J522\\ScorpiusTx-dotara.bin'"
4	Tell Tx to get out of standalone mode.	TX HID (Diags)	i2c -w 6 0x39 6 <b>Note:</b> -Send this command 2x times with 1s delay. There may be I2C error reported with this command, but can be ignored.
5	Tell Tx to enter Quiesce Mode	TX HID	<b>Note:</b> Need to send the below command after every 2nd time of the above command within <b>3sec</b> or with minimum or no delay as possible of above command. You cannot enter Quiesce mode without exiting the standalone mode. smokey ScorpiusHid --run --test "Set" --args "ReportID=0x09, ReportPayload='{0x01}'"
6	Read Status (Version)	Tx HID	smokey ScorpiusHid --run --test "Get" --args "ReportID=0xBB"

**Command to read Tx FW version:**

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

Example:-This reads back 4 bytes: 0x01 0x00 0x02 0x05

Main FW Type (byte1&2): 0x0001

Main FW Version (byte3&4): 0x0502

Test Parameter	Insight Keys Recorded	Notes
Tx Fw Version	SCR_P_Tx_Version	

### 8.2. Rx FW Version @ QT4

Ginger SN: diags get mlbsn

Eload SN: diags get eloadsn

Versions: get versions

——> application: 2.6.19, this line is the Ginger FW version



## 8.3. Initial MTP Sector Check @ QT0A & QT4 Before Test.

**Description:** Make sure FW is in a good state at the Before of the test. [TBD]

**Failure Mode(s) Captured:** TBD

**Test Setup and Procedure:** Refer

**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.

32 Bit	
0	Signature (0x01)
1	Version
2	Ltx_nH
3	Frequency_Hz
4	RAC_mOhm
5	Rsyst_MTP
6	m_q17
7	Rsyst_main
8	Device_Type
9	Ctx_pF
10	Arcas_Vrect_Target_adj
11	Callisto_Vrect_Target_adj
12	RESERVED[20]....
13	Checksum (Word31)

32 Bit	
0	Signature (0x01)
1	Version
2	Ctx_pF
3	Ctx_pF
4	L_sense_Gain_Tx
5	L_sense_Gain_Rx
6	L_sense_Offset_Tx
7	L_sense_Offset_Rx
8	Scorp_VBoost_GCAL
9	Scorp_VBoost_OCAL
10	Scorp_VSNS_GCAL
11	Scorp_VSNS_OCAL
12	Scorp_ISNS_GCAL
13	Scorp_ISNS_OCAL
14	Scorp_VCTX_GCAL
15	Scorp_VCTX_OCAL
16	Device_Type
17	Board SN (byte 1-4)
18	Board SN (byte 5-8)
19	Board SN (byte 9-12)
20	Board SN (byte 13-16)
21	Board SN (byte 17)
22	Scorp_VSYS_ANA_m
23	Scorp_VSYS_ANA_c
24	Scorp_VSYS_IPB_b
25	RESERVED[13]....
26	Checksum (Word31)

32 Bit (only 16 Bit utilized)	
0	Reserved
1	Reserved
2	Reserved
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

32 Bit (only 16 Bit utilized)	
0	Reserved
1	Reserved
2	Reserved
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

Figure 1 : MTP Word Locations

Step	Description	Interface	Command / Notes																																
<b>Note:</b> This command i.e. Quiesce Mode needs to be set once at beginning of testing i.e. from Section 8.3 MTP Sector Check or unless unit is rest/power cycled or Nominal Mode has been set. If the unit is power cycled you will need to load fw again.																																			
1	Tell Tx to get out of standalone mode.	Tx Diags	i2c -w 6 0x39 6 <b>Note:-Send this command 2x times.</b> There may be I2C error reported with this command, but can be ignored.																																
2	Tell Tx to enter Quiesce Mode	Tx Diags	<b>Note:</b> Need to send the below command after every 2nd time of the above command within 3sec or with minimum or no delay as possible of above command. You cannot enter Quiesce mode without exiting the standalone mode.  smokey ScorpiusHid --run --test "Set" --args "ReportID=0x09, ReportPayload={0x01}"																																
Skip the above 2 steps if the unit is already in Quiesce Mode																																			
3	Read MTP Sector 127 (written at SFCT station)	Tx Diags	smokey ScorpiusHid --run --test "Print_Sector" --args "MTP_sector=127" <b>Example:-Overlay will read Words that are printed:-</b> <table><tr><td>Word 0 : 0x00000001</td><td>Word 1 : 0x00000002</td><td>Word 2 : 0x00305070</td><td>Word 3 : 0x00000000</td></tr><tr><td>Word 4 : 0x00000000</td><td>Word 5 : 0x00000000</td><td>Word 6 : 0x0A0A0A0A</td><td>Word 7 : 0x0B0B0B0B</td></tr><tr><td>Word 8 : 0x0C0C0C0C</td><td>Word 9 : 0x0D0D0D0D</td><td>Word 10 : 0x05170000</td><td>Word 11 : 0x33323130</td></tr><tr><td>Word 12 : 0x37363534</td><td>Word 13 : 0x42413938</td><td>Word 14 : 0x46454443</td><td>Word 15 : 0x00000041</td></tr><tr><td>Word 16 : 0x0D0D0D0D</td><td>Word 17 : 0x0D0D0D0D</td><td>Word 18 : 0x00000000</td><td>Word 19 : 0x00000000</td></tr><tr><td>Word 20 : 0x00000000</td><td>Word 21 : 0x00000000</td><td>Word 22 : 0x00000000</td><td>Word 23 : 0x00000000</td></tr><tr><td>Word 24 : 0x00000000</td><td>Word 25 : 0x00000000</td><td>Word 26 : 0x00000000</td><td>Word 27 : 0x00000000</td></tr><tr><td>Word 28 : 0x00000000</td><td>Word 29 : 0x00000000</td><td>Word 30 : 0x00000000</td><td>Word 31 : 0xDBDBEB3E</td></tr></table>	Word 0 : 0x00000001	Word 1 : 0x00000002	Word 2 : 0x00305070	Word 3 : 0x00000000	Word 4 : 0x00000000	Word 5 : 0x00000000	Word 6 : 0x0A0A0A0A	Word 7 : 0x0B0B0B0B	Word 8 : 0x0C0C0C0C	Word 9 : 0x0D0D0D0D	Word 10 : 0x05170000	Word 11 : 0x33323130	Word 12 : 0x37363534	Word 13 : 0x42413938	Word 14 : 0x46454443	Word 15 : 0x00000041	Word 16 : 0x0D0D0D0D	Word 17 : 0x0D0D0D0D	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 : 0xDBDBEB3E
Word 0 : 0x00000001	Word 1 : 0x00000002	Word 2 : 0x00305070	Word 3 : 0x00000000																																
Word 4 : 0x00000000	Word 5 : 0x00000000	Word 6 : 0x0A0A0A0A	Word 7 : 0x0B0B0B0B																																
Word 8 : 0x0C0C0C0C	Word 9 : 0x0D0D0D0D	Word 10 : 0x05170000	Word 11 : 0x33323130																																
Word 12 : 0x37363534	Word 13 : 0x42413938	Word 14 : 0x46454443	Word 15 : 0x00000041																																
Word 16 : 0x0D0D0D0D	Word 17 : 0x0D0D0D0D	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 : 0xDBDBEB3E																																





Step	Description	Interface	Command / Notes
4	Read MTP Sector 126 (written at FATP station-QTOA)	Tx Diags	smokey ScorpiusHid --run --test "Print_Sector" --args "MTP_sector=126" Example:-Overlay will read Words that are printed:- <div> <div>Word 0 : 0x00000000</div> <div>Word 1 : 0x00000000</div> <div>Word 2 : 0x00000000</div> <div>Word 3 : 0x00000000</div> <div>Word 4 : 0x00000000</div> <div>Word 5 : 0x00000000</div> <div>Word 6 : 0x00000000</div> <div>Word 7 : 0x00000000</div> <div>Word 8 : 0x00000000</div> <div>Word 9 : 0x00000000</div> <div>Word 10 : 0x00000000</div> <div>Word 11 : 0x00000000</div> <div>Word 12 : 0x00000000</div> <div>Word 13 : 0x00000000</div> <div>Word 14 : 0x00000000</div> <div>Word 15 : 0x00000000</div> <div>Word 16 : 0x00000000</div> <div>Word 17 : 0x00000000</div> <div>Word 18 : 0x00000000</div> <div>Word 19 : 0x00000000</div> <div>Word 20 : 0x00000000</div> <div>Word 21 : 0x00000000</div> <div>Word 22 : 0x00000000</div> <div>Word 23 : 0x00000000</div> <div>Word 24 : 0x00000000</div> <div>Word 25 : 0x00000000</div> <div>Word 26 : 0x00000000</div> <div>Word 27 : 0x00000000</div> <div>Word 28 : 0x00000000</div> <div>Word 29 : 0x00000000</div> <div>Word 30 : 0x00000000</div> <div>Word 31 : 0x00000000</div> </div>
5	Location to store Signature, LTx, frequency_Hz, Checksum into MTP	Test Overlay	Sector 126 :-Word 0(Signature = 0x01); Word 1(Version = 0x02); Word 2(LTx); Word 3(Frequency_Hz), Word 31 (Checksum).
6	Check if is units are calibrated at SFCT	Test Overlay	Check if Signature @ MTP Sector 127 Word 0 = 0x00000001 @ <b>QT0A</b>
	Check if is units are calibrated at SFCT & QTOA	Test Overlay	Check if Signature @ MTP Sector 127 Word 0 = 0x00000001 @ <b>QT0A &amp; QT4</b> Check if Signature @ MTP Sector 126 Word 0 = 0x00000001 @ <b>QT0A &amp; QT4</b>
7	Check if Checksum is correct	Test Overlay	Pass if <b>Word 31 = 2's compliment of</b> $\left[Sum(Word\ 0 + Word\ 2 + \dots + Word\ 30)\right]$

**Acceptance criteria:**

Test Parameter	Insight Keys Recorded	Comments/Notes
Sector 127		
Check Sum - Sector 127 (Word 31)	SCRP_Check Sum_127_MTP_BEFORE	Will need this Values to be compared against MTP Check after test <b>Section 8.7</b> .
Version (Word 1)	SCRP_Version_127_MTP_BEFORE	
Signature (Word 0)	SCRP_Signature_127_MTP_BEFORE	
Tx HWID_MTP (Word 10):- J51x - 0x05170000 J52x - 0x05200000	SCRP_TX_HWID_127_MTP_BEFORE	
CTx MTP (Word 2)	SCRP_CTx_127_MTP_BEFORE	
VBoost_Control MTP (Word 6)	SCRP_VBoost_127_MTP_BEFORE	
Vsense MTP (Word 7)	SCRP_VSense_127_MTP_BEFORE	
Isense MTP (Word 8)	SCRP_Isense_127_MTP_BEFORE	
LFOD MTP (Word 9)	SCRP_LFOD_127_MTP_BEFORE	
VSYS_ANA (Word 16)	SCRP_VSYS_ANA_127_MTP_BEFORE	
VSYS_1P8 (Word 17)	SCRP_VSYS_1P8_127_MTP_BEFORE	
MLB Serial No. (Word 11 to Word 15 - Bits<1:17>)	SCRP_MLB_SN_127_MTP_BEFORE	
Sector 126		
Check Sum - Sector 126 (Word 31)	SCRP_Check Sum_126_MTP_BEFORE	Ignore this value for QTOA until the LPP Free Air Calibration is done.
Version (Word 1)	SCRP_Version_126_MTP_BEFORE	
Signature (Word 0)	SCRP_Signature_126_MTP_BEFORE	
LPP Inductance_MTP (Word 2)	SCRP_LPP_L_126_MTP_BEFORE	
LPP Frequency_MTP (Word 3)	SCRP_LPP_FREQ_126_MTP_BEFORE	



## 8.4. QT0A

### 8.4.1.Flex Connectivity test

#### Description:

#### Failure Mode(s) Captured:

#### Test Setup and Procedure:

Step	Description	Interface	Command / Notes
1	No Rx Coil Connect/Present	Fixture	
2	PPVCC_MAIN(VSYS_ANA) Record this as <b>x1</b>	Tx HID	<b>PPVCC_MAIN(VSYS_ANA):</b> smokey ScorpiusHid --run --test "Set" --args "ReportID=0x31, ReportPayload={0x06; 0x00; 0x8C}" note: the last part "0x8C" donates the number of samples with a multiplier of 32x. i.e 0x8C = 140 x 32 = 4480 samples -----> <b>Fixture wait 2 sec</b> <----- smokey ScorpiusHid --run --test "Get" --args "ReportID=0x31" <b>Response--&gt;</b> byte0: [u8] ID (GetAdclD = 0x31) byte1-4: [u32] Floating point value read from ADC (eg 0xYYYYYYYY) byte5: [u8] Error Code (eg. 0x00 - no error) byte6: [u8] Reserved (eg. 0x00) byte7-8: [u16] ADC raw value (eg. 0xXXXX) byte9-12: [u32] Channel_Id that was read (eg. 0x00000007 = VSYS_1P8)
3	Calculate PPVCC_MAIN(VSYS_ANA) actual	Overlay	$y_1 = m x_1 + c$ Where m = slope & c = offset -->from Word16 = VSYS_ANA_Offset_MTP <<16    VSYS_ANA_Slope_MTP <b>Note : Convert m &amp; c values into decimal before calculating y1</b>
3	Record value of VSYS_1P8 Record this as <b>x1</b>	Tx HID	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x31, ReportPayload={0x07; 0x00; 0x8C}" note: the last part "0x8C" donates the number of samples with a multiplier of 32x. i.e 0x8C = 140 x 32 = 4480 samples -----> <b>Fixture wait 2 sec</b> <----- smokey ScorpiusHid --run --test "Get" --args "ReportID=0x31" <b>Response--&gt;</b> byte0: [u8] ID (GetAdclD = 0x31) byte1-4: [u32] Floating point value read from ADC (eg 0xYYYYYYYY) byte5: [u8] Error Code (eg. 0x00 - no error) byte6: [u8] Reserved (eg. 0x00) byte7-8: [u16] ADC raw value (eg. 0xXXXX) byte9-12: [u32] Channel_Id that was read (eg. 0x00000007 = VSYS_1P8)
4	Calculate VSYS_1P8 actual	Overlay	$y_1 = x_1 + b$ Where b = offset -->from Word17 = value from step 14 above in Hex <b>Note : Convert b value into decimal before calculating X1</b>
4	Command for following variables: Tx:- Vbatt, lbatt	Tx (Diags & HID)	pmuadc --read all <b>Vbatt:-</b> potomac vbat : xxxx.xxxx mV; <b>lbatt:-</b> ibat_out: xxxx.xxx mA <b>Example ---&gt;</b> 00024088:2240013A] :-> pmuadc --read all vddout: 4199.9389 mV vbat: 3036.0195 mV brick_id: 3.6630 mV brick_id_usb_d+: 0mV brick_id_usb_d-: 0mV brick_id2: 3.6630 mV ..... ibuck9: 0.0000 mA ibuck11: 0.0000 mA ibuck14: 0.0000 mA <b>ibat_out: 23858.3638 mA</b> BIST buck0: 775.0915 mV BIST buck1: 75091 mV ..... potomac vsys_lo : 4214.2857 mV potomac ich_1a : 0.2442 mA potomac tbat : -2.0451 C <b>potomac vbat : 4225.2747 mV</b> potomac ich_6a : 1.4652 mA
5	Difference between VSYS-ANA & Vbatt	Fixture	$V_{Flex\_Drop} = V_{batt} - V_{SYS\_ANA\_actual}$
6	Set Boost Voltage to 6.1V <b>Note:</b> Minimum Vboost is 6100mV, Don't set Vboost < 6100mV.	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0xD4; 0x17; 0x88; 0x13}" <b>Payload: ---&gt;</b> Byte0-1: Boost voltage (eg. 0x17D4 = 6100mV)
7	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. <b>VSense:</b> smokey ScorpiusHid --run --test "Set" --args "ReportID=0x31, ReportPayload={0x00; 0x00; 0x0F}" -----> <b>Fixture wait 2 sec</b> <----- smokey ScorpiusHid --run --test "Get" --args "ReportID=0x31, ReportPayload={}" <b>Response ---&gt;</b> bytes1-4 = Floating point value from ADC --> <b>VSense_MCU</b>
<b>Dotara Heart Beat Connection Test</b>			
8	Pull Test Pin TP0640 High (i.e. "DOTAR_WAKE_HEART_BEAT")	Tx Diags	pmugpio --port 4 --pin 20 --output 1
9	Read the this signal from MCU	Tx HID	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x40, ReportPayload={0x9C; 0x3C; 0x00, 0x40}" -----> <b>Fixture wait 2 sec</b> <----- smokey ScorpiusHid --run --test "Get" --args "ReportID=0x40" <b>Response--&gt;</b> byte 0 = report ID byte 1 = error code (0 = no error) byte 6, second bit = (0 : low, 1: high)
10	Pull Test Pin TP0640 Low (i.e. "DOTAR_WAKE_HEART_BEAT")	Tx Diags	pmugpio --port 4 --pin 20 --output 0



Step	Description	Interface	Command / Notes
11	Read the this signal from MCU	Tx HID	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x40, ReportPayload={0x9C; 0x3C; 0x00, 0x40}" ————> Fixture wait 2 sec <———— smokey ScorpiusHid --run --test "Get" --args "ReportID=0x40" <b>Response</b> ————> byte 0 = report ID byte 1 = error code (0 = no error) byte 6, second bit = (0 : low, 1: high)
<b>Grape to Dotara Sync Connection Test</b>			
12	Pull Test Pin TP064H High ("KONA_TO_DOTARA_TIME_SYNC")	Tx Diags	pmugpio --port 4 --pin 13 --output 1
13	Read this signal from MCU	Tx HID	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 is high)
14	Pull Test Pin TP064H Low ("KONA_TO_DOTARA_TIME_SYNC")	Tx Diags	pmugpio --port 4 --pin 13 --output 1
15	Read this signal from MCU	Tx HID	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 is high) 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
<b>Dotara to AOP IRQ Connection Test</b>			
16	Pull Test Pin TP9349 High (i.e. "SCORPIUS_TO_AOP_INT")	Tx Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x6c; 0x35; 0x00; 0x40; 0x01; 0x00; 0x00; 0x00}"
17	Read AOP_FUN18 on AOP side	TX Diags	socgpio --port5 --pin22 --get
18	Pull Test Pin TP9349 low (i.e. "SCORPIUS_TO_AOP_INT")	Tx Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x6c; 0x36; 0x00; 0x40; 0x01; 0x00; 0x00; 0x00}"
19	Read AOP_FUN18 on AOP side	TX Diags	socgpio --port5 --pin22 --get
<b>AOP to Dotara Connection Test</b>			
20	Disable SWD for GPIO reading	Tx Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x08; 0x36; 0x00; 0x40; 0x01; 0x00; 0x00; 0x00}"
21	Pull Test Pin TP0649 High (i.e. "DOTARA_SWDIO")	Tx Diags	socgpio --port 0 --pin 140 --output 1
22	Pull Test Pin TP0648 High (i.e. "DOTARA_SWDCLK")	Tx Diags	socgpio --port 0 --pin 107 --output 1
23	Read status of this pin on Dotara	Tx Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x40, ReportPayload={0x00; 0x0C; 0x00: 0x40}" ————> Fixture wait 2 sec <———— smokey ScorpiusHid --run --test "Get" --args "ReportID=0x40" <b>Response</b> ————> 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)
24	Pull Test Pin TP0649 Low (i.e. "DOTARA_SWDIO")	Tx Diags	socgpio --port 0 --pin 140 --output 0
25	Pull Test Pin TP0648 Low (i.e. "DOTARA_SWDCLK")	Tx Diags	socgpio --port 0 --pin 107 --output 0
26	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_WAKE_HEART_BEAT"	SCRP_DOTARA_WAKE_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
	SCRP_DOTARA_WAKE_HEART_BEAT_LOW	0	N/A	
"KONA_TO_DOTARA_TIME_SYNC_1V8"	SCRP_GPIO_GRAPE_TO_DOTARA_TIME_SYNC_High	1	N/A	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 Note: Convert Hex response to Bin
	SCRP_GPIO_GRAPE_TO_DOTARA_TIME_SYNC_Low	0	N/A	
"DOTARA_SWDIO"	SCRP_DOTARA_SWDIO_1V8_High	1	N/A	Note: Convert Hex response to Bin and check the Bit0 & Bit4 of byte6 For High —> Bit 1 & Bit4 = 1, For Low —> Bit 1 & Bit4 = 0
	SCRP_DOTARA_SWDIO_1V8_Low	0	N/A	
"DOTARA_SWDCLK"	SCRP_DOTARA_SWDIO_1V8_High	1	N/A	
	SCRP_DOTARA_SWDIO_1V8_Low	0	N/A	
"DOTARA_TO_AOP_IRQ"	SCRP_DOTARA_TO_AOP_IRQ_High	1	N/A	
	SCRP_DOTARA_TO_AOP_IRQ_Low	0	N/A	

Net Name	Insight Keys Recorded	LL	Nominal	UL	Units	Comments
PPVCC_MAIN(VSYS_ANA) Actual	SCR_P_VSYS_ANA_Actual	TBD	TBD	TBD	mV	
VSYS_1P8 actual	SCR_P_VSYS_1P8_Actual	TBD	TBD	TBD	mV	
Vbatt	SCR_P_Vbatt	TBD	TBD	TBD	mV	
Ibatt	SCR_P_Ibatt	TBD	TBD	TBD	mA	
VFlex_drop	SCR_P_VFlex-Drop	TBD	TBD	TBD	mV	
VSense @6.1V	SCR_P_VSENSE_6V1	TBD	TBD	TBD	mV	

### 8.4.2.LPP Free Air Calibration

**Description:** Write free air ( without Rx coil ) LPP Inductance and Frequency values in NVRAM

**Failure Mode(s) Captured:**

### Test Setup and Procedure:

Step	Description	Interface	Command / Notes
1	No Rx Coil Connect/Present	Fixture	
2	Send 1.4uS LPP pulse	Tx Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x05, ReportPayload={0x0; 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	smokey ScorpiusHid --run --test "Get" --args "ReportID=0x05" <b>Response:</b> (Received LSB First, Length should be 23bytes) <div style="display: flex;"><div style="flex: 1;">byte0: byte1: byte2: bytes3-6: bytes7-10: bytes19-22: bytes23-26:</div><div style="flex: 1;">ReportId (should equal 0x05) Error code (0x00-&gt; no error) Sub-cmd (should be 0x00) Floating point value of frequency Floating point value of inductance Buffer address of raw ADC data Number of raw ADC data elements (of size uint16_t)</div></div>
5	Collect raw ADC samples and upload to Insight	Tx Diags & Fixture	Collect Pointer to raw LPP data by sending the following command from bytes15-18 in the above response.Use the above info to read the raw data and upload to insight. Use the command Below to read the raw ADC buffered data smokey ScorpiusHid --run --test "Mem16" --args "Address=<address>, Length=<number of bytes to read>" smokey ScorpiusHid --run --test "Mem16" --args "Address=<buffer address>, Length=220" The LPP data is 660 bytes. Therefore 3 loops of above should finished reading all the LPP data
6	Delay for Write to take effect		Delay 60ms
7	Record parameters as per the table below		Apply limits accordingly
8	Location to store Calibrated values of Inductance (Ltx_nH) & frequency_Hz into MTP and also Signature and version.	Test Overlay	Sector 126 :- Word 0(Signature = 0x01); Word 1(Version = 0x02); Word 2(Ltx_nH); Word 3(frequency_Hz)
10	Calculating Check Sum for writing into MTP. Value of Word 0 is 2's compliment of Sum of all values are to be written into MTP i.e. cal values of Sector 126--> Word31 = Sum(Word0 to Word30)	Test Overlay	<b>Sector 126: Word 31:</b> 2's compliment of $\left[Sum\left(Word~0 + Word~2 + \dots + Word~30\right)\right]$ <b>Example: —&gt; Word 31:</b> 2's Compliment of $\left(22261F1F\right)=DDD9E0E1$
11	Set Boost Voltage to 6.1V	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0xD4; 0x17; 0x88; 0x13}" <b>Payload: ——&gt;</b> Byte0-1: Boost voltage (eg. 0x17D4 = 6100mV)
12	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}""
13	Update MTP Sector 126 with Custom/Calibration Data Note: The default values of unused words need to remain unchanged (Refer to note2 in section 8.3 above about using the read/modify/write process).	Tx Diags	<div><b>Command Format to use for Sector Write</b> smokey ScorpiusHid --run --test "Write_Sector" --args "MTP_sector=127, MTP_Words={word0 [Signature]; word1 [Version]; word2 [Ltx_nH]; word3 [frequency_Hz]; word4; word5; word6; word7; word8; word9; word10; word11 [MLB SN: bytes0-3; word12; word13; word14; word15; word16; word17; word18; word19; word20; word21; word22; word23; word24; word25; word26; word27; word28; word29; word30; word31 [Checksum]]"</div> <div><div>Example:</div><div><div>Word0: Word2: Word31:</div><div><div>Signature = Ltx_nH = Checksum =</div><div><div>0x00000001 0xABCDDEFGH 0xDBDBE83E</div></div></div><div><div>Word1: Word3:</div><div><div>Version = frequency_Hz =</div><div><div>0x00000002 0xE0EE0E0E</div></div></div></div><div><b>Note : Refer to instructions in step 10 above on how to calculate this.</b> <b>Example Command to Write Sector:</b> smokey ScorpiusHid --run --test "Write_Sector" --args "MTP_sector=126, MTP_Words={0x00000001; 0x00000002; 0xABCDDEFGH; 0xE0EE0E0E; 0x00000000; 0xDDD9E0E1}" <b>—————&gt; Wait 1 sec &lt;————</b> smokey ScorpiusHid --run --test "Print_Sector" --args "MTP_sector=126" Example:-After Writing MTP Sctor Values are: <div><div><div>Word 0 : 0x00000001 Word 4 : 0x00000000 Word 8 : 0x00000000 Word 12 : 0x00000000 Word 16 : 0x00000000 Word 20 : 0x00000000 Word 24 : 0x00000000 Word 28 : 0x00000000</div><div><div>Word 1 : 0x00000002 Word 5 : 0x00000000 Word 9 : 0x00000000 Word 13 : 0x00000000 Word 17 : 0x00000000 Word 21 : 0x00000000 Word 25 : 0x00000000 Word 29 : 0x00000000</div><div><div>Word 2 : 0xE0EE0E0E Word 6 : 0x00000000 Word 10 : 0x00000000 Word 14 : 0x00000000 Word 18 : 0x00000000 Word 22 : 0x00000000 Word 26 : 0x00000000 Word 30 : 0x00000000</div><div><div>Word 3 : 0xF0F0F0F0 Word 7 : 0x00000000 Word 11 : 0x00000000 Word 15 : 0x00000000 Word 19 : 0x00000000 Word 23 : 0x00000000 Word 27 : 0x00000000 Word 31 : 0xDDD9E0E1</div></div></div></div></div></div></div></div></div>



Step	Description	Interface	Command / Notes
14	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}"
15	Pull Low test pin <b>TP93EF</b> i.e. <b>"AOP_TO_DOTARA_RESET_L"</b> to reset Scorpius	Tx Diags	pmugpio --pin 18 --output 0 --pushpull
	Wait 500ms	Fixture	
	Pull High test pin <b>TP93EF</b> i.e. <b>"AOP_TO_DOTARA_RESET_L"</b>	Tx Diags	pmugpio --pin 18 --output 1 --pushpull
16	Wait 1s	Fixture	
17	Preparation	Tx Diags	pmugpio --pin 14 --output 1 --pushpull
18	Tell Tx to get out of standalone mode.	Tx Diags	i2c -w 6 0x39 6 <b>Note:- Send this command 2x times.</b> There may be I2C error reported with this command, but can be ignored.
19	Load Tx FW	Tx Diags	<b>Note:</b> Need to send this command every time within <b>3sec</b> of above command. You cannot enter Load FW without exiting the standalone mode. smokey ScorpiusHid --run --test "FWLoad" --args "PathToFwLoad='nandfs:\\AppleInternal\\Diags\\Scorpius\\J517J522\\ScorpiusTx-dotara.bin'"
20	Wait 1s	Fixture	Scorpius FW will take less than 1 second to boot
21	Read MTP Sector 126	Tx Diags	smokey ScorpiusHid --run --test "Print_Sector" --args "MTP_sector=126" Example:- Overlay will read Words that are printed: Word 0 : 0x00000001      Word 1 : 0x00000002      Word 2 : 0x0E0E0E0E      Word 3 : 0x0F0F0F0F 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 : 0xDD9E0E1

**Acceptance criteria:**

Test Parameter	Insight Keys Recorded	LL	UL	Unit	Offset Positions	Notes
LPP Inductance	SCRP_LPP_Inductance_Free_Air_Cal	15.49	18.72	μH	Air	
LPP Frequency	SCRP_LPP_FREQ_Free_Air_Cal	75.75	85.81	kHz	Air	
Check Sum - Sector 126 (Word 31)	<b>SCRP_Check Sum_126_MTP_BEFORE</b>	-	-	Hex	Air	Need to be in Hex. Will need these values to be compared against MTP Check after test <b>Section 8.7</b> .
Version (Word 1)	<b>SCRP_Version_126_MTP_BEFORE</b>	-	-	Hex	Air	
Signature (Word 0)	<b>SCRP_Signature_126_MTP_BEFORE</b>	-	-	Hex	Air	
LPP Inductance_MTP (Word 2)	<b>SCRP_LPP_L_126_MTP_BEFORE</b>	-	-	Hex	Air	
LPP Frequency_MTP (Word 3)	<b>SCRP_LPP_FREQ_126_MTP_BEFORE</b>	-	-	Hex	Air	



## 8.5. QT4 - Scorpius Test

### 8.5.1.Low Power Ping (LPP)

**Description:** Check the frequency and inductance for LPP at free air vs nominal position coupling.

**Failure Mode(s) Captured:** Poorly assembled / manufactured coils

**Test Setup and Procedure:**

Step	Description	Interface	Command / Notes
1	Connect coils at nominal position	Fixture	
2	Send 1.4uS LPP pulse	Tx 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
6	Record parameters as per the table below	Fixture	Apply limits accordingly
7	Calculate Δ Tx Frequency & Δ Tx Inductance	Tx Diags & Fixture	Δ Tx Frequency = SCRP_LPP_FREQ_MTP_BEFORE (From Section 8.3) - SCRP_LPP_FREQ (from Step 4) Δ Tx Inductance = SCRP_LPP_Inductance (from Step 4) - SCRP_LPP_L_MTP_BEFORE (From Section 8.3)

#### Acceptance criteria:

Test Parameter	Insight Keys Recorded	LL	UL	Unit	Notes
LPP Frequency	SCRP_LPP_FREQ	64.61	72.87	kHz	
LPP Inductance	SCRP_LPP_Inductance	21.5	25.7	μH	
Δ Tx Frequency	SCRP_LPP_FREQ_delta	5000	21193	kHz	This is to make sure that the delta is similar to fw calculation and within the range
Δ Tx Inductance	SCRP_LPP_Inductance_delta	3.3	10.5	μH	



## 8.5.2.Power, Efficiency & Ping Pong Tests

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

### Failure Mode(s) Captured:

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

### Test Setup and Procedure:

Order of load ramping as follows:

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

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

Step	Description	Interface	Command
Set load and coupling position		Fixture	Repeat all below tests for the following Load conditions <b>0.1C; 3C; 10C</b>
<b>Power &amp; Efficiency Testing</b>			
A	PPVCC_MAIN(VSYS_ANA) Record this as <b>x1</b>	Tx HID	<b>PPVCC_MAIN(VSYS_ANA):</b> smokey ScorpiusHid --run --test "Set" --args "ReportID=0x31, ReportPayload={0x06; 0x00; 0x8C}" note: the last part "0x8C" donates the number of samples with a multiplier of 32x. i.e 0x8C = 140 x 32 = 4480 samples -----> Fixture wait 2 sec <----- smokey ScorpiusHid --run --test "Get" --args "ReportID=0x31" <b>Response--&gt;</b> byte0: [u8] ID (GetAdcID = 0x31) byte1-4: [u32] Floating point value read from ADC (eg 0xYYYYYYYY) byte5: [u8] Error Code (eg. 0x00 - no error) byte6: [u8] Reserved (eg. 0x00) byte7-8: [u16] ADC raw value (eg. 0xXXXX) byte9-12: [u32] Channel_Id that was read (eg. 0x00000007 = VSYS_1P8)
B	Calculate PPVCC_MAIN(VSYS_ANA) actual <b>VSYS_ANA_Actual = y1</b>	Overlay	$y_1 = m x_1 + c$ —> Where m = slope & c = offset —> from Word16 = VSYS_ANA_Offset_MTP <<16    VSYS_ANA_Slope_MTP <b>Note : Convert m &amp; c values into decimal before calculating y1</b>
D	Record value of VSYS_1P8 Record this as <b>x1</b>	Tx HID	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x31, ReportPayload={0x07; 0x00; 0x8C}" note: the last part "0x8C" donates the number of samples with a multiplier of 32x. i.e 0x8C = 140 x 32 = 4480 samples -----> Fixture wait 2 sec <----- smokey ScorpiusHid --run --test "Get" --args "ReportID=0x31" <b>Response--&gt;</b> byte0: [u8] ID (GetAdcID = 0x31) byte1-4: [u32] Floating point value read from ADC (eg 0xYYYYYYYY) byte5: [u8] Error Code (eg. 0x00 - no error) byte6: [u8] Reserved (eg. 0x00) byte7-8: [u16] ADC raw value (eg. 0xXXXX) byte9-12: [u32] Channel_Id that was read (eg. 0x00000007 = VSYS_1P8)
D	Calculate VSYS_1P8 actual <b>VSYS_1P8_Actual = y1</b>	Overlay	$y_1 = x_1 + b$ —> Where b = offset —> from Word17 = value from step 14 above in Hex Note : Convert b value into decimal before calculating y1
E	Command for following variables: Tx:- Vbatt, lbatt	Tx (Diags & HID)	pmuadc --read all <b>Vbatt:-</b> potomac vbatt : xxxx.xxxx mV; <b>lbatt:-</b> ibat_out: xxxx.xxx mA <b>Example</b> --->00024088:2240013A] :-> pmuadc --read all vddout: 4199.9389 mV vbat: 3036.0195 mV brick_id: 3.6630 mV brick_id_usb_d+: 0mV brick_id_usb_d-: 0mV brick_id2: 3.6630 mV ibuck9: 0.0000 mA ibuck11: 0.0000 mA ibuck14: 0.0000 mA <b>ibat_out: 23858.3638 mA</b> BIST buck0: 775.0915 mV ibuck9: 0.0000 mA BIST buck1: 7.5091 mV potomac vsys_1a : 4214.2857 mV potomac ich_1a : 0.2442 mA potomac tbat : -2.0451 C <b>potomac vbatt : 4225.2747 mV</b> potomac ich_6a : 1.4652 mA
F	Difference between VSYS-ANA & Vbatt	Fixture	$V_{Flex\_Drop} = V_{batt} - V_{SYS\_ANA\_actual}$
<b>For 0.1C &amp; 3C</b>			
1	Repeat Step A, B, C & D	Tx Diags & Fixture	<b>@Standby i.e. before 0.1C testing</b>
2	Set boost to meet the load conditions. <b>Note: Minimum Vboost is 6100mV, Don't set Vboost &lt; 6100mV.</b>	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0xD4; 0x17; 0x88; 0x13}" <b>Payload: —&gt;</b> 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}" <b>Eg 0x4650:</b> 18000cdeg = 180deg phase



Step	Description	Interface	Command
4	Repeat Step A, B, C & D	Tx Diags & Fixture	<b>During 0.1C &amp; 3C loading</b>
<b>For 10C</b>			
2	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}" <b>Eg 0x4650:</b> 18000cdeg = 180deg phase
3	Set boost to meet the load conditions. <b>Note:</b> Minimum Vboost is 6100mV, Don't set Vboost < 6100mV.	TX Diags	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x03, ReportPayload={0xD4; 0x17; 0x88; 0x13}" <b>Payload: —&gt;</b> Byte0-1: Boost voltage (eg. 0x17D4 = 6100mV)
4	Repeat Step A, B, C & D	Tx Diags & Fixture	<b>During 10C loading</b>
5	Command for following variables: Vsense, Isense, LFOD (VCTx) <b>Note :</b> Disable LFOD before taking Vsense & Isense Reading and Enable LFOD back before taking LFOD(VCTx) reading.	TX Diags	<b>Disable LFOD before reading Isense:</b> <b>smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x98; 0x36; 0x00; 0x40; 0x80; 0x01; 0x00; 0x00}"</b> Check status of LFOD <b>smokey ScorpiusHid --run --test "Set" --args "ReportID=0x40, ReportPayload={0x98; 0x34; 0x00; 0x40}"</b> <b>————&gt; Fixture wait 2 sec &lt;————</b> <b>smokey ScorpiusHid --run --test "Get" --args "ReportID=0x40"</b> <b>Response —&gt;</b> bits 7 & bit 8 = 0 if Disabled, 1 if enabled Note: Here, a "set" report command is first sent followed by a "get" report to return the requested data. <b>VSense:</b> <b>smokey ScorpiusHid --run --test "Set" --args "ReportID=0x31, ReportPayload={0x00; 0x00; 0x0F}"</b> <b>————&gt; Fixture wait 2 sec &lt;————</b> <b>smokey ScorpiusHid --run --test "Get" --args "ReportID=0x31"</b> <b>Response —&gt;</b> bytes1-4 = Floating point value from ADC —> <b>VSense_kmxx_MCU</b> <b>Isense:</b> <b>smokey ScorpiusHid --run --test "Set" --args "ReportID=0x31, ReportPayload={0x12; 0x00; 0x0F}"</b> <b>————&gt; Fixture wait 2 sec &lt;————</b> <b>smokey ScorpiusHid --run --test "Get" --args "ReportID=0x31"</b> <b>Response —&gt;</b> bytes1-4 = Floating point value from ADC —> <b>Isense_kmxx_MCU</b> <b>Enabled LFOD after Isense reading:</b> <b>smokey ScorpiusHid --run --test "Set" --args "ReportID=0x41, ReportPayload={0x98; 0x35; 0x00; 0x40; 0x80; 0x01; 0x00; 0x00}"</b> <b>Wait 1 sec after setting back LFOD before doing next test.</b> <b>LFOD(VCTx):</b> <b>smokey ScorpiusHid --run --test "Set" --args "ReportID=0x0B, ReportPayload={0x18; 0x03}"</b> <b>————&gt; Fixture wait 2 sec &lt;————</b> <b>smokey ScorpiusHid --run --test "Get" --args "ReportID=0x0B"</b> <b>Response—&gt;</b> 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.
6	Measure Dotara (U6200) Temp	Tx HID	smokey ScorpiusHid --run --test "Set" --args "ReportID=0x31, ReportPayload={0x08; 0x00; 0x8C}" <b>&lt;-- Trigger reading of Temp1 (channel 8)</b> smokey ScorpiusHid --run --test "Set" --args "ReportID=0x31, ReportPayload={0x09; 0x00; 0x8C}" <b>&lt;--Trigger reading of Temp2 (channel 9)</b> smokey ScorpiusHid --run --test "Get" --args "ReportID=0x31"
<b>Ping Pong Testing</b>			
7	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
8	Choose Comm1	Rx I2C	Write I2C packet: (39) c0 ae 80 80 1e 01 00 05 AD Ginger command: ikt write 0x0xF0000B80 0xAD050001
9	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}" <b>Payload: —&gt;</b> byte0-1: Number of packets to send: 10 byte2-3: Delay between packets: 100ms
10	Wait 1 second for RX to send packets before reading buffer	Fixture	Wait 1 second
11	Read back data that was captured from the Tx.	Tx Diags	smokey ScorpiusHid --run --test "Get" --args "ReportID=0x02" <b>Response:</b> byte0: ID(PingPongID = 0x02) byte1: Status(eg. 0x00 = complete) [0 = Complete; 1 = In-Progress] byte2: Last error(eg. 0x00 = no errors) byte3-4: Pings Sent(eg. 0x000A = 10 pings sent) byte5-6: Pongs Received(eg. 0x000A = 10 pongs received) <b>Note:- If byte1:Status is in process then repeat the step</b>
12	Repeat step 1 to 11 with All loading and coupling positions		



**Acceptance criteria:**

Test Parameter	Insight Keys Recorded	LL	UL	Units	Comments/Notes
PPVCC_MAIN(VSYS_ANA)Actual @ Standby	SCR_PPVCC_MAIN@Standby	TBD	TBD	mV	
VSYS_1P8 @ Standby	SCRP_VSYS_1P8@Standby	1650	1950	mV	
Vbatt @ Standby	SCR_P_Vbatt@Standby	TBD	TBD	mV	
Ibatt @ Standby	SCRP_Ibatt@Standby	TBD	TBD	mA	
VFlex_Drop @ Standby	SCRP_VFlex_Drop@Standby	TBD	TBD	mA	
<b>Load 0.1C</b>					
PPVCC_MAIN @ 0.1C	SCR_PPVCC_MAIN@0.1C	TBD	TBD	mV	
VSYS_1P8 @ 0.1C	SCRP_VSYS_1P8@0.1C	1650	1950	mV	
Vbatt@0.1C	SCR_P_Vbatt@0.1C	TBD	TBD	mV	
Ibatt@0.1C	SCRP_Ibatt@0.1C	TBD	TBD	mA	
VFlex_Drop@0.1C	SCRP_VFlex_Drop@0.1C	TBD	TBD	mA	
Vsense @ 0.1C	SCRP_Vsense@0.1C	5980	6500	mV	min = 6100mV * 0.98
Isense @ 0.1C	SCRP_Isense@0.1C	80	160	mA	
Vctx_IPeak @ 0.1C	SCRP_Vctx_Ipk@0.1C	300	630	mA	
Vrect_FXST @ 0.1C	SCRP_Vrect@0.1C	6.3	6.7	mV	Fixture Cmd: Vrect Target = 6.5V ±2%
Irect_FXST @ 0.1C	SCRP_Irect@0.1C	35	45	mA	Iktara ballast load = 40mA. <b>No fixture load required.</b>
Rx_Loading_Power @ 0.1C	SCRP_Rx_Loading_Power@0.1C	0.2205	0.3015	mW	Vrect * Irect
Efficiency @ 0.1C	SCRP_Efficiency@0.1C	35	65	%	Rx_Power / (Vsense * Isense)
Number of Pings Sent @ 0.1C	SCRP_Pings_Sent@0.1C	10	10	-	
Number of Pongs Received @ 0.1C	SCRP_Pongs_Recieved@0.1C	10	10	-	
Dotara Surface Temperature @ 0.1C	SCRP_Temp1_MCU@0.1C SCR_P_Temp2_MCU@0.1C	20	61	°C	Based on J307 P1 data
<b>Load 3C</b>					
PPVCC_MAIN @ 3C	SCR_PPVCC_MAIN@3C	TBD	TBD	mV	
VSYS_1P8 @ 3C	SCRP_VSYS_1P8@3C	TBD	TBD	mV	
Vbatt@3C	SCR_P_Vbatt@3C	TBD	TBD	mV	
Ibatt@3C	SCRP_Ibatt@3C	TBD	TBD	mA	
VFlex_Drop@3C	SCRP_VFlex_Drop@3C	TBD	TBD	mA	
Vsense @ 3C	SCRP_Vsense@3C	5980	7000	mV	
Isense @ 3C	SCRP_Isense@3C	210	300	mA	
Vctx_IPeak_ @ 3C	SCRP_Vctx_Ipk@3C	400	850	mA	
Vrect_FXST @ 3C	SCRP_Vrect@3C	7840	8160	mV	Fixture Cmd: Vrect Target = 8V ±2%
Irect_FXST @ 3C	SCRP_Irect@3C	113	128	mA	Fixture Cmd: Irect Target = 113mA +iktara load(~0 to 15mA)
Rx_Loading_Power @ 3C	SCRP_Rx_Loading_Power@3C	885.92	1044.48	mW	Vrect * Irect
Efficiency @ 3C	SCRP_Efficiency@3C	46	66	%	Rx_Power / (Vsense * Isense)
Number of Packets Sent @ 3C	SCRP_Packets_Sent@3C	10	10	-	
Number of Packets Received @ 3C	SCRP_Packets_Recieved@3C	10	10	-	
Dotara Surface Temperature @ 3C	SCRP_Temp1_MCU@3C SCR_P_Temp2_MCU@3C	20	61	°C	Based on J307 P1 data
<b>Load 10C</b>					
PPVCC_MAIN @ 10C	SCR_PPVCC_MAIN@10C	TBD	TBD	mV	
VSYS_1P8 @ 10C	SCRP_VSYS_1P8@10C	TBD	TBD	mV	
Vbatt@10C	SCR_P_Vbatt@10C	TBD	TBD	mV	
Ibatt@10C	SCRP_Ibatt@10C	TBD	TBD	mA	



Test Parameter	Insight Keys Recorded	LL	UL	Units	Comments/Notes
VFlex_Drop@10C	SCRP_VFlex_Drop@10C	TBD	TBD	mA	
Vsense @ 10C	SCRP_Vsense@10C	9000	13000	mV	
Isense @ 10C	SCRP_Isense@10C	380	550	mA	
Vctx_IPeak_ @ 10C	SCRP_Vctx_Ipk@10C	730	1380	mA	
Vrect_FXST @ 10C	SCRP_Vrect@10C	13860	14140	mV	Fixture Cmd: Vrect Target = 14v
Irect_FXST @ 10C	SCRP_Irect@10C	217	231	mA	Fixture Cmd: Irect Target = 214mA
Rx_Loading_Power @ 10C	SCRP_Rx_Loading_Power@10C	3007.62	3266.34	mW	Vrect * Irect
Efficiency @ 10C	SCRP_Efficiency@10C	47	65	%	Rx_Power / (Vsense * Isense)
Number of Packets Sent @ 10C	SCRP_Packets_Sent@10C	10	10	-	
Number of Packets Received @ 10C	SCRP_Packets_Recieved@10C	10	10	-	
Dotara Surface Temperature @ 10C	SCRP_Temp1_MCU@10C SCRP_Temp2_MCU@10C	20	61	°C	Based on J307 P1 data

### 8.3. Final MTP Sector Check @ QT0A & QT4 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 <b>TP93EF</b> i.e. " <b>AOP_TO_DOTARA_RESET_L</b> " to reset Scorpius	Tx Diags	pmugpio --pin 18 --output 0 —pushpull
	Wait 500ms	Fixture	
	Pull High test pin <b>TP93EF</b> i.e. " <b>AOP_TO_DOTARA_RESET_L</b> "	Tx Diags	pmugpio --pin 18 --output 1 —pushpull
2	Wait 1s	Fixture	
3	Preparation	Tx Diags	pmugpio --pin 14 --output 1 --pushpull
4	Tell Tx to get out of standalone mode.	Tx Diags	i2c -w 6 0x39 6 <b>Note:-Send this command 2x times.</b> There may be I2C error reported with this command, but can be ignored.
5	Load Tx FW	Tx Diags	<b>Note:</b> Need to send this command every time within <b>3sec</b> of above command. You cannot enter Load FW without exiting the standalone mode. smokey ScorpiusHid --run --test "FWLoad" --args "PathToFwLoad=\\nandfs:\\AppleInternal\\Diags\\Scorpius\\J517J522\\ScorpiusTx-dotara.bin"
6	Wait 1s	Fixture	Scorpius FW will take less than 1 second to boot
7	Tell Tx to enter Quiesce Mode	Tx Diags	<b>Note:</b> Need to send the below command after every 2nd time of the above command within 3sec or with minimum or no delay as possible of above command. You cannot enter Quiesce mode without exiting the standalone mode. smokey ScorpiusHid --run --test "Set" --args "ReportID=0x09, ReportPayload={0x01}"
8	Read MTP Sector 127	Tx Diags	smokey ScorpiusHid --run --test "Print_Sector" --args "MTP_sector=127" Example:-Overlay will read Words that are printed:- <div> <div>Word 0 : 0x00000001</div> <div>Word 4 : 0x00000000</div> <div>Word 8 : 0x0C0C0C0C</div> <div>Word 12 : 0x37363534</div> <div>Word 16 : 0x00000000</div> <div>Word 20 : 0x00000000</div> <div>Word 24 : 0x00000000</div> <div>Word 28 : 0x00000000</div> </div> <div> <div>Word 1 : 0x00000002</div> <div>Word 5 : 0x00000000</div> <div>Word 9 : 0x0D0D0D0D</div> <div>Word 13 : 0x42413938</div> <div>Word 17 : 0x00000000</div> <div>Word 21 : 0x00000000</div> <div>Word 25 : 0x00000000</div> <div>Word 29 : 0x00000000</div> </div> <div> <div>Word 2 : 0x00030570</div> <div>Word 6 : 0x0A0A0A0A</div> <div>Word 10 : 0x03070001</div> <div>Word 14 : 0x46454443</div> <div>Word 18 : 0x00000000</div> <div>Word 22 : 0x00000000</div> <div>Word 26 : 0x00000000</div> <div>Word 30 : 0x00000000</div> </div> <div> <div>Word 3 : 0x00000000</div> <div>Word 7 : 0x0B0B0B0B</div> <div>Word 11 : 0x33323130</div> <div>Word 15 : 0x00000004</div> <div>Word 19 : 0x00000000</div> <div>Word 23 : 0x00000000</div> <div>Word 27 : 0x00000000</div> <div>Word 31 : 0xDBDE8E3E</div> </div>
9	Read MTP Sector 126	Tx Diags	smokey ScorpiusHid --run --test "Print_Sector" --args "MTP_sector=126" Example:-Overlay will read Words that are printed:- <div> <div>Word 0 : 0x00000000</div> <div>Word 4 : 0x00000000</div> <div>Word 8 : 0x00000000</div> <div>Word 12 : 0x00000000</div> <div>Word 16 : 0x00000000</div> <div>Word 20 : 0x00000000</div> <div>Word 24 : 0x00000000</div> <div>Word 28 : 0x00000000</div> </div> <div> <div>Word 1 : 0x00000000</div> <div>Word 5 : 0x00000000</div> <div>Word 9 : 0x00000000</div> <div>Word 13 : 0x00000000</div> <div>Word 17 : 0x00000000</div> <div>Word 21 : 0x00000000</div> <div>Word 25 : 0x00000000</div> <div>Word 29 : 0x00000000</div> </div> <div> <div>Word 2 : 0x00000000</div> <div>Word 6 : 0x00000000</div> <div>Word 10 : 0x00000000</div> <div>Word 14 : 0x00000000</div> <div>Word 18 : 0x00000000</div> <div>Word 22 : 0x00000000</div> <div>Word 26 : 0x00000000</div> <div>Word 30 : 0x00000000</div> </div> <div> <div>Word 3 : 0x00000000</div> <div>Word 7 : 0x00000000</div> <div>Word 11 : 0x00000000</div> <div>Word 15 : 0x00000000</div> <div>Word 19 : 0x00000000</div> <div>Word 23 : 0x00000000</div> <div>Word 27 : 0x00000000</div> <div>Word 31 : 0x00000000</div> </div>
10	Location to store Calibrated values of VBoost, Vsense, Isense, LFOD & CTx into MTP and other values into MTP :- Signature, Version,HWID, MLB SN, Checksum. <a href="#">Follow Figure 1 for Reference</a>	Test Overlay	Sector 127 :-Word 0(Signature = 0x01); Word 1(Version = 0x02); Word 2(CTx); Word 6(VBoost); Word 7(Vsense); Word 8(Isense); Word 9(LFOD); Word 10(HWID); Word 11 - 15(MLB SN - 17 byte); Word 31(Checksum)
11	Location of Signature, Version, LTx, frequency_Hz, Checksum into MTP	Test Overlay	Sector 126 :-Word 0(Signature = 0x01); Word 1(Version = 0x02); Word 2(LTx); Word 3(Frequency_Hz); Word 31(Checksum)
12	Check if Checksum is correct	Test Overlay	Pass if <b>Word 31 = 2's compliment of</b> $\left[Sum(Word\ 0 + Word\ 2 + \dots + Word\ 30)\right]$



Step	Description	Interface	Command / Notes
13	Pull Low test pin <b>TP93EF</b> i.e. " <b>AOP_TO_DOTARA_RESET_L</b> " to reset Scorpius	Tx Diags	pmugpio --pin 18 --output 0 —pushpull
	Wait 500ms	Fixture	
	Pull High test pin <b>TP93EF</b> i.e. " <b>AOP_TO_DOTARA_RESET_L</b> "	Tx Diags	pmugpio --pin 18 --output 1 —pushpull

**Acceptance Criteria:**

Test Parameter	Insight Keys Recorded	Comments/Notes
Sector 127		
Check Sum - Sector 127 (Word 31)	SCRP_Check Sum_127_MTP_AFTER	@ QT0A & QT4: Pass if this values match with MTP check before test i.e. Section 8.3
Version (Word 1)	SCRP_Version_127_MTP_AFTER	
Signature (Word 0)	SCRP_Signature_127_MTP_AFTER	
Tx HWID_MTP (Word 10):- J51x - 0x05170000 J52x - 0x05200000	SCRP_TX_HWID_127_MTP_AFTER	
CTx MTP (Word 2)	SCRP_CTx_127_MTP_AFTER	
VBoost_Control MTP (Word 6)	SCRP_VBoost_127_MTP_AFTER	
Vsense MTP (Word 7)	SCRP_VSense_127_MTP_AFTER	
Isense MTP (Word 8)	SCRP_Isense_127_MTP_AFTER	
LFOD MTP (Word 9)	SCRP_LFOD_127_MTP_AFTER	
VSYS_ANA (Word 16)	SCRP_VSYS_ANA_127_MTP_AFTER	
VSYS_1P8 (Word 17)	SCRP_VSYS_1P8_127_MTP_AFTER	
MLB Serial No. (Word 11 to Word 15 - Bits<1:17>)	SCRP_MLB_SN_127_MTP_AFTER	
Sector 126		
Check Sum - Sector 126 (Word 31)	SCRP_Check Sum_126_MTP_BEFORE	@ QT0A: Pass if this values match with LPP Free Air Calibration test i.e. Section 8.4 @ QT0A @ QT4:Pass if this values match with MTP check before test i.e. Section 8.3@ QT4
Version (Word 1)	SCRP_Version_126_MTP_BEFORE	
Signature (Word 0)	SCRP_Signature_126_MTP_BEFORE	
LPP Inductance_MTP (Word 2)	SCRP_LPP_L_126_MTP_BEFORE	
LPP Frequency_MTP (Word 3)	SCRP_LPP_FREQ_126_MTP_BEFORE	



## A. Feature DRI Comments for Changes to this Document

Feature	DRI	Description/Comments/Reason for Change	Date	Approved and released in Version:
Power Transfer	Mikhal	Minimum boost requirement has changed from 6000mV to 6100mV.	21 February 2020	Mikhal/Bhushan/ P1_V1.1
Power Transfer	Nan	Updated observable limits in 8.5.2, based on J4xx FATP Scorpius and J5xx Char data	10 March 2020	P1_V1.2
LPP	Rex	Updated LPP limits for QT0a & QT4	11 March 2020	
Power Transfer	Bhushan/ Rex	Updated Power flow test procedure to include flex drop measurement	12 March 2020	
QT0a	Bhushan/ Rex	Added flex connectivity test.	12 March 2020	
Power	Daniel R	Added VSYS_1P8 to both QT0a and Scorpius Test	18 March 2020	
QT0A	Bhushan/ Rex	Updated Flex Connectivity test at QT0A	3 April 2020	Bhushan/Rex/Nan/ P1_V1.3
LPP & VCTX	Bhushan	Updated command and response format of LPP and VCTX respectively		
Dotara	Bhushan	Added Dotara Temperature measurement At QT4		
Power Transfer	Bhushan/Jin	Updated procedure to Disable LFOD during Vsense & Isense reading.		