TABOR ELECTRONICS

LSX ATP validation

Rev. 0.7

Document Revision History

Revision	Date	Description	Author
0.5	11-Sep-25	• Original version. To be reviewd	Arie Oster
0.6	8-Oct-25	• Updated with more details	Arie Oster
0.7	24-Mar-26	• Update with ATP tool feedback	Arie & Dima

1 Introduction

This document describes the procedure to test LSX before releasing to package

1.1 Start

1.1.1 Burn the latest approved FW and FPGA

Burn the latest approved FW and FPGA (from the release area). Use Vivado to burn FPGA “multi” file.
Reboot the device

1.1.2 LSX port

LSX TCP port needs to be updated according to the product:
Single channel – Port 6001, IP add 192.168.7.1
Reboot the device

1.2 Automation Validation

The tables below list the validated tests to be run on each unit.

Table 1.1 LSX tests list

Test name	Equipment	Expected time	comments
Power accuracy	PM		
Power resolution	PM		
Max power	PM		
Power linearity	PM		
Frequency accuracy	SA		
Frequency resolution	Counter		
Harmonic and non-harmonic	SA		
List mode (switching time)	SA		UFS If enable
Phase Noise	PNA		
AM tests	SA		
FM tests	SA		
PM tests	SA		
Ref in, Ref out, Trigger internal and external	Manual tests		

Table 1.2 List of basic validation tests

1.3 Qualification Procedure

The following specifications and performance verification tests verify that the LSX device is working according to specifications.

Table 1.3 LSX specification - frequency

Model	Range	Comments
LSX 8G	Freq range: 50 kHz to 8 GHz	Resolution: 0.001 Hz, Phase offset: 0.01 deg
Temp. Stability:	±10 ppb max	over range 0 to 50c (32F to 122F)

Table 1.4 LSX specification - Amplitude

	Range	Comments
LSX	Max 15dBm, min -70dBm	Resolution 0.01dBm
Power Mute:	-70 dBm	
Output Return Loss:	-10 dBm	
Accuracy (dB):	-50dBm to +15dBm	
50Khz to 9GHz:	±0.7 (typ.)	

1.4 Environmental Conditions

Tests should be performed under laboratory conditions having an ambient temperature of 25°C, ±5°C and at relative humidity of less than 80%. If the instrument has been subjected to conditions outside these ranges, allow at least one additional hour for the instrument to stabilize before beginning the tests.

1.5 Warm-up Period

Most equipment is subject to a small amount of drift when it is first turned on. To ensure accuracy, turn on the power to the LSX and allow it to warm-up for at least 30 minutes before beginning the tests.

1.6 Recommended Test Equipment

Recommended test equipment for troubleshooting, calibration and performance checking is listed in the table below. Test instruments other than those listed may be used only if their specifications equal or exceed the required characteristics.

Table 1.5 Recommended Test Equipment

Equipment	Model No.	Manufacturer
Spectrum Analyzer	N9000B or N9020B	Keysight
Phase Noise Analyzer	PNA	R&S
Power Meter	12150L	BNC
Universal frequency counter	6020	Tabor or Keysight
Oscilloscope	MSOS404A	Keysight

2 Test Plan

Notes

The test plan is written for the 8GHz module

2.1 Power measurements – 4 tests

2.1.1 Power linearity

Test Equipment: Power Meter

Preparation:

1. Connect the LSX output to the power meter input

Test Procedure:

1. Perform output power test according to the table below, starts with 10dBm
2. Decrease the power by 1dB and perform the test again
3. Repeat step 2 down to power of -20 dBm
4. Select the next frequency and repeat steps 1 to 3
   a. 0.05 MHz ≤ frequency ≤ 1 MHz; increment size of 0.2 MHz (5 frequencies)
   b. 2 MHz ≤ frequency ≤ 10 MHz; increment size of 2 MHz (5 frequencies)
   c. 100 MHz ≤ frequency ≤ 8000 MHz; increment size of 200 MHz (99 frequencies)

Table 2.1 Power vs. Frequency

Output Frequency	Output Power	Power Reading	Pass
50 kHz	10 dBm	50Khz-9Ghz	±0.7 (typ.)
50 kHz	-20 dBm	Above 9GHz	±1.0 (typ.)
….			
8 GHz	10 dBm		
8 GHz	-20 dBm		

2.1.2 Power resolution – 0.01dBm

Test Equipment: Power Meter

Preparation:

1. Connect the LSX output to the power meter input

Test Procedure:

1. Perform output power test according to the table below, starts with 10dBm
2. Run the test on 4 different frequencies (50kHz, 1500MHz, 7500MHz, 8000MHz)

Table 2.2 Power resolution

Output Frequency	Output Power	Power Reading	Pass
50 kHz	9.99 dBm	50Khz-9Ghz	±0.7 (typ.)
50 kHz	10 dBm	Above 9GHz	±1.0 (typ.)
50 kHz	10.01 dBm		
50 kHz	-9.99 dBm		
50 kHz	-10 dBm		
50 kHz	-10.01 dBm		
50 kHz	-39.99 dBm		
50 kHz	-40 dBm		
50 kHz	-40.01 dBm		
….			
8 GHz	-40 dBm		
8 GHz	-40.01 dBm		
Overall, 9 power level for 5 freq = 45 points			

2.1.3 Max power >15dBm

Test Equipment: Power Meter

Preparation:

1. Connect the LSX output to the power meter input

Test Procedure:

1. Perform output power test according to the description below
2. Set output power to 20dBm
3. Select the frequency to 50KHz and increase the freq as below:
    a. 0.05 MHz ≤ frequency ≤ 1 MHz; increment size of 0.2 MHz (5 frequencies)
    b. 2 MHz ≤ frequency ≤ 10 MHz; increment size of 2 MHz (5 frequencies)
    c. 100 MHz ≤ frequency ≤ 8000 MHz; increment size of 40 MHz (498 frequencies)

2.1.4 Power accuracy (±0.7dBm < 9GHz, ±1dBm > 9GHz)

Test Equipment: Power Meter

Preparation:

1. Connect the LSX output to the power meter input

Test Procedure:

1. Perform output power test according to the description below
2. Set output power to -10dBm
3. Select the frequency to 50KHz and increase the freq as below:
    a. 0.05 MHz ≤ frequency ≤ 1 MHz; increment size of 0.2 MHz (5 frequencies)
    b. 2 MHz ≤ frequency ≤ 10 MHz; increment size of 2 MHz (5 frequencies)
    c. 100 MHz ≤ frequency ≤ 8000 MHz; increment size of 40 MHz (498 frequencies)
4. Repeat step 2 and 3 for 0dBm and 10dBm

2.2 Freq tests – 2 tests

2.2.1 Frequency Accuracy

Test Equipment: Spectrum Analyzer

Preparation:

1. Configure the SA as follows:
    a. Connect the LSX output to the SA input
    b. Connect the LSX 10MHz output Ref to the SA 10MHz Ref input
2. Configure the LSX as follows:
    a. Power: 10dBm
    b. Output: On

Test Procedure:

1. Perform frequency Accuracy tests according to the table below.

Table 2.3 Frequency Accuracy

Test Number	Output Frequency	Error Limits	SA Reading	Pass	Fail
1	50 KHz	±2 Hz (SA accuracy)			
2	100 KHz				
3	1 MHz				
4	10 MHz				
5	100 MHz				
6	1 GHz				
7	3 GHz				
8	8 GHz				

2.2.2 Frequency Resolution

Test Equipment: Universal freq. Counter

Preparation:

1. Configure the counter as follows:
   a. Gate: DIGITS
   b. DIGITS: 12
   c. Measurement: Frequency 1
2. Connect the LSX 10MHz output Ref to the counter 10MHz Ref input
3. Connect the LSX output to the counter input channel 1

Test Procedure:

1. Perform frequency resolution tests by setting the requested frequency in the table below and verify that the frequency changed as expected (1mHz resolution)

Table 2.4 Frequency resolution

Test number	Output freq (MHz)	Counter digit number	Delta freq counter reading	Pass/fail
1	199.999999999			
2	200			
3	200.000000001			
4	799.999999999			
5	800			
6	800.000000001			
7	1899.999999999			
8	1900			
9	1900.000000001			

2.3 Harmonic Distortion

Test Equipment: Spectrum Analyzer

Preparation:

1. Configure the Spectrum as follows:
   a. Measurement: Harmonic Distortion
2. Connect the LSX output to the spectrum input
3. Configure the LSX as follows:
   a. Output: On
   b. Frequency: As specified in the test
   c. Power: As specified in the test

Test Procedure:

1. Perform Harmonic Distortion tests in 3 power levels, 10 dBm, 0 dBm and -10dBm.
2. Select the freq from the table below

Table 2.5 Harmonic Distortion

Output freq (MHz)	Error Limits	Pass	Fail
100	-40 dBc <8GHz		
250	-30 dBc>8GHz		
450			
750			
900			
1500			
2500			
3500			
4500			
5400			
6500			
7500			

2.4 Spurious In-Band Test

Test Equipment: Spectrum Analyzer

Preparation:

1. Configure the Spectrum as follows:
   a. Start frequency: As specified in the test
   b. Stop frequency: As specified in the test
   c. Res BW: 30 kHz
2. Connect the LSX output to the spectrum input
3. Configure the LSX as follows:
   a. Frequency: As specified in table below
   b. Output: On
   c. Power: 5 dBm.

Test Procedure:

1. Perform Spurious tests according to the table below.

Table 2.6 Spurious

Test Step	Output Frequency (MHz)	Start Frequency	Stop Frequency	Error Limits	Max Spurious Reading	Pass	Fail
1	1000.1	500	1500	-60 dBc			
2	2000	1500	2400	-60 dBc			
3	3500	2400	3400	-60 dBc			
4	4000	2400	3400	-60 dBc			
5	550	3400	3900	-60 dBc			
6	2300	3900	4900	-60 dBc			
7	1500	4900	5900	-60 dBc			
8	3500	5900	6900	-60 dBc			
9	4000	5900	6900	-60 dBc			
10	3500	6900	7900	-60 dBc			
11	4000	6900	7900	-60 dBc			

2.5 Spurious Next to Carrier

Test Equipment: Spectrum Analyzer

Preparation:

1. Configure the Spectrum as follows:
   a. Center Frequency: as specified in the test
   b. Res BW: 200 kHz
   c. Video BW: 400 Hz
2. Connect the LSX output to the spectrum input
3. Configure the LSX as follows:
   a. Frequency: As specified in the test
   b. Output: On
   c. Power: 5 dBm.

Test Procedure:

1. Perform Spurious tests using Table below
2. Select the next frequency and repeat steps 1
   20 MHz ≤ frequency ≤ 100 MHz; increment size of 10 MHz
   Spectrum Frequency Span: 20 MHz
   150 MHz ≤ frequency ≤ 1000 MHz; increment size of 50 MHz
   Spectrum Frequency Span: 30 MHz
   1500 MHz ≤ frequency ≤ 20000 MHz; increment size of 500 MHz
   Spectrum Frequency Span: 40 MHz

Table 2.7 Spurious

Test Step	Output Frequency (MHz)	Error Limits	Max Spurious Reading	Pass	Fail
1	20	-60 dBc			
2	30	-60 dBc			
…					
	8000	-60 dBc			

2.6 Phase Noise

Test Equipment: Phase Noise Analyzer (PNA)

Preparation:

1. Configure the PNA as follows:
   a. Carrier frequency: as specified by the test
   b. Res BW: 1E5
   c. Start Frequency: 100 Hz
   d. Stop Frequency: 100 MHz
   e. Correlation Count: 10
   f. Measurement: Phase Noise at 10kHz offset
2. Connect the LSX output to the PNA input
3. Configure the LSX as follows:
   a. Frequency: As specified by the test
   b. Output: On
   c. Power: 5 dBm

Test Procedure:

1. Perform Phase Noise tests according to the table below.
2. Select the next frequency and repeat steps 1

Table 2.8 Phase Noise

Test Step	Output Frequency	Error Limits	Phase Noise Reading	Pass	Fail
1	500 MHz	-132 dBc/Hz			
2	1000 MHz	-132 dBc/Hz			
3	7500 MHz				
4	8000 MHz				

2.7 List Mode

Test Equipment: Scope or SA

Preparation:

1. Connect the LSX output to the scope channel 1 input
2. Configure the scope as follows:
   a. Amplitude: 200 mV per division
   b. Time base: 100 µs per division
   c. Trigger: Normal
   d. Trigger edge: Rise
3. Configure the LSX as follows:
   a. Output: ON
   b. Run mode: List
   c. List step 1: Frequency 1 GHz, Power 0dBm, Dwell 500 µs
   d. List step 2: Frequency 2 GHz, Power 0dBm, Dwell 500 µs
   e. List step 3: Frequency 3 GHz, Power 0dBm, Dwell 500 µs

Test Procedure:

1. Perform List Mode tests according to the table below.
2. Measure the frequency of each step.

Table 2.9 List Mode - Frequency Switching Speed

Switching time Limit	Switching time Reading	Pass	Fail
500 µs ± 7nsec			

3. Configure the LSX as follows:
   a. List step 1: Frequency 1 GHz, Power 5dBm, Dwell 500 us
   b. List step 2: Frequency 2 GHz, Power 0dBm, Dwell 1000 us
   c. List step 3: Frequency 3 GHz, Power -5dBm, Dwell 1500 us
4. Perform List Mode Frequency, Power and Dwell tests according to the table below.

Table 2.10 List Mode - Frequency

Frequency	Power	Dwell time	Frequency Reading	Power Reading	Dwell time Reading	Pass	Fail
1 GHz	5dBm	500 µs					
2 GHz	0dBm	1000 µs					
3 GHz	-5dBm	1500 µs					

5. Repeat with option FS enable and check time between signals.
6. Repeat with option UFS enable and check time between signals.

2.8 Frequency Modulation

Test Equipment: Scope with Jitter analysis, Function Generator

Preparation:

1. Connect the LSX output to the scope channel 1 input
2. Connect the function generator output to the LSX FM input
3. Configure the scope as follows:
   a. Amplitude: 200 mV per division
   b. Time base: 100 us per division
   c. Jitter analysis: ON
4. Configure the function generator as follows:
   a. Amplitude: 1 Vpp
   b. Frequency: 1 MHz
   c. Output: ON
5. Configure the LSX as follows:
   a. Output: ON
   b. FM modulation: ON
   c. Frequency deviation: 5 MHz
   d. Modulation source: External

Test Procedure:

1. Perform Frequency Modulation tests according to the table below.

Table 2.11 Frequency Modulation – External Source

Frequency Deviation Reading	Modulation Frequency Reading	Pass	Fail

2. Configure the function generator as follows:
   a. Output: OFF
3. Configure the LSX as follows:
   a. Output: ON
   b. FM modulation: ON
   c. Modulation Frequency: 1 MHz
   d. Frequency deviation: 5 MHz
   e. Modulation source: Internal

Test Procedure:

1. Perform Frequency Modulation tests according to the table below.

Table 2.12 Frequency Modulation –Internal Source

Frequency Deviation Reading	Modulation Frequency Reading	Pass	Fail

2.9 Amplitude Modulation

Test Equipment: Scope, Function Generator

Preparation:

1. Connect the LSX output to the scope channel 1 input
2. Connect the function generator output to the LSX AM input
3. Configure the scope as follows:
   a. Amplitude: 500 mV per division
   b. Time base: 5 us per division
4. Configure the function generator as follows:
   a. Amplitude: 1 Vpp
   b. Frequency: 100 kHz
   c. Output: ON
5. Configure the LSX as follows:
   a. Output: ON
   b. AM modulation: ON
   c. Modulation source: External

Test Procedure:

1. Perform Amplitude Modulation tests according to the table below.

Table 2.13 Amplitude Modulation – External Source

Modulation Depth Reading	Modulation Frequency Reading	Pass	Fail

2. Configure the function generator as follows:
   a. Output: OFF
3. Configure the LSX as follows:
   a. Output: ON
   b. AM modulation: ON
   c. Modulation source: Internal
   d. Modulation Frequency: 100 kHz
   e. Modulation Depth: 75%

Test Procedure:

1. Perform Amplitude Modulation tests according to the table below.

Table 2.14 Amplitude Modulation – Internal Source

Modulation Depth Reading	Modulation Frequency Reading	Pass	Fail

2.10 Pulse Modulation

Test Equipment: Scope, Function Generator or pulse generator

Preparation:

1. Connect the LSX output to the scope channel 1 input
2. Connect the function generator output to the LSX M Pulse input
3. Configure the scope as follows:
   a. Amplitude: 200 mV per division
   b. Time base: 100 µs per division
4. Configure the function generator as follows:
   a. Function shape: Square
   b. Amplitude: 1 Vpp
   c. Offset: 1V
   d. Output: ON
   e. Duty Cycle: As specified in the test
   f. Frequency: As specified in the test
5. Configure the LSX as follows:
   a. Output: ON
   b. Pulse modulation: ON
   c. Modulation source: External

Test Procedure:

1. Perform Frequency Modulation tests according to the table below.

Table 2.15 Pulse Modulation – External Source

Function Generator Duty Cycle	Function Generator Frequency	Pulse Duration Reading	Pulse Repetition Reading	Pass	Fail
50%	1 MHz				
30 %	10 MHz				

2. Configure the function generator as follows:
   a. Output: OFF
3. Configure the LSX as follows:
   a. Output: ON
   b. Pulse modulation: ON
   c. Modulation source: Internal
   d. Pulse Width: As specified in the test
   e. Pulse Repetition Rate: As specified in the test

Test Procedure:

1. Perform Frequency Modulation tests according to the table below.

Table 2.16 Pulse Modulation – Internal Source

Pulse Width	Pulse Repetition	Frequency Deviation Reading	Modulation Frequency Reading	Pass	Fail
500 ns	1 MHz				
30 ns	10 MHz				

2.11 Ref In

Test Equipment: Scope, Signal Generator

Preparation:

1. Connect the LSX output to the scope channel 1 input
2. Connect the signal generator 10MHz Ref output to the scope channel 2 input
3. Connect the signal generator output to the LSX Ref In input
4. Set the signal generator output ON and configure it as specified in the test table.
5. Configure the LSX as follows:
   a. Frequency: 10 MHz
   b. Output: On
   c. Power: 5 dBm

Test Procedure:

1. Perform Ref In tests using Table 2.4 by verified that the phase between the LSX output and the signal generator 10MHz Ref out is locked:
2. Measure delta between min and max tolerance: ±1.5ns
3. Increase the signal generator power as requested in the test and perform Ref In tests again

Table 2.17 Ref In

Test Number	Signal Generator Frequency	Signal Generator Power	Pass	Fail
1	100 MHz	-5 dBm		
2	100 MHz	0 dBm		
3	100 MHz	10 dBm		
4	10 MHz	-5 dBm		
5	10 MHz	0 dBm		
6	10 MHz	10 dBm		

2.12 Ref Out

Test Equipment: Scope

Preparation:

1. Connect the LSX 10 MHz Ref out to the scope channel 1 input
2. Connect the LSX output the scope channel 2 input
3. Configure the LSX as follows:
   a. Output: ON
   b. Frequency: 10 MHz

Test Procedure:

1. Perform Ref Output tests using Table 2.5 by verifying that the phase between the LSX output and Ref Output is locked.
2. Measure delta between min and max tolerance: ±1ns
3. Connect the LSX 100 MHz Ref output to the scope channel 1 input.
4. Change the LSX output frequency to 100MHz and verify that the phase between the LSX output and Ref Output is looked.

Table 2.18 RefClkOut

Ref Out Frequency	Output Frequency	Pass	Fail
10 MHz	10 MHz		
100 MHz	100 MHz		

2.13 External Trigger Input

Test Equipment: Scope, Function Generator

Preparation:

1. Connect the LSX output to the scope channel 1 input
2. Split the Function Generator output and connect it to the LSX Trigger input and scope channel 2 input
3. Configure the Function Generator as follows:
   a. Function shape: Square
   b. Frequency: 10 kHz
   c. Duty Cycle: 20 %
   d. Amplitude: 4Vpp
   e. Offset: 2V
   f. Output: ON
4. Configure the LSX as follows:
   a. Output: ON
   b. AM Modulation: ON
   c. Modulation Frequency: 100kHz
   d. Modulation Depth: 50%
   e. Run Mode: Trigger
   f. Trigger Source: External
   g. Trigger Edge: As specified by the test

Test Procedure:

1. Perform External Trigger tests according to the table below.

Table 2.19 External Trigger

Trigger Edge	Pass	Fail
Positive		
Negative		

2.14 Internal Trigger

Test Equipment: Scope

Preparation:

1. Connect the LSX output to the scope channel 1 input
2. Configure the scope as follows:
    a. Amplitude: 500 mV per division
    b. Time base: 50% of the LSX Trigger Timer
    c. Trigger mode: Triggered
    d. Trigger Level: 0.5
3. Configure the LSX as follows:
    a. Output: ON
    b. Frequency: 100 MHz
    c. Run Mode: Trigger
    d. Trigger Source: Internal
    e. Trigger Timer: As specified by the test
    f. AM Modulation: ON
    g. Modulation Frequency: 100 kHz
    h. Modulation Depth: 50%

Test Procedure:

1. Perform the Internal Trigger tests according to the table below.
2. Measure the delay between two nearby output signals.

Table 2.20 Internal Trigger

Timer	Trigger Period Limit	Delay Reading	Pass	Fail
1 ms	1msec ± 7nsec			
100 µs	100µsec ± 7nsec			

2.15 EPR Option - Output Power vs Frequency

Test Equipment: Spectrum

Preparation:

1. Connect the LSX output to the power meter input
2. Configure the LSX as follows:
   a. Spectrum: Minimum span
   b. Frequency: As specified in the test
   c. Output: On
   d. Power: As specified in the test

Test Procedure:

1. Perform output power test according to the table below.

Table 2.21 Power vs Frequency

Test Number	Output Frequency	Output Power	Error Limits	Power Reading	Pass	Fail
1	1 MHz	25 dBm	±0.5 dB			
2	1 MHz	0 dBm	±0.5 dB			
3	1 MHz	-70 dBm	±0.5 dB			
4	1 MHz	-120 dBm	±0.5 dB			
5	100 MHz	25 dBm	±0.5 dB			
6	100 MHz	0 dBm	±0.5 dB			
7	100 MHz	-70 dBm	±0.5 dB			
8	100 MHz	-120 dBm	±0.5 dB			
9	1 GHz	25 dBm	±0.5 dB			
10	1 GHz	0 dBm	±0.5 dB			
11	1 GHz	-70 dBm	±0.6 dB			
12	1 GHz	-120 dBm	±0.6 dB			
13	3 GHz	25 dBm	±0.5 dB			
14	3 GHz	0 dBm	±0.5 dB			
15	3 GHz	-70 dBm	±0.6 dB			
16	3 GHz	-120 dBm	±0.6 dB			
17	6 GHz	25 dBm	±0.7 dB			
18	6 GHz	0 dBm	±0.7 dB			
19	6 GHz	-70 dBm	±1.0 dB			
20	6 GHz	-120 dBm	±1.0 dB			
21	12 GHz	25 dBm	±1.0 dB			
22	12 GHz	0 dBm	±1.0 dB			
23	12 GHz	-70 dBm	±1.5 dB			
24	12 GHz	-120 dBm	±1.5 dB			