APPLICATION NOTE

Analyzing UXM IQ captures with the SJ001A WaveJudge Wireless Analyzer Toolset

Import, Decode and Troubleshoot UXM IQ Captures

Insightful Wireless Analysis to Diagnose and Adjudicate Root Cause of Problems

Troubleshooting functional and interoperability issues in 5G is not easy. We need to determine what Protocol messages were sent, relative to what PHY events occurred, and the timing of those messages and events. With Sanjole Solutions, Keysight can address new use cases moving forward.

This Application Note describes the process to import, decode and troubleshoot UXM IQ captures. This is really useful to complement the capabilities of Keysight Network Emulation Solutions, and to adjudicate disputes created when multiple vendors' products and analysis logs are contradictory, causing undue delays and increasing engineering expenses.

This paper demonstrates how to analyze UXM 5G IQ captures using the Keysight WaveJudge Wireless Analyzer Toolset

S S

Testing 5G

requires diagnosing the root causes of problems between layers, which often takes hours, days or even weeks.

The SJ001A WaveJudge Wireless Analyzer Toolset

provides visibility into protocol and physical layer interaction in wireless transmissions, with the ability to record and review the conditions when performance is optimal and compare when the results are less than expected.



Table of Contents

| Analyzing UXM IQ captures with the SJ001A WaveJudge Wireless Analyzer Toolset |
|--|
| Insightful Wireless Analysis to Diagnose and Adjudicate Root Cause of Problems1 |
| Table of Contents2 |
| Preliminary Steps |
| A. Configure 5G NR as scenario (Please perform this if you don't have a following setting)4 |
| B. Click on Add Cell \rightarrow 5G NR Cell4 |
| C. Configure 5G NR cell with any valid configuration. Do not need to take care of the 5GNR configuration right now |
| How to load an IQ capture onto WaveJudge6 |
| PRACH Analysis10 |
| Parameters10 |
| WaveJudge Verification10 |
| SSB Analysis14 |
| Parameters14 |
| WaveJudge Verification14 |
| VSA Verification |
| PDCCH+PDSCH Analysis |
| Parameters |
| WaveJudge Verification22 |
| Troubleshooting |
| Sanjole Wireless Analyzers |

Preliminary Steps

1. Run WaveJudge (this step has to be done once only). The shortcut should be available on the desktop.



Figure 1. WaveJudge Icon, available on the desktop

2. If there is an error message observed about the license during WaveJudge launching, please check the following information:



Figure 2. License Request Process

It may be also required to change the settings the first time that WaveJudge is opened under your profile. If so, click on OK and make sure that Cell is configured as below. Click on Apply to apply the changes. If you have already the default setting, you can just use it.

A. Configure 5G NR as scenario (Please perform this if you don't have a following setting)

| Configure Test | |
|----------------|--|
| Configure Test | Configure Test Scenario Standard 5G NR |
| Set up Capture | 3 Single base station (one cell) Two cells Start custom test scenario |

Figure 3. Configure 5G NR Test Scenario

B. Click on Add Cell \rightarrow 5G NR Cell

| Configure Test Scenario | 3GPP LTE Cell | |
|---|--|--------------------|
| Single base station (one cell) | 5G NR Cell Add 5GTF Cell to test co | onfigur |
| Start custom test scenario | Add UL/DL 5GTF Cell 5 | -C |
| | Add Rx Port | JI/div iel ?? : |
| Go to 5G Card/Carrier Configuration | WiFi/WiGig Cell | |
| Exclude Transport Payload in IntelliJudge capturepy | Transmitter Mobile WiMAX Cell | |
| | Fixed WiMAX Cell | Frequ |

Figure 4. Add 5G NR Cell

C. Configure 5G NR cell with any valid configuration. Do not need to take care of the 5GNR configuration right now.



Figure 5. Configure 5G NR cell

How to Load an IQ Capture onto WaveJudge

1. Perform an IQ capture (either using TAP or L1 Capture tool) with the info to be analyzed.

2. Convert that IQ capture files to WaveJudge format. For that, you can use an iq2sanjole converter program or Matlab (e.g. fid = fopen(\'y1_DL1.iq\'); $x = fread(fid, inf, \int16\', 0, \int16\')$.

Instructions to use this are simple. You can type convertiq.exe –help to get more details about the input/output allowed parameters. This tool allows converting .IQ files to Sanjole format, VSA format, or IQ format (if you desire to cut the capture, making it shorter or capturing only a part of the entire capture).

| C:\WINDOWS\system32\cmd.exe | | | | | | |
|---|--|--|--|--|--|--|
| Microsoft Windows [Version Copyright <c> 2009 Microsof</c> | 6.1.7601] t Corporation. All rights reserved. | | | | | |
| C:\Users\rubegarc>cd C:\Users\rubegarc\Documents\5GNR\5GNR_L1Capture\IQ2Sanjole converter\v2.0 | | | | | | |
| C:\Users\rubegarc\Documents Convert a UXM IQ file into | \5GNR\5GNR_L1Capture\IQ2Sanjole converter\v2.0>convertiq.exe —help VSA or SanJole text file | | | | | |
| You can use this tool to co You can use it to perform a of the capture that you wil You can even generate a new IQ swapped or which contain | nvert a UXM IQ capture into a USA or SanJole text file. nd IQ swap. You can also use it to select a section l convert (i.e. by providing a start and a length). UXM IQ capture file (normally one that has been s only part of the original input file samples) | | | | | |
| Note that this program need | s pcre64.dll (from https://nim-lang.org/download/dlls.zip) to run. | | | | | |
| Usage: convertiq [to FORMAT | -o OUTFILE -n ANTENNAS -s START -1 LENGTHfs=FREQ] [iqswap] <iqfiles></iqfiles> | | | | | |
| Options: | | | | | | |
| to=FORMAT -oout=FILENAME -nnum-antennas=NUM iqswap -sstart=START | Target output format (sanjole, vsa or iq) [Default: sanjole] Output filename (defaults to iqfile1 plus ".txt") The number of antennas (defaults to the number of input files) Swap the I and Q The start position for the conversion in samples or ms. To specify a number of samples simply provide an integer value. To specify a time in miliseconds append "us" to the value (e.g. 125us) To specify miliseconds append "ms" and for seconds append "s" You can use a negative file to _add_ some zero samples to the beginning of the capture. | | | | | |
| -1length=LENGTH | Use this to skip (or add) initial samples or miliseconds [default: 0] The maximum length of the converted file in samples or ms To specify a number of samples simply provide an integer value. To specify a time in miliseconds append "us" to the value (e.g. 125us) To specify miliseconds append "ms" and for seconds append "s" Use this to limit the size of the output file. Bu default the companying more till the sed of the file | | | | | |
| fs=SAMPLING_FREQ | Sampling frequency of the input capture in Hz [default: 153.6e6] Note that this is only used to calculate the number of samples given a start or length in time (i.e. us, ms or s). That is, this is not used to do any kind of resampling of the input file. | | | | | |
| C:\Users\rubegarc\Documents | \5GNR\5GNR_L1Capture\IQ2Sanjole converter\v2.0> | | | | | |

Figure 6. Convert IQ help details

Example:

IQ Captures named as \rightarrow y1_DL1.iq, y2_DL1.iq

Command to execute: convertiq.exe --to sanjole -o capture.txt -s 0 y1_DL1.iq y2_DL1.iq

This command will generate a capture.txt file that can be opened by WaveJudge software. This file structure is 8 columns. The first four columns belong to 1st antenna port, and the other four columns belong to the 2nd antenna port.

- First column: I numerical values of 1st antenna port.
- Second column: Q numerical values of 1st antenna port.
- Third column: I numerical values of 2nd antenna port.
- Fourth column: Q numerical values of 2nd antenna port.

| | | _ | | | _ | | _ | | - |
|--------|--------|-----|------|----|---|---|---|---|---|
| 862137 | -2041 | | -13: | 28 | | 0 | | 0 | ſ |
| 862138 | 3337 | | 292 | 5 | | 0 | | 0 | |
| 862139 | 4135 | | 406 | D | | 0 | | 0 | |
| 862140 | 793 -: | 25: | 19 | 0 | 1 | 0 | | | |
| 862141 | -2592 | | -20 | 87 | | 0 | | 0 | |
| 862142 | 340 3 | 54 | 0 | 0 | | | | | |
| 862143 | 4151 | | -193 | 35 | | 0 | | 0 | |
| 862144 | -2719 | | 112 | 0 | | 0 | | | |
| 862145 | -3077 | | 3324 | 4 | | 0 | | 0 | |
| 862146 | 4026 | | 195 | 3 | | 0 | | 0 | |
| 862147 | 953 1 | 168 | 3 | 0 | | 0 | | | |
| 862148 | -2454 | | 866 | 0 | | 0 | | | |
| 862149 | -2427 | | 136 | 7 | | 0 | | 0 | |

Figure 7. Capture.txt columns format

3. Open WaveJudge and click on File \rightarrow Import \rightarrow I/Q Samples from text file.

| 🚏 Wa | veJudge - [capture1.txt] | | | |
|------|--|------------|----------------------|------------------------|
| File | Edit View Actions Tools Window Help | | | |
| | New Test Configuration | Ctrl+N ge | Cipher¶ <i>Judge</i> | GPS: 🔲 1J: LTE 🔲 📳 |
| : 🚰 | Open | Ctrl+O pce | ss interval: | 0 ms 👉 📥 📩 |
| | Open Combined IntelliJudge/VSA Capture | | | WaveJ |
| | Open Multiple IntelliJudge Capture Files | е | Start T | i Port D Error Checkin |
| | Load IntelliJudge LTE MAC Settings | | | |
| | Save Current Capture | Ctrl+S | | |
| | Save Test Configuration Ctrl+: | Shift+S | | |
| 1 | Save WaveJudge Capture | | | |
| | Save WaveJudge Capture Selection As | | | |
| | Save IntelliJudge Capture | | | |
| | Save IntelliJudge Capture Selection As | | | |
| | Save Combined IntelliJudge/WaveJudge Capture | | | |
| - | Save Multiple IntelliJudge Captures | | | |
| | Load Bookmarks | | | |
| | Save Bookmarks | Ctrl+B | | |
| | Capture Information | | | |
| - | Import | • | I/Q Samples (| from text file |
| 8 | Export | • | I/Q Sample Ir | mport with Options |
| | Exit | | WiFi PCAP | |

Figure 8. Selecting the .txt file

Select the .txt file generated in step #2 and wait until it is imported completely.

| Import I/Q Samp | ples | × |
|-------------------|---|--------------|
| | Importing I/Q samples from E:\USERS\Documents\SanJo\capture1.txt | |
| • | Please wait | |
| Elapsed: 00:00:02 | 2 360000 / 2457600 Remaining: 00:00 Total: 00:01 |):13 0:16 |
| | Cancel | |

Figure 9. Importing the .txt file

4. Once imported, click on the Reprocess button.

| 👬 W | aveJudo | je - [cap | ture1.txt] | | | | | |
|------|------------|-----------|------------|-------|--------|--------|--------|----------------|
| File | e Edit | View | Actions | Tools | Window | Help | | |
| : 🔛 | 2. | |) 💕 🔒 | 🈓 🗓 | Captu | ure nn | Repeat | 001 IntelliJud |
| Sto | oped at O | ms / 107 | ms | | | | 8 😵 🙎 | 🗲 🔹 🚺 Pr |
| Type | Cell 2: DL | on RX 1 | | | | | [| Reprocess |

Figure 10. Reprocessing (after importing)

5. Once completed, you should be able to see the signal on WaveJudge (at least, on time domain).

6. Start to configure the **5G NR parameters and/or Scheduling elements** to properly decode the signal. If it already exists, you may load an existing WaveJudge configuration file and apply it to the current I/Q capture. This will make the analysis easier and faster.

To do this:

- a. In WaveJudge, File \rightarrow Open
- b. Select the WaveJudge Configuration file.

| 脊 WaveJu | udge - [capture1.txt] | Open WaveJudge/IntellJudge Capture or Configuration File San De San | | | | | |
|----------|--------------------------------|--|---|---------------------------------------|-------------------------|--|--|
| File E | Edit View Actions Tools | Organize New Folder | | | | | |
| | en | 🖃 🚖 Favorites | Name * | Date modified | Туре | | |
| | Desktop | Desktop Downloads | capture decoded using l1analyzer captura1_PDSCH.def | 4/2/2018 4:27 PM 4/3/2018 12:18 AM | File folder DEF File | | |
| | | Recent Places | captura1_PDSCH | 4/3/2018 12:18 AM | WaveJudge Configuration | | |
| | e 🧊 Libraries 🕀 🖻 Documents | | Test_PDSCH | 4/2/2018 5:10 PM | WaveJudge File | | |

Figure 11. Opening and selecting an existing WaveJudge configuration file

PRACH Analysis

Parameters



Figure 12. PRACH Analysis Parameters

WaveJudge Verification

1. Time domain power \rightarrow OK

| For | mat | Nseq | Тср | Tseq | T _{GP} | Use case |
|-----|-----|------|----------------------|-----------------------|--------------------|------------|
| А | 1 | 2 | 288 • T _S | 2048 • T _S | 0 • T _s | Small cell |

 $T_s = \frac{1}{8 \cdot 30720}$ ms for 120 kHz subcarrier spacing

PRACH Format A1 = $288 \cdot T_{s+} 2 \cdot 2048 \cdot T_{s+} 0 \cdot T_{s} \approx 18 \ \mu s$



Figure 13. PRACH in time domain

2. Mapping location \rightarrow OK (2 OFDM symbols (1st and 2nd) in Format A1)



Figure 14. PRACH mapping location

3. Number of subcarriers \rightarrow OK

144 subcarriers = 12 PRBs.



Figure 15. PRACH subcarriers

4. Cell ID = $0 \rightarrow OK$

| | Cell 1: DL on RX 1 | | *** | | | | | |
|-----------|--------------------|----------------|----------------|---------|---------|-------|------|--------|
| | | | | | | | | |
| Slot List | | | | | 80 | | | |
| | ■ [0] | | | slot 0 | | | | |
| | | | | slot 1 | | | | |
| | . [2] | | <u> </u> | slot 2 | | | | |
| Name | Start Ti Port Dire | ection Cell ID | Error Checking | # Bytes | Frame N | EVM | Code | N Reso |
| PRACH | 0006.00 1 U | 0 | | | 0 | 00.00 | 1 | |

Figure 16. Cell ID in PRACH

SSB Analysis

Parameters

| % General Parameters | | | | | | | |
|----------------------|---------------------------------|--|---|--|--|--|--|
| fO | = 0; | % RF frequency in Hz (set to 0 to skip ph | ase pre-compensation) | | | | |
| n_cell_id | = 28; | % Cell ID | [0 : 1007] | | | | |
| sfn | = 0; | % System frame number | [0 1023] | | | | |
| n_hf | = 0; | <pre>% Half-frame number</pre> | [0, 1] | | | | |
| mu | = 3; | % Subcarrier scaling (2 ^ mu) * 15 kHz | [0, 1, 3] | | | | |
| n_fft | = 1024; | % FFT size | [512 : 4096] n_fft * (2 ^ mu) * 15 kHz = 122.88 Msps | | | | |
| k_0 | = 0; | % Subcarrier offset in OFDM signal transm | uission [-6, 0, +6] | | | | |
| n_rb | = 66; | % Number of resource blocks | [20 : 275] n_rb * 12 * (2 ^ mu) * 15 kHz <= 100 MHz | | | | |
| n_bwp_start | = 0; | % Bandwidth part start [0:274]. | | | | | |
| dc_notch | = false; | % DC notch | | | | | |
| n_ant | = 2; | % Number of antennas | [1 : 2] | | | | |
| periodicity | = 20; | % Periodicity of generated signal (in ms |) [5, 10, 15, 20] | | | | |
| | | | | | | | |
| % SSB Paramete | rs | | | | | | |
| mu_ssb | = 3; | % Subcarrier scaling for SSB (2 ^ mu) * 1 | 5 kHz [0, 1, 3, 4] | | | | |
| n_fft_ssb | = 1024; | % FFT size for SSB | [512 : 4096] n_fft * (2 ^ mu) * 15 kHz = 122.88 Msps | | | | |
| k_0_ssb | = 0; | % Subcarrier offset in OFDM signal transm | ussion for SSB [-6, 0, +6] | | | | |
| n_rb_ssb | = 66; | % Number of resource blocks for SSB | [20 : 275] n_rb_ssb * 12 * (2 ^ mu_ssb) * 15 kHz <= 100 MHz | | | | |
| pss_gain | = 1; | <pre>% Gain for PSS</pre> | <pre>(< 2.0) - linear maginitude</pre> | | | | |
| sss_gain | = 1; | % Gain for PSS | <pre>(< 2.0) - linear maginitude</pre> | | | | |
| pbch_tbs | = 24; | % Number of bits for PBCH | | | | | |
| pbch_payload | <pre>= zeros(1, pbch_tbs)</pre> | ;% High layer payload for PBCH (must be 24 | bits) | | | | |
| pbch_trch_en | = true; | % Enables channel encoding | [true, false] | | | | |
| pbch_data_gain | 1 = 1; | % Gain for PBCH data | <pre>(< 2.0) - linear maginitude</pre> | | | | |
| pbch_dmrs_gain | (= 1; | % Gain for PBCH DMRS | <pre>(< 2.0) - linear maginitude</pre> | | | | |
| ssb_1 | = 64; | % Number of SSB in a SSB Burst Set | <pre>(<= 30 kHz: 4 or 8; 120 kHz: 64)</pre> | | | | |
| ssb_map30 | = 0; | % Mapping alternative for SSB at 30 kHz | [0, 1] | | | | |
| ssb_re | = 0; | % First RE of SSB | [0 : (n_rb_ssb - 20) * 12] | | | | |
| ssb_p1_id | = [1 1]; | % P1 index for 2 antennas for all SSBs | (index starts at 0) | | | | |
| ssb_p2_id | <pre>= ones([1 64]);</pre> | <pre>% P2 index for all SSBs in a SSB Burst Se</pre> | t (index starts at 0) | | | | |

Figure 17. General and SSB Parameters

WaveJudge Verification

5. Time domain power \rightarrow OK



Figure 18. SSB Time Domain Power

6. Mapping location \rightarrow OK



Figure 19. SSB Mapping Location

7. Number of subcarriers \rightarrow OK

240 subcarriers = 20 PRBs



Figure 20. Number of Subcarriers

8. Cell ID = $28 \rightarrow OK$

Cell 1: DL on RX 1

| [0] | Frame 0, CellID=28 | ٠ |
|--------------|--------------------|---|
| 🗉 Slot List | Count: 80 | |
| ⊡ [0] | slot 0 | |
| 🖂 Assignment | Count: 5 | |
| ⊡ [0] | PSS | |

Figure 21. Cell ID in SSB

9. SSB Burst composition \rightarrow OK



Figure 22. SSB Burst Composition

10. Periodicity (20 ms) \rightarrow OK



Figure 23. SSB 20 ms periodicity

11. Error checking \rightarrow OK

| Cell 1: DL on RX 1 | | | | | | WaveJu | dge | |
|-------------------------------|--------------------|------|--------|------------|------|-----------|------------|---|
| □ [0] | Frame 0, CellID=28 | | Name | Start Time | Port | Direction | Error Chec | ŧ |
| Slot List | Count: 80 | | Slot | 0000.00 | 1 | | | |
| □ [0] | slot 0 | | PBCH | 0004.99 | 1 | D | ПК | 3 |
| 🗆 Assignment | Count: 5 | | PBCH | 0004.99 | 1 | D | OK | 3 |
| □ [0] | PSS | | PSS | 0004.00 | 1 | D D | on | Ŭ |
| KOffs | -24 | - 11 | 222 | 0004.99 | 1 | D D | | |
| . [1] | SSS | - 11 | Clas | 0004.00 | 1 | 0 | | |
| □ [2] | PBCH | - 11 | DDCU | 0004.33 | 1 | D | OF | |
| Modu | I QPSK | - 11 | | 0005.12 | 1 | 0 | | 2 |
| Block | 0 | - 11 | L DCC | 0005.12 | 1 | 0 | UK | 3 |
| TB Si | 32 | - 11 | P55 | 0005.12 | 1 | U | | |
| ⊞ [3] | PDCCH | - 11 | 555 | 0005.12 | 1 | D | | |
| ± [4] | PBCH | - 11 | Slot | 0005.12 | 1 | _ | | |
| ⊞ [1] | slot 1 | - 11 | PBCH | 0005.24 | 1 | D | UK | 3 |
| | slot 2 | - 11 | PBCH | 0005.24 | 1 | D | ок | 3 |
| <u>⊞</u> [3] | slot 3 | - 11 | PSS | 0005.24 | 1 | D | | |
| <u>⊞ [4]</u> | slot 4 | - 11 | SSS | 0005.24 | 1 | D | | |
| E [5] | slot 5 | - 11 | Slot | 0005.24 | 1 | | | |
| <u>ш</u> (6) | slot 6 | - 11 | PBCH | 0005.37 | 1 | D | OK | 3 |
| <u>⊞ [/]</u> | slot / | - 11 | PBCH | 0005.37 | 1 | D | OK | 3 |
| ⊞ [8] | slot 8 | - 11 | PSS | 0005.37 | 1 | D | | |
| E [9] | slot 9 | - 11 | SSS | 0005.37 | 1 | D | | |
| <u>⊞</u> [10] | slot TU | - 11 | Slot | 0005.37 | 1 | | | |
| <u>⊞ [11]</u> | slot 11 | -11 | PBCH | 0005.49 | 1 | D | OK | 3 |
| | slot 12 | - 11 | РВСН | 0005.49 | 1 | D | ОК | 3 |
| E [13] | SIDE 1.3 | - 11 | PSS | 0005 49 | 1 | D | | |
| | slot 14 | - 11 | SSS | 0005.49 | 1 | - D | | |
| | slot 16 | - 11 | Slot | 0005.49 | 1 | 5 | | |
| | slot 10 | - 11 | PRCH | 0005.62 | 1 | n | 0K | 2 |
| E [17] | slot 17 | - 11 | DDCU | 0005.02 | 1 | D D | OK | 2 |
| E [10] | slot 19 | - 11 | Dec | 0005.02 | | D | UK | 3 |
| E [10] | slot 10 | - 11 | 666 | 0005.62 | | D | | |
| E [20] | slot 20 | | 000 | 0003.62 | 1 | U | | |
| E [27] | slot 21 | | I SIOC | 0005.62 | - | | or | |
| E [23] | slot 22 | | PBCH | 0005.74 | - | D | UK | 3 |
| E [24] | slot 24 | | PBCH | 0005.74 | 1 | U | UK | 3 |
| € (25) | slot 25 | | PSS | 0005.74 | 1 | U | | |
| | slot 26 | | SSS | 0005.74 | 1 | D | | |
| | slot 27 | | Slot | 0005.74 | 1 | | | |
| | slot 28 | | PBCH | 0005.87 | 1 | D | OK | 3 |
| ⊞ [29] | slot 29 | | PBCH | 0005.87 | 1 | D | OK | 3 |
| E (30) | slot 30 | | PSS | 0005.87 | 1 | D | | |
| | 1.4.01 | - | ISSS | 0005 87 | 1 | D | | |

Figure 24. SSB Error Checking

12. EVM and constellation \rightarrow OK



Figure 25. PSS EVM and Constellation



Figure 26. SSS EVM and Constellation



Figure 27. PBCH EVM and Constellation

13. Spectral power (RB Offset) \rightarrow OK



Figure 28. SSB Spectral Power

VSA Verification



Figure 29. SSB VSA Verification

PDCCH+PDSCH Analysis

Parameters

- PDCCH parameters (kma missed)
- CCE Start = 0
- CCE Length = 1
- TB Size = 56
- RNTI = 1
- Data n ID = 28
- DMRS n ID = 30
- Symbol Length = 1
- PDSCH parameters (extracted from.kma)

```
%% This is an example of a PDSCH configuration file
%% SIGNAL TYPE
standard = 'nr' % Only supported standard is NR
signal_type = 'PDSCH'
SE LOG MODE
mode_interactive = true
                                                            % If false then the console is closed inmediately
SS CAPTURE FILES
y0_file = 'C:\LocalTemp\TestTBPDSCH\y5_DL1.iq'
y1_file = 'C:\LocalTemp\TestTBPDSCH\y6_DL1.iq'
                                                                                           % File containing samples for antenna 0 at Fs_capt
% File containing samples for antenna at Fs_capt
                                                               & Sampling frequency of the capture expressed in samples per second
Fs_capt = 122.88e6
% Slot info
% Slot info
ns = 52 % Slot number within a frame
sample_offset = 798720 % offset to start cutting the slot (at Fs_capt)
cfo = 0 % CFO to apply in Hz
soft_en = true % Soft decoding enable [true:
llr_fix = false % Indicates if fixed-point representation for
snr_value = %0 % SNR
                                                                                                                               [true: soft-decoding, false: hard-decoding]
                                                               % Indicates if fixed-point representation for LLR is used
% General Parameters
n_cell_id = 28
mu = 3
                                                           % Cell ID
                                                                                                                                          [0 : 1007]
[0, 1, 3]
                                                               % Cell ID [0 : 1007]
§ Subcarrier scaling (2 ^ mu) * 15 kHz [0, 1, 3]
% RF frequency in Hz (set to 0 if no pre-compensation is needed)
fO
                 = 1024
= 66
= 0
                                                               % KF Irequency in n2 (set to 0 if no pre-compensation is needed)
% FFT size
% Number of resource blocks
% l1 : 275] BW = n_fft * (2 ^ mu) * 15 kHz
% Subcarrier offset in OFDM signal reception [-6, 0, +6]
% Bandwidth part start [0:274].
n_fft
n_rb
k_0
n_bwp_start = 0
dc_notch = false
                                                              & DC notch
n_rnti = 1 % UE RNTI
n_id = 28 % PDSCH N_ID for scrambling
                                                                 % Number of antennas
% Number of PDSCH layers
% IMCS for PDSCH
n_ant
n_layers
                    = 1
= 1
                                                                                                                                          [1, 2]
[1, 2]
                                                                                                                                         (0 : 27) if 256QAM is enabled; (0 : 28) otherwise
                                  - 0
imcs
                                                               % IMCS for PDSCH
% Enables 256QAM
% PDSCH N OH parameter
% First PDSCH PRB
% Last PDSCH PRB
% First PDSCH symbol
% Last PDSCH symbol
% First DMRS OFDM symbol
% First DMRS OFDM symbol
% Select between simples
 en_256gam
                                 = false
                                 = 0
n oh prb
                                                                % PDSCH N_OH parameter
% First PDSCH PRB [0 : (n_rb - 1)]
% Last PDSCH PRB [0 : (n_rb - 1)]
% First PDSCH symbol ([0 : 3] for mapping type Å, [0 : 12] for mapping type B)
% Last PDSCH symbol ([1 : 3] for mapping type Å, [0 : 12] for mapping type B)
% First DRSS OFDW symbol ([2, 3]: Mapping type Å; 0: Mapping type B)
% Select between single and double-symbol DMRS (1: Single-symbol; 2: Double-symbol)
% DMRS additional positions [0 : 3]
% DMRS type
first_prb
last_prb
                                 = 65
                              = 1
= 11
= 2
first_symb
last_symb
dmrs_10
dmrs_len
dmrs_add_pos
                                   = 1
                                   = 0
dmrs_type
dmrs_boosting
                                   = 1
= 0
= 0
                                                                 % DMRS type
% Boosting applied to DMRS
                                                                                                                                          [1, 2]
                                                                                                                                            (dB)
                                                                 % DMRS NSCID
% N_ID to use for DMRS
                                                                                                                                          10 : 11
dmrs n scid
                                                                   [0 : 1]

* N_ID to use for DMRS [0 : 65535]

* Antenna port indexes used for DMRS p = 1000 + X

* Number of DMRS CDM groups without data

* Enable PTRS

* Parameter - ----
 dmrs_n_id
                                  = 28
dmrs p
                                   = 0
dmrs_cdm_no_data = 1
ptrs_en = false
                                                                  % Parameter L_PTRS
% Parameter K_PTRS
% Parameter DL-PTRS-RE-offset
ptrs 1
                                  = 1
                                                                                                                                                                                                      [1, 2, 4]
ptrs_k
                                                                                                                                                                                                      [2, 4]
[0 : 3]
ptrs_re_offset
                                 = 0
                                    - 0
                                                                   % Association between PT-RS port and DMRS port dmrs_p(ptrs_p)
ptrs_p
```

Figure 30. PDSCH Parameters

WaveJudge Verification

1. Time domain power \rightarrow OK



Figure 31. PDCCH+PDSCH Time Domain Power



2. Mapping location and number of subcarriers \rightarrow OK

Figure 32. PDCCH+PDSCH Mapping Location

3. Cell ID = $28 \rightarrow OK$

| [0] | Frame 6, CellID=28 | |
|-------------------------------------|--------------------|--|
| 🖬 Slot List | Count: 80 | |
| □ [0] | slot 0 | |
| Assignment List | Count: 4 | |
| ⊞ [0] | PSS | |
| ⊞ [1] | SSS | |
| ⊞ [2] | PBCH | |
| ⊞ [3] | PBCH | |
| | | |

Figure 33. PDCCH+PDSCH Cell ID

4.- Error checking \rightarrow OK

| □ [52] | slot 52 | Name | Start Ti | Port | D | Error |
|---------------------|-------------------|-------|----------|------|---|-------|
| Assignment List | Count: 2 | Slot | 0013.63 | 2 | | |
| □ [0] | PDCCH | Slot | 0013.75 | 2 | | |
| CCE Start | 0 | Slot | 0013.88 | 2 | | |
| CCE Length | 1 | Slot | 0014.00 | 2 | | |
| TB Size | 56 | Slot | 0014.13 | 2 | | |
| BNTI | 1 | Slot | 0014.25 | 2 | | |
| Data n ID | 28 | Slot | 0014 38 | 2 | | |
| DMRS n ID | 30 | Slot | 0014 50 | 2 | | |
| Symbol Length | 1 | Slot | 0014.63 | 2 | | |
| ⊡ [1] | PDSCH | Slot | 0014.05 | 2 | | |
| ⊞ CodeWords | Count: 1 | Slot | 0014.70 | 2 | | |
| BNTI | 1 | SIOC | 0014.00 | 2 | | |
| Symbol Start | 1 | SIDE | 0015.00 | 2 | | |
| Symbol Stop | 11 | Slot | 0015.13 | 2 | | |
| RB start | 0 | Slot | 0015.25 | 2 | | |
| RB Length | 66 | Slot | 0015.38 | 2 | | |
| DMRS-config-type | 1 | Slot | 0015.50 | 2 | | |
| DMRS-typeA-pos | 2 | Slot | 0015.63 | 2 | | |
| DMRS-add-pos | 0 | Slot | 0015.75 | 2 | | |
| Antenna Port Config | 0 | Slot | 0015.88 | 2 | | |
| Transmission Scheme | SingleAntennaPort | Slot | 0016.00 | 2 | | |
| Mapping Type | A | Slot | 0016.13 | 2 | | |
| n SCID | 0 | Slot | 0016.25 | 2 | | |
| Data n ID | Use N Cell ID | Slot | 0016.38 | 2 | | |
| DMRS n ID | Use N Cell ID | PDCCH | 0016.50 | 2 | D | ОК |
| DMRS Duration | SingleSymbol | PDSCH | 0016 50 | 2 | D | ОК |
| L PTRS | 1 | Slot | 0016 50 | 2 | - | U.L. |
| K PTRS | 2 | elat | 0010.00 | 2 | | |

Figure 34. PDCCH+PDSCH Error Checking

5. EVM and constellation \rightarrow OK

| | | WaveJudge Messages List | Rel Amplitude UI Constellation: Cell 1 DL All | | | |
|-------|------------------------------|------------------------------|---|---------------------|-----------------------------|--|
| Name | Start Ti., Port D., Error Ch | necking #Bytes Frame N., EVM | 1 Code N Reso Power Tir | | | |
| Slot | 0013.63 2 | 6 | | 0.9 | | |
| Slot | 0013.75 2 | 6 | | 0.8 | | |
| Slot | 0013.88 2 | 6 | | 07 | | |
| Slot | 0014.00 2 | 6 | | 0.1 | | |
| Slot | 0014.13 2 | 6 | | | 0 0 0 0 0 0 | |
| Slot | 0014.25 2 | 6 | | 0.5 | | |
| Slot | 0014.38 2 | 6 | | 0.4 | | |
| Slot | 0014.50 2 | 6 | | 0.3 | | |
| Slot | 0014.63 2 | 6 | | 0.2 | | |
| Slot | 0014.75 2 | 6 | | | | |
| Slot | 0014.88 2 | 6 | | 0.1 | | |
| Slot | 0015.00 2 | 6 | | • | V | |
| Slot | 0015.13 2 | 6 | | -0.1 - O | | |
| Slot | 0015.25 2 | 6 | | -0.2 | | |
| Slot | 0015.38 2 | 6 | | -0.3 | | |
| Slot | 0015.50 2 | 6 | | -04 | | |
| Slot | 0015.63 2 | 6 | | -0.4 | | |
| Slot | 0015.75 2 | 6 | | -0.5 | | |
| Slot | 0015.88 2 | 6 | | -0.6 | | |
| Slot | 0016.00 2 | 6 | | -0.7 | | |
| Slot | 0016.13 2 | 6 | | -0.8 | | |
| Slot | 0016.25 2 | 6 | | .0.9 | | |
| Slot | 0016.38 2 | 6 | | -0.0 | | |
| PDCCH | 0016.50 2 D OK | 7 6 -80.34 | | -0.8 -0.6 | -0.4 -0.2 0 0.2 0.4 0.6 0.8 | |
| PDSCH | 0016.50 2 D OK | 261 6 -73.55 | 66 | | 0.2 UI/div Rel Amplitude UI | |
| Slot | 0016.50 2 | 6 | | | Summary: BX 1 Al | |
| Slot | 0016.63 2 | 6 | | Carrier Freq Err: 0 | .000 kHz = 0.000 ppm | |
| 71.4 | 0010 75 0 | - | | Carrier Freq Err: 0 | .000 kHz = 0.000 ppm | |

Figure 35. PDCCH+PDSCH EVM and Constellation



6. Spectral power (RB Offset) \rightarrow OK

Figure 36. PDCCH+PDSCH Spectral Power

Troubleshooting

1. If the following error message appears during WaveJudge launching, click on OK and operate as usual. Root cause of this problem has not been identified yet.



Figure 37. Error Message during WaveJudge Launch

2. The following steps describe how to face errors shown in below figure:

| Name | Start Ti | Port | D | Error Checking | # Bytes | Frame N | EVM | Code |
|----------|----------|------|---|----------------|---------|---------|--------|------|
| Slot | 0000.00 | 2 | | | | 6 | | |
| PBCH | 0010.00 | 2 | D | OK | 3 | 6 | -69.44 | |
| PBCH | 0010.00 | 2 | D | OK | 3 | 6 | -67.97 | |
| PSS | 0010.00 | 2 | D | | | 6 | -72.35 | |
| SSS | 0010.00 | 2 | D | | | 6 | -71.19 | |
| BCCH-RRC | 0010.00 | | D | Data Underflow | 3 | | | |
| BCCH-RRC | 0010.00 | | D | Data Underflow | 3 | | | |
| Slot | 0010.00 | 2 | | | | 6 | | |
| PBCH | 0010.13 | 2 | D | OK | 3 | 6 | -68.95 | |
| PBCH | 0010.13 | 2 | D | OK | 3 | 6 | -69.02 | |
| PSS | 0010.13 | 2 | D | | | 6 | -00.49 | |
| SSS | 0010.13 | 2 | D | | | 6 | -00.49 | |
| BCCH-RRC | 0010.13 | | D | Data Underflow | 3 | | | |
| BCCH-RRC | 0010.13 | | D | Data Underflow | 3 | | | |
| Slot | 0010.13 | 2 | | | | 6 | | |
| PBCH | 0010.25 | 2 | D | OK | 3 | 6 | -69.37 | |
| PBCH | 0010.25 | 2 | D | OK | 3 | 6 | -69.62 | |
| PSS | 0010.25 | 2 | D | | | 6 | -72.35 | |
| SSS | 0010.25 | 2 | D | | | 6 | -71.15 | |
| BCCH-RRC | 0010.25 | | D | Data Underflow | 3 | | | |
| BCCH-RRC | 0010.25 | | D | Data Underflow | 3 | | | |

Figure 38. Data Underflow Errors

Disable RRC messages doing:

2. Right click over Message List area -> Click on Chart Properties



Figure 39. Disabling RRC Messages - Chart Properties

Disable RRC, NAS, IP, & Other



Figure 40. Disabling RRC Messages - Disabling Options

| Name | Start Ti | Port | D | Error Checking | # Bytes | Frame N | EVM Co |
|------|----------|------|---|----------------|---------|---------|--------|
| Slot | 0000.00 | 2 | | ^ | | 6 | |
| РВСН | 0010.00 | 2 | D | OK | 3 | 6 | -69.44 |
| РВСН | 0010.00 | 2 | D | OK | 3 | 6 | -67.97 |
| PSS | 0010.00 | 2 | D | | | 6 | -72.35 |
| SSS | 0010.00 | 2 | D | | | 6 | -71.19 |
| Slot | 0010.00 | 2 | | | | 6 | |
| PBCH | 0010.13 | 2 | D | OK | 3 | 6 | -68.95 |
| PBCH | 0010.13 | 2 | D | OK | 3 | 6 | -69.02 |
| PSS | 0010.13 | 2 | D | | | 6 | -00.49 |
| SSS | 0010.13 | 2 | D | | | 6 | -00.49 |
| Slot | 0010.13 | 2 | | | | 6 | |
| PBCH | 0010.25 | 2 | D | OK | 3 | 6 | -69.37 |
| PBCH | 0010.25 | 2 | D | OK | 3 | 6 | -69.62 |
| PSS | 0010.25 | 2 | D | | | 6 | -72.35 |
| SSS | 0010.25 | 2 | D | | | 6 | -71.15 |
| Slot | 0010.25 | 2 | | | | 6 | |
| PBCH | 0010.38 | 2 | D | OK | 3 | 6 | -69.40 |
| PBCH | 0010.38 | 2 | D | OK | 3 | 6 | -69.21 |
| PSS | 0010.38 | 2 | D | | | 6 | -00.49 |
| SSS | 0010.38 | 2 | D | | | 6 | -00.49 |

3. After the previous steps the View should look like the figure below:

Figure 41. View after correcting the errors

Sanjole Wireless Analyzers

Sanjole Wireless Analyzers are industry-leading over-the-air communication sniffers, trusted as undisputed "source of truth" to find anomalies, uncover issues and quickly identify root cause in complex wireless systems.

With the addition of the Sanjole solutions, Keysight portfolio enhances its capabilities to provide industry-leading, end-to-end 5G solutions across the entire wireless ecosystem. Sanjole's software offerings will enhance Keysight's 5G solutions for modem, chipset, and radio access network (RAN) customers. Together, Keysight and Sanjole will be able to provide communications standards-validated interoperability testing, enable fast debugging, and accelerate time to deployment for customers.

To learn more about Sanjole Wireless Analyzers, please visit www.keysight.com/find/sanjole.

Learn more at: www.keysight.com

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at: www.keysight.com/find/contactus

