First 5G EMF levels measurements in Italy

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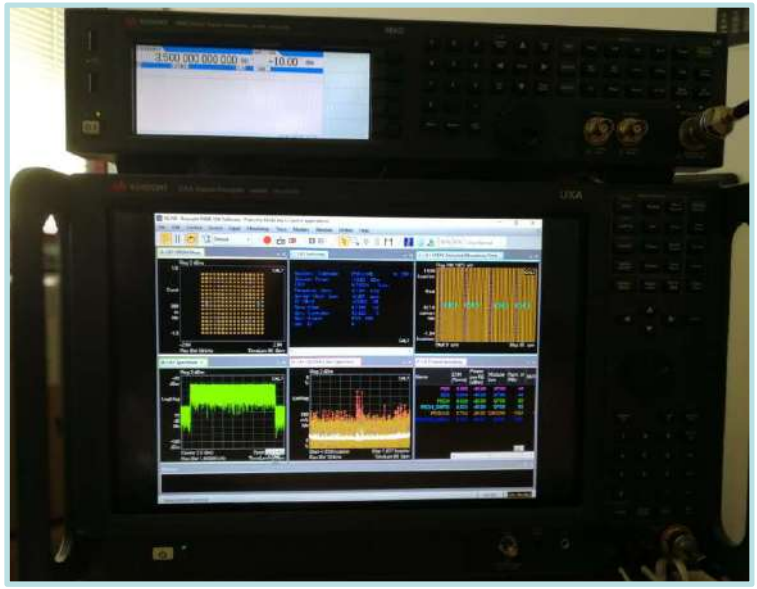
MEASUREMENTS ON A CONTROLLED LABORATORY SIGNAL

first measurement session on ideal 5G signals at the Keysight laboratories in Rome



VECTORIAL GENERATOR
KEYSIGHT MXG N5182B

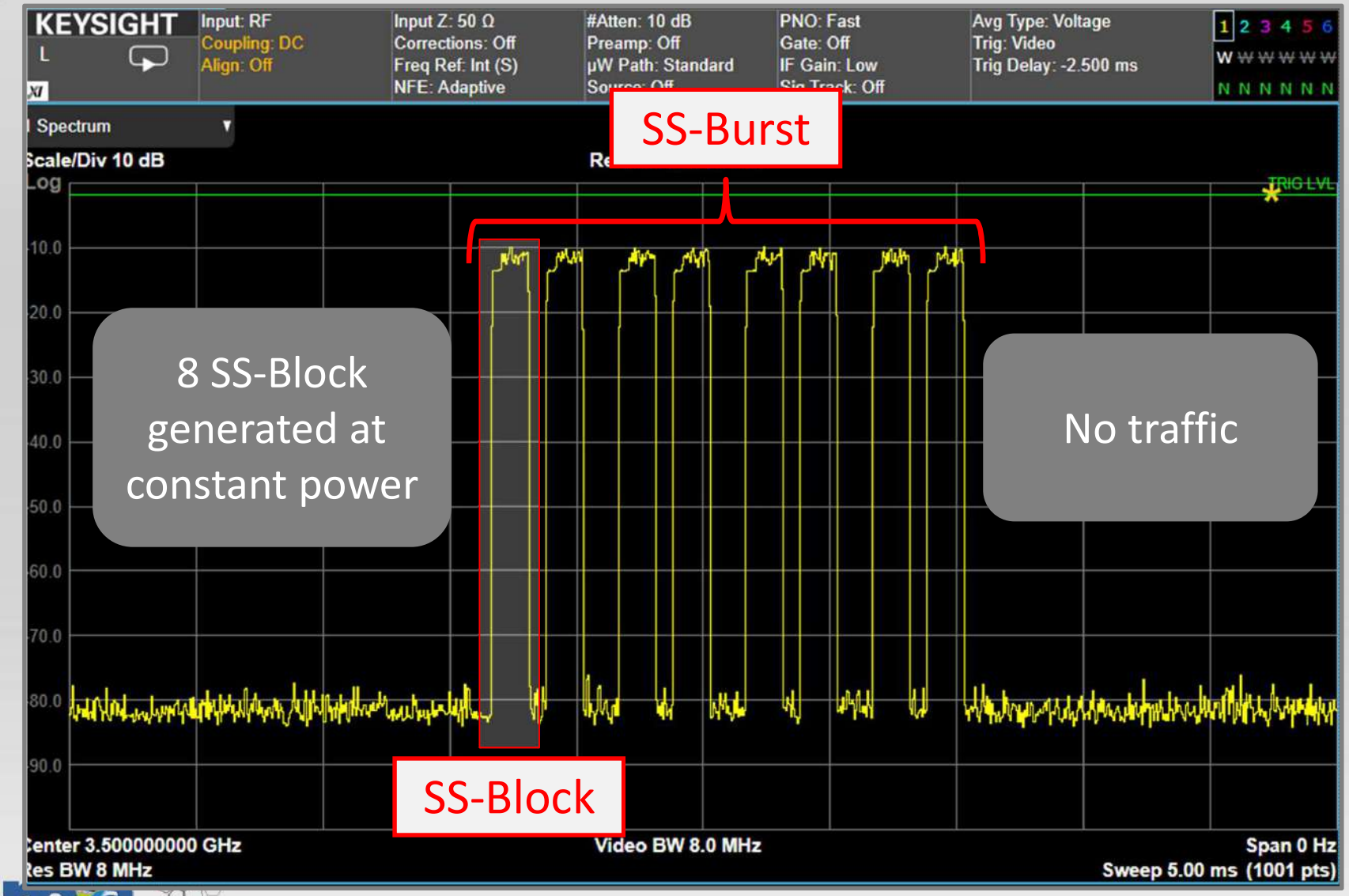
VECTORIAL ANALYZER
KEYSIGHT UXA N9040B

1. Bandwidth 100 MHz
2. Numerology $\mu = 1$ → $\Delta f = 30$ kHz
3. Configurations: Case B and Case C → 8 SS-Block / frame
4. Due modes: with traffic and without traffic
5. Signals measured directly from the cable→ no antenna

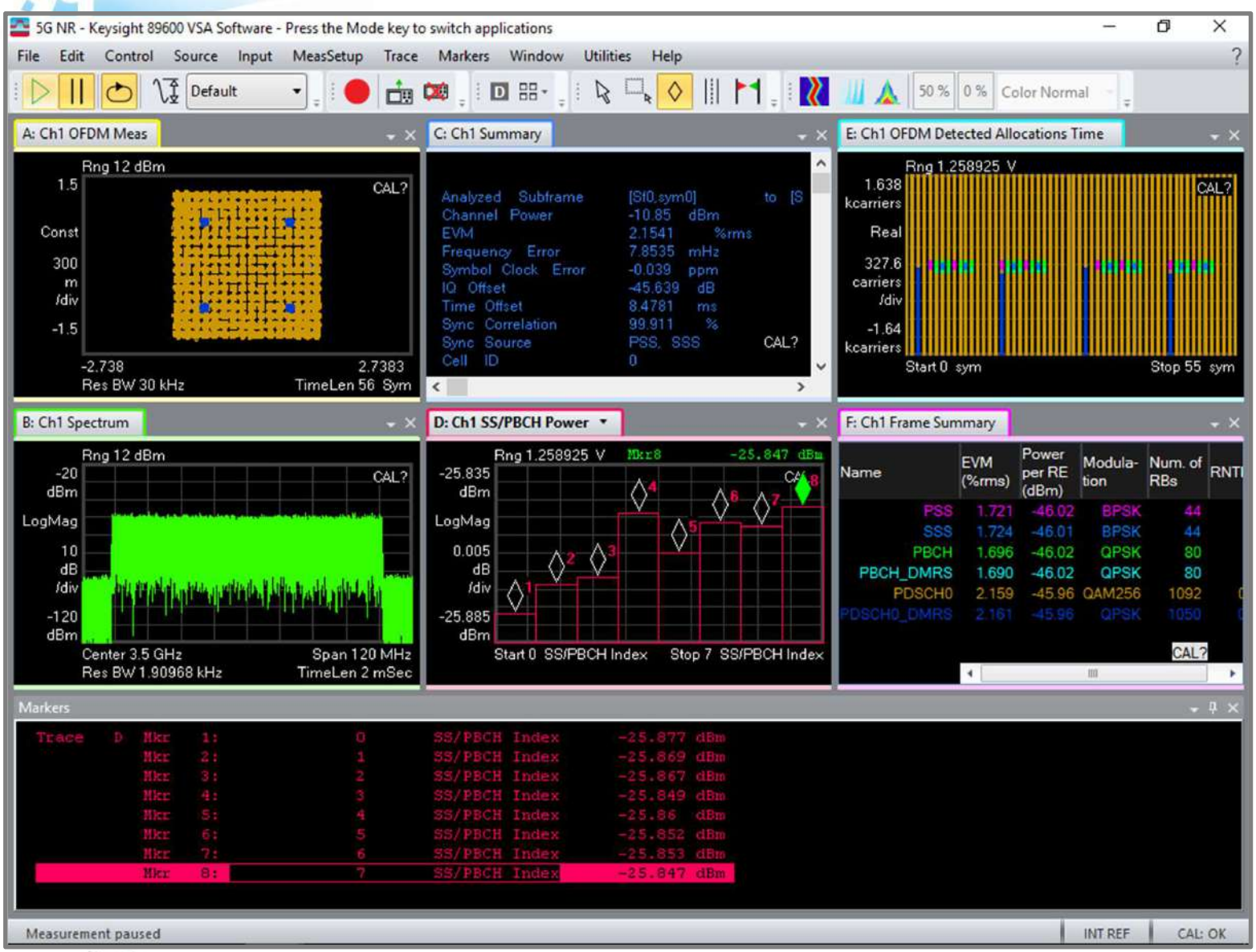
SPECTRUM


KEYSIGHT
Input: RF
Coupling: DC
Align: Off
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 6 dB
Preamp: Off
µW Path: Standard
Source: Off
PNO: Fast
Gate: Off
IF Gain: Low
Sig Track: Off
Avg
Trig:
1 Spectrum
Mkr1 3.459 96 GHz
-22.49 dBm
Scale/Div 10 dB
Ref Level -10.00 dBm
Log
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100
Center 3.4999 GHz
Res BW 2.7 MHz
Video BW 2.7 MHz
Span 277.3 MHz
Sweep ~1.47 ms (1001 pts)
Feb 14, 2019
1:20:09 AM

TIME DOMAIN MEASUREMENT



DECODING

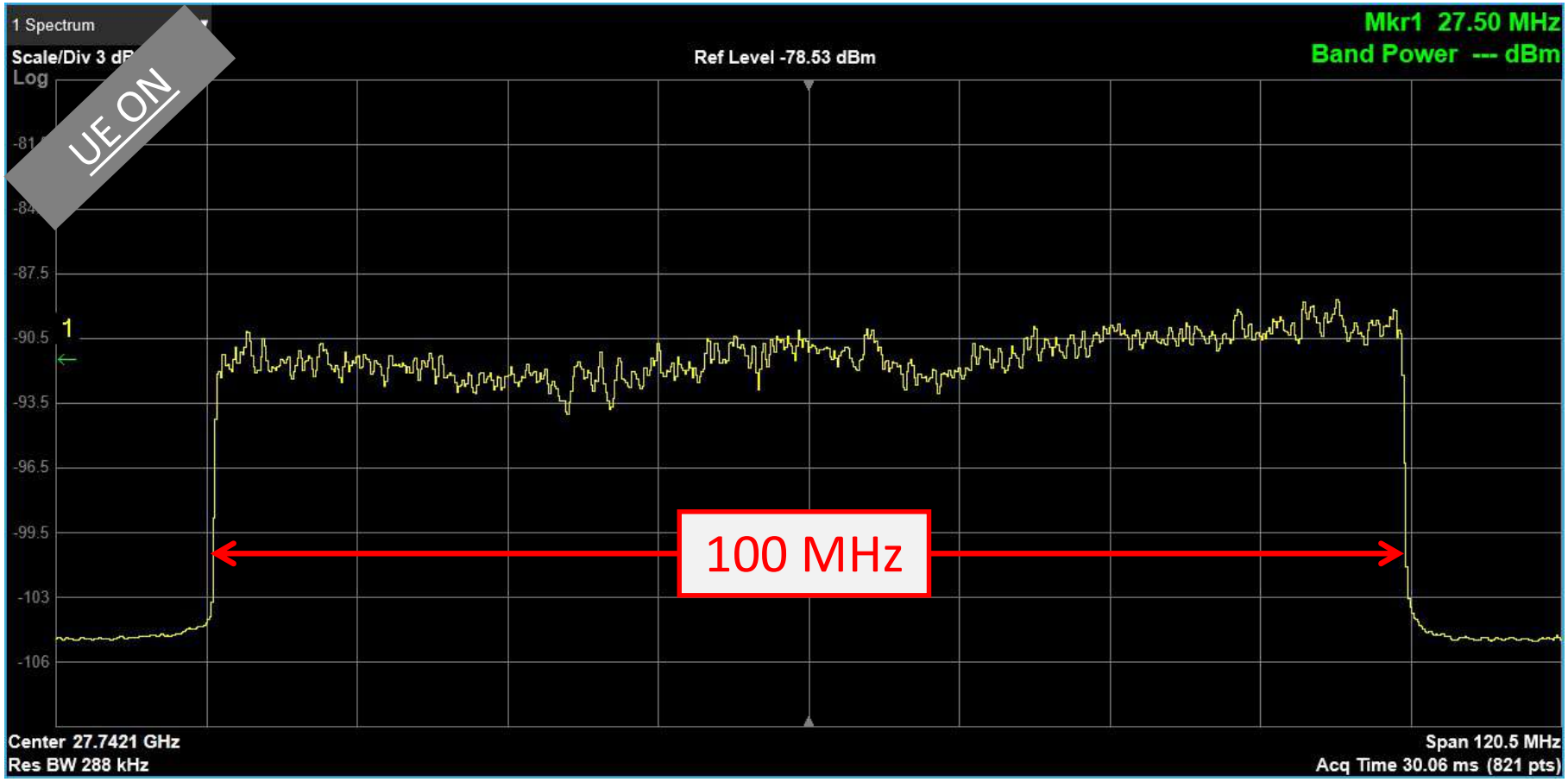

5G NR - Keysight 89600 VSA Software - Press the Mode key to switch applications
File Edit Control Source Input MeasSetup Trace Markers Window Utilities Help
Default
50 % 0 % Color Normal
A: Ch1 OFDM Meas
Rng 12 dBm
CAL?
Const
1.5
300 m /div
-1.5
-2.738
2.7383
Res BW 30 kHz
TimeLen 56 Sym
C: Ch1 Summary
Analyzed Subframe [Sf0,sym0] to [S
Channel Power -10.85 dBm
EVM 2.1541 %rms
Frequency Error 7.8535 mHz
Symbol Clock Error -0.039 ppm
IQ Offset -45.639 dB
Time Offset 8.4781 ms
Sync Correlation 99.911 %
Sync Source PSS, SSS
Cell ID 0
CAL?
E: Ch1 OFDM Detected Allocations Time
Rng 1.258925 V
CAL?
1.638 kcarriers
Real
327.6 carriers /div
-1.64 kcarriers
Start 0 sym
Stop 55 sym
B: Ch1 Spectrum
Rng 12 dBm
CAL?
-20 dBm
LogMag
10 dB /div
-120 dBm
Center 3.5 GHz
Span 120 MHz
Res BW 1.90968 kHz
TimeLen 2 mSec
D: Ch1 SS/PBCH Power
Rng 1.258925 V
Mkr8 -25.847 dBm
-25.835 dBm
LogMag
0.005 dB /div
-25.885 dBm
Start 0 SS/PBCH Index
Stop 7 SS/PBCH Index
F: Ch1 Frame Summary
Name EVM (%rms) Power per RE (dBm) Modulation Num. of RBs RNTI
PSS 1.721 -46.02 BPSK 44
SSS 1.724 -46.01 BPSK 44
PBCH 1.696 -46.02 QPSK 80
PBCH_DMRS 1.690 -46.02 QPSK 80
PDSCH0 2.159 -45.96 QAM256 1092
PDSCH0_DMRS 2.161 -45.96 QPSK 1050
CAL?
Markers
Trace D Mkr 1: 0 SS/PBCH Index -25.877 dBm
Mkr 2: 1 SS/PBCH Index -25.869 dBm
Mkr 3: 2 SS/PBCH Index -25.867 dBm
Mkr 4: 3 SS/PBCH Index -25.849 dBm
Mkr 5: 4 SS/PBCH Index -25.86 dBm
Mkr 6: 5 SS/PBCH Index -25.852 dBm
Mkr 7: 6 SS/PBCH Index -25.853 dBm
Mkr 8: 7 SS/PBCH Index -25.847 dBm
Measurement paused
INT REF
CAL: OK

MEASUREMENTS ON A ON-AIR TEST SIGNAL (mm-wave band)

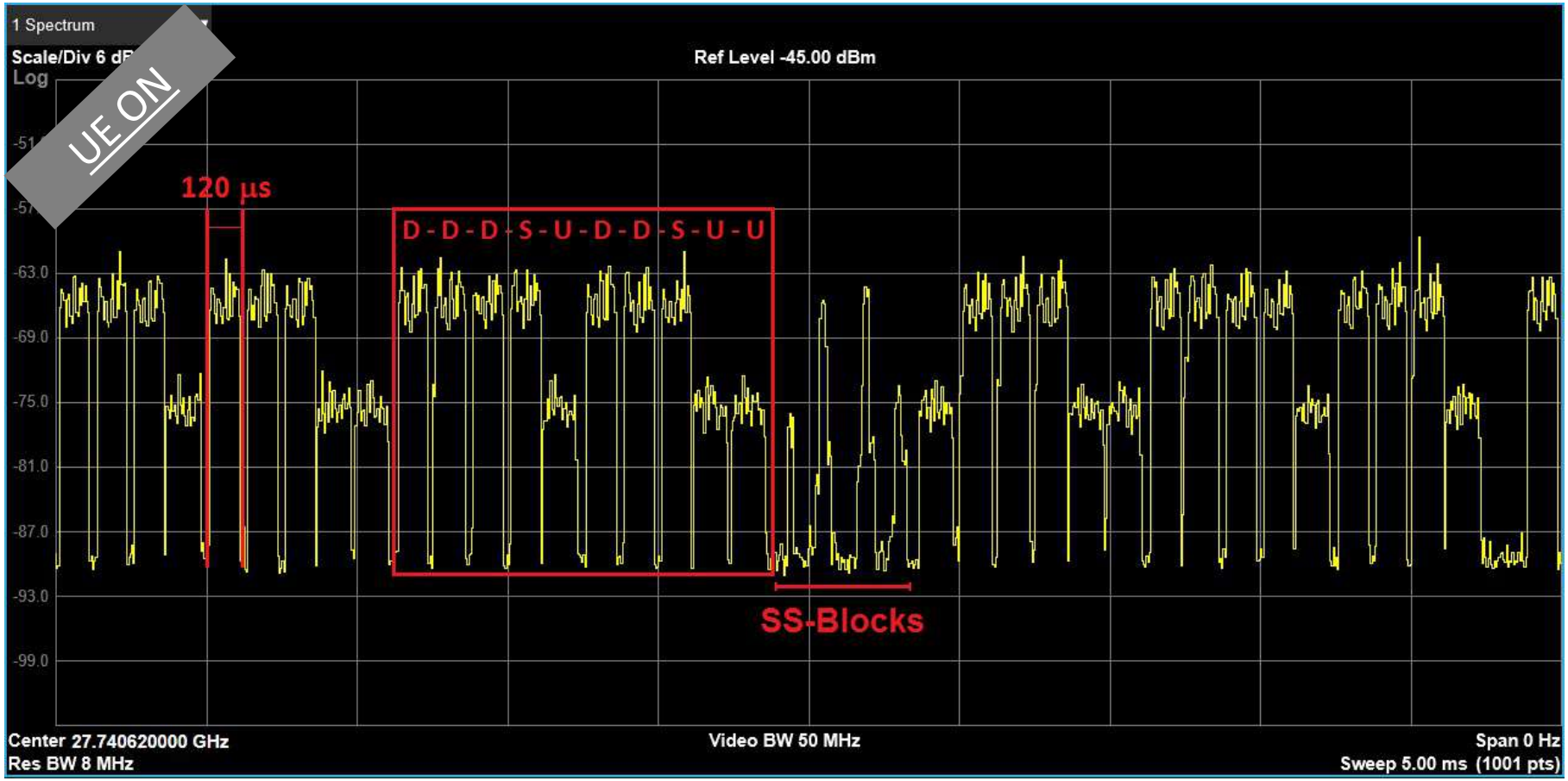
Signal characteristics

1. Centre frequency 27742.06 MHz
2. Bandwidth 100 MHz
3. $\mu = 4$ for SS-Block → $\Delta f = 240$ kHz
4. $\mu = 3$ for data transmission → $\Delta f = 120$ kHz
5. 12 SS-Block / frame [SS-Burst]
6. Duplexing TDD → D-D-S-U-D-D-S-U-U
7. slot S structure → D:G:U=10:4:0
8. SS-Burst period → 5 ms
9. Measurements with UE ON and OFF

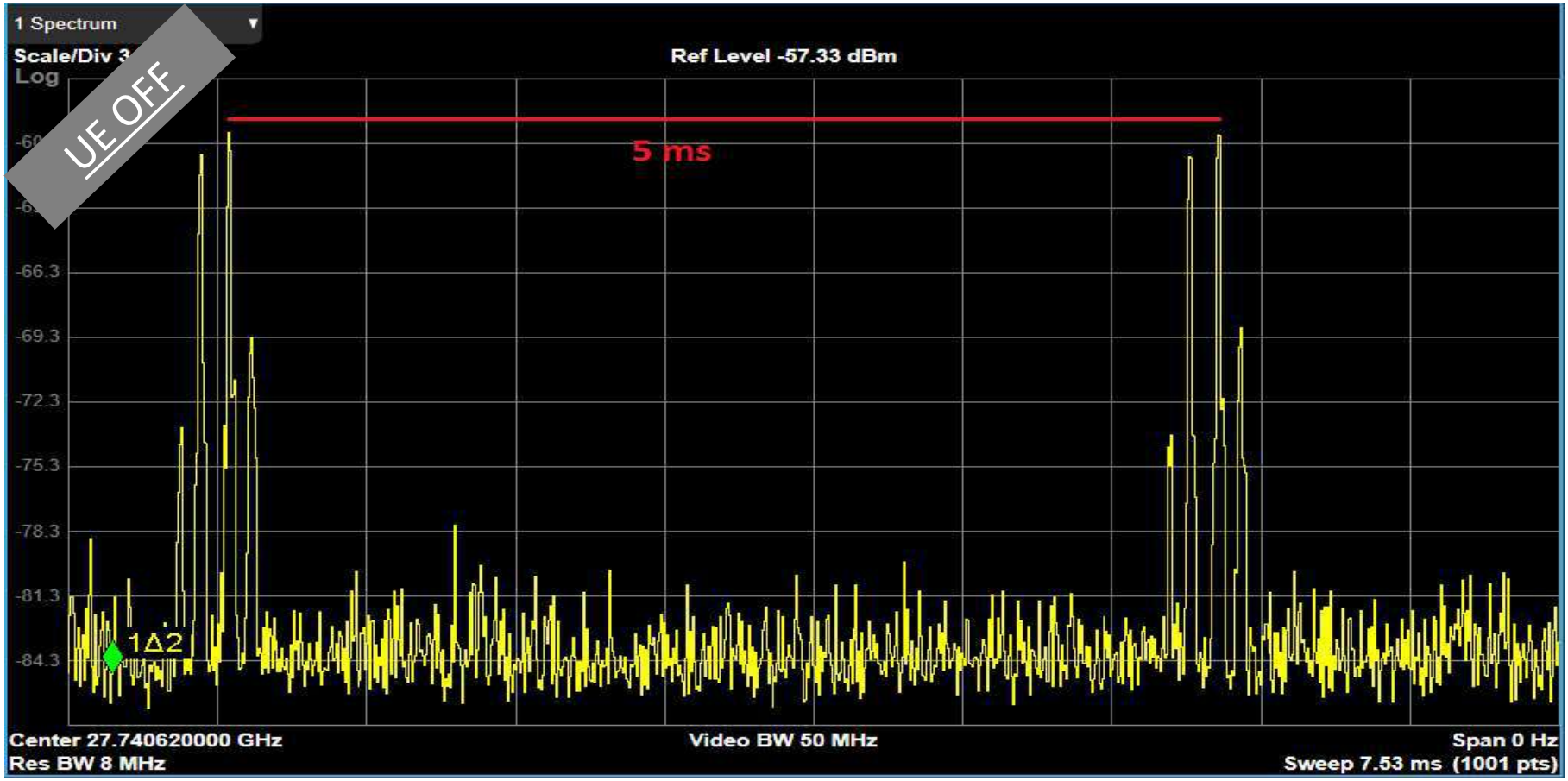
SPECTRUM


1 Spectrum
Scale/Div 3 dB
Log
Ref Level -78.53 dBm
Mkr1 27.50 MHz
Band Power --- dBm
UE ON
-81
-84
-87.5
-90.5
-93.5
-96.5
-99.5
-103
-106
1
100 MHz
Center 27.7421 GHz
Res BW 288 kHz
Span 120.5 MHz
Acq Time 30.06 ms (821 pts)

TIME DOMAIN MEASUREMENT



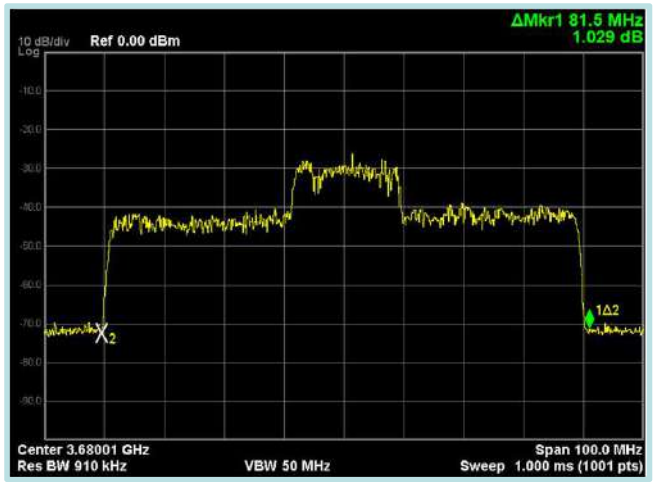
TIME DOMAIN MEASUREMENT

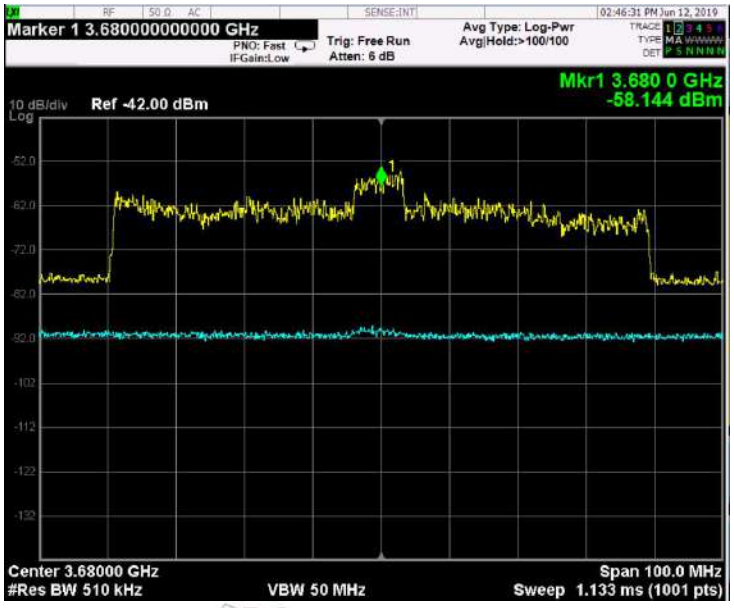


DECODING


UE OFF
A: Ch1 OFDM Meas
Rng -36 dBm
1.5
-1.5
-3.74
3.74
Res BW 120 kHz
TimeLen 160 Sym
C: Ch1 Summary
Analyzed Subframe [St0.sym0] to [St0.sym79]
Channel Power -73.43 dBm
EVM 1514.9 %rms
Frequency Error -539.2 kHz
Symbol Clock Error 92.54 ppm
IQ Offset -28.427 dB
Time Offset 7.5948 ms
Sync Correlation 99.189 %
Sync Source PSS, SSS
Cell ID 11
E: Ch1 Frame Summary
Name EVM (%rms) Power per RE (dBm) Modulation Num. of RBs RNTI
PSS 892.578 -92.87 BPSK 88 ***
SSS 1407.676 -92.89 BPSK 88 ***
PBCH 1313.908 -92.93 QPSK 160 ***
PBCH_DMRS 2365.922 -92.99 QPSK 160 ***
B: Ch1 Spectrum
Rng -36 dBm Peak:56
Mkr1Δ2 57 600 000.00 Hz -2.198 dB
-98.05 dBm
LogMag
3.1 dB /div
-129.05 dBm
Center 27.7426 GHz
Res BW 5.3488 kHz
Span 80 MHz
TimeLen 714.5898 uSec
D: Ch1 SS/PBCH Power
Rng 5.011872 mV
Mkr12 11 SS/PBCH Index -84.135 dBm
-50 dBm
LogMag
5 dB /div
-100 dBm
Start 0 SS/PBCH Index
Stop 11 SS/PBCH Index
E: Ch1 OFDM Detected Allocations Time
-49.3 carriers
Real
32.4 carriers /div
-373 carriers
Left 0 sym
Right 115.64 sym
Markers
Trace B Mkr 1Δ2: 57 600 000.00 Hz -2.198 dB
Mkr 8: 27 711 686 083.75 Hz -109.339 dBm
Mkr 9: 27 740 532 031.25 Hz Power -65.896 dBm
Trace D Mkr 1: 0 SS/PBCH Index -76.973 dBm
Mkr 2: 1 SS/PBCH Index -83.541 dBm
Mkr 3: 2 SS/PBCH Index -84.142 dBm
Mkr 4: 3 SS/PBCH Index -66.277 dBm
Mkr 5: 4 SS/PBCH Index -78.328 dBm
Mkr 6: 5 SS/PBCH Index -83.964 dBm
Mkr 7: 6 SS/PBCH Index -65.933 dBm
Mkr 8: 7 SS/PBCH Index -76.826 dBm
Mkr 9: 8 SS/PBCH Index -83.896 dBm
Mkr 10: 9 SS/PBCH Index -75.85 dBm
Mkr 11: 10 SS/PBCH Index -78.821 dBm
Mkr 12: 11 SS/PBCH Index -84.135 dBm

ON-AIR SIGNALS (3.5GHz band)





Signal characteristics

1. Centre frequency 3680 MHz
2. Bandwidth 100 MHz
3. $\mu = 1 \rightarrow \Delta f = 30$ kHz
4. 6 SS-Block / frame [SS-Burst]
5. Duplexing TDD → DDDDDDDSUU
6. slot S structure → D:G:U=6:4:4
7. SS-Burst period → 20 ms

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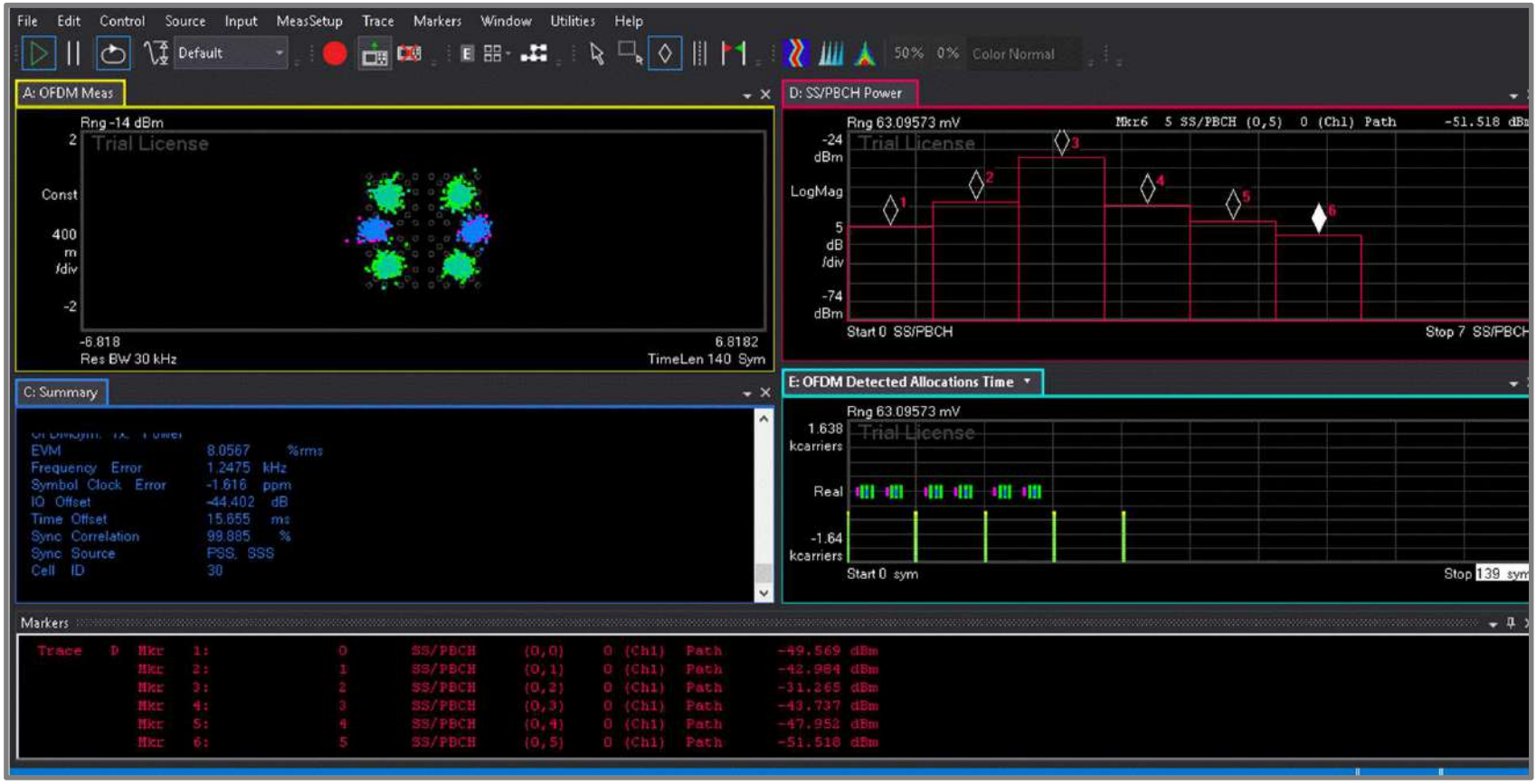
DECODING


File Edit Control Source Input MeasSetup Trace Markers Window Utilities Help
Default
50% 0% Color Normal
A: OFDM Meas
Rng -14 dBm
Trial License
Const
-6.818
Res BW 30 kHz
6.8182
TimeLen 140 Sym
D: SS/PBCH Power
Rng 63.09573 mV
Mkr6 5 SS/PBCH (0,5) 0 (Ch1) Path -51.518 dBm
LogMag
Start 0 SS/PBCH
Stop 7 SS/PBCH
C: Summary
EVM 8.0567 %rms
Frequency Error 1.2475 kHz
Symbol Clock Error -1.616 ppm
IQ Offset -44.402 dB
Time Offset 15.655 ms
Sync Correlation 99.885 %
Sync Source PSS, SSS
Cell ID 30
E: OFDM Detected Allocations Time
Rng 63.09573 mV
Real
Start 0 sym
Stop 139 sym
Markers
Trace D Mkr 1: 0 SS/PBCH (0,0) 0 (Ch1) Path -49.569 dBm
Mkr 2: 1 SS/PBCH (0,1) 0 (Ch1) Path -42.984 dBm
Mkr 3: 2 SS/PBCH (0,2) 0 (Ch1) Path -31.265 dBm
Mkr 4: 3 SS/PBCH (0,3) 0 (Ch1) Path -43.737 dBm
Mkr 5: 4 SS/PBCH (0,4) 0 (Ch1) Path -47.952 dBm
Mkr 6: 5 SS/PBCH (0,5) 0 (Ch1) Path -51.518 dBm

TIME DOMAIN MEASUREMENTS ON A TEST SIGNAL (3.5GHz band – with traffic forced by a devoted smartphone)