Application Report
SLVA575 – March 2013

DPI Evaluation TPS65381-Q1

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ABSTRACT

The TPS65381 is a multi-rail power supply designed to supply microcontrollers in safety critical applications, such as those found in automotive. The devices supports Texas Instruments TMS570LS series 16/32-Bit RISC Flash MCU and other microcontrollers with dual-core lockstep (LS) or loosely coupled architectures (LC).
The TPS65381 integrates multiple supply rails to power the MCU, CAN or FlexRay and an external sensor. An asynchronous buck switch-mode power supply converter with internal FET converts the input battery voltage to a 6V pre-regulator output. This 6V is used to supply the other regulators.
A fixed 5V linear regulator with internal FET is integrated to be used as e.g. CAN supply. A second linear regulator with also internal FET regulates the 6V to a selectable 5V or 3.3V MCU IO voltage.
The TPS65381 comprises a linear regulator controller with external FET and resistor divider, regulating the 6V to an externally adjustable core voltage between 0.8V and 3.3V.
The DPI (Direct Power Injection) evaluation will show the robustness of the TPS65381 device during HF Power injection at Global Pins. This test cannot replace other customer tests like BCI (Bulk Current Injection), but it gives a first indication how the device behave under HF stress.

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Figures

1 DPI test TPS65381

To ensure the EMC performance of the TPS65381, a BCI test in the real application is needed.

- The BCI (Bulk Current injection) test is difficult in an early phase of the system development since ECU is not available yet.
- Without BCI test results failures might be detected too late in the development flow.
- The DPI test is one way to detect EMC weakness of the device even if it does not ensure the pass of the BCI test.
- For the DPI test the TPS65381 is used on standard EVM at room temperature (about 25^{o}C). The DUT (Device under Test) is soldered on the board. Additional capacitors 0f 100uF/50V and 100nF were added from VBATP to GND to bring the circuit closer to a real application and stabilize the supply voltage locally.
- The DPI tests was performed in DIAGNOSTIC or ACTIVE mode, all voltage regulators turned on with certain resistive loads, unless otherwise noted
- The TPS65381 was stressed with injected HF power at certain nodes and the reaction of the device will be observed. Step by step the forward power will be increased up to 30dBm(1W) maximum peak. This test was performed at certain frequencies.
- Certain signals are observed in digital way and analog output voltages with a multimeter/oscilloscope.
- For each first failure the HF power and the type of failure was documented.
- The same procedure will be performed for the next frequency.
- The 16 suggested frequencies are: 1MHz, 2MHz, 3MHz, 5MHZ, 8MHz, 10MHz, 20MHz, 30MHz, 50MHz, 80MHz, 100MHz, 200MHz, 300MHz, 500MHz, 800MHz, 1GHz
- DPI test signal is CW and AM 1KHZ modulation and 80% modulation.

2 DPI set up

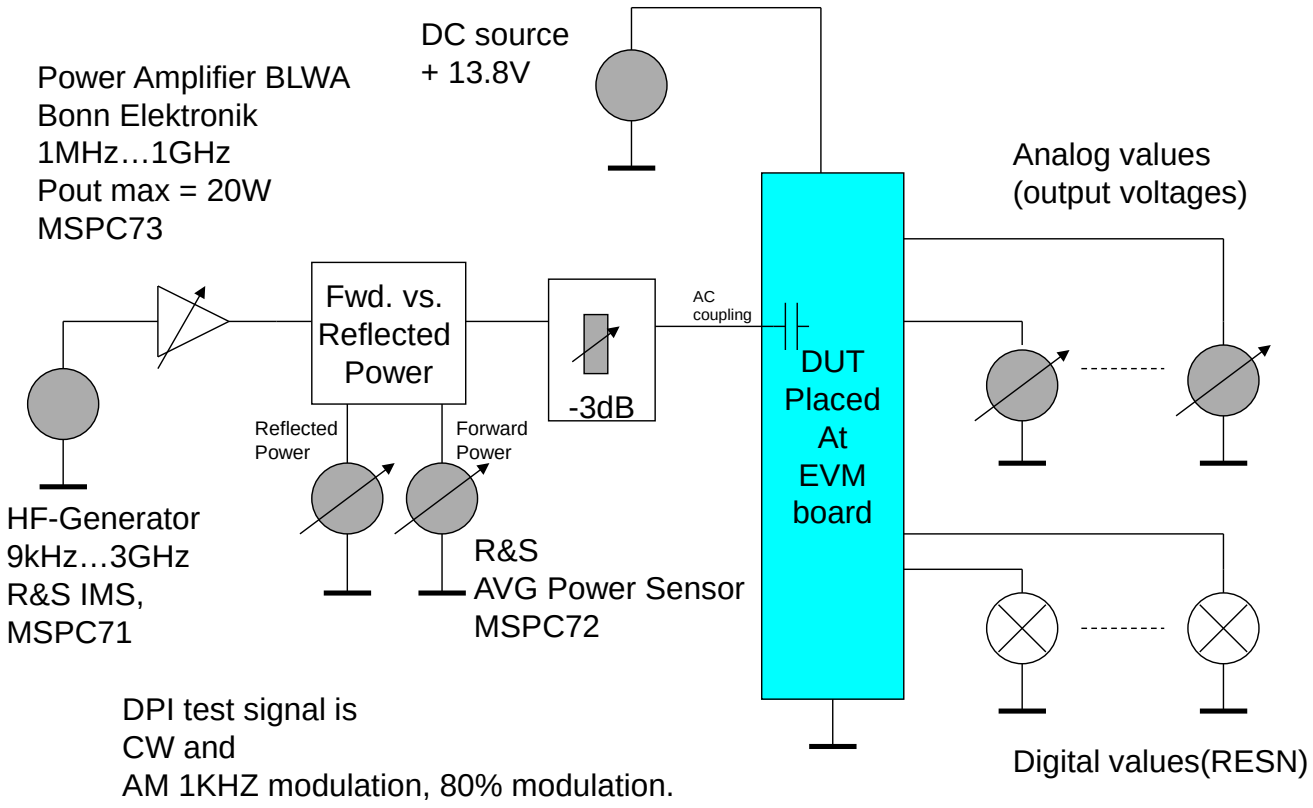

Figure 1, DPI Set Up

3 The test flow

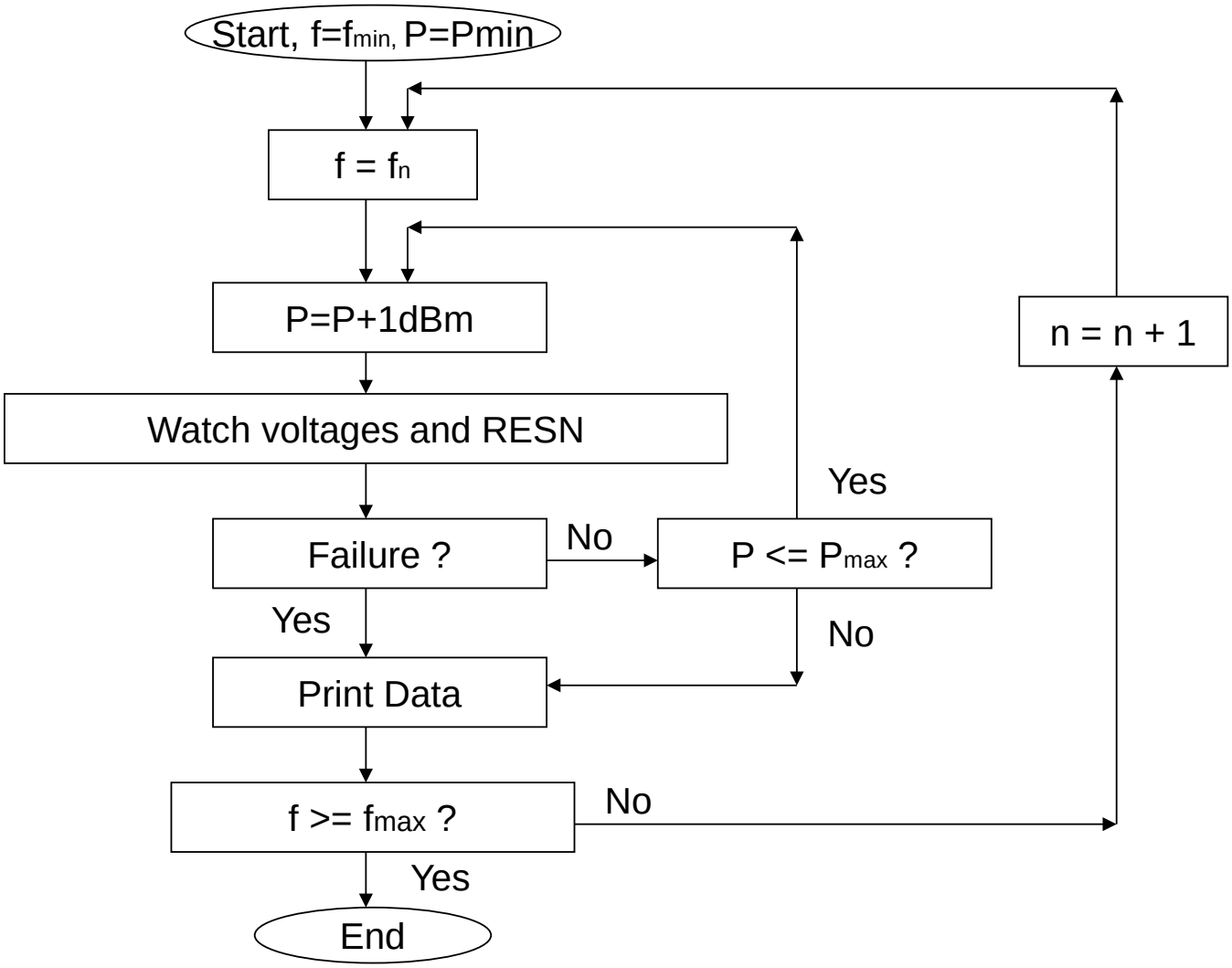

Figure 2, Test Flow

4 Equipment used for the DPI test

- Standard EVM TPS65381_RevB, additional Caps 100nF + 100µF at VBATP and VBAT_SAFING
- Power Supply Statron, MSPC16
- HF-Generator, Rohde & Schwarz, IMS, 9kHz-3GHz, MSPC71
- HF Amplifier, Bonn Elektronik, BLWA 0110-20, 1MHz-1GHz, 20W, MSPC72
- Power Sensor, Rohde & Schwarz, NRP-Z91, MSPC72
- Multimeter Fluke 175, MSPC57, MSPC83
- Multimeter Keithley 2000, MSPC50
- MultiMate Keithley 2100, MSPC94, MSPC95
- Oscilloscope Le Croy 6100, MSPC9

5 Application data

Used board: Standard EVM TPS65381_RevB, additional Caps at VBATP and VBAT_SAFING (100nF + 100µF Elko). About 75% of max. load was defined as standard load. The device was stresses with standard load and for VBat=VBATP+VBAT_SAFING with no load condition.

- VBat = 3.8V , T_A = 25°C, I_{VBAT} = 0.444A
- VDD6
  - 6V
  - No load
- VDD1
  - 1.2V, 0.444 (74%of Imax)A, Pv = 2.2W
  - 2.7Ω 0.55W
- VDD3/5
  - 5V, 0.23A (77% of Imax), Pv = 0.23W
  - 22Ω 1.2W

- VDD5
  - 5.0V, 0.24A (77% of Imax), Pv = 0.23W
  - 22Ω 1.2W
- VSOUT
  - 5V, 0.073A (73% of Imax), Pv = 0.073W
  - 68Ω 0.4W

6 The nodes stressed with DPI in application circuit TPS65381

- Global Pins
  - VBATP + VBAT_SAFING
  - IGN
  - VSOUT1

7 The observed signal during DPI stress

- Supply current
  - IVBAT
- Voltages
  - VDD1
  - VDD3/5
  - VDD5
  - NRES
  - VSOUT1 in case VSOUT1 was tested

8 Test Results

8.1 VBATP+VBAT_SAFING, CW

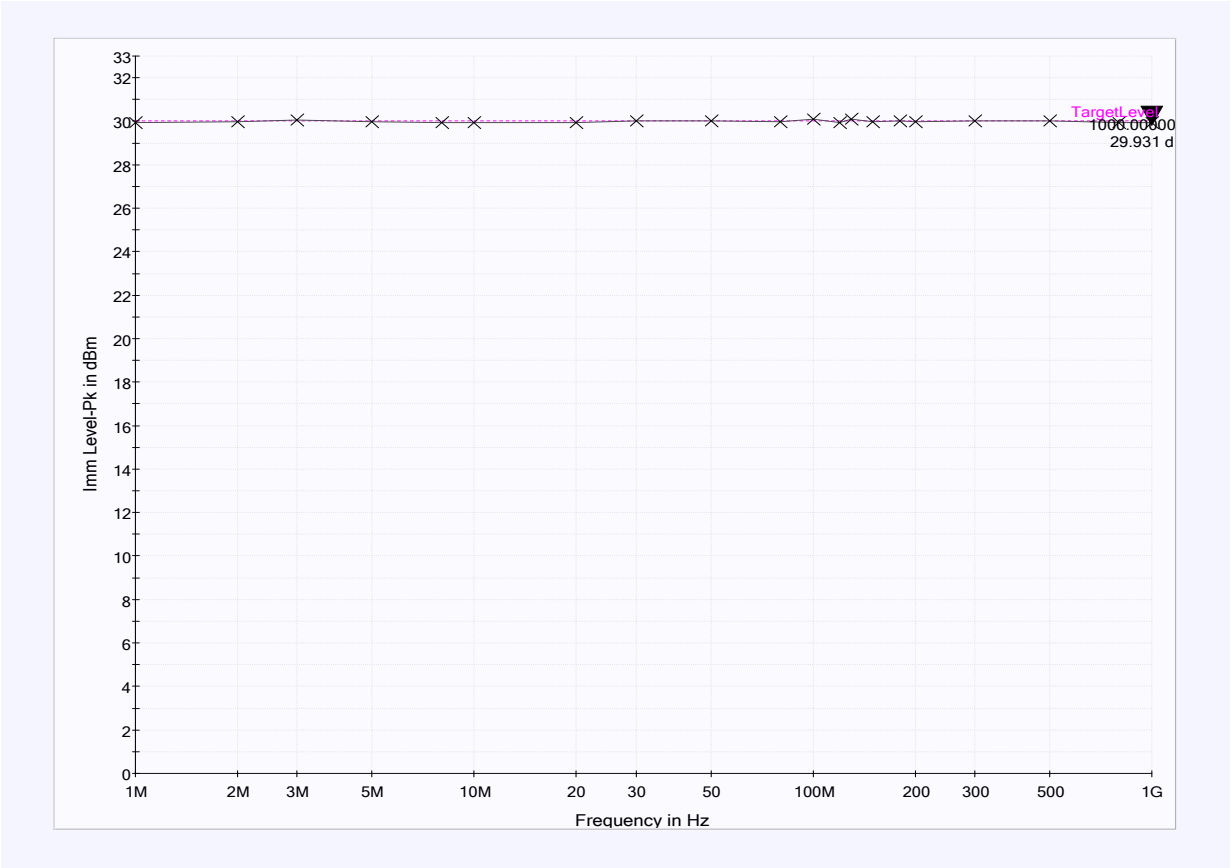

Figure 3, VBAT+VBAT_SAFING, CW

8.2 VBATP+VBAT_SAFING, AM

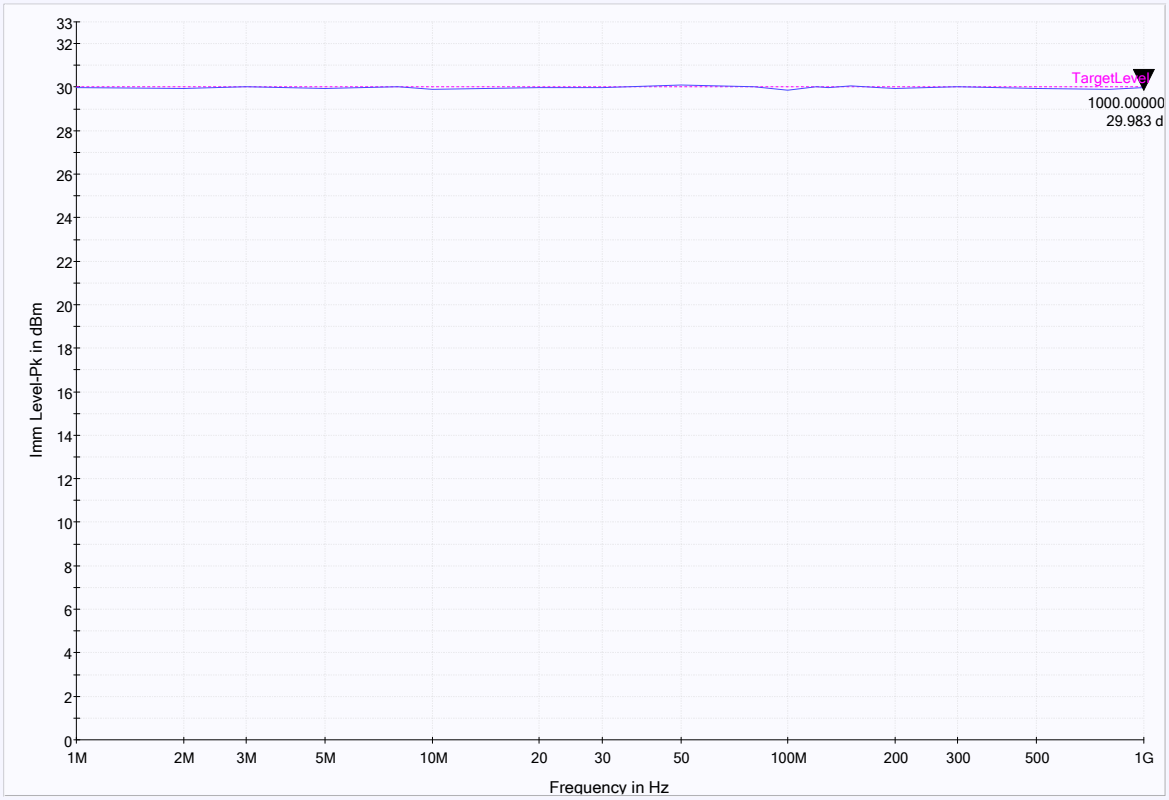

Figure 4, VBATP+VBAT_SAFING, AM

8.3 IGN, CW

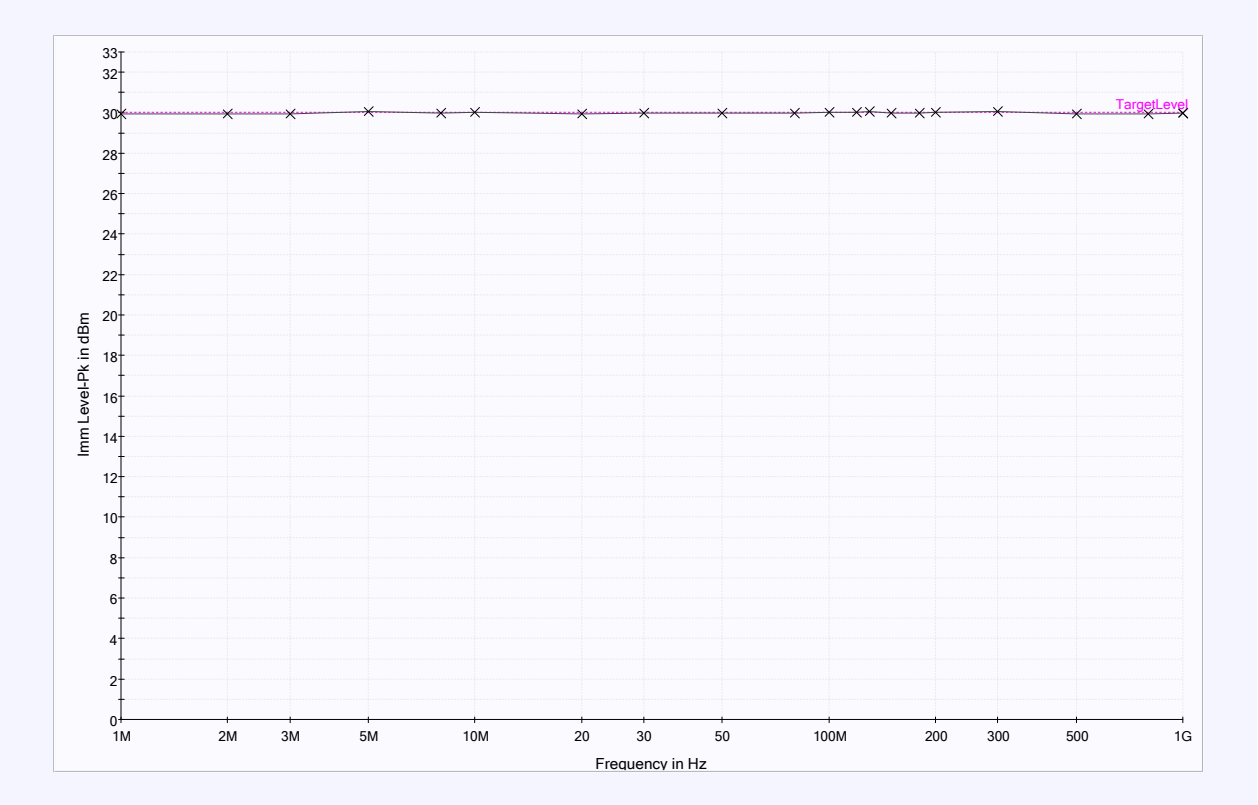

Figure 5, IGN, CW

8.4 IGN, AM

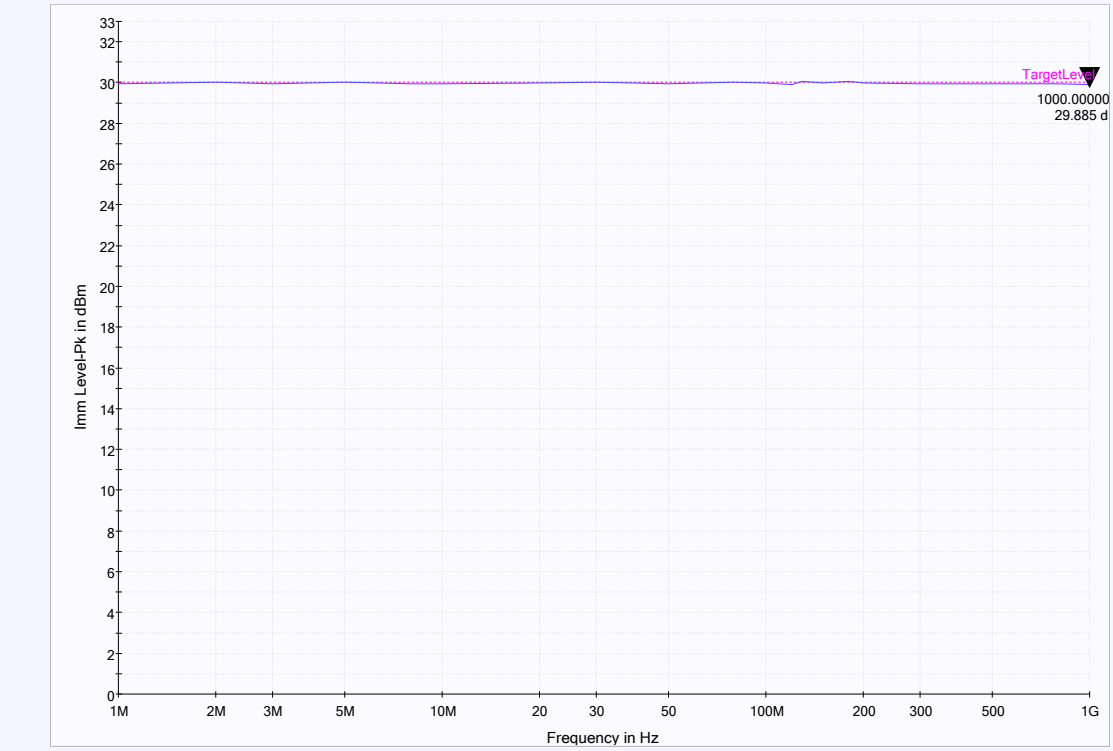

Figure 6, IGN, AM

8.5 VSOUT1, CW

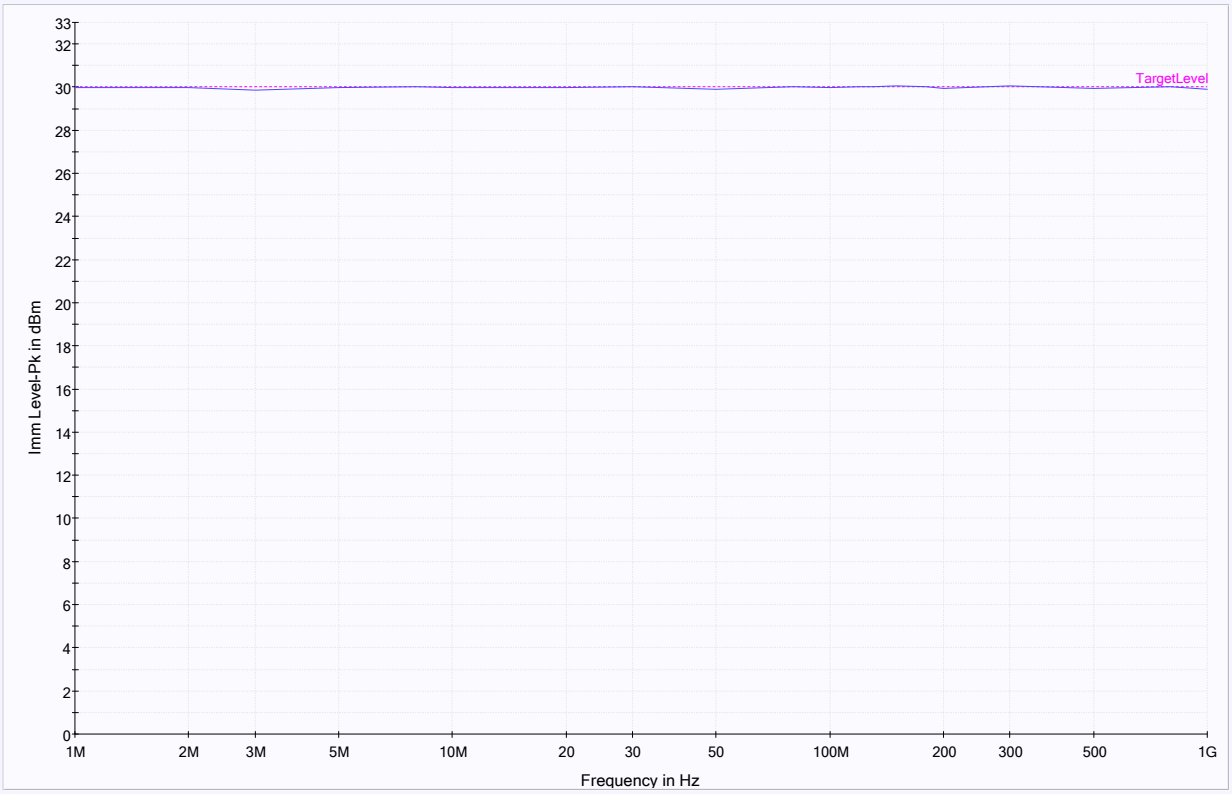

Figure 7, VSOUT1, CW

8.6 VSOUT1, AM

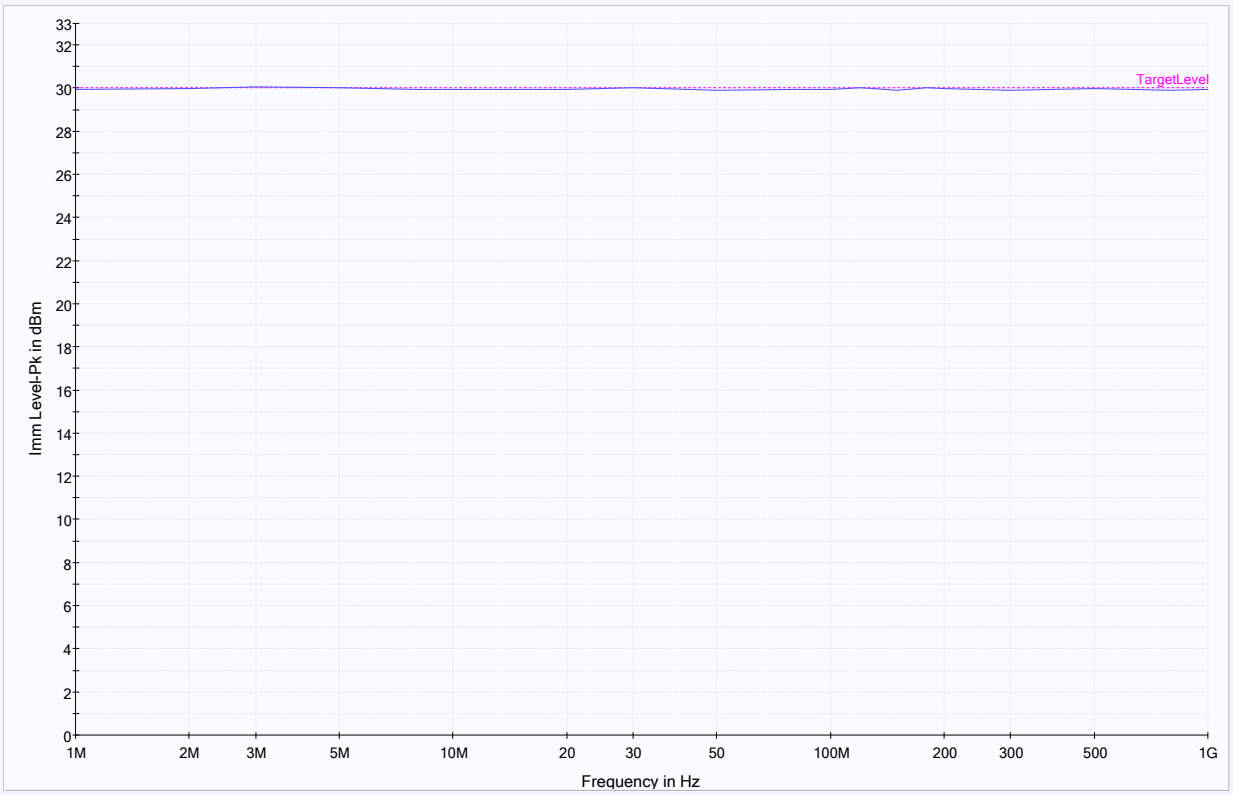

Figure 8, VSOUT1, AM

8.7 VBATP+VBAT_SAFING, no load, CW

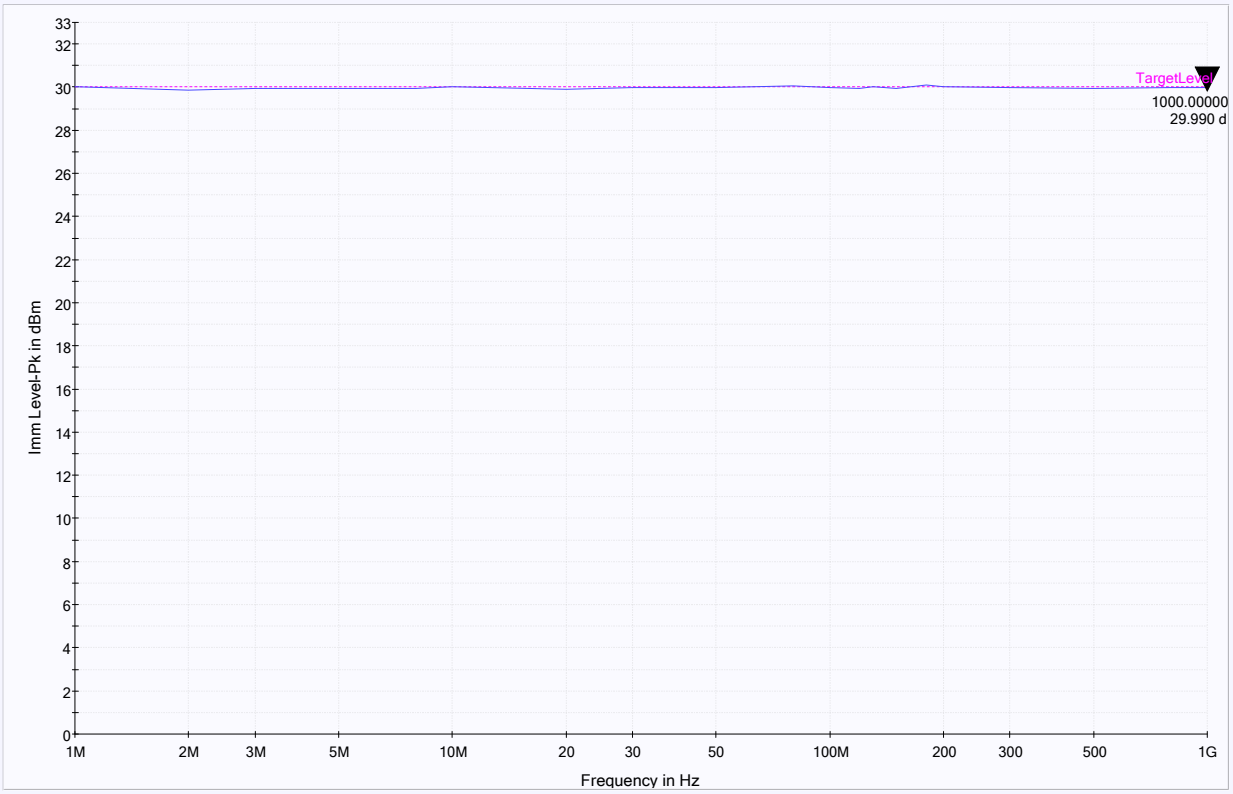

Figure 9, VBAT+VBAT_SAFING, no load, CW

8.8 VBATP+VBAT_SAFING+add. Cap, no load, AM

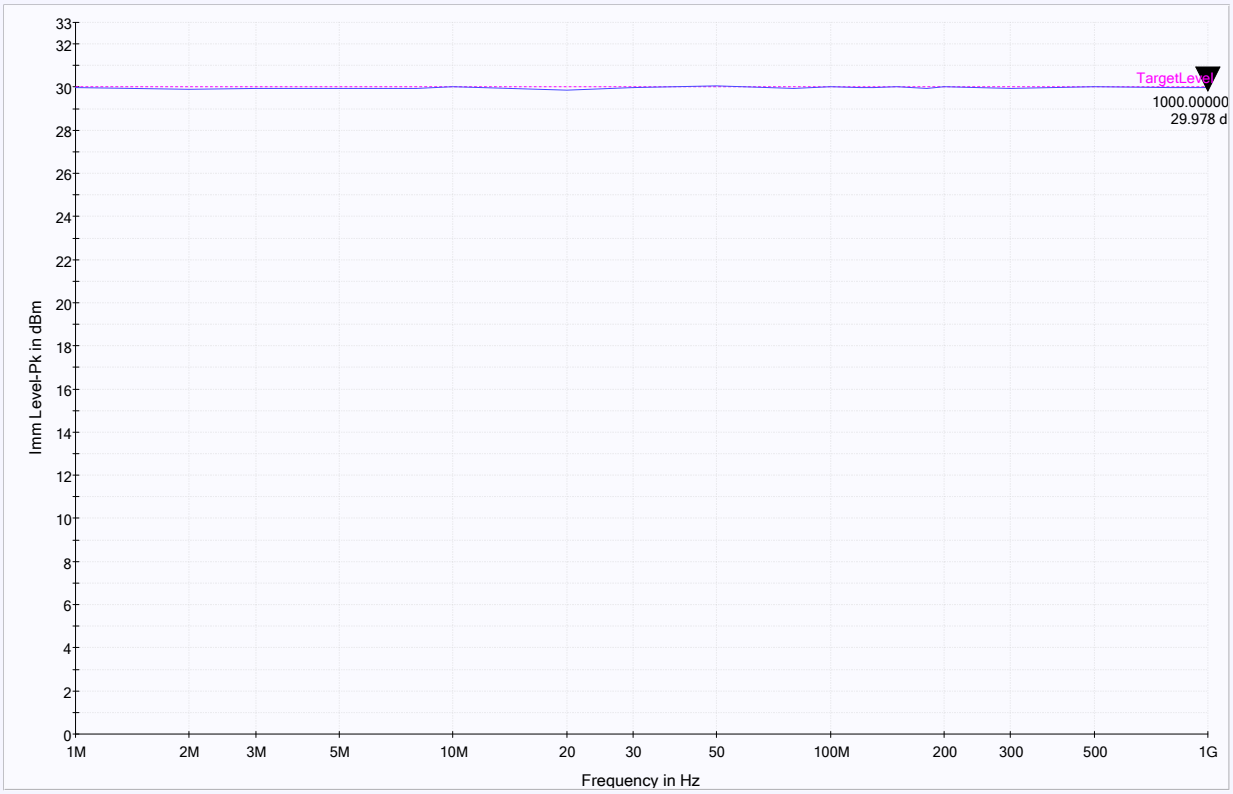

Figure 10, VBATP+VBAT_SAFING, no load, AM

9 DPI Test Summary

- DPI Tests global pins
  - With typical load and no external load conditions the device can withstand DPI at global pins up to 30dBm in frequency range from 1MHz to 1GHz without any observed influence to functionality.

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