Application Report
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# DPI Evaluation TPS65310-Q1

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## ABSTRACT

The TPS65310A-Q1 is a power management unit, meeting the requirements of DSP controlled automotive systems (e.g. Advanced Driver Assistance Systems). With its integration of commonly used features it helps to significantly reduce board space and system costs.

The device includes one high voltage buck controller for pre-regulation combined with two buck and one boost converter for post regulation. A further integrated LDO rounds up the power supply concept and offers a flexible system design with in total five independent voltage rails. The device offers a low power state LPM0 with all rails off to reduce current consumption in case the system is constantly connected to the battery line. All outputs are protected against overload and over temperature.

An external PMOS makes the device capable of sustaining voltage transients up to 80 V (protection feature). This external PMOS can also be used in safety critical applications to protect the system in case one of the rails shows a malfunction (under-/overvoltage, over current).

Internal Soft start ensures controlled start up for all supplies. Each power supply output has adjustable output voltage based on the external resistor network settings.

The DPI (Direct Power Injection) evaluation will show the robustness of the TPS65310 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.

## Contents



## Figures

# 1 DPI test TPS65310

To ensure the EMC performance of the TPS65310, 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 TPS65310 is used on standard EVM at room temperature (about 25$^{o}$C). The DUT (Device under Test) is soldered on the board.
- The TPS65310 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 30 dBm (1 W) maximum peak. This test was performed at certain frequencies.
- Certain signals are observed in digital way and analog output voltages with a multimeter or 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: 1 MHz, 2 MHz, 3 MHz, 5 MHZ, 8 MHz, 10 MHz, 20 MHz, 30 MHz, 50 MHz, 80 MHz, 100 MHz, 200 MHz, 300 MHz, 500 MHz, 800 MHz, 1 GHz
- DPI test signal is CW and AM 1 KHZ modulation and 80% modulation.

## 2 DPI set up

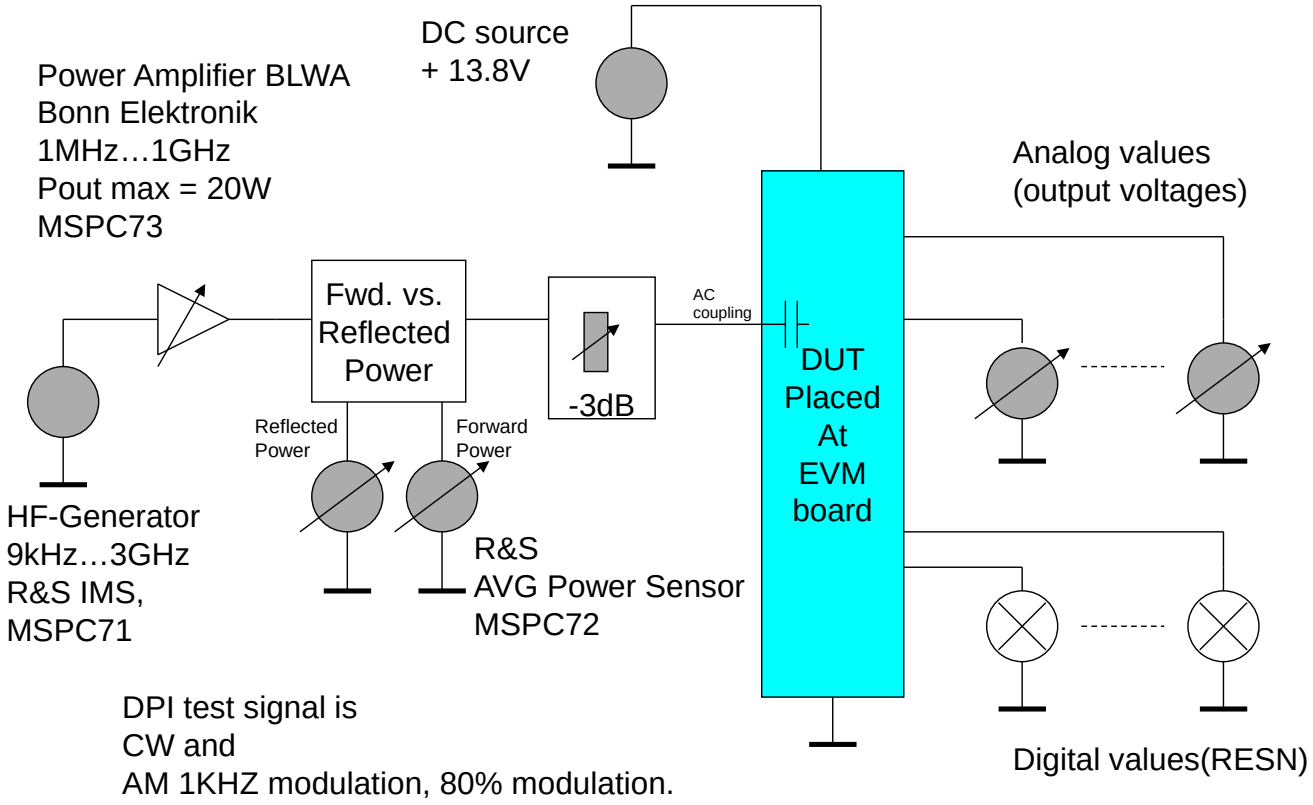



**Figure 1. DPI Set Up**

## 3 The Test Flow

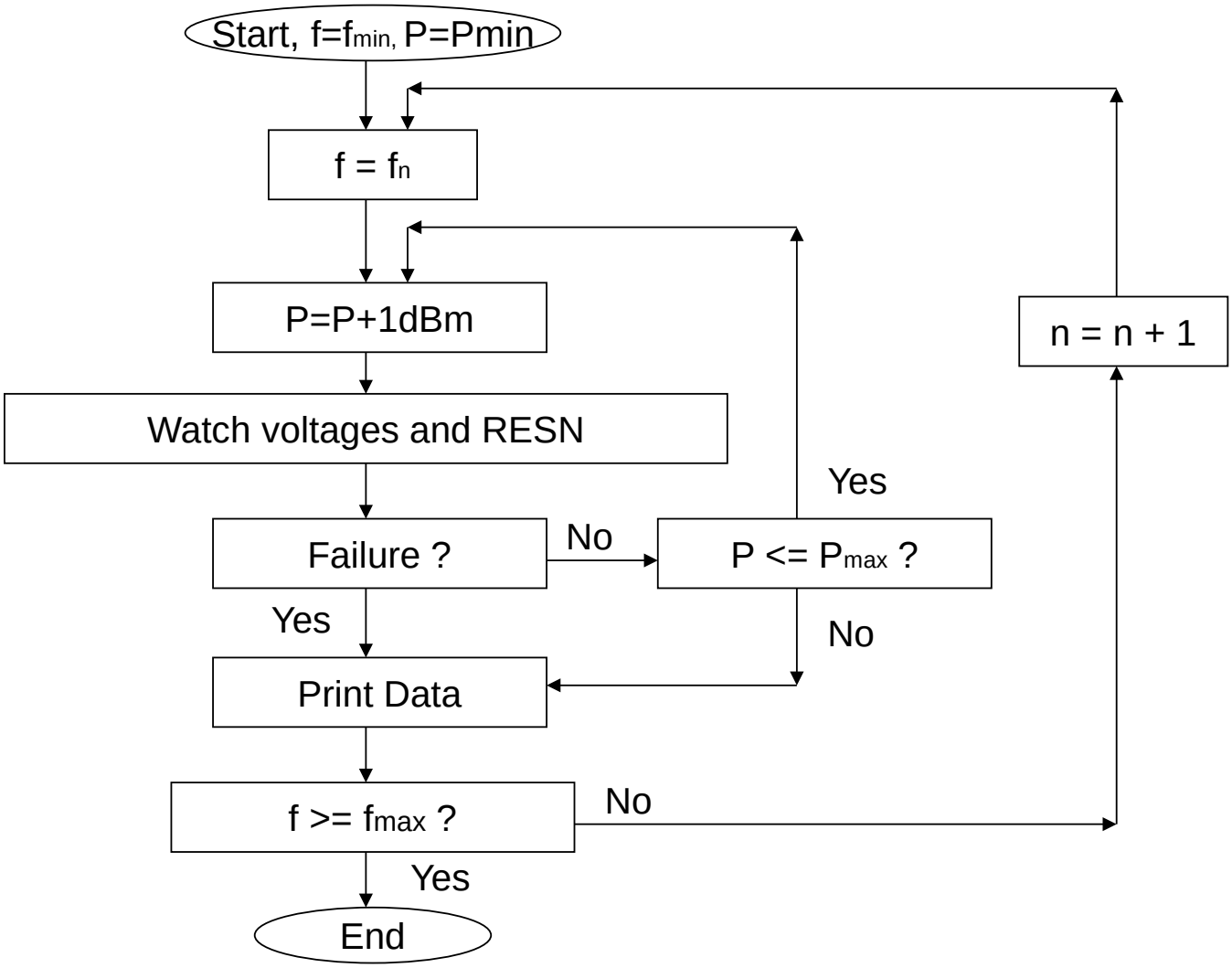



**Figure 2. Test Flow**

# 4 Equipment used for the DPI test

- TPS65310_EMC Rev A, DPI population
- Power Supply Statron, MSPC16
- HF-Generator, Rohde & Schwarz, IMS, 9kHz-3GHz, MSPC71
- HF Amplifier, Bonn Elektronik, BLWA 0110-20, 1 MHz–1 GHz, 20 W, 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: TPS65310_EMC Rev A, DPI population. The device was stresses with standard load and with no load condition.

- Used board: TPS65310_EMC Rev A, DPI population
- Vbat = 13.3 V
- Buck1
  - 3.8 V
  - No load
- Buck2
  - 3.3 V, 0.45 A
  - 7.4 Ohm
- Buck3
  - 1.2 V, 0.4 A
  - 2.7 Ohm
- Boost
  - 5.0 V, 0.4 A
  - 12 Ohm
- LDO
  - 2.5 V, 0.06 A
- 40 Ohm

# 6 Nodes Stressed with DPI in Application Circuit TPS65310

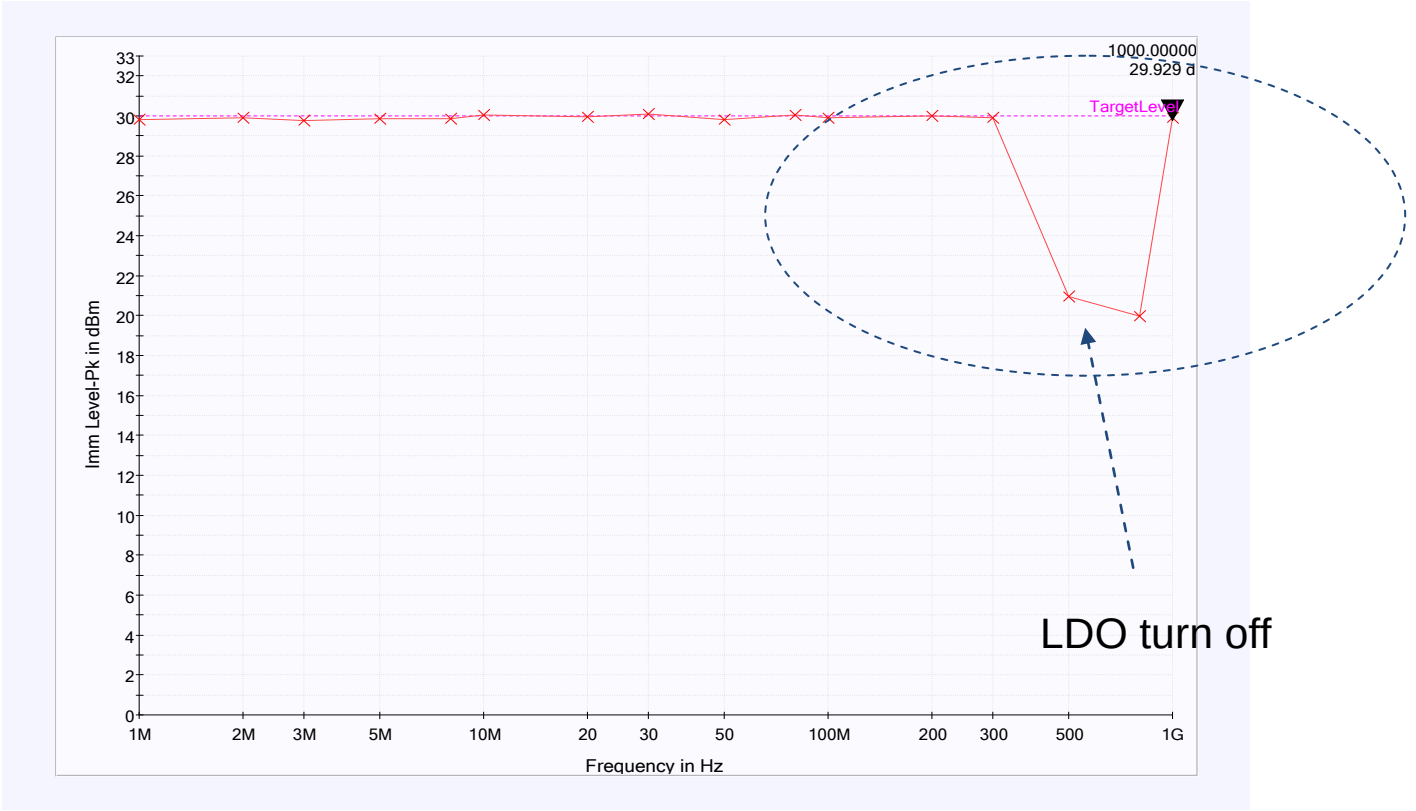
- Global Pins
  - VSSENSE
  - VIN
  - VINPROT(not tested, decision during EMC board development)
  - WAKE
  - HSSENSE
- Local Pins
  - HSCTRL
  - LDO
  - VBOOST
  - VSUP2,3,4 = VBUCK1 connected together, only tested VSUP2 = J22
  - S1_BUCK1(S1,S2 together)
  - VMONx,VSENSEx, not testable

# 7 Observed Signal During DPI Stress

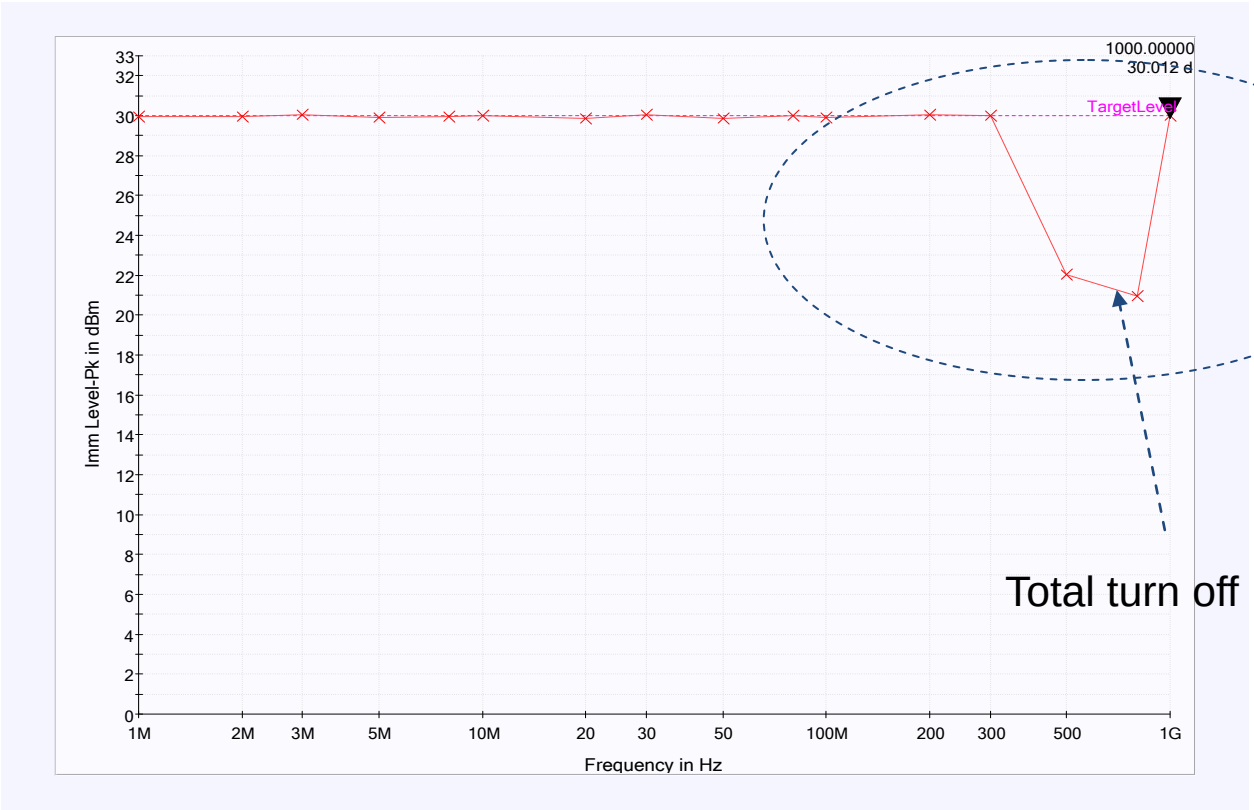
- BUCK1
- BUCK2
- BUCK3
- BOOST
- LDO
- SPI register failure

# 8 Test Results

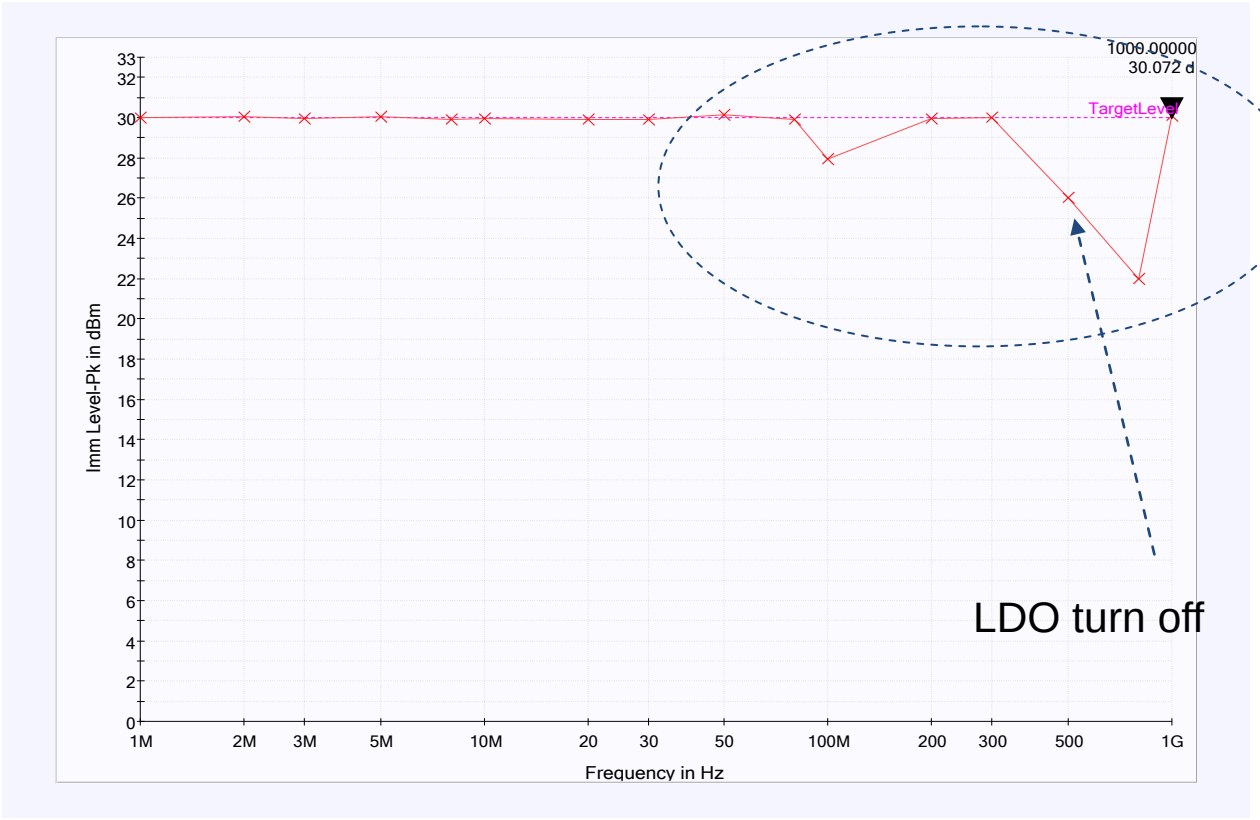
## 8.1 J26, VSSENSE, CW, Load



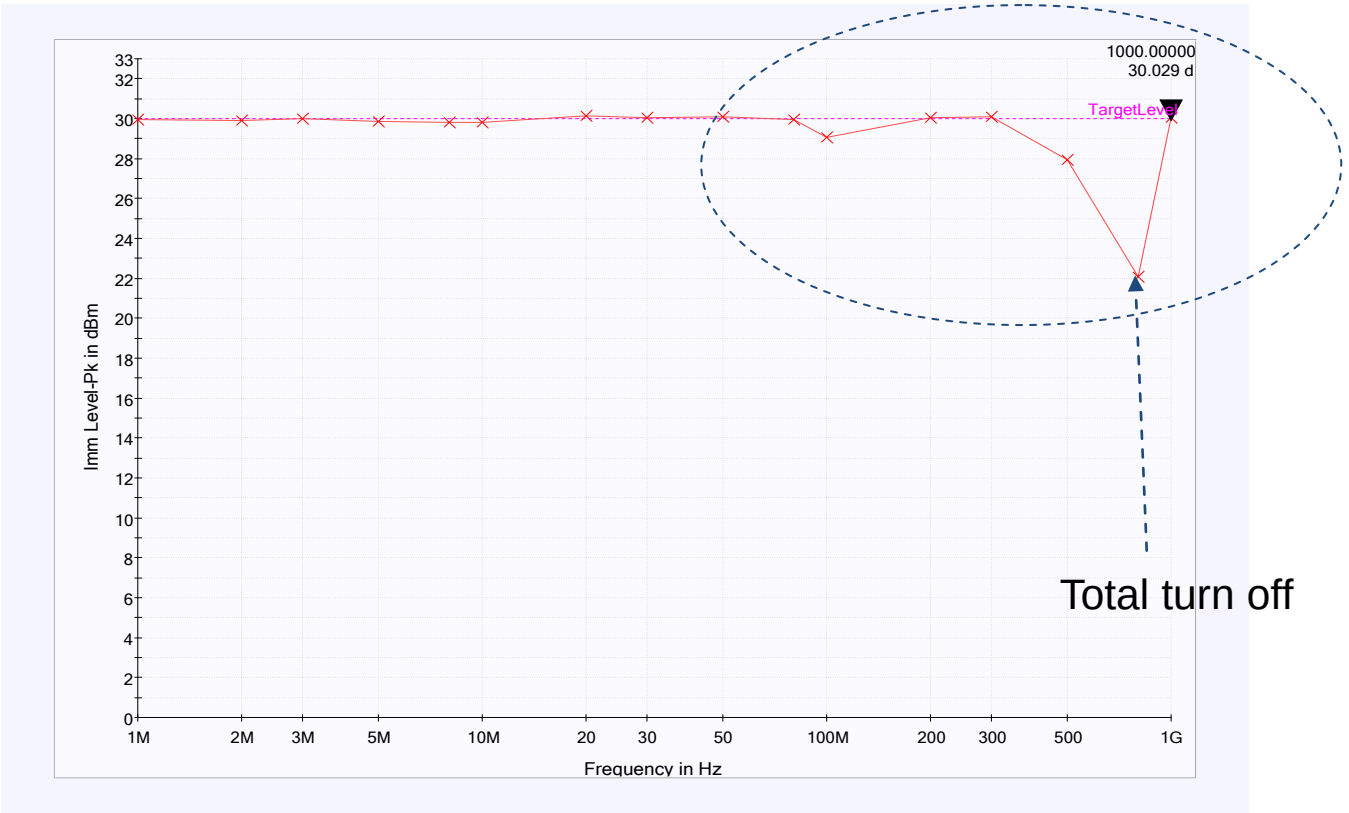
## 8.2 J26, VSSENSE, AM, Load



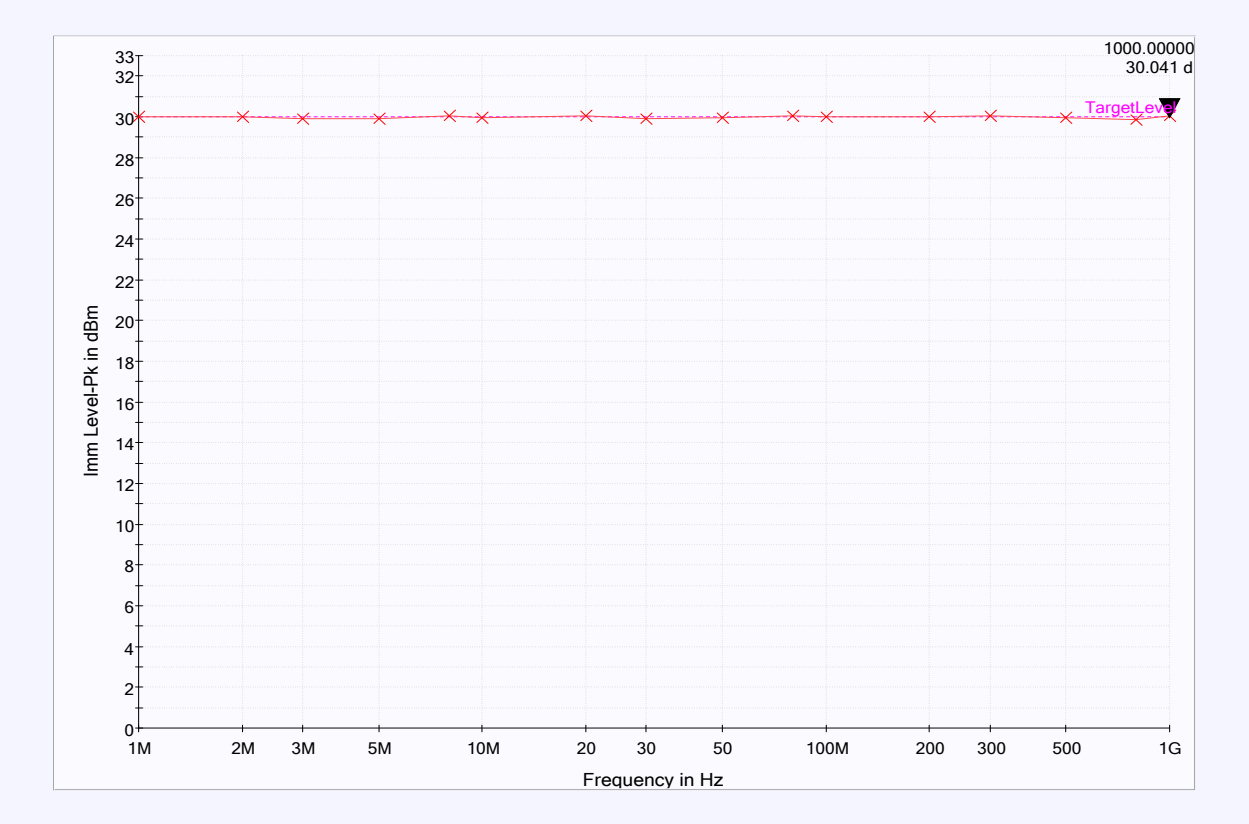
## 8.3 J25, VIN, CW, Load



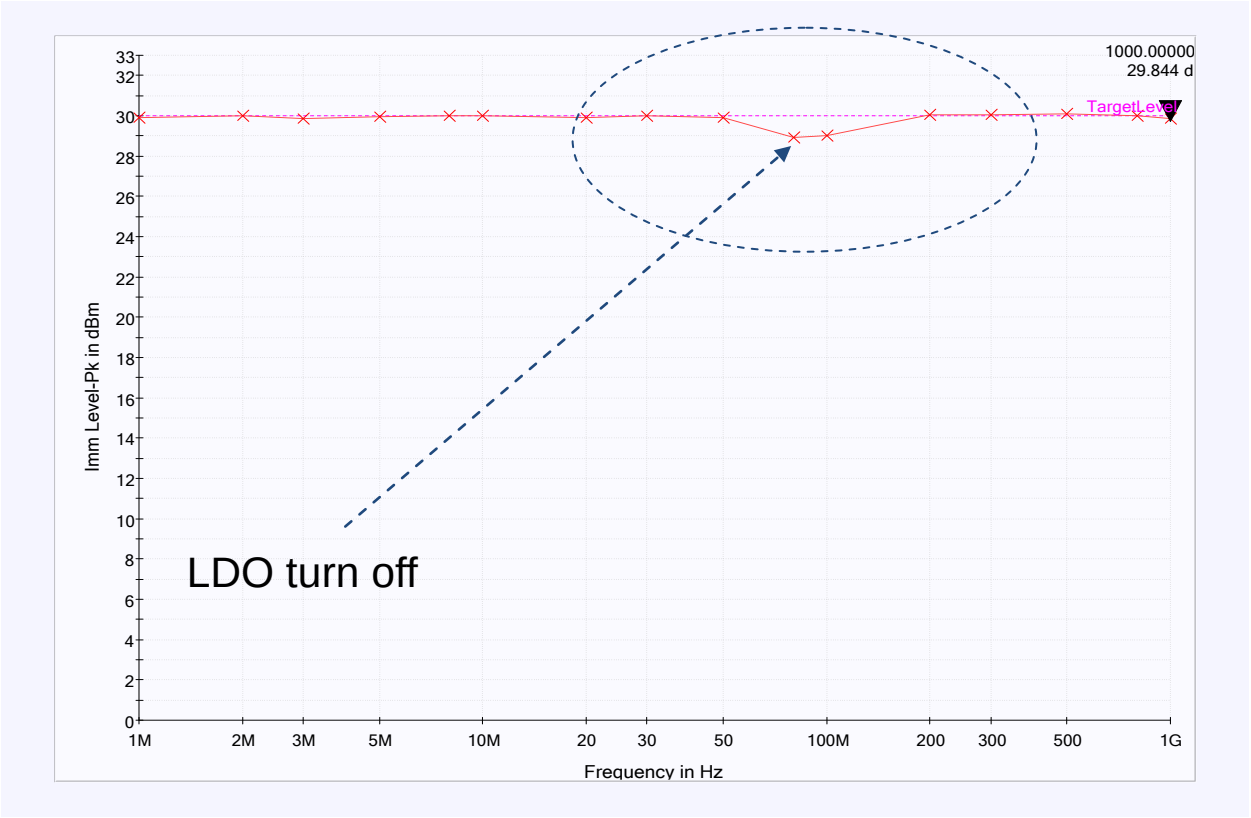
## 8.4 J25, VIN, AM, Load



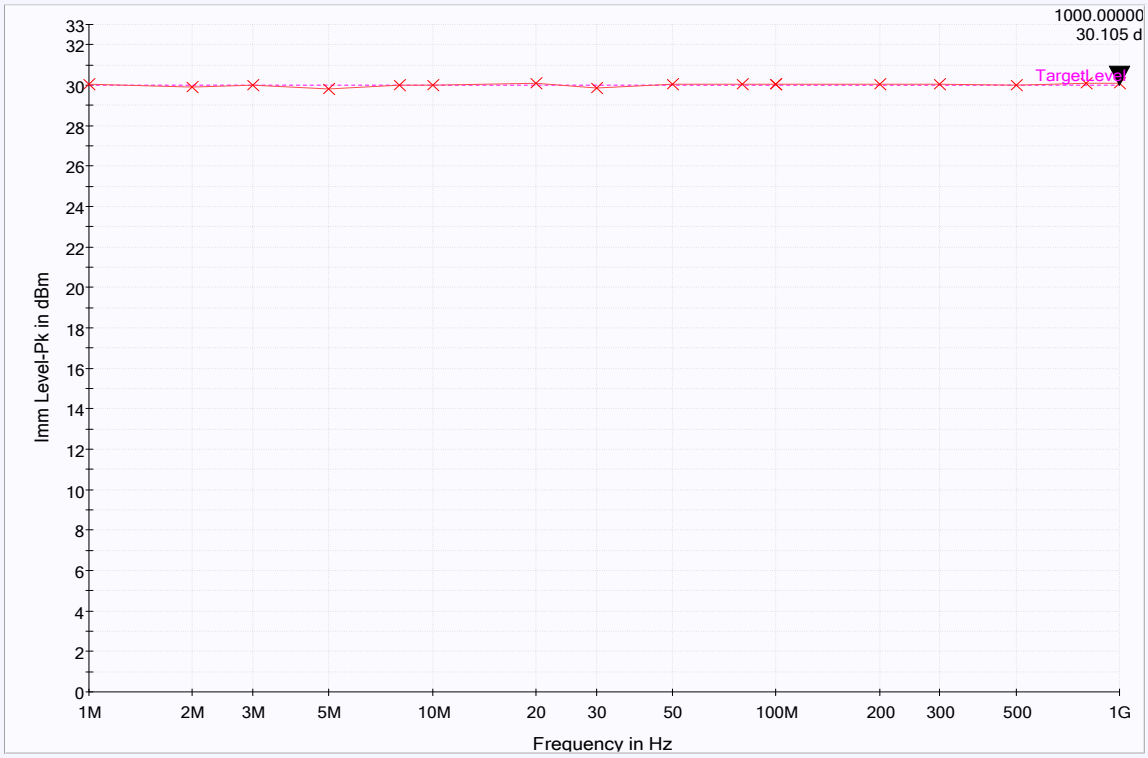
## 8.5 J21, WAKE, CW, Load



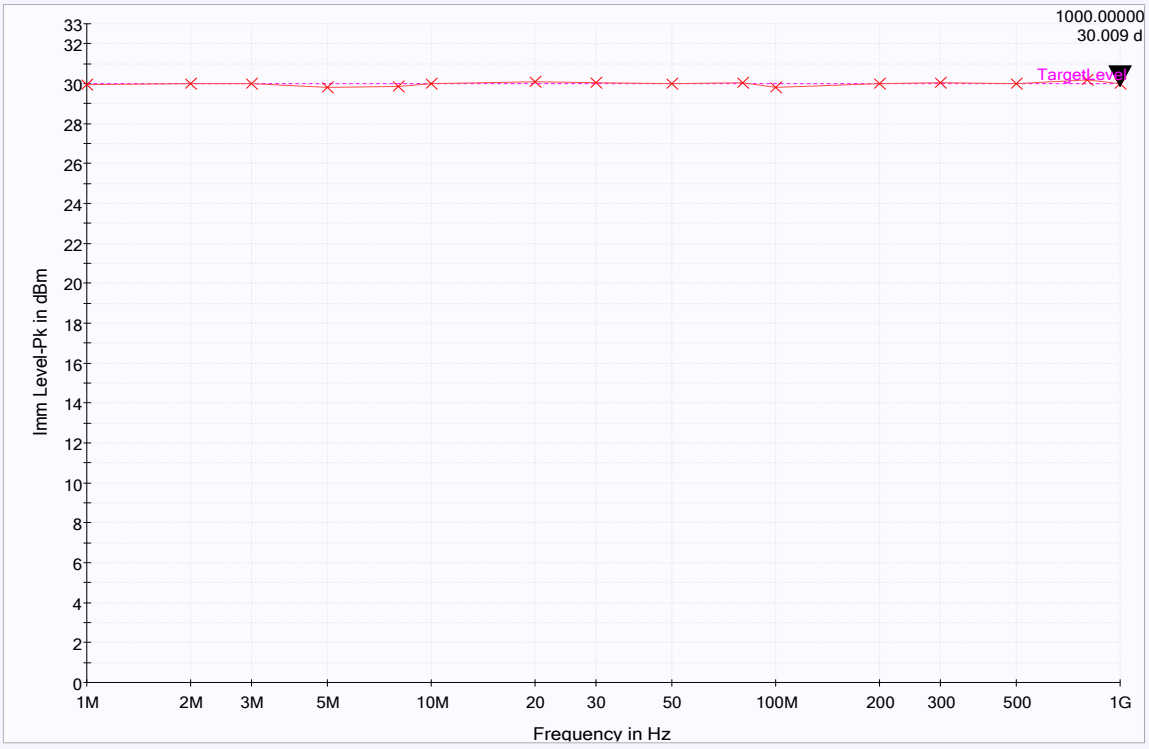
## 8.6 J21, WAKE, AM, Load



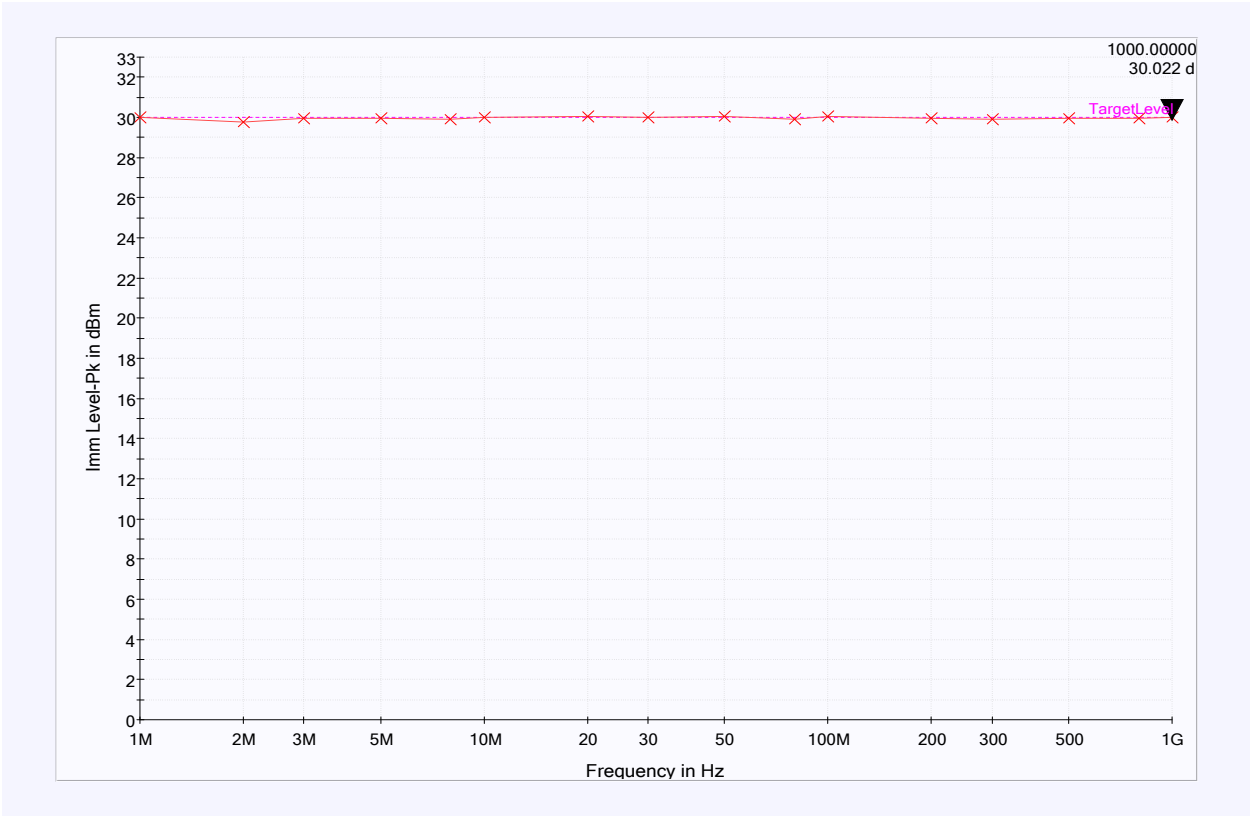
## 8.7 J10, HSSENSE, CW, Load



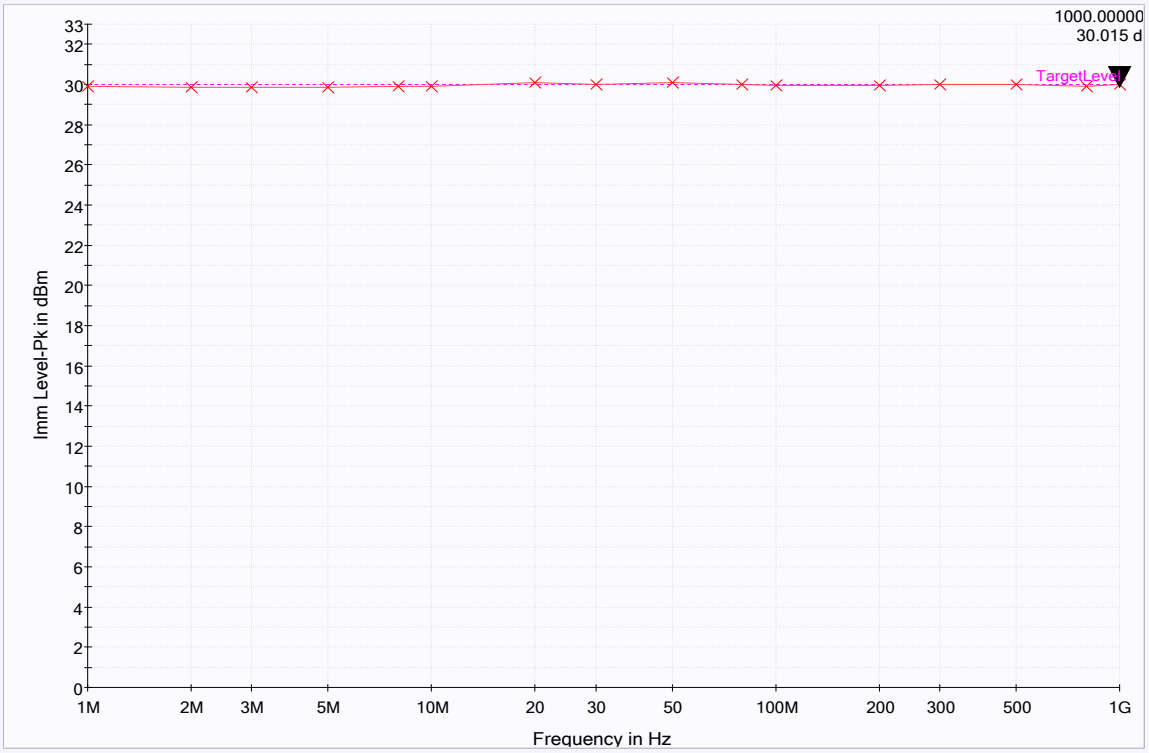
## 8.8 J10, HSSENSE, AM, Load



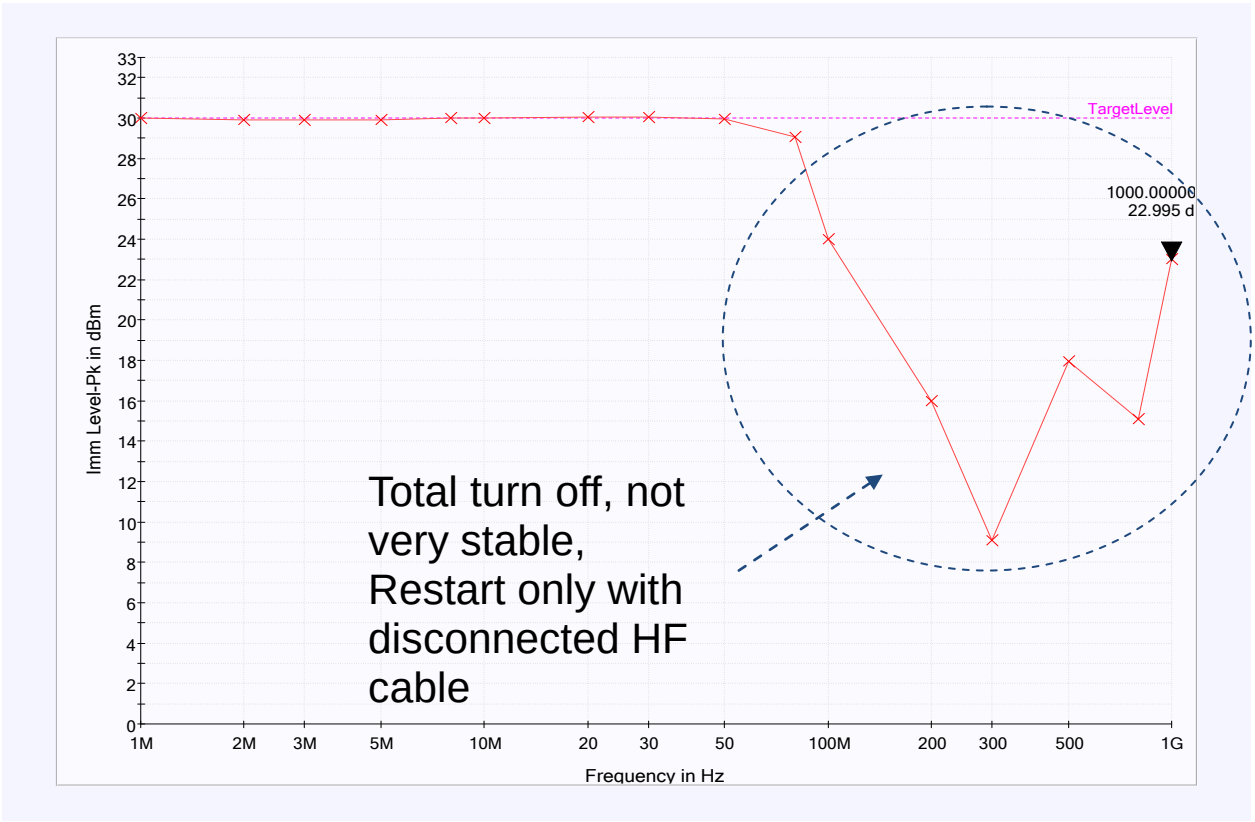
## 8.9 J11, HSCTRL, CW, Load



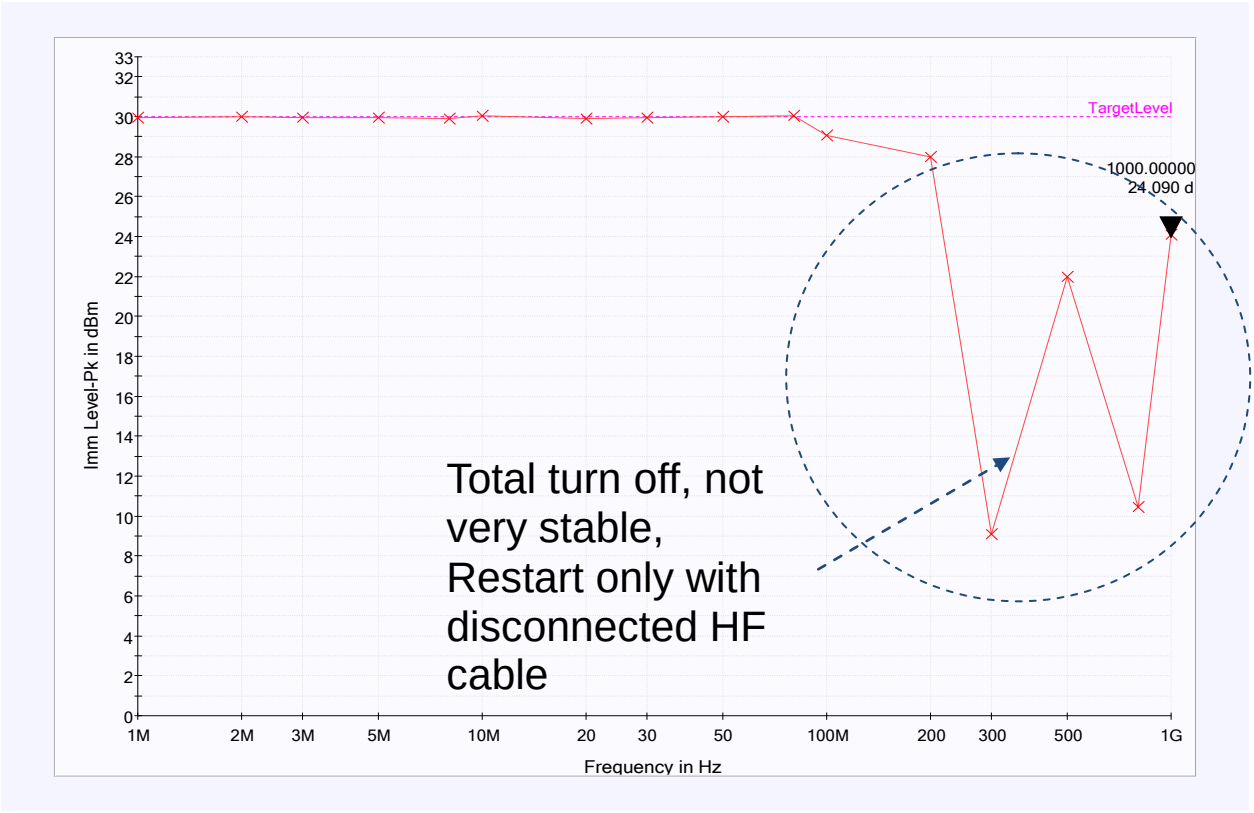
## 8.10 J11, HSCTRL, AM, Load



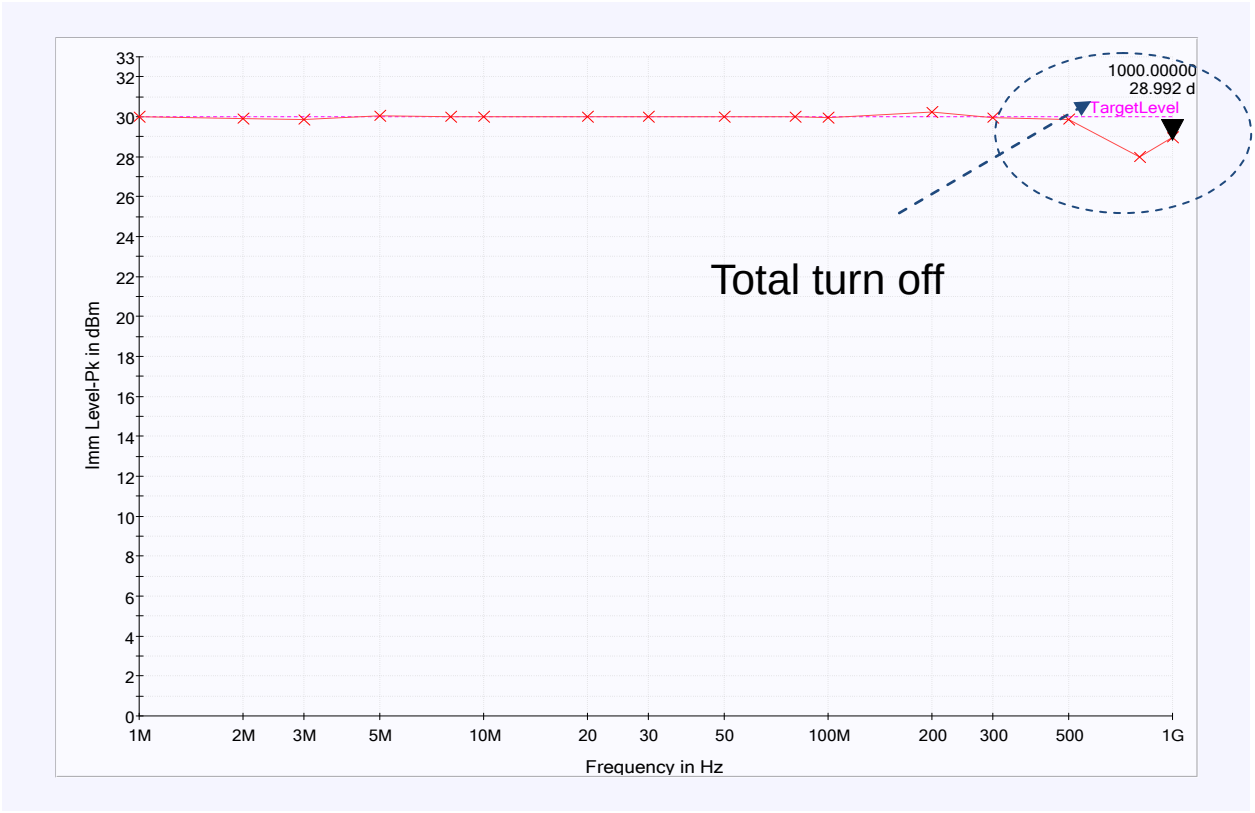
## 8.11 J20, LDO, CW, Load



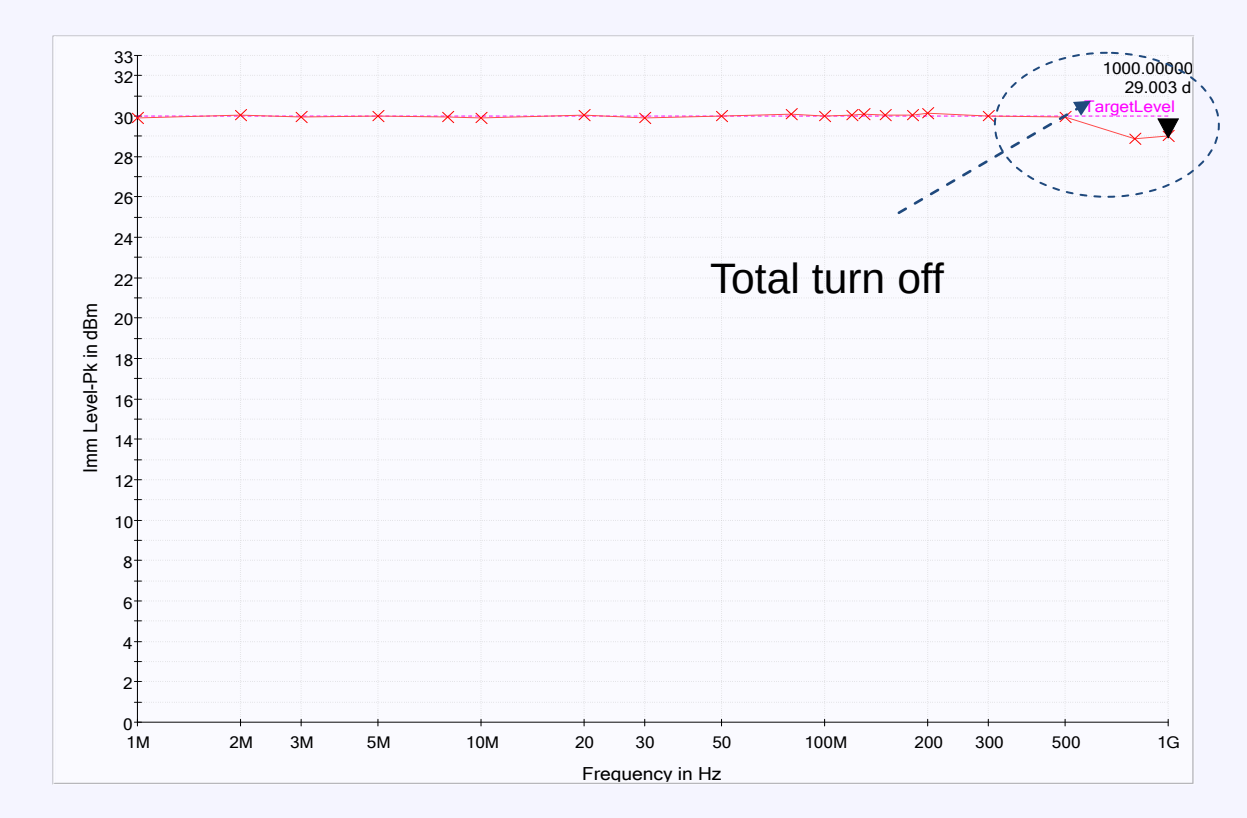
## 8.12 J20, LDO, AM, Load



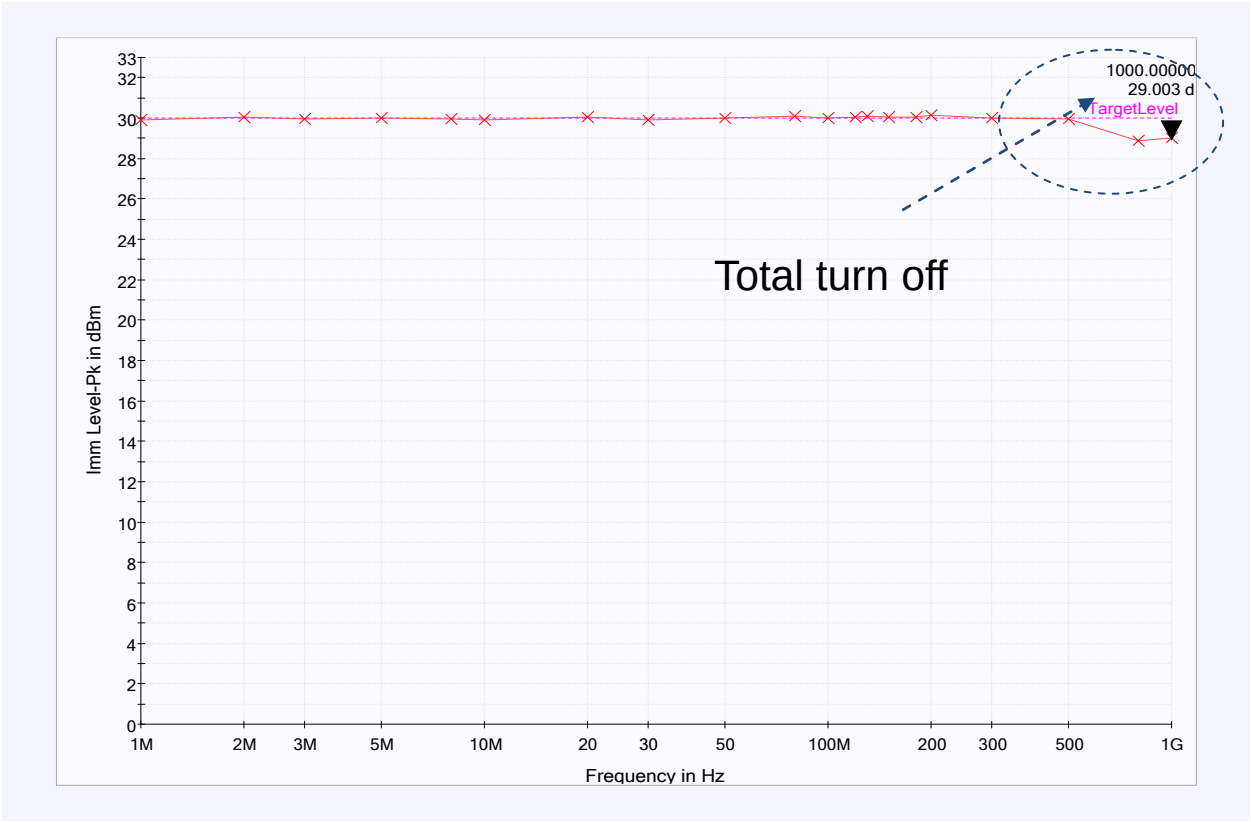
## 8.13 J19, VBOOST, CW, Load



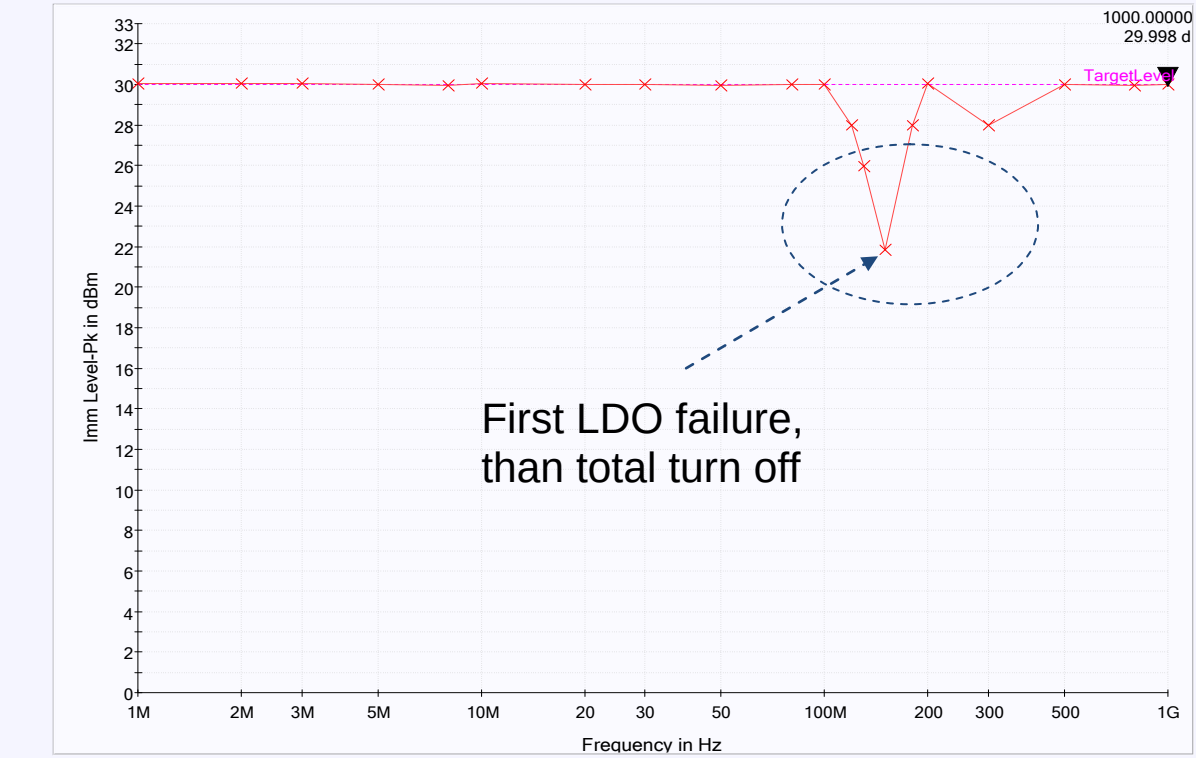
## 8.14 J19, VBOOST, AM, Load



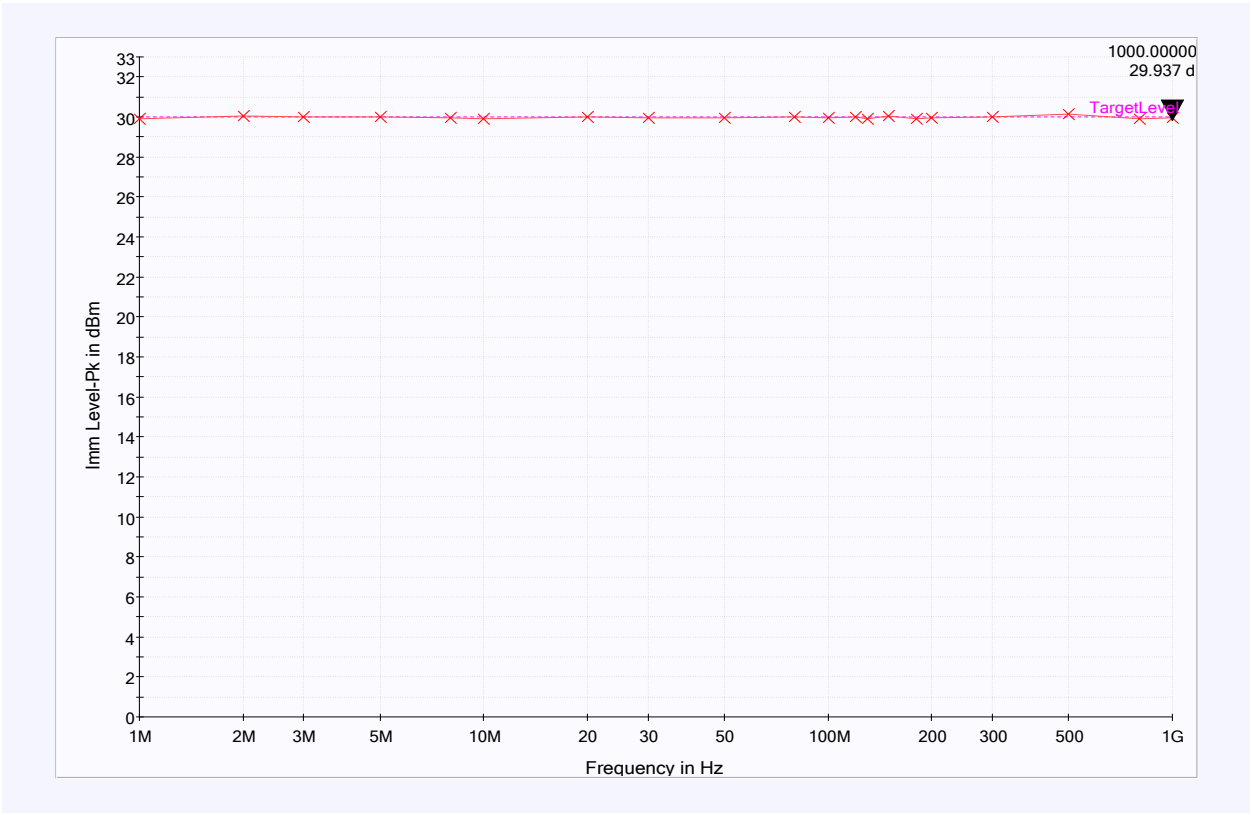
## 8.15 J19, VBOOST, AM, Load



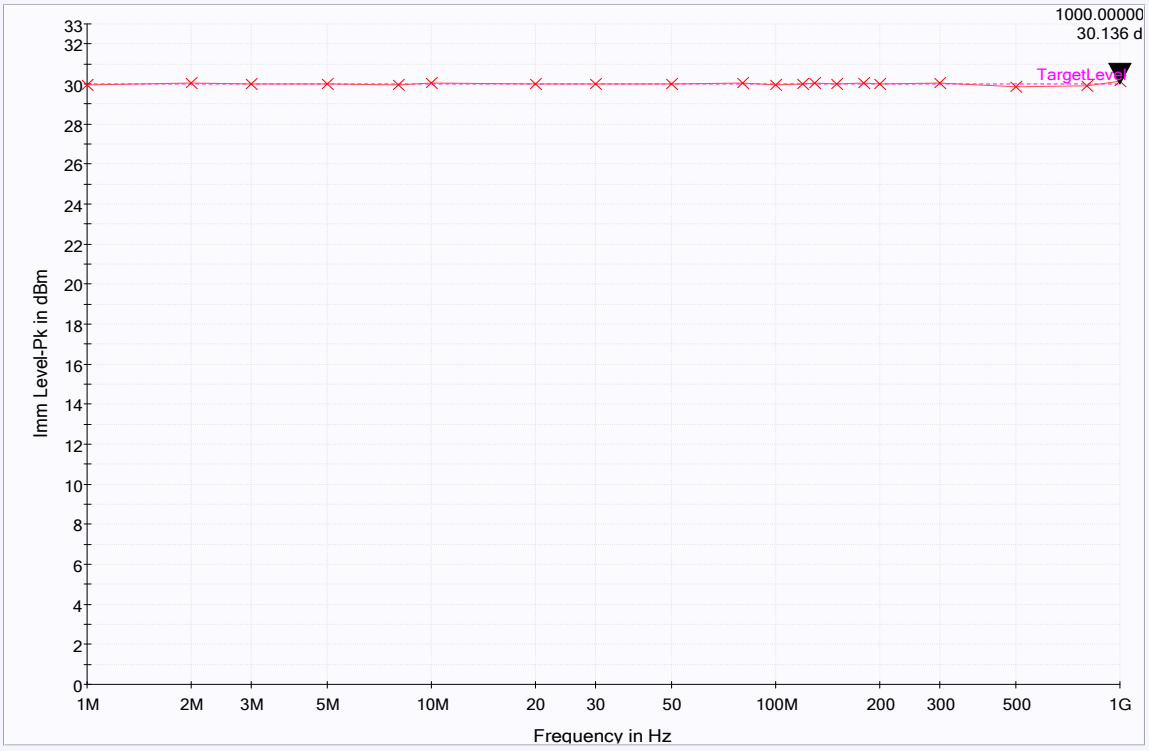
## 8.16 J22, VSUP2, CW, Load



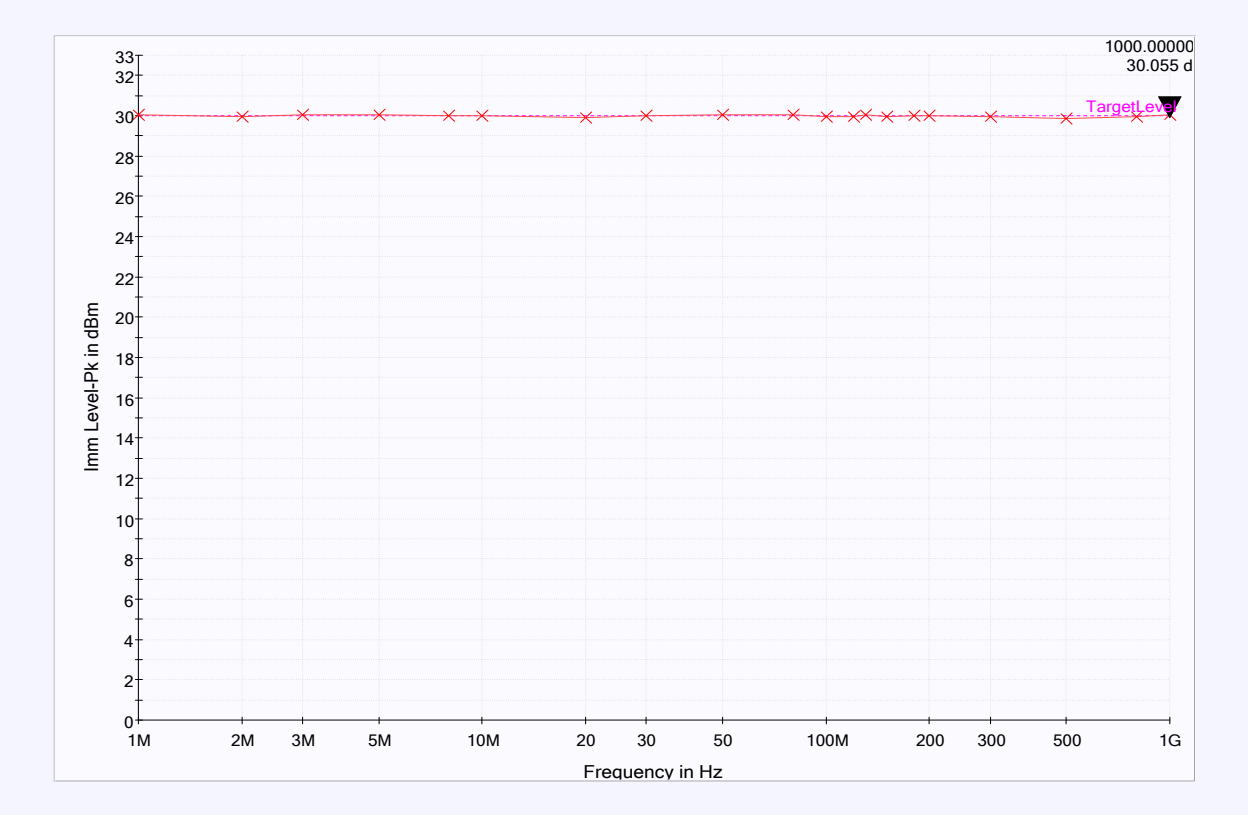
## 8.17 J22, VSUP2, AM, Load



## 8.18 J24, S1_Buck, CW, Load



## 8.19 J24, S1_Buck, AM, Load




## 8.20 J3, VSENSE1, CW, load

By connecting the HF Amplifier to the EMC board J3, total failure observed even without HF injection.

## 8.21 J7, VSENSE2, CW, load

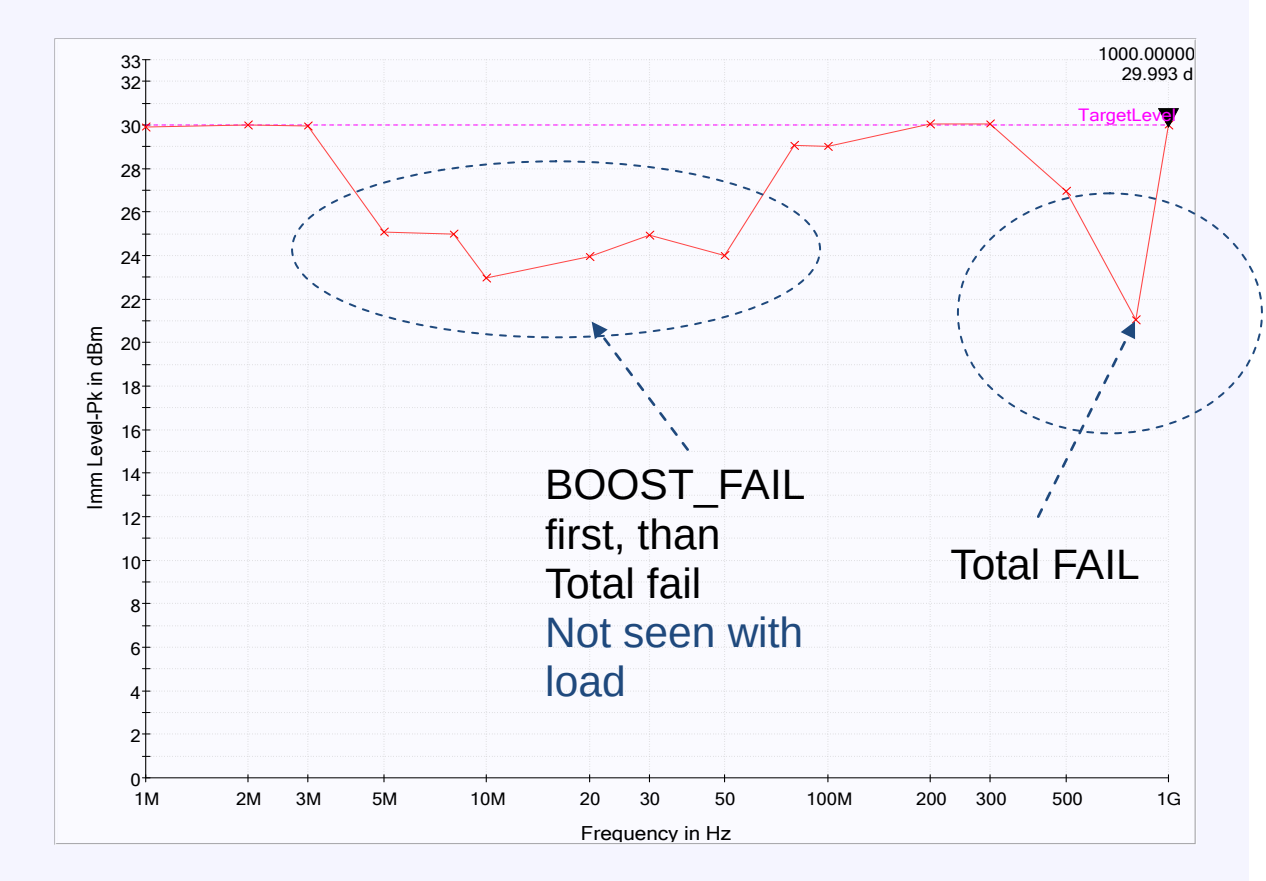
By connecting the HF Amplifier to the EMC board J3, total failure observed even without HF injection.

## 8.22 J5, VSENSE3, CW, load

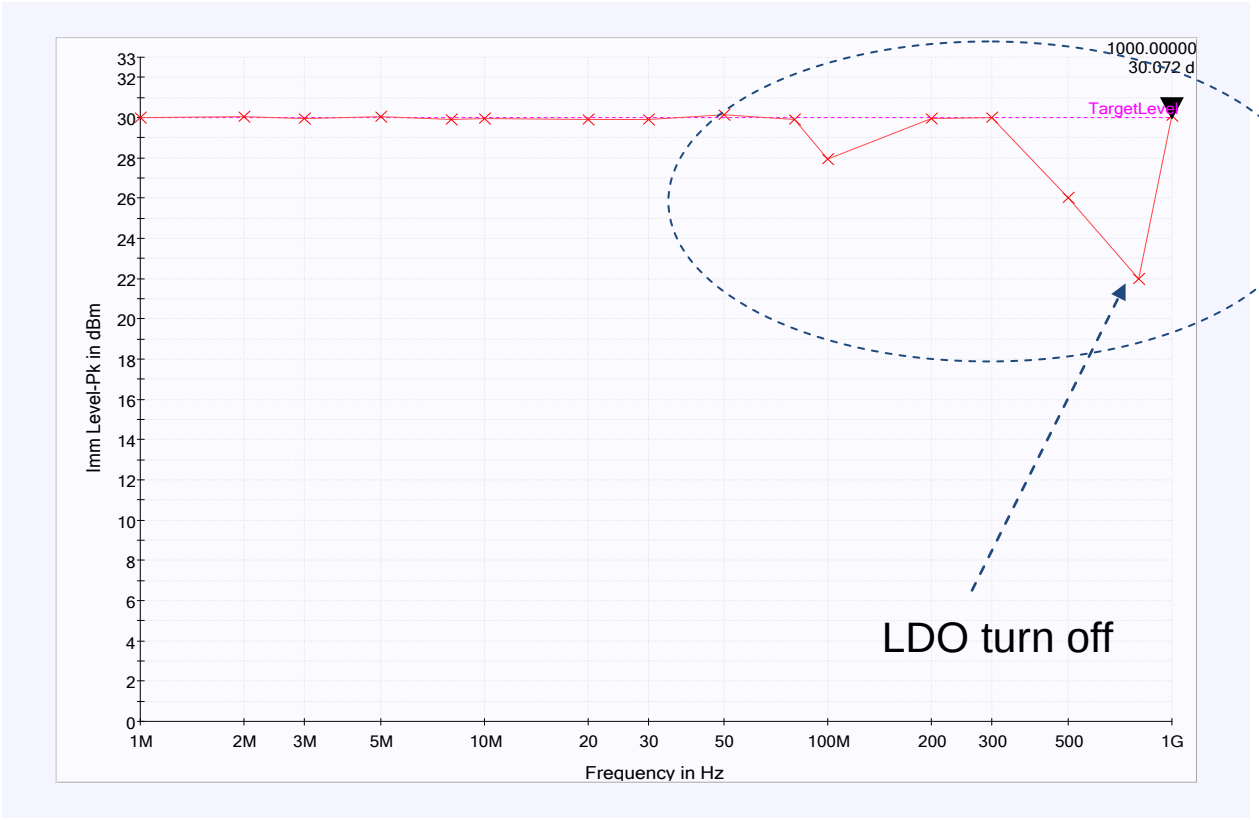
By connecting the HF Amplifier the EMC board J5, device was operating without HF.

By turning on the HF amplifier, the device was broken and not starting anymore.

## 8.23 J25, VIN, CW, No Load



## 8.24 J25, VIN, CW, Load



# 9 DPI Test Summary

- DPI Tests global pins
  - VSSENSE: Minor influence above 300 MHz down to 20 dBm
  - VIN: Minor influence at 100 MHz 28 dBm, above 300 MHz down to 22 dBm
  - WAKE: Minor influence 100 MHz AM down to 29 dBm
  - HSSENSE: No influence
  - With no load condition a difference performance was observed at VI pin at lower frequencies.
- DPI Tests local pins
  - HSCTRL: No influence
  - LDO: Major influence starting at 80 MHz down to 9 dBm @ 300 MHz, not very reproducible, since this is a local pin it might be not critical, verification on ECU level is needed (CAS BCI test).
  - VBOOST: Minor influence above 500 MHz down to 28 dBm
  - VSUPx: Minor influence above 100 MHz, down to 22 dBm
  - S1_BUCK: No influence
- DPI Tests at local pins, internal
  - VMON and VSENSE not testable due to influence of coupling network to normal operation of the application

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