# UM10473

## OL2300 Demo board user manual

Rev. 01 — 29 August 2011 | User manual

### Document information

| Info | Content |
|---|---|
| Keywords | OL2300, User manual, UHF, RF, transmitter, fractional-N-PLL |
| Abstract | This user manual describes the architecture and functionalities of the OL2300 UHF transmitter evaluation board. |

### Revision history

| Rev | Date | Description |
|---|---|---|
| v.1 | 20110829 | initial version |

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# 1. Introduction

OL2300 is a UHF ASK/FSK fractional-N transmitter IC. The device provides a fully integrated fractional-N PLL frequency synthesizer and a power amplifier to drive an external antenna.

The purpose of this manual is to provide an introduction to the evaluation board named "LID1204", which is intended to evaluate the internal functional blocks of the OL2300..

The evaluation board is equipped with a serial RS232 interface to connect the board to a PC. A Windows GUI provides a means to access the different special function registers of OL2300. The onboard controller PCF7941 acts as a logical interface between RS232 and OL2300 and it is programmed accordingly.

The power amplifier output of OL2300 is matched to 50 Ω and can be directly connected to appropriate measurement devices.

The evaluation board is available in two versions; one for the 315 MHz and one for the 434 MHz ISM frequency bands. Each version has a different mounting for the crystal and different matching network of the 50 Ω SMA connector output.

An 868 MHz version can be created by using the 434 MHz board, and changing some of the component values (see Figure 1).

Section 2 “Evaluation board schematic” gives details of component placement, usage and typical measurement results.


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## 2. Evaluation board schematic

The schematic of the evaluation board is shown in Figure 1.

The 125 kHz transponder antenna of the PCF7941 and the three switches are not mounted.

The transmitter section of the board is isolated by removing the following six jumpers: TX_SUPPLY, EN, SCK, SDIO, CKOUT, SDO. The jumpers allow the following:

- evaluation of the onboard OL2300 IC in combination with another µC
- monitoring of the SPI connection
- current measurements

The crystal which is connected to the oscillator pins of OL2300 is an NDK NX5032GA. A frequency of 13.28963 MHz is chosen to cover the 434 MHz band as well as the 868 MHz and the 915 MHz bands. However, for the 868 MHz and 915 MHz band, the matching network must be adapted accordingly.

In the 315 MHz version, the crystal frequency is 18.37036 MHz. The reference clock frequency is divided by two to keep the PLL frequency below the specified maximum of 920 MHz. To achieve this frequency limitation, the internal XTAL clock divider is set to XOSL = 1.

The UHF matching network is adapted to transform the 50 Ω terminated output impedance of connector X2 to the optimal impedance of the RF power amplifier. This is done in a way to attain the highest possible output power in power mode III (PAM=3) with a harmonic suppression of at least –50 dBc.



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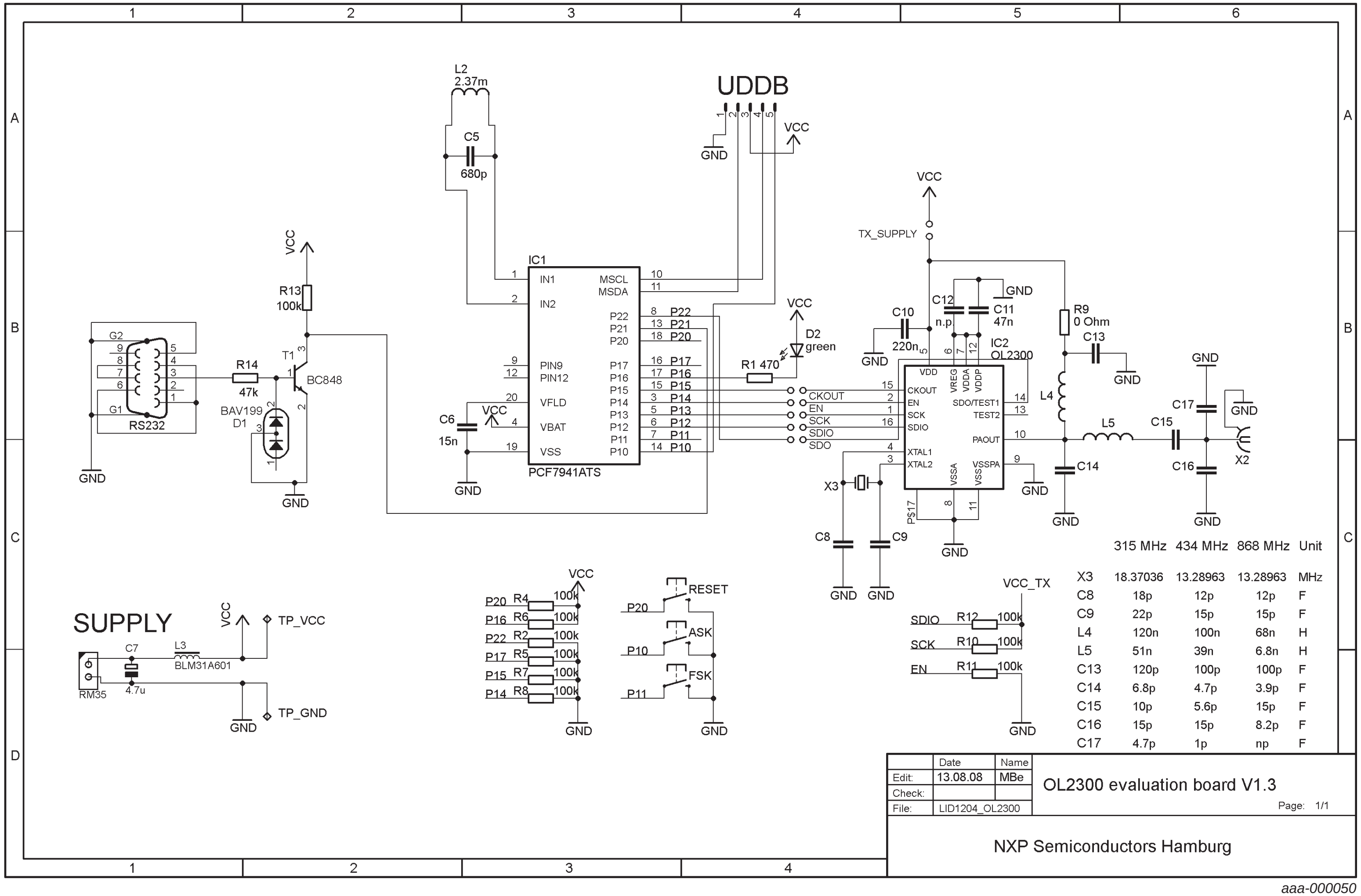


**Fig 1. Schematic of OL2300 RF evaluation board**


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# 3. Component placement

Figure 2 shows the component layout on the evaluation board as viewed from the top side.

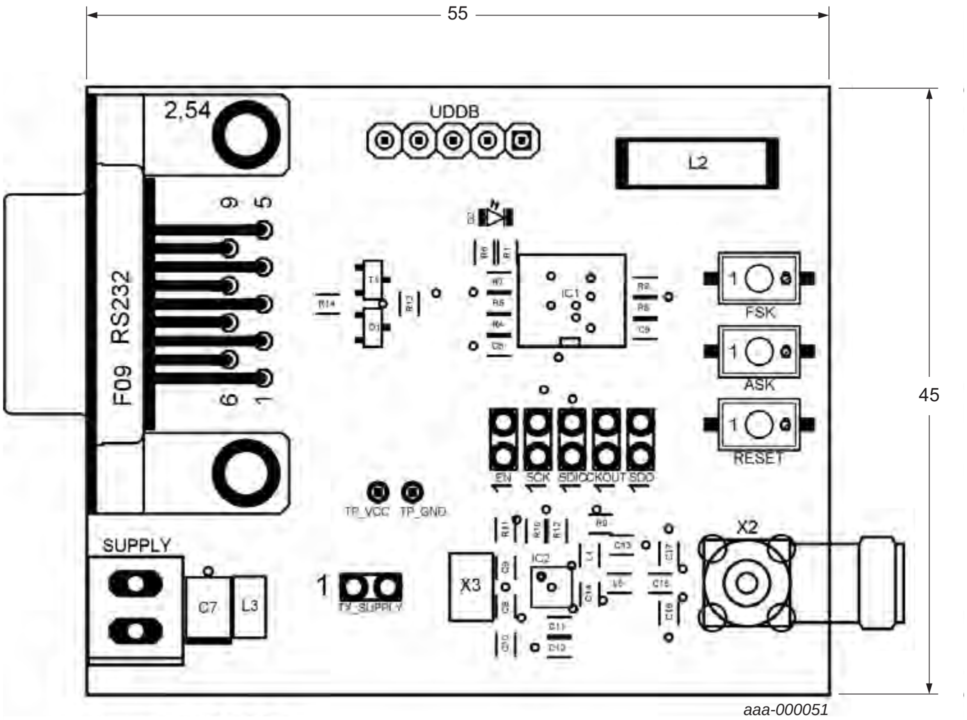


**Fig 2. Component layout - evaluation board top side**


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# 4. Usage

Connect a supply voltage (2.1 V up to 3.6 V) to the supply connector, according to the indications on the board layout. For safety reasons, the maximum current is limited to 50 mA.

When a serial connection between the evaluation board and a PC is established, the Windows software 'Frantic.exe' can be run. On start-up, the program initializes the special function register set of OL2300 using the first available COM port. The communication port used by the progam is shown in the left lower corner of the GUI. Each interaction with the Windows program is immediately transferred to reflect the changes in the register set of OL2300. The Windows program provides context-sensitive help.

A 50 Ω spectrum analyzer is directly connected to X2. Ensure that the analyzer input attenuator setting matches the RF output power level of the evaluation board using a starting reference value of +20 dBm.


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# 5. Measurement results

The evaluation board measurements are made under the following conditions, unless otherwise stated:

- Supply voltage $V_{CC}$ = 2.7 V
- Power mode PAM = 3 with CASC = 0 and ENRAD = 0
- Output amplitude AMH = 15
- Temperature T = room temperature
- Carrier frequency $f_C$ = 433.92 MHz

Detailed measurements have been performed for the 434 MHz version of the evaluation board only.

Measurement instruments:

- Spectrum Analyzer: Rohde & Schwarz FSP7
- Multimeter: Agilent 34401A

The following results indicate typical values only and vary as a result of device spreads, component tolerances or temperature changes.

## 5.1 General

**Table 1. Typical performance**

| Symbol | Parameter | Conditions | Version (MHz) | | | Unit |
|---|---|---|---|---|---|---|
| | | | 315 | 434 | 868 | |
| $I_{pd}$ | power-down current | - | <10 | <10 | <10 | nA |
| $I_{CC}$ | supply current | XTAL on | 250 | 250 | 250 | µA |
| | | PLL locked | 2.1 | 2.7 | 2.7 | mA |
| | | PA enabled | 12.1 | 13.5 | 13 | mA |
| $P_o$ | output power | - | 9.8 | 9.3 | 8.5 | dBm |
| $P_{sp}$ | spurious output power | reference | –47 | –47 | –42 | dBc |
| | | harmonic | –54 | –52 | –46 | dBc |

- Center frequency: 315 MHz
- Data rate: 4.8 kbps Manchester coded (symbol rate = 9600 chips/s)
- Modulation type: FSK
- Frequency deviation: 4.8 kHz


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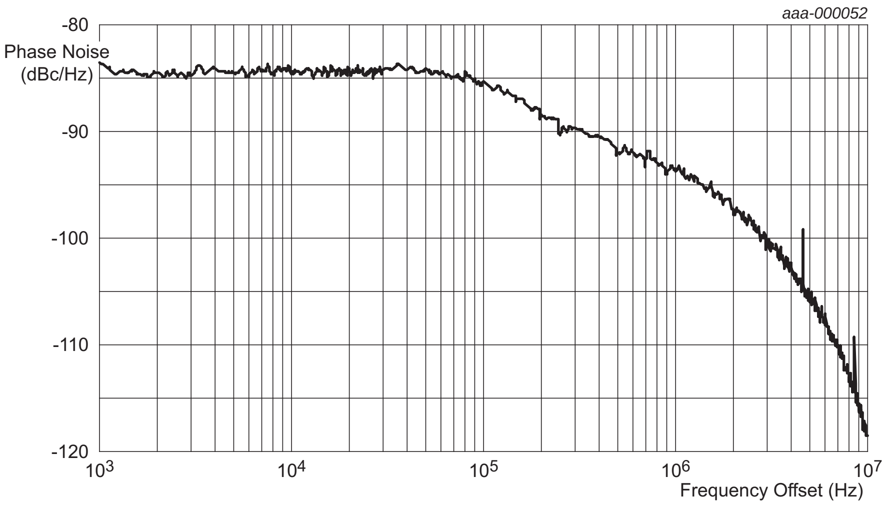


Fig 3. Carrier phase noise

## 5.2 Output power ($P_o$)

### 5.2.1 $P_o$ = f(AMH, PAM)

The data provided in Table 2 is based on the power of the carrier when measured during CW operation.

Table 2. Output power [f(AMH, PAM)]

| AMH | $P_o$ = (dBm) | | | | $I_{CC}$ (mA) | | | |
|---|---|---|---|---|---|---|---|---|
| | PAM = 0 | PAM = 1 | PAM = 2 | PAM = 3 | PAM = 0 | PAM = 1 | PAM = 2 | PAM = 3 |
| 0 | –75 | –75 | –75 | –75 | 2.62 | 2.62 | 2.62 | 2.62 |
| 1 | –21.97 | –19.40 | –15.20 | –10.30 | 2.86 | 2.94 | 3.16 | 3.66 |
| 2 | –15.70 | –13.14 | –8.98 | –4.10 | 3.10 | 3.27 | 3.70 | 4.71 |
| 3 | –12.14 | –9.66 | –5.58 | –0.76 | 3.35 | 3.60 | 4.24 | 5.71 |
| 4 | –9.32 | –7.05 | –3.12 | –1.60 | 3.60 | 3.91 | 4.74 | 6.66 |
| 5 | –7.55 | –5.25 | –1.30 | 3.35 | 3.84 | 4.22 | 5.25 | 7.60 |
| 6 | –6.27 | –3.87 | 0.18 | 4.77 | 4.03 | 4.49 | 5.73 | 8.49 |
| 7 | –4.93 | –2.56 | 1.45 | 5.84 | 4.28 | 4.81 | 6.23 | 9.29 |
| 8 | –3.55 | –1.30 | 2.54 | 6.64 | 4.52 | 5.12 | 6.71 | 9.99 |
| 9 | –2.80 | –0.50 | 3.41 | 7.27 | 4.71 | 5.37 | 7.15 | 10.62 |
| 10 | –2.06 | 0.30 | 4.24 | 7.79 | 4.89 | 5.63 | 7.59 | 11.21 |
| 11 | –1.38 | 1 | 4.95 | 8.20 | 5.09 | 5.90 | 8.01 | 11.72 |
| 12 | –0.52 | 1.79 | 5.63 | 8.54 | 5.32 | 6.19 | 8.44 | 12.20 |
| 13 | 0.01 | 2.34 | 6.17 | 8.82 | 5.51 | 6.44 | 8.83 | 12.63 |
| 14 | 0.41 | 2.80 | 6.65 | 9.06 | 5.65 | 6.64 | 9.18 | 13.03 |
| 15 | 0.93 | 3.32 | 7.09 | 9.27 | 5.84 | 6.90 | 9.54 | 13.41 |

Figure 4 is based on measurement data provided in Table 2


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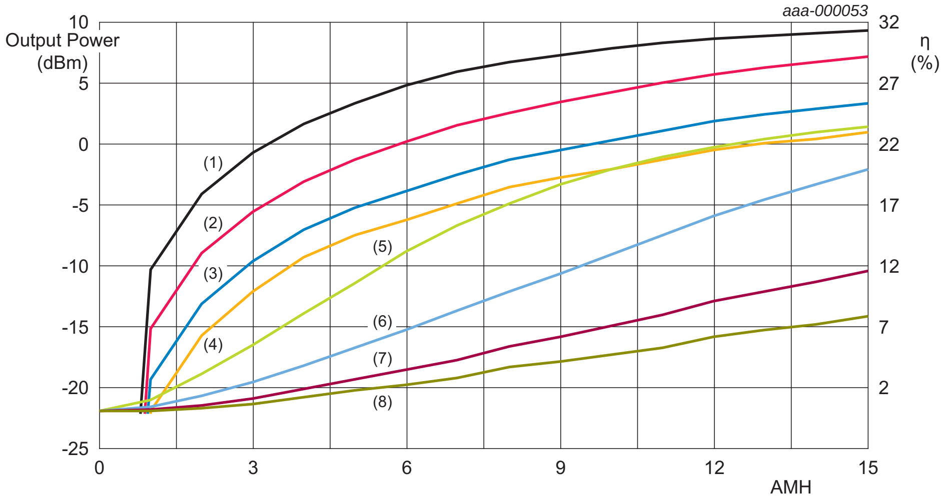


Plot (1) represents output power PAM = 3

Plot (2) represents output power PAM = 2

Plot (3) represents output power PAM = 1

Plot (4) represents output power PAM = 0

Plot (5) represents efficiency PAM = 3

Plot (6) represents efficiency PAM = 2

Plot (7) represents efficiency PAM = 1

Plot (8) represents efficiency PAM = 0

**Fig 4. Output power as a function of AMH and PAM**

### 5.2.2 $P_o = f(V_{CC}, CASC, ENRAD)$

**Table 3. Output power [f (VCC, CASC, ENRAD)]**

| $V_{CC}$ (V) | CASC = 0, ENRAD = 0 | | CASC = 1, ENRAD = 1 | |
|---|---|---|---|---|
| | $P_o$ = (dBm) | $I_{CC}$ (mA) | $P_o$ = (dBm) | $I_{CC}$ (mA) |
| 2.1 | 6.86 | 10.81 | 6.42 | 10.01 |
| 2.2 | 7.32 | 11.30 | 6.74 | 10.27 |
| 2.3 | 7.76 | 11.76 | 7.04 | 10.51 |
| 2.4 | 8.17 | 12.19 | 7.31 | 10.74 |
| 2.5 | 8.55 | 12.61 | 7.57 | 10.96 |
| 2.6 | 8.91 | 13.02 | 7.80 | 11.17 |
| 2.7 | 9.25 | 13.41 | 8.02 | 11.37 |
| 2.8 | 9.58 | 13.78 | 8.21 | 11.56 |
| 2.9 | 9.88 | 14.15 | 8.39 | 11.74 |
| 3.0 | 10.17 | 14.51 | 8.54 | 11.90 |
| 3.1 | 10.43 | 14.82 | 8.68 | 12.06 |
| 3.2 | 10.68 | 15.11 | 8.80 | 12.20 |
| 3.3 | 10.91 | 15.39 | 8.90 | 12.33 |
| 3.4 | 11.14 | 15.65 | 8.98 | 12.45 |
| 3.5 | 11.34 | 15.91 | 9.06 | 12.56 |
| 3.6 | 11.54 | 16.16 | 9.11 | 12.66 |

Figure 5 is based on measurement data provided in Table 3


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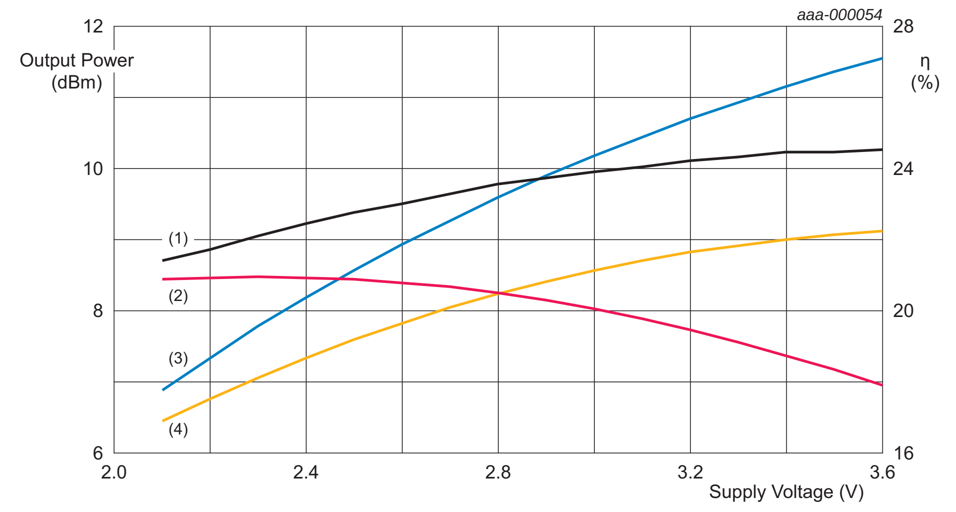


Plot (1) is efficiency CASC = 0, ENRAD = 0

Plot (2) is efficiency CASC = 1, ENRAD = 1

Plot (3) is output power CASC = 0, ENRAD = 0

Plot (4) is output power CASC = 1, ENRAD = 1

**Fig 5. Output as a function of supply voltage and flags CASC and ENRAD**

## 5.3 Output Spectrum

The most significant spurious RF outputs of the OL2300 as measured at the RF output connector are shown in Figure 6 to Figure 9. The spectrum analyzer is connected directly to the evaluation board. The spectrum analyzer settings can be seen. Measurements are made under conditions: CW, VCC = 2.7 V, AMH = 15.

### 5.3.1 315 MHz

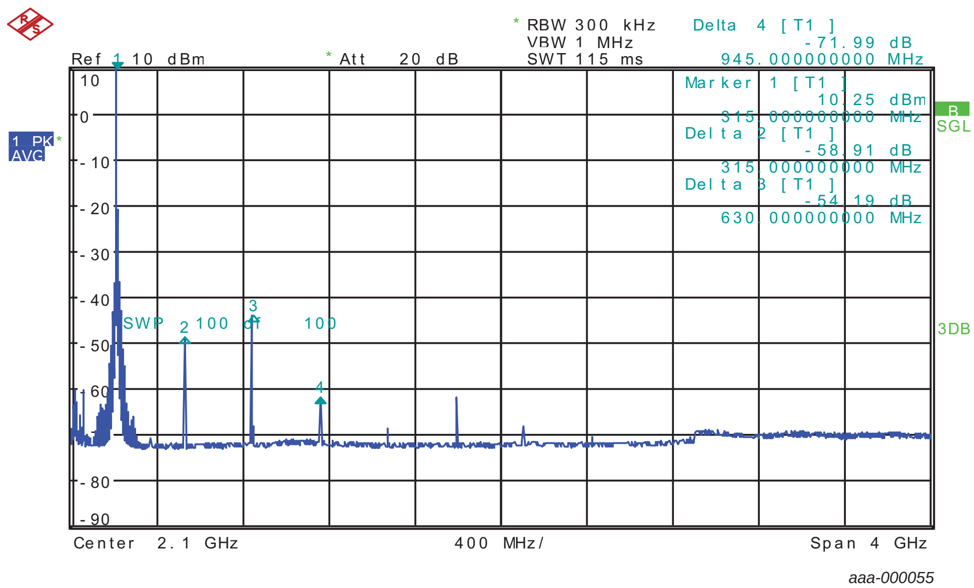


**Fig 6. Harmonic spurious signals**


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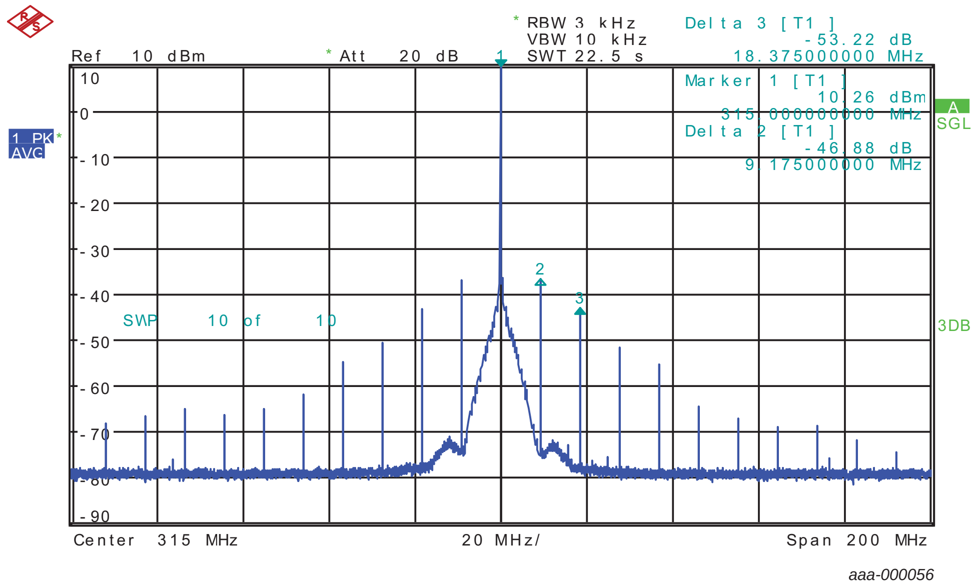


**Fig 7. Reference spurious signals**

### 5.3.2 434 MHz

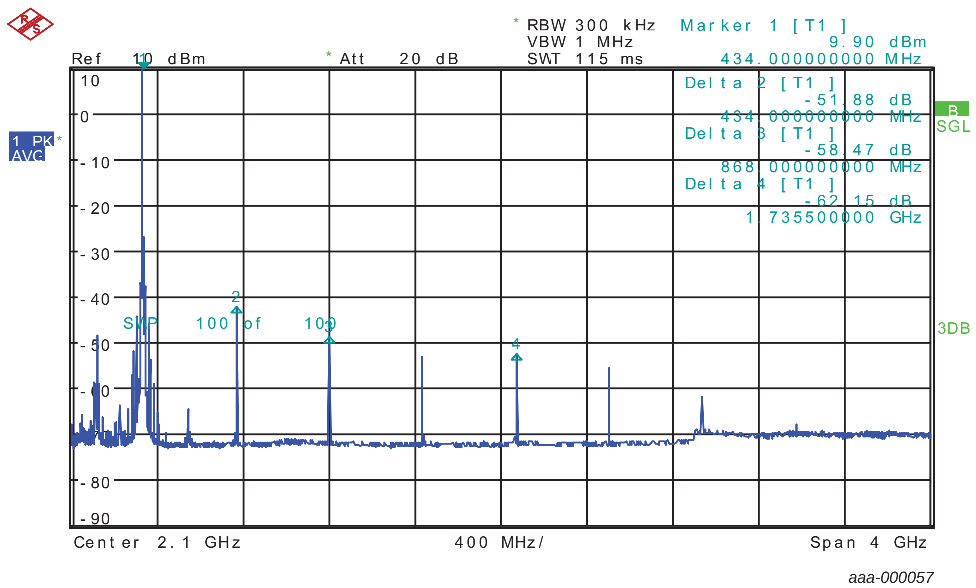


**Fig 8. Harmonic spurious signals**


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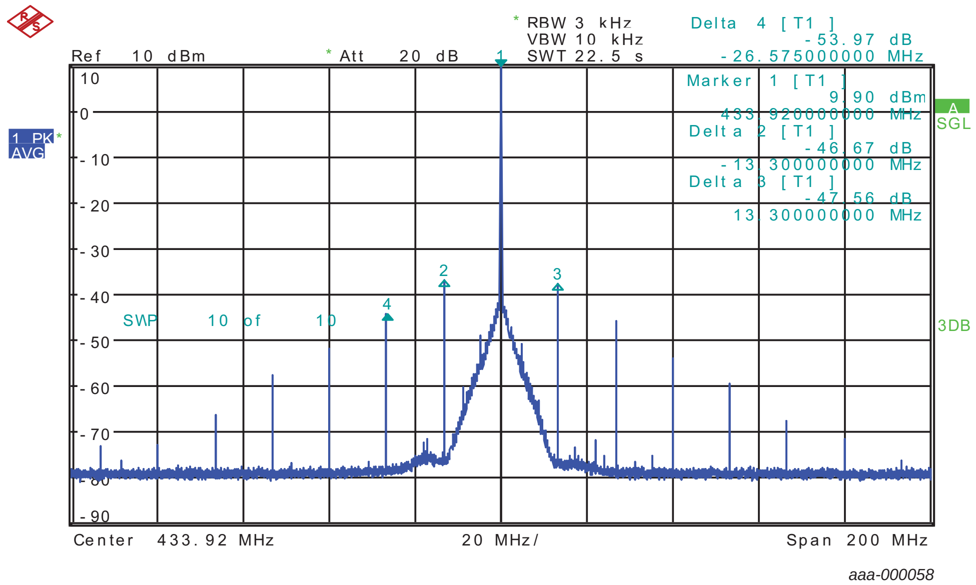


**Fig 9. Reference spurious signals**



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## 5.4 ASK modulation

The output of OL2300, when set to ASK modulation, is measured in frequency and time domain for ASK and Soft-ASK. Figure 10 and Figure 11 show the results.

A modulation frequency of 20 kHz is used for the measurements.

$V_{CC}$ = 2.7 V, AMH = 15, AML = 0, RBW = 300 kHz

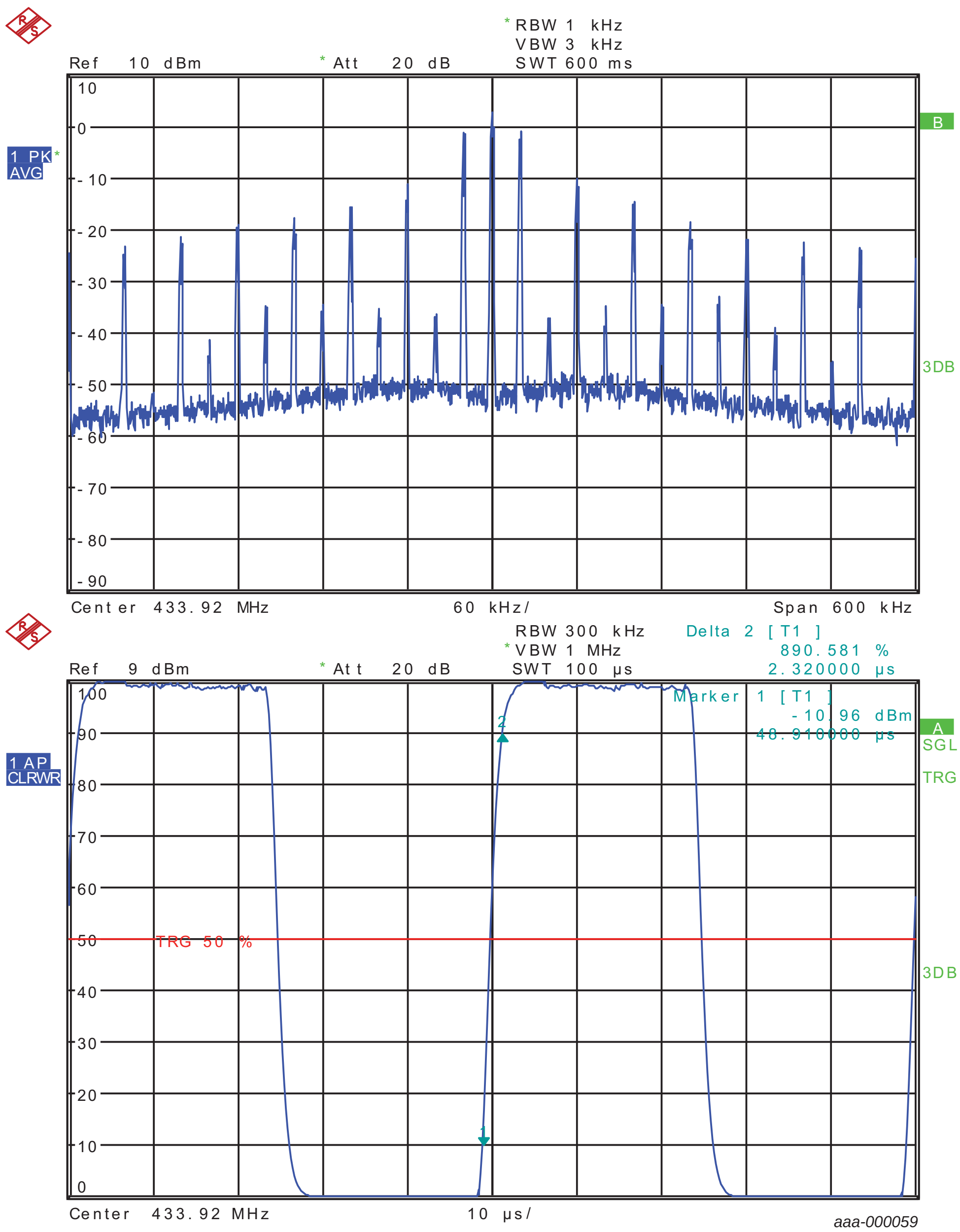


**Fig 10. ASK signal in frequency and time domain, RMP = 0 > $t_{SA}$ = 0 µs**


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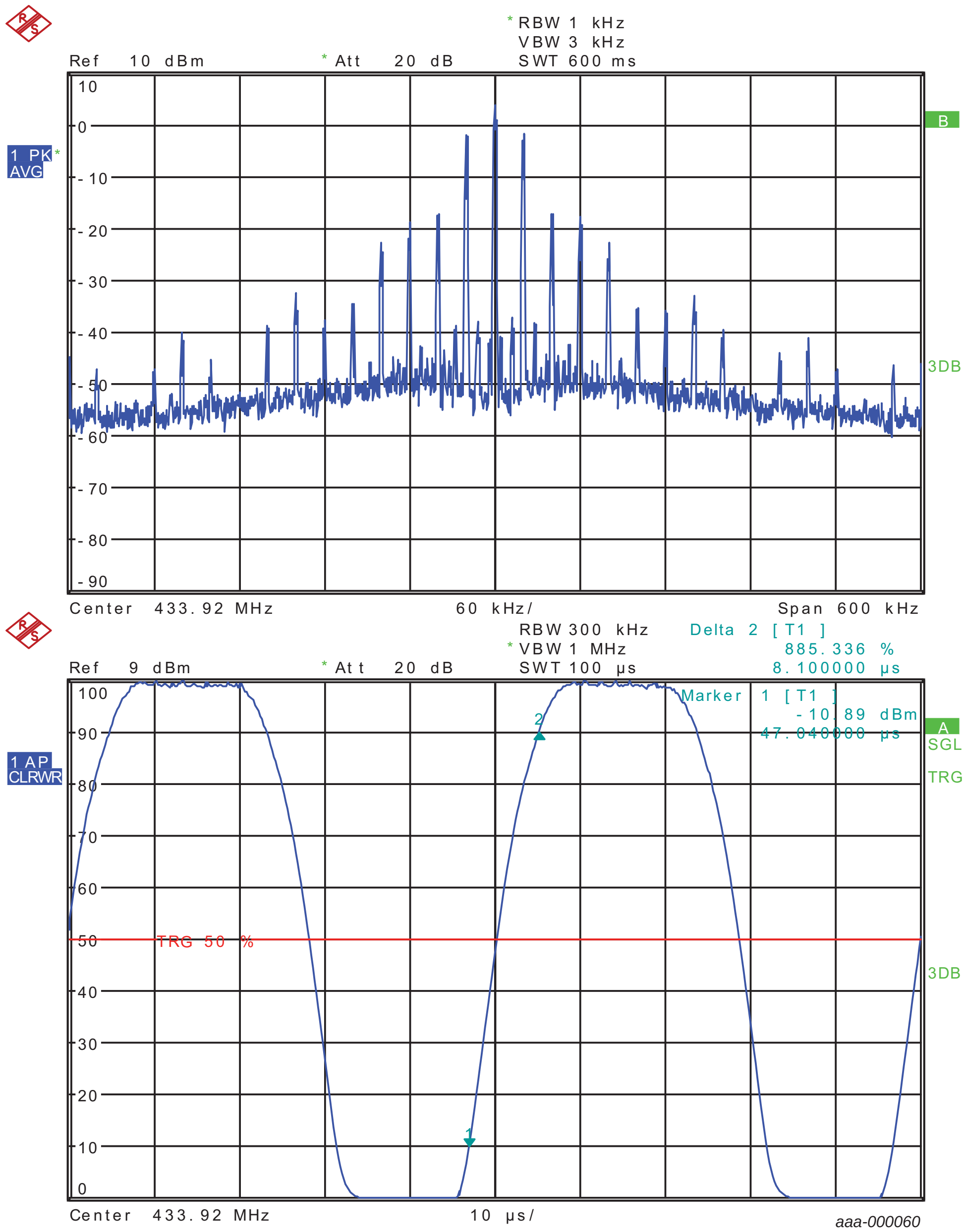


**Fig 11. Soft-ASK signal in frequency and time domain, RMP = 10 > $t_{SA}$ = 11.3 µs**


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### 5.5 FSK modulation

The output of OL2300, when set to FSK modulation, is measured in frequency and time domain for FSK and Soft-FSK. Figure 12 and Figure 13 show the results.

OL2300 was set to a modulation frequency of 20 kHz using an FSK deviation of 20.3 kHz.

$V_{CC}$ = 2.7 V, AMH = 15, AML = 0, RBW = 200 kHz.

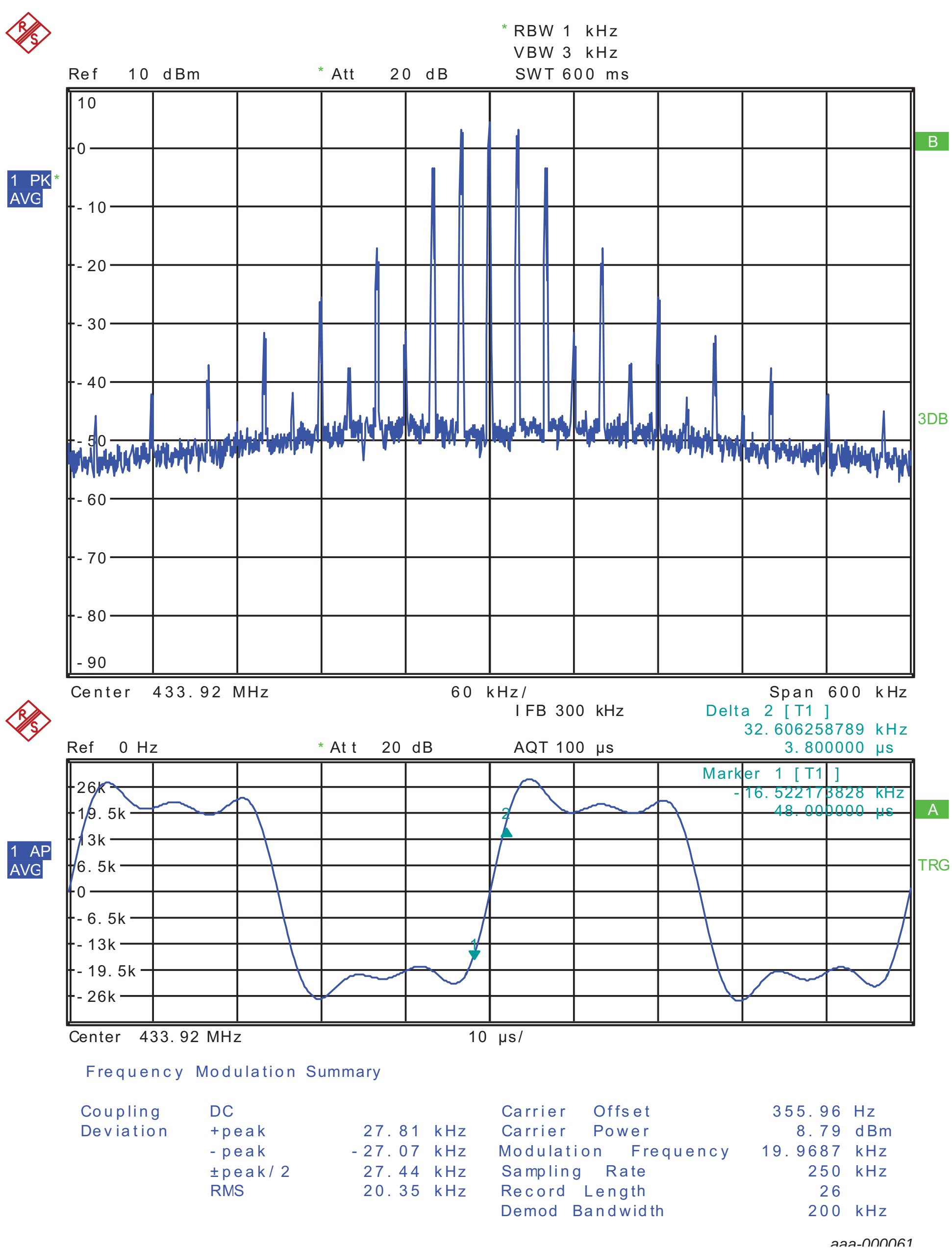


**Fig 12. FSK signal in frequency and time domain, RMP = 0 > $t_{SF}$ = 0 µs**


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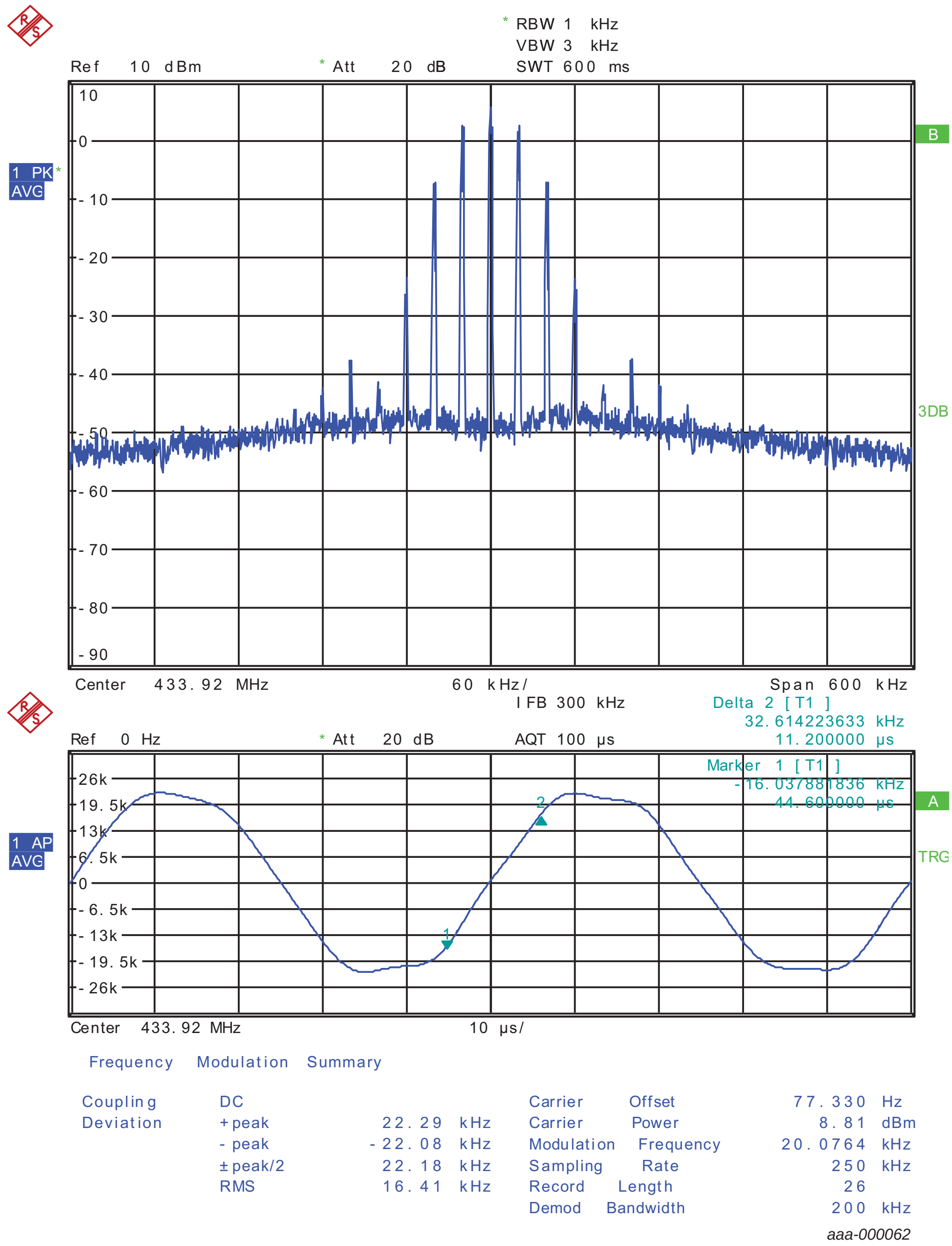


**Fig 13. Soft-FSK signal in frequency and time domain, RMP = 2 > $t_{SF}$ = 15 µs**


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