Modulated Wideband Power Amplifier

1 Introduction

The TBMDA3 modulated wideband power amplifier is designed in order to create an inexpensive signal source for immunity testing of electronic building blocks and products. It is designed to be driven by the tracking generator output of spectrum analyzers. With an input power range of -5dBm…0dBm, it can boost the output power of a tracking generator up to 5W. The TBMDA3 is ideal to drive Tekbox near field probes in order to find the sensitive spot of an electronic circuit or to create electric fields up to 550V/m when driving the Tekbox TEM Cell TBTC0, 300V/m when driving the TBTC1, 150V/m when driving the TBTC2 or 100V/m when driving the TBTC3. Test signals for immunity testing can be CW, AM or PM modulated. Consequently, the TBMDA3 provides built in modulation capability to generate 1 kHz AM or PM signals. In PM mode, the TBMDA3 can also generate a 217 Hz Signal with 12.5% duty cycle in order to simulate mobile phone TDMA noise.

Picture 1 – TBMDA3 modulated wideband driver amplifier, front view

Picture 2 – TBMDA3 modulated wideband driver amplifier, rear view

Modulated Wideband Power Amplifier

Application:

General-purpose power amplifier

Signal source for immunity testing, driving near field probes

Signal source for immunity testing, driving TEM Cells

Features:

CW amplifier (modulation off)

1 kHz, 80% AM modulation

1 kHz, 50% duty cycle pulse modulation

217 Hz, 12.5% duty cycle pulse modulation

2 Electrical Specifications

Technical Data:

Input / Output: 50 Ohm, N female

Supply Voltage range: 110 V…240 V

Supply power consumption: 20 W

Maximum input power: +3 dBm

Operating temperature range: -20°C to 50°C

Frequency range: 10 MHz – 1 GHz

1dB output compression point @ 10MHz: +36 dBm typ.

1dB output compression point @ 100 MHz: +37 dBm typ.

1dB output compression point @ 500 MHz: +36 dBm typ.

1dB output compression point @ 1 GHz: +34 dBm typ.

Noise figure: 9 dB

Harmonics: < - 10 dBc typ.

Internal modulation frequency AM: 1 kHz ±10%

Internal modulation frequencies PM: 1 kHz ±10%, 217 Hz ±20%

Duty cycle, PM: 50% ±10% @ 1 kHz; 12.5% ±20% @ 217 Hz

Gain:

3 MHz	7 MHz	10 MHz	25 MHz	100 MHz	200 MHz	300 MHz	400 MHz	500 MHz
22.5 dB	39.6 dB	42.7 dB	44.7 dB	44.7 dB	44.4 dB	43.7 dB	42.6 dB	42.3 dB

600 MHz	700 MHz	800 MHz	900 MHz	1 GHz	1.1 GHz	1.2 GHz		
41.8 dB	41.9 dB	40.6 dB	41.5 dB	39.9 dB	37.5 dB	29.8 dB		

Table 1 – TBMDA3 gain

Modulated Wideband Power Amplifier

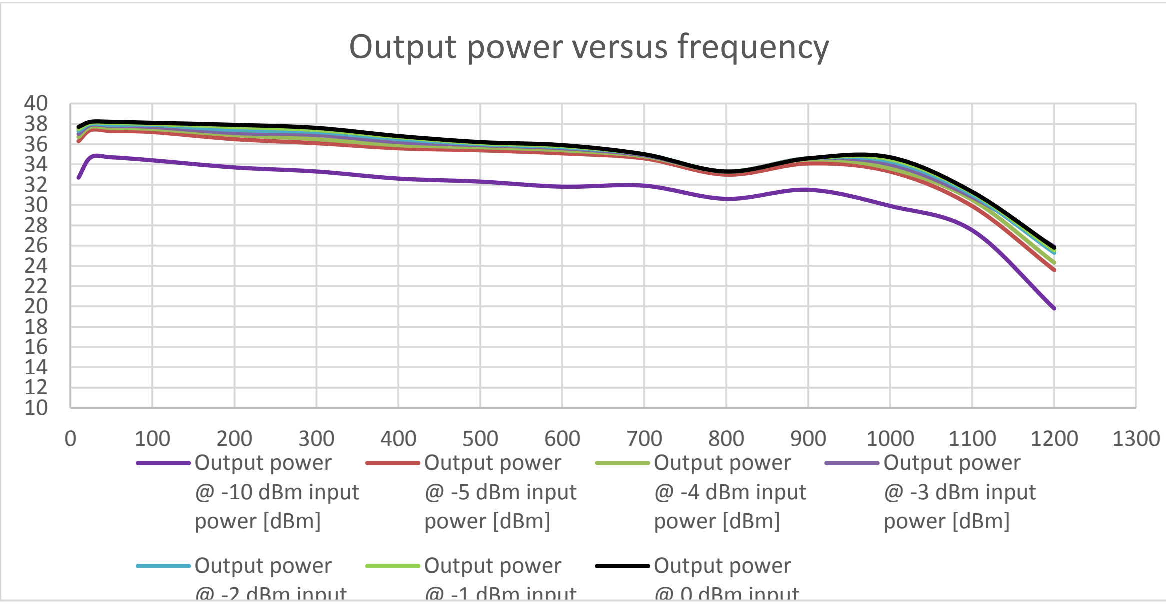

Figure 1 – TBMDA3, output power versus frequency, 3MHz – 1.2GHz

Frequency [MHz]	Output power @ -10 dBm input power [dBm]	Output power @ -5 dBm input power [dBm]	Output power @ -4 dBm input power [dBm]	Output power @ -3 dBm input power [dBm]	Output power @ -2 dBm input power [dBm]	Output power @ -1 dBm input power [dBm]	Output power @ 0 dBm input power [dBm]
3	11.5	17	18.3	19.6	20.7	21.3	21.4
7	29.6	34.2	34.7	35	35.4	35.6	35.9
10	32.7	36.3	36.7	37	37.3	37.5	37.7
25	34.7	37.4	37.7	37.9	38	38.1	38.2
50	34.7	37.3	37.6	37.8	37.9	38.1	38.2
100	34.4	37.2	37.5	37.7	37.9	38	38.1
200	33.7	36.5	36.9	37.1	37.4	37.7	37.9
300	33.3	36.1	36.5	36.9	37.2	37.4	37.6
400	32.6	35.6	35.9	36.2	36.5	36.7	36.8
500	32.3	35.4	35.7	35.9	36	36.1	36.2
600	31.8	35.1	35.4	35.6	35.7	35.8	35.9
700	31.9	34.6	34.8	34.9	35	35	35
800	30.6	33	33.3	33.3	33.3	33.3	33.3
900	31.5	34.1	34.5	34.6	34.6	34.6	34.6
1000	29.9	33.3	33.6	34	34.3	34.5	34.7
1100	27.5	29.9	30.5	30.8	31	31.2	31.3
1200	19.8	23.6	24.3	25.9	25.3	25.5	25.8

Table 2 – TBMDA3 power table

- Comment to the Table 1, 2 and Figure1: Units with serial number above TBMDA318014 have 2dB higher gain, but the same saturated output power (-10dBm input power ->-12dBm input power, etc.)

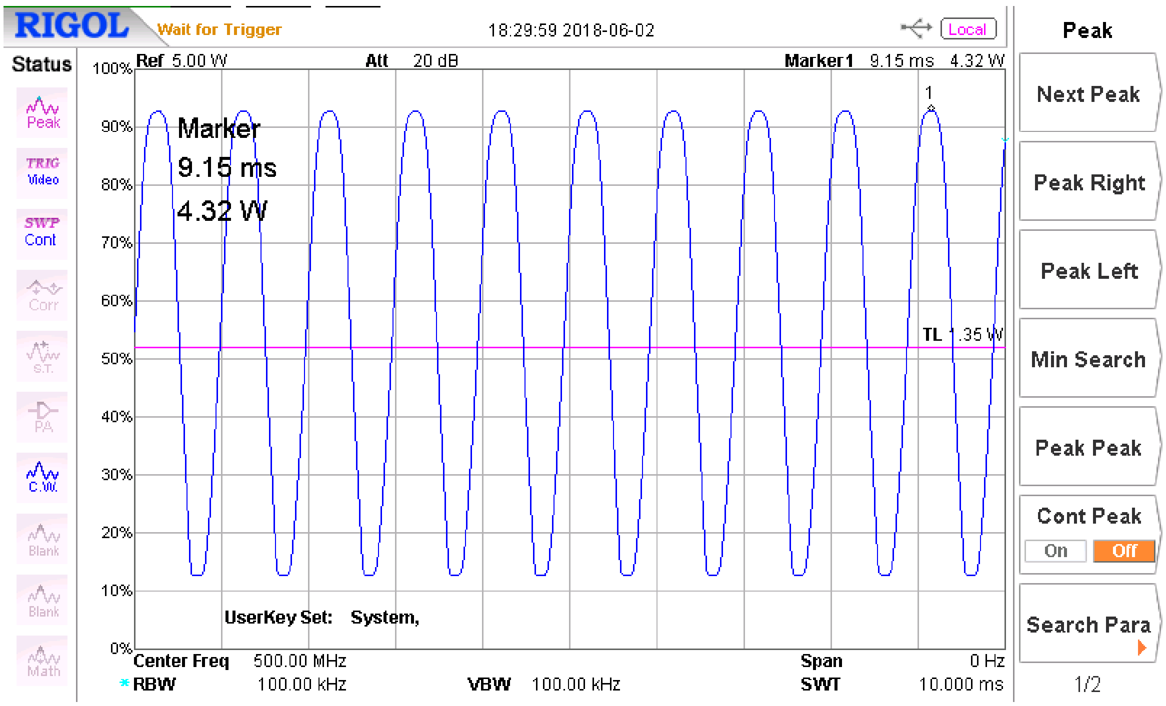

Figure 2 – 1 kHz, 80 % AM envelope, 500 MHz

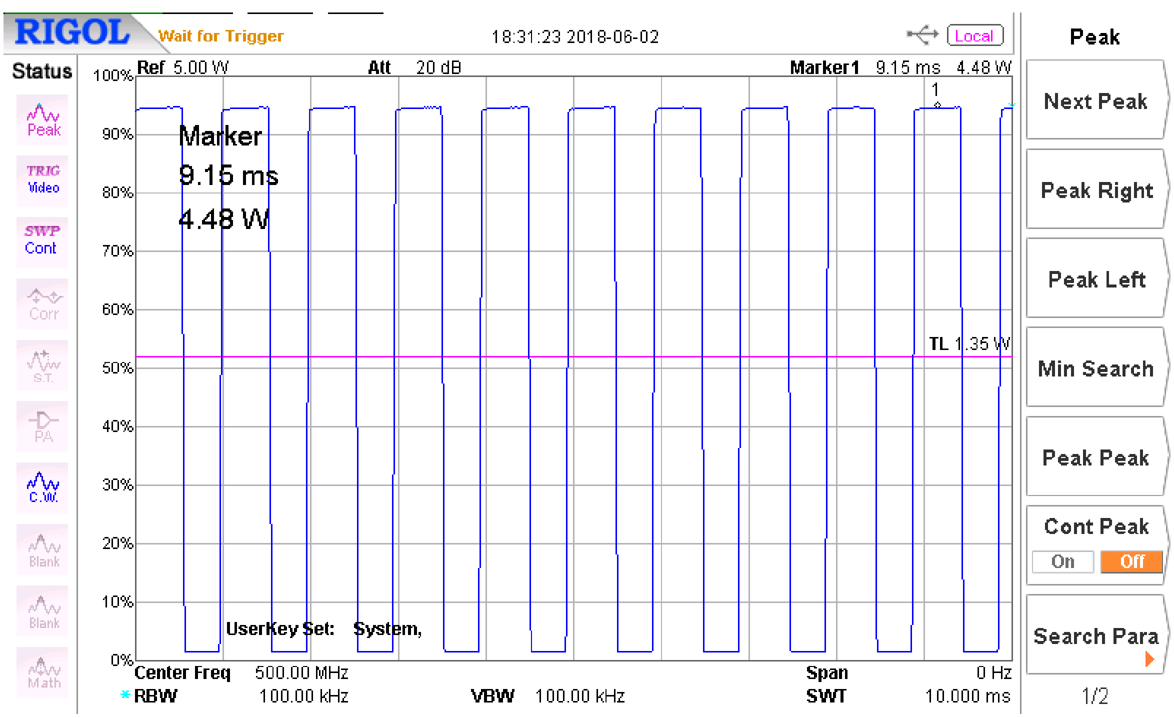

Figure 3 – 1 kHz, 50 % PM envelope, 500 MHz

Modulated Wideband Power Amplifier

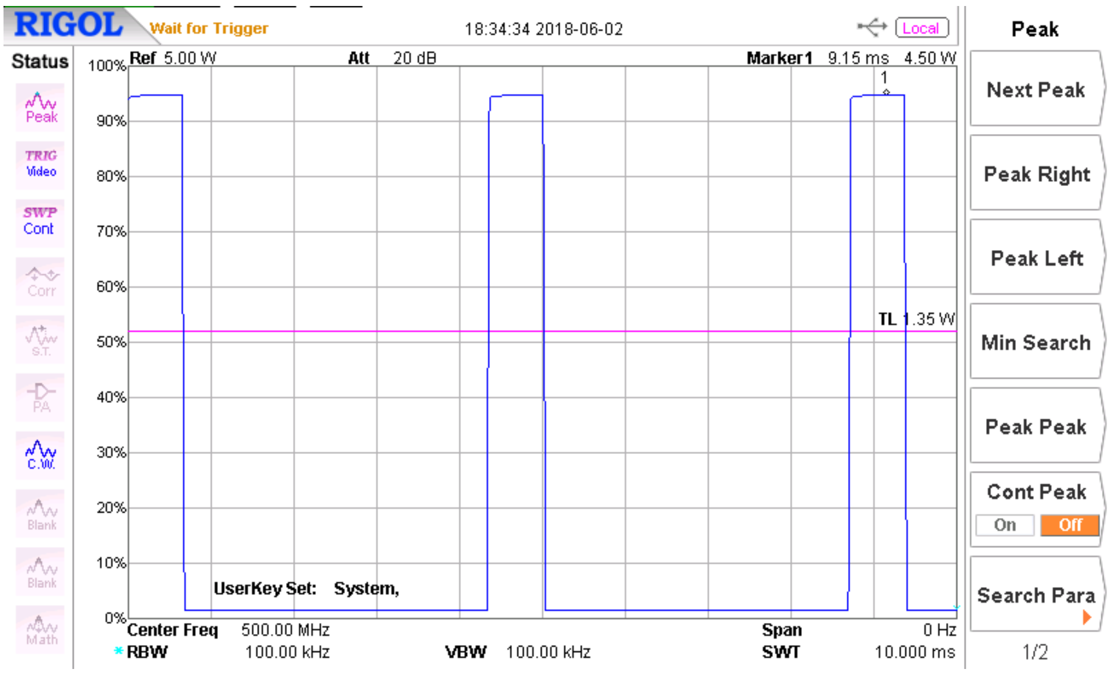

Figure 4 – 217 Hz, 12.5 % PM envelope, 500 MHz

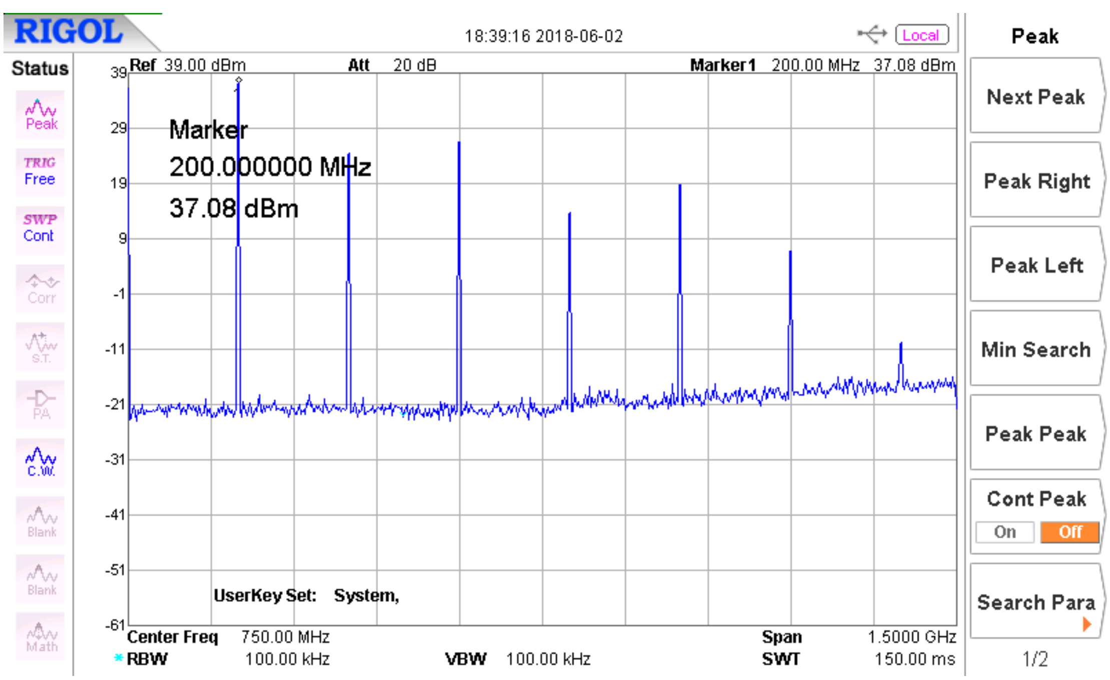

Figure 5 – CW, harmonics, 200 MHz

Modulated Wideband Power Amplifier

3 Applications

Immunity testing using a TEM cell

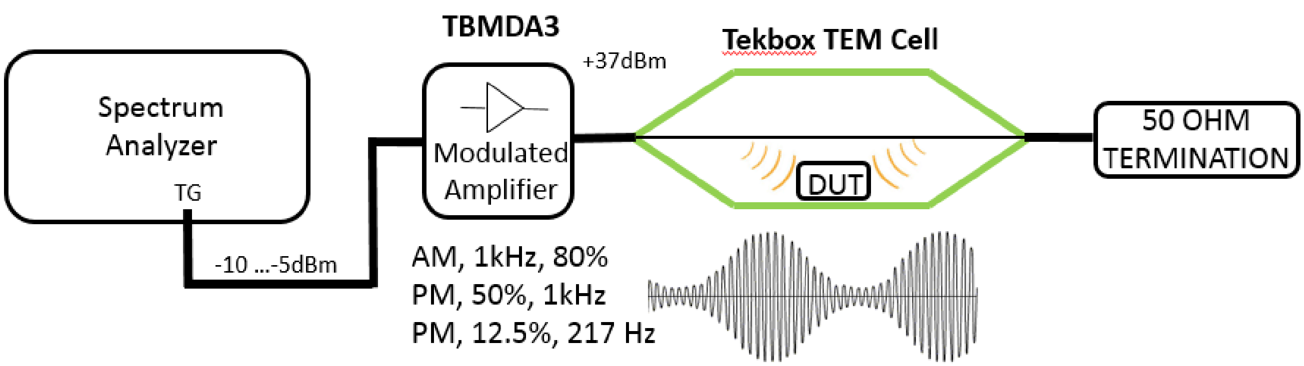

Figure 6 – immunity testing set up

Immunity testing using near field probes

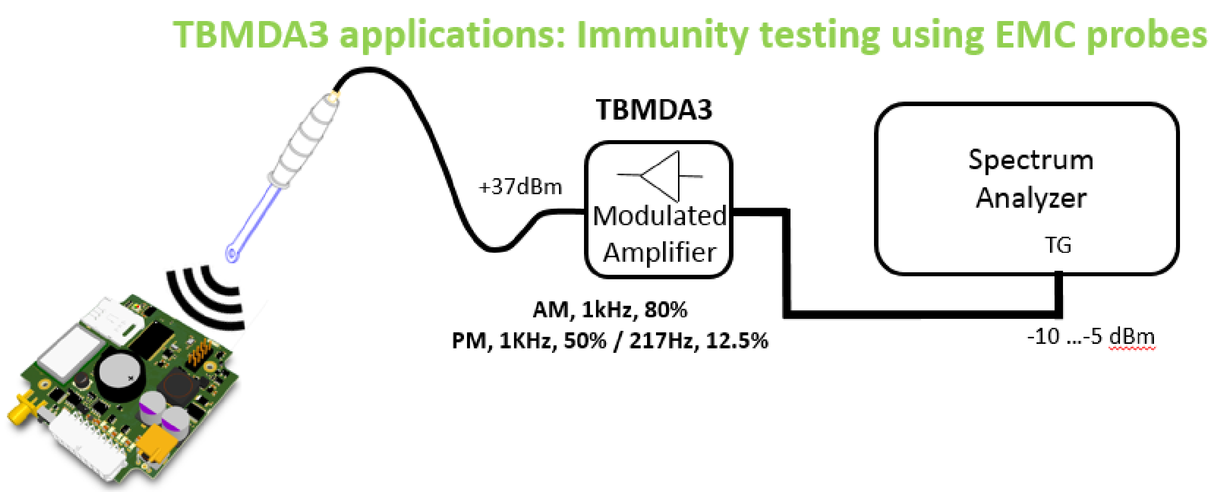

Figure 7 – immunity testing set up

4 TEM Cell field strength

A typical pre compliance set up for immunity testing is typically not sophisticated enough to measure the real field strength inside the TEM cell. However, the field strength can be approximated mathematically.

The E-field (V/m) between septum and lower (upper) wall of a TEM cell is E = V/d where V is the RMS voltage of the applied signal and d is the distance between septum and lower (upper) wall. This is based on the simplified assumption that the E field would be perfectly homogenous/evenly distributed. A more practical formula is E = V*Cor/d where Cor is a correction factor for the average field strength over the volume of the DUT derived from the analysis of the field distribution over the cross section of the cell.

Assuming the DUT is placed in the center of the cell and in the middle between bottom wall and septum, we can however use the simplified formula with sufficient accuracy.

TBTC0: d = 2.8 cm -> $E_{[V/m]} = (\sqrt{(P*50\Omega)})*35.7$

TBTC1: d = 5 cm -> $E_{[V/m]} = (\sqrt{(P*50\Omega)})*20$

TBTC2: d = 10 cm -> $E_{[V/m]} = (\sqrt{(P*50\Omega)})*10$

TBTC3: d = 15 cm -> $E_{[V/m]} = (\sqrt{(P*50\Omega)})*6.66$

The power P in the formulas above hast to be entered in [Watt]

$P_{[W]} = 0.001*(10\text{^} (P_{[dBm]}/10))$

Frequency [MHz]	Input power [dBm]	Output power [dBm]	Field strength TBTC0 [V/m]	Field strength TBTC1 [V/m]	Field strength TBTC2 [V/m]	Field strength TBTC3 [V/m]
7	-5	34.2	409	229	115	76
10	-5	36.3	521	292	146	97
25	-5	37.4	592	332	166	110
50	-5	37.3	585	328	164	109
100	-5	37.2	578	324	162	108
200	-5	36.5	534	299	149	100
300	-5	36.1	510	285	143	95
400	-5	35.6	481	269	135	90
500	-5	35.4	470	263	132	88
600	-5	35.1	454	254	127	n.a
700	-5	34.6	429	240	120	n.a
800	-5	33	357	200	100	n.a
900	-5	34.1	405	227	113	n.a
1000	-5	33.3	369	207	103	n.a

Table 3 – calculated field strength for TBMDA3 driving Tekbox TEM cells

5 PC Software for immunity testing

The Tekbox EMCview SW is regularly updated and now supports immunity testing with a feature for automated tracking generator control. This significantly simplifies immunity testing, especially in case of repeated testing during validation of DUT modifications/improvements.

Tekbox EMCview currently supports Rigol, Siglent, R&S FPC and FPH series spectrum analyzers.

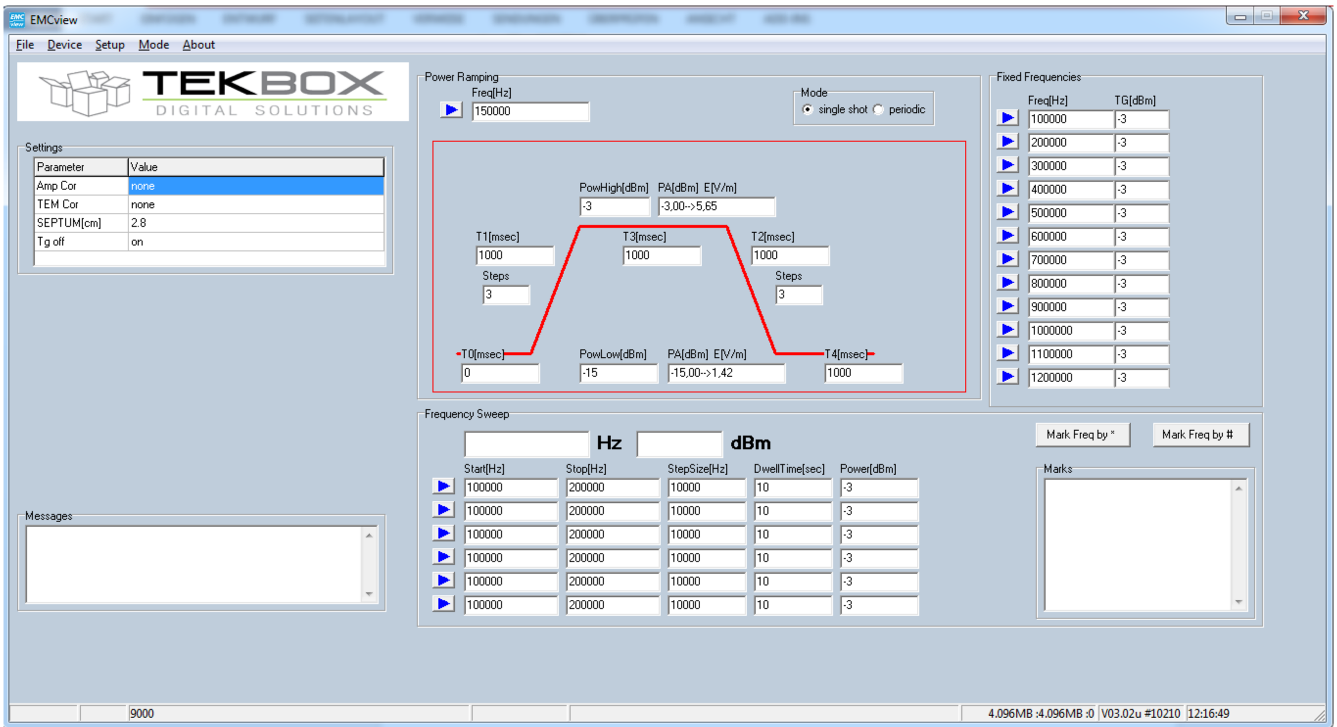

Figure 8 – screenshot of the tracking generator control feature of EMCview

WARNING:

Never connect the output of the TBMDA3 directly to the input of a spectrum analyzer. Check the maximum input ratings of the spectrum analyzer and protect it with an appropriate attenuator.

Example:

Rigol DSA815 – maximum input power rating: +20dBm

6 Ordering Information

Part Number	Description
TBMDA3	modulated power amplifier, 2 pcs 75cm N-male to N-male cables, 1 pc 30dB / 10W attenuator with N-connectors, power cord

Table 5 – Ordering Information

7 History

Version	Date	Author	Changes
V1.0	2.6.2018	Mayerhofer	Creation of the document
V1.1	6.9.2018	Mayerhofer	Correction of Chapter 6

Table 6 – History