AR241036

BLF989E, 700 to 860 Mhz

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AMPLEON

Application Report

Document information	
Status	Company public
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Abstract	Measurement results of an A-symmetric Ultra Wideband Doherty design with BLF989E for 700 to 860 Mhz

1. Revision History

Table 1: Report revisions

Revision	Date	Description	Author
0.0	20240422	Final version	Walter Sneijers

2. Contents

3. List of figures

4. List of tables

5. General description

This report presents the measurement results of the A-symmetric Ultra Wideband Doherty demo AR241036. The device BLF989E used is 180Wavg DVB-T, 9th generation LDMOS in a SOT539 package. BLF989E lower section is the Main amplifier, the upper section is the Peak amplifier. The power ratio is 1:1.5 for optimum efficiency with DVB-T (and ATSC-3) signals. The presented demo was designed for the frequency band 700 to 860 Mhz (a relative bandwidth of 21%).

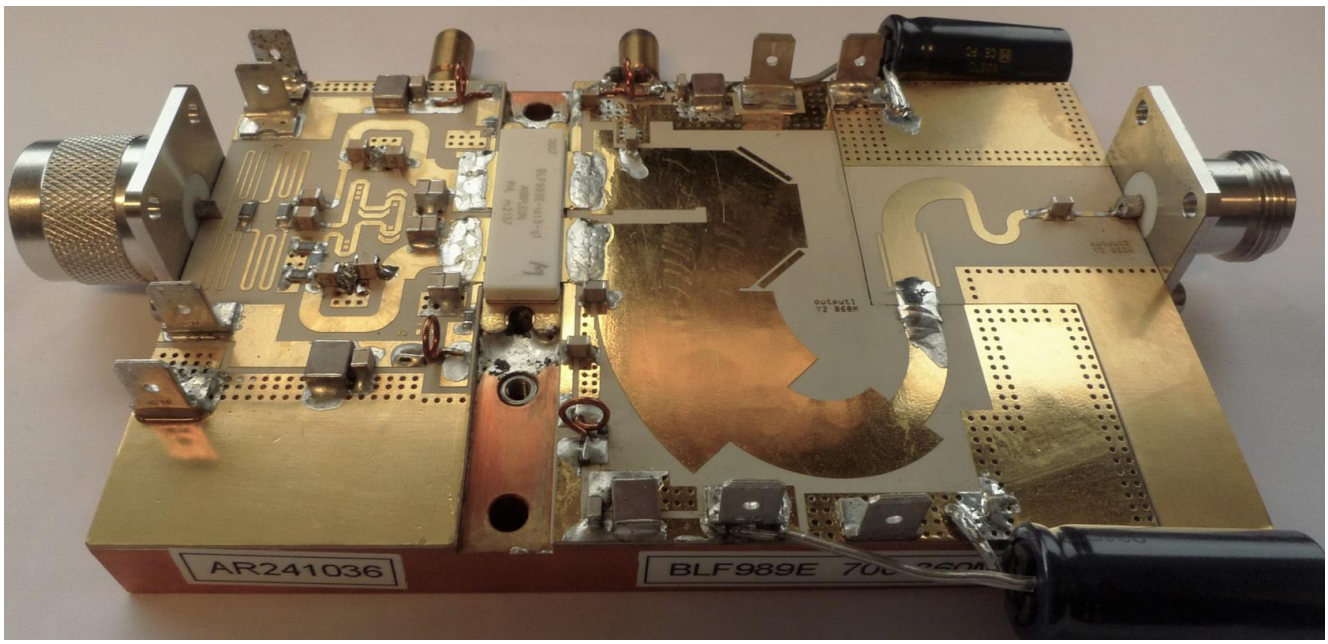

Figure 1 AR241036, 700-860Mhz demo top view

6. Biasing and practical aspects

The efficiencies presented are based on the currents of the drain feeds only.
I.e. the biasing currents for the gate circuitry have not been included.
The biasing is as follows:

V_{DD_MAIN}	=	50V
V_{DD_PEAK}	=	50V
V_{GS_MAIN}	=	approx. 2.2V, leading to an I_{DQ_MAIN}=600mA
V_{GS_PEAK}	=	0.5V (range 0.3 – 0.7 V, can vary dependent on frequency and device)

The application is built on a copper heatsink and is water cooled.
The application is designed on 2 different (output) pcb materials to realise practical line widths near the transistor drains and 50Ω output.
Both transistor and pcb's are soldered on a baseplate to achieve optimum performance.
Special care is needed when the pcb's are not soldered on the baseplate to prevent bad grounding contact near the transistor and/or the transformer interface (connection of the 2 output pcb's).

7. Performance Summary

Table 2: Performance summary, in band 700-860Mhz

Parameter	Condition-1	Condition-2	Unit	Pulsed CW	DVB-T
Power		Idq_m=0.6A Vgs_p=0.5V	W		180
Gain		Idq_m=0.6A Vgs_p=0.5V	dB		15.5 – 16.5
Drain Efficiency		Idq_m=0.6A Vgs_p=0.5V	%		48 - 52
P_{6dB}	100µs/10%	Idq_m=0.6A Vgs_p=0.5V	W	1000	-
PAR output signal	CCDF0.01%	Idq_m=0.6A Vgs_p=0.5V	dB		7 – 7.5
PAR output signal -c	Pre-corrected[1,2] CCDF0.01%	Idq_m=0.6A Vgs_p=0.5V	dB		> 7.5
Shoulder distance[1,2,3]		Idq_m=0.6A Vgs_p=0.5V	dBc		< -37
MER		Idq_m=0.6A Vgs_p=0.5V	dBc		> 34

Note 1: Input PAR DVB-T signal 9.5dB @ CCDF0.01%

Note 2: Pre-distorter: ProTelevision PT3000

Note 3: Shoulder distance ±4.3Mhz

The amplifier can deliver 180W average DVB-T power or pulsed CW 1000W (P6dB) over the whole bandwidth 470-700Mhz.
All RF measurements were performed with a 1000Mhz LPF coupled towards the power meter. This avoids any harmonic content in the measured output power.
The wideband Klopfenstein transformer has 5 sections.
Note that the amplifier will not isolate mismatch impedances in the harmonic band.

Pre-correction:
The pre-corrected measurements were performed with a ProTelevision PT3000 exciter.
Idq/Vgs settings can be optimised for each channel. Note that some UHF channels need more correction on AM-AM (and AM-PM) distortion, which can be influenced by Vgs_p.

Vgs_p(eak) has a significant impact on efficiency. Best trade-off between (peak) power and efficiency was achieved at a Vgs_p of 0.5V. Different transistor batches can result in different Vgs settings dependent on transistor Vgs_threshold level.

8. Performance Details

The amplifier was measured with a DVB-T 8K signal (8Mhz signal bandwidth) and with a pulsed CW signal. Vgs_p is (normally) fixed at 0.5V but can be varied at each channel, likewise Idq_main or Vdd. The measured freq range is 650 – 900Mhz.

8.1 DVB-T measurement (no correction), Pavg=180W

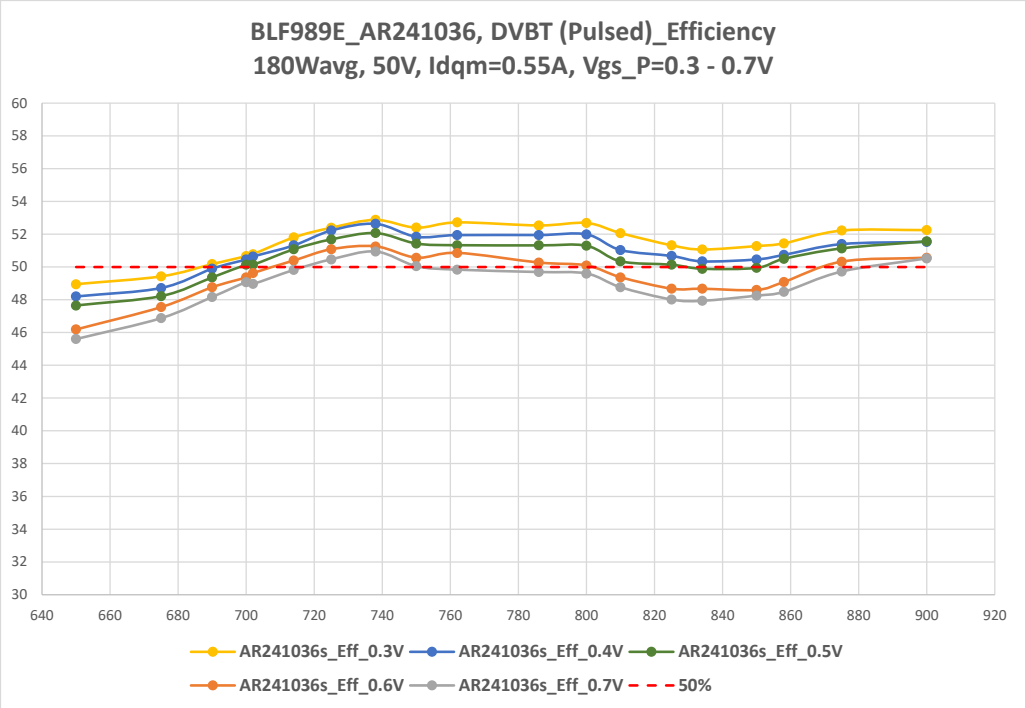

Figure 2 DVB-T, (Drain) efficiency (not corrected) Vgs_p=0.3 – 0.7V

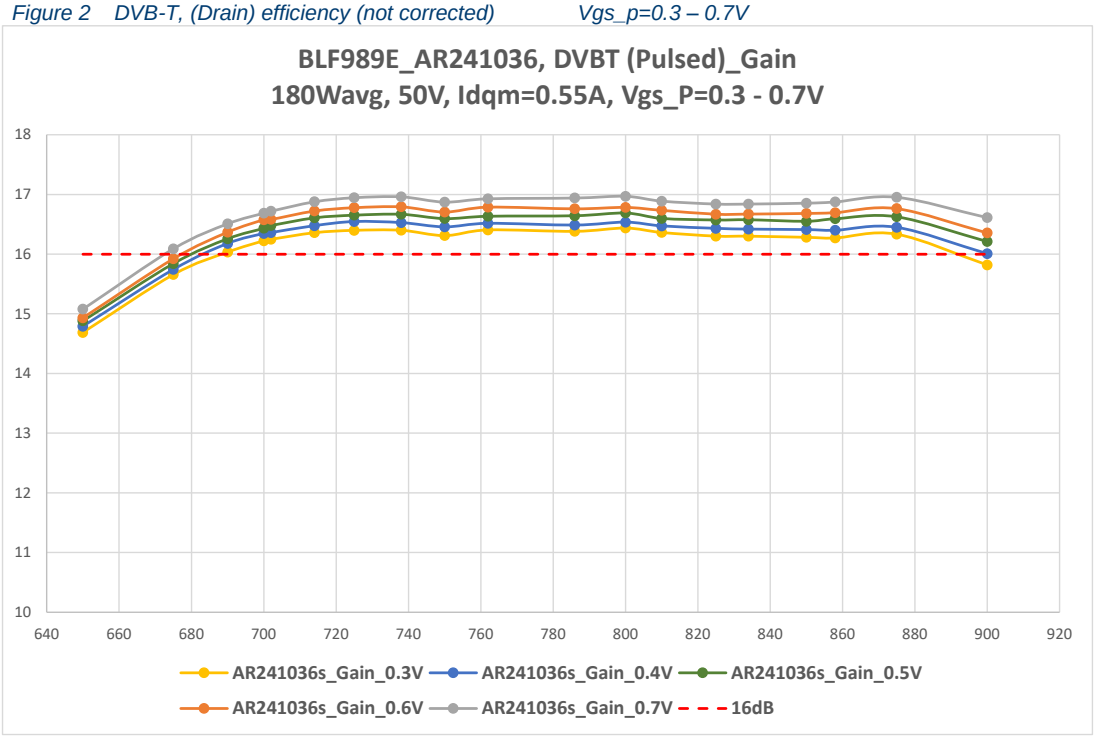

Figure 3 DVB-T, Gain (not corrected) Vgs_p=0.3 – 0.7V

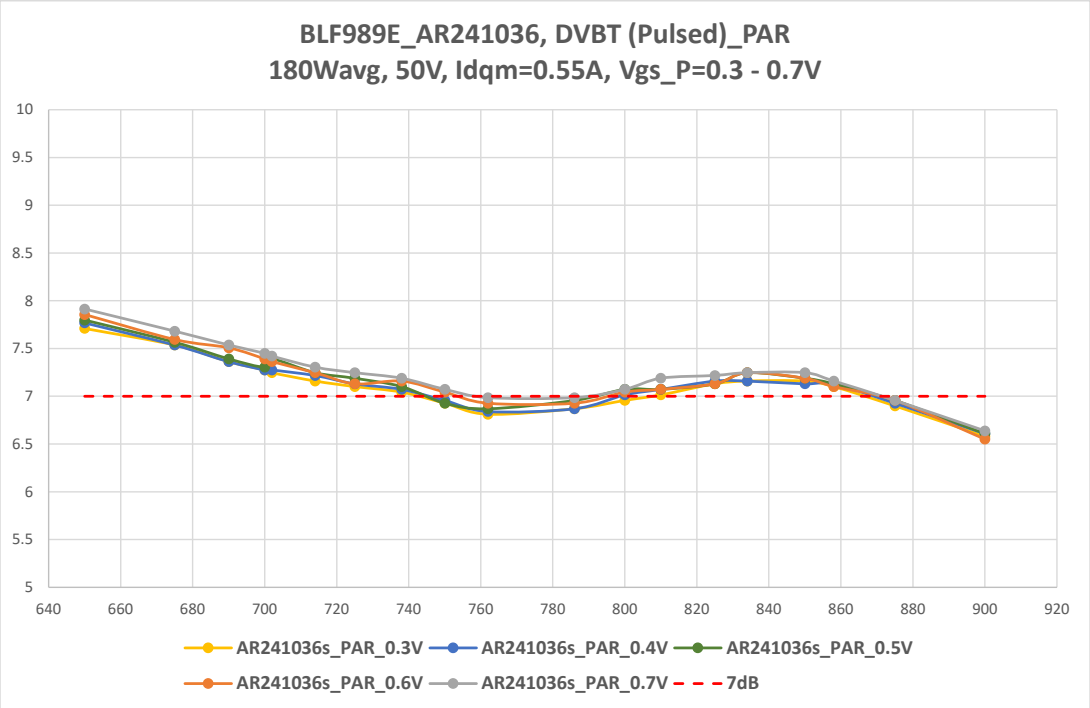

Figure 4 DVB-T PAR (not corrected) Vgs_p=0.3 – 0.7V

8.2 DVB-T measurements with pre-correction, Pavg=180W

Pre-corrected data (ProTelevision PT3000).
The measured freq range is 700 – 860Mhz.

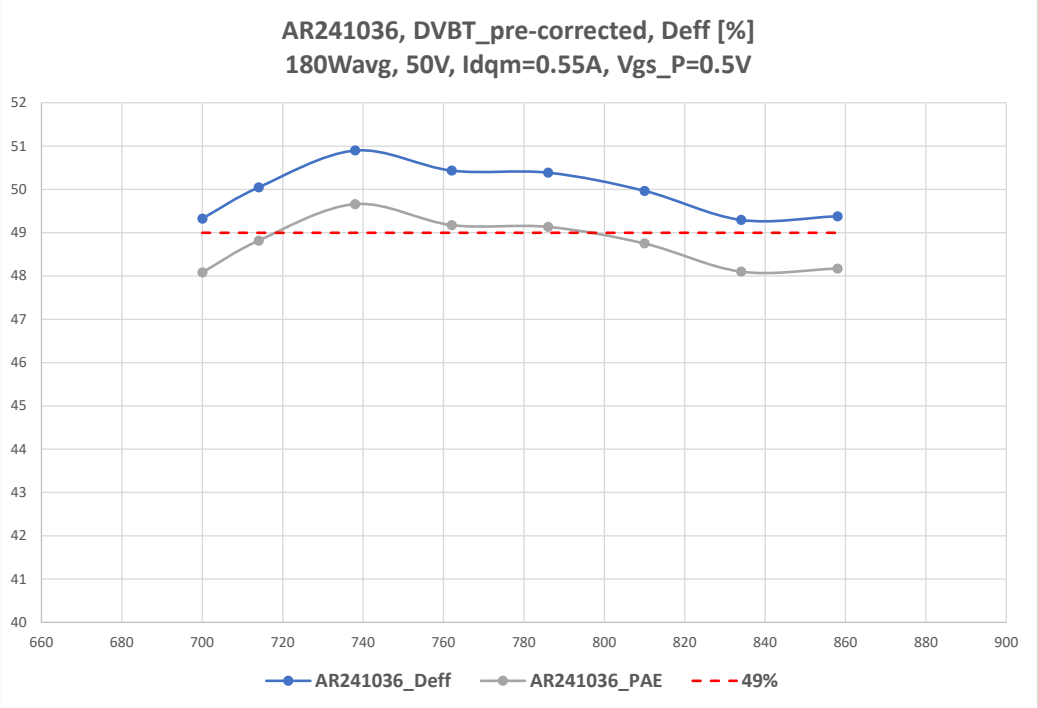

Figure 5 DVB-T, (Drain + power added) efficiency Pre-corrected values

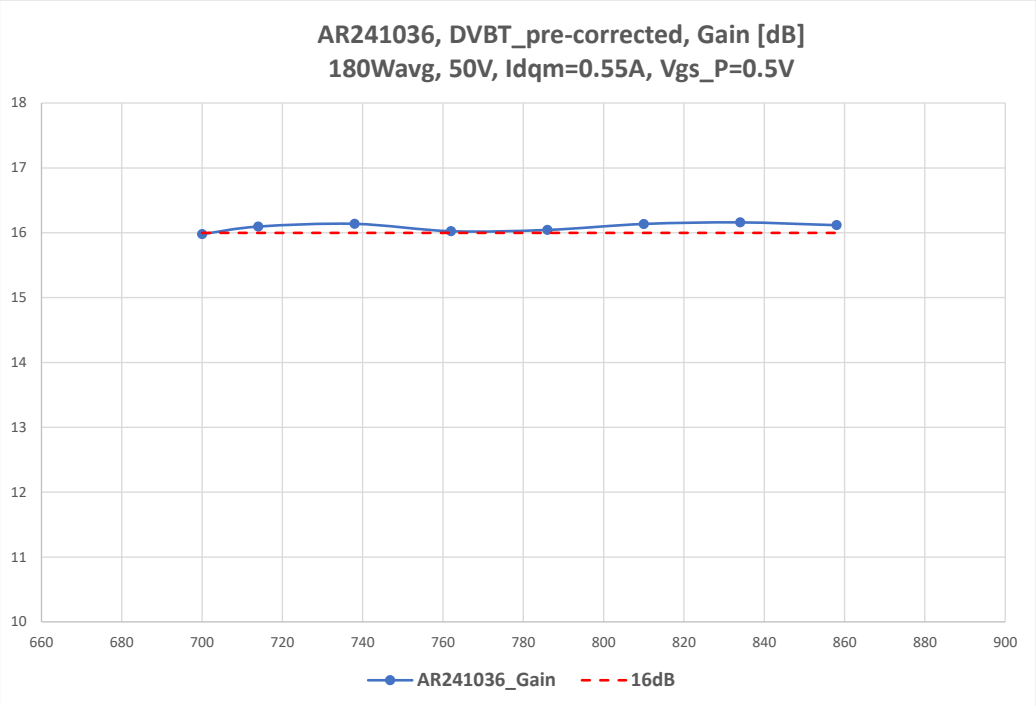

Figure 6 DVB-T, Gain Pre-corrected values

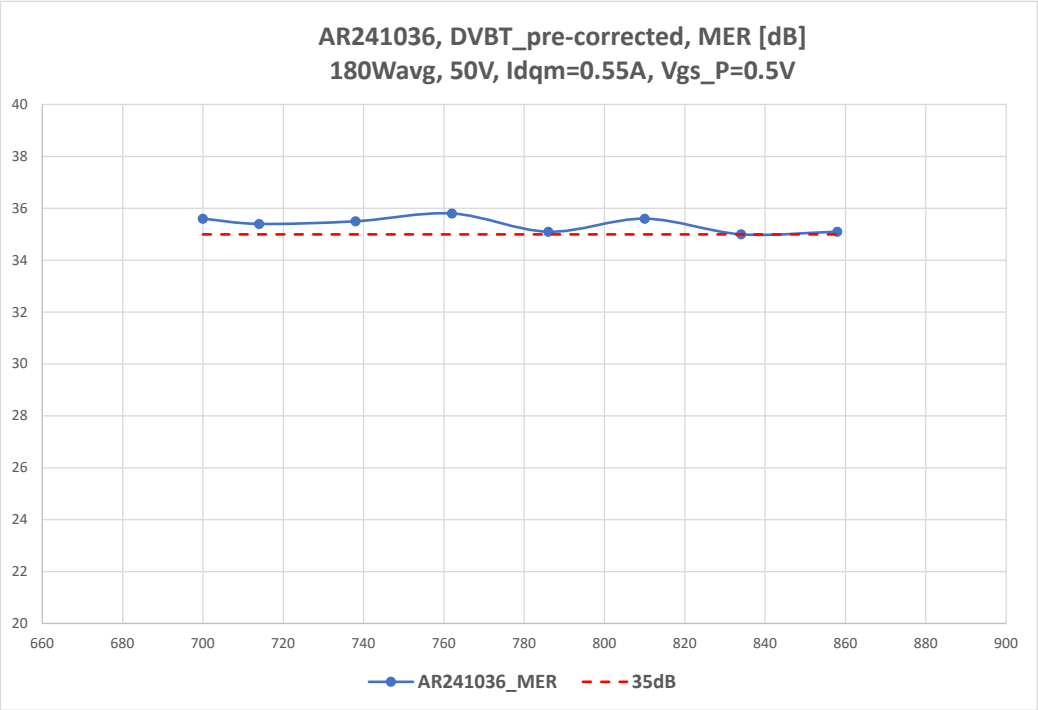

Figure 7 DVB-T, MER Pre-corrected values

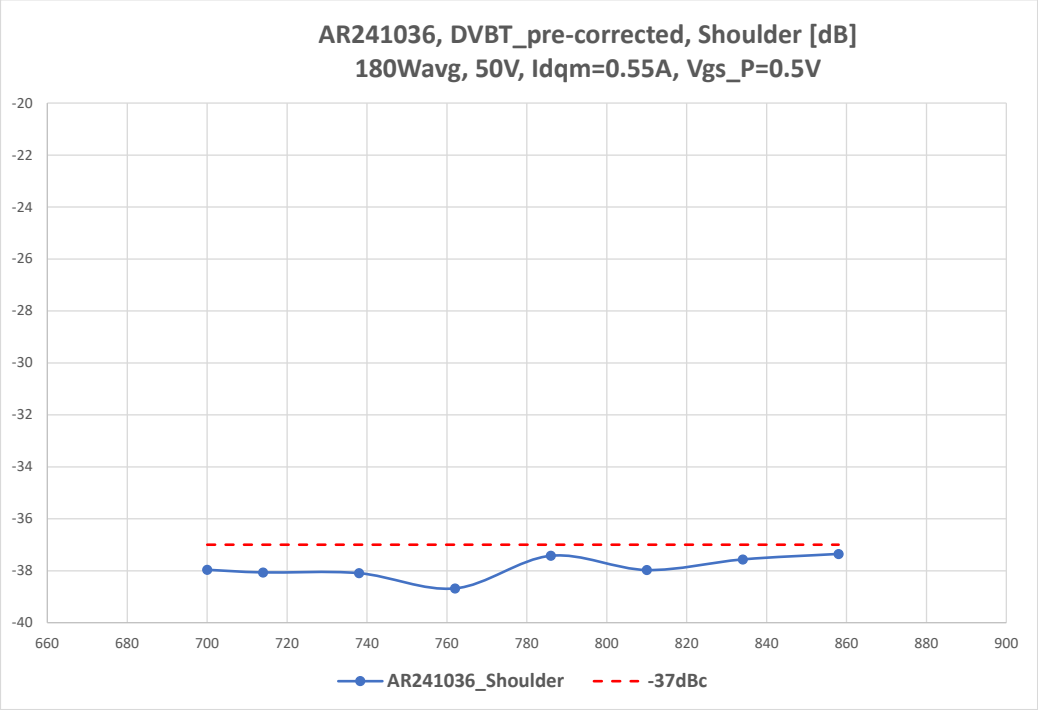

Figure 8 DVB-T, Shoulder 4.3Mhz Pre-corrected values

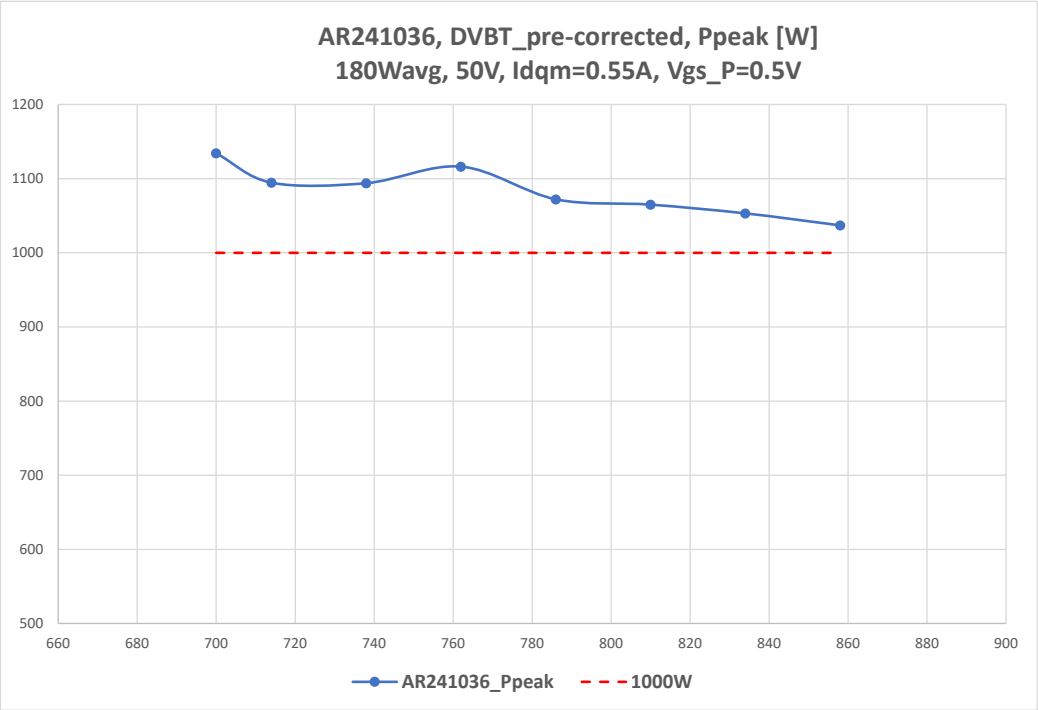

Figure 9 DVB-T, Ppeak Pre-corrected values

AR241036																
Idqm [A]	**Vgs_p [V]**	**FREQ**	**Pin (dBm)**	**Pout (dBm**	**Gain (dB)**	**Eff (%)**	**_PAE (%)**	**V1 (V)**	**Id1 (A)**	**Id2 (A)**	**Pdc (W)**	**peak (Wat**	**Pavg [W]**	**PAR (dB)**	**MER (%)**	**PR4M3 (dB**
0.55	0.5	**700**	36.60	52.58	**15.98**	**49.33**	48.08	49.79	3.93	3.44	366.87	1134.23	180.97	7.97	**35.6**	**-37.96**
0.55	0.5	**714**	36.47	52.57	**16.10**	**50.05**	48.82	49.79	3.91	3.34	360.77	1094.50	180.55	7.83	**35.4**	**-38.06**
0.55	0.5	**738**	36.42	52.56	**16.14**	**50.90**	49.66	49.81	3.83	3.29	354.52	1093.84	180.44	7.83	**35.5**	**-38.09**
0.55	0.5	**762**	36.54	52.56	**16.03**	**50.44**	49.18	49.80	3.86	3.32	357.85	1116.20	180.48	7.91	**35.8**	**-38.68**
0.55	0.5	**786**	36.52	52.56	**16.05**	**50.39**	49.13	49.80	3.82	3.37	358.10	1072.09	180.43	7.74	**35.1**	**-37.42**
0.55	0.5	**810**	36.43	52.56	**16.14**	**49.97**	48.75	49.80	3.92	3.33	361.09	1064.91	180.43	7.71	**35.6**	**-37.97**
0.55	0.5	**834**	36.41	52.57	**16.16**	**49.29**	48.10	49.78	4.00	3.37	366.83	1053.12	180.83	7.65	**35**	**-37.56**
0.55	0.5	**858**	36.45	52.56	**16.12**	**49.38**	48.17	50.09	3.94	3.35	365.41	1036.95	180.44	7.59	**35.1**	**-37.35**

Table 3: AR241036, Pre-corrrected data 700 – 860 Mhz

The top table shows the pre-corrected measurements at 180Wavg. A minimum MER of 35dB with a shoulder distance of approx. 38dBc was achieved over the band 700-860Mhz.
A trade-off between power/linearity and efficiency can be made via Vgs_P and Vdd.

8.3 Pulsed CW measurements

Pulse condition: 100µs/10%. P6dB gives the best indication of the peak power capability.

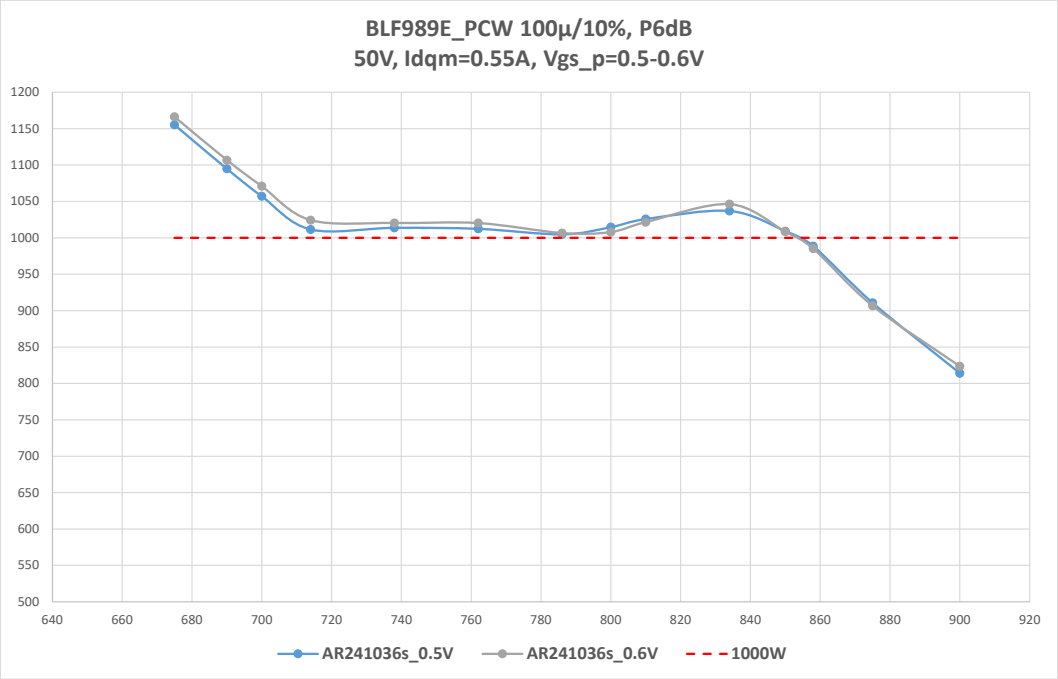

Figure 10 Pulsed CW, P6dB [W] Vgs_p = 0.4 ÷ 0.7V

8.4 Pulsed CW power sweeps

Pulse condition: 100µs/10%. Vdd=50V

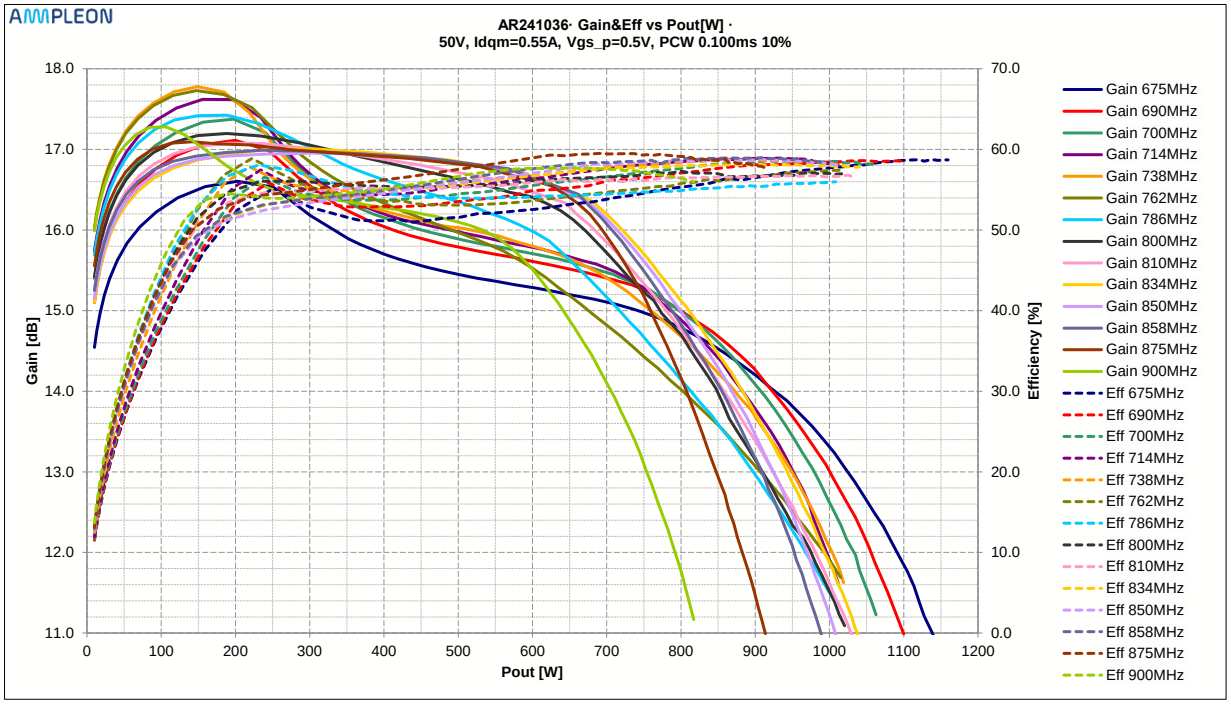

Figure 11 Pulsed CW, Gain [dB] + eff [%] as function of Pout [W] Vgs_p=0.5V

Good pre-correction at 180Wavg (DVB-T) can be achieved when the pulsed CW power at P6dB is approx. 0.95 – 1 kW. This was achieved in the band 700-860Mhz.

9. Hardware

9.1 Board Image

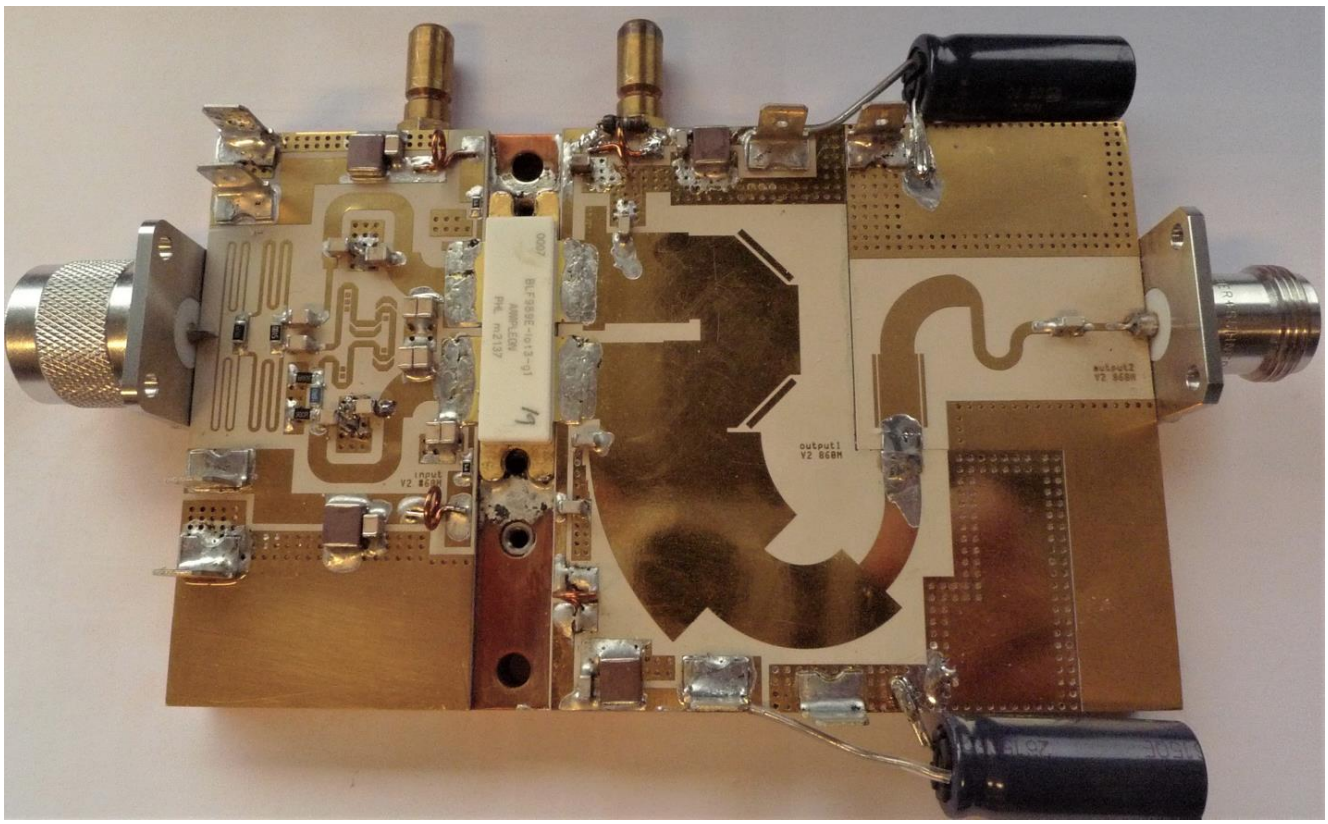

Figure 12 Picture of AR241036, 700-860Mhz board

Total board dimensions: 130 x 80mm

9.2 Copper Layout

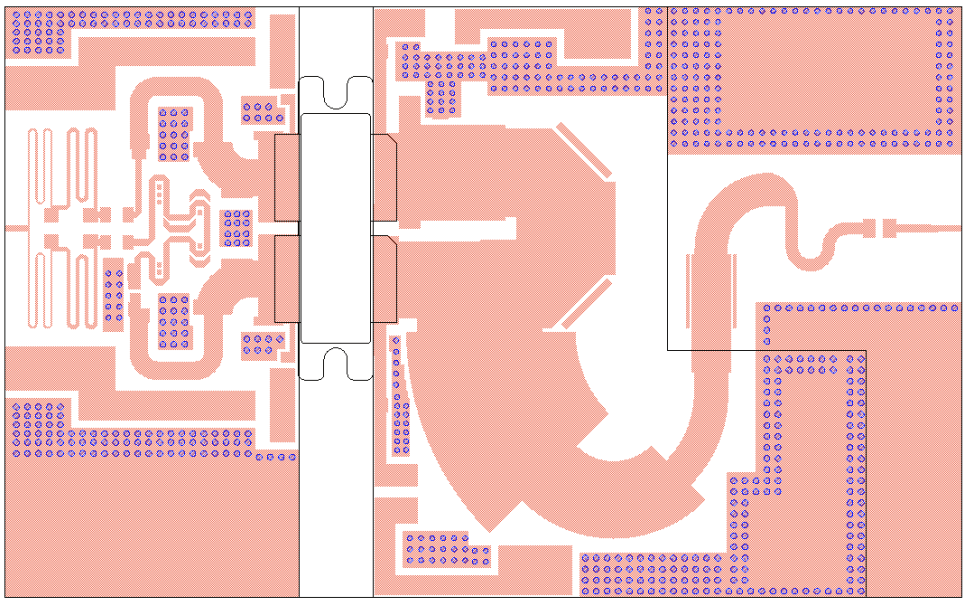

Figure 13 Layout drawing

9.3 Component Mapping

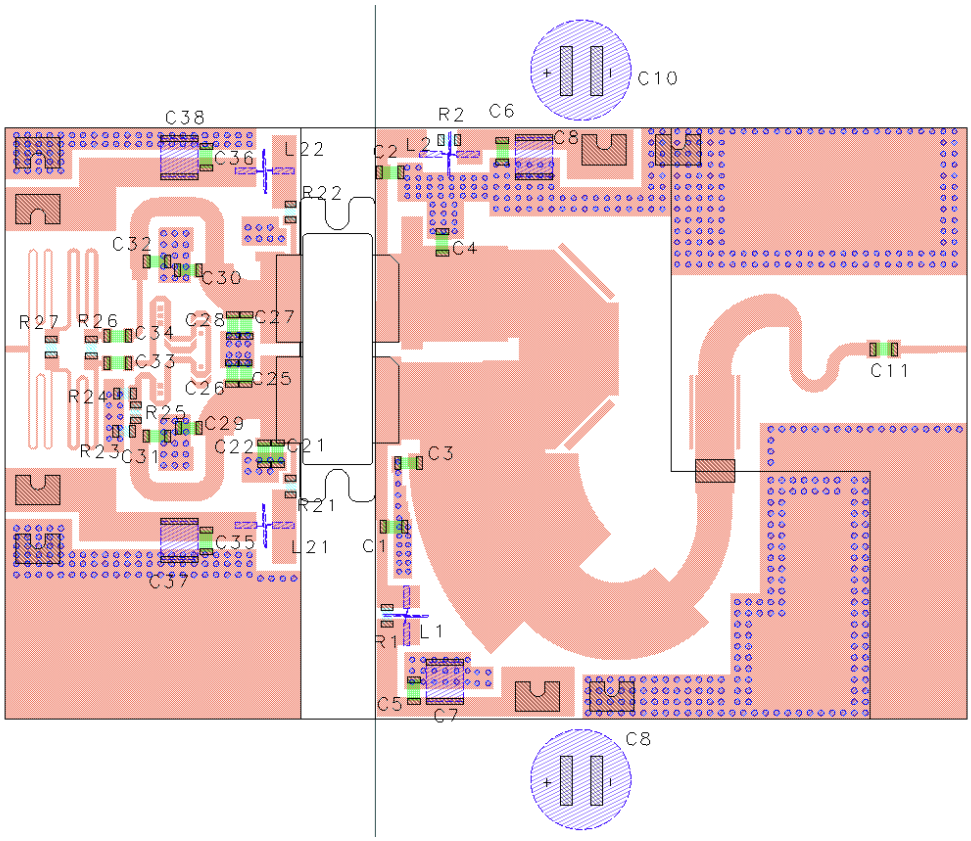

Figure 14 Component drawing

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