AFT09MS031N, AFT05MS031N Application in **Tetra** and **DMR/dPMR**

Li Jun | RFPP FAE

JULY.2015

External Use

Analog to Digital Revolution

Advantages of digital radio:

1. Frequency efficiency improved. Use the same frequency resource but improved volume;

2. Safety. The communication is encrypted and burst transmitted;

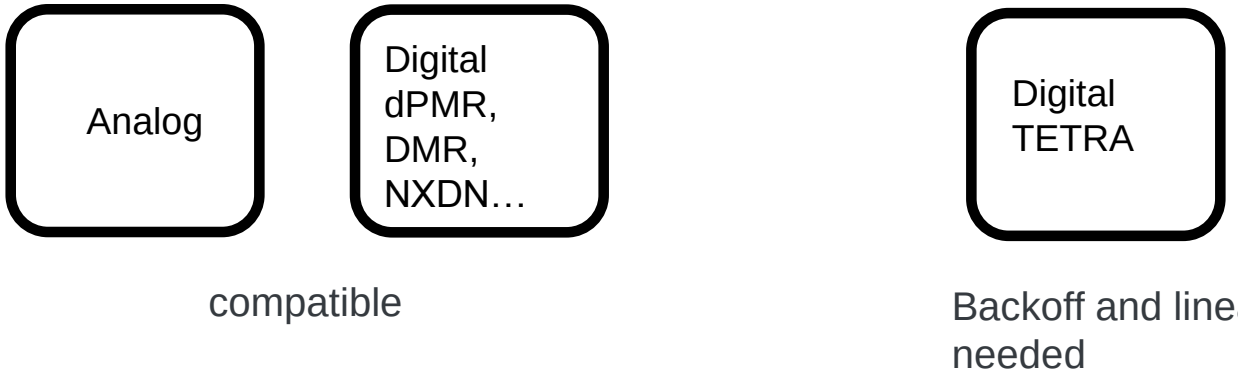
3. Traffic management. Intelligent channel resource allocation;

4. Diversify communication modes: peer to peer, peer to group, group to group;

5. Digital data. Voice, text, multimedia…

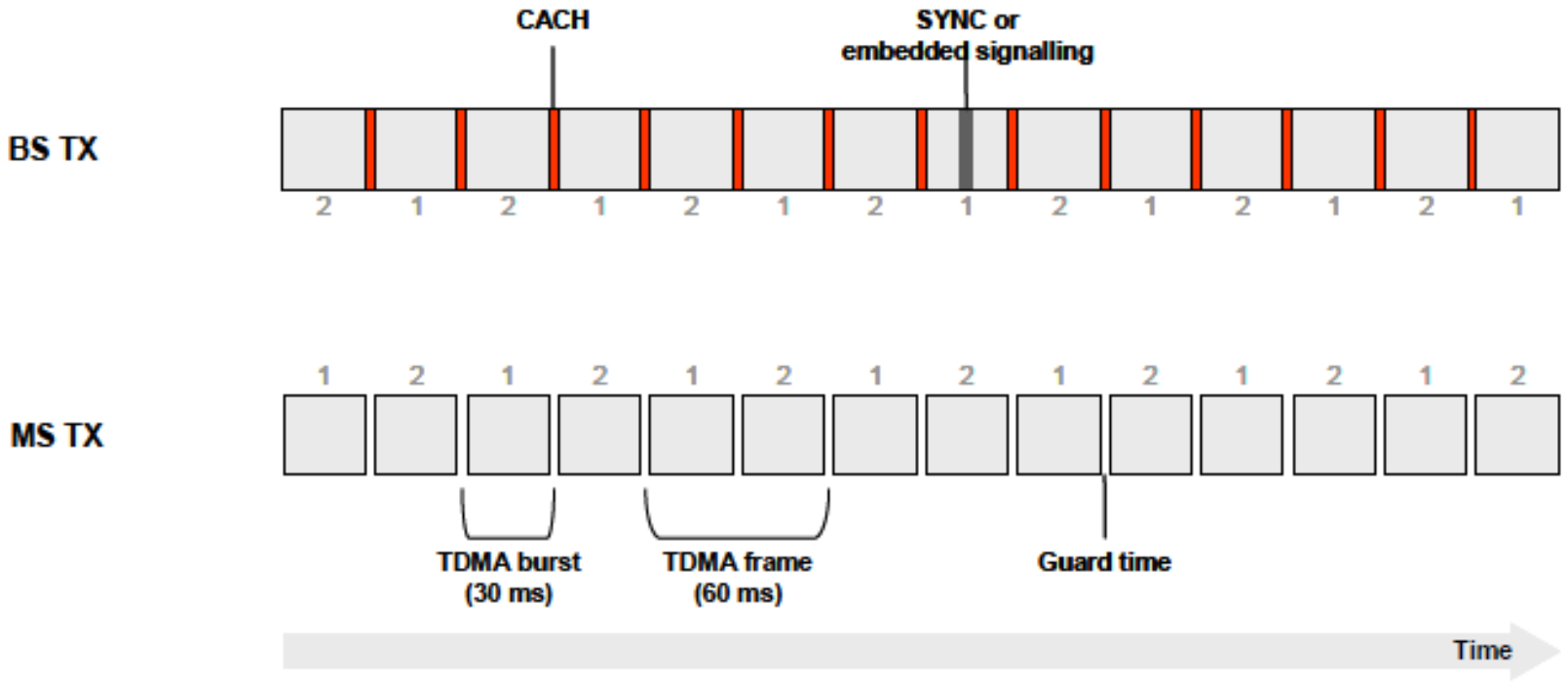
Analog to Digital Revolution

- Some digital radio uses constant envelope modulation, so it can still re-use the analog radio PA design; For those high order QAM and OFDM modulations, power back off and linearizer is necessary.



Digital LMR--DMR

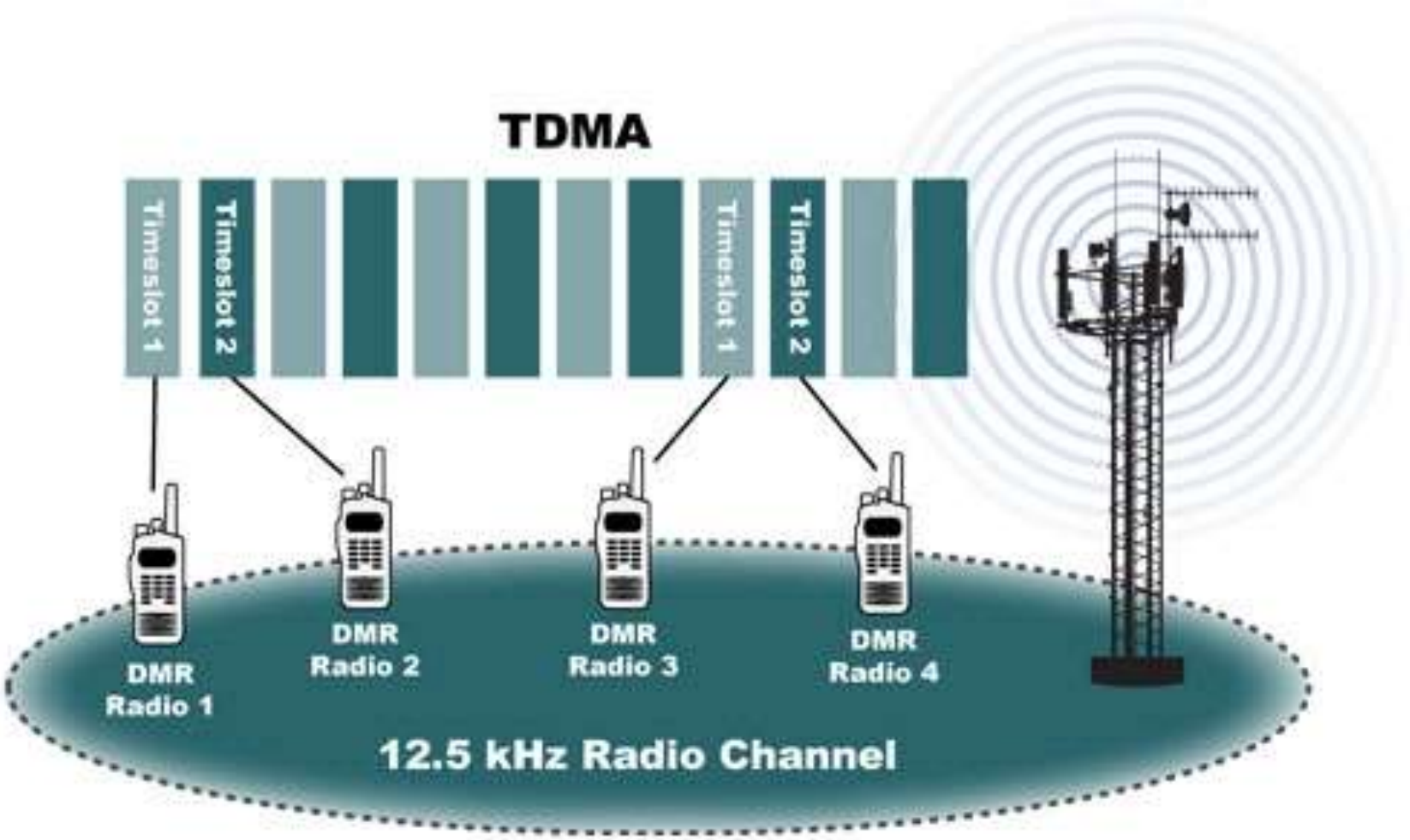
- DMR spec:
  1. 4FSK modulation in 12.5kHz bandwith;
  2. TDMA with 2 time slots.



NOTE: The example timing in figure 4.2 applies to a two frequency BS.

Figure 4.2: TDMA timing overview

DMR TDMA diagram



The Mobile Station Burst Timing

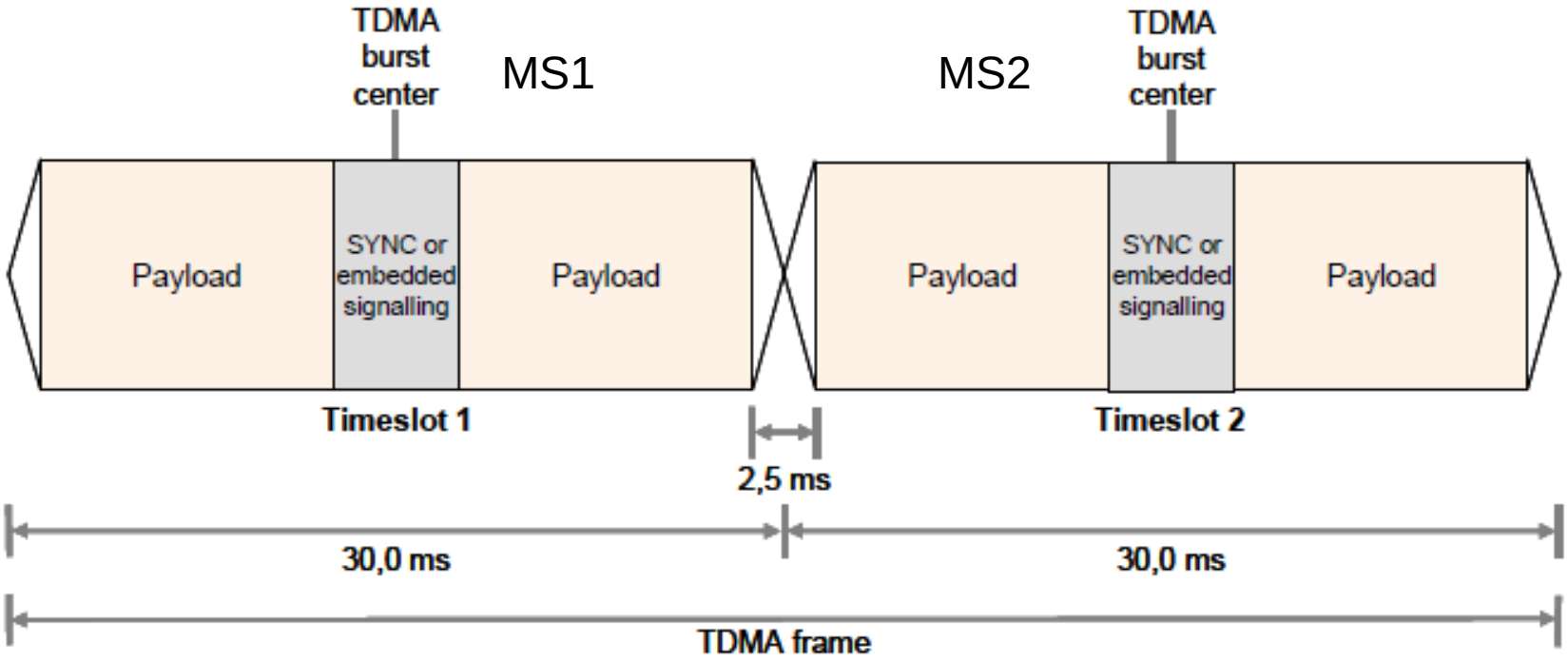


Figure 4.4: MS sourced TDMA frame

2.5ms guard time between 2 slots

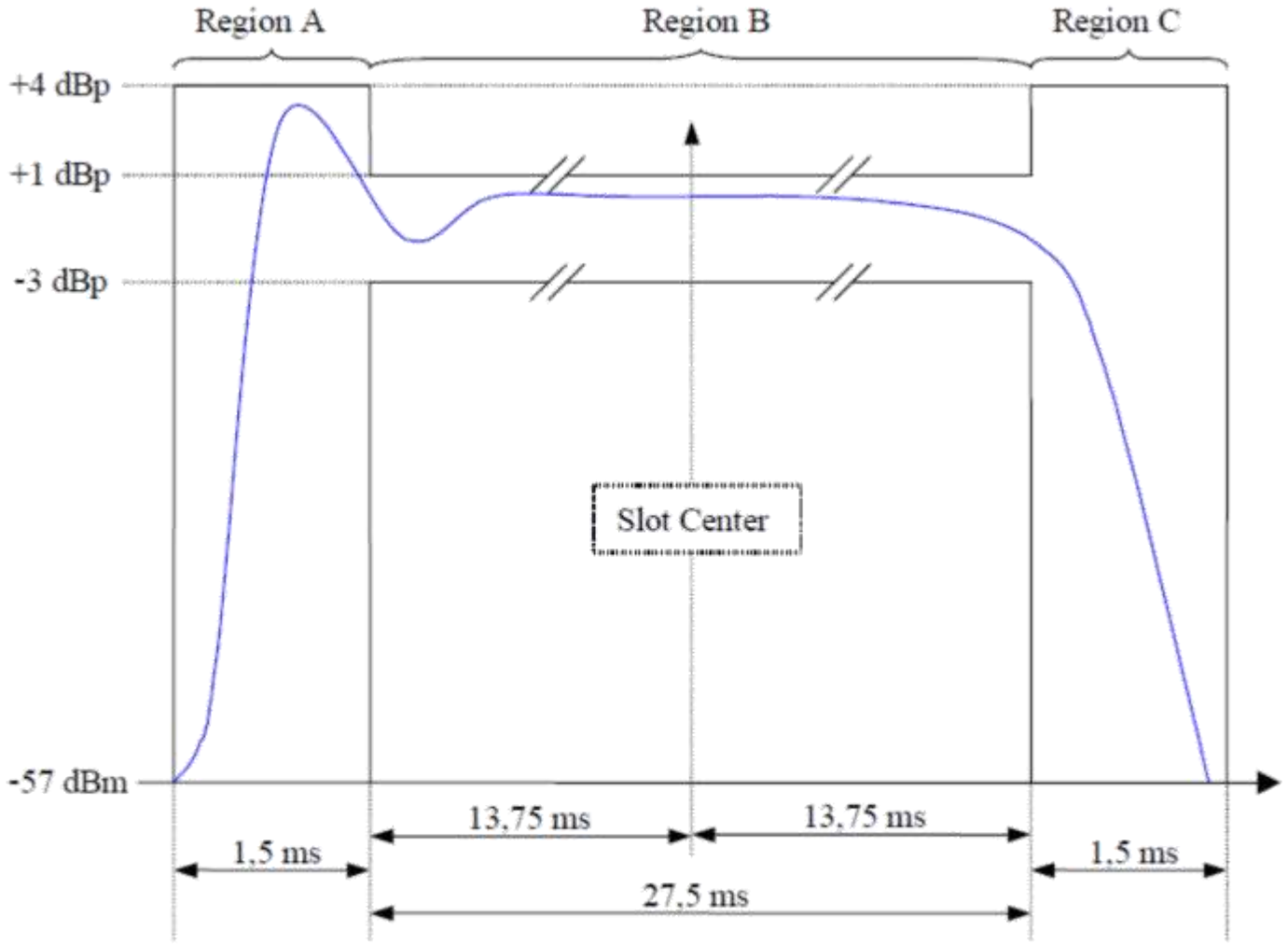


Figure 10.3: Power waveform mask for normal burst

TDD test on AFT0531

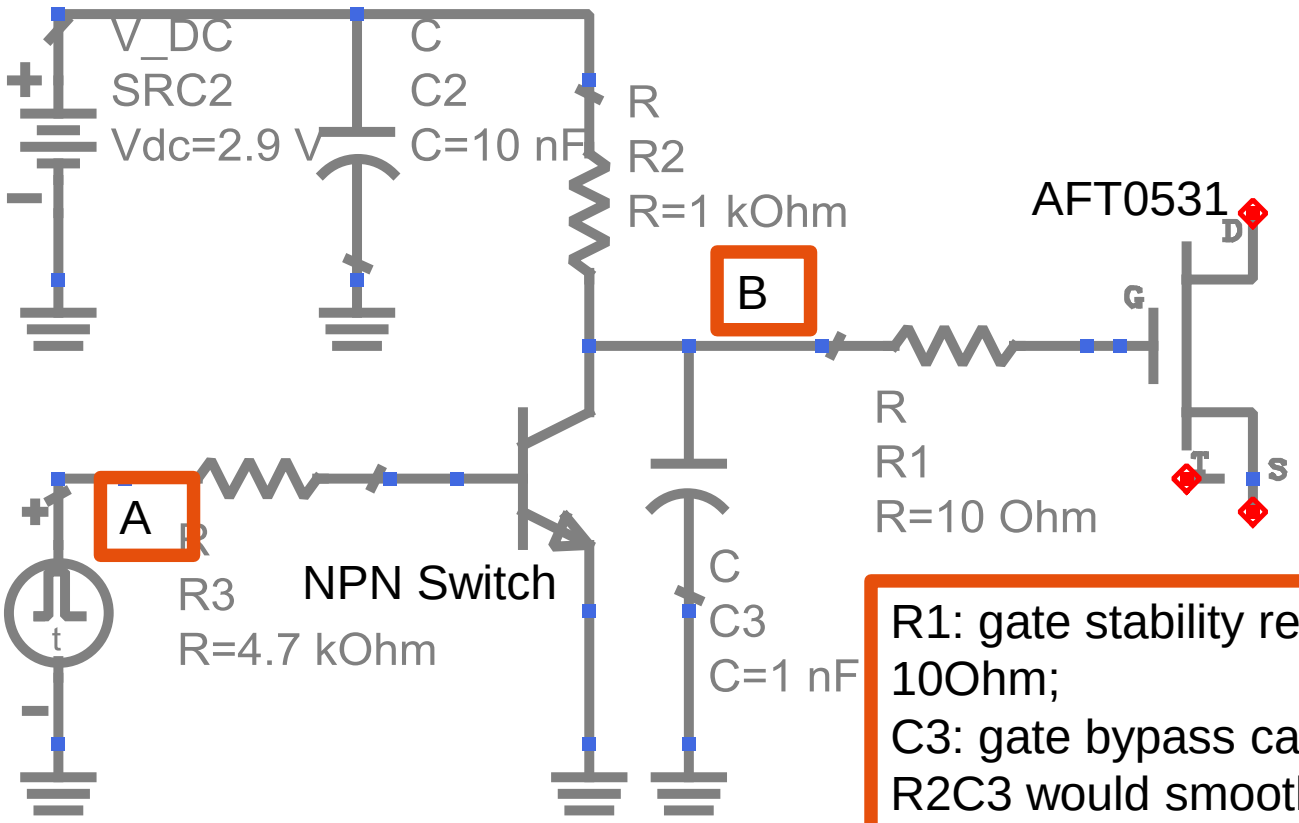
1. AFT0531 VHF demo is used for test;
2. Test at 135MHz. The CW data is below:

Freq (MHz)	Pin (dBm)	Pout (dBm)	Gain (dB)	IRL (dB)	Eff (%)	Vds (V)	Ids (A)
135	30	46	16	-8	71.2	13.6	4.13

3. TTL pulse (30ms/60ms) is used to switch the AFT0531 gate with 1W Pin continuous on;

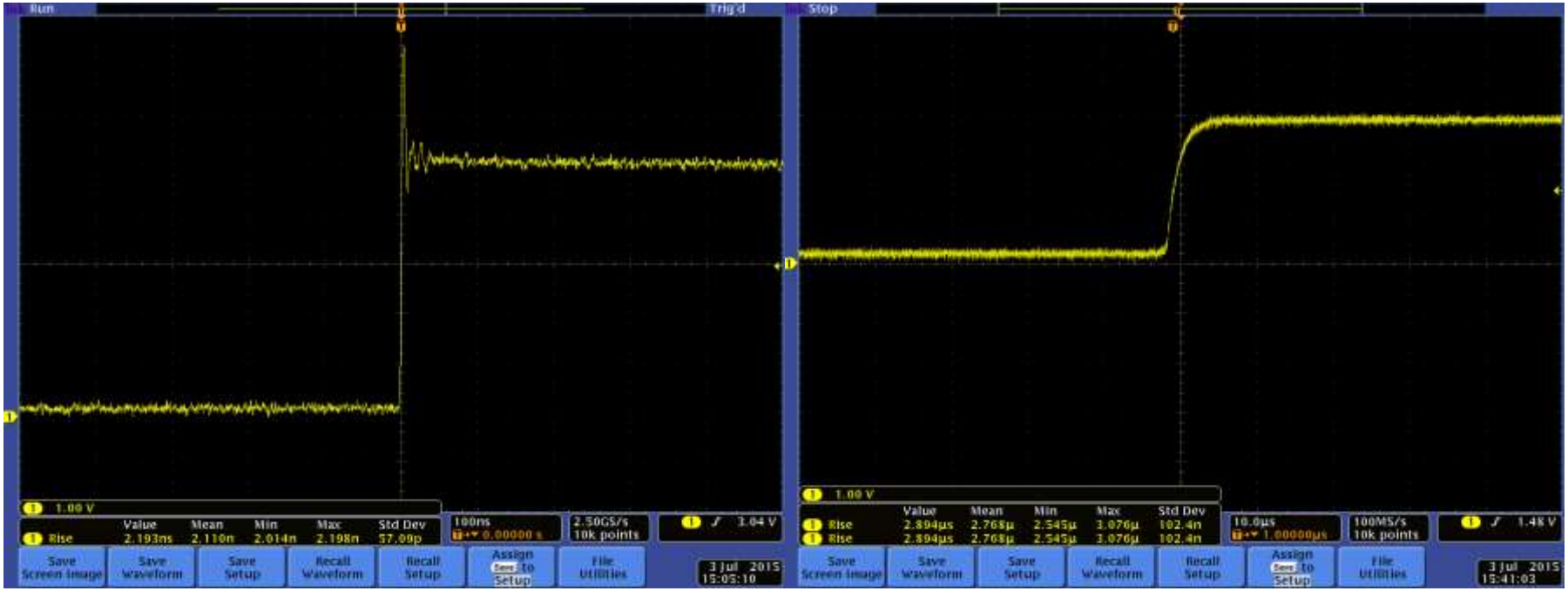
4. ***The test lasts for 10min. AFT0315 is OK.***

Test setup diagram



R1: gate stability resistor 10Ohm;
C3: gate bypass cap 1nF;
R2C3 would smooth the pulse with time constant=1us.

Pulse waveform



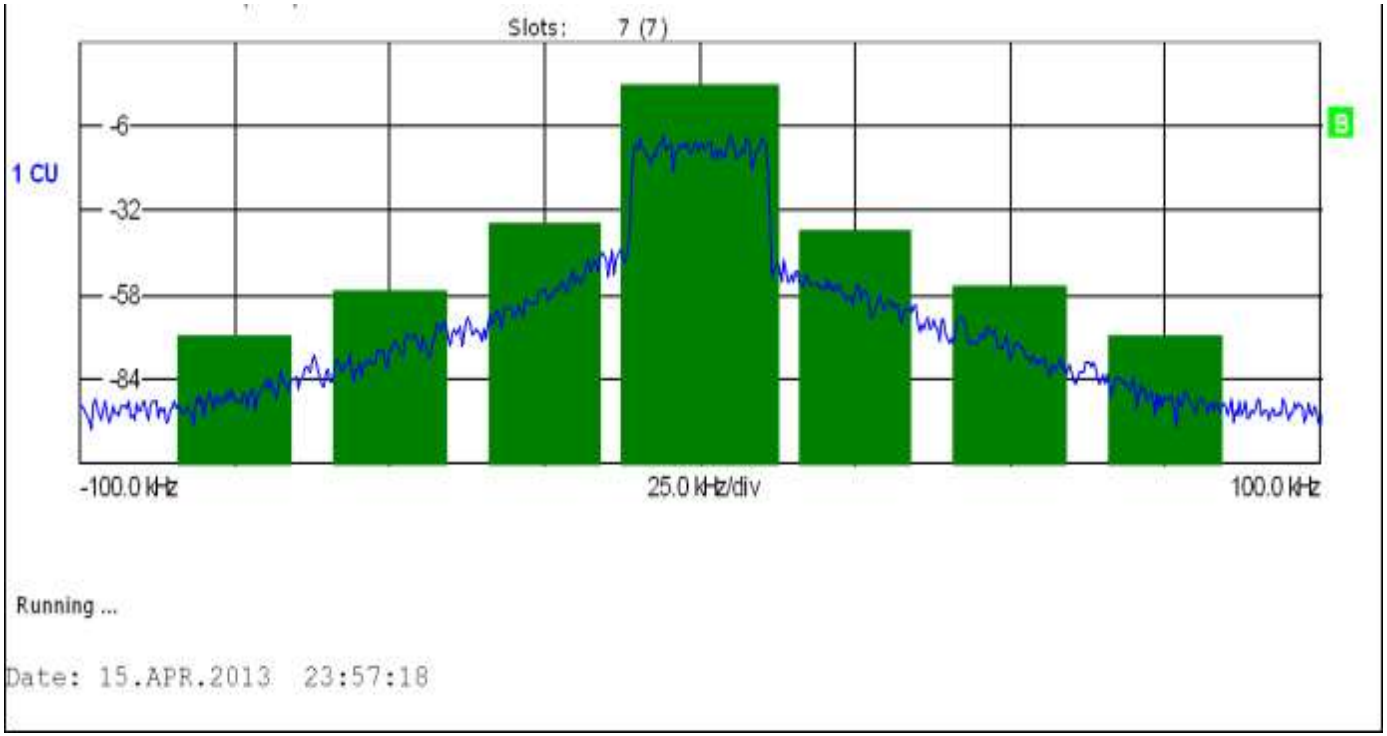
Pulse generator waveform
Rising time:<0.1us

VGS waveform
Rising time:<3us

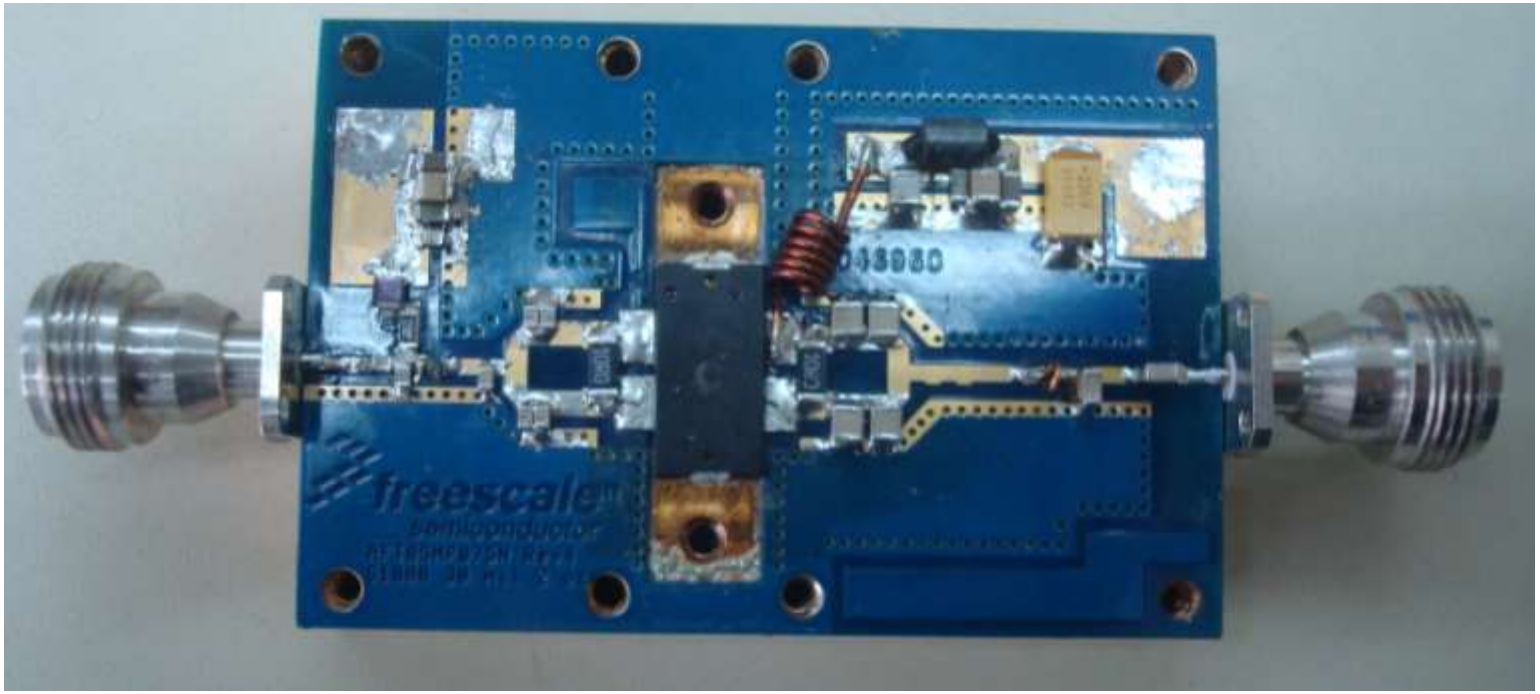
Test lasts for 10min. AFT0315 is OK.

Digial LMR--TETRA

- TETRA1--QPSK modulation in 25kHz, 3.6dB peak to average ratio;
- TETRA2--OFDM 25kHz, 10dB peak to average ratio!
- Linear amplifier is required to meet the spectrum mask;

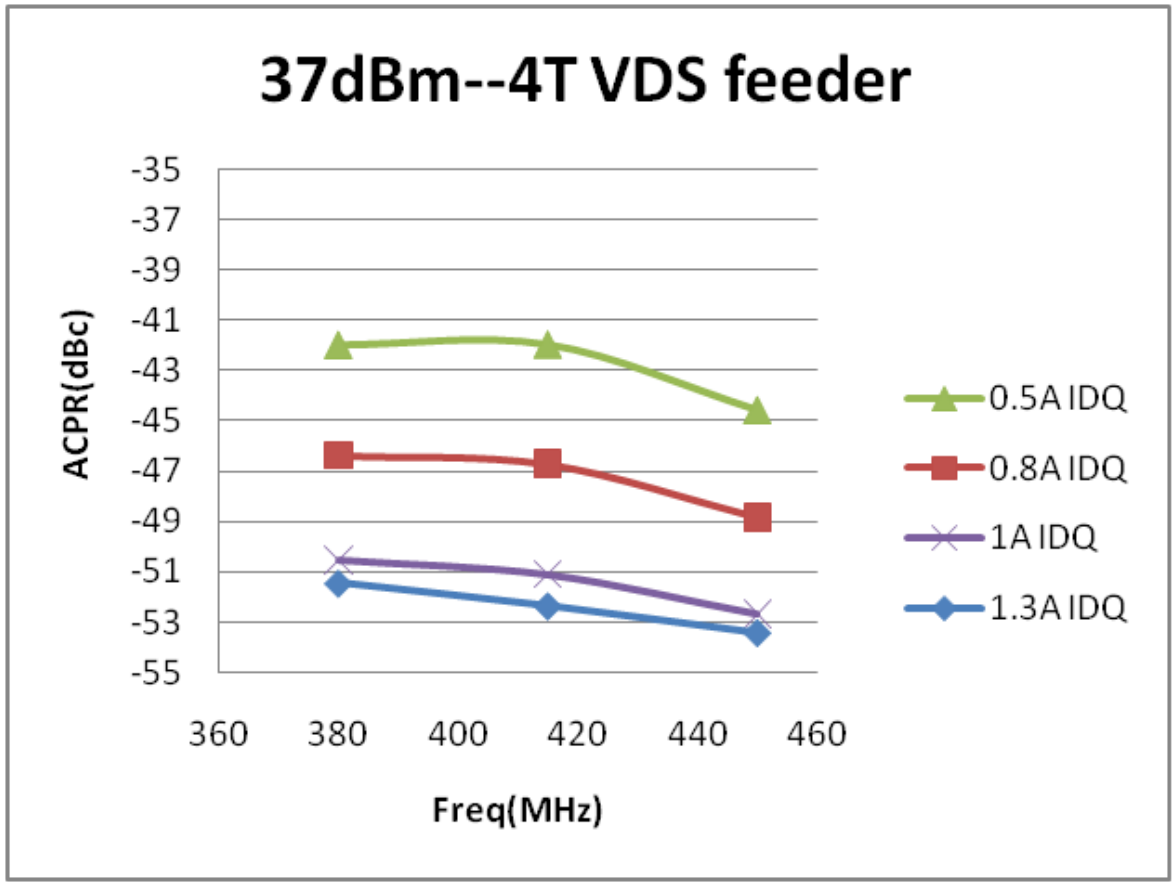


AFT05MP075 5-10W TETRA2 PA



Frequency band: 380-475MHz;
VDS=13.2V.

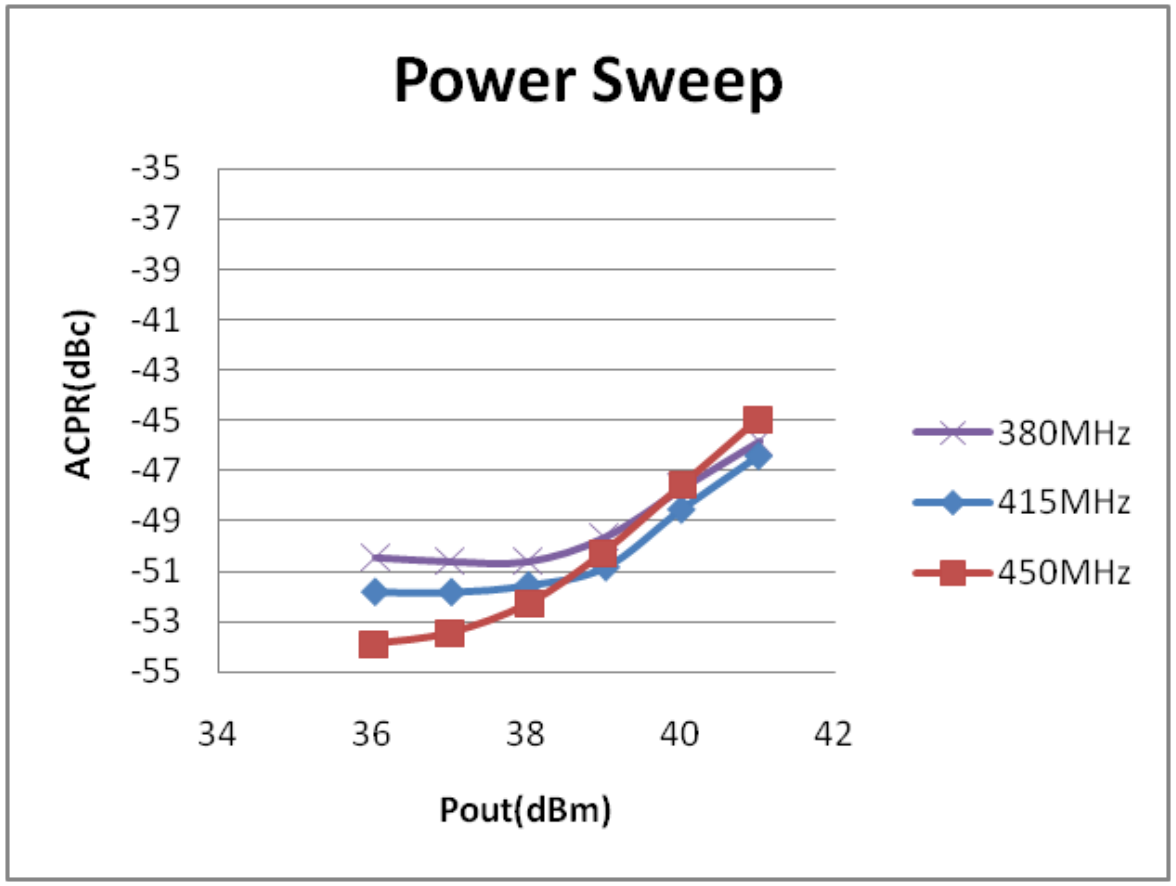
Linearity under 10dB PAR signal



Test signal: IS95 1C
10.3dB PAR
Pout=37dBm

The APCR improved to 50dBc after IDQ and VDS feeder changed.

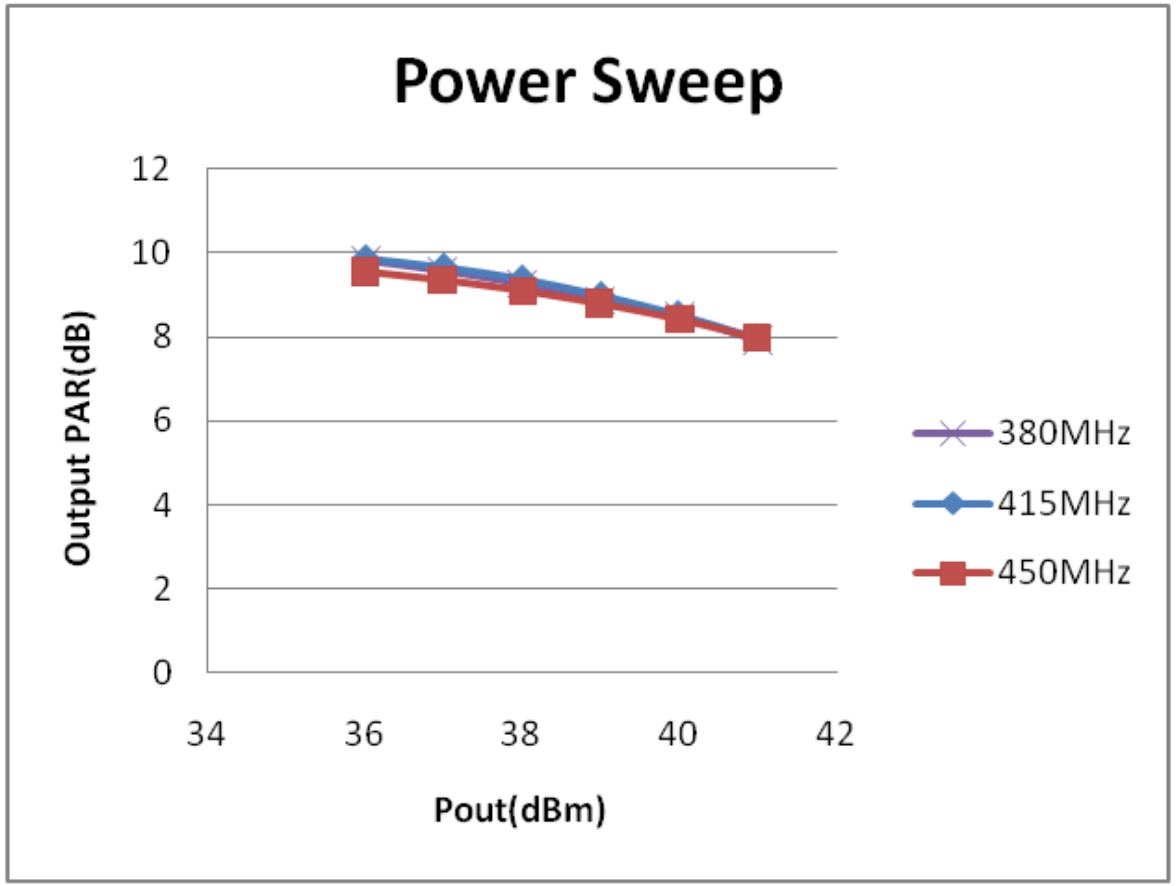
Linearity vs Output Power



Test signal: IS95 1C
10.3dB PAR
Pout=37dBm
1A IDQ

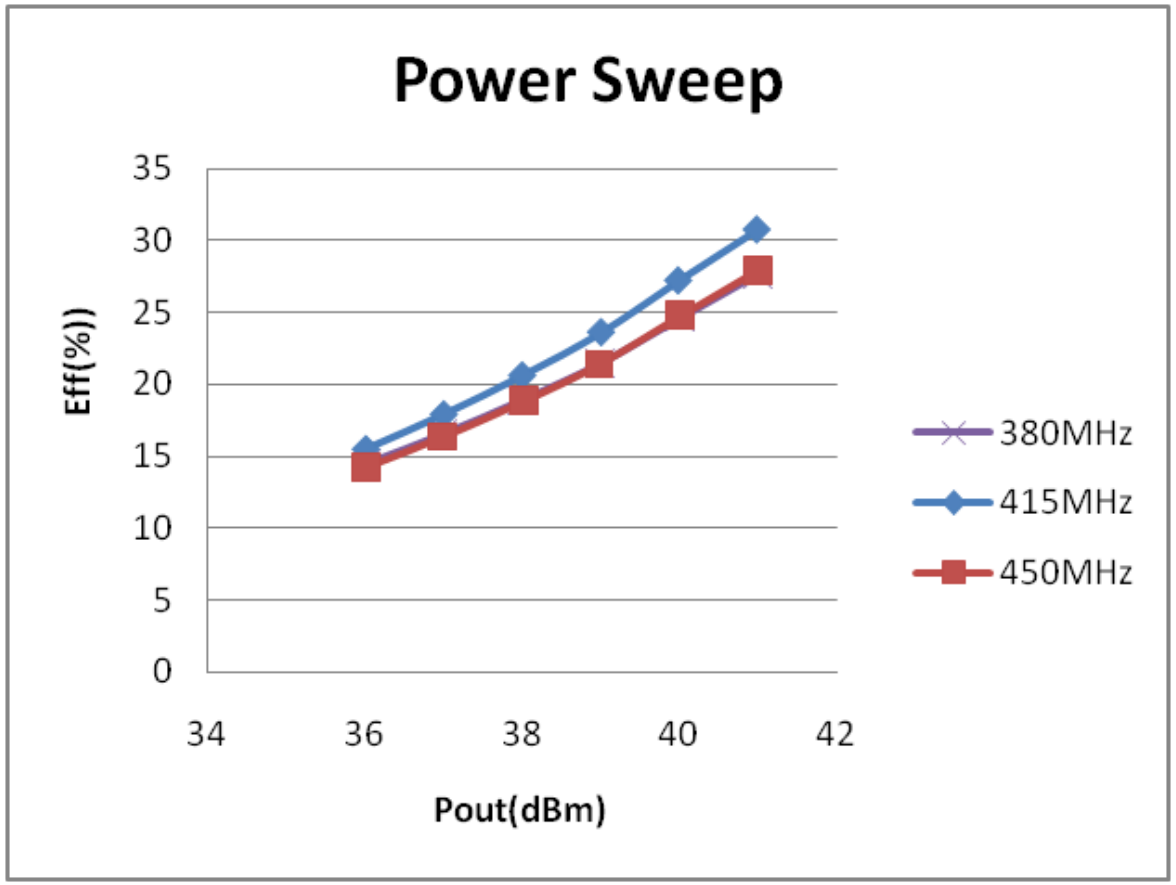
The APCR remains below 50dBc until 39dBm Pout.

PAR vs Output Power



Test signal: IS95 1C
10.3dB PAR
Pout=37dBm
1A IDQ

Efficiency vs Output Power

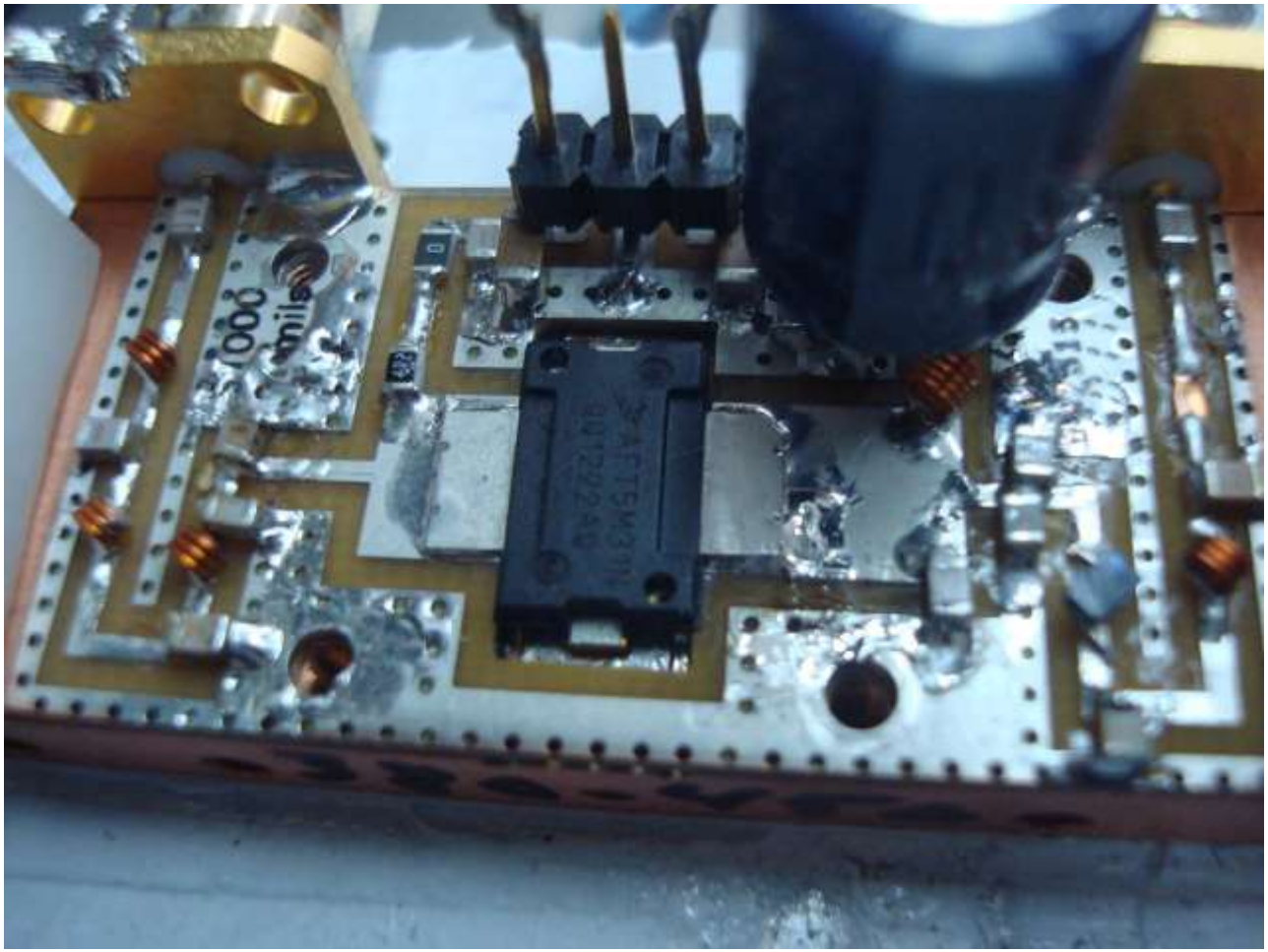


Test signal: IS95 1C
10.3dB PAR
Pout=37dBm
1A IDQ

Conclusion

- With proper VDS feeder inductance and bypass caps, 0575 380-450MHz demo linearity can be improved by 10dB (dual bias has 2dB improvement) ;
- 0575 has super linearity performance under high PAR complex modulated signal.

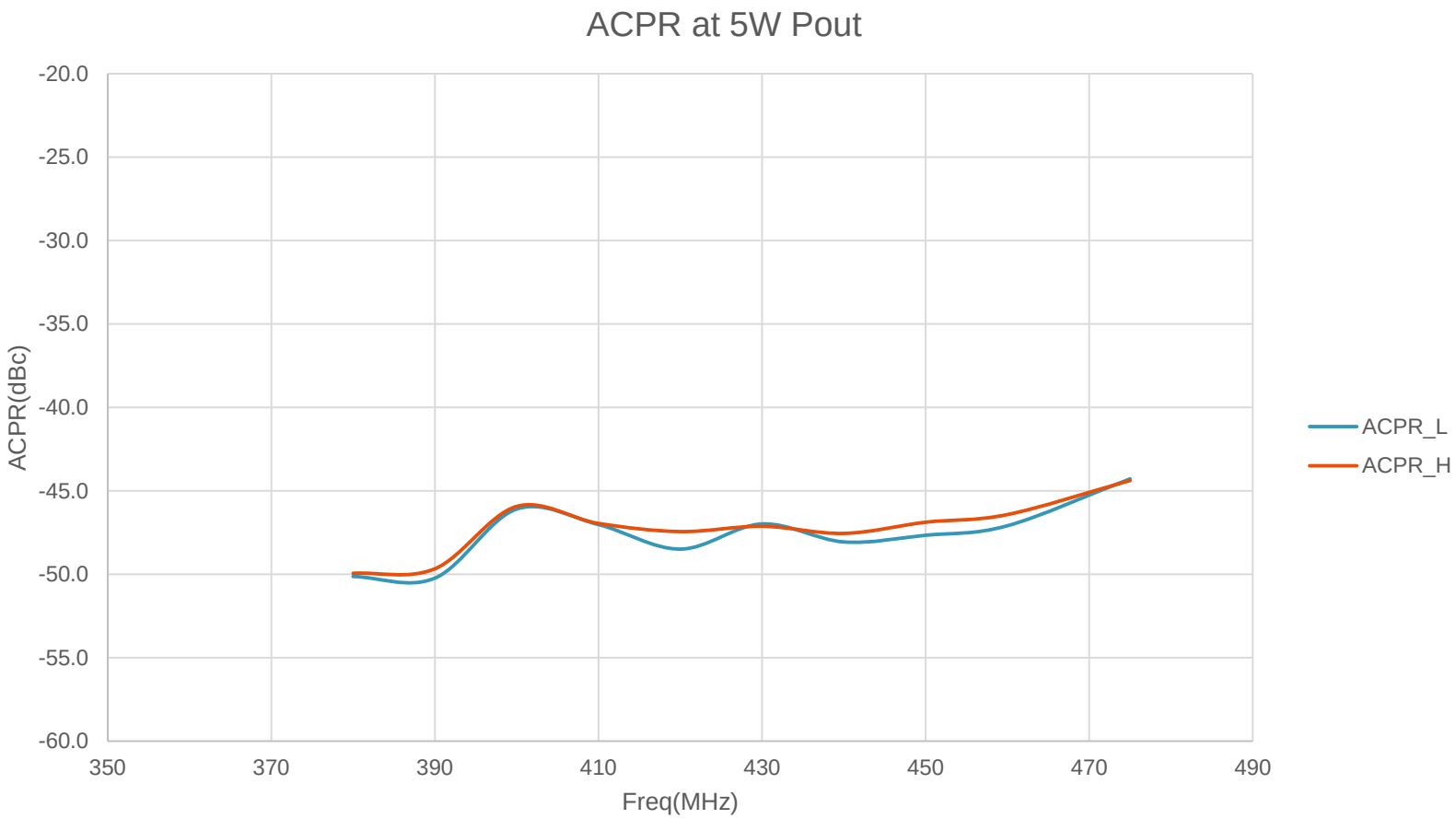
AFT0531 5W TETRA2 PA



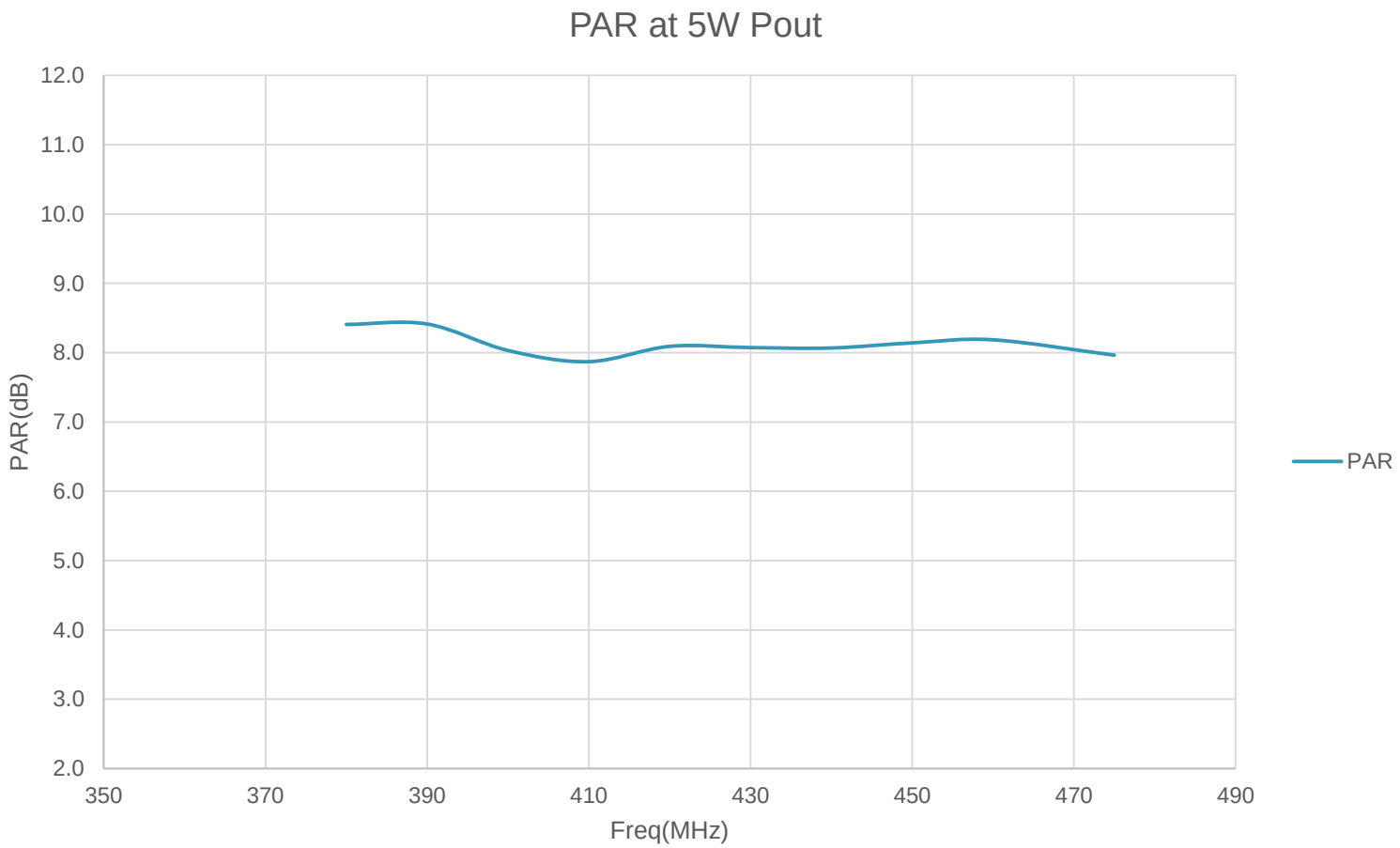
AFT0531 380-475MHz CW data

Freq (MHz)	Pin (dBm)	Pout (dBm)	Pout (W)	Gain (dB)	IRL (dB)	Eff (%)	Vds (V)	Vgs (V)	Idmm (A)	Idmmq (A)
380	27.0	45.3	33.7	18.3	-9.8	59.4	13.2	3.1	4.3	0.5
390	27.0	45.5	35.8	18.5	-10.5	62.9	13.2	3.1	4.3	0.5
400	27.0	45.4	34.9	18.4	-10.6	64.1	13.2	3.1	4.1	0.5
410	27.0	45.2	33.3	18.2	-10.6	63.2	13.2	3.1	4.0	0.5
420	27.0	45.7	36.9	18.7	-10.6	70.4	13.2	3.1	4.0	0.5
430	27.0	45.7	37.3	18.7	-10.9	72.4	13.2	3.1	3.9	0.5
440	27.0	45.6	36.6	18.6	-11.3	71.6	13.2	3.1	3.9	0.5
450	27.0	45.6	36.6	18.6	-11.8	70.1	13.2	3.1	3.9	0.5
460	27.0	45.6	36.4	18.6	-12.2	68.1	13.2	3.1	4.0	0.5
470	27.0	45.5	35.7	18.5	-11.6	67.2	13.2	3.1	4.0	0.5
475	27.0	45.4	34.7	18.4	-10.9	66.9	13.2	3.1	3.9	0.5

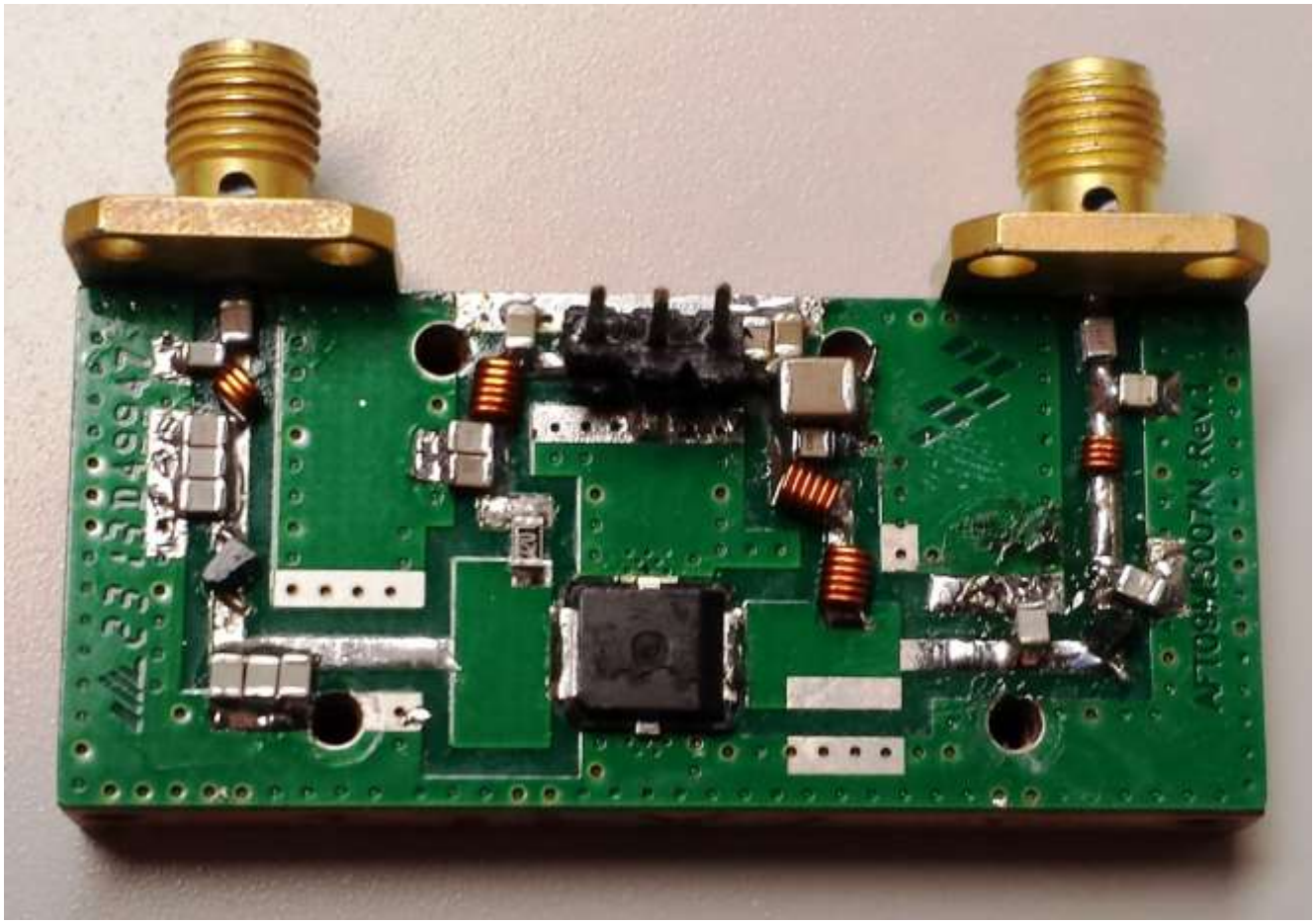
AET0531 380-475MHz output linearity



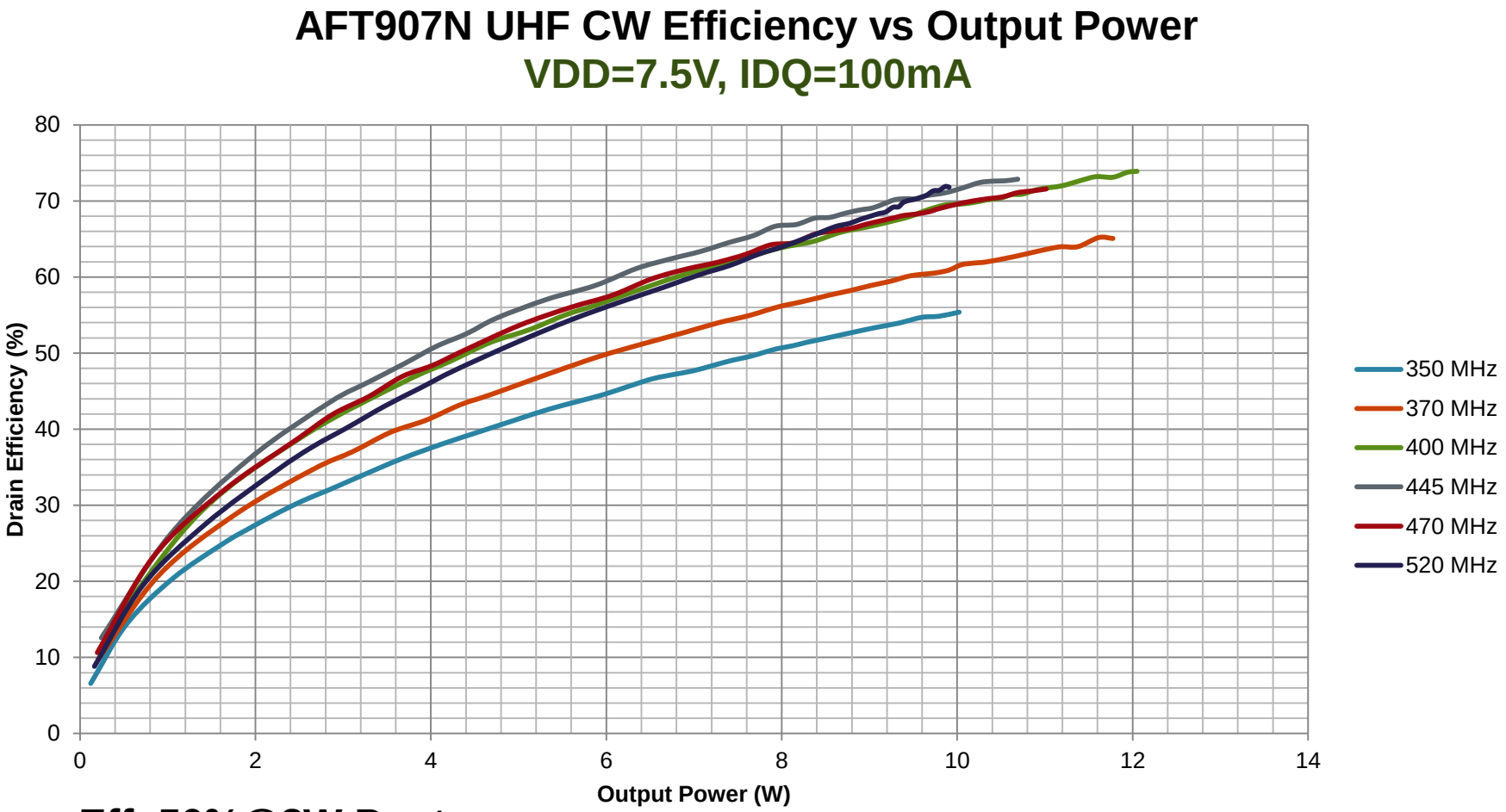
AFT0531 380-475MHz output PAR



AFT09MA007 4W 350-520MHz TETRA1



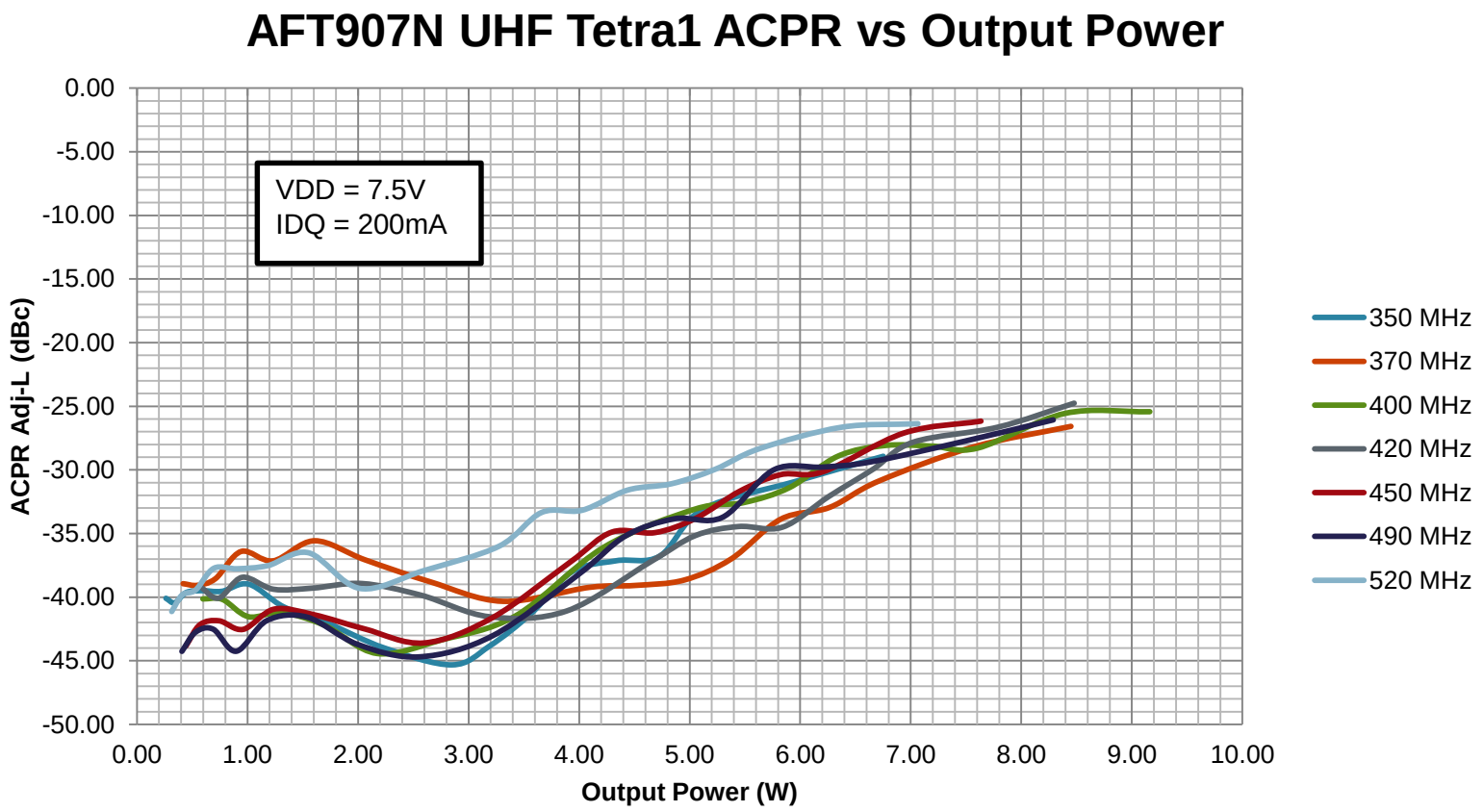
CW performance



Eff>50%@8W Pout

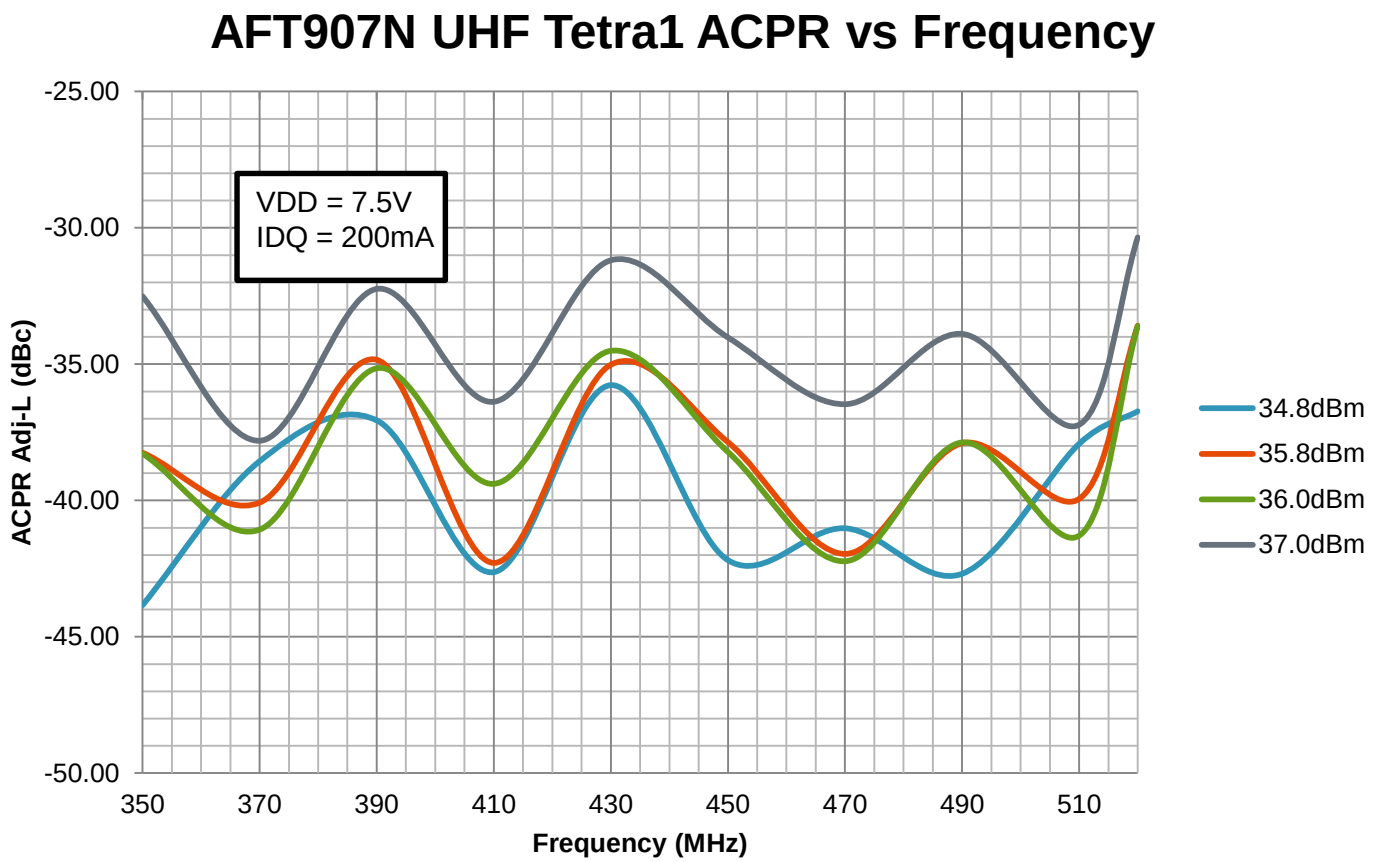
Eff>50%@5W Pout for freq>370MHZ

Power vs. linearity



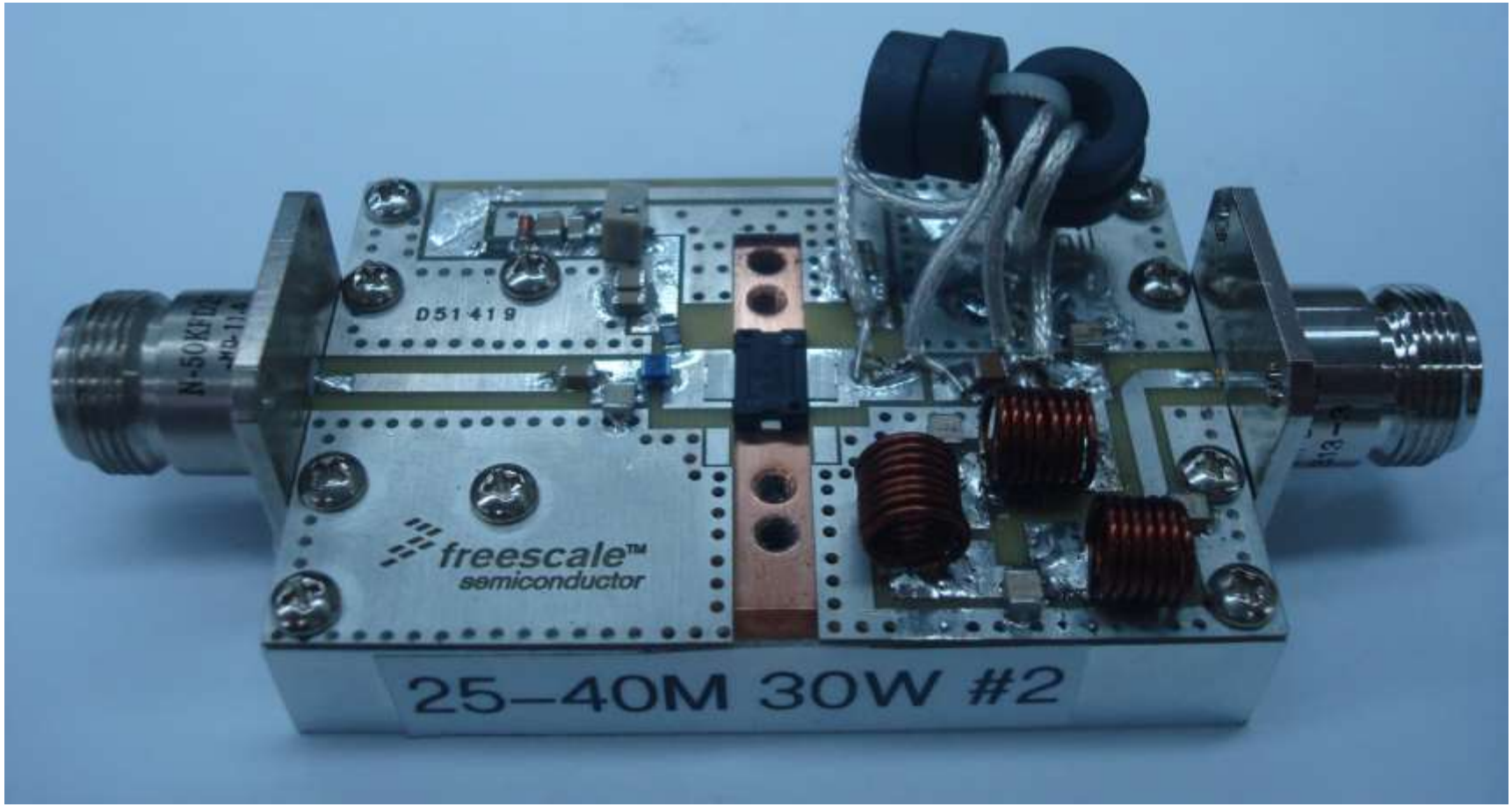
ACPR <-35dB @4W Pout from 350-490MHz

Freq vs. linearity



ACPR <-35dB @4W Pout from 350-490MHz

AFT05MS031 30W SSB Application



2 tone linearity-100kHz

Part ID	Freq (MHz)	Pin (dBm)	Pout (dBm)	PEP (W)	Gain (dB)	IRL (dB)	IM3L (dB)	IM3H (dB)	IM5L (dB)	IM5H (dB)	Eff (%)	IdSupply (A)	Vds (V)	Vgs (V)	IdSupplyq (A)
30W_12.5V	27.5	16.3	41.8	30.0	25.5	-13.8	-31.5	-31.8	-36.9	-37.2	47.6	2.5	12.5	3.1	0.7
30W_12.5V	30	16.6	41.7	29.9	25.2	-15.0	-38.2	-40.8	-42.7	-43.2	44.4	2.7	12.5	3.1	0.7
30W_12.5V	35	16.8	41.8	30.1	25.0	-18.6	-31.8	-33.4	-39.9	-40.0	43.1	2.8	12.5	3.1	0.7
30W_12.5V	40	17.1	41.8	30.0	24.7	-19.6	-31.9	-33.0	-38.4	-38.7	41.7	2.9	12.5	3.1	0.7
40W-13.8V	27.5	17.6	43.0	40.0	25.4	-13.8	-27.3	-27.1	-33.8	-34.1	49.9	2.9	13.8	3.1	0.7
40W-13.8V	30	17.8	43.0	40.1	25.2	-15.1	-35.8	-36.8	-38.5	-38.7	46.9	3.1	13.8	3.1	0.7
40W-13.8V	35	18.0	43.0	40.0	25.0	-18.6	-30.1	-31.0	-36.8	-36.9	45.2	3.2	13.8	3.1	0.7
40W-13.8V	40	18.4	43.0	40.0	24.6	-19.5	-29.0	-29.5	-35.1	-35.2	43.6	3.3	13.8	3.1	0.7

Conclusion

1. Freescale LMR power devices have excellent performance under digital LMR modulation;

2. It can handle ~us gate switch speed under saturation Pout;

3. Combined with super power ability and linearity make it quite good for high PAR modulation applications.

www.Freescale.com