AR222014

ART700FH 24-30MHz

V5.0 — 28 March 2023

AMPLEON

Application Report

Document information

Info	Content
Status	General Publication
Author(s)	Bill Goumas
Abstract	Measurement results of the ART700FH LDMOS Device Measured at 50V over 24-30MHz

1 Revision History

Table 1. Report revisions

Revision No.	Date	Description	Author
1.0	20220204	Initial document	Bill Goumas
2.0	20220419	Add IR Scan and tuning data	Bill Goumas
3.0	20220422	Change to General Publication	Bill Goumas
4.0	20220610	Clean up typos	Bill Goumas
5.0	20230327	Add IM data	Bill Goumas

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5 General Description

This report presents the measurements of an ART1K6FH device in a circuit optimized for 27MHz. An older demo board that had been built with the BLF184 was used as the starting point. The board has been tested over 24-30 MHz at 50V.

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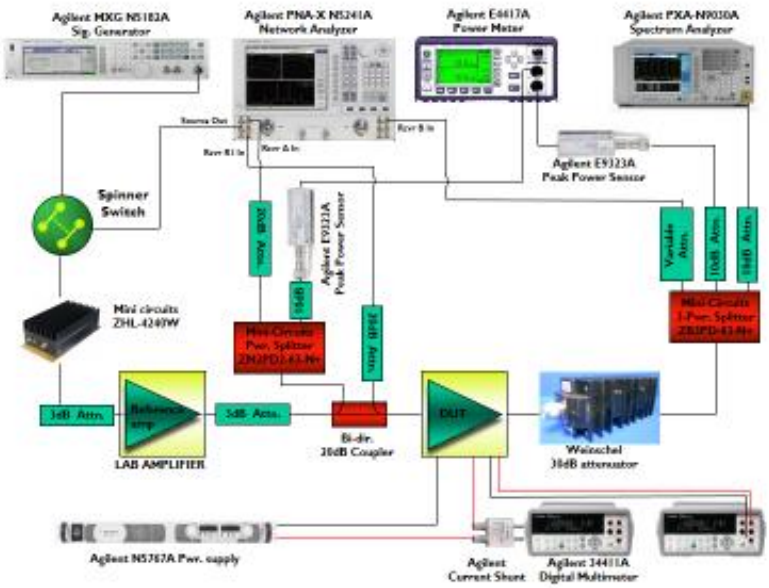
6 Biasing

6.1 Bias Details

Idq is set via the pot on the bias board. Vg~2.2 for Idq=500-600mA.

7 Test Bench Set Up

Figure 1.Test Bench Equipment set up



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8 Summary

The ART700FH was dropped into the previous generation device BLF184XR board that had been optimized for 27MHz. Initial data showed P3dB>700W without any changes.

Initial tuning was done. See section 10 for details and section 9.2-9.3 for results. Max Power of 800W with 2dB compression was achieved.

Next tuning was done with an LC network on an external PC Board. Best results are shown in section 9.4. At 800W, compression is ~4.5dB with ~75% efficiency. Changing the bias towards Class B can increase the efficiency by ~2% and is shown in Figure 6.

Table 2 below shows the comparison between initial tune and the best tuning performance.

Table 2. Performance Comparison Vdd=50V, Idq=500mA, 10% Duty Cycle

	Initial tune	Final Tune
P1(dBm)	58.43	57.83
P2(dBm)	58.97	58.34
P3(dBm)	59.3	58.59
P5(dBm)		59
Gain(dB) at 800W	21	18.5
Eff(%) at 800W	65	75

Thermal

IR scans were done at 10%, 25%, 50% Duty at Pout=600-800W. Results are shown in section 11.

At 10% duty, for Pout=800W all components are < 70°C. This is without any external airflow on the components.

At 25% duty, for Pout=800W, all components are < 75°C. This is with external air flow blowing across the output coax transformer.

At 50% duty, Pout=600W is about the maximum that the demo can be run at. Here the components are ~95°C. This is with external airflow. AT Pout=600W and 25% duty, max temp is ~65°C. At 50% Duty and Pout=600W, max temp is ~93°C so the projected temperatures are excessive even at 600W output.

Next step will be to increase the diameter of the coax in the output transformer to achieve CW operation.

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9 Performance Details

9.1 Small Signal Results

Vdd=50V, Idq=600mA , Initial Tune with output network

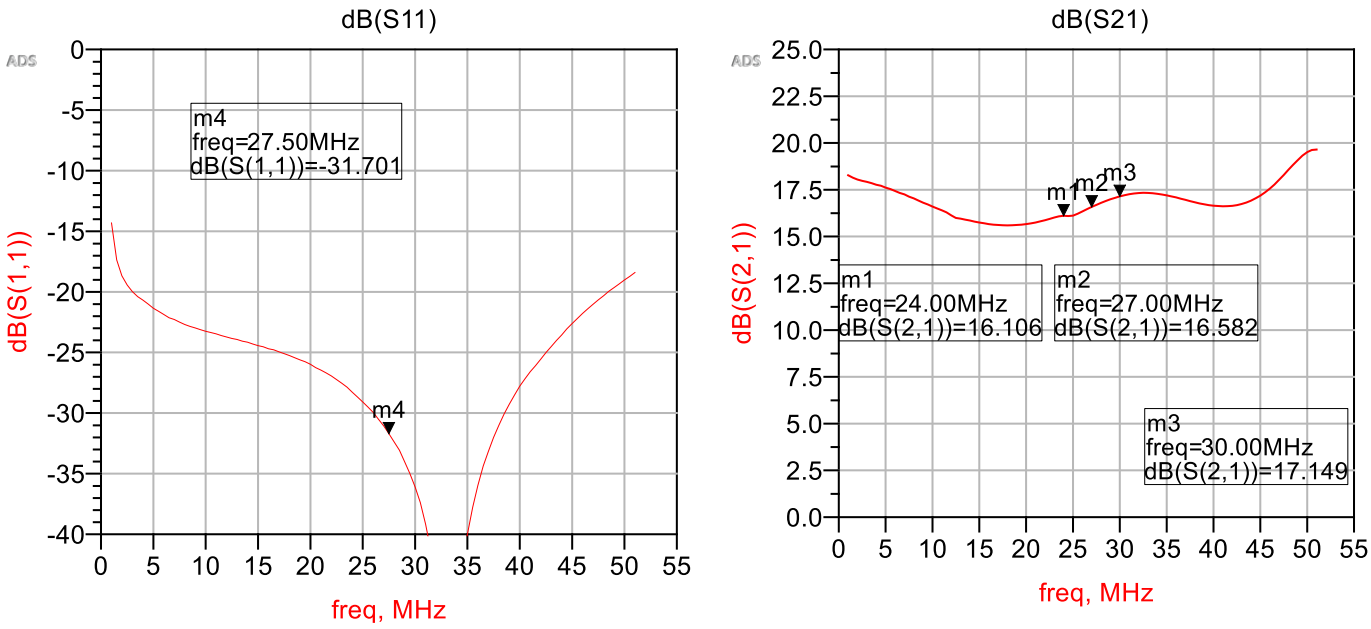

Figure 2. Small SIgnal Data, Vdd=50V, Idq=600mA

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9.2 Pulse Gain, Efficiency vs Pout – Initial Tune

Vdd=50V, Idq=600mA, 10% Duty Cycle

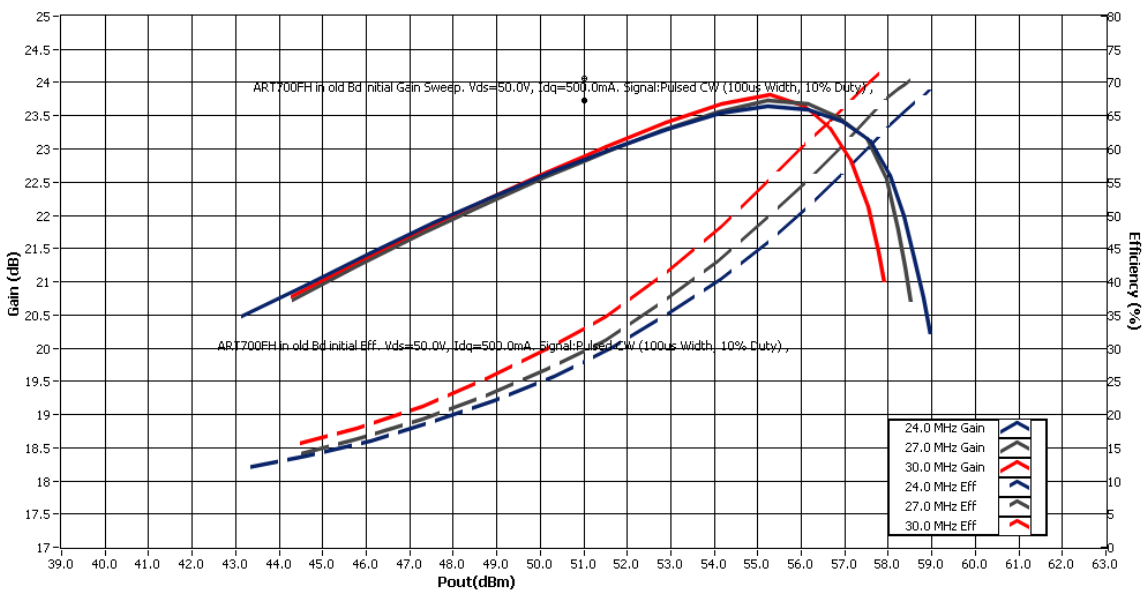

Figure 3. Gain(dB), EFF(%) vs Power Out(dBm)

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9.3 Pulse Gain, Efficiency vs Pout Sweep Duty Cycle

Vdd=50, Idq=600mA, Initial Tune

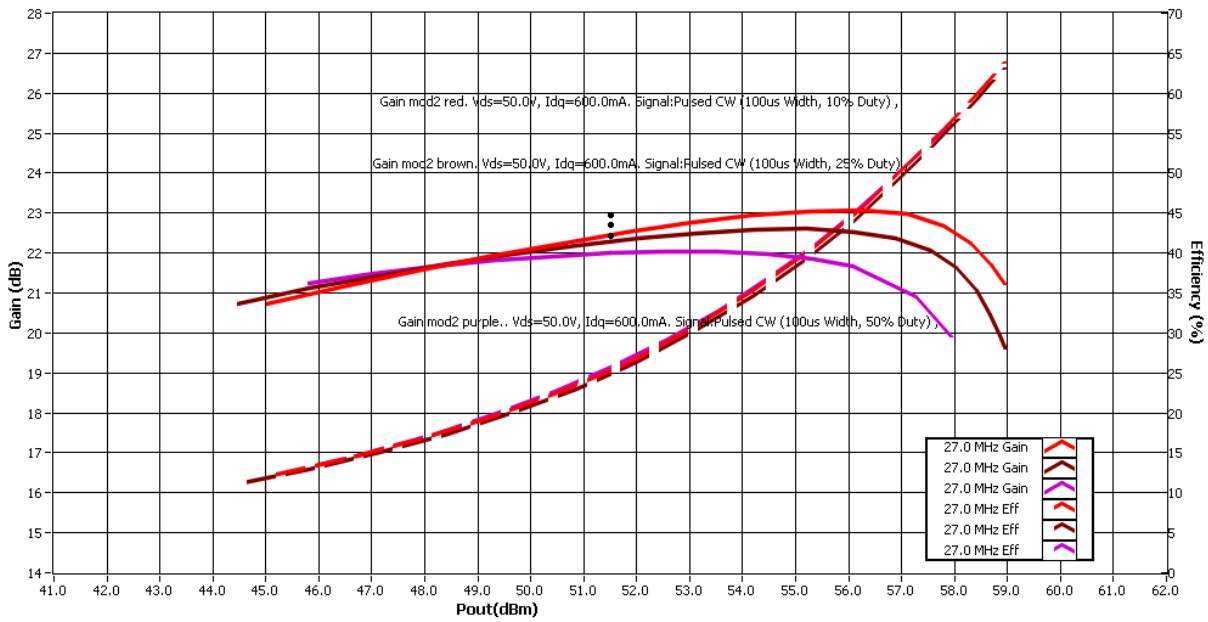

Figure 4. Gain(dB), EFF(%) vs Power Out(dBm)

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9.4 Gain, Efficiency vs Pout, Into best tuning with external Network

Vdd=50, Idq=600mA, black=no tuner, Blue=external tuning network

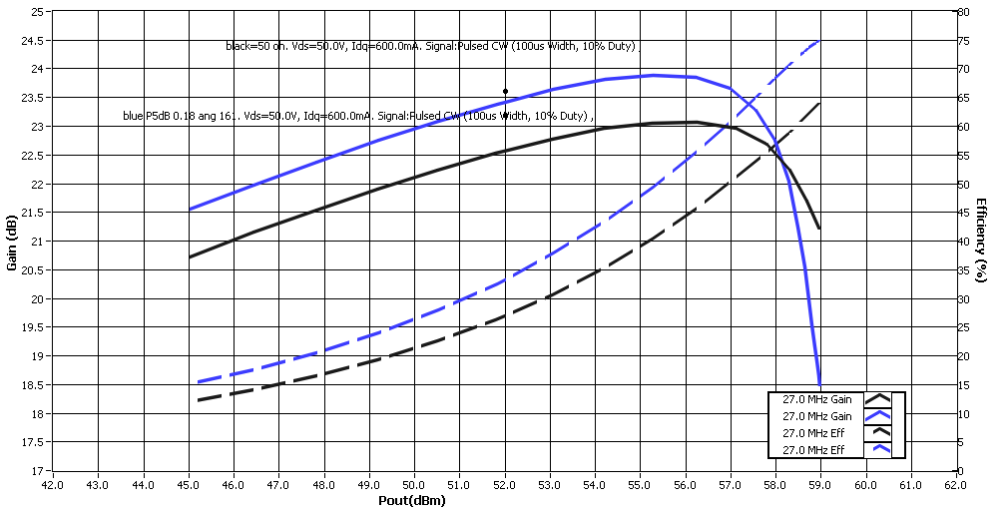

Figure 5. Gain(dB), EFF(%) vs Power Out(dBm)

Best Tuner Load, Vary Idq, Vdd=50V. Blue=600mA, Brown=100mA

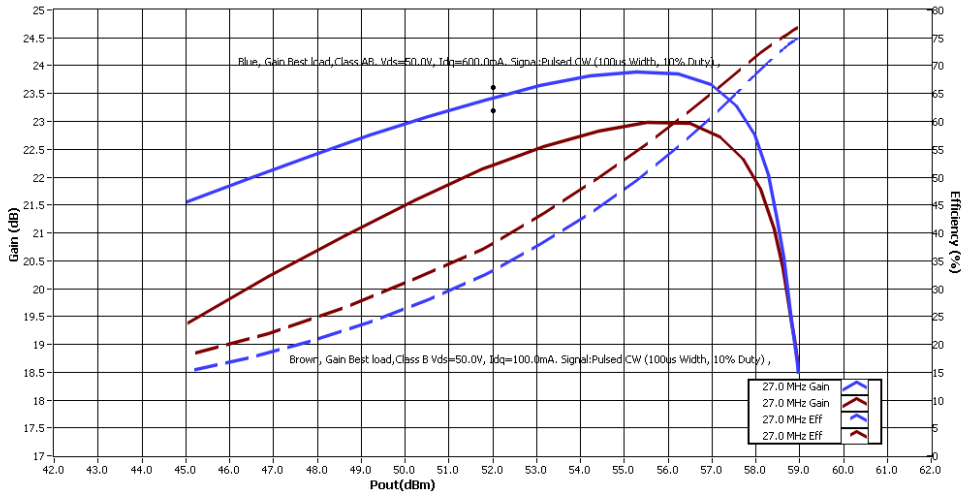

Figure 6.Gain(dB), EFF(%) vs Power Out(dBm)

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9.5 Tuning Network Results

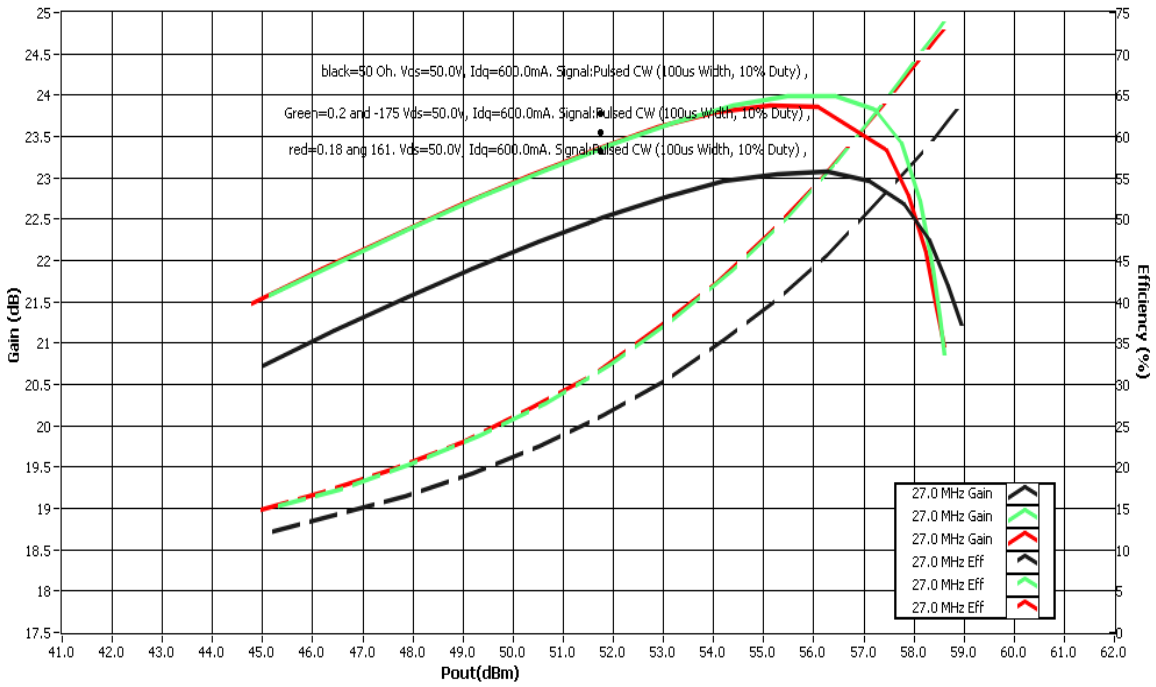

Figure 7. Gain(dB), EFF(%) vs Power Out(dBm)

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9.6 P1,P3 dB after Initial Tuning

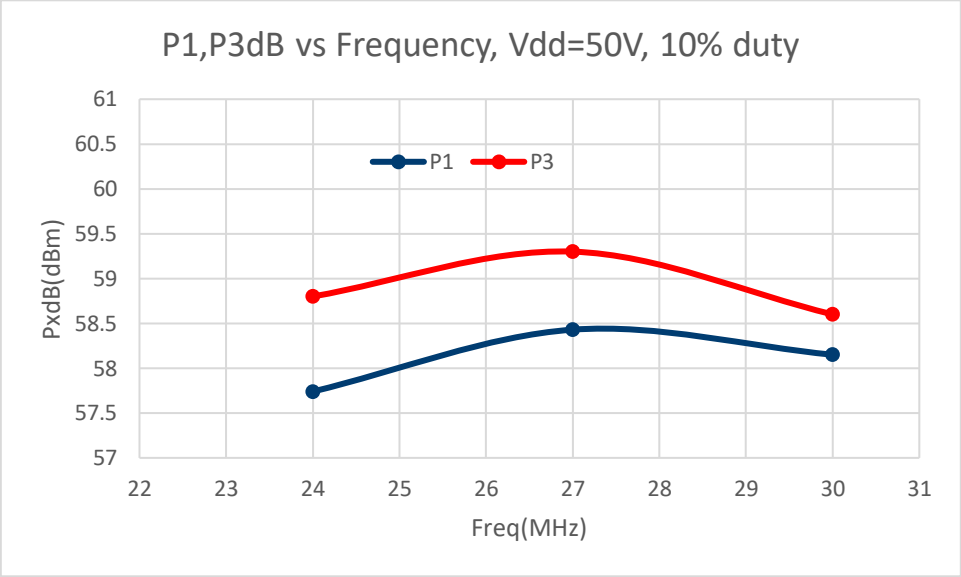

Figure 8. P1 and P3dB vs Frequency

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9.7 IMD after Initial Tuning

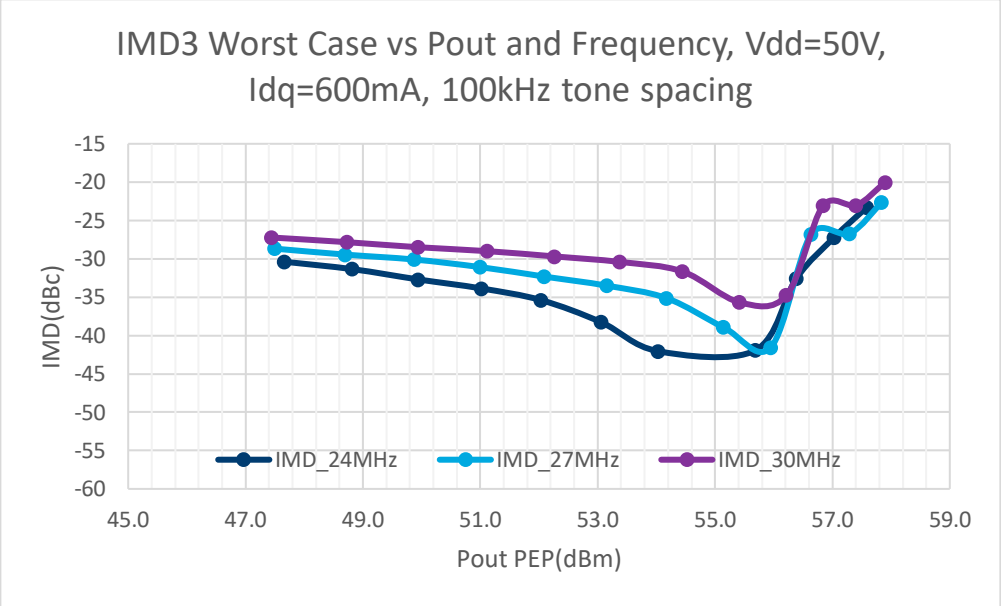

Figure 9. IMD3 vs Pout(dBm)

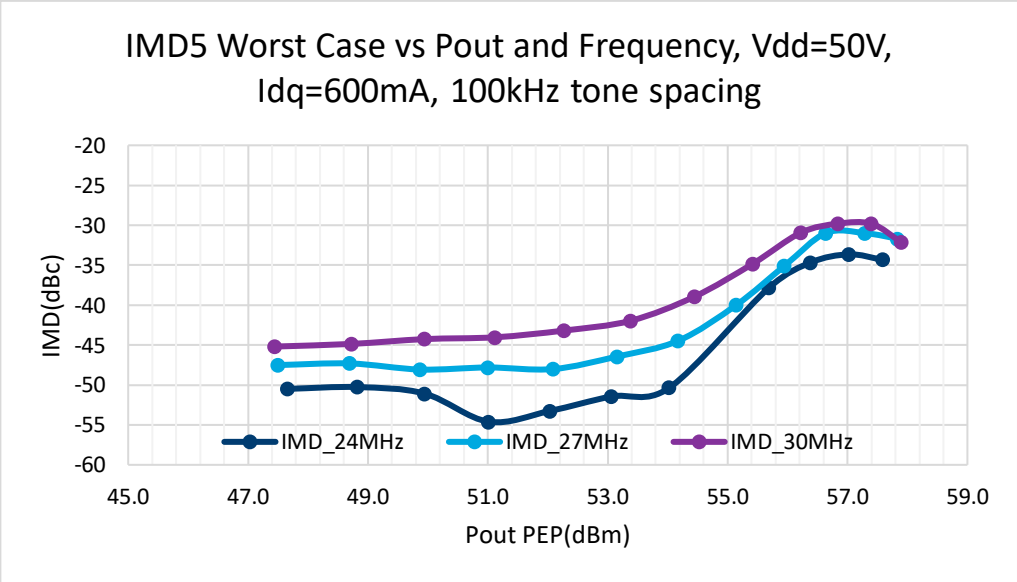

Figure 10. IMD5 vs Pout(dBm)

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9.8 IMD3 vs Pout, Sweep Idq after Initial Tuning

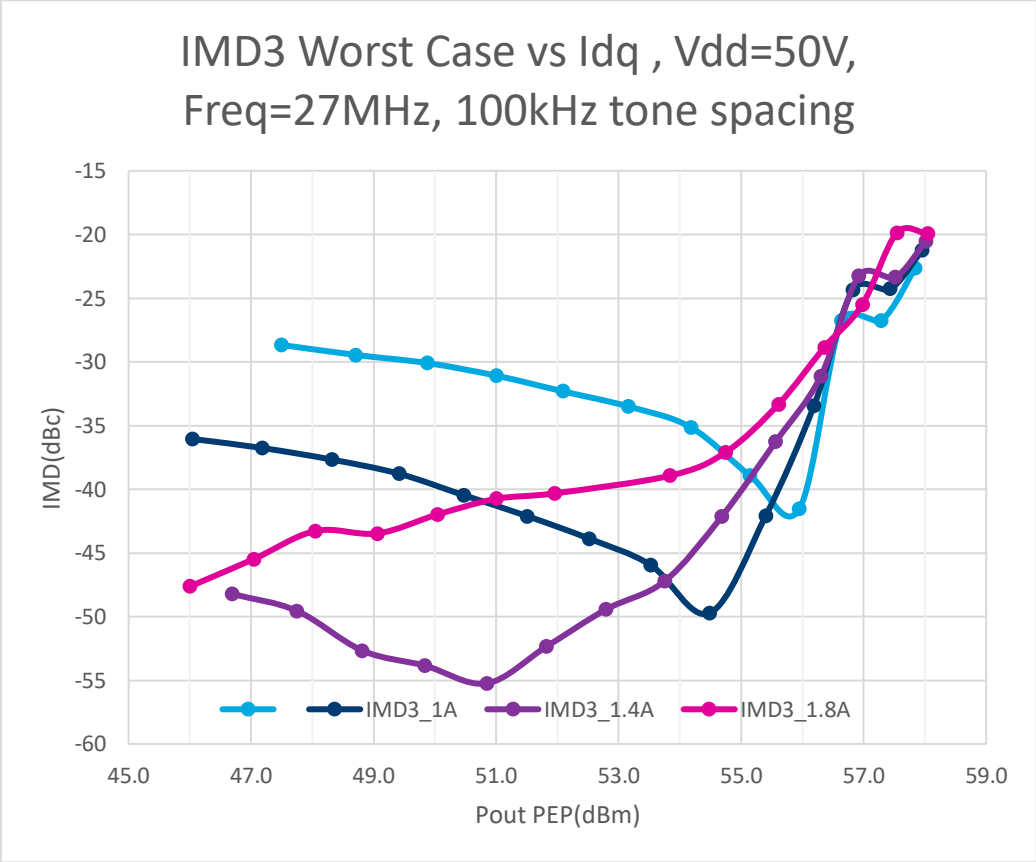

Figure 11. IMD3 vs Pout(dBm)

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10 Tuning Notes

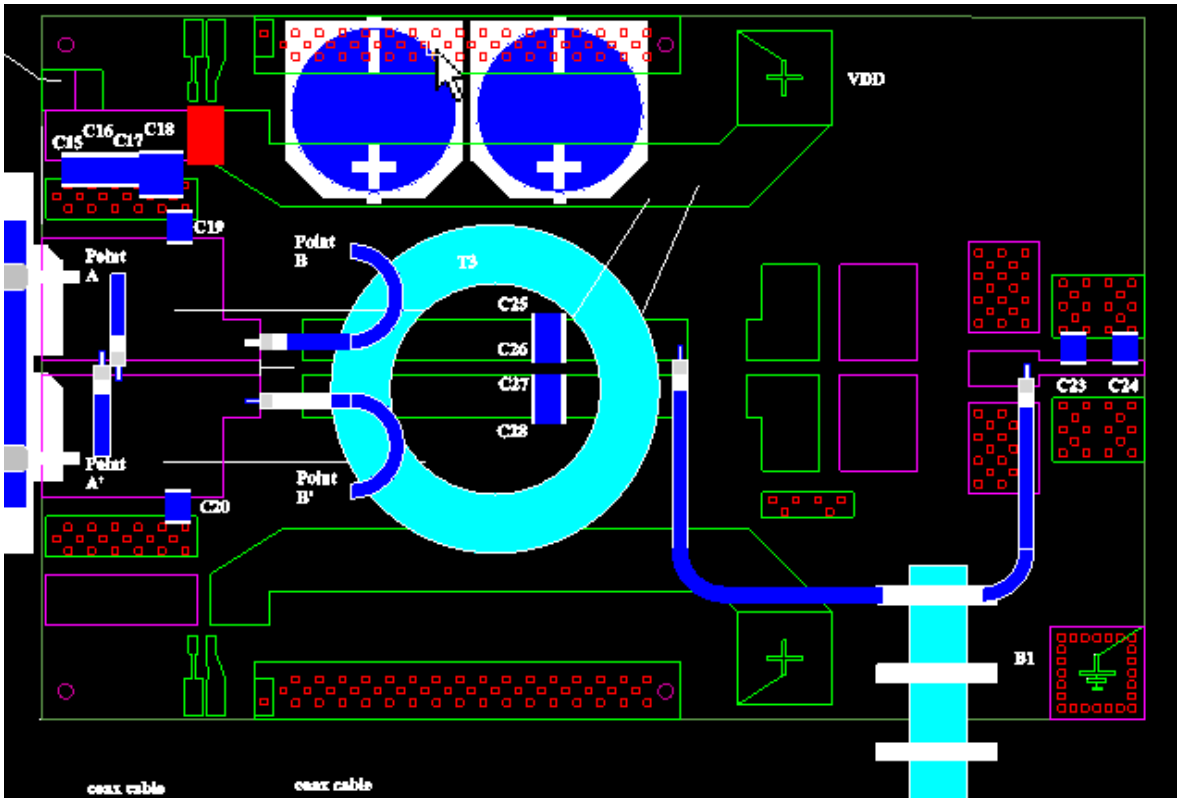
10.1 Output Network Key Components

Initial tuning was done by varying C19,C20 and C23. Best results for power showed ~P2dB of 59dBm(800W).

Initial values for data shown in section 9.2-9.3 is 62pF for C23, C24=0. C19 and C20 are 300pF

Another tuning factor is the length of the coaxial cables in T2 and T4 . This was not modified as part of the tuning exercise.

Next step was to add an external board with an LC network . Mini Load pull was done by testing the board into ~6 points at 1.5:1 VSWR around the smith chart. Section 9.4 and 9.5 show the 2 best loads. Values of the pi network on the external PC board are 15pF,202nH and 82pF.



Next steps are to build another board using bigger coax for T2 and T4 to allow CW operation and implement the pi network from the external board onto the output.

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10.2 Modeling

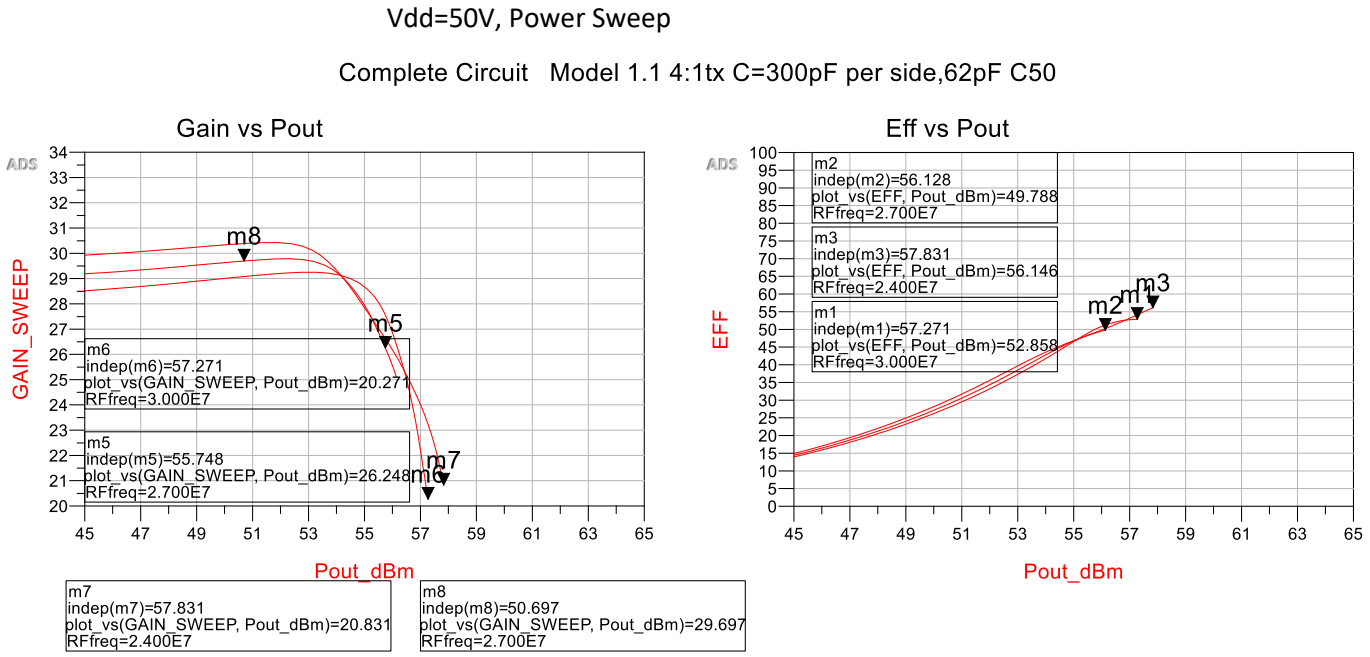

Figure 12. Simulated Gain, Eff vs Pout(dBm)

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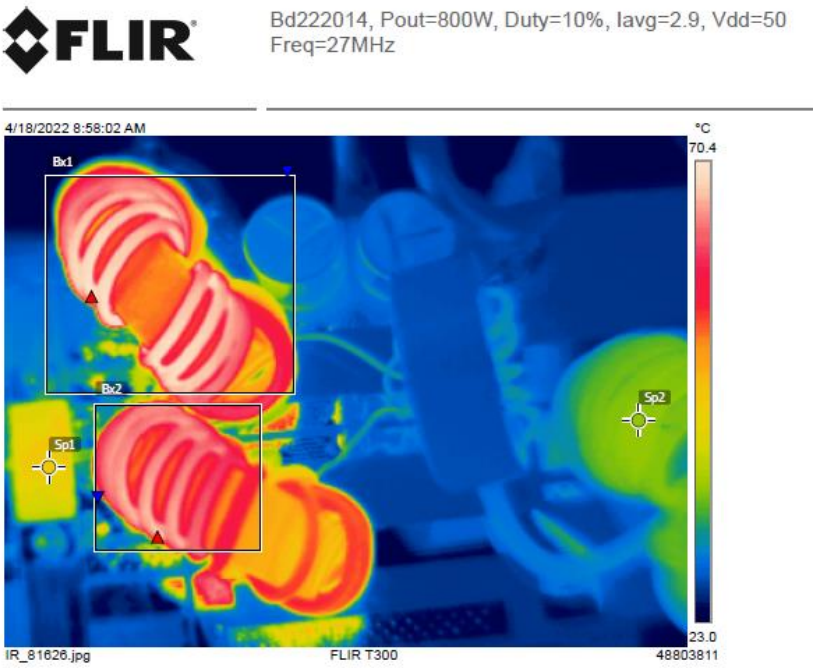
11 IR Scans

11.1 IR Scan, Pout=800W, 10% Duty

After 15 minute soak



Measurements

Bx1	Max	70.4 °C
	Min	23.4 °C
	Average	49.2 °C
Bx2	Max	68.0 °C
	Min	25.3 °C
	Average	56.9 °C
Sp1		48.5 °C
Sp2		38.2 °C

Parameters

Emissivity	0.95
Refl. temp.	20 °C

Figure 13. IR Scan, 10% Duty

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11.2 IR Scan, Pout=800W, 25% Duty

With external airflow

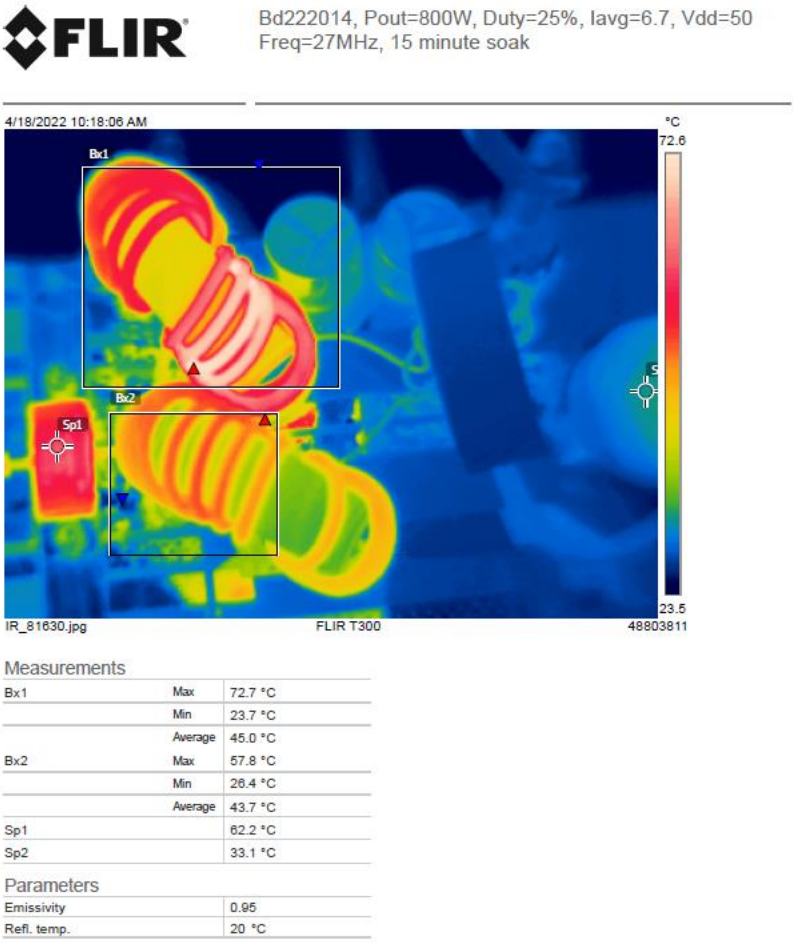

Figure 14.IR Scan, Pout=800W, 25%Duty Cycle

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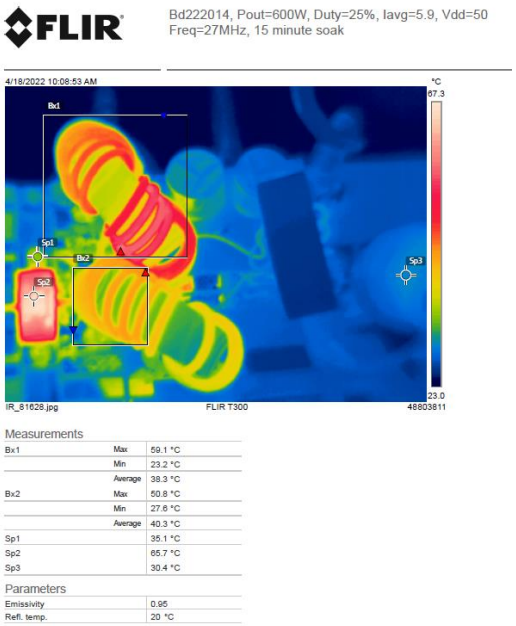
11.3 IR Scan, Comparison, Pout=600W

25% Duty



50% Duty

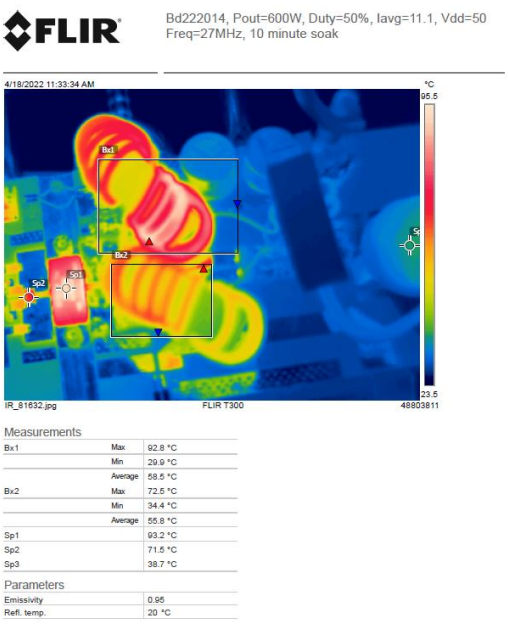


Figure 15. IR Scans, Pout=600W

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11.4 External Air Flow Set up

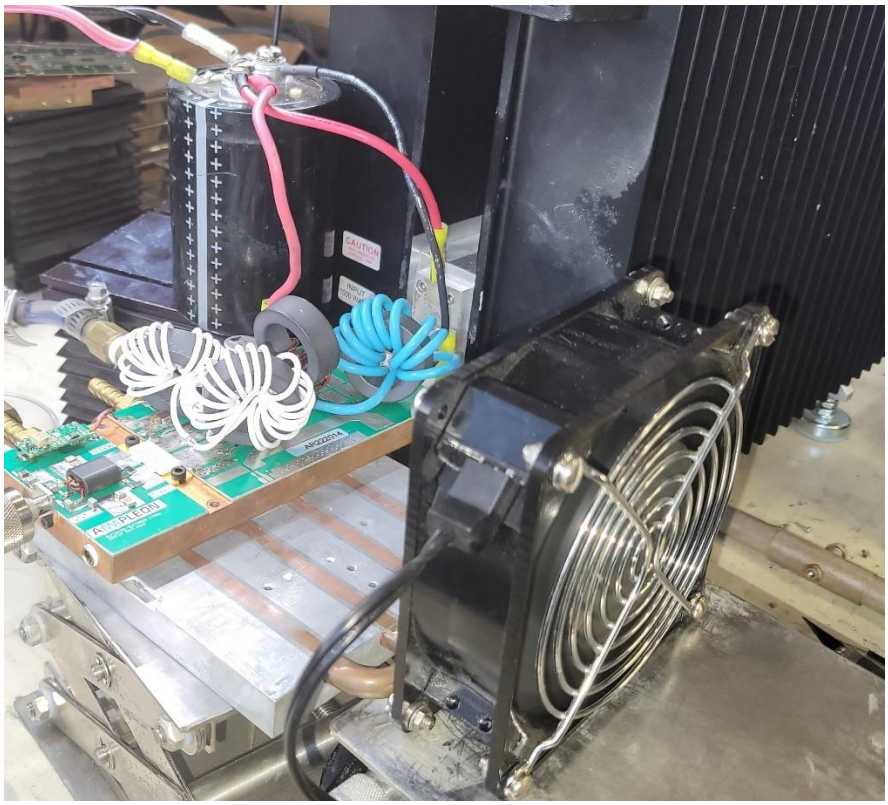

Figure 16. External Air Flow Bench Set-up

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12 Hardware

12.1 Board photographs

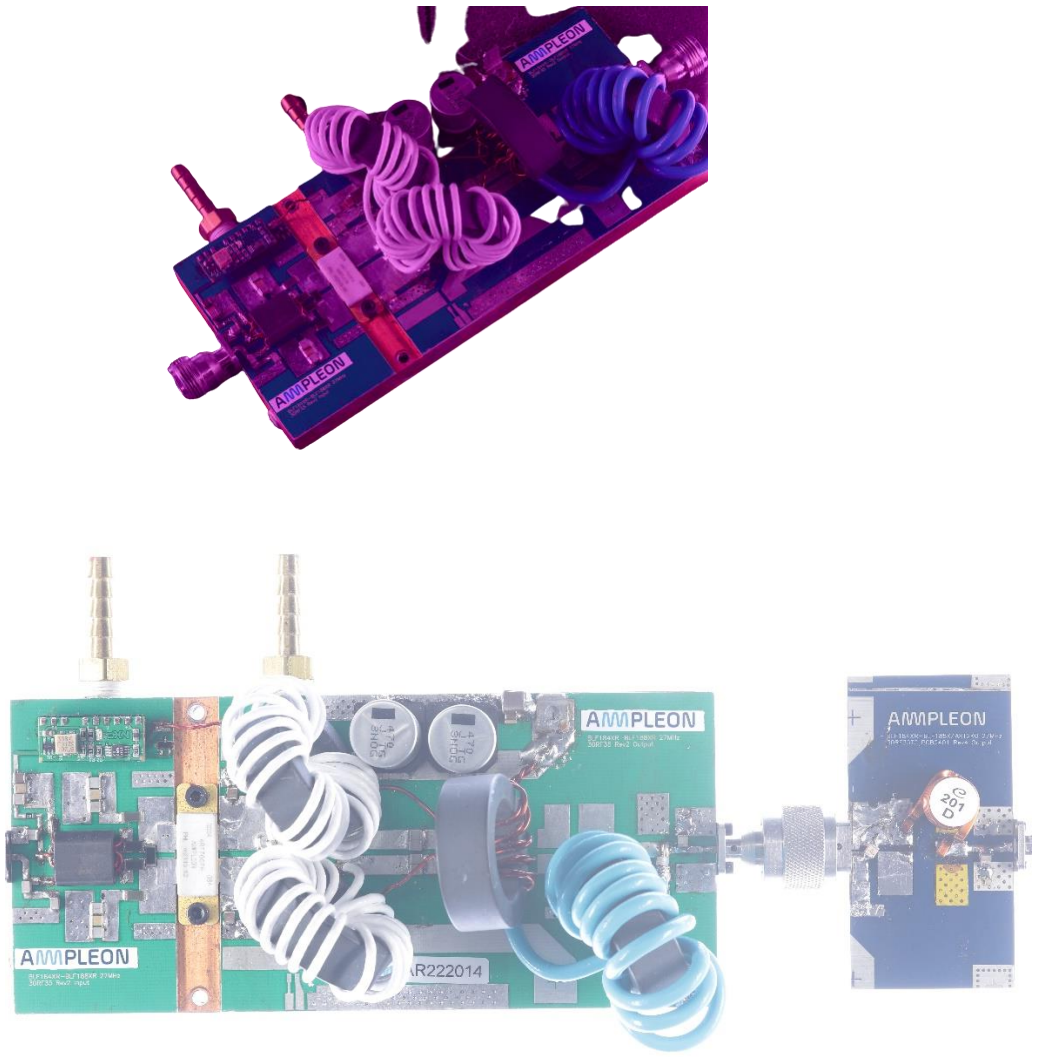

Figure 17. Board Photographs

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12.2 PCB layout

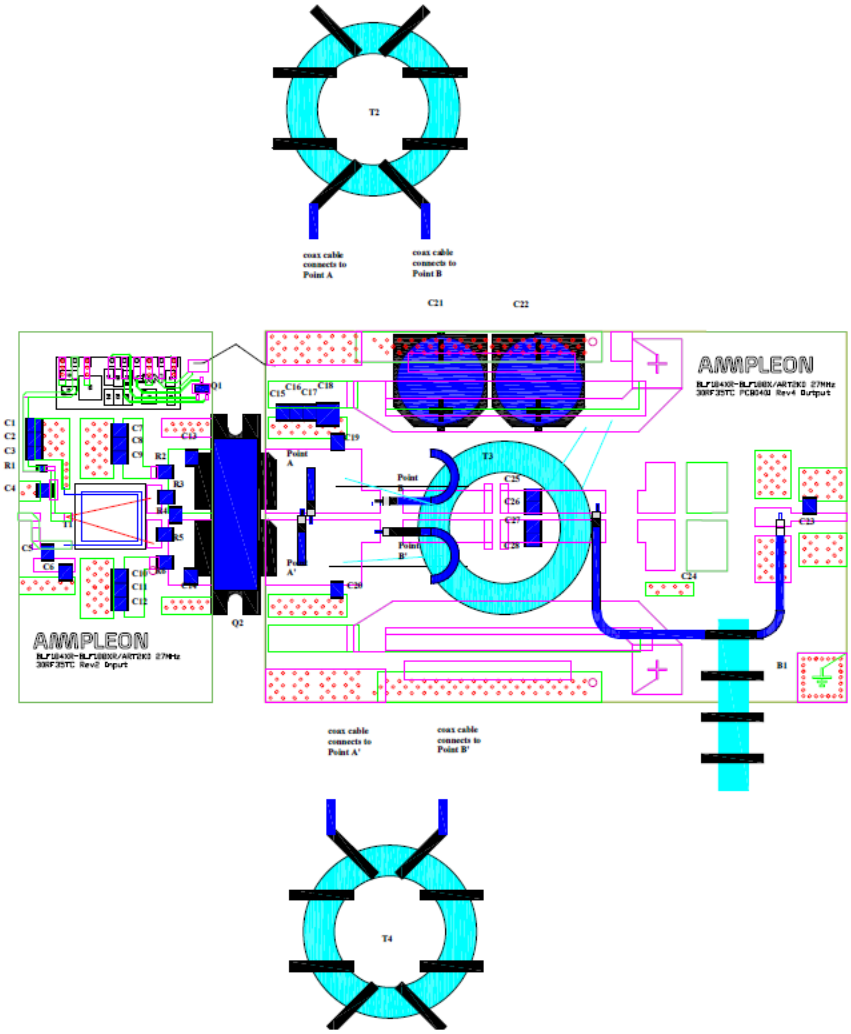

Figure 18.PCB Layout

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12.3 Bill of materials

Table 3. BOM

Designator	Description	Part#	Manufacturer
PCB	PCB 30 mil Taconic RF35 BLF184XR-BLF188XR 27MHz	BLF184XR-BLF188XR 27MHz Input Rev 2	Avanti
PCB	PCB 30 mil Taconic RF35	PCB0401 Output Rev 4	Avanti
Q1	NPN Transistor	2N2222	Fairchild
Q2	LDMOS Power Transistor	ART700FH	Ampleon
A1	LDMOS Bias Module	CA-330-11	Ampleon
R1	5.1Ω	Generic	0805
R2,R6	10Ω AlN	NGC-2010WA10R0J	IMS
R3,R5	1Ω AlN	NDC-2010WA1R00J	IMS
R4	20Ω, AlN	NGC-2010WA20R0J	IMS
C1	10uF	GRM32DF51H106ZA01L	Murata
C2,C8,C11,C16	100nF	12101C104KAT2A	AVX
C3,C4,C9,C10, C13,C14,C16	1000pF	100B or 1111N	ATC or Pplus
C7,C12,C25, C26,C27,C28	10nF	C3225C0G2E103J	TDK
C17	2.2uF	GRM32ER72A225KA35L	Murata
C18	10uF,100V	C5750X7S2A106M	TDK
C19,C20	300pF	100B or 1111N	ATC or Pplus
C21,C22	470 uF, 63V, Electrolytic	PCE3667CT-ND	Panasonic
C23	62pF	100B or 1111N	ATC or Pplus
T1	4:1 RF Transformer 43 material	Communications Concepts	600-4-43
T2,T4	19 turns 40", 28 coax on Ferrite	M27500-E22(1)STJ	Silver State Wire
		FT-140-61	Amidon
B1	13 turns 30 ", 0.141 50Ω coax on Ferrite	UT-141-50	
		FT-140-61	Amidon
T3	2 x 7 turns 18 AWG bifilar wount on Ferrite		
		FT-140-61	Amidon

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12.4 PCB materials

Table 4. Board Specifications

Parameter	Value
Manufacturer	Taconic
Type	RF35
Thickness	30 mils, 1oz. copper
Layers	2, top/bottom. Bottom all copper

12.5 Device markings

Table 5. Device Specifications

Parameter	Value
Manufacturer	Ampleon
Device	ART700FH
Date Code	M2118

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