# AR222014

## ART1K6FH 24-30MHz

AMPLEON

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Application Report

**Document information**

| Info | Content |
|---|---|
| Status | Company Public |
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| 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 |

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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.

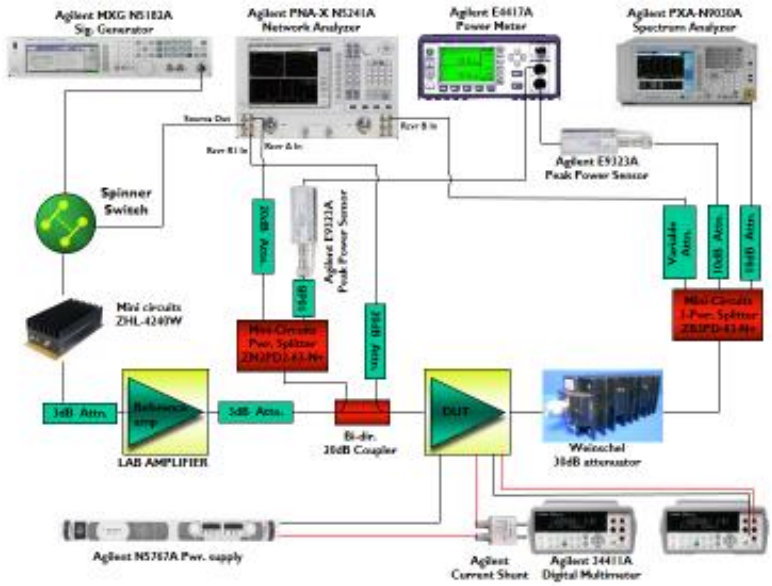
# 6 Biasing

## 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**



# 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.

# 9 Performance Details

## 9.1 Small Signal Results

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

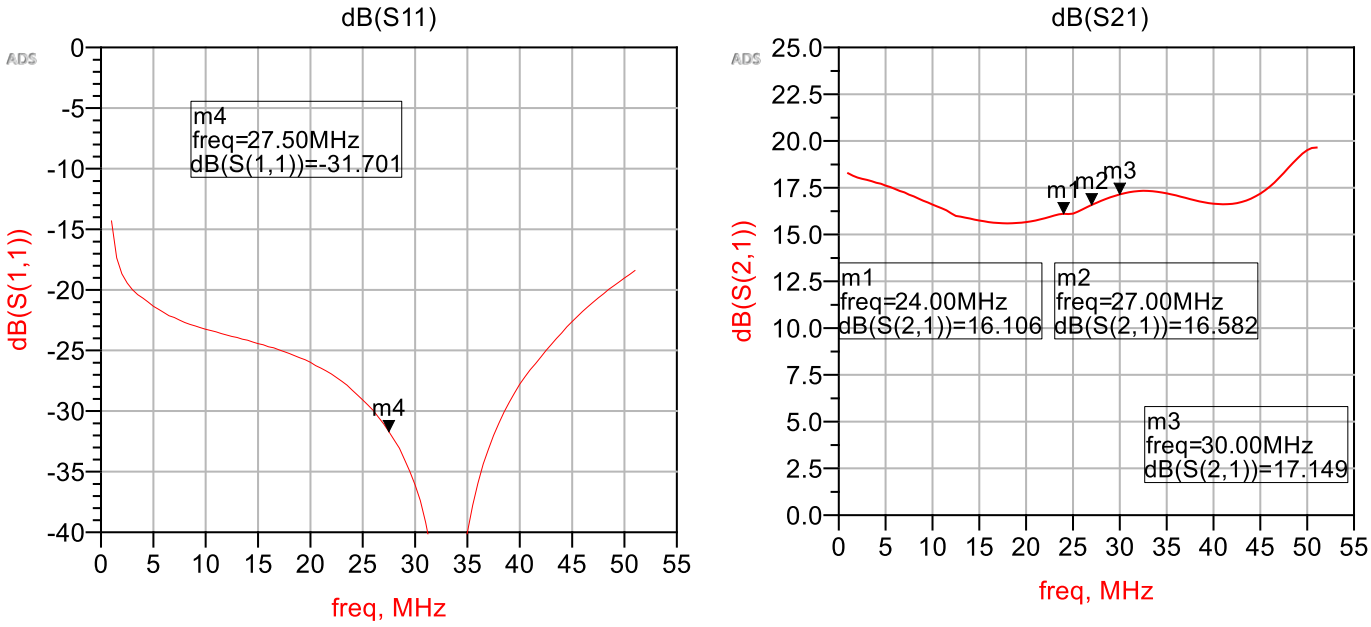



**Figure 2. Small SIgnal Data, Vdd=50V, Idq=600mA**

## 9.2 Pulse Gain, Efficiency vs Pout – Initial Tune

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

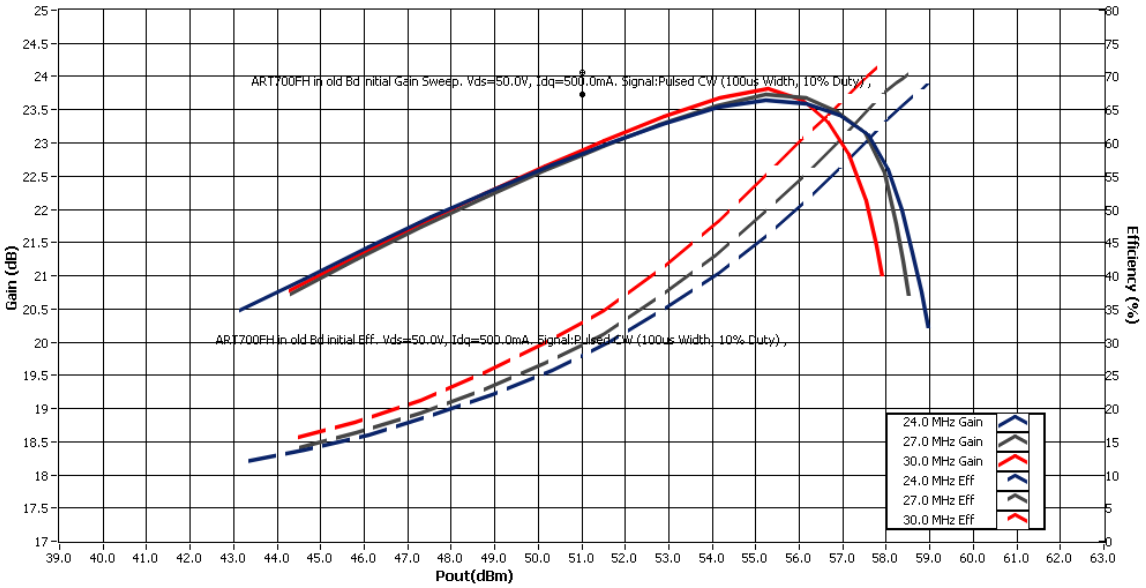



**Figure 3. Gain(dB), EFF(%) vs Power Out(dBm)**

## 9.3 Pulse Gain, Efficiency vs Pout Sweep Duty Cycle

Vdd=50, Idq=600mA, Initial Tune

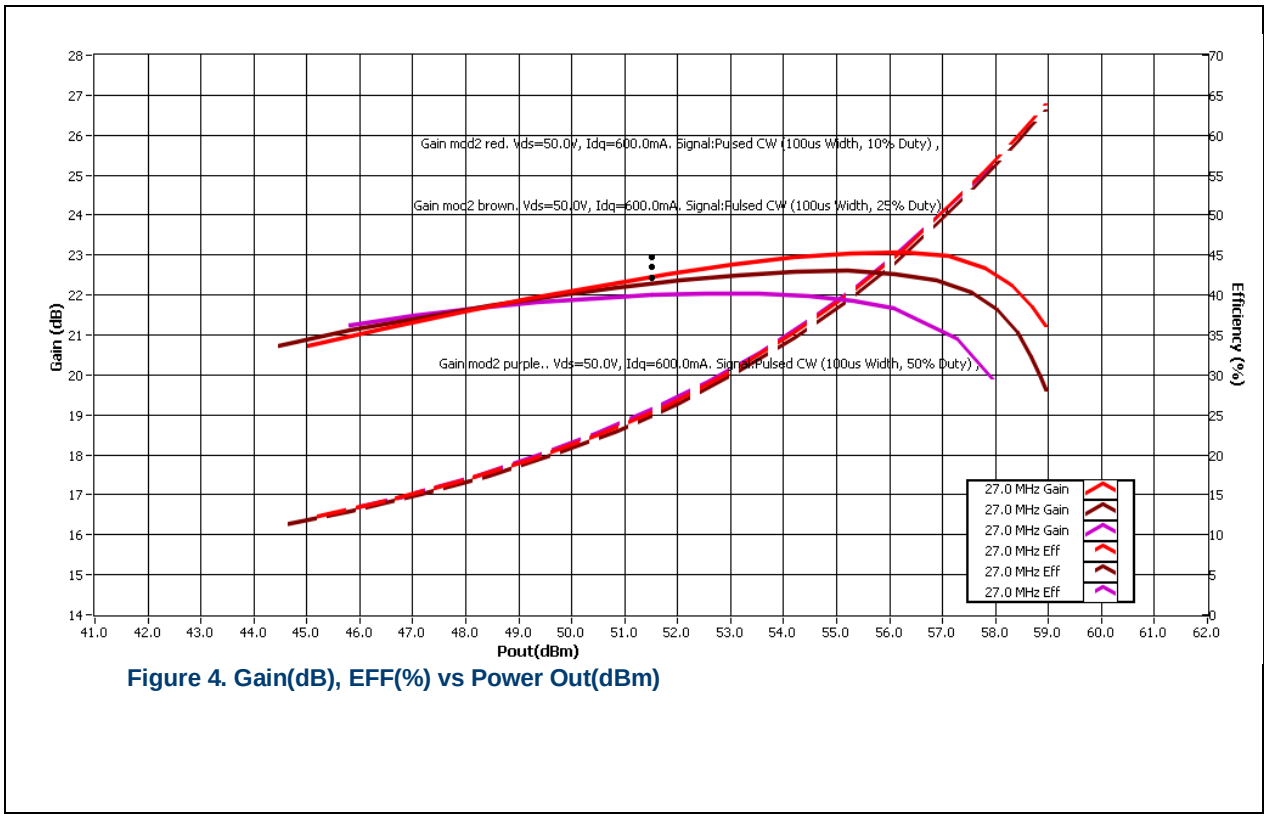



**Figure 4. Gain(dB), EFF(%) vs Power Out(dBm)**

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

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

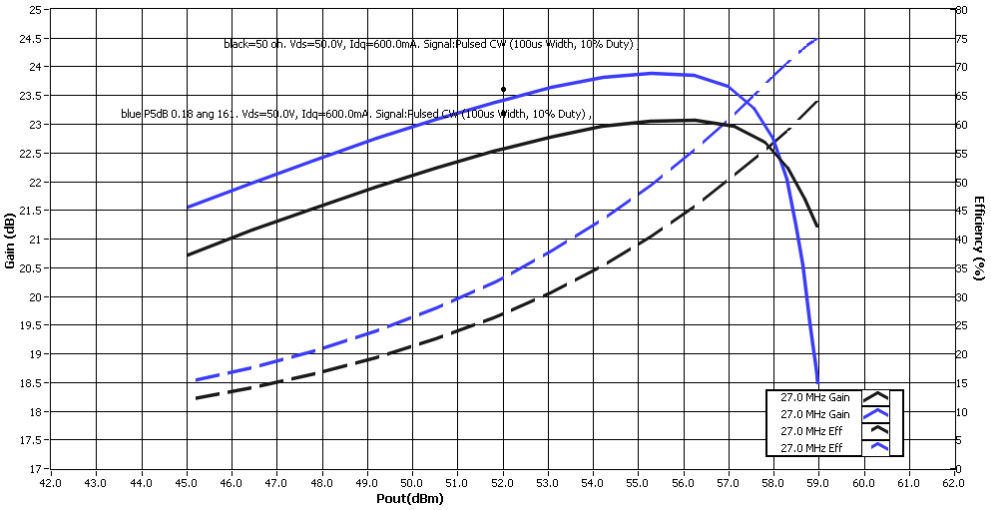



**Figure 5. Gain(dB), EFF(%) vs Power Out(dBm)**

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

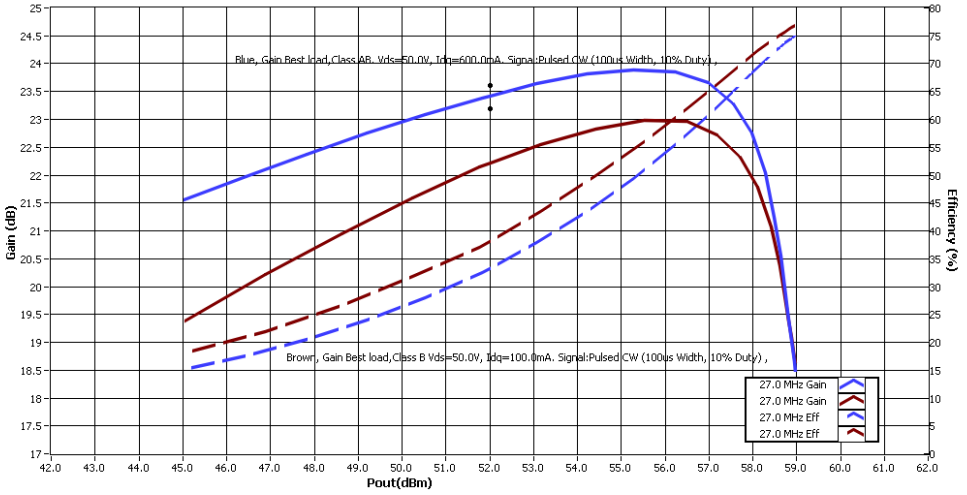



**Figure 6.Gain(dB), EFF(%) vs Power Out(dBm)**

## 9.5 Tuning Network Results

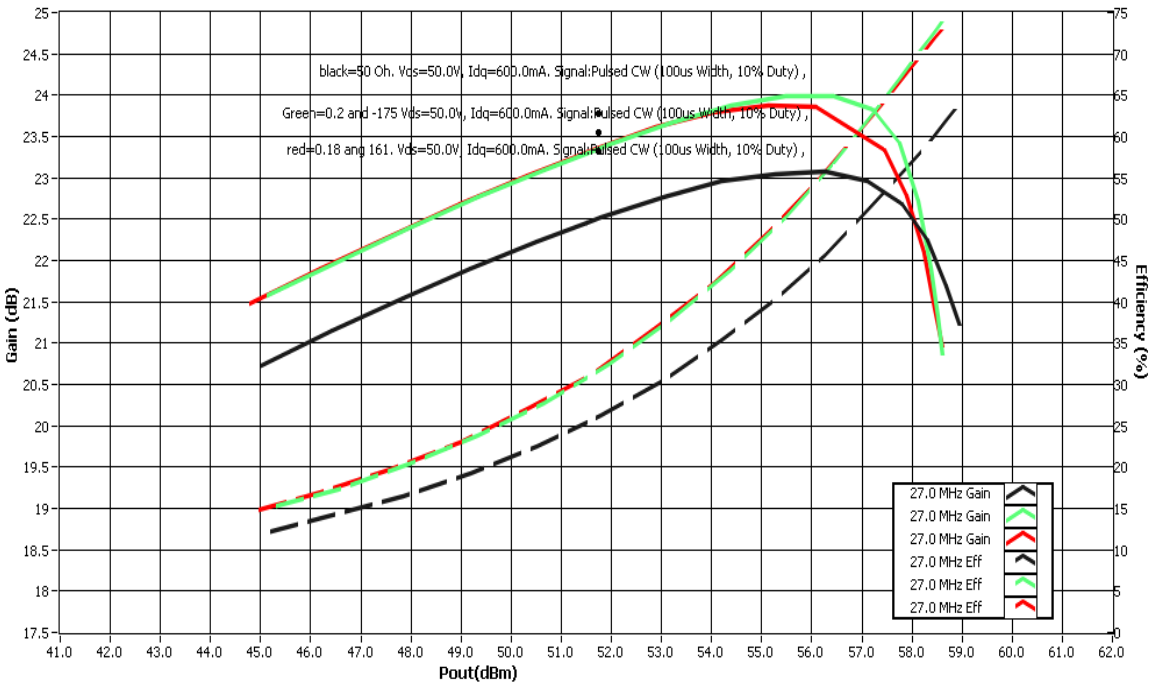



**Figure 7. Gain(dB), EFF(%) vs Power Out(dBm)**

## 9.6 P1,P3 dB after Initial Tuning

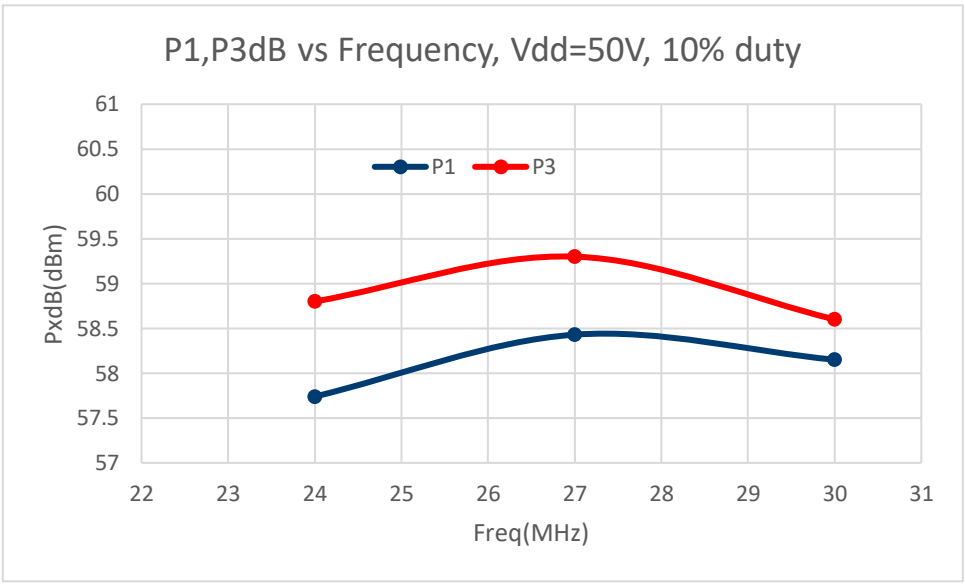



**Figure 8. P1 and P3dB vs Frequency**

# 10 Tuning Notes

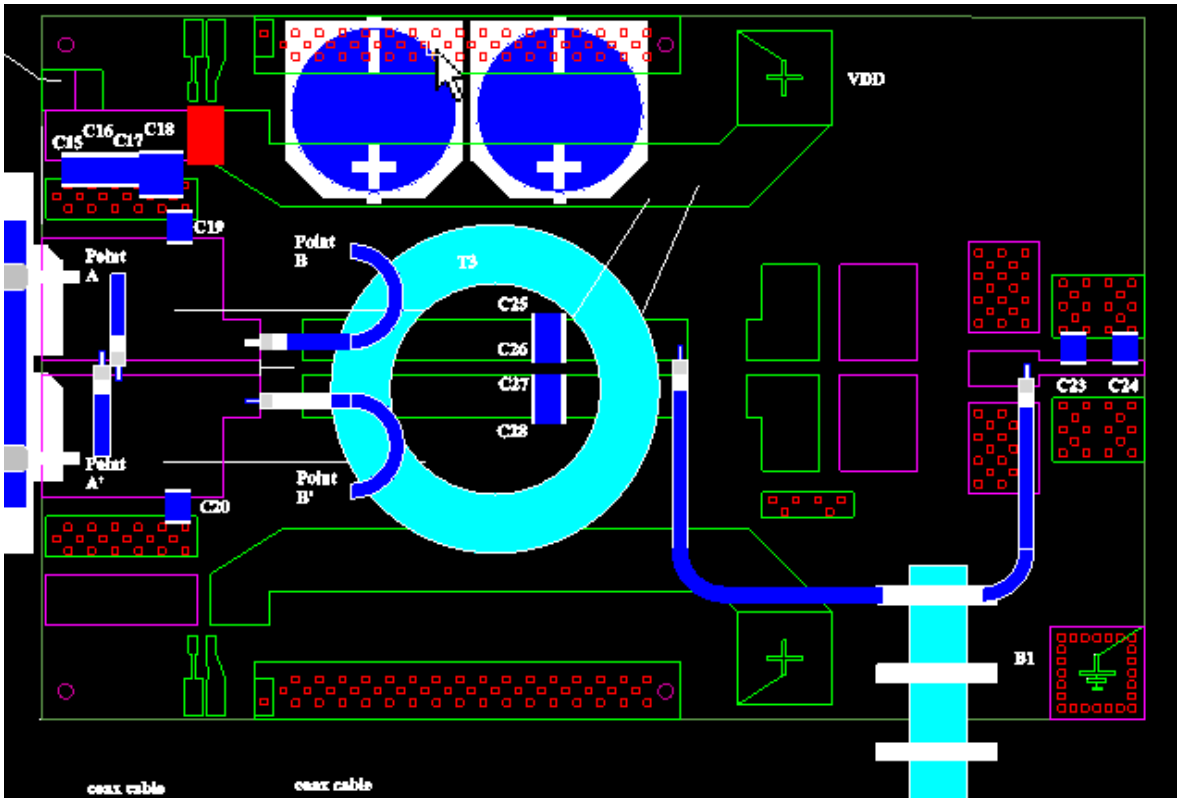
## 10.1 Output Network Key Components

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.**

## 10.2 Modeling

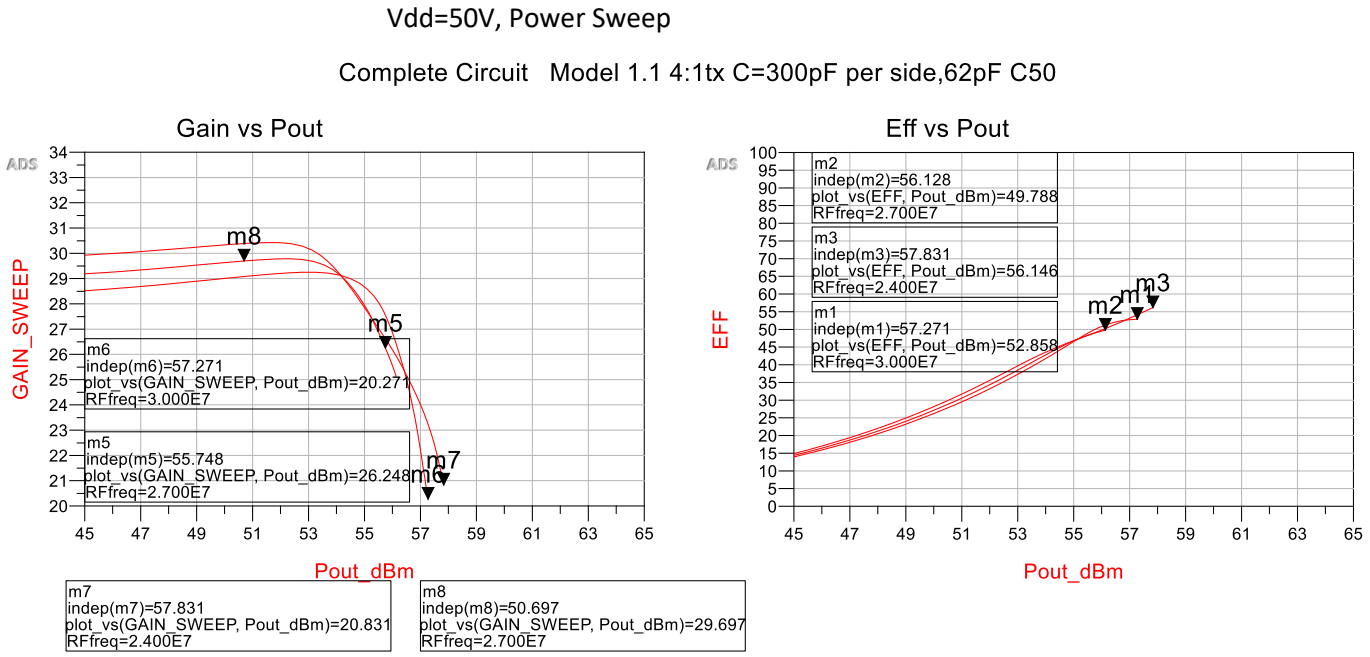



**Figure 9. Simulated Gain, Eff vs Pout(dBm)**

# 11 IR Scans

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

After 15 minute soak

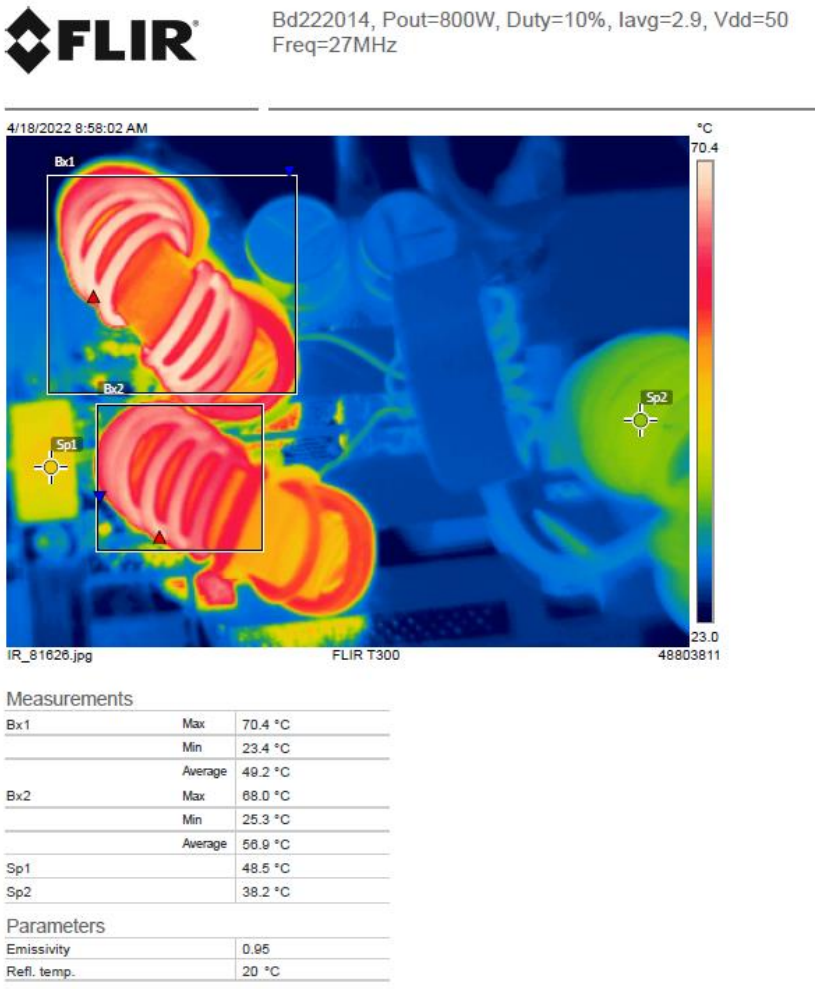
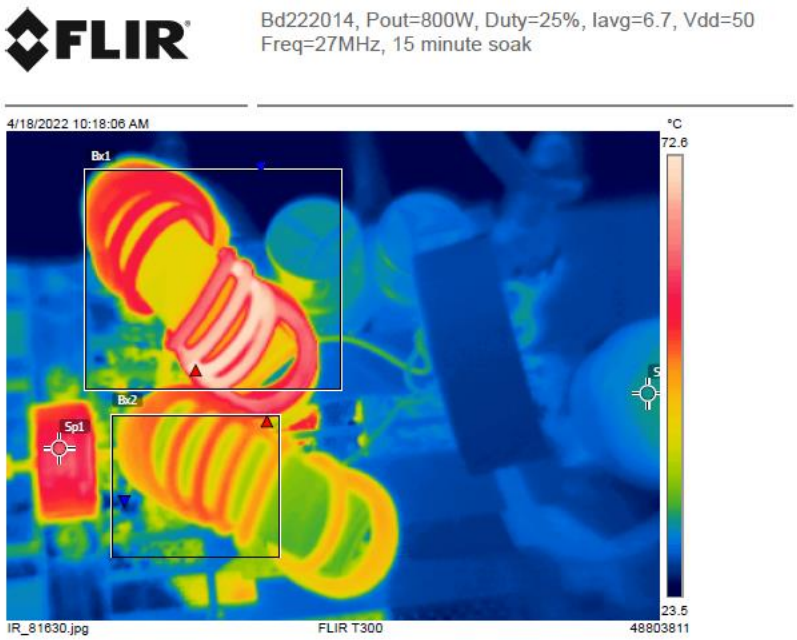



**Figure 10. IR Scan, 10% Duty**

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

With external airflow




Measurements

| | | |
|---|---|---|
| Bx1 | Max | 72.7 °C |
| | Min | 23.7 °C |
| | Average | 45.0 °C |
| Bx2 | Max | 57.8 °C |
| | Min | 26.4 °C |
| | Average | 43.7 °C |
| Sp1 | | 62.2 °C |
| Sp2 | | 33.1 °C |

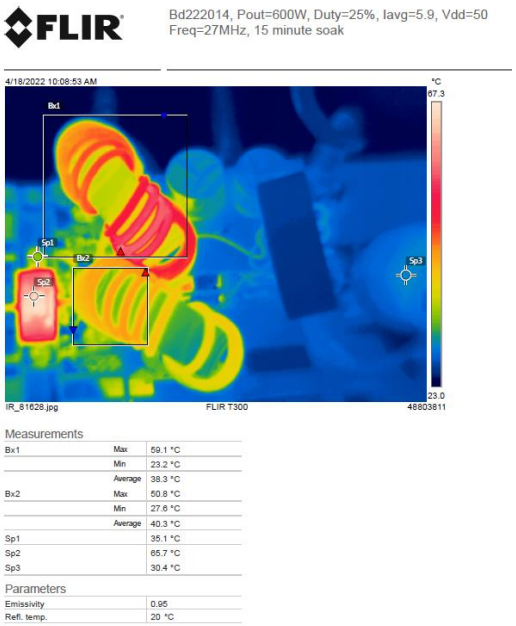
Parameters

| | |
|---|---|
| Emissivity | 0.95 |
| Refl. temp. | 20 °C |

**Figure 11.IR Scan, Pout=800W, 25%Duty Cycle**

## 11.3 IR Scan, Comparison, Pout=600W

25% Duty




50% Duty

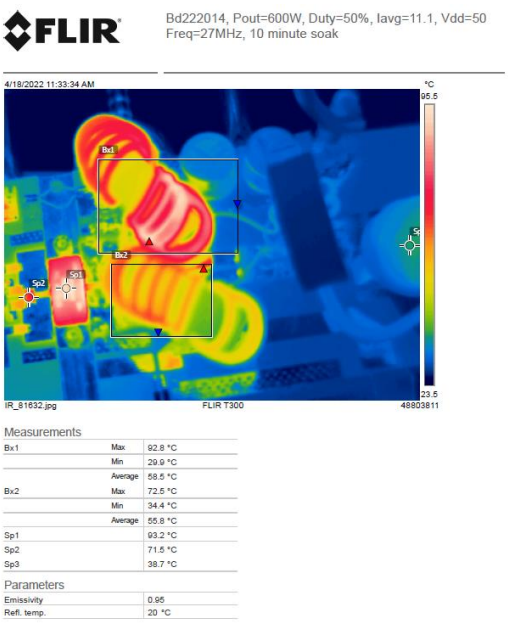



**Figure 12. IR Scans, Pout=600W**

## 11.4 External Air Flow Set up

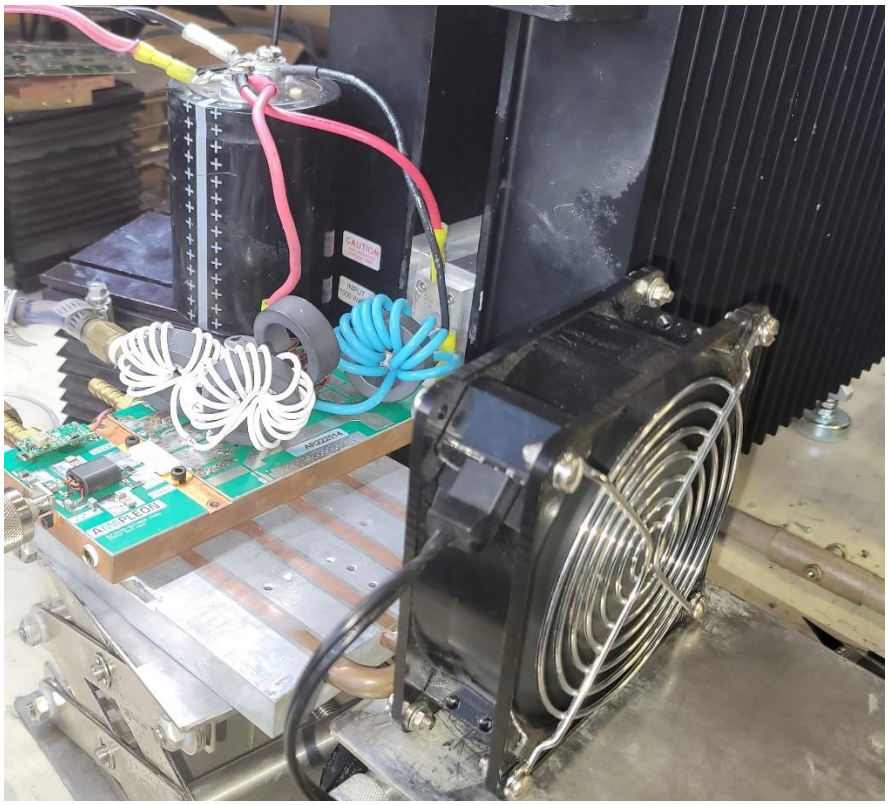


Figure 13. External Air Flow Bench Set-up

# 12 Hardware

## 12.1 Board photographs

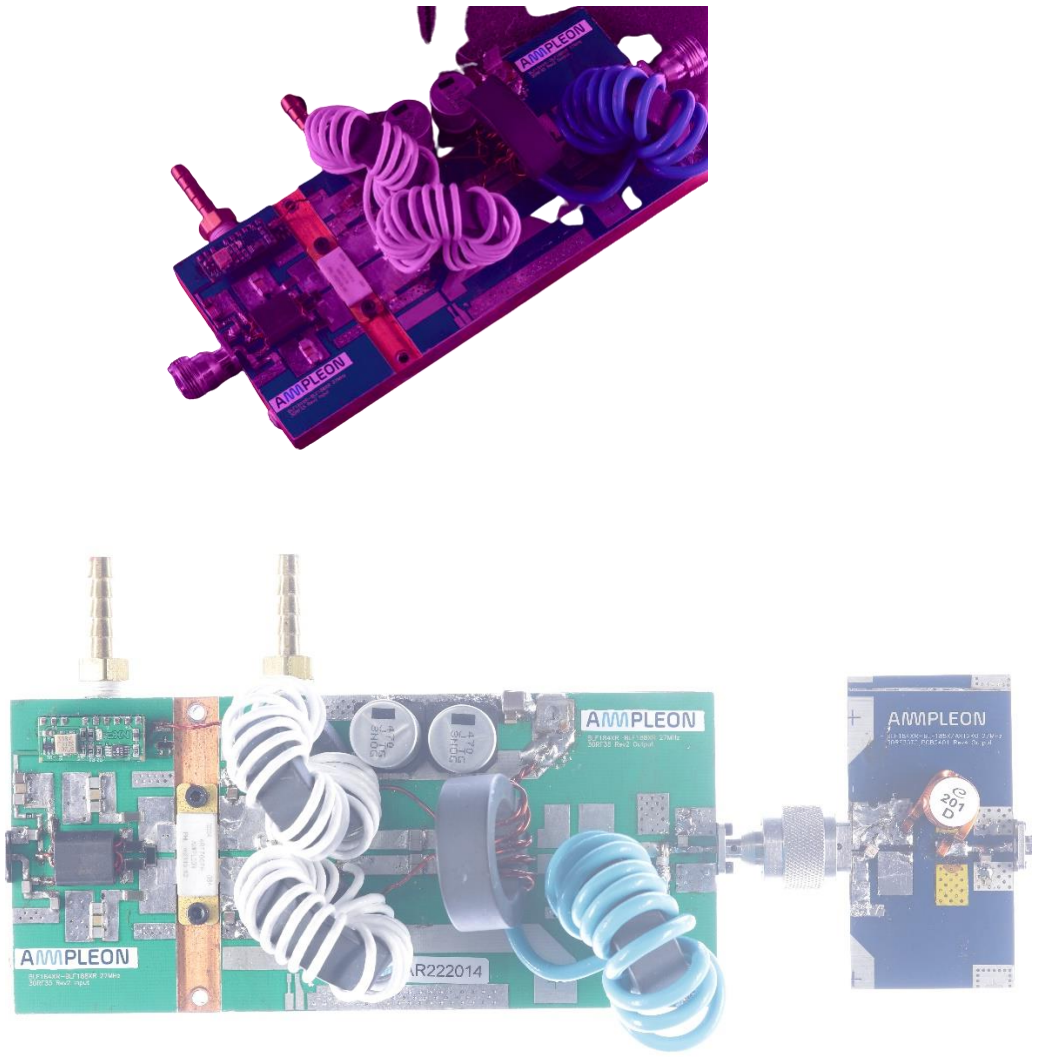



Figure 14. Board Photographs

## 12.2 PCB layout

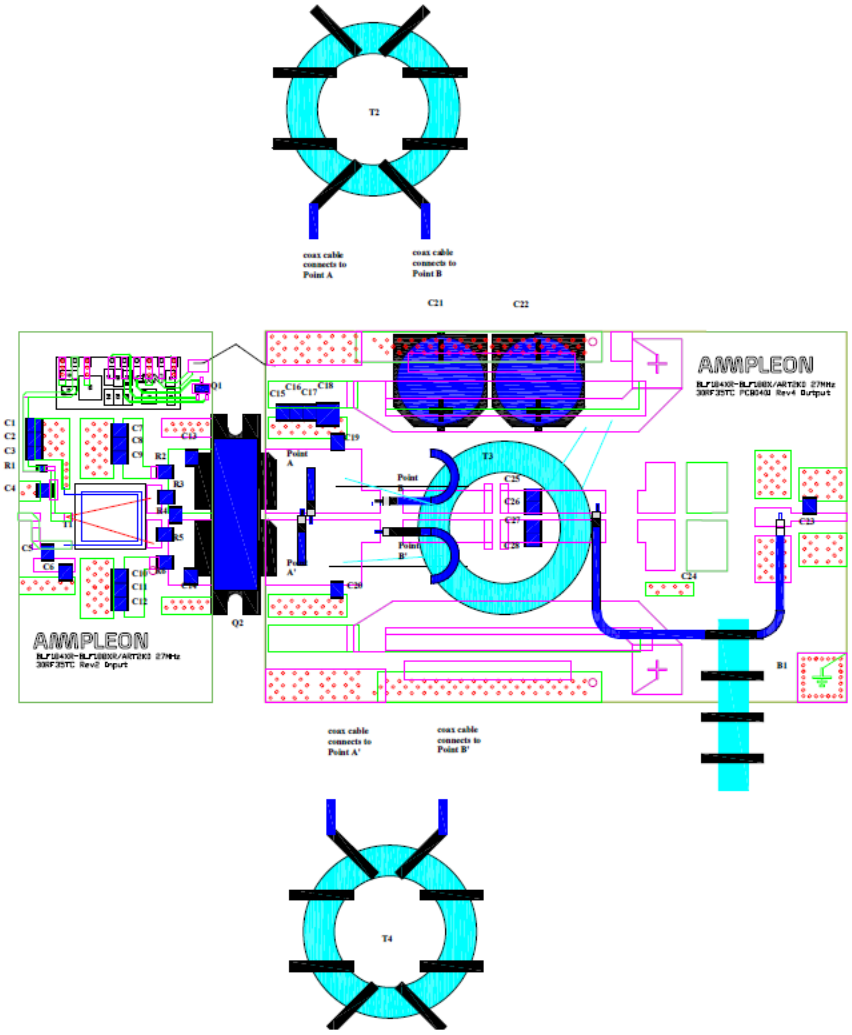



Figure 15.PCB Layout

## 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<br>FT-140-61 | Silver State Wire<br>Amidon |
| B1 | 13 turns 30 ", 0.141 50Ω coax on Ferrite | UT-141-50<br>FT-140-61 | <br>Amidon |
| T3 | 2 x 7 turns 18 AWG bifilar wount on Ferrite | <br>FT-140-61 | <br>Amidon |

## 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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