AR231100

ART35FE, 13.56 MHz

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AMPLEON

Application Report

Document information	
Status	General Publication
Abstract	Measurement results of a demo board at 13.56 MHz with the ART35FE

1. Revision History

Table 1 Report revisions

Revision	Date	Description	Author
1.0	2023.09.12	Initial document	Gabriel Pasca

2. Contents

3. List of figures

4. List of tables

5. General description

This report presents an evaluation of a demo board designed as a driver for the 13.56 MHz ISM frequency band, utilizing the ART35FE transistor built on 65V ART technology. This band is prevalent in a wide array of Industrial, Scientific, and Medical (ISM) applications, such as plasma generation, food processing, industrial heating & drying and material processing.

The printed circuit boards (PCBs) ware securely fastened using screws, eliminating the need for soldering the board itself. However, the transistor was connected via soldering to ensure optimal electrical conductivity and mechanical stability. The demo board is impedance-matched to 50 Ω at both the input and output, making it compatible with standard RF equipment and test setups.

Figures 1 and 2 showcase the top view of the demo board and its corresponding schematic, providing visual insights into its design and configuration.

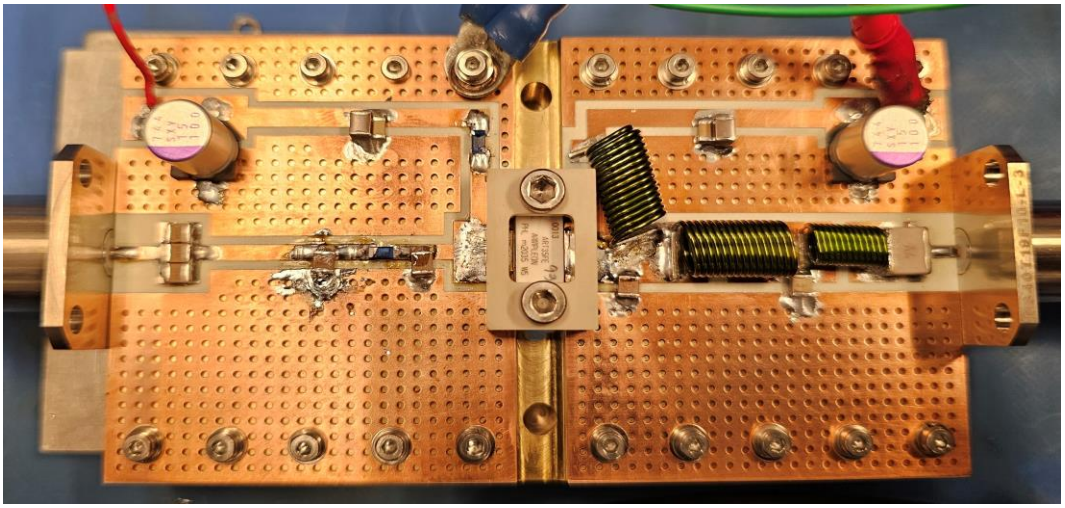

Figure 1 Demo top view

Parameter	Description	Unit
Laminate Type	Rogers 4350B	
Dk	3.48	
Df	0.0037 @10 GHz	
Laminate thickness	0.762	mm
Copper thickness	1 oz top/bottom	
Overall dimensions	106 x 60	mm
Cooling type	Indirect water cooling	
Device Package	SOT467	

Table 2 Test circuit information

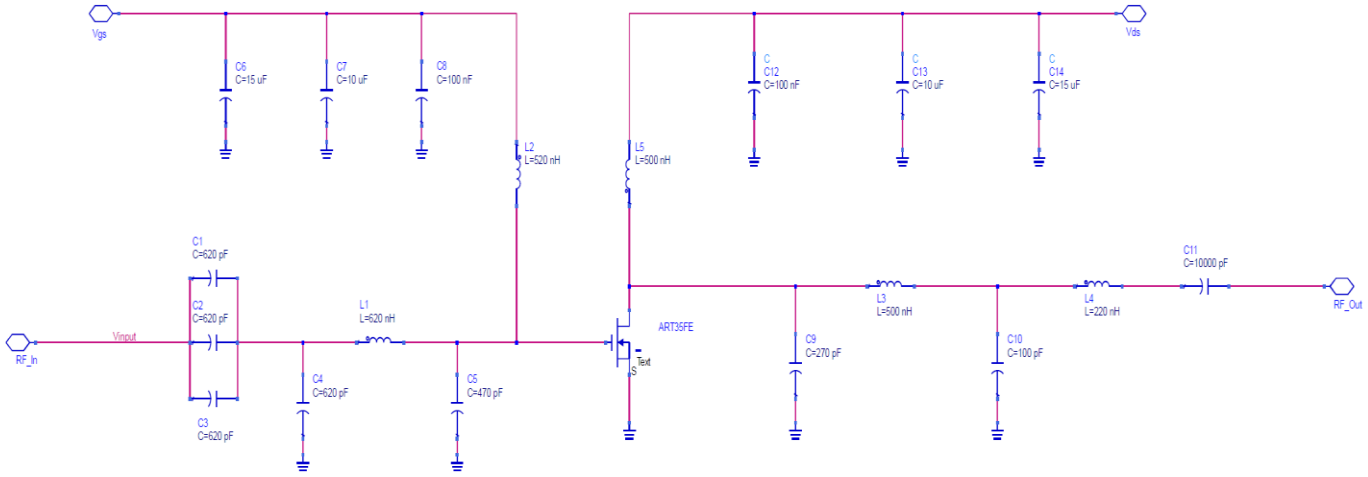

Figure 2 Schematic of the demo

5.1 Simulation Results

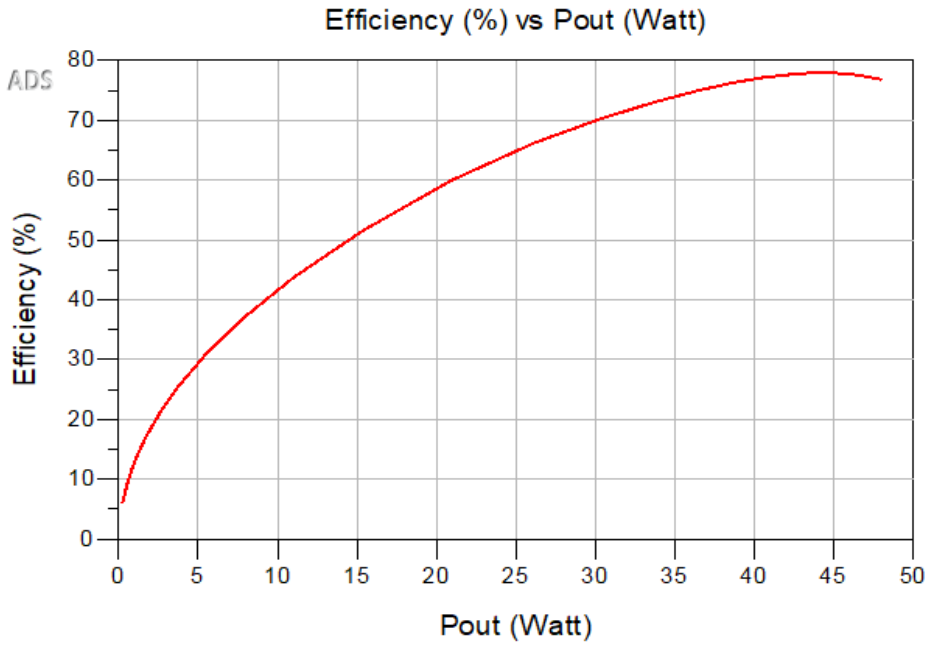

Figure 3 Simulated Efficiency vs Output Power

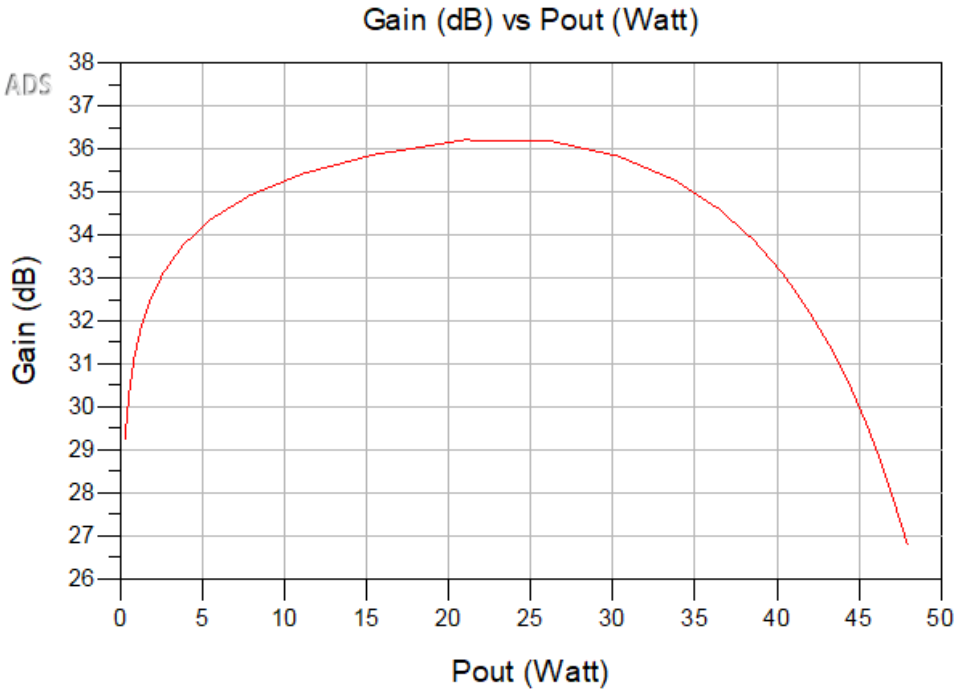

Figure 4 Simulated Gain vs Output Power

5.2 RF characteristics

5.2.1 Efficiency and Gain vs Output Power in CW mode at different VDS levels

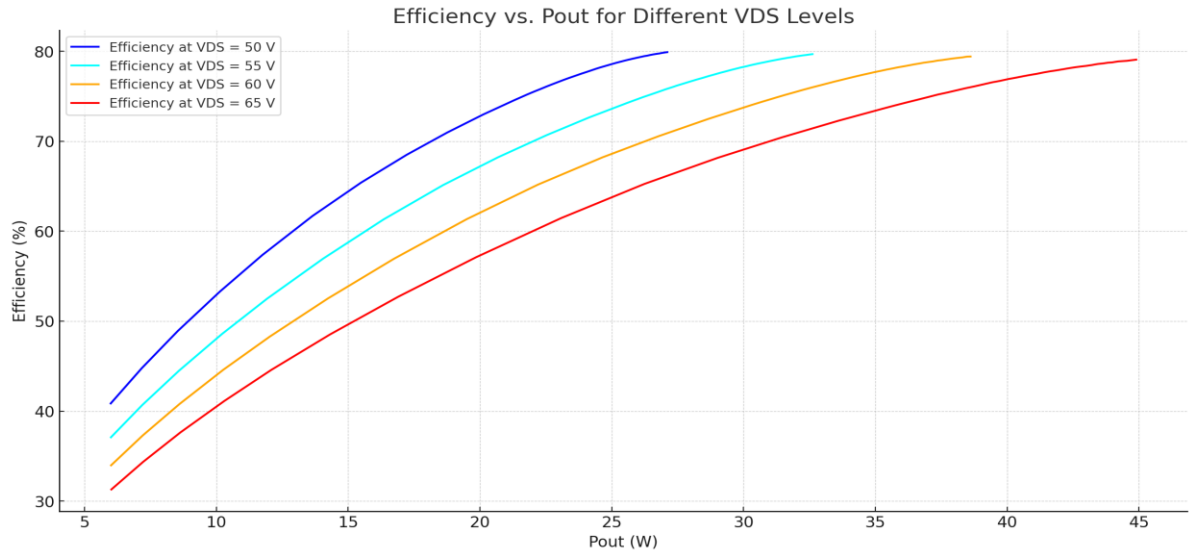

Figure 5 Efficiency vs Output Power at different VDS levels

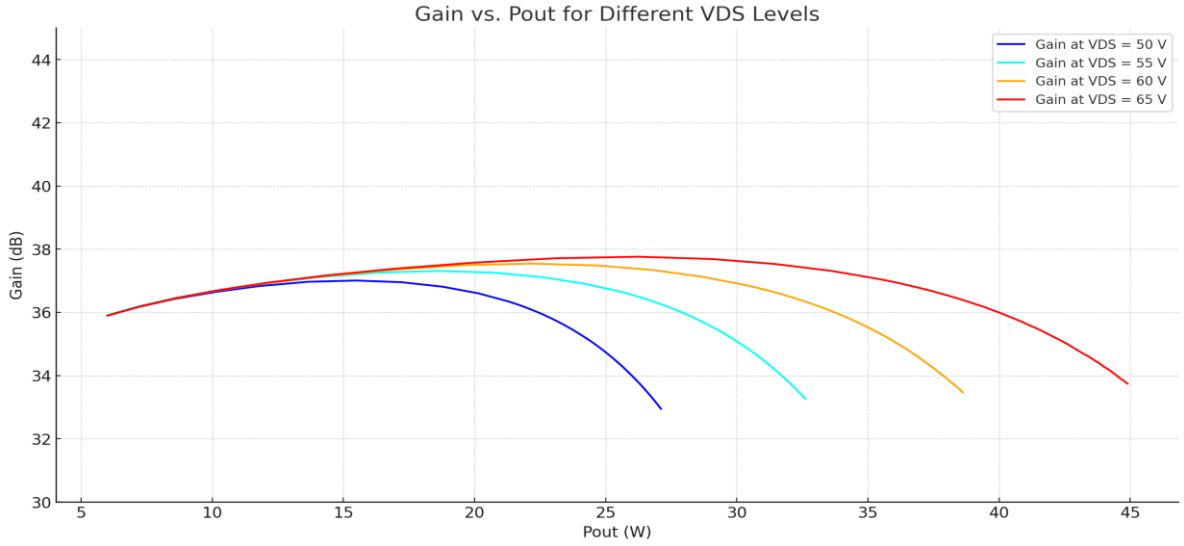

Figure 6 Efficiency and Gain vs Output Power at different VDS levels

V_{DS} (V)	Gmax (dB)	P1dB (W)	P2dB (W)	P3dB (W)	Eff_P1dB (%)	Eff_P2dB (%)	Eff_P3dB (%)
50	29.2	22	25	**26**	75.9	78.2	**79.3**
55	29.4	27	29	**31**	75.6	77.9	**79.0**
60	37.5	32	35	**37**	75.3	77.6	**78.8**
65	37.7	37	40	**43**	74.9	77.2	**78.4**

Table 3 RF characteristics in CW mode at F=13.56MHz, Idq = 25mA

5.2.2 Efficiency and Gain vs Output Power in CW mode at different Idq levels

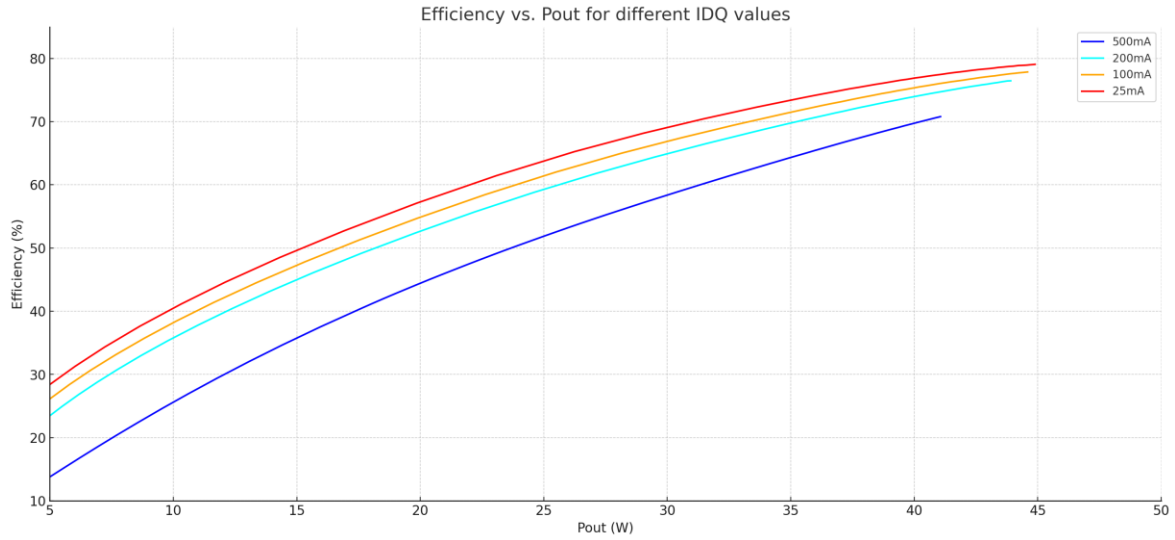

Figure 7 Efficiency vs Output Power at different Idq levels

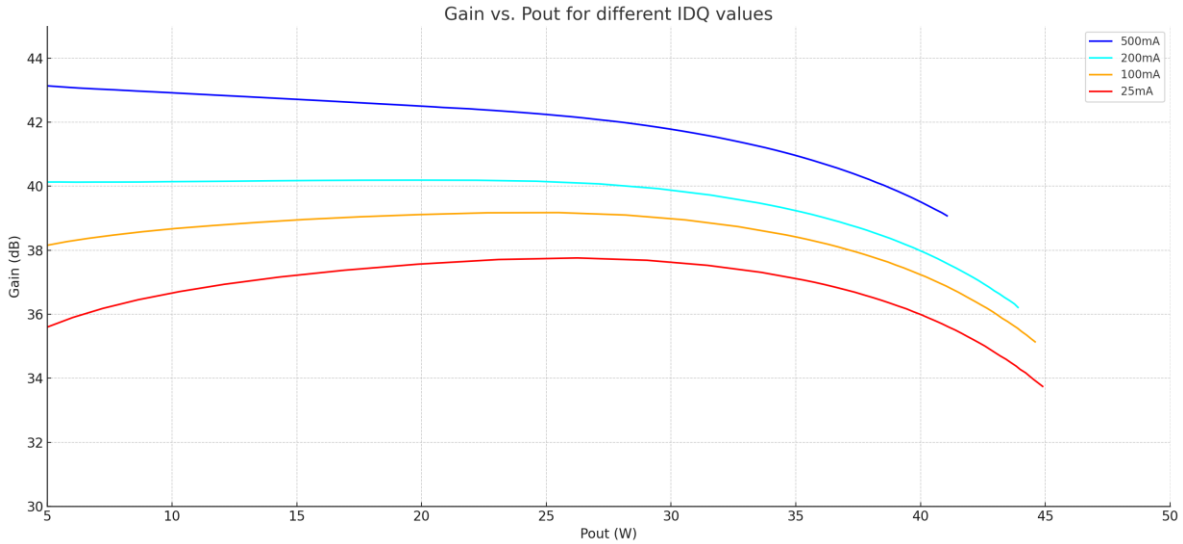

Figure 8 Gain vs Output Power at different Idq levels

$I_{Dq(mA)}$	Gmax (dB)	P1dB (W)	P2dB (W)	P3dB (W)	Eff_P1dB (%)	Eff_P2dB (%)	Eff_P3dB (%)
25	37.7	37	40	**43**	74.9	77.2	**78.4**
100	39.2	36	40	**42**	72.6	75.5	**76.9**
200	40.2	35	39	**42**	69.8	73.4	**75.3**
500	43.1	26	34	**38**	53.9	63.3	**67.8**

Table 4 RF characteristics in CW mode at F=13.56MHz, Vds = 65 V

5.3 Harmonic Performance

The focused plot for the ART35FE between 5W to 45W at 13.56 MHz reveals key insights for its role as a driver in high-power RF applications. The harmonic levels indicate effective suppression of unwanted frequencies and validate the device's design for optimal performance. This range-specific analysis is critical for ensuring the ART35FE can reliably drive subsequent amplification stages in various applications.

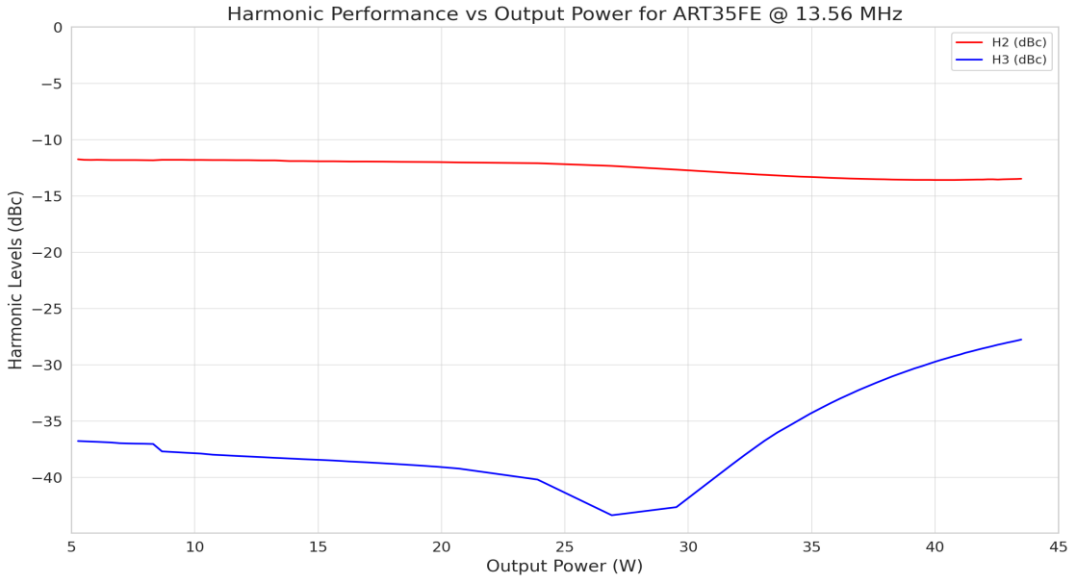

Figure 9 Harmonic Performance vs Output Power

5.4 S-Parameter S21 measurements

The *S*21 S-parameters in Figure 11 indicate a peak at 13.56 MHz, which aligns with the ISM band specifications for target applications. This peak is an indicator of maximum power transfer, high efficiency, and low harmonic distortion in real-world applications.

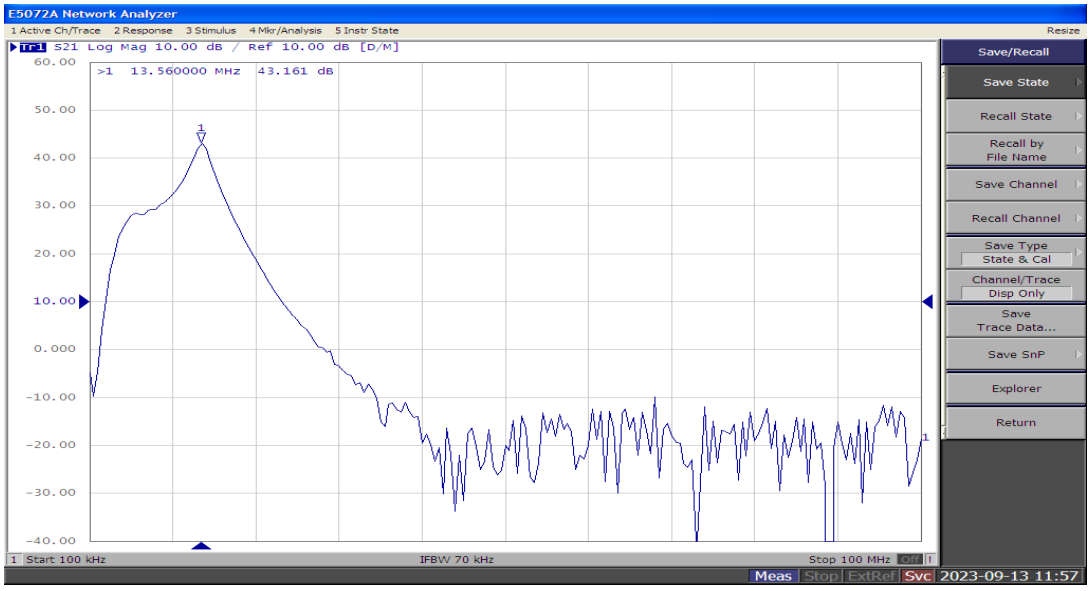

Figure 10 S21 (dB) over frequency (MHz), Vdd = 65V, Idq = 500mA, Pin = -20 dBm

5.5 Thermal characteristics

Figure 12 presents an infrared (IR) thermal image of the demo board after it has reached a state of thermal equilibrium in a no-cooling environment. The highest recorded temperature on the device under these conditions is Tcase = 58°C, the ambient temperature Tambient = 25 °C

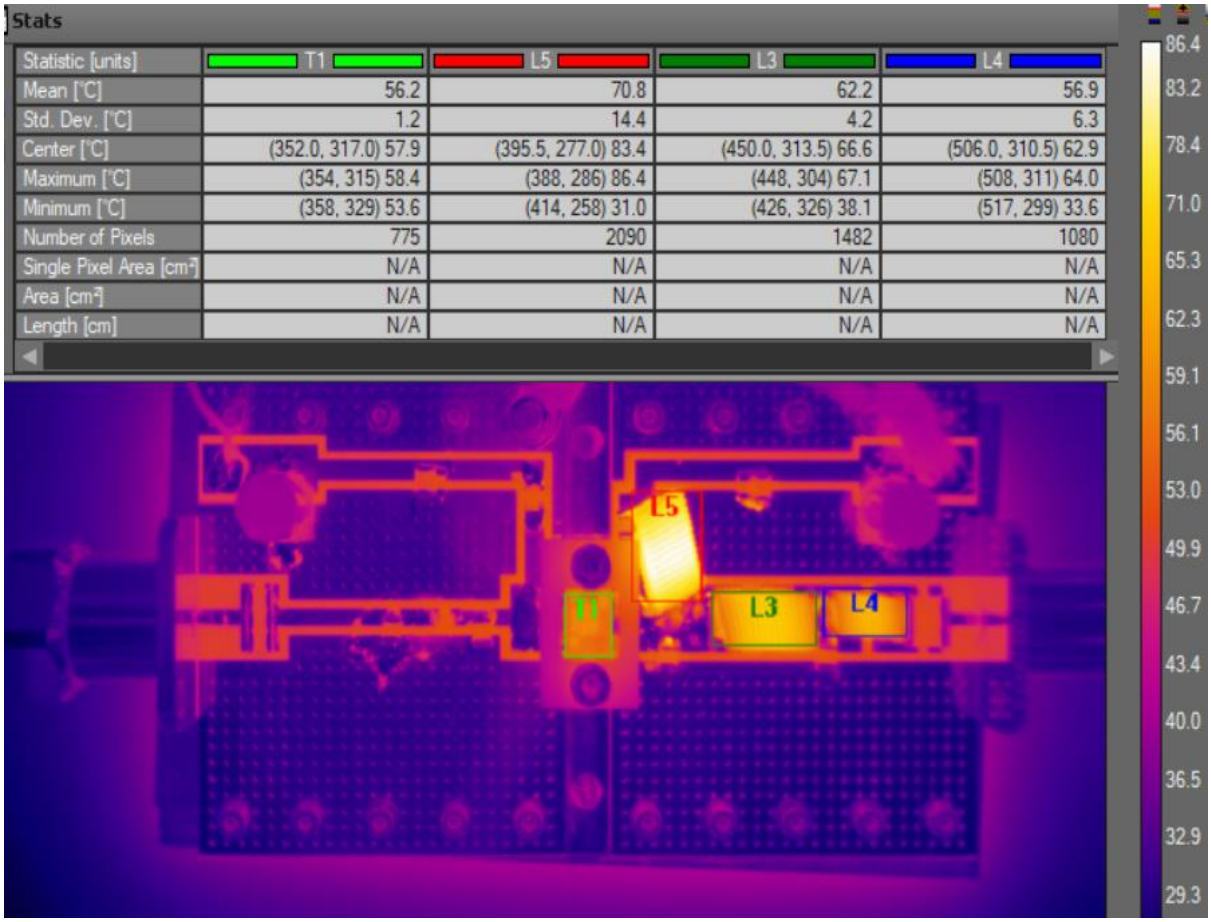

Figure 11 IR image of the demo after reaching thermal equilibrium and operating at P3dB, VDD = 65V

6. Hardware

6.1 Bill of materials

Designator	Group	Value	Tolerance	Name	Manufacturer	Quantity
C1, C2, C3, C4	Capacitor	620pF	±2%	800B621GT100XT	KYOCERA AVX	4
C5	Capacitor	470pF	±2%	800B471GT200XT	KYOCERA AVX	1
C6, C14	Capacitor	15uF	±20%	100SXV15M	Panasonic	2
C7, C13	Capacitor	10uF	±10%	GRM32EC72A106KE05L	Murata	2
C8, C12	Capacitor	0.1uF	±10%	GRM188R72A104KA35D	Murata	2
C9	Capacitor	270pF	±2%	800B271GT200XT	KYOCERA AVX	1
C10	Capacitor	100pF	±2%	800B101GT500XT	KYOCERA AVX	1
C11	Capacitor	10nF	±5%	222522000103JQTAF9LM	Knowles Syfer	1
L1	Inductor	620nH	±5%	1206CS-621XJE	Coilcraft	1
L2	Inductor	560nH	±5%	1206CS-561XJE	Coilcraft	1
L3	Inductor	500nH 4.3A	±2%	2929SQ-501GEC	Coilcraft	1
L4	Inductor	220nH	±2%	2222SQ-221GEC	Coilcraft	1
L5	Inductor	500nH 4.3A	±2%	2929SQ-501GEC	Coilcraft	1
Q1	Transistor	35 W		ART35FE	Ampleon	1
X1	Connector			13_N-50-0-33/133_NE	HUBER+SUHNER	1
X2	Connector			23_N-50-0-33/133_NE	HUBER+SUHNER	1
PCB In	Board			ART35FE-DB1-013 IN	Cibel	1
PCB Out	Board			ART35FE-DB1-013 OUT	Cibel	1

Table 5 Bill of Materials

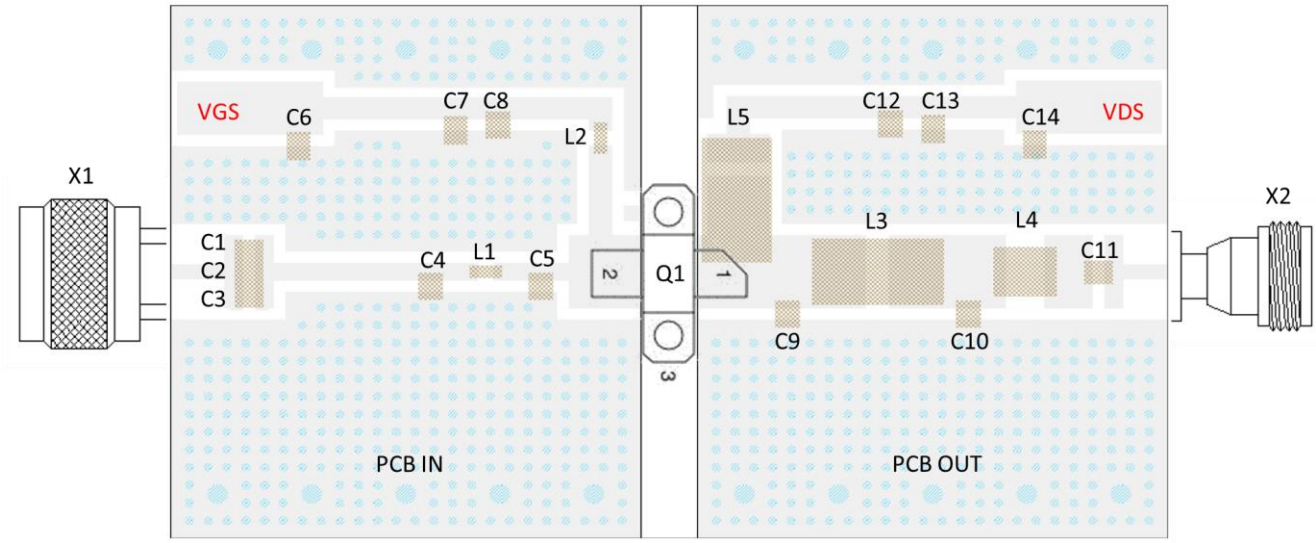

Figure 12 Component mapping

6.2 User Guide

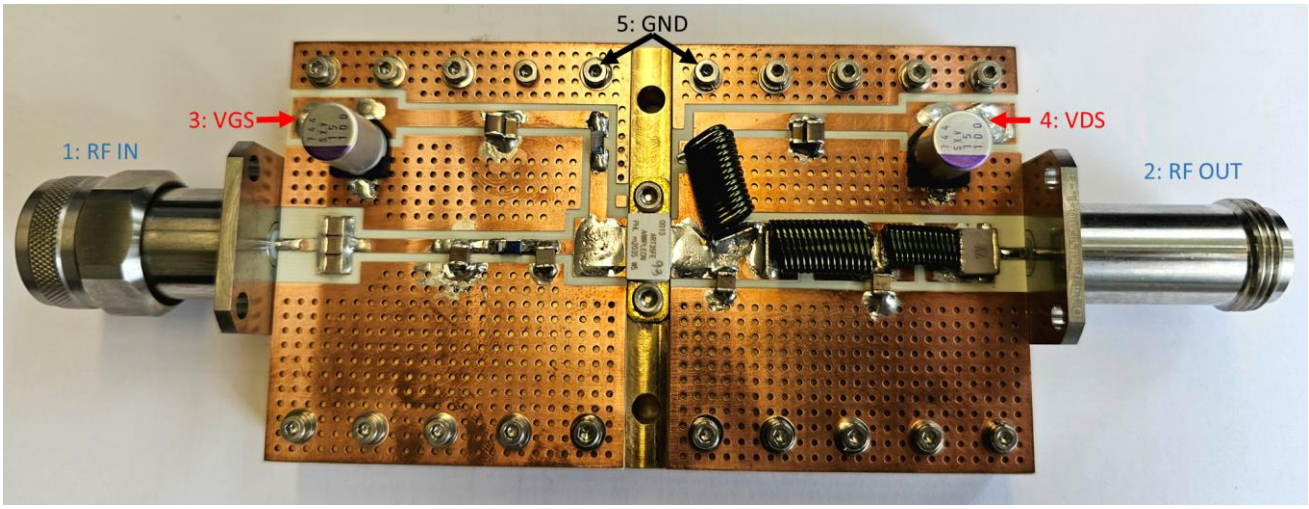

Figure 13 Application board pin configuration

Symbol	Pin	Description
RF_{IN}	1	RF input
RF_{OUT}	2	RF output
V_{GS}	3	Gate-source voltage
V_{DS}	4	Drain-source voltage
GND	5	Negative supply terminal for V_{DS} and V_{GS}

Table 6 Pin Description

6.3 Board specifications

Parameter	Value
Manufacturer	Ampleon
Device	ART35FE
PCB marking	ART35FE-DB1-013

Table 7 Device specifics

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