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CLF24H4LS300P, 2.4-2.5GHz

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AMPLEON

Application Report

Document information	
Status	General Publication
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Abstract	Measurement results of 2.4-2.5GHz amplifier with the CLF24H4LS300P

1. Revision History

Table 1: Report revisions

Revision	Date	Description	Author
1.0	2023.11.02	Initial document	Naser H.R Miveroud

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5. Description

This report presents measurement results of Ampleon's 2.4-2.5GHz 300W GaN amplifier. The device used is CLF24H4LS300P, 50V GaN HEMT transistor. The presented demo is operating at full 2.4-2.5GHz ISM band. The results are presented for a typical application. However, the demo can be tuned for different efficiency/power tradeoffs.
The amplifier has very small size and utilizes proper treatment of the harmonic impedances to deliver high efficiency and yields excellent harmonic suppression.

For further details and conditions, customers can contact an Ampleon marketing/sales representative.

Table 2: Mechanical characteristics

Parameter	Description	Unit
L x W	60 x 30	mm
PCB assembly height	5	mm

Table 3: Board Specifications

Parameter	Value
Manufacturer	Rogers
Type	TC350
Dk	3.5 @ 10GHz
Df	0.002 @ 10GHz
Total PCB thickness	0.508 mm (20mil)
Copper thickness	35um (1 oz)
Board dimensions	60 x 30 mm

6. Demo Board

Figure 1 illustrates the demo board's top view. The PCB and the transistor are soldered to the copper base plate.

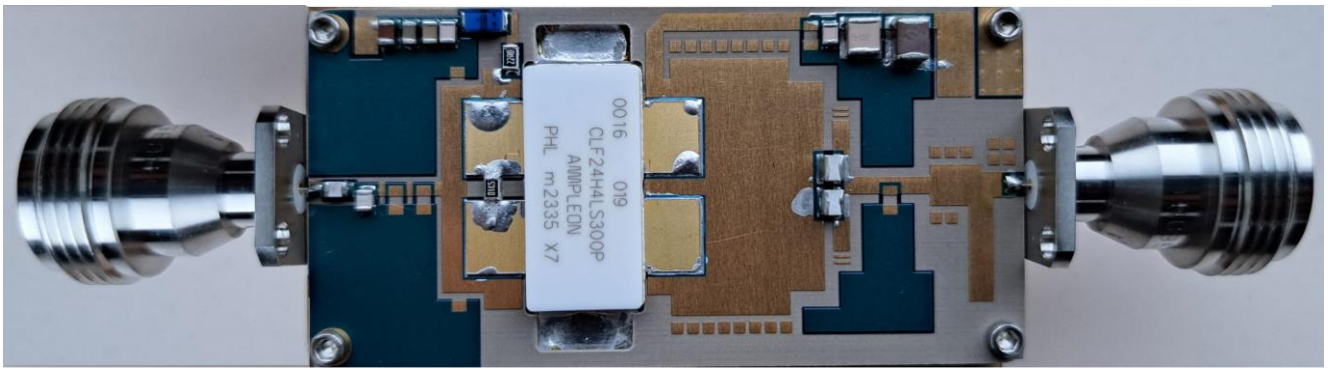

Figure 1 Demo board's top view

Table 4 summarizes the key parameters of the demo. Output power is 350W in CW mode. Measurement is done at the output connector (RF OUT) of the demo followed by a high power load and a 2.4-2.5 GHz circulator for accurate power and efficiency measurement.

Tables 5 and 6, and Figures 3 to 8 depict detailed values of the measurement for the demo.

Table 4: General Specifications, Base plate temperature = 25º C

Symbol	Parameter	Unit	Min	Typ	Max
F	Frequency of operation	MHz	2400	-	2500
V_{DD}	Drain voltage of GaN transistor	V	-	-	50
I_{DD}	Current consumption of GaN transistor	A	-	9.5	-
P_{OUT}	Output power[1]	W	-	350	-
η_{DRAIN}	Drain efficiency[2]	%	-	75	-
P_{DISS}	Dissipated power	W	-	115	-
H	Level of harmonics	dBc	-	-	- 30
IRL	Input return loss	dB	-	10	-

[1] *Typical output power of 350W is achieved with V_{DD} = 50V at 3dB compression point (P_{3dB}).*

[2] *Typical efficiency of 75% is achieved with V_{DD} = 50V at 3dB compression point (P_{3dB}).*

6.1 RF characteristics

Test signal: CW; VDD = 50V, VGS = -5V ; T_{base} = 25ºC.

Table 5: RF characteristics in CW mode, VDD = 50V, VGS = -5V

Freq (MHz)	Gmax (dB)	P1dB (W)	P3dB (W)	Eff_P1dB (%)	Eff_P3dB (%)	Eff_max (%)	Pout @ Eff_max (W)
2400	15.0	345	**360**	75.5	75.3	**75.5**	**347**
2450	15.0	330	**348**	74.3	74.6	**75.0**	**347**
2500	15.0	300	**321**	73.0	73.1	**73.3**	**320**

Test signal: CW pulsed, 100us pulse width,20% duty cycle VDD = 50V, VGS = -5V; water cooling, T_{base} = 25ºC.

Table 6: RF characteristics in CW Pulsed mode, VDD = 50V, VGS = -5V

Freq (MHz)	Gmax (dB)	P1dB (W)	P3dB (W)	Eff_P1dB (%)	Eff_P3dB (%)	Eff_max (%)	Pout @ Eff_max (W)
2400	15.3	345	**362**	76.0	75.8	**76.0**	**360**
2450	15.3	330	**353**	74.9	75.5	**75.5**	**353**
2500	15.3	300	**326**	73.6	73.6	**73.9**	**326**

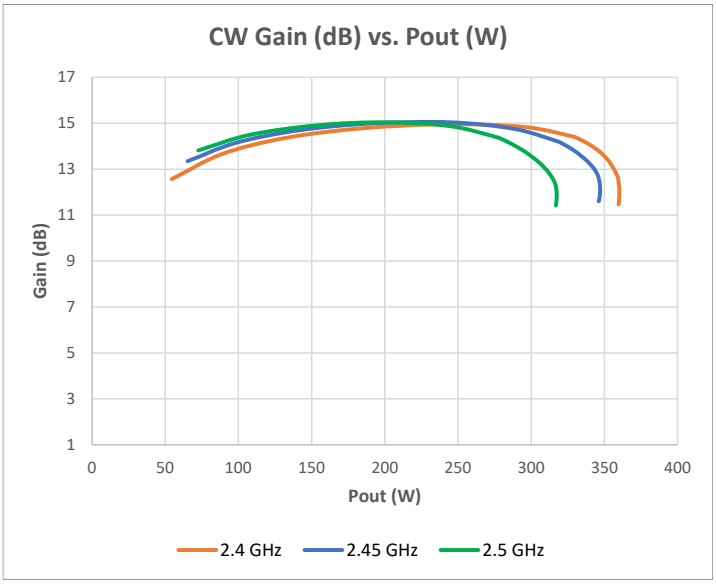

Figure 2 Gain (dB) over output power (W), CW signal, VDD = 50V, VGS = -5V

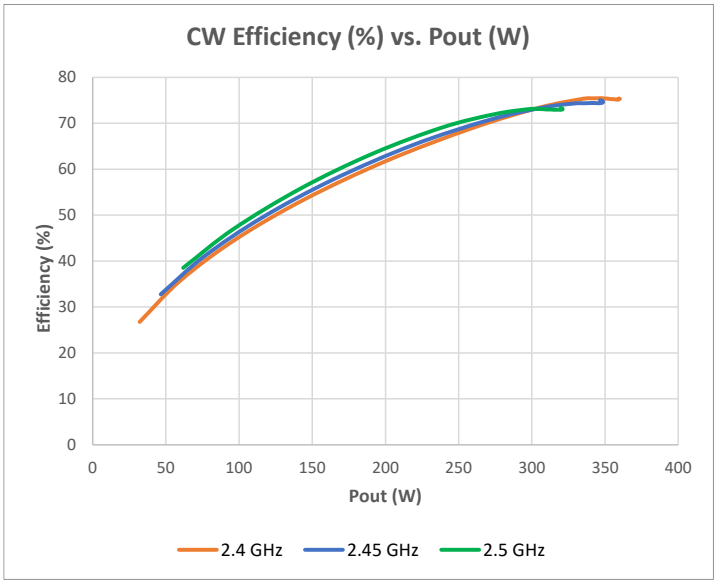

Figure 3 Efficiency (%) over output power (W), CW signal, VDD = 50V, VGS = -5V

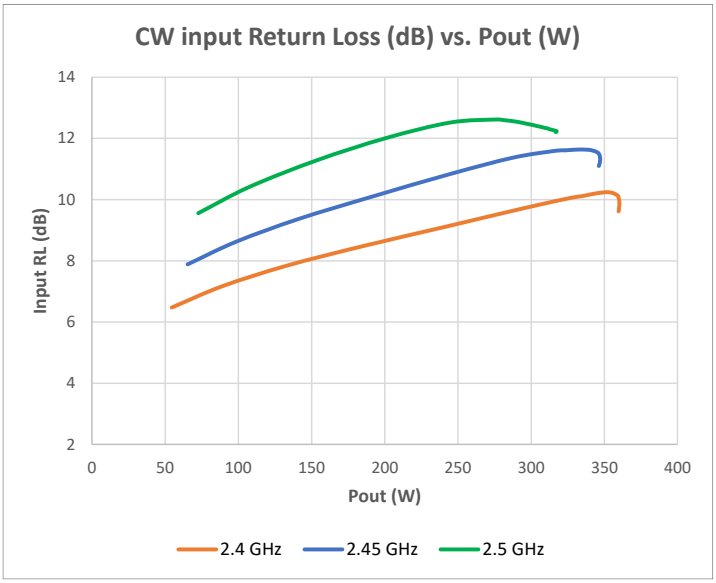

Figure 4 Input return loss (dB) over output power (W), CW signal, VDD = 50V, VGS = -5V

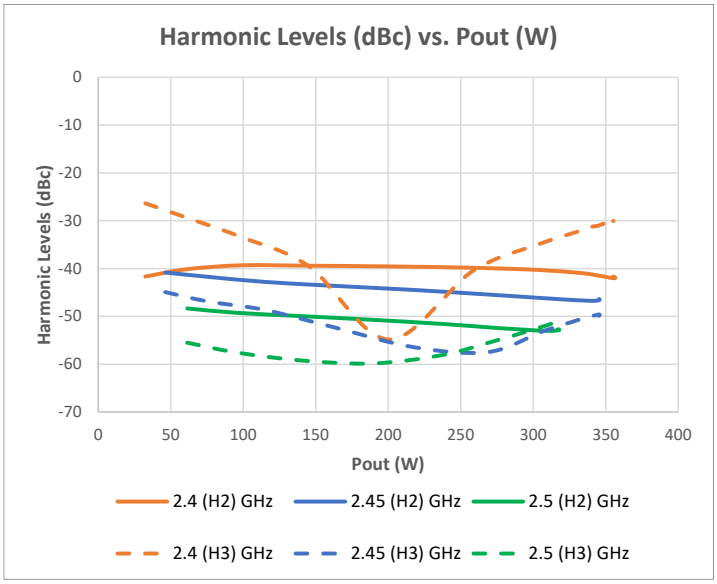

Figure 5 2nd (H2) and 3rd (H3) harmonic levels over output power (W), CW signal, VDD = 50V, VGS = -5V

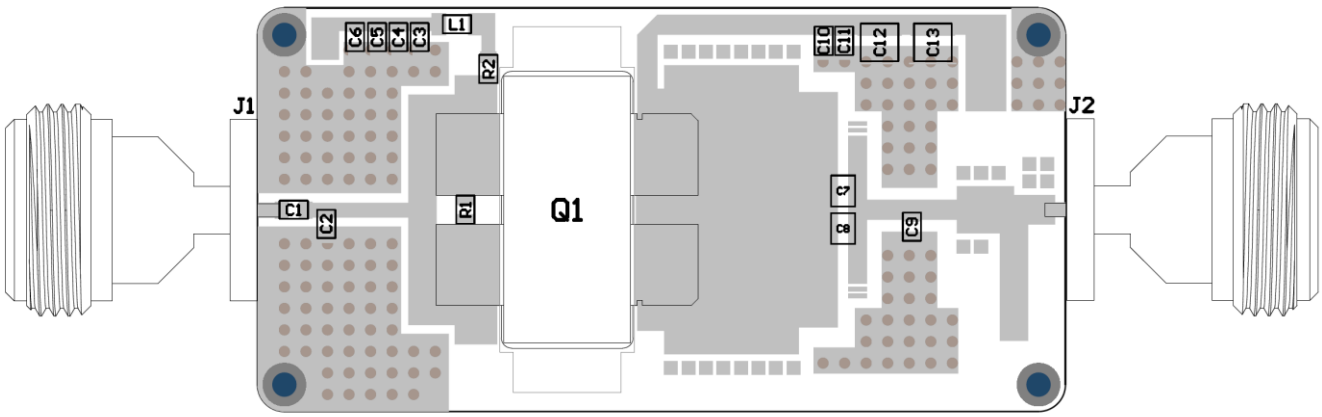

Figure 6 PCB and component layout

6.1 Bill of materials

Table 7: Bill of Materials

Designator	Group	Value	Tolerance	Name	Manufacturer	Quantity
C1	Capacitor	33pF	±5%	ATC600F330JW250XT	ATC	1
C2	Capacitor	1.1pF	±0.1pF	ATC600F1R1BW250XT	ATC	1
C3	Capacitor	100pF	%5	ATC600F101JW250XT	ATC	1
C4	Capacitor	100nF		0805 X7R	Various	1
C5	Capacitor	220nF		0805 X7R	Various	1
C6	Capacitor	4.7uF		0805 X7R	Murata	1
C7+, C8+	Capacitor	1.2pF	±0.1pF	ATC800R1R2BW500T	ATC	2
C9	Capacitor	0.9pF	±0.1pF	ATC600F0R9BW250XT	ATC	1

C10, C11	Capacitor	100pF	%5	ATC600F101JW250XT	ATC	1
C12	Capacitor	1000pF	±5%	ATC800B102JW50XT	ATC	1
C13	Capacitor	10uF	±10%	C3225X7R2A106K	TDK	1
R1	Resistor	5.1Ω	±5%		various	1
R2	Resistor	22Ω	±5%		various	1
L1	Inductor	12nH	±5%	1206CS-120XJRB	Coilcraft	2
J1, J2	Connector	N-Type		23_N-500-16/133_NE	HUBER+SHUNER	2
Q1	GaN Transistor			CLF24H4LS300P	Ampleon	1

[+] Mount Horizontally

6.2 Correct Power ON/OFF Sequence

Depletion mode transistors including GaN require proper sequence to power ON and OFF. If the correct procedure is not followed, the device can be damaged immediately or to be degraded.

To Turn the device ON:

1. Set VGS to -5V
2. Apply VDS = 50V
3. In needed, slowly increase VGS until reaching desired Idq level
4. Apply input RF signal

To Turn the device OFF:

1. Turn the input RF signal off
2. Reduce VGS to -5V
3. Reduce VDS to 0V (in case there is a big capacitor on the drain bias, give enough time to the capacitor to be discharged)
4. Turn the VGS off (VGS =0V)

7. Abbreviations

Table 8: Abbreviations

Parameter	Description
F	Frequency
CW	Continuous Wave
Gmax	Maximum Gain
P1dB	1 dB Compression Point of the Gain
V_{DD}	Drain Voltage
VGS	Gate Voltage
η_{DRAIN}	Drain Efficiency
GaN	
VSWR	Voltage Standing Wave Ratio
δ	Duty Cycle

t_p	Pulse Width
RF	Radio Frequency
P_L	Power Delivered to 50Ω Load at RF OUT Connector
S21	Small Signal Gain (S-parameter measurement in 50Ω System)
Pin	Input Power to the Amplifier at RF IN Connector
Pout	Output Power of Amplifier at RF OUT Connector

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