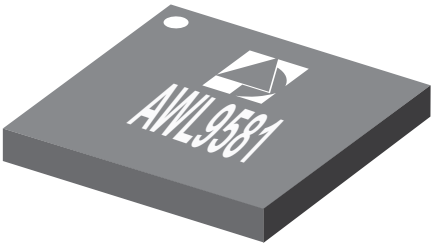
AWL9581

802.11a/n/ac Power Amplifier, LNA and Tx/Rx Switch

DATA SHEET - Rev 2.2

FEATURES

- Supports emerging 802.11ac high-data rate standard
- Fully integrated FEIC including 5GHz Power Amplifier, Low Noise Amplifier with Bypass mode and SP2T TX/RX Switch
- 1.8% Dynamic EVM @ P_{OUT} = 16 dBm with 802.11ac MCS9-HT80 waveform
- 30 dB of Linear Power Gain
- Power Detector with High Accuracy over 3:1 VSWR
- 2.8 dB RX Path Noise Figure with 13 dB Gain LNA Mode
- Single 3.0 to 4.8 V Supply Voltage
- 50 Ω-Internally Matched RF Ports
- Leadfree and RoHS Compliant
- 2.5 x 2.5 x 0.40 mm QFN Package



2.5 mm x 2.5 mm x 0.40 mm
Surface Mount Front End IC

APPLICATIONS

- 802.11a/n/ac WLAN for Fixed, Mobile and Handheld applications

PRODUCT DESCRIPTION

The ANADIGICS AWL9581 is a high performance InGaP HBT FEIC that incorporates a 5GHz Power Amplifier, Low Noise Amplifier, RF Switch, and Power Detector. The FEIC is designed for WLAN transmit and receive applications in the 4.9 – 5.875 GHz band. Matched to 50 Ohms and DC blocked at all RF inputs and outputs, the part requires no additional RF matching components off-chip.

The antenna port is switched between WLAN transmit and WLAN receive with low loss switches. The integrated power detector circuit facilitates accurate power control under varying load conditions.

All circuits are biased by a single +3.6 V supply and consume ultra low current in the OFF mode. The PA exhibits unparalleled linearity and efficiency for 802.11a/n/ac WLAN systems under the toughest signal conditions within these standards.
The AWL9581 is manufactured using advanced InGaP HBT technology that offers state-of-the-art performance, reliability, temperature stability and ruggedness.

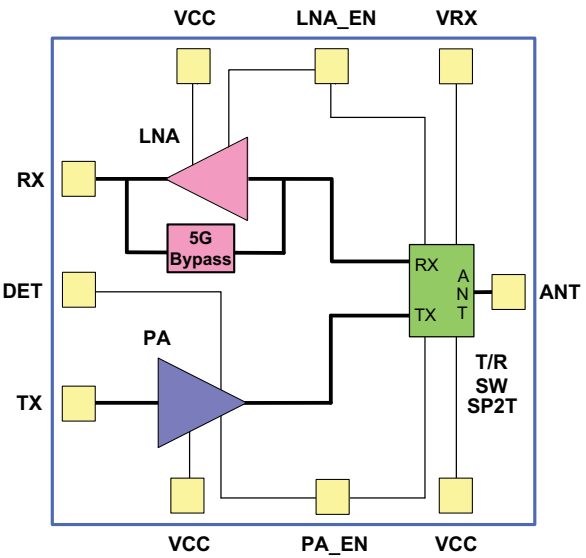


Figure 1: Block Diagram

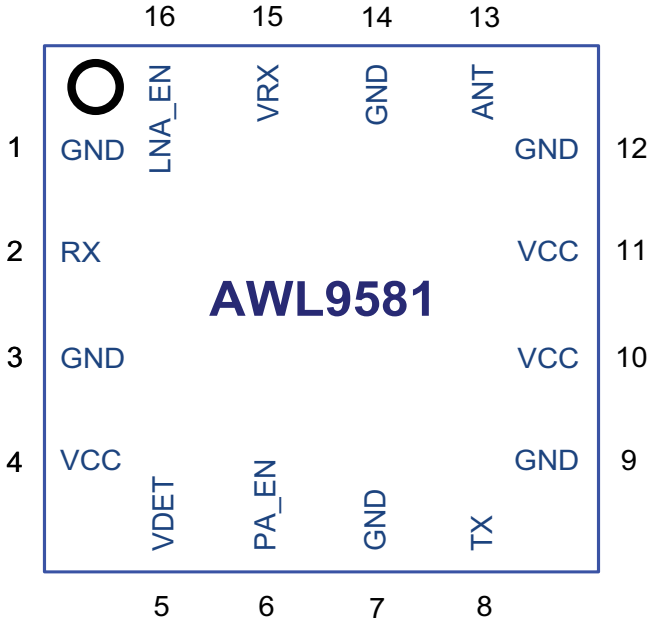


Figure 2: Pinout Diagram

Table 1: Pin Description Table

PIN	NAME	DESCRIPTION	PIN	NAME	DESCRIPTION
1	GND	Ground	9	GND	Ground
2	RX	5 GHz receive output port	10	VCC	Power Supply
3	GND	Ground	11	VCC	Power Supply
4	VCC	Power Supply	12	GND	Ground
5	VDET	Power detector output. DC coupled	13	ANT	Antenna port
6	PA_EN	Power Amplifier Enable. On/Off control for the Tx path power amplifier	14	GND	Ground
7	GND	Ground	15	VRX	Switch control receive path
8	TX	5 GHz RF transmit input port	16	LNA_EN	LNA Enable. On/Off control for the Rx path low noise amplifier

ELECTRICAL CHARACTERISTICS

Table 2: Absolute Minimum and Maximum Ratings

PARAMETER	MIN	MAX	UNIT	COMMENTS
DC Power Supply	-	+6.0	V	
RF Input Level, 5 GHz PA	-	+5	dBm	Modulated
Operating Ambient Temperature	-40	+85	°C	
Storage Temperature	-55	+125	°C	
Storage Humidity	-	85	%	
Junction Temperature	-	150	°C	
ESD Tolerance	1000	-	V	Human body model (HBM)
	1000	-	V	Charged device model (CDM)
	100	-	V	Machine model (MM)
MSL Rating	MSL-1	-	-	

Functional operation to the specified performance is not implied under these conditions. Operation of any single parameter in excess of the absolute ratings may cause permanent damage. No damage occurs if one parameter is set at the limit while all other parameters are set within normal operating ranges.

Table 3: Operating Ranges

PARAMETER	MIN	TYP	MAX	UNIT	COMMENTS
Operating Frequency Ranges	4900	-	5875	MHz	802.11a/n/ac
DC Power Supply Voltage (V_{CC})	+3.0	+3.6	+4.8	V	With RF applied
Control Pin Voltage (PA_EN, LNA_EN, VRX)	+2.8 0	+3.2 0	+4.8 +0.4	V	Logic High/On Logic Low/Off
Operating Temperature	-40	-	+85	°C	

The device may be operated safely over these conditions; however, parametric performance is guaranteed only over the conditions defined in the electrical specifications.

Table 4: Electrical Specifications - 5GHz TX Mode
(TC = +25°C, VCC = +3.6V, PA_EN = +3.2V, VRX = 0.0V, LNA_EN = 0.0V) 64 QAM OFDM 54 Mbps

PARAMETER	MIN	TYP	MAX	UNIT	COMMENTS
Operating Frequency	5170		5835	MHz	
Power Gain	26	30		dB	
Gain Flatness		+/-0.25		dB	Over any 80 MHz BW
Error Vector Magnitude (EVM)		-26 215		dB mA	POUT = 20 dBm, Dyn Mode 6 Mbps data rate, Avg during packet
		-35 180	-30 225	dB mA	POUT = 18 dBm, Dyn Mode 54 Mbps data rate, Avg during packet
		-36 150	-32 190	dB mA	POUT = 16 dBm, Dyn Mode 54 Mbps data rate, Avg during packet
		-38 95		dB mA	POUT = 5 dBm, Dyn Mode 54 Mbps data rate, Avg during packet
Transmit Mask	Pass			N/A	OFDM, All rate, POUT = 20 dBm
PA Noise Figure		5		dB	
Input Return Loss		15		dB	
Output Return Loss		15		dB	
Output Spurious Levels - Harmonics 2 fo 3 fo 4 fo		 -30 -40 -60		 dBm/ MHz	 For Power levels up to 20 dBm OFDM 6 Mbps
Settling Time		0.5		uS	Within 0.5 dB of final value
Quiescent Current (Icq)		85	120	mA	

Table 5: Electrical Specifications - 5GHz Tx Mode
(Tc = +25°C, Vcc = +3.6V, PA_EN = +3.2V, VRX = 0.0V, LNA_EN = 0.0V) 802.11n/ac

PARAMETER	MIN	TYP	MAX	UNIT	COMMENTS
Operating Frequency	5170		5835	MHz	
Error Vector Magnitude (EVM) and Current Consumption		-35 180	-30 220	dB mA	POUT = 18 dBm, MCS7 - HT20
		-34 160	-30 195	dB mA	POUT = 17 dBm, MCS7 - HT40
		-35 150	-33 185	dB mA	POUT = 16 dBm, MCS9 - HT80
Transmit Mask	Pass			N/A	802.11ac MCS7-MCS9, HT20 - HT80 at respective power levels noted above

Table 6: Electrical Specifications - 5GHz TX Mode Power Detector
(TC = +25°C, VCC = +3.6V, PA_EN = +3.2V, VRX = 0.0V, LNA_EN = 0.0V)

PARAMETER	MIN	TYP	MAX	UNIT	COMMENTS
Detector Voltage	780	840	900	mV	POUT = +18 dBm, 54 Mbps, 5170 MHz
	805	865	925	mV	POUT = +18 dBm, 54 Mbps, 5500 MHz
	840	900	960	mV	POUT = +18 dBm, 54 Mbps, 5825 MHz
Total Internal Load Impedance		3		kΩ	
Load Accuracy		+/-0.5		dB	Output Power variation at 3:1 VSWR all phases
Detector Directivity		19		dB	Output Power variation at 3:1 VSWR all phases

Table 7: Electrical Specification - 5GHz RX LNA Mode
(TC = +25°C, VCC = +3.6V, LNA_EN = +3.2V, VRX = +3.2V, PA_EN = 0.0V)

PARAMETER	MIN	TYP	MAX	UNIT	COMMENTS
Operating Frequency	4900		5875	MHz	
Gain - LNA Mode	10	13		dB	
Gain Flatness		+/-0.25		dB	Across any 40 MHz band
Rx Noise Figure		2.8		dB	
Input Return Loss		6		dB	
Output Return Loss		12		dB	
IIP3		0		dBm	
Settling Time		0.5		uS	Within 0.5 dB of final value
Rx Current		9	13	mA	

Table 8: Electrical Specification - 5GHz RX Bypass Mode
(TC = +25°C, VCC = +3.6V, VRX = +3.2V, LNA_EN = 0.0V, PA_EN = 0.0V)

PARAMETER	MIN	TYP	MAX	UNIT	COMMENTS
Operating Frequency	4900		5875	MHz	
Gain - RX Bypass Mode		-5.5		dB	
Gain Flatness		+/-0.25		dB	Across any 40 MHz band
Rx Noise Figure		5.5		dB	
Input Return Loss		12		dB	
Output Return Loss		8		dB	
IIP3		+23		dBm	
Settling Time		0.5		uS	Within 0.5 dB of final value

Table 9: Electrical Specifications - Switch and Control Pin
(TC = +25°C, VCC = +3.6V, Vcontrol High = +3.2V, Vcontrol Low = 0.0V)

PARAMETER	MIN	TYP	MAX	UNIT	COMMENTS
Control Pin Steady State Input Current (PA_EN)		20 0.5		uA uA	Logic Hi/On Logic Low/OFF
Control Pin Steady State Input Current (VRX)		10 0.5		uA uA	Logic Hi/On Logic Low/OFF
Control Pin Steady State Input Current (LNA_EN)		580 0.5		uA uA	Logic Hi/On Logic Low/OFF
Idle Current		6	14	uA	Total from all bias Pins, Controls in OFF mode Vcc = 3.6V
TX-RX Isolation		25		dB	

Table 10: Switch Modes of Operation

Mode of Operation	PA_EN	LNA_EN	VRX
TX Mode	**HIGH**	LOW	LOW
RX LNA Mode	LOW	**HIGH**	**HIGH**
RX Bypass Mode	LOW	LOW	**HIGH**
Power on Reset	LOW	LOW	LOW

Vcc = +3.0 V to +4.8 V; Logic State LOW = 0 V to +0.4 V;
Logic State HIGH = +2.8 V to +4.8 V

MCS7 - HT20 PERFORMANCE DATA

Figure 3: Gain vs. Output Power Across Frequency (V_{CC} = +3.6 V, T_C = +25°C)

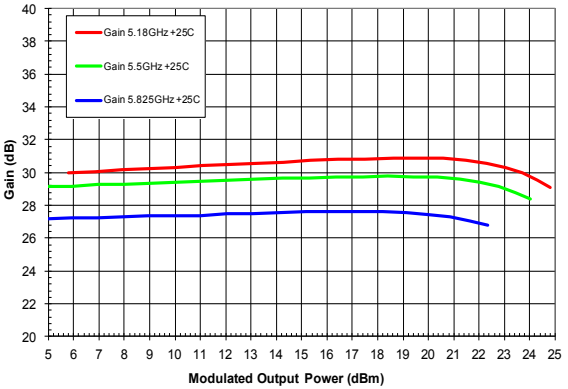


Figure 4: Gain vs. Output Power Across Voltage (Frequency = 5.18 GHz, T_C = +25°C)

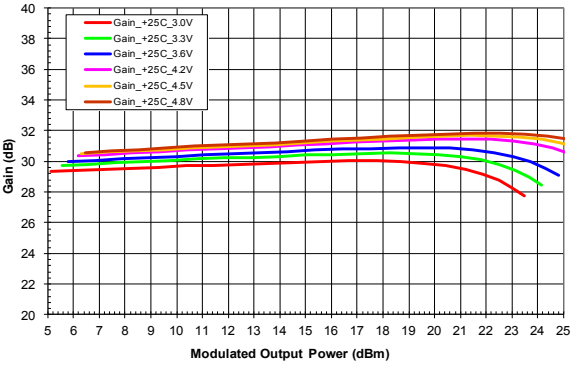


Figure 5: Gain vs. Output Power Across Voltage (Frequency = 5.5 GHz, T_C = +25°C)

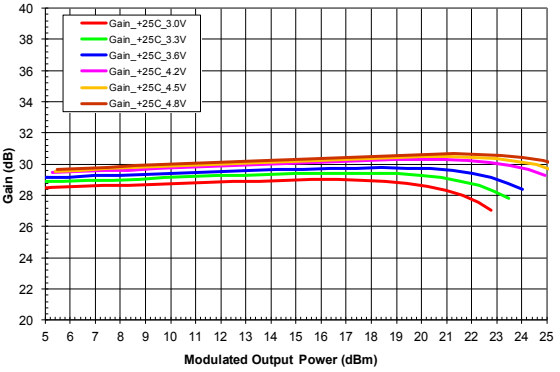


Figure 6: Gain vs. Output Power Across Voltage (Frequency = 5.825 GHz, T_C = +25°C)

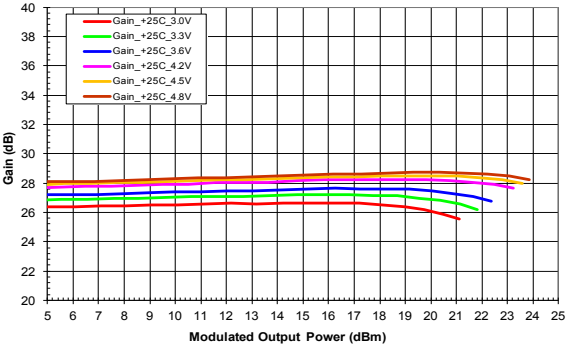


Figure 7: V_{DET} vs. Output Power Across Voltage and Temp (Frequency = 5.18 GHz)

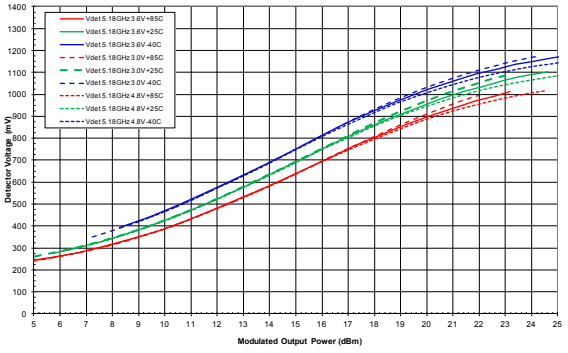
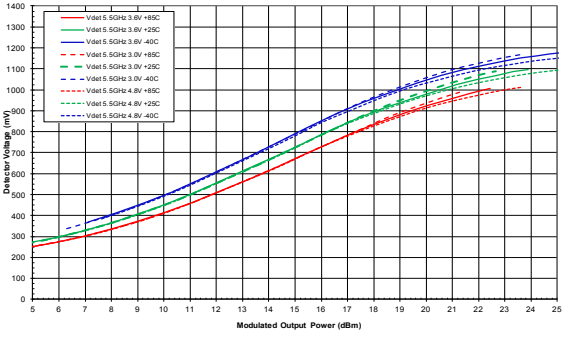
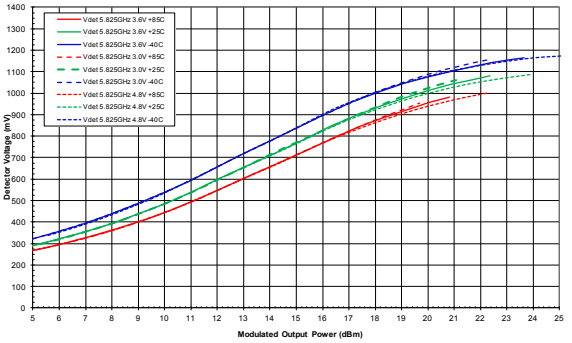


Figure 8: V_{DET} vs. Output Power Across Voltage and Temp (Frequency = 5.5 GHz)



MCS7 - HT20 PERFORMANCE DATA

Figure 9: V_{DET} vs. Output Power Across Voltage and Temp (Frequency = 5.825 GHz)



MCS7 - HT40 PERFORMANCE DATA

Figure 10: EVM and Icc vs. Output Power Across Frequency (Vcc = +3.6 V, Tc = +25°C)

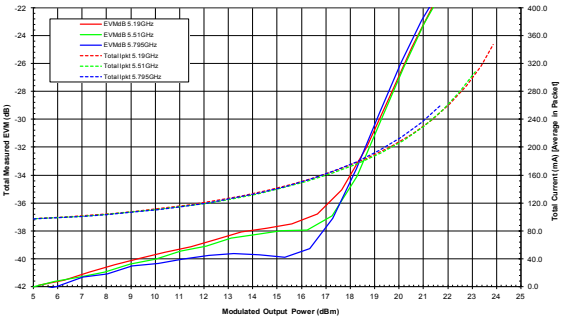


Figure 11: Gain vs. Output Power Across Frequency (Vcc = +3.6 V, Tc = +25°C)

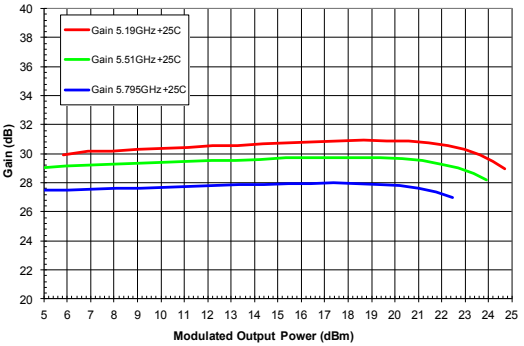


Figure 12: Gain vs. Output Power Across Voltage (Frequency = 5.19 GHz, Tc = +25°C)

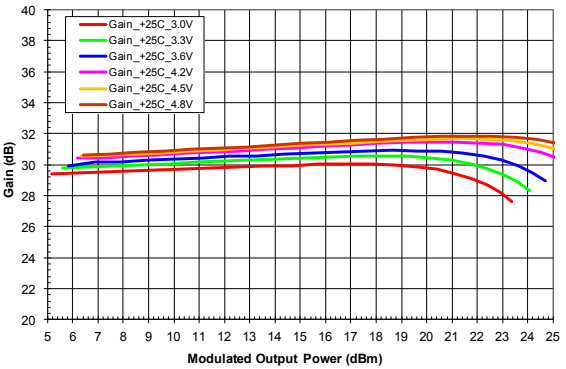


Figure 13: Gain vs. Output Power Across Voltage (Frequency = 5.51 GHz, Tc = +25°C)

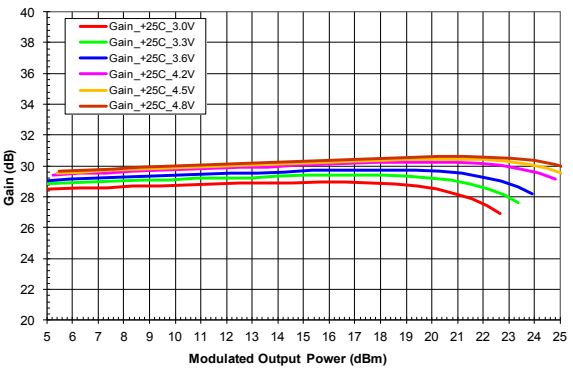


Figure 14: Gain vs. Output Power Across Voltage (Frequency = 5.795 GHz, Tc = +25°C)

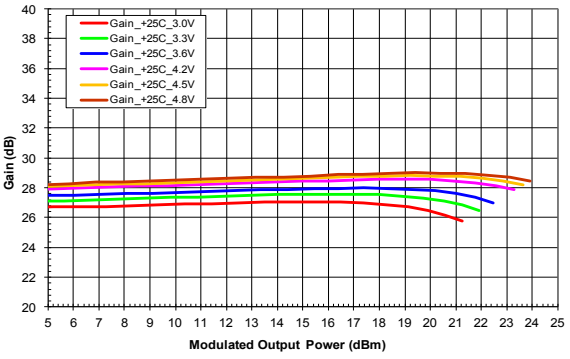
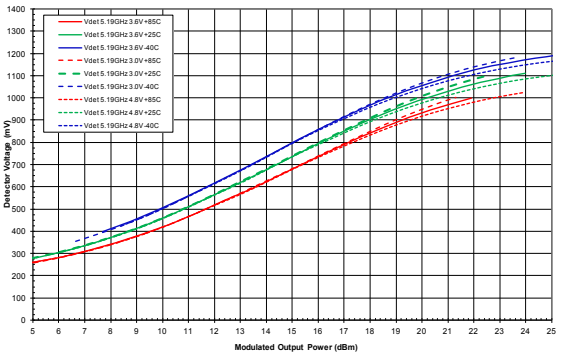


Figure 15: VDET vs. Output Power Across Voltage and Temp (Frequency = 5.19 GHz)



MCS7 - HT40 PERFORMANCE DATA

Figure 16: V_{DET} vs. Output Power Across Voltage and Temp (Frequency = 5.51 GHz)

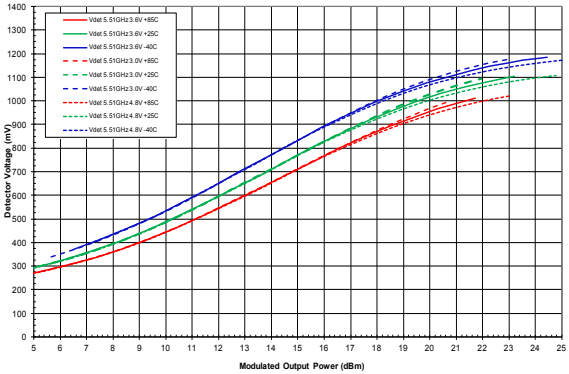
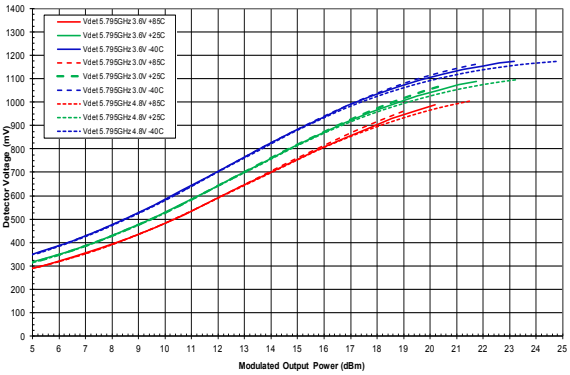


Figure 17: V_{DET} vs. Output Power Across Voltage and Temp (Frequency = 5.795 GHz)



MCS9 - HT80 PERFORMANCE DATA

Figure 18: EVM and ICC vs. Output Power Across Frequency (VCC = +3.6 V, TC = +25°C)

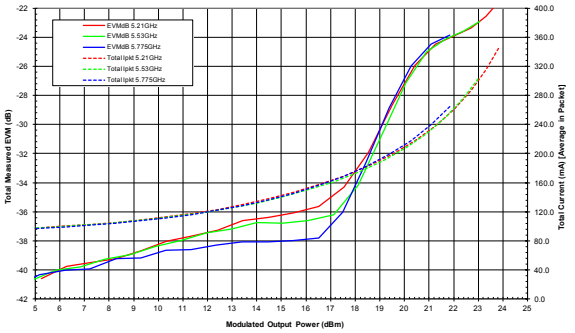


Figure 19: Gain vs. Output Power Across Frequency (VCC = +3.6 V, TC = +25°C)

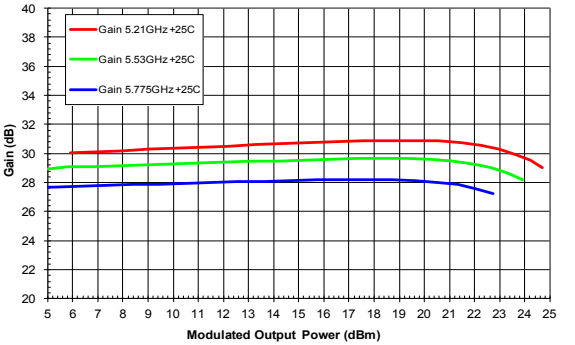


Figure 20: Gain vs. Output Power Across Voltage (Frequency = 5.21 GHz, TC = +25°C)

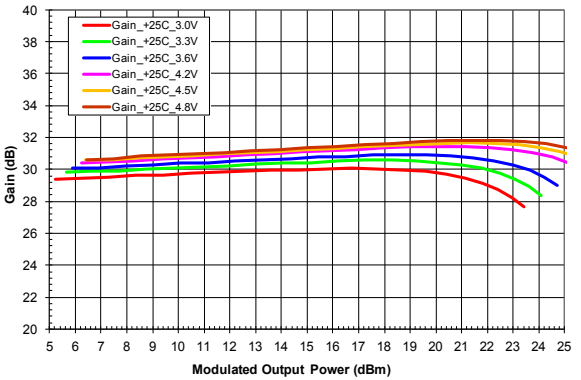


Figure 21: Gain vs. Output Power Across Voltage (Frequency = 5.53 GHz, TC = +25°C)

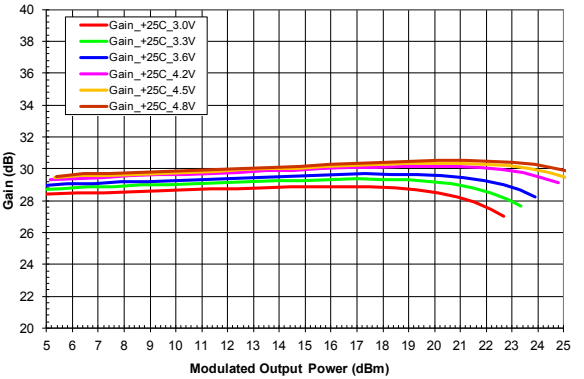


Figure 22: Gain vs. Output Power Across Voltage (Frequency = 5.775 GHz, TC = +25°C)

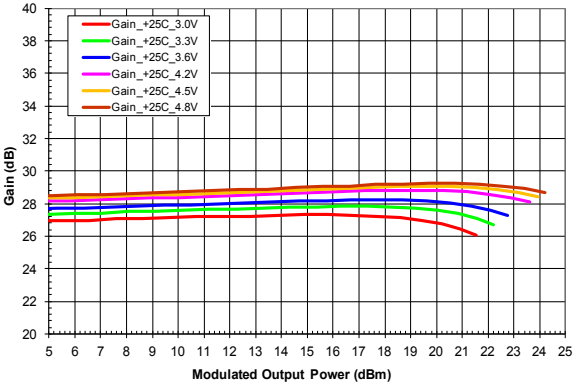
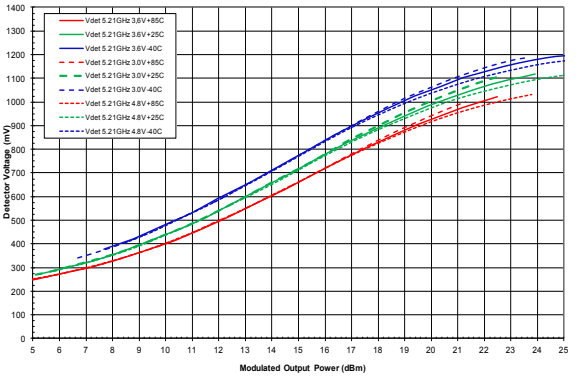


Figure 23: VDET vs. Output Power Across Voltage and Temp (Frequency = 5.21 GHz)



MCS9 - HT80 PERFORMANCE DATA

Figure 24: V_{DET} vs. Output Power Across Voltage and Temp (Frequency = 5.53 GHz)

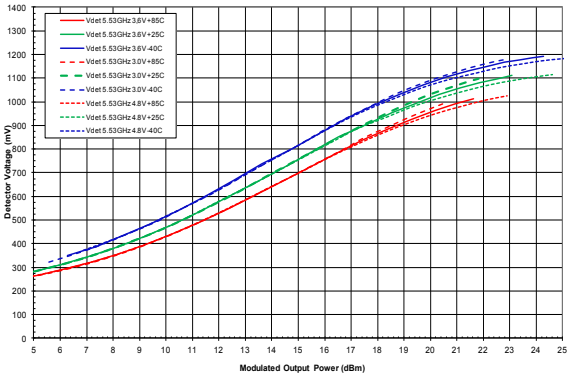
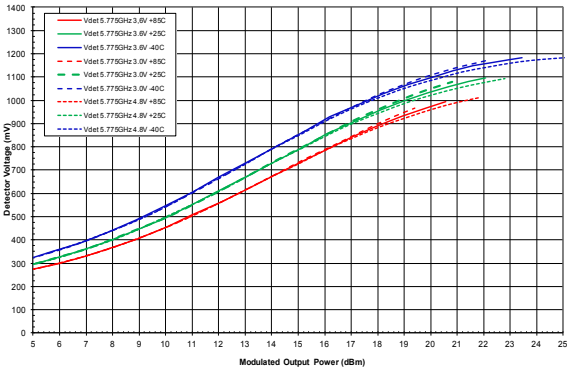


Figure 25: V_{DET} vs. Output Power Across Voltage and Temp (Frequency = 5.775 GHz)



Rx PERFORMANCE DATA

Figure 26: LNA Gain vs. Frequency Across Voltage and Temp

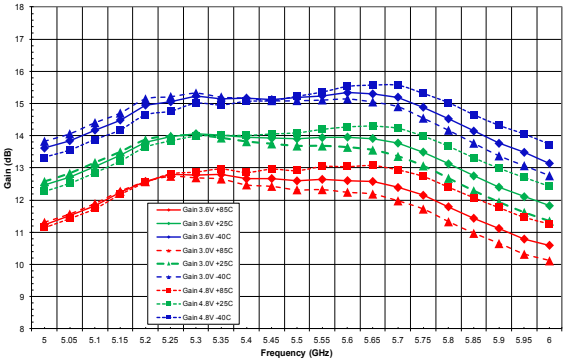
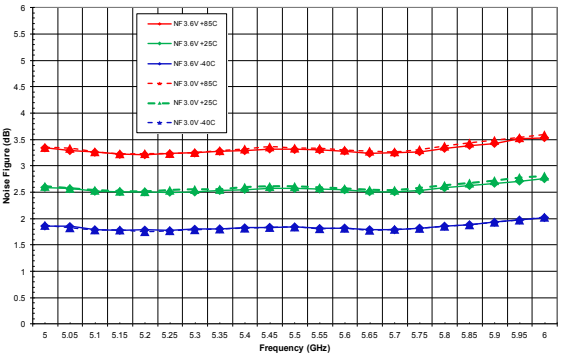


Figure 27: LNA NF vs. Frequency Across Voltage and Temp



APPLICATION SCHEMATIC

Although not shown in the schematic, a large value capacitor (~ 10 uF) should be connected to the voltage supply lines for low frequency decoupling.

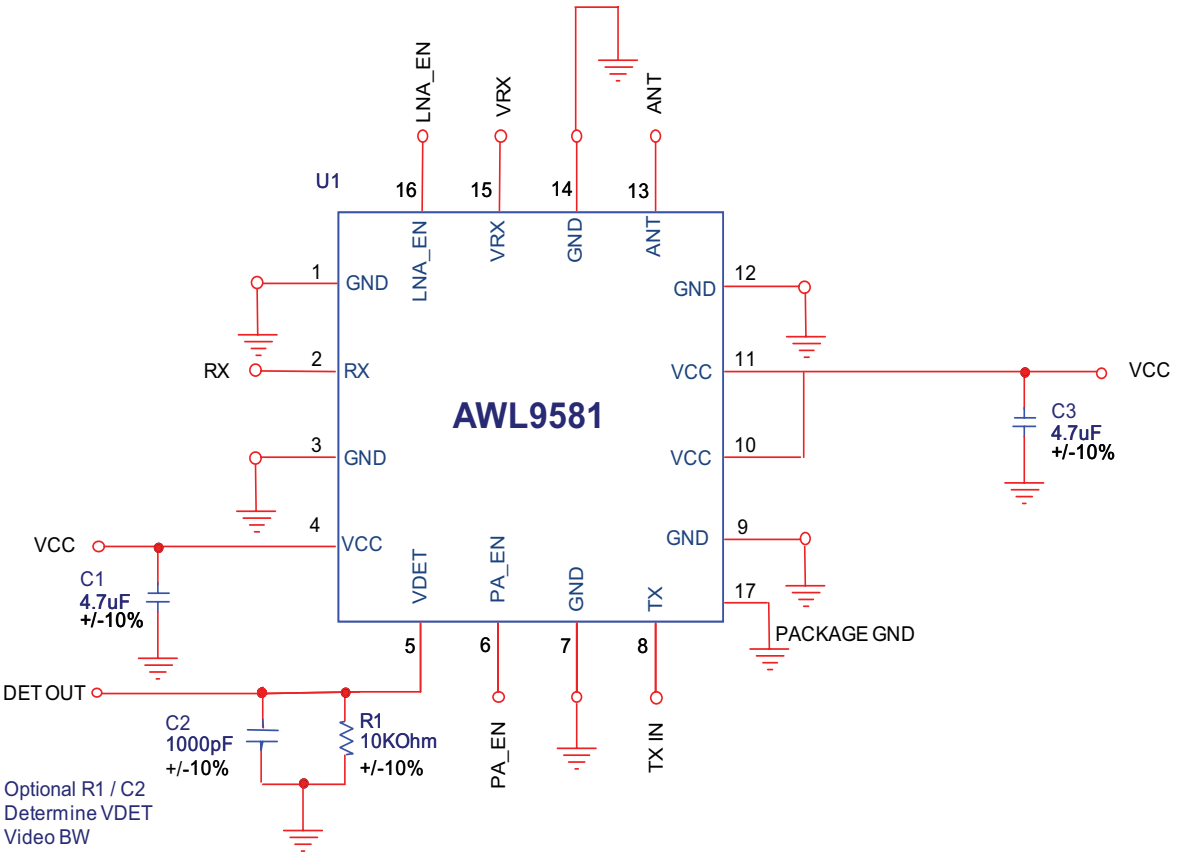
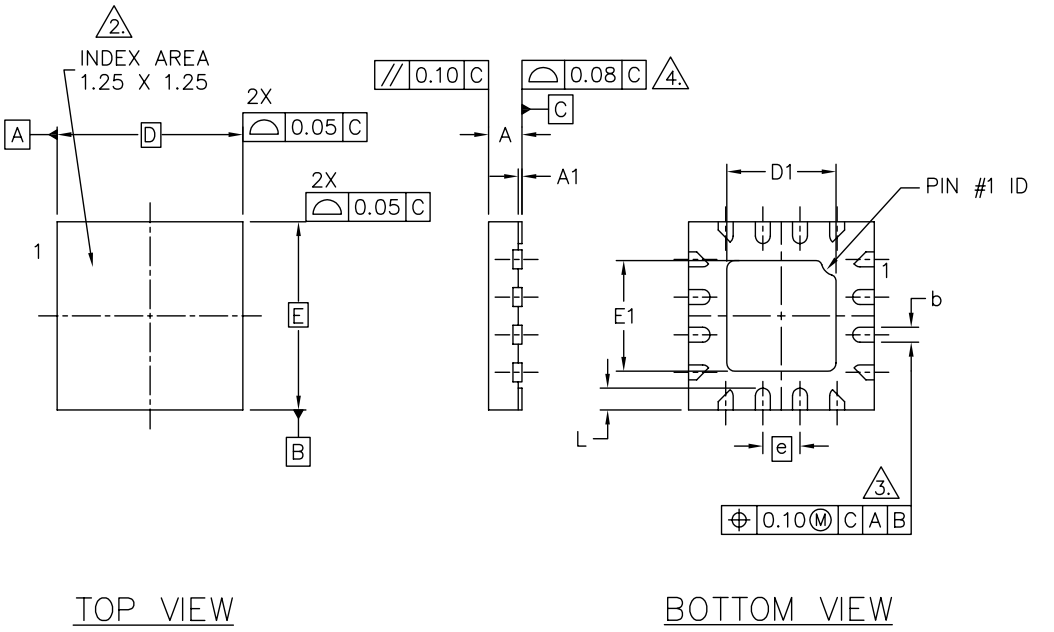


Figure 28: Application Schematic

PACKAGE OUTLINE



SYMBOL	DIMENSIONS–MM			NOTE
	MIN.	NOM.	MAX.	
A	–	–	0.40	
A1	0.00	0.02	0.05	
b	0.15	0.20	0.25	
D		2.50 BSC		
D1	1.32	1.47	1.57	
E		2.50 BSC		
E1	1.32	1.47	1.57	
e		0.50 BSC		
L	0.19	0.29	0.39	

SYMBOL	DIMENSIONS–INCHES			NOTE
	MIN.	NOM.	MAX.	
A			0.016	
A1	0.000	0.001	0.002	
b	0.006	0.008	0.010	
D		0.098 BSC		
D1	0.052	0.058	0.062	
E		0.098 BSC		
E1	0.052	0.058	0.062	
e		0.020 BSC		
L	0.0075	0.011	0.015	

NOTES :

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. TERMINAL #1 IDENTIFIER AND PAD NUMBERING CONVENTION SHALL CONFORM TO JESD 95–1 SPP–012.
3. DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30mm FROM TERMINAL TIP.
4. BILATERAL COPLANARITY ZONE APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

Figure 29: Package Outline - 16 Pin, 2.5 x 2.5 x 0.40 mm QFN

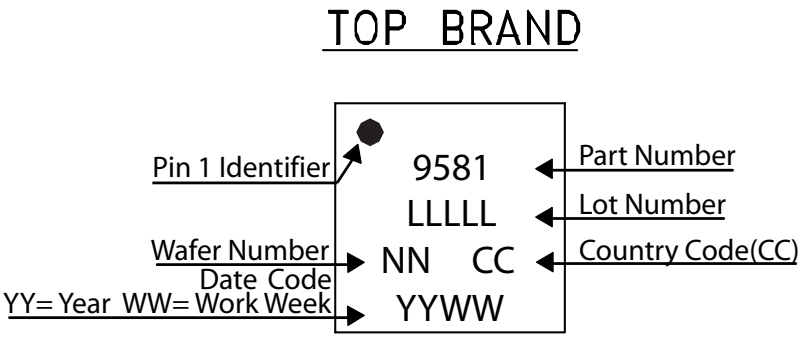
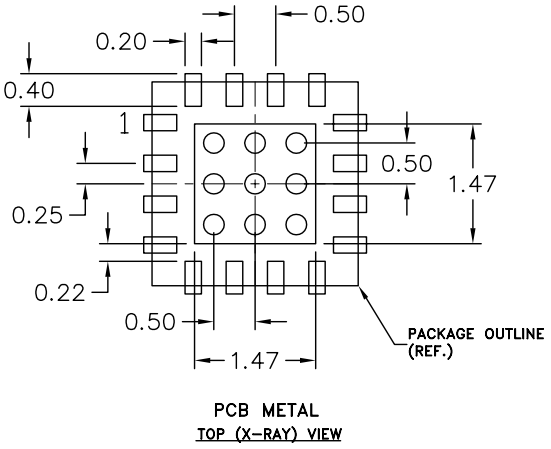


Figure 30: Branding Specification

PCB AND STENCIL DESIGN GUIDELINE



PCB METAL
TOP (X-RAY) VIEW

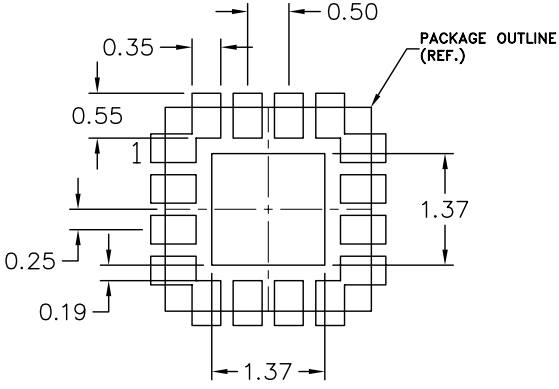
NOTES:
(1) OUTLINE DRAWING REFERENCE: P8002535

(2) UNLESS SPECIFIED DIMENSIONS ARE SYMMETRICAL ABOUT CENTER LINES SHOWN.

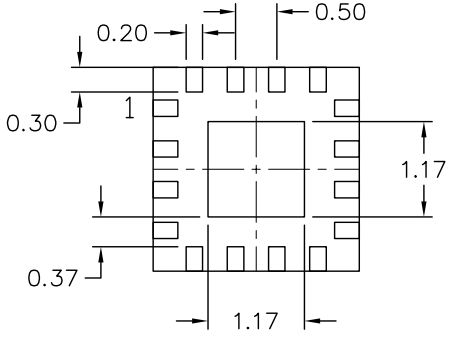
(3) DIMENSIONS IN MILLIMETERS.

(4) VIAS SHOWN IN PCB METAL VIEW ARE FOR REFERENCE ONLY. NUMBER & SIZE OF THERMAL VIAS REQUIRED DEPENDENT ON HEAT DISSIPATION REQUIREMENT AND THE PCB PROCESS CAPABILITY.

(5) RECOMMENDED STENCIL THICKNESS: APPROX. 0.125mm (5 Mils)



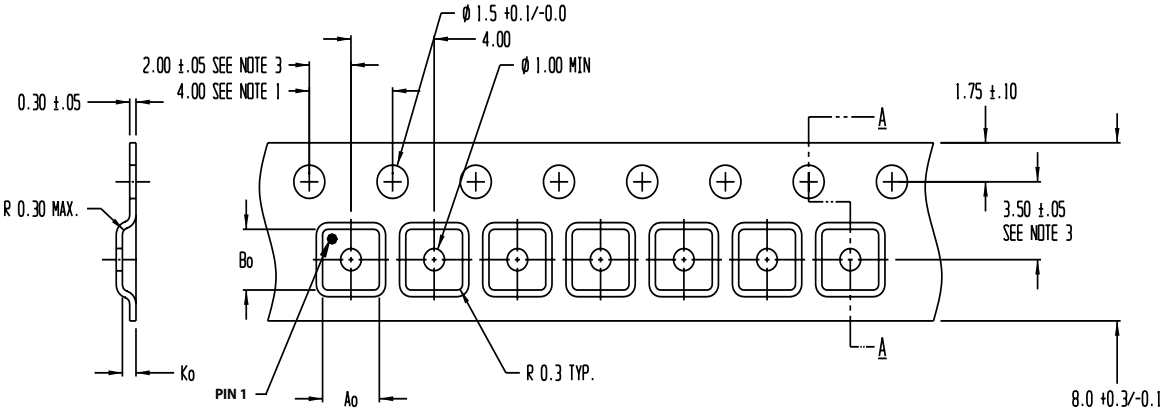
PCB SOLDER MASK
TOP (X-RAY) VIEW



STENCIL APERTURE
TOP (X-RAY) VIEW

Figure 31: Recommended PCB Layout

COMPONENT PACKAGING



Ao = 2.73 ± 0.05
Bo = 2.73 ± 0.05
Ko = 0.65

Notes:
(1) 10 Sprocket hole pitch cumulative tolerance ± 0.2
(2) Camber in compliance with EIA 481.
(3) Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole.

Figure 32: Carrier Tape

ORDERING INFORMATION

ORDER NUMBER	TEMPERATURE RANGE	PACKAGE DESCRIPTION	COMPONENT PACKAGING
AWL9581P7	-40 °C to +85 °C	16 pin, 2.5 x 2.5 x 0.40 mm Surface Mount Module	Bags
AWL9581P9	-40 °C to +85 °C	16 pin, 2.5 x 2.5 x 0.40 mm Surface Mount Module	Partial Reel
AWL9581V2	-40 °C to +85 °C	16 pin, 2.5 x 2.5 x 0.40 mm Surface Mount Module	5000 piece T/R
EVB9581	-40 °C to +85 °C	Evaluation Board	Evaluation Board

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