AWL9281

802.11b/g/n/ac Power Amplifier, LNA and Tx/Rx/BT Switch

DATA SHEET - Rev 2.6

FEATURES

- Supports emerging 802.11ac high-data rate standard
- Fully integrated FEIC including 2.4 GHz Power Amplifier, Low Noise Amplifier with Bypass mode and SP3T TX/RX/BT Switch
- 1.8% Dynamic EVM @ P_{OUT} = +17 dBm with 802.11ac, MCS9-HT40 waveform
- 28 dB of Linear Power Gain
- 0.5 dB BT Band RF Switch Insertion Loss
- Power Detector with High Accuracy over 3:1 VSWR
- 2.2 dB RX Path Noise Figure with 15 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

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

PRODUCT DESCRIPTION

The ANADIGICS AWL9281 is a high performance InGaP HBT FEIC that incorporates a 2.4 GHz Power Amplifier, Low Noise Amplifier, RF Switch and Power Detector. The FEIC is designed for WLAN transmit and receive applications in the 2.4 - 2.5 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, WLAN receive and BlueTooth 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 802.11b/g/n/ac WLAN systems under the toughest signal conditions within these standards.

The AWL9281 is manufactured using advanced InGaP HBT technology that offers state-of-the-art performance, reliability, temperature stability and ruggedness.

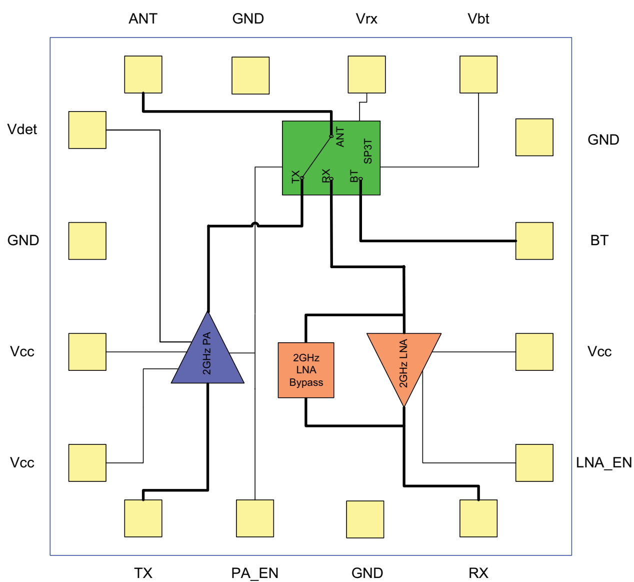


Figure 1: Block Diagram

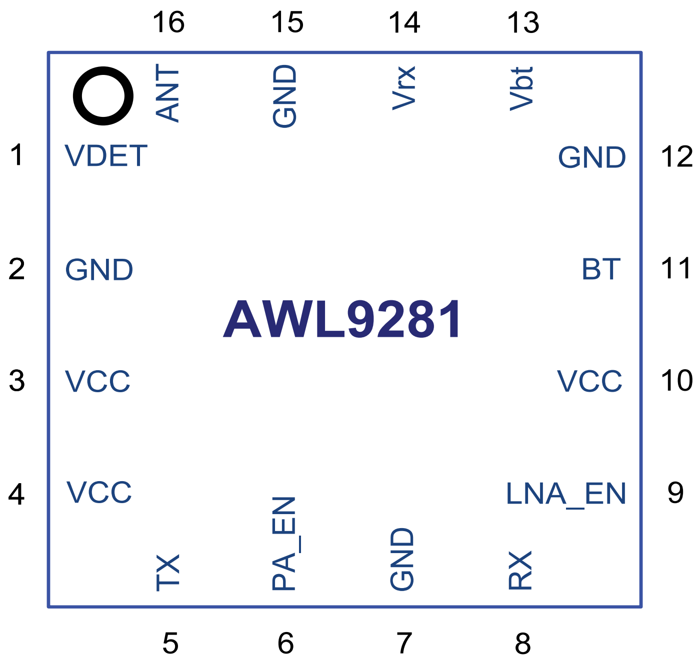


Figure 2: Pinout Diagram

Table 1: Pin Description

PIN	NAME	DESCRIPTION
1	VDET	Power detector output
2	GND	Ground
3	V_{CC}	Power Supply. Bias for the transistors in the part.
4	V_{CC}	Power Supply. Bias for the transistors in the part.
5	TX	RF transmit input port. DC blocked internally.
6	PA_EN	Power Amplifier Enable. On/Off control for the Tx path power amplifier
7	GND	Ground
8	RX	RF receive output port. DC blocked internally.
9	LNA_EN	LNA Enable. On/Off control for the Rx path low noise amplifier
10	V_{CC}	Power Supply. Bias for the transistors in the part.
11	BT	Bluetooth RF port
12	GND	Ground
13	Vbt	Bluetooth enable. On/Off control for Bluetooth RF path.
14	Vrx	Switch control for receive path
15	GND	Ground
16	ANT	Antenna Port. Common connection for the PA, LNA, and Bluetooth paths. DC blocked internally.

ELECTRICAL CHARACTERISTICS

Table 2: Absolute Minimum and Maximum Ratings

PARAMETER	MIN	MAX	UNIT	COMMENTS
DC Power Supply	-	+6.0	V	
RF Input Level, 2.4 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)
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	2400	-	2500	MHz	802.11b/g/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, Vbt)	+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 - TX Mode
(T_C = +25°C, V_{CC} = +3.6V, PA_EN = +3.2V, Vrx = 0.0V, Vbt = 0.0V, LNA_EN = 0.0V)
64 QAM OFDM 54 Mbps

PARAMETER	MIN	TYP	MAX	UNIT	COMMENTS
Operating Frequency	2400	-	2500	MHz	
Power Gain	24	28	30	dB	
Gain Flatness	-	+/-0.25	-	dB	
Error Vector Magnitude (EVM) [1]	- -	-29 195	-26 -	dB mA	P_{OUT} = 19.5 dBm, Dyn Mode 54 Mbps data rate, Avg during packet
	- -	-34 175	-31 -	dB mA	P_{OUT} = 18 dBm, Dyn Mode 54 Mbps data rate, Avg during packet
	- -	-35 150	-32 -	dB mA	P_{OUT} = 16 dBm, Dyn Mode 54 Mbps data rate, Avg during packet
	- -	-40 110	-36 -	dB mA	P_{OUT} = 5 dBm, Dyn Mode 54 Mbps data rate, Avg during packet
Transmit Mask	- - - -	22 23.5 19 19	- - - -	dBm	802.11b DBPSK 1 Mbps data rate, Raised Root Cosine filtering. 802.11b DBPSK 1 Mbps data rate, Gaussian filtering. 802.11n MCS0-HT20 802.11n MCS0-HT40
PA Noise Figure	-	5	-	dB	
Input Return Loss	-	12	-	dB	
Output Return Loss	-	12	-	dB	
Output Spurious Levels - Harmonics 2 f_O 3 f_O 4 f_O	- - -	-20 -40 -40	- - -	dBm/MHz	For Power levels up to 22 dBm 1 Mbps CCK
Settling Time	-	0.5	-	uS	Within 0.5 dB of final value
Quiescent Current (Icq)	-	100	-	mA	

Notes:
(1) EVM includes system noise floor of 0.6% (-44 dB).

Table 5: Electrical Specifications - Tx Mode
(T_C = +25°C, V_{CC} = +3.6V, PA_EN = +3.2V, Vrx = 0.0V, Vbt = 0.0V, LNA_EN = 0.0V) 802.11n/ac

PARAMETER	MIN	TYP	MAX	UNIT	COMMENTS
Operating Frequency	2400	-	2500	MHz	
Error Vector Magnitude (EVM) [(1)] and Current Consumption	- -	-31 185	-28 -	dB mA	P_{OUT} = 19 dBm, MCS7 - HT20
	- -	-32 175	-29 -	dB mA	P_{OUT} = 18 dBm, MCS8 - HT20
	- -	-36 160	-33 -	dB mA	P_{OUT} = 17 dBm, MCS9 - HT40
Transmit Mask	Pass	-	-	N/A	802.11n, 802.11ac at respective modulation and power levels noted above

Notes:
(1) EVM includes system noise floor of 0.6% (-44 dB).

Table 6: Electrical Specifications - TX Mode Power Detector
(T_C = +25°C, V_{CC} = +3.6V, PA_EN = +3.2V, Vrx = 0.0V, Vbt = 0.0V, LNA_EN = 0.0V)

PARAMETER	MIN	TYP	MAX	UNIT	COMMENTS
Detector Voltage	- - - -	200 300 750 950	- - - -	mV	P_{OUT} = 0 dBm P_{OUT} = 10 dBm P_{OUT} = 18 dBm P_{OUT} = 22 dBm
Total Internal Load Impedance	-	1.5	-	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 - RX LNA Mode
(T_C = +25°C, V_{CC} = +3.6V, LNA_EN = +3.2V, Vrx = +3.2V, Vbt = 0.0V, PA_EN = 0.0V)

PARAMETER	MIN	TYP	MAX	UNIT	COMMENTS
Operating Frequency	2400	-	2500	MHz	
Gain - LNA Mode	11	14.5	16	dB	
Gain Flatness	-	+/-0.25	-	dB	Across any 40 MHz band
Rx Noise Figure	-	2.2	2.7	dB	
Input Return Loss	-	5	-	dB	
Output Return Loss	-	12	-	dB	
IIP3	-	0	-	dBm	
Settling Time	-	0.5	-	uS	Within 0.5 dB of final value
Rx Current	-	9	-	mA	

Table 8: Electrical Specification - RX Bypass Mode
(T_C = +25°C, V_{CC} = +3.6V, Vrx = +3.2V, LNA_EN = 0.0V, Vbt = 0.0V, PA_EN = 0.0V)

PARAMETER	MIN	TYP	MAX	UNIT	COMMENTS
Operating Frequency	2400	-	2500	MHz	
Gain - RX Bypass Mode	-8	-5	-3	dB	
Gain Flatness	-	+/-0.25	-	dB	Across any 40 MHz band
Rx Noise Figure	-	6	-	dB	
Input Return Loss	-	12	-	dB	
Output Return Loss	-	12	-	dB	
IIP3	-	+23	-	dBm	
Settling Time	-	0.5	-	uS	Within 0.5 dB of final value

Table 9: Electrical Specifications - Bluetooth Path
(T_C = +25°C, V_{CC} = +3.6V, Vrx = 0.0V, Vbt = +3.2V, PA_EN = 0.0V, LNA_EN = 0.0V)

PARAMETER	MIN	TYP	MAX	UNIT	COMMENTS
Operating Frequency	2400	-	2500	MHz	
Insertion Loss	-	0.5	-	dB	
Gain Flatness	-	+/-0.25	-	dB	Across any 40 MHz band
Input Return Loss	-	10	-	dB	
Output Return Loss	-	10	-	dB	
BT - RX Isolation	-	20	-	dB	BT to RX
BT - TX Isolation	-	30	-	dB	BT to TX
Settling Time	-	0.5	1.0	μs	

Table 10: Electrical Specifications - Switch and Control Pin
(T_C = +25°C, V_{CC} = +3.6V, Vcontrol High = +3.2V, Vcontrol Low = 0.0V)

PARAMETER	MIN	TYP	MAX	UNIT	COMMENTS
Control Pin Steady State Input Current (PA_EN)	9	10 0.5	40	uA uA	Logic Hi/On Logic Low/OFF
Control Pin Steady State Input Current (Vbt, Vrx)	-	10 0.5	-	uA uA	Logic Hi/On Logic Low/OFF
Control Pin Steady State Input Current (LNA_EN)	-	300 0.5	-	uA uA	Logic Hi/On Logic Low/OFF
Leakage Current	0	3	10	uA	Total from all bias Pins, Controls in OFF mode Vcc = 3.6V
TX-RX Isolation	-	36	-	dB	

Table 11: Switch Modes of Operation

MODES OF OPERATION	PA_EN	LNA_EN	Vrx	Vbt
TX	**HIGH**	LOW	LOW	LOW
RX	LOW	**HIGH**	**HIGH**	LOW
RX Bypass	LOW	LOW	**HIGH**	LOW
BT	LOW	LOW	LOW	**HIGH**
Power On Reset	LOW	LOW	LOW	LOW

MCS7 - HT20 PERFORMANCE DATA

Figure 3: EVM and Icc vs. Output Power Across Frequency (Vcc = +3.6 V, Tc = +25°C)

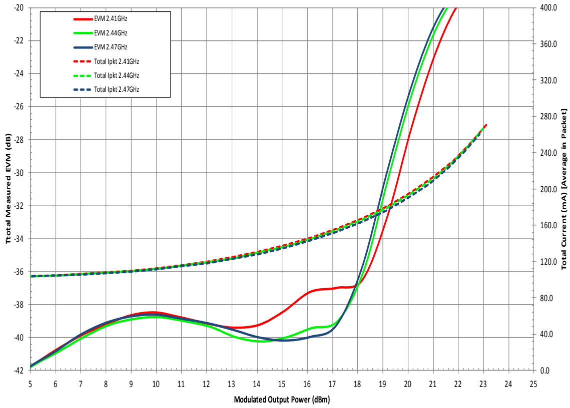


Figure 4: EVM and Icc vs. Output Power Across Frequency (Vcc = +3.3 V, Tc = +25°C)

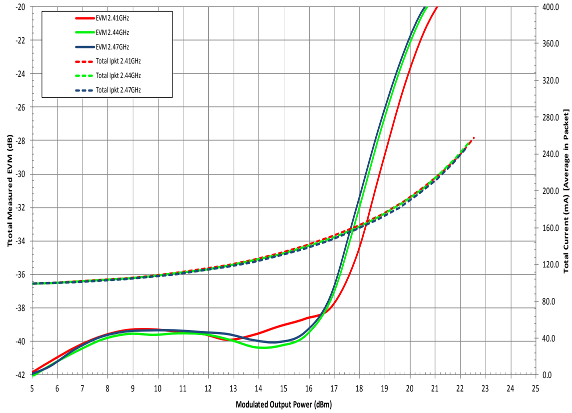


Figure 5: EVM and Icc vs. Output Power Across Temp (Frequency = 2.44 GHz, Vcc = +3.6 V)

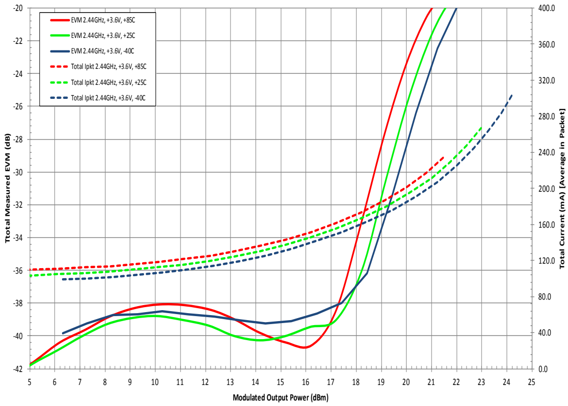


Figure 6: Gain vs. Output Power Across Frequency (Vcc = +3.6 V, Tc = +25°C)

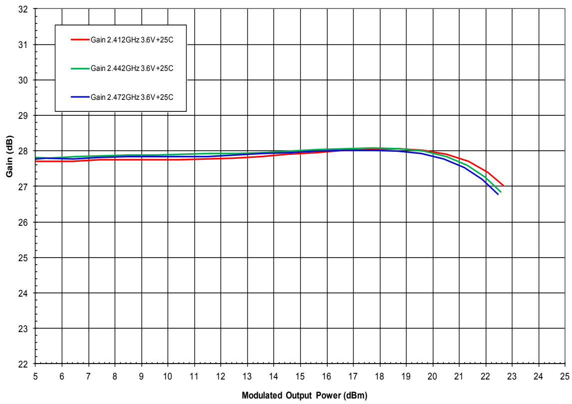


Figure 7: Gain vs. Output Power Across Voltage and Temp (Frequency = 2.412 GHz)

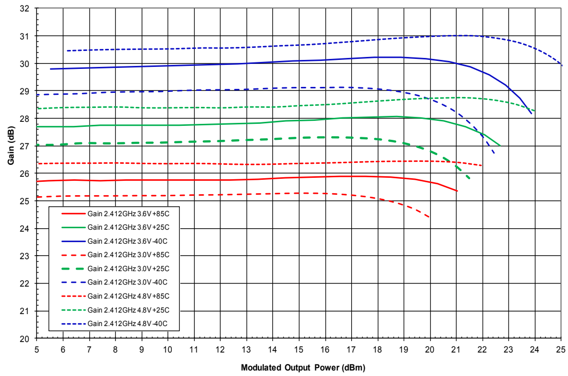
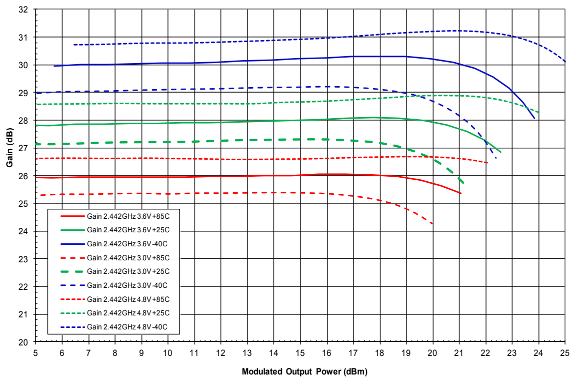


Figure 8: Gain vs. Output Power Across Voltage and Temp (Frequency = 2.442 GHz)



MCS7 - HT20 PERFORMANCE DATA

Figure 9: Gain vs. Output Power Across Voltage and Temp (Frequency = 2.472 GHz)

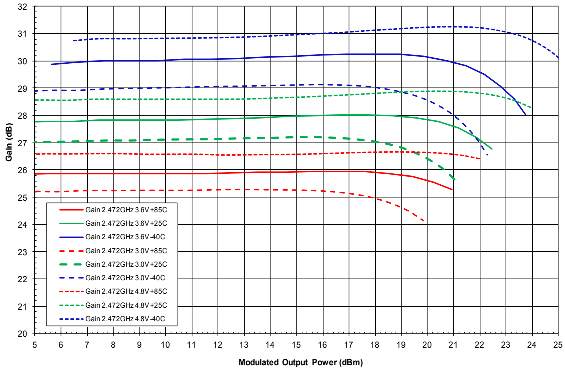


Figure 10: V_{DET} vs. Output Power Across Voltage and Temp (Frequency = 2.412 GHz)

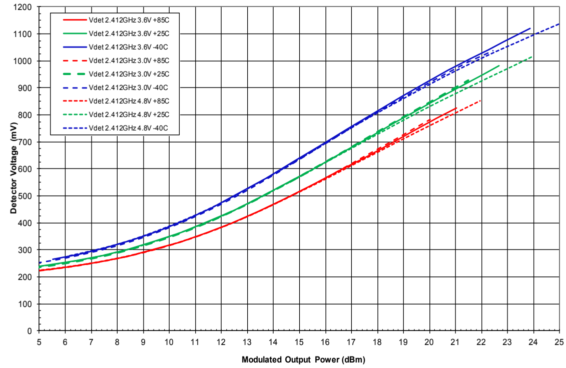


Figure 11: V_{DET} vs. Output Power Across Voltage and Temp (Frequency = 2.442 GHz)

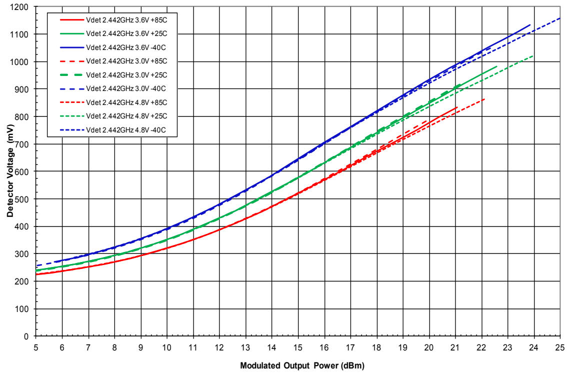
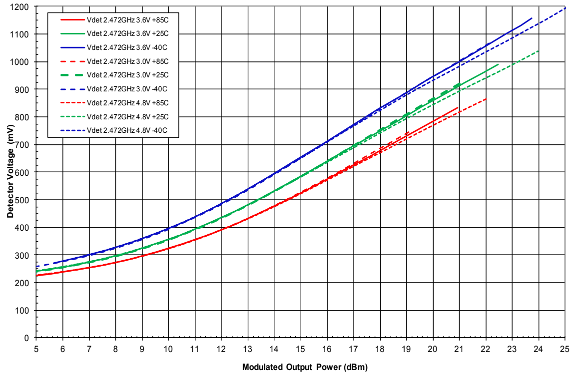


Figure 12: V_{DET} vs. Output Power Across Voltage and Temp (Frequency = 2.472 GHz)



MCS8 - HT20 PERFORMANCE DATA

Figure 13: EVM and Icc vs. Output Power Across Frequency (Vcc = +3.6 V, Tc = +25°C)

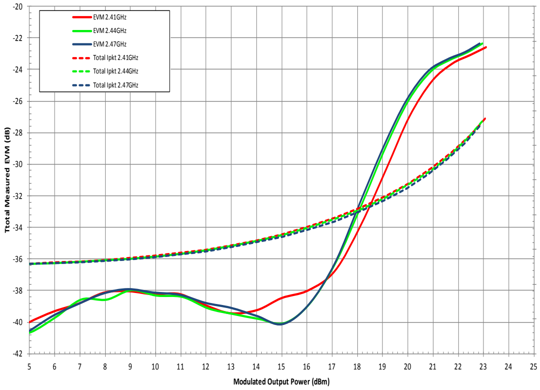


Figure 14: EVM and Icc vs. Output Power Across Frequency (Vcc = +3.3 V, Tc = +25°C)

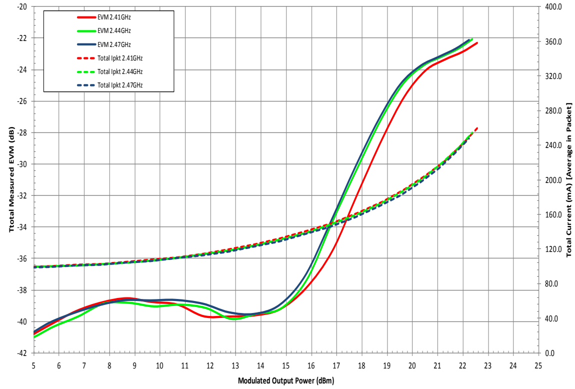


Figure 15: EVM and Icc vs. Output Power Across Temp (Frequency = 2.44 GHz, Vcc = +3.6 V)

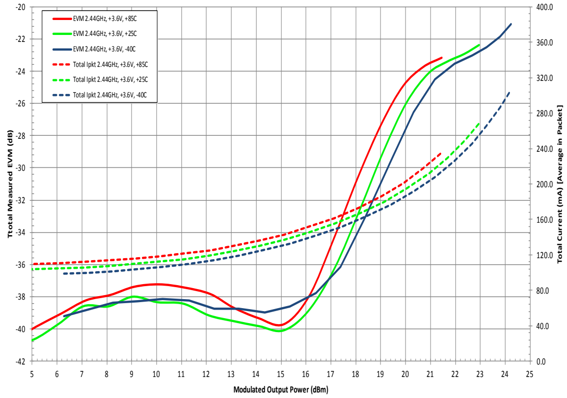


Figure 16: Gain vs. Output Power Across Frequency (Vcc = +3.6 V, Tc = +25°C)

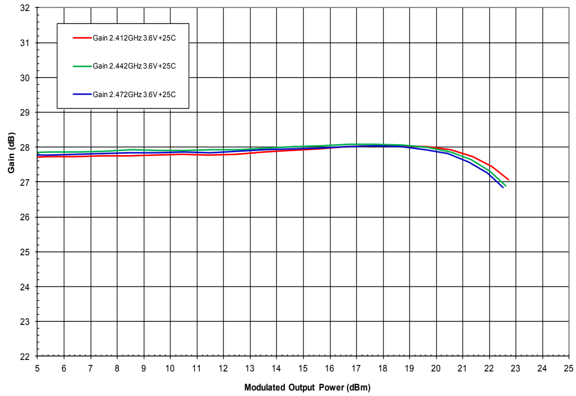


Figure 17: Gain vs. Output Power Across Voltage and Temp (Frequency = 2.412 GHz)

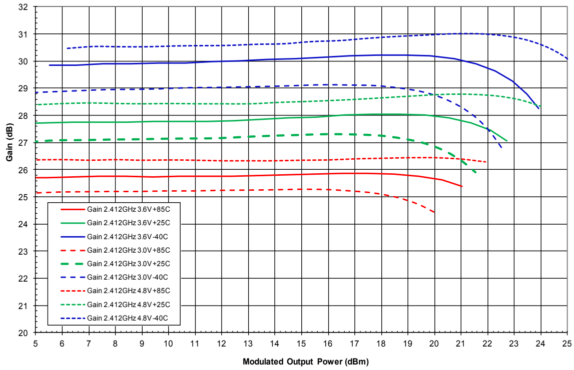
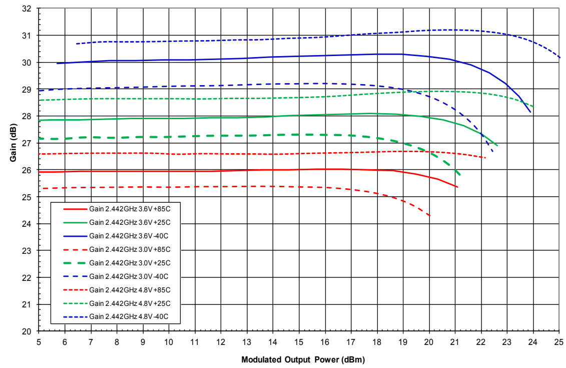


Figure 18: Gain vs. Output Power Across Voltage and Temp (Frequency = 2.442 GHz)



MCS8 - HT20 PERFORMANCE DATA

Figure 19: Gain vs. Output Power Across Voltage and Temp (Frequency = 2.472 GHz)

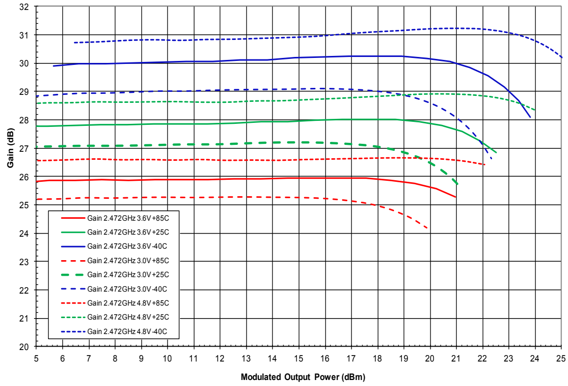


Figure 20: VDET vs. Output Power Across Voltage and Temp (Frequency = 2.412 GHz)

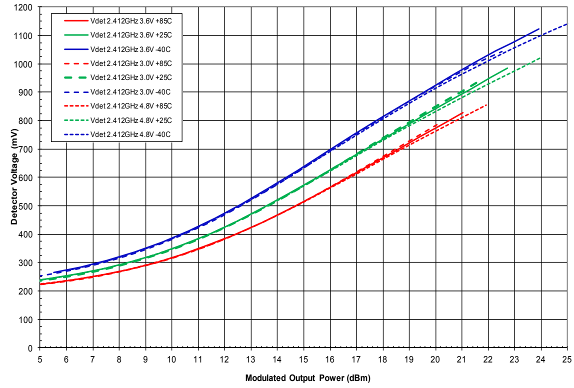


Figure 21: VDET vs. Output Power Across Voltage and Temp (Frequency = 2.442 GHz)

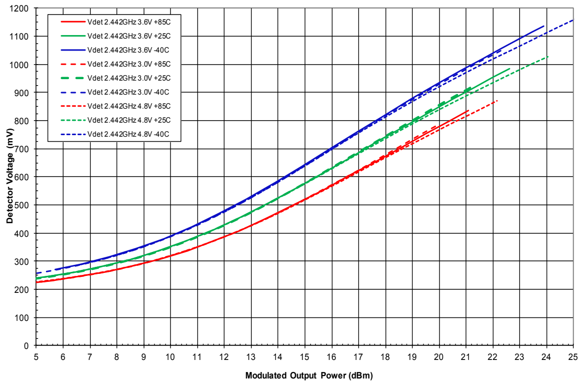
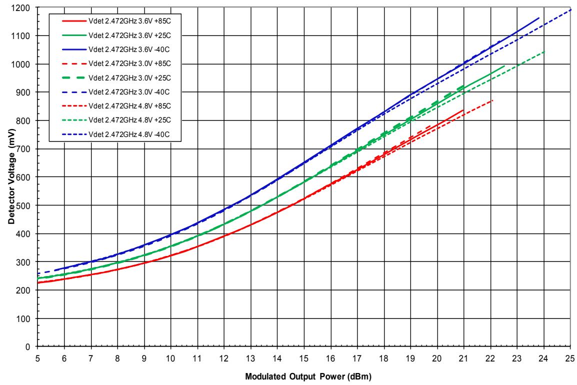


Figure 22: VDET vs. Output Power Across Voltage and Temp (Frequency = 2.472 GHz)



MCS9 - HT40 PERFORMANCE DATA

Figure 23: EVM and Icc vs. Output Power Across Frequency (Vcc = +3.6 V, Tc = +25°C)

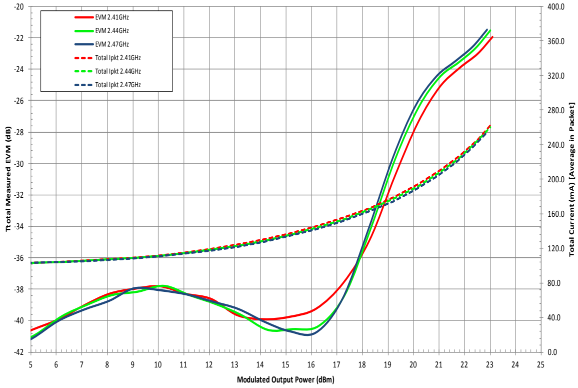


Figure 24: EVM and Icc vs. Output Power Across Frequency (Vcc = +3.3 V, Tc = +25°C)

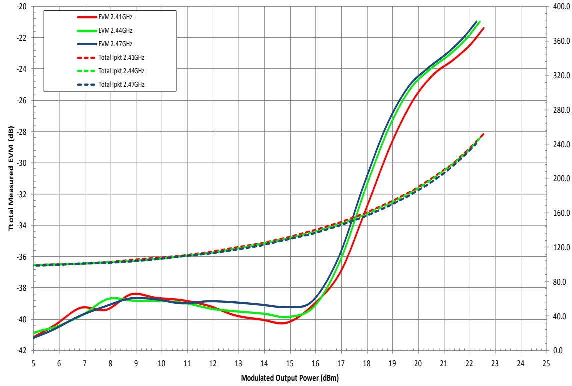


Figure 25: EVM and Icc vs. Output Power Across Temp (Frequency = 2.44 GHz, Vcc = +3.6 V)

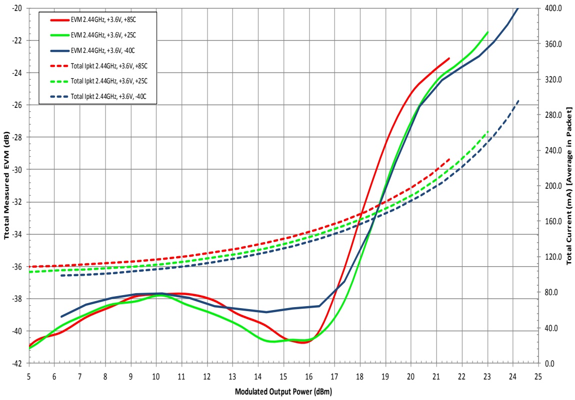


Figure 26: Gain vs. Output Power Across Frequency (Vcc = +3.6 V, Tc = +25°C)

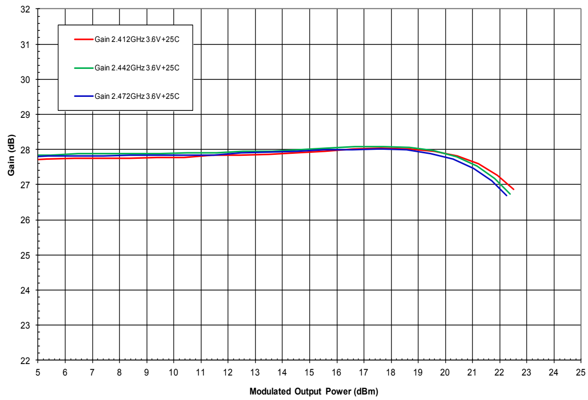


Figure 27: Gain vs. Output Power Across Voltage and Temp (Frequency = 2.412 GHz)

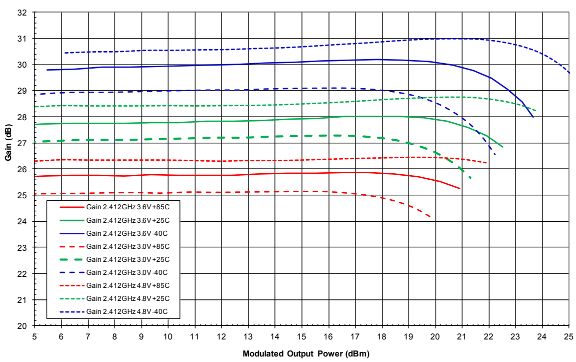
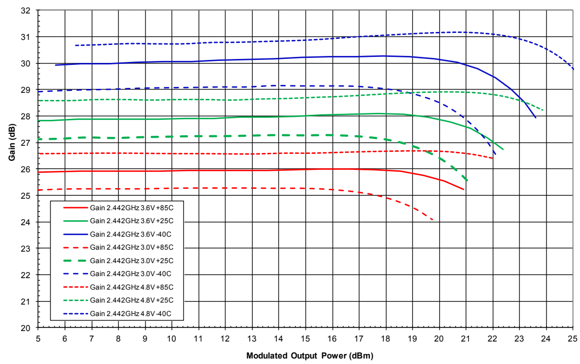


Figure 28: Gain vs. Output Power Across Voltage and Temp (Frequency = 2.442 GHz)



MCS9 - HT40 PERFORMANCE DATA

Figure 29: Gain vs. Output Power Across Voltage and Temp (Frequency = 2.472 GHz)

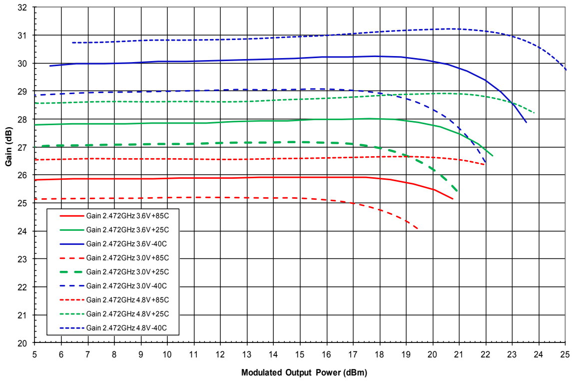


Figure 30: V_{DET} vs. Output Power Across Voltage and Temp (Frequency = 2.412 GHz)

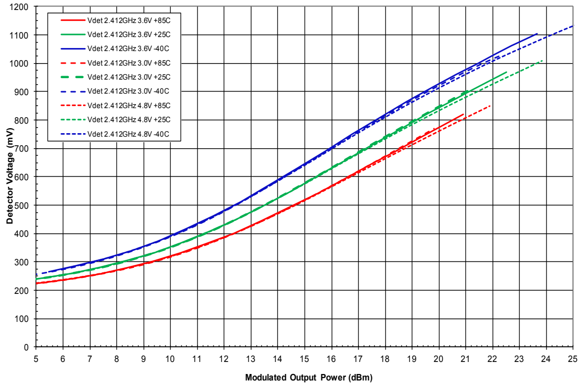


Figure 31: V_{DET} vs. Output Power Across Voltage and Temp (Frequency = 2.442 GHz)

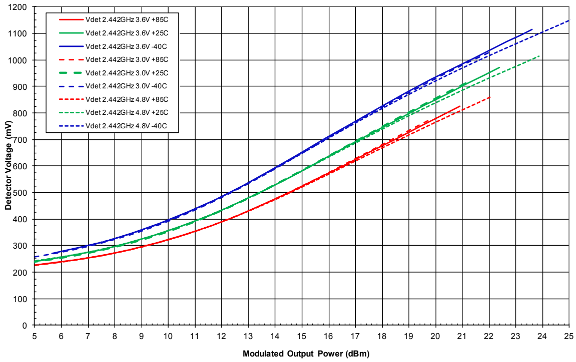
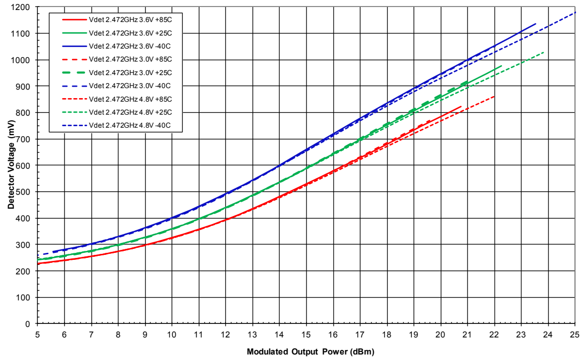


Figure 32: V_{DET} vs. Output Power Across Voltage and Temp (Frequency = 2.472 GHz)



Rx PERFORMANCE DATA

Figure 33: LNA Gain vs. Frequency Across Voltage and Temp

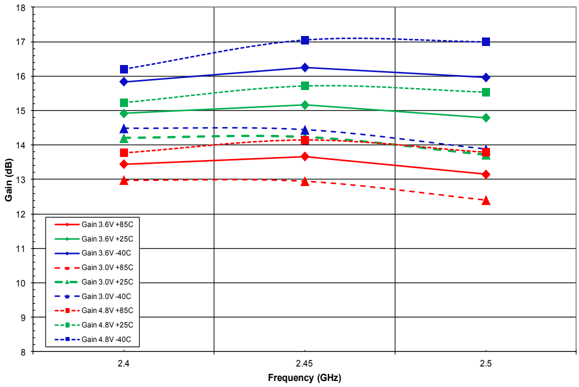
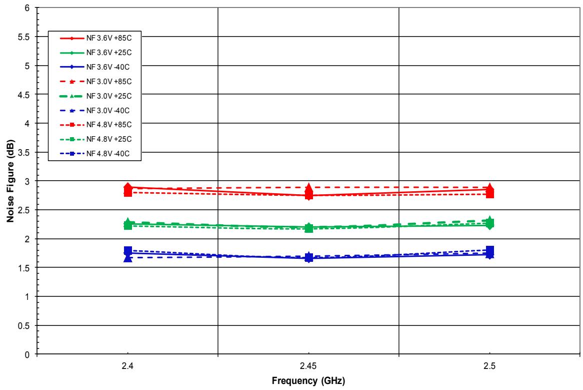


Figure 34: LNA NF vs. Frequency Across Voltage and Temp



MCS0 - HT20 TRANSMIT MASK PERFORMANCE DATA

Figure 35: Transmit Mask Ouput Power vs. Frequency Across Voltage (T_C = -40°C)

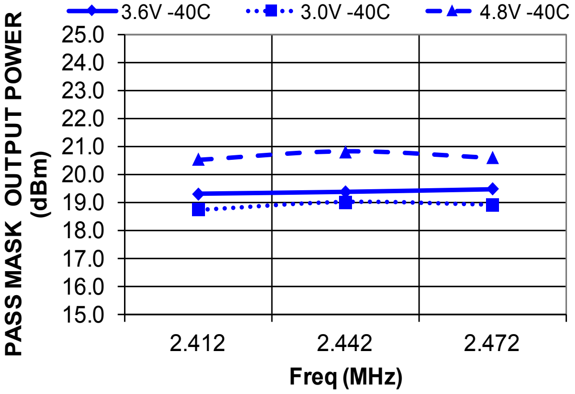


Figure 36: Transmit Mask Ouput Power vs. Frequency Across Voltage (T_C = +25°C)

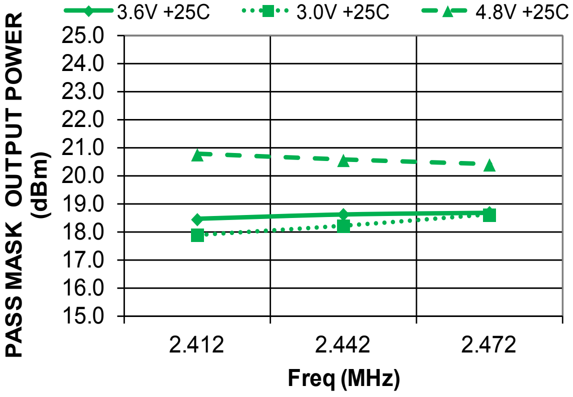
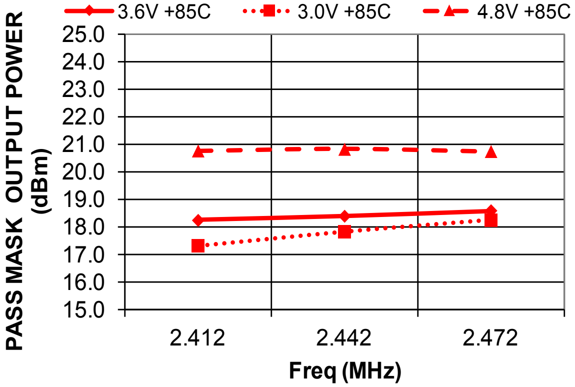
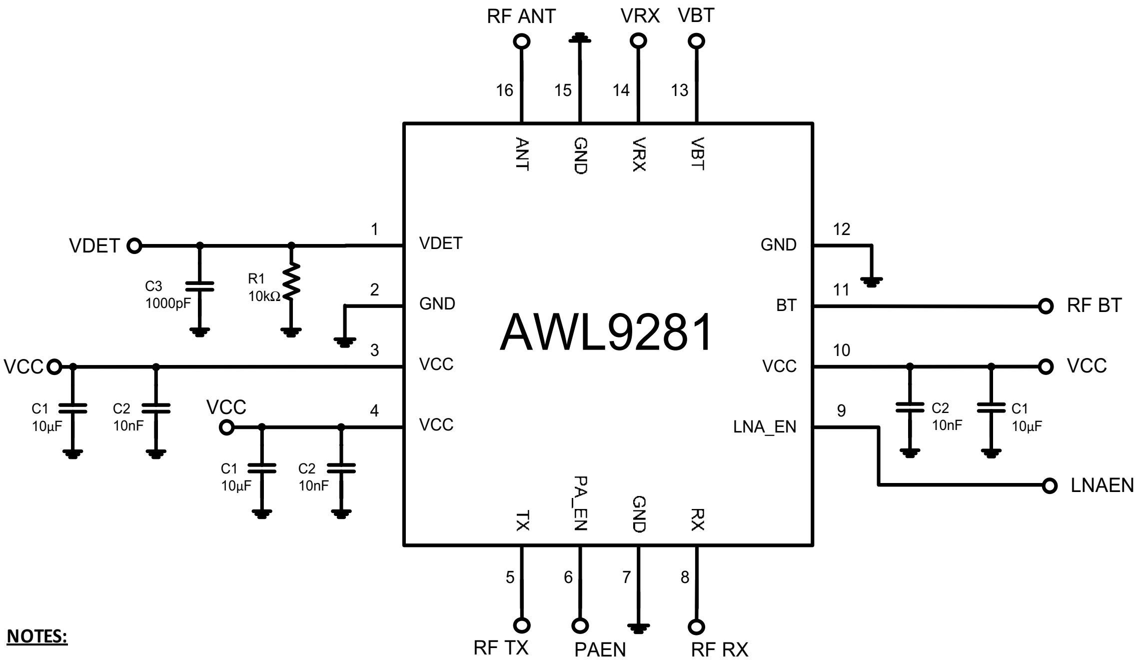


Figure 37: Transmit Mask Ouput Power vs. Frequency Across Voltage (T_C = +85°C)



APPLICATION Schematic

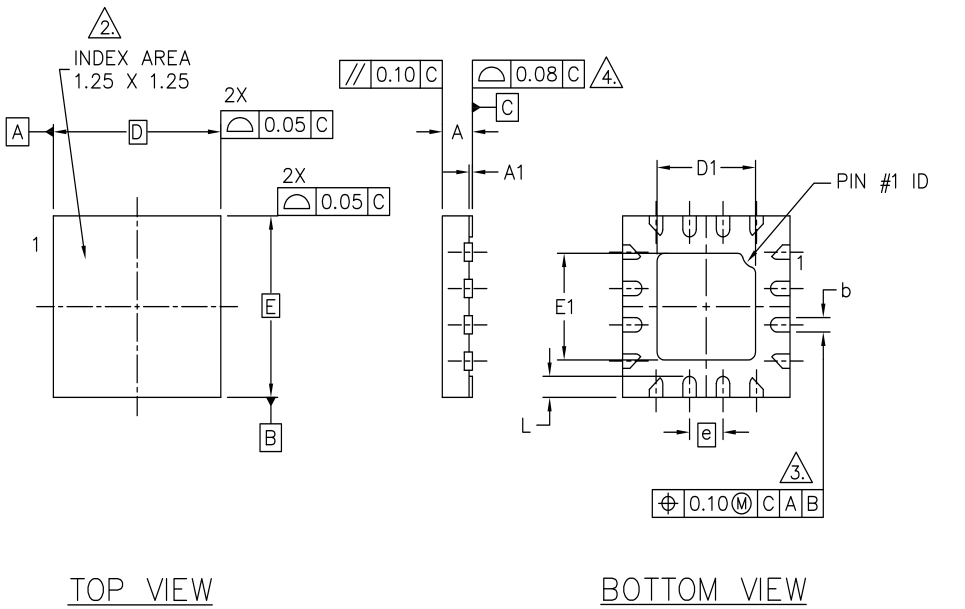
Although not shown in the schematic, a large value capacitor (~ 10 uF) should be connected to the voltage supply lines for low frequency decoupling.



NOTES:

1. **PA_EN:** Internal pull-down resistor.
   LNA_EN: No internal pull-up/down resistor.
   VRX: No internal pull-up/down resistor.
   VBT: No internal pull-up/down resistor.
2. External pull-up/down resistors are not required on any control lines to maintain or limit idle current.
3. A 'low' voltage state (0.0V to +0.4V) should be applied on Vrx and Vbt control lines to avoid possible EVM degradation in transmit mode. If this low logic level cannot be maintained in transmit mode and it 'floats', we recommend using a pull down resistor external to our part on the Vrx/Vbt pins.

Figure 38: Evaluation Board Schematic



SYMBOL	DIMENSIONS-MM MIN.	NOM.	MAX.	NOTE	SYMBOL	DIMENSIONS-INCHES MIN.	NOM.	MAX.	NOTE
A	–	–	0.40		A			0.016	
A1	0.00	0.02	0.05		A1	0.000	0.001	0.002	
b	0.15	0.20	0.25		b	0.006	0.008	0.010	
D		2.50 BSC			D		0.098 BSC		
D1	1.32	1.47	1.57		D1	0.052	0.058	0.062	
E		2.50 BSC			E		0.098 BSC		
E1	1.32	1.47	1.57		E1	0.052	0.058	0.062	
e		0.50 BSC			e		0.020 BSC		
L	0.19	0.29	0.39		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 39: Package Outline - 16 Pin, 2.5 x 2.5 x 0.40 mm QFN

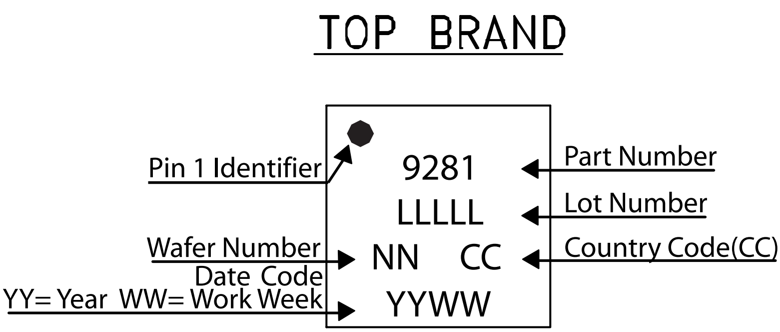
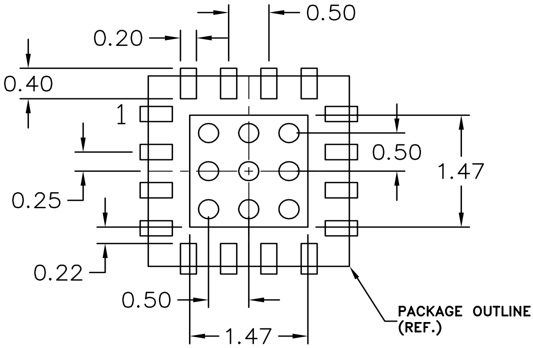


Figure 40: Branding Specification



PCB METAL
TOP (X–RAY) VIEW

NOTES:

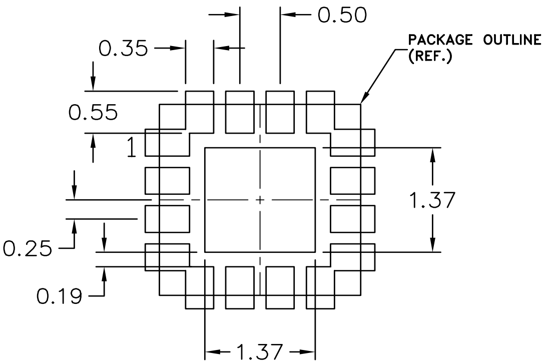
(1) OUTLINE DRAWING REFERENCE: P8002535

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

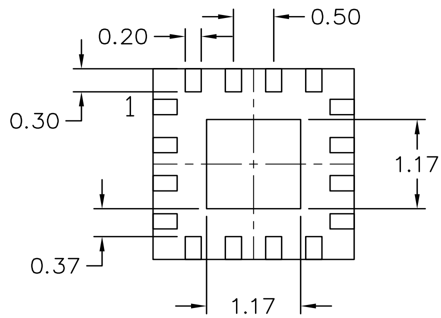
(3) DIMENSIONS IN MILLIMETERS.

(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)



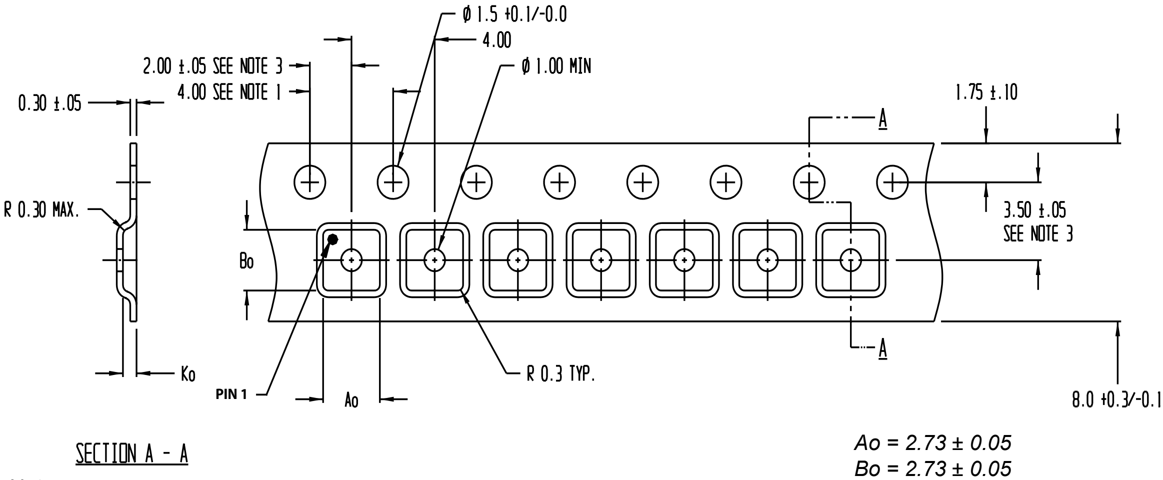
PCB SOLDER MASK
TOP (X–RAY) VIEW



STENCIL APERTURE
TOP (X–RAY) VIEW

Figure 41: 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 42: Carrier Tape

ORDERING INFORMATION

ORDER NUMBER	TEMPERATURE RANGE	PACKAGE DESCRIPTION	COMPONENT PACKAGING
AWL9281P7	-40 °C to +85 °C	16 pin, 2.5 x 2.5 x 0.40 mm Surface Mount Module	Bags
AWL9281P9	-40 °C to +85 °C	16 pin, 2.5 x 2.5 x 0.40 mm Surface Mount Module	Partial Reel
AWL9281V2	-40 °C to +85 °C	16 pin, 2.5 x 2.5 x 0.40 mm Surface Mount Module	5000 piece T/R
EVB9281	-40 °C to +85 °C	Evaluation Board	Evaluation Board

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IMPORTANT NOTICE

WARNING