AWU6601

HELP3™ Band 1 / WCDMA / TD-SCDMA
3.4 V / 28.25 dBm Linear PA Module

Data Sheet - Rev 2.0

FEATURES

- HSPA Compliant
- InGaP HBT Technology
- Low Quiescent Current with only 2 Bias Modes
- Simpler Calibration
- Low Leakage Current in Shutdown Mode: <1 μA
- Internal Voltage Regulator
- Integrated "daisy chainable" directional couplers with CPLIN and CPLOUT Ports
- Optimized for a 50 Ω System
- Low Profile Miniature Surface Mount Package
- RoHS Compliant Package, 260 °C MSL-3

WCDMA/HSPA Mode

- High Efficiency: (R99 waveform)

  40 % @ POUT = +28.25 dBm

  25 % @ POUT = +17 dBm

  Low Quiescent Current: 8 mA

TD-SCDMA Mode

  36 % @ POUT = +27 dBm

  20 % @ POUT = +16 dBm

M45 Package
10 Pin 3 mm x 3 mm x 1 mm
Surface Mount Module

APPLICATIONS

- Wireless Handsets and Data Devices for
  - WCDMA/HSPA IMT-Band
  - TD-SCDMA 1.8/2.0 GHz Band

PRODUCT DESCRIPTION

The AWU6601 HELP3™ PA is a 3rd generation WCDMA product for UMTS handsets. This PA incorporates ANADIGICS' HELP3™ technology to provide low power consumption without the need for an external voltage regulator. A "daisy chainable" directional coupler is integrated in the module thus eliminating the need of external couplers. The device is manufactured on an advanced InGaP HBT MMIC technology offering state-of-the-art reliability, temperature stability, and ruggedness. There are two selectable bias modes that optimize efficiency for different output power levels, and a shutdown mode with low leakage current, which increases handset talk and standby time. The self-contained 3 mm x 3 mm x 1 mm surface mount package incorporates matching networks optimized for output power, efficiency, and linearity in a 50 Ω system.

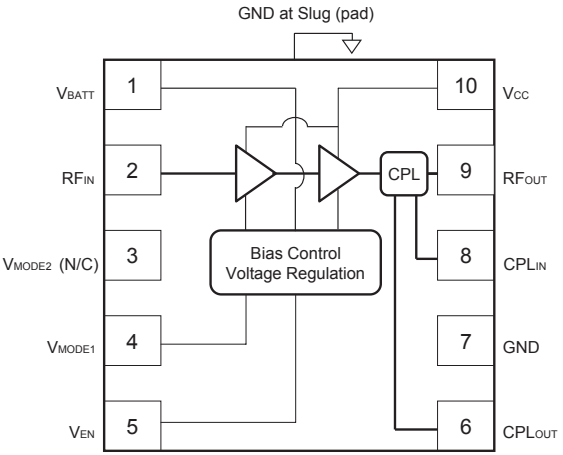


Figure 1: Block Diagram

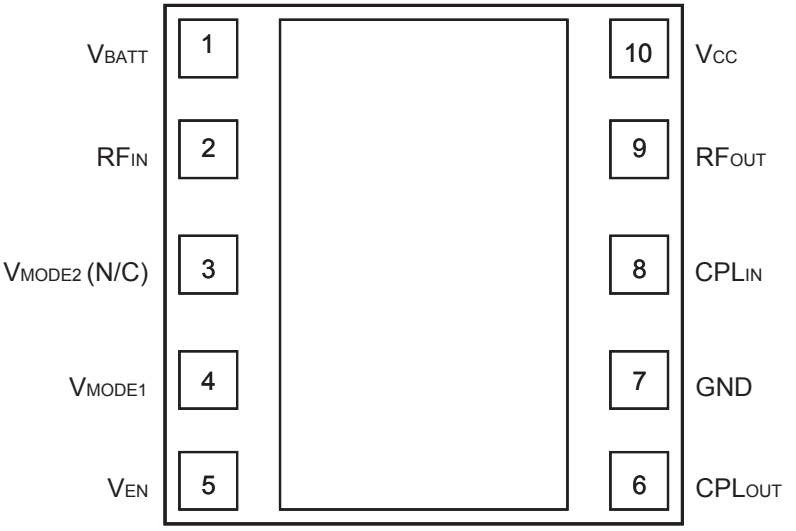


Figure 2: Pinout (X-ray Top View)

Table 1: Pin Description

PIN	NAME	DESCRIPTION
1	V_{BATT}	Battery Voltage
2	RF_{IN}	RF Input
3	V_{MODE2} (N/C)	No Connection
4	V_{MODE1}	Mode Control Voltage 1
5	V_{EN}	PA Enable Voltage
6	CPL_{OUT}	Coupler Output
7	GND	Ground
8	CPL_{IN}	Coupler Input
9	RF_{OUT}	RF Output
10	V_{CC}	Supply Voltage

ELECTRICAL CHARACTERISTICS

Table 2: Absolute Minimum and Maximum Ratings

PARAMETER	MIN	MAX	UNIT
Supply Voltage (V_{CC})	0	+5	V
Battery Voltage (V_{BATT})	0	+6	V
Control Voltages (V_{MODE1}, V_{ENABLE})	0	+3.5	V
RF Input Power (P_{IN})	-	+10	dBm
Storage Temperature (T_{STG})	-40	+150	°C

Stresses in excess of the absolute ratings may cause permanent damage. Functional operation is not implied under these conditions. Exposure to absolute ratings for extended periods of time may adversely affect reliability.

Table 3: Operating Ranges

PARAMETER	MIN	TYP	MAX	UNIT	COMMENTS
Operating Frequency (f)	1920 1880 2010	- - -	1980 1920 2025	MHz	UMTS Band 1 TD-SCDMA Band TD-SCDMA Band
Supply Voltage (V_{CC})	+3.2	+3.4	+4.2	V	$P_{OUT} \leq$ +28.25 dBm
Enable Voltage (V_{ENABLE})	+2.15 0	+2.4 0	+3.1 +0.5	V	PA "on" PA "shut down"
Mode Control Voltage (V_{MODE1})	+2.15 0	+2.4 0	+3.1 +0.5	V	Low Bias Mode High Bias Mode
RF Output Power (P_{OUT}) R99 WCDMA, HPM HSPA (MPR=0), HPM R99 WCDMA, LPM HSPA (MPR=0), LPM	 27.75(1) 26.75(1) 16.5(1) 15.5(1)	 28.25 27.25 17 16	 28.25 27.25 17 16	dBm	 3GPP TS 34.121-1, Rel 8 Table C.11.1.3, Subtest 1
RF Output Power (P_{OUT}), TD-SCDMA TD-SCDMA (HPM) TD-SCDMA (LPM)	 26.5 15.5	 27 16.0	 27 16.0	dBm	 3GPP TS 25.62 Section 6.2.1
Case Temperature (T_C)	-30	-	+90	°C	

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

Notes:
(1) For operation at V_{CC} = +3.2 V, P_{OUT} is derated by 0.5 dB.

Table 4: Electrical Specifications - UMTS/WCDMA Mode
(T_C = +25 °C, V_{CC} = +3.4 V, V_{BATT} = +3.4 V, V_{ENABLE} = +2.4 V, 50 Ω system, R99 waveform)

PARAMETER	MIN	TYP	MAX	UNIT	COMMENTS	
					P_{OUT}	V_{MODE1}
Gain	24.5 11.5	26.5 13.5	29 16.5	dB	+28.25 dBm +17 dBm	0 V 2.4 V
ACLR1 at 5 MHz offset (1)	- -	-41 -42	-38 -38	dBc	+28.25 dBm +17 dBm	0 V 2.4 V
ACLR2 at 10 MHz offset	- -	-55 -55	-48 -48	dBc	+28.25 dBm +17 dBm	0 V 2.4 V
Power-Added Efficiency (1)	36 21	40 25	- -	%	+28.25 dBm +17 dBm	0 V 2.4 V
Quiescent Current (Icq) Low Bias Mode	-	8	12	mA	V_{MODE1} = +2.4 V	
Mode Control Current	-	0.3	0.6	mA	through V_{MODE} pin, V_{MODE1} = +2.4 V	
Enable Current	-	0.3	0.6	mA	through V_{ENABLE} pin	
BATT Current	-	3.0	5	mA	through V_{BATT} pin, V_{MODE1} = +2.4 V	
Leakage Current	-	<1	5	µA	V_{BATT} = +4.2 V, V_{CC} = +4.2 V, V_{ENABLE} = 0 V, V_{MODE1} = 0 V	
Noise in Receive Band(2)	-	-137	-135	dBm/Hz	$P_{OUT} \leq$ +28.25 dBm, V_{MODE1} = 0V	
	-	-143	-138	dBm/Hz	$P_{OUT} \leq$ 17 dBm, V_{MODE1} = +2.4 V	
Harmonics 2fo 3fo, 4fo	- -	-42 -50	-35 -35	dBc	$P_{OUT} \leq$ +28.25 dBm	
Input Impedance	-	-	2:1	VSWR		
Coupling Factor	-	19.5	-	dB		
Directivity	-	20	-	dB		
Spurious Output Level (all spurious outputs)	-	-	-70	dBc	$P_{OUT} \leq$ +28.25 dBm In-band load VSWR < 5:1 Out-of-band load VSWR < 10:1 Applies over all operating conditions	
Load mismatch stress with no permanent degradation or failure	8:1	-	-	VSWR	Applies over full operating range	

Notes:
(1) ACLR and Efficiency measured at 1950 MHz.
(2) Noise measured at 2110 MHz to 2170 MHz.

Table 5: Electrical Specifications - TD-SCDMA Mode
(T_C = +25 °C, V_{CC} = +3.4 V, V_{BATT} = +3.4 V, V_{ENABLE} = +2.4 V, 50 Ω system)

PARAMETER	MIN	TYP	MAX	UNIT	COMMENTS	
					P_{OUT}	V_{MODE1}
Gain	24 11.5	27 13.5	- -	dB	+27 dBm +16 dBm	0 V 2.4 V
ACLR1 at 1.6 MHz offset	- -	-42 -42	-38 -38	dBc	+27 dBm +16 dBm	0 V 2.4 V
ACLR2 at 3.2 MHz offset	- -	-55 -55	-48 -48	dBc	+27 dBm +16 dBm	0 V 2.4 V
Power-Added Efficiency (without DC/DC Converter)	33 18	36 20	- -	%	+27 dBm +16 dBm	0 V 2.4 V
Quiescent Current (Icq) Low Bias Mode	-	8	12	mA	V_{MODE1} = +2.4 V	
Mode Control Current	-	0.3	0.6	mA	through V_{MODE} pin, V_{MODE1} = +2.4 V	
Enable Current	-	0.3	0.6	mA	through V_{ENABLE} pin, V_{EN} = +2.4 V	
BATT Current	-	3.0	5	mA	through V_{BATT} pin, V_{MODE1} = +2.4 V	
Leakage Current	-	<1	5	µA	V_{BATT} = +4.3 V, V_{CC} = +4.3 V, V_{ENABLE} = 0 V, V_{MODE1} = 0 V	
Harmonics 2fo 3fo, 4fo	 - -	 - -	 -35 -35	dBc	$P_{OUT} \leq$ +27 dBm	
Input Impedance	-	-	2:1	VSWR		
Load mismatch stress with no permanent degradation or failure	8:1	-	-	VSWR	Applies over full operating range	

APPLICATION INFORMATION

To ensure proper performance, refer to all related Application Notes on the ANADIGICS web site: http://www.anadigics.com

Shutdown Mode

The power amplifier may be placed in a shutdown mode by applying logic low levels (see Operating Ranges table) to the V_{ENABLE} and V_{MODE1} voltages.

Bias Modes

The power amplifier may be placed in either a Low Bias mode or a High Bias mode by applying the appropriate logic level (see Operating Ranges table) to V_{MODE1}. The Bias Control table lists the recommended modes of operation for various applications. V_{MODE2} is not necessary for this PA.

Two operating modes are available to optimize current consumption. High Bias/High Power operating mode is for P_{OUT} levels $\geq$ 16 dBm. At around 17 dBm output power, the PA should be "Mode Switched" to Medium/Low power mode for lowest quiescent current consumption.

Table 6: Bias Control (WCDMA/UMTS)

APPLICATION	P_{OUT} LEVELS	BIAS MODE	V_{ENABLE}	V_{MODE1}	V_{CC}	V_{BATT}
UMTS - high power (High Bias Mode)	> +16 dBm	High	+2.4 V	0 V	3.2 - 4.2 V	$\geq$ 3.2 V
UMTS - med/low power (Low Bias Mode)	$\leq$ +17 dBm	Low	+2.4 V	+2.4 V	3.2 - 4.2 V	$\geq$ 3.2 V
Optional lower V_{CC} in low power mode	$\leq$ +7 dBm	Low	+2.4 V	+2.4 V	1.5 V	$\geq$ 3.2 V
Shutdown	-	Shutdown	0 V	0 V	3.2 - 4.2 V	$\geq$ 3.2 V

Table 7: Bias Control (TD-SCDMA)

APPLICATION	P_{OUT} LEVELS	BIAS MODE	V_{ENABLE}	V_{MODE1}	V_{CC}	V_{BATT}
TD-SCDMA - high power (High Bias Mode)	> +15 dBm	High	+2.4 V	0 V	3.2 - 4.2 V	$\geq$ 3.2 V
TD-SCDMA - med/low power (Low Bias Mode)	$\leq$ +16 dBm	Low	+2.4 V	+2.4 V	3.2 - 4.2 V	$\geq$ 3.2 V
Shutdown	-	Shutdown	0 V	0 V	3.2 - 4.2 V	$\geq$ 3.2 V

CHARACTERIZATION DATA
(WCDMA Rel 99, V_{CC} = 3.4 V, V_{EN} = 2.4 V, T = 25 °C)

Figure 3: Gain vs Output Power

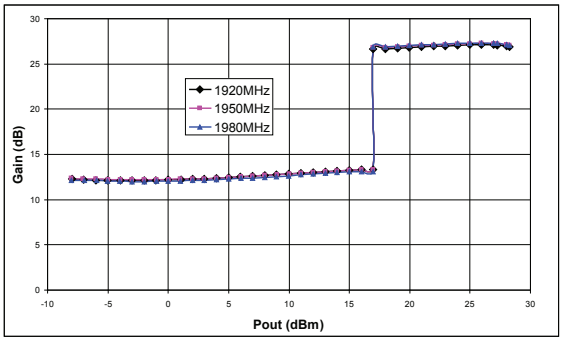


Figure 4: Current vs Output Power

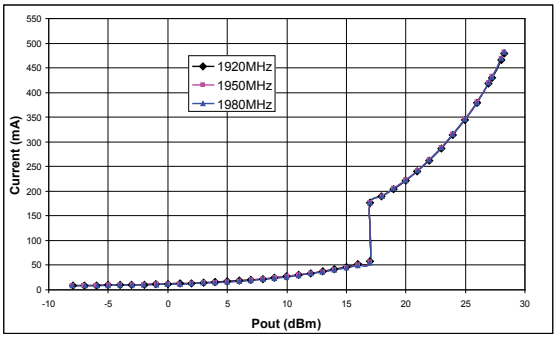


Figure 5: ACLR1 (5 MHz offset) vs Output Power

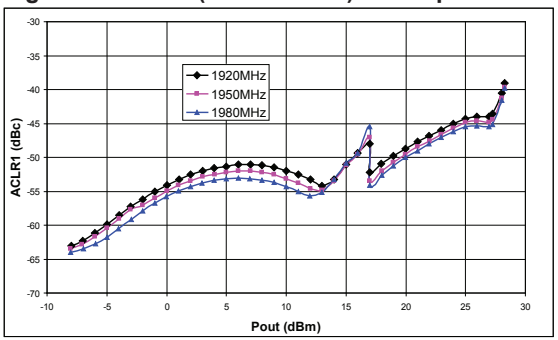


Figure 6: ACLR2 (10 MHz offset) vs Output

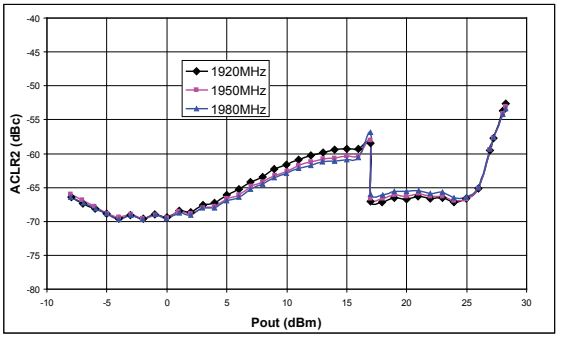
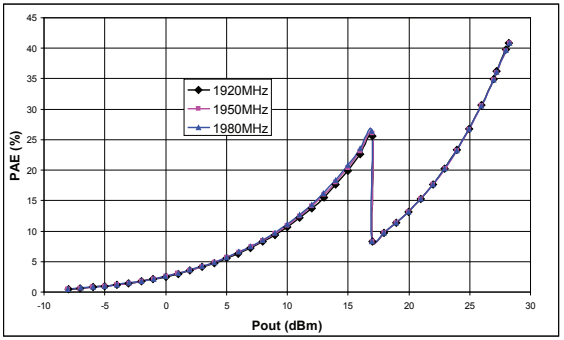


Figure 7: Efficiency vs Output Power



CHARACTERIZATION DATA
(HSPA, Rel 8, V_{CC} = 3.4 V, V_{EN} = 2.4 V, T = 25 °C)

Figure 8: Gain vs Output Power

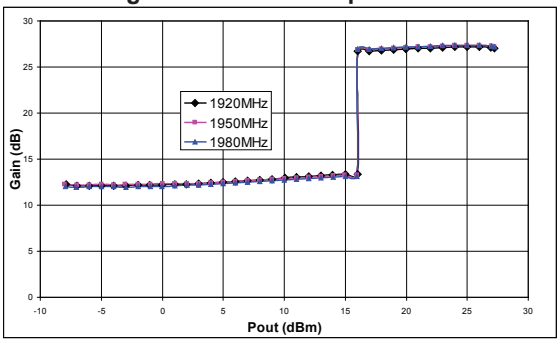


Figure 9: Current vs Output Power

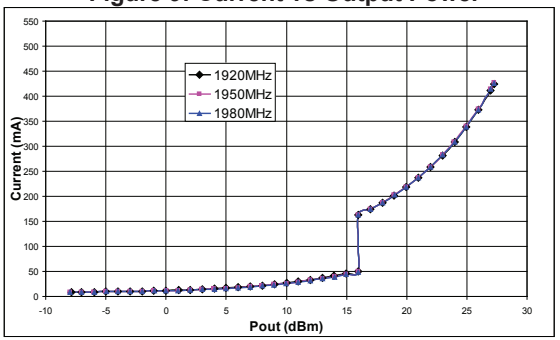


Figure 10: ACLR1 (5MHz offset) vs Output Power

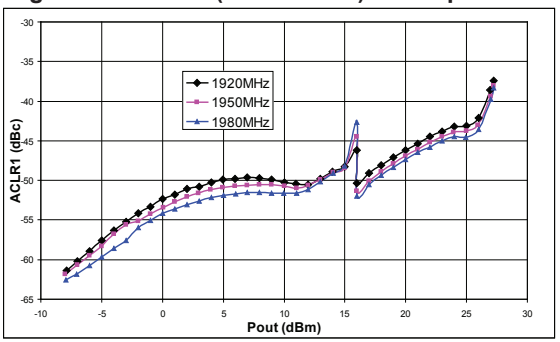


Figure 11: ACLR2 (10MHz offset) vs Output

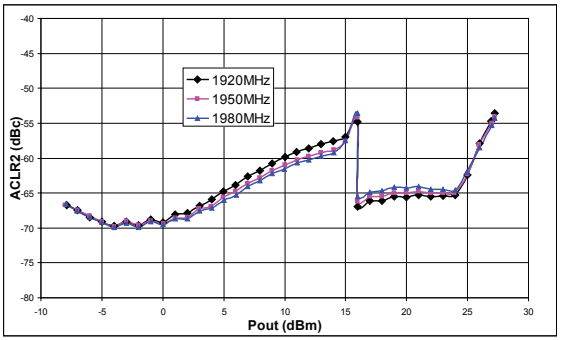
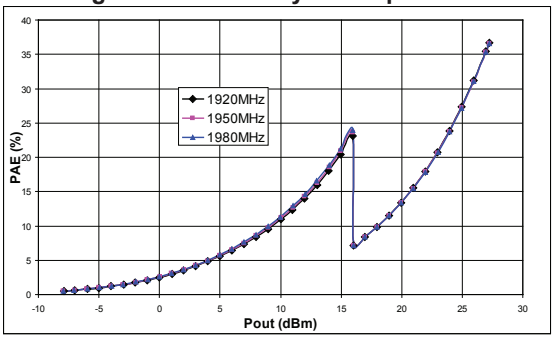


Figure 12: Efficiency vs Output Power



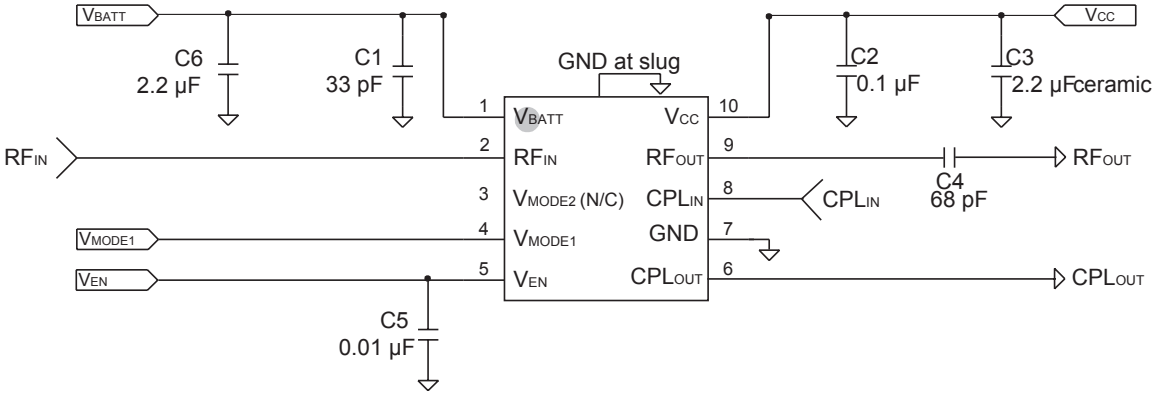


Figure 13: Evaluation Board Schematic

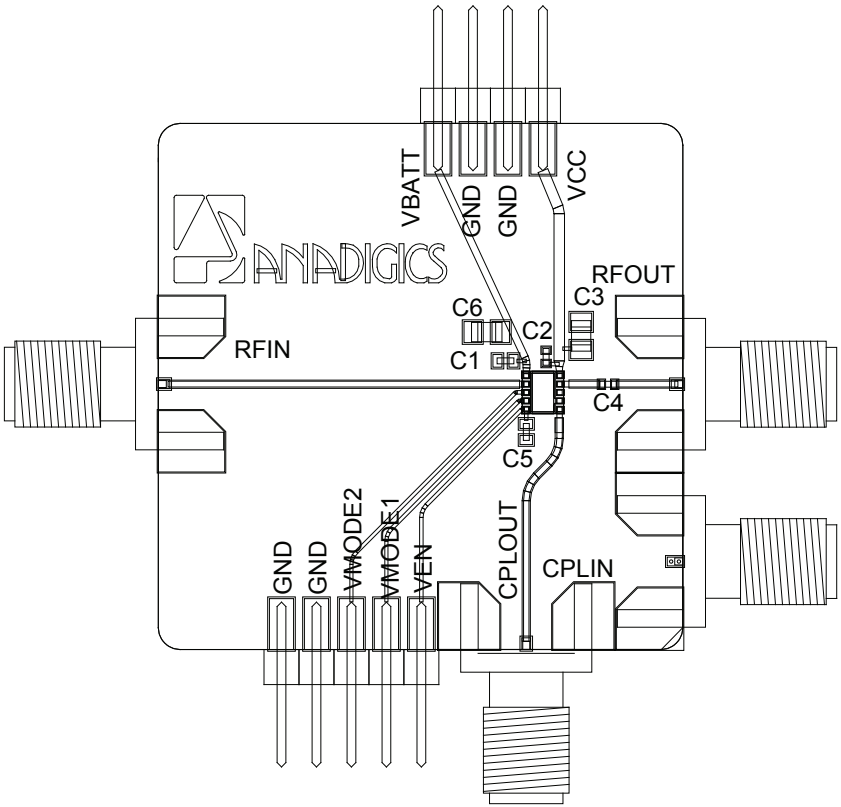


Figure 14: Evaluation Board Layout

HELP3

The AWU6601 power amplifier module is based on ANADIGICS proprietary HELP3™ technology. The PA is designed to operate up to 17 dBm in the low power mode, thus eliminating the need for three gain state, while still maintaining low quiescent current and high efficiency in low and medium power levels. The PA can still be operated as 3 gain state device if the customer chooses to. The directional "daisy chainable" coupler is integrated within the PA module, therefore there is no need for external couplers.

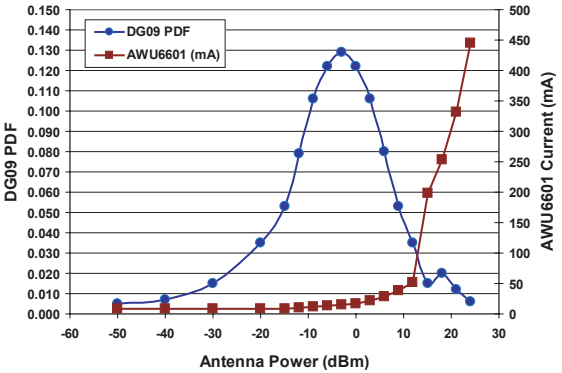
The AWU6601 has an integrated voltage regulator, which eliminates the need for an external constant voltage source. The PA is turn on/off is controlled by V_{EN} pin. A single V_{MODE} control logic (V_{MODE1}) is needed to operate this device.

The DG09 power distribution (fig 15) highlights the need to improve the current consumption in low and medium power level. The AWU6601 is designed to operate up to 17 dBm in the low power mode with very low quiescent current. Current consumption for AWU6601 is also plotted in the figure 5.

AWU6601 requires only two calibration sweeps for system calibration, thus saving calibration time.

Figure 16 shows one application example on mobile board. C1 and C2 are RF bypass caps and should be placed nearby pin 1 and pin 10. Bypass caps C9 and C5 may not be needed. Also a "T" matching topology is recommended at PA RF_{IN} and RF_{OUT} ports to provide matching between input TX Filter and Duplexer / Isolator.

Figure 15: PDF and Current



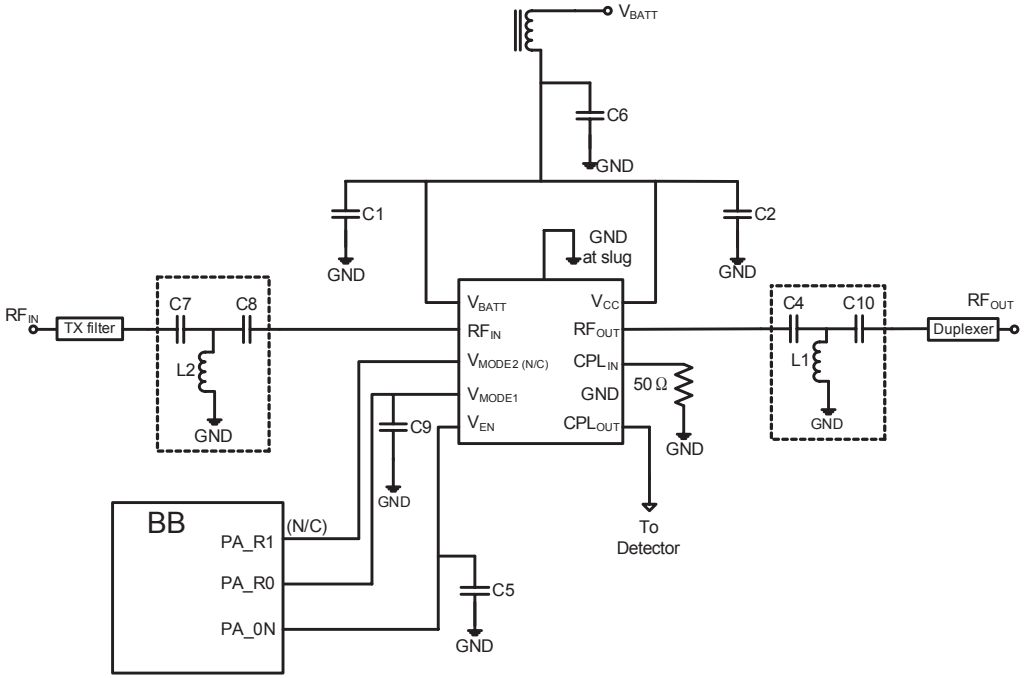
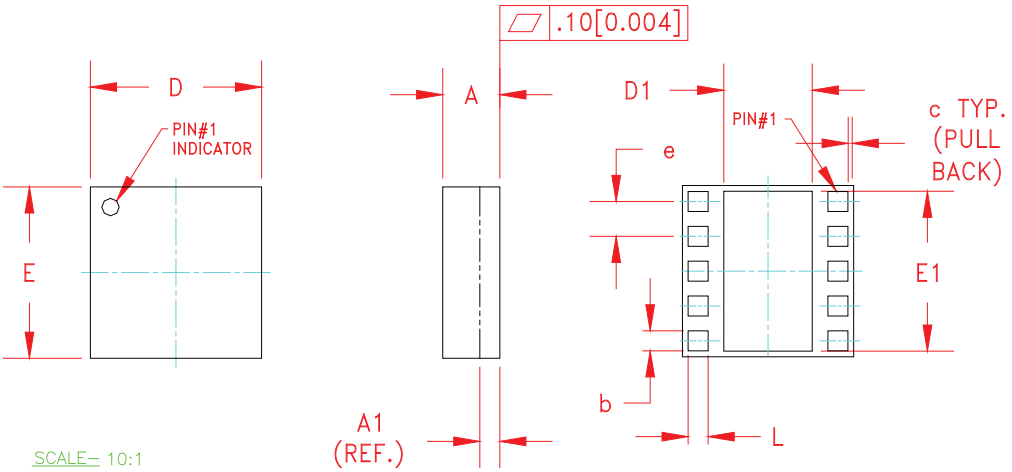


Figure 16: Typical Application Circuit

PACKAGE OUTLINE



SYMBOL	MILLIMETERS			INCHES			NOTE
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	
A	0.91	1.03	1.13	0.035	0.041	0.044	–
A1	PLEASE REFER TO LAMINATE CONTROL DRAWING						–
b	0.32	0.35	0.40	0.013	0.014	0.016	3
c	–	0.10	–	–	0.004	–	–
D	2.88	3.00	3.12	0.113	0.118	0.123	–
D1	1.45	1.50	1.57	0.057	0.059	0.062	3
E	2.88	3.00	3.12	0.113	0.118	0.123	–
E1	2.70	2.75	2.85	0.106	0.108	0.112	3
e		0.60			0.024		3
L	0.32	0.35	0.40	0.013	0.014	0.016	3

NOTES:

1. CONTROLLING DIMENSIONS: MILLIMETERS
2. UNLESS SPECIFIED TOLERANCE=±0.076[0.003].
3. PADS (INCLUDING CENTER) SHOWN UNIFORM SIZE FOR REFERENCE ONLY. ACTUAL PAD SIZE AND LOCATION WILL VARY WITHIN MIN. AND MAX. DIMENSIONS ACCORDING TO SPECIFIC LAMINATE DESIGN.
4. UNLESS SPECIFIED DIMENSIONS ARE SYMMETRICAL ABOUT CENTER LINES SHOWN.
5. LAMINATE CONTROL DRAWING SPECIFIED BY PART NUMBER.

Figure 17: M45 Package Outline - 10 Pin 3 mm x 3 mm x 1 mm Surface Mount Module

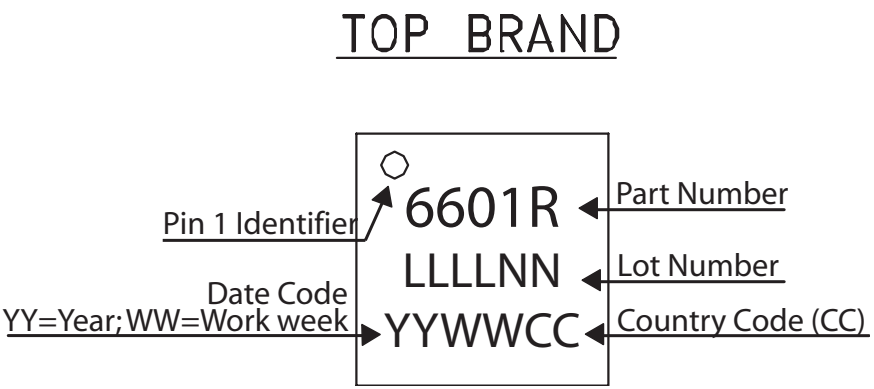
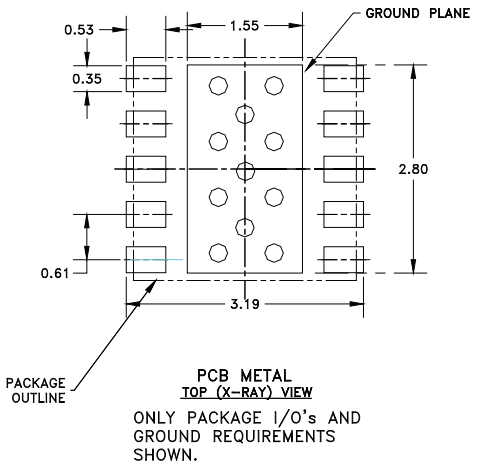


Figure 18: Branding Specification - M45 Package

PCB AND STENCIL DESIGN GUIDELINE



NOTES:

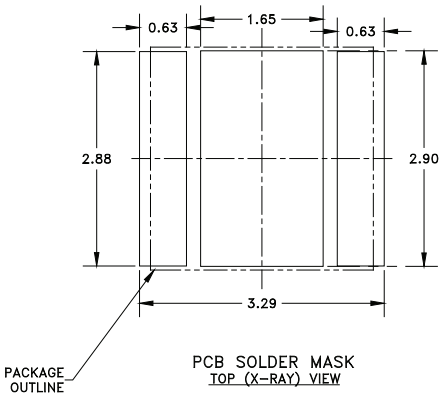
(1) OUTLINE DRAWING REFERENCE: P8002478_E

(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. 0.150mm (6 Mils)



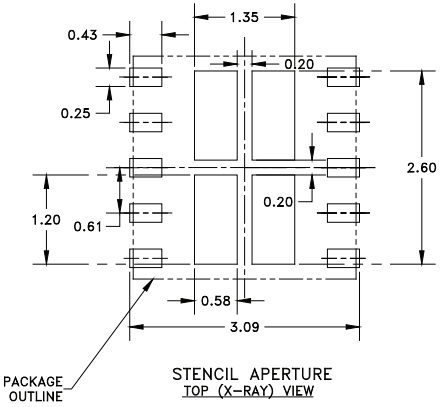
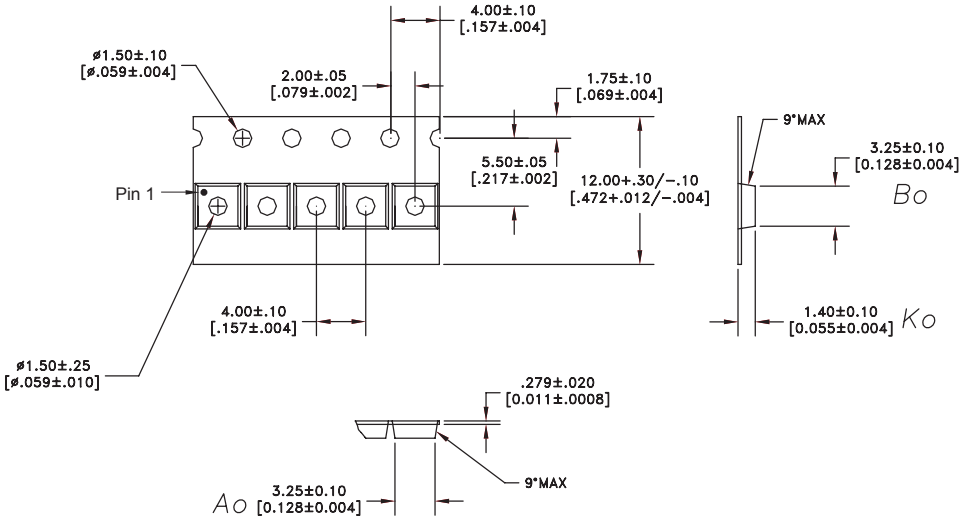


Figure 19: Recommended PCB Layout Information

COMPONENT PACKAGING



NOTES:

DIMENSIONS ARE IN MILLIMETERS [INCHES]

1. MATERIAL: 3000 (CARBON FILLED POLYCARBONATE)
100% RECYCLABLE.

DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994

Figure 20: Tape & Reel Packaging

Table 8: Tape & Reel Dimensions

PACKAGE TYPE	TAPE WIDTH	POCKET PITCH	REEL CAPACITY	MAX REEL DIA
3 mm x 3 mm x 1 mm	12 mm	4 mm	2500	7"

ORDERING INFORMATION

ORDER NUMBER	TEMPERATURE RANGE	PACKAGE DESCRIPTION	COMPONENT PACKAGING
AWU6601RM45Q7	-30 °C to +90 °C	RoHS Compliant 10 Pin 3 mm x 3 mm x 1 mm Surface Mount Module	Tape and Reel, 2500 pieces per Reel
AWU6601RM45P9	-30 °C to +90 °C	RoHS Compliant 10 Pin 3 mm x 3 mm x 1 mm Surface Mount Module	Partial Tape and Reel

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