

3G/4G MMBB PAM

Functional Block Diagram

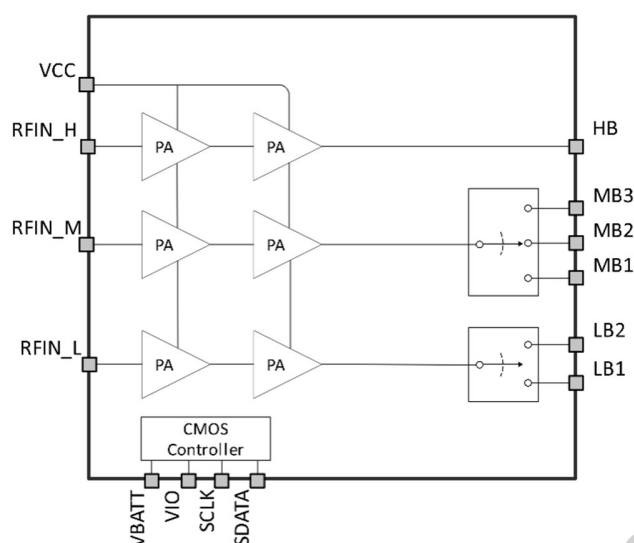


Figure 1 KCT56816-2 Functional Block Diagram

Product Description

The KCT56816-2 is a multimode multiband (MMMB) Power Amplifier Module (PAM) that supports 3G/4G handsets and operates efficiently in WCDMA and LTE modes. The module is fully programmable through a Mobile Industry Processor Interface (MIPI).

The PAM consists of the 3G/4G PA block for low, high and mid-bands, and a Multi-Function Control (MFC) block. A CMOS integrated circuit uses standard MIPI controls to provide the internal MFC interface and operation.

Applications

- Multi-band 3G/LTE handsets
- WCDMA Bands I, II, III, IV, V, VIII, IX
- FDD LTE Bands 1, 2, 3, 4, 5, 8, 7
- TDD LTE Bands 34, 38, 39, 40, 41

Feature Overview

- Support LTE Power Class 3
- 1 HB Tx RF Port
- 3 MB Tx RF Ports
- 2 LB Tx RF Ports
- Support MIPI RFFE v2.1
- Package size:
3.0×3.0×0.77(max)mm
22-pad configuration
LGA package

Pin Configuration and Description

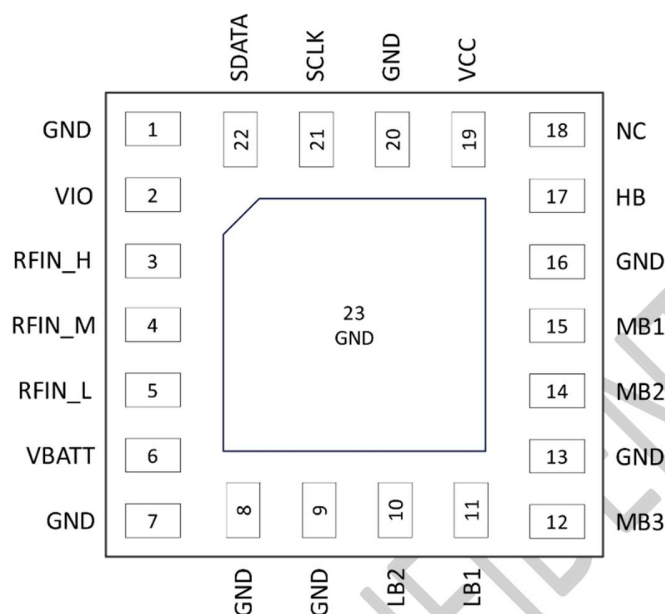


Figure 2 Pin Assignment (Top View)

Table 1 PIN Definitions

PIN NO	LABEL	DESCRIPTION	PIN NO	LABEL	DESCRIPTION
1	GND	Ground	12	MB3	MB PA RF Output
2	VIO	VIO Voltage for RFFE	13	GND	Ground
3	RFIN_H	HB PA RF Input	14	MB2	MB PA RF Output
4	RFIN_M	MB PA RF Input	15	MB1	MB PA RF Output
5	RFIN_L	LB PA RF Input	16	GND	Ground
6	VBATT	VBATT Supply for PA and controller	17	HB	HB PA RF Output
7	GND	Ground	18	NC	NC
8	GND	Ground	19	VCC	VCC Supply for PA
9	GND	Ground	20	GND	Ground
10	LB2	LB PA RF Output	21	SCLK	SCLK for RFFE
11	LB1	LB PA RF Output	22	SDATA	SDATA for RFFE

Absolute Maximum Ratings

Table 2 Absolute Maximum Ratings

PARAMETER	CONDITION	MIN	TYP	MAX	UNITS
DC Supply Voltage	No RF, VBATT	-0.5	-	6	V
	No RF, VCC	-	-	6	V
	With RF, VBATT	-0.5	-	6	V
	With RF, VCC	-	-	5.5	V
MIPI Supply Voltage	VIO	-0.5	-	2	V
Digital Control Signal Voltage	SCLK, SDATA	-0.5	-	2	V
RF Input Power	TX input, CW 50ohm	-	-	10	dBm
Operating Temperature	Ambient	-40	-	+100	°C
Storage Temperature	Ambient	-40	-	+150	°C
ESD	HBM	-1K	-	1K	V
ESD	CDM	-500	-	500	V

*Exposure to maximum rating conditions for extended periods may reduce device reliability. There is no damage to device with only one parameter set at the limit and all other parameters set at or below their nominal value. Exceeding any of the limits listed here may result in permanent damage to the device.

Recommended Operating Conditions^{1,2}

Table 3 Operating Conditions

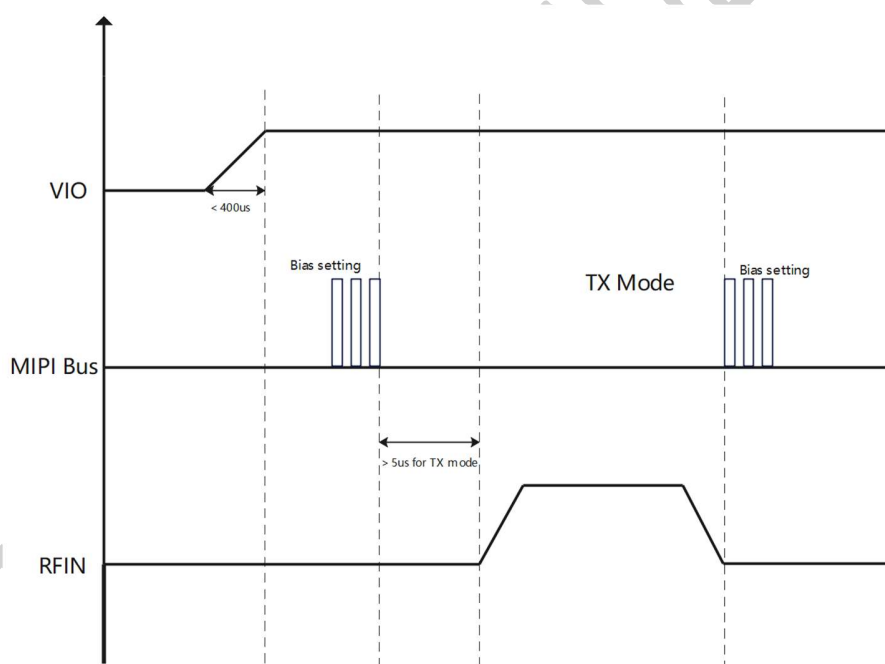
PARAMETER	CONDITION	MIN	TYP	MAX	UNITS
Supply Voltage VCC	VCC	0.5	3.4	4.6	V
Supply Voltage VBATT	VBATT	3	3.4	4.6	V
MPII Supply Voltage	VIO	1.62	1.8	1.98	V
Digital Control Signal Low	SCLK, SDATA	0	-	0.2 x VIO	V
Digital Control Signal High	SCLK, SDATA	0.8 x VIO	-	VIO	V
Leakage Current	VCC, VIO	-	-	10	μA
Leakage Current	VBATT	-	-	5	μA
Operating Temperature	Trange, Ambient	-40	+25	+85	°C

Test Conditions

Table 4 Test Conditions

PARAMETER	Specification			UNITS	Description
	MIN	TYP	MAX		
Supply Voltage VCC	3.4			V	Normal Test Condition(NTC)
Supply Voltage VBATT	3.4			V	
Operating Temperature Trange	+25			°C	
Supply Voltage VCC	3.2	3.4	4.6	V	Extreme Test Conditions(ETC)
Supply Voltage VBATT	3.2	3.4	4.6	V	
Operating Temperature Trange	-40	+25	+85	°C	

Timing Diagram



The recommended control timing for TX mode operation is shown above. The falling edge of the SCLK during Parity Bit is the master timing reference for all hardware events. Failure to comply with the specification may result in RF output distortion or PA module damage.

HB Tx PA Specifications

Table 5 HB LTE RF Performance

Conditions: VBAT=3.4V, VCC=3.4V, T_A=25°C, LTE QPSK/10MHz/12RB Waveform, Characteristic Impedance [Z₀]=50Ω, Unless Otherwise Noted

PARAMETER	CONDITION	MIN	TYP	MAX	UNITS
Operating Frequency	B7	2500	-	2570	MHz
	B38	2570	-	2620	MHz
	B40	2300	-	2400	MHz
	B41	2496	-	2690	MHz
Maximum Output Power	Prated_NTC	28	-	-	dBm
	Prated_ETC	27	-	-	dBm
Power Gain HPM	Pout = Prated_NTC	-	32	-	dB
Power Gain LPM	Pout ≤ 3dBm	-	18	25	dB
Gain Variation over temperature		-	±2	-	dB
Power Added Efficiency	Pout = Prated_NTC	-	32.5	-	%
Total Supply Current	Pout = Prated_NTC	-	560	-	mA
Quiescent Current	HPM		190		mA
	LPM		60		
IBAT	Pout = Prated_NTC	-	8	-	mA
Adjacent Channel Leakage Power Ratio	EUTRA ACLR, Pout ≤ Prated_NTC-MPR	-	-38	-	dBc
	EUTRA ACLR, Pout ≤ Prated_ETC-MPR	-	-	-	dBc
	UTRA ACLR1, Pout ≤ Prated_NTC-MPR	-	-40	-	dBc
	UTRA ACLR1, Pout ≤ Prated_ETC-MPR	-	-	-	dBc
	UTRA ACLR2, Pout ≤ Prated_NTC-MPR	-	-45	-	dBc
	UTRA ACLR2, Pout ≤ Prated_ETC-MPR	-	-	-	dBc
EVM	Pout ≤ Prated_NTC-MPR	-	2	-	%
Harmonics	2f ₀	-	-10	-	dBm
	3f ₀	-	-15	-	dBm
	≥ 4f ₀	-	-15	-	dBm
Tx Noise	LTE HB RX Band 2620MHz to 2690MHz	-	-140	-	dBm/Hz
	GNSS Band 1574MHz to 1577MHz	-	-140	-	dBm/Hz
	ISM 2.4G Band 2400MHz to 2482MHz	-	-104	-	dBm/Hz
	ISM 5G Band 5150MHz to 5850MHz	-	-130	-	dBm/Hz
Turn On Time	Gain settled to within 0.5dB of Prated_NTC	-	-	5	us
Turn Off Time	Gain settled to below Prated_NTC - 30dB	-	-	5	us
Input VSWR	No external matching	-	2.5:1	-	
Stability	Load VSWR = 6:1, Pout = Prated, all phase, ETC	-	-	-36	dBm
Ruggedness	Load VSWR = 10:1, Pout = Prated+2dB, all phase, ETC	No damage			

MB Tx PA Specifications

Table 6 MB LTE RF Performance

Conditions: VBAT=3.4V, VCC=3.4V, TA=25°C, LTE QPSK/10MHz/12RB Waveform, Characteristic Impedance [Z0]=50Ω, Unless Otherwise Noted

PARAMETER	CONDITION	MIN	TYP	MAX	UNITS
Operating Frequency	B1	1920	-	1980	MHz
	B2	1850	-	1910	MHz
	B3	1710	-	1785	MHz
	B4	1710	-	1755	MHz
	B34	2010	-	2025	MHz
	B39	1880	-	1920	MHz
Maximum Output Power	Prated_NTC, MBx output port	27.5	-	-	dBm
	Prated_ETC, MBx output port	26.5	-	-	dBm
Power Gain	Pout = Prated_NTC	-	29.5	-	dB
Power Gain LPM	Pout ≤ 3dBm	-	20	25	dB
Gain Variation over temperature		-	±2	-	dB
Power Added Efficiency	Pout = Prated_NTC	-	28	-	%
Total Supply Current	Pout = Prated_NTC	-	580	-	mA
Quiescent Current	HPM		240		mA
	LPM		60		
IBAT	Pout = Prated_NTC	-	8	-	mA
Adjacent Channel Leakage Power Ratio	EUTRA ACLR, Pout ≤ Prated_NTC-MPR	-	-38	-	dBc
	EUTRA ACLR, Pout ≤ Prated_ETC-MPR	-	-	-	dBc
	UTRA ACLR1, Pout ≤ Prated_NTC-MPR	-	-40	-	dBc
	UTRA ACLR1, Pout ≤ Prated_ETC-MPR	-	-	-	dBc
	UTRA ACLR2, Pout ≤ Prated_NTC-MPR	-	-42	-	dBc
	UTRA ACLR2, Pout ≤ Prated_ETC-MPR	-	-	-	dBc
EVM	Pout ≤ Prated_NTC-MPR	-	2	-	%
Harmonics	2f0	-	-10	-	dBm
	3f0	-	-15	-	dBm
	≥ 4f0	-	-15	-	dBm
Tx Noise	LTE B1 RX Band 2110MHz to 2170MHz	-	-145	-	dBm/Hz
	LTE B2 RX Band 1930MHz to 1990MHz	-	-133	-	dBm/Hz
	LTE B3 RX Band 1805MHz to 1880MHz	-	-133	-	dBm/Hz
	LTE B4 RX Band 2110MHz to 2155MHz	-	-145	-	dBm/Hz
	GNSS Band 1574MHz to 1577MHz	-	-133	-	dBm/Hz
	ISM 2.4G Band 2400MHz to 2482MHz	-	-140	-	dBm/Hz
	ISM 5G Band 5150MHz to 5850MHz	-	-148	-	dBm/Hz
Turn On Time	Gain settled to within 0.5dB of Prated_NTC	-	-	5	us
Turn Off Time	Gain settled to below Prated_NTC - 30dB	-	-	5	us
Input VSWR	No external matching	-	2.5:1	-	
Stability	Load VSWR = 6:1, Pout = Prated, all phase, ETC	-	-	-36	dBm

Ruggedness	Load VSWR = 10:1, Pout = Prated+2dB, all phase, ETC	No damage
------------	---	-----------

KCT NDA, CONFIDENTIAL

LB Tx PA Specifications

Table 7 LB LTE RF Performance

Conditions: VBAT=3.4V, VCC=3.4V, TA=25°C, LTE QPSK/10MHz/12RB Waveform, Characteristic Impedance [Z0]=50Ω, Unless Otherwise Noted

PARAMETER	CONDITION	MIN	TYP	MAX	UNITS
Operating Frequency	B5	824	-	849	MHz
	B8	880	-	915	MHz
Maximum Output Power	Prated_NTC	27.5	-	-	dBm
Power Gain	Prated_ETC	26.5	-	-	dBm
	Pout = Prated_NTC	-	31	-	dB
Power Gain LPM	Pout ≤ 3dBm	-	20	25	dB
Gain Variation over temperature		-	±2	-	dB
Power Added Efficiency	Pout = Prated_NTC	-	30	-	%
Total Supply Current	Pout = Prated_NTC	-	540	-	mA
Quiescent Current	HPM		140		mA
	LPM		55		
IBAT	Pout = Prated_NTC	-	8	-	mA
Adjacent Channel Leakage Power Ratio	EUTRA ACLR, Pout ≤ Prated_NTC-MPR	-	-40	-	dBc
	EUTRA ACLR, Pout ≤ Prated_ETC-MPR	-	-	-	dBc
	UTRA ACLR1, Pout ≤ Prated_NTC-MPR	-	-40	-	dBc
	UTRA ACLR1, Pout ≤ Prated_ETC-MPR	-	-	-	dBc
	UTRA ACLR2, Pout ≤ Prated_NTC-MPR	-	-42	-	dBc
	UTRA ACLR2, Pout ≤ Prated_ETC-MPR	-	-	-	dBc
EVM	Pout ≤ Prated_NTC-MPR	-	2	-	%
Harmonics	2f0	-	-10	-	dBm
	3f0	-	-15	-	dBm
	≥ 4f0	-	-15	-	dBm
Tx Noise	LTE B5 RX Band 869MHz to 894MHz	-	-130	-	dBm/Hz
	LTE B8 RX Band 925MHz to 960MHz	-	-130	-	dBm/Hz
	GNSS Band 1574MHz to 1577MHz	-	-143	-	dBm/Hz
	ISM 2.4G Band 2400MHz to 2482MHz	-	-145	-	dBm/Hz
	ISM 5G Band 5150MHz to 5850MHz	-	-132	-	dBm/Hz
Turn On Time	Gain settled to within 0.5dB of Prated_NTC	-	-	5	us
Turn Off Time	Gain settled to below Prated_NTC - 30dB	-	-	5	us
Input VSWR	No external matching	-	2.5:1	-	
Stability	Load VSWR = 6:1, Pout = Prated, all phase, ETC	-	-	-36	dBm
Ruggedness	Load VSWR = 10:1, Pout = Prated+2dB, all phase, ETC	No damage			

Application Circuit Schematic

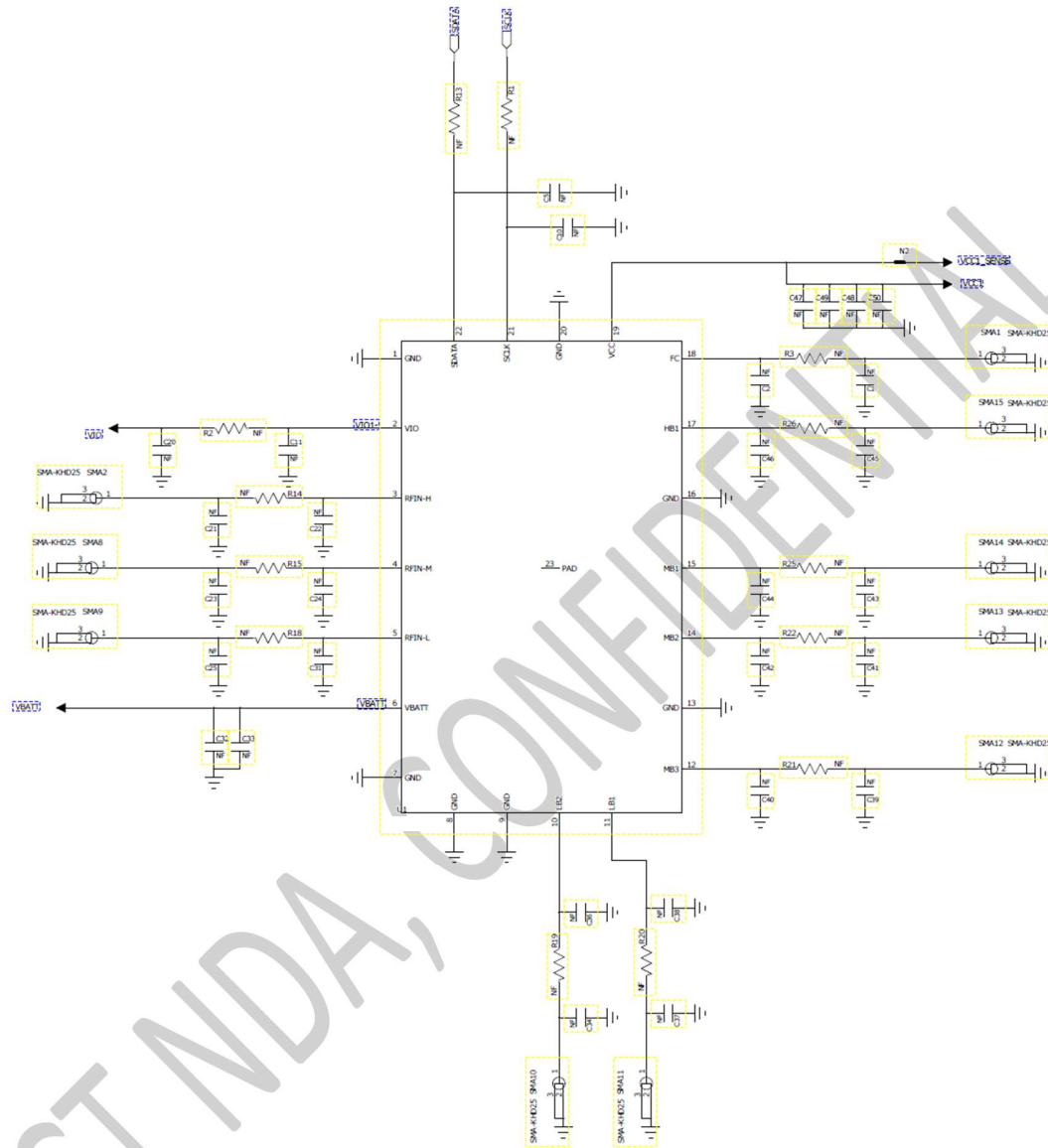


Figure 3 Application Circuit Schematic

Evaluation Board Layout

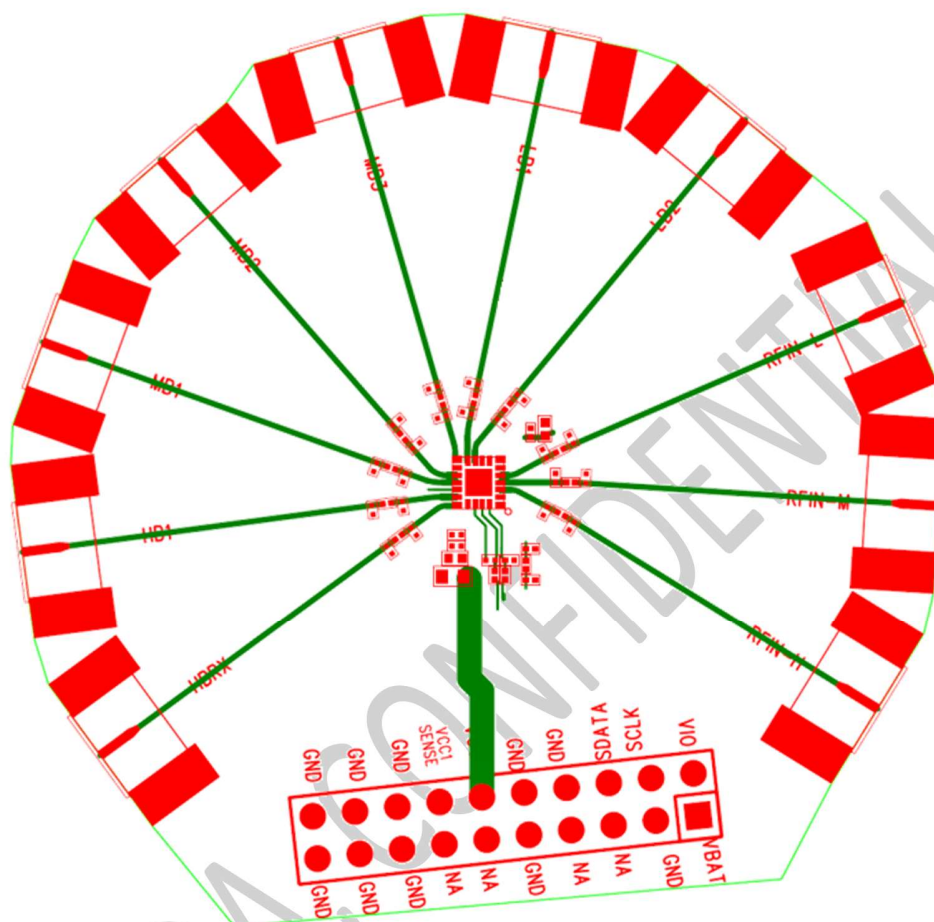


Figure 4 Evaluation Board Layout (TOP)

RFFE Register Definition

Table 8 MIPI RFFE Register Definition

Register Address	Register Name	Bit Position	Description	Default	Notes	Trigger Support	R/W
0x00	PA Mode Control	[7]	Reserved	0	Reserved	Trigger 0	R/W
		[6:3]	PA Band Select Control Mode	0000	0000 = PA's Disabled		
					0001 = LB2_TX		
					0010 = LB1_TX		
					0011 = MB3_TX		
					0100 = MB2_TX		
					0101 = MB1_TX		
					0110 = HB_TX		
					0111 = Reserved		
					1000-1111 = PA's Disabled (High Switch Isolation)		
		[2]	PA Enable	0	0=Off 1=On		
		[1]	PA mode	0	0=HPM 1=LPM		
		[0]	Reserved	0	Reserved		
0x01	PA Bias Control	[7:4]	REG2 Bias Reference	0000	REG2 Bias Reference	Trigger 0	R/W
		[3:0]	REG1 Bias Reference	0000	REG1 Bias Reference		
0x03	PA Cap Control	[7:0]	PA Cap Control	00000000	PA Cap Control	Trigger 0	R/W
0x1B	Group_SID	[7:4]	Reserved	0000	Reserved	NO	R/W
		[3:0]	Group Slaved ID	0000	GSID		
0x1C	PM_TRIG	[7:6]	PWR_MODE	10	00 = Normal Operation (Active)	NO	R/W
					10 = Low Power		
					01 = Default Settings (Startup)		
					11 = Reserved		
		[5]	Trigger Mask 2	0	0 = Trigger Enable 1 = Trigger Disable		
		[4]	Trigger Mask 1	0	0 = Trigger Enable 1 = Trigger Disable		
		[3]	Trigger Mask 0	0	0 = Trigger Enable 1 = Trigger Disable		
		[2]	Trigger Register 2	0	1 = Latch Register 2 Contents		
		[1]	Trigger Register 1	0	1 = Latch Register 1 Contents		
		[0]	Trigger Register 0	0	1 = Latch Register 0 Contents		

0x1D	Product ID	[7:0]	Product ID	0101 1001	Product ID = 0x59	NO	R
0x1E	Manufactur e ID	[7:0]	Manufacture ID [7:0]	1011 1001	Manufacture ID [7:0] = 0xB9	NO	R
0x1F	User ID	[7:4]	Manufacture ID [11:8]	0100	Manufacture ID[9:8] = 0x4		R
		[3:0]	USID	1111	USID=0x0F		R/W
0x23	SW_RST	[7]	UDR Software Reset	0		NO	R/W
		[6:0]	Reserved	000 0000			

KCT NDA, CONFIDENTIAL

Package Outline Dimensions

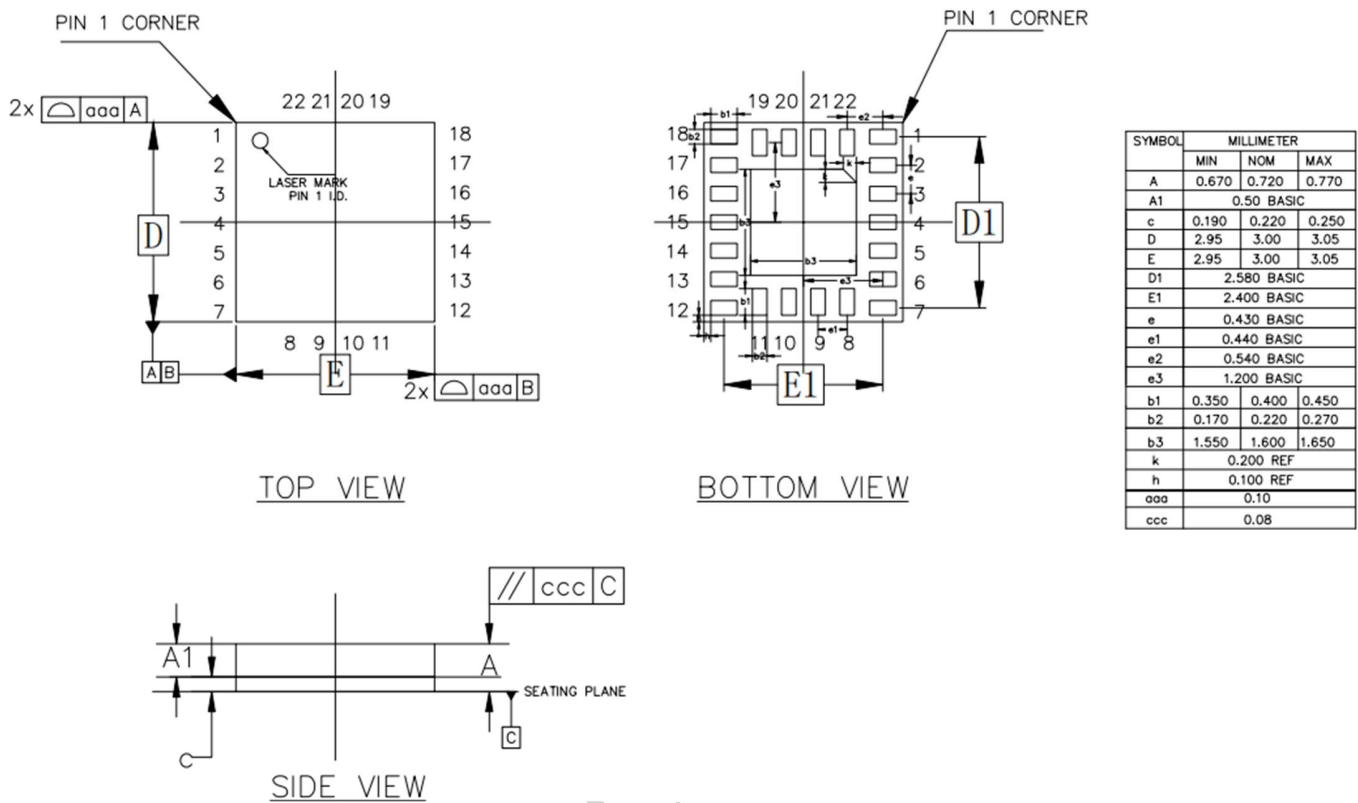


Figure 5 Package Outline Dimensions

Tape and Reel Dimensions

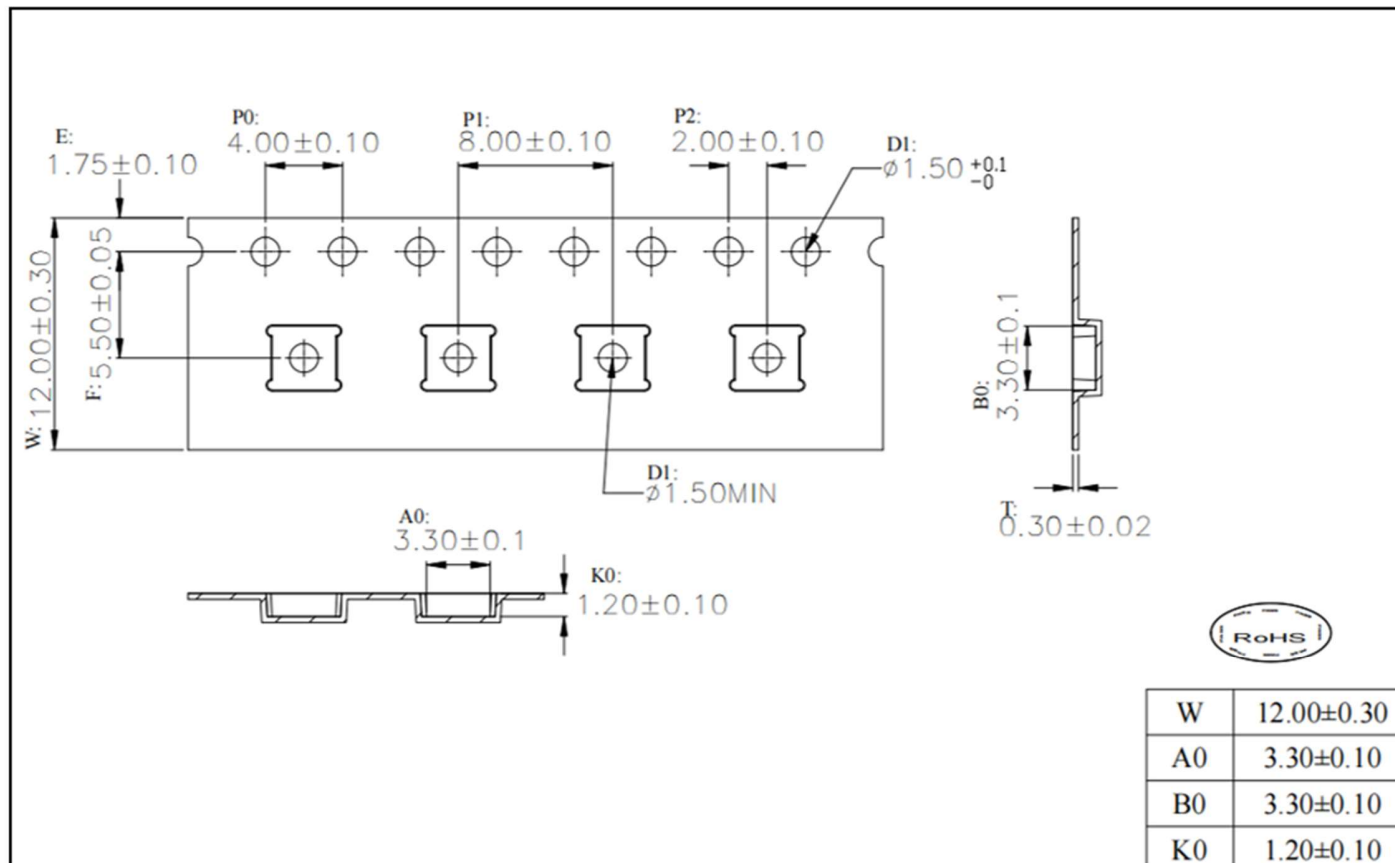


Figure 6 Tape and Reel Dimensions

Marking Specifications

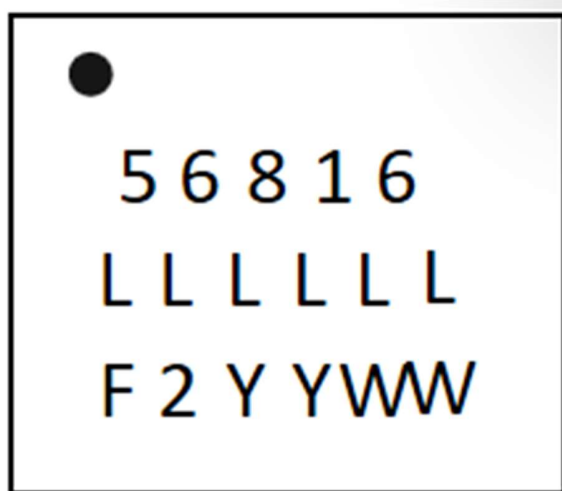


Figure 6 Marking Specifications

Table 9 Device marking line definitions

LINE	MARKING	DESCRIPTION
Row1	Pin 1 dot	Direction of Pin 1
Row2	56816	Product Name
Row3	LLLLLL	Lot Number
Row4	F2YYWW	Manufacture Code(Variable)

Handling Precautions

The device package is sensitive to moisture absorption, so it must be baked and vacuum-packed before shipment. This product is rated to Moisture Sensitivity Level 3 (MSL3) at 260 °C and can be used for lead or lead-free soldering. Be sure to follow the instructions on the package label regarding unpacking exposure to moisture. Otherwise, problems of moisture absorption will occur during solder assembly when the part is subjected to the high temperature. This product is easily damaged by Electrostatic discharge (ESD) of equipment or human body. Proper precautions must be taken when handling, packing and testing devices.



ESD sensitive device

KCT NDA, CONFIDENTIAL

Solderability

Compatible with both lead-free (260°C max. reflow temperature) and tin/lead (245°C max. reflow temperature) soldering processes. Package lead plating: Electrolytic plated Au over Ni.

KCT NDA, CONFIDENTIAL

Recommended Reflow Profile

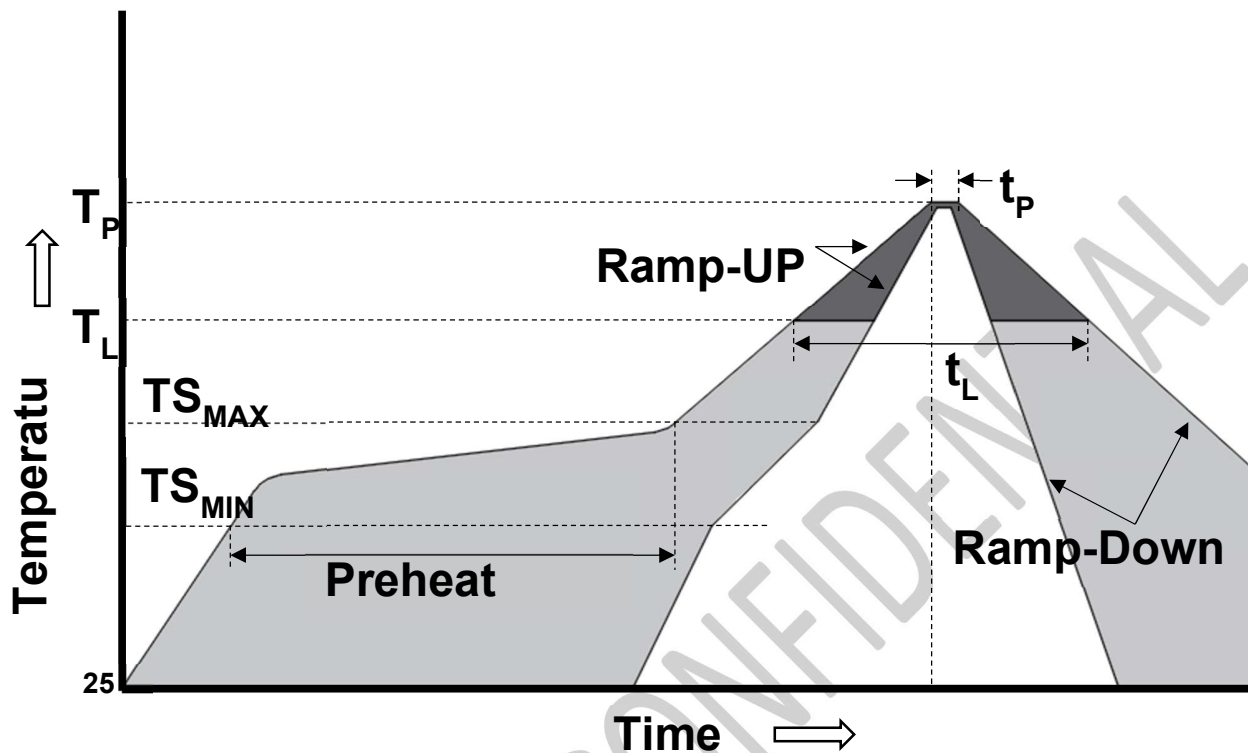


Figure 7 Recommended Reflow Profile

Table 10 Reflow Parameter

REFLOW PROFILE	PARAMETER
Preheat Temperature (TSMIN to TS MAX)	150°C to 200°C
Preheat Time(t_s)	60 to 180 Seconds
Ramp-Up Rate (TS MAX to T_P)	3°C/s MAX
Time Above T_L 217°C(t_L)	30 to 70 Seconds
Peak Temperature (T_P)	250°C+0/-5°C
Time within 5°C of Peak Temperature(t_P)	20 Seconds MAX
Ramp-Down Rate (TS MAX to T_P)	6°C/s MAX
Time for 25°C to Peak Temperature(t_{25-T_P})	10 Seconds MIN

RoHS Compliance

This part is compliant with the 2011/65/EU RoHS directive (Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment), as amended by Directive 2015/863/EU.

This product also has the following attributes:

- Lead Free
- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A (C₁₅H₁₂Br₄O₂) Free
- SVHC Free



ORDERING INFORMATION

Table 11 Ordering Information

Product Part Number	Package Type	Package Quantity
KCT56816-2	13" tape and reel	5000pcs / reel