



# SC1887: Adaptive RF Power Amplifier Linearizer

## General Description

SC1887 is a fully-adaptive, RF-in / RF-out pre-distortion solution for precisely compensating RF power amplifier non-linearities including AM/AM and AM/PM distortion, spectral regrowth, and code domain errors. The SC1887 substantially increases power amplifier efficiency by reducing out-of-band energy. SC1887 is a complete system-on-a-chip (SoC) solution. The product is used in the transmitter amplification chain to linearize the final power amplification stages. The SC1887 measures the feedback signal from the power amplifier output, and optimizes the correction function by minimizing distortion. SC1887 correction function is implemented and applied to the transmit signal using only RF-domain analog signal processing circuitry allowing the SC1887 to operate over a wide bandwidth at very low power consumption.

## Features

- ◆ RF-in / RF-out single chip solution implemented in standard CMOS
- ◆ Low Power Consumption
  - Standard: 1100mW
  - Low-Power: 500mW
- ◆ Wide Operating Frequency Range
  - 698-1000 MHz
  - 1600-2800 MHz
- ◆ Supports input signal bandwidth up to 60 MHz & Peak-to-Average Ratios up to 10dB
- ◆ Fully Adaptive Compensation
- ◆ Up to 26dB ACLR improvement\*
- ◆ Packaged in 9x9 mm QFN package
- ◆ -40 to +85 °C Operating Range
- ◆ Fully RoHs compliant

\* Greater improvement is possible under particular applications. Performance depends upon amplifier, bias & waveform.

## **For More Information Contact Scintera Sales at:**

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408-636-2600 • <http://www.scintera.com>

## Applications

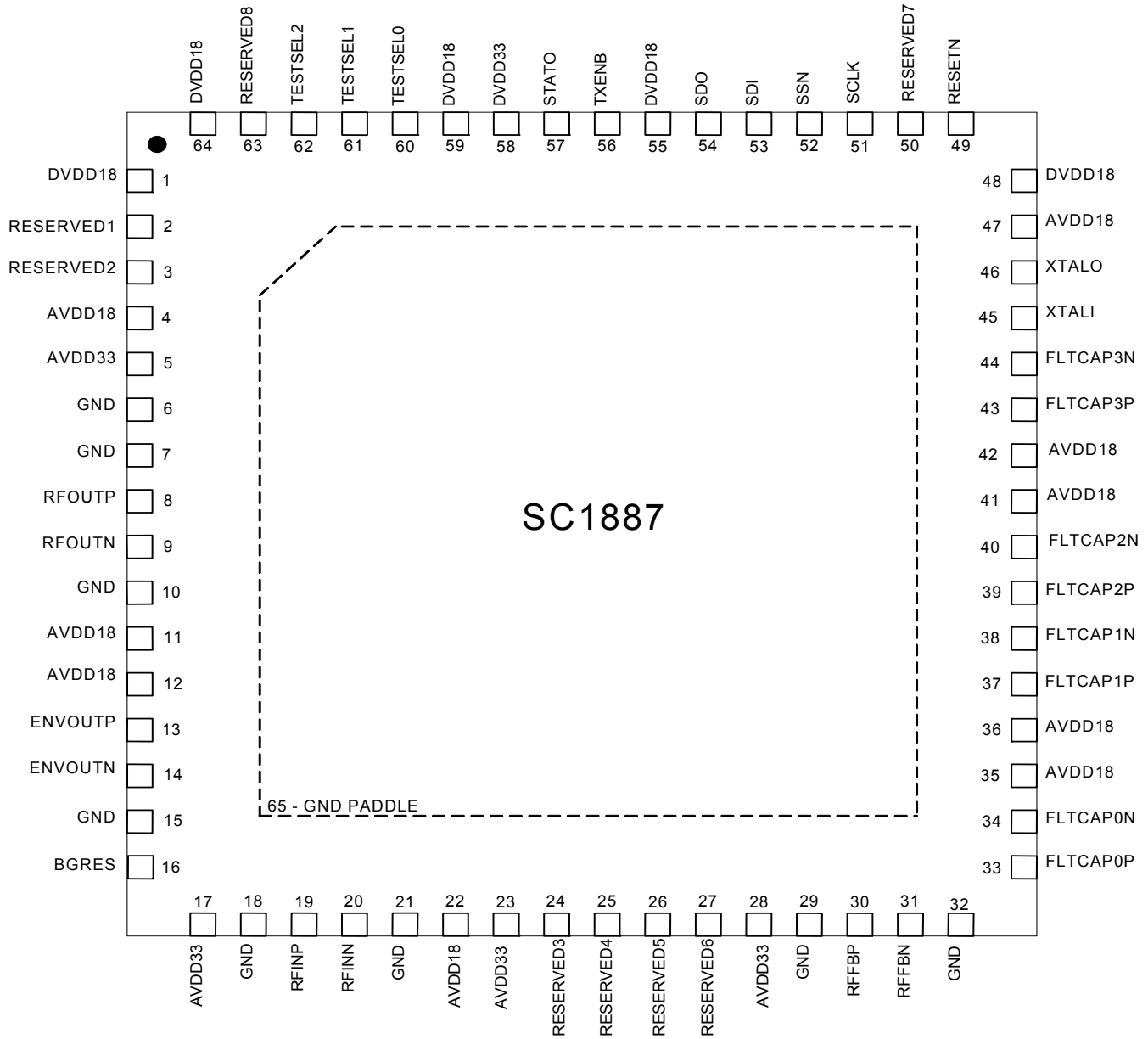
- ◆ Linearization of amplifiers requiring higher bandwidth and multi-carrier waveforms.
- ◆ Class A/AB and Doherty amplifiers
- ◆ LDMOS and GaN amplifiers
- ◆ For WCDMA, WiMax, TD-SCDMA, CDMA2000, DVBH, MediaFLO, and LTE systems.
- ◆ Wireless Infrastructure: Traditional in-cabinet BTS amplifiers, Remote Radio Units (RRU), Tower Mounted Power Amplifiers, Repeaters and Booster amplifiers, Micro Cells, Pico/Femto Cells, Distributed Antenna Systems, Active Antenna Systems, MIMO Systems
- ◆ Software defined radios (SDR) and HMS/Mobile military communications

## Benefits

- ◆ Ease of use
  - Single chip RFin/RFout solution
  - Single device operates over wide range of frequencies
  - No software development required
  - No training, algorithm development, control required – automatically calibrates and adjusts to the signal and PA environment
  - Supports wide range of modulation schemes.
- ◆ Low power consumption enables linearization of broad range of power amplifiers from 1W to >50W
- ◆ Smaller total system form factors
  - Reduced heat sink size and weight
  - Small implementation size (<500 sq mm)
- ◆ Reduces operating costs
  - Reduces energy consumption supporting Green initiatives
  - Reduces amplifier power consumption and cooling power consumption
  - Increases amplifier reliability
- ◆ Reduces BOM costs
  - Reduced heat sink costs
  - Reduced backoff reduces transistor costs



# Pinout Configuration (Top View)



# Pin Description

PIN	NAME	TYPE	FUNCTION
1	DVDD18	Supply	+1.8V DC Supply Voltage for digital circuits (Should be separately filtered from the other DVDD18 pins.)
2	RESERVED1	Reserved	Do not connect. Reserved for internal use.
3	RESERVED2	Reserved	Do not connect. Reserved for internal use.
4	AVDD18	Supply	+1.8V DC Supply Voltage for analog circuits. Required a 1000pF shunt capacitance near Pin connection
5	AVDD33	Supply	+3.3V DC Supply Voltage segregated for a single analog circuit using pin #6 for GND. Required a 1000pF shunt capacitance near Pin connection
6	GND	Supply	Ground segregated for a single analog circuit using pin #5 for the supply
7	GND	RF Shield	Ground for shield of RF signal
8	RFOUTP	Analog Out	RF Output Signal, 50Ω differential output, 25Ω per end
9	RFOUTN		
10	GND	RF Shield	Ground for shield of RF signal
11	AVDD18	Supply	+1.8V DC Supply Voltage for analog circuits. Required a 1000pF shunt capacitance near Pin connection
12	AVDD18	Supply	+1.8V DC Supply Voltage for analog circuits. Required a 1000pF shunt capacitance near Pin connection
13	ENVOUTP	Analog Out	Do not connect. Reserved for internal use.
14	ENVOUTN		
15	GND	Supply	Ground segregated for a bandgap reference using pin #17 for the supply
16	BGRES	Analog In	Bandgap Resistor. 12.4KΩ, 1%, metal film, temp-coef <100ppm/°C to GND
17	AVDD33	Supply	+3.3V DC Supply Voltage segregated for a bandgap reference using pin #15 for GND. Required a 1000pF shunt capacitance near Pin connection
18	GND	RF Shield	Ground for shield of RF signal
19	RFINP	Analog In	RF Input Signal, 100Ω differential input, 50Ω per end
20	RFINN		
21	GND	RF Shield	Ground for shield of RF signal
22	AVDD18	Supply	+1.8V DC Supply Voltage for analog circuits. Required a 1000pF shunt capacitance near Pin connection
23	AVDD33	Supply	+3.3V DC Supply Voltage for analog circuits. Required a 1000pF shunt capacitance near Pin connection
24	RESERVED3	Analog Out	Do not connect. Reserved for internal use.
25	RESERVED4		
26	RESERVED5	Analog Out	Do not connect. Reserved for internal use.
27	RESERVED6		
28	AVDD33	Supply	+3.3V DC Supply Voltage for analog circuits. Required a 1000pF shunt capacitance near Pin connection
29	GND	RF Shield	Ground for shield of RF signal
30	RFFBP	Analog In	RF Feedback Signal, 100Ω differential input, 50Ω per end
31	RFFBN		
32	GND	RF Shield	Ground for shield of RF signal
33	FLTCAP0P	Analog In	Dedicated external filter capacitor #0
34	FLTCAP0N		
35	AVDD18	Supply	+1.8V DC Supply Voltage for analog circuits
36	AVDD18	Supply	+1.8V DC Supply Voltage for analog circuits
37	FLTCAP1P	Analog In	Dedicated external filter capacitor #1
38	FLTCAP1N		
39	FLTCAP2P	Analog In	Dedicated external filter capacitor #2
40	FLTCAP2N		
41	AVDD18	Supply	+1.8V DC Supply Voltage for analog circuits
42	AVDD18	Supply	+1.8V DC Supply Voltage for analog circuits
43	FLTCAP3P	Analog In	Dedicated external filter capacitor #3
44	FLTCAP3N		
45	XTALI	Analog In	20 MHz clock reference from crystal or resonator.
46	XTALO	Analog Out	
47	AVDD18	Supply	+1.8V DC Supply Voltage for analog circuits. Required a 1000pF shunt capacitance near Pin connection
48	DVDD18	Supply	+1.8V DC Supply Voltage for digital circuits
49	RESETN	Digital In	Reset when "Low". Power-up sequence on a "High". Has internal pull-up. 3.3V logic
50	RESERVED7	Reserved	Do not connect. Reserved for internal use. Has internal pull-up.
51	SCLK	Digital In	SPI clock (recommend 4 MHz; permitted 50 KHz to 4 MHz). Has internal pull-down. 3.3V logic
52	SSN	Digital In	SPI slave select enabled "Low". Has internal pull-up. 3.3V logic
53	SDI	Digital In	SPI slave data input to RFPAL. Has internal pull-down. 3.3V logic
54	SDO	Digital Out	SPI slave data output from RFPAL. Tri-state. 3.3V logic
55	DVDD18	Supply	+1.8V DC Supply Voltage for digital circuits
56	TXENB	Digital In	Transmit Enable input has internal pull-up and can "no connect". 3.3V logic. It can be optionally used to sync to TDD downlink transmit.
57	STATO	Digital Out	General purpose Status Output as defined in Firmware Release Notes. 3.3V logic open-drain output with internal pull-up and can be wired-OR with other compatible signals. This pin can't drive a status LED directly.
58	DVDD33	Supply	+3.3V DC Supply Voltage for digital circuits. Requires a 1000pF shunt capacitance near Pin connection
59	DVDD18	Supply	+1.8V DC Supply Voltage for digital circuits
60	TESTSEL0	Digital In	To be connected to a GPIO pin from the same source as the SPI Interface. Has internal pull-down.
61	TESTSEL1	Reserved	Do not connect. Reserved for internal use. Has internal pull-up.
62	TESTSEL2	Reserved	Do not connect. Reserved for internal use. Has internal pull-up.
63	RESERVED8	Reserved	Do not connect. Reserved for internal use. Has internal pull-up.
64	DVDD18	Supply	+1.8V DC Supply Voltage for digital circuits.
65	GND PADDLE	Supply	Common Ground for entire integrated circuit. Also provides path for thermal dissipation.

## Electrical Characteristics

### ABSOLUTE MAXIMUM RATINGS

Supply Voltage (VDD33 to GND) ..... -0.3 to +3.8V  
 Supply Voltage (VDD18 to GND) ..... -0.2 to +2.2V  
 Input Voltage (1.8V pins\*) ..... -0.2 to VDD18 + 0.2V  
 Input Voltage (3.3V pins\*\*) ..... -0.3 to VDD33 + 0.3V  
 Input into the BALUN (RMS) ..... +7dBm  
 Junction Temperature ..... +150°C  
 Storage Temperature ..... -65°C to +150°C  
 Lead Soldering Temperature (30 sec)..... +260°C  
 ESD Rating..... 1000V (HBM); 200V (CDM)

Warning: Any stress beyond the ranges indicated may damage the device permanently. The specified stress ratings do not imply functional performance in these ranges. Exposure of the device to the absolute maximum ratings for extended periods of time is likely to degrade the reliability of this product

### OPERATING RATING

Operating Ambient Temperature.....-40°C to +85°C

### DC Characteristics

PARAMETER	MIN	TYP	MAX	UNITS
Supply Voltage (VDD33 to GND)	3.1	3.3	3.5	V
Supply Voltage (VDD18 to GND)	1.7	1.8	1.9	V
Supply Peak Current <sup>1</sup> (VDD33 to GND)			150	mA
Supply Peak Current <sup>1</sup> (VDD18 to GND)			900	mA
Average Power Dissipation: Fully Adaptive-power		1100		mW
Average Power Dissipation: Power-Save Mode		500		mW

1 – Peak Current includes supplied decoupling network

### RADIO FREQUENCY SIGNALS

PARAMETER	SYMBOL	CONDITIONS	MIN	RECOMMENDED	MAX	UNITS
Operating Frequency	f	High-Band	1600		2800	MHz
Operating Frequency	f	Low-Band	698		1000	MHz
RFIN_BLN Range for Maximum Correction	P <sub>RFIN_BLN</sub>	RMS Power <sup>1</sup>	-9	-6	-4	dBm
RFFB_BLN Range for Maximum Correction	P <sub>RFFB_BLN</sub>	RMS Power <sup>1</sup>	-19	-14	-12	dBm
RFIN_BLN Operating Range	P <sub>RFIN_BLN</sub>	RMS Power <sup>1</sup>	-40		-4	dBm
RFFB_BLN Operating Range	P <sub>RFFB_BLN</sub>	RMS Power <sup>1</sup>	-45		-12	dBm
RF input signal Peak-to Avg. Ratio <sup>3</sup>	PAR <sub>IN</sub>	CCDF <sup>4</sup> Probability=10 <sup>-4</sup>	5		10	dB
Correction Bandwidth <sup>5</sup>	BW <sub>correction</sub>	Wideband Modulation	1.25		60	MHz
Noise Power at RFOUT <sup>2</sup>		Out of Balun			-125	dBm/Hz

1 – A Peak to Average Ratio (PAR) of 5 to 10 dB is used for this table

2 – Worst case over PVT under typical input power and correction conditions.

3 – Higher PAR values can be supported but at a reduction to a combination of the input signal range and IM correction limits.

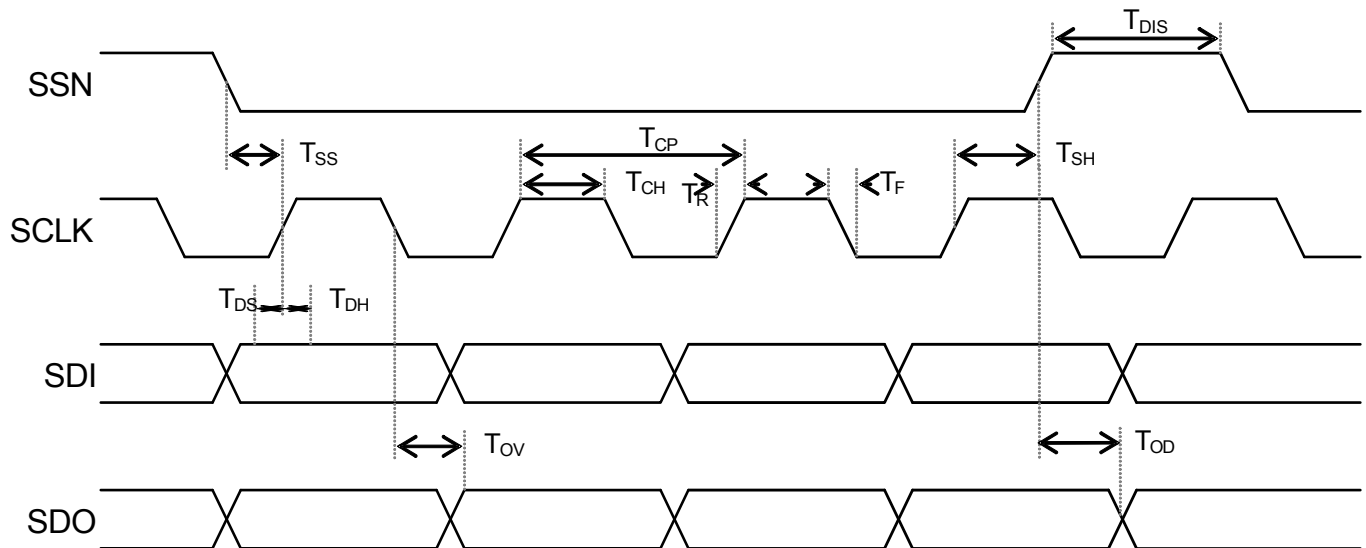
4 – CCDF = Complementary Cumulative Distribution Function; a measurement of peak to average ratio or crest factor.

5 – 60 MHz operation requires a fully occupied signal bandwidth. Otherwise, only 40 MHz is supported.

## DIGITAL I/O – DC CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
CMOS Input logic low	$V_{IL}$		-0.3		0.8	V
CMOS Input logic high	$V_{IH}$	$V_{DD} = 3.3V$	2.0			V
CMOS Output logic low	$V_{OL}$				0.4	V
CMOS Output logic high	$V_{OH}$	$V_{DD} = 3.3V$	2.4			V
CMOS Output Current	$I_{OL} / I_{OH}$				$\pm 1.0$	mA

## Serial Peripheral Interface (SPI) Bus Specifications



PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Select Setup Time	$T_{SS}$		30			ns
Select Hold Time	$T_{SH}$		70			ns
Select Disable Time	$T_{DIS}$		100			ns
Data Setup Time	$T_{DS}$		10			ns
Data Hold Time	$T_{DH}$		10			ns
Rise Time	$T_R$		25			ns
Fall Time	$T_F$		25			ns
Clock Period	$T_{CP}$		250			ns
Clock High Time	$T_{CH}$		125			ns
Time to Output Valid	$T_{OV}$				40	ns
Output Data Disable	$T_{OD}$				40	ns

Use of the SPI is optional as SC1887 is capable of fully autonomous operation. Use of the SPI interface offers the user access to certain monitoring and diagnostic functions as well as other planned advanced features. The SPI bus interface is also used to program the internal EEPROM, allowing field upgrades and firmware updates.

## Package Information

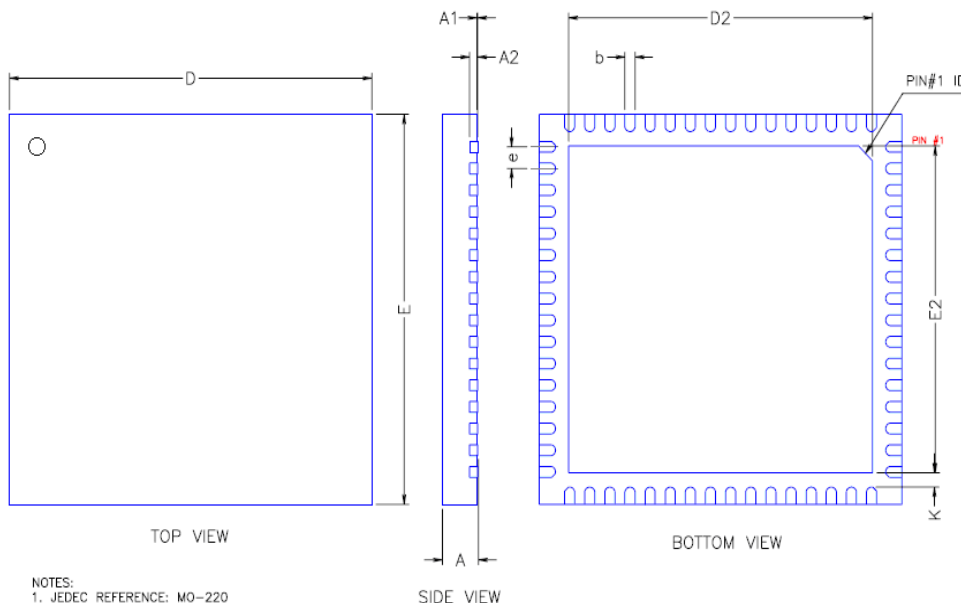
The device is offered in a 9mm x 9mm, 64-pin, QFN leadless package with a 0.5mm lead pitch. This package has an exposed ground paddle on the bottom of the package which must be soldered to the ground plane of the printed circuit board. The paddle is important for thermal dissipation as well as electrical grounding performance. The leads and the ground paddle are finished with 100% matte-Sn and constructed using Green materials and is RoHS compliant.

## THERMAL RESISTANCE CHARACTERISTICS

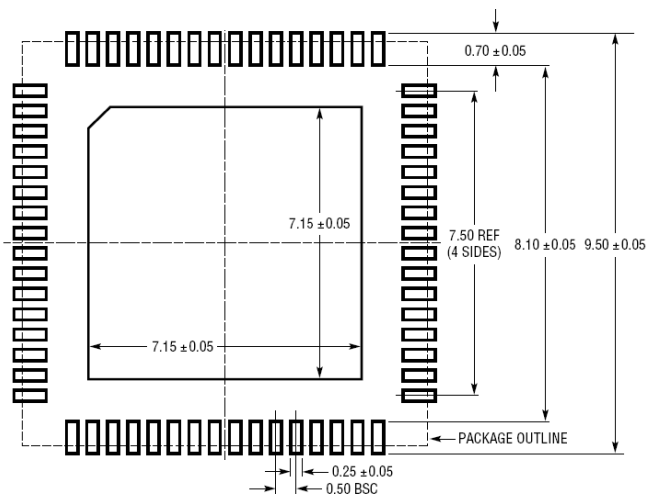
PARAMETER	SYMBOL	CONDITIONS	TYP	UNITS
Junction to Case Thermal Resistance	$\Theta_{JC}$	Still Air	0.8	°C/W

## RoHS PACKAGE MECHANICAL DIMENSIONS

COMMON DIMENSIONS				
DEFINITION	SYMBOL	64LD QFN 9.00x9.00		
		MIN	NOM	MAX
Overall Package Height	A [QFN]	0.85	0.90	0.95
Stand-off Height	A1	0.00	0.03	0.05
Lead Thickness	A2	0.25 REF		
Lead Width	b	0.20	0.25	0.30
Package Width	D	8.90	9.00	9.10
PAD Width	D2	7.50	7.55	7.60
Package Length	E	8.90	9.00	9.10
PAD Length	E2	7.50	7.55	7.60
Lead Pitch	e	0.50 BSC		
Pad-Lead Clearance	k	0.20	-	-
Lead Length	L	0.35	0.40	0.45
Lead Count	N	64		

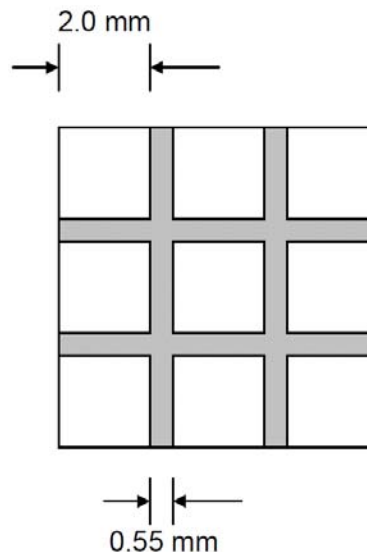


## PCB LAYOUT



RECOMMENDED SOLDER PAD PITCH AND DIMENSIONS  
APPLY SOLDER MASK TO AREAS THAT ARE NOT SOLDERED

## Recommended Solder Paste Pattern for GND Pad



## ESD Information



ESD (Electro-Static Discharge) sensitive device. Although this product incorporates ESD protection circuitry, permanent damage may occur on devices subjected to electrostatic discharges. Proper ESD precautions are recommended to avoid performance degradation or device failure.

### Electro-Static Discharge (ESD) Protection Characteristics

Test Methodology	Class	Voltage	UNIT
Human Body Model (per JESD22-A114)	1C	1000	V
Charge Device Model (per JESD22-C101)	II	200	V

### Moisture Sensitivity Level

Test Methodology	Rating	Package Peak Temperature	UNIT
Per JESD22-A113	3A	260	°C

## Product Ordering Information

SC1887 -FR   -FW

Frequency Range	Firmware
<b>04</b> = Low Band only (698-1000 MHz)	1221 = version 1.2.21
<b>07</b> = High Band only (1600-2800 MHz)	Optional, if omitted uses latest FW
May not omit this field.	

## Evaluation Kits Available

Part Number	Frequency Range
SC1887-EVK2200	2100-2700 MHz
SC1887-EVK1900	1800-2200 MHz
SC1887-EVK900	698-960 MHz