Rev 1.2; October 2011

SC1887-03: Adaptive RF Power Amplifier Linearizer

General Description

SC1887-03 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 SC1887-03 substantially increases power amplifier efficiency by reducing out-of-band energy. SC1887-03 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 SC1887-03 measures the feedback signal from the power amplifier output, and optimizes the correction function by minimizing distortion. SC1887-03 correction function is implemented and applied to the transmit signal using only RF-domain analog signal processing circuitry allowing the SC1887-03 to operate over a wide bandwidth at very low power consumption.

Features

- RF-in/RF-out integrated SoC in standard CMOS
- Low Power Consumption: 1W
- UHF Frequency Range: 470-862MHz
- Input Signal Bandwidth: up to 10 MHz
- Fully Adaptive Compensation
- Greater than 8dB ACLR improvement*
- Packaged in 9x9 mm QFN package
- Operating Case Temperature: -40 to +80^{o}C
- Fully RoHs compliant

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

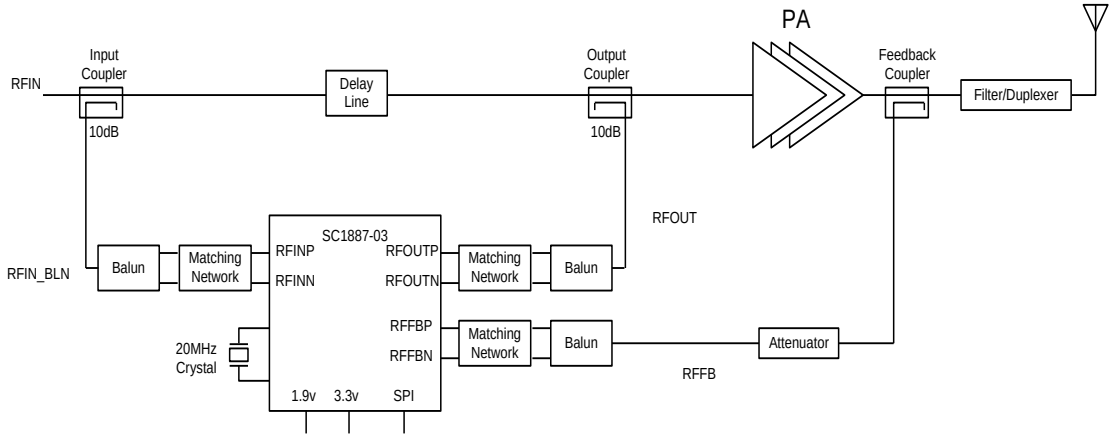
Applications

- DVB (T/H/T2), CMMB, DTMB, ISDB-T and ATSC
- Broadcast Infrastructure: Digital terrestrial UHF amplifiers, exciters, drivers and transmitters
- Class A/AB and Doherty amplifiers
- LDMOS and GaN amplifiers

Benefits

- Ease of use
  - Integrated RFin/RFout solution
  - Operates over entire UHF band
  - 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 power amplifiers down to 1W
- Smaller total system form factors
  - Reduced heat sink size and weight
  - Small implementation size (9 cm^2)
- Reduces operating costs
  - Reduces energy consumption supporting Green initiatives
  - Reduces amplifier power consumption and thermal dissipation
  - Increases amplifier reliability
- Reduces BOM costs
  - Reduced power supply & heat sink costs
  - Reduced back-off reduces transistor costs

Application Block Diagram

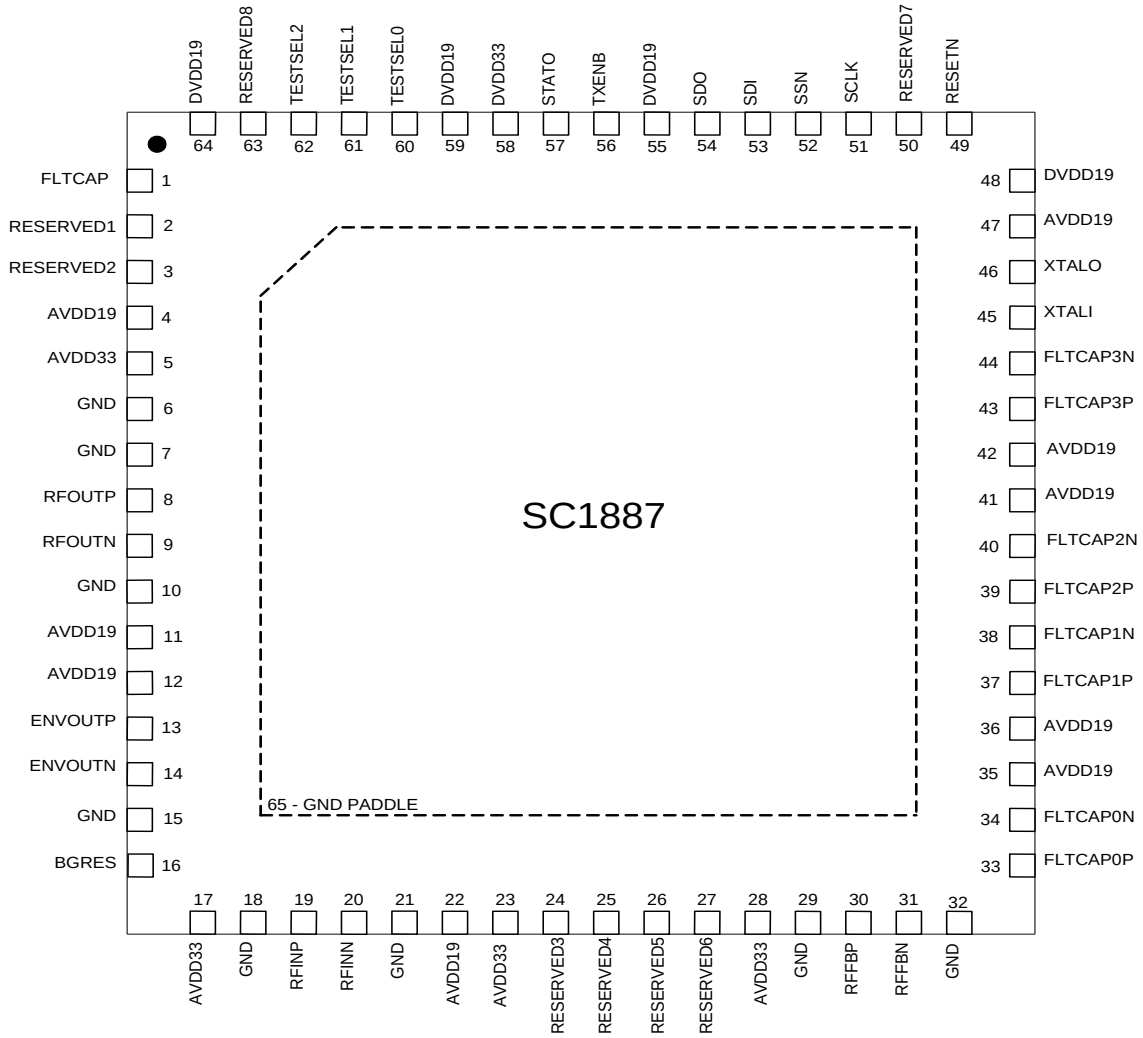


Introduction to Predistortion using the SC1887-03

Wideband signals in today's telecommunications systems have high peak-to-average ratios and stringent spectral regrowth specifications. These specifications place high linearity demands on power amplifiers. Linearity may be achieved by backing off output power at the price of reducing efficiency. However, this increases the component and operating costs of the power amplifier. Better linearity may be achieved through the use of digital pre-distortion and other linearization techniques, but many of these are time consuming and costly to implement.

With the SC1887-03, the complex signal processing is done in the RF domain. This results in a simple system-on-chip that offers wide signal bandwidth, broad frequency of operation, and very low power consumption. It is an elegant solution that reduces development costs and speeds time to market. Applicable across a broad range of digital broadcast standards — including DVB (T/H/T2), CMMB, DTMB, ATSC and ISDB-T — the powerful analog signal processing engine is capable of linearizing even the most efficient power amplifier topologies. The SC1887-03 is a true RFin and RFout solution, supporting modular power amplifier designs that are independent of the baseband and transceiver subsystems. The SC1887-03 delivers the required efficiency and performance demanded by today's broadcast systems.

Pinout Configuration (Top View)



Pin Description

PIN	NAME	TYPE	FUNCTION
1	FLTCAP	Analog In	Dedicated external filter capacitor. Connected to DVDD19 through 23.2Ω 1% resistor
2	RESERVED1	Reserved	Do not connect. Reserved for internal use.
3	RESERVED2	Reserved	Do not connect. Reserved for internal use.
4	AVDD19	Supply	+1.9V 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	AVDD19	Supply	+1.9V DC Supply Voltage for analog circuits. Required a 1000pF shunt capacitance near Pin connection
12	AVDD19	Supply	+1.9V 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/ºC 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	AVDD19	Supply	+1.9V 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 Out	Dedicated external filter capacitor #0
34	FLTCAP0N		
35	AVDD19	Supply	+1.9V DC Supply Voltage for analog circuits
36	AVDD19	Supply	+1.9V DC Supply Voltage for analog circuits
37	FLTCAP1P	Analog Out	Dedicated external filter capacitor #1
38	FLTCAP1N		
39	FLTCAP2P	Analog Out	Dedicated external filter capacitor #2
40	FLTCAP2N		
41	AVDD19	Supply	+1.9V DC Supply Voltage for analog circuits
42	AVDD19	Supply	+1.9V DC Supply Voltage for analog circuits
43	FLTCAP3P	Analog Out	Dedicated external filter capacitor #3
44	FLTCAP3N		
45	XTALI	Analog In	20 MHz clock reference from crystal or resonator.
46	XTALO	Analog Out	
47	AVDD19	Supply	+1.9V DC Supply Voltage for analog circuits. Required a 1000pF shunt capacitance near Pin connection
48	DVDD19	Supply	+1.9V DC Supply Voltage for digital circuits
49	RESETN	Digital In	Reset when "Low". Power-up sequence on á "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	DVDD19	Supply	+1.9V 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	DVDD19	Supply	+1.9V 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	DVDD19	Supply	+1.9V 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 (VDD19 to GND).....-0.2 to +2.2V
Input Voltage (1.9V pins).....-0.2 to VDD19 + 0.2V
Input Voltage (3.3V pins).....-0.3 to VDD33 + 0.3V
Input into the BALUN (RMS) .....+7dBm
Junction Temperature ..... +150ºC
Storage Temperature .....-65ºC to +150ºC
Lead Soldering Temperature (30 sec) ..... +260ºC
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 Case Temperature……-40ºC to +80ºC

DC Characteristics

PARAMETER	MIN	TYP	MAX	UNITS
Supply Voltage (VDD33 to GND)	3.1	3.3	3.5	V
Supply Voltage (VDD19 to GND)	1.8	1.9	2.0	V
Supply Peak Current[1] (VDD33 to GND)			150	mA
Supply Peak Current[1] (VDD19 to GND)			900	mA
Average Power Dissipation: Fully Adaptive-power		980		mW

1 – Peak Current includes supplied decoupling network

RADIO FREQUENCY SIGNALS

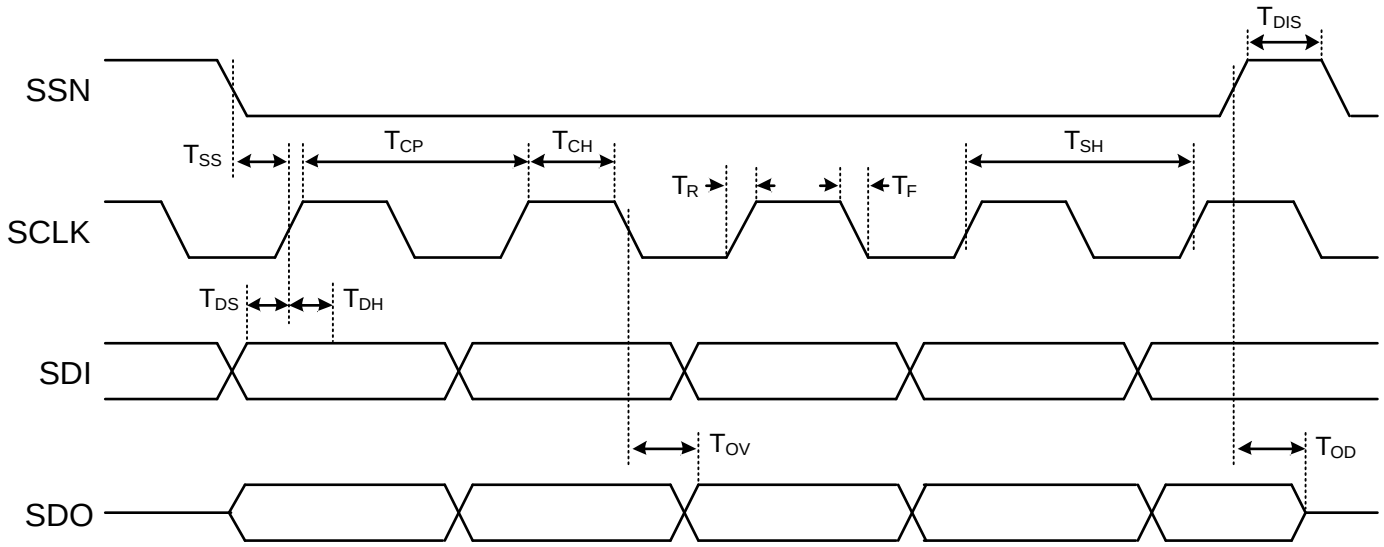
PARAMETER	SYMBOL	CONDITIONS	MIN	RECOMMENDED	MAX	UNITS
Operating Frequency	f	Ultra Low-Band	470		862	MHz
RFIN_BLN Peak Range (into the Balun) for Maximum Correction	$P_{RFIN\_BLN\_P}$	Peak Power[1]	-5	3	5	dBm
RFIN_BLN RMS Range (into the Balun) for Maximum Correction	$P_{RFIN\_BLN\_P}$	RMS Power[2]	-10	-7	-5	dBm
RFFB_BLN peak Range for Maximum Correction	$P_{RFFB\_BLN\_P}$	Peak Power[1]	-14	-4	-2	dBm
RFFB_BLN RMS Range for Maximum Correction	$P_{RFFB\_BLN\_P}$	RMS Power[2]	-19	-14	-12	dBm
RFIN_BLN Operating Range (into the Balun) [2]	$P_{RFIN\_BLN\_R}$	RMS Power	-40		-5	dBm
RFFB_BLN Operating Range[2]	$P_{RFFB\_BLN\_R}$	RMS Power	-45		-12	dBm
Input Signal Bandwidth	BW_{signal}	Wideband Modulation	1.2		10	MHz
Noise Power at RFOUT[3]		Out of Balun			-125	dBm/Hz

1 –Peak Power = RMS Power + Peak to Average Ratio (PAR)
2 – Assuming 5 to 10dB PAR.
3 – Worst case over PVT under typical input power and correction conditions.

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}	VDD = 3.3V	2.0			V
CMOS Output logic low	V_{OL}				0.4	V
CMOS Output logic high	V_{OH}	VDD = 3.3V	2.4			V
CMOS Output Current	I_{OL} / I_{OH}				±1.0	mA

Serial Peripheral Interface (SPI) Bus Specifications



PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Select Setup Time	T_{SS}		100			ns
Select Hold Time	T_{SH}		250			ns
Select Disable Time	T_{DIS}		100			ns
Data Setup Time	T_{DS}		25			ns
Data Hold Time	T_{DH}		45			ns
Rise Time	T_R				25	ns
Fall Time	T_F				25	ns
Clock Period	T_{CP}		250			ns
Clock High Time	T_{CH}		100			ns
Time to Output Valid	T_{OV}				100	ns
Output Data Disable	T_{OD}				0	ns

Use of the SPI is optional as SC1887-03 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.

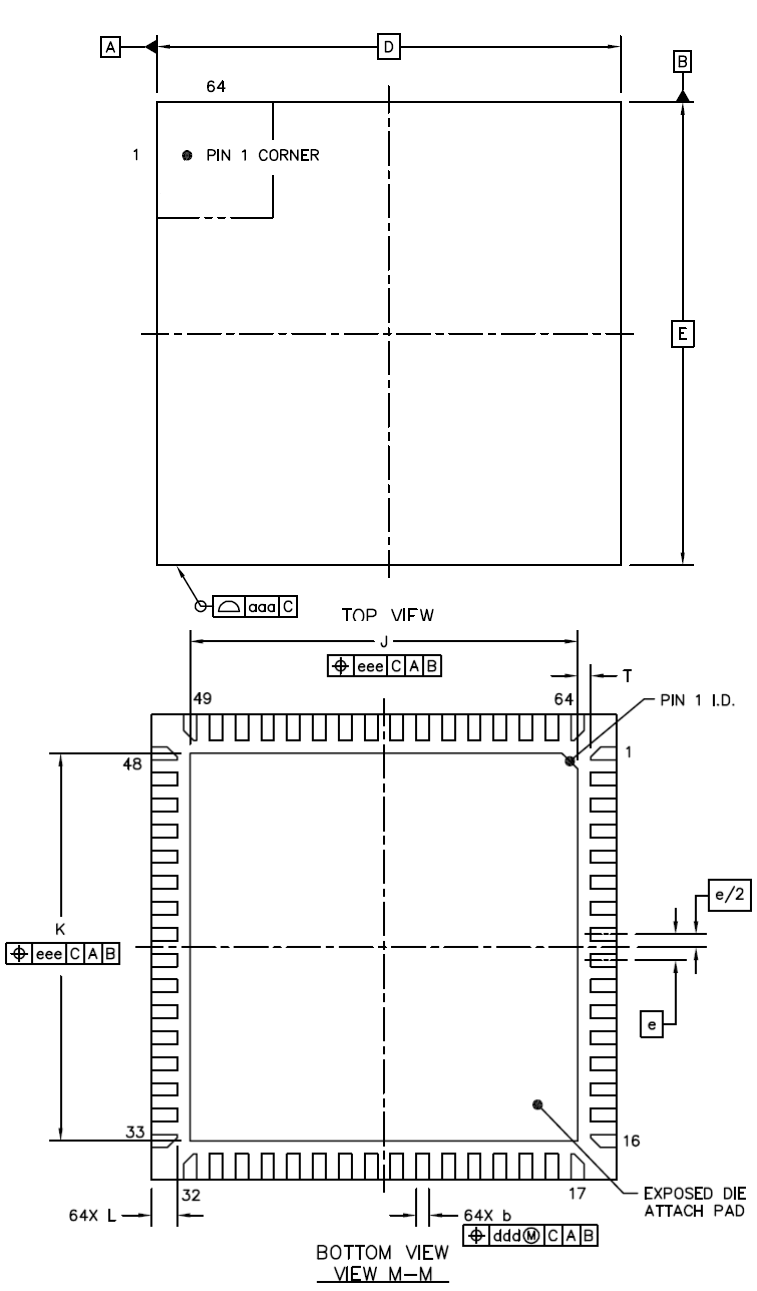
Package Information

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	Θ_{JC}	Still Air	0.8	ºC/W

RoHS PACKAGE MECHANICAL DIMENSIONS

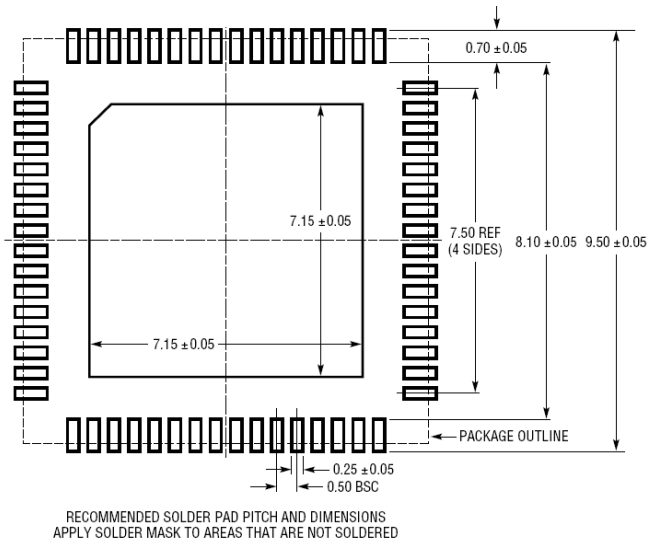


		SYMBOL	MIN	NOM	MAX
TOTAL THICKNESS		A	0.8	0.85	0.9
STAND OFF		A1	0	0.035	0.05
MOLD THICKNESS		A2	---	0.65	0.67
L/F THICKNESS		A3		0.203 REF	
LEAD WIDTH		b	0.2	0.25	0.3
BODY SIZE	X	D		9 BSC	
	Y	E		9 BSC	
LEAD PITCH		e		0.5 BSC	
EP SIZE	X	J	7.4	7.5	7.6
	Y	K	7.4	7.5	7.6
LEAD LENGTH		L	0.45	0.5	0.55
PACKAGE EDGE TOLERANCE		aaa		0.1	
MOLD FLATNESS		bbb		0.1	
COPLANARITY		ccc		0.08	
LEAD OFFSET		ddd		0.1	
EXPOSED PAD OFFSET		eee		0.1	
		T	0.15	0.25	0.35

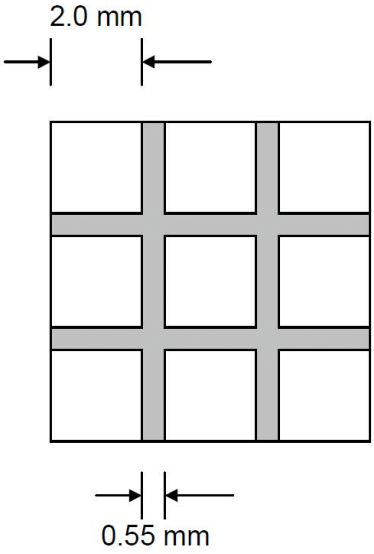
NOTES

1.0 COPLANARITY APPLIES TO LEADS, CORNER LEADS AND DIE ATTACH PAD.

PCB LAYOUT



Recommended Solder Paste Pattern for GND Pad



Top Mark

Line	Top Mark	Description
1	SCINTERA	Company Name
2	SC1887	Product Part Number
3	XXXXXXXXXX	Foundry Lot Number (up to 10 characters)
4	WW YY RRRR	Date Code - Work Week Date Code - Year Reserved

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	250	V

Moisture Sensitivity Level

Test Methodology	Rating	Package Peak Temperature	UNIT
Per JESD22-A113	3	260	ºC

Product Ordering Information

Part Number	Description
SC1887A-03A00	IC, RFPAL, Frequency range (470-862MHz), FW revision (1.2.40)

Shipping designator:
E = 7” tape & reel
Append shipping designator (E) at end of part number. If left blank, designates bulk shipping option.

Evaluation Kit Ordering Information

Part Number	Description
SC1887-EVK500	Eval Kit, Frequency range (470-862MHz)
SC-USB-SPI	Adapter, SPI-USB Interface/Controller

For More Information Contact Scintera:
1154 Sonora Court, Sunnyvale, CA 94086 • 408-636-2600 • http://www.scintera.com