SC1889: Adaptive RF Power Amplifier Linearizer & Dual RMS Power Measurement Unit (PMU)

General Description

The SC1889 is part of Scintera's 2nd generation RF PA linearizer (RFPAL) family providing increased ACLR correction over the previous generation as well as support for EVDO, TD-SCDMA, WiMAX, HSDPA, LTE and TD-LTE waveforms. The SC1889 is a fully-adaptive, RFin / RFout predistortion linearization solution that precisely compensates RF power amplifier (PA) non-linearities including AM/AM and AM/PM distortion, spectral regrowth, memory effects and other system level impairments.

The SC1889 substantially increases the final stage PA efficiency by reducing out-of-band energy. The SC1889 is a complete system-on-chip (SoC) solution optimized for Class A/AB and Doherty RF power amplifiers operating at a power level of 5 W to 60 W (RMS). The SC1889 measures the feedback signal from the power amplifier output, and optimizes the correction function by minimizing distortion. SC1889 correction function is generated using RF-domain analog signal processing allowing the SC1889 to operate over a wide bandwidth at very low power consumption.

Features

SC1889 (PC = 00): RFPAL

- RFin/RFout PA linearizer SoC in standard CMOS
- Fully Adaptive Compensation
- Low Power Consumption:
  - Duty cycled (9 %) feedback: 420 mW
  - Full adaptation: 1.06 W
- Frequency Range: 698 MHz - 2800 MHz
- Input Signal Bandwidth: up to 60 MHz
- Up to 28 dB ACLR & 38 dB IMD improvement*
- Packaged in 9x9 mm QFN package
- Operating Case Temperature: -40 °C to +100 °C
- Fully RoHS compliant, Green Materials
- Pin compatible with SC1887 and SC1869

* Performance dependent on amplifier, bias & waveform

SC1889 (PC = 11): RFPAL + PMU (optional) *

- Dual rms power detection unit (RFIN and RFFB)
  - 30 dB of dynamic range
  - ± 0.10 dB typical accuracy (top 20 dB)
  - ± 0.50 dB typical accuracy (bottom 10 dB)
- Frequency Range: 698 MHz - 2200 MHz

* Refer to SC18X9-PMU0011 datasheet for detailed specifications.

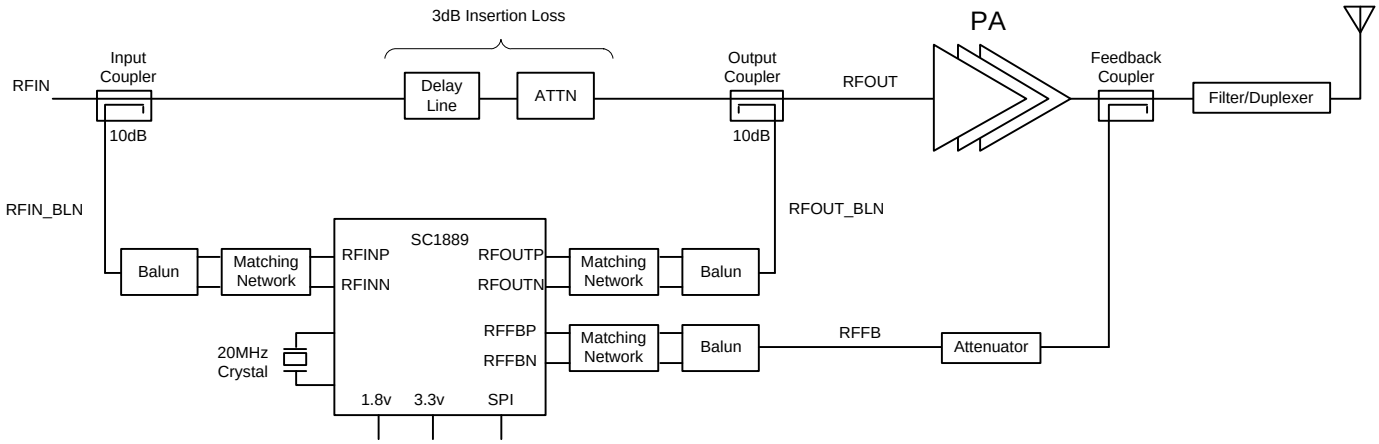
Applications

- Cellular infrastructure
  - Single/multi-carrier, multi-standard: WCDMA/EVDO, TD-SCDMA, WiMAX, WCDMA/HSDPA, LTE & TD-LTE
  - Traditional in-cabinet BTS amplifiers, RRU, tower mounted power amplifiers, microwave backhaul, booster amplifiers, microcells, picocells, DAS, AAS and MIMO systems
- Other applications
  - Software defined radios (SDR), mobile military communications and TV white space
  - Any application requiring PA linearization
- Wide range of PAs and output power
  - Amplifier: Class A/AB and Doherty
  - PA output power: up to 60 W (RMS)
  - PA Process: LDMOS, GaAs and GaN

Benefits

- Ease of use
  - Integrated RFin/RFout solution
  - Operates over wide frequency 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
- 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 and total volume
  - Power supply, heat sink and enclosure
  - Reduced back-off reduces transistor costs

Application Block Diagram



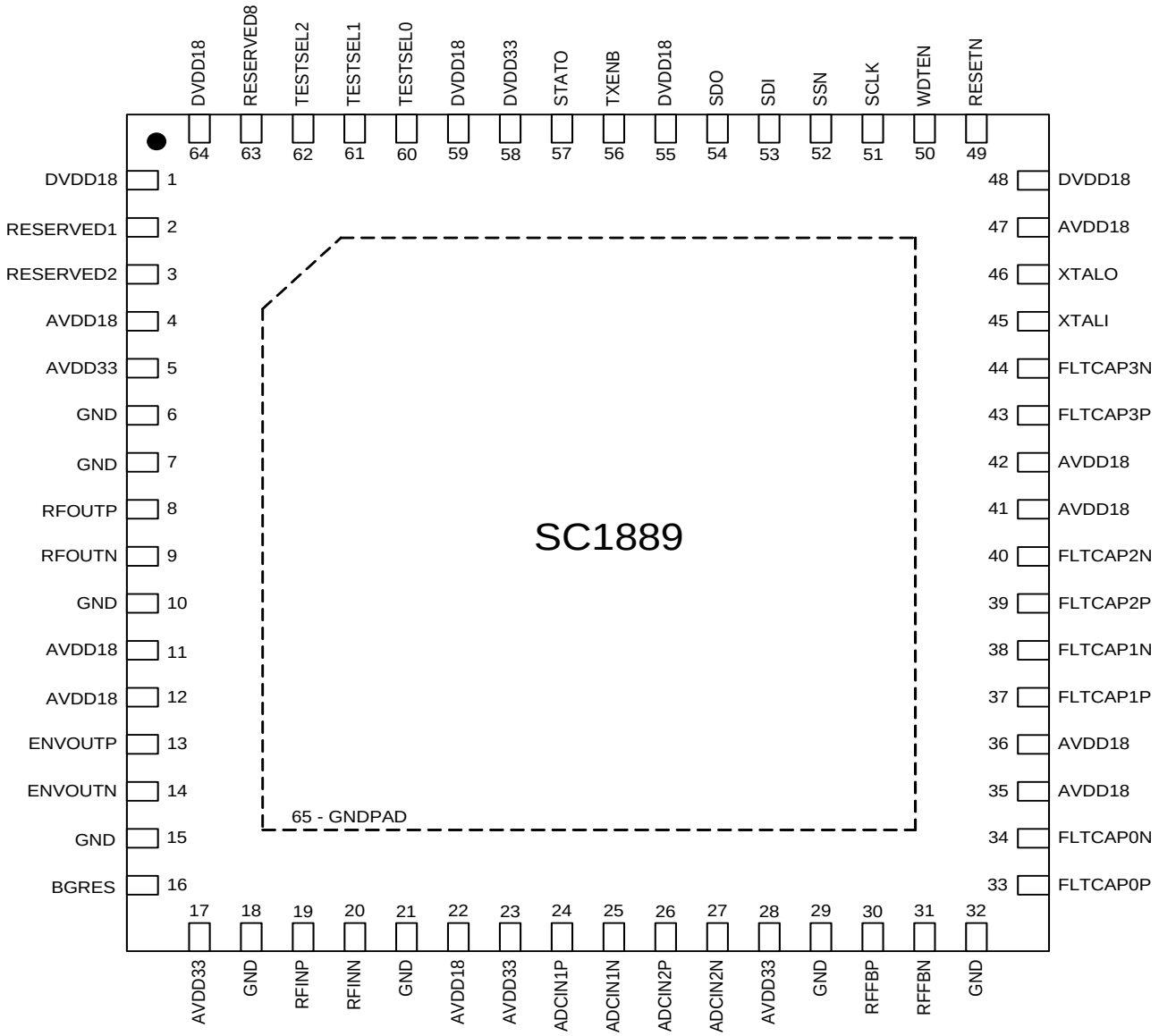
Introduction to Predistortion using the SC1889

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.

Wireless service providers are deploying networks with wider coverage, greater subscriber density, and higher data rates. These networks require more efficient power amplifiers. Additionally, the emergence of distributed architectures and active antenna systems is driving the need for smaller and more efficient power amplifier implementations. Further, there continues to be a strong push toward reducing the total capital and operating costs of base stations.

With the SC1889, the complex signal processing is done in the RF domain resulting 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 signals — including 2G, 3G, 4G wireless, and other modulation types — the powerful analog signal processing engine is capable of linearizing the most efficient power amplifier topologies. The SC1889 is a true RFin and RFout solution, supporting modular power amplifier designs that are independent of the baseband and transceiver subsystems. The SC1889 delivers the required efficiency and performance demanded by today's wireless systems.

Pinout Configuration (Top View)



Pin Description

PIN	NAME	TYPE	FUNCTION
1	DVDD18	Supply	+1.8V DC Supply Voltage for digital circuits.
2	RESERVED1	Analog Out Reserved	Do not connect. Reserved for internal use.
3	RESERVED2	Analog Out Reserved	Do not connect. Reserved for internal use.
4	AVDD18	Supply	+1.8V DC Supply Voltage for analog circuits.
5	AVDD33	Supply	+3.3V DC Supply Voltage for analog circuits.
6	GND	Supply	Ground.
7	GND	RF Shield	Ground for shield of RF signal.
8	RFOUTP	Analog Out	RF Output Signal, differential output. See S-parameters for complex impedance values.
9	RFOUTN		
10	GND	RF Shield	Ground for shield of RF signal.
11	AVDD18	Supply	+1.8V DC Supply Voltage for analog circuits.
12	AVDD18	Supply	+1.8V DC Supply Voltage for analog circuits.
13	ENVOUTP	Analog Out Reserved	Envelope Out. Do not connect. Reserved for future use.
14	ENVOUTN		
15	GND	Supply	Ground.
16	BGRES	Analog In	Bandgap Resistor.
17	AVDD33	Supply	+3.3V DC Supply Voltage for analog circuits.
18	GND	RF Shield	Ground for shield of RF signal.
19	RFINP	Analog In	RF Input Signal, differential input. See S-parameters for complex impedance values.
20	RFINN		
21	GND	RF Shield	Ground for shield of RF signal.
22	AVDD18	Supply	+1.8V DC Supply Voltage for analog circuits.
23	AVDD33	Supply	+3.3V DC Supply Voltage for analog circuits.
24	ADCIN1P	Analog In Reserved	Do not connect. Reserved for future use. Low frequency ADC#1 positive analog input (requires separate FW activation).
25	ADCIN1N		Do not connect. Reserved for future use. Low frequency ADC#1 negative analog input (requires separate FW activation).
26	ADCIN2P	Analog In Reserved	Do not connect. Reserved for future use. Low frequency ADC#2 positive analog input (requires separate FW activation).
27	ADCIN2N		Do not connect. Reserved for future use. Low frequency ADC#2 negative analog input (requires separate FW activation).
28	AVDD33	Supply	+3.3V DC Supply Voltage for analog circuits.
29	GND	RF Shield	Ground for shield of RF signal.
30	RFFBP	Analog In	RF Feedback Signal, differential input. See S-parameters for complex impedance values.
31	RFFBN		
32	GND	RF Shield	Ground for shield of RF signal.

PIN	NAME	TYPE	FUNCTION
33	FLTCAP0P	Analog Out	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 Out	Dedicated external filter capacitor #1.
38	FLTCAP1N		
39	FLTCAP2P	Analog Out	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 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	AVDD18	Supply	+1.8V DC Supply Voltage for analog circuits.
48	DVDD18	Supply	+1.8V DC Supply Voltage for digital circuits.
49	RESETN	Digital In	Reset when "Low". Has internal pull-up to DVDD33.
50	WDTEN	Digital In	Watch Dog Timer Enable. WDTEN enabled when high. Has internal pull-up to DVDD33. See applications schematic for further details.
51	SCLK	Digital In	SPI clock. Has internal pull-down to GND.
52	SSN	Digital In	SPI slave select enabled "Low". Has internal pull-up to DVDD33.
53	SDI	Digital In	SPI slave data input to RFPAL. Has internal pull-down to GND.
54	SDO	Digital Out	SPI slave data output from RFPAL. Tri-state. DVDD33 logic.
55	DVDD18	Supply	+1.8V DC Supply Voltage for digital circuits.
56	TXENB	Digital In Reserved	Transmit Enable. Do not connect. Reserved for future use. Has internal pull-up to DVDD33. See applications schematic for further details.
57	STATO	Digital Out	General purpose Status Output as defined in Firmware Release Notes. Open-drain output with internal pull-up to DVDD33.
58	DVDD33	Supply	+3.3V DC Supply Voltage for digital circuits.
59	DVDD18	Supply	+1.8V DC Supply Voltage for digital circuits.
60	TESTSEL0	Digital In	Test Select 0. Required for FW upgrades. Has internal pull-down to GND. See applications schematic for further details.
61	TESTSEL1	Digital In Reserved	Do not connect. Reserved for internal use. Has internal pull-up to DVDD33.
62	TESTSEL2	Digital In Reserved	Do not connect. Reserved for internal use. Has internal pull-up to DVDD33.
63	RESERVED8	Digital In Reserved	Do not connect. Reserved for internal use. Has internal pull-up to DVDD33.
64	DVDD18	Supply	+1.8V DC Supply Voltage for digital circuits.
65	GNDPAD	Supply	Common Ground for entire integrated circuit. Also provides path for thermal dissipation.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (VDD33 to GND).....-0.3 V to +3.8 V
Supply Voltage (VDD18 to GND).....-0.2 V to +2.2 V
Input Voltage (1.8 V pins).. -0.2 V to VDD18 + 0.2 V
Input Voltage (3.3 V pins).. -0.3 V to VDD33 + 0.3 V
Input into the BALUN (RMS) .....+7 dBm
Junction Temperature ..... +150 ºC
Storage Temperature .....-65 ºC to +150 ºC

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……-40 ºC to +100 ºC

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 (VDD33 to GND)[1,2,3, 5]		59		mA
Supply Peak Current (VDD18 to GND)[1,2,3, 5]		592		mA
Average Power Dissipation: Full Scale Adaptation, Track & PMU[3, 5]		1060		mW
Average Power Dissipation: Duty Cycled Feedback[2,4,5]		420		mW

1 – Peak Current includes supply decoupling network. Refer to Hardware Design Guide for proper sizing of the on board-regulators.
2 – Characterized at typical voltages, 25°C operating case temperature and 20MHz input signal BW.
3 – Continuous adaptation, tracking (100% duty cycled feedback) & power measurement unit active or inactive.
4 – Duty cycled feedback power dissipations averaged over ON time of 100ms (9%) and OFF time of 1.024s (91%).
5 – Power dissipation may be FW dependent. Refer to the FW release notes for any changes to values listed above.

RADIO FREQUENCY SIGNALS

PARAMETER	SYMBOL	CONDITIONS	MIN	RECOMMENDED	MAX	UNITS
Operating Frequency[1]	F		698		2800	MHz
RFIN_BLN Range for Maximum Correction	$P_{RFIN\_BLN\_P}$	Peak Power	-4	4	6	dBm
RFIN_BLN Range for Maximum Correction	P_{RFIN_BLN}	RMS Power[2]	-9	-6	-4	dBm
RFFB_BLN Range for Maximum Correction	$P_{RFFB\_BLN\_P}$	Peak Power	-14	-4	-2	dBm
RFFB_BLN Range for Maximum Correction	P_{RFFB_BLN}	RMS Power[2]	-19	-14	-12	dBm
RFIN_BLN Operating Range	P_{RFIN_BLN}	RMS Power[2]	-40		-4	dBm
RFFB_BLN Operating Range	P_{RFFB_BLN}	RMS Power[2]	-45		-12	dBm
RF input signal Peak-to Avg. Ratio[3]	PAR_{IN}	CCDF[4] Probability=10^{-4}		5 to 10		dB
Input Signal Bandwidth	BW_{signal}		1.2		40 or 60[5]	MHz
Noise Power[6]		Referred to 0dBm at PA input		-138	-135	dBm/Hz

1 – See Operating Frequency Ranges table below for frequency limits of each defined band.
2 – A Peak to Average Ratio (PAR) of 5 to 10 dB is used for this table.
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 – > 40 MHz operation requires a fully occupied signal bandwidth.
6 – Worst case over PVT.

OPERATING FREQUENCY RANGES

FREQUENCY RANGE[1]	RECOMMENDED APPLICATIONS	DESIGNATION
698 MHz to 960 MHz	Low band cellular (698 MHz to 960 MHz)	-04
800 MHz to 1450 MHz	IF for SATCOMM (1000 MHz to 1400 MHz)	-05
1350 MHz to 2450 MHz	LTE for Japan (1400 MHz to 1510MHz)	-06
1600 MHz to 2800 MHz	High Band cellular (1600 MHz to 2800 MHz)	-07

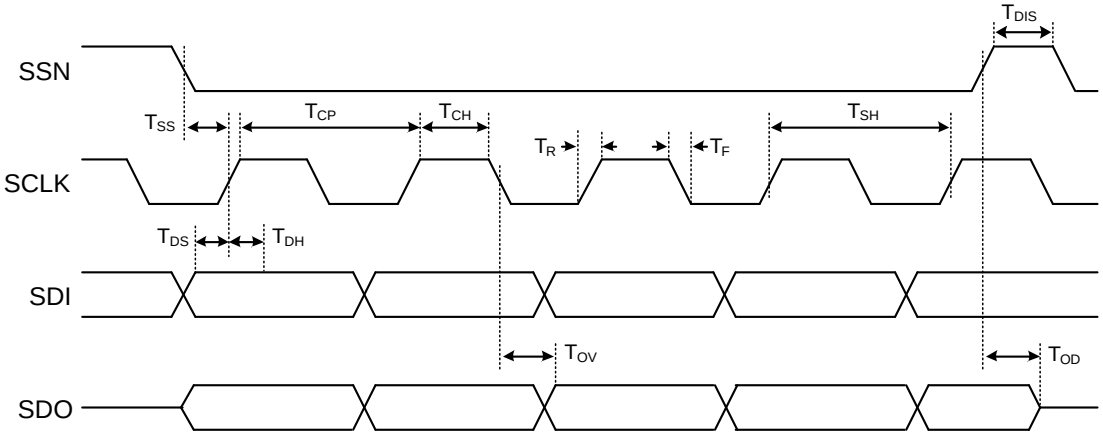
1 – Default is -07. May be reprogrammed by user for other ranges listed above. Refer to design guide for programming information.

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
SDO CMOS Output Current	I_{OL} / I_{OH}	Tri-State	-4.0		4.0	mA
STATO CMOS Output Current	I_{OL} / I_{OH}	Open Drain	-4.0		0.0	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 SC1889 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 changes to the operating frequency range, field upgrades and firmware updates.

CRYSTAL REQUIREMENTS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
ESR					50	Ω
Capacitive load to ground				10	12	pF
Frequency Accuracy					250	ppm
Frequency Drift		Including aging and temperature			100	ppm

Top Mark

LINE	TOP MARK	DESCRIPTION
1	SCINTERA	Company Name
2	SC1889	Product Part Number
2	A	Product Revision
2	-11	Product Configuration (PC): BLANK = RFPAL Base Configuration -11 = RFPAL + PMU configuration
3	XXXXXXXXXX	Foundry Lot Number (up to 10 characters)
4	WW	Date Code - Work Week
4	YY	Date Code - Year
4	RRRR	Reserved

ESD

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

Package Information

Specifications regarding the 64-pin, 9mm x 9mm QFN package and the recommended solder pad layout are available online at http://www.scintera.com/pdfs/64p-9x9QFN-package-and-solder-pad-information.pdf.

Additional information regarding quality, reliability, package and environmental information can be found online at http://www.scintera.com/resource-center/quality-reliability-package-environmental-information/.

Product Ordering Information

PART NUMBER	DESCRIPTION
SC1889A-00A00	IC, RFPAL, 698-2800 MHz, FW3.0.11
SC1889A-00B00	IC, RFPAL, 698-2800 MHz, FW3.0.17.01
SC1889A-00B11	IC, RFPAL+PMU, 698-2800 MHz, FW3.0.17.01

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
SC1889-EVK900	Eval Kit, RFPAL, 698-960 MHz
SC1889-EVK1500	Eval Kit, RFPAL, 1400-1800 MHz
SC1889-EVK1900	Eval Kit, RFPAL,1800-2200 MHz
SC1889-EVK2200	Eval Kit, RFPAL, 2100-2800 MHz
SC-USB-SPI	Adapter, SPI-USB Interface/Controller

EVKs will ship with most recent release of FW with all functions enabled.

For More Information Contact Scintera:
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