SC1889-PMU0011
Dual RMS Power Measurement Unit for SC1889

General Description

Specifically designed to address the demanding requirements of cellular infrastructure applications, the RFPAL™ PMU ensures very accurate RF power measurements over a wide range of operating conditions with no increase in footprint or added external bill of material (BoM). With a single point of calibration performed at the OEM factory, the RFPAL PMU provides an absolute accuracy (typical) of ±0.1dB over the first 20dB of the input range and ±0.5dB over the last 10dB of input range for both the RFIN and RFFB inputs (measured at the balun). The RFPAL PMU greatly simplifies the overall system design by providing all measurements as digital codes that can be easily read through the SPI bus.

Applications

- Transmit Power Control (TPC)
- Power Amplifier Gain Measurement
- Transmit Power Distribution Function
- Transmitter Signal Strength Indication (TSSI)
- System Monitoring

Features

- Dual RMS Power Measurement Unit (PMU)
  - RFIN
  - RFFB
- Input Dynamic Range of 30dB in 50Ω
- Accurate RMS-to-Digital Conversion
  - Operation from 698MHz to 2200MHz
  - ±0.1dB Accuracy (Top 20dB)
  - ±0.5dB Accuracy (Bottom 10dB)
- Waveform and Modulation Independent
- Low Measurement Error Over Entire Power Range
- Single-Point Power Calibration
- Simultaneous RFIN and RFFB Measurements for PA Gain Measurement

Benefits

- Integrated RFPAL + PMU Function:
  - SC1889A-00B11
- No Additional External Components or Increased Footprint Over Existing RFPAL Implementation
- Accurate Direct RMS-to-Digital Conversion with Single Point Calibration at OEM Factory
- Easily Compensate for Tx/Rx Duty-Cycle Changes
- Flat Error Function vs. Power (No Ripple Effect Due to Log-Amplifier Saturation)

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Applications Block Diagram

Refer to the appropriate IC data sheet for application block diagram. PMU function requires no change in base RFPAL schematic, layout, or bill of material.

Pin Configuration (Top View)

Refer to the appropriate IC data sheet for the pin configuration. PMU function requires no change in base RFPAL schematic, layout, or bill of material.

Electrical Characteristics

All electrical characteristics are defined within the appropriate IC data sheet, unless specified below.

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[1,2,3] (VDD33 to GND)		59		mA
Supply Peak Current[1,2,3] (VDD18 to GND)		592		mA
Average Power Dissipation: Power Measurement[3,4]		1060		mW

Note 1: Peak current includes supply decoupling network. Refer to Hardware Design Guide for sizing of on-board regulators.
Note 2: Characterized at typical voltages, 25°C operating case temperature and 20MHz input signal BW.
Note 3: Power measurement updated every 300ms. The integration time (measurement window) fixed to 40ms.
Note 4: Average power dissipation is based on FW3.0.17.

POWER MEASUREMENT UNIT

(V_{AVDD18} = 1.8V, V_{AVDD33} = 3.3V, V_{DVDD18} = 1.8V, operation at T_A = +25°C, unless otherwise specified.)

PARAMETER	SYMBOL	CONDITIONS[1, 2]	MIN	TYP	MAX	UNITS
Frequency Range[3]			698		2200	MHz
RFIN_BLN Range[4]		RMS power, referred to 50Ω impedance into a 1:2 balun	-34		-4	dBm
RFFB_BLN Range[4]		RMS power, referred to 50Ω impedance into a 1:2 balun	-42		-12	dBm
RFIN_BLN Log Slope	$\mu RFIN_{slope}$	Linear regression between -4 and -24dBm, 100 readings		341.3		LSB/dB
RFFB_BLN Log Slope	$\mu RFFB_{slope}$	Linear regression between -12 and -32dBm, 100 readings		341.3		LSB/dB
RFIN_BLN Log Slope Variation	$\sigma RFIN_{slope}$	Linear regression between -4 and -24dBm, 100 readings		±1.2		LSB/dB
RFFB_BLN Log Slope Variation	$\sigma RFFB_{slope}$	Linear regression between -12 and -32dBm, 100 readings		±1.2		LSB/dB

Note 1: Test conditions: 2-tone CW (3dB PAR), 5MHz bandwidth, and centered at 2140MHz, unless otherwise specified.
Note 2: Power measurement updated every 300ms. The integration time (measurement window) fixed to 40ms.
Note 3: For operation above 2200MHz, contact factory.
Note 4: RMS power (MAX) + peak to average ratio (PAR) must not exceed the peak power limits specified in the respective IC data sheets. As long as this condition is met, there is no limitation on the maximum PAR.

POWER MEASUREMENT UNIT (continued)

(V_{AVDD18} = 1.8V, V_{AVDD33} = 3.3V, V_{DVDD18} = 1.8V, operation at T_A = +25°C, unless otherwise specified.)

PARAMETER	SYMBOL	CONDITIONS[1, 2]		MIN	TYP	MAX	UNITS
RFIN_BLN Log Intercept	$\mu RFIN_{intercept}$	Linear regression between -4 and -24dBm			-14.4		dBm
RFFB_BLN Log Intercept	$\mu RFFB_{intercept}$	Linear regression between -12 and -32dBm			-4.4		dBm
RFIN_BLN Log Intercept Variation	$\sigma RFIN_{intercept}$	Linear regression between -4 and -24dBm, 100 readings of single IC			±0.12		dB
RFFB_BLN Log Intercept Variation	$\sigma RFFB_{intercept}$	Linear regression between -12 and -32dBm, 100 readings of single IC			±0.12		dB
RFIN_BLN Error as Referred to Best-Fit Line[3]		-4dBm to -24dBm		-0.25		+0.25	dB
		-24dBm to -34dBm		-1.5		+1.5	
RFFB_BLN Error as Referred to Best-Fit Line[3]		-12dBm to -32dBm		-0.30		+0.30	dB
		-32dBm to -42dBm		-1.5		+1.5	
RFIN_BLN, RFFB_BLN Deviation from 2-Tone CW Response		6.5dB PAR (WCDMA 1 carrier)			±0.1		dB
		10dB PAR (WCDMA 1 carrier)			±0.1		
		9.1dB PAR (WCDMA 12 carriers)			±0.1		
RFIN_BLN Deviation vs. Temperature[4]		Deviation from output at +25°C, −40°C < T_{CASE} < +100°C	RFIN_BLN = −4dBm	-0.55	±0.1	+0.55	dB
			RFIN_BLN = −24dBm	-0.55	±0.1	+0.55	
			RFIN_BLN = −34dBm	-1.5	±0.5	+1.5	
RFFB_BLN Deviation vs. Temperature[4]		Deviation from output at +25°C, −40°C < T_{CASE} < +100°C	RFFB_BLN = −12dBm	-0.35	±0.1	+0.35	dB
			RFFB_BLN = −32dBm	-0.35	±0.1	+0.35	
			RFFB_BLN = −42dBm	-1.5	±0.5	+1.5	

Note 1: Test conditions: 2-tone CW (3dB PAR), 5MHz bandwidth, and centered at 2140MHz, unless otherwise specified.
Note 2: Power measurement updated every 300ms. The integration time (measurement window) fixed to 40ms.
Note 3: Tested in production.
Note 4: Guaranteed by bench characterization.

POWER MEASUREMENT UNIT (continued)
(V_{AVDD18} = 1.8V, V_{AVDD33} = 3.3V, V_{DVDD18} = 1.8V, operation at T_A = +25°C, unless otherwise specified.)

PARAMETER	SYMBOL	CONDITIONS[1, 2]		MIN	TYP	MAX	UNITS
(RFIN_BLN) – (RFFB_BLN) Log Slope	μRFIN-$RFFB_{slope}$				0		LSB/dB
(RFIN_BLN) – (RFFB_BLN) Log Slope Variation	σRFIN-$RFFB_{slope}$				±1.2		LSB/dB
(RFIN_BLN) – (RFFB_BLN) Error as Referred to Best-Fit Line[3]		RFIN_BLN range (RFFN_BLN = RFIN_BLN – 7dB)	-4dBm to -24dBm	-0.30		+0.30	dB
			-24dBm to -34dBm	-1.5		+1.5	
(RFIN_BLN) – (RFFB_BLN) Deviation from 2-Tone CW Response		6.5dB PAR (WCDMA 1 carrier)			±0.1		dB
		10dB PAR (WCDMA 1 carrier)			±0.1		
		9.1dB PAR (WCDMA 12 carriers)			±0.1		
(RFIN_BLN) – (RFFB_BLN) Deviation vs. Temperature[4]		Deviation from output at 25°C, $-40°C < T_{CASE} < +100°C$	RFIN_BLN = −4dBm	-0.50	±0.1	+0.50	dB
			RFIN_BLN = −24dBm	-0.50	±0.1	+0.50	
			RFIN_BLN = −34dBm	-1.5	±0.5	+1.5	

Note 1: Test conditions: 2-tone CW (3dB PAR), 5MHz bandwidth and centered at 2140MHz, unless otherwise specified.
Note 2: Power measurement updated every 300ms. The integration time (measurement window) fixed to 40ms.
Note 3: Tested in production.
Note 4: Guaranteed by bench characterization.

Analysis

The RFIN and RFFB log slope and intercept are derived using a linear regression performed on data collected under nominal operating conditions. The error from linear response to the CW waveform is the dB difference in output from the ideal output. This is a measure of the linearity of the device response to both CW and modulated waveforms. Error from the linear response to the CW waveform is a measure of relative accuracy because the system has yet to be calibrated. However, it verifies the linearity and the effect of modulation on the device response. Error from the 25°C performance uses the performance of a given device and waveform type as the reference. This error is largely dominated by output variations associated with temperature.

The PMU codes are represented as 16-bit signed integer and are converted to dBm (referenced to the balun input) using the following formula:

For RFIN:

$$P[Balun](dBm) = \frac{RFIN\ PMU\ (Code) * 3.01}{1024} + OFFSET_{RFIN}(dBm)$$

For RFFB:

$$P[Balun](dBm) = \frac{RFFB\ PMU\ (Code) * 3.01}{1024} + OFFSET_{RFFB}(dBm)$$

The $OFFSET_{RFIN}$ and $OFFSET_{RFFB}$ are dependent on end system characteristics and also on the part-to-part variation of the RFPAL. For absolute accuracy, the PMU calibration procedure outlined in the release notes and SPI programming guide must be followed.

Measurement Considerations

In order to provide sufficient integration samples to allow precise measurements of signals, the default integration time (measurement window) is fixed to 40ms. Note that if the measurement window is not a multiple of the system frame length, then the power measurement window will span an incomplete frame and cause a measurement error. However; the synchronization of the frame and measurement window is not required to achieve precise measurements.

TDD Considerations—Operation with < 100% PA Duty Cycle

The PMU fully supports accurate measurement of TDD waveforms. The PMU does not differentiate between samples taken when the PA is on versus when the PA is off. Though easily compensated, this condition will affect the reading for waveforms with less than 100% duty cycle (e.g., TDD applications). For example, the PMU value read for a 50% duty cycle waveform will be 3dB lower than the value for the same signal but with a 100% duty cycle. Calculating the offset associated with TDD measurements is straightforward and may be handled by the PMU depending on the system requirements. Refer to the Release Notes for additional details on different methods.

Measurements (General)

Data presented in the figures on the following pages is based on typical operating conditions at +25°C, V_{AVDD18} = 1.8V, V_{AVDD33} = 3.3V, and V_{DVDD18} = 1.8V, unless otherwise specified. All data-based 2-tone CW, 5MHz bandwidth, and centered at 2140MHz, unless otherwise specified. PMU errors reported as deviation from the linear regression.

Measurements (PMU vs. Temperature)

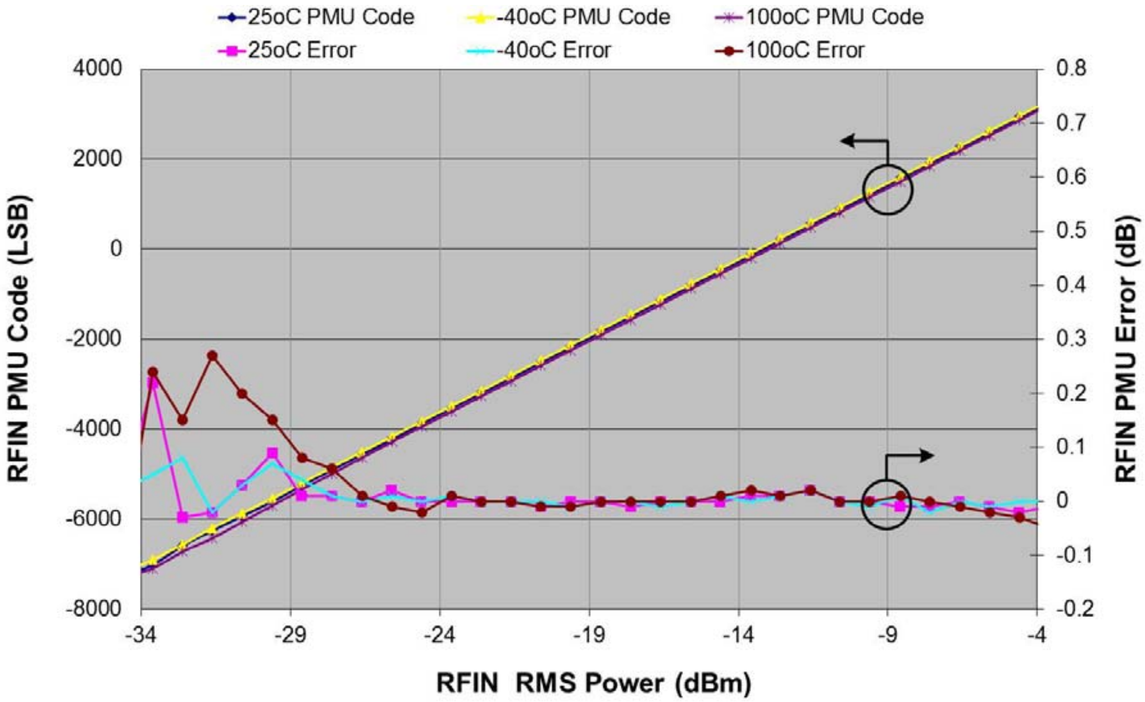

Figure 1. RFIN PMU Code vs. RFIN RMS Power

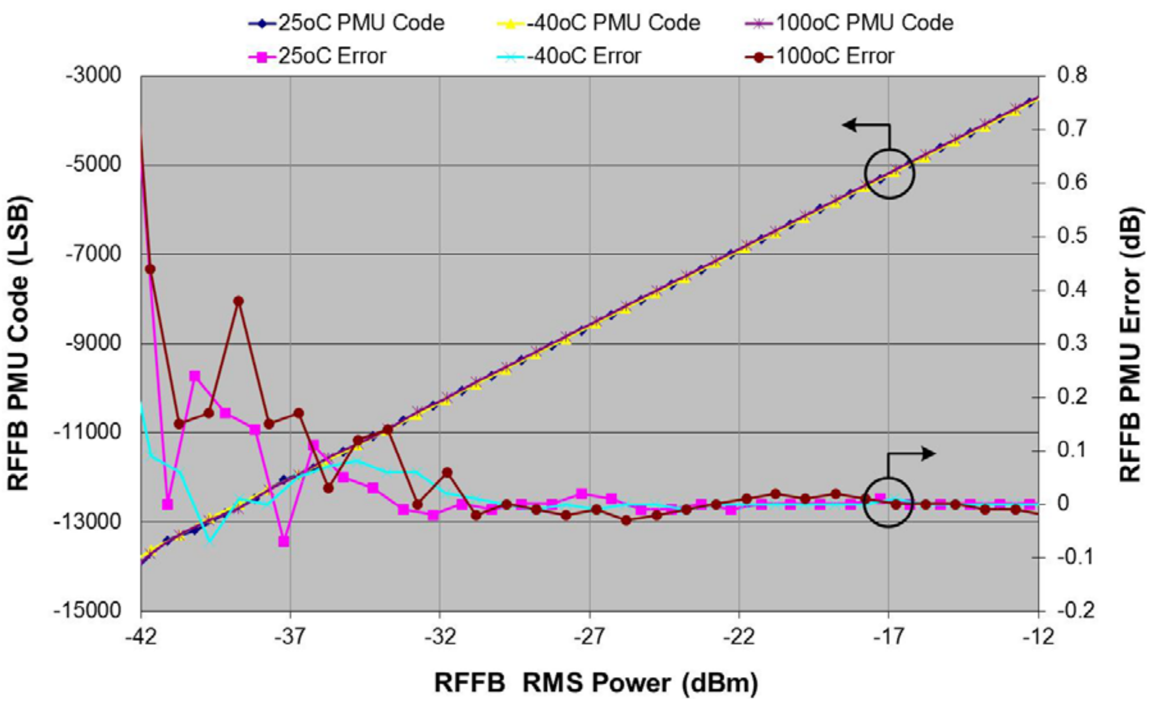

Figure 2. RFFB PMU Code vs. RFFB RMS Power

Measurements (PMU vs. Temperature) (continued)

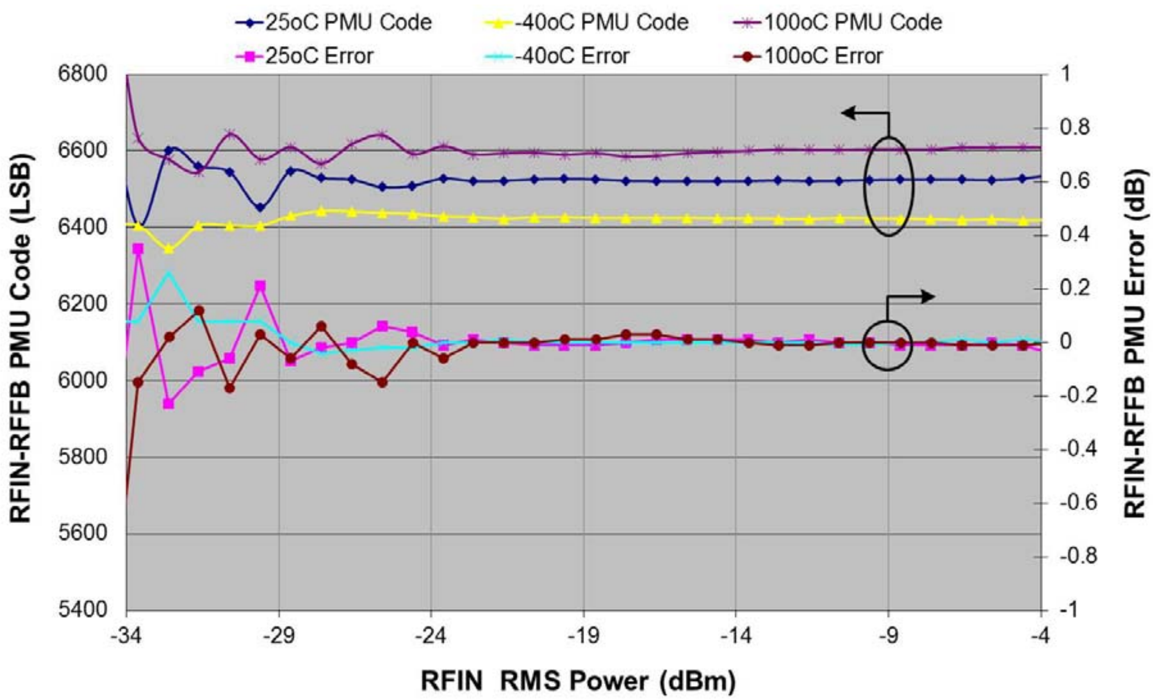

Figure 3. RFIN-RFFB PMU Code vs. RFIN RMS Power

Note: FOR RFIN-RFFB MEASUREMENTS, RFFB = RFIN – 8dB.

Measurements (PMU vs. Frequency)

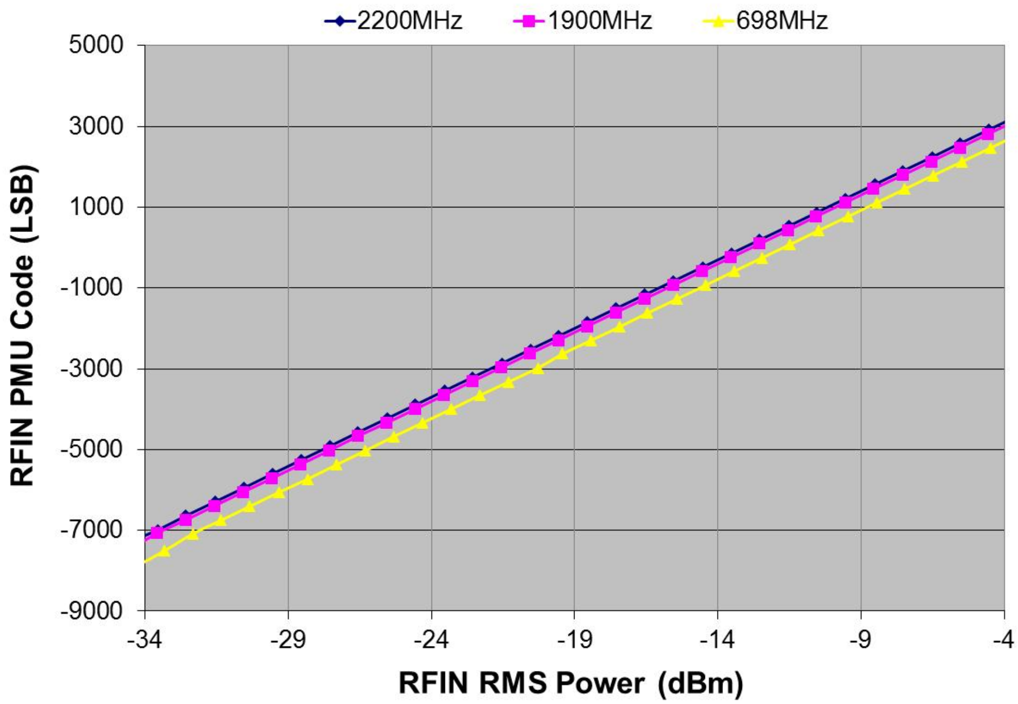

Figure 4. RFIN PMU Code vs. RFIN RMS Power

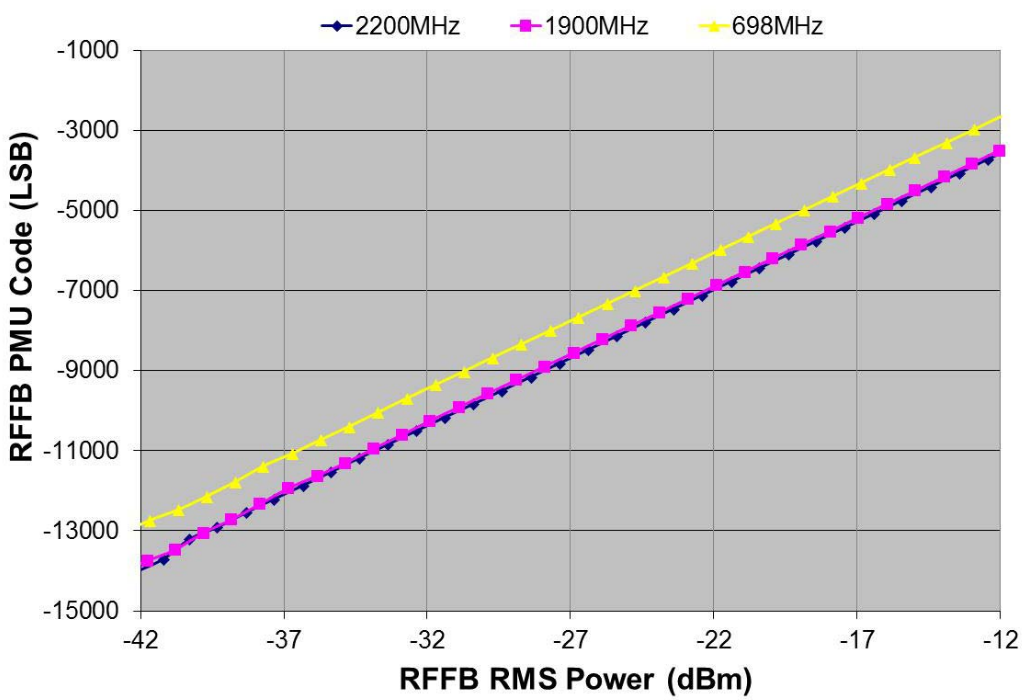

Figure 5. RFFB PMU Code vs. RFFB RMS Power

Measurements (PMU vs. Frequency) (continued)

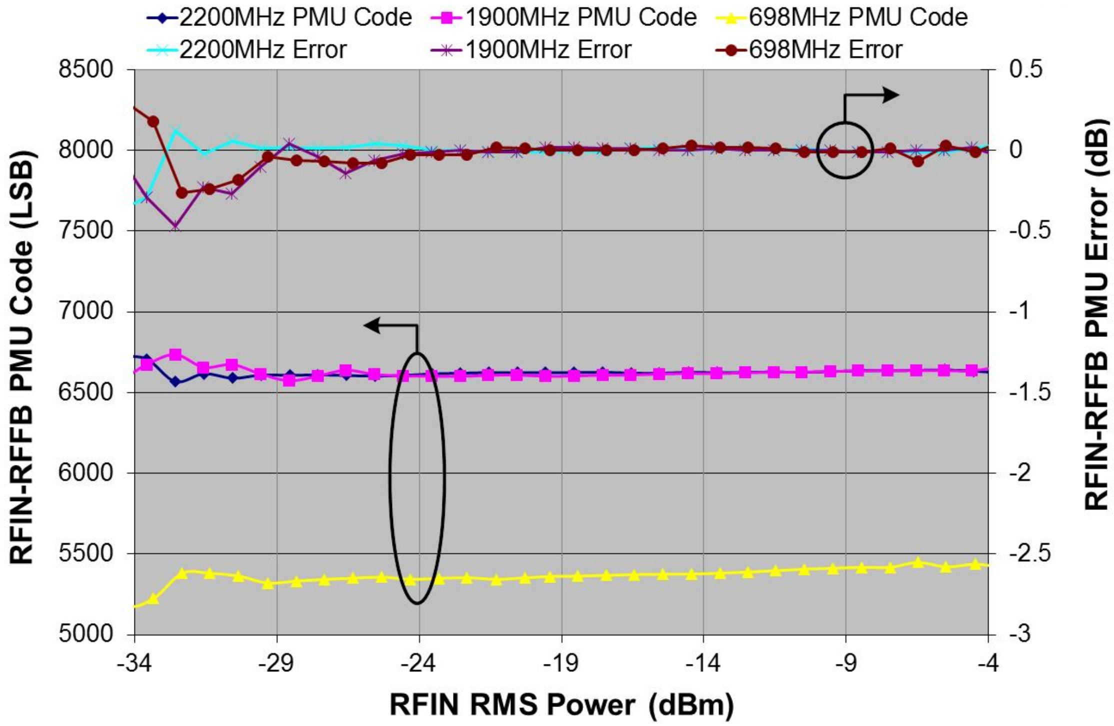

Figure 6. RFIN-RFFB PMU Code vs. RFIN RMS Power

Note: FOR RFIN-RFFB MEASUREMENTS, RFFB = RFIN – 8dB.

Measurements (PMU vs. Waveform)

Note that differences in starting points are due to differences in the peak-to-average ratio (PAR) of the different WCDMA waveforms compared to CW waveform.

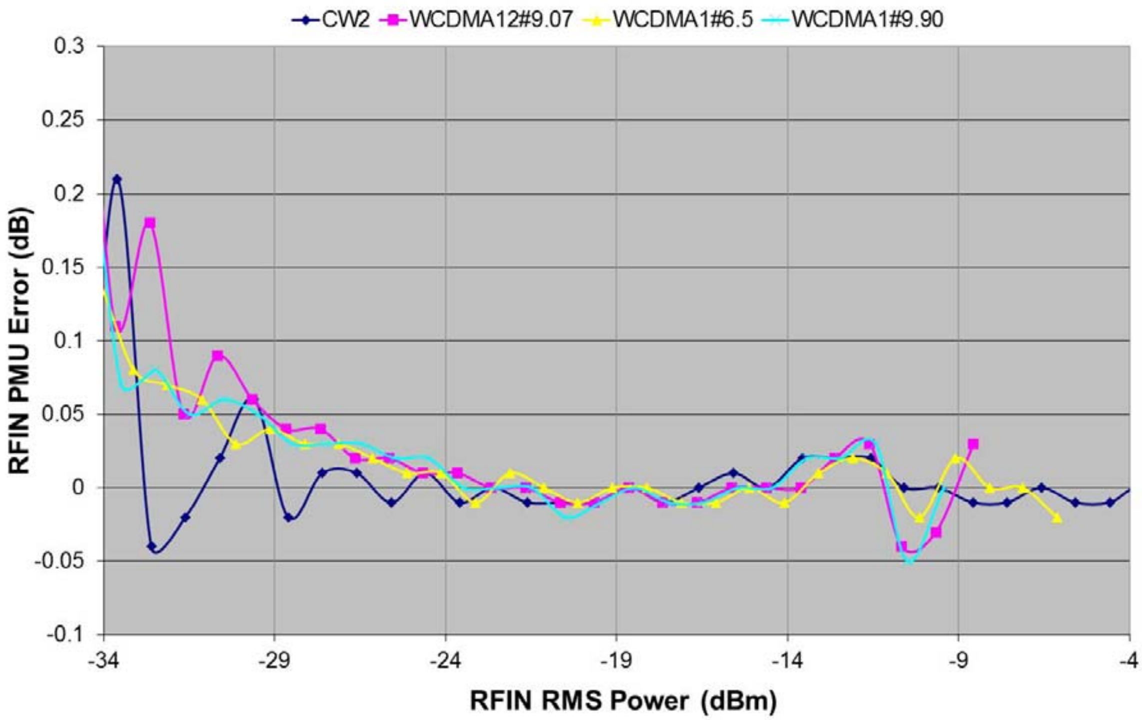

Figure 7. RFIN PMU Error vs. RFIN RMS Power

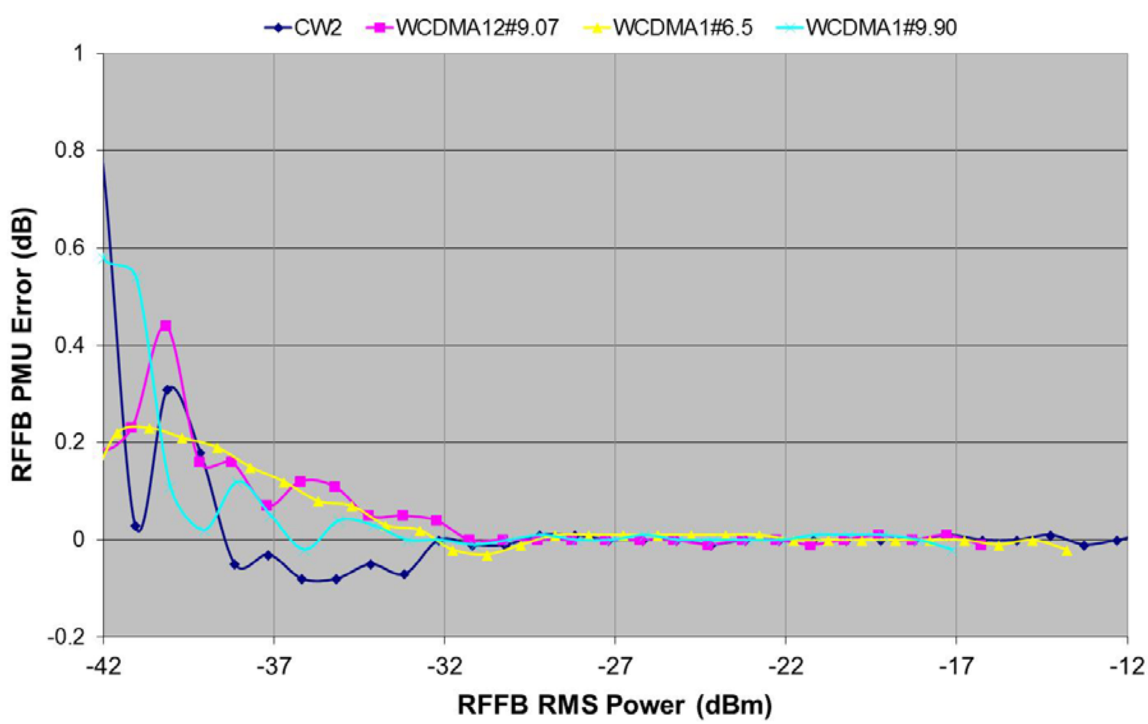

Figure 8. RFFB PMU Error vs. RFFB RMS Power

Measurements (PMU vs. Waveform) (continued)

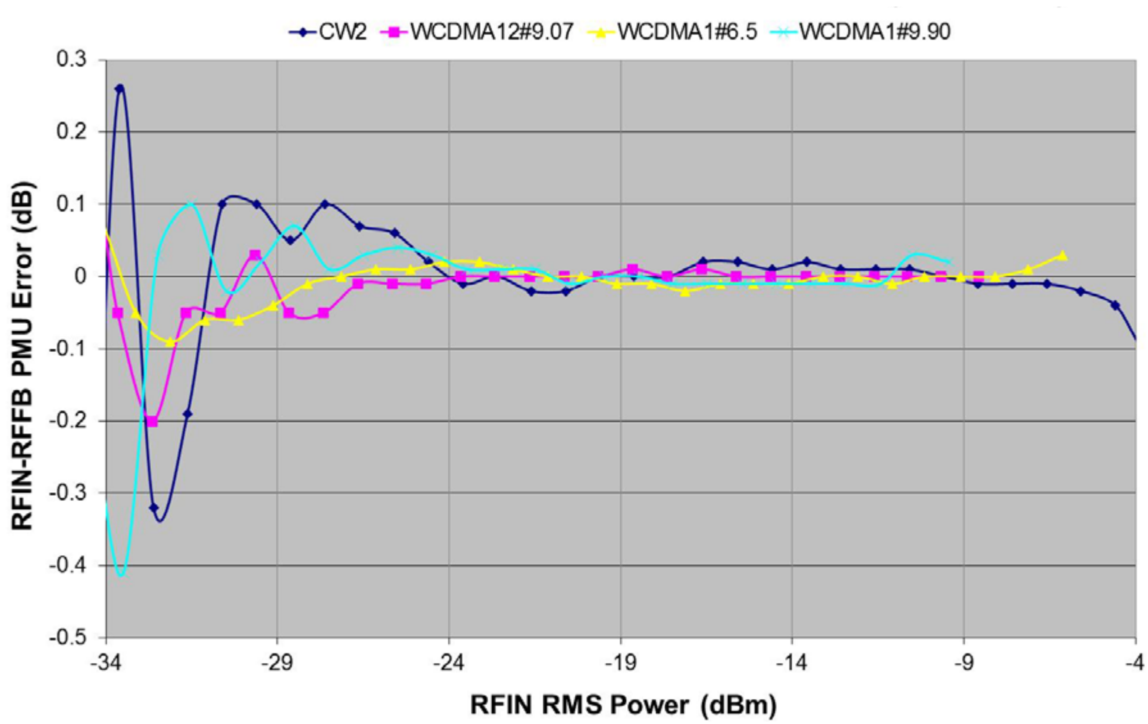

Figure 9. RFIN-RFFB PMU Error vs. RFIN RMS Power

Note: FOR RFIN-RFFB MEASUREMENTS, RFFB = RFIN – 8dB.

CW = 2-tone continuous wave, 5MHz BW
WCDMA12#9.07 = 12 carrier WCDMA, PAR = 9.07dB, 60MHz BW
WCDMA1#6.5 = 1 carrier WCDMA, PAR = 6.5dB, 5MHz BW
WCDMA1#9.90 = 1 carrier WCDMA, PAR = 9.90dB, 5MHz BW

Top Mark

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

Ordering Information

PART	DESCRIPTION
SC1889A-00B11	IC, RFPAL+PMU, 698MHz to 2800MHz, FW 3.0.17.62

Note that the PMU function frequency range is more restricted than the RFPAL frequency range. The frequency of operation given in the DESCRIPTION above refers to the RFPAL base function.

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

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0.1	8/14		—

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