ANALOG DEVICES

Circuit Note

CN-0150

Circuits from the Lab™ Reference Circuits

Circuits from the Lab™ reference circuits are engineered and tested for quick and easy system integration to help solve today's analog, mixed-signal, and RF design challenges. For more information and/or support, visit www.analog.com/CN0150.

Devices Connected/Referenced	
AD8318	1 MHz to 8 GHz, 70 dB, Logarithmic Detector/Controller
AD7887	2.7 V to 5.25 V, Micropower, 2-Channel, 125 kSPS, 12-Bit ADC in 8-Lead MSOP
ADR421	Precision, Low Noise, 2.5 V Reference

Software-Calibrated, 1 MHz to 8 GHz, 60 dB RF Power Measurement System Using a Logarithmic Detector

EVALUATION AND DESIGN SUPPORT

Circuit Evaluation Boards

CN-0150 Circuit Evaluation Board (EVAL-CN0150A-SDPZ)

System Demonstration Platform (EVAL-SDP-CB1Z)

Design and Integration Files

Schematics, Layout Files, Bill of Materials

CIRCUIT FUNCTION AND BENEFITS

This circuit measures RF power at any frequency from 1 MHz to 8 GHz over a range of approximately 60 dB. The measurement result is provided as a digital code at the output of a 12-bit ADC with serial interface and integrated reference. The output of the RF detector has a glueless interface to the ADC and uses most of the ADC's input range without further adjustment.

A simple two-point system calibration is performed in the digital domain.

The AD8318 maintains accurate log conformance for signals of 1 MHz to 6 GHz and provides useful operation to 8 GHz. The device provides a typical output voltage temperature stability of ±0.5 dB.

The AD7887 ADC can be configured for either dual or single channel operation via the on-chip control register. There is a default single-channel mode that allows the AD7887 to be operated as a read-only ADC, thereby simplifying the control logic.

Typical data is shown for the two devices operating over a −40°C to +85°C temperature range.

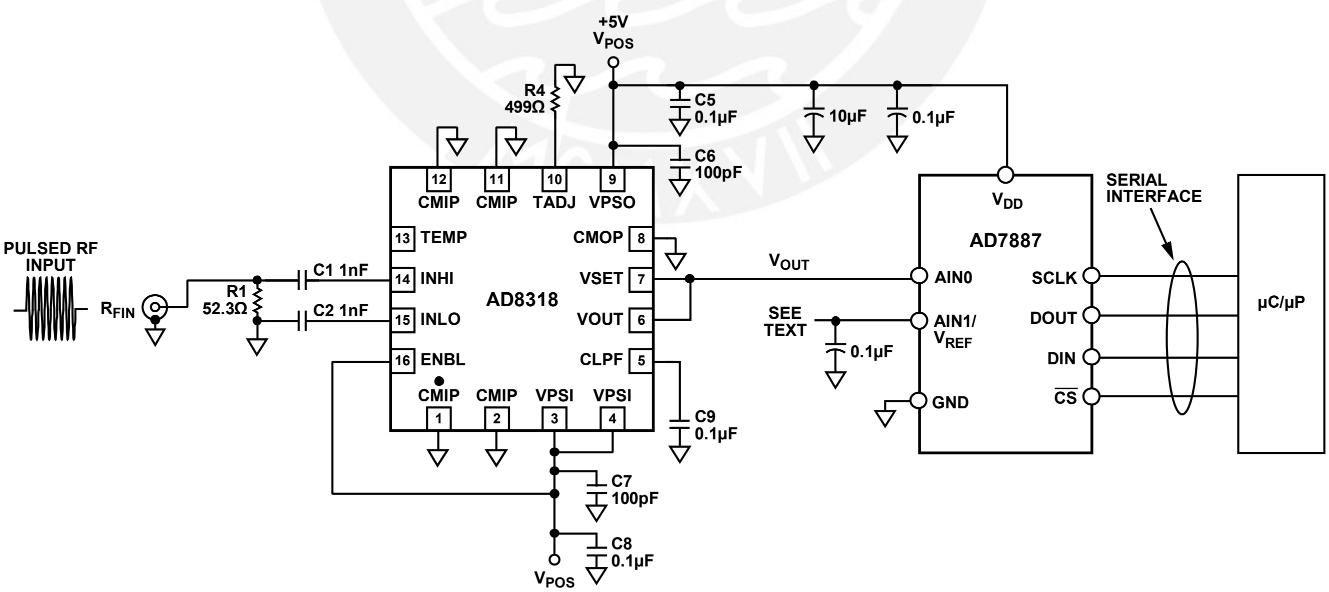

Figure 1. Software-Calibrated RF Measurement System (Simplified Schematic: All Connections Not Shown)

Rev. C

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CIRCUIT DESCRIPTION

The RF signal being measured is applied to the AD8318. The device is configured in its so-called measurement mode, with the VSET and VOUT pins connected together. In this mode, the output voltage vs. the input signal level is linear-in-dB (nominally −24 mV/dB) and has a typical output voltage range of 0.5 V to 2.1 V.

The AD8318 output is connected directly to the AD7887, 12-bit ADC. The ADC uses its internal reference and is configured for a 0 V to 2.5 V input, resulting in an LSB size of 610 μV. With the RF detector providing a nominal −24 mV/dB, the digital resolution is 39.3 LSBs/dB. With this much resolution, there is little value in trying to scale the 0.5 V to 2.1 V signal from the RF detector to exactly fit the 0 V to 2.5 V range of the ADC.

The transfer function of the detector can be approximated by the equation

$$V_{OUT} = SLOPE \times (P_{IN} - INTERCEPT)$$

where SLOPE is in mV/dB (−24 mV/dB nominal); INTERCEPT is the x-axis intercept with a unit of dBm (20 dBm nominal); and P_{IN} is the input power expressed in dBm. A typical plot of detector output voltage vs. input power is shown in Figure 2.

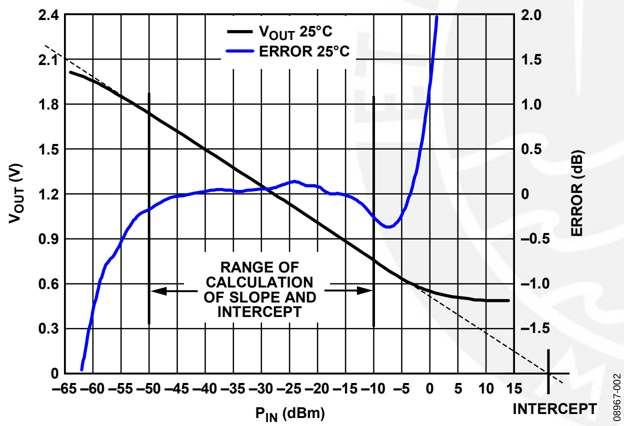

Figure 2. Typical Output Voltage vs. Input Signal Level for the AD8318

At the output of the ADC, the equation can be written as

$$CODE\_OUT = SLOPE\_ADC \times (PIN - INTERCEPT)$$

where *SLOPE_ADC* is in codes/dB and *PIN* and *INTERCEPT* are in dBm. Figure 3 shows a typical detector power sweep in terms of input power and observed ADC codes.

Because the slope and intercept of the system vary from device to device, a system level calibration is required. A calibration is performed by applying two known signal levels close to the endpoints of the AD8318 linear input range and measuring the corresponding output codes from the ADC. The calibration points chosen should be well within the linear operating range of the device (−10 dBm and −50 dBm in this case).

Using the two known input power levels, *PIN_1* and *PIN_2*, and the corresponding observed ADC codes, *CODE_1* and *CODE_2*, *SLOPE_ADC*, and *INTERCEPT* can be calculated using the following equations:

$$SLOPE\_ADC = (CODE\_2 - CODE\_1)/(PIN\_2 - PIN\_1)$$

$$INTERCEPT = PIN\_2 - (CODE\_2/SLOPE\_ADC)$$

Once *SLOPE_ADC* and *INTERCEPT* are calculated and stored (in nonvolatile RAM) during factory calibration, they can be used to calculate an unknown input power level, PIN, when the equipment is in operation in the field using the equation

$$PIN = (CODE\_OUT/SLOPE\_ADC) + INTERCEPT$$

Figure 3 through Figure 8 show how the system transfer function deviates from this straight line equation, particularly at the endpoints of the transfer function. This deviation is expressed in dB using the equation

$$Error\ (\text{dB}) = Measured\ Input\ Power - True\ Input\ Power = (CODE\_OUT/SLOPE\_ADC) + INTERCEPT - PIN\_TRUE$$

where:
CODE_OUT is the ADC output code.
SLOPE_ADC is the stored ADC slope in codes/dB.
INTERCEPT is the stored intercept.
PIN_TRUE is the exact (and unknown) input level.

The plots shown in Figure 3 through Figure 8 show the typical system performance that can be obtained using the AD8318 and AD7887BR in an RF power measurement system. The graphs depict the RF input power in dBm vs. the ADC output code and output error in dB (scaled on the axes on the right side of the plots). They were generated from data taken with various input power levels, frequencies, and temperatures and with both internal and external ADC voltage references. The charts show improved system performance and lower temperature drift with the use of a low drift external ADC voltage reference. (See the Common Variations section for more details about the use of an external reference.

A complete design support package for this circuit note can be found at www.analog.com/CN0150-DesignSupport.

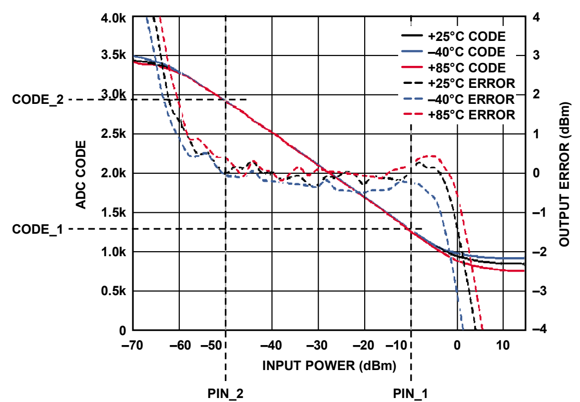

Figure 3. Input = 900 MHz, ADC Using an Internal 2.5 V Reference

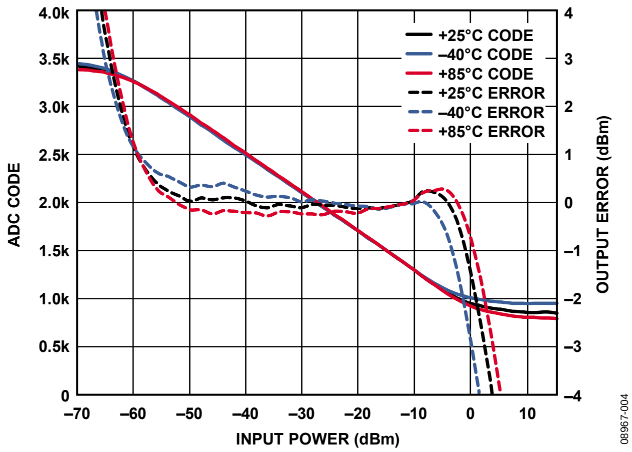

Figure 4. Input = 900 MHz, ADC Using an External 2.5 V Reference

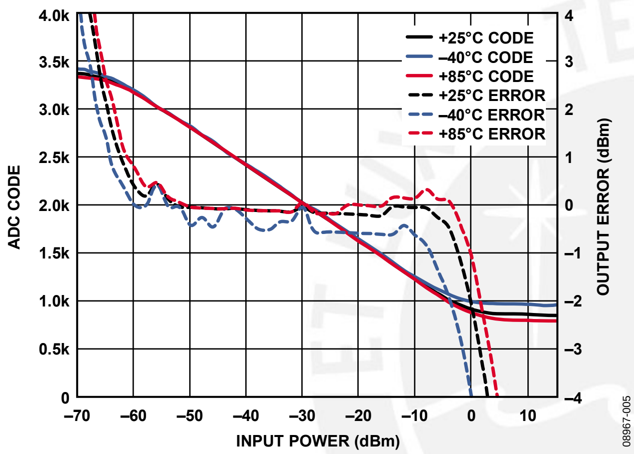

Figure 5. Input = 1.9 GHz, ADC Using an Internal 2.5 V Reference

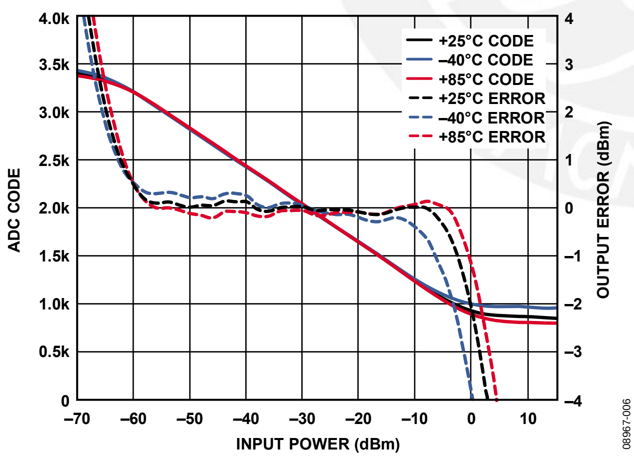

Figure 6. Input = 1.9 GHz, ADC Using an External 2.5 V Reference

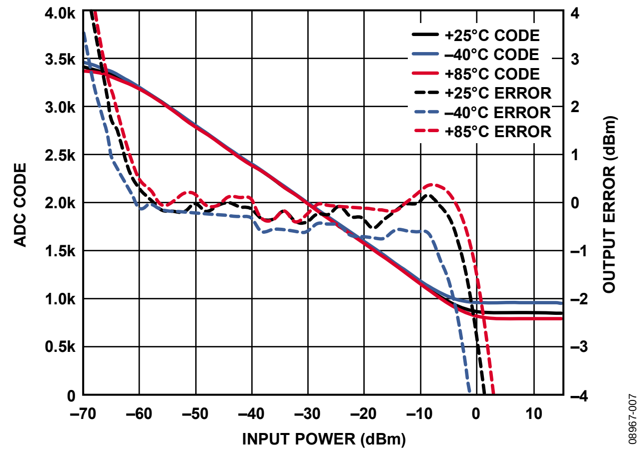

Figure 7. Input = 2.2 GHz, ADC Using an Internal 2.5 V Reference

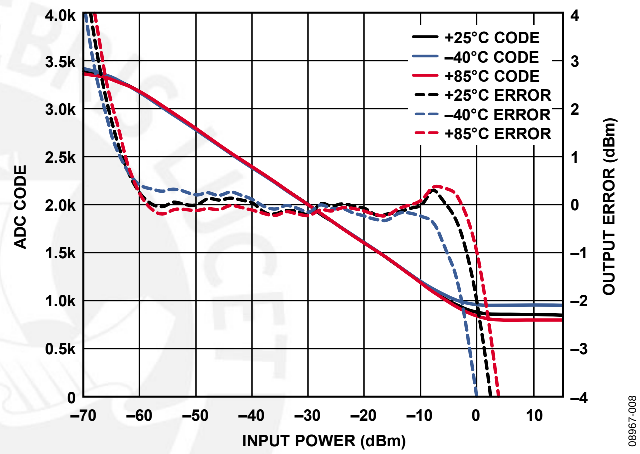

Figure 8. Input = 2.2 GHz, ADC Using an External 2.5 V Reference

COMMON VARIATIONS

The AD7887 is a 2-channel, 12-bit ADC with an SPI interface. The second input channel of this device can be connected to the AD8318 TEMP pin. This provides a convenient measure of the ambient temperature around the AD8318. Like the AD8318 power measurement output, the TEMP voltage output should also be calibrated.

If the end application requires only a single channel, the 12-bit AD7495 can be used. In multichannel applications that require multiple ADCs and DAC channels, the AD7294 can be used. In addition to providing four 12-bit DAC outputs, this subsystem chip includes four uncommitted ADC channels, two high-side current sense inputs, and three temperature sensors. Current and temperature measurements are digitally converted and available to read over the I^2C-compatible interface.

The temperature stability of the circuit can be improved using an external ADC reference. The AD7887 internal 2.5 V reference has a 50 ppm/°C drift, which is approximately 15 mV over a 125°C range. Because the detector has a slope of −24 mV/dB, the ADC reference drift contributes approximately ±0.3 dB to the temperature drift error budget. The AD8318 temperature drift is approximately ±0.5 dB over a similar temperature range. (This varies with frequency. See the AD8318 data sheet for more details.)

If an external voltage reference is to be used, the ADR421 2.5 V reference is recommended. Its 1 ppm/°C temperature drift results in a reference voltage variation of only 312 µV from −40°C to +85°C. This has a negligible effect on the overall temperature stability of the system.

If a less dynamic range is required, the AD8317 (55 dB) or AD8319 (45 dB) log detector can be used. If a true rms responding power measurement is required, the AD8363 (50 dB) or ADL5902 (65 dB) can be used.

CIRCUIT EVALUATION AND TEST

This circuit uses the EVAL-CN0150A-SDPZ circuit board and the EVAL-SDP-CB1Z System Demonstration Platform (SDP) evaluation board. The two boards have 120-pin mating connectors, allowing for the quick setup and evaluation of the circuit's performance. The EVAL-CN0150A-SDPZ board contains the circuit to be evaluated, as described in this note, and the SDP evaluation board is used with the CN0150A evaluation software to capture the data from the EVAL-CN0150A-SDPZ circuit board.

Equipment Needed

- PC with a USB port and Windows® XP or Windows Vista® (32-bit), or Windows 7 (32-bit)
- EVAL-CN0150A-SDPZ Circuit Evaluation Board
- EVAL-SDP-CB1Z SDP Evaluation Board
- CN0150A Evaluation Software
- Power supply: 6 V or 6 V wall wart
- Environmental chamber
- RF signal source
- Coaxial RF cable with SMA connectors

Getting Started

Load the evaluation software by placing the CN0150A evaluation software CD in the CD drive of the PC. Using **My Computer**, locate the drive that contains the evaluation software CD and open the readme file. Follow the instructions contained in the readme file for installing and using the evaluation software.

Functional Block Diagram

See Figure 1 of this circuit note for the circuit block diagram and the **EVAL-CN150A-SDPZ-SCH-Rev0.pdf** file for the circuit schematics. This file is contained in the CN0150 Design Support Package.

Setup

Connect the 120-pin connector on the EVAL-CN0150A-SDPZ circuit board to the CON A connector on the EVAL-SDP-CB1Z evaluation (SDP) board. Use nylon hardware to firmly secure the two boards, using the holes provided at the ends of the 120-pin connectors. Using an appropriate RF cable, connect the RF signal source to the EVAL-CN0150A-SDPZ board via the SMA RF input connector. With power to the supply off, connect a 6 V power supply to the +6V and GND pins on the board. If available, a 6 V wall wart can be connected to the barrel connector on the board and used in place of the 6 V power supply. Connect the USB cable supplied with the SDP board to the USB port on the PC. Note: Do not connect the USB cable to the mini USB connector on the SDP board at this time.

Test

Apply power to the 6 V supply (or wall wart) connected to EVAL-CN0150A-SDPZ circuit board. Launch the evaluation software and connect the USB cable from the PC to the USB mini connector on the SDP board.

Once USB communications are established, the SDP board can now be used to send, receive, and capture serial data from the EVAL-CN0150A-SDPZ board.

The data in this circuit note were generated using a Rohde & Schwarz SMT-03 RF signal source and an Agilent E3631A power supply. The signal source was set to the frequencies indicated in the graphs, and the input power was stepped and data recorded in 1 dB increments.

Temperature testing was performed using a Test Equity Model 107 environmental chamber. The EVAL-CN0150A-SDPZ evaluation board was placed in the chamber via a slot in the test chamber door, with the SDP evaluation board extending outside.

Information and details regarding how to use the evaluation software for data capture can be found in the CN0150A evaluation software readme file.

Information regarding the SDP board can be found in the SDP User Guide.

LEARN MORE

CN0150 Design Support Package:
http://www.analog.com/CN0150-DesignSupport

SDP User Guide

MT-031 Tutorial, *Grounding Data Converters and Solving the Mystery of "AGND" and "DGND,"* Analog Devices.

MT-077 Tutorial, *Log Amp Basics*, Analog Devices.

MT-078 Tutorial, *High Speed Log Amps*, Analog Devices.

MT-101 Tutorial, *Decoupling Techniques*, Analog Devices.

Whitlow, Dana. *Design and Operation of Automatic Gain Control Loops for Receivers in Modern Communications Systems*. Chapter 8. Analog Devices Wireless Seminar. 2006.

Data Sheets and Evaluation Boards

CN-0150 Circuit Evaluation Board (EVAL-CN0150A-SDPZ)

System Demonstration Platform (EVAL-SDP-CB1Z)

AD7887 Data Sheet

AD7887 Evaluation Board

AD8318 Data Sheet

AD8318 Evaluation Board

ADR421 Data Sheet

REVISION HISTORY

2/12—Rev. B to Rev. C

3/11—Rev. A to Rev. B

8/10— Rev. 0 to Rev. A

4/10—Revision 0: Initial Version

I²C refers to a communications protocol originally developed by Philips Semiconductors (now NXP Semiconductors).

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Circuits from the Lab™ Reference Circuits

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Devices Connected/Referenced	
ADL5902	50 MHz to 9 GHz, 65 dB TruPwr™ Detector
AD7466	Micropower, 12-Bit, 200 kSPS SAR ADC

Software-Calibrated, 50 MHz to 9 GHz, RF Power Measurement System

EVALUATION AND DESIGN SUPPORT

Circuit Evaluation Boards

- **CN-0178 Circuit Evaluation Board (EVAL-CN0178-SDPZ)**
- **System Demonstration Platform (EVAL-SDP-CB1Z)**

Design and Integration Files

- **Schematics, Layout Files, Bill of Materials**

CIRCUIT FUNCTION AND BENEFITS

This circuit uses the ADL5902 TruPwr™ detector to measure the rms signal strength of RF signals with varying crest factors (peak-to-average ratio) over a dynamic range of approximately 65 dB and operates at frequencies from 50 MHz up to 9 GHz.

The measurement result is provided as serial data at the output of a 12-bit ADC (AD7466). A simple 4-point system calibration at ambient temperature is performed in the digital domain.

The interface between the RF detector and the ADC is straightforward, consisting of two signal scaling resistors and no active components. In addition, the ADL5902 internal 2.3 V reference voltage provides the supply and reference voltage for the micropower ADC. The AD7466 has no pipeline delay and is operated as a read-only SAR ADC.

The overall circuit achieves temperature stability of approximately ±0.5 dB.

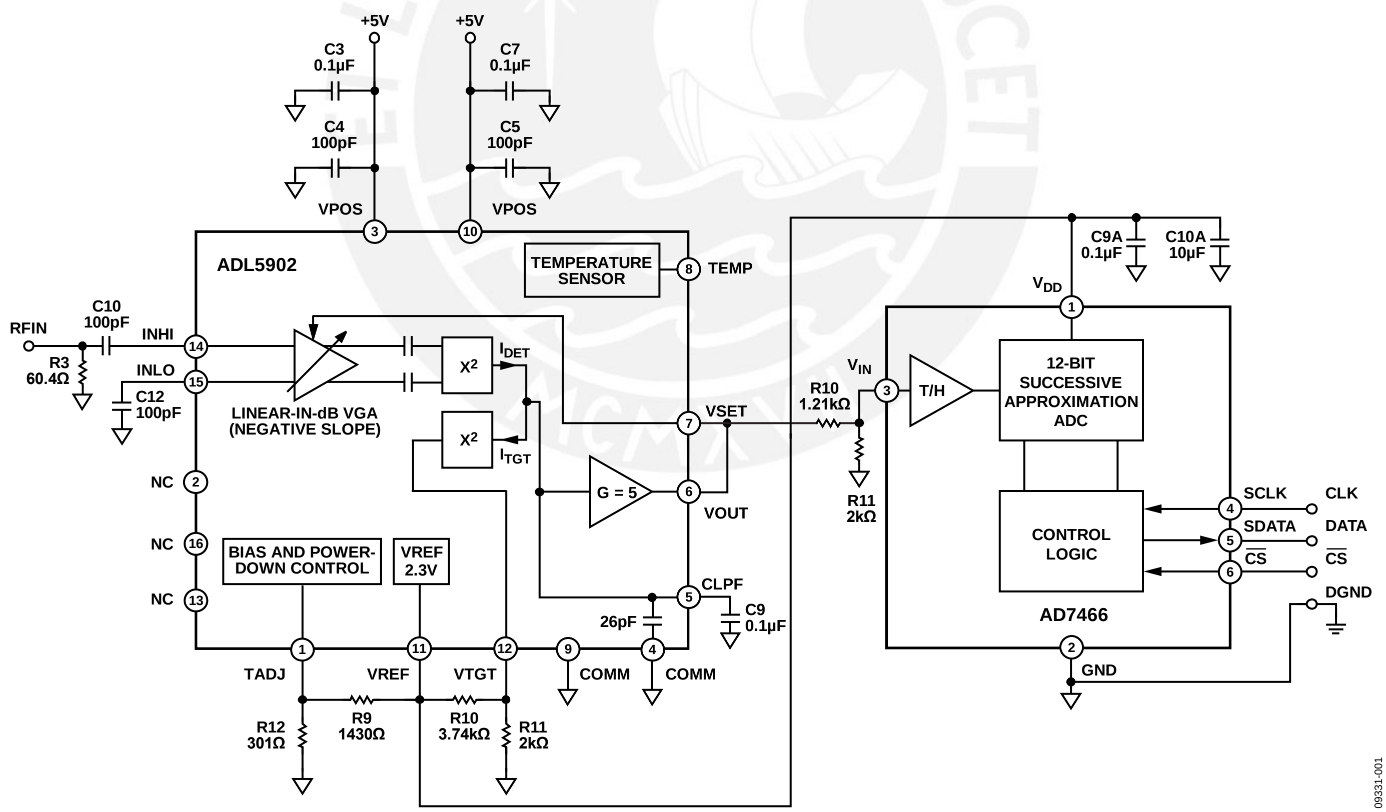

Figure 1. Software-Calibrated RF Power Measurement System

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Data is shown for the two devices operating over a −40°C to +85°C temperature range.

CIRCUIT DESCRIPTION

The RF signal being measured is applied to the input of the ADL5902, a linear-in-dB rms-responding rms detector. The external 60.4 Ω resistor, R3, combined with the relatively high input impedance of the ADL5902 ensures a broadband 50 Ω match to the RF input. The ADL5902 is configured in its so-called "measurement mode," with the VSET and VOUT pins connected together. In this mode the output voltage is proportional to the logarithm of the rms value of the input. In other words, the reading is presented directly in decibels and is scaled to 1.06 V per decade, or 53 mV/dB.

The power supply voltage and reference voltage for the AD7466 12-bit ADC are provided by the ADL5902 internal 2.3 V reference. Because the AD7466 consumes so little current (16 µA when sampling at 10 kSPS), the ADL5902's reference voltage output can supply the ADC, as well as the temperature compensating and rms accuracy-scaling network consisting of R9, R10, R11, and R12.

The ADC full-scale voltage is equal to 2.3 V. The maximum detector output voltage (when operating in its linear input range) is approximately 3.5 V (see ADL5902 data sheet figures 6, 7, 8, 12, 13, and 14) and must, therefore, be scaled down by a factor of 0.657 before driving the AD7466. This scaling is implemented using a simple resistor divider R10 and R11 (1.21 kΩ and 2.0 kΩ). These values provide an actual scaling factor of 0.623, which ensures that the ADL5902 RF detector does not overdrive the ADC by building in some room for resistor tolerance.

A typical plot of detector output voltage vs. input power is shown in Figure 2 (without output scaling).

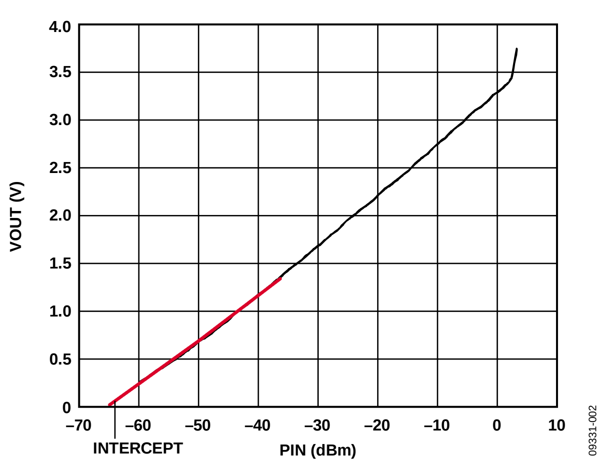


Figure 2. ADL5902 RMS Detector, Output Voltage vs. Input Power @ 900 MHz

The transfer function of the detector can be approximated by the equation

VOUT = SLOPE_DETECTOR × (PIN − INTERCEPT)

where *SLOPE_DETECTOR* is in mV/dB; *INTERCEPT* is the x-axis intercept with a unit of dBm; *PIN* is the input power in dBm.

At the output of the ADC, VOUT is replaced by the ADC's output code, and the equation can be rewritten as

CODE = SLOPE × (PIN − INTERCEPT)

where *SLOPE* is the combined slope of the detector, the scaling resistors, and the ADC, and has the unit of counts/dB; *PIN* and *INTERCEPT* still have the unit of dBm.

Figure 3 shows a typical detector power sweep in terms of input power and observed ADC output codes for a 700 MHz input signal.

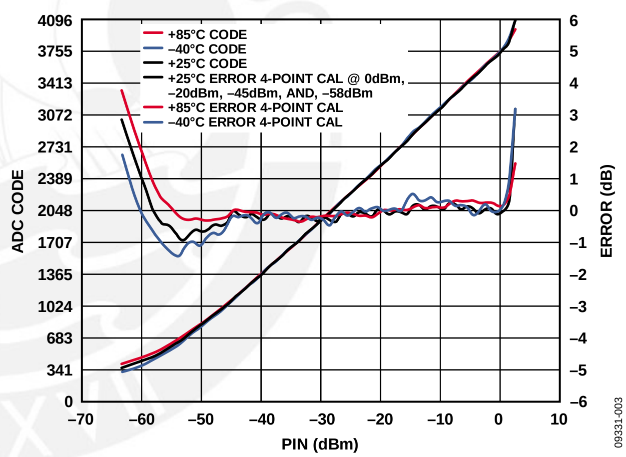


Figure 3. ADC Output Code and Error vs. RF Input Power @ 700 MHz

Overall *SLOPE* and *INTERCEPT* will vary from system to system. This variation is caused by part to part variations in the transfer function of the RF detector, the scaling resistors, and the ADC. As a result, a system level calibration is required to determine the complete system *SLOPE* and *INTERCEPT*. In this application, a 4-point calibration is used to correct for some nonlinearity in the RF detector's transfer function, particularly at the low end. This 4-point calibration scheme yields three *SLOPE* and three *INTERCEPT* calibration coefficients, which should be stored in nonvolatile RAM (NVM) after calibration.

The calibration is performed by applying four known signal levels to the ADL5902 and measuring the corresponding output codes from the ADC. The calibration points chosen should be within the linear operating range of the device. In this example, calibration points at 0 dBm, −20 dBm, −45 dBm, and −58 dBm were used.

The *SLOPE* and *INTERCEPT* calibration coefficients are calculated using the equations

SLOPE1 = (CODE _1 – CODE_2)/(PIN_1 – PIN_2)

INTERCEPT1= CODE_1/(SLOPE_ADC × PIN_1)

This calculation is then repeated using *CODE_2/CODE_3* and *CODE_3/CODE_4* to calculate *SLOPE2/INTERCEPT2* and *SLOPE3/INTERCEPT3*, respectively. The six calibration coefficients should then be stored in NVM along with *CODE_1, CODE_2, CODE_3*, and *CODE_4*.

When the circuit is in operation in the field, these calibration coefficients are used to calculate an unknown input power level, *PIN*, using the equation

PIN = (CODE/SLOPE) + INTERCEPT

In order to retrieve the appropriate *SLOPE* and *INTERCEPT* calibration coefficients during circuit operation, the observed *CODE* from the ADC must be compared to *CODE_1, CODE_2, CODE_3*, and *CODE_4*. For example if the *CODE* from the ADC is between *CODE_1* and *CODE_2*, then the *SLOPE1* and *INTERCEPT1* should be used. This step can also be used to provide an underrange or overrange warning. For example, if the *CODE* from the ADC is greater than *CODE_1* or less than *CODE_4*, it indicates that the measured power is outside of the calibration range

Figure 3 also shows the transfer function variation of the circuit vs. the above straight line equations. This error function is caused by bending at the edges of the transfer function, small ripple in the linear operating range, and drift over temperature. The error is expressed in dB using the equation

Error (dB) = Calculated RF Power − True Input Power

= (CODE/SLOPE) + INTERCEPT – PIN_TRUE

Figure 3 also includes plots of error vs. temperature. In this case the measured ADC codes at +85°C and −40°C are compared to the straight line equations at ambient. This is consistent with a real world system where system calibration is generally only practical at ambient temperature.

Figure 4 and Figure 5 show the performance of the circuit at 1 GHz and 2.2 GHz, respectively.

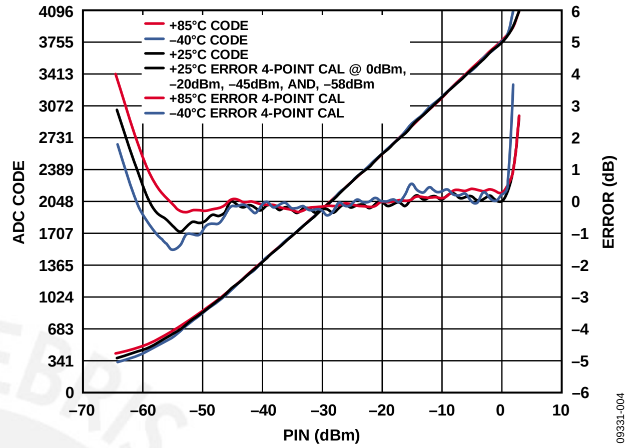


Figure 4. ADC Output Code and Error vs. RF Input Power @ 1 GHz

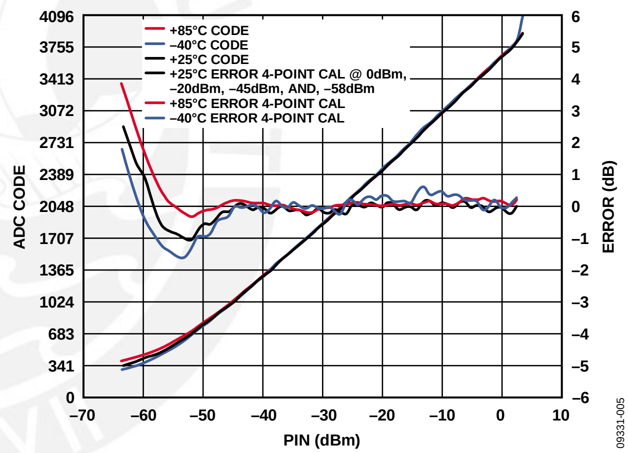


Figure 5. ADC Output Code and Error vs. RF Input Power @ 2.2 GHz

The performance of this or any high speed circuit is highly dependent on proper PCB layout. This includes, but is not limited to, power supply bypassing, controlled impedance lines (where required), component placement, signal routing, and power and ground planes. (See MT-031 Tutorial, MT-101 Tutorial, and article, *A Practical Guide to High-Speed Printed-Circuit-Board Layout*, for more detailed information regarding PCB layout.)

A complete design support package for this circuit note can be found at www.analog.com/CN0178-DesignSupport.

COMMON VARIATIONS

For applications that require less RF detection range, the AD8363 rms detector can be used. The AD8363 has a detection range of 50 dB and operates at frequencies up to 6 GHz. For non-rms detection applications, the AD8317/AD8318/AD8319 or ADL5513 can be used. These devices offer varying detection ranges and have varying input frequency ranges up to 10 GHz (see CN-0150 for more details).

The AD7466 is a single channel, 12-bit ADC with SPI interface. If the end application requires a multichannel ADC, the dual 12-bit AD7887 can be used. In multichannel applications that require multiple ADC and DAC channels, the AD7294 can be used. In addition to providing four 12-bit DAC outputs, this subsystem chip includes four uncommitted ADC channels, two high-side current sense inputs, and three temperature sensors. Current and temperature measurements are digitally converted and available to read over the I^2C-compatible interface.

CIRCUIT EVALUATION AND TEST

This circuit uses the EVAL-CN0178-SDPZ circuit board and the EVAL-SDP-CB1Z System Demonstration Platform (SDP) evaluation board. The two boards have 120-pin mating connectors, allowing for the quick setup and evaluation of the circuit's performance. The EVAL-CN0178-SDPZ board contains the circuit to be evaluated, as described in this note, and the SDP evaluation board is used with the CN0178 evaluation software to capture the data from the EVAL-CN0178-SDPZ circuit board.

Equipment Needed

- PC with a USB port and Windows® XP or Windows Vista® (32-bit), or Windows® 7 (32-bit)
- EVAL-CN0178-SDPZ Circuit Evaluation Board
- EVAL-SDP-CB1Z SDP Evaluation Board
- CN0178 Evaluation Software
- Power supply: +6 V, or +6 V "wall wart"
- Environmental chamber
- RF signal source
- Coaxial RF cable with SMA connectors

Getting Started

Load the evaluation software by placing the CN0178 Evaluation Software disc in the CD drive of the PC. Using "My Computer," locate the drive that contains the evaluation software disc and open the Readme file. Follow the instructions contained in the Readme file for installing and using the evaluation software.

Functional Block Diagram

See Figure 1 of this circuit note for the circuit block diagram, and the file "EVAL-CN0178-SDPZ-SCH-Rev0.pdf" for the circuit schematics. This file is contained in the CN0178 Design Support Package.

Setup

Connect the 120-pin connector on the EVAL-CN0178-SDPZ circuit board to the connector marked "CON A" on the EVAL-SDP-CB1Z evaluation (SDP) board. Nylon hardware should be used to firmly secure the two boards, using the holes provided at the ends of the 120-pin connectors. Using an appropriate RF cable, connect the RF signal source to the EVAL-CN0178-SDPZ board via the SMA RF input connector. With power to the supply off, connect a +6 V power supply to the pins marked "+6 V" and "GND" on the board. If available, a +6 V "wall wart" can be connected to the barrel connector on the board and used in place of the +6 V power supply. Connect the USB cable supplied with the SDP board to the USB port on the PC. Note: Do not connect the USB cable to the mini USB connector on the SDP board at this time.

Test

Apply power to the +6 V supply (or "wall wart") connected to EVAL-CN0178-SDPZ circuit board. Launch the Evaluation software, and connect the USB cable from the PC to the USB mini-connector on the SDP board.

Once USB communications are established, the SDP board can now be used to send, receive, and capture serial data from the EVAL-CN0178-SDPZ board.

The data in this circuit note were generated using a Rohde & Schwarz SMT-03 RF signal source, and an Agilent E3631A power supply. The signal source was set to the frequencies indicated in the graphs, and the input power was stepped and data recorded in 1 dB increments.

Temperature testing was performed using a Test Equity Model 107 environmental chamber. The CN0178-SDPZ evaluation board was placed in the chamber via a slot in the test chamber door, with the SDP evaluation board extending outside.

Information and details regarding how to use the evaluation software for data capture can be found in the CN0178 Evaluation Software ReadMe file.

Information regarding the SDP board can be found in the SDP User Guide.

LEARN MORE

CN0178 Design Support Package: http://www.analog.com/CN0178-DesignSupport

SDP User Guide

Ardizzoni, John. *A Practical Guide to High-Speed Printed-Circuit-Board Layout*, Analog Dialogue 39-09, September 2005.

CN-0150 Circuit Note, *Software-Calibrated, 1 MHz to 8 GHz, 70 dB RF Power Measurement System Using the AD8318 Logarithmic Detector* , Analog Devices.

MT-031 Tutorial, *Grounding Data Converters and Solving the Mystery of "AGND" and "DGND"*, Analog Devices.

MT-073 Tutorial, *High Speed Variable Gain Amplifiers (VGAs)*, Analog Devices.

MT-077 Tutorial, *Log Amp Basics*, Analog Devices.

MT-078 Tutorial, *High Speed Log Amps*, Analog Devices.

MT-081 Tutorial, *RMS-to-DC Converters*, Analog Devices.

MT-101 Tutorial, *Decoupling Techniques*, Analog Devices.

Whitlow, Dana. *Design and Operation of Automatic Gain Control Loops for Receivers in Modern Communications Systems*. Chapter 8. Analog Devices Wireless Seminar. 2006.

Data Sheets and Evaluation Boards

CN-0178 Circuit Evaluation Board (EVAL-CN0178-SDPZ)

System Demonstration Platform (EVAL-SDP-CB1Z)

ADL5902 Data Sheet

ADL5902 Evaluation Board

AD7466 Data Sheet

AD7466 Evaluation Board

REVISION HISTORY

3/11—Rev. 0 to Rev. A

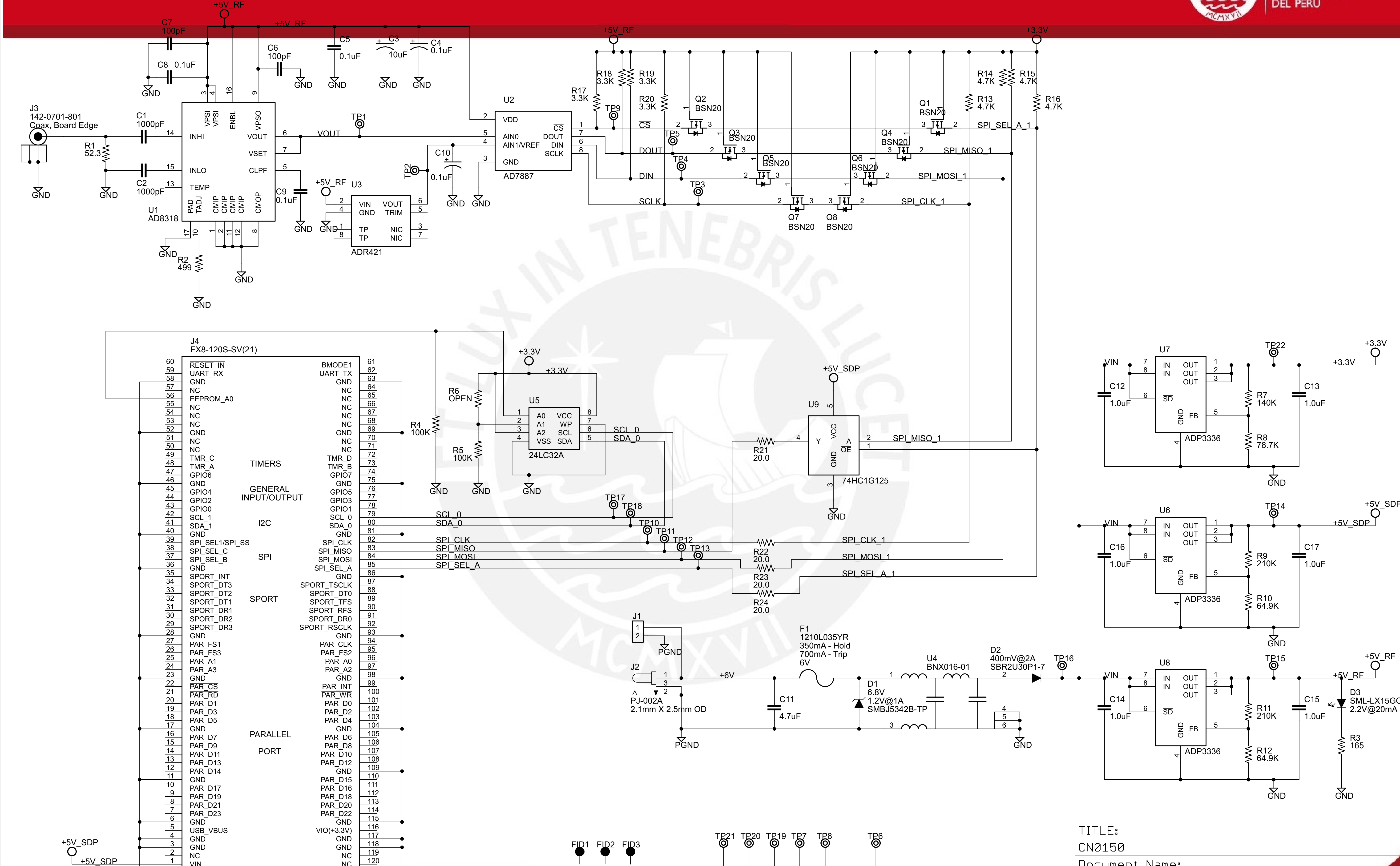
Added Evaluation and Design Support Section............................1
Added Circuit Evaluation and Test Section..................................4

10/10—Rev. 0: Initial Version

I²C refers to a communications protocol originally developed by Philips Semiconductors (now NXP Semiconductors).

CN09331-0-3/11(A)

www.analog.com



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CN0150

Document Name:
CN0150-SCH-B

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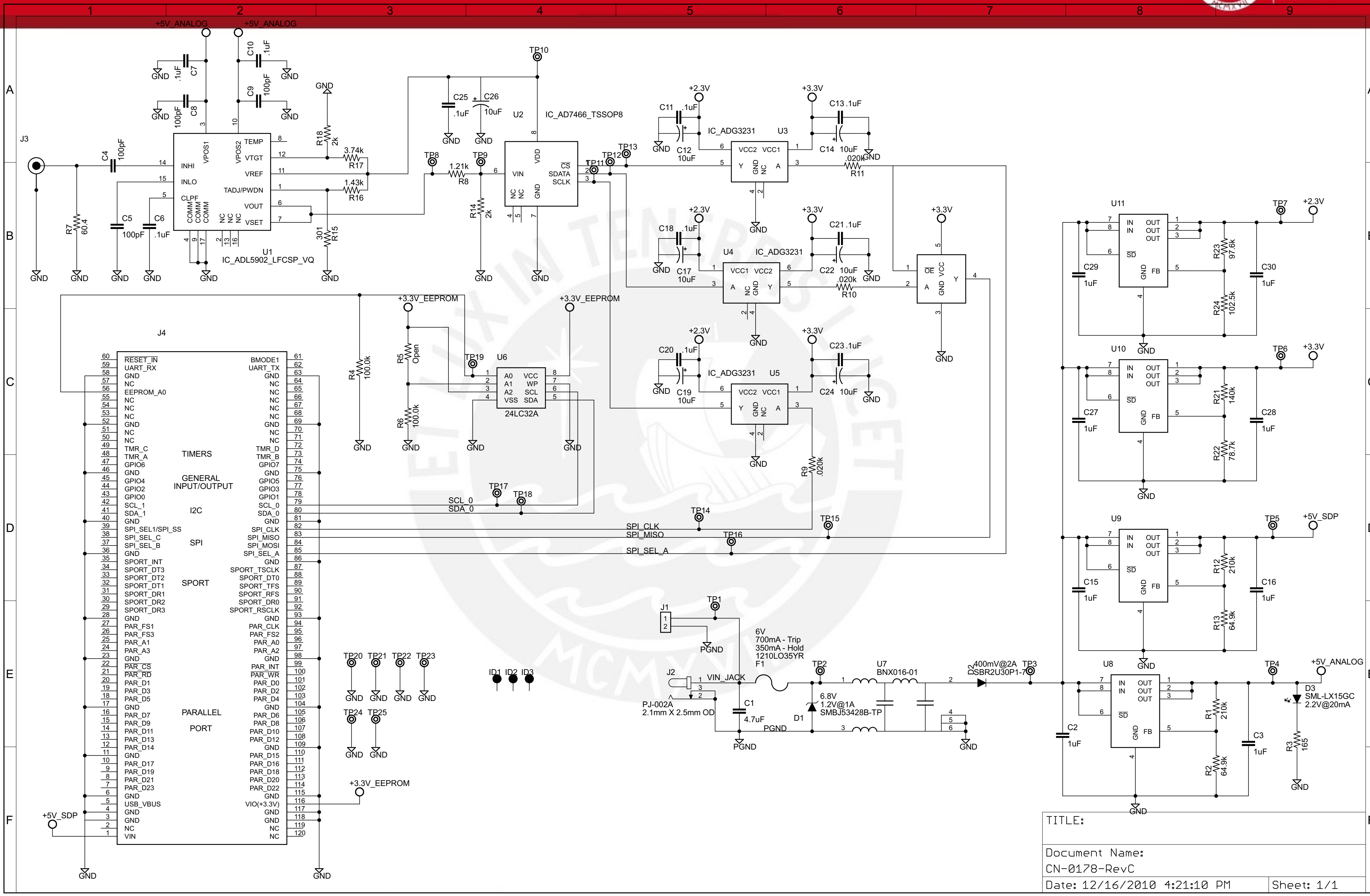
+5V_ANALOG
J3
C4 100pF
R7 60.4
C5 100pF
C6 .1uF
C7 .1uF
C8 100pF
C9 100pF
C10 .1uF
U1
IC_ADL5902_LFCSP_VQ
INHI
INLO
CLPF
VPOS1
VPOS2
TEMP
VTGT
VREF
TADJ/PWDN
VOUT
VSET
R17 3.74k
R16 1.43k
R18 2k
R15 301
TP8
TP9
TP10
R8 1.21k
R14 2k
C25 .1uF
C26 10uF
U2
IC_AD7466_TSOP8
VIN
VDD
SDATA
SCLK
TP11
TP12
TP13
IC_ADG3231
U3
U4
U5
C11 .1uF
C12 10uF
C13 .1uF
C14 10uF
R11 .020k
C18 .1uF
C17 10uF
C21 .1uF
C22 10uF
R10 .020k
C20 .1uF
C19 10uF
C23 .1uF
C24 10uF
R9 .020k
+2.3V
+3.3V
J4
TIMERS
GENERAL INPUT/OUTPUT
I2C
SPI
SPORT
PARALLEL PORT
RESET_IN
UART_RX
EEPROM_A0
BMODE1
UART_TX
SCL_0
SDA_0
SPI_CLK
SPI_MISO
SPI_MOSI
SPI_SEL_A
USB_VBUS
VIO(+3.3V)
VIN
+3.3V_EEPROM
U6
24LC32A
R4 100.0k
R5 Open
R6 100.0k
TP17
TP18
TP14
TP15
TP16
TP19
TP20
TP21
TP22
TP23
TP24
TP25
ID1
ID2
ID3
J1
TP1
PGND
6V
700mA - Trip
350mA - Hold
1210LO35YR
F1
J2
PJ-002A
2.1mm X 2.5mm OD
VIN_JACK
C1 4.7uF
TP2
D1
6.8V
1.2V@1A
SMBJ5342B-TP
U7
BNX016-01
D2
400mV@2A
DSBR2U30P1-7
TP3
U11
U10
U9
U8
TP7
TP6
TP5
TP4
+5V_SDP
C29 1uF
C30 1uF
R23 97.6k
R24 102.5k
C27 1uF
C28 1uF
R21 140k
R22 78.7k
C15 1uF
C16 1uF
R12 210k
R13 64.9k
C2 1uF
C3 1uF
R1 210k
R2 64.9k
D3
SML-LX15GC
2.2V@20mA
R3 165
GND
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Document Name:
CN-0178-RevC
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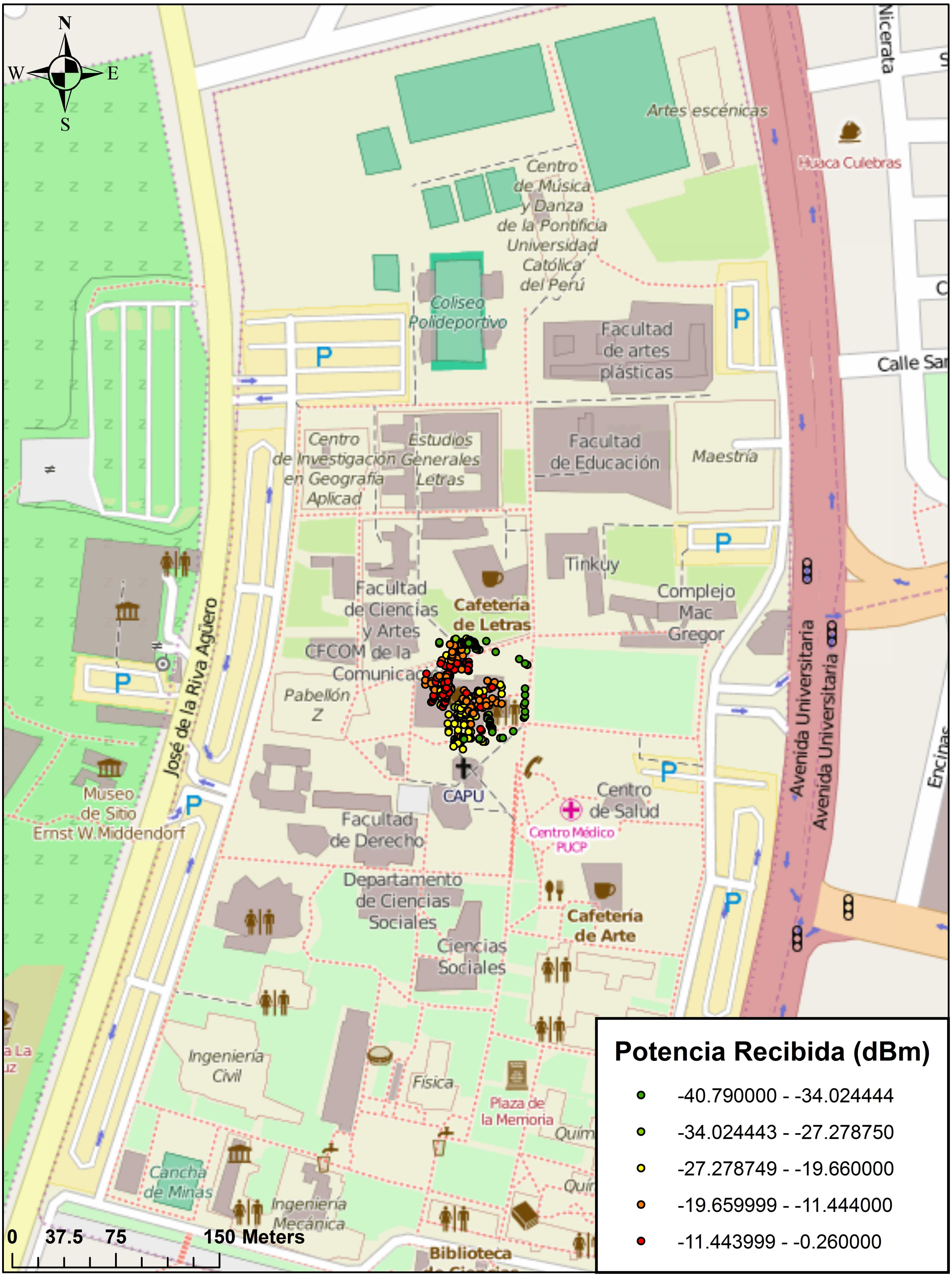
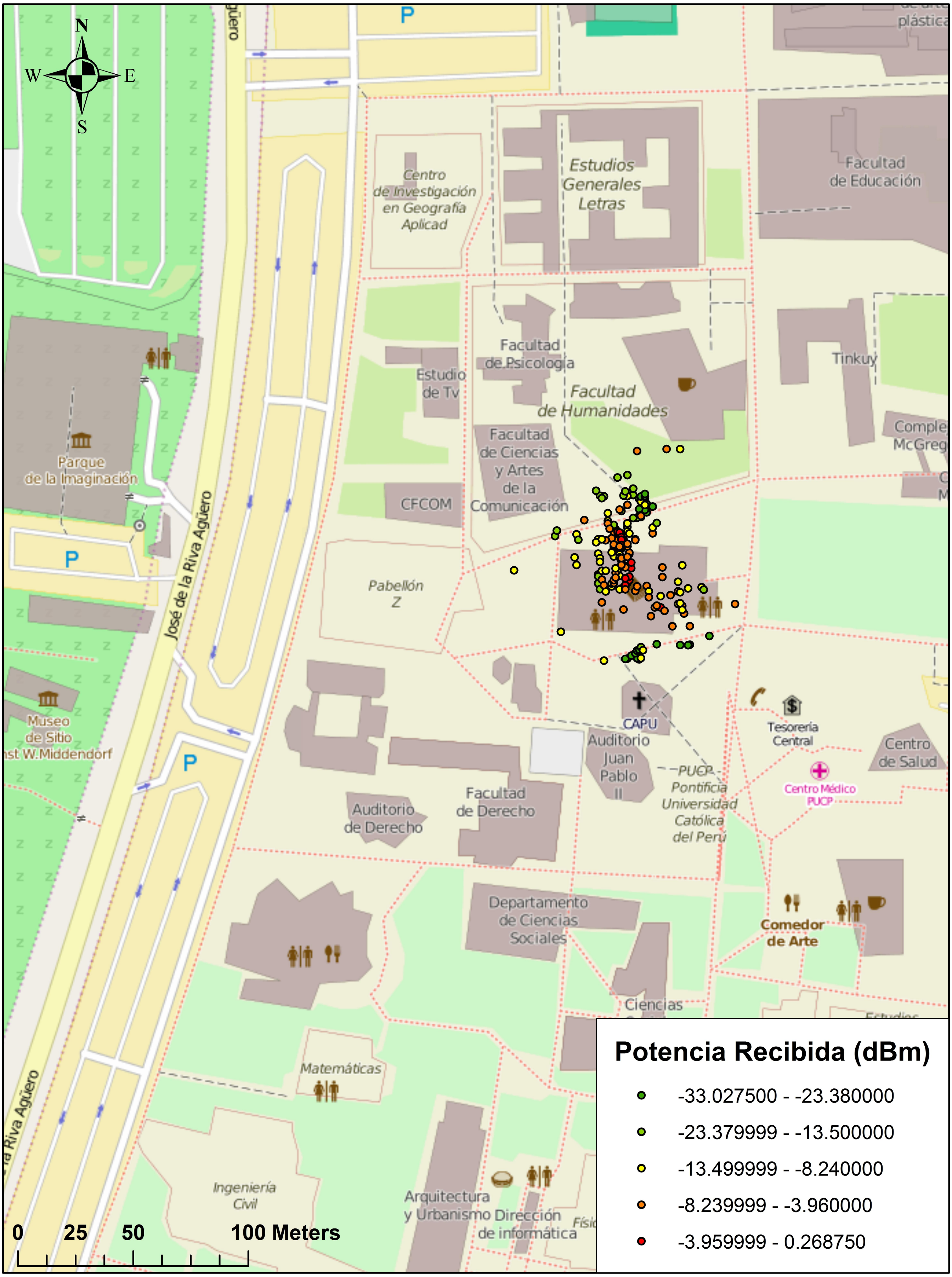
Medición con la antena de retorno de 1900 MHz



Medición con la antena de retorno de 850 MHz



GUIA DE USO DEL ANALIZADOR DE CAMPOS ELECTROMAGNÉTICOS SRM-3006 DEL NARDA SAFETY TEST SOLUTIONS

A continuación se describirán los pasos realizados a la hora de analizar los puntos medidos por el equipo SRM-3006.

1. El equipo viene con el software SRM-3006_Tools, el cual te permite realizar operaciones básicas como la de configurar el equipo según la medición a realizar, descargar y visualizar los datos almacenados en el equipo, entre otras opciones básicas. Como se necesita trabajar con los datos almacenados, se necesita descargar el software SRM-3006_TS, el cual te permite una evaluación de los datos, para el caso de la presente tesis, te permite realizar la integración del todo el rango medido.
2. Una vez descargo el software e importado todos los puntos medidos almacenados en el equipo (en formato .CSV), se procederá a trabajar con las mediciones. Para ello se debe crear una database en formato .srmdb, realizando los siguientes pasos: File>New>Database como se observa en la figura 1.

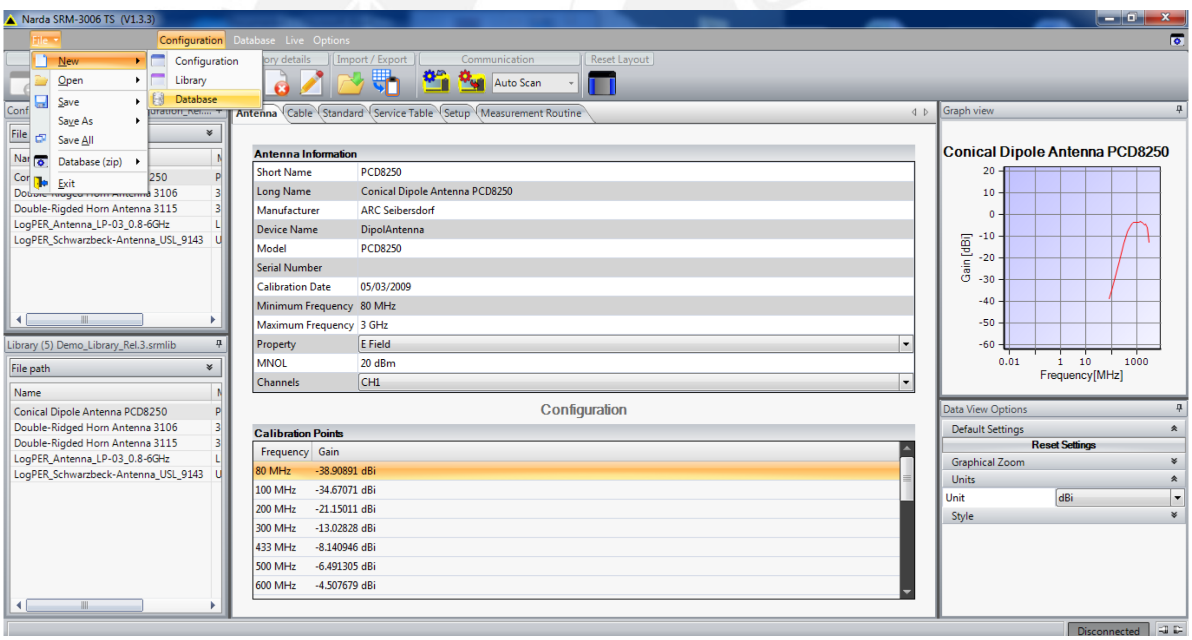


Figura 1: Creación de una database en el software SRM-3006_TS

3. Luego de haber creado la database, se procederá a almacenar toda la data importada del analizador dentro del archivo .srmdb creado. Para ello en la pestaña Database debajo del pestaña Import/Export se encuentra la opción Data. Luego de darle clic, se abrirá el cuadro de la figura 2. Allí se selecciona Folder, ya que en mi caso importe una gran cantidad de datos y los almacené una carpeta (folder), luego seleccionas la ubicación del folder y finalmente te aparecerá la figura 3, con

todos los datos que se encontraron en tu folder. Seleccionas lo que se requieren, en mi caso todo, y le das a la opción Save.

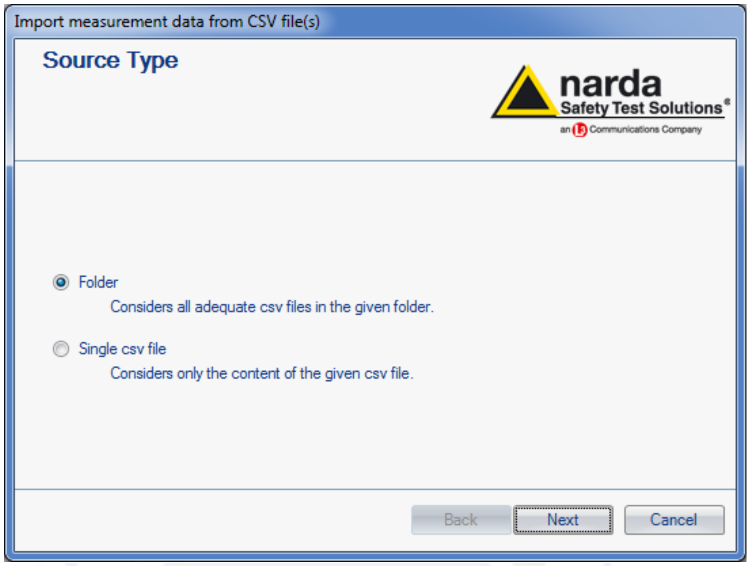


Figura 2: Cuadro de importación de datos

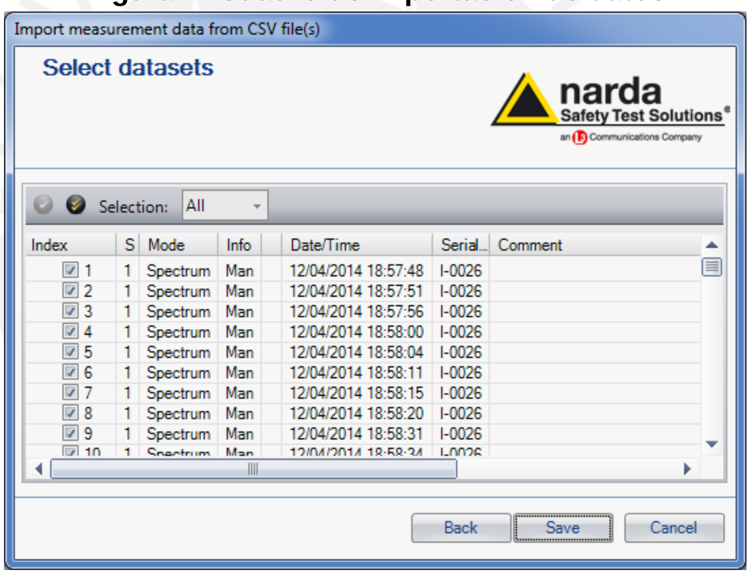


Figura 3: Cuadra de selección de datos a analizar

4. Luego se empezaran a importar toda la data seleccionada (figura 4) y se podrá visualizar cada punto medido en la parte inferior izquierda, en el cuadra Database. Finalmente se selecciona el dato y en la esquina derecha inferior se encuentra habilitada el cuadro de Evaluation, en donde se encuentra la opción Integration. Se puede realizar la integración de manera manual en la misma grafica o bien seleccionando una frecuencia de integración mínima o máxima (figura 5).

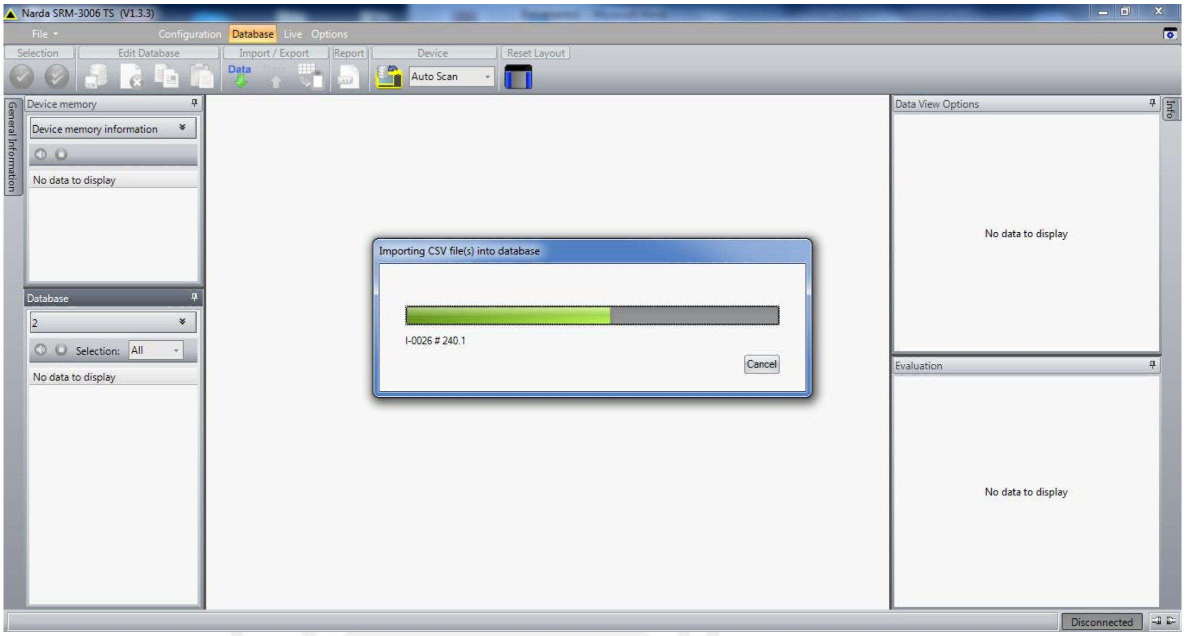


Figura 4: Importación de los datos en la archivo database creado

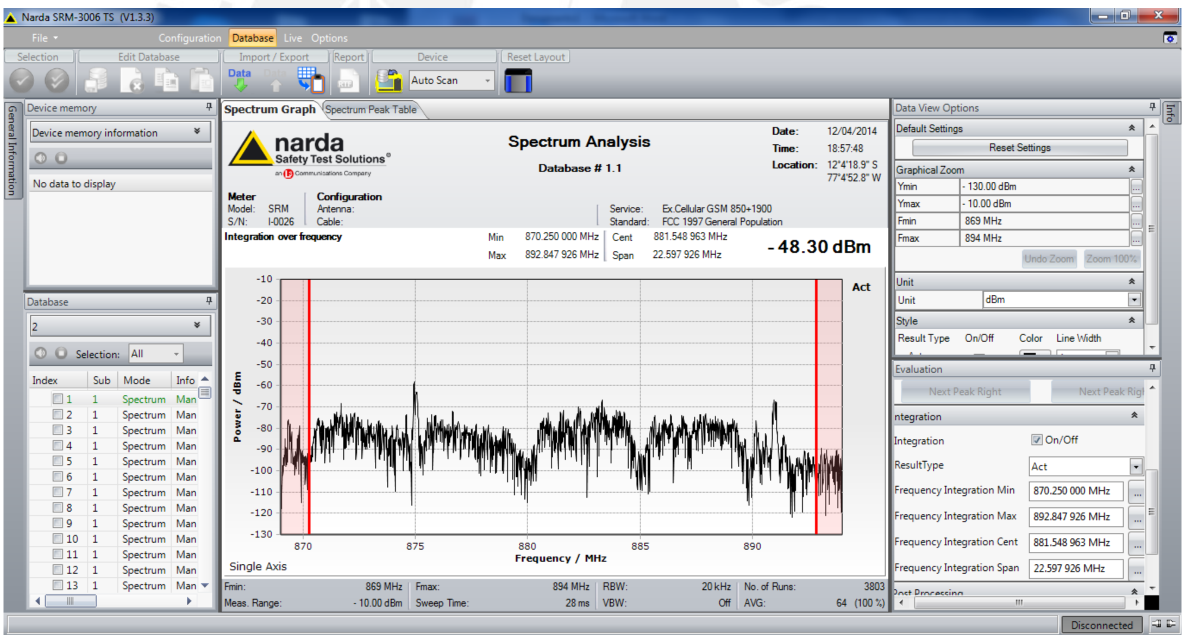


Figura 5: Evaluación de uno de los datos importados

Elaborado por Giancarlo Villena Prado

RESULTADOS DE LAS PRUEBAS DEL SISTEMA

Como se mencionó en el documento de tesis, los resultados fueron analizados a través de la herramienta API de Google Maps. A continuación se escribirán los URL's donde se puede analizar con mayor detalle cada punto analizado según la prueba realizada:

1. **Pruebas realizadas a nivel del suelo:**

   - **Prueba con la antena de retorno de 850 MHz**

     https://www.google.com/fusiontables/DataSource?docid=1vIPy-IPD416j_5FfYPz_-rczxCwhib-JDq4x2bUX#map:id=3

   - **Prueba con la antena de retorno de 1900 MHz**

     https://www.google.com/fusiontables/DataSource?docid=1xHSgUc9fNnzYJ-eid7jwPIHdhL7ScaOS0_4vcYsO&pli=1#map:id=3

2. **Pruebas realizadas en el drone alrededor de la antena de telefonía celular:**

   - **Prueba con la antena de retorno de 850 MHz**

     https://www.google.com/fusiontables/DataSource?docid=1bcI5O7JU-rGrXqTD2Pyfwg5di53QpBS6n-0CMVR6#map:id=3

   - **Prueba con la antena de retorno de 1900 MHz**

     https://www.google.com/fusiontables/DataSource?docid=1tgQ1_rEmwQhw8svLCCdyuGjq7zc1UV2Z2-RNrD57&pli=1#map:id=3