

# LTC5587

## 6GHz RMS Power Detector with 12-bit Digital Output

### DESCRIPTION

Demonstration circuit 1638A is a Mean-Squared Power Detector with integrated 12-bit ADC featuring the LTC<sup>®</sup>5587 IC.

The LTC5587 is a wide dynamic range Mean Squared RF Power Detector, operational from 10MHz to 6GHz, with sample rate up to 500ksps. The input dynamic range at 2.14GHz, with  $\pm 1$ dB nonlinearity, is 40dB (from  $-34$ dBm to  $+6$ dBm, single-ended 50  $\Omega$  input). The detector output,  $V_{OUT}$  is also the input to the internal ADC, the digital output slope is typically 70LSB/dB, and the typical output variation over temperature is  $\pm 1$ dB at 2.14GHz.

LTC5587 has the internal 12-bit SPI compatible ADC. DC1638A demonstrates the performance in conjunction with DC590B Quick-Eval board. The DC590B board samples the ADC at approximately 200Hz. Faster sampling rate is possible, contact LTC applications for more information.

The 1638A Demo Circuit input is optimized for wide frequency range of 1.75GHz to 2.2GHz. However, input match can be shifted down to 10MHz or up to 6GHz with simple external matching.

**Design files for this demo board are available. Call the LTC factory.**

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**Typical Performance Summary ( $V_{CC} = V_{DD} = 0V_{DD} = 3.3V$ ,  $V_{EN} = 3.3V$ ,  $V_{REF} = 1.8V$ ,  $V_{OUT} = \text{ADC OUTPUT(LSB)} * 1.8/4096$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted. Test circuit shown in Figure 1.)**

| PARAMETER                          | CONDITION  | TYPICAL VALUE           |
|------------------------------------|--|-------------------------|
| $0V_{DD}$ Supply Voltage           |  | 1.0 to $V_{DD}$         |
| $V_{DD}$ Supply Voltage            |  | 2.7V to 3.6V            |
| $V_{CC}$ Supply Voltage            | Should be equal to $V_{DD}$                        | 2.7V to 3.6V            |
| $V_{REF}$ Reference Voltage        |  | 1.4 to $V_{DD} + 0.05V$ |
| Total Supply Current               | No RF input signal, ADC operational at 500ksps     | 3mA                     |
| Shutdown Current                   | $V_{EN} = 0.3V$ , $CONV = 3.3V$ , ADC Sleep-Mode   | 0.2 $\mu$ A             |
| EN Voltage                         | Low, Chip Disabled<br>HIGH, Chip Enabled           | 0.3V max<br>2V min      |
| EN Input Current                   | $V_{EN} = 0V$<br>$V_{EN} = 3.3V$                   | 0 $\mu$ A<br>20 $\mu$ A |
| Output Detector Voltage, $V_{OUT}$ | No Input Signal Present                            | 0.18V                   |
| Rise Time(1000pF on $V_{OUT}$ )    | 0.2V to 1.6V, 10% to 90%, $F_{RF} = 2140$ MHz      | 1 $\mu$ s               |
| Fall Time(1000pF on $V_{OUT}$ )    | 1.6V to 0.2V, 90% to 10%, $F_{RF} = 2140$ MHz      | 8 $\mu$ s               |
| Input Frequency Range              | With external matching components                  | 10MHz to 6GHz           |
| <b>f = 880MHz</b>                  |  |                         |
| RF Input Power Range               | CW input: Externally Matched to 50 $\Omega$ Source | -34 to 6 dBm            |
| Linear Dynamic Range, CW           | $\pm 1$ dB linearity error                         | 40 dB                   |
| Output Slope                       |  | 73LSB/dB                |
| Logarithmic Intercept              |  | -42dBm                  |

|                                 |  |              |
|---------------------------------|--|--------------|
| Output Variation vs Temperature | $P_{IN} = -34$ to $+6$ dBm                             | $\pm 1$ dB   |
| Deviation from CW Response      | EDGE $3\pi/8$ Shifted 8PSK, $P_{IN} = -34$ to $+6$ dBm | $\pm 0.1$ dB |
| <b>f = 2140MHz</b>              |  |              |
| RF Input Power Range            | CW input: Externally Matched to $50\Omega$ Source      | -34 to 6 dBm |
| Linear Dynamic Range, CW        | $\pm 1$ dB linearity error                             | 43 dB        |
| Output Slope                    |  | 73 LSB/dB    |
| Logarithmic Intercept           |  | -42dBm       |
| Output Variation vs Temperature | $P_{IN} = -34$ to $+6$ dBm                             | $\pm 1$ dB   |
| Deviation from CW Response      | 12 dB peak-to-average ratio (4 carrier WCDMA)          | $\pm 0.5$ dB |
| <b>F=3500MHz</b>                |  |              |
| Linear Dynamic Range, CW        | $\pm 1$ dB linearity error                             | 36dB         |
| Slope                           |  | 73LSB/dB     |
| Logarithmic Intercept           |  | -40dBm       |
| Output Variation vs Temperature | $P_{IN} = -30$ to $+6$ dBm                             | $\pm 1$ dB   |
| Deviation from CW Response      | WiMAX OFDM Burst; $P_{IN} = -34$ to $+4$ dBm           | $\pm 0.5$ dB |
| <b>ADC Resolution</b>           |  |              |
| ADC Resolution                  | (no missing code)                                      | 12 bits      |
| Differential Linearity Error    | EN=0V, Voltage on $V_{OUT}=0V$ to 1.8V, $V_{REF}=1.8V$ | $\pm 0.25$   |
| Measurement Resolution          | 1LSB= $V_{REF}/(4096 * 29mV/dB)$ , $V_{REF}=1.8V$      | 15m dB       |

Table 1. Jumper Description for DC1638A

| JUMPER | FUNCTION                               | RANGE/SETTING (DEFAULT) |
|--------|--|-------------------------|
| JP1    | VDD, ADC power supply voltage          | 3.3V                    |
| JP2    | VREF, ADC reference input voltage      | VREG=1.8V               |
| JP3    | OVDD, ADC output driver supply voltage | 3.3V                    |

## DC590B QUICK START PROCEDURE

The DC590B is a USB controller board that allows PC to communicate through serial data interface. The Quick start guide for DC590B can be found here: <http://cds.linear.com/docs/Reference%20Design/dc590B.pdf>. Download and install the QuickEval software supplied for DC590B here: [http://www.linear.com/designtools/software/quick\\_eval.jsp](http://www.linear.com/designtools/software/quick_eval.jsp). Connect DC590B to the host PC with the USB A/B cable.

1. Connect the DC1638A to the DC590B USB serial controller board using the supplied 14-conductor ribbon cable.
2. Set **VCCIO on DC590B to 3.3V** on the USB controller board.
3. Set the JP4, the "EN", which will enable the EEPROM for DC590B to automatically recognize the DC1638A board with LTC5587 when connected.
4. Set JP5 to ON, for both ISO and SW, they provide the VCCIO voltage to DC1638.
5. JP1, and JP2 are not used. Leave open.

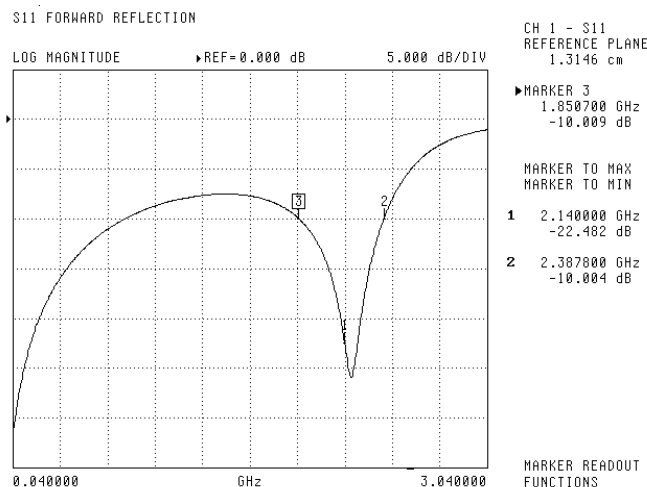
## DC1638A QUICK START PROCEDURE

Demonstration circuit 1638A is easy to set up to evaluate the performance of the LTC5587. Refer to [Figure 2](#) for measurement equipment setup and follow the procedure below:

1. Connect DC power negative (-) supply to GND test point.
2. Connect DC power positive(+) supply to VCC and EN.
3. Set JP1(VDD) to 3.3V. This will power the LTC5587 Digital supply using the on board 3.3V regulator. The on board 3.3V regulator receives power from the DC590B board.
4. Set JP2(VREF) to VREG. This will supply the VREF using the on board 1.8V regulator. The on board 1.8V regulator receives power from the VCC supply.
5. Set JP3(OVDD) to 3.3V. This will power up the ADC output digital driver using the on board 3.3V regulator, which gets the power from DC590B.
6. Connect the signal generator's output to J1(RFIN), using the SMA connector. A 3dB attenuator pad may be used to improve broadband match, which will shift the detected power range up by 3dB.
7. The LTC5587 software control panel automatically opens when the DC1638A demo board is connected to the DC590B board. Using the Quick Eval software, set the VREF voltage to 1.8V.
8. Click on Collect to start reading the ADC.

### NOTES:

1. The voltage on the EN test point must never exceed  $V_{CC} + 0.3V$ .



**Figure 1. Standard Demo Board Return Loss**

2. For digitally modulated signals, an oscilloscope can be used to observe the AC components of the output.
3. If no DC power supply is available, DC1638A can also be power up using the on board 3.3V regulator. Connect the 3.3V test point to VCC and EN.
4. Pin 6,  $C_{SQ}$  is the Optional Low Frequency Range Extension Capacitor. Use this pin for frequencies below 250MHz. Connect 0.01uF from Pin 8 to ground for 10MHz operation.
5. The software can display either ADC count, or the calculated voltage based on the ADC VREF input. Go to tools=>options to select.
6. The vertical axis can be toggled between Auto and Full by clicking on it at the upper left corner of the control panel.
7. Do not exceed +15dBm, the absolute maximum average RF input power.
8.  $V_{out}$  is the analog input voltage to the ADC. VREF defines the full-scale output range of ADC, 0V to VREF.

9. The Software allows datalog of output data, and saves the file as .adc format, which Microsoft Excel® can be used to open. Equivalent output voltage can be calculated from the ADC code based on the  $V_{REF}$  as follows.

$$V_{out} = \left( \frac{ADC\ Code * V_{ref}}{4096} \right)$$

Where  $V_{REF}=1.8V$  for the standard demo board.

10. Linearity Error at any input power level can be calculated from the  $V_{out}$ , given the best fit slope and Log intercept, as follows:

$$Linearity\ Error = \left( \frac{V_{out}}{slope} \right) + Log\ Intercept + Pin$$

Best fit slope is taken for  $P_{in}$  from -20dBm to 0dBm.

11. Averaging Function can be turned on by clicking on the upper left hand corner on the front control panel, Figure 3.

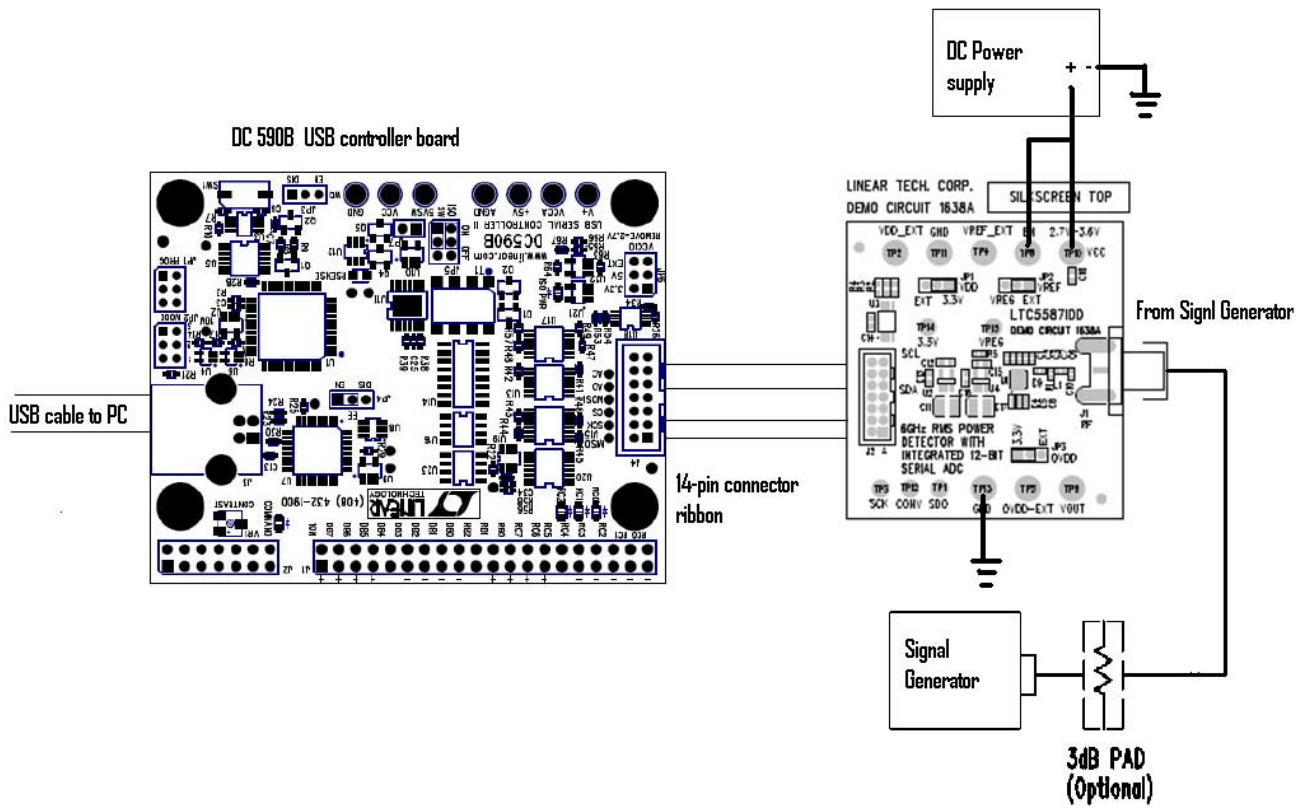


Figure 2. Proper test setup to connect DC1638A demo board to DC590A

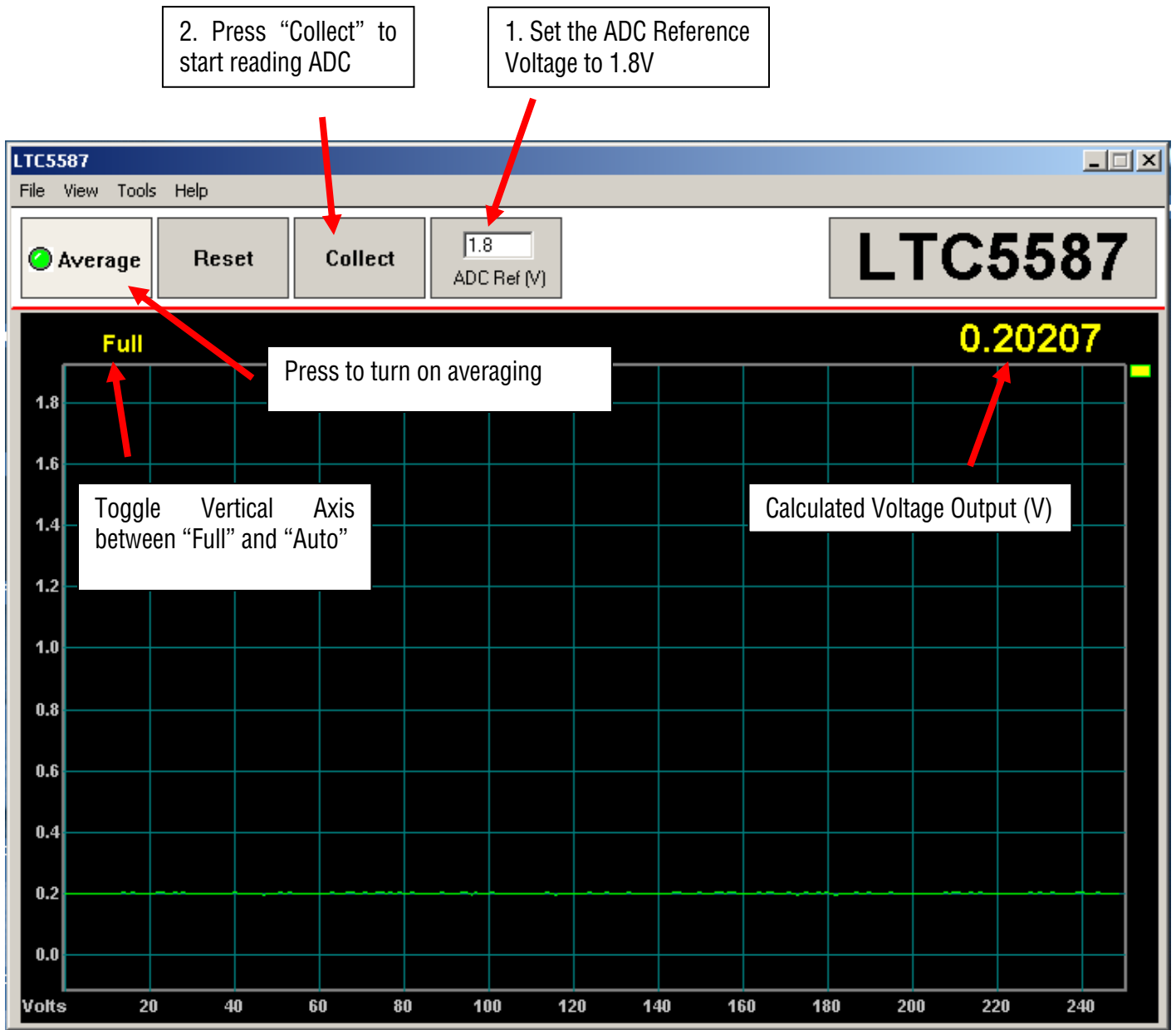
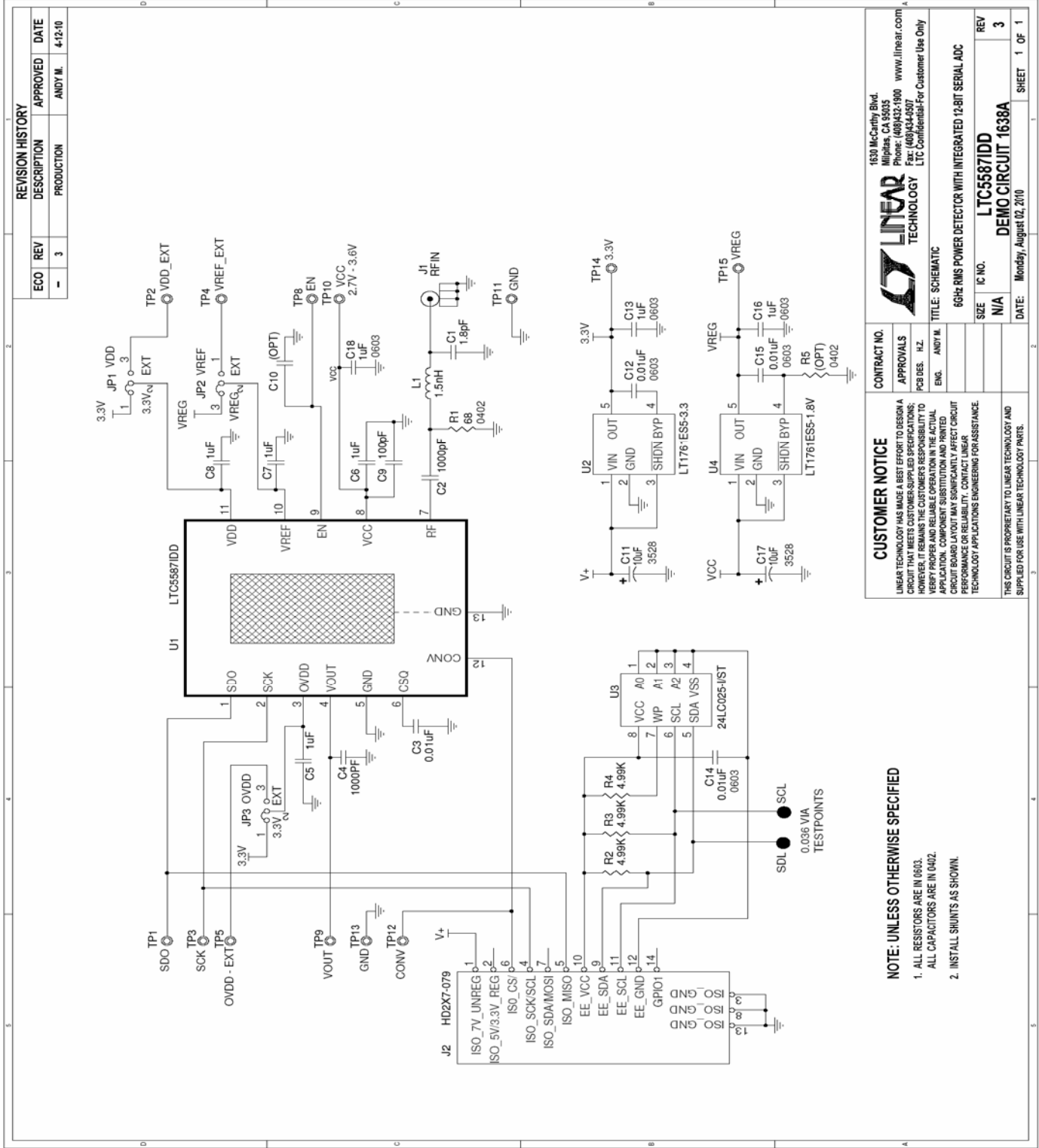


Figure 3. Front Control Panel for LTC5587. With no RF input signal.

Table 2. RF Input Modifications for various Frequency Ranges.

| FREQUENCY RANGE | RF <sub>IN</sub> MATCH |       |
|-----------------|------------------------|-------|
|                 | L1                     | C1    |
| 0.04 to 1.8GHz  | 3.3nH                  | 1.8pF |
| 1.75 to 2.2GHz  | 1.5nH                  | 1.8pF |
| 2.4 to 2.9GHz   | 0                      | 1.5pF |
| 2.8 to 3.8GHz   | 0                      | 0.7pF |
| 4.5 to 6.0GHz   | 0                      | 0     |



| REVISION HISTORY |     |             |          |         |
|------------------|-----|-------------|----------|---------|
| ECO              | REV | DESCRIPTION | APPROVED | DATE    |
| -                | 3   | PRODUCTION  | ANDY M.  | 4-12-10 |

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**CONTRACT NO.**

**APPROVALS**

PCB DES. H.Z.

ENG. ANDY M.

**TITLE:** SCHEMATIC

66Hz RMS POWER DETECTOR WITH INTEGRATED 12-BIT SERIAL ADC

SIZE: N/A

IC NO.: LTC5587IDD

REV: 3

DATE: Monday, August 02, 2010

SHEET 1 OF 1

**NOTE: UNLESS OTHERWISE SPECIFIED**

- ALL RESISTORS ARE IN 0603.
- ALL CAPACITORS ARE IN 0402.
- INSTALL SHUNTS AS SHOWN.

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