

# Model SR555 / SR556 Operation Manual

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## Current Preamplifier



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## **Certification**

Stanford Research Systems certifies that this product met its published specifications at the time of shipment.

## **Warranty**

The Stanford Research Systems product is warranted against defects in materials and workmanship for a period of one (1) year from the date of shipment.

## **Service**

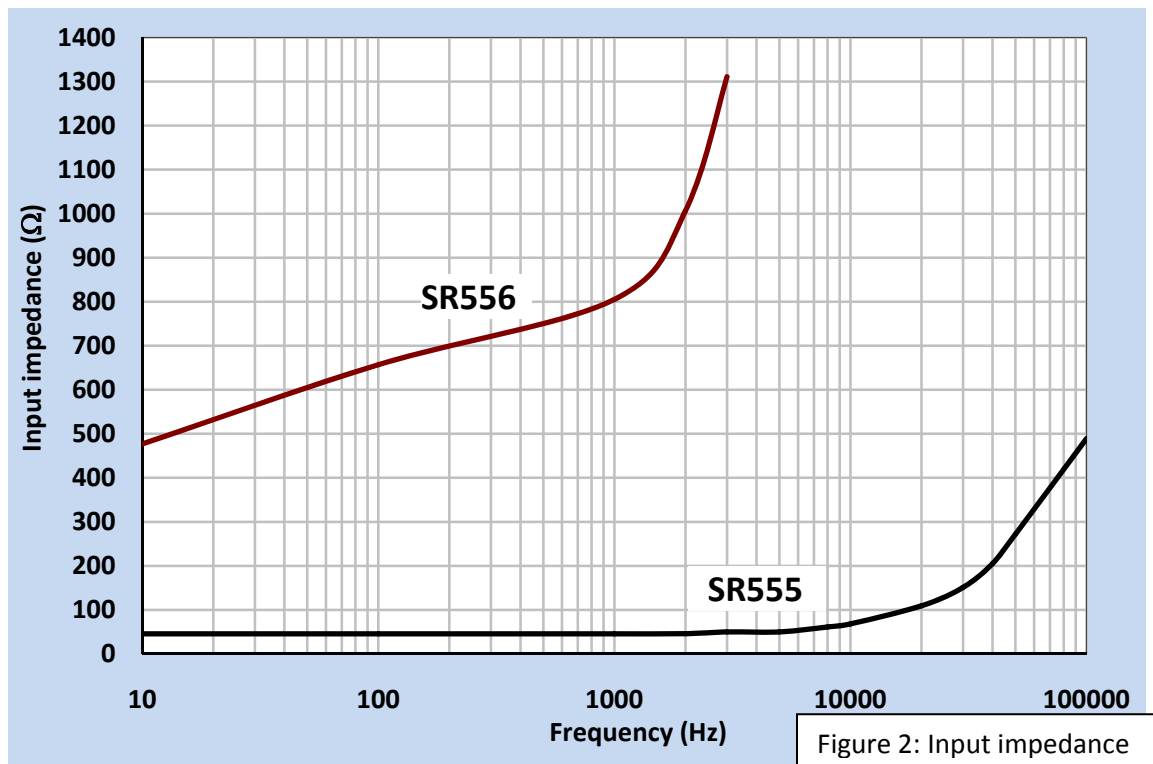
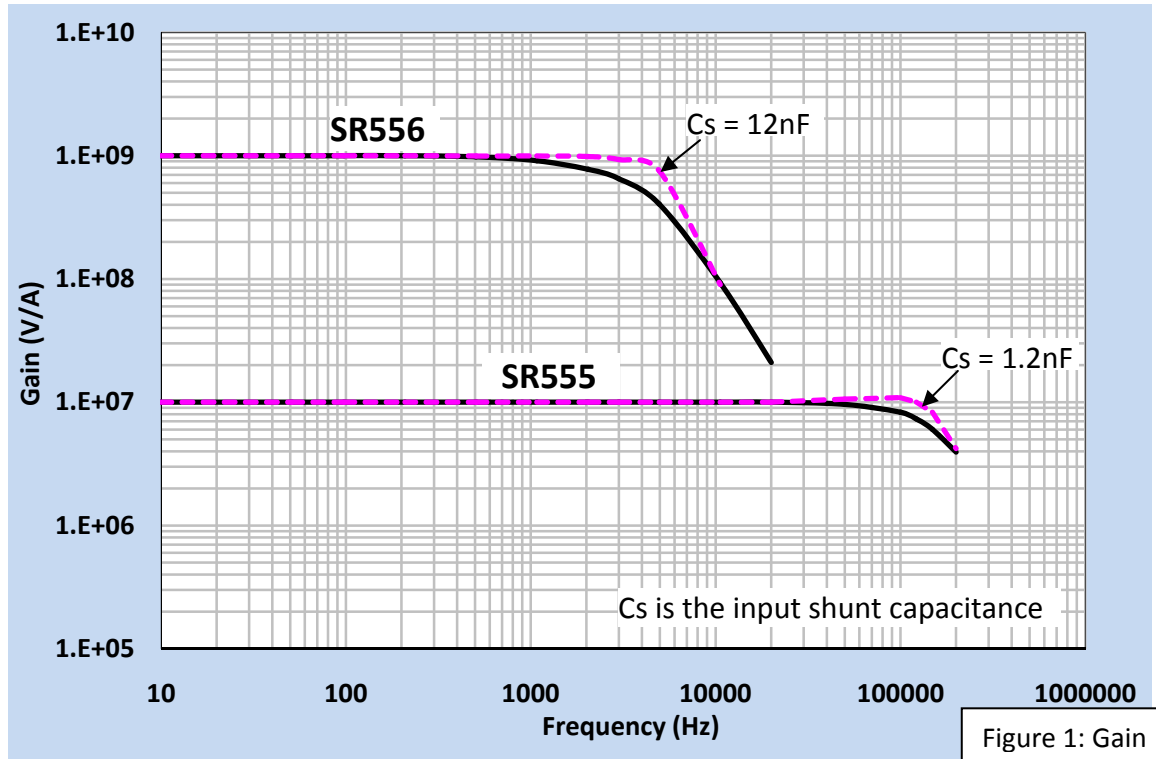
For warranty service or repair, this product must be returned to a Stanford Research Systems authorized service facility. Contact Stanford Research Systems or an authorized representative before returning this product for repair.

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This manual is SRS Part Number 9-01686-903.

## 1. Specifications

|                            | SR555                                                                                                        | SR556                         |
|----------------------------|--------------------------------------------------------------------------------------------------------------|-------------------------------|
| Gain (Transimpedance)      | $10^7$ V/A                                                                                                   | $10^9$ V/A                    |
| Gain accuracy              | ±1%                                                                                                          | ±1%                           |
| Gain stability             | ±50 ppm / °C                                                                                                 | ±50 ppm / °C                  |
| Bandwidth                  | DC – 120 kHz (-3dB)                                                                                          | DC – 3 kHz (-3dB)             |
| Rise-/Fall-time            | 2.9 μs                                                                                                       | 120 μs                        |
| Input current noise (typ)  | 42 fA/√Hz @ 1kHz                                                                                             | 5.0 fA/√Hz @ 1kHz             |
| Input voltage noise (typ)  | 4.5 nV/√Hz @ 1kHz                                                                                            |                               |
| Input bias current         | 3 pA typ.                                                                                                    |                               |
| Input offset voltage       | ±150 μV max                                                                                                  |                               |
| Input voltage range        | -9V – +9V (Outside of this range may cause permanent damage)                                                 |                               |
| Input resistance (DC)      | 50 Ω                                                                                                         | 50 Ω                          |
| Input capacitance          | 16 pF                                                                                                        | 12 pF                         |
| Input current range        | ±1 μA (for linear operation)                                                                                 | ±10 nA (for linear operation) |
| External input capacitance | Up to 1nF                                                                                                    | Up to 10nF                    |
| Bias input                 | -5 – +5 Vdc                                                                                                  |                               |
| Bias input impedance       | 1 MΩ                                                                                                         |                               |
| Bias rejection             | -76 dB typ. (Output response to DC bias input)                                                               |                               |
| Bias settling time         | <150 ms                                                                                                      | <250 ms                       |
| Output                     | 20Vpp max, balanced differential<br>10mA max<br>50Ω output impedance                                         |                               |
| Power                      | +20V ±10% / 80mA<br>-20V ±10% / 50mA<br>(Supplied by SR510, SR530, SR810, SR830, or SR124 via control cable) |                               |
| Mechanical                 | 3.1" × 1.4" × 5.1"(WHD)                                                                                      |                               |
| Weight                     | 10 oz                                                                                                        |                               |

## 2. Typical Characteristics



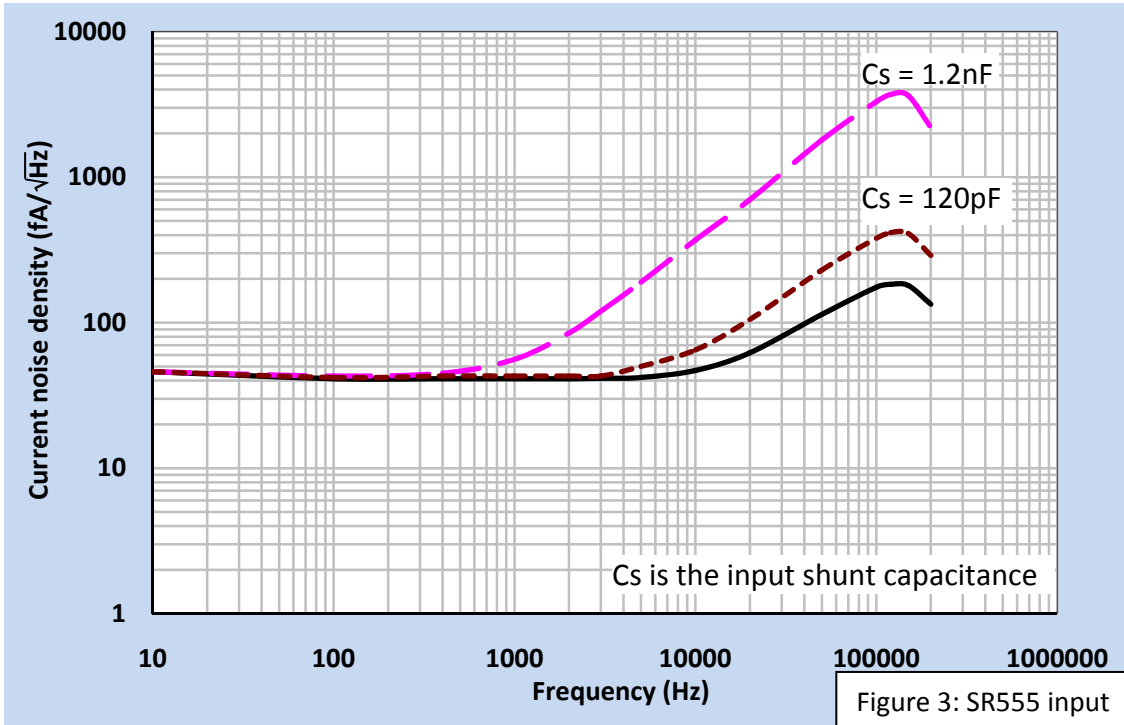


Figure 3: SR555 input current noise density

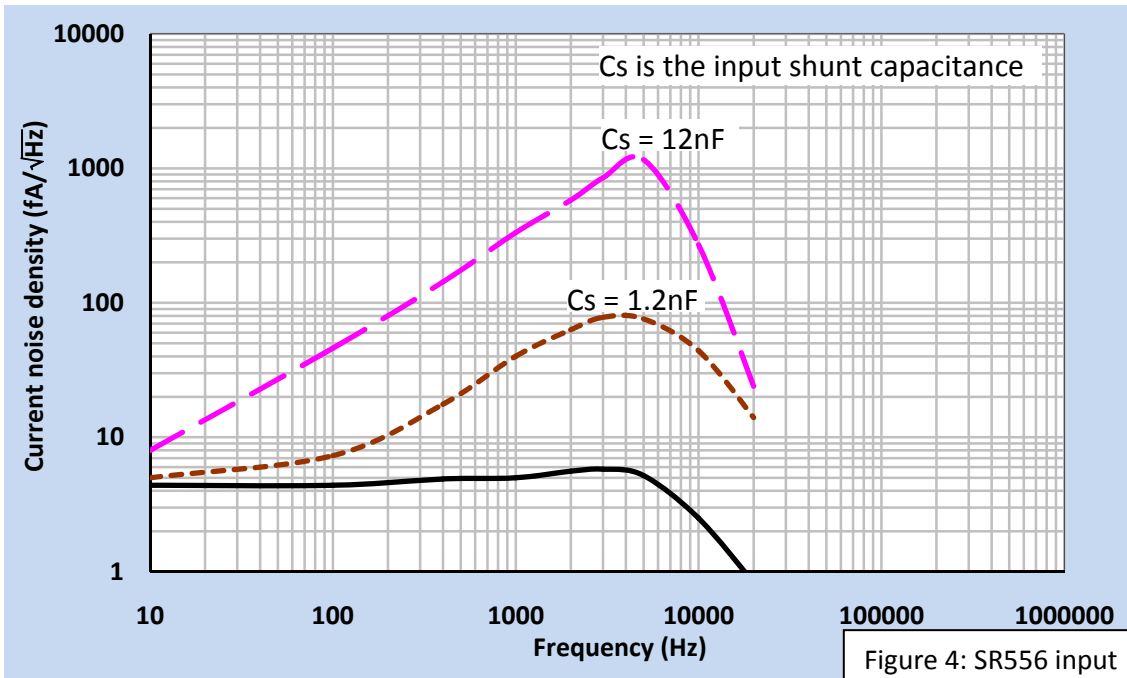
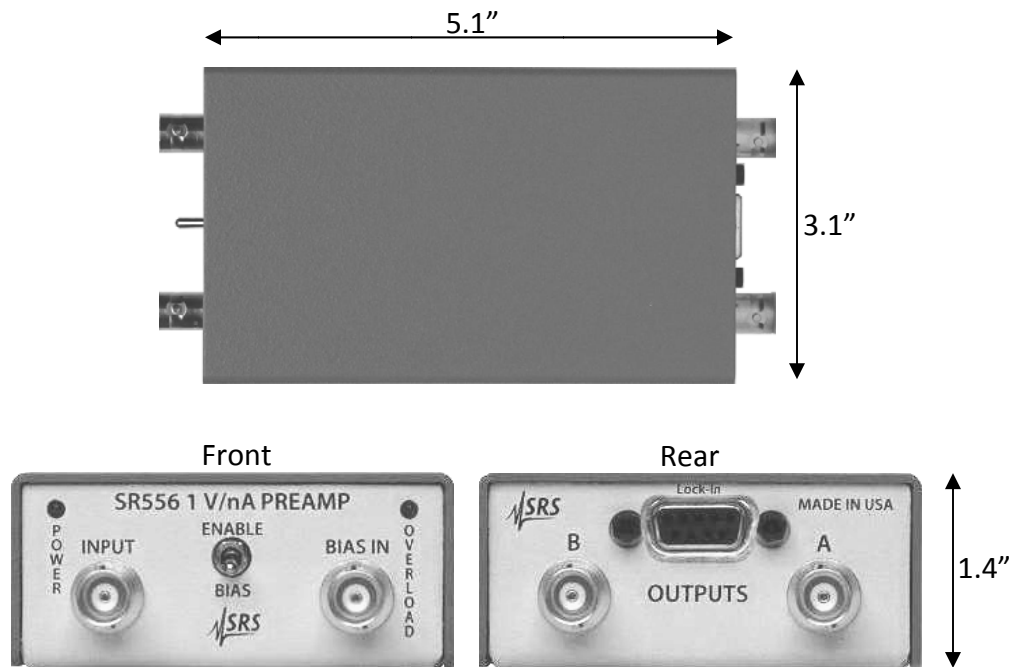
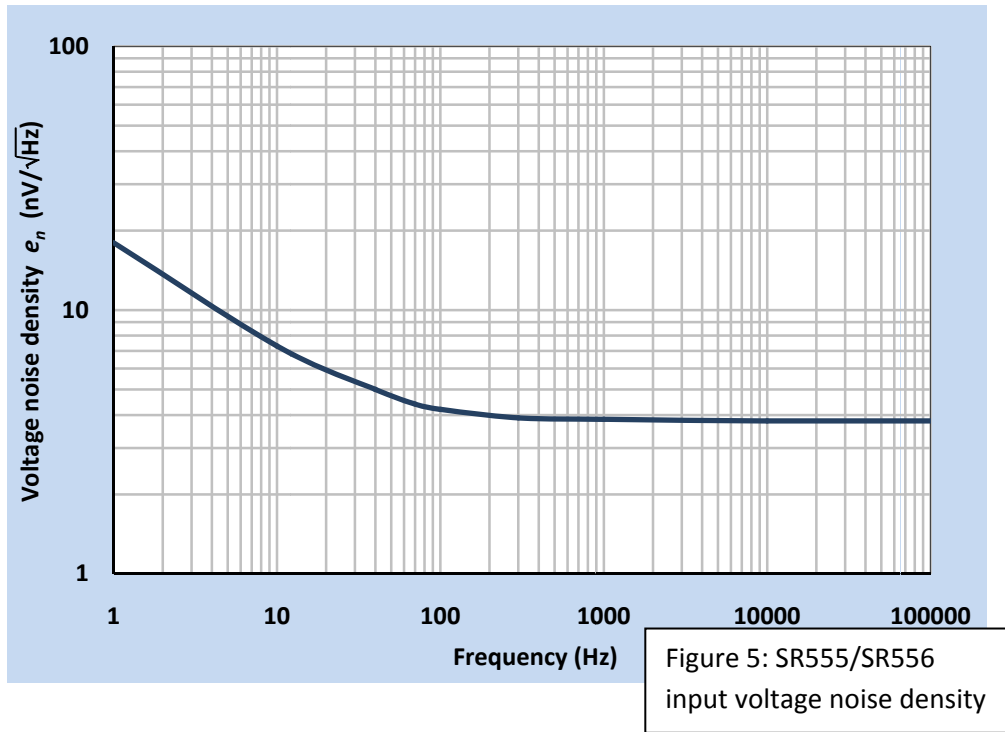


Figure 4: SR556 input current noise density



### 3. Description

The block diagram below shows the SR555/SR556 current amplifier which converts input current into a differential output voltage. The total differential output voltage is given by  $V_A - V_B = i \times R_f$ . A current amplifier is also called a Transimpedance Amplifier, or a TIA.

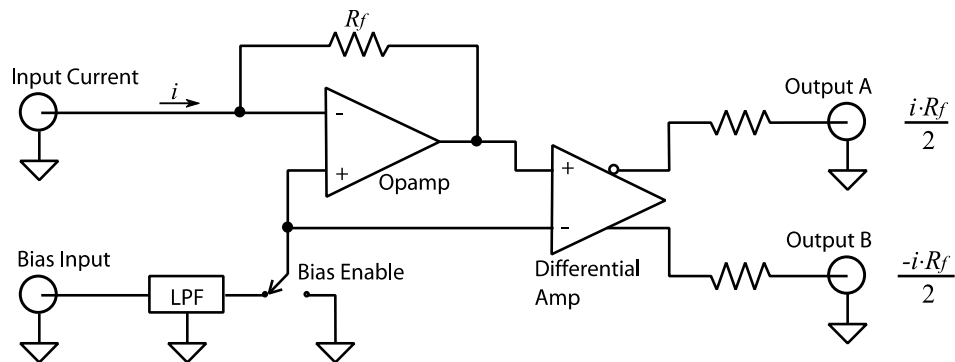


Figure 7 A block diagram of SR555/SR556 current amplifiers

Unlike a simple resistor, the transimpedance amplifier presents a low-impedance node to the source. This node is generally a virtual ground. In the SR555/SR556, this node voltage can be set at the user provided voltage by switching to “Bias Enable”. This bias voltage will not be present in the output signal since it is subtracted out by the post differential amplifier.

The SR555/SR556 can be located close to the source to eliminate long cables, capacitive loading and noise pickup. The two output signals should be used differentially for best results. The capacitance from long input cables or intrinsic capacitance from the input source will add up to the total source capacitance  $C_s$ . This will react with the opamp voltage noise  $e_n$  (shown in Figure 5) to add an effective current noise of  $2\pi f C_s e_n$  to the equivalent input noise, as shown in Figures 3 and 4 (so-called “noise gain peaking”). It should be noted that  $C_s$  has virtually no effect on the *signal* gain, as shown in Figure 1.

The SR555 and SR556 are ideal low-noise current preamplifiers for SRS’ lock-in amplifiers, and can also be used for any other small current detection purposes.

## 4. Using the SR555/SR556 with a Lock-In

Power is supplied to the SR555/SR556 via the 9 pin cable which is supplied with the unit. If it is used as a pre-amplifier for a SRS' lock-in amplifier, attach one end of the cable to the connector on the rear of the SR555/SR556. With the lock-in power off, connect the other end of the cable to the "PREAMP" connector on the rear of the lock-in. Both ends of the cable are equivalent. If a longer cable is required, any standard cable with male 9-pin D-sub connectors on both sides, wired pin-to-pin, will suffice.

The Output A of the SR555/SR556 should be connected to the (A) Input of the lock-in. The Output B should be connected to the (B) Input of the lock-in. Equal-length, BNC-terminated coax cables should be used for both connections, and for best results the two cables may be twisted together to minimize inductive pickup. The lock-in Input Selector should be set to (A-B). Note that the output of the SR555/SR556 is a balanced, differential signal presented across the A and B outputs, making it important to receive the output signal differentially.

For applications in which the input current node should be left unbiased (0 V potential), the "Bias Enable" switch should be left in the down position on the SR555/SR556.

For applications in which a non-zero potential is to be established at the input current node, the "BIAS IN" BNC connector is used. This is a DC input that programs the non-inverting node of the input opamp, and sets the voltage of input current signal. The DC bias voltage is subtracted by the differential amplifier and will not be sensed by the lock-in amplifier.

The overall sensitivity of the lock-in plus the preamplifier is *not* displayed on the lock-in front panel. It is necessary to divide the displayed sensitivity by the preamplifier gain:  $10^7$  V/A for the SR555, or  $10^9$  V/A for the SR556.

## 5. Using the SR555/SR556 without a Lock-In

The SR555/SR556 can be powered with an external power supply. Power is applied through the 9 pin connector as described in the table below:

| Pin | Voltage           | Current |
|-----|-------------------|---------|
| 1   | +20 VDC $\pm$ 10% | 80 mA   |
| 6   | -20 VDC $\pm$ 10% | 50 mA   |
| 7,8 | Ground            |         |

Both DC voltages are required. Either Pin 7 or pin 8, or both may be used as ground. All other pins are not used. There are two protection diodes connected between the internal regulators and the +20V and -20V input pins.



## 6. Circuit Description

The transimpedance amplifier consists of opamps U1, U2 and gain resistor R7 (R3 for SR555). Input current coming through J1 and R1 will pass through R7 and sink to the output node of U2. A corresponding voltage will be present at TP1. The bias voltage signal from J2 is low-pass filtered and fed to the non-inverting node of U1. R8 through R10, C3, and C25 form the low pass filter, and are buffered by a follower U3. SW1 is used to enable or disable the bias voltage. TP2 is either grounded or equal to the follower U3 output voltage. U4 and RN1 form a fully differential amplifier / low pass filter whose differential output is proportional to the current signal from J1 (bias voltage is subtracted).

U5 and U6 regulate the DC power inputs from connector J5 to provide internal  $\pm 15V$  power supplies. U11 provide the +5V and used by U10 and overload LED.

## 7. Parts Lists

### a. SR555

| <i>Part Number</i> | <i>Reference</i>                    | <i>Value</i> |
|--------------------|-------------------------------------|--------------|
| 5-00570            | C3,C25                              | .1U          |
| 5-00299            | C4,C5,C8,C9,C10,<br>C11,C17,C18,C24 | .1U          |
| 5-00260            | C6,C7                               | 470U         |
| 5-00383            | C12                                 | 470P         |
| 5-00377            | C13,C14                             | 150P         |
| 5-00848            | C19,C20,<br>C21,C22,C23             | 1.0U         |
| 3-00230            | D1,D5                               | 1N5240A      |
| 3-00945            | D2                                  | BAT54S       |
| 3-00010            | D3                                  | GREEN        |
| 3-00011            | D4                                  | RED          |
| 3-00003            | D6, D7                              | 1N4001       |
| 1-01344            | J5                                  | DB-9 Female  |
| 1-01320            | J6,J7                               | 5 PIN        |
| 6-00174            | L1,L2                               | 6611 TYPE 43 |
| 4-00191            | R1,R12,R13                          | 49.9         |
| 4-01760            | RN1                                 | 668-A-2001-A |

|         |                              |         |
|---------|------------------------------|---------|
| 4-00925 | R2,R6,R23                    | 10      |
| 4-02539 | R3                           | 10.0M   |
| 4-01021 | R4                           | 100     |
| 4-01213 | R5                           | 10.0K   |
| 4-01551 | R8                           | 1.0M    |
| 4-01309 | R9,R10,R24                   | 100K    |
| 4-00800 | R11                          | 1       |
| 4-01184 | R15,R17,R18,<br>R19, R20,R30 | 4.99K   |
| 4-01181 | R16,R21                      | 4.64K   |
| 4-01347 | R22                          | 249K    |
| 4-01088 | R25,R26,R27,R28              | 499     |
| 2-00022 | SW1                          | DPDT    |
| 3-00998 | U3                           | OPA227  |
| 3-02155 | U4                           | THS4131 |
| 3-00711 | U5                           | 78L15   |
| 3-01301 | U6                           | 79L15   |
| 3-00728 | U7,U8,U9                     | LM393   |
| 3-00662 | U10                          | 74HC14  |
| 3-00116 | U11                          | LM78L05 |

**b. SR556**

| <i>Part Number</i> | <i>Reference</i>                    | <i>Value</i> |
|--------------------|-------------------------------------|--------------|
| 5-00389            | C2                                  | 1500P        |
| 5-00570            | C3,C25                              | .1U          |
| 5-00299            | C4,C5,C8,C9,C10,<br>C11,C17,C18,C24 | .1U          |
| 5-00260            | C6,C7                               | 470U         |
| 5-00456            | C12                                 | .015U        |
| 5-00450            | C13,C14                             | .0047U       |
| 5-00848            | C19,C20,<br>C21,C22,C23             | 1.0U         |
| 3-00230            | D1,D5                               | 1N5240A      |
| 3-00945            | D2                                  | BAT54S       |
| 3-00010            | D3                                  | GREEN        |
| 3-00011            | D4                                  | RED          |
| 3-00003            | D6, D7                              | 1N4001       |
| 1-01344            | J5                                  | DB-9 Female  |
| 1-01320            | J6,J7                               | 5 PIN        |
| 6-00174            | L1,L2                               | 6611 TYPE 43 |
| 4-00191            | R1,R12,R13                          | 49.9         |
| 4-01760            | RN1                                 | 668-A-2001-A |

|         |                             |         |
|---------|-----------------------------|---------|
| 4-00925 | R2,R23                      | 10      |
| 4-01021 | R4                          | 100     |
| 4-01213 | R5                          | 10.0K   |
| 4-01261 | R6                          | 31.6K   |
| 4-02537 | R7                          | 1.00G   |
| 4-01551 | R8                          | 1.0M    |
| 4-01309 | R9,R10,R24                  | 100K    |
| 4-00800 | R11                         | 1       |
| 4-01184 | R15,R17,R18,<br>R19,R20,R30 | 4.99K   |
| 4-01181 | R16,R21                     | 4.64K   |
| 4-01347 | R22                         | 249K    |
| 4-01088 | R25,R26,R27,R28             | 499     |
| 2-00022 | SW1                         | DPDT    |
| 3-00998 | U3                          | OPA227  |
| 3-02155 | U4                          | THS4131 |
| 3-00711 | U5                          | 78L15   |
| 3-01301 | U6                          | 79L15   |
| 3-00728 | U7,U8,U9                    | LM393   |
| 3-00662 | U10                         | 74HC14  |
| 3-00116 | U11                         | LM78L05 |