

## ABSOLUTE MAXIMUM RATINGS

These are stress ratings only and functional operation of the device at these ratings or any other above those indicated in the operation sections of the specifications below is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

### Power Supply Voltage

(V+ to GND or GND to OUT).....+5.6V  
 LV Input Voltages.....(OUT - 0.3V) to (V+ + 0.3V)  
 FC and OSC Input Voltages.....The least negative of  
 (OUT - 0.3V) or (V+ - 5.6V) to (V+ + 0.3V)

OUT and V+ Continuous Output Current.....200mA  
 Output Short-Circuit Duration to GND (Note 1).....1s  
 Operating Temperature Ranges

SP6661E.....-40°C to +85°C  
 Continuous Power Dissipation ( $T_{AMB} = 70^{\circ}\text{C}$ )  
 NSOIC (derate 5.88mW/°C above +70°C).....471mW  
 $\mu$ SOIC (derate 4.10mW/°C above +70°C).....330mW  
 Operating Temperature.....-40°C to +85°C  
 Storage Temperature.....-65°C to +150°C  
 Lead Temperature (soldering 10s).....+300°C

## ELECTRICAL CHARACTERISTICS

| PARAMETER                                                                                                                              | MIN.     | TYP.     | MAX. | UNITS    | CONDITIONS                                   |
|----------------------------------------------------------------------------------------------------------------------------------------|----------|----------|------|----------|----------------------------------------------|
| <b>Inverter Circuit at Low Frequency with 22<math>\mu</math>F Capacitors</b>                                                           |          |          |      |          |                                              |
| V+ = +5.0V, C1 = C2 = C3 = 22 $\mu$ F, FC = open, LV = GND, $T_{AMB} = T_{MIN}$ to $T_{MAX}$ ; refer to Figure 1 test circuit. Note 2  |          |          |      |          |                                              |
| Supply Voltage Range                                                                                                                   | 1.5      |          | 5.3  | V        | $R_L = 500\Omega$                            |
| Start-Up Voltage                                                                                                                       |          | 0.93     |      | V        |                                              |
| Supply Current                                                                                                                         |          | 3        | 6    | mA       | No Load                                      |
| Max Output Current                                                                                                                     | 200      |          |      | mA       |                                              |
| Oscillator Input Current                                                                                                               |          | $\pm 1$  |      | $\mu$ A  |                                              |
| Oscillator Frequency                                                                                                                   | 70       | 120      | 170  | kHz      |                                              |
| Output Resistance                                                                                                                      |          | 5        | 7    | $\Omega$ | $I_L = 100\text{mA}$ , Note 3                |
| Voltage Conversion Efficiency                                                                                                          | 99.0     | 99.9     |      | %        | No Load                                      |
| Power Efficiency                                                                                                                       | 80<br>70 | 89<br>82 |      | %        | $I_L = 100\text{mA}$<br>$I_L = 200\text{mA}$ |
| <b>Doubler Circuit at Low Frequency with 22<math>\mu</math>F Capacitors</b>                                                            |          |          |      |          |                                              |
| V+ = +5.0V, C1 = C2 = C3 = 22 $\mu$ F, FC = open, LV = GND, $T_{AMB} = T_{MIN}$ to $T_{MAX}$ ; refer to Figure 22 test circuit. Note 2 |          |          |      |          |                                              |
| Supply Voltage Range                                                                                                                   | 2.5      |          | 5.3  | V        | $R_L = 1\text{k}\Omega$                      |
| Start-Up Voltage                                                                                                                       |          | 1.5      |      | V        |                                              |
| Supply Current                                                                                                                         |          | 3        | 6    | mA       | No Load                                      |
| Max Output Current                                                                                                                     | 200      |          |      | mA       |                                              |
| Oscillator Input Current                                                                                                               |          | $\pm 1$  |      | $\mu$ A  |                                              |
| Oscillator Frequency                                                                                                                   | 70       | 120      | 170  | kHz      |                                              |
| Output Resistance                                                                                                                      |          | 4.5      | 7    | $\Omega$ | $I_L = 100\text{mA}$ , Note 3                |
| Voltage Conversion Efficiency                                                                                                          | 99.0     | 99.9     |      | %        | No Load                                      |
| Power Efficiency                                                                                                                       | 89<br>79 | 94<br>90 |      | %        | $I_L = 100\text{mA}$<br>$I_L = 200\text{mA}$ |

| PARAMETER                                                                                                                                                    | MIN.     | TYP.     | MAX. | UNITS | CONDITIONS                                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|----------|------|-------|--------------------------------------------------|
| <b>Inverter Circuit at High Frequency with 3.3μF Capacitors</b>                                                                                              |          |          |      |       |                                                  |
| V+ = +5.0V, C1 = C2 = C3 = 3.3μF, FC = V+, LV = GND, T <sub>AMB</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> ; refer to <i>Figure 1</i> test circuit. Note 2 |          |          |      |       |                                                  |
| Supply Voltage Range                                                                                                                                         | 1.5      |          | 5.3  | V     | R <sub>L</sub> = 500Ω                            |
| Start-Up Voltage                                                                                                                                             |          | 0.93     |      | V     |                                                  |
| Supply Current                                                                                                                                               |          | 10       | 18   | mA    | No Load                                          |
| Max Output Current                                                                                                                                           | 200      |          |      | mA    |                                                  |
| Oscillator Input Current                                                                                                                                     |          | ±8       |      | μA    |                                                  |
| Oscillator Frequency                                                                                                                                         | 500      | 900      | 1250 | kHz   |                                                  |
| Output Resistance                                                                                                                                            |          | 5        | 7    | Ω     | I <sub>L</sub> = 100mA, Note 3                   |
| Voltage Conversion Efficiency                                                                                                                                | 99.0     | 99.6     |      | %     | No Load                                          |
| Power Efficiency                                                                                                                                             | 78<br>65 | 84<br>79 |      | %     | I <sub>L</sub> = 100mA<br>I <sub>L</sub> = 200mA |
| <b>Doubler Circuit at High Frequency with 3.3μF Capacitors</b>                                                                                               |          |          |      |       |                                                  |
| V+ = +5.0V, C1 = C2 = C3 = 3.3μF, FC = V+, LV = GND, T <sub>AMB</sub> = T <sub>MIN</sub> to T <sub>MAX</sub> ; refer to <i>Figure 2</i> test circuit. Note 2 |          |          |      |       |                                                  |
| Supply Voltage Range                                                                                                                                         | 2.5      |          | 5.3  | V     | R <sub>L</sub> = 1kΩ                             |
| Start-Up Voltage                                                                                                                                             |          | 1.5      |      | V     |                                                  |
| Supply Current                                                                                                                                               |          | 10       | 18   | mA    | No Load                                          |
| Max Output Current                                                                                                                                           | 200      |          |      | mA    |                                                  |
| Oscillator Input Current                                                                                                                                     |          | ±8       |      | μA    |                                                  |
| Oscillator Frequency                                                                                                                                         | 500      | 900      | 1250 | kHz   |                                                  |
| Output Resistance                                                                                                                                            |          | 4.5      | 7    | Ω     | I <sub>L</sub> = 100mA, Note 3                   |
| Voltage Conversion Efficiency                                                                                                                                | 99.0     | 99.9     |      | %     | No Load                                          |
| Power Efficiency                                                                                                                                             | 87<br>79 | 92<br>89 |      | %     | I <sub>L</sub> = 100mA<br>I <sub>L</sub> = 200mA |

NOTE 1: Specified output resistance is a combination of internal switch resistance and capacitor ESR.

NOTE 2: In the test circuit capacitors C1, C2 and C3 are 22μF, 0.05 maximum ESR, ceramic or 3.3μF, 0.05Ω maximum ESR, ceramic. Capacitors with higher ESR may reduce output voltage and efficiency. Refer to Capacitor Selection section.

NOTE 3: Specified output resistance is a combination of internal switch resistance and capacitor ESR. Refer to Optimizing Capacitor Selection.

## Optimizing Capacitor Selection

Refer to *Figure 1* for the total output resistance for various capacitance values and oscillator frequencies. The reservoir and charge pump capacitor values are equal. The capacitance values required to maintain comparable ripple and output resistance typically diminish proportionately as the pump frequency of the **SP6661** increases.

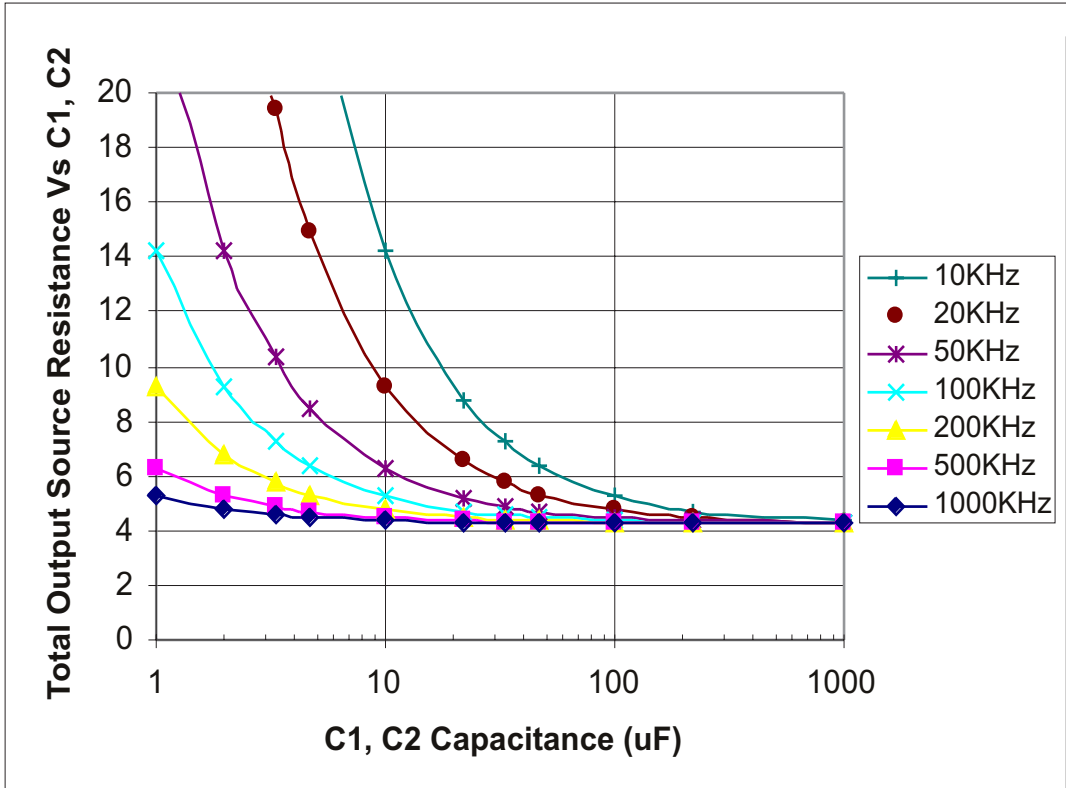
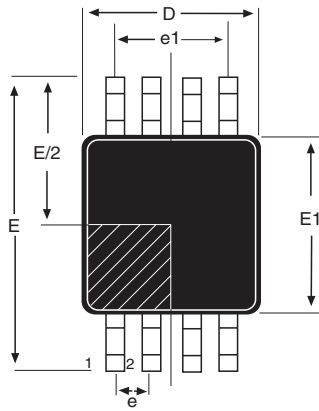
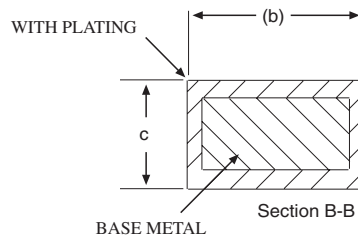
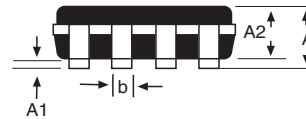
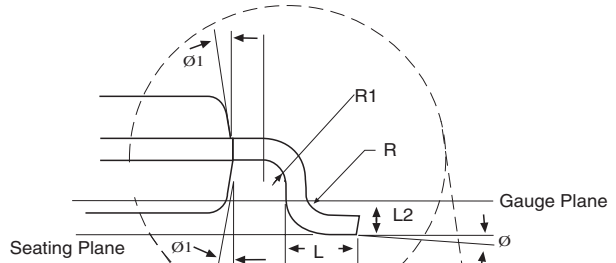


Figure 1. Total Output Resistance for various capacitance values and oscillator frequencies.

| Pin Number | Pin Symbol | Description                                                                                                                                                                                                                                    |
|------------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1          | FC         | Frequency Control for the internal oscillator. FC = open, $f_{osc} = 120\text{kHz}$ typical; FC = V+ $f_{osc} = 900\text{kHz}$ typical.                                                                                                        |
| 2          | CAP+       | Connect to the positive terminal of the charge pump capacitor.                                                                                                                                                                                 |
| 3          | GND        | (Voltage Inverter Circuit) Ground.                                                                                                                                                                                                             |
| 3          | GND        | (Positive Voltage Doubler Circuit) Positive supply voltage input.                                                                                                                                                                              |
| 4          | CAP-       | Connect to the negative terminal of the charge pump capacitor.                                                                                                                                                                                 |
| 5          | OUT        | (Voltage Inverter Circuit) Negative voltage output pin.                                                                                                                                                                                        |
| 5          | OUT        | (Positive Voltage Doubler Circuit) Ground pin for power supply.                                                                                                                                                                                |
| 6          | LV         | Low -voltage operation input pin in 660 circuits. In SP6661 circuits can be connected to GND, OUT or left open as desired with no effect.                                                                                                      |
| 7          | OSC        | Control pin for the oscillator. Internally connected to 15pF capacitor. An external capacitor can be added to slow the oscillator. Be careful to minimize stray capacitance. An external oscillator can be connected to overdrive the OSC pin. |
| 8          | V+         | (Voltage Inverter Circuit) Positive voltage input pin for the power supply.                                                                                                                                                                    |
| 8          | V+         | (Positive Voltage Doubler Circuit) Positive voltage output.                                                                                                                                                                                    |

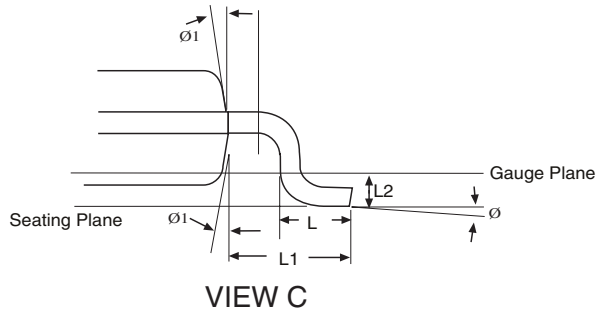
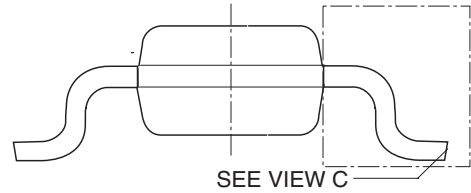
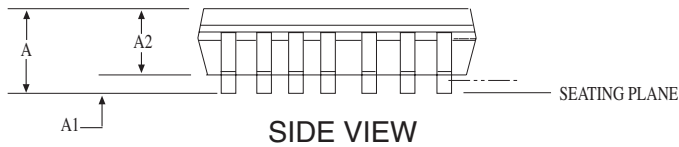
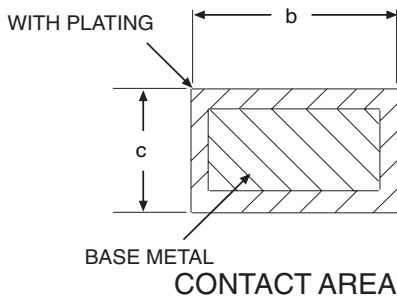
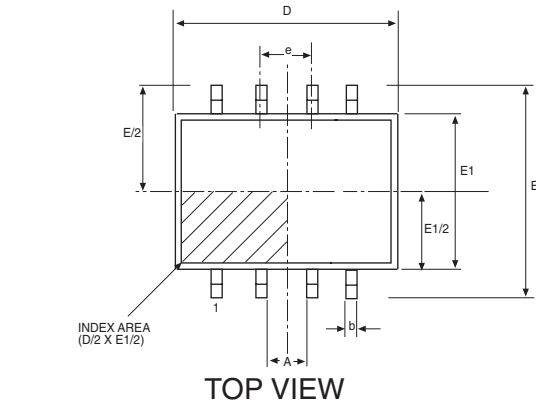


Pin #1 identifier must be indicated within this shaded area ( $D/2 * E1/2$ )



| 8-PIN MSOP<br>JEDEC MO-187<br>(AA) Variation | Dimensions in (mm) |      |      |
|----------------------------------------------|--------------------|------|------|
|                                              | MIN                | NOM  | MAX  |
| A                                            | -                  | -    | 1.10 |
| A1                                           | 0                  | -    | 0.15 |
| A2                                           | 0.75               | 0.85 | 0.95 |
| b                                            | 0.22               | -    | 0.38 |
| c                                            | 0.08               | -    | 0.23 |
| D                                            | 3.00 BSC           |      |      |
| E                                            | 4.90 BSC           |      |      |
| E1                                           | 3.00 BSC           |      |      |
| e                                            | 0.65 BSC           |      |      |
| e1                                           | 1.95 BSC           |      |      |
| L                                            | 0.40               | 0.60 | 0.80 |
| L1                                           | 0.95 REF           |      |      |
| L2                                           | 0.25 BSC           |      |      |
| N                                            | -                  | 8    | -    |
| R                                            | 0.07               | -    | -    |
| R1                                           | 0.07               | -    | -    |
| Ø                                            | 0°                 | -    | 8°   |
| Ø1                                           | 0°                 | -    | 15°  |

## 8-PIN MSOP



| DIMENSIONS<br>Minimum/Maximum<br>(mm) | 8 Pin NSOIC<br>(JEDEC MS-012,<br>AA - VARIATION) |     |      |
|---------------------------------------|--------------------------------------------------|-----|------|
| COMMON HEIGHT DIMENSION               |                                                  |     |      |
| SYMBOL                                | MIN                                              | NOM | MAX  |
| A                                     | 1.35                                             | -   | 1.75 |
| A1                                    | 0.10                                             | -   | 0.25 |
| A2                                    | 1.25                                             | -   | 1.65 |
| b                                     | 0.31                                             | -   | 0.51 |
| c                                     | 0.17                                             | -   | 0.25 |
| D                                     | 4.90 BSC                                         |     |      |
| E                                     | 6.00 BSC                                         |     |      |
| E1                                    | 3.90 BSC                                         |     |      |
| e                                     | 1.27 BSC                                         |     |      |
| L                                     | 0.40                                             | -   | 1.27 |
| L1                                    | 1.04 REF                                         |     |      |
| L2                                    | 0.25 BSC                                         |     |      |
| Ø                                     | 0°                                               | -   | 8°   |
| Ø1                                    | 5°                                               | -   | 15°  |

## 8 PIN NSOIC

## ORDERING INFORMATION

| Part Number           | Temperature Range        | Package Type                |
|-----------------------|--------------------------|-----------------------------|
| SP6661EN . . . . .    | -40°C to +85°C . . . . . | 8-Pin NSOIC                 |
| SP6661EN/TR . . . . . | -40°C to +85°C . . . . . | 8-Pin NSOIC                 |
| SP6661EU . . . . .    | -40°C to +85°C . . . . . | 8-Pin MSOP                  |
| SP6661EU/TR . . . . . | -40°C to +85°C . . . . . | 8-Pin MSOP                  |
| SP6661EB . . . . .    |                          | 8-Pin MSOP Evaluation Board |

Available in lead free packaging. To order add "-L" suffix to part number.

Example: SP6661EN/TR = standard; SP6661EN-L/TR = lead free

/TR = Tape and Reel

Pack quantity is 2,500 for MSOP & NSOIC.



ANALOG EXCELLENCE

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