# High Frequency 200mA Charge Pump Inverter or Doubler

## FEATURES

- Inverts or Doubles Input Supply Voltage
- 92% Power Efficiency at 100mA
- 120kHz/900kHz Selectable Oscillator Frequency
- 4.5Ω Output Resistance Using 3.3μF Ceramic Caps
- Low Voltage Battery Operation
- Ideal for 3.6V Lithium Ion Battery or 5.0V Input
- High Output Current – 200mA
- Low Profile Solution
- 1.5V Inverter Startup Guaranteed




*Now Available in Lead Free Packaging*

- Pin-Compatible High-Current Upgrade of the ICL7660 and 660 Industry Standard
- Smallest Package Available for the 660 Industry Standard – 8 pin MSOP

The product (or products) mentioned in this data sheet are no longer being manufactured and may not be ordered (OBS)

## DESCRIPTION

The **SP6661** is a CMOS DC-DC Monolithic Voltage Converter that can be implemented as a Voltage Inverter or a Positive Voltage Doubler. As a Voltage Inverter, a -1.5V to -5.0V output can be converted from a +1.5V to +5.0V input. As a Voltage Doubler, a +5.0V to +10.0V output can be provided from a +2.5V to +5.0V input. The **SP6661** is ideal for both battery-powered and board level voltage conversion applications with a typical operating current of 3mA and a high efficiency (>90%) over most of its load-current range. Typical end products for this device are disk drive supplies, operational amplifier and interface power supplies, medical instruments, and hand held and laptop computers. The **SP6661** is available in 8-pin NSOIC, and μSOIC packages.

## TYPICAL APPLICATIONS CIRICUIT

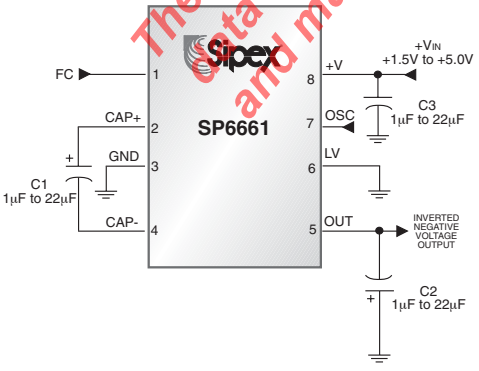



*Figure 1: Voltage Inverter*

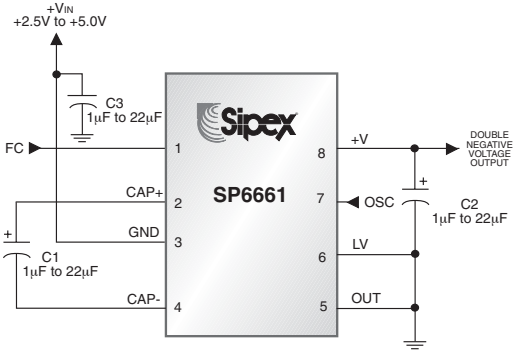



*Figure 2: Voltage Doubler*

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## 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˚C)
NSOIC (derate 5.88mW/˚C above +70˚C).....471mW
µSOIC (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 |
|---|---|---|---|---|---|
| **Inverter Circuit at Low Frequency with 22µF Capacitors** | | | | | |
| V+ = +5.0V, C1 = C2 = C3 = 22µF, 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 | $R_L$ = 500Ω |
| Start-Up Voltage | | 0.93 | | V | |
| Supply Current | | 3 | 6 | mA | No Load |
| Max Output Current | 200 | | | mA | |
| Oscillator Input Current | | ±1 | | µA | |
| Oscillator Frequency | 70 | 120 | 170 | kHz | |
| Output Resistance | | 5 | 7 | Ω | $I_L$ = 100mA, Note 3 |
| Voltage Conversion Efficiency | 99.0 | 99.9 | | % | No Load |
| Power Efficiency | 80<br>70 | 89<br>82 | | % | $I_L$ = 100mA<br>$I_L$ = 200mA |
| | | | | | |
| **Doubler Circuit at Low Frequency with 22µF Capacitors** | | | | | |
| V+ = +5.0V, C1 = C2 = C3 = 22µF, 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 | $R_L$ = 1kΩ |
| Start-Up Voltage | | 1.5 | | V | |
| Supply Current | | 3 | 6 | mA | No Load |
| Max Output Current | 200 | | | mA | |
| Oscillator Input Current | | ±1 | | µA | |
| Oscillator Frequency | 70 | 120 | 170 | kHz | |
| Output Resistance | | 4.5 | 7 | Ω | $I_L$ = 100mA, Note 3 |
| Voltage Conversion Efficiency | 99.0 | 99.9 | | % | No Load |
| Power Efficiency | 89<br>79 | 94<br>90 | | % | $I_L$ = 100mA<br>$I_L$ = 200mA |

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| PARAMETER | MIN. | TYP. | MAX. | UNITS | CONDITIONS |
|---|---|---|---|---|---|
| | | | | | |
| **Inverter Circuit at High Frequency with 3.3µF Capacitors** | | | | | |
| V+ = +5.0V, C1 = C2 = C3 = 3.3µF, FC = V+, 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 | $R_L$ = 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 | $I_L$ = 100mA, Note 3 |
| Voltage Conversion Efficiency | 99.0 | 99.6 | | % | No Load |
| Power Efficiency | 78<br>65 | 84<br>79 | | % | $I_L$ = 100mA<br>$I_L$ = 200mA |
| | | | | | |
| **Doubler Circuit at High Frequency with 3.3µF Capacitors** | | | | | |
| V+ = +5.0V, C1 = C2 = C3 = 3.3µF, FC = V+, LV = GND, $T_{AMB}$ = $T_{MIN}$ to $T_{MAX}$; refer to *Figure 2* test circuit. Note 2 | | | | | |
| Supply Voltage Range | 2.5 | | 5.3 | V | $R_L$ = 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 | $I_L$ = 100mA, Note 3 |
| Voltage Conversion Efficiency | 99.0 | 99.9 | | % | No Load |
| Power Efficiency | 87<br>79 | 92<br>89 | | % | $I_L$ = 100mA<br>$I_L$ = 200mA |

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

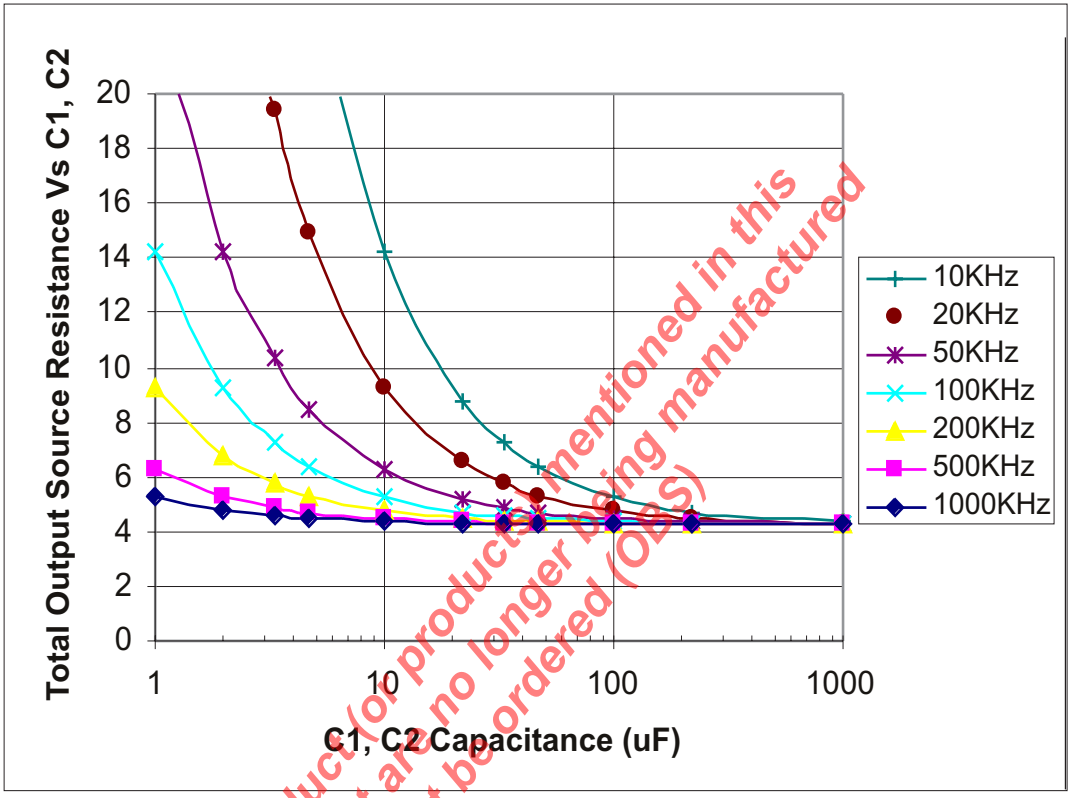
NOTE 2: In the test circuit capacitors C1, C2 and C3 are 22µF, 0.05 maximum ESR, ceramic or 3.3µF, 0.05Ω maximum ESR, ceramic. Capacitors with higher ESR may reduce output voltage and efficiency. Refer to Capacitor Selection section.

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

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## 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.




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

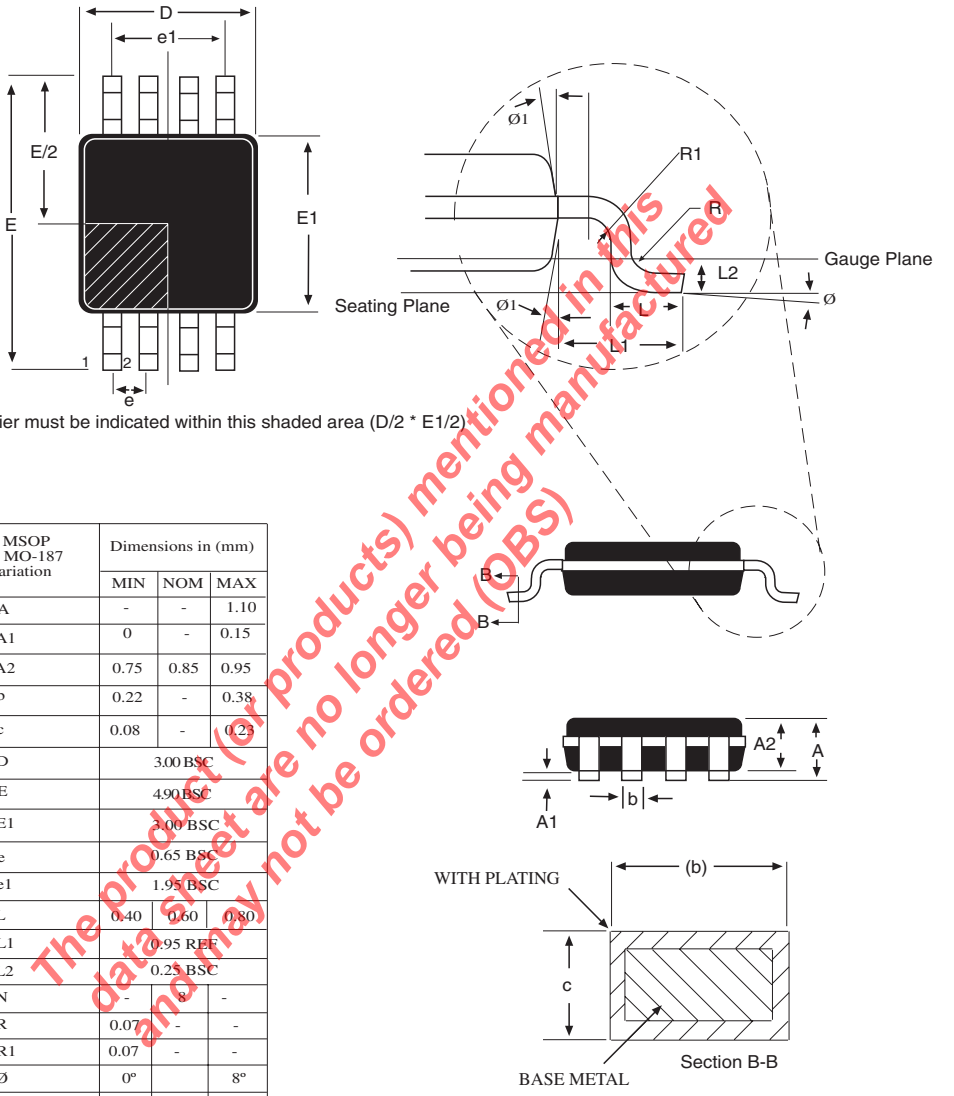
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## PIN DESCRIPTION

| Pin Number | Pin Symbol | Description |
|---|---|---|
| 1 | FC | Frequency Control for the internal oscillator. FC = open, $f_{osc}$ = 120kHz typical; FC = V+ $f_{osc}$ = 900kHz 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. |

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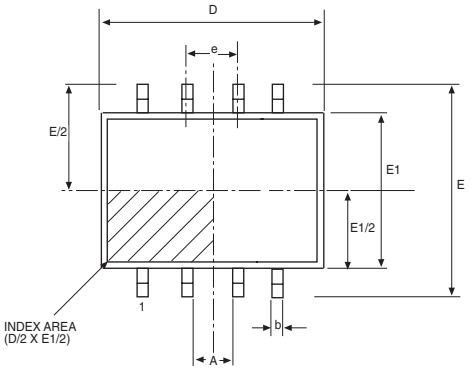

Pin #1 indentifier must be indicated within this shaded area (D/2 * E1/2)

| 8-PIN MSOP JEDEC MO-187 (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° |

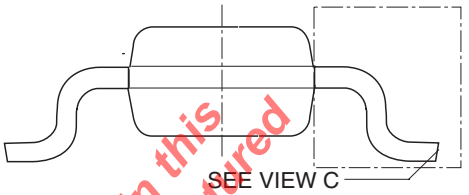
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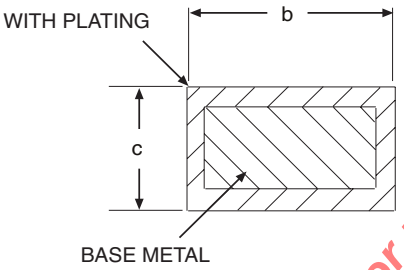
## 8-PIN MSOP

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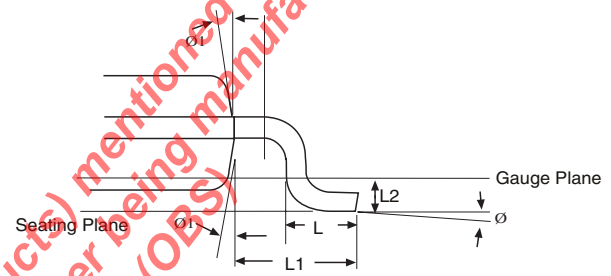



TOP VIEW

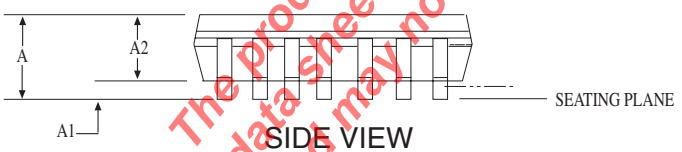



CONTACT AREA




VIEW C




SIDE VIEW

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| DIMENSIONS Minimum/Maximum (mm) | 8 Pin NSOIC (JEDEC MS-012, 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 | 0º | - | 8º |
| Ø1 | 5º | - | 15º |

## 8 PIN NSOIC

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## 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.

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ANALOG EXCELLENCE

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