# AIC7660

## Switched-Capacitor Voltage Converter

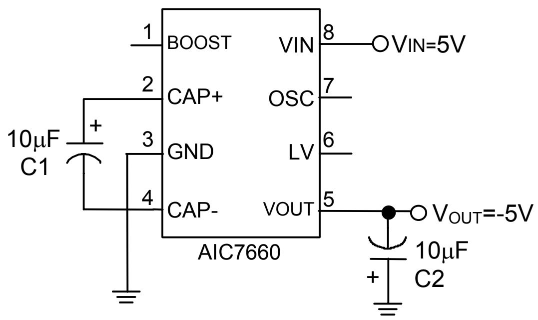
## FEATURES

- Lowest Output Impedance (Typical 35Ω at $V_{IN}$=5V).
- Improved Direct Replacement for the Popular 7660.
- 1.5V to 6V Operation.
- No External Diode Required.
- Simple Conversion of +5V to -5V.
- Low Quiescent Current (Typical 36μA at $V_{IN}$=5V).
- High Power Efficiency (Typical 98%)
- Boost Pin for Higher Switching Frequency.
- Improved SCR Latch-up Protection.

## APPLICATIONS

- RS-232 Power Supplies.
- Handheld Instruments.
- Data Acquisition Systems.
- Supply Splitter, $V_{OUT}= \pm V_{IN}/2$.
- Operational Amplifier Supplies.
- Panel Meter.

## TYPICAL APPLICATION CIRCUIT




**Negative Voltage Converter**

## DESCRIPTION

The AIC7660 is a monolithic CMOS switched capacitor voltage converter. Designed to be an improved direct replacement for the popular 7660 and LTC1044, the main function of the AIC7660 is to convert a positive input voltage in the range of 1.5V to 6V to the corresponding negative output voltage in the range of -1.5V to -6V. The input voltage can also be doubled ($V_{OUT} = 2V_{IN}$), divided ($V_{OUT} = V_{IN}/2$), or multiplied ($V_{OUT} = \pm nV_{IN}$), as shown in application examples.

The chip contains a series DC power supply regulator, oscillator, control circuitry and four output power MOS switches. The frequency of oscillator can be lowered by the addition of an external capacitor to the OSC pin, or the oscillator may be over-driven by an external clock.

The boost function is available to raise the oscillator frequency to optimize performance in specific applications. The “LV” terminal may be tied to GND to improve low input voltage ($V_{IN} \leq 3.0V$) operation, or be left floating for input voltage larger than 3.0V to improve power dissipation.

The AIC7660 provides performance superior to previous designs by combining low output impedance, low quiescent current with high efficiency, and by eliminating diode drop voltage losses. The only required external components are two low cost electrolytic capacitors.

## ORDERING INFORMATION

AIC7660XXXX

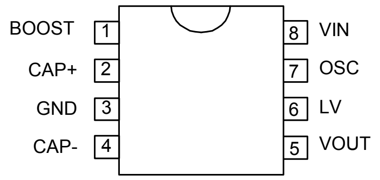
- PACKING TYPE
  - TR: TAPE & REEL
  - TB: TUBE
- PACKAGE TYPE
  - N8: DIP-8
  - S8: SOP-8
- P: LEAD FREE COMMERCIAL

Example: AIC7660PS8TR

→ in Lead Free SOP-8 Package & Tape & Reel Packing Type
(PN8 is not available in TR packing type.)

**PIN CONFIGURATION**

DIP-8, SOP-8
TOP VIEW

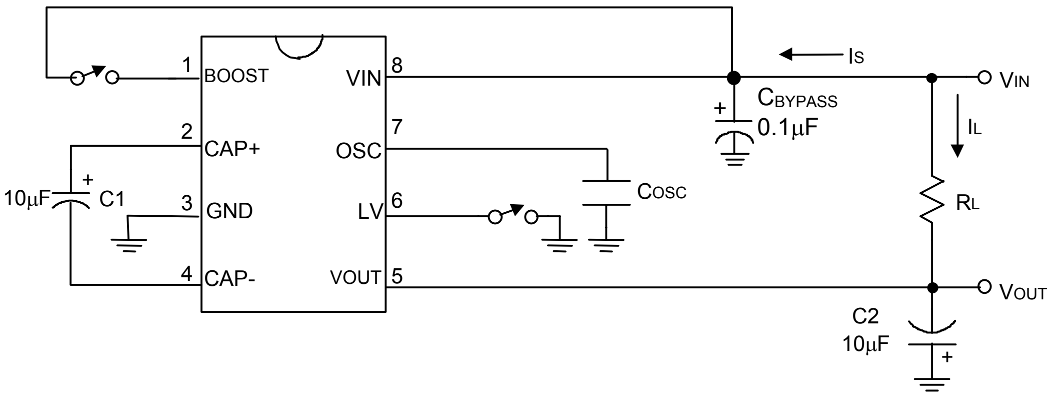



## ABSOLUTE MAXIMUM RATINGS

| | | |
|---|---|---|
| Supply Voltage (VIN to GND, or GND to VOUT) | | 6.0V |
| Input Voltage on Pin 1, 6 and 7 | | -0.3V ~ $V_{IN}$ + 0.3V |
| Operating Temperature Range | | -40°C ~ 85°C |
| Junction Temperature | | 125°C |
| Storage Temperature Range | | -65°C ~ 150°C |
| Lead Temperature (Soldering, 10sec) | | 260°C |
| Thermal Resistance Junction to Case, $R\theta_{JC}$ | DIP-8 | 60°C /W |
| | SOP-8 | 40°C /W |
| Thermal Resistance Junction to Ambient, $R\theta_{JA}$ | DIP-8 | 100°C /W |
| (Assume no ambient airflow, no heatsink) | SOP-8 | 160°C /W |

**Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.**

## ■ TEST CIRCUIT




## ■ ELECTRICAL CHARACTERISTICS

**($V_{IN}$=5.0V, $T_A$=25°C, BOOST and LV pin Floating, OSC pin OPEN, unless otherwise specified.) (Note 1)**

| PARAMETER | TEST CONDITIONS | SYMBOL | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Supply Current | $R_L = \infty$ | $I_S$ | | 30 | 50 | µA |
| Minimum Supply Voltage | $R_L = \infty$ | $V_{INL}$ | 1.5 | | | V |
| Maximum Supply Voltage | $R_L = \infty$ | $V_{INH}$ | | | 6 | V |
| Output Resistance | $I_L$ =20mA,<br>$F_{OSC}$ =10KHz | $R_{OUT}$ | | 35 | 70 | Ω |
| Oscillator Frequency | $C_{OSC}$=0<br>BOOST Pin=GND or Floating<br>Boost Pin=$V_{IN}$ | $F_{OSC}$ | | <br>10<br>50 | | KHz |
| Power Efficiency | $R_L$= 5K, $F_{OSC}$=10KHz | η | 96 | 98 | | % |
| Voltage Conversion Efficiency | $R_L = \infty$ | $V_{OUTEFF}$ | 98 | 99.9 | | % |

Note 1: Specifications are production tested at $T_A$=25°C. Specifications over the -40°C to 85°C operating temperature range are assured by design, characterization and correlation with Statistical Quality Controls (SQC).

## TYPICAL PERFORMANCE CHARACTERISTICS

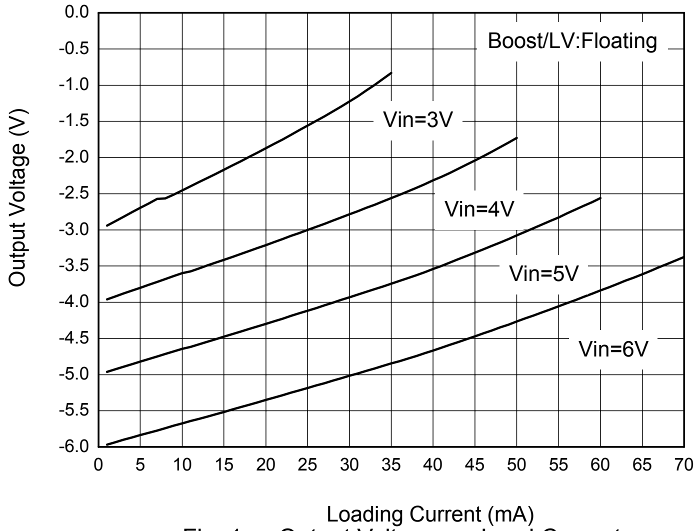



Fig. 1 Output Voltage vs. Load Current

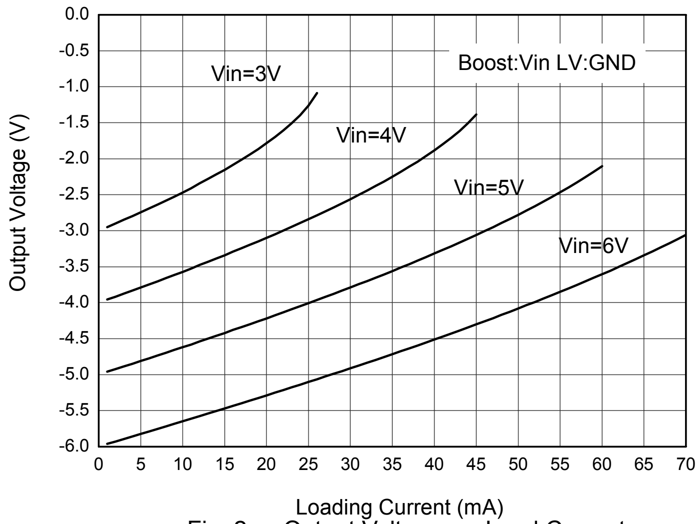



Fig. 2 Output Voltage vs. Load Current

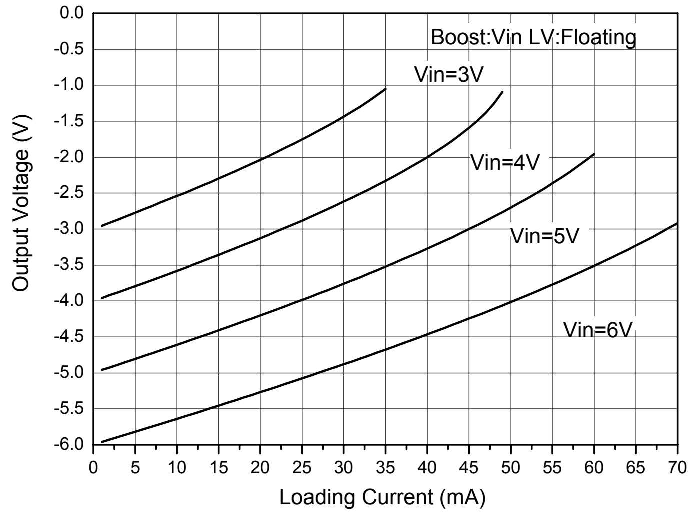



Fig. 3 Output Voltage vs. Load Current

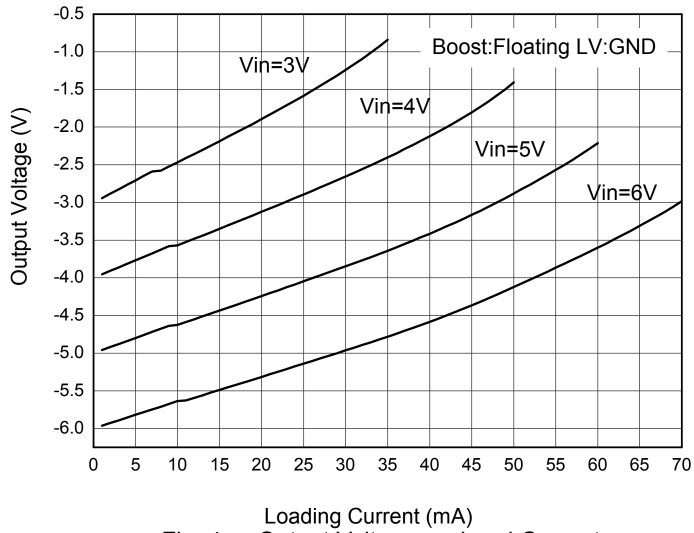



Fig. 4 Output Voltage vs. Load Current

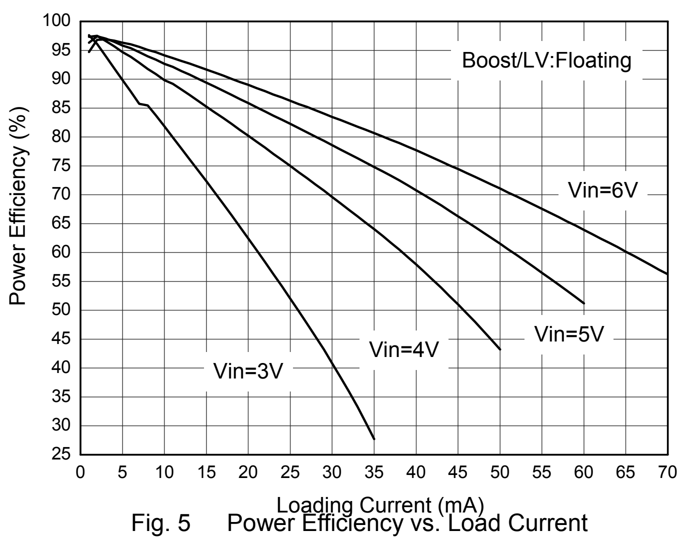



Fig. 5 Power Efficiency vs. Load Current

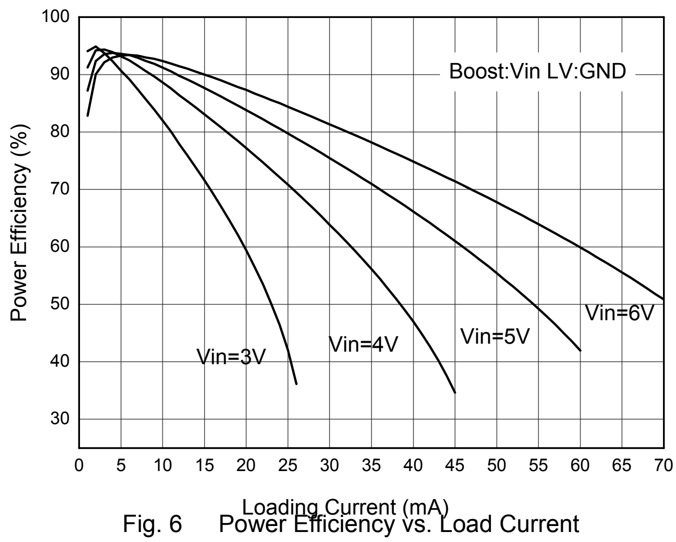



Fig. 6 Power Efficiency vs. Load Current

## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

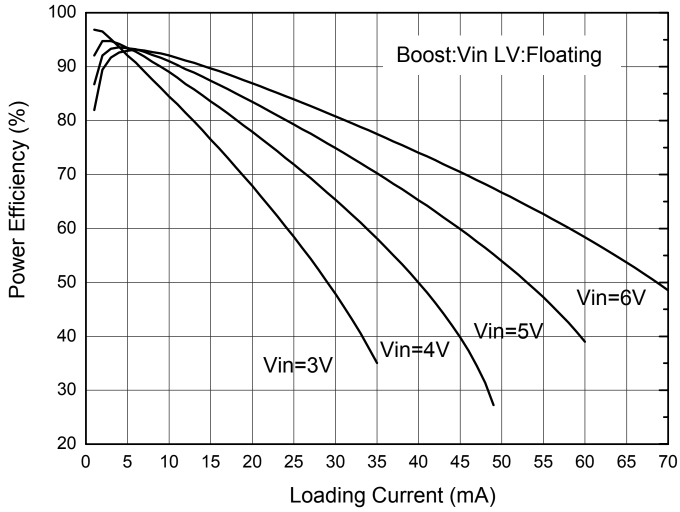



Fig. 7 Power Efficiency vs. Load Current

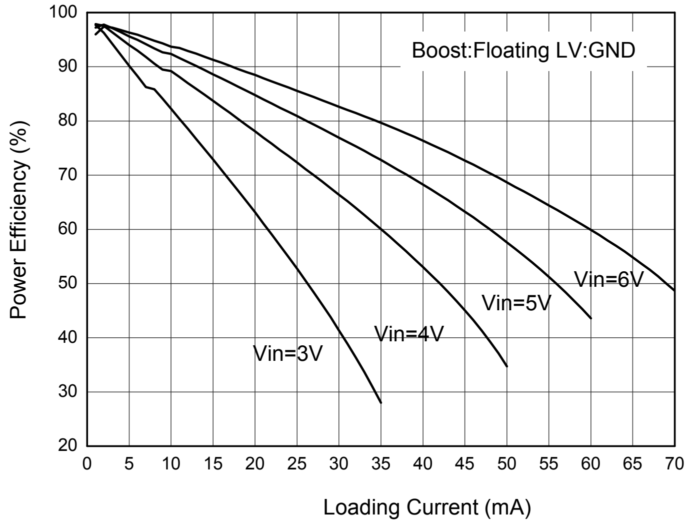



Fig. 8 Power Efficiency vs. Load Current

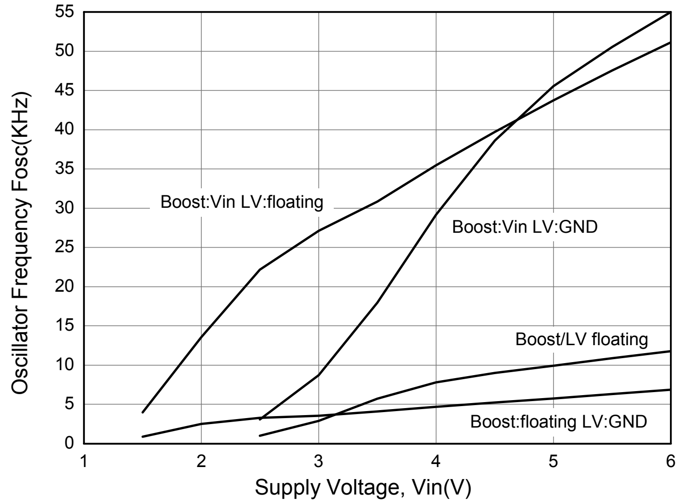



Fig. 9 Oscillator Frequency vs. Supply Voltage

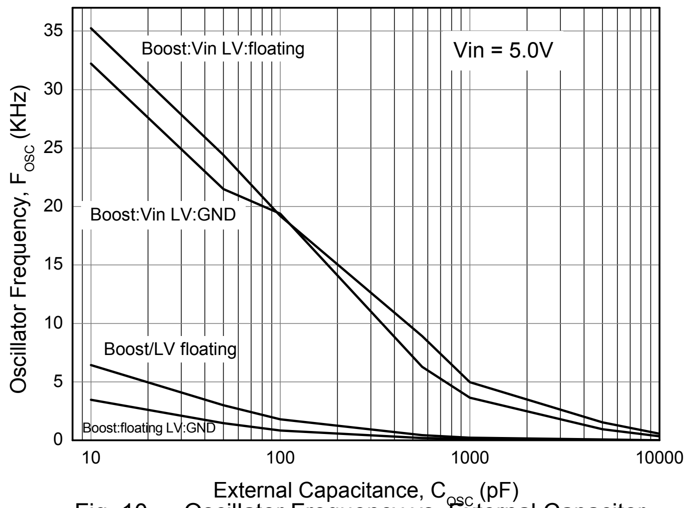



Fig. 10 Oscillator Frequency vs. External Capacitor

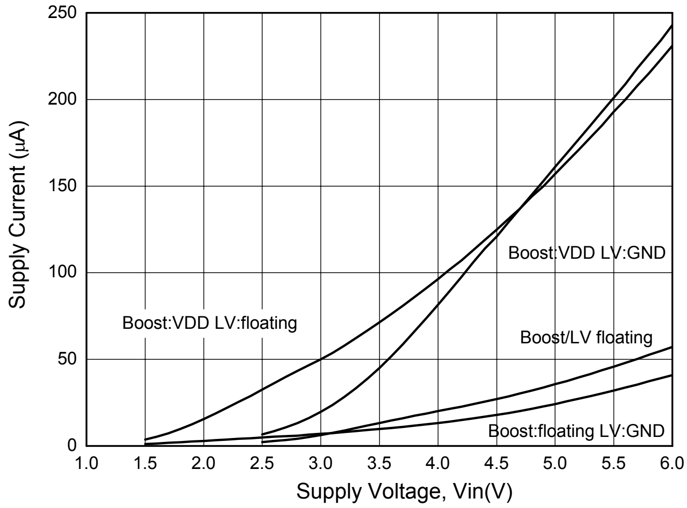



Fig. 11 Supply Current vs. Supply Voltage

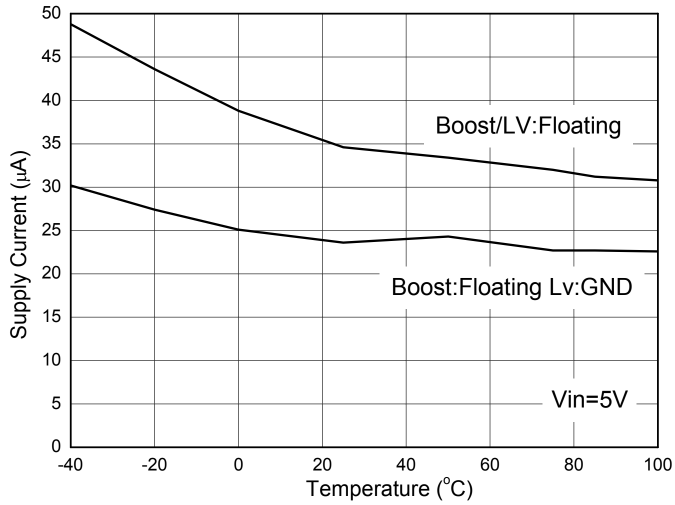



Fig. 12 Supply Current vs. Temperature

## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

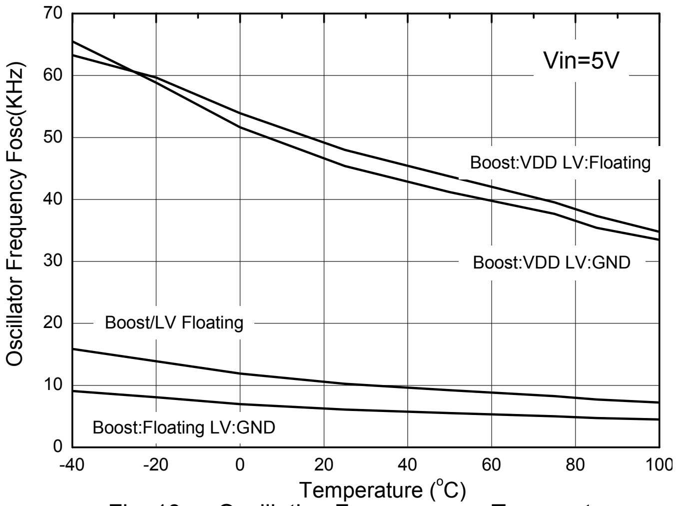
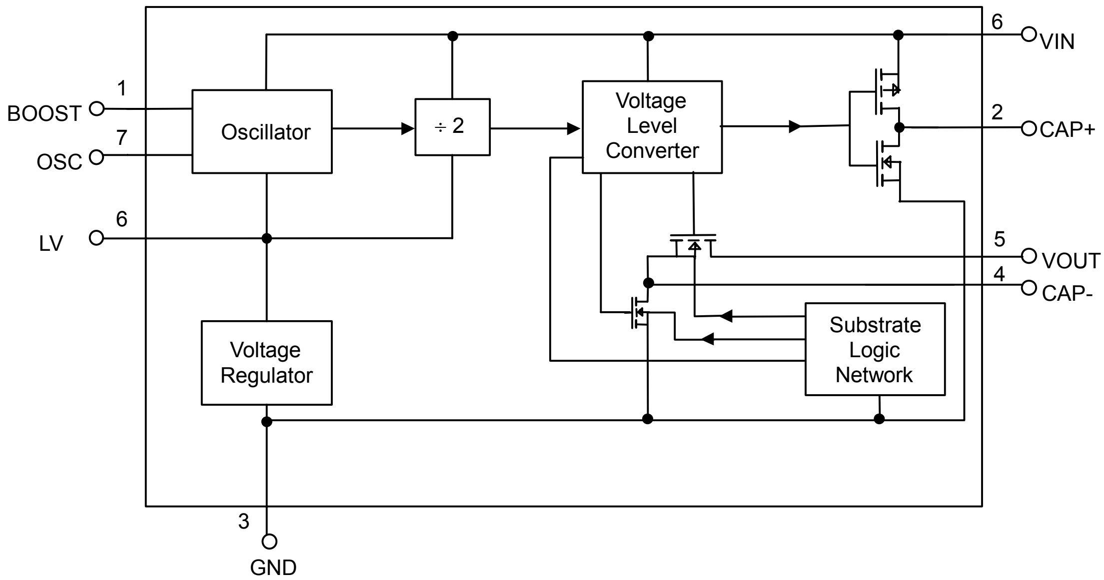



Fig. 13 Oscillation Frequency vs. Temperature

## BLOCK DIAGRAM




## PIN DESCRIPTIONS

PIN 1: BOOST - The frequency of oscillator will be 5 times if boost pin is connected to $V_{IN}$.

PIN 2: CAP+ - To be connected to the positive side of the flying capacitor.

PIN 3: GND - Ground

PIN 4: CAP- - To be connected to the negative side of flying capacitor.

PIN 5: VOUT - Negative output voltage, typically connected to a 10μF capacitor.

PIN 6: LV - If $V_{IN}$ is below 3.0V, LV should be tied to GND. For $V_{IN}$ greater than 3.0V, LV can be floating.

PIN 7: OSC - The frequency of oscillator can be lowered by the addition of an external capacitor to the OSC pin. Or the oscillator may be over-driven by an external clock.

PIN 8: VIN - Input supply.

## APPLICATION EXAMPLES

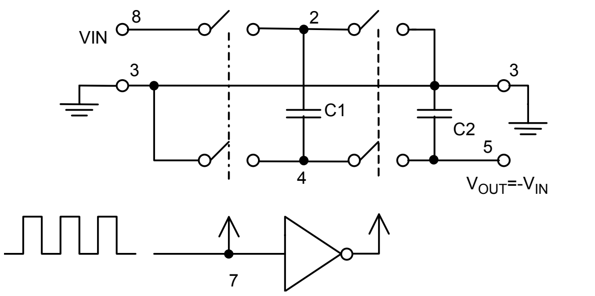



Fig. 14 Idealized Negative Voltage Converter

Fig. 14 shows the idealized negative voltage converter.

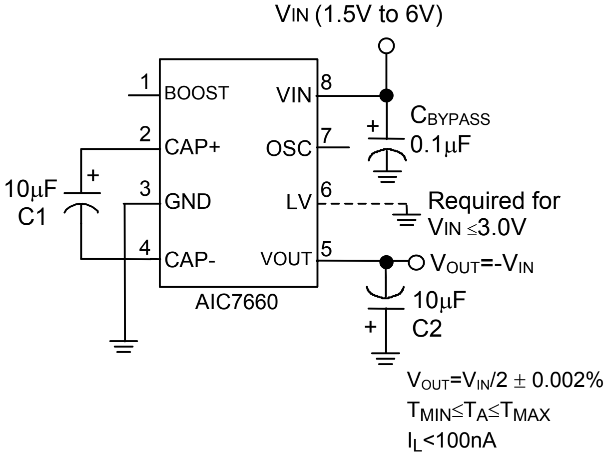



Fig. 15 Negative Voltage Converter

Fig. 15 shows a typical connection, which will provide a negative supply from an available positive supply without the need of any external diodes. The LV pin should be connect to ground for $V_{IN}\leq3.0V$, or may be "floated" for $V_{IN}>3.0V$.

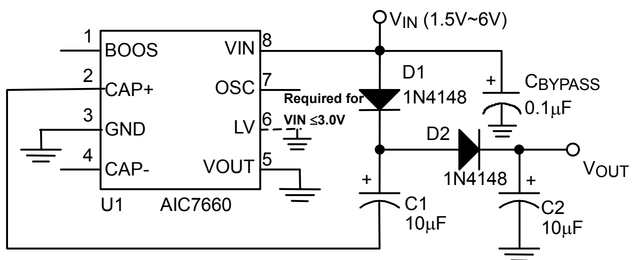



Fig. 16 Voltage Doubling

Fig. 16 shows a method of voltage doubling. $V_{OUT}=2V_{IN}-2V_D$. To reduce the voltage drops across diodes, use Schottky diodes.

## ■ APPLICATION EXAMPLES (Continued)

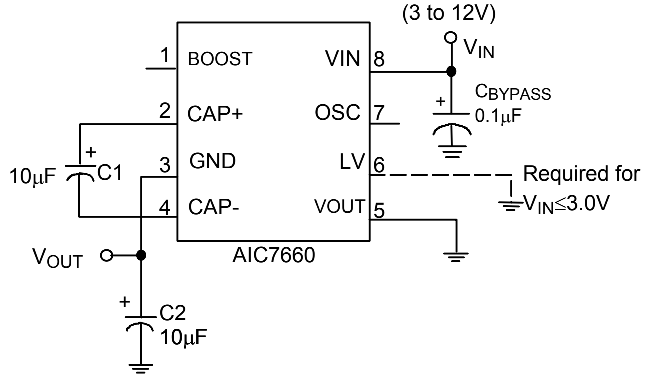



Fig. 17 Ultra Precision Voltage Divider

An ultra precision voltage divider is shown in Fig. 17. To achieve the 0.002% accuracy as indicated, the load current should be kept below 100nA. However, with a slight loss in accuracy, the load current can be increased.

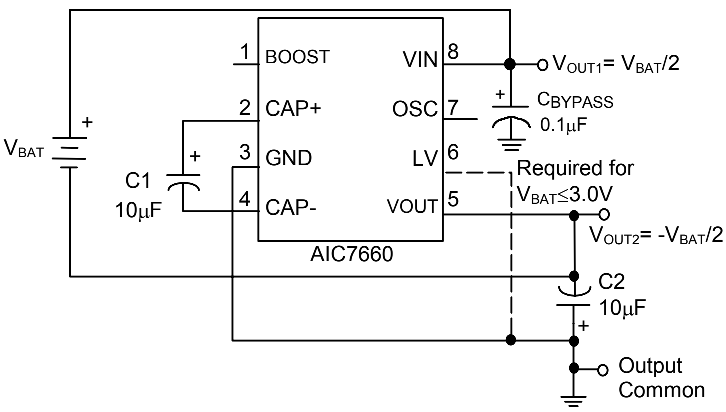
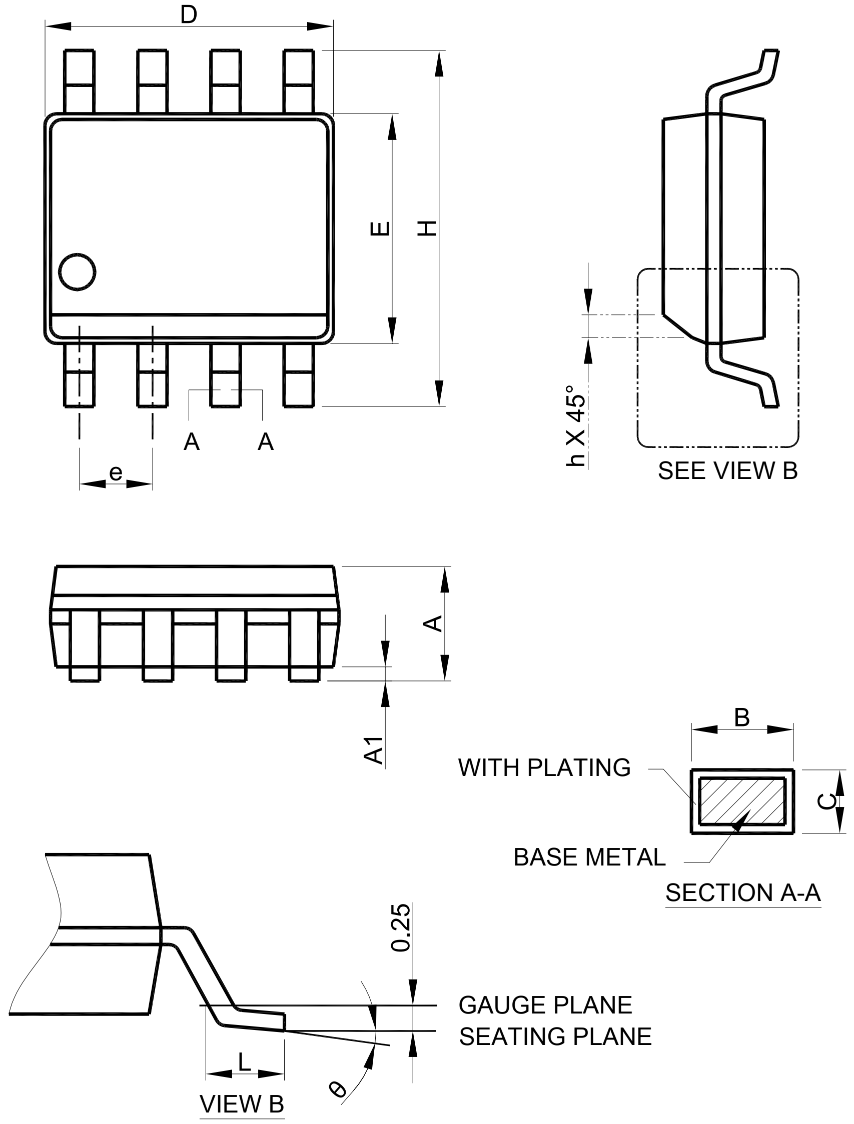



Fig. 18 Battery Splitter

A common need in many systems is to obtain (+) and (-) supplies from a single battery or power supply system. Where current requirements are low, the circuit shown in Fig. 18 is a simple solution.

## PHYSICAL DIMENSIONS (unit: mm)

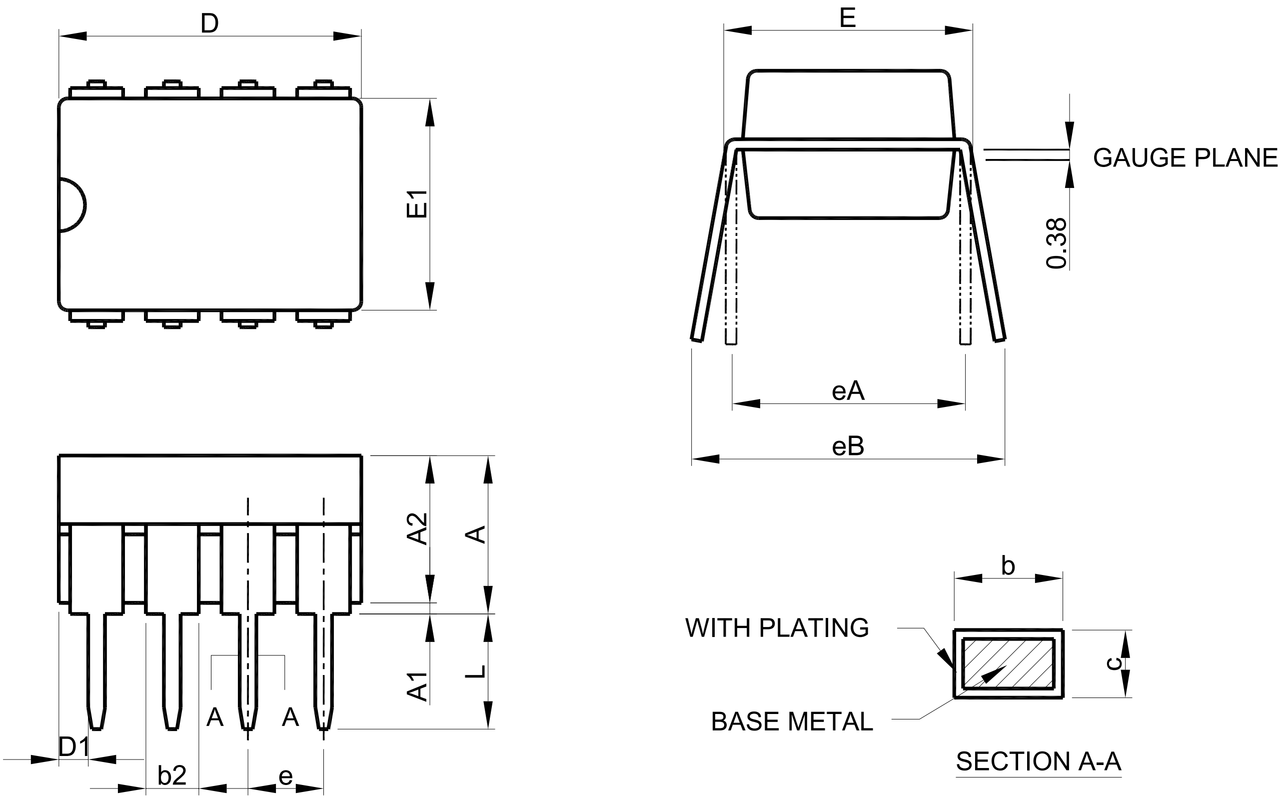
- **SOP-8**




| SYMBOL | SOP-8 | |
|---|---|---|
| | MILLIMETERS | |
| | MIN. | MAX. |
| A | 1.35 | 1.75 |
| A1 | 0.10 | 0.25 |
| B | 0.33 | 0.51 |
| C | 0.19 | 0.25 |
| D | 4.80 | 5.00 |
| E | 3.80 | 4.00 |
| e | 1.27 BSC | |
| H | 5.80 | 6.20 |
| h | 0.25 | 0.50 |
| L | 0.40 | 1.27 |
| θ | 0° | 8° |

Note: 1. Refer to JEDEC MS-012AA.
2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side .
3. Dimension "E" does not include inter-lead flash or protrusions.
4. Controlling dimension is millimeter, converted inch dimensions are not necessarily exact.

- **DIP-8**




Note: 1. Refer to JEDEC MS-001BA
2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 10 mil per side .
3. Dimension "D1"and "E1" do not include inter-lead flash or protrusions.
4. Controlling dimension is millimeter, converted inch dimensions are not necessarily exact.

| SYMBOL | DIP-8 | |
|---|---|---|
| | MILLIMETERS | |
| | MIN. | MAX. |
| A | | 5.33 |
| A1 | 0.38 | |
| A2 | 2.92 | 4.95 |
| b | 0.36 | 0.56 |
| b2 | 1.14 | 1.78 |
| c | 0.20 | 0.35 |
| D | 9.01 | 10.16 |
| D1 | 0.13 | |
| E | 7.62 | 8.26 |
| E1 | 6.10 | 7.11 |
| e | 2.54 BSC | |
| eA | 7.62 BSC | |
| eB | | 10.92 |
| L | 2.92 | 3.81 |

**Note:**

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