

## DC/DC CONVERTER CONTROL CIRCUITS

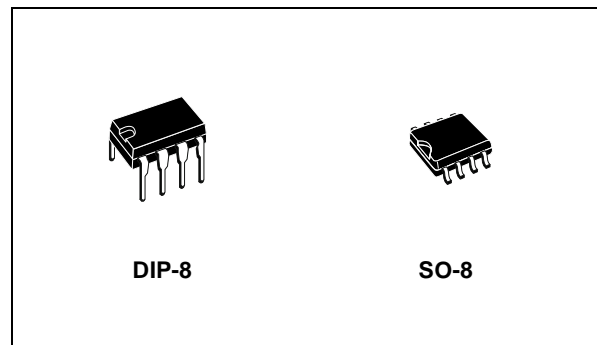
- OUTPUT SWITCH CURRENT IN EXCESS OF 1.5A
- 2% REFERENCE ACCURACY
- LOW QUIESCENT CURRENT: 2.5mA (TYP.)
- OPERATING FROM 3V TO 40V
- FREQUENCY OPERATION TO 100KHz
- ACTIVE CURRENT LIMITING

### DESCRIPTION

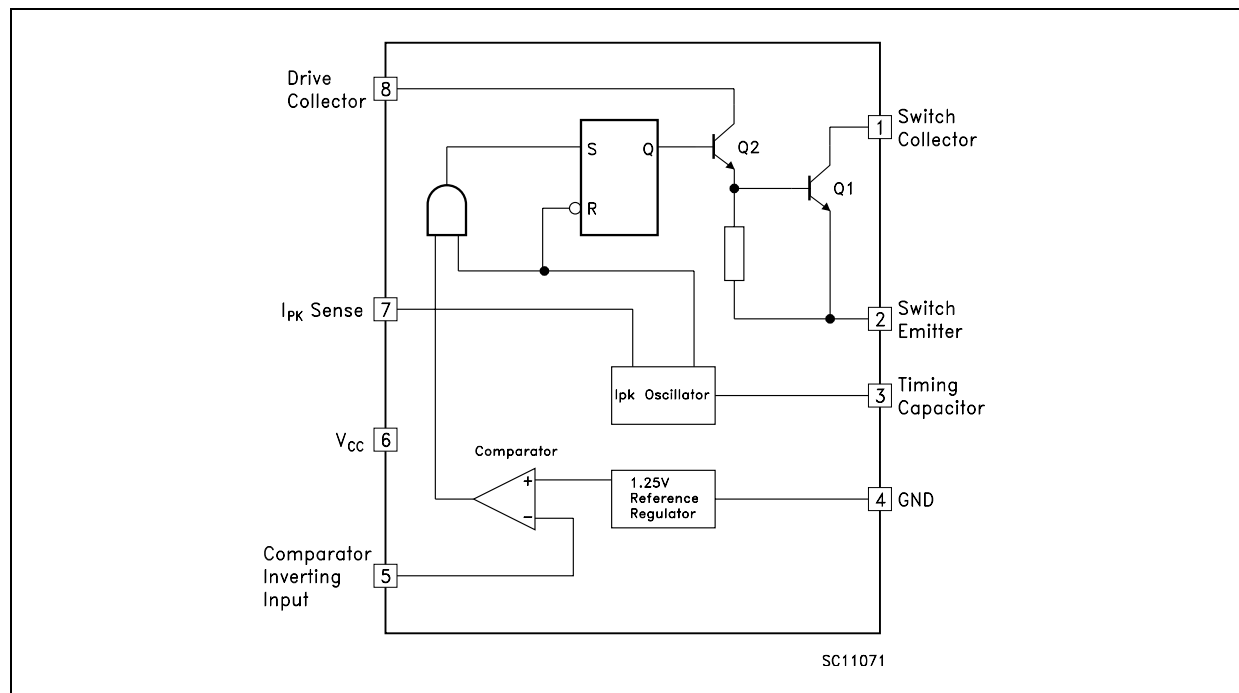
The MC34063A/E series is a monolithic control circuit delivering the main functions for DC/DC voltage converting.

The device contains an internal temperature compensated reference, comparator, duty cycle controlled oscillator with an active current limit circuit, driver and high current output switch. Output voltage is adjustable through two external resistors with a 2% reference accuracy.

Employing a minimum number of external components the MC34063A/E devices series is designed for Step-Down, Step-Up and Voltage-Inverting applications.



### BLOCK DIAGRAM



**ABSOLUTE MAXIMUM RATINGS**

| Symbol           | Parameter                                       | Value                | Unit       |    |
|------------------|---|----------------------|------------|----|
| V <sub>CC</sub>  | Power Supply Voltage                            | 50                   | V          |    |
| V <sub>IR</sub>  | Comparator Input Voltage Range                  | -0.3 to 40           | V          |    |
| V <sub>SWC</sub> | Switch Collector Voltage                        | 40                   | V          |    |
| V <sub>SWE</sub> | Switch Emitter Voltage (V <sub>SWC</sub> = 40V) | 40                   | V          |    |
| V <sub>CE</sub>  | Switch Collector to Emitter Voltage             | 40                   | V          |    |
| V <sub>DC</sub>  | Driver Collector Voltage                        | 40                   | V          |    |
| I <sub>DC</sub>  | Driver Collector Current                        | 100                  | mA         |    |
| I <sub>SW</sub>  | Switch Current                                  | 1.5                  | A          |    |
| P <sub>TOT</sub> | Power Dissipation at T <sub>A</sub> = 25°C      | for DIP-8            | 1.25       | W  |
|                  |   | for SO-8             | 0.625      |    |
| T <sub>J</sub>   | Operating Junction Temperature                  | 150                  | °C         |    |
| T <sub>STG</sub> | Storage Temperature Range                       | -40 to 150           | °C         |    |
| T <sub>OP</sub>  | Operating Ambient Temperature Range             | for AC and EC SERIES | 0 to 70    | °C |
|                  |   | for AB SERIES        | -40 to 85  |    |
|                  |   | for EB SERIES        | -40 to 125 |    |

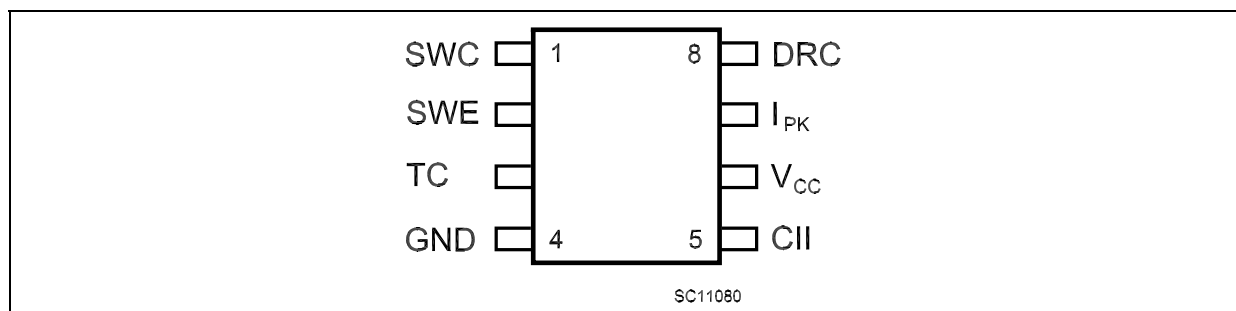
Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.

**THERMAL DATA**

| Symbol                | Parameter                               | DIP-8 | SO-8 | Unit |
|-----------------------|---|-------|------|------|
| R <sub>thj-amb</sub>  | Thermal Resistance Junction-ambient (*) | 100   | 160  | °C/W |
| R <sub>thj-case</sub> | Thermal Resistance Junction-case        | 42    | 20   | °C/W |

(\*) This value depends from thermal design of PCB on which the device is mounted.

**CONNECTION DIAGRAM (top view)**



**PIN DESCRIPTION**

| Pin N° | Symbol          | Name and Function          |
|--------|-----------------|----------------------------|
| 1      | SWC             | Switch Collector           |
| 2      | SWE             | Switch Emitter             |
| 3      | TC              | Timing Capacitor           |
| 4      | GND             | Ground                     |
| 5      | CII             | Comparator Inverting Input |
| 6      | V <sub>CC</sub> | Voltage Supply             |
| 7      | I <sub>PK</sub> | I <sub>PK</sub> Sense      |
| 8      | DRC             | Voltage Driver Collector   |

## ORDERING CODES

| TYPE      | DIP-8      | SO-8       | SO-8 (TAPE & REEL) |
|-----------|------------|------------|--------------------|
| MC34063AB | MC34063ABN | MC34063ABD | MC34063ABD-TR      |
| MC34063AC | MC34063ACN | MC34063ACD | MC34063ACD-TR      |
| MC34063EB | MC34063EBN | MC34063EBD | MC34063EBD-TR      |
| MC34063EC | MC34063ECN | MC34063ECD | MC34063ECD-TR      |

(\*) The "A" version is not recommended for new designs.

**ELECTRICAL CHARACTERISTICS** (Refer to the test circuits,  $V_{CC} = 5V$ ,  $T_A = T_{LOW}$  to  $T_{HIGH}$ , unless otherwise specified, see note 2)

## OSCILLATOR

| Symbol               | Parameter                         | Test Conditions                                 | Min. | Typ. | Max. | Unit    |
|----------------------|-----------------------------------|---|------|------|------|---------|
| $f_{OSC}$            | Frequency                         | $V_{PIN5} = 0V$ $C_T = 1 nF$ $T_A = 25^\circ C$ | 24   | 33   | 42   | KHz     |
| $I_{CHG}$            | Charge Current                    | $V_{CC} = 5$ to $40V$ $T_A = 25^\circ C$        | 24   | 33   | 42   | $\mu A$ |
| $I_{DISCHG}$         | Discharge Current                 | $V_{CC} = 5$ to $40V$ $T_A = 25^\circ C$        | 140  | 200  | 260  | $\mu A$ |
| $I_{DISCHG}/I_{CHG}$ | Discharge to Charge Current Ratio | $PIN 7 = V_{CC}$ $T_A = 25^\circ C$             | 5.2  | 6.2  | 7.5  | $\mu A$ |
| $V_{IPK(sense)}$     | Current Limit Sense Voltage       | $I_{CHG} = I_{DISCHG}$ $T_A = 25^\circ C$       | 250  | 300  | 350  | mV      |

## OUTPUT SWITCH

| Symbol        | Parameter                                 | Test Conditions   | Min. | Typ. | Max. | Unit    |
|---------------|---|---|------|------|------|---------|
| $V_{CE(sat)}$ | Saturation Voltage, Darlington Connection | $I_{SW} = 1 A$ $PIN 7, 8$ connected   |      | 1    | 1.3  | V       |
| $V_{CE(sat)}$ | Saturation Voltage                        | $I_{SW} = 1 A$ $R_{PIN8} = 82 \Omega$ to $V_{CC}$<br>Forced $\beta \sim 20$ |      | 0.45 | 0.7  | V       |
| $h_{FE}$      | DC Current Gain                           | $I_{SW} = 1 A$ $V_{CE} = 5 V$ $T_A = 25^\circ C$                            | 50   | 120  |      |         |
| $I_{C(off)}$  | Collector Off-State Current               | $V_{CE} = 40 V$   |      | 0.01 | 100  | $\mu A$ |

## COMPARATOR

| Symbol       | Parameter                         | Test Conditions               | Min.  | Typ. | Max.  | Unit |
|--------------|-----------------------------------|-------------------------------|-------|------|-------|------|
| $V_{TH}$     | Threshold Voltage                 | $T_A = 25^\circ C$            | 1.225 | 1.25 | 1.275 | V    |
|              |                                   | $T_A = T_{LOW}$ to $T_{HIGH}$ | 1.21  |      | 1.29  |      |
| $Reg_{line}$ | Threshold Voltage Line Regulation | $V_{CC} = 3$ to $40 V$        |       | 1    | 5     | mV   |
| $I_{IB}$     | Input Bias Current                | $V_{IN} = 0 V$                |       | -5   | -400  | nA   |

TOTAL DEVICE

| Symbol                | Parameter                 | Test Conditions  | Min.         | Typ. | Max. | Unit |    |
|-----------------------|---------------------------|--|--------------|------|------|------|----|
| I <sub>CC</sub>       | Supply Current            | V <sub>CC</sub> = 5 to 40 V<br>C <sub>T</sub> = 1 nF<br>PIN 7 = V <sub>CC</sub><br>V <sub>PIN5</sub> > V <sub>TH</sub><br>PIN 2 = GND<br>Remaining pins open | for MC34063A |      | 2.5  | 4    | mA |
|                       |                           |  | for MC34063E |      | 1.5  | 4    |    |
| V <sub>START-UP</sub> | Start-Up Voltage (Note 4) | T <sub>A</sub> = 25°C<br>C <sub>T</sub> = 1 μF, PIN 5 = 0  | for MC34063A |      | 2.1  |      | V  |
|                       |                           |  | for MC34063E |      | 1.5  |      |    |

NOTES:

- 1) Maximum package power dissipation limit must be observed.
- 2) T<sub>LOW</sub> = 0°C, T<sub>HIGH</sub> = 70°C (AC and EC series); T<sub>LOW</sub> = -40°C, T<sub>HIGH</sub> = 85°C (AB series); T<sub>LOW</sub> = -40°C, T<sub>HIGH</sub> = 125°C (EB series).
- 3) If Darlington configuration is not used, care must be taken to avoid deep saturation of output switch. The resulting switch-off time may be adversely affected. In a Darlington configuration the following output driver condition is suggested:  
Forced β of output current switch = I<sub>CCOUTPUT</sub> / (I<sub>CDRIVER</sub> - 1mA) ≥ 10  
\* Current less due to a built in 1KΩ anti leakage resistor.
- 4) Start-up Voltage is the minimum Power Supply Voltage at which the internal oscillator begins to work.

TYPICAL PERFORMANCE CHARACTERISTICS

Figure 1 : Emitter Follower Configuration Output Saturation Voltage vs Emitter Current

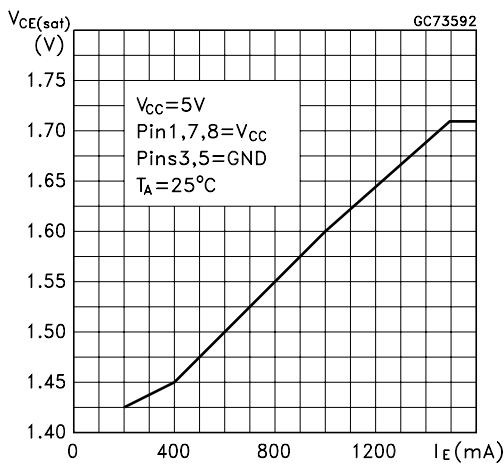


Figure 2 : Output Switch ON-OFF Time vs Oscillator Timing Capacitor

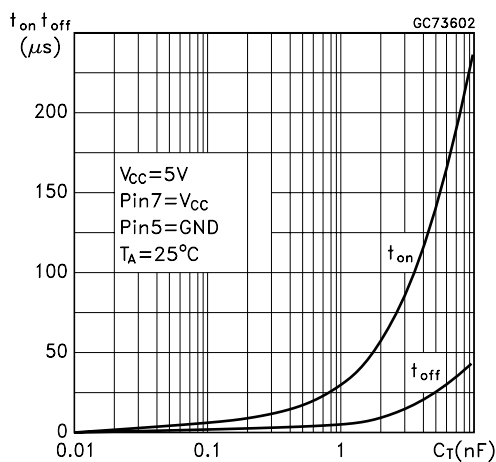


Figure 3 : Common Emitter Configuration Output Switch Saturation Voltage vs Collector Current

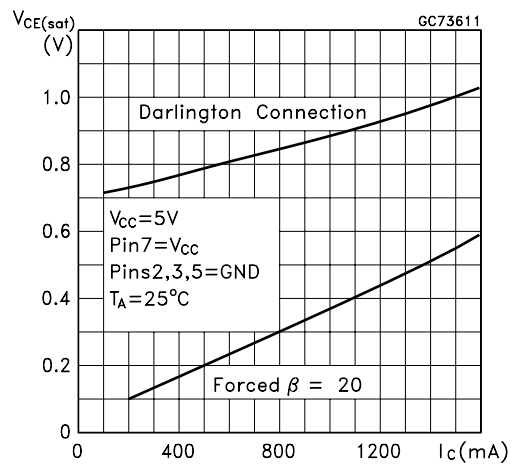
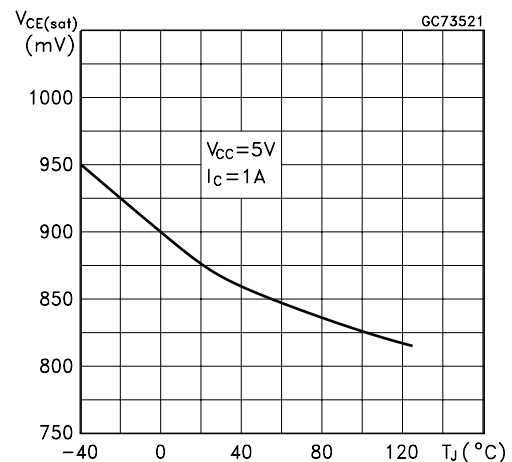
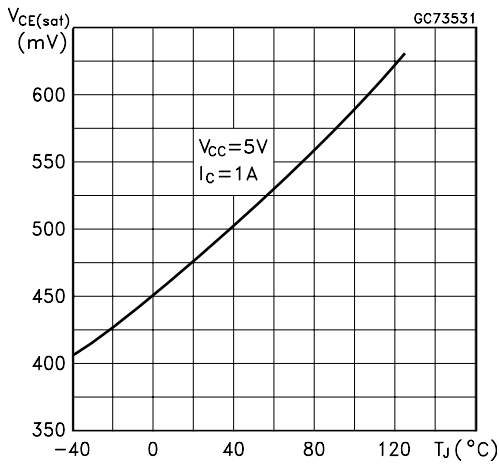


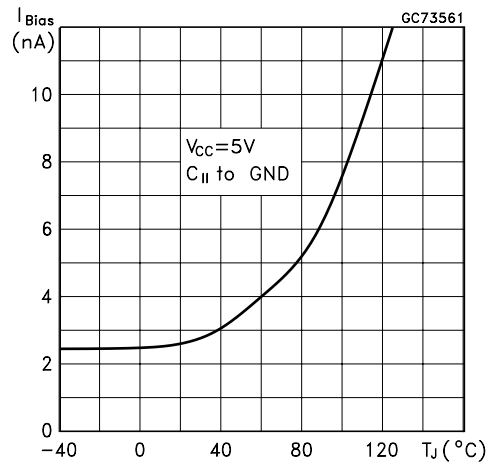
Figure 4 : Darlington Configuration Collector Emitter Saturation Voltage (VCE(sat)) vs Temperature



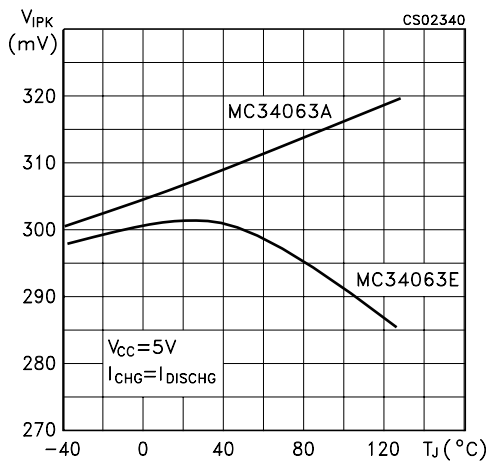
**Figure 5 : Power Collector Emitter Saturation Voltage ( $V_{CEsat}$ ) vs Temperature**



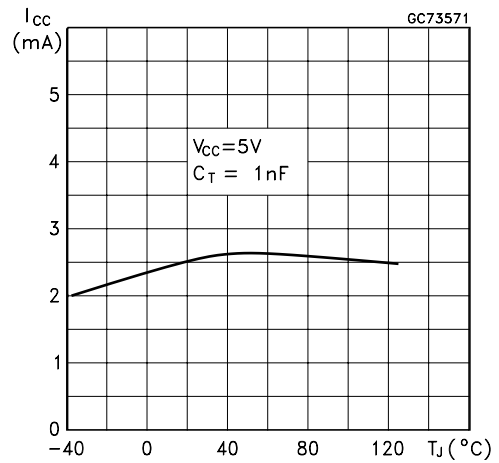
**Figure 8 : Bias Current vs Temperature**



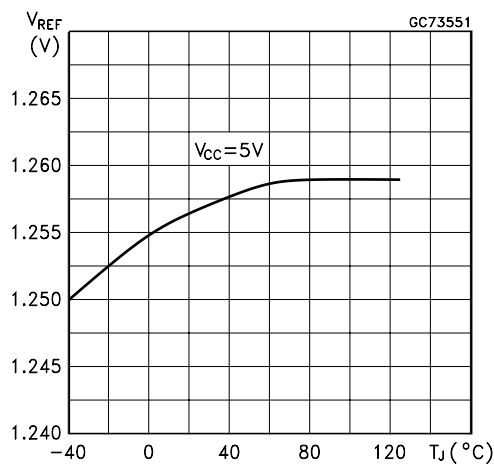
**Figure 6 : Current Limit Sense Voltage ( $V_{IPK}$ ) vs Temperature**



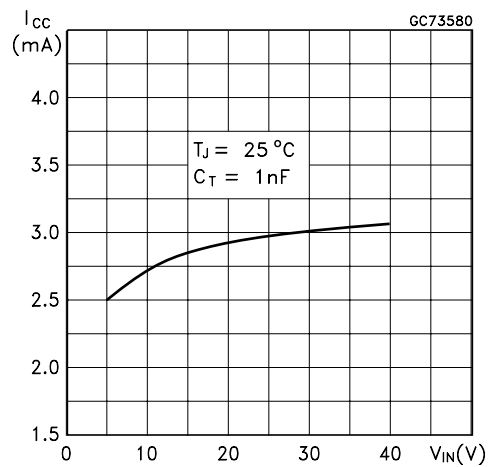
**Figure 9 : Supply Current vs Temperature**



**Figure 7 : Reference Voltage vs Temperature**

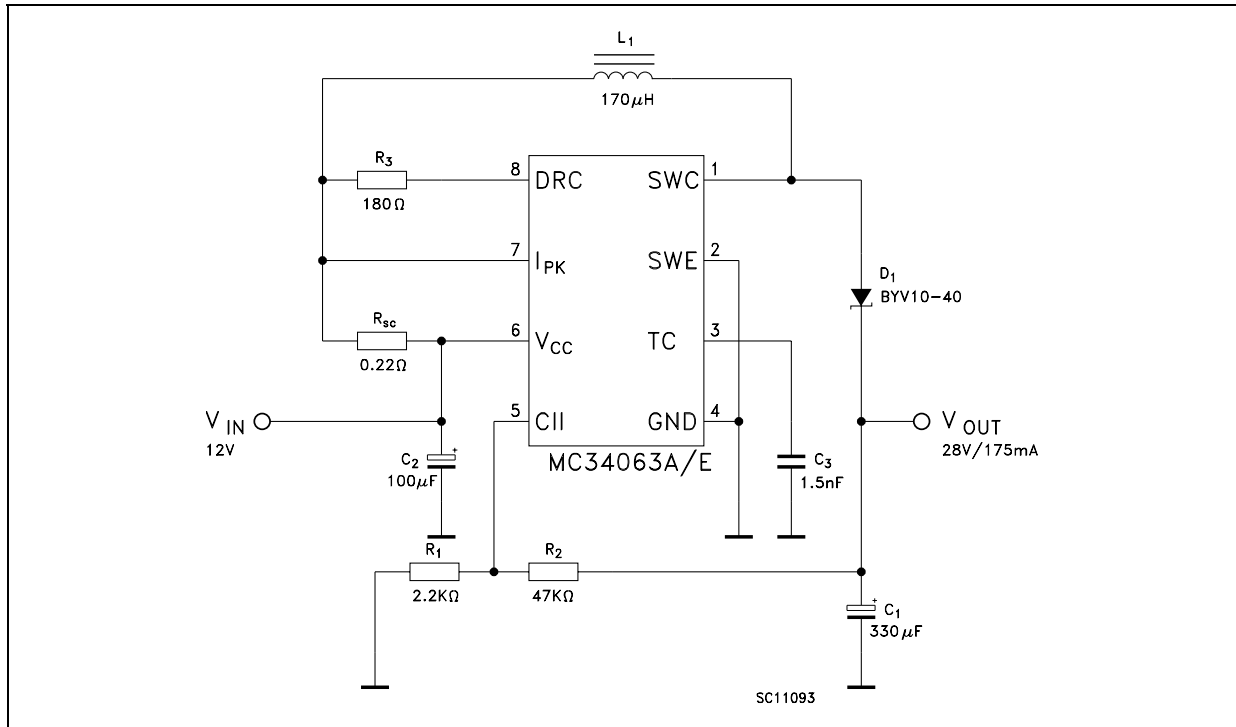


**Figure 10 : Supply Current vs Input Voltage**

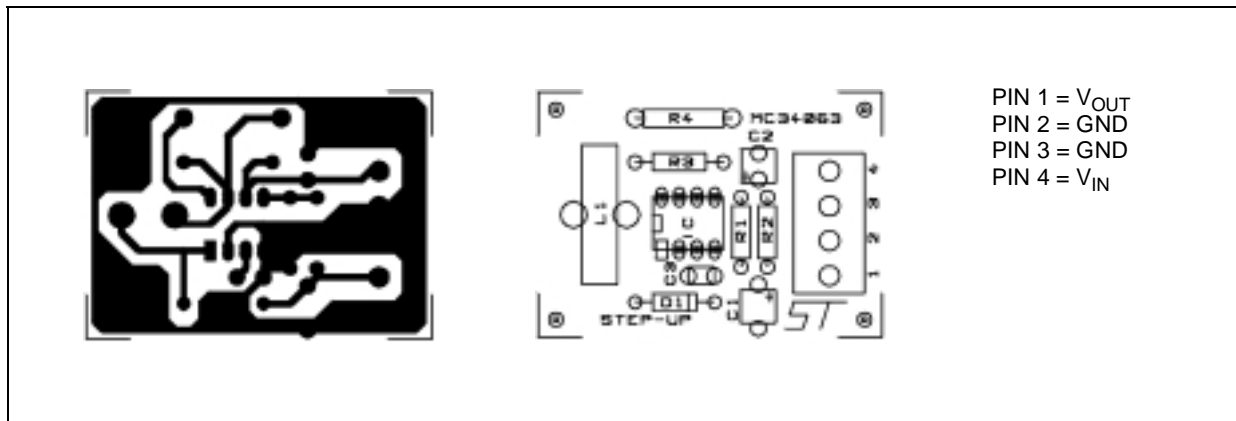


TYPICAL APPLICATION CIRCUIT

Step-UP Converter



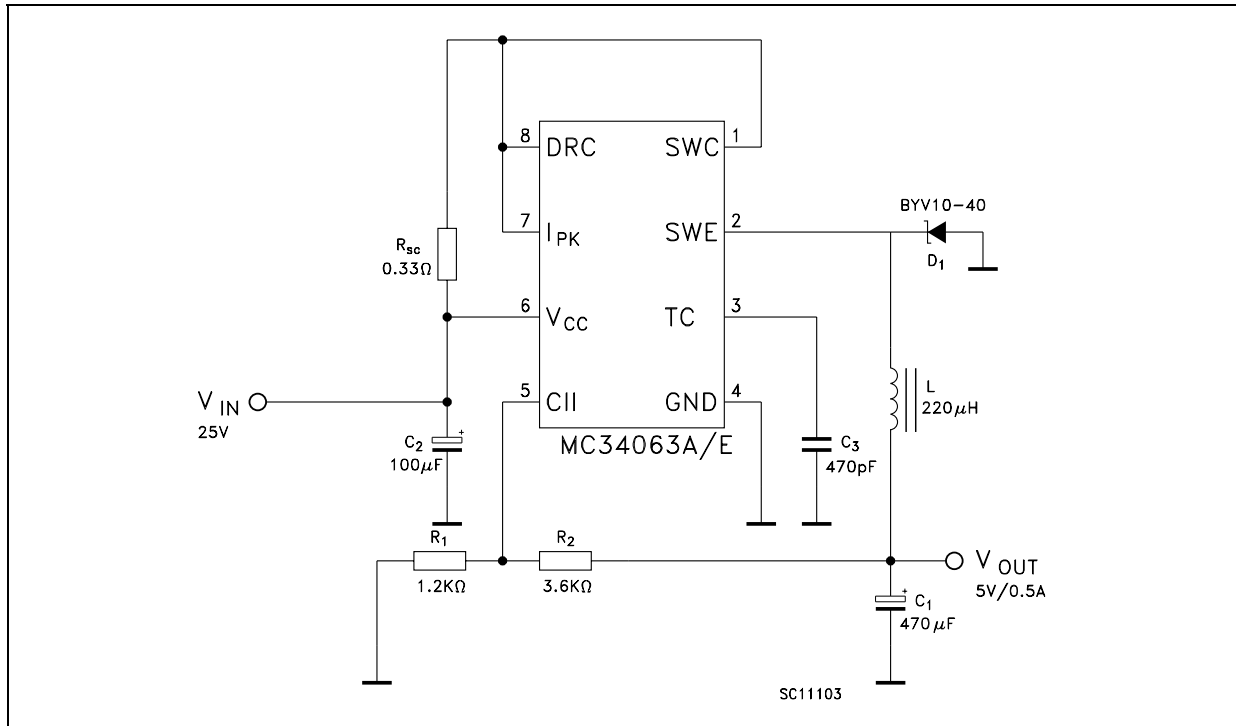
Printed Demoboard



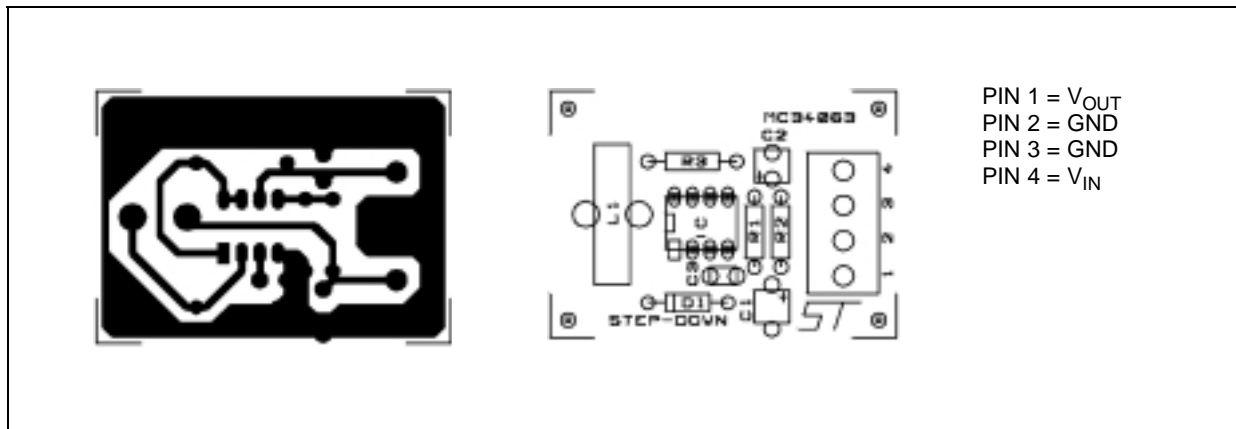
Test Condition ( $V_{OUT} = 28V$ )

| Test            | Conditions                              | Value (Typ.) | Unit |
|-----------------|---|--------------|------|
| Line Regulation | $V_{IN} = 8$ to $16$ V, $I_O = 175$ mA  | 30           | mV   |
| Load Regulation | $V_{IN} = 12$ V, $I_O = 75$ to $175$ mA | 10           | mV   |
| Output Ripple   | $V_{IN} = 12$ V, $I_O = 175$ mA         | 300          | mV   |
| Efficiency      | $V_{IN} = 12$ V, $I_O = 175$ mA         | 89           | %    |

Step-Down Converter



Printed Demoboard

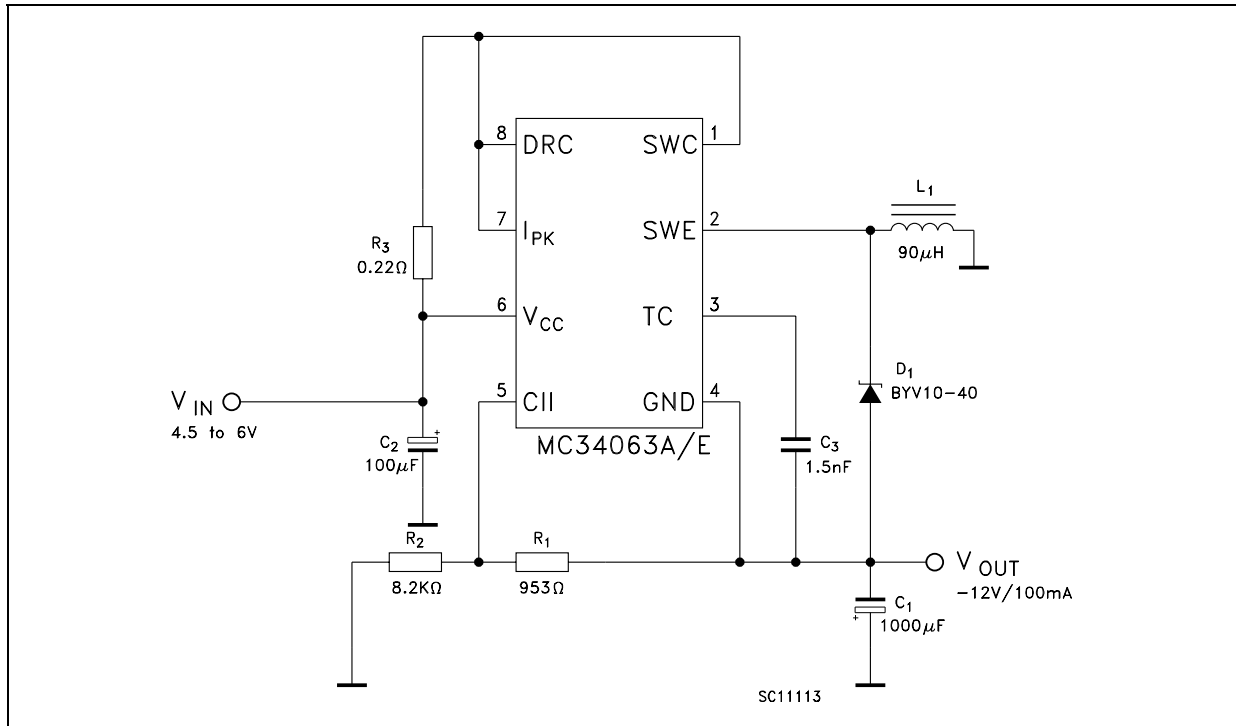


Test Condition ( $V_{OUT} = 5V$ )

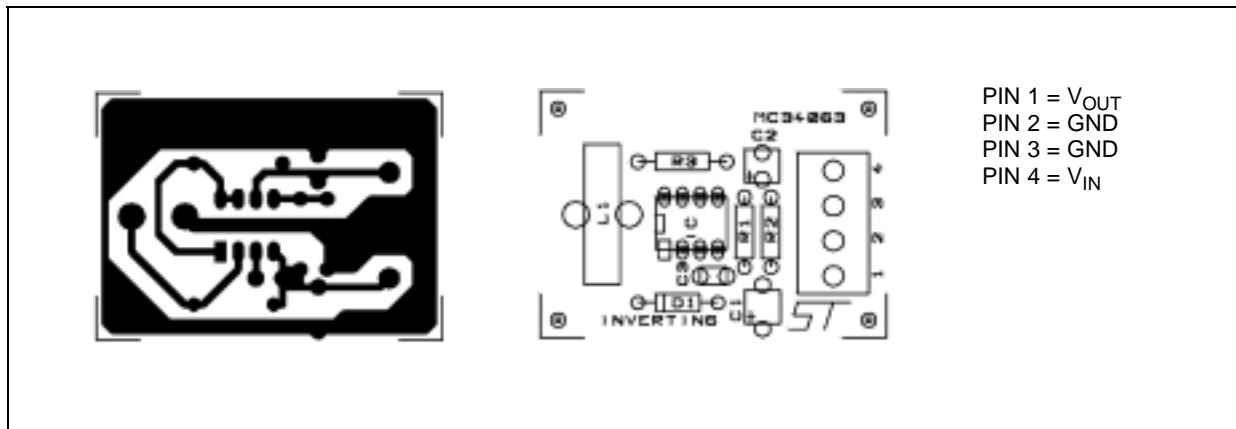
| Test            | Conditions  | Value (Typ.) | Unit |
|-----------------|---|--------------|------|
| Line Regulation | $V_{IN} = 15 \text{ to } 25 \text{ V}$ , $I_O = 500 \text{ mA}$ | 5            | mV   |
| Load Regulation | $V_{IN} = 25 \text{ V}$ , $I_O = 50 \text{ to } 500 \text{ mA}$ | 30           | mV   |
| Output Ripple   | $V_{IN} = 25 \text{ V}$ , $I_O = 500 \text{ mA}$                | 100          | mV   |
| Efficiency      | $V_{IN} = 25 \text{ V}$ , $I_O = 500 \text{ mA}$                | 80           | %    |
| $I_{SC}$        | $V_{IN} = 25 \text{ V}$ , $R_{LOAD} = 0.1 \Omega$               | 1.2          | A    |

# MC34063A/E

## Voltage Inverting Converter



## Printed Demoboard



Test Condition ( $V_{OUT} = -12V$ )

| Test            | Conditions                                | Value (Typ.) | Unit |
|-----------------|---|--------------|------|
| Line Regulation | $V_{IN} = 4.5$ to $6$ V, $I_O = 100$ mA   | 15           | mV   |
| Load Regulation | $V_{IN} = 5$ V, $I_O = 10$ to $100$ mA    | 20           | mV   |
| Output Ripple   | $V_{IN} = 5$ V, $I_O = 100$ mA            | 230          | mV   |
| Efficiency      | $V_{IN} = 5$ V, $I_O = 100$ mA            | 58           | %    |
| $I_{SC}$        | $V_{IN} = 5$ V, $R_{LOAD} = 0.1$ $\Omega$ | 0.9          | A    |



Calculation

| Parameter                  | Step-Up<br>(Discontinuous mode)                                   | Step-Down<br>(Continuous mode)  | Voltage Inverting<br>(Discontinuous mode)                         |
|----------------------------|---|---|---|
| $t_{on}/t_{off}$           | $\frac{V_{OUT} + V_F - V_{IN(min)}}{V_{IN(min)} - V_{sat}}$       | $\frac{V_{OUT} + V_F}{V_{IN(min)} - V_{sat} - V_{OUT}}$                     | $\frac{ V_{OUT}  + V_F}{V_{IN} - V_{sat}}$                        |
| $(t_{on} + t_{off})_{max}$ | $1/f_{min}$   | $1/f_{min}$   | $1/f_{min}$   |
| $C_T$                      | $4.5 \times 10^{-5} t_{on}$                                       | $4.5 \times 10^{-5} t_{on}$   | $4.5 \times 10^{-5} t_{on}$                                       |
| $I_{PK(switch)}$           | $2I_{out(max)}[(t_{on}/t_{off})+1]$                               | $2I_{out(max)}$   | $2I_{out(max)}[(t_{on}/t_{off})+1]$                               |
| $R_{SC}$                   | $0.3/I_{PK(switch)}$  | $0.3/I_{PK(switch)}$  | $0.3/I_{PK(switch)}$  |
| $C_O$                      | $\frac{I_{out} t_{on}}{V_{ripple(p-p)}}$                          | $\frac{I_{PK(switch)}(t_{on} + t_{off})}{8V_{ripple(p-p)}}$                 | $\frac{I_{out} t_{on}}{V_{ripple(p-p)}}$                          |
| $L_{(min)}$                | $\frac{V_{IN(min)} - V_{sat}}{I_{PK(switch)}} \times t_{on(min)}$ | $\frac{V_{IN(min)} - V_{sat} - V_{out}}{I_{PK(switch)}} \times t_{on(min)}$ | $\frac{V_{IN(min)} - V_{sat}}{I_{PK(switch)}} \times t_{on(min)}$ |

NOTES:

$V_{SAT}$  = Saturation voltage of the output switch

$V_F$  = Forward voltage drop of the output rectifier

THE FOLLOWING POWER SUPPLY CHARACTERISTICS MUST BE CHOSEN:

$V_{IN}$  = Nominal input voltage

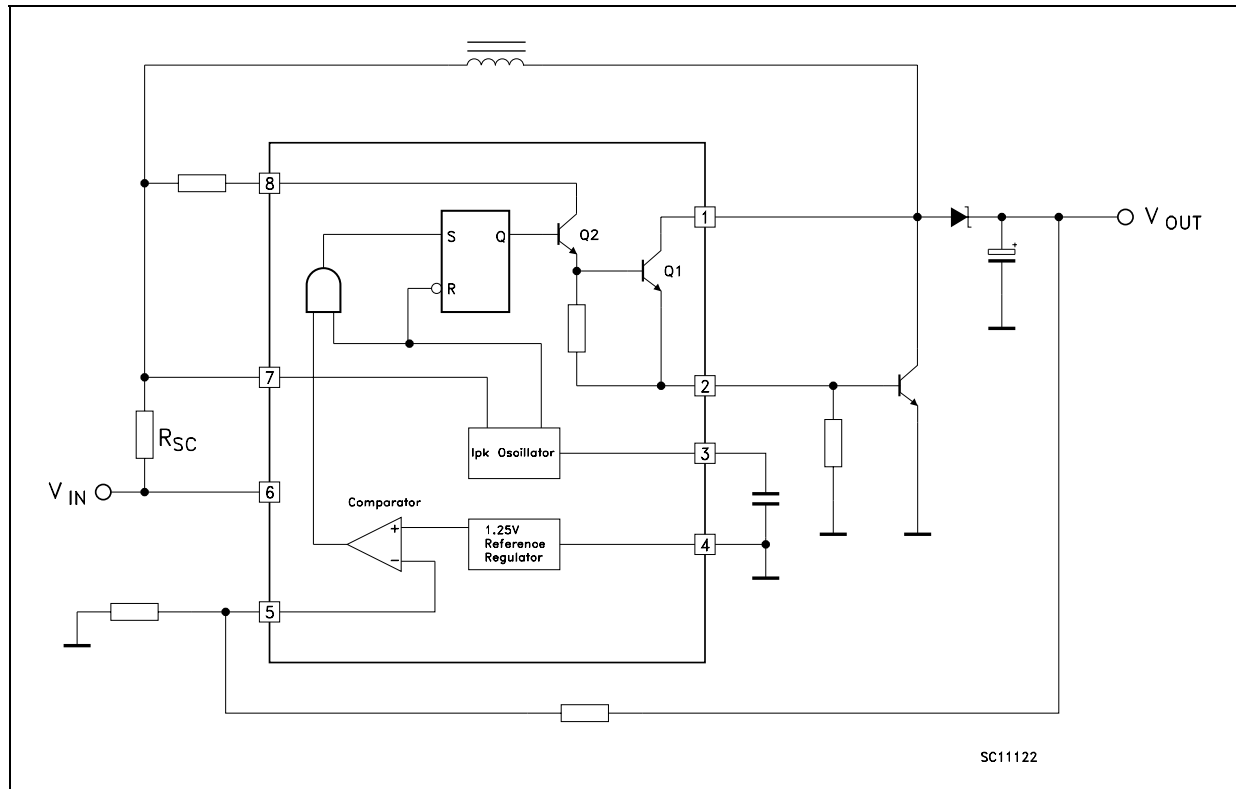
$V_{OUT}$  = Desired output voltage,  $|V_{OUT}| = 1.25(1+R_2/R_1)$

$I_{OUT}$  = Desired output current

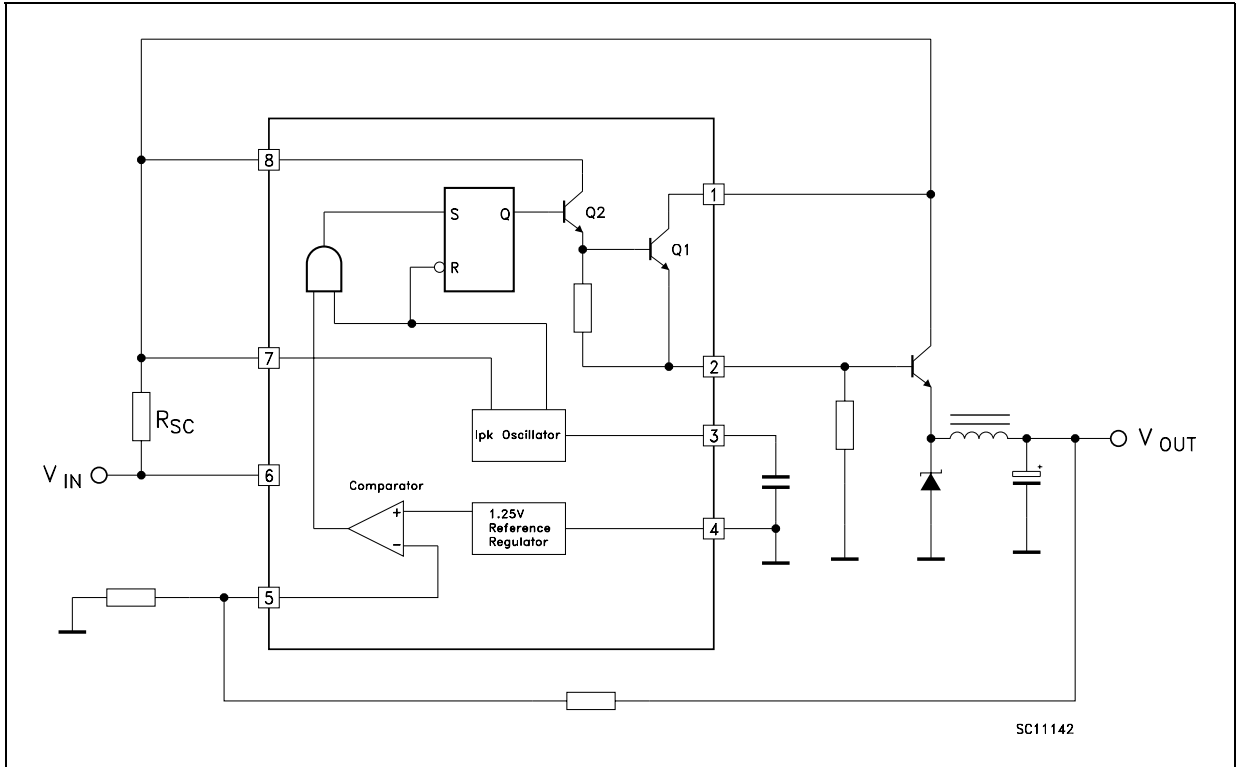
$f_{MIN}$  = Minimum desired output switching frequency at the selected values of  $V_{IN}$  and  $I_O$

$V_{RIPPLE}$  = Desired peak to peak output ripple voltage. In practice, the calculated capacitor value will need to be increased due to its equivalent series resistance and board layout. The ripple voltage should be kept to a low value since it will directly affect the line and load regulation.

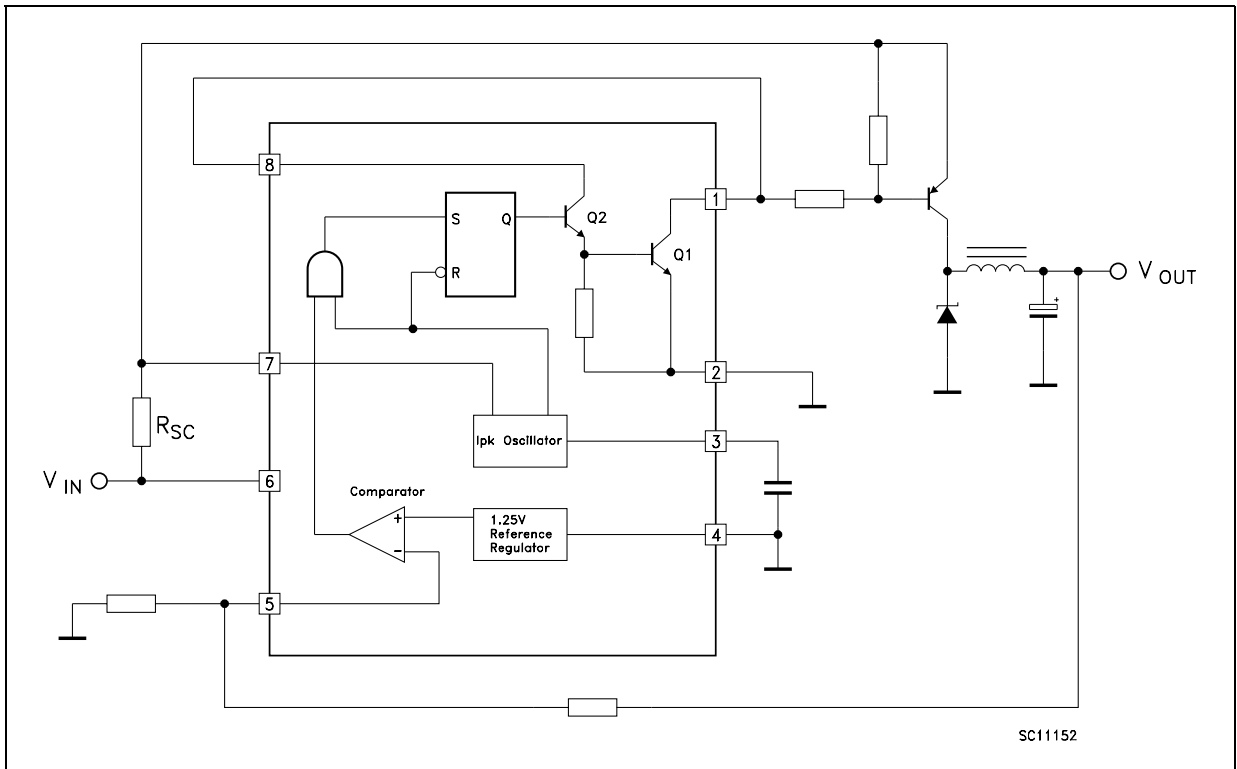
Step-Up With External NPN Switch



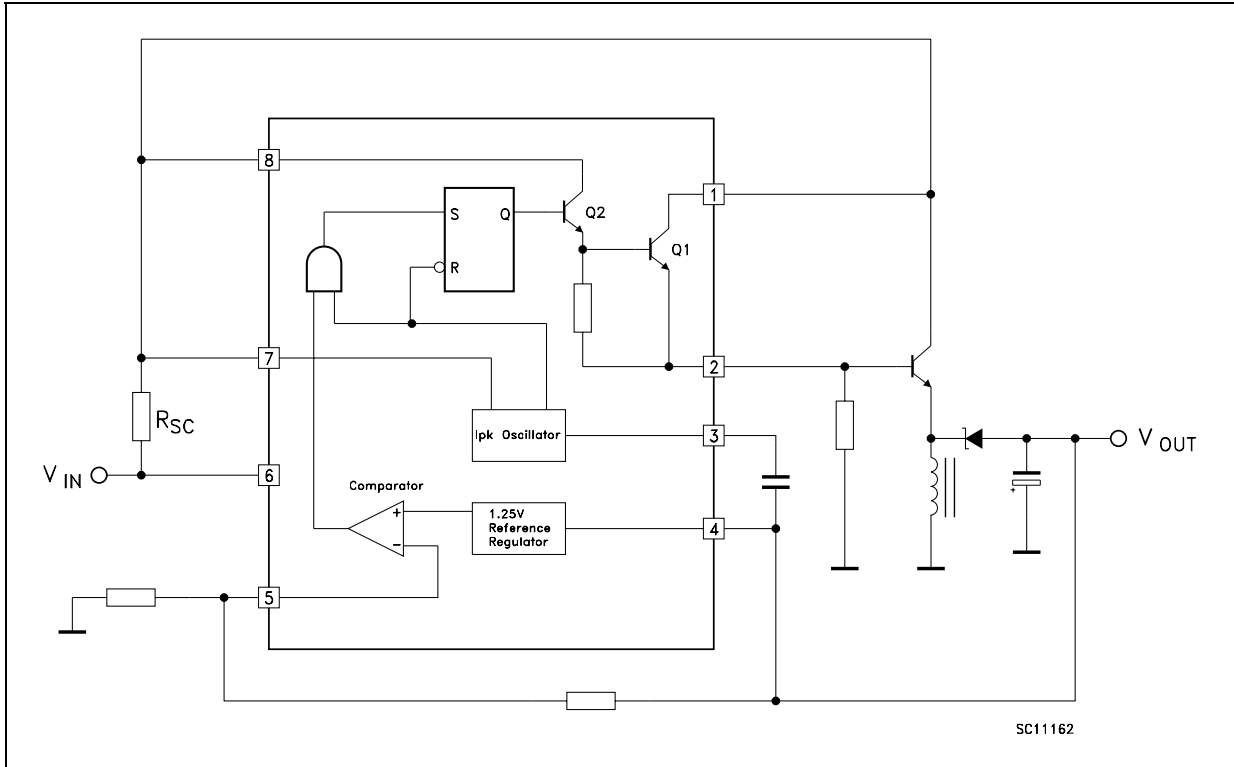
Step-Down With External NPN Switch



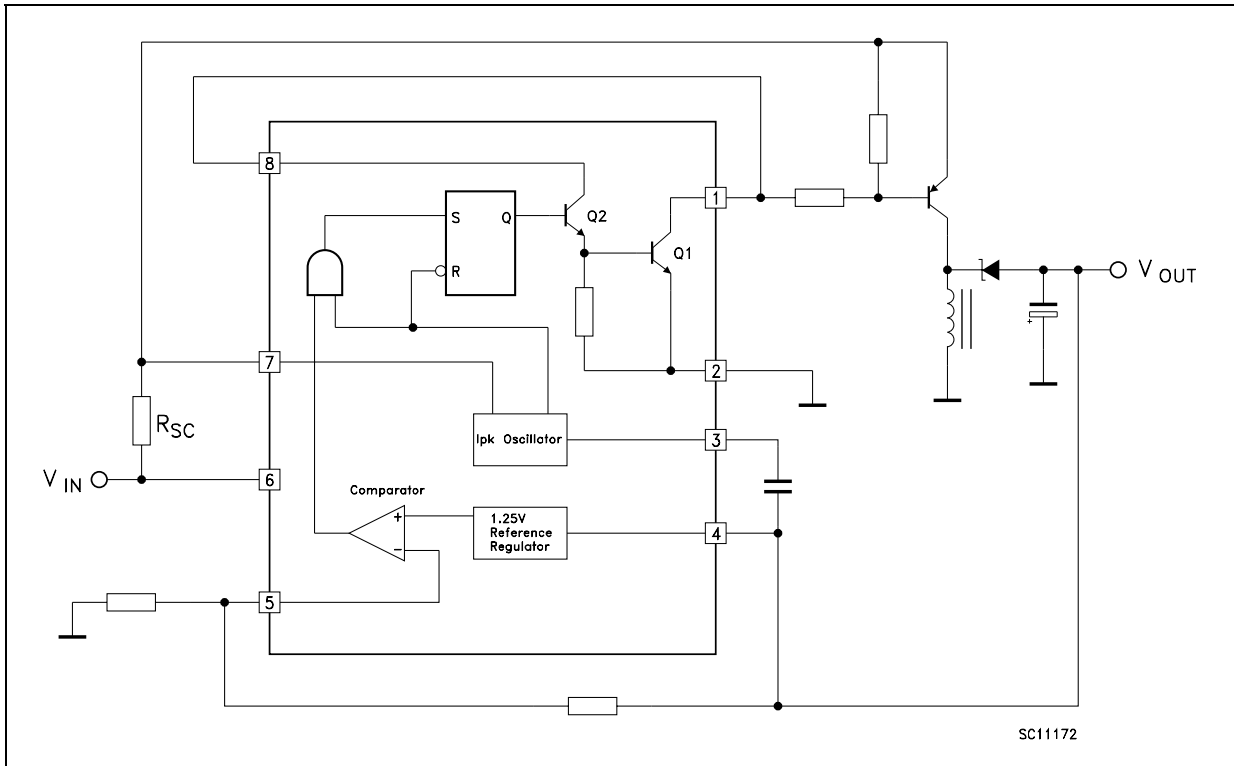
Step-Down With External PNP Switch



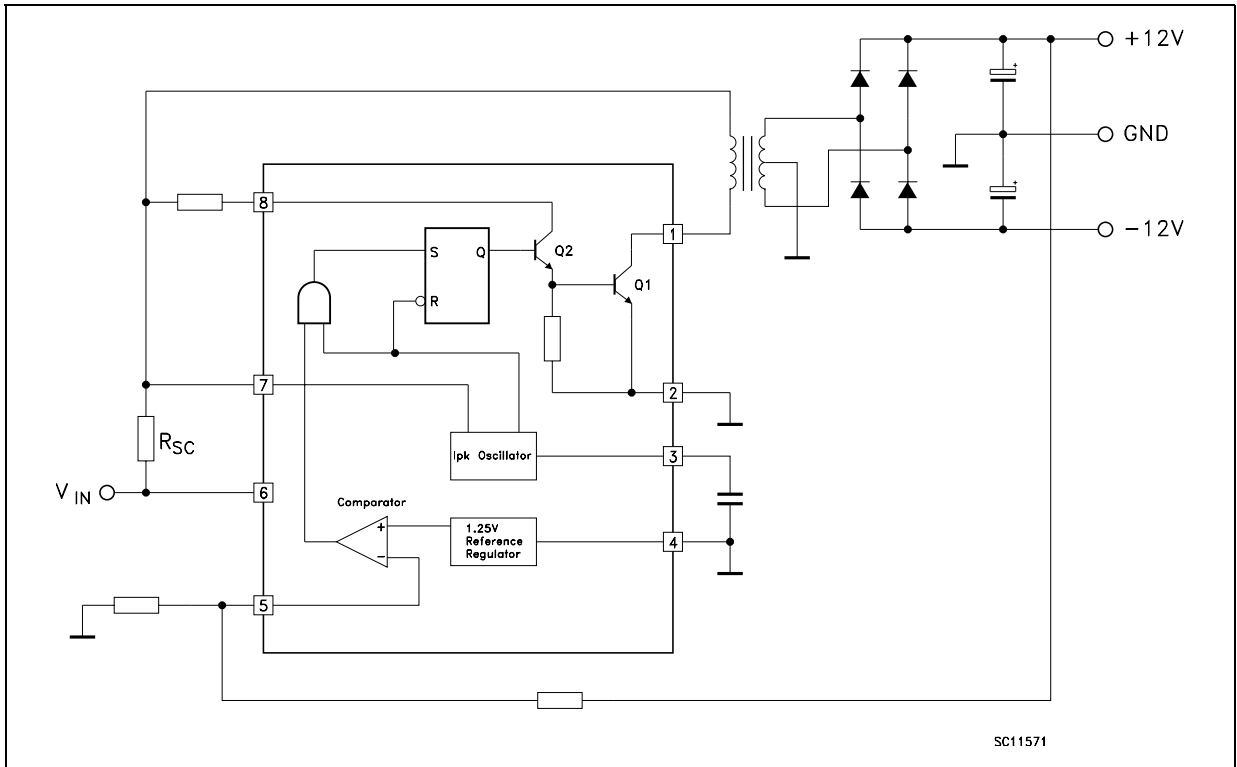
Voltage Inverting With External NPN Switch



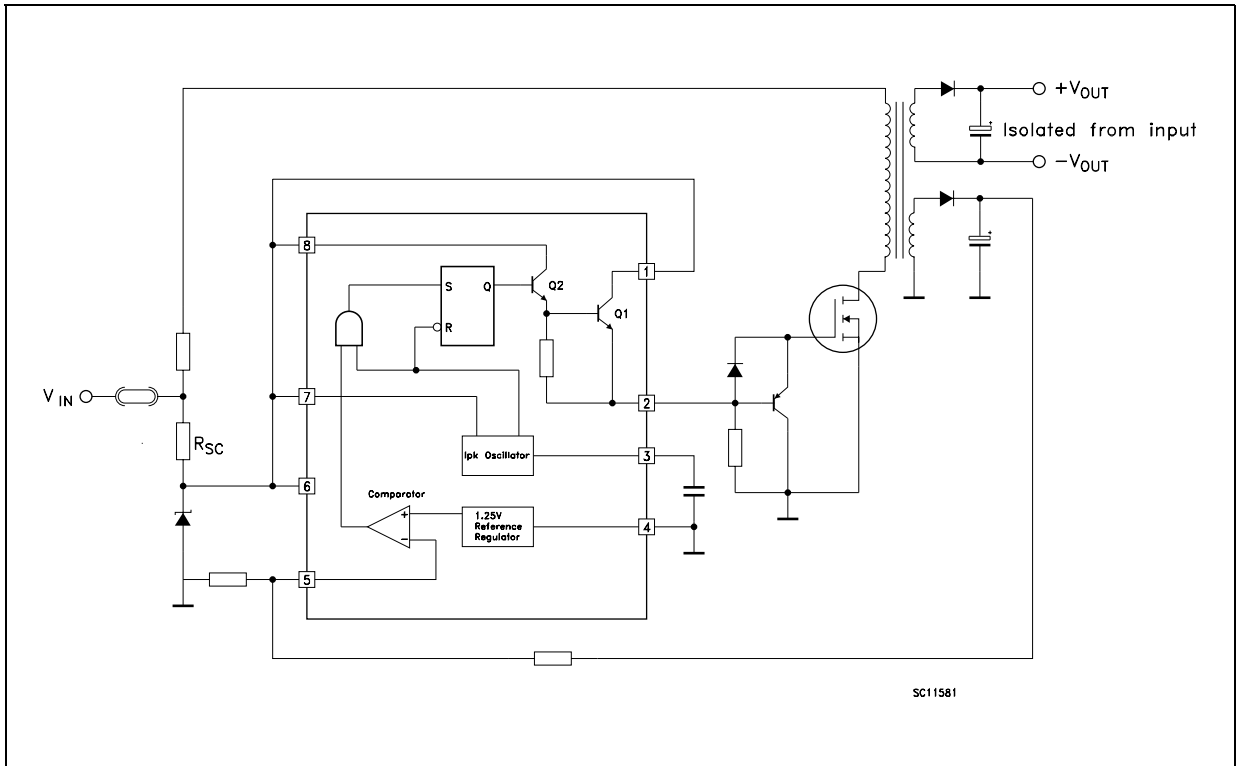
Voltage Inverting With External PNP Saturated Switch



Dual Output Voltage

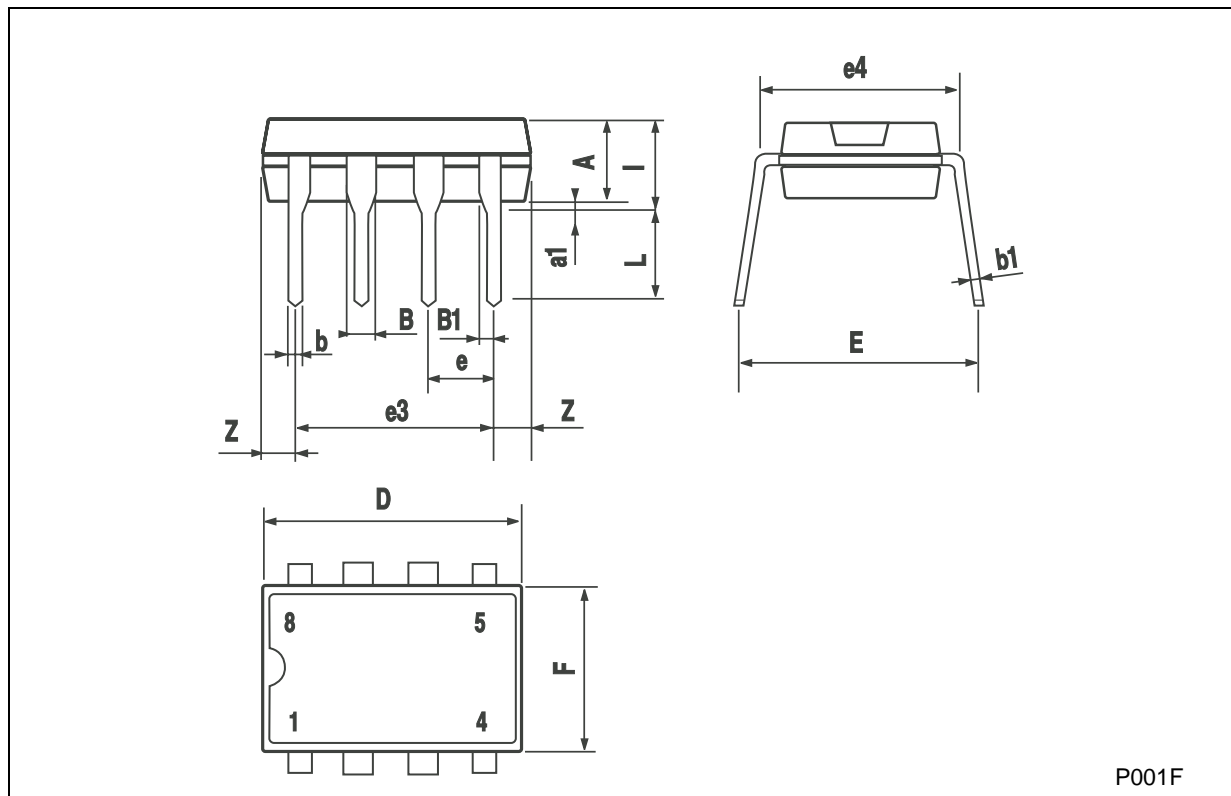


Higher Output Power, Higher Input Voltage



|                                      |  |  |  |  |  |  |
|--------------------------------------|--|--|--|--|--|--|
| <b>Plastic DIP-8 MECHANICAL DATA</b> |  |  |  |  |  |  |
|--------------------------------------|--|--|--|--|--|--|

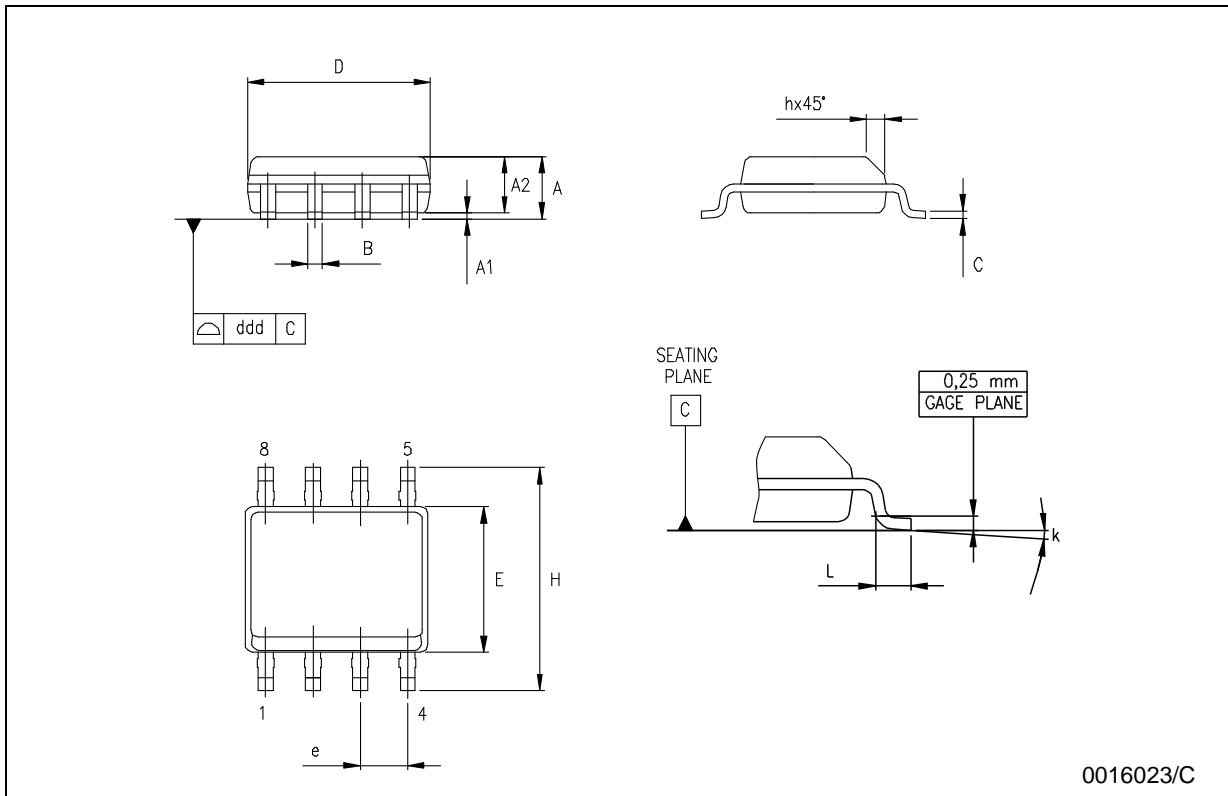
| DIM. | mm.  |      |      | inch  |       |       |
|------|------|------|------|-------|-------|-------|
|      | MIN. | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A    |      | 3.3  |      |       | 0.130 |       |
| a1   | 0.7  |      |      | 0.028 |       |       |
| B    | 1.39 |      | 1.65 | 0.055 |       | 0.065 |
| B1   | 0.91 |      | 1.04 | 0.036 |       | 0.041 |
| b    |      | 0.5  |      |       | 0.020 |       |
| b1   | 0.38 |      | 0.5  | 0.015 |       | 0.020 |
| D    |      |      | 9.8  |       |       | 0.386 |
| E    |      | 8.8  |      |       | 0.346 |       |
| e    |      | 2.54 |      |       | 0.100 |       |
| e3   |      | 7.62 |      |       | 0.300 |       |
| e4   |      | 7.62 |      |       | 0.300 |       |
| F    |      |      | 7.1  |       |       | 0.280 |
| I    |      |      | 4.8  |       |       | 0.189 |
| L    |      | 3.3  |      |       | 0.130 |       |
| Z    | 0.44 |      | 1.6  | 0.017 |       | 0.063 |



P001F

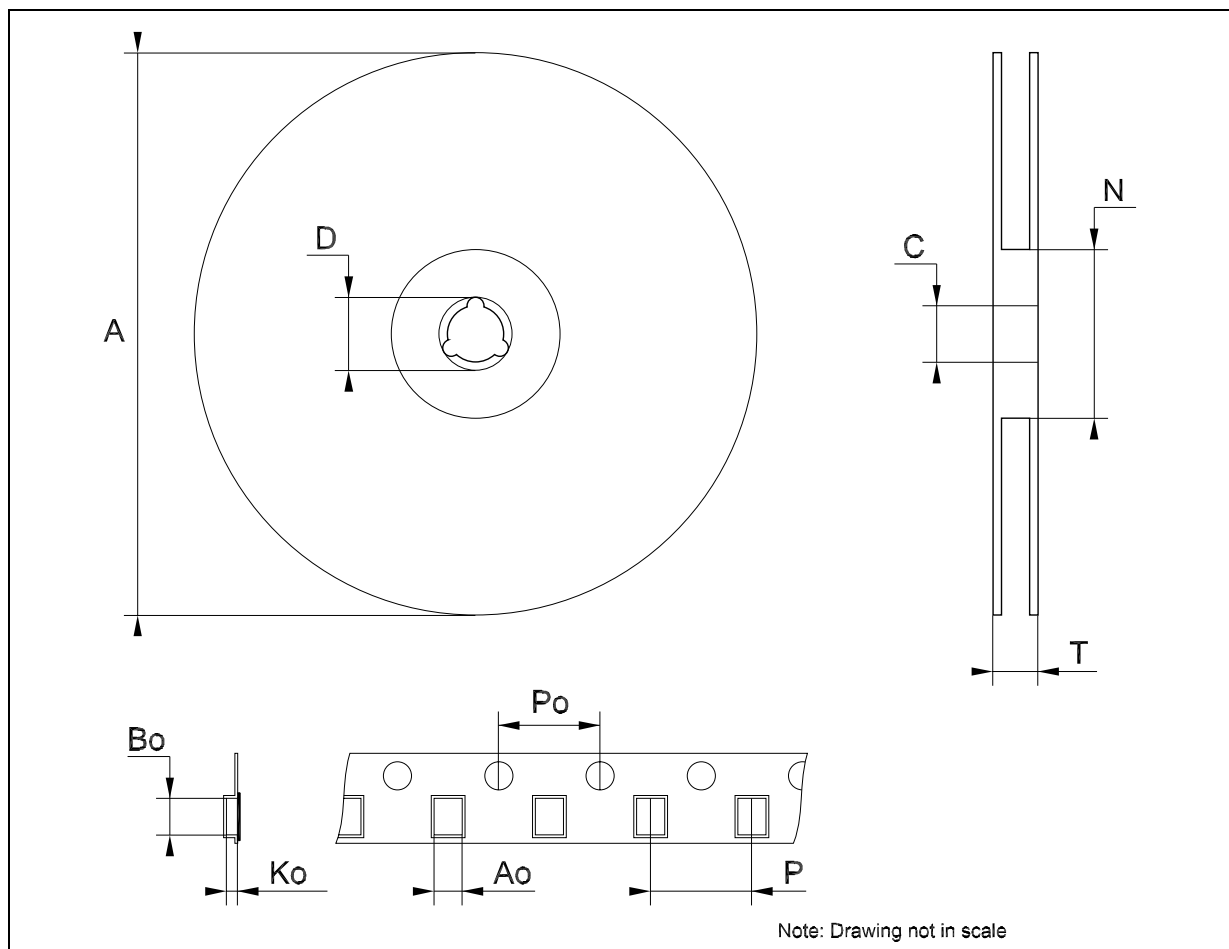
**SO-8 MECHANICAL DATA**

| DIM. | mm.       |      |      | inch  |       |       |
|------|-----------|------|------|-------|-------|-------|
|      | MIN.      | TYP. | MAX. | MIN.  | TYP.  | MAX.  |
| A    | 1.35      |      | 1.75 | 0.053 |       | 0.069 |
| A1   | 0.10      |      | 0.25 | 0.04  |       | 0.010 |
| A2   | 1.10      |      | 1.65 | 0.043 |       | 0.065 |
| B    | 0.33      |      | 0.51 | 0.013 |       | 0.020 |
| C    | 0.19      |      | 0.25 | 0.007 |       | 0.010 |
| D    | 4.80      |      | 5.00 | 0.189 |       | 0.197 |
| E    | 3.80      |      | 4.00 | 0.150 |       | 0.157 |
| e    |           | 1.27 |      |       | 0.050 |       |
| H    | 5.80      |      | 6.20 | 0.228 |       | 0.244 |
| h    | 0.25      |      | 0.50 | 0.010 |       | 0.020 |
| L    | 0.40      |      | 1.27 | 0.016 |       | 0.050 |
| k    | 8° (max.) |      |      |       |       |       |
| ddd  |           |      | 0.1  |       |       | 0.04  |



## Tape &amp; Reel SO-8 MECHANICAL DATA

| DIM. | mm.  |     |      | inch  |      |        |
|------|------|-----|------|-------|------|--------|
|      | MIN. | TYP | MAX. | MIN.  | TYP. | MAX.   |
| A    |      |     | 330  |       |      | 12.992 |
| C    | 12.8 |     | 13.2 | 0.504 |      | 0.519  |
| D    | 20.2 |     |      | 0.795 |      |        |
| N    | 60   |     |      | 2.362 |      |        |
| T    |      |     | 22.4 |       |      | 0.882  |
| Ao   | 8.1  |     | 8.5  | 0.319 |      | 0.335  |
| Bo   | 5.5  |     | 5.9  | 0.216 |      | 0.232  |
| Ko   | 2.1  |     | 2.3  | 0.082 |      | 0.090  |
| Po   | 3.9  |     | 4.1  | 0.153 |      | 0.161  |
| P    | 7.9  |     | 8.1  | 0.311 |      | 0.319  |



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