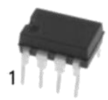
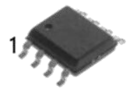
DC-to- DC Converter Control Circuits

FEATURES

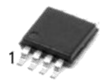
- Operation from 3.0V to 40V input
- Low standby current
- Current limiting
- Output switch current up to 1.5A
- Adjustable output voltage
- Operation at frequencies up to 100kHz
- Precision reference (2%)



DIP-8



SOP-8



MSOP-8

ORDERING INFORMATION

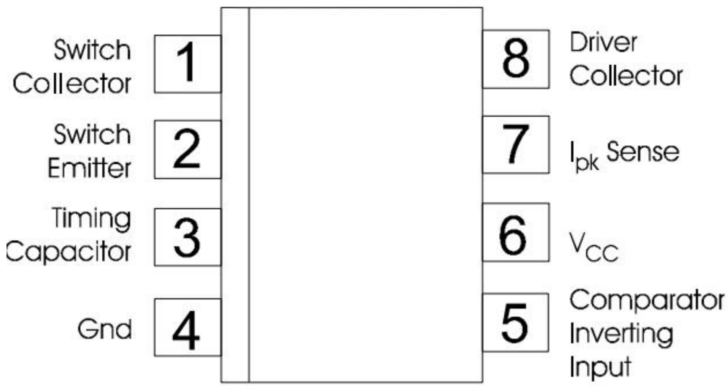
DEVICE	Package Type	MARKING	Packing	Packing Qty
MC33063N	DIP-8	MC33063	TUBE	2000pcs/box
MC33063M/TR	SOP-8	MC33063	REEL	2500pcs/reel
MC33063MM/TR	MSOP-8	33063	REEL	2500pcs/reel

DESCRIPTION

The MC33063 series is a monolithic control circuit containing primary functions required for DC-to-DC converters.

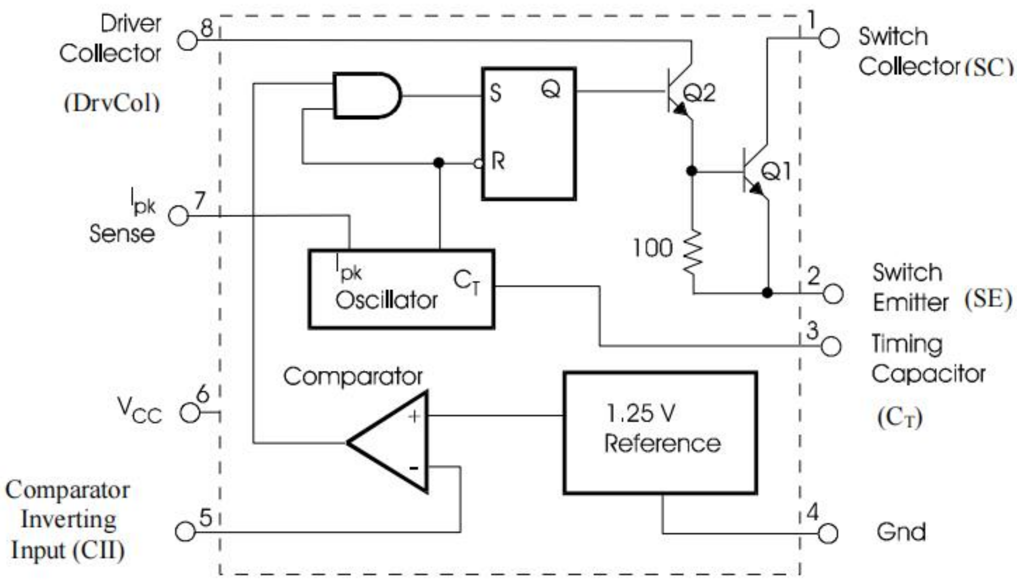
These devices consist of an internal temperature-compensated reference, comparator, controlled duty cycle oscillator withan active current limit circuit, driver and high current output switch. This series was specifically designed to be incorporated in step-down and step-up and voltage-inverting applications with a minimum number of external components.

PIN CONNECTIONS



DIP8/SOP8/MSOP8
(Top view)

SCHEMATIC DIAGRAM



(Bottom view)

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power supply voltage	V_{CC}	40	V
Comparator input voltage range	V_{IR}	-0.3 to +40	V
Switch collector voltage	$V_{C(Switch)}$	40	V
Switch emitter voltage (VPin1=40V)	$V_{E(Switch)}$	40	V
Switch collector-to-emitter voltage	$V_{CE(Switch)}$	40	V
Driver collector voltage	$V_{C(Driver)}$	40	V
Driver collector current (Note 1)	$I_{C(Driver)}$	100	mA
Switch current	I_{Sw}	1.5	A
Operating junction temperature	T_J	+150	°C
Operating ambient temperature range	T_A	-40 to +85	°C
Storage temperature range	T_{STG}	-65 to + 150	°C
ESD (HBM)		2500	V

ELECTRICAL CHARACTERISTICS (V_{CC}=5.0V, T_A=T_{Low} to T_{High}, unless otherwise specified.)

Characteristics	Symbol	Min	Typ	Max	Unit
OSCILLATOR					
Frequency (VPin5=0V, C_T=1.0nF, T_A=25°C)	fosc	24	33	42	kHz
Charge current (V_{CC}=5.0V to 40V, T_A=25°C)	Ichg	24	35	42	μA
Discharge current (V_{CC}=5.0V to 40V, T_A=25°C)	Idischg	140	220	260	μA
Discharge-to-charge current ratio (Pin7 to V_{CC}, T_A=25°C)	Idischg/Ichg	5.2	6.5	7.5	-
Current limit sense voltage (Ichg=Idischg, T_A=25°C)	VIpk(sense)	250	300	350	mV
OUTPUT SWITCH (Note 2)					
Saturation voltage, Darlington connection ISw=1.0A, Pins1, 8 connected	$V_{CE(sat)}$	-	1.0	1.3	V
Saturation voltage, Darlington connection (ISw=1.0A, R_{Pin8}=82Ω to V_{CC}, forced β=20)	$V_{CE(sat)}$	-	0.45	0.7	V
DC current gain (ISw=1.0A, V_{CE}=5.0, T_A=25°C)	h_{FE}	50	75	-	-
Collector off-state current (V_{CE}=40V)	$I_{C(off)}$	-	1.0	100	μA
COMPARATOR					
Threshold voltage	V_{th}	1.225 1.21	1.25 -	1.275 1.29	V
Threshold voltage line regulation(V_{CC}=3.0V to 40V)	Reg_{line}	-	1.4	5.0	mV
Input bias current(Vin=0V)	I_{IB}	-	-20	-400	nA
TOTAL DEVICE					
Supply current (V_{CC}=5.0V to 40V, C_T=1.0nF, Pin7=V_{CC}, VPin5>Vth, Pin2 =Gnd, remaining pins - open	I_{CC}	-	-	4.0	mA

Notes:
1. Maximum package power dissipation limits must be observed.
2. Low duty cycle pulse techniques are used during the test to maintain the junction temperature as close to the ambient temperature as possible.

TYPICAL PERFORMANCE CHARACTERISTICS

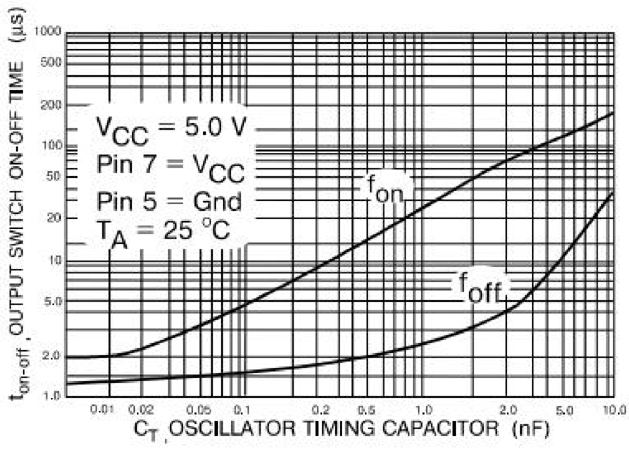


Fig.1.Output Switch on-off time versus Oscillator timing capacitor

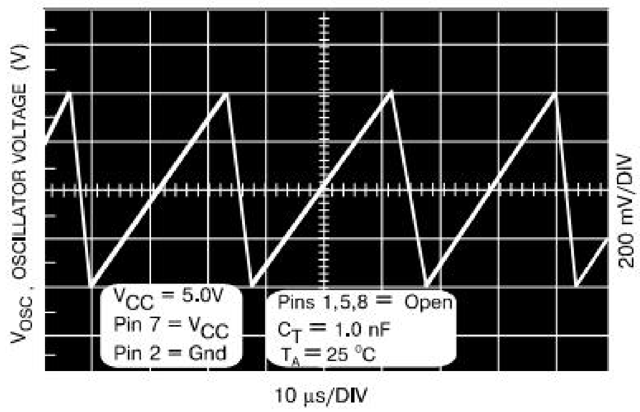


Fig.2.Timing capacitor waveform

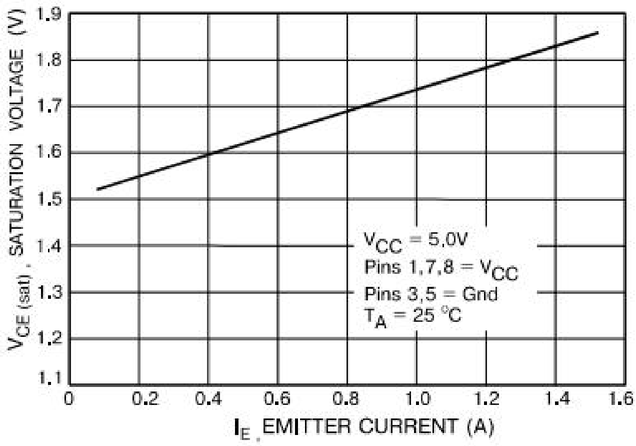


Fig.3. Emitter follower configuration output saturation voltage versus Emitter current

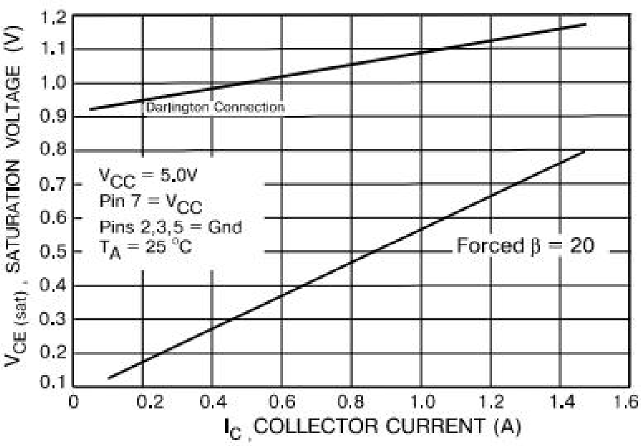


Fig.4. Common emitter configuration output saturation voltage versus Collector current

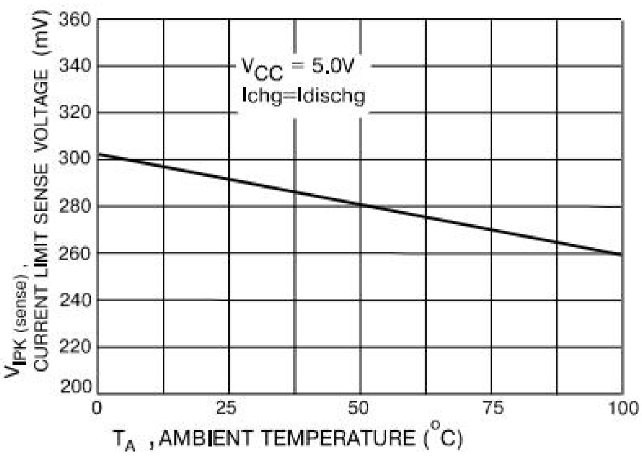


Fig.5. Current limit sense voltage versus Temperature

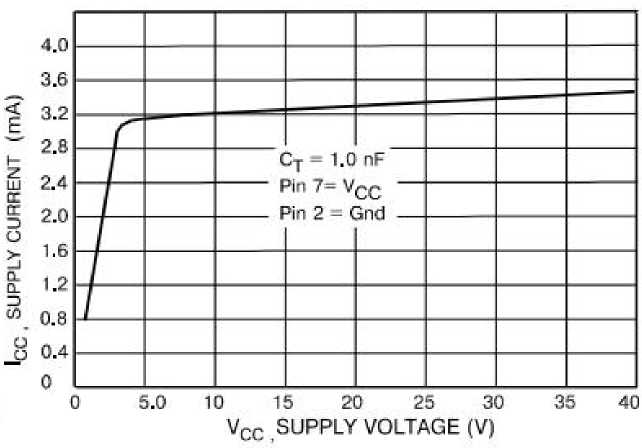


Fig.6. Standby supply current versus Supply voltage

APPLICATION INFORMATION

Fig.1. Step–up converter

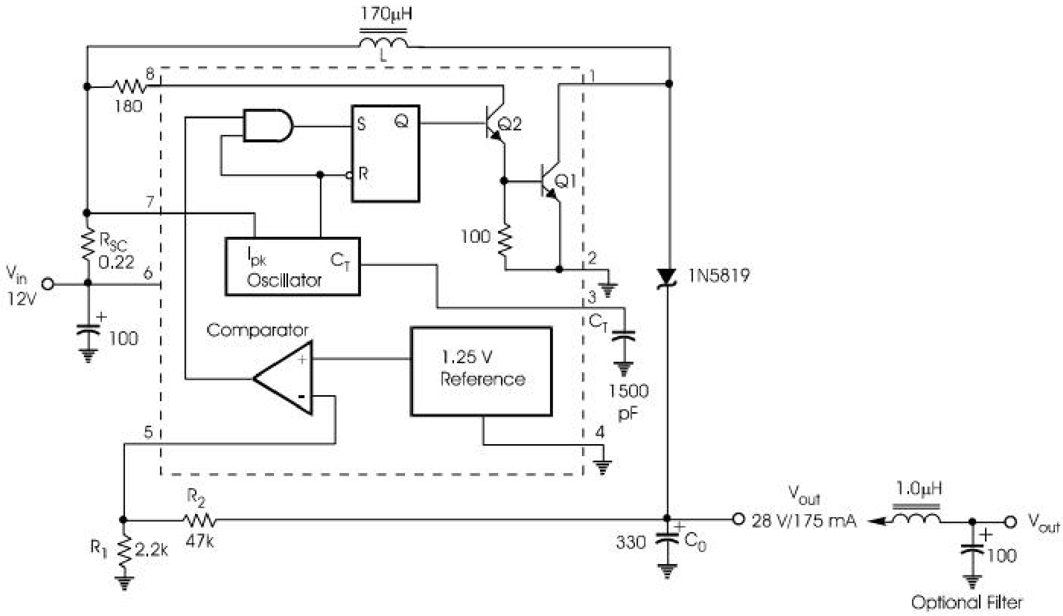
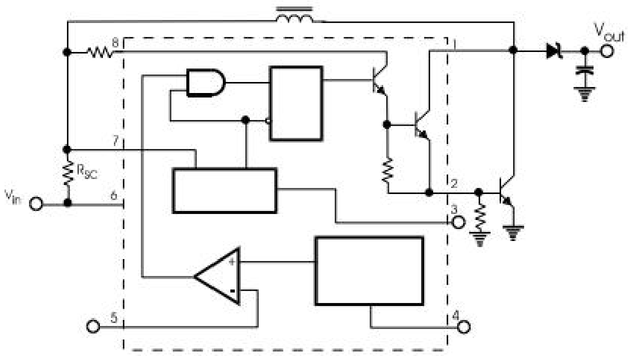
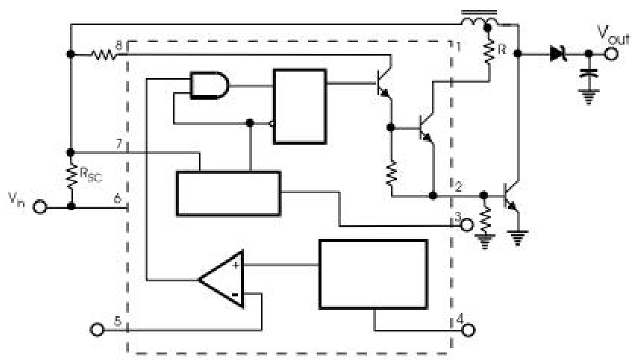


Fig.2. External current boost connections for IC Peak greater than 1.5A

2a. External NPN switch



2b. External NPN saturated switch



Note: R → 0 at constant V_{IN}

Fig.3. Step-down Converter

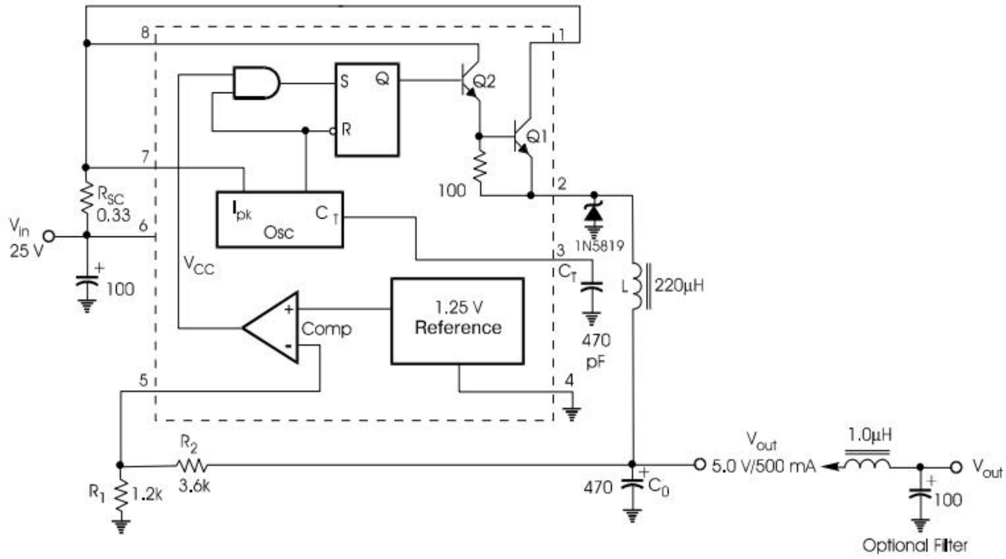


Fig.4. External current boost connections for Ic Peak greater than 1.5A

4a. External NPN switch **4b. External PNP saturated switch**

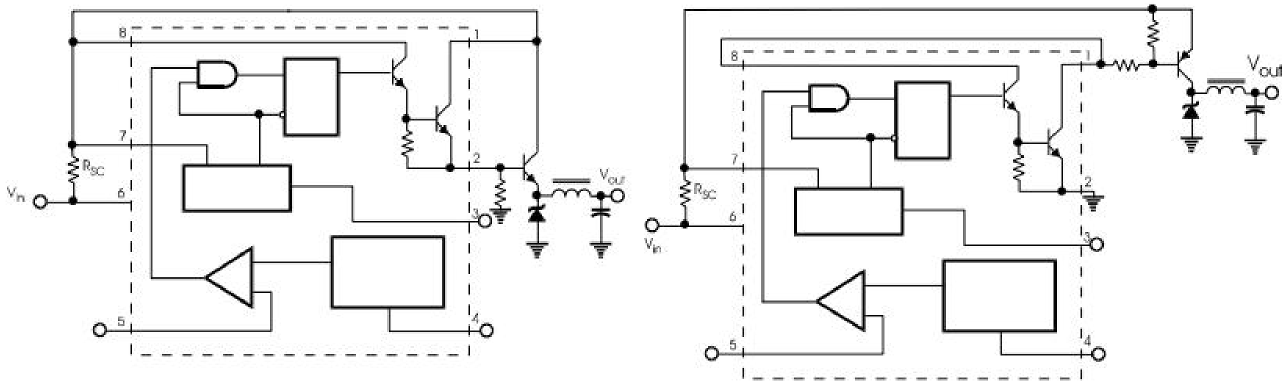


Fig.5. Voltage inverting converter

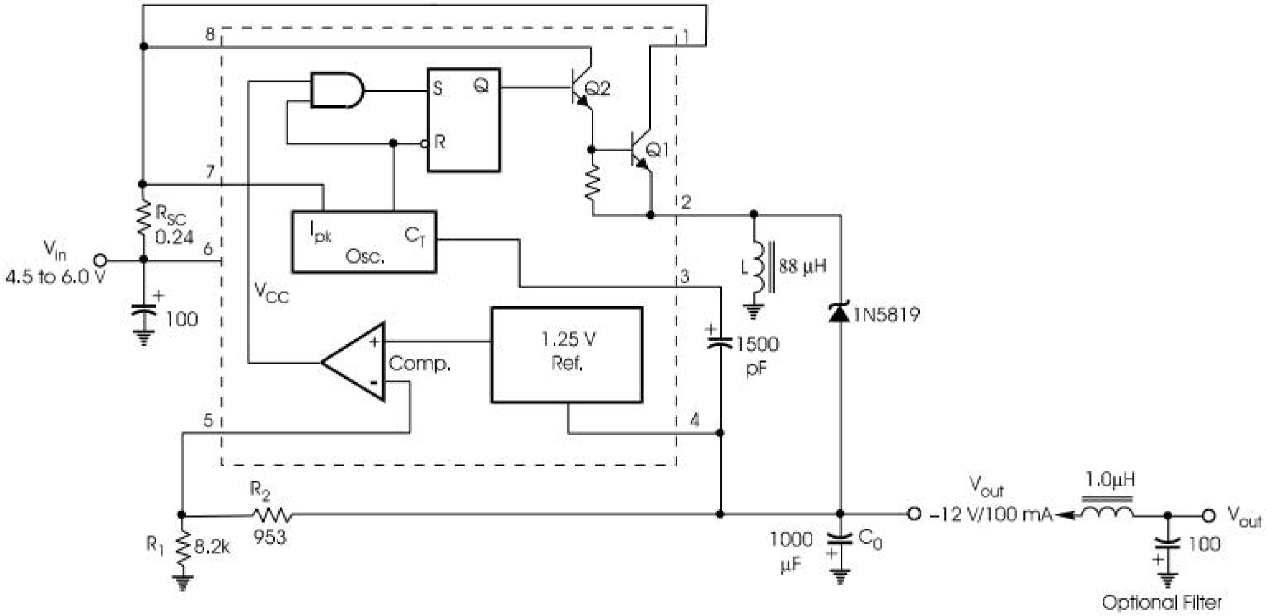
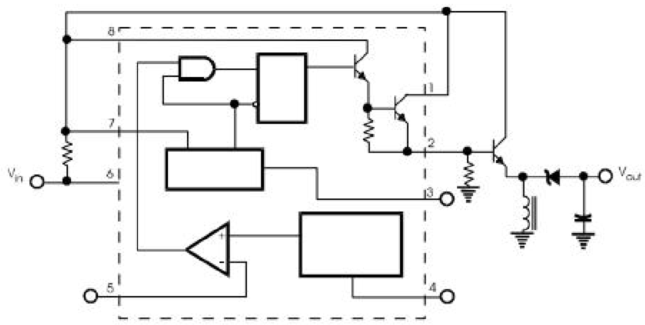
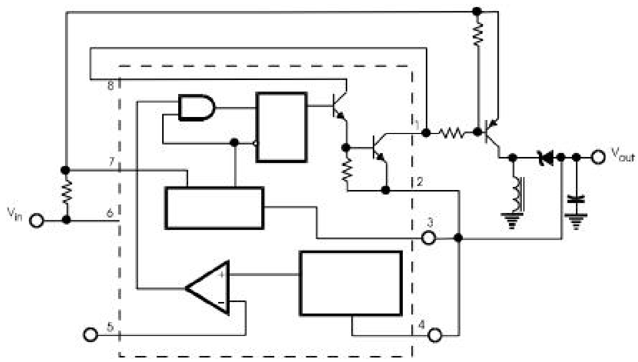


Fig.6. External current boost connections for $I_{C\ Peak}$ greater than 1.5A

6a. External NPN switch



6b. External PNP saturated switch



DESIGN FORMULA

Calculation	Step-up	Step-down	Voltage-inverting
ton	$\frac{Vout + VF - Vin(min)}{Vin(min) - Vsat}$	$\frac{Vout + VF}{Vin(min) - Vsat - Vout}$	$\frac{\lvert Vout \rvert + VF}{Vin + Vsat}$
(ton + toff)max	$\frac{1}{fmin}$	$\frac{1}{fmin}$	$\frac{1}{fmin}$
C_T	4.0×10^{-5} ton	4.0×10^{-5} ton	4.0×10^{-5} ton
$I_{pk(switch)}$	$2I_{out\ (max)} \left(\frac{ton}{toff} + 1\right)$	$2I_{out(max)}$	$2I_{out\ (max)} \left(\frac{ton}{toff} + 1\right)$
Rsc	$0.3/I_{pk(Switch)}$	$0.3/I_{pk(Switch)}$	$0.3/I_{pk(Switch)}$
L(min)	$\left(\frac{Vin(min) - Vsat}{Ipk\ (switch)}\right) \times ton(max)$	$\left(\frac{Vin(min) - Vsat - Vout}{Ipk\ (switch)}\right) \times ton(max)$	$\left(\frac{Vin(min) - Vsat}{Ipk\ (switch)}\right) \times ton(max)$
Co	$9 \frac{Ioutton}{Vripple(pp)}$	$\frac{Ipk(switch)(ton + toff)}{8Vripple(pp)}$	$9 \frac{Ioutton}{Vripple(pp)}$

TERMS AND DEFINITIONS

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.

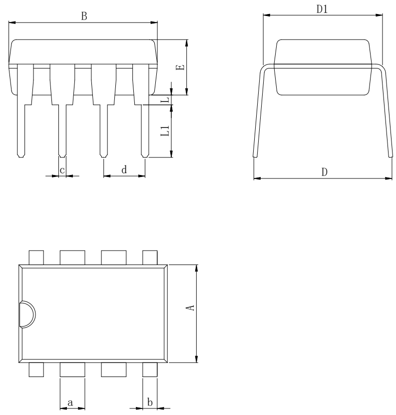
V_{out} – Desired output voltage, $\lvert Vout \rvert = 1.25\left(1 + \frac{R2}{R1}\right)$

f_{min} – Minimum desired output switching frequency at the selected values of V_{in} and I_{out}.

$V_{ripple(p\text{-}p)}$ – 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.

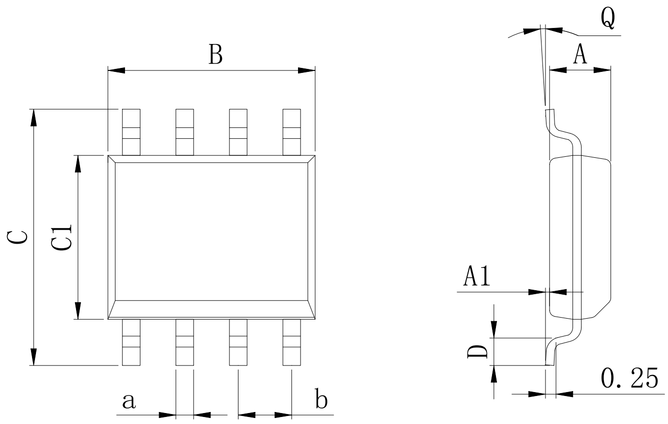
Physical Dimensions

DIP8



Dimensions In Millimeters(DIP8)										
Symbol:	A	B	D	D1	E	L	L1	a	b	c	d
Min:	6.10	9.00	8.40	7.42	3.10	0.50	3.00	1.50	0.85	0.40	2.54 BSC
Max:	6.68	9.50	9.00	7.82	3.55	0.70	3.60	1.55	0.90	0.50	

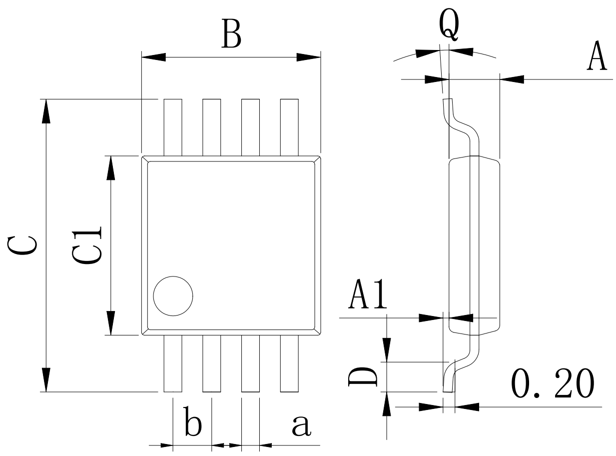
SOP8 (150mil)



Dimensions In Millimeters(SOP8)									
Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	1.35	0.05	4.90	5.80	3.80	0.40	0°	0.35	1.27 BSC
Max:	1.55	0.20	5.10	6.20	4.00	0.80	8°	0.45	

Physical Dimensions

MSOP8



Dimensions In Millimeters(MSOP8)									
Symbol:	A	A1	B	C	C1	D	Q	a	b
Min:	0.80	0.05	2.90	4.75	2.90	0.35	0°	0.25	0.65 BSC
Max:	0.90	0.20	3.10	5.05	3.10	0.75	8°	0.35	

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