

## 5V/3.3V-Adjustable High-PSRR Low-Noise LDO

## HM7671 Series

## CMOS Voltage Regulator With ON/OFF Switch

## 1A

### PRODUCT DESCRIPTION

HM7671 series are highly accurate, low-noise, high power supply rejection ratio (PSRR), low-dropout voltage regulator (LDO) with high output current capability manufactured in CMOS processes. It can deliver up to 1A of current while consuming 40 $\mu$ A of quiescent current. Internal circuitry includes a reference voltage generator, an error amplifier, driver transistor, over-current protection circuit, short-circuit protection circuit, thermal shutdown circuit and a phase compensation circuit. The HM7671 operates by default as a fixed output voltage regulator (default output voltage: 5V or 3.3V) while usage of an external resistor divider allows adjustable output voltages as low as 0.7V. Additional features include enable function, power good flag and output noise reduction pin.

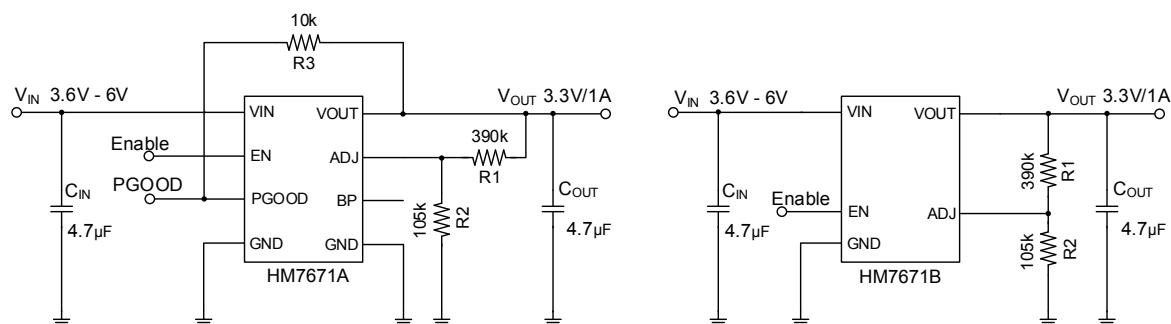
### FEATURES

- Highly Accurate:  $\pm 2\%$
- Low Quiescent Current: 40 $\mu$ A
- Dropout Voltage: 160mV@3.3V/1A
- Maximum Output Current: 1A
- Input Voltage Range: 2~6V
- Output Voltage Noise: 115 $\mu$ Vrms@V<sub>OUT</sub>=3.3V
- High PSRR: 70dB@1kHz
- Temperature Stability:  $\pm 50$ ppm/ $^{\circ}$ C
- ON/OFF Logic = Enable High
- Power Good and Enable Functions
- Standby Current: 10nA
- C<sub>OUT</sub> Discharge Circuit when EN Disable is Active
- Protections Circuits: Current Limit, Short Circuit, and Thermal Protections
- Output Capacitor: Low ESR Ceramic Capacitor Compatible
- RoHS compliant "Green"/Halogen Free 8-pin Exposed pad SOIC (ESOP8) packages, TO252-4, SOT89-3 and SOT23-5 packages

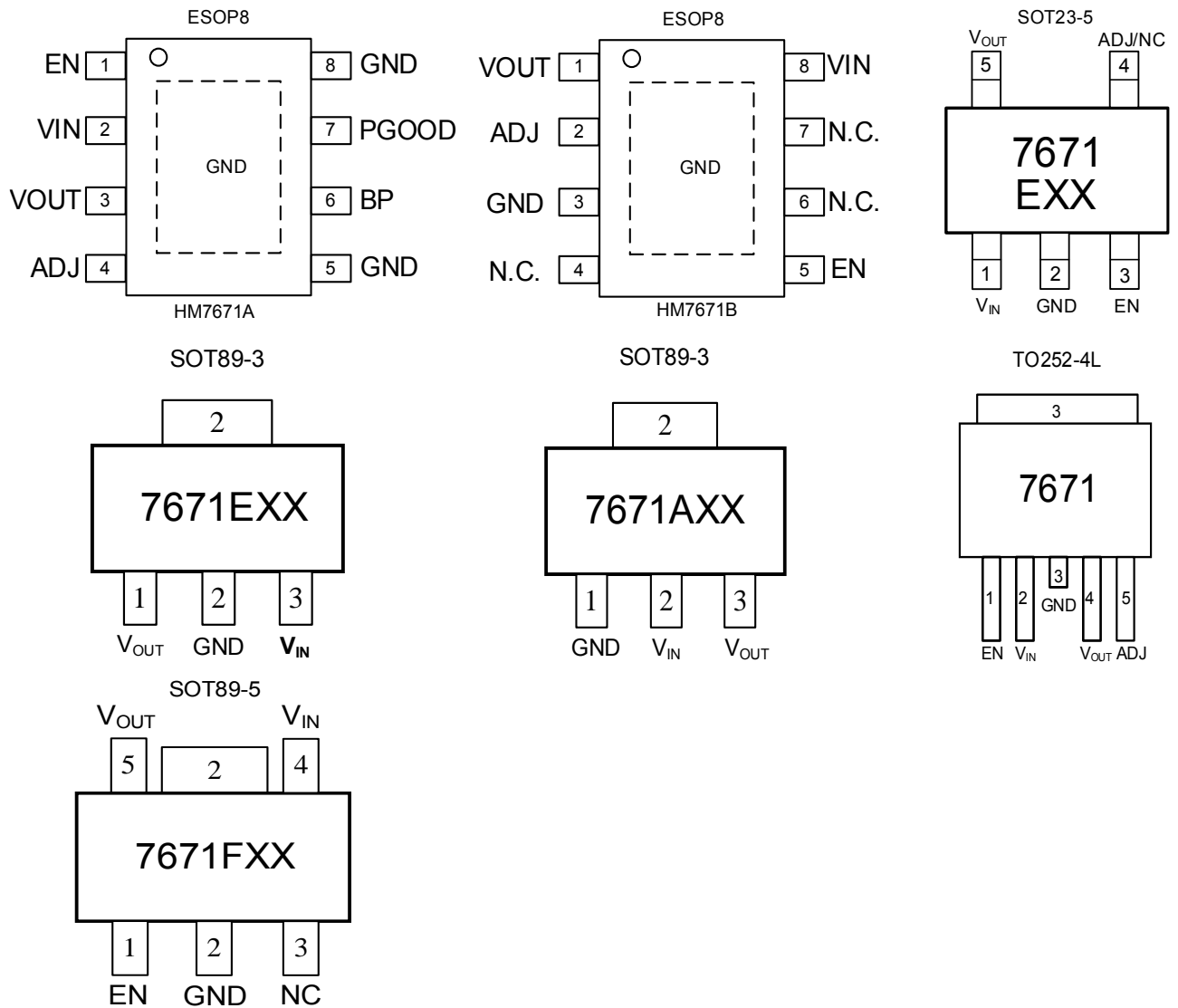
### APPLICATIONS

- Smart wearer
- Long-life battery-powered devices
- Portable mobile devices, such as mobile phones, cameras, and so on
- Wireless communication equipment

### TYPICAL APPLICATION CIRCUIT:



## PIN CONFIGURATION (TOP VIEW)



## PRODUCT SELECTIONS

Type	Fixed Output Voltage (note 1*)	ADJ	Accuracy (note 2*)	Package (note 3*)	MARKING (note 4*)
HM7671A50ES	5V	Yes	±2%	ESOP8	7671A
HM7671B50ES	5V	Yes	±2%	ESOP8	7671B
HM7671B33ES	3.3V	Yes	±2%	ESOP8	7671B33
HM7671E50MR	5V	Yes/No	±2%	SOT23-5	7671E50
HM7671E33MR	3.3V	Yes/No	±2%	SOT23-5	7671E33
HM7671E33PR	3.3V	No	±2%	SOT89-3	7671E33
HM7671A33PR	3.3V	No	±2%	SOT89-3	7671A33
HM7671F33P5	3.3V	No	±2%	SOT89-5	7671F33
HM7671F40P5	4.0V	No	±2%	SOT89-5	7671F40
HM7671E50T	5V	Yes	±2%	TO252-4L	7671

### Notes:

1\* Customer can request to customize the output voltage ranged from 1.2V to 5V if desired voltage is not found in the selections.

2\* Customer can request customization of accuracy requirement.

3\* Customer can request customization of package choice.

4\* Please pay attention to the MARKING of the product package type.

## PIN DESCRIPTION

Name	ESOP8 (HM7671A)	ESOP8 (HM7671B)	SOT23-5 (HM7671EXX)	Description
VOUT	3	1	5	Regulator Output pin.
ADJ	4	2	-	Adjustable Pin. Output Voltage can be set by external feedback resistors when using a resistive divider. Or, connect ADJ to GND for $V_{OUT} = 5V$ or $3.3V$ , set by internal feedback resistors.
GND	5,8	3	2	Ground Signal
EN	1	5	3	Enable Pin. Minimum 1.6V to enable the device. Maximum 0.4V to shutdown the device.
VIN	2	8	1	Power Input Pin. Must be closely decoupled to GND pin with a 4.7 $\mu F$ or greater ceramic capacitor.
BP	6	-	-	Bypass pin. Connect a 1 $\mu F$ capacitor to GND to reduce output noise. Bypass pin can be left floating if unnecessary.
PGOOD	7	-	-	Power Good open Drain Output
N.C.	-	4,6,7	-	Non Connection (Used to connect GND or OPEN state.)
GND	Exposed Pad	Exposed Pad	-	Connect to GND.

## ABSOLUTE MAXIMUM RATINGS

(Unless otherwise indicated: Ta=25°C)

PARAMETER	SYMBOL	RATINGS		UNITS
Input Voltage	V <sub>IN</sub>	-0.3 ~ 7		V
Output Voltage	V <sub>OUT</sub>	-0.3 ~ V <sub>IN</sub> +0.3		
Power Dissipation	P <sub>D</sub>	Internally Limited		
Thermal Resistance	R <sub>θJB</sub> <sup>(1)</sup>	ESOP8	80	°C/W
		SOT23-5	180	
		SOT89-3	100	
		TO252-4	60	
Operating Ambient Temperature	T <sub>opr</sub>	-40 ~ +85		°C
Storage Temperature	T <sub>stg</sub>	-40 ~ +125		
ESD Protection	ESD HBM	4000		V

**Note:** Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device.

<sup>(1)</sup> Mounted on JEDEC standard 4layer (2s2p) PCB test board

## ELECTRICAL CHARACTERISTICS

Unless otherwise indicated,  $V_{IN} = V_{OUT} + 1V$ ,  $C_{IN} = 4.7\mu F$ ,  $C_{OUT} = 4.7\mu F$ ,  $C_{BYP} = 1\mu F$ ,  $T_J = 25^\circ C$ .

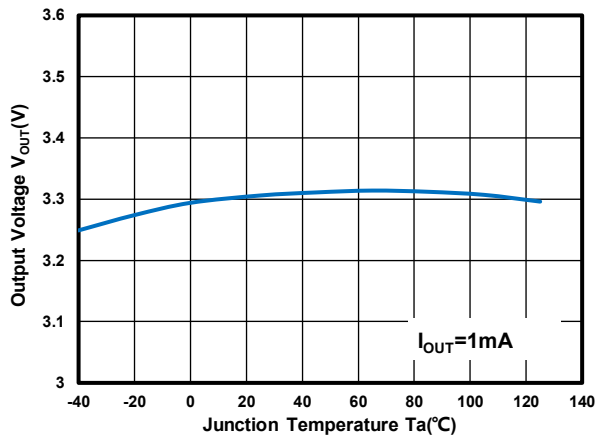
PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Input Voltage	$V_{IN}$		2		6	V
Output Voltage Tolerance	$V_{OUT(S)}$	$I_{OUT} = 1mA$	-2		+2	%
Continuous Output Current	$I_{OUT}$	$V_{IN} > 2.1V$	1			A
Ground Current	$I_{GND}$	$V_{EN} = V_{IN}$ , no load		40		$\mu A$
		$V_{EN} = V_{IN}$ , $I_{OUT} = 100mA$		390		
Shutdown Current	$I_{SHUT}$	$V_{EN} = 0$		0.01		$\mu A$
Output Current Limit	$I_{LIM}$			1.4		A
Current Fold Back				0.4		
Dropout Voltage <sup>2</sup>	$V_{DROP}$	$V_{EN} = V_{IN}$ , $I_{OUT} = 1A$ , $V_{OUT} = 1.8V$		210	300	mV
		$V_{EN} = V_{IN}$ , $I_{OUT} = 1A$ , $V_{OUT} = 3.3V$		160	250	
		$V_{EN} = V_{IN}$ , $I_{OUT} = 1A$ , $V_{OUT} = 5V$		150	240	
Line Regulation		$V_{OUT(S)} + 1V \leq V_{IN} = V_{EN} \leq 6V$ $I_{OUT} = 1mA$		3	15	mV
Load Regulation	$\Delta V_{OUT2}$	$V_{IN} = V_{EN} = V_{OUT(S)} + 1.0V$ $1mA \leq I_{OUT} \leq 1A$		10	20	mV
Temperature Stability	$\frac{\Delta V_{OUT}}{\Delta T_a \cdot V_{OUT(S)}}$	$V_{IN} = V_{EN} = V_{OUT(S)} + 1.0V$ $I_{OUT} = 1mA$ $-40^\circ C \leq T_A \leq 125^\circ C$		$\pm 50$		ppm/ $^\circ C$
Reference Voltage Tolerance			0.686	0.7	0.714	V
ADJ Pin Current		$V_{ADJ} = V_{REF}$		10		nA
ADJ Pin Threshold			0.05	0.1	0.2	V
Enable Turn-On Threshold		Output ON	1.6			V
Enable Turn-Off Threshold		Output OFF			0.4	V
Shutdown Pin Current				0.1	0.5	$\mu A$
Shutdown Exit Delay Time				0		$\mu s$
Max Output Discharge Resistance to GND during Shutdown				30		$\Omega$
PGOOD Rise Threshold	$PG_{HTh}$			90		%
PGOOD Hysteresis	$PG_{HYS}$			10		%
PGOOD Delay	$PG_{DLY}$			1		ms
PGOOD Sink Capability		$I_{PGOOD} = 10mA$		0.05		V
Power Supply Ripple Rejection	PSRR	$f = 1kHz$ , $I_{OUT} = 10mA$		70		dB
		$f = 10kHz$ , $I_{OUT} = 10mA$		68		
		$f = 100kHz$ , $I_{OUT} = 10mA$		47		
		$f = 1MHz$ , $I_{OUT} = 10mA$		55		
Output Noise Voltage	$V_{OUTN}$	$C_{BP} = 1\mu F$ , $V_{OUT} = 3.3V$ $f = 10Hz \sim 100KHz$		115		$\mu V_{RMS}$
Thermal Shutdown Temperature	$T_{SD}$			175		$^\circ C$
Thermal Shutdown Hysteresis	$T_{SD\_HYS}$			35		$^\circ C$

Notes:

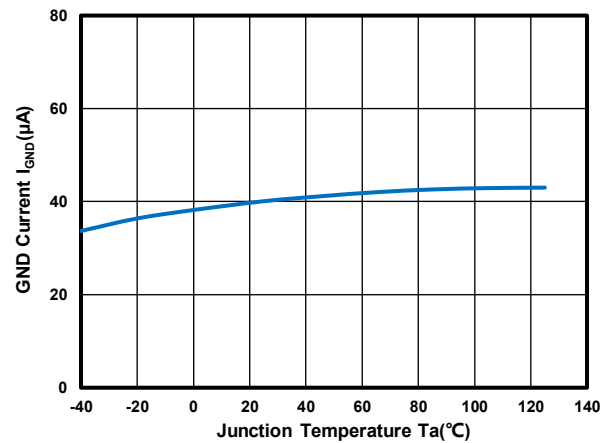
1.  $V_{OUT(S)}$ : Output voltage when  $V_{IN} = V_{OUT} + 1V$ ,  $I_{OUT} = 1mA$ .
2.  $V_{DROP} = V_{IN1} - (V_{OUT(S)} \times 0.98)$  where  $V_{IN1}$  is the input voltage when  $V_{OUT} = V_{OUT(S)} \times 0.98$ .
3.  $I_{LIM}$ : Output current when  $V_{IN} = V_{OUT(S)} + 1V$  and  $V_{OUT} = 0.95 \times V_{OUT(S)}$ .

## TYPICAL PERFORMANCE CHARACTERISTICS

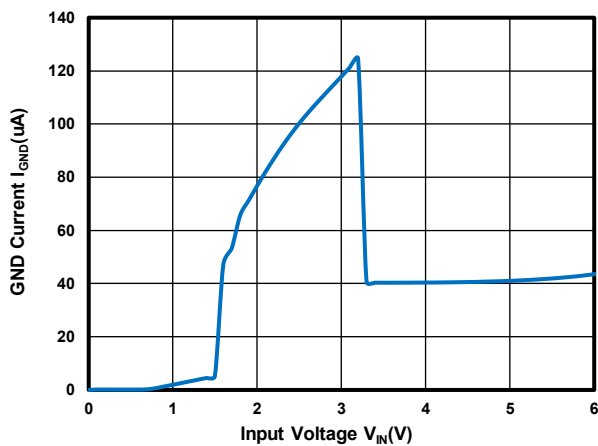
Test Conditions:  $V_{IN}=V_{OUT}+1.0V$ ,  $C_{IN}=4.7\mu F$ ,  $C_{OUT}=4.7\mu F$ ,  $T_A=25^\circ C$ , unless otherwise indicated.



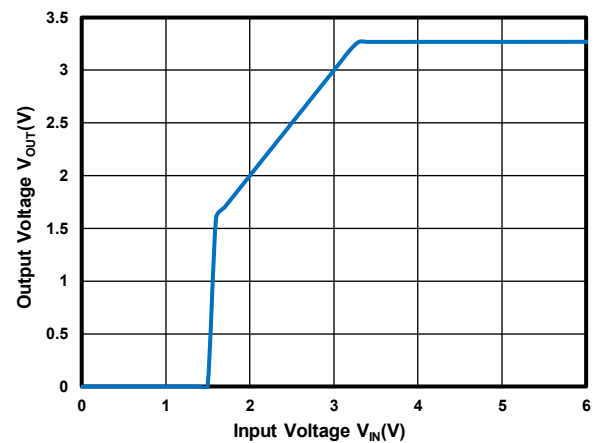
Output Voltage vs. Temperature at  $V_{OUT}=3.3V$



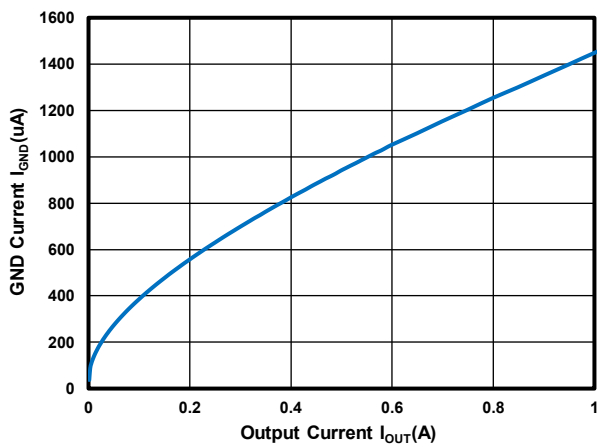
GND Current vs. Temperature at  $V_{OUT}=3.3V$



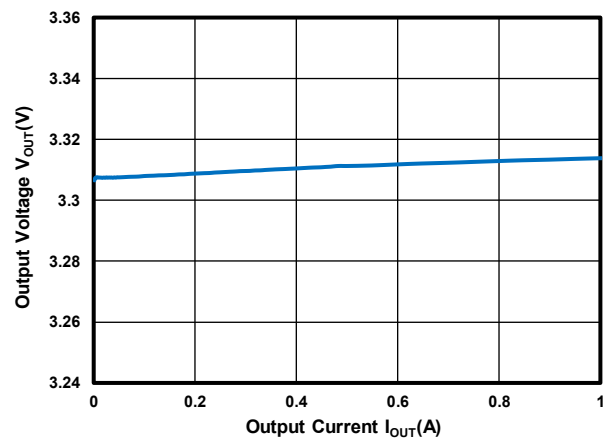
GND Current vs. Input Voltage at  $V_{OUT}=3.3V$



Output Voltage vs. Input Voltage at  $V_{OUT}=3.3V$



GND Current vs. Output Current at  $V_{OUT}=3.3V$



Output Voltage vs. Output Current at  $V_{OUT}=3.3V$

## ELECTRICAL CHARACTERISTICS

Unless otherwise indicated,  $V_{IN} = V_{OUT} + 1V$ ,  $C_{IN} = 4.7\mu F$ ,  $C_{OUT} = 4.7\mu F$ ,  $C_{BYP} = 1\mu F$ ,  $T_J = 25^\circ C$ .

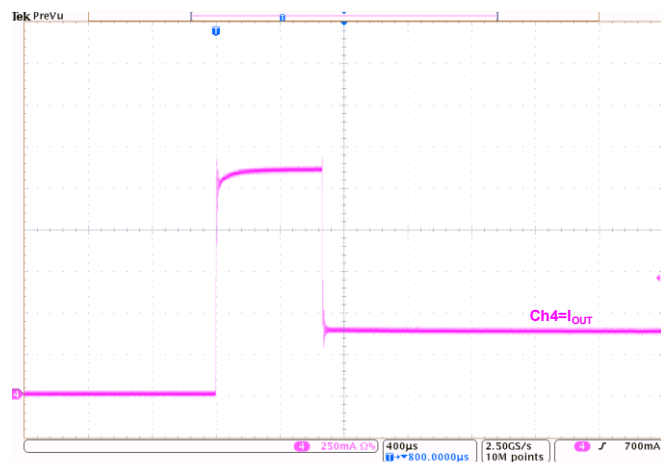
PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Input Voltage	$V_{IN}$		2		6	V
Output Voltage Tolerance	$V_{OUT(S)}$	$I_{OUT} = 1mA$	-2		+2	%
Continuous Output Current	$I_{OUT}$	$V_{IN} > 2.1V$	1			A
Ground Current	$I_{GND}$	$V_{EN} = V_{IN}$ , no load		40		$\mu A$
		$V_{EN} = V_{IN}$ , $I_{OUT} = 100mA$		390		
Shutdown Current	$I_{SHUT}$	$V_{EN} = 0$		0.01		$\mu A$
Output Current Limit	$I_{LIM}$			1.4		A
Current Fold Back				0.4		
Dropout Voltage <sup>2</sup>	$V_{DROP}$	$V_{EN} = V_{IN}$ , $I_{OUT} = 1A$ , $V_{OUT} = 1.8V$		210	300	mV
		$V_{EN} = V_{IN}$ , $I_{OUT} = 1A$ , $V_{OUT} = 3.3V$		160	250	
		$V_{EN} = V_{IN}$ , $I_{OUT} = 1A$ , $V_{OUT} = 5V$		150	240	
Line Regulation		$V_{OUT(S)} + 1V \leq V_{IN} = V_{EN} \leq 6V$ $I_{OUT} = 1mA$		3	15	mV
Load Regulation	$\Delta V_{OUT2}$	$V_{IN} = V_{EN} = V_{OUT(S)} + 1.0V$ $1mA \leq I_{OUT} \leq 1A$		10	20	mV
Temperature Stability	$\frac{\Delta V_{OUT}}{\Delta T_a \cdot V_{OUT(S)}}$	$V_{IN} = V_{EN} = V_{OUT(S)} + 1.0V$ $I_{OUT} = 1mA$ $-40^\circ C \leq T_A \leq 125^\circ C$		$\pm 50$		ppm/ $^\circ C$
Reference Voltage Tolerance			0.686	0.7	0.714	V
ADJ Pin Current		$V_{ADJ} = V_{REF}$		10		nA
ADJ Pin Threshold			0.05	0.1	0.2	V
Enable Turn-On Threshold		Output ON	1.6			V
Enable Turn-Off Threshold		Output OFF			0.4	V
Shutdown Pin Current				0.1	0.5	$\mu A$
Shutdown Exit Delay Time				0		$\mu s$
Max Output Discharge Resistance to GND during Shutdown				30		$\Omega$
PGOOD Rise Threshold	$PG_{HTh}$			90		%
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PGOOD Delay	$PG_{DLY}$			1		ms
PGOOD Sink Capability		$I_{PGOOD} = 10mA$		0.05		V
Power Supply Ripple Rejection	PSRR	$f = 1kHz$ , $I_{OUT} = 10mA$		70		dB
		$f = 10kHz$ , $I_{OUT} = 10mA$		68		
		$f = 100kHz$ , $I_{OUT} = 10mA$		47		
		$f = 1MHz$ , $I_{OUT} = 10mA$		55		
Output Noise Voltage	$V_{OUTN}$	$C_{BP} = 1\mu F$ , $V_{OUT} = 3.3V$ $f = 10Hz \sim 100KHz$		115		$\mu V_{RMS}$
Thermal Shutdown Temperature	$T_{SD}$			175		$^\circ C$
Thermal Shutdown Hysteresis	$T_{SD\_HYS}$			35		$^\circ C$

Notes:

1.  $V_{OUT(S)}$ : Output voltage when  $V_{IN} = V_{OUT} + 1V$ ,  $I_{OUT} = 1mA$ .
2.  $V_{DROP} = V_{IN1} - (V_{OUT(S)} \times 0.98)$  where  $V_{IN1}$  is the input voltage when  $V_{OUT} = V_{OUT(S)} \times 0.98$ .
3.  $I_{LIM}$ : Output current when  $V_{IN} = V_{OUT(S)} + 1V$  and  $V_{OUT} = 0.95 \times V_{OUT(S)}$ .

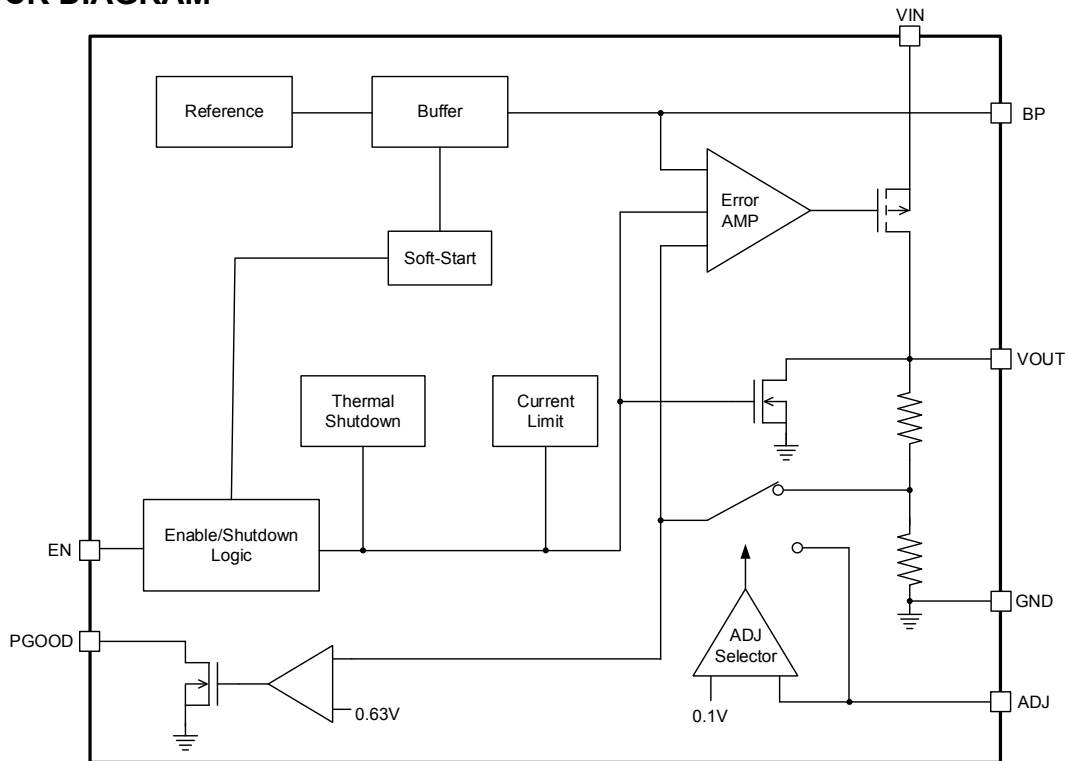
## TYPICAL PERFORMANCE CHARACTERISTICS(CONTINUED)

Test Conditions:  $V_{IN}=V_{OUT}+1.0V$ ,  $C_{IN}=4.7\mu F$ ,  $C_{OUT}=4.7\mu F$ ,  $T_A=25^{\circ}C$ , unless otherwise indicated.



Output Current Fold-back at  $V_{OUT}=3.3V$

## BLOCK DIAGRAM



## THEORY OF OPERATION

The HM7671 is a low-dropout voltage regulator with low quiescent current, low noise and high PSRR. It can support load current up to 1A. It incorporates current-limit and thermal protection features.

### SHUTDOWN

By connecting EN pin to GND, the HM7671 can be shutdown to reduce the supply current to 0.01μA (typ.). In this mode, the output voltage of HM7671 is equal to 0V.

### CURRENT LIMIT and SHORT CIRCUIT PROTECTION

The HM7671 includes current limit protection feature, which monitors and controls the maximum output current. If the output is overloaded or shorted to ground, this can protect the device from being damaged. When output is shorted to ground, current limit will be adjusted to about 25% of the rated current limit to protect the device.

### THERMAL PROTECTION

The HM7671 includes a thermal protection feature that protects the IC by turning off the pass transistor when the maximum junction temperature  $T_J$  exceed 175°C.

### POWER DISSIPATION

The power dissipation across the device can be calculated as:

$$P_D = I_{OUT} * (V_{IN} - V_{OUT})$$

The total junction temperature is calculated as:

$$T_J = T_A + (P_D * \theta_{JA})$$

where,  $T_J$  is the junction temperature,  $T_A$  is the ambient temperature and  $\theta_{JA}$  is the thermal resistance between junction to ambient. There is a temperature rise associated with this power dissipated while operating in a given ambient temperature. If the calculated junction temperature exceeds maximum junction temperature specification, then the built-in thermal protection feature is triggered as described previously. To insure reliable performance, the maximum allowable power dissipation for a given ambient temperature must be considered and it can be calculated as follows:

$$P_{D(MAX)} = (T_{J(MAX)} - T_A) / \theta_{JA}$$



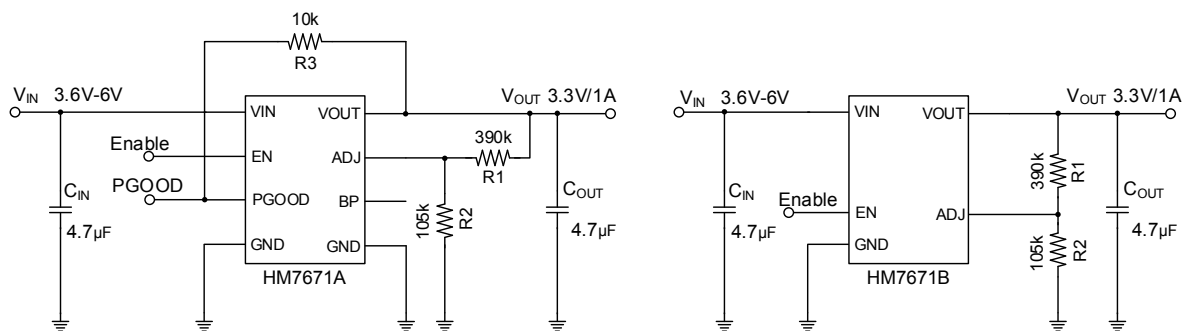
where,  $T_{J(MAX)}$  is the maximum junction temperature,  $T_A$  is the ambient temperature and  $\theta_{JA}$  is the thermal resistance between junction to ambient. In order to insure the best thermal flow, proper mounting of the IC is required.

## INPUT & OUTPUT CAPACITORS

HM7671 is optimized for use with ceramic capacitors. In order to ensure stability of the device, please place an output ceramic capacitor of 4.7 $\mu$ F or bigger at the  $V_{OUT}$  pin and GND pin as close as possible. An input capacitor of 4.7 $\mu$ F is recommended. X5R or X7R ceramic capacitors are recommended as they have the best temperature and voltage characteristics. If the impedance of the power supply is high, which is caused by forgetting installing input capacitor or installing too small value capacitor, the oscillation may occur.

When large output current switching (>500mA) are required in the application, a greater value of input/output capacitors ( $\geq 10 \mu$ F) would be recommended to ensure the device to operate smoothly.

## TYPICAL APPLICATION SCHEMATIC



## PROGRAMMING THE OUTPUT VOLTAGE

HM7671's internal feedback resistors set the output voltage  $V_{OUT}$  to 5V or 3.3V when the ADJ pin is connected to GND. Alternatively; the output voltage is adjustable via the external feedback resistor network R1 and R2 by calculating the following formula:

$$V_{OUT} = V_{REF} * \left(1 + \frac{R1}{R2}\right)$$

where,  $V_{REF}$  is the reference voltage set internally at 0.7V nominal.

## NOISE BYPASS CAPACITOR (For HM7671A)

A 1 $\mu$ F bypass capacitor at BP pin can reduce output voltage noise. This pin can be left floating if it is unnecessary.

## POWER-GOOD FUNCTION

The power-good circuit monitors the voltage at the feedback pin to indicate the status of the output voltage. When the output voltage falls below the PGOOD fall threshold voltage ( $PG_{LTH}$ ), the PGOOD pin open-drain output engages and pulls the PGOOD pin close to GND. When the output voltage exceeds PGOOD rise threshold voltage ( $PG_{HTH}$ ), the PGOOD pin becomes high impedance. By connecting a pullup resistor to external pullup supply voltage (default for  $V_{OUT}$ ), any downstream device can receive power-good as a logic signal that can be used for sequencing. Make sure that the external pullup supply voltage results in a valid logic signal for the receiving device. Using a pullup resistor from 10 k $\Omega$  to 100 k $\Omega$  is recommended.

## LAYOUT CONSIDERATION

1. Connect the bottom-side pad to a large ground plane for good thermal conductivity and to reduce the thermal resistance of the device.
2. The input Capacitor  $C_{IN}$  and output capacitor  $C_{OUT}$  must be placed as close as possible to the pins  $V_{IN}$  and  $V_{OUT}$  respectively.
3. Use short wires to connect the power supply to pins  $V_{IN}$  and GND on the board.

## Notes on Use

1. The input capacitor ( $C_{IN}$ ) and the output capacitor ( $C_{OUT}$ ) should be placed to the as close as possible with a shorter wiring.
2. If the impedance of the power supply is high, which is caused by forgetting installing input capacitor or installing too small value capacitor, the oscillation may occur.
3. Please pay attention to the operation conditions of input and output voltage and load current, such that the power consumption in the IC should not exceed the allowable power consumption of the package even though the chip has short circuit protection.

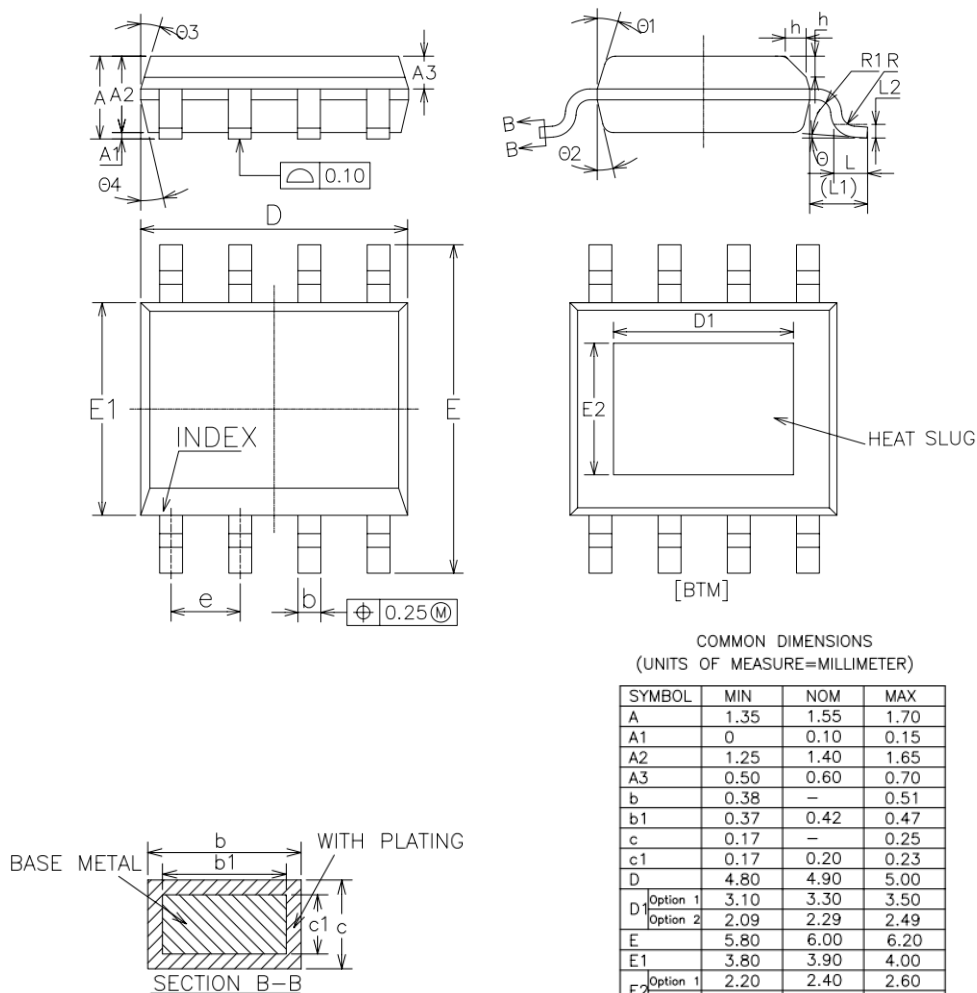
IC has a built-in anti-static protection (ESD) circuit, but please do not add excessive stress to the IC.

## Ordering Information

Part Name	Package	Marking	Packing quantity	
HM7671A50ES	ESOP8	7671A	4000/ Tape & Reel	All packages are lead-free
HM7671B50ES	ESOP8	7671B	4000/ Tape & Reel	
HM7671B33ES	ESOP8	7671B33	4000/ Tape & Reel	
HM7671E50MR	SOT23-5	7671E50	3000/ Tape & Reel	
HM7671E33MR	SOT23-5	7671E33	3000/ Tape & Reel	
HM7671E33PR	SOT89-3	7671E33	1000/ Tape & Reel	
HM7671A33PR	SOT89-3	7671A33	1000/ Tape & Reel	
HM7671F33P5	SOT89-5	7671F33	1000/ Tape & Reel	
HM7671F40P5	SOT89-5	7671F40	1000/ Tape & Reel	
HM7671E50T	TO252-4	7671	2500/ Tape & Reel	

## PACKAGING INFORMATION

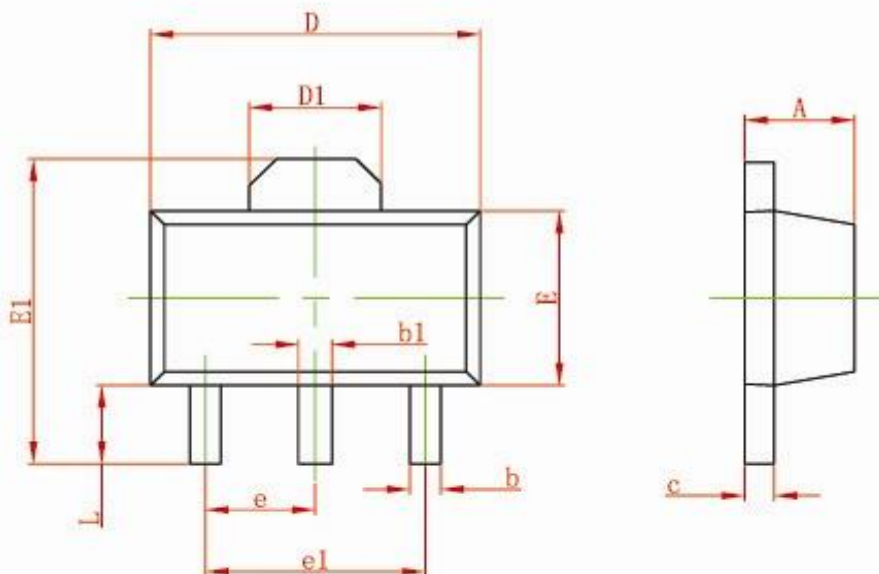
ESOP8 PACKAGE OUTLINE DIMENSIONS



## PACKAGING INFORMATION(CONTINUED)

### 封装尺寸

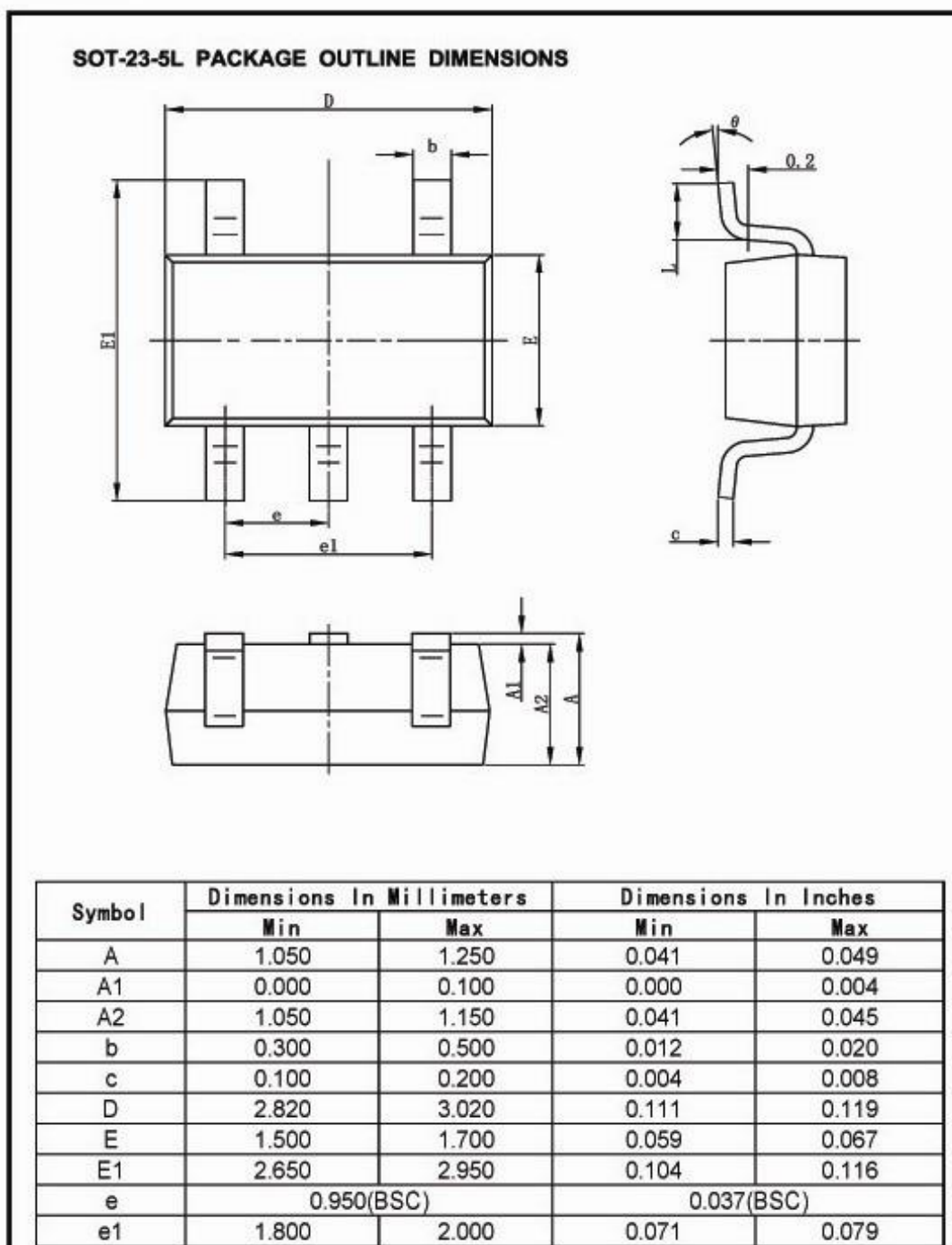
SOT-89-3L PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.400	1.600	0.055	0.063
b	0.320	0.520	0.013	0.197
b1	0.400	0.580	0.016	0.023
c	0.350	0.440	0.014	0.017
D	4.400	4.600	0.173	0.181
D1	1.550 REF		0.061 REF	
E	2.300	2.600	0.091	0.102
E1	3.940	4.250	0.155	0.167
e	1.500 TYP		0.060TYP	
e1	3.000 TYP		0.118TYP	

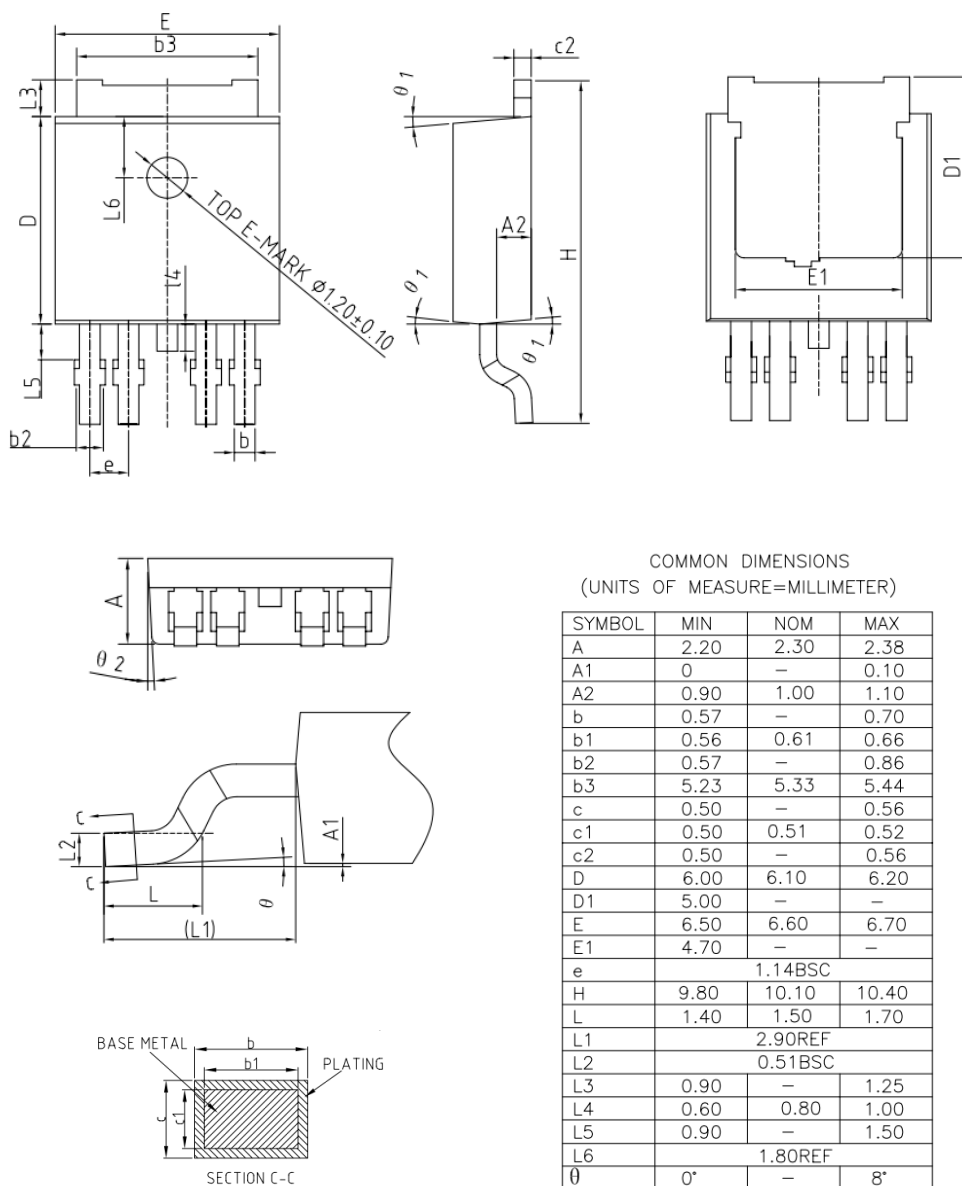
## PACKAGING INFORMATION(CONTINUED)

### 封装尺寸



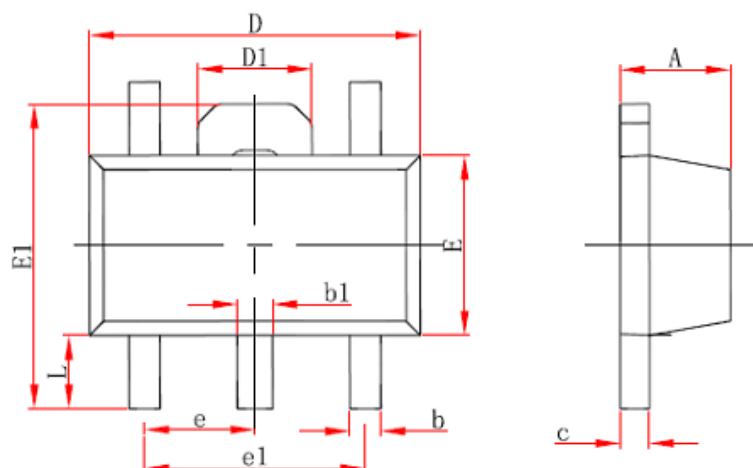
## PACKAGING INFORMATION(CONTINUED)

TO252-4L PACKAGE OUTLINE DIMENSIONS



## PACKAGING INFORMATION(CONTINUED)

### SOT-89-5L PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.400	1.600	0.055	0.063
b	0.320	0.520	0.013	0.020
b1	0.380	0.580	0.015	0.023
c	0.350	0.440	0.014	0.017
D	4.400	4.600	0.173	0.181
D1	1.550 REF.		0.061 REF.	
E	2.300	2.600	0.091	0.102
E1	3.940	4.250	0.155	0.167
e	1.500 TYP.		0.060 TYP.	
e1	3.000 TYP.		0.118 TYP.	
L	0.900	1.200	0.035	0.047