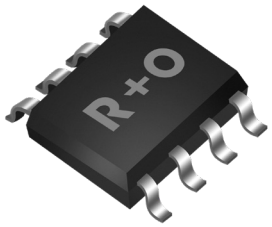
2.0A, 150KHz Buck DC to DC Converter

Features

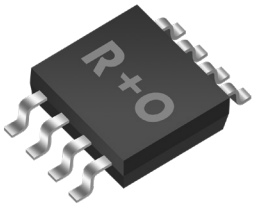
- 3.3V, 5V, 12V and Adjustable Output Versions
- Maximum Duty Cycle 100%
- Minimum Drop Out 1.5V
- Wide Input Voltage Range up to 25V
- Guaranteed 2A Output Current
- Excellent line and load regulation
- 150 kHz Fixed Frequency Internal Oscillator
- TTL Shutdown Capability, Low Power Standby Mode
- Built in thermal shutdown and current limit function
- Built in second current limit function
- Adjustable Version Output Voltage Range, 1.23V to 24V

Supply Voltage
+4.5V ~ +25V
Output Current
2.0A (Max.)

SOP-8



ESOP-8



Applications

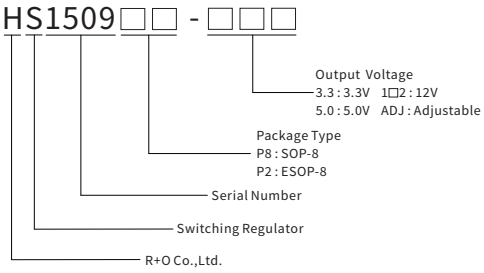
- LCD Monitor and LCD TV
- Digital Photo Frame
- Set - up Box
- ADSL Modem
- Telecom / Networking Equipment

General Description

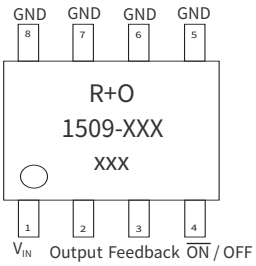
The HS1509 series of regulator is a 150 KHz fixed frequency PWM buck (step-down) DC-DC converter, capable of driving a 2A load with high efficiency, low ripple and excellent line and load regulation. Requiring a minimum number of external components, the regulator is simple to use and include internal frequency compensation and a fixed-frequency oscillator.

The PWM control circuit is able to adjust the duty ratio linearly from 0 to 100%. An enable function, an over current protection function is built inside. When second current limit function happens, the operation frequency will be reduced from 150KHz to 50KHz. An internal compensation block is built in to minimize external component count.

Part Numbering



Pin Configuration & Marking



SOP-8/ESOP-8

Pin Description

Pin Number	Pin Name	Description
1	V_{IN}	This pin is the positive input supply for the HS1509 series buck switching regulator. In order to minimize voltage transients and to supply the switching currents needed by the regulator, a suitable input bypass capacitor must be present.
2	Output	Internal switch, the voltage at this pin switches between ($+V_{IN}$ - V_{SAT}) and approximately -0.5V. To minimize coupling to sensitive circuitry, the PCB copper area connected to this pin should be kept to a minimum.
5~8	GND	Circuit Ground.
3	Feedback	Senses the regulated output voltage to complete the feedback loop.
4	$\overline{ON}$ / OFF	Allows the switching regulator circuit to be shut down using logic level signals.

Ordering Information

Order Number	Package	Package Code	Unit Weight(g)	Tube/Reel(pcs)	Box(pcs)	Carton(pcs)	Delivery Mode	MSL
HS1509P8 - 3.3	SOP-8	R3	0.077	100/4000	8000	80000	13'' reel	3
HS1509P8 - 5.0	SOP-8	R3	0.077	100/4000	8000	80000	13'' reel	3
HS1509P8 - 12	SOP-8	R3	0.077	100/4000	8000	80000	13'' reel	3
HS1509P8 - ADJ	SOP-8	R3	0.077	100/4000	8000	80000	13'' reel	3
Order Number	**Package**	**Package Code**	**Unit Weight(g)**	**Tube/Reel(pcs)**	**Box(pcs)**	**Carton(pcs)**	**Delivery Mode**	**MSL**
HS1509P2 - 3.3	ESOP-8	R3	0.0748	100/4000	8000	80000	13'' reel	3
HS1509P2 - 5.0	ESOP-8	R3	0.0748	100/4000	8000	80000	13'' reel	3
HS1509P2 - 12	ESOP-8	R3	0.0748	100/4000	8000	80000	13'' reel	3
HS1509P2 - ADJ	ESOP-8	R3	0.0748	100/4000	8000	80000	13'' reel	3

Functional Block Diagram

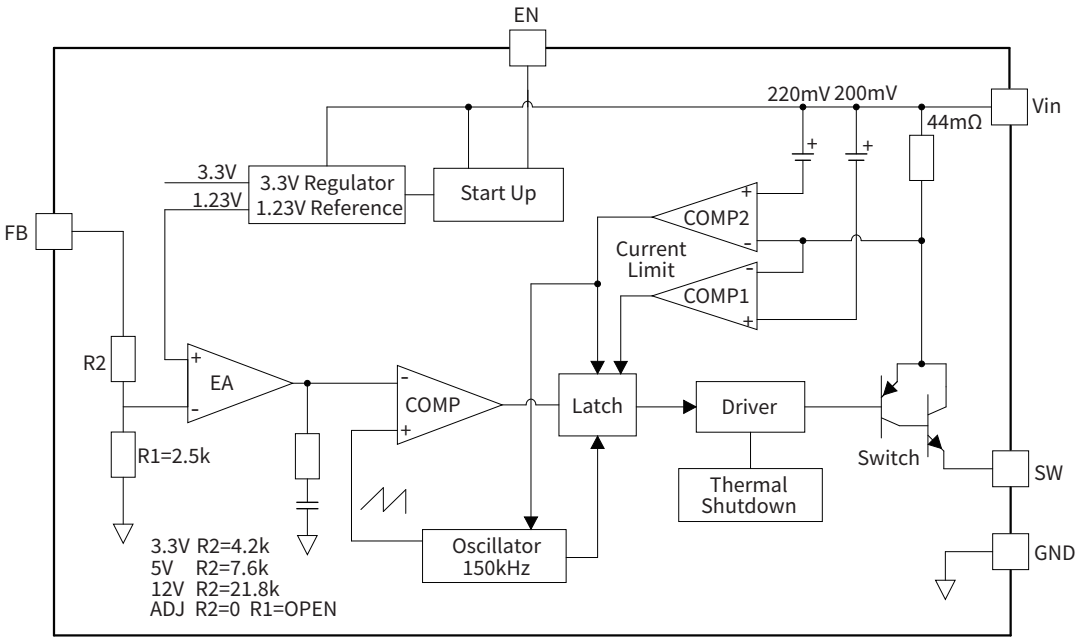


Figure 1.Internal Block Diagram

Typical Application Circuit

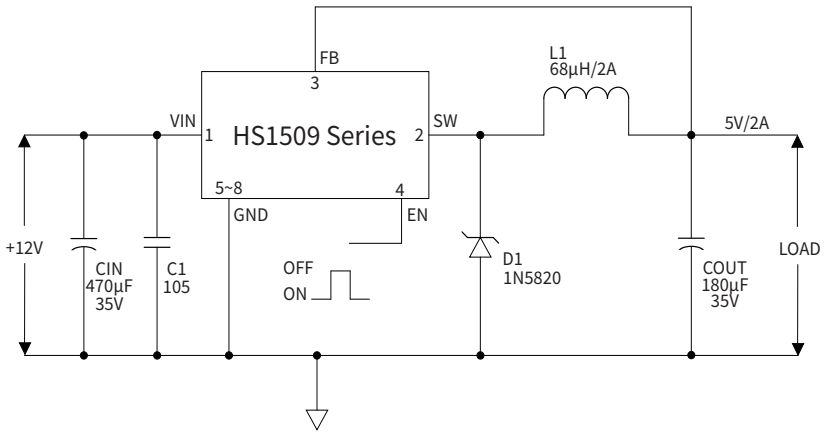


Figure 2.HS1509 Series Typical Application Circuit

Absolute Maximum Ratings (T_A=25°C Unless otherwise specified)

Parameter	Symbol	Value	Unit
Maximum Supply Voltage	V_{IN}	-0.3 to 25	V
$\overline{ON}$ / OFF Pin Input Voltage	$V_{\overline{ON}/OFF}$	-0.3V to +V_{IN}	V
Output Voltage to Ground(steady state)	V_{OUT}	-0.3V to +V_{IN}	V
Feedback Pin Voltage	V_{FB}	-0.3V to +V_{IN}	V
Thermal Resistance (SOP-8)(Junction to Ambient, No Heatsink, Free Air)	R_{JA}	100	°C /W
Power Dissipation	P_{DMAX}	Internally Limited	mW
Storage Temperature Range	T_{stg}	-65 to +150	°C
Maximum Junction Temperature	T_J	-40 to +125	°C
ESD Susceptibility (Human Body Model)	ESD	2	KV
Lead Temperature (Soldering, 10 Seconds)	T_L	260	°C

Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

Recommended Operating Conditions

Parameter Name	Symbol	Value	Unit
Supply Voltage	V_{IN}	4.5 to 25	V
Operating Junction Temperature Range	T_{opr}	-40 to +85	°C

Electrical Characteristics (V_{IN} = 12V for the 3.3V, 5V, and ADJ versions, V_{IN} = 24V for the 12V version; C_{IN} = 220μF / 50V.)

Parameter Name	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Input Operation Voltage	V_{IN}	T_A = 25°C , I_{OUT} = 500mA	4.5	--	25	V
Oscillator Frequency	f_o	T_A=25°C	127	150	173	kHz
V_{SAT} Saturation Voltage	V_{SAT}	V_{FB} = 0V, I_{OUT} = 2A	--	1.2	1.4	V
Max. Duty Cycle(ON)	DC_{MAX}	V_{FB} = 0V	--	100	--	%
Switch Current Limit	I_{CL}	V_{FB} = 0V	--	4.0	--	A
Quiescent Supply Current	I_Q	$V_{ON/OFF}$ = 0V, V_{FB} = V_{IN}	--	2	10	mA
Standby Quiescent Current	I_{STBY}	$V_{ON/OFF}$ = 5V	--	80	200	μA
ON / OFF Pin Logic Input Level	V_{IH}	V_{OUT}=0V	--	1.4	--	V
	V_{IL}	V_{OUT} = Nominal Output Voltage	--	0.8	--	V
ON / OFF Pin Input Current	I_{IH}	$V_{ON/OFF}$ = 2.5V(OFF)	--	5	15	μA
	I_{IL}	$V_{ON/OFF}$ = 0.5V(ON)	--	0.2	5	μA

Electrical Characteristics(Cont.) (T_A=25°C Unless otherwise specified)

Parameter Name	Symbol	Test Conditions	Min.	Typ.	Max.	Units
HS1509 - 3.3 (System parameters test circuit figure 3)						
Output Voltage	V_{OUT}	4.75V ⩽ V_{IN} ⩽ 25V 0.2A ⩽ I_{LOAD} ⩽ 2A	3.168	3.3	3.432	V
Efficiency	η	V_{IN} = 12V, V_{OUT} = 3.3V, I_{LOAD} = 2A		75		%
HS1509 - 5.0 (System parameters test circuit figure 3)						
Output Voltage	V_{OUT}	7V ⩽ V_{IN} ⩽ 25V 0.2A ⩽ I_{LOAD} ⩽ 2A	4.80	5.00	5.20	V
Efficiency	η	V_{IN} = 12V, V_{OUT} = 5.0V, I_{LOAD} = 2A		82		%
HS1509 - 12 (System parameters test circuit figure 3)						
Output Voltage	V_{OUT}	15V ⩽ V_{IN} ⩽ 25V 0.2A ⩽ I_{LOAD} ⩽ 2A	11.52	12.00	12.48	V
Efficiency	η	V_{IN} = 25V, V_{OUT} = 12V, I_{LOAD} = 2A		90		%
HS1509 - ADJ (System parameters test circuit figure 3)						
Output Voltage	V_{OUT}	4.5V ⩽ V_{IN} ⩽ 25V 0.2A ⩽ I_{LOAD} ⩽ 2A	1.193	1.230	1.267	V
Efficiency	η	V_{IN} = 12V, V_{OUT} = 3V, I_{LOAD} = 2A		74		%

Test Circuit and Layout guidelines

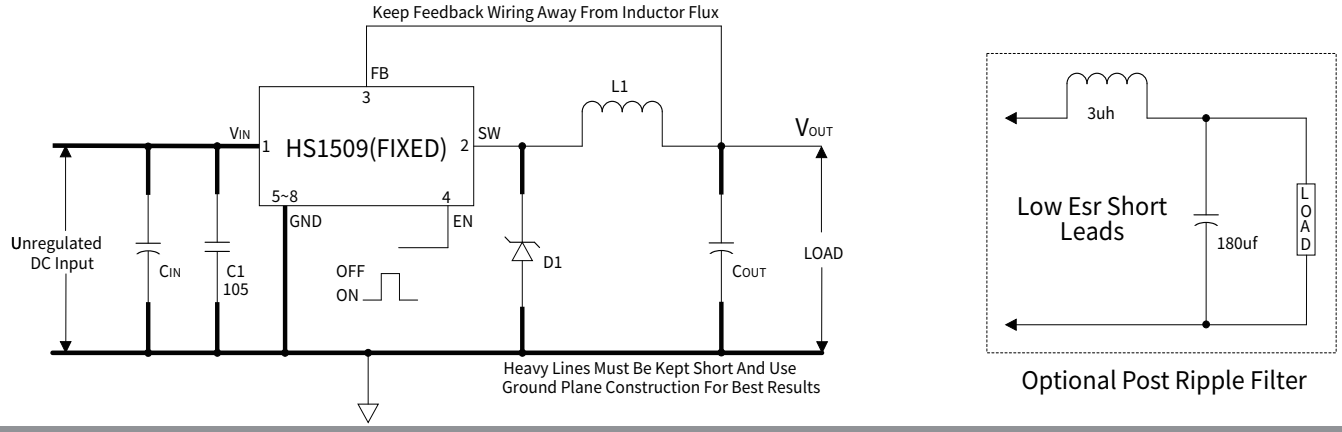


Fig.3-1 Fixed Output Voltage Versions

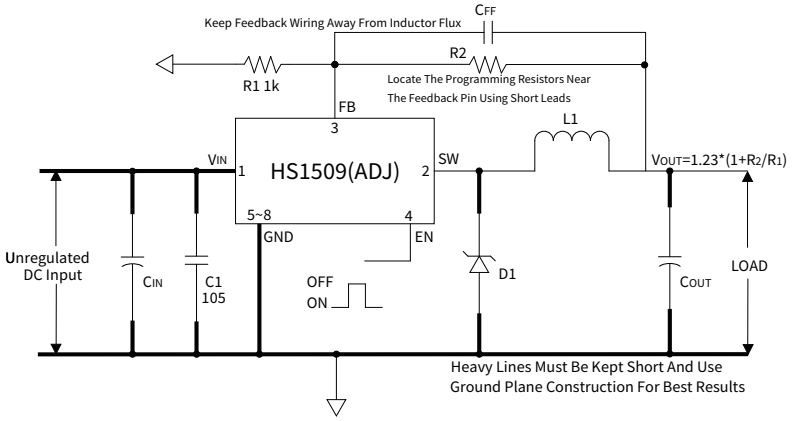


Fig.3-2 Adjustable Output Voltage Versions

Test Circuit(Cont.)

Select R_1 to be approximately 1K, use a 1% resistor for best stability. C_1 and C_{FF} are optional, in order to increase stability and reduce the input power line noise, C_{IN} and C_1 must be placed near to P_{IN1} and P_{IN5} ~ P_{IN8}.

For output voltages greater than approximately 10V, an additional capacitor C_{FF} is required. The compensation capacitor is typically between 100 pF and 33 nF, and is wired in parallel with the output voltage setting resistor R_2. It provides additional stability for high output voltage, low input-output voltages, and very low ESR output capacitors, such as solid tantalum capacitors. C_{FF}=1/(31*1000*R_2). This capacitor type can be ceramic, plastic, silver mica, etc. (Because of the unstable characteristics of ceramic capacitors made with Z5U material, they are not recommended.)

Typical Applications & Efficiency

HS1509 - 3.3

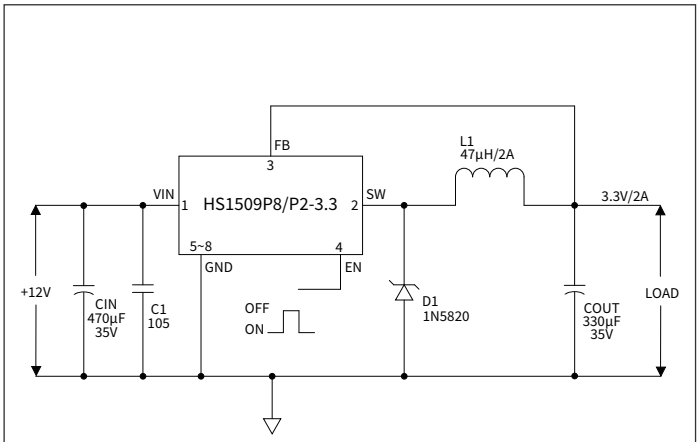


Fig.4 HS1509 - 3.3 System Parameters Test Circuit

HS1509 - 5.0

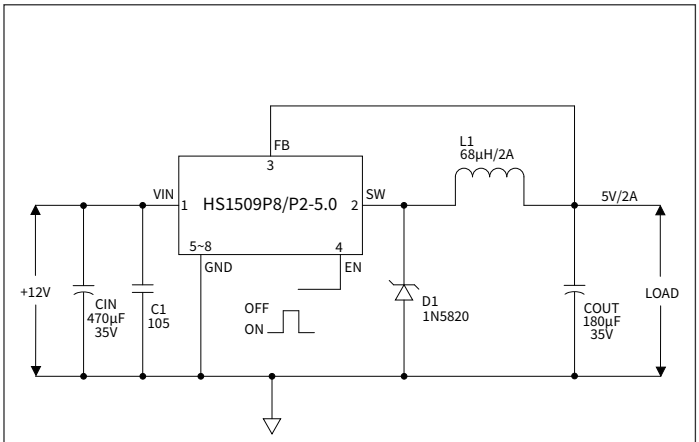


Fig.5 HS1509 - 5.0 System Parameters Test Circuit

HS1509 - 12

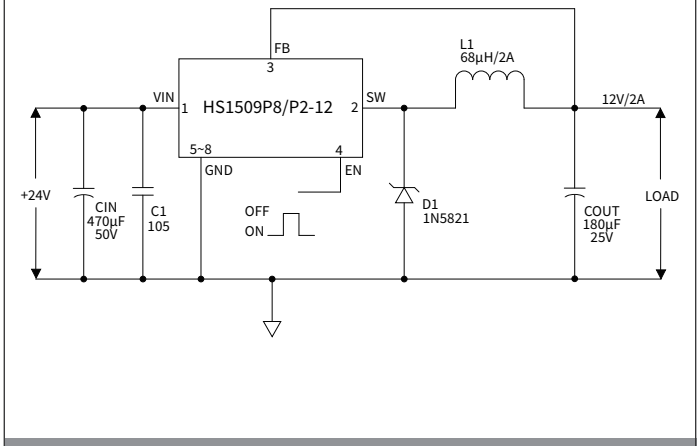


Fig.6 HS1509 - 12 System Parameters Test Circuit

HS1509 - ADJ

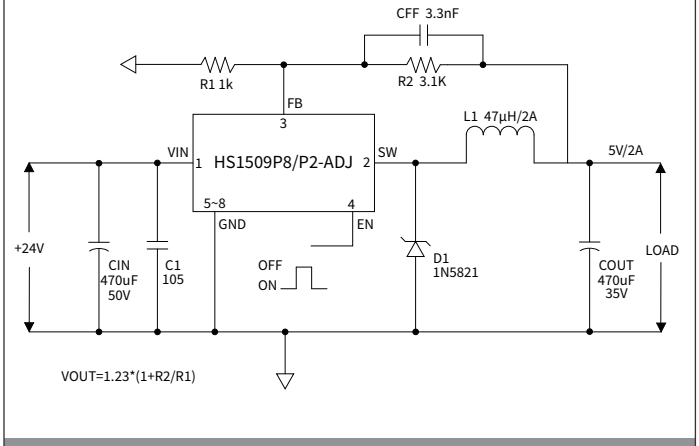


Fig.7 HS1509 - ADJ System Parameters Test Circuit

HS1509 Series Buck Regulator Design Procedure (Fixed Output)

Conditions			Inductor (L_1)	Output Capacitor (C_{OUT})			
				Through Hole Electrolytic		Surface Mount Tantalum	
Output Voltage(V)	Load Current	Input Voltage Max.(V)	Inductance(μH)	Panasonic HFQ Series(μF/V)	Nichicon PL Series(μF/V)	AVX TPS Series (μF/V)	Sprague 595D Series (μF/V)
3.3	2A	6	22	470/25	470/35	330/6.3	390/6.3
		10	33	330/35	330/35	330/6.3	390/6.3
5.0	2A	9	22	470/25	560/16	220/10	330/10
		20	68	180/35	180/35	100/10	270/10
12	2A	15	33	330/25	330/25	100/16	180/16
		20	68	180/25	180/25	100/16	120/20

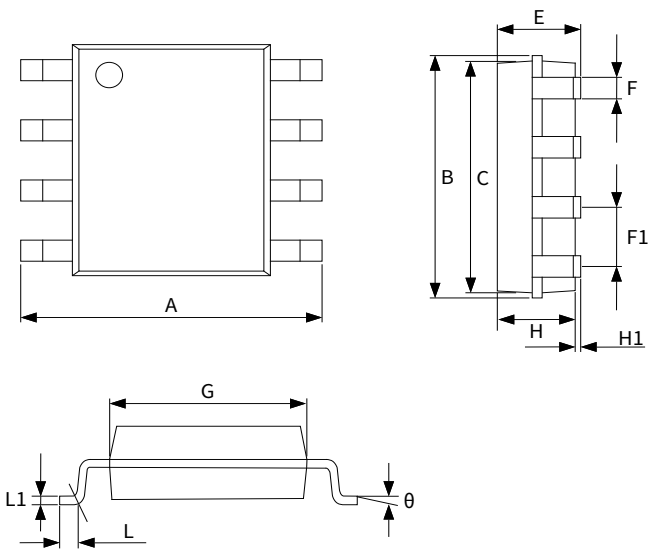
HS1509 Series Buck Regulator Design Procedure (Adjustable Output)

Output Voltage(V)	Through Hole Output Electrolytic			Surface Mount Output Capacitor		
	Panasonic HFQ Series(μF/V)	Nichicon PL Series(μF/V)	Feedforward Capacitor	AVX TPS Series (μF/V)	Sprague 595D Series(μF/V)	Feedforward Capacitor
2	820/35	820/35	33nF	330/6.3	470/4	33nF
4	560/35	470/35	10nF	330/6.3	390/6.3	10nF
6	470/25	470/35	3.3nF	220/10	330/10	3.3nF
9	330/25	330/25	1.5nF	100/16	180/16	1.5nF
12	330/25	330/25	1.0nF	100/16	180/16	1.0nF
15	220/25	220/35	680pF	68/20	120/20	680pF

Diode Selection Table

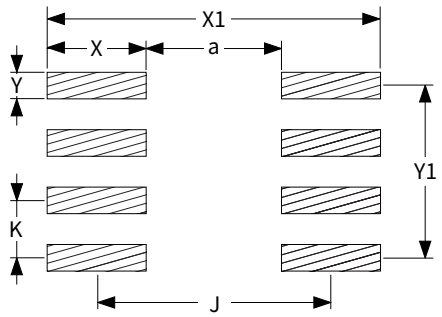
Current	Surface Mount	Through Hole	V_R (The same as system maximum input voltage)				
			20V	30V	40V	50V	60V
1A		●	1N5817	1N5818	1N5819	--	--
3A		●	1N5820	1N5821	1N5822	--	--
		●	MBR320	MBR330	MBR340	MBR350	MBR360
	●		SK32	SK33	SK34	SK35	SK36
	●		--	30WQ03	30WQ04	30WQ05	--
		●	--	31DQ03	31DQ04	31DQ05	--
		●	SR302	SR303	SR304	SR305	SR306

Package Outline Dimensions (SOP-8)



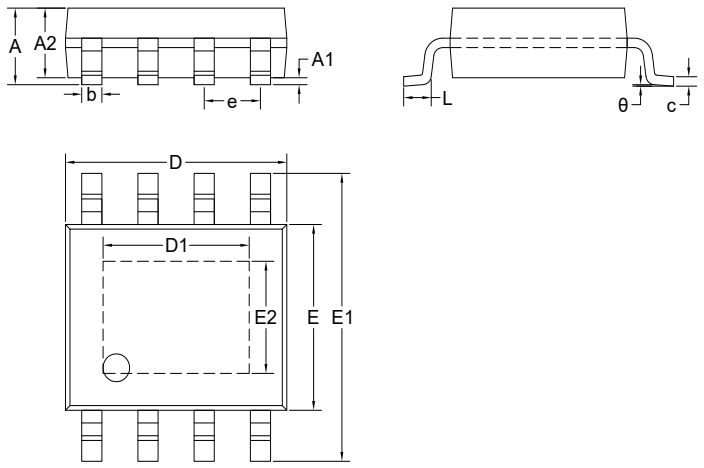
Symbol	Dimensions			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	5.70	6.30	0.224	0.248
B	5.13MAX.		0.202MAX.	
C	4.72	5.12	0.186	0.201
E	1.80MAX.		0.071MAX.	
F	0.31	0.51	0.0122	0.020
F1	1.27TYP.		0.050TYP.	
G	3.75	4.15	0.148	0.163
H	1.35	1.65	0.053	0.065
H1	0.1	0.25	0.004	0.010
L	0.3	0.7	0.012	0.028
L1	0.21TYP.		0.008TYP.	
θ	-	8°	-	8°

Suggested Pad Layout



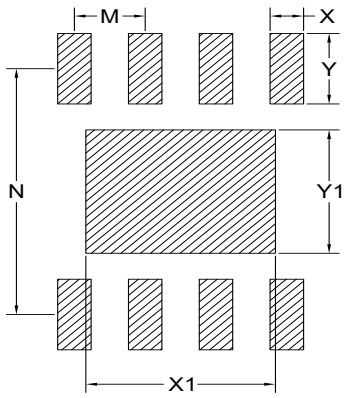
Symbol	Dimensions			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
a	2.90	3.10	0.114	0.122
J	5.10	5.30	0.201	0.209
K	1.17	1.37	0.046	0.054
X	2.10	2.30	0.083	0.091
X1	7.30	7.50	0.287	0.295
Y	0.50	0.70	0.020	0.028
Y1	3.71	3.91	0.146	0.154

Package Outline Dimensions (ESOP-8)



Symbol	Dimensions			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	1.35	1.70	0.053	0.067
A1	0.05	0.20	0.002	0.008
A2	1.30	1.50	0.051	0.059
b	0.356	0.456	0.014	0.018
c	0.203 BSC		0.008 BSC	
D	4.80	5.00	0.189	0.197
D1	3.302 BSC		0.130 BSC	
E	3.80	4.00	0.150	0.157
E1	5.80	6.20	0.228	0.244
E2	2.413 REF		0.095 REF	
e	1.27 REF		0.050 REF	
L	0.40	0.60	0.016	0.024
θ	0	6°	0	6°

Suggested Pad Layout



Symbol	Dimensions			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
X	-	0.60	-	0.024
X1	-	3.40	-	0.134
Y	-	1.55	-	0.061
Y1	-	2.71	-	0.107
M	-	1.71	-	0.067
N	-	5.40	-	0.213