Low Noise & Low voltage Single-Coil Fan/Motor Driver

❖ GENERAL DESCRIPTION

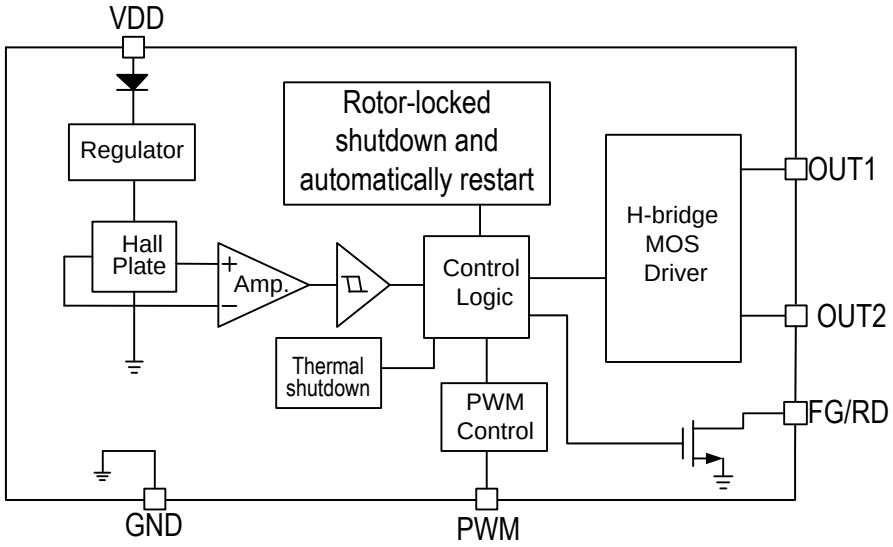
The MA7151 is an integrated Hall sensor with H-Bridged output driver designed for brushless DC motor applications. The device includes an on-chip Hall sensor for magnetic sensing, an amplifier that amplifies the Hall voltage, a comparator to provide switching hysteresis for noise rejection, a bi-directional drivers for sinking and driving large current load.

To avoid coil burning, rotor-lock shutdown detection circuit shut down the output driver if the rotor is blocked and then the automatic recovery circuit will try to restart the motor. This function repeats while rotor is blocked. Until the blocking is removed, the motor recovers running normally.

❖ FEATURES

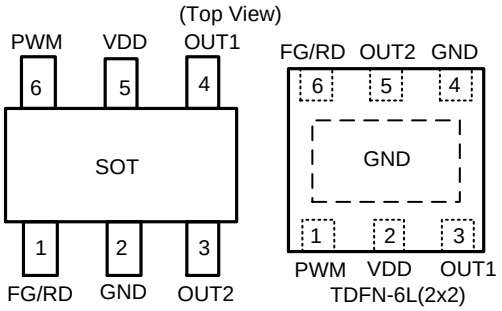
- On-Chip High sensitivity Hall-effect Sensor
- Operating Voltage: 1.8V to 5.5V
- H-Bridge Output Drivers for Single Coil
- Thermal Shutdown and Reverse voltage Protection
- Low Output Switching Current Noise
- -40°C to 125°C Operating Temperature
- Rotor-locked shutdown and automatically restart function
- For 3V and 5V DC Motor / FAN systems
- Low Profile SOT23-6L ,TSOT23-6L , SOT23-6F and TDFN 2X2-6L Package

❖ BLOCK DIAGRAM



❖ PIN ASSIGNMENT

The package of MA7151; the pin assignment is given by:



Name	Description
FG/RD	Frequency Generation / Rotation Detection (open drain output)
GND	Ground.
OUT2	Output 2
OUT1	Output 1
VDD	Supply Voltage
PWM	PWM Signal Input Terminal.

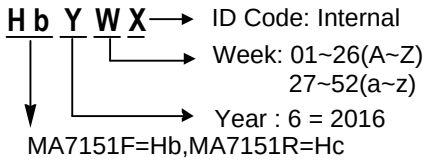
❖ RDER/MARKING INFORMATION

Order Information

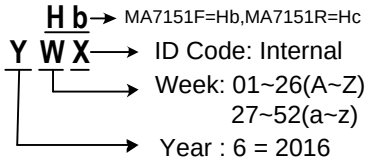
MA7151XXX

F=FG R=RD	Package Type C: SOT23-6L CT:TSOT23-6L CP:SOT23-6F D2:TDFN2X2-6L	Packing Blank: Tube A : Taping

Top Marking(SOT)



Top Marking (TDFN)



❖ A BSOLUTE MAXIMUM RATINGS (at T_A=25°C)

Characteristics		Symbol	Rating	Unit
Supply Voltage		V_{CC}	-7 to 7	V
Magnetic Flux Density		B	Unlimited	Gauss
Output Current	Continuous	I_O	500	mA
	Hold		800	
	Peak (start up)		1000	
Power Dissipation		P_D	550	mW
Storage Temperature Range		T_{STG}	-65 to +150	°C
Thermal Resistance from Junction to case		θ_{JC}	110	°C/W
Thermal Resistance from Junction to ambient		θ_{JA}	225	°C/W
Recommended Operating Conditions (T_A=25 °C)				
Supply Voltage		V_{CC}	1.8 to 5.5	V
Junction Temperature		T_J	150	°C
Operating Temperature		T_O	-40 to 125	°C

❖ ELECTRICAL CHARACTERISTICS

(V_{DD} = 5V, T_A = +25°C, unless otherwise noted.)

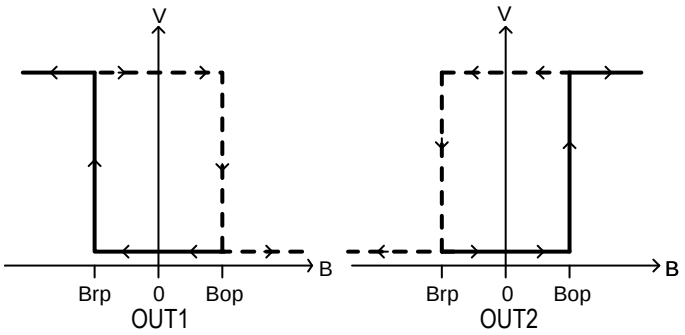
Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Average Supply Current	I_{DD}	3V,No load	-	2.2	3.5	mA
Average Supply Current	I_{DD}	5V,No load	-	3.6	5	mA
On resistance(RPMOS+RNMOS)	$R_{DS(ON)}$	5V,400mA	-	0.8	1.4	Ω
On resistance(RPMOS+RNMOS)	$R_{DS(ON)}$	3V,200mA	-	1.0	1.8	Ω
FG Output Low Voltage		5V,5mA	-	0.3	0.5	V
Output Switching Slope Duration	TSW	3V	-	200	-	uS
Output Switching Slope Duration	TSW	5V	-	160	-	uS
PWM Input H Level	V_{PWMH}		0.5VDD	-	VDD	V
PWM Input L Level	V_{PWML}		0	-	0.14VDD	V
PWM Input Frequency	F_{PWM}		0.2	-	30	KHz
Locked Protection On	Tlrp-on		-	0.45	-	Sec
Locked Protection Off	Tlrp-off		-	2.7	-	Sec
Thermal Shutdown Threshold	T_{SHUT}		150	-	-	°C
Magnetic				(1mT=10 Gauss)		
Operating Point	B_{OP}		5	30	50	Gauss
Releasing Point	B_{RP}		-50	-30	-5	Gauss
Hysteresis	B_{HYS}		-	60	-	Gauss

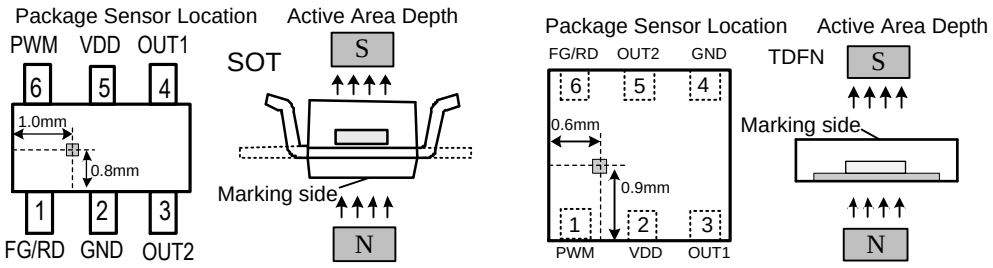
Note: Guaranteed by design.

Driver output vs. magnetic pole

Characteristics	Test Conditions	OUT1	OUT2
North pole	B < Brp	High	Low
South pole	B > Bop	Low	High

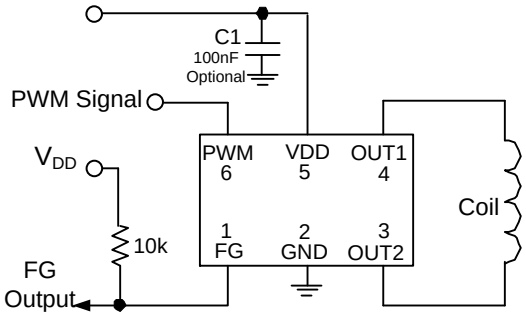
Note: The magnetic pole refer to diagram



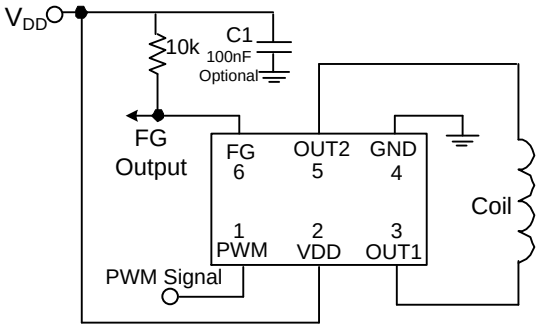


❖ APPLICATION CIRCUIT

1. SOT(FG)

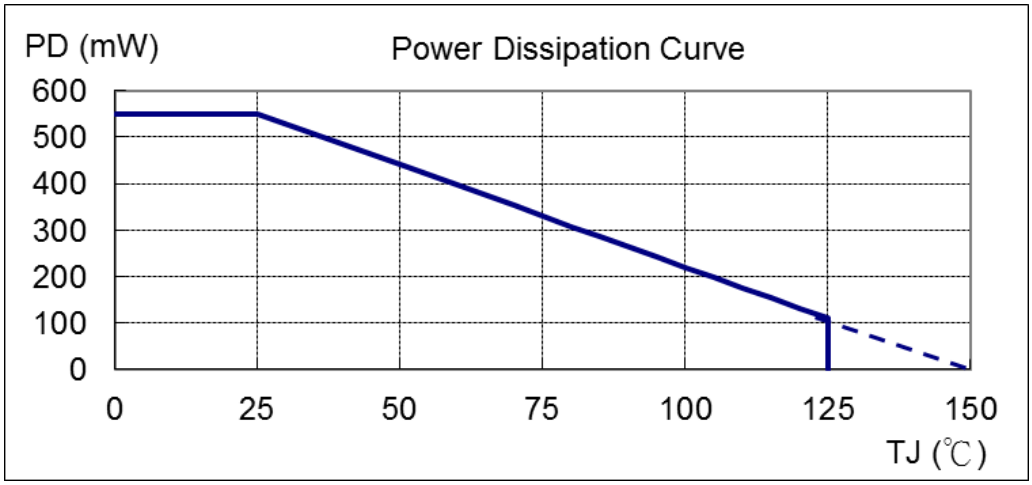


2. TDFN(FG)



❖ PERFORMANCE CHARACTERISTICS

T_A (°C)	25	50	60	70	80	85	90	95	100
PD (mW)	550	440	396	352	308	286	264	242	220
T_A (°C)	**105**	**110**	**115**	**120**	**125**	**130**	**135**	**140**	**150**
PD (mW)	198	176	154	132	110	88	66	44	0



❖ Functional Descriptions

Bias generator
The bias generator provides precise, temperature- and process-insensitive bias references for the analog blocks. These references guarantee proper operation of the IC under all conditions specified in this specification.

Oscillator
The built-in oscillator provides the clock signal for the digital control logics

Power-on Reset
Used to detect the power-up ramp and reset the digital circuits.

Chopper Amplifier
To achieve a higher magnetic sensitivity the chopper amplifier structure is adopted in this design. Use of this structure dynamically removes both the offset and flicker noise at the same time.

PWM control
PWM(pulse-width modulation) is used for the speed control. 2 types of PWM input signals can be used :

1. Voltage mode PWM :

Applying a DC voltage to the PWM pin and the MA7151 will generate PWM pulses internally with the "ON" duty cycle ratio according to the diagram below(Figure.1), which can be utilized by the user to control the speed of the motor. The rotation speed will be higher if the voltage applied to the PWM pin is higher.

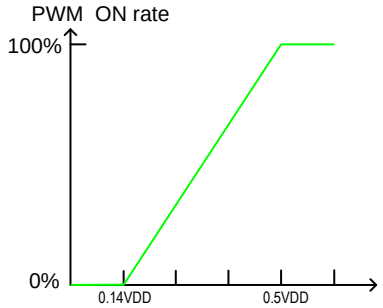


Figure.1

2. Pulse mode PWM :

User can also apply PWM pulses directly to the PWM pin. The MA7151 will pass this pulse to the coil driver with the original duty-cycle ratio.

Note:

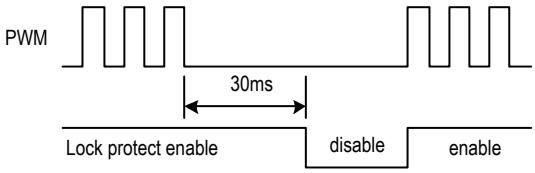
(1) While using pulse mode PWM, the "High" Value of the input pulse should be higher than 0.5*VDD and the "Low" value should be lower than 0.14*VDD

(2) The lower-limit for the PWM pulse frequency is 200Hz, and the recommended frequency range is higher than 30KHz where the PWM input pulses will not generate acoustic noise.

Note. The "PWM" pin contains an internal pull-up resistor so the MA7151 will rotate at full-speed (100% ON) when this pin is left un-connected(floating).

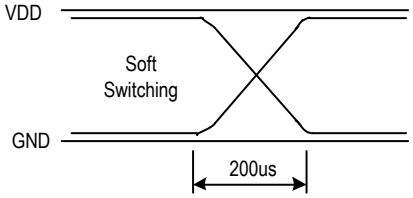
PWM signal and Standby Mode

This IC would enter standby mode when the PWM input keeps low level for then 30ms(typ.). In standby mode, it will shutdown amplifier and FG. In standby mode, the lock protection function doesn't work, therefore, starting fan is unobstructed when releasing standby mode.

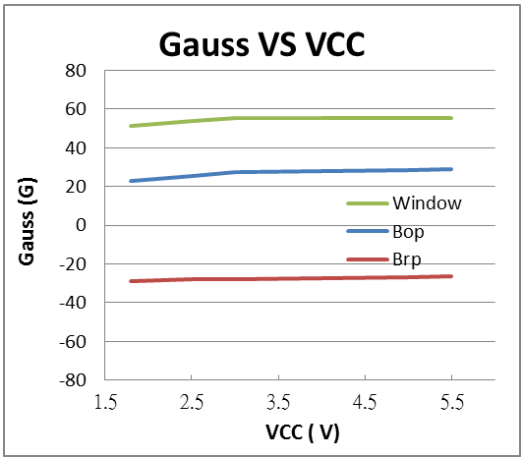


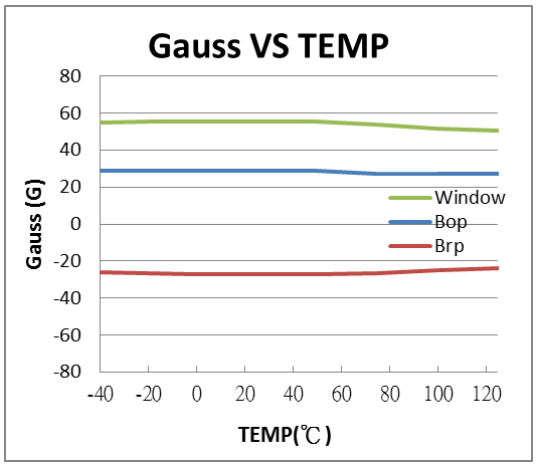
Soft Switching

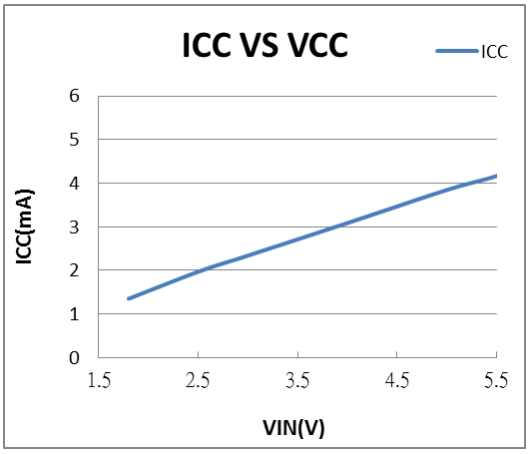
MA7151 uses soft switching of the motor coil current during commutation for to minimize audible switching noise and electromagnetic interference (EMI) to provide a low noise solution.

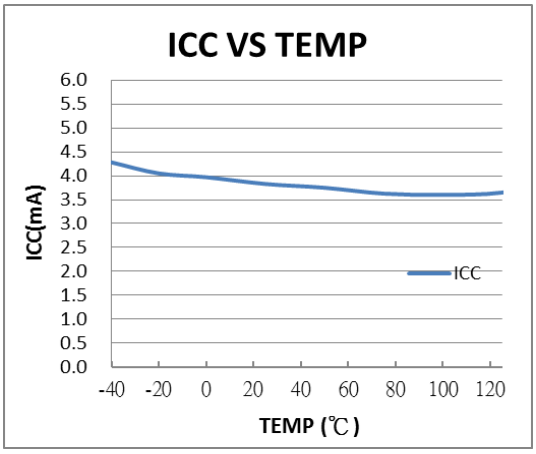


❖ TYPICAL CHARACTERISTICS

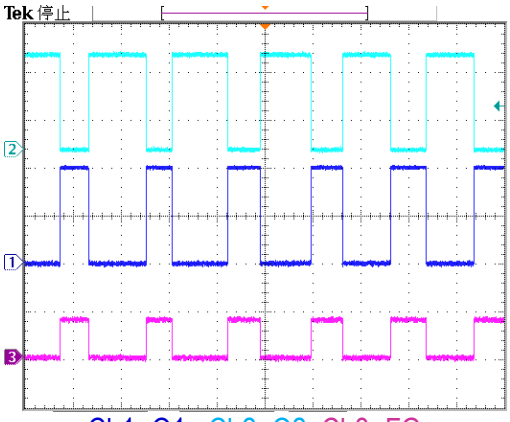






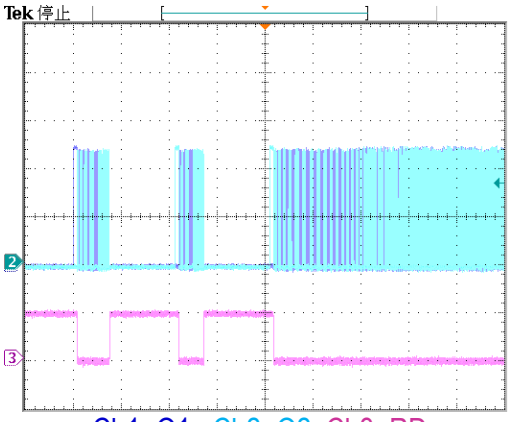


VDD5V FG PIN WAVEFORM



Ch1=O1 , Ch2=O2 ,Ch3=FG

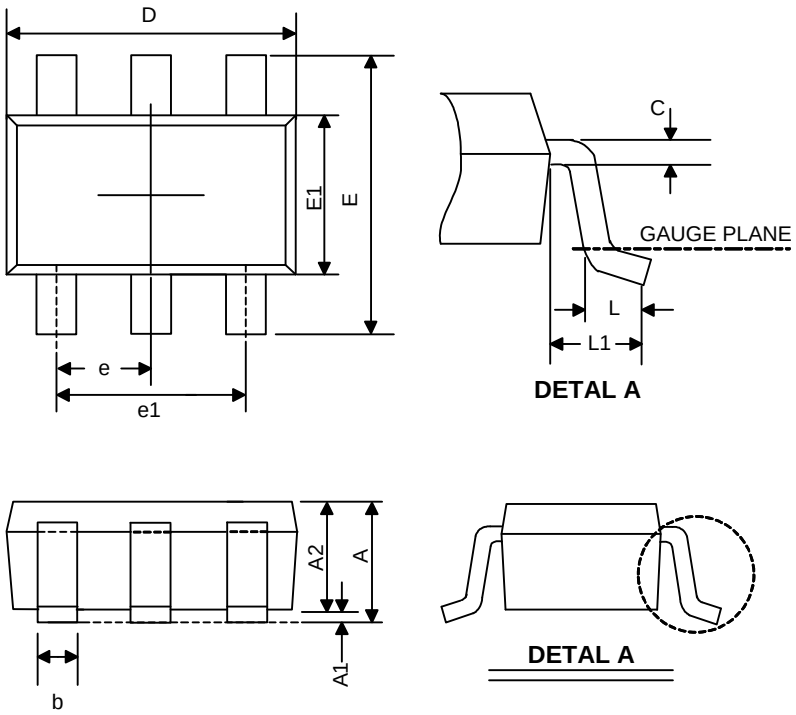
VDD5V RD PIN WAVEFORM



Ch1=O1 , Ch2=O2 ,Ch3=RD

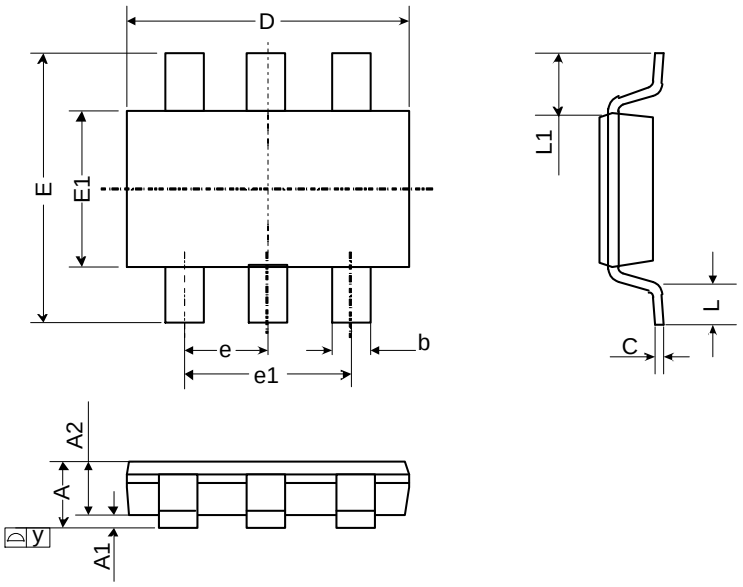
❖ PACKAGE OUTLINES

1. SOT23-6L



Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	1.05	-	1.45	0.041	-	0.057
A1	0.05	-	2.15	0.002	-	0.085
A2	0.90	1.10	1.30	0.035	0.043	0.051
b	0.30	-	0.50	0.012	-	0.020
C	0.08	-	0.22	0.003	-	0.009
D	2.70	2.90	3.10	0.106	1.114	0.122
E1	1.40	1.60	1.80	0.055	0.063	0.071
E	2.60	2.80	3.00	0.102	0.110	0.118
L	0.30	-	0.60	0.012	-	0.024
L1	0.50	0.60	0.70	0.020	0.024	0.028
e1		1.90BSC			0.075BSC	
e		0.95BSC			0.037BSC	

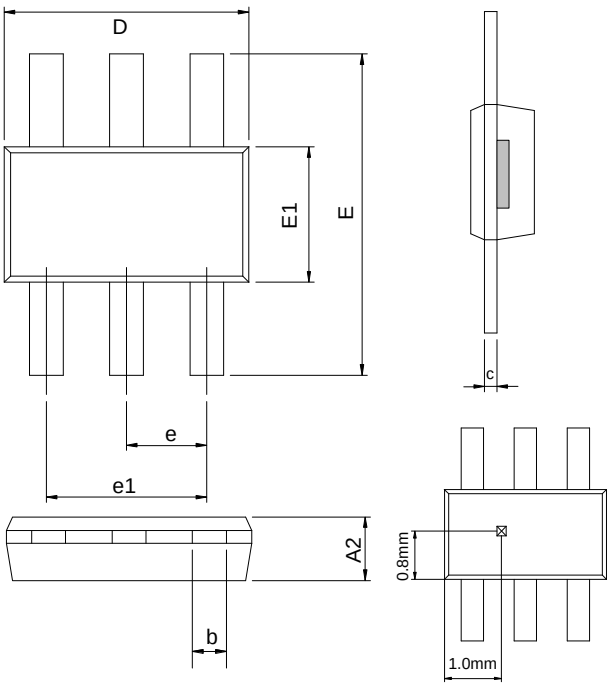
2. TSOT23-6L



Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	1.10	-	-	0.043
A1	0.00	-	0.10	0	-	0.004
A2	0.70	0.90	1.00	0.028	0.035	0.039
b	0.30	0.40	0.50	0.012	0.016	0.020
C	0.08	0.14	0.20	0.003	0.006	0.008
D	2.80	2.90	3.00	0.110	0.114	0.118
E	2.60	2.80	3.00	0.102	0.110	0.118
E1	1.50	1.60	1.70	0.059	0.063	0.067
e	0.95 BSC.			0.037 BSC.		
e1	1.90 BSC.			0.075 BSC.		
L	0.30	0.45	0.60	0.012	0.018	0.024
L1	0.60 REF.			0.024 REF.		
y	-	-	0.10	-	-	0.004

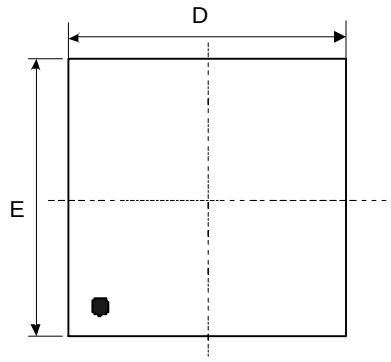
JEDEC outline: MO-193 AA

3. SOT23-6F

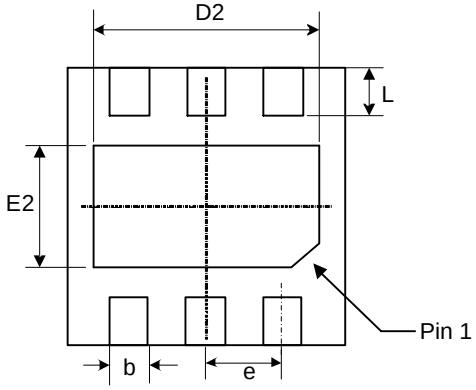


Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A2	0.85	1.00	1.15	0.033	0.039	0.045
b	0.30	0.40	0.55	0.012	-	0.020
c	0.08	-	0.22	0.003	-	0.009
D	2.70	2.90	3.10	0.106	1.114	0.122
E1	1.40	1.60	1.80	0.055	0.063	0.071
E	3.90	4.10	4.25	0.153	0.161	0.167
e1		1.90BSC			0.075BSC	
e		0.95BSC			0.037BSC	

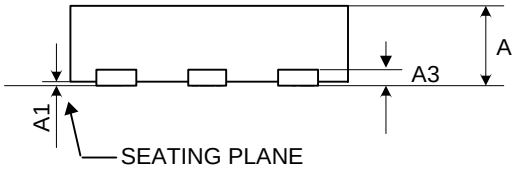
4. TDFN2X2-6L



(Top View)



(Bottom View)



(SIDE View)

Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	0.7	0.75	0.8	0.028	0.03	0.031
A1	0	0.02	0.05	0	0.001	0.002
A3	0.203 REF.			0.008 REF.		
b	0.2	0.28	0.35	0.009	0.011	0.013
D	1.95	2	2.05	0.077	0.079	0.081
D2	1.35	1.5	1.65	0.055	0.059	0.063
E	1.95	2	2.05	0.077	0.079	0.081
E2	0.75	0.9	1.05	0.031	0.035	0.039
e	0.65 BSC.			0.026 BSC.		
L	0.2	0.3	0.4	0.008	0.012	0.016