40-V High-Voltage Comparators with Open-Drain Output

Features

- Wide Single-supply Voltage Range or Dual Supplies: +2 V to +40 V or ±1 V to ±20 V
- Low Supply Current: 460 μA per Channel (Typ)
- Propagation Delay: 1 μs
- Low Offset Voltage: ±4 mV (Max, −40°C to 85°C)
- Low Input Bias Current: 60 nA (Typ)
- Input Common-mode Voltage Range Includes Ground
- Internal Differential Input Voltage Range Equal to the Supply Voltage
- Open-Drain Output for Maximum Flexibility
- Low Output Saturation
- −40°C to 85°C Operation Range

Applications

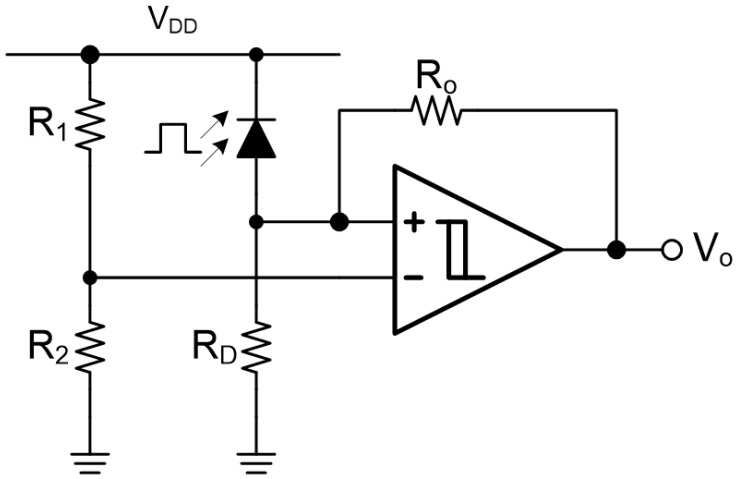
- Peak and Zero-Crossing Detectors
- Threshold Detectors/Discriminators
- Sensing at the Ground or Supply Line
- Logic Level Shifting or Translation
- Window Comparators
- IR Receivers

Description

The devices in this series consist of single, dual, or quad independent comparators on a single monolithic substrate. The common mode input voltage range includes ground even when operated from a single supply, and the low power supply current drain makes these comparators suitable for battery operation. These types are designed to directly interface with TTL and CMOS. The current drain is independent of the supply voltage. The outputs can be connected to other open-collector outputs to achieve wired-AND relationships.

The operating temperature range of the devices is from −40°C to +85°C.

Typical Application Circuit



Contents

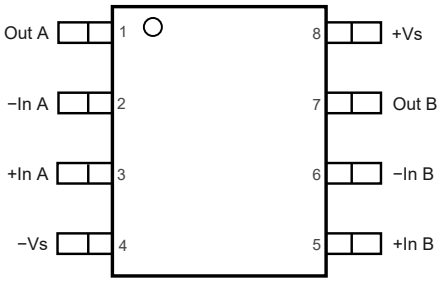
Features **1**
Applications **1**
Description **1**
Typical Application Circuit **1**
Revision History **3**
Pin Configuration and Functions **4**
Specifications **6**
Absolute Maximum Ratings (1) 6
ESD, Electrostatic Discharge Protection 6
Recommended Operating Conditions 6
Thermal Information 7
Electrical Characteristics 8
Typical Performance Characteristics 10
Detailed Description **12**
Overview 12
Functional Block Diagram 12
Application and Implementation **13**
Application Information 13
Typical Application 14
Tape and Reel Information **15**
Package Outline Dimensions **17**
SOP8 17
MSOP8 18
TSSOP8 19
SOP14 20
TSSOP14 21
Order Information **22**
IMPORTANT NOTICE AND DISCLAIMER **23**

Revision History

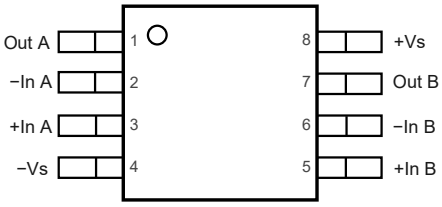
Date	Revision	Notes
2025-09-16	Rev.A.0	Initial version.
2026-01-13	Rev.A.1	Removed Order Information description about: (1) For future products, contact the 3PEAK factory for more information and samples.

Pin Configuration and Functions

LM393-SO1R
SOP8
Top View



LM393-VS1R
MSOP8
Top View



LM393-TS1R
TSSOP8
Top View

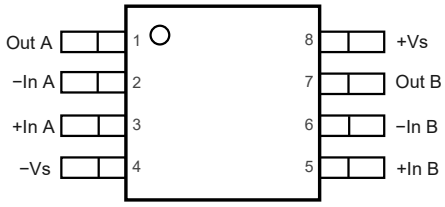
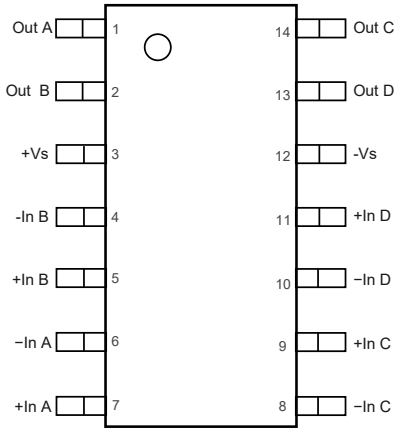


Table 1. Pin Functions: LM393-SO1R/LM393-VS1R/LM393-TS1R

Pin No.			Name	I/O	Description
LM393-SO1R	LM393-VS1R	LM393-TS1R			
1	1	1	Out A	O	Output.
2	2	2	−In A	I	Inverting input.
3	3	3	+In A	I	Non-inverting input.
4	4	4	$-V_S$	−	Negative power supply.
5	5	5	+In B	I	Non-inverting input.
6	6	6	−In B	I	Inverting input.
7	7	7	Out B	O	Output.
8	8	8	$+V_S$	−	Positive power supply.

LM339-SO2R
SOP14 Package
Top View



LM339-TS2R
TSSOP14 Package
Top View

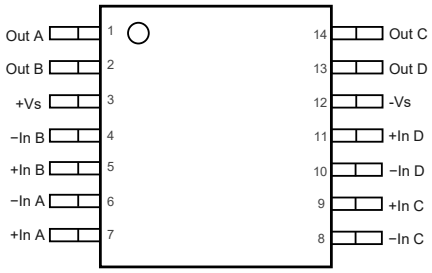


Table 2. Pin Functions: LM339-SO2R/LM339-TS2R

Pin No.		Name	I/O	Description
LM339-SO2R	LM339-TS2R			
1	1	Out A	O	Output
2	2	Out B	O	Output
3	3	$+V_S$		Positive power supply
4	4	−In B	I	Inverting input
5	5	+In B	I	Non-inverting input
6	6	−In A	I	Inverting input
7	7	+In A	I	Non-inverting input
8	8	−In C	I	Inverting input
9	9	+In C	I	Non-inverting input
10	10	−In D	I	Inverting input
11	11	+In D	I	Noninverting input
12	12	$-V_S$		Negative power supply
13	13	Out D	O	Output
14	14	Out C	O	Output

Specifications

Absolute Maximum Ratings (1)

Parameter		Min	Max	Unit
	Supply Voltage, $(+V_S) – (-V_S)$	−0.3	42	V
	Input Voltage	$(-V_S) – 0.3$	42	V
	Input Current: +IN, −IN (2)	−10	10	mA
	Output Current: OUT	−10	10	mA
	Output Short-Circuit Duration (3)		Infinite	
T_J	Maximum Junction Temperature		150	°C
T_A	Operating Temperature Range	−40	85	°C
T_{STG}	Storage Temperature Range	–65	150	°C
T_L	Lead Temperature (Soldering 10 sec)		260	°C

(1) 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.
(2) The inputs are protected by ESD protection diodes to the negative power supply. If the input extends more than 500 mV beyond the negative power supply, the input current should be limited to less than 10 mA.
(3) A heat sink may be required to keep the junction temperature below the absolute maximum. This depends on the power supply voltage and how many comparators are shorted. Thermal resistance varies with the amount of PC board metal connected to the package. The specified values are for short traces connected to the leads.

ESD, Electrostatic Discharge Protection

Parameter		Condition	Level	Unit
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001 (1)	3.5	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002 (2)	1.5	kV

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

Recommended Operating Conditions

Parameter		Min	Typ	Max	Unit
V_S	Supply Voltage, $(+V_S) – (-V_S)$	2		40	V

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
SOP8	158	43	°C/W
MSOP8	210	45	°C/W
TSSOP8	191	44	°C/W
SOP14	97	47	°C/W
TSSOP14	108	43	°C/W

Electrical Characteristics

All test conditions: V_S = 5 V, $R_{PULL-UP}$ = 5.1 k, T_A = 25°C, unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Power Supply						
I_Q	Quiescent Current per Comparator	V_S = 5 V, No Load, Output High, V_{INP} = 1 V, V_{INN}= 0 V		0.37	0.5	mA
		V_S = 5 V, No Load, Output Low, V_{INP}= 0 V, V_{INN}= 1 V, T_A = −40°C to 85°C			0.55	mA
		V_S = 40 V, No Load, Output High, V_{INP} = 1 V, V_{INN}= 0 V		0.46	0.65	mA
		V_S = 40 V, No Load, Output High, V_{INP} = 1 V, V_{INN}= 0 V, T_A = −40°C to 85°C			0.725	mA
Input Characteristics						
V_{OS}	Input Offset Voltage (1)	V_S = 5 V, V_{CM} = 0 V	−2		2	mV
		V_S = 5 V, V_{CM} = 0 V, T_A = −40°C to 85°C	−3		3	mV
V_{OS} TC	Input Offset Voltage Drift (2)	V_S = 5 V, V_{CM} = 0 V, T_A = −40°C to 85°C		2		µV/°C
V_{OS}	Input Offset Voltage (1)	V_S = 5 V, V_{CM} = 3 V	−2		2	mV
		V_S = 5 V, V_{CM} = 3 V, T_A = −40°C to 85°C	−3		3	mV
V_{OS} TC	Input Offset Voltage Drift (2)	V_S = 5 V, V_{CM} = 3 V, T_A = −40°C to 85°C		2		µV/°C
V_{OS}	Input Offset Voltage (1)	V_S = 5 V, V_{CM} = 3.5 V	−3		3	mV
V_{OS}	Input Offset Voltage (1)	V_S = 40 V, V_{CM} = 0 V	−3		3	mV
		V_S = 40 V, V_{CM} = 0 V, T_A = −40°C to 85°C	−3.5		3.5	mV
V_{OS} TC	Input Offset Voltage Drift (2)	V_S = 40 V, V_{CM} = 0 V, T_A = −40°C to 85°C		2		µV/°C
V_{OS}	Input Offset Voltage (1)	V_S = 40 V, V_{CM} = 38 V	−3		3	mV
		V_S = 40 V, V_{CM} = 38 V, T_A = −40°C to 85°C	−4		4	mV
V_{OS} TC	Input Offset Voltage Drift (2)	V_S = 40 V, V_{CM} = 38 V, T_A = −40°C to 85°C		2		µV/°C
V_{OS}	Input Offset Voltage (1)	V_S = 40 V, V_{CM} = 38.5 V	−4		4	mV
I_B	Input Bias Current	V_S = 40 V, V_{CM} = 0 V	−100	−60	0	nA
		V_S = 40 V, V_{CM} = 0 V, T_A = −40°C to 85°C	−150			nA
I_{OS}	Input Offset Current	V_S = 40 V, V_{CM} = 0 V	−30	0	30	nA
I_{OS} TC	Input Offset Current Drift (2)	V_S = 40 V, V_{CM} = 0 V, T_A = −40°C to 85°C		10		pA/°C
I_B	Input Bias Current	V_S = 40 V, V_{CM} = 38 V	−100	−30	0	nA

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
		V_S = 40 V, V_{CM} = 38 V, T_A = −40°C to 85°C	−150			nA
I_{OS}	Input Offset Current	V_S = 40 V, V_{CM} = 38 V	−30	0	30	nA
I_{OS} TC	Input Offset Current Drift (2)	V_S = 40 V, V_{CM} = 38 V, T_A = −40°C to 85°C		10		pA/°C
A_V	Large-signal Differential-voltage Amplification (4)	V_S = 15 V, V_O = 1.4 V to 11.4 V, RL ≥ 15 kΩ to V_{CC}	50	500		V/mV
		V_S= 15 V, V_O = 1.4 V to 11.4 V, RL ≥ 15 kΩ to V_{CC}, T_A = −40°C to 85°C	5			V/mV
V_{CM}	Common-mode Input Voltage Range	V_S = 40 V	0		38.5	V
		V_S = 40 V, T_A = −40°C to 85°C	0		38	V
Output						
I_{OH}	High-level Output Current	V_S = 5 V, V_{OH} = 5 V, V_{ID} = 1 V		8	25	nA
		V_S = 5 V, V_{OH} = 5 V, V_{ID} = 1 V, T_A = −40°C to 85°C			2000	nA
		V_S = 5 V, V_{OH} = 40 V, V_{ID} = 1 V		35	100	nA
		V_S = 5 V, V_{OH} = 40 V, V_{ID} = 1 V , T_A = −40°C to 85°C			4000	nA
I_{OL}	Low-level Output Current	V_S = 5 V, V_{OL} = 1.5 V, V_{ID} = −1 V	10	17		mA
		V_S = 5 V, V_{OL} = 1.5 V, V_{ID} = −1 V, T_A = −40°C to 85°C	9			mA
V_{OL}	Output Voltage Low	V_S = 5 V, I_{OL} = 4 mA, V_{ID} = −1 V		40	100	mV
		V_S = 5 V, I_{OL} = 4 mA, V_{ID} = −1 V, T_A = −40°C to 85°C (2)			150	mV
Switching Characteristics (3)						
t_{RT}	Response Time	V_S = 5 V, R_L connected to 5 V through 5.1 kΩ, C_L= 15 pF, 100-mV input step with 5-mV overdrive (2)		1		µs
		V_S = 5 V, R_L connected to 5 V through 5.1 kΩ, C_L = 15 pF, TTL-level input step (2)		0.3		µs

(1) The input offset voltage is the average of the input-referred trip points.
(2) Provided by bench tests and design simulation.
(3) Delay time is measured from the mid-point of the input to the mid-point of the output.
(4) Provided by design simulation.

Typical Performance Characteristics

All test conditions: V_S = 5 V, V_{CM} = 2.5 V, $R_{PULL-UP}$ = 5.1 k, unless otherwise noted.

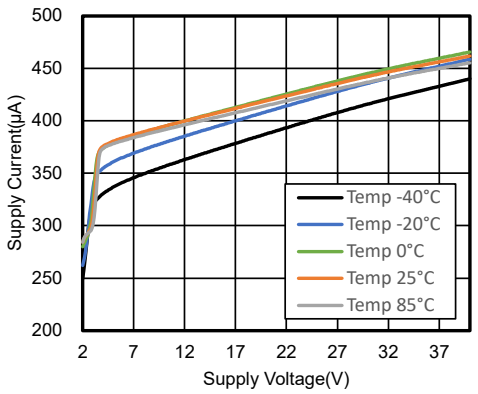


Figure 1. Supply Current vs. Supply Voltage, Output High

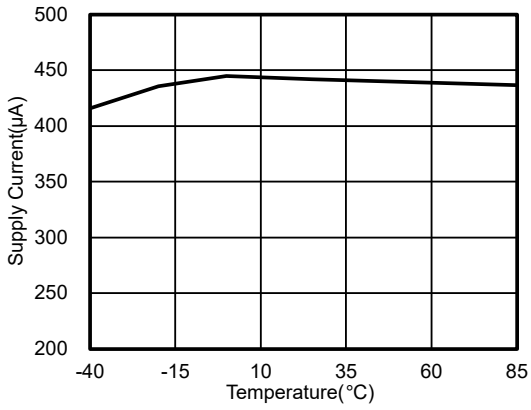


Figure 2. Supply Current vs. Temperature

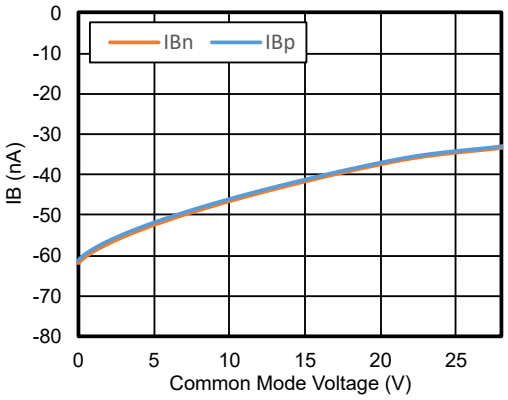


Figure 3. IB vs. Common-Mode Voltage

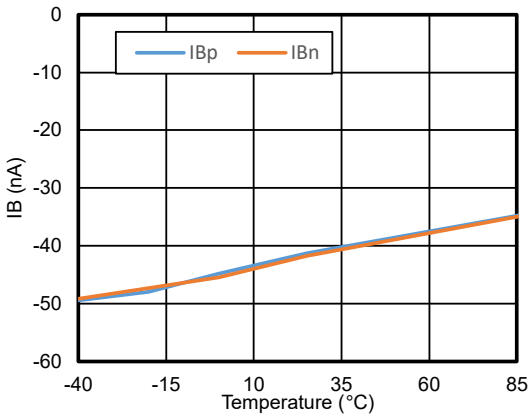


Figure 4. IB vs. Temperature

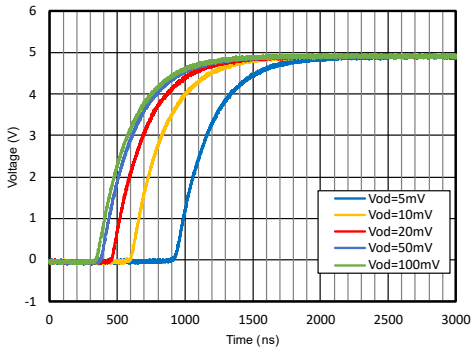


Figure 5. Propagation Delay, Low to High, 5 V

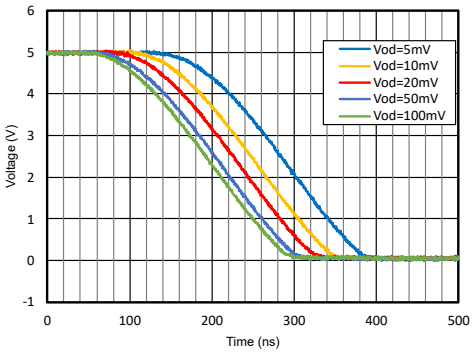


Figure 6. Propagation Delay, High to Low, 5 V

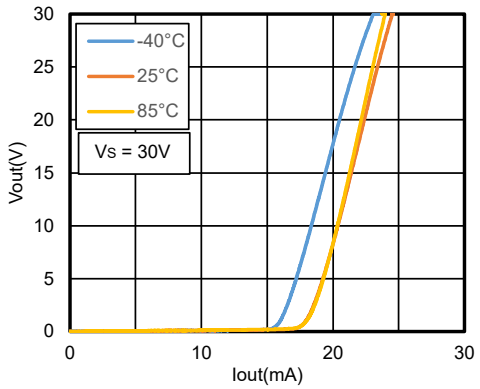


Figure 7. Output Voltage vs. Output Sinking Current, 5 V

Detailed Description

Overview

The devices in this series consist of single/dual/quad independent single- or dual-supply voltage comparators on a single monolithic substrate. The common-mode input voltage range includes ground even when operated from a single supply, and the low power supply current drain makes these comparators suitable for battery operation. These types are designed to directly interface with TTL and CMOS. The current drain is independent of the supply voltage. The outputs can be connected to other open-collector outputs to achieve wired-AND relationships.

Functional Block Diagram

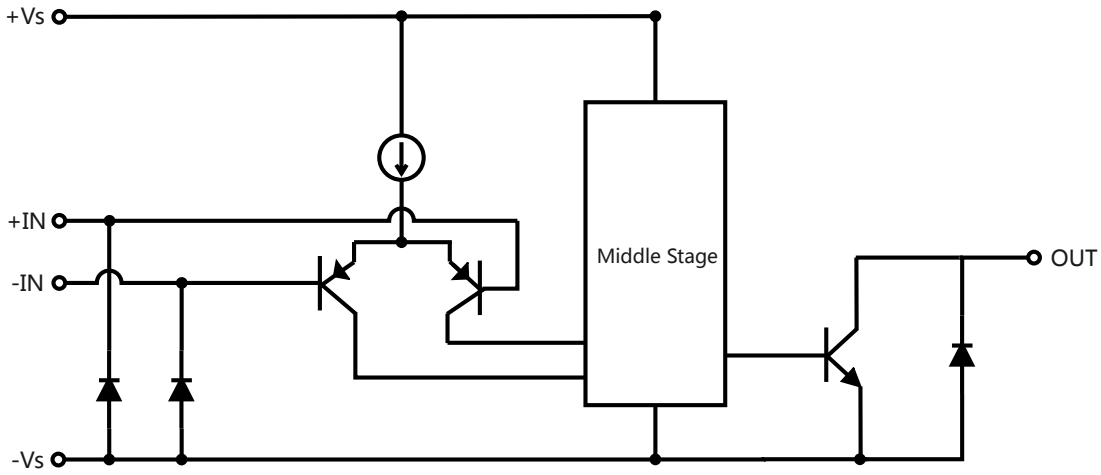


Figure 8. Functional Block Diagram

Application and Implementation

> Note
>
> Information in the following application sections is not part of the 3PEAK's component specification and 3PEAK does not warrant its accuracy or completeness. 3PEAK's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

Application Information

Power Supply Layout and Bypass

The power supply pins of LM393 and LM339 families should have local bypass capacitors (i.e., 0.01 μF to 0.1 μF) within 2 mm for high-frequency performance. They can also use a bulk capacitor (i.e., 1 μF or larger) within 100 mm to provide large and slow currents. This bulk capacitor can be shared with other analog parts.

A good ground layout improves performance by decreasing the amount of stray capacitance and noise at the inputs and outputs of the comparator. To decrease stray capacitance, minimize PCB lengths and resistor leads, and place external components to the pins of the comparator as close as possible.

Operation Outside of the Common Input Voltage Range

A list of input voltage situations and the corresponding outcomes are as follows:

1. When both −IN and +IN are within the common-mode range:
   a. If the voltage at the −IN pin is higher than the voltage at the +IN pin and the offset voltage, the output is low, and the output MOSFET is sinking current.
   b. If the voltage at the −IN pin is lower than the voltage at the +IN pin and the offset voltage, the output is high impedance.
2. When the voltage at the −IN pin is higher than the common-mode voltage range and the voltage at the +IN pin is within the common-mode voltage range, the output is low, and the output MOSFET is sinking current.
3. When the voltage at the +IN pin is higher than the common-mode voltage range and the voltage at the −IN pin is within the common-mode voltage range, the output is high impedance.
4. When the voltages at the −IN and +IN pins are both higher than the common-mode voltage range, the output is in an uncertain state.

Typical Application

IR Receiver

The device is an ideal candidate to be used as an infrared receiver shown in Figure 9. The infrared photo diode creates a current relative to the amount of infrared light present. The current creates a voltage across R_D. When this voltage level crosses the voltage applied by the voltage divider to the inverting input, the output transitions. Optional R_O provides additional hysteresis for noise immunity.

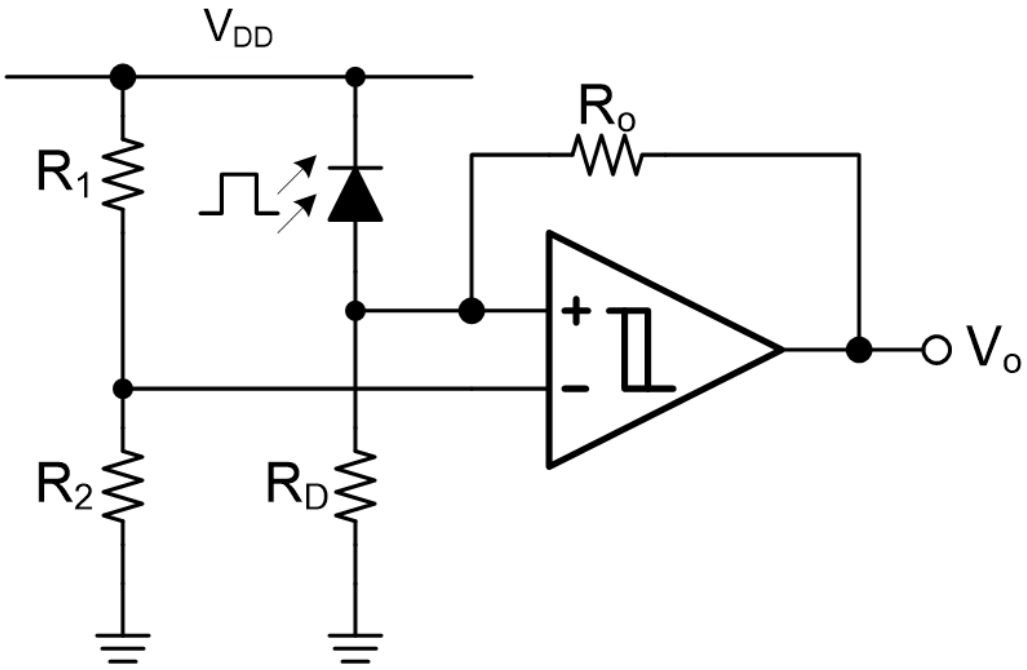
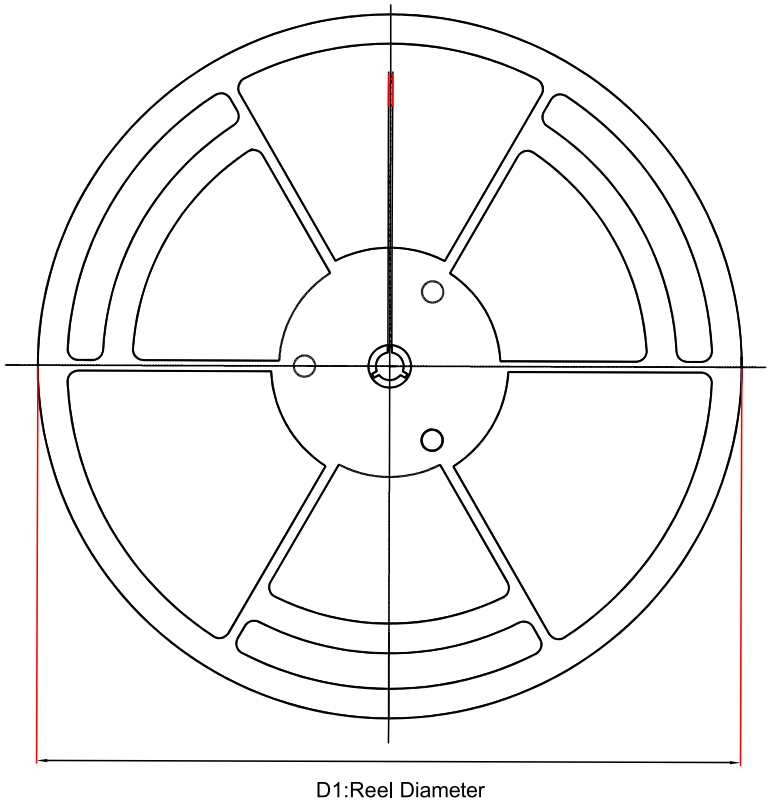
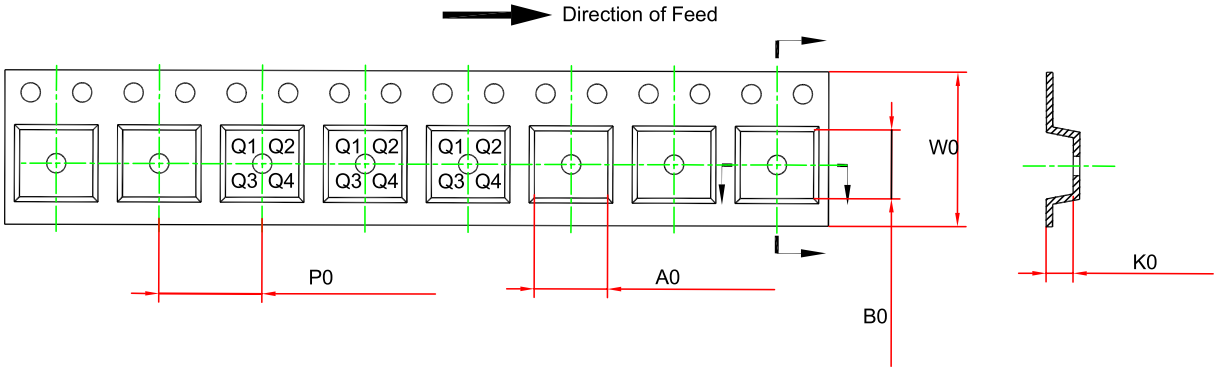


Figure 9. Typical Application Circuit

Tape and Reel Information





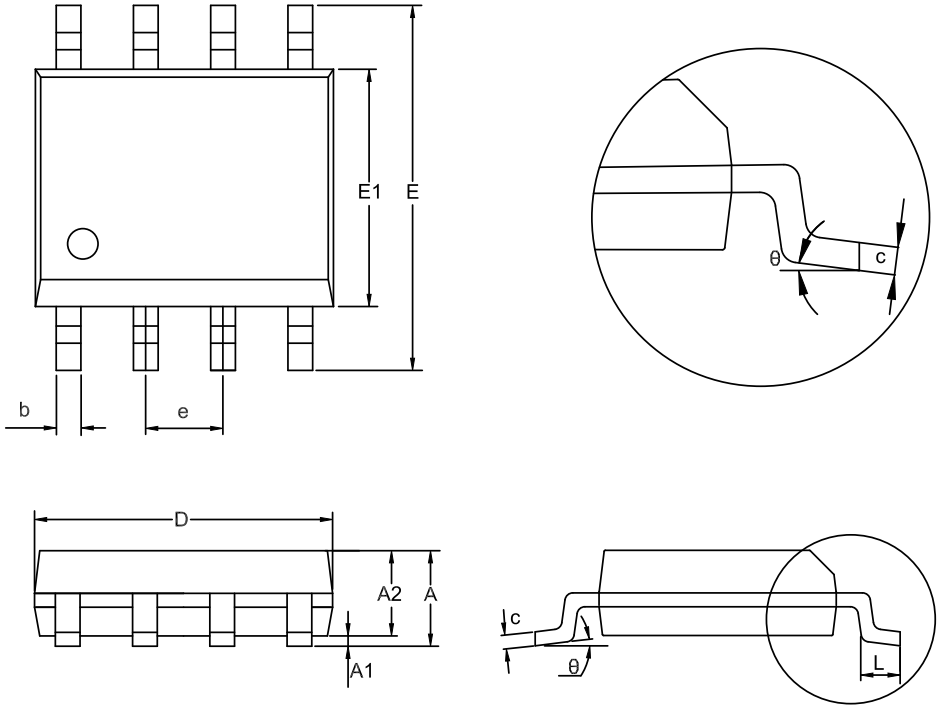
Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) (1)	B0 (mm) (1)	K0 (mm) (1)	P0 (mm)	W0 (mm)	Pin1 Quadrant
LM393-SO1R	SOP8	330	17.6	6.5	5.4	2	8	12	Q1
LM393-VS1R	MSOP8	330	17.6	5.3	3.4	1.3	8	12	Q1
LM393-TS1R	TSSOP8	330	17.6	6.8	3.4	1.8	8	12	Q1
LM339-SO2R	SOP14	330	21.6	6.5	9.3	2.1	8	16	Q1
LM339-TS2R	TSSOP14	330	17.6	6.8	5.5	1.5	8	12	Q1

(1) The value is for reference only. Contact the 3PEAK factory for more information.

Package Outline Dimensions

SOP8

Package Outline Dimensions SO1(SOP-8-A)



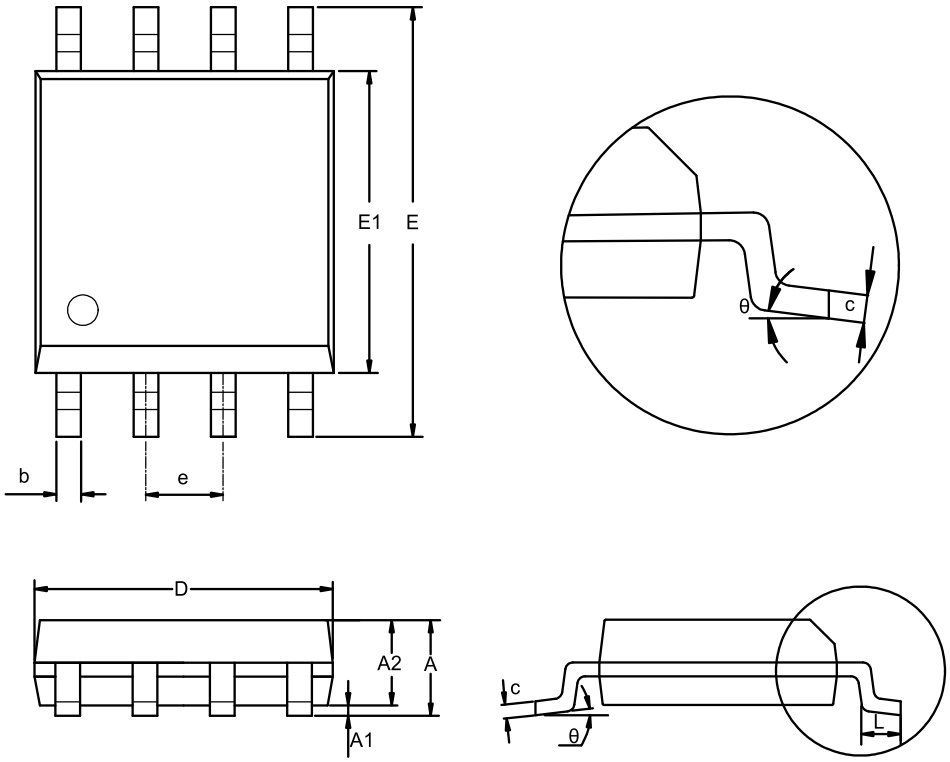
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.550	0.049	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050 BSC	
L	0.400	1.000	0.016	0.039
θ	0	8°	0	8°

NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

MSOP8

Package Outline Dimensions VS1(MSOP-8-A)



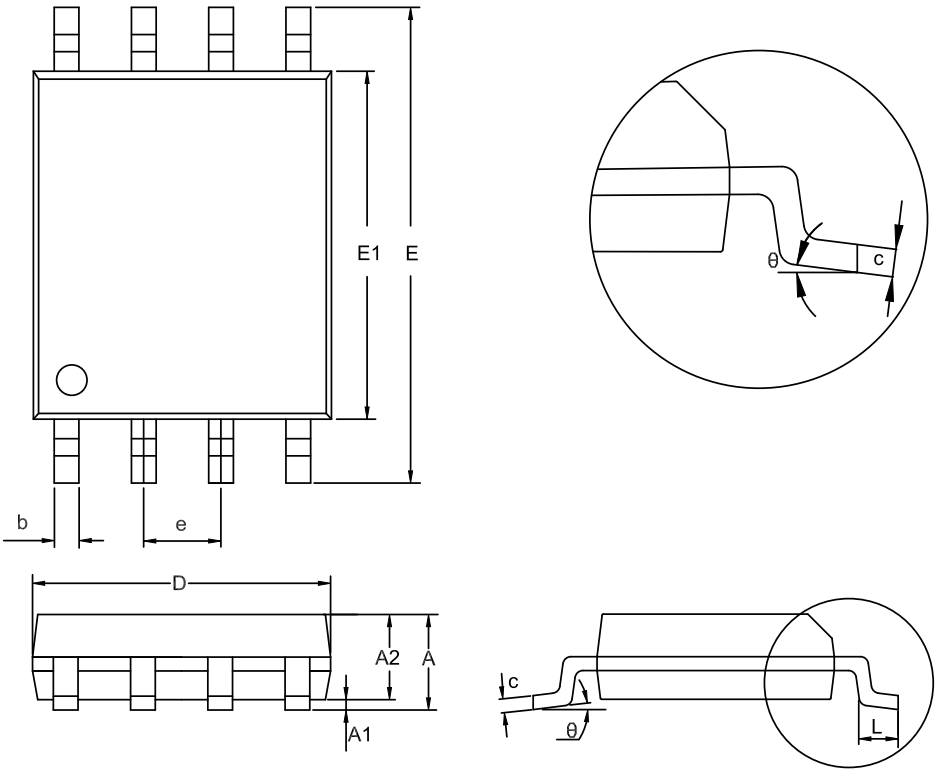
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.800	1.100	0.031	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	4.700	5.100	0.185	0.201
E1	2.900	3.100	0.114	0.122
e	0.650 BSC		0.026 BSC	
L	0.400	0.800	0.016	0.031
θ	0	8°	0	8°

NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

TSSOP8

Package Outline Dimensions TS1(TSSOP-8-A)



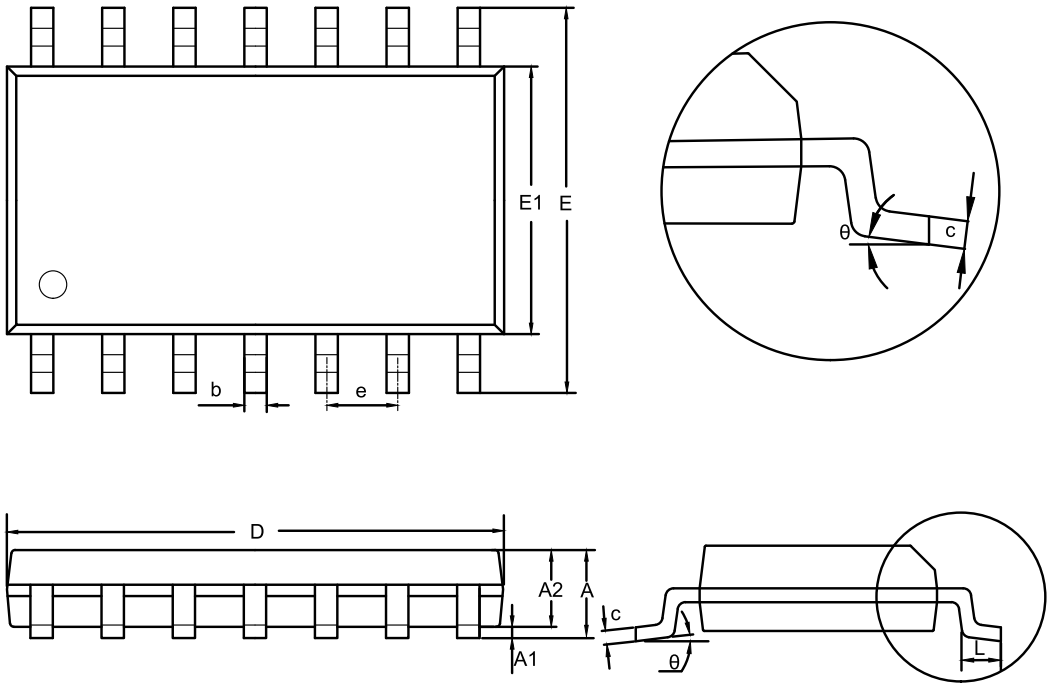
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.900	1.200	0.035	0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	2.900	3.100	0.114	0.122
E	6.200	6.600	0.244	0.260
E1	4.300	4.500	0.169	0.177
e	0.650 BSC		0.026 BSC	
L	0.450	0.750	0.018	0.030
θ	0	8°	0	8°

NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

SOP14

Package Outline Dimensions SO2(SOP-14-A)



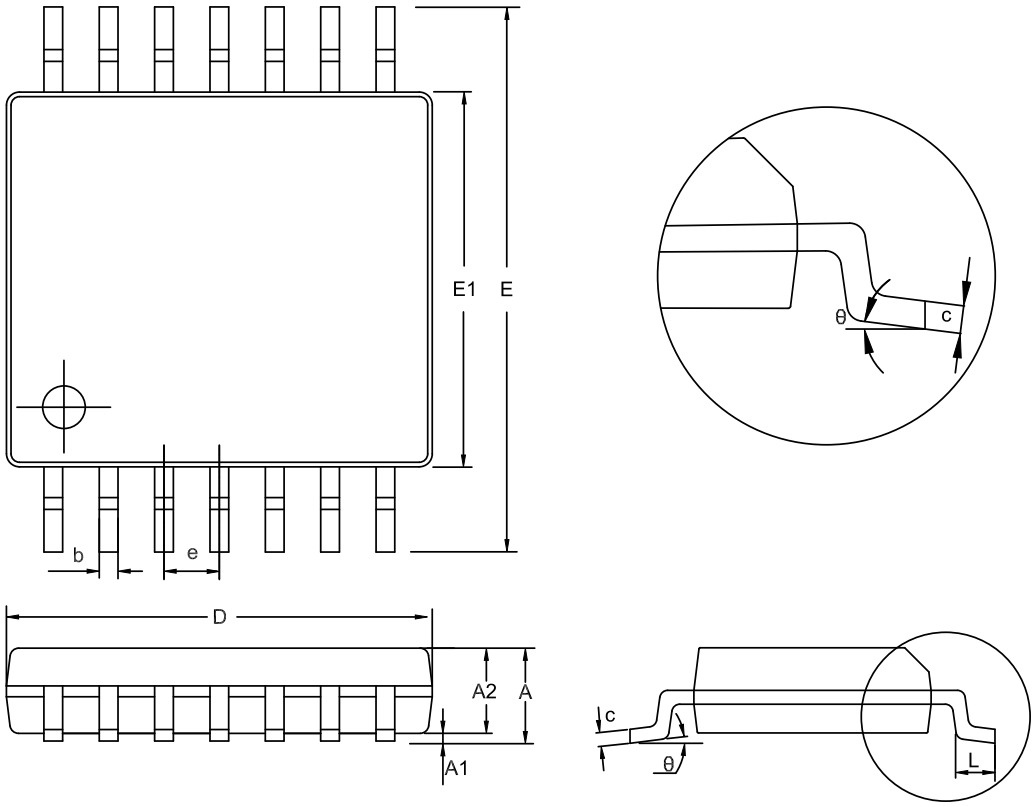
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.650	0.049	0.065
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D	8.450	8.850	0.333	0.348
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0	8°	0	8°

NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

TSSOP14

Package Outline Dimensions TS2(TSSOP-14-A)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.900	1.200	0.035	0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.900	5.100	0.193	0.201
E	6.200	6.600	0.244	0.260
E1	4.300	4.500	0.169	0.177
e	0.650 BSC		0.026 BSC	
L	0.450	0.750	0.018	0.030
θ	0	8°	0	8°

NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
LM393-SO1R	−40 to 85°C	SOP8	L393	3	Tape and Reel, 4000	Green
LM393-VS1R	−40 to 85°C	MSOP8	L393	3	Tape and Reel, 3000	Green
LM393-TS1R	−40 to 85°C	TSSOP8	L393	3	Tape and Reel, 3000	Green
LM339-SO2R	−40 to 85°C	SOP14	L339	3	Tape and Reel, 2500	Green
LM339-TS2R	−40 to 85°C	TSSOP14	L339	3	Tape and Reel, 3000	Green

Green: 3PEAK defines "Green" to mean RoHS compatible and free of halogen substances.

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