General-Purpose Low-Voltage Open-Drain Output Comparator

Features

* Supply Voltage Range: +1.8V to +5.5V
* Rail to Rail with fail safe protection
* Low Supply Current 50μA (TYP)
  per channel at VS = 5V
* Input Common-Mode Voltage Range
  Includes Ground
* Low Output Saturation Voltage 150mV Typical
* Open-Drain Output for Maximum Flexibility
* SPECIFIED UP TO +125°C

Applications

* Hysteresis Comparators&Oscillators
* Window Comparators
* Industrial Equipment
* Test and Measurement

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE(NOM)
HCRM331	SOT23-5	1.60mmX2.92mm
HCRM393	SOP8/SOIC-8	4.90mmX3.90mm
	MSOP8	3.00mmX3.00mm
HCRM339	SOP14	8.65mmX3.90mm
	TSSOP14	5.00mmX4.40mm

(1) For all available packages, see the addendum at the end of the data sheet.

General Description

The HCRM331 and HCRM393 is the single and dual comparator version, the HCRM339 is quad comparator version, and both are open-drain output comparators for maximum flexibility. It can operate from 1.8V to 5.5V, and have low power consuming 50μA (TYP) per channel.

The HCRM331, HCRM393 and HCRM339 are the most cost effective solutions for applications where low voltage operation, low power and space saving are the primary specifications in circuit design for portable consumer products.

The HCRM331, HCRM393 and HCRM339 are available in Green SOT23-5, SOP8, MSOP8, SOP14 and TSSOP-14 packages.

It operates over an ambient temperature range of -40°C to +125°C.

Packaging Appearance

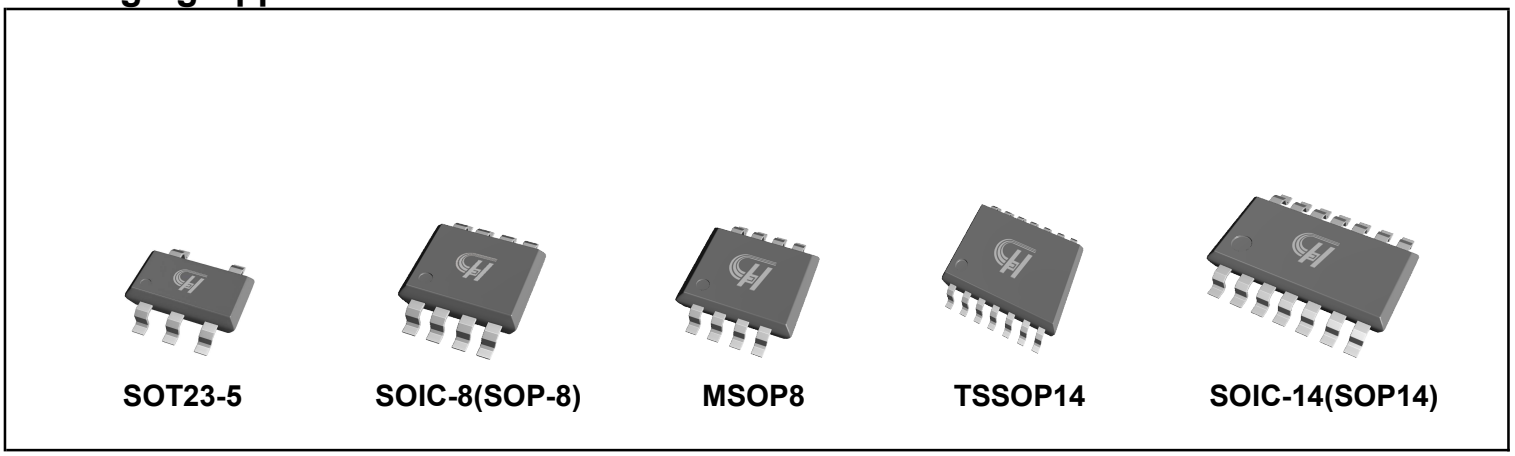
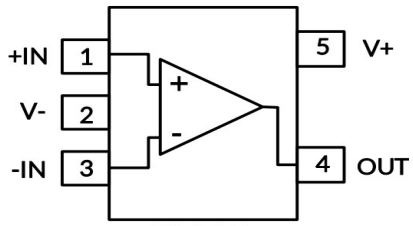


Figure 1. Packaging Appearance of HCRM331/HCRM393/HCRM339

General-Purpose Low-Voltage Open-Drain Output Comparator

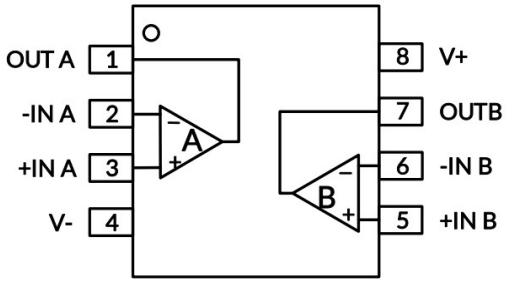
Pin Configuration and Functions (Top View)

HCRM331



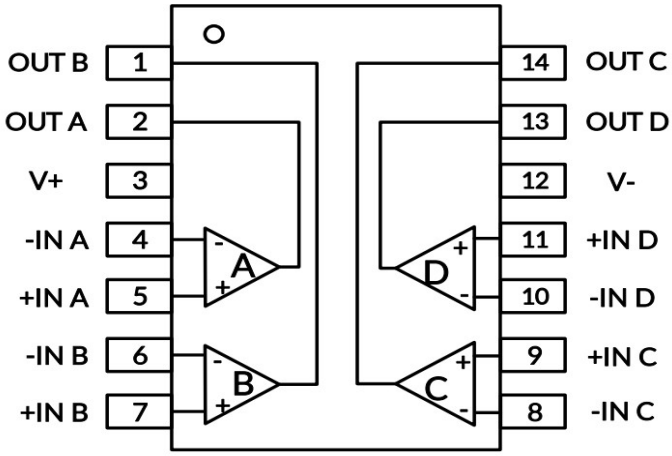
SOT23-5

HCRM393



SOP8/MSOP8

HCRM339



SOP14/TSSOP14

Pin Description

SOT23-5 Pin Description			
SOT23-5	Name	I/O (1)	Description
1	+IN	I	Noninverting Input
2	V-	P	Negative (lowest) Power Supply
3	-IN	I	Inverting Input
4	OUT	O	Output
5	V+	P	Positive (highest) Power Supply

SOIC8/SOP8/MSOP8 Pin Description			
SOIC8(SOP8) /MSOP8	Name	I/O (1)	Description
1	OUTA	O	Output, Channel A
2	-INA	I	Inverting Input, Channel A
3	+INA	I	Noninverting Input, Channel A
4	V-	P	Negative (lowest) Power Supply
5	+INB	I	Noninverting Input, Channel B
6	-INB	I	Inverting Input, Channel B
7	OUTB	O	Output, Channel B
8	V+	P	Positive (highest) Power Supply

(1). I=Input, O=Output, P=Power

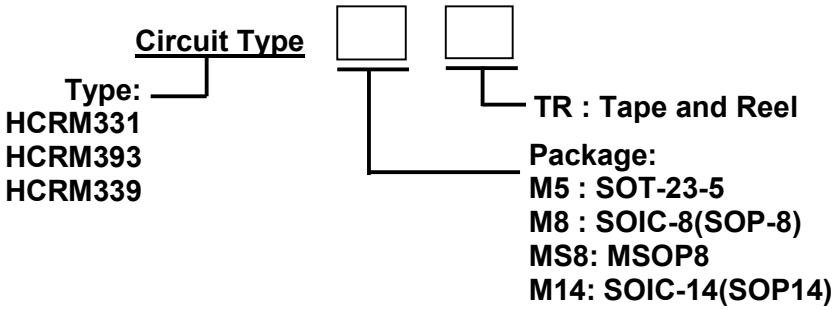
General-Purpose Low-Voltage Open-Drain Output Comparator

Pin Description(Con.)

SOIC14(SOP14)/TSSOP14Pin Description			
SOIC14(SOP14) /TSSOP-14	Name	I/O (1)	Description
1	OUTB	O	Output, Channel B
2	OUTA	O	Output, Channel A
3	V+	P	Positive (highest) Power Supply
4	-INA	I	Inverting Input, Channel A
5	+INA	I	Noninverting Input, Channel A
6	-INB	I	Inverting Input, Channel B
7	+INB	I	Noninverting Input, Channel B
8	-INC	I	Inverting Input, Channel C
9	+INC	I	Noninverting Input, Channel C
10	-IND	I	Inverting Input, Channel D
11	+IND	I	Noninverting Input, Channel D
12	V-	P	Negative (lowest) Power Supply
13	OUTD	O	Output, Channel D
14	OUTC	O	Output, Channel C

(1). I=Input, O=Output, P=Power

Ordering Information



Ordering Code note b

Part Number	Marking ID note2	Package	MSL(3)	Package Type
HCRM331M5TR	331	SOT23-5	MSL3	3000pcs, Tape&Reel
HCRM393M8TR	HCRM393XX	SOIC-8(SOP8)	MSL3	4000pcs, Tape&Reel
HCRM393MS8TR	HCRM393XX	MSOP8	MSL3	4000pcs, Tape&Reel
HCRM339M14TR	HCRM339XX	SOIC-14(SOP14)	MSL3	2500pcs, Tape&Reel
HCRM339TM14TR	HCRM339XX	TSSOP-14	MSL3	3000pcs, Tape&Reel

Note 2: The "XX" is date code.

3: HCRSEMI's classify the MSL level with using the common preconditioning setting in our assembly factory conforming to the JEDEC industrial standard J-STD-20F. Please align with HCRSEMI if your end application is quite critical to the preconditioning setting or if you have special requirement.

SPECIFICATIONS

Absolute Maximum Ratings(Over operating free-air temperature range(unless otherwise noted) [1]

Symbol	Parameter		Min	Max	Unit
Voltage	Supply, Vs=(V+) - (V-)		-	7	V
	Input Pin (IN+, IN-) [2]		(V-)-0.3	(V+)+0.3	
	Signal output pin		(V-)-0.3	(V+)+0.3	
Current	Signal input pin (IN+, IN-) [2]		-10	10	mA
	Signal output pin		-55	55	mA
	Output Short-circuit [3]		Continuous		
θJA	Package thermal impedance	SOT23-5	-	230	'C/W
		SOIC8(SOP8)	-	110	
		MSOP8	-	165	
		SOIC14(SOP14)	-	105	
		TSSOP14	-	90	
Temperature	Operating range, TA		-40	+125	'C
	Junction, TJ		-40	+150	
	Storage, TSTG		-65	+150	

Note (1). Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.

(2). Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current limited to 10mA or less.

(3). Short-circuit from output to VCC can cause excessive heating and eventual destruction.

ESD Ratings

Symbol	Parameter		Value	Unit
V(ESD)	Electrostatic Discharge	Human-body model(HBM), per ANSI/ESDA/JEDEC JS-001, all pins	±2000	V
		Charged device mode (CDM), per JEDEC specification JESD22-C101, all pins	±1000	

Recommended Operating Conditions

Over operating free-air temperature range (unless otherwise noted)

Symbol	Parameter		Min.	Max.	Unit
VI	Supply Voltage, Vs=(V+) - (V-)	Single-Supply	1.8	5.5	V
		Dual-Supply	±0.9	±2.75	
TA	Operating Temperature Range,		-40	+125	'C

General-Purpose Low-Voltage Open-Drain Output Comparator

Electrical Characteristics (VS=5.0V)

(At TA= +25'C, VCM=VS/2, unless otherwise noted.) note1

Parameter	System	Conditions	Min.(2)	Typ.(3)	Max.(2)	Unit
Power Supply						
Operating Voltage Range	VS	-	1.8	-	5.5	V
Quiescent Current per channel	IQ	-	-	50	150	uA
Power-Supply Rejection Ratio	PSRR	VS=1.8V to 5.5V, VCM=(V)+0.5V	-	70	-	dB
Input						
Input Offset Voltage	VOS	-	-3.5	±0.6	3.5	mV
Input Offset Voltage Drift	ΔVOS/ΔT	VCM=VS/2, -40'C<=TA<=125'C	-	±0.5	-	uV/'C
Input Bias Current (4)(5)	IB		-	±1	±10	pA
Input Offset Current (4)	IOS		-	±1	±10	pA
Common-Mode Voltage Range	VCM	TA=-40'C to 125'C	(V-)-0.1	-	(V+)+0.1	V
Common-Mode Rejection Ratio	CMRR	VCM=-0.1 to 5.6V	-	70	-	dB
Output						
Saturation Voltage	VSAT	IO<=4mA	-	150	350	mV
Output pull-up voltage range	VOH		-	-	5.6	V
Output Current(Sinking)	IO	VO<=1.5V	-	27	-	mA
Output Leakage Current	ILEAK		-	0.01	10	nA
SWITCHING						
Propagation Delay H to L (6)	TPHL	RPU=5.1KΩ, Overdrive=10mV	-	205	-	ns
		RPU=5.1KΩ, Overdrive=100mV	-	185	-	
Propagation Delay L to H (6)	TPLH	RPU=5.1KΩ, Overdrive=10mV	-	660	-	
		RPU=5.1KΩ, Overdrive=100mV	-	700	-	
Fall Time	TF	RPU=5.1KΩ, Overdrive=100mV	-	42	-	ns

Note (1). Electrical table values apply only for factory testing conditions at the temperature indicated. Factory testing conditions result in very limited self-heating of the device.

(2). Limits are 100% production tested at 25°C. Limits over the operating temperature range are ensured through correlations using statistical quality control (SQC) method.

(3). Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration.

(4). This parameter is ensured by design and/or characterization and is not tested in production.

(5). Positive current corresponds to current flowing into the device.

(6). High-to-low and low-to-high refers to the transition at the input.

Electrical Characteristics (VS=2.7V)

(At TA= +25'C, VCM=VS/2, unless otherwise noted.) note1

Parameter	System	Conditions	Min.(2)	Typ.(3)	Max.(2)	Unit
Power Supply						
Operating Voltage Range	VS	-	1.8	-	5.5	V
Quiescent Current per channel	IQ	-	-	48	140	uA
Power-Supply Rejection Ratio	PSRR	VS=1.8V to 5.5V, VCM=(V)+0.5V	-	70	-	dB
Input						
Input Offset Voltage	VOS	-	-3.5	±0.6	3.5	mV
Input Offset Voltage Drift	ΔVOS/ΔT	VCM=VS/2, -40'C<=TA<=125'C	-	±0.5	-	uV/'C
Input Bias Current (4)(5)	IB		-	±1	±10	pA
Input Offset Current (4)	IOS		-	±1	±10	pA
Common-Mode Voltage Range	VCM	TA=-40'C to 125'C	(V-)-0.1	-	(V+)+0.1	V
Common-Mode Rejection Ratio	CMRR	VCM=-0.1 to 2.8V	-	70	-	dB
Output						
Saturation Voltage	VSAT	IO<=2.2mA	-	144	-	mV
Output pull-up voltage range	VOH		-	-	5.6	V
Output Current(Sinking)	IO	VO<=1.5V	9	13	-	mA
Output Leakage Current	ILEAK		-	0.01	10	nA
SWITCHING						
Propagation Delay H to L (6)	TPHL	RPU=5.1KΩ, Overdrive=10mV	-	250	-	ns
		RPU=5.1KΩ, Overdrive=100mV	-	230	-	
Propagation Delay L to H (6)	TPLH	RPU=5.1KΩ, Overdrive=10mV	-	680	-	
		RPU=5.1KΩ, Overdrive=100mV	-	702	-	
Fall Time	TF	RPU=5.1KΩ, Overdrive=100mV	-	52	-	ns

Note (1). Electrical table values apply only for factory testing conditions at the temperature indicated. Factory testing conditions result in very limited self-heating of the device.

(2). Limits are 100% production tested at 25°C. Limits over the operating temperature range are ensured through correlations using statistical quality control (SQC) method.

(3). Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration.

(4). This parameter is ensured by design and/or characterization and is not tested in production.

(5). Positive current corresponds to current flowing into the device.

(6). High-to-low and low-to-high refers to the transition at the input.

Electrical Characteristics (VS=1.8V)

(At TA= +25'C, VCM=VS/2, unless otherwise noted.) note1

Parameter	System	Conditions	Min.(2)	Typ.(3)	Max.(2)	Unit
Power Supply						
Operating Voltage Range	VS	-	1.8	-	5.5	V
Quiescent Current per channel	IQ	-	-	40	135	uA
Power-Supply Rejection Ratio	PSRR	VS=1.8V to 5.5V, VCM=(V)+0.5V	-	70	-	dB
Input						
Input Offset Voltage	VOS	-	-3.5	±0.6	3.5	mV
Input Offset Voltage Drift	ΔVOS/ΔT	VCM=VS/2, - 40'C<=TA<=125'C	-	±0.5	-	uV/'C
Input Bias Current (4)(5)	IB		-	±1	±10	pA
Input Offset Current (4)	IOS		-	±1	±10	pA
Common-Mode Voltage Range	VCM	TA=-40'C to 125'C	(V-)-0.1	-	(V+)+0.1	V
Common-Mode Rejection Ratio	CMRR	VCM=-0.1 to 1.9V	-	70	-	dB
Output						
Saturation Voltage	VSAT	IO<=1.5mA	-	144	-	mV
Output pull-up voltage range	VOH		-	-	5.6	V
Output Current(Sinking)	IO	VO<=0.8V	3	5	-	mA
Output Leakage Current	ILEAK		-	0.01	10	nA
SWITCHING						
Propagation Delay H to L (6)	TPHL	RPU=5.1KΩ, Overdrive=10mV	-	272	-	ns
		RPU=5.1KΩ, Overdrive=100mV	-	270	-	
Propagation Delay L to H (6)	TPLH	RPU=5.1KΩ, Overdrive=10mV	-	712	-	
		RPU=5.1KΩ, Overdrive=100mV	-	706	-	
Fall Time	TF	RPU=5.1KΩ, Overdrive=100mV	-	110	-	ns

Note (1). Electrical table values apply only for factory testing conditions at the temperature indicated. Factory testing conditions result in very limited self-heating of the device.

(2). Limits are 100% production tested at 25°C. Limits over the operating temperature range are ensured through correlations using statistical quality control (SQC) method.

(3). Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration.

(4). This parameter is ensured by design and/or characterization and is not tested in production.

(5). Positive current corresponds to current flowing into the device.

(6). High-to-low and low-to-high refers to the transition at the input.

Typical Characteristics

At T_A=+25'C, V_S=5V, V_{CM}=Vs/2, C_L=15pF unless otherwise noted.

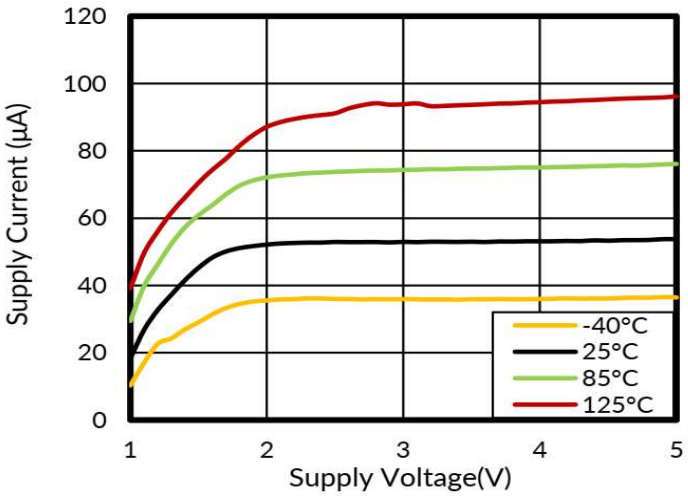


Figure 2. Supply Current vs supply voltage output high

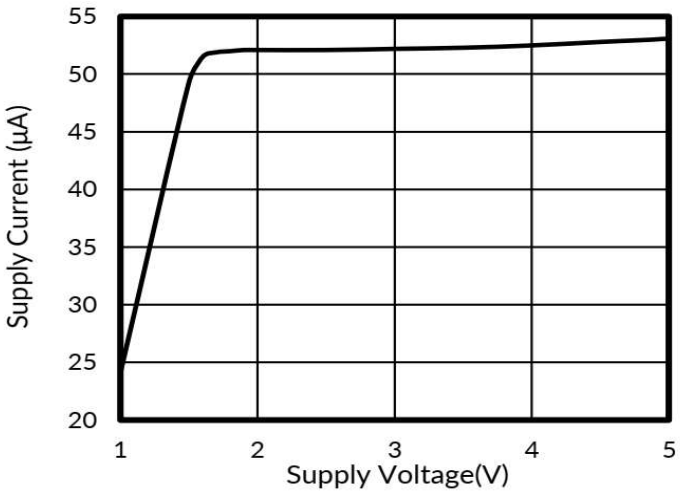


Figure 3. Supply Current vs supply voltage output Low

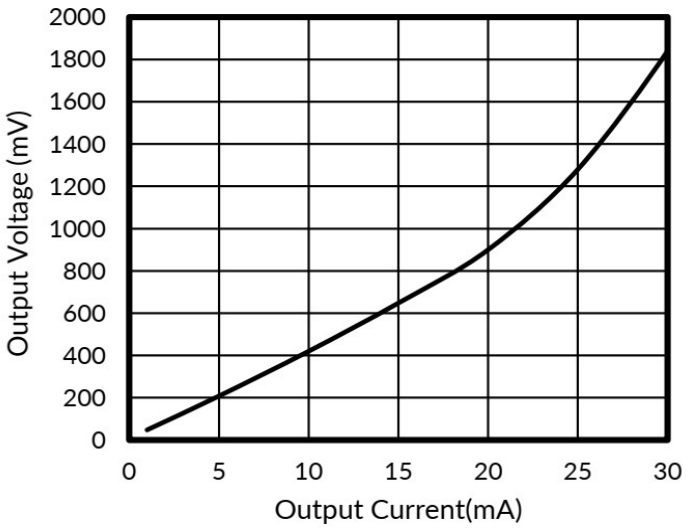


Figure 4. Output Voltage vs Output Current

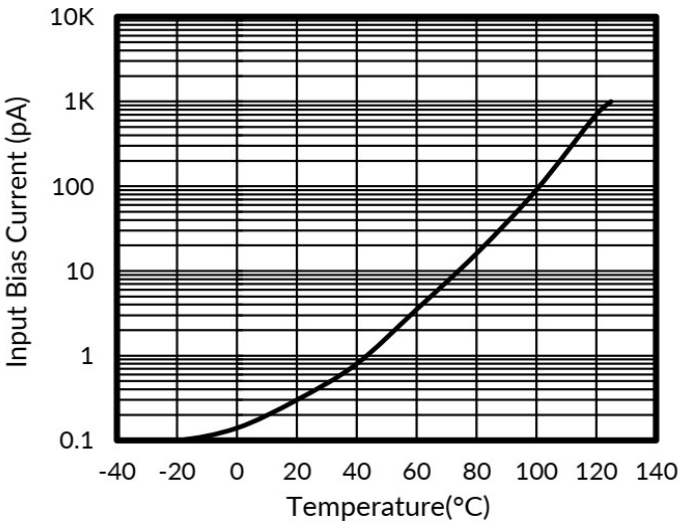


Figure 5. Input Bias Current vs Temperature

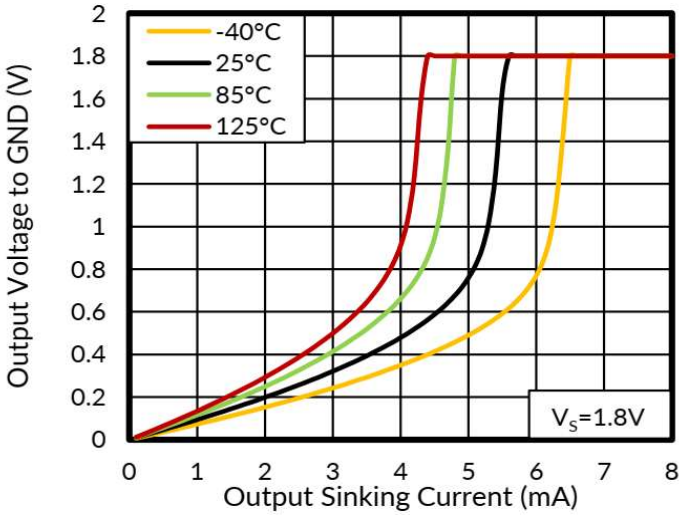


Figure 6. Output Sinking Current vs Output Voltage

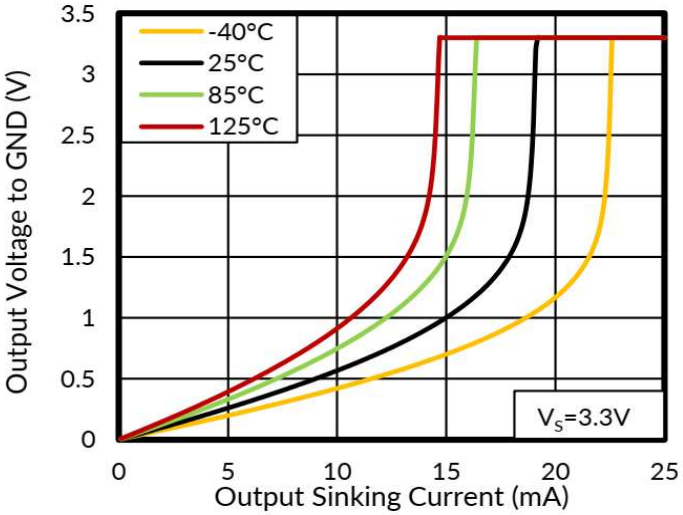


Figure 7. Output Sinking Current vs Output Voltage

Typical Characteristics(Con.)

At T_A=+25'C, V_S=5V, V_{CM}=Vs/2, C_L=15pF unless otherwise noted.

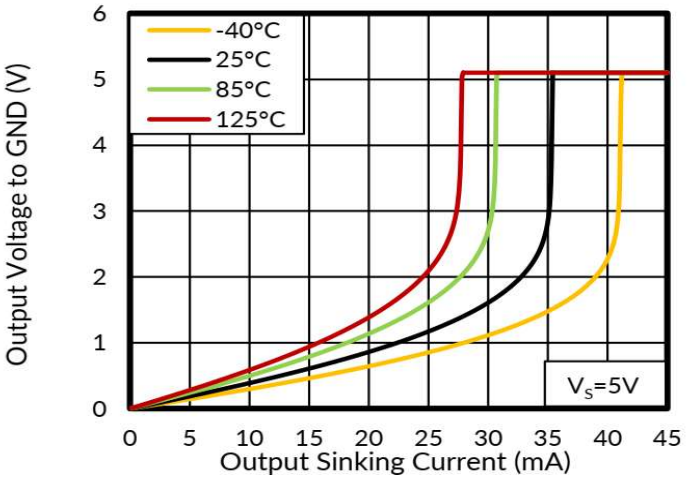


Figure 8. Output Sinking Current vs output Voltage

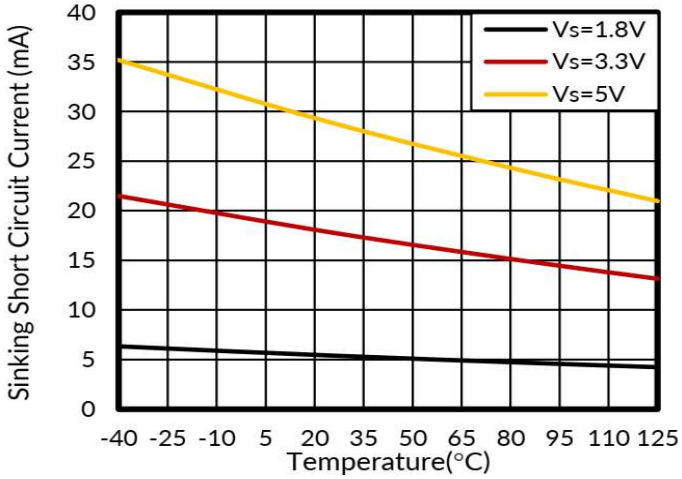


Figure 9. Sinking Short Circuit Current vs Temperature

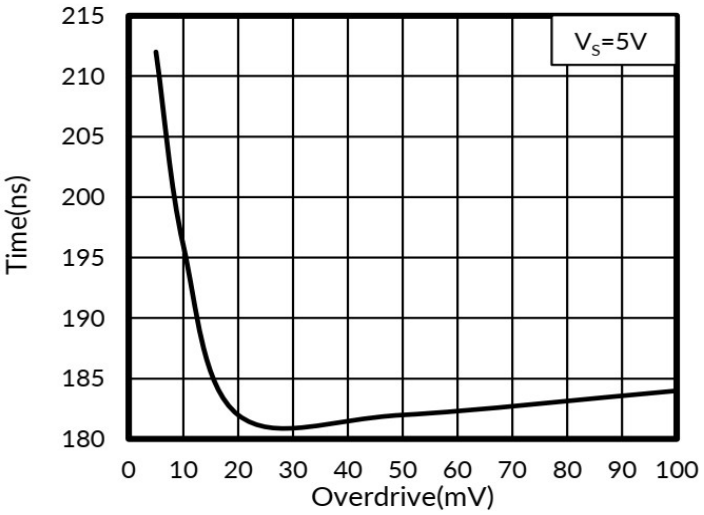


Figure 10. Response Time vs Input Overdrives Negative Transition

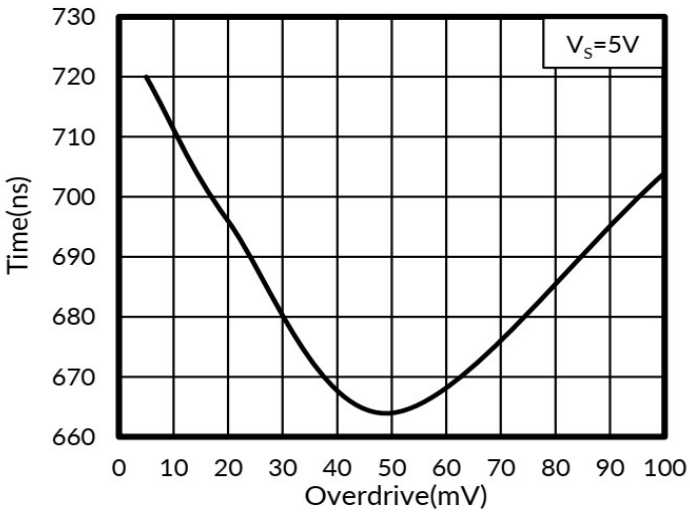


Figure 11. Response Time vs Input Overdrives Positive Transition

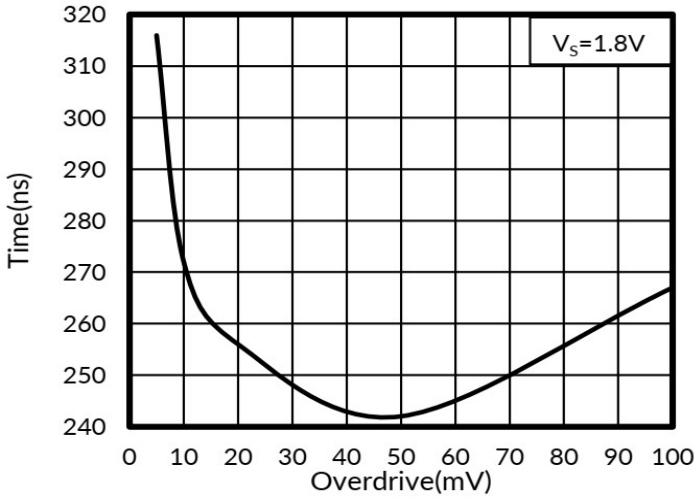


Figure 12. Response Time vs Input Overdrives Negative Transition

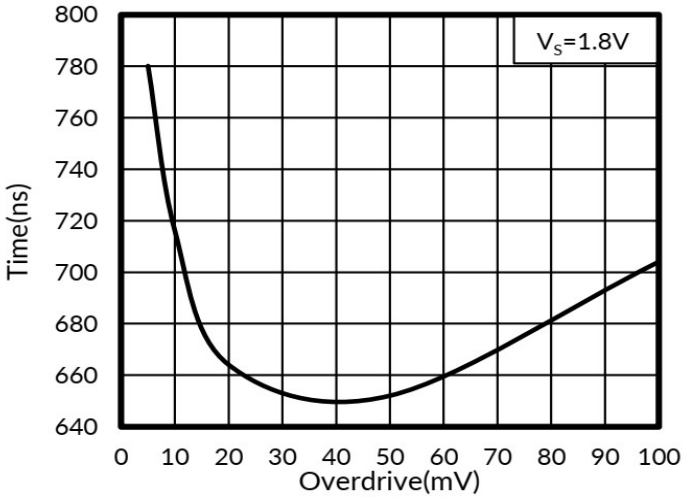


Figure 13. Response Time vs Input Overdrives Positive Transition

General-Purpose Low-Voltage Open-Drain Output Comparator

Detailed Description

Overview

The HCRM331, HCRM393 and HCRM339 family of comparators can operate up to 5.5V on the supply pin. This standard device has proven ubiquity and versatility across a wide range of applications. This is due to its low power and high speed. The open-drain output allows the user to configure the output's logic low voltage (VOL) and can be utilized to enable the comparator to be used in AND functionality.

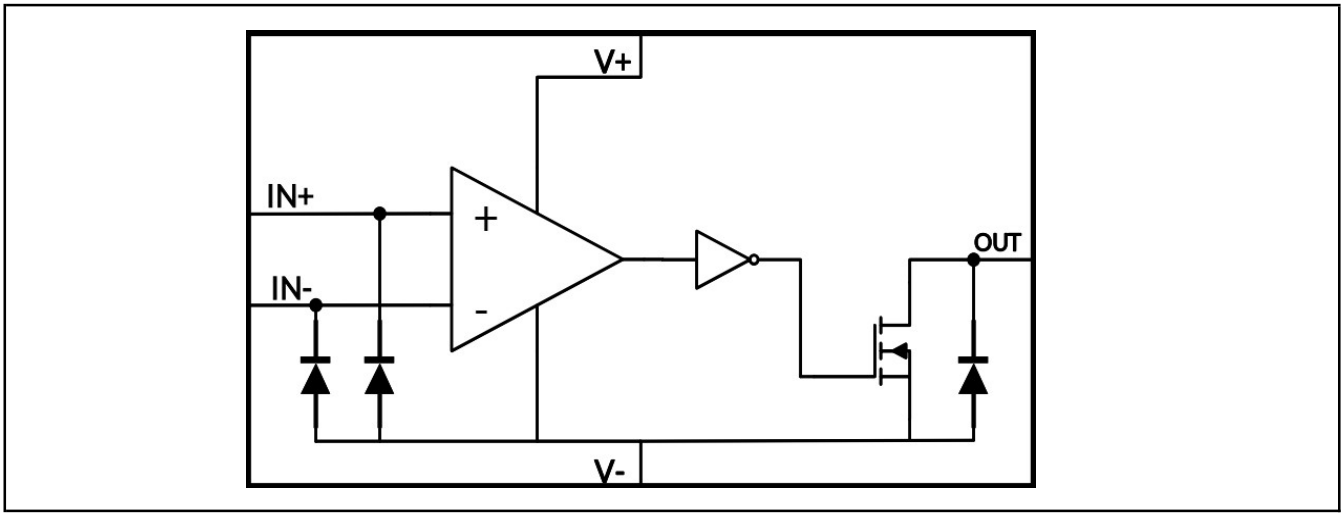


Figure 14. Functional Block Diagram of HCRM331/HCRM393/HCRM339

Application and Implementation

Application Information

The HCRM331, HCRM393 and HCRM339 will typically be used to compare a single signal to a reference or two signals against each other. Many users take advantage of the open drain output (logic high with pull-up) to drive the comparison logic output to a logic voltage level to an MCU or logic device.

Power Supply Recommendations

For fast response and comparison applications with noisy or AC inputs, it is recommended to use a bypass capacitor on the supply pin to reject any variation on the supply voltage. This variation causes temporary fluctuations in the comparator's input common mode range and create an inaccurate comparison.

Typical Application

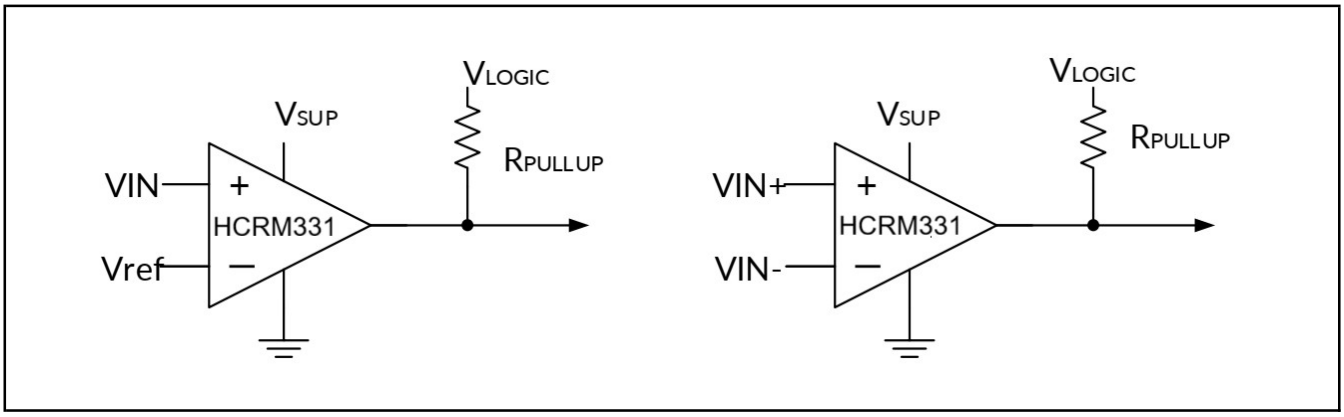


Figure 15. Typical Application Schematic

Layout

Layout Guidelines

For accurate comparator applications without hysteresis it is important maintain a stable power supply with minimized noise and glitches, which can affect the high-level input common mode voltage range. In order to achieve this, it is best to add a bypass capacitor between the supply voltage and ground. This should be implemented on the positive power supply and negative supply (if available). If a negative supply is not being used, do not put a capacitor between the IC's GND pin and system ground.

Layout Example

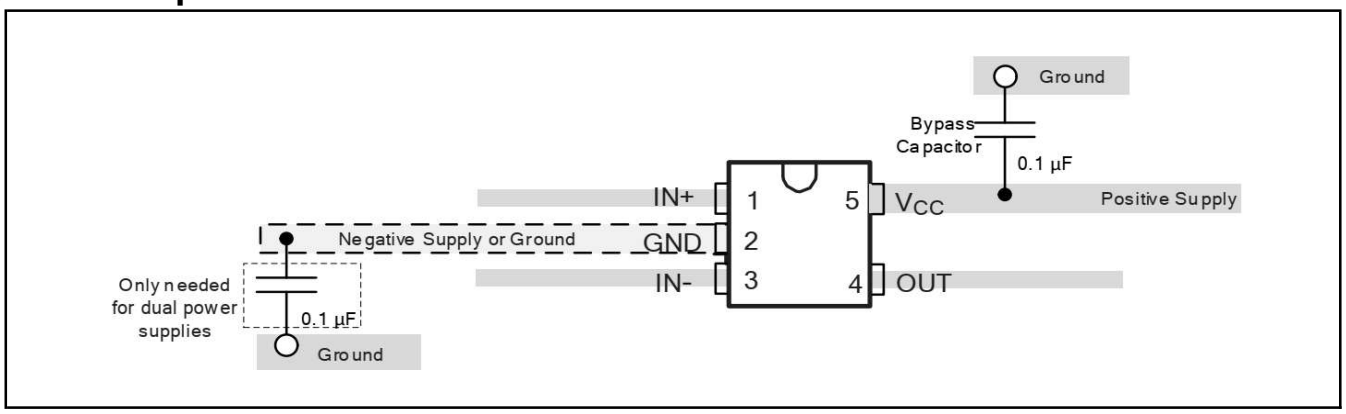
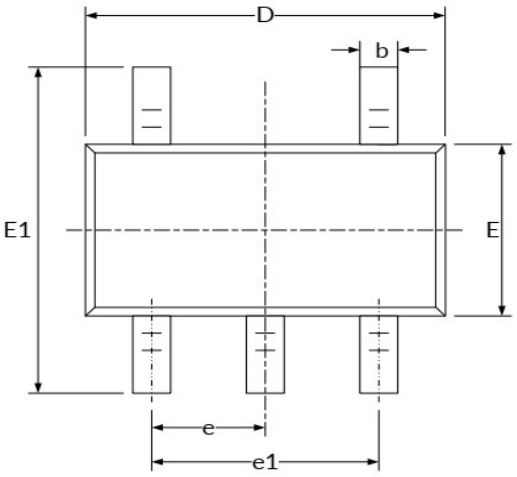


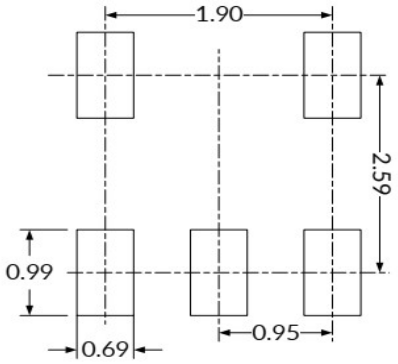
Figure 16. HCRM331 Layout Example

Mechanical Dimensions

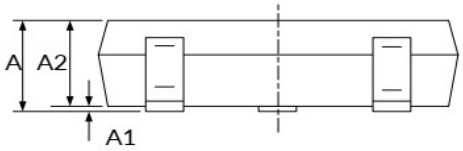
M5 PKG: SOT23-5

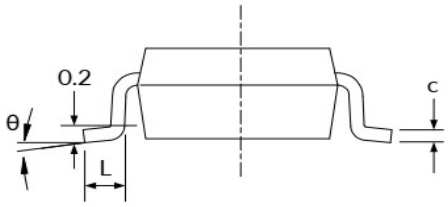
Unit: mm (inch)





RECOMMENDED LAND PATTERN (Unit: mm)





Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D (1)	2.820	3.020	0.111	0.119
E (1)	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC) (2)		0.037(BSC) (2)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

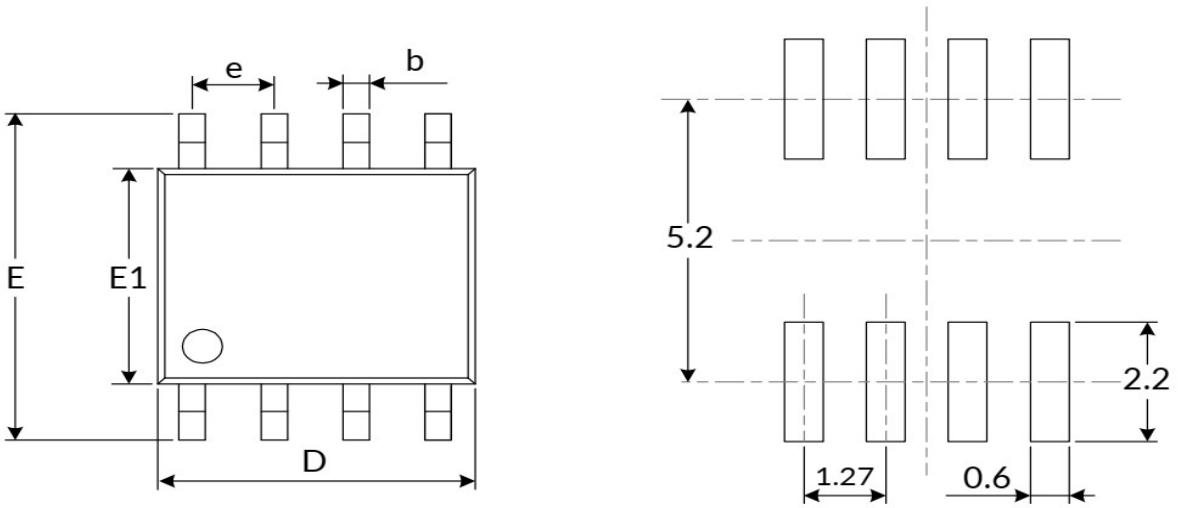
NOTE:

1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

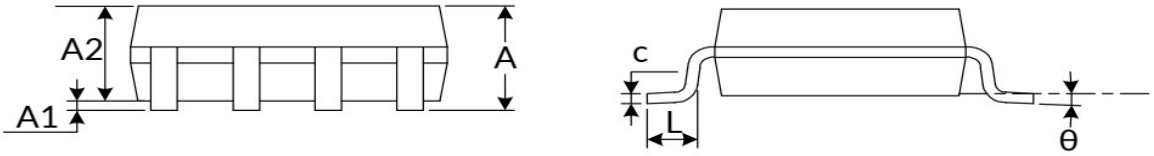
Mechanical Dimensions(Con.)

M8 PKG: SOIC-8(SOP-8)

Unit: mm (inch)



RECOMMENDED LAND PATTERN (Unit: mm)



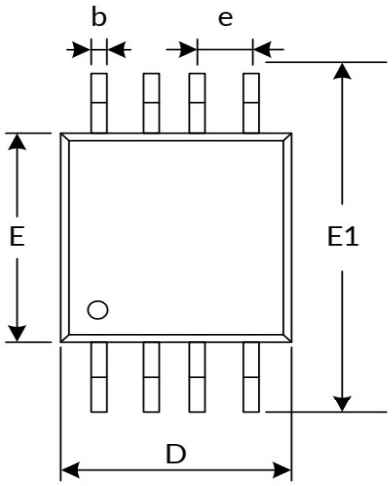
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D (1)	4.800	5.000	0.189	0.197
e	1.270(BSC) (2)		0.050(BSC) (2)	
E	5.800	6.200	0.228	0.244
E1 (1)	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

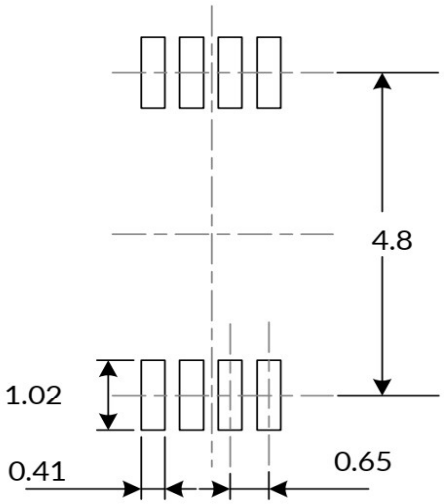
NOTE:
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

Mechanical Dimensions(Con.)

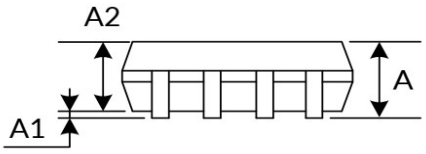
MS8 PKG: MSOP8

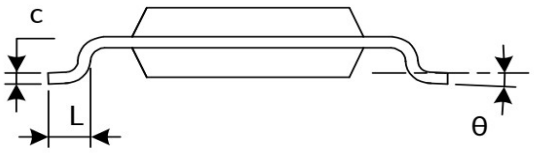
Unit: mm (inch)





RECOMMENDED LAND PATTERN (Unit: mm)





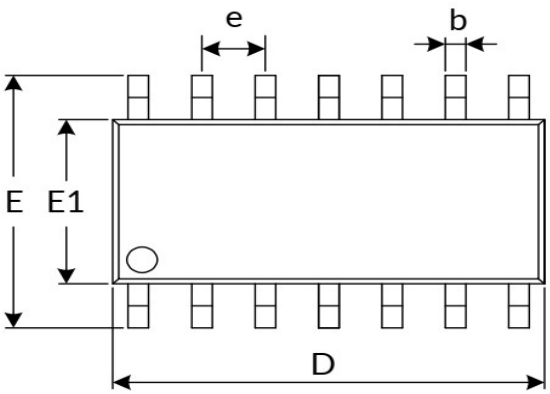
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D (1)	2.900	3.100	0.114	0.122
e	0.650(BSC) (2)		0.026(BSC) (2)	
E (1)	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

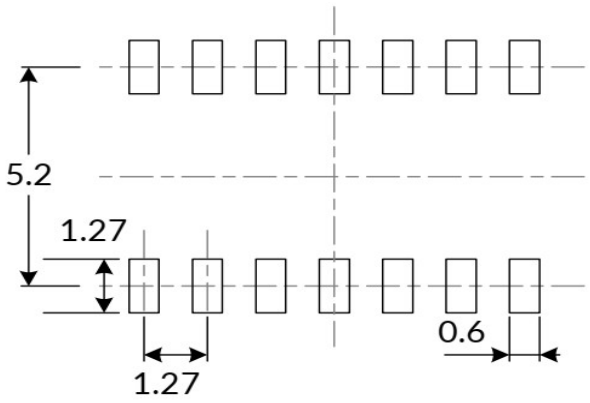
NOTE:
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

Mechanical Dimensions(Con.)

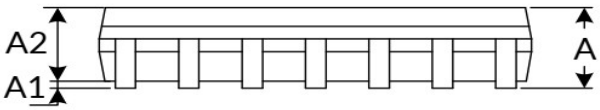
M14 PKG: SOIC-14(SOP14)

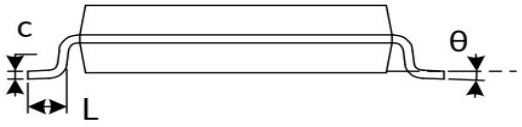
Unit: mm (inch)





RECOMMENDED LAND PATTERN (Unit: mm)





Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D (1)	8.450	8.850	0.333	0.348
e	1.270(BSC) (2)		0.050(BSC) (2)	
E	5.800	6.200	0.228	0.244
E1 (1)	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

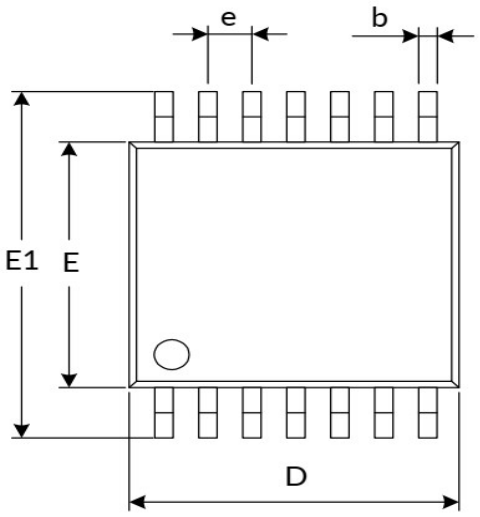
NOTE:

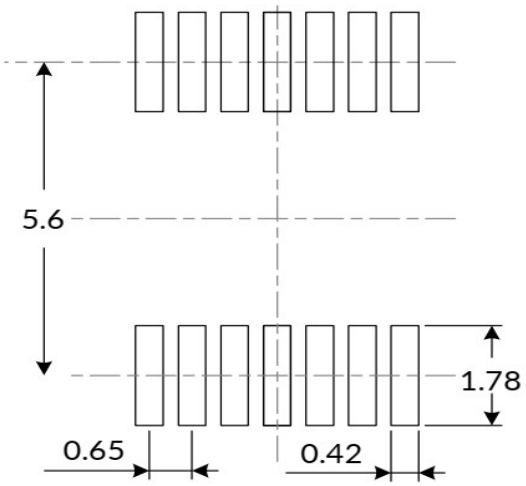
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

Mechanical Dimensions(Con.)

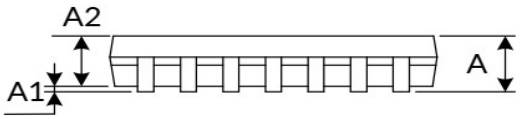
TM14 PKG: TSSOP-14

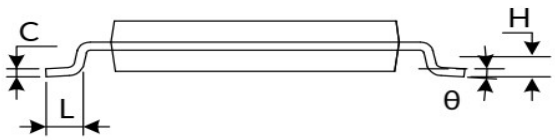
Unit: mm (inch)





RECOMMENDED LAND PATTERN (Unit: mm)





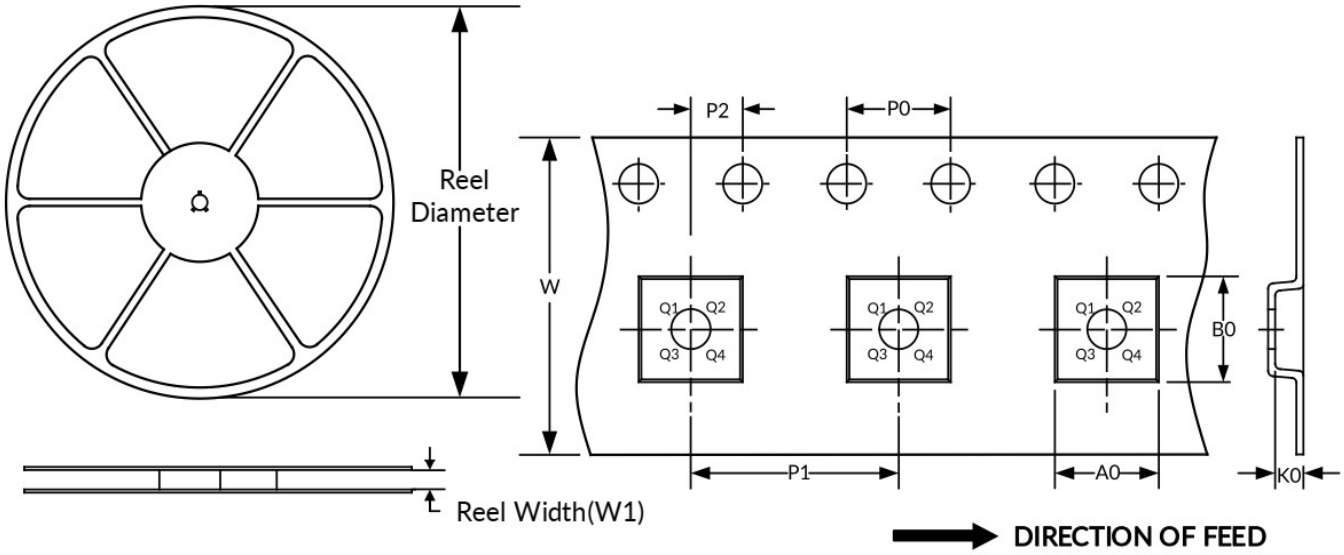
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D (1)	4.860	5.100	0.191	0.201
E (1)	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650(BSC) (2)		0.026(BSC) (2)	
L	0.500	0.700	0.020	0.028
H	0.25(TYP)		0.01(TYP)	
θ	1°	7°	1°	7°

NOTE:
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

TAPE DIMENSION



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width(mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOT23-5	7”	9.5	3.20	3.20	1.40	4.0	4.0	2.0	8.0	Q3
SOP8	13”	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1
MSOP8	13”	12.4	5.20	3.30	1.50	4.0	8.0	2.0	12.0	Q1
SOP14	13”	16.4	6.60	9.30	2.10	4.0	8.0	2.0	16.0	Q1
TSSOP14	13”	12.4	6.95	5.60	1.20	4.0	8.0	2.0	12.0	Q1

NOTE:
1. All dimensions are nominal.
2. Plastic or metal protrusions of 0.15mm maximum per side are not included.

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