



钜地半导体
Tudi Semiconductor

Product Specification

TUDI-LM339B, LM2901B,
LM339, LM239, LM139, LM2901

四路差分比较器

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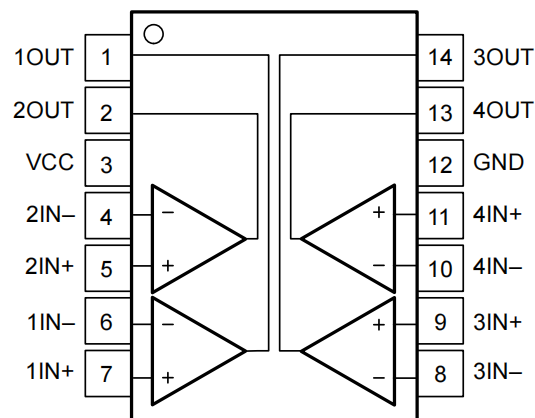
**semiconductor device
manufacturer**

- Design
- research and development
- production
- and sales



特性

- 全新 LM339B 和 LM2901B
- 改进了 B 版本的规格
 - 最大额定值：高达 38V
 - ESD 等级 (HBM)：2kV
 - 低输入失调电压：0.37mV
 - 低输入偏置电流：3.5nA
 - 低电源电流：每个比较器 200μA
 - 更短的响应时间 (1μs)
 - LM339B 的工作温度范围
- B 版本可直接取代 LM239、LM339 和 LM2901 的 A 和 V 版本
- 共模输入电压范围包括接地
- 差分输入电压范围等于最大额定电源电压：±38V
- 低输出饱和电压
- 输出与 TTL、MOS 和 CMOS 兼容
- 对于单通道版本，请参阅 TL331B
- 对于双通道版本，请参阅 LM393B 或 LM2903B



D, DB, N, NS, PW Packages
14-Pin SOIC, SSOP, PDIP, SOP, TSSOP

应用

- 扫地机器人
- 单相 UPS
- 服务器 PSU
- 无绳电动工具
- 无线基础设施
- 电器
- 楼宇自动化
- 工厂自动化与控制
- 电机驱动器
- 信息娱乐系统与仪表组

说明

LM339B 和 LM2901B 器件是业界通用 LM339 和 LM2901 比较器系列的下一代版本。下一代 B 版本比较器具有更低的失调电压、更高的电源电压能力、更低的电源电流、更低的输入偏置电流和更低的传播延迟，并通过专用 ESD 钳位提高了 2kV ESD 性能和输入耐用性。LM339B 和 LM2901B 可直接替代 LM239、LM339 和 LM2901(“A”和“V”版本)。

所有器件都包含四个独立的电压比较器，这些比较器可在宽电压范围内由单电源供电运行。静态电流不受电源电压的影响。



表 5-1. Pin Functions

PIN			I/O	DESCRIPTION
NAME ⁽¹⁾	D, DB, N, NS, PW, DYY, J	WQFN		
OUT1 ⁽¹⁾	1	16	Output	Output pin of the comparator 2
OUT2 ⁽¹⁾	2	15	Output	Output pin of the comparator 1
V _{CC}	3	1	—	Positive supply
IN2 - ⁽¹⁾	4	5	Input	Negative input pin of the comparator 1
IN2+ ⁽¹⁾	5	6	Input	Positive input pin of the comparator 1
IN1 - ⁽¹⁾	6	2	Input	Negative input pin of the comparator 2
IN1+ ⁽¹⁾	7	4	Input	Positive input pin of the comparator 2
IN3 -	8	7	Input	Negative input pin of the comparator 3
IN3+	9	8	Input	Positive input pin of the comparator 3
IN4 -	10	9	Input	Negative input pin of the comparator 4
IN4+	11	11	Input	Positive input pin of the comparator 4
GND	12	12	—	Negative supply
OUT4	13	13	Output	Output pin of the comparator 4
OUT3	14	14	Output	Output pin of the comparator 3
NC	—	3	—	No Internal Connection - Leave floating or GND
NC	—	10	—	No Internal Connection - Leave floating or GND
Thermal Pad	—	PAD	—	Connect directly to GND pin

- (1) Some manufacturers transpose the names of channels 1 & 2. Electrically the pinouts are identical, just a difference in the channel naming convention.



6 Specifications

6.1 Absolute Maximum Ratings for LM339B and LM2901B

over operating free-air temperature range (unless otherwise noted)⁽¹⁾

	MIN	MAX	UNIT
Supply voltage: $V_S = (V+) - (V-)$	-0.3	38	V
Differential input voltage: V_{ID} ⁽²⁾		±38	V
Input pins (IN+, IN -)	-0.3	38	V
Current into input pins (IN+, IN -)		-50	mA
Output pin (OUT)	-0.3	38	V
Output sink current		25	mA
Output short-circuit duration ⁽³⁾		Unlimited	s
Junction temperature, T_J		150	°C
Storage temperature, T_{stg}	-65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* can cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods can affect device reliability.
- (2) Differential voltages are at IN+ with respect to IN-.
- (3) Short circuits from outputs to V+ can cause excessive heating and eventual destruction.

6.2 Absolute Maximum Ratings for Non-B Versions

over operating free-air temperature range (unless otherwise noted)⁽¹⁾

	MIN	MAX	UNIT
V_{CC} Supply voltage ⁽²⁾		36	V
V_{ID} Differential input voltage ⁽³⁾		±36	V
V_I Input voltage range (either input)	- 0.3	36	V
I_K Input current ⁽⁵⁾		- 50	mA
V_O Output voltage		36	V
I_O Output current		20	mA
Duration of output short circuit to ground ⁽⁴⁾		Unlimited	
T_J Operating virtual-junction temperature		150	°C
Case temperature for 60s	FK package	260	°C
Lead temperature 1.6mm (1/16in) from case for 60s	J package	300	°C
T_{stg} Storage temperature	- 65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* can cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods can affect device reliability.
- (2) All voltage values, except differential voltages, are with respect to network ground.
- (3) Differential voltages are at xIN+ with respect to xIN - .
- (4) Short circuits from outputs to V_{CC} can cause excessive heating and eventual destruction.
- (5) Input current flows through parasitic diode to ground and can turn on parasitic transistors that can increase I_{CC} and can cause output to be incorrect. Normal operation resumes when the input is removed.



6.3 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	±2000	V
		Human-body model (CDM), per ANSI/ESDA/JEDEC JS-002 ⁽²⁾	±1000	

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

6.4 Recommended Operating Conditions for LM339B and LM2901B

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

	MIN	MAX	UNIT
Supply voltage: $V_S = (V+) - (V-)$	2	36	V
Ambient temperature, T_A , LM339B	- 40	85	°C
Ambient temperature, T_A , LM2901B	- 40	125	°C
Input Voltage Range, V_{IVR}	(V-) - 0.1	(V+) - 2.0	V

6.5 Recommended Operating Conditions, Non-B Versions

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

			MIN	MAX	UNIT
V _{CC}	Supply voltage	Non-V devices	2	30	V
		V devices	2	32	V
T _J	Junction temperature	LM139x	- 55	125	°C
		LM239x	- 25	85	
		LM339x	- 0	70	
		LM2901x	- 40	125	

6.6 Thermal Information

THERMAL METRIC ⁽¹⁾		All Devices						UNIT
		N (PDIP)	D (SOIC)	PW (TSSOP)	DB (SSOP)	NS (SOP)	RTE (QFN)	
		14 PINS	14 PINS	14 PINS	14 PINS	14 PINS	16 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	114.9	111.2	136.6	111.8	96.2	67.6	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	93.8	66.9	66.6	63.6	56.1	72.3	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	77.7	67.8	79.8	60.5	56.9	43.1	°C/W
ψ_{JT}	Junction-to-top characterization parameter	60.4	28.0	17.8	26.2	24.8	6.3	°C/W
ψ_{JB}	Junction-to-board characterization parameter	76.7	67.4	79.3	58.5	56.4	42.8	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	-	-	-	-	-	26.4	°C/W

- (1) For more information about traditional and new thermal metrics, see the Semiconductor and IC Package Thermal Metrics report, [SPRA953](#).



6.7 Electrical Characteristics for LM339B

$V_S = 5V$, $V_{CM} = (V -)$; $T_A = 25^\circ C$ (unless otherwise noted).

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	$V_S = 5$ to $36V$	- 3.5	± 0.37	3.5	mV
		$V_S = 5$ to $36V$, $T_A = -40^\circ C$ to $+85^\circ C$	- 5.5		5.5	
I_B	Input bias current			- 3.5	- 25	nA
		$T_A = -40^\circ C$ to $+85^\circ C$			- 50	nA
I_{OS}	Input offset current		- 25	± 0.5	25	nA
		$T_A = -40^\circ C$ to $+85^\circ C$	- 50		50	nA
V_{CM}	Common mode range ⁽¹⁾	$V_S = 3$ to $36V$	(V -)		(V+) - 1.5	V
		$V_S = 3$ to $36V$, $T_A = -40^\circ C$ to $+85^\circ C$	(V -)		(V+) - 2.0	V
A_{VD}	Large signal differential voltage amplification	$V_S = 15V$, $V_O = 1.4V$ to $11.4V$; $R_L \geq 15k$ to (V+)	50	200		V/mV
V_{OL}	Low level output Voltage {swing from (V -)}	$I_{SINK} \leq 4mA$, $V_{ID} = -1V$		110	400	mV
		$I_{SINK} \leq 4mA$, $V_{ID} = -1V$ $T_A = -40^\circ C$ to $+85^\circ C$			550	mV
I_{OH-LKG}	High-level output leakage current	(V+) = $V_O = 5V$; $V_{ID} = 1V$		0.1	50	nA
		(V+) = $V_O = 36V$; $V_{ID} = 1V$			100	nA
I_{OL}	Low level output current	$V_{OL} = 1.5V$; $V_{ID} = -1V$; $V_S = 5V$	6	21		mA
I_Q	Quiescent current (all comparators)	$V_S = 5V$, no load		0.8	1.2	mA
		$V_S = 36V$, no load, $T_A = -40^\circ C$ to $+85^\circ C$		1	1.6	mA

- (1) When the voltage at either input goes negative by more than 0.3V, the output can be incorrect and excessive input current can flow. The upper end of the common-mode voltage range is limited by $V_{CC} - 2V$. However only one input needs to be in the valid common mode range, the other input can go up the maximum V_{CC} level and the comparator provides a proper output state. Either or both inputs can go to maximum V_{CC} level without damage.



6.8 Electrical Characteristics for LM2901B

$V_S = 5V$, $V_{CM} = (V-) ; T_A = 25^{\circ}C$ (unless otherwise noted).

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	$V_S = 5$ to $36V$	- 3.5	± 0.37	3.5	mV
		$V_S = 5$ to $36V$, $T_A = -40^{\circ}C$ to $+125^{\circ}C$	- 5.5		5.5	
I_B	Input bias current		- 3.5		- 25	nA
		$T_A = -40^{\circ}C$ to $+125^{\circ}C$			- 50	nA
I_{OS}	Input offset current		- 25	± 0.5	25	nA
		$T_A = -40^{\circ}C$ to $+125^{\circ}C$	- 50		50	nA
V_{CM}	Common mode range ⁽¹⁾	$V_S = 3$ to $36V$	(V -)		(V+) - 1.5	V
		$V_S = 3$ to $36V$, $T_A = -40^{\circ}C$ to $+125^{\circ}C$	(V -)		(V+) - 2.0	V
A_{VD}	Large signal differential voltage amplification	$V_S = 15V$, $V_O = 1.4V$ to $11.4V$; $R_L \geq 15k$ to (V+)	50	200		V/mV
V_{OL}	Low level output Voltage {swing from (V -)}	$I_{SINK} \leq 4mA$, $V_{ID} = -1V$		110	400	mV
		$I_{SINK} \leq 4mA$, $V_{ID} = -1V$ $T_A = -40^{\circ}C$ to $+125^{\circ}C$			550	mV
I_{OH-LKG}	High-level output leakage current	(V+) = $V_O = 5V$; $V_{ID} = 1V$		0.1	50	nA
		(V+) = $V_O = 36V$; $V_{ID} = 1V$			100	nA
I_{OL}	Low level output current	$V_{OL} = 1.5V$; $V_{ID} = -1V$; $V_S = 5V$	6	21		mA
I_Q	Quiescent current (all comparators)	$V_S = 5V$, no load		0.8	1.2	mA
		$V_S = 36V$, no load, $T_A = -40^{\circ}C$ to $+125^{\circ}C$		1	1.6	mA

- (1) When the voltage at either input goes negative by more than 0.3V, the output can be incorrect and excessive input current can flow. The upper end of the common-mode voltage range is limited by $V_{CC} - 2V$. However only one input needs to be in the valid common mode range, the other input can go up the maximum V_{CC} level and the comparator provides a proper output state. Either or both inputs can go to maximum V_{CC} level without damage.



6.9 Electrical Characteristics for LM139 and LM139A

at specified free-air temperature, $V_{CC} = 5V$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS ⁽¹⁾		T _A ⁽²⁾	LM139			LM139A			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V _{IO} Input offset voltage	V _{CC} = 5V to 30V, V _{IC} = V _{ICR} min, V _O = 1.4V		25°C		2	5		1	2	mV
			Full range				9		4	
I _{IO} Input offset current	V _O = 1.4V		25°C		3	25		3	25	nA
			Full range				100		100	
I _{IB} Input bias current	V _O = 1.4V		25°C		- 25	- 100		- 25	- 100	nA
			Full range				- 300		- 300	
V _{ICR} Common-mode input-voltage range ⁽³⁾			25°C	V _{CC}	0 to - 1.5		V _{CC}	0 to - 1.5	V	
			Full range		0 to - 2		0 to - 2			V _{CC} - 2
A _{VD} Large-signal differential-voltage amplification	V _{CC+} = ±7.5V, V _O = - 5V to 5V		25°C		200		50	200	V/mV	
I _{OH} High-level output current	V _{ID} = 1V	V _{OH} = 5V	25°C		0.1		0.1		nA	
		V _{OH} = 30V	Full range			1		1	μ A	
V _{OL} Low-level output voltage	V _{ID} = - 1V, I _{OL} = 4mA	25°C		150	400		150	400	mV	
		Full range			700			700		
I _{OL} Low-level output current	V _{ID} = - 1V, V _{OL} = 1.5V	25°C		6	16		6	16	mA	
I _{CC} Supply current (four comparators)	V _O = 2.5V, No load	25°C		0.8	2		0.8	2	mA	

(1) All characteristics are measured with zero common-mode input voltage, unless otherwise specified.

(2) Full range (MIN to MAX) for LM139 and LM139A is $-55^{\circ}C$ to $+125^{\circ}C$. All characteristics are measured with zero common-mode input voltage, unless otherwise specified.

(3) The voltage at either input or common-mode must not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is $V_{CC+} - 1.5V$; however, one input can exceed V_{CC} , and the comparator provides a proper output state as long as the other input remains in the common-mode range. Either or both inputs can go to 30V without damage.



6.10 Electrical Characteristics for LMx39 and LMx39A

at specified free-air temperature, $V_{CC} = 5V$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS ⁽¹⁾	T_A ⁽²⁾	LM239 LM339			LM239A LM339A			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{CC} = 5V$ to $30V$, $V_{IC} = V_{ICR}$ min, $V_O = 1.4V$	$25^\circ C$		2	5		1	3	mV
		Full range			9			4	
I_{IO} Input offset current	$V_O = 1.4V$	$25^\circ C$		5	50		5	50	nA
		Full range			150			150	
I_{IB} Input bias current	$V_O = 1.4V$	$25^\circ C$		- 25	- 250		- 25	- 250	nA
		Full range			- 400			- 400	
V_{ICR} Common-mode input-voltage range ⁽³⁾		$25^\circ C$		0 to $V_{CC} - 1.5$			0 to $V_{CC} - 1.5$		V
		Full range		0 to $V_{CC} - 2$			0 to $V_{CC} - 2$		
A_{VD} Large-signal differential-voltage amplification	$V_{CC} = 15V$, $V_O = 1.4V$ to $11.4V$, $R_L \geq 15k\Omega$ to V_{CC}	$25^\circ C$		50	200		50	200	V/mV
I_{OH} High-level output current	$V_{ID} = 1V$	$V_{OH} = 5V$		0.1	50		0.1	50	nA
		$V_{OH} = 30V$			1			1	μA
V_{OL} Low-level output voltage	$V_{ID} = -1V$, $I_{OL} = 4mA$	$25^\circ C$		150	400		150	400	mV
		Full range			700			700	
I_{OL} Low-level output current	$V_{ID} = -1V$, $V_{OL} = 1.5V$	$25^\circ C$		6	16		6	16	mA
I_{CC} Supply current (four comparators)	$V_O = 2.5V$, No load	$25^\circ C$		0.8	2		0.8	2	mA

- (1) All characteristics are measured with zero common-mode input voltage, unless otherwise specified.
- (2) Full range (MIN to MAX) for LM239/LM239A is $-25^\circ C$ to $+85^\circ C$, and for LM339/LM339A is $0^\circ C$ to $70^\circ C$. All characteristics are measured with zero common-mode input voltage, unless otherwise specified.
- (3) The voltage at either input or common-mode must not be allowed to go negative by more than $0.3V$. The upper end of the common-mode voltage range is $V_{CC+} - 1.5V$; however, one input can exceed V_{CC} , and the comparator provides a proper output state as long as the other input remains in the common-mode range. Either or both inputs can go to $30V$ without damage.



6.11 Electrical Characteristics for LM2901, LM2901V and LM2901AV

at specified free-air temperature, $V_{CC} = 5V$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS ⁽¹⁾		T _A ⁽²⁾	LM2901			UNIT
					MIN	TYP	MAX	
V _{IO}	Input offset voltage	V _{IC} = V _{ICR} min, V _O = 1.4V, V _{CC} = 5V to MAX ⁽³⁾	Non-A devices	25°C	2		7	mV
				Full range	15			
			A-suffix devices	25°C	1		2	
				Full range	4			
I _{IO}	Input offset current	V _O = 1.4V		25°C	5	50	nA	
				Full range	200			
I _{IB}	Input bias current	V _O = 1.4V		25°C	- 25	- 250	nA	
				Full range	- 500			
V _{ICR}	Common-mode input-voltage range ⁽⁴⁾			25°C	V _{CC} - 1.5		V	
				Full range	V _{CC} - 2			
A _{VD}	Large-signal differential-voltage amplification	V _{CC} = 15V, V _O = 1.4V to 11.4V, R _L ≥ 15kΩ to V _{CC}		25°C	25	100	V/mV	
I _{OH}	High-level output current	V _{ID} = 1V	V _{OH} = 5V	25°C	0.1	50	nA	
			V _{OH} = V _{CC} MAX ⁽³⁾	Full range	1		μ A	
V _{OL}	Low-level output voltage	V _{ID} = - 1V, I _{OL} = 4mA	Non-V devices	25°C	150	500	mV	
			V-suffix devices		150	400		
			All devices	Full range	700			
I _{OL}	Low-level output current	V _{ID} = - 1V,	V _{OL} = 1.5V	25°C	6	16	mA	
I _{CC}	Supply current (four comparators)	V _O = 2.5V, No load	V _{CC} = 5V	25°C	0.8	2	mA	
			V _{CC} = MAX ⁽³⁾		1	2.5		

(1) All characteristics are measured with zero common-mode input voltage, unless otherwise specified.

(2) Full range (MIN to MAX) for LM2901 is - 40°C to +125°C. All characteristics are measured with zero common-mode input voltage, unless otherwise specified.

(3) $V_{CC} \text{ MAX} = 30V$ for non-V devices, and 32V for V-suffix devices

(4) The voltage at either input or common-mode must not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is $V_{CC+} - 1.5V$; however, one input can exceed V_{CC} , and the comparator provides a proper output state as long as the other input remains in the common-mode range. Either or both inputs can go to $V_{CC} \text{ MAX}$ without damage.



6.12 Switching Characteristics for LM139 and LM139A

$V_{CC} = 5V$, $T_A = 25^\circ C$

PARAMETER	TEST CONDITIONS		LM139 LM139A	UNIT
			TYP	
Response time	R_L connected to 5V through 5.1k Ω , $C_L = 15pF^{(1) (2)}$	100mV input step with 5mV overdrive	1.3	μs
		TTL-level input step	0.3	

(1) C_L includes probe and jig capacitance.

(2) The response time specified is the interval between the input step function and the instant when the output crosses 1.4V.

6.13 Switching Characteristics for LM339B and LM2901B

$V_S = 5V$, $V_{O_PULLUP} = 5V$, $V_{CM} = V_S/2$, $C_L = 15pF$, $R_L = 5.1k\Omega$, $T_A = 25^\circ C$ (unless otherwise noted).

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{response}$	Propagation delay time, high-to-low; Small scale input signal ⁽¹⁾	Input overdrive = 5mV, Input step = 100mV		1000		ns
$t_{response}$	Propagation delay time, high-to-low; TTL input signal ⁽¹⁾	TTL input with $V_{ref} = 1.4V$		300		ns

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

6.14 Switching Characteristics for LMx39 and LMx39A

$V_{CC} = 5V$, $T_A = 25^\circ C$

PARAMETER	TEST CONDITIONS		LM239 LM239A LM339 LM339A	UNIT
			TYP	
Response time	R_L connected to 5V through 5.1k Ω , $C_L = 15pF^{(1) (2)}$	100mV input step with 5mV overdrive	1.3	μs
		TTL-level input step	0.3	

(1) C_L includes probe and jig capacitance.

(2) The response time specified is the interval between the input step function and the instant when the output crosses 1.4V.

6.15 Switching Characteristics for LM2901

$V_{CC} = 5V$, $T_A = 25^\circ C$

PARAMETER	TEST CONDITIONS		LM2901	UNIT
			TYP	
Response time	R_L connected to 5V through 5.1k Ω , $C_L = 15pF^{(1) (2)}$	100mV input step with 5mV overdrive	1.3	μs
		TTL-level input step	0.3	

(1) C_L includes probe and jig capacitance.

(2) The response time specified is the interval between the input step function and the instant when the output crosses 1.4V.



7 Detailed Description

7.1 Overview

These dual comparators have the ability to operate up to absolute maximum of 36V (38V for the "B" version) on the supply pin. This device has proven ubiquity and versatility across a wide range of applications. This is due to very wide supply voltages range, low I_q and fast response of the devices.

The open-collector outputs allow the user to level shift to the desired logic level independent of V_{CC} , while also enabling AND functionality when multiple outputs are connected together.

7.2 Functional Block Diagram

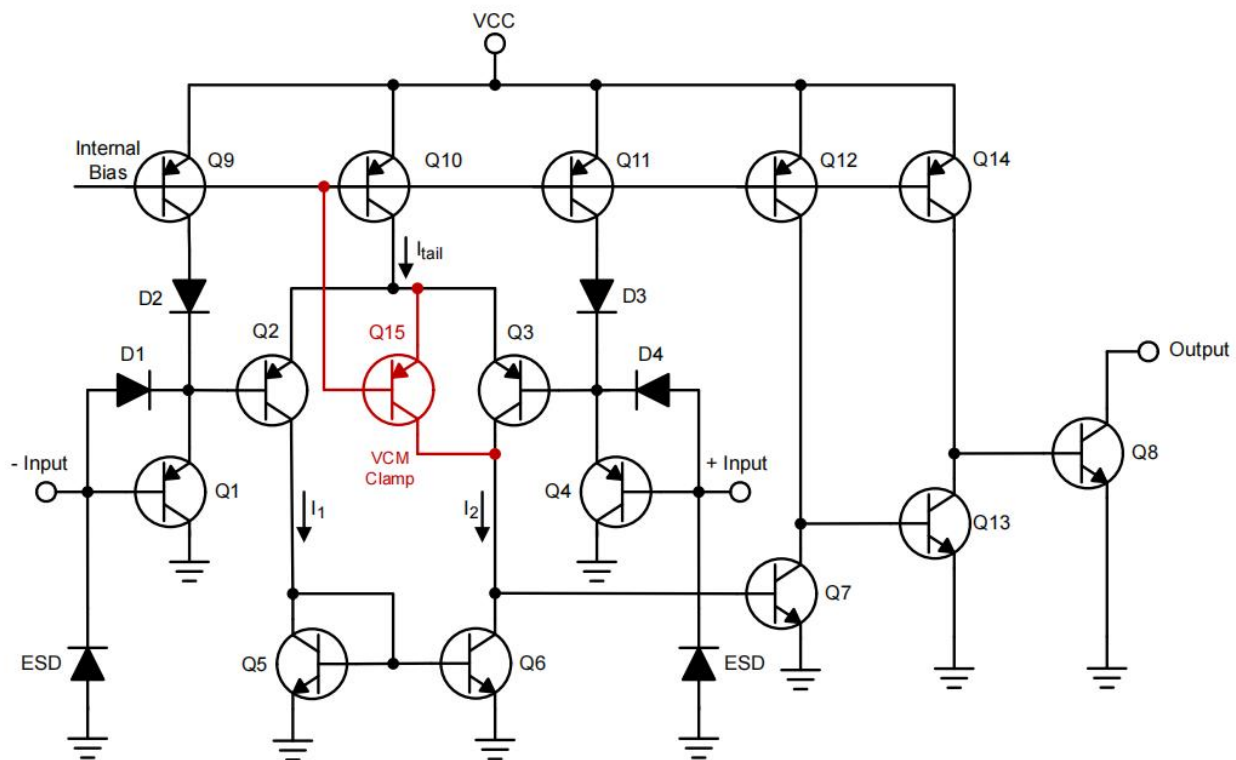


图 7-1. Schematic (Each Comparator)

7.3 Feature Description

The comparator consists of a PNP Darlington pair input, allowing the device to operate with very high gain and fast response with minimal input bias current. The input Darlington pair creates a limit on the input common mode voltage capability, allowing the comparator to accurately function from ground to $V_{CC} - 2V$ over temperature. A clamp is added around Q3 to mimic the both inputs above input voltage range behavior of the original classic silicon.

The output consists of an open drain NPN (pull-down or low side) transistor. The output NPN sinks current when the negative input voltage is higher than the positive input voltage and the offset voltage. The V_{OL} is resistive and scales with the output current. Please see the "Output Low Voltage vs. Output Sinking Current" graphs for V_{OL} values with respect to the output current.

7.4 Device Functional Modes

7.4.1 Voltage Comparison

The comparator operates solely as a voltage comparator, comparing the differential voltage between the positive and negative pins and outputting a logic low or high impedance (logic high with pullup) based on the input differential polarity.



8.1 Application Information

Typically, a comparator compares either a single signal to a reference, or to two different signals. Many users take advantage of the open-drain output to drive the comparison logic output to a logic voltage level to an MCU or logic device. The wide supply range and high voltage capability makes LMx39 or LM2901x an excellent choice for level shifting to a higher or lower voltage.

8.2 Typical Application

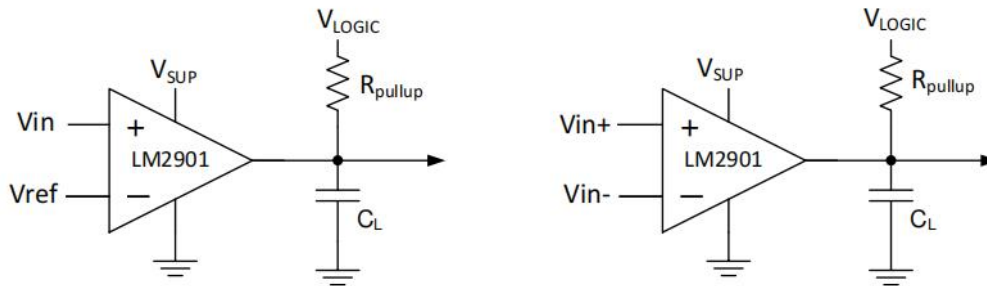


图 8-1. Single-ended and Differential Comparator Configurations

8.2.1 Design Requirements

For this design example, use the parameters listed in 表 8-1 as the input parameters.

表 8-1. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
Input Voltage Range	0V to $V_{sup}-2V$
Supply Voltage	4.5V to V_{CC} maximum
Logic Supply Voltage	0V to V_{CC} maximum
Output Current (R_{PULLUP})	1 μ A to 4mA
Input Overdrive Voltage	100mV
Reference Voltage	2.5V
Load Capacitance (C_L)	15pF

8.2.2 Detailed Design Procedure

When using the LMx39 in a general comparator application, determine the following:

- Input voltage range
- Minimum overdrive voltage
- Output and drive current
- Response time

8.2.2.1 Input Voltage Range

When choosing the input voltage range, the input common mode voltage range (V_{ICR}) must be taken in to account. If temperature operation is below 25°C the V_{ICR} can range from 0V to $V_{CC} - 2.0V$. This limits the input voltage range to as high as $V_{CC} - 2.0V$ and as low as 0V. Operation outside of this range can yield incorrect comparisons.



The following is a list of input voltage situation and the outcomes:

1. When both IN- and IN+ are both within the common-mode range:
 - a. If IN- is higher than IN+ and the offset voltage, the output is low and the output transistor is sinking current
 - b. If IN- is lower than IN+ and the offset voltage, the output is high impedance and the output transistor is not conducting
2. When IN- is higher than common-mode and IN+ is within common-mode, the output is low and the output transistor is sinking current
3. When IN+ is higher than common-mode and IN- is within common-mode, the output is high impedance and the output transistor is not conducting
4. When IN- and IN+ are both higher than common-mode, see Section 2 of [Application Design Guidelines for LM339, LM393, TL331 Family Comparators Including the New B-versions](#).

8.2.2.2 Minimum Overdrive Voltage

Overdrive voltage is the differential voltage produced between the positive and negative inputs of the comparator over the offset voltage (V_{IO}). To make an accurate comparison, the overdrive voltage (V_{OD}) must be higher than the input offset voltage (V_{IO}). Overdrive voltage can also determine the response time of the comparator, with the response time decreasing with increasing overdrive.

8.2.2.3 Output and Drive Current

Output current is determined by the load and pullup resistance and logic and pullup voltage. The output current produces a low-level output voltage (V_{OL}) from the comparator, where V_{OL} is proportional to the output current.

The output current can also effect the transient response.

8.2.2.4 Response Time

Response time is a function of input over-drive. See the [Typical Characteristics](#) graphs for typical response times. The rise and fall times can be determined by the load capacitance (C_L), load/pull-up resistance (R_{PULLUP}) and equivalent collector-emitter resistance (R_{CE}).

- The rise time (τ_R) is approximately $\tau_R = R_{PULLUP} \times C_L$
- The fall time (τ_F) is approximately $\tau_F = R_{CE} \times C_L$
 - R_{CE} can be determined by taking the slope of [图 6-31](#) in the linear region at the desired temperature, or by dividing the V_{OL} by I_{OUT}



8.3 Power Supply Recommendations

For fast response and comparison applications with noisy or AC inputs, use a bypass capacitor on the supply pin to reject any variation on the supply voltage. This variation can affect the common-mode range of the comparator input and create an inaccurate comparison.

8.4 Layout

8.4.1 Layout Guidelines

For accurate comparator applications without hysteresis maintaining a stable power supply with minimized noise and glitches is critical. Best practice is to add a bypass capacitor between the supply voltage and ground. This can 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 GND pin and system ground.

Minimize coupling between outputs and inverting inputs to prevent output oscillations. Do not run output and inverting input traces in parallel unless there is a V_{CC} or GND trace between output and inverting input traces to reduce coupling. When series resistance is added to inputs, place resistor close to the device.

8.4.2 Layout Example

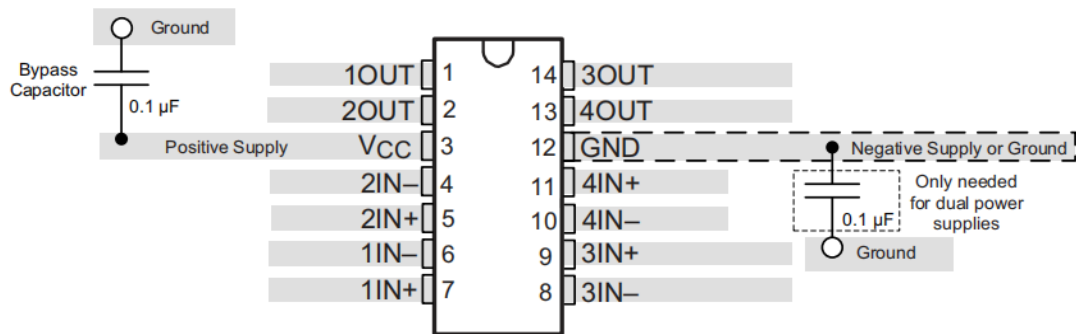


图 8-4. LMx39 Layout Example

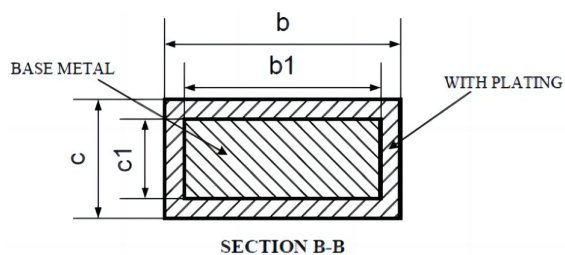
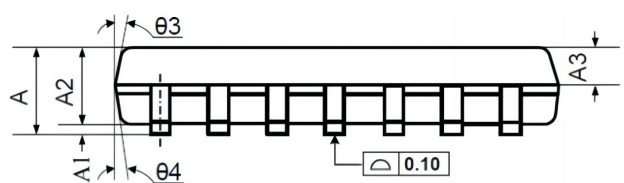
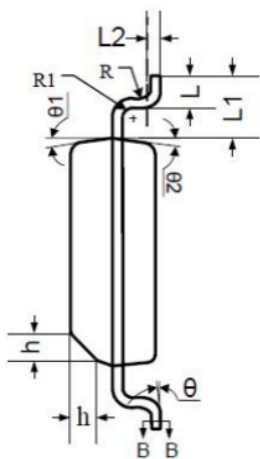
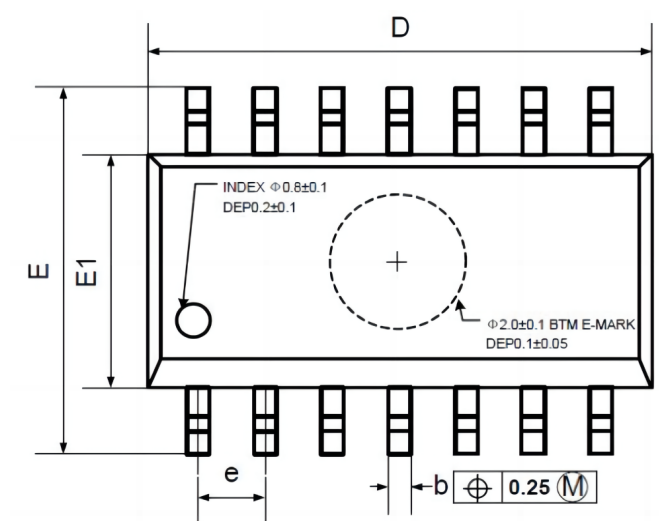


ORDERING INFORMATION

Order Number	Package	Package Quantity	Marking On The park	Temperature
LM139ADR	SOP14	Tape,Reel,2500	LM139A	-55°C to 125°C
LM139DR	SOP14	Tape,Reel,2500	LM139	
LM239ADR	SOP14	Tape,Reel,2500	LM239A	-25°C to 85°C
LM239DR	SOP14	Tape,Reel,2500	LM239	
LM239N	DIP14	Tube,25,A box of 1000	LM239N	
LM239PWR	TSSOP14	Tape,Reel,2500	L239	
LM2901AVQDR	SOP14	Tape,Reel,2500	(2901AV,L2901AV)	-40°C to 125°C
LM2901AVQPWR	TSSOP14	Tape,Reel,2500	(2901AV,L2901AV)	
LM2901BIDR	SOP14	Tape,Reel,2500	LM2901B	
LM2901BIPWR	TSSOP14	Tape,Reel,2500	LM2901B	
LM2901DR	SOP14	Tape,Reel,2500	LM2901	
LM2901N	DIP14	Tube,25,A box of 1000	LM2901N	
LM2901NSR	SOP14	Tape,Reel,2500	LM2901	
LM2901PWR	TSSOP14	Tape,Reel,2500	L2901	
LM2901VQDR	SOP14	Tape,Reel,2500	L2901V	
LM2901VQPWR	TSSOP14	Tape,Reel,2500	L2901V	
LM339ADBR	TSSOP14	Tape,Reel,2500	L339A	0°C to 70°C
LM339ADR	SOP14	Tape,Reel,2500	LM339A	
LM339AN	DIP14	Tube,25,A box of 1000	LM339AN	
LM339ANSR	SOP14	Tape,Reel,2500	LM339A	
LM339APWR	TSSOP14	Tape,Reel,2500	L339A	
LM339BIDR	SOP14	Tape,Reel,2500	LM339B	-40°C to 85°C
LM339BIPWR	TSSOP14	Tape,Reel,2500	LM339B	
LM339DR	SOP14	Tape,Reel,2500	LM339	0°C to 70°C
LM339N	DIP14	Tube,25,A box of 1000	LM339N	
LM339NSR	SOP14	Tape,Reel,2500	LM339	
LM339PWR	TSSOP14	Tape,Reel,2500	L339	

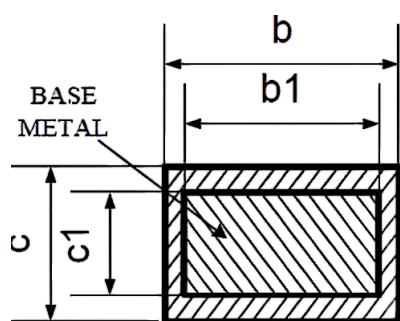
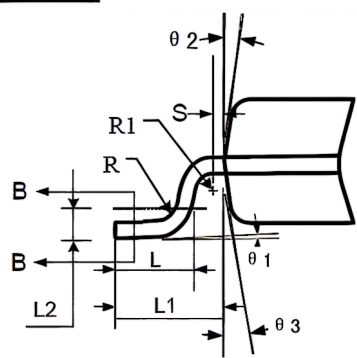
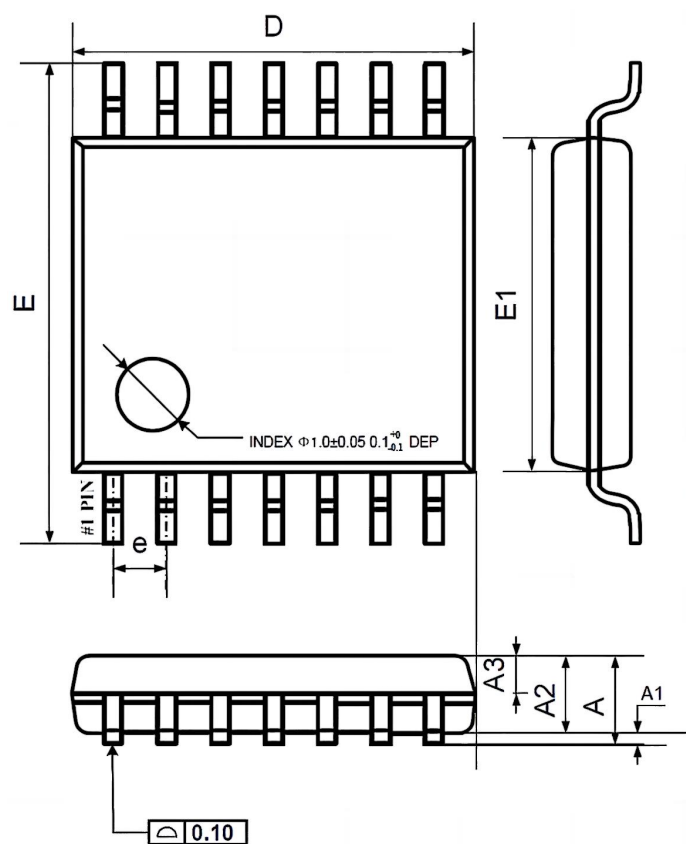


Package SOP14



Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	1.35	1.60	1.75
A1	0.10	0.15	0.25
A2	1.25	1.45	1.65
A3	0.55	0.65	0.75
b	0.36		0.49
b1	0.35	0.40	0.45
C	0.16		0.25
c1	0.15	0.20	0.25
D	8.53	8.63	8.73
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27 BSC		
L	0.45	0.60	0.80
L1	1.04 REF		
L2	0.25 BSC		
R	0.07		
R1	0.07		
h	0.30	0.40	0.50
θ	0°		8°
$\theta 1$	6°	8°	10°
$\theta 2$	6°	8°	10°
$\theta 3$	5°	7°	9°
$\theta 4$	5°	7°	9°

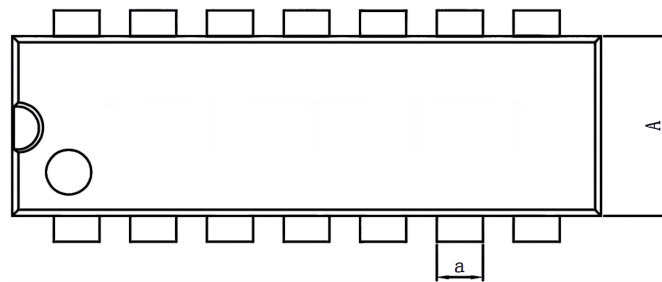
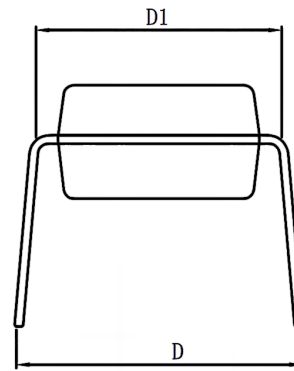
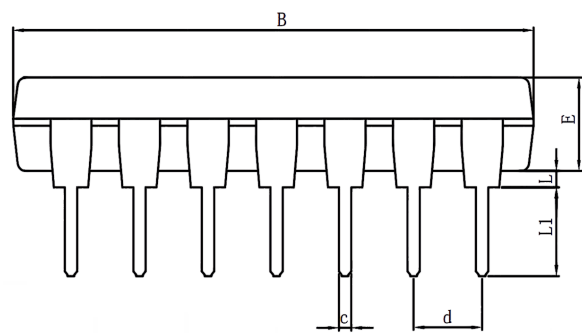
Package TSSOP14



Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	—	—	1.20
A1	0.05	—	0.15
A2	0.90	1.00	1.05
A3	0.34	0.44	0.54
b	0.20	—	0.28
b1	0.20	0.22	0.24
C	0.10	—	0.19
c1	0.10	0.13	0.15
D	4.86	4.96	5.06
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	0.65 BSC		
L	0.45	0.60	0.75
L1	1.00 REF		
L2	0.25 BSC		
R	0.09	—	—
R1	0.09	—	—
S	0.20	—	—
θ1	0°	—	8°
θ2	10°	12°	14°
θ3	10°	12°	14°



Package DIP14



DIM.	MIN	TYP	MAX	DIM.	MIN	TYP	MAX
A	6.100	6.300	6.680	a	1.504	1.524	1.544
B	18.940	19.200	19.560	C	0.437	0.457	0.477
D	8.200	8.700	9.200	d	2.530	2.540	2.550
D1	7.42	7.62	7.82	L	0.500	—	0.800
E	3.100	3.300	3.550	L1	3.000	3.200	3.600



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