TC54

Voltage Detector

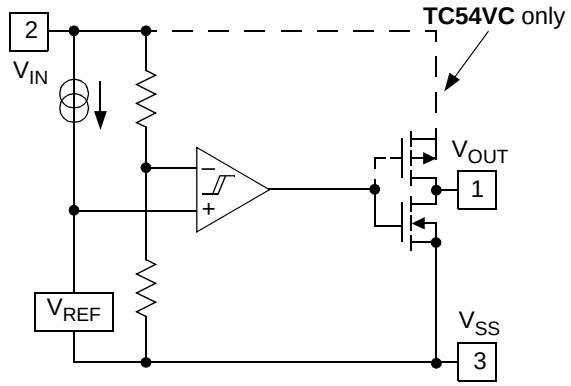
Features

- Precise Detection Thresholds: Standard ±2.0%, Custom ±1.0%
- Small Packages: 3-Pin SOT-23A, 3-Pin SOT-89, TO-92 and 5-Pin SOT-23A (7.7V only)
- Low Current Drain: Typ. 1 µA
- Wide Detection Range: 1.1V to 6.0V and 7.7V
- Wide Operating Voltage Range: 0.7V to 10V

Applications

- Battery Voltage Monitoring
- Microprocessor Reset
- System Brown-Out Protection
- Switching Circuit in Battery Backup
- Level Discriminator

Functional Block Diagram



TC54VN has open-drain output.
TC54VC has complementary output.

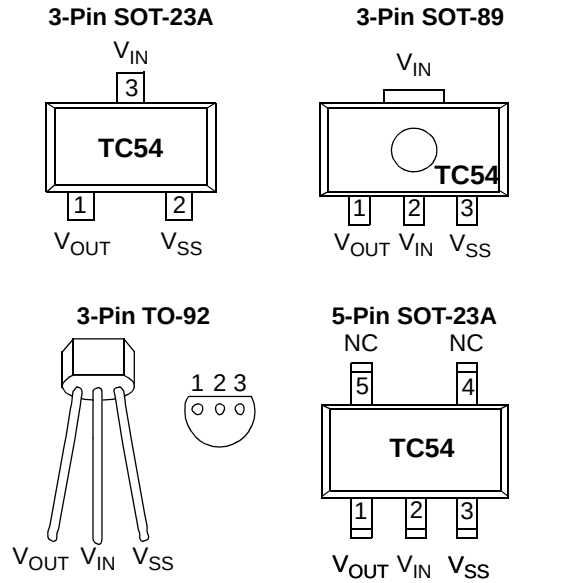
General Description

The TC54 series are CMOS voltage detectors that are especially well suited for battery-powered applications because of their extremely low 1 µA operating current and small surface-mount packaging. Each part is laser-trimmed to the desired threshold voltage, which can be specified from 1.4V to 7.7V for a 2% tolerance and from 1.5V to 6.0V for a 1% tolerance.

The device includes a comparator, low-current high-precision reference, laser-trimmed divider, hysteresis circuit and output driver. The TC54 is available with either an open-drain or complementary output stage.

During operation, the TC54's output (V_{OUT}) remains in the logic-high state as long as V_{IN} is greater than the specified threshold voltage (V_{DET}–). When V_{IN} falls below V_{DET}–, the output is driven to a logic-low. V_{OUT} remains low until V_{IN} rises above V_{DET}– by an amount V_{HYST}, whereupon it resets to a logic-high.

Package Types



Note: 3-Pin SOT-23A is equivalent to the EIAJ SC-59
5-Pin SOT-23A is equivalent to the EIAJ SC-74A. (7.7V ONLY)

1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Input Voltage .....+12V

Output Current .....50 mA

Output Voltage: CMOS.....(V_{SS} – 0.3V) to (V_{IN} + 0.3V)
Open-Drain.....(V_{SS} – 0.3V) to 12V

Power Dissipation ($T_A \leq 70°C$):
3-Pin SOT-23A .....240 mW
3-Pin SOT-89.....500 mW
5-Pin SOT-23A .....240 mW
3-Pin TO-92.....300 mW

Operating Temperature Range.....-40°C to +85°C

Storage Temperature Range.....-65°C to +150°C

† Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operation sections of the specifications is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

PIN FUNCTION TABLE

Symbol	Description
V_{OUT}	Digital Output
V_{IN}	Analog Input
V_{SS}	Ground Terminal
NC	No Connect
NC	No Connect

DC CHARACTERISTICS

Electrical Specifications: Unless otherwise noted, T_A = +25°C.

Parameter	Sym	Min	Typ	Max	Units	Test Conditions
Operating Voltage	V_{IN}	0.7	—	10.0	V	(V_{DET} –) = 0.8 to 6.0V
Quiescent Current	I_{SS}	—	0.8	2.7	µA	V_{IN} = 2.0V
		—	0.9	3.0		V_{IN} = 3.0V
		—	1.0	3.2		V_{IN} = 4.0V
		—	1.1	3.6		V_{IN} = 5.0V
Threshold Voltage **(Note 1)**	V_{DET} –	1.37	1.4	1.43	V	**TC54VX14**
		2.06	2.1	2.14		**TC54VX21**
		2.65	2.7	2.75		**TC54VX27**
		2.84	2.9	2.96		**TC54VX29**
		2.94	3.0	3.06		**TC54VX30**
		4.12	4.2	4.28		**TC54VX42**
		4.21	4.3	4.39		**TC54VX43**
		7.54	7.7	7.86		**TC54VX77 (5-pin SOT-23A only)**
Hysteresis Voltage	V_{HYST}	28	70	112	mV	V_{DET} = 1.4V (typ)
		42	105	168		V_{DET} = 2.1V (typ)
		54	135	216		V_{DET} = 2.7V (typ)
		58	145	232		V_{DET} = 2.9V (typ)
		60	150	240		V_{DET} = 3.0V (typ)
		84	210	336		V_{DET} = 4.2V (typ)
		86	215	344		V_{DET} = 4.3V (typ)
		154	385	616		V_{DET} = 7.7V (typ)
Output Current	I_{OUT}	—	7.7	—	mA	V_{OL} = 0.5V, V_{IN} = 2.1V
		—	10.1	—		V_{IN} = 3.0V
		—	11.5	—		V_{IN} = 4.0V
		—	13.0	—		V_{IN} = 5.0V
		—	-10.0	—		**TC54VC Only:** $V_{OH} = V_{IN} – 2.1V$, V_{IN} = 8.0V
Tempco of (V_{DET}–)	T_C (V_{DET} –)	—	±100	—	ppm/°C	-40°C ≤ T_A ≤ 85°C
Delay Time	t_{DLY}	—	—	0.2	ms	V_{DET} – → V_{OUT} inversion

Note 1: For other voltage options, please contact your regional Microchip sales office.

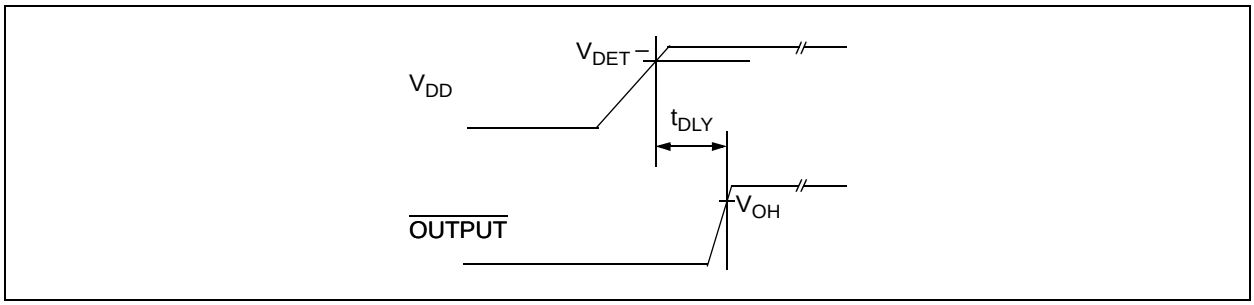


FIGURE 1-1: *Timing Diagram.*

2.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 2-1.

TABLE 2-1: PIN FUNCTION TABLE

Pin No. (3-Pin SOT-23A)	Pin No. (3-Pin SOT-89) (3-Pin TO-92)	Pin No. (5-Pin SOT-23A)	Symbol	Description
1	1	1	V_{OUT}	Digital Output
3	2	2	V_{IN}	Analog Input
2	3	3	V_{SS}	Ground Terminal
—	—	4	NC	No Connect
—	—	5	NC	No Connect

2.1 Digital Output (V_{OUT})

V_{OUT} goes low when V_{IN} drops below $V_{DET}-$ and returns high when V_{IN} rises above $V_{DET}- + V_{HYST}$. (See Figure 3-1).

2.2 Analog Input (V_{IN})

V_{IN} can be used for power supply monitoring or a voltage level that requires monitoring.

2.3 Ground Terminal (V_{SS})

V_{SS} provides the negative reference for the analog input voltage. Typically, the circuit ground is used.

2.4 No Connect (NC)

No internal connection.

3.0 DETAILED DESCRIPTION

In normal steady-state operation when $V_{IN} > V_{DET}-$, the output will be at a logic-high (see Figure 3-1). In the case of the TC54VN, this is an open-drain condition. If the input falls below $V_{DET}-$, the output will pull down (Logic 0) to V_{SS}. Generally, V_{OUT} can pull down to within 0.5V of V_{SS} at rated output current and input voltage. (See **Section 1.0 "Electrical Characteristics"**).

The output (V_{OUT}) will stay valid until the input voltage falls below the minimum operating voltage (V_{INMIN}) of 0.7V. Below this minimum operating voltage the output is undefined. During power-up (or anytime V_{IN} has fallen below V_{INMIN}), V_{OUT} will remain undefined until V_{IN} rises above V_{INMIN}. Once this occurs, the output will become valid. V_{OUT} will be in its active-low state, while $V_{INMIN} < V_{IN} < V_{DET}+$ (therefore, $V_{DET}+ = V_{DET}- + V_{HYST}$). If the input rises above $V_{DET}+$, the output will assume its inactive state (high for TC54VC, open-drain for TC54VN).

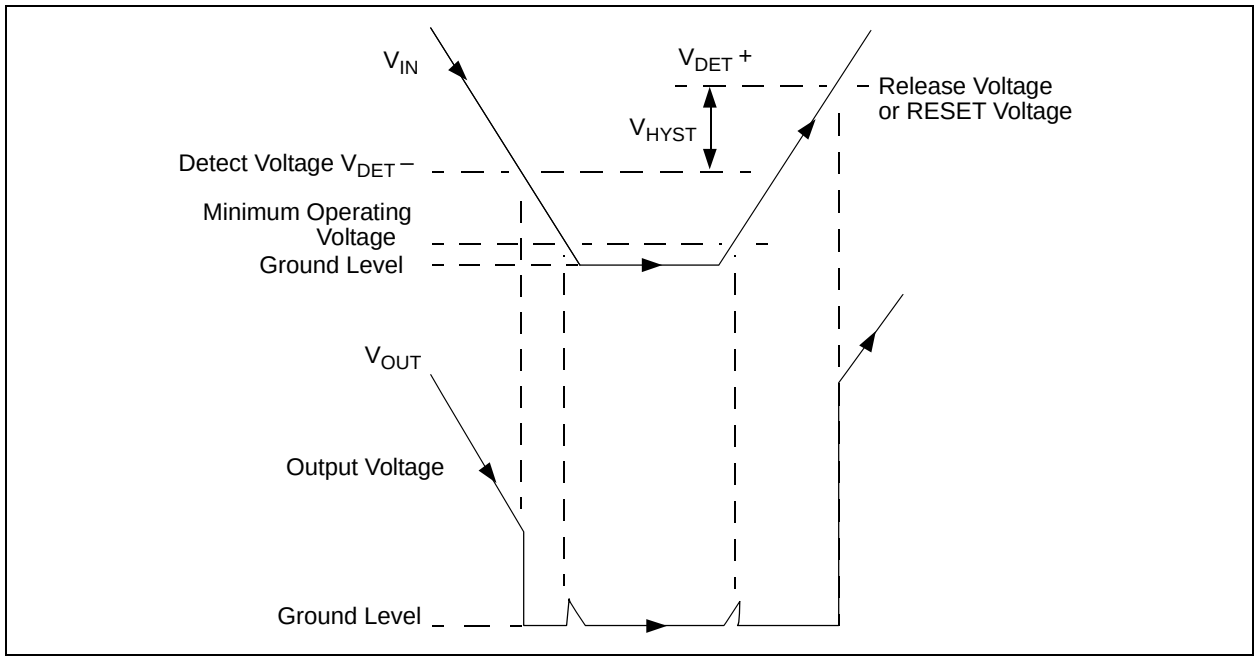


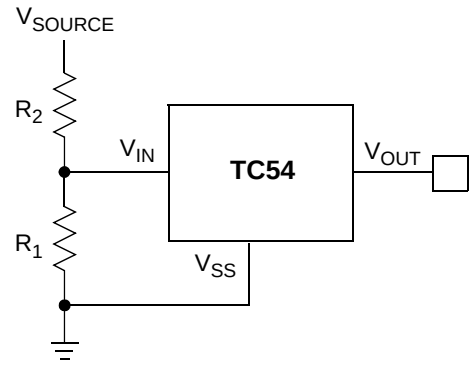
FIGURE 3-1: *Timing Diagram.*

4.0 APPLICATIONS INFORMATION

4.1 Modifying The Trip Point, V_{DET} –

Although the TC54 has a pre-programmed V_{DET} –, it is sometimes necessary to make adjustments during prototyping. This can be accomplished by connecting an external resistor divider to a TC54, which has a V_{DET} – lower than that of V_{SOURCE} (Figure 4-1).

To maintain detector accuracy, the bleeder current through the divider should be significantly higher than the 1 µA operating current required by the TC54. A reasonable value for this bleeder current is 100 µA (100 times the 1 µA required by the TC54). For example, if V_{DET} – = 2V and the desired trip point is 2.5V, the value of $R_1 + R_2$ is 25 kΩ (2.5V/100 µA). The value of $R_1 + R_2$ can be rounded to the nearest standard value and plugged into the equation of Figure 4-1 to calculate values for R_1 and R_2. 1% tolerance resistors are recommended.



$$V_{SOURCE} = \frac{R_1}{R_1 + R_2} = V_{DET}$$

Where:

V_{SOURCE} = Voltage to be monitored

(V_{DET} –) = Threshold Voltage setting of TC54

Note: In this example, V_{SOURCE} must be greater than (V_{DET} –)

FIGURE 4-1: *Modify trip-point of the TC54 using external resistor divider.*

4.2 Other Applications

Low operating power and small physical size make the TC54 series ideal for many voltage detector applications, such as those shown in Figures 4-2, 4-3 and 4-4. Figure 4-2 shows a low-voltage gate drive protection circuit that prevents overheating of the logic-level MOSFET due to insufficient gate voltage. When the input signal is below the threshold of the TC54VN, its output grounds the gate of the MOSFET. Figure 4-3 and Figure 4-4 show the TC54 in conventional voltage monitoring applications.

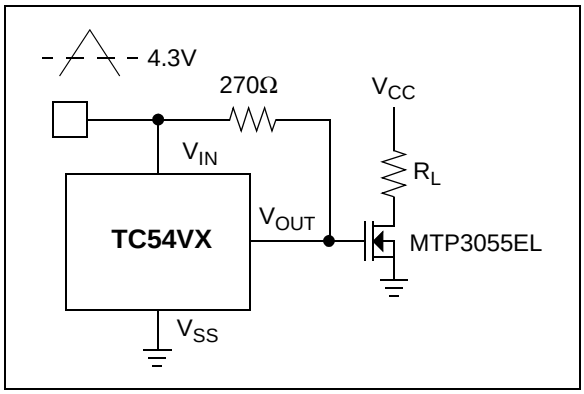


FIGURE 4-2: *MOSFET Low Drive Protection.*

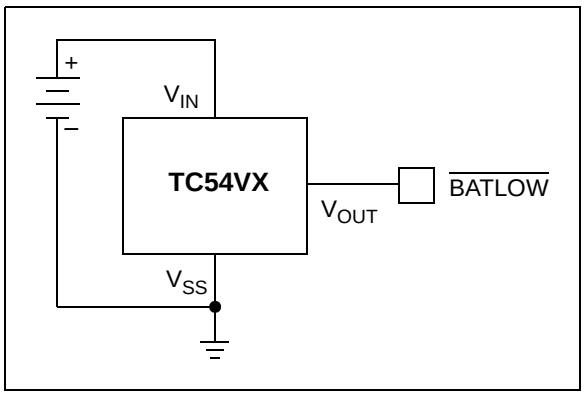


FIGURE 4-3: *Battery Voltage Monitor.*

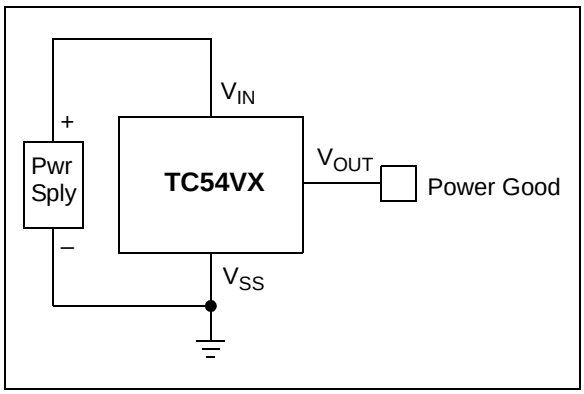
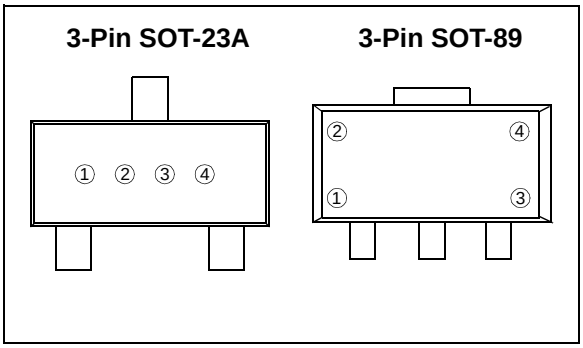


FIGURE 4-4: *Power Good Monitor.*

5.0 PACKAGING INFORMATION

5.1 Package Marking Information



① represents output configuration (CMOS or Nch) and first integer of voltage

Ex: CMOS 3.x = Ⓓ ◯ ◯ ◯

Symbol	Output	Voltage
B	CMOS	1.
C	CMOS	2.
D	CMOS	3.
E	CMOS	4.
F	CMOS	5.
H	CMOS	6.
I	CMOS	7.

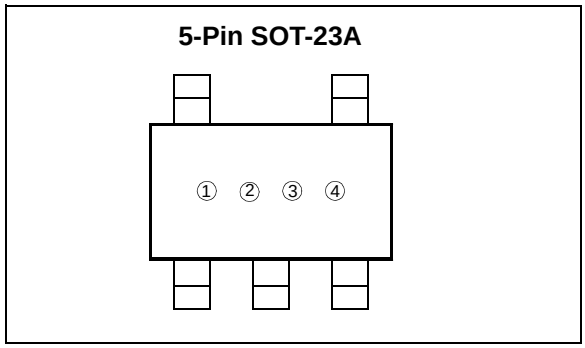
Symbol	Output	Voltage
L	Nch	1.
M	Nch	2.
N	Nch	3.
P	Nch	4.
R	Nch	5.
S	Nch	6.
T	Nch	7.

② represents first decimal of output voltage (0-9)

Ex: CMOS 3.x = Ⓓ ④ ◯ ◯

Symbol	Voltage	Symbol	Voltage
0	.0	6	.6
1	.1	7	.7
2	.2	8	.8
3	.3	9	.9
4	.4		
5	.5		

③ & ④ represents assembly lot code



① represents output configuration and first integer of voltage

Symbol	Output	Voltage
T	Nch	7.

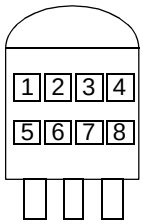
② represents first decimal of output voltage

Symbol	Voltage
0	.0
1	.1
2	.2
3	.3
4	.4
5	.5
6	.6
7	.7
8	.8
9	.9

③ & ④ represents assembly lot code

Package Marking Information (Continued)

3-Pin TO-92



①, ②, & ③ = 54X (fixed)

④ represents output configuration (CMOS or Nch)
Ex: CMOS 3.x = Ⓒ ◯ ◯ ◯

Symbol	Output
C	CMOS
N	N-Channel

⑤ represents first integer of detect voltage

Symbol	Voltage
2	2.
3	3.
4	4.
5	5.
6	6.

⑥ represents first decimal of detect voltage

Symbol	Voltage	Symbol	Voltage
0	.0	5	.5
1	.1	6	.6
2	.2	7	.7
3	.3	8	.8
4	.4	9	.9

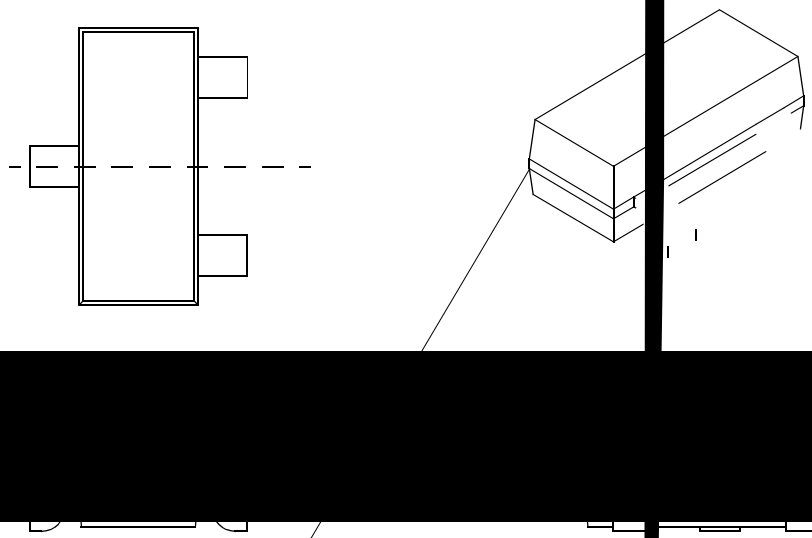
⑦ represents the output Delay Time

Symbol	Delay Time
0	No Delay

⑧ respresents the device accuracy

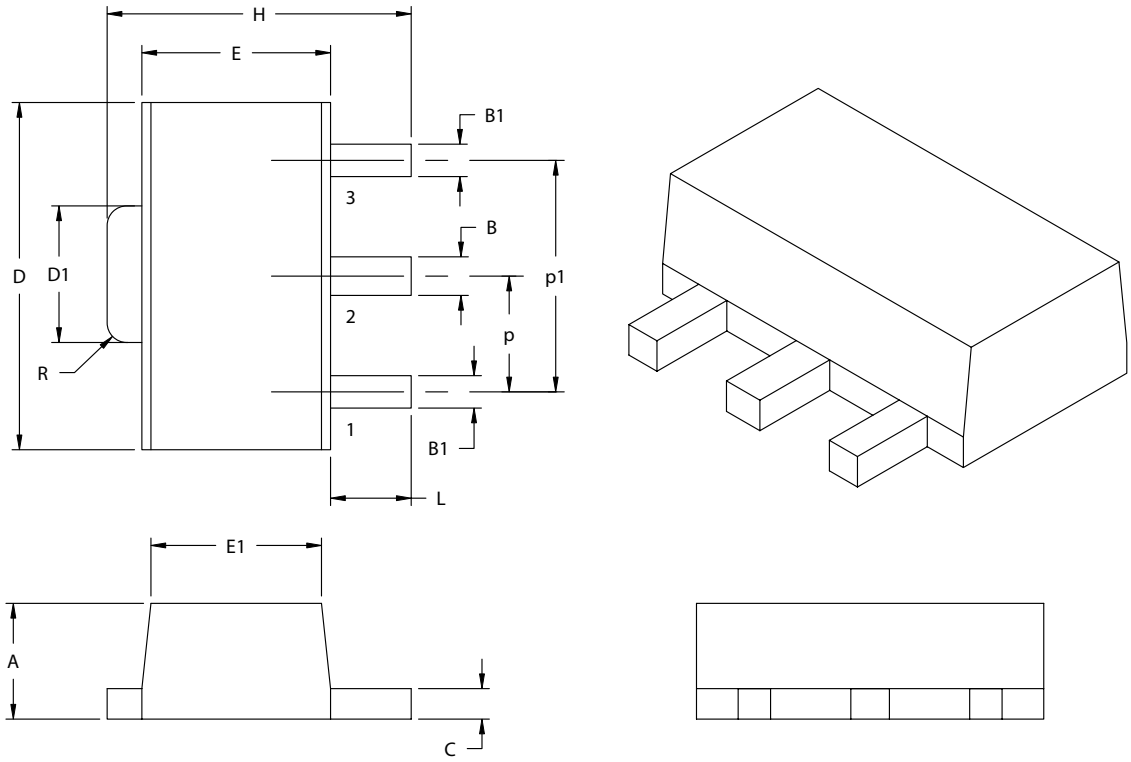
Symbol	Accuracy
1	±1.0% (custom)
2	±2.0% (standard)

3-Lead Plastic Small Outline Transistor (CB) (SOT23A)



Dimension Limits		INCHES			MILLIMETERS*		
		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		3			3	
Pitch	p		.037			0.95	
Outside lead pitch (basic)	p1		.075			1.90	
Overall Height	A	.035		.055	0.90	–	1
Molded Package Thickness	A2	.035	–	.051	0.90	–	
Standoff	A1	.000	–	.004	0.00	–	
Overall Width	E	.098	–	.118	2.50	–	
Molded Package Width	E1	.055	–	.071	1.40	–	
Overall Length	D	.106	–	.122	2.70	–	
Foot Length	L	.014	–	.022	0.35	–	
Foot Angle	ϕ					–	
Lead Thickness	c	.004	–	.014	0.10	–	
Lead Width	B	.012	–	.019	0.30	–	

3-Lead Plastic Small Outline Transistor (MB) (SOT89)



Units		INCHES		MILLIMETERS*	
Dimension Limits		MIN	MAX	MIN	MAX
Pitch	p	.059 BSC		1.50 BSC	
Outside lead pitch (basic)	p1	.118 BSC		3.00 BSC	
Overall Height	A	.055	.063	1.40	1.60
Overall Width	H	.155	.167	3.94	4.25
Molded Package Width at Base	E	.090	.102	2.29	2.60
Molded Package Width at Top	E1	.084	.090	2.13	2.29
Overall Length	D	.173	.181	4.40	4.60
Tab Length	D1	.064	.072	1.62	1.83
Tab Corner Radii	R	.010		0.254	
Foot Length	L	.035	.047	0.89	1.20
Lead Thickness	c	.014	.017	0.35	0.44
Lead 2 Width	B	.017	.022	0.43	0.56
Leads 1 & 3 Width	B1	.014	.019	0.36	0.48

*Controlling Parameter

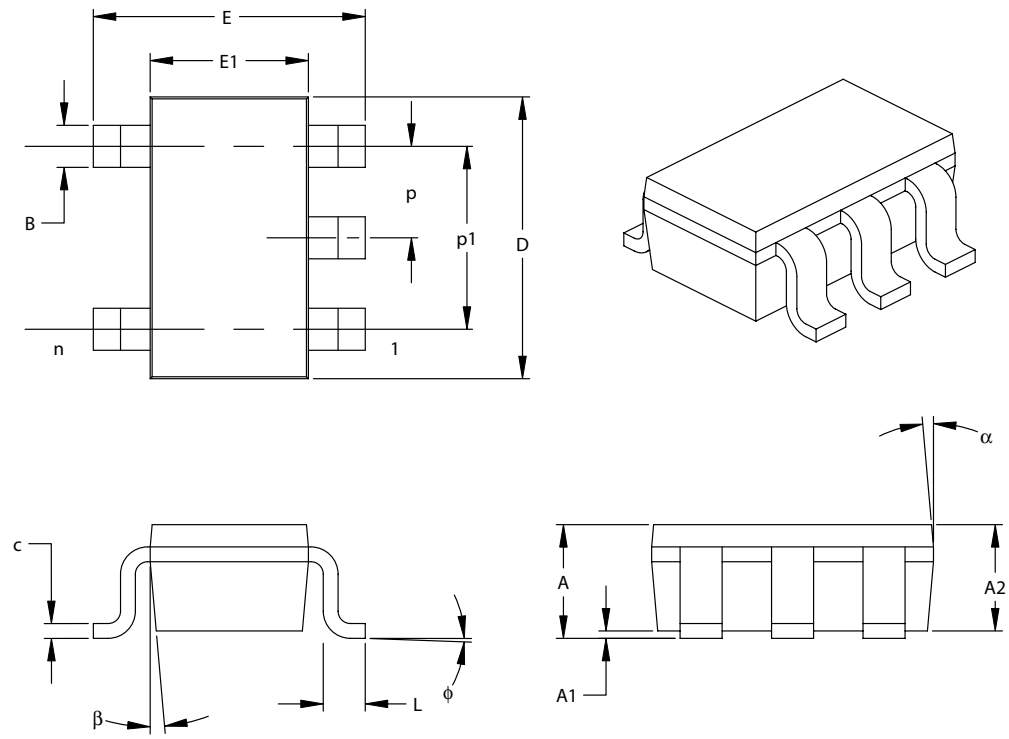
Notes:

Dimensions D and E1 do not include mold or flash protrusions. Mold flash or protrusions shall not exceed .005" (0.127mm) per side.

JEDEC Equivalent: TO-243

Drawing No. C04-29 Revised 07-24-03

5-Lead Plastic Small Outline Transistor (CT) (SOT23)



Units		INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		5			5	
Pitch	p		.038			0.95	
Outside lead pitch (basic)	p1		.075			1.90	
Overall Height	A	.035	.046	.057	0.90	1.18	1.45
Molded Package Thickness	A2	.035	.043	.051	0.90	1.10	1.30
Standoff	A1	.000	.003	.006	0.00	0.08	0.15
Overall Width	E	.102	.110	.118	2.60	2.80	3.00
Molded Package Width	E1	.059	.064	.069	1.50	1.63	1.75
Overall Length	D	.110	.116	.122	2.80	2.95	3.10
Foot Length	L	.014	.018	.022	0.35	0.45	0.55
Foot Angle	ϕ	0	5	10	0	5	10
Lead Thickness	c	.004	.006	.008	0.09	0.15	0.20
Lead Width	B	.014	.017	.020	0.35	0.43	0.50
Mold Draft Angle Top	α	0	5	10	0	5	10
Mold Draft Angle Bottom	β	0	5	10	0	5	10

*Controlling Parameter

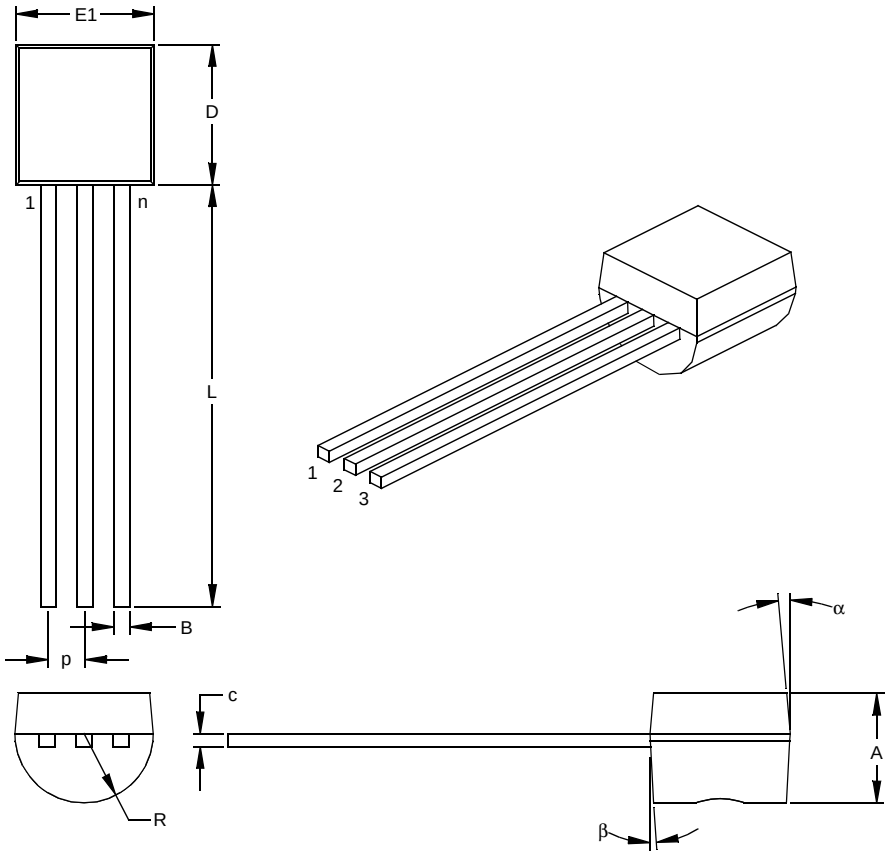
Notes:

Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .005" (0.127mm) per side.

EIAJ Equivalent: SC-74A

Drawing No. C04-091

3-Lead Plastic Transistor Outline (ZB) (TO-92)



Units		INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		3			3	
Pitch	p		.050			1.27	
Bottom to Package Flat	A	.130	.143	.155	3.30	3.62	3.94
Overall Width	E1	.175	.186	.195	4.45	4.71	4.95
Overall Length	D	.170	.183	.195	4.32	4.64	4.95
Molded Package Radius	R	.085	.090	.095	2.16	2.29	2.41
Tip to Seating Plane	L	.500	.555	.610	12.70	14.10	15.49
Lead Thickness	c	.014	.017	.020	0.36	0.43	0.51
Lead Width	B	.016	.019	.022	0.41	0.48	0.56
Mold Draft Angle Top	α	4	5	6	4	5	6
Mold Draft Angle Bottom	β	2	3	4	2	3	4

*Controlling Parameter
Notes:
Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010” (0.254mm) per side.
JEDEC Equivalent: TO-92
Drawing No. C04-101

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

PART NO.	X	XX	X	X	X	XX	XX
Device	Output Config.	Detected Voltage	Extra Feature Code	Tolerance	Temp.	Pkg	Taping Direction

Device:	TC54V:	Voltage Detector
Output Configuration:	N = Nch Open-Drain C = CMOS Output	
Detected Voltage:	14 = 1.4V 21 = 2.1V 27 = 2.7V 29 = 2.9V 30 = 3.0V 42 = 4.2V 43 = 4.3V	
Extra Feature Code:	0 = Fixed	
Tolerance:	1 = 1% (custom) 2 = 2% (standard)	
Temperature:	E = -40°C to +85°C	
Package:	CB = 3-Pin SOT-23A (equivalent to EIAJ SC-59) MB = 3-Pin SOT-89 CT = 5-Pin SOT-23A (equivalent to EIAJ SC-74A) (7.7V ONLY) ZB = Transistor Outline (TO-92), 3-lead	
Taping Direction:	713 = Standard Taping	

Examples:

a) TC54VC1402ECB713: 1.4V Voltage Detector, 2% Tol., SOT-23A-3-TR.

b) TC54VC1402EMB713: 1.4V Voltage Detector, 2% Tol., SOT-89-3-TR.

c) TC54VC1402EZB: 1.4V Voltage Detector, 2% Tol., TO-92.

d) TC54VC2102ECB713: 2.1V Voltage Detector, 2% Tol., SOT-23A-3-TR.

e) TC54VC2102EMB713: 2.1V Voltage Detector, 2% Tol., SOT-89-3-TR.

f) TC54VC2102EZB: 2.1V Voltage Detector, 2% Tol., TO-92.

g) TC54VC2702ECB713: 2.7V Voltage Detector, 2% Tol., SOT-23A-3-TR.

h) TC54VC3002ECB713: 3.0V Voltage Detector, 2% Tol., SOT-23A-3-TR.

i) TC54VN4202ECB713: 4.2V Voltage Detector, 2% Tol., SOT-23A-3-TR.

j) TC54VN7702ECT713: 7.7V Voltage Detector, 2% Tol., SOT-23A-3-TR.

Sales and Support

Data Sheets

Products supported by a preliminary Data Sheet may have an errata sheet describing minor operational differences and recommended workarounds. To determine if an errata sheet exists for a particular device, please contact one of the following:

1. Your local Microchip sales office
2. The Microchip Corporate Literature Center U.S. FAX: (480) 792-7277
3. The Microchip Worldwide Site (www.microchip.com)

Please specify which device, revision of silicon and Data Sheet (include Literature #) you are using.

Customer Notification System

Register on our web site (www.microchip.com/cn) to receive the most current information on our products.

NOTES:

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

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ISO/TS 16949:2002

Microchip received ISO/TS-16949:2002 quality system certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona and Mountain View, California in October 2003. The Company's quality system processes and procedures are for its PICmicro® 8-bit MCUs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

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