

# LinCMOS™ QUADRUPLE LOW-VOLTAGE DIFFERENTIAL COMPARATORS

TLV2354, TLV2354Y

SLCS012C – MAY 1992 – REVISED AUGUST 2000

- Wide Range of Supply Voltages  
2 V to 8 V
- Fully Characterized at 3 V and 5 V
- Very-Low Supply-Current Drain  
240  $\mu$ A Typ at 3 V
- Common-Mode Input Voltage Range  
Includes Ground
- High Input Impedance . . .  $10^{12} \Omega$  Typ
- Fast Response Time . . . 200 ns Typ for  
TTL-Level Input Step
- Extremely Low Input Bias Current  
5 pA Typ
- Output Compatible With TTL, MOS, and  
CMOS
- Built-In ESD Protection

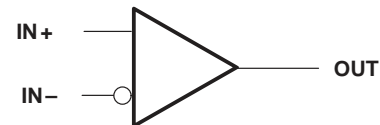
## description

The TLV2354 consists of four independent, low-power comparators specifically designed for single power-supply applications and operate with power-supply rails as low as 2 V. When powered from a 3-V supply, the typical supply current is only 240  $\mu$ A.

The TLV2354 is designed using the Texas Instruments LinCMOS™ technology and, therefore, features an extremely high input impedance (typically greater than  $10^{12} \Omega$ ), which allows direct interfacing with high-impedance sources. The outputs are N-channel open-drain configurations that require an external pullup resistor to provide a positive output voltage swing, and they can be connected to achieve positive-logic wired-AND relationships. The TLV2354I is fully characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ . The TLV2354M is fully characterized for operation from  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ .

The TLV2354 has internal electrostatic-discharge (ESD)-protection circuits and has been classified with a 1000-V ESD rating using human body model testing. However, care should be exercised in handling this device as exposure to ESD may result in degradation of the device parametric performance.

## symbol (each comparator)



## AVAILABLE OPTIONS

T <sub>A</sub>	V <sub>IOMax</sub> at 25°C	PACKAGED DEVICES						CHIP FORM (Y)
		SMALL OUTLINE (D) <sup>†</sup>	CHIP CARRIER (FK)	CERAMIC DIP (J)	PLASTIC DIP (N)	TSSOP (PW) <sup>‡</sup>	CERAMIC FLATPACK (W)	
$-40^{\circ}\text{C}$ to $85^{\circ}\text{C}$	5 mV	TLV2354ID	—	—	TLV2354IN	TLV2354IPW	—	TLV2354Y
$-55^{\circ}\text{C}$ to $125^{\circ}\text{C}$	5 mV	—	TLV2354MFK	TLV2354MJ	—	—	TLV2354MW	

<sup>†</sup> The D package is available taped and reeled. Add the suffix R to the device type (e.g., TLV2352IDR).

<sup>‡</sup> The PW packages are only available left-ended taped and reeled (e.g., TLV2354IPW).



These devices have limited built-in protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

LINCMOS is a trademark of Texas Instruments.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS  
INSTRUMENTS**

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

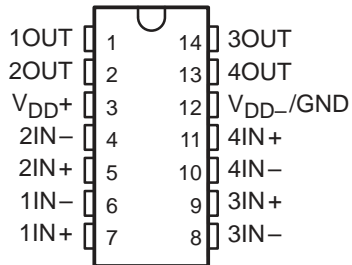
Copyright © 2000, Texas Instruments Incorporated  
On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

# TLV2354, TLV2354Y

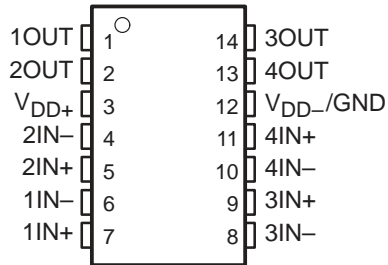
## LinCMOS™ QUADRUPLE LOW-VOLTAGE DIFFERENTIAL COMPARATORS

SLCS012C – MAY 1992 – REVISED AUGUST 2000

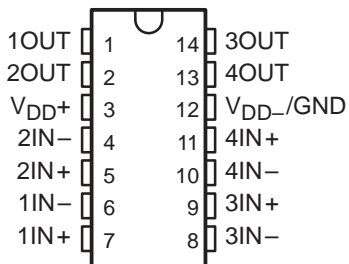
**TLV2354I**  
D OR N PACKAGE  
(TOP VIEW)



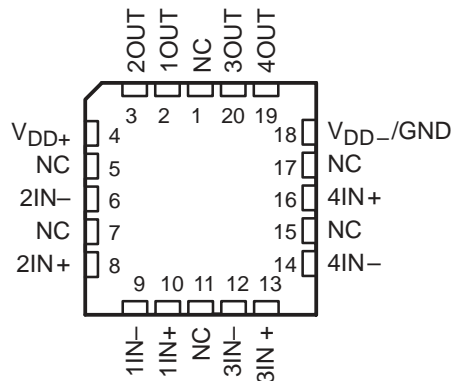
**TLV2354I**  
PW PACKAGE  
(TOP VIEW)



**TLV2354M**  
J OR W PACKAGE  
(TOP VIEW)



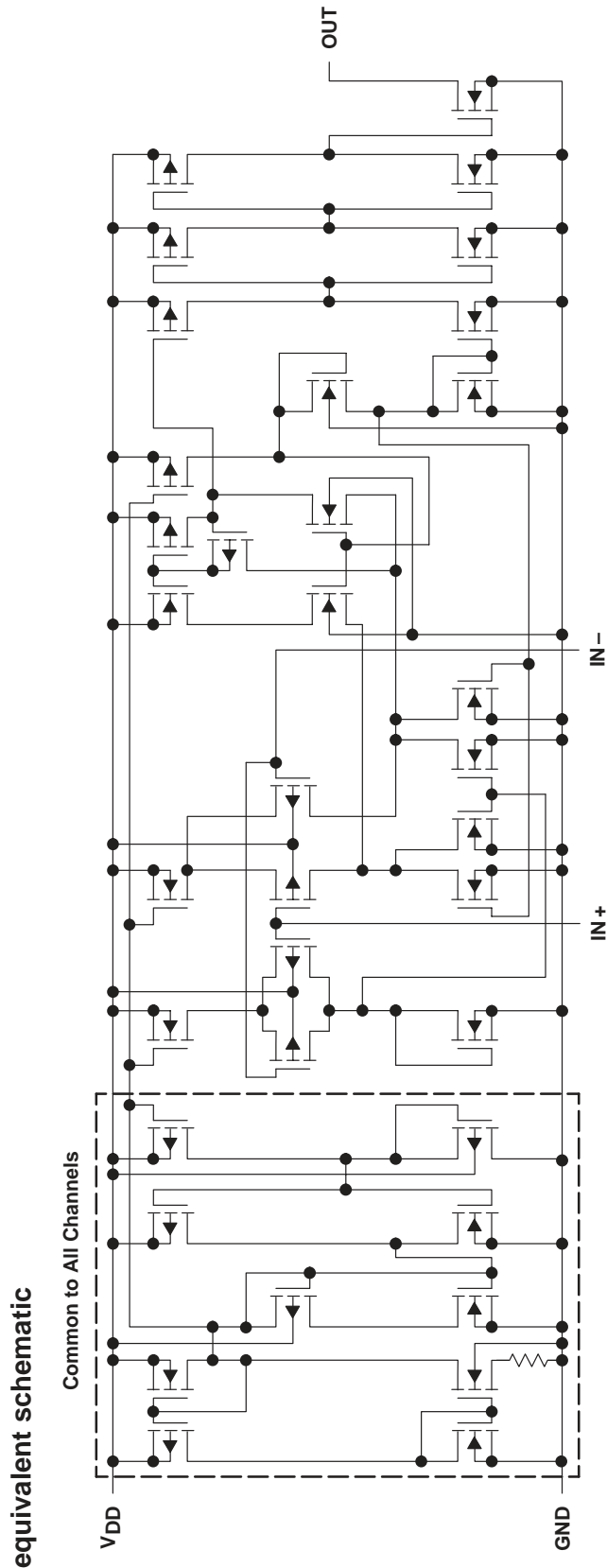
**TLV2354AM, TLV2354M**  
FK PACKAGE  
(TOP VIEW)



NC – No internal connection

# TLV2254, TLV2254Y LinCMOS™ QUADRUPLE LOW-VOLTAGE DIFFERENTIAL COMPARATORS

SLCS012C – MAY 1992 – REVISED AUGUST 2000

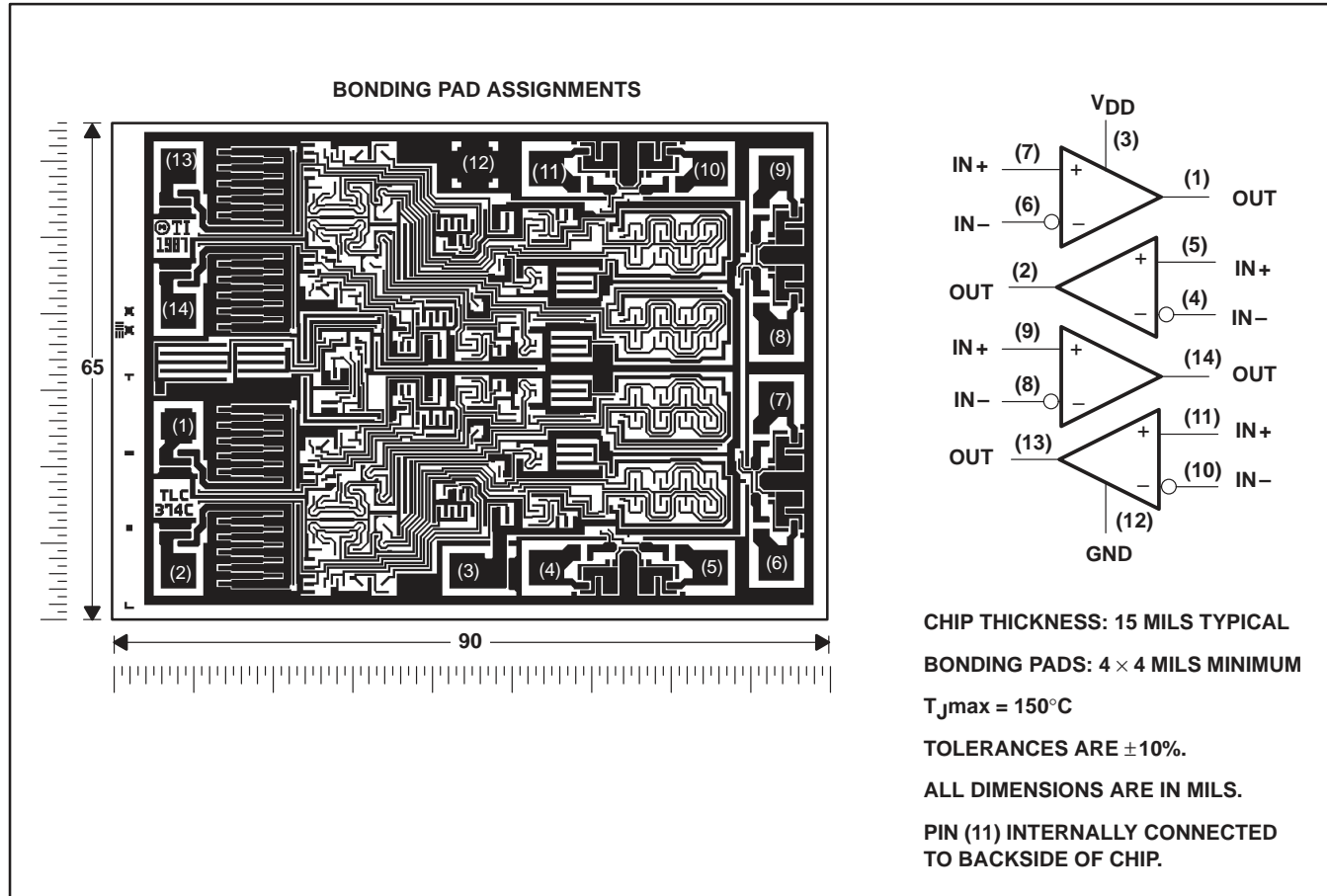


# TLV2354, TLV2354Y LinCMOS™ QUADRUPLE LOW-VOLTAGE DIFFERENTIAL COMPARATORS

SLCS012C – MAY 1992 – REVISED AUGUST 2000

## TLV2354Y chip information

This chip, when properly assembled, displays characteristics similar to the TLV2354. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding pads. This chip may be mounted with conductive epoxy or a gold-silicon preform.



# TLV2354, TLV2354Y

## LinCMOS™ QUADRUPLE LOW-VOLTAGE DIFFERENTIAL COMPARATORS

SLCS012C – MAY 1992 – REVISED AUGUST 2000

### absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, $V_{DD}$ (see Note 1)	8 V
Differential input voltage, $V_{ID}$ (see Note 2)	$\pm 8$ V
Input voltage range, $V_I$	–0.3 to 8 V
Output voltage, $V_O$	8 V
Input current, $I_I$	$\pm 5$ mA
Output current, $I_O$	20 mA
Duration of output short-circuit current to GND (see Note 3)	unlimited
Continuous total power dissipation	See Dissipation Rating Table
Operating free-air temperature range, $T_A$ : TLV2354I	–40°C to 85°C
TLV2354M	–55°C to 125°C
Storage temperature range	–65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D, N, or PW package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: FK, J, or W package	300°C

† Stresses beyond 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 beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES:
1. All voltage values, except differential voltages, are with respect to network ground.
  2. Differential voltages are at the noninverting input terminal with respect to the inverting input terminal.
  3. Short circuits from outputs to  $V_{DD}$  can cause excessive heating and eventual device destruction.

**DISSIPATION RATING TABLE**

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR	$T_A = 85^\circ\text{C}$ POWER RATING	$T_A = 125^\circ\text{C}$ POWER RATING
D	950 mW	7.6 mW/°C	494 mW	—
FK	1375 mW	11.0 mW/°C	715 mW	275 mW
J	1375 mW	11.0 mW/°C	715 mW	275 mW
N	1150 mW	9.2 mW/°C	598 mW	—
PW	700 mW	5.6 mW/°C	364 mW	—
W	700 mW	5.5 mW/°C	370 mW	150 mW

### recommended operating conditions

		MIN	MAX	UNIT
Supply voltage, $V_{DD}$		2	8	V
Common-mode input voltage, $V_{IC}$	$V_{DD} = 3$ V	0	1.75	V
	$V_{DD} = 5$ V	0	3.75	
Operating free-air temperature, $T_A$	TLV2354I	–40	85	°C
	TLV2354M	–55	125	



# TLV2354, TLV2354Y

## LinCMOS™ QUADRUPLE LOW-VOLTAGE DIFFERENTIAL COMPARATORS

SLCS012C – MAY 1992 – REVISED AUGUST 2000

### electrical characteristics at specified free-air temperature†

PARAMETER	TEST CONDITIONS	T <sub>A</sub> ‡	TLV2354I						UNIT
			V <sub>DD</sub> = 3 V			V <sub>DD</sub> = 5 V			
			MIN	TYP	MAX	MIN	TYP	MAX	
V <sub>IO</sub> Input offset voltage	V <sub>IC</sub> = V <sub>ICRmin</sub> , See Note 4	25°C	1		5	1		5	mV
		Full range	7			7			
I <sub>IO</sub> Input offset current		25°C	1			1			pA
		85°C			1			1	nA
I <sub>IB</sub> Input bias current		25°C	5			5			pA
		85°C			2			2	nA
V <sub>ICR</sub> Common-mode input voltage range		25°C	0 to 2			0 to 4			V
		Full range	0 to 1.75			0 to 3.75			
I <sub>OH</sub> High-level output current	V <sub>ID</sub> = 1 V	25°C	0.1			0.1			nA
		Full range	1			1			μA
V <sub>OL</sub> Low-level output voltage	V <sub>ID</sub> = -1 V, I <sub>OL</sub> = 2 mA	25°C	115		300	150		400	mA
		Full range	600			700			
I <sub>OL</sub> Low-level output current	V <sub>ID</sub> = -1 V, V <sub>OL</sub> = 1.5 V	25°C	6	16		6	16		mA
I <sub>DD</sub> Supply current	V <sub>ID</sub> = 1 V, No load	25°C	240		500	290		600	μA
		Full range	700			800			

† All characteristics are measured with zero common-mode input voltage unless otherwise noted.

‡ Full range is -40°C to 85°C. IMPORTANT: See Parameter Measurement Information.

NOTE 4: The offset voltage limits given are the maximum values required to drive the output above 4 V with V<sub>DD</sub> = 5 V, 2 V with V<sub>DD</sub> = 3 V, or below 400 mV with a 10-kΩ resistor between the output and V<sub>DD</sub>. They can be verified by applying the limit value to the input and checking for the appropriate output state.

### switching characteristics, V<sub>DD</sub> = 3 V, T<sub>A</sub> = 25°C

PARAMETER	TEST CONDITIONS	TLV2354I			UNIT	
		MIN	TYP	MAX		
Response time	R <sub>L</sub> = 5.1 kΩ, C <sub>L</sub> = 15 pF§, See Note 5	100-mV input step with 5-mV overdrive			640	ns

§ C<sub>L</sub> includes probe and jig capacitance.

NOTE 5: The response time specified is the interval between the input step function and the instant when the output crosses V<sub>O</sub> = 1 V with V<sub>DD</sub> = 3 V or when the output crosses V<sub>O</sub> = 1.4 with V<sub>DD</sub> = 5 V.

### switching characteristics, V<sub>DD</sub> = 5 V, T<sub>A</sub> = 25°C

PARAMETER	TEST CONDITIONS	TLV2354I			UNIT	
		MIN	TYP	MAX		
Response time	R <sub>L</sub> = 5.1 kΩ, C <sub>L</sub> = 15 pF§, See Note 5	100-mV input step with 5-mV overdrive			650	ns
		TTL-level input step			200	

§ C<sub>L</sub> includes probe and jig capacitance.

NOTE 5: The response time specified is the interval between the input step function and the instant when the output crosses V<sub>O</sub> = 1 V with V<sub>DD</sub> = 3 V or when the output crosses V<sub>O</sub> = 1.4 with V<sub>DD</sub> = 5 V.



# TLV2354, TLV2354Y

## LinCMOS™ QUADRUPLE LOW-VOLTAGE DIFFERENTIAL COMPARATORS

SLCS012C – MAY 1992 – REVISED AUGUST 2000

### electrical characteristics at specified free-air temperature†

PARAMETER	TEST CONDITIONS	T <sub>A</sub> ‡	TLV2354M						UNIT
			V <sub>DD</sub> = 3 V			V <sub>DD</sub> = 5 V			
			MIN	TYP	MAX	MIN	TYP	MAX	
V <sub>IO</sub> Input offset voltage	V <sub>IC</sub> = V <sub>ICRmin</sub> , See Note 4	25°C	1		5	1		5	mV
		Full range				10			
I <sub>IO</sub> Input offset current		25°C	1			1			pA
		125°C				10			nA
I <sub>IB</sub> Input bias current		25°C	5			5			pA
		125°C				20			nA
V <sub>ICR</sub> Common-mode input voltage range		25°C	0 to 2			0 to 4			V
		Full range	0 to 1.75			0 to 3.75			
I <sub>OH</sub> High-level output current	V <sub>ID</sub> = 1 V	25°C	0.1			0.1			nA
		Full range				1			μA
V <sub>OL</sub> Low-level output voltage	V <sub>ID</sub> = -1 V, I <sub>OL</sub> = 2 mA	25°C	115		300	150		400	mV
		Full range				700			
I <sub>OL</sub> Low-level output current	V <sub>ID</sub> = -1 V, V <sub>OL</sub> = 1.5 V	25°C	6	16		6	16		mA
I <sub>DD</sub> Supply current	V <sub>ID</sub> = 1 V, No load	25°C	240		500	290		600	μA
		Full range				800			

† All characteristics are measured with zero common-mode input voltage unless otherwise noted.

‡ Full range is -55°C to 125°C. IMPORTANT: See Parameter Measurement Information.

NOTE 4: The offset voltage limits given are the maximum values required to drive the output above 4 V with V<sub>DD</sub> = 5 V, 2 V with V<sub>DD</sub> = 3 V, or below 400 mV with a 10-kΩ resistor between the output and V<sub>DD</sub>. They can be verified by applying the limit value to the input and checking for the appropriate output state.

### switching characteristics, V<sub>DD</sub> = 3 V, T<sub>A</sub> = 25°C

PARAMETER	TEST CONDITIONS	TLV2354M			UNIT
		MIN	TYP	MAX	
Response time	R <sub>L</sub> = 5.1 kΩ, C <sub>L</sub> = 100 pF§, See Note 5 100-mV input step with 5-mV overdrive	1400			ns

§ C<sub>L</sub> includes probe and jig capacitance.

NOTE 5: The response time specified is the interval between the input step function and the instant when the output crosses V<sub>O</sub> = 1 V with V<sub>DD</sub> = 3 V or when the output crosses V<sub>O</sub> = 1.4 with V<sub>DD</sub> = 5 V.

### switching characteristics, V<sub>DD</sub> = 5 V, T<sub>A</sub> = 25°C

PARAMETER	TEST CONDITIONS	TLV2354M			UNIT
		MIN	TYP	MAX	
Response time	R <sub>L</sub> = 5.1 kΩ, C <sub>L</sub> = 100 pF§, See Note 5 100-mV input step with 5-mV overdrive	1300			ns
		900			

§ C<sub>L</sub> includes probe and jig capacitance.

NOTE 5: The response time specified is the interval between the input step function and the instant when the output crosses V<sub>O</sub> = 1 V with V<sub>DD</sub> = 3 V or when the output crosses V<sub>O</sub> = 1.4 with V<sub>DD</sub> = 5 V.



# TLV2354, TLV2354Y

## LinCMOS™ QUADRUPLE LOW-VOLTAGE DIFFERENTIAL COMPARATORS

SLCS012C – MAY 1992 – REVISED AUGUST 2000

### electrical characteristics at specified free-air temperature, $T_A = 25^\circ\text{C}^\dagger$

PARAMETER	TEST CONDITIONS	TLV2354Y						UNIT
		$V_{DD} = 3\text{ V}$			$V_{DD} = 5\text{ V}$			
		MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{IC} = V_{ICRmin}$ , See Note 4		1	5		1	5	mV
$I_{IO}$ Input offset current			1			1		pA
$I_{IB}$ Input bias current			5			5		pA
$V_{ICR}$ Common-mode input voltage range		0 to 2			0 to 4			V
$I_{OH}$ High-level output current	$V_{ID} = 1\text{ V}$		0.1			0.1		nA
$V_{OL}$ Low-level output voltage	$V_{ID} = -1\text{ V}$ , $I_{OL} = 2\text{ mA}$		115	300		150	400	mV
$I_{OL}$ Low-level output current	$V_{ID} = -1\text{ V}$ , $V_{OL} = 1.5\text{ V}$	6	16		6	16		mA
$I_{DD}$ Supply current	$V_{ID} = 1\text{ V}$ , No load		240	500		290	600	$\mu\text{A}$

<sup>†</sup> All characteristics are measured with zero common-mode input voltage unless otherwise noted.

NOTE 4: The offset voltage limits given are the maximum values required to drive the output above 4 V with  $V_{DD} = 5\text{ V}$ , 2 V with  $V_{DD} = 3\text{ V}$ , or below 400 mV with a 10-k $\Omega$  resistor between the output and  $V_{DD}$ . They can be verified by applying the limit value to the input and checking for the appropriate output state.



**TYPICAL CHARACTERISTICS**

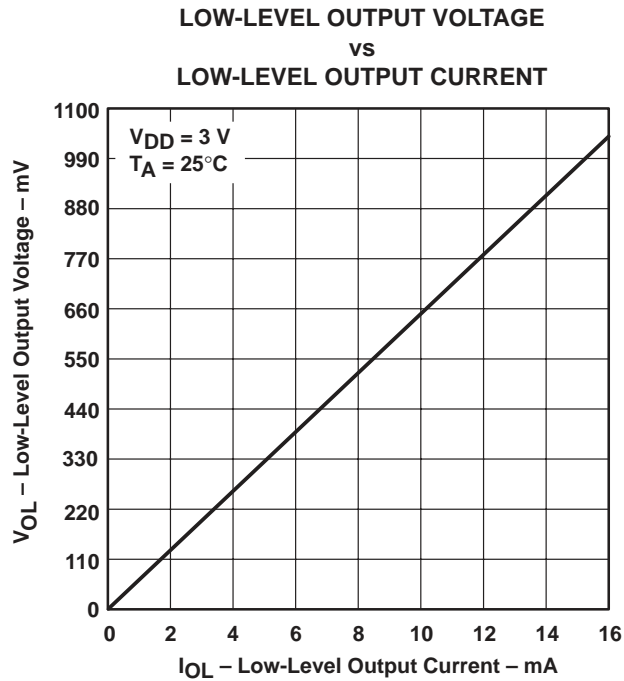


Figure 1

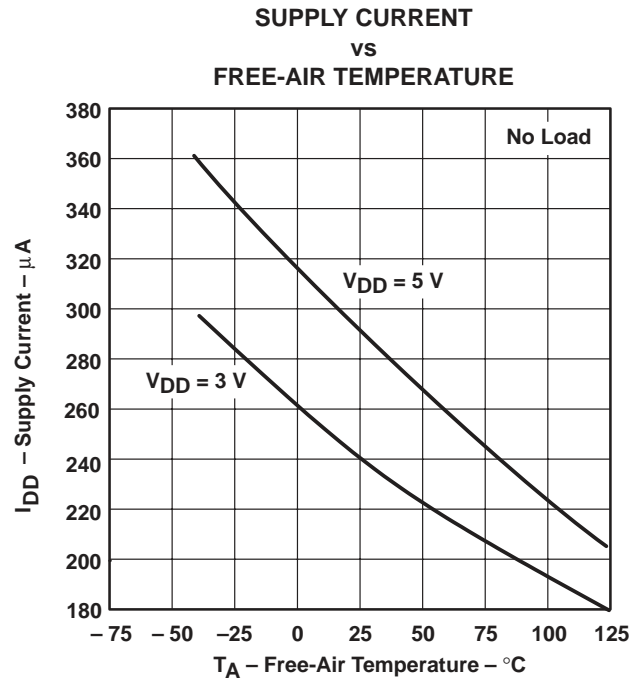


Figure 2

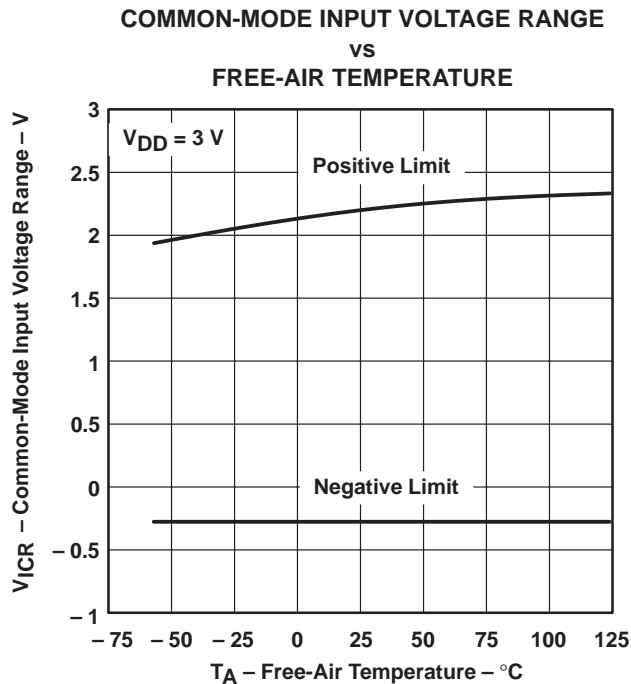


Figure 3

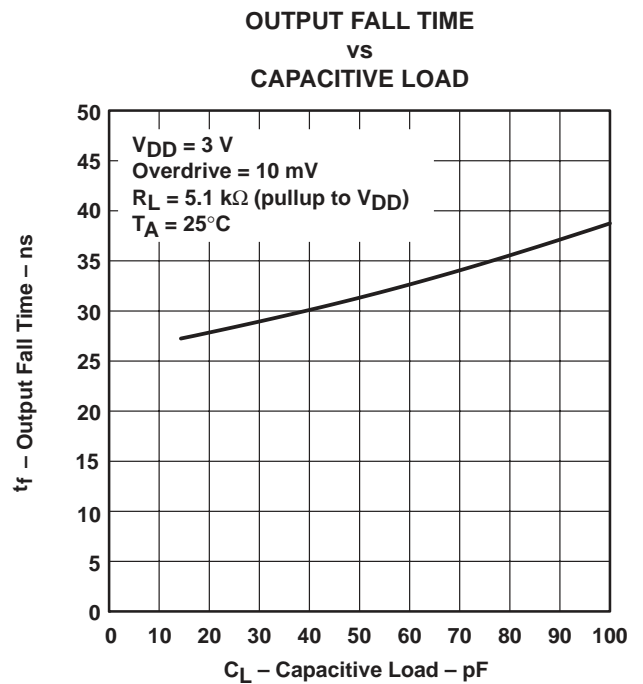


Figure 4

TYPICAL CHARACTERISTICS

HIGH-TO-LOW-LEVEL OUTPUT  
 PROPAGATION DELAY  
 FOR VARIOUS OVERDRIVE VOLTAGES

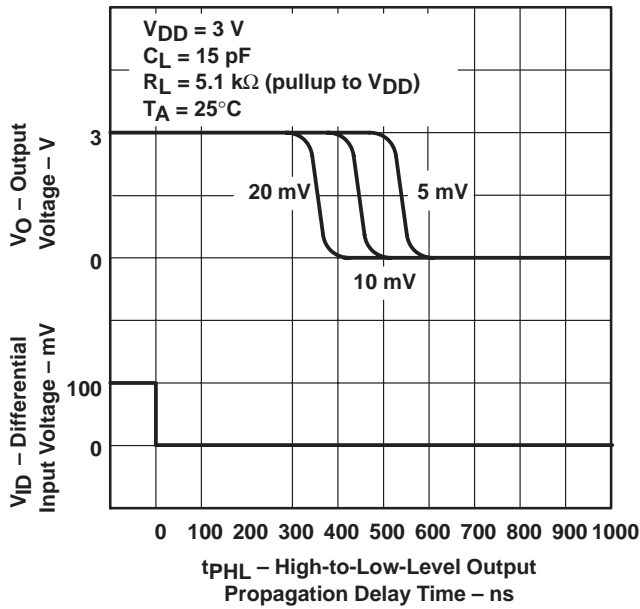


Figure 5

HIGH-TO-LOW-LEVEL OUTPUT  
 PROPAGATION DELAY  
 FOR VARIOUS CAPACITIVE LOADS

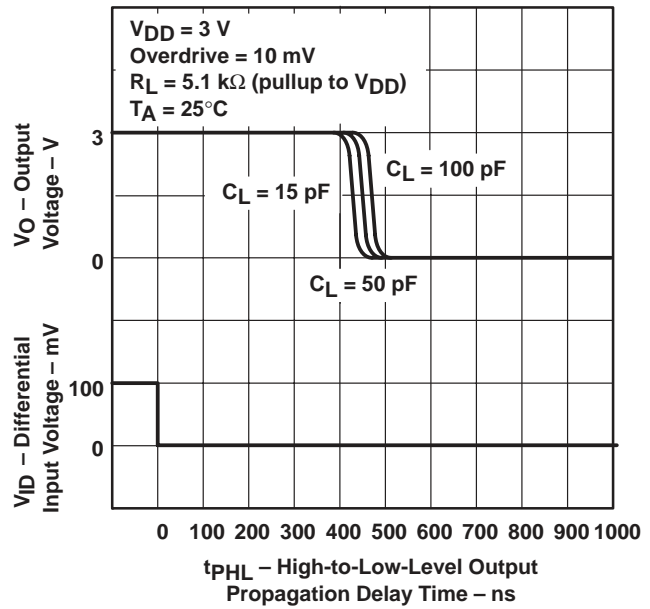


Figure 6

LOW-TO-HIGH-LEVEL OUTPUT  
 PROPAGATION DELAY  
 FOR VARIOUS OVERDRIVE VOLTAGES

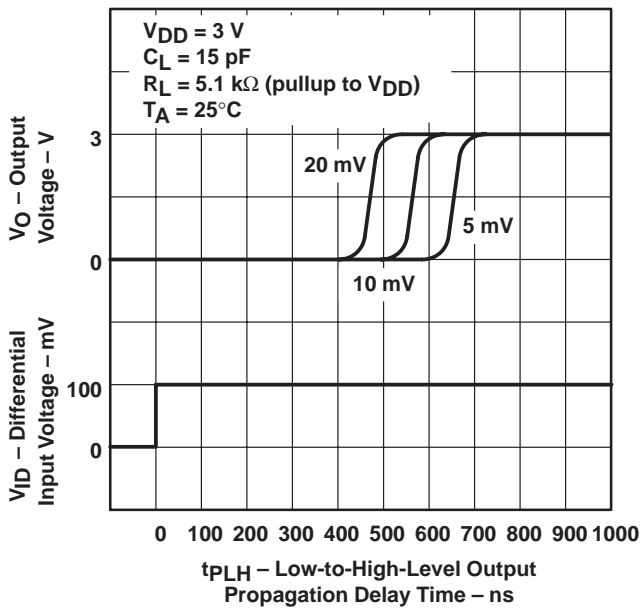


Figure 7

LOW-TO-HIGH-LEVEL OUTPUT  
 PROPAGATION DELAY  
 FOR VARIOUS CAPACITIVE LOADS

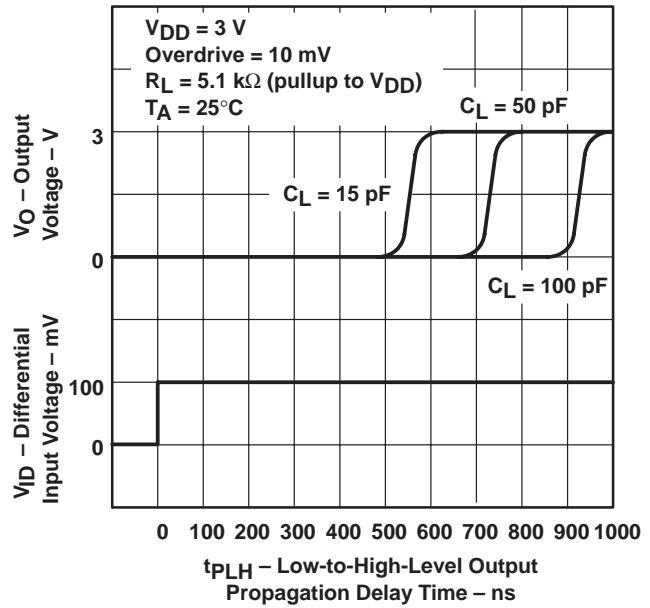


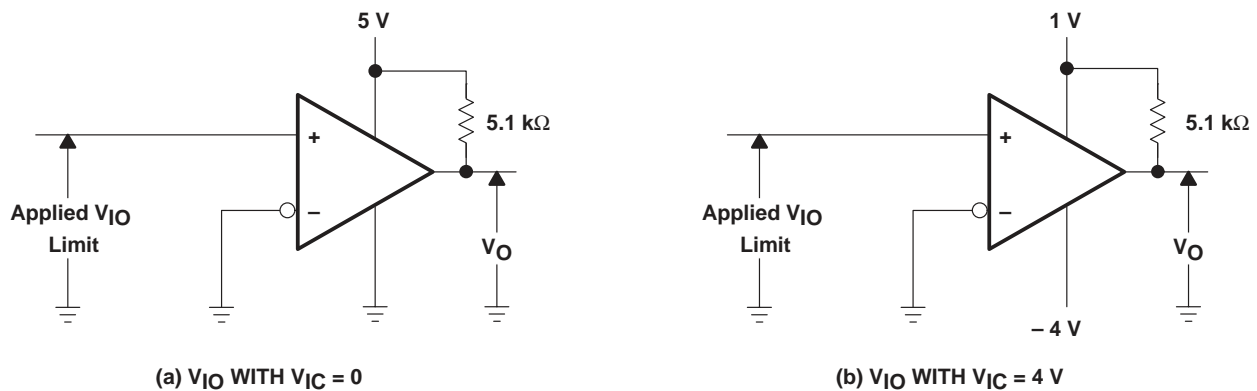
Figure 8

### PARAMETER MEASUREMENT INFORMATION

The digital output stage of the TLV2354 can be damaged if it is held in the linear region of the transfer curve. Conventional operational amplifier/comparator testing incorporates the use of a servo loop that is designed to force the device output to a level within this linear region. Since the servo-loop method of testing cannot be used, the following alternatives for measuring parameters such as input offset voltage, common-mode rejection, etc., are offered.

To verify that the input offset voltage falls within the limits specified, the limit value is applied to the input as shown in Figure 9(a). With the noninverting input positive with respect to the inverting input, the output should be high. With the input polarity reversed, the output should be low.

A similar test can be made to verify the input offset voltage at the common-mode extremes. The supply voltages can be slewed as shown in Figure 9(b) for the  $V_{ICR}$  test rather than changing the input voltages to provide greater accuracy.



**Figure 9. Method for Verifying That Input Offset Voltage Is Within Specified Limits**

A close approximation of the input offset voltage can be obtained by using a binary search method to vary the differential input voltage while monitoring the output state. When the applied input voltage differential is equal but opposite in polarity to the input offset voltage, the output changes states.

# TLV2354, TLV2354Y LinCMOS™ QUADRUPLE LOW-VOLTAGE DIFFERENTIAL COMPARATORS

SLCS012C – MAY 1992 – REVISED AUGUST 2000

## PARAMETER MEASUREMENT INFORMATION

Figure 10 illustrates a practical circuit for direct dc measurement of input offset voltage that does not bias the comparator in the linear region. The circuit consists of a switching-mode servo loop in which U1a generates a triangular waveform of approximately 20-mV amplitude. U1b acts as a buffer, with C2 and R4 removing any residual dc offset. The signal is then applied to the inverting input of the comparator under test while the noninverting input is driven by the output of the integrator formed by U1c through the voltage divider formed by R9 and R10. The loop reaches a stable operating point when the output of the comparator under test has a duty cycle of exactly 50%, which can only occur when the incoming triangle wave is sliced symmetrically or when the voltage at the noninverting input exactly equals the input offset voltage.

Voltage dividers R9 and R10 provide a step up of the input offset voltage by a factor of 100 to make measurement easier. The values of R5, R8, R9, and R10 can significantly influence the accuracy of the reading; therefore, it is suggested that their tolerance level be 1% or lower.

Measuring the extremely low values of input current requires isolation from all other sources of leakage current and compensation for the leakage of the test socket and board. With a good picoammeter, the socket and board leakage can be measured with no device in the socket. Subsequently, this open-socket leakage value can be subtracted from the measurement obtained with a device in the socket to obtain the actual input current of the device.

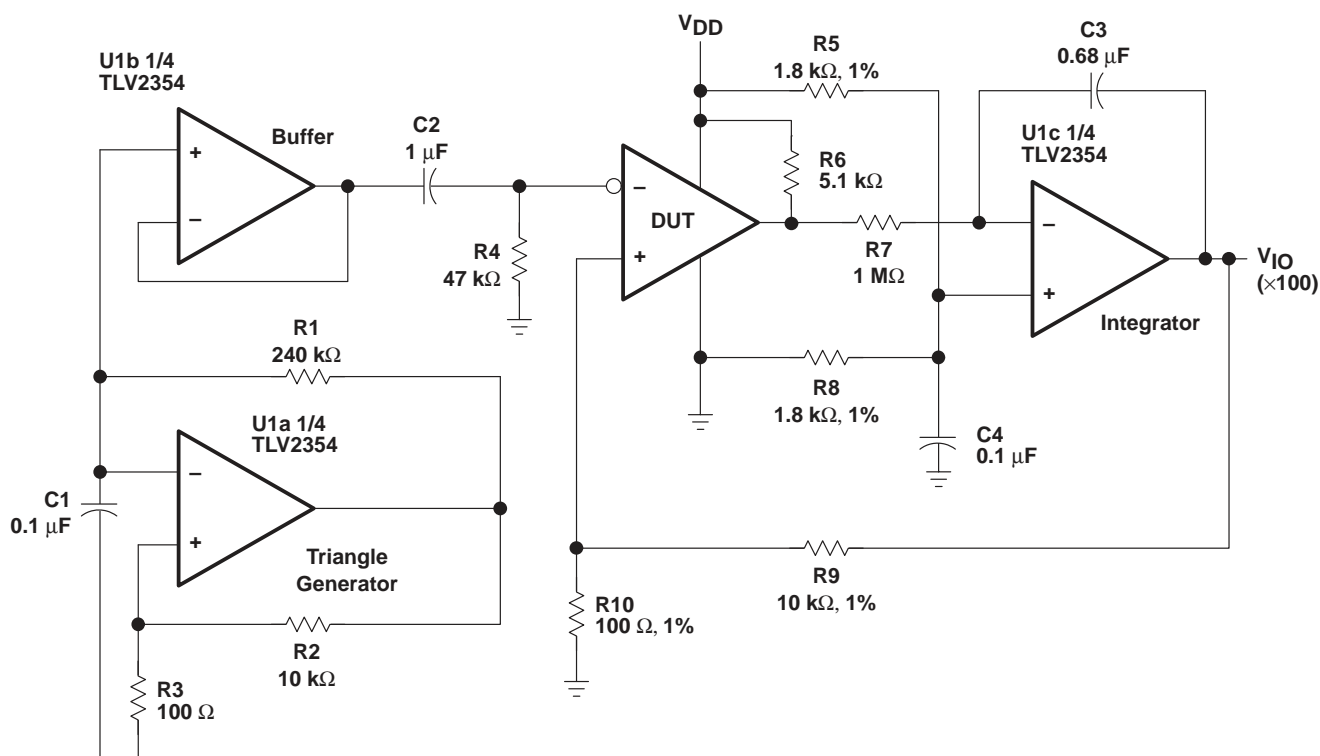
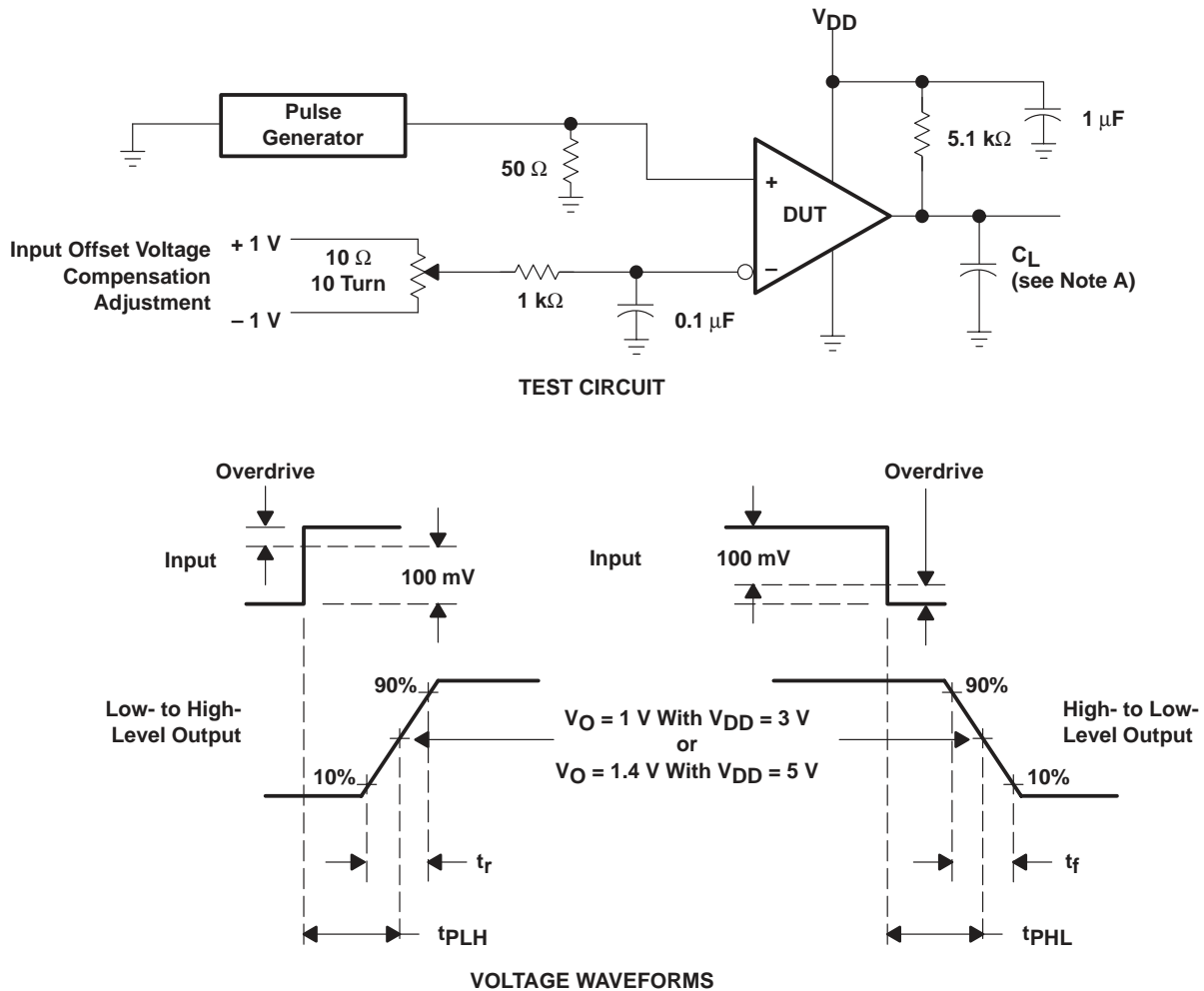


Figure 10. Circuit for Input Offset Voltage Measurement

### PARAMETER MEASUREMENT INFORMATION

Propagation delay time is defined as the interval between the application of an input step function and the instant when the output crosses  $V_O = 1\text{ V}$  with  $V_{DD} = 3\text{ V}$  or when the output crosses  $V_O = 1.4\text{ V}$  with  $V_{DD} = 5\text{ V}$ . Propagation delay time, low-to-high-level output, is measured from the leading edge of the input pulse, while propagation delay time, high-to-low-level output, is measured from the trailing edge of the input pulse. Propagation-delay-time measurement at low input signal levels can be greatly affected by the input offset voltage. The offset voltage should be balanced by the adjustment at the inverting input (as shown in Figure 11) so that the circuit is just at the transition point. Then a low signal, for example a 105-mV or 5-mV overdrive, causes the output to change state.



NOTE A:  $C_L$  includes probe and jig capacitance.

**Figure 11. Propagation Delay, Rise, and Fall Times Test Circuit and Voltage Waveforms**

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
5962-9688201Q2A	ACTIVE	LCCC	FK	20	1	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962- 9688201Q2A TLV2354 MFKB	<a href="#">Samples</a>
5962-9688201QCA	ACTIVE	CDIP	J	14	1	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-9688201QC A TLV2354MJB	<a href="#">Samples</a>
5962-9688201QDA	ACTIVE	CFP	W	14	1	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-9688201QD A TLV2354MWB	<a href="#">Samples</a>
TLV2354ID	LIFEBUY	SOIC	D	14	50	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TLV2354I	
TLV2354IDR	ACTIVE	SOIC	D	14	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TLV2354I	<a href="#">Samples</a>
TLV2354IPW	ACTIVE	TSSOP	PW	14	90	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TY2354	<a href="#">Samples</a>
TLV2354IPWR	ACTIVE	TSSOP	PW	14	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TY2354	<a href="#">Samples</a>
TLV2354MFKB	ACTIVE	LCCC	FK	20	1	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962- 9688201Q2A TLV2354 MFKB	<a href="#">Samples</a>
TLV2354MJB	ACTIVE	CDIP	J	14	1	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-9688201QC A TLV2354MJB	<a href="#">Samples</a>
TLV2354MWB	ACTIVE	CFP	W	14	1	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-9688201QD A TLV2354MWB	<a href="#">Samples</a>

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF TLV2354, TLV2354M :**

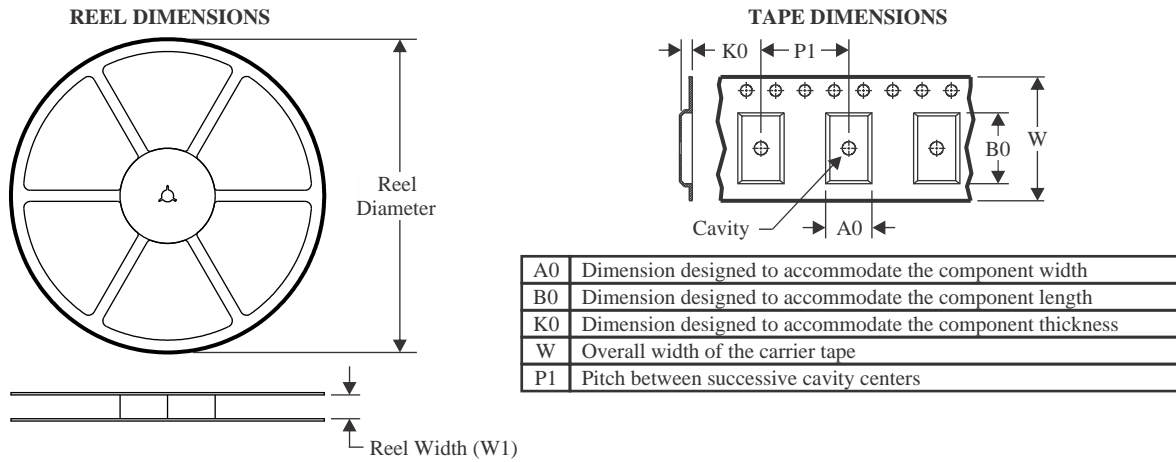
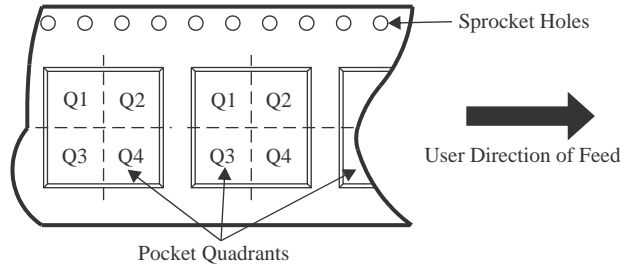
● Catalog : [TLV2354](#)

● Military : [TLV2354M](#)

NOTE: Qualified Version Definitions:

● Catalog - TI's standard catalog product

● Military - QML certified for Military and Defense Applications

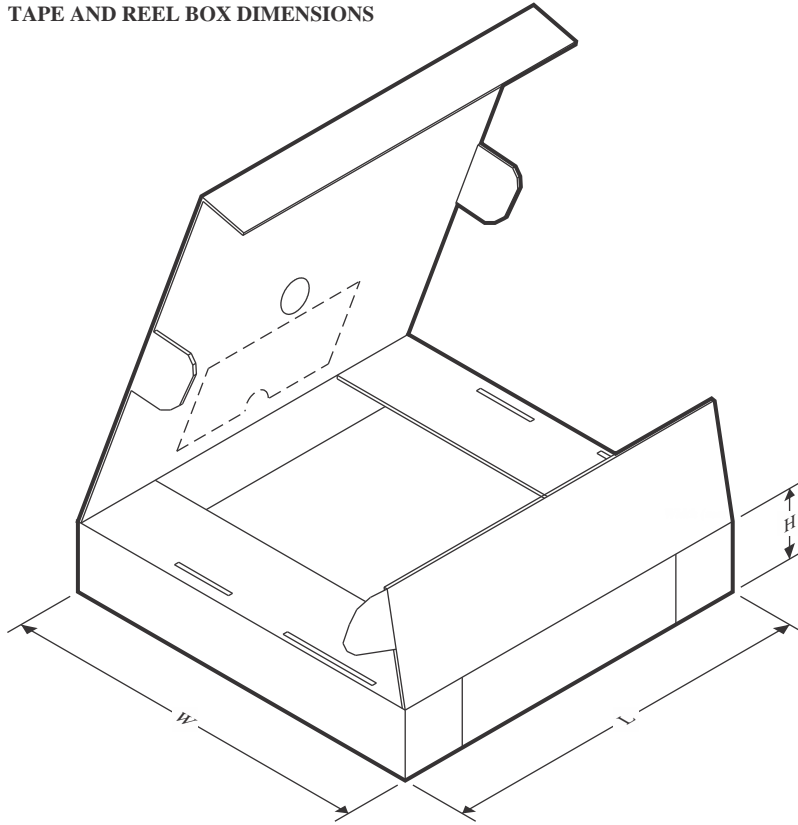
**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TLV2354IDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TLV2354IPWR	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

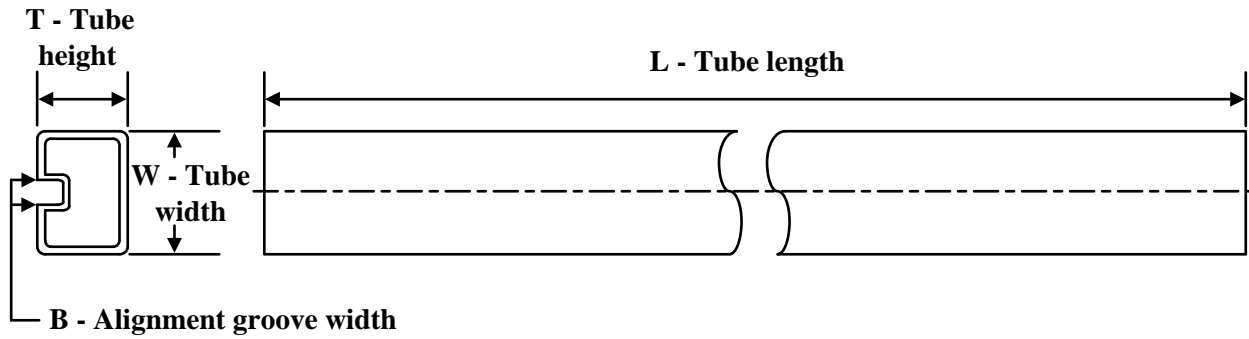


## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TLV2354IDR	SOIC	D	14	2500	350.0	350.0	43.0
TLV2354IPWR	TSSOP	PW	14	2000	356.0	356.0	35.0

**TUBE**


\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
5962-9688201Q2A	FK	LCCC	20	1	506.98	12.06	2030	NA
5962-9688201QDA	W	CFP	14	1	506.98	26.16	6220	NA
TLV2354ID	D	SOIC	14	50	505.46	6.76	3810	4
TLV2354IPW	PW	TSSOP	14	90	530	10.2	3600	3.5
TLV2354MFKB	FK	LCCC	20	1	506.98	12.06	2030	NA
TLV2354MWB	W	CFP	14	1	506.98	26.16	6220	NA

## IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#) or other applicable terms available either on [ti.com](https://www.ti.com) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2023, Texas Instruments Incorporated