



# High-Current VCOM Drive Buffers for TFT LCDs

## General Description

The MAX9550/MAX9551/MAX9552 provide a VCOM source for TFT LCDs. The MAX9550/MAX9551/MAX9552 source and sink a large current to quickly restore the VCOM voltage, making it ideal for TFT LCDs. The output settles to within 0.1% in less than 2 $\mu$ s. In addition, the MAX9550/MAX9551/MAX9552 directly drive the capacitive load in the VCOM layer of the TFT LCDs without the need for a series resistor.

The MAX9550/MAX9551/MAX9552 feature single, dual, and quad channel VCOM amplifiers, respectively. The MAX9550/MAX9551/MAX9552 can drive up to 800mA of peak current per channel and operate up to 20V. The devices feature soft-start to reduce inrush current, output short-circuit protection, and thermal shutdown.

The MAX9550 is available in a space-saving 5-pin thin SOT23 package, and an 8-pin  $\mu$ MAX<sup>®</sup> package with an exposed paddle. The MAX9551 is available in an 8-pin  $\mu$ MAX package with an exposed paddle. The MAX9552 is available in a 14-pin TSSOP package. All devices are specified over the -40°C to +85°C temperature range.

## Applications

TFT-LCD Panels  
Instrument Control Voltage Sources

Pin Configuration appears at end of data sheet.

## Features

- ◆ Operates Up To 20V
- ◆ 800mA Peak Output Current
- ◆ Settles to Within 0.1% of  $V_{OUT}$  in Less than 2 $\mu$ s
- ◆ Excellent Load Regulation
- ◆ Thermal-Shutdown Protection
- ◆ Short-Circuit Protection to Both Rails
- ◆ Soft-Start to Reduce Inrush Current

## Ordering Information

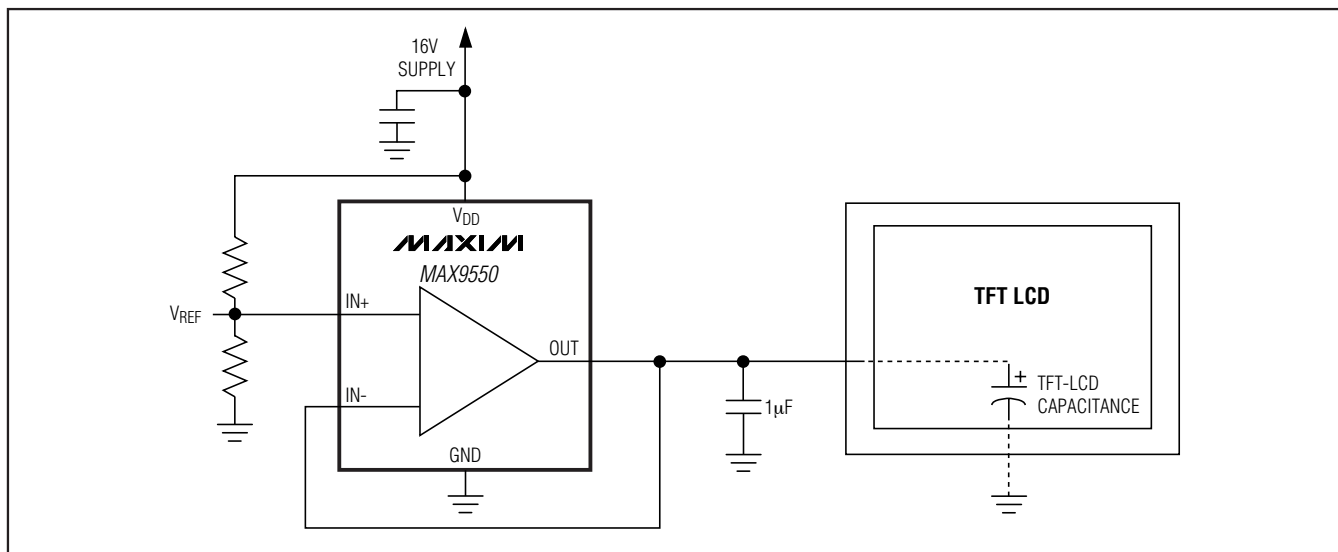
PART	AMPS	PIN-PACKAGE	PKG CODE	TOP MARK
MAX9550EZK+T	1	5 Thin SOT23-5	Z5-1	ADSG
MAX9550EUA+	1	8 $\mu$ MAX-EP*	U8E-2	AABA
MAX9551EUA+	2	8 $\mu$ MAX-EP*	U8E-2	—
MAX9552EUD+	4	14 TSSOP-EP*	U14E-3	—

**Note:** All devices specified over the -40°C to +85°C operating temperature range.

+Denotes lead-free package.

\*EP = Exposed paddle.

## Typical Operating Circuit



$\mu$ MAX is a registered trademark of Maxim Integrated Products, Inc.



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## ABSOLUTE MAXIMUM RATINGS

Supply Voltage ( $V_{DD}$  to GND) .....-0.3V to +22V  
 Any Other Pin to GND .....-0.3V to ( $V_{DD} + 0.3V$ )  
 IN+/IN- (current) ..... $\pm 20mA$   
 OUT, OUT\_ (current).....1A  
 Continuous Power Dissipation ( $T_A = +70^\circ C$ )  
 5-Pin Thin SOT23 (derate 9.5mW/ $^\circ C$  above  $+70^\circ C$ )....727mW

8-Pin  $\mu$ MAX (derate 10.3mW/ $^\circ C$  above  $+70^\circ C$ ) .....824.7mW  
 14-Pin TSSOP (derate 20.8mW/ $^\circ C$  above  $+70^\circ C$ ) .....1667mW  
 Operating Temperature Range .....-40 $^\circ C$  to +85 $^\circ C$   
 Junction Temperature .....+150 $^\circ C$   
 Storage Temperature Range .....-65 $^\circ C$  to +150 $^\circ C$   
 Lead Temperature (soldering, 10s).....+300 $^\circ C$

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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS

( $V_{DD} = 16V$ , GND = 0V,  $V_{CM} = V_{OUT} = V_{DD} / 2$ ,  $C_L = 1\mu F$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ .) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	
<b>DC CHARACTERISTICS</b>							
Supply Voltage Range	$V_{DD}$	Inferred from PSRR test and transient load test	7		20	V	
Quiescent Current	$I_{CC}$	Per channel		2	4	mA	
Low Output Voltage	$V_{OL}$	$I_L = -4mA$		0.04	0.1	V	
High Output Voltage	$V_{OH}$	$I_H = +4mA$		$V_{DD} - 0.04$	$V_{DD} - 0.1$	V	
Input Offset Voltage	$V_{OS}$		-10	+1	+10	mV	
Input Bias Current	$I_B$			0.01	1	$\mu A$	
Input Resistance	$R_{IN}$			1		M $\Omega$	
Common-Mode Input Voltage	CMVR	Inferred from CMRR	2		$V_{DD} - 2$	V	
Common-Mode Rejection Ratio	CMRR	$2V \leq V_{IN} \leq (V_{DD} - 2V)$	80	96		dB	
Power-Supply Rejection Ratio	PSRR	$V_{OUT} = 3.5V$ , $V_{DD} = 7V$ to 16V	80	96		dB	
Continuous Output Current	$I_O$	$V_{DD} = 7V$ , $V_{OUT} = 3.5V$ , guaranteed by load, regulation test	55			mA	
Output Load Regulation	LR1	$I_{OUT} = 0mA$ to 50mA		6	13	mV	
		$I_{OUT} = 0mA$ to -50mA		6	13		
Output Load Regulation	LR2	$V_{DD} = 7V$ , $V_{OUT} = 3.5V$	$I_{OUT} = 0mA$ to -55mA		6.5	15	mV
			$I_{OUT} = 0mA$ to 55mA		6.5	15	
Thermal Shutdown				+160		$^\circ C$	
Thermal Hysteresis				15		$^\circ C$	

# High-Current VCOM Drive Buffers for TFT LCDs

MAX9550/MAX9551/MAX9552

## ELECTRICAL CHARACTERISTICS (continued)

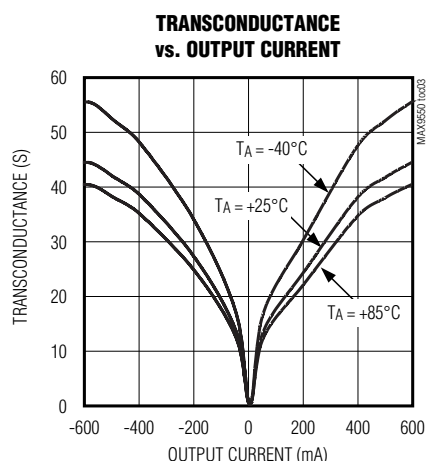
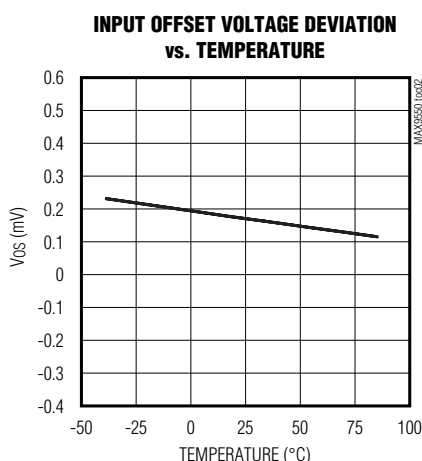
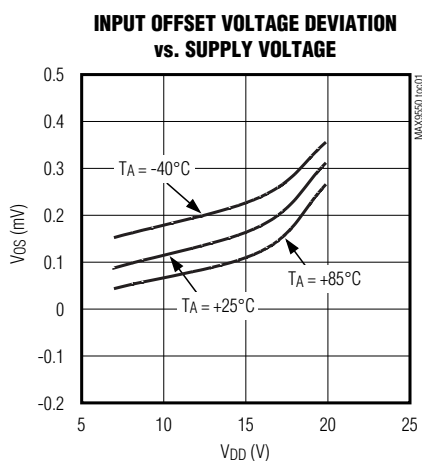
( $V_{DD} = 16V$ ,  $GND = 0V$ ,  $V_{CM} = V_{OUT} = V_{DD} / 2$ ,  $C_L = 1\mu F$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ .) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>AC CHARACTERISTICS</b>						
Settling Time	$t_s$	Settling to 0.1% of $V_{OUT}$ , $I_L = 0$ to 600mA, $C_L = 1\mu F$ , $R_S = 2.2\Omega$ , $C_S = 0.1\mu F$ (Figure 1)		2.0		$\mu s$
Input Capacitance	$C_{IN}$			1.5		pF
Transconductance	$g_m$	$I_{OUT} = \pm 50mA$		13		S
		$I_{OUT} = \pm 500mA$		42		
Transient Output Current	$I_{OUTMAX}$	$A_v = 1$	$V_{DD} = 7V$ , $V_{IN} = 1.5V$ pulse for 100 $\mu s$	$\pm 200$	$\pm 290$	mA
			$V_{DD} = 16V$ , $V_{IN} = 1.5V$ pulse for 100 $\mu s$	$\pm 600$	$\pm 830$	

**Note 1:** All devices are 100% production tested at  $T_A = +25^\circ C$ . All temperature limits are guaranteed by design.

## Typical Operating Characteristics

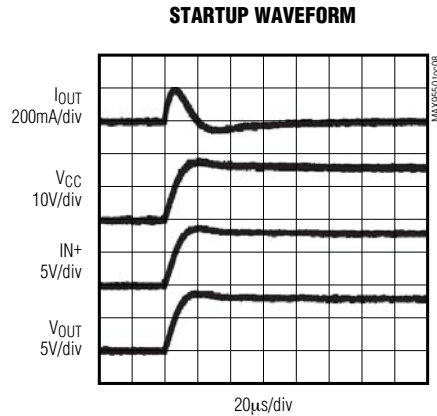
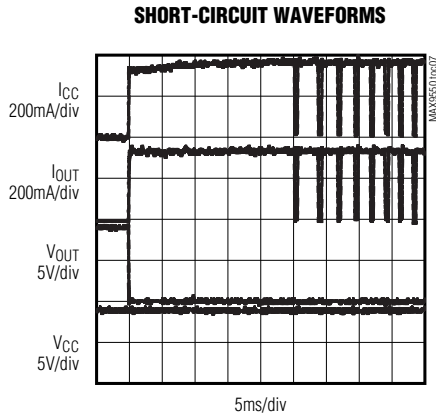
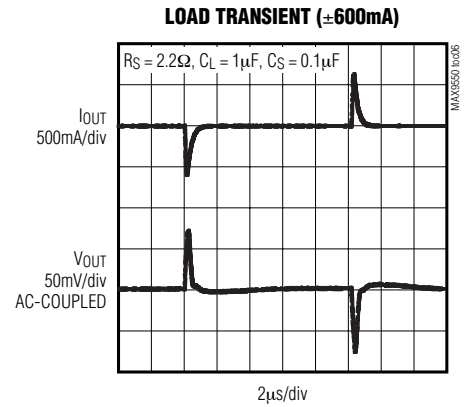
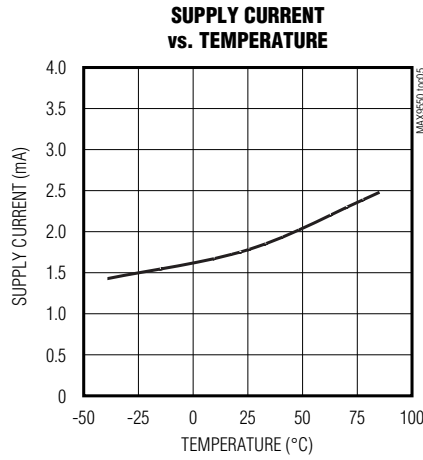
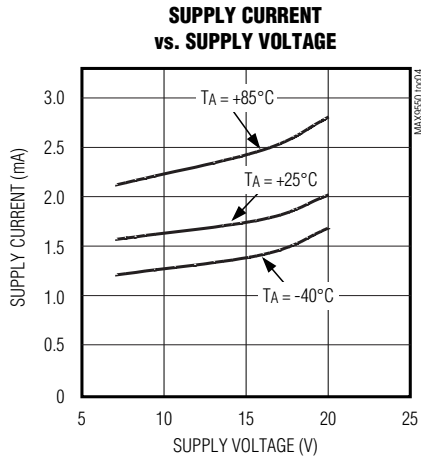
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# High-Current VCOM Drive Buffers for TFT LCDs

## Typical Operating Characteristics (continued)

( $V_{DD} = 16V$ ,  $GND = 0V$ ,  $V_{CM} = V_{OUT} = V_{DD} / 2$ ,  $C_L = 1\mu F$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



# High-Current VCOM Drive Buffers for TFT LCDs

## Pin Description

PIN				NAME	FUNCTION
MAX9550		MAX9551	MAX9552		
THIN SOT23	μMAX				
1	6	—	—	OUT	VCOM Output
2	4	4	11	GND	Ground
3	3	—	—	IN+	Positive Input
4	2	—	—	IN-	Negative Input
5	7	8	4	VDD	Positive Supply Input
—	—	1	1	OUTA	VCOM Output A
—	—	3	3	INA+	Positive Input A
—	—	2	2	INA-	Negative Input A
—	1, 5, 8	—	—	N.C.	No Connection. Not internally connected.
—	—	5	5	INB+	Positive Input B
—	—	6	6	INB-	Negative Input B
—	—	7	7	OUTB	VCOM Output B
—	—	—	8	OUTC	VCOM Output C
—	—	—	9	INC-	Negative Input C
—	—	—	10	INC+	Positive Input C
—	—	—	12	IND+	Positive Input D
—	—	—	13	IND-	Negative Input D
—	—	—	14	OUTD	VCOM Output D
—	EP	EP	EP	EP	Exposed Paddle. EP is internally connected to GND. Connect EP to GND.

MAX9550/MAX9551/MAX9552

# High-Current VCOM Drive Buffers for TFT LCDs

## Detailed Description

The MAX9550/MAX9551/MAX9552 operational transconductance amplifiers (OTA) hold the VCOM voltage stable while providing the ability to source and sink a high current quickly (800mA typ) into a capacitive load such as the backplane of a TFT-LCD panel. The output settles to within 0.1% in less than 2 $\mu$ s. The fast settling time is achieved by increasing the transconductance of the buffer as the output current increases (see the *Typical Operating Characteristics*).

In addition, the MAX9550/MAX9551/MAX9552 directly drive the capacitive load in the VCOM layer of the TFT LCD without the need for a series resistor.

The MAX9550/MAX9551/MAX9552 unity-gain bandwidth is:

$$GBW = g_M / 2\pi C_{OUT}$$

where  $C_{OUT}$  is the capacitive load at the output and  $g_M$  is the transconductance.

To insure buffer stability, place a 1 $\mu$ F low-ESR capacitor as close to the OUT pin as possible. However, this value may be reduced if the TFT-LCD panel load provides some of the capacitance and the resistance in series when this capacitance is low. Connect the feedback at OUT using a Kelvin connection at the low-ESR capacitor.

## Thermal Shutdown with Temperature Hysteresis

The MAX9550/MAX9551/MAX9552 are capable of high output currents and therefore, feature thermal-shutdown protection with temperature hysteresis. When the die temperature reaches +160°C, the devices shut down. When the die cools down by 15°C, the devices turn on again.

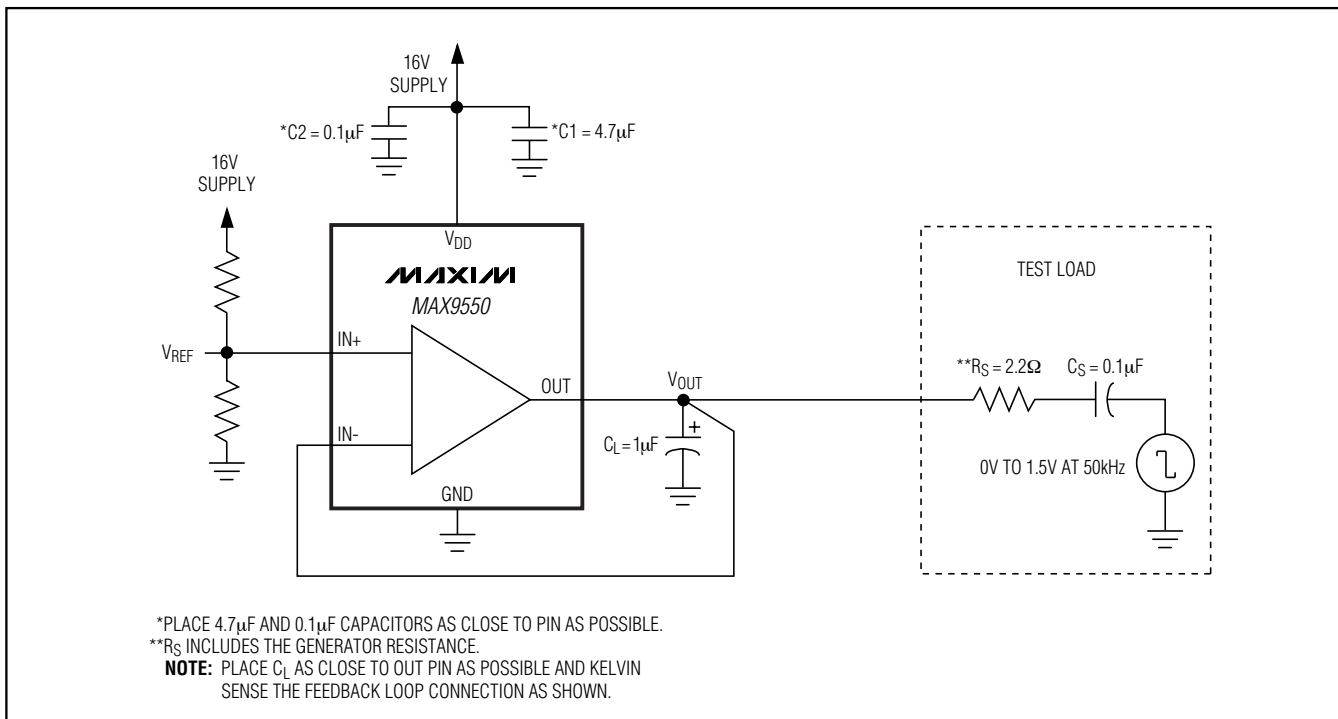


Figure 1. Settling Time Test Circuit

# High-Current VCOM Drive Buffers for TFT LCDs

## Applications Information

### Output Load Capacitor

The output load capacitor must have a low ESR value (50mΩ or lower) and it must be placed as close as possible to the OUT pin to ensure buffer stability (see Figure 2). Ceramic capacitors are an excellent choice.

### Power Supplies and Bypass Capacitors

The MAX9550/MAX9551/MAX9552 operate from a 6V to 20V single supply, or from ±3V to ±10V dual supplies. Proper supply bypassing ensures stability while driving high transient loads. The MAX9550/MAX9551/MAX9552 require minimum 4.7μF (C1) and 0.1μF (C2) power-supply bypass capacitors placed as close as possible to

the power-supply pin (V<sub>DD</sub>). See Figure 2. For dual-supply operation, use 4.7μF and 0.1μF bypass capacitors on both supplies (V<sub>DD</sub> and GND) with each capacitor placed as close as possible to the V<sub>DD</sub> and GND pins.

### Layout and Grounding

The exposed paddle on the μMAX and TSSOP packages provides a low thermal resistance for heat dissipation. Solder the exposed paddle to a ground plane for best results. Do not route traces under these packages. For dual-supply operation, the exposed paddle (EP) must be electrically connected to the negative supply or it can be left unconnected.

MAX9550/MAX9551/MAX9552

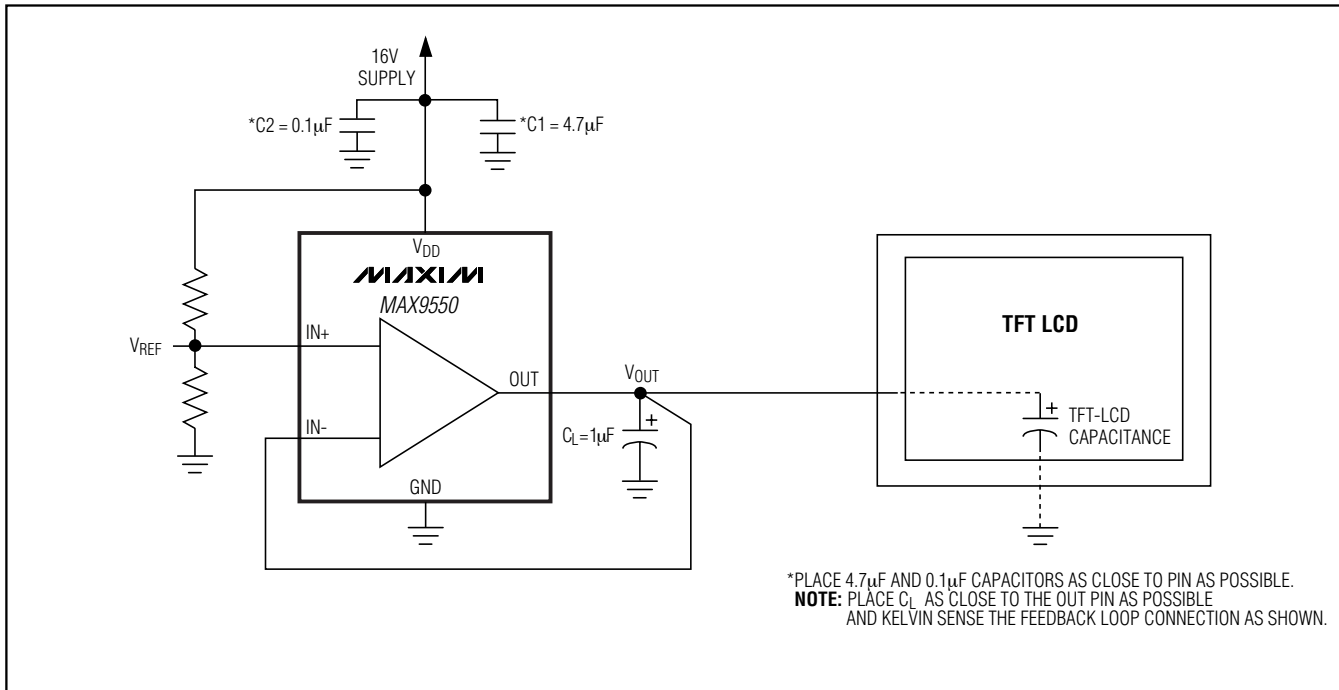
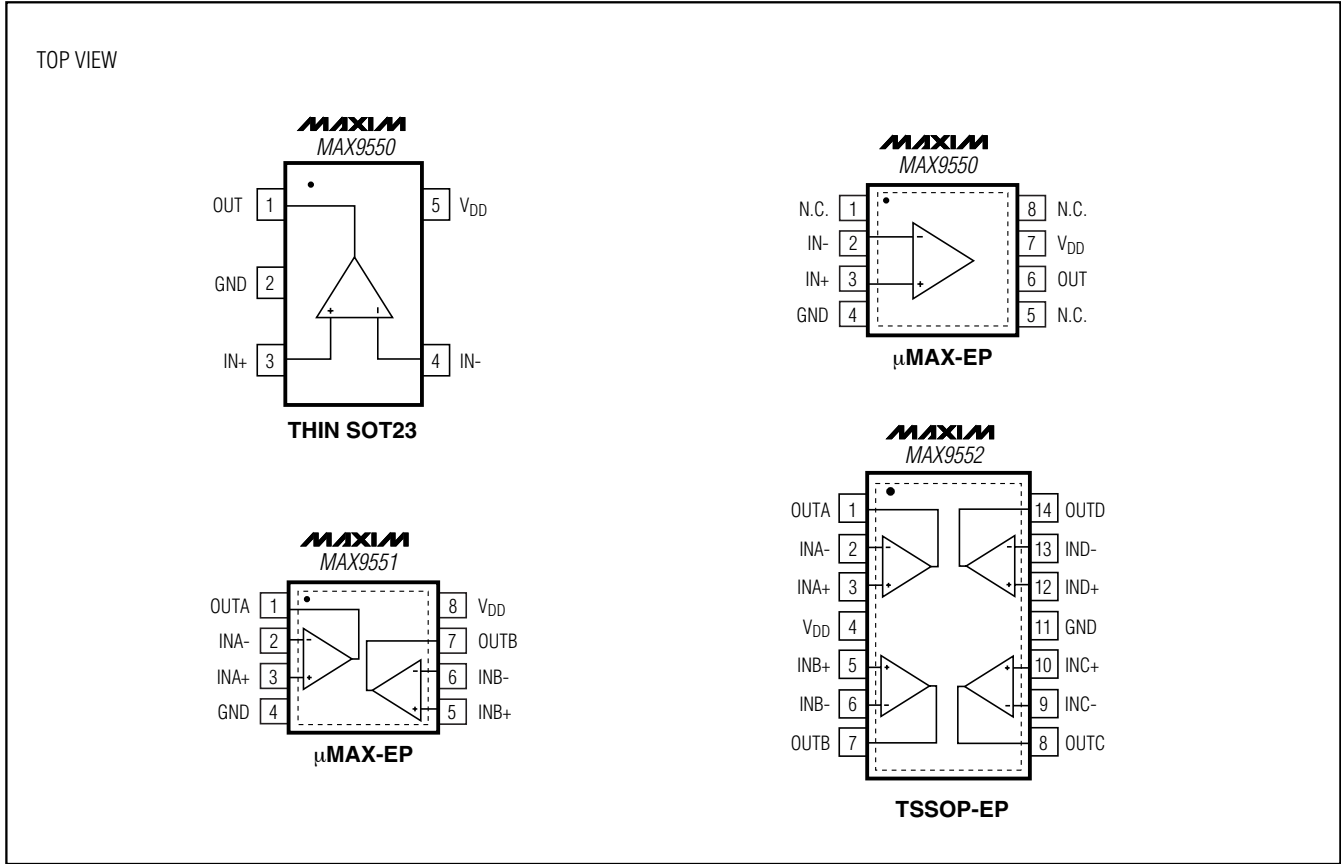


Figure 2. Typical TFT-LCD Backplane Drive Circuit

# High-Current VCOM Drive Buffers for TFT LCDs

## Pin Configurations



## Chip Information

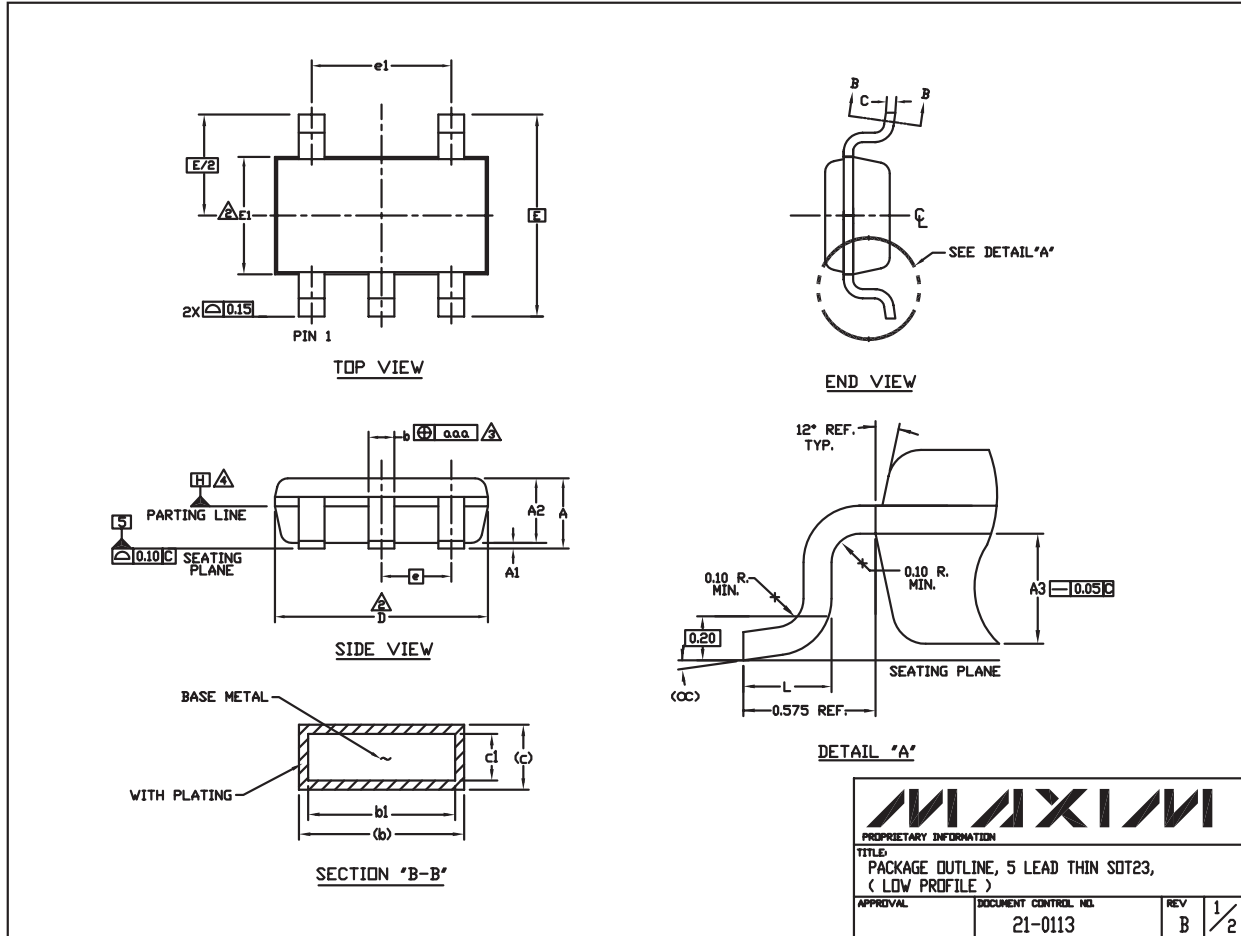
PROCESS: BiCMOS



# High-Current VCOM Drive Buffers for TFT LCDs

## Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)



MAX9550/MAX9551/MAX9552

# High-Current VCOM Drive Buffers for TFT LCDs


## Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)

### NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. "D" AND "E1" ARE REFERENCE DATUM AND DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS, AND ARE MEASURED AT THE BOTTOM PARTING LINE. MOLD FLASH OR PROTRUSION SHALL NOT EXCEED 0.15mm ON "D" AND 0.25mm ON "E" PER SIDE.
3. THE LEAD WIDTH DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.07mm TOTAL IN EXCESS OF THE LEAD WIDTH DIMENSION AT MAXIMUM MATERIAL CONDITION.
4. DATUM PLANE "H" LOCATED AT MOLD PARTING LINE AND COINCIDENT WITH LEAD, WHERE LEAD EXITS PLASTIC BODY AT THE BOTTOM OF PARTING LINE.
5. THE LEAD TIPS MUST LINE WITHIN A SPECIFIED TOLERANCE ZONE. THIS TOLERANCE ZONE IS DEFINED BY TWO PARALLEL LINES. ONE PLANE IS THE SEATING PLANE, DATUM [-C-]; AND THE OTHER PLANE IS AT THE SPECIFIED DISTANCE FROM [-C-] IN THE DIRECTION INDICATED. FORMED LEADS SHALL BE PLANAR WITH RESPECT TO ONE ANOTHER WITH 0.10mm AT SEATING PLANE.
6. THIS PART IS COMPLIANT WITH JEDEC SPECIFICATION MO-193 EXCEPT FOR THE "e" DIMENSION WHICH IS 0.95Mmm INSTEAD OF 1.00mm. THIS PART IS IN FULL COMPLIANCE TO EIAJ SPECIFICATION SC-74.

SYMBOLS			
	MIN	NOM	MAX
A	-	-	1.10
A1	0.05	0.075	0.10
A2	0.85	0.88	0.90
A3	0.50 BSC		
b	0.30	-	0.45
b1	0.25	0.35	0.40
c	0.15	-	0.20
c1	0.12	0.127	0.15
D	2.80	2.90	3.00
E	2.75 BSC		
E1	1.55	1.60	1.65
L	0.30	0.40	0.50
e1	1.90 BSC		
e	0.95 BSC		
OC	0°	4°	8°
aaa	0.20		

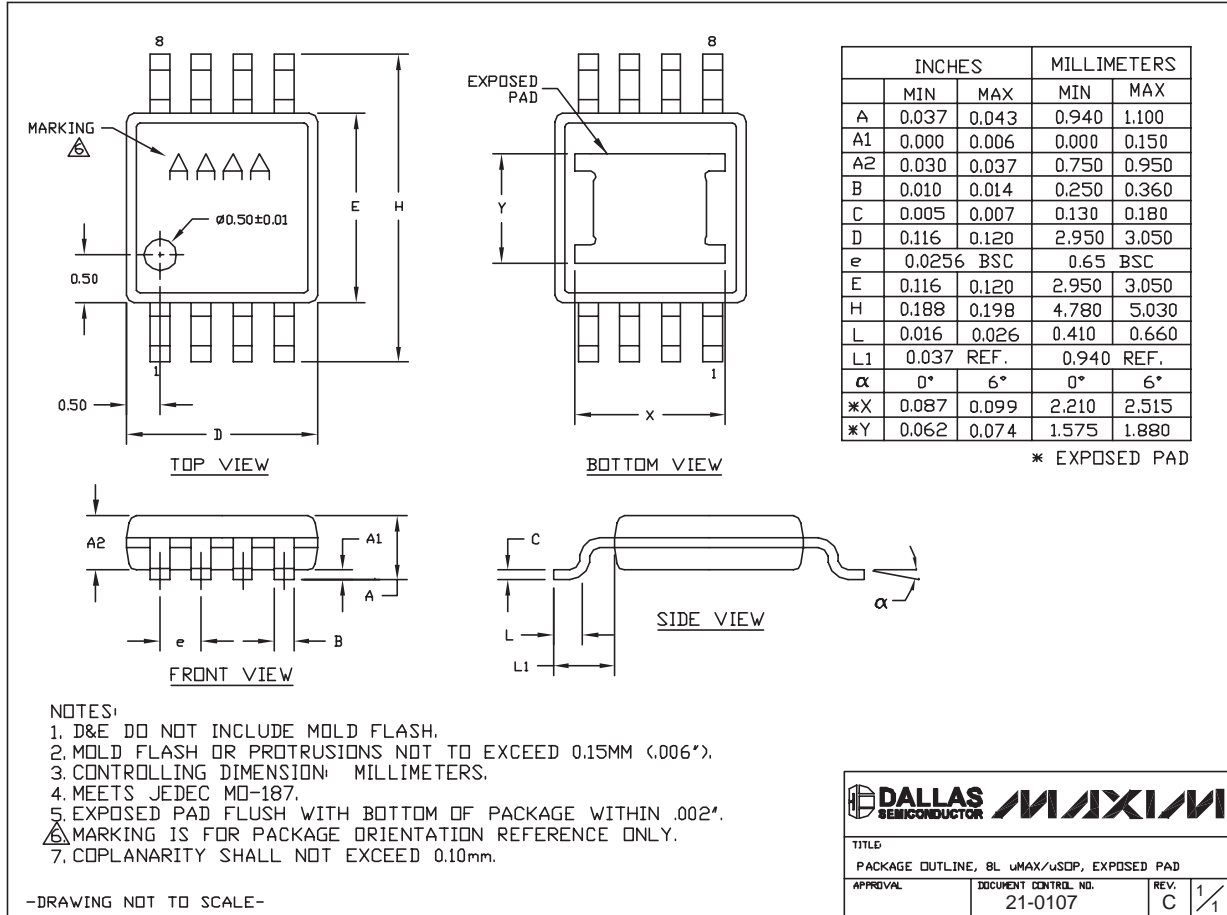
			
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<small>APPROVAL</small>	<small>DOCUMENT CONTROL NO.</small> 21-0113	<small>REV</small> B	<small>2</small> / <small>2</small>

# High-Current VCOM Drive Buffers for TFT LCDs

## Package Information (continued)

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MAX9550/MAX9551/MAX9552



# High-Current VCOM Drive Buffers for TFT LCDs

## Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)

SYMBOL	COMMON DIMENSIONS			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	---	1.10	---	0.043
A1	0.00	0.15	0.000	0.006
A2	0.05	0.95	0.003	0.037
b	0.19	0.30	0.007	0.012
b1	0.19	0.25	0.007	0.010
c	0.090	0.20	0.004	0.008
c1	0.090	0.135	0.004	0.0053
D	SEE VARIATIONS		SEE VARIATIONS	
E	4.30	4.50	0.169	0.177
e	0.65 BSC		0.026 BSC	
H	6.25	6.50	0.246	0.256
L	0.50	0.70	0.020	0.028
N	SEE VARIATIONS		SEE VARIATIONS	
Y	2.05	3.15	0.112	0.124
α	0°	8°	0°	8°

JEDEC	N	VARIATIONS				
		MILLIMETERS		INCHES		
		MIN.	MAX.	MIN.	MAX.	
MD-153						
ABT-1	14	D	4.90	5.10	0.193	0.201
		X	2.95	3.25	0.116	0.128
ABT	16	D	4.90	5.10	0.193	0.201
		X	2.85	3.15	0.112	0.124
ACT	20	D	6.40	6.60	0.252	0.260
		X	4.00	4.34	0.157	0.171
AET	28	D	9.60	9.80	0.378	0.386
		X	5.35	5.65	0.211	0.222

**NOTES:**

- DIMENSIONS D AND E DO NOT INCLUDE FLASH.
- MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15mm PER SIDE.
- CONTROLLING DIMENSION: MILLIMETERS.
- MEETS JEDEC OUTLINE MD-153. SEE JEDEC VARIATIONS TABLE.
- "N" REFERS TO NUMBER OF LEADS.
- EXPOSED PAD FLUSH WITH BOTTOM OF PACKAGE WITHIN .002".
- THE LEAD TIPS MUST LIE WITHIN A SPECIFIED ZONE. THIS TOLERANCE ZONE IS DEFINED BY TWO PARALLEL PLANES. ONE PLANE IS THE SEATING PLANE, DATUM [-C-]; THE OTHER PLANE IS AT THE SPECIFIED DISTANCE FROM [-C-] IN THE DIRECTION INDICATED.
- MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
- NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.

-DRAWING NOT TO SCALE-

**DALLAS SEMICONDUCTOR** **MAXIM**

TITLE: PACKAGE OUTLINE, TSSOP, 4.40 MM BODY, EXPOSED PAD

APPROVAL	DOCUMENT CONTROL NO. 21-0108	REV. E	1/1
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TSSOP 4.4mm BODY, EPS

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