32-Tap FleaPoT™, 2-Wire Digital Potentiometers

ABSOLUTE MAXIMUM RATINGS

V_{DD} to GND ....-0.3V to +6V
All Other Pins to GND ....-0.3V to (V_{DD} + 0.3)V
Input and Output Latch-Up Immunity ....±200mA
Maximum Continuous Current into H, L, and W
   MAX5460/MAX5461/MAX5462 (100kΩ) ....±0.6mA
   MAX5463/MAX5464/MAX5465 (50kΩ) ....±1.3mA
   MAX5466/MAX5467/MAX5468 (10kΩ) ....±1.3mA

Continuous Power Dissipation (T_A = +70°C)
   5-pin SC70 (derate 3.1mW/°C above T_A = +70°C)..........247mW
   5-pin SOT23 (derate 7.1mW/°C above T_A = +70°C)........571mW
   6-pin SC70 (derate 3.1mW/°C above T_A = +70°C)..........245mW
   6-pin SOT23 (derate 8.7mW/°C above T_A = +70°C).....695.7mW
Operating Temperature Range ....-40°C to +85°C
Junction Temperature ....+150°C
Storage Temperature Range ....-65°C to +150°C
Soldering Temperature (soldering, 10s) ....+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 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} = +2.7V to +5.5V, V_H = V_{DD}, V_L = 0, T_A = -40°C to +85°C. Typical values are at V_{DD} = +2.7V, T_A = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
DC PERFORMANCE						
Resolution			32			Taps
End-to-End Resistance		MAX5460/MAX5461/MAX5462	75	100	125	kΩ
		MAX5463/MAX5464/MAX5465	37.5	50	62.5	
		MAX5466/MAX5467/MAX5468	7.5	10	12.5	
End-to-End Resistance Tempco	TC_R			35		ppm/°C
Ratiometric Resistance Tempco				5		ppm/°C
Integral Nonlinearity	INL			±0.5	±1	LSB
Differential Nonlinearity	DNL				±1	LSB
Full-Scale Error				±0.1		LSB
Zero-Scale Error					1	LSB
Wiper Resistance	R_W	MAX5462/MAX5465		600	1200	Ω
		MAX5468		160	240	
DIGITAL INPUTS						
Input High Voltage	V_{IH}		$0.7 \times V_{DD}$			V
Input Low Voltage	V_{IL}				$0.3 \times V_{DD}$	V
TIMING CHARACTERISTICS (Figures 1, 2)						
U/$\overline{D}$ Mode to $\overline{CS}$ Setup	t_{CU}		25			ns
$\overline{CS}$ to U/$\overline{D}$ Step Setup	t_{CI}		50			ns
$\overline{CS}$ to U/$\overline{D}$ Step Hold	t_{IC}		25			ns
U/$\overline{D}$ Step Low Period	t_{IL}		25			ns
U/$\overline{D}$ Step High Period	t_{IH}		25			ns
Up/Down Toggle Rate (Note 1)	f_{TOGGLE}			1		MHz
Output Settling Time (Note 2)	t_{SETTLE}	100kΩ variable resistor configuration, C_L = 10pF		1		µs
		100kΩ potentiometer configuration, C_L = 10pF		0.25		

MAX5460–MAX5468

ELECTRICAL CHARACTERISTICS (continued)

(V_{DD} = +2.7V to +5.5V, V_H = V_{DD}, V_L = 0, T_A = -40°C to +85°C. Typical values are at V_{DD} = +2.7V, T_A = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
POWER SUPPLIES						
Supply Voltage	V_{DD}		2.7		5.5	V
Active Supply Current (Note 3)	I_{DD}				25	µA
Standby Supply Current (Note 4)	I_{SD}	V_{DD} = +5V		0.3	1	µA

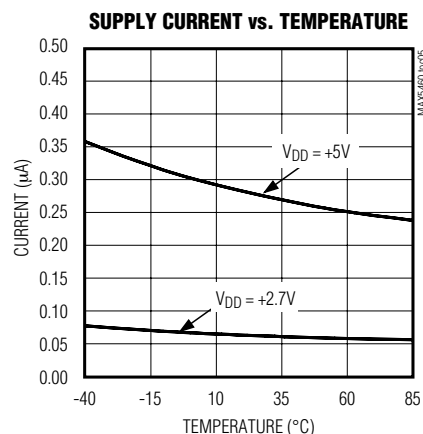**Note 1:** Up/Down Toggle Rate:
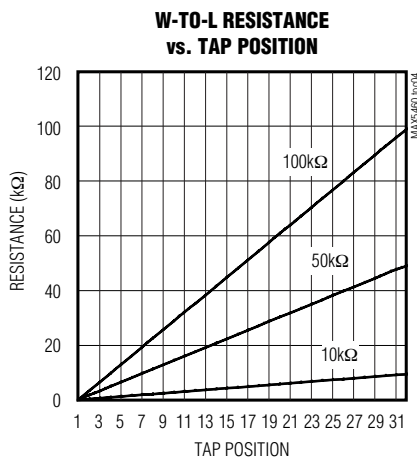
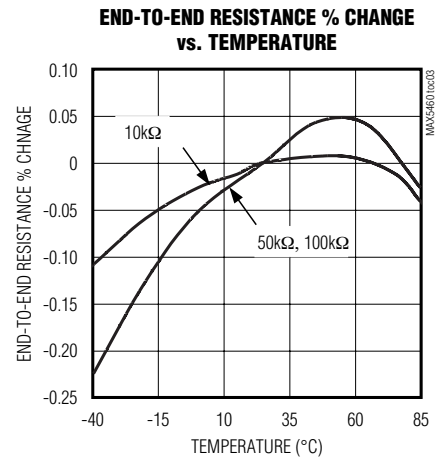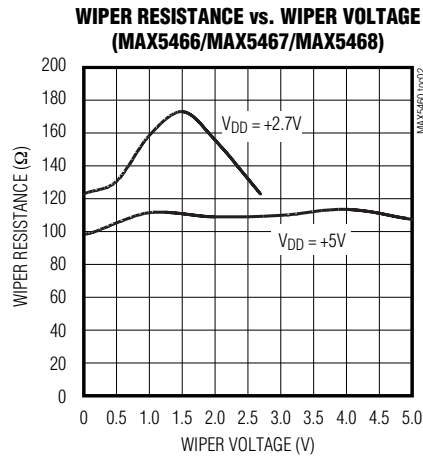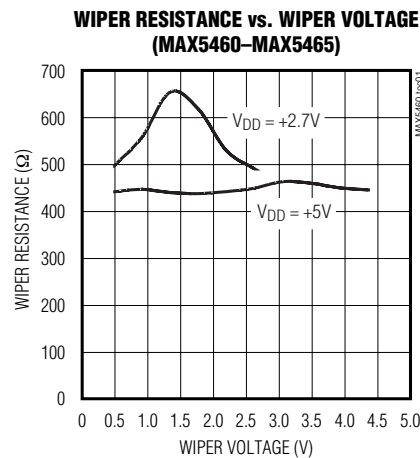$$f_{TOGGLE} = \frac{1}{t_{SETTLE}}$$

Note 2: Typical settling times are dependent on end-to-end resistance.
Note 3: Supply current taken while changing wiper tap, f_{TOGGLE} = 1MHz.
Note 4: Supply current taken while wiper position is fixed.

Typical Operating Characteristics

(T_A = +25°C, unless otherwise noted.)
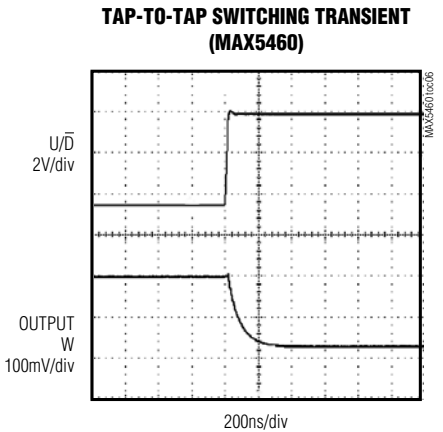
WIPER RESISTANCE vs. WIPER VOLTAGE (MAX5460–MAX5465)

WIPER RESISTANCE vs. WIPER VOLTAGE (MAX5466/MAX5467/MAX5468)

END-TO-END RESISTANCE % CHANGE vs. TEMPERATURE

W-TO-L RESISTANCE vs. TAP POSITION

SUPPLY CURRENT vs. TEMPERATURE

TAP-TO-TAP SWITCHING TRANSIENT (MAX5460)

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MAX5460–MAX5468

Typical Operating Characteristics (continued)

(T_A = +25°C, unless otherwise noted.)

R-DNL ERROR vs. INPUT CODE (100kΩ)

R-INL ERROR vs. INPUT CODE (100kΩ)

R-DNL ERROR vs. INPUT CODE (50kΩ)

R-INL ERROR vs. INPUT CODE (50kΩ)

R-DNL ERROR vs. INPUT CODE (10kΩ)

R-INL ERROR vs. INPUT CODE (10kΩ)
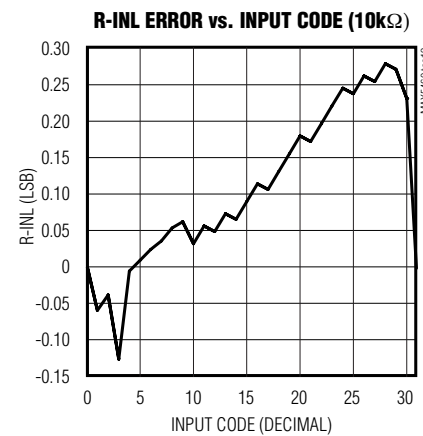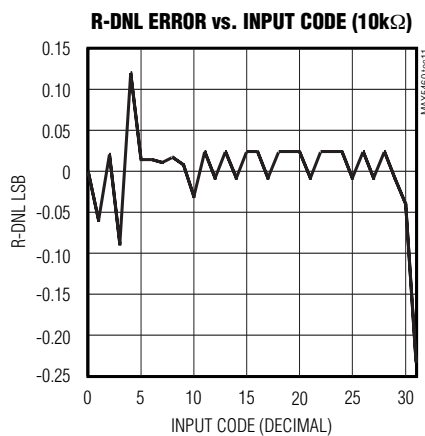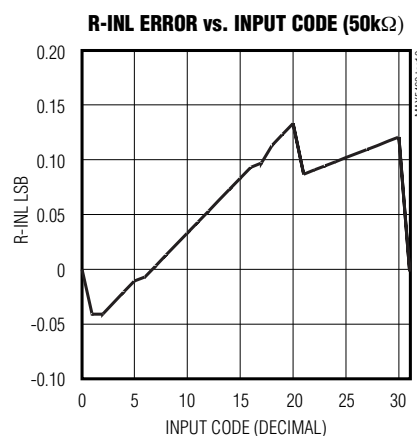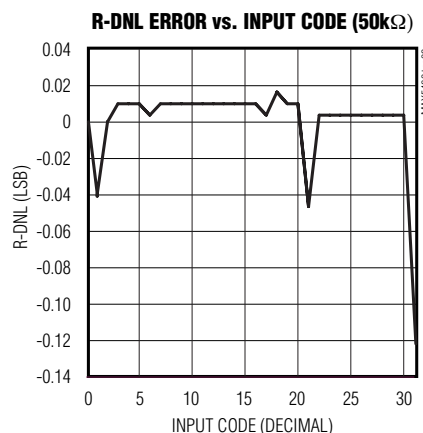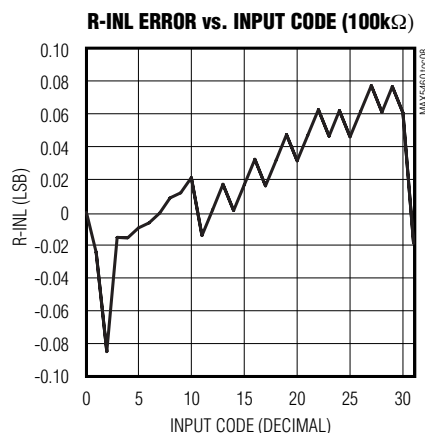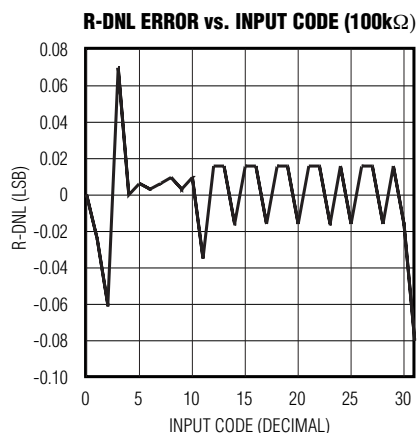
Pin Description

PIN			NAME	FUNCTION
MAX5460 MAX5463 MAX5466	MAX5461 MAX5464 MAX5467	MAX5462 MAX5465 MAX5468		
1	1	1	V_DD	Power Supply
2	2	2	GND	Ground
3	3	3	U/$\overline{D}$	Up/$\overline{Down}$ Control Input. With $\overline{CS}$ low, a low-to-high transition increments or decrements the wiper position.
4	4	4	$\overline{CS}$	Chip Select Input. A high-to-low $\overline{CS}$ transition determines the mode: increment if U/$\overline{D}$ is high, or decrement if U/$\overline{D}$ is low.
5	6	6	H	High Terminal of Resistor
—	5	—	L	Low Terminal of Resistor
—	—	5	W	Wiper Terminal of Resistor

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Detailed Description

The MAX5460–MAX5468 consist of a fixed resistor and a wiper contact with 32-tap points that are digitally controlled through a 2-wire serial interface. Three resistance values are available: 10kΩ (MAX5466/MAX5467/MAX5468), 50kΩ (MAX5463/MAX5464/MAX5465), and 100kΩ (MAX5460/MAX5461/MAX5462).

The MAX5462/MAX5465/MAX5468 are designed to operate as potentiometers. In this configuration, the low terminal of the resistor array is connected to ground (pin 2).

The MAX5461/MAX5464/MAX5467 perform as variable resistors. In these devices, the wiper terminal and high terminal of the resistor array are connected at pin 5. The MAX5460/MAX5463/MAX5466 are similar variable resistors, except the low terminal is connected to ground (pin 2).

Digital Interface Operation

The MAX5460–MAX5468 have two modes of operation when the serial interface is active: increment and decrement mode. The serial interface is only active when $\overline{CS}$ is low.

The $\overline{CS}$ and U/$\overline{D}$ inputs control the position of the wiper along the resistor array. When $\overline{CS}$ transitions from high to low, the part will go into increment mode if U/$\overline{D}$ is high, and into decrement mode if U/$\overline{D}$ is low. Once the mode is set, the device will remain in that mode until $\overline{CS}$ goes high again. A low-to-high transition at the U/$\overline{D}$ pin will increment or decrement the wiper position depending on the current mode (Figures 1 and 2).

When the $\overline{CS}$ input transitions to high (serial interface inactive), the value of the counter is stored and the wiper position is maintained.

Note that when the wiper reaches the maximum (or minimum) tap position, the wiper will not wrap around to the minimum (or maximum) position.

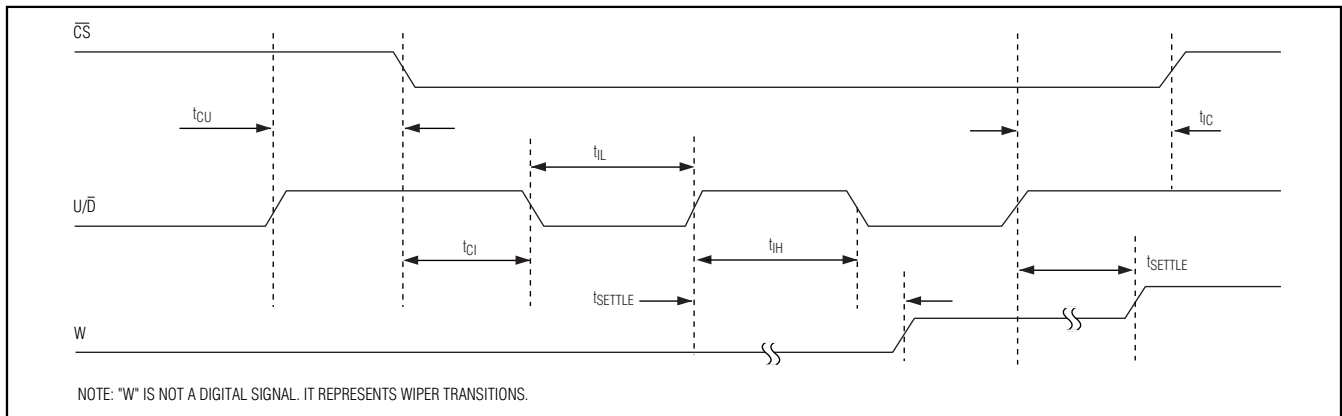NOTE: "W" IS NOT A DIGITAL SIGNAL. IT REPRESENTS WIPER TRANSITIONS.

Figure 1. Serial Interface Timing Diagram, Increment Mode

NOTE: "W" IS NOT A DIGITAL SIGNAL. IT REPRESENTS WIPER TRANSITIONS.
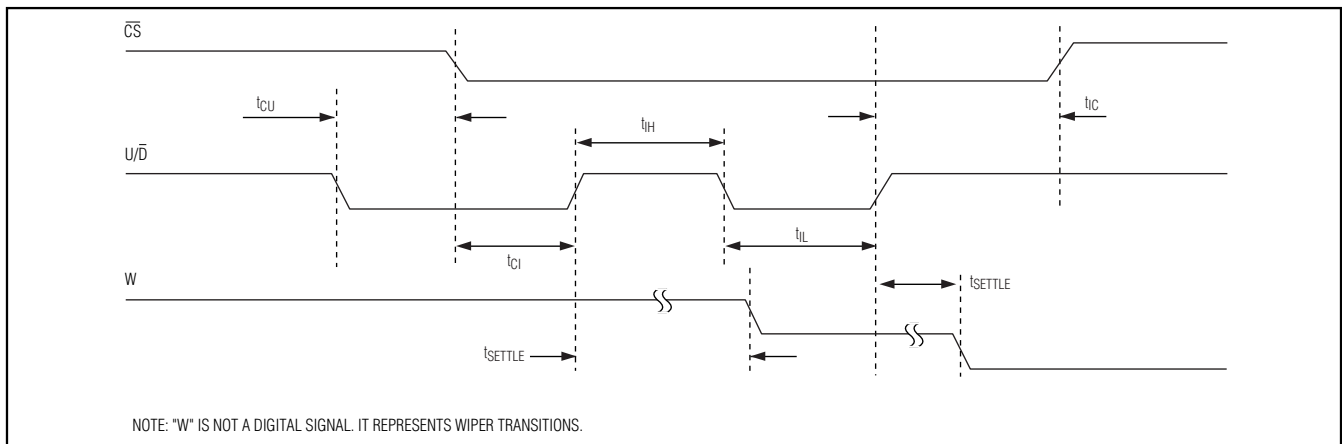
Figure 2. Serial Interface Timing Diagram, Decrement Mode

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32-Tap FleaPoT™, 2-Wire Digital Potentiometers

Power-On Reset

All parts in this family feature power-on reset (POR) circuitry that sets the wiper position to midscale at power-up. By default, the chip is in the increment mode.

_____Applications Information

The MAX5460–MAX5468 are intended for circuits requiring digitally controlled adjustable resistance, such as LCD contrast control, where voltage biasing adjusts the display contrast.

Controlling a Switch-Mode LCD Bias Generator

Figure 3 shows an application where the variable resistor is used with a MAX1771 to make an adjustable positive LCD-bias circuit. The output of the MAX1771 is a positive voltage that is digitally controlled through the MAX5461/MAX5464/MAX5467. Similarly, Figure 4 shows the application of the variable resistor in a digitally controlled negative LCD-bias circuit along with the MAX774/MAX775/MAX776.

Alternative Positive LCD Bias Control

Alternatively, use an op amp to provide buffering and gain to the output of the MAX5462/MAX5465/MAX5468. Connect the mechanical potentiometer to the positive input of a noninverting op amp (Figure 5) to select a portion of the input signal by digitally controlling the wiper terminal. Figure 6 shows a similar circuit for the MAX5461/MAX5464/MAX5467.

Adjustable Gain

Figure 7 shows how to use the variable resistor to digitally adjust the gain of a noninverting op amp configuration. Connect the MAX5461/MAX5464/MAX5467 in series with a resistor to ground to form the adjustable gain control of a noninverting amplifier. The MAX5460–MAX5468 have a low 5ppm/°C ratiometric tempco that allows for a very stable adjustable gain configuration over temperature.
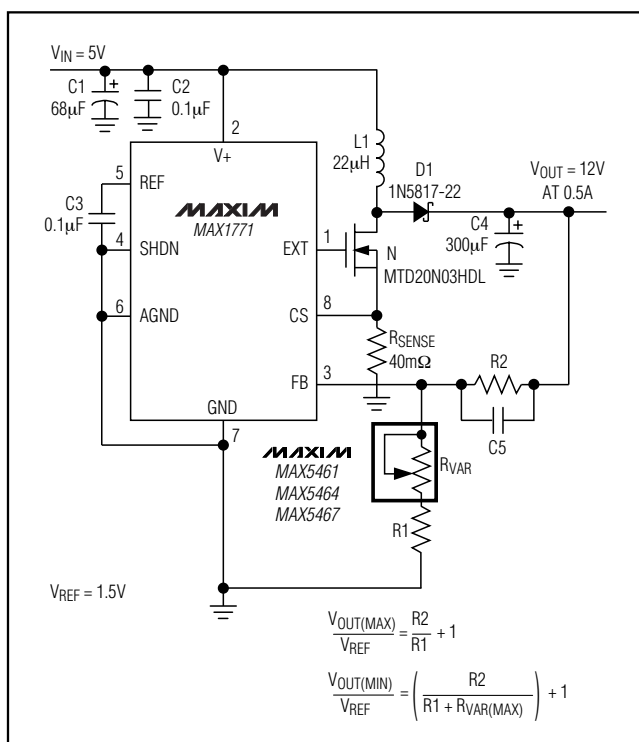
Figure 3. Adjustable Positive LCD Bias

$$\frac{V_{OUT(MAX)}}{V_{REF}} = \frac{R2}{R1} + 1$$

$$\frac{V_{OUT(MIN)}}{V_{REF}} = \left(\frac{R2}{R1 + R_{VAR(MAX)}}\right) + 1$$
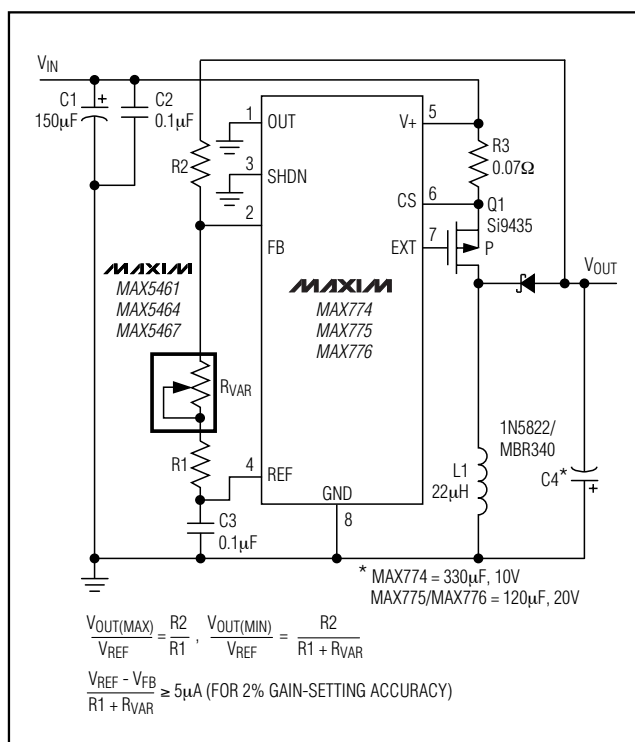
Figure 4. Adjustable Negative LCD Bias

$$\frac{V_{OUT(MAX)}}{V_{REF}} = \frac{R2}{R1}, \quad \frac{V_{OUT(MIN)}}{V_{REF}} = \frac{R2}{R1 + R_{VAR}}$$

$$\frac{V_{REF} - V_{FB}}{R1 + R_{VAR}} \geq 5\mu A \text{ (FOR 2\% GAIN-SETTING ACCURACY)}$$

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Figure 5. Positive LCD Bias Control
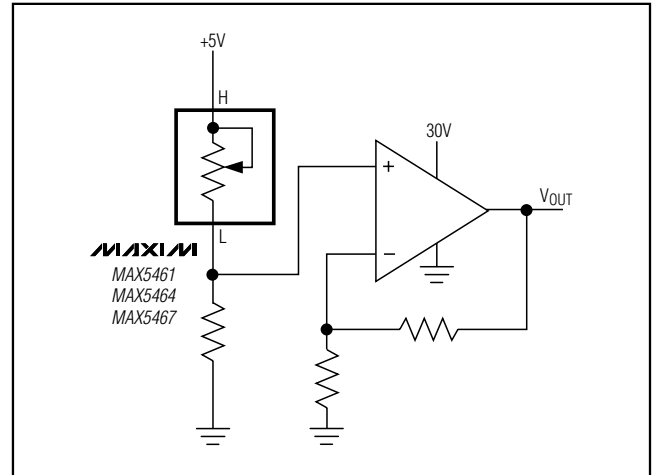
Figure 6. Positive LCD Bias Control
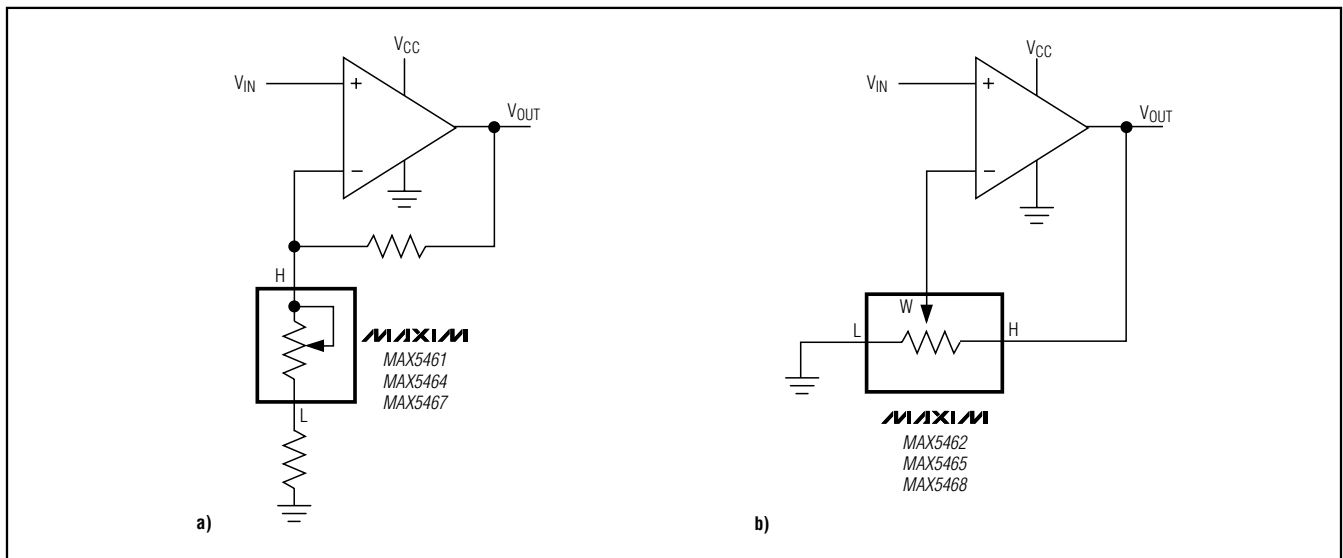
Figure 7. Adjustable Gain Circuit

MAX5460–MAX5468

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32-Tap FleaPoT™, 2-Wire Digital Potentiometers

_____Functional Diagram
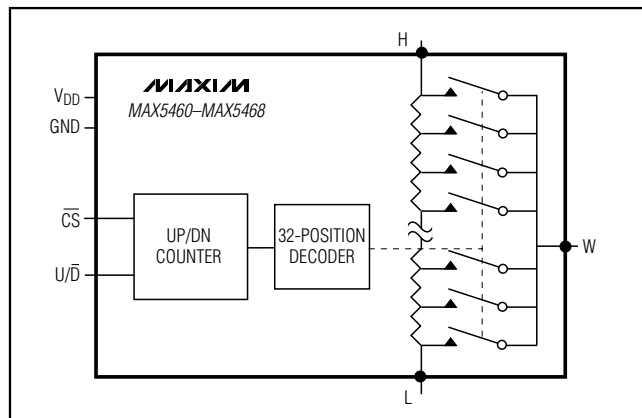
_____Chip Information

TRANSISTOR COUNT: 792

32-Tap FleaPoT™, 2-Wire Digital Potentiometers

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**.)

COMMON DIMENSIONS		
SYMBOL	MIN	MAX
A	0.80	1.10
A1	0.00	0.10
A2	0.80	1.00
b	0.15	0.30
c	0.10	0.18
D	1.80	2.20
e	0.65 BSC.	
E	1.15	1.35
HE	1.80	2.40
L	0.10	0.40
L1	0.425 TYP.	
Q1	0.10	0.40

NOTE:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONS ARE INCLUSIVE OF PLATING.
3. DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH & METAL BURR.
4. COMPLY TO EIAJ SC70 EXCEPT FOR PIN COUNT AND DIMENSION "b".
5. COPLANARITY 4 MILS. MAX.
6. FOOT LENGTH MEASURED AT INTERCEPT POINT BETWEEN DATUM "A" AND LEAD SURFACE.
7. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
8. LEAD CENTERLINES TO BE AT TRUE POSITION AS DEFINED BY BASIC DIMENSION "e", ±0.05.

DALLAS SEMICONDUCTOR / MAXIM

TITLE: PACKAGE OUTLINE, 5L SC70

DOCUMENT CONTROL NO. 21-0076 REV. C 1/1

−DRAWING NOT TO SCALE−

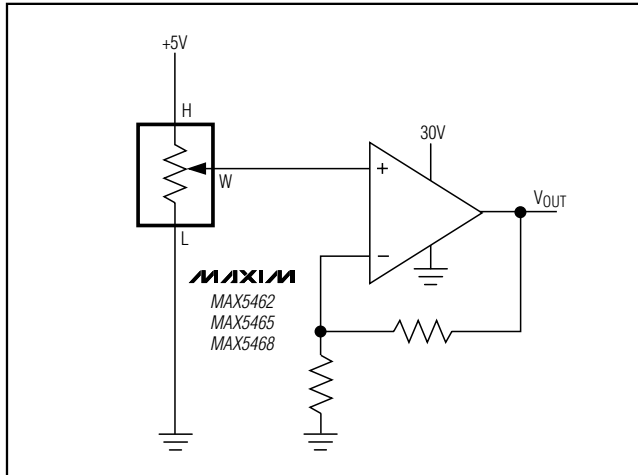| SYMBOL	MIN	MAX
A	0.90	1.45
A1	0.00	0.15
A2	0.90	1.30
b	0.35	0.50
C	0.08	0.20
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.75
L	0.35	0.60
L1	0.60 REF	
e	0.95 BSC.	
e1	1.90 BSC.	
α	0°	8°

TOP VIEW

SIDE VIEW

FRONT VIEW

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. FOOT LENGTH MEASURED AT INTERCEPT POINT BETWEEN DATUM A & LEAD SURFACE.
3. PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH & METAL BURR. MOLD FLASH, PROTRUSION OR METAL BURR SHOULD NOT EXCEED 0.25 MM.
4. PACKAGE OUTLINE INCLUSIVE OF SOLDER PLATING.
5. MEETS JEDEC MO178, VARIATION AA.
6. LEADS TO BE COPLANAR WITHIN 0.10 mm.
7. SOLDER THICKNESS MEASURED AT FLAT SECTION OF LEAD BETWEEN 0.08mm AND 0.15mm FROM LEAD TIP.

DALLAS SEMICONDUCTOR / MAXIM

PROPRIETARY INFORMATION

TITLE: PACKAGE OUTLINE, SOT-23, 5L

DOCUMENT CONTROL NO. 21-0057 REV. E 1/1

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MAX5460–MAX5468

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**.)

SYMBOL	MIN	MAX
A	0.90	1.45
A1	0.00	0.15
A2	0.90	1.30
b	0.35	0.50
C	0.08	0.20
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.75
L	0.35	0.60
L1	0.60 REF.	
e1	1.90 BSC.	
e	0.95 BSC.	
α	0°	10°

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. FOOT LENGTH MEASURED AT INTERCEPT POINT BETWEEN DATUM A & LEAD SURFACE.
3. PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH & METAL BURR. MOLD FLASH, PROTRUSION OR METAL BURR SHOULD NOT EXCEED 0.25 MM.
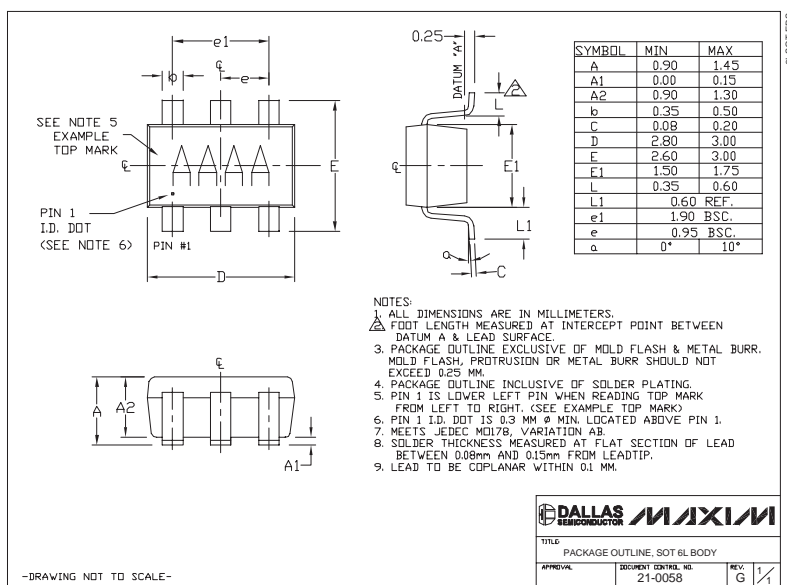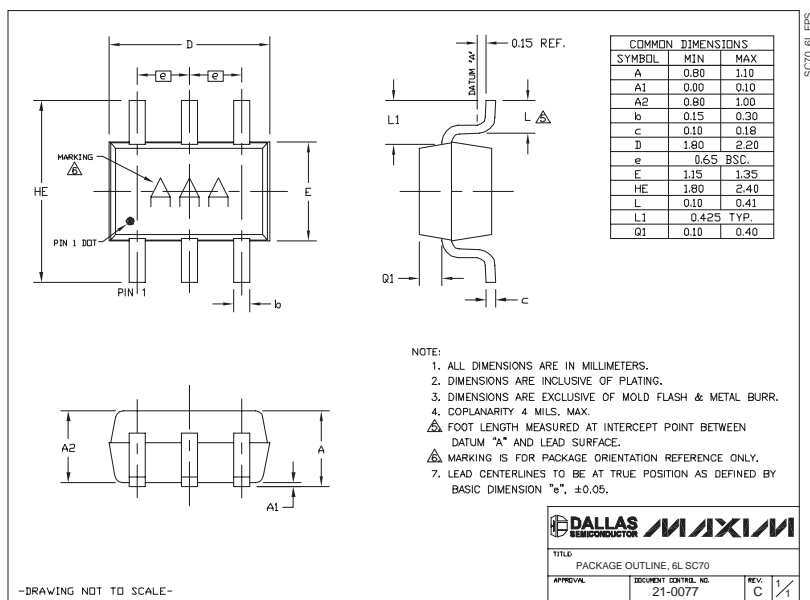4. PACKAGE OUTLINE INCLUSIVE OF SOLDER PLATING.
5. PIN 1 IS LOWER LEFT PIN WHEN READING TOP MARK FROM LEFT TO RIGHT. (SEE EXAMPLE TOP MARK)
6. PIN 1 I.D. DOT IS 0.3 MM Ø MIN. LOCATED ABOVE PIN 1.
7. MEETS JEDEC MO178, VARIATION AB.
8. SOLDER THICKNESS MEASURED AT FLAT SECTION OF LEAD BETWEEN 0.08mm AND 0.15mm FROM LEADTIP.
9. LEAD TO BE COPLANAR WITHIN 0.1 MM.

DALLAS SEMICONDUCTOR /VI/IXI/VI

TITLE: PACKAGE OUTLINE, SOT 6L BODY

APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0058	G	1/1

–DRAWING NOT TO SCALE–

COMMON DIMENSIONS		
SYMBOL	MIN	MAX
A	0.80	1.10
A1	0.00	0.10
A2	0.80	1.00
b	0.15	0.30
c	0.10	0.18
D	1.80	2.20
e	0.65 BSC.	
E	1.15	1.35
HE	1.80	2.40
L	0.10	0.41
L1	0.425 TYP.	
Q1	0.10	0.40

NOTE:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONS ARE INCLUSIVE OF PLATING.
3. DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH & METAL BURR.
4. COPLANARITY 4 MILS. MAX.
5. FOOT LENGTH MEASURED AT INTERCEPT POINT BETWEEN DATUM "A" AND LEAD SURFACE.
6. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
7. LEAD CENTERLINES TO BE AT TRUE POSITION AS DEFINED BY BASIC DIMENSION "e", ±0.05.

DALLAS SEMICONDUCTOR /VI/IXI/VI

TITLE: PACKAGE OUTLINE, 6L SC70

APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0077	C	1/1

–DRAWING NOT TO SCALE–

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