Digitally Controlled Potentiometer (XDCP)

The Intersil ISL90460 is a digitally controlled potentiometer (XDCP). Configured as a variable resistor, the device consists of a resistor array, wiper switches, a control section, and volatile memory. The wiper position is controlled by a 2-pin Up/Down interface.

The potentiometer is implemented by a resistor array composed of 31 resistive elements and a wiper switching network. Between each element and at either end are tap points accessible to the wiper terminal. The position of the wiper element is controlled by the $\overline{CS}$ and U/$\overline{D}$ inputs.

The device can be used in a wide variety of applications including:

- LCD contrast control
- Parameter and bias adjustments
- Industrial and automotive control
- Transducer adjustment of pressure, temperature, position, chemical, and optical sensors
- Laser Diode driver biasing
- Gain control and offset adjustment

Ordering Information

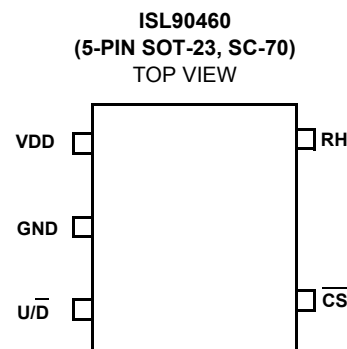| PART NUMBER	RTOTAL	PACKAGE	TEMP RANGE (°C)
ISL90460TIE527	100K	SC-70	-40 to +85
ISL90460TIE527Z (See Note)	100K	SC-70 (Pb-free)	-40 to +85
ISL90460UIE527	50K	SC-70	-40 to +85
ISL90460UIE527Z (See Note)	50K	SC-70 (Pb-free)	-40 to +85
ISL90460WIE527	10K	SC-70	-40 to +85
ISL90460WIE527Z (See Note)	10K	SC-70 (Pb-free)	-40 to +85
ISL90460TIH527	100K	SOT-23	-40 to +85
ISL90460TIH527Z (See Note)	100K	SOT-23 (Pb-free)	-40 to +85
ISL90460UIH527	50K	SOT-23	-40 to +85
ISL90460UIH527Z (See Note)	50K	SOT-23 (Pb-free)	-40 to +85
ISL90460WIH527	10K	SOT-23	-40 to +85
ISL90460WIH527Z (See Note)	10K	SOT-23 (Pb-free)	-40 to +85

Add "-TK" suffix for tape and reel.

NOTE: Intersil Pb-free plus anneal products employ special Pb-free material sets; molding compounds/die attach materials and 100% matte tin plate termination finish, which are RoHS compliant and compatible with both SnPb and Pb-free soldering operations. Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020.

Features

- Volatile Solid-State Potentiometer
- 2-pin UP/DN Interface
- DCP Terminal Voltage, 2.7V to 5.5V
- Tempco 35ppm/°C Typical
- 32 Wiper Tap Points
- Low Power CMOS
  - Active current 25µA max.
  - Supply current 0.3µA
- Available R_{TOTAL} Values = 10kΩ, 50kΩ, 100kΩ
- Temp Range -40°C to +85°C
- Packages
  - 5 lead SC-70, SOT-23
- Pb-Free Plus Anneal Available (RoHS Compliant)

Pinout

ISL90460
(5-PIN SOT-23, SC-70)
TOP VIEW

VDD — RH
GND
U/$\overline{D}$ — $\overline{CS}$

Block Diagram

GENERAL
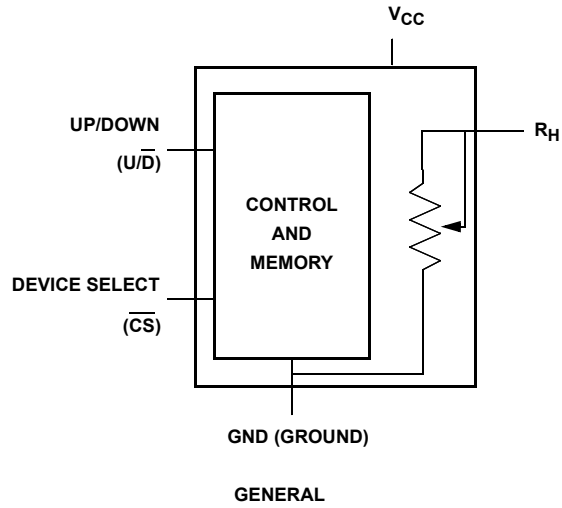
Pin Descriptions

SOT-23/SC-70 5-PIN	SYMBOL	DESCRIPTION
1	VDD	Supply voltage
2	GND	Ground
3	U/$\overline{\text{D}}$	Up - Down
4	$\overline{\text{CS}}$	Chip select
5	RH	High terminal/Wiper terminal

Absolute Maximum Ratings

Storage temperature . . . .-65°C to +150°C
Voltage on $\overline{CS}$, U/$\overline{D}$ and V_{CC} with respect to GND . . . . . -1V to +7V
Lead temperature (soldering 10 seconds) . . . . .300°C
I_W (10 seconds) . . . . ±6mA
Power rating 1mW

Recommended Operating Conditions

Temperature Range (Industrial) . . . .-40°C to 85°C
Supply Voltage (V_{CC}) . . . . 2.7V to 5.5V

CAUTION: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only; functional operation of the device (at these or any other conditions above those listed in the operational sections of this specification) is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Potentiometer Specifications   Over recommended operating conditions unless otherwise stated

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP (Note 4)	MAX	UNIT
R_{TOT}	End to end resistance	W version	8	10	12	kΩ
		U version	40	50	60	kΩ
		T version	80	100	120	kΩ
V_R	R_H, R_L terminal voltages		0		V_{CC}	V
	Noise	Ref: 1kHz		-120		dBV
R_W	Wiper Resistance			600		Ω
I_W	Wiper Current				0.6	mA
	Resolution		32			Taps
	Absolute linearity (Note 1)	$R_{H(n)(actual)} - R_{H(n)(expected)}$			±1	MI (Note 3)
	Relative linearity (Note 2)	$R_{H(n+1)} - [R_{H(n)} + MI]$			±0.5	MI (Note 3)
	R_{TOTAL} temperature coefficient			±35		ppm/°C
$C_H/C_L/C_W$	Potentiometer capacitances	See circuit #3		10/10/25		pF

NOTES:

1. Absolute linearity is utilized to determine actual wiper voltage versus expected voltage = $(R_{H(n)}(actual) - R_{H(n)}(expected)) = ±1$ MI Maximum. n = 1 .. 29 only.

2. Relative linearity is a measure of the error in step size between taps = $R_{H(n+1)} - [R_{H(n)} + MI] = ±0.5$ MI, n = 1 .. 29 only.

3. 1 MI = Minimum Increment = $R_{TOT}/31$.

4. Typical values are for $T_A = 25°C$ and nominal supply voltage.

DC Electrical Specifications   Over recommended operating conditions unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP (Note 4)	MAX	UNIT
I_{CC}	V_{CC} active current (Increment)	$\overline{CS} = 0V$, U/$\overline{D} = f_{clock} = 1MHz$ and $V_{CC} = 3V$			25	μA
I_{SB}	Standby supply current	$\overline{CS} = V_{CC}$, U/$\overline{D} = V_{SS}$ or $V_{CC} = 3V$		0.3	1	μA
I_{LI}	$\overline{CS}$ input leakage current	$V_{IN} = V_{SS}$ to V_{CC}			±1	μA
I_{LI}	U/$\overline{D}$ input leakage current	$V_{IN} = V_{SS}$ to V_{CC}			±1	μA
V_{IH}	$\overline{CS}$, U/$\overline{D}$ input HIGH voltage		V_{CC} x 0.7			V
V_{IL}	$\overline{CS}$, U/$\overline{D}$ input LOW voltage				V_{CC} x 0.3	V
C_{IN}	$\overline{CS}$, U/$\overline{D}$ input capacitance	$V_{CC} = 3V$, $V_{IN} = V_{SS}$, $T_A = 25°C$, f = 1MHz		10		pF

Timing Specifications

Over recommended operating conditions unless otherwise specified) (Figures 1 and 2)

SYMBOL	PARAMETER	MIN	TYP (Note 4)	MAX	UNIT
t_{CU}	U/$\overline{D}$ to $\overline{CS}$ setup	25			ns
t_{CI}	$\overline{CS}$ to U/$\overline{D}$ setup	50			ns
t_{IC}	$\overline{CS}$ to U/$\overline{D}$ hold	25			ns
t_{IL}	U/$\overline{D}$ LOW period	300			ns
t_{IH}	U/$\overline{D}$ HIGH period	300			ns
f_{TOGGLE}	Up/Down toggle rate		1		MHz
t_{SETTLE}	Output settling time		1		µs
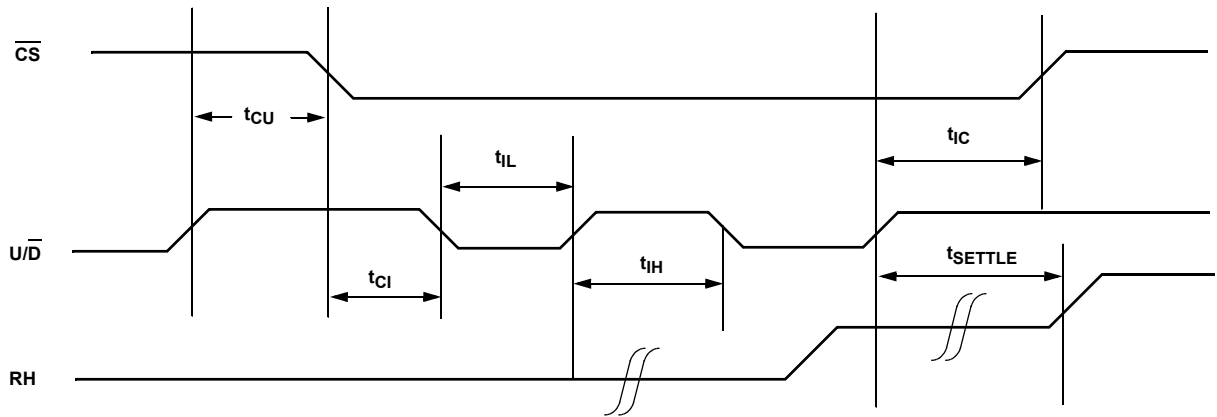
FIGURE 1. SERIAL INTERFACE TIMING DIAGRAM, INCREMENT
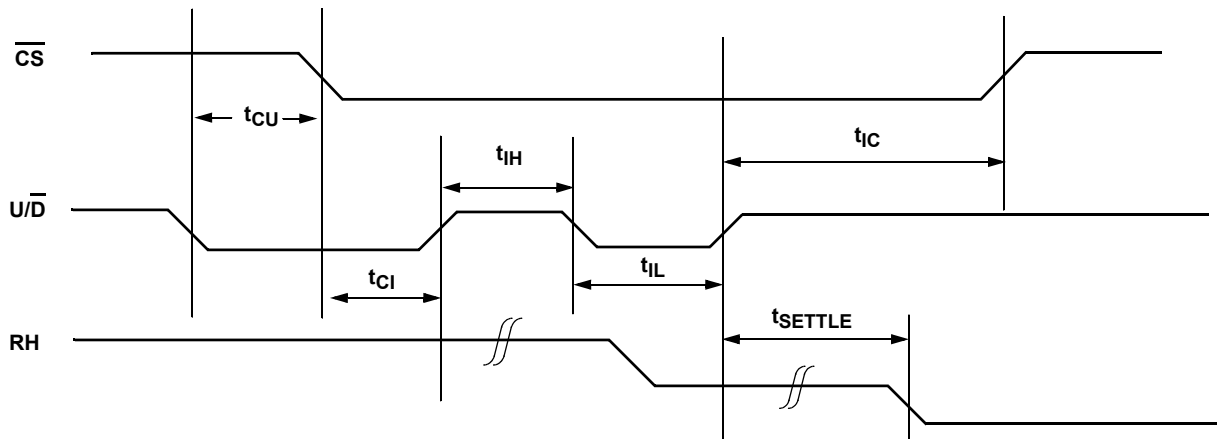
FIGURE 2. SERIAL INTERFACE TIMING DIAGRAM, DECREMENT

Pin Descriptions

R_H

The ISL90460 contains a digital potentiometer connected as a rheostat or variable resistor. The wiper and one terminal of the digital potentiomerter is tied to the RH pin, and the other terminal of the potentiometer is tied to the ground pin (GND). The resistance from the RH pin to ground will vary with the potentiometer setting; at the highest setting, the resistance will be the maximum (Rtot), at the lowest setting it will be a minimum.

Up/Down (U/$\overline{D}$)

The U/$\overline{D}$ input controls the direction of the wiper movement and whether the counter is incremented or decremented.

Chip Select ($\overline{CS}$)

The device is selected when the $\overline{CS}$ input is LOW. The current counter value is stored in volatile memory when $\overline{CS}$ is returned HIGH. When $\overline{CS}$ is high, the device is placed in low power standby mode.
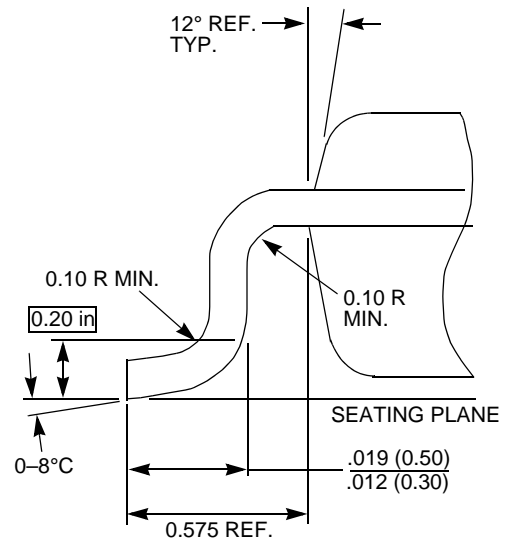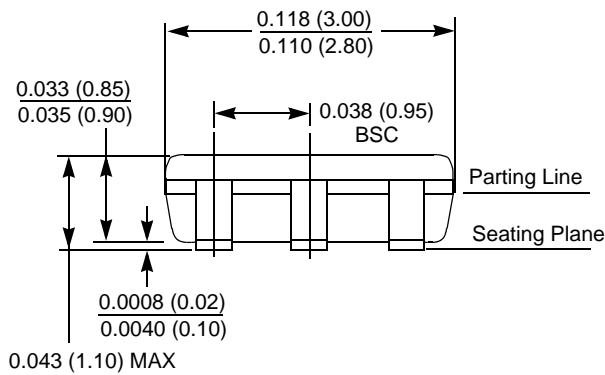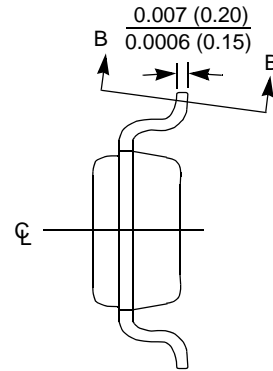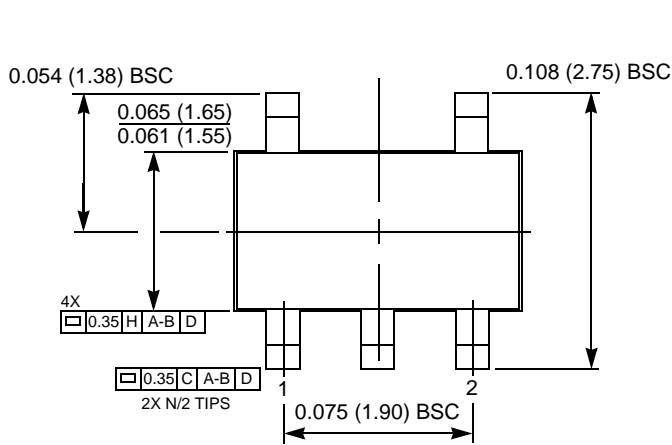
Principles of Operation

There are two sections of the ISL90460: the input control, counter and decode section; and the resistor array. The input control section operates just like an up/down counter. The output of this counter is decoded to turn on a single electronic switch connecting a point on the resistor array to the wiper output. The resistor array is comprised of 31 individual resistors connected in series. At either end of the array and between each resistor is an electronic switch that transfers the connection at that point to the wiper. The wiper is connected to the R_H terminal, forming a variable resistor from R_H to GND.

The wiper, when at either fixed terminal, acts like its mechanical equivalent and does not move beyond the last position. That is, the counter does not wrap around when clocked to either extreme.

If the wiper is moved several positions, multiple taps are connected to the wiper for t_{IW} (U/$\overline{D}$ to V_W change). The 2-terminal resistance value for the device can temporarily change by a significant amount if the wiper is moved several positions.

5-Lead, SOT23, Package Code G5

0.054 (1.38) BSC

0.108 (2.75) BSC

$\dfrac{0.065 (1.65)}{0.061 (1.55)}$

$\dfrac{0.007 (0.20)}{0.0006 (0.15)}$

B

B

4X
0.35 H A-B D

0.35 C A-B D
2X N/2 TIPS

1

2

0.075 (1.90) BSC

Ç

$\dfrac{0.118 (3.00)}{0.110 (2.80)}$

$\dfrac{0.033 (0.85)}{0.035 (0.90)}$

0.038 (0.95)
BSC

Parting Line

Seating Plane

$\dfrac{0.0008 (0.02)}{0.0040 (0.10)}$

0.043 (1.10) MAX

12° REF.
TYP.

0.10 R MIN.

0.10 R
MIN.

0.20 in

0–8°C

SEATING PLANE

$\dfrac{.019 (0.50)}{.012 (0.30)}$

0.575 REF.

NOTES:

1. ALL DIMENSIONS IN INCHES (IN PARENTHESES IN MILLIMETERS)
2. PACKAGE DIMENSIONS EXCLUDE MOLDING FLASH
3. DIMENSIONING AND TOLERANCES PER ASME, Y14.5-1994
4. THIS PART IS COMPLIANT WITH JEDEC SPECIFICATION MO-193.
5. THIS PART IS FULL COMPLIANCE TO EIAJ SPECIFICATION SC-74

Small Outline Transistor Plastic Packages (SC70-5)
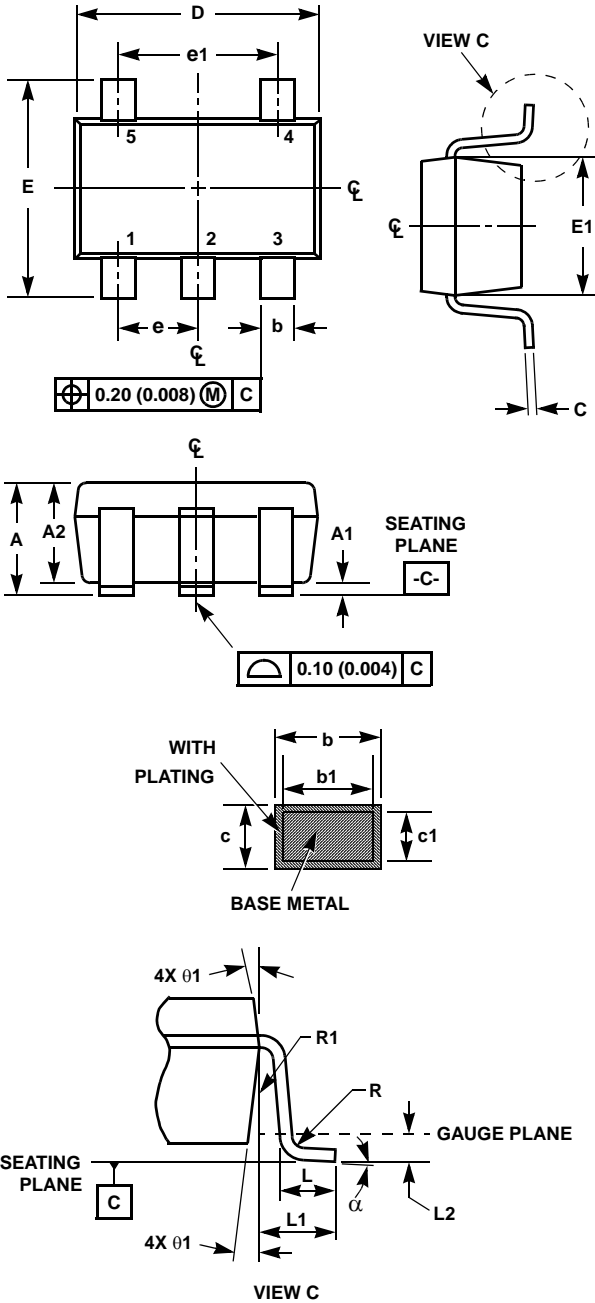
SC70-5
5 LEAD SMALL OUTLINE TRANSISTOR PLASTIC PACKAGE

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.031	0.043	0.80	1.10	-
A1	0.000	0.004	0.00	0.10	-
A2	0.031	0.039	0.80	1.00	-
b	0.006	0.012	0.15	0.30	-
b1	0.006	0.010	0.15	0.25	
c	0.003	0.009	0.08	0.22	6
c1	0.003	0.009	0.08	0.20	6
D	0.071	0.087	1.80	2.20	3
E	0.071	0.094	1.80	2.40	-
E1	0.045	0.053	1.15	1.35	3
e	0.0256 Ref		0.65 Ref		-
e1	0.0512 Ref		1.30 Ref		-
L	0.010	0.018	0.26	0.46	4
L1	0.017 Ref.		0.420 Ref.		-
L2	0.006 BSC		0.15 BSC		
α	0°	8°	0°	8°	-
N	5		5		5
R	0.004	-	0.10	-	
R1	0.004	0.010	0.15	0.25	

NOTES:

1. Dimensioning and tolerances per ASME Y14.5M-1994.

2. Package conforms to EIAJ SC70 and JEDEC MO-203AA.

3. Dimensions D and E1 are exclusive of mold flash, protrusions, or gate burrs.

4. Footlength L measured at reference to gauge plane.

5. "N" is the number of terminal positions.

6. These Dimensions apply to the flat section of the lead between 0.08mm and 0.15mm from the lead tip.

7. Controlling dimension: MILLIMETER. Converted inch dimensions are for reference only.

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