LR3694

Power Supply IC for PIT LCD System

DESCRIPTION

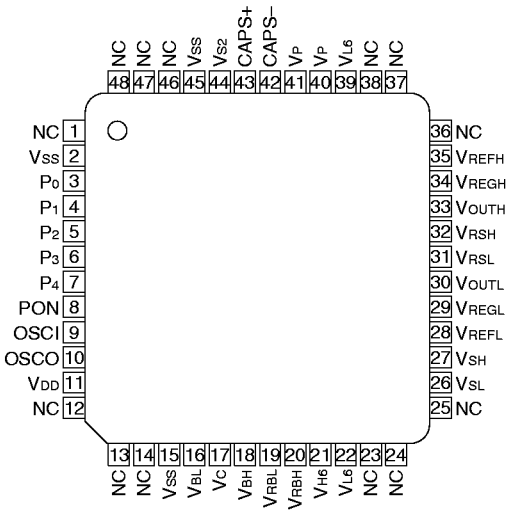
The LR3694 is a power supply IC for driving an LCD system of personal information tools. It consists of a CMOS charge pump type two times positive booster circuit and a voltage conversion circuit. It can generate the four bias levels and the common base level for driving a LCD system with each power supply (V_P, V_{DD}, V_{H6}, V_{L6}). When combined with the LH155E segment driver with a built-in RAM, LH1537 common driver, and LR3696 power supply IC, it can create a low power consuming LCD system suitable for battery-operated portable information-oriented equipment.

FEATURES

- Supply voltages
  - V_{DD}, V_P = +2.4 to +3.3 V
  - V_{H6} = +14.4 to +19.8 V
  - V_{L6} = −16.5 to −12.0 V
- Built-in CMOS charge pump type positive booster circuit (two times positive booster circuit)
- Built-in voltage conversion circuit :
  Generates LCD driving voltages (V_{SH}, V_{BH}, V_{BL}, V_{SL}) based on the external power supplies (V_{H6}, V_{L6}) and the two times positive boosted voltage
- Built-in electronic volume circuit :
  Possible to control the LCD drive voltages (V_{SH}, V_{BH}, V_{BL}, V_{SL}) in 32 steps
- Built-in power off function by external signal (PON)
- Built-in oscillation circuit for the positive booster clock signal (by external feedback resistor)
- Operating temperature : −30 to +85 °C
- Package :
  48-pin TQFP (TQFP048-P-0707) 0.5 mm pin-pitch

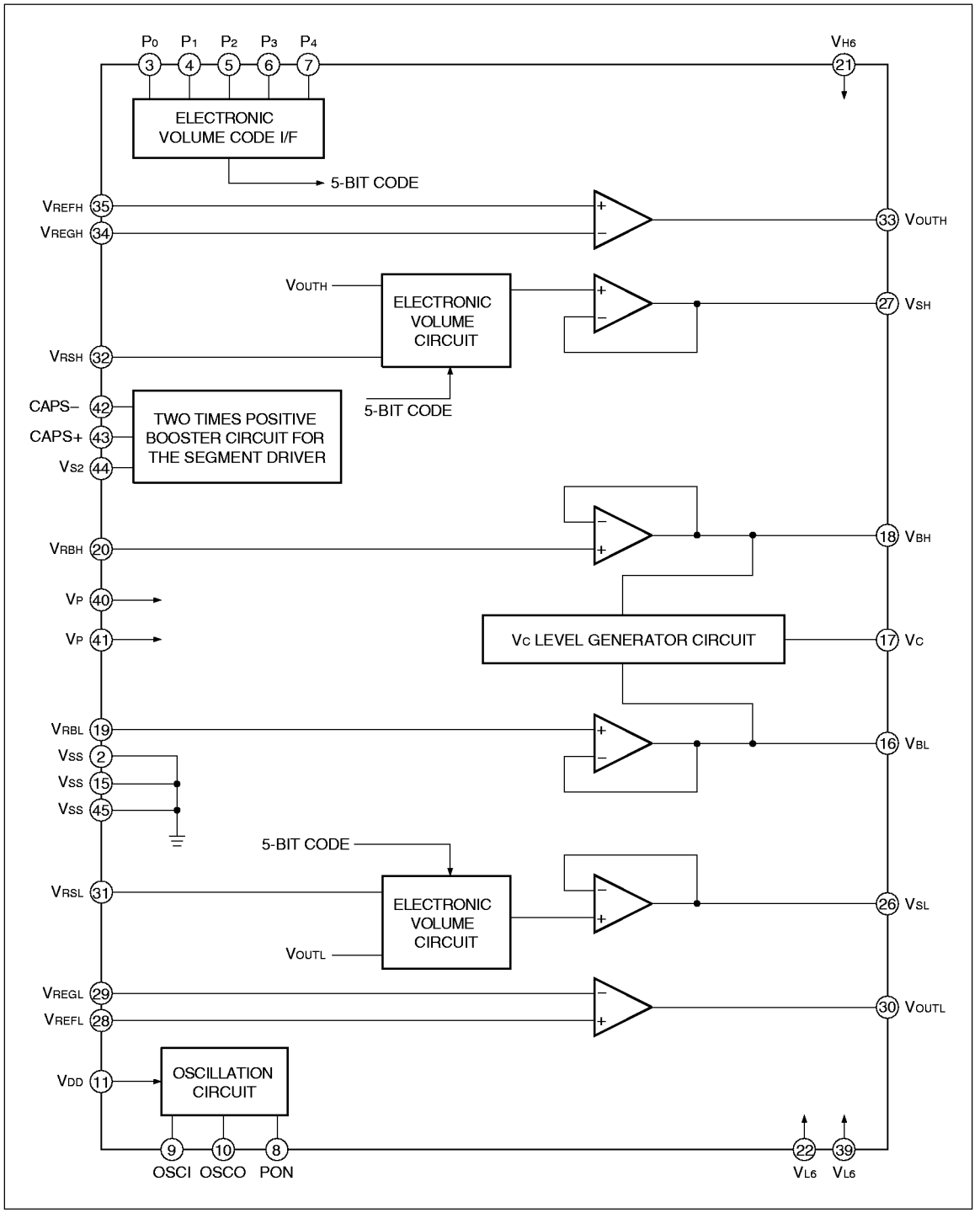
PIN CONNECTIONS

48-PIN TQFP TOP VIEW



(TQFP048-P-0707)

BLOCK DIAGRAM



PIN DESCRIPTION

Positive Booster Circuit Pins

SYMBOL	I/O	DESCRIPTION
CAPS+	O	Used to connect the positive side of a capacitor for the internal positive booster circuit that generates the voltages for driving the segment drivers. A capacitor must be connected between this pin and the CAPS– pin.
CAPS–	O	Used to connect the negative side of a capacitor for the internal positive booster circuit that generates the voltages for driving the segment drivers. A capacitor must be connected between this pin and the CAPS+ pin.
V_{S2}	O	Used as an output pin for two times positive boosted voltage for driving the segment drivers. A capacitor must be connected between this pin and the V_{SS} pin.

Voltage Conversion Circuit

SYMBOL	I/O	DESCRIPTION
V_{OUTH}	O	Used as an output pin of the non-inverting operational amplifier. The amplification ratio is set by the external resistor value.
V_{REFH}	I	Used as a non-inverting input pin of the internal non-inverting amplifier. Because the input impedance is high, this pin should be used with caution, due to the possible effects of noise influences.
V_{REGH}	I	Used as an inverting input pin of the internal non-inverting amplifier. Because the input impedance is high, this pin should be used with caution, due to the possible effects of noise influences.
V_{OUTL}	O	Used as an output pin of the inverting operational amplifier. The amplification ratio is set by the external resistor value.
V_{REFL}	I	Used as a non-inverting input pin of the internal inverting amplifier. Because the input impedance is high, this pin should be used with caution, due to the possible effects of noise influences.
V_{REGL}	I	Used as an inverting input pin of the internal inverting amplifier. Because the input impedance is high, this pin should be used with caution, due to the possible effects of noise influences.
V_{SH}	O	Used as an output pin to supply the positive power for the common driver. This pin outputs the voltage level between V_{OUTH} and V_{RSH} through the electronic volume circuit.
V_{RSH}	I	Used as an input pin to set the electronic volume level to generate the positive power supply V_{SH} for the common driver. Because the input impedance is high, this pin should be used with caution, due to the possible effects of noise influences.
V_{SL}	O	Used as an output pin to supply the negative power for the common driver. This pin outputs the voltage level between V_{OUTL} and V_{RSL} through the electronic volume circuit.
V_{RSL}	I	Used as an input pin to set the electronic volume level to generate the negative power supply V_{SL} for the common driver. Because the input impedance is high, this pin should be used with caution, due to the possible effects of noise influences.
V_{BH}	O	Used as an output pin to supply the positive power for the segment driver. This pin outputs the impedance conversion level based on the V_{RBH} pin input level.

SYMBOL	I/O	DESCRIPTION
V_{RBH}	I	Used as an input pin to set the positive power supply V_{BH} for the segment driver. Because the input impedance is high, this pin should be used with caution, due to the possible effects of noise influences.
V_{BL}	O	Used as an output pin to supply the negative power for the segment driver. This pin outputs the impedance conversion level based on the V_{RBL} pin input level.
V_{RBL}	I	Used as an input pin to set the negative power supply V_{BL} for the segment driver. Because the input impedance is high, this pin should be used with caution, due to the possible effects of noise influences.
V_C	O	Used as an output pin to supply the non-selected level of the common driver. This pin outputs the internal generated middle voltage level of V_{BH} and V_{BL}.

Power Supply Pins

SYMBOL	I/O	DESCRIPTION
V_{DD}	Power supply	Used as a power supply pin for the oscillation circuit and the electronic volume I/F. This pin should be connected to +2.4 to +3.3 V. This pin must be connected to the V_P pin at the outside of this IC and supplied the same voltage of the V_P pin.
V_P	Power supply	Used as a power supply pin for the positive booster circuit and the voltage conversion circuit. This pin should be connected to +2.4 to +3.3 V. This pin must be connected to the V_{DD} pin at the outside of this IC and supplied the same voltage of the V_{DD} pin.
V_{SS}	Power supply	Used as a ground pin, which must be connected to 0 V.
V_{H6}	Power supply	Used as a power supply pin for the voltage conversion circuit. This pin should be connected to +14.4 to +19.8 V.
V_{L6}	Power supply	Used as a power supply pin for the voltage conversion circuit. This pin should be connected to −12.0 to −16.5 V.

Pins for Oscillation Circuit and Power ON/OFF Control

SYMBOL	I/O	DESCRIPTION
OSCI	I	Used as an oscillation circuit input pin. (Feedback resistor must be inserted between this pin and the OSCO pin).
OSCO	I/O	Used as an oscillation circuit input/output pin. (Feedback resistor must be inserted between this pin and the OSCI pin.)
PON	I	Used as an ON/OFF control input pin for the internal power supply circuit. PON = "H" : The oscillation circuit and the internal power supply circuit are active. PON = "L" : The oscillation circuit and the internal power supply circuit are not active.

Electronic Volume Code Input Interface

SYMBOL	I/O	DESCRIPTION
P_4-P_0	I	Used as the electronic volume code input pins. The 5-bit digital code inputs from these pins select one output level of the 32 levels of the electronic volume output voltage. The V_{SH} level and V_{SL} level are selected by the 5-bit code inputs from these pins. Range of the selectable voltage of this circuit is determined by the input levels of V_{RBH}, V_{RBL}, V_{RSH} and V_{RSL} pins.

INPUT/OUTPUT CIRCUITS

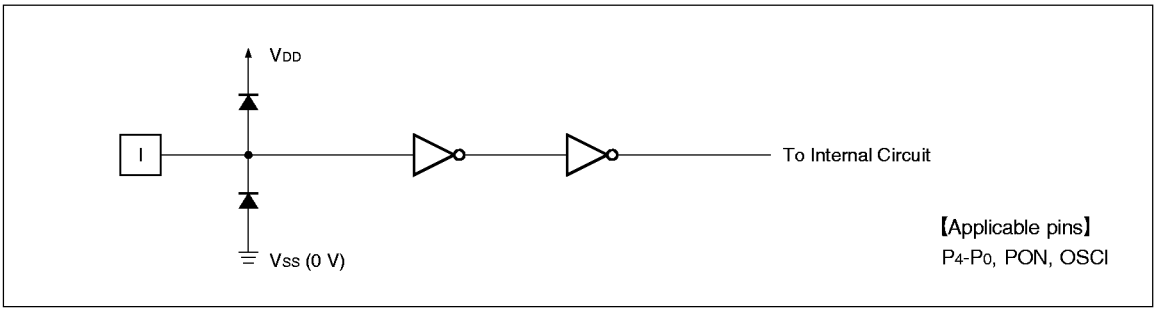


Fig. 1 Input Circuit (1)

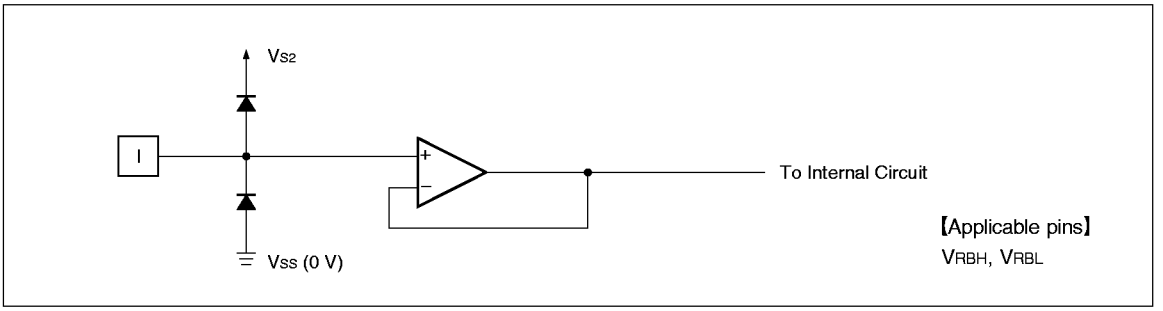


Fig. 2 Input Circuit (2)

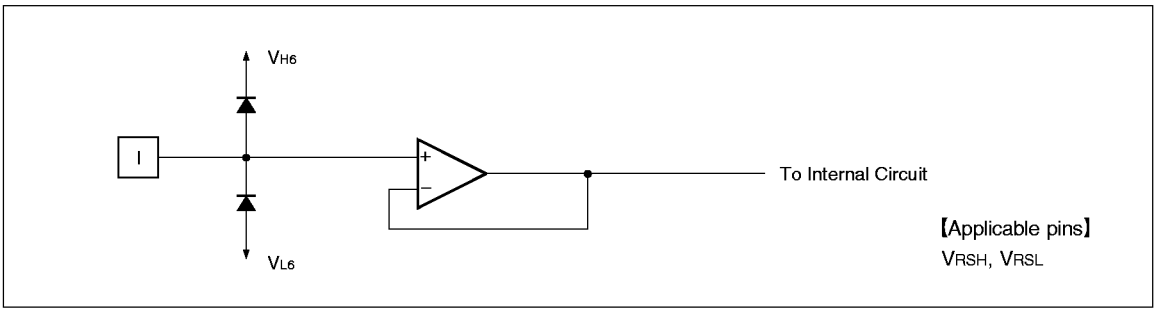


Fig. 3 Input Circuit (3)

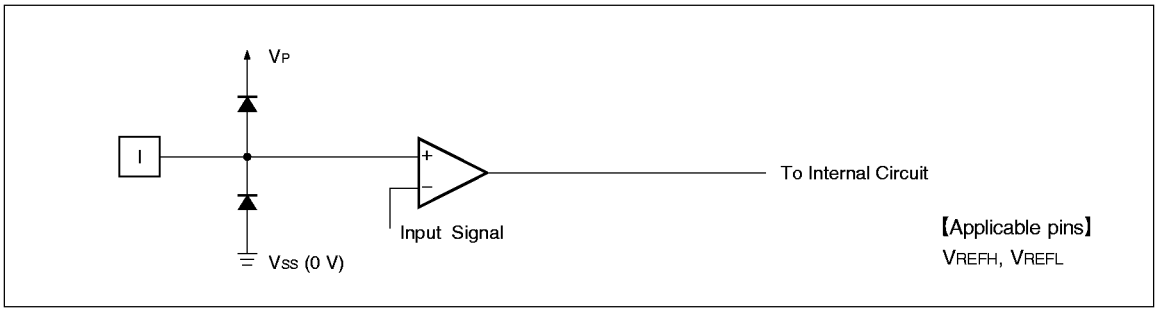


Fig. 4 Input Circuit (4)

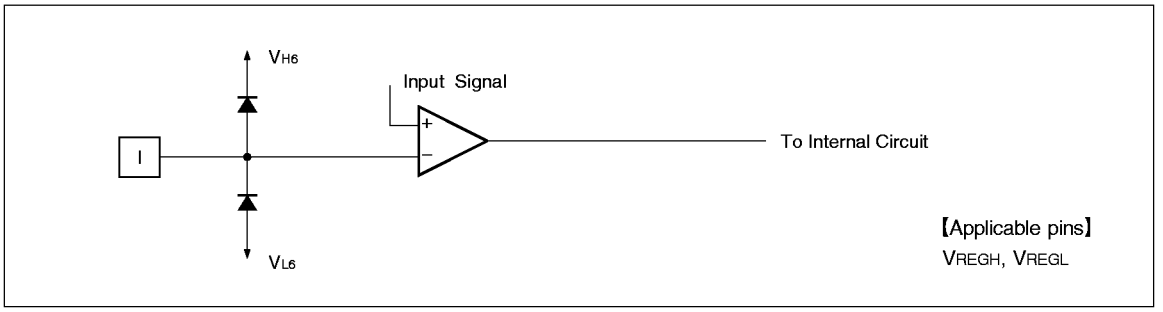


Fig. 5 Input Circuit (5)

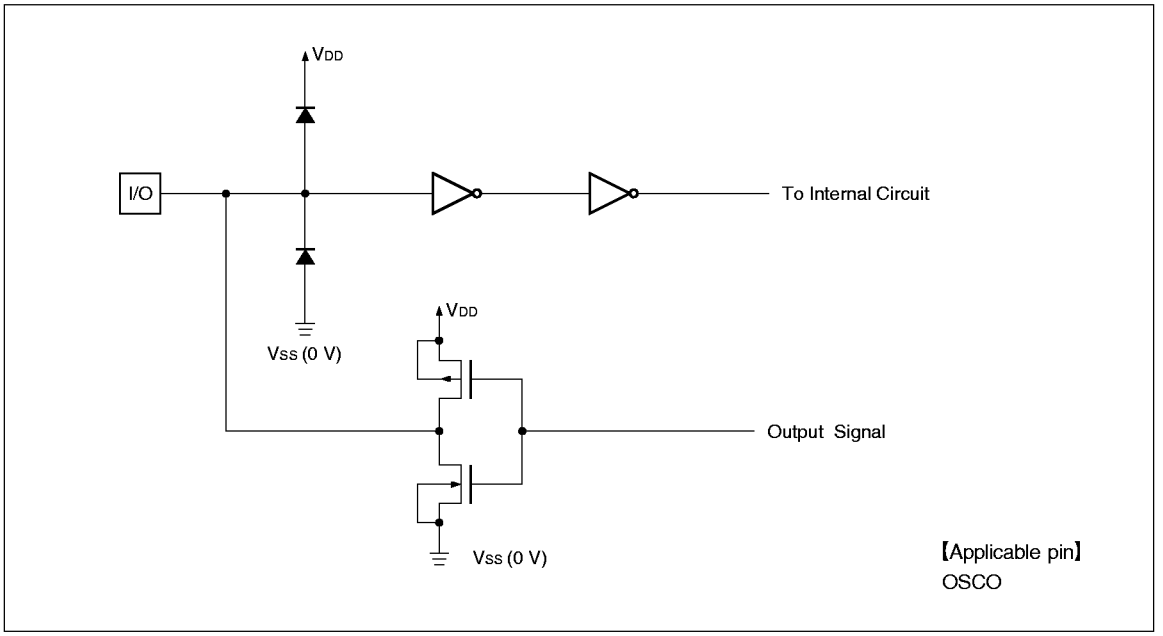


Fig. 6 Input/Output Circuit

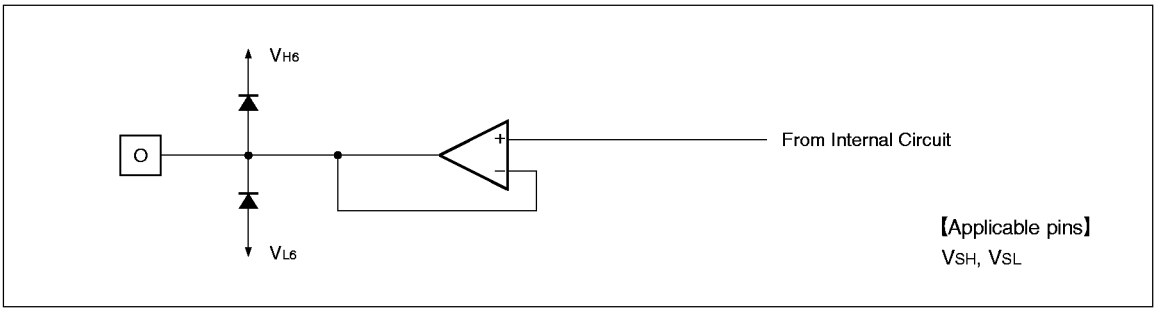


Fig. 7 Output Circuit (1)

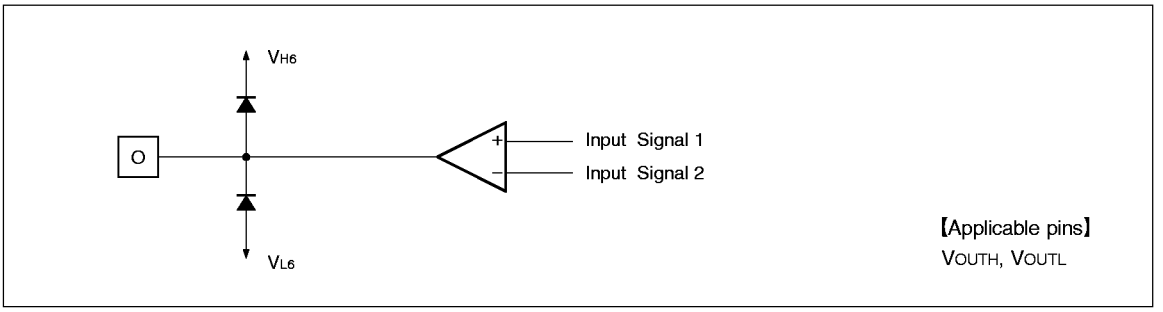


Fig. 8 Output Circuit (2)

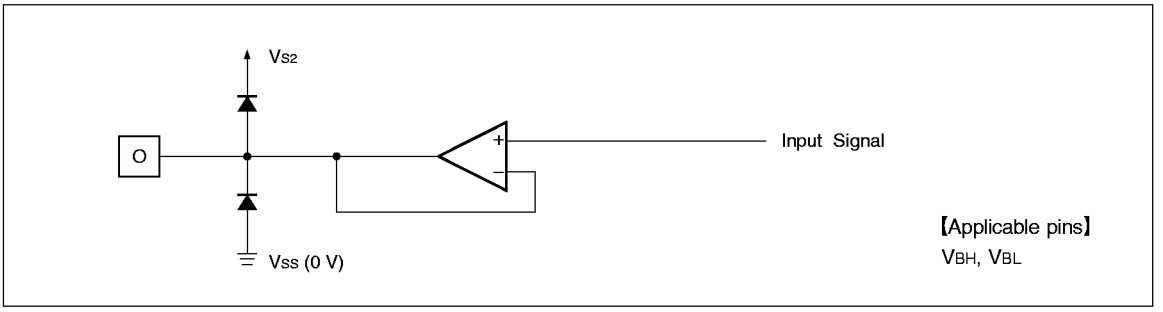


Fig. 9 Output Circuit (3)

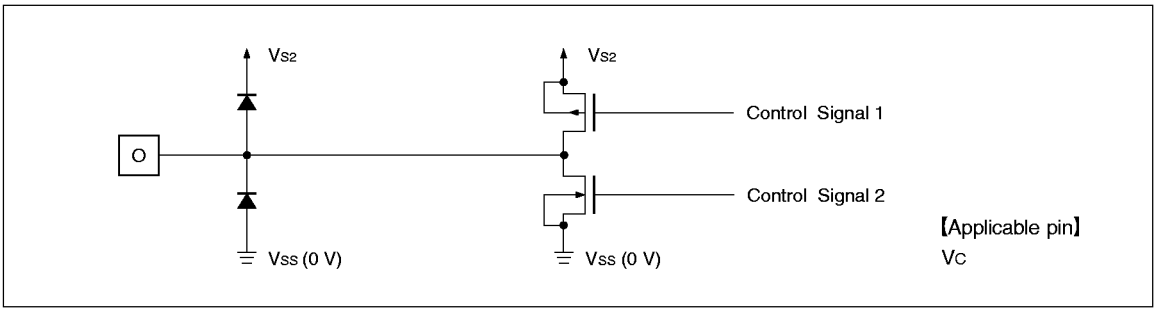


Fig. 10 Output Circuit (4)

FUNCTIONAL DESCRIPTION

Two Times Positive Booster Circuit

With capacitors of C_1 set up between CAPS+ and CAPS−, and between V_{S2} and V_{SS}, a potential difference between V_P and V_{SS} is positive boosted by two times and then is output to V_{S2} pin.

The two times positive booster circuit is active when an oscillation circuit is active, that is, when the input signal to PON pin is "H", because a clock signal generated by the oscillation circuit is used as the booster clock.

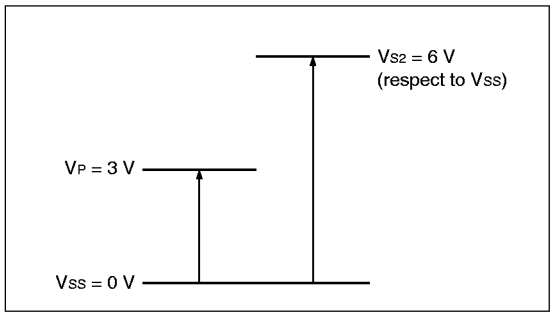


Fig. 11 Two Times Positive Booster Circuit

Voltage Conversion Circuit

Voltages which are necessary to drive an LCD panel are generated by the voltage conversion circuit. The power supply IC consists of the electronic volume circuit and the voltage conversion circuit. Voltages of V_{SH} and V_{SL} which are necessary to drive an LCD panel are generated by transmitting high voltages inputted on V_{H6} and V_{L6} pins to the voltage conversion circuit through the electronic volume circuit.

Voltages of V_{BH} and V_{BL} are generated by impedance conversion of V_{RBH} and V_{RBL} pins' input levels on two times positive booster circuit for segment drivers.

Voltage of V_C is middle level of V_{BH} and V_{BL}, and is generated inside, and is output to V_C pin.

The power supply circuit is controlled by the PON input pin. With PON set to "L", the positive booster circuit, the electronic volume circuit and the voltage conversion circuit are turned off. In this case, V_{BH}, V_{BL} and V_C pins output V_{SS} level, and V_{SH} and V_{SL} pins are high impedance.

Refer to "**Relation of Each Voltage on A Display System**".

Input levels of V_{RBH} pin and V_{RBL} pin are output to V_{BH} and V_{BL} pins through impedance conversion. Therefore the voltages, which should be output from V_{BH} and V_{BL} pins, need to be input to V_{RBH} and V_{RBL} pins from the outside. And because input impedances of V_{RBH} pin and V_{RBL} pin are high, connect these pins to bypass capacitors for avoiding influences of noises from the outside. Constants of those capacitors should be determined by observing the behavior of actual set.

Electronic Volume Circuit

The LR3694 contains the electronic volume circuit, therefore with its function and control of input levels, LCD drive voltage levels (V_{SL}, V_{SH}) can be adjusted to control the contrast of LCD panel. LCD drive voltage levels (V_{SH}, V_{SL}) can be set one level of 32 steps by setting 5-bit data to the electronic volume code pins P_4 to P_0.

P_4	P_3	P_2	P_1	P_0	LCD DRIVE VOLTAGE (V_{SH}, V_{SL}, V_{BH}, V_{BL})
0	0	0	0	0	Low
0	0	0	0	1	:
		:			:
1	1	1	1	0	:
1	1	1	1	1	High

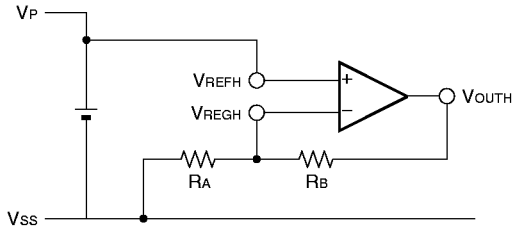
The range of available voltages for LCD drive voltage (V_{SH}, V_{SL}) depends upon voltage levels of V_{RSH} pin and V_{RSL} pin. Therefore set each LCD drive voltage level according to the range.

Because input impedances of V_{RSH} and V_{RSL} pins are high, be sufficiently cautious of influences of noises from the outside.

LCD DRIVE VOLTAGE	VOLTAGE RANGE SET PINS	RANGE OF THE ELECTRONIC VOLUME
V_{SH}	V_{RSH}	32 steps between V_{OUTH} and V_{RSH}
V_{SL}	V_{RSL}	32 steps between V_{OUTL} and V_{RSL}

V_{OUTH} and V_{OUTL} levels used as standard levels of the electronic volume of V_{SH} and V_{SL} are determined by the internal amplifier circuit. V_{OUTH} level is generated by a non-inverting amplifier circuit composed of external resistors, and V_{OUTL} level is generated by an inverting amplifier circuit composed of external resistors.

V_{OUTH} GENERATION CIRCUIT



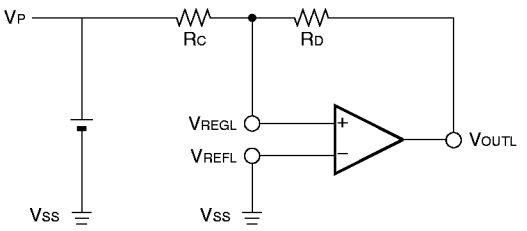
Example of V_{OUTH} generation circuit
$V_{OUTH} = (1 + R_B/R_A)\ V_P$···(Expression 1)

In the above figure, the V_{OUTH} level can be determined by adjusting the external resistors R_A and R_B on condition that $|V_{OUTH}| < |V_{H6}|$. In this case, V_P is used as the power supply that outputs a constant voltage level.

(Example of determination of R_A and R_B)
In order to set V_{OUTH} = 15 V (with respect to V_{SS}) such that V_P = 3.0 V and $R_A + R_B$ = 6.0 MΩ (determined by current value between V_{OUTH} and V_{SS}. In this case, the current value is 2.5 µA.), R_A and R_B are determined as below.

R_A = 1.2 MΩ
R_B = 4.8 MΩ

V_{OUTL} GENERATION CIRCUIT



Example of V_{OUTH} generation circuit
$V_{OUTL} = -(R_D/R_C)\ V_P$···(Expression 2)

In the above figure, the V_{OUTL} level can be determined by adjusting the external resistors R_C and R_D on condition that $|V_{OUTL}| < |V_{H6}|$. In this case, V_{SS} is used as the power supply that outputs a constant voltage level.

(Example of determination of R_C and R_D)
In order to set V_{OUTL} = −15 V (with respect to V_{SS}) such that V_P = 3.0 V and $R_C + R_D$ = 6.0 MΩ (determined by current value between V_{OUTL} and V_P. In this case, the current value is 2.5 µA.), R_C and R_D are determined as below.

R_C = 1.0 MΩ
R_D = 5.0 MΩ

Voltage Adjuster Circuit

The range of adjustable voltage for V_{SH} and V_{SL} depends upon voltage levels of V_{RSH} and V_{RSL} pins on the electronic volume circuit.

Therefore according to the range, each voltage level should be set by external voltage adjuster circuit. Because input impedances of V_{RSH} and V_{RSL} pins are high, be sufficiently cautious of influences of noises from the outside.

The voltages input to V_{RSH} and V_{RSL} pins are determined only by the resistor rate of R_1 and R_2, and that of R_3 and R_4.

The current between V_{OUTH} and V_{SS} is determined by the total resistance of R_1 and R_2. The current between V_{OUTL} and V_P is determined by the total resistance of R_3 and R_4. Therefore the values of resistors R_1, R_2, R_3 and R_4 should be selected according to those voltages and currents.

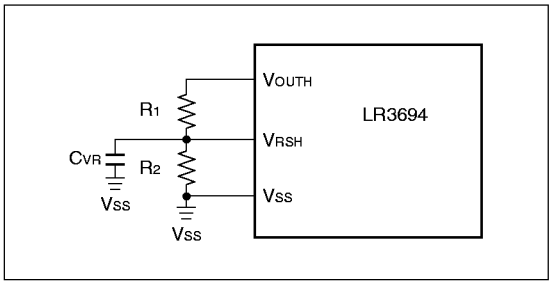


Fig. 12 Example of Positive Voltage Adjuster Circuit

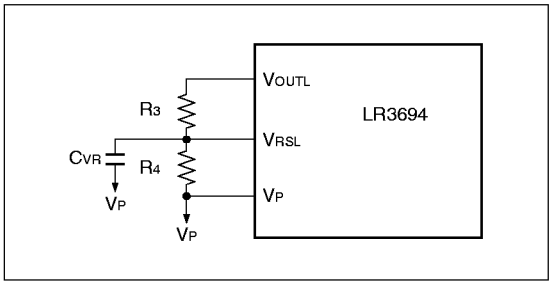


Fig. 13 Example of Negative Voltage Adjuster Circuit

Each voltage input to V_{RBH} and V_{RBL} pins is output to V_{BH} and V_{BL} pins through the impedance conversion circuit. The middle level of V_{BH} and V_{BL} is generated inside this IC and is output to V_C pin.

The input levels of V_{RBH} and V_{RBL} are determined by resistor divider of voltages between V_{SH} and V_{SL}, generated by the voltage control circuit and the electronic volume code inputs. The input level sets the output level, V_{BH}, V_{BL} and V_C.

Therefore even in case of changing the electronic volume code inputs, control of contrast without the change of bias ratio of V_{SH}, V_{BH}, V_C, V_{BL} and V_{SL} is possible.

Because the two times positive boosted level generated in the internal positive booster circuit for segment drivers is used as the power supply of the internal amplifier for outputting V_{BH} and V_{BL} levels, constants of R_5 and R_6 have to be determined so as to keep the relations shown below.

$V_{SS} < V_{RBL} < V_{RBH} < V_{S2}$
(two times positive boosted level)

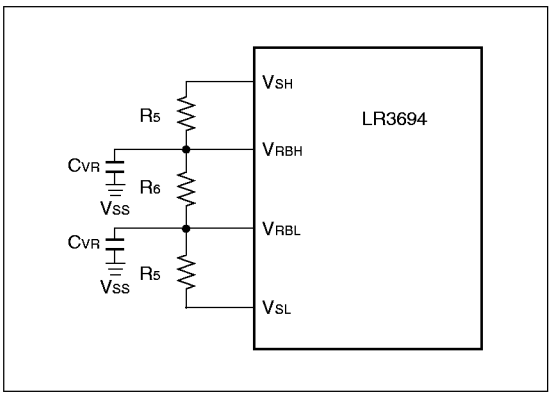
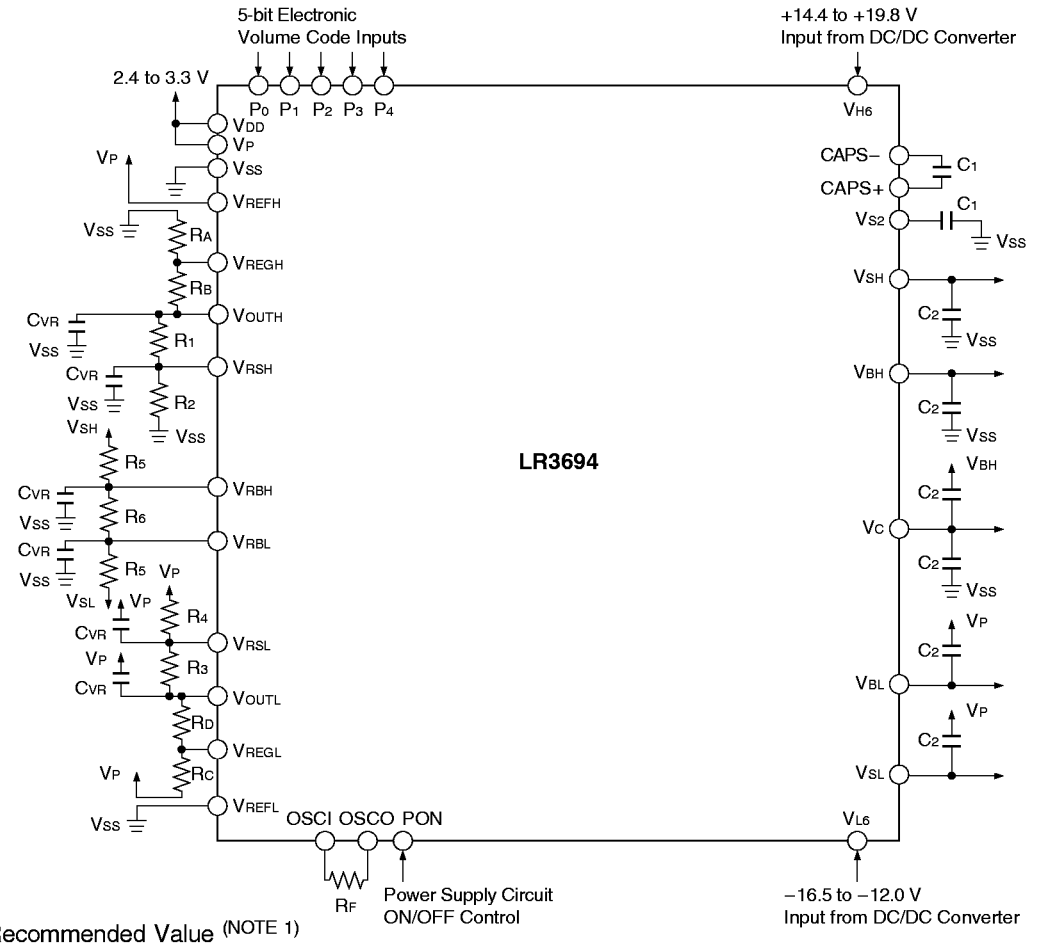


Fig. 14 Example of Control Circuit for V_{BH} and V_{BL} Levels

Example of External Circuit Connection



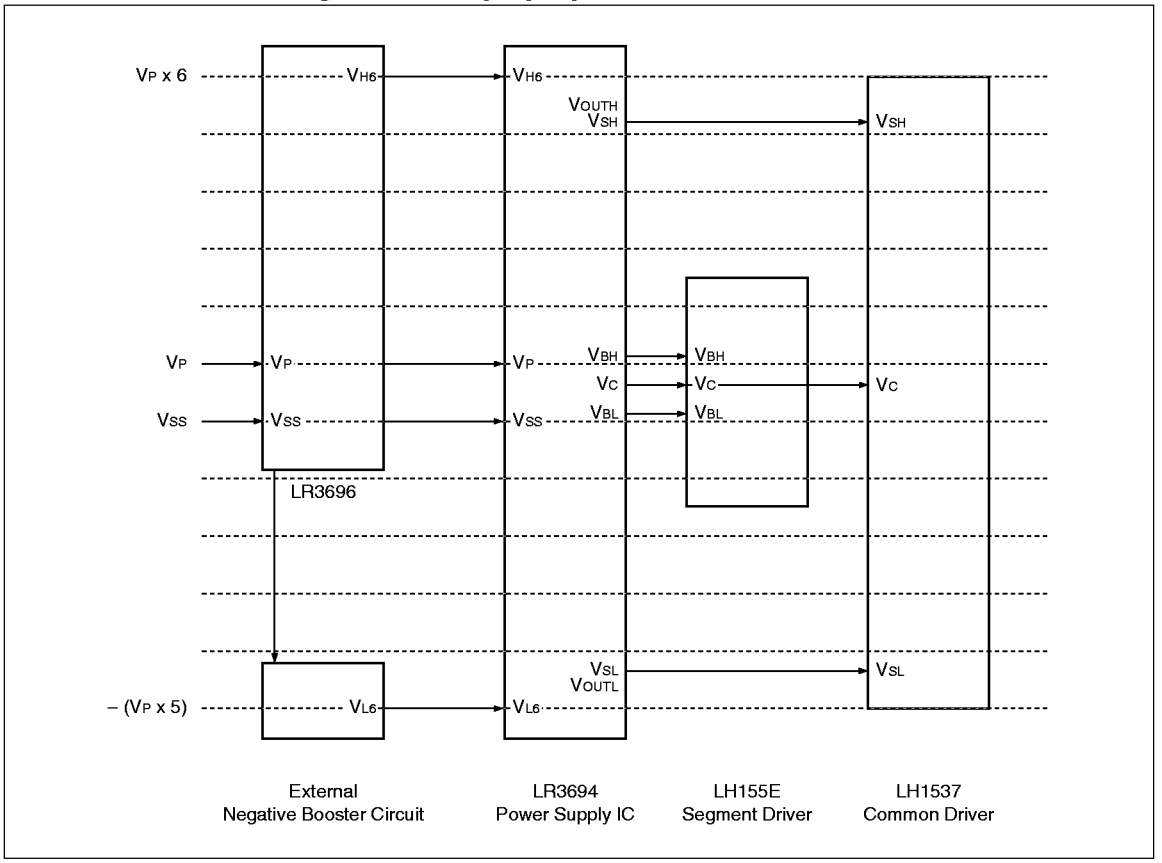
Recommended Value (NOTE 1)

C_1	4.7 µF
C_2	4.7 µF
C_{VR}	0.1 to 0.22 µF
R_F	1.8 MΩ
$R_1 + R_2$	3.0 to 6.0 MΩ
$R_3 + R_4$	3.0 to 6.0 MΩ
$R_5 + R_6$	6.0 to 12.0 MΩ
$R_A + R_B$	3.0 to 6.0 MΩ
$R_C + R_D$	3.0 to 6.0 MΩ

NOTE :

1. When selecting the external parts, select the suitable constants of the external parts to stabilize LCD drive voltage according to the LCD panel condition and the operation on the actual LCD system.

Relation of Each Voltage on A Display System



Oscillation Circuit

This is a CR oscillation circuit with an external feedback resistor R_F.

This circuit is used for generating the clock signal of the positive booster circuit.

Power Supply Circuit ON/OFF Control

By controlling the input voltage level of the PON pin, the states of the internal power supply circuit can be controlled. When the input level of PON pin is at the "L" level, the internal power supply circuit of the LR3694 is not active. When the input level of PON pin is at the "H" level, the internal power supply circuit of the LR3694 is active.

PARAMETER	CONDITION
V_{BH}	Output V_{SS} level
V_C	Output V_{SS} level
V_{BL}	Output V_{SS} level
V_{SH}	High impedance
V_{SL}	High impedance
Oscillation circuit	Not active
Positive booster circuit	Not active

Each shown condition with OFF state of the internal power supply circuit. (PON = "L")

PRECAUTIONS

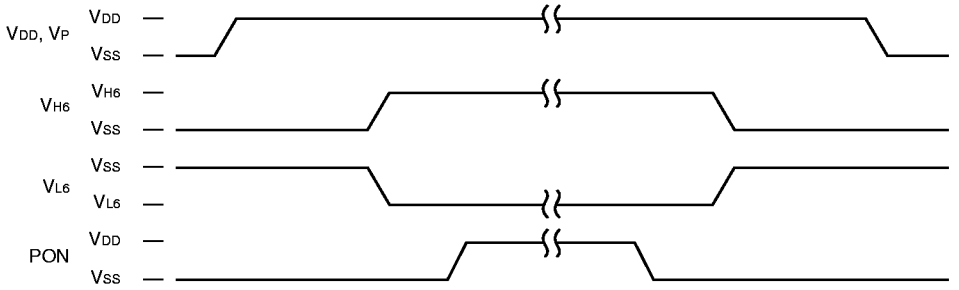
The LR3694 can generate LCD drive voltage levels for each LCD driver IC.

But when this IC changes from active state to inactive state with no discharge route of stabilizing capacitors connected to V_{SH} or V_{SL}, it is possible that the remaining charge maintain certain voltage level on V_{SH} or V_{SL} pins. Because the remaining charge may exert a harmful influence on the LCD panel or other circuits, be sure to construct discharge circuits that discharge the remaining charge on stabilizing capacitors and make V_{SH} and V_{SL} pins V_{SS} level when the IC is not active.

Power supply voltage (V_{H6} – V_{L6}) for this IC is very high, so this IC may be permanently damaged by a high current which may flow if voltages are supplied to the V_{H6} and V_{L6} pins while the power supply pins V_{DD} and V_P for 3 V system are floating. Observe to the power supply sequence shown below.

- When connecting the power supply pins, connect power supply pins (V_{DD}, V_P) for 3 V system at first, and then connect the V_{H6} and V_{L6} pins. When disconnecting the power supply pins, disconnect V_{H6} and V_{L6} at first, and then disconnect the V_{DD} and V_P pins.

Recommended sequence when connecting the power supply is as below.



ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	APPLICABLE PINS	RATING	UNIT	NOTE
Supply voltage (1)	V_{DD}	V_{DD}	−0.3 to +3.5	V	1, 2, 3
Supply voltage (2)	V_P	V_P	−0.3 to +3.5	V	
Supply voltage (3)	V_{H6}	V_{H6}	−0.3 to +21.8	V	
Supply voltage (4)	V_{L6}	V_{L6}	−18.0 to 0	V	
Input voltage (1)	V_{I1}	P_4-P_0, PON	−0.3 to V_{DD} + 0.3	V	
Input voltage (2)	V_{I2}	V_{REFH}, V_{REGH} V_{REFL}, V_{REGL}	−0.3 to V_P + 0.3	V	
Input voltage (3)	V_{I3}	V_{RBH}, V_{RBL}	−0.3 to 2 x V_P + 0.3	V	
Input voltage (4)	V_{I4}	V_{RSH}	−0.3 to V_{H6} + 0.3	V	
Input voltage (5)	V_{I5}	V_{RSL}	−5 x V_P − 0.3 to V_P + 0.3	V	
Storage temperature	T_{STG}		−45 to +125	°C	

NOTES :

1. T_A = +25 °C
2. The maximum applicable voltage on any pin with respect to V_{SS} (0 V).
3. Don't supply external voltage to the output pins and the pins that connect a capacitor for the positive booster circuit.

RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	APPLICABLE PINS	MIN.	TYP.	MAX.	UNIT	NOTE
Supply voltage	V_{DD}	V_{DD}	+2.4		+3.3	V	1
	V_P	V_P	+2.4		+3.3	V	
	V_{H6}	V_{H6}	+14.4		+19.8	V	
	V_{L6}	V_{L6}	−16.5		−12.0	V	
Operating voltage	V_{OUTH}	V_{OUTH}	+10.0		V_{H6} − 1.6	V	1
	V_{OUTL}	V_{OUTL}	V_{L6} + 1.6		V_P − 10.0	V	
Input voltage	V_{REFH}	V_{REFH}	+2.0		V_P	V	1
	V_{REGH}	V_{REGH}		V_{REFH}		V	1
	V_{RSH}	V_{RSH}	+9.0		V_{H6} − 5.0	V	1
	V_{RBH}	V_{RBH}	+2.0		V_{S2} − 0.6	V	1, 2
	V_{REFL}	V_{REFL}	V_{SS}		+1.0	V	1
	V_{REGL}	V_{REGL}		V_{REFL}		V	1
	V_{RSL}	V_{RSL}	V_{L6} + 5.0		V_P − 9.0	V	1
	V_{RBL}	V_{RBL}	+0.6		V_{S2} − 2.0	V	1, 2
Operating temperature	T_{OPR}		−30		+85	°C	

NOTES :

1. The applicable voltage on any pin with respect to V_{SS} (0 V).
2. V_{S2} is the two times positive boosted voltage.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, V_{SS} = 0 V, V_{DD} = +2.4 to +3.3 V, V_P = +2.4 to +3.3 V, T_{OPR} = −30 to +85 °C)

PARAMETER	SYMBOL	CONDITIONS	APPLICABLE PINS	MIN.	TYP.	MAX.	UNIT	NOTE
Input "Low" voltage	V_{IL}		P_4-P_0, PON	0		0.2V_{DD}	V	
Input "High" voltage	V_{IH}			0.8V_{DD}		V_{DD}	V	
Input leakage current	I_{LI}	V_I = V_{SS} or V_{DD}		−10		+10	µA	
Standby current (1)	I_{STB1}	V_{DD} = 3 V	V_{DD}			20	µA	1
Standby current (2)	I_{STB2}	V_P = 3 V	V_P			20	µA	2
Standby current (3)	I_{STB3}	V_{H6} = 19.8 V	V_{H6}			20	µA	3
Standby current (4)	I_{STB4}	V_{L6} = −16.5 V	V_{L6}			20	µA	4
Oscillation frequency	f_{OSC}	R_F = 1.8 MΩ±2% V_{DD} = 3 V	OSCO	38			kHz	5
Supply current (1)	I_{DD}	V_{DD}, V_P = 3 V No-load	V_{DD}			30	µA	6
Supply current (2)	I_P	V_{DD}, V_P = 3 V No-load	V_P			170	µA	7
Supply current (3)	I_{H6}	V_{H6} = 19.8 V No-load	V_{H6}			170	µA	8
Supply current (4)	I_{L6}	V_{L6} = −16.5 V No-load	V_{H6}			60	µA	9
Two times positive boosted output voltage	V_{OH2}	V_P = 3 V I_{VBH} = −2.0 mA	V_{S2}	V_{S2} − 1.5			V	10

NOTES :

1. Current at V_{DD} pin on condition that oscillation circuit is not active and the internal power supply circuit is set OFF (PON = V_{SS}).
2. Current at V_P pin on condition that oscillation circuit is not active and the internal power supply circuit is set OFF (PON = V_{SS}).
3. Current at V_{H6} pin on condition that oscillation circuit is not active and the internal power supply circuit is set OFF (PON = V_{SS}).
4. Current at V_{L6} pin on condition that oscillation circuit is not active and the internal power supply circuit is set OFF (PON = V_{SS}).
5. Oscillation frequency on condition that feedback resistor (R_F = 1.8 MΩ) is set between OSCI and OSCO.
6. Supply current on condition that the internal power supply circuit is set ON (PON = "H") and the electronic volume register code is "11111". Every power supply pin for driving LCD is no-load.
   Measuring conditions : R_F = 1.8 MΩ, V_{DD} = V_P = 3 V
7. Supply current on condition that the internal power supply circuit is set ON (PON = "H") and the electronic volume register code is "11111".
   Every power supply pin for driving LCD is no-load.
   Measuring conditions :
   V_{DD} = V_P = V_{REFH} = 3 V, V_{REFL} = V_{SS} = 0 V, C_1 = C_2 = 4.7 µF, R_1 + R_2 = R_3 + R_4 = 6 MΩ, R_5 + R_5 + R_6 = 12 MΩ, R_F = 1.8 MΩ, R_A = 1.2 MΩ, R_B = 4.8 MΩ, R_C = 1.2 MΩ, R_D = 4.8 MΩ
8. Supply current on condition that the internal power supply circuit is set ON (PON = "H") and the electronic volume register code is "11111".
   Every power supply pin for driving LCD is no-load.
   Measuring conditions :
   V_{DD} = V_P = V_{REFH} = 3 V, V_{REFL} = V_{SS} = 0 V, V_{H6} = 19.8 V, V_{L6} = −16.5 V, R_F = 1.8 MΩ, C_1 = C_2 = 4.7 µF, R_1 + R_2 = R_3 + R_4 = 6 MΩ, R_5 + R_5 + R_6 = 12 MΩ, R_A = 1.2 MΩ, R_B = 4.8 MΩ, R_C = 1.2 MΩ, R_D = 4.8 MΩ
9. Supply current on condition that the internal power supply circuit is set ON (PON = "H") and the electronic volume register code is "11111".
   Every power supply pin for driving LCD is no-load.
   Measuring conditions :
   V_{DD} = V_P = V_{REFH} = 3 V, V_{REFL} = V_{SS} = 0 V, V_{H6} = 19.8 V, V_{L6} = −16.5 V, R_F = 1.8 MΩ, C_1 = C_2 = 4.7 µF, R_1 + R_2 = R_3 + R_4 = 6 MΩ, R_5 + R_5 + R_6 = 12 MΩ, R_3 = 4 MΩ, R_A = 1.2 MΩ, R_B = 4.8 MΩ, R_C = 1.2 MΩ, R_D = 4.8 MΩ
10. Output voltage of V_{S2} pin on condition that current of 2.0 mA flow out from V_{BH} pin, V_P = 3 V, and two times positive booster circuit is active.

PACKAGE

(Unit : mm)

48 TQFP (TQFP048-P-0707)