LSI/CSI

LS7642
LS7642FO

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VOLTAGE CONTROLLED LIGHT DIMMER with SOFT ON/OFF

FEATURES:
• Analog input for direct control of illumination
• Soft turn-on or turn-off with touch or pushbutton
• Controls high-voltage Halogen or Incandescent lamps
• Controls low-voltage halogen lamps via
  magnetic or electronic transformers
• Automatic safety shutdown for magnetic transformers
• Controls CFLs and fluorescent lamps via dimming ballasts
• Extension input for remote operation
• Suited for 50Hz or 60Hz AC
• Single 5V power supply
• **LS7642**, **LS7642FO** (DIP); **LS7642-S**, **LS7642FO-S** (SOIC)
                - See Figure 1 -

PIN ASSIGNMENT - TOP VIEW

VDD (+V)	1	8	TRIG/
BCV	2	7	Vss (-V)
TEST	3	6	EXT
SYNC	4	5	SENS/

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FIGURE 1

GENERAL DESCRIPTION
LS7642 is an innovative light dimmer allowing direct control of illumination with analog voltage. The analog voltage applied at the brightness control input directly controls the conduction angle of a triac in series with the lamp. For manual dimming applications such as, wall switches, floor and table lamps etc, a sliding or rotary potentiometer with a center tap can serve as the controlling element. For automated applications such as uC controlled illumination, dawn, dusk and daylight emulation in chicken coops etc., the control voltage can be provided by the uC with built-in or external D/A converter creating accurate control of dimming patterns. Turn-on and turn-off of the lamp is made with a touch or push-button or uC signal applied at the SENSE/ input or the EXT input. In both turn-on and turn-off events, the brightness is softly ramped up and ramped down, respectively.

SAFETY SHUTDOWN:
A typical electronic dimmer may not operate properly with the inductive load encountered when driving a magnetic transformer-coupled low-voltage halogen lamp. The inductive load may cause a phenomenon called half-waving wherein the triac fires in alternate AC half cycles leading to thermal destruction of the load transformer. This problem is addressed by the **LS7642** in two steps as described below:

1. Delayed triac turn-off.
When a trigger pulse is due to occur at a conduction angle which coincides with the on state of the triac, the trigger pulse is delayed until the triac has turned off. This eliminates the underlying cause of half-waving.

2. Delayed triac turn-on.
With inductive loads, the holding current needed to maintain the triac on state may seriously lag behind the gate trigger signal causing the triac to turn off prematurely. If the frequency of occurrences of the delayed turn-on exceeds a preset threshold, a shutdown is initiated by turning off the trigger pulses. The safety shutdown threshold value is accumulated in a 4-bit up/down counter. The count increments for every occurrence of delayed turn-on and decrements once every 8 AC cycles. If the count reaches 15, the safety shutdown is invoked.
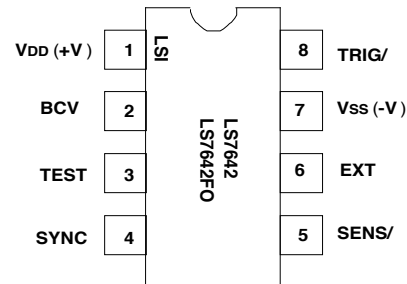
INPUT/OUTPUT DESCRIPTION:

VDD (Pin 1) Supply voltage positive terminal.

BCV (Pin 2) Brightness control input. The voltage applied at the BCV input controls the triac conduction angle and hence the brightness of the lamp. The brightness varies in direct proportion to the applied voltage. For manual control of brightness, the BCV voltage can be supplied from the center tap of a potentiometer connected between VDD and VSS. In non-manual instrumentation application where a uC is the controlling agent, the BCV voltage can directly be provided by the uC. The dynamic range of the BCV voltage is between 25% and 88% of the applied power supply. For VDD = 5.0V this translates to a range between 1.25V for the minimum brightness and 4.4V for the maximum brightness. There are 81 discrete brightness steps of 1.4°/39mV increments in the dynamic range of 1.25V and 4.4V of the BCV voltage. The corresponding conduction angles are 45° at the dimmest and 159° at the brightest.

TEST (Pin 3) For factory use only, should be left unconnected.

SYNC (Pin 4) The AC line frequency is applied to this input for synchronizing all internal timings relative to the AC zero crossing. The load on/off status information is also derived from this input for enforcing the safety shutdown protocol.

SENS/ (Pin 5) A momentary logic low applied to this input either with a touch or a push-button switch, causes the state of the TRIG/ output to switch; the lamp is turned on if the pre-touch state was off and turned off if the pre-touch state was on. When turning on the brightness is softly ramped up from off through minimum to the brightness set by the BCV input. When turning off the brightness is softly ramped down from the pre-touch brightness to off. The ramp rate for either case is 1.4°/33.3ms at 60Hz or 1.4°/40ms at 50Hz.

EXT (Pin 6) The EXT input has the same functionality as the SENS/ input. It is designed to discriminate ac pick-ups when remotely located touch plates are connected to the dimmer units with long cables. A logic high is the active level at the EXT input.

Vss (Pin 7) Supply voltage negative terminal.

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TRIG/ (Pin 8) The TRIG/ can be turned on or off by applying the active logic level at either the SENS/ or the EXT input for a brief duration. In the Off state, the TRIG/ sits at steady high level turning off the triac in series with the lamp. In the On state, the TRIG/ outputs a low going pulse once every half cycle of the AC at a conduction angle set by the voltage at the BCV input.

Upon power up the TRIG/ output defaults to the following states:
For **LS7642** the TRIG/ is off.
For **LS7642FO** the TRIG/ is on

ABSOLUTE MAXIMUM RATINGS:

PARAMETER	SYMBOL	VALUE	UNIT
DC supply voltage	$V_{DD} - V_{SS}$	+7	V
Any input voltage	V_{IN}	$V_{SS} - 0.3$ to $V_{DD} + 0.3$	V
Operating temperature	T_A	0 to +90	ºC
Storage temperature	T_{STG}	-65 to +150	ºC

DC ELECTRICAL CHARACTERISTICS:
($T_A = +25ºC$, all voltages referenced to V_{SS}. $V_{DD} = +5V$ unless otherwise noted.)

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT	CONDITION
Supply voltage	V_{DD}	4.5	5.0	5.5	V	-
Supply current	I_{DD}	-	300	400	μA	Output unloaded, $V_{DD} = 5V$
SYNC Lo	V_{ISL}	-	-	2.1	V	-
SYNC Hi	V_{ISH}	2.9	-	-	V	-
BCV input:						
Dynamic Voltage Range	V_b	1.25	-	4.4	V	$V_{DD} = 5V$
Voltage increment per step	$V_b/ø$	-	39	-	mV	$ø = 1.4º$, $V_{DD} = 5V$
EXT, SENS/ Lo	V_{IEL}	-	-	1.5	V	-
EXT, SENS/ Hi	V_{IEH}	3.5	-	-	V	-
TRIG/ Lo	V_{OL}	-	0.2	-	V	-
TRIG/ Hi	V_{OH}	-	5.0	-	V	-
TRIG/ Sink Current	I_{TSNK}	35	-	-	mA	$V_{OTRIG} = 2.5V$

TRANSIENT CHARACTERISTICS (See Figures 2, 3 and 4):

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT	CONDITION
SYNC Frequency	f_S	40	-	70	Hz	-
EXT, SENS/ Touch Duration	T_{S1}	67	-	infinite	ms	60Hz
	T_{S1}	80	-	infinite	ms	50Hz
TRIG/ pulse width (see Note 2)	T_W	-	130	-	μs	60Hz
	T_W	-	156	-	μs	50Hz
Conduction Angle	$ø$	45	-	159	deg	-
ø incremental steps (Note 1)	$ø$	-	1.4	-	deg	-
On/Off slew rate	S_S	-	1.4	-	deg/33.33ms	60Hz
	S_S	-	1.4	-	deg/40ms	50Hz

Note 1: Total number of steps = 82.
Note 2: $T_W = 488us$ (60Hz), 586us (50Hz) available. Contact factory for details.
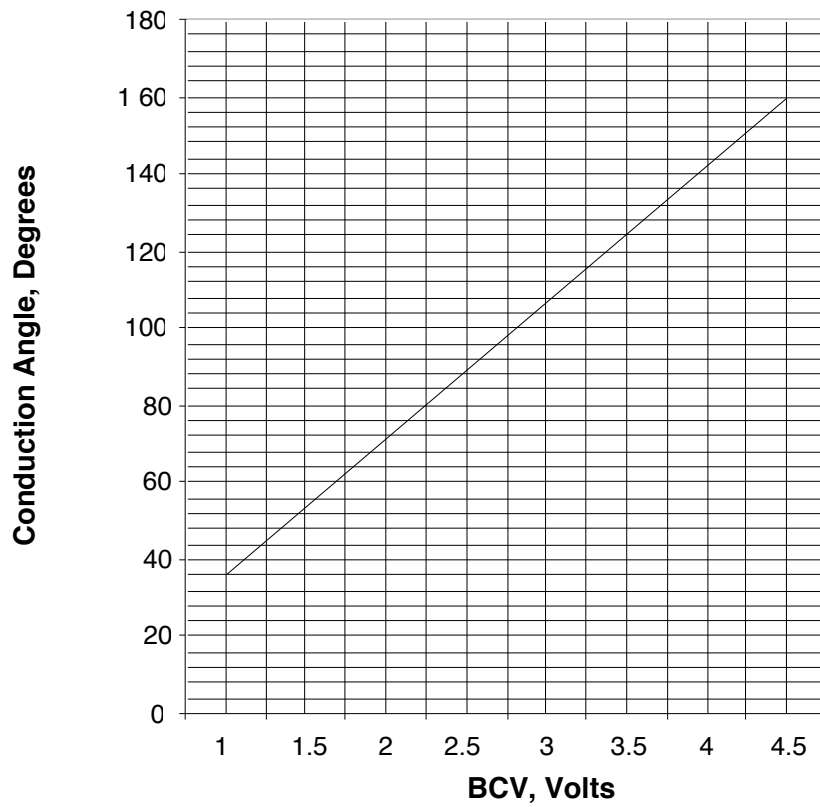
FIGURE 2. BCV Volts vs TRIG/ Conduction Angle (VDD = 5V)
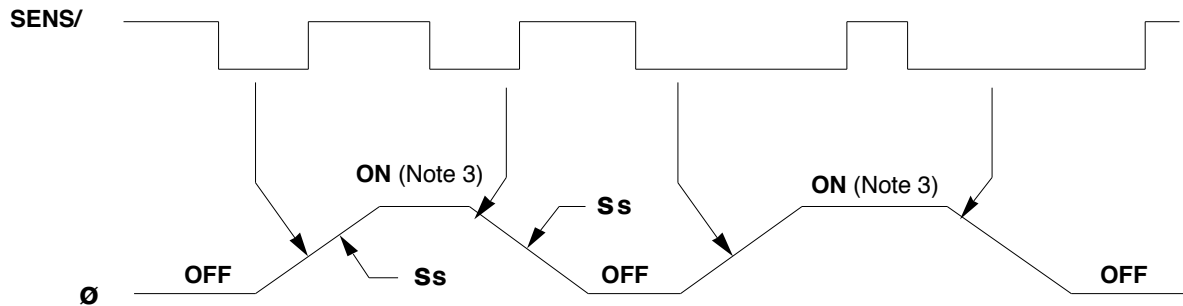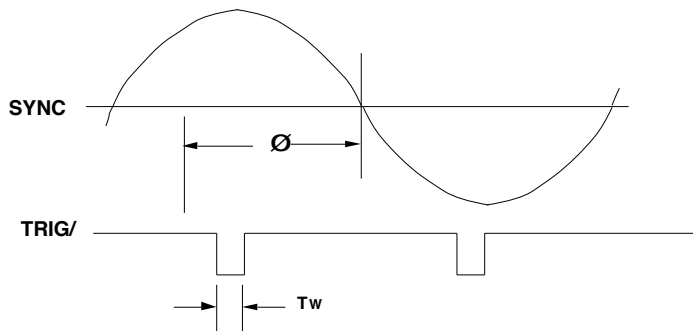

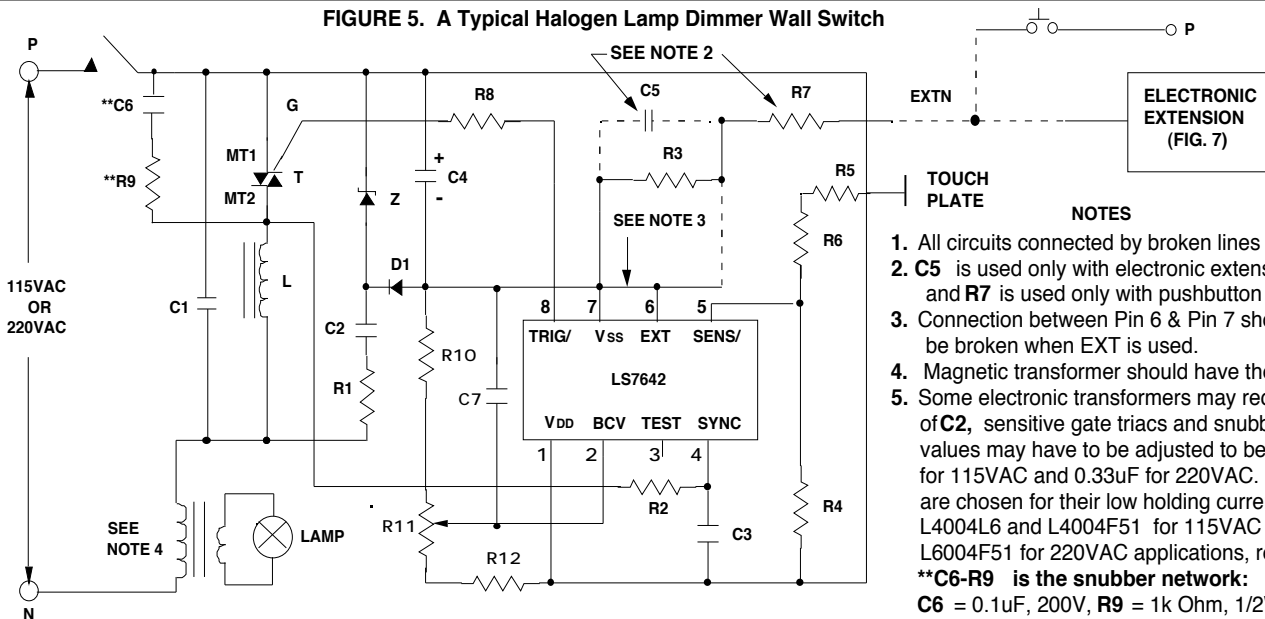Conduction Angle, Degrees vs BCV, Volts

FIGURE 3. TOUCH to ON/OFF RAMP RATE

NOTE 3. On-state brightness level is set by the analog voltage, Vb, at the BCV input

FIGURE 4. TRIG/ OUTPUT CONDUCTION ANGLE, Ø

SYNC

Ø

TRIG/

Tw

FIGURE 5. A Typical Halogen Lamp Dimmer Wall Switch

P

**C6

**R9

MT1

G

T

MT2

Z

L

C1

C2

R1

SEE NOTE 4

LAMP

115VAC OR 220VAC

N

D1

C4

R8

SEE NOTE 2

C5

R3

SEE NOTE 3

R7

EXTN

R5

TOUCH PLATE

R6

ELECTRONIC EXTENSION (FIG. 7)

P

R1O

C7

R11

R12

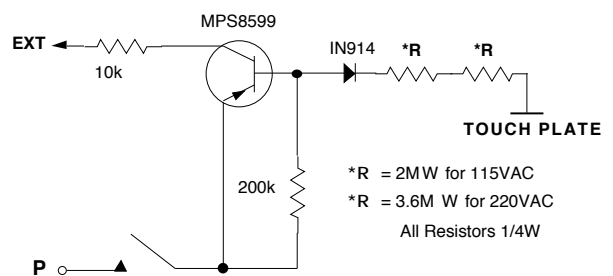| 8	7	6	5
TRIG/	Vss	EXT	SENS/
	LS7642		
VDD	BCV	TEST	SYNC
1	2	3	4

R2

C3

R4

NOTES

1. All circuits connected by broken lines are optional.
2. **C5** is used only with electronic extension and **R7** is used only with pushbutton switch.
3. Connection between Pin 6 & Pin 7 should be broken when EXT is used.
4. Magnetic transformer should have thermal protection.
5. Some electronic transformers may require larger values of **C2,** sensitive gate triacs and snubber networks. **C2** values may have to be adjusted to be as high as 0.47uF for 115VAC and 0.33uF for 220VAC. Sensitive gate triacs are chosen for their low holding current. Typical triacs are L4004L6 and L4004F51 for 115VAC and L6004L6 and L6004F51 for 220VAC applications, respectively.

   **C6-R9 is the snubber network:
   C6 = 0.1uF, 200V, **R9** = 1k Ohm, 1/2W (115VAC);
   C6 = 0.05uF, 400V, **R9** = 1k Ohm, 1W (220VAC)

6. The values selected for R10, R11, and R12 will produce the full dimming range. To reduce the maximum intensity, increase the value of R12. To increase the minimum intensity, increase the value of R10. Increasing either R10 or R12 will reduce the dimming range. R10 may have to be increased for very low wattage loads.

C1 = 0.15μF, 200V
* C1 = 0.15μF, 400V
C2 = 0.22μF, 200V
* C2 = 0.15μF, 400V
C3 = 0.002μF, 10V

*Component change for 220VAC
**Snubber Network (See Note 5)

C4 = 100μF, 10V
C5 = 0.1μF, 10V
C6 = 0.01uF, 10V
C7 = 0.1uF, 10V
R1 = 270 , 1/2W
*R1 = 1k , 1W
R2 = 680k , 1/4W
*R2 = 1.5M , 1/4W
R3 = 1.5M , 1/4W

R4 = 1M to 5M , 1/4W
(Select for Sensitivity)
R5, R6 = 2.7M , 1/4W
*R5, R6 = 4.7M , 1/4W
R7 = 150k , 1/4W
R8 = 62 , 1/4W
R10 = 33k , 1/4W
R11 = 100k Pot., 1/4W
R12 = 16k , 1/4W

D1 = 1N4148
Z = 5.6V, 1W (Zener)
T = Q4004L4 Typical Triac **(1)**
* T = Q5003L4 Typical Triac **(1)**
L = 100μH (RFI Filter)
* L = 200μH (RFI Filter)
(1) For loads greater than 6A, use an alternistor

FIGURE 6. ELECTRONIC EXTENSION

EXT

10k

MPS8599

IN914

*R

*R

TOUCH PLATE

200k

*R = 2M W for 115VAC
*R = 3.6M W for 220VAC
All Resistors 1/4W

P

EXTENSIONS: All On / Off switching functions can be implemented by utilizing the EXT input. Use a pushbutton or the electronic switch in conjunction with a Touch Plate as shown in Figure 6. When the plate is touched, a logic high level is generated at the EXT input of the IC for both half-cycles of the line frequency. (See Figure 5)

APPLICATION EXAMPLE:

A typical implementation of the light dimmer circuit is shown in Fig. 5. Here the lamp is turned on and off by touching the touch plate. The function of different components are as follows:

- The 5V DC supply for the chip is provided by Z, D1, R1, C2 and C4.
- R2 and C3 generate the filtered signal for the SYNC input AC phase synchronization.
- R3 and C5 act as a filter circuit for the electronic extension. If extensions are not used, the EXT input (Pin 6) should be tied to Vss (Pin 7).
- R4, R5 and R6 set up the sensitivity of the SENS/ input.
- R8 provides current limiting and isolation between the chip output and the triac gate.
- C1 and L are RFI filter circuits.
- R10, R11, R12 and C7 selects and adjusts the dimming level.

Figure 7. LS7642 Block Diagram

$$Vo = \left(\frac{Vs}{128}\right) * N,$$
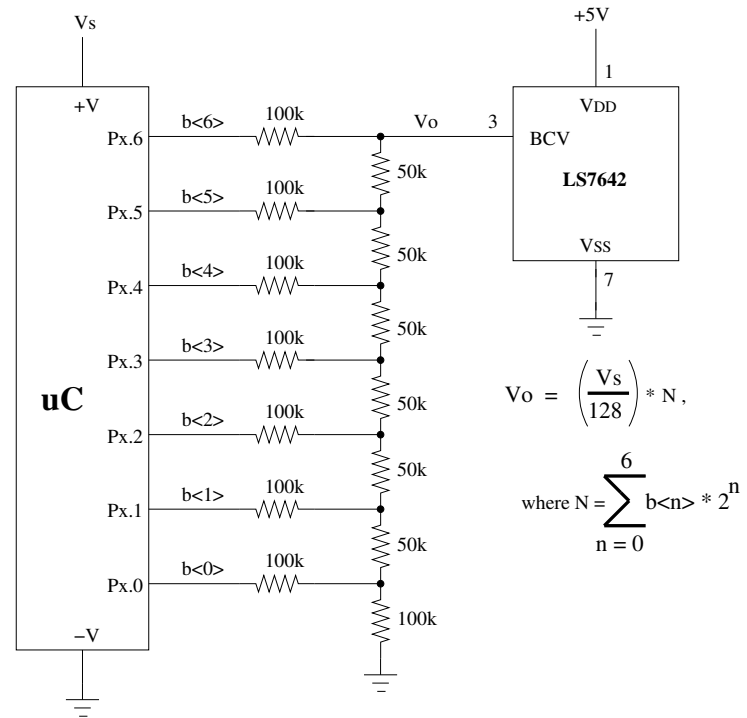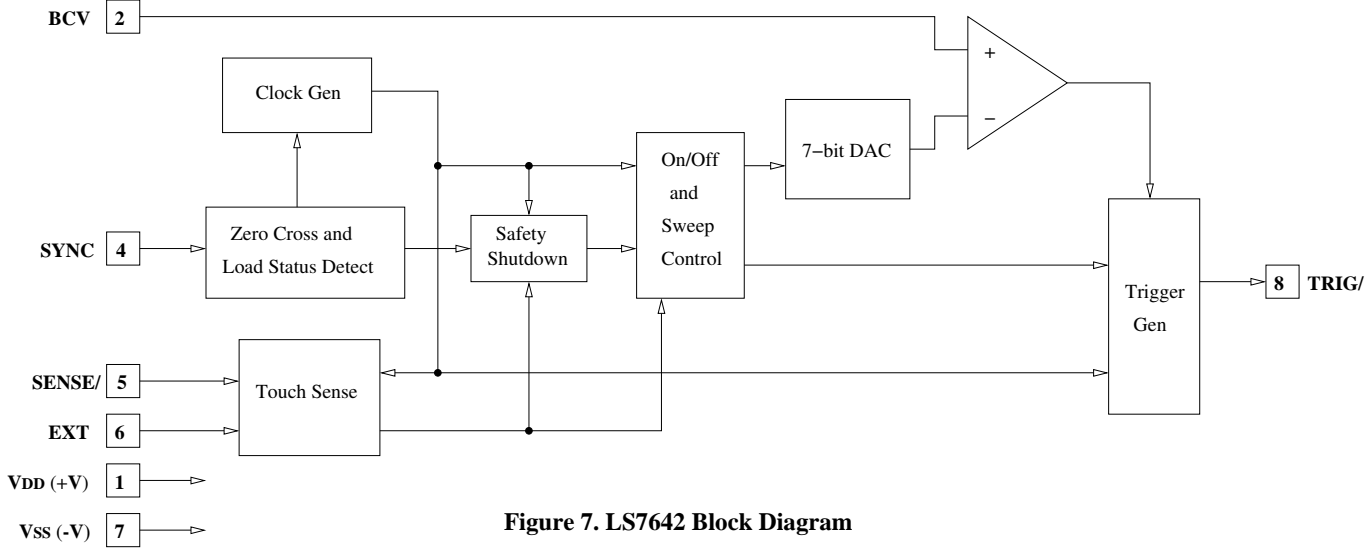
$$\text{where } N = \sum_{n=0}^{6} b\langle n\rangle * 2^n$$

Figure 8. Digital Control of Brightness with a uC.