LSI/CSI

LS7631/7632

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TOUCH CONTROL HALOGEN LAMP DIMMER

May 2001

FEATURES:

- Control of incandescent and transformer-coupled halogen lamps
- Transformer can be Magnetic or Electronic
- Automatic safety shutdown
- PLL synchronization allows use as a Wall Switch
- Three operating modes
- Extension input for remote activation
- 50Hz/60Hz AC line frequency
- +5V Power Supply (V_{DD}-V_{SS})
- LS7631, LS7632 (DIP); LS7631-S, LS7632-S (SOIC)

BACKGROUND AND GENERAL DESCRIPTION:

An electronic lamp dimmer may not operate properly with the inductive load encountered when driving a transformer-coupled low-voltage halogen lamp. The operating problems are a direct result of the current-voltage phase lag produced by the inductive load, such as when the triac current does not drop below the holding-current cut-off level at the time in a half-cycle when a triac trigger pulse is issued. This results in the triac not firing in that half-cycle, producing a phenomenon called half-waving, wherein the triac fires in alternate half-cycles only, which may lead to the thermal destruction of the load transformer.

The problems encountered in driving an inductive load are addressed by the LS7631/LS7632 CMOS ICs as follows:

1. Compensation for delayed triac cut-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. Compensation for delayed triac turn-on.
At the set conduction angle, a triac trigger pulse of 130.2µs (60 Hz) is issued by the dimmer IC. If the triac fails to fire, a second trigger pulse of 260.4µs width is issued a millisecond later as a second attempt to fire the triac during the same half-cycle.

3. Safety-shutdown.
If the frequency of occurrences off the delayed cut-off and delayed turn-on exceeds a preset threshold, a shutdown is initiated by turning off the triac trigger pulses. The safety-shutdown threshold value is accumulated in a 4-bit Up/Down counter. The count increments for every occurrence of delayed cut-off or delayed turn-on and decrements once every 8 SYNC pulses (AC line cycles). The counter will not decrement below zero. If the count reaches 15, the safety-shutdown is effected.

INPUT/OUTPUT DESCRIPTION:

V_{DD} (Pin 1)
Supply voltage positive terminal.

Vss (Pin 7)
Supply voltage negative terminal.

PIN ASSIGNMENT - TOP VIEW

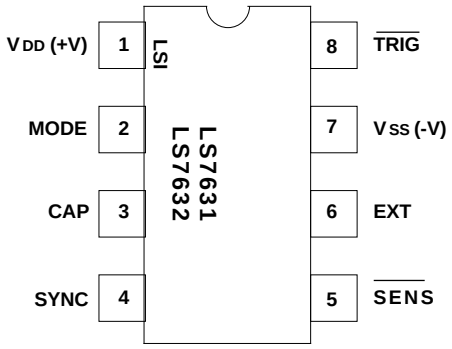


FIGURE 1

MODE (Pin 2)
Both LS7631 and LS7632 can operate in 3 different modes called Mode 0, Mode 1 and Mode 2. A full description of the 3 operating modes is provided in Table 1. The MODE input level selects one of the 3 operating modes as follows:

MODE Input Level	Selected Mode
Vss	Mode 0
Float	Mode 1
V_{DD}	Mode 2

CAP (Pin 3)
PLL filter capacitor input. A 0.02µF capacitor should be connected to this input.

SYNC (Pin 4)
When the AC line frequency is applied to this input all internal timings are synchronized to the AC phase through a PLL circuit. The Load On/Off status information is also derived from this input.

$\overline{\text{SENS}}$ (Pin 5)
A Logic 0 applied to this input alters the $\overline{\text{TRIG}}$ output either by turning it on, turning it off or by changing its conduction angle. Specifically which action takes place is dependent on the type of activation of the $\overline{\text{SENS}}$ input, namely SHORT touch (activation length = T_{S1}) and LONG touch (activation length = T_{S2}). A full description of the effects of a LONG touch and a SHORT touch in different modes is provided in Table 1.

EXT (Pin 6)
Same functionality as the $\overline{\text{SENS}}$ input, except that a Logic 1 is the active level at this input. EXT input is intended to be operated from a remote site with long cable connection, when noise can be expected. The sampling method used at this input makes it less sensitive to noise.

$\overline{\text{TRIG}}$ (Pin 8)
The $\overline{\text{TRIG}}$ output is a low level pulse occurring once every half-cycle of the AC and is intended to drive the gate of a triac in series with the load. The conduction angle, ø, of the $\overline{\text{TRIG}}$ pulse can be varied by means of LONG and SHORT touches at either the $\overline{\text{SENS}}$ or the EXT input.

The functional differences between LS7631 and LS7632 are:
LS7631 - When a LONG touch is applied, the dimming direction automatically reverses whenever maximum or minimum conduction angles are reached.
LS7632 - When a LONG touch is applied, the dimming stops whenever maximum or minimum conduction angles are reached. In order to change dimming levels from maximum or minimum, LONG touch must be removed and reapplied.The purpose of this feature is to allow the user to positively locate maximum and minimum conduction angles.

LS7632 NOTE

If the User applies a LONG Touch when the $\overline{\text{TRIG}}$ Conduction Angle is within a "few" degrees of Maximum or Minimum, the $\overline{\text{TRIG}}$ Conduction Angle can move to Maximum or Minimum and stop without the User being able to observe a change in brightness. Therefore, the User should be instructed that if no change in brightness is observed in response to a LONG Touch, the LONG Touch should be removed and reapplied in order to produce a change in brightness.

TABLE 1
TOUCH TYPE

MODE	SHORT		LONG		DIMMING REVERSAL (Note 5)
	PRE-TOUCH Ø	POST TOUCH Ø	PRETOUCH Ø	POST-TOUCH Ø	
0	OFF	MAX(Note 1)	OFF/MIN	Varies up from MIN	N/A
	ON	OFF	MAX	Varies down from MAX	N/A
			INTERMEDIATE	Varies from INTERMEDIATE	NO
1	OFF	MEMORY	OFF	Varies from memory(Notes 2, 3,4)	YES
		(Notes 2,3)	MIN	Varies up from MIN	N/A
	ON	OFF	MAX	Varies down from MAX	N/A
			INTERMEDIATE	Varies from INTERMEDIATE	YES
2	OFF	MAX(Note 1)	OFF/MIN	Varies up from MIN	N/A
	ON	OFF	MAX	Varies down from MAX	N/A
			INTERMEDIATE	Varies from INTERMEDIATE	YES

Note 1: A soft turn-on is produced by slewing up the conduction angle, ø, from minimum at the rate of 1.4°/4.17ms (60Hz). There are a total of 84 discrete values of ø.
Note 2: A soft turn-on is produced by slewing up ø, from minimum to memory. Upon power-up the memory value is defaulted to maximum conduction angle.
Note 3: "Memory" refers to the conduction angle, ø, which existed prior to the current off-state.
Note 4: A soft turn-on is produced by slewing up ø from minimum to memory upon which the dimming is started.
Note 5: NO = Dimming direction does not reverse from prior dimming direction.
YES = Dimming direction does reverse from prior dimming direction.
N/A = Does not apply.

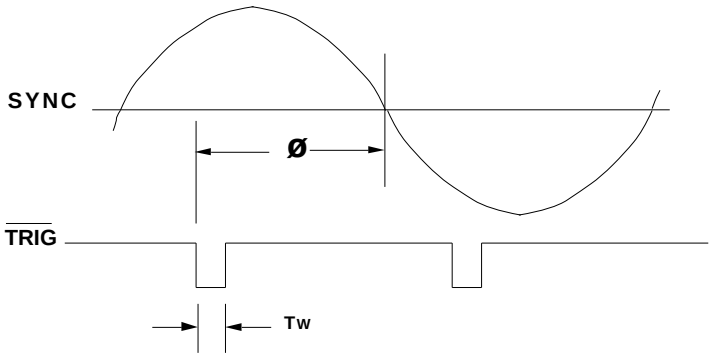


FIGURE 2.

$\overline{\text{TRIG}}$ OUTPUT CONDUCTION ANGLE, Ø

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	°C
Storage temperature	T_{STG}	-65 to +150	°C

DC ELECTRICAL CHARACTERISTICS:
(T_A = +25°C, all voltages referenced to Vss. 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} = 5.5V
SYNC Lo	V_{ISL}	-	-	2.1	V	-
SYNC Hi	V_{ISH}	2.9	-	-	V	-
EXT, $\overline{\text{SENS}}$ Lo	V_{IEL}	-	-	1.5	V	-
EXT, $\overline{\text{SENS}}$ Hi	V_{IEH}	3.5	-	-	V	-
$\overline{\text{TRIG}}$ Lo	V_{OL}	-	0.2	-	V	-
$\overline{\text{TRIG}}$ Hi	V_{OH}	-	5.0	-	V	-
$\overline{\text{TRIG}}$ Sink Current	I_{TSNK}	35	-	-	mA	V_{OTRIG} = 2.5V

TIMING CHARACTERISTICS (See Figures 2, 3 and 4**):**

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT	CONDITION
SYNC Frequency	f_S	40	-	70	Hz	-
SHORT Touch	T_{SI}	42	-	333	ms	60Hz
	T_{SI}	50	-	400	ms	50Hz
LONG Touch	T_{S2}	342	-	infinite	ms	60Hz
	T_{S2}	410	-	infinite	ms	50Hz
$\overline{\text{TRIG}}$ pulse width	T_W	-	130.2	-	µs	60Hz
	T_W	-	156.2	-	µs	50Hz
Conduction Angle	ø	41	-	158	deg	-
ø incremental steps (Note 1)	Δø	-	1.4	-	deg	-
Soft-on slew rate	S_S	-	1.4	-	deg/4.17ms	60Hz
	S_S	-	1.4	-	deg/5ms	50Hz
A_0 to A_1/A_2 to A_0 slew rate	S_{AA}	-	1.4	-	deg/33.3ms	60Hz
(Note 2)	S_{AA}	-	1.4	-	deg/40ms	50Hz
A_1 to B_1/B_2 to A_2 slew rate	S_{BA}	-	1.4	-	deg/66.7ms	60Hz
(Note 3)	S_{BA}	-	1.4	-	deg/80ms	50Hz
B_1 to B_2 delay	T_{BD}	-	500	-	ms	60Hz
(Note 4)	T_{BD}	-	600	-	ms	50Hz

Note 1: Total number of steps = 83.
Note 2: Number of steps from A_0 to A_1, or A_2 to A_0 = 68.
Note 3: Number of steps from A_1 to B_1 or B_2 to A_2 = 15.
Note 4: ø is at minimum between B_1 and B_2. T_{BD} is applicable to LS7631 only. In LS7632 when minimum ø is reached, dimming direction reverses only if the LONG Touch is terminated and reapplied.

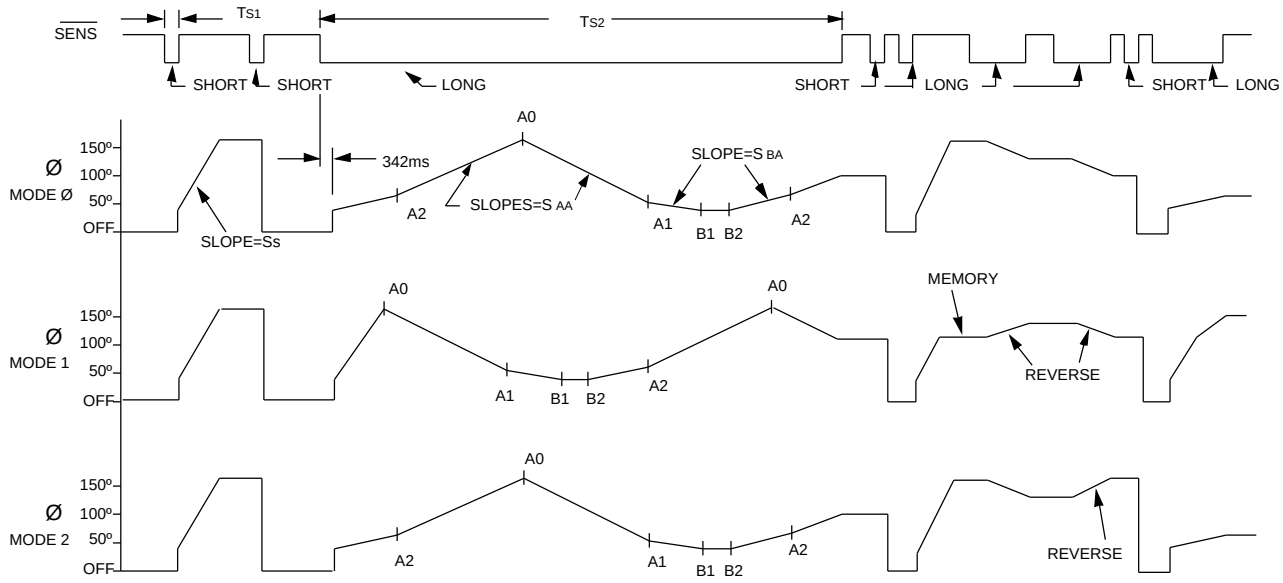


FIGURE 3. LS7631 $\overline{\text{TRIG}}$, Ø, vs TOUCH ($\overline{\text{SENS}}$ OR EXT)

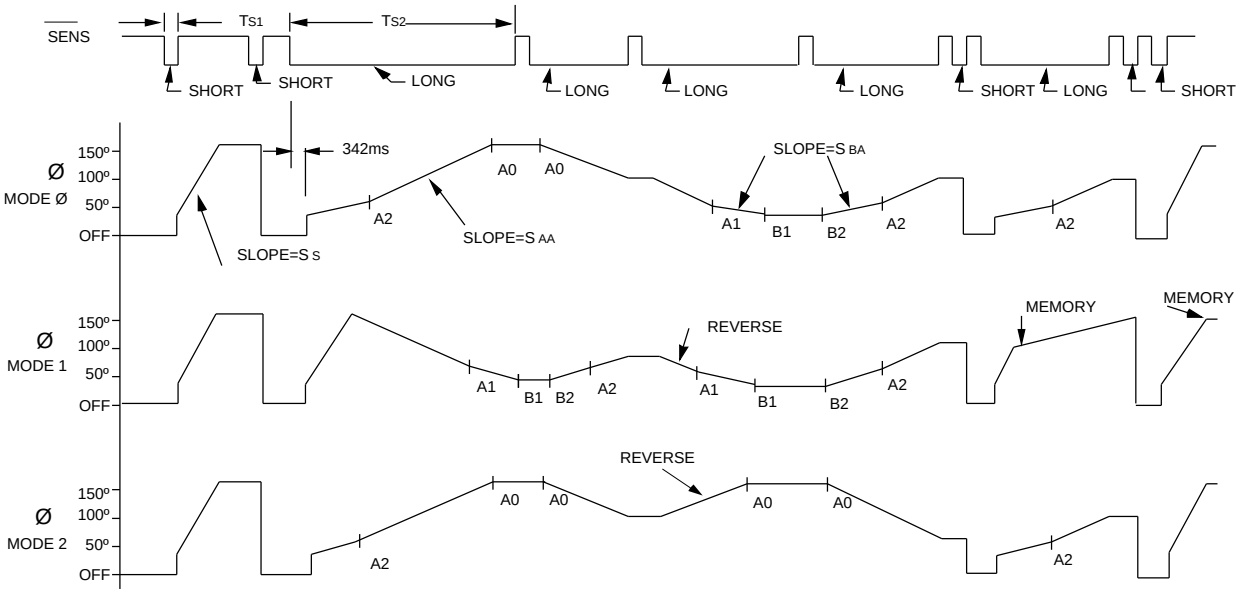
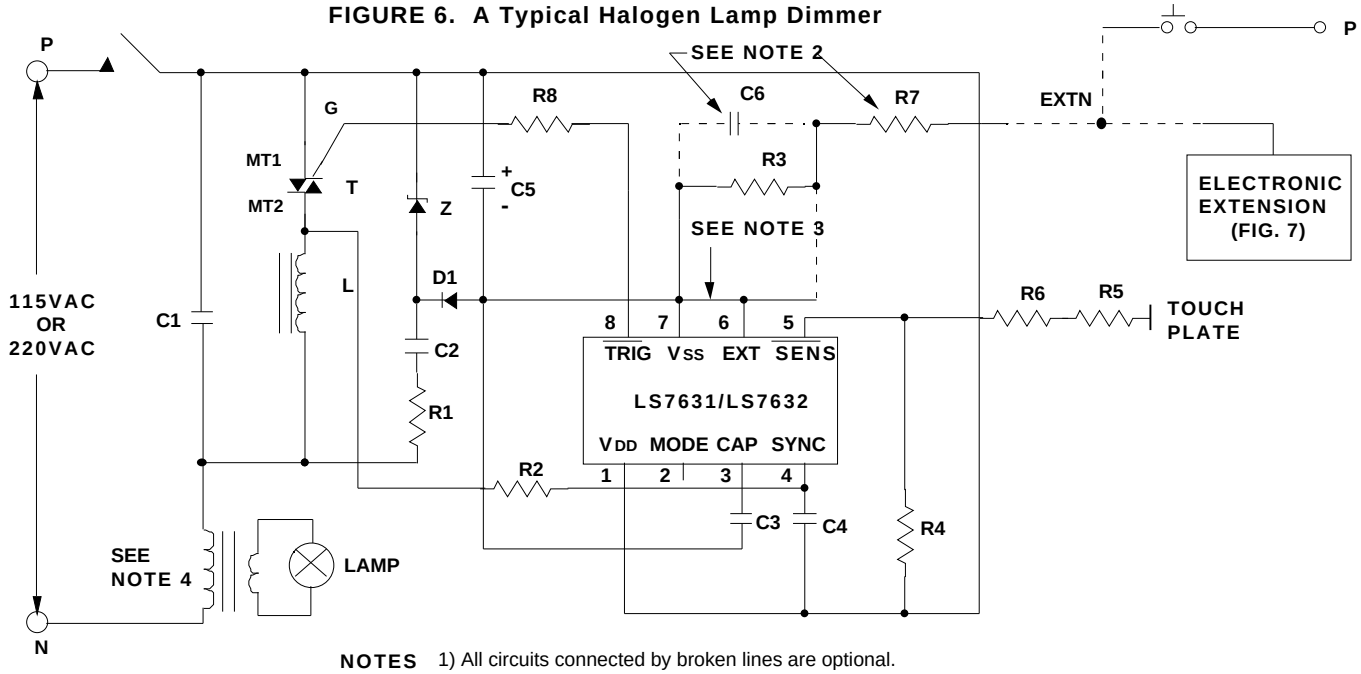


FIGURE 4. LS7632 $\overline{\text{TRIG}}$, Ø, vs TOUCH ($\overline{\text{SENS}}$ OR EXT)

FIGURE 6. A Typical Halogen Lamp Dimmer



NOTES
1) All circuits connected by broken lines are optional.
2) C6 is used only with electronic extension and R7 is used only with mechanical switch.
3) Connection between Pin 6 & Pin 7 should be broken when EXT is used.
4) As a precaution, transformer should have thermal protection.

115V

C1 = 0.15µF, 200V
C2 = 0.15µF, 200V
C3 = 0.02µF, 12V
C4 = 0.002µF, 12V
C5 = 100µF, 12V
C6 = 0.1µF, 12V
R1 = 270Ω, 1/2W
R2 = 680kΩ, 1/4W
R3 = 1.5MΩ, 1/4W
R4 = 1MΩ to 5MΩ, 1/4W (Select for sensitivity)
R5, R6 = 2.7MΩ, 1/4W
R7 = 150kΩ, 1/4W
R8 = 62Ω, 1/4W
D1 = 1N4148
Z = 5.6V, 1W (Zener)
(2) T = Q4004L4 Typical Triac
L = 100µH (RFI Filter)

220V (1)

(1) All components same as 115V except as shown below:

C1 = 0.15µF, 400V
C2 = 0.082µF, 400V
R1 = 1kΩ, 1W
R2 = 1.5MΩ, 1/4W
R5, R6 = 4.7MΩ, 1/4W
(2) T = Q5003L4 Typical Triac
L = 200µH (RFI Filter)

(2) For loads greater than 6A, use an Alternistor

APPLICATION EXAMPLE:

A typical implementation of the light dimmer circuit is shown in Fig. 6. Here the brightness of the lamp is set 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 C5.
- R2 and C4 generate the filtered signal for the SYNC input for synchronizing the internal PLL with the line frequency.
- R3 and C6 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.
- C3 is the filter capacitor for the internal PLL.
- R8 provides current limiting and isolation between the chip output and the triac gate.
- C1 and L are RF filter circuits.

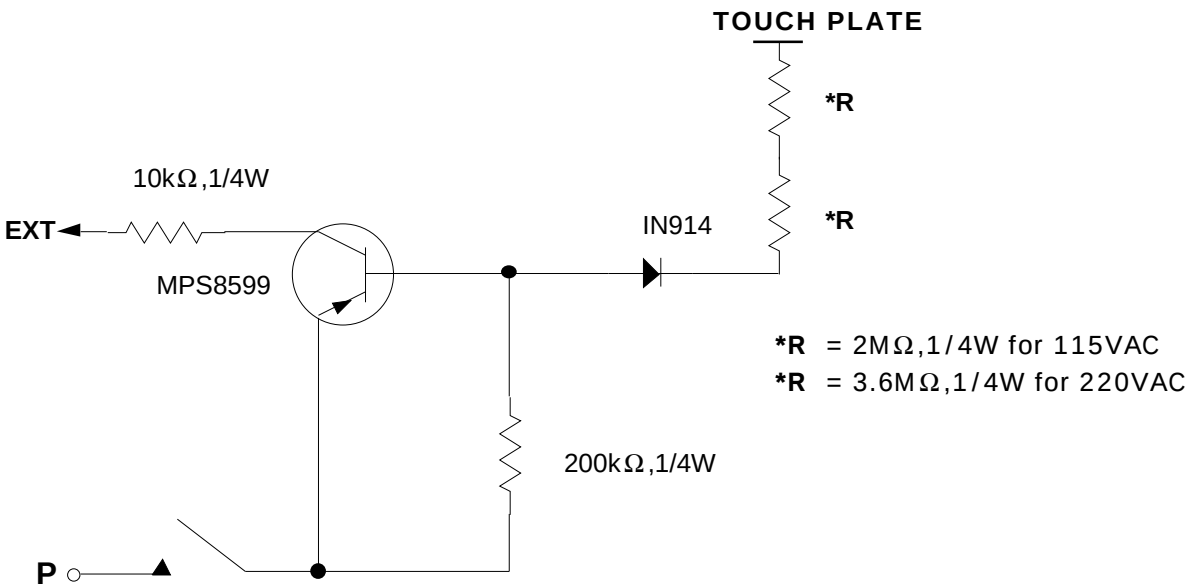


FIGURE 7. ELECTRONIC EXTENSION

EXTENSIONS: All switching and dimming functions can be implemented by utilizing the EXT input. This can be done by either a mechanical switch or the electronic switch in conjunction with a Touch Plate as shown in Figure 7. 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 6)