

## TOUCH CONTROL LAMP DIMMER

January 2003

### FEATURES:

- Phase-lock loop synchronization allows use in Wall Switch applications.
- Provides brightness control of incandescent lamps with touch plates or pushbutton switches.
- Controls the duty cycle from 23% to 88% (conduction angles for AC half-cycles between 41° and 158°, respectively.)
- Operates at 50Hz/60Hz line frequency.
- Extension input for remote activation.
- +12V to +18V Power Supply voltage (Vss - VDD).
- LS7232ND (DIP); LS7232ND-S (SOIC) - See Figure 1

### DESCRIPTION:

LS7232ND is a MOS integrated circuit designed to control brightness of incandescent lamps. The output of this IC controls the brightness of a lamp by controlling the firing angle of a triac connected in series with the lamp. All internal timings are synchronized with the line frequency by means of a built-in phase-lock loop circuit. The output occurs once every half-cycle of the line frequency. Within the half-cycle, the output can be positioned anywhere between 158° conduction angle for maximum brightness and 41° conduction angle for minimum brightness in relation to the AC line frequency. The positioning of the output is controlled by applying a low level at the  $\overline{\text{SENS}}$  input or a high level at the EXT input.

These functions may be implemented with very few interface components, as shown in Figure 5. When implemented in this manner, touching of the Touch Plate causes the lamp brightness to change as follows:

1. If the Touch Plate is touched momentarily (42ms to 333ms), the lamp is:
  - a) turned off if it was on,
  - b) turned on if it was off.
 The brightness resulting is either full brightness or, depending on the mode, a previous brightness stored in the IC memory.
2. If the Touch Plate is touched for a prolonged time (more than 342ms) the light intensity changes slowly. As long as the touch is maintained, the change continues; the direction of change reverses whenever the maximum or minimum brightness is reached.

### INPUT/OUTPUT DESCRIPTION:

#### Vss (Pin 1)

Supply voltage positive terminal.

#### MODE (Pin 2)

The LS7232ND can operate in either of 3 modes, Mode 0, Mode 1 or Mode 2. A full description of the operating modes is provided in Table 1. The MODE input level selects the operating mode as follows:

### PIN ASSIGNMENT - TOP VIEW

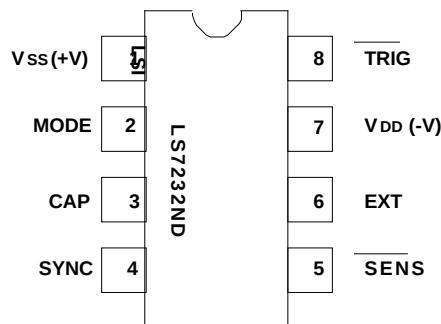


FIGURE 1

| MODE Input | Mode | Functional Equivalent* |
|------------|------|------------------------|
| VDD        | 0    | LS7231                 |
| Vss        | 1    | LS7232                 |
| Float      | 2    | LS7233                 |

**\*NOTE:** The LS7232ND can replace LS7231, LS7232 and LS7233 where the DOZE input is not used. The LS7232 PCB requires no change. The LS7233 PCB requires that the Pin 2 connection be opened. The LS7231 PCB requires that the Pin 2 connection be made to VDD instead of Vss.

#### CAP (Pin 3)

The CAP input is for the PLL filter capacitor.

A 0.047μF capacitor should be connected to this input.

#### SYNC (Pin 4)

The AC Line Frequency is applied to this input through an external RC circuit (See Figure 5). The Phase-Lock Loop in the IC synchronizes all internal timings to the AC signal at the SYNC input.

#### $\overline{\text{SENS}}$ (Pin 5)

A low level activates this input (See Table 1) which controls the turn-on, turn-off and conduction angle,  $\phi$  (See Figure 3), of the TRIG signal with respect to the SYNC input.

#### EXT (Pin 6)

The EXT input is functionally identical to the  $\overline{\text{SENS}}$  input except that a high level activates this input. It is recommended that the EXT input be used instead of the  $\overline{\text{SENS}}$  input when long extension wires are employed between the IC and the Sensing Circuitry (See Figure 5 and Figure 6) because the EXT input is less susceptible to noise.

The functional differences of the modes of the LS7232ND are explained in Table 1 and the TRIG output conduction angle diagrams in Figure 4.

**TABLE 1**  
**TOUCH TYPE**

| MODE              | TOUCH TYPE                     |                               |                                |                                                                                                      | DIMMING DIRECTION REVERSAL (Note 3) |
|-------------------|--------------------------------|-------------------------------|--------------------------------|------------------------------------------------------------------------------------------------------|-------------------------------------|
|                   | SHORT (Ts1 Duration)           |                               | LONG (Ts2 Duration)            |                                                                                                      |                                     |
|                   | PRE-TOUCH<br>Ø                 | POST-TOUCH<br>Ø               | PRE-TOUCH<br>Ø                 | POST-TOUCH<br>Ø                                                                                      |                                     |
| 0<br><br>(LS7231) | Off<br>Max<br>Intermediate     | Max<br>Off<br>Off             | Off<br>Max<br>Intermediate     | Starts varying at Min<br>Starts varying at Max<br>Starts varying at Pre-Touch brightness             | N/A<br>N/A<br>NO                    |
| 1<br><br>(LS7232) | Off<br><br>Max<br>Intermediate | Memory (Note 1)<br>Off<br>Off | Off<br><br>Max<br>Intermediate | Starts varying at Memory (Note 2)<br>Starts varying at Max<br>Starts varying at Pre-Touch brightness | YES<br><br>N/A<br>YES               |
| 2<br><br>(LS7233) | Off<br>Max<br>Intermediate     | Max<br>Off<br>Off             | Off<br>Max<br>Intermediate     | Starts varying at Min<br>Starts varying at Max<br>Starts varying at Pre-Touch brightness             | N/A<br>N/A<br>YES                   |

**NOTE 1:** "Memory" refers to the conduction angle,  $\emptyset$ , which existed prior to the current off-state.

First time after power-up, the Memory value defaults to maximum conduction angle.

**NOTE 2:** First time after power-up, LONG touch causes intensity to vary starting at minimum conduction angle.

**NOTE 3:** NO = Dimming direction does not reverse from prior dimming direction.

YES = Dimming direction does reverse from prior dimming direction.

N/A = Does not apply

**VDD** (Pin 7)

Supply voltage negative terminal.

**TRIG** (Pin 8)

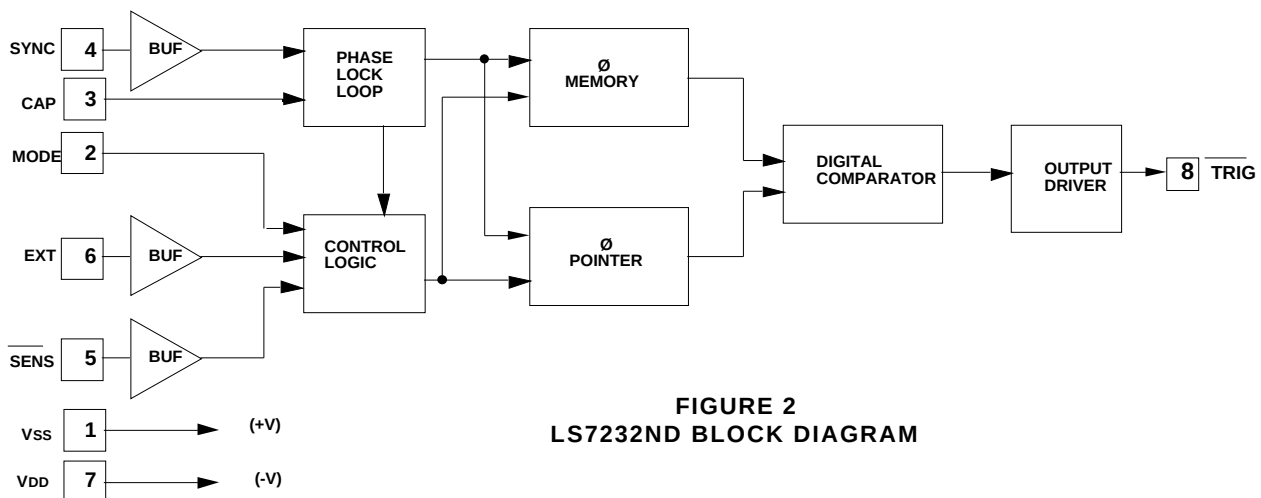
The TRIG output is a low level pulse occurring once every half-cycle of the SYNC input. The conduction angle,  $\emptyset$ , of the output in relation to the SYNC signal controls the lamp brightness.

In continuous dimming operation (i.e. when the  $\overline{\text{SENS}}$  input is continuously held low) the TRIG conduction angle,  $\emptyset$ , sweeps up and down between  $41^\circ$  and  $158^\circ$  continuously. The time vs  $\emptyset$  curve is not linear (See Figure 4). Between two maxima on this curve, there are 4 discontinuous points labeled A1, B1, B2, A2.

The discontinuities are as follows:

1. From maximum to A1. In this region,  $\emptyset$  is changed by equal increments ( $D\emptyset$ ) for every 2 SYNC clocks.
2. From A1 to B1. In this region, the increments ( $D\emptyset$ ) take place for every 4 SYNC clocks.
3. From B1 to B2. In this region  $\emptyset$  is held at a constant level ( $D\emptyset = 0$ ).
4. From B2 to A2. Same as 2.
5. From A2 to Max. Same as 1.

The slower rate of change in  $\emptyset$  over A1B1B2A2 region is to accommodate for eye adjustment at lower light intensity.



**FIGURE 2**  
**LS7232ND BLOCK DIAGRAM**

**ABSOLUTE MAXIMUM RATINGS:**

| PARAMETER             | SYMBOL           | VALUE                                         | UNIT |
|-----------------------|------------------|-----------------------------------------------|------|
| DC Supply Voltage     | V <sub>SS</sub>  | +20                                           | V    |
| Any Input Voltage     | V <sub>IN</sub>  | V <sub>SS</sub> - 20 to V <sub>SS</sub> + 0.5 | V    |
| Operating Temperature | T <sub>A</sub>   | 0 to +80                                      | °C   |
| Storage Temperature   | T <sub>STG</sub> | -65 to +150                                   | °C   |

**DC ELECTRICAL CHARACTERISTICS:** (T<sub>A</sub> = 25°C, all voltages referenced to V<sub>DD</sub>)

| PARAMETER                 | SYMBOL           | MIN                   | TYP                 | MAX                   | UNIT | CONDITION                                                        |
|---------------------------|------------------|-----------------------|---------------------|-----------------------|------|------------------------------------------------------------------|
| Supply Voltage            | V <sub>SS</sub>  | +12                   | —                   | +18                   | V    | —                                                                |
| Supply Current            | I <sub>SS</sub>  | —                     | 1.0                 | 1.4                   | mA   | V <sub>SS</sub> = +15V, output off                               |
| <b>Input Voltages:</b>    |                  |                       |                     |                       |      |                                                                  |
| <b>SYNC</b> Lo            | V <sub>IRL</sub> | 0                     | —                   | V <sub>SS</sub> - 9.5 | V    | —                                                                |
| <b>SYNC</b> Hi            | V <sub>IRH</sub> | V <sub>SS</sub> - 5.5 | —                   | V <sub>SS</sub>       | V    | —                                                                |
| <b>SENS</b> Lo            | V <sub>IOL</sub> | 0                     | —                   | V <sub>SS</sub> - 8   | V    | —                                                                |
| <b>SENS</b> Hi            | V <sub>IOH</sub> | V <sub>SS</sub> - 2   | —                   | V <sub>SS</sub>       | V    | —                                                                |
| <b>EXT</b> Lo             | V <sub>IVL</sub> | 0                     | —                   | V <sub>SS</sub> - 8   | V    | —                                                                |
| <b>EXT</b> Hi             | V <sub>IVH</sub> | V <sub>SS</sub> - 2   | —                   | V <sub>SS</sub>       | V    | —                                                                |
| <b>Input Current:</b>     |                  |                       |                     |                       |      |                                                                  |
| <b>SYNC, SENS, EXT</b> Hi | I <sub>IH</sub>  | —                     | —                   | 110                   | μA   | With Series 1.5MW Resistor to AC Line                            |
| <b>SYNC, SENS, EXT</b> Lo | I <sub>IL</sub>  | —                     | —                   | 100                   | nA   | —                                                                |
| <b>TRIG</b> Hi Voltage    | V <sub>OH</sub>  | —                     | V <sub>SS</sub>     | —                     | V    | —                                                                |
| <b>TRIG</b> Lo Voltage    | V <sub>OL</sub>  | —                     | V <sub>SS</sub> - 8 | —                     | V    | V <sub>SS</sub> = +15V                                           |
| <b>TRIG</b> Sink Current  | I <sub>OS</sub>  | 25                    | —                   | —                     | mA   | V <sub>SS</sub> = +15V<br>V <sub>OL</sub> = V <sub>SS</sub> - 4V |

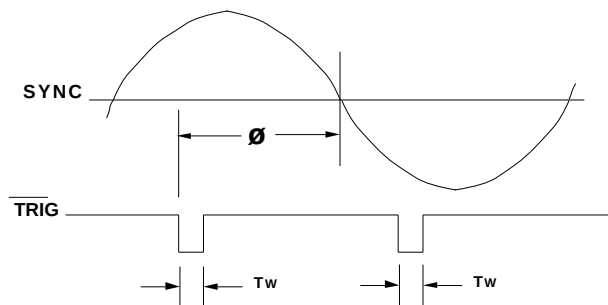
**TIMING CHARACTERISTICS** (See Figures 2 and 3):

All timings are based on f<sub>s</sub> = 60Hz, unless otherwise specified. 50Hz timings are 1.2 times 60Hz timings.

| PARAMETER                                    | SYMBOL          | MIN | TYP  | MAX      | UNIT |
|----------------------------------------------|-----------------|-----|------|----------|------|
| <b>SYNC</b> Frequency                        | f <sub>s</sub>  | 40  | —    | 70       | Hz   |
| <b>SHORT TOUCH</b><br>(ON/OFF Operation)     | T <sub>S1</sub> | 42  | —    | 333      | ms   |
| <b>LONG TOUCH</b><br>(Dimming Operation)     | T <sub>S2</sub> | 342 | —    | infinite | ms   |
| <b>TRIG</b> Pulse Width                      | T <sub>w</sub>  | —   | 33   | —        | μs   |
| <b>TRIG</b> Conduction-Angle<br>(See Note 1) | Ø               | 41  | —    | 158      | deg  |
| Ø Period (Max to Max in continuous dimming)  | —               | —   | 7.64 | —        | sec  |
| <b>A1B1 = B2A2</b> duration                  | —               | —   | 934  | —        | ms   |
| <b>B1B2</b> Min. intensity dwell             | —               | —   | 500  | —        | ms   |

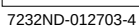
**NOTE 1.**

In the circuit schematic shown in Figure 5, the SYNC input signal is delayed in phase with respect to the AC Line by about 7°. This delay reduces the conduction angle, Ø, with respect to the AC Line by 7° from the values shown above.

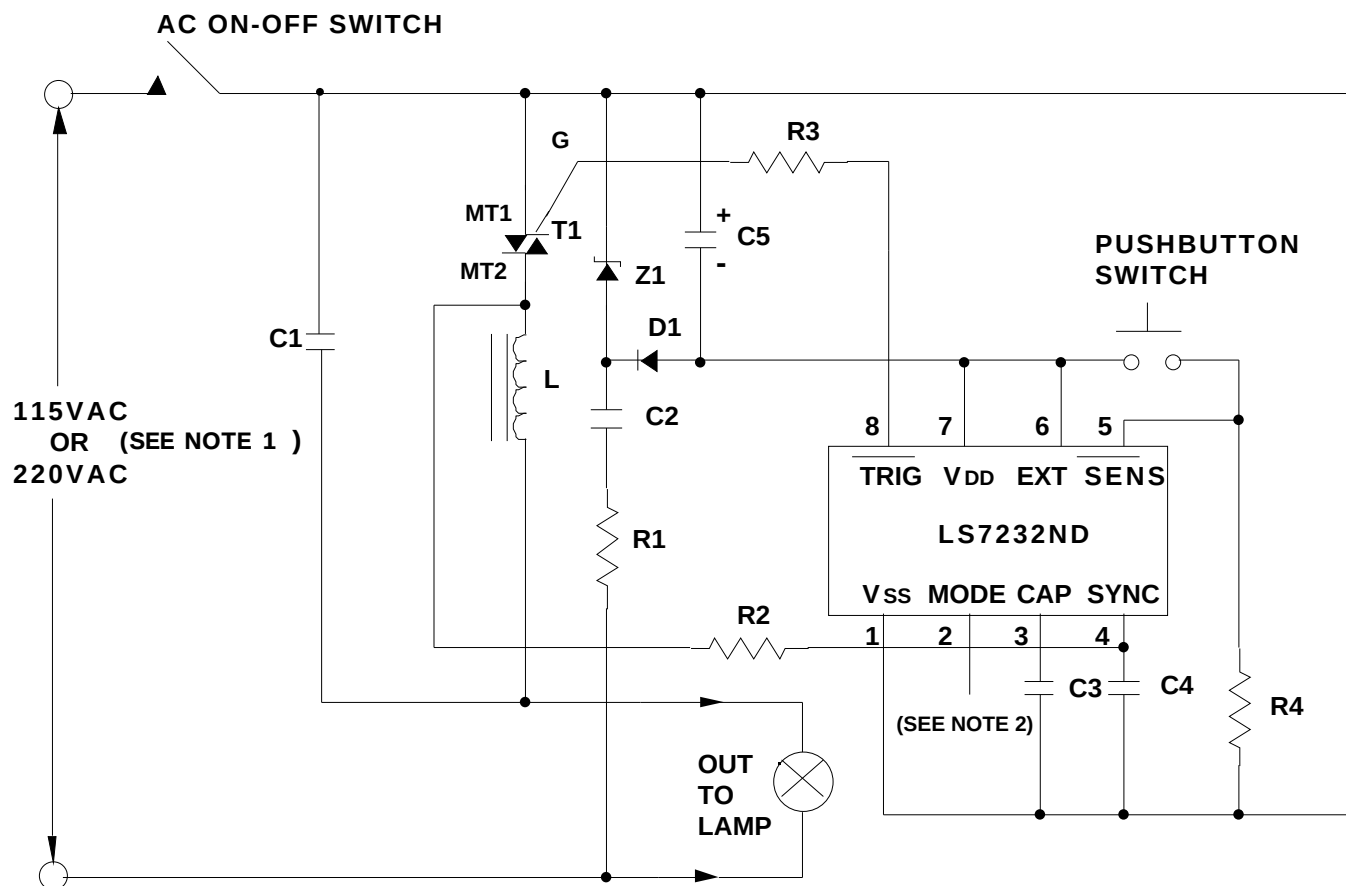
**FIGURE 3. TRIG OUTPUT CONDUCTION ANGLE, Ø**

A typical implementation of a lamp dimmer circuit is shown in Fig. 5. Here the brightness of the lamp is set by touching the Touch Plate. The functions of different components are as follows:

- In the case of momentary power failure, the circuit state remains unchanged for a period of up to 1 sec. For longer power interruptions, the output is shut off.



**FIGURE 7. A SWITCH-OPERATED LAMP DIMMER**



**NOTE 1:** Operation is independent of Line Plug Polarity

**NOTE 2:** See I/O Description for MODE (Pin 2)

#### 115V

C1 = 0.15 $\mu$ F, 200V  
 C2 = 0.22 $\mu$ F, 200V  
 C3 = 0.047 $\mu$ F, 25V  
 C4 = 470pF, 25V  
 C5 = 47 $\mu$ F, 25V  
 R1 = 270 $\Omega$ , 1/4W  
 R2 = 1.5M $\Omega$ , 1/4W  
 R3 = 100 $\Omega$ , 1/4W  
 R4 = 1M $\Omega$ , 1/4W  
 D1 = IN4148  
 Z1 = 15V, 1W (Zener)  
 T1 = Q4008L4 (Typical)  
 L = 100 $\mu$ H (RFI Filter)

#### 220V

C1 = 0.15 $\mu$ F, 400V  
 C2 = 0.1 $\mu$ F, 400V  
 C3 = 0.047 $\mu$ F, 25V  
 C4 = 470pF, 25V  
 C5 = 47 $\mu$ F, 25V  
 R1 = 1k $\Omega$ , 1/4W  
 R2 = 1.5M $\Omega$ , 1/4W  
 R3 = 100 $\Omega$ , 1/4W  
 R4 = 1M $\Omega$ , 1/4W  
 D1 = IN4148  
 Z1 = 15V, 1W (Zener)  
 T1 = Q5004L4 (Typical)  
 L = 200 $\mu$ H (RFI Filter)

#### APPLICATIONS:

1. Foot-Switch Dimmer for large floor lamps.
2. Hand-Switch Dimmer for end-table lamps.

The information included herein is believed to be accurate and reliable. However, LSI Computer Systems, Inc. assumes no responsibilities for inaccuracies, nor for any infringements of patent rights of others which may result from its use.