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LSI/CSI

LS7331

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TOUCH SENSITIVE LIGHT DIMMER AND A.C. MOTOR SPEED CONTROLLER* WITH COMPUTER CONTROL AND MONITORING

FEATURES:

- Provides speed control of A.C. motors and brightness control of incandescent lamps without the use of mechanical switches.
- Controls brightness/motor speed by controlling the a-c "duty cycle" hence reducing the power dissipation
- Controls the "duty cycle" from 23% to 88% (on time angles for a-c half cycles between 41° and 159° respectively.
- Allows computer control of lamp or motor operation.
- Provides outputs to computer indicating when lamp is at full brightness and when it is varying in brightness.
- Has an output that indicates when loss of power has occurred.
- Operates on 50 Hz/60 Hz line frequency.
- Input for extensions or remote sensors.
- Input for slow dimming.
- 12V to 18V DC supply voltage.

DESCRIPTION:

LS 7331 is a monolithic, ion implanted MOS circuit that is specifically designed for the control of brightness of incandescent lamps or speed of AC motors used on the a-c line. The outputs of these chips control the brightness of a lamp or speed of an AC motor by controlling the firing angle of a triac connected in series with the lamp or AC motor. All internal timings are synchronized with the line frequency by means of a built-in phase locked loop circuit. The output occurs once every half cycle of the line frequency. Within the half-cycle, the output can be positioned anywhere between 159° phase angle for maximum brightness/speed and 41° phase angle for minimum brightness/speed in relation to the line frequency. The positioning of the output is controlled by applying a low level at the sensor input or a high level at the slave input. Alternately, the sensor input can be applied via a microprocessor or computer. The DIM and FULL outputs are used to indicate the present state of the lamp or motor to the computer.

These functions may be implemented with very few interface components, which are described in the application examples. When implemented in this manner, a touching of the sensor plate or a control signal from the computer causes the lamp brightness or motor speed to change as follows:

1. If the sensor is touched or a control signal is applied momentarily (32ms to 332ms), the lamp or motor is:

   (a) turned off if it was on,

   (b) turned on if it was off. The brightness/speed to which the light/motor is turned on is either full brightness/speed, or depending on the circuit type, a previous brightness/speed stored in the memory.

PIN ASSIGNMENT — TOP VIEW
STANDARD 14 PIN PLASTIC DIP

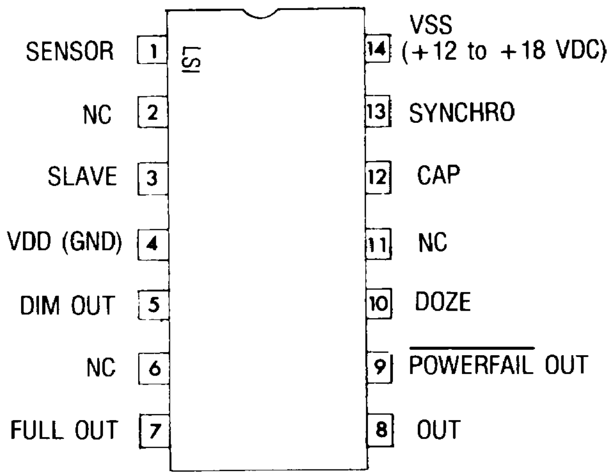

FIGURE 1

*Some motors may require a higher minimum duty cycle (Mask Option)

2. If the sensor is touched or the control signal is applied for a prolonged time (more than 332ms) the light intensity/speed changes slowly. As long as the touch is maintained, the change continues; the direction of change reverses whenever the maximum or minimum brightness/speed is reached.

   The circuit also provides an input for slow dimming. By applying a slow clock to this input, the lamp can be dimmed slowly until total turn off occurs. This feature can be useful in children's bedroom lights.

INPUT/OUTPUT DESCRIPTION:

VSS (Pin 14).
Supply voltage positive terminal.

DOZE (Pin 10).
A clock applied to this input causes the brightness/speed to decrease in equal increments with each negative transition of the clock. Eventually, when the lamp/motor turns off, this input has no further effect. The lamp/motor can be turned on again by activating either the SENSOR input or the SLAVE input. For the transition from maximum brightness/speed to off, a total of 83 clock pules are needed at the DOZE input.

TABLE I

	SENSOR (TOUCH) DURATION			
	MOMENTARY (32ms to 332ms) (note 1)		PROLONGED (More than 332ms) (note 1)	
	PRE-TOUCH BRIGHTNESS	POST-TOUCH BRIGHTNESS	PRE-TOUCH BRIGHTNESS	POST-TOUCH BRIGHTNESS
LS 7331	Off	Max	Off	Starts varying at Min
	Max	Off	Max	Starts varying at Max
	Intermediate	Off	Intermediate	Starts varying at Pre-Touch brightness in same direction as previous prolonged touch

NOTE 1. The time figure is based on 60Hz synchro frequency. For 50Hz the figures are 39ms and 399ms.

When either the SENSOR or the SLAVE input is active, the DOZE input is disabled.

CAP (Pin 12).
The CAP input is for external component connection. A capacitor of .047μF$\pm$20% should be used at this input.

SYNCHRO (Pin 13).
The a-c line frequency (50Hz/60Hz), when applied to this input, synchronizes all internal timings through a phase locked loop. The signal for this input may be obtained from the line voltage by employing the circuit arrangement shown in the application notes.

SENSOR (Pin 1).
A low level applied to the SENSOR input controls the turn on or turn off of the output as well as its phase angle with respect to the SYNCHRO input. A description of this is provided in the general description and Table 1.

SLAVE (Pin 3).
The SLAVE input is functionally similar to the SENSOR input with the exception that the active level is a logical high as compared to the logical low level for the SENSOR input. It is recommended that the SLAVE input be used instead of the SENSOR input when long extension wires are used between the sensing plates (or switches) and the dimmer chips.

VDD (Pin 4).
Supply voltage negative terminal.

$\overline{\text{OUT}}$ (Pin 8).
The output is a low level pulse occurring once every half cycle of the SYNCHRO signal. The phase angle, $\emptyset$ of the output in relation to the SYNCHRO signal controls the lamp brightness/motor speed.

In continuous dimming operation (i.e., when the SENSOR input is continuously held low) the output phase angle, $\emptyset$ sweeps up and down between 41° and 159° continuously. The time vs $\emptyset$ curve, however, is not a linear one (see Fig. 3). Between two maxima on this curve, there are 4 discontinuous points labeled A_1, B_1, B_2, A_2. The discontinuities are as follows:

1. From maximum to A_1. In this region, $\emptyset$ is changed by equal increments ($\Delta\emptyset$) for every 2 SYNCHRO clocks.
2. From A_1 to B_1. In this region, the increments ($\Delta\emptyset$) take place for every 4 SYNCHRO clocks.
3. From B_1 to B_2. In this region $\emptyset$ is held at a constant level ($\Delta\emptyset = 0$).
4. From B_2 to A_2. Same as 2.

From A_2 to Maximum. Same as 1.

The slower rate of change in 0 over $A_1B_1B_2A_2$ region is to accommodate for eye adjustment at lower light intensity

DIM OUT (Pin 5).
This CMOS compatible output is high whenever the circuit is in the continuous dimming mode of operation. When the lamp/motor is off or at full brightness/speed, this output is low.

FULL OUT (Pin 7).
This CMOS compatible output is high when the lamp/motor is a full brightness/speed. If the lamp is off or in the continuous dimming mode, this output is low.

$\overline{\text{POWER FAIL OUT}}$ (Pin 9).
If the SYNCHRO input does not occur for two successive cycles, then a loss of power is assumed to have occurred and this output becomes low. This output will become positive again one cycle after power is restored. This output is CMOS compatible.

APPLICATION EXAMPLES:
A typical implementation of the light dimmer/motor speed control circuit is shown in Fig. 5. Here the brightness of the lamp/speed of the motor is set by touching the sensor plate or by applying a control signal to Q_1, from the counter. The functions of different components are as follows:

- The 15V DC supply for the chip is provided by Z, D1, R1, C2 and C5.
- R_2 and C_4 generate the filtered signal for the SYNCHRO input for synchronizing the internal PLL with the line frequency.
- R_3 and C_7 act as a filter circuit for the electronic extension. If extensions are not used the slave input (Pin 3) should be tied to V_{DD} (Pin 7).
- R_4, R_5, R_6 set up the sensitivity of the sensor input. C_6 provides noise filtering.
- C_3 is the filter capacitor for the internal PLL.
- R_9 provides current limiting and isolation between the chip output and the triac gate.
- C_1 and L are RF filter circuits.

ABSOLUTE MAXIMUM RATINGS:

PARAMETER	SYMBOL	VALUE	UNITS
DC supply voltage	VSS	+20	Volt
Any pinput voltage	V_{IN}	VSS + .5	Volt
Operating Temperature	T_A	0 to + 80	°C
Storage Temperature	Tstg	-65 to +150	°C

DC ELECTRICAL CHARACTERISTICS:
(T_A = 25°C, all voltages referenced to VDD)

PARAMETER	SYMBOL	MIN.	TYP	MAX	UNIT	CONDITIONS/ REMARKS
Supply Voltage	V_{SS}	+12	—	+18	Volts	
Supply Current	I_{SS}	—	1.0	1.4	mA	@ V_{SS} = +15V, output off
Input Voltage						
Doze LO	V_{IZL}	0	—	V_{SS}-6	Volts	
Doze HI	V_{IZH}	VSS-2	—	V_{SS}	Volts	
Synchro LO	V_{IRL}	0	—	V_{SS}-9.5	Volts	
Synchro HI	V_{IRH}	V_{SS}-5.5	—	V_{SS}	Volts	
Sensor LO	V_{IOL}	0	—	V_{SS}-8	Volts	
Sensor HI	V_{IOH}	V_{SS}-2	—	V_{SS}	Volts	
Slave LO	V_{IVL}	0	—	V_{SS}-8	Volts	
Slave HI	V_{IVH}	V_{SS}-2	—	V_{SS}	Volts	
Slave Current:						
Synchro, Sensor & Slave HI	I_{IH}	—	—	700	μA	V_{input}=V_{SS} =+15V
Synchro, Sensor & Slave LO	I_L	—	—	15	nA	Leakage current
Doze HI	—	—	—	5	nA	
Doze LO	—	—	—	5	nA	
Output HI Vltg		—	V_{SS}	—	Volts	
Output LO Vltg		—	V_{SS}-8	—	Volts	
Output Sink Current	—	25	—	—	mA	@V_{SS}=+15V V_O = V_{SS}-4
Dim, Full	V_{OL}	—	—	0.5	Volts	
& Power Fail	V_{OH}	VSS-1	—	Volts		

FREQUENCY CHARACTERISTICS (See Fig. 2 & 3)

All timings are based on f_S = 60Hz, unless otherwise specified.

PARAMETER	SYMBOL	MIN	TYP.	MAX.	UNIT
Synchro Frequency	f_S	40	—	70	Hz
Sensor Duration (ON/OFF Oper.)	T_{S1}	32	—	332	ms
Sensor Duration (Dimming Oper.)	T_{S2}	332	—	infinite	ms
Doze Frequency	—	—	—	500	Hz
Output Pulse Width	TW	—	33	—	µS
Output Phase-Angle (Note 1)	0	41	—	159	degrees
ϕ Period (Max to Max in continuous dimming)	—	—	7.28	—	sec.
$A_1B_1 = B_2A_2$ duration	—	—	934	—	ms
B_1B_2. Min. intensity dwell	—	—	500	—	ms

Note 1. In the circuit arrangement described in the application notes, the synchro input signal is delayed in phase in relation to the line frequency by about 6° resulting in a ϕ range between 35° and 152° With higher R-C value the phase angle range may be shifted down further.

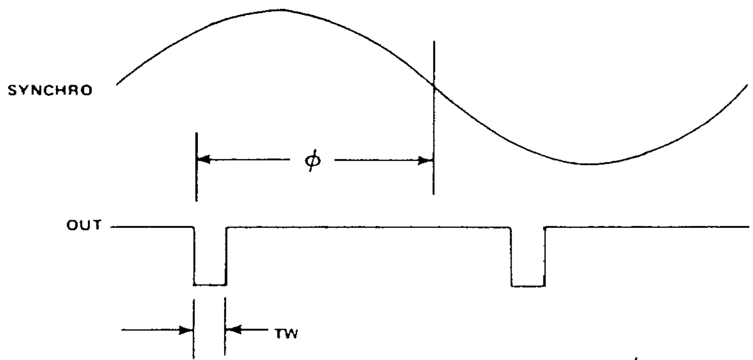

FIGURE 2 OUTPUT PHASE ANGLE ϕ

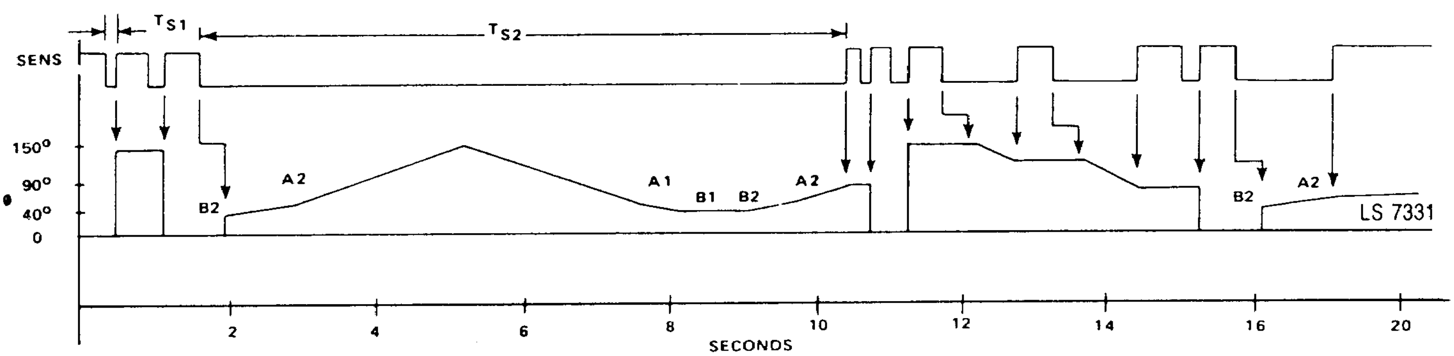

FIGURE 3
OUTPUT PHASE ANGLE, ø Vs, SENSOR OUTPUT

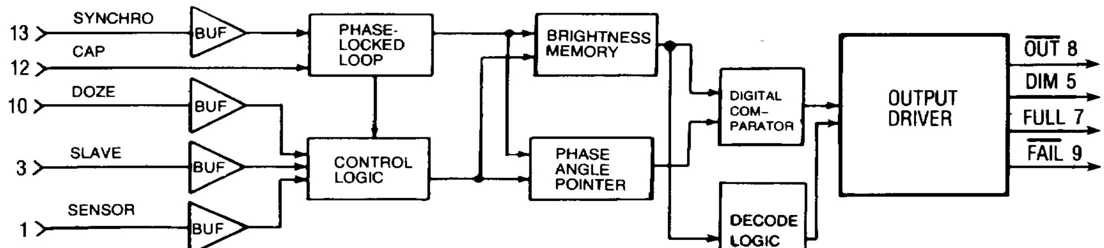

FIGURE 4
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BLOCK DIAGRAM

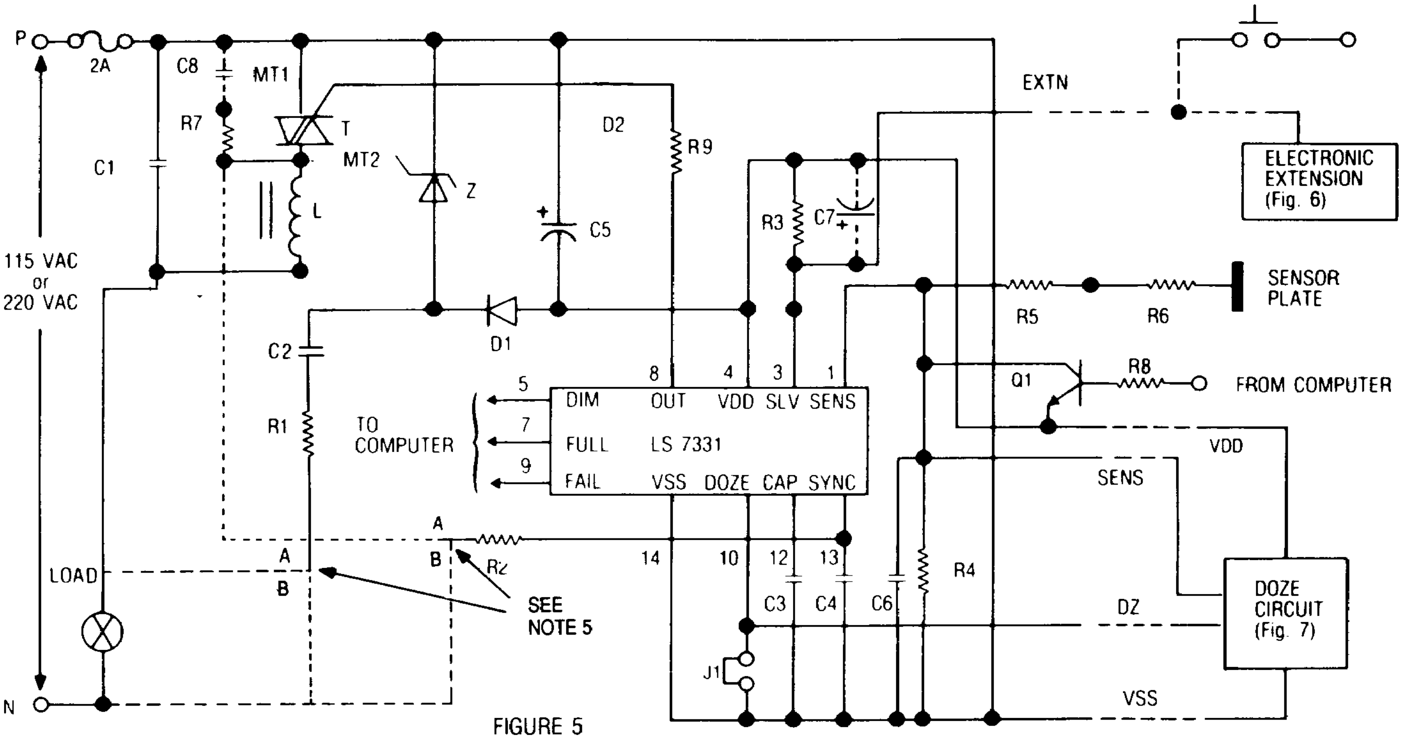

FIGURE 5

A TYPICAL LIGHT DIMMER/MOTOR SPEED CONTROL

Notes:
1) All circuits connected by broken lines are optional
2) C7 is used only when electronic extension is connected
3) Jumper between Pin 10 & VSS should be broken when Doze circuit is used.
4) Network C8-R7 is needed for inductive loads (such as motors) only.
5) Use Connection A when Neutral is not available.
   Use Connection B when Neutral is available.

115 VAC

C1 = 0.15μF/150VAC
C2 = 0.33μF/150VAC
C3 = See C2 Value Table
C4 = 470pF/25VAC
C5 = 47μF/25V
C6 = 680pF/50V
C7 = 0.2μF/25V
C8 = 0.047μF/150VAC (see note #4)
R1 = 270Ω/1W
R2 = 1.5MΩ/¼W
R3 = 680KΩ/¼W
R4 = 1MΩ to 5MΩ/¼W (select for sensitivity)
R5, R6 = 2.7MΩ/¼W
R7 = 1.8KΩ/2W (see note #4)
R8 = 10KΩ/¼W
R9 = 100Ω/¼W
Q1 = 2N2222 or equivalent
D1 = *1N4148*
Z = 15V/1W (Zener)
T = T2500D or Q4004L4 Triac (Typical)
L = 100μH (RFI Filter)

C2 Value Table

C2 = 0.33μF/150VAC, Connection A
C2 = 0.22μF/150VAC, Conenction B

220 VAC

C1 = 0.15μF/300VAC
C2 = See C2 Value Table
C3 = 0.47μF/ 25V
C4 = 470pF/25VAC
C5 = 47μF/25V
C6 = 680pF/50V
C7 = 0.2μF/25V
C8 = 0.047μF/300VAC (see note #4)
R1 = 1KΩ/2W
R2 = 1.5MΩ/¼W
R3 = 680KΩ/¼W
R4 = 1MΩ to 5MΩ/¼W (select for sensitivity)
R5, R6 = 2.7MΩ/¼W
R7 = 1.8KΩ/2W (see note #4)
R8 = 10KΩ/¼W
R9 = 100Ω/¼W
Q1 = 2N2222 or equivalent
D1 = *1N4148*
Z = 15V/1W (Zener)
T = T2500D or Q4004L4 Triac (Typical)
L = 100μH (RFI Filter)

C2 Value Table

C2 = 0.22μF/300VAC, Connection A
C2 = 0.1μF/300VAC, Conenction B

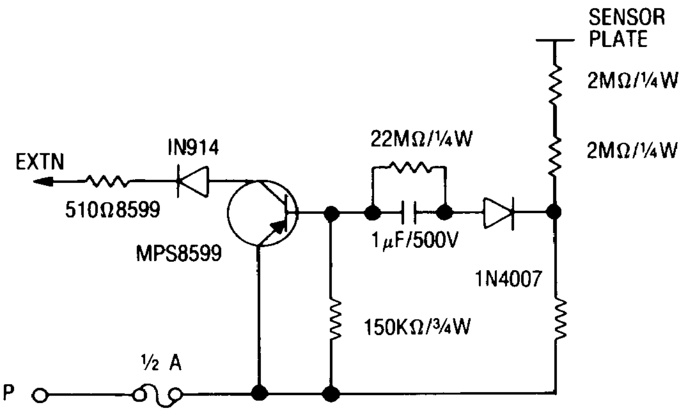

FIGURE 6 — ELECTRONIC EXTENSION

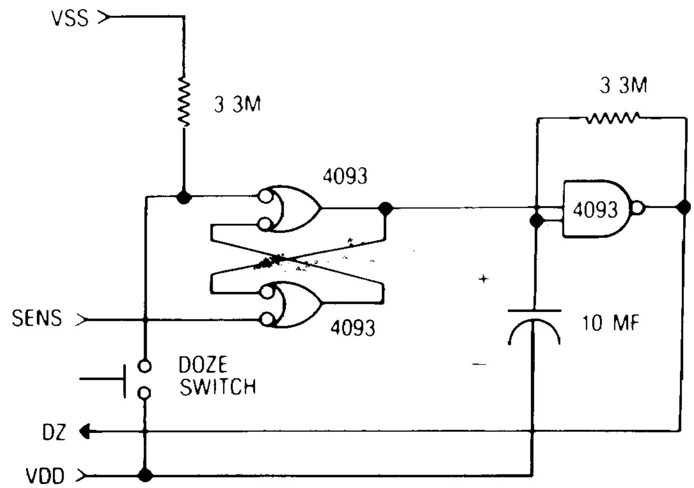

FIGURE 7 DOZE CIRCUIT

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.

EXTENSIONS: (Fig. 6).
All switching and dimming functions can also be implemented by utilizing the slave input. This can be done by either a mechanical switch or the electronic switch in conjunction with a sensing plate as shown in Fig. 6. When the plate is touched, a logical high level is generated at the EXTENSION terminal for both half cycles of the line frequency.

DOZE CIRCUIT: (Fig. 7).
The Doze circuit shown in Fig. 7 generates a slow clock (0.04Hz) at the DZ terminal. If the sensor plate (Fig. 5) is not touched, the SENS terminal of the Doze circuit of Fig. 7 sits at a logical high level. A momentary pressing of the Doze switch sets the SR flip-flop, enabling the oscillator. Every negative transition of the clock (DZ terminal) causes the light intensity to be reduced by equal increments, until eventually the light is shut off. The oscillator has no further effect on the dimmer circuit. When the light/motor is turned on again by touching the sensor plate, the SR flip-flop is reset and the DZ clock is turned off.

When the Doze circuit is used, the connection between Doze input (Pin 10) and V_{SS} (Pin 14) as shown in Fig. 5, should be removed

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