

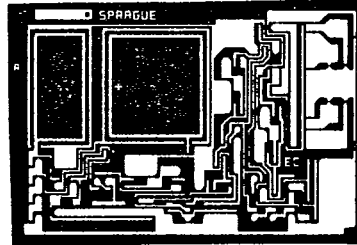
**ULN-3311D/T AND ULN-3312D/T
PRECISION LIGHT SENSORS
With Calibrated Current Amplifiers**

FEATURES

- Two-Terminal Operation
- Linear Over a Wide Range
- Precalibrated
- Wide Operating Voltage Range
- High Output

Direct replacements for photocells and phototransistors, the ULN-3311D/T and ULN-3312D/T precision light sensors are two-terminal monolithic integrated circuits that linearly convert light level into electrical current. The light-controlled current sources are linear over a wide range of supply voltages and light levels and require no external calibration.

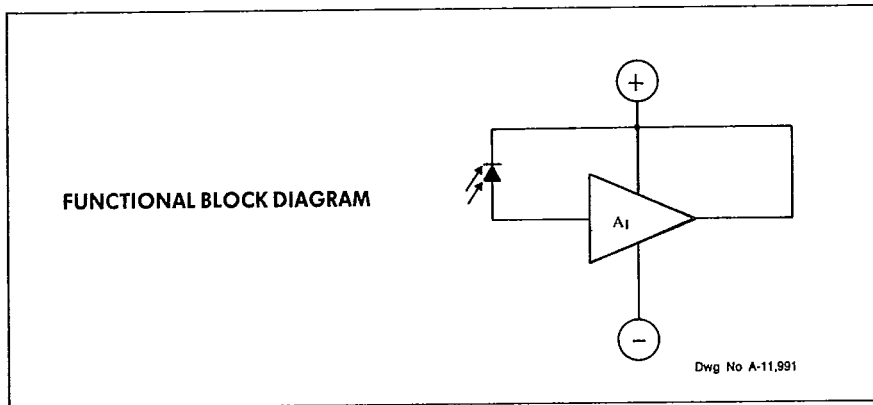
Each precision light sensor (PLS) consists of a photodiode and a calibrated current amplifier. The design of the amplifier allows derivation of its supply current from the same terminal as the photodiode cathode and the amplifier output. Since this supply current is a linear function of the photodiode current, it acts as part of the signal current. On-chip resistor-trimming techniques are used during manufacture to adjust each PLS to specified sensitivity. A $100 \mu\text{W}/\text{cm}^2$ GaAlAs LED emission provides the light source for this calibration.



The ULN-3311D and ULN-3312D are furnished in a hermetically sealed metal package with glass end cap conforming to JEDEC outline TO-52 (TO-206AC). The ULN-3311T and ULN-3312T are supplied in an inexpensive clear plastic package. Both devices are rated for operation over the temperature range of -40°C to $+70^\circ\text{C}$.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	24 V
Operating Temperature Range	-40°C to $+70^\circ\text{C}$
Storage Temperature Range	
(ULN-3311D and ULN-3312D)	-55°C to $+150^\circ\text{C}$
(ULN-3311T and ULN-3312T)	-55°C to $+110^\circ\text{C}$



APPLICATIONS INFORMATION

ULN-3311D/T and ULN-3312D/T precision light sensors can be used to replace several types of light sensors:

Photocells exhibit a change in resistance proportional to light intensity. However, they are highly inaccurate. They exhibit light memory, which makes their response dependent on the previous light level.

Phototransistors exhibit no light memory, but show as much as 50% variation in sensitivity among parts of the same type due to process and beta variations. Output current as a function of light level is linear only over a very small range.

Photodiodes have an output current that is a linear function of illumination, but the output is very small. The output current is typically in the range of tens of nanoamperes. These devices also show wide unit-to-unit sensitivity variations.

Sprague Electric precision light sensors are two-terminal replacements for photocells, phototransistors, and photodiodes. They are internally calibrated, have relatively high output currents, and are linear over a very wide range of light levels. Low-level amplifiers and adjustable controls can be eliminated. The precision light sensors are also ideal for use in arrays where matched characteristics are often required. Unpackaged chips are available on special order.

Both the hermetically sealed ULN-3311D and ULD-3312D sensors and the low-cost ULN-3311T and ULN-3312T plastic-encapsulated sensors are cost-effective solutions to precise light-sensing or light-measurement applications.

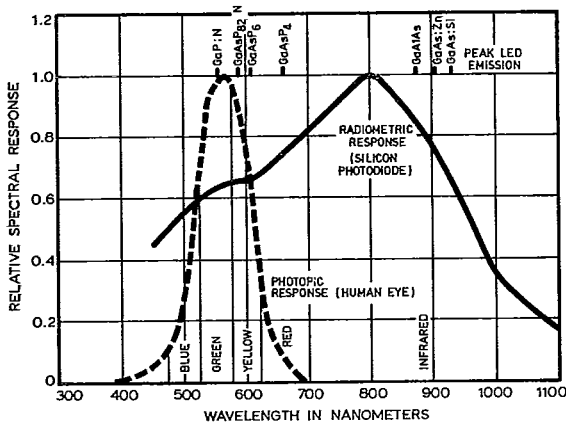
ELECTRICAL CHARACTERISTICS at $T_A = +25^\circ\text{C}$, $V_{CC} = 12\text{V}$

Characteristic	Device Type	Limits			
		Min.	Typ.	Max.	Units
Initial Accuracy at $100\ \mu\text{W}/\text{cm}^2$	All	—	—	± 7.2	%
Sensitivity	ULN-3311D	240	—	320	$\text{nA}/\mu\text{W}/\text{cm}^2$
	ULN-3311T	280	—	350	$\text{nA}/\mu\text{W}/\text{cm}^2$
	ULN-3312D	280	—	360	$\text{nA}/\mu\text{W}/\text{cm}^2$
	ULN-3312T	350	—	420	$\text{nA}/\mu\text{W}/\text{cm}^2$
Operating Voltage Range	All	2.7	12	24	V
Output Linearity, 10 to $10\text{k}\ \mu\text{W}/\text{cm}^2$	All	—	—	± 7.2	%
Dark Current	All	—	—	100	nA
Power Supply Rejection, $(\Delta I_o/I_o)\Delta V$	All	$\circ 40$	50	—	dB
Temperature Coefficient of Sensitivity	All	—	3500	—	$\text{ppM}/^\circ\text{C}$

NOTE: Light source is an infrared LED with a peak output wavelength of 880 nm.

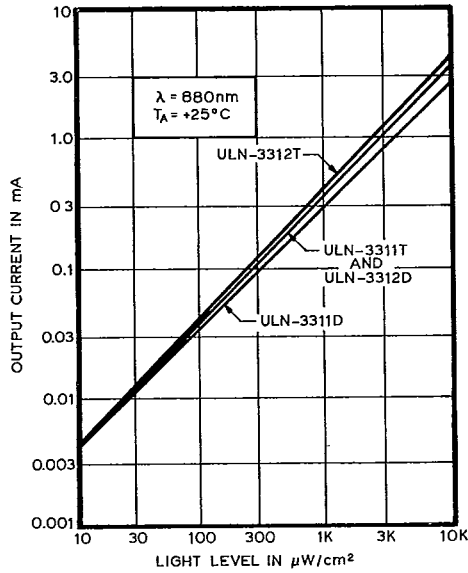
TYPICAL CHARACTERISTICS

**RELATIVE SPECTRAL RESPONSE
AS A FUNCTION OF WAVELENGTH OF LIGHT**



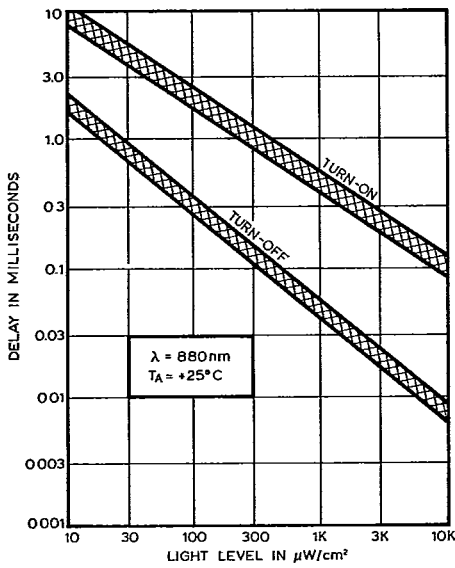
Dwg. No. A-12,135A

**OUTPUT CURRENT
AS A FUNCTION OF ILLUMINANCE**



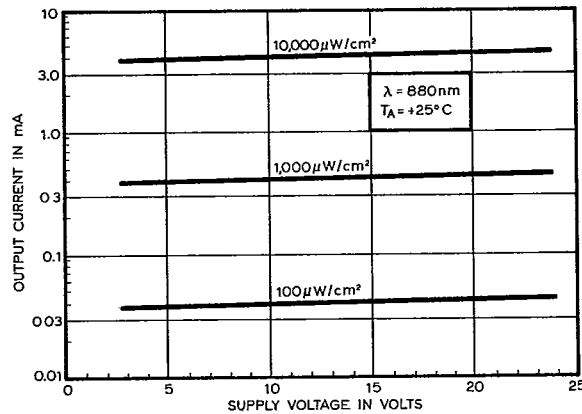
Dwg No A-14,271

**PROPAGATION DELAY
AS A FUNCTION OF ILLUMINANCE**



Dwg No A-12,138A

**OUTPUT CURRENT
AS A FUNCTION OF SUPPLY VOLTAGE**



Dwg No. A-12,137A

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TYPICAL APPLICATIONS

Figure 1 shows a ULN-3311D/T or ULN-3312D/T integrated circuit replacing a photocell or phototransistor for the precise linear detection of a light level. Use of the precision light sensor eliminates the need for external calibration because it is calibrated to an initial accuracy of better than 7.2% during manufacture.

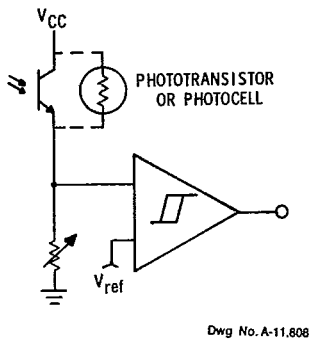


Figure 1A
LIGHT-LEVEL DETECTOR
REQUIRING EXTERNAL CALIBRATION

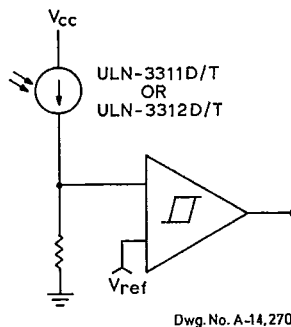


Figure 1B
LIGHT-LEVEL DETECTOR USING PLS

In Figure 2, two precision light sensors are used in a differential configuration to detect the edge of an object. When the light level on the first sensor is half of that on the second, the circuit switches. This circuit operates over a wide range of ambient light levels. No external calibration is required.

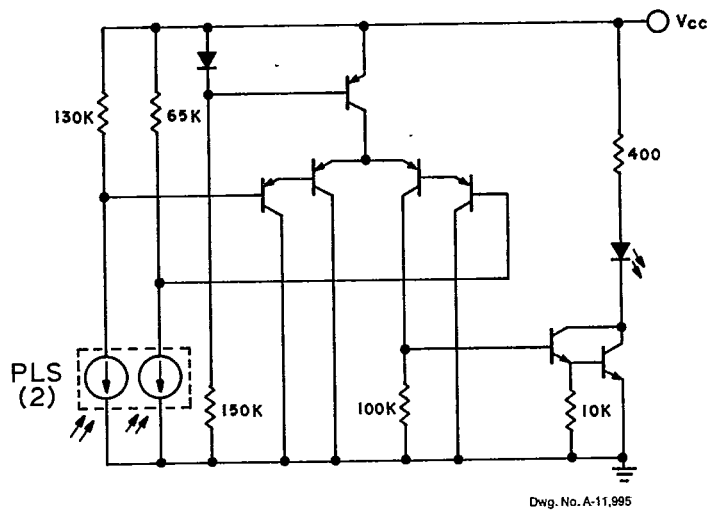
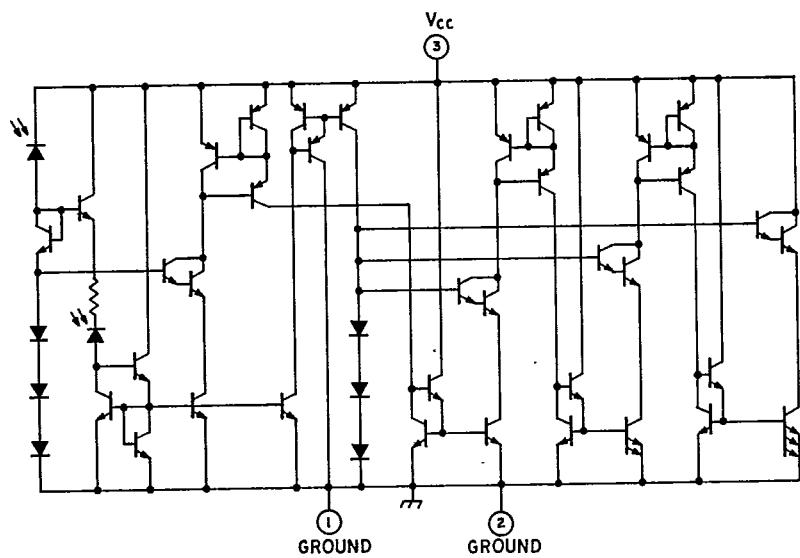


Figure 2
DIFFERENTIAL EDGE DETECTOR

SCHEMATIC

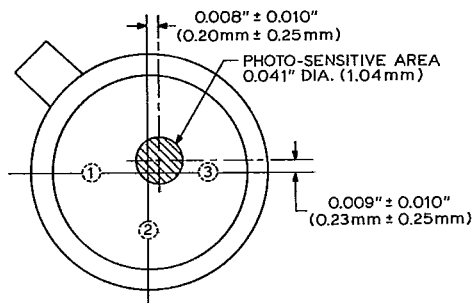


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**ULN-3311D/T AND ULN-3312D/T
PRECISION LIGHT SENSORS**

ULN-3311D AND ULN-3312D

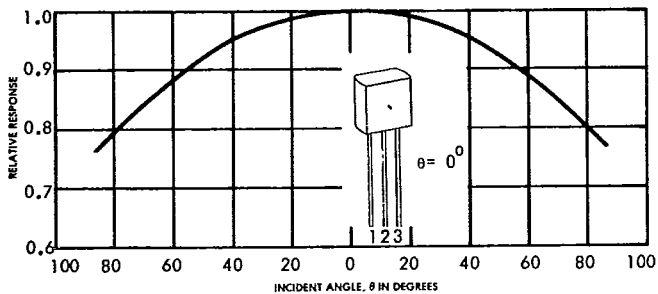
SENSOR-CENTER LOCATION



Dwg No A-14,274

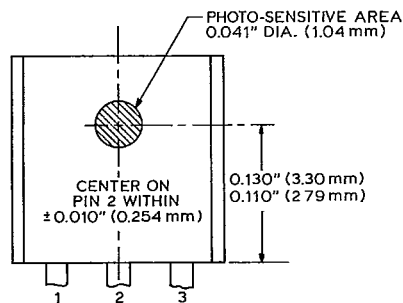
ULN-3311T AND ULN-3312T

**RELATIVE RESPONSE
AS A FUNCTION OF THE ANGLE OF INCIDENCE**



Dwg No A-12,134

SENSOR-CENTER LOCATION



Dwg No A-14,275