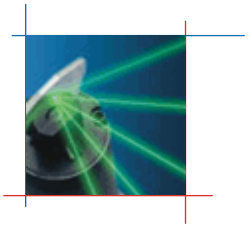
Application Note No. 12
April 1982



CONTINUOUS POSITION SENSING SERIES

DUAL AXIS

PIN-SC/4D, SC/I0D, SC/lO, SC/25, SC/50

SINGLE AXIS

PIN-LSC/4, LSC/5D, LSC/30D

These series are sensitive, linear, and fast silicon photodetectors that provide two electrical output signals, specifying the X only position (LSC Series) or X and Y position (Dual Axis SC Series) of an input right spot signal that is relative to fixed internal coordinates.

When the input light spot is exactly at the device center, no electrical signals are generated. By moving the light spot over the active area, continuous electrical signals are provided at the terminals giving the exact light spot position at each instant of time. These electrical signals are proportionately related to the light spot position from the center, and thus provide an analog error signal proportional to displacement.

The input light beam to these detectors may be any diameter, since the position of the centroid of the light spot is indicated and provides electrical output signals proportional to the position from center. When any light beam, no matter what its diameter (as long as it falls within the active area), is positioned at the device center, a complete null is obtained in the difference of any of the currents through the terminals on that axis to the center terminal. When just one of the axis feedthrus is connected to an external battery and load resistor, the current arising from the total light flux falling on the detector is collected at that one terminal. It is essentially the difference in current from each of the terminal feedthrus to the center terminal that gives the position indication. A separate reading of the total light falling on the detector can be obtained from a current meter placed between battery and ground. (See fig. 1) This total light power monitoring is particularly useful for applications where the focused light spot is changed in intensity.

These position detectors operate on a different principle than typical quadrant detectors with resulting differences in characteristics. There is no “dead” region between the quadrants as in a typical four quadrant detector, since the detectors employ only one front barrier contact and two or four back ohmic contacts. A position indication is obtained even if all light is in one corner, in comparison to standard four quadrant detectors. No defocusing of the light spot is necessary since overlap between quadrants is no longer required. The null position may be electrically controlled by varying the load resistance values.

ACTIVE AREA:

This is given as length on a side of a square. A light spot on this active area will give a position signal directly proportional to the position .

DARK LEAKAGE CURRENT:

The currents indicate total current through the device and do not result in a position or offset error.

POSITION SENSITIVITY:

For each milliwatt of light power at 8500Å, there will be a minimum of .X μa of current differential (see data sheet) created by each .001" of movement of the light spot from the null position. Current imbalance will remain proportional with respect to position from null and incident power.

Example: Pin SC/ 10 -- 3mw of incident radiation at 8500Å incident 6 mils in the negative "X" axis direction (no Y component assumed) will create a current imbalance of 3.6 μa.

AXIS ORIENTATION:

(SC Series) The X-axis alignment is parallel to within + 3° of the square formed by the four contact pins.

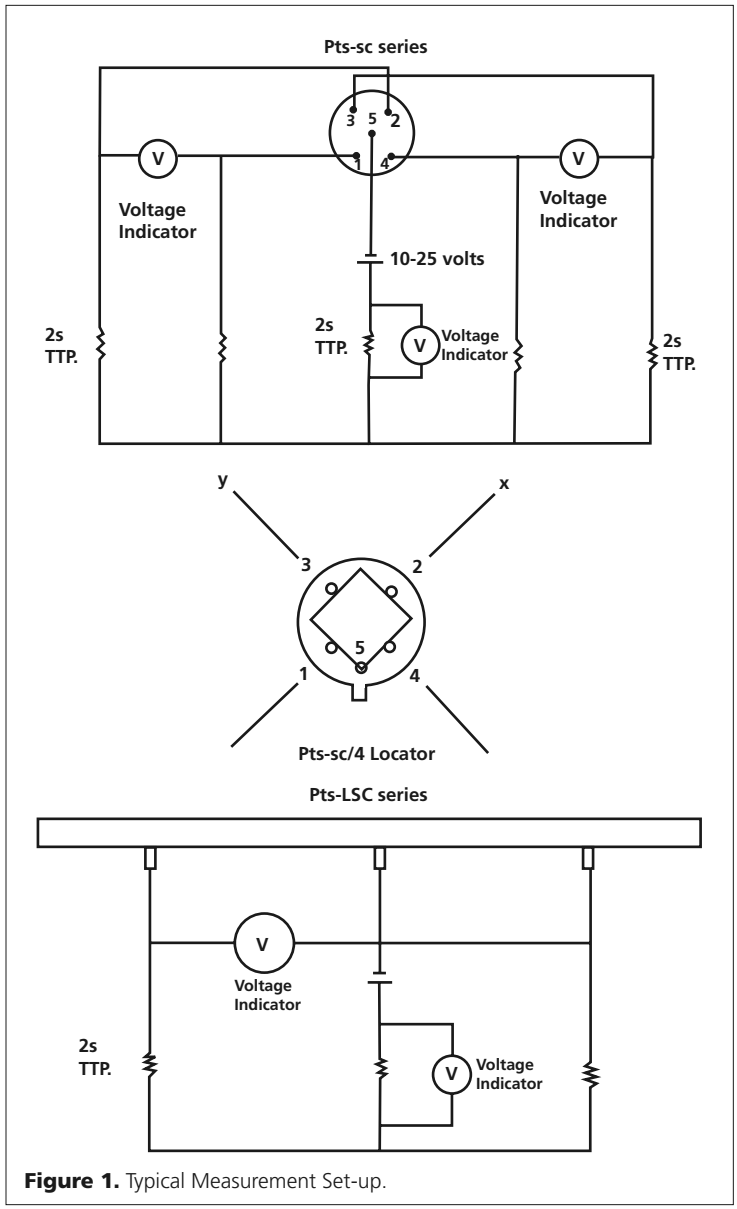


Figure 1. Typical Measurement Set-up.

It is suggested that applications incorporate a back bias of at least 5 volts to get good linearity and responsivity. Increasing above this amount decreases unit capacity but does not increase responsivity or sensitivity significantly.

Metering devices can be any high quality differential input type. Movements for most applications, however, require one stage of voltage/current amplification. For this we suggest the UDT Model 301A Sum and Difference Amplifier. The 301A exhibits a frequency response (to 3db down) of D.C. to kHz and output voltage of + 10 volts.

A trimming resistor is used to obtain a null when the light spot is at device center. The null position can be shifted by using differing load resistors from leg to leg. The 1K load resistor may be replaced by a much larger or smaller value (1 meg to 10 ohms), depending on the magnitude of the input light signal. Fastest response times are obtained with the lowest load resistor value.

The equivalent circuit for the SC series of position sensitive photodetectors is given below. The input light spot generates a constant current i_s. This current is generated at a particular point on the junction surface which corresponds to a pickoff point on the internal resistance film, R_i. C_d is the junction capacitance. As the light spot moves around the surface, the pickoff point in the equivalent circuit moves across the resistive track. The current is i_s split into the two legs R_{LI} and R_{L2}; the amount of current flowing in each leg depends on the resistance values of $R_{il} + R_{L1}$ and $R_{i2}. + R_{L2}$.

If $R_{il} > R_{LI}$ and $R_{i2} > R_{L2}$, the current flowing in each leg depends entirely upon R_{L1} and R_{L2}' and these resistance values are linearly proportional to light spot position.

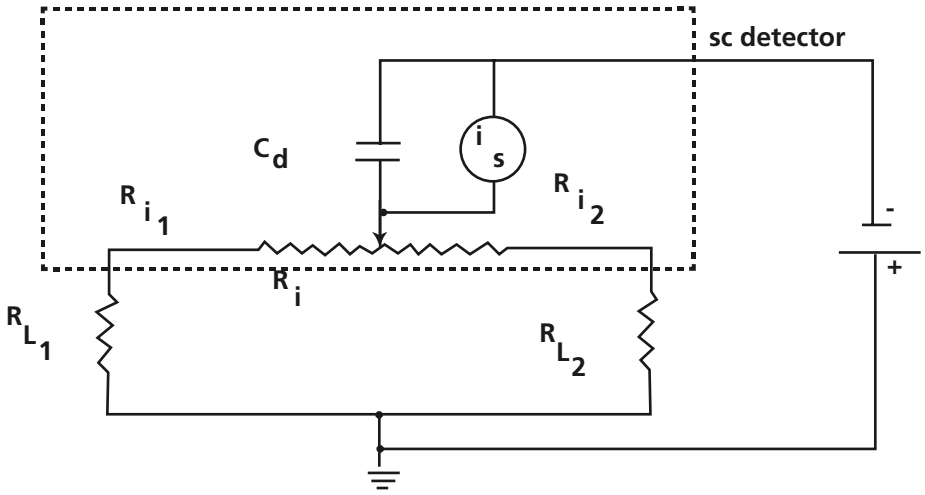


Figure 2. Equivalent circuit for SC series