SensorLine

User's Manual

Catalog #100136 Rev. E

May 2005

intelitek

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1 Introduction

1.1 About SensorLine

SensorLine is an educational panel which demonstrates the principles of sensor and control technology. It contains a variety of analog and digital sensors, as well as components which affect or reflect the operation of the sensors.

The unit has a number of devices which can be activated and controlled in various configurations. Students can connect different components, change physical parameters, and measure sensor responses. By designing and assembling basic control circuits using the sensors, students will learn how digital and analog sensors function. Students will also learn how a sensor's analog signal is converted to a digital output. SensorLine can simulate and demonstrate the use of sensors in industrial applications.

SensorLine includes a 12VDC power supply and elements for triggering and testing sensor responses, such as a light source, filters, magnets, air pump, and aluminum, iron, wood and plastic blocks.

SensorLine system can be integrated with other panels, such as HydraFlex, PneuFlex, PneuLine and PLC Line.

1.2 Warnings

Avoid damaging the SensorLine:

- Do not tamper with any of the components on the SensorLine panel.
  Use only as directed.
- *Do not connect 12VDC (any red socket) to the (-) socket.* Doing so will blow the unit's 0.5A, 250V/S.B. fuse.
- It is strongly recommended that you prepare a circuit diagram before making an actual connection.

The panel contains a number of banana sockets.

- Red sockets must *always* be connected to one another.
- Black sockets must *never* be connected to each other;
  black sockets must be connected to either a GND or a COM socket.
- The power supply can be replaced only with UL approved power supply.

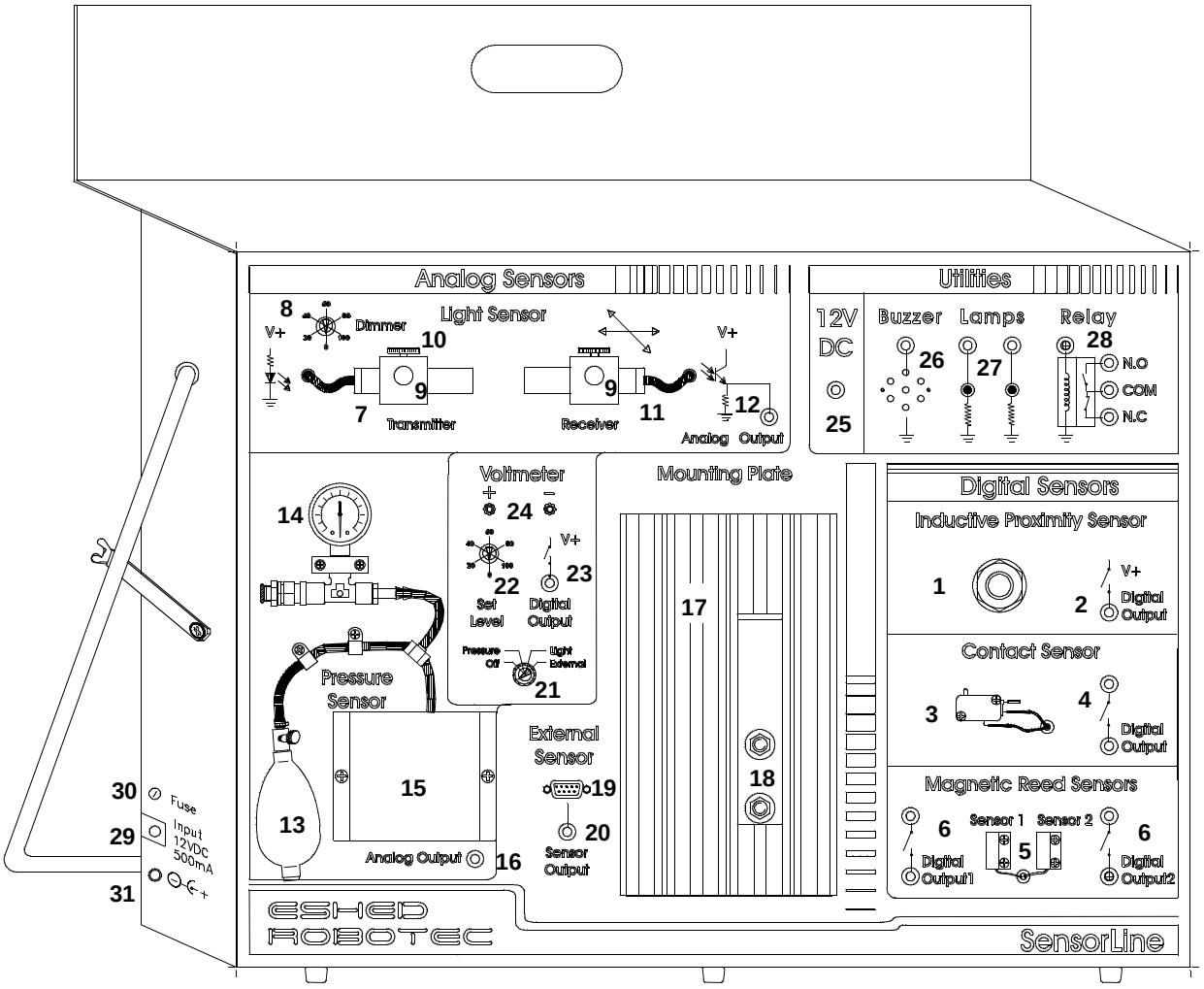
1.3 Components

1.3.1 Prerequisites

- Laboratory worktable, approximately 1m x 05.m
- One 110/220VAC power outlet.

1.3.2 SensorLine

The following diagram shows the SensorLine. Numbers in the diagram refer to the component list given here.



Proximity Sensor

1 Inductive Proximity Sensor
2 Inductive Proximity Sensor Voltage Digital Output Banana Socket

Contact Sensor

3 Contact Sensor
4 Contact Sensor Digital Output Banana Sockets

Magnetic Reed Sensor

5 Magnetic Reed Sensors
6 Magnetic Reed Sensors Digital Output Banana Sockets

Light Sensor

7 Light Transmitter
8 Dimmer
9 Holder for Light Transmitter/Receiver
10 Adjusting Knob
11 Light Receiver
12 Light Receiver Analog Output Banana Socket

Pressure Sensor

13 Pressure Pump
14 Pressure Gauge
15 Pressure Transducer
16 Pressure Voltage Analog Output Banana Socket

External Sensors

17 Mounting Plate for additional sensors
18 Sensor Holder
19 External Sensor D9 female Connector.
20 External Sensor Digital/Analog Output Banana Socket

Sensor Selector Unit

21 Input Selector Knob
22 Voltage Setting Knob
23 Digital Output Banana Socket
24 Voltmeter Probe Contacts

Utilities

25 12VDC Output Banana Socket
26 Buzzer Input Banana Socket
27 Lamps Input Banana Sockets
28 Relay Unit (4 Banana Sockets)
29 Power Input 12VDC 400mA
30 Fuse 0.5A, 250V/S.B.
31 GND Socket
32 12VDC Power Supply Unit

Accessories

33 Banana Plug Cables:
- 3 red - 60 cm
- 1 black - 60cm
- 2 gray - 60cm

34 Lab Experiment Materials (including vinyl storage bag)
- Small mirror
- Triangular metric ruler (with right angle)
- 1 clear plastic block (flat)
- 1 tinted plastic block (flat)
- 1 dark plastic block (gray cylinder)
- 1 anodized aluminum block (cube)
- 1 wood block (green cube)
- 1 small iron block (cube)
- 1 large iron block (cube)
- 2 permanent magnets
- Optic fiber cable

35 5 spare 0.5A fuses

36 Voltmeter

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1.3.3 Optional Items for SensorLine

The following items can be ordered for use with the SensorLine training unit.

- *Sensor Applications Technology - Standalone CD*
- Temperature Probe
- Laboratory training unit
  - PLC Line
  - PneuLine
  - PneuFlex
  - HydraFlex
- Robot Controller
  - SCORBOT Controller-A
  - SCORBOT Controller-B
- Proximity Capacitive sensor
- Proximity Optical Diffuse Reflective sensor

2 Components

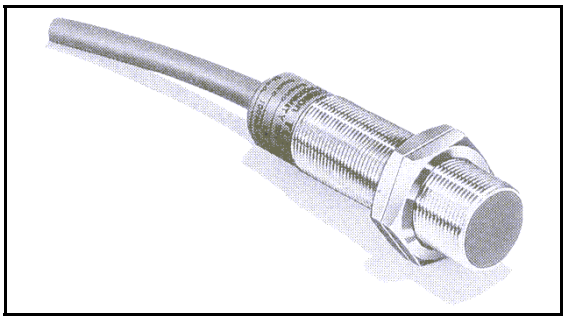
The diagrams in this chapter are for illustration purposes and do not necessarily represent the actual SensorLine components.

2.1 Inductive Proximity Sensor

Principle of Operation

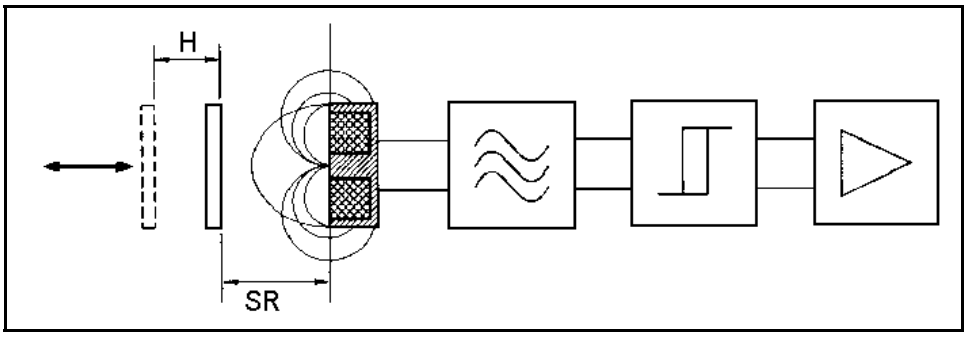
The inductive proximity sensor operates by means of an L/C resonant oscillator which generates, with the aid of a coil located in the open pot core, a high frequency alternating electromagnetic field. This field emerges from the active face of the sensor.

When an electrically conductive material (such as a steel block) moves into the electromagnetic field, an induced eddy current occurs. This eddy current extracts energy from the L/C resonant circuit in the sensor, and produces a reduction in the oscillation amplitude. This reduction in the amplitude is converted by the associated electronic circuitry into a clear electronic signal, and changes the state of the sensor.



Inductive Proximity Sensor

When the electrically conductive material is removed from the alternating field, the oscillation amplitude increases which, by way of the electronic circuitry, restores the sensor to its initial state.



Inductive Proximity Sensor - Block Diagram

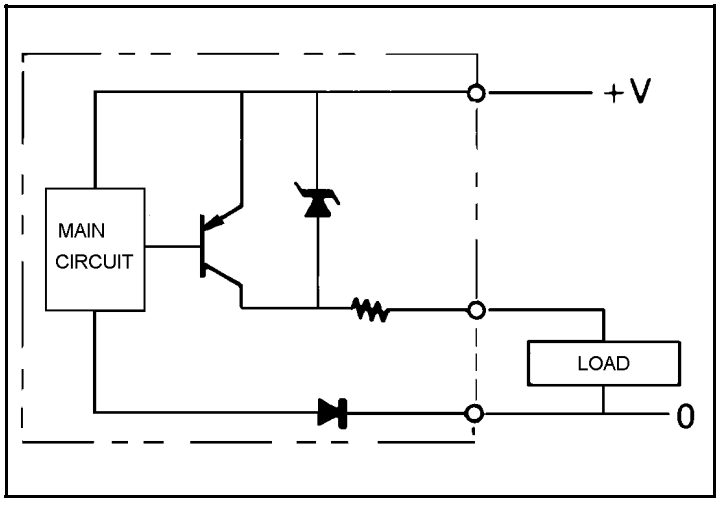
Activation

- When the sensor detects an electrically conductive material, the switch is activated; 12V is connected to the sensor's digital output socket.
- When the electrically conductive material is removed from the sensor's field, the switch reverts to its initial state; 12V is disconnected from the output socket.

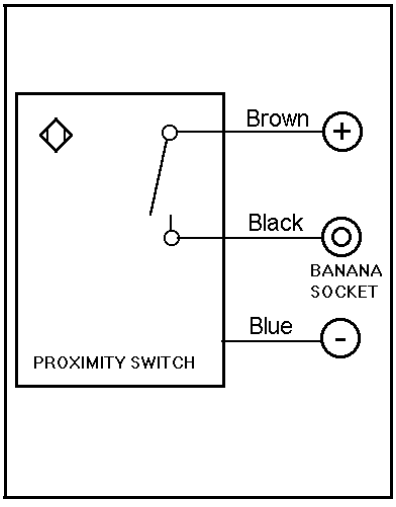
Specifications

Proximity Inductive Sensor unit includes: Industrial inductive proximity sensor; red banana socket.

Proximity Inductive Sensor Specifications	
Output Type	DC switching, PNP
Logic Function	Normally Open, NO
Shield	Non-Shielded
Switching Distance	5 mm (Fe 37 actuator, 18x1mm)
LED	Yes
Supply Voltage	10–30 VDC
Voltage Drop	<3 V
Maximum Load Current	100 mA
Maximum Leaking Current	<0.01 mA
No Load Current	<15 mA
Response Time for Switching On/Off	0.2 ms/0.2/ms
Maximum Switching Frequency	1 KHz
Short Circuit Protection	Yes
Hysteresis	<15%
Repeat Accuracy	<1%
Ambient Temperature	–25°– +75°C
Temperature Drift	<10%
Protection Degree	IP67



Inductive Proximity Sensor - Circuit Diagram



Inductive Proximity Sensor - Wiring

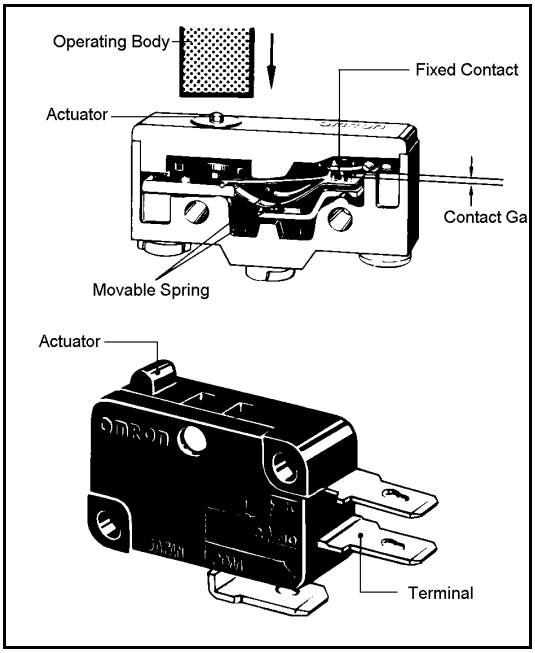
2.2 Contact Sensor

Principle of Operation

The contact sensor is a miniature contact switch. Unlike a solid-state switch, which uses a semiconductor device, this type of switch uses mechanical contacts to break or make the external circuit.

The switch has a fixed contact and a movable contact, which are slightly separated, and an actuator (such as a plunger, lever or spring). When a specific force is applied to the actuator, it moves the movable contact into contact with the fixed contact to make the external circuit.

When the movable contact disengages, the external circuit is broken.



Contact Sensor

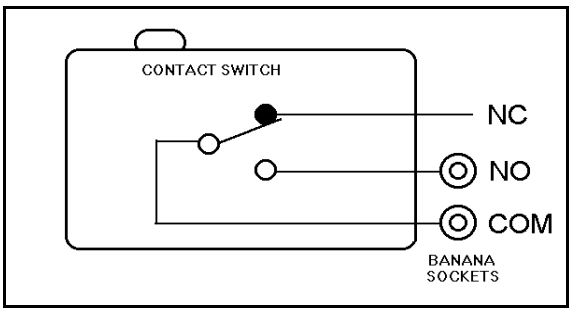
Activation

When the switch is activated, N.O. is connected to COM and N.C. is disconnected.

Specifications

Contact Sensor unit includes: industrial mechanical switch; two red banana sockets.

Contact Sensor Specifications	
Logic Function	Normally Open, N.O.
Resistive Load	16 A, 250 V
Maximum Operating Current	18 A
Minimum Permissible Load	20 mA
Operating Force	400 gr
Actuator Type	Leaf spring

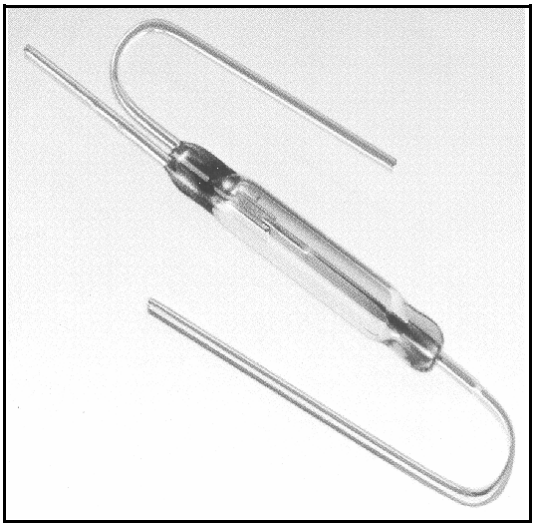


Contact Sensor - Circuit and Wiring Diagram

2.3 Magnetic Reed Sensor

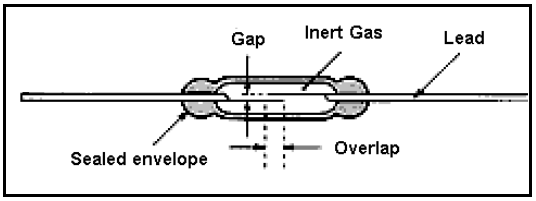
Principle of Operation

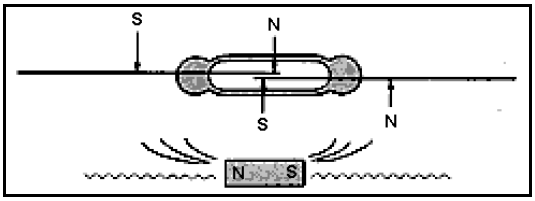
The reed switch consists of a pair of flexible reeds made of a magnetic material, and sealed in a glass tube filled with inert gas. The reeds overlap but are separated by a small gap. The contact area of each reed is plated with a noble metal to provide the switch with stable characteristics and long life.



Magnetic Reed Sensor

Application of a magnetic field, generated by a permanent magnet or a coil, to the reed switch causes both reeds to be magnetized. This produces an N-pole at the contact area of one reed and an S-pole at the contact area of the other reed. If the magnetic attracting force overcomes the resistive force caused by elasticity of the reed, the reeds come in contact and the circuit is closed. Once the magnetic field is removed the reeds are separated again by the effect of elasticity of the reed and the circuit is opened.

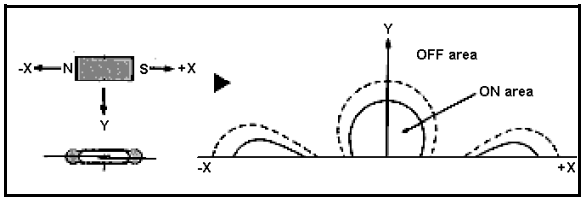




Activation

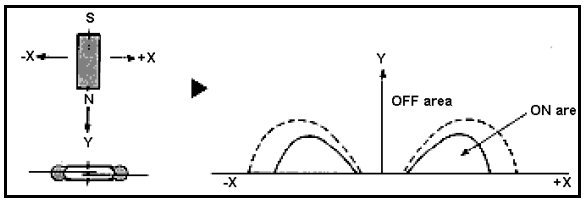
The most common means of activating a reed switch is with a magnet. The following drawings are examples of switching.

- Horizontal: a magnet moved parallel to a reed switch operates it from one to three times.



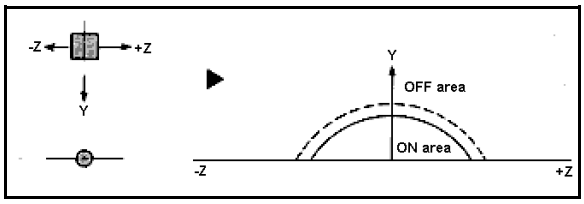
Horizontal

- Perpendicular: a magnet moved perpendicularly along the reed switch operates it two times.

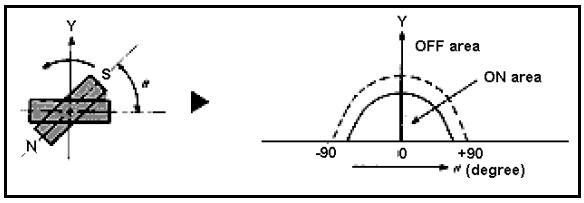


Perpendicular

- Transverse: a magnet moved across the reed switch operates it once. This is the recommended means off actuating the reed switch.
- Rotational: a magnet swung towards and away from the reed switch operates it once.



Transverse

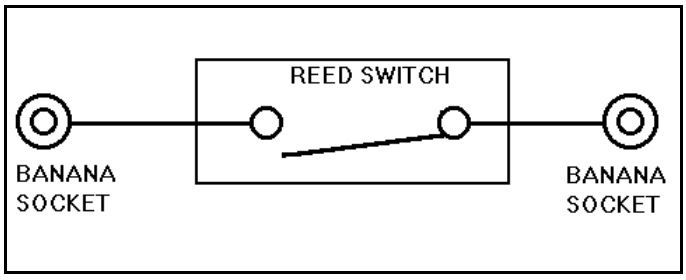


Rotational

Specifications

Magnetic Reed Sensor unit includes: two magnet reed switches; two red banana sockets.

Magnetic Reed Sensor Specifications	
Logic Function	Normally Open, N.O.
Contact Form	Dry
Rated Power Maximum	10 W
Switching Voltage Maximum	200 VDC
Switching Current Maximum	1 A
Carry Current	1 A
Contact Resistance Maximum	150 mOhm
Breakdown Voltage Minimum	250 VDC
Operate Time, including bounce	0.5 ms
Release Time	0.1 ms
Operating Temperature	-5°C – +70°C
Magnetic Sensitivity	10–19

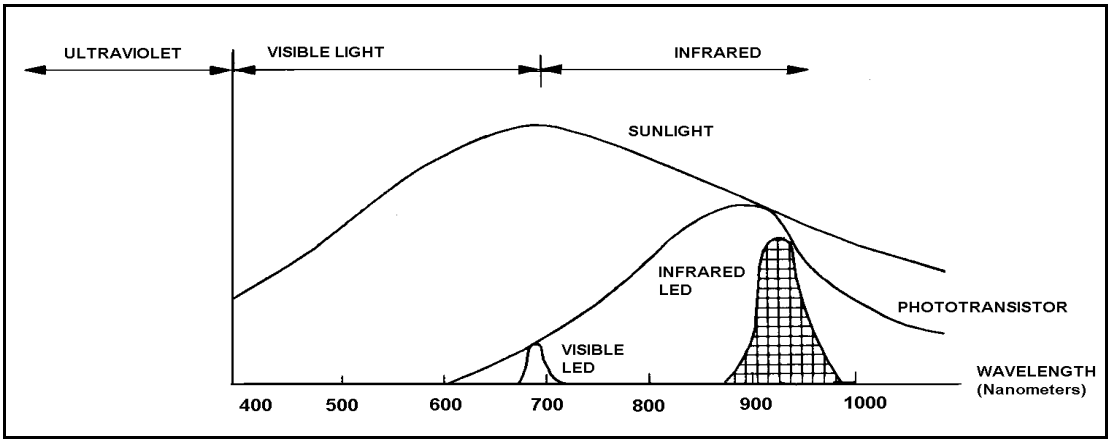


Reed Sensor - Circuit and Wiring Diagram

2.4 Light (Photoelectric) Sensor

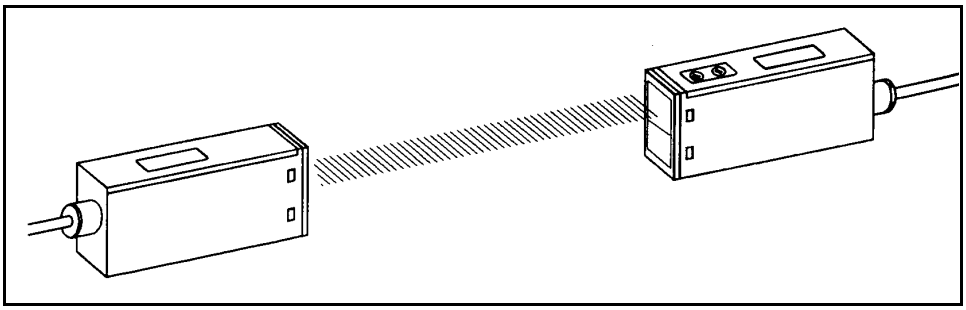
Principle of Operation

Photoelectric sensors can detect various materials at long ranges without contact. Photoelectric sensors can be divided into four categories according to function: through-beam, retro-reflective, diffuse reflection and fiber-optics with amplification. These sensors make use of physical properties typical of light-sensitive elements, changing their electrical features based on the light intensity in which they come in contact. Their working principle is based on the fact that a light beam (with a wavelength within the infrared spectrum), emitted at the right moment by a light emitter (LED or IRED) is reflected back to a receiver (usually a phototransistor) by the object to be sensed. The light intensity variation striking the receiver depends on the presence or absence of the object to be detected (target) and changes the electrical state in the receiver element.



Spectral Response of Phototransistor

The SensorLine light sensor is a through-beam photoelectric switch. In this type of sensor the transmitter and receiver are contained in separate housings. When the two units are aligned, the light beam travels from the transmitter directly to the receiver. Objects breaking the light beam cause a change at the receiver from light to dark and this change initiates an output signal.



Through-Beam Light Sensor

Specifications

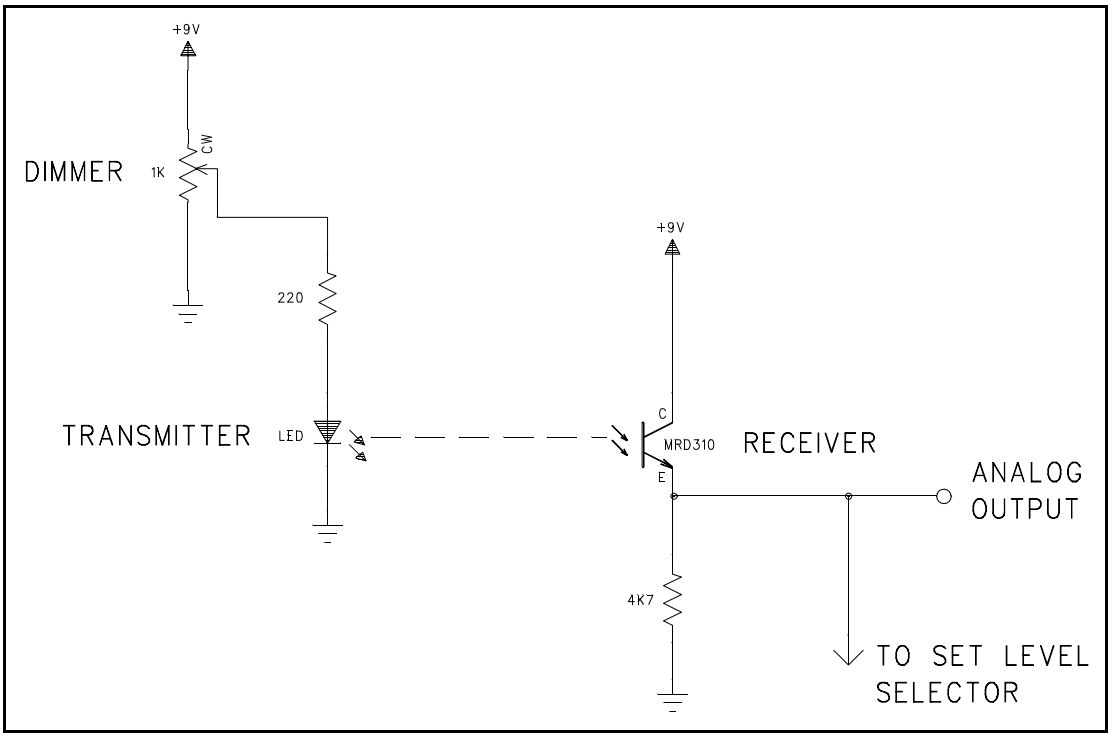
Light Sensor unit includes: transmitter; receiver; scaled dimmer for controlling input voltage; red banana socket.

Light Sensor Unit		
	Transmitter	Receiver
Operating Voltage	9 VDC	9 VDC
Current Consumption Maximum	25 mA	10 mA
Monochromatic Light	7000 Ang Red	—
Sensitivity	2000 lux	2000 mCd
Circuit Protection	Yes	Yes

Activation

Analog Output: connect the light sensor Analog Output to a Lamp. The intensity of the LED will vary in accordance with the sensor's output signal.

Digital Output: connect the Lamp to the Selector Digital Output and set the Selector Switch to Lamp. The LED will light up at it strongest intensity for each sensor output signal.



Light Sensor - Circuit Diagram

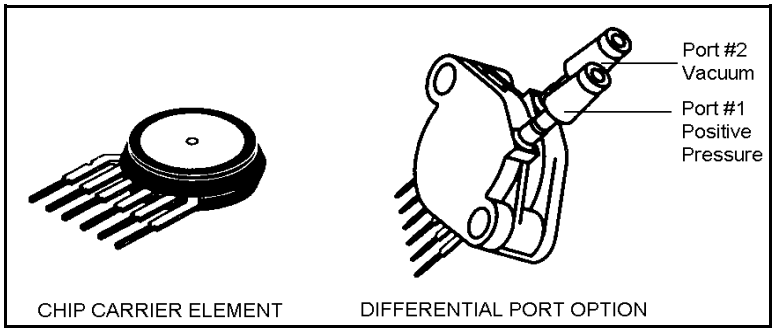
2.5 Pressure Sensor

Principle of Operation

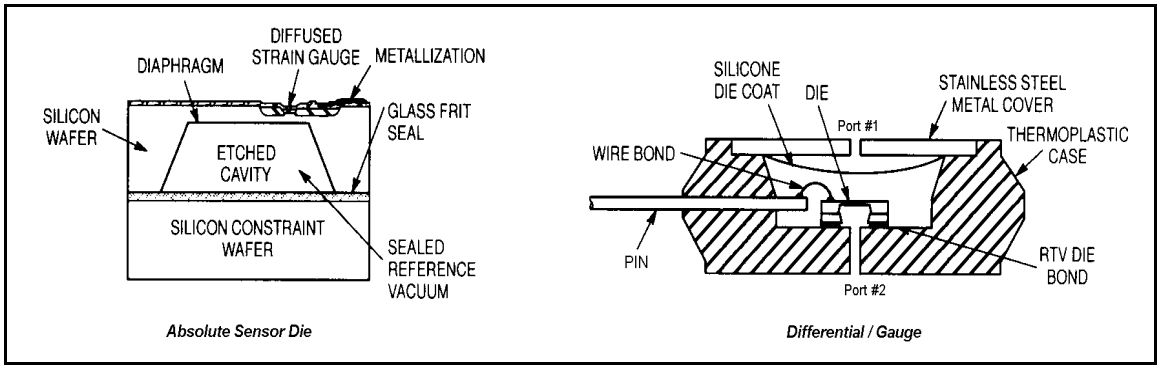
The pressure sensor consists of a silicon piezoresistor (strain gauge) which is implanted on a thin silicon diaphragm. Applying pressure to the diaphragm results in a resistance change in the strain gauge, which in turn causes a change in the output voltage which is proportional to the applied pressure.

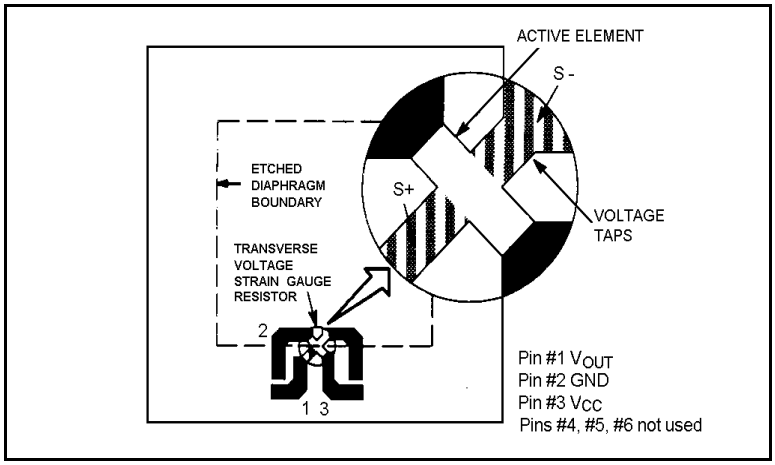
- Absolute pressure sensor measures external pressure relative to a zero pressure reference sealed inside the cavity of the chip. The output is proportional to the pressure difference between this reference and pressure applied externally.
- Differential pressure sensor is designed to accept simultaneously two independent pressure sources. The output is proportional to the pressure difference between the two sources.

The SensorLine uses a differential pressure sensor.



Pressure Sensor

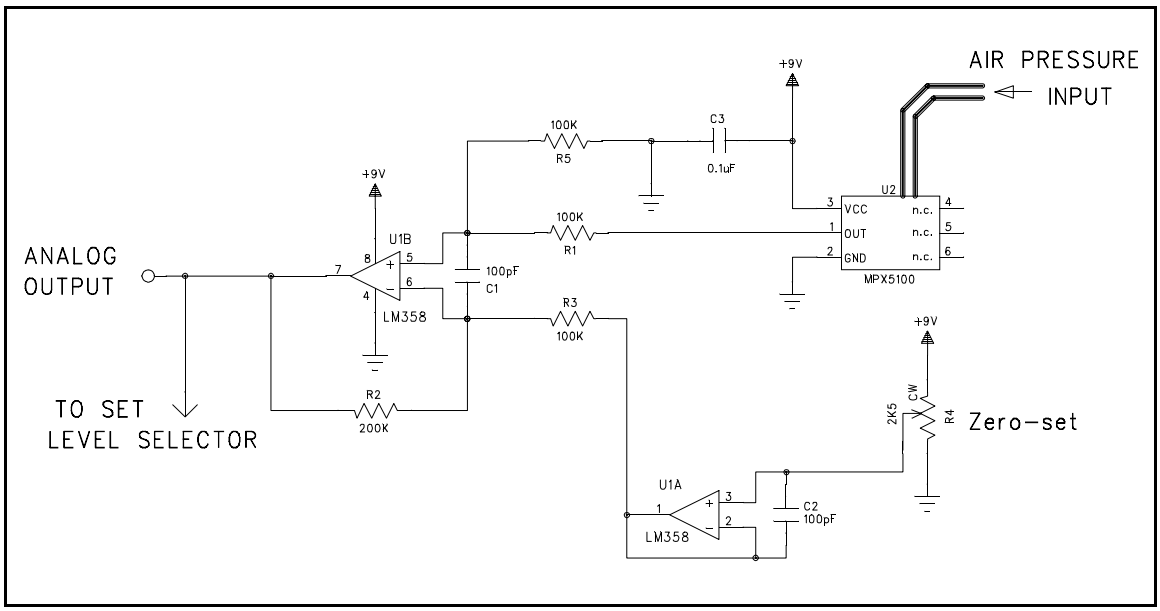




Specifications

Pressure Sensor unit includes: pressure pump; analog pressure gauge; pressure transducer; 2 red banana sockets.

Pressure Sensor Specifications			
	Pump	Pressure Gauge	Pressure Transducer
Maximum Pressure	400 mm/Hg	300 mm/Hg	760 mm/Hg (1 bar)
Operating Voltage	—	—	4.75–5.25VDC
Current Consumption Maximum	—	—	10 mA



Pressure Sensor - Circuit Diagram

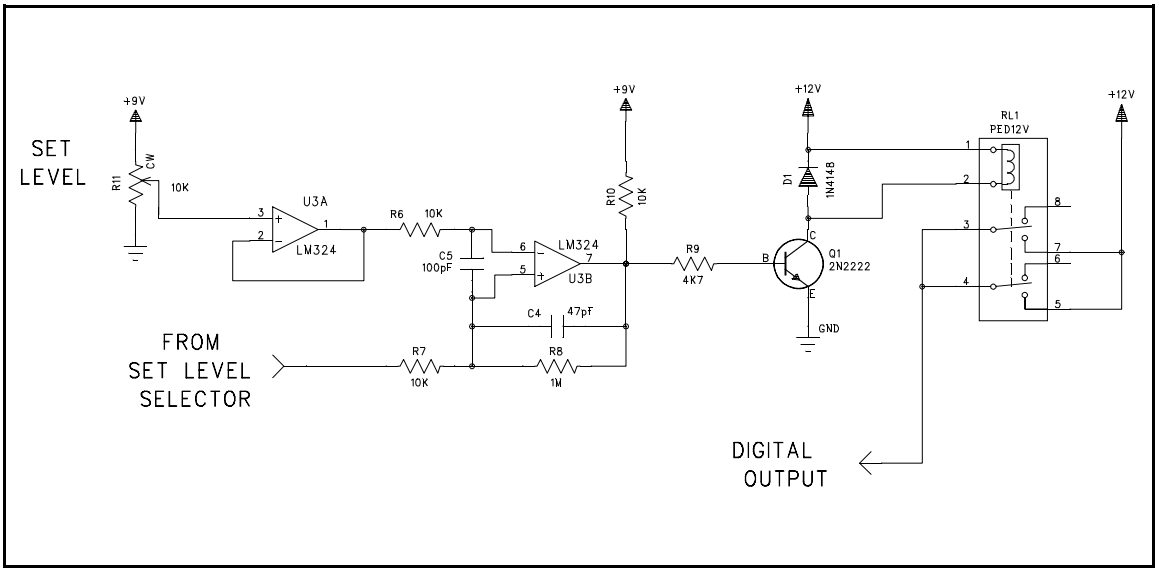
2.6 Selector

The sensor selector unit enables the measurement of sensor output and the adjustment of the voltage level at which an analog output signal is converted to a digital one.

Specifications

Selector unit includes:

- 2 banana sockets (+red , – black) for connection to voltmeter probes.
- Selector Switch for selecting Pressure Sensor, Light Sensor, External Sensor, or Off.
- Dial for setting the voltage level at which output switches on.
- Red banana socket for 12V digital output



Selector Unit - Circuit Diagram

2.7 Utilities

2.7.1 Buzzer

The buzzer sounds when 12VDC is applied to the Buzzer input socket.

Specifications

- Red banana socket for 12V input
- Supply voltage: 12 VDC
- Current: 20mA

2.7.2 Lamps

Either LED lights up when 12VDC is applied to the corresponding Lamp input socket.

Specifications

- 2 LEDs
- 2 red banana sockets for 12V input
- Supply voltage: 12VDC

2.7.3 Relay

The relay is normally open (N.O.): when 12 VDC is applied to the red banana socket (coil), the N.C. pole is disconnected from COM and the N.O. pole is shorted to COM.

Specifications

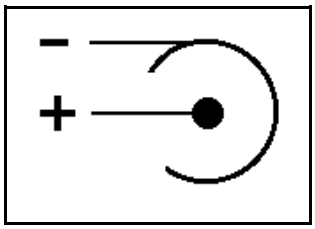
- Red banana sockets for 12V input
- Black banana socket for COM connection
- Gray banana socket for NO (normally open) connection
- Gray banana socket for NC (normally closed) connection
- Supply voltage: 12VDC

2.7.4 12VDC

The 12VDC socket connects the devices on the SensorLine panel to the 12VDC power supply.

2.7.5 Power Input

The power input unit is located on the side of the panel.



12VDC Input Socket

Specifications

Input: 100 ~ 240 VAC, 50 ~ 60 Hz
Output: 12VDC, 15W minimum
12VDC Input socket as shown in the figure on the right.
Note: Connect only the provided adaptor to the power supply.
The power supply can be replaced only with UL approved power supply.

2.8 External Sensors

SensorLine panel includes a female D9 connector, which enables the connection and integration of external sensors to the system. External sensors may be either analog or digital.

SensorLine D9 Connector Pin-Out		
Pin	Function	Note
1	+5 VDC	For analog sensor
2	VOUT	Return analog voltage from analog sensor
3	NPN Input	Sensor output signal
4	Not used	
5	GND	Ground
6	+12 VDC	For external sensor
7	PNP Input	Sensor output signal
8	Not used	
9	GND	Ground

Warning: Improper connection of external sensors to the SensorLine panel may damage the sensor. Heed the following instructions!

In order to connect an external sensor to the SensorLine, the sensor must have the following specifications:

- Output Type: PNP (source) or NPN (sink)
- Operating Voltage: 12 VDC
- Current Consumption: 100–500 mA

Wiring for External Sensor D9 Male Connector

PNP		
Pin	Lead Color	Function
6	Brown	12 VDC
7	Black	Sensor Output Signal
5	Blue	GND

NPN		
Pin	Lead Color	Function
6	Brown	12 VDC
3	Black	Sensor Output Signal
5	Blue	GND

Activation

Digital Sensor: when an external digital sensor detects its target, 12 VDC is directed to the External Sensor Output socket.

Analog Sensor: the Selector Switch must be switched to External; the External Sensor Output socket is inactive; voltage can be measured and/or adjusted through the the Selector unit.

2.9 Optional Sensors

2.9.1 Temperature Probe (Analog)

Principal of Operation

The temperature probe is a general-purpose laboratory temperature sensor which is intended for use with the SensorLine panel.

The probe produces a voltage output which is linear with respect to the temperature it senses.

The probe has a Teflon coating which protects it from damage in most environment. Although the probe can be exposed to many chemicals without damage, it is recommended that the probe be used with water only. If the seal on the probe is damaged, liquid may get into the probe and cause faulty readings.

Activation

- Connect the sensor's D9 male connector to the D9 female **External Sensor** connector on the SensorLine panel.
- Set the sensor selector switch to **External**.
- Connect the probes of your voltmeter to the **Voltmeter** contact points.
- Turn the **Set Level** dial to adjust the A/D (digital output) switching threshold.

Specifications

Temperature sensor includes: general purpose laboratory probe; D9 connector cable.

Temperature Probe (Analog)		
Range	-15°C to 110°C (5° to 230°F)	
Linearity	0.55 °C	
Resolution	Depends upon voltmeter.	
Power	0.15 mA @ 5 VDC	
Response time (for 90% change in reading):	water (with stirring): moving air:	6 to 8 seconds (typical) 30 seconds

D9 Male Connector Pinout		
Pin	Lead Color	Function
1	Pink	+5V
2	Red	Sensor Output Signal (Vout)
5	Black	GND

2.9.2 Proximity Optical Diffuse Reflective Sensor (Digital)

Principal of Operation

This sensor is a photoelectric proximity switch.

The sensor contains two basic elements in a single housing: light transmitter, which emits infrared light; light receiver, an optical transistor which is sensitive to infrared light.

When the transmitted beam strikes an object in its path, the beam is diffusely reflected (depending on the object's surface structure and color) back to the receiver. If the intensity of the reflected light is sufficient, the sensor will output an ON signal.

Activation

- Connect the sensor's D9 male connector to the D9 female **External Sensor** connector on the SensorLine panel.
- Set the sensor selector switch to **External**.
- Connect the probes of your voltmeter to the **Voltmeter** contact points.
- Turn the **Set Level** dial to adjust the A/D (digital output) switching threshold.

Specifications

Proximity optical sensor includes: diffuse reflective photoelectric sensor; D9 connector cable; fasteners.

Proximity Optical Diffuse Reflective Sensor	
Sensing Method	Diffuse Reflective
Minimum Sensing Distance	100 mm
Supply Voltage	12 VDC
Maximum Output Current	100 mA
Light Source	Infrared LED
Operating State of Output	Light-On
Switching Output	NPN Open Collector