

# Sensors

# EFS Series

## Electrical/Electromagnetic Sensors Surface Potential Sensors

### FEEDBACK TYPE

At a new price and featuring better than  $\pm 0.05V$  detector output variation noise, this recently developed feedback surface voltage sensor supports the improved image quality of next generation color printers. This voltage sensor is constructed using TDK's unique, high precision, highly stable detection circuit which feeds the measured photosensitive drum surface potential back to the

electrical field density control chopper and probe shield cover. Output of this probe is highly precise and quite stable, almost unaffected by temperature fluctuations or probe spacing (probe positioning). The adverse effects of electrical disturbances between the photosensitive drum and the sensor electrode are greatly reduced.

### FEATURES

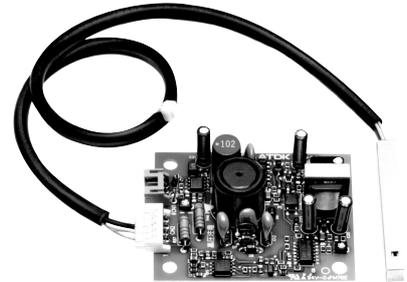
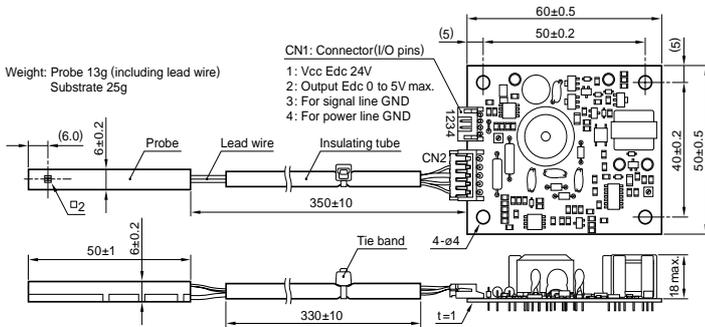
- Unique optimized structure, circuit design and streamlined manufacturing system have achieved the world's smallest class of miniaturization, weight reduction and greater performance in response to market needs along with a new pricing structure.
- Extremely stable output performance is maintained for long periods by the unique structural design with a piezoelectric element with conversion efficiency optimized and at accurate driving provided by the superelastic alloy chopper.
- Quick responsiveness of high speed 11ms (typical) to support increasing need for high speed and high quality image.
- Through the action of TDK's unique feedback circuit, the sensor non-electrode probe components are given the same potential as that measured by the sensor, thereby limiting the range of detector output (0 to 4.5V range) fluctuations to less than  $\pm 0.05V$ . Problems have been solved that were once unavoidable when using conventional analog output type sensors, such as dependence of output voltage upon probe spacing and temperature environment. The world's top level of sensor stability performance has been attained; nearly 0% output voltage variation for over a 1.5 to 3.5mm sensor-probe spacing range and for a 0 to +50°C temperature range.

### APPLICATIONS

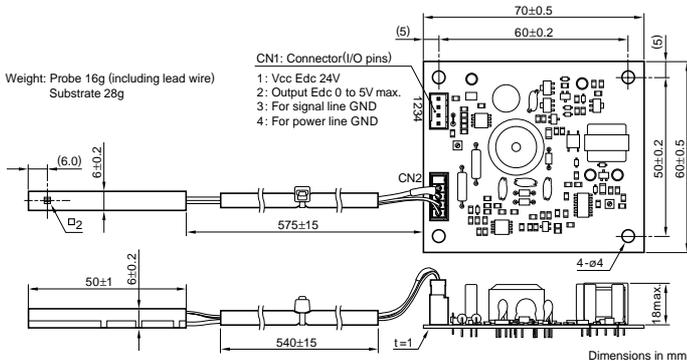
Surface electrical potential measurements in various equipment, including the drum or paper in a copier, laser printer, etc.

### SHAPES AND DIMENSIONS

#### EFS-22D



#### EFS-21D/EFS-31D



\*All probes share common specifications.

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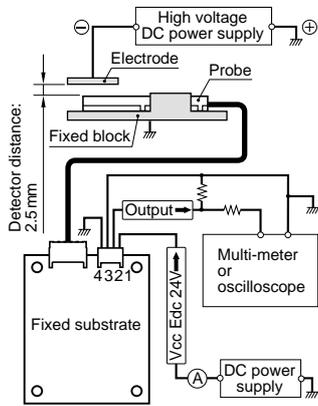
### ELECTRICAL CHARACTERISTICS

Type	Measured voltage range Ve(V)	Power supply voltage Vcc(V)	Output voltage(Measured voltage)* Vo(V)	Output variation $\Delta V_o$	Response time (ms)	Rise time tr (ms)	Fall time tf (ms)	Detector distance (mm)	Power consumption current Idc(mA)
EFS-21D	-1000 to 0	24±10%	0[0], 2.5[-500], 4.5[-900]	±0.05	20max.	11typ.	13.5typ.	1.5 to 3.5	100max.
EFS-22D	-1000 to 0	24±10%	0[0], 2.5[-500], 4.5[-900]	±0.05	20max.	11typ.	13.5typ.	1.5 to 3.5	100max.
EFS-31D	0 to +1000	24±10%	0[0], 2.5[+500], 4.5[+900]	±0.05	20max.	11typ.	13.5typ.	1.5 to 3.5	100max.

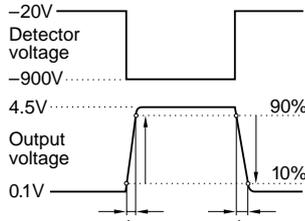
\* Outputs 1/200th the measured voltage.

- Temperature range operating : 0 to +50°C storage : -20 to +60°C
- Humidity range (without wet-bulb) operating : 10 to +90(%)RH storage: 5 to 95(%)RH
- Maximum humidity temperature : 38°C (without wet-bulb)

### MEASURING CIRCUIT

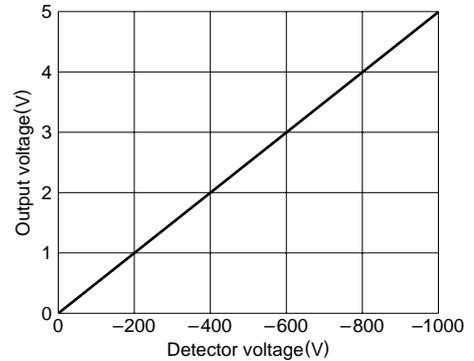


### DETERMINATION OF RESPONSE TIME

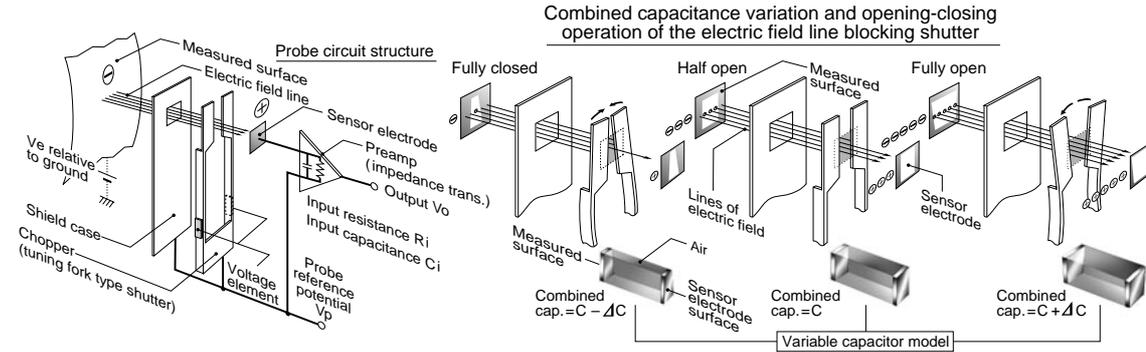


The tr time period defined as the time required for the output voltage to rise from 10 to 90% in response to a 1ms min. step decrease in measured voltage from -20 to -900V.  
The tf time period defined as the time required for the output voltage to fall from 90 to 10%.

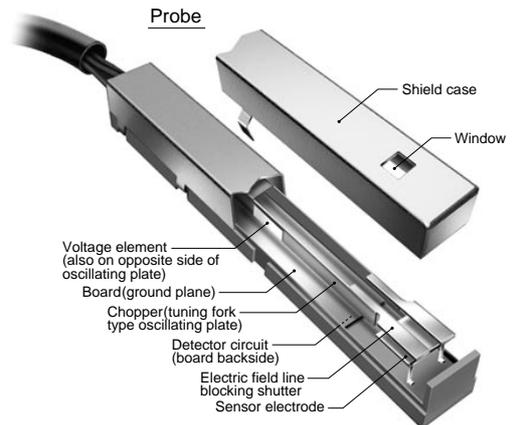
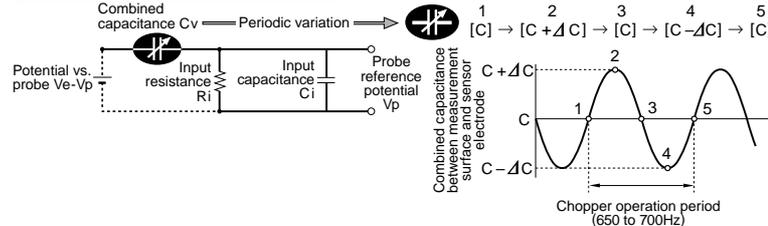
### OUTPUT VOLTAGE vs. DETECTOR VOLTAGE CHARACTERISTICS



### SURFACE POTENTIAL SENSING MECHANISM



### Surface mechanism equivalent circuit



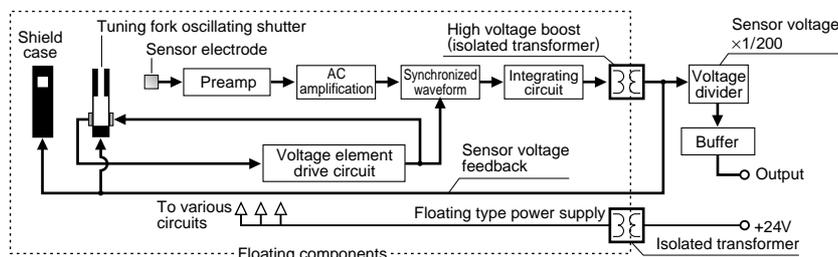
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### EXAMPLE OF OPERATION

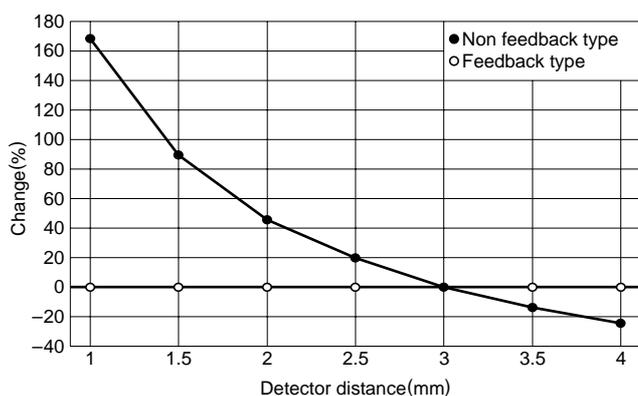


At a fixed distance from the measured surface, a positive charge is induced on the probe's internal sensor electrode surface through the air by an corresponding static charge on the measured surface. The chopper (tuning fork oscillator type shutter) is made to oscillate during sensor measurement. Since the leading edge of the shutter periodically opens and closes, the induced charge (electric field line density) on the sensor electrode surface increases and decreases sinusoidally. In other words, this mechanism increases and decreases the number of electric field lines (electrical-mechanical energy conversion) by utilizing flexure of the oscillating shutter to periodically increase-decrease the effective area of a voltage element placed near the oscillating shutter. This is equivalent

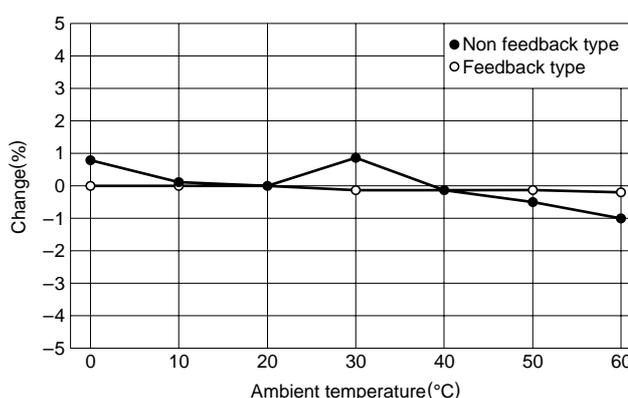
to a variable capacitor. The periodic movement is converted into a changing capacitance, which is output as sensor potential AC voltage  $V_0$  from a preamp using impedance conversion (high→low). This AC signal is amplified, passes through an integrating circuit, and then undergoes high voltage step-up by an isolated transformer. So that the difference between the probe standard potential and the measured potential is always zero, this voltage is fed back as the probe standard potential. The high voltage output (controlled to have the same potential as the measured surface) is fed to a voltage divider, and 1/200th of the measured surface voltage is output from the sensor.

### TYPICAL CHARACTERISTICS

#### OUTPUT VOLTAGE CHANGE DEPENDING ON DETECTOR DISTANCE



#### OUTPUT VOLTAGE CHANGE DEPENDING ON TEMPERATURE



### PRECAUTIONS IN HANDLING

- High voltage rises on the substrate and probe during operation of this type of surface potential sensor. Take sufficient care to prevent electrical shock.
- The combination of a substrate and a probe has been set individually for each sensor by factory adjustment. Do not change the original combination or tamper with the variable resistor on the substrate.
- Take care to keep the sensor free from impact which could be caused by dropping or hitting the sensor.
- Please ask TDK about the details of the probe holder.