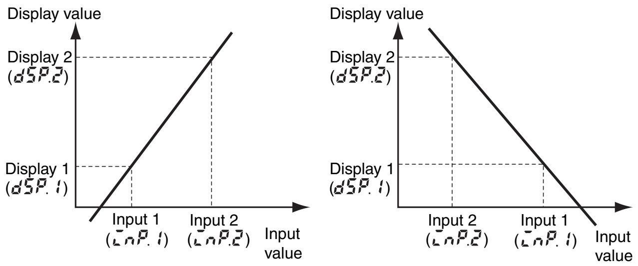
■ Main Functions

Scaling

Scaling is a function that converts the signal output from various sensors into physical measurement units (pressure, level, flow, etc.) before displaying it.

There are two scaling methods, one of which sets two points: any input value and its corresponding converted value. The other method is teaching by actual inputs.



Position Meter

The present measurement value is displayed as a position in relation to the scaling width on a 20-gradation position meter.

Average Processing

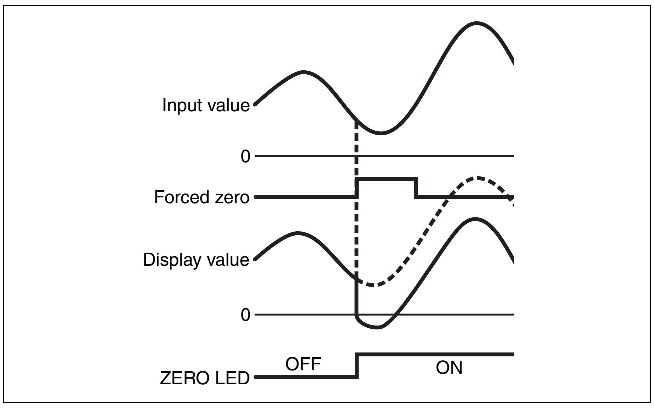
Average processing of input signals with extreme variations eliminates flicker in the display and reduces the effect of noise in the input signal.

There are two types of averages that can be used, the simple average and the moving average.

Forced Zero

It is possible to shift the present value to zero by selecting zero from the front-panel keys. It is useful for setting reference values for measurement.

Timing Chart of a Forced Zero



Timing Hold

Prompted by an external timing signal, it can simultaneously measure the maximum value, minimum value, and the difference between maximum and minimum values.

Maximum/Minimum Hold

Holds the maximum and minimum measurement values.

Display Color Selection

The color of the PV display can be set to either green or red. It is also possible to set the current value to change color according to the status of the comparative output.

Bank Selection

It is possible to switch between eight comparative value banks using the keys on the front-panel or external inputs.

Digital Panel Meter Glossary

RS-232C (Recommended Standard 232C)

RS-232C is a modem interface standard for serial communications defined by the Electronic Industries Alliance (EIA). It defines the electrical specifications, type, and function of the signal line, as well as the mechanical characteristics.

RS-422 and RS-485 (Recommended Standard 422 and 485)

Both RS-422 and RS-485 are standards that specify the electrical characteristics of a balanced differential interface between drivers and receivers defined by the EIA, both are similar in many aspects.

RS-422 allows multiple signal receivers to connect to one driver (signal sender) on the same bus. It does not consider multiple drivers. RS-485 is an extension to RS-422, permitting multiple drivers with tri-state output, and allowing for a multi-drop (party line) structure.

It is possible to transmit at a higher speed with an RS-485 compared to the RS-232C standard, which is suitable only for transmission below 20 kbits/s.

RFI (Radio Frequency Interference)

The effect from external electromagnetic fields. A type of EMI (Electromagnetic Interference).

Isolation

DC isolation of the input and output signals of a device.

For example, when using a thermocouple to measure the temperature within an electric oven, isolation is used to obtain accurate measurements.

Analog Signal

A signal with a continuous amplitude.

Annunciator

A process monitoring system whereby indicators are installed on the panel and control console to represent different stages of the process. If an error occurs, the corresponding indicator lights and an alarm sounds to provide notification of the error.

EMI (Electromagnetic Interference)

The effect of external electromagnetic fields on device circuits and parts.

Impedance

Refer to *Output Impedance* and *Input Impedance*.

SSR (Solid State Relay)

Also called a non-contact relay, a solid state relay is an electronic switch that works without any moving parts. The most common is a photo-triac.

Response

Refer to *Frequency Response* and *Step Response*.

Response Time

For a step response, the response time is the time taken for a target value, display value, or an output signal to settle within a specified range of the final value.

(For DC output devices, it often means the time taken for the signal get from 0% to 90%.)

Temperature Coefficient

For the ambient operating temperature of a device, the amount of temperature change due to the ambient temperature deviating from the reference temperature causes changes in the physical properties of the device. The temperature coefficient is the relative change of a physical property when the temperature is changed. (Often indicated as a percentage of the span per unit of temperature.)

Cascade Control

Cascade control is a feedback control system that uses the output of one controller to manipulate the set point of other controllers.

Accuracy

When using an OMRON signal generator and measurement device to take measurements under normal operating conditions, accuracy is defined as the difference between the ideal output and the actual output expressed as a percentage of the output span.

Allowable Load Resistance

The range of load resistance values for which performance is given.

Common Mode Rejection Ratio

Describes how well an instrument can reject the effect of common-mode voltage entering on the input from the output. It is usually expressed in decibels (dB). It is the ratio between the common-mode voltage on the input terminals of the device and the differential input signals required to achieve the same characteristics in the output signal.

Common Mode Voltage

Noise voltage caused by external induction appears at the two input terminals. It has the same amplitude and phase at both input terminals. The common-mode voltage is the algebraic average of the instantaneous values of the two voltages.

Error

The difference between measured value, set value, or rated value, and the measured or supplied true value.

Repeatability/Reproducibility

The extent to which the measurements of the same item under the same conditions match when any or all of the following are changed; the person who is taking the measurements, the measuring device, the location, or time. (The degree of repeatability is usually expressed as a percentage of the span.)

Difference Input

The difference between two input terminals when a common-mode voltage is applied to both terminals.

Cyclic Redundancy Check (CRC)

A type of block check for data transmission. It is a popular error checking method as it is simple to implement and has an excellent error detecting ability.

Root-Mean-Square Value

The square root of the mean of the squares of the instantaneous values of AC current or voltage. Also called RMS value.

Time Constant

For a first-order linear time-invariant system, the time constant is the time taken for the step response to reach about 63% of its final value.

Frequency Response

The change in gain and phase of the steady-state output as a response to the input frequency of a sinusoidal wave.

Output Impedance

Impedance of an active device seen from its output terminals. Like input impedance, it can also be called output resistance.

Output Bias

Output value when the product is idle (i.e., when the input is at the minimum value or there is no input).
For example, if the output is 1 to 5 V, 1 V is the output bias. If the output is 0 to 5 V, 0 V is the output bias.

Signal

Refer to *Analog Signal* and *Digital Signal*.

Step Response

Response of a system to an instantaneous change in input from one constant value to another.

Span

Difference between the maximum and minimum values of a range.

For example, if the range is –15 to 100°C, the span is 115°C.

Split Control

Controlling two or more different elements with one control signal.

For example, for a system that controls hot water temperature with separate control valves for hot and cold water, if both valve position motors are set at 0% to 50%, the hot water valve is controlled open at 100% to 0% but the cold water valve remains at 0%. If the setting is at 50% to 100%, the hot water valve remains at 0% and the cold water valve is controlled open at 0% to 100%.

Control

Refer to *Cascade Control*, *Split Control*, *PID Control*.

Insulation Resistance

The electrical resistance between two conductors separated by insulating material. The electrical resistance between inputs, outputs, and power source circuits is often of concern for electrical measurements.

Zero Elevation

Shifting the measurement range to the positive direction is called zero elevation.

For example, if the measurement range is –25 to +100°C, zero elevation is 25°C.

Zero Suppression

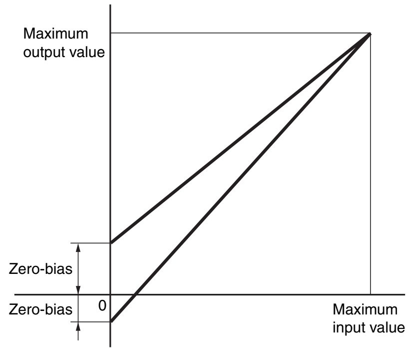
Shifting the measurement range to the negative direction is called zero suppression.

For example, if the measurement range is 0.2 to 1.0 kgf/cm^2, the zero suppression is 0.2 kgf/cm^2.

Zero Bias

Zero-suppression and zero-elevation together is called zero bias.

(Generally it means that the bias is zero.)



Resistance Temperature Sensor

A temperature sensor that uses a resistor element which varies in resistance depending on the temperature. The resistor element may be made from platinum, nickel, or bronze. The platinum type is common used for measurements in the temperature range between –200 and 650°C. In addition to the two-wire configuration, there are three-wire and four-wire configurations to compensate the lead-wire resistances. The three-wire configuration has one line connected to one end of the resistor and two on the other, and the four-wire configuration has two lines connected on either terminals of the resistor.

Time Sharing

A technique used to run two or more processes concurrently with one processor by alternating the run time.

Dielectric Strength/Withstand Voltage

The amount of voltage the insulation of an electrical device can withstand in a fixed period of time.

Neutral Zone

The area between the two set points of a three-position switch.

Linearity

The degree of deviation from a linear relationship between input and output signals. (The degree of linearity is generally indicated as a percentage of the span.)

Digital Signal

Signals that express numbers in a discrete state.

Electric Power

The amount of work done by electricity in one unit of time. In other words, the amount of electrical energy consumed in one unit of time.

Refer to *Reactive Power*, *Apparent Power*, and *Active Power*.

Input

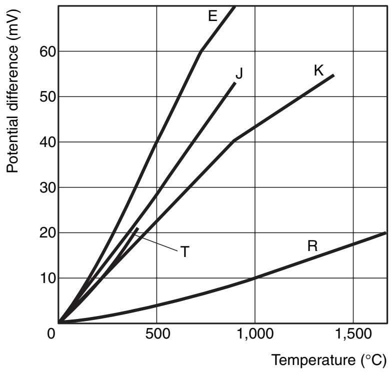
Refer to *Differential Input* and *Floating Input*.

Input Impedance

Impedance of an active device seen from its input terminals. Often indicated by the equivalent impedance of the parallel resistance and capacitance. For DC measuring devices it is simply called input resistance.

Thermocouple

A thermocouple is a type of temperature sensor that uses two conductors of different metals that generate a voltage across its junction due to the thermoelectric effect. The potential difference across the junction corresponds to the temperature at the measuring junction (thermocouple junction) compared to the temperature at the reference junction (also known as the cold junction), which is held at a constant temperature (e.g., 0°C). The potential difference depends on the type of metals used in addition to the difference in temperatures at the junctions. Common types of thermocouples are R (platinum/platinum rhodium), K (chromel/alumel), E (chromel/constantan), and T (copper/constantan).



Normal Mode Rejection Ratio

Describes how well an instrument can reject the effect of normal-mode voltage entering on the input from the output. It is usually expressed in decibels (dB). It is the ratio between the normal-mode voltage on the input terminals of the device and the increase required in the input signals to achieve the same characteristics in the output signal.

Normal Mode Voltage

Undesirable input voltage superimposed on the measurement voltage, such as potential difference of the measuring conductors or induction voltage. Also called series mode voltage.

Burnout (Protection)

When there is no input, the output is increased or decreased, to whichever way is safe.

For example, when temperature is controlled using a thermocouple as the sensor, if the thermocouple breaks down due to a burnout, the input is cut off. When this is detected, it may be incorrectly determined as a temperature drop, resulting in the heat controller increasing the temperature and causing overheating. By implementing a burnout protection function, this kind of overheating can be prevented.

Byte

A group of adjacent bits treated as one unit. Often consists of 8 bits.

Bus

A signal communications line where many devices share the same connection. Data can be transferred from any of the signal sources to any of the receivers connected to the bus.

- **GP-IB**
  One of the buses established by IEEE-USA. IEEE-488
- **VME Bus**
  One of the buses established by IEEE-USA. IEEE-1014
- **Multibus**
  One of the buses established by IEEE-USA. IEEE-796

Parity Check

A parity bit is added to a data set as a binary digit to indicate whether the number of ones in a given set of bits is even or odd. It acts as an error detecting code.

Proportional Plus Integral Plus Derivative Control (PID Control)

A control loop that uses signals proportional to the linear combination of the input, the time integral of the input, and the time derivative of the input to control the output.

Binary Coded Decimal (BCD)

Each digit of a decimal number is represented by four binary bits.

For example, decimal number 23 would be expressed as 0010 0011.

Hysteresis

Properties of equipment and devices where the output value depends on the immediately preceding history of the applied input.

Apparent Power

Apparent power is the simple product of voltage and current supplied to an AC device and is expressed in VA (volt-amperes). It describes the ability of AC devices and power sources to supply current at a given voltage to transformers and motors.

Bit

Short for "binary digit." It is either 1 or 0, and refers to a digit in a binary numeral system. It is the smallest unit of information.

Proportional Band

The range of change in the input (%) required for the output to go from 0% to 100% during proportional action.

Load Resistance

Refer to *Tolerated Load Resistance*.

Dead Band

The range of input variations where the no change is detected in the output variable. This characteristic is also called the neutral zone.

Frame

In a multiplex structure, a message is transmitted using a time-sharing method. Under this arrangement, a frame is a set of consecutive pulse signals conveying the information on the transmission line.

Floating Input

Input terminals that are isolated from the outer casing, power source, and various output terminals (JIS definition).

Negative Logic

There are two ways to assign high and low voltage levels and to the information bits 0 and 1. One is to make 0 correspond to low, and 1 to high, which is called positive logic. The other is in reverse, where 0 corresponds to high and 1 to low, which is called negative logic.

Compensating Lead Wire

An insulated pair of conductors with similar properties to the thermocouple is connected between the thermocouple terminals and the reference junction to compensate for measurement errors caused by temperature change at the thermocouple terminals.

Reactive Power

The portion of power supply (apparent power) that is actually used by an AC machine is the active power, and the portion of power due to stored energy, which returns to the source in each cycle, is known as reactive power. The unit for reactive power is Var.

It is the product of the voltage and current flowing in the device multiplied by the sine value of the phase difference (θ).

Reactive power Q = Voltage E × Current I × Reactive ratio sinθ (Var)

and

Active power P^2 + Reactive power Q^2 = Apparent power S^2

Active Power

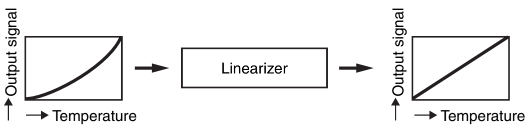
The portion of the power supply that is used by an AC machine is called active power, in units of W (watts). It is the product of voltage, current, and the cosine value of the phase difference (θ). The value cosθ is referred as the power ratio, meaning the portion of power that is useful.

Power Factor

When AC voltage E is applied to a load (the device), the phase of the AC current I flowing in it generally lags behind the voltage E by amount θ. More specifically, when the load is purely resistive, there is no phase shift. When the load is inductive (i.e. a coil), it lags by θ. When the load is capacitive (i.e. a condenser), it leads by θ.

Linearizer

For example with a thermocouple, a detection signal (mV) which has a non-linear relationship with the measurement (temperature) can be used as an input. A linearizer takes this signal and converts it into an output signal that is proportional (linear relationship) to the measured value.



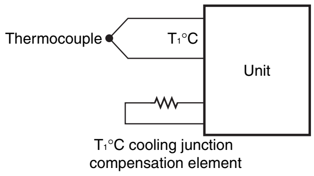
Relay Contact

- **Make contact** (normally open (NO) contact)
- **Break contact** (normally closed (NC) contact)
- **Transfer contact** (double-throw contact)
  Made from two contacts, one normally open contact and one normally closed contact with a common terminal.

Cold Junction Compensation

Also called reference junction compensation. When measuring temperature using thermocouples, the reference terminal may not be held at 0°C, but at the surrounding temperature of T_1°C instead.

Without any compensation, the thermocouple output will be reduced by T_1°C. This is compensated by adding potential difference to the internal amplifier corresponding to T_1°C.



Range

The difference between minimum and maximum values that an input or output can reach.

Load Cell

A load cell is a sensor that detects load or force. A strain gauge is a commonly used type of load cell.

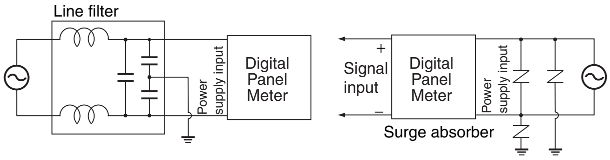
- **Bridge Resistance**
  The standard resistance seen from the load cell input/output terminals (AB/CD) at ambient temperature. Normally 350 Ω.
- **Excitation Voltage**
  Supply voltage applied across the load cell bridge resistance (A–B), normally 5 or 10 V.
- **Rated Output Voltage**
  The voltage output when the maximum load corresponding to an additional 1 V is applied to the load cell. Normally 2 mV/V.

Precautions for Correct Use of Digital Panel Meters

Refer to *Safety Precautions for All Digital Panel Meters*.

Countermeasures Against Noise

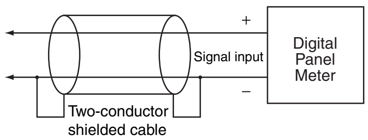
1. Install the product as far as possible from devices that generate strong high-frequency fields (such as high frequency welders or sewing machines) or surges.
2. Install surge absorbers or noise filters on nearby devices that generate noise (particularly motors, transformers, solenoids, magnet coils, and other devices that have a high inductive component).



3. To prevent inductive noise, separate the terminal block wiring for the product from high-voltage or high-current power lines. Do not route the wiring for the product in parallel with or tie it in a bundle with power lines. It is also effective to separate the conduits and ducts, or use shielded cables.

Countermeasures Against Inductive Noise

Analog Signal Inputs



Temperature Inputs

Separate the lead wire that connects the product with a temperature sensor from the load line to prevent the product from being affected by inductive noise.

4. When using a noise filter for the power supply, check the voltage and current and install the filter as close as possible to the Digital Panel Meter.
5. Do not install the product near radios, television sets, or wireless devices. Doing so may cause reception interference.

Water Resistance

Products that have no specified degree of protection and IP☐0 models are not waterproof.

Q&A for Digital Panel Meters

Q1 **Q1 Are the settings retained when power is turned OFF?**

A1 The settings are stored in non-volatile memory and therefore retained even if power is turned OFF. (Non-volatile memory can be written 100,000 times.)

Communications settings are also saved to the non-volatile memory, so do not exceed the specified number of rewrites.

Applicable models: K3HB-X, K3HB-V, K3HB-R, K3HB-P, K3HB-C, K3HB-H, K3GN, K3MA-J, K3MA-L, K3MA-F

Q2 **What is the display error for the K3HB-X?**

A2

Example 1: For the K3HB-X, the input range is 0.0 to 400.0 V (AC voltage input type) and the input is 100 V.

The accuracy for an AC voltage input, range A (measurement range 0.0 to 400.0 V) device is ±0.3% rdg ±5 digits. The corresponding display error is as follows:

100 V × (±0.3%) = ±0.3 V

±5 digits = ±0.5 V

Display accuracy = 100 V ±0.8 V

However, when the input range is 0.0 to 400.0 V and the input signal is below 10% of the maximum input value (e.g. 30 V), the accuracy becomes ±0.15%.

Example 2: For the K3HB-X, the input range is 0.0 to 400.0 V for a model with an AC voltage input and the input is 30 V.

The accuracy for an AC voltage input, range A (measurement range 0.0 to 400.0 V) device when the input is less than 10% of the maximum input value (in this case 10% of 400.0 V is 40.0 V) is ± 0.15% F.S.

400 V × (±0.15%) = ±0.6 V

Display accuracy = 30 V ±0.6 V

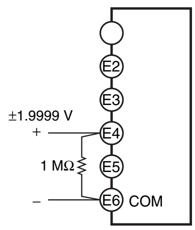
For other input ranges, refer to the table below.

■ Input Range (Measurement Range and Accuracy) (CAT II)

Input type	Range	Setting	Measurement range	Input impedance	Accuracy	Allowable instantaneous overload (30 s)
K3HB-XVD (DC voltage)	A	A ud	±199.99 V	10 MΩ min.	±0.1% rdg ±1 digit max.	±400 V
	B	b ud	±19.999 V	1 MΩ min.		±200 V
	C	C ud	±1.9999 V			
	D	d ud	1.0000 to 5.0000 V			
K3HB-XAD (DC current)	A	A Ad	±199.99 mA	1 Ω max.	±0.1% rdg ±1 digit max.	±400 mA
	B	b Ad	±19.999 mA	10 Ω max.		±200 mA
	C	C Ad	±1.9999 mA	33 Ω max.		
	D	d Ad	4.000 to 20.000 mA	10 Ω max.		
K3HB-XVA (AC voltage) (See note 3.)	A	A uA	0.0 to 400.0 V	1 MΩ min.	±0.3% rdg ±1 digit max.	700 V
	B	b uA	0.00 to 199.99 V			
	C	C uA	0.000 to 19.999 V		±0.5% rdg ±1 digit max.	400 V
	D	d uA	0.0000 to 1.9999 V			
K3HB-XAA AC current	A	A AA	0.000 to 10.000 A	(0.5VA CT) (See note 4.)	±0.5% rdg ±1 digit max.	20 A
	B	b AA	0.0000 to 1.9999 A	(0.5VA CT) (See note 4.)		
	C	C AA	0.00 to 199.99 mA	1 Ω max.	±0.5% rdg ±1 digit max.	2 A
	D	d AA	0.000 to 19.999 mA	10 Ω max.		

Note: 1. The accuracy is for an input frequency range of 40 Hz to 1 kHz (except for AC current inputs A and B for which the range is 50 to 60 Hz) and an ambient temperature of 23 ±5°C. The error, however, increases below 10% of the maximum input value.

DC voltage input (all ranges): 10% or less of max. input = ±0.15% FS
DC current input (all ranges): 10% or less of max. input = ±0.1% FS
AC voltage input (A: 0.0 to 400.0 V): 10% or less of max. input = ±0.15% FS
AC voltage input (B: 0.00 to 199.99 V): 10% or less of max. input = ±0.2% FS
AC voltage input (C: 0.000 to 19.999 V; D: 0.0000 to 1.9999 V): 10% or less of max. input = ±1.0% FS
AC current input (A: 0.000 to 10.000 A): 10% or less of max. input = ±0.25% FS
AC current input (B: 0.0000 to 1.9999 A): 10% or less of max. input = ±0.5% FS
AC current input (C: 0.00 to 199.99 mA; D: 0.000 to 19.999 mA): 10% or less of max. input = ±0.15% FS



When DC voltage input models are used with a ±1.9999 V range, make sure that the connections between input terminals are not open. If the input terminals are open, the display will show large variations. Connect resistance of approximately 1 MΩ between the input terminals if they are open.

2. "rdg" means "reading" and refers to the input error.

3. The K3HB-XVA☐☐ complies with UL standards when the applied input voltage is within the range 0 to 150 VAC. If the input voltage is higher than 150 VAC, install an external transformer or take other measures to drop the voltage to 150 VAC or lower.

4. The value (0.5 VA CT) is the VA consumption of the internal CT (current transformer).

Applicable model: K3HB-X

Q3 Is there a function that prevents the output from chattering?

A3

There are the following two methods.

1. Hysteresis: Chattering can be prevented by setting the reset width.
2. Average processing: Increasing the frequency of averaging using simple averaging stabilizes the display and prevents output chattering.

Applicable models: K3HB-X, K3HB-V, K3HB-R, K3HB-H, K3GN, K3MA-J, K3MA-L, K3MA-F

Q4 Can the number of rotations and the speed be displayed using monitor outputs of any inverter? (For example, FM output terminal outputs max. 1440 Hz voltage pulse.)

A4

If the Digital Panel Meter takes a voltage pulse input, the number of rotations and rotational speed can be displayed using the scaling and pre-scaling functions.
For the K3MA-F, a value that is proportional to the input frequency is displayed (display value $D = F \times \alpha$). For example, if the frequency is 1,440 Hz and you want to display the value of 100, then set inP to 1440 and dSP to 00100.
For the K3HB-R, the display value is shown as $D = F \times 60 \times \alpha$.
F: Input frequency (Hz)
α: Scaling value

Applicable models: K3MA-F, K3HB-R

Note: PWM output type inverters do not change the frequency even when the pulse duty ratio changes, therefore the K3MA-F and K3HB-R cannot be used.

Q5 Is there a function that can be used to force values near zero to zero?

A5

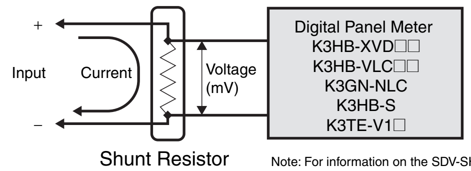
The zero limit function can be used to force values near zero to zero.

Applicable models: K3HB-X, K3HB-V, K3HB-S, K3HB-H, K3MA-J

Reference Material for Digital Panel Meters

■ Measuring High DC Currents

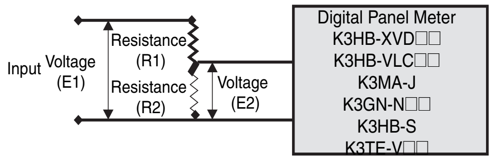
For some OMRON products, shunt resistors are used in the input section to convert a DC current to a DC voltage to measure high DC voltages when the measurement range is exceeded (e.g., 2 A).



Note: For information on the SDV-SH□ Shunt Resistor, refer to *SDV*. Select the Shunt Resistor considering the maximum current that will be applied to it.

■ Measuring DC voltages

To measure a DC current that exceeds the measurement range of the OMRON product, install an external voltage dividing circuit to divide the voltage.



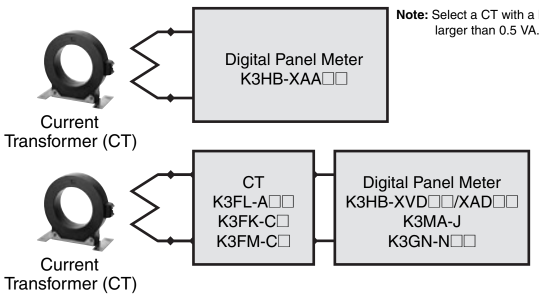
* Formula to use for dividing the voltage.

$$E2 = \frac{R2}{R1 + R2} \times E1$$

Note 1: Use the following formula to estimate the capacity (W) of R1 and R2.
$W = 3\ (I^2 \times (R1\ or\ R2))$
2: I is the current flow to R1 or R2.

■ Measuring High AC Currents

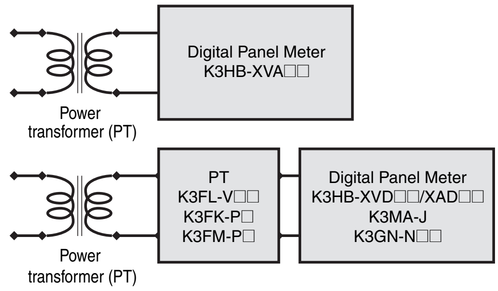
To measure an AC current that exceeds the measurement range of the OMRON product, install an external current transformer (CT) to reduce the current flow. Also, install an external CT transducer to convert a DC voltage to a DC current signal for measurement.



Note: Select a CT with a load larger than 0.5 VA.

■ Measuring High AC Voltages

To measure an AC voltage that exceeds the measurement range of the OMRON product, install an external power transformer (PT) to reduce the voltage. Also, install a PT transducer to convert a DC voltage to a DC current signal for measurement.

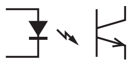
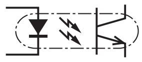
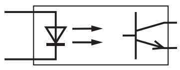
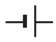
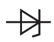


■ Measuring Other Forms of Signals, Sensor Signals, and Non-linear Signals

To measure anything related to electrical output, such as power, reactive power, power factor, frequency or phase, any signals from sensors, or any non-linear signals, install a power transducer or a signal converter to convert DC voltage into DC current.

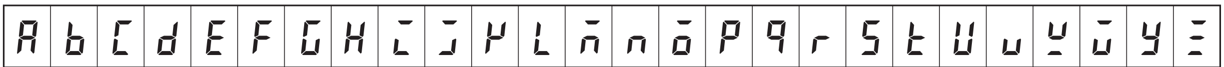
Power	K3FL-W□□
Reactive power	K3FL-Q□□
Power factor	K3FL-C□□
Frequency	K3FL-F□□
Phase	K3FL-P□□
Load cell	K3FK-G/GS
Non-linear signal	K3FK-X

■ Summary of Element Symbols

Element	Symbol		Details
	Denotation in product catalogs	Denotation by JIS	
NO contact	 or 	 or 	Contacts are open when the relay is inactive.
NC contact			Contacts are closed when relay is inactive.
Double-throw contact			Transfer contacts (also called double-throw contacts) control two circuits, one normally open contact and one normally closed contact with a common terminal.
Diode			
Photocoupler	 or 		
AC power source			
DC power source			
NPN transistor			
PNP transistor			
Zener diode			

■ Parameter Display

The following symbols are used to represent the characters for parameter names on a Digital Panel Meter.



A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z

ALL DIMENSIONS SHOWN ARE IN MILLIMETERS.
To convert millimeters into inches, multiply by 0.03937. To convert grams into ounces, multiply by 0.03527.

OMRON

Terms and Conditions of Sale

1. Offer; Acceptance. These terms and conditions (these "Terms") are deemed part of all quotes, agreements, purchase orders, acknowledgments, price lists, catalogs, manuals, brochures and other documents, whether electronic or in writing, relating to the sale of products or services (collectively, the "Products") by Omron Electronics LLC and its subsidiary companies ("Omron"). Omron objects to any terms or conditions proposed in Buyer's purchase order or other documents which are inconsistent with, or in addition to, these Terms.
2. Prices; Payment Terms. All prices stated are current, subject to change without notice by Omron. Omron reserves the right to increase or decrease prices on any unshipped portions of outstanding orders. Payments for Products are due net 30 days unless otherwise stated in the invoice.
3. Discounts. Cash discounts, if any, will apply only on the net amount of invoices sent to Buyer after deducting transportation charges, taxes and duties, and will be allowed only if (i) the invoice is paid according to Omron's payment terms and (ii) Buyer has no past due amounts.
4. Interest. Omron, at its option, may charge Buyer 1-1/2% interest per month or the maximum legal rate, whichever is less, on any balance not paid within the stated terms.
5. Orders. Omron will accept no order less than $200 net billing.
6. Governmental Approvals. Buyer shall be responsible for, and shall bear all costs involved in, obtaining any government approvals required for the importation or sale of the Products.
7. Taxes. All taxes, duties and other governmental charges (other than general real property and income taxes), including any interest or penalties thereon, imposed directly or indirectly on Omron or required to be collected directly or indirectly by Omron for the manufacture, production, sale, delivery, importation, consumption or use of the Products sold hereunder (including customs duties and sales, excise, use, turnover and license taxes) shall be charged to and remitted by Buyer to Omron.
8. Financial. If the financial position of Buyer at any time becomes unsatisfactory to Omron, Omron reserves the right to stop shipments or require satisfactory security or payment in advance. If Buyer fails to make payment or otherwise comply with these Terms or any related agreement, Omron may (without liability and in addition to other remedies) cancel any unshipped portion of Products sold hereunder and stop any Products in transit until Buyer pays all amounts, including amounts payable hereunder, whether or not then due, which are owing to it by Buyer. Buyer shall in any event remain liable for all unpaid accounts.
9. Cancellation; Etc. Orders are not subject to rescheduling or cancellation unless Buyer indemnifies Omron against all related costs or expenses.
10. Force Majeure. Omron shall not be liable for any delay or failure in delivery resulting from causes beyond its control, including earthquakes, fires, floods, strikes or other labor disputes, shortage of labor or materials, accidents to machinery, acts of sabotage, riots, delay in or lack of transportation or the requirements of any government authority.
11. Shipping; Delivery. Unless otherwise expressly agreed in writing by Omron:
    a. Shipments shall be by a carrier selected by Omron; Omron will not drop ship except in "break down" situations.
    b. Such carrier shall act as the agent of Buyer and delivery to such carrier shall constitute delivery to Buyer;
    c. All sales and shipments of Products shall be FOB shipping point (unless otherwise stated in writing by Omron), at which point title and risk of loss shall pass from Omron to Buyer; provided that Omron shall retain a security interest in the Products until the full purchase price is paid;
    d. Delivery and shipping dates are estimates only; and
    e. Omron will package Products as it deems proper for protection against normal handling and extra charges apply to special conditions.
12. Claims. Any claim by Buyer against Omron for shortage or damage to the Products occurring before delivery to the carrier must be presented in writing to Omron within 30 days of receipt of shipment and include the original transportation bill signed by the carrier noting that the carrier received the Products from Omron in the condition claimed.
13. Warranties. (a) Exclusive Warranty. Omron's exclusive warranty is that the Products will be free from defects in materials and workmanship for a period of twelve months from the date of sale by Omron (or such other period expressed in writing by Omron). Omron disclaims all other warranties, express or implied. (b) Limitations. OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, ABOUT NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OF THE PRODUCTS. BUYER ACKNOWLEDGES THAT IT ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. Omron further disclaims all warranties and responsibility of any type for claims or expenses based on infringement by the Products or otherwise of any intellectual property right. (c) Buyer Remedy. Omron's sole obligation hereunder shall be, at Omron's election, to (i) replace (in the form originally shipped with Buyer responsible for labor charges for removal or replacement thereof) the non-complying Product, (ii) repair the non-complying Product, or (iii) repay or credit Buyer an amount equal to the purchase price of the non-complying Product; provided that in no event shall Omron be responsible for warranty, repair, indemnity or any other claims or expenses regarding the Products unless Omron's analysis confirms that the Products were properly handled, stored, installed and maintained and not subject to contamination, abuse, misuse or inappropriate modification. Return of any Products by Buyer must be approved in writing by Omron before shipment. Omron Companies shall not be liable for the suitability or unsuitability or the results from the use of Products in combination with any electrical or electronic components, circuits, system assemblies or any other materials or substances or environments. Any advice, recommendations or information given orally or in writing, are not to be construed as an amendment or addition to the above warranty. See http://www.omron247.com or contact your Omron representative for published information.
14. Limitation on Liability; Etc. OMRON COMPANIES SHALL NOT BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS OR PRODUCTION OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED IN CONTRACT, WARRANTY, NEGLIGENCE OR STRICT LIABILITY. Further, in no event shall liability of Omron Companies exceed the individual price of the Product on which liability is asserted.
15. Indemnities. Buyer shall indemnify and hold harmless Omron Companies and their employees from and against all liabilities, losses, claims, costs and expenses (including attorney's fees and expenses) related to any claim, investigation, litigation or proceeding (whether or not Omron is a party) which arises or is alleged to arise from Buyer's acts or omissions under these Terms or in any way with respect to the Products. Without limiting the foregoing, Buyer (at its own expense) shall indemnify and hold harmless Omron and defend or settle any action brought against such Companies to the extent based on a claim that any Product made to Buyer specifications infringed intellectual property rights of another party.
16. Property; Confidentiality. Any intellectual property in the Products is the exclusive property of Omron Companies and Buyer shall not attempt to duplicate it in any way without the written permission of Omron. Notwithstanding any charges to Buyer for engineering or tooling, all engineering and tooling shall remain the exclusive property of Omron. All information and materials supplied by Omron to Buyer relating to the Products are confidential and proprietary, and Buyer shall limit distribution thereof to its trusted employees and strictly prevent disclosure to any third party.
17. Export Controls. Buyer shall comply with all applicable laws, regulations and licenses regarding (i) export of products or information; (iii) sale of products to "forbidden" or other proscribed persons; and (ii) disclosure to non-citizens of regulated technology or information.
18. Miscellaneous. (a) Waiver. No failure or delay by Omron in exercising any right and no course of dealing between Buyer and Omron shall operate as a waiver of rights by Omron. (b) Assignment. Buyer may not assign its rights hereunder without Omron's written consent. (c) Law. These Terms are governed by the law of the jurisdiction of the home office of the Omron company from which Buyer is purchasing the Products (without regard to conflict of law principles). (d) Amendment. These Terms constitute the entire agreement between Buyer and Omron relating to the Products, and no provision may be changed or waived unless in writing signed by the parties. (e) Severability. If any provision hereof is rendered ineffective or invalid, such provision shall not invalidate any other provision. (f) Setoff. Buyer shall have no right to set off any amounts against the amount owing in respect of this invoice. (g) Definitions. As used herein, "including" means "including without limitation"; and "Omron Companies" (or similar words) mean Omron Corporation and any direct or indirect subsidiary or affiliate thereof.

Certain Precautions on Specifications and Use

1. Suitability of Use. Omron Companies shall not be responsible for conformity with any standards, codes or regulations which apply to the combination of the Product in the Buyer's application or use of the Product. At Buyer's request, Omron will provide applicable third party certification documents identifying ratings and limitations of use which apply to the Product. This information by itself is not sufficient for a complete determination of the suitability of the Product in combination with the end product, machine, system, or other application or use. Buyer shall be solely responsible for determining appropriateness of the particular Product with respect to Buyer's application, product or system. Buyer shall take application responsibility in all cases but the following is a non-exhaustive list of applications for which particular attention must be given:
   (i) Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this document.
   (ii) Use in consumer products or any use in significant quantities.
   (iii) Energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
   (iv) Systems, machines and equipment that could present a risk to life or property. Please know and observe all prohibitions of use applicable to this Product.
   NEVER USE THE PRODUCT FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY OR IN LARGE QUANTITIES WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON'S PRODUCT IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.
2. Programmable Products. Omron Companies shall not be responsible for the user's programming of a programmable Product, or any consequence thereof.
3. Performance Data. Data presented in Omron Company websites, catalogs and other materials is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of Omron's test conditions, and the user must correlate it to actual application requirements. Actual performance is subject to the Omron's Warranty and Limitations of Liability.
4. Change in Specifications. Product specifications and accessories may be changed at any time based on improvements and other reasons. It is our practice to change part numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the Product may be changed without any notice. When in doubt, special part numbers may be assigned to fix or establish key specifications for your application. Please consult with your Omron's representative at any time to confirm actual specifications of purchased Product.
5. Errors and Omissions. Information presented by Omron Companies has been checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical or proofreading errors or omissions.

OMRON
AUTOMATION & SAFETY

OMRON AUTOMATION AND SAFETY • THE AMERICAS HEADQUARTERS • Chicago, IL USA • 847.843.7900 • 800.556.6766 • www.omron247.com

OMRON CANADA, INC. • HEAD OFFICE
Toronto, ON, Canada • 416.286.6465 • 866.986.6766 • www.omron247.com

OMRON ELECTRONICS DE MEXICO • HEAD OFFICE
México DF • 52.55.59.01.43.00 • 01-800-226-6766 • mela@omron.com

OMRON ELECTRONICS DE MEXICO • SALES OFFICE
Apodaca, N.L. • 52.81.11.56.99.20 • 01-800-226-6766 • mela@omron.com

OMRON ELETRÔNICA DO BRASIL LTDA • HEAD OFFICE
São Paulo, SP, Brasil • 55.11.2101.6300 • www.omron.com.br

OMRON ARGENTINA • SALES OFFICE
Cono Sur • 54.11.4783.5300

OMRON CHILE • SALES OFFICE
Santiago • 56.9.9917.3920

OTHER OMRON LATIN AMERICA SALES
54.11.4783.5300

OMRON EUROPE B.V. • Wegalaan 67-69, NL-2132 JD, Hoofddorp, The Netherlands. • +31 (0) 23 568 13 00 • www.industrial.omron.eu

Authorized Distributor:

Automation Control Systems
• Machine Automation Controllers (MAC) • Programmable Controllers (PLC)
• Operator interfaces (HMI) • Distributed I/O • Software

Drives & Motion Controls
• Servo & AC Drives • Motion Controllers & Encoders

Temperature & Process Controllers
• Single and Multi-loop Controllers

Sensors & Vision
• Proximity Sensors • Photoelectric Sensors • Fiber-Optic Sensors
• Amplified Photomicrosensors • Measurement Sensors
• Ultrasonic Sensors • Vision Sensors

Industrial Components
• RFID/Code Readers • Relays • Pushbuttons & Indicators
• Limit and Basic Switches • Timers • Counters • Metering Devices
• Power Supplies

Safety
• Laser Scanners • Safety Mats • Edges and Bumpers • Programmable Safety Controllers • Light Curtains • Safety Relays • Safety Interlock Switches

CSM_Digital_Panel_TG_E_3_1 05/14 Note: Specifications are subject to change. Printed in U.S.A.

Printed on recycled paper.