

JIS

JAPANESE INDUSTRIAL STANDARD

**Electrical Measuring Transducers for
Converting A.C. Electrical Quantities
into D.C. Electrical Quantities**

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In the event of any doubt arising,
the original Standard in Japanese is to be final authority.

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Electrical Measuring Transducers
for Converting A.C.
Electrical Quantities into D.C.
Electrical Quantities

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1. Scope

This Japanese Industrial Standard specifies AC-DC transducers, hereafter referred to as the "transducers", for indoor use which convert such a.c. electrical quantities as voltage, current, active power, reactive power, phase angle, power factor, reactive factor and frequency into d.c. voltages or currents corresponding to the input quantities to the instrument, for the purpose of measurement of such a.c. electrical quantities.

Transducers which require external auxiliary power supply are included.

Remarks 1. Transducers shall be capable of operating continuously under the following conditions:

Ambient temperature	-10 to 50°C
Relative humidity	30 to 85 %
Altitude	1000 m or below

- The frequency of input is 15 Hz to 1 kHz inclusive, but power frequency band is the principal zone.
- This Standard applies to each input quantity for a transducer for measurement of plural input quantities, and to each output for a double-output transducer.
- This Standard is applicable as practical to a transducer which is a part of measuring system for non-electrical quantities if the transducer is considered to be covered by this Standard.
- Detectors, transmitters, etc. are not included.

Applicable Standards:

JIS C 0911-Vibration Testing Procedure for Electric Machines and Equipment

JIS C 0912-Shock Testing Procedure for Electric Machines and Equipment

JIS C 1301-Insulation Resistance Testers (Magneto Generator Operated)

JIS C 1302-Insulation Resistance Testers (Battery Operated)

Corresponding International Standard:

IEC 688-1 Electrical measuring transducers for converting a.c. electrical quantities into d.c. electrical quantities.
Part 1: General purpose transducers

Reference Standards:

JIS C 1002-Glossary of Terms Used in Electronic Measuring Apparatus

JIS C 1102-Electrical Indicating Instruments

JIS Z 8103-Glossary of Terms Used in Instrumentation

2. Definitions

2.1 General Terms

- (1) transducer A device for converting a.c. electrical quantities into direct currents or voltages by means of electronic circuits for measurement purposes.
- (2) transducer with offset zero (biased) A transducer which gives a predetermined bias output when the input is zero.
- (3) transducer with suppressed zero A transducer which gives zero or a constant bias output when the input is zero.
- (4) double-output transducer A transducer which converts an input quantity into two corresponding outputs.
- (5) measuring element A unit which converts an input quantity into a corresponding output quantity.
- (6) auxiliary power supply An a.c. or d.c. electrical supply other than the circuit to be measured which is necessary for the operation of the transducer.
- (7) response time The time from the instant when the input changes from a certain value to another value (referred to as the "application of an input step") until the output reaches and remains within a prescribed band from the final steady value.
- (8) total distortion factor The ratio of the r.m.s. value of distorted wave excluding the fundamental wave to the r.m.s. value of the original distorted wave.

2.2 Terms in Relation with Input

- (1) input range The range of inputs to be converted.
- (2) effective input range The range covered by the input range where the specified performances are ensured.

Remark: The effective input range may sometimes coincide with the input range.

- (3) rated input value The upper limit value of effective input range. However, it means power factor 1 for power factor transducers, and reactive factor 1 reactive factor transducers.
- (4) rated voltage The voltage marked on the transducer which is the reference input voltage of active power transducer, reactive power transducer, phase angle transducer, power factor transducer, reactive factor transducers or frequency transducers.
- (5) rated current The current marked on the transducer which is the reference input current of active power transducer, reactive power transducer, phase angle transducer, power factor transducer, or reactive factor transducer.

- (6) rated frequency The frequency marked on the transducer which is the reference input frequency of a voltage transducer, current transducer, active power transducer, reactive power transducer, phase angle transducer, power factor transducer, reactive factor transducer or frequency transducer.
- (7) rated power factor The power factor marked on the transducer which is the reference input power factor of active power transducer or power factor transducer.
- (8) rated reactive factor The reactive factor marked on the transducer which is the reference reactive factor of the input of a reactive power transducer or reactive factor transducer.

2.3 Terms in Relation with Output

- (1) output range The range of converted output quantities i.e., the outputs corresponding to the input range.
- (2) effective output range The range covered by the output range where the specified performances are ensured, i.e. the outputs corresponding to the effective input range.

Remark: The effective output range may sometimes coincide with the output range.

- (3) rated output value The upper limit value of effective output range. However, it means the output value corresponding to power factor 1 for a power factor transducer, and that to reactive factor 1 for a reactive factor transducer.
- (4) rated output load The value or range of resistance marked on a transducer which is the total load resistance connectable across the output terminals of the transducer.
- (5) output reference value The designed output value corresponding to an input value.
- (6) output span (hereafter designated "span") The algebraic difference between the upper and lower limit values of the effective output range.
- (7) reversible output An output which reverses polarity in response to a change of polarity of the input.
- (8) output ripple The peak-to-peak value of the ripple part which appears in the output when the input is in a steady input state.

2.4 Terms in Relation with Error, Accuracy Class, Etc.

- (1) error The true value of output minus the output reference value.
- (2) fiducial value A value to which reference is made in order to specify the percentage error, and it shall be the span unless otherwise specified. However, the fiducial value of a transducer having a reversible and symmetrical output may be either the span or $\frac{1}{2}$ of the span.

- (3) percentage error The ratio in percentage of the error and the fiducial value.
- (4) tolerance The permissible values of limits on percentage error under the standard atmospheric conditions for testing.
- (5) influence quantity A quantity, other than the measured quantity, which may affect the measured results.
- (6) effect The change in output of a transducer when an influence quantity is changed from its reference value.
- (7) accuracy class A class of transducer classified according to the tolerance and the limits of influence.
- (8) class index The number which designates the accuracy class.
- (9) preconditioning Such procedures to be carried out prior to the tests of transducers that the rated output load is connected to the specimen, the input and the auxiliary power supply are applied for the specified duration.

3. Classification and Ratings

3.1 Classification Transducers are classified according to their electrical input quantities and accuracy classes as given in Table 1.

Table 1

Electrical input quantity	Class index		
Voltage transducer			
Current transducer	0.1	0.2	0.25
Power transducer (single-phase, three-phase)	0.3	0.5	1.0
Reactive power transducer (single-phase, three-phase)	1.5	2.0	2.5
Phase angle transducer (single-phase, three-phase)			
Power factor transducer (single-phase, three-phase)	0.3	0.5	1.0
Reactive factor transducer (single-phase, three-phase)	2.0	3.0	5.0
Frequency transducer	0.1	0.2	0.3
	0.5	1.0	1.5
	2.0	2.5	3.0

3.2 Ratings

3.2.1 Rated Values of Input Side The rated values of input side quantities of transducers shall be as given in Table 2.

Table 2

Classification of inputs	Rated value	Description
Rated voltage V	$\frac{110}{\sqrt{3}}$, 110, $\frac{220}{\sqrt{3}}$, 220	1. Not applicable to voltage or current transducer. 2. $110/\sqrt{3}$ and $220/\sqrt{3}$ indicate phase voltage of three-phase circuit.
Rated current A	1, 5	Not applicable to voltage, current or frequency transducer.
Rated frequency Hz	50, 60, 50/60	—
Rated power factor	1	Applicable to power and power factor transducers
Rated reactive factor	1	Applicable to reactive power and reactive factor transducers.

3.2.2 Rated Values of Output Side and Output Range

- (1) The rated output voltage and output voltage range of a transducer shall have the values given in Table 3.

Table 3

Unit: mV	
Rated output voltage	Output voltage range
10	0 to 10
50	0 to 50
100	0 to 100

Table 3 (Continued)

Unit: V	
Rated output voltage	Output voltage range
1	0 to 1
5	0 to 5
5	1 to 5
10	0 to 10
± 1	- 1 to 0 to 1
± 5	- 5 to 0 to 5
± 10	-10 to 0 to 10

- (2) The rated output current and output current range of a transducer shall have the values given in Table 4.

Table 4

Unit: mA	
Rated output current	Output current range
0.5	0 to 0.5
1	0 to 1
2.5	0 to 2.5
5	0 to 5
10	0 to 10
20	0 to 20
20	4 to 20
± 0.5	-0.5 to 0 to 0.5
± 1	-1 to 0 to 1
± 5	-5 to 0 to 5
± 10	-10 to 0 to 10

3.2.3 Rated Output Load

- (1) The rated output load of a transducer which employs a voltage as the output shall be determined as agreed between the parties concerned with the acceptance.

- (2) The rated output load of a transducer which employs a current as the output shall have one of the values given below.

250 Ω , 500 Ω , 1 k Ω , 1.5 k Ω , 3 k Ω , 5 k Ω and 10 k Ω

4. Performances

4.1 Tolerance When the transducer is tested in accordance with 6.2, the error shall not exceed ± 100 % of the class index in each accuracy class.

4.2 Operation and Effect

4.2.1 Response Time The response time of a transducer shall not exceed 2 s when tested as specified in 6.3 (1). However, if agreed between the parties concerned with the acceptance, such a case is an exception.

4.2.2 Output Ripple When the output ripple of a transducer is tested as specified in 6.3 (2), its peak-to-peak value shall not exceed 3 % of the output span. However, if agreed between the parties concerned with the acceptance, such a case is an exception.

4.2.3 Effect of Self-heating When the effect of self-heating on a transducer is tested as specified in 6.3 (3), the variation in output expressed as a percentage of the fiducial value shall not exceed 100 % of the class index in each accuracy class.

4.2.4 Effect of Temperature When the effect of temperature on a transducer is tested as specified in 6.3 (4), the variation in output expressed as a percentage of the fiducial value shall not exceed 100 % of the class index in each accuracy class.

4.2.5 Effect of External Magnetic Field When the effect of magnetic field of external origin on a transducer is tested as specified in 6.3 (5), the variation in output expressed as a percentage of the fiducial value shall not exceed 100 % of the class index in each accuracy class.

4.2.6 Effect of Voltage When the effect of voltage on a transducer is tested as specified in 6.3 (6), the variation in output expressed as a percentage of the fiducial value shall not exceed 50 % of the class index in each accuracy class. However, voltage transducers and current transducers are excepted.

4.2.7 Effect of Auxiliary Power Supply Voltage The effect of auxiliary power supply voltage on a transducer requiring an auxiliary power supply is tested as specified in 6.3 (7), the variation in output expressed as a percentage of the fiducial value shall not exceed 50 % of the class index in each accuracy class.

4.2.8 Effect of Current When the effect of current on phase angle, power factor and reactive factor transducers is tested as specified in 6.3 (8), the variation in output expressed as a percentage of the fiducial value shall not exceed 100 % of the class index in each accuracy class.

4.2.9 Effect of Frequency When the effect of frequency on a transducer is tested as specified in 6.3 (9), the variation in output expressed as a percentage of the fiducial value shall not exceed 50 % of the class index in each accuracy class. However, frequency transducers are excepted.

Remark: This performance is applicable for voltage balance type ones only for reactive power, phase angle, power factor and reactive factor transducers.

4.2.10 Effect of Power Factor When the effect of power factor on active power and reactive power transducers is tested as specified in 6.3 (10), the variation in output expressed as a percentage of the fiducial value shall not exceed 100 % of the class index in each accuracy class.

4.2.11 Effect of Mutual Interference between Measuring Elements When the effect of mutual interference between measuring elements on an active power transducer of three-phase three-wire system is tested as specified in 6.3 (11), the variation in output expressed as a percentage of the fiducial value shall not exceed 50 % of the class index in each accuracy class.

4.2.12 Effect of Unbalanced Currents When the effect of unbalanced currents on an active power transducer of three-phase three-wire system is tested as specified in 6.3 (12), the variation in output expressed as a percentage of the fiducial value shall not exceed 100 % of the class index in each accuracy class.

4.2.13 Effect of Output Load When the effect of output load on a transducer the rated output load of which is indicated by a range is tested as specified in 6.3 (13), the variation in output expressed as a percentage of the fiducial value shall not exceed 50 % of the class index in each accuracy class.

4.2.14 Effect of Waveform When the effect of waveform on voltage, current and frequency transducers is tested as specified in 6.3 (14), the variation in output expressed as a percentage of the fiducial value shall not exceed 100 % of the class index in each accuracy class. However, this effect is not applicable for voltage and current transducers of rectifier type in operating principle.

4.3 Strength

4.3.1 Continuous Overload When a transducer is subjected to the continuous overload as specified in 6.4.1, the transducer shall not cause inappropriate temperature rise or electrical damage. Further, the specimen shall satisfy the tolerance specified in 4.1 when it is returned under the standard atmospheric conditions for testing and thermal equilibrium is attained.

4.3.2 Instantaneous Overload When a transducer is subjected to the instantaneous overload as specified in 6.4.2, the transducer shall not be damaged electrically or thermally. Further, the specimen shall satisfy the tolerance specified in 4.1 when it is returned under the standard atmospheric conditions for testing and thermal equilibrium is attained.

4.3.3 Insulation Resistance The insulation resistance shall be not less than 10 M Ω when tested in accordance with 6.4.3.

4.3.4 Power Frequency Withstand Voltage When the power frequency withstand voltage test is carried out as specified in 6.4.4, the transducer shall not be damaged electrically or mechanically.

4.3.5 Lightning Impulse Withstand Voltage When the lightning impulse withstand voltage test is carried out as specified in 6.4.5, the transducer shall not be damaged electrically or mechanically. Further, the specimen shall satisfy the tolerance specified in 4.1 when it is returned under the standard atmospheric conditions for testing and thermal equilibrium is attained.

4.3.6 Shock When the shock test is carried out as specified in 6.4.6, the transducer shall not be damaged mechanically. The difference in output values before and after the test expressed as a percentage of the fiducial value shall not exceed 100 % of the class index in each accuracy class.

4.3.7 Vibration When the vibration test is carried out as specified in 6.4.7, the transducer shall not be damaged mechanically. The difference in output values before and after the test expressed as a percentage of the fiducial value shall not exceed 100 % of the class index in each accuracy class.

5. Construction

5.1 Construction in General Transducers shall have appropriate construction to their own purpose of use, shall be robust mechanically and durable.

The measuring elements or the like shall be contained in an enclosure to avoid damage due to ingress of dust or foreign matters.

5.2 Polarity of Reversible Output The polarity of reversible output shall be as follows:

- (1) For active power transducers, the output corresponding to the polarity marked on the input terminals shall be positive.
- (2) For reactive power, phase angle, power factor and reactive factor transducers, the leading phase shall, as a rule, be named as negative and the lagging phase as positive.

5.3 Terminal and Mark

5.3.1 Terminal The terminals shall have appropriate construction to the purpose of use and shall be sufficiently robust mechanically.

5.3.2 Mark Marks shall be attached to terminals or in their vicinity so that the connection is clearly understood.

6. Tests

6.1 Testing Conditions Transducers shall be tested under the standard testing conditions in accordance with the standard testing procedures.

- (1) Standard Testing Conditions The standard testing conditions means such conditions that the located state of transducer satisfies all the conditions prescribed below.

(1.1) External Conditions

Ambient temperature	23 ± 2°C
Relative humidity	45 to 70 %
Auxiliary power supply	A.C. of sine wave, rated voltage or current ± 1 %, rated frequency ± 2 % D.C. without including pulses, rated voltage or rated current ± 1 %
External magnetic field	Geomagnetic field