

# The maximum system voltage is the key for insulation test of PV (photovoltaic) modules. It can also be used to check for PID.

The insulation tests in international standards IEC61215 Edition 2.0 2005-04, IEC61646 Edition 2.0 2008-05, and IEC61730-2 2004-10 are composed of 3 tests: the withstanding voltage test, insulation resistance test, and wet leakage test. The TOS9213AS is capable of insulation tests up to a maximum system voltage of 1500 V.

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## DC WITHSTANDING VOLTAGE/ INSULATION RESISTANCE TESTER **TOS9213AS**

### ●IEC61730-2 standard test

The applied voltage varies depending on the applicable class in IEC61730-2. For Class A, the voltage is raised at a speed of 500 V/s or less to [2000 V + 4 times of the maximum system voltage] and then maintained for 1 min. Example: With a mega-solar system that has a maximum system voltage of 1500 V, the applied voltage is [2000 + 4 x 1500] V = 8000 V.

\* (Excluding tester accuracy and similar factors)

### ●Insulation resistance test and wet leakage test

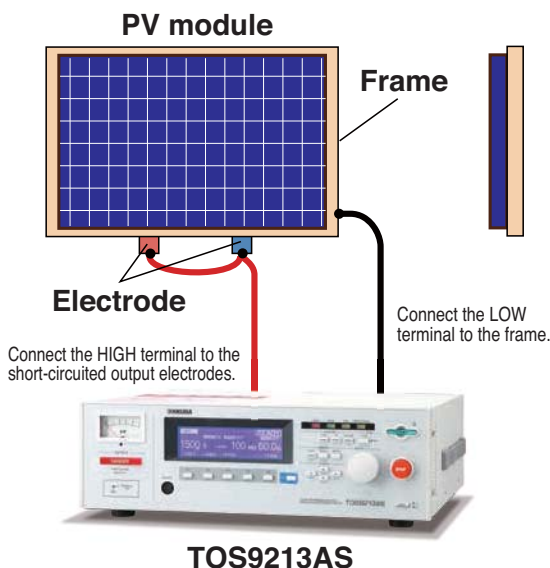
With each standard, the voltage is raised to a speed of 500 V/s or less to 500 V or the module maximum system voltage (whichever is higher) and maintained at that voltage.

As the maximum system voltage in solar power generation projects continues to trend higher, the TOS9213AS can raise the DC voltage that is applied at the insulation resistance test up to 1500 V.

### ●Reproduction of PID

When performing tests for PID (Potential Induced Degradation), which is a problem with current PV modules, a negative polarity DC power source is required. By turning OFF the timer setting in the TOS9213AS insulation resistance test mode, it is possible to perform these tests with the TOS9213AS in the same way. (Maximum current capacity: 1 mA up to 1020 V, 0.1 mA at or above 1020 V)

### Image of insulation tests with the TOS9213AS



\* The module connection method for PID reproduction is the same as for the insulation tests. By selecting the TOS9213AS insulation resistance test mode (IR), the applied voltage will have negative polarity.

#### Features/ Functions

- 10 kV / 5 mA, maximum output power of 50 W in DC withstanding voltage test.
- -25 V to -1500 V / 0.01 MΩ to 9.99 MΩ insulation resistance test.
- Conforms to international standards including IEC61215 Ed2.0, IEC61646 Ed2.0, and IEC61730-2.
- Low output ripple of (100 Vp-p at 10 kV) in consideration of capacitive load.
- The rise time control function allows the voltage build-up rate to be set. Also includes a discharge function.
- Judgment of the insulation resistance test can be selected between resistance value and current value.
- Capable to apply high-voltage and monitor current for PID. (-1500 VDC / 100 μA)

# Specifications

## DC Withstanding Voltage Test Mode

Output section (DC)		
Output-voltage range		0.05V ~ 10.0kV
	Resolution	10V
	Accuracy	± (1.5% of setting + 20V)
Maximum rated load ※ 1		50W (10kV/5mA)
Maximum rated current		5mA
Ripple	No load at 10 kV	100Vp-p Typ.
	Maximum rated load	100Vp-p Typ.
Voltage regulation		1 % or less [maximum rated load → no load]
Short-circuit current		40 mA Typ.
Discharge function		Forced discharge at the end of test (discharge resistance: 500 k Ω) The discharge time can be set to a value from 0.5 s to 300 s (*2).
Start voltage		The voltage at the start of the test can be set as the start voltage.
	Setting range	0% to 99% of the test voltage (resolution of 1%)
Output-voltage monitoring function		If the output voltage exceeds ±(10% of setting + 50 V), output is cut off and the protection function activates.
Voltmeter		
Analog	Scale	10kV DC F.S
	Accuracy	± 5% F.S
	Indicator	Mean-value responsive
Digital	Measurement range	0.00 ~ 10.5kV DC
	Resolution	10V
	Accuracy	± (1.0% of reading + 20V)
	Response	Mean-value responsive(response time of 200 ms)
	HOLD function	The voltage measured at the end of test is held during the PASS and FAIL period.

\*1 Limitation on output

The tester's withstanding voltage generator is designed to radiate half as much heat as the rated output, in consideration of the size, weight, cost, and other factors of the tester. It is therefore necessary to use the tester within the ranges specified below. Operations deviating from these ranges may heat the output section excessively, thereby activating the protective circuit. In such a case, suspend the test and wait until the temperature falls to the normal level.

Output limitation in withstanding voltage testing

Ambient temperature		Upper reference	Pause	Output time
$t \leq 40^{\circ}\text{C}$	DC	$2.5\text{mA} \leq i$	At least as long as the output time	Maximum of 1 minute
		$i < 2.5\text{mA}$	At least as long as the judgement wait time (WAIT TIME)	Continuous output possible (Output time = voltage rise time + test time + voltage fall time)

\*2 About the discharge time setting

If you set the discharge time to 0.0 s or if the voltage between the output terminals exceeds approximately 30 V even after the specified discharge time has passed, the TOS9213S/ TOS9213AS will continue discharging until the voltage between the output terminals falls below approximately 30 V.

Ammeter	
Measurement range	0.00 ~ 5.5mA DC
Accuracy (*3)	$0\text{ }\mu\text{A} \sim 2.00\text{mA} : \pm (3\% \text{ of reading} + 5\text{ }\mu\text{A})$
	$2.01\text{mA} \sim 5.50\text{mA} : \pm (3\% \text{ of reading} + 10\text{ }\mu\text{A})$
Response	Mean-value responsive (response time of 200 ms)
Hold function	The measured current at the end of the test is held during the PASS period.

Judgement function	
Setting range for the upper reference (UPPER)	$1\text{ }\mu\text{A} \sim 999\text{ }\mu\text{A}$ 1 $\mu\text{A}$ STEP $1.00\text{mA} \sim 5.50\text{mA}$ 0.01mA STEP
Setting range for the lower reference (LOWER)	$1\text{ }\mu\text{A} \sim 999\text{ }\mu\text{A}$ 1 $\mu\text{A}$ STEP $1.00\text{mA} \sim 5.50\text{mA}$ 0.01mA STEP (With the LOWER OFF function)
Judgement accuracy (*3)	$0\text{ }\mu\text{A} \sim 2.00\text{mA} : \pm (3\% \text{ of setting} + 5\text{ }\mu\text{A})$ $2.01\text{mA} \sim 5.50\text{mA} : \pm (3\% \text{ of setting} + 10\text{ }\mu\text{A})$
Response switching function	The current detection response for UPPER FAIL judgement can be set to FAST/ MID/SLOW (*4)
Time	
Setting range for the voltage rise time (RISE TIME)	0.1s ~ 200s
Setting range for the test time (TEST TIME)	0.3s ~ 999s (With the TIMER OFF function)

\*3 When the GND LOW/GUARD setting is set to LOW, the humidity must not exceed 70 % rh.

\*4 In the MID and SLOW modes, depending on the discharge method, the voltage monitoring function may operate and the TOS9213S/ TOS9213AS may enter the PROTECTION status before UPPER FAIL detection takes place.

## Insulation Resistance Test Mode

Output section										
Output-voltage range		— 25V ~ — 1500V								
	Resolution	1V								
	Accuracy	± (1.5% of setting + 2V)								
Maximum rated load		1W (— 1000V/1mA)、0.15W (— 1500V/0.1mA)								
Maximum rated current		1mA (0.1 mA maximum when the test voltage setting exceeds -1020 V)								
Ripple	No load at 1 kV	2 Vp-p or less								
	Maximum rated load	10 Vp-p or less								
Voltage regulation		1% or less [Maximum rated load → no load]								
Short-circuit current		12 mA or less								
Discharge function		Forced discharge at the end of test (discharge resistance: 25 k Ω) The discharge time can be set to a value from 0.5 s to 300 s (*2).								
Output-voltage monitoring function		If the output voltage exceeds ±(10% of the setting + 50 V), output is cut off and the protection function activates.								
Voltmeter										
Analog	Scale	10kV DC F.S								
	Accuracy	± 5% F.S								
	Indicator	Mean-value responsive / root-mean-square value scale								
Digital	Measurement range	0 ~ — 1700V								
	Resolution	1V								
	Accuracy	± (1.0% of reading + 1V)								
Resistance meter										
Measurement range		0.01 M Ω - 9.99 G Ω (at rated current range of 50 nA to 1 mA maximum)								
Accuracy										
<table><tr><td>50nA ≤ i ≤ 100nA</td><td>100nA &lt; i ≤ 200nA</td><td>200nA &lt; i ≤ 1 μA</td><td>1 μA &lt; i ≤ 1mA</td></tr><tr><td>± (20% of reading.)</td><td>± (10% of reading.)</td><td>± (5% of reading.)</td><td>± (2% of reading.)</td></tr></table>			50nA ≤ i ≤ 100nA	100nA < i ≤ 200nA	200nA < i ≤ 1 μA	1 μA < i ≤ 1mA	± (20% of reading.)	± (10% of reading.)	± (5% of reading.)	± (2% of reading.)
50nA ≤ i ≤ 100nA	100nA < i ≤ 200nA	200nA < i ≤ 1 μA	1 μA < i ≤ 1mA							
± (20% of reading.)	± (10% of reading.)	± (5% of reading.)	± (2% of reading.)							
[i=measured current]										
[In the humidity range of 20 % to 70 % R.H (no condensation), with no disturbance such as swinging of the test leadwire]										

Judgement function		
Judgement method		In UPPER and LOWER judgement, you can switch between resistance value-based judgement and current value-based judgement. The action for the judgement method by the current value-based judgement, Display, Buzzer, SIGNAL I/O can be referred to the action in Withstanding Voltage Test Mode.
Setting range for the upper reference (UPPER)	Resistance value-based judgment	0.01M Ω ~ 9.99G Ω [Below the maximum rated current]
	Current value-based judgment	0.1 $\mu\text{A}$ ~ 1.00mA
Setting range for the lower reference (LOWER)	Resistance value-based judgment	0.01M Ω ~ 9.99G Ω [Below the maximum rated current]
	Current value-based judgment	0.1 $\mu\text{F}$ ~ 1.00mA
Time		
Setting range for the voltage rise time (RISE TIME)		0.1s ~ 200s
Setting range for the test time (TEST TIME)		0.5 s to 999 s With the TIMER OFF function

## General Specifications

Power requirements	Nominal voltage range (Allowable voltage range)	AC100V ~ 120V/200V ~ 240V Selectable (AC85V ~ 132V/170V ~ 250V)
Power consumption	Using no load (READY)	100 VA or less
	Using the rated load	Maximum of 200 VA
Allowable frequency range		47 Hz to 63 Hz
Insulation resistance		30 M Ω or more (500 V DC) [between the AC LINE and chassis]
Withstanding voltage		1390 V AC, 2 seconds, 20 mA or less [between the AC LINE and chassis]
Earth continuity		25 A AC/0.1 Ω or less
Safety		Conforms to the requirements of the following standard. EN61010-1 (Class I, Pollution degree 2)
Warranty range Temperature / Humidity		5 °C to 35 °C / 20 % to 80 % rh (No condensation)
Operating range Temperature / Humidity		20 °C to 40 °C / 20 % to 80 % rh (No condensation)
Storage range Temperature / Humidity		— 20 °C to 70 °C / 90 % RH or less (No condensation)
Dimensions		430 (455) W × 132 (150) × 400 (440) D mm
Weight		Approx. 13 kg
Accessory		AC Power cord: 1 pc, High-voltage test leadwire TL01- TOS (1.5 m): 1 set, Interlock jumper: 1 pc, [HIGH VOLTAGE DANGER sticker: 1 sheet, Fuse: 1 pc, Operation Manual: 1 copy]