



# **TSVR SERIES STATIC VOLTAGE REGULATOR**

## **1-50kVA**

**1 Phase Input-1 Phase Output**

**USER MANUAL**



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## 1. SAFETY NOTICES

- Contacting with live parts may result in serious wounds and even death.
- Electrical safety precautions should be taken before any set up, maintenance or measurement operation.
- Do not perform connection, measurement and maintenance operations alone. Keep one person with you who can help you in any emergency situation.
- Do not use the device without protective ground connection.
- Electrical connections should only be performed by professional electricians.
- Read this manual carefully before using the device and save it for later reference.
- Ensure that ambient conditions are met with the regulations described in this manual.
- Ensure that cooling fan ventilation holes are open.
- Failure to provide required ambient conditions will result in problems with the device.
- Do not perform any operations which you are unsure about.
- When you encounter a problem in any step throughout this guide, do not skip to next step. Contact our support department for help.

## 2. FIRST CONTROLS

- Check the device for any damage which may have occurred during shipping processes.
- Check the device nameplate to ensure that the information is consistent with your purchase order.

## 3. GENERAL WORKING MECHANISM

These devices use tapped transformers and Silicon Controlled Rectifiers (SCRs or thyristors) to regulate voltage. Proper taps are selected on individual transformer of each phase and independent voltage regulation between phases is accomplished. An electronic system controls the whole system with the help of a microcontroller. The electronic system requires initial power to start up. After the electronic system gets power it starts self-tests and then controls the regulation system against any problems. If electronic system finds no problem it continues with the rest of the steps to start the regulation.

## 4. TECHNICAL INFORMATION

### 4.1. Electrical Properties

PARAMETER		MIN	NOMINAL	MAX	UNIT
S	Power	-	-	20	KVA
Vin	Input voltage	110	220	253	V (AC P-N)
Vout	Output voltage	213	220	227	V (AC P-N)
f	Input Frequency	45	50	65	Hz

### 4.2. Ambient Conditions

PARAMETER		MIN	NOMINAL	MAX	UNIT
T	Temperature	-10	20	40	°C
RH	Relative Humidity	-	50	90	%
Alt	Altitude	-	-	2000	m

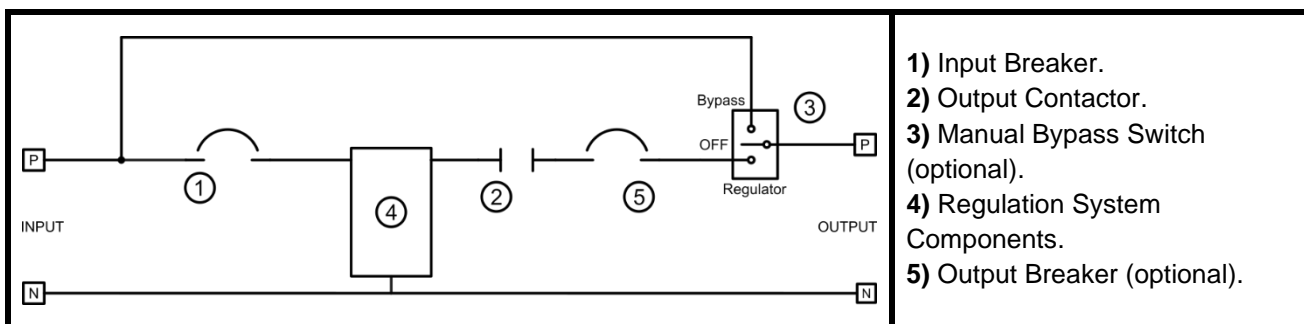
### 4.3. Optional Systems and Parts in the Device

Control and protection elements contained in your device are indicated with (x) mark in below table.

Optional Systems and Parts	
Input Breaker	x
Output Breaker	
Output Contactor	
Manual Bypass Switch	
Isolated Transformers	
Remote Management Unit	x

## 5. SINGLE LINE DIAGRAM

Below single line diagram contains optional Manual Bypass Switch and optional Output Breaker too. See above table to determine if your device has these optional parts.



## 6. SWITCHING and PROTECTION ELEMENTS

Not all of the elements explained in this part might be present in your device. See technical information part to determine which elements are contained in your device.

### 6.1. Input Breaker - Standard

Input Breaker controls the input power to regulation system. It also provides protection against overload or short circuit situations. Whenever user turns on this breaker, the regulation system gets power. Turning on the Input Breaker will not immediately supply power to output terminals. Output power will be available after device completes self-tests.

### 6.2. Output Breaker - Optional

Optional Output Breaker provides manual control of the output power of the regulation system. This breaker also provides protection against overloads or short circuits.

### 6.3. Manual Bypass Switch - Optional

Manual Bypass Switch controls the manual bypass system. For detailed explanations about this switch see Manual Bypass System part.

### 6.4. Output Contactor - Optional

Output Contactor is controlled by the electronic control system. This contactor is turned on when the regulation system is ready. This way regulated energy is transferred to the output terminals.

## 7. MANUAL BYPASS SYSTEM

- Manual Bypass System is optionally included in the device. See technical information part to determine if your device has this system.
- Manual Bypass System control is achieved by a rotary transfer switch which has 3 different modes.
- There will be output power interruption when Manual Bypass System mode is changed. Turn off your loads and turn off external output breaker before changing the mode of Manual Bypass System.

### 7.1.1. Bypass Mode

When Manual Bypass Switch is turned to label **Bypass (or Line)** the manual bypass mode is activated. In this mode regulation system is bypassed and input terminals are directed to output terminals. In case of a fault in regulation system or whenever loads are wanted to be fed with unregulated mains power this mode can be selected. Turning off the Input Breaker or Output Breaker will not affect the operation of the manual bypass mode. These breakers cannot break the output power while in manual bypass mode. See single line diagrams. In manual bypass mode it is possible to turn off the input breaker and shut down the device to save the no load power consumption of the device.

Output voltage values seen on front panel are not the actual output terminal voltage values in manual bypass mode, these voltage values are the output voltage values of regulation system.

### 7.1.2. Output Off Mode

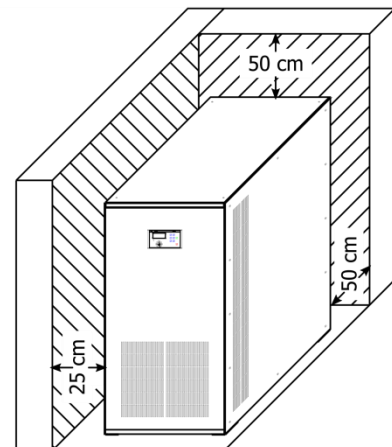
When Manual Bypass Switch is turned to label **Output Off (0 or Off)**, the output terminals are isolated. In this mode input power to regulation system is not turned off, only output power to loads is turned off. See single line diagrams.

### 7.1.3. Regulator Mode

When Manual Bypass Switch is turned to label **Regulator**, the regulation system is directed to output terminals. In this mode there will be regulated power at the output terminals. Output voltage values seen on front panel are actual output terminal voltage values in regulator mode.

## 8. INSTALLATION LOCATION

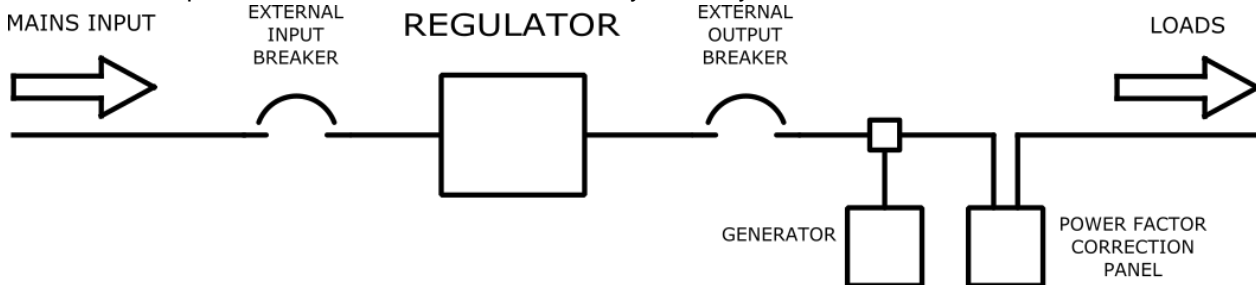
- No liquid or solid objects should enter into the device. Check the enclosure protection of the device and decide a suitable location.
- Ensure that ambient conditions are met in the location. See Technical Information part for ambient conditions.
- Ensure that below conditions are met for the location where you intend to place the device.
- The location should not take direct sun light.
- There will be at least 2 meters between device and any combustible material.
- There will be at least 25 cm between device and any other object or wall.
- There will be at least 50 cm space behind the device to the wall.
- There will be at least 50 cm space in front of any fan airflow outlet of the device.
- There will be no flammable liquid or gas container in the location.
- Generator connection to the system should be after the device.
- Power factor correction device connection to the system should be between device and loads.



- Contact support department if any of the above conditions are not possible to be met.

## 9. MAKING THE CONNECTIONS OF THE DEVICE

- Below block diagram shows the recommended status of the electrical system and external protection elements after you have installed the regulator.
- The external input breaker can be the main input breaker of the building.
- External output breaker is recommended for safety of the system.



- The steps starting with the sign (OP) indicates that this step is related to an optional element. Skip to next step if you do not have this optional element.
- Use a reliable true RMS multimeter to perform measurements.

1. Turn off your loads.
2. Turn off the main input breaker of the building.
3. Turn off the external input breaker if you have it in your system.
4. Using a reliable multimeter, ensure that there is no energy on the conductors which will be connected to the input terminals of the device.
5. Turn off the Input Breaker of the device.
6. (OP) Turn off the Optional Output Breaker of the device.
7. (OP) Turn the Optional Manual Bypass Switch to Output Off (0 or Off) position.
8. Turn off the external output breaker if you have it in your system.
9. See Appendix 1 for properties of the conductors to be connected to the device.
10. See Appendix 2 for information about the input output and other terminals of the device.
11. Connect input, output and protective ground conductors to their terminals and tighten their screws with proper amount of torque. See Appendix 3 for tightening torque values.
12. After you have completed connections, check the labels and conductors again.

## 10. SUPPLYING POWER TO LOADS

- Complete below steps in order to supply power to loads.
- The steps starting with the sign (OP) indicates that this step is related to an optional element. Skip to next step if you do not have this optional element.
- Use a reliable true RMS multimeter to perform measurements.

1. Ensure that the breakers mentioned in the Making the Connections of the Device part are turned off.
2. Ensure that the input, output and protective ground connections are completed properly as described in the Making the Connections of the Device part.
3. Turn on the main input breaker of the building and turn on the external input breaker if you have it in your system. This will supply power to input terminals of the device.
4. Measure voltage at the input terminals of the device. Ensure that voltage at the input terminals is at expected value.
5. Measure voltage at output terminals; ensure that there is no energy at the output terminals.
6. (OP) Continue with following sub steps if your device has a Manual Bypass Switch. Skip to next step if it does not have a Manual Bypass Switch.
  - 6.1. Turn the manual bypass switch to bypass mode. This will direct the power at input terminals to output terminals.

- 6.2. Measure voltage at output terminals. Ensure that voltage at output terminals is same with voltage at input terminals.
- 6.3. Turn the Manual Bypass Switch to regulator mode.
7. Turn on the Input Breaker. This will power up the regulation system and the front panel.
8. Electronic system starts self-tests after the regulation system is powered up. These controls last in 10 to 30 seconds. After self-tests are completed, regulated power is automatically directed to output terminals. While optional Manual Bypass Switch is at regulator mode, there will be no power at output terminals until the startup self-tests are completed.
9. (OP) In devices which contain optional Output Breaker, regulated power to output terminals can be controlled manually. After starting up the regulation system, turn on the optional Output Breaker to direct the regulated power to output terminals.
10. Measure voltage at output terminals. Ensure that output voltage is within the limits indicated in the Technical Information part.
11. Turn on the external output breaker if you have it in your system.
12. Turn on your loads.
13. After turning on the loads control the load percentage value shown on the front panel. Ensure that load percentage value is below 100%. See Front Panel and LCD section for information about front panel.
14. If load percentage value is not below 100% you will have to disconnect some of your loads. If this is not possible, contact support department.
15. After turning on the loads and ensuring that there is no problem, enter the input, output voltage and load percentage value to the commissioning form. Sign a copy of commissioning form and send it to support department. This is required for validation of device warranty.

## 11. TURNING OFF THE DEVICE

1. Turn off your loads before turning off the device.
  2. Turn off the external output breaker if you have it in your system.
  3. Turn off the optional Output Breaker.
  4. Turn off the Input Breaker. This will cut off the power to the regulation system.
  5. Turn off the external input breaker if you have it in your system.
- After turning off the Input Breaker it is possible to feed the loads with unregulated mains power by turning the optional Manual Bypass Switch to bypass mode.

## 12. FRONT PANEL and LCD

### 12.1. General Information

- Device front panel starts working when the Input Breaker is turned on and regulation system is energized.
- "INPUT" labeled light indicates that input power to the device and its main control board is present.
- "OUTPUT" labeled light shows the status of the main control board of the device. If the light is on, then the main control board of this phase has completed self-tests and turned on the Output Contactor.
- "FAULT" labeled red light turns on when regulation system has a problem. Go to Error Menu (Fault Screen) in the front panel LCD and check the fault code. See fault codes part in this manual for explanations of the fault codes.

### 12.2. LCD Screen

#### 12.2.1. General Information

- Screen number: The string at the upper right corner indicates the screen number being shown (M1, M2...).
- Switching between screens: Use "Up" and "Down" buttons on the front panel to switch between screens.
- Selecting an option or entering a submenu: Press and hold "Up" or "Down" button to enter into a submenu or select an option.



- Cursor symbol ( > ) at the beginning of a row indicates that this row has an option which can be changed.
- Edit option symbol ( = ) at the beginning of a row indicates that the option or value on this row is selected and can be changed by pressing “Up” or “Down” buttons.
- Press and hold “Up” or “Down” button to change the edit option symbol to cursor symbol.
- Select Save & Exit option to save, apply and exit the settings you have made.

#### **12.2.2. M1 - Input Output Voltage and Load Percentage Screen**

- Displays the input, output voltages and the load percentage of the regulation system.

#### **12.2.3. M2 - Frequency Screen**

- Displays the input line frequency measured by the electronic system.
- This value is displayed for only information purposes. The device cannot change the frequency.
- The device will work in any frequency value inside the range indicated in the electrical properties table.

#### **12.2.4. M3 - Ongoing Fault Screen**

- Displays the ongoing fault of the regulation system. Check Fault Codes part in this manual for the explanation of the fault code.

#### **12.2.5. M4 - Fault Records Entrance Screen**

- Fault records list can be accessed from this screen.
- Press and hold “Up” or “Down” button to enter into the fault records menu.
- Press “Up” or “Down” button to switch between fault code records.
- See Fault Codes part in this manual for explanation of fault codes.
- Press and hold “Up” or “Down” button to exit from fault records menu to main menu.

#### **12.2.6. M4.X - Fault M. (Fault Records List)**

- This screen allows checking the records of previous fault codes.
- Whenever a fault is occurred, its fault code is recorded in this screen.
- Lower number indicates the more recently occurred fault.

#### **12.2.7. M5 - Settings Entrance Screen**

- Settings can be accessed from this screen.
- Press and hold “Up” or “Down” button to enter into the settings.

#### **12.2.8. M5.1 Out Val Setting**

- First setting in the setting menu is Out Val. This is the regulation system target output voltage value.
- Change this value to your preferred output voltage value.

#### **12.2.9. M5.2 Offset**

- Second setting in the settings menu is Offset. This is the target output voltage sensitivity value.
- The output voltage can go plus minus this amount of voltage from Out Val voltage. If this setting is set too low which might be beyond the capability of the device, the regulation system can behave unexpectedly. Do not change this value unless instructed by the technical service personnel.

#### **12.2.10. M6 Sys Info**

- This menu shows device firmware versions and eeprom options. It is informative only. There is no user changable settings

### **13. CONTROLS AFTER INSTALLATION**

- After first installation, turn on as much load as possible which will not exceed load percentage shown on front panel over 100%. Wait for a few hours for ambient temperature to stabilize. Ensure that the temperature stays inside the allowed range indicated in the Technical Specifications part.
- Check the environmental conditions once in 6 months.

- Check cooling fan airflow holes once in 6 months to ensure that they are not blocked. The cooling fans might be controlled by a thermic switch which turns on fans at certain temperature level. These fans might not start running when you start up the device.

## 14. TROUBLESHOOTING

### 14.1. Fault Codes

- Below table explains the fault codes and recommended actions. See next section for information about other situations.

Error Format ; yaaa

y : for 1 means L1 Phase

y : for 2 means L2 Phase

y : for 3 means L3 Phase

y : for 4 means General Failure

aaa: means specific error code

EXAMPLE: 2010 means L2 Phase current zero failure

Code	Description	Code	Description
y000	No Error	y042	Load Higher than %100
y001	input Voltage very high	y043	Load Higher than %125
y002	input Voltage high	y044	Load Higher than %150
y003	input Voltage very low	y045	Load Higher than %175
y004	input Voltage low	y046	Load Higher than %200
y005	output voltage very high	y047	Wait Other Phase
y006	output voltage high	y048	Paralel Reg - Wait Open RL1 Command
y007	output voltage very low	y049	Paralel Reg -Wait Open RL2 Command
y008	output voltage low	y051	Paralel Reg -Common Output Terminal Voltage synchronization error
y009	user close the main output via remote controller	y052	Paralel Reg- Command Signal Error 1
y010	Current Zero Failure	y053	Paralel Reg -Command Signal Error 2
y011	Thyristor Open Circuit input	y054	Paralel Reg -PMU – MB Communication Error
y012	Thyristor Open Circuit output	y055	Paralel Reg -PMU make reset the control mainboard
y013	Thyristor Fuse Off	y056	Paralel Reg -Command Signal Error 3
y015	Short Circuit Failure	y057	Paralel Reg -PMU Close the RL1 Relay
y016	user switch the by pass via remote controller	y058	Paralel Reg -PMU Close the RL2 Relay
y017	Over Temperature	y059	Paralel Reg -PMU – MB Communcation error bad packet
y018	Current Zero Failure Input Thyristor(SCR)	y060	Communication Error Between Mainboard and Frontpanel
y019	Current Zero Failure Output Thyristor	y061	Paralel Reg - Communication Error Between Frontpanel and PMU
y020	Current Zero Failure 1x number Thyristor	y062	Paralel Reg -ManualByPass is active in this device or other devices.
y021	Current Zero Failure 1 number Thyristor	y063	Mainboard have closed output cause of FP Other Phase Com Error (Single Transformer without Contactor)
y022	Current Zero Failure 2 number Thyristor	y064	Frontpanel - RMU Communication problem
y023	Current Zero Failure 3 number Thyristor	y070	The Phase did not pass Energy Saver Mode cause of other phases
y024	Current Zero Failure 4 number Thyristor	y071	The Phase did not pass Energy Saver Mode cause of Load Higher Than %100 in bypass Mode

y025	Current Zero Failure 5 number Thyristor	y072	The Phase is ByPass Mode cause of Other Phase and Phases did not communication with frontpanel
y026	Current Zero Failure 6 number Thyristor	y073	The Phase is ByPass Mode cause of Other Phase and Phases was not same output mode.
y027	Current Zero Failure 7 number Thyristor	y074	MCCB with motor or Contactor does not work with Mainboard Command Short Circuit Command
y028	Current Zero Failure 8 number Thyristor	y075	MCCB with motor or Contactor does not work with Mainboard Command Open Circuit Command
y029	Current Zero Failure 9 number Thyristor	y101	Paralel Reg -PMU does not connect other device
y030	Thyristor Open Circuit Failure 1x number Thyristor	y102	Paralel Reg -PMU – MB L1 Phase communication Error
y031	Thyristor Open Circuit Failure 1 number Thyristor	y103	Paralel Reg -PMU – MB L2 Phase communication Error
y032	Thyristor Open Circuit Failure 2 number Thyristor	y104	Paralel Reg -PMU – MB L3 Phase communication Error
y033	Thyristor Open Circuit Failure 3 number Thyristor	y105	Paralel Reg -PMU – MB L1 Phase Command Error
y034	Thyristor Open Circuit Failure 4 number Thyristor	y106	Paralel Reg -PMU – MB L2 Phase Command Error
y035	Thyristor Open Circuit Failure 5 number Thyristor	y107	Paralel Reg -PMU – MB L3 Phase Command Error
y036	Thyristor Open Circuit Failure 6 number Thyristor	y110	Paralel Reg -PMU - Other PMUs closed the device
y037	Thyristor Open Circuit Failure 7 number Thyristor	y2xx	Special Product Error Codes
y038	Thyristor Open Circuit Failure 8 number Thyristor	y3xx	System hardware failures inform us
y039	Thyristor Open Circuit Failure 9 number Thyristor	y4xx	System hardware failures inform us
y040	Input Square Wave Low Failure	y9xx	Device Protect itself. Device will Wait “xx” minute
y041	input Square Wave High Failure		

## 14.2. Other Situations

### 14.2.1. Output voltage is not at desired level.

- Control the SETOUT setting in settings menu.
- Input voltage level might be out of range of allowed limits. If input voltage level is not within the limits desired output voltage cannot be generated.
- There can be a voltage measurement calibration problem. This can happen after a long period of device working time. See below explanation.

### 14.2.2. Front panel displaying wrong voltage values.

- Measure input and output voltages from the input and output terminals with a multimeter. Compare measured values with the front panel displayed values. A voltage measurement calibration on the mainboards might be required if there are more than 3 volts difference between multimeter measurement and front panel displayed values.
- Voltage calibration operation will require opening the covers of the device. Contact support department for detailed instructions.

### 14.2.3. Front panel displaying wrong load percentage value.

- Load percentage value shown on front panel is only for the electronic system to detect overloads. There can be up to 10% deviation from actual value.
- If the deviation is more than 10%, load calibration on mainboards is required. Contact support department for detailed instructions.

#### 14.2.4. Building lights are flickering.

- This problem occurs when device settings are not set properly.
- Contact support department to solve this problem.

#### 14.2.5. Comm Error string on the front panel.

- Front panel cannot communicate with mainboard.
- See fault codes table.

#### 14.2.6. Front panel is not displaying one or more of the voltage values.

- One or more of the regulation system components might be damaged.
- Contact support department.

### APPENDICES

#### 14.3. Appendix 1 - Input and Output Conductor Properties

- Below table contains information about the cross sectional area of the conductors to be connected to device terminals.
- Cross sectional area values indicated in this table are recommended minimum values.
- Find the conductor cross sectional area corresponding to your device power rating.
- Neutral and protective earth cable sizes are same with input phase cable sizes.
- Input and output conductor sizes are different because input and output voltage and currents are different.

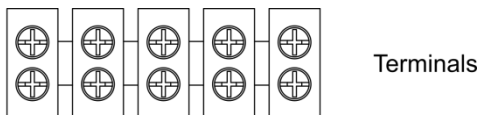
Power per phase (kVA)	Input Conductor Size (mm <sup>2</sup> )	Output Conductor Size (mm <sup>2</sup> )
3	5	3
5	8	6
8	14	10
10	20	15
15	30	23
20	40	30
30	61	45
40	81	61
50	101	76

#### 14.4. Appendix 2 - Input and Output Terminal Configurations

##### 14.4.1. General Rules

- Input conductors will be connected to terminals with label INPUT. Output conductors will be connected to terminals with label OUTPUT.
- Phase connection terminals are labeled as L.
- Neutral connection terminals are labeled as N or Neutral.
- Protective Earth connection terminal is labeled as PE.

##### 14.4.2. Screw Terminals



Terminals

INPUT	OUTPUT	PE
L	N	⊕

Labels

- Terminals and labels at the back of the device are shown above.

- Terminal screw diameter might change according to device power. Measure terminal screw diameters and determine the tightening torque value from Appendix 3.
- Stranded wires must be crimped with cord end terminals before connecting to screw terminals.

#### Appendix 3 - Tightening Torque Values

- Diameter row on the below table indicates the diameter of the bolt or screw in millimeter.

Diameter	Tightening Torque (N.m)
M3	1.14
M3.5	1.8
M4	2.7
M4.5	3.9
M5	5.4
M6	9.2

Diameter	Tightening Torque (N.m)
M7	15
M8	22
M10	44
M12	76
M14	122
M16	190

#### 14.5. Appendix 4 - Enclosure Protection Class

##### 14.5.1. IP Protection Class

Level	First digit identifies the protection level against solid objects.	Second digit identifies the protection level against liquids
0	No protection	No protection
1	Protection against objects larger than 50 mm.	Protection against liquid dripping from above.
2	Protection against objects larger than 12.5 mm.	Protection against liquid dripping from above when device is inclined towards any side at 15° or more.
3	Protection against objects larger than 2.5 mm.	Protection against spray of liquid from above when device is inclined towards any side at 60° or more.
4	Protection against objects larger than 1 mm.	Protection against liquid that sprayed or poured from any angle to the device.
5	Limited protection against objects as small as dust particles.	Protection against liquid that sprayed with a 6.3 mm radius nozzle to the device from any angle.
6	Full protection against objects as small as dust particles.	Protection against liquid that sprayed with a 12.5 mm radius nozzle with pressure to the device from any angle.

##### 14.5.2. Example:

IP20 protection class indicates that device has protection against only solid objects larger than 12.5 mm. There is no protection against liquids.



**AGKK15130**