EQUIPMENT CATALOG

ON-LINE CONDENSIVE BUSHING MONITOR

Treetech

On-line Condensive Bushing Monitor

Condensive bushings are accessories applied on high and extra-high voltage equipment, such as power transformers, shunt reactors and high voltage circuit breakers. In general, despite the equipment's individual cost being relatively low as compared to the overall cost of the equipment to which it is attached, a failure in the bushing's insulation can bring about severe damage to the equipment.

Capacitance and dissipation factor (tangent delta) are important factors in the early detection of deterioration of the insulation in bushings, current transformers and other apparatus.

The Treetech's Bushing Monitor BM allows these parameters to be monitored on-line during regular operation. This condition based assessment technique allows potentially catastrophic failures to be avoided, by detecting problems while still in the incipient phase.

Main features

AUTONOMOUS MONITORING SYSTEM

Installed on the machine body (transformer, reactor), BM does not require the installation of computers and / or special software for operation.

ROBUST HARDWARE

BM project exceeds EMC (Electromagnetic Compatibility) standards to withstand severe electromagnetic substation conditions and operating temperature of -40 to 85 °C.

SPARE BUSHINGS OPERATION

Spare bushings pre-programmed for operation in case of single-phase transformer banks.

PROTECTION AGAINST TAP OPENING

Indicator alarm of activity to protect against the opening of the bushing TAP.

DISPLAY INDICATION

Current values of capacitance (C1), tangent Delta (C1), trends of capacitance and delta tangent evolution, prediction of time to reach alarm values, line and phase voltages, leakage currents, and temperature measurements on the display.

TAP ADAPTERS

Connection through adapters to test or voltage TAPs of capacitive bushings, plus innovative monitoring capability through DPBs (Bushing Potential Devices).

VOLTAGE SUPPLY

Universal voltage input, 38 to 265 Vdc / Vac.

MODULAR SYSTEM

Configurable for monitoring of 3, 6 or 9 bushings.

INPUT FOR TEMPERATURE SENSORS

Inputs for two temperature sensors Pt-100 at 0 °C, allowing recording and correlation of variations in insulation with the oscillations of the ambient temperature, the oil, or others.

ALARM TIMING

High or very high bushing leakage current alarms with adjustable timing, identifying defects of fast or very fast evolution and reducing the risk of catastrophic failures.

Main features

SELF-DIAGNOSIS

Verification of the consistency of high and very high leakage current alarms by measuring the sum of currents, with blocking of undue alarms and indication of self-diagnosis in case of inconsistency detection.

OUTPUT CONTACTS

Eight output contacts, 1 fixed (NC) for self diagnosis, and seven configurable (5 NO and 2 NC) for alarms by absolute values, high evolution trends or low leakage curents. Operation mode programmable NO or NC.

DATA HISTORY

Internal clock and non-volatile memory for storage of history of capacitance and tangent delta data and alarm events.

SIMPLIFIED PROGRAMMING

Simplified programing divided into basic settings (sufficient for most applications) and advanced parameters. User password protected programming menu

AUTOMATIC ALARM SETTING

Automatic adjustment of alarm values for high or very high leakage currents during the learning period, with user-programmed safety margin in percentage.

ANALOG OUTPUTS

Two programmable analog outputs for remote readings of capacitances and tangent delta. Configurable output range: 0...1mA, 0...5mA, 0...10mA, 0...20mA or 4...20mA.

SERIAL COMMUNICATION

Serial communication port selectable RS485 or RS232 with Modbus RTU and DNP3 protocols.

OTHER COMMUNICATION TYPES

Communication via fiber optic cable, using external electrical-optical converter.

REDUCED SIZES

Despite its advanced features, the Bushing Monitor is extremely small in size, 96x96x161 mm

Operating Philosophy

The constructive structure of condensive bushings gives rise to the appearance of a capacitance between the bushings central conductor and ground, as shown in figure 1.

Once the bushing has been energized, this capacitance allows the passage of a leakage current to ground, 90° ahead of the voltage as shown in figure 2. In this same figure, we can see that, due to losses in the dielectric, this leakage current also has a resistive component, in phase with the voltage.

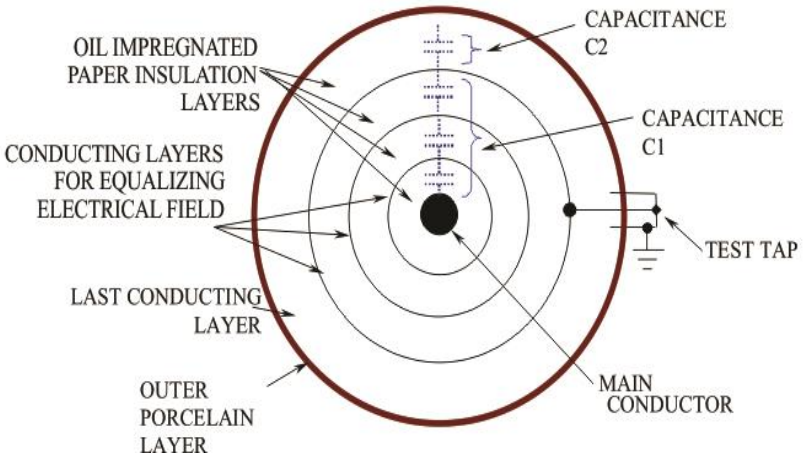


Figure 1 – Constructive form of a capacitive bushing

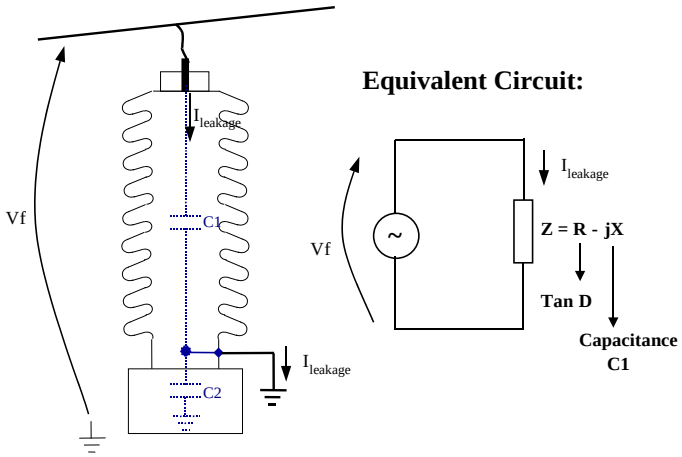


Figure 2 - Equivalent circuit of an energized capacitive bushing

We then have that any change in these two insulation parameters of the bushing (capacitance and tangent delta) causes a corresponding change in the leakage current (capacitive and resistive component respectively).

BM System Topology

The BM bushing monitoring system has a modular conception, and is composed of three basic parts:

ADAPTER FOR TEST TAP OR VOLTAGE TAP

Provides the electric connection to the tap of the bushing, also ensuring its mechanical rigidity and weatherproofing seal. It incorporates protection against overvoltages and overcurrents due to transient phenomena and also against accidental opening of the measuring circuit, preventing the tap from remaining open. This protection can provide a low impedance path for the leakage current for unlimited time. In case of operation, the Measurement Module closes its autodiagnostic contact and the Interface Module provides visual alarm besides closing the user programmed contacts.

MEASURING MODULE BM-MM

Receives the leakage currents from the three bushings in a three-phase set, carries out measuring of these currents and a first level of mathematical and statistical processing of the information, making this data available to the Interface Module (BM-HMI) through a serial communication port RS485.

INTERFACE MODULE BM-HMI

Receives information from one, two or three measuring modules (BM-MM) and carries out their mathematical and statistical processing, making the results available as the current values for capacitance and tangent delta for each bushing displaying these on the front panel displays.

Technical data

Interface Module BM-HMI

Condition	Interval / Description
Power supply	85 a 265 Vac/Vdc – 50/60 Hz
Maximum consumption	< 8 W
Operating temperature	- 40 to + 85 °C
Protection degree	IP 20
Connections – Removable terminals	0,3 to 2,5 mm², 22 to 12 AWG
Fixation	Panel fixation

Temperature measurement	
Sensor	Pt100Ω at 0 °C with ongoing self-calibration
Measurement range	-55 to +200 °C
MAximum error at 20 °C	0,2% of full scale
Deviation for temperature variation	20 ppm/°C
Connection options	Up to 2 three wire sensors

Outputs	Interval / Description
Output relays	Potential free contacts
Type and functions (standard)	5 NO (configurable) + 3 NC (2 configurable + 1 self-diagnosis)
Maximum switching power	70 W(dc) / 220 VA(ac)
Maximum switching voltage	250 Vdc / 250 Vac
Maximum conduction current	5 A
Analog outputs	2 programmable with common positive
Maximum error	0,5 % of full scale
Output range	Programmable (0-1,0-5,0-10,0-20 e 4-20mA)
Maximum load	0...1 mA , 10 kΩ 0...5 mA , 2 kΩ 0...10 mA , 1 kΩ 0...20 mA , 500 Ω 4...20 mA , 500 Ω

Communication	
Serial communication ports	1 RS-485 for BM-MM + 1 RS-485/RS-232 for supervisory
Communication protocols	Modbus-RTU and DNP3

Memory	
Mass memory	Non-volatile, FIFO (First in first out) type
Capacity	712, 420 or 297 records (for 1, 2 or 3 BM-MM connected)
Recording interval	1 to 720 hours

TAP Adapter

The mechanical construct for the tap adapter varies in accordance with the model and manufacturer of the bushing. Tap adapters are equipped with protection against opening of the tap thus preventing the occurrence of hazardous voltage levels in case of disconnection of the cable that takes leakage currents to the Measurement Module.

Condition	Interval / Description
Maximum voltage developed with disconnection of cables	14 ± 2 Vac
Permanent conduction cap. at 125°C w/ cables disconnected	2 x 250 mA (*redundant protection*)
Operating temperature	-25 to +120 °C
Protection degree	IP 65 (NEMA 4)
Cable section	0.3 to 1.5 mm² (22 to 14 AWG)
Maximum tightening torque	15 N.m
Maximum vertical load	20 kg

Measurement Module BM-MM

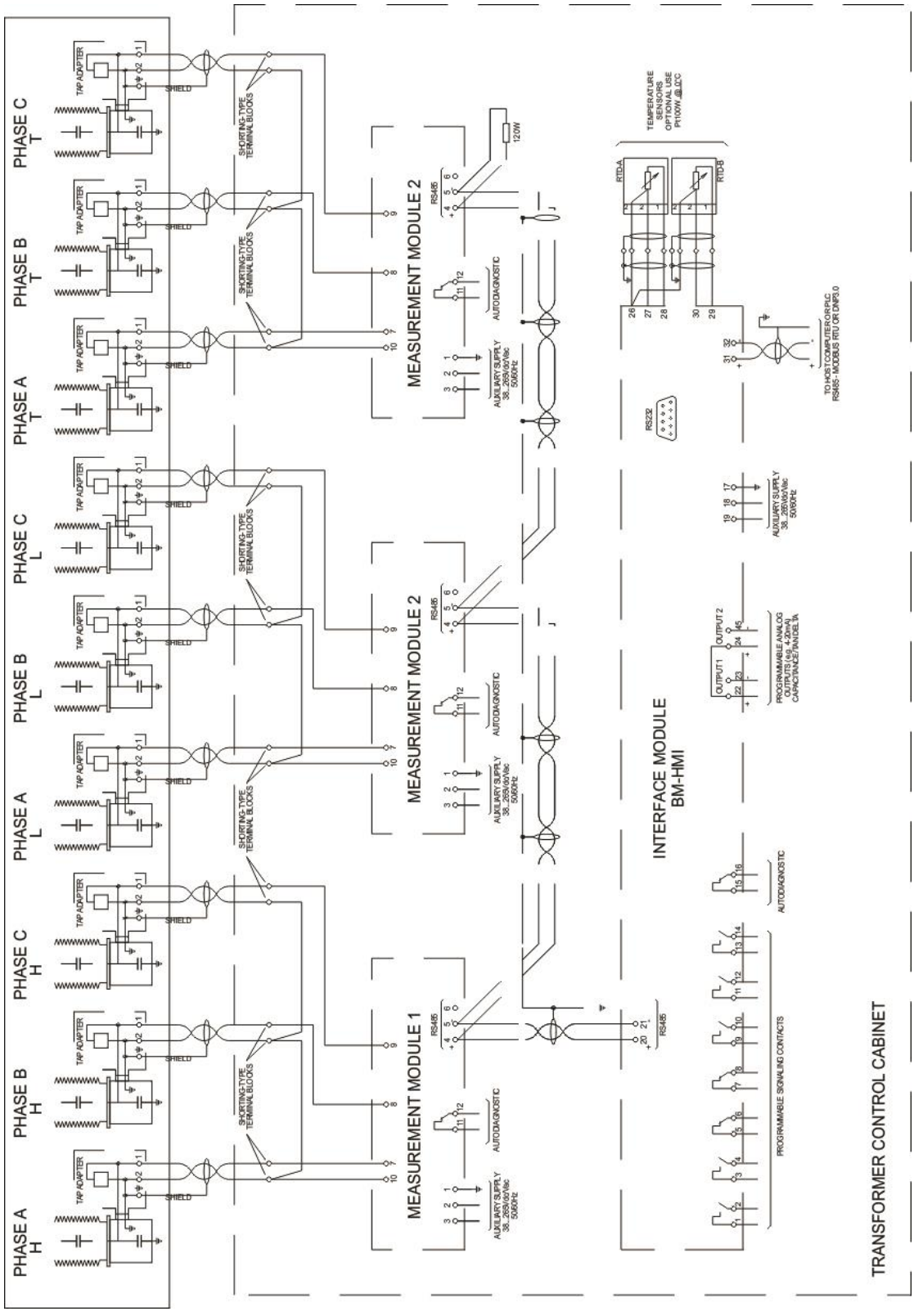
Condition	Interval / Description
Power supply	85 to 265 Vac/Vdc – 50/60 Hz
Maximum consumption	5 W
Operating temperature	- 40 to + 85 °C
AC current measurement inputs	3 for bushing leakage currents (0...100mA)
Protection degree	IP 20
Fixation	DIN rail mounting 35 mm
Serial communication port	RS485 for connection to BM-HMI
Connections (except mA inputs)	0,3 to 2,5 mm², 22 to 12 AWG
Connections (mA inputs)	1,5 to 2,5 mm²,16 to 12 AWG using appropriate eye type terminals

Monitored magnitudes	
Capacitance	0...6500 pF
Tangent delta	0...9,999%

Outputs	Interval / Description
Output relays	1 NC for self-diagnosis
Maximum switching power	70 W(dc) / 220 VA(ac)
Maximum switching voltage	250 Vdc / 250 Vac
Maximum conduction current	5 A

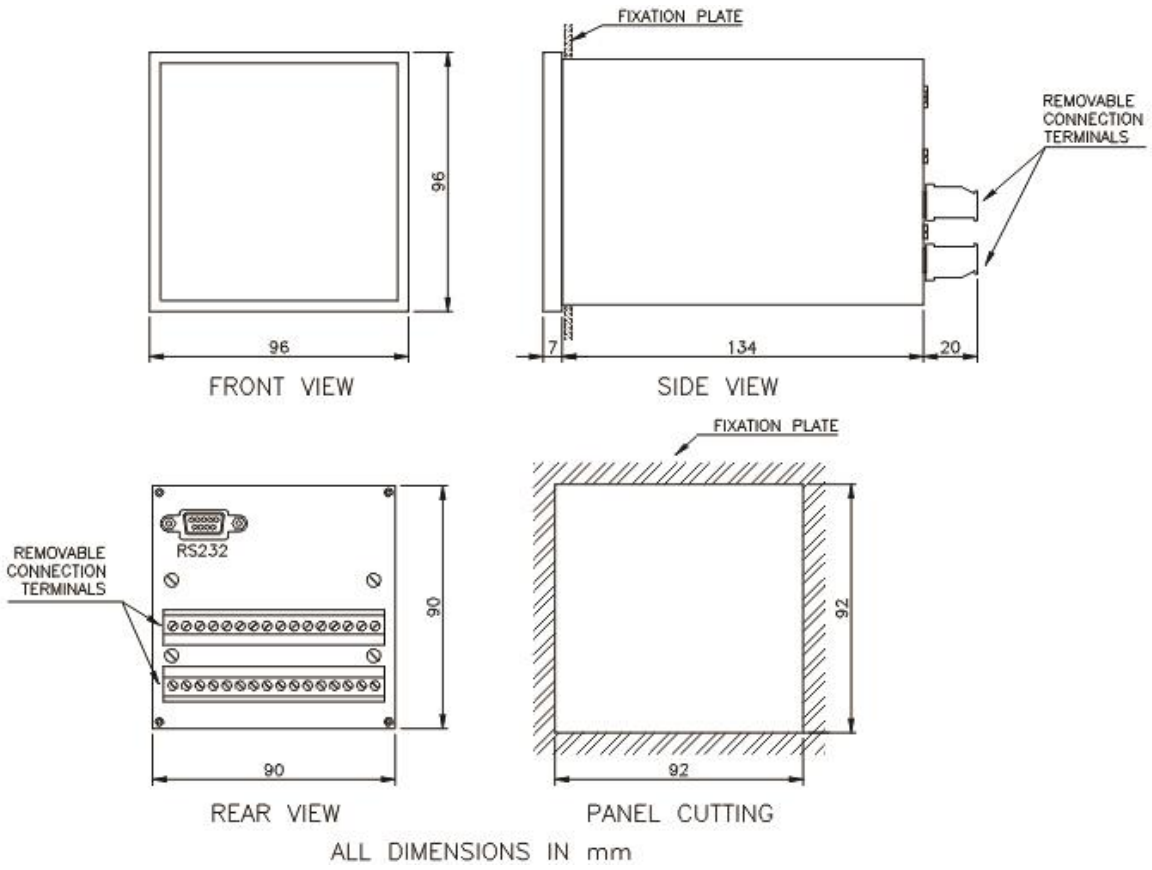
Connection diagram

Example of application to a three-phase transformer monitoring 3 sets of bushings. It is also possible to monitor bushings on single-phase transformer banks.

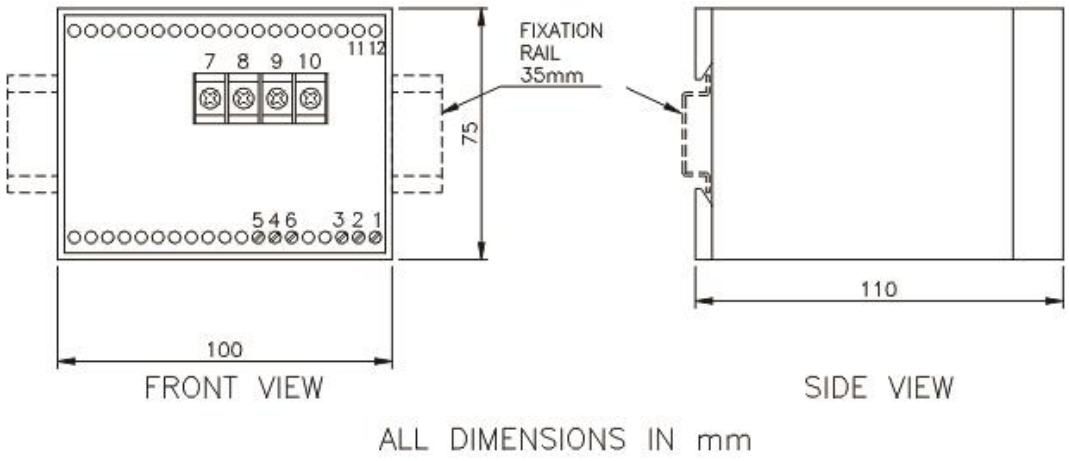


Dimensions

Interface Module BM-HMI

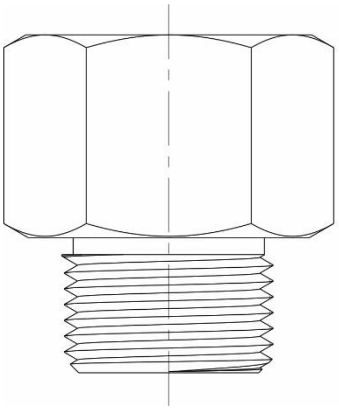


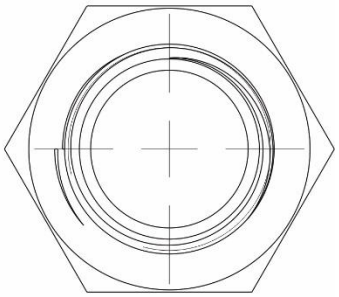
Measurement Module BM-MM



Accessories

- ✓ **Thread adapter BSPxPG**





FEATURES	
Material	Nickel-plated brass
Male thread	PG11
Female thread	BSP ½”

Order specifications

The BM Bushing Monitor is a universal equipment, having its characteristics selected in its programming menus through its front panel or the RS-232 or RS-485 ports. The power input is universal.

Thus, in the purchase order of the device only it is necessary to specify:

- ✓ Quantity of BM-MM Measurement Modules (with each BM-MM receiving signals from 3 bushings on a three-phase set);
- ✓ Number of BM-HMI Interface Modules (each BM-HMI can be connected from one to three BM-MM Measurement Modules);
- ✓ Number of TAP adapters with respective manufacturers, bushing models and types of tap (test or voltage).

Order specification example:

For one transformer (or bank of transformers) where is necessary to monitor three 500 kV and three 230 kV bushings the order specification could be:

- ✓ 2 BM-MM Measurement Module;
- ✓ 1 BM-HMI Interface Module;
- ✓ 3 Tap adapters for bushings ABB brand, type GOE with voltage tap;
- ✓ 3 Tap adapters for bushings Trench brand, type COT with test tap.

Type testing

Immunity to surges (IEC 60255-22-5)	
Differential mode	1 kV, 5 per polarity (+/-)
Common Mode	2 kV, 5 per polarity (+/-)
Immunity to Electric Transients (IEC 60255-22-1 and IEEE C37.90.1)	
Peak value of 1st cycle	2,5 kV
Frequency	1,1 MHz
Time and repetition rate	2 seconds, 400 surges/s
Decay to 50%	5 cycles
Voltage pulse (IEC 60255-5)	
Wave form	1,2 / 50 s
Amplitude	5 kV
Pulse number	3 negative and 3 positive, interval 5 s
Applied voltage (IEC 60255-5)	
Bearable voltage at the industrial frequency	2 kV 60Hz 1 min. against ground
Immunity to irradiated electromagnetic fields (IEC 61000-4-3 and IEC 60255-22-3)	
Frequency	26 to 1000 MHz
Field intensity	10 V/m
Immunity to conducted electromagnetic disturbances (IEC 60255-22-6)	
Frequency	0,15 to 80 MHz
Field intensity	10 V/m
Electrostatic discharges (IEC 60255-22-2 and IEEE C37.90.3)	
Air mode	8 kV, 10 discharges/polarity
Contact mode	6 kV, 10 discharges/polarity
Immunity to rapid electric transients (IEC60255-22-4 and IEEE C37.90.1)	
Power supply, inputs and outputs	4 kV
Serial communication	2 kV
Damp heat, cyclic: (IEC 60068-2-14)	
Temperature range	-40 to +85 °C
Total test time	96 hours
Vibration response (IEC 60255-21-1)	
Application	3 axis (X, Y and Z), sinusoidal
Amplitude	0,075 mm, 10 to 58 Hz 1 G, 58 to 150 Hz
Time	160 min/axis
Vibration resistance (IEC 60068-2-2)	
Application mode	3 axis (X, Y and Z), sinusoidal
Frequency	10 to 150 Hz
Intensity	2 G
Time	160 min/axis

BRAZIL
Treetech Sistemas Digitais Ltda
Praça Claudino Alves, 141, Centro
CEP 12.940-000 - Atibaia/SP
+ 55 11 2410-1190
comercial@treetech.com.br
www.treetech.com.br