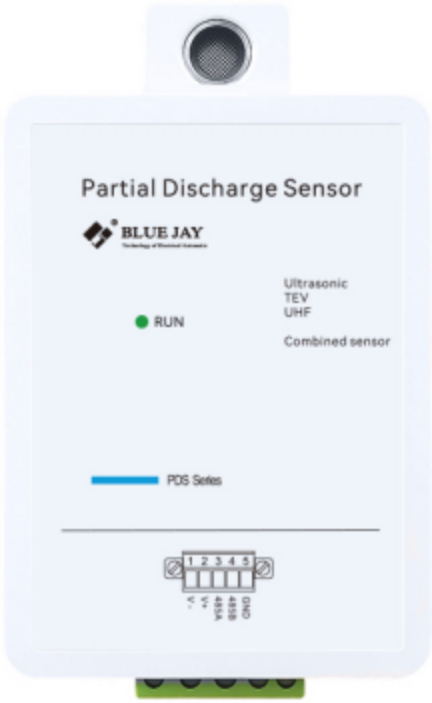
SCM-PDS3
Partial Discharge Sensor

User Manual



Version:1.11

Revision: 2025.08

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Read me

When you use SCM-PDS3 partial discharge sensor, be sure to read this user manual carefully, and be able to fully understand the implications, the correct guidance of operations in accordance with user manual, which will help you make better use of SCM-PDS3 partial discharge sensor, and help to solve the various problems at the scene.

1. Always keep safe distance between the high voltage part and the instrument, probe and operator.

2. Measurements must not be taken when thunderstorms are nearby.

3. Do not operate the instrument or accessories in explosive atmospheres.

4. After the battery alarm of the instrument, please turn off the power to charge.

5. Do not open the instrument without permission, this will affect the warranty of the product. The factory is not responsible for self-disassembly.

6. When the instrument is transported, it should avoid rain erosion and prevent collision and falling.

7. When storing and keeping the instrument, attention should be paid to the ambient temperature and humidity, and it should be protected from dust, moisture, shock, acid, and corrosive gas.

- **Please read this user manual carefully**
- **Please save this document**

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Directory

1.- SUMMARIZE

Partial discharge sensors are critical for assessing power equipment insulation integrity. PD signals (weak electrical pulses) serve as early indicators of insulation deterioration, which can escalate into catastrophic failures if undetected. The SCM-PDS3 sensor integrates three PD detection methods: Ultrasonic (AA), Transient Earth Voltage (TEV), and Ultra-High Frequency (UHF) delivering a comprehensive monitoring solution for medium/high-voltage equipment including transformers and switchgears.

Additionally, it incorporates ambient noise, temperature, and humidity monitoring to eliminate environmental interference and enhance diagnostic accuracy. Compact and highly portable, the PDS3 features rapid measurements, exceptional anti-interference capability, and supports data upload via its integrated RS-485 interface, making it an all-in-one solution for field-based condition assessment.

FEATURES

- Rugged, compact design;
- Non-intrusive detection method;
- Strong magnets to attach sensor;
- Rapid detection of partial discharge conditions;
- Suitable for extreme environment, outdoor substation;
- Measures PD in high-frequency UHF range;
- Ensures sensitive PD measurements in noisy environments;
- RS485, Modbus-RTU, SCADA systems.

APPLICATIONS

- Substations, switchgear, transformers;
- Large-scale power generation facilities;
- Photovoltaic inverters, collector lines;
- Key motors, power distribution systems;
- UPS systems, key distribution cabinets, bus ducts;
- Commercial center power distribution.

2.- TECHNICAL SPECIFICATION

Sensor common	
Power supply	24VDC
Static power consumption	<10mW
Installation method	4* strong magnet, wall mount
Data sampling period	1S
PD pattern refresh period	2S
Communication	RS485/ Modbus RTU
Dimension	134mm*100*42mm
Operating temperature	-40~85°C
Ultrasonic sensor (AA)	
Detect range	0 ~ 60dBμV
Resolution / Accuracy	1dBμV
Pass band	Center frequency 40 kHz, ±1 kHz
TEV sensor	
Detect range	0~60dBmV
Pass band	3~100MHz
Resolution / Accuracy	1dBmV / ±1dBmV
UHF sensor	
Detect range	-70~10dBm
Pass band	300~1500MHz
Average effective height	≥10mm
Environmental sensors	
Noise detection range	30~80dB (Class C)
Temp. measurement range	-40~85°C; Accuracy±0.5°C
Humidity measurement range	5~95%RH°; Accuracy ±2%RH

3.- FUNCTION INTRODUCTION

3.1.- PD measurement technology introduction

-. Ultrasonic measurement (AA)

Partial discharges generate acoustic signals (20-200kHz) through mechanical stress oscillations in dielectrics. This sensor employs piezoelectric ceramic elements to detect vibrations via surface coupling with cabinet structures. Maintaining intimate contact with the cabinet surface is essential for optimal acoustic wave transmission efficiency, making it suitable for surface discharge monitoring in switchgear.

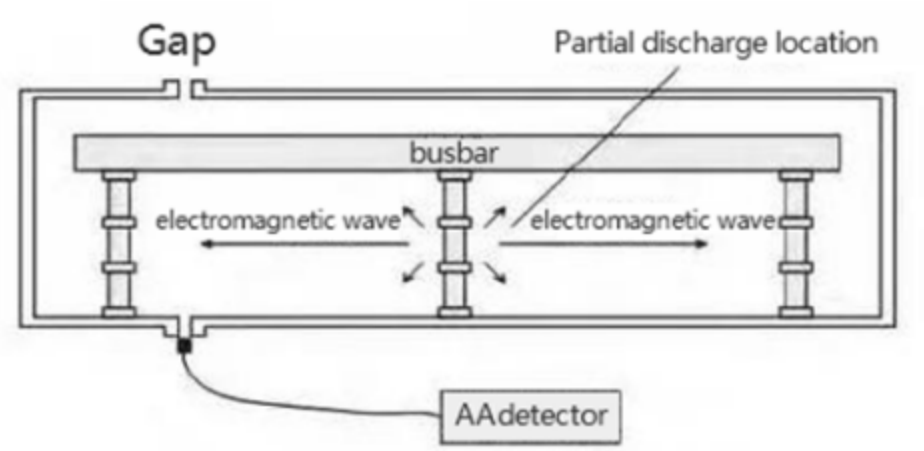


Figure 1. Ultrasonic detection mechanism

Insulation condition of switchgear:

Data	Definition
-6~0dBμV, no discharge sound	No partial discharge.
0 ~ 60dBμV, short discharge sound	Slight discharge, and attention should be paid to it later.
Above 60dBμV, have discharge sound	Obvious discharge, should be judged in combination with TEV.

Note:

The demarcation point (60dBμV) is slightly different in different regions, so it is recommended to use 60dBμV as the demarcation point, so that the operating status of the switchgear can be warned in advance.

-. TEV measurement

Partial discharges excite 3-100MHz electromagnetic waves on metal cabinet surfaces, which convert to Transient Earth Voltage (TEV) at insulation discontinuities. Utilizing capacitive coupling sensors for non-intrusive signal acquisition, TEV amplitude correlates with discharge magnitude and attenuation along the propagation path. This method is specifically designed for surface discharge detection in metal-enclosed equipment.

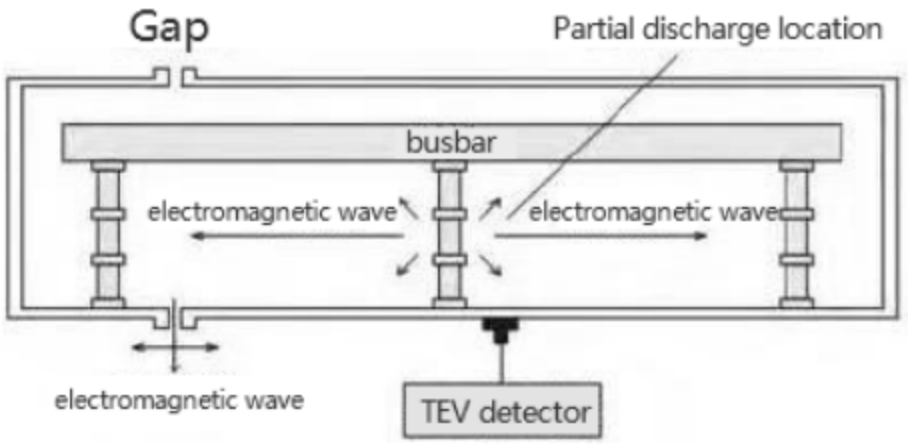


Figure 2. TEV detection mechanism

Insulation condition of switchgear:

Data	Definition
The reading is <20dB.	No partial discharge,
The reading is 20-29dB.	Slight discharge.
The reading is 29-40dB.	Moderate partial discharge should report and shorten the inspection cycle.
The reading is 40-50dB.	Serious partial discharge should report and shorten the inspection cycle, and be checked when power failure.
The reading is 50-60dB.	Severe partial discharge, power outage and maintenance as soon as possible.

-. UHF measurement

This technique detects nanosecond-scale discharge pulses (<1ns rise time) by capturing 300MHz-3GHz electromagnetic waves, effectively avoiding corona interference below 300MHz. With high sensitivity and anti-interference capabilities, UHF enables discharge source localization and insulation defect classification. It is particularly effective for internal discharge detection in power transformers and other dielectric media, mitigating the bandwidth constraints of acoustic and TEV methods.

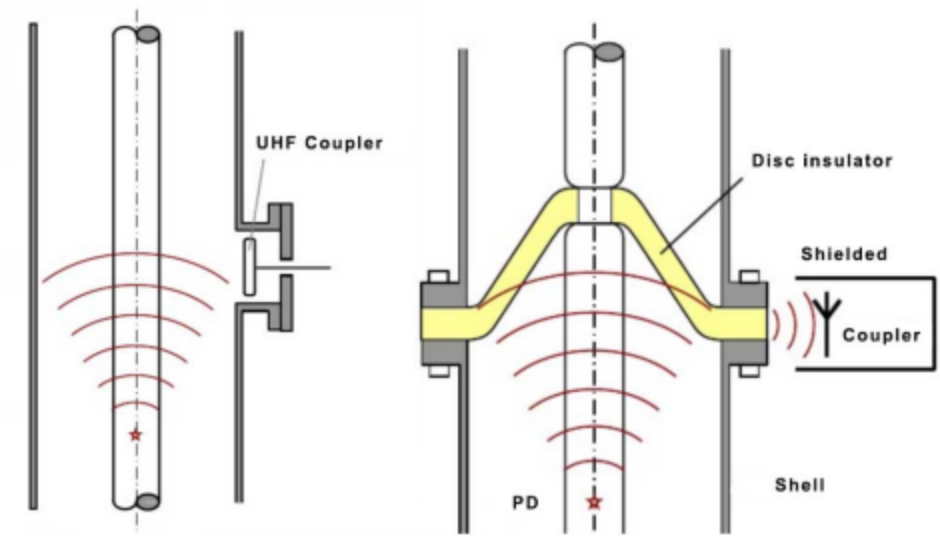


Figure 3. UHF detection mechanism

Note:

All the above sensors are connected through the sensor extension port at the bottom of the host. When the sensor is connected through the same extension port, the host will automatically identify the sensor type, select the sampling channel of the corresponding frequency, and display the relevant parameters of the sensor on the top of the interface.

3.2.- PD Pattern analysis function introduction

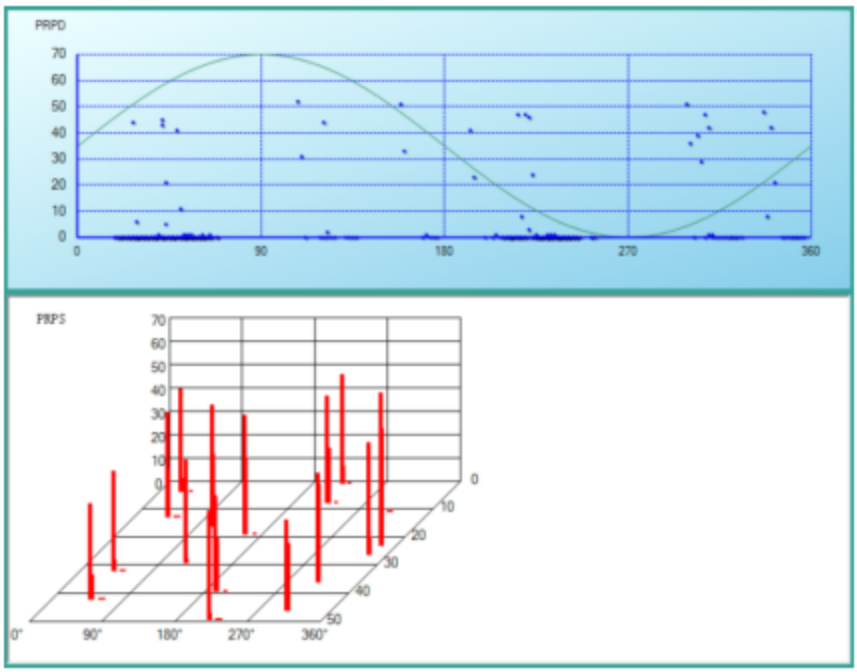
This device enables real-time data acquisition and pattern upload, the internal refresh frequency is 2 seconds. When monitoring data triggers an alarm, alarm validity verification is performed via:

PRPD patterns: (2D phase-amplitude mapping for discharge phase distribution analysis)
PRPS patterns: (3D phase-time-amplitude mapping for pulse sequence evolution analysis)

Patterns are constructed from 1-second data packets, each comprising 50 cycles of 50Hz power frequency. Through analysis of discharge cluster morphology and phase correlation characteristics, the system can distinguish genuine partial discharges from electromagnetic interference and diagnoses insulation defects including corona, surface discharge, and internal voids, Typical pattern examples are shown below:

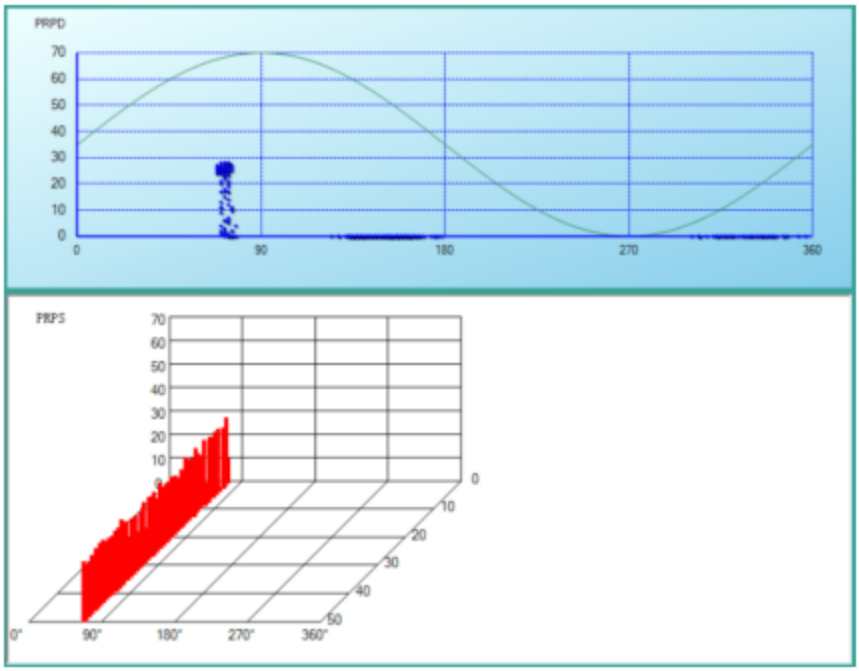
-. Non-periodic discharge patterns

Characterized by high-amplitude discharges with weak correlation to 50Hz/100Hz phases, requiring closer scrutiny for potential floating discharge or random noise sources.



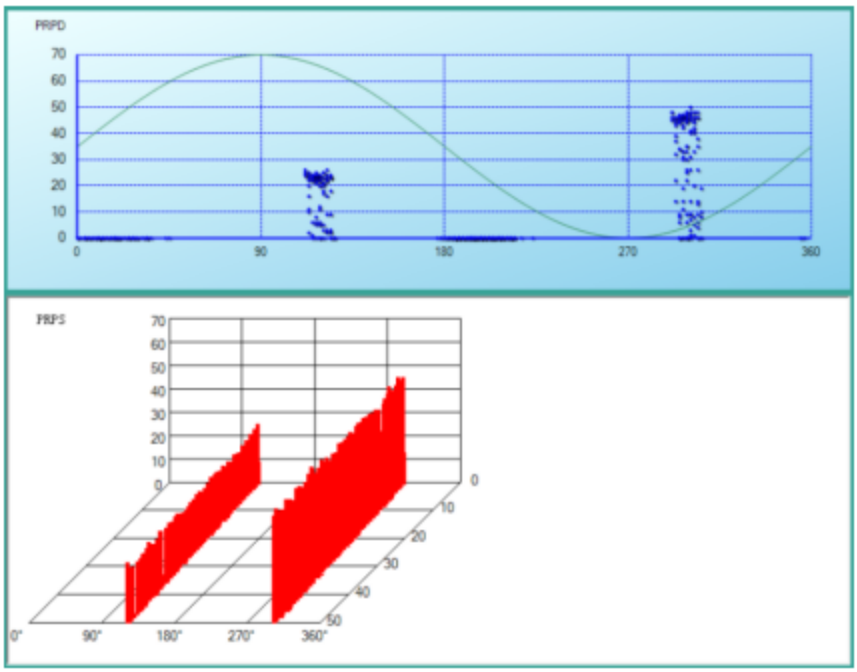
-. Power-frequency synchronous patterns (50Hz)

Exhibits one discharge cluster per power frequency cycle, demonstrating typical power-frequency correlated features analogous to corona discharge (e.g., sharp electrode emissions).



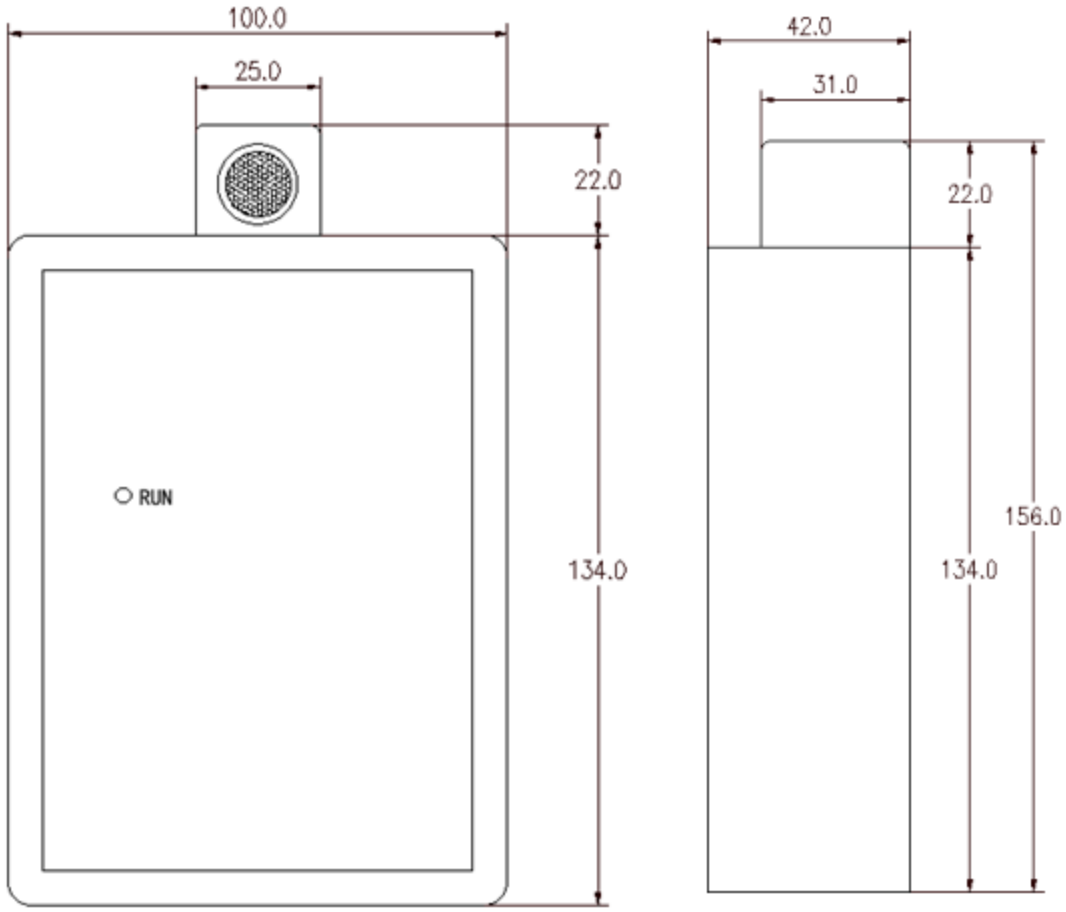
-. Harmonic-synchronous patterns (100Hz)

Shows two discharge clusters per power cycle phase-separated by 180°, indicating strong 100Hz harmonic correlation consistent with internal voids or surface tracking discharges.



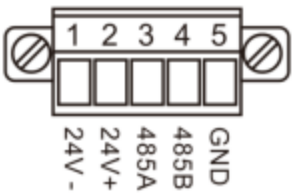
4.- INSTALLATION AND START-UP

4.1.- Dimension



Front view **Side view**

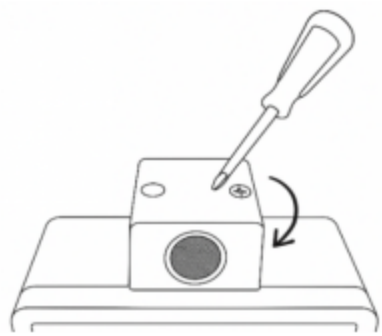
4.2.- Terminal definition



No.	Marked	Notes
1-2	**24V +/ -**	Power supply
3-4	**RS485 +/ -**	Communication interface
5	**GND**	Grounding

4.3.- PD sensor mounting method

The sensor is equipped with a highly sensitive microphone on top to collect ultrasonic signals from the switchgear. Depending on the application scenario, the microphone's orientation can be adjusted for optimal detection results, by default, the sensor is factory-set to face forward.



Method-1: Mounting on switchgear surface

When sensor is mounted on switchgear surface, the microphone must be rotated close to the cabinet, ensuring closely contact. that can enable the microphone to effectively capture ultrasonic signals.

Method-2: Mounting on switchgear inside

When sensor is mounted inside the switchgear, the microphone must face the switchgear interior to directly receive the ultrasonic signals.

5.- COMMUNICATION INTERFACE

This document defines the communication protocol specification of SCM-PDS3, please strictly follow this communication protocol to connect with the device. Baud rate: 9600; data bits: 8; parity bit N; stop bit: 1.

5.1.- MODBUS © protocol

Modbus RTU Frame Format:

Host inquiry:

Address code	**1 BYTE**	Slave device address **1-247**
Function code	**1 BYTE**	Function codes
Data code	**4 BYTES**	Starting address, high byte Starting address, low byte Number of registers, high byte Number of registers, low byte
Error Check code	**2 BYTES**	Cyclical Redundancy Check (**CRC**)

Slave response:

Address code	**1 BYTE**	Slave device address **1-247**
Function code	**1 BYTE**	Function codes
Data length	**N**	Total data length
Data range	**-**	Data Area
Error Check code	**2 BYTES**	Cyclical Redundancy Check (**CRC**)

MODBUS FUNCTIONS

Code	Meaning	Description
FUNCTION 03	**Read holding register**	Read device setting data
FUNCTION 04	**Read input register**	Read device measurement data
FUNCTION 06	**Write single register**	Writes a value into a single holding register.
FUNCTION 10	**Write multiple register**	Writes values into multiple holding registers
FUNCTION 64	**Read TEV value**	Read TEV value and phase angle
FUNCTION 65	**Read AA value**	Read AA value and phase angle
FUNCTION 66	**Read UHF value**	Read UHF value and phase angle

Note:

Starting address:0X0000, the first byte is the high bit, and the second byte is the low bit.

5.2.- Register Map

5.2.1.- Reading the setting value, read only, Fun 03 to read.

Reg.	Byte mode		Definition
00x00	INT	1	Device address
00x01	INT	1	Baud rate: 1: 4800; 2:9600 **(Default)** 3:19200; 4:38400; 5:115200
00x02	INT	1	AA setting value
00x03	INT	1	TEV setting value
00x04	INT	1	UHF setting value

5.2.2.- Reading collected values from the device, read only, Fun 04 to read.

Reg.	Data	Byte mode		Value range
00x00	AA discharge times	INT	1	0-4095
00x01	AA discharge amplitude	INT	1	0~60,unit: dBuV
00x02	AA discharge average value	INT	1	0~60,unit: dBuV
00x03	AA alarm status	INT	1	0-normal; 1-alarm
00x04	TEV discharge times	INT	1	0-4095
00x05	TEV discharge amplitude	INT	1	0~60,unit: dBmV
00x06	Environmental noise value	INT	1	0~60, unit: dBmV
00x07	TEV alarm status	INT	1	0-normal; 1-alarm
00x08	UHF discharge times	INT	1	0-4095
00x09	UHF discharge amplitude	INT	1	-70~10,unit: dBm
00x0A	UHF discharge average value	INT	1	-70~10,unit: dBm
00x0B	UHF alarm status	INT	1	0-normal; 1-alarm
00x0C	Noise value	INT	1	30~80, unit: dB
00x0D	Temperature	INT	1	-40~85, unit: °C
00x0E	Humidity	INT	1	5~95, unit: %RH

Note:

UHF related values read from register are stored in **16-bit two's complement format**; positive numbers represent themselves, while negative numbers must be converted from two's complement to signed decimal to obtain the actual value.

5.2.3.- Writing the single setting value, write only, Fun 06 to write.

Reg.	Byte mode		Definition
00x00	INT	1	Device address
00x01	INT	1	Baud rate: 1: 4800; 2:9600 **(Default)** 3:19200; 4:38400; 5:115200
00x02	INT	1	AA setting value
00x03	INT	1	TEV setting value
00x04	INT	1	UHF setting value

5.2.4.- Writing the multiple setting value, write only, Fun 10 to write.

Reg.	Byte mode		Definition
00x00	INT	1	Device address
00x01	INT	1	Baud rate: 1: 4800; 2:9600 **(Default)** 3:19200; 4:38400; 5:115200
00x02	INT	1	AA setting value
00x03	INT	1	TEV setting value
00x04	INT	1	UHF setting value

Notes:

1.- Initial alarm trip logic (any one condition met):

When AA threshold is set to 30 dBμV and the simultaneous discharge count exceeds 10 pulses.
When TEV threshold is set to 30 dBμV and the simultaneous discharge count exceeds 10 pulses.
When UHF threshold is set to -30 dBm and the simultaneous discharge count exceeds 10 pulses.

2.- UHF negative threshold values (e.g., –30 dBm) must be converted to 16-bit two's complement format before writing to the register.

3.- Noise value refers to the environmental noise value, only for user reference, not to participate in the calculation of AA and TEV measurement value.

5.2.5.- Read PD pattern data, read only, Fun 64, 65, 66 to read.

Phase angle range: 0-200, with a phase resolution of 1.8°.

Each data point is stored in one register: the high 8 bits (H8) represent the phase angle (which should be multiplied by 1.8° to get the actual value), and the low 8 bits (L8) represent the discharge amplitude.

Function 64 to read TEV pattern data: amplitude value range: 0~60.

Register	Definition
0	Sample point 1 H8: Phase angle; L8: Discharge amplitude
1	Sample point 2 H8: Phase angle; L8: Discharge amplitude
…	
499	Sample point 500 H8: Phase angle; L8: Discharge amplitude

Function 65 to read AA pattern data: amplitude value range: 0~60.

Register	Definition
0	Sample point 1 H8: Phase angle; L8: Discharge amplitude
1	Sample point 2 H8: Phase angle; L8: Discharge amplitude
…	
499	Sample point 500 H8: Phase angle; L8: Discharge amplitude

Function 66 to read UHF pattern data: amplitude value range: 0~80.

Register	Definition
0	Sample point 1 H8: Phase angle; L8: Discharge amplitude
1	Sample point 2 H8: Phase angle; L8: Discharge amplitude
…	
499	Sample point 500 H8: Phase angle; L8: Discharge amplitude

Note: UHF range is -70 dBm to 10 dBm. During parsing: Actual = L8 - 70.
Example: L8 = 60 → Actual is 60-70 = -10 dBm.

Command example:

Host inquiry	01 65 00 00 01 F4 4D D5
Slave response	01 65 03 E8 10 00 10 00 10 00 10 00 10 00 74 3C 78 35 8C 22 8C 00 8C 00 …… 42 69

Message description:

01 = device address, **65** = function code, **03 E8** = data length (1000 bytes). Each byte pair represents one data point, total 500 points.

Eg: Data 1=10 00 (10=16*1.8° actual phase 28.8°. 00=0, actual amplitude 0)

6.- SAFETY CONSIDERATIONS

All installation specification described at the previous chapters named: **INSTALLATION AND STARTUP, INSTALLATION MODES and SPECIFICATIONS.**

Please note that with the instrument powered on, the terminals could be dangerous to touching and cover opening actions or elements removal may allow accessing dangerous parts. This instrument is factory-shipped at proper operation condition.

- The device must have a professional installation and maintenance.
- Any operation of the device, you must cut off the input signal and power.

7.- TECHNICAL SERVICE

For any inquiry about the instrument performance or whether any failure happens, contact to Blue Jay's technical service.

Blue Jay - After-sales service

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