679

APD 系列局放监测装置

使用说明书 V1.5

APD series Partial Discharge Detector

Operation Manual V1.5

安科瑞电气股份有限公司
Acrel Co., LTD.

申　明

DECLARATION

本公司保留对本手册所描述之产品规格进行修改的权利，恕不另行通知。

订货前，请垂询当地代理商以获悉本产品的最新规格。

We reserve all the rights to revise product specification without notice. Please consult local agent to get the latest information of our products specification.

目　录

Contents

1. 安装使用

1 Installation Guide

1.1 产品概述

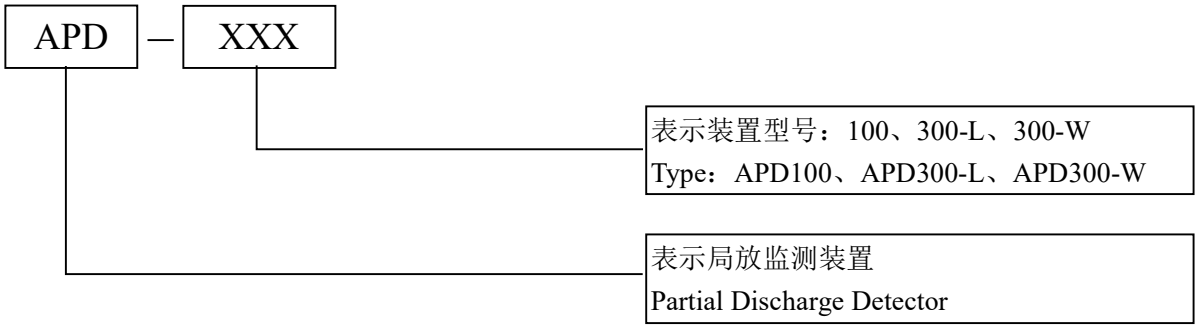
1.1 Product Introduction

现阶段电力系统中，金属封闭开关设备得到广泛应用，因此开关柜运行的是否稳定可靠是重中之重。中压电气设备的绝缘内部如气泡间隙、杂质、尖刺等缺陷，在强电场作用下使得开关柜绝缘内部的电场分布不均匀，在缺陷部位的电场强度会增大，从而容易导致该部位发生未贯穿整个绝缘的放电，即局部放电。局部放电一般不会引起开关柜内部绝缘的穿透性击穿，但是却会导致绝缘介质的局部损坏。若其长期存在，则会在一定条件下造成绝缘装置电气强度的破坏，最终造成开关柜内部绝缘击穿。对于电气设备而言，电气设备发生局部放电现象是导致其绝缘老化或劣化甚至损坏从而引发设备损毁及电力系统事故的重要原因之一，同时也是设备绝缘完整性退化的标志。因此对电气设备的局部放电进行监检测是评估设备绝缘状况的重要手段，也是发现设备潜伏性故障实现故障预警，避免故障发生的有效措施之一。APD 系列中压开关柜局部放电监测装置通过通过特高频传感器（UHF）、地电波传感器（TEV）和超声波传感器（AE）监测检测电气设备运行时的局部放电信号，从而判断高压电气设备内部是否存在绝缘隐患，提前预警，保障电力系统安全可靠运行。

At this stage, metal-enclosed switchgear is widely used in the power system, so the stability and reliability of the switchgear operation is the top priority. Defects such as bubble gaps, impurities, spikes and other defects in the insulation of medium-voltage electrical equipment make the electric field distribution inside the insulation of the switch cabinet uneven under the action of strong electric field, and the electric field strength in the defective part will increase, which will easily lead to the discharge of the part that does not penetrate the entire insulation, that is, partial discharge. Partial discharge generally does not cause the penetrating breakdown of the internal insulation of the switchgear, but it can lead to local damage to the insulating medium. If it exists for a long time, it will cause the destruction of the electrical strength of the insulation device under certain conditions, and eventually cause the insulation breakdown inside the switchgear. For electrical equipment, partial discharge of electrical equipment is one of the important reasons for the aging or deterioration or even damage of its insulation, resulting in equipment damage and power system accidents, and it is also a sign of degradation of equipment insulation integrity. Therefore, the partial discharge monitoring of electrical equipment is an important means to evaluate the insulation status of the equipment, and it is also one of the effective measures to find the latent fault of the equipment to achieve fault warning and avoid the occurrence of failure. The APD series medium-voltage switchgear partial discharge detector device detects the partial discharge signal of the electrical equipment during operation through ultra-high frequency sensors (UHF), ground wave sensors (TEV) and ultrasonic sensors (AE), so as to judge whether there are hidden insulation hazards inside the high-voltage electrical equipment, give early warning, and ensure the safe and reliable operation of the power system.

1.2 型号说明

1.2 Type Introduction



1.3 技术指标

1.3 Technical Features

型号 Type / 参数 Parameters	APD100
检测通道 Number of channels	1 路 One
测量范围 Measuring range	-60dBm~+10dBm
测量内容 Measurement content	放电幅值、放电频次 Discharge amplitude and frequency
采样周期 Sampling	1s
匹配阻抗 Matching impedance	50Ω
工作电源 Power supply	DC10~30V
功耗 Power dissipation	≤3W
通信方式 Communication	RS485 * 1、LORA * 1
波特率(bps) Baud rate	2400、4800、9600、19200 （RS485）
通信协议 Communication protocol	MODBUS-RTU（RS485）
继电器输出 Relay output	1 路常开；5A/AC250V，5A/DC30V 1 circuit normally open relay
安装方式	35mm 导轨式安装

Installation		35mm guide rail installation
工作环境 Usage environment		温度：-25 ℃～+70 ℃；相对湿度≤95% Temperature: -25 ℃~+70 ℃; Relative humidity ≤ 95%
特高频传感器 UHF sensor	检测带宽 Bandwidth	300MHz~1600MHz
	等效高度 Effective height	≥10.5mm
	接口类型 Interface	SMA
	连接电缆 Connecting cables	同轴电缆 Coaxial cable
	防护等级 Protective class	IP65
	安装方式 Installation	磁吸式 Magnetic

型号 Type **参数 Parameters**			APD300-L	APD300-W
电源 Power			DC 9-36V	可充电锂电池 Rechargeable lithium battery
电池寿命 Battery life			--	充电 2 小时，续航 2 年 2 hours of charging, 2 years of battery life
通信方式 Communication			RS485（MODBUS-RTU）	LORA
采样周期 Sampling			4s	2h
局放监测传感器 PD monitoring sensors	超声波 AE	测量范围 Measuring range	0～70dBμV	
		谐振频率 Resonant frequency	40kHz±1kHz	
	地电波 TEV	测量范围 Measuring range	0～60dBmV	
		测量信号带宽 Bandwidth	3MHz～100MHz	
	特高频	测量范围	-70～10dBm	

	UHF	Measuring range	
		测量频段 Bandwidth	300MHz～1500MHz
		平均等效高度 Average equivalent height	≥10mm
	环境 Environment	噪声测量范围 Noise measuring range	30dB～130dB
		温度测量范围 Temp measuring range	-40℃～85℃
		湿度测量范围 Humidity measuring range	0～100%RH
工作环境 Usage environment		温度 Temperature	-40℃～85℃
		湿度 Relative humidity	≤95%RH
尺寸 Size		终端外形尺寸 Terminal form factor	135mm*100mm*42mm
安装 Installation		安装方式 Installation	磁吸式 Magnetic

1.4 产品安装及尺寸

1.4 Product installation and dimensions

1.4.1 APD100 安装及尺寸

1.4.1 APD100 installation and dimensions

APD100 特高频局放监测装置采用导轨（DIN35mm）安装方式，可安装在开关柜二次仪表室；特高频传感器采用磁吸安装方式，吸附在开关柜电缆室柜壁。产品详细尺寸见图，单位 mm。

The APD100 UHF partial discharge detector adopts a guide rail (DIN35mm) installation method and can be installed in the secondary instrument room of the switchgear; The UHF sensor adopts a magnetic suction installation method and is adsorbed on the wall of the switchgear cable room. The detailed dimensions of the product are shown in the figure, in mm.

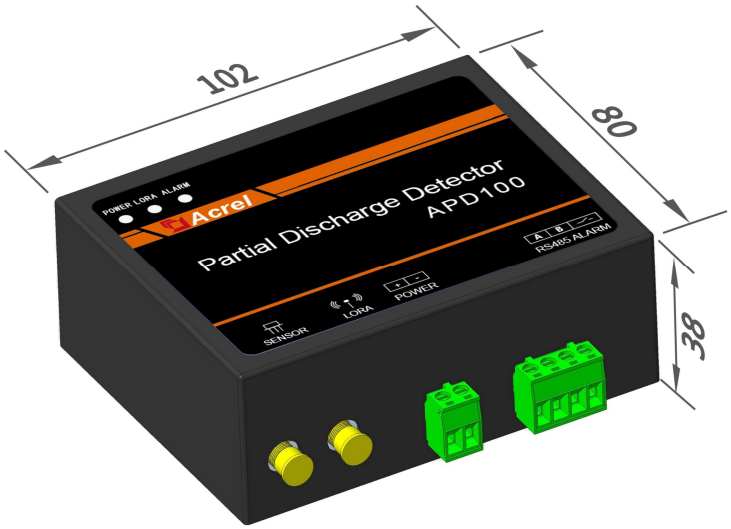


图 1.1 APD100 局放监测装置

Figure 1.1 APD100 Partial Discharge Detector

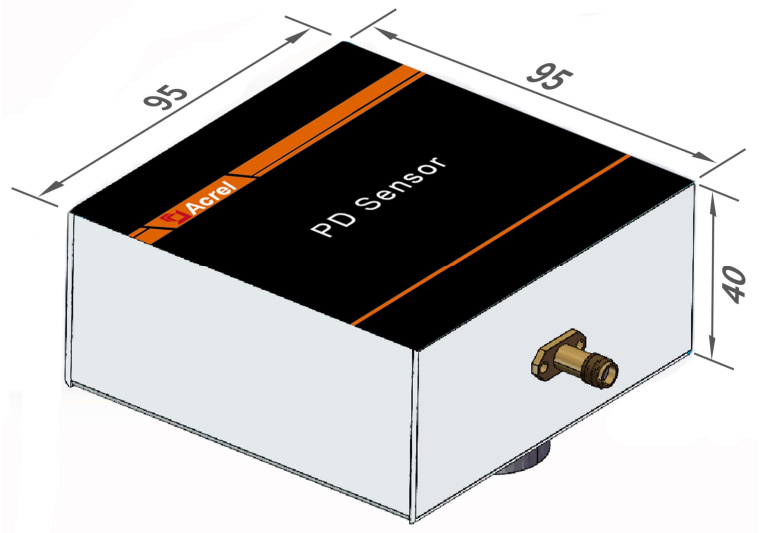


图 1.2 特高频局放传感器

Figure 1.2 UHF Sensor

1.4.2 APD300-L 安装及尺寸

1.4.2 APD300-L installation and dimensions

APD300-L 三合一有线局放传感器采用强磁吸附安装方式，吸附在开关柜电缆室内柜壁。产品详细尺寸见图，单位 mm。

APD300-L triple-in-one wired partial discharge sensor adopts a strong magnetic adsorption mounting method and is installed on the cabinet wall in the cable compartment of the switchgear. The detailed dimensions of the product are shown in the figure, in mm.

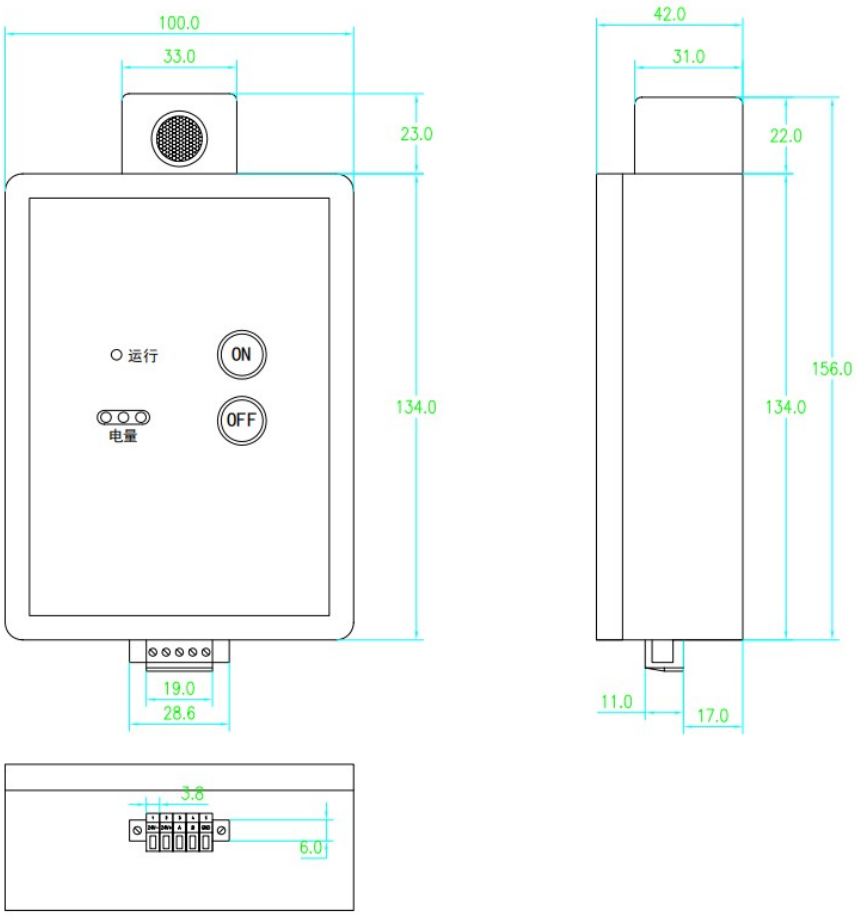


图 1.3 APD300-L 尺寸图

Figure 1.3 APD300-L Dimensional

图 1.4 APD300-L 三合一有线局放传感器

Figure 1.4 APD300-L triple-in-one wired partial discharge sensor

1.4.3 APD300-W 安装及尺寸

1.4.3 APD300-W installation and dimensions

APD300-W 三合一无线局放传感器采用强磁吸附安装方式，吸附在每个开关柜的断路器室或电缆室门板外，无需高压停电。产品详细尺寸见图，单位 mm。

APD300-W triple-in-one wireless partial discharge sensor adopts a high-strength magnetic mounting system, installed on the external door panels of either the circuit breaker compartment or cable compartment in each switchgear unit, without the need for high voltage power outage. The detailed dimensions of the product are shown in the figure, in mm.

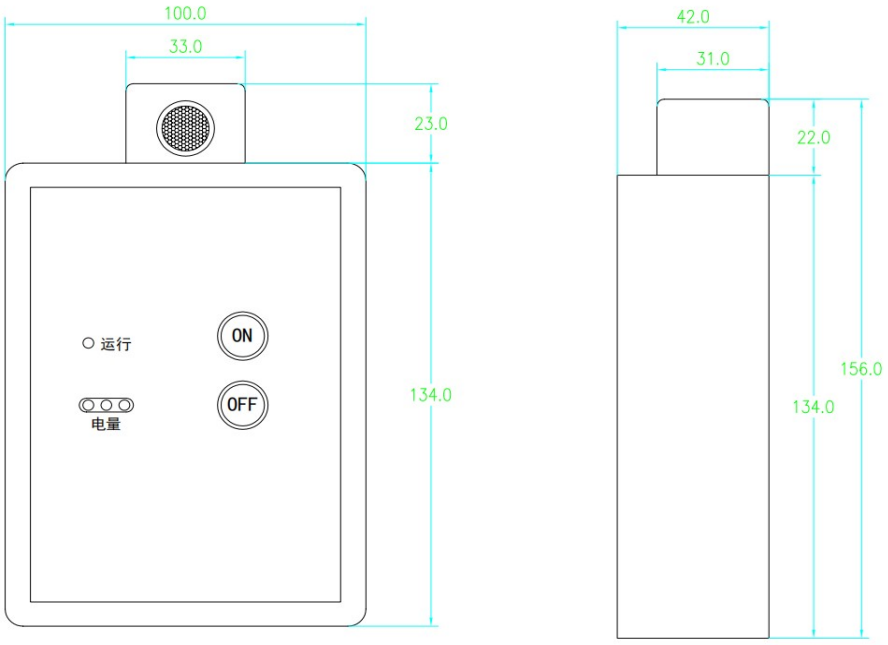


图 1.5 APD300-W 尺寸图

Figure 1.5 APD300-W Dimensional

图 1.6 APD300-W 三合一无线局放传感器

Figure 1.6 APD300-W triple-in-one wireless partial discharge sensor

1.5 接线方法

1.5 Wiring

1.5.1APD100

特高频局放监测装置 APD100 接线端子示意图如下，“SENSOR”接口通过同轴电缆连接特高频传感器；“POWER”接口为装置的工作电源接入，可接入 DC10~30V 电压；通信接口包括 RS485 通信口和 LORA 无线（**无线通信需配合我司无线收发器 ATC600-C 使用**）；“ALARM”为告警干接点输出。

处于报警使能时，APD100 局放装置连续 5 次采样周期的放电量大于报警阈值，ALARM 告警指示灯亮，“ALARM”告警出口闭合。

The schematic diagram of the APD100 wiring terminal is as follows. The "SENSOR" interface is connected to the UHF sensor through a coaxial cable; The "POWER" interface is used to connect the working power supply of the device, which can be connected to DC10~30V voltage; The communication interface includes RS485 communication port and LORA wireless (**wireless communication needs to be used in conjunction with our wireless transceiver ATC600-C**); "ALARM" is the alarm dry contact output.

When the alarm is enabled, the discharge amount of the APD100 partial discharge detector for 5 consecutive sampling cycles is greater than the alarm threshold, the ALARM indicator light is on, and the "ALARM" alarm outlet is closed.

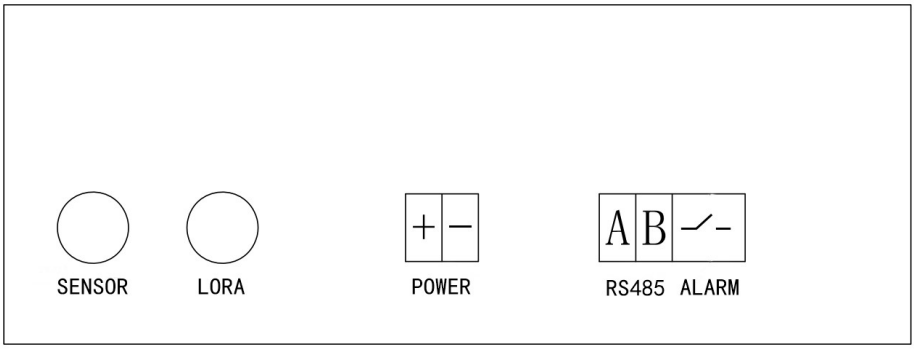


图 1.7　APD100 端子图

Figure 1.7 APD100 terminal diagram

1.5.2 APD300-L

三合一有线局放传感器 APD300-L 接线端子示意图如下，针脚定义：端口 1：电源正极； 端口 2：电源负极；端口 3：RS485 通信 A；端口 4：RS485 通信 B。通信接口 RS485，波特率 9600。

AE 幅值超过 AE 报警定值同时 AE 放电次数超过 10 次，AE 报警标志位致 1；TEV 幅值超过 TEV 报警定值同时 TEV 放电次数超过 10 次，TEV 报警标志位致 1；UHF 幅值超过 UHF 报警定值同时 UHF 放电次数超过 10 次，UHF 报警标志位致 1。

The schematic diagram of the APD300-L triple-in-one wired partial discharge sensor terminal is as follows, and the pin definition: port 1: power supply positive; Port 2: Power Negative; Port 3: RS485 communication A; Port 4: RS485 communication B. Communication interface RS485, baud rate 9600.

If the AE amplitude exceeds the AE alarm value, and the number of AE discharges exceeds 10 times, the AE alarm flag will cause 1; If the TEV amplitude exceeds the TEV alarm value, and the number of TEV discharges exceeds 10 times, the TEV alarm flag will cause 1; If the UHF amplitude exceeds the UHF alarm value and the number of UHF discharges exceeds 10 times, the UHF alarm flag is 1.

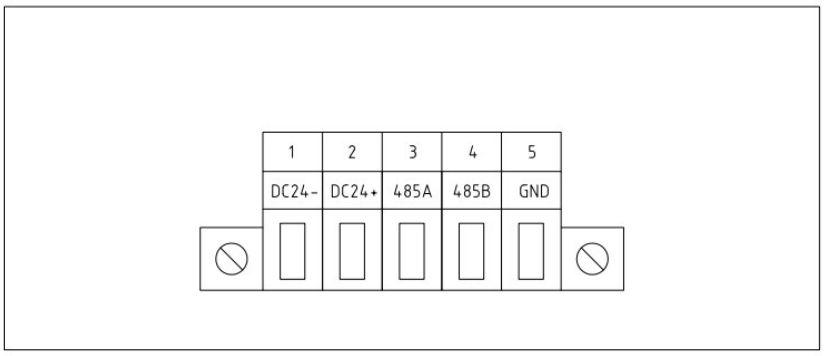


图 1.8　APD300-L 端子图

Figure 1.8 APD300-L terminal diagram

1.5.3 APD300-W

三合一无线局放传感器 APD300-W 指示灯图如下，“ON”为电池打开按钮，“OFF”为电池关闭按钮，并具备运行指示灯和电量指示灯。LoRa 无线传输数据，无任何外设连接接口（**无线通信需配合我司无线收发器 ATC600-PD 使用**）。

The APD300-L triple-in-one wireless partial discharge sensor indicator is shown below, "ON" is the battery on button, "OFF" is the battery off button, and has a running indicator and a battery indicator. LoRa transmits data wirelessly, without any peripheral connection interface (**wireless communication needs to be used with our wireless transceiver ATC600-PD**).

图 1.9　APD300-W 无线指示图

Figure 1.9 APD300-W wireless indicator

无线收发器 ATC600 接线端子。1、2 号为辅助电源端子，3、4 为 DO1 输出，5、6 为 DO2 输出，7、8 为 RS485 接口的 A、B 端子。

Wireless temperature measurement transceiver ATC600 terminal block. 1、2 are power terminals, 3、4 are DO1 output, 5、6 are DO2 output, 7、8 is A and B terminal of RS485 interface.

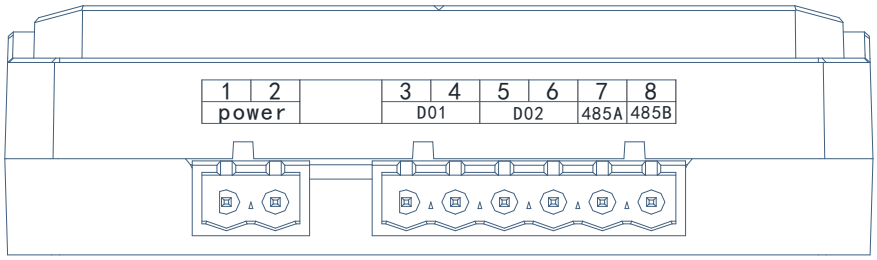


图 1.10　ATC600 端子图

Figure 1.10 ATC600 terminal diagram

1.6 无线接收器

1.6 Wireless receiver

无线接收器通过 LORA 无线接收局放数据，并通过 RS485 传输给上位机或者服务器。无线接收器 ATC600-C 可以接收 80 个 APD100，无线接收器 ATC600-PD 可以接收 40 个 APD300-W（**无线模式点表详见《416 接收器说明书》**）。

The wireless receiver receives PD data through LoRa wireless and transmits it to the host computer or server through RS485. The wireless receiver ATC600-C can receive 80 APD100, and the wireless receiver ATC600-PD can receive 40 APD300-W (**The communication registers for wireless mode are detailed in the《416 Receiver Instruction Manual》**).

2. 通讯指南

2 Communications

在本章主要讲述如何利用软件通过通讯口来读写 APD 局放监测装置的数据。本章内容的掌握需要您具有 MODBUS 协议的知识储备并且通读了本册其他章节所有内容，对本产品功能和应用概念有较全面的了解。本章内容包括：通讯应用格式详解，本机的参量地址表。

This chapter mainly discusses how to use software to read and write data of APD partial discharge detector through communication port. Mastering the content of this chapter requires you to have a knowledge base of the MODBUS protocol and have read through all other chapters of this volume to have a comprehensive understanding of the product's functions and application concepts. This chapter includes a detailed explanation of communication application formats and a parameter address table for this machine.

2.1 通讯格式详解

2.1 Detailed Explanation of Communication Format

本节所举实例将尽可能的使用如下表所示的格式，数据为十六进制。

The examples presented in this section will use the format shown in the following table as much as possible, with data in hexadecimal.

2.1.1 读取数据（功能码 03H/04H）

2.1.1 Read Data (Function code 03H/04H)

此功能允许用户获得设备采集与记录的数据及系统参数。主机一次请求的数据个数没有限制，但不能超出定义的地址范围。

This function allows users to obtain data and system parameters collected and recorded by the device. There is no limit to the number of data requested by the host at once, but it cannot exceed the defined address range.

例如，主机发送查询数据帧：

For example, master send data frame:

地址 Address	功能码 Fun	起始地址 Start address	寄存器数量 Register Count	CRC16 校验码 CRC16

		高 Hi	低 Lo	高 Hi	低 Lo	低 Lo	高 Hi
01H	03H	00H	01H	00H	02H	95H	CBH

装置返回响应数据帧：

Slave answer data frame:

地址 Address	功能码 Fun	字节数 Byte count	数据 1 Data 1		数据 2 Data 2		CRC16 校验码 CRC16	
			高 Hi	低 Lo	高 Hi	低 Lo	低 Lo	高 Hi
01H	03H	04H	00H	01H	00H	04H	AAH	30H

2.1.2 预置单个寄存器（功能码 06H）

2.1.2 Preset Single Register (Function code 06H)

此功能码允许用户改变单个寄存器的内容，可通过此功能码将工作参数写入装置。

User can write active parameter into the single register with this function code.

例如，主机发送：

For example, master send data frame:

地址 Address	功能码 Fun	寄存器地址 Start address		预置值 Value		CRC16 校验码 CRC16	
		高 Hi	低 Lo	高 Hi	低 Lo	低 Lo	高 Hi
01H	06H	00H	01H	00H	02H	59H	CBH

装置返回响应数据帧：

Slave answer data frame:

地址 Address	功能码 Fun	寄存器地址 Start address		预置值 Value		CRC16 校验码 CRC16	
		高 Hi	低 Lo	高 Hi	低 Lo	低 Lo	高 Hi
01H	06H	00H	01H	00H	02H	59H	CBH

2.2 通讯地址表

2.2 Parameter address table

2.2.1 APD100 地址表

2.2.1APD100 address table

地址 Address	**参数 Parameter**	**属性 Attribute**	**数值范围 Range**	**数据类型 Data type**

0000H	预留 Reserve	R	预留，不可修改 Reserve, Unmodifiable	Uint16
0001H	通讯地址 Address	R/W	1-247，默认为 1 1-247，Default is 1	Uint16
0002H	通讯波特率 Baud rate	R/W	01:1200; 02:2400; 03:4800; 04:9600; 05:14400; 06:19200; 07:115200;默认 9600; Default value is 0x00FF,Baud rate is 9600	Uint16
0003H ~0004H	预留 Reserve	R	预留，不可修改 Reserve, Unmodifiable	Uint16
0005H	放电量报警阈值 PD alarm threshold	R/W	-60dBm~+15dBm，默认-20dBm; Default is -20dBm	Int16
0006H ~0008H	预留 Reserve	R	预留，不可修改 Reserve, Unmodifiable	Uint16
0009H	放电次数 PD frequency	R	0~65535	Uint16
000AH	放电量 PD capacity	R	-60dBm~+15dBm	Int16
000BH	放电量报警状态 PD alarm status	R	0， 无报警；1，报警; 0,Normal; 1,Alarm	Uint16
000CH ~000EH	预留 Reserve	R	预留，不可修改 Reserve, Unmodifiable	Uint16
000FH	报警使能 PD alarm enable	R/W	0， 不使能；1，使能；默认 1; 0,OFF; 1,ON; Default is 1	Uint16
0010H ~0012H	预留 Reserve	R	预留，不可修改 Reserve, Unmodifiable	
0013 ~0016H	产品序列号 Product ID	R/W	产品序列号，7 个字节 Product ID, 7 bytes	UINT16
0017H	LORA 信道 Lora channel	R/W	0~22，默认 0：470750000Hz Default is 0:470750000Hz	UINT16
0018H	LORA 带宽 Lora bandwidth	R/W	7~9,125kHz,250kHz,500kHz; 默认 9:500kHz; Default is 9:500kHz	UINT16
0019H	LORA 扩频因子 Lora SF	R/W	6~10，默认 10：1024； Default is 10:1024	UINT16
001AH	LORA- ERRORCODING	R/W	ERRORCODING,1~4 默认 2；[1: 4/5, 2: 4/6, 3: 4/7, 4: 4/8]; Default is 2:4/6	UINT16
001BH	Lora CRC 使能 Lora CRC enable	R/W	0~1，默认 1；[0: OFF, 1: ON]; Default is 1:ON	UINT16

001CH	LORA 包头模式 Lora Header	R/W	0~1 默认 0； [0: OFF, 1: ON]; Default is 0:OFF	UINT16
001DH	LORA 发射功率 Lora transmitting power	R/W	0~20，默认 20dBm; Default is 20dBm	UINT16

2.2.2 APD300-L 地址表

2.2.2APD300-L address table

1、读取全遥测数据

1. Read full telemetry data

该命令用于请求装置采集到的模拟量，功能码为 0x04，寄存器分布如下：

This command is used to request the analog quantity collected by the device, the function code is 0x04, and the register distribution is as follows:

地址 Address	参数 Parameter	属性 Attribute	数值范围 Range	数据类型 Data type
0000H	AE 放电次数 AE frequency	R	0~4095	Int16
0001H	AE 放电幅值 AE capacity	R	0dBμV~60dBμV	Int16
0002H	AE 放电均值 AE average capacity	R	0dBμV~60dBμV	Int16
0003H	AE 告警 AE alarm status	R	0，无报警；1，报警; 0,Normal; 1,Alarm	Int16
0004H	TEV 放电次数 TEV frequency	R	0~4095	Int16
0005H	TEV 放电幅值 TEV capacity	R	0dBmV~60dBmV	Int16
0006H	TEV 环境基值 TEV average capacity	R	0dBmV~60dBmV	Int16
0007H	TEV 告警 TEV alarm status	R	0，无报警；1，报警; 0,Normal; 1,Alarm	Int16
0008H	UHF 放电次数 UHF frequency	R	0~4095	Int16
0009H	UHF 放电幅值 UHF capacity	R	-70dBm~+10dBm	Int16
000AH	UHF 放电均值 UHF average capacity	R	-70dBm~+10dBm	Int16
000BH	UHF 告警 UHF alarm status	R	0，无报警；1，报警; 0,Normal; 1,Alarm	Int16

000CH	噪声值 Noise level	R	30dB~130dB	Int16
000DH	温度值 Temperature value	R	-40℃～85℃（×10);	Int16
000EH	湿度值 Humidity value	R	0%RH~100%RH (×10);	Int16

备注：报警初始判定逻辑放电次数 10，超声波定值 30 dBuV 同时放电次数超过 10 次，TEV 定值 30 dBmV 同时放电次数超过 10 次，UHF 定值-30 dBm 同时放电次数超过 10 次。

Note: The initial judgment of the alarm is that the number of logical discharges is 10, the number of simultaneous discharges of ultrasonic value of 30 dBuV is more than 10 times, the number of simultaneous discharges of TEV value of 30 dBmV is more than 10 times, and the number of simultaneous discharges of UHF value of -30 dBm is more than 10 times.

2、读写定值数据

2. Read and write fixed value data

读取功能码为 0x03，写单个功能码为 0x06，写多个功能码为 0x10，寄存器分布如下：

The function code is 0x03 for reading, 0x06 for writing a single function code, and 0x10 for writing multiple function codes, and the register distribution is as follows:

地址 Address	参数 Parameter	属性 Attribute	数值范围 Range	数据类型 Data type
0000H	通讯地址 Address	R/W	1-255	Uint16
0001H	通讯波特率 Baud rate	R/W	01:4800; 02:9600; 03:19200;04:38400; 05:115200; 默认 9600;Baud rate is 9600	Uint16
0002H	AE 定值 AE alarm value	R/W	10dBμV~60dBμV，默认值：30dBμV Default is 30dBμV	Int16
0003H	TEV 定值 TEV alarm value	R/W	1dBmV~60dBmV，默认值：30dBmV Default is 30dBmV	Int16
0004H	UHF 定值 UHF alarm value	R/W	-70dBm~+10dBm，默认值：-30dBm Default is -30dBm	Int16

注：[1] R—只读；W—只写； R/W—读/写。

Note:[1]R—Read;W—Write；R/W—Read/Write.

总部：安科瑞电气股份有限公司
地址：上海市嘉定区育绿路 253 号
电话：0086-021-69158161
网址：www.acrel.cn
邮箱：acrelsh@email.acrel.cn
邮编：201801
生产基地：江苏安科瑞电器制造有限公司
地址：江苏省江阴市南闸街道东盟工业园区东盟路 5 号
电话：0086-510-86179966
网址：www.jsacrel.cn
邮箱：jyacrel001@email.acrel.cn
邮编：214405

Headquarters: Acrel Co., Ltd.
Trade Company: Acrel E-Business(Shanghai)Co., Ltd.
Address: No.253 Yulv Road, Jiading District, Shanghai, China
TEL.: 0086-21-69156352
Web-site: www.acrel-electric.com
E-mail: sales@acrel-electric.com
Postcode: 201801
Manufacturer: Jiangsu Acrel Electrical Manufacturing Co., Ltd.
Address: No.5 Dongmeng Road, Dongmeng industrial Park, Nanzha Street, Jiangyin City, Jiangsu Province, China
TEL./Fax: 0086-510-86179970
Web-site: www.jsacrel.com
E-mail: sales@email.acrel.cn
Postcode: 214405