米朗 MIRAN®

中国工信部高精度传感器一条龙应用计划示范项目

国家级专精特新“小巨人”企业，国家级高新技术企业

中国工业强基重点产品，中国工信部传感器一条龙应用计划示范企业

固定式测斜仪/智能测斜仪

Fixed skew meter/intelligent skew meter



MCX固定式测斜仪/智能测斜仪

MCX Fixed Skew Meter/Intelligent Skew Meter

- Demonstration project of one-stop application plan for high-precision sensors of Ministry of Industry and Information Technology of China
- National level specialized and special new "little giant" enterprise, national level high-tech enterprise
- Key products of strong industrial base in China, demonstration enterprise of sensor one-stop application plan of Ministry of Industry and Information Technology of China

固定式测斜传感器/智能测斜仪
Fixed Skew Sensor/Intelligent Skew Meter

产品实物图Product Picture







产品型号选型Product Model Selection

MCX □ □□ - R - □

- MCX：米朗智能测斜仪传感器 Miran intelligent skew meter sensor
- □：D：单轴 D: uni；S：双轴 S: spherical
- □□：10：±10°；15：±15°；30：±30°；60：±60°
- R：R485输出 R: RS485 output
- □：A：电子仓是32mm的圆管，导轮间距500mm A: The electronic compartment is a round tube of 32mm,guide wheel spacing 500mm；B：试孔器（不含电子仓部分） B: Pilot hole tester (without electronic bin section)

例如Example:

MCXD30-R-A：米朗智能测斜仪传感器，单轴，测量范围为±30°，输出方式为RS485输出，电子仓是32mm的圆管，导轮间距500mm。

MCXD30-R-A: Miran intelligent skew meter sensor, single axis, measuring range ±30°, output mode RS485 output, electronic compartment is 32mm round tube, guide wheel spacing 500mm.

产品概述Product Overview

固定式测斜仪是本公司基于高精度六轴传感器结合单片机嵌入式系统研发的一款固定式倾角测量仪。智能固定式测斜仪与PVC测斜管配套使用。用以观测边坡、基坑，铁路等相对水平的双轴倾斜角度，配合自动实时监测系统也可适合于滑坡地质活动的长期监测。钻孔的多级设置，可以测量每个深度的倾角，将倾角进行位移换算，适用于常规测量方式难以观测到的隐蔽部位的形变量。

固定式测斜仪内部由电子仓部分（高精度角度敏感元件及芯片组），以及外部不锈钢组件，滑轮组件等构成。外部为一根四芯屏蔽线引出。通常安装固定式测斜仪还需要安装附件，如测斜管，不锈钢丝，吊环等，需根据现场情况合理地进行配置。

Fixed inclinometer is a fixed inclinometer developed by our company based on high-precision six-axis sensor combined with microcontroller embedded system. Intelligent fixed inclinometer is used with PVC inclinometer tube. It is used to observe the relative horizontal biaxial inclination angle of slopes, pits, railroads, etc. With the automatic real-time monitoring system, it can also be suitable for long-term monitoring of landslide geological activities. The multi-stage setting of the borehole can measure the inclination angle at each depth, and the inclination angle can be converted into displacement, which is suitable for the deformation of hidden parts that are difficult to be observed by conventional measurement methods.

Fixed inclinometer internal by the electronic warehouse part (high-precision angle sensitive components and chipset), as well as external stainless steel components, pulley components and other components. Externally, a four-core shielded cable leads out. Usually the installation of fixed inclinometer also need to install accessories, such as inclined tube, stainless steel wire, rings, etc., according to the site conditions reasonable configuration.

电气连接Electrical Connection

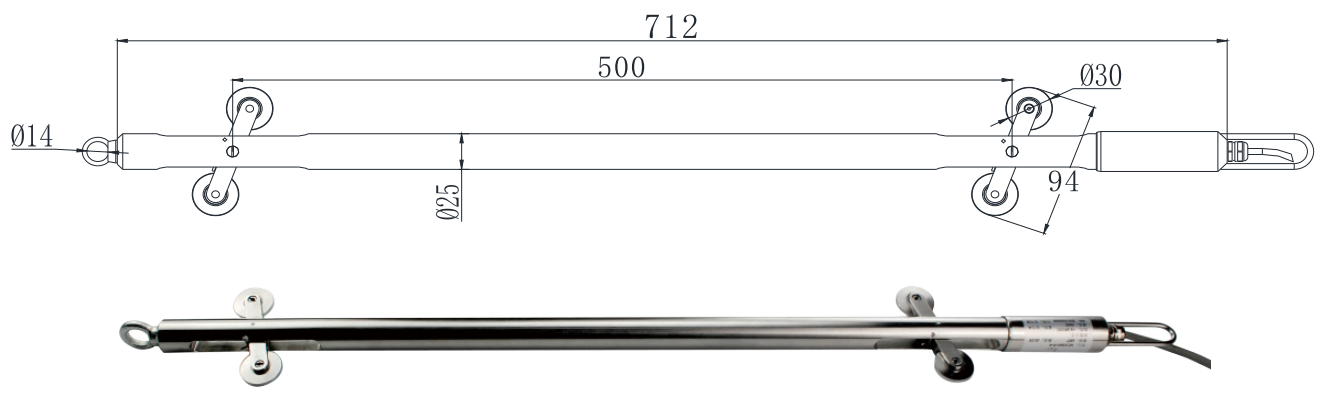
	棕色 BROWN	黑色 BLACK	蓝色 BLUE	白色 WHITE
接线定义 wiring definition	供电电源+ power supply+	供电电源- power supply -	485信号(A) 485 signal (A)	485信号(B) 485 signal (B)

性能参数Performance Parameters

性能指标Performance indicators

型号 Model	MCX固定式测斜传感器/智能测斜仪 MCX fixed skew sensor/intelligent skew meter
电源电压 Supply Voltage	+9V+28V DC
工作电流 Operating Current	14mA(+24VDC)
工作温度 Operating Temperature	-20℃~+80℃
测量范围 Measurement Range	单轴/双轴：±10°、±15°、±30°、±60° single-axis/dual-axis: ±10°,±15°, ±30°, ±60°
分辨率 Resolution	0.01°
线性度 Linearity	10°以内，0.01°； 10°-30°，0.02°； 30°-60°，0.05°
输出信号 Output Signal	485总线 485 bus
通信协议 Communications Protocol	Modbus—RTU
导向轮间距 Guide Wheel Spacing	500mm
配套线长度 Mating Cable Length	默认2m，加长定制请联系业务 default 2m, please contact business for longer customization

产品尺寸图Product Dimension Drawing



PVC测斜管概述 Overview of PVC inclinometer tube

PVC测斜管可与智能固定式测斜仪配套使用，用以观测堤坝、边坡、基坑，铁路等相对水平的双轴倾斜角度，配合自动实时监测系统也可适合于滑坡地质活动的长期监测等。测斜管与测斜管接头采用凹凸槽连接，并用自攻螺丝固定，对接更牢靠，密封性能佳，使用更方便。测斜管内有供测斜仪探头定向的90°间隔的导槽，以保证坚固、耐环境腐蚀及测斜管导槽无扭旋等特点。

The PVC inclinometer tube can be used in conjunction with the intelligent fixed-type inclinometer to measure the relative horizontal biaxial inclination angles of structures such as dams, slopes, excavations, railways, etc. When combined with the automatic real-time monitoring system, it is also suitable for long-term monitoring of geological activities such as landslides. The inclinometer tube and the connecting joint of the inclinometer tube are connected by concave-convex grooves and fixed with self-tapping screws. The connection is more reliable, has excellent sealing performance, and is more convenient to use. There are 90° spaced guide grooves in the inclinometer tube to guide the probe of the inclinometer, ensuring features such as firmness, resistance to environmental corrosion, and no twisting or rotation of the guide grooves of the inclinometer tube.

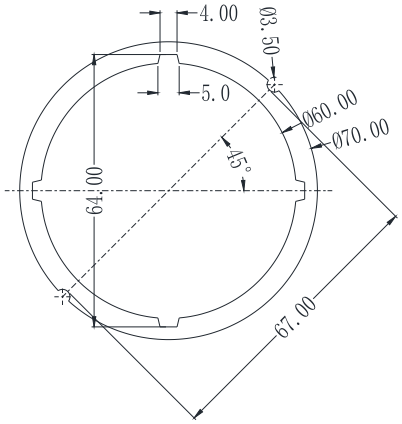
性能参数Performance Parameters

型号 Model	PVC测斜管 PVC inclinometer tube
规格 Specification	ϕ70mm
外径 Outer diameter	ϕ70mm
内径 Inner diameter	ϕ60mm
PVC直接管壁厚 The wall thickness of the PVC direct pipe	6mm
PVC直接管长 Length of the direct PVC pipe	200mm
PVC测斜管壁厚 PVC inclinometer wall thickness measurement	5.5mm
PVC测斜管长 Length of the PVC inclinometer tube	2m或4m 2m or 4m
壁厚偏差 Wall thickness deviation	≤14%
导槽扭角 Guide slot twist angle	≤0.2°/m

PVC测斜管尺寸图PVC Skew Pipe Dimensions

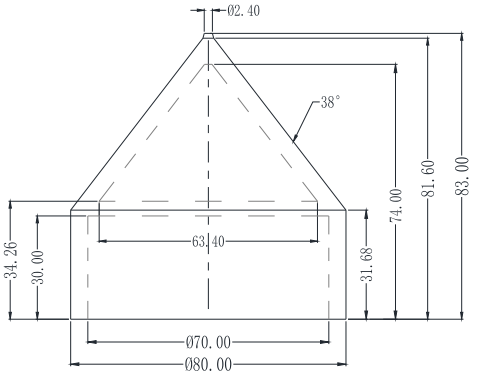
配合测斜仪监测不同深度的水平位移
Monitoring of horizontal displacements at different depths in conjunction with inclinometers

PVC测斜管规格尺寸
PVC inclined pipe specification size



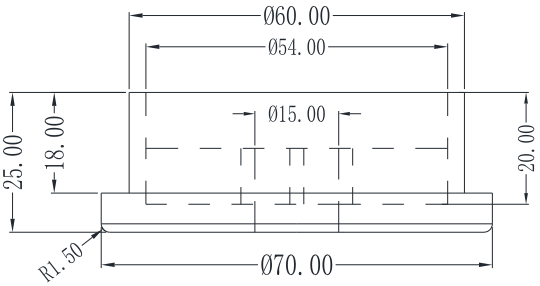


PVC测斜管前端堵头
Plugs for the front end of PVC inclinometer tubes

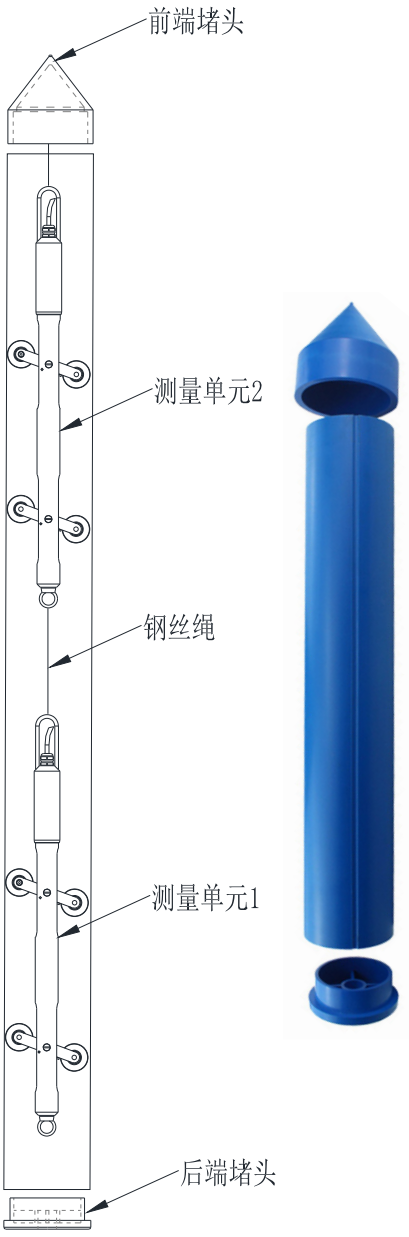




PVC测斜管后端堵头
Plugs for the rear end of PVC inclinometer tubes





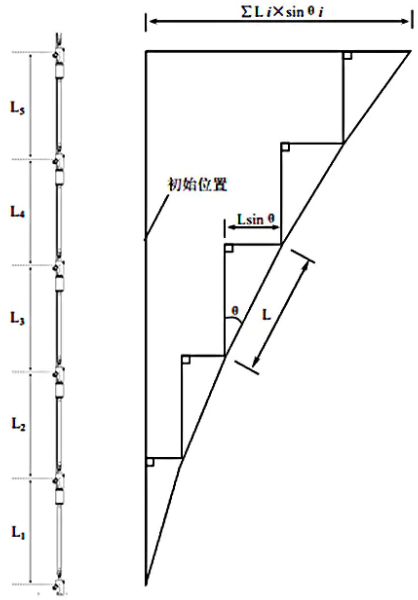


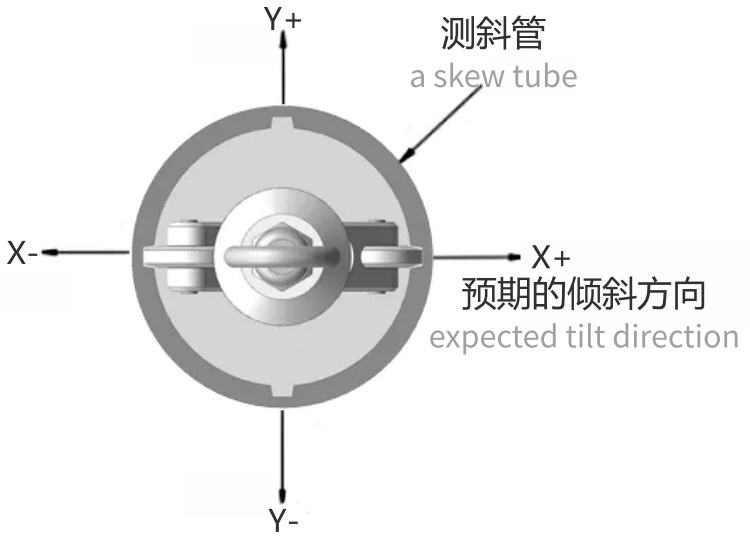
安装示意图
Installation diagram

位移计算方法参考
Displacement calculation method reference

米朗MCX固定式测斜仪具有智能识别功能，输出信号为RS485数字量，直接显示工程物理量（角度值），不需要计算，以下公式仅供参考。

Miran MCX fixed inclinometer has intelligent recognition function, the output signal is RS485 digital, directly display the engineering physical quantity (angle value). No need to calculate, the following formula is for reference only.





测斜仪的轴向XY方向，X轴Y轴正方向标刻在壳体外部，与正方向相对的则为负方向。测斜仪导轮侧为X轴方向，与之垂直侧为Y轴方向。

实际的安装条件下，导轮的方向（即x轴的方向）应朝向预期倾斜的方向进行安装。测斜仪放入测斜管的指定位置后，要进行初始角度值的确定。安装完成后，读取测斜仪当前的角度值，待数据稳定后取当前位置角度的均值作为传感器的初始角度值，记为Angle_X0，Angle_Y0；之后所有传感器的角度值均依照此初始角度值为基准进行计算。

初始值在x轴方向上的水平位移用DX0表示，在y轴方向上的位移用DY0表示，在整体位移用D0表示。传感器测量的角度数据Angle_x，Angle_y在标距L（即相邻两传感器之间的轮距），经过三角函数运算得到该测量标距下的水平位移，位移方向依据x，y轴测量的角度数据的符号为准，+为正向，-为负向。实际使用中，都是以相对位移来进行数据分析，相对位移即为每一个测量点相对于初始位置的位移。

The axial XY direction of the inclinometer, X axis Y axis positive direction is marked on the outside of the housing, and the opposite of the positive direction is the negative direction. The X-axis direction is on the side of the inclinometer's guide wheel, and the Y-axis direction is on the side perpendicular to it.

Under actual installation conditions, the direction of the guide wheel (i.e., the direction of the x-axis) should be installed toward the direction of the expected inclination. After the inclinometer is put into the designated position of the inclined pipe, the initial angle value should be determined. After the installation is completed, read the current angle value of the inclinometer, and after the data is stabilized, take the average value of the angle of the current position as the initial angle value of the sensor, which is recorded as Angle_X0, Angle_Y0; after that, all the angle values of the sensor are calculated according to this initial angle value as a benchmark.

The initial value of the horizontal displacement in the x-axis direction is expressed as DX0, the displacement in the y-axis direction is expressed as DY0, and the overall displacement is expressed as D0. Angle data measured by the sensor Angle_x, Angle_y in the scale L (i.e., wheelbase between two neighboring sensors), after trigonometric operations to obtain the measurement of the scale under the horizontal displacement, displacement direction based on the x, y-axis measurements of the angle of the data of the sign shall prevail, + for the positive direction, - for the negative direction. In practice, the relative displacement is used to analyze the data, the relative displacement is the displacement of each measurement point relative to the initial position.

位移计算公式参考Displacement formula reference:

X轴初始方向的位移：DX0 = L*sin（Angle X0）

Y轴初始方向的位移：Dy0 = L*sin（Angle_Y0）

初始位置的整体位移：D0 = （Dx02+Dy02）1/2

X轴方向的水平位移：DXn = L*sin（Angle Xn）

X轴方向的相对位移：ADXn = DXn-DX0

Y轴方向的水平位移：DYn = L*sin（Angle Yn）

Y轴方向的相对位移：ADYn = DYn-DY0

displacement in the initial direction of the X-axis: DX0 = L*sin (Angle X0)

displacement in the initial direction of the Y-axis: Dy0 = L*sin (Angle_Y0)

overall displacement at initial position:D0 = (Dx02+Dy02) 1/2

horizontal displacement in the x-direction: DXn = L*sin (Angle Xn)

relative displacement in X-axis direction: ADXn = DXn-DX0

horizontal displacement in the Y-direction: DYn = L*sin (Angle Yn)

relative displacement in the y-direction: ADYn = DYn-DY0

安装注意事项Installation Precautions

米朗MCX固定式测斜仪常用于需要自动化实时监测的场合，比如安装在测孔内测量角度，安装在大坝上实时监测坝体安全，安装在观测人员不易到达的危险高边坡上，观测人员只要在观测室进行遥测即可，省时省力。米朗MCX固定式测斜仪是可重复使用的测量仪器，需要与测斜管配套使用。因此，安装固定测斜仪前必须先埋设测斜管。

Miran MCX fixed Inclinometers are commonly used where automated real-time monitoring is required, such as in borehole measurements, on dams for real-time monitoring of dam safety, and on hazardous high slopes that are not easily accessible to the observer, who can simply telemetry from the observation room, saving time and effort. Miran MCX fixed Inclinometer is a reusable measuring instrument, which needs to be used together with the inclinometer tube. Therefore, it is necessary to bury the pipe before installing the fixed inclinometer.

一、测斜管的安装Installation of inclined tubes

1.先将测斜管装上后端堵头，用螺丝或胶固定。测斜管与测斜管之间用直接头连接，测斜管与直接头之间用螺丝固定后涂胶填缝密封。

1. First, install the inclinometer tube on the back end of the plug and fix it with screws or glue. The inclinometer tube and inclinometer tube are connected with a direct head, and the inclinometer tube and the direct head are fixed with screws and then caulked with glue to seal.

2.测斜管在安装中应注意导槽的方向，导槽方向必须与设计要求的方向一致。安装时将装好接头的测斜管依次逐节放入钻孔中，直至连接下放到设计深度的孔底。

2. In the installation of the inclined pipe, attention should be paid to the direction of the guide groove, which must be consistent with the direction of the design requirements. Installation will be equipped with a good connector of the inclinometer tube sequentially into the borehole section by section, until the connection is lowered to the bottom of the hole at the designed depth.

3.露在地表上的测斜管应注意做好管口保护，盖上前端堵头防止物体落入。测斜管地表管口段应浇注成混凝土墩台，以保护管口及其转角的稳定性。墩台上应设置测绘标点。

3. Exposed on the surface of the inclinometer tube should pay attention to good protection of the mouth, cover the front plug to prevent objects from falling into. Inclinometer surface pipe mouth section should be poured into a concrete pier to protect the stability of the pipe mouth and its corners. The pier should be set on the mapping markers.

4.安装完成后的测斜管可先用模拟测斜仪试放，保证模拟测斜仪在测斜管导槽内能从上到下或从下到上都很平稳顺畅通过，以此作为测斜管安装完好的标志。

4. After the completion of the installation of the inclined tube can be used to simulate the inclinometer test put, to ensure that the analog inclinometer in the inclined tube guide groove can be from top to bottom or from bottom to top are very smooth and smooth through, as the inclined tube as a sign of completion of the installation of the inclined tube.

二、测斜仪的安装Installation of the inclinometer

1.检查传感器部件是否工作正常（以铅垂线为基准倾向高端导向轮一侧读数增大，倾向另一侧读数减小），多个固定测斜仪安装时用钢丝绳首尾相连，按设计图纸要求的数量装成一个个测量单元。吊装是按一个个测量单元的顺序放入测斜管内，每个测量单元之间用钢丝绳连接，连接一定要牢靠，各个测量单元的所有导向轮方向必须一致。

1. Check whether the sensor components are working properly (with the plumb line as the reference tends to high-end guide wheel side readings increase, tends to the other side of the readings

decrease), a number of fixed inclinometer installation with a steel wire rope connected to the first and last, according to the number of design drawings required for the installation of a measurement unit. Lifting is according to the order of a measuring unit into the inclinometer tube, each measuring unit connected with a wire rope, the connection must be secure, the direction of all the guide wheels of each measuring unit must be the same.

2.如在测孔内只安装一套固定测斜仪，只要把固定测斜仪头部与钢丝绳连接即可。

2. If only one set of fixed inclinometers is installed in the borehole, simply connect the head of the fixed inclinometer to the wire rope.

3.在安装时要根据被测体需要观测的位移方向，先将测杆导轮的正方向（高轮方向）对准测斜管的测量平面的主方向，缓缓滑入测管内。

3. In the installation should be based on the body to be observed in the direction of displacement, first of all, the positive direction of the rod guide wheel (high wheel direction) aligned with the main direction of the measurement plane of the measurement of the inclined tube, slowly sliding into the measurement tube.

4.理顺仪器电缆，每放一段深度用自锁扎带把电缆同吊装钢丝绳扎在一起，不要扎在固定测斜仪的测杆部件上。将一段吊装的钢丝绳牢牢固定在孔口附近，将电缆按设计走向埋设。

4. Straighten the instrument cable and tie the cable to the lifting wire rope with self-locking ties at each depth of placement, not to the rod components that hold the inclinometer in place. Securely fasten a section of hoisting wire rope near the hole, and bury the cable in the designed direction.

5.需要注意的是每套固定测斜仪要按顺序作好编号记录，所有电缆要松弛不能拉紧。下放完成后应核查仪器高程是否准确，并拉动吊装钢丝绳用读数仪检查每支传感器的工作是否正常，随后记录稳定的初始读数。如发现问题可拉出固定测斜仪重新安装。

5. It should be noted that each set of fixed inclinometers should be sequentially numbered and recorded, and all cables should be slack and not stretched. After the lowering is completed, the elevation of the instrument should be verified to see if it is accurate, and the lifting wire rope should be pulled to check if each sensor is working properly with the readout meter, and then

record the stable initial readings. If problems are found the fixed inclinometer can be pulled out and reinstalled.

6.最后孔口应设保护设施，观测电缆按设计走向固定埋设。

6. The final orifice should be provided with protective facilities, and the observation cable should be fixed and buried in accordance with the designed direction.

每一处新的项目工地，在正式开始监测前，请务必对测孔进行一次检查，以确保测孔是正常的，有效的，以避免做无用功，或者出现探头下不去的问题，测孔器就是专门为此设计的一个检查工具，也是基坑监测的必备工具。

Every new project site, before the official start of monitoring, please be sure to carry out a check of the hole to ensure that the hole is normal, effective, in order to avoid useless work, or the probecan not go down the problem, the hole detector is specially designed for this purpose of a checking tool, but also a necessary tool for pit monitoring.

Modbus-RTU通信协议概述
Overview of Modbus-RTU Communication Protocols

1.传感器支持的功能码：

1. Function codes supported by the sensor:

03H读多个寄存器，10H写多个寄存器。

03H read multiple registers, 10H write multiple registers.

默认通信参数：波特率 9600，无校验，数据位8，停止位1，传感器默认地址01。

default communication parameters: baud rate 9600, no parity, data bit 8, stop bit 1, sensor default address 01.

2.各功能码存放方式以及寄存器映射：

2. Function code storage and register mapping:

测量数据以及产品参数（Read holding rgister---modbus 功能码：03H）
Measurement data and product parameters (read holding rgister---modbus function code: 03H)

参数 Parameters	Modbus 保持寄存器地址（16位） Modbus holding register address (16 bits)
X轴角度 X-axis angle	0000H（整数）、0001H（小数） 0000H (integer), 0001H (decimal)
Y轴角度 Y-axis angle	0002H（整数）、0003H（小数） 0002H (integer), 0003H (decimal)
保留 Reservations	0004H、0005H
温度1 Temperature 1	0006H
保留 Reservations	0007H

写多个寄存器数据（Write Multipleregisters---modbus 功能码：10H）
Write multipleregisters data (Write Multipleregisters---modbus function code: 10H)

参数 Parameters	Modbus 保持寄存器地址（16位） Modbus holding register address (16 bits)
保留 Reservations	0000H
保留 Reservations	0001H
修改地址 Change Address	0002H
修改波特率 Modify Baud Rate	0003H
保留 Reservations	0004H

应用领域Areas of application



• 铁路机车监测
Railroad locomotive monitoring



• 输水轨道监测
Water conveyance track monitoring



• 基坑工程监测
Pit engineering monitoring



• 边坡角度监测
Slope angle monitoring



• 滑坡地质监测
Geological monitoring of landslides



• 工程勘测
Engineering surveys



• 大坝安全监测
Dam safety monitoring



• 钻孔测量
Borehole measurement

• • •

智能固定式测斜仪与PVC测斜管配套使用。用以观测边坡、基坑，铁路等相对水平的双轴倾斜角度，配合自动实时监测系统也可适合于滑坡地质活动的长期监测。钻孔的多级设置，可以测量每个深度的倾角，将倾角进行位移换算，适用于常规测量方式难以观测到的隐蔽部位的形变量。

Intelligent fixed inclinometer is used together with PVC inclinometer tube. It is used to observe the relative horizontal biaxial inclination angle of slopes, pits, railroads, etc. With the automatic real-time monitoring system, it is also suitable for long-term monitoring of landslide geological activities. The multi-stage setting of the borehole can measure the inclination angle at each depth, and the inclination angle can be converted into displacement, which is suitable for the deformation of hidden parts that are difficult to be observed by conventional measurement methods.



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（尤其是在尺寸方面要求特别严格的，或者在产品实物没收到之前，就要先在自己设备上加工做好安装孔位和确定安装空间位置的，要特别注意,要在购买前3天内与我们书面再次确认好产品的实际尺寸，以免造成不必要的返工等损失，若没有在购买前3天内与我们书面确认尺寸而造成后续安装困难等损失，我司不予承担，最终尺寸要以产品实物为准。）

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主要著作人：王工

Main author: Wang designer

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