数字漏电流传感器 Digital DC Leakage Current Sensor

SLD1S1K-10mA/RS485

SLD1S1K 系列是一种测量直流微电流的数字传感器。测量方式为穿孔方式，无插入损耗，孔径为 φ 20mm 。输入信号为直流微电流，输出为 RS485 通讯口。

The SLD1S1K series is a digital sensor for measuring DC microcurrents. The measurement method is perforation, no insertion loss, and the aperture is φ20mm. The input signal is DC micro current, and the output is RS485 communication port.

电气参数(Ta=25℃)

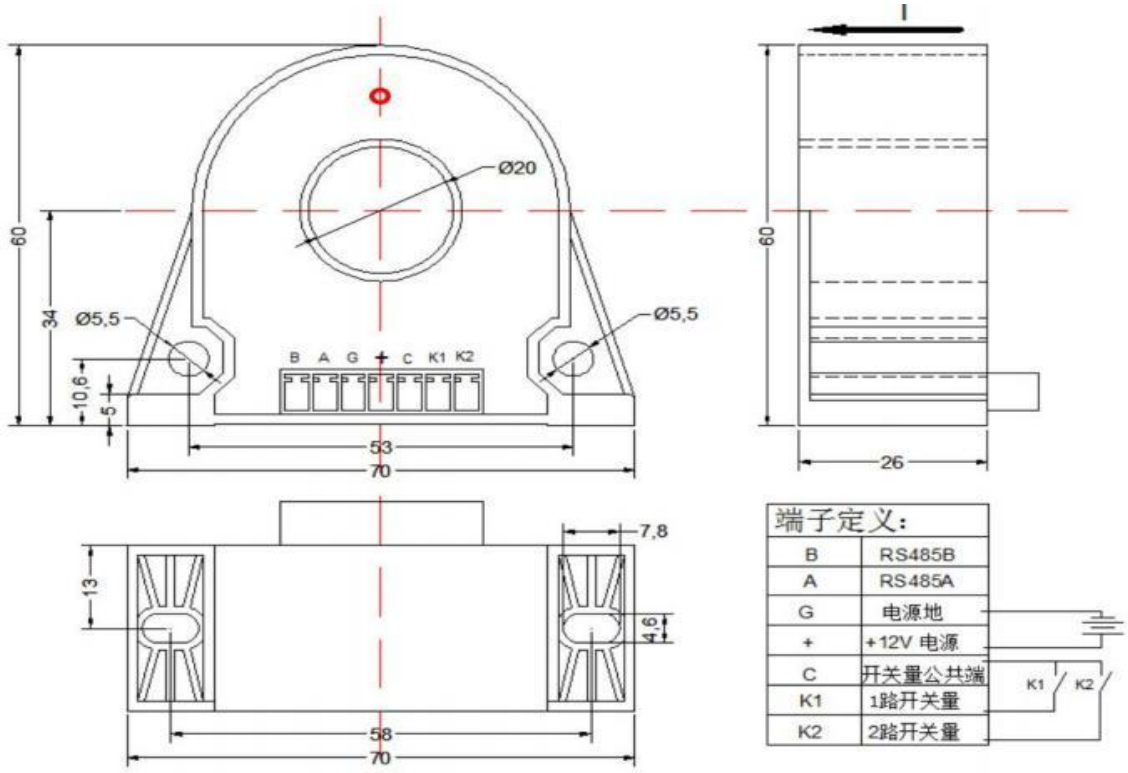
型号 Type / 参数 Parameter	SLD1S1K-10mA/RS485	单位
额定输入电流(Ipn) Rated input current (Ipn)	±10	mA
测量电流范围(Ipm) Measuring Current Range (Ipm)	0~±80	mA
输出接口 Output interface	RS485	
分辨率 Resolution	10	uA
波特率 Baud rate	9600（无校验）	bps
电源电压 (Vc) Supply voltage (Vc)	+8~+12	VDC
功耗电流(Ic) Power consumption current (Ic)	@8VDC，K1、K2 开 ≤20mA	mA
精度（X） Accuracy (X)	±1	%FS
线性度（ε） Linearity (ε)	≤1	%FS
失调电流(Ioe) Offset current (Ioe)	≤±250	uA
温漂(TC) Temperature bleaching (TC)	20	uA/℃

刷新时间(tr) Refresh time (tr)	≤500	mS
操作温度（TA） Operating temperature (TA)	-10 to +70	℃
存储温度（TS） Storage temperature (TS)	-10 to +75	℃
绝缘电压（Vd） Insulation voltage (Vd)	@ 50HZ/60HZ，1min 3	KV
绝缘阻抗(Ris) Insulation impedance (Ris)	@ DC 500V 500	M Ω
爬电距离（dCp） Creepage distance (dCp)	13	mm
空间间距（dCi） Spatial Spacing (dCi)	13	mm

应用 Application

- 微电流检测
  Microcurrent detection
- 直流电源系统绝缘在线监测
  DC power system insulation online monitoring

结构参数 Dimension



端子定义：	
B	RS485B
A	RS485A
G	电源地
+	+12V 电源
C	开关量公共端
K1	1路开关量
K2	2路开关量

备注：所有尺寸单位 mm，通用公差±1mm
Note: All dimensions in mm, general tolerance ±1mm

使用说明 Remarks

1.当待测电流从传感器穿过，即可通过 RS485 获取当前被测电流数据。
2.可按用户需求定制不同额定输入电流和输出电压的传感器。
3.本产品为弱电流检测产品，传感器容易受运输、测试环境等因素影响，零点会有变化，但 2V 以内不影响传感器的线性度。建议客户在使用本产品时，将传感器安装到系统待传感器稳定后进行零点测试，当零点偏大时，进行软件校零处理。也可用 2.0 无感一字螺丝刀进行电位器调零，直至零点恢复正常；再将系统报警值设置在 2V。
4.错误的接线以及超出产品测量电流范围可能导致传感器损坏。
1. When the current to be measured passes through the sensor, the current data can be obtained through the RS485 port.
2. Sensors with different rated input current and output voltage can be customized according to user needs.
3. This product is a weak current detection product, the sensor is easily affected by transportation, test environment and other factors, the zero point will change, but the linearity of the sensor will not be affected within 2V. When using this product, it is recommended that the customer install the sensor into the system and carry out zero test after the sensor is stable. When the zero is too large, carry out software zero correction processing. The potentiometer can also be zeroed with 2.0 non-inductive flat-head screwdriver until the zero point returns to normal; Then set the system alarm value at 2V.
4. Incorrect wiring and out of the range of product measurement current may cause sensor damage.

执行标准 Enforce standards

- UL94-V0.
- EN60947-1:2004
- IEC60950-1:2001
- EN50178:1998

通讯协议 Communication protocol

1. 直流互感器技术要求

Dc transformer technical requirements

1.1 通信要求 Communication requirement

●互感器通讯时的波特率固定为 9600bps。

The baud rate of the transformer is fixed at 9600bps.

●硬件接 口：RS485。

Hardware connector: RS485.

●通讯设置：1 起始位，8 位数据，1 停止位，无校验位。

Communication Settings: 1 start bit, 8 data bits, 1 stop bit, no check bit.

●通讯方式：半双工通讯；主板下发命令，CT 返回数据；CT 接收到主机完整数据包后，延时 1~3ms 时间后返回数据，10ms 后不能再返回数据。

Communication mode: half duplex communication; The motherboard sends the command, CT returns the data; After receiving the complete data packet from the host, CT returns the data after a delay of 1 to 3ms, and cannot return the data after 10ms.

1.2 CT 通信数据格式 CT communication data format

●数据包格式：长度＝6+n，n 可以为 0；格式为长度（1 字节），ID（两字节），CMD（1 字节），数据（n 字节），CRCH,CRCL。

Packet format: length = 6+n, n can be 0;The format is length (1 byte), ID (2 bytes),CMD (1 byte), data (n bytes), CRCH,CRCL.

注：所有数据除 CRC 值外都采用小端格式。

Note: All data except CRC values are in small-endian format.

●长度：数据包的字节数。长度＝6+n，n 可以为 0。

Length: The number of bytes of the packet. Length = 6+n, and n can be 0.

- ID：分为两种，第一种：CT 固定编号，从 1~65534 有效，第二种：运行时根据固定 ID 号重新编码，从 0~65534 有效。其中 65535 即 0XFFFF 作为广播地址，CT 接收到广播地址除了ID 识别数据包外，都不可返回数据，但要执行相应操作。

ID: divided into two types, the first: CT fixed number, from 1 to 65534 valid, the second: run according to the fixed ID number recoding, from 0 to 65534 valid. Where 65535 is 0XFFFF as the broadcast address, CT received broadcast address in addition to ID identification packets, can not return data, but to perform the corresponding operation.

- CMD：命令码，其中 BIT7,BIT6 做了定义。主机下发 BIT7＝0，CT 返回 BIT7=1，使用固定 ID 进行通讯识别，BIT6=0，使用编号识别，BIT6=1 。BIT0~BIT5 表示命令码，详见CT 信号采集模块用到的寄存器分配表。数据：指通讯的有效数据。

  CMD: command code, where BIT7 and BIT6 are defined. Host sends BIT7= 0, CT returns BIT7= 1, uses fixed ID for communication identification, BIT6=0, uses serial number identification, BIT6= 1. BIT0~BIT5 shows the command code, see the register allocation table used by the CT signal acquisition module. Data: refers to the effectiveness of communication

  Data.

CRCH,CRCL：CRC 校验码，具体生成请参考附录 1。

CRCH,CRCL: CRC verification code. For details, see Appendix 1.

1.3 CT 信号采集模块用到的命令
Commands used in CT signal acquisition module

以使用固定 ID（300）通讯为例，使用编码通讯时，把 CMD BIT6 置 1 即可。

For example, when communicating with a fixed ID (300), set CMD BIT6 to 1 when communicating with an encoding.

1.3.1 命令：0X00（读取版本号）Command: 0X00 (read version number)

版本号用 16 位无符号数表示，100 表示 V1.00

The version number is represented by a 16-bit unsigned number, with 100 representing V1.00

主机下发：0X06 0X2C 0X01 0X00 CRCH CRCL

CT 返回： 0X08 0X2C 0X01 0X80 0X64 0X00 C1 C2 CRCH CRCL

注：红色 0X06 指数据长度，绿色 0X2C（低） 0X01（高）指 ID（300），黄色 0X00 指命令；0X64 表示 V1.00，C1 C2 公司代码。

Note: Red 0X06 indicates length, green 0X2C (low) 0X01 (high) indicates ID (300), yellow 0X00 indicates command; 0X64 indicates V1.00, C1 C2 company code.

1.3.2 命令：0X01（识别 CTID 号）Command: 0X01 (Identify CTID number)

执行此命令时，通讯口只接一个 CT，使用广播地址发送，CT 返回数据。

When this command is executed, the communication interface is connected to only one CT, which is sent using the broadcast address, and the CT returns data.

主机下发：0X06 0XFF 0XFF 0X01 CRCH CRCL

CT 返回：0X0A AL AH 0X81 IDL IDH NUMBL NUMBH CRCH CRCL

1.3.3 命令：0X07（设置 CTID 号）Command: 0X07 (Set the CTID number)

执行此命令时，通讯口只接一个 CT，使用广播地址发送，CT 返回数据。

When this command is executed, the communication interface is connected to only one CT, which is sent using the broadcast address, and the CT returns data.

主机下发：0X08 0XFF 0XFF 0X07 IDL IDH CRCH CRCL

CT 返回：0X0A AL AH 0X87 IDL IDH NUMBL NUMBH CRCH CRCL

例：设置 ID 为 0x0102，下发命令为 08 ffff07 02 01 E1 8D，传感器设置成功后返回：0A 02 01 87 02 01 FF FF 07 52

For example, if the ID is 0x0102 and the command is 08 ffff07 02 01 E1 8D, the sensor returns 0A 02 01 87 02 01 FF FF 07 52 after being successfully set

1.3.4 命令：0X08（校准零点）Command: 0X08 (Calibration zero)

执行此命令时，通讯口可接多个 CT，使用广播地址发送，CT 不返回数据。

When this command is executed, the communication interface is connected to only one CT, which is sent using the broadcast address, and the CT returns data.

主机下发：0X06　0XFF　0XFF　0X08　CRCH　CRCL

1.3.5 命令：0X09（校准满量程）Command: 0X09 (Calibrate full scale)

执行此命令时，通讯口可接多个 CT，使用广播地址发送，CT 不返回数据。

When this command is executed, the communication interface is connected to only one CT, which is sent using the broadcast address, and the CT returns data.

主机下发：0X06　0XFF　0XFF　0X09　SCALL　SCALM1　SCALM2　SCALH　CRCH　CRCL

注：SCALL　SCALM1　SCALM2　SCALH 为满量程电流值，放大倍数 1000，例：10mA，表示为 10，000。

Note: SCALL SCALM1 SCALM2 SCALH is the full scale current value with a magnification of 1000, for example, 10mA, expressed as 10,000.

1.3.6 命令：0X10（读取采样电流值）Command: 0X10 (Read the sampled current value)

使用 32 位有符号整数表示，电流单位：uA。
Use a 32-bit signed integer, current unit: uA.
主机下发：0X06 0X2C 0X01 0X10 CRCH CRCL
CT 返回：0X0B 0X2C 0X01 0X90 STAT CURL CURM1 CURM2 CURH CRCH CRCL

注：从 CT 通入电流到CT 采样值稳定时间最长为 1s，即 CT 通入电流，3 秒后可能读取稳定的电流值。STAT 详见附录 2。CURL,CURM1,CURM2,CURH 为实际电流值。
Note: The maximum stability time from the CT incoming current to the CT sampling value is 1s, that is, the CT incoming current, and the stable current value may be read after 3 seconds. STAT is detailed in Appendix 2. CURL,CURM1,CURM2,CURH are the actual current values.

1.3.7 命令：0X14（返回校验值）Command: 0X14 (return check value)

主机下发：0X06 0X2C 0X01 0X14 CRCH CRCL
CT 返回：0X0E 0X2C 0X01 0X94 SCALL SCALM1 SCALM2 SCALH ZERORL ZERORM1 ZERORM2 ZERORH CRCH CRCL

注：数字表示同上。
Note: Numbers are shown as above.

1.3.8 命令：0X15（返回 CTAD 采样值）Command: 0X15 (Return CTAD sampling value)

主机下发：0X06 0X2C 0X01 0X15 CRCH CRCL
CT 返回：0X0B 0X2C 0X01 0X95 STAT SAMPL SAMPM1 SAMPM2 SAMPH CRCH CRCL

注：STAT 请参照附录, SAMPL~SAMPH 为 CTAD 采样值。
Note: STAT please refer to the appendix, SAMPL~SAMPH are CTAD sampling values.

1.3.9 命令：0X18（返回 ID 及编号）Command: 0X18 (Return ID and number)

主机下发：0X06 0X2C 0X01 0X18 CRCH RCL
CT 返回： 0X0A 0X2C 0X01 0X98 IDL IDH NUMBL NUMBH CRCH CRCL

注： IDL,IDH 为 CT 固定 ID 号， NUMBL，NUMBH 为 CT 编号，此命令广播时没有数据返回。
Note: IDL,IDH are CT fixed ID numbers, NUMBL, NUMBH are CT numbers, no data is returned when this command is broadcast.

附录 1：

CRC 校验程序，在小端系统可以直接运行。VC6.0 实际运行通过。

```
#ifndef DEF_H_
#define DEF_H_

#define U16 unsigned short
#define U32 unsigned int
```

```
#define U8     unsigned char
#define S16 short
#define S32 int
#define F32 float
#endif

#if !defined(AFX_CRC_H__4D713B9F_3315_4581_8940_B0A07ACC8A5F__INCLUDED_)
#define AFX_CRC_H__4D713B9F_3315_4581_8940_B0A07ACC8A5F__INCLUDED_

#include "def.h"
const U16 CrcTable8[256]=
    {
     0x0000,0x1021,0x2042,0x3063,0x4084,0x50A5,0x60C6,0x70E7,
     0x8108,0x9129,0xA14A,0xB16B,0xC18C,0xD1AD,0xE1CE,0xF1EF,
     0x1231,0x0210,0x3273,0x2252,0x52B5,0x4294,0x72F7,0x62D6,
     0x9339,0x8318,0xB37B,0xA35A,0xD3BD,0xC39C,0xF3FF,0xE3DE,
     0x2462,0x3443,0x0420,0x1401,0x64E6,0x74C7,0x44A4,0x5485,
     0xA56A,0xB54B,0x8528,0x9509,0xE5EE,0xF5CF,0xC5AC,0xD58D,
     0x3653,0x2672,0x1611,0x0630,0x76D7,0x66F6,0x5695,0x46B4,
     0xB75B,0xA77A,0x9719,0x8738,0xF7DF,0xE7FE,0xD79D,0xC7BC,
     0x48C4,0x58E5,0x6886,0x78A7,0x0840,0x1861,0x2802,0x3823,
     0xC9CC,0xD9ED,0xE98E,0xF9AF,0x8948,0x9969,0xA90A,0xB92B,
     0x5AF5,0x4AD4,0x7AB7,0x6A96,0x1A71,0x0A50,0x3A33,0x2A12,
     0xDBFD,0xCBDC,0xFBBF,0xEB9E,0x9B79,0x8B58,0xBB3B,0xAB1A,
     0x6CA6,0x7C87,0x4CE4,0x5CC5,0x2C22,0x3C03,0x0C60,0x1C41,
     0xEDAE,0xFD8F,0xCDEC,0xDDCD,0xAD2A,0xBD0B,0x8D68,0x9D49,
     0x7E97,0x6EB6,0x5ED5,0x4EF4,0x3E13,0x2E32,0x1E51,0x0E70,
     0xFF9F,0xEFBE,0xDFDD,0xCFFC,0xBF1B,0xAF3A,0x9F59,0x8F78,
     0x9188,0x81A9,0xB1CA,0xA1EB,0xD10C,0xC12D,0xF14E,0xE16F,
     0x1080,0x00A1,0x30C2,0x20E3,0x5004,0x4025,0x7046,0x6067,
     0x83B9,0x9398,0xA3FB,0xB3DA,0xC33D,0xD31C,0xE37F,0xF35E,
     0x02B1,0x1290,0x22F3,0x32D2,0x4235,0x5214,0x6277,0x7256,
     0xB5EA,0xA5CB,0x95A8,0x8589,0xF56E,0xE54F,0xD52C,0xC50D,
     0x34E2,0x24C3,0x14A0,0x0481,0x7466,0x6447,0x5424,0x4405,
     0xA7DB,0xB7FA,0x8799,0x97B8,0xE75F,0xF77E,0xC71D,0xD73C,
     0x26D3,0x36F2,0x0691,0x16B0,0x6657,0x7676,0x4615,0x5634,
     0xD94C,0xC96D,0xF90E,0xE92F,0x99C8,0x89E9,0xB98A,0xA9AB,
     0x5844,0x4865,0x7806,0x6827,0x18C0,0x08E1,0x3882,0x28A3,
     0xCB7D,0xDB5C,0xEB3F,0xFB1E,0x8BF9,0x9BD8,0xABBB,0xBB9A,
     0x4A75,0x5A54,0x6A37,0x7A16,0x0AF1,0x1AD0,0x2AB3,0x3A92,
     0xFD2E,0xED0F,0xDD6C,0xCD4D,0xBDAA,0xAD8B,0x9DE8,0x8DC9,
     0x7C26,0x6C07,0x5C64,0x4C45,0x3CA2,0x2C83,0x1CE0,0x0CC1,
     0xEF1F,0xFF3E,0xCF5D,0xDF7C,0xAF9B,0xBFBA,0x8FD9,0x9FF8,
     0x6E17,0x7E36,0x4E55,0x5E74,0x2E93,0x3EB2,0x0ED1,0x1EF0,
    };
```

```
class CCrc8
{
public:
    CCrc8();
    virtual ~CCrc8();
public:
    void AddCrc(U8* buf);
    BOOL CheckCrc(U8* buf);
    void AddCrc(U8* buf,U32 count);
    BOOL CheckCrc(U8* buf,U32 count);

private:
};
#endif// !defined(AFX_CRC_H__4D713B9F_3315_4581_8940_B0A07ACC8A5F__INCLUDED_)

// Crc.cpp: implementation of the CCrc class.
//
//////////////////////////////////////////////////////////////////////

#include "stdafx.h"

#include "Crc.h"

#ifdef _DEBUG
#undef THIS_FILE
static char THIS_FILE[]=__FILE__;
#define new DEBUG_NEW
#endif

//////////////////////////////////////////////////////////////////////
// Construction/Destruction
//////////////////////////////////////////////////////////////////////
/*********************************************************
//功能描述:构造函数
//函数入口:无
//函数出口:无
//操      作:无
//版      本:V1.0
//作      者:
//时      间:2004.12.14 09:04
*********************************************************/
CCrc8::CCrc8()
{

}
```

```
/*********************************************************
//功能描述:析构函数
//函数入口:无
//函数出口:无
//操　　作:无
//版　　本:V1.0
//作　　者:
//时　　间:2004.12.14 09:05
*********************************************************/
CCrc8::~CCrc8()
{

}

/*********************************************************
//功能描述:8 位 CRC 校验程序
//函数入口:buf=数据缓冲区,count=数据长度
//函数出口:无
//操　　作:在数据缓冲区末尾加上 CRC 校验数据
//版　　本:V1.0
//作　　者:
//时　　间:2004.12.14 09:30
*********************************************************/
void CCrc8::AddCrc(U8* buf,U32 count)
{

    U32 i;
    U16 crcword=0xffff;
    U16 table;

    count -= 2;

    for( i=0; i<count; i++ )
    {
        table = (crcword>>8)^buf[i];
        crcword = (crcword<<8)^(CrcTable8[table]);
    }
    buf[i++] = (U8)( crcword >> 8 );
    buf[i]= (U8)( crcword & 0xff);
}

/*********************************************************
//功能描述:检查 CRC 校验码
//函数入口:buf=数据缓冲区,count=数据长度
//函数出口:校验成功返回 TRUE,失败返回 FALSE
//操　　作:对数据进行校验
```

```
//版      本:V1.0
//作      者:
//时      间:2004.12.14 09:31
*********************************************************/
BOOL CCrc8::CheckCrc(U8* buf,U32 count)
{
    U32 i;
    U16 crcword=0xffff;
    U16 table;

    for( i=0; i<count; i++ )
    {
        table = (crcword>>8)^buf[i];
        crcword = (crcword<<8)^(CrcTable8[table]);
    }
    crcword ^= 0xffff;
    if( crcword == 0xe2f0 )
    {
        return TRUE;
    }
    else
    {
        return FALSE;
    }
}
```

附录 2：

STAT 定义：

BIT0：1＝系统正常

BIT1：1＝采样完成，即一次完整的采样已完成，此时电流值及采样值有效。

BIT2：1＝校验值无效，此时采样值有效，电流值无效。

BIT3：1＝CT 注册无效，如无注册码，一定清零。

BIT4：1＝开关量 1 输入闭合，0＝开关量 1 输入断开。

BIT5：1＝开关量 2 输入闭合，0＝开关量 2 输入断开。

BIT6：1＝报警有效。

BIT7：1＝预报警有效。

CTRL 定义：

BIT0：1＝执行保存参数，执行后自动清零。

BIT1：1＝启动重新采样，执行后自动清零。

BIT2：1＝预报警有效，测试预报警值，0＝预报警无效，不测试预报警，但不用清除预报警位。

BIT3：1＝报警有效，测试报警值，0＝无效，不测试报警值，但不用清除预警位。

其它备用。