# Split Core Hall Effect DC Current Sensor CYHCTD-S3K with Analog and Digital Outputs

The sensor CYHCTD-S3K is a Hall Effect current sensor for the measurement of DC current. The sensor has a galvanic isolation between the high power primary conductor and the secondary electronic circuit. The sensor has different analog and digital output signals under different power supplies. The data communication between sensor and digital equipment can be realized directly through the interface RS-485 MODBUS.

| Features and Advantages | Applications |
|---|---|
| • DC current measurement<br>• High measuring accuracy<br>• Analog and digital output signal (0-5V, 0-10V, RS-485 Modbus)<br>• Split Core, easy installation<br>• Protection against overvoltage<br>• Protection against reversed polarity<br>• Output protection against electrical disturbances | • **Photovoltaic equipment**<br>• Battery banks, such as, monitoring load current and charge current, verifying operation<br>• Transportation, measuring traction power<br>• Phase fired controlled heaters<br>• Directly connect to PLC<br>• Sense motor stalls and short circuits<br>• Industrial instrumentation |

## 1. Specifications

### Analog Electrical Data:

| | |
|---|---|
| Rated input current (DC) | 25A,30A,40A,50A,60A,70A,80A,90A,100A,200A,300A,400A,500A |
| Analog output signals | 0-5VDC, 0-10VDC |
| Power supply | +12V DC, +15VDC, +24V DC |
| Measuring accuracy | ±1.0%FS for 25A~49A; ±0.5%FS for 50A~500A |
| Linearity (10% - 100%), 25°C | ±0.5%FS for 25A~49A, ±0.2%FS for 50A~500A |
| Zero offset voltage | ±10mV |
| Hysteresis error | ±10mV |
| Thermal drift of offset voltage | ≤300ppm/°C |
| Thermal Drift (-10°C to 50°C) | ≤1000ppm/°C |
| Galvanic isolation | 3 kV DC, 1min. |
| Isolation resistance | ≥100MΩ |
| Response time | ≤10μs for instantaneous output |
| Frequency Bandwidth (-3dB) | DC – 8kHz |
| di/dt following accuracy | 50A/μs |
| Overload capacity | 5 times of rated current |
| Current consumption | ≤25mA |
| Output load | ≥2kΩ |

### General Data:

| | |
|---|---|
| Mounting | 35mm DIN Rail |
| Case style and Window size | S3K with aperture Ø20mm |
| Protection of Case | IP20 |
| Operating temperature | -40°C ~ +85°C |
| Storage temperature | -55°C ~ +100°C |
| Relative humidity | 5%~95% no dew |
| MTBF | ≥ 100k hours |

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### Digital Electrical Data:

| | |
|---|---|
| Digital output | Current I (real value with 2 decimal places in binary code) |
| Output interface: | RS-485, MODBUS |
| Baud rate: | 1200, 2400, 4800, 9600 (default), 19.2K, 38.4K, 57.6K, 115.2K bps |
| Refreshing period | 0.5ms |
| Measuring accuracy | ±0.5%FS |
| Linearity (10% - 100%), 25°C | ±0.2%FS |
| Galvanic isolation | 2500V rms for 1 min. per UL 1577 |
| Bus protection | ±15kV ESD protection on RS-485 input/output pins, open- and short circuit, fail-safe receiver inputs |
| Power consumption | <650mW (under power supply +12V) |

## 2. Definition of Part number

| CYHCTD | - | S3K | - | M | - | x | n | y |
|---|---|---|---|---|---|---|---|---|
| (1) | | (2) | | (3) | | (4) | (5) | (6) |

| (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|
| Series name | Case style | Rated input current (M=U/B+m) | Analog output voltage | Power supply | Interface |
| CYHCTD | S3K | m = 25A, 30A, 40A, 50A, 60A, 70A, 80A, 90A, 100A, 200A, 300A, 400A, 500A | **x=3:** 0-5V DC<br>**x=8:** 0-10V DC | **n=2:** +12V DC<br>**n=3:** +15V DC<br>**n=4:** +24V DC | **y=3:** RS485, MODBUS |

U: unidirectional; B: bidirectional (please give U or B in the part number)

**Example 1:** CYHCTD-S3K-U50A-843 for DC Current Sensor with
Rated input current: 0-50A DC
Analog output voltage: 0-10V DC
Power supply: +24V DC
Interface: RS-485, MODBUS

**Example 2:** CYHCTD-S3K-B50A-843 for DC Current Sensor with
Rated input current: -50A ~ 0 ~ 50ADC
Analog output voltage: 0 ~ 5V ~ 10VDC
Power supply: +24V DC
Interface: RS-485, MODBUS

Relation between Input and Output:

| Sensor CYHCTD-S3K-U50A-843 | | Sensor CYHCTD-S3K-B50A-843 | |
|---|---|---|---|
| Input current (A) | Output voltage (V) | Input current (A) | Output voltage (V) |
| 0 | 0 | -50 | 0 |
| 12.5 | 2.5 | -25 | 2.5 |
| 25 | 5 | 0 | 5 |
| 37.5 | 7.5 | 25 | 7.5 |
| 50 | 10 | 50 | 10 |

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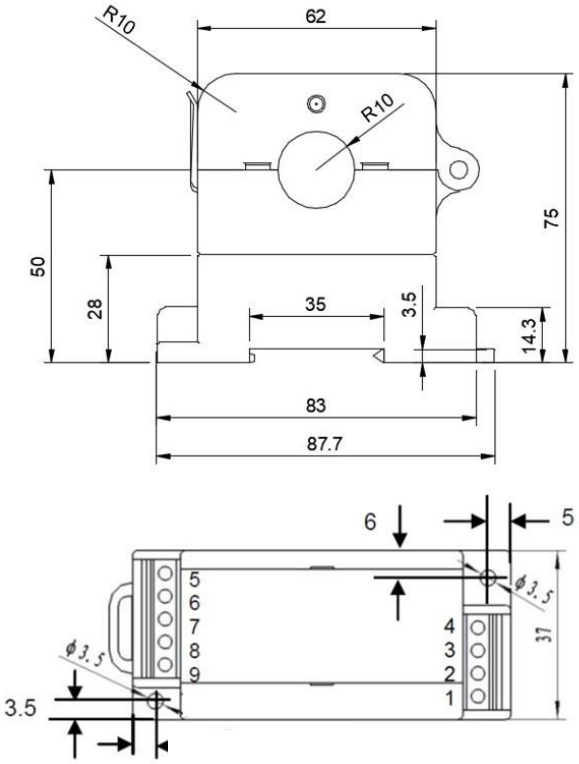
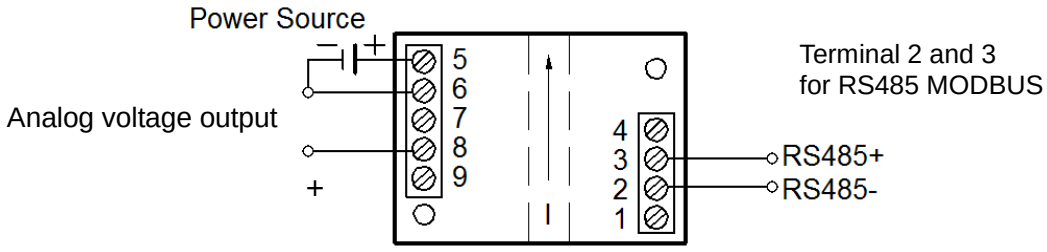
# 3. Case Style and Connection

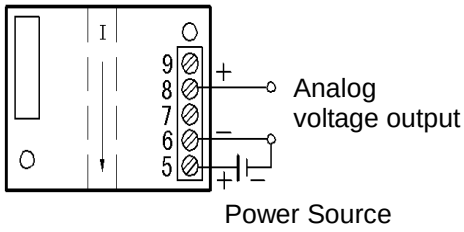

83 x 37 x 75mm

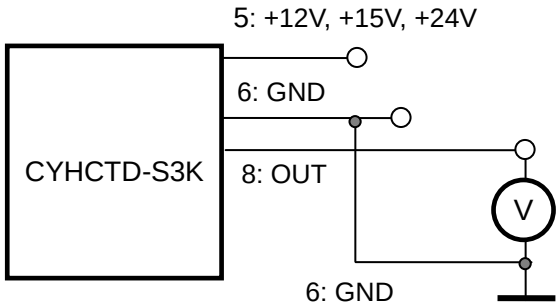
Case S3 with aperture Ø20mm

**Connection to Master Equipment with RS-485 interface**




**Wiring of Terminals for voltage output:**




5: +12V, +15V, +24V Power Supply  6: GND  8: Analog voltage output

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# 4. Communication Protocol and Order Sets

The orders of the digital Hall Effect current sensor series CYHCTD are MODBUS format. Their output communication protocol is RS-485 interface protocol.

## 4.1 Register Address Table

| Register Address | Content | Register Number | R/W | Data Range |
|---|---|---|---|---|
| 0x0010 | Reserved | 1 | | |
| 0x0011 | Current | 1 | R | According to measuring range |
| 0x0012-0x001F | Reserved | 14 | | |
| 0x0020 | Address and baud rate | 1 | R/W | Address 0x01-0xF7<br>Baud rate 0x03-0x0A |
| 0x0021 | Device name | 2 | R | “CTSK” |
| 0x0023 | Serial data format | 1 | R/W | Parity check 0x00-0x02<br>Length of stop bit 0x00-0x02 |
| 0x0024 | Internal output low-pass filter cutoff frequency*10 | 1 | R/W | 1-10000 |
| 0x0025-0x002F | Reserved | 11 | | |

Notice: 0x means the number is hex number, same as below.

## 4.2 Frame Format and Example

### 4.2.1 Function code 0x03 - read data from digital sensors

**Request frame of master equipment**

| | | |
|---|---|---|
| Sensor address | (0x01-0xF7 | 1 byte) |
| Function code | (0x03 | 1 byte) |
| Start register address | (2 bytes) | |
| Register number | (2 bytes) | |
| CRC | (2 bytes) | |

Notice: CRC means Cyclic Redundancy Check. In this product CRC is calculated according to CRC-16 (Modbus) standard, same as below.

**Examples:**

(1) Read current value

| Address | Function | Register Address | | Register Number | | CRC-L | CRC-H |
|---|---|---|---|---|---|---|---|
| 0x01 | 0x03 | 0x00 | 0x11 | 0x00 | 0x01 | 0xD4 | 0x0F |

(2) Read device name and settings

| Address | Function | Register Address | | Register Number | | CRC-L | CRC-H |
|---|---|---|---|---|---|---|---|
| 0x01 | 0x03 | 0x00 | 0x20 | 0x00 | 0x05 | 0x84 | 0x03 |

**Answer frame of digital sensors**

| | | |
|---|---|---|
| Sensor address | (0x01-0xF7 | 1 byte) |
| Function code | (0x03 | 1 byte) |
| Data byte length | (2*register number | 1 byte) |
| Data read from register | (Register contents | 2*register number bytes) |
| CRC | (2 bytes) | |

## Examples:

### (1) Received current value

| Address | Function | Data byte length | Data | | CRC-L | CRC-H |
|---|---|---|---|---|---|---|
| 0x01 | 0x03 | 0x02 | 0x0B | 0xB8 | 0xBF | 0x06 |

Current value format

2 bytes data in binary code with 2 decimal places, original code by positive values, twos complement code by negative values

data range -3000~3000 (measuring range is 30A as an example)

Notice: By unidirectional sensor outputs are always positive, the minimum output value is 0 or 0x0000.

Signification: 3000 corresponds positive input with rated value. E.g. when input current equals 30A DC, expected output result is 3000 or 0x0BB8; when input current equals -30A DC, expected output result is -3000 or 0xF448 (means 0x0000-0x0BB8=0xF448).

### (2) Received device name and settings

| Address | Function | Length | Data | | | | CRC-L | CRC-H |
|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x03 | 0x0A | 0x0106 | 0x43545333 | 0x0000 | 0x0000 | 0x07 | 0x54 |

Explanation:

0x0106 is sensor address and baud rate.

Valid addresses: 0x01 to 0xF7

Baud rate: 0x03 -- 1200 bps, 0x04 -- 2400 bps, 0x05 -- 4800 bps,
0x06 -- 9600 bps (default), 0x07 -- 19.2 kbps,
0x08 -- 38.4 kbps, 0x09 -- 57.6 kbps, 0x0A -- 115.2kbps

0x43545333 is the ASCII code of “CTS3”.

0x0000 is parity check and length of stop bit.

Parity check: 0x00 -- none (default), 0x01 -- odd, 0x02 -- even

Length of stop bit: 0x00 -- 1 bit (default), 0x01 -- 1.5 bits, 0x02 -- 2 bits

0x0000 is the cutoff frequency of internal output low-pass filter.

Internal low-pass filter cutoff frequency: 0 -- no low-pass filter (default),
others -- cutoff frequency*10

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### 4.2.2 Function code 0x10 --- write data to digital sensors

**Request frame of master equipment**

| | | |
|---|---|---|
| Sensor address | (0x01-0xF7 | 1 byte) |
| Function code | (0x10 | 1 byte) |
| Start register address | (2 bytes) | |
| Register number | (2 bytes) | |
| Data byte length | (2*register number | 1 byte) |
| Data write to register | (2*register number bytes) | |
| CRC | (2 bytes) | |

**Examples:**

(1) Change address and baud rate

Address from 01 (default) to 02, baud rate from 9600 (default) to 19.2K.

| Address | Function | Register Address | | Register Number | | Data Number | Data | | CRC-L | CRC-H |
|---|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x10 | 0x00 | 0x20 | 0x00 | 0x01 | 0x02 | 0x02 | 0x07 | 0xE1 | 0x92 |

Explanation:

Data 0x0207 is written into register 0x0020. The high byte 0x02 means the sensor address on the RS485 bus. The low byte 0x07 means the baud rate of communication.

(2) Change serial data format

Parity check from none (default) to even, length of stop bit from 1 bit (default) to 2 bits.

| Address | Function | Register Address | | Register Number | | Data Number | Data | | CRC-L | CRC-H |
|---|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x10 | 0x00 | 0x23 | 0x00 | 0x01 | 0x02 | 0x02 | 0x02 | 0x21 | 0xA2 |

Explanation:

Data 0x0202 is written into register 0x0023. The high byte 0x02 means the parity check. The low byte 0x02 means the length of stop bit.

(3) Change cutoff frequency of internal output low-pass filter

From no low-pass filter (default) to cutoff frequency 65.5Hz.

| Address | Function | Register Address | | Register Number | | Data Number | Data | | CRC-L | CRC-H |
|---|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x10 | 0x00 | 0x24 | 0x00 | 0x01 | 0x02 | 0x02 | 0x8F | 0xE0 | 0x70 |

Explanation:

This current sensor has a first order digital low-pass filter for output, which keeps the output result with higher stability when cutoff frequency is low. But a lower cutoff frequency also causes slower response. User can turn off this low-pass filter or adjust the cutoff frequency by setting this register.

Data 0x028F is written into register 0x0024. 0x028F=655, which corresponds cutoff frequency 65.5Hz.

**Answer frame of digital sensors**

| | | |
|---|---|---|
| Sensor address | (0x01-0xF7 | 1 byte) |
| Function code | (0x10 | 1 byte) |
| Start register address | (2 bytes) | |
| Register number | (2 bytes) | |
| CRC | (2 bytes) | |

**Examples:**

(1) Received correct answer of changing address and baud rate

| Address | Function | Register Address | | Register Number | | CRC-L | CRC-H |
|---|---|---|---|---|---|---|---|
| 0x01 | 0x10 | 0x00 | 0x20 | 0x00 | 0x01 | 0x00 | 0x03 |

(2) Received correct answer of changing serial data format

| Address | Function | Register Address | | Register Number | | CRC-L | CRC-H |
|---|---|---|---|---|---|---|---|
| 0x01 | 0x10 | 0x00 | 0x23 | 0x00 | 0x01 | 0xF0 | 0x03 |

(3) Received correct answer of changing cutoff frequency

| Address | Function | Register Address | | Register Number | | CRC-L | CRC-H |
|---|---|---|---|---|---|---|---|
| 0x01 | 0x10 | 0x00 | 0x24 | 0x00 | 0x01 | 0x41 | 0xC2 |

### 4.2.3 Error frame from digital sensors

**Error frame of digital sensors**

| | | |
|---|---|---|
| Sensor address | (0x01-0xF7 | 1 byte) |
| Function code | (0x80 \| function code | 1 byte) |
| Error Code | (0x01-0x04 | 1 byte) |
| CRC | (2 bytes) | |

The symbol “|” means logic “OR”

Error code

0x01: illegal function
0x02: illegal register address
0x03: illegal data value or register number
0x04: sensor failures (read or write error)

## Examples:

(1) Wrong function code has been send

For example, the function code 0x04 has been sent in a sending frame. Received error answer is

| Address | Function | Error Code | CRC-L | CRC-H |
|---|---|---|---|---|
| 0x01 | 0x84 | 0x01 | 0x82 | 0xC0 |

(2) Wrong register address has been send

The sending frame is for reading the current value as showed in paragraph 4.2.1, but the register address is 0x0001. Received error answer is

| Address | Function | Error Code | CRC-L | CRC-H |
|---|---|---|---|---|
| 0x01 | 0x83 | 0x02 | 0xC0 | 0xF1 |

(3) Wrong register number has been send

The sending frame is for reading device name and settings as showed in paragraph 4.2.1, but the register number is 0x0010. In this situation, the last register address that should be written is 0x0030, which is beyond the valid address range 0x0010 to 0x002F. Received error answer is

| Address | Function | Error Code | CRC-L | CRC-H |
|---|---|---|---|---|
| 0x01 | 0x83 | 0x02 | 0xC0 | 0xF1 |

(4) Register number must be greater than 0

The sending frame is for reading the current value as showed in paragraph 4.2.1, but the register number is 0x0000. Received error answer is

| Address | Function | Error Code | CRC-L | CRC-H |
|---|---|---|---|---|
| 0x01 | 0x83 | 0x03 | 0x01 | 0x31 |

(5) Wrong data number has been send

The sending frame is for changing cutoff frequency as showed in paragraph 4.2.2, but the data number is 0x03, which doesn't match register number*2. Received error answer is

| Address | Function | Error Code | CRC-L | CRC-H |
|---|---|---|---|---|
| 0x01 | 0x90 | 0x03 | 0x0C | 0x01 |

(6) Data written is beyond valid data range

The sending frame is for changing device address and baud rate as showed in paragraph 4.2.2, but the data is 0xF807, which is beyond the valid device address range 0x01-0xF7. Received error answer is

| Address | Function | Error Code | CRC-L | CRC-H |
|---|---|---|---|---|
| 0x01 | 0x90 | 0x03 | 0x0C | 0x01 |

(7) The case (0x04: Sensor failures) should not occur in this sensor

**Notes:**

1. If digital sensor address or CRC is wrong, no answer frame or error frame will be back from sensor.
2. Low byte of CRC is transmitted first. By register address, register number and data, high byte is transmitted first.
3. Register word length is 16 bits (2 bytes).

4. Every valid request frame has a corresponding answer. The master equipment should send the next request after the answer has been received. The maximum waiting time for data reading equals to the data refreshing period. And the waiting time for configuration changing is up to 25ms.

**Application Notes:**

1. Connect the terminals of power source, output respectively and correctly, never make wrong connection.
2. Two potentiometers can be adjusted, only if necessary, by turning slowly to the required accuracy with a small screw driver.
3. The best accuracy can be achieved when the window is fully filled with bus-bar (current carrying conductor).
4. The in-phase output can be obtained when the direction of current of current carrying conductor is the same as the direction of arrow marked on the transducer case.