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# Signal processing unit CYSPU-F98B for frequency and speed measurement

The signal processing unit CYSPU-F98B uses a low-power microprocessor to process periodic analog signals and is used to determine the frequency of tachometers and gear sensors, e.g. CYGTS101DC, CYGTS101DC-S, CYGTS104U, CYGTS104X, which provide a square wave pulse or two square wave pulses with phase difference. For frequency measurement, this signal processing unit has a large frequency measuring range from 10Hz to 1MHz with a measuring accuracy of 0.05%. The frequency value can be easily converted into rotational speed as output value. In addition, the direction of rotation can be determined by two square waves with a phase difference.

The measurement results can be displayed via the LCD module or communicated via the RS485 interface based on the MODBUS protocol. The device works with a supply voltage of 4.5V to 24VDC.

## 1.    Specifications

### Features

- Processing of analog square signals
- Wide frequency measuring range from 10Hz to 1MHz
- Very high measuring accuracy 0.05%
- Intuitive reading of the frequency, rotational speed values and direction on the LCD
- Output of the frequency and speed values via RS-485 Modbus
- EMI resistant
- Wide operating temperature range: -20°C ~ +70°C (with display), -40°C ~ +85°C (without display)
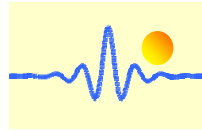
### Application

- Frequency measurement of square waves
- Speed measurement using speed sensors or gear tooth sensors
- Determination of the rotating direction
- Equipment for precise speed measurement and control
- Speedometer
- Drive control and blocking protection

### Technical Data

| Part number | CYSPU-F98B | Supply voltage | +4,5V ~ +24V |
|---|---|---|---|
| Frequency measurement range F | Square wave input: 10Hz ~ 1MHz | | |
| Speed measuring range ω | ω =60F/N (RPM), with N as pulse/period number per revolution | | |
| Measuring accuracy | 0.05% | | |
| Data Output | LCD display or RS485 interface | | |
| Display | 16-digit LCD | | |
| Refresh rate of LCD display | 25Hz | | |
| Baud rate for RS485 | 1200, 2400, 4800, 9600 (Default), 19.2K, 38.4K, 57.6K, 115.2K bps | | |
| Data output rate [1] | 10 S/s ~ 1024 S/s (samples/second) | | |
| Power consumption | <1200mW (under power supply + 12V) | | |
| Galvanic isolation | 2500V rms for 1 min. according to UL 1577 | | |
| Bus protection | ±15kV ESD protection on RS-485 input/output pins, open- and short circuit, fail-safe receiver inputs | | |

(1) When continuous data output mode is selected, the number of data results per second is the data output rate.
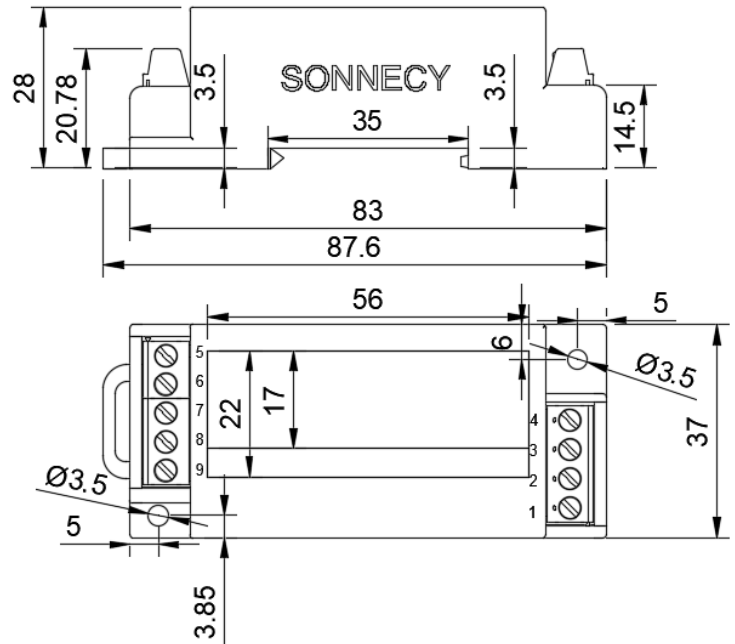
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## Absolute Grenzwerte

| Supply voltage | +4.5V ~ +30V DC |
|---|---|
| Reverse protection voltage (max) | -30V |
| Input voltage (Square Wave) | 0V ~ +22V |
| Operating temperature range | -20°C ~ +70°C (with display), -40°C ~ +85°C (without display) |

## 2.    Case Style and Connection
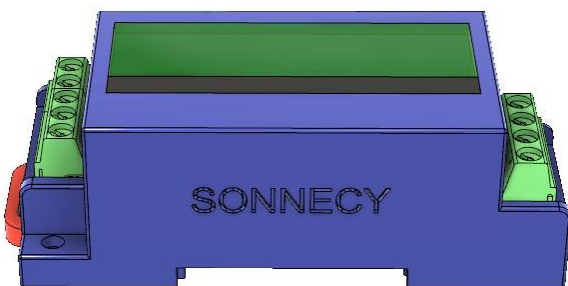
Case: 83 X 37 X 28 mm
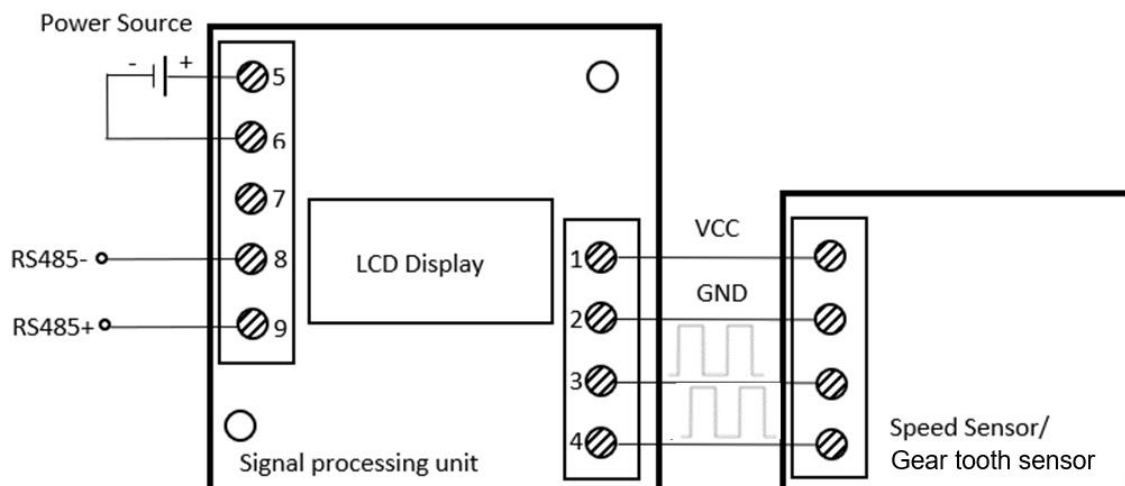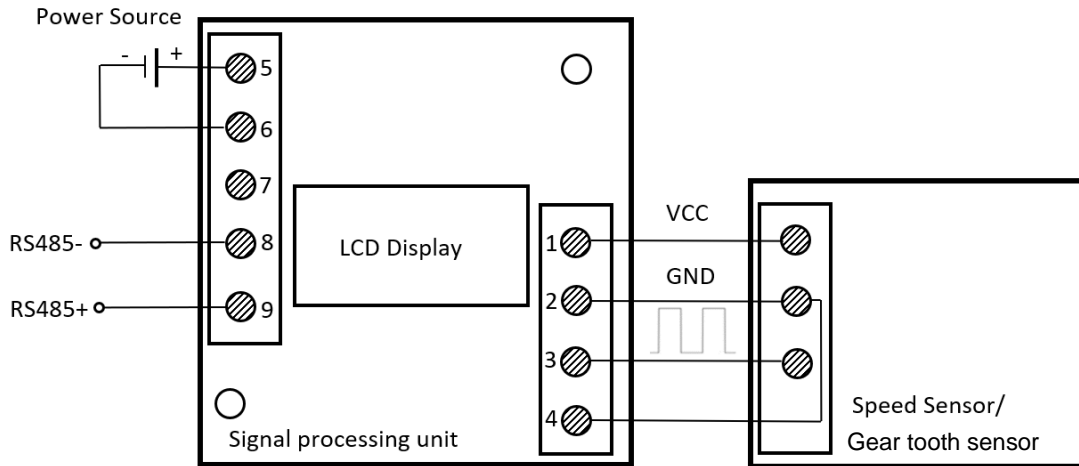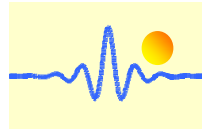
LCD module: 22 X 56 mm

**Connection to the speed sensor / gear tooth sensor with two square inputs with a phase difference between 0° and 360°**

∗    If the phase difference of the square pulses at pin 3 compared to the square pulse at pin 4 is between 0° and 180°, the direction of rotation is defined as clockwise (CW). Otherwise, the direction is considered as counterclockwise (CCW).

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## Connection to speed sensor / gear tooth sensor with a square wave signal input



## Connection to square wave signal source
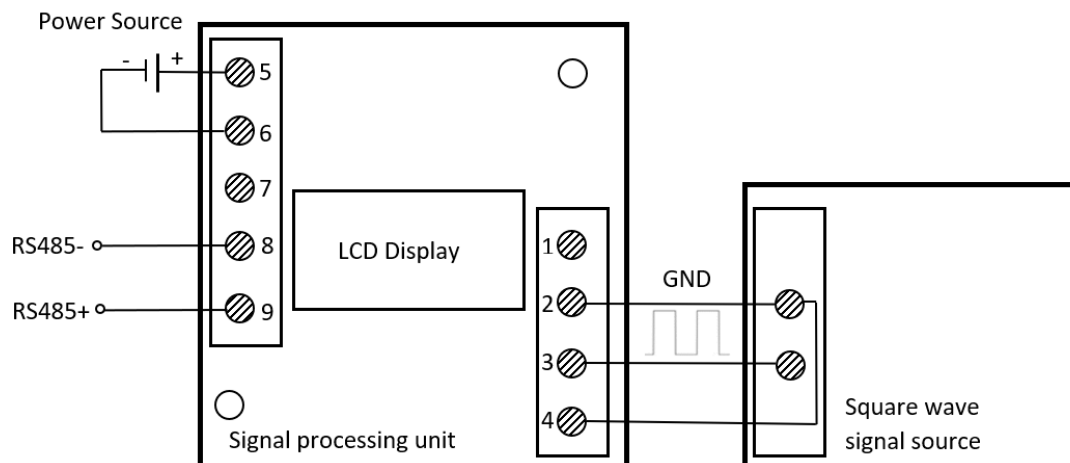


## 3.     Communication Protocol and Order Sets

This digital signal processing unit uses MODBUS-RTU protocol format and has RS485 output interface for long distance data transmission.

## 3.1 Register Address Table

| Register Address | Content | Register Number | R/W | Data Range |
|---|---|---|---|---|
| 0x0010 | Frequency (Hz) | 2 | R | According to the Measuring range |
| 0x0012 | Rotational Speed (RPM) | 2 | R | According to the formula for speed conversion |
| 0x0014 | Direction | 1 | R | 0x0001 (Clockwise), 0x0002 (Counterclockwise) |

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| 0x0015 - 0x001F | Reserved | 11 | - | - |
|---|---|---|---|---|
| 0x0020 | Address und baud rate | 1 | R/W | Address 0x01 - 0x07<br>Baud rate 0x03 - 0x0A |
| 0x0021 | Device designation | 5 | R | "CYSPU-F98B" |
| 0x0026 | Serial data format | 1 | R/W | Parity check 0x00 - 0x02<br>Length of stop bit 0x00-0x02 |
| 0x0027 | Number of teeth | 1 | R/W | Positive integers |
| 0x0028 | Display Mode selection | 1 | R/W | Display mode 0x0000 or 0x0100 |
| 0x0029 | Data output with RS485 | 1 | R/W | Query data output: 0x0000, 0x0100<br>Continuous data output: 0x0001, 0x0101 |
| 0x002A-0x002F | Reserved | 6 | - | - |

**Note: 1.** 0x means the number is hex number, as described below.

## 3.2 Frame format and example

### 3.2.1 Function code 0x03 - read data from the signal processing unit

**Request frame of master equipment**

| Address of the signal processing unit | 0x01 – 0xF7 | 1 byte |
|---|---|---|
| Function code | 0x03 | 1 byte |
| Start register address | 2 bytes | |
| Register number | 2 bytes | |
| CRC | 2 bytes | |

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

**Examples:**

(1) Read frequency value

| Address | Function | Register address | | Register number | | CRC-L | CRC-H |
|---|---|---|---|---|---|---|---|
| 0x01 | 0x03 | 0x00 | 0x10 | 0x00 | 0x02 | 0xC5 | 0xCE |

(2) Read rotational speed value

| Address | Function | Register address | | Register number | | CRC-L | CRC-H |
|---|---|---|---|---|---|---|---|
| 0x01 | 0x03 | 0x00 | 0x12 | 0x00 | 0x02 | 0x64 | 0x0E |

(3) Read rotational direction

| Address | Function | Register address | | Register number | | CRC-L | CRC-H |
|---|---|---|---|---|---|---|---|
| 0x01 | 0x03 | 0x00 | 0x14 | 0x00 | 0x01 | 0xC4 | 0x0E |

(4) Read device name and settings

| Address | Function | Register address | | Register number | | CRC-L | CRC-H |
|---|---|---|---|---|---|---|---|
| 0x01 | 0x03 | 0x00 | 0x20 | 0x00 | 0x0A | 0xC4 | 0x07 |

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## Answer frame of the signal processing unit

| Address of the signal processing unit | 0x01 – 0xF7 | 1 byte |
|---|---|---|
| Function code | 0x03 | 1 byte |
| Data byte length | 2 x register number | 1 byte |
| Data read from register | Register content | 2 x register number bytes |
| CRC | 2 bytes | |

**Examples:**

(1) Receive frequency value

| Address | Function | Data byte length | Data | | | | CRC-L | CRC-H |
|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x03 | 0x04 | 0x00 | 0x0F | 0x42 | 0x40 | 0xFB | 0x60 |

Frequency value format：

**4 bytes:** The first byte indicates the number of fractional digits of the frequency value, which is known as $N_{fd}$. The first byte is in the range 0x00-0x06. To obtain the frequency value, the last three bytes need to be converted to decimal numbers. The frequency value is equal to this decimal integer divided by the $N_{fd}$ power of 10. For example, the 4-byte data is 0x000F4240, then the first byte 0x00 means that $N_{fd}$ is 0. The decimal number of 0x0F4240 is 1000000. Finally, considering the number of decimal places, the frequency value is 1MHz.

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Data range: 10Hz ~ 1MHz

(2) Receive speed value

| Address | Function | Data byte length | Data | | | | CRC-L | CRC-H |
|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x03 | 0x04 | 0x00 | 0x4C | 0x4B | 0x40 | 0x0C | 0xE4 |

Rotational speed value format：

**4 bytes:** The first byte indicates the number of fractional digits of the speed value, which is known as $N_{fd}$. The first byte is in the range 0x00-0x06. To obtain the speed value, the last three bytes need to be converted to decimal numbers. The speed value is equal to this decimal integer divided by the $N_{fd}$ power of 10. For example, the 4-byte data is 0x004C4B40, then the first byte 0x00 means that $N_{fd}$ is 0. The decimal number of 0x0F4240 is 5000000. Finally, considering the number of decimal places, the speed value is 5MRPM.

Conversion to speed value: ω=60F/N (ω: Speed value, F: Frequency value, N: Number of teeth)
Data range: 50RPM ~ 5MRPM (For gears with 12 teeth)

(3) Receive rotational direction

| Address | Function | Data byte length | Data | CRC-L | CRC-H |
|---|---|---|---|---|---|
| 0x01 | 0x03 | 0x02 | 0x0001 | 0x79 | 0x84 |

Explanation:

0x0001 means the clockwise rotation direction (CW), while 0x0002 refers to the counterclockwise direction of rotation (CCW). 0x0000 represents an uncertain direction of rotation. The determination of the rotation direction is only possible with two square wave inputs with phase difference.

(4) Receive device name and settings

| Address | Function | Length | Data | | | | | | CRC-L | CRC-H |
|---|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x03 | 0x20 | 0x0106 | 1* | 0x0000 | 0x000C | 0x0000 | 0x0000 | 0x7C | 0x4D |

Explanation:

0x0106 is address of the signal processing unit and baud rate.
Valid addresses: 0x01 to 0xF7

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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

The ASCII code 1* (10 bytes) describes the name of the device, namely "CYSPU-F98B ".

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 bit, 0x02 -- 2 bit

0x000C is the number of teeth of the target gear for the speed sensor. This value is converted to a decimal number and results in a number of teeth to 12. If it is 0x0000 (default) there is no conversion from frequency value to speed value (speed value equals the frequency value when N=1).

0x0000 describes the display mode.
Display mode:            0x0000 -- Frequency value (default),     0x0100-- Rotational speed value

0x0000 indicates the output mode of the data using the RS485 bus.
Query data output: 0x0000 (default)
Continuous data output: 0x0001

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### 3.2.2 Function code 0x10 --- write data to the signal processing unit

**Request frame of master equipment**

| Address of the signal processing unit | 0x01-0xF7 | 1 byte |
|---|---|---|
| Function code | 0x10 | 1 byte |
| Start register address | 2 bytes | |
| Register number | 2 bytes | |
| Data byte length | 2 x register number | 1 Byte |
| Data write to register | 2 x 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.

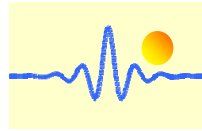| Address | Function | Register Address | | Register Number | | Data Number | Data | | CRC-L | CRC-H |
|---|---|---|---|---|---|---|---|---|---|---|
| 0x01 | 0x10 | 0x00 | 0x20 | 0x00 | 0x01 | 0x02 | 0x02 | 0x07 | 0xE1 | 0x92 |

Explanation:

The data 0x0207 are written into the register 0x0020. The high byte 0x02 means the address of the signal processing unit on the RS485 bus. The low byte 0x07 means the communication baud rate.

(2) Change serial data format

Parity check is 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 | 0x26 | 0x00 | 0x01 | 0x02 | 0x02 | 0x02 | 0x21 | 0xF7 |

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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 the number of teeth on the target gear

The standard register value is 0x0000, which means that the frequency value is not converted to the speed value. The number of teeth 12 is written into the corresponding register according to the lower instruction.

| Address | Function | Register Address | | Register Number | | Data Number | Data | | CRC-L | CRC-H |
|---------|----------|---------|------|---------|------|-------|------|------|-------|-------|
| 0x01 | 0x10 | 0x00 | 0x27 | 0x00 | 0x01 | 0x02 | 0x00 | 0x0C | 0xA0 | 0x82 |

Explanation:

> For the signal processing of the speed sensor, there is a mathematical relationship between the signal frequency and the speed value. By giving the number of teeth of the target wheel, the signal frequency can be converted into the speed value. If the conversion is not needed, this register value can be set to the value 0x0000.

(4) Change the display mode

There are two types for displaying the measurement results, i.e., frequency value and speed value. Decide whether to display the frequency value or the speed value by the following command.

Displayed value: Frequency value (default).

| Address | Function | Register Address | | Register Number | | Data Number | Data | | CRC-L | CRC-H |
|---------|----------|---------|------|---------|------|-------|------|------|-------|-------|
| 0x01 | 0x10 | 0x00 | 0x28 | 0x00 | 0x01 | 0x02 | 0x00 | 0x00 | 0xA0 | 0x78 |

Displayed value: Speed value.

| Address | Function | Register Address | | Register Number | | Data Number | Data | | CRC-L | CRC-H |
|---------|----------|---------|------|---------|------|-------|------|------|-------|-------|
| 0x01 | 0x10 | 0x00 | 0x28 | 0x00 | 0x01 | 0x02 | 0x01 | 0x00 | 0xA1 | 0xE8 |

(5) Change the data output mode of the RS485 bus

There are two types of data output. The default is query data output. When a query command is input, it can immediately output a current data. Whenever new data needs to be read, a new query command is required. Another type of data output is to continuously output the current data, which can accurately reflect the changes in the current data.
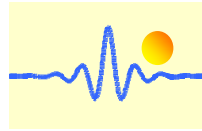The data will be output continuously after inputting the following commands, that is continuous data output.

| Address | Function | Register Address | | Register Number | | Data Number | Data | | CRC-L | CRC-H |
|---------|----------|---------|------|---------|------|-------|------|------|-------|-------|
| 0x01 | 0x10 | 0x00 | 0x29 | 0x00 | 0x01 | 0x02 | 0x00 | 0x01 | 0x60 | 0x69 |

| Address | Function | Register Address | | Register Number | | Data Number | Data | | CRC-L | CRC-H |
|---------|----------|---------|------|---------|------|-------|------|------|-------|-------|
| 0x01 | 0x10 | 0x00 | 0x29 | 0x00 | 0x01 | 0x02 | 0x01 | 0x01 | 0x61 | 0xF9 |

The low 8-bit byte 0x01 of data 0x0001 or 0x0101 indicates the continuous data output. The high byte represents the data type, frequency value (0x00) or speed value (0x01).

When the data is continuously output, and the signal measurement has started, the input of any command on the RS485 bus should be prohibited, otherwise the sending data and the receiving data conflict and an error occurs. If the parameters need to be set, the continuous data output mode must be cancelled before

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inputting the corresponding command to ensure that the RS485 bus is free. Canceling the continuous data output can be achieved by restarting or sending the following commands.

Send the following command to interrupt the continuous output mode.

| Address | Function | Register Address | | Register Number | | Data Number | Data | | CRC-L | CRC-H |
|---------|----------|------|------|------|------|------|------|------|------|------|
| 0x01 | 0x10 | 0x00 | 0x29 | 0x00 | 0x01 | 0x02 | 0x00 | 0x00 | 0xA1 | 0xA9 |

Send the following command after 1 s interval to reset the device.

| Address | Function | Register Address | | Register Number | | Data Number | Data | | CRC-L | CRC-H |
|---------|----------|------|------|------|------|------|------|------|------|------|
| 0x01 | 0x10 | 0x00 | 0x29 | 0x00 | 0x01 | 0x02 | 0x01 | 0x02 | 0x20 | 0x68 |

After the above operation it returns to the default query data output. At this moment, the corresponding write and read commands can be used to read or change the parameters. If the continuous data output needs to be used, the continuous output mode must be activated.

**Answer frame of the signal processing unit**

| | | |
|---|---|---|
| Address of the signal processing unit | 0x01-0xF7 | 1 byte |
| Function code | 0x10 | 1 byte |
| Start register address | 2 bytes | |
| Register number | 2 bytes | |
| CRC | 2 bytes | |

**Examples:**

(1) Receive 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) Receive correct answer of changing serial data format

| Address | Function | Register Address | | Register Number | | CRC-L | CRC-H |
|---------|----------|------|------|------|------|------|------|
| 0x01 | 0x10 | 0x00 | 0x26 | 0x00 | 0x01 | 0xE0 | 0x20 |

(3) Receive correct answer of changing the number of teeth of the target wheel

| Address | Function | Register Address | | Register Number | | CRC-L | CRC-H |
|---------|----------|------|------|------|------|------|------|
| 0x01 | 0x10 | 0x00 | 0x27 | 0x00 | 0x01 | 0xB1 | 0xC2 |

(4) Receive correct answer of changing the display mode

| Address | Function | Register Address | | Register Number | | CRC-L | CRC-H |
|---------|----------|------|------|------|------|------|------|
| 0x01 | 0x10 | 0x00 | 0x28 | 0x00 | 0x01 | 0x81 | 0xC1 |

(5) Receive correct answer of changing the data output mode of the RS485 bus

| Address | Function | Register Address | | Register Number | | CRC-L | CRC-H |
|---------|----------|------|------|------|------|------|------|
| 0x01 | 0x10 | 0x00 | 0x29 | 0x00 | 0x01 | 0xD0 | 0x01 |

### 3.2.3 Function code 0x02 --- Data continuous output

The function code 0x02 can be activated or disabled according to the instructions in section 3.2.2 (5). If the function code 0x02 is activated, the data will be continuously exported.

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| Address | Function | Data Type | Data byte length | Data | | | | CRC-L | CRC-H |
|---------|----------|-----------|------------------|------|------|------|------|-------|-------|
| 0x01 | 0x02 | 0x00 | 0x04 | 0x00 | 0x0F | 0x42 | 0x40 | 0xFB | 0x60 |

| Address | Function | Data Type | Data byte length | Data | | | | CRC-L | CRC-H |
|---------|----------|-----------|------------------|------|------|------|------|-------|-------|
| 0x01 | 0x02 | 0x01 | 0x04 | 0x00 | 0x4C | 0x4B | 0x40 | 0x0C | 0xE4 |

**Answer frame of the signal processing unit**

| | | |
|---|---|---|
| Address of the signal processing unit | 0x01-0xF7 | 1 byte |
| Function code | 0x02 | 1 byte |
| Data type | 0x00/0x01 | 1 byte |
| Data byte length | 2 x register number | 1 byte |
| Data read from register | Register content | 2 x register number bytes |
| CRC | 2 bytes | |

Note:
1. There are two data types, frequency value (0x00) or speed value (0x01).
2. The first byte of the data indicates the number of fractional digits of the data value $N_{fd}$. To obtain the data value, the last three bytes need to be converted to decimal numbers. The frequency value is equal to this decimal integer divided by the $N_{fd}$ power of 10.
3. If the function code 0x02 is activated, the write command must be disabled. Otherwise, the data receive and send conflict. If the parameters need to be changed, the function 0x02 must be first disabled (See section 3.2.2 (5)).

### 3.2.4 Error frame from the signal processing unit

**Error frame of the signal processing unit**

| | | |
|---|---|---|
| Address of the signal processing unit | 0x01-0xF7 (0x00) | 1 byte |
| Function code | 0x80 l function code (0x00) | 1 byte |
| Error code | 0x10-0x04 | 1 byte |
| CRC | 2 bytes | |

The symbol "|" means logic "OR"

**Error code**

0x01: illegal function
0x02: illegal register address
0x03: illegal register number
0x04: illegal data value
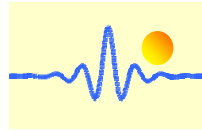0x05: wrong device address or wrong CRC

**Examples:**

(1) Wrong function code has been sent

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

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

(2) Wrong register address has been sent

The sending frame is for reading the current value as showed in paragraph 3.2.1, but the register address is 0x0001. Received error message is:

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

(3) Wrong register number has been sent

The sending frame is for reading device name and settings as showed in paragraph 3.2.1, 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 message 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 3.2.1, but the register number is 0x0000. Received error message is:

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

(5) Wrong data number has been sent

The sending frame is used to write data in the signal processing unit, as shown in section 3.2.2. If the data number does not match the register number x 2, an error occurs. Received error message 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 3.2.2, but the data is 0xF807, which is beyond the valid device address range 0x01-0xF7. Received error message is:

| Address | Function | Error code | CRC-L | CRC-H |
|---------|----------|------------|-------|-------|
| 0x01 | 0x90 | 0x04 | 0x4D | 0xC3 |

(7) Wrong device address or wrong CRC have been sent

The sending frame has the wrong device address or the wrong CRC. If a device address of 0x01 is mistaken for address 0x02 to send it a command, an error will occur. Received error message is:
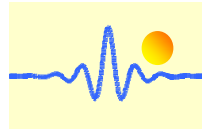
| Address | Function | Error code | CRC-L | CRC-H |
|---------|----------|------------|-------|-------|
| 0x00 | 0x00 | 0x05 | 0xB1 | 0xC3 |

**Notes:**

1. Low byte of CRC is transmitted first. In the case of register address, register number and data, the high byte is transferred first.
2. Register word length is 16 bits (2 bytes).
3. 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. The waiting time for configuration changing is up to 25ms.

# 4 Display Selection

The signal processing unit CYSPU-F98B uses an LCD module with 2 x16 characters. There are two display modes available for this product, namely frequency and speed display.

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For speed calculations the conversion factor is required, e.g. for gear tooth sensors the number of teeth of the target wheel. This value should be written into the register (register address 0x0027) (see section 3.2.2 (3)).

The display mode depends on the high 8-bit byte stored in this register (register address 0x0028). In the default, the LCD display of the signal processing unit shows the frequency value when the high 8-bit byte in this register is 0x00. For speed display, the high 8-bit byte is 0x01. If the display mode needs to be converted, this byte must be changed (see section 3.2.2 (4)).

**Examples:**

(1) Write conversion factor N for speed calculations into register 0x0027

| Address | Function | Register Address | | Register Number | | Data Number | Data | | CRC-L | CRC-H |
|---------|----------|------------------|---|-----------------|---|-------------|------|------|-------|-------|
| 0x01 | 0x10 | 0x00 | 0x27 | 0x00 | 0x01 | 0x02 | 0x00 | 0x0C | 0xA0 | 0x82 |

0x0C is the conversion factor N, then the conversion to speed value can be derived: $\omega=60F/N$ ($\omega$: speed value, F: frequency value, N: number of teeth).

(2) Write display mode 0x01 for speed display into register 0x0028

| Address | Function | Register Address | | Register Number | | Data Number | Data | | CRC-L | CRC-H |
|---------|----------|------------------|---|-----------------|---|-------------|------|------|-------|-------|
| 0x01 | 0x10 | 0x00 | 0x28 | 0x00 | 0x01 | 0x02 | 0x01 | 0x00 | 0xA1 | 0xE8 |

The high 8-bit byte of data for speed display must be 0x01.

The measurement results are displayed on the LCD as follows. CW means Clockwise, CCW means Counterclockwise (Refer to section 2*).



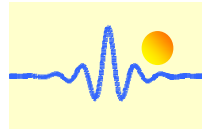Startup, it takes 3s



Frequency display



Speed display

(With number of teeth N=12)

# 5  Characteristics of continuous data output

The data from the digital signal processing unit will be output via the RS485 bus, which by default requires an input command for each data acquisition. To achieve continuous data output, the corresponding operation instruction is described in section 3.2.2 (5). The following is the output rate of continuous data output mode.

| Measurement Signal | Frequency Measuring range F | Output Rate |
|--------------------|----------------------------|-------------|
| Square wave input | 10Hz - 1MHz | 10 - 1024 Samples/s |

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# 6 Application Examples

The CYSPU-F98B can be used with a speed sensor, a gear tooth sensor or a signal source. There are many kinds of gear tooth speed sensors for speed measurement, such as CYGTS104U, CYGTS104X, CYGTS101DC, CYGTS101DC-S, etc. The following are various examples of speed measurement systems built with the signal processing unit CYSPU-F98B.

## 6.1 Speed test system with Hall Effect gear tooth sensor CYGTS104U Or CYGTS104X

The gear tooth sensor CYGTS104U or CYGTS104X are based on the Hall Effect principle. In use, it must be used together with the target iron gear. It measures the periodic motion of the teeth by detecting changes in the magnetic field and outputs two square wave signals with phase difference. Pull-up resistors of 1kΩ to 10kΩ must be connected between power supply and output. To obtain frequency values or speed values directly, the following measuring system can be set up.
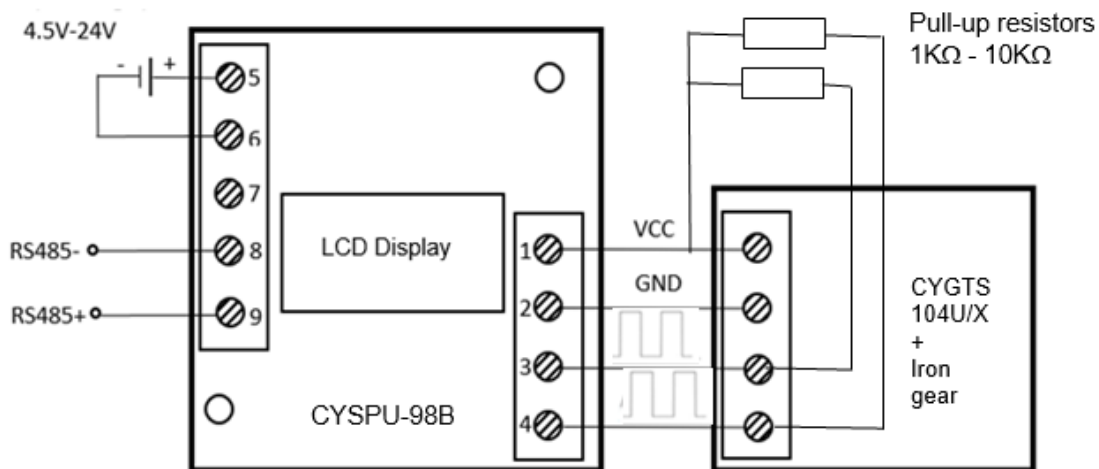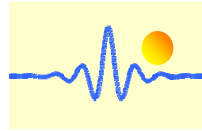


In this case the CYSPU-F98B processing unit gets two square wave inputs, thus rotational direction can be determined.

## 6.2 Speed test system with Hall Effect gear tooth sensor CYGTS101DC

The Hall Effect gear sensor CYGTS101DC uses a Hall Effect IC to detect the magnetic field during the rotational motion of a ferrous target gear. It has only a square wave signal (open collector NPN) at the output. A pull-up resistor of 1kΩ to 10kΩ must be connected between power supply and output. To process the square wave signal, the following measuring system can be built.

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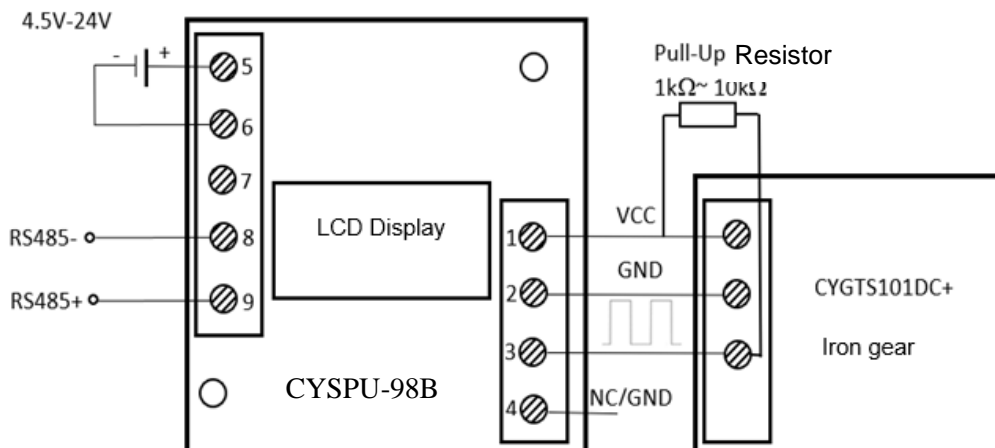
## 6.3 Speed test system with Hall Effect gear tooth sensor CYGTS101DC-S

The gear tooth sensor CYGTS101DC-S is also based on the Hall Effect principle. It uses a differential Hall Effect IC. The output is an open collector (NPN) square wave signal. A pull-up resistor of 1k to 10k must be connected between the output terminal und the power supply. To obtain the speed values, the following measuring system should be set up.
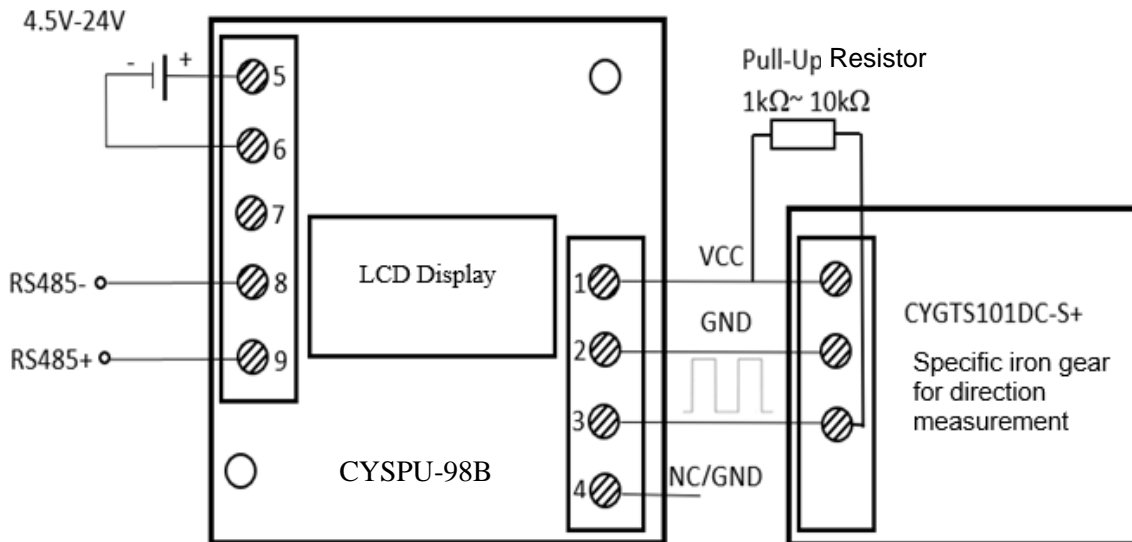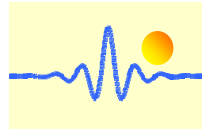


## 6.4 Test performance of speed test systems

Various tests using the measuring systems mentioned in 6.1-6.3 have been carried out in order to evaluate the measuring accuracy and the repeatability of the measuring systems. The results are shown in the following table, where σ is the standard derivation of the repeated measurements, μ represents the mean value of the repeated measurements.

| Gear tooth sensor | Signal Input (Measuring range: 3 - 3000 RPM) | Average deviation [1] | | $3\sigma / \mu$ [2] | | Direction detection |
|---|---|---|---|---|---|---|
| | | Min | Max | Min | Max | |
| CYGTS104U | Two square wave inputs | -0.39% | + 0.43% | 0.39% | 0.54% | Yes |
| CYGTS104X | Two square wave inputs | - 0.26% | + 0.47% | 0.42% | 0.56% | Yes |
| CYGTS101DC | A square wave input | - 0.22% | + 0.25% | 0.42% | 0.89% | No |
| CYGTS101DC-S | A square wave input | - 0.25% | + 0.40% | 0.25% | 0.88% | No |

(1) It refers to the relative deviation of the average of the 100 values measured in each group from the theoretical value.
(2) In statistics, the empirical rule states that 99.7% of data occurs within three standard deviations of the mean value within a normal distribution.

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## Application Notes:

1. Connect the voltage source, the input and the output correctly, never make a wrong connection.

2. The signal processing unit with LCD indicator should avoid contact between the screen and hard objects to avoid damaging the LCD. To ensure a long life of the LCD screen, please also make sure that the LCD screen is tidy, especially to avoid long-term stains and water droplets on the LCD module.

3. The better the signal-to-noise ratio of the input signals, the higher the measurement accuracy.

4. If the function code 0x02 is activated, the write command must be disabled. Otherwise, the data receive send conflict. If the parameters need to be changed, the function 0x02 must be first disabled. (See section 3.2.2 (5)).

5. The ambient temperature should be controlled within the operating temperature range of the product.

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