Signal processing unit CYSPU-F98A for frequency and speed measurement

The signal processing unit CYSPU-F98A 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, CYGTS102DC and CYGTS102OR, which provide a square-wave pulse, a sine wave signal or square and sine wave signals at the same time. For frequency measurement, this signal processing unit has a large frequency measuring range from 0.1Hz to 1MHz with a measuring accuracy of 0.1%. The frequency value can be easily converted into rotational speed as output value.
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 and sinusoidal signals
- Wide frequency measuring range from 0.1Hz to 1MHz
- Very high measuring accuracy 0.05~ 0.1%
- Excellent real-time performance for low frequency measurements
- Intuitive reading of the frequency and rotational speed values 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 and sine waves
- Speed measurement using speed sensors or gear tooth sensors
- Equipment for precise speed measurement and control
- Speedometer
- Drive control and blocking protection

Technical Data

Part number	CYSPU-F98A	Supply voltage	+4,5V ~ +24V
Frequency measurement range F	Sine signal input: 0,1Hz ~ 50kHz		
	Square wave input: 10Hz ~ 1MHz		
	Square wave and sine signal inputs: 0,1Hz ~ 1MHz		
Speed measuring range ω	ω =60F/N (RPM), with N as pulse/period number per revolution		
Measuring accuracy	Sine signal input: 0,1Hz ~ 50kHz, 0.1%		
	Square wave input: 10Hz ~ 1MHz, 0.05%		
	Square wave and sine signal inputs: 0,1Hz ~ 1MHz, 0.05%~0.1%		
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)	250 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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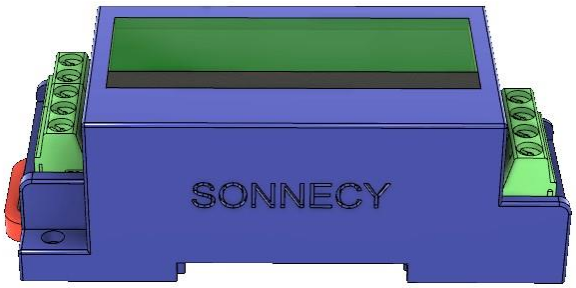
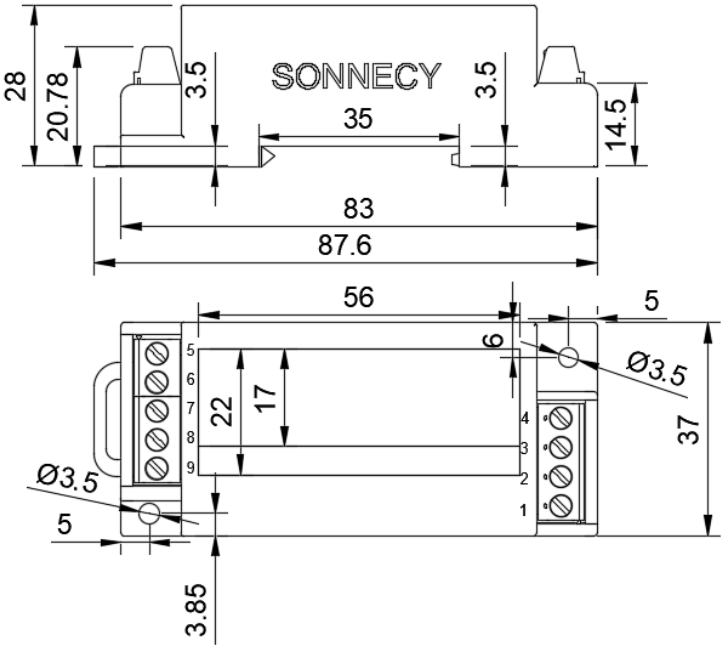
Absolute Grenzwerte

Supply voltage	+4.5V ~ +30V DC
Reverse protection voltage (max)	-30V
Input voltage (Sine Wave)	0V ~ +3.3V
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

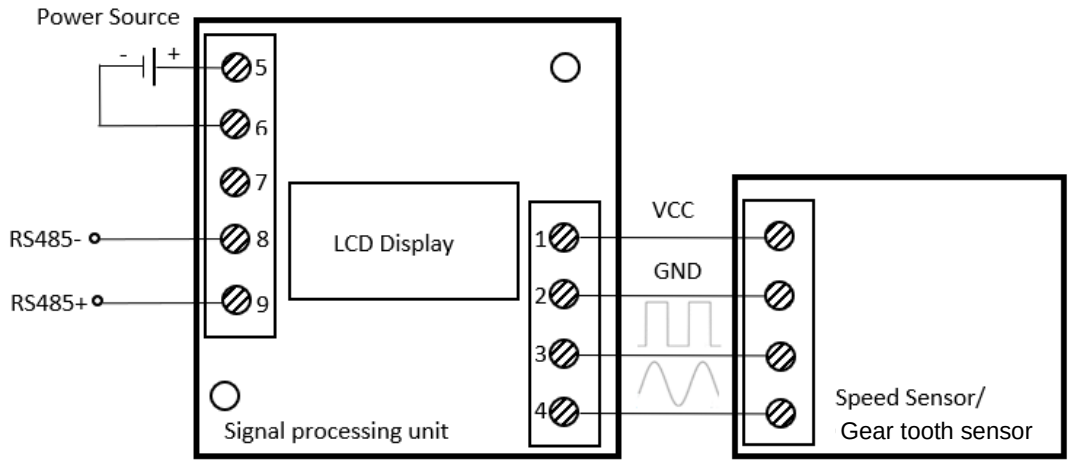




Case: 83 X 37 X 28 mm

LCD module: 22 X 56 mm

Connection to the speed sensor / gear tooth sensor with square and sine inputs



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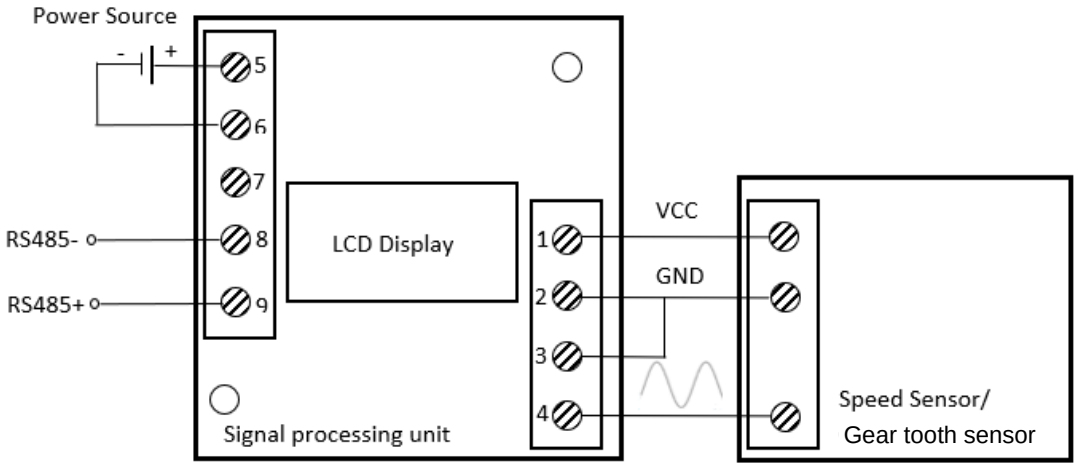
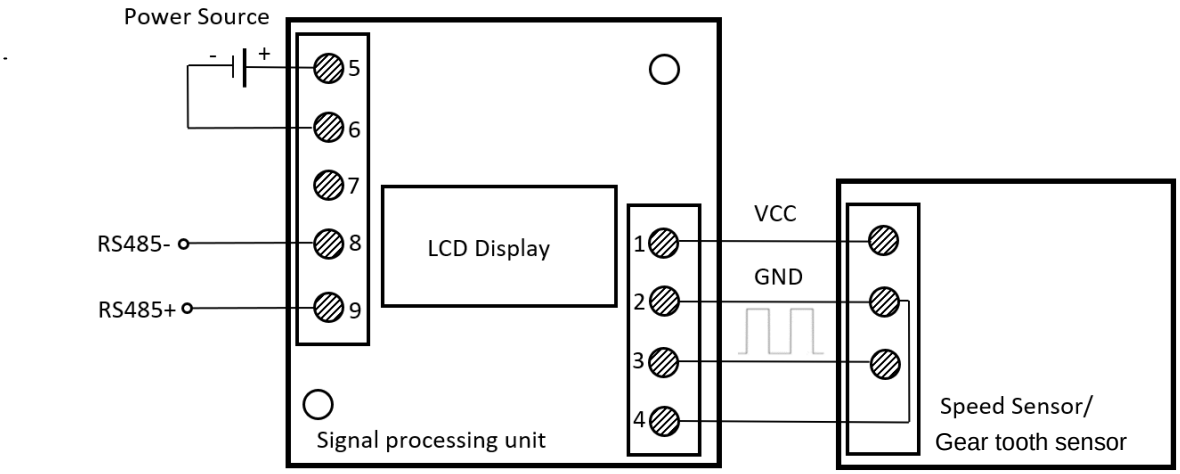
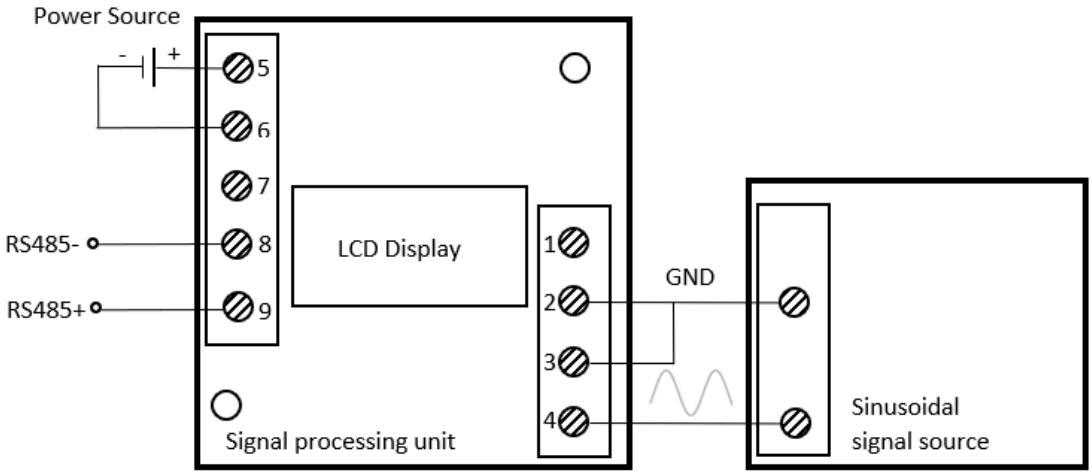
Connection to the speed sensor / gear tooth sensor with sinusoidal signal input



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



Connection to a sinusoidal signal source



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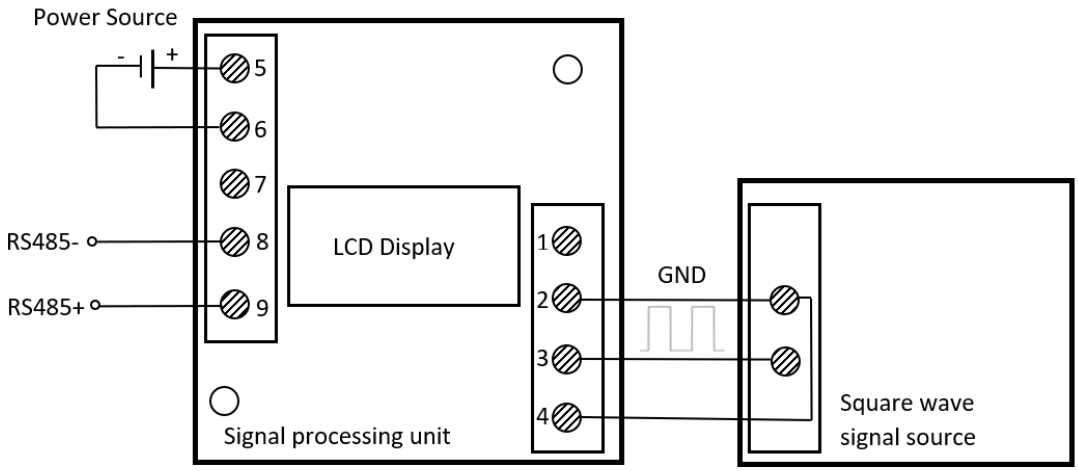
Connection to square wave signal source



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 - 0x001F	Reserved	12	-	-
0x0020	Address und baud rate	1	R/W	Address 0x01 - 0x07 Baud rate 0x03 - 0x0A
0x0021	Device designation	5	R	“CYSPU-F98A “
0x0026	Serial data format	1	R/W	Parity check 0x00 - 0x02 Length of stop bit 0x00-0x02
0x0027	Number of teeth	1	R/W	Positive integers
0x0028	Mode selection	1	R/W	Display mode 0x00 - 0x01 (High byte), Measurement mode 0x01 - 0x03 (Low byte)
0x0029	Data output with RS485	1	R/W	Query data output: 0x0000, 0x0100 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 device name and settings

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

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.

Data range: 0.1Hz ~ 1MHz

(2) Receive speed value

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

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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: 0.5RPM ~ 5MRPM (For gears with 12 teeth)

(3) Receive device name and settings

Address	Function	Length	Data						CRC-L	CRC-H
0x01	0x03	0x14	0x0106	1*	0x0000	0x000C	0x0001	0x0000	0x5D	0xFA

Explanation:

0x0106 is address of the signal processing unit 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

The ASCII code 1* (10 bytes) describes the name of the device, namely “CYSPU-F98A ".

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).

0x0001 describes the display mode and the measurement mode.
Display mode: 0x00 -- Frequency value (default), 0x01-- Rotational speed value
Measurement mode: 0x01 -- Square wave input (default),
0x02 -- Sine signal input
0x03 -- Square wave and sine signal inputs.
0x0000 indicates the output mode of the data using the RS485 bus.
Query data output: 0x0000 (default)
Continuous data output: 0x0001

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

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 and the measurement mode

There are two types for displaying the measurement results, i.e., frequency value and speed value. In addition, three measurement modes are available, namely measurement using sine signal, measurement using square wave and measurement using both sine signal and square wave.

Displayed value: Frequency value (default), Measurement mode: Mode 1 Square wave input (default).

Address	Function	Register Address		Register Number		Data Number	Data		CRC-L	CRC-H
0x01	0x10	0x00	0x28	0x00	0x01	0x02	0x00	0x01	0x61	0xB8

Displayed value: Frequency value (default), Measurement mode: Mode 2 Sine signal input.

Address	Function	Register Address		Register Number		Data Number	Data		CRC-L	CRC-H
0x01	0x10	0x00	0x28	0x00	0x01	0x02	0x00	0x02	0x21	0xB9

Displayed value: Frequency value (default), Measurement mode: Mode 3 Square wave & sine signal inputs.

Address	Function	Register Address		Register Number		Data Number	Data		CRC-L	CRC-H
0x01	0x10	0x00	0x28	0x00	0x01	0x02	0x00	0x03	0xE0	0x79

Displayed value: Speed value, Measurement mode: Mode 1 Square wave input (default).

Address	Function	Register Address		Register Number		Data Number	Data		CRC-L	CRC-H
0x01	0x10	0x00	0x28	0x00	0x01	0x02	0x01	0x01	0x60	0x28

Displayed value: Speed value, Measurement mode: Mode 2 Sine signal input.

Address	Function	Register Address		Register Number		Data Number	Data		CRC-L	CRC-H
0x01	0x10	0x00	0x28	0x00	0x01	0x02	0x01	0x02	0x20	0x29

Displayed value: Speed value, Measurement mode: Mode 3 Square wave & sine signal inputs.

Address	Function	Register Address		Register Number		Data Number	Data		CRC-L	CRC-H
0x01	0x10	0x00	0x28	0x00	0x01	0x02	0x01	0x03	0xE1	0xE9

(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 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 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 and measurement 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.

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:

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	0x03	0x01	0x31

(4) Register number must be greater than 0

The sending frame is for reading the frequency 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-F98A uses an LCD module with 2 x16 characters. There are two display modes available for this product, namely frequency and speed display.

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: ω=60F/N (ω: 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	0x01	0x60	0x28

The high 8-bit byte of data for speed display must be 0x01. The low 8-bit byte of data determines the measurement mode. Here mode 1 stands for measurement with the square wave signal input.

The measurement results are displayed on the LCD as follows.

Startup, it takes 3s

Frequency display in mode 1

Speed display in mode 1

(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.

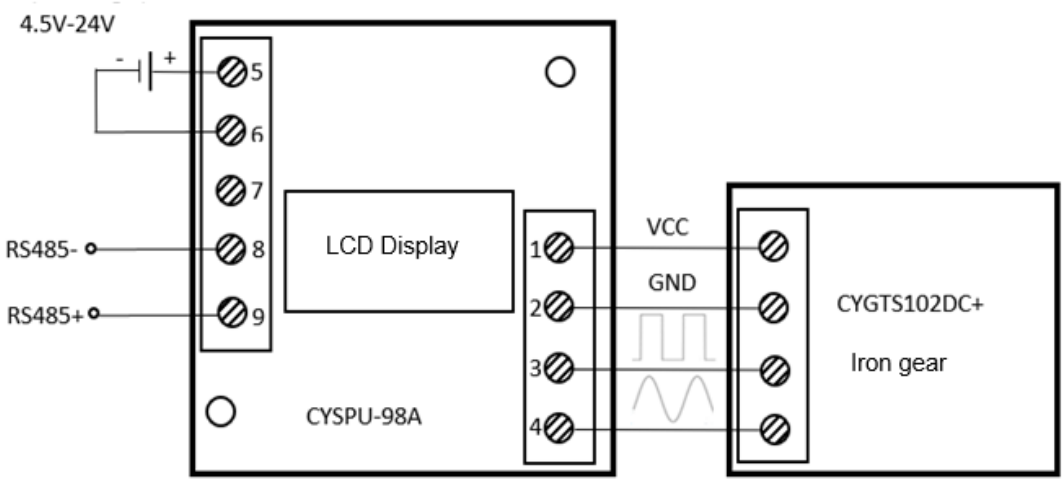
Measurement Mode	Frequency Measuring range	Output Rate
MOD1 - Square wave input	10Hz - 1MHz	10 - 1024 Samples/s
MOD2 - Sine signal input	0.1Hz - 1Hz	256 Samples/s
	1Hz - 25 Hz	512 Samples/s
	25Hz – 50kHz	10 - 1024 Samples/s
MOD3 - Square wave and sine signal inputs	0.1Hz - 1Hz	256 Samples/s
	1Hz - 25 Hz	512 Samples/s
	25Hz - 1MHz	25 - 1024 Samples/s

6 Application Examples

The CYSPU-F98A can be used with the speed sensor, gear tooth sensor or signal source. There are many kinds of gear tooth speed sensors for speed measurement, such as CYGTS102DC, CYGTS102OR, CYGTS101DC, CYGTS101DC-S, etc. The following are various examples of speed measurement systems built with the signal processing unit CYSPU-F98A.

6.1 Speed test system with Hall Effect gear tooth sensor CYGTS102DC

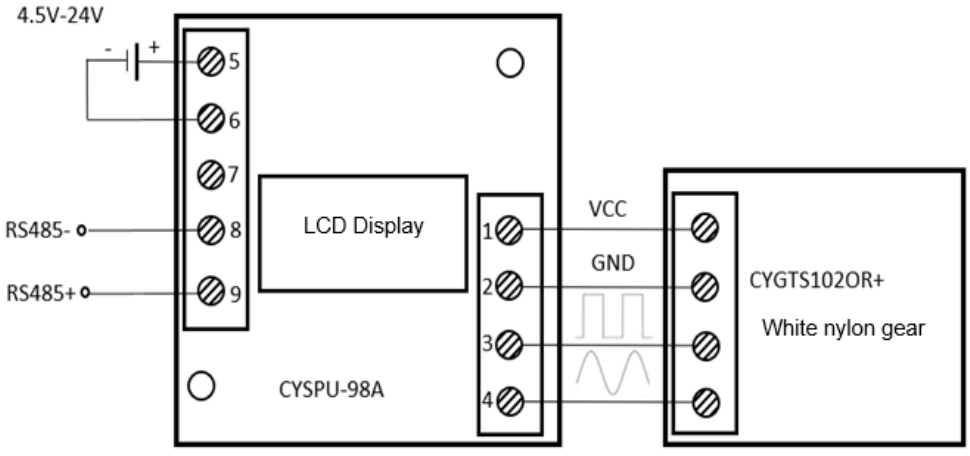
The gear tooth sensor CYGTS102DC is based on the Hall Effect principle. In use, it must be used together with the target iron gear. It measures the periodic motion of the teeth by detecting changes in the magnetic field and outputs both sine and square wave signals. To obtain frequency values or speed values directly, the following measuring system can be set up.



In this case the CYSPU-F98A processing unit gets both sine and square wave inputs, thus all three modes can be selected. Mode selection can be done by inputting the corresponding command via RS485.

6.2 Speed test system with optical reflective gear tooth sensor CYGTS102OR

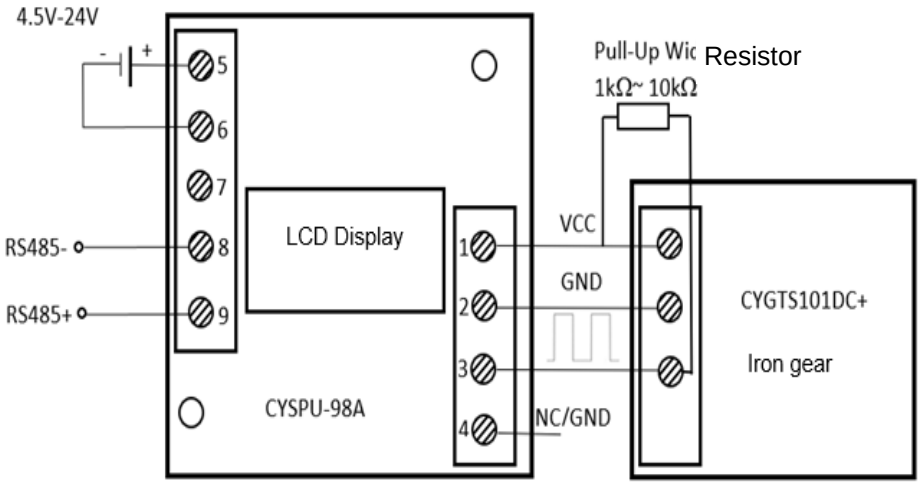
The gear tooth sensor CYGTS102OR is based on the principle of optical reflection. In use, it must be used with a specific gear, such as a white nylon gear. It measures periodic movements of the teeth by detecting changes in the intensity of the reflected light and outputs both sine and square wave signals. To obtain frequency values or speed values directly, the following measuring system can be set up.



In this case the CYSPU-F98A processing unit also gets both sine and square wave inputs, all three modes can be selected. Mode selection can be done by inputting the corresponding command via RS485.

6.3 Speed test system with Hall Effect gear tooth sensor CYGTS101DC

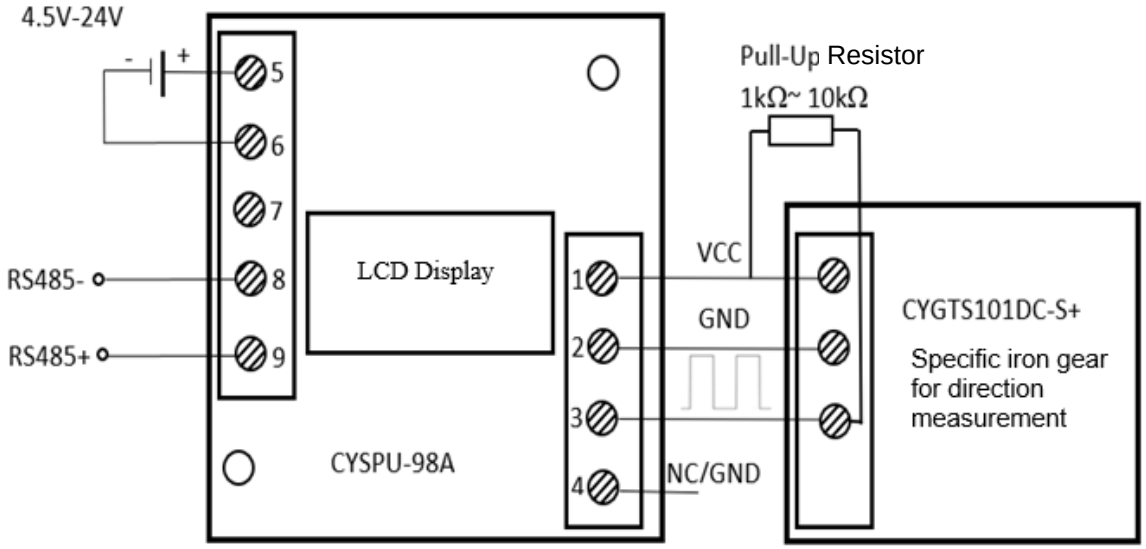
The Hall Effect gear sensor CYGTS101DC uses a Hall Effect IC to detect the magnetic field during the rotational motion of a ferrous target gear. It has only a square wave signal (open collector NPN) at the output. A pull-up resistor of 1kΩ to 10kΩ must be connected between power supply and output. To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



In this test system, only mode 1 is available, and the signal processing is performed only for square wave measurements.

6.4 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.



In this test system, only mode 1 is available, and the signal processing is performed only for square wave measurements.

6.5 Test performance of speed test systems

Various tests using the 4-measuring system mentioned in 6.1 to 6.4 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	Measurement Mode (Measuring range: 3 - 3000 RPM)	Average deviation (1)		3σ / μ (2)	
		Min	Max	Min	Max
CYGTS102DC	MOD1 - Square wave input	- 0.13%	+ 0.12%	0.11%	0.77%
	MOD2 - Sine signal input	- 0.22%	+ 0.57%	0.09%	1.38%
	MOD3 - Square wave and sine signal inputs	- 0.53%	+ 0.28%	0.10%	0.78%
CYGTS102OR	MOD1 - Square wave input	- 0.29%	+ 0.22%	0.12%	0.82%
	MOD2 - Sine signal input	- 0.28%	+ 0.44%	0.20%	0.98%
	MOD3 - Square wave and sine signal inputs	- 0.29%	+ 0.33%	0.10%	0.80%
CYGTS101DC	MOD1 - Square wave input	- 0.22%	+ 0.25%	0.42%	0.89%
CYGTS101DC-S	MOD1 - Square wave input	- 0.25%	+ 0.40%	0.25%	0.88%

(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.

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.