

Model

## CS1W-CTS21

Synchronous Serial Interface (SSI) Unit

### INSTRUCTION SHEET

Thank you for purchasing an OMRON product. Read this instruction sheet thoroughly and familiarise yourself with the functions and characteristics of the product before using it. To ensure safe and correct use of this Unit, also read the following Operation Manual (Cat. No. W339-E1): SYSMAC CS1 Series Programmable Controllers.

Keep this instruction sheet for future reference.

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**⚠ DANGER** Do not attempt to take the Unit apart and do not touch any internal parts while the power is being supplied. Doing either of these may result in electrical shock, and serious or fatal injury.

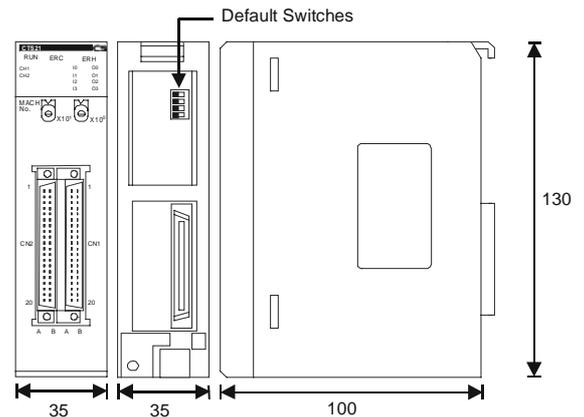
**⚠ Caution** Leave the protective label on top of the Unit as long as the Unit is not mounted and wired completely, in order to prevent wire clippings or other materials from getting inside the Unit. When the mounting and wiring has been completed, the label must be removed to allow air circulation and heat radiation.

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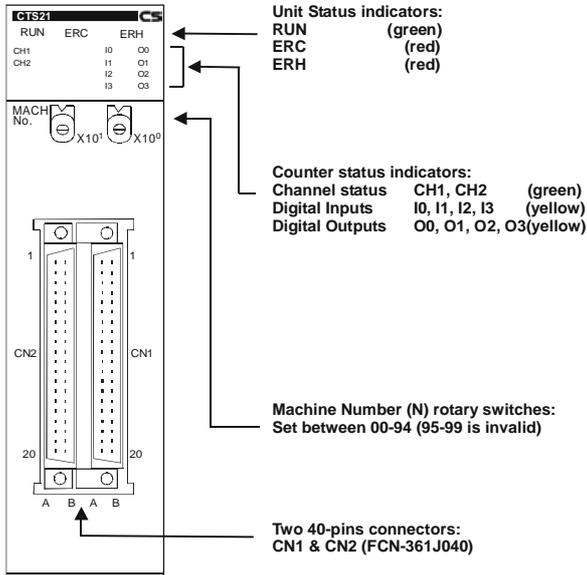
### ■ Unit specifications

Unit type	CS1 Special I/O Unit
Applicable PC models	CS1-series PCs
Storage temperature	-20 to +75 °C
Ambient temperature	0 to +55 °C
Ambient humidity	10 to 90 % (non-condensing)
EMC compliance	EN 50081-2, EN 61131-2
Current consumption	320 mA (5V via backplane)
Weight	230 g (typical)
Number of words allocated	<ul style="list-style-type: none"> <li>20 CIO-words. First word allocated = CIO2,000 + (Nx10)</li> <li>200 DM-words. First word allocated = D20,000 + (Nx100)</li> </ul>

### ■ Dimensions



### ■ Nomenclature



### ■ Quick Start

1. Set all Default Switches to Off. The Unit is now configured as follows: 400kHz clock frequency, 24 bit Gray-coded and a 40µs monoflop time, for both SSI channels.
2. Set Machine Number.
3. Mount and wire the Unit, the two SSI encoders and the encoders power supply.
4. Turn power on.
5. Create I/O Table.
6. Both green CH1 and CH2 indicators should now turn on.
7. The encoder data can now be read from CIO n+10/11 and CIO n+15/16.

**Note:** If you only want to connect one SSI encoder, the other SSI channel has to be disabled in DM m+20, see section *Default Switches* and section *Configuring the Unit via DM* for further details.

### ■ LED Indicators

Name	Colour	State	Unit status
RUN	green	On	Normal operation
		Off	Initialisation error
ERC	red	On	Unit error (check CIO n+6, n+7)
		Off	Unit has no errors
ERH	red	On	CS1-CPU Unit error
		Off	CS1-CPU Unit has no errors

Name	Colour	State	Counter channel status
CH1, CH2	green	On	Channel configured and is communicating without errors
		Off	Channel is not configured or a communication error has occurred
I0, I1 I2, I3	yellow	On	Digital Input turned on
		Off	Digital Input turned off
O0, O1 O2, O3	yellow	On	Digital Output turned on
		Off	Digital Output turned off

### ■ Notes on Mounting

The CS1W-CTS21 can be mounted to CS1W-BC□□3 CPU Backplanes or CS1W-BI□□3 Expansion Backplanes.

### ■ Machine Number Switch

Name	Function
MACHINE No.	Sets the Machine Number* (00 – 94).
MACH No.	<ul style="list-style-type: none"> <li>Machine Numbers 95-99 cannot be set and will generate an error.</li> <li>Make sure each Machine Number is used only once per CS1-CPU.</li> <li>Be sure to turn off the power to the Unit before setting the Machine Number.</li> </ul>

\* The CS1W-CTS21 uses the space for 2 machine numbers.

## ■ Connector (CN1 and CN2) Pin-layout

Use the following table to make connections directly to the soldering terminals of the connector jack(s) (see *Nomenclature* section for position of connectors 1 and 2 and rows A and B):

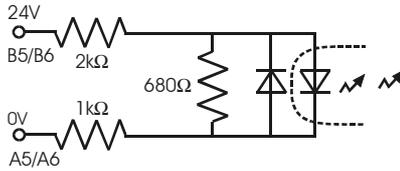
Connector 2 (CN2)				Connector 1 (CN1)			
Row A		Row B		Row A		Row B	
A1	0V_PS <sup>1</sup>	24V_PS <sup>2</sup>	B1	A1	0V_PS <sup>1</sup>	24V_PS <sup>2</sup>	B1
A2	O2 NPN	O2 PNP	B2	A2	O0 NPN	O0 PNP	B2
A3	O3 NPN	O3 PNP	B3	A3	O1 NPN	O1 PNP	B3
A4			B4	A4			B4
A5	0V I2	24V I2	B5	A5	0V I0	24V I0	B5
A6	0V I3	24V I3	B6	A6	0V I1	24V I1	B6
A7			B7	A7			B7
A8	0V ENC2_PS <sup>3</sup>	+ ENC2_PS <sup>4</sup>	B8	A8	0V ENC1_PS <sup>3</sup>	+ ENC1_PS <sup>4</sup>	B8
A9			B9	A9			B9
A10	DATA2 -	DATA2 +	B10	A10	DATA1 -	DATA1 +	B10
A11			B11	A11			B11
A12	CLOCK2 -	CLOCK2 +	B12	A12	CLOCK1 -	CLOCK1 +	B12
A13			B13	A13			B13
A14			B14	A14			B14
A15			B15	A15			B15
A16			B16	A16			B16
A17			B17	A17			B17
A18			B18	A18			B18
A19			B19	A19			B19
A20	0V ENC_PS <sup>3</sup>	+ ENC_PS <sup>4</sup>	B20	A20	0V ENC_PS <sup>3</sup>	+ ENC_PS <sup>4</sup>	B20

SSI signals are marked grey, PS = Power Supply Lines, O0-O3 = Digital Outputs, I0-I3 = Digital Inputs. <sup>(1)</sup><sup>(2)</sup><sup>(3)</sup><sup>(4)</sup>: All these pins are internally connected. The following terminal blocks can be used: XW2B-40G4 or XW2B-40G5, with the following cables: XW2Z-xxxB, where 'xxx' indicates the length of the cable in centimetres.

## ■ Input Specifications

Item	Digital Inputs
Input Voltage	24VDC (19.6V to 26.4V)
Input Current (typical)	7.6mA
ON Voltage (min.)	19.6V
OFF Voltage (max.)	4V
Max. repetition rate	1kHz
Min. pulse width	10µs

Digital Input Equivalent Circuitry:



The digital inputs are isolated from each other, are reverse polarity protected and have a fixed noise filter of 10kHz.

## ■ Output Specifications

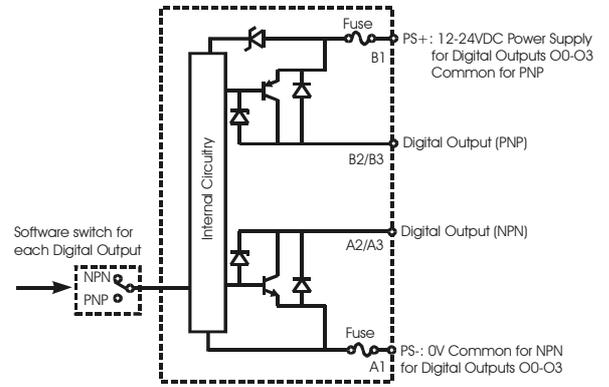
Item	Specification
Driver Type	Open Collector (NPN/PNP selectable)
Operating Voltage Range	12-24V (10.2 to 26.4V)
Maximum Switching Capacity	46mA at 10.2V to 100mA at 20.4V to 26.4V (400mA max./common) (linear behaviour)
Minimum Switching Current	5mA
Output ON-delay	0.1ms max.
Output OFF-delay	0.1ms max.
Leakage Current	0.1mA max.
Residual Voltage	1.5V max.

The power supplied to the Unit, to feed the Digital Outputs, has to be supplied externally and should be a double insulated class II (over-voltage) type with ratings from 12 to 24VDC (10.2 to 26.4VDC). Characteristics of the Power Supply Input circuitry are summarised in the following table.

Item	Specification
Operating Voltage Range	10.2-26.4VDC
Current Consumption	25mA max. (excl. load current)
Internal Fault Protection	Two 1A (not replaceable) fuses in Power Supply lines
Reverse Polarity Protection	Yes

The Digital Outputs are insulated from the I/O-bus but not from each other. They are not short circuit protected.

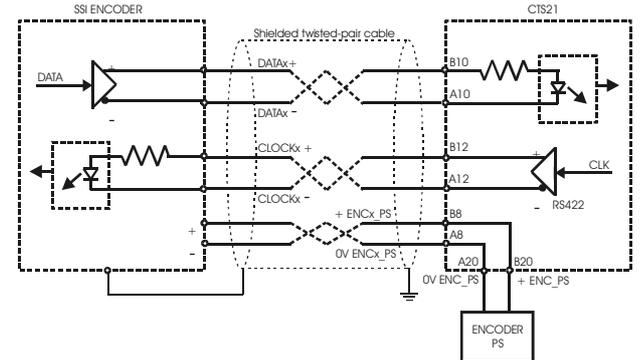
Digital Output Circuitry:



## ■ SSI Communication

Item	Specification
CLK lines	Non-isolated differential line driver, RS422 compliant
DATA lines	Electrically isolated differential line receiver, RS422 compliant
Number of data-bits	9 to 31 (default: 24)
Value coding	Gray/Binary/Tannenbaum/Raw (default Gray)
Clock frequency	100kHz to 1.5MHz
Monoflop time	10µs to 99,990µs (default: 40µs)
Sample rate	About 2500 Samples/sec with 2 encoders connected (with default settings)

SSI Circuitry:



Notes:

- Electrical isolation is provided for each data input line. Electrical isolation is not provided for the outgoing clock lines. The encoder power supply can be connected to one of the unit's connectors.
- The power supply should match the encoders specifications.
- Use shielded twisted pair, 4x2x0.25mm<sup>2</sup> (+ optional 2x0.5mm<sup>2</sup> for PS).
- The shield must be connected to the SSI encoder and to the frame-ground near the PLC-system.
- The SSI protocol has no mechanism to reject noise. See section *Noise Prevention* for more information.

As an indication the following clock frequency, cable length relationship can be used:

100kHz: < 400m, 300kHz: < 100m  
200kHz: < 200m, 400kHz: < 50m.

To indicate to the user that valid data has been received from the SSI encoder, each time the "New Valid data received" bit in CIO is set. During normal operation, the SSI Unit can detect three kinds of communication errors (see section *Error Processing*). At the occurrence of a communication error on channel 1(2):

- the corresponding error code is set in CIO n+6, n+7
- the corresponding error code is stored inside the SSI Unit
- the Global Error Indication bit in CIO (n+8, bit 00) is set
- the ERC-LED is turned on
- the corresponding CH1(2)-LED is turned off

This status will remain, even if during the next SSI-communication no error is detected by the SSI Unit. In this case only the "New valid SSI data received" bit in CIO will be set, indicating that for the current SSI data in CIO no communication error was detected. To clear the above error status, the "Clear Error" bit in CIO has to be set.

The following table describes the possible statuses of the SSI Unit after proper initialisation:

ERC LED / Global error bit	CH LED	New Valid SSI data received bit	Status
Off	On	On	The channel SSI data in CIO can be used; no error has occurred.
Off	On	Off	No new channel SSI data has been received since last cyclic refresh; no error has occurred.
Off	Off	Off	Channel is not configured for SSI communication (see DM m+10/20).
On	Off	On	The channel SSI data in CIO can be used; a communication error has occurred earlier *.
On	Off	Off	The channel SSI data in CIO cannot be used; a communication error has occurred *.
On	On	On	The channel SSI data in CIO can be used; a non-communication error has occurred *.
On	On	Off	No new channel SSI data has been received since last cyclic refresh; a non-communication error has occurred *.

\* See Error Processing section for countermeasures.

## Default Switches

Name	Function
	Sets to default mode or configuration mode (the switch is located at the back of the Unit):
	Pin   Position   Function
	1   On   DM settings for channel 1 are used
	1   Off   Default values for channel 1 settings are used *
	2   On   DM settings for channel 2 are used
2   Off   Default values for channel 2 settings are used *	
3   Off   Not used	
4   On   DM settings for non-channel related settings are used	
4   Off   Default settings for non-channel related settings are used *	

\* See next section.

## Configuring the Unit via DM

m = DM20000 + (Nx100), with N the Machine Number of the Unit.

DM Word	Bit	Function
<b>General</b>		
m	00-03	Output NPN (=0, default) or PNP (=1) for Digital Output 0 to 3.
	04-11	Not used
	12-15	Output State Control: This setting determines the behaviour of the outputs in case the PLC CPU is set in program mode or in case a PLC Bus Error occurs. 0 = The outputs will be switched ON and OFF as normal, controlled by the unit (default). 1 = The outputs will keep the last state in which they were before the PLC CPU is set in program mode. 2 = The outputs will be set to a predefined (DM-setting) safety pattern
m+1	00-03	Output Safety Pattern: The 4 outputs will be set to this safety pattern if the PLC is in program mode and the output state control is set to using a safety pattern.
	04-15	Not used
m+2	00-15	Interrupt Task Offset: BCD value: [0..248]. PLC task interrupt is issued corresponding to digital input number and edge *. (0 is default)
m+3	00-15	Digital Input 0 Function *: 0 = No function (default) 1 = Issue interrupt to PLC on rising edge 2 = Issue interrupt to PLC on falling edge 3 = Issue interrupt to PLC on both edges
m+4	00-15	Digital Input 1 Function *: Same as Input 0, see m+3.

DM Word	Bit	Function
m+5	00-15	Digital Input 2 Function *: Same as Input 0, see m+3.
m+6	00-15	Digital Input 3 Function *: Same as Input 0, see m+3.
m+7	00-15	Additional SSI-communication start-up delay **: 0 = 2000ms delay (default) 1 = 1050ms delay 2 = 500ms delay 3 = no delay
m+8 to m+9	00-15	Not used

\* In case of an interrupt on a rising edge, the interrupt task number equals: offset + digital input number\*2. In case of an interrupt on a falling edge, the interrupt task number is: offset + digital input number\*2 + 1 (where *digital input number* is 0..3). At most 30 PLC interrupt requests can be kept pending in the internal FIFO-buffer of the SSI Unit, also refer to CIO n+8 bit 01 and error code 0480. Note that the interrupt functionality is only available in case the SSI Unit is mounted on a PLC CPU Backplane.

\*\* This delay is additional to the PLC-system start-up time.

DM Word	Bit	Function
<b>SSI Channel 1 ***</b>		
M+10	00-15	SSI baudrate: 0 = 400kHz (default) 1 = 100kHz 2 = 200kHz 3 = 300kHz 4 = 400kHz 5 = 500kHz 6 = 1MHz 7 = 1.5MHz FFFF = No encoder connected (the rest of settings is not processed)
m+11	00-15	Value coding: 0 = Gray code (default) 1 = Binary 2 = Raw SSI data only (settings m+13..16 are not processed)
m+12	00-15	Encoder resolution: Number of data bits: [9..31] (in BCD), 0 means value = 24 (default)
m+13	00-15	Leading bits ****: Number of bits preceding encoder data: [0..31] (in BCD) (0 is default) $\Sigma m+12..13 \leq 31$
m+14	00-15	Trailing bits ****: Number of bits following encoder data: [0..31] (in BCD) (0 is default) $\Sigma m+12..14 \leq 31$
m+15	00-15	Optional SSI encoder status bits (see CIO n+12 bits 00-07): Number of bits succeeding trailing bits: [0..8] (0 is default) $\Sigma m+12..15 \leq 31$
m+16	00-07	Parity check: 0 = no parity check (default) 1 = check for even parity 2 = check for odd parity Parity is calculated over all bits received.
	08-15	Not used
m+17	00-15	Mono-flop time: check if the data line is high after the mono-flop time has expired. Set in tens of microseconds (BCD). 0 implies 40µs (default).
m+18	00-15	Reserved. Should be zero.
m+19	00-15	Not used
<b>SSI Channel 2 ***</b>		
m+20 to m+29	00-15	Same as SSI channel 1, see m+10 to m+19
<b>Other</b>		
m+30 to m+199	00-15	Not used

\*\*\* Refer to the operation manual of the SSI encoder for proper configuration of the SSI Unit's channels.

\*\*\*\* Trailing and leading bits are to be used for connecting Tannenbaum coded SSI-encoders. E.g. for a 24-bit Tannenbaum encoder with 10 multi-turn and 10 single-turn-bits and 1 status bit, centred around bit 12/13, the leading bits have to be set to 2 and the trailing bits to 2.

## ■ Operating the Unit via CIO

n = CIO2000 + (Nx10), with N the Machine Number of the Unit.

Word (output)	Bit	Function
<b>General</b>		
n	00-03	Digital Outputs (On=1, Off=0)
	04-15	Not used
n+1	00	Read (next) Error (0→1) from error history
	01	Clear all Errors (0→1) from error history
	02-15	Not used
n+2	00-15	Not used

Word (input)	Bit	Function
<b>General</b>		
n+3	00-03	Output Status (On=1, Off=0)
	04-15	Not used
n+4	00-15	Not used
n+5	00-03	Input Status (On=1, Off=0)
	04-15	Not used
n+6, n+7	00-15	Error Code (See <i>Error Processing</i> section for details)
n+8	00	Global Error Indication
	01	External PLC Interrupt pending*
	02	Unit initialising after restart or power-up**
	03-14	Not used
	15	General DM settings are configured with default values by default switch pin 4
n+9	00-15	Not used
<b>SSI Channel 1</b>		
n+10, n+11	00-15	Current SSI data
n+12	00-07	Optional SSI encoder status (see DM m+15)
	08	New valid SSI data received
	09-14	Not used
	15	Channel is configured with default values by default switch pin 1
n+13, n+14	00-15	Not used
<b>SSI Channel 2</b>		
n+15, n+16	00-15	Current SSI data
n+17	00-07	Optional SSI encoder status (see DM m+25)
	08	New valid SSI data received
	09-14	Not used
	15	Channel is configured with default values by default switch pin 2
n+18, n+19	00-15	Not used

\*ON for one PLC-scan.

\*\*After a falling edge of this bit, the digital inputs, outputs and SSI communication are operational.

## ■ Error Processing

At the occurrence of an error:

- the corresponding error code is transferred to words CIO n+6, n+7
- the corresponding error code is stored inside the SSI Unit
- the Global Error Indication bit in CIO (n+8, bit 00) is set
- the ERC-LED or ERH-LED is turned on

The following errors codes can be reported in CIO n+6, n+7:

n+6	n+7	Description
0300	DM Offset	The DM-setting located at D20000 + (Nx100) + <i>DM Offset</i> is Out of Range (N = Machine Number).
0310	DM Offset	The DM-setting located at D20000 + (Nx100) + <i>DM Offset</i> is an invalid BCD-code (N = Machine Number). (The range of a valid BCD-code for a digit is 0-9. If one or more digits is within range A - F an invalid BCD-code is specified).

Countermeasure: DM-configuration errors can be cleared by correcting the faulty settings in Data Memory and consecutively transferring the new configuration data again to the Unit. To transfer the configuration data you can choose from one out of two possibilities:

- Turn the power of the CS1-system ON.
- Restart the Unit

n+6	n+7	Description
0480	External Interrupt Task No.	The interrupt-FIFO inside the SSI Unit is full and the interrupt assigned to External Interrupt Task could not be executed.

Countermeasure: If the speed with which the Unit generates interrupts is higher than the speed with which the CS1-CPU executes the interrupts, the FIFO-buffer inside the Unit runs full and the "Interrupt FIFO full" error is generated. The error can be cleared by the CIO Clear al Errors command. The error indicates that the load of interrupts on the CS1-CPU is too high. Clearing the error as mentioned before most probably needs additional measures to be taken in order to prevent this error from happening in the future:

- Disable one or more interrupts of the Unit, which caused the error.
- Reduce the execution time of the assigned External Interrupt Tasks or the interrupt request rate.

n+6	n+7	Description
0490	CH No. 00	Parity error in SSI channel <i>CH No.</i>

Countermeasure: Check if the unit is configured to check for the correct type of parity (even or odd). Check the SSI-encoder.

n+6	n+7	Description
0490	CH No. 01	SSI-encoder channel <i>CH No.</i> not ready

Countermeasure: This error appears in case the data line is low right before the communication with the encoder connected to channel *CH No.* is started. Check the cabling between the unit and the SSI-encoder. Check the SSI-encoder.

n+6	n+7	Description
0490	CH No. 02	SSI-encoder channel <i>CH No.</i> time-out

Countermeasure: This error appears in case the data line is and stays low after the mono-flop time has expired on channel *CH No.* Check if the unit is configured for the correct encoder settings. Check the cabling between the unit and the SSI-encoder. Check the SSI-encoder.

n+6	n+7	Description
0002	Time-out in ms (hex)	A cyclic refresh time-out error was generated caused by a PLC system error or you have chosen to disable the Cyclic Refresh of the SSI Unit in the CS1-PLC settings. This error will be cleared as soon as Cyclic Refresh or IORF will take place.
000E	0000	An error has occurred on the I/O Bus causing the SSI Unit to be in an undefined state. On occurrence of an I/O Bus error you can configure the Outputs to keep their last state or to have a predefined state (refer to DM m/m+1)

Countermeasure: Turn ON the power supply again or restart the system. If the error persists then replace the CS1-CPU.

## ■ Noise Prevention

The symptoms of picking up noise are random jumps in the SSI data values read (CIO n+10/11 and n+15/16). For applications that expect a continuous change of SSI data values, the PLC application can e.g. identify noise by detecting an unexpected large change in the SSI data values or data values outside the expected range.

The best way to prevent noise is by proper wiring the unit as described in the *SSI Communication* section.

An alternative could be to use an SSI encoder equipped with parity.

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