Temperature Regulation Solution

Quick Start Guide

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Contents

ABBREVIATIONS

PLC	Programmable Logic Controller
HMI	Human Machine Interface
TC	Temperature Controller
SSR	Solid State Relay
FB	Function Block
PV	Process Value
SP	Set Point
P	Proportional Band
I	Integral
D	Derivative
AT	Auto Tuning
MV	Manipulated Value
Hex	Hexadecimal (symbol: #)
Dec	Decimal (symbol: &)

EXECUTIVE SUMMARY

The OMRON Industrial Automation product portfolio consists of many products ranging from Human Machine Interfaces to advanced 2-PID Temperature Controllers. Other products also include Sensors, Programmable Logic Controllers for low to high-end applications and many more products.

It is often necessary to combine key product features to generate specific application solutions. One of the application solutions is the Temperature Regulation Solution. This Solution combines key features from OMRON Temperature Controllers (TC), Programmable Logic Controllers (PLC) and Human Machine Interfaces (HMI) into a complete stand-alone solution to control and visualize Temperature Control using OMRON's 2PID functionality.

The Temperature Regulation Solution combines the Compact HMI NB, Compact PLC CP1 and E5_C TC product series in three different solutions. The solutions consist of three variants, respectively: On-Panel, In-Panel and the In-Panel Integrated Temperature Regulation.

The first solution targets On-Panel Temperature Regulation using the Compact HMI NB product series and E5_C TC product series that are mountable on a panel. While the first solution provides an On-Panel solution, the second solution targets In-Panel Temperature Regulation using the Compact HMI NB product series, Compact PLC CP1 product series and E5_C TC product series that are mountable on a DIN-rail within a panel. The final solution targets Integrated In-Panel Temperature Regulation using the Compact HMI NB product series, Compact PLC CP1 product series with CP1W-TS Expansion Unit including a 2-PID Function Block.

This document describes the three solutions in technical detail. Items described for each solution are system configuration, communication methods, wiring diagram and parameterization of the products. The document first summarizes the differences between the PID- and 2-PID Control Systems.

INTENDED AUDIENCE

This manual is intended for the following personnel, who must also have knowledge of electrical systems (an electrical engineer or the equivalent):

- Personnel in charge of installing automation systems
- Personnel in charge of designing automation systems
- Personnel in charge of managing automation systems and facilities

PID CONTROL ALGORITHMS

Proportional-Integral-Differential (PID) algorithms can be used to control a very wide range of physical quantities. They are therefore one of the most popular regulation methods for a wide range of industrial processes. However, each process is unique. For example, you may require fast ramp-up to a final Set Point (Step Response). Or, you may need high stability during control without overshoot when a disturbance occurs (Disturbance Response). Or you may want both.

With a conventional PID algorithm, it is unlikely to achieve both goals at the same time. So you may need to make compromises, solving only part of the problem. With the OMRON 2-PID algorithm no such compromise is necessary.

PID Control Algorithm

The standard control system available is the PID Control System. *Figure 1 PID Control System Schematic* illustrates the control system for a standard PID Control System.

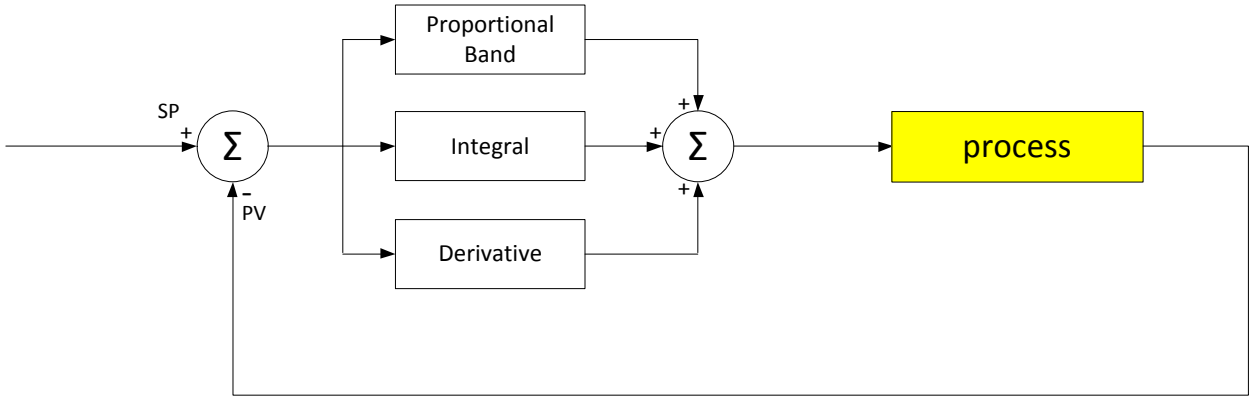


Figure 1 PID Control System Schematic

Figure 2 PID Control System features contain the essential features of a PID Control System.

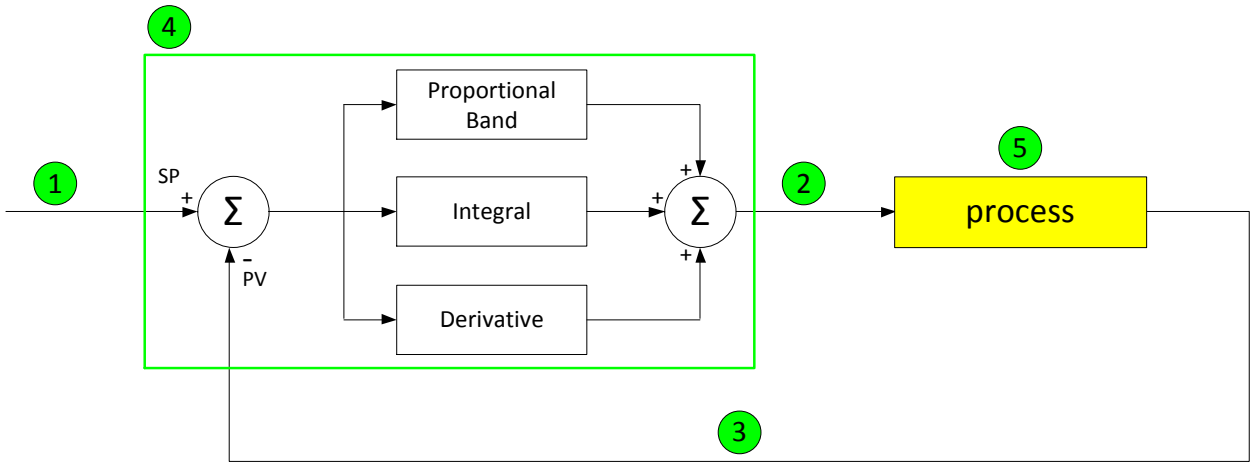


Figure 2 PID Control System features

The legend below describes the features.

1. Set Point
2. Control Output
3. Process Value
4. PID Control Algorithm
5. Process

Figure 3 PID Control System Diagram translates the control system into a diagram. The diagram illustrates how to connect the equipment to each other. The numbers represent the features.

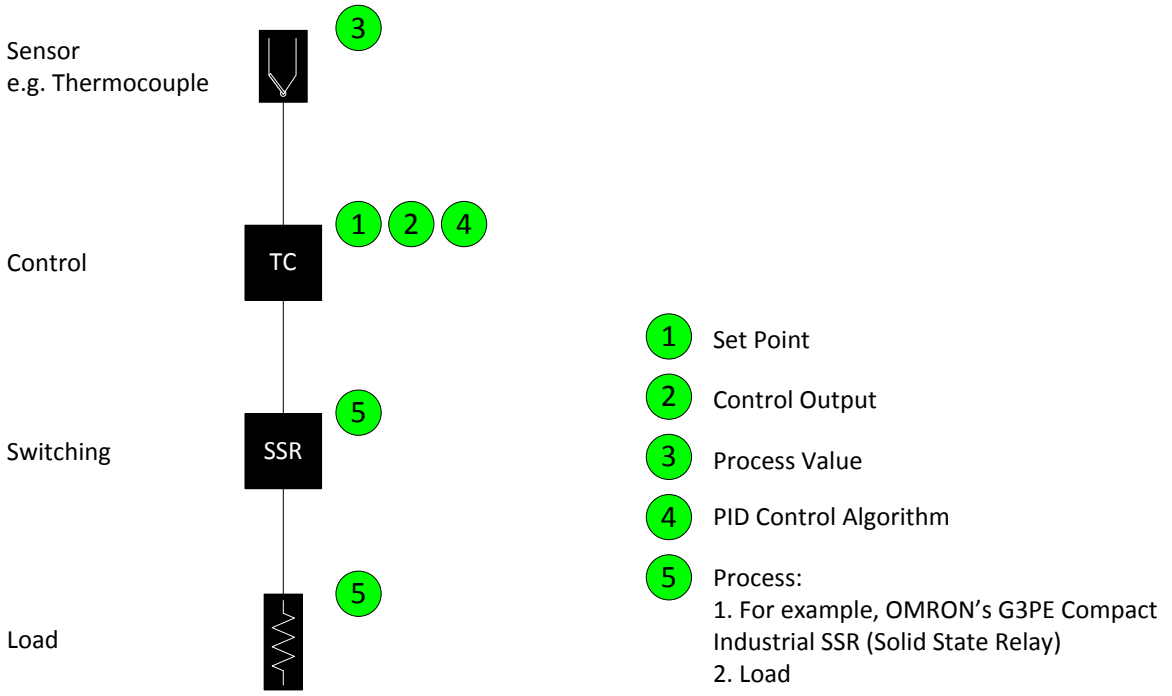


Figure 3 PID Control System Diagram

The Set Point, Control Output and PID Control Algorithm parameters are set or controlled with the temperature controller. Measuring the Process Value is achieved using a sensor --for example a thermocouple-- connected to the temperature controller. The process consists of switching and load equipment. The switching equipment connected to the Control Output can be an OMRON's G3PE Compact Industrial Solid State Relay. The switching equipment powers a load such as a heater.

2-PID Control Algorithm

OMRON's unique solution for outstanding disturbance response and step response control is the 2-PID Control System.

It is possible to tune the P-, I- and D-parameters for good disturbance response. The parameter alpha (α) adds additional responsiveness against disturbances. The parameter α sets the reaction speed. Alpha (α) is adjustable between 0.0 and 1.0. Value 1.0 result in minimal overshoot but slow response while 0.0 provides the fastest response but less stable. The factory default value of 0.65 is suitable for most applications. *Figure 4 Alpha (α) Response Characteristics* displays the response of the control system depending on the alpha (α) value.

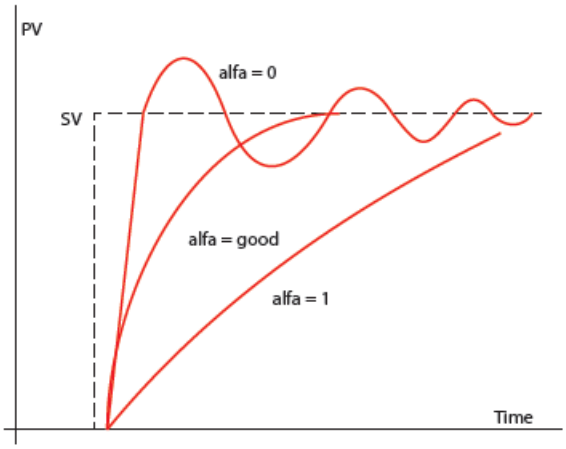


Figure 4 Alpha (α) Response Characteristics

Figure 5 Comparison PID and 2-PID Response Characteristics compares the step- and disturbance response between a standard PID- and OMRON's 2-PID Control System. The first image illustrates a standard PID that has good reaction responsiveness against disturbance but the step response is less stable. The second image illustrates a standard PID that has good step responsiveness but less disturbance responsiveness compared to the first image. The third image implies for OMRON's 2-PID control system that includes an outstanding step and disturbance responsiveness.

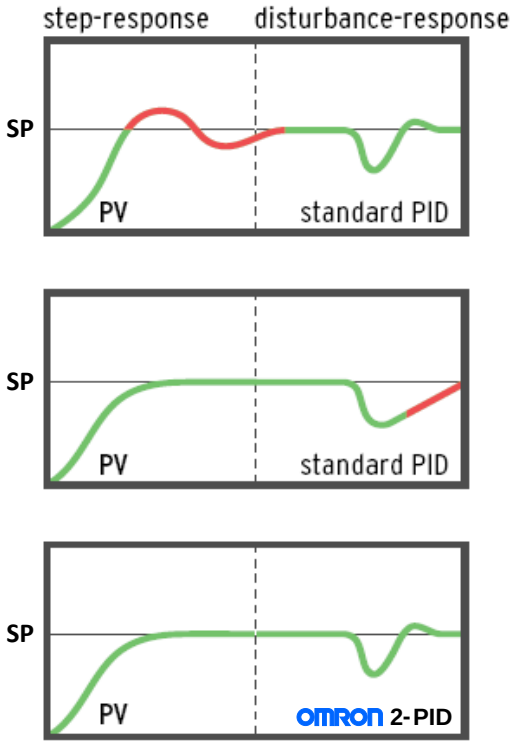


Figure 5 Comparison PID and 2-PID Response Characteristics

Figure 6 2-PID Control System Schematic illustrates the control system for OMRON's 2-PID Control System.

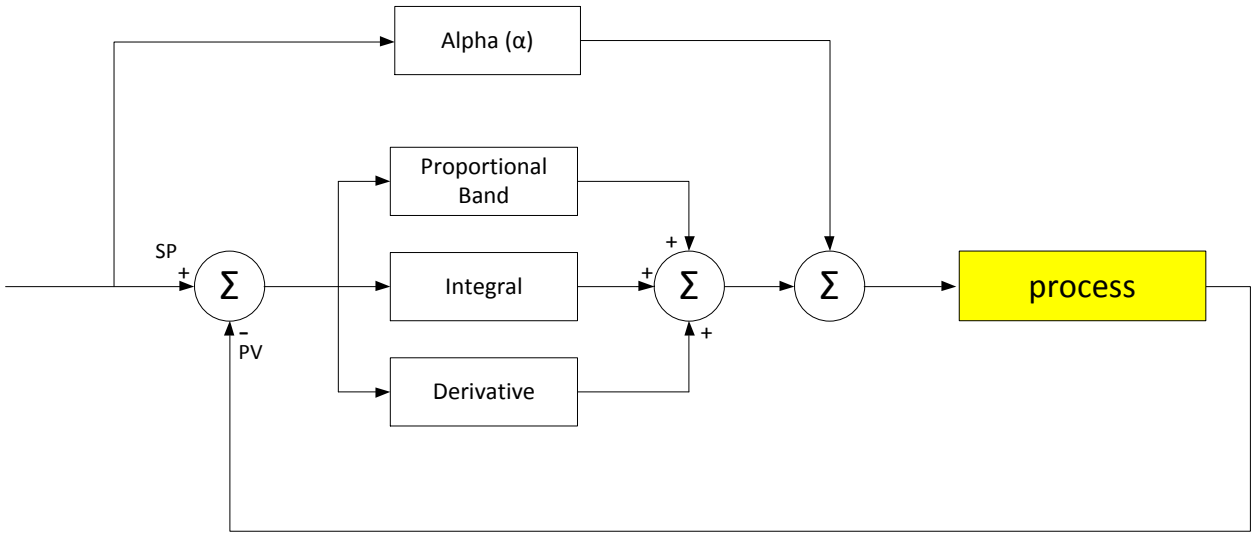


Figure 6 2-PID Control System Schematic

Figure 7 2-PID Control System features illustrates the essential features of a 2-PID Control System.

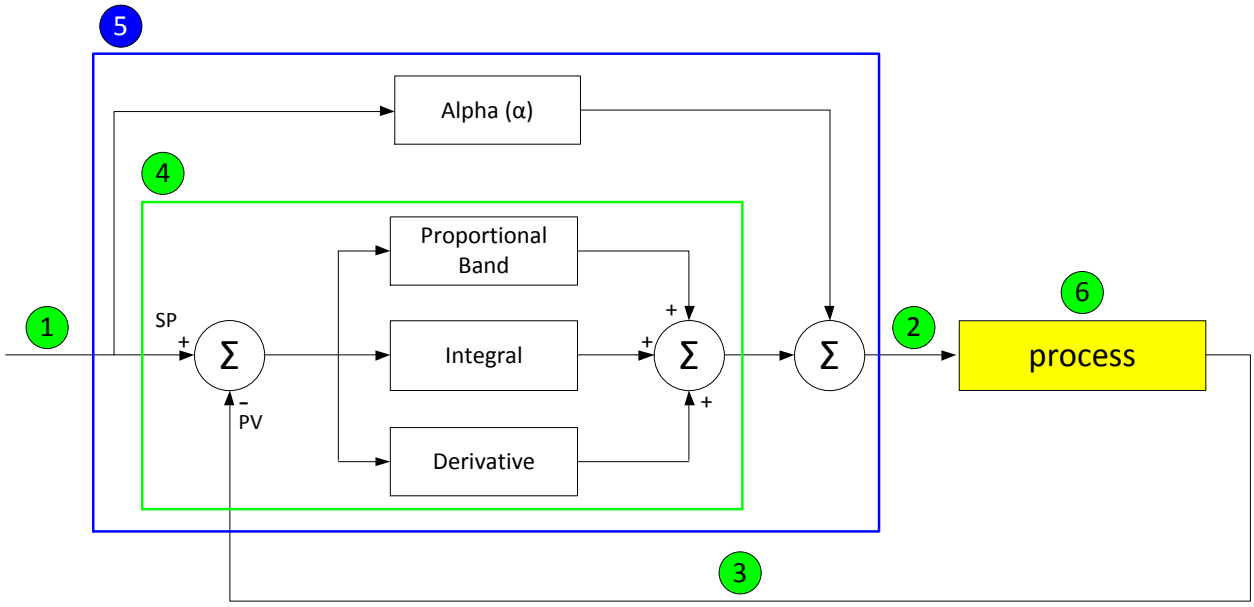


Figure 7 2-PID Control System features

The legend below describes the features.

1. Set Point
2. Control Output
3. Process Value
4. PID Control Algorithm
5. 2-PID Control Algorithm
6. Process

Figure 8 2-PID Control System Diagram translates the 2-PID control system schematic into a diagram. OMRON's control equipment that supports the 2-PID Control System are: for example, E5_C Temperature Controllers and OMRON's PLC instruction[1]. The numbers represent the features.

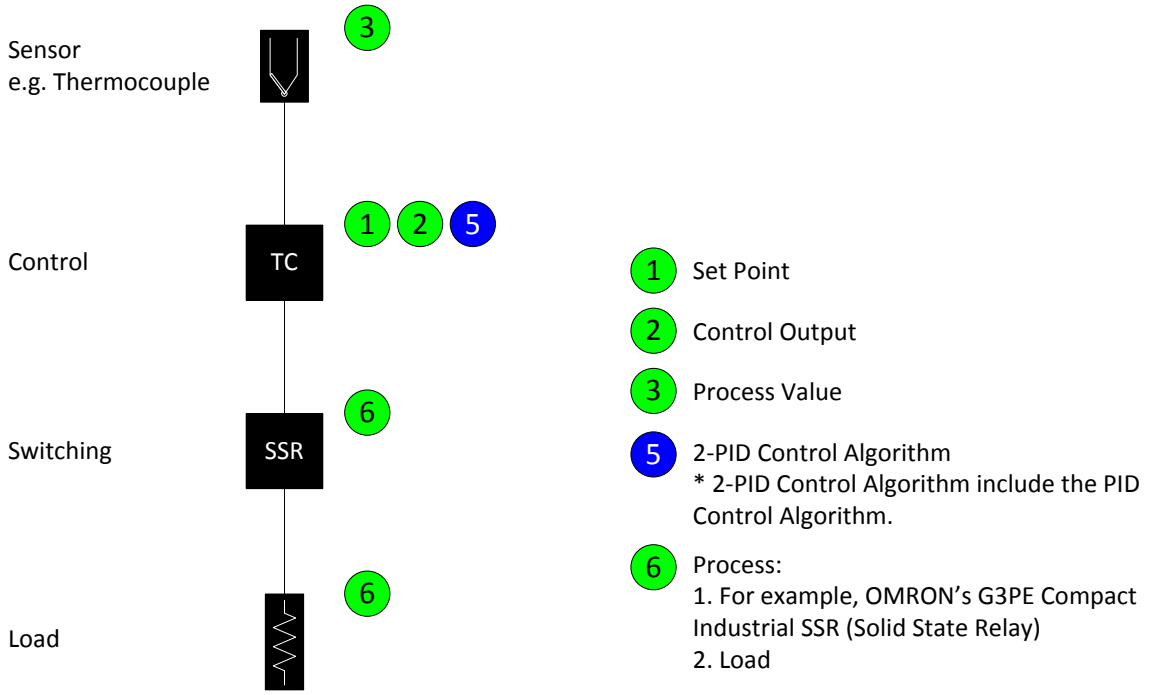


Figure 8 2-PID Control System Diagram

The Set Point, Control Output and 2-PID Control Algorithm parameters are set or controlled with the temperature controller. The Process Value is measured with a sensor --for example a thermocouple-- connected to the temperature controller. The process consists of switching and load equipment. The Control Output (MV) connects to switching equipment such as an OMRON's G3PE Compact Industrial Solid State Relay. The switching equipment powers a load such as a heater.

Figure 9 2-PID Control System Diagram with OMRON products illustrates several OMRON product series that meet the requirements[2] for the Temperature Regulation Solution.

[1] The Temperature Control 2-PID Function Block has the OMRON's PLC instruction embedded.
[2] The switching equipment may vary depending on the application requirements. G3PE Compact Industrial SSR is used as example.

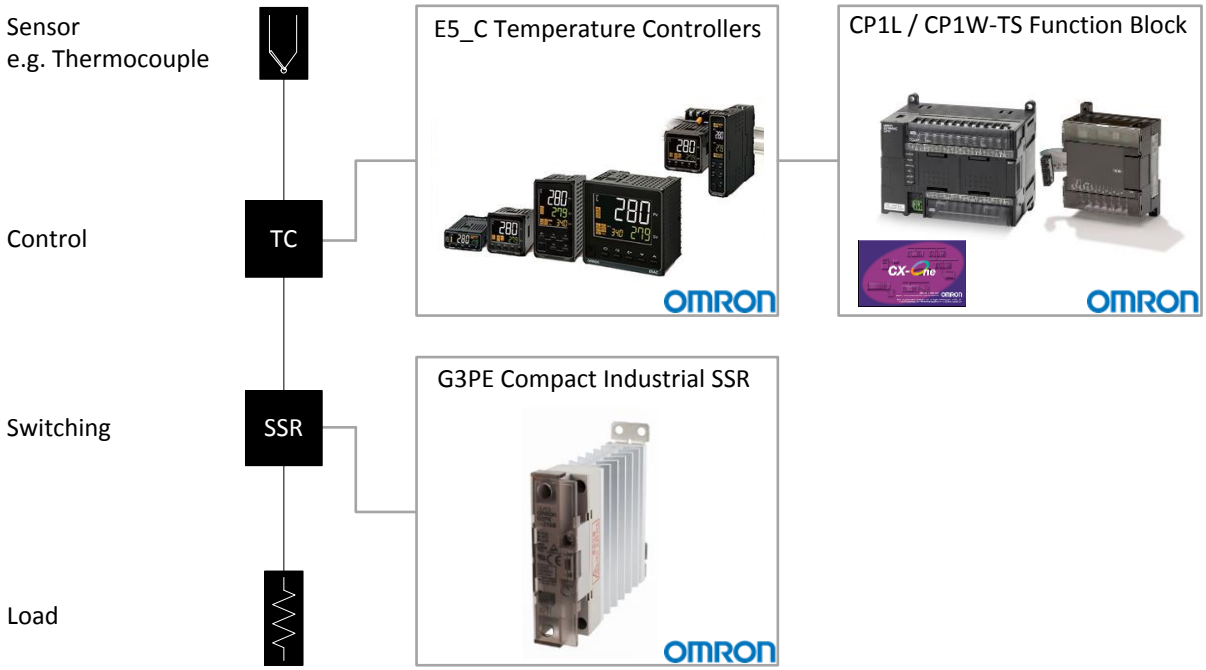


Figure 9 2-PID Control System Diagram with OMRON products

1 ON-PANEL TEMPERATURE REGULATION

The following chapter describes the On-Panel Temperature Regulation solution.

1.1 Introduction

The On-Panel Temperature Regulation solution consists of two OMRON products, respectively the E5_C On-Panel Temperature Controller(s) and the Compact NB HMI. The applied protocol is Modbus RTU using RS-485 communication. Up to 32 units, including the NB HMI connected in a one-to-many configuration executes the communication between the devices.

The Compact NB HMI adds valuable features such as visually displaying the course of temperature within a specified amount of time. It can log the trend data onto an external memory in .csv format for easy reading and can also read / write specific parameters from and to the Temperature Controller(s).

1.2 System Configuration

The On-Panel Temperature Regulation solution consists of an NB HMI and E5_C Temperature Controllers mounted on a panel. The NB HMI communicates with the Temperature Controllers using Modbus RTU via RS-485.

Please refer to *Appendix A: E5_C Hardware Information* for detailed product information about the E5_C Temperature Controllers such as model selection and pin-out.

Modbus RTU

The Modbus RTU configuration consists of the following products:

- Compact NB HMI (non-model specific)
- E5_C Temperature Controllers[3]

Figure 10 Modbus RTU communication illustrates the generic overview of the On-Panel Temperature Regulation configuration.

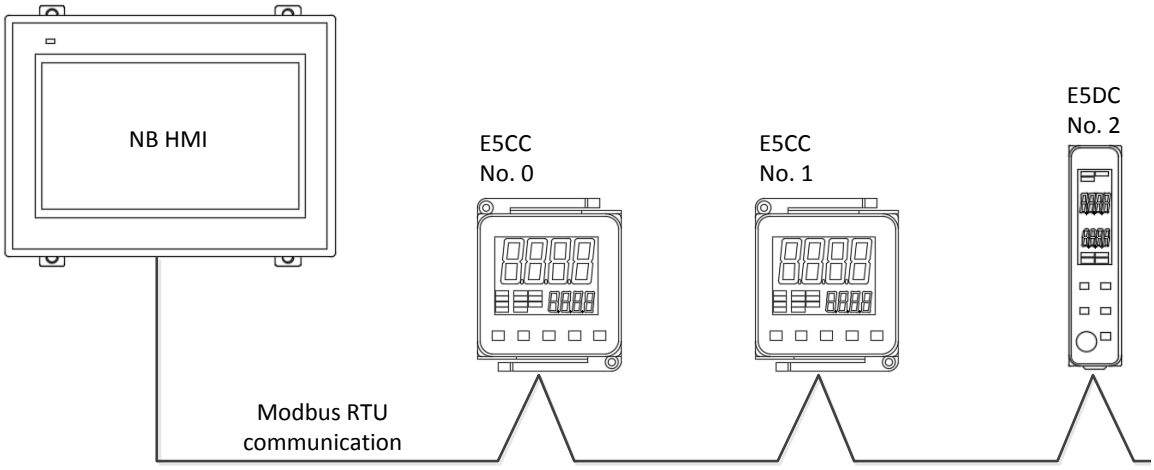


Figure 10 Modbus RTU communication

[3] Supported E5_C models are E5GC, E5CC(-U), E5EC, E5AC and E5DC. The product size varies per model. Please consult manual H174 E5_C Digital Temperature Controllers User's Manual, section 1-1 Appearance, Features, and Functions of the E5_C for more information about the models.

1.3 Wiring Diagrams

Precaution for Usage:

- Use a shielded twisted-pair cable with a wire gauge of AWG24, shunt capacitance of 16 pF per foot (0.3048 meter) and 120Ω characteristic impedance.
    - Shunt Capacitance: The capacitive resistance limits the total cable length. Applications with long cable lengths benefit from using low capacitance cable.
    - 120Ω Characteristic impedance: The correct cable impedance prevents signal reflections.
- Do not position the RS-485 cable next to power cables to avoid Electromagnetic Interference on the signal.
- Maximum RS-485 cable length is 50 meters.
- The NB 5-, 7- and 10-inch HMI models have an internal 120Ω termination resistor. Connect pin 4 to 5 at COM2 to enable the Termination Resistor to reduce signal reflections on the cable.
- Connect a 120Ω Termination Resistor at the last E5DC node to reduce signal reflections on the cable.
- The RS-485 communication can be either 1:1 or 1:N.

1.3.1 One Panel

Figure 11 Wiring Diagram using one panel illustrates the wiring diagram between the NB HMI COM2 and E5_C Temperature Controllers in a single panel. The cable shielding connected to the FG connection located at COM2 of the Compact NB HMI.

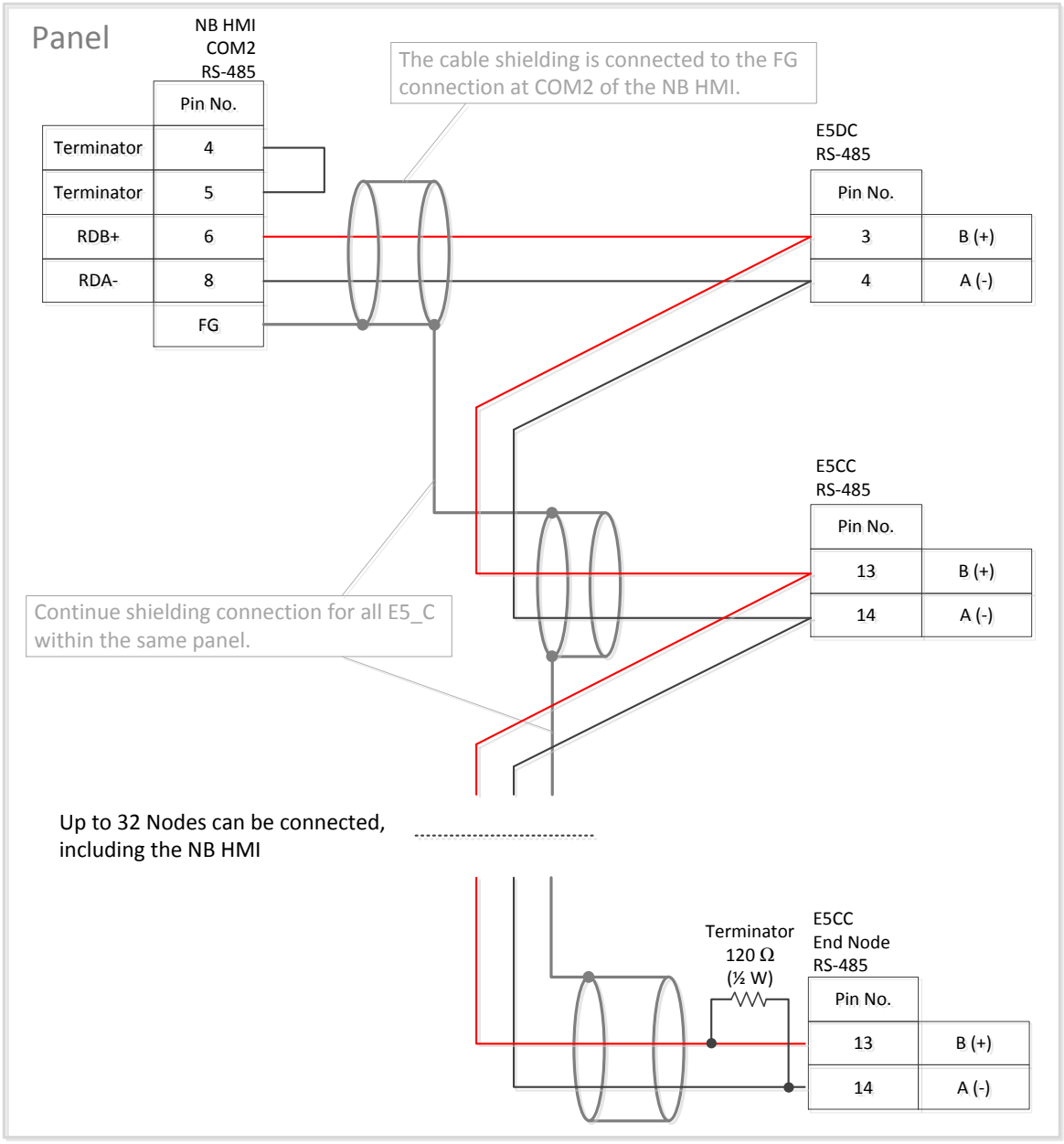


Figure 11 Wiring Diagram using one panel

1.3.2 Multiple Panels

Mounting the equipment on multiple Panels changes the method required to connect the shielding. Signal disruption from Electrical Magnetic Interference is more likely with this configuration therefore it is not recommendable to connect the cable shielding at the FG connection at COM2 of the Compact NB HMI. Instead, connect the RS-485 cable shielding on both sides at the panels ground connection as illustrated in *Figure 12 Cable diagram using multiple panels*.

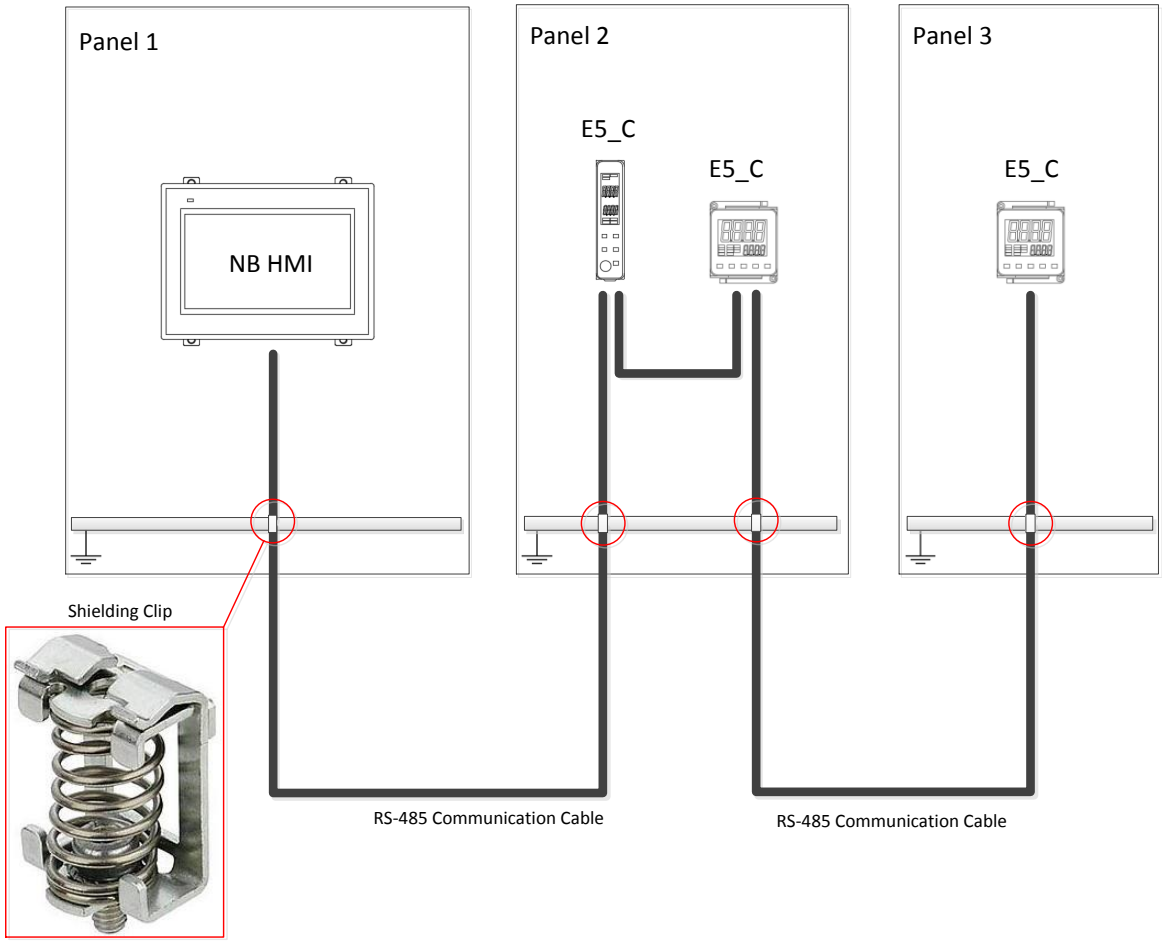


Figure 12 Cable diagram using multiple panels

For optimal protection against potential Electromagnetic Interference within the panels, continue the cable shielding until the communication cable reaches the equipment. Only remove the cable insulation where the cable should connect with the shielding clip. It is recommended not to remove the cable shielding after the shielding clip. Refer to *Figure 13 Wiring Diagram using multiple panels* for the wiring diagram.

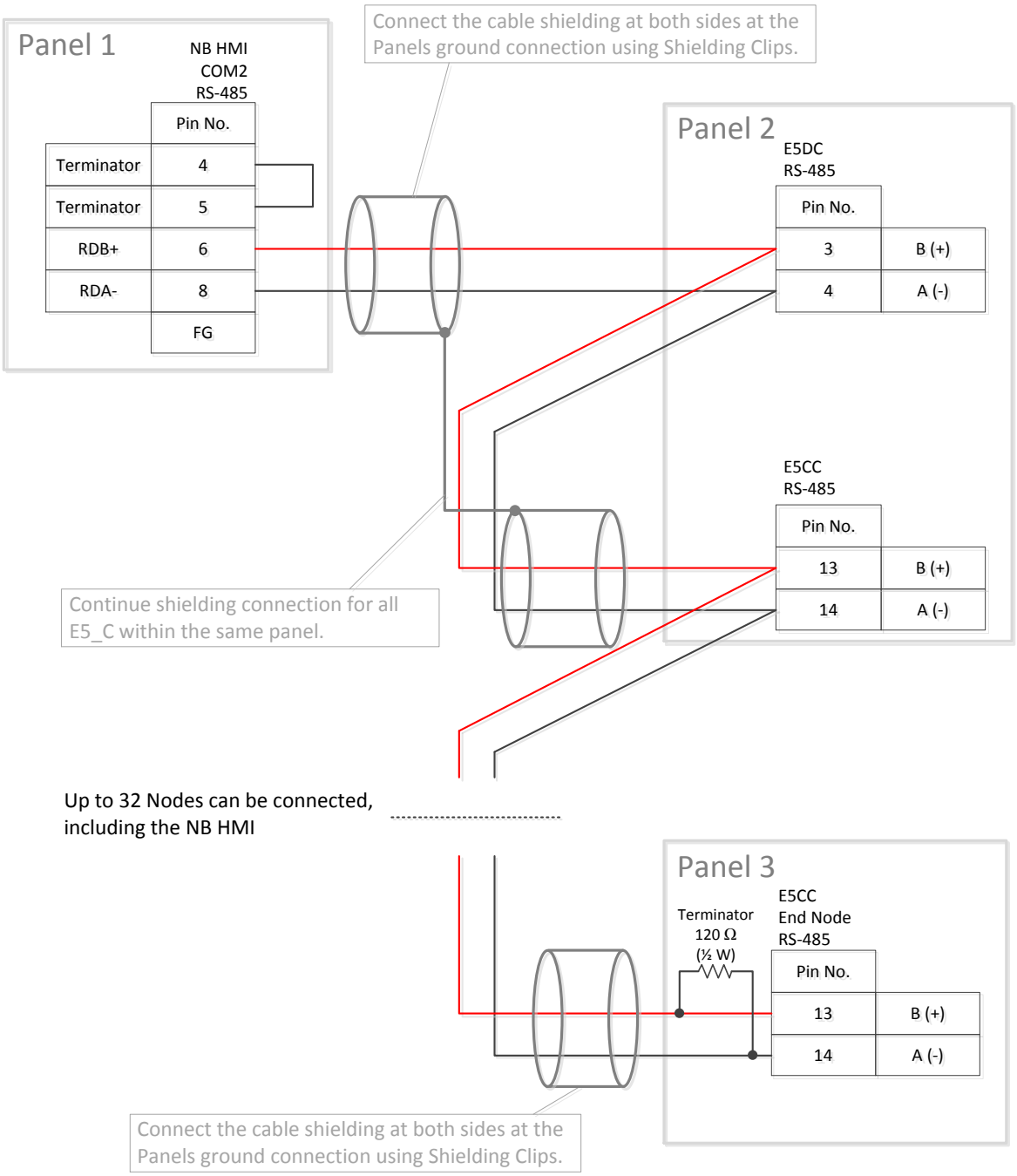


Figure 13 Wiring Diagram using multiple panels

1.4 Communication Settings

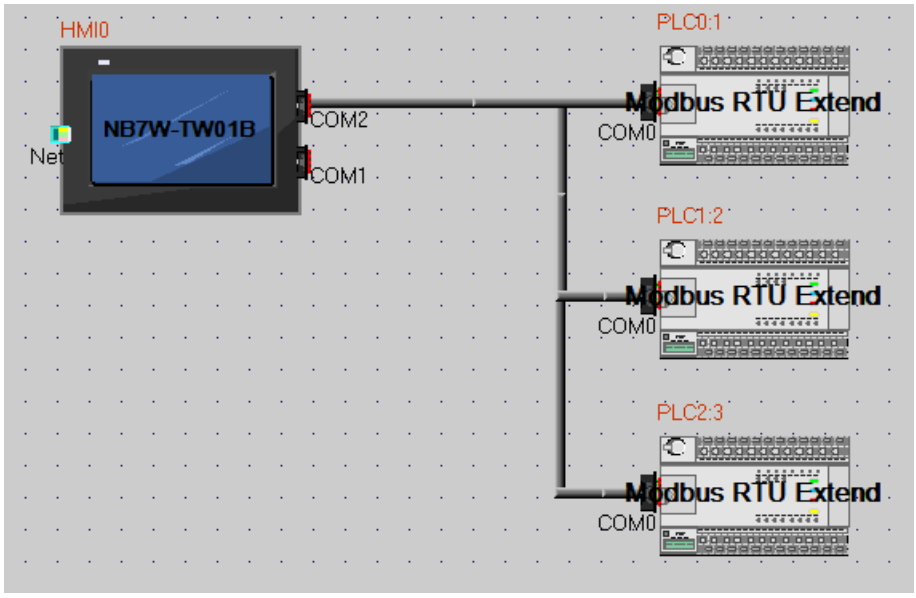
The following section describes how to setup communication between the Compact NB HMI and E5_C Temperature Controllers using Modbus RTU protocol.

NB-Designer

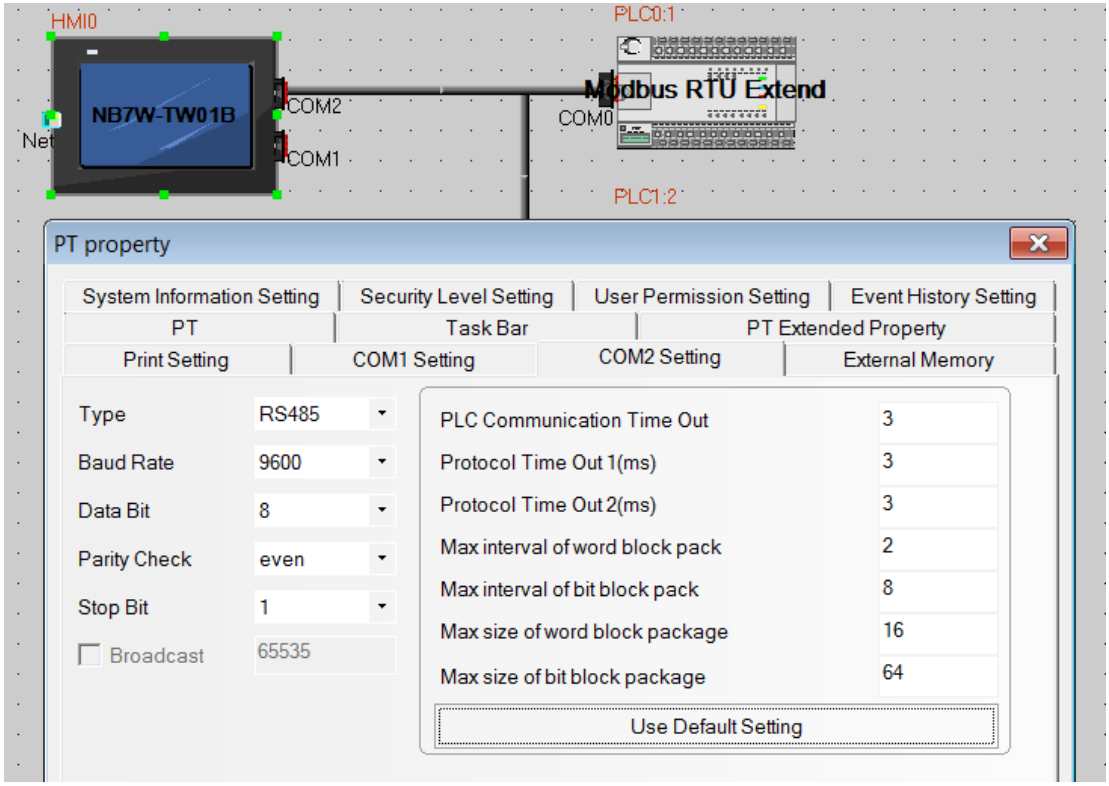
The methods below explain the NB-Designer configuration procedure. The first method illustrates how to visual configure the network configuration. In order to reduce time in developing the network configuration, assigning a station number in screen objects such as 'Number Inputs' is also possible. Method 2 describes how to assign station numbers in screen objects.

Method 1: Visually Design your Network Configuration.

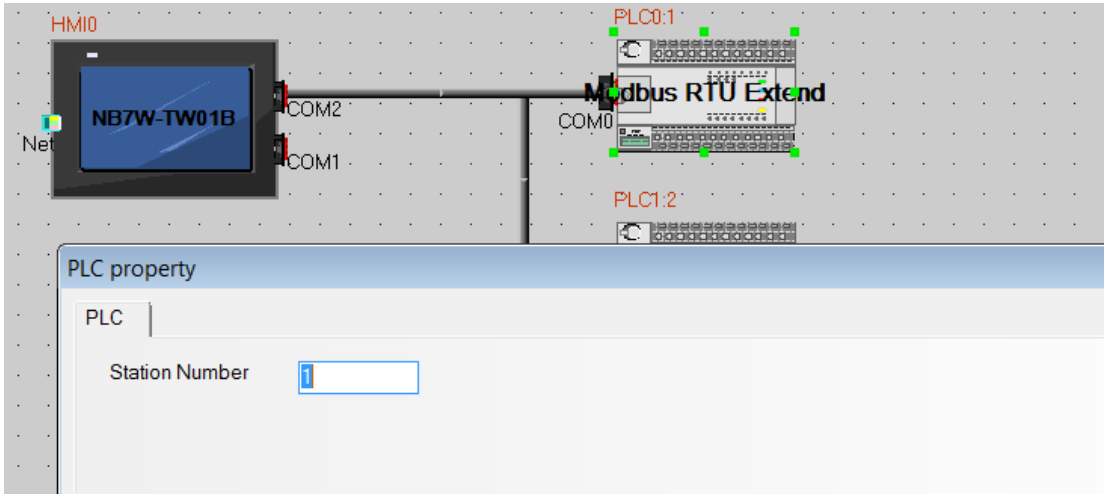
I. Design your network configuration, for example:



II. Define the NB HMI COM2 settings.

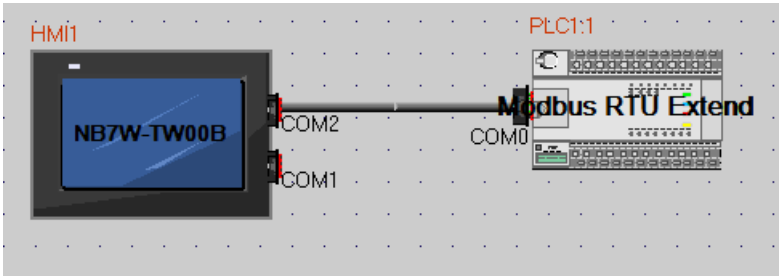


III. Assign the Modbus Slave Node Addresses.

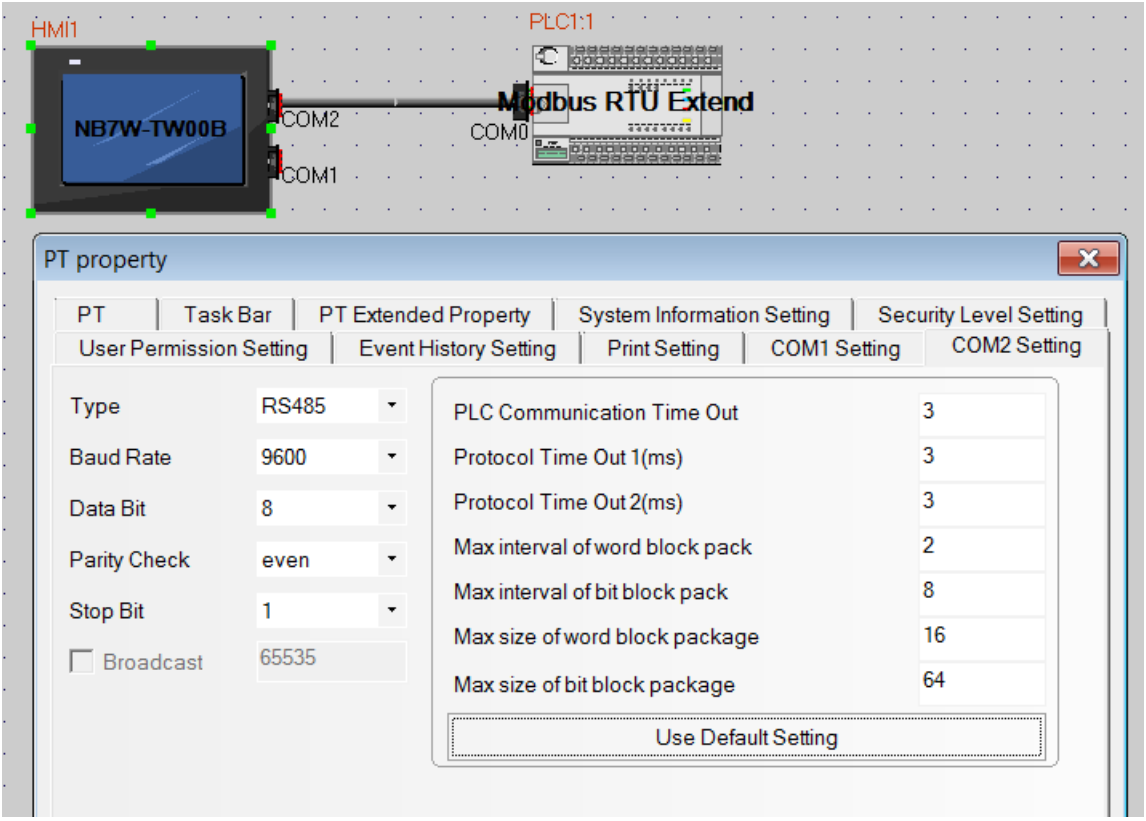


Method 2: Assign the Modbus Slave Node Address directly in screen objects

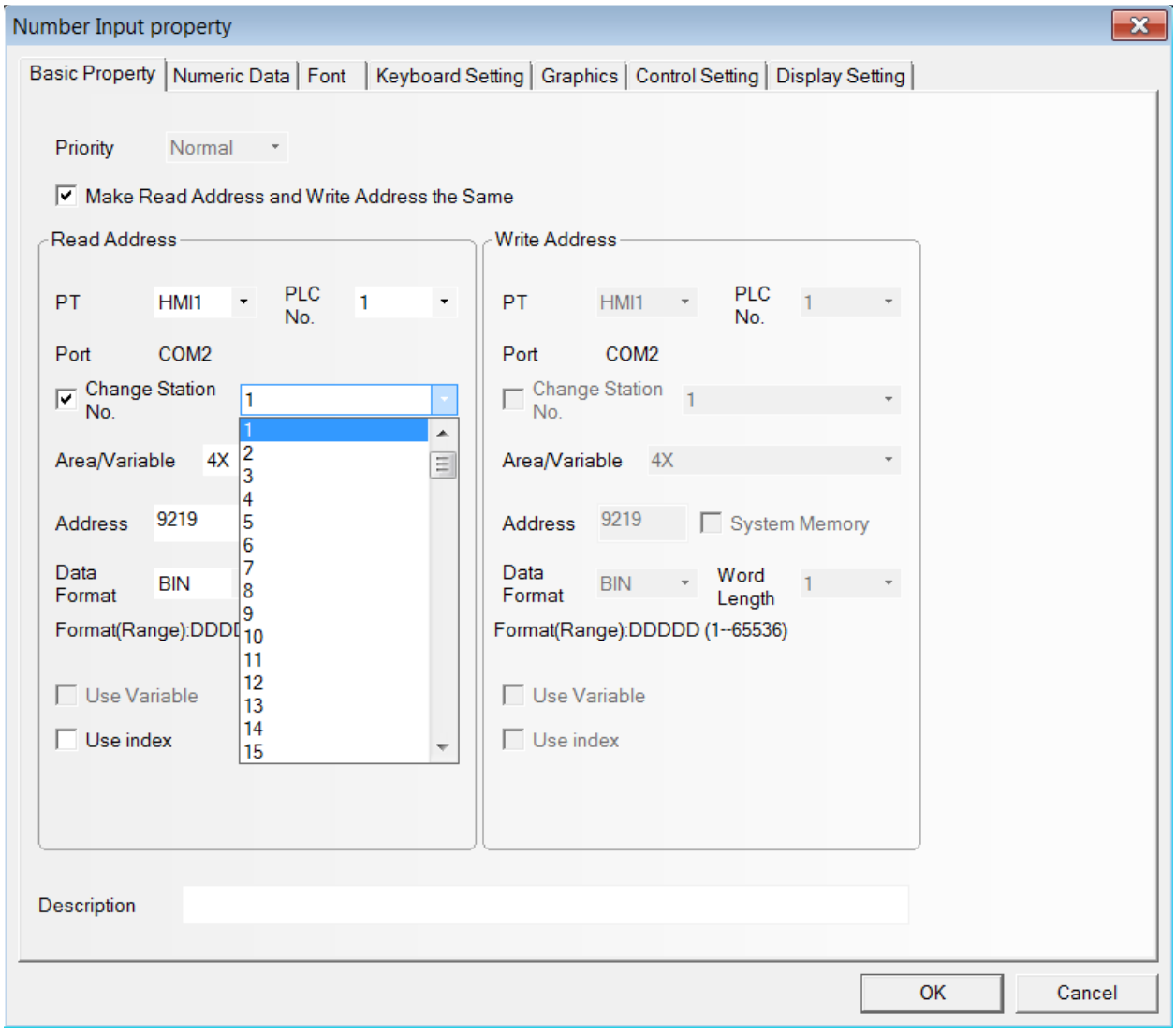
I. Design the network configuration as shown below.



II. Define the NB HMI COM2 settings.



III. Assign a different Modbus Slave Node Address using the 'Change Station No.' checkbox in screen objects.



Temperature Controller

The Compact NB HMI communicates with the E5_C Temperature Controllers using the Modbus RTU protocol. The steps below describe how to configure the TC.

I. Configure the following essential *Temperature Controller* parameters[4] as shown below.

Parameter Name	Displayed characters	Setting Range	Description
Protocol Setting	PSEL	Mod	Modbus Protocol
Unit Number	U-No	1 to 99	Modbus Slave Node Address[5]
Baud rate	bPS	9.6 : 9600 19.2 : 19200 38.4 : 38400 57.6 : 57600	Baud rate in bits / second
Data Length	LEN	8 (bit)	Data Length is fixed
Stop Bits	Sbit	1 or 2	Depends on Parity: Even / Odd : 1 None : 2
Parity	PRTY	NONE EVEN odd	None Even Odd
Send Data Wait Time	SdWt	0 to 99 ms	

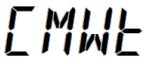
When the Protocol is set to Modbus, the following communication parameters are applicable:

- Data Length = 8 bits (the data length is fixed for Modbus communication)
- Stop bits = 1 (when parity is Even or Odd)
  = 2 (when parity is None)

The 'Data Length' and 'Stop Bits' parameters are not displayed when the Protocol Setting parameter is set to Modbus.

[4] *Appendix B: E5_C Communication Parameter Setup* describes how to navigate to the communications setting level using the TCs interface buttons.
[5] Apply the Modbus Slave Node Address as configured in NB-Designer.

II. Configure the optional communication related parameter as shown below.

Parameter Name	Displayed characters	Setting Range	Description
Communications Writing		ON or OFF	ON: The TC parameters are Read / Write for external devices such as the Compact CP1 PLC. OFF: The TC parameters are Read Only for external devices. It is recommendable to set this parameter ON to enable Read / Write actions for the TC parameters from the Compact CP1 PLC.

1.5 Modbus RTU Protocol

The following section describes the Modbus RTU Communication between the Compact NB HMI and E5_C Temperature Controller(s).

1.5.1 Modbus Registers

The following table lists several standard Modbus registers. The items expressed in hexadecimal in the "Setting (monitor) value" column are the setting range in the Modbus specifications. Values in parentheses "()" are the actual setting range.

Modbus Register (2-byte)	Parameter Name	Setting (monitor) value	Level
#2402	PV	Temperature: Use the specified range for each sensor. Analog: Scaling lower limit − 5% FS to Scaling upper limit + 5% FS	Operation
#2103	Set Point	SP lower limit to SP upper limit	
#2406	Status [6] [7]	Refer to section 1.5.2 Status Details	
#2407	Status [8]	Refer to section 1.5.2 Status Details	
#2D0F	Set Point Upper Limit	The range of values (without decimal point) is as follows: Temperature input: SP lower limit + 1 to Input range upper limit Analog input: SP lower limit + 1 to Scaling upper limit	Initial Setting
#2D10	Set Point Lower Limit	The range of values (without decimal point) is as follows: Temperature input: Input range lower limit to SP upper limit − 1 Analog input: Scaling lower limit to SP upper limit − 1	
#2708	Control Period (heating)	H'FFFFFFFE (−2): 0.1 s H'FFFFFFFF (−1): 0.2 s H'00000000 (0): 0.5 s H'00000001 to H'00000063 (1 to 99)	
#2A00	Proportional Band	H'00000001 to H'0000270F (0.1 to 999.9)	Adjustment
#2A01	Integral Time	Standard, heating/cooling, or close position proportional control: H'00000000 to H'0000270F (0 to 9999: Integral/derivative time unit is 1 s.) (0.0 to 999.9: Integral/derivative time unit is 0.1 s.) Floating position-proportional control: H'00000001 to H'0000270F (1 to 9999: Integral/derivative time unit is 1 s.) (0.1 to 999.9: Integral/derivative time unit is 0.1 s.)	
#2A02	Derivative Time	H'00000000 to H'0000270F (0 to 9999: Integral/derivative time unit is 1 s.) (0.0 to 999.9: Integral/derivative time unit is 0.1 s.)	

Please refer to H175-E1-08 E5_C Digital Temperature Controllers Communications Manual, section 5-1 Variable Area (Setting Range) List for the complete Modbus register list.

[6] The parameter 'Status' is not displayed on the Controller display.
[7] In 2-byte mode, the rightmost 16 bits are read.
[8] In 2-byte mode, the leftmost 16 bits are read.

1.5.2 Status Details

The following table describes the 'Status' parameter in detail.

Bit position		Status	Bit Description	
			0	1
Status (lower word)	0	Heater overcurrent (CT1)	Not generated	Generated
	1	Heater current hold (CT1)	Update	Hold
	2	A/D converter error	Not generated	Generated
	3	HS alarm (CT1)	OFF	ON
	4	RSP input error	Not generated	Generated
	5	-	OFF	-
	6	Input error	Not generated	Generated
	7	Potentiometer input error	Not generated	Generated
	8	Control output (heating) / open output	OFF	ON
	9	Control output (cooling)/close output	OFF	ON
	10	HB (heater burnout) alarm (CT1)	OFF	ON
	11	HB (heater burnout) alarm (CT2)	OFF	ON
	12	Alarm 1	OFF	ON
	13	Alarm 2	OFF	ON
	14	Alarm 3	OFF	ON
	15	Program end output	OFF	ON
Status (upper word)	16	Event input 1	OFF	ON
	17	Event input 2	OFF	ON
	18	Event input 3	OFF	ON
	19	Event input 4	OFF	ON
	20	Write mode	Backup mode	RAM write mode
	21	Non-volatile memory	RAM = Non-volatile memory	RAM ≠ Non-volatile memory
	22	Setup area	Setup area 0	Setup area 1
	23	AT execute/cancel	AT canceled	AT execution in progress
	24	RUN/STOP	Run	Stop
	25	Communications writing	OFF (disabled)	ON (enabled)
	26	Auto/manual switch	Automatic mode	Manual mode
	27	Program start	Reset	Start
	28	Heater overcurrent (CT2)	Not generated	Generated
	29	Heater current hold (CT2)	Update	Hold
	30	-	OFF	-
	31	HS alarm (CT2)	OFF	ON

Precaution for usage:

- Status bits marked as "-" are always OFF.
- When read in setup area 1, the status of the bits will be as follows:
  - Overcurrent: Last value held
  - A/D converter error: Last value held
  - Input error: Last value held
  - HB and HS outputs: Cleared
  - Program end output: Cleared
  - Current hold: Last value held
  - Heating and cooling outputs: Cleared
  - Alarm outputs: Cleared
- Status (lower Word) Bit 1: When the control output ON time is less than 30 ms for a control period of 0.1 s or 0.2 s or when it is less than 100 ms for any other control period, the bit is set to "1" and the heater current is held at the last current value.

1.5.3 Assigning Modbus Registers in NB-Designer

The Compact NB HMI supports several Modbus communication protocols. The most notable protocols are Modbus RTU, Modbus ASCII and Modbus TCP. The Compact NB HMI uses different communication drivers of the Modbus RTU in terms of using Function Codes. The most extensive Modbus communication driver is Modbus RTU Extend. Modbus RTU Extend supports a wide range of function codes.

Please refer to V108 Host Connection Manual for more information about the different Modbus communication drivers for the Compact NB HMI.

The E5_C Temperature Controller supports function code #06 Write Single Variable / Operation Command. The only Modbus communication driver that supports function code #06 is the Modbus RTU Extend communication driver. Therefore, the following information refers to Modbus RTU Extend when using Modbus communication.

Section *1.4 Communication Settings* described how to visual design the Modbus network within NB-Designer as illustrated in *Figure 14 NB-Designer Network Configuration pane*. This section continues explaining how to register Modbus registers for Modbus Node 1.

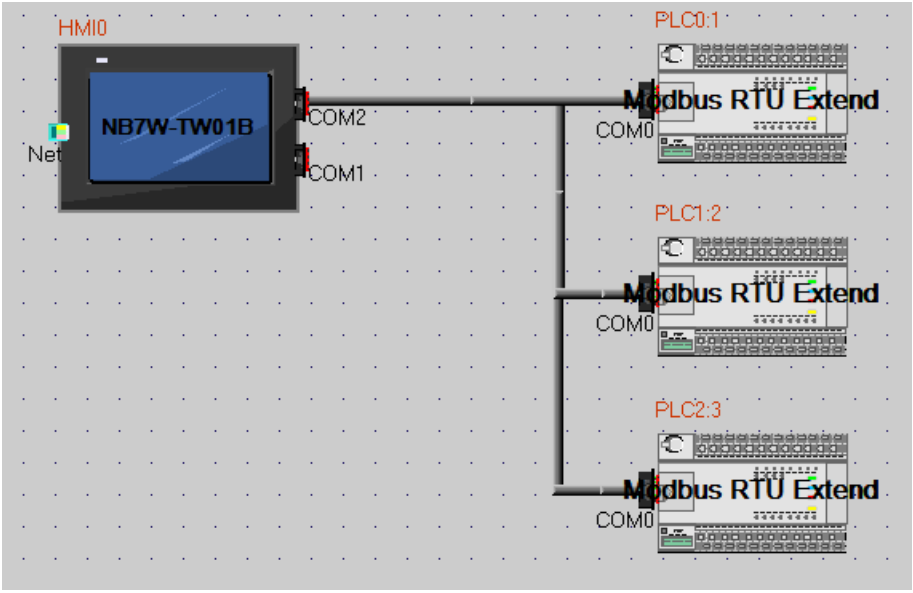


Figure 14 NB-Designer Network Configuration pane

1.5.1 Modbus Registers illustrated several parameters to read from the TC. The Modbus Address allocation provided is in hexadecimal format however, NB-Designer uses the decimal format. For example:

The hexadecimal address of the *Process Value* is #2402. Converting the address into a decimal format reads &9218.

NB-Designer uses an offset of +1 for the Modbus Address allocation because an address allocation of 0 is invalid in NB-Designer. As a result, the Modbus register allocated for the Process Value is &9219 as shown in *Figure 15 Assigning the Process Value register as Modbus Address*. Set the Area / Variable setting to 4X.

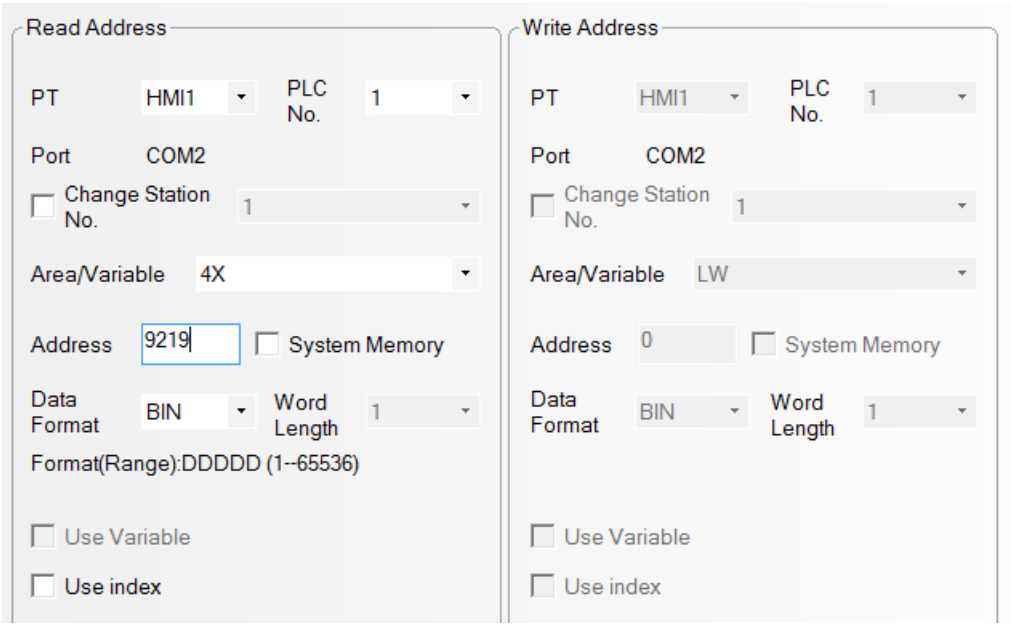


Figure 15 Assigning the Process Value register as Modbus Address

The Modbus Address offset allocation is applicable for all Modbus communication drivers.

2 IN-PANEL TEMPERATURE REGULATION

The following chapter describes the In-Panel Temperature Regulation solution.

2.1 Introduction

The In-Panel Temperature Regulation solution consists of three OMRON products, respectively the E5DC In-Panel Temperature Controller, Compact CP1 PLC and the Compact NB HMI. The CP1 PLC uses the CP1W-CIF11 / CIF12 option board to support RS-485 communication between the PLC and the Temperature Controllers. The communication between the devices is programless and it just requires configuring the parameters within the temperature controllers to establish communication.

'Programless Communication' features reading and writing parameters from and to the temperature controller from user specified data memory addresses located in the CP1 PLC. Up to 32 temperature controllers can connect to a CP1 PLC. The PLC is the central hub for controlling the process while it also contains the functionality to communicate with a Compact NB HMI.

The Compact NB HMI adds valuable features such as visual displaying the course of temperature within a specified amount of time. It can log the trend data onto an external memory in .csv format for easy reading and can also read / write specific parameters to the Temperature Controller(s) via the CP1 PLC.

2.2 Programless Communication

This section describes the 'Programless Communication' feature of the E5_C Temperature Controllers.

2.2.1 Introduction

The 'Programless Communication' feature in the E5_C Temperature Controllers enables easy and convenient communication between the Compact CP1 PLC and the Temperature Controllers. Up to 32 E5_C controllers can connect to the PLC.

Each E5_C controller has 30 Words allocated in the PLC memory that automatically synchronizes if communication is established. Each individual E5_C can assign up to 13 parameters for both reading and writing from and to the PLC memory. In total 26 parameters are synchronized between the PLC and the Temperature Controller. The PLC memory allocation is user defined and therefore provides the flexibility to customize according the user preferences.

Figure 16 PLC Memory Allocation illustrates the PLC memory allocation when assigned multiple Temperature Controllers.

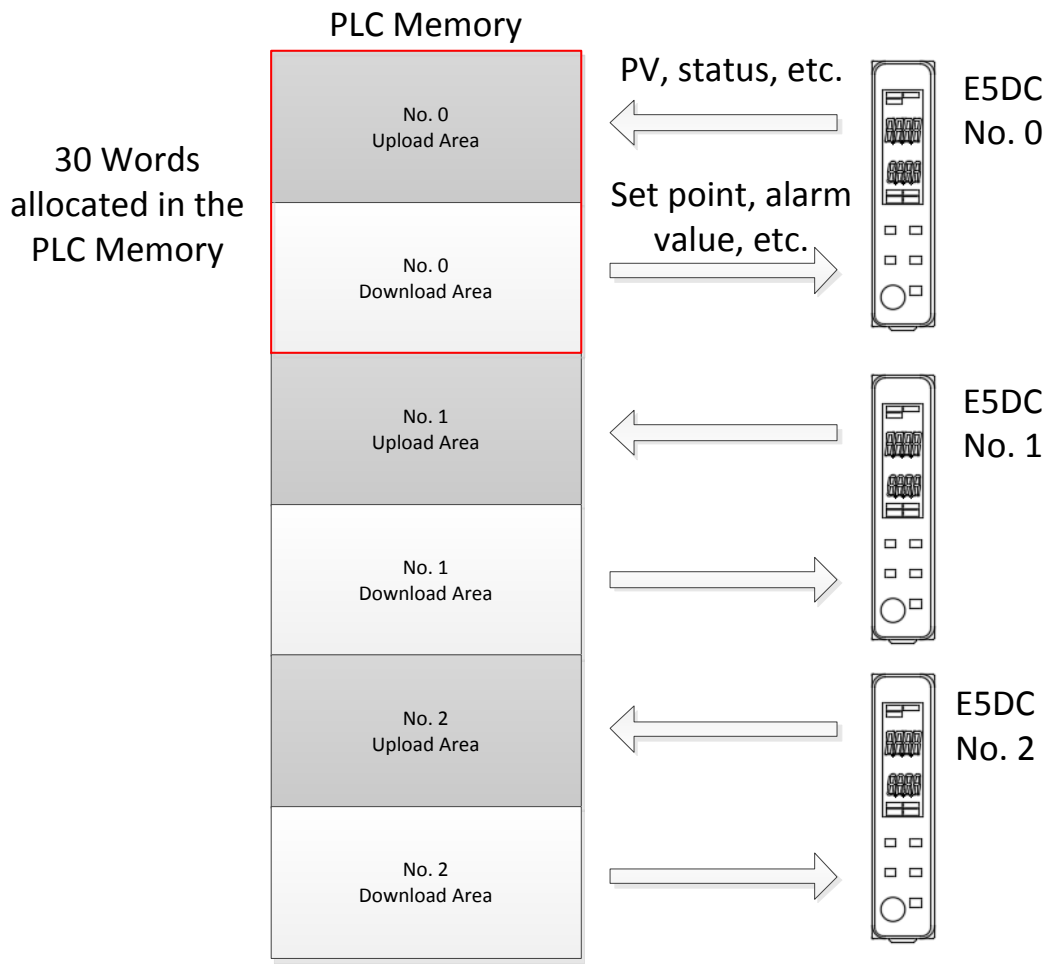


Figure 16 PLC Memory Allocation

2.2.2 Communication Process

The Master (the E5_C Controller with communication unit number 0) starts 'Programless Communication' approximately five seconds after the power supply is on. When the master starts communication, the slaves (the E5_C Controllers with a communication unit number other than 0) also start communication.

Figure 17 Communication Process illustrates the process of the 'Programless Communication' starting at Unit No. 0, the master unit. The master unit shall first start synchronizing the data with the Compact CP1 PLC. After the master finished synchronizing the data, Unit No. 1 shall start synchronizing the data with the Compact CP1 PLC. This process continues until the highest communications unit number has completed the synchronize process, then the process restarts at Unit No. 0.

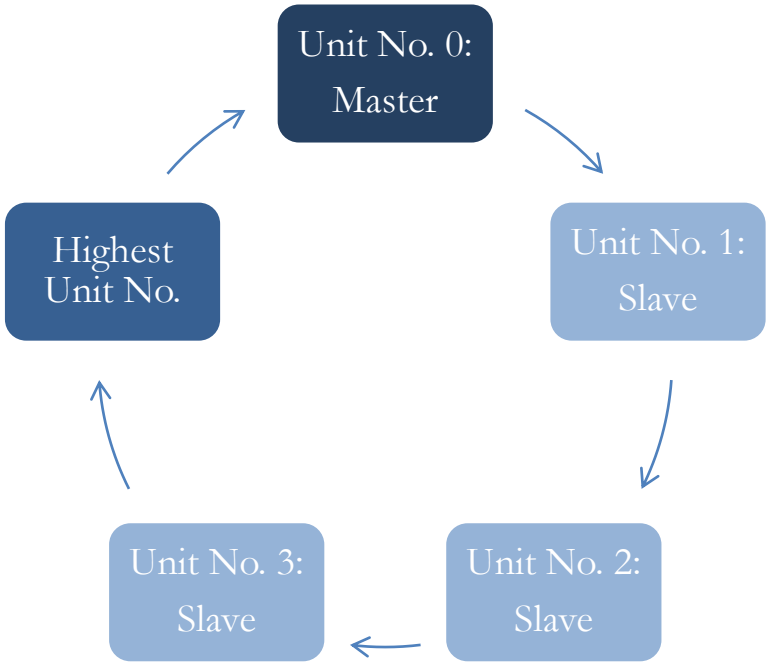


Figure 17 Communication Process

Please refer to H175 E5_C Digital Temperature Controllers Communications manual, section 6-1 Programless Communication for more information about the 'Programless Communication' feature.

Precautions for Usage:

- 'Programless Communication' is supported with the following product versions:
  - E5CC version 1.1 or higher
  - E5EC version 1.1 or higher
  - E5AC version 1.1 or higher
  - E5DC version 1.0 or higher
  - E5GC version 2.2 or higher
- 'Programless Communication' uses RS-485 as the communication method.
- The communication does not start until the power supply to the master is on.
- The communication cycle will increase while waiting for communication from the stopped E5_C Controllers.
- After communication has started, it will continue for the remaining E5_C Controllers even if one or more (including the master) stops.
- Assign unit numbers in sequential order, for example 0, 1, 2, 3, etc. otherwise communication issues shall occur.

2.3 System Configuration

As mentioned in the previous section RS-485 communications is required for 'Programless Communication' between the Compact PLC and Temperature Controllers. The CP1W-CIF11 (/ CIF12) option board add RS-485 / RS-422 communication to the Compact CP1 PLC. The option board is mandatory for the Compact CP1 PLCs in all configurations to support RS-485 communication with the Temperature Controllers. The only exception is the CP1E-N_S1 model, which supports a built-in RS-485 port.

Achieving communication between the Compact HMI and PLC is accomplished using various methods such as Serial and Ethernet.

The first communication method is serial using RS-232, RS-485 or RS-422 with all NB HMI models. RS-232 is the most common serial connection and therefore this document only refers to the RS-232 method. RS-232 serial communication supports a 1:1 connection only. The CP1W-CIF01 option board supports RS-232 communication. The CP1E model support built-in port supports RS-232 communication.

The second communication method is Ethernet related. The Ethernet configuration utilizes the CP1L-E with built-in Ethernet port to achieve Ethernet communication with the NB HMI.

Table 1 System Configurations illustrate what products are required to achieve specific configurations.

Table 1 System Configurations

Product	Serial CP1E	Serial CP1E-N_S1	Serial CP1L-E	Ethernet
NB__-TW00B	Yes	Yes	Yes	-
NB__-TW01B	Yes	Yes	Yes	Yes
E5DC	Yes	Yes	Yes	Yes
CP1E	Yes		-	-
CP1E-N_S1	-	Yes	-	-
CP1L-E	-	-	Yes	Yes
CP1W-CIF01	-	-	Yes	-
CP1W-CIF11 / CIF12	Yes	-	Yes	Yes

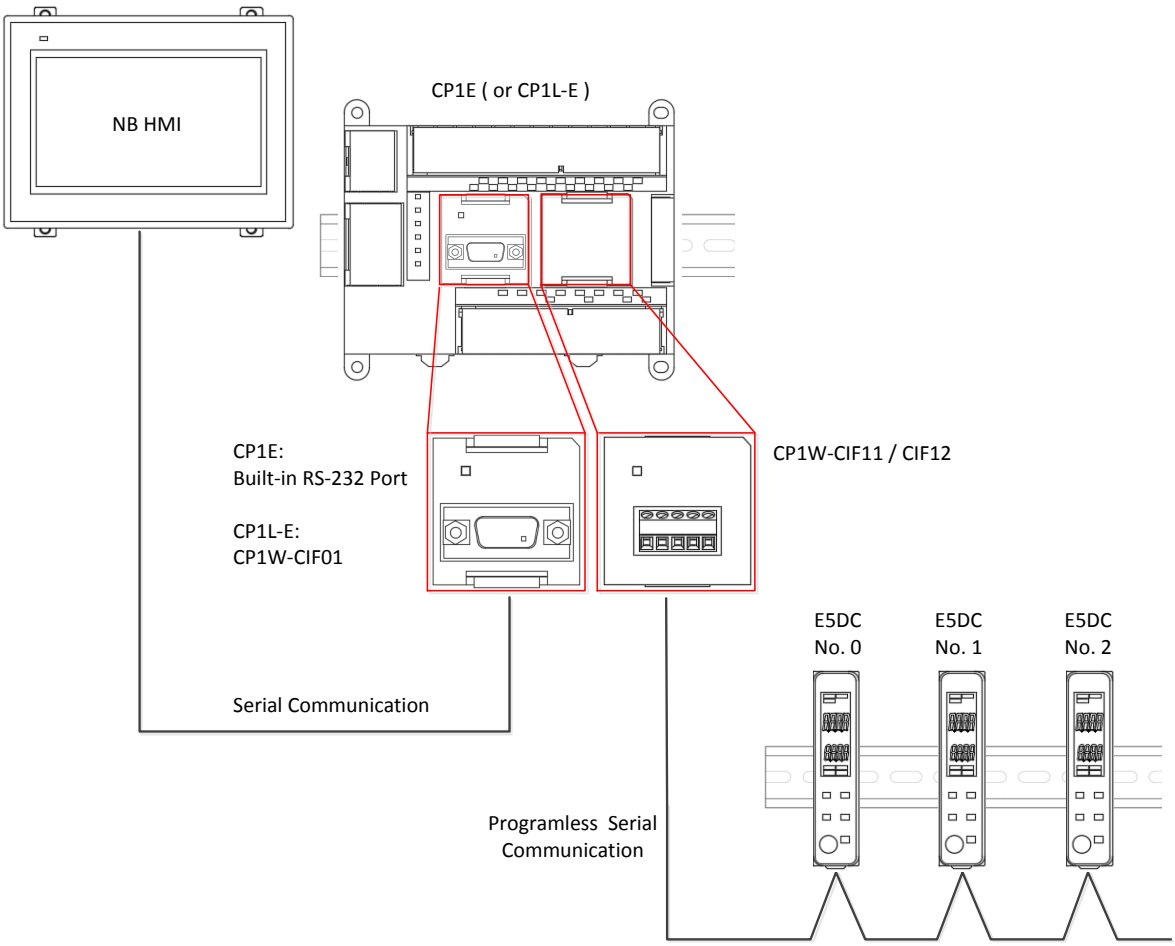
Please refer to *Appendix A: E5_C Hardware Information* for detailed product information about the E5_C Temperature Controllers, such as model selection and pin-out.

The next paragraphs contain the various communication configuration overviews.

2.3.1 Serial

The configuration consists of the following products:

- Compact NB HMI (non-model specific)
- Compact CP1 PLC
  - CP1E with built-in RS-232 Port
  - CP1L-E + CP1W-CIF01 RS-232 Option Board
- XW2Z-200T or XW2W-500T communication cable
- CP1W-CIF11 or CIF12 Option Board
- E5DC Temperature Controllers



Precaution for usage:

- Please refer to W479 CP1E CPU Unit Hardware User Manual for detailed information about CP1E models.
- Please refer to W516 CP1L-EL/EM CPU Unit Operation Manual for detailed information about CP1L-E models.
- CP1L-E Firmware Version 1.06 or higher is required.
- CP1L-E produced with the following Lot No.[9] use firmware version 1.06 or higher:
  - CP1L-EL20 : Lot No. 11813M or later
  - CP1L-EM30 : Lot No. 18813M or later
  - CP1L-EM40 : Lot No. 24813M or later

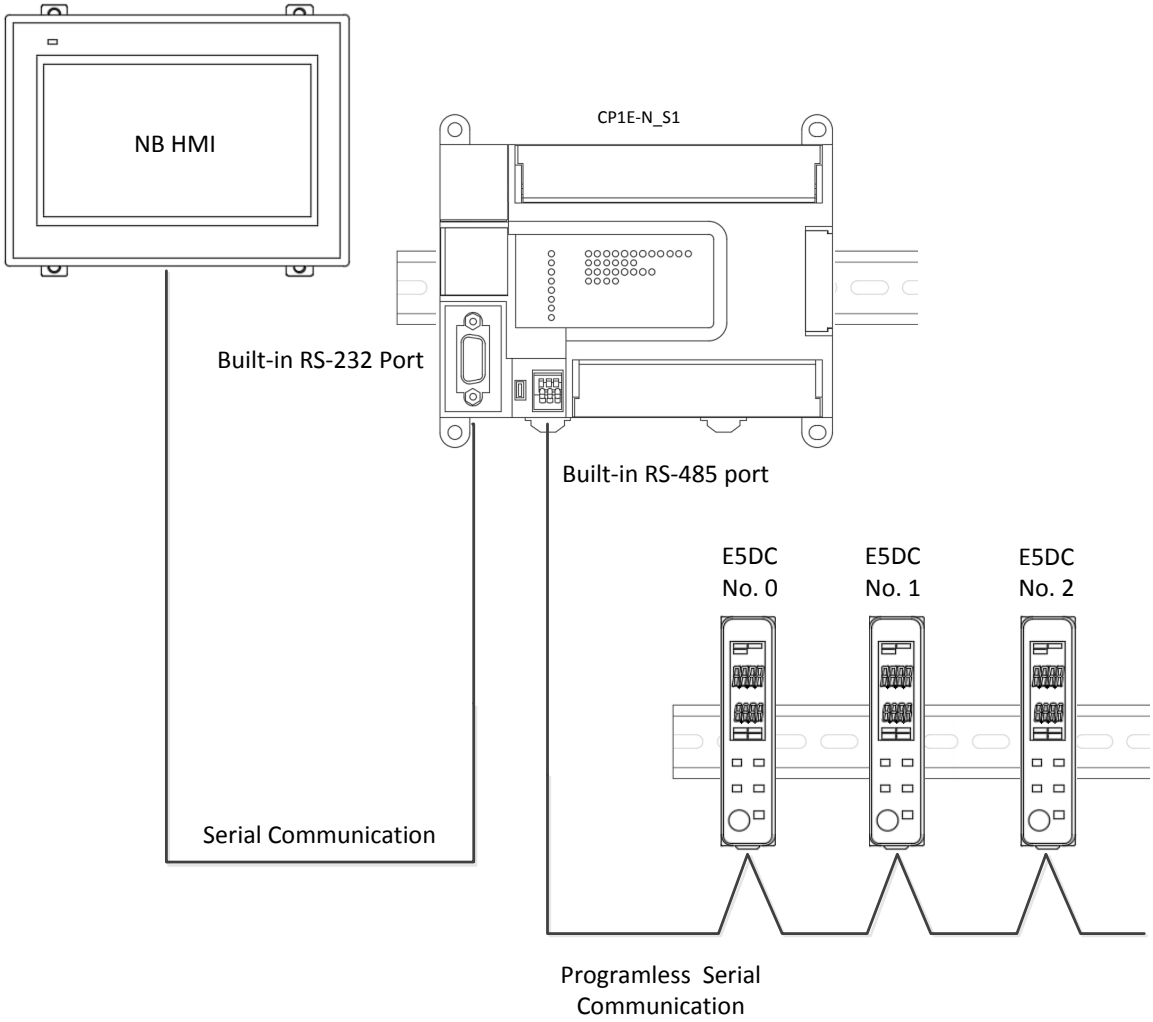
  Please contact your local OMRON representative if the manufactured CP1L-E has a Lot No. of an earlier date than the provided Lot No. above.
- CX-Programmer version 9.4 or higher is required for the CP1L-E model.

[9] The following example explains how to interpret the Lot No. code: 11813M = 11 August 2013.

2.3.2 Serial CP1E-N_S1

The configuration consists of the following products:

- Compact NB HMI (non-model specific)
- Compact CP1E-N_S1 PLC with built-in RS-232 and RS-485 Ports
- XW2Z-200T or XW2W-500T communication cable
- E5DC Temperature Controllers



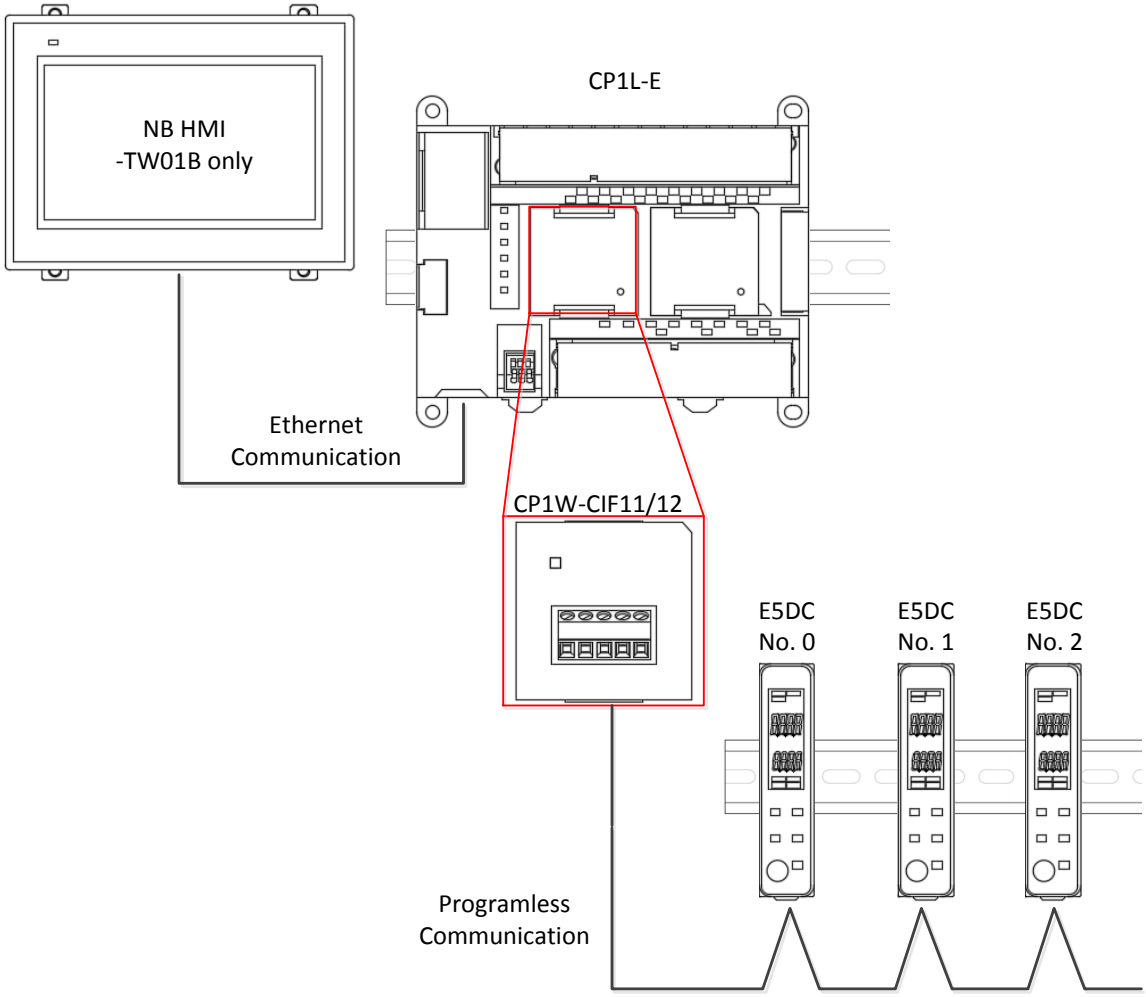
Precaution for usage:

- CJ1W-CIF11 converter module cannot be connected to the built-in RS-232 port of the CP1E-N_S(1) model.

2.3.3 Ethernet

The configuration consists of the following products:

- Compact NB HMI (-TW01B model only)
- Compact CP1L-E with built-in Ethernet Port PLC
- CP1W-CIF11 or CIF12 RS-485/422 option board
- E5DC Temperature Controllers



Precaution for usage:

- CP1L-E Firmware Version 1.06 or higher is required.
- CP1L-E produced with the following Lot No.[10] use firmware version 1.06 or higher:
  - CP1L-EL20 : Lot No. 11813M or later
  - CP1L-EM30 : Lot No. 18813M or later
  - CP1L-EM40 : Lot No. 24813M or later

  Please contact your local OMRON representative if the manufactured CP1L-E has a Lot No. of an earlier date than the provided Lot No. above.
- CX-Programmer version 9.4 or higher is required for the CP1L-E model.

[10] The following example explains how to interpret the Lot No. code: 11813M = 11 August 2013.

2.4 Wiring Diagrams

Precaution for Usage:

Generic

- Use a shielded twisted-pair cable with a wire gauge of AWG24, shunt capacitance of 16 pF per foot and 120Ω characteristic impedance.
    - Shunt Capacitance: The capacitive resistance limits the total cable length. Applications with long cable lengths benefit from using low capacitance cable.
    - 120Ω Characteristic impedance: The correct cable impedance prevents signal reflections.
- Do not position the RS-485 cable next to power cables to avoid Electromagnetic Interference on the signal.
- Connect a 120Ω Termination Resistor at the last E5DC node to reduce signal reflections on the cable.
- The RS-485 communication can be either 1:1 or 1:N.

CP1W-CIF11 (/CIF12)

- Turn on DIP Switch 1 to enable the Termination Resistor to reduce signal reflections on the cable.
- Turn on DIP Switch 2 and 3 to enable RS-485 (2-wire) communication.
- Turn on DIP Switch 5 and 6 to enable flow control in the serial communication.
- CP1W-CIF11: Maximum cable length is 50 meters due to non-galvanic signal isolation.
- CP1W-CIF12: Maximum cable length is 500 meters due to galvanic signal isolation.

CP1E-N_S1 Built-in RS-485 Port

- The built-in RS-485 port has a single DIP Switch that enables the Termination Resistor. Turn it on to enable the Termination Resistor to reduce signal reflections on the cable.
- The maximum cable length is 50 meters.

2.4.1 One Panel

CP1W-CIF11 (/ CIF12) Option Board

Figure 18 CP1W-CIF11 / CIF12 wiring diagram using one panel illustrates the wiring diagram between the CP1W-CIF11 / CIF12 and E5DC Temperature Controllers.

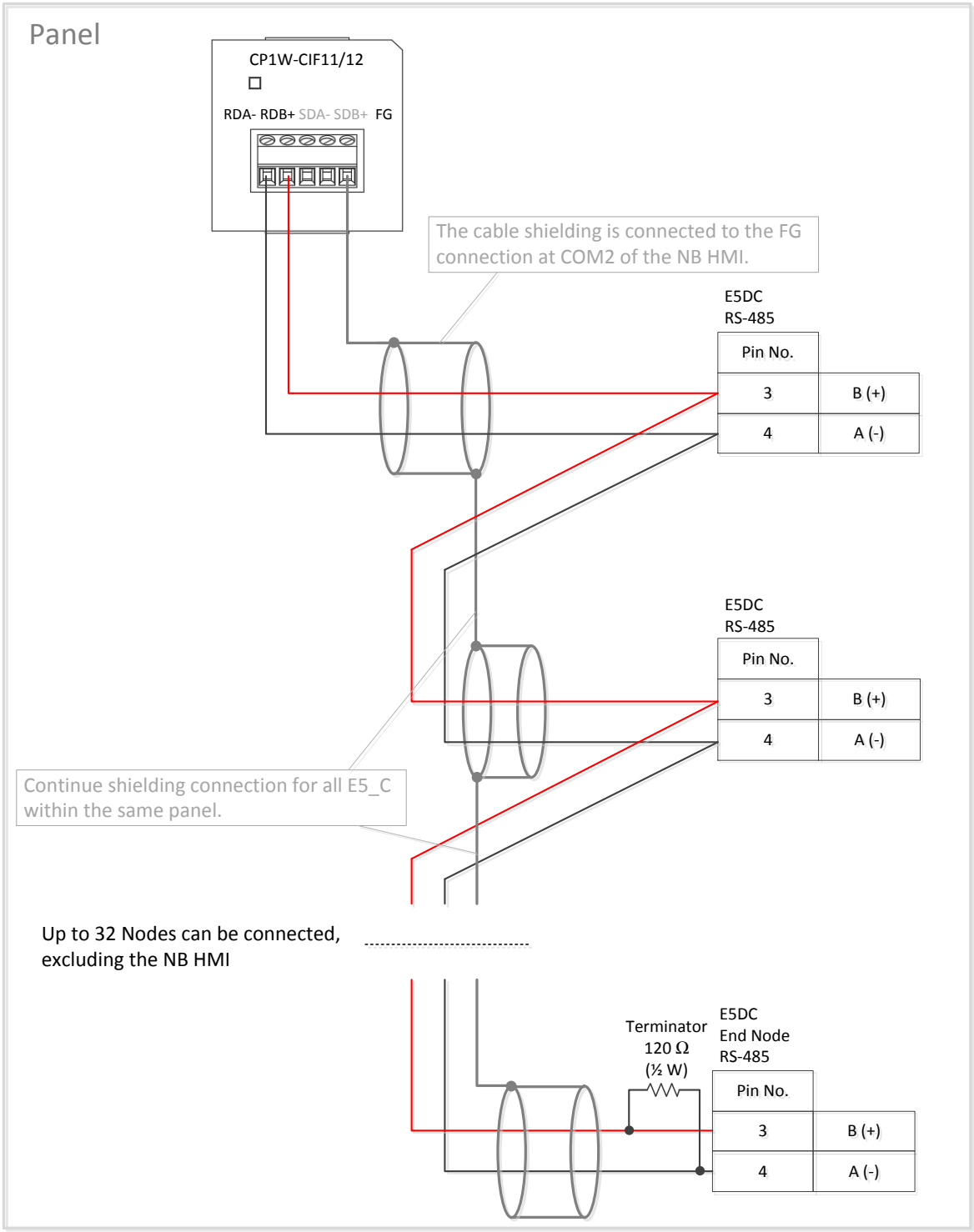


Figure 18 CP1W-CIF11 / CIF12 wiring diagram using one panel

CP1E-N_S1 Built-in RS-485 Port

Figure 19 CP1E-N_S1 built-in RS-485 port wiring diagram using one panel illustrates the wiring diagram between the built-in RS-485 port and E5DC Temperature Controllers.

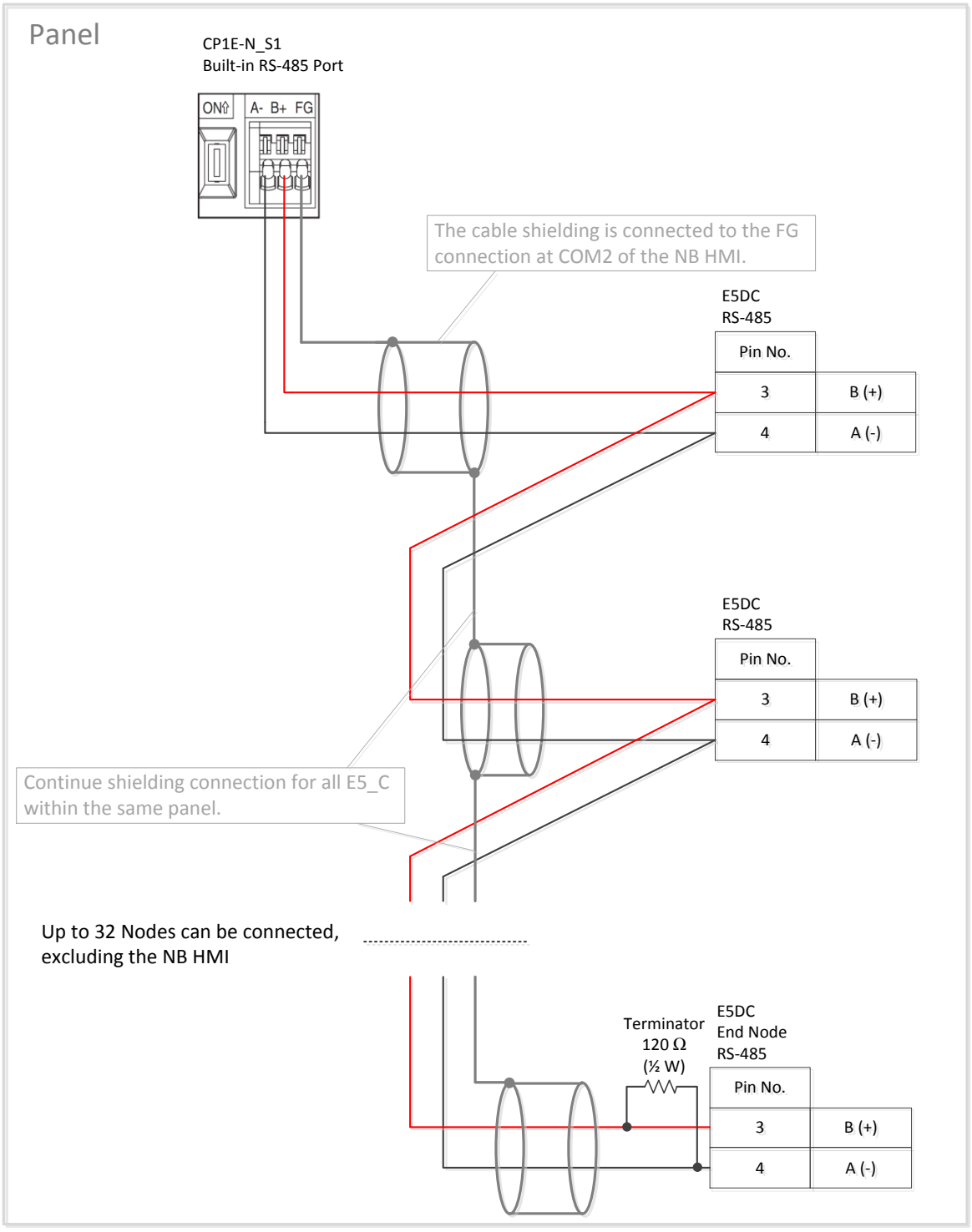


Figure 19 CP1E-N_S1 built-in RS-485 port wiring diagram using one panel

2.4.2 Multiple Panels

Mounting the equipment in multiple Panels changes the method used to connect the shielding. Signal disruption from Electrical Magnetic Interference is more likely with this configuration therefore it is not recommendable to connect the cable shielding at the FG connection at the built-in RS-485 port or CP1W-CIF11 / CIF12. Instead, connect the RS-485 cable shielding on both sides at the panels ground connection as illustrated in *Figure 20 Cable diagram using multiple panels*.

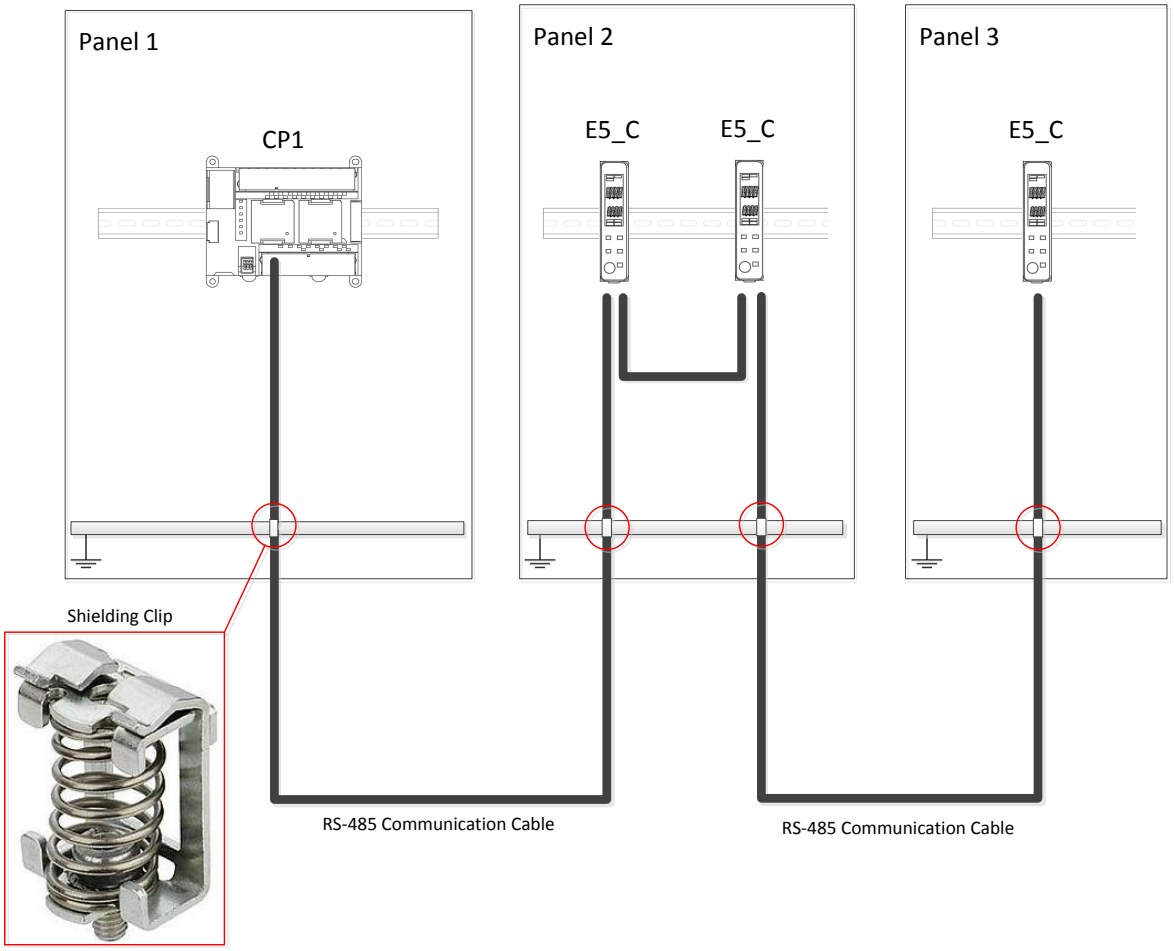


Figure 20 Cable diagram using multiple panels

For optimal protection against potential Electromagnetic Interference within the panels, continue the cable shielding until the communication cable reaches the equipment. Only remove the cable insulation where the cable should connect with the shielding clip. It is recommended not to remove the cable shielding after the shielding clip.

Refer to *Figure 21 CP1W-CIF11 / CIF12 wiring diagram using multiple* panels and *Figure 22 CP1E-N_S1 Built-in RS-485 Port wiring diagram using multiple panels* below.

CP1W-CIF11 (/ CIF12) Option Board

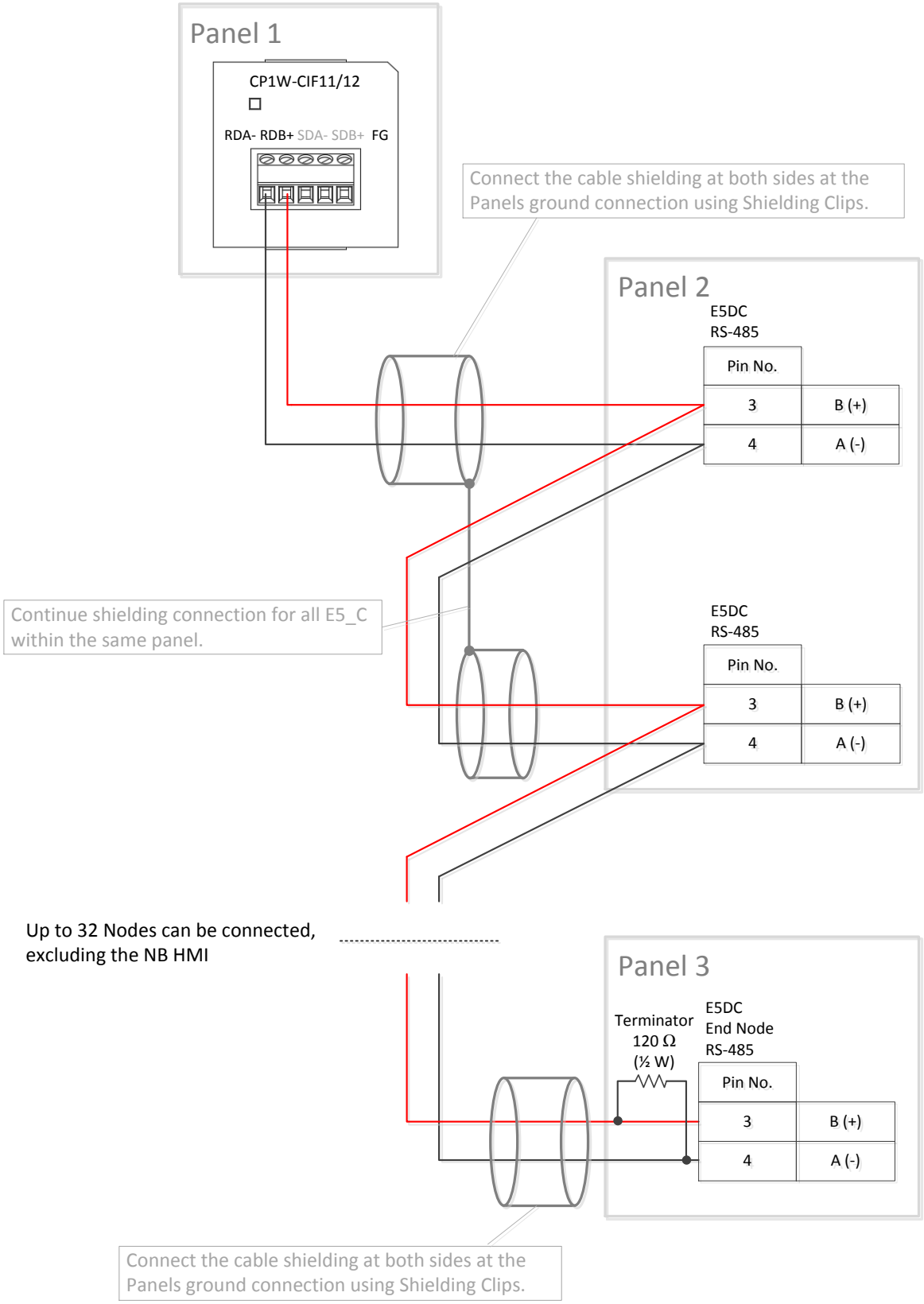


Figure 21 CP1W-CIF11 / CIF12 wiring diagram using multiple panels

CP1E-N_S1 Built-in RS-485 Port

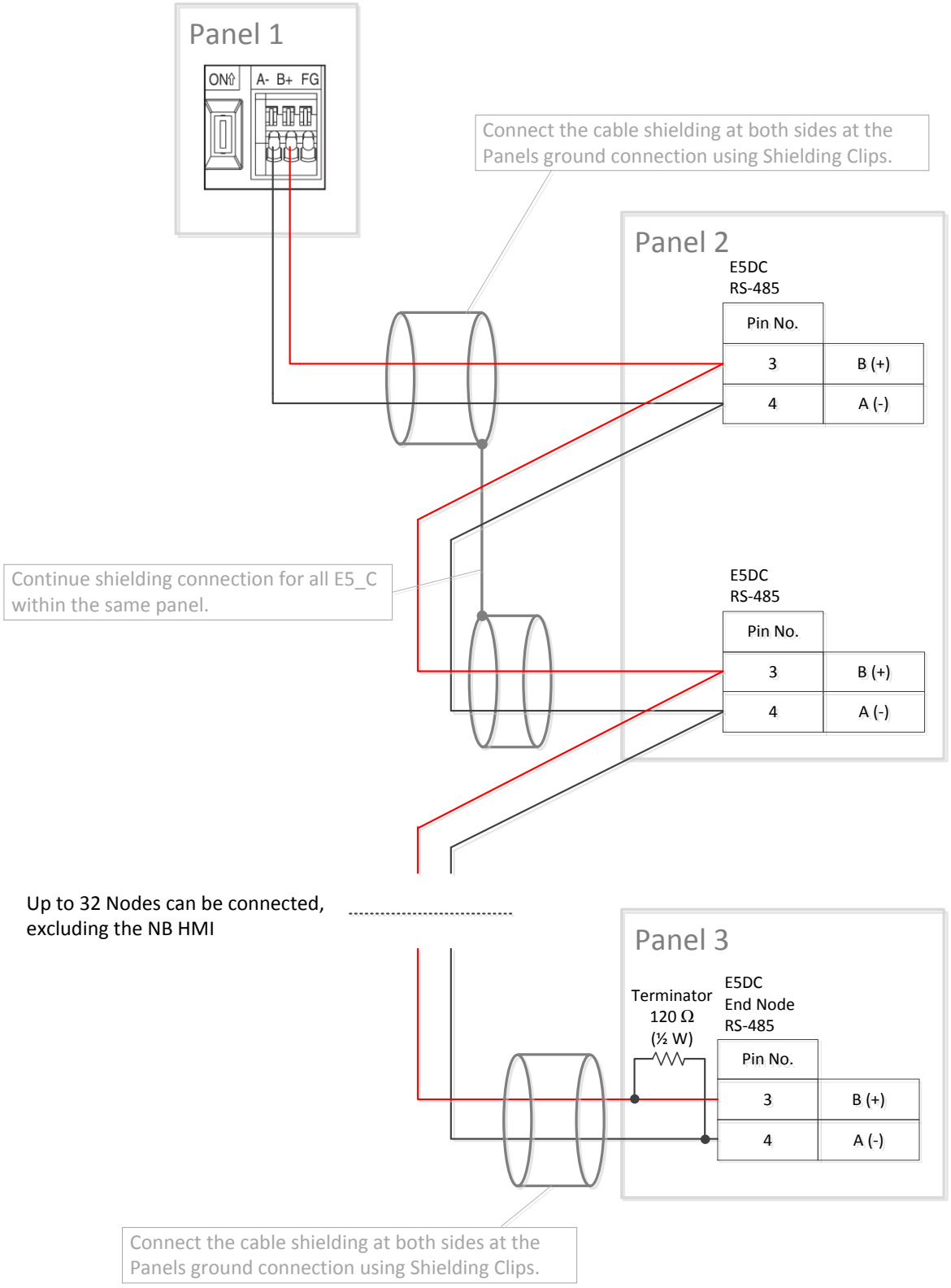


Figure 22 CP1E-N_S1 Built-in RS-485 Port wiring diagram using multiple panels

2.5 Communication Settings

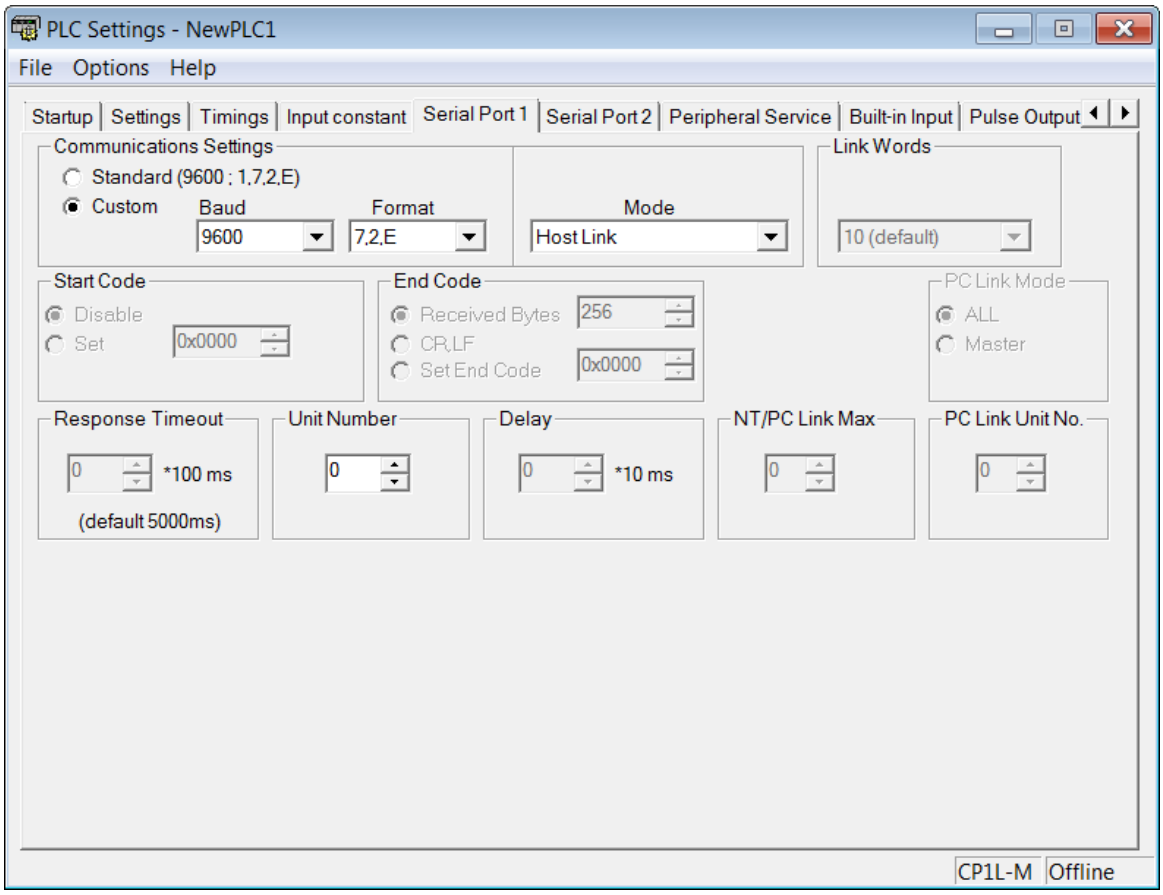
2.5.1 HMI Connection Methods

The following paragraph describes how to setup Ethernet or Serial communication between the Compact NB HMI and CP1 PLC.

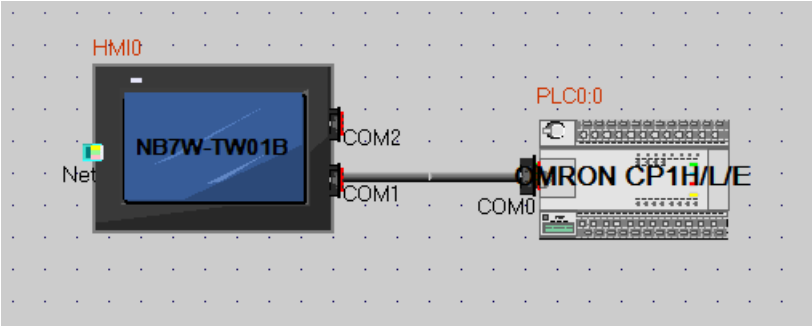
Method 1: Serial

As explained in section 2.3 System Configuration, serial communication shall be accomplished using CP1W-CIF01 RS-232 option board or Built-in RS-232 Port of the CP1E PLC model.

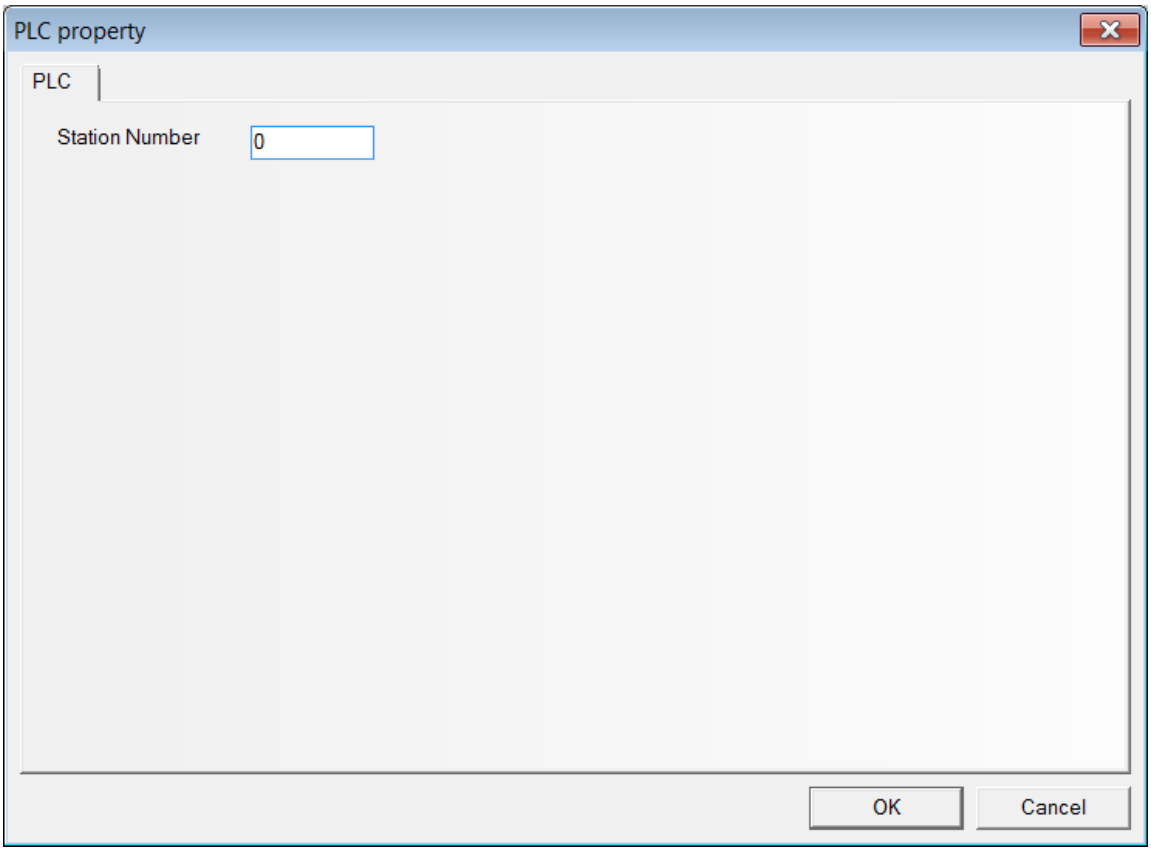
I. Configure the Compact CP1 PLC serial port using *CX-Programmer* as shown below.



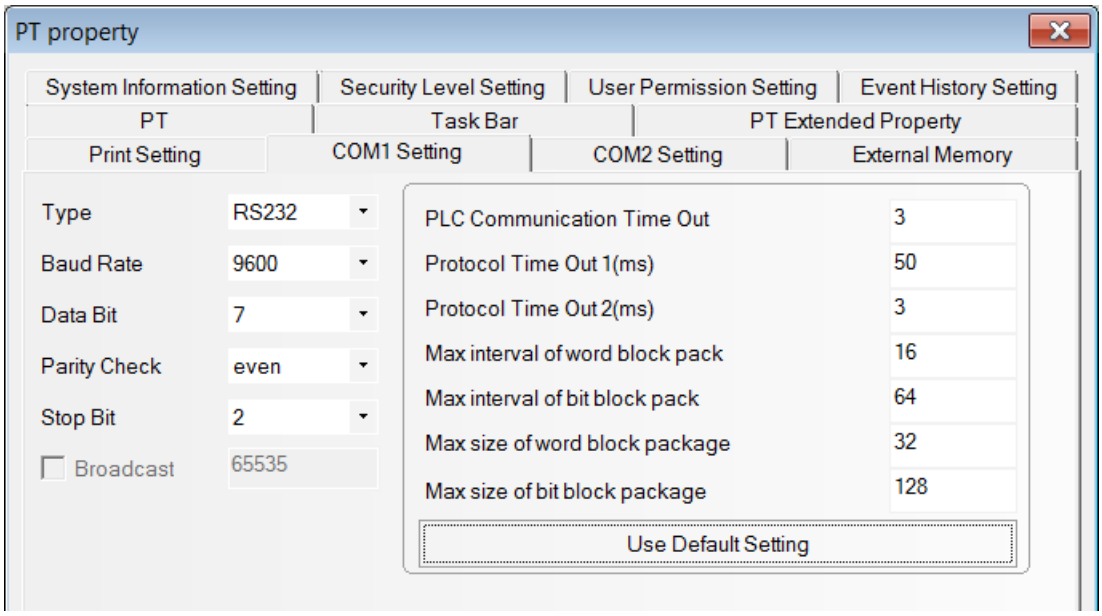
II. Design the network configuration in *NB-Designer* as shown below.



III. Define the PLC Settings.



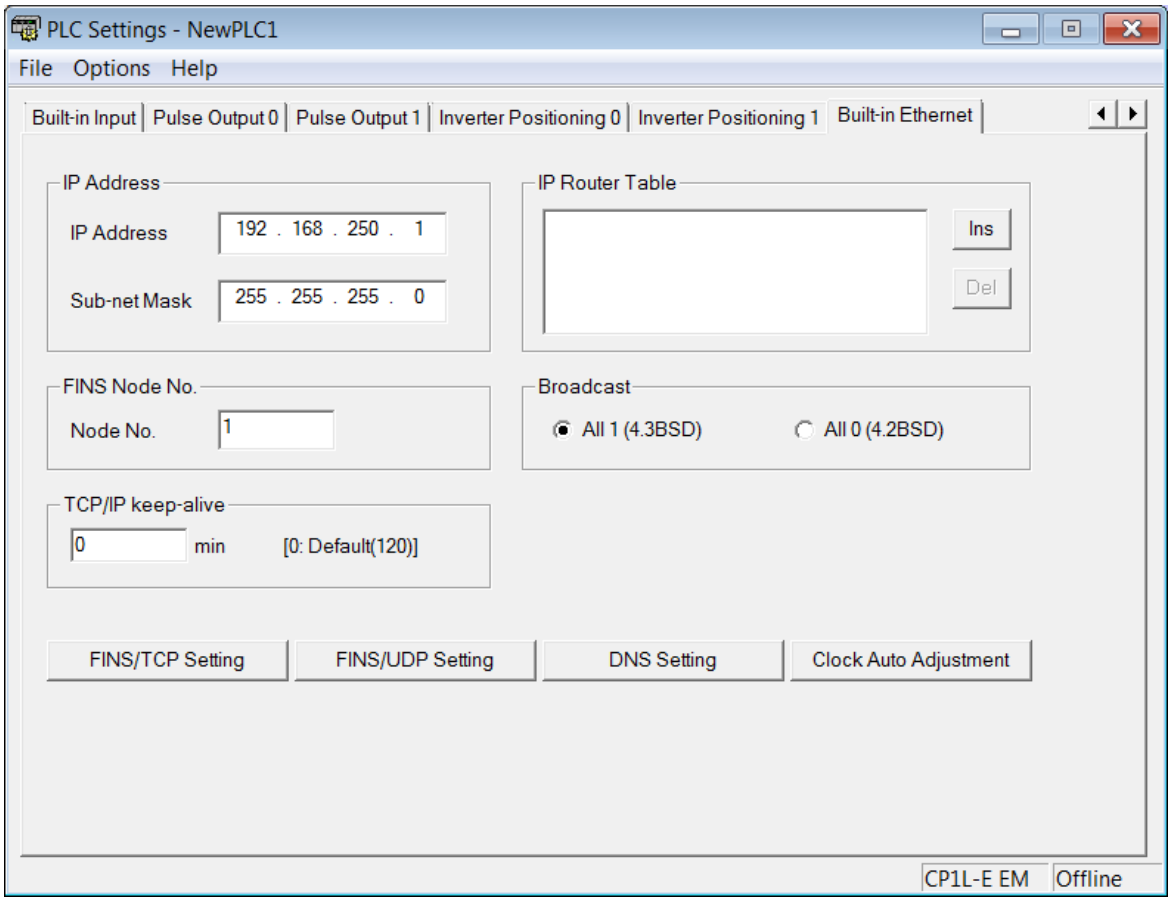
IV. Define the NB HMI COM1 Settings.



Method 2: Ethernet

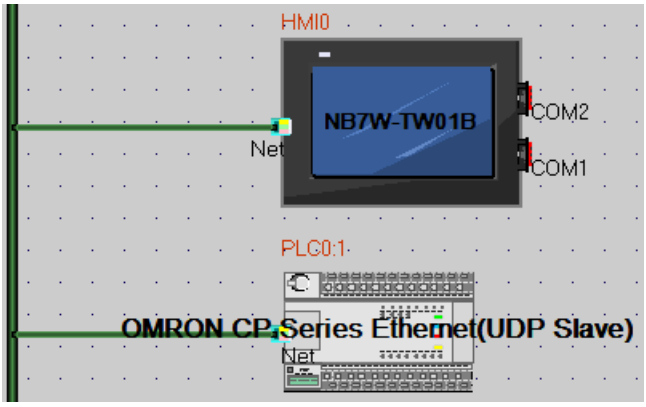
Ethernet communication is standard available when using the Compact NB HMI–TW01B and the CP1L-E models. The Compact NB HMI–TW00B models do not support Ethernet communication.

I. Configure the Compact CP1 PLC built-in Ethernet port using *CX-Programmer* as shown below.

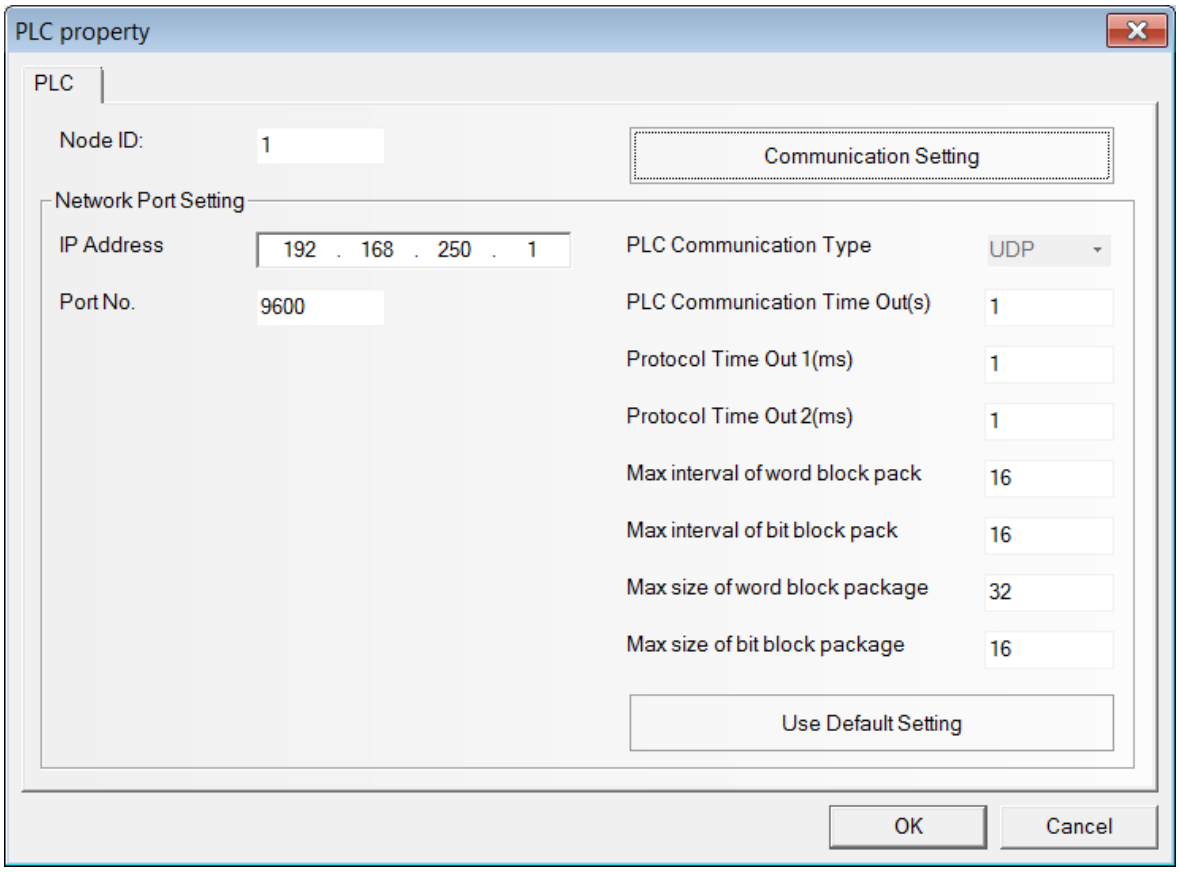


The FINS Node No. should be equal to the IP address last digit, as illustrated above.

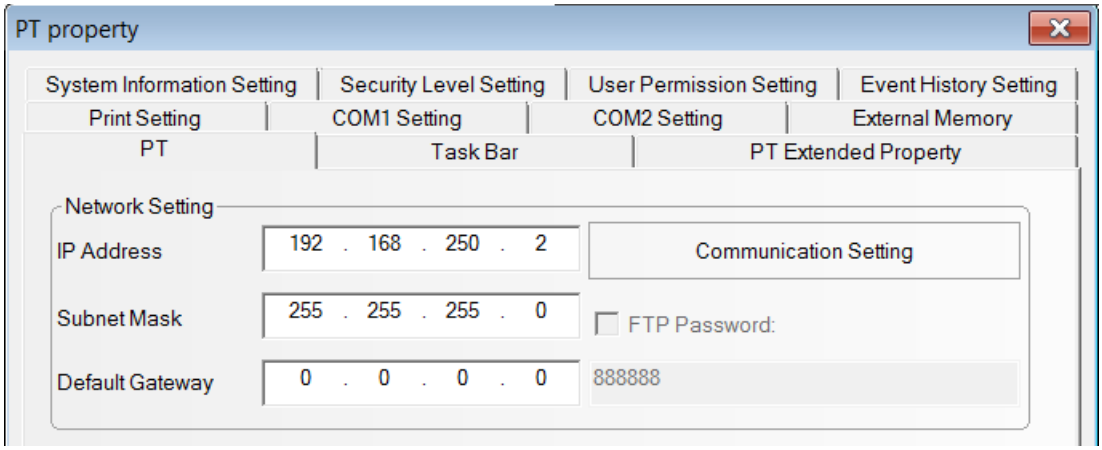
II. Design the network configuration in *NB-Designer* as shown below.



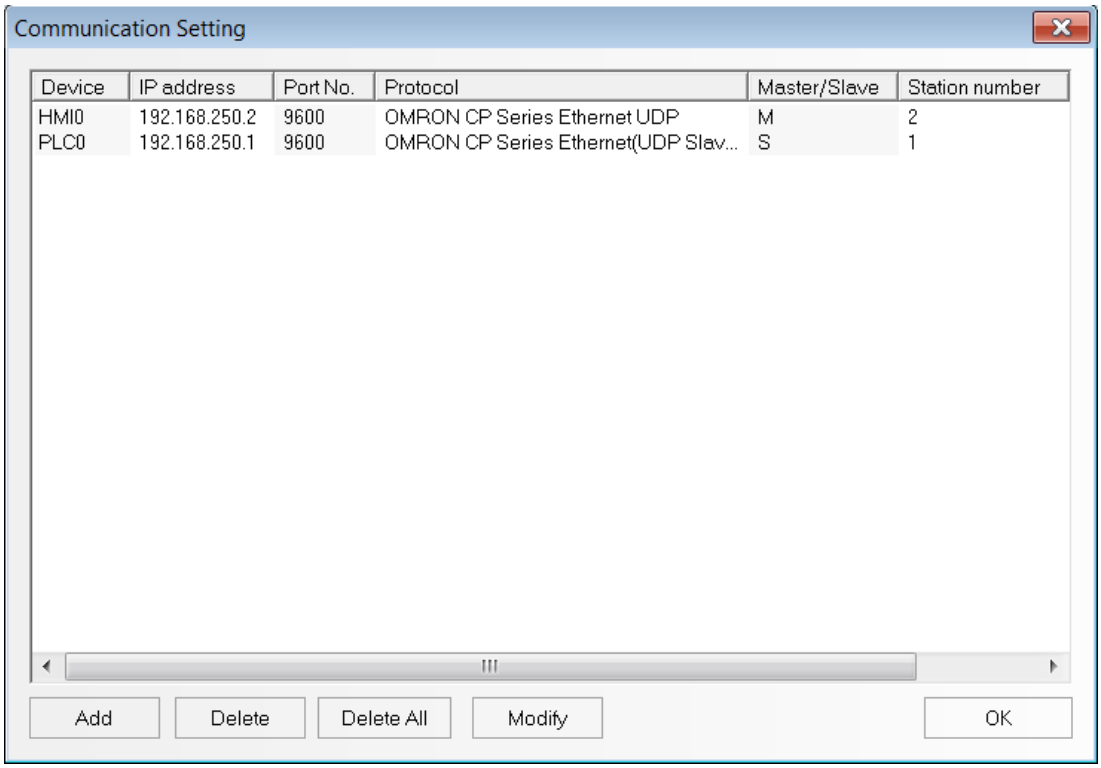
III. Define the PLC Settings.



IV. Define the NB HMI Ethernet Port Settings.



V. Define the Communication Settings.

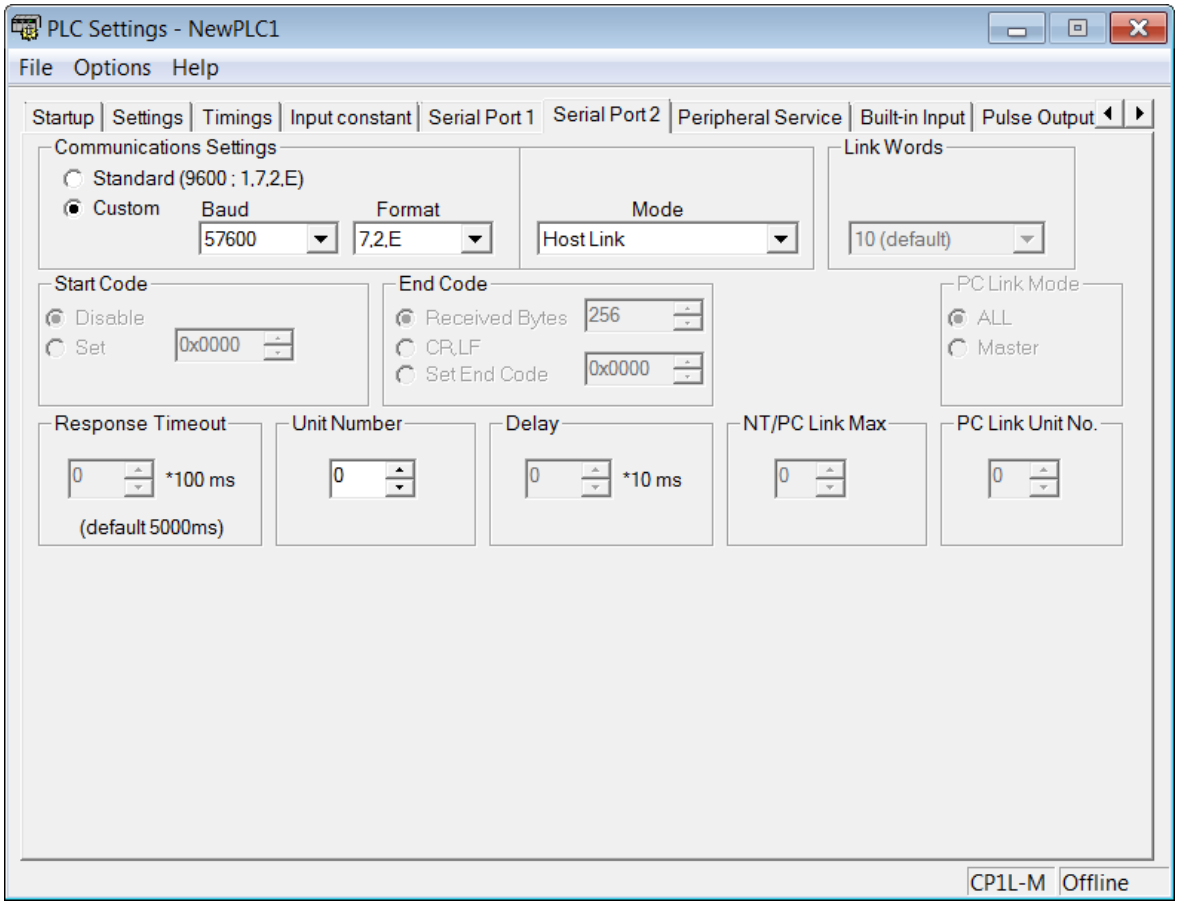


2.5.2 TC Connection Method

The Compact CP1 PLC communicates with the E5_C Temperature Controllers using Host Link (FINS) over the RS-485 protocol. The CP1 requires the CP1W-CIF11/12 option board to support RS-485 communication for compatibility with the TC.

The steps below describe how to establish communication between the PLC and TC.

I. Configure the Compact CP1 PLC serial port using *CX-Programmer* as shown below.



II. Configure the following essential *Temperature Controller* parameters[11] as shown below.

Parameter Name	Displayed characters	Setting Range	Description
Protocol Setting	PSEL	FINS	Host Link (FINS)
Unit Number	U-No	0 to 99	0 : Master 1 to 31 : Slave
Baud rate	bPS	9.6 : 9600 19.2 : 19200 38.4 : 38400 57.6 : 57600*	Baud rate in bit / second * Recommended baud rate when using OMRON PLCs
Send Data Wait Time	SdWt	0 to 99 ms	
Highest Communications Unit No.	MAxU	0 to 99	Set the Unit No. of the last E5_C in the RS-485 network.
Area	AREA	0 : DM 13 : EMC 1 : EM0 14 : EMD 2 : EM1 15 : EME 3 : EM2 16 : EMF 4 : EM3 17 : EM10 5 : EM4 18 : EM11 6 : EM5 19 : EM12 7 : EM6 20 : EM13 8 : EM7 21 : EM14 9 : EM8 22 : EM15 10 : EM9 23 : EM16 11 : EMA 24 : EM17 12 : EMB 25 : EM18	Applicable address range for the Memory Areas : 0 to 32767
First Address Upper Word	AdRH	0 to 99	Specify the first address of the PLC (upper word).
First Address Lower Word	AdRL	0 to 9999	Specify the first address of the PLC (lower word).
Receive Data Wait Time	RWAt	100 to 9999 ms	
Communications Node Number	UNCt	0 to 99	Specify Host Link unit number for the OMRON PLC.
Upload Settings 1 to 13	UP 1 to 13	0 to 98	Specify (13) read parameters from E5_C.
Download Settings 1 to 13	dN 1 to 13	30 to 98	Specify (13) write parameters to E5_C.

[11] *Appendix B: E5_C Communication Parameter Setup* describes how to navigate to the communications setting level using the interface buttons on the TC.

III. Configure optional communication related parameters as shown below.

Parameter Name	Displayed characters	Setting Range	Description
Communications Writing	CMWT	ON or OFF	ON: The TC parameters are Read / Write for external devices such as the Compact CP1 PLC. OFF: The TC parameters are Read Only for external devices. It is recommendable to set this parameter ON to enable Read / Write actions for the TC parameters from the Compact CP1 PLC.
Communications Monitor	PLCM	-	Read the total communication cycle time between all participating TCs and the PLC. The measured cycle time is shown in milliseconds. During normal operation, the range is 0 to 9999 ms. If the cycle time exceeds 9999 ms then the following characters are displayed: 3333 If an error occurs then the following characters are displayed: C.ERR If the 'Communication Monitor' parameter is stored in the PLC memory, the cycle time is shown as 0 to FFFF hex (0 to 65,535 decimal). An error is indicated by FFFF hex.

Please refer to manual H175-E1-08 E5_C Digital Temperature Controllers Communications Manual, section 6-2 E5_C Setup for more information about configuring the E5_C for 'Programless Communication'.

3 IN-PANEL INTEGRATED TEMPERATURE REGULATION

The following chapter describes the In-Panel Integrated Temperature Regulation solution.

3.1 Introduction

The In-Panel Integrated Temperature Regulation solution consists of three OMRON products, respectively the Compact CP1 PLC, CP1W-TS Temperature Sensor Units and the Compact NB HMI. The CP1W-TS is an expansion unit of the CP1 PLC that primarily reads Thermocouple or Platinum Resistance Thermometer Inputs but can also read Analog Inputs [12]. The solution utilizes a 2-PID Function Block[13] that simultaneously achieves two characteristics, set point tracking and disturbance suppression.

The Compact NB HMI adds valuable features such as visual displaying the course of temperature within a specified amount of time. It can log the trend data onto an external memory in .csv format for easy reading and can also read / write specific parameters from and to the Temperature Controller(s).

[12] The CP1W-TS003 Temperature Sensor Unit also supports Analog Inputs.
[13] The CP1L(-E) models support Function Blocks. The CP1E model does not support Function Blocks.

3.2 Temperature Control 2-PID Function Block

The following section describes the functionality of the Temperature Control 2-PID Function Block for the CP1W-TS Expansion Units.

3.2.1 Symbol

Figure 23 TC 2-PID Function Block Symbol Overview shows the outline of the Function Block.

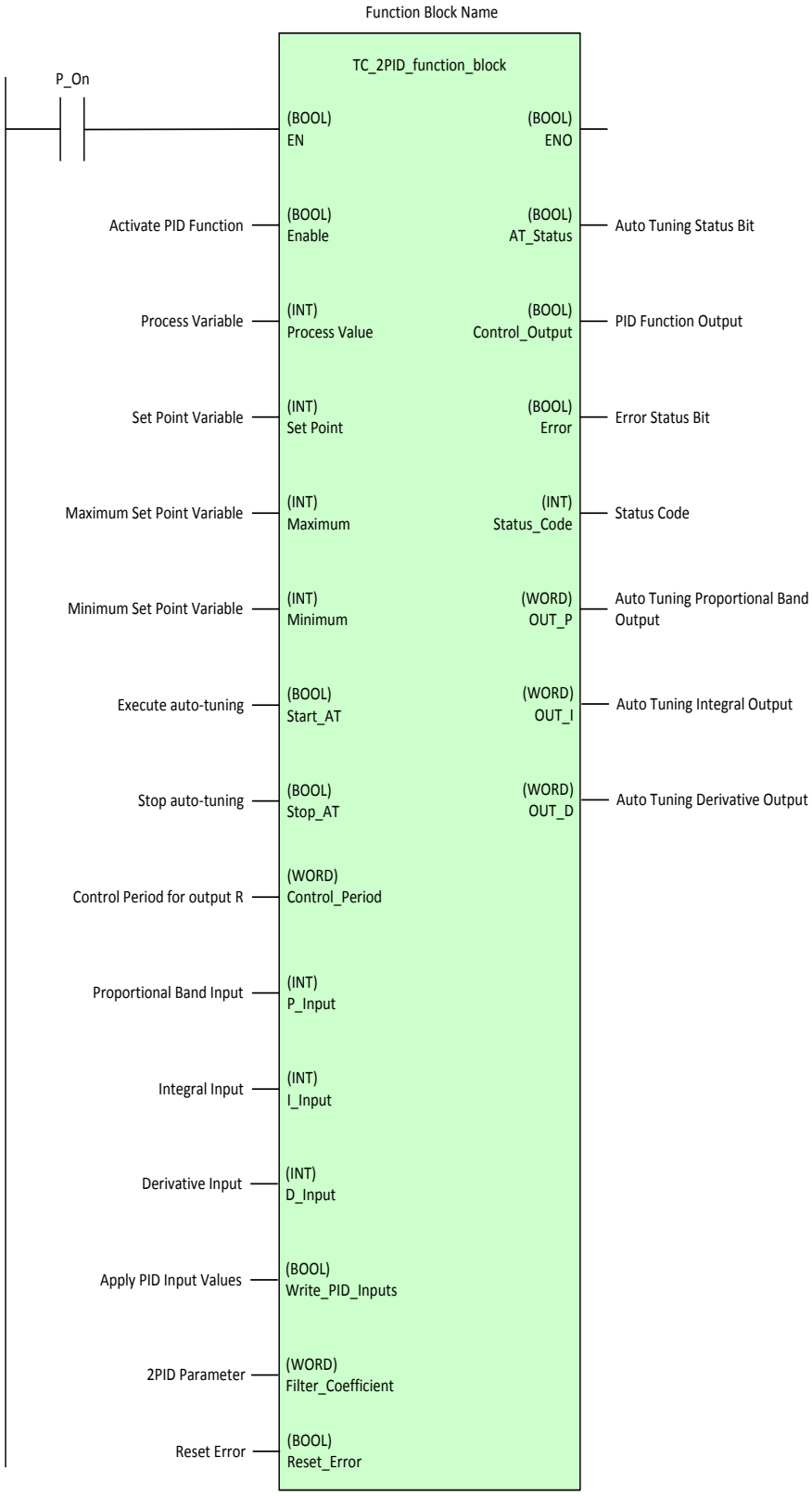


Figure 23 TC 2-PID Function Block Symbol Overview

3.2.2 Supported Models

Table 2 Supported Sensor Input Type for the CP1W-TS Models indicates what sensor input type is supported with each CP1W-TS model.

Table 2 Supported Sensor Input Type for the CP1W-TS Models

Model	Input Description
CP1W-TS001	2 Thermocouple Type K or J Inputs
CP1W-TS002	4 Thermocouple Type K or J Inputs
CP1W-TS003	4 Thermocouple Type K or J Inputs (Input 3 and 4 can also operate as Analog Input; 0 to 10V, 1 to 5V or 4 to 20 mA)
CP1W-TS004	12 Thermocouple Type K or J Inputs
CP1W-TS101	2 Platinum Resistance Thermometer Type Pt100 or JPt100 Inputs
CP1W-TS102	4 Platinum Resistance Thermometer Type Pt100 or JPt100 Inputs

3.2.3 Conditions for Usage

- P_On (Always On Bit) should be connected to the EN input.
- The Enable input operates the PID Control.
- All input parameters should confirm the specification range.

3.2.4 Function Description

The TC_2PID_function_block adds PID Control with Auto-Tuning feature for the CP1W-TS expansion units.

Prerequisite for the Function Block to operate correctly, P_On (Always On Bit) should be connected to the EN Input. The PLC evaluates the function block status every PLC cycle. Simultaneously the Control Output is not operating unless the Enable input is on, thus preventing uncontrolled execution of any equipment controlled by the PID Control.

The Process Value input is of sensor input type Thermocouple, Platinum Resistance Thermometer or Analog. The Set Point is user defined and related based on the type of sensor input plus the operating range of the sensor input. The operating range may differ per sensor type. The maximum and minimum parameters contain the operating range of the sensor input. Please consult the specific sensor datasheet for the accurate operating range.

The P, I, D and Control Period parameters determine the responsiveness of the PID Control function. The P, I and D parameters can be configured using two different methods. The first method is configuring the parameters manually. The second method automatically detects the ideal parameters using the built-in Auto-Tuning (only AT-100% is supported, AT-40% is not supported) feature using the Limit Cycle method. While the Auto-Tuning process is in progress, the Auto-Tuning Status Bit is on. Once the Auto-Tuning is completed, the Auto-Tuning Status Bit is off and P, I and D Output parameters show the result of the Auto-Tuning process. Starting and stopping of the Auto-Tuning process is executed manually.

The Control Period parameter defines the responsiveness of the Control Output. It evaluates at specified time interval the output status of the 2-PID function.

Errors generated by the TC_2PID_function_block cause the Control Output to stop operating. In the event of an error, the Error Bit is on and the status code shall adjust accordingly. In order to continue the 2PID Control Function, the error has to be reset manually.

3.2.5 Function Block Precautions

- Switching off the Enable input causes the Control Output to turn off.
- Invalid input values prohibit the Control_Output from operating. It remains off until the input parameters are within the correct range and resetting the error.
- It is required to acknowledge an error using the Reset_Error input before the Function Block can operate.

3.2.6 EN Input Condition

Connect P_On (Always On Bit) to EN Input in order to operate the Function Block.

3.2.7 Variable Restrictions

Table 3 Variable Restrictions

Variable Type	Restriction
Input	Control_Period has an operating range from 1.00 to 99.99 seconds.
Input	Maximum and Minimum Set Point Values should be consistent with the connected Temperature Sensor.
Input	Filter_Coefficient has input range from α = 0.00 to 0.99 (#0100 to #0163).
Output	The Auto-Tuning (AT-100%) process starts at the differential up signal at Start_AT.
Output	The Auto-Tuning (AT-100%) process stops at the differential up signal at Stop_AT.
Output	The AT_Status bit turns automatically off once the Auto-Tuning process is completed.
Output	The OUT_P, OUT_I and OUT_D variables display the used PID parameters.

3.2.8 Status Codes

Table 4 Status Codes

Status Code	Description
#0000	No Error or Normal Operation
#0001	Manually Aborted Auto-Tuning (AT-100%)
#0002	Manually Started Auto-Tuning (AT-100%)
#0600	Invalid Input Entry at Control Period Input
#0601	Invalid PID parameter Settings detected
#0602	Invalid Input Entry at Minimum and/or Maximum Parameter Inputs
#0603	Invalid Input Entry at Filter Coefficient (2-PID parameter) α Input

3.2.9 Application Examples

Thermocouple Input

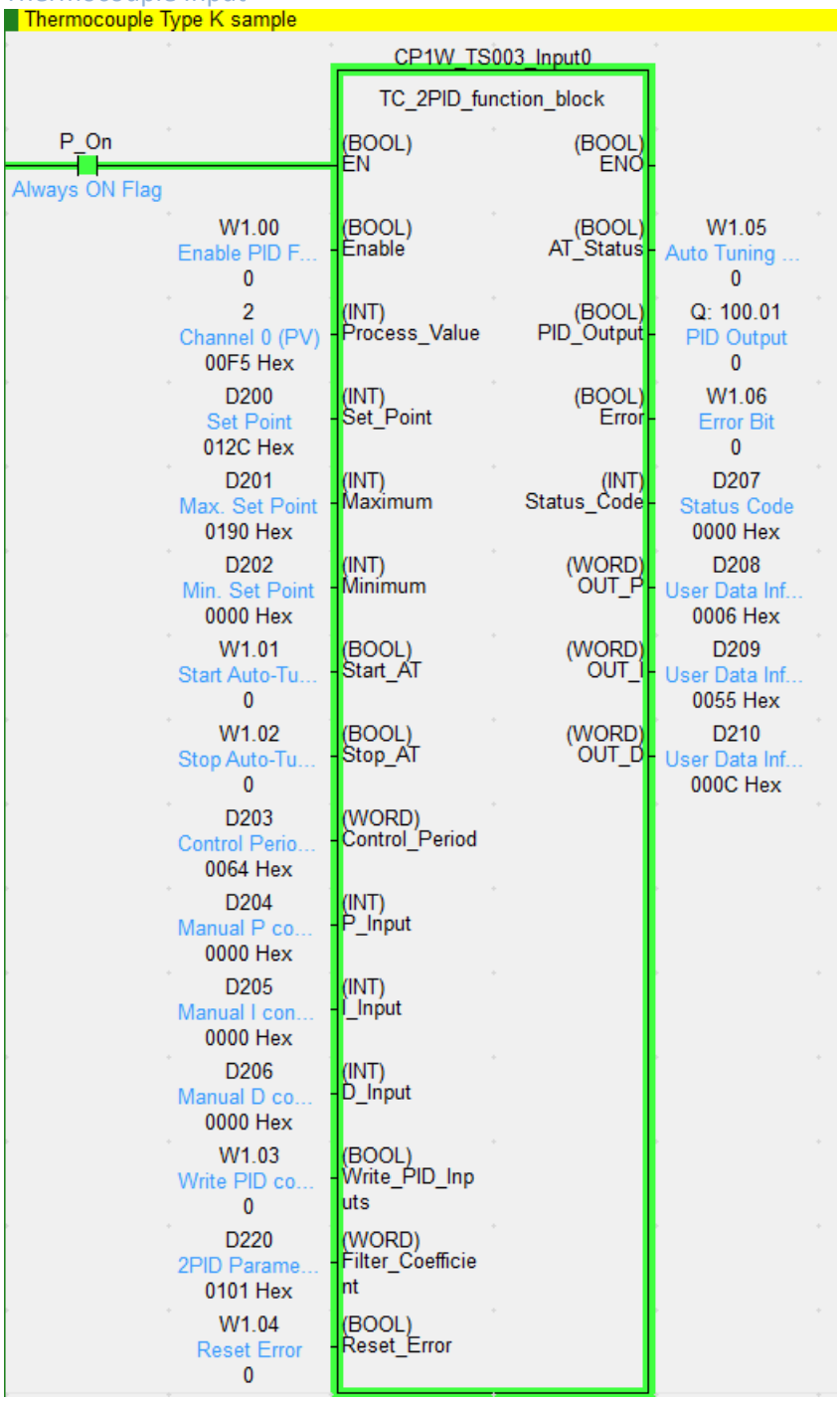


Figure 24 Thermocouple Input Example

- Please confirm that all parameters are set and are within the range specification. Otherwise, an error occurs depending on what input parameter is invalid.
- The data range at the Process Value that include one digit after the decimal point are stored without the decimal point, i.e., 10 times the actual value is stored, e.g. Unit: 0.1C° -> 500.0 C° = &5000 = #1388.
- The Set Point parameter is the target value for the PID control system. Additional parameters related to Set Point are the Maximum and Minimum parameters. They define the maximum and minimum range for the Set Point parameter.
- The PID parameters can be configured manually using P_Input, I_Input and D_Input. The Write_PID_Inputs input is required to write the PID input parameters.
- If no PID parameters are stored, the function block shall generate a #0601 error when attempting to enable the 2-PID function. The user can manually start the Auto-Tuning Process causing the status code #0002 to occur. While the Auto-Tuning process in ongoing, the AT_Status bit is turned on and will turn off when the Auto-Tuning process has been completed.
- OUT_P, OUT_I and OUT_D parameters are used as User Data Information outputs to inform the user what PID parameters are applicable for the 2-PID function.
- The Control Period parameter defines the responsiveness of the Control Output. The operating range is 1.00 to 99.99 seconds. For example, when the Control Period is set to #0064 = &100 (1 second), the 2-PID function evaluates every 1 second whether to switch on or off the Control_Output.
- The Error Bit turns on when an error has occurred. Please refer to Status Codes for detailed information regarding what type of error has occurred.

Analog Input (CP1W-TS003 Only)

- Please confirm that all parameters are set and are within the range specification. Otherwise, an error occurs depending on what input parameter is invalid.
- The data range at the Process Value is based on the Analog Input. For example, 4 to 20 mA is converted into #0000 to #2EE0.
- The Set Point parameter is the target value for the PID control system. Additional parameters related to Set Point are the Maximum and Minimum parameters. They define the maximum and minimum range for the Set Point parameter.
- The PID parameters can be configured manually using P_Input, I_Input and D_Input. The Write_PID_Inputs input is required to write the PID input parameters.
- If no PID parameters are stored, the function block shall generate a #0601 error when attempting to enable the 2-PID function. The user can manually start the Auto-Tuning Process and a status code of #0002 shall occur. While the Auto-Tuning process in ongoing, the AT_Status bit is turned on and will turn off when the Auto-Tuning process has been completed.
- OUT_P, OUT_I and OUT_D parameters are used as User Data Information outputs to inform the user what PID parameters are applicable for the 2-PID function.
- The Control Period parameter defines the responsiveness of the Control Output. The operating range is 1.00 to 99.99 seconds. For example, when the Control Period is set to #0064 = &100 (1 second), the 2-PID function evaluates every 1 second whether to switch on or off the Control_Output.
- The Error Bit turns on when an error has occurred. Please refer to Status Codes for detailed information regarding what type of error has occurred.

3.2.10 Variable Tables

Table 5 Input Variables

Name	Variable name	Data type	Default	Setting Range	Description
EN	EN	BOOL			To control execution of the Function Block
Activate PID Function	Enable	BOOL		0, 1	Enable the 2-PID function
Process Variable	Process_Value	INT		-32768 to 32767	Sensor Input Signal
Set Variable	Set_Point	INT	0	-32768 to 32767	Define Set Point value
Maximum Set Variable	Maximum	INT	32767	**Min** to 32767	Define maximum Set Point value
Minimum Set Variable	Minimum	INT	-32768	-32768 to **Max**	Define minimum Set Point value
Execute Auto-Tuning (AT-100%)	Start_AT	BOOL	0	0, 1	Execute the Auto-Tuning (*Limit Cycle* method) process
Stop Auto-Tuning (AT-100%)	Stop_AT	BOOL	0	0, 1	Manual Stop the Auto-Tuning process
Control Period for Control_Output	Control_Period	WORD	#0064	#0064 to #270F (1.00 to 99.99 sec.)	Define the control period for Control_Output. For example, #0064 is 1 second. The state of Control_Output is evaluated every 1 second.
Proportional Band Input	P_Input	INT		#0001 to #270F	Manually configure the “P” parameter for the 2-PID function.
Integral Input	I_Input	INT		#0001 to #1FFF	Manually configure the “I” parameter for the 2-PID function.
Derivative Input	D_Input	INT		#0001 to #1FFF	Manually configure the “D” parameter for the 2-PID function.
Apply PID Input Values	Write_PID_Inputs	BOOL	0	0, 1	Write the manually configured PID parameters to the 2-PID Control Function.
2-PID Parameter	Filter_Coefficient	WORD	0	#0000, #0100 to #0163	#0000 : α = 0,65 (default) Setting from #0100 to #0163 : α = 0,00 to α = 0,99
Reset Error	Reset_Error	BOOL	0	0, 1	Reset active error

Table 6 Output Variables

Name	Variable name	Data type	Description
ENO (May be omitted.)	ENO	BOOL	1 (ON) : Function Block processed normally 0 (OFF) : Function Block not processed or ended in an error
Auto-Tuning Status Bit	AT_Status	BOOL	1 (ON) : Auto-Tuning process operational 0 (OFF) : Auto-Tuning process NOT operational
Control Output	Control_Output	BOOL	2-PID Control Output
Error Status Bit	Error	BOOL	1 (ON) : Error Exist 0 (OFF) : Normal Operation
Error Code Information	Status_Code	INT	#0000 : No Error or Normal Operation #0001 : Manually Aborted Auto-Tuning #0002 : Manually Started Auto-Tuning #0600 : Invalid Input Entry at Control Period Input #0601 : Invalid PID parameter Settings detected #0602 : Invalid Input Entry at Minimum and/or Maximum Parameter Inputs
Proportional Band value used in the control loop	OUT_P	WORD	"P" parameter used by the 2-PID Control Function. The parameter is written manually or by the Auto-Tuning process.
Integral Output value used in the control loop	OUT_I	WORD	"I" parameter used by the 2-PID Control Function. The parameter is written manually or by the Auto-Tuning process.
Derivative Output value used in the control loop	OUT_D	WORD	"D" parameter used by the 2-PID Control Function. The parameter is written manually or by the Auto-Tuning process.

3.2.11 Version History

Table 7 Version History

Version	Date	Contents
1.00	3-September-2015	Original production
1.01	7-December-2015	Improved documentation

3.3 System Configuration

As mentioned in the previous section, the Compact CP1 PLC controls the Temperature Control process using the Temperature Control PID Function Block for the CP1W-TS Expansion Unit(s).

Achieving communication between the Compact HMI and PLC is accomplished using various methods such as Serial and Ethernet.

The first communication method is serial using RS-232, RS-485 or RS-422 with all NB HMI models. RS-232 is the most common serial connection and therefore this document only refers to the RS-232 method. RS-232 serial communication supports a 1:1 connection only. The CP1W-CIF01 option board supports RS-232 communications. The CP1E built-in port supports RS-232 communications.

The second communication method is Ethernet related. The Ethernet configuration utilizes the CP1L-E with a built-in Ethernet port to achieve Ethernet communication with the NB HMI.

Table 8 Communication Configurations illustrates what products are required to achieve specific configurations.

Table 8 Communication Configurations

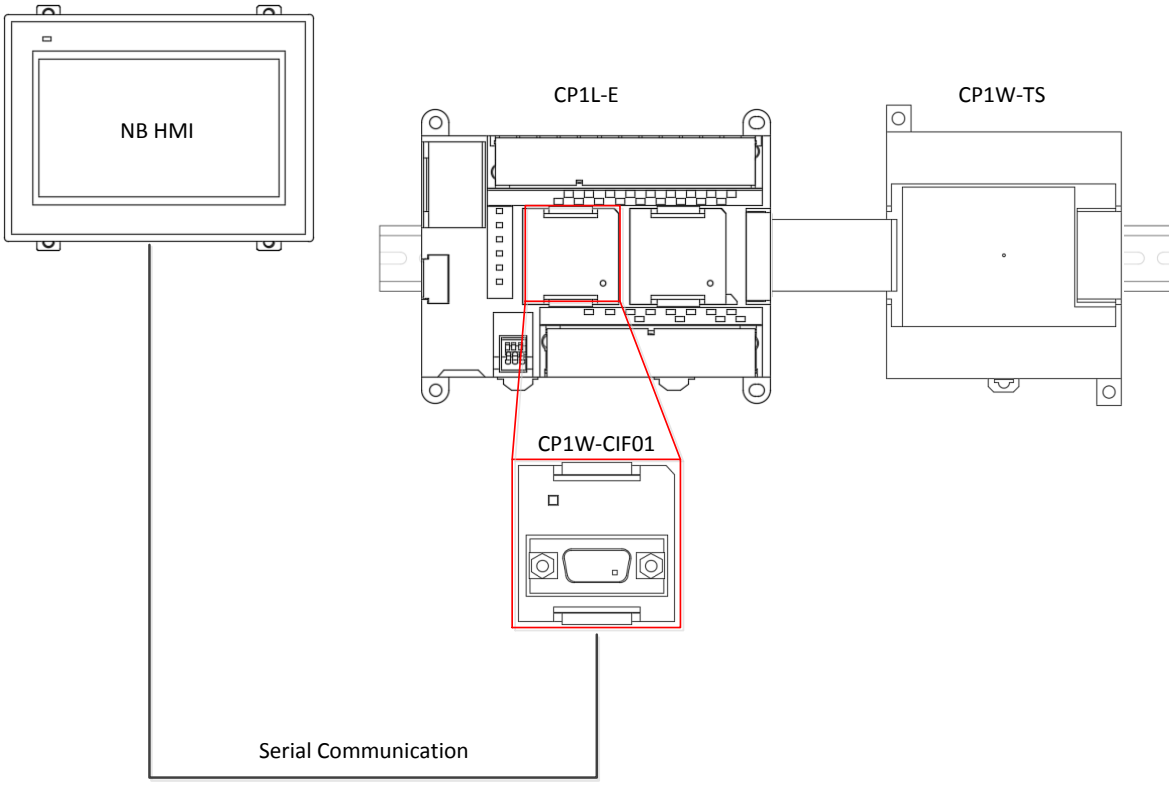
	Serial	Ethernet
NB__-TW00B	Yes	-
NB__-TW01B	Yes	Yes
CP1L-E	Yes	Yes
CP1W-CIF01	Yes	-
CP1W-TS	Yes	Yes

The next sections contain the various communication configuration overviews.

3.3.1 Serial

The Serial configuration consists of the following products:

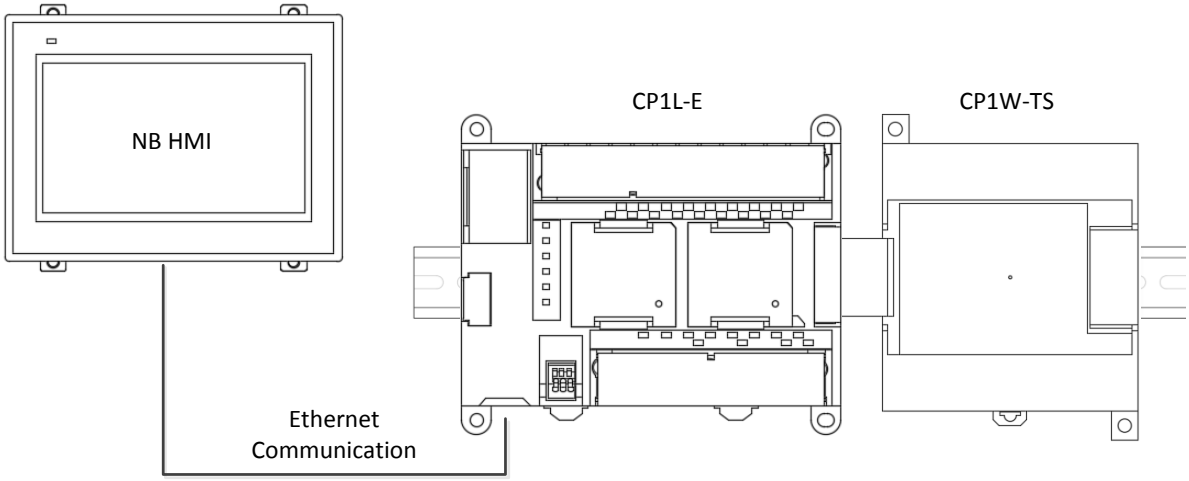
- Compact NB HMI (non-model specific)
- Compact CP1L-E PLC
- CP1W-CIF01 RS-232 option board
- XW2Z-200T or XW2W-500T communication cable
- CP1W-TS Expansion Unit



3.3.2 Ethernet

The Ethernet configuration consists of the following products:

- Compact NB HMI (-TW01B model only)
- Compact CP1L-E with built-in Ethernet Port PLC
- CP1W-TS Expansion Unit



3.4 Communication Settings

This chapter describes how to establish communication between the Compact NB HMI and Compact CP1 PLC using various methods.

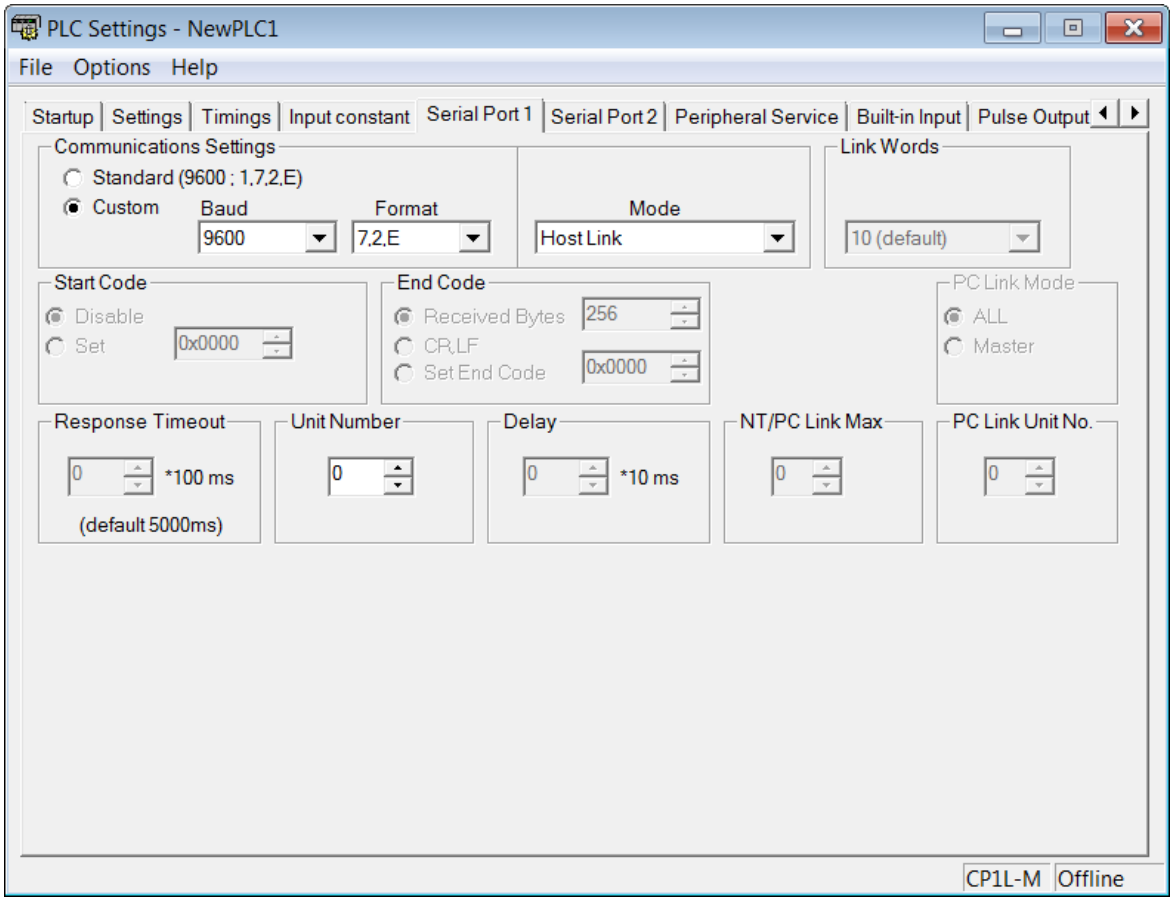
3.4.1 HMI Connection Methods

The following section describes how to setup Ethernet or Serial communication between the Compact NB HMI and CP1 PLC.

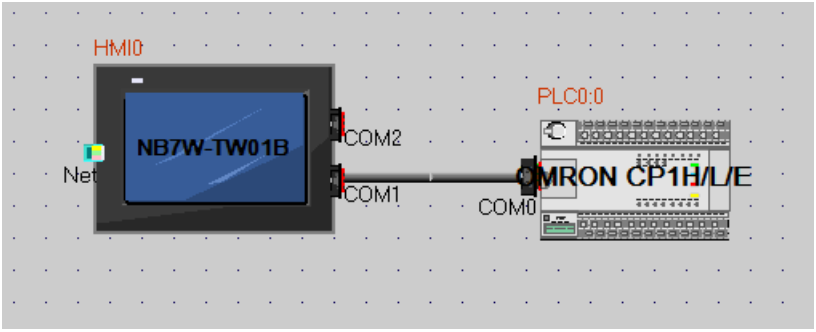
Method 1: Serial

As explained in section *3.3 System Configuration*, serial communication is achieved using the CP1W-CIF01 RS-232 option board.

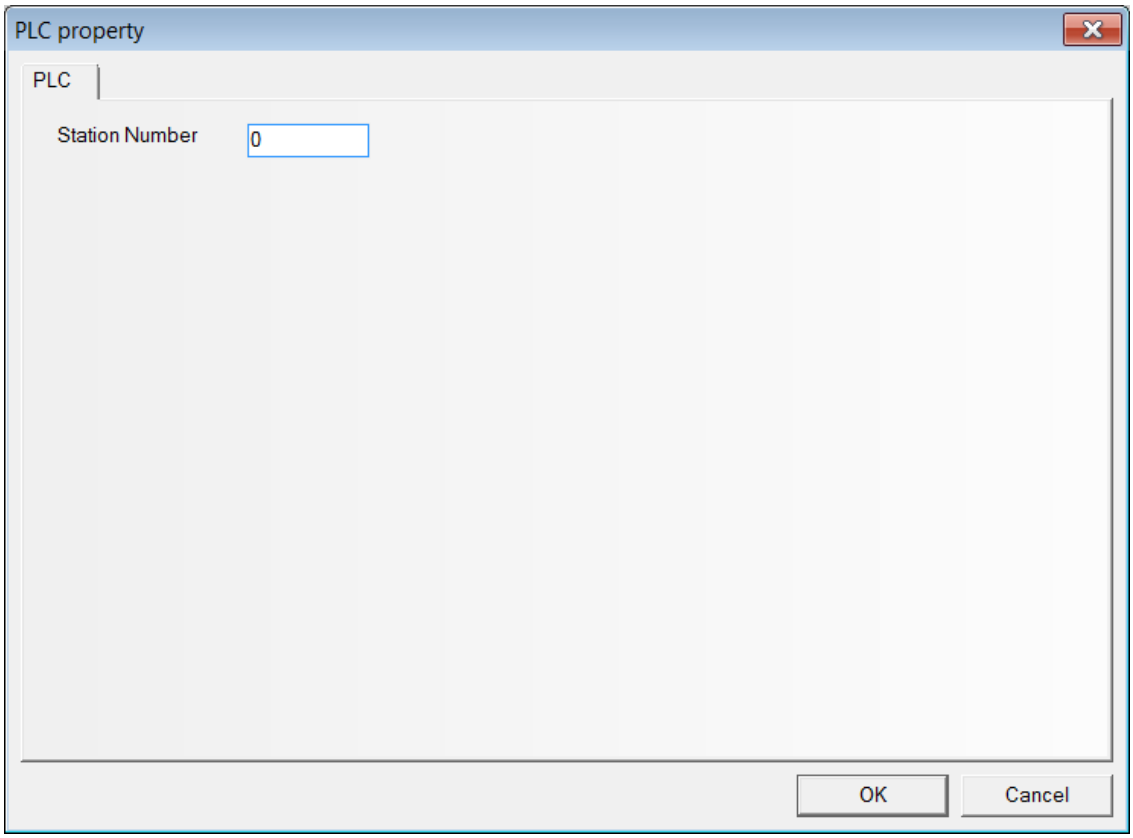
I. Configure the Compact CP1 PLC serial port using *CX-Programmer* as shown below.



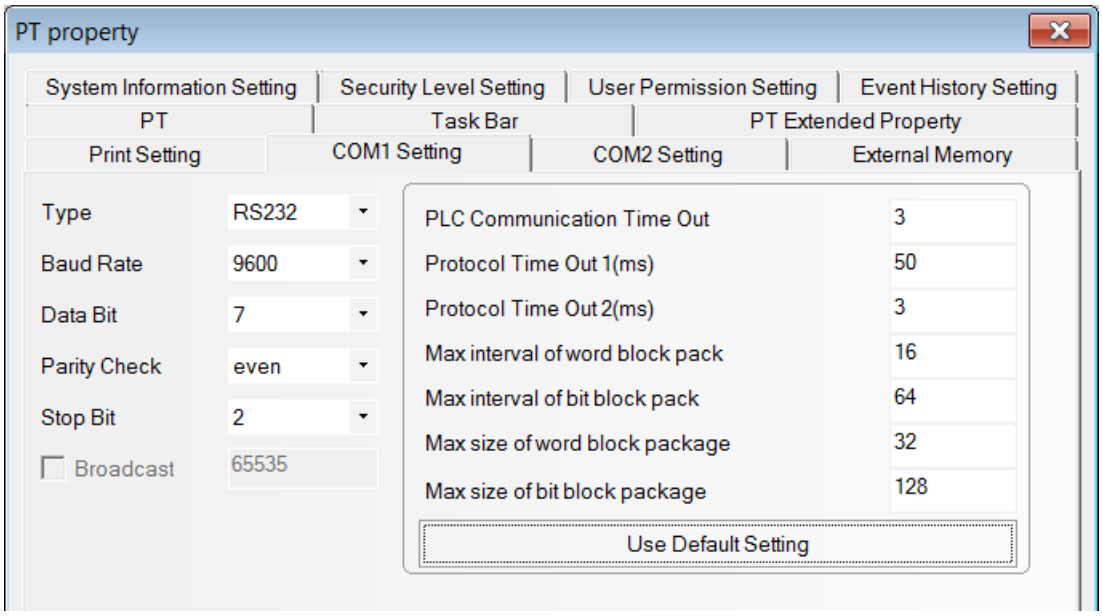
I. Design the network configuration in *NB-Designer* as shown below.



II. Define the PLC Settings of PLC0:0



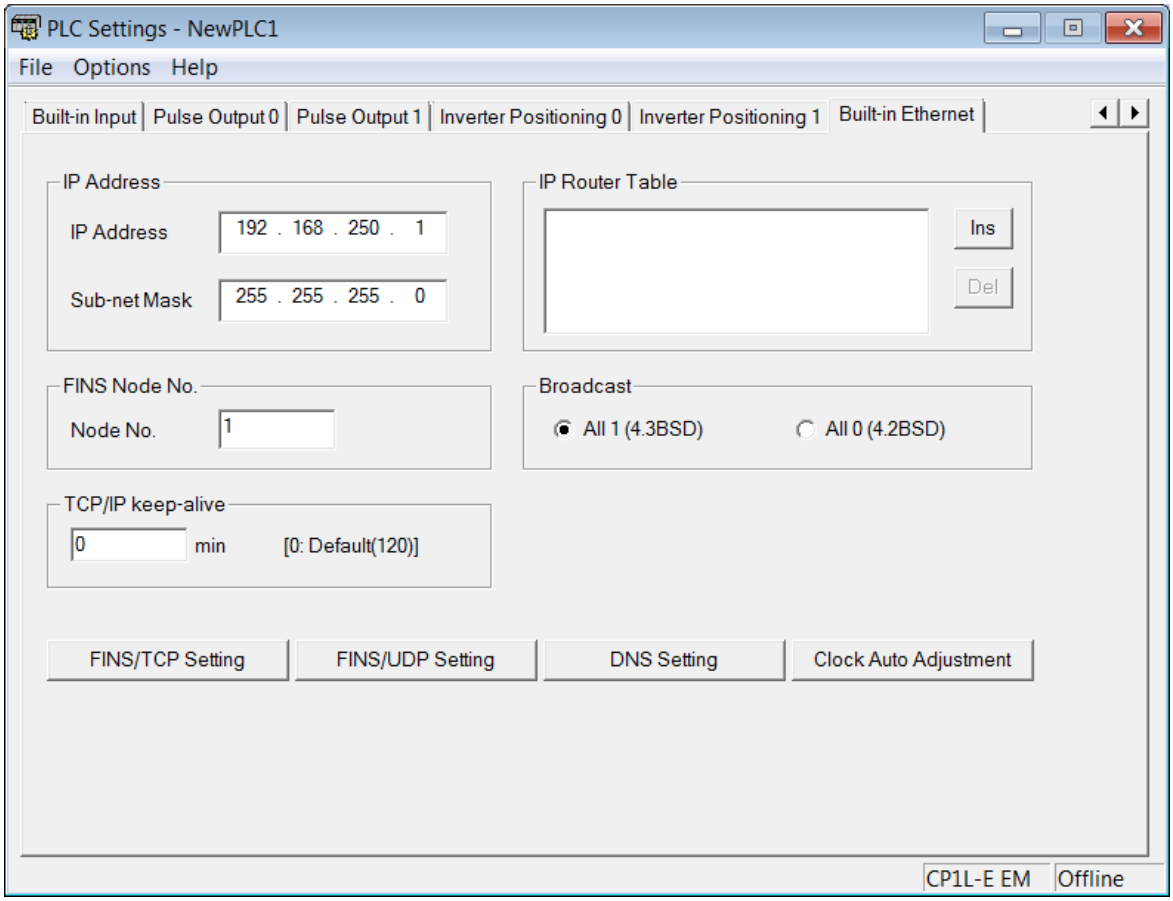
III. Define the NB HMI COM1 Settings



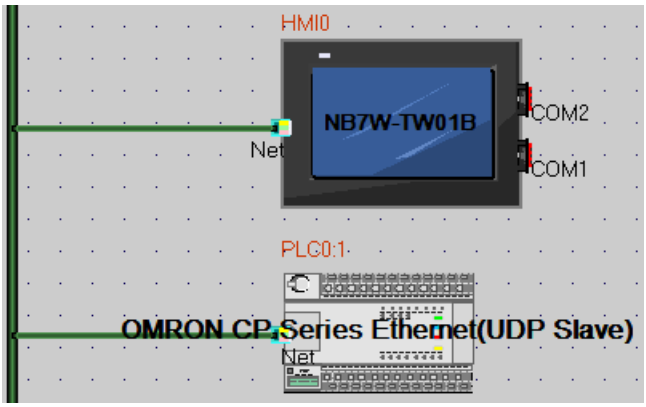
Method 2: Ethernet

Ethernet communication is standard when using the Compact NB HMI–TW01B and the CP1L-E models. The Compact NB HMI–TW00B models do not support Ethernet communication. The following paragraphs illustrate how to configure the Ethernet Port settings.

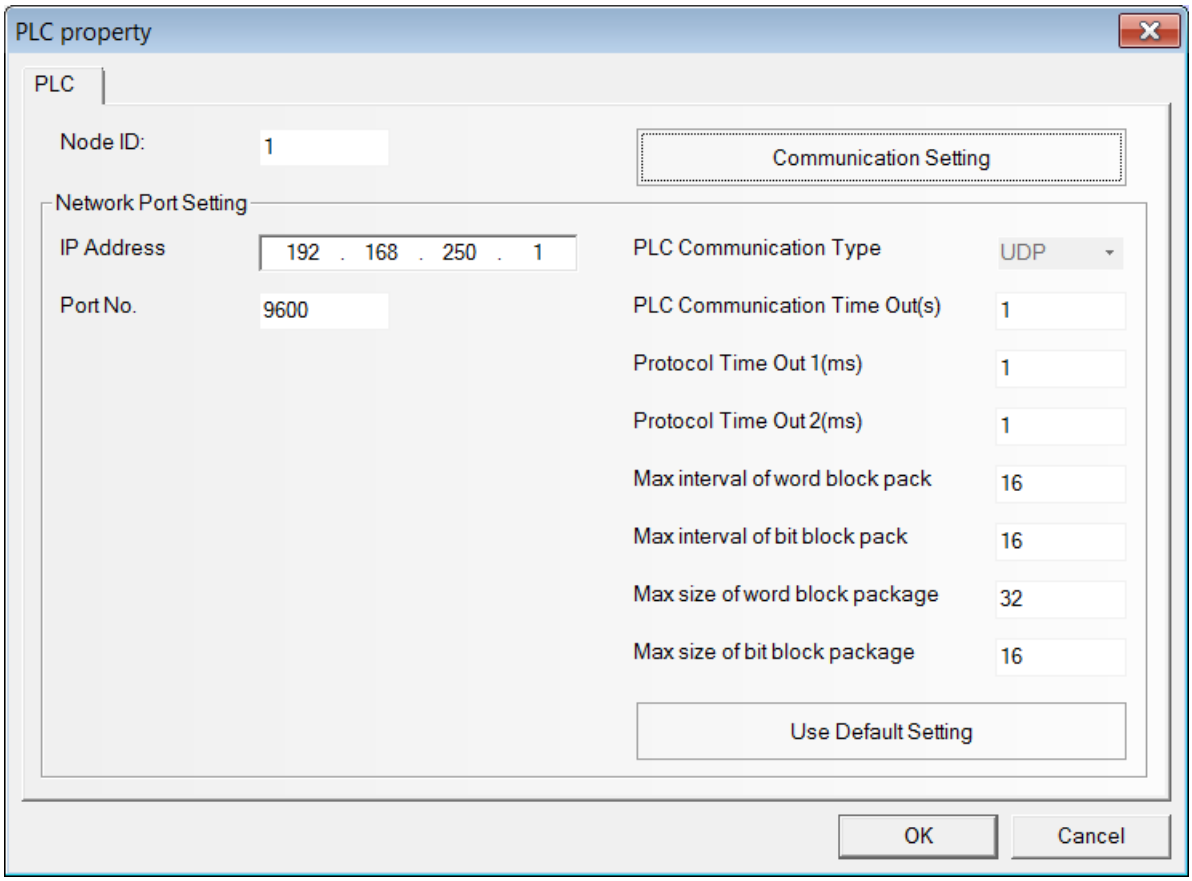
I. Configure the Compact CP1 PLC built-in Ethernet port using *CX-Programmer* as shown below.



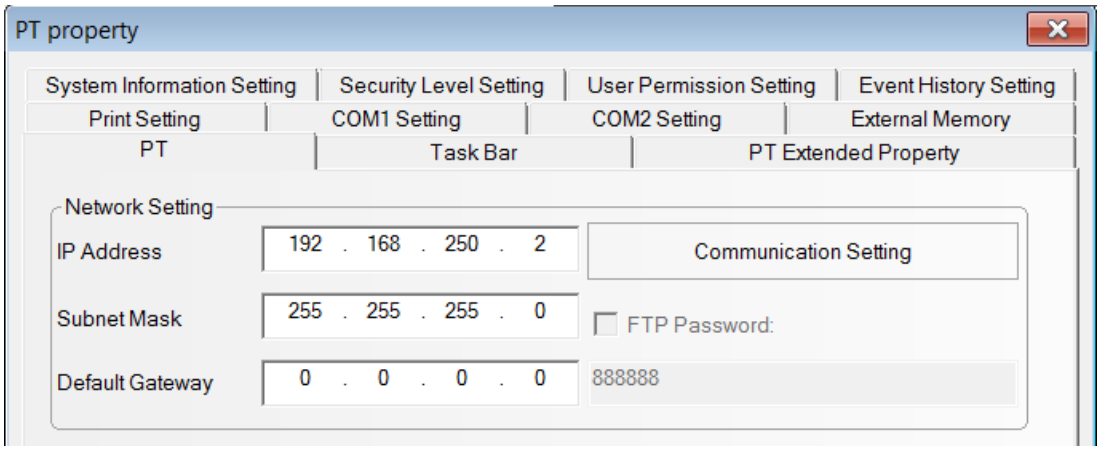
I. Design the network configuration in *NB-Designer* as shown below.



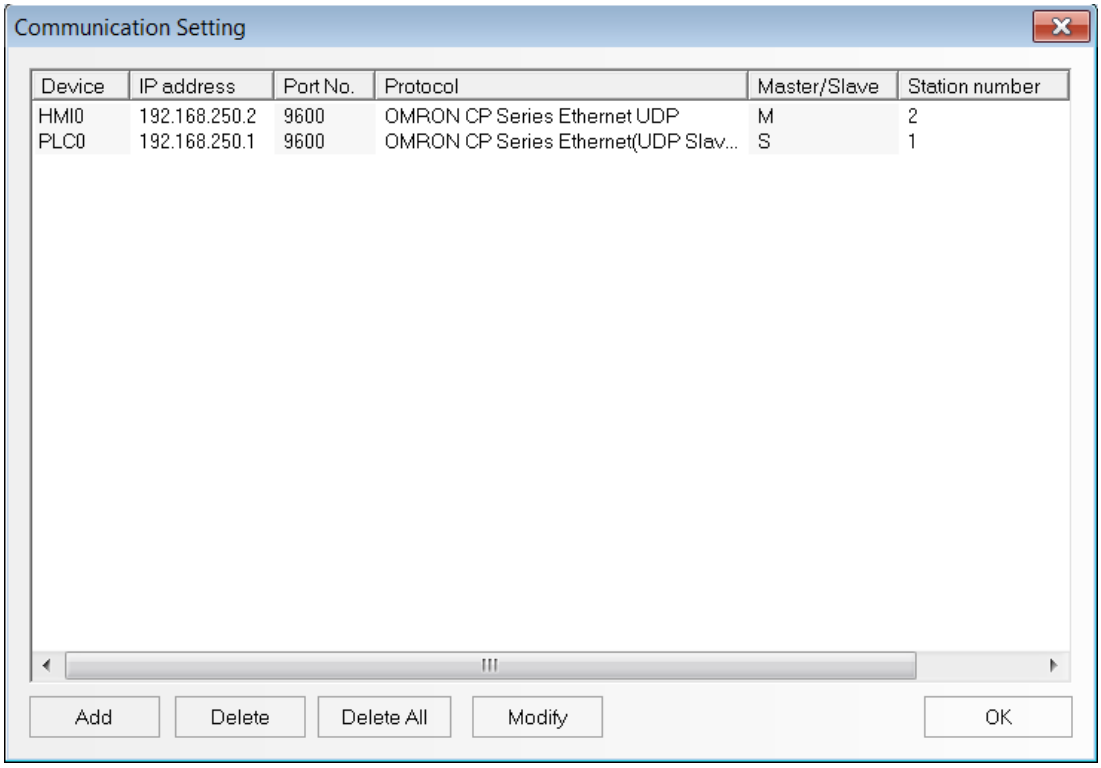
II. Define the PLC Settings.



III. Define the NB HMI Ethernet Port Settings.



IV. Define the Communication Settings.



REFERENCES

H174-E1-06 E5_C Digital Temperature Controllers User's Manual
H175-E1-08 E5_C Digital Temperature Controllers Communications Manual
H182-E1-01 E5CC / E5EC Solutions Guide for FAQs

V106-E1-11 NB-Designer Operation Manual
V107-E1-08 Setup Manual
V108-E1-11 Host Connection Manual
V109-E1-08 Startup Guide Manual

W462-E1-08 CP1L CPU Unit Operation Manual
W471-E1-07 CP1L CPU Unit Operation Manual
W479-E1-08 CP1E CPU Unit Hardware User's Manual
W480-E1-07 CP1E CPU Unit Software User's Manual
W516-E1-02 CP1L-EL/EM CPU Unit Operation Manual

APPENDIX

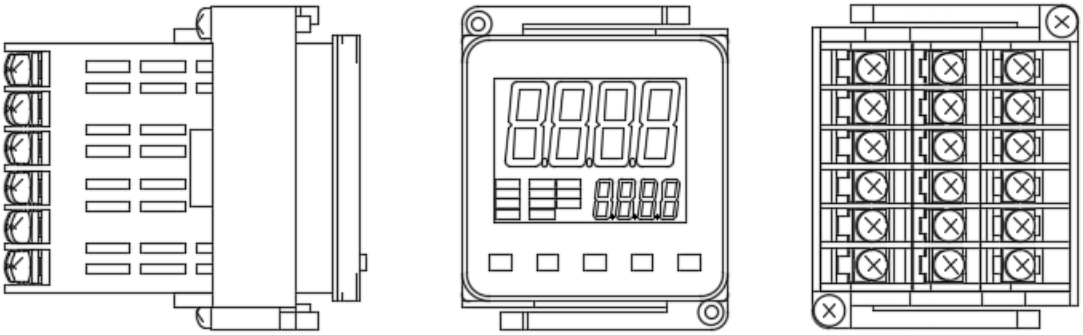
Appendix A: E5_C Hardware Information
Appendix B: E5_C Communication Parameter Setup

Appendix A: E5_C Hardware Information

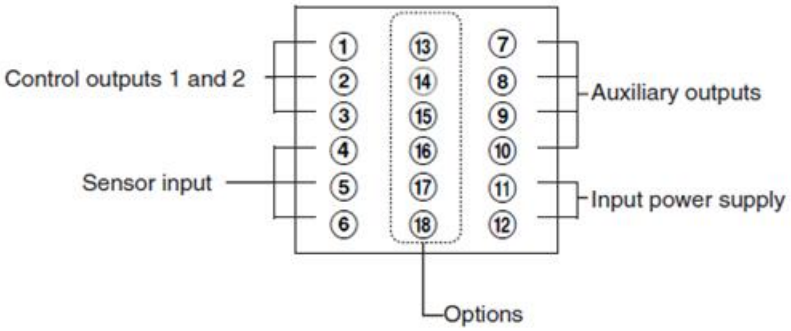
E5CC Temperature Controller

The E5CC Temperature Controller supports On-Panel mounting. Please refer to manual H174-E1-06, section 2-1-3 Mounting, for more information how to mount the unit on a panel.

Model



Pin-out



Options Specification

The options specification of the E5CC is given in the following location (red symbols) within the model number.

$$E5CC-\square\square\square\square\square M-\square\square\square$$

The options code specifies additional features of the Temperature Controller, such as RS-485 communication.

Code	Specifications	Remarks
000	None	
001	Event Inputs 1 and 2, and CT1	
002[14]	Communications (R-485) and CT1	
003	Communications (RS-485), CT1, and CT2	
004	Communications (RS-485), and Event Inputs 3 and 4	
005	Event Inputs 1 to 4	
006	Event Inputs 1 and 2, and Transfer Output	Transfer Output: Current: 4 to 20 mA DC Voltage: 1 to 5 VDC
007	Event Inputs 1 and 2, and Remote SP Input	Remote SP Input: Current: 4 to 20 or 0 to 20 mA DC Voltage: 1 to 5, 0 to 5, or 0 to 10 VDC

Option codes 002, 003 and 004 support RS-485 communication. The pin-out overview shown in *Figure 25 Options Specific Pin-out* displays the pin out for the RS-485 communication.

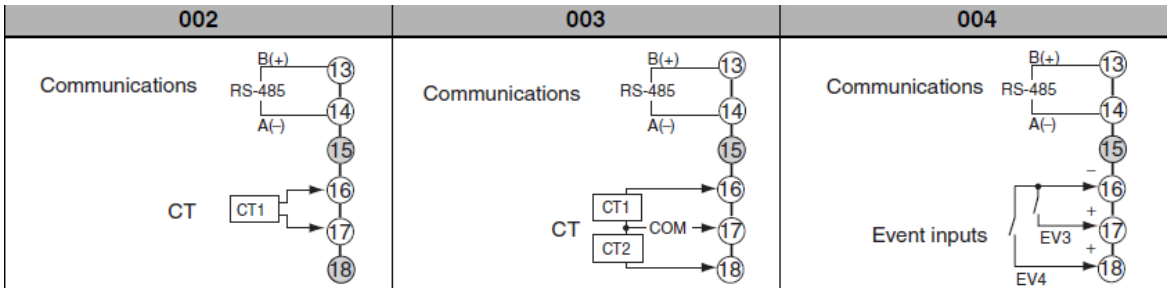


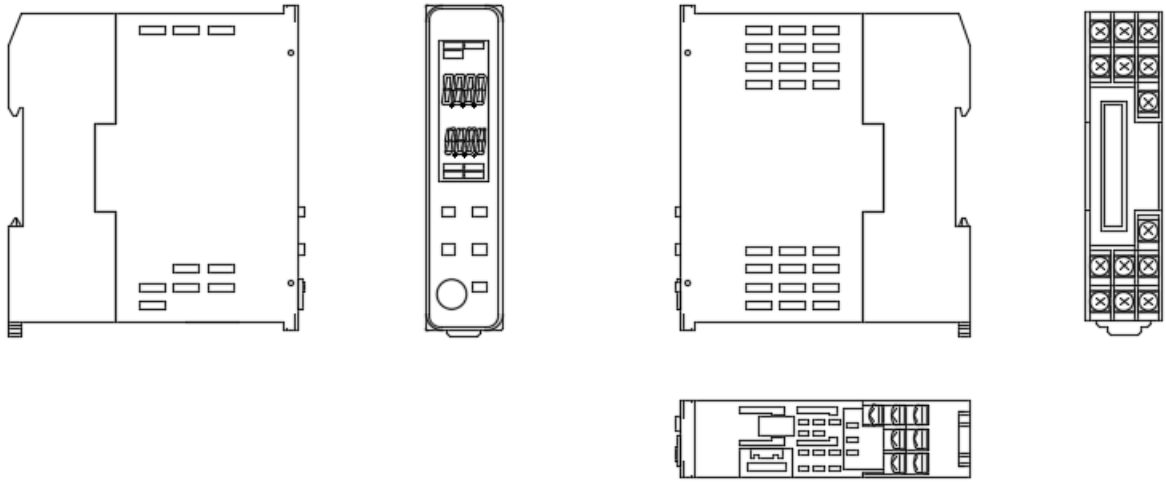
Figure 25 Options Specific Pin-out [15]

[14] This model cannot be selected if 5 (screw terminals with cover) is selected for the terminal type.
[15] Do not wire the grey terminals.

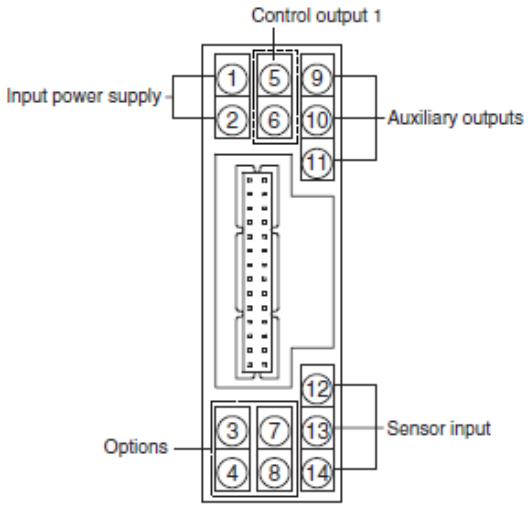
E5DC Temperature Controller

The E5DC Temperature Controller support On-Panel and DIN-rail mounting. Please refer to manual H174-E1-06, section 2-1-3 Mounting, for more information how to mount the unit.

Model



Pin-out



Options Specification

The options specification of the E5DC is given in the following location in the model number. The options code specifies additional features of the Temperature Controller, such as RS-485 communication.

$$E5DC - \square\square\square\square SM - \square\square\square$$

Code	Specifications
000	None
002	Communications (R-485) and CT1
015	Communications (RS-485)
016	Event Input 1
017	Event Inputs 1 and CT1

Options code 002 and 015 support RS-485 communication. The pin-out overview shown in *Figure 26 Options Specific Pin-out* displays the pin out for the RS-485 communication.

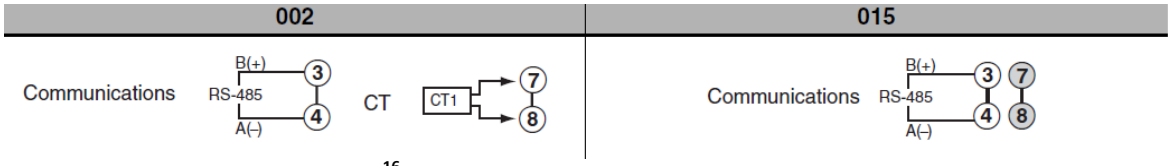


Figure 26 Options Specific Pin-out [16]

[16] Do not wire the grey terminals.

Appendix B: E5_C Communication Parameter Setup

I. Press the Key for at least three seconds to move from the "operation level" to the "initial setting level".

II. Press the Key for less than one second to move the "initial setting level" to the "communications setting level".

III. Select the parameters as shown below by pressing the Key.

IV. Use the or Keys to change the parameters set values.

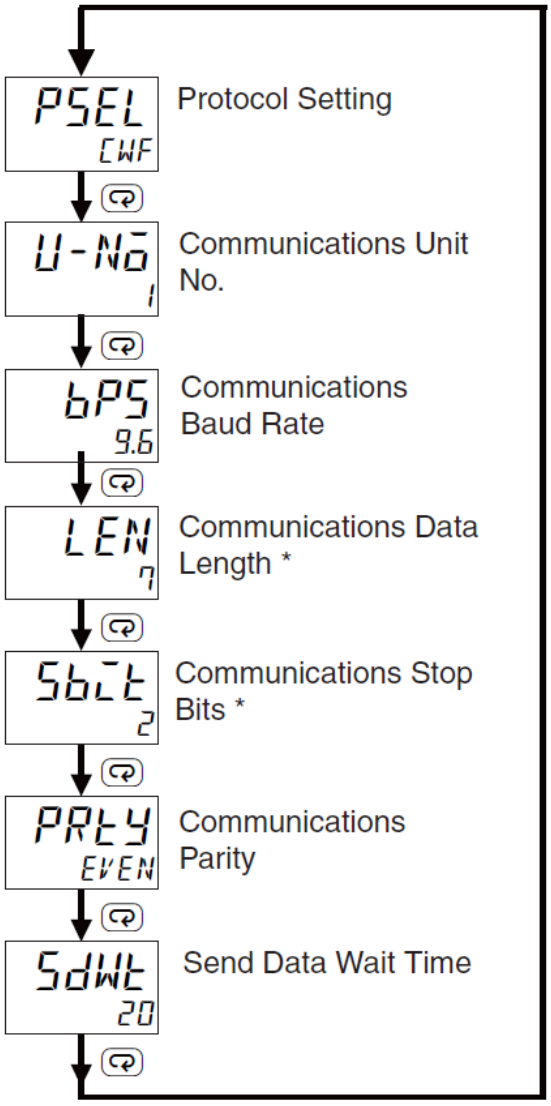


Figure 27 E5_C Parameter Navigation

The 'Data Length' and 'Stop Bits' parameters are not displayed when the Protocol Setting parameter is set to Modbus.

Please refer to H175-E1-08 E5_C Digital Temperature Controllers Communications Manual, section 1-1-8 for detailed description about the communications parameters.