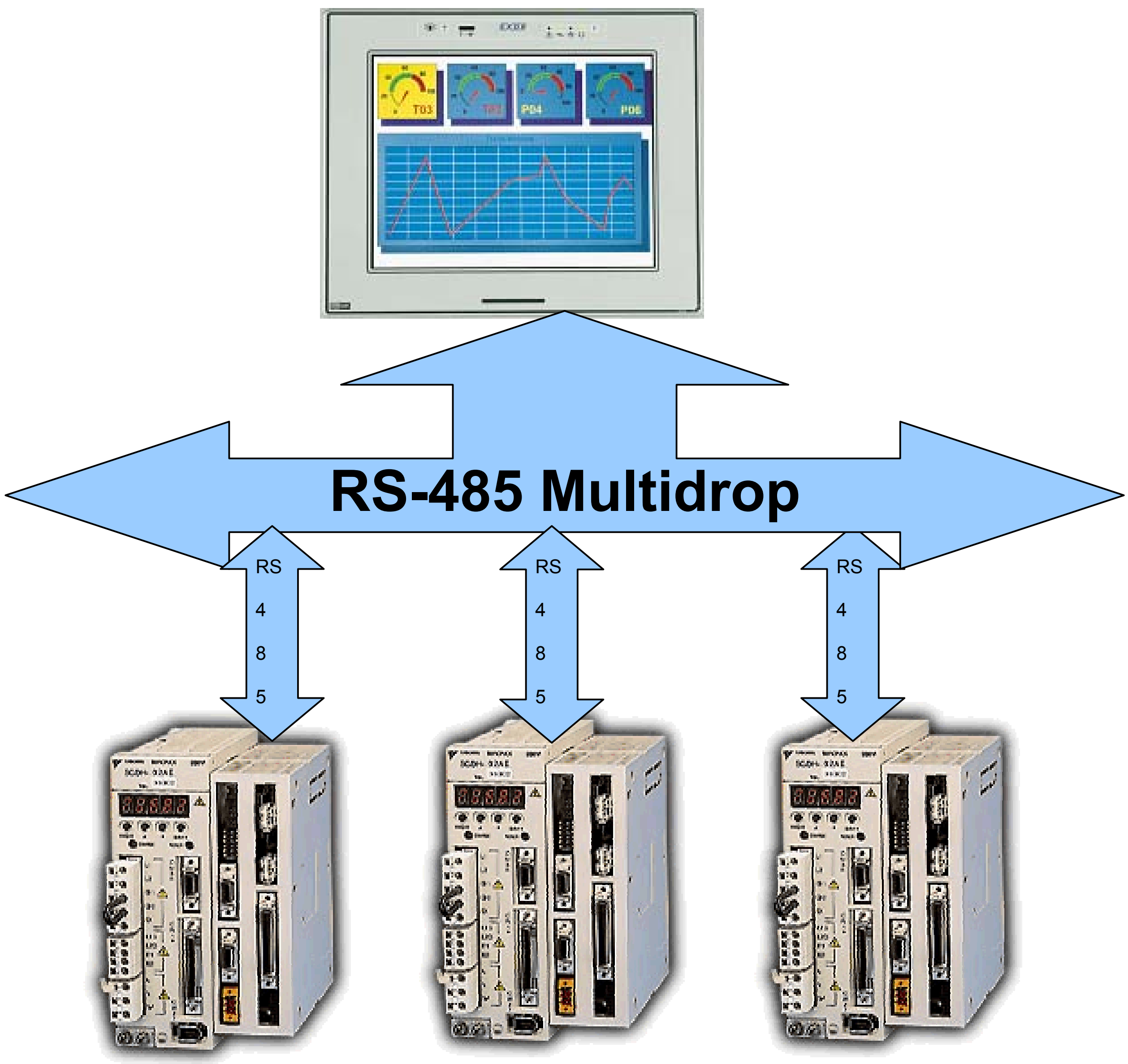
TECHNICAL NOTE
MOTION PRODUCT AND ENGINEERING GROUP

Subject: Multiple MP940s Connected to HMI

Product: MP940 & HMI

Summary: This technical note details the steps needed to configure an HMI with multiple MP940's in a two-wire RS-485 multi-drop network. A technical overview of the RS-485 standard is also provided.



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HMI with Multiple MP940's (Multi-drop)

Wiring and Installation

One HMI panel can communicate with multiple MP940s by connecting them in an RS-485 multidrop communications network. Yaskawa recommends using a **Two-wire** RS-485 connection method for ease of cabling and installation. In this configuration, the HMI will serve as the Master node, and each MP940 will participate as a slave node. All communications over the network are performed using Yaskawa's Memobus protocol (Refer to Yaskawa manual SIE-C815-13.60E "Memobus Descriptive Information" for details on the Memobus protocol).

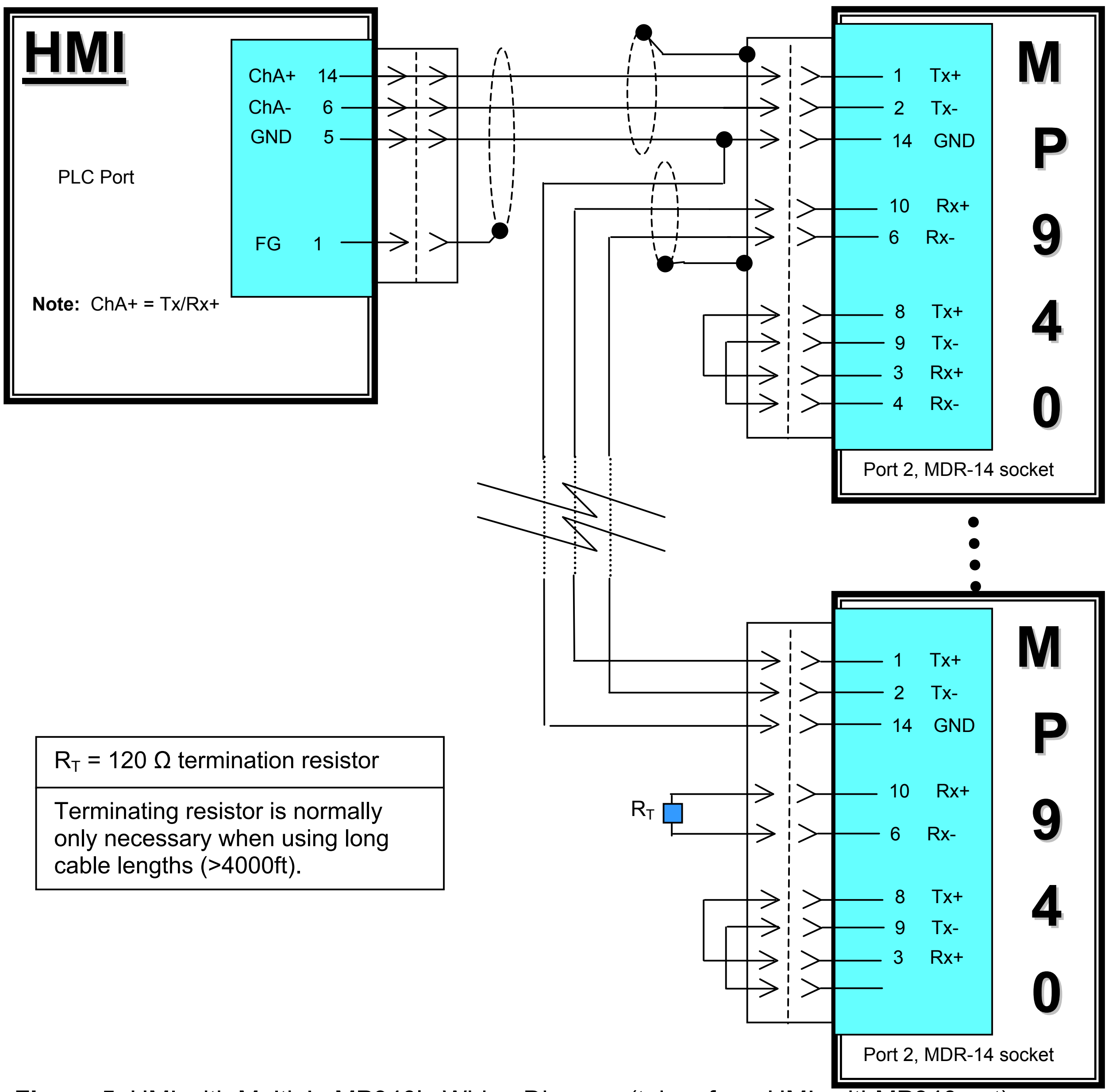
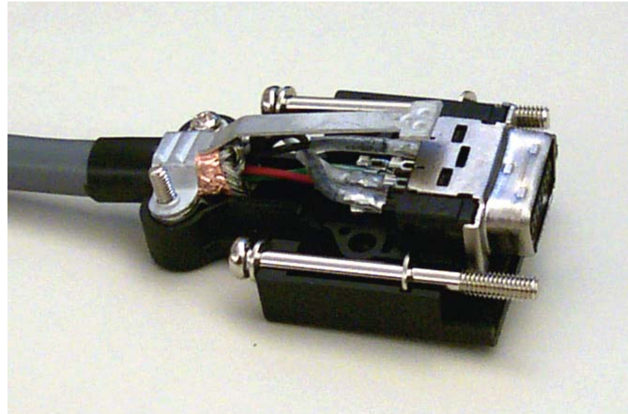


Figure 5 HMI with Multiple MP940's Wiring Diagram (taken from HMI_withMP940.ppt)

Wiring & Installation Notes:



1.) At cable ends, fold back shield and wrap with a thin copper tape. This will maximize contact area.

2.) Cable shields at MP940 side should be placed inside the 3M connector shield clamp

3.) The last MP940 (axis N) may need a 120 Ω terminating resistor (Refer to Chapter 1.3 Termination).

4.) Max number of axis (n) = 1 to 63 (slave), Maximum cable length is 300 meter, Max transmission speed = 19.2k Baud 8-Bit Memobus RTU

5.) In the case of long cable lengths, it may be necessary to terminate the shield at the local Field Ground location for that amplifier

6.) MP940 mating connector is 14 pin. Yaskawa kit "YSC-1" includes 3M parts -

Connector: 10114-3000VE

Shell: 10314-52A0-008

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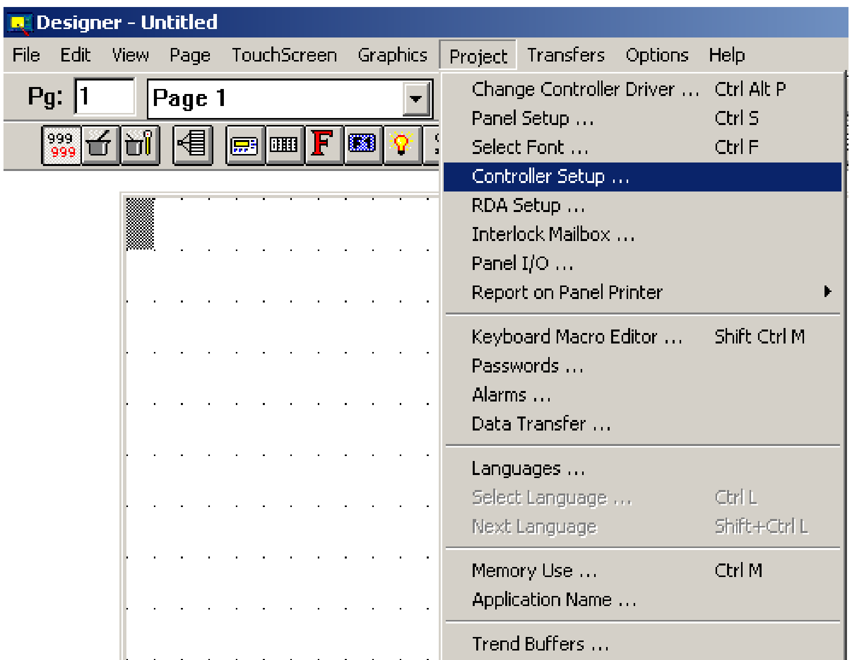
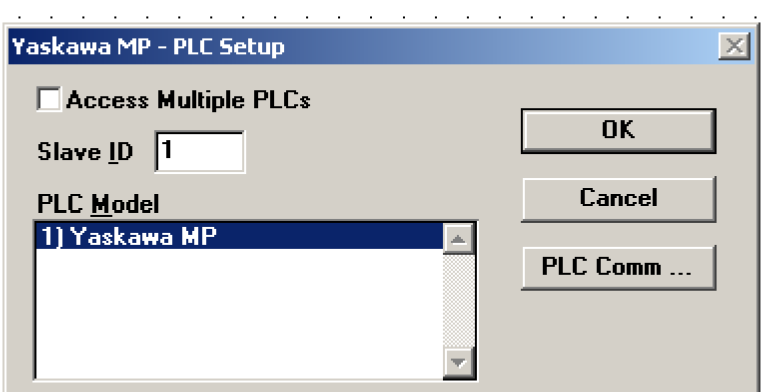
Designer Software – Multiple Controller setup

When connecting multiple MP940's to an EXOR HMI, the HMI serves as the Master node. All MP940's are then connected as Slave nodes. All communications are performed using the Yaskawa Memobus protocol (Refer to Yaskawa manual SIE-C815-13.60E "Memobus Descriptive Information" for details on the Memobus protocol). In order to configure the HMI to act as Master, you must first configure it to communicate with multiple MP940's within the Designer software.



To do this first go to the **Project** drop-down menu, then select **Controller Setup….**



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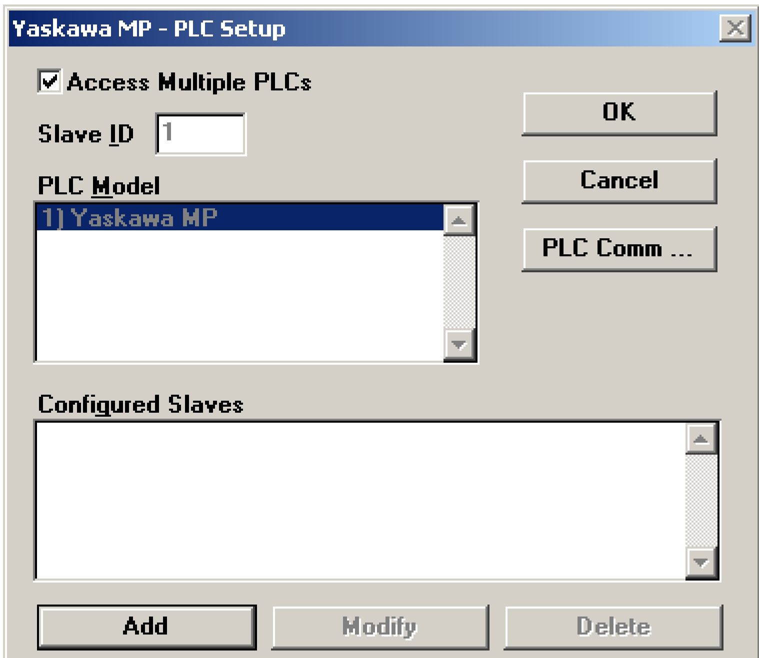
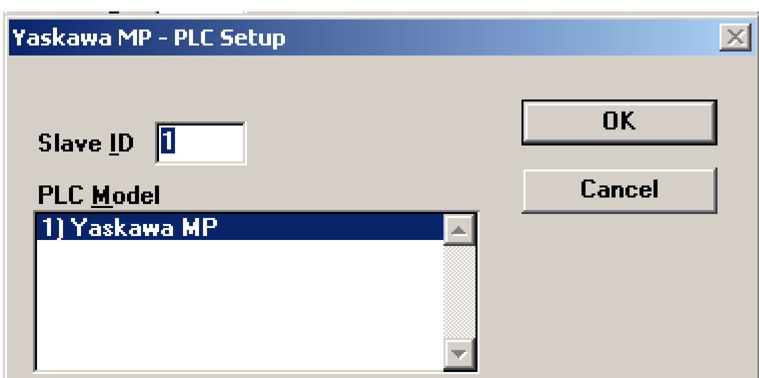
Next select the 

checkbox



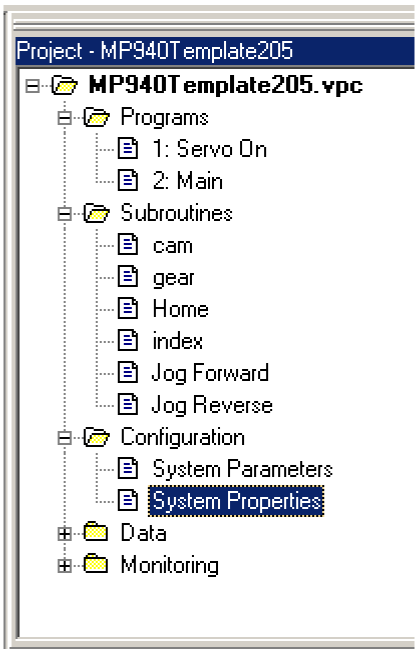
Click on the  button to add MP940's to the network as Slave nodes.



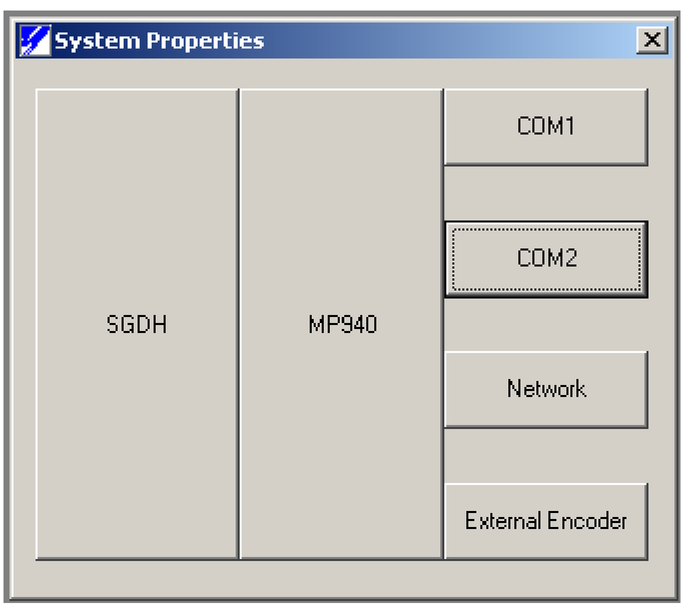
Select the Slave node number for the controller specified by entering a number in the **Slave ID** text box. Each slave in the network will have a unique Slave ID number.

MW+ Software – RS485 Settings

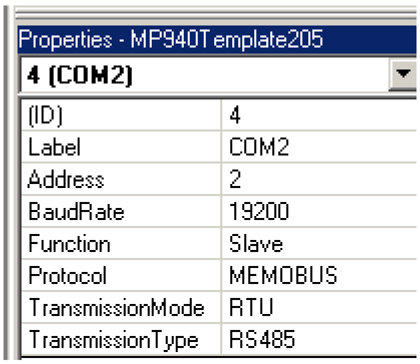
The MP940 must be configured to participate as a slave node in the RS-485 network. The MP940 has two serial communications ports, Port1 and Port2. Port 1 can be used for standard RS-232 communications. Port2 can be used for either RS-422 point-to-point or RS-485 multidrop communications. In order to configure the MP940 to communicate on an RS-485 network, you must change the following property settings within the Motion Works+ software.



Double-click on System Properties to open the MP940 system properties screen.



Click on COM2 to display the property settings for Port2.



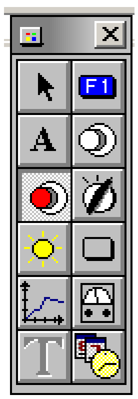
Change the property settings to match the following values:

Address = MP940's slave node ID or address. These address values correspond to the slave nodes configured earlier in the HMI Designer software (Chapter 2.2). Each slave node on the RS485 network should have a unique address.
Function = Slave
Protocol = Memobus
Transmission Mode = RTU
Transmission Type = RS485

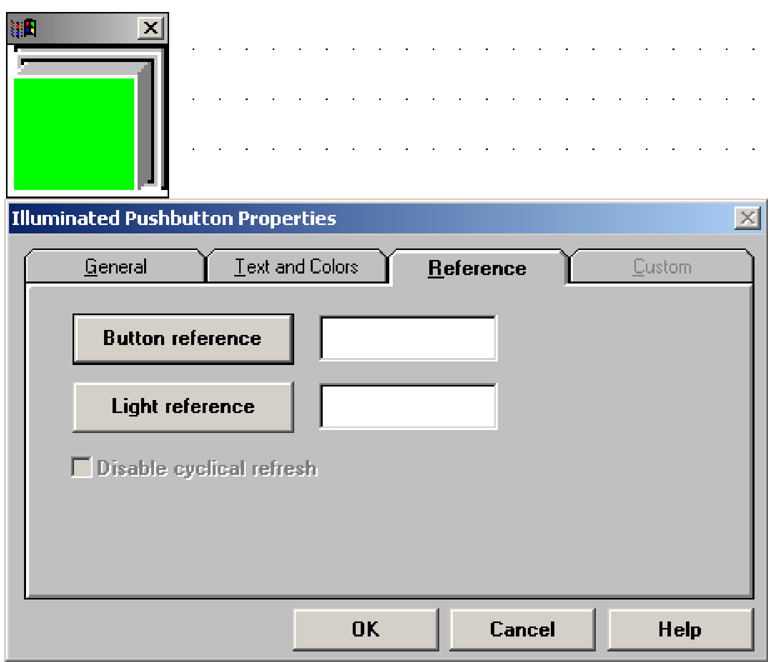
Designer Software – Component Examples

Once you have added Slave nodes within your Designer software, and have properly configured each slave within MW+, your RS-485 network is now properly configured. You can now create screens using Designer software and upon downloading the project, communicate to each slave node individually. This will allow you to display register values (using data fields, buttons, indicator lights, gauges, trends,etc.) or to write to each MP940 slave node individually (using data fields, buttons, or function keys).

Illuminated Pushbutton Example (Touchscreen models only)

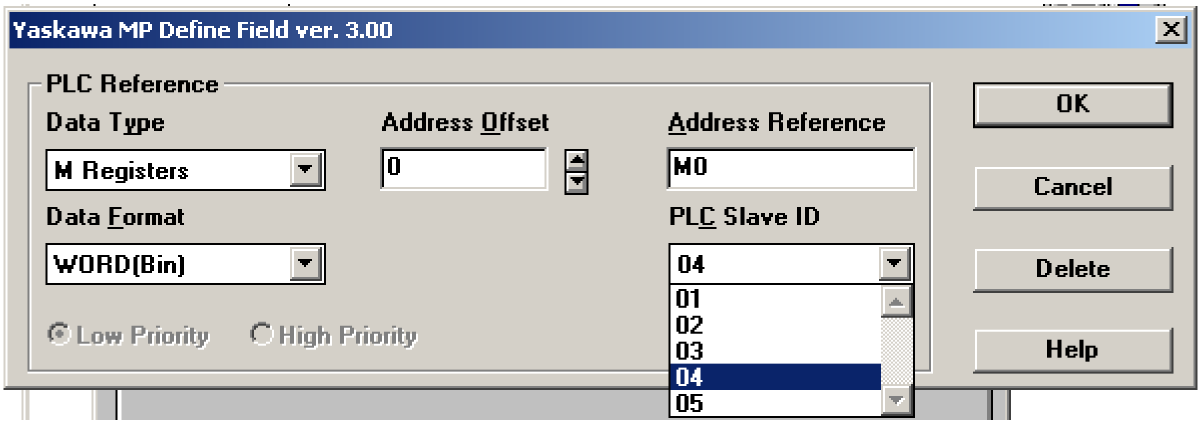


First select the **Illiminated Pushbutton** from the toolbar. Note when hovering mouse pointer over Toolbar Icons, a brief description of the Icon will be displayed.



Click on the **Button reference** to select the Controller register (word or bit) in which a button press action will change (momentary, maintained, ON, or OFF).

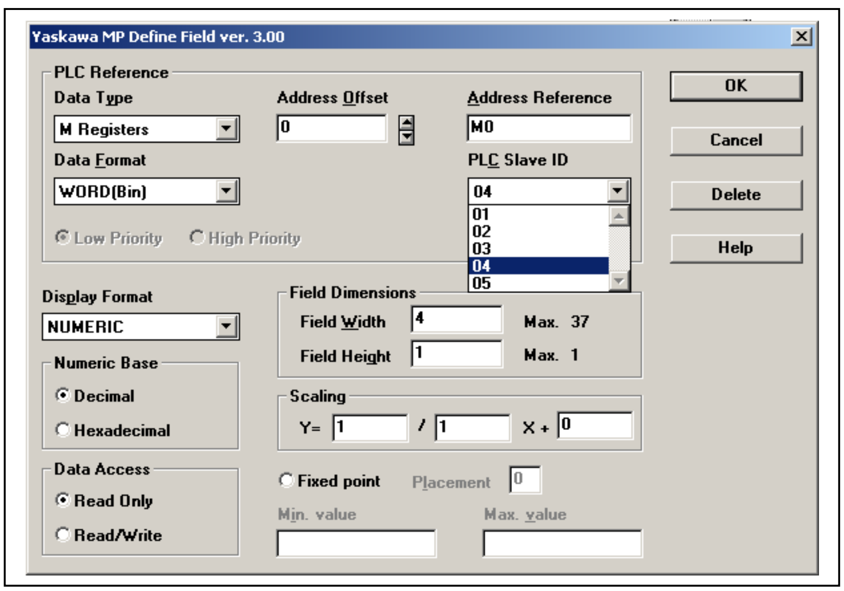
Click on the **Light Reference** button to select the Controller register (word or bit) that the Indicator Light on the button will reference (ON or OFF color).



Using the **PLC Slave ID** drop down, select which MP940 Slave node you which to reference (slave nodes were configured earlier in Chapter 2.3). Using the **Address Offset** text box enter the register address you would like to reference. Using the **Data Format** drop down, select whether you want to write to an entire word (register) or a bit within that register.

Data Field Example

To create a data field, simply double-click anywhere on your Designer workspace. This will open up the Define Data Field Properties window.



Within the PLC Reference frame, use the **Data Type** drop down to select if you would like to reference an I or M register. Using the **Data Format** drop down select if the register you are referencing is a Word, Long, Float, or Bit. Enter the register address you would like to reference in the **Address Offset** text box. Select the MP940 slave node you would like to reference using the PLC Slave ID drop down.

RS-485: Technical Overview

Note: The following is only a basic overview of the EIA RS-485 communications standard. For detailed information it is recommended viewing Texas Instruments application note SLLA070A, which can be viewed on Texas Instruments website at www.ti.com. Other RS-485 resources can be found at http://www.national.com/apnotes/ or www.bb-elec.com

EIA Standard RS-485 Data Transmission allows multiple devices to communicate over a balanced differential transmission line in a multi-drop configuration. Up to 32 devices can participate in the multi-drop or 'party line' configuration, at distances up to 1200 meters (4000 feet). Communication is performed at half-duplex on a single pair of wires (two wire), or full duplex on two pairs (four wire). Data is transmitted *differentially* on two wires twisted together, referred to as a "twisted pair." The properties of differential signals provide high noise immunity and long distance capabilities.

Differential Signals

RS-485 signals are transmitted differentially over a pair of wires, generally referred to as A and B. The EIA-RS-485 standard shows the voltages V_{OA}, V_{OB}, and V_O as shown in Figure 1. The driver generates complementary voltages on A and B, generally ranging from 2 to 6 volts. The receiver then responds to the voltage difference between A and B. If the voltage difference V_{OA-OB} is greater than +200mV, the receiver will recognize a positive logic state (High). If the voltage difference V_{OA-OB} is less than –200mV the receiver will recognize a negative logic state (Low). The receiver must sense a difference of at least +/-200mV, and anything less is considered 'indeterminate'. The 200mV minimum is required to allow for attenuation on the transmission line.

A driver can also have an enable signal, which is used to 'tri-state' or disconnect the driver from it's A or B output terminals. The enable signal is used in RS-485 communications to allow only the driver currently communicating on the network to be enabled, thus effectively disconnecting all other drivers on the network. If more than one driver is enabled or allowed to communicate on the network at the same time, the signal may be corrupted and this condition is referred to as line contention.

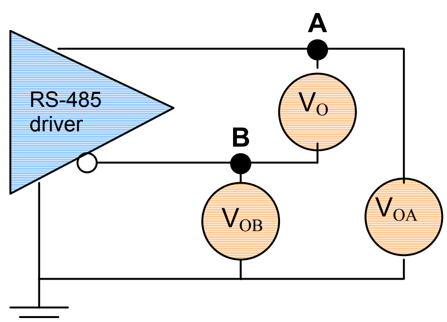


Figure 1 Differential Voltages V_{OA}, V_{OB}, and V_O

Two-wire and Four-Wire

An RS-485 network can be configured in two ways, "two-wire" or "four-wire." In a "two-wire" network the transmitter and receiver of each device are connected to a twisted pair of wires (Figure 2). "Four-wire" networks have one *master* node connected to many *slave* nodes. The *master* driver is connected to each of the *slave* receivers on one twisted pair (Figure 3). The *slave* drivers are all connected to the *master* receiver on a second twisted pair. In either configuration, devices are addressable, allowing each node to be communicated independently. Only one device can drive the line at a time, so drivers must be disabled, meaning they are put into a high-impedance mode (tri-state) when not in use. A consequence of tri-stating the drivers is a delay between the end of a transmission and when the driver is tri-stated. This turn-around delay is an important part of a two-wire network because during that time no other transmissions can occur (not the case in a four-wire configuration).

Two-wire 485 networks have the advantage of lower wiring costs and the ability for nodes to talk amongst themselves. On the downside, a two-wire mode is limited to half-duplex and requires attention to turn-around delay. Four-wire networks allow full-duplex operation, but are limited to master-slave situations (i.e. a "master" node requests information from individual "slave" nodes). "Slave" nodes cannot communicate with each other.

NOTE: When referring to *two-wire* and *four-wire*, note that *two-wire* is really two wires + ground (three wires in cable), and *four-wire* is really four wires + ground (five wires in cable).

NOTE: The EIA RS-485 Specification labels the data wires **A** and **B**, but many manufacturers label their wires **+** and **-**. Typically (but not always), the **-** wire should be connected to the **A** line, and the **+** wire to the **B** line. Reversing the polarity will not damage a 485 device, but it will not communicate. As a rule always connect **A** to **A** and **B** to **B**, as shown in Figures 2 and 3.

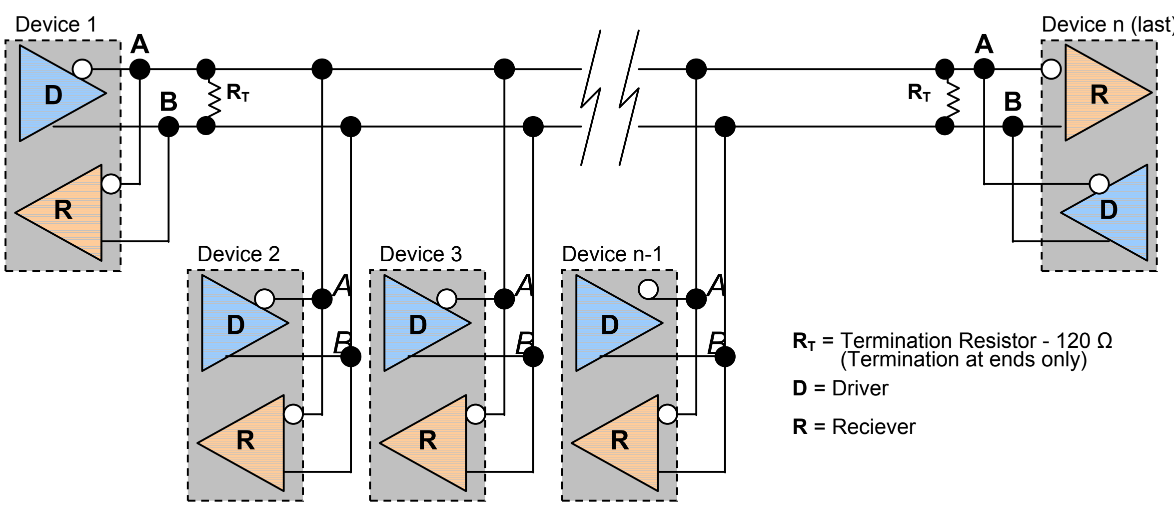


***Figure 2** – Typical Two-Wire configuration.*

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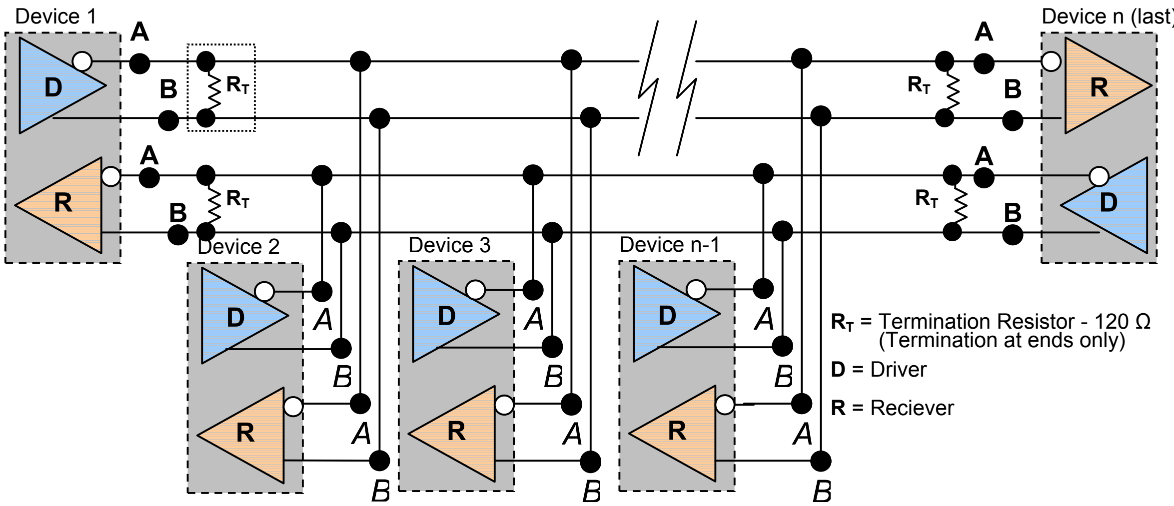


Figure 3 – Typical Four-wire configuration

NOTE: The transmission line is terminated on both ends of the line but not at any of the drop points in the middle of the line. Termination should only be used with high data rates and long wiring runs (termination discussed in Chapter 1.3 next).

Termination

Termination is used to match the impedance of a node to the impedance of the transmission line being used. When impedances are mismatched, the transmitted signal is not completely absorbed by the load and a portion of it is reflected back into the transmission line. If the source, transmission line and load impedance are equal these reflections are eliminated. There are disadvantages of termination as well. Termination increases load on the drivers, increases installation complexity, changes biasing requirements and makes system modification more difficult.

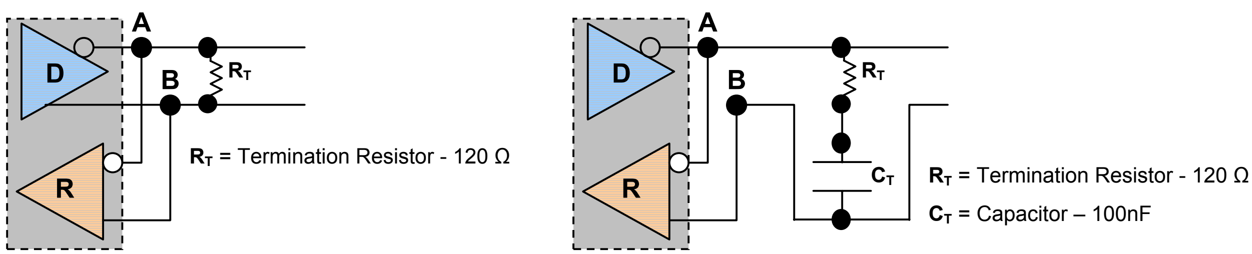
The decision whether or not to use termination should be based on the cable length and data rate used by the system. A good rule of thumb is if the propagation delay of the data line is less than one bit width, termination is not needed. This rule makes the assumption that reflections will damp out in several trips up and down the data line. Since the receiving UART (Universal Asyncronous Receive/Transmit) will sample the data in the middle of the bit, it is important that the signal level be solid at that point. For example, in a system with 2000 feet of data line, the propagation delay can be calculated by dividing the cable length by the propagation velocity of the cable. This value, typically 66 to 75% of the speed of light (c), is specified by the cable manufacturer. For this example, a round trip covers 4000 feet of cable. Using a propagation velocity of 0.66 × c, one round trip is completed in approximately 6.2 µs.

Example:

Length / .66c ⇨ 4000ft / .66(9.84 x 10^8)ft/s = 6.16 x 10^6 ⇨ 6.2 µs

If we assume the reflections will damp out in three "round trips" up and down the cable length, the signal will stabilize **18.6 µs** after the leading edge of a bit. At 9600 baud one bit is **104 µs** wide (1 / 9600 bits/s). Since the reflections are damped out much before the center of the bit, termination is not required. For most industrial applications a termination is not required unless high data rates (>100k baud) or long cable lengths (>4000ft) are required. As communications to the MP940 are typically at 19.2k baud, data rate is relatively low and termination is generally not required.

There are several methods of terminating data lines. The method recommended by Yaskawa (if necessary) is parallel termination. A resistor is added in parallel with the receiver's **A** and **B** lines in order to match the data line characteristic impedance specified by the cable manufacturer (120 Ω is a common value). This value describes the intrinsic impedance of the transmission line and is not a function of the line length. A terminating resistor of less than 90 ohms should not be used. Termination resistors should be placed only at the first and last node of the data line, and no more than two terminations should be placed in any system that does not use repeaters. This type of termination clearly adds heavy DC loading to a system and may overload some device drivers and port powered RS-232 to RS-485 converters. Another type of termination, AC coupled termination, adds a small capacitor in series with the termination resistor to eliminate the DC loading effect. Although this method eliminates DC loading, capacitor selection is highly dependent on the system properties. System designers interested in AC termination are encouraged to read Texas Instruments application report SLLA070A for further information.



Parallel Termination AC-Coupled Termination

Figure 4 Parallel and AC-Coupled Termination

Signal Ground

While a differential signal does not require a signal ground to communicate, the ground wire serves an important purpose. The signal ground line is recommended in order to keep the common mode voltage that the receiver must accept within the –7 to +12 volt range. Over a distance of hundreds or thousands of feet there can be very significant differences in the voltage level of "ground." RS-485 networks can typically maintain correct data with a difference of -7 to +12 Volts. If the grounds differ more than that amount, data will be lost and often the port itself will be damaged. The function of the signal ground wire is to tie the signal ground of each of the nodes to one common ground. However, if the differences in signal grounds are too great, further attention is necessary. Optical isolation is one cure to this problem.

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