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Direct Logic 405

Shared Data

Network

CoProcessor

F4-SDN



Order Number: F4-SDN-M

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CHAPTER 1: INTRODUCTION

The Shared Data Network CoProcessor, F4-SDN, is used to share data at high speeds between up to 16 Direct Logic 405 CPU's.

A Shared Data Network CoProcessor (SDN) is installed in each PLC rack that will be on the shared data network (ShareNET).

Each SDN on ShareNET constantly sends a block of data from its DL405 CPU to every other SDN on ShareNET. Each SDN takes the data that is received from the network and writes the data to a block of V-Memory in its own 405 CPU. The address of the module sending the data determines where in V-Memory the data is placed.

This network is useful in applications where multiple independent 405 CPUs control different parts of the same process. ShareNET allows each 405 CPU on the network to know, in real time, what every other 405 CPU on the network is doing.

The F4-SDN ShareNET communication protocol uses address recognition hardware and CRC16 error checking. This system provides superior reliability.

FACTS Engineering ShareNET has an undetected bit error rate near zero.

ShareNet Specifications

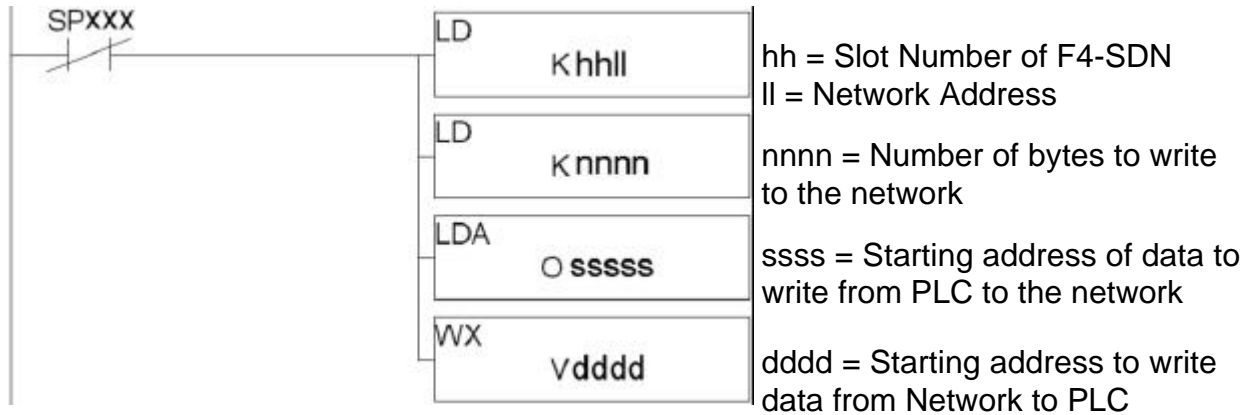
| | |
|---|---|
| Communication Rate | 250K bps |
| Electrical Interface | RS485 (Three wire) |
| Maximum Distance | 4000 Feet (1219 Meters) between extreme ends of the network |
| Protocol | FACTS Engineering Proprietary |
| Error Detection | Address Recognition Hardware with 16-bit Cyclic Redundancy Check (CRC16) |
| Maximum Number of F4-SDNs per Network | 16 (Address is user selectable) |
| Maximum Number of V-Memory Locations Broadcast to the network per F4-SDN | 16 (32 Bytes) User selectable from 1 to 32 bytes |
| Maximum Number of V-Memory Locations received from the network per F4-SDN | 256 (512 Bytes) Up to 32 bytes may be received from each active F4-SDN |
| Maximum Number of F4-SDNs per 405 CPU | 2 (Must install in CPU Base) |
| Impact on PLC Scan Time | Adds 4 to 28 milliseconds |

CHAPTER 2: CONFIGURATION

Only one rung of ladder logic is required to configure and operate the Shared Data Network CoProcessor (SDN).

The ladder rung constantly transfers data from the PLC to the SDN in the base. The SDN then writes the data to all the other SDNs on the network. The configuration rung also specifies the F4-SDN's slot, the network address, the number of bytes to write to the network, and where in the PLC to write the received data.

Slot Dependent Special Relay



The WX instruction will turn ON the Special Purpose (SP) BUSY relay associated with the slot where the F4-SDN module is installed. The following table shows the relay to use for each of the eight possible slots where the F4-SDN can be installed.

If the F4-SDN module is not communicating with the PLC then the ERROR Relay associated with the SDN's slot is energized.

| Special Purpose (SP) Data Communications Relays | | | | | | | | |
|---|-----|-----|-----|-----|-----|-----|-----|-----|
| Slot | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| BUSY | 120 | 122 | 124 | 126 | 130 | 132 | 134 | 136 |
| ERROR | 121 | 123 | 125 | 127 | 131 | 133 | 135 | 137 |

Define CoProcessor Slot Number and Network Address

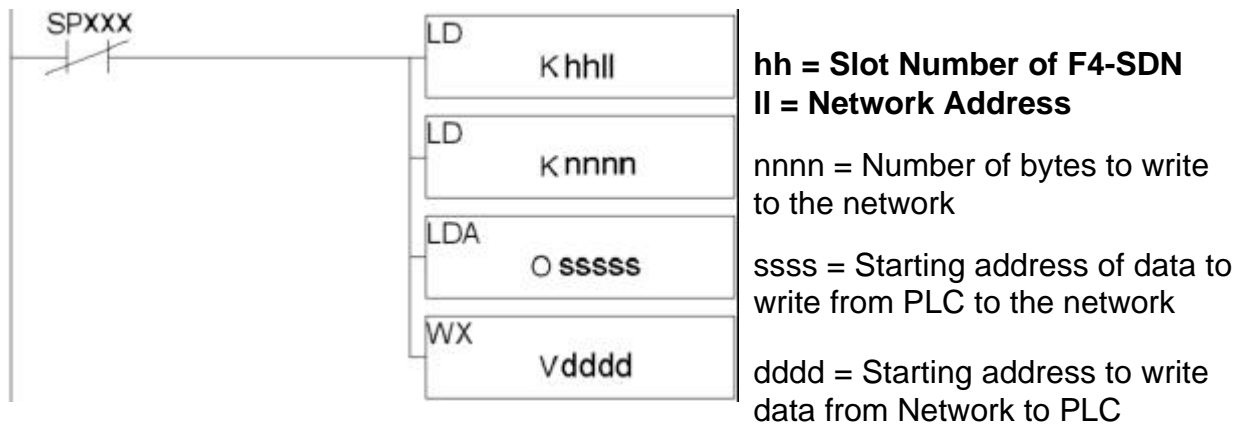
The first LD (LOAD) instruction of the configuration rung uses a high byte and a low byte to specify the slot and network address.

The high byte (**hh**) is the slot where the F4-SDN is installed. The range of valid slot numbers is 0 to 7 BCD.

The low byte (**ll**) is the network address of this module. The range of valid ShareNet addresses is 1 to 16 BCD.

Every F4-SDN on the network must have a unique address.

For optimum performance, network addresses should be assigned consecutively beginning with address 1. There is no relationship between network address and the SDN's physical location on the network.



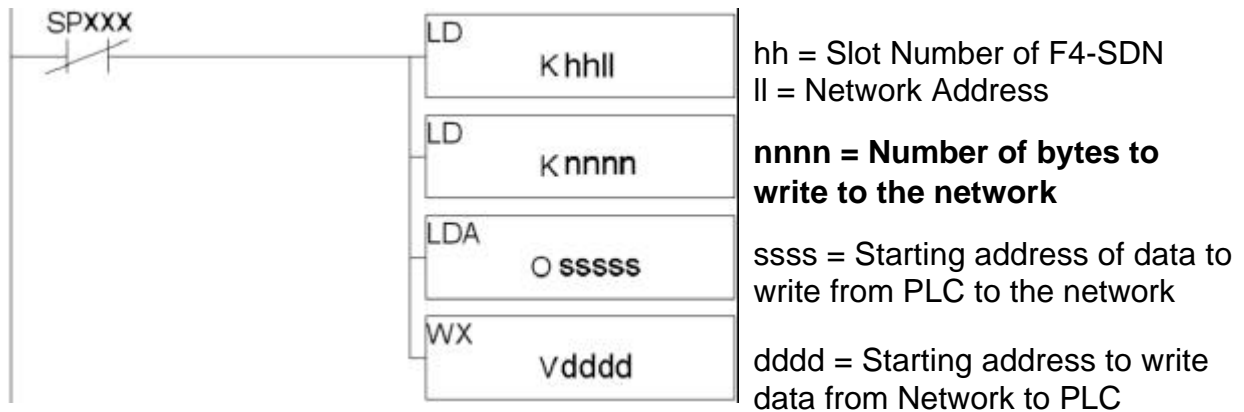
Number of Bytes to Write to Network

The second LD (LOAD) instruction of the configuration rung specifies the number of bytes to write from this network address to the other Shared Data Network CoProcessors.

The F4-SDN module may write from 1 to 32 bytes to the network. The value that you place here will depend on the amount of data your application needs to share.

Every address on the network must be configured for the same number bytes.

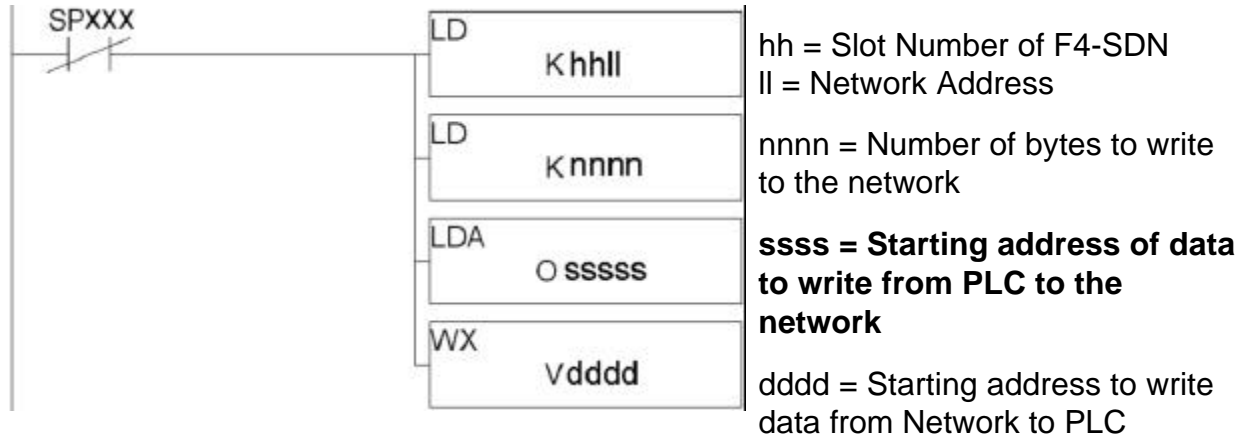
For optimum performance, specify the minimum number of bytes required to support your application.



Start Address of PLC Data Written to Network

The LDA (LOAD ADDRESS) instruction of the configuration rung specifies the starting V-Memory address of the data that will be written to the F4-SDN network. You may place any valid V-Memory reference here.

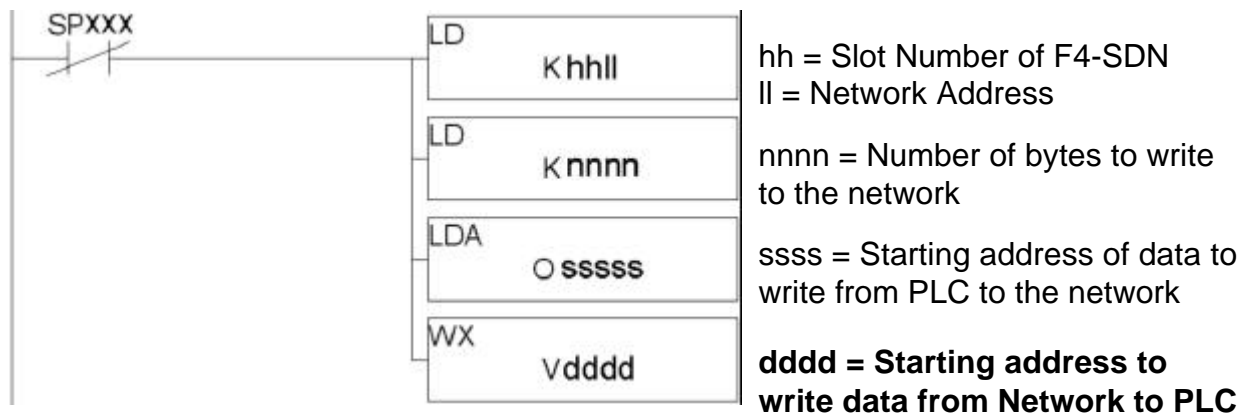
The O in the LDA instruction stands for Octal. To specify V1400 as the starting data address use O1400. To specify V40400 as the starting address use O40400.



Start Address of Network Data Written to PLC

The WX instruction of the configuration rung specifies the V-Memory location that will be the start of the data received from the network. The F4-SDN allows only user V-Memory references here. The PLC CPU V-Memory range is V1400 to (V7350 - 16 x Number of Bytes). This location should be the start of a contiguous block of unused V-Memory large enough for the number of addresses on the network multiplied by the number of words each PLC writes to the network (number of bytes / 2).

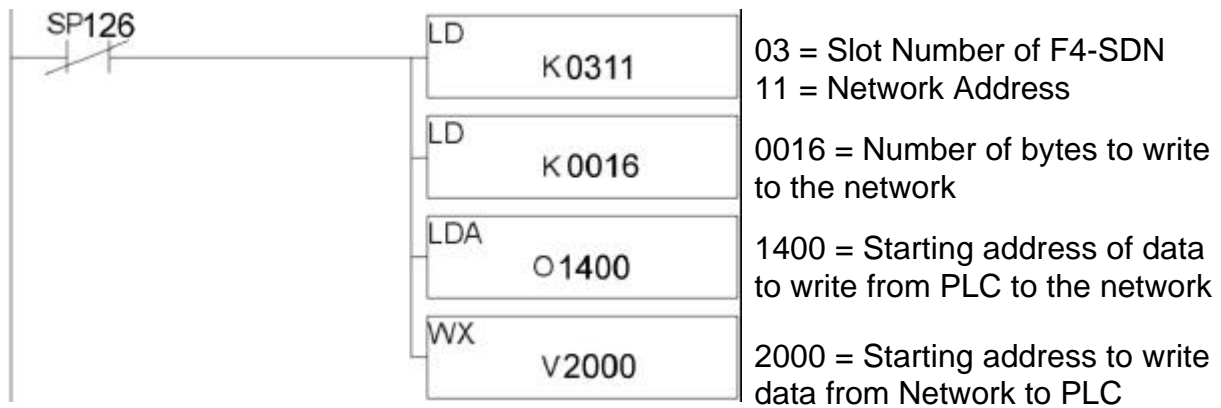
Addresses which don't transmit their data within 2 seconds get zeros written to the block of memory corresponding to their network address. F4-SDNs will not transmit data if they are powered off, if the cable is not connected to that address, or if the configuration rung is incorrect.



NOTE: On power up the block of V-memory starting at this address will be cleared (zeroed). The number of V-memory locations cleared is determined by the number of bytes specified in the second LD instruction multiplied by 16 possible addresses.

Example: There are 16 F4-SDNs on the network. This F4-SDN is installed in slot 3 of a F4-CPU. It has a network address of 11. Starting with V1400, 8 V-Memory locations (16 bytes) will be sent to all the other SDNs in the network. The data received from the network will be placed starting at V2000.

The following rung will configure and run the F4-SDN as described above.



In this example:

Data from SDN at address 1 will be placed at V2000-2007

Data from SDN at address 2 will be placed at V2010-2017

Data from SDN at address 3 will be placed at V2020-2027

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.

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Data from SDN at address 14 will be placed at V2150-2157

Data from SDN at address 15 will be placed at V2160-2167

Data from SDN at address 16 will be placed at V2170-2177

Firmware Version and Configuration Error Code

On power-up, the Shared Data Network CoProcessor stores in a dedicated slot dependent V-Memory location the module's firmware version and a configuration error code.

The high byte is the firmware version for the F4-SDN in BCD. The low byte is an error code in BCD.

Error Codes

0 = No Errors Detected

1 = Invalid Number of Bytes
(Bytes to Write > 32)

2 = Invalid Network Address
(Network Address > 16)

3 = Invalid Data Address
(Start<1400 or Start>7350-(16xNumber of Words)+1)

Example: To interpret the version and error code for a F4-SDN installed in slot 3, display V7363 in TC/HEX format on a computer or display V7363 with the 405 Hand Held Programmer (keystrokes are: CLR CLR V7363 WD-ST).

If the display shows a value of 1000 then this is firmware version 1.0 with no errors.

If the display shows a value of 1001 then this is firmware version 1.0 with an invalid number of bytes.

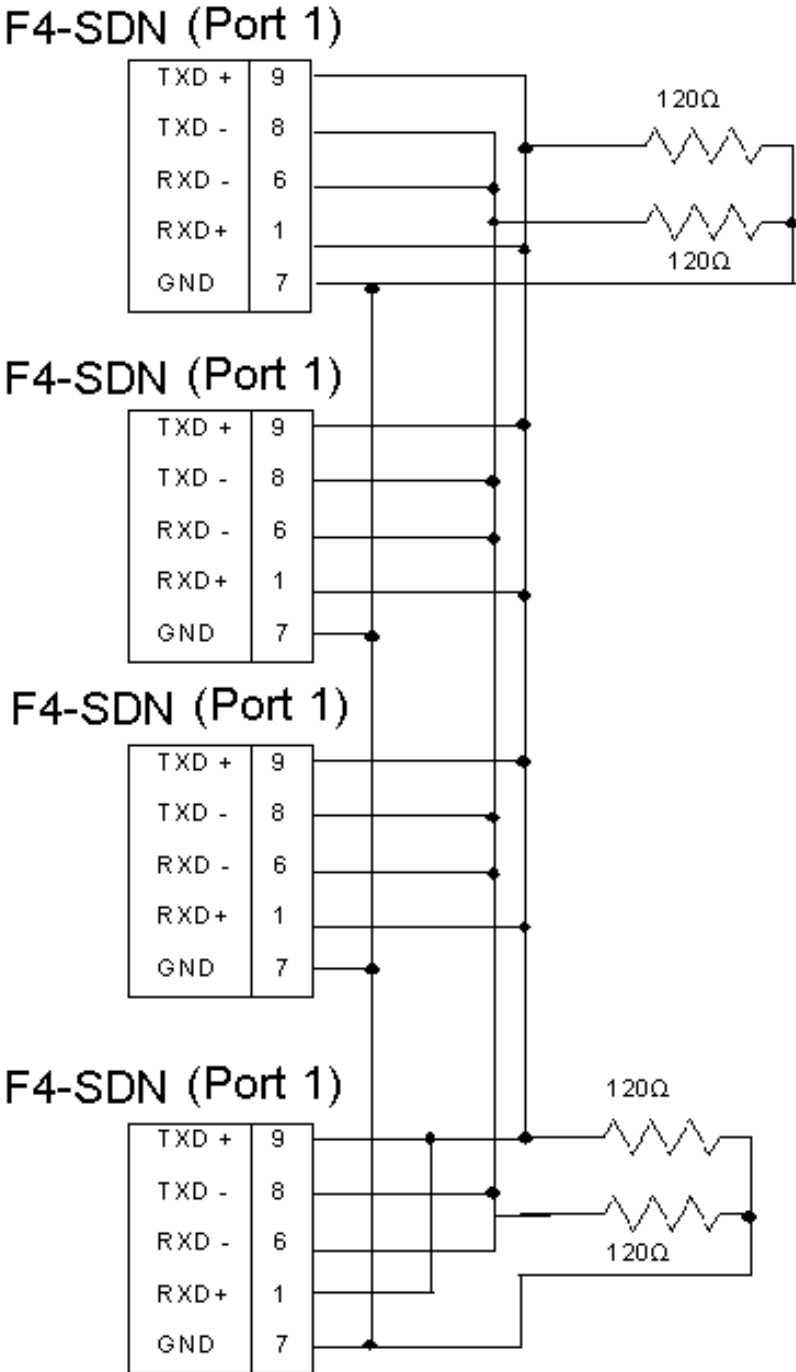
If the display shows a value of 1002 then this is firmware version 1.0 with an invalid network address.

If the display shows a value of 1003 then this is firmware version 1.0 with an invalid data address.

| Firmware Version and Configuration Error Code Locations | | | | | | | | |
|---|-------|-------|-------|-------|-------|-------|-------|-------|
| Slot # | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| V-Memory | V7352 | V7355 | V7360 | V7363 | V7366 | V7371 | V7374 | V7377 |

CHAPTER 3: PORT CONNECTIONS AND NETWORK WIRING

The F4-SDN uses the RS485 electrical interface. The following diagram shows how the network connection is made. Terminating resistors should only be installed at the extreme ends of the network. The maximum distance between the extreme ends of the network is 4000 ft.



Cable Shielding

Shielding improves noise immunity (magnetic field protection). It is important to ground the shield only at one end of the cable run. Grounding one end only provides the least high frequency signal attenuation and the best rejection of unwanted signals.

Grounding both ends of the shield will cause magnetic field induced noised currents to flow through shield. Noise may then appear on the data lines due to transformer like coupling with the shield.

If the cable shield must be used as the signal ground conductor then placing a 100 Ω resistor in series with the shield and the signal ground connection will reduce noise producing ground currents (shield and resistor not shown in diagram).

Connecting Cables and Line Termination

A dual twisted pair plus ground connection between Shared Data Network CoProcessors is recommended. Proper termination of the balanced transmission line is required to prevent data errors. A typical AWG 22 solid wire with .060 inch plastic cover, twisted 4.5 times per foot has a characteristic impedance of about 120 Ω . Thus the selection of the two 120 Ω line-to-ground terminating resistors.

Different cables will have different terminating resistor requirements. The values illustrated are the minimum which can be used.

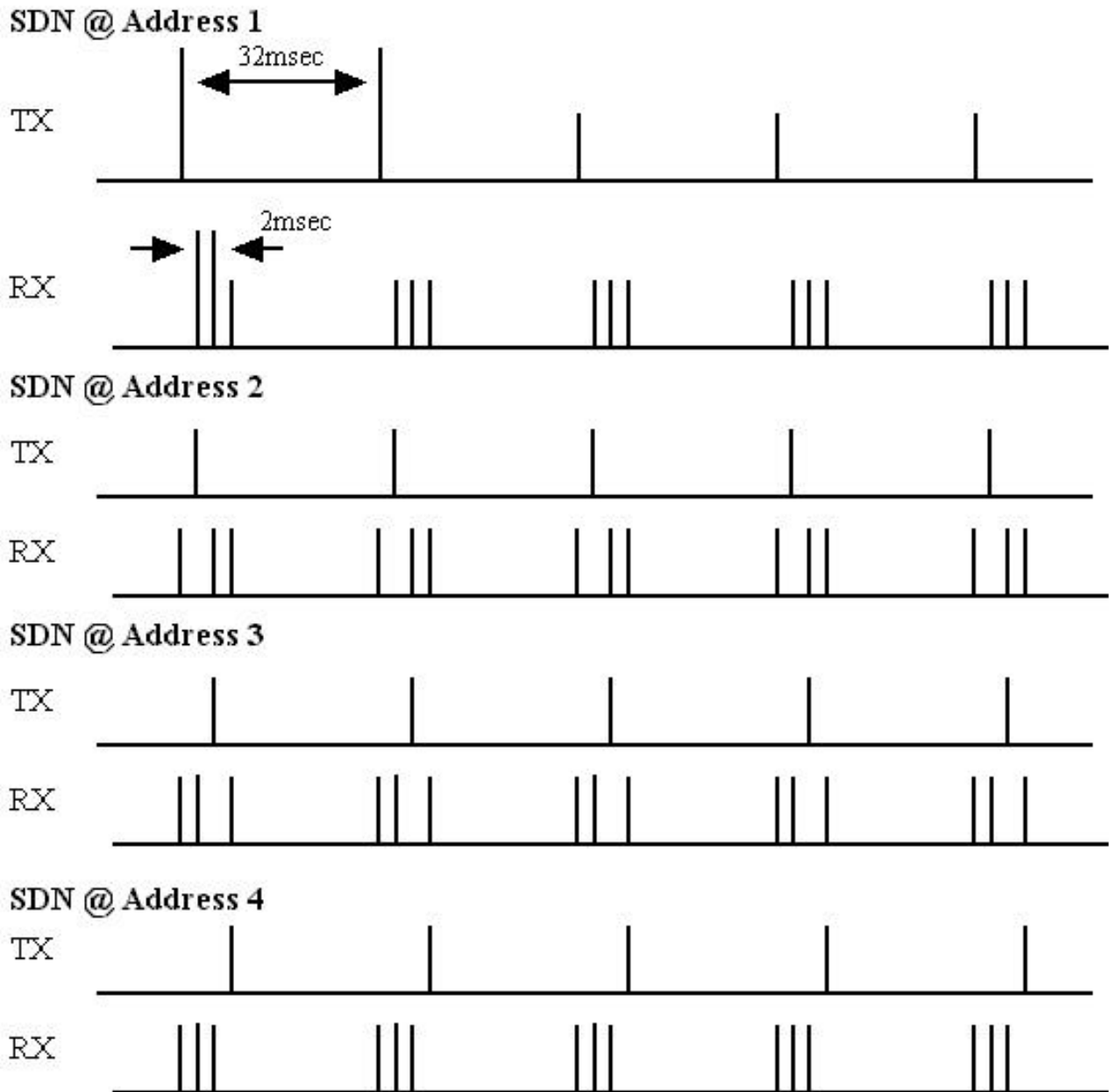
Line-to-ground termination is preferred to the often shown line-to-line termination (120 Ω on one end or 240 Ω on each end). In noisy or long line applications the much better line-to-ground common-mode rejection capability is particularly important. In multidrop networks, the line must be terminated at the extreme ends only as shown in the previous diagram. Addition of intermediate terminations will adversely load the line.

CHAPTER 4: SHARED DATA NETWORK OPERATION

The 405 Shared Data Network operates on a time slice basis. Each of the 16 possible addresses gets a time slice to transmit the maximum data frame.

Two milliseconds are allocated to each of sixteen possible network addresses. Thus every active Shared Data Network CoProcessor transmits PLC data every 32 milliseconds.

The following diagram shows the order and the timing of ShareNet with 4 F4-SDNs installed.



PLC to F4-SDN Communication Time

The rung of ladder logic with the WX instruction constantly writes the V-Memory data that will be transmitted from this network address. The frequency that the WX instruction executes is directly dependent on the PLC scan time. When the time slice for this network address to transmit comes around, it will transmit the data from the last completed WX.

F4-SDN to F4-SDN Communication Time

ShareNET communication time is 32 milliseconds. This communication time is a constant. It does not depend on the number of bytes written or the number of F4-SDNs on the network.

F4-SDN to PLC Communication Time

The amount of data the SDN writes to the PLC is equal to the number of bytes each SDN writes multiplied by the highest active network address.

When the amount of data received from the network exceeds 256 bytes (128 V-Memory locations) the F4-SDN will write the first 256 bytes in one PLC scan and the remaining data (up to 256 additional bytes) in the next PLC scan. The time that is required to do this write is dependent on the PLC scan time.

If the number of bytes each SDN writes is less than 256 bytes, then SDN will write to the PLC on every scan.

Network Throughput

ShareNet communication time is fixed at 32 msec.

The maximum time for new data to be passed from a PLC at address A and updated in a PLC at address B is dependent on scan time.

Total amount of network data < 256 bytes:

Scan Time of PLC A + 32 msec + Scan Time of PLC B = Maximum Delay

Total amount of network data > 256 bytes:

Scan Time of PLC A + 32 msec + 2 x PLC B Scan Time = Max. Delay

APPENDIX A: SHARED DATA NETWORK EXAMPLE

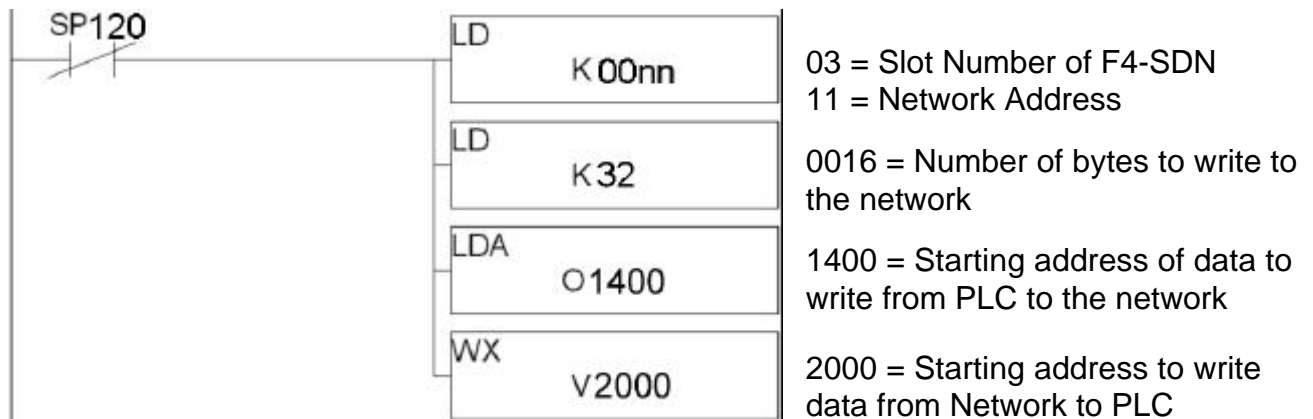
There are four (4) PLCs. Thirty Two bytes (16 V-Memory locations) per PLC will be transferred over the network.

Each PLC will send V1400 to V1417 to the network.

Each PLC will place data received from the network starting at V2000.

The F4-SDN modules will be placed in Slot 0 in all four PLCs. Thus, except for the network address, the configuration rung is the same for all PLCs.

Configuration Logic



Memory Map for Example

| | Addr 1 Data | Addr 2 Data | Addr 3 Data | Addr 4 Data |
|--------------|-------------------------|-------------------------|-------------------------|-------------------------|
| PLC 1 | V2000-2017 ¹ | V2020-2037 | V2040-2057 | V2060-2077 |
| PLC 2 | V2000-2017 | V2020-2037 ¹ | V2040-2057 | V2060-2077 |
| PLC 3 | V2000-2017 | V2020-2037 | V2040-2057 ¹ | V2060-2077 |
| PLC 4 | V2000-2017 | V2020-2037 | V2040-2057 | V2060-2077 ¹ |

¹ This is a copy of the block of V-Memory data that gets written from this network address to all the other SDN's in this example. The actual data written is specified in the LDA parameter of the Configuration Ladder Logic.

APPENDIX B: TROUBLE SHOOTING

Description of Normal Operation

At power up, the POWER LED is ON.

The TXD and RXD LEDs flash ON and OFF. They flash so fast that they appear to be constantly ON.

The data which is broadcast from this network address to the other SDNs is also copied back into the block of V-Memory which contains the data received from the network.

The data received from other active SDNs on the network is written to the appropriate place in this PLCs V-Memory.

The slot dependent module busy special relay is ON.

The module writes the firmware version to the slot dependent V-Memory location with no error codes.

The module signs on in the I/O configuration table as "D4-CCM".

Common ShareNet Problems and Solutions

Problem: ERROR LED Flashes, SDN returns Error Code = 3.

Cause 1: SDN data table start address is too low.
[WX Vdddd], where dddd < 1400.

Solution: Enter a higher data table start address and power cycle the PLC.

Cause 2: SDN data table end address is too high.
[WX Vnnnn], where dddd > (7350 - (16 x Bytes x 2)).

Solution: Enter a lower data table start address and power cycle the PLC.

Problem: ERROR LED Flashes, SDN returns Error Code = 2.

Cause: SDN network address is out of range.

Solution: Enter a unique network address for this SDN and power cycle the PLC. Network address range is 1 to 16 BCD.

Problem: ERROR LED Flashes, SDN returns Error Code = 1.

Cause: Number of bytes equal to zero or greater than 32.

Solution: Enter the same number of bytes as the other SDNs on the network. Number of bytes may range from 1 to 32.

Problem: SDN does not transmit, Power LED stays ON.

Cause 1: PLC is not executing the WX Instruction because it contains invalid parameters.
1st LD - Wrong Slot or Network Address = 0 or > 90
2nd LD - Number of Bytes = 0
LDA - All allowed O (Octal) parameters are valid
WX - Any data type other than V

Solution: Enter a valid WX rung and power cycle the PLC.

Cause 2: Module Busy Relay is OFF.

Solution: Verify that the SP (Special Relay) for the slot the SDN is installed in is used.

Cause 3: Module does NOT sign on in I/O configuration as a "D4-CCM".

Solution: Verify that there are no bent pins on the back plane connector.

Verify that the slot the SDN is installed in is NOT manually configured for the wrong module type. It should automatically configure as ""D4-CCM".

Verify that the module has NOT been installed or removed with power to the PLC base. If it has, power cycle the PLC.

Problem: The SDN Transmits and Receives, the Power LED is ON solid and there are no error codes but, some blocks of V-Memory corresponding to active SDNs contain zeroes or random blocks of data received from the network are zeroed and then return to valid data values.

Cause 1: Those addresses have the same network address as another SDN or are not configured for the same number of bytes as the rest of the SDNs.

Solution: All active network addresses must be configured with a unique network addresses.

Every active address must be configured to write the same number of bytes to the network. Enter the correct configuration for the offending addresses and power cycle those PLCs.

Cause 2: The cabling to those addresses is incorrect or defective.

Solution: Check the cable and module connector for shorts or opens and verify connections are correct.

Cause 3: The cable is not properly terminated.

Solution: Refer to the section in this manual on network termination.