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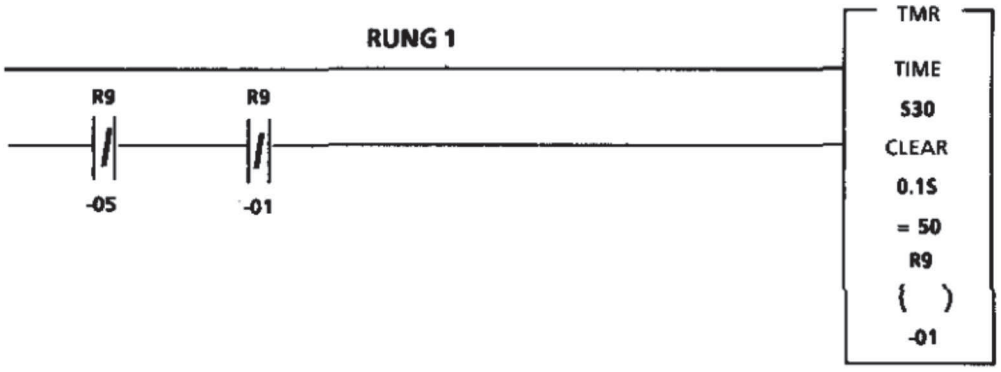
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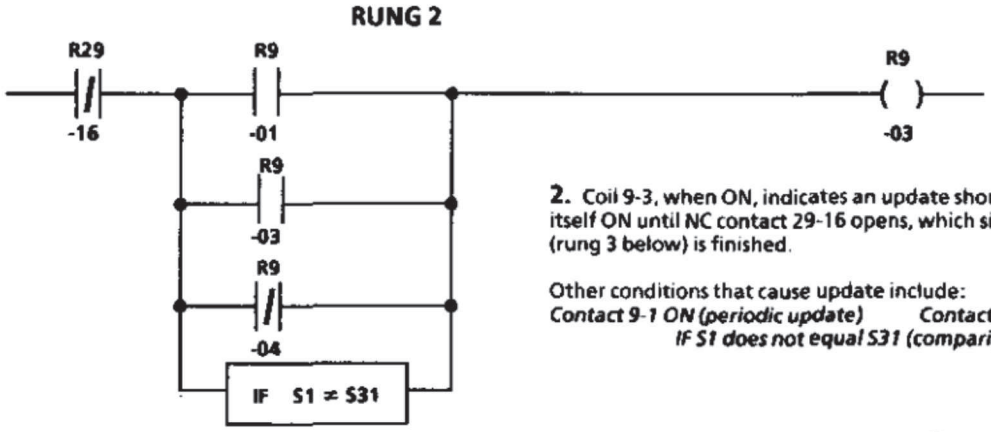
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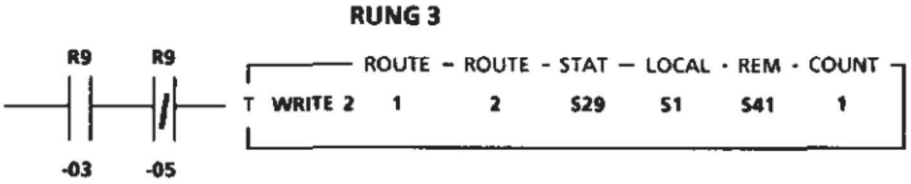
1. MASTER TIMER for fault detection and periodic update. Set the DECODE (" = XX") for the maximum delay between communication updates.

When timer reaches DECODE, coil 9-1 turns ON for one scan. This enables rung #2 below and also resets the timer. NC contact 9-5 also resets timer if a fault occurs.

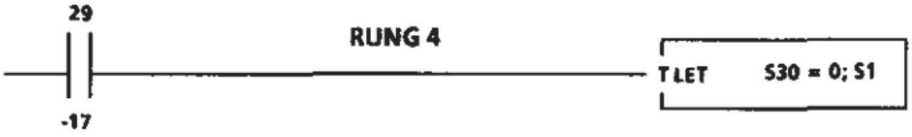


2. Coil 9-3, when ON, indicates an update should be sent. Coil 9-3 seals itself ON until NC contact 29-16 opens, which signifies the WRITE rung (rung 3 below) is finished.

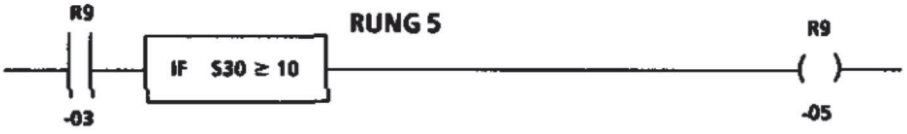
Other conditions that cause update include:
Contact 9-1 ON (periodic update) *Contact 9-4 (HALT/RUN update)*
IF S1 does not equal S31 (comparison of data)



3. This WRITE rung sends an update when contact 9-3 turns ON. **CAUTION:** *THIS RUNG CHANGES THE CONTENTS OF REGISTER 41 IN THE REMOTE DEVICE.* When the update is sent, bit 17 of status register 29 turns ON.

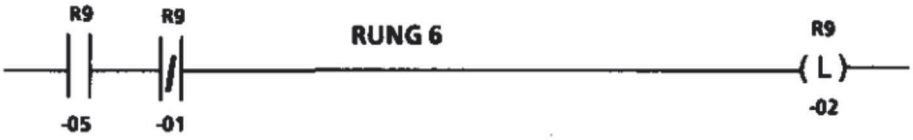


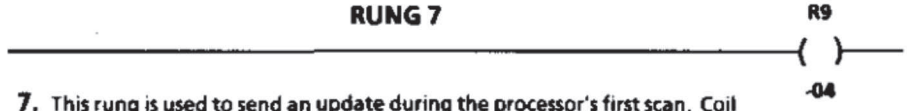
4. When NO contact 29-17 is ON (WRITE rung in progress), timer S30 resets and S1 is copied into register S31. This keeps the latest information in S31. Once rung 4 is solved, the IF in rung 2 turns OFF.



5. When coil 9-5 is ON, a comm. fault has occurred. This causes the comm. rung to reset and enable again. Finally, latch coil 9-2 (in rung 7 below) turns ON to indicate a fault has occurred.

The S30 ≥ 10 comparison is used to detect loss of communication via the regular updates. The value compared to S30 should be large enough to allow rung 3 to finish its message.





6. Latch coil 9-2 indicates a fault was detected in rung 5. This coil remains ON until reset by an unlatch 9-2, or by data entry.

7. This rung is used to send an update during the processor's first scan. Coil 9-4 is OFF during the first scan until its rung is scanned; this enables NC contact 29-16 in rung 2. After the first scan, coil 9-4 turns ON, disabling contact 29-16.

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6 TNIM OPERATION

This section explains how the communication transfer function of the Class 8030 Type CRM-580 TNIM operates. It also provides an explanation of why a TNIM system could be used to provide uninterrupted SY/NET Network communication between a pair of redundant controllers.

NOTE: *In the following section "controller" can be a SY/MAX Processor, D-LOG Data Controller, personal computer with SY/MATE software, or similar device with SY/MAX protocol.*

6.1 System Overview

In a redundant control system, a pair of controllers exist to ensure the operation of a critical control function is not disrupted by the failure of a single controller. (**NOTE:** *Failure could be caused by controller power loss, component malfunction, etc.*)

In this type of system, one of the controllers is referred to as the "primary" controller and the other is the "backup" controller. If the primary controller should fail, system control is transferred to the backup controller which then assumes primary *status. When the failed controller (previously the* primary) returns to service, it assumes backup status and the system is again operating at full potential.

The transfer operation is usually automatic. In the simplest form, a transfer system can be thought of as a make-before-break switch (refer to Figure 6.1).

When used in a transfer system, an individual CRM-580 is interfaced to the primary and to the backup controller (refer to Figure 6.2). In a transfer system, the two TNIM's thumbwheel numbers must be selected as an even/odd pair. Refer to Section 3.1.

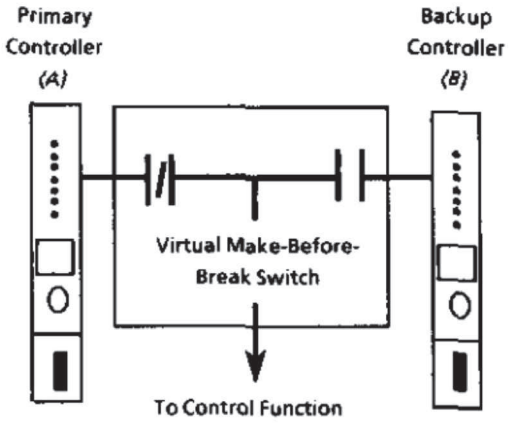


Figure 6.1 Transfer System

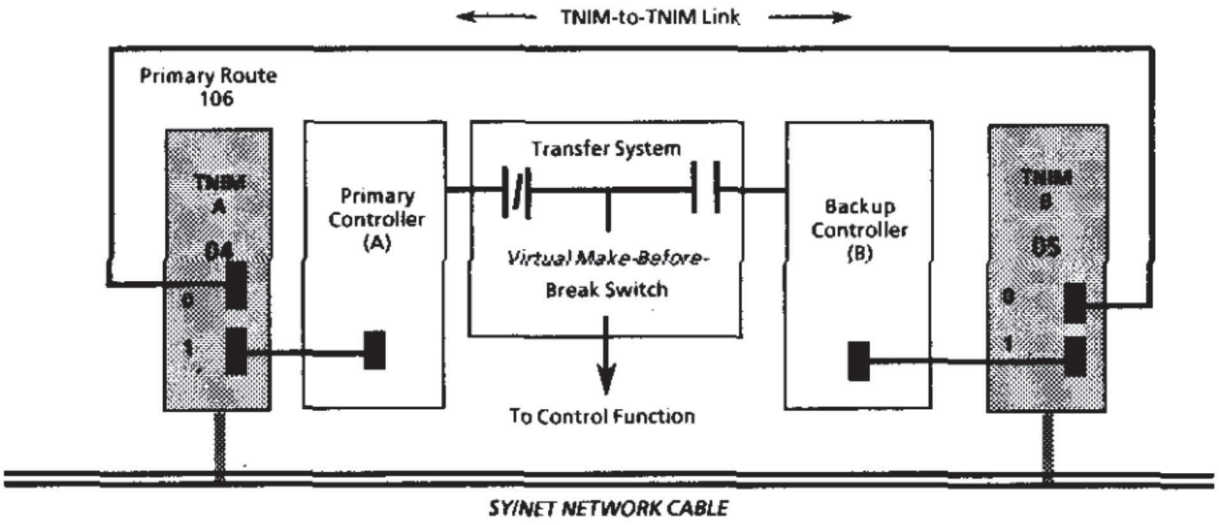


Figure 6.2 TNIM-to-TNIM Link

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The main function of the TNIM pair is to maintain the communication route of the primary controller (primary route) even after system transfer. The primary route (106 in the example) is always one greater than that of the odd numbered TNIM (105) (refer to Figure 6.2). Recall that with other SY/NET NIMs the communication ROUTE is strictly a function of the NIM's Network Interface Number (thumbwheel address). The TNIM pair differs from a standard NIM by maintaining the primary communication ROUTE. When used with an I/O transfer system, the TNIM also provides the following communication system advantages:

1. Enables fewer communication instructions for any device on the SY/NET network that communicates to the transfer system controllers. Because the device does not need to determine which is the primary and backup controller, you eliminate the need for different communication rungs in each controller.

2. Communication instructions for the primary and backup controller can be identical, thereby simplifying their control programs.

The TNIM also allows communication instructions to be directed to each module's network device number. This allows data and/or program changes to occur to the backup controller during system operation.

The basic operation of the TNIM pair is as follows:

1. Upon system power-up, both TNIMs in the pair assume backup status.

2. Under the command of the current primary controller the associated TNIM is directed to assume primary communication status.

3. Before assuming primary status the directed TNIM:
   A. assumes the transition state to make sure both TNIMs are not in primary status,
   B. checks the status of the paired partner to make sure it is properly configured, (NDN, baud rate, etc.)
   C. commands the partner to assume backup status, and after the new backup TNIM has acknowledged this command.

4. Assumes primary status.

When a backup TNIM is directed to go to the primary state, the backup TNIM attempts to communicate to the primary TNIM. The backup TNIM first attempts to communicate via the network port. If this is not successful, the backup TNIM uses the TNIM-to-TNIM link (port 0).

If the primary processor fails during normal system operation the same sequence of events occurs as during power-up. In all cases, the transfer between the primary and backup TNIM is initiated under the supervision of the controller which assumes primary status.

6.2 TNIM Transfer Implementation

TNIM transfer is implemented by the current primary controller performing a priority WRITE or ALARM communication command to TNIM internal register 20 with a value of one (1). The current state of each TNIM can also be read from register 20. The operational states and their values are:

0 = Backup
1 = Transition
2 = Primary

NOTE: *The TNIM can only be placed in the primary state by a controller connected to port 1. Writes to TNIM register 20, to cause a change of state from the network port are not accepted.*

TNIM transfer can be initiated in one of the following ways:

1. When the primary controller fails, a flag is set in the backup controller instructing it to assume primary control (SY/MAX LTI/RTI configuration). The new primary controller informs the associated TNIM (current backup) to switch to primary status and the primary TNIM to switch to backup status (refer to Section 6.2.1).

2. The backup system polls the primary system on a periodic basis for failure (in the primary controller or primary TNIM communication). When a failure is detected, the backup controller assumes primary control and directs the backup TNIM to switch to primary status (non-LTI/RTI configuration, refer to Section 6.2.3).

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CAUTION

The TNIM system IS NOT a "bumpless" system. When an active TNIM receives the processor command to become inactive, if any messages reside in that TNIM, an error message is returned to the requesting device. Refer to Figure 7.1. The device that sent the message to the TNIM does not receive a reply and should re-transmit the message. If it does, a normal response is returned from the TNIM. This re-transmission, however, must be guaranteed.

6.2.1 TNIM OPERATION WITH A SY/MAX TRANSFER INTERFACE SYSTEM

The SY/MAX Class 8030 Type CRM-230, 230 Local/Remote Transfer Interface System (LTI/RTI) is used to automatically shift control of the I/O system from the primary SY/MAX processor (Model 400, 500, 700) to the backup processor upon failure of the primary processor (refer to Figure 6.3).

The LTI/RTI interface sets bit, 8161-20 (ON = 1) in the processor that currently has primary status and resets it (OFF = 0) in the backup processor. For details on the operation of the Transfer Interface System refer to Instruction Bulletin 3098-251-xx.

When the CRM-580 TNIM pair is used with a Transfer System, TNIM transfer is controlled by the current primary processor. For the primary processor to implement a TNIM transfer, a priority WRITE or ALARM command to the current backup TNIM's internal register 20 with a value of 1 is required.

Figure 6.4 shows the two rungs that are required in each processor of a Transfer System in order to implement bidirectional TNIM communication transfer. The rungs should be programmed as close to the beginning of the control program as possible.

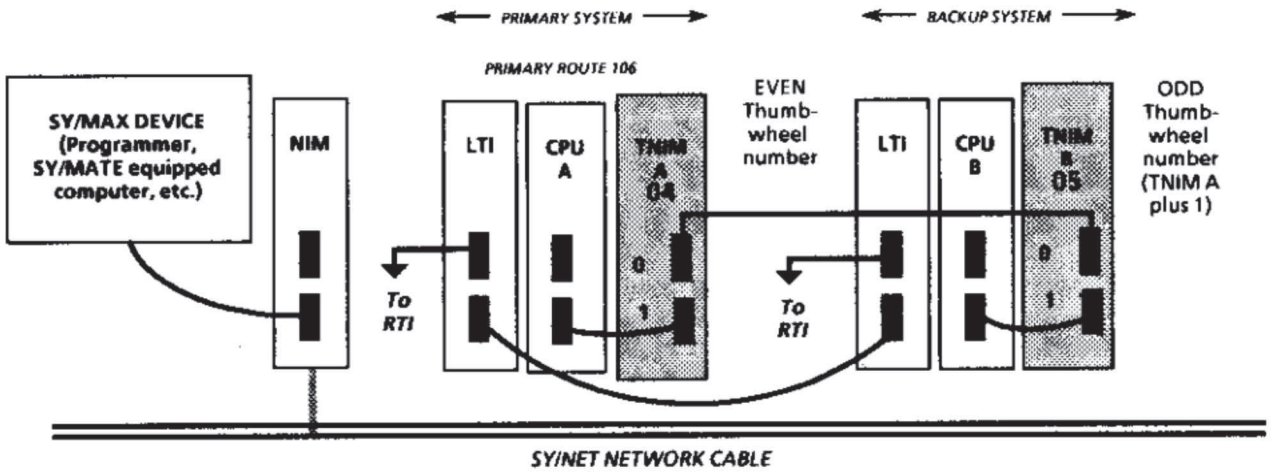


Figure 6.3 TNIM System Configuration

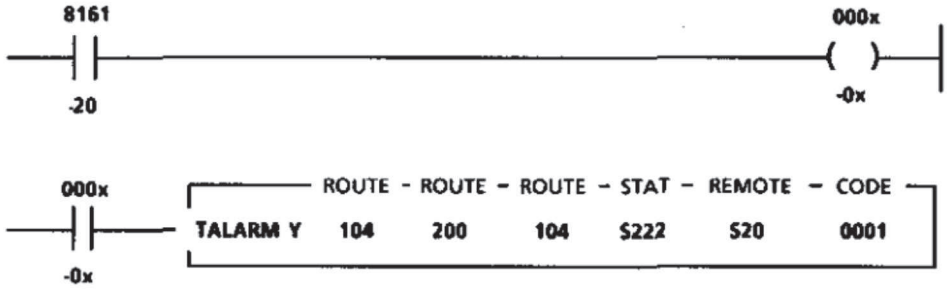
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CAUTION

Do not attempt to program the primary processor using the primary route. A system transfer occurring during the program load could cause the program to load incorrectly.

If the rungs in Figure 6.4 are programmed in each processor of a Transfer System the following sequence of events would occur upon failure of the current primary processor:

1. Backup processor assumes primary control and status bit 8161-20 is set to 1 (ON). This energizes coil 000x-00.
2. Upon scanning contact 000x-0x (rung 2), the TALARM command is executed placing the current backup TNIM in the TRANSITION state (1).
3. The TRANSITION state TNIM informs the partnered TNIM (current primary) to assume the backup state (0).
4. When the backup acknowledge is returned to the TRANSITION TNIM, it assumes the primary state.



WHERE:

contact 8161-20 = LTI Primary/Backup Status Bit
coil 000x-0x = an internal relay
Y = processor communication channel
Route 104 = the source Route of the processor connected to TNIM port 1
Route 200 = Route to enable TNIM transfer
S222 = a unique communication status register
S20 = internal TNIM register which enables TNIM status change

CODE 0001 = the constant value (0001) loaded into internal TNIM register S20 when the rung is executed

NOTE: *1. Internal relay 000x-0x in Figure 6.4 ensures the TALARM rung is executed on processor power-up.*
2. Route 104 could be replaced by Route 201. This would allow the same identical rungs to be used in both the primary and backup processor.

Figure 6.4 TALARM RUNG

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6.2.2 TNIM FAILURE DETECTION IN A TRANSFER SYSTEM

The Class 8030 Type CRM-230/232 Transfer System determines if the primary controller has failed (component malfunction, power loss, etc.), but not the primary TNIM. If the primary TNIM has a component malfunction and fails, its associated controller would be unable to communicate with other devices on the SY/NET network. A failed TNIM (or any NIM) could be detected by observing the status registers of the associated controller's communication rungs.

If a communication rung, initiated by the primary controller fails to be serviced by the TNIM and/or receiving NIM, that rungs status register will contain an error. Refer to Section 7, Troubleshooting.

If errors are generated in communication rungs to several different controllers on the network then it could be assumed that the Primary TNIM is in fault. In this case the Primary processor could be HALTED as part of its control program. This would force a system and TNIM transfer to regain network communication to the transfer system. Figure 6.5 shows a network configuration example. Figure 6.6 shows the ladder rungs needed to determine if the primary TNIM has failed and how to implement a system transfer by halting the primary controller.

To implement a system transfer upon a controller or TNIM malfunction, combine the rungs in Figure 6.4 with the rungs in Figure 6.6 and store them as part of the control program in each transfer system controller.

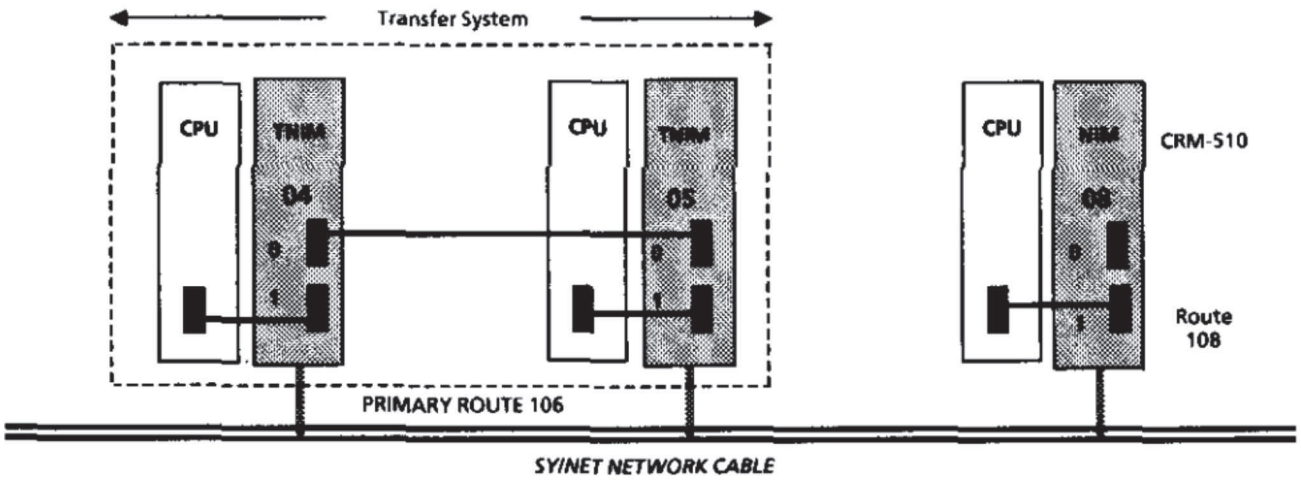
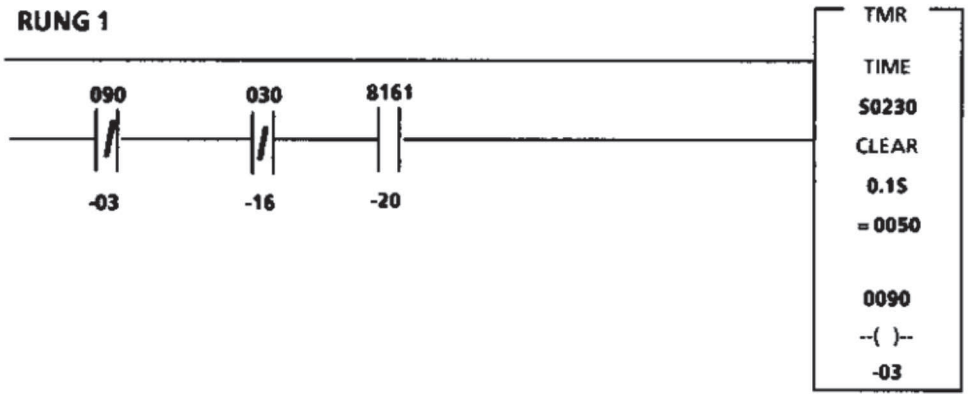
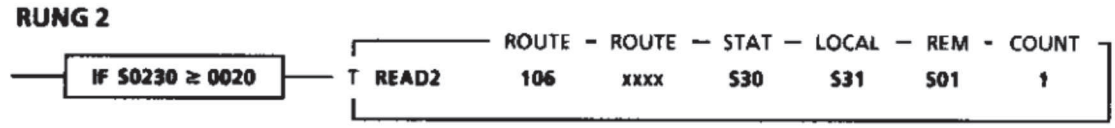


Figure 6.5 TNIM Transfer System

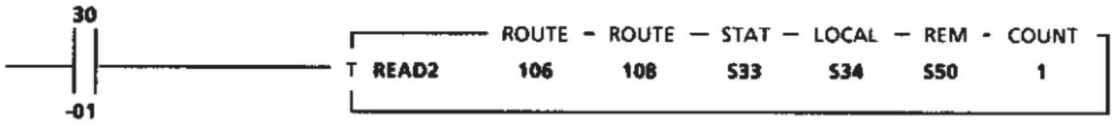
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1. Timer used to initiate communications (poll) to the backup controller and one other controller on the network. The timer starts to time when the controller assumes primary status (8161-20) and resets after 5 seconds (90-3) or when communications to the backup controller is satisfactory (30-16).



2. Initiates communication to the backup controller (ROUTE xxxx) from the primary (Route 106) every two seconds. ROUTE xxxx will depend on which processor is being polled (ROUTE 104 or 105 in Figure 6.5).



3. Initiates communication to another controller on the network if a communication error occurred in Rung 2. This is indicated by bit 30-1 of the previous rung's status register being set (= 1).

NOTE: Additional rungs, such as Rung 3 could be added to the program. Rung 3, which initiates communication to another controller (if present), can identify if the communication failure was the result of the current primary TNIM. If communication fails to several controllers, then the probability that the initiating controller's TNIM is at fault is greater.



4. HALTS the current primary processor on communication failure in Rungs 2 and 3. HALTING the primary processor will cause the backup to assume primary I/O control and communication responsibility. If the rungs from Figure 6.4 are present in its program.

Figure 6.6 TNIM Polling Program In Each CPU LTI/RTI System

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6.2.3 TNIM OPERATION IN A POLLING SYSTEM CONFIGURATION
(Not a Transfer System)

A polling configuration is used with a pair of controllers that do not have a flag (non-LTI/RTI *system) to enable automatic transfer of their* communication function, such as the SY/MAX Class 8020 Model 300 processor, Class 8030 D-LOG Data Controller, computer or similar device with SY/MAX protocol (refer to Figure 6.7).

In a polling configuration, a pre-designated primary and backup controller are present. The backup periodically polls the primary to determine if it is still performing its control function (in RUN) and is communicating to other devices on the network. During the polling operation, when the backup controller determines the primary system is non-operational (in HALT) or not communicating, the backup would assume primary control and direct the TNIM pair to switch states (primary to backup, backup to primary). The new primary controller does this by executing a WRITE or ALARM command to backup TNIM register 20 with a value of 1.

The backup controller can determine if the primary controller is non-operational in several ways:

1. If the system uses SY/MAX Class 8020 processors, the backup controller can monitor the primary controller's RUN/HALT bit 8186-1 (1=HALT, 0=RUN or DISABLE outputs), or bit 15 of the communication rungs status register (1=CPU in RUN, 0=CPU in HALT).

2. If the system uses Class 8030 D-LOG Data Controllers, it can monitor bit 8186-3 (1=RUN) and 8186-16 (1=ERROR).

3. In all controller configurations, if several attempts to communicate to the primary controller fails, it can be assumed either the controller or primary TNIM has failed. Monitor for a communication error in the status register (bit 1 set,=1). Refer to the appropriate SY/MAX Class 8020 Processor Instruction Bulletin or the Class 8030 D-LOG Data Controller Instruction Bulletin 30598-272-xx.

Figure 6.8 is an example of a program which can be used in the primary controller and backup (polling) processor of a non LTI/RTI system. The program polls for both a primary processor *HALT* and/or communication failure.

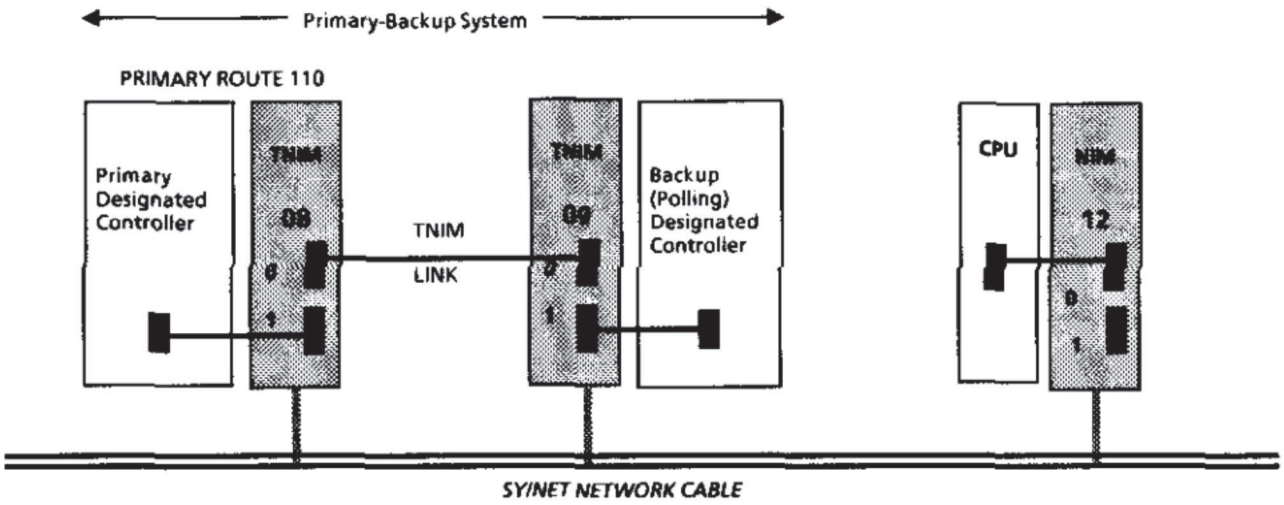
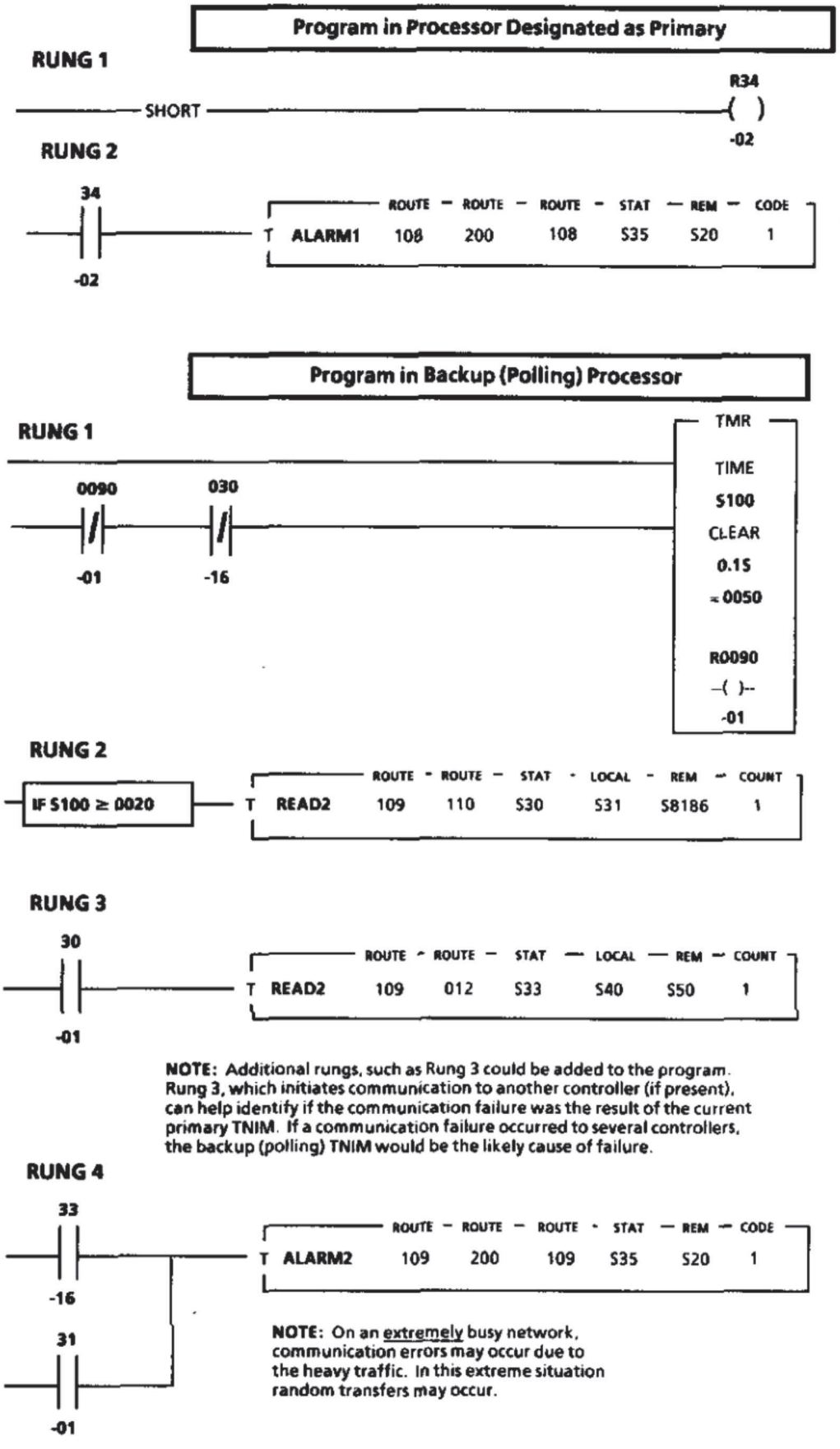


Figure 6.7 Polling Configuration

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1. Energize relay coil 34-2 on processor transition from HALT to RUN.

2. Initiate communication rung to place TNIM connected to processor at ROUTE 108 in primary status.

1. Timer used to initiate communications (poll) from the backup to the primary controller, and one other controller on the network. The timer continually times and resets after 5 seconds (90-01) or when communication to the primary controller is satisfactory (30-16).

2. Initiates communication to read the primary controller's operational status register (S8186) (Route 0110 in Figure 6.7).

3. Initiates communication to another controller on the network if a communication error occurred in Rung 2. An error is indicated by bit 30-1 of the previous rungs status register being set (= 1).

4. Commands the processor designated as backup to direct the current backup TNIM to assume primary status if the following conditions occur:
a) the processor currently designated as primary HALTS (31-1 equal to 8186-1)
b) the current primary TNIM has a communication failure and satisfactory communication (33-16) with another controller is maintained (indicates current primary TNIM error).

Figure 6.8 Polling Program

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6.2.4 GENERAL APPLICATION CONSIDERATIONS

During TNIM transfer, the transition state allows the backup TNIM to place the current primary TNIM in the backup state, prior to backup TNIM assuming the primary state and primary network address (Route). This prevents both TNIMs from simultaneously operating in the primary state. While attempting to place the current primary in the backup state, the following conditions (cases) could occur.

CASE 1
Operation complete (command acknowledged):

The backup TNIM that is to enter the primary state, receives a reply from its partner, the primary TNIM, indicating the backup state was accepted.

While the backup TNIM is in the transition state, it initiates two communication messages to the primary TNIM. The communication messages are a READ of the type and revision, and a WRITE to instruct the primary TNIM to enter the backup state. In a network environment that is excessively noisy, the partnered TNIM could give an acknowledgment to one of the messages, but not give a reply message. This could result in the instructed TNIM staying locked in the transition state. This situation is not likely to occur.

Solution

An application solution is to place a timer in the control program which starts to time when the initial command to enter the transition state is issued. If the commanded TNIM does not reply (as indicated by bit 1 of the communication rungs status register being set = 1) within a certain amount of time:

A. the command can be reissued,

B. register 20 of the commanded TNIM could be read to determine the current status,

C. both a and b.

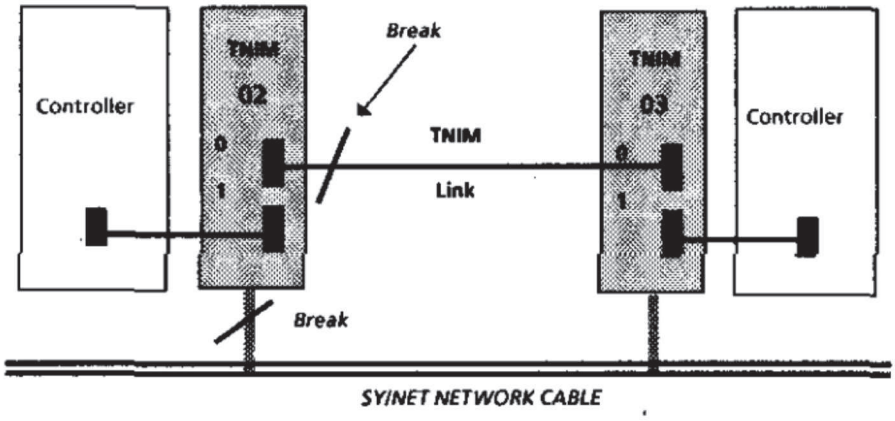


Figure 6.7 CASE 2 - No Acknowledgement

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CASE 2
No acknowledgment:

A communication acknowledgment was not received from the partnered TNIM through either the network or TNIM-to-TNIM Link (port 0). This situation would occur as follows:

A. TNIM (02) primary, TNIM (03) backup (refer to Figure 6.7).

B. The network and TNIM-to-TNIM link between NIM (02) and (03) are both broken.

C. TNIM (03) is commanded to assume the primary state by its associated processor.

D. TNIM (03) goes primary, but returns an error 153 (in the communication commands status register) and sets its supplemental error register 21 = 2 to indicate the partnered TNIM did not acknowledge the command through either the network or TNIM-to-TNIM Link.

E. TNIM (02) is re-connected to the network.

F. Both TNIM (02) and TNIM (03) are primary.

Solution

Case 2 has two possible application solutions:

1. Power cycle and reconnect the TNIM which should not be in the primary state. TNIM (02) in the example.

2. Have the desired primary controller reissue the command to its associated TNIM to go primary. This temporarily places the primary back in the transition state but returns the partnered TNIM in the backup state.

CASE 3
Network Waiting:

The commanded TNIM is receiving network or TNIM-to-TNIM Link waits (SYNS) from the partnered TNIM. While this is occurring the TNIM commanded remains in the transition state. This condition could occur if the existing primary TNIM was handling an excessive number of messages. The transfer from backup to primary will occur.

CASE 4
Partnered TNIM not a TNIM:

Prior to sending the message to the existing primary TNIM to become backup, the commanded TNIM verifies the partnered TNIM is in fact a TNIM. If it finds the partner is not a TNIM, the commanded TNIM enters the primary state, returns error 153 in the communication rung status register, and posts error 3 in the supplemented error register 21.

NOTE: *In all cases, if error code 153 is returned, the commanded TNIM did enter the primary state.*

For more information on error codes refer to Section 7, *Troubleshooting*.

6.2.5 TNIM SWITCHING TIME

The time it takes the TNIM to switch from backup to primary is dependent on several factors:

1. Primary processor scan time.

2. Amount of communication being managed by the primary processor other than the Transfer communication rung.

3. Network communication traffic.

Based on these variables, the TNIM transfer time can be between 140 ms to several seconds with the communication ports set to 9600 baud.

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7 TROUBLESHOOTING

7.1 Error Codes

When sending or receiving READ, WRITE, or ALARM rungs to and from the CRM-580, error codes may appear in the *STAT (status) register of the* rungs to indicate communication problems. This section explains some of the more common error codes.

Figure 7.1 defines the error codes that may be in the status register of a communication rung processed by a TNIM. See the programming device's Instruction Bulletin for a *complete* list of error codes and solutions.

TNIM Register 21

Internal TNIM register 21 stores supplemental error codes which are helpful to diagnose a potential system problem. These errors would result when a transfer is made to the primary state. In all cases, the transfer to primary is made, but an error 153 is returned in the status register of the "go primary" command rung. Note that an error indicates a potential problem in the communication between the TNIM pair, but the commanded TNIM did enter the primary state. The supplemental error codes and their meanings are as follows:

0= No error.

1= The partnered TNIM did not acknowledge the command via the network port, but did acknowledge via the TNIM-to-TNIM link.

2= The partnered TNIM did not acknowledge the command via the network or TNIM-to-TNIM link.

3= The partnered TNIM is not a TNIM with a minimum revision of 2.00.

This information can be helpful in the diagnostics portion of your program(s).

ERROR CODE	DESCRIPTION
1	Processor command sent with the wrong OPCODE.
3	Processor command sent with the wrong ADDRESS.
13	This is a processor-generated error, indicating a communication (link) error has occurred. Check processor status register 8175 to isolate the problem.
17	Remote device inactive, possible network *cable problem*
29	Processor command sent with the wrong ROUTING
41	Processor's local register did not contain either "0" or "1".
*57	COMM Port buffer was forced to empty. When the TNIM transfers to the backup state, the transmit buffers are examined for command messages. All command messages are then changed to reply messages with an error code of 57. This allows the remote devices to re-transmit the messages.
*151	Illegal communication to COMM port or excessive ENABLE/DISABLE messages attempted.
*153	(Transfer error) If this was noted by the TNIM. Check the primary TNIM internal register 21 to see what caused the error.
-16384	The operation was completed successfully. Remote CPU is in RUN (Bit 15 ON).
-32768	The operation was completed successfully. Remote CPU is in HALT (Bit 15 is OFF).

* The error codes are unique to the CRM-580

Figure 7.1 TNIM Error Codes

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7.2 CRM-580 Indicator LEDs

The front panel of the TNIM (see Section 1, *Module Overview)* contains an array of eight LEDs. Some of these LEDs can be useful in troubleshooting:

NETWORK ..... Activity is occurring over the SY/NET.

Rx 0 ..... Data is being received through COMM port 0.

Tx 0 ..... Data is being transmitted out of COMM port 0.

Rx 1 ..... Data is being received through COMM port 1.

Tx 1 ..... Data is being transmitted out of COMM port 1.

NET ERROR ..... This red light shows a communication error has occurred while receiving or transmitting network data. Typically, this indicates all CRM-580 buffers are full or a message was sent to a non-existent or powered-down device.

PRIMARY ..... This red light indicates the current state of the TNIM:

- **ON STEADY** ... In PRIMARY state.
- **OFF** ..... In BACKUP state.
- **FLASHING** .... In TRANSITION from BACKUP to PRIMARY.

POWER ..... CRM-580 is receiving +5VDC

These LEDs can be used to troubleshoot communication problems as explained below.

7.2.1 TX 0, RX 0, TX 1, RX 1 LEDS

The four LEDs, listed above indicate messages are being transmitted or received out of or into COMM port 0 or COMM port 1.

NOTE: *The COMM port 0 (used solely for the TNIM-to-TNIM link) is inactive until a transfer occurs. The only exception is the automatic communication check, which is explained below.*

An automatic COMM port communication check is made every two seconds. This check takes place in both the primary and backup TNIMs, and confirms the presence of the other TNIM or the attached processor. This check only takes place while the CRM-580 is in an "idle" state, a state without regular COMM port communication occurring.

The communication check is in the form of a small message sent to the device attached to the COMM 1 port, and to the backup TNIM through the COMM 0 port. If the device attached to the COMM 1 port *is* a SY/MAX device, the device responds with a small reply message. This data transfer is transparent to the user and to the user program.

During the CRM-580's idle time, if the two-second check does *not* complete successfully through one or both ports, a communication problem has developed. Use Figure 7.2 to identify the problem. Figure 7.2 can be applied to either the COMM 0 or COMM 1 port.

If the suggestions in Figure 7.2 fail to correct a problem, a TNIM *manual self-test* may be required. See Section 7.3 for the self-testing procedure.

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LED STATUS ("0" or "1")		POSSIBLE CAUSE
Tx	Rx	
OFF	OFF	1. Power not reaching TNIM (check POWER LED). 3. COMM port cable loose or missing (RTS/CTS not talking)
ON for one second OFF for one second	*OFF*	1. *Remote device has no* power. 2. Remote device cable is loose or missing. 3. Baud rate mismatch between TNIM and device. 4. Remote device is not a SY/MAX family device.
FLASHING (Non-SYNC)	FLASHING (Non-SYNC)	1. Baud rates of CRM-580 and attached device not matched. 2. Self-test (Section 8.3) is required.
SYNC	FLASHING	Port is operating.

Figure 7.2 COMM Port Error Indications

7.2.2 NETWORK ERROR LED

The brightness of the NETWORK LED is directly related to how much network activity is present. Typically this LED is quite dim; as activity increases it gets brighter. Because data sent over the network is in "packet" form, the NETWORK LED will always flicker slightly.

If the NETWORK LED ever stops flickering and glows steadily, it's likely that noise has been coupled into the network cable by grounding or power problems. Make sure that the network cables are not touching any metal objects, and that power supplies and racks are properly grounded.

7.2.3 PRIMARY LED

The PRIMARY LED indicates the current state of the TNIM: Primary, Transition, or Backup. The partnered TNIM PRIMARY LEDs should never indicate the same state. If both TNIMs show Primary (ON) indication, power-cycling of the Backup system is required. (Note: Make sure communication cables are properly connected.) This LED is also used during the self-test sequence. See Section 7.3, Self-Test Procedure.

7.3 Self-Test Procedure

7.3.1 AUTOMATIC TEST

Each time power is applied to either CRM-580, it goes through a brief self-test. The NET ERROR and PRIMARY LEDs flash in a defined sequence to indicate the test is in progress. When both LEDs go *OFF, the test is complete and regular module* operation begins.

If during power-up self-test, an internal fault is found during the power-up self-test, the start-up sequence halts and the NET ERROR and PRIMARY LEDs flash a certain number of times to indicate what fault is occurring. See Figure 7.3 for what each pattern of flashes means.

A more complete user-invoked self-test is described in the next section.

7.3.2 MANUAL TEST

For a more complete test of internal CRM-580 circuitry, use the following self-test procedure.

NOTE: *Two test plugs (Square D Class 8010 Type CTP-11) for the CRM-580 COMM ports are required to run the following self-test. The network port does not require a test plug.*

SELF-TEST PROCEDURE:

1. Remove power from the rack containing the CRM-580.
2. Remove any cables from the CRM-580's COMM and NETWORK ports.
3. Remove the CRM-580 from the rack.
4. Set switch 7 on switchblock S4 DOWN (ON). This enables the SELF-TEST mode.
5. Reinsert the CRM-580 into the rack.
6. Place the Type CTP-11 test plugs in both COMM ports.
7. Apply power to the CRM-580 assembly rack.

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When power is applied to the CRM-580 (step 7), the following two LED patterns occur:

PATTERN #1

- The Tx 1 and Rx 1 LEDs flash.
- Next, the Tx 0 and Rx 0 LEDs flash.
- While the above LEDs are flashing, the NET ERROR and PRIMARY LEDs also flash.

Pattern #1 repeats approximately 50 times. The 50 sequences of pattern #1 take about 75 seconds to complete.

PATTERN #2

At the end of 75 seconds, the NETWORK LED turns ON and OFF in pattern #2 to indicate data is being sent out of the network port. The pattern repeats four times. The four sequences of the pattern take about 15 seconds.

If the self-test passes, the above pattern sequences start over after 90 seconds. If an internal failure occurs, the NET ERROR and PRIMARY LEDs flash together in a sequence. The number of flashes within the sequence indicates which part of the CRM-580 is faulty, as shown in Figure 7.3.

NUMBER OF FLASHES	CRM-580 PROBLEM
1	ROM Checksum Error
2	RAM Error
3	COMM Port 0 or 1 Error
4	Network Port Error

Figure 7.3 Self-Test Error Codes

NOTE: *None of the problems shown in Figure 7.3 are user-serviceable. The module must be returned to Square D for repair.*

To end the self-test, remove rack power. Remove the CRM-580 from the rack, and set switch 7 on switchblock S4 UP (OFF). Remove the test plugs from the COMM ports, and reinsert the CRM-580 into the rack assembly.

7.4 PLC System Inspection

If the CRM-580 and its attached devices are OK and problems on the SY/NET local area network persist, some *system* troubleshooting is required. The following procedure can help identify which part of the network is defective.

ASSUMPTIONS

Prior to troubleshooting the network, the following conditions are assumed:

- All devices on the network are Square D SY/MAX devices.
- All racks are receiving power, and all modules within the racks are powered up.
- All ERROR lights on any NIM are OFF.

EQUIPMENT REQUIRED

- One Class 8010 Type SPR-2xx or 3xx CRT Programmer, or personal computer fitted with a SY/MATE programming package.
- One Class 8010, Model 300, 400, 500, 600, or 700 Processor.
- Two Network Interface Modules (CRM-580, CRM-510 or equivalent SY/NET interface module).
- Two Class 8030 Type CC-100 cables.
- Appropriate network cable.
- Network Hardware: Two network "tee" connectors, two terminators, two cable ends.

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LAYOUT *(Figure 7.4)*

The principle involved with network troubleshooting is to start with a separate small network, verify its operation, and gradually increase its size and combine it with the main network until the troublesome element appears.

Using the equipment listed in EQUIPMENT REQUIRED, construct the network shown in Figure 7.4. *This network should NOT be connected to an operating network at first.*

PROCEDURE

By isolating the small network in Figure 7.4, and then gradually working into the main network, problems can be isolated and eliminated. Perform the following four steps. Some of the steps involve network connections, some do not.

1. Verify Operation of Processor and Programmer (Non-Network Operation)

A. Connect a programming device (CRT Programmer or a computer equipped with the SY/MATE Programming Package) to the processor comm port 1 using a CC-100 series cable.

> **CAUTION**
>
> ***Do not apply power to any equipment*** **until instructed.**

B. Apply power to the processor, turn the keyswitch to HALT, and then turn the programmer ON. The SY/MAX menu must appear before going to step C.

C. Press the programmer's STATUS function key (leftmost function key on Class 8010 SPR-2xx or SPR-3xx).

At this point the programmer should be displaying the ONLINE/STATUS screen, which shows the condition of the attached processor.

NOTE: *If "CLEAR MEMORY NEEDED" appears, a clear all operation must be performed on the processor. Use the appropriate function key on the programmer.*

If TRANSMISSION ERROR appears, check the CC-100 cable and connectors. Attempt to communicate through the processor's other communication port.

If an ONLINE/STATUS screen fails to appear at this point, the programming device or processor may be bad.

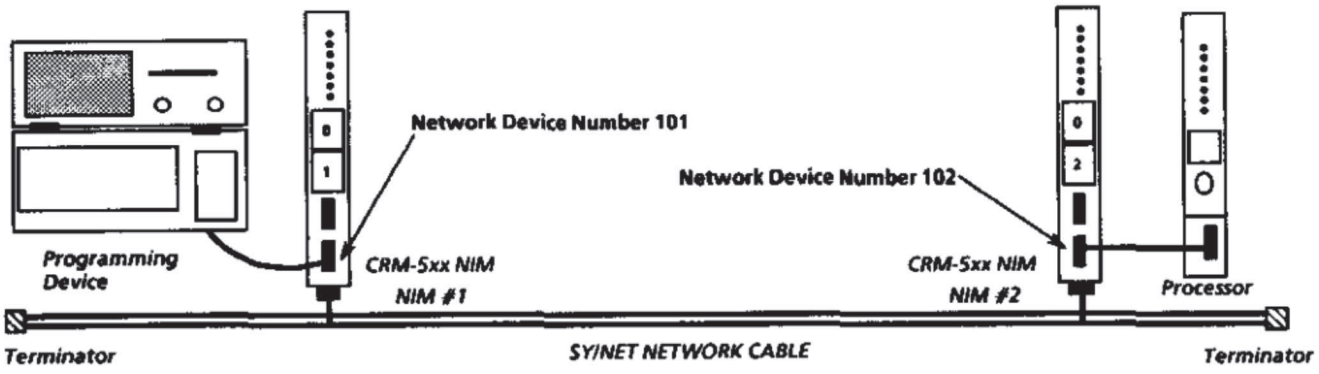


Figure 7.4 Basic Troubleshooting Layout

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2. **Verify Correct Processor to NIM Operation (Non-Network Operation)**

   A. Connect the processor to the NIM #2 COMM port 1 using a CC-100 series cable.

   B. Turn the processor's keyswitch to HALT.

   C. Apply power to the processor and the NIM #2.

   D. Watch the Tx 1 and Rx 1 LEDs on the NIM #2.

   E. Repeat steps A through D, except connect the processor to comm port 0 (skip this step if the NIM is a CRM-580) and monitor the Tx 0 and Rx 0 LEDs.

If communication is occurring between the NIM and the processor, the Tx 1 or Tx 0 LED on the NIM will flash briefly every two seconds which indicates it is performing a communication check. See Section 8, *Theory Of Operation*.

If the check is *not* taking place, communication is not occurring between the NIM and processor., Check the cable connection before going to step 3.

3. **Verify Correct Programmer to NIM Operation (Non-Network Operation)**

   A. Connect a programming device (CRT Programmer or a computer equipped with the SY/MATE Programming Package) to the NIM's #1 COMM port 1 using a CC-100 cable.

   B. Apply power to the NIM #1, and THEN apply power to the programming device. The SY/MAX INIT (Initial) menu must be displayed before going to step C.

   C. Watch the NIM's Tx 1 and Rx 1 LEDs.

   D. Repeat steps A through D, except connect the programmer to COMM port 0 (skip this step if the NIM is a CRM-580) and monitor the Tx 0 and Rx 0 LEDs.

If communication is occurring between NIM #1 and the programming device, the Tx 0 or Tx 1 LED will flash briefly every two seconds which indicates a communication check. See Section 8, *Theory Of Operation*.

If the check is *not* taking place, communication is not occurring between the NIM and programming device. Check the cable connection before going to step 4.

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4. Route the Programming Device to the Processor "Over the Network"

A. Using the network cable and connectors, assemble the small test network shown in Figure 7.4. *DO NOT CONNECT THIS TEST NETWORK TO THE MAIN NETWORK AT THIS POINT.*

B. Access the power-up menu of the programming device.

C. Enter the Network Device Numbers for the programming device and processor. In Figure 7.4 these are "101" and "102", respectively. DO NOT USE ROUTE ADDRESSES OF "200" OR ABOVE. These are addresses reserved for specialized network operations, see Section 4.2.

D. Press the programming device's STATUS function key. (Display the CPU status page.)

If the processor's status screen appears, the network routing and connection is good. Reconnect the NIMs to the overall network and again confirm communication between NIMs, programming device, and processor.

The most common errors that occur over a network are ERROR 29 (Illegal Route) and ERROR 17 (Inactive Device).

ERROR 29: The Illegal Route error results when the ROUTE value entered for the programming device does not match the thumbwheel setting of the NIM.

ERROR 17: This Inactive Device error is produced when a TNIM cannot communicate with another remote NIM.

There are several causes of ERROR 17:

1. *The specified Network Device Number DOES NOT EXIST.* This may be a result of:
   - Incorrect ROUTE number.
   - No NIM on the network has the thumbwheel number specified.
   - The remote NIM is not powered-up.
   - The remote NIM's network port connection is loose or missing.
2. *The remote NIM's COMM port that is specified by a ROUTE number, is not working.* This could result from:
   - The cable on that COMM port is loose or missing.
   - The device attached to that COMM port is not working or OFF.
   - The device attached to that COMM port is not a SY/MAX family device.

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7.5 Local Field Service Support

If all the steps within this section fail to correct a problem with the NIM or network, support from the field may now be needed. Before calling, make sure the following pieces of information are written down:

- The SERIES NUMBER of the NIMs. This will be a letter A, B, C, D, etc.
- Whether the problem occurred WHILE THE NETWORK WAS OPERATING or IMMEDIATELY AFTER THE NIMs WERE POWERED-UP.
- The DIP SWITCH SETTINGS of all NIMs involved with the troublesome network.

An EMERGENCY SERVICE number is given on the last page of this manual for calls made on weekends or after regular business hours during the week. PLEASE USE THE EMERGENCY SERVICE NUMBER FOR EMERGENCIES ONLY.

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8 THEORY OF OPERATION

8.1 Power Cycling

8.1.1 POWER-UP

When power is applied to a CRM-580, it automatically enters a brief self-test sequence. This sequence, described fully in Section 7, *Troubleshooting*, does the following:

- Tests internal PROM for checksum.
- Clears internal RAM.
- Performs a READ/WRITE test on the RAM.
- Flashes the NET ERROR and PRIMARY lights to verify each portion of the self-test.

If a TNIM passes the self-test, it automatically goes into the BACKUP mode until the controller instructs it to go to the PRIMARY mode. If any part of the self-test fails, the NET ERROR and PRIMARY lights flash in a sequence which identifies the problem. See Section 7.3 to identify a particular sequence.

CAUTION

Any messages received by either TNIM during the power-up cycle are ignored, and the device that originated the message receives an error.

If both partnered TNIMs pass the power-up tests, the primary controller can command the attached TNIM to assume the PRIMARY state. The designated primary TNIM sends a command to its partner to make sure it is in the BACKUP state. Anytime *either* TNIM becomes PRIMARY, the other TNIM is instructed to assume BACKUP status. Normal system operation now begins.

See Section 6, *TNIM Operation*, for complete details on the transfer function.

8.1.2 POWER-DOWN

When the primary CRM-580 detects that its incoming power is being removed (the AC-FAIL signal from the SY/MAX power supply drops below 0.3V), it goes into a shutdown routine and does the following:

- Communication in and out of all three ports is stopped.
- The network port is shut off, disconnecting the primary CRM-580 from the primary SY/NET network.
- A halt state is entered, and continues until proper power is restored and the TNIM enters the backup state.

CAUTION

All messages stored within the active *CRM-580 at the time power is removed* are NOT transferred to the backup, and are erased.

8.2 Message Coordination

The CRM-580 (or any other SY/NET NIM) handles two basic types of messages - messages through the high-speed network port and messages in and out of the two COMM ports.

8.2.1 NETWORK MESSAGES

Description

Network communication occurs only between Network Interface Modules, and consists of a stream of synchronous data in a format known as HDLC (High-level Data Link Control). HDLC provides data transfer, message acknowledgment, and error recovery. All SY/MAX network ports "talk" with each other using HDLC.

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When a network message is received by the primary CRM-580, it does one of three things with the message:

1. *Routes it to one of the COMM ports* (and hence to a SY/MAX device such as a processor) based on the message's internal ROUTE statement.

2. *Creates an error message* in response to the received message.

3. *Holds the message internally* for later use.

In all three scenarios, the CRM-580 *always* acknowledges the received network message (except *broadcast* messages - see Section 4.2).

Network Access

Since all network communication occurs over a single twinaxial cable, messages must be coordinated to prevent "collisions". The TNIM, and all other NIMs on a network, cannot transmit at random. They must first gain access to the network.

Access to the SY/NET network is controlled by a time-sharing scheme that accomplishes the following:

- Allows every NIM a chance to transmit a message.
- Prevents a single module from tying up the network.
- Provides a device top priority if it is sending an alarm message.

Within each NIM is a timer that has an upper limit determined by which *network size* is selected on the DIP switches (see Section 3.2.6, Network Size):

- *If network size is set to "100"* (as it is set from the factory), the clock times to *20 milliseconds* and then resets to zero.
- *If network size is "30"*, the timer times to *six milliseconds* before resetting.

For either network size, each module has a 200 microsecond "window" in which it can send a message (20 mS/100 NIMs or 6 mS/30 NIMs = 200 microseconds per NIM).

All the NIM timers on the network are synchronized with each other, since they are all reset at the same time. The timers reset either when power is applied to the NIM, or after any NIM on the network sends a message.

CAUTION

If noise is coupled into the network cable, the timers will reset.

Module Priority

Each NIM is assigned a Network Device Number (NDN) by dialing in a two-digit number on its front-panel thumbwheel (see Section 3.1, *Network Device Number Thumbwheels*). The *lower* this number is, the *higher the transmission priority* of that module. For example, module #17 transmits before module #26. The NIM with "00" as its NDN gets the first chance to transmit its message. Refer to Figure 8.1.

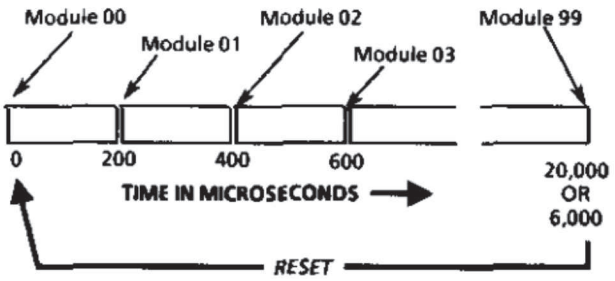


Figure 8.1 Transmission Access to Network

NOTE: *The PRIMARY TNIM will accept messages and transmit messages for its NDN (thumbwheel) and PRIMARY time slot.*

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System Power-up

The following sequence occurs when power is applied to any NIM:

1. When power is first applied to the network, all NIMs on the network reset their timers to zero and begin timing.

2. If, at the instant the timers are reset to zero, module #00 has a message to transmit, it does so. If it doesn't have a message by the end of its 200 microsecond window, the time window for module #01 opens and it can transmit.

3. If module #01 *does* transmit a message, all module timers are reset to zero and module #00 time window opens. If module #01 *does not* transmit, the timers continue timing.

4. At the end of 400 microseconds, module #02's time window opens. As with module #01, if module #02 has a message to send it does so, and the timers reset to zero. After the timers reset, module #00 time window opens, followed by module #01, and then module #02.

5. After all modules on the network have transmitted and the timers reach 20,000 microseconds (100 NIMs × 200), or 6,000 microseconds (30 NIMs × 200) they reset to zero. All modules can once again transmit, and the sequence starts again.

NOTE: *A message in progress CANNOT be interrupted.*

Since the priority of transmission depends on the NDN of the NIM, a lower-numbered NIM could "hog" the network if it has numerous messages to send. The following example shows how this is avoided.

EXAMPLE: Under a strict "lowest NDN first" priority system, module #07 will *always* gain access to the network before module #20. All NIM timers reset to zero after module #07 transmits. If module #07 has *multiple* messages to send, module #20 may never get a chance to send its message. To prevent this, the SY/NET does the following:

1. Module #07 has several messages to transmit. Module #20 has a single message to send.

2. When 1400 microseconds has elapsed and *module #07's time window opens, it* transmits *one* of its messages.

3. All NIM timers reset to zero, and begin counting again.

4. When 1400 microseconds has again elapsed, module #07's time window is blocked. Module #08's window opens at 1600 microseconds.

5. After 4000 microseconds, module #20 can transmit its single message.

6. After either 20,000 microseconds (100 NIMs) or 6,000 microseconds (30 NIMs), all timers reset to zero and the block on module #07 is removed.

7. When 1,400 microseconds elapses, module #07 sends the second of its messages and all timers reset to zero. The block on #07 goes into effect again until all time windows are open.

This EQUAL priority blocking procedure guarantees that all NIMs on a network have at least one chance to send a message during the regular 20,000 or 6,000 microsecond cycle.

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8.2.2 COMM PORT MESSAGES

The two COMM ports ("0" and "1") on the CRM-580's front panel handle all "low-speed" non-network communication, and are used to direct an incoming network message to the appropriate SY/MAX device.

The "COMM 0" port is used solely for the TNIM-to-TNIM link, and cannot be addressed. The "COMM 1" port is where the primary and backup controllers are attached (see Section 2.0, *Hardware Installation and Specifications*, for the pinout of the COMM ports). The ports support RS-422 communication (with handshaking), and cannot *directly* support RS-232C devices. (An RS-232C to RS-422 adaptor is available from Square D. Order a Class 8010 Type CRM-601 converter.)
As shown in Figure 8.2, the COMM 1 port sends messages to or receive messages from a 21-message buffer. When the buffer receives a 22 message, it overflows and illuminates the NET ERROR LED. A device attempting to send a message to the COMM 1 port will not get through, and must re-transmit its message when the number of messages in the buffer drops below 21.

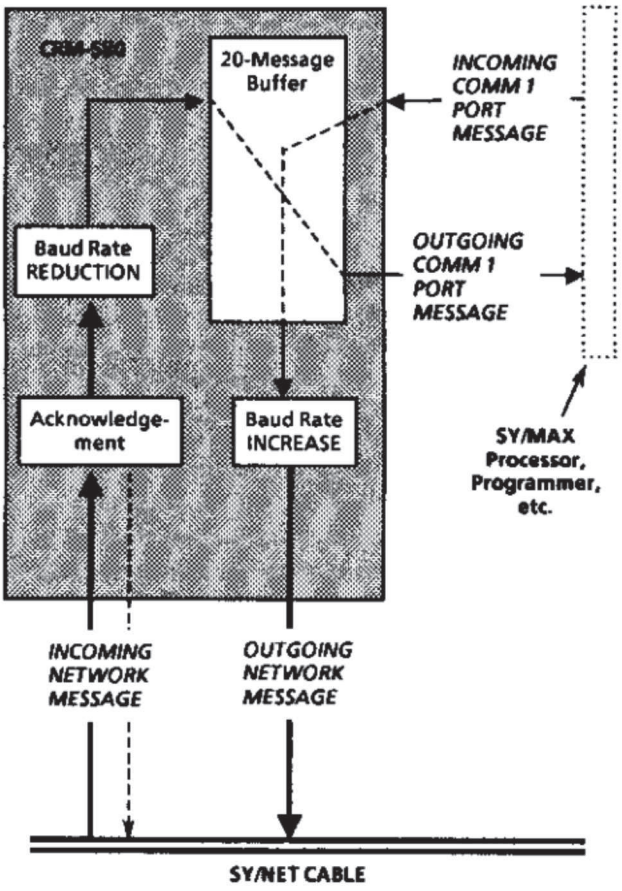


Figure 8.2 Buffer Operation

8.3 Message Buffering

In addition to coordinating network messages, the CRM-580 also serves as a *message buffer*. Buffering involves the holding of messages for future use.

Figure 8.2 shows the operation of the CRM-580 buffer.

As messages are received through the primary CRM-580's network port, the following occurs:

1. The CRM-580 waits until the complete message has been received.

2. An acknowledgment is sent by the CRM-580 to the NIM that sent the message.

3. The message is placed in a FIFO stack (see the *Message Buffer* explanation) along with up to 20 other messages.

4. When the message reaches the bottom of the stack it is transmitted out of COMM port "1" (In the CRM-580 COMM port 0 is dedicated for the TNIM-to-TNIM link) to an attached SY/MAX device such as a controller, CRT programmer, etc.

When a SY/MAX device wants to transmit a message over the network, the inverse of the above sequence occurs. The active CRM-580 receives the message from the device and acknowledges it. The message is then sent out the CRM-580's network port.

NOTE: *If more than 20 messages are received by the active CRM-580 simultaneously, the CRM-580 buffer will overflow and the NET ERROR lamp will flash. As soon as one of the 20 buffer positions opens up, the error is cleared. Since the device originating the error-causing message will re-transmit, the second try should successfully load the CRM-580's buffer.*

For more information on errors, see Section 7 *Troubleshooting*.

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APPENDIX A AN INTRODUCTION TO NETWORKS

This appendix provides an overview of industrial control networks, including:

- A history of networks
- How networks operate
- Some of the technical terms used in discussing networks
- Benefits of networks
- Drawbacks of networks

A.1 List of Terms

Any discussion of high technology requires some preliminary explanations of the technology's jargon. The following are some of the more common network terms:

Access ..... Availability to a specific piece of network data.

Baseband ..... A single-frequency channel (cable) used for data transmission. A lower-cost alternative to *broadband* cable.

Bridge ..... A connection between two or more similar devices that requires no signal conversion (all devices "speak the same language").

Broadband ..... A single cable carrying multiple frequencies of data (multiplexed).

CSMA/CD ..... A method of getting many pieces of data into one cable, an acronym for Carrier Sense Multiple Access with Collision Detection.

Gateway ..... A device that performs protocol (language) conversion, and allows devices with incompatible operating systems to work together.

IEEE-802 ..... The Institute of Electronic and Electrical Engineering's standard for Local Area Networks (LANs)

ISO ..... International Standards Organization.

Layer ..... A phase within a proposed standard that deals with one function of a network.

Protocol ..... The language or word configuration used for inter-device communication. Usually involves error detection and word size/structure.

Redundancy ..... Duplication of hardware or software for purposes of reliability.

Throughput ..... The effective message rate, not data (amount of data over time) rate. Throughput is what can be done in a given time, not just how much data can be crammed through in the shortest time.

Token ..... A code that gives a device the authority to "speak" on the network.

A.2 A Brief Network History

A.2.1 THE PROGRAMMABLE CONTROLLER

The programmable controller is a fairly recent development in industrial process control. When first introduced, the programmable controller (sometimes called a PLC) was meant to replace relays as a reliable solid-state device that offered great flexibility. The PLC required less panel space than relays, reduced installation costs, and cut retooling time drastically (no more rewiring entire walls of relays). The technology also meant that the largest, most complex relay controllers were usually the most economically replaceable.

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The very simplicity of the PLC led to a complexity of applications, when management realized that many seemingly unrelated tasks could be (and should be) tied together. Product flow through a factory was suddenly seen as interrelated, even though each work area in the factory had different control needs.

It was from this realization that the industrial control network was born.

A.2.2 THE NEED FOR A NETWORK

In its simplest form, an industrial control network is a group of two programmable controllers communicating with each other. At first, this communication was done with "crosstalk modules" that took the output from one PLC and converted them to inputs for the other PLC, and vice-versa.

In cases when the crosstalk module was not available, I/O racks and modules had to be dedicated to the task, which naturally increased both the complexity and expense of the system. Data transfer could only be accomplished by dedicating four I/O's for *each digit* transferred, and then writing a BCD (Binary Coded Decimal) *decode* program in the receiving PLC to load a register with the incoming value.

But pressure from management was for *information*, such as the number of parts produced in a shift, or the amount of downtime a machine experienced in a given time. Management wanted this information not only gathered together, but also formatted and printed on paper for easy reading. Maintenance people also found that the information gathered in this way helped in preventive maintenance. The interest grew rapidly.

Using I/O to link more and more individual programmable controllers soon became a very cumbersome operation, sometimes more difficult to implement than the "old-fashioned" relay walls.

What was desired was a single cable to connect all the islands together.

A.2.3 THE SOLUTION

A single "network cable" run around the perimeter of a factory greatly simplified interconnection of the numerous programmable controllers. Devices were developed (Network Interface Modules) that tapped into the cable to allow data to be sent and received to and from the programmable controllers.

Three types of network cable are used:

1. *BASEBAND CABLE* allows only a single frequency (channel) of data transmission. This is typically twinaxial cable.

2. *BROADBAND CABLE* allows several frequencies (channels) of data to be multiplexed over a single conductor. This is usually coaxial cable.

3. *FIBER OPTIC CABLE* provides an extremely wide bandwidth, and has the added advantage of being electrically inert. This is an important consideration when running cable through areas containing explosive vapors, which may be ignited by a fault in a metallic conductor.

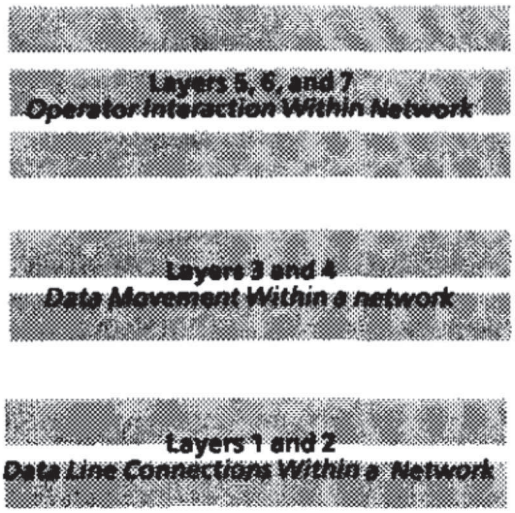
A.2.4 REFINEMENTS AND COMPATIBILITY

As is the way of industry, different manufacturers of programmable controllers created different, incompatible systems. As long as all the parts of a programmable controller system were made by one company, gateways were simply installed wherever data had to be inserted or removed from the network. Programming many distant controllers, and hence equipment, from a central point became a reality.

But programmable controllers were not designed to gather information and process it into meaningful reports. The need to pipe the information from the PLCs into the mainframe computers used by accounting departments became a concern. Computers and PLCs, however, do not interface directly. Standards were needed for PLC manufacturers to agree upon.

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Since so much diversity existed among vendor's products, certain groups and societies decided to standardize some of the PLC's functions. In order for different devices to interface on the same network, ISO standard DIS7498 was created. This standard defines seven layers of network communication:



Within ISO standard DIS7498 are other standards dealing with each layer of development. Among these is the IEEE proposed standard 802, which deals with the lowest two layers of the ISO structure. The remaining five layers of the ISO structure deal more with the interaction of PLCs and mainframe computers, and less with PLC-to-PLC communication.

Everyone involved with PLCs agrees that standardization is a good idea, and concepts such as MAP (Manufacturing Automation Protocol) are in *the works that will some day completely standardize* a plant's automation network. MAP allows devices from *any* manufacturer (subscribing to the MAP plan) to share a common network. See the following *Gateways* section.

A.2.5 BRIDGES

Consider a scenario involving three PLCs from a single manufacturer. Each of these PLCs is controlling a single function of a larger process; the functions are progressive. Each of the three PLCs can examine the other two PLC's I/O status and internal registers. This scenario is an example of a *bridge*. A protocol problem does not exist because all three controllers speak the same language.

A bridge is the ideal interconnection between components in an automated factory system, and uses inexpensive low-voltage cable ranging in length from a few feet to many thousands of feet.

A bridge is also an example of *distributed control:* the PLCs operate independently of each other yet communicate together as a network. The advantage to this set-up is that if one PLC fails, the network as a whole continues to operate. If an entire factory were controlled by one PLC, the PLC's failure would shut down the entire plant.

A.2.6 GATEWAYS

The complexity of a PLC system grows when the need for reports on such things as production and inventory are thrown into the system. A host computer (in an accounting department, for example) may be used for this information gathering; unfortunately, the host computer and the PLC network usually don't speak the same language. This is where a gateway is needed.

A gateway acts as a two-way translator between two or more incompatible devices. Coaxial cable is typically used to install the gateway, providing space for installing "tees" for low-cost future expansion to other devices and other gateways.
A primary task of a gateway is *baud rate conversion*. PLCs speak to each other at one baud rate (typically around 9,600), while information sent over a phone line via a modem is at 300 or 600 baud. Network speed is in a different realm altogether, frequently operating in the kilobaud or even megabaud regions. Here the gateway speeds up or slows down data transmission, and provides maximum efficiency ("throughput").

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A.2.7 WHEN THE NETWORK GETS BUSY

Up to this point the networks discussed are simple, low-activity systems. What happens, however, when many devices on the same network want to talk at once?

The problem of multiple devices wanting to talk at the same time is handled by one of two schemes:

1. *CSMA/CD*
2. Token-passing

CSMA/CD serves requests to speak on a first-come-first-serve basis, a method of access that has several drawbacks:

- If many devices have many messages to send, network access quickly decreases efficiency to below 40%.
- Data collisions are likely.
- Collision detection (the "/CD" in CSMA/CD) is done by stopping all network activity for a random amount of time, then restarting. This reduces throughput, sometimes drastically.

Token-Passing allows only one device to speak over a network at a time. A token, or code, is passed among the devices on the network. Whichever device picks up the token becomes the master, and remains so until it's done transmitting. A danger in this approach is that the temporary master might be doing something mundane while a crisis is occurring at a different location. Another danger is that a token can be lost.

A.2.8 THE BEST OF BOTH WORLDS

A solution to the problems in CSMA/CD and token-passing is a time-supervised token passing (TSTP) network, which is how the Square D SY/NET network operates. With a TSTP network, the token can never be indefinitely lost, nor can one device "hog" the token for as long as it wants.

A.2.9 HOW ARE MESSAGES HANDLED?

Integrity is an important factor in data transmission. A typical sequence of events for a network transmission is as follows:

- The transmitting device checks with a receiving device to see if the receiving device is ready to accept a message.
- After the transmission is received, the receiving device acknowledges the message by sending a message back to the transmitter. This acknowledgment includes bit count.
- If what was received is less or more than what was sent, a parity error is generated.
- A repeat transmission occurs until the message is properly received.

Many of these transmission parameters are user-adjustable (for example, the number of re-transmissions is variable).

The designer of the network must take into account all these variables, and create programs that allow some flexibility when errors are detected, but rigid enough to shut down systems in the event of a major problem. Redundant processors, interface modules, bridges, even cabling help assure a PLC system that will operate properly under any conceivable situation.

A.2.10 CONCLUSION

As factories become more and more automated, networks become increasingly important. Networks provide data gathering, processing, storage, and reports. Networks allow programming a device (or number of devices) from thousands of feet, even several miles, away by a person in one central location.

As more and more vendors jump on the PLC bandwagon, the complexity of networks and their related gateways and interfaces is bound to increase. But ISO and IEEE standards, along with MAP developments, should gradually sort out the tangle of incompatibility and create an environment of friendly networks.

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APPENDIX B INSTALLING A CABLE END

B.1 Procedure

The Class 8030 Type CCK-211 Cable End consists of ten parts as shown in Figure B.1:The network cable

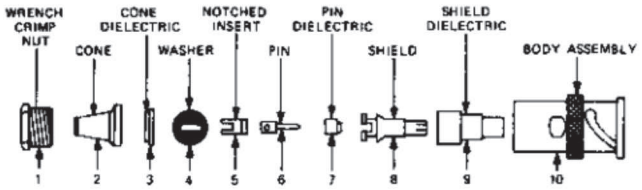


Figure B.1 Network Cable End

(Belden #9272 or equal) can be dissected into seven parts as shown in Figure B.2:

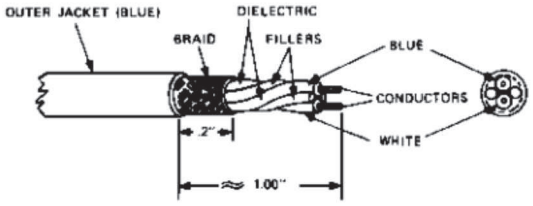


Figure B.2 Network Cable Components

The following procedure explains how to mount the cable end to the Belden 9272 cable:

1. Place the WRENCH CRIMP NUT (1) onto the cable. Threaded part of the nut should face to the right.

2. Strip off about one inch of the cable's blue outer jacket. Do not damage the shield on the pairs inside.

3. Cut back the braided shield to within 0.2 inch of the cable's outer jacket.
4. Cut the fillers off the blue and white wires.

5. Thread the blue and white wires through the CONE (2). Press the cone into the cable until it's recessed into the outer jacket (the outer jacket flares out).

6. Place the small end of the CONE DIELECTRIC (3) over the blue and white wires and seat it inside the cone.

7. Place the red WASHER (4) over the blue and white wires, and seat it against the cone dielectric.

8. Cut the blue and white wires to a length of 0.35 inch, as measured from the red washer.

9. Strip 0.2 inch of insulation of the blue and white wires.

10. Tin the blue wire.

11. Bend the white wire at a slight angle away from the blue wire.

12. Place the white NOTCHED INSERT (5) over the blue wire and press it on until it's flush with the red washer.

13. Place the PIN (6) over the blue wire. Make sure the pin is flush with the notched insert.

14. Carefully solder the pin to the blue wire by applying the solder to the hole in the side of the pin.

15. When solder is cool, test the connection by lightly pulling the pin with a pair of pliers. A common problem with pin connections is cold solder joints.

16. Place the PIN DIELECTRIC (7) over the pin.

17. Place the SHIELD (8) over the pin/dielectric assembly and seat it against the red washer. Thread the white wire through the notch in the shield

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18. Strip the white wire back about 0.25 inch.

19. Wrap the conductor of the white wire around the shield, and solder. Let cool.

NOTE: *DO NOT let the solder and wire extend beyond the ridge on the shield, or the white wire may come in contact with the connector body.*

20. Place the SHIELD DIELECTRIC (9) over the shield. Press on until flush with the red washer.

21. Place the BODY ASSEMBLY (10) over the shield assembly.

22. Thread the wrench crimp nut into the body assembly.

23. BEFORE INSTALLING THE CABLE ASSEMBLY INTO A NETWORK, do a continuity check on the cable/connector assembly. There must be at least 10K ohms of resistance between the blue and white wires, or between either wire and the shield.

    IF A RESISTANCE READING OF LESS THAN 10K OHMS IS OBSERVED, CHECK FOR A SHORT IN THE CABLE END OR THE CABLE ITSELF.

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