Redundancy

Reliance
Electric

Industrial

CONTROLS

Instruction Manual J-3038PA

Overview

The following is the description of how redundancy is implemented. There will be an active rack and a standby rack. In each rack, there may be up to four Redundancy Processor to link them together. At the end of each scan the AutoMate(s) will transfer selected data to the Redundancy Processor which will then transfer it over the coax to the standby rack. The standby unit will monitor the ready relay on the active unit. If the ready relay on the active unit ever drops out the standby unit will take over control of the system.

All I/O used in a Redundant system must be remote mounted. The RIOP in the standby unit is only listening to the network to keep track of which nodes are present. When the standby unit becomes active, it then becomes the master of the remote I/O network.

To support RNET in this system, one RNET card is used in the active rack and one RNET card is used in the standby rack. Both cards are connected to the network as normal. The node number that is set on the front of the RNET card needs to be the same for both units. The RNET in the standby rack will then add one to its node number. If, for example, both cards are set up to be node 1, then the active unit will be node 1 and the standby unit will be node 2. When the standby rack becomes active, it will change its number back to node 1. In this way the active unit will always be node 1. Care needs to be taken when assigning node numbers for the system to leave two nodes for every rack that is redundant.

SYSTEM DIAGRAM
SINGLE I/O SYSTEM

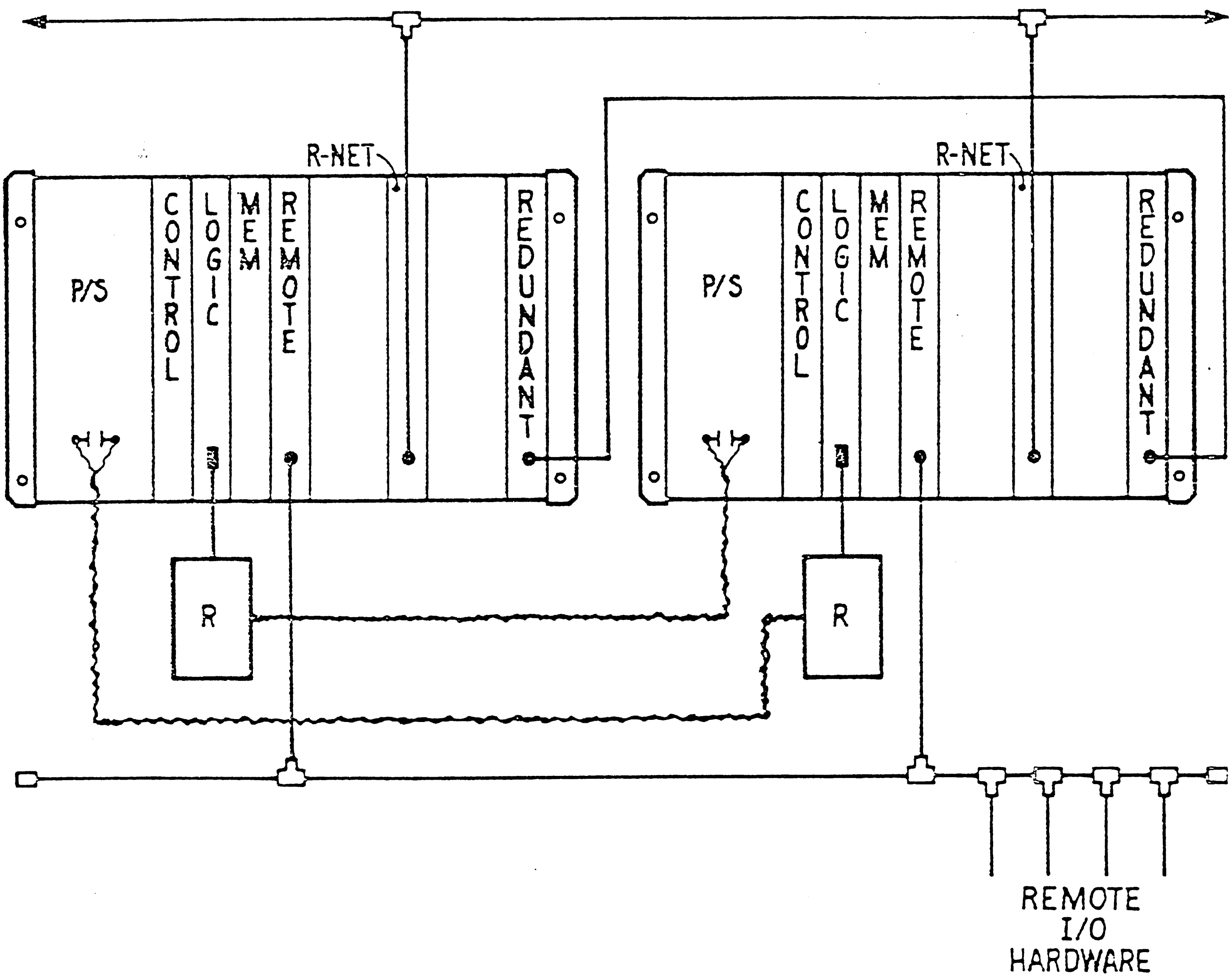

Figure 1

Note: The above example shows AutoMate 40, this also applies to an AutoMate 30

Data Transfer Limitations

The Data buffers on the Redundancy Processor cards contain 4032 words, and this limits the maximum number of data words that can be sent via a single Redundancy Card. For this reason, the data to be sent can be configured by the user, and the user should send only the data actually used by the program. If a single Redundancy Processor is not adequate for sending all the data for a system - for example, a large A40 or a multiple processor system - then up to four Redundancy Processors can be utilized and the data transfer load shared between them.

Timing

There are two time factors to consider when using a redundant system: Scan time impact and communications time between active and standby units.

The scan of a Redundant system is increased by an amount necessary to transfer data from the AutoMate Processor(s) to the Redundancy Processor. This time is part of the End-of-Scan overhead and is dependent on the amount of data being transferred. The time can be estimated as shown below. (Remember maximum number of words that can be transfered by a single redundancy card is 4032.)

A30 9 microseconds per word
Min - 1.2 milliseconds (138 Registers)
Max - 36.3 milliseconds

A40 5.2 microseconds
Min - 8 milliseconds (1546 Registers)
Max - 84 milliseconds (4 Redundancy Processors)

Note, if more than one processor is present in the rack, all processors will wait for the processor with the longest scan to maintain synchronization.

The second time factor is the time taken to transfer data from the active to the standby unit. This transfer takes place in parallel to the processor scan and therefore does not lengthen the processor scan execpt as noted below. This time is also dependent on the amount of data to be transferred and can be estimated as shown below.

A30 27 microseconds per word
Min - 3.7 milliseconds per word
Max - 109 milliseconds per word

A40 27 microseconds
Min - 41.6 milliseconds per word
Max - 109 milliseconds per word

Note, if the processor scan time is shorter than the data transfer time, then the processor(s) will have to wait for transfer completion before restarting.

Note, the data transfer time between active and standby units can be reduced by using multiple Redundancy Processors and transferring a part of the data through each. This will not reduce the scan time impact due to transfer from AutoMate processor to Redundancy Processor.

The timing diagram figure 2 shows the timing assuming a single processor and a scan time longer than the data transfer time.

```
ACTIVE          ACTIVE              STANDBY             STANDBY
PROC            PROC                PROC                PROC

+--------+
| SCAN   |
|        |
|        |
|        |
|        |
|        |
|        |
|        |
|        |
|        |
+--------+

+--------+
|        |
|  I/O   |
| UPDATE |
|        |
+--------+

+--------+          +--------+
| DATA   |          | DATA   |
| TRANS. | -------> | TRANS. |
|        |          |        |
+--------+          +--------+

+--------+          +--------+          +--------+          +-|
|        |          |        |          |        |          |  -|
| SCAN   |          | XMIT   |          |RECEIVE |          |    -|
|        |          |   TO   | -------> | FROM   |          |      _
|        |          |STANDBY |          |ACTIVE  |          | DIAG.  |
|        |          |        |          |        |          |        |
|        |          +--------+          +--------+          +--------+
|        |
|        |                              +--------+          +--------+
|        |                              | DATA   |          | DATA   |
|        |                              | TRANS. | ------>  | TRANS. |
+--------+                              |        |          |        |
                                        +--------+          +--------+
```

Figure 2
Example Timing Diagram of Data Transfer

CONFIGURATION

A controller will support redundancy if a Redundancy Processor is found in the rack and at least 16 20K registers are defined. When these conditions are met the selection of how much data to send via each Redundancy Processor is done as follows.

Register 20000 is entered with the slot number of the Redundancy Processor to use for sending the system data. In an A30 that is registers 00 - 77 and 2000 - 2077. In an A40 the system data is register 0 - 2777. For an A30 this will be 276 bytes and for an A40 this will be 3092 bytes. Register 20000 is loaded in OCTAL.

Register 20001 is loaded with the number of highest PID block used. For an A30, valid numbers range from 0 to 40. For an A40, valid numbers range from 0 to 80. For every PID block 12 bytes of data are transferred plus 6 bytes of header. If a zero is entered no PID data will be sent. Register 20001 is loaded in DECIMAL.

Register 20002 is loaded with the number of highest LOOP block used. For an A30, valid numbers range from 0 to 20. For an A40, valid numbers range from 0 to 40. For every LOOP block 8 bytes of data are transferred plus 6 bytes of header. If a zero is entered no LOOP data will be sent. Register 20002 is loaded in DECIMAL.

Registers 20003 - 20016 are used to select other data to be sent to the standby unit. Holding registers and 20K registers are not sent unless requested. In an A30 that is registers 2100 - 3676 and 20020 - 27777. In an A40 that is registers 3000 - 17476 and 20020 - 157777. For every register range entered there will be 6 bytes of header plus 2 bytes for every register. Therefore, it is desireable to group the Registers used together as much as possible, so that they can be sent as a single group. An even number of registers MUST always be entered. These registers are loaded in OCTAL.

Register 20003 is entered with the slot number of the Redundancy Processor to use for sending selected register data.
Register 20004 is entered with the beginning of a register range.
Register 20005 is entered with the ending of a register range.

Register 20006 is entered with the slot number of the Redundancy Processor to use for sending selected register data.
Register 20007 is entered with the beginning of a register range.
Register 20010 is entered with the ending of a register range.

Register 20011 is entered with the slot number of the Redundancy Processor to use for sending selected register data.
Register 20012 is entered with the beginning of a register range.
Register 20013 is entered with the ending of a register range.

Register 20014 is entered with the slot number of the Redundancy Processor to use for sending selected register data.
Register 20015 is entered with the beginning of a register range.
Register 20016 is entered with the ending of a register range.

Register 20017 must have a -1 entered. This is used to signal that data is complete. When changing configuration start by entering a zero here, then make changes in active and standby units. Then put the -1 back and cycle power on both the active and standby units. Register 20017 is loaded in DECIMAL.

User Register Assigned As A System Registers

When the processor detects that it is to be part of a redunancy system, user register 3677 in AutoMate 30 or 17477 in an AutoMate 40, is reasigned as a system register which is used with the system rail.

Transfer Wiring

In order for the Master or Slave AutoMate Chassis to know the state of its counterpart, it is necessary to interconnect the two chassis with a few digital signals. This is accomplished via a dedicated Rail connected to port 0 of the processor card. (If more than one processor card is present, then the dedicated rail connects to port 0 of the processor in the lowest slot #.)

The I/O of this dedicated Rail have predetermined functions. It is not necessary to configure this Rail as part of the digital I/O. This is handled by the system software, and is automatically configured as Register 3677 in an AutoMate 30 or 17477 in an AutoMate 40. As shown in the table below, bits .00 through .04 have predefined functions and the remaining bits can be used by the application program as needed. (Of course, .05 is an output.)

TABLE 1

Reg. A30	Reg. A40		
3677	17477	Rail 0 input status if primary AutoMate	
		.00	(Input) Ready relay from other rack
		.01	(Input) Active select, used on power up
		.02	(Input) Active output from other rack
		.03	(Input) Transfer control
		.04	(Output) Active
		.05	(Output) Spare

It is important that the power supplies and control wiring are powered from two separate sources as indicated. This is necessary to insure the integrity of the overall Redundancy concept and to insure the Master and Slave are coordinated properly.

Input .00 of each chassis is controlled by the ready contact of the opposite chassis. This is the signal that tells the slave to become a master and actually causes transfer. This is always required.

Input .01 of one chassis is hardwired On, and Input .01 of the opposite chassis is hardwired Off. These signals determine which chassis will be the master on initial power up. They have no effect after that; however, bit .01 of the Register (3677 or 17477) can be read by a "host" via RNET to determine which chassis is in control.

RNET will always communicate to the chassis in control, and the state of this bit will therefore indicate which chassis is presently in control.

This is always required.

Input .02 of each chassis is controlled by output .04 of the opposite chassis. Output .04 is energized when that chassis in the Master. The interconnection of these signals insures that Master and Slave are coordinated properly.

Input .03 of each chassis can be wired to a switch or other device. When this input of the Master chassis is energized, the Master will be shut down, and a transfer will take place. This is an option and can be used in those applications when a manual transfer is desired - perhaps for making programming changes. Note, this input will cause the master to go into a System Fault condition, and it must be powered down and up to reset it. To accomplish the transfer the application program would use this input to set the programmable fault coil(76.05, A30 or 1776.05, A40).

Output .04 can also be used by the customer to indicate which unit is active. The diagrams show an Active indicator as an example of this.

Note, if no lamp or other load is used across Output .04, then a load resistor must be added to prevent leakage from turning on the input. 5.0K , 5 watt is recommended.

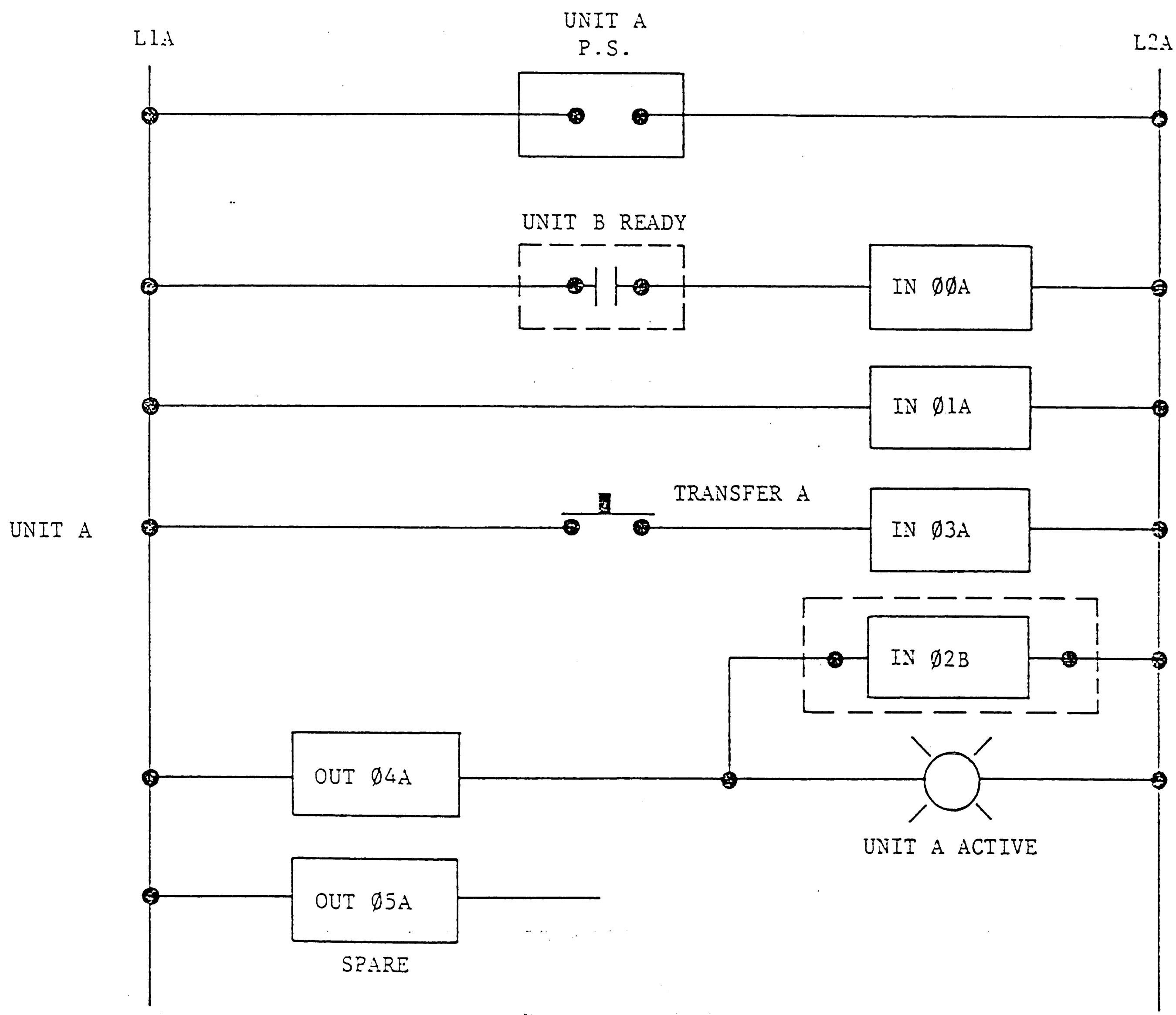

Figure 3
Example of Field Wiring for Unit A

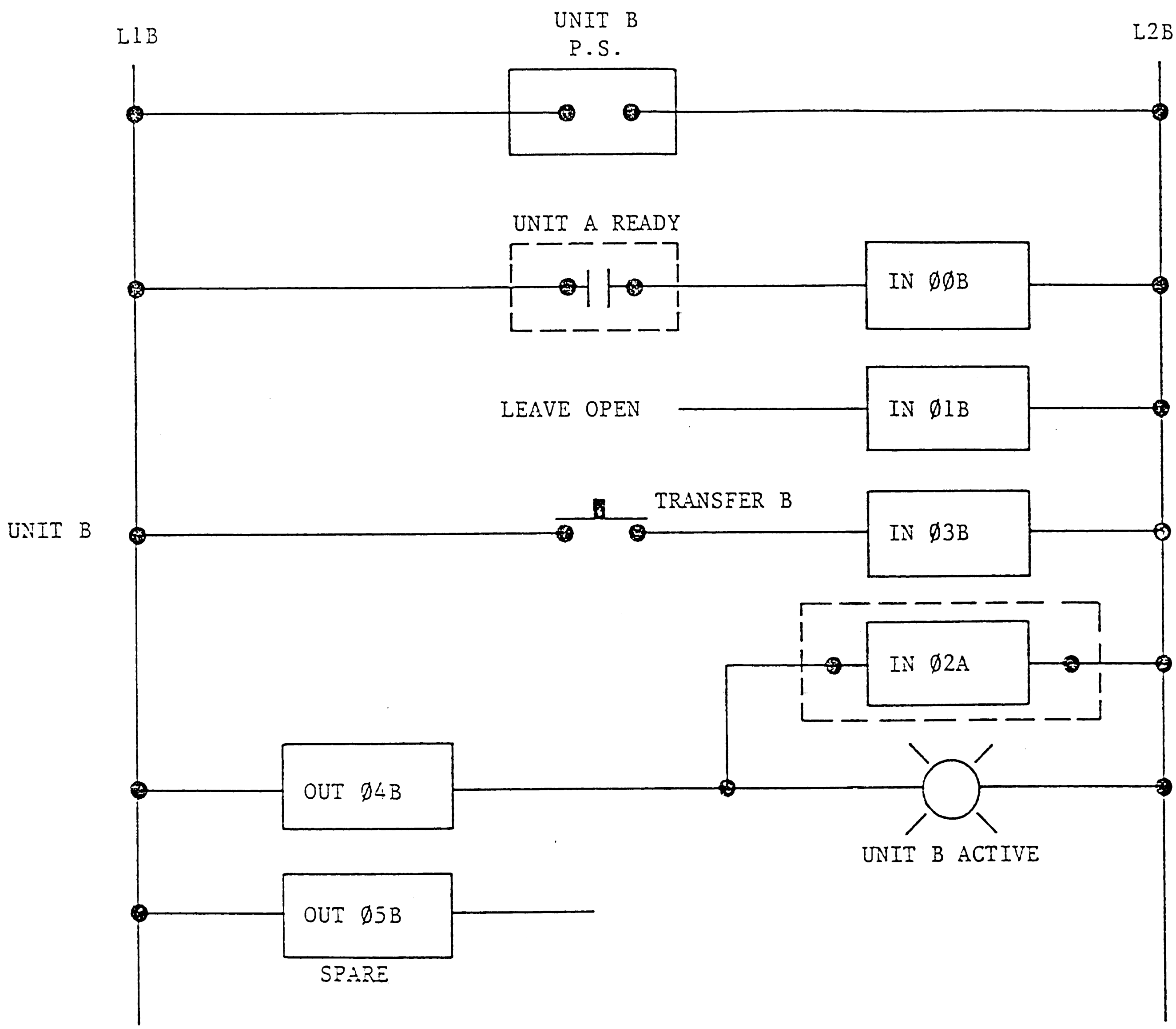

Figure 4
Example of Field Wiring for Unit B

The following explains the Error LED codes

The bottom four LEDs on the redundency processor are red and are used to show diagnostic codes. There are two types of errors that can be detected; warnings and fatal errors. If the top yellow LED is on it is only a warning. If the top yellow LED is off a fatal error was detected.

Warnings:

Top Red LED:	CRC error The message received had a bad CRC.
Second Red LED:	Did not respond. The standby RDX did not respond with acknowledge. This error will also be displayed if there is any difference between what registers are configured in the active and standby controllers, or if an odd number of registers are configured.

Fatal Errors:

Decoding of fatal errors is done with an 8, 4, 2, 1 code where the top red LED is worth 8, the next red LED is worth 4 and so on.

Code 1:	EPROM fault The checksum of the executive is bad.
Code 2:	RAM fault The read write test of the local RAM has failed.
Code 3:	DUAL PORT RAM fault The read write test of the dual port RAM has failed.
Code 4:	Transmit - Receive fault The self test of the transmitter and receiver failed.
Code 10:	Bufer empty Buffer of data from Automate was empty when it signaled that data was ready.
Code 11:	Slot mismatch The slot specified in the message to the standby RDX doesn't have an automate processor in it.
Code 12:	Unused vector An unused interrupt vector was generated.
Code 13:	Address error The processor tried to access a word on an odd byte.
Code 14:	Watch dog The system watch dog was set by some other card in the rack.
Code 15:	Bus error The processor failed to access memory successfully.

Software Revisions

In order for Redundant Systems to work properly, the software executives of the system components must be of a certain version or higher. The table below shows the necessary versions.

45C300-307	V3.4 and up
45C410-411	V1.3 and up
45C201	V3.1 and up
45C202	V2.3 and up
45C204	V1.0 and up
45C37	V2.1 and up
45C107	V5.3 and up

Note, that Redundancy capabilities have been added to these products as enhancements. There will be a slight update charge if a user desires to update any product purchased before these capabilities were added.

Software Considerations

The application programs written for standard AutoMate applications will run in Redundant systems with the following three considerations.

1. The entire concept of the Redundant system is based on detecting any problem that occurs in the Master system and initiating a transfer. The internal diagnostics of the AutoMate system provide an excellent means of doing this. However, many of the diagnostics are user programmable using error bits and the Programmable Fault Coil. Therefore, it is very important that the programmer consider the diagnostics carefully and include them in the Programmable Fault circuit.

2. There is a short period during transfer when data from Remote Input Cards is invalid. This is indicated to the program via the drop fault bits. Immediately after transfer, these bits will be true and will go low as soon as valid data has been received.

   Therefore, the user's application program must use the Drop Fault bits to disable all REMIN Blocks so that they do not read the invalid data. Other parts of the program that utilize data from the REMIN blocks may also need to be interlocked using the drop fault bits.

   Generally, the data will be valid after one scan.

3. The bumpless transfer feature of the Redundant system requires that all REMOUT blocks be executed by the slave processor (which has now become the master) immediately after transfer and before beginning I/O update. To accomplish this, a "dummy" scan is executed before starting I/O update. Therefore, it is necessary that all REMOUT blocks be executed on the first scan. This can be accomplished by insuring all REMOUT blocks are in the main program Loop and not in GOTO, GOSUB, or LOOP routines. It can also be accomplished by adding extra REMOUT blocks to duplicate those in the GOTO, GOSUB, or LOOP routines.

   These REMOUT blocks would then only be executed during the first scan.

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