SOFTWARE SP798-61

RADIAL COMMUNICATION NETWORK

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INTRODUCTION

The increasing need for low cost PC-networks has resulted in a new software package for the NCMZ-798 module. This software provides Westinghouse PC-users a way of exchanging information between remotely located PC's.

A basic system consists of a central PC (advanced PC-700 or PC-900) and a NCMZ-798 module supporting two (2) remotely located PC's. The module's two RS-232C ports, configured as a Data Terminal Equipment (DTE), interface directly to any PC-700, -900 or -1100 via the communication or computer interface port. When the distance between the central and remote PC's exceeds 50 feet, the port(s) can be configured as Data Communication Equipment (DCE) for modem requirements.

The port's communications rate is jumper selectable between 150 to 9600 baud. Each port can exchange a maximum of 15 holding registers in and 15 holding register out between the central and remote PC's. If more than two remote substations are required, other NCMZ-798 modules can be added to the system.

OPERATION

The module communicates with the central PC over a dedicated pair of I/O registers. The processor receives data from the module over IR(n), and transmits data back to the module over OR(n). On power-up, or any time the operator key on the central PC is switched from the program to run position, the module reads the port configuration registers from the central PC and stores the data in its internal memory. The configuration registers define the number of holding registers transmitted and received between the central and remote processors, thereby specifying the length of the transmit and receive data table in the central processor.

The remote processor(s), on the other hand, use a fixed data table in memory between HR9 and HR40 for storing transmitted and received data.

This initialization procedure is indicated by a 2-hertz flashing status LED. Once initialization and synchronization with the remote PC(s) is completed, the LED will remain on and actual data transfer will begin. Along with the user defined data registers, the central PC is also provided with information on the remote PC's status: run, run/modify, program or fault.

The configuration words define, for each remote station, the number of registers to be transmitted to the remote processor and the number of registers to be received from the remote processor, plus spares for each type. The start/end specification of this register table in the central processor is determined from the total number defined by the configuration words. The register tables contain the actual data transmitted and received, and should be placed immediately after the configuration words.

I/O BUS PROTOCOL

All communication control is performed by the module, which reduces the required PC ladder program to a minimum. Basically, there are two command-types which have to be distinguished by the PC ladder program: 1. read registers and 2. write registers. A valid read command on the assigned input register results in a data move to the assigned output register. A valid write command on the input register results in a temporary "data expect", thus on the next I/O update, data is moved from the input register to the selected holding register.

All data moves are accomplished by the REGISTER TO TABLE and TABLE TO REGISTER instructions. The command definition on IR(n) is as shown in Figure 1.

```
IR(n)
BIT#  16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
      R  W
```

If bit 16=1 then the Module reads data from the PC.
If bit 15=1 then the Module writes data to the PC.

Figure 1.

Again, all communication control is handled by the module and the communications ladder diagram. The only other requirement is loading the data of the transmit registers. The read and write bits of IR(n) are under the control of the module and will be set automatically during the read and write cycles.

The recommended ladder diagram for this module is shown in Figure 4. The sample ladder diagram is for the maximum configuration of 15 registers in and out, for two remote processors.

SYSTEM CONFIGURATION WORDS

The configuration words located in the central processor define for each remote station:

1. The number of registers to be transmitted
2. The number of registers to be received
3. Spare transmit registers for future expansion
4. Spare receive registers for future expansion

The start and end of the tables in the central processor can be calculated from the allotments for present and future register assignments. The register tables contain the actual data transmitted and the actual data received. In addition, the register table includes the configuration words and remote processor status words.

The start and end specification of the remote register tables are set for a fixed location in the remote processor, regardless of the number of transmit and receive registers.

Configuration Word Format:

Bits 16-13:	Specify the number of HR's transmitted from the central PC to the remote PC.
Bits 12-09:	Specify the number of HR's received by the central PC from the remote PC.
Bits 08-05:	Specify the number of spare (commands).
Bits 04-01:	Specify the number of spare (inputs).

The physical location of the configuration words is the first and second words of the assigned table in the central processor. The table length is specified by the RT and TR instructions in the PC ladder program. The required length is calculated as:

	Registers transmitted to processor no. 1
plus	Registers transmitted to processor no. 2
plus	Registers received from processor no. 1
plus	Registers received from processor no. 2
plus	Future registers transmitted to processor no. 1
plus	Future registers transmitted to processor no. 2
plus	Future registers received from processor no. 1
plus	Future registers received from processor no. 2
plus	Configuration words (two)
plus	Remote processor status words (two)

The maximum total is 64. Note the number of active and future registers combined cannot exceed 15.

The user can define the register data table to reside anywhere in the central programmable controllers register memory. An example of the central PC's register data table, for a configured system, is illustrated in Figure 2.

CENTRAL PROCESSOR'S DATA TA8LE

HR	DESCRIPTION	CONTENTS
HR 1	Configuration word PC1	2221 (hex)
HR 2	Configuration word PC2	1212 (hex)
HR 3	Status of remote PC1	
HR 4	Register 1 to remote PC1 (1st trans. reg.)	
HR 5	Register 2 to remote PC1 (2nd trans. reg.)	
HR 6	Spare register 1 (no data transmitted)	
HR 7	Spare register 2 (no data transmitted)	
HR 8	Input register 1 from remote PC1 (1st rec. reg.)	
HR 9	Input register 2 from remote PC1 (2nd rec. reg.)	
HR 10	Spare input register 1 (no data received)	
HR 11	Status of remote PC2	
HR 12	Register 1 to remote PC2 (first trans. reg.)	
HR 13	Spare register 1 (no data transmitted)	
HR 14	Input register 1 from remote PC2 (1st rec. reg.)	
HR 15	Input register 2 from remote PC2 (2nd rec. reg.)	
HR 16	Spare input register 1 (no data received)	
HR 17	Spare input register 2 (no data received)	

Figure 2.

The first two registers in the table (HR 1 and 2) serve as configuration words for ports A & B on the communications card. Port A (HR 1) is configured for the central processor to transmit two data registers to remote processor No.1 and for the central processor to receive two data registers from remote processor No.1. The system is also configured with two spare transmit and one spare receive register, defining a seven register data block in the central PC.

In a similar fashion HR 2 configures PORT B. The definition is shown in Figure 2 above.

The example above would require a table length of 17 and a table end of HR 17 for the RT and TR instructions in the given ladder program.

The remote processor's register data table is shown in Figure 3. Note that the remote processor's data table is fixed to start at register 9. The length of the table is fixed and uses the register space to HR0039.

REMOTE PROCESSOR'S DATA TABLE

HR	OFFSET	DESCRIPTION
HR9	0	Copy of port configuration word.
HR10	1	Receive register (input) #1
HR11	2	" " " #2
HR12	3	" " " #3
HR13	4	" " " #4
HR14	5	" " " #5
HR15	6	" " " #6
HR16	7	" " " #7
HR17	8	" " " #8
HR18	9	" " " #9
HR19	10	" " " #10
HR20	11	" " " #11
HR21	12	" " " #12
HR22	13	" " " #13
HR23	14	" " " #14
HR24	15	" " " #15
HR25	16	Transmit register (output)#1
HR26	17	" " " #2
HR27	18	" " " #3
HR28	19	" " " #4
HR29	20	" " " #5
HR30	21	" " " #6
HR31	22	" " " #7
HR32	23	" " " #8
HR33	24	" " " #9
HR34	25	" " " #10
HR35	26	" " " #11
HR36	27	" " " #12
HR37	28	" " " #13
HR38	29	" " " #14
HR39	30	" " " #15

Figure 3.

Status Word Definition

The four least significant bits of the PC status register (offset 2 and 10) are used to describe the processor's current status: run, run/modify, program or fault. Bit 8 is set periodically by the module to validate this information. Bits 16 to 9 are used for testing, and will show an alternating bit pattern AA and 55. The module will write and read back this location each time that data is exchanged between the remote and central PC.

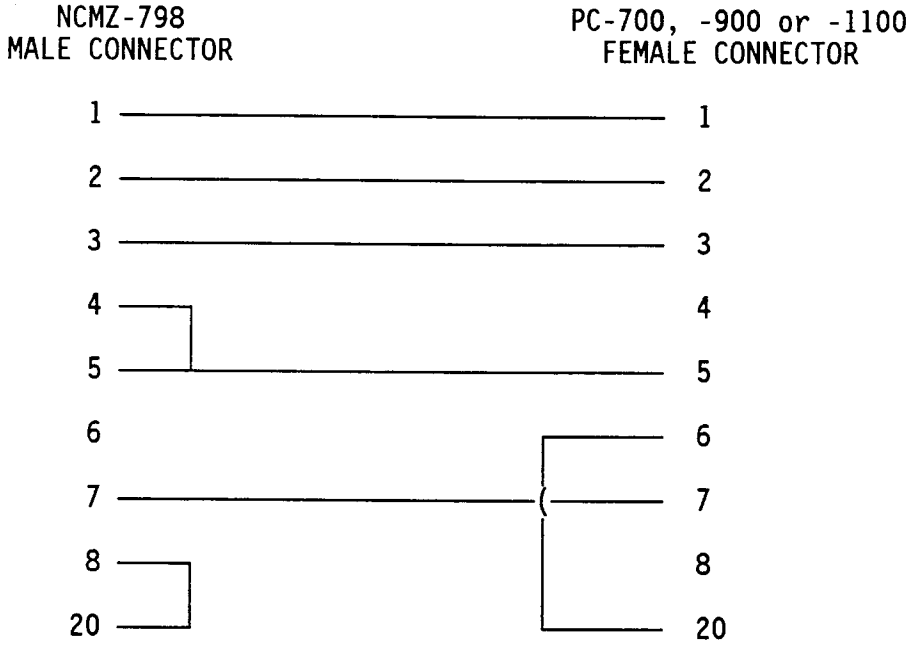
FRONT STATUS LED INDICATIONS

The front status LED can be a helpful tool when troubleshooting the system. The flashing mode indicates the communication link operation condition as follows:

LED OPERATION	STATUS
Always OFF	RAM or PROM error
Flashing 2 Hz.	I/O bus communnication error or start-up
Flashing 1 Hz.	Port A communication error
Flashing 0.5 Hz.	Port B communication error
Always ON	Normal operation

COMMUNICATIONS CABLE WIRING CONNECTIONS

PC-TO-PC COMMUNICATIONS CABLE (DTE-TO-DTE)



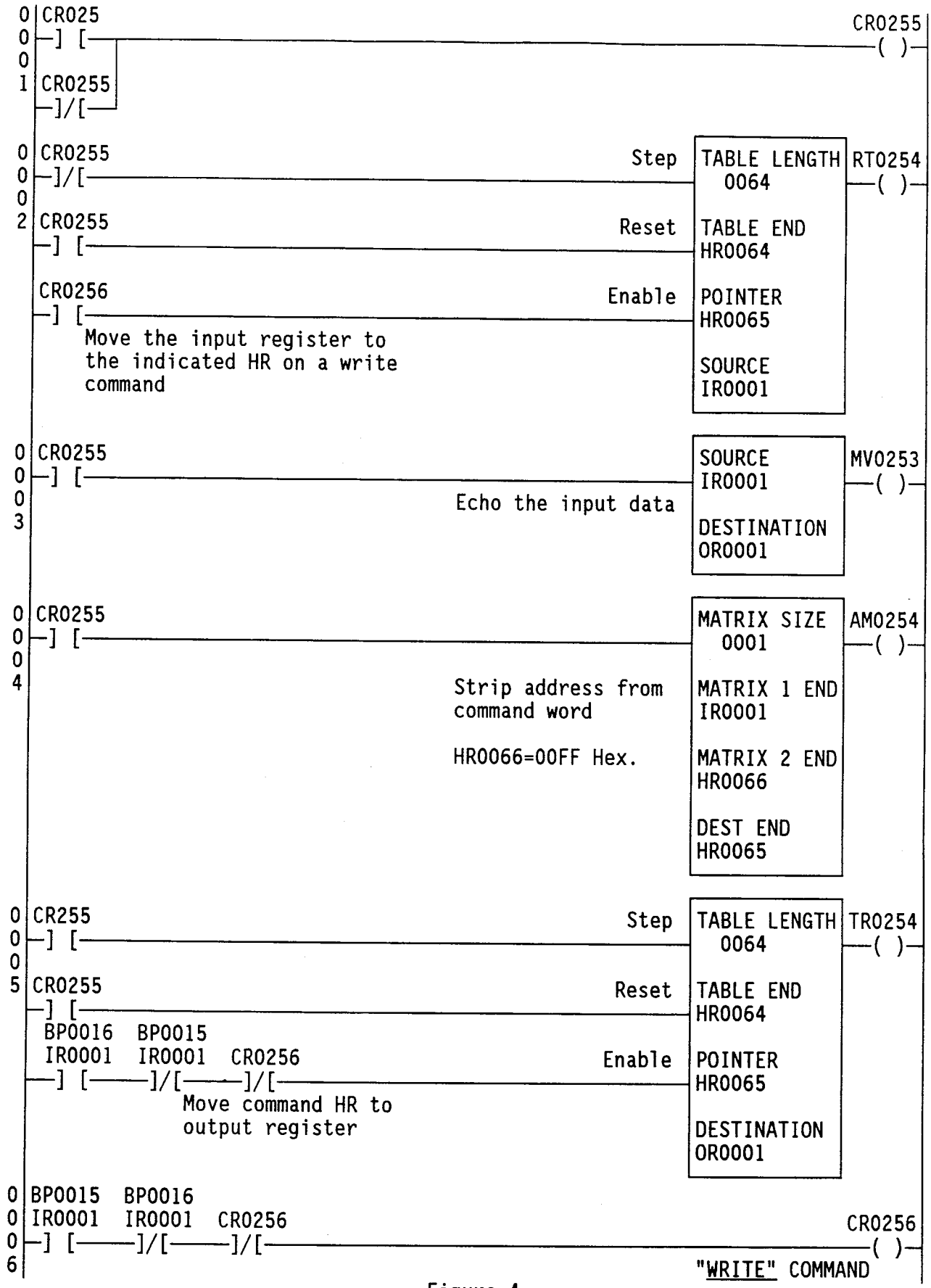

0 CR025
0] [
0
1 CR0255
]/[
CR0255
( )
0 CR0255
0]/[
0
2 CR0255
] [
Step
TABLE LENGTH
0064
RT0254
( )
Reset
TABLE END
HR0064
CR0256
] [
Enable
POINTER
HR0065
Move the input register to
the indicated HR on a write
command
SOURCE
IR0001
0 CR0255
0] [
0
3
SOURCE
IR0001
MV0253
( )
Echo the input data
DESTINATION
OR0001
0 CR0255
0] [
0
4
MATRIX SIZE
0001
AM0254
( )
Strip address from
command word
MATRIX 1 END
IR0001
HR0066=00FF Hex.
MATRIX 2 END
HR0066
DEST END
HR0065
0 CR255
0] [
0
5 CR0255
] [
Step
TABLE LENGTH
0064
TR0254
( )
Reset
TABLE END
HR0064
BP0016 BP0015
IR0001 IR0001 CR0256
] [ ]/[ ]/[
Enable
POINTER
HR0065
Move command HR to
output register
DESTINATION
OR0001
0 BP0015 BP0016
0 IR0001 IR0001 CR0256
0] [ ]/[ ]/[
6
CR0256
( )
"WRITE" COMMAND

Figure 4

NCMZ-798-NETWORK Module

Application Notes

1. If only one remote PC is to be used, load the other configuration word with 0000H.
2. This module utilizes and controls the following modem control signals;

Signal Name	Pin #
Request to Send (RTS)	4
Clear to Send (CTS)	5
Data Carrier Detect (DCD)	8
Data Terminal Ready (DTR)	20

3. The module, as standard, is jumpered for direct connection to a PC. If it is desired to communicate via modem, reconnect the appropriate jumper block (J-A or J-B) as shown in figure 8, page 5 of the Instruction Leaflet (IL).

4. An alternate method of connecting to a modem is the construction of a null modem cable. Jumper blocks J-A/J-B are then strapped for communication with a DTE (Normal direct to PC connection).

Modem Cabling (Utilizing a null modem cable between the modem and NCMZ module)

NCMZ-798	Modem	Modem	PC700/900/1100
1	1		1
2	3		2
3	2		3
4	5		4
5	4		5
6	6		6
7	7		7
8	20		8
20	8		20

For this cabling scheme to work properly, the modem must raise pin 8 (DCD) whenever a carrier is received. Test this by measuring the voltage between pin 8 and pin 7 of the modem whenever a carrier is received by the modem. The correct voltage should be approximately +12 VDC (pin 8 more positive that pin 7). If the signal is -12 VDC, or is 0, remove cabling between pins 8 and 20 of the modem with pins 20 and 8 of the module, then jumper pins 8 and 20 of the NCMZ module together.

If at anytime during data transmission with a remote PC the carrier is lost (pin 8 of the modem goes negative), the NCMZ module will indicate a communication failure. A communication failure halts module operation. (See note 8)

5. The module will interpret the loss of modem control signals as failed communication. This communication failure is indicated by the LED flashing at either the 1 Hz or 0.5 Hz rate.

6. During start-up, the module follows the following sequence;

a. Send 00H byte out port A.
b. Send 00H byte out port B.
c. If during the transmission of null bytes, a response was heard on either port, cease transmission of null bytes out that port. If the module is observed transmitting null bytes continuously, check to see it the remote PC is responding with the correct 6 byte reply. If not, verify that the remote PC communicates with a program loader. If it does, verify that cabling is correct.
d. After approximately 10 seconds, the module will attempt to read the two configuration registers from the Central PC. If the module is unable to read configuration data from the Central PC, or both configuration registers contain 0000H, the module will attempt to read those registers once every 10 seconds until data is loaded into the module. During this start-up phase, the LED will flash at a 2 Hz rate. If the 2 Hz flashing continues for more than 10 seconds, the module was unable to read either of the configuration registers or both registers contained zero. Verify that at least one of the registers contains a non-zero value, then verify rack address setting and I/O cabling. Also verify that the Central PC ladder is correct since invaild ladder or pointers could cause the module to read the wrong configuration register locations from the Central PC.
e. After successfully loading the configuration registers into the module, a check is made by the module to see if it had been successful in communicating with the requested PC port. If the module had previouly synchronized with the requested PC port, normal read/writes occur with the remote PC. If the module had not been successful in communicating with the requested PC, the appropriate error is displayed on the LED status indicator.

7. If communication errors occur simultaneously on both Port A and Port B, the LED will flash at the 1 Hz rate (Port A comm fail). This could occur if the modules configuration registers indicate that both Port A and Port B should have processors connected, but the module was unable to communicate with either port.

8. A communication failure with one remote will cause the card to enter a fault recovery (re-synch) cycle. All communications with the Central PC, as well as the second remote PC, will stop. Normal operations will continue once the failed communications channel is able to resych with the remote PC.

9. The module communicates with remote stations using conventional Numa-Logic 6-Byte "Word Read" and "Word Write" statements.

10. Update time is a function of PC scan times, number of remote PC's, number of remote registers read or transmitted, and the serial communication baud rate.

11. If the remote PC keyswitch is turned to "Stop/Program", the NCMZ module will stop reading registers from and writing registers to this remote. The module will instead continuously poll the remote PC's status register (8205H) until the module detects that the remote PC is running.

12. Even if only one remote station is programmed, the Central PC must reserve Holding Register space for both the port A and port B remote status. (see examples below)

Examples of Programming

A. One Central PC, one Remote PC connected via modems through the NCMZ module's port A. Read 2 registers from remote, write 2 registers to remote.

	Central PC Table	Description
HRx+ 0	2200 H u	Port A configuration word
HRx+ 1	0000 H u	Port B configuration word
HRx+ 2	xxxx H c	Remote PC (Port A) fault and keyswitch status
HRx+ 3	tttt H u	1st Word transmitted to remote PC's HR0010
HRx+ 4	tttt H u	2nd Word transmitted to remote PC's HR0011
HRx+ 5	rrrr H c	1st Word received from remote PC's HR0025
HRx+ 6	rrrr H c	2nd Word received from remote PC's HR0026
HRx+ 7	yyyy H c	Remote PC (Port B) fault and keyswitch status

```
! !
! +--- U - entered by user
!      C - entered by module
!
+----- H - hexadecimal value (of course, the data values can be
           interpretted in other number systems also)
```

where:

xxxx - Remote Status of PC. The upper nybble value alternates between 1010 1010 and 0101 0101 (AA/55) as the module scans the remote PC. If communications is lost with the remote, this value ceases to change value. A ladder program could check for communications failure by noting that this value stops changing.

The lower nybble bits have the following significance:

```
0  0  0  0

!  !  !  !
!  !  !  +-- Stop/Program Mode
!  !  +----- Run/~~Modify~~ PRG PROT
!  +-------- Run/~~Program Protect~~ MODIFY
+----------- Fault
```

tttt - 16 bit value transmitted to remote PC

rrrr - 16 bit value received from remote PC

yyyy - Remote Status of PC. If this port is not configured (as in this example), this value of status is equal to 0000. This register is reserved, however, as the module continues to write 0000H into this location.

B. One central PC, one remote PC connected via modem through the NCMZ module's port B. Read 3 registers from remote, write 2 registers to remote.

	Central PC Table	Description

HRx+ 0	0000 H u	Port A configuration word
HRx+ 1	2300 H u	Port B configuration word
HRx+ 2	0000 H c	Remote PC (Port A) fault and keyswitch status
HRx+ 3	xxxx H c	Remote PC (Port B) fault and keyswitch status
HRx+ 4	tttt H u	1st Word transmitted to remote PC's HR0010
HRx+ 5	tttt H u	2nd Word transmitted to remote PC's HR0011
HRx+ 6	rrrr H c	1st Word received from remote PC's HR0025
HRx+ 7	rrrr H c	2nd Word received from remote PC's HR0026
HRx+ 8	rrrr H c	3rd Word received from remote PC's HR0027

As in the example 'A', the remote PC status word for a port that has not been configured (HRx+ 2 in this example) is always a zero.

C. One central PC, two remote PC's connected via modem through the NCMZ module's port A and port B. Port A - Read 3 register from remote, write 4 registers to remote. Port B - Read 4 registers from second remote, write 2 registers to this remote.

	Central PC Table	Description
HRx+ 0	4300 H u	Port A configuration word
HRx+ 1	2400 H u	Port B configuration word
HRx+ 2	xxxx H c	Remote PC (Port A) fault and keyswitch status
HRx+ 3	tttt H u	1st Word transmitted to remote PC's HR0010
HRx+ 4	tttt H u	2nd Word transmitted to remote PC's HR0011
HRx+ 5	tttt H u	3rd Word transmitted to remote PC's HR0012
HRx+ 6	tttt H u	4th Word transmitted to remote PC's HR0013
HRx+ 7	rrrr H c	1st Word received from remote PC's HR0025
HRx+ 8	rrrr H c	2nd Word received from remote PC's HR0026
HRx+ 9	rrrr H c	3rd Word received from remote PC's HR0027
HRx+10	xxxx H c	Remote PC (Port B) fault and keyswitch status
HRx+11	tttt H u	1st Word transmitted to remote PC 2's HR0010
HRx+12	tttt H u	2nd Word transmitted to remote PC 2's HR0011
HRx+13	rrrr H c	1st Word received from remote PC 2's HR0025
HRx+14	rrrr H c	2nd Word received from remote PC 2's HR0026
HRx+15	rrrr H c	3rd Word received from remote PC 2's HR0027
HRx+16	rrrr H c	4th Word received from remote PC 2's HR0028