

C114HI

**3 in 1 RS-232/422/485
Industrial Serial Board**

Apr. 1998 (2nd Edition)

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Chapter 1 Introduction

The Smart 3 in 1 Multiport Async Solutions

The C114HI is a RS-232/RS-422/RS-458 4-port serial communication interface board. Each port can be configured to RS-232, RS-422 or RS-458 individually. It is designed for the system manufacturers, integrators or VARs that want to provide all high performance, reliability and quality multiple port data communication system.

The C114HI provides a low cost, high performance solution for connecting up to 4 devices such as terminals, modems and printers to PC-based host computer. It belongs to the C104 family and features high speed and isolation protection.

The C114HI is so flexible in configuration that they are compatible with virtually all kinds of other manufacturer's 4 port non-intelligent boards using 16550 UART.

Operating System Support

The family is operational under most popular operating systems such as Windows NT, Windows 95, SCO UNIX/XENIX/OpenServer, DOS, Windows 3.x, OS/2, Linux, QNX, FreeBSD, MUMPS, PICK OS, IMS Multiuser DOS, etc. However, **MOXA device drivers** for Windows NT, Windows 95, DOS, Windows 3.x and Linux are provided for better installation, configuration and performance. In this manual, chapters for **MOXA Windows NT, Windows 95, DOS and Windows 3.x** device drivers are included. For other compatible systems not mentioned, please refer to the respective operating system's manual for how to install and configure the standard driver.

MOXA Serial Comm Tool

For easy application development, MOXA provides an easy-use serial communication library under Windows NT/95 (*PComm*) and Windows 3.x/DOS (**API-232**). Users can use this library to develop your own applications using Microsoft C, Turbo C, Assembly, QuickBASIC, Turbo Pascal, Clipper, Visual Basic, Visual C++, Borland Delphi, etc. **Utilities**, such as diagnostic and monitor, are included for diagnosing the board/port or monitoring the communication status.

1.1 Features

The C114HI 4 port RS-232/422/485 board provides the following advanced features:

- u 16 bit AT bus architecture, more IRQs supported
- u ASIC-designed, easily configured by software (IO-IRQ/DOS)
- u Independent I/O address and IRQ settings for each of 4 serial ports
- u 4 high speed, up to 921.6K bps, TI550C UARTs with on-chip hardware flow control, no data loss (16550 compatible)
- u Compatible with PC standard ports: COM1 ~ COM4
- u Supports isolation protection for RS-422/RS-485
- u Supports 2-wire or 4-wire RS-485 operation modes
- u Supports RS-485 auto data direction switching feature
- u Supports Windows NT/95, DOS and Windows 3.x device drivers
- u Compatible with most popular Operating Systems

1.2 Specifications

- u Bus interface : ISA(EISA compatible)
- u Number of ports : 4
- u I/O address : 0x0000 ~ 0xFFFF
- u IRQ : 2, 3, 4, 5, 7, 10, 11, 12, 15
- u Data bits : 5, 6, 7, 8
- u Stop bits : 1, 1.5, 2
- u Parity : none, even, odd, space, mark
- u UART : 4»TI550C
- u Speed : 50 ~ 921.6K bps
- u Connectors : 4»DB-9 male (DTE)
- u Data signals : RS-232: TxD, RxD, RTS, CTS, DTR, DSR, DCD, GND
RS-422: TxD+/-, RxD+/-, RTS+/-, CTS+/-, DCD, GND
RS-485: TxD+/-, RxD+/-, GND
- u Isolation protection : max. 2000V for RS-422 or RS-485
- u Operating temp. : 0 ~ 55° C
- u Dimensions : 22 cm»11.5 cm
- u C114HI is compatible with various operating systems. However, Moxa supports proprietary drivers for better performance. See the driver list below.

	C114HI
Windows NT	✓/C
Windows 95	✓/C
Windows 3.x	✓/C
DOS	✓/C
Linux	R/C
OS/2	C
SCO UNIX/OpenServer	C
SCO XENIX	C
QNX	C
FreeBSD	C
PICK OS	C
MUMPS	C
Multiuser DOS	C

✓: Driver supported by Moxa and shipped with product

R: Driver supported by Moxa but shipped by request

C: Driver supported by OS

Note: MOXA FTP site is available for driver download

1.3 Check List

Upon unpacking the C114HI package, you should find the following items included:

1. C114HI 4 port RS-232/RS-422/RS-485 board
2. This User's Manual
3. Windows NT/95 driver diskette »ë1, DOS/Windows 3.x (API-232) driver diskette»ë1, *PComm* diskette»ë1
4. 30 cm cable (DB-37 to 4»ëDB-9 male connectors)

1.4 Installation Guide

To install C114HI in a system, follow the instructions of Chapter "Hardware Installation and IO-IRQ" and then O.S. specific instruction of Chapter "Software Installation".

Chapter 2 Hardware Installation and IO-IRQ

2.1 IO-IRQ Configuration Utility

Before installing any driver for C114HI in the system, it is necessary to run DOS configuration utility, **IO-IRQ.EXE**, to configure the ports, such as I/O address, IRQ, Interrupt vector, etc. The utility is in the API-232 (DOS/Windows 3.x) driver diskette. And select "**C104 family**" for C114HI to configure.

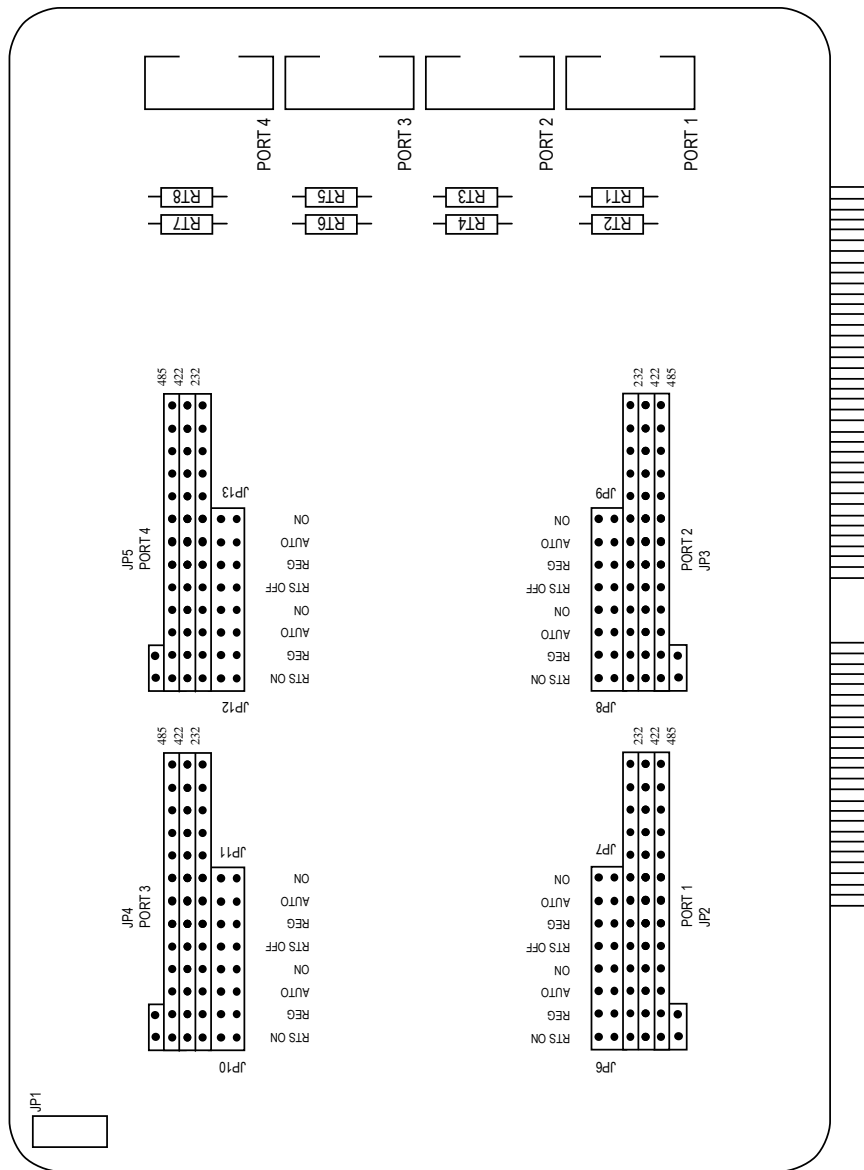
The C114HI uses on-board **EEPROM** to save the board's configuration which can be accessed (read or written) via the Configuration Access Port (**CAP**). While the JP1 jumper cap of C114HI is removed, the CAP address is always equal to the same address of the first port. When the JP1 jumper cap is installed, the CAP address will be forced to 0xA700.

To save time, please determine in which operating system, e.g. Windows or OS/2 or SCO UNIX, the C114HI board will be used. In order to ease the configuration, the commonly used I/O address and IRQ combinations supported by most popular OSs have been collected in the IO-IRQ utility. Press "**F3 - Select OS Compatibility**" on 3rd level menu to bring the suggested list and choose a proper one. You can, however, enter the I/O and IRQ manually if none of the items is suitable.

For example, if the C114HI board is to be installed under SCO UNIX system as the primary (first) four port board, using SCO UNIX system serial driver, here is one of the possible settings,

- a. Press "**F3 - Select OS Compatibility**" on 3rd level menu.
- b. Then choose the entry of "**SCO UNIX 1 (Arnet Compatible...)**" which will designate the C114HI's I/O base address to 0x280, IRQ to 4 and interrupt vector to 0x2C2.

Be careful not to conflict the I/O address and IRQ of the C114HI board with the existing board's.



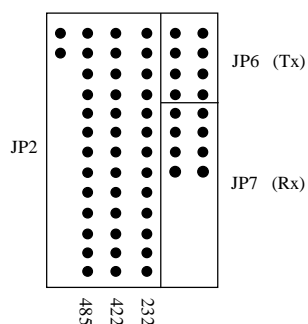
C114HI's Layout

2.2 Jumper Settings for Interface

Jumpers for the first and second ports are symmetric with those for the third and fourth ports as shown in the above picture.

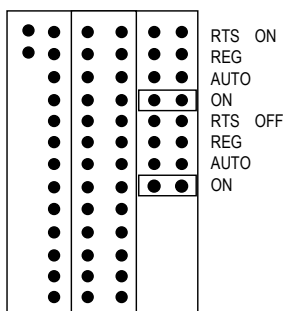
Port 1	Port 2	Port 3	Port 4	Selection Function
JP 2	JP 3	JP 4	JP 5	Interface & RS-485 Operation Mode
JP 6	JP 8	JP 10	JP 12	RS-422/RS-485 Transmitter Mode
JP 7	JP 9	JP 11	JP 13	RS-422/RS-485 Receiver Mode

For illustration, jumper settings of the first port is shown below.



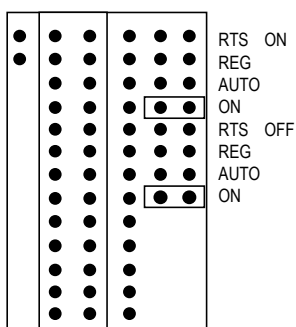
Jumper Settings for RS-232 Port

Put the jumpers in the positions as depicted. Do not care Tx (JP6) and Rx (JP7).



Jumper Settings for RS-422 Port

Put the jumpers in the positions exactly as depicted.

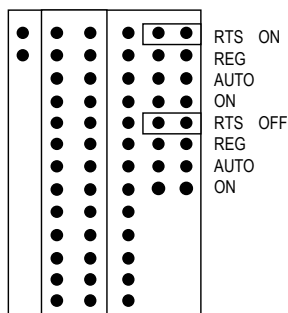


Tx: ON
Rx: ON

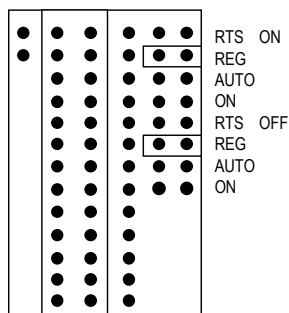
Jumper Settings for RS-485 Port

There are many combinations of configuration for RS-485. To control the enable/disable mode of the transmitter and receiver, there are 3 options: "RTS ON", "REG" and "AUTO" for the transmitter (jumpers for Tx) and 3 options: "RTS OFF", "REG" and "AUTO" for the receiver (jumpers for Rx) Please decide which you need and put the jumpers in positions as depicted.

Full Duplex Operation Mode

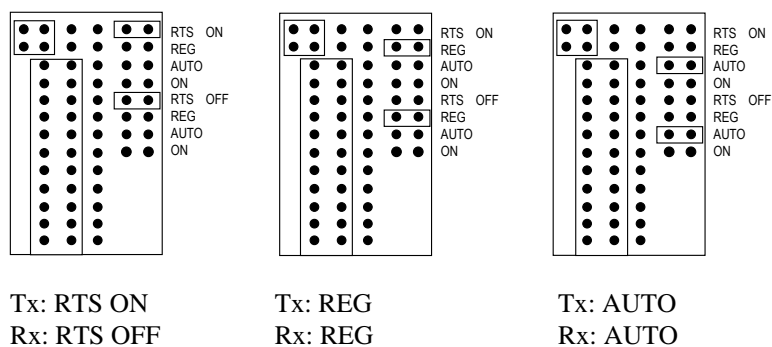


Tx: RTS ON
Rx: RTS OFF



Tx: REG
Rx: REG

Half Duplex Operation Mode



Please also refer to Chapter 9 for RS-485 programming and Appendix A.3 for RS-485 cable wiring.

2.3 C114HI Board Installation

To install C114HI, please follow the steps below.

- Step 1.** Choose a PC installed with DOS system or prepare a MS-DOS boot disk for your PC.
- Step 2.** Power off PC.
- Step 3.** Set the interface type to RS-232, RS-422 or RS-485 for each port with the jumpers on board.
- Step 4.** Install the C114HI board into a 16-bit slot.

The C114HI has the following default (factory) settings,

I/O address	:	0x180 (1st port),	0x188 (2nd port)
		0x190 (3rd port),	0x198 (4th port)
IRQ	:	10 (shared by four ports)	
Interrupt vector	:	0x1C0	
Configuration Access Port (CAP)	:	0x180	

If you are going to install multiple C114HI boards, configure one board at a time to prevent hardware conflict. Make sure no existing devices have the same I/O address as the CAP address, e.g. 0x180. If so, try to avoid the conflict by doing either one of the following (a or b).

- a. Short the jumper at position JP1 on the upper-left corner of C114HI. This will force the CAP address to 0xA700.
- b. Change or disable the existing board's I/O address.

ATTENTION! *For safety and to prevent C114HI from damage, please don't attempt to install or remove the jumper cap of JP1 until the power of PC is off.*

- Step 5.** Power on the PC and enter DOS system.
- Step 6.** Execute IO-IRQ.EXE included in the API-232 software driver diskette and follow the on-line help to configure the C114HI which belongs to the C104 family.
- Step 7.** Do software installation described in Chapter 3. After completing both the hardware and software configurations, the board is ready for use. Remember to connect the DB-37 to 4»èDB-9 cable.

Chapter 3 Software Installation

The C114HI boards are compatible with various operating systems such as SCO UNIX/XENIX, OS/2, QNX, PICK OS, MUMPS, Linux, and IMS Multiuser DOS. Please refer to the relative operating system's manual for how to configure the board.

The C114HI boards support Windows NT, Windows 95, DOS and Windows 3.x device drivers. The compatible SCO UNIX/XENIX and OS/2 drivers are also described in this Chapter.

3.1 Windows NT/95, DOS/Windows 3.x

Please refer to Chapter "For Windows NT Users" or "For Windows 95 Users", "For DOS Users" or "For Windows 3.x Users" for more details.

3.2 SCO UNIX/XENIX

Because the SCO UNIX/XENIX has bundled a 4 port board driver, additional driver is not necessary. The following description is based on the SCOUNIX/XENIX driver. Under SCO UNIX/XENIX, if the C114HI is used as the first 4 port board, one possible configuration would be:

```
IRQ = 4 (i.e. COM1)
I/O base address = 0x280 (Arnet compatible)
Vector = 0x2C2 (0x280 + offset 0x42)
```

For second 4 port board, the C114HI can be configured as:

```
IRQ = 3 (i.e. COM2)
I/O base address = 0x300 (Arnet compatible)
Vector = 0x342
```

Use the following SCO UNIX/XENIX command to start the software installation of a new serial board:

```
# mkdev serial
```

The screen will show:

```
You would like to install a:
1. 1 port card
2. 2 port card
3. 4 port card
4. ....
```

Enter number 3 to choose "4 port card". The screen then shows:

```
The card is configured as:
1. COM1
2. COM2
3. COM3
4. COM4
```

For first C114HI 4 port board, choose number 1 (COM1); for second, number 2 (COM2). Then the screen shows like:

```
Which card do you have?
1. Arnet base address 0xaaa
2. Arnet base address 0xbbb
3. Hostess base address 0xccc
4. ....
```

For first C114HI 4 port board, select "Arnet base address 0x280"; for second, "Arnet base address 0x300". Follow the on-line instruction to complete the rest of the installation procedure.

Once the installation is successfully completed, the following serial devices along with their modem devices (upper-case) will be added to the system.

```
tty1a  tty1b  tty1c  tty1d  (first C114HI)
tty2a  tty2b  tty2c  tty2d  (second C114HI)
```

Be sure to activate the device by using SCO command:

```
# enable ttyxx
```

3.3 OS/2

The C114HI can be driven either by the default device driver accompanying with

OS/2 or by the COM.SYS device driver provided by Device Driver Source Kit for OS/2.

COM.SYS Default Device Driver

The default device driver can only apply to standard COM1 and COM2 ports. It is active when the system is booted up. Please configure the first and second ports of the C114HI as COM1 (3F8, IRQ4) and COM2 (2F8H, IRQ3), respectively. Interrupt vector is not used. Remember to disable the COM1/COM2 on the host if exist.

COM.SYS Device Driver from Device Driver Source Kit for OS/2

The COM.SYS device driver can support up to 4 COM ports with user-defined I/O port addresses and interrupt levels. To enable it, a line describing C114HI's configuration (same as configured in IO-IRQ program) should be added to file C:\CONFIG.SYS and then reboot the system again.

Syntax:

```
DEVICE=PATH\COM.SYS (COM#, PORT@, IRQ#, BADINT, FIFO) ...
```

Where

PATH : the path of the device driver COM.SYS
COM# : the com port number (1~4)
PORT@ : the port's base I/O address
IRQ# : the IRQ level to use for the port, no IRQ sharing.
BADINT : what to do for bad interrupt i (ignore), d (disable port), p (post to application).
FIFO : if this is a FIFO port or not (t or f)

Example:

```
DEVICE= C:\COM.SYS (1, 3F8, 4, d, t) (2, 2F8, 3, d, t) (3, 2C0, 5, d, t) (4, 2C8, 7, d, t)
```


Chapter 4 For Windows NT Users

In this chapter, software driver installation, configuration and upgrade/removal procedure are described. If it is necessary for you to develop your own applications, we strongly recommend the easy but powerful *PComm* serial comm tool, which includes library for easy programming and useful utilities for diagnostic and monitor. Finally, Windows NT-specific troubleshooting is included.

4.1 Software Installation

The following is the procedure for installing the C114HI device driver under Windows NT 4.0 (or NT 3.51):

1. Login NT as **Administrator**.
2. Enter [**Control Panel**] group, then select [**Network**] icon, and then [**Adapters**] folder. (Enter [**Control Panel**] folder, then select [**Network**] icon for NT 3.51.)
3. Click [**Add**] button, then [**Have Disk...**] button for "Select Network Adapter". (Click [**Add Adapter...**] button, then "<Other> **Requires disk from manufacturer**" item for "Network Adapter Card:" for NT 3.51.)
4. Specify the exact path for the driver diskette, e.g. **A:\WINDOWS.NT**. Click [**Continue/OK**].
5. Select "**MOXA C102/C104/C168 Family Adapter**" in "Select OEM Option" dialog. Click [**OK**] to start installation.
6. When MOXA C102/C104/C168 Configuration Panel is popped up, to configure the board(s) and ports, please refer to the Section "**Board and Port Configuration**" for more details.
7. Select [**OK**] for "Network Settings" dialog. Restart system as prompted.

4.2 Board and Port Configuration

The following is the procedure for configuring the C114HI driver under Windows NT 4.0 (or NT 3.51):

1. Enter [**Control Panel**] group, then select [**Network**] icon, and then [**Adapters**] folder. (Enter [**Control Panel**] folder, then select [**Network**] icon for NT 3.51.)
2. Select "**MOXA C102/C104/C168 Adapter**" item for "Installed Adapter Cards:", then [**Configure/Properties**] button to start the "MOXA C102/C104/C168 Family Configuration Panel" dialog.

When the configuration panel is popped up:

Click [**Add**] button to add a board.

Click [**Remove**] button to remove a board.

Click [**Properties**] button to set up a board with correct "Board Type", "IRQ", "INT Vector", "I/O Address", "COM Number" and "Received FIFO Trigger Level", where the possible parameters are as follows:

Board Type: C104, C168 Family.

IRQ No.: 2, 3, 4, 5, 7, 10, 11, 12, 15

INT Vector: I/O address for interrupt vector from 00000H to 0FFFFH. To use INT vector, type in the hardware INT vector I/O address. If not using INT vector, type 0 or leave blank as the INT vector.

There are two modes for the C114HI driver. One is using INT vector, the other is not using INT vector. INT vector is one byte of I/O address, in which each bit is used to indicate the occurrence of interrupt for corresponding port. Driver employing INT vector scheme is supposed to have better performance than employing polling scheme.

Sequential Port Mapping: For I/O Address, specify the I/O address of the first port and subsequent ports are set to continuous I/O addresses by the offset of 8 bytes. For instance, if the first port is set to 0x180, then the second port is set to 0x188 sequentially. For COM number, specify the COM number of the first port

and subsequent ports are mapped to continuous COM numbers. For instance, if the first port is mapped to COM10, then the second port is mapped to COM11 sequentially. For receive FIFO trigger level (bytes), every port will have the same trigger level as set. For 16550-compatible type of UART, receive FIFO trigger level is 1, 4, 8 or 14 bytes. The default is 14 bytes.

Non-sequential Port Mapping: For I/O Address, set the I/O address of each port independently. For COM number, set the COM number of each port independently. For receive FIFO trigger level (bytes), set the trigger level of each port independently. For 16550-compatible type of UART, receive FIFO trigger level is 1, 4, 8 or 14 bytes. The default is 14 bytes.

At most 4 boards of C114HI can be installed together as long as the IRQ and I/O address resources are sufficient and available in a system.

3. Unless the system restarted, the latest configuration will not take effect.

4.3 Board Initialization Status Checking

There are two alternative ways to find out if ports of the board are initialized successfully:

1. Enter [**Control Panel**] group and then [**Ports**] icon, to check the port list and see if all configured ports are already added in the system correctly.

If no configured port shown in the port list, refer to Section "**Troubleshooting**" for solutions.

2. Enter [**Administrative**] group, then [**Event Viewer**] icon, and then [**System Event Log**] to check for message like "COM10 (C104 port 4) O.K." for each configured port.

If message is "Can not find the configured C102/C104/C168 (CAP=0xXXXX) !", refer to Section "**Troubleshooting**" for solutions.

4.4 Driver Upgrade/Removal

To upgrade driver, remove the installed driver first and install the new one.

To remove driver,

1. Enter [**Control Panel**] group, then select [**Network**] icon, and then [**Adapters**] folder. (Enter [**Control Panel**] folder, then select [**Network**] icon for NT 3.51.)
2. Select "**MOXA C102/C104/C168 Adapter**" in adapter list, then [**Remove**] button to start removing the MOXA board.

4.5 Baud Rate Settings

When the board is configured as **High Speed Spectrum**, any port driven by the **Moxa-provided driver** will display the exact working speed. For example, the displayed speed 38.4 Kbps is equal to the working speed 38.4 Kbps.

However, if the port is driven by **non Moxa-provided driver**, such as **standard serial driver**, the real working speed is equal to **8 times** of the displayed speed. For example, a port, if set to Normal Speed Spectrum with 38.4 Kbps, will work at 38.4 Kbps for sure; while a port, if set to High Speed Spectrum with displayed speed 38.4 Kbps, will actually work at 307.2 Kbps (38.4 Kbps»ë8).

4.6 MOXA Serial Comm Tool: *PComm*

PComm is a software package consisting of MOXA serial communication library and utilities for diagnostic and monitor as well as example programs under Windows NT/95. Please see Chapter "*PComm*" for details.

4.7 Troubleshooting

The error messages and solutions are stated as clearly as possible. If all the possible solutions fail, the board or connection box might be defective. Please check the board or connection box ONE AT A TIME and find out the defective one.

1. **Can not find the configured C114HI (CAP=0xXXXX)!**

To avoid this, please double check the board settings from the driver configuration for each board installed, then shut down the system before

checking the following items:

- Plug in the board(s) properly.
- Inspect carefully on the settings of I/O address for each board installed.
- Sometimes slot for plugging board is malfunctioned.
In this case, please try other slots until good one is found.
- The board might be defective.
- For "quick installation" users, make sure the jumper JP1 is always short and the additional I/O address 0xA700 is not occupied by other devices.

If some other device use 0xA700 at the same time, I/O address conflict occurs. For example, a **partially decoded** device is using I/O address **0x300**. This will cause conflict with 0xA700, a **fully decoded** I/O address. In this case, either find out the other device causing conflict and change its I/O address if possible. Or use normal installation procedure for C114HI board, instead, to avoid conflict.

2. The C114HI's software and hardware configuration mismatch (CAP=0XXXXX)!

- To avoid this, please check the board settings of the software configuration via entering [Control Panel] group, then [Network] icon, then [Adapters] folder and then [MOXA C102/C104/C168 Configuration Panel] for each board installed, then shut down the system and run Io-irq.exe to check the board settings of the hardware configuration. Make sure both are same.
- The board might be defective.

Chapter 5 For Windows 95 Users

In this chapter, software driver installation, configuration and removal procedure are described. If it is necessary for you to develop your own applications, we strongly recommend that try out the easy but powerful *PComm* serial comm tool, which includes MOXA serial communication library for easy programming and utilities for diagnostic and monitor. Finally, Windows 95-specific troubleshooting is included.

5.1 Driver Installation - Setup95.exe

1. Run **Setup95.exe** in the driver diskette.
2. Select "**MOXA C102/C104/C168 Family Driver**" to install the driver.
3. When MOXA C102_C104_C168 Configuration Panel is popped up, to configure the board(s) and ports, please refer to the Section "**Board and Port Configuration**" for more details.

After this, users already complete the whole installation.

4. Restart Windows 95.
5. Check the board initialization status after logging in the system. Refer to Section "**Board Initialization Status Check**" for details.

5.2 Board and Port Configuration

You will enter the configuration program when installing the driver. Or you can click on the Taskbar [**Start**] button, then select [**Programs**] menu, then [**MOXA Utilities**] menu, and then [**MOXA C102_C104_C168 Configuration Panel**] icon. When the configuration panel popped up:

Click [**Add**] button to add a board.

Click [**Remove**] button to remove a board.

Click [**Properties**] button to set up a board with correct "Board Type", "IRQ", "INT Vector", "I/O Address", "COM Number" and "Received FIFO Trigger Level", where the possible parameters are as follows:

Board Type: C104, C168 Family.

IRQ: 2, 3, 4, 5, 7, 10, 11, 12, 15.

INT Vector: I/O address for interrupt vector from 00000H to 0FFFFH. To use INT vector, type in the hardware INT vector I/O address. If not using INT vector, type 0 or leave blank as the INT vector.

There are two modes for the C114HI driver. One is using INT vector, the other is not using INT vector. INT vector is one byte of I/O address, in which each bit is used to indicate the occurrence of interrupt for corresponding port. Driver employing INT vector scheme is supposed to have better performance than employing polling scheme.

Sequential Port Mapping: For I/O Address, specify the I/O address of the first port and subsequent ports are set to continuous I/O addresses by the offset of 8 bytes. For instance, if the first port is set to 0x180, then the second port is set to 0x188 sequentially. For COM number, specify the COM number of the first port and subsequent ports are mapped to continuous COM numbers. For instance, if the first port is mapped to COM10, then the second port is mapped to COM11 sequentially. For receive FIFO trigger level (bytes), every port will have the same trigger level as set. For 16550-compatible type of UART, receive FIFO trigger level is 1, 4, 8 or 14 bytes. The default is 14 bytes.

Non-sequential Port Mapping: For I/O Address, set the I/O address of each port independently. For COM number, set the COM number of each port independently. For receive FIFO trigger level (bytes), set the trigger level of each port independently. For 16550-compatible type of UART, receive FIFO trigger level is 1, 4, 8 or 14 bytes. The default is 14 bytes.

At most 4 boards of C114HI can be installed together as long as the IRQ and I/O port resources are sufficient and available in a system.

Unless the system restarted, the latest configuration will not take effect.

5.3 Board Initialization Status Checking

All the error conditions, during the initialization of Windows 95, will be popped up onto the screen. Otherwise, everything should be fine.

If message like "Can not find the configured C102/C104/C168 (CAP=0XXXX) !" or "The C102/C104/C168's software and hardware configuration mismatch (CAP=0XXXX) !" shows, refer to Section "Troubleshooting" for solutions.

5.4 Driver Upgrade/Removal

To upgrade the driver, simply install the driver again.

To remove driver, just remove all the configured boards. Once the MOXA driver is installed, it exists permanently in Windows 95 like other adapters do. Removing changes nothing but that particular board's existence in Windows 95 Registry.

5.5 Baud Rate Settings

When *Smartio* board is configured as **High Speed Spectrum**, any port driven by the **Moxa-provided driver** will display the exact working speed. For example, the displayed speed 38.4 Kbps is equal to the working speed 38.4 Kbps. However, if the port is driven by **non Moxa-provided driver**, such as **standard serial driver**, the real working speed is equal to **8 times** of the displayed speed. For example, a port, if set to Normal Speed Spectrum with 38.4 Kbps, will work at 38.4 Kbps for sure; while a port, if set to High Speed Spectrum with displayed speed 38.4 Kbps, will actually work at 307.2 Kbps (38.4 Kbps \times 8).

5.6 MOXA Serial Comm Tool: *PComm*

PComm is a software package consisting of MOXA serial communication library and utilities for diagnostic and monitor as well as example programs under Windows NT/95. Please see Chapter "*PComm*" for details.

5.7 Troubleshooting

The error messages and solutions are stated as clearly as possible. If all the possible solutions fail, the board or connection box might be defective. Please check the board or connection box ONE AT A TIME in the system and find out the defective one.

1. Can not find the configured C114HI (CAP=0xXXXX)!

To avoid this, please double check the board settings via clicking on [Start] button, then [Programs] menu, then [MOXA Utilities] menu, and then [MOXA C102_C104_C168 Configuration Panel] icon for each board installed, then shut down the system before checking the following items:

- Plug in the board(s) properly.
- Inspect carefully on the setting of I/O address for each board installed.
- Sometimes slot for plugging board is malfunctioned.
In this case, please try other slots until good one is found.
- The board might be defective.
- For "quick installation" users, make sure the jumper JP1 is always short and the additional I/O address 0xA700 is not occupied by other devices.

If some other device use 0xA700 at the same time, I/O address conflict occurs. For example, a **partially decoded** device is using I/O address **0x300**. This will cause conflict with 0xA700, a **fully decoded** I/O address. In this case, either find out the other device causing conflict and change its I/O address if possible. Or use normal installation procedure for C114HI board, instead, to avoid conflict.

2. The C114HI's software and hardware configuration mismatch (CAP=0xXXXX)!

- To avoid this, please check the board settings of the software configuration via clicking on [Start] button, then [Programs] menu, then [MOXA Utilities] menu, and then [MOXA C102_C104_C168 Configuration Panel] icon for each board installed, then shut down the system and run Io-irq.exe to check the board settings of the hardware configuration. Make sure both are same.
- The board might be defective.

Chapter 6

PComm

PComm, the professional serial comm tool for PC, is a software package under Windows NT/95, which consists of powerful serial communication library for easy programming in most popular languages, useful utilities such as diagnostic and monitor, illustrative example programs and comprehensive on-line documents.

The serial communication library is especially for users who develop a system for data communication, remote access, data acquisition or industrial control in the Windows NT/95 environment, which offers an easier solution compared with the more complex Windows Win32 COMM API.

6.1 Installation

To install *PComm*, please run `\Setup.exe` in the diskette.

Note that the MOXA Windows NT/95 device driver is required as using *PComm* diagnostic and monitor utilities.

6.2 Programming Library

The serial communication library is to assist users to develop programs for serial communications **for any COM port** complying with Microsoft Win32 API. It can ease the implementation of multi-process and multi-thread serial communication programs and hence greatly reduce the developing time.

For complete library function description and example programs for Visual C++, Visual Basic and Delphi, please see help file and example programs in *PComm* directory for more details.

6.3 Utilities

The followings are short descriptions of each utility. For details, please see on-line

help in the diskette.

Diagnostic

A convenient diagnostic program provides internal and external testing, such as IRQ, TxD/RxD, UART, CTS/RTS, DTR/DSR, DTR/DCD testing, etc., for the MOXA boards and ports to verify correct operation of both the software and hardware.

Monitor

A useful port status monitoring program allows users to watch the selected MOXA COM ports' data transmitting/receiving throughput and communication line status which are updated and displayed on the screen at every time interval. In addition, users may click on one of the specific displayed port in order to see the current communication parameters and status of that port.

Chapter 7 For DOS Users

The C114HI is useful for office automation and industrial control as well as data acquisition and communication. Because many users need to implement an industrial control system or data acquisition system in the DOS environment, but DOS did not have any better communication API, thus Moxa has developed device drivers and library functions under DOS. Furthermore, Data Scope utility is very helpful for troubleshooting and debugging the serial communications.

In this chapter, driver installation, setup, loading and removal procedure are described. Utility, **Data Scope**, is explained, which is good for terminal emulation, data scope and diagnostics. Related issues such as device naming and programming are also stated.

Moxa device driver is a port-based one and supports maximum of **8** serial ports. Settings of each port can be set independently.

7.1 Driver Installation, Setup, Loading and Unloading

MOXA provides a software package that assists users to develop and/or debug programs for serial communications under DOS. It supports device drivers for the MOXA boards such as C114HI, *Smartio* C104H/C168H Family, *Intellio* C218/C320 Series and standard PC COM ports, etc.

Driver Installation

Run the installation program, **DOSINST.EXE**, in the DOS/Windows 3.x (API-232) software diskette. Specify the target directory (e.g. **C:\MOXA**) where software driver and library will be copied to. Press **F2** to start the installation.

Driver Setup

1. Change to target directory and run the setup program, **BIN\SETUP.EXE**.

This program is to configure IRQ, port number, etc., of the MOXA boards. The configuration will be referred to by the later executed DOS driver. Note that

before running SETUP program, execute Io-irq to designate I/O address and IRQ.

2. Choose "**C102/C104/C168 Series Multiport Board**" in the "DRIVER SELECTION" dialog and then enter or modify each port's configuration which are the port initial value when driver is loaded.
3. Use **F8** function to load the on-board configuration for *Smartio* C104/C168 Family. Use other functions to modify settings if necessary. Finally remember to use **F10** function to save the configuration.

Some noticeable functions keys and fields are explained below.

Press **F1**: "Help" to learn an up-to-date instructions.

Press **F3**: "Add port" to add one port entry and modify the settings if necessary.

Press **F4**: "Delete port" to delete the port entry where the cursor stops.

Press **F5**: "Group edit" to set the selected ports (as a group) to the same settings.

Press **F6**: "INT vector" to specify the interrupt vector I/O address and set the status for each port. Interrupt-driven scheme is applied for those ports using interrupt vector while polling scheme for those ports not using interrupt vector. The former is more efficient and has better performance in terms of driver. In addition, for two C104 boards in a system, two separate interrupt vectors are required which can be accomplished with **F3: Toggle one/two INT vector**.

Press **F8**: "Load config" to load the hardware configuration set by Io-irq.exe. This is the most convenient way of configuration, comparing to add port one by one with function F3.

Port number: This is actually the port ID of each port. The application software will refer to the port by its port number (ID). Duplicated port number is not allowed.

Base I/O address: The I/O address of each port. Overlapped or duplicated I/O address is not allowed.

Interrupt number: The IRQ number of each port. Several ports may share one common IRQ.

TxD buffer size: The transmit (output) buffer reserved for the port.

RxD buffer size: The receive (input) buffer reserved for the port.

Driver Loading

Having completed the setup, load the driver, **BIN\SER-DRV.EXE**, at the DOS prompt. The driver will detect the multiport board automatically. If the board(s) is(are) detected, a message similar to below will show:

```
Universal 2/4/8 Serial Port Communication Driver (Ver x.x)
Device Driver Setup O.K.
```

Which means the board and the driver have been successfully installed. At this point, user is ready to execute application that supports API functions, or start developing applications.

If there is no matched port, the screen will show a message like:

```
Universal 2/4/8 Serial Port Communication Driver (Ver x.x)
No Serial Port Found!!
```

Please refer to Appendix "Troubleshooting" for possible reasons and solutions.

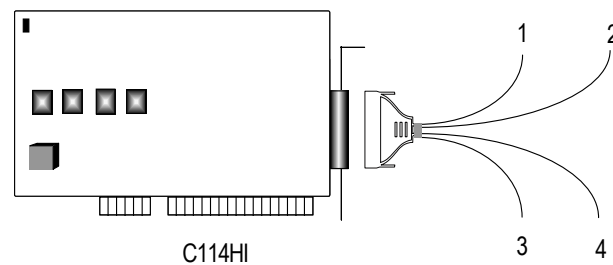
Driver Unloading

To unload the driver from memory, type **SER-DRV/Q** at the DOS prompt.

7.2 MOXA Serial Port Naming Convention

Each MOXA serial port are referenced as port number in terms of programming. The port numbers are automatically assigned once the starting port number is decided by user when configuring the ports of the board. Duplication of the port numbers is not allowed.

For example, if 4 ports are configured and the starting port number is 1, then the mapping of serial port numbers will be as depicted.



7.3 Baud Rate Settings

Be aware that, for *Smartio* boards configured as **High Speed Spectrum**, the real working speed is equal to **8 times** of the displayed speed. For example, a port, if set to Normal Speed Spectrum with 38.4 Kbps, will work at 38.4 Kbps for sure; while a port, if set to High Speed Spectrum with shown speed 38.4 Kbps, will actually work at 307.2 Kbps (38.4 Kbps \times 8). This is applicable to Moxa-provided driver and utility, such as Setup and Data Scope, and also any non Moxa-provided driver and utility, such as **Telix**.

7.4 DOS API-232 Library and Programming

For DOS programming, API-232 includes powerful libraries supporting languages like Microsoft C, Turbo C, Macro Assembly, QuickBasic, Turbo Pascal, Clipper, etc. Sample programs for each supported language are included, and placed in the sub-directory `..\EXAMPLE\language` of the API-232 directory.

In addition, for DOS C language only, there are also Modem Control and File Transfer library available, supporting Hayes compatible modem control as well as ASCII, KERMIT, XMODEM, YMODEM and ZMODEM file transfer protocol functions.

For complete and last-minute API function description, see file **API-232.TXT** in the API-232 directory for more details.

7.5 Data Scope

The Data Scope, **BIN\SCOPE.EXE**, is a suite of utility programs that can help users with system troubleshooting and serial communication debugging. There are three major functions:

1. The Data Scope utility offers transparent monitoring of serial communication lines and allows data to be streamed to disk storage for later analysis.
2. The TTY terminal emulation utility allows user to view the signal status and transfer data interactively or files using ASCII, XMODEM, YMODEM, ZMODEM and KERMIT protocols.
3. The diagnostic test utility provides port connection test with two MOXA ports connected via a properly-wired cable.

Please see on-line help as running **BIN\SCOPE.EXE** for more usage and capability information.

Chapter 8 For Windows 3.x Users

MOXA API-232 is a software package that assists users to develop and/or debug programs for serial communications under Windows 3.x (and also DOS).

In this chapter, driver installation and configuration procedure are described. Utility, **TTY**, is explained, which is good for terminal emulation. Related issues such as driver removal, baud rate settings, programming and existing applications are also stated.

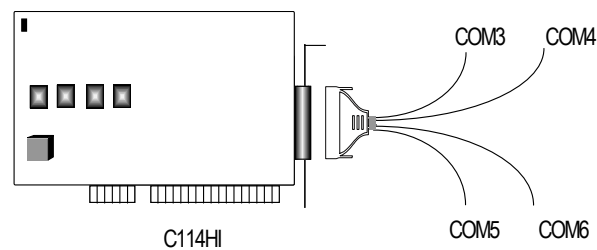
Installation

To install, run **WININST.EXE** in the DOS/Windows 3.x driver (API-232) diskette, select **COMM Driver** and **C104**, and then do configuration as prompted.

Configuration

The Windows-based configuration program, **CONFIG**, has the easiest way to configure the 4 ports of C104, either from COM1 to COM4, from COM2 to COM5, from COM3 to COM6, from COM4 to COM7, from COM5 to COM8 or from COM6 to COM9, depending on user's need. Normally COM1 is used by mouse and to fully use the 4 MOXA ports, thus COM3 to COM6 is recommended. In this case, the original COM1 and COM2 on PC will be still available.

For example, if 4 ports are configured and starting from COM3, then the mapping of serial port numbers will be as depicted.



Due to the limitations of Windows 3.x operating system itself, only up to 9 COM ports are supported, i.e., COM1 to COM9. Hence, C104 with 4 ports or other 4 port non-intelligent boards, maximum 6 ports is supported if the existing standard COM ports (COM1 and COM2) are included.

After successful installation, the **MOXA program group** will be created which contains all the useful programs Moxa provided. **Restarting Windows 3.x system** is required for MOXA Standard Windows-compatible COMM Driver after installation. When system restarted, the MOXA COMM Driver is ready to go.

Driver Removal

The program, **Remove**, in the **MOXA program group** is provided to remove the installed driver from the Windows.

Baud Rate Settings

For those *Smartio C104* boards configured as **High Speed Spectrum**, the real working speed is equal to **8 times** of the displayed speed. For example, a port, if set to Normal Speed Spectrum with 38.4 Kbps, will work at 38.4 Kbps for sure; while a port, if set to High Speed Spectrum with shown speed 38.4 Kbps, will actually work at 307.2 Kbps (38.4 Kbps»8). This is applicable to Moxa-provided utility, such as CONFIG and TTY, existing applications and programming which are described later in this chapter.

Utility

The utility, **TTY**, in the **MOXA program group** is intended to help users monitor and debug RS-232 communications under Windows 3.x which can manipulate ports from COM1 to COM9. It is just a simplest example program which can send and receive data after each port opened with selected communication parameters. Multiple windows for ports simultaneously are available for a demonstration of multitasking feature of Windows 3.x. The Windows-provided application, **Terminal**, can only make use of COM1 to COM4 which is obviously a restriction.

Windows 3.x COMM API Programming

MOXA Windows-compatible COMM Driver supports **Microsoft Windows COMM API** such as OpenComm(), ReadComm(), WriteComm(), etc. It supports any language conforming to the Windows COMM API like Microsoft C, Borland C, Visual C, Visual Basic, Delphi, etc. Sample programs for only Microsoft C, Borland C and Visual Basic are supported. For other languages' sample programs, please refer to the language-provided communication example programs.

Existing Applications

Many Windows software packages, such as pcANYWHERE, LabView, FIX, WinFax Pro, Fax Server, PROCOMM PLUS, LapLink, etc. can access MOXA C104 COM ports directly since these applications follow the Microsoft Windows COMM API.

Chapter 9 RS-232/422/485 Programming

The C114HI could be used for RS-232, RS-422 or RS-485 communications. It comes with a high level RS-232 Application Programming Library, API-232, for serial communication control under DOS, Windows 3.x, Windows NT and Windows 95. With proper jumper settings and cable wiring, users can program as follows :

9.1 RS-232 Programming

Please refer to the API-232 User's Manual or the documentation file \API-232.TXT in the API-232 or Windows NT/95 driver diskette.

9.2 RS-422 Programming

When RS-422 is needed, there is no difference from RS-232 in programming except that the jumper settings must be "Tx ON" and "Rx ON".

9.3 RS-485 Programming

The C114HI has four independent ports and each port has one receiver and one transmitter. Both of the transmitter and receiver can be either enabled or disabled in order to achieve not only point-to-point communication but also the multidrop communication.

Depending on the jumper settings described in Section 2.2, there are three ways for controlling transmitter and receiver of the port.

1. RTS ON/OFF

When the RTS signal is true, the transmitter is enabled and the receiver is disabled. Otherwise, the transmitter is in the high impedance status and can not transmit any signal.

A statement of as following will set RTS signal true and turn on the transmitter:

```
outportb(BASE + 4, 3);
```

Or use the following function in API-232 library:

```
sio_RTS(port, 1);
```

A statement as following will clear the RTS signal and turn off the transmitter :

```
outportb(BASE + 4, 0);
```

Or use the following function in API-232 library:

```
sio_RTS(port, 0);
```

Besides, the following function in API-232 library is provided especially for RS-485 programming:

```
sio_putb_x();
```

Please refer to API-232 User's Manual for more details.

2. REG

The transmitter(or receiver) is controlled by the control register BASE + 7 bit 1 (or bit 0), where BASE is the base I/O address of the port. When the corresponding bit is set to "1", the transmitter/receiver is enabled. Setting the bit to "0" will turn the transmitter/receiver off to high impedance status and the 16x50 UART chip will not transmit/receive any signal. In Turbo C language, a statement as following will turn on the transmitter :

```
outportb(BASE + 7, 1);
```

A statement as following will turn on the receiver:

```
outportb(BASE + 7, 2);
```

A statement as following will turn off both the transmitter and receiver:

```
outportb(BASE + 7, 0);
```

A statement as following will turn on both the transmitter and the receiver:

```
outportb(BASE + 7, 3);
```

3. AUTO

In the AUTO mode, the transmitter is enabled and the receiver is disabled whenever outgoing data is available. Otherwise, the transmitter is disabled and the receiver is enabled. No handshaking signals, such as RTS, are necessary. Users can build a RS-485 network with just two wires. The RS-485 control is completely transparent to users. This feature means RS-485 acts just like RS-232 in half duplex operation mode. Applications written for half-duplex RS-232 can be used without modification.

Please refer to the sample program rs485.c in the \DOS\EXAMPLE\C directory for more programming details.

Appendix A Pinouts and Cable Wiring

C114HI is suitable for RS-232, RS-422 or RS-485 communications. Each port can be set to RS-232, RS-422 or RS-485 interface independently via the jumpers. Refer to Chapter "Hardware Installation and IO-IRQ" for more details.

In data communications, the term **DTE** is Data Terminal Equipment like terminal or PC COM1/2. The term **DCE** is Data Communication Equipment like modem. Their precise pinouts and cable wiring are as follows.

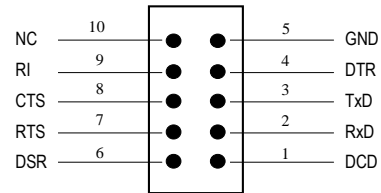
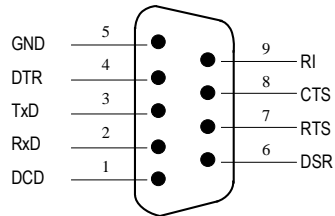
The following comparison table is for EIA Standards RS-232, RS-422 and RS-485.

	Mode of operation	No. of Drv.	No. of Rcv.	Max. length (FT)	Max. Rate (bps)
RS-232	single ended	1	1	50	20K
RS-422	differential	1	10	4000	10M
RS-485	differential	32	32	4000	10M

A.1 RS-232

The following lists pinouts of the RS-232 port.

C114HI DB-9 Male Connector		C114HI Pin-head Connector	
1	DCD	1	DCD
2	RxD	2	RxD
3	TxD	3	TxD
4	DTR	4	DTR
5	GND	5	GND
6	DSR	6	DSR
7	RTS	7	RTS
8	CTS	8	CTS
9	RI	9	RI
		10	NC



RS-232 cable wiring is as follows:

Type 1: To connect C114HI to a DTE.

C114HI DB-9 Male		DTE DB-25 Male	
3	TxD	3	RxD
2	RxD	2	TxD
7	RTS	5	CTS
8	CTS	4	RTS
6	DSR	20	DTR
4	DTR	6	DSR
5	GND	7	GND
1	DCD	8	DCD

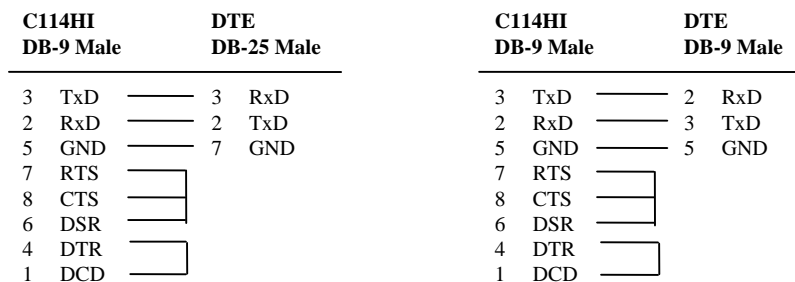
C114HI DB-9 Male		DTE DB-9 Male	
3	TxD	2	RxD
2	RxD	3	TxD
7	RTS	8	CTS
8	CTS	7	RTS
6	DSR	4	DTR
4	DTR	6	DSR
5	GND	5	GND
1	DCD	1	DCD

Type 2: To connect C114HI to a DCE.

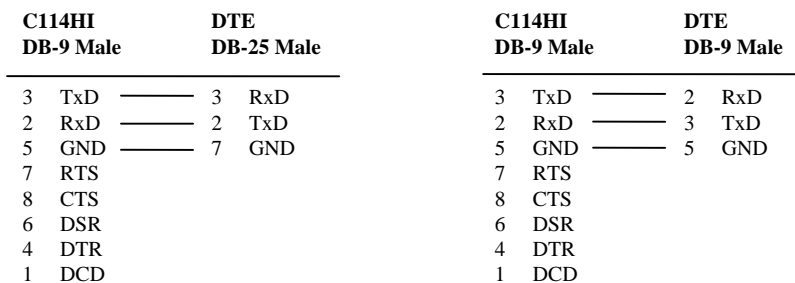
C114HI DB-9 Male		DCE DB-25 Female	
3	TxD	2	RxD
2	RxD	3	TxD
7	RTS	4	CTS
8	CTS	5	RTS
6	DSR	6	DTR
5	GND	7	GND
4	DTR	20	DSR
1	DCD	8	DCD

Type 3: To connect C114HI to a DTE with 3-pin wiring.

If [Hardware flow control] feature is set to "ON", user must loop back (or short) the RTS with CTS and DSR with DTR, DCD on MOXA site.



If [Hardware flow control] feature is set to "OFF", users could just leave RTS, CTS, DSR, DTR, DCD open.



A.2 RS-422

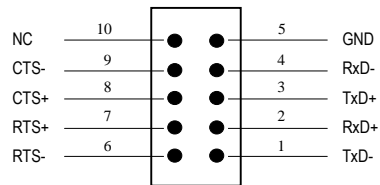
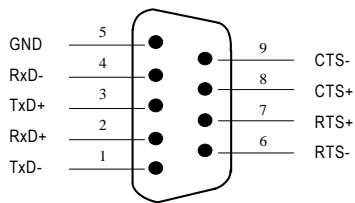
The following lists pinouts of the RS-422 port.

C114HI DB-9 Male Connector

1	TxD-(A)
2	RxD+(B)
3	TxD+(B)
4	RxD-(A)
5	GND
6	RTS-(A)
7	RTS+(B)
8	CTS+(B)
9	CTS-(A)

C114HI Pin-head Connector

1	TxD-(A)
2	RxD+(B)
3	TxD+(B)
4	RxD-(A)
5	GND
6	RTS-(A)
7	RTS+(B)
8	CTS+(B)
9	CTS-(A)
10	NC



RS-422 cable wiring is as follows:

C114HI site	Remote site
1 TxD-	RxD-
2 RxD+	TxD+
3 TxD+	RxD+
4 RxD-	TxD-
5 GND	GND
6 RTS-	CTS-
7 RTS+	CTS+
8 CTS+	RTS+
9 CTS-	RTS-

A.3 RS-485

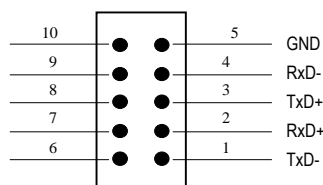
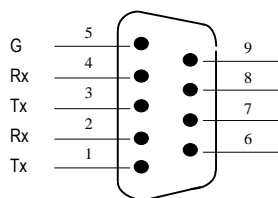
The pinouts of the RS-485 port are the same as RS-422 except that only TxD+, TxD-, RxD+, RxD- and GND are used. The following lists pinouts of the RS-422 port.

C114HI DB-9 Male Connector

1	TxD-(A)
2	RxD+(B)
3	TxD+(B)
4	RxD-(A)
5	GND

C114HI Pin-head Connector

1	TxD-(A)
2	RxD+(B)
3	TxD+(B)
4	RxD-(A)
5	GND

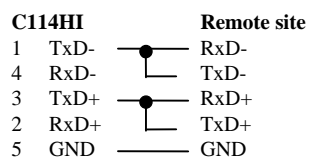


There are two operation modes for RS-485. Note that when jumper set to half duplex, TxD+ with RxD+ and TxD- with RxD- **are shorted internally on board**. Only TxD+ and TxD- are good for connection.

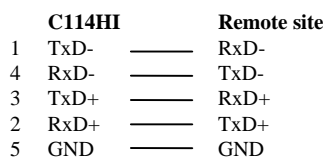
1. Point-to-Point

Point-to-Point configuration means two devices located at two different places can be linked together to communicate via RS-485 interface.

Point-to-Point RS-485 Half-Duplex



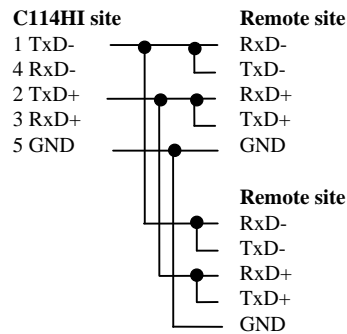
Point-to-Point RS-485 Full-Duplex



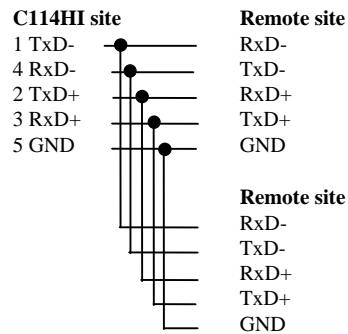
2. Multidrop

Multidrop configuration means that more than two devices can be linked together to communicate one another via RS-485 interface. In this configuration, one of the device serves as master device while the rest of the devices as slaves.

Multidrop RS-485 Half-Duplex



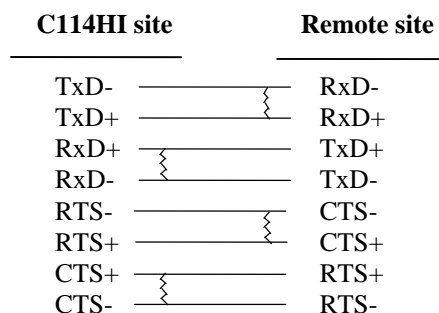
Multidrop RS-485 Full-Duplex



A.4 Impedance Matching and Termination Resistors

When an electrical signal travels through two different resistance junctions in a transmission line, the mismatched impedance between cable and receiver will sometimes cause signal reflection. Signal reflection causes signal distortion, which in turn will contribute communication errors. The solution to this problem is to establish the same impedance at the receiver ends by connecting a termination resistor in parallel with the same impedance as the cable's characteristic impedance. The value of termination is determined by cable. Please refer to your cable supplier for more information regarding the characteristic impedance for your cable.

It is normally sufficient when the value of the termination resistor equals the characteristic impedance of the transmission line. The resistors should be added near the receiving side. See below RS-422 example.

**Note:**

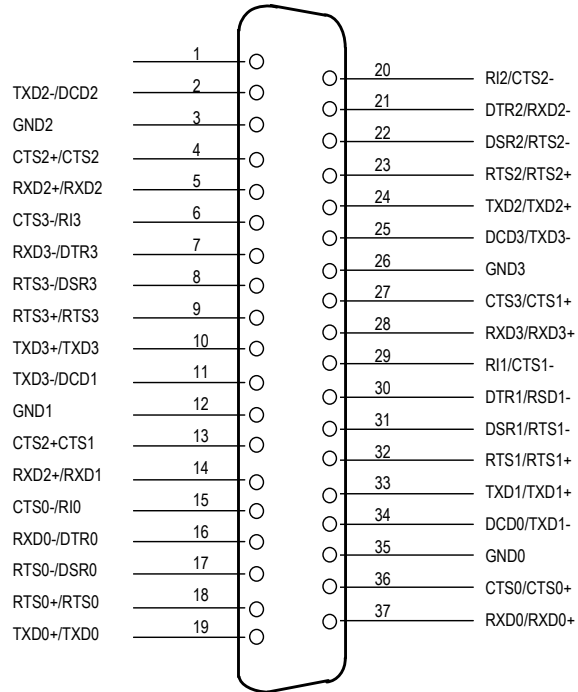
1. ξ stands for termination resistor near the receiving side
2. The suggested termination resistor for AWG #26 cable is 100 ohm.
3. The suggested termination resistor for phone cable is 100 ohm.

For C114HI, RT1 to RT8 reserved on the board are to be used to install termination resistors for impedance matching. These resistors are not installed at the factory. Users should install the resistors with appropriate resistance according to the application.

- RT1 is for CTS+/- of C114HI port 1.
- RT2 is for RxD+/- of C114HI port 1.
- RT3 is for CTS+/- of C114HI port 2.
- RT4 is for RxD+/- of C114HI port 2.
- RT5 is for CTS+/- of C114HI port 3.
- RT6 is for RxD+/- of C114HI port 3.
- RT7 is for CTS+/- of C114HI port 4.
- RT8 is for RxD+/- of C114HI port 4.

A.5 Pinouts of DB-37 Connector

The following lists pinouts of the C114HI DB-37 connector on the bracket.



Note: make shield grounded to the connector.

Appendix B High Speed Operations

This section describes the use of high speed capability supported by C114HI. There are two speed spectra which are

Normal Speed Spectrum	High Speed Spectrum
50	400
75	600
110	880
134.5	1076
150	1200
300	2400
600	4800
1200	9600
1800	14400
2400	19200
4800	38400
7200	57600
9600	76800
19200	153600
38400	307200
57600	460800
115200	921600

The corresponding speed in High Speed Spectrum is exactly eight times the speed in Normal Speed Spectrum. A port, if set to Normal Speed Spectrum with 38.4K bps, will work at 38.4K bps for sure; while a port, if set to High Speed Spectrum with 38.4K bps, will actually work at 307.2K bps ($307.2K = 38.4K \times 8$). Choose either one of the two speed spectra by running DOS utility: IO-IRQ.EXE.

- Hint:**
1. Check what speed range is needed for a port.
 2. If a port will work at speed slower than 400 bps, e.g. 75 bps, then choose Normal Speed Spectrum by running IO-IRQ.
 3. If a port will work at speed faster than 115.2K bps, e.g. 460.8K, or at a special speed, e.g. 400 bps, then choose High Speed Spectrum by running IO-IRQ.

For UNIX Users

For the C114HI board configured as High Speed Spectrum, the real working speed is equal to 8 times of the displayed speed (with "stty" command).

Appendix C Troubleshooting

1. Board not found.

- a. The software base addresses do not match with the hardware ones.
- b. The base I/O addresses selected conflict with other devices. Avoid it and refer to Appendix E.
- c. The board is not properly plugged in the system. Reinstall it.
- d. The board is defective. Return it for repair.

2. Board found but can not transfer data.

- a. Wrong cable wiring. Correct it.
- b. Wrong IRQ setting or conflict. Change it.

3. Why the DOS utility IO-IRQ can not access C114HI to configure?

There are several reasons that may lead to this trouble:

- a. The user forgot or does not know the Configuration Access Port (CAP) of the board. Refer to the next question and answer.
- b. The CAP of the board conflicts with other add-on board's I/O address. Please change one of them.
- c. The board is not plugged in a right or good slot. Please plug the board in a good 16-bit ISA slot.
- d. The board may malfunction. Please return for repair.

4. What to do if user forget or does not know the Configuration Access Port (CAP) of the board?

Steps to recall CAP :

- ú Power off the PC.
- ú Install jumper cap onto the JP1 of the board.
- ú Power on the PC. Now the CAP address of the board is forced to 0xA700.
- ú Execute IO-IRQ under DOS.

- ú Enter CAP address 0xA700 to access the board and configure it.
- ú Keep in mind the CAP.
- ú Exit IO-IRQ and power off PC.
- ú Remove the jumper cap on the position JP1.
- ú Power on PC.

Appendix D I/O Port Address Map

The following is the list of the I/O port address commonly used, which is for preventing I/O address conflict when configuring C114HI.

IO/ Address	Device
000-01F	DMA controller 1
020-03F	interrupt controller
040-05F	Timer
060-06F	Keyboard
070-07F	Real-time clock
080-09F	DMA page register
0A0-0BF	Interrupt controller 2
0C0-0DF	DMA controller
0F0-0FF	Math coprocessor
100-1EF	not usable
1F0-1F8	Fixed disk
200-207	Game I/O
278-27F	Parallel printer port 2 (LP2:)
2F8-2FF	Serial Port 2 (COM2:)
300-31F	Prototype card
360-36F	Reserved
378-37F	Parallel printer port 1 (LP1:)
3B0-3BF	Monochrome display
3C0-3CF	Reserved
3D0-3DF	Color graphics display
3F0-3F7	Diskette controller
3F8-3FF	Serial port 1 (COM 1:)

RETURN PROCEDURE

For product repair, exchange or refund, the customer must:

- ✓ Provide evidence of original purchase
- ✓ Obtain a Product Return Agreement (PRA) from the sales representative or dealer
- ✓ Fill out the Problem Report Form (PRF) as detailed as possible for shorter product repair time.
- ✓ Carefully pack the product in anti-static package, and send it, pre-paid, to the dealer. The PRA should show on the outside of the package, and include a description of the problem along with the return address and telephone number of a technical contact.