7188XC Series

Hardware User's Manual

7000 New Features
1. Self Tuner Inside
2. Multiple Baud Rate
3. Multiple Data Format
4. Dual WatchDog Inside
5. True Distributed Control
6. High Speed & High Density I/O

→ | Your Powerful Tools |

↓

| Create New Ideas |

↓

| Create New Applications |

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1.   Introduction

The 7188XC series is a series of expandable embedded controllers designed for industry applications. They can be used to replace the PC or PLC in harsh environments. The 7188X series can be ordered as following:

Order Items	Module name	O. S.
7188XA(D)	Expandable Embedded controller	MiniOS7
7188XB(D)	Expandable Embedded controller	MiniOS7
7188XC(D)	Expandable Embedded controller	MiniOS7
7XXX	7XXX without 7-SEG display	MiniOS7
7XXXD	7XXX with 7-SEG display	MiniOS7

The 7000 series modules have been very successful during the past three years. Over one hundred thousand modules have been shipped to locations all over the world. The reasons for our success are given as follows:

● Time-to-market & cost-effective solutions
● Durable, stable, flexible, & easy to program
● Over 50 various I/O modules are supported
● Can be used in harsh, noisy industry environments

However, even though the 7000 family is so versatile, there are some applications that cannot be initially solved, such as:

● High speed applications
● Special hardware requirement applications
● Special software requirement applications
● A combinations of special hardware & software applications

Therefore, we developed an I/O expansion bus for the 7188X family to

solve all the above applications above. The I/O expansion bus can be used to implement various I/O functions such as D/I, D/O, A/D, D/A, Timer/Counter, UART, flash memory, battery backup SRAM, AsicKey & other I/O functions. **Nearly all kinds of I/O functions can be implemented by this bus.**

The I/O expansion bus includes serial & parallel interface. The parallel interface is very similar to ISA bus, so the user can move the old ISA bus design to the I/O expansion bus with very little modification.

Furthermore, the I/O pins of the serial bus are programmable. They can be programmed as D/I, or D/O. Some pins can be configured to D/I or D/O or timer input or timer output. There are many serial interface devices today. The features of these serial devices are given as follows:

- Smaller size compared to parallel devices
- Lower cost compared to parallel devices
- Easier to design for isolation applications

The serial interface of the I/O expansion bus can link to these serial devices very easily. The design of the I/O Expansion Bus makes the idea of a "Customized 7000 Module" come true. The features of a "Customized 7000 Module" are given as follows:

- **7188X+X?? → Single module solution → a "Customized 7000 Module"**
- 7000 compatible command sets & RS-485 networking
- Easy hardware/software interface for user to design & manufacture their own special hardware & software
- Time-to-market ODM solution for user's special requirements (any high speed, complex or combined functions of D/I/O, A/D, D/A,.., etc.)
- Durable, stable, flexible, time-to-market & cost-effective total solution.

Some "Customized 7000 Modules" are available as follows:
- IKIT-12: Arbitrary Waveform Generator=7188XCD+X300
- More "Customized 7000 Modules" will be ready in the near future

Refer to "I/O Expansion Bus in 7188X/7188E User's Manual" for more information.

Refer to " 7000 Bus Converter User Manual   chapter 1 for more information as follows:

1.1 7000 Overview
1.2 7000 Related Documentation
1.3 7000 Common Features
1.4 7000 System Network Configuration
1.5 7000 Dimensions

Package List
In addition to this manual, the package includes the following items:
- One 7188XC series hardware module
- One hardware manual (this manual)
- One release note
- One software utility disk or CD
- One download cable   → CA0910F for 7188XC

Note
If any of these items are missing or damaged, contact the local distributors for more information. Save the shipping materials and cartons in case you want to ship in the future.

Release Note
It is recommended to read the release note first. All important information will be given in release note as follows:
- Where the "7188X/7521 Software User's Manual" is
- Where the "I/O Expansion Bus for 7188X/7188E User's Manual" is
- Where the software driver & diagnostic programs are

1.1 Features

1.1.1 General features

- AMD's embedded CPU, Am188™ES: 20M
- SRAM: 128K bytes
- Flash ROM: 256K bytes
- Built-in EEPROM
- Built-in RTC&NVRam: 7188XC series can add a RTC/NVRAM
- Built-in COM port: COM1, COM2
- Industry D/I/O onboard
- User defined D/I/O
- Built-in 5-digit LED display interface
- COM driver support interrupt & 1K QUEUE input buffer
- Built-in I/O expansion bus interface
- Built-in watchdog timer for harsh environments
- Built-in power protection circuit
- Built-in RS-485 network protection circuit
- Built-in self-tuner ASIC controller on RS-485 port
- Program download from PC
- Built-in OS: MiniOS7 of ICP DAS
- Operating temperature: -25°C to +75°C
- Can be used in harsh environments for industry applications

NOTE:

1. ODM wanted

2. "Customized 7000 Modules" wanted

1.1.2 What is MiniOS7?

The MiniOS7 is an embedded O.S. designed for the 7188X/7521 series. **Developed by ICP DAS Co. Ltd;** It is used to replace the ROMDOS used in the 7188 series. Several brands of DOS have been created by various companies. In all cases, DOS--whether PC-DOS, MS-DOS, or ROM-DOS--is a set of commands or code which tells the computer how to process information. DOS runs programs, manages files, controls information processing, directs input and output, and performs many other related functions. **The MiniOS7 provides the equivalent functions of ROMDOS while, in addition, providing user specific functions for the 7188X/7521 family.**

Comparison table between MiniOS7 & ROM-DOS?

	MiniOS7	ROMDOS
Power up time	0.1 sec	4 ~ 5 sec
More compact size	<64K bytes	64K bytes
Supports I/O expansion bus	Yes	No
Supports AsicKey	Yes	No
Flash ROM management	Yes	No
O.S. update (download)	Yes	No
Built-in hardware diagnostic functions	Yes	No
Direct control of the 7000 series modules	Yes	No
Customer ODM functions	Yes	No
Free charge	Yes	No

Note: We reserve the right to change the specifications of MiniOs7 without notice

1.1.3 What is the Self-Tuner ASIC?

The 2-wire RS-485 port is designed to directly drive the 7000 series modules. It is a half-duplex 2-wire RS-485 network. Send/receive directional control in a 2-wire RS-485 network is very important. Therefore, The 7188X/7521 series equip a Self-Tuner ASIC controller for all RS-485 ports. The Self-Tuner ASIC controller will auto detect & control the send/receive direction of the RS-485 network. Consequently, the application program does not have to worry about the send/receive directional control of the RS-485 network.

1.1.4 What is the I/O Expansion Bus?

The 7188XC family support I/O expansion buses. The I/O expansion bus can be used to implement various I/O functions such as D/I, D/O, A/D, D/A, Timer/Counter, UART, flash memory, battery backup SRAM, AsicKey & other I/O functions. Nearly all kinds of I/O functions can be implemented on this bus.

1.1.5 What is the AsicKey?

The I/O expansion bus supports AsicKey. The AsicKey equips a complex machine for validation checking. Included in this is 128 bytes of private data for the same purpose. It provides very strong protection against illegal copies. Every legal user has a unique AsicKey & unique software library, the user can self check this key, or the software library will check the key automatically. In this main, it is nearly impossible to remove the AsicKey protection.

1.1.6 7188XC = Addressable RS-232 Converter?

The 7188XC is designed as an embedded controller. Therefore, any software can be downloaded into it. If the firmware for an "Addressable RS-232 Converter" is downloaded into a 7188XC, they will act as an "Addressable RS-232 Converter". Consequently, the most low cost, "Addressable RS-232 Converter" is the **7188XC+ "Addressable RS-232 Converter Firmware"**.

| 7188XC | → | **The most low cost embedded controller** |

+

| Addressable RS-232 Converter Firmware | → | **The most low cost "Addressable RS-232 Converter" (without isolation on RS-485 port)** |

1.2 Pin Assignment

COM1

i-7188XC

Embedded Controller
CPU 80188-20
COM1 : RS-232 / RS-485
COM2 : RS-485
D/O   : 3 Channels
D/I   : 3 Channels
X1-X3 : User Defined

COM2

1												13
X3	X2	X1	DO3	DO2	DO1	DI 3	DI 2	DI 1 / INIT*	(Y)D2+	(G)D2 -	(R)Vs+	(B)GND
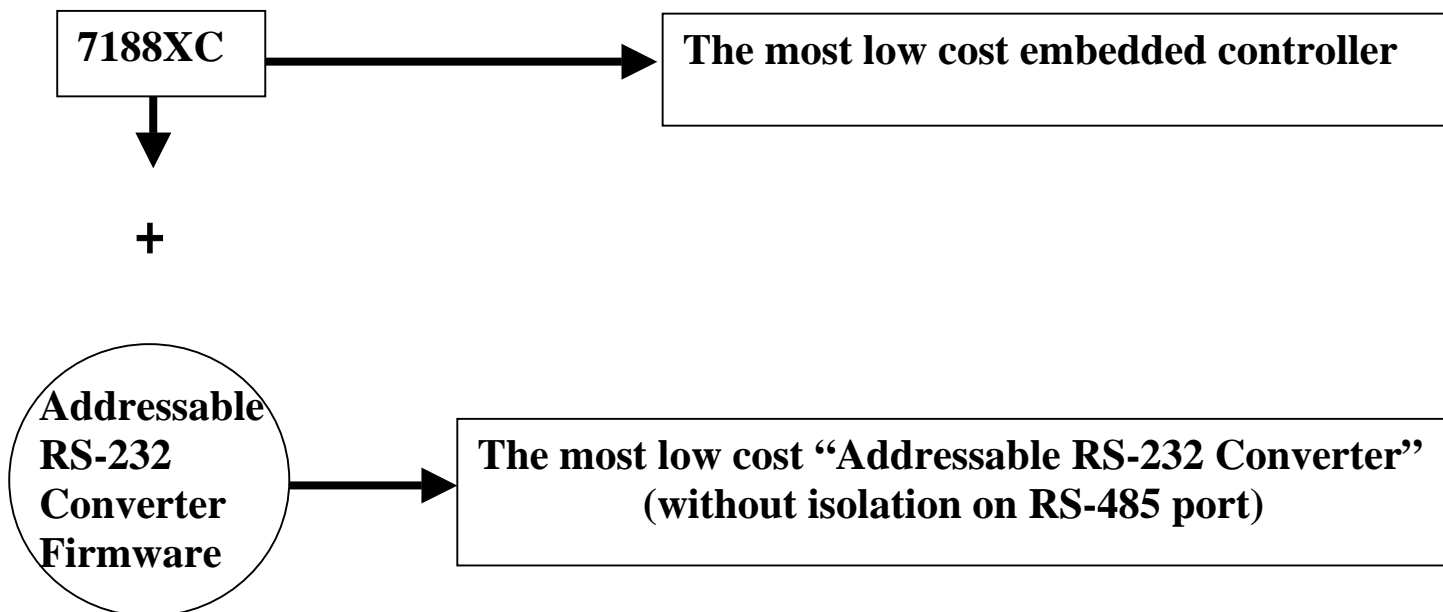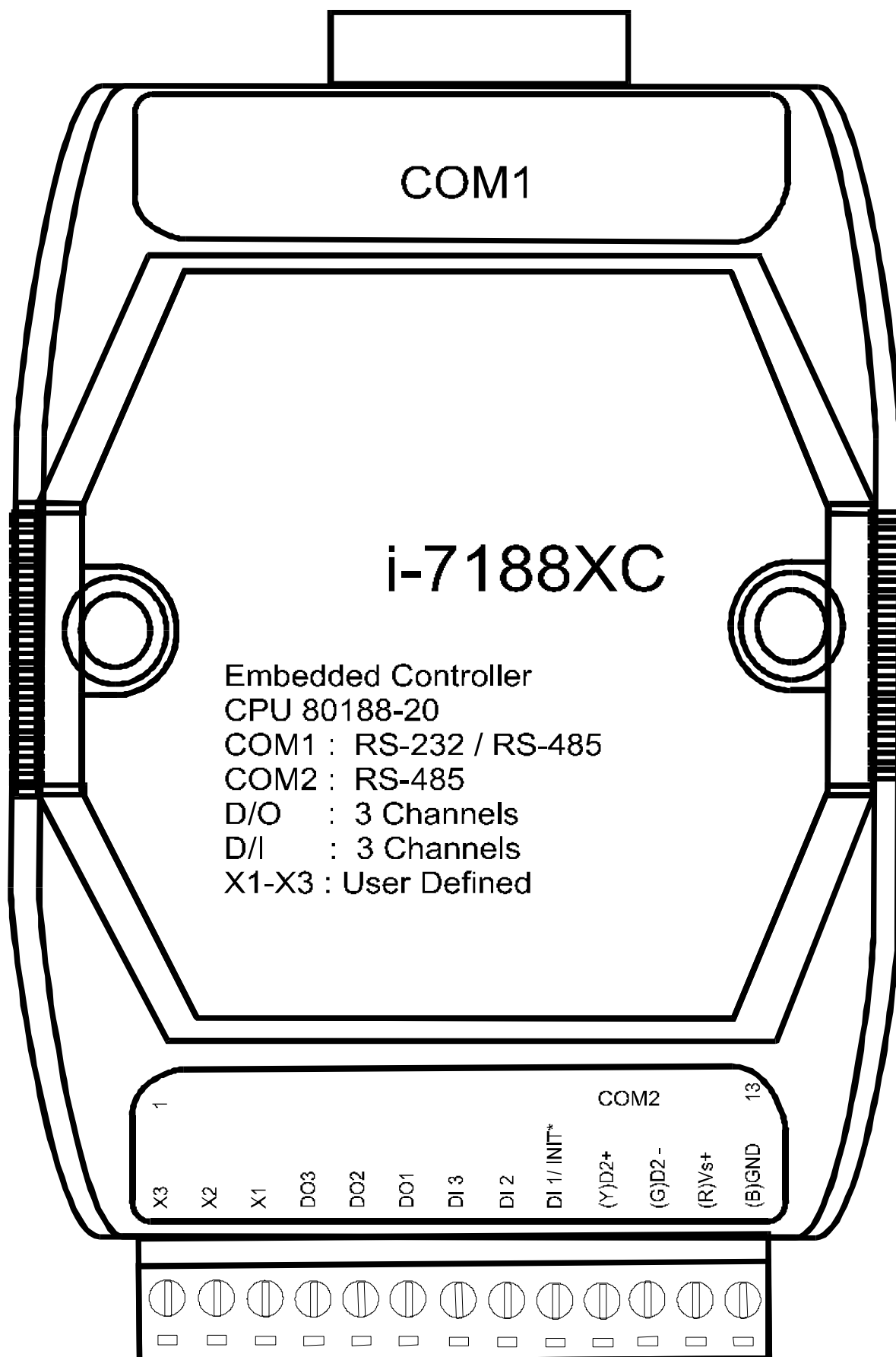
Pin assignment of 13-pin screw terminal block(7188XC/7188XCD):

Pin	Name	Description
1	X3	Connects to I/O expansion board
2	X2	Connects to I/O expansion board
3	X1	Connects to I/O expansion board
4	DO3	Digital output, 150mA, 30V
5	DO2	Digital output, 150mA, 30V
6	DO1	Digital output, 150mA, 30V
7	DI3	Digital input, 3.5V ~ 30V
8	DI2	Digital input, 3.5V ~ 30V
9	DI1/ INIT*	Initial pin or digital input, 3.5V ~ 30V
10	D2+	DATA+ pin of COM2 (RS-485)
11	D2-	DATA- pin of COM2 (RS-485)
12	+VS	V+ of power supply (+10 to +30VDC unregulated)
13	GND	GND of power supply

Pin assignment of COM1 connector (DB-9 Male):

Pin	Name	Description
1	Data+	DATA+ of RS-485 port
2	TXD	Transmits Data (RS-232)
3	RXD	Receives Data (RS-232)
4	N/C	No Connection
5	GND	Signal ground of RS-232
6	N/C	No Connection
7	CTS	Clear To Send (RS-232)
8	RTS	Request To Send (RS-232)
9	Data-	DATA- of RS-485 port

Note: The COM1 can be used as a RS-232 port or a RS-485 port. It is not recommended to use both RS-232 & RS-485 at the same time.

1.3 Specifications

General environment

- Operating temperature: -25°C to +75°C
- Storage temperature:-40°C to +85°C
- Humidity: 0 to 90 %
- Built-in Watch Dog Timer (1.6 seconds)
- Built-in power protection & network protection circuit
- Program downloadable from PC
- Built-in I/O expansion bus interface

1.3.1 Specifications of 7188XC & 7188XCD

System

- Module name: embedded controller
- CPU: Am188™ES, 20M Hz
- SRAM: 128K bytes
- FLASH ROM: 256K bytes
- COM port: COM1, COM2
- Built-in EEPROM, D/I, D/O
- Supports I/O Expansion Bus
- **Program download port: COM1**

EEPROM

- 2048 bytes (8 blocks, each block has 256 bytes)
- Data retention > 100 years
- 1,000,000 erase/write cycles

Flash Memory

- 256K bytes
- Erase unit is one sector(64K bytes)
- 100,000 erase/write cycles

COM1

- RS-232 or RS-485
- RS-232: TXD,RXD,RTS,CTS,GND
- RS-485: D1+, D1-, self-tuner ASIC inside

- Communication speed: 115200 max.

COM2
- RS-485: D2+, D2-, self-tuner ASIC inside
- Communication speed: 115200 max.
- Direct connect to 7000 RS-485 network

D/I
- 3 channels
- Logic low level: 0V ~ 1V
- Logic high level: 3.5V ~ 30V (for -25°C to +70°C)
                    3.5V ~ 25V (for -25°C to +75°C)

D/O
- 3 channels, 150mA, 30V max.

Display
- 7-segmemt LED: 5-digit (for 7188XCD)

Power
- Power requirements: 10 to 30VDC(non-regulated)
- Power consumption: 2.0W for 7188XC
                      3.0W for 7188XCD

For ODM User
- Flash ROM can be upgraded to 512K bytes
- COM2 can be upgraded to 3000V isolated
- EEPROM can be 32K bytes
- **Real Time Clock is available**
  - Year-2000 compliance
  - Seconds, minutes, hours, date of the month
  - Month, year, valid **from 1980 to 2079**
  - NVSRAM: 31 bytes, battery backup, valid up to 10 years

1.4　Block Diagram


```
                    ┌──────────────────┐
                    │ SRAM=128K        │
                    │ Flash-ROM=256K   │
                    └──────────────────┘
                             ▲▼

┌──────────────┐     ┌──────────────┐     ┌──────────────┐
│ COM1         │◄───►│              │◄───►│ Watchdog     │
│ RS-232/RS-485│     │              │     │ circuit      │
└──────────────┘     │              │     └──────────────┘

┌──────────────┐     │              │     ┌──────────────┐
│ D/O=3 channel│◄───►│  80188-20    │◄───►│ EEPROM       │
│ 150 mA, 30V  │     │  16 bits timer│    │ (2K)         │
└──────────────┘     │              │     └──────────────┘
┌──────────────┐     │              │     ┌──────────────┐
│ D/I=3 channel│◄───►│              │     │ 5-digit LED  │
│ 3.5V ~30V    │     │              │────►│ (options)    │
└──────────────┘     │              │     │              │
┌──────────────┐     │              │     └──────────────┘
│ COM2,RS-485  │◄───►│              │
└──────────────┘     └──────────────┘
                        ▲      ↘
                       +5V      ┌──────────────┐
          ┌──────────────┐      │ User defined │
          │ +10V to +30V │      │ pin=3        │
          │ power converter│    └──────────────┘
          └──────────────┘

7188XC
```
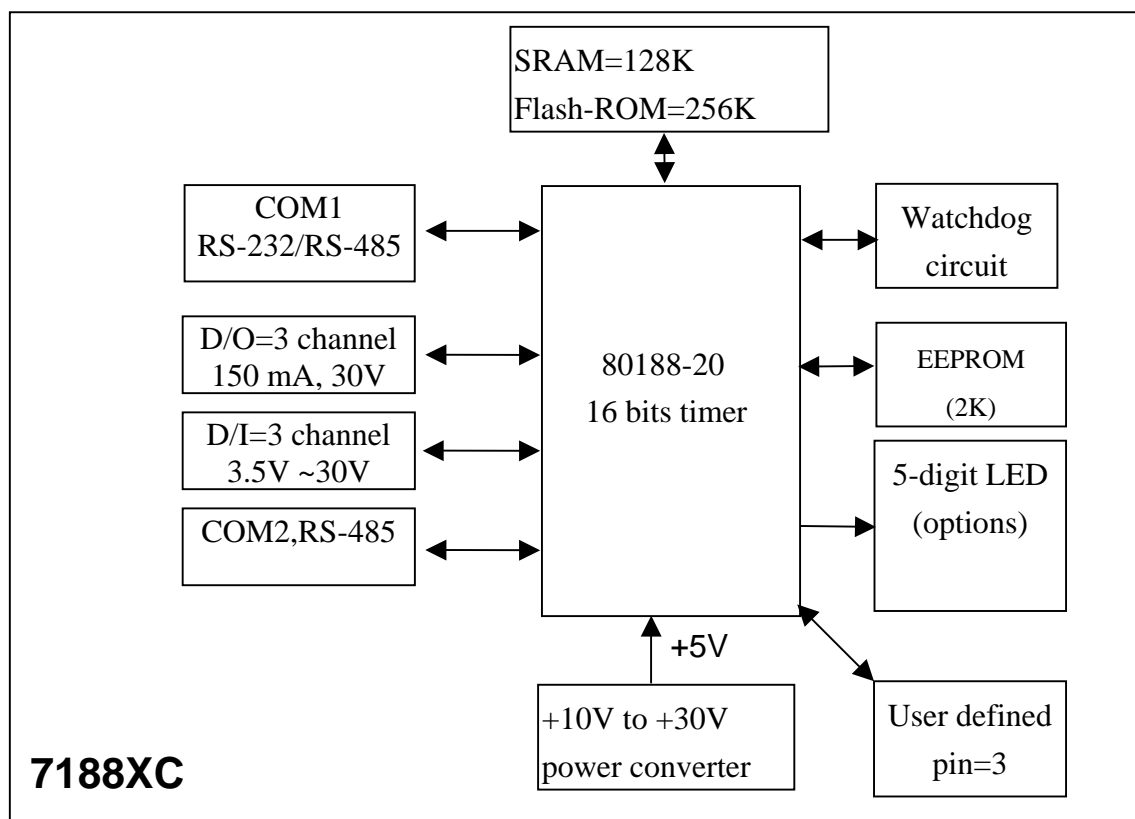
1.5 Program download

1.5.1 Valid for the 7188XC(D)

7188XC/7188XCD

COM1		7188XC/7188XCD	
1	Data+	GND	13
2	TXD	+VS	12
3	RXD	D2-	11
4	N/C	D2+	10
5	GND	Di1/Init	9
6	N/C	DI2	8
7	CTS	DI3	7
8	RTS	DO1	6
9	Data-	DO2	5
		DO3	4
		X1	3
		X2	2
		X3	1

Ext. GND — 13
Ext. 24V — 12

Connect INIT* to GND to disable autoexec.bat

COM1

Download cable CA0910F

PC COM-1/2/3/4

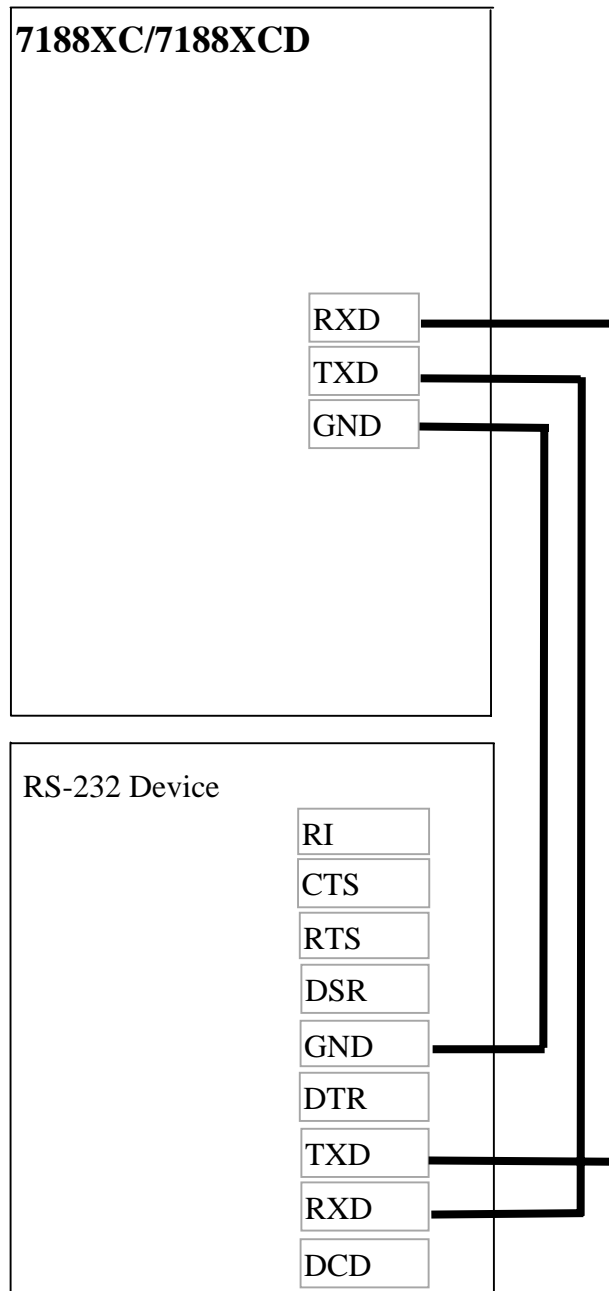| 9	RI
8	CTS
7	RTS
6	DSR
5	GND
4	DTR
3	TXD
2	RXD
1	DCD
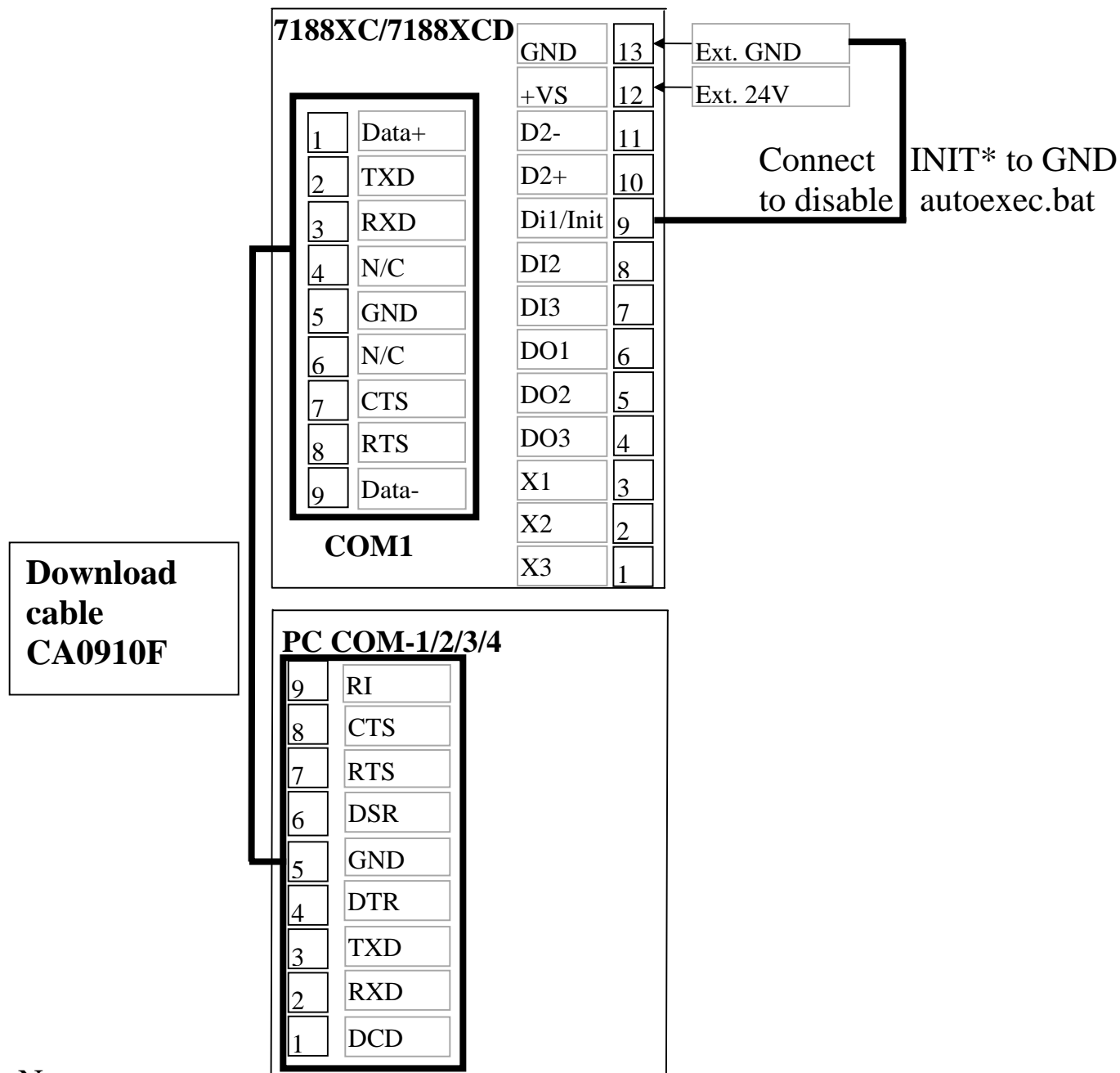
Note:
- Connect the COM1 of the 7188XC & PC's COM-1/2 port with the download cable, CA0910F

1.5.2 Using a 3-wire RS-232 port

7188XC/7188XCD

| RXD |
| TXD |
| GND |

RS-232 Device

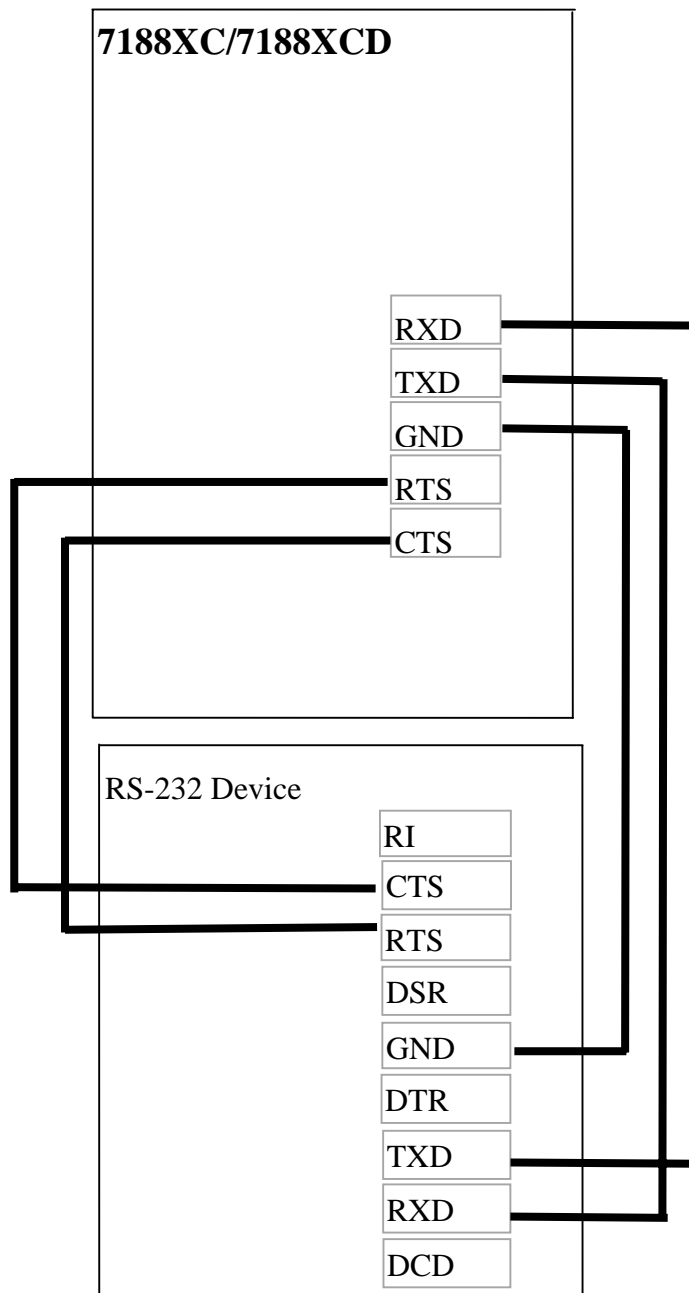| RI |
| CTS |
| RTS |
| DSR |
| GND |
| DTR |
| TXD |
| RXD |
| DCD |

There are 3 wires as following:

- Connect RXD to TXD of RS-232 device
- Connect TXD to RXD of RS-232 device
- Connect GND to GND of RS-232 device

1.5.3 Using a 5-wire RS-232 port

7188XC/7188XCD

RXD	
TXD	
GND	
RTS	
CTS	

RS-232 Device

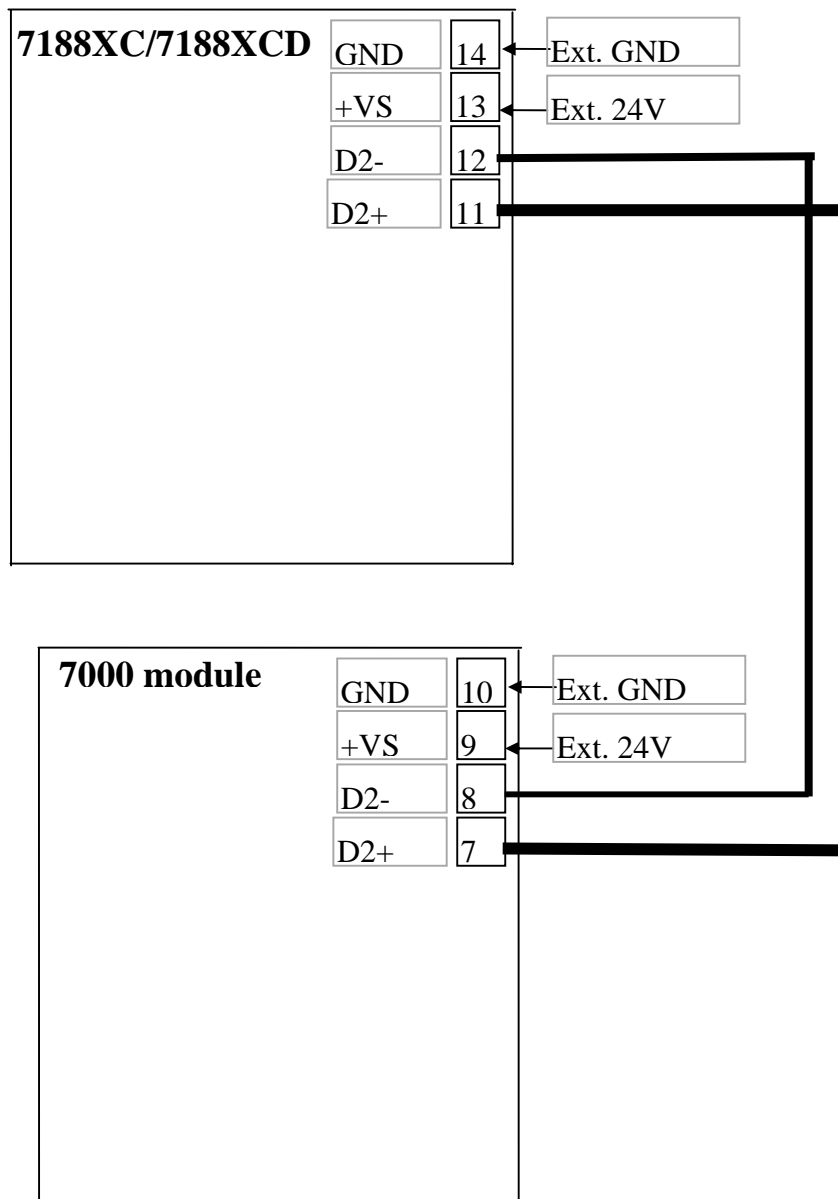| |
|---|
| RI |
| CTS |
| RTS |
| DSR |
| GND |
| DTR |
| TXD |
| RXD |
| DCD |

There are 5 wires as follows:

- Connect RXD to TXD of RS-232 device
- Connect TXD to RXD of RS-232 device
- Connect RTS to CTS of RS-232 device
- Connect CTS to RTS of RS-232 device
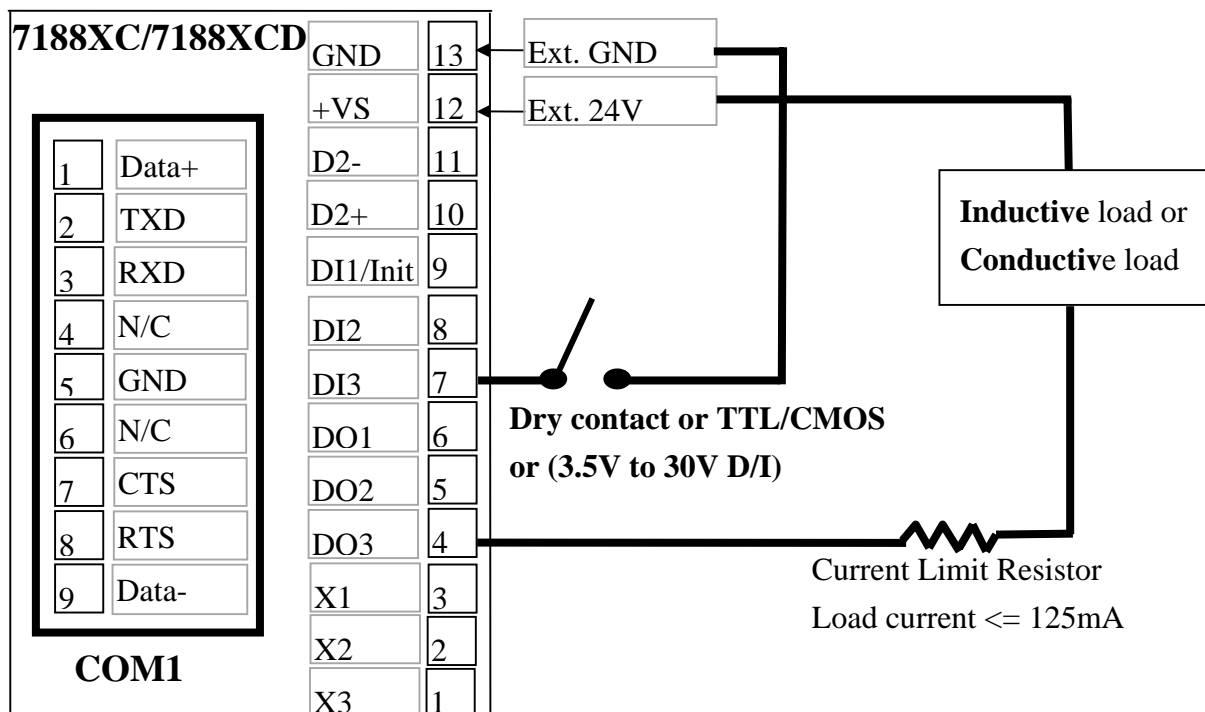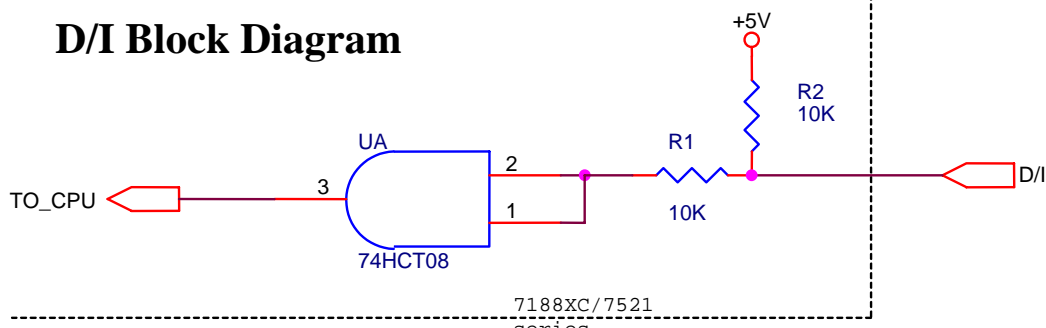- Connect GND to GND of RS-232 device

1.5.4 Using a RS-485 port

7188XC/7188XCD

GND	14	← Ext. GND
+VS	13	← Ext. 24V
D2-	12	
D2+	11	

7000 module

GND	10	← Ext. GND
+VS	9	← Ext. 24V
D2-	8	
D2+	7	

Note:
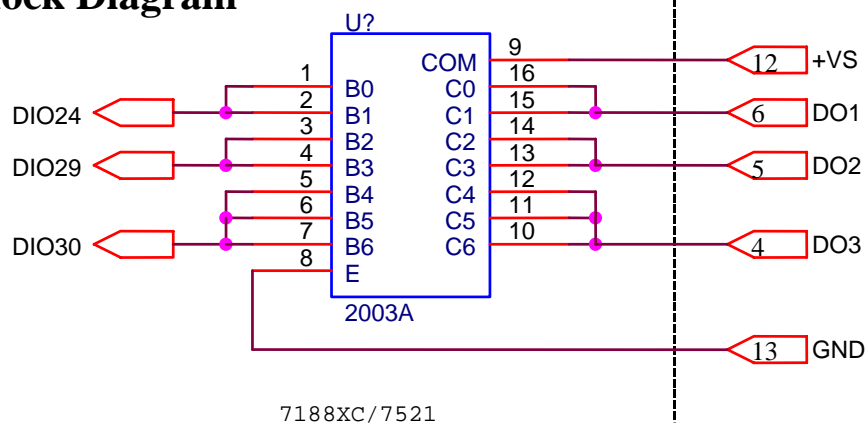- The RS-485 interface can directly drive 256 sets of 7000 modules without a repeater

1.5.5 Using D/I/O of the 7188XC

D/I Block Diagram

D/O Block Diagram

1.6   Comparison Table

Comparison table between the 7188 & the 7188X series:

	7188(D)	7188XC(D)	7188XB(D)	7188XA(D)
CPU clock	80188, 40M Hz	80188,20M Hz	80188, 40M Hz	80188, 40M Hz
SRAM	256K	128K	256K	512K
Flash ROM	256K/512K	256K (512K for ODM)	512K	512K
COM1	RS-232 with modem control or RS-485	RS-232 or RS-485 with self-tuner inside	RS-232 or RS-485 with self-tuner inside	RS-232 with modem control or RS-485 with self-tuner inside
COM2	RS-485,	RS-485 with self-tuner inside	RS-485 with self-tuner inside	RS-485 with self-tuner inside, 3000V isolation
COM3	RS-232 (txd,rxd)	No Com3	No Com3	RS-232 (txd,rxd)
COM4	RS-232 (txd,rxd)	No Com4	No Com4	RS-232 (txd,rxd)
User defined pins	0	3	14	0
Modem control	COM1	No	No	COM1
RTC	Yes	No	Yes	Yes
64 bits hardware unique serial number	No	No	Yes	Yes
EEPROM	2K bytes	2K bytes	2K bytes	2K bytes
D/I(3.5V~30V)	0	3 channels	1 channel	2 channels
D/O(150mA, 30V)	0	3 channels	1 channel	2 channels
I/O expansion bus	No	Yes	Yes	Yes
Support AsicKey	No	Yes	Yes	Yes
Operation system	MiniOS7	MiniOS7	MiniOS7	MiniOS7
Programming language	TC/MSC/BC	TC/MSC/BC	TC/MSC/BC	TC/MSC/BC
Program download	COM4	COM1	COM1	COM4

Comparison table of 7188E series:

	7188EA(D)	7188EX(D)	7188E2(D)
CPU clock	80188, 40M Hz	80188, 40M Hz	80188, 40M Hz
SRAM	512K	512K	256K
Flash ROM	512K	512K	256K
COM1	RS-232 or RS-485 with self-tuner inside	RS-232 or RS-485 with self-tuner inside	RS-232 or RS-485 with self-tuner inside
COM2	RS-485 with self-tuner inside, non-isolated	RS-485 with self-tuner inside, non-isolated	RS-485 with self-tuner inside, non-isolated
RTC	Yes	Yes	No
64 bits hardware unique serial number	Yes	Yes	No
EEPROM	2K bytes	2K bytes	2K bytes
D/I(3.5V~30V)	6 channels	0	0
D/O(150mA, 30V)	7 channels	0	0
User Defined pins	0	14	0
I/O expansion bus	Yes (but used by system)	Yes	No
Support AsicKey	Yes	Yes	No
Operation system	MiniOS7	MiniOS7	MiniOS7
Programming language	TC/MSC/BC	TC/MSC/BC	TC/MSC/BC
Program download	COM1	COM1	COM1
Ethernet interface	10BaseT	10Base-T	10BaseT

Comparison table of CPU modules:

	Description
7188	Embedded Controller
7188XA	Expandable Embedded Controller with I/O Expansion Bus
7188XB	Expandable Embedded Controller with I/O Expansion Bus, high I/O expansion
7188XC	Expandable Embedded Controller with I/O Expansion Bus, low cost
7521/22/23	Embedded Communication Controller, 1/2/3 channels
7188EA	Embedded Internet/Ethernet Controller, DI * 6 channels, DO * 7 channels
7188EX	Embedded Internet/Ethernet Controller with I/O Expansion Bus
7188E1	Internet Communication Controller, RS232 * 1
7188E2	Internet Communication Controller, RS232 * 1 + RS485*1
7188E3	Internet Communication Controller, RS232 * 1 + RS485 * 1+RS422/485 * 1 + DI * 4 +DO * 4
7188E4	Internet Communication Controller, RS232 * 3 + RS485*1
7188E5	Internet Communication Controller, RS232 * 4 + RS485*1
7188E8	Internet Communication Controller, RS232 * 7 + RS485*1

1.7 Reconfiguring the 7188XC(D)

From pin-4 to pin-8 of the 7188XC(D) there are three D/O & two D/I pins. For the application of "Customized 7000 Modules", these 5 D/I/O pins can be hardware reconfigured to other functions as follows:

Step 1: Remove the reconfiguration-resistor as follows:
- **If DO3 is reconfigured, remove R19**
- **If DO2 is reconfigured, remove R20**
- **If DO1 is reconfigured, remove R21**
- **If DI3 is reconfigured, remove R22**
- **If DI2 is reconfigured, remove R23**

Then, the onboard D/I/O functions can be disabled.

Step 2: Install a 5-pin male reconfiguration-jumper into the TP0 of the 7188XC(D).

Step 3: Design a 5-pin female reconfiguration-jumper in X??? for connection to TP1. Then the external signals from pin-4 to pin-8 can be connected to X???. The user can refigure these 5 D/I/O pins to their special requirements now.

Note: If the DO2 is reconfigured to D/I, its initial state must be High. If its initial state is LOW, system clock will be reduced to 10M. So all clock-related libraries will only be at half-speed.

The X100 is an 8-channel D/I board designed for the 7188XC(D). It removes all 5 resistors, R19 ~ R23, and reconfigures all these pins as D/I pins. It installs another 5-pin female reconfiguration-jumper into TP1 of the 7188XC(D). **Therefore, user can select the original 3_DO_2_DI functions or new 5_DI functions by setting the jumper in different positions.** Refer to "I/O Expansion Bus in the 7188X/7188E User's Manual" for more information.

2. Operation Principles

2.1 System Mapping

2.1.1 Address Mapping of the 7188XB/7188XC

Device	Address mapping
Flash ROM	256K: from C000:0000 to F000: FFFF
	512K: from 8000:0000 to F000: FFFF
SRAM	128K: from 0000:0000 to 1000: FFFF
	256K: from 0000:0000 to 3000: FFFF
COM1 BASE	0XFF80 to 0XFF88
COM2 BASE	0XFF10 to 0XFF18

Interrupt No.	Interrupt mapping
0	Divided by zero
1	Trace
2	NMI
3	Break point
4	Detected overflow exception
5	Array bounds exception
6	Unused opcode exception
7	ESC opcode exception
8	Timer 0
9	Reserved
0A	DMA-0
0B	DMA-1
0C	\INT0 of I/O expansion bus
0D	\INT1 of I/O expansion bus
10	XB: \INT4 of I/O expansion bus
	XC: Reserved
11	COM2
12	Timer 1

13	Timer 2
14	COM1

2.1.2 Address Mapping of the X505, X506, X507

		X505	X506	X507
DI		N/A	N/A	0
DO		N/A	N/A	0
COM3	**BASE**	**0X10**	**0X10**	**0X10**
	INT	**INT0**	**INT0**	**INT0**
COM4	**BASE**	**0X18**	**0X18**	N/A
	INT	**INT1**	**INT0**	N/A
COM5	**BASE**	**0X20**	**0X20**	N/A
	INT	**INT4**	**INT1**	N/A
COM6	**BASE**	N/A	**0X28**	N/A
	INT	N/A	**INT1**	N/A
COM7	**BASE**	N/A	**0X30**	N/A
	INT	N/A	**INT4**	N/A
COM8	**BASE**	N/A	**0X38**	N/A
	INT	N/A	**INT4**	N/A

2.2 How to Debug User's Programs

The **download_ports** of the 7188XC family are given as follows:
- 7188XC → **Use COM1**

When the 7188XC family series is powered-up, it will initialize the **download_port** to the following configuration:
- **Start-bit=1, data-bit=8, stop-bit=1, no parity**
- **Baud rate = 115200 BPS**

Then, the 7188XC will send all power-up information to the **download_port**. The user will see all power-up messages as follows:
- Power-off PC & 7188XC
- Install the download cable between **download_port** of 7188XC & COM1 of PC (refer to Sec. 1.6.1)
- Power-up PC & Run 7188X.EXE
- Power-up 7188XC
- All power-up message will be shown on the monitor of the PC

After the power-up stage, the 7188XC will use the **download_port** as its standard input/output. So the standard output of 7188XC will be shown on the PC's monitor. If the user presses any key on the PC's keyboard, this key will be sent to the 7188XC as standard input. Therefore the keyboard & monitor of PC can be used as standard input & output of the7188XC as follows:
- Use 7188X.EXE as a bridge between the 7188XC & PC
- Run 7188X.EXE in PC to set up this bridge
- **Keyboard of PC   → standard input of 7188XC**
- **Monitor of PC   → standard output of 7188XC**

In this way, the 7188XC can read data from the keyboard & display it on the monitor. So program debugging will be more convenient & effective.

Note: 7188X.EXE is included on the companion floppy disk/CD.

2.3　How to Download User's Program

Refer to Sec. 2.2 to find the **download_port** first.

The user can download the program into the 7188XC as follows:

- Power-off PC & the 7188XC
- Install the download cable between **download_port** of the 7188XC & COM1 of PC (refer to Sec. 1.6.1)
- Power-up PC & Run 7188X.EXE
- Power-up the 7188XC
- All power-up messages will be shown on the monitor of the PC
- Key-in "load", press Enter key, & wait for system request message
- Press Alt-E, the screen will ask you to input filename,
- Key-in the filename & press Enter key, the file will be download into the 7188XC
- Key-in the filename & press Enter. This will start to execute this file
- Pressing Alt & X at the same time will quit the 7188X.EXE

2.4　Using the download_port as a COM port

The user can use the **download_port** of the 7188XC series as a general purpose RS-232 port as follows:

- Download user's program & autoexec.bat to the 7188XC first.
- Power off the 7188XC & remove the download the cable from PC.
- If they are connected, disconnect the INIT*-pin from GND-pin of the 7188XC.
- Power on the 7188XC (no standard input, no standard output, no debug information)
- Install the download cable between new RS-232 device & **download_port** of the 7188XC
- Initialize the **download_port** to new configuration.
- The **download_port** is a general purpose RS-232 port now.
- **Refer to "7188X/7521 Software User's Manual" for demo programs**

2.5 COM ports Comparison

The COM port of the 7188XC series can be RS-232 or RS-485 as follows:

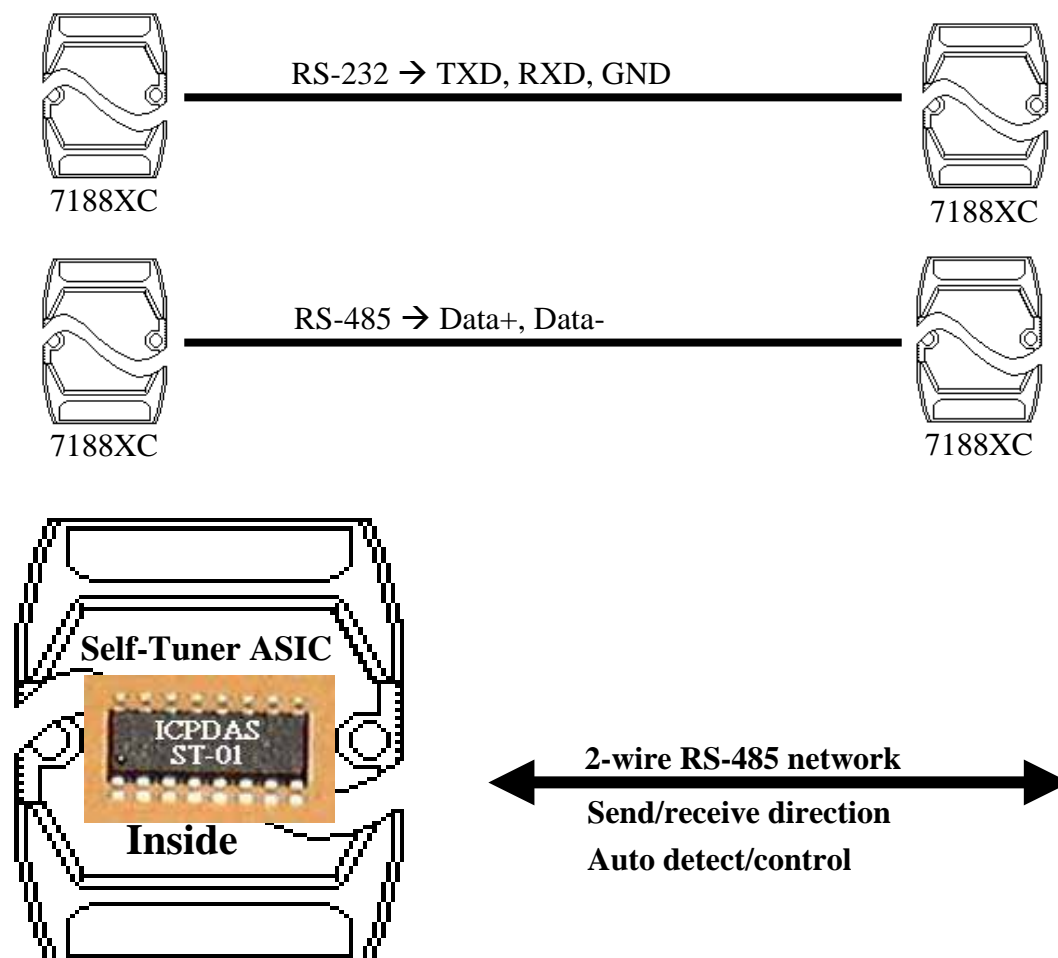| type	Pins name
2-wire RS-485	Data+, Data-
3-wire RS-232	Txd,Rxd,Gnd
5-wire RS-232	Txd,Rxd,Gnd,Rts,Cts
9-wire RS_232	Txd,Rxd,Gnd,Rts,Cts,Dcd,Dtr,Dsr,Ri

The COM ports of the 7188XC are given as follows:

COM port	Hardware
COM1	80188's on-chip UART-0, 5-wire RS-232 & 2-wire RS-485
COM2	80188's on-chip UART-1, 2-wire RS-485

2.6   The RS-485 Port & Self-Tuner ASIC

The 2-wire RS-485 port is designed to directly drive 7000 series modules. It is a half-duplex 2-wire RS-485 network. Send/receive directional control in a 2-wire RS-485 network is very important. Therefore, the 7188X series equip a Self-Tuner ASIC controller for all RS-485 ports. The Self-Tuner ASIC controller will auto detect & control the send/receive direction of the RS-485 network. In this main, the application program does not have to worm about the send/receive direction control of the RS-485 network. For example, the software program for one-to-one communication is nearly the same.

```
ToCom(port, sent_data);       /* send one sent_char to RS-232/RS-485     */
                              /* no direction control                    */
while IsCom(port);            /* wait one echo_char from RS-232/RS-485 */
echo_data=ReadCom(port);   /* read this echo_data                      */
```

RS-232 → TXD, RXD, GND

7188XC   7188XC

RS-485 → Data+, Data-

7188XC   7188XC

Self-Tuner ASIC

ICPDAS
ST-01

Inside

2-wire RS-485 network

Send/receive direction

Auto detect/control

2.7   Using Red LED & 7-SEG LED Display

The red LED of the 7188XC series can be turned-ON or turned-OFF by its software program. The 5 digits of the seven-segment LED are also programmable. **The 5-digit LED is very useful in real world applications.** It can be used to replace the monitor & touch-screen for many applications.

2.8   Using RTC & NVSRAM

The RTC & NVSRAM are located on the same chip. There is a Li-battery to backup the RTC & NVSRAM for 10 years. The features of the RTC are given as follows:

- MiniOS7 supports RTC time & date

- Seconds, minutes, hours, date of the month

- Month, day of week, year, Leap year valid up to 2079

- NVSRAM: 31 bytes, data valid for 10 years

Note1: Only 7188XA & 7188XB support RTC & NVRAM.

Note2: The 7188XC series can add a RTC/NVRAM for the OEM/ODM user.

2.9   Using EEPROM

The EEPROM is designed to store the data which is not changed very frequently. This data is given as follows:

● Module ID, configuration settings

● COM port configuration settings

● Small databases

The erase/write cycle of the EEPROM is limited, the user should not change the EEPROM frequently for testing. The EEPROM can **erase/write in single byte**, so it is very useful in real world applications.

2.10   Using the Watchdog Timer

The watchdog timer of the 7188XC series is fixed at 1.6 sec. **When the 7188XC is powered up, the watchdog timer will be always enabled.** If the 7188XC do not refresh the watchdog timer every 1.6 seconds, the watchdog will RESET the 7188XC .

The MiniOS7 of the 7188XC will automatically refresh the watchdog after power up. The user program can call the software driver to tell MiniOS7 to stop refreshing the watchdog timer, then the user program must refresh the watchdog timer. If the user program does not refresh the watchdog timer every 1.6 seconds, the watchdog timer will RESET the 7188XC.

2.11　Using the I/O Expansion Bus

The 7000 series modules have been very successful in during the past three years. Over one hundred thousand modules have been shipped to locations all over the world. The reasons for our success is given as follows:

- Time-to-market & Cost effective solutions
- Durable, Stable, Flexible & Easy programming
- Over 50 Various I/O Modules are supported
- Can be used in harsh & noisy industry environments

However, even though the 7000 family is so versatile, there are some applications that cannot be solved. These applications are given as follows:

- High speed applications
- Special hardware requirement applications
- Special software requirement applications
- A combination of special hardware & software applications

Therefore, we developed an I/O expansion bus for the 7188X family to solve all the above applications. The I/O expansion bus can be used to implement various I/O functions such as D/I, D/O, A/D, D/A, Timer/Counter, UART, flash memory, battery backup SRAM, AsicKey & other I/O functions. **Nearly all kinds of I/O functions can be implemented by this bus.**

The I/O expansion bus includes serial & parallel interface. The parallel interface is very similar to ISA bus, so the user can move the old ISA bus design to the I/O expansion bus with very little change.

The I/O pins of serial bus are programmable. They can be programmed as D/I, or D/O. Some pins can be configured to D/I or D/O or timer input or timer output. There are many serial interface devices available today. The features of these serial devices are given as follows:

- Smaller size compared to parallel devices
- Lower cost compared to parallel devices
- Easier to design for isolated applications

The serial interface of the I/O expansion bus make interface to these serial devices very easy.

The combination of serial & parallel interface make the I/O expansion bus very convenient & powerful for various industry applications. There are many design examples given in "I/O Expansion Bus in the 7188X User's Manual". All hardware circuit & software driver sources are OPEN for modification. From these examples, the user can make new applications or modify them for their special requirements. The system design steps are given as follows:

Step 1: list all functions required
Step 2: for all functions, goto step 3. If all functions are solved → STOP
Step 3: if this function can be solved by 7000 module → goto step 2
Step 4: if this function can be solved by 7188X+X??? → goto step 2
Step 5: user designed special hardware for I/O expansion bus
Step 6: user writes special software driver for this hardware
Step 7: combine the special hardware & software as a new module
Step 8: goto step 2

After the above steps, user can combine the standard 7000 modules & special modules to solve all applications in the same RS-485 network. The system is given as following:
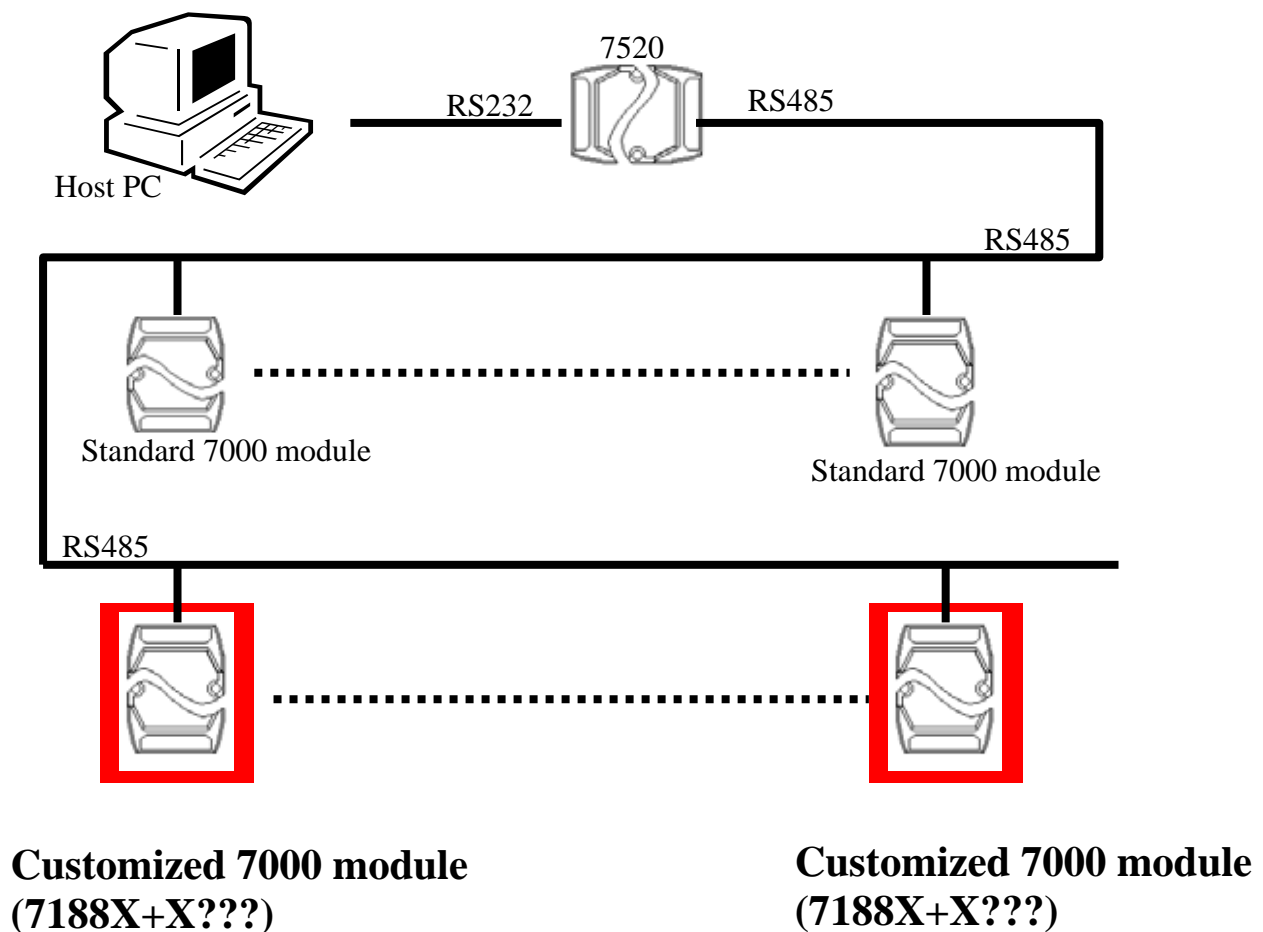
2.11.1　　Definition of an I/O Expansion Bus

The I/O expansion bus of the 7188XC series can be divided into 3 groups as follows:

1. Power supply & reset signals: VCC, GND, RESET, /RESET

2. , Parallel Bus:

- System clock: CLOCKA

- Asynchronous ready control: ARDY

- Address bus: A0 ~ A6

- Data bus: D0 ~ D7

- Interrupt control: INT0, INT1

- Chip select & read/write strobe: /CS, /WR, /RD

3. Serial Bus: TO_0, TO_1, TI_0, TI_1, SCLK, DIO9, DIO4, DIO14

Refer to "I/O Expansion Bus for 7188X/7188E User's Manual" for more information.

2.11.2   Definition

The definition of the I/O expansion bus is given as follows:

JP1 pin definition & description:

No	Name	Description
1	GND	Ground of PCB
2	GND	Ground of PCB
3	CLOCKA	Synchronous clock output of CPU
4	ARDY	Asynchronous ready input (level sensitive, OPEN=ready)
5	INT0	Interrupt request input of channel 0(asynchronous, active high)
6	INT1	Interrupt request input of channel 1(asynchronous, active high)
7	VCC	Power supply of PCB
8	RESET	Power up reset pulse (active high)
9	GND	Ground of PCB
10	/RESET	Power up reset pulse (active low)
11	TO_0	Timer output 0 of CPU (can be used as programmable D/I/O)
12	TO_1	Timer output 1 of CPU (can be used as programmable D/I/O)
13	TI_0	Timer input 0 of CPU (can be used as programmable D/I/O)
14	TI_1	Timer input 1 of CPU (can be used as programmable D/I/O)
15	SCLK	Common serial clock output of 7188 series
16	DIO9	Programmable D/I/O bit
17	DIO4	Programmable D/I/O bit
18	DIO14	Programmable D/I/O bit
19	VCC	Power supply of PCB
20	VCC	Power supply of PCB

- CLOCKA: 20.2752M for 7188XC
- ARDY: leave this pin OPEN for no wait states applications
- INT0, INT1: leave these two pins OPEN for no interrupt applications
- TO_0, TO_1: can be used as CPU's timer output or programmable D/I/O
- TI_0, TI_1: can be used as CPU's timer input or programmable D/I/O
- DIO4, DIO9, DIO14: programmable D/I/O bit
- SCLK: the 7188X series use this signal as a CLOCK source to drive all on-board serial devices, so it is always programmed as D/O. Changing this signal to other configurations will cause serious errors. User can use this signal to drive external serial devices without any side effects.

JP2 pin definition & description:

No	Name	Description
1	**A0**	Address bus
2	**D0**	Data bus
3	**A1**	Address bus
4	**D1**	Data bus
5	**A2**	Address bus
6	**D2**	Data bus
7	**A3**	Address bus
8	**D3**	Data bus
9	**A4**	Address bus
10	**D4**	Data bus
11	**A5**	Address bus
12	**D5**	Data bus
13	**A6**	Address bus
14	**D6**	Data bus
15	**A7 or N/C**	**This pin is reserved & must be N/C for 7188XC & 7521 series**
16	**D7**	Data bus
17	**INT4 or N/C**	Interrupt request input of channel 4(asynchronous, active high), **this pin is reserved & must be N/C for 7188XC & 7521 series**
18	**/WR**	Write strobe output (synchronous, active low)
19	**/CS**	Chip select output (synchronous, active low)
20	**/RD**	Read strobe output (synchronous, active low)

- Address bus (output): A0 ~ A6, A7
- Data Bus (tri-state, bi-direction): D0 to D7
- INT4: leave this pin OPEN for no interrupt applications
- /CS, /RD, /WR: These 3 signals will be synchronous to CLOCKA (in JP1.3) & asynchronous to ARDY (JP1.4)
- The CS\ will be active if program inport/outport from I/O address 0 to 0xff.
- **The pin_15 & pin_17 are reserved by 7188XC series; user must leave these two pins N/C for 7188XC series.**

Refer to "I/O Expansion Bus in the 7188X/7188E User's Manual" for more information.

2.11.3   Parallel Bus Timing Diagram
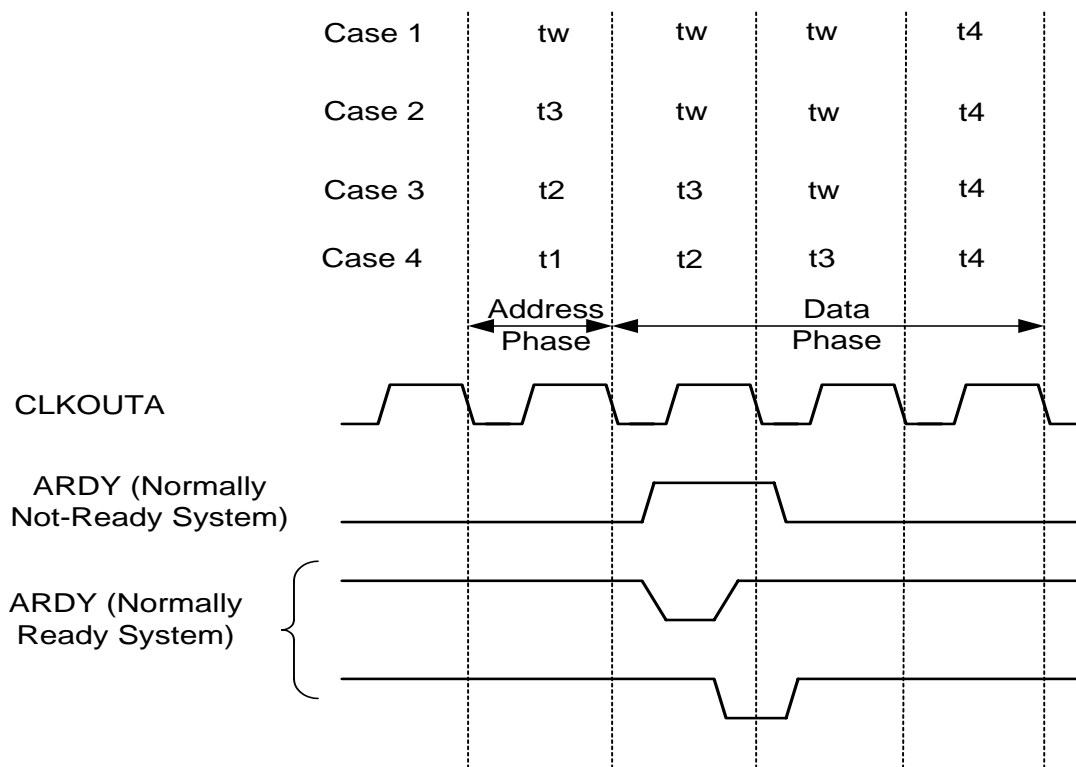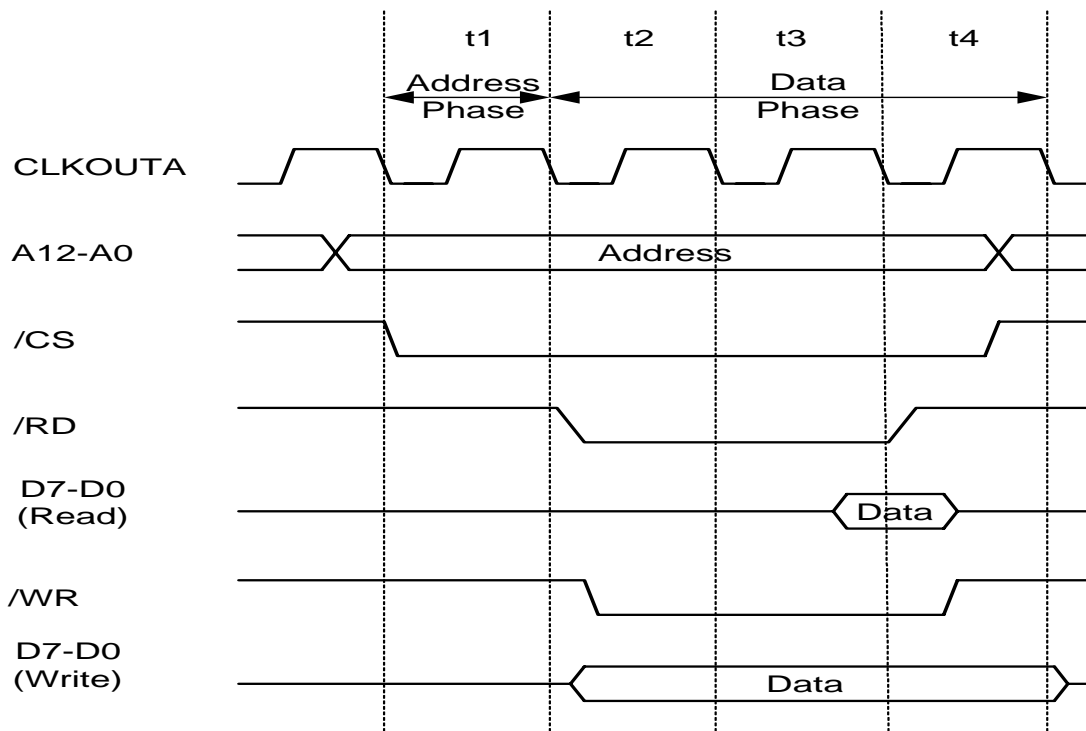
2.11.4   I/O Expansion Boards

I/O expansion board for prototype & test:

Board	Descriptions	
X000	Prototype Board (Small size)	XA/XC
X001	Prototype Board (Large size)	XA/XC
X002	Prototype Board	XA/XB/XC/EX
X003	Self-test board for 7188XC	XC
X004	Self-test board for 7188XB/EX	XB/EX
X005	Prototype Board (small size)	XB/EX
X006	Prototype Board (Large size)	XB/EX
More…...		

I/O expansion board for D/I, D/O, D/I/O, or Timer/Counter :

X100	8 channels of D/I, 3.5V~30V	XC
X101	8 channels of D/O, TTL(64mA)	XC
X102	2 channels of relay output	XC
X103	7 channels of isolated D/I(3.5V ~ 30V)	XC
X104	8 channels of D/I/O(single channel programmable)	XC
X105	8 channels of D/I/O(8-channel programmable)	XC
X106	2*D/O or 3*D/I	XC
X107	6 channels of D/I + 7 channels of D/O	XB/XC
X400	3 channels 16-bit Timer/ Counter expansion Board	XC
More…...		

I/O expansion board for A/D,D/A:

X200	1 channel of 12-bit A/D(0~2.5V)	XC
X201	4 channels of 12-bit A/D(0~20mA)	XC
X202	7 channels of 12-bit A/D(0~20mA)	XB/EX
X204	2 channels of 12-bit A/D(+/- 1V)	XC
X300	2 channels of 12-bit D/A(0~4.095V)	XC
X301	1 channel of 12-bit A/D(0~2.5V) and 1 channel of 12-bit D/A(0~4.095V)	XC
X302	1 channel of 12-bit A/D(+/- 5V) and 1 channel of 12-bit D/A(+/- 5V)	XC
More…...		

I/O Expansion Board for A/D, D/A, D/I, D/O:

X203	2 channels of 12-bit A/D(0~20mA)	XB/EX
X303	1 channel of 12-bit A/D(+/- 5V) and 1 channel of 12-bit D/A(+/- 5V)	XB/EX
X304	3 channels of 12-bit A/D(+/- 5V) and 1 channel of 12-bit D/A(+/- 5V)	XB/EX
X305	7 channels of 12-bit A/D(+/- 5V) and 1 channel of 12-bit D/A(+/- 5V)	XB/EX
More…....		

I/O Expansion Board for RS-232/422, D/I, D/O:

| X500	1 channel of RS-232, modem control, 115.2K max.	XC
X501	1 channel of 4-wire RS-232 (RTS, CTS, TXD, RXD), 115.2K max	XC
X502	1 channel of 4-wire RS-232 (RTS, CTS, TXD, RXD) & 1 channel of 2-wire RS-232 (TXD, RXD) ,115.2K max	XC
X503	1 channel of 4-wire RS-232 (RTS, CTS, TXD, RXD), 115.2K max	XB/EX
X504	1 channel of 4-wire RS-232 (RTS, CTS, TXD, RXD) & 1 channel of 8-wire RS-232 (RI,DCD,DTR,DSR,CTS,RTS, CTS, TXD, RXD) ,115.2K max	XB/EX
X505	1 channel of 4-wire RS-232 (RTS, CTS, TXD, RXD), 115.2K max	XB/EX
X506	1 channel of 2-wire RS-232 (TXD, RXD), 115.2K max	XB/EX
X507	1 channel of 4-wire RS-422/485 and DI/O (RXD3+, RXD3-, TXD3+, RXD3-) , 115.2K max	XB/EX
X508	1 channel of 4-wire RS-232 and DI/O (RTX,CTX,TXD, RXD) , 115.2K max	XB/EX
X509	1 channel of 2-wire RS-232 and DI/O (TXD, RXD), 115.2K max	XB/EX
X510	1 channel of 2-wire RS-232/485 and DI/O , RS-232(TXD, RXD) , RS-485(D+,D-),115.2K max	XB/EX
More…....		

I/O Expansion Board for storage devices:

X600/2	2M bytes NAND Flash	XA/XB/XC/EX
X600	4M bytes NAND Flash	XA/XB/XC/EX
X601	8M bytes NAND Flash	XA/XB/XC/EX
X602	16M bytes NAND Flash	XA/XB/XC/EX
X603	32M bytes NAND Flash	XA/XB/XC/EX
X607	128K battery backup SRAM	XA/XB/XC/EX
X608	512K battery backup SRAM	XA/XB/XC/EX
More…...		

Refer to "I/O Expansion Bus in the 7188X/7188E User's Manual" for more information.

3. Applications

3.1 Embedded Controllers

MMICON (or PC or touch-screen)

RS-232

7188XC

RS-485

7000 module   7000 module
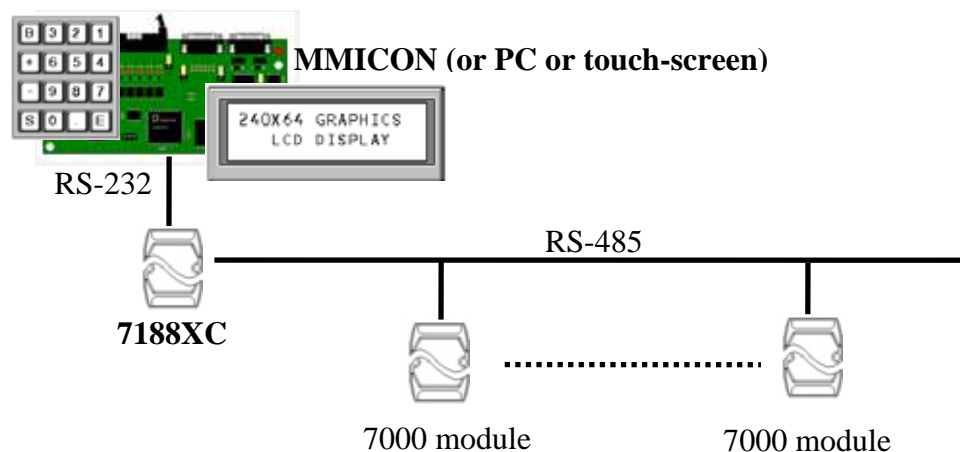
Applications:
- **4500 replacement & enhancement (not compatible)**
- **PC-Based controller replacement**
- **PLC replacement**
- **Special controller replacement**

The 7188XC series can be use as embedded controller for general applications. Therefore it can be used to replace PC, PLC or special controllers.

Programming Tool	TC/MSC/BC
Debug Tool	Via standard input/output (keyboard & monitor of PC)
Man Machine Interface	• MMICON • Keyboard & monitor of PC • Touch Screen (RS-232 or RS-485 interface)
Program	Stored in Flash ROM
Input/Output	• Onboard D/I or D/O • From I/O Expansion Bus • 7000 series modules, can directly control 256 modules = thousands of I/O points

3.2 Local Real Time Controller
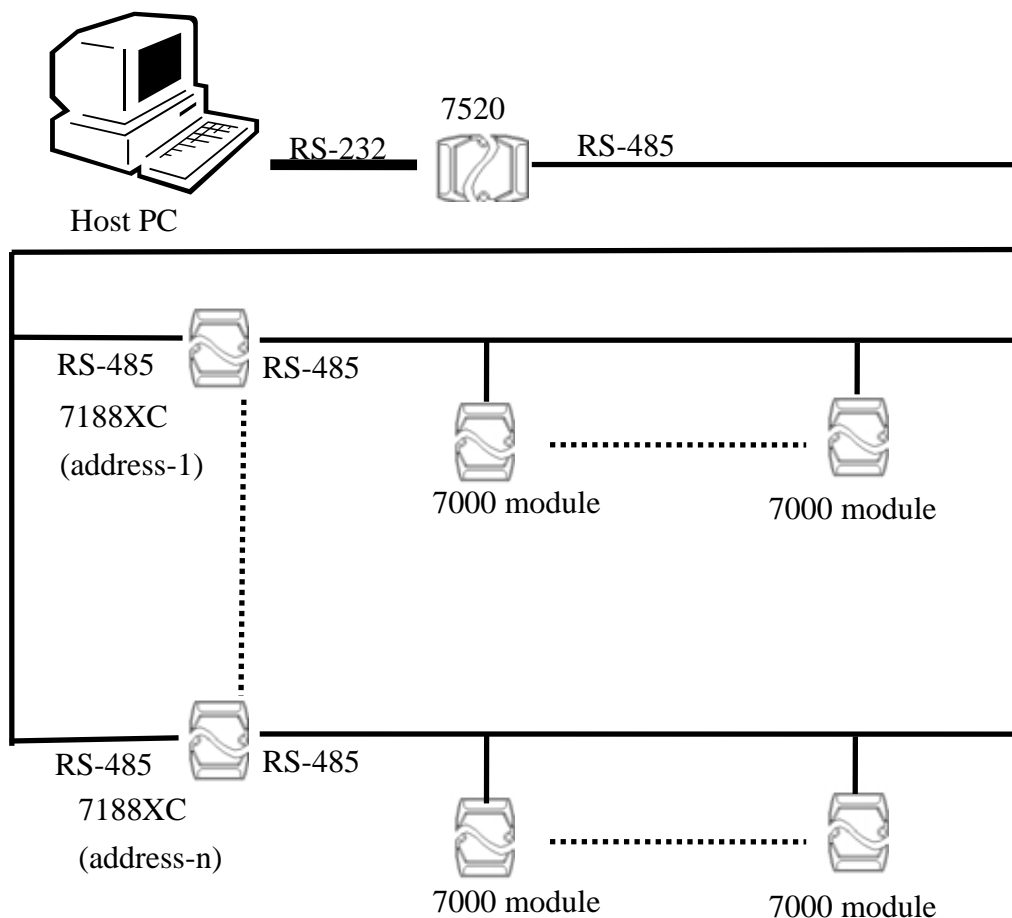
The 7000 series modules are slave devices; the control programs are implemented in host PC. The working steps are given as follows:

1. PC sends out commands to 7000 modules for input data.
2. PC analyzes this input data & generates some output data
3. PC send out commands to 7000 modules for output data

If there are hundreds of 7000 modules, the PC will take a long time to analyze & control these modules.

The control program can be implemented in a local 7188XC. The PC only has to send control arguments to the 7188XC, the 7188XC will control the local 7000 modules based on these control arguments. In this way, the PC can handle thousands of 7000 modules with the 7188XC.
Some control functions are **timing critical**. The local 7188XC can handle these functions without the PC in real time.

3.3   Remote Local Controller
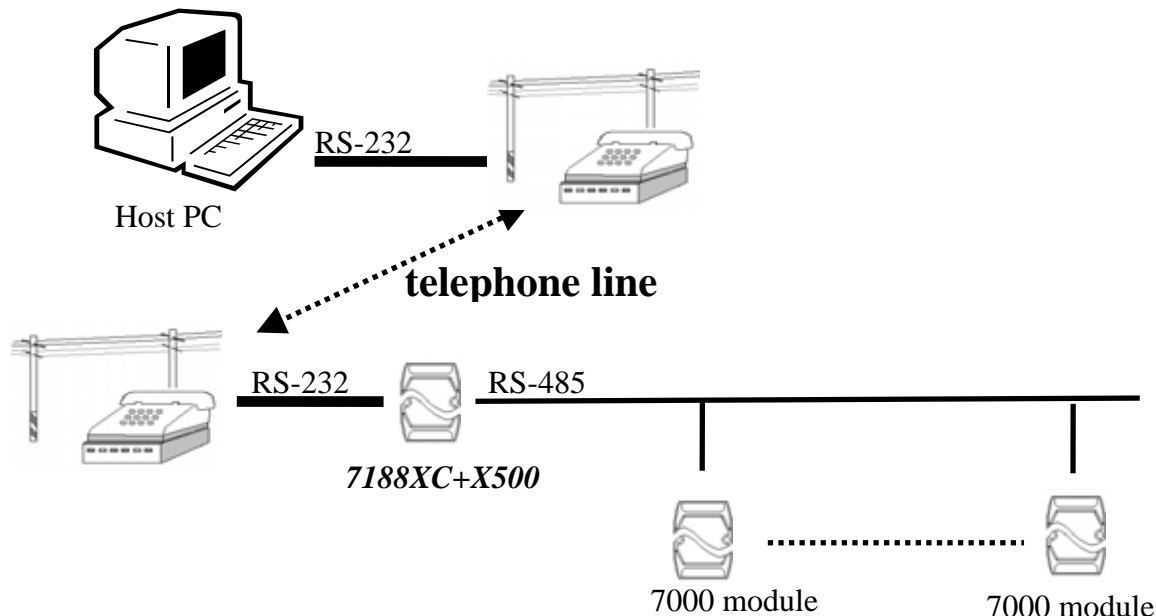
The control program is implemented in a local 7188X. The 7188X will directly control the 7000 modules based on these control arguments.

The PC can access the remote 7188X for the following items:
- Query & record the remote system status
- Download the control arguments to remote 7188X

The remote 7188X can communicate to the PC for the following items:
- Emergency events call back
- Remote system status send back

Note: The 7188XC/7521 must add a X500 to control the modem.

3.4 I/O Expansion of PLC applications

PLC COM1:RS-232

TOUCH SCREEN

COM2:RS-485

7188XC

7000 series
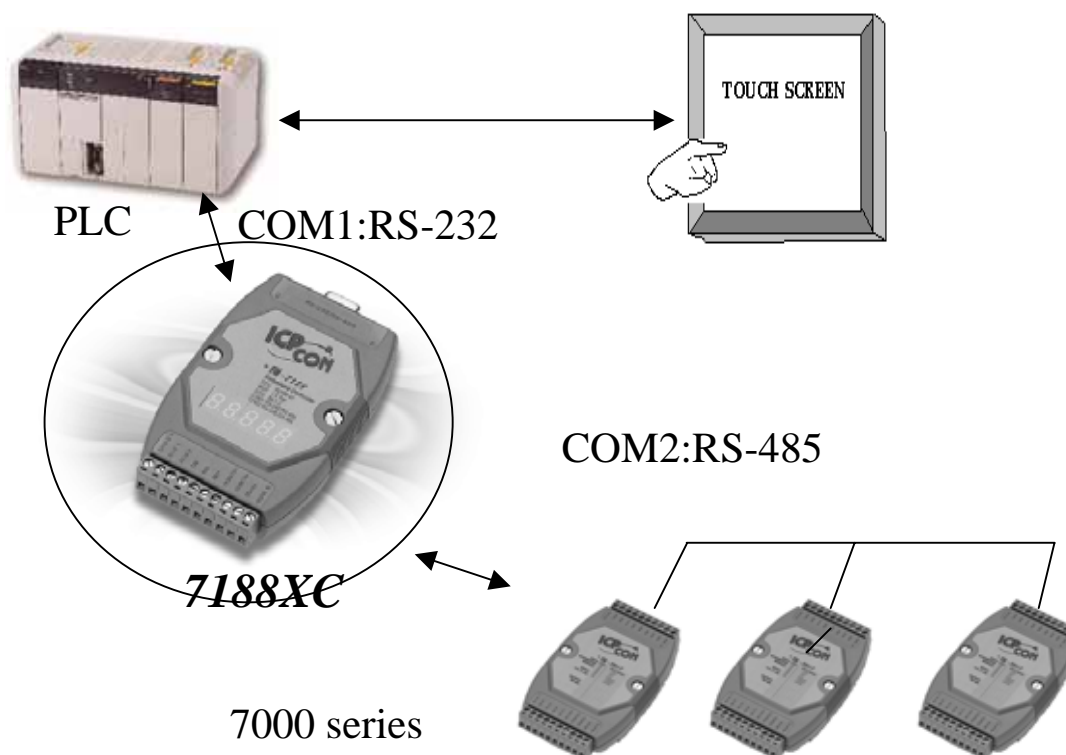
There is a Man Machine Interface in most PLCs. This interface is originally designed for MMI applications. The 7188XC can use this interface to build a bridge between PLC & 7000 modules.

The 7188XC can directly read/write the internal memory of the PLC. Therefore the **PLC can access the 7000 input modules** as follows:
1. The 7188XC sends commands to the 7000 input modules
2. The 7188XC writes this data to the PLC's internal memory
3. The PLC accesses this data from the internal memory

The **PLC can control the 7000 output modules** as follows:
1. The PLC writes data to its internal memory
2. The 7188XC reads this output data from the PLC's memory
3. The 7188XC sends commands to the 7000 output modules

In this way, the input data of the 7000 modules can be shown on the touch screen. Also, the user can control the output of the 7000 modules from the touch screen.

3.5 Radio Modem Applications

Device A

Device B
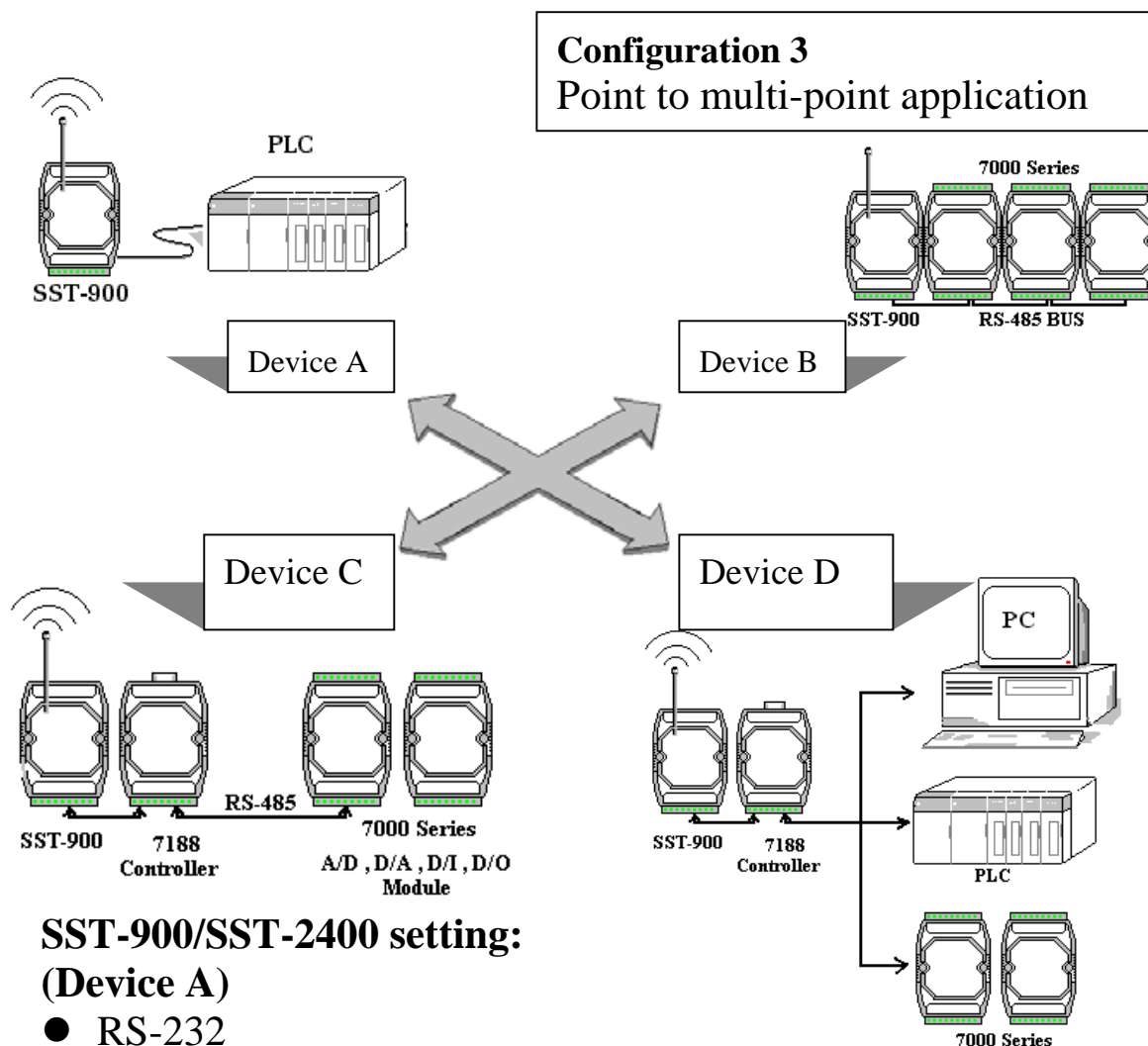
Device C

Device D

SST-900/SST-2400 setting:
(Device A)
- RS-232
- Half-duplex mode
- Synchronous way
- Slave state
- Baud rate=9600
- Channel=3
- Frequency=915.968MHz

The 7188XC series is a embedded controller. Because the 7188XC series is programmable, **it can be used as a bridge between the SST-900 & external devices.** These devices can be PLC, controller or 7000 modules.

SST-900/SST-2400 setting:
(Device B/C/D)
- RS-485 or RS-232
- Half-duplex mode
- Synchronous way
- Slave state
- Baud rate=9600
- Channel=3
- Frequency=915.968MHz