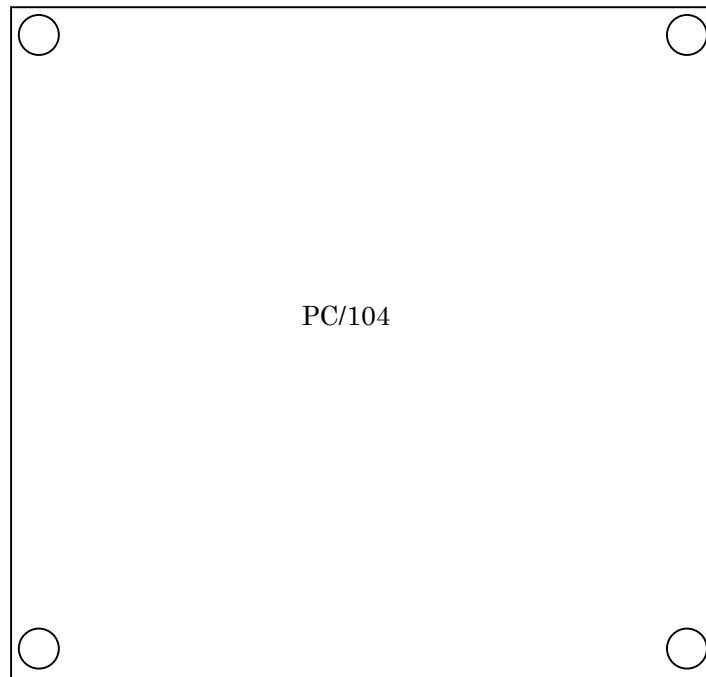


Real Solution for FA & LA



12bit 8ch Analog Inputs,
12bit 1ch Analog Output,
and 4bits Digital I/O Board

MFU-541PC104

User's Manual

For MICRO SCIENCE
PC/104-BUS
Board

MICRO SCIENCE., Co Ltd

2-37-12, Nishiogikita, Suginami-ku,
Tokyo, 167-0042, JAPAN

Phone: +81-3-3396-8362 (Japanese only)

Fax: +81-3-3301-5593 (also English)

Mar 11, 2002

Table of Contents

Caution	3
Legal Notice	3
Software License Agreement	4
Customer Support Policy	5
Price List and Ordering Information	6

Section 1. Introduction

1-1. Guide this Manual	7
1-2. Functional Specification	7
1-3. Functional Description	9
1-4. Layout of the Board	10
1-5. Settings on the Board	11
1-6. Analog Input and Output Connector	12
1-7. Digital Input and Output Connector	13

Section 2. Input and Output (details)

2-1. Analog Input	15
2-2. Analog Output	15
2-3. Analog Input and Output Ranges	16
2-4. Digital Input and Output	17

Section 3. General Programming

3- 1. General Programming information	19
3- 2. General Sampling Sequence	20
3- 3. I/O Register Memory Map	21
3- 4. Reset the Board, and get ID	22
3- 5. Interrupt Control	23
3- 6. Update Analog Output	24
3- 7. Start A-to-D conversion	25
3- 8. Board Status	26
3- 9. Read AD-data	27
3-10. General Purpose Digital I/O	28

Section 4. Maintenance and Appendix

4-1. Trouble Shootings	29
4-2. Calibration	30
4-4. Q & A form	32

Caution

Unpacking

This package contain a MFU-541PC104 board, a User's Manual, and 4 pieces of 15mm spacer

Upon receipt the package, visually inspect the board for missing or damaged materials. This product was shipped in perfect condition as it was new.

Examine the package for physical damage. In the event of damage, save all packing materials and notify your courier to validate shipping claims.

Anti-static discharge

The MFU-541PC104 contains components that are susceptible to static discharge, and should be handled with appropriate caution. The anti-static packing material protects components from being damaged by static discharge.

Should the MFU-541PC104 board need to be returned for repair at a later date, it can be safely done by packing it in the original materials.

Warranty

MICRO SCIENCE warrants that this product was manufactured free of defect in materials or workmanship under normal use and service as described in this User's Manual. Obligations under this warranty are limited to replacing or repairing at MICRO SCIENCE's option.

Any said of products, at MICRO SCIENCE's factory or facility, should have to be prepaid transportation charges, and which are after examination disclosed to the satisfaction of MICRO SCIENCE to be thus defective, for a period within one year shipment.

These provisions do not extend the original warranty period of any product which has either been repaired or replaced by MICRO SCIENCE.

This warranty does not contain a guarantee, either expressed or implied, of merchantability or fitness for particular purpose.

This warranty shall not apply to any such products which have been repaired or altered except by MICRO SCIENCE or which have been subject to misuse, negligence, or accident.

MICRO SCIENCE assumes no liability for damages or loss consequent to use of this product. This product is not designed for a level of reliability for use in life support or critical applications. It is customer's sole responsibility to determine if this product is suitable for the application.

Disclaimer

The information contained in this document has been carefully examined and is believed to be entirely accurate.

However, MICRO SCIENCE assumes no responsibility for errors or omissions.

MICRO SCIENCE reserves the right to make changes to this manual without prior notification in accordance with the purpose of product support and or improvement.

Proprietary Notice

This entire document is not to be photocopied, transcribed, recorded, communicated, or reproduced by any means without permission of MICRO SCIENCE.

The foregoing does not apply to vendor proprietary rights or rights under the patents of third parties.

Use of this product does not convey a license either expressed or implied.

Applicable Laws

Any claim relating to MICRO SCIENCE's products shall be governed by the internal laws of Japan.

Copyright 2002 by
MICRO SCIENCE, Co. LTD

Software License Agreement

This Agreement constitutes the license between MICRO SCIENCE, Co and the purchaser of MICRO SCIENCE products.

Definitions

In this Agreement, a "FILE" shall mean a contiguous collection of machine-readable symbols, bytes, characters, or codes which may be used by the CPU on the user's computer or processing equipment.

A "PROGRAM" is a file or related group of files which may be loaded and processed on the user's computer or processing equipment to perform the functions.

A "SOFTWARE" shall mean one or more FILES or PROGRAMS.

Usage

The files that supplied to MICRO SCIENCE customers are solely for the purpose of illustrating how MICRO SCIENCE products operate or to allow modifications of this software by the customer for a particular application. In the case of binary executable only files, the user may not disassemble, reverse compile, reverse engineer or otherwise remove the proprietary status of these programs.

The programs and files on MICRO SCIENCE-supplied media are copyrighted by and the proprietary of MICRO SCIENCE, Co. All supplied programs and files except for executable-only files may be reproduced, transferred, copied, printed out, displayed, modified, or used in the customer's application as long as they control MICRO SCIENCE products

Binary executable –only files of customer's application which used MICRO SCIENCE software may be distributed to anyone without restriction.

All supplied source files and the source files of customer's application which used MICRO SCIENCE software may not be disclosed, copied, reproduced, or transferred to third parties without written permission.

Disclaimer

Although the MICRO SCIENCE software have been carefully checked and executed, errors are possible. However, MICRO SCIENCE assumes no responsibility for damages or loss arising from loading and running the software which are originally supplied, or has been modified for a particular purpose.

This software is not designed for a level of reliability for use life support, or critical applications.

It is customer's sole responsibility to determine if this software is suitable for the application.

MICRO SCIENCE retains the right to modify this software without prior notification in accordance with the purpose of product support and improvement.

Customer Product Support Policy

MICRO SCIENCE will answer the written questions including FAX, or Email in Japanese or English from the registered user about this product.
Send us the question form in this manual filled with the information.

We do not answer on phone with any language but Japanese.
Although MICRO SCIENCE may offer advice, we will not design the user's application.

Price List (# Jan, 2002)

Items	#Unit Price	Description
MFU-541PC104	\$ 340.00	12bit/8 Analog Inputs, 1 Analog Output, and Digital I/O
User's Manual	\$10.00	Printed one. (PDF file is free for download from WEB)

The product consists of a MFU-541PC104 board and 4 pieces of standoff.

WEB : www.microscience.co.jp/eng/

Section 1. Introduction

1-1. Guide this Manual

This Manual contains a complete set of hardware and programming information for the MFU-541PC104 board, including configuration, installation, and I/O connection.

Section 1 contains the outline of functional descriptions and detail specifications, the installation, and setup procedure for the board.

Section 2 contains the detail of analog input, Output, and the digital data.

Section 3 contains the programming information and the register specifications.

Section 4 contains the calibration procedure, trouble-shootings, and repair.

The last page is the request form for the Q and A.

1-2. Functional Specification

Analog Input	
####: on-board switch programmable. (typical unless otherwise noted and stated at 20 °C)	
Number of channels	8SE(single-ended) Inputs
Resolution / Code	12Bits (4096 counts) / Offset Binary
Analog Input Range	-10 to +10v/ -5 to +5v/ -2.5 to +2.5v (####)
Measurement Accuracy	0.105%FS (-10 to +10v Range/ Fine tuned in the factory) 0.125%FS (Not fine tuned Range)
Non-Linearity	0.025%FS
Input Noise	1LSB
Temperature Coefficient	25 ppm/C
Input Impedance	>100M ohm
Input Bias Current	< 50nA
Cross Talk	-65dB (between each channel)

Analog Output	
####: on-board switch programmable. (typical unless otherwise noted and stated at 20 °C)	
Number of channels	1(single-ended) Output
Resolution / Code	12Bits (4096 counts) / Straight or Offset Binary
Analog Output Range	-10 to 10v / 0 to +10v (####)
Measurement Accuracy	0.05%FS (0 to +10v Range/ Fine tuned in the factory) 0.0625%FS (-10 to 10v Range / Not fine tuned)
Non-Linearity	0.0125%FS
Settling time	10 micro-sec (20v swing to 0.05%FS on 500pF load)
Glitch	15 nvs (on ± 10v Range)
Temperature Coefficient	25ppm/C
Output Impedance	> 0.5 ohm
Driving Capability	5K ohm, 500pF

General Purpose Digital I/O

Input	4 bit (74HCT-type TTL level, Pulled up with 10K ohm)
Output	4 bit (TTL level, latched output)

System Configuration

Bus Compatibility	PC/104 Bus All signals are driven or accepted by the C-MOS device. (74HCT type)
Board Address ###	Higher 12Bits: programmable by on-board switches. Lower 4Bits: on-board logic decoded for multiple I/O ports.
Interrupt ###	IRQ3,4,5,6,7,9

I/O Connectors

Analog Input, and Output	26pin FRC type (2.54mm pitch)
Digital Input and Output	20pin FRC type (2.54mm pitch)

Physical, Environmental

Operating Temperature Range	0 to +55
Storage Temperature Range	-10 to +85
Relative Humidity	80% (Non-condensing)
Power Supply, Consumption	+5v 0.6 A

1-3. Functional Description

MFU-541PC104 is designed for multiple analog input, single analog output, and general purpose digital I/O functions.

On the analog input stage, the board accepts analog data up to 8 single-ended inputs. The analog-to-digital converter has 12 bit resolution, 10 micro-sec conversion time, and has a built-in sample-hold element. Analog input range is selectable with the on-board switch from -10 to +10v, -5 to +5v, and -2.5 to +2.5v.

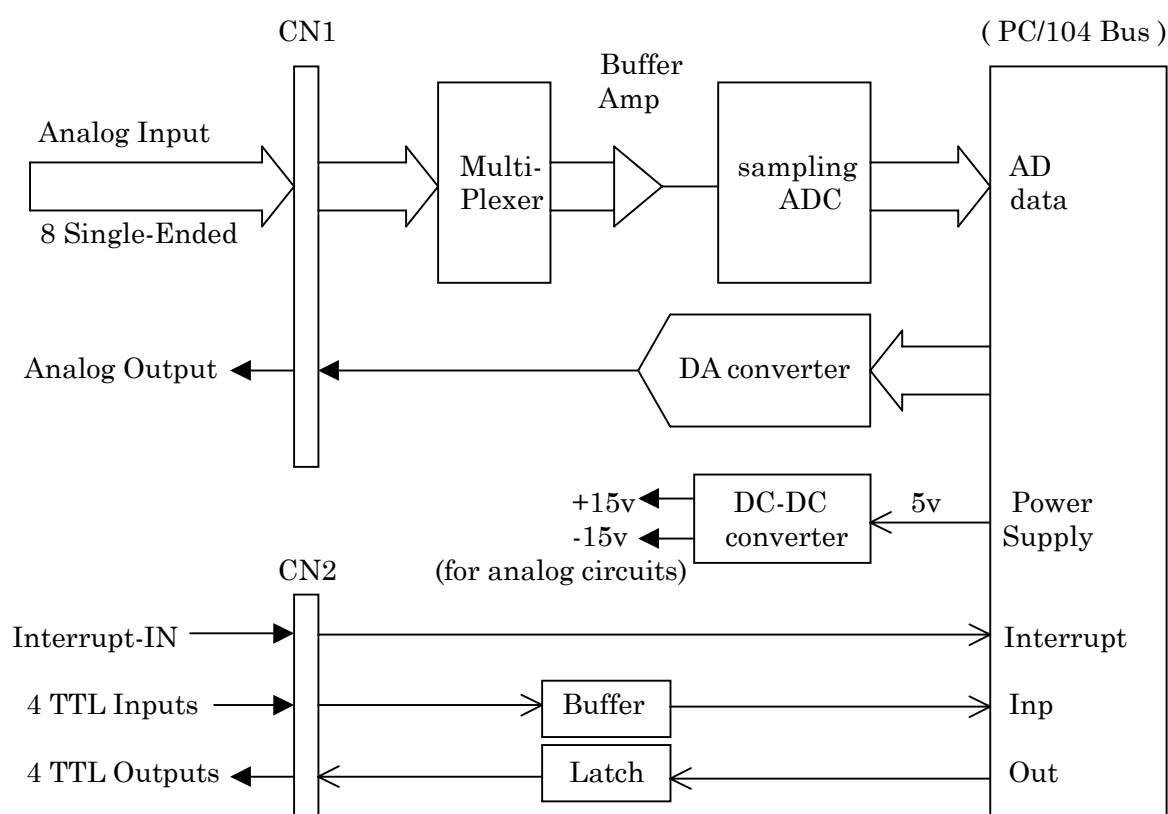
On the analog Output stage, the digital-to-analog converter has 12 bit resolution, 10 micro-sec settling time, and has a built-in data latch element. Analog output range is selectable with the on-board switch from -10 to +10v, and 0 to +10v.

Set the jumper-plug on the Interrupt level, if you use the function with the external digital input..

Because against the noise or cross-talk between Analog Input and Digital I/O, they are assigned for individual bracket.

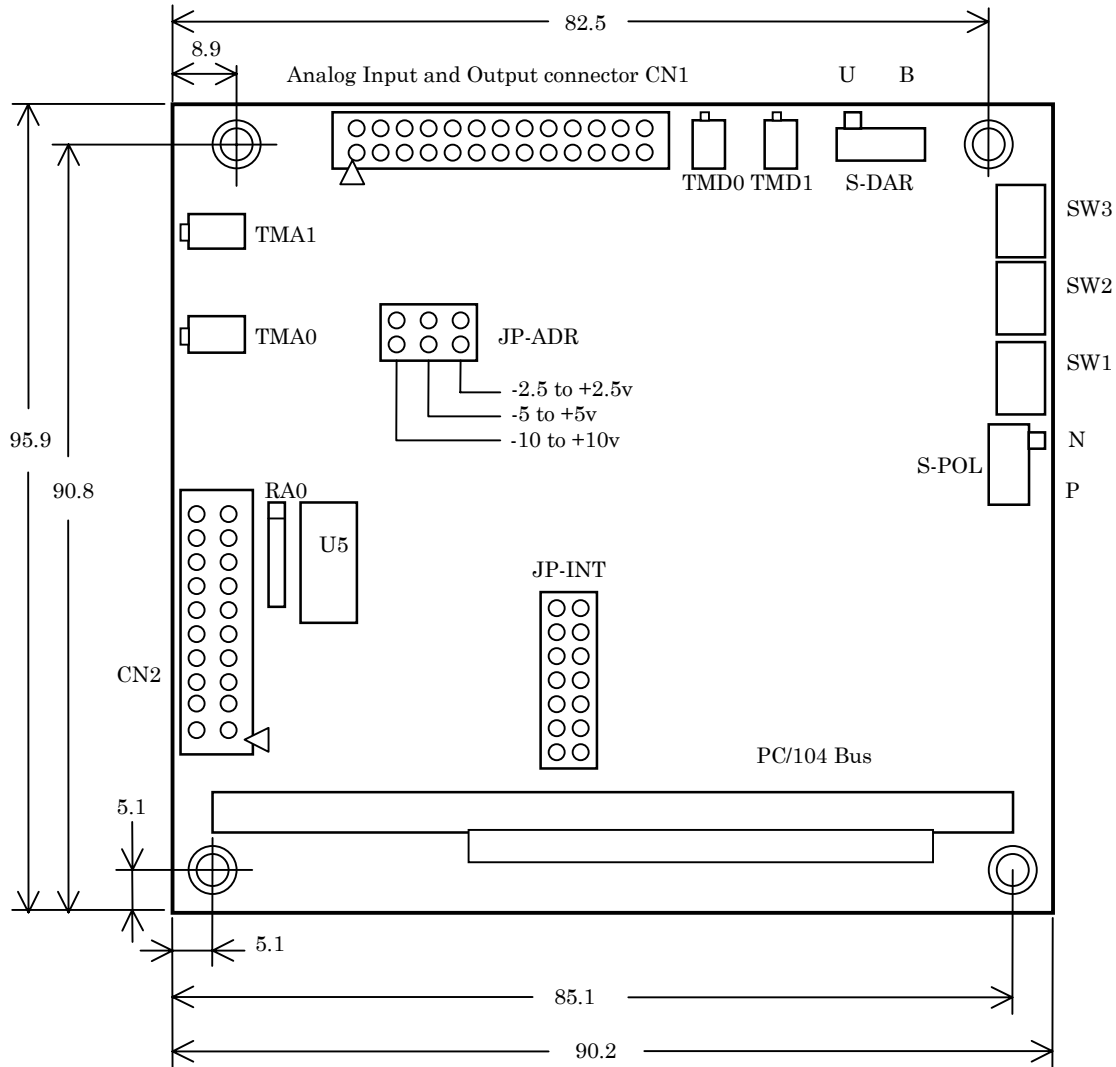
The base address of the board is programmable with the on-board switches.

Figure 1-3. Functional Block Diagram



1-4. Layout of the board

Figure 1-4.



Unit: mm

At shipping, on-board programmable elements are set to < > position.

#SW1, SW2, SW3: Program switch for Base Address of the board. <0,1,D> / see 1-5-1./

#JP-INT: Select jumper-switch for Interrupt Level. <NC> / see 1-5-2./

#S-POL: Select switch for Polarity of General Purpose Output. <N> / see 1-5-3./

#S-DAR: Select switch for Analog Output Range. <U=0 to +10v> / see 1-5-4./

#JP-ADR: Select switch for Analog Input Range. <-10 to +10v> / see 1-5-4./

#TMA0: POT for Analog Input offset trimming, #TMA1: for gain trimming. /see 1-5-5/

#TMD0: POT for Analog Output offset trimming, #TMD1: for gain trimming. /see 1-5-5/

#RA0: Pull-up resistor for Digital Output. <Not assembled> /see 1-5-6/

#U5: Digital Output element. <74LS04> /see 1-5-7/

#CN1: Connector for Analog Input and Output(26pin, FRC)

#CN2: Connector for Digital Input and Output (20pin, FRC)



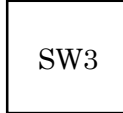
1-5. Settings on the board

1-5-1. BASE ADDRESS

MFU-541PC104 appears as a 16-byte block of registers within the host CPU's I/O address space. This address block must not conflict with other system I/O devices. You can program the on-board switches SW1, SW2, and SW3 as BASE ADDRESS of the board.

These hex-a-decimal defined switches are set to SW1=0, SW2=1, SW3=D at the factory of MICRO SCIENCE, that define the BASE ADDRESS to "01D0" hex. MFU-541PC104 occupies upper 16 byte address from the BASE. See section 3-3 for more information.

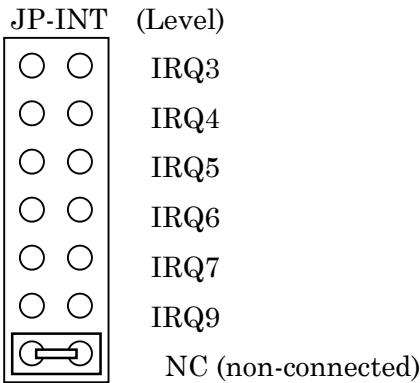
Figure 1-5A. Setting the BASE ADDRESS

Address Line →	AB15 to AB12	AB11 to AB08	AB07 to AB04	AB03 to AB00
On-board Hex-a-decimal → Switches				on-board logic decoded for multiple ports
Factory setting →	0	1	D	(F to 0)

1-5-2. Interrupt Level

External Digital input of MFU-541PC104 can cause an interrupt request to the CPU. Select the interrupt level by the jumper-switch "JP-INT", and program Write (BASE+2H) register to enable the state. See section 3-5 for the details.

Figure 1-5B. select the Interrupt Level.



1-5-3. Polarity of Digital Output

MFU-541PC104 has 4 bit TTL level digital output for general purpose. Select the logical polarity of the output by the switch "S-POL".

This switch is set to "N" at the factory of MICRO SCIENCE that defines the logical polarity to "Negative". You can also switch to "P" for "Positive". See section 3-10 for the programming.

1-5-4. Analog Input and Output Range : See section 2-3 for detail.

1-5-5. Analog Input and Output Calibration : See section 4-2 for detail.

1-5-6. Pull-up Resistor for Digital Output : See section 2-4 for detail.

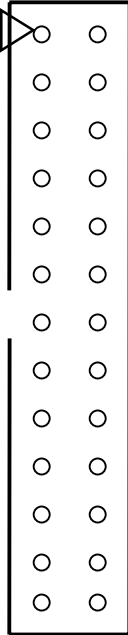
1-5-7. Digital Output element : See section 2-4 for detail.

1-6. Analog Input and Output Connector

Analog Inputs and Output are available on a 26-pin FRC-type male connector CN1 on the board as illustrated in Figure 1-4.

The plug is also provided for general purpose, come with the board.

Figure 1-6. Analog Inputs and Output Connector CN1 pin assignment

sign	/Function/	pin assign		sign	/Function/
CH0	/ch0 Input/	1		2	AG /analog common/
CH1	/ch1 Input/	3		4	AG /analog common/
CH2	/ch2 Input/	5		6	AG /analog common/
CH3	/ch3 Input/	7		8	AG /analog common/
CH4	/ch4 Input/	9		10	AG /analog common/
CH5	/ch5 Input/	11		12	AG /analog common/
CH6	/ch6 Input/	13		14	AG /analog common/
CH7	/ch7 Input/	15		16	AG /analog common/
		17		18	
		19		20	
		21		22	
DA	Analog Output	23		24	AG /analog common/
		25		26	

<Note.1> AGs are the Analog Common.

They are not only connected each other but also connected with the Digital Common on the board.

<Note.2> On-board bracket : Model=HIF3FC-26PA-2.54DSA /made by HIROSE/

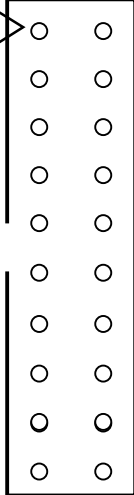
Plug : Model=HIF3BA-26DA-2.54R(11) /made by HIROSE/

1-7. Digital Input and Output Connector

Digital Inputs and Outputs are available on a 20-pin FRC-type male connector CN2 on the board as illustrated in Figure 1-7. They are General Purpose 4-bit Inputs and 4-bit Outputs.

All Inputs are 74HCT-type TTL level, and pulled-up with 10K resistor.
All outputs are latched, and have the capability for 10 TTL load.
The plug is also provided for general purpose, come with the board.

Figure 1-7. Digital Input and Output Connector CN2 pin assignment

sign	Function	pin assign			sign /Function/
D0-IN	General Purpose Digital Input	1		2	DG /Digital common/
D1-IN	General Purpose Digital Input	3		4	DG /Digital common/
D2-IN	General Purpose Digital Input	5		6	DG /Digital common/
D3-IN	General Purpose Digital Input	7		8	DG /Digital common/
Q0-OUT	General Purpose Digital Output	9		10	DG /Digital common/
Q1-OUT	General Purpose Digital Output	11		12	DG /Digital common/
Q2-OUT	General Purpose Digital Output	13		14	DG /Digital common/
Q3-OUT	General Purpose Digital Output	15		16	DG /Digital common/
INT-IN	External Digital Interrupt Input	17		18	DG /Digital common/
+5v	+5v Power Supply Output	19		20	DG /Digital common/

<Note.1> DGs are the Digital Common.

They are not only connected each other but also connected with the Analog Common on the board.

<Note.3> On-board bracket : Model = HIF3FC-20PA-2.54DSA /made by HIROSE/
Plug : Model = HIF3BA-20DA-2.54R(11) /made by HIROSE/

Section 2. Input and Output (details)

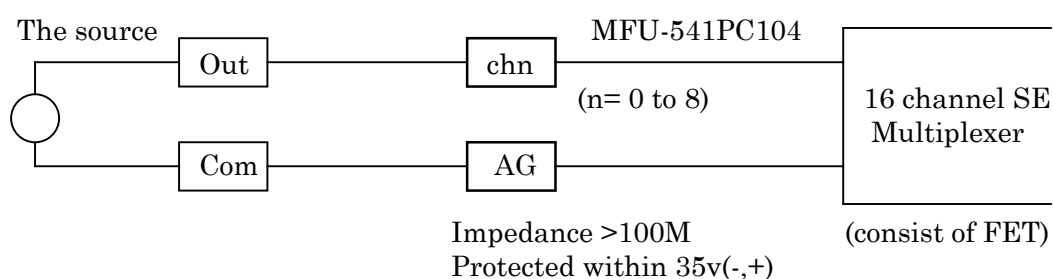
2-1. Analog Input

An analog input is selected by the Multiplexer and input to the A-to-D converter through the Buffer Amplifier, then converted to digital data and waiting for read out with the status flag.

<Note>

It is not equal to 0v input that non-used analog input with the terminal open, because of the high impedance and stray charge with the capacity.

Figure 2-1. Analog input connection (shows only 1 analog input)



2-2. Analog Output

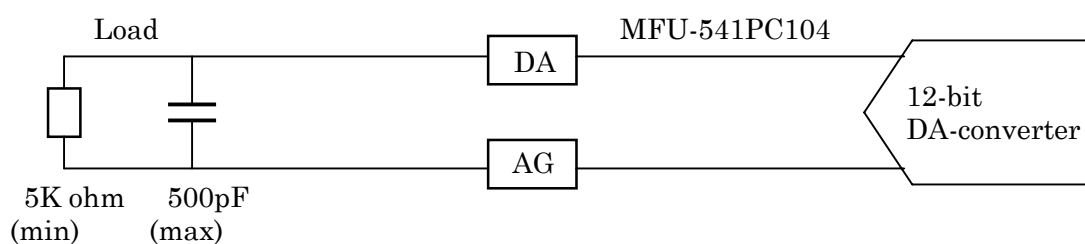
Analog output shall be updated by the DA-data with software command. It can drive 5K ohm and 500pF load. Be careful for the capacity of the cable, load over 500pF cause trouble with un-stable output voltage.

Note, twisted-pair or sealed cable has 50-70pF for each meter.

<Note-2>

Analog output shall be set to 0v at the reset operation including power on process.

Figure 2-2.



2-3. Analog Input and Output Ranges

Analog Input Range is selectable by the jumper-switch “JP-ADR” from -10v to +10v, -5v to +5v, and -2.5v to +2.5v.

Analog Output Range is selectable with the switch “S-DAR”, set position “U” for uipolar range “0 to +10v”, or set position “B” for bipolar range “-10v to +10v”.

The relation between digital data and analog voltage is follows.

Resolution.

$$\text{Res} = \text{Vspan} / 4096 \quad < \text{v/digit} >$$

Where Vspan is the width of the range.

For example, 20v for -10v to +10v range.

Digital data.

$$D = (V / \text{Res}) \quad : \text{ for Uni-polar Range.}$$

$$D = (V / \text{Res}) + 2048 \quad : \text{ for Bi-polar Range.}$$

Where “V” is the analog voltage.

Analog voltage.

$$V = (D \times \text{Res}) \quad : \text{ for Uni-polar Range.}$$

$$V = (D - 2048) \times \text{Res} \quad : \text{ for Bi-polar Range.}$$

Table 2-3A. Digital-data vs Analog-voltage

Digital-data	Analog voltage <V>			
Hex (Decimal)	-10v to +10v	-5v to +5v	-2.5v to +2.5v	0 to +10v
FFF (4095)	+9.99512	+4.99756	+2.49878	+9.99756
801 (2049)	+0.00488	+0.00244	+0.00122	
800 (2048)	0.00000	0.00000	0.00000	+5.00000
7FF(2047)	-0.00488	-0.00244	-0.00122	
001 (0001)	-9.99512	-4.99756	-2.49878	+0.00244
000 (0000)	-10.00000	-5.00000	-2.50000	0.00000

Figure 2-3A. Uni-polar Range

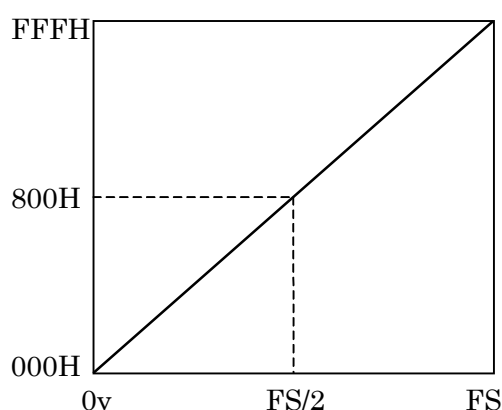


Figure 2-3B. Bi-polar Range

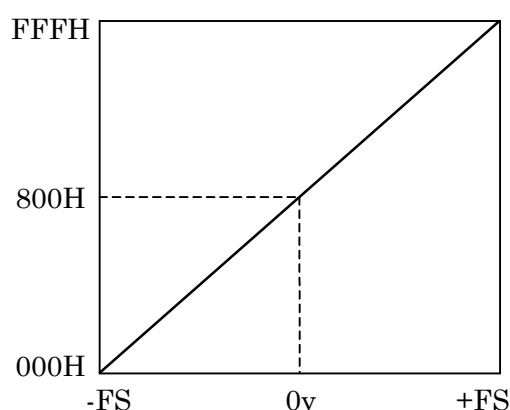


Table 2-3B. Accuracy

Analog Input	Accuracy for -10v to +10v Range (optimized on trimming)	0.105%FS
	Accuracy for the other Range	0.125%FS
Analog Output	Accuracy for 0v to +10v Range (optimized on trimming)	0.05%FS
	Accuracy for the other Range	0.065%FS

2-4. Digital Input and Output

All Digital Inputs are 74HCT-type TTL level, and pulled-up to +5v with 10K ohm resistor.

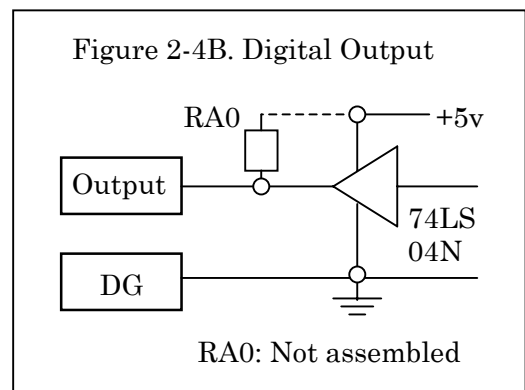
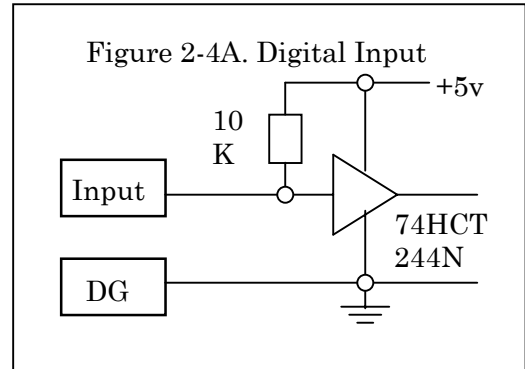
All Digital Outputs are also TTL level, latched, and you can select the logical polarity by on-board switch S-POL. MICRO SCIENCE set S-POL to "N" as Negative Logic, that cause the output to "TTL-High" level at the hardware reset in power-on process. General Purpose Output does not clear by the software reset with Read (BASE+7H) command but clear by hardware reset.

<Note>

74LS04 is assembled in the socket as a TTL level digital output device at the factory of MICRO SCIENCE.

You can replace it by 74LS06 or 74LS07 for change to open collector level.

See section 3-10 for programming.



Section 3. General Programming

3-1. General Programming Information

Handling

MFU-541PC104 appears to the host PC/104 bus CPU as a block of contiguous 16 hardware registers mapped within the I/O address space.

These registers control the operation of MFU-541PC104 as long as they are accessed using 16bit I/O addressing with each 8bit data transfers.

These registers include Reset-board, AD-conversion command, DA-conversion command, Interrupt, Status, and General Purpose Digital I/O.

Operation

Entire information for programming are specified and explained in order as follows.

(section 3-2)

General software sequences for analog input, analog output, and digital I/O.

(section 3-3 to 3-10)

The functions of each register. These are the elements for programming.

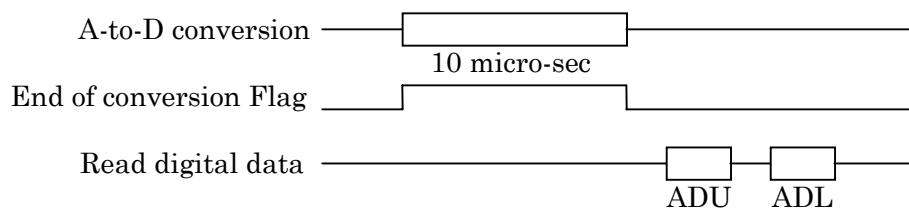
3-2. General Software Sequence

Analog Input

Write A-to-D conversion command with the analog input channel address, then wait for complete conversion, then read digital data.
See section 3-7 to 3-9 for details.

```
for (ch=0; ch <= 7; ch++)
{
    outp (BASE+0x0, ch)
    while ( (inp(BASE+0x2) & 0x1) == 0x1)
        ADU(ch) = inp (BASE+0x0)
        ADL(ch) = inp (BASE+0x1)
}
```

Figure 3-2A.

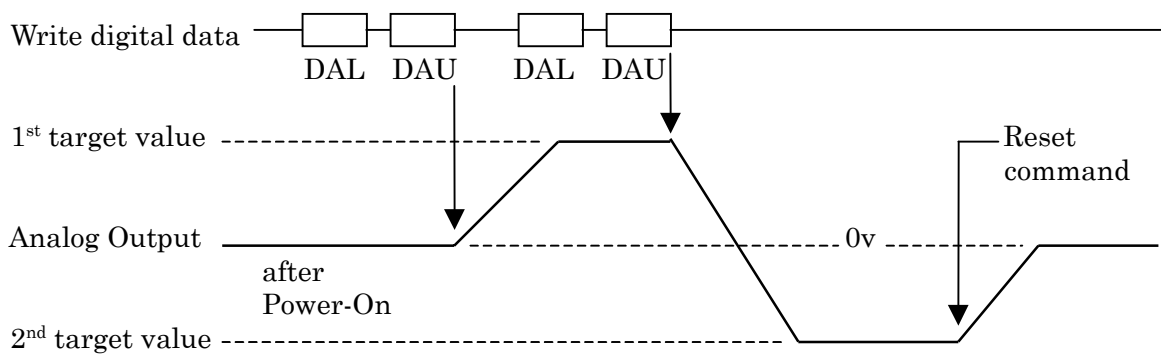


Analog Output

Write D-to-A conversion command with the digital data that specify the analog output for update.
Be sure write lower byte first, follow upper byte, and the word data shall be updated simultaneously.
See section 3-6 for details.

```
outp (BASE+0x6, DAL) ; Lower byte
outp (BASE+0x7, DAU) ; Upper byte
```

Figure 3-2B



<Note-1>

Analog output shall be forced to 0v at the power-on hardware reset and Software Reset command.

<Note-2>

Analog output shall be set to 0.05%FS of target value within 10 micro-sec

Digital Input and Output

Read from the specified input address, and Write to the specified latched output address.
The lower 4-bits of the byte must be valid.
See section 3-10 for details.

```
Dinp = (BASE+0x3) ; lower 4-bits
outp (BASE+0x3, Dout) ; lower 4-bits
```

3-3. I/O Register Memory Map

MFU-541PC104 appears as a 16-byte block of registers within the host CPU's I/O address space. This address block must not conflict with other system I/O devices.

You can program the on-board switches SW1, SW2, and SW3 as BASE ADDRESS of the board.

These hex-a-decimal defined switches are set to SW1=0, SW2=1, SW3=D at the factory of MICRO SCIENCE, that specify the BASE ADDRESS to "01D0" hex.

MFU-541PC104 occupies upper 16 byte address from the BASE.

See figure 1-4 for the location of the board.

Figure 1-5A. Setting the BASE ADDRESS

Address Line →	AB15 to AB12	AB11 to AB08	AB07 to AB04	AB03 to AB00
On-board Hex-a-decimal Switches →	SW1	SW2	SW3	on-board logic decoded for multiple ports
Factory setting →	0	1	D	(F to 0)

Table 3-3. MFU-541PC104 Register Assignment. (All the port consist of 8bit.)

I/O Address	Direction	Description	Refer to
BASE +7H	Read	Reset Board, and get ID.	Section 3-4
	Write	Upper byte of Analog Output (DA) Data	Section 3-6
BASE +6H	Read		
	Write	Lower byte of Analog Output (DA) Data	Section 3-6
BASE +5H	Read		
	Write		
BASE +4H	Read		
	Write		
BASE +3H	Read	General purpose Digital input (4-bits)	Section 3-10
	Write	General purpose Digital output (4-bits, latched)	Section 3-10
BASE +2H	Read	Status	Section 3-8
	Write	Interrupt Source and State.	Section 3-5
BASE +1H	Read	Upper byte of AD-data	Section 3-9
	Write		
BASE +0H	Read	Lower byte of AD-data	Section 3-9
	Write	Start A-to-D conversion with the input address	Section 3-7

	Not-used
--	----------

3-4. Reset the Board, and get ID

```
rst = inp (BASE+0x7) ; /* Reset the Board */
```

Read (BASE+7H) register cause the board reset.

All registers of the board must be initialized except for the last values of General Purpose Digital Output described in section 3-10.

The operation process shall be broken, and previous AD-data must be lost.

Where “rst” is the ID that depend on the board, “1DH” for MFU-541PC104.

Table 3-4. Read (BASE+7H) Register Bit Field.

Bit	Description
B7	1DH is the ID for MFU-541PC104.
B6	
B5	
B4	
B3	
B2	
B1	
B0	

3-5. Interrupt Control

```
outp (BASE+0x2, isd ) ; /* Interrupt Source */
```

Write (BASE+2H) Register specifies enable or disable the Interrupt Source.

Specified interrupt input edge into the MFU-541PC104 shall cause an interrupt request to the host CPU.

Interrupt request may be used to synchronize the Input, Output, or service request.

Interrupt Level is selected by the jumper switch “JP-INT” illustrated in Figure 1-5B.

Table 3-5A. Select the Interrupt Level.

“JP-INT”	Level
IRQ 3	3
IRQ 4	4
IRQ 5	5
IRQ 6	6
IRQ 7	7
IRQ 9	9
NC	Non-use

Table 3-5B. Write (BASE+2H) Register Bit Field

Bit	Interrupt Timing	“=1” specifies	“=0” specifies	On Reset
B7	Control the Interrupt input “INT-IN”	Enable	Disable	0
B6	Valid edge of Interrupt input “INT-IN”	+ (rising edge)	- (falling edge)	0
B5	Not-used			0
B4	Clear or not for Interrupt status flag.	Clear	Non-effect	0
B3	Not-used			0
B2	Not-used			0
B1	Not-used			0
B0	Not-used			0

Bit “**B7**” specify that enable or disable to interrupt by “INT-IN”

Bit “**B6**” specify the valid edge of Digital Interrupt Input “INT-IN” If it enabled.

Bit “**B4**” works that clear or not clear the Interrupt status flag specified in section 3-8.

3-6. Update Analog Output

```

outp (BASE+0x6, DAL ) ; /* Lower byte of DA-data */
outp (BASE+0x7, DAL ) ; /* Upper byte of DA-data */

```

Write lower byte first, then follow upper byte to each register address, and latch of the DA-converter shall be updated at the timing of writing upper byte.

See section 3-2 for timing information.

Table 3-6A. Write (BASE+6H) Register Bit Field / write first /

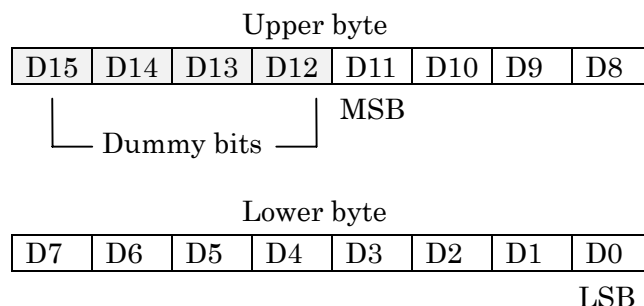
Bit	Description
B7	Bit D7 of DA-data
B6	Bit D6 of DA-data
B5	Bit D5 of DA-data
B4	Bit D4 of DA-data
B3	Bit D3 of DA-data
B2	Bit D2 of DA-data
B1	Bit D1 of DA-data
B0	Bit D0 of DA-data (LSB)

Table 3-6B. Write (BASE+7H) Register Bit Field / write second /

Bit	Description
B7	Not-used (Dummy)
B6	Not-used (Dummy)
B5	Not-used (Dummy)
B4	Not-used (Dummy)
B3	Bit D11 of DA-data (MSB)
B2	Bit D10 of DA-data
B1	Bit D9 of DA-data
B0	Bit D8 of DA-data

One 12-bits DA-data consists of upper 4-bits and lower 8-bits. They should be written as a pair of byte data. Upper 4-bits of the upper byte are ignored as a dummy.

The code of the data is straight-binary for 0 to +10v as uni-polar, or offset-binary for -10v to +10v as bi-polar output range.



3-7. Start A-to-D conversion

outp (BASE+0x0, channel) ; /* Start A-to-D conversion */

Write (BASE+0H) Register specifies the analog input channel and start A-to-D conversion

Three process that consists of select the analog input channel, sampled and hold, A-to-D conversion must be executed in regular order within 10 micro-sec.

Table 3-7A. Write(BASE+0H) Register Bit Field

Bit	Description
B7	Not-used
B6	Not-used
B5	Not-used
B4	Not-used
B3	Not-used
B2	Analog Input channel address.(see Table 3-7B)
B1	
B0	



Table 3-7B

B2	B1	B0	Analog Input channel
1	1	1	7
1	1	0	6
1	0	1	5
1	0	0	4
0	1	1	3
0	1	0	2
0	0	1	1
0	0	0	0

3-8. Board Status

```
sts = inp (BASE+0x2) ; /* Board Status */
```

Read (BASE+2H) Register provides the Status of the Board that allows the host CPU to watch the conversion process and interrupt state.

Table 3-8. Read(BASE+2H) Register Bit Field

Bit	Term	"=1" specifies	"=0" specifies	On Reset
B7	Not-used			0
B6	Current State of input "INT-IN"	High	Low	0
B5	Not-used			0
B4	Not-used			0
B3	Interrupt Status Flag	Set	Cleared	0
B2	Not-used			0
B1	Not-used			0
B0	A-to-D conversion State	Busy	Ready	0

<Note-1>

Bit "B6" is the current state of the external digital interrupt input "INT-IN".

It is usable for the general purpose digital input, in case of disable for the interrupt
See section 3-5 for programming.

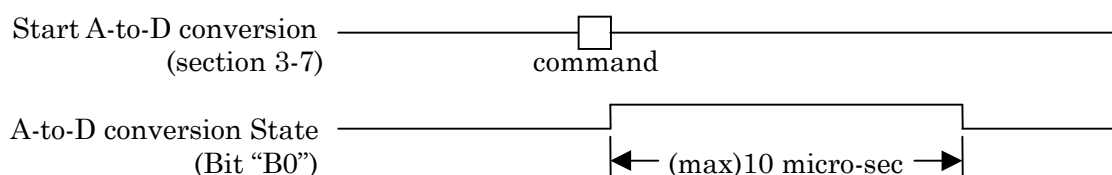
<Note-2>

Bit "B3" shows the interrupt status that must be set with the valid edge of the interrupt apply to "INT-IN". This event flag must be cleared just after read out. "INT-IN" is also usable for polled method with set the jumper switch "JP-INT" to "NC" and program interrupt control register to enable.
See section 3-5 for details.

<Note-3>

Bit "B0" must be set when the A-to-D conversion is busy, and be cleared when the conversion complete.

Figure 3-8. A-to-D conversion State



3-9. Read AD-data

```
ADL = inp (BASE+0x0) ; /* Lower byte of AD-data */
ADU = inp (BASE+0x1) ; /* Upper byte of AD-data */
```

Read AD-data after conversion complete that should be recognized with the status flag mentioned in section 3-8.

AD-data must be latched and waiting for read out until reset command or next conversion command.

Table 3-9A. Read (BASE+0H) Register Bit Field

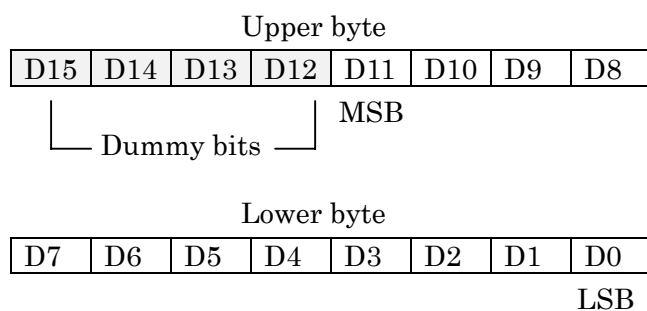
Bit	Description
B7	Bit D7 of AD-data
B6	Bit D6 of AD-data
B5	Bit D5 of AD-data
B4	Bit D4 of AD-data
B3	Bit D3 of AD-data
B2	Bit D2 of AD-data
B1	Bit D1 of AD-data
B0	Bit D0 of AD-data (LSB)

Table 3-9B. Read (BASE+1H) Register Bit Field

Bit	Description
B7	Not-used (=0)
B6	Not-used (=0)
B5	Not-used (=0)
B4	Not-used (=0)
B3	Bit D11 of AD-data (MSB)
B2	Bit D10 of AD-data
B1	Bit D9 of AD-data
B0	Bit D8 of AD-data

One 12-bits AD-data consists of upper 4-bits and lower 8-bits. They should be read as a pair of byte data. Upper 4-bits of the upper byte are ignored as a dummy.

The code of the data is offset-binary for every bi-polar input range.



3-10. General Purpose Digital I/O

Din = inp (BASE+0x3) ; /* General Purpose Digital inputs */
 outp (BASE+0x3, channel) ; /* General Purpose Digital outputs */

Digital Inputs

Read (BASE+3H) Register specifies the current state of 4-bit external 74HCT-type TTL level inputs assigned on Connector “CN2”.

See section 1-4, 1-7 and 2-4 for more information.

Table 3-10A. Read (BASE+3H) Register Bit Field.

Bit	Input assignment	“=1” specifies	“=0” specifies
B7 B6 B5 B4	Not used		
B3	“D3-IN” : General Purpose TTL Digital input	High (or Open)	Low
B2	“D2-IN” : General Purpose TTL Digital input	High (or Open)	Low
B1	“D1-IN” : General Purpose TTL Digital input	High (or Open)	Low
B0	“D0-IN” : General Purpose TTL Digital input	High (or Open)	Low

Digital Outputs

Write (BASE+3H) Register specifies the TTL latched 4-bit outputs for general purpose assigned on Connector “CN2”.

See section 1-4, 1-7 and 2-4 for more information.

Table 3-10B. Write (BASE+3H) Register Bit Field. / **Where S-POL set to “N”** /

Bit	Output assignment	“=1” specifies	“=0” specifies	on Hardware Reset
B7 B6 B5 B4	Not used			0 0 0 0
B3	“Q3-OUT” as General Purpose Digital Output	Low	High	0
B2	“Q2-OUT” as General Purpose Digital Output	Low	High	0
B1	“Q1-OUT” as General Purpose Digital Output	Low	High	0
B0	“Q0-OUT” as General Purpose Digital Output	Low	High	0

<Note-1>

Write (BASE+3H) Register is not cleared by Read (BASE+7H) Register as a Board-Reset Command, but cleared by the hardware reset in the power-on process.

<Note-3>

Logical Polarity is set to Negative with setting the switch S-POL to “N” on shipping cause the outputs to TTL high state at the hardware reset in the power-on process.

<Note-2>

74LS04 is assembled in the socket as a TTL level digital output device at the factory of MICRO SCIENCE.

You can replace it by 74LS06 or 74LS07 for change to open collector level.

Section 4. Maintenance and Appendix

4-1. Trouble Shootings

Reconfirm.

The MFU-541PC104 supplied by MICRO SCIENCE is fully calibrated and tested. If it doesn't work on your system, reconfirm following issues.

- (1) Check the I/O BASE address specified by the on-board switch SW1, SW2, and SW3. On the IBM PC/AT compatible system, the I/O address must be mapped between "0H" to "3FFH" or the image of this range except for the occupied address by the other devices or the peripherals.
- (2) Debug your software or applications. For example, if the Interrupt level is correct or if conflict with any other devices.
- (3) Be careful to input the signal at the Input of the External Digital inputs. Applying the voltage of higher than +7v or lower than -0.5v to the 74HCT-type TTL level inputs shall cause permanent destruction of the front-ended devices. For example, Multi Wave Form Generator is that!

What's wrong?

Fill in and send (Letter, Fax, or Email) the Q&A form to MICRO SCIENCE where you didn't find anything wrong.

Although we will study about your system and answer by the letter what you should better to do, we don't write or debug application software.

Sorry, we won't answer with any language but Japanese on the phone. Please write us Japanese or English.

Replace the Board or Repair for free.

MICRO SCIENCE will replace or repair the Board for free which are after examination disclosed to the satisfaction of MICRO SCIENCE to be thus defective, for a period within one year of shipment. This warranty shall not apply which have been subject to misuse, negligence, or accident. See "Caution/Warranty" for details in page-3.

Repair the Board.

MICRO SCIENCE will repair, calibrate, or test the Board on request. These products should have to prepaid the transportation at MICRO SCIENCE. Be sure, give us the information with the products, maybe Q&A form is useful for the report.

Then user have to pay the proper cost in few weeks according to the bill after accept the returned products.

4-2. Calibration

MFU-541PC104 is supplied by MICRO SCIENCE fully calibrated and tested . However, before execute the user application and or at the chance of inspection for the system maintenance, you had better to calibrate the Board with the standard source.

for Analog Input

Start the program that execute A-to-D conversion and display the data on screen. Apply reference voltage to the Analog Input of the Board, then trim the potentiometers to have the correct AD-data as shown in Table 4-2A.

The adjust points are required only 2 values that represent as the edge of the Range. Take 5 minutes for warm up before calibration to have the specified accuracy. You had better to average 5 or more data against the noise

Procedures.

- (1) Trim the potentiometer "TMA0" to have the data "800H" with the input voltage is "0v" for the OFFSET adjustment.
- (2) Trim the potentiometer "TMA1" to have the data "FFFH" with the input voltage is "+Full-Scale Voltage" for the GAIN adjustment.

Repeat OFFSET and GAIN adjustments alternately until no further accuracy improvement can be obtained.

Table 4-2A. Calibration table for Analog input

Analog Input Range >>>		-10 to +10v	-5 to +5v	-2.5 to +2.5v		
Offset Trimming	Reference	0v	0v	0v		
	Adjust to	800H	800H	800H		
	Potentiometer	TMA0	TMA0	TMA0		
Gain Trimming	Reference	+9.99512v	+4.99756v	+2.49878v		
	Adjust to	FFFH	FFFH	FFFH		
	Potentiometer	TMA1	TMA1	TMA1		

<Note-1>

Analog inputs of MFU-541PC104 are calibrated at the factory of MICRO SCIENCE within 0.105% of Full-Scale accuracy in the range of -10v to +10v for optimizing, and within 0.125% of Full-Scale accuracy in the other range, though MFU-541PC104 has 0.025% of Full-Scale non-linearity.

<Note-2>

The AD-data may be including typical 1-LSB noise in the real application system. Averaging with 5 or more data should be recommended.

for Analog Output

Start the program that execute D-to-A conversion and measure the output voltage by the volt-meter, then trim the potentiometers to have the correct output voltage as shown in Table 4-2B.

The adjust points are required only 2 values that represent as the edge of the Range. Take 5 minutes for warm up before calibration to have the specified accuracy.

Procedures.

- (1) Trim the potentiometer "TMD0" to have the output voltage "0v" with the DA-data is "000H" in 0 to +10v range, or "800H" in -10v to +10v range for the OFFSET adjustment.
- (2) Trim the potentiometer "TMD1" to have the output voltage "+9.99756v" in 0 to +10v range, or "9.99512v" in -10v to +10v range with the DA-data is "FFFH" for the GAIN adjustment.

Repeat OFFSET and GAIN adjustments alternately until no further accuracy improvement can be obtained.

Table 4-2B. Calibration table for Analog output

Analog Input Range >>>		-10 to +10v	0 to +10v			
Offset Trimming	Reference	0v	0v			
	Adjust to	800H	000H			
	Potentiometer	TMD0	TMD0			
Gain Trimming	Reference	+9.99512v	+9.99756v			
	Adjust to	FFFH	FFFH			
	Potentiometer	TMD1	TMD1			

<Note-3>

Analog output of MFU-541PC104 is calibrated at the factory of MICRO SCIENCE within 0.05% of Full-Scale accuracy in the range of 0 to +10v for optimizing, and within 0.0625% of Full-Scale accuracy in the range of -10v to +10v, though MFU-541PC104 has 0.0125% of Full-Scale non-linearity.

Q & A form (in English or Japanese)

To:
 MICRO SCIENCE., Co. LTD
 Customer Support Div
 2-37-12, Nishiogi-kita,
 Suginami-ku,
 Tokyo, Japan

From:

Fax: +81-3-3301-5593
 Email: qas@microscience.co.jp

Fax:
 Email:

MFU-541PC104	serial # =	Purchase Date:
Preferences on- Board	SW1 =	S-POL= JP-ADR=
	SW2 =	JP-INT = S-DAR=
	SW3 =	
Other Devices In the system	Product: Occupied Resources: (I/O Address =), (Interrupt =)	
System Information	CPU:	
	OS :	
Software	Language:	
	Compiler:	

(Information)

<Note> MICR SCIENCE does not answer on phone with any language but Japanese.