1. Introduction
The FX1N-2AD-BD analog input expansion board (hereafter called "2AD" or "expansion module") is to be installed in an FX1S or FX1N series PLC, to increase the analog input by 2 points.

1.1 Features of 2AD
1) Analog input of two points can be increased using 2AD. If a 2AD is used, internal mounting in the top of the PLC means that there is no need for a change to the installation area of the PLC.
2) Voltage input (0 ~10V) or current input (4 ~ 20mA) for analog to digital conversion can be set by switching the auxiliary relays assigned to each channel.
Moreover, a digital value after conversion of each channel is stored in special data register allocated to each channel, as shown in the table below.
However, the analog to digital conversion characteristic cannot be adjusted.

Table 1.1: Allocated Device

<table>
<thead>
<tr>
<th>Device</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M8112</td>
<td>Switch of input mode of Ch1 flag OFF:</td>
</tr>
<tr>
<td>M8113</td>
<td>Switch of input mode of Ch2 flag OFF:</td>
</tr>
<tr>
<td>DB112</td>
<td>Digital value of Ch1</td>
</tr>
<tr>
<td>DB113</td>
<td>Digital value of Ch2</td>
</tr>
</tbody>
</table>

1.2 External Dimensions and Each Part Name
Dimensions: mm (inches) Accessory: Top cover for board "x1", M3 self-tapping screw "3" (to fix top cover "x1", to mount board "2")

b) Mounting holes (2.34.0 / 0.18")

1.3 System Configuration
- Only one expansion board can be used on one FX1S and FX1N PLC main unit.
- Do not try to install two or more expansion boards. (They will not function.)
- The 2AD cannot be used with a FX1N-EEPROM-8L or FX1N-5DM.

1.4 Applicable PLC

<table>
<thead>
<tr>
<th>PLC Type</th>
<th>Applicable version</th>
</tr>
</thead>
<tbody>
<tr>
<td>FX1S series</td>
<td>V2.00 or later</td>
</tr>
<tr>
<td>FX1N series</td>
<td>V2.00 or later</td>
</tr>
</tbody>
</table>

2. Specifications
2.1 General Specifications
Same as the programmable controller main unit. (Refer to the programmable controller main unit manual)

2.2 Power Supply Specifications
Power supplied by internal feed of the programmable controller main unit.

2.3 Performance Specifications

<table>
<thead>
<tr>
<th>Table 2.1: Performance Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
</tr>
<tr>
<td>-----------------------</td>
</tr>
<tr>
<td>Range of analog input</td>
</tr>
<tr>
<td>Digital output</td>
</tr>
<tr>
<td>Resolution</td>
</tr>
<tr>
<td>Integrated accuracy</td>
</tr>
<tr>
<td>A/D conversion time</td>
</tr>
<tr>
<td>Input characteristics</td>
</tr>
<tr>
<td>Occupation point</td>
</tr>
</tbody>
</table>

Note:
- *1 The A/D conversion is started following the END statement. A/D conversion of Channel 1 and 2 is performed in turn and not in simultaneous operation. Channel 1 conversion is completed in approximately 15ms, however, at the End statement conversion of the present value stored in DB112 is dependent on PLC scan time. Channel 2 will start at the same time that Channel 1 completes the refresh of DB112.

3. Installation

Caution:
- Cut off all phases of power source before installing / removing or performing wiring work on the master in order to avoid electric shock or damage of product.
- After the installation and wiring etc. replace the PLCs top cover before power ON.

Note:
- Securely Install the expansion board, and fix to the PLC. Defective contact can cause malfunction.
- The tightening torque for fix the board or top cover is 0.3 ~ 0.6 Nm. Tighten securely to avoid malfunction.
- Only one expansion board can be used per main unit of FX1S and FX1N PLC. Do not try to install two or more expansion boards.
- Moreover, the 2AD cannot be used with the FX1N-EEPROM-8L or the FX1N-5DM.

The following is a generic explanation of how to install an expansion board to the PLC.

- a) Top cover for expansion board
- b) M3 self-tapping screw to mount expansion board
- c) M3 self-tapping screw to fix top cover
- d) External port for optional equipment
- e) Expansion board

Note: Do not remove this screw.

1) Remove the top cover of the main unit in an gap.
2) Plug expansion board "a)" into the external port "d)"
3) Fix expansion board to main unit using M3 self-tapping screws "c)". (Tightening torque: 0.3 ~ 0.6N m)
4) Attach top cover for expansion board "a)" removing section "a)" exposing connector etc.
5) Secure top cover with M3 self-tapping screw "b)". (Tightening torque: 0.3 ~ 0.6N m)
1. Introduction
The FX1N-2AD-BD analog input expansion board (hereafter called “2AD” or “expansion board”) is to be installed in an FX1S or FX1N series PLC, to increase the analog input by 2 points. 

1.1 Features of 2AD
1) Analog input of two points can be increased using 2AD. If a 2AD is used, internal mounting in the top of the PLC means that there is no need for a change to the installation area of the PLC.
2) Voltage input (0 ~ 10V) or current input (4 ~ 20mA) for analog to digital conversion can be set by switching the auxiliary relays assigned to each channel.

Moreover, a digital value after conversion of each channel is stored in special data register allocated to each channel, as shown in the table below.
However, the analog conversion characteristics cannot be adjusted.

1.2 External Dimensions and Each Part Name

Dimensions: mm (inches) Accessory: Top cover for board

- a) Terminals to connect analog module: The top face of this terminal block is higher than the top face of the panel cover of the programmable controller by approximately 7mm (0.28`).
- b) Mounting holes: (24.0 / 0.18`) Connecter for PLC

1.3 System Configuration
- Only one expansion board can be used on one FX1S and FX1N PLC main unit. Do not try to install two or more expansion boards. (They will not function).
- The 2AD cannot be used with a FX1N-EEPROM-L or FX1N-SDM.

1.4 Applicable PLC
- FX1S series PLC
- FX1N series PLC

Table 1.3: Applicable Programmable Controller

<table>
<thead>
<tr>
<th>PLC Type</th>
<th>Applicable version</th>
</tr>
</thead>
<tbody>
<tr>
<td>FX1S series</td>
<td>V2.00 or later</td>
</tr>
<tr>
<td>FX1N series</td>
<td>V2.00 or later</td>
</tr>
</tbody>
</table>

2. Specifications

2.1 General Specifications
Same as the programmable controller main unit. (Refer to the programmable controller main unit manual)

2.2 Power Supply Specifications
Power supplied by internal feed of the programmable controller main unit.

2.3 Performance Specifications

Table 2.1: Performance Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage input</td>
<td>DC 4 ~ 20mA (input resistance 250Ω)</td>
</tr>
<tr>
<td>Current input</td>
<td>DC 0 ~ 10V (input resistance 300kΩ)</td>
</tr>
<tr>
<td>Resolution</td>
<td>±1% (Against the full scale)</td>
</tr>
<tr>
<td>Integrated accuracy</td>
<td>±1% (Against the full scale)</td>
</tr>
<tr>
<td>A/D conversion time</td>
<td>Approx. 30ms (15ms x 2 channels)</td>
</tr>
<tr>
<td>Digital output</td>
<td>12bit binary</td>
</tr>
</tbody>
</table>

Associated Manual

<table>
<thead>
<tr>
<th>Manual Name</th>
<th>Manual Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FX1S Series Programmable controllers Hardware Manual</td>
<td>JY992D93001</td>
<td>Describes contents related to hardware of the FX1S series PLC, such as specifications, wiring and installation.</td>
</tr>
<tr>
<td>FX1N Series Programmable controllers Hardware Manual</td>
<td>JY992D93001</td>
<td>Describes contents related to hardware of the FX1N series PLC, such as specifications, wiring and installation.</td>
</tr>
<tr>
<td>FX Series or FX Series Programming Manual II</td>
<td>JY992D88101</td>
<td>Describes instructions in FX-series FX1S/FX1N/FX2N/FX2NC series.</td>
</tr>
</tbody>
</table>

Note:
- Owing to the very great variety in possible application of this equipment, you must satisfy yourself as to its suitability for your specific application.

Guidelines for the Safety of the User and Protection of the FX1N-2AD-BD Analog Input Expansion Board

This manual contains text, diagrams and explanations which will guide the reader in the correct installation, safe use and operation of the FX1N-2AD-BD Analog Input Expansion Board and should be read and understood before attempting to install or use the unit. Further information can be found in the associated manuals listed below.

Specifications are subject to change without notice

Note's on the Symbols Used in this Manual

1) Indicates that the identified danger will cause physical and property damage.
2) Indicates that the identified danger could possibly cause physical and property damage.

- Under no circumstances will Mitsubishi Electric be liable or responsible for any consequential damage that may arise as a result of the installation or use of this equipment.
- All examples and diagrams shown in this manual are intended only as an aid to understanding the text, not to guarantee operation. Mitsubishi Electric will accept no responsibility for actual use of the product based on these illustrative examples.
- Owing to the very great variety in possible application of this equipment, you must satisfy yourself as to its suitability for your specific application.

- The term 'completed equipment' refers to a third party constructed device which contains or uses the product associated with this manual.

- Note: on the Symbols Used in this Manual

- Indispensable manual

- Manual Name | Manual Number | Description |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>FX1S Series Programmable controllers Hardware Manual</td>
<td>JY992D93001</td>
<td>Describes contents related to hardware of the FX1S series PLC, such as specifications, wiring and installation.</td>
</tr>
<tr>
<td>FX1N Series Programmable controllers Hardware Manual</td>
<td>JY992D93001</td>
<td>Describes contents related to hardware of the FX1N series PLC, such as specifications, wiring and installation.</td>
</tr>
<tr>
<td>FX Series or FX Series Programming Manual II</td>
<td>JY992D88101</td>
<td>Describes instructions in FX-series FX1S/FX1N/FX2N/FX2NC series.</td>
</tr>
</tbody>
</table>

Note:
- Owing to the very great variety in possible application of this equipment, you must satisfy yourself as to its suitability for your specific application.

- The term 'completed equipment' refers to a third party constructed device which contains or uses the product associated with this manual.

- Note: on the Symbols Used in this Manual

- Indispensable manual

- Manual Name | Manual Number | Description |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>FX1S Series Programmable controllers Hardware Manual</td>
<td>JY992D93001</td>
<td>Describes contents related to hardware of the FX1S series PLC, such as specifications, wiring and installation.</td>
</tr>
<tr>
<td>FX1N Series Programmable controllers Hardware Manual</td>
<td>JY992D93001</td>
<td>Describes contents related to hardware of the FX1N series PLC, such as specifications, wiring and installation.</td>
</tr>
<tr>
<td>FX Series or FX Series Programming Manual II</td>
<td>JY992D88101</td>
<td>Describes instructions in FX-series FX1S/FX1N/FX2N/FX2NC series.</td>
</tr>
</tbody>
</table>
1. Introduction

The FX1N-2AD-BD analog input expansion board (hereafter called "2AD" or "expansion board") is to be installed in an FX1S or FX1N series PLC, to increase the analog input by 2 points.

1.1 Features of 2AD

1) Analog input of two points can be increased using 2AD. If a 2AD is used, internal mounting in the top of the PLC means that there is no need for a change to the installation area of the PLC.

2) Voltage input (0 ~ 10V) or current input (4 ~ 20mA) for analog to digital conversion can be set by switching the auxiliary relays assigned to each channel.

Moreover, a digital value after conversion of each channel is stored in special data register allocated to each channel, as shown in the table below.

However, the analog to digital conversion characteristic cannot be adjusted.

Table 1.1: Allocated Device

<table>
<thead>
<tr>
<th>Device</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M8112</td>
<td>Switch of input mode of Ch1 flag</td>
</tr>
<tr>
<td>M8113</td>
<td>Switch of input mode of Ch2 flag</td>
</tr>
<tr>
<td>DB8112</td>
<td>Digital value of Ch1</td>
</tr>
<tr>
<td>DB8113</td>
<td>Digital value of Ch2</td>
</tr>
</tbody>
</table>

1.2 External Dimensions and Each Part Name

Dimensions: mm (inches) Accessory: Top cover for board

a) Terminals to connect analog module

The top face of this terminal block is higher than the top face of the panel cover of the programmable controller by approximately 7mm (0.28”).

b) Mounting holes (2 × 4.0 / 0.16”)

b) Connector for PLC

1.3 System Configuration

- Only one expansion board can be used on one FX1S and FX1N PLC main unit.
- Do not try to install two or more expansion boards. (They will not function)
- The 2AD cannot be used with a FX1N-EEMPR0M-8L or FX1N-5DM.

1.4 Applicable PLC

Table 1.3: Applicable Programmable Controller

<table>
<thead>
<tr>
<th>PLC Type</th>
<th>Applicable version</th>
</tr>
</thead>
<tbody>
<tr>
<td>FX1S series</td>
<td>V2.00 or later</td>
</tr>
<tr>
<td>FX1N series</td>
<td>V2.00 or later</td>
</tr>
</tbody>
</table>

Associated Manual

<table>
<thead>
<tr>
<th>Manual Name</th>
<th>Manual Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FX1S Series Programmable controllers Hardware Manual</td>
<td>JY992D98301</td>
<td>Describes contents related to hardware of the FX1S series PLC, such as specifications, wiring and installation.</td>
</tr>
<tr>
<td>FX1N Series Programmable controllers Hardware Manual</td>
<td>JY992D98301</td>
<td>Describes contents related to hardware of the FX1N series PLC, such as specifications, wiring and installation.</td>
</tr>
<tr>
<td>FX Series or Programmable controllers Programming Manual II</td>
<td>JY992D88101</td>
<td>Describes instructions in FX1S/FX1N/FX2N/FX2NC series.</td>
</tr>
</tbody>
</table>

*Indispensable manual

2. Specifications

2.1 General Specifications

Same as the programmable controller main unit. (Refer to the programmable controller main unit manual)

2.2 Power Supply Specifications

Power supplied by internal feed of the programmable controller main unit.

2.3 Performance Specifications

Table 2.1: Performance Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage input</td>
<td>D0C 0 ~ 10V (input resistance 300kΩ) Absolute maximum input: -0.5V, +15V</td>
</tr>
<tr>
<td>Current input</td>
<td>DC 4 ~ 20mA (input resistance 250Ω) Absolute maximum input: -2mA, +60mA</td>
</tr>
</tbody>
</table>

2.4 Performance Specifications

Resistor | 2.5V (13V ±400Ω) |

2.5 Integrated accuracy

±1% Against the full scale

2.6 Integrated accuracy

(0 ~ 10V: ±0.1V) ±1% Against the full scale

2.7 Integrated accuracy

(4 ~ 20mA: ±0.1%)

Note: The A/D conversion is started following the END statement. A/D conversion of Channel 1 and 2 is performed in turn and not in simultaneous operation. Channel 1 conversion is completed in approximately 15ms, however, at the End statement conversion of the present value stored in DB8112 is dependent on PLC scan time. Channel 2 will start at the same time that Channel 1 completes the refresh of DB8112.

Table 2.2: Allocation Terminal

<table>
<thead>
<tr>
<th>Terminal name</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1+</td>
<td>Voltage input terminal for channel 1(Ch1)</td>
</tr>
<tr>
<td>I1+</td>
<td>Current input terminal for channel 1(Ch1)</td>
</tr>
<tr>
<td>VI+</td>
<td>Common terminal for each channel</td>
</tr>
<tr>
<td>ID+</td>
<td>Voltage input terminal for channel 2(Ch2)</td>
</tr>
<tr>
<td>I2+</td>
<td>Current input terminal for channel 2(Ch2)</td>
</tr>
</tbody>
</table>

3. Installation

Caution:

- Cut off all phases of power source before installing / removing or performing wiring work on the master in order to avoid electric shock or damage of product.
- After the installation and wiring etc. replace the PLCs top cover before power ON.

Note:

- Securely Install the expansion board, and fix to the PLC. Defective contact can cause malfunction.
- The tightening torque for fix the board or top cover is 0.3 ~ 0.6 Nm. Tighten securely to avoid malfunction.

Note:

Only one expansion board can be used per main unit of FX1S and FX1N PLC. Do not try to install two or more expansion boards.

Moreover, the 2AD cannot be used with the FX1N-EEMPR0M-8L or the FX1N-5DM.

The following is a generic explanation of how to install an expansion board to the PLC.

Note: Do not remove this screw.

1) Remove the top cover of the main unit's main door.
2) Plug expansion board “a” into the external port “d”.
3) Fix expansion board to main unit using M3 self-tapping screws “c”.
   (Tightening torque: 0.3 ~ 0.6N m)
4) Attach top cover for expansion board “a” removing section “a” to expose connector etc.
5) Secure top cover with M3 self-tapping screw “b”.
   (Tightening torque: 0.3 ~ 0.6 N m)
5. Example Program

Analog input: A/D converter

4.1 Applicable cables

- AWG26 – 16 for connection with input.
- AWG16 – 2.5 for connection with output.
- AWG4 – 6.0 for connection with power supply.

4.2 Wiring

The channel not used is short-circuit and uses the terminal "V+" and the terminal "V-". The channel number enters "O".

5.1 Allocated Device

Table 5.1: Allocation of Device

<table>
<thead>
<tr>
<th>Device</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M8112</td>
<td>OFF: Voltage input mode (0 ~ 10V) ON: Current input mode (4 ~ 20mA)</td>
</tr>
<tr>
<td>M8113</td>
<td>OFF: Voltage input mode (0 ~ 10V) ON: Current input mode (4 ~ 20mA)</td>
</tr>
</tbody>
</table>

5.2 Basic Example Program

**Table 5.1: Allocation of Device**

<table>
<thead>
<tr>
<th>Device</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB112</td>
<td>Digital value of Ch1</td>
</tr>
<tr>
<td>DB113</td>
<td>Digital value of Ch2</td>
</tr>
</tbody>
</table>

**Note:**

- Drive M8112 and M8113 which specifies the analog to digital conversion characteristic with special auxiliary relays M8112 and M8113.
- Do not change the Ch1 or Ch2 flag of the interface terminal of the digital output device while the analog to digital conversion is operating.
- The analog to digital conversion is not executed correctly when M8112 or M8113 are turned ON and OFF during the conversion process.
- Do not change the digital value of D8112 or D8113 after A/D conversion in the 2AD, by manipulating the user program, a programming tool, or GOT (graphic operation terminal), etc.

The following program example sets Ch1 in the voltage input mode, Ch2 in the current input mode, with the A/D converted digital value of each channel stored in D0 and D1.

```
• M8000

M8000
M8112
M8000
M8113

10000

FNC 20
ADD
FNC 23
DIV

D10
D0
D10
D0

Digital value from A/D converter (D8112,D8113)

Digital value used in user program (D60) 4000

0 4000 8000 12000 16000 20000

0 4mA 8mA 12mA 16mA 20mA

Analog input
```

*1 If a digital value is not stored in D0 or D2, D8112 and D8113 can be used directly for set values and other instructions, etc. of timers and counters.

**5.3 Example Application Program**

As the 2AD does not have Offset and Gain capabilities, if values are required outside the standard specification range, additional program commands are required to either multiply or divide the conversion values. For an example application, please see FX programming manual II.

**Note:**

- Accuracy and resolution of the analog to digital conversion are different from the specification because the additional program commands.
- The original range of the analog input is not changed.

**5.3.1 Example Application Program 1**

In voltage input mode, the 2AD converts analog values from 0 ~ 10V to the digital output of 0 ~ 4000. If using a digital range of 0 ~ 10000 in the program, the range must be converted from 0 ~ 4000 to 0 ~ 10000 as shown in the programming example below. Digital values that are converted from analog values are stored in D8112 or D8113.

The analog input does not have exact resolution of 8 μA because the digital value is converted from a range of 0 ~ 2000 to 4000 ~ 20000.

```
D10
D0

Digital value from A/D converter (D8112,D8113)

Digital value used in user program (D60) 4000

0 4000 8000 12000 16000 20000

0 4mA 8mA 12mA 16mA 20mA

Analog input
```

If a digital value in the range of 4000 ~ 20000 is used in D60, please see below.

Digital value used in user program: 
```
D60 = 8 x (D8112 or D8113) + 4000
```

The program example based on the equation above is as shown in the figure below. (In Ch2 case)
4. Wiring

Caution:
- Cut off all phases of power source before installing / removing or performing wiring work on the expansion board in order to avoid electric shock or damage of product.
- Do not lay signal cable near to high voltage power cable or house them in the same trunking duct. Effects of noise or surge induction may occur. Keep signal cables a safe distance of more than 100 mm (3.94") from these power cables.
- Ground the shield wire or the shield of a shielded cable. Do not, however, ground at the same point as high voltage lines.
- Never solder the end of any cables.
- Make sure that the number of connected cables is not more than the unit has been designed for.
- Never connect cables of a non permitted size.
- Fix cables so that any stress is not directly applied on the terminal block or the cable connection area.
- Tighten the terminals to a torque of 0.5 ~ 0.6 N·m. Do not tighten terminal screws exceeding the specified torque. Failure to do so may cause equipment failures or malfunctions.

4.1 Applicable cables
- Use AWG26 ~ 16 for connection with input.
- Do not lay signal cable near to high voltage power cable or house them in the same trunking duct. Effects of noise or surge induction may occur. Keep signal cables a safe distance of more than 100 mm (3.94") from these power cables.
- Drive M8112 and M8113 which specifies the analog to digital conversion characteristic in user program (D60). The A/D converted digital value of each channel stored in D0 and D1.
- The original range of the analog input is not changed.

4.2 Wiring

The channel not used is short-circuit and uses the terminal "V+" and the terminal "VI-". The channel number enters "0".

Voltage input mode (0 ~ 10V)

Grounding resistance 100Ω or less

Current input mode (4 ~ 20mA)

Grounding resistance 100Ω or less

*1 Connect a 0.1 ~ 0.47µF at 25V DC capacitor in position "*1" when there is voltage ripple in the voltage input or there will be a lot of noise.

*2 For current input, short circuit "V+O" and "I-" as shown in the diagram.

5. Example Program

5.1 Allocated Device

Table 5.1: Allocation of Device

<table>
<thead>
<tr>
<th>Device</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D8112</td>
<td>Digital value of Ch1</td>
</tr>
<tr>
<td>D8113</td>
<td>Digital value of Ch2</td>
</tr>
</tbody>
</table>

5.2 Basic Example Program

Table 5.1: Allocation of Device

<table>
<thead>
<tr>
<th>Device</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D8112</td>
<td>Digital value of Ch1</td>
</tr>
<tr>
<td>D8113</td>
<td>Digital value of Ch2</td>
</tr>
</tbody>
</table>

Note:
- Drive M8112 and M8113 which specifies the analog to digital conversion characteristic with special auxiliary relays M8112 and M8113.
- The original range of the analog input is not changed.

5.3 Example Application Program

In current input mode, the 2AD converts analog values from 4 ~ 20mA to the digital output of 0 ~ 2000. If using a digital range of 0 ~ 10000 in the program, the range must be converted from 0 ~ 2000 to 4000 ~ 20000 as shown in the programming example below. Digital values that are converted from analog values are stored in D8112 or D8113. The analog input does not have exact resolution of 2.5 µA because the digital value is converted from a range of 0 ~ 2000 to 4000 ~ 20000.

5.3.1 Example Application Program 1

In voltage input mode, the 2AD converts analog values from 0 ~ 10V to the digital output of 0 ~ 4000. If using a digital range of 0 ~ 10000 in the program, the range must be converted from 0 ~ 4000 to 0 ~ 10000 as shown in the programming example below. Digital values that are converted from analog values are stored in D8112 or D8113. The analog input does not have exact resolution of 2.5 mV because the digital value is converted from a range of 0 ~ 4000 to 0 ~ 10000.

5.3.2 Example Application Program 2

In current input mode, the 2AD converts analog values from 4 ~ 20mA to the digital output of 0 ~ 2000. If using a digital range of 4000 ~ 20000 in the program, the range must be converted from 0 ~ 2000 to 4000 ~ 20000 as shown in the programming example below. Digital values that are converted from analog values are stored in D8112 or D8113. The analog input does not have exact resolution of 8 µA because the digital value is converted from a range of 0 ~ 2000 to 4000 ~ 20000.
4. Wiring

Caution:
Cut off all phases of power source before installing / removing or performing wiring work on the expansion board in order to avoid electric shock or damage of product.

Note:
- Do not lay signal cable near to high voltage power cable or house them in the same trunking duct. Effects of noise or surge induction may occur. Keep signal cables a safe distance of more than 100 mm (3.94") from these power cables.
- Ground the shield wire or the shield of a shielded cable. Do not, however, ground at the same point as high voltage lines.
- Never solder the end of any cables. Make sure that the number of connected cables is not more than the unit has been designed for.
- Never connect cables of a non permitted size.
- Fix cables so that any stress is not directly applied on the terminal block or the cable connection area.
- Tighten the terminals to a torque of 0.5 ~ 0.6 Nm. Do not tighten terminal screws exceeding the specified torque. Failure to do so may cause equipment failures or malfunctions.

4.1 Applicable cables
- Use AWG26 ~ 16 for connection with input.
- Drive M8112 and M8113 which specifies the analog to digital conversion characteristic with M8000 ("a" type contact of the RUN monitor) or M8001 ("b" type contact of the RUN monitor).
- Do not change the ON/OFF state while the analog to digital conversion is operating. The analog to digital conversion is not executed correctly when M8112 or M8113 are turned ON and OFF during the conversion process.

5. Example Program

5.1 Allocated Device

<table>
<thead>
<tr>
<th>Device</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D8112</td>
<td>Digital value of Ch1</td>
</tr>
<tr>
<td>D8113</td>
<td>Digital value of Ch2</td>
</tr>
</tbody>
</table>

5.2 Basic Example Program

Note:
- Drive M8112 and M8113 which specifies the analog to digital conversion characteristic with M8000 ("a" type contact of the RUN monitor) or M8001 ("b" type contact of the RUN monitor).
- Do not change the ON/OFF state while the analog to digital conversion is operating. The analog to digital conversion is not executed correctly when M8112 or M8113 are turned ON and OFF during the conversion process.
- Do not change the digital value of D8112 or D8113 after A/D conversion in the 2AD, by manipulating the user program, a programming tool, or GOT (graphic operation terminal), etc.

5.3 Example Application Program 1

In voltage input mode, the 2AD converts analog values from 0 ~ 10V to the digital output of 0 ~ 4000. If using a digital range of 4000 ~ 20000 in the program, the range must be converted from 0 ~ 2000 to 4000 ~ 20000 as shown in the programming example below. Digital values that are converted from analog values are stored in D8112 or D8113. The input analog do not have exact resolution of 8 µin because the digital value is converted from a range of 0 ~ 2000 to 4000 ~ 20000.

5.3.1 Example Application Program 2

In current input mode, the 2AD converts analog values from 4 ~ 20mA to the digital output of 0 ~ 2000. If using a digital range of 4000 ~ 20000 in the program, the range must be converted from 0 ~ 2000 to 4000 ~ 20000 as shown in the programming example below. Digital values that are converted from analog values are stored in D8112 or D8113.

The analog input do not have exact resolution of 8 µin because the digital value is converted from a range of 0 ~ 2000 to 4000 ~ 20000.

5.4 Wiring

The channel not used is short-circuit and uses the terminal “V+” and the terminal “VI-”. The channel number enters “O”.

- Single cable: Remove sheath, then connect cable.
- Stranded cable: Remove sheath, twist core wire, then connect cable.

4mA
20mA
250Ω
120kΩ
18kΩ
18kΩ
2502Ω
2502Ω
AG
AG
100Ω or less
100Ω or less

Grounding resistance
Grounding resistance

If a digital value in the range of 4000 ~ 20000 is used in D60, please see below.
Digital value used in user program: D60 = 8 × (D8112 or D8113) ÷ 4000

If a digital value in the range of 0 ~ 10000 is used in D60, please see below.
Digital value used in user program: D60 = 8 × (D8112 or D8113) ÷ 4000

The program example based on the equation above is as shown in the figure below. (In Ch2 case)
1. Introduction

The FX1N-2AD-BD analog input expansion board (hereafter called "2AD" or "expansion board") is to be installed in an FX1N or FX3N series PLC, to increase the analog input by 2 points.

1.1 Features of 2AD

1) Analog input of two points can be increased using 2AD. If a 2AD is used, internal mounting in the top of the PLC means that there is no need for a change in the installation area of the PLC.

2) Voltage input (-10V) or current input (4 ~ 20mA) for analog to digital conversion can be set by switching the auxiliary relays assigned to each channel.

Moreover, a digital value after conversion of each channel is stored in special data register allocated to each channel, as shown in the table below.

However, the analog to digital conversion characteristic cannot be adjusted.

Table 2.1: Performance Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Voltage input</th>
<th>Current input</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute maximum</td>
<td>DC 0 ~ 10V (input resistance 300kΩ)</td>
<td>DC 4 ~ 20mA (input resistance 250Ω)</td>
</tr>
<tr>
<td>Digital output</td>
<td>×128 binary</td>
<td></td>
</tr>
<tr>
<td>Resolution</td>
<td>2.5V (10V /4000)</td>
<td>8μA (20mA / 4mA /2000)</td>
</tr>
<tr>
<td>Integrated accuracy</td>
<td>±1% Against the full scale</td>
<td>±1% Against the full scale</td>
</tr>
<tr>
<td>A/D conversion time</td>
<td>Approx. 30ms (15ms x 2 channels)</td>
<td>DB112 or DB113 are updated after the END instruction</td>
</tr>
</tbody>
</table>

1.2 External Dimensions and Each Part Name

Dimensions: mm (inches) Accessory: Top cover for board

Table 1.1: Allocated Device

<table>
<thead>
<tr>
<th>Device</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB112</td>
<td>Switch of input mode of Ch1 flag</td>
</tr>
<tr>
<td>OFF</td>
<td>Voltage input mode (0 ~ 10V)</td>
</tr>
<tr>
<td>ON</td>
<td>Current input mode (0 ~ 4mA)</td>
</tr>
<tr>
<td>MB113</td>
<td>Switch of input mode of Ch2 flag</td>
</tr>
<tr>
<td>OFF</td>
<td>Voltage input mode (0 ~ 10V)</td>
</tr>
<tr>
<td>ON</td>
<td>Current input mode (0 ~ 20mA)</td>
</tr>
</tbody>
</table>

Table 1.2: Allocation Terminal

<table>
<thead>
<tr>
<th>Terminal name</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1+</td>
<td>Voltage input terminal for channel 1 (Ch1)</td>
</tr>
<tr>
<td>I1+</td>
<td>Current input terminal for channel 1 (Ch1)</td>
</tr>
<tr>
<td>V2+</td>
<td>Voltage input terminal for channel 2 (Ch2)</td>
</tr>
<tr>
<td>I2+</td>
<td>Current input terminal for channel 2 (Ch2)</td>
</tr>
<tr>
<td>VI+</td>
<td>Common terminal for each channel</td>
</tr>
</tbody>
</table>

| Mounting holes (2): (24.0 / 18.0) |
| Connector for PLC |

1.3 System Configuration

• Only one expansion board can be used on one FX1N and FX3N/PLC main unit.

Do not try to install two or more expansion boards. (They will not function.)

• The 2AD cannot be used with a FX1N/EEPROM-8L or FX1N/SDM.

1.4 Applicable PLC

Table 1.3: Applicable Programmable Controller

<table>
<thead>
<tr>
<th>PLC Type</th>
<th>Applicable version</th>
</tr>
</thead>
<tbody>
<tr>
<td>FX3N series</td>
<td>FX1N series</td>
</tr>
<tr>
<td>V2.00 or later</td>
<td>V2.00 or later</td>
</tr>
</tbody>
</table>

2. Specifications

2.1 General Specifications

Same as the programmable controller main unit. (Refer to the programmable controller main unit manual)

2.2 Power Supply Specifications

Power supplied by internal feed of the programmable controller main unit.

2.3 Performance Specifications

Table 2.1: Performance Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Voltage input</th>
<th>Current input</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute maximum</td>
<td>DC 0 ~ 10V (input resistance 300kΩ)</td>
<td>DC 4 ~ 20mA (input resistance 250Ω)</td>
</tr>
<tr>
<td>Digital output</td>
<td>×128 binary</td>
<td></td>
</tr>
<tr>
<td>Resolution</td>
<td>2.5V (10V /4000)</td>
<td>8μA (20mA / 4mA /2000)</td>
</tr>
<tr>
<td>Integrated accuracy</td>
<td>±1% Against the full scale</td>
<td>±1% Against the full scale</td>
</tr>
<tr>
<td>A/D conversion time</td>
<td>Approx. 30ms (15ms x 2 channels)</td>
<td>DB112 or DB113 are updated after the END instruction</td>
</tr>
</tbody>
</table>

3. Installation

Caution:

• Cut off all phases of power source before installing / removing or performing wiring work on the master in order to avoid electric shock or damage of product.

• After the installation and wiring etc. replace the PLCs top cover before power ON.

Note:

• Securely Install the expansion board, and fix to the PLC. Defective contact can cause malfunction.

• The tightening torque for fix the board or top cover is 0.3 – 0.6 N.m. Tighten securely to avoid malfunction.

Note:

Only one expansion board can be used per main unit of FX1N and FX1N/PLC. Do not try to install two or more expansion boards.

Moreover, the 2AD cannot be used with the FX1N/EEPROM-8L or the FX1N/SDM.

The following is a generic explanation of how to install an expansion board to the PLC.

a) Top cover for expansion board
b) M3 self-tapping screw to mount expansion board
c) M3 self-tapping screws to fix top cover
d) External port for optional equipment
e) Expansion board

Note: Do not remove this screw.

1) Remove the top cover of the main unit.
2) Plug expansion board "a)" into the external port "d)"
3) Fix expansion board to main unit using M3 self-tapping screws "c)". (Tightening torque: 0.3 – 0.6 N.m)
4) Attach top cover for expansion board "a)" removing section "a)" to expose connector etc.
5) Secure top cover with M3 self-tapping screws "b)". (Tightening torque: 0.3 – 0.6 N.m)
4. Wiring

Cut off all phases of power source before installing / removing or performing wiring work on the expansion board in order to avoid electric shock or damage of product.

Note:
- Do not lay signal cable near to high voltage power cable or house them in the same trunking duct. Effects of noise or surge induction may occur. Keep signal cables a safe distance of more than 100 mm (3.94") from these power cables.
- Ground the shield wire or the shield of a shielded cable. Do not, however, ground at the same point as high voltage lines.
- Never solder the end of any cables. Make sure that the number of connected cables is not more than the unit has been designed for.
- Never connect cables of a non permitted size.
- Fix cables so that any stress is not directly applied on the terminal block or the cable connection area.
- Tighten the terminals to a torque of 0.5 ~ 0.6 Nm. Do not tighten terminal screws exceeding the specified torque. Failure to do so may cause equipment failures or malfunctions.

4.1 Applicable cables
- Use AWG26 ~ 16 for connection with input.
- Tighten the terminals to a torque of 0.5 ~ 0.6 Nm. Do not tighten terminal screws exceeding the specified torque. Failure to do so may cause equipment failures or malfunctions.
- When using a different type of cable, defective contact at the terminal is possible. Use a crimp terminal to achieve a good contact.

Table 4.1: Liner and Sectional Area

<table>
<thead>
<tr>
<th>Linear Area (mm²)</th>
<th>Sectional Area (mm²)</th>
<th>Terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1288</td>
<td>Stranded cable: Remove sheath, twist core wire, then connect cable.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Single cable: Remove sheath, then connect cable.</td>
<td></td>
</tr>
<tr>
<td>1.309</td>
<td>6mm² (0.23&quot;)</td>
<td></td>
</tr>
</tbody>
</table>

4.2 Wiring

The channel not used is short-circuit and uses the terminal "V+" and the terminal "VI-". The channel number enters "0".

Current input mode (4 ~ 20mA)

- Use a digital range of 0 ~ 10000 in the program, the range must be converted from 0 ~ 4000 to 0 ~ 10000 as shown in the programming example below. Digital values that are converted from analog values are stored in D8112 or D8113.
- The analog input does not have exact resolution of 2.5 mV because the digital value is converted from a range of 0 ~ 4000 to 0 ~ 10000.

Table 5.1: Allocation of Device

<table>
<thead>
<tr>
<th>Device</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB112</td>
<td>Digital value of Ch1</td>
</tr>
<tr>
<td>DB113</td>
<td>Digital value of Ch2</td>
</tr>
</tbody>
</table>

5.2 Basic Example Program

**Note:**
- Drive M8112 and M8113 which specifies the analog to digital conversion characteristic with M8000 ("a" type contact of the RUN monitor) or M8001 ("b" type contact of the RUN monitor).
- Do not change the ON/OFF state while the analog to digital conversion is operating.
- Do not change the digital value of D8112 or D8113 after A/D conversion in the 2AD, by manipulating the user program, a programming tool, or a tool (graphical operation terminal), etc.

The following program example sets Ch1 in the voltage input mode, Ch2 in the current input mode, with the A/D converted digital value of each channel stored in D0 and D1.

<table>
<thead>
<tr>
<th>D00</th>
<th>M8000</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>ON</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>D10</th>
<th>M8001</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>ON</td>
</tr>
</tbody>
</table>

Stores Digital value of Ch1 D0.
Stores Digital value of Ch2 D2.

1 If a digital value is not stored in D0 or D2.

5.3 Example Application Program

As the 2AD does not have Offset and Gain capabilities, if values are required outside the standard range, additional program commands are required to either multiply or divide the conversion values. For an example application, please see FX programming manual II.

**Note:**
- Accuracy and resolution of the analog to digital conversion are different from the specification because the additional program commands.
- The original range of the analog input is not changed.

5.3.1 Example Application Program 1

In voltage input mode, the 2AD converts analog values from 0 ~ 10V to the digital output of 0 ~ 2000. If using a digital range of 0 ~ 10000 in the program, the range must be converted from 0 ~ 4000 to 0 ~ 10000 as shown in the programming example below. Digital values that are converted from analog values are stored in D8112 or D8113.

The analog input does not have exact resolution of 2.5 mV because the digital value is converted from a range of 0 ~ 4000 to 0 ~ 10000.

**Table 5.1: Allocation of Device**

<table>
<thead>
<tr>
<th>Device</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB112</td>
<td>Digital value of Ch1</td>
</tr>
<tr>
<td>DB113</td>
<td>Digital value of Ch2</td>
</tr>
</tbody>
</table>

5.3.2 Example Application Program 2

In current input mode, the 2AD converts analog values from 4 ~ 20mA to the digital output of 0 ~ 2000. If using a digital range of 4000 ~ 20000 in the program, the range must be converted from 0 ~ 2000 to 4000 ~ 20000 as shown in the programming example below. Digital values that are converted from analog values are stored in D8112 or D8113.

The analog input does not have exact resolution of 8 µA because the digital value is converted from a range of 0 ~ 2000 to 4000 ~ 20000.

**Table 5.1: Allocation of Device**

<table>
<thead>
<tr>
<th>Device</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB112</td>
<td>Digital value of Ch1</td>
</tr>
<tr>
<td>DB113</td>
<td>Digital value of Ch2</td>
</tr>
</tbody>
</table>

6. Example Program

Analog input (0 ~ 10V, 4 ~ 20mA) input to each channel is stored in data registers (D8112, D8113) as digital values. The values are stored automatically at each END instruction and calculated using the analog to digital conversion characteristic, specified with special auxiliary relays M8112 and M8113.

5.1 Allocated Device

Table 5.1: Allocation of Device

<table>
<thead>
<tr>
<th>Device</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M8112</td>
<td>Switch of input mode of Ch1 flag</td>
</tr>
<tr>
<td></td>
<td>OFF: Voltage input mode (0 ~ 10V)</td>
</tr>
<tr>
<td></td>
<td>ON: Current input mode (4 ~ 20mA)</td>
</tr>
<tr>
<td>M8113</td>
<td>Switch of input mode of Ch2 flag</td>
</tr>
<tr>
<td></td>
<td>OFF: Voltage input mode (0 ~ 10V)</td>
</tr>
<tr>
<td></td>
<td>ON: Current input mode (4 ~ 20mA)</td>
</tr>
</tbody>
</table>