

**AM716**

**User Manual**

**IM23H53-E**

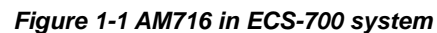
# Table of Contents

<b>FF Interface Module AM716 .....</b>	<b>1</b>
<b>Section 1 Overview.....</b>	<b>1</b>
1.1 Features .....	2
1.2 Matching Products.....	2
<b>Section 2 Specifications .....</b>	<b>3</b>
<b>Section 3 Usage.....</b>	<b>4</b>
3.1 Module Unit Structure .....	4
3.2 Indicator LEDs .....	5
3.2.1 Indicator LEDs of AM716.....	5
3.2.2 Indicator LEDs of MB728-S .....	5
3.3 Wiring .....	5
<b>Section 4 Application .....</b>	<b>8</b>
4.1 Segment Components .....	8
4.1.1 FF Power Conditioner .....	8
4.1.2 FF Junction Box and Branch Module .....	8
4.1.3 FF Cable .....	9
4.1.4 FF Instrument.....	10
4.1.5 FF Surge Protector (Selectable).....	11
4.2 Segment Wiring Example .....	11
4.2.1 AM716-S Segment Wiring Example .....	11
4.3 Terminal Resistor Setting.....	12
4.4 Notes .....	13
4.5 Troubleshooting .....	13
4.6 Segment Design.....	14
4.7 Segment Constraint.....	15
4.7.1 Distance Constraint .....	15
4.7.2 Power Consumption and Voltage Attenuation .....	16
4.7.3 Communication Process (Macrocycle) .....	17
<b>Section 5 FF Configuration Application .....</b>	<b>18</b>
<b>Section 6 Revision.....</b>	<b>19</b>

## Section 1 Overview

AM716 can acquire the real-time input (output) data of FF instrument and send them to the controller, to achieve centralized control to FF instruments. AM716 can also delegate control to the field instruments to achieve decentralized control. It also supports standard FF function blocks and manages all block parameters of field instruments via the FF configuration software and SAMS instrument management software.

The position of AM716 in ECS-700 is shown in Figure 1-1. AM716 is located at the I/O module layer and can connect FF instrument to ECS-700 by I/O bus. One control station at most can be connected with 64 pairs of redundant AM716 or 64 pairs of non-redundant AM716.



## 1.1 Features

The features of AM716 are shown below:

- Support 4-way independent Fieldbus H1 Segments.
- Support module redundancy.
- Support module hot swapping.
- Support all Fieldbus H1 instruments certified by Fieldbus Foundation.
- Support whole segment download for FF configuration.
- Support alarm and communication diagnosis.
- Support data retention with Nonvolatile memory

## 1.2 Matching Products

The version requirements of the controller and configuration software used with AM716 are as follows. If in doubt, please confirm with the operation and maintenance personnel in time:

- It can be used with FCU712-S V15.18.00 and above and VisualField V4.50.02.00 and above.
- It can be used with all versions of FCU713-S and VisualField V4.50.00.00 and above.

## Section 2 Specifications

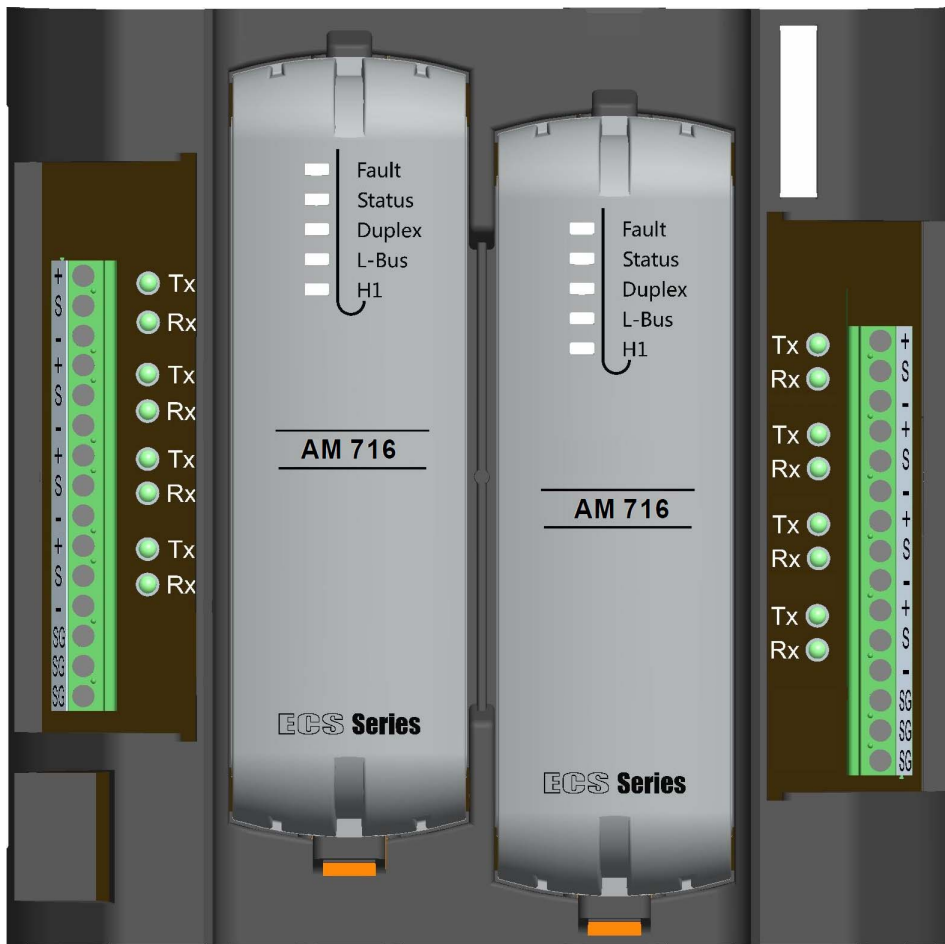
**Table 2-1 Specifications**

Parameter	Specifications
FF H1 Segment Connection	4 Segments
FF H1 Instrument Maximum Connection for Single Segment	16 FF Instruments
FF H1 Segment Wire Maximum Length	1900m (Include Branch Length)
Redundant Recovery Time	<10s
Power Supply/ Explosion-protection	Bus Power Supply/ Intrinsically Safe Explosion-protection
Input and Output Connection Supported by Segment	50
Input Tags Supported by AM716	80
Output Tags Supported by AM716	40
Local I/O Communication Rate	1Mbps
FF H1 Communication Rate	31.25Kbps
Rack Power Rated Voltage	24V
Power Consumption	2.5W <sup>1</sup>
FF H1 Rated Voltage (Only for AM716-P)	24V
IP Protection Level	IP30

## Section 3 Usage

### 3.1 Module Unit Structure

FF H1 interface module unit consists of the module AM716 and the base MB728. Appearance of the unit structure is shown in Figure 3-1.



**Figure 3-1 Appearance of FF H1 interface module unit**

## 3.2 Indicator LEDs

### 3.2.1 Indicator LEDs of AM716

**Table 3-1 Indicator LEDs of AM716**

LED	Normal	Abnormal	Instruction for Abnormal
Fault	OFF	ON	Serious Fault
		Flash	——
Status	ON	OFF	Module Not Powered
		Flash in 2s	Module Cold Started
		Flash in each 400ms	Configurasion Error
Duplex	ON		Work Module
	OFF		Standby Module
L-Bus	ON	OFF	Both L-BUS Channels Fault
		Flash	Address Conflict on L-BUS
H1	ON	OFF	Both H1 Segments Fault
		Flash	One of H1 Segments Fault

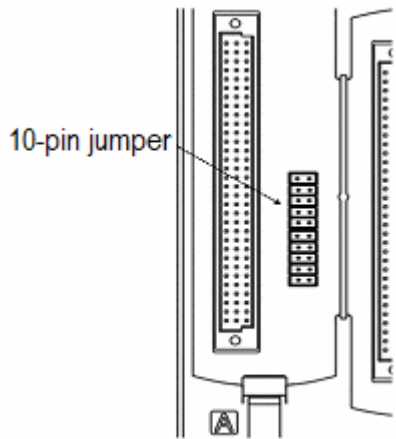
### 3.2.2 Indicator LEDs of MB728-S

**Table 3-2 Indicator LEDs of MB728-S**

LED	Normal	Abnormal	Instruction for Abnormal
Tx	Flash	OFF	No H1 Signal is sent.
Rx	Flash	OFF	No H1 Signal is received.

## 3.3 Wiring

In the left slot of MB728-S which is the base of FF access module, there is a ten-needle jumper. When it wears jumper cap, it is redundant. One base can be installed with one pair of redundant AM716. When the cap is put away, then the base is non-redundant. One base can be installed with two non-redundant AM716. The factory setting is in redundant mode by default.



**Figure 3-2 Jumper in redundant mode**

There are 15 terminals in each side of the base, as shown in Figure 3-1. The corresponding terminals on left and right are connected directly in the base and the user can wire on left, right or both sides as required. There are 8 indicator LEDs between the terminals and module slots in both sides. The indicator LEDs will work when AM716 is plugged in the slot of this side.

The instruction of terminal and indicator light are shown in Figure 3-2. The terminal instruction is shown in Table 3-3.



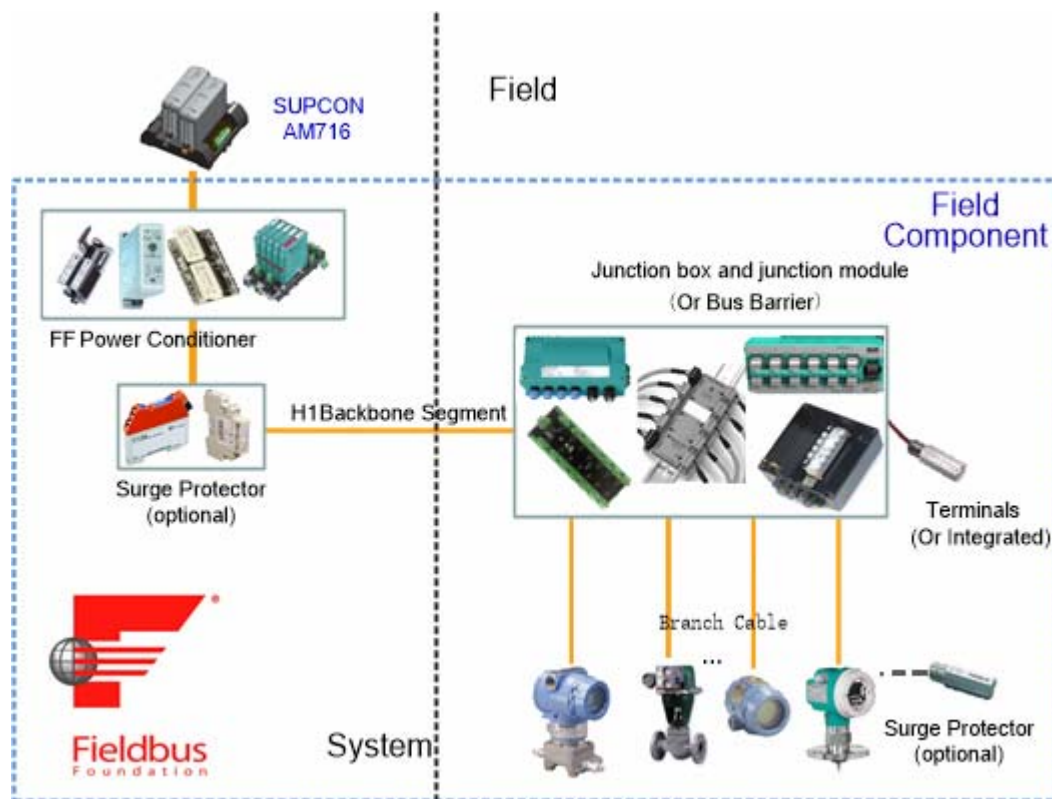
**Table 3-3 Terminal instruction**

Left Terminals		Instruction	Right Terminals	
No. (from top to bottom)	Sign		Sign	No. (from top to bottom)
1	+	Positive of Segment 0	+	1
2	S	Shield of Segment 0	S	2
3	-	Negative of Segment 0	-	3
4	+	Positive of Segment 1	+	4
5	S	Shield of Segment 1	S	5
6	-	Negative of Segment 1	-	6
7	+	Positive of Segment 2	+	7
8	S	Shield of Segment 2	S	8
9	-	Negative of Segment 2	-	9
10	+	Positive of Segment 3	+	10
11	S	Shield of Segment 3	S	11
12	-	Negative of Segment 3	-	12
13	SG	Grounding Terminal of Shield	SG	13
14	SG	Grounding Terminal of Shield	SG	14
15	SG	Grounding Terminal of Shield	SG	15

## Section 4 Application

### 4.1 Segment Components

As shown in Figure 4-1, the components of FF segment include the H1 interface module, power conditioner; branch module (wiring module), surge protector, FF cable, terminator and instrument, etc.



**Figure 4-1 FF H1 Components**

#### 4.1.1 FF Power Conditioner

The H1 fieldbus can achieve the power supply for several field instruments and bidirectional digital communication on the same shielded twisted pair. The fieldbus H1 interface module is used to achieve the bidirectional communication with the field instruments. The power supply of fieldbus instruments are achieved by FF power conditioner. FF conditioner is necessary on each segment and set as redundancy generally.

#### 4.1.2 FF Junction Box and Branch Module

The foundation recommends that the wiring of branches and trunk should be completed in the junction box. All cable heads should be connected in an individual terminal. There should be no 2

cable heads connect the same terminal. The junction box can apply pluggable terminal, whose wiring specification is (12~24) AWG.

The junction box should be weather-proof, and the proof level should not be less than IP65. The junction box should also be anticorrosion. The material for junction box can be duralumin, stainless steel and fiber-glass reinforced plastic as required. The cable interface can apply cable sealed joint or fast connector. All branches of junction box should integrate the function of short circuit protection. SUPCON<sup>®</sup> Fieldbus branch protection module has the function of short-circuit protection, which can avoid the influence of whole segment caused by short-circuit accident of branch and keep normal working of segment.

For the junction box in explosion-protection area, different explosion-protection scheme can be selected according to the fact. For Zone 1/0 (or Division 1), the branch of junction box should be certified by intrinsically safe explosion-protection, like the EEx ia IIC. For Zone 2 (or Division 2), the branch of junction box should be certified by limited non-sparking explosion-protection, i.e. EEx nL IIC. Although the instruments in explosion isolated field not support hot-operation, few users are still used to do it. Thus, the branch of junction box should be certified by increased safety explosion-protection, i.e. EEx e IIC T4, which is applied in Zone 1/2 (or Division 1/2).

The branch module in the junction box, also called wiring module (MEGABLOCK), should support standard DIN rail installation, and the branch module should have independent function of short circuit protection. The short circuit of one branch will not influence other branches of the whole segment. The branch module can have 4, 6, 8, 10 or 12 branches, including 2 trunk terminals, one for system trunk wiring and the other for outside, to meet the requirements of user.

The common models of wiring modules include SUPCON FSP120, FSP160, etc.

The segment terminator with integration can be selected in wiring module, which has “T” type marker. Each branch has power indicator which shows that power supply of the branch is normal.

At the same time, it is required that the shell of wiring box should has the function of protection grounding, which can connects with field ground piles, which is close to wiring box, or metallic shell of cable bridge.



**Attention:**

**The shield of each branch should connect to wiring module independently and can't touch each other or the shell of wiring box.**

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#### 4.1.3 FF Cable

The shield twisted pair cable of FF bus should conform to the FF physical layer standards of IEC. The classical specifications of FF bus cable are shown below:

- Cable Specifications: 18 AWG (0.8mm<sup>2</sup>)
- Shield: 90% covered
- Weakness: 3db/km when 39kHz
- Maximum capacitance: 150pF/m
- Property Impedance: 100 (when 1.25 kbit/s)

This cable is also called A cable. When using it, the cable length of each H1 segment can reach 1900m (including the backbone and branch cables). The distributed resistance of the cable is 44Ω/km. FF bus cable can apply special cover color to be distinguished from other signal wires. FF bus cable can apply the multi-core cable, in which each twisted pair cable is shield individually. FF bus cable can also apply the embedded cable.

The cable specifications and transmission distance are shown below:

Cable Type	Cable Model	Transmission Rate	Max Transmission Distance
<b>A Shield Twisted Pair</b>	<b>#18AWG</b>	<b>H1 31.25Kbps</b>	<b>1900m</b>
	<b>#22AWG</b>	<b>H2 1Mbps</b>	<b>750m</b>
	<b>#22AWG</b>	<b>H2 2.5Mbps</b>	<b>500m</b>
<b>B Shield Several Twisted Pairs</b>	<b>#22AWG</b>	<b>H1 31.25Kbps</b>	<b>1200m</b>
<b>C No Shield Twisted Pair</b>	<b>#22AWG</b>	<b>H1 31.25Kbps</b>	<b>400m</b>
<b>D Multi-core Shield Cable</b>	<b>#16AWG</b>	<b>H1 31.25Kbps</b>	<b>200m</b>

**Figure 4-2 FF Cable Specifications**



**Attention:**

As for the item which is built newly, it must choose A-kind cable.

#### 4.1.4 FF Instrument

The system supports all FF instruments certified by Fieldbus Foundation. These FF instruments must have corresponding DD (instrument description) files can be downloaded from the website of the manufacturer. The mainstream FF instrument manufacturers include ABB, EMERSON, HONEYWELL, YOKOGAWA, ENDRESS+HAUSER and SMAR, etc.



**Figure 4-3 FF Instruments**

#### **4.1.5 FF Surge Protector (Selectable)**

The surge protection for segment should be provided in the thunder-prone area or near the large instrument of inductive load, to prevent the anti-surge instrument from the obvious filed signal weakness. FF surge protection can belong to SUPCON® or be the third-party instrument.

### **4.2 Segment Wiring Example**

#### **4.2.1 AM716-S Segment Wiring Example**

In Figure 4-4, set AM716-S segment linked to MTL9189 power conditioner (FF 8 segments power) as an example to show the FF H1 segment wiring. Figure 4-4 is only an example, and the wiring can be varied as required.

If there is redundant HOST interface in FF power supply selected, in other words, the power supply is redundant with AM716-S wiring, and redundant HOST interface should be linked to the other terminal in MB728-S.

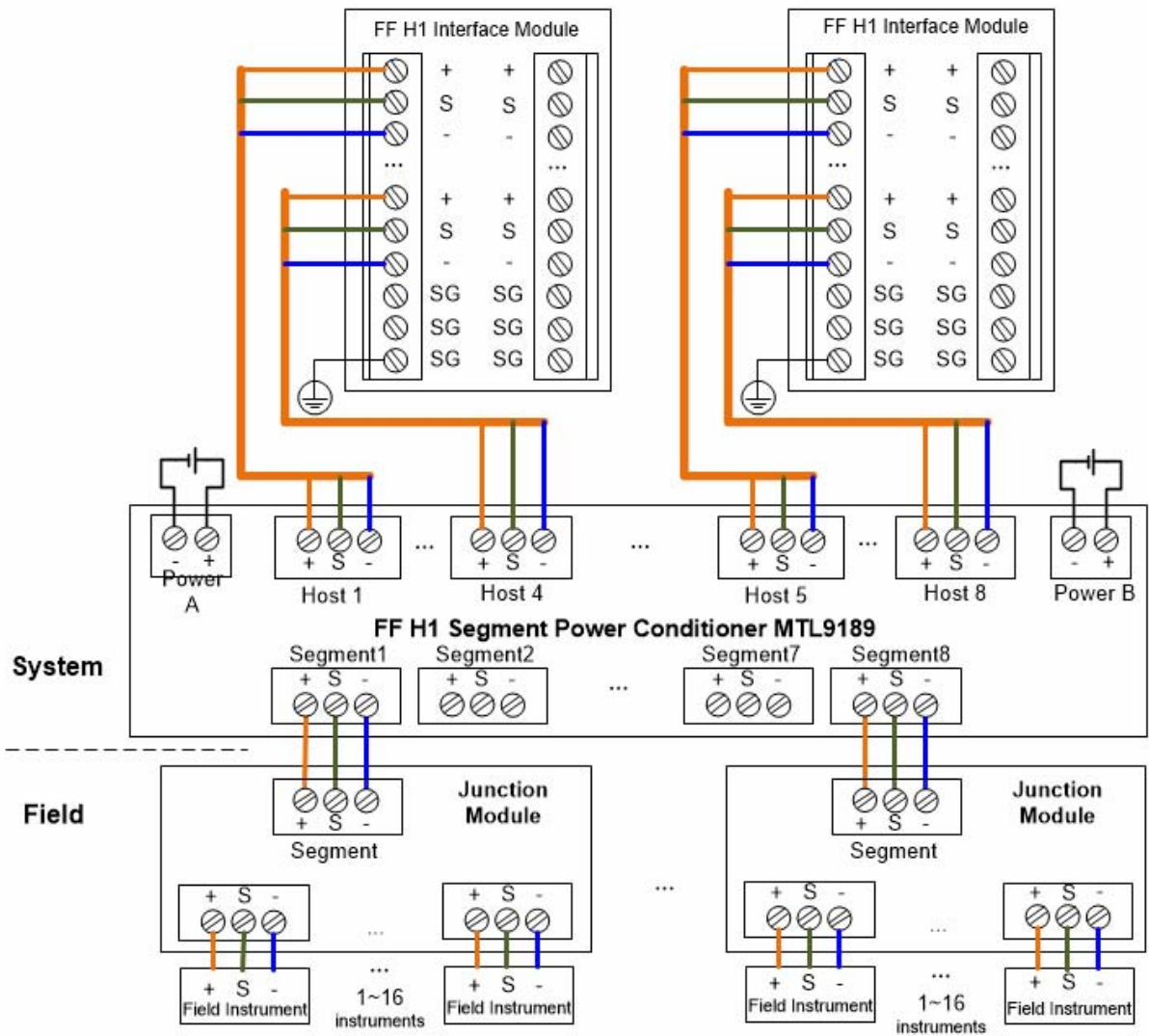


Figure 4-4 AM716-S Segment Wiring



**Attention:**

When the wiring between FF H1 segment power supply and the AM716-S are redundant, make sure the polarity connection of bus and terminal is correct. Misconnection will lead to power short circuit.

### 4.3 Terminal Resistor Setting

As project required, both sides of FF bus should install a terminal resistor (terminator) to eliminate the echo of high frequency signal. In system side, terminal resistor integrates in FF power conditioner; in field side, it integrates in wiring module (MEGABLOCK).

**Attentions:**

- The integrated terminal resistor of FSP160 has installed in the bus when factory setting and needs confirmation on site.
- 

## 4.4 Notes

- The shield wire of FF should be grounded on the single point of system, and should connect the shield port of MB728-S terminal.
- The FF instrument should be grounded nearby in the field, and the cable shield layer should be suspended.
- Make sure the module, base, rack and cabinet are in the same protection ground.
- MB728-S is redundant base and the AM716 should be set as redundant in configuration. Otherwise, a slight fault will appear.

## 4.5 Troubleshooting

- If all LEDs are off, the power connection has fault, please check it.
- If the indicator LED "Fault" is on, there is a hardware fault. Please replace the module and re-download the configuration.
- If the indicator LED "Status" is flashing in frequency of 400ms, at least one channel of segment configuration mismatch with hardware configuration.
- If the indicator LED "Status" is flashing in frequency of 2s, the module is in the status of cold startup.
- If the indicator LED "L-Bus" is off, both channels of L-BUS have fault. Please check them.
- If the indicator LED "L-Bus" is flashing, the L-BUS is in the status of address conflict.
- If the indicator LED "H1" is off, both H1 segments have fault. Please check the H1 segments and the wiring of the filedbus instruments.
- If the indicator LED "H1" is flashing, one H1 segment has fault. Please check the H1 segments and the wiring of the filed instruments.
- If the indicator LED "Status" in one side is on and the other side is flash, when AM716 works redundantly and the configuration is downloaded correctly, please check whether FF configuration software has configured AM716 in non-redundant mode.
- If the indicator LED "Tx" and "Rx" in the one side of MB734-S base are normal but in the other side, the indicator light "Tx" is off and the indicator light "Rx" is on, when AM716 works redundantly, please check the terminal resistor on site.

## 4.6 Segment Design

1. **Instrument Function:** select the FF instrument with the correct control function block.
2. **Instrument Position:** it should satisfy the requirements of technique design (include determining the dangerous place). The segment should be designed after determining the instrument position.
3. **Technique Control Requirements:** include selecting the measurement and control, etc. The complicate control requirements should also be considered, such as the serial control and split control etc.
4. **Stability Requirements:** the control strategy is in transducer, valve localizer or controller, the control loop number of the same segment and the key valve number (refer to the valve levels), etc.

**Importance levels of valve are shown below:**

### Level1

The failure of level1 valve will lead to the whole system fault and cause the shut-down of whole instruments or other unavoidable loss over million dollars. This kind of fault can apply general valve fault mode.

**Design Requirements:** the valve and related measuring instruments (transducer) of level1 should connect the same H1 network of level1 control. If the service is independent, the segment can have a valve and related transducer of level1. If the service is associated, it can have 2 valves and related transducers of level1. “**Association**” refers to that either valve can close the same instrument (such as the flow of fired heater). Follow notes below to make sure the interoperability:

- All field instruments of level1 in the loop are provided by one manufacturer.
- The interoperability of host connectors and all field instruments of level1 in the loop should be tested independently.
- In the life span of network, the versions of instruments and connectors should be compatible.

### Level2

The failure of level2 valve will lead to the whole system fault and cause the shut-down of whole instruments or other unavoidable loss over million dollars. But the process dynamic time of level2 valve allows the fast recovery from fault status. It could be fast fixing the fault or applying manual control. The related container material and energy capacity, location and the operability of the valve also should be considered. The difference between level1 valve and level2 valve are their operability for single fault.

**Design Requirements:** the valve and related measuring instruments (transducer) of level2 should connect the same H1 network for control. If the service is independent, the segment can have a valve and related transducer of level2. If the service is associated, it can have 2 valves of level1, or



one valve of level2 and one valve of level3 and their related transducers. “**Association**” refers to that either valve can close the same instrument (such as the flow of fired heater). Follow notes below to make sure the interoperability:

- All field instruments of level2 in the loop are provided by one manufacturer.
- The interoperability of host connectors and all field instruments of level2 in the loop should be tested independently.
- In the life span of network, the versions of instruments and connectors should be compatible.

### Level3

The failure of level3 valve will not lead to the whole instruments shut-down or serious loss. The level3 valve can switch to the fault position and operator is no need to apply any instant measures.

**Design Requirements:** the level3 valve can locate in the same segment with 3 level3 valves or 1 level2 valve at most. The network containing level3 control can apply products from several (certified) manufacturers, including the measurement instrument. The design paper of segment should mark the importance level and note observably that not any accessories should be added in the segment.

## 4.7 Segment Constraint

### 4.7.1 Distance Constraint

Except the intrinsically safe explosion-protection (it has individual limits), when applying the fieldbus A cable, the total length of backbone and branch should be less than 1900m. The length of branch is recommended as follow:

**Table 4-1 The length of branch**

Communication Instrument No. In Segment	Max Length of Branch Cable
15~18	60m
13~14	90m
1~12	120m

For the segment certified by the intrinsically safe Entity, the cable length of backbone and branch should not exceed the recommended values above, and user should check computation of the total capacitance and inductance by the intrinsically safe certified parameter.

For the segment certified by the intrinsically safe FISCO, the cable length of backbone and branch should not exceed 1000m, and the length of branch should not exceed 30m.

The calculation example is shown below:

Whole Length of Segment=Backbone + All Branches

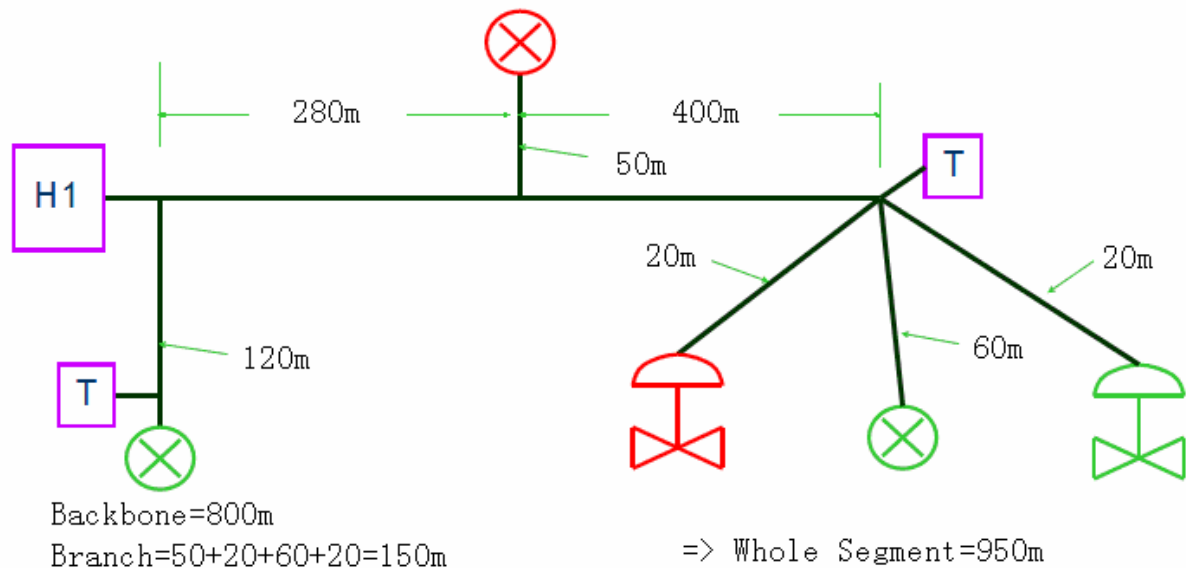
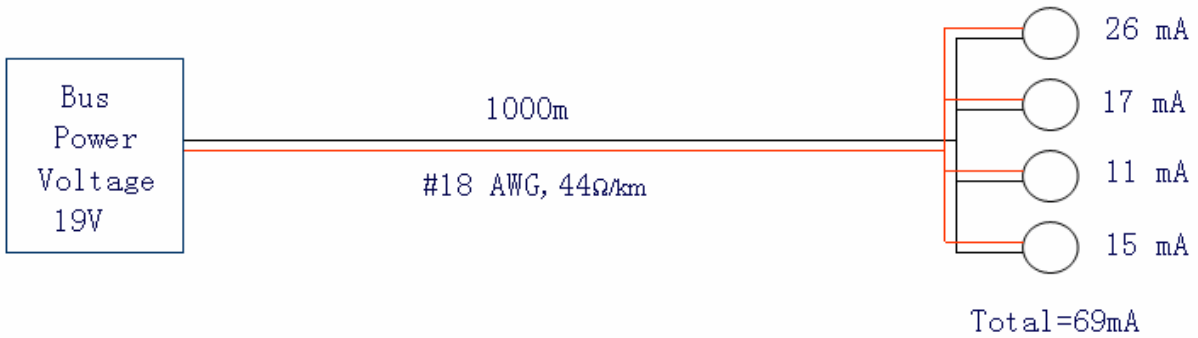


Figure 4-5 FF H1 segment wiring

#### 4.7.2 Power Consumption and Voltage Attenuation

The segment load checking computation can confirm the maximum field instruments actually connected and the length of cable in the segment. FF power unit refers to the instruments powering the H1 segment, such as the FF power supply, repeater, intrinsically safe power (Entity or FISCO) etc, which have the powering function individually, i.e. output voltage and current. The larger the output current is, the more field instruments can be supported. The higher the output voltage is, the longer the segment cable can be supported.

The standards of FF stipulate that the current consumption of field instrument should be less than 10mA, while the maximum is not stipulated. The current consumption of mainstream FF instrument is (10~30) mA and exact power consumption target is shown in instrument manual. When a branch is short circuit, the protection circuit will consume certain extra current, like about (40~60) mA. The checking computation of load current can confirm whether the output current of FF power unit is larger than the sum of field instrument current consumption and the protection current of at least one branch.



$$\begin{aligned} \text{Voltage Calculation} &= 19 - (1000 \times 44 / 1000 \times 69 / 1000) \\ \text{Voltage Calculation} &= 19 - 3.036 \\ \text{Voltage Calculation} &= 15.964\text{V} \end{aligned}$$

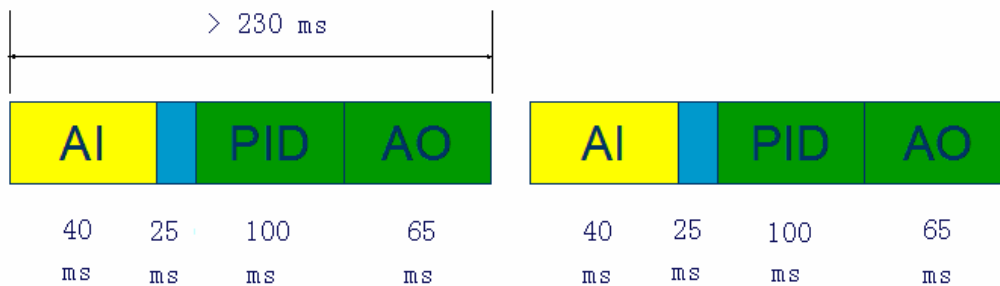
**Figure 4-6 Segment voltage calculation**

According to the FF standard, the work voltage of field instrument is (9~23) VDC. As the cable has distributed resistance (for example, the loop resistance of fieldbus A cable is 44Ω/km), the segment load current will have voltage drop on the cable unavoidably. So the load voltage equals to the output voltage of FF power unit minus the pressure drop of segment load current on cable. The checking computation for load voltage is used to confirm that the load voltage cannot be less than 9 VDC. The calculation of voltage pressure drop is shown in Figure 4-6.

#### 4.7.3 Communication Process (Macrocycle)

The segment “LAS” should execute the periodic and non-periodic data communication schedule simultaneously, and generally 60% time should be for non-periodic data communication time. The time of macrocycle is determined by the execution time and number of function block.

The example of calculating macrocycle time is shown below:



The macrocycle time of segment should be 230ms.

**Figure 4-7 Segment macrocycle calculation**

Besides, the limit of system for the number of function block called by each segment, or the limit for VCR number of each segment, will limit the number of instrument connected.

## **Section 5 FF Configuration Application**

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Please refer to the *FF Software Configuration User Manual*.

## Section 6 Revision

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*Table 6-1 Retrofit list of the version*

Document Version	Corresponding Product Version	Remarks
V1.0 (20220118)	Applicable to AM716-S V10.10.00	