

# Chapter 5 Power Supply Wiring, Power Consumption Calculation, and Power Sequence Requirements

FBS-PLC internally has three kinds of circuit: a 5VDC logic circuit, a 24VDC driver circuit (driver output devices, for example: relay, transistor, and etc), and a 24VDC input circuit. Only the 5VDC logic circuit and 24VDC output circuit are powered by the built-in power supply for main/expansion units or powered by expansion power supply modules (FBs-EPW-AC, FBs-EPW-D24), and the 24VDC input circuit can be choose to powered by the external power supply or the built-in power supply of main/expansion units or 24VDC sensor of FBs-EPW-AC/D12/D24. Expansion modules other than main/expansion units do not contain any power supply and are powered by the power supply inside the main/expansion units or expansion power supply (FBs-EPW-AC, FBs-EPW-D24). Main/expansion units or expansion power supply with their model numbers suffixed with “-D12/-D24” means is operated by DC power source. Otherwise, AC power source is used.

<b>Caution</b>
<p>In industrial environments, main power may irregularly experience a surge current or high voltage pulse caused by the start or shut down of high power equipment. Users are advised to take necessary measures (for example, the use of isolation transformer or other MOV suppression devices) for the protection of PLC and its peripherals.</p>

## 5.1 Specifications and Wiring of AC Power Sourced Power Supply

The available AC power supplies of FBS-PLC are the 14 Watt (SPW14-AC) supply for 10/14 PTs main unit, the 24 Watt (SPW24-AC) supply for 20~60PTs main/expansion unit, and the 14 Watt expansion supply (FBs-EPW-AC) for expansion modules. Except that the FBs-EPW-AC is an independent module, SPW14-AC and SPW24-AC are to be installed on a main unit or inside an expansion unit, where their appearances are invisible. The following table lists the specifications:

Spec		Model	SPW14-AC	SPW24-AC	FBs-EPW-AC
Item					
Input Range	Voltage	100 ~ 240VAC, -15% / +10%			
	Frequency	50 / 60HZ ±5%			
Max. Power Consumption		21W / 14W	36W / 24W	21W / 14W	
Inrush Current		20A@264VAC			
Allowable Power Interrupt		< 20ms			
Fuse Spec.		2A · 250V			
Isolation Type		Transformer/Photocouple Isolation, 1500VAC/minute			
Output Power*1	5VDC (logic circuit)	N/A*2	5V, ±5%, 1A(max)	5V, ±5%, 0.4A(max)	
	24VDC (output circuit)	24V±10%, 200mA(max)*3	24V, ±10%, 400mA(max)	24V, ±1%, 250mA(max)	
	24VDC (input circuit)	24V,±10%, 400mA(max)	24V, ±10%, 400mA(max)	24V, ±10%, 250mA(max)	

Note \*1 : The 5VDC (for logic circuit) output power and the 24VDC (for output circuit) power can be accessed from the “I/O expansion output header” located on the right side of the main/expansion units for expansion modules. And the 5VDC power is also used by communication board (CBxx) or communication module (CMxx). The 24VDC power for input circuits is provided from the farthest 2 upper left terminals (labeled “+24V OUT.”) on the input terminal block of main/expansion unit to input circuit in expansion module or other sensors.

Note \*2 : The 5VDC power of 10/14PTs main unit is generated from the 24VDC power in the output circuit, with specifications of 5VDC±10% and 400mA (max) (Circuit is located on the I/O board of 10/14PTs main unit).

Note \*3 : Without any I/O expansion interface, the 24VDC power in 10/14PTs main unit is for its output circuit alone and cannot be used for other purposes.

**⚠ Caution**

The schematic diagram of AC power supply wiring in main/expansion units is shown below. Also be cautious about the following:

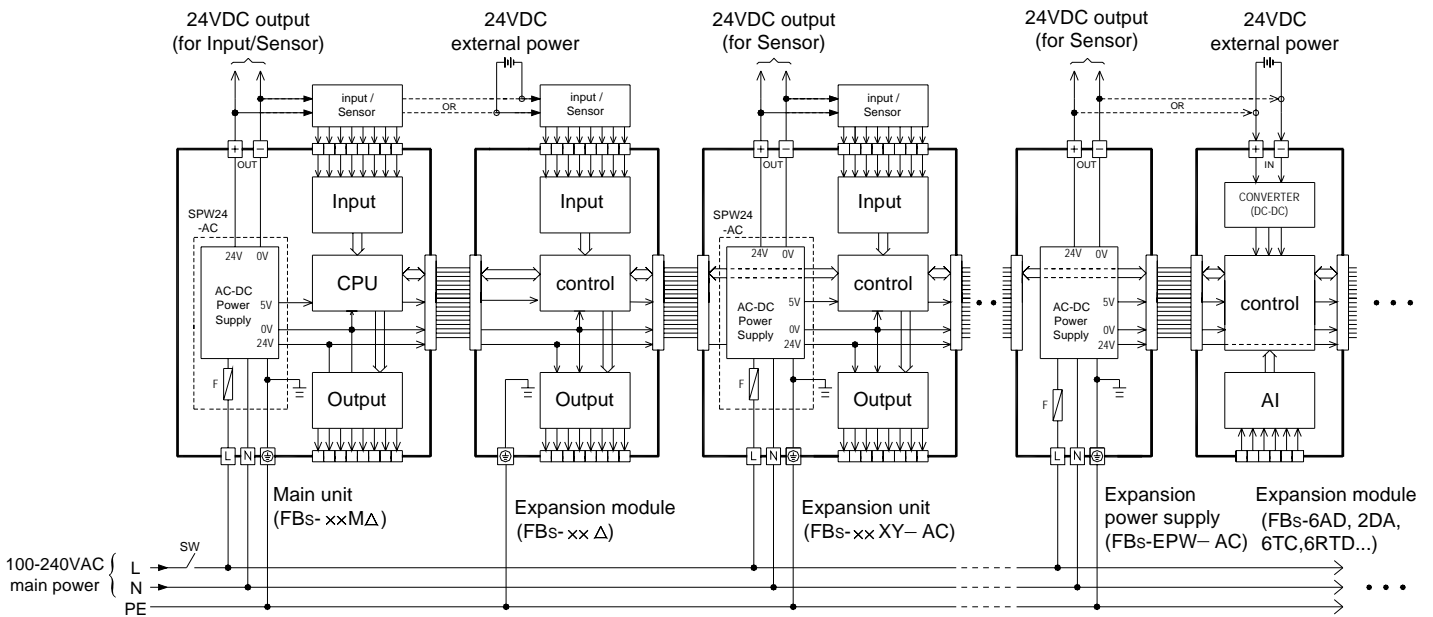
Please follow the wiring schemes regulated by local national standards to use single-pole switch (break hot wire "L"), or double-pole switch (break both "L" and "N"), to turn on or off the AC input power.

In wiring, hot wire "L" must be connected to the **L** terminal on unit, while the ground line "N" connected to the **N** terminal. Please use wires with diameters 1mm<sup>2</sup>~2mm<sup>2</sup>.

All **Ⓧ** terminals on main unit and expansion unit/module have to be connected to the EG (Earth Ground) terminal of main power system as shown in the figure below, with wire diameters larger than 2mm<sup>2</sup>.

**⚠ Warning**

Output of power for sensor cannot be connected in parallel with other powers, in which the conflict between two sets of power will decrease their lifetime or cause immediate damage. This will induce unexpected malfunction of PLC and cause serious or even deadly damage to people or equipment.



## 5.2 Specifications and Wiring of DC Power Sourced Power Supply

The available DC power sourced power supplies of FBS-PLC are the 14 Watt (SPW14-D12/D24) supply for 10/14PTs main unit, the 24 Watt (SPW24-D/12D24) supply for 20~60PTs main/expansion unit, and the 14 Watt expansion supply (FBS-EPW-D24) for expansion modules. Besides the FBS-EPW-D24 is an independent module, SPW14-D12/D24 and SPW24-D12/D24 are to be installed on a main unit or inside an expansion unit, where their appearances are invisible. The following table lists the specifications:

Spec. Item	Model	SPW14-D12/D24	SPW24-D12/D24	FBs-EPW-D24
	Rated Voltage		12 or 24VAC, -15%/+20%	
Max. Power Consumption		21W / 14W	26W / 24W	21W / 14W
Inrush Current		20A @ 12 or 24VDC		20A@24VDC
Allowable Power Interrupt		<20ms		
Fuse Spec.		3A(D12)/1.5A(D24), 125V	5A(D12)/2.5A(D24), 125V	1.5A, 125V
Isolation Type		Transformer/Photo Coupler Isolation, 500VDC/minute		
Power*1 Output	5VDC(logic circuit)	N/A*2	5V, ±5%, 1A(max)	5V, ±5%, 0.4A(max)
	24VDC(output circuit)	24V±10%, 200mA(max)*3	24V, ±10%, 400mA(max)	24V, ±10%, 250mA(max)
	24VDC(input circuit)	24V±10%, 400mA(max)	24V, ±10%, 400mA(max)	24V, ±10%, 250mA(max)

Note \*1 : The 5VDC (for logic circuit) output power and the 24VDC (for output circuit) power can be accessed from the "I/O expansion output header" located on the right side of main/expansion units for expansion modules. The 24VDC power for input circuit is provided from the farthest 2 upper left terminals (labeled "+24V OUT-") on the input terminal block of main/expansion unit to input circuit in expansion module or other sensors.

Note \*2 : The 5VDC power of 10/14PTs main unit is generated by the oscillations of the 24VDC power in the output circuit, with specifications of 5VDC±10% and 400mA (max) (Circuit is located on the I/O board of 10/14PTs main unit)

Note \*3 : Without any I/O expansion interface, the 24VDC power in 10/14PTs main unit is for its output circuit alone and cannot be used for other purposes.

**⚠ Caution**

The schematic diagram of DC power supply in main/expansion unit is shown below. Also be cautious about the following:

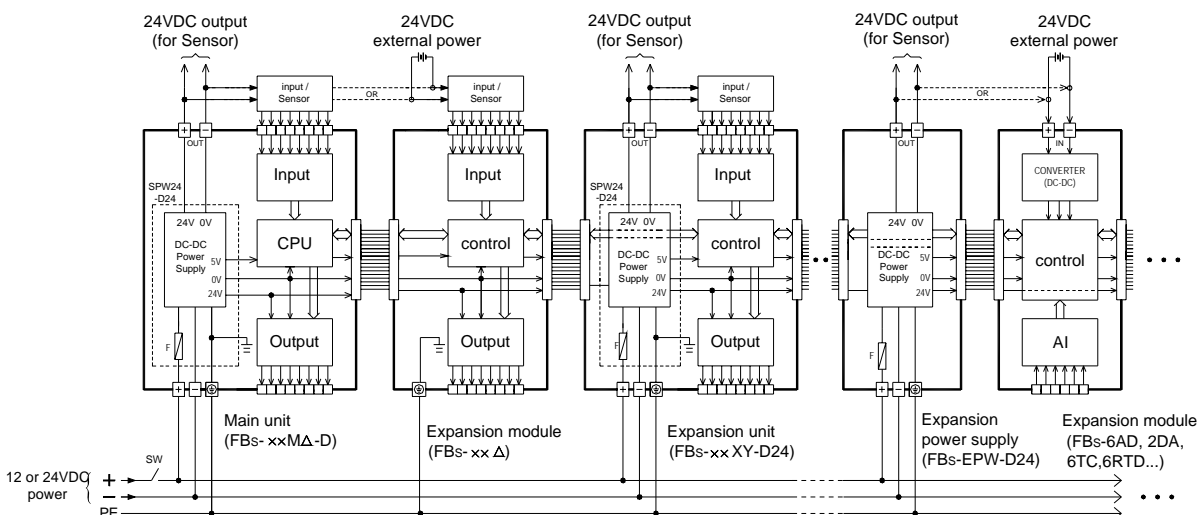
Please follow the wiring schemes regulated by local national standards to choose single-pole switch (break 24V+) or double-pole switch (break both 24V+ and 24V-) in order to turn on or off DC input power.

Wiring of 24V+ input power must be connected to the terminal labeled by **+**, while the 24V- end is connected to the **-** terminal, Please use wires with diameters of 1mm<sup>2</sup>~2mm<sup>2</sup>.

The **G** terminals on main unit and all digital expansion units/modules must be connected to the EG (Earth Ground) terminal on main power system according to the scheme shown in the following figure, using wire diameters larger than 2mm<sup>2</sup>.

**⚠ Warning**

Output of 24VDC power for input circuit cannot be connected in parallel with other powers, in which the conflict between two sets of power will decrease their lifetime or cause immediate damage. This will induce unexpected malfunction of PLC and cause serious or even deadly damage to people or equipment.



### 5.3 Residual Capacity of Main/Expansion Unit & Current Consumption of Expansion Module


Besides its own circuits usage, the residual capacities of three sets of built-in power supply of main/expansion unit are big enough for other expansion modules usage. In addition, the expansion power (FBs-EPW) module can also provides the power for expansion modules usage. As each model of the main/expansion unit has AC/DC power or modules, it has different residual capacity, various models of expansion modules also consume different amounts of current. In practice, one has to consider the match between the two to avoid overload in any of the three sets of output power. In the following, the worst case of the available residual capacity in each main/expansion unit and the maximum power consumption of expansion modules are described below spare.

#### 5.3.1 Residual Capacity of Main/Expansion Unit

Model		Extra Capacity	Output Power		
			5VDC(logic circuit)	24VDC(output circuit)	24VDC(input circuit)
			-output communication block or expansion cable-	-output expansion cable-	-output terminal block-
AC P O W E R	Main Unit	FBs-10/14MA	300mA	—	340mA
		FBs-20MA	753 mA	335mA	310mA
		FBs-24MA	722 mA	325mA	295mA
		FBs-32MA	712 mA	315mA	262mA
		FBs-40MA	688 mA	295mA	244mA
		FBs-60MA	644 mA	255mA	190mA
		FBs-10/14MC	300 mA	—	340mA
		FBs-20MC	753 mA	335mA	310mA
		FBs-24MC	722 mA	325mA	295mA
		FBs-32MC	712 mA	315mA	262mA
		FBs-40MC	688 mA	295mA	244mA
		FBs-60MC	644 mA	255mA	190mA
		FBs-20MN	710mA	310mA	325 mA*
		FBs-32MN	670mA	297mA	280 mA*
		FBs-44MN	627 mA	276 mA	250 mA*
	Expansion Unit	FBs-24XY-⊙	948 mA	350mA	337mA
		FBs-40XY-⊙	918 mA	320mA	292mA
		FBs-60XY-⊙	880 mA	280mA	238mA
DC P O W E R	Main Unit	FBS-10/14MA-D24	300mA	—	270mA
		FBS-20MA-D24	753mA	Total 295mA	
		FBS-24MA-D24	722mA	Total 270mA	
		FBS-32MA-D24	712mA	Total 227mA	
		FBS-40MA-D24	688mA	Total 189mA	
		FBS-60MA-D24	644mA	Total 95mA	
		FBS-10/14MC-D24	300mA	—	270mA
		FBS-20MC-D24	753mA	Total 295mA	
		FBS-24MC-D24	722mA	Total 270mA	
		FBS-32MC-D24	712mA	Total 227mA	
		FBS-40MC-D24	688mA	Total 189mA	
		FBS-60MC-D24	644mA	Total 95mA	

		FBS-20MN-D24	710mA	Total 285mA*
		FBS-32MN-D24	670mA	Total 227mA*
		FBS-44MN-D24	627mA	Total 176mA*
	Expansion Unit	FBS-24XY - ◎	948mA	Total 337mA
		FBS-40XY - ◎	918mA	Total 262mA
		FBS-60XY - ◎	880mA	Total 168mA

- In the above table, the residual capacity is calculated according to the most power-consuming model (for example, MCT) of in each main/expansion unit by its I/O point number, under the maximum load condition (with both DI and DO ON). The basic units for calculation are 7.5mA/PT for high/medium speed DI, 4.5mA/PT for low speed DI (Ultra high speed DI does not use the 24VDC power in input circuit), 10mA/PT for high speed DO, 7.5mA/PT for medium speed DO, and 5mA for low speed DO and relay output. (excluding the SSR model).
- See Sections 5.1 and 5.2 for the residual capacity of expansion power (-EPW-AC and -EPW-D24)

 Warning
Either for the built-in power supply of the main/expansion unit or the expansion power supply for the expansion unit, the total amount of current cannot exceed the value listed in the above table. Any violation will cause a voltage drop by overloading the power supply, or intermittent powered with the supply in protection mode, either of which will result in unexpected action of PLC and cause harm to people or damage to equipment.

### 5.3.2 Maximum Current Consumption of Expansion Module

Without its own power supply, expansion modules must be supported by the main/expansion unit, expansion power, or external power supply (24VDC input circuit alone). The following table lists the maximum consumption current of each expansion module.

Model	Current	5VDC Logic Circuit	24VDC Output Circuit	24VDC Input Circuit
		-input expansion cable-		--input terminal block--
Digital I/O Expansion Module	FBS-24XY	54 mA	85mA	63mA
	FBS-40XY	83 mA	136mA	108mA
	FBS-60XY	119 mA	124mA	162mA
	FBS-8XY	30 mA	34mA	18mA
	FBS-8X	30 mA	—	36mA
	FBS-8Y	29 mA	68mA	—
	FBS-16XY	40 mA	68mA	36mA
	FBS-16Y	40 mA	136mA	—
	FBS-20X	35 mA	—	90mA
	FBS-24X	54 mA	—	108mA
	FBS-24YT	66 mA	—	—
	Numeric I/O Expansion Module	FBS-32DGI	14 mA	—
FBS-7SG1		24 mA	—	213 mA
FBS-7SG2		24 mA	—	396 mA
FBS-6AD		25 mA	—	53 mA
FBS-2DA		33 mA	—	90 mA
FBS-4DA		35 mA	—	137 mA
FBS-4A2D		35 mA	—	103 mA
FBS-2TC		30 mA	—	21 mA
FBS-6TC		30 mA	—	29 mA
FBS-6RTD		32 mA	—	16 mA
FBS-16TC		30 mA	—	58 mA
FBS-16RTD		32 mA	—	19 mA
FBS-6NTC		33 mA	—	16 mA

	FBs-2A4TC	39 mA	—	52 mA
	FBs-2A4RTD	39 mA	—	32 mA
	FBs-B4AD	25 mA	—	—
	FBs-B2DA	223 mA	—	—
	FBs-B2A1D	158 mA	—	—
Voice Output Module	FBs-VOM	500 mA	—	—
Special Modules	FBs-4PT	25 mA	—	82 mA
	FBs-1LC	32 mA	—	48 mA
Communication Board (CB)	FBs-CB2	13 mA	—	—
	FBs-CB22	26 mA	—	—
	FBs-CB5	51 mA	—	—
	FBs-CB55	95 mA	—	—
	FBs-CB25	55 mA	—	—
	FBs-CBE	50 mA	—	—
Communication Module (CM)	FBs-CM22	18 mA	—	—
	FBs-CM55	95 mA	—	—
	FBs-CM25	70 mA	—	—
	FBs-CM25E	110 mA	—	—
	FBs-CM55E	120 mA	—	—
	FBs-CM25C	—	—	41 mA
	FBs-CM5R	—	—	26 mA
	FBs-CM5H	—	—	135 mA
Others	FBs-BDAP	47 mA	—	—
	FBs-BPEP	58 mA	—	—
	FBs-DAPB	—	—	75 mA
	FBs-DAPC	193 mA	—	—
	FP-08	125 mA	—	—

- The above table lists the required current for the maximum consumption in each expansion module. The 24VDC input circuit consumes 4.5mA less per point of OFF state DI in DI/O module, while the 24VDC output circuit consumes 5mA less per point of OFF state DO. The effect of power consumption variation regarding the ON/OFF state of DI/DO of expansion modules other than DI/O are less significant and can be neglected.
- The effect of residual capacity variation regarding the ON/OFF state of DI/DO for 5VDC logic circuit can be neglected.

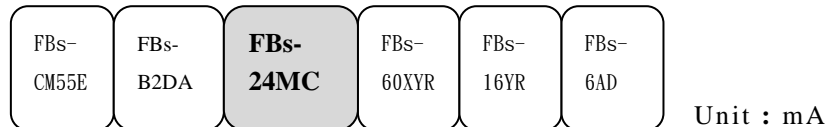
### 5.3.3 Calculation Example of Power Capacity

Power module selection is depending on the sum of current consumption of all modules. Therefore, user must know the current consumption of each module. Please refer to the above table, which has the maximum current consumption of each expansion module.

Before power module selection, we need to calculate the total current consumptions. Calculations need to be divided into two sections, DC5V (Bus Power) current consumption and DC24V (Bus Power) current consumption.

User must consider the match between power and expansion modules cannot cause BusPower output power of any one group of overload use.

Example 1: The below diagram is a system modules, try to calculate the power supply used of the system.



							Result
Internal 5VDC logic power supply	-120	-223	+722	-119	-40	-25	+195 (OK)
Internal 24VDC logic power supply	-	-	+325	-124	-136	-	+65 (OK)
External 24VDC Sensor power supply	-	-	+295	-162	-	-53	+80 (OK)

- Result: (1) First calculate current consumption of internal 5VDC logic power supply  
 $+722\text{mA} - 120\text{mA} - 223\text{mA} - 119\text{mA} - 40\text{mA} - 25\text{mA} = +195 \text{ mA}$  (OK)
- (2) And then calculate current consumption of internal 24VDC logic power supply  
 $+325\text{mA} - 124\text{mA} - 136\text{mA} = +65 \text{ mA}$  (OK)
- (3) Calculate current consumption of external 24VDC Sensor power supply  
 $+295\text{mA} - 162\text{mA} - 53\text{mA} = +80 \text{ mA}$  (OK)

In conclusion, the total current consumption of the above five modules cannot exceed the total current consumption of the main unit, so do not need to expand any power supply module.

Example 2: The below diagram is a system modules, try to calculate the power supply used of the system.



								Result
Internal 5VDC logic power supply	-120	-223	+722	-119	-40	-40	-25	+155 (OK)
Internal 24VDC logic power supply	-	-	+325	-124	-136	-136	-	-71 (overload)
External 24VDC Sensor power supply	-	-	+295	-162	-	-	-53	+80 (OK)

- Result: (1) First calculate current consumption of internal 5VDC logic power supply  
 $+722\text{mA} - 120\text{mA} - 223\text{mA} - 119\text{mA} - 40\text{mA} - 40\text{mA} - 25\text{mA} = +155\text{ mA}$  (OK)  
 (2) And then calculate current consumption of internal 24VDC logic power supply  
 $+325\text{mA} - 124\text{mA} - 136\text{mA} - 136\text{mA} = -71\text{ mA}$  (overload)  
 (3) Calculate current consumption of external 24VDC Sensor power supply  
 $+295\text{mA} - 162\text{mA} - 53\text{mA} = +80\text{ mA}$  (OK)

In conclusion, the total current consumption of internal 24VDC logic power supply of above six expansions exceeds power capacity of the main unit, so needs to expand power supply module as in example 3.

Example 3: The below diagram is a system modules, try to calculate the power supply used of the system.

	FBS- CM55E	FBS- B2DA	<b>FBS- 24MC</b>	FBS- 60XYR	FBS- 16YR	FBS- 6AD	Result	<b>FBS- EPW-AC</b>	FBS- 16YR	Result
	(1)							(2)		
Internal 5VDC logic power supply	-120	-223	<b>+722</b>	-119	-40	-25	+195 (OK)	<b>400</b>	-40	+360(OK)
Internal 24VDC logic power supply	-	-	<b>+325</b>	-124	-136	-	+65 (OK)	<b>250</b>	-136	+114 (OK)
External 24VDC Sensor power supply	-	-	<b>+295</b>	-162	-	-53	+80 (OK)	<b>250</b>	-	+250 (OK)

Unit : mA

Result: (1) First calculate the current consumption of expansion modules which provided from the main unit.

- current consumption of internal 5VDC logic power supply  
 $+722\text{mA} - 120\text{mA} - 223\text{mA} - 119\text{mA} - 40\text{mA} - 25\text{mA} = 195\text{mA}$  (OK)  
 current consumption of internal 24VDC logic power supply  
 $+325\text{mA} - 124\text{mA} - 136\text{mA} = 65\text{ mA}$  (OK)  
 current consumption of external 24VDC Sensor power supply  
 $+295\text{mA} - 162\text{mA} - 53\text{mA} = 80\text{ mA}$  (OK)

(2) then calculate the current consumption of expansion modules which provided from expansion power supply module

- current consumption of internal 5VDC logic power supply  
 $+400\text{mA} - 40\text{mA} = +360\text{ mA}$  (OK)  
 current consumption of internal 24VDC logic power supply  
 $+250\text{mA} - 136\text{mA} = +114\text{ mA}$  (OK)  
 current consumption of external 24VDC Sensor power supply  
 $+250\text{mA} - 0\text{mA} = +250\text{ mA}$  (OK)

In conclusion, add one expansion power supply(FBS-EPW-AC) , in this way it can satisfy the total current consumption of six expansion modules.



## 5.4 Requirement of Power Sequence in Main Unit & Expansion Unit/Module

When the power is on, the FBS-PLC main unit first detects the type and number of expansion unit/module attached to its expansion interface and get the actual I/O configuration. Therefore, while the main unit performs detection, the power in expansion unit/module should be already UP, otherwise, the detected I/O configuration will not correct. Namely, the power of expansion unit/module should be ON simultaneously or even earlier. There will be no time sequence error when main unit/expansion unit/module are connected together to one power. If the expansion unit and main unit powered by different powers (or the same power but different switches), or external power supply is used for expansion modules, time sequence of both powers should be considered. To solve the problem of the expansion unit/module power not get ready before main unit power does, FBS-PLC provides a special R4150 register which can delay the detection time of I/O configuration. The time base of R4150 is 0.01sec with a default value of 100 (namely a 1sec delay), which can be set from 100~500 (1~5sec), as shown in the figure below. If the expansion unit power cannot be UP within 1sec after main unit power is ON, the R4150 time needs to be set longer to delay the detection by CPU. It cannot exceed 5sec, however, otherwise the configuration of expansion interface cannot be detected.

