VIGOR ELECTRIC CORP.

VIGOR

PROGRAMMABLE CONTROLLERS

VB-2VC

VB-2VC SPECIAL FUNCTION BLOCK
USER'S GUIDE

This manual contains text, diagrams and explanations which will guide the reader in the correct installation and operation of the VB -2VC special function block and should be read and understood before attempting to install or use the unit.
Further information can be found in the VB PROGRAMMING MANUAL and VB SERIES HARDWARE MANUAL.

1. OVERVIEW

VB-2VC is equipped with 2 channels which can perform programmable current limitation and is intended for inductive loads driving. The VB-2VC is particularly suitable for proportional Electro-Hydraulic valves or solenoids control. Because of its excellent stability ,outstanding slope mode and fully digital programming cause it overshadows many other solutions.

Following descriptions highlight the features of VB-2VC ：

● High current driving capability（up to 1055mA per channel）

● Equipped with high resolution 12 bit DAC for high precision control

● Fully digital control including MIN and MAX current, rising or falling Slope and Mode of slope

● In addition to SV, all other settings can be set in run time for fitting different event condition dynamically.

● Provide another S-type slope mode for accelerating and decelerating automatically

● Very wide range of adjustment of slope

● High efficiency switching mode operation for reducing power dissipation

● High voltage operation（up to 45V）for high power valves application

● Operation by single DC power（Vs）or just only voltage on 24（+,−）supplied for downgrade power supply cost

● Thermal shutdown protection

● Equipped with Poly Switch（self-recovery Fuse）for downgrade the maintenance cost

● Equipped with EEPROM to backup basic settings
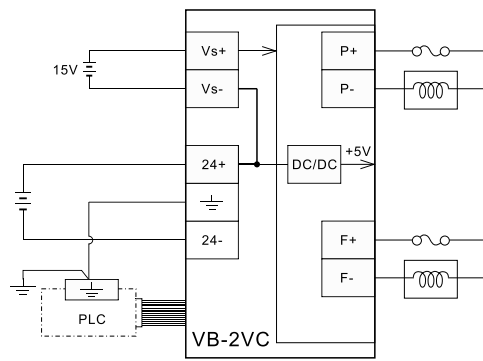
1.1 External dimensions
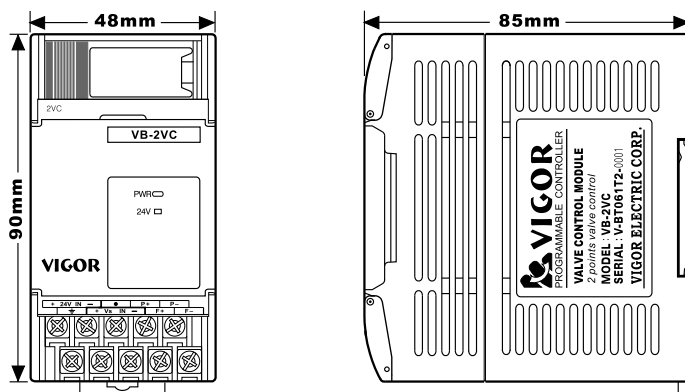
1.2 Using crimp terminations
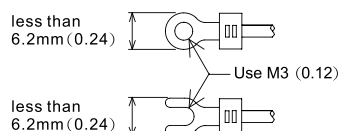
● Use crimp terminations of the type indicated on the left.

● Secure the termination using a tightening torque of between 5 and 8kg cm.

● Wire only to the module terminals discussed in this manual. Leave all others vacant.

2. WIRING

- Refer to wiring diagram, there are two voltage sources wired to VB-2VC. Because Vs− was connected to 24+ internally, these two voltage sources are connected serially in structure, the voltage applied to both channels of valves will be the total voltage on Vs+ and 24−.

- If any valve which its voltage requirement is more than voltage on 24 (+,−), a proper voltage source should be wired to Vs (+,−), otherwise, user can just short the Vs+ and Vs− for getting Vs+ wiring to the 24+ and working as the power supply of valve.

- Not only the voltage value need to be considered, but also the current capacities of both power supplies do.

- An external fuse is highly recommended for each channel and should be selected proper rating for their own valve.

NOTE :

Any unuse channel just leave it open and a zero value should be set to MIN and SV BFMs for the corresponding channel. In all circumstances, user DO NOT short P+ and P− or F+ and F−, doing so may damage the VB-2VC . User should avoid such a situation to happen.

3. SPECIFICATION

3.1 Environmental specification

Item	Specification
Environmental specifications（excluding following）	Same as those for the VB series base unit
Dielectric withstand voltage	500V AC, 1min（between all terminals and ground）

3.2 Power supply specification

Item	Specification
Digital circuits	5V DC, 45mA （internal power supply from base unit）
24V	12V ～ 24V, 2.3A*
Vs	0 ～ 21V, 2.3A*
Voltage applied to valves （Vs+ , 24−）	12V ～ 45V

*NOTE: the current capacity can be smaller properly if meet the current requirement of valves applied.

3.3 Performance specification

Item	Specification
Channels supported	2
Maximum Driving Current per channel	1055mA*
Current resolution of both channel	271μA ±5%
Slope mode of each channel	Linear or S-type
Switching frequency	25 KHz
Poly switch rating of each channel	1.85A @ 20℃
	1.17A @ 60℃

*NOTE: When VB-2VC be driven with large current（more than 80% of full scale）and be kept for a long enough time（more than 8 minutes）or worked under heavy duty, the rising temperature may up to 50℃, user should not try to touch the power resisters on the top of VB-2VC and an externally forced heatsink handling（like fan）is highly recommended.

4. INSTALLATION NOTES AND USAGE

There are three steps about the usage of VB-2VC listed as following :

1. To decide the voltage of the two power supplies -- Vs (+,−) and 24 (+,−)

2. To choose the mode of slope (Linear or S-type)

3. To decide the slope

When all these three things have done, user only need to set target current to VB-2VC (by writing a new value to SV BFM).

In oder to explain clearly, we make some definitions and put them in proper positions.

4.1 How to decide the voltage on 24 (+,−) and VS (+,−)

> **Definition − − V*drop***
>
> VB-2VC will consume some voltages necessary for current control. We call such voltages as Vdrop.
> The amount of voltage value will vary dependent on the programming current flowing to the valve. Typically, V*drop* may up to 5.6V. Consideration about derating, we assume it to 8V.

- If a valve with 43.5Ω impedence
  and its full scale current up to 600mA,
  so the max voltage on valve will be
  43.5Ω × 0.6A = 26.1V
  and the totally voltage we need will be
  26.1V + 8V = 34.1V , where 8V is the V*drop*
  If we already have a 24V wire to 24+ and 24−,
  so the voltage on Vs+ and Vs− should be
  34.1V − 24V = 10.1V.

- If a valve with 10Ω impedence
  and its full scale current up to 750mA,
  so the max voltage on valve will be
  10Ω × 0.75A = 7.5V
  and the totally voltage we need will be
  7.5V + 8V = 15.5V
  15.5V is already smaller than 24V and if both valves are the same,
  users can just short Vs+ and Vs− cause Vs+ wire to 24+ terminal.
  User even can just supply the voltage on 24 (+,−) low to 15.5V.

- When a VB-2VC wired with two different voltage requirements of valves, the bigger one should be applied to. Even so, VB-2VC still can perform the control well but the smaller one of valve which has a lower inductance may cause a little more ripple current on it.

- When a VB-2VC wired with two of the same voltage requirement of valves, or an application which equipped with two VB-2VC, a properly lower voltage but matching the requirement of the valve can reduce the ripple current on valve for more precision control. Doing so will improve linear characteristics especially driving on low current area.

4.2 The mode of slope

VB-2VC has two slope modes. One is linear and the other is S-type.

- Refer to figure 1 and figure 2, the linear slope mode is easy to understand. The current on valves will increase or decrease proportionally to the past time until it reach the target current.
  User need to set "time of rising" and "time of falling" for getting the slope they want. For different current gap approach, the slope can be chosen again for getting more smoother motion.

Figure 1. Current rising by linear slope.   Figure 2. Current falling by linear slope.
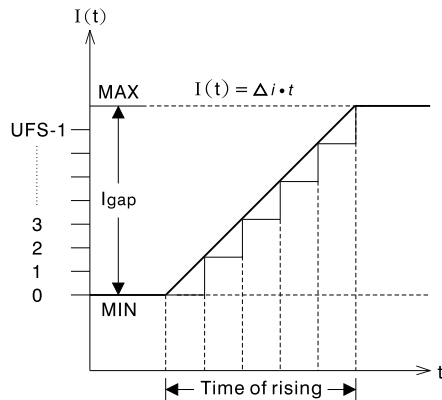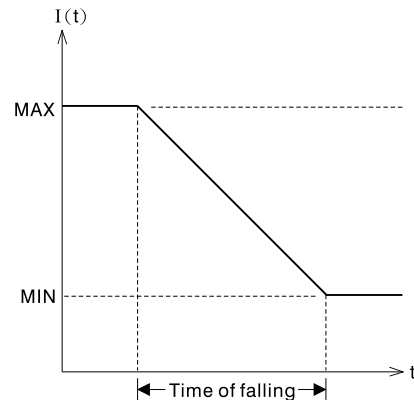
- Refer to figure 3 and figure 4, the S-type slope mode has smoother motion nearby start and target current by way of acceleration and deceleration automatically without sacrifice more time spent. From start to middle point M, the function of current $I(t)$ increase by square exponential, the slope is a variable of t and equal to 2t. From point M to target current, the slope will be fed in a reverse way.

Figure 3. Current rising by S-type slope.   Figure 4. Current falling by S-type slope.

5. Buffer Memory Assignment (BFM)

The VB series PLC communicates with VB-2VC through access of buffer memories.

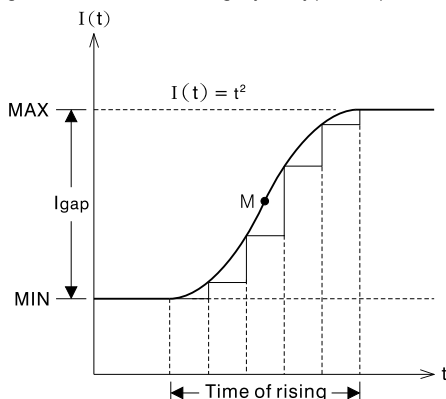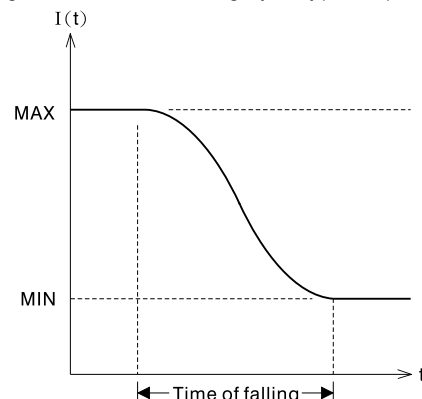| BFM No.		Description		Setting range	Default value		Access attribute
CH0,P	CH1,F				CH0,P	CH1,F	
0		Status, see Table 1		—	0		R
1		Flag, see Table 2		—	0		R
2		Error Address of Access		—	255		R
3		Error code, see Table 3		—	0		R
4		Command for Error Reset		0,1	0		R/W
5		Command for BFMs Initialization		0,1	0		R/W
6		Command for EEPROM writing		0,1	0		R/W
7		To control		0,1	1		R/W
8		To turn OFF to MIN if PLC switch to STOP		0,1	0		R/W
9		Reserved		—	0		—
10	15	MIN	Unit : mA	$0 \sim MAX - 1$	0	100	R/W
11	16	MAX		$MIN + 1 \sim 1055$	750	540	R/W
12	17	Slope mode		0,1	0		R/W
13	18	Time of Rising	Unit : mS	$20 \sim 65535$	360	480	R/W
14	19	Time of Falling		$20 \sim 65535$	420	560	R/W
20	21	UFS		$2 \sim 16384$	4096		R/W
22	23	SV		$0 \sim UFS - 1$	0		R/W
24 ~ 29		Reserved		—	0		—
30		Model code		—	2026		R
31		Reserved		—	0		—

5.1 Buffer Memory contents description

- BFM #0, Status

This BFM used to indicate the status of VB-2VC, user's PLC program should check these status before they try to write a new SV or other BFMs.

Table 1

Bit No.	Bit Name	Description for turn to "ON" state
b15	EEwr	EEPROM is in writing
b14 ~ b5	NOT USE	—
b4	CUT-1	Channel 1 Current being updated to target
b3 ~ b1	NOT USE	—
b0	CUT-0	Channel 0 Current being updated to target

When b0 or b4 are turning to ON state, user should not try to set another new value to corresponding channel's SV BFMs.

When b15 is turning to ON state, further coming EEPROM writing command will be ignored.

- BFM #1 Flag

Table 2

Bit No.	Description
b15*	Check sum error of EEPROM
b14*	System communication error
b13 ~ b3	NOT USE
b2	Setting value out of valid range
b1	Access to inhibited Area or write to read only or read to write only Address
b0	Access area not a sub-set of BFMs defined by VB-2VC.

＊b15 or b14 turn on when an error has been cause by noise or when a failure has occurred in VB-2VC . If the errors are not eliminated even after power is turned off once then on again, contact Vigor Electric Crop. For product maintenance service

＊When any bit between b0 to b2 turned to ON state, User should refer to BFM #2 and #3, check and correct their PLC program for eliminating the error flag.

- BFM #2 Error Address of Access

  This BFM indicates the position of BFMs which an error had been occurred caused by BFMs access. When this BFM has a value other than 255, user should check their PLC program whether there is any mistake or not suitable access to BFMs. Refer to BFM #1 and BFM #3 for more information.

- BFM #3 Error code

  When this BFM has a value other than 0, user should check their PLC program . If there are more than one errors, this BFM only records the last one.

  Table 3

 | Error code | Description |
  |---|---|
  | 1* | Check sum error when reading data from EEPROM. |
  | 2* | Function From/To communication error |
  | 3 | The range of Access Target specified by Function From/To is not a subset of BFMs which is defined by VB-2VC |
  | 4 | Access to inhibited area or write to Read-only or read from write-only area. |
  | 5 | Setting value out of valid range |

- BFM #4 Command for Resetting the error

  When the value changed from 0 to 1 (⬆, rising edge) , the contents of the three BFMs (#1 ~ #3) will be Reset to the default value.

  But if there is any error occurred again, the corresponding BFMs will be written a new value, user should try to find out the factor which may cause such a error to occur.

- BFM #5 Command for BFMs initialization

  When the value changed from 0 to 1 (⬆, rising edge) the contents of BFMs between #7 and #23 will be Reset to the default value which is defined by VB-2VC.

- BFM #6 Command for setting data value write to EEPROM

  When the value changed from 0 to 1 (⬆, rising edge) the contents of BFMs between #7 and #25 will be written to the EEPROM. Those values in EEPROM will be the default values when the power next time turns to on.

  > **NOTE** :
  > User should check the bit 15 in BFM # 0.
  > Within the time period this bit turning ON, VB-2VC will ignore further such commands coming.

  Refer to Table 4, when an event cause action to "Approach to MIN", the SV BFMs is actually rewritten by zero. If the assemble setting is turn to "normal control" again, the value in SV BFMs need to be set again.

  Table 4

BFM #7	BFM #8	PLC state 0 : STOP 1 : RUN	Action
0	✕	✕	Approach to MIN
1	0	✕	Normal control
	1	0	Approach to MIN
		1	Normal control

  ✕ : Don't care

- BFM #7 Command for perform control

  Under normal control, this BFM should have a value written by 1. Once this BFM was written with a zero value, the current of valves will decrease and approach to MIN by user defined Falling slope.

- BFM #8 Turn OFF current to MIN if PLC switch to "STOP" state

  When this BFM has a zero value and a value 1 in BFM #7, VB-2VC will continue its control activity and in spite of the "STOP" state of PLC.However, once this BFM was written by value 1 and if the state of PLC From "RUN" turns to "STOP", the current of valves will decrease and approach to MIN according to user defined falling slope.

- BFM #10, #15 MIN

  The value in these two BFMs specifies the minimum current flow on valve when the value in SV BFMs be set to zero. Normally, a very small amount of current on valve can't cause any mechanism movement.We call such area as "Dead Zone". A proper value can be set to these two BFMs to shift that zone and improve the reaction characteristics of valve.
  The unit of these two BFMs is 'mA'. A value between 0 and MAX-1 can be set to these two BFMs, and the value can't be greater than MAX.

- BFM #11, #16 MAX

  Valves have their own max applied current capacities Normally. VB-2VC can drive up to 1055mA for each channel. For many applications which the current capacities of applied valves are much lower than the specification of current driving capacity of VB-2VC, proper values should be set to these two BFMs to protect the valves.

  A value between MIN+1 and 1055mA can be set to these two BFMs, but the value can't be less than MIN.

- BFM #12, #17 slope mode

  VB-2VC has two slope modes. mode 1 is linear and mode 0 is S-type.
  Refer to 4.2 for more information.

- BFM #13, #18 Time of Rising

  This two BFMs should be set with a time value to specify the time will be spent when the current of load rising

  from MIN to MAX . According to following formula $\quad$ Slope_rising = $\dfrac{MAX\text{-}MIN}{Time\ of\ rising}$

  Normally once MAX and MIN be set, with a suitable value, we won't change their value any more, so these two BFMs can program the rising slope too.
  These BFMs will be referred when a new value setting to SV BFMs is "higher" than the old one.
  Refer to 4.2 for more information.

- BFM #14, #19 Time of falling

  This two BFMs should be set with a time value to specify the time will be spent when the current of load falling

  from MAX to MIN . According to following formula $\quad$ Slope_falling = $\dfrac{MIN\text{-}MAX}{Time\ of\ falling}$

  Normally once MAX and MIN be set, with a suitable value, we won't change their value any more, so these two BFMs can program the falling slope too.
  These BFMs will be referred when a new value setting to SV BFMs is "lower" than the old one.
  Refer to 4.2 for more information.

- BFM #20, #21 UFS (User define Full Scale)

  These two BFMs means --- How many segments does user want to perform partition from MIN to MAX.
  After these BFMs been set with a value 'S'.
  The valid range of SV will be [0..S-1]

  and the current resolution will be $\dfrac{MAX\text{-}MIN}{S}$

- BFM #22, #23 SV

  When a value between 0 and UFS-1 written to SV BFM, the current of valve will approach to target current according to user defined slope.

  For example, if the value in SV BFMs set by value 'X' the current flow valve on will be $X \cdot \left(\dfrac{MAX\text{-}MIN}{S}\right) + MIN$
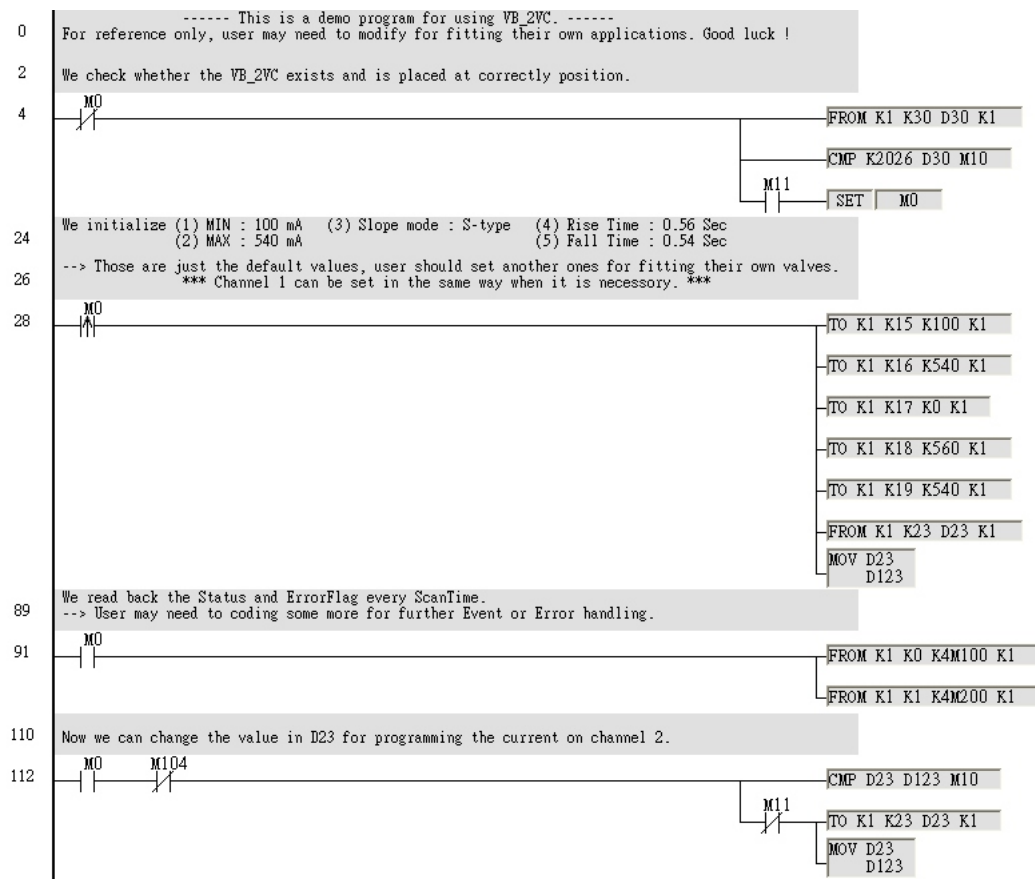
- BFM #24, #29 Reserved

- BFM #30 : Model code

  The model code or ID number for the special module can be read from buffer memory BFM #30 by using the FROMcommand. This number for the VB-2VC unit is K2026. The programmable controller can use this facility in its program to identify the special module before commencing data transfer from or to the special module.

6. EXAMPLE PROGRAM

In the program shown below, the VB-2VC block occupies the position of special block number 1（that is the first closest block to the programmable controller）.

```
                ------ This is a demo program for using VB_2VC. ------
0    For reference only, user may need to modify for fitting their own applications. Good luck !

2    We check whether the VB_2VC exists and is placed at correctly position.

     M0
4   |/|-----------------------------------------------------[FROM K1 K30 D30 K1]
                                                            [CMP K2026 D30 M10]
                                                     M11
                                                    |--|---[SET   M0]

     We initialize (1) MIN : 100 mA  (3) Slope mode : S-type   (4) Rise Time : 0.56 Sec
24              (2) MAX : 540 mA                      (5) Fall Time : 0.54 Sec
     --> Those are just the default values, user should set another ones for fitting their own valves.
26              *** Channel 1 can be set in the same way when it is necessory. ***

     M0
28  |↑|-----------------------------------------------------[TO K1 K15 K100 K1]
                                                            [TO K1 K16 K540 K1]
                                                            [TO K1 K17 K0 K1]
                                                            [TO K1 K18 K560 K1]
                                                            [TO K1 K19 K540 K1]
                                                            [FROM K1 K23 D23 K1]
                                                            [MOV D23
                                                                  D123]

     We read back the Status and ErrorFlag every ScanTime.
89   --> User may need to coding some more for further Event or Error handling.

     M0
91  |--|----------------------------------------------------[FROM K1 K0 K4M100 K1]
                                                            [FROM K1 K1 K4M200 K1]

110  Now we can change the value in D23 for programming the current on channel 2.

     M0   M104
112 |--|--|/|------------------------------------------------[CMP D23 D123 M10]
                                                     M11
                                                    |/|----[TO K1 K23 D23 K1]
                                                            [MOV D23
                                                                  D123]
```

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7. DIAGNOSTICS

7.1 Preliminary checks

（1）Check whether the power supply and output wiring and/or extension cables are properly connected on VB-2VC inductive load driver special function block.

（2）Check that the VB system configuration rules have not been broken, i.e. the number of special function blocks does not exceed 8 for VB2 and 2 for VB0.

（3）Ensure that the correct operating range has been selected for the application.

（4）Check that there is no power overload on either the 5V or 24V power sources, remember the loading on an MPU or a powered extension unit varies according to the number of extension blocks or special function blocks connected.

（5）Put the Main Processing Unit（MPU）into RUN.

7.2 Error checking

If the VB-2VC special function block does not seem to operate normally, check the following items.

- Check the status of the POWER LED.
  Lit   : The extension cable is properly connected.
  Otherwise : Check the connection of the extension cable.

- Check the external wiring.

- Check the status fo the " 24V"LED.
  Lit   : VB-2VC is ON, 24V DC power source is ON.
  Otherwise : Possible 24V DC power failure or possible VB-2VC failure.

7.3 Checking special function block numbers

Other special units of blocks that use FROM/TO commands, such as analog input blocks, analog output blocks and high-speed counter blocks, can be directly connected to the base unit of the VB programmable controller or to the right side of other extension blocks or units. Each special block is consecutively numbered from 1 to 8 beginning from the one closest to the base unit. A maximum of eight（VB2）special blocks can be connected.

No.1   No.2   No.3
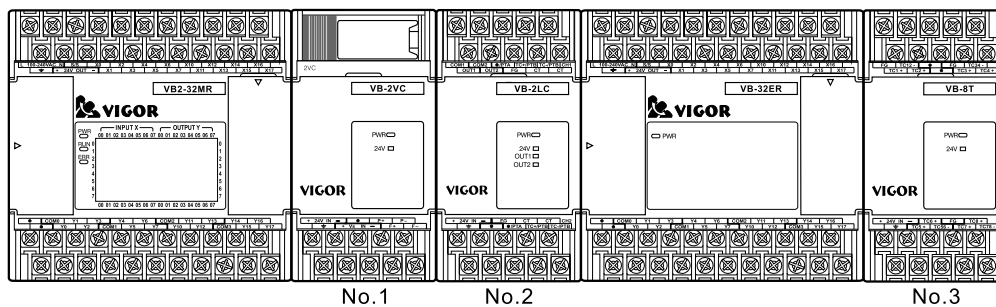
8. EMC CONSIDERATIONS

Electromagnetic compatibility or EMC must be considered before using the VB-2VC.

VEC recommend the VB-2VC has better to get an independent power supply. Because the power supply used to drive inductive loads by PWM switching which may generate some noise glitch on it and may not suitable supplied to another precision or noise sensitive module again.

If some form of cable protection is used, the "Shield" must be terminated at the FG ⏚ terminals as shown in section 2.

EMC considerations should include selection of good quality cables, good routing of those cables away from potential noise sources.

Guidelines for the safety of the user and protection of the VB-2VC

- This manual has been written to be used by trained and competent person. This is defined by the European directives for machinery, low voltage and EMC.

- If in doubt at any stage during the installation of the VB-2VC always consult a professional electrical engineer who is qualified and trained to the local and national standards. If in doubt about the operation or use of the VB-2VC please consult the nearest VEC distributor.

- Under no circumstances will VEC 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. VEC will accept no responsibility for actual use of the product based on these illustrative examples.

Manual number   :

Manual revision : A

Date   : September 2006

VIGOR ELECTRIC CORP.