Technical Note - Drive Modbus Register-based Digital Output Activation

Overview:

The purpose of this application note is to provide guidance on how to program a Yaskawa drive's digital output in such a way that it opens/closes based on the contents of an individual Modbus register within the drive.

Applicable Products:

- GA800
- A1000
- U1000
- Z1000U

Purpose:

Yaskawa drives' digital outputs have many different uses and functions that can be programmed. However, there are times when a user wants the drive's digital output to behave based on a specific function or variable that is not listed in the digital output settings. For example, say the user wants the digital output to close during a specific fault of overvoltage (OV) only. There is a setting of "E" that the user can set to close the output during a fault. However, the setting of "E" will cause the digital output to close not only during an OV fault, but any fault. The setting of "E" will not satisfy the case of closing the digital output during the OV fault only. However, there is a digital output setting that can greatly expand the possible behaviors of the digital outputs. The setting H2-0X=62 or 63 can utilize any Modbus register from the drive and open/close a digital output based on that Modbus register's contents.

Modbus Registers:

The Yaskawa Technical Manual is where the Modbus register table can be found for each drive. Some registers are broken down into bits while other registers represent a variable such as output current for example. The digital output function described in this application note will be most beneficial for the registers that are broken up bit by bit.

Table 5.11 MEMOBUS/Modbus Communications Command Data

| Register No. (Hex.)	Description		
0000	Reserved		
0001	Run command, multi-function input command		
	bit 0		When $H5\text{-}12 = 0$, Forward run/stop 1: Forward run, 0: Stop When $H5\text{-}12 = 1$, run/stop 1: Run, 0: Stop
	bit 1		When $H5\text{-}12 = 0$, Reverse run/stop 1: Reverse run, 0: Stop When $H5\text{-}12 = 1$, Forward/Reverse run 1: Reverse, 0: Forward run
	bit 2		External Fault 1: EF0 [Option Card External Fault]
	bit 3		Fault Reset 1: Reset command
	bit 4		Multi-function input 1 When $H1\text{-}01 = 40$ [Forward RUN (2-Wire)], the multi-function input command is "ComRef." **Note:** When you switch the bit ON as ComRef, the frequency reference source changes to MEMOBUS/Modbus communications. When you connect a communication option to the drive, the frequency reference source gives priority to the communications option.

Please note: The settings H2-0X=62/63, 162/163 are not available in the A1000 drive models 4A0930 and 4A1200.

Also note: Even though there are 3 multi-function digital outputs on the GA800 drive, there are only two sets of settings (62 & 63) in which a total of two Modbus registers may be used.

The table below shows the three multi-function digital output settings on the GA800 drive. Setting H2-01=62 for example will force the M1/M2 digital output to open/close based on the Modbus register selected in H2-07 and the specific bit or bits selected in H2-08.

No. (Hex.)	Name	Description	Default (Range)
H2-01 (040B)	Term M1-M2 Function Selection	V/f CL-V/f OLV CLV AOLV OLV/PM AOLV/PM CLV/PM EZOLV Sets the function for MFDO terminal M1-M2. Note: Set this parameter to *F* when the terminal is not being used or to use the terminal in through mode.	0 (0 - 1A7)
H2-02 (040C)	Term M3-M4 Function Selection	V/f CL-V/f OLV CLV AOLV OLV/PM AOLV/PM CLV/PM EZOLV Sets the function for MFDO terminal M3-M4. Note: Set this parameter to *F* when the terminal is not being used or to use the terminal in through mode.	1 (0 - 1A7)
H2-03 (040D)	Term M5-M6 Function Selection	V/f CL-V/f OLV CLV AOLV OLV/PM AOLV/PM CLV/PM EZOLV Sets the function for MFDO terminal M5-M6. Note: Set this parameter to *F* when the terminal is not being used or to use the terminal in through mode.	2 (0 - 1A7)
Setting	**Function**	**Description**	
62	Modbus Reg 1 Status Satisfied	V/f CL-V/f OLV CLV AOLV OLV/PM AOLV/PM CLV/PM EZOLV The terminal activates when the bit specified by *H2-08 [Modbus Register 1 Bit Select]* for the MEMOBUS register address set with *H2-07 [Modbus Register 1 Address Select]* activates.	
63	Modbus Reg 2 Status Satisfied	V/f CL-V/f OLV CLV AOLV OLV/PM AOLV/PM CLV/PM EZOLV The terminal activates when the bit specified by *H2-10 [Modbus Register 2 Bit Select]* for the MEMOBUS register address set with *H2-09 [Modbus Register 2 Address Select]* activates.	
No. (Hex.)	**Name**	**Description**	**Default (Range)**
H2-07 (0B3A)	Modbus Register 1 Address Select	V/f CL-V/f OLV CLV AOLV OLV/PM AOLV/PM CLV/PM EZOLV Sets the address of the MEMOBUS/Modbus register output to the MFDO terminal.	0001 (0001 - 1FFF)
H2-08 (0B3B)	Modbus Register 1 Bit Select	V/f CL-V/f OLV CLV AOLV OLV/PM AOLV/PM CLV/PM EZOLV Sets the bit of the MEMOBUS/Modbus register output to the MFDO terminal.	0000 (0000 - FFFF)
H2-09 (0B3C)	Modbus Register 2 Address Select	V/f CL-V/f OLV CLV AOLV OLV/PM AOLV/PM CLV/PM EZOLV Sets the address of the MEMOBUS/Modbus register output to the MFDO terminal.	0001 (0001 - 1FFF)
H2-10 (0B3D)	Modbus Register 2 Bit Select	V/f CL-V/f OLV CLV AOLV OLV/PM AOLV/PM CLV/PM EZOLV Sets the bit of the MEMOBUS/Modbus register output to the MFDO terminal.	0000 (0000 - FFFF)

After setting H2-01=62, the desired Modbus register must be programmed into H2-07. A complete list of Modbus registers is located in the drive's technical manual. Each register has a hexadecimal address which must be set into H2-07 as a hexadecimal value. Lastly, the Modbus register's bit or bits must be specified in H2-08. Every Modbus register consists of a 16-bit word. The figure below shows a breakdown of the 16-bit word into 4 nibbles:
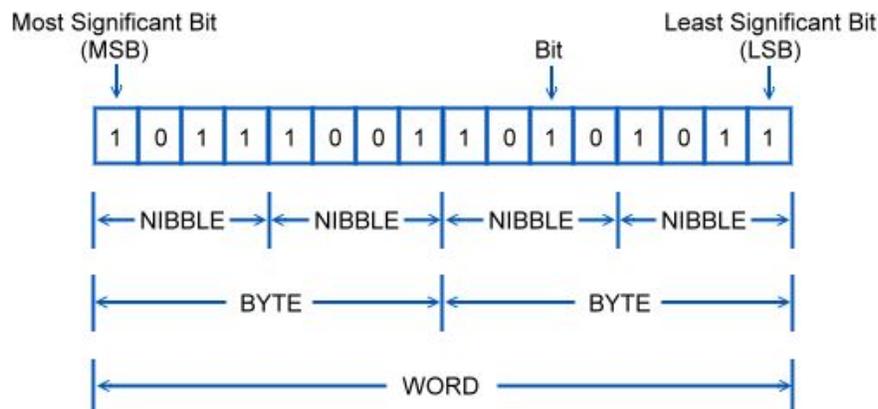
H2-08 must be programmed as a 4-digit setting, no matter which bit is desired. Each digit in the H2-08 setting represents a nibble of the 16-bit register. As shown above, there are 4 nibbles in a 16-bit register, each nibble consisting of 4 bits. In order to trigger the digital output based on the least significant bit of the least significant nibble, H2-08 should be set to 0001 (0001 in binary equals 1 in hexadecimal). Likewise, in order to trigger the most significant bit of the least significant nibble, H2-08 should be set to 0008 (1000 in binary equals 8 in hexadecimal).

Some examples of binary to hexadecimal:

- 1010 = A

- 0111 = 7

- 1101 = D

- 0100 = 4

Example #1:

It is desired to close the M1/M2 digital output only if the drive faults on overvoltage (OV). Any other drive fault should not activate M1/M2. The only digital output setting possible would be H2-01=62. H2-07 can then be set to 0021h which contains the bit for OV fault. Since the OV fault bit is bit 1, H2-08 may be programmed to 0002 indicating that the digital output should close only when bit 1 in register 0021h is "high." All other bits in the register will be ignored.

Register No. (Hex.)	Description	
	Fault Description 1	
	bit 0	oC [Overcurrent], GF [Ground Fault]
	bit 1	ov [DC Bus Overvoltage]
	bit 2	oL2 [Drive Overloaded]
	bit 3	oH1 [Heatsink Overheat], oH2 [External Overheat (H1-XX=B)]
	bit 4	rH [Braking Resistor Overheat], rr [Dynamic Braking Transistor Fault]
	bit 5	Reserved
0021	bit 6	FbL [PID Feedback Loss], FbH [Excessive PID Feedback]
	bit 7	EF0 [Option Card External Fault], EF1 to EF8 [External Fault]
	bit 8	CPFxx [Hardware Fault] **Note:** Includes *oFx*.
	bit 9	oL1 [Motor Overload], oL3, L4 [Overtorque Detection 1/2], UL3, L4 [Undertorque Detection 1/2]
	bit A	PGo [Encoder (PG) Feedback Loss], PGoH [Encoder (PG) Hardware Fault], oS [Overspeed], dEv [Speed Deviation]
	bit B	During Uv [Undervoltage] detection

"OR" Configuration:

It is possible for the drive's digital output to look at 2 or more bits within the same Modbus register. When programmed in this manner, the digital output will act as an OR configuration. This means that if any of the selected bits is high, then the digital output will close.

Below are truth tables which illustrate how the drive's digital output will behave based on the H2-0X setting of 62/63 or 162/163 (inverse). When setting 62/63 is selected, the digital output can be programmed to operate based on more than 1 bit. For example, if H2-08=3, then the digital output will close if bit 0 OR bit 1 OR both go high in that Modbus register. If the digital output is set to 162/163, then the output will operate exactly inverse, meaning all possible outcomes will be opposite from setting 62/63. When the inverse 162/163 setting is used, the digital output follows a NOR gate when multiple bits are selected.

H2-01 = 62/63

2 Input OR gate		
A	B	A+B
0	0	0
0	1	1
1	0	1
1	1	1

H2-01 = 162/163

2 Input NOR gate		
A	B	$\overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

Example #2:

It is desired to close the M1/M2 digital output when the drive is either at zero speed OR is at speed agree. Looking down the list of Modbus registers, register 004Bh has both of these drive statuses in the same register. During zero speed is bit 1 and during speed agree is bit 4. So the drive settings would go as follows: Set H2-01=62, H2-07=004Bh, H2-08=0012.

H2-01 and H2-07 are fairly straightforward as to how to set them. H2-08 however can be tricky and a little confusing. Breaking down register 004Bh, focusing only on bit 4 and bit 1 results in 0000 0000 0001 0010 shown in nibbles separated by a space. The first 2 nibbles starting from the left are both 0. The third is 1 and the forth is 2. Combine all four nibbles and you get 0012 which gets set in H2-08.

Register No. (Hex.)	Description	
	U1-12 [Drive Status]	
	bit 0	1: During run
	bit 1	1: During zero speed
	bit 2	1: During reverse
	bit 3	1: During reset signal input
	bit 4	1: During speed agreement
004B	bit 5	1: Drive operation ready
	bit 6	1: Minor Fault
	bit 7	1: Fault
	bit 8	1: oPExx [Operation Error] generation
	bit 9	1: Recovery from momentary power loss, 0: Power recovery
	bit A	1: Motor 2 Selection
	bit B	Reserved
	bit E	ComRef status/ NetRef status
	bit F	ComCtrl status/ NetCtrl status

Example #3:

It is desired to program a drive digital output that can close both when the run command is from the operator keypad AND during speed agree. It is possible to create this functionality by utilizing 2 separate digital outputs. Register 002Ch contains both desired bits. The drive settings are as follows: H2-01=62, H2-02=63, H2-07=002Ch, H2-08=0400, H2-09=002Ch, H2-10=0004. These settings use M1/M2 and M3/M4.

In order to connect them as an AND function, they need to be used in series so that the output will be "high" when both digital outputs are closed. One way to do this is to jumper terminals M2 and M3 together and use terminals M1 and M4 as the contact terminals.

Register No. (Hex.)	Description	
	Drive Status 2	
	bit 0	During Run 1: During run
	bit 1	During zero speed 1: During zero speed
	bit 2	Speed agreement 1: During agreement
	bit 3	User-defined speed agreement 1: During agreement
	bit 4	Frequency Detection 1 1: Output frequency $\leq$ L4-01
	bit 5	Frequency Detection 2 1: Output frequency $\geq$ L4-01
	bit 6	Drive ready 1: Run ready
002C	bit 7	During low voltage detection 1: During detection
	bit 8	During baseblock 1: Drive output during baseblock
	bit 9	Frequency reference mode 1: No communication option, 0: Communication option
	bit A	Run command mode 1: No communication option, 0: Communication option
	bit B	During overtorque/undertorque 1, 2 detection
	bit C	Frequency reference loss 1: Loss

Other Possible Combinations:

In addition to having the digital output act on a single bit or multiple bits within a register, or even using the inverse function 162/163, there are other possible combinations, such as using two separate digital outputs (one programmed for 62 and the other programmed to 63) which could be wired in series with each other to produce an AND circuit.