

## MD520

## Free Programming Function

## MD520



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## 1 GENERAL DATA

|           |                                    |
|-----------|------------------------------------|
| Authors:  | Daniel Rioja                       |
| Date:     | 11.08.2023                         |
| Hardware: | MD520                              |
| Software: | InoProShop v1.5.2, InoLoader v3.16 |
| Info:     | MD520 Free Programming function.   |

## 2 PURPOSE OF THIS DOCUMENT

The purpose of this document is to give a clear explanation about all the logic modules included on the Free Programming function on MD520 and help to learn how to use this tool.

If it is necessary to update the firmware, the PC Comms kit-02 and the InoLoader v3.16 software will also be used. The keypad SOP-20 can be also used to this purpose. To do so, first it is needed to upload the firmware version on the SOP-20 keypad. Then, connect the SOP-20 to the device via RS485 port and once the keypad has started, press the right arrow key to access the menu and go to 4-Authority. Once in, enter on 1-Login and enter the password: "1430" and press again the right arrow key. Once logged in, go to 6-System Control, and then go to 2-Update Device and select the firmware file uploaded previously to the keypad. Finally wait for the end of the update.

## 3 OVERVIEW

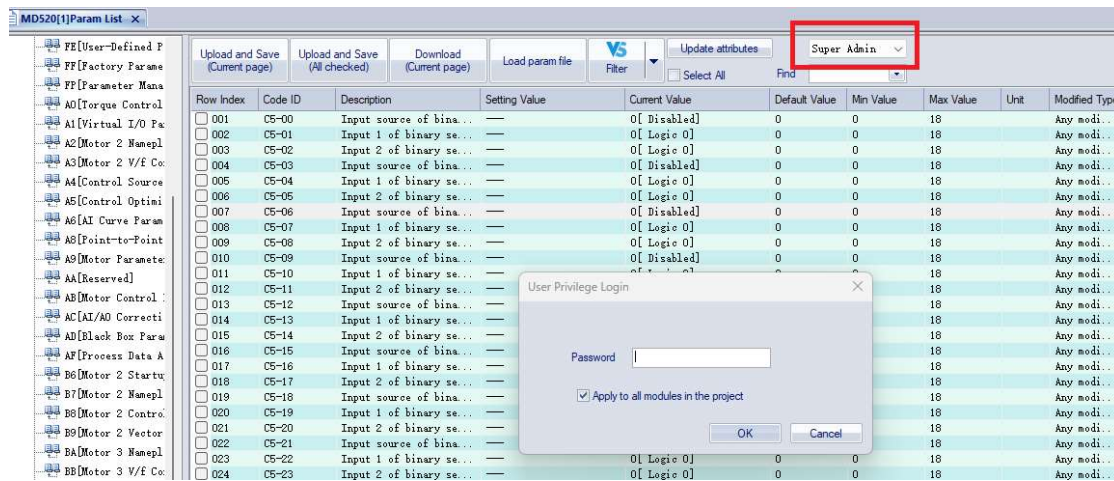
The MD520 Free Programming function provides a series of functionalities that results in a customized control for the application where the drive is going to be used.

This functionality allows to make more complex applications with less equipment, just using the drive(s).

To establish the connection with the drive, is recommended to use a SOP-20 keypad or a MDKE-10 keypad, with it connected to the drive via RS485 port, and connected to the PC via micro-USB (SOP-20 keypad) or USB-C (MDKE-10 keypad).

## 4 UNLOCK FREE PROGRAMMING FUNCTION

In order to be capable of using this function, the password: "1430" has to be set in the parameter FP-09. It is also important to select Super Admin mode (password: "SuperAdmin") instead of General User mode:



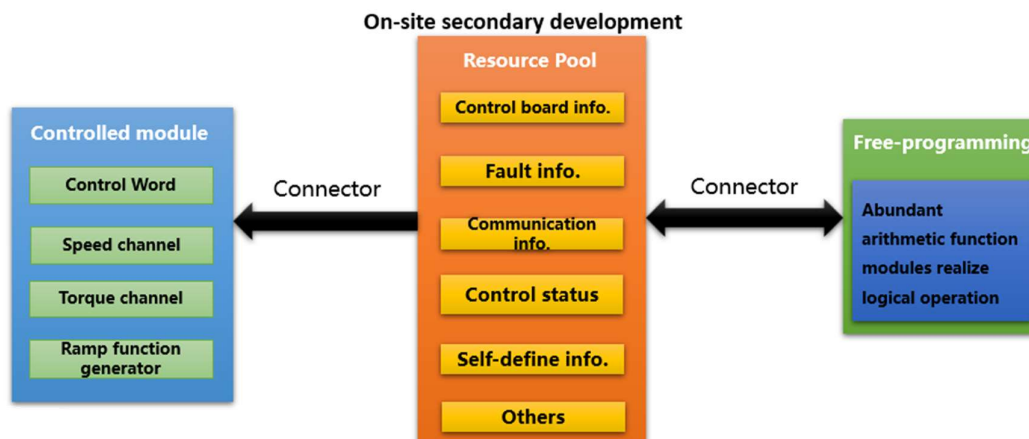
After this, click Update attributes to import all the parameters and its state or value to InoDriverShop. Once this process is done, the following groups of parameters below should appear on the list of parameters:

- Cx group parameters. These are the parameters which work as inputs for the logic modules. They range from C0 to CE.
- Lx group parameters. These are the connectors used as outputs of the logic modules. There are three types: Bit-connectors (L0-L4), Word-connectors (L5-L9) and floating-point-connectors (LB-LD).

## 5 PARAMETER INTERCONNECTION SYSTEM

Parameter interconnection system is a flexible setting method to connect input and output functions; This function can flexibly define ports according to the actual process requirements on site. The on-site secondary development and application can be realized by using the parameter interconnection system.

For example, when the input of DI2 is set as the output of DI1, once DI1 is turned on, DI1 and DI2 will be set to 1 at the same time.



## 5.1 CONNECTORS

The connectors can be used on two different ways:

- **InoDriverShop:** While using the PC software for programming the drive, on the parameters which admit connectors, a function will be displayed at the end of the list that goes as "Other [X-connector]" (X can be changed by 'B' for bit-connector, 'K' for k-connector (referred to Word-connectors or Doble-Word-connectors), or 'F' for floating-point-connector).

| Row Index                    | Code ID | Description                                                        | Setting Value | Current Value                                       | Default |
|------------------------------|---------|--------------------------------------------------------------------|---------------|-----------------------------------------------------|---------|
| <input type="checkbox"/> 001 | F0-00   | Load type                                                          | —             | 0[ Heavy load applic...                             | 0       |
| <input type="checkbox"/> 002 | F0-01   | Motor 1 control mode                                               | —             | 1[ FVC]                                             | 2       |
| <input type="checkbox"/> 003 | F0-02   | Command source                                                     | —             | 1[ Terminal]                                        | 0       |
| <input type="checkbox"/> 004 | F0-03   | Main frequency source X                                            | —             | 0[ Digital setting (...                             | 0       |
| <input type="checkbox"/> 005 | F0-04   | Auxiliary frequency source Y                                       | —             | 0[ Digital setting (non-retentive at power failure) | 0       |
| <input type="checkbox"/> 006 | F0-05   | Base value of range of auxiliary frequency source for superposi... | —             | 1[ Digital setting (retentive at power failure)]    | 0       |
| <input type="checkbox"/> 007 | F0-06   | Range of auxiliary frequency source Y for superposition            | —             | 2[ AI1]                                             | 0,00    |
| <input type="checkbox"/> 008 | F0-07   | Frequency source superposition                                     | —             | 3[ AI2]                                             | 0,00    |
| <input type="checkbox"/> 009 | F0-08   | Preset frequency                                                   | —             | 4[ AI3]                                             | 0,00    |
| <input type="checkbox"/> 010 | F0-09   | Running direction                                                  | —             | 5[ Pulse reference (BI5)]                           | 0,00    |
| <input type="checkbox"/> 011 | F0-10   | Maximum frequency                                                  | —             | 6[ Multi-reference]                                 | 0,00    |
| <input type="checkbox"/> 012 | F0-11   | Source of frequency upper limit                                    | —             | 7[ Single PLC]                                      | 0,00    |
| <input type="checkbox"/> 013 | F0-12   | Frequency upper limit                                              | —             | 8[ PID]                                             | 0,00    |
| <input type="checkbox"/> 014 | F0-13   | Frequency upper limit offset                                       | —             | 9[ Communication]                                   | 0,00    |
| <input type="checkbox"/> 015 | F0-14   | Frequency lower limit                                              | —             | Other[ F-connector]                                 | 0,00    |

As can be seen, on the parameter F0-03 the type of connector admitted is a F-connector (floating-point), this is because the type of parameter. In this case F0-03 is the parameter which defines the source of the main frequency for the drive. When using an F-connector as the source of the frequency, the value of it can be changed by the control modules implemented on the Free Programming function.

Once this function is selected, the next window will appear, as shown below.

| Row Index                    | Code ID | Description                                                        | Setting Value | Current Value    |
|------------------------------|---------|--------------------------------------------------------------------|---------------|------------------|
| <input type="checkbox"/> 001 | F0-00   | Load type                                                          | —             | 0[ Heavy load a  |
| <input type="checkbox"/> 002 | F0-01   | Motor 1 control mode                                               | —             | 1[ FVC]          |
| <input type="checkbox"/> 003 | F0-02   | Command source                                                     | —             | 1[ Terminal]     |
| <input type="checkbox"/> 004 | F0-03   | Main frequency source X                                            | —             | 0[ Digital sett  |
| <input type="checkbox"/> 005 | F0-04   | Auxiliary frequency source Y                                       | —             | 0[ Digital sett  |
| <input type="checkbox"/> 006 | F0-05   | Base value of range of auxiliary frequency source for superposi... | —             | 0[ Relative to   |
| <input type="checkbox"/> 007 | F0-06   | Range of auxiliary frequency source Y for superposition            | —             | 100              |
| <input type="checkbox"/> 008 | F0-07   | Frequency source superposition                                     | —             | 0                |
| <input type="checkbox"/> 009 | F0-08   | Preset frequency                                                   | —             | 20,00            |
| <input type="checkbox"/> 010 | F0-09   | Running direction                                                  | —             | 0[ Default dire  |
| <input type="checkbox"/> 011 | F0-10   | Maximum frequency                                                  | —             | 250,00           |
| <input type="checkbox"/> 012 | F0-11   | Source of frequency upper limit                                    | —             | 0[ F0-12]        |
| <input type="checkbox"/> 013 | F0-12   | Frequency upper limit                                              | —             | 50,00            |
| <input type="checkbox"/> 014 | F0-13   | Frequency upper limit offset                                       | —             | 0,00             |
| <input type="checkbox"/> 015 | F0-14   | Frequency lower limit                                              | —             | 0,00             |
| <input type="checkbox"/> 016 | F0-15   | Carrier frequency                                                  | —             | 6,0              |
| <input type="checkbox"/> 017 | F0-16   | Carrier frequency offset                                           | —             | 0[ No]           |
| <input type="checkbox"/> 018 | F0-17   | Acceleration time                                                  | —             | 1,0              |
| <input type="checkbox"/> 019 | F0-18   | Deceleration time                                                  | —             | 1,0              |
| <input type="checkbox"/> 020 | F0-19   | Acceleration time                                                  | —             | 1[ 0.1s]         |
| <input type="checkbox"/> 021 | F0-20   | Offset frequency                                                   | —             | 0[ F0-21]        |
| <input type="checkbox"/> 022 | F0-21   | Offset frequency                                                   | —             | 0,00             |
| <input type="checkbox"/> 023 | F0-22   | Deceleration time                                                  | —             | 2[ 0.01 Hz]      |
| <input type="checkbox"/> 024 | F0-23   | Retentive time                                                     | —             | 0[ Non-retentive |
| <input type="checkbox"/> 025 | F0-24   | Motor parameter                                                    | —             | 0[ Motor param   |
| <input type="checkbox"/> 026 | F0-25   | Acceleration time                                                  | —             | 0[ F0-10 (maxim  |
| <input type="checkbox"/> 027 | F0-26   | Base frequency                                                     | —             | 0[ Running freq  |
| <input type="checkbox"/> 028 | F0-27   | Free programming function                                          | —             | 0                |
| <input type="checkbox"/> 029 | F0-28   | Communication                                                      | —             | 0[0 Modbus]      |
| <input type="checkbox"/> 030 | F0-29   | Load type                                                          | —             | 0[ Heavy load a  |

Here we can see all the connectors of the same type (in this case F-connectors). Only one connector can be selected. We can change from parameter groups to select the connector needed. Also, at the lower left corner the address of the connector can be introduced to select it directly. Also, when selecting a connector manually, the address can be seen. Once selected the connector wanted, press OK and then DOWNLOAD the parameters changed on the drive.

- **Led Keypad:** Connectors can also be selected from the keypad. When the parameter to set is selected (for example following the last example, F0-03), all the values that correspond to the functions available for this parameter can be seen. When the value displayed goes above 1000, we can select the connector wanted using its address. To know which parameter is being selected, follow the next table:

| Parameter Group | Address Group |
|-----------------|---------------|
| L0              | 10--          |
| L1              | 11--          |
| L2              | 12--          |
| L3              | 13--          |
| L4              | 14--          |
| L5              | 15--          |
| L6              | 16--          |
| L7              | 17--          |
| L8              | 18--          |
| L9              | 19--          |
| LB              | 20--          |
| LC              | 21--          |
| LD              | 22--          |

Inside of each Address Group, the tens and units digits range from 00 to the highest parameter number inside that Parameter Group.

## 5.2 CONNECTOR TYPES

As mentioned before, there are 4 types of connectors, which can be seen in more detail below:

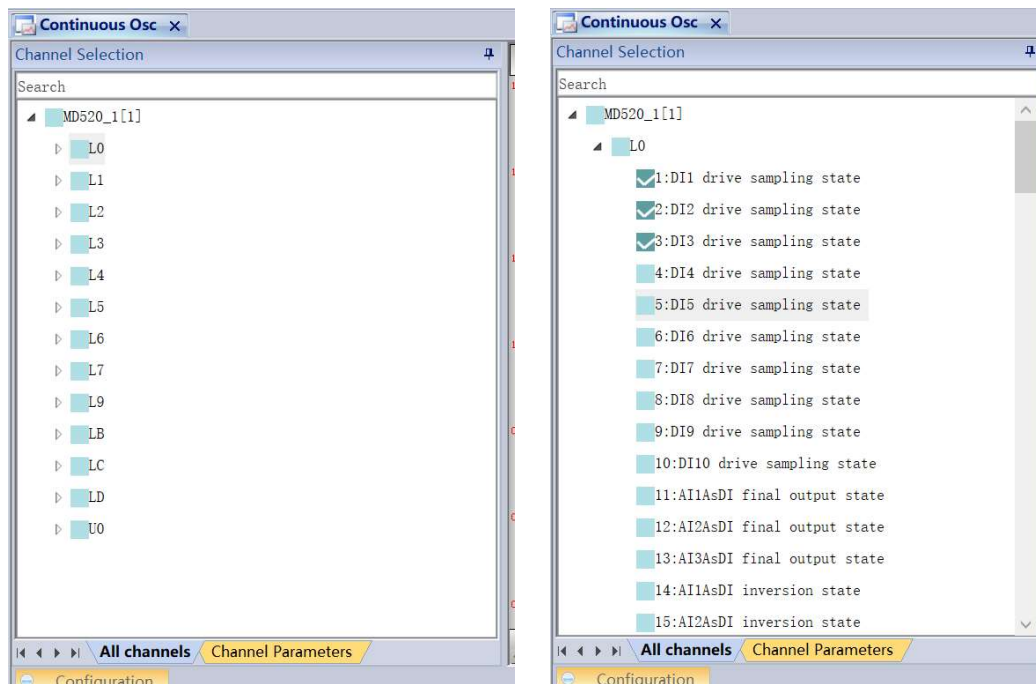
- **Bit connector:** It includes DI input, DO output, drive operation status, bit output status in common functions, fault status information, bit output status in logic block, etc. They are located in the function code groups L0 to L4.

| Row... | Code ID | Description                |
|--------|---------|----------------------------|
| 001    | L0-00   | DI1 drive sampling state   |
| 002    | L0-01   | DI2 drive sampling state   |
| 003    | L0-02   | DI3 drive sampling state   |
| 004    | L0-03   | DI4 drive sampling state   |
| 005    | L0-04   | DI5 drive sampling state   |
| 006    | L0-05   | DI6 drive sampling state   |
| 007    | L0-06   | DI7 drive sampling state   |
| 008    | L0-07   | DI8 drive sampling state   |
| 009    | L0-08   | DI9 drive sampling state   |
| 010    | L0-09   | DI10 drive sampling state  |
| 011    | L0-10   | AI1AsDI final output state |
| 012    | L0-11   | AI2AsDI final output state |
| 013    | L0-12   | AI3AsDI final output state |
| 014    | L0-13   | AI1AsDI inversion state    |
| 015    | L0-14   | AI2AsDI inversion state    |
| 016    | L0-15   | AI3AsDI inversion state    |
| 017    | L0-16   | DI1 drive output state     |
| 018    | L0-17   | DI2 drive output state     |
| 019    | L0-18   | DI3 drive output state     |
| 020    | L0-19   | DI4 drive output state     |
| 021    | L0-20   | DI5 drive output state     |
| 022    | L0-21   | DI6 drive output state     |
| 023    | L0-22   | DI7 drive output state     |
| 024    | L0-23   | DI8 drive output state     |
| 025    | L0-24   | DI9 drive output state     |

- **Word connector:** It includes status word, control word, speed, voltage, current, torque and other parameters, as well as data received by communication or analog signals detected by AI/AO, and are located in the function code groups L5 to LD.
- L5~L7 are single word connectors, L9 is double word connector, and LB~LD are floating point connectors.

| Row... | Code ID | Description                             |
|--------|---------|-----------------------------------------|
| 001    | L5-00   | System status word 1                    |
| 002    | L5-01   | System status word 2                    |
| 003    | L5-02   | Main status word of drive               |
| 004    | L5-03   | Auxiliary status word of drive          |
| 005    | L5-04   | Main status word of motor               |
| 006    | L5-05   | Auxiliary status word of motor          |
| 007    | L5-06   | Current state of system state machine   |
| 008    | L5-07   | System state machine switchover command |
| 009    | L5-08   | System running state                    |
| 010    | L5-09   | Current stop mode                       |
| 011    | L5-10   | Deceleration to stop/DC braking state   |
| 012    | L5-17   | Bus voltage                             |
| 013    | L5-20   | IGBT temperature                        |
| 014    | L5-21   | LED control word                        |
| 015    | L5-22   | IDS control word                        |
| 016    | L5-23   | SOP control word                        |
| 017    | L5-24   | Command channel system command          |
| 018    | L5-25   | LED command clear flag                  |
| 019    | L5-26   | SOP command clear flag                  |
| 020    | L5-27   | IDS command clear flag                  |
| 021    | L5-28   | Terminal module command                 |
| 022    | L5-29   | Input state of terminal module A        |
| 023    | L5-30   | Input state of terminal module B        |
| 024    | L5-31   | Running mode (normal/jogging)           |
| 025    | L5-32   | Logging source 1/2                      |

Connectors can also be used on the Continuous Oscilloscope. To do so, connectors can be found on the list of parameters to be displayed, organized by Parameters Groups as on the parameter list.



## 5.3 VDI AND VDO

Virtual digital inputs/outputs can be used to execute additional functions internally on the drive. It can be useful when more inputs/outputs are needed on a Free Programming application and the real inputs/outputs are already used for other functions.

Also, this allows to use analog inputs as digital inputs, which adds more possibilities.

| Row Index                    | Code ID | Description                 | Setting Value | Current Value    | Default Value | Min Value | Max Value | Unit |
|------------------------------|---------|-----------------------------|---------------|------------------|---------------|-----------|-----------|------|
| <input type="checkbox"/> 001 | A1-00   | VDI1 function               | ---           | 0 [ No function] | 0             | 0         | 85        |      |
| <input type="checkbox"/> 002 | A1-01   | VDI2 function               | ---           | 0 [ No function] | 0             | 0         | 80        |      |
| <input type="checkbox"/> 003 | A1-02   | VDI3 function               | ---           | 0 [ No function] | 0             | 0         | 80        |      |
| <input type="checkbox"/> 004 | A1-03   | VDI4 function               | ---           | 0 [ No function] | 0             | 0         | 80        |      |
| <input type="checkbox"/> 005 | A1-04   | VDI5 function               | ---           | 0 [ No function] | 0             | 0         | 80        |      |
| <input type="checkbox"/> 006 | A1-05   | VDI active state source     | ---           | 0                | 0             | 0         | 55555     |      |
| <input type="checkbox"/> 007 | A1-06   | VDI state                   | ---           | 0                | 0             | 0         | 11111     |      |
| <input type="checkbox"/> 008 | A1-07   | AI1 (used as DI) function   | ---           | 0 [ No function] | 0             | 0         | 80        |      |
| <input type="checkbox"/> 009 | A1-08   | AI2 (used as DI) function   | ---           | 0 [ No function] | 0             | 0         | 80        |      |
| <input type="checkbox"/> 010 | A1-09   | AI3 (used as DI) function   | ---           | 0 [ No function] | 0             | 0         | 80        |      |
| <input type="checkbox"/> 011 | A1-10   | AI (used as DI) active mode | ---           | 0                | 0             | 0         | 111       |      |
| <input type="checkbox"/> 012 | A1-11   | VD01 function               | ---           | 0 [ No output]   | 0             | 0         | 43        |      |
| <input type="checkbox"/> 013 | A1-12   | VD02 function               | ---           | 0 [ No output]   | 0             | 0         | 43        |      |
| <input type="checkbox"/> 014 | A1-13   | VD03 function               | ---           | 0 [ No output]   | 0             | 0         | 43        |      |
| <input type="checkbox"/> 015 | A1-14   | VD04 function               | ---           | 0 [ No output]   | 0             | 0         | 43        |      |
| <input type="checkbox"/> 016 | A1-15   | VD05 function               | ---           | 0 [ No output]   | 0             | 0         | 43        |      |

It is important to know that the source of activation for virtual digital inputs (VDI) can be changed. This can be done by parameter A1-05:

| Row Index                    | Code ID | Description                  | Setting Value | Current Value    | Default Value | Min Value | Max Value | Unit |
|------------------------------|---------|------------------------------|---------------|------------------|---------------|-----------|-----------|------|
| <input type="checkbox"/> 001 | A1-00   | VDI1 function                | ---           | 0 [ No function] | 0             | 0         | 85        |      |
| <input type="checkbox"/> 002 | A1-01   | VDI2 function                | ---           | 0 [ No function] | 0             | 0         | 80        |      |
| <input type="checkbox"/> 003 | A1-02   | VDI3 function                | ---           | 0 [ No function] | 0             | 0         | 80        |      |
| <input type="checkbox"/> 004 | A1-03   | VDI4 function                | ---           | 0 [ No function] | 0             | 0         | 80        |      |
| <input type="checkbox"/> 005 | A1-04   | VDI5 function                | ---           | 0 [ No function] | 0             | 0         | 80        |      |
| <input type="checkbox"/> 006 | A1-05   | VDI active state source      | ---           | 0                | 0             | 0         | 55555     |      |
| <input type="checkbox"/> 007 | A1-06   | VDI state                    | ---           | 0                | 0             | 0         | 11111     |      |
| <input type="checkbox"/> 008 | A1-07   | AI1 (used as DI) function    | ---           | 0 [ No function] | 0             | 0         | 80        |      |
| <input type="checkbox"/> 009 | A1-08   | AI2 (used as DI) function    | ---           | 0 [ No function] | 0             | 0         | 80        |      |
| <input type="checkbox"/> 010 | A1-09   | AI3 (used as DI) function    | ---           | 0 [ No function] | 0             | 0         | 80        |      |
| <input type="checkbox"/> 011 | A1-10   | AI (used as DI) active mode  | ---           | 0                | 0             | 0         | 111       |      |
| <input type="checkbox"/> 012 | A1-11   | VD01 function                | ---           | 0 [ No output]   | 0             | 0         | 43        |      |
| <input type="checkbox"/> 013 | A1-12   | VD02 function                | ---           | 0 [ No output]   | 0             | 0         | 43        |      |
| <input type="checkbox"/> 014 | A1-13   | VD03 function                | ---           | 0 [ No output]   | 0             | 0         | 43        |      |
| <input type="checkbox"/> 015 | A1-14   | VD04 function                | ---           | 0 [ No output]   | 0             | 0         | 43        |      |
| <input type="checkbox"/> 016 | A1-15   | VD05 function                | ---           | 0 [ No output]   | 0             | 0         | 43        |      |
| <input type="checkbox"/> 017 | A1-16   | VD01 output delay (invalid)  | ---           | 0.0              | 0.0           | 0.0       | 3600.0    | s    |
| <input type="checkbox"/> 018 | A1-17   | VD02 output delay (invalid)  | ---           | 0.0              | 0.0           | 0.0       | 3600.0    | s    |
| <input type="checkbox"/> 019 | A1-18   | VD03 output delay (invalid)  | ---           | 0.0              | 0.0           | 0.0       | 3600.0    | s    |
| <input type="checkbox"/> 020 | A1-19   | VD04 output delay (invalid)  | ---           | 0.0              | 0.0           | 0.0       | 3600.0    | s    |
| <input type="checkbox"/> 021 | A1-20   | VD05 output delay (invalid)  | ---           | 0.0              | 0.0           | 0.0       | 3600.0    | s    |
| <input type="checkbox"/> 022 | A1-21   | VD0 active mode              | ---           | 0                | 0             | 0         | 11111     |      |
| <input type="checkbox"/> 023 | A1-22   | VD01 output switch-on delay  | ---           | 0.0              | 0.0           | 0.0       | 3600.0    | s    |
| <input type="checkbox"/> 024 | A1-23   | VD02 output switch-on delay  | ---           | 0.0              | 0.0           | 0.0       | 3600.0    | s    |
| <input type="checkbox"/> 025 | A1-24   | VD03 output switch-on delay  | ---           | 0.0              | 0.0           | 0.0       | 3600.0    | s    |
| <input type="checkbox"/> 026 | A1-25   | VD04 output switch-on delay  | ---           | 0.0              | 0.0           | 0.0       | 3600.0    | s    |
| <input type="checkbox"/> 027 | A1-26   | VD05 output switch-on delay  | ---           | 0.0              | 0.0           | 0.0       | 3600.0    | s    |
| <input type="checkbox"/> 028 | A1-27   | VD01 output switch-off delay | ---           | 0.0              | 0.0           | 0.0       | 3600.0    | s    |
| <input type="checkbox"/> 029 | A1-28   | VD02 output switch-off delay | ---           | 0.0              | 0.0           | 0.0       | 3600.0    | s    |
| <input type="checkbox"/> 030 | A1-29   | VD03 output switch-off delay | ---           | 0.0              | 0.0           | 0.0       | 3600.0    | s    |
| <input type="checkbox"/> 031 | A1-30   | VD04 output switch-off delay | ---           | 0.0              | 0.0           | 0.0       | 3600.0    | s    |
| <input type="checkbox"/> 032 | A1-31   | VD05 output switch-off delay | ---           | 0.0              | 0.0           | 0.0       | 3600.0    | s    |

Writing Parameters

Parameter Name A1-05

Description VDI active state source

| Bit No. | Value                           |
|---------|---------------------------------|
| 1       | VDI1 active state source [VDO1] |
| 2       | VDI2 active state source [VDO2] |
| 3       | VDI3 active state source [VDO3] |
| 4       | VDI4 active state source [VDO4] |
| 5       | VDI5 active state source [VDO5] |

Current 0

OK Cancel

Writing Parameters

Parameter Name A1-05

Description VDI active state source

|   |                                              |
|---|----------------------------------------------|
| 1 | 0 [VDO1]                                     |
| 2 | 0 [VDO1]                                     |
| 3 | 1 [A1-06]                                    |
| 4 | 2 [DI1]                                      |
| 5 | 3 [Communication setpoint (bit 10 of F4-50)] |
| 6 | 4 [AI1]                                      |
| 7 | 5 [Reserved]                                 |

Current 0

OK Cancel

With this functionality, the connectors from the outputs of the logic modules can be used to execute commands to the drive.

## 6 FREE PROGRAMMING LOGIC MODULES

### 6.1 OVERVIEW OF FREE PROGRAMMING LOGIC MODULES

| Free programming logic modules | Setting parameter groups | Connectors parameter groups | Quantity |
|--------------------------------|--------------------------|-----------------------------|----------|
| Word to Bits conversion        | C1-00~C1-07              | L1-76~L3-03                 | 8        |
| Bits to Word conversion        | C1-12~C1-83              | L7-21~L7-24                 | 4        |
| W-DW conversion                | C2-00~C2-15              | LD-31~LD-34<br>L9-00~L9-03  | 4        |
| DW-W conversion                | C2-32~C2-43              | LD-35~LD-38<br>L7-25~L7-32  | 4        |
| Logic AND-OR                   | C3-00~C3-51              | L3-36~L3-47                 | 12       |
| Logic NOT                      | C3-56~C3-71              | L3-52~L3-67                 | 16       |
| Logic XOR/XNOR                 | C3-72~C3-95              | L3-68~L3-75                 | 8        |
| Absolute Value                 | C4-00~C4-07              | LD-08~LD-12<br>L9-08~L9-10  | 8        |
| ADD/SUBTRACT Modules           | C4-08~C4-39              | LD-13~LD-17<br>L9-11~L9-13  | 8        |
| MULTIPLY/DIVIDE Modules        | C4-40~C4-63              | LD-18~LD-22<br>L9-14~L9-16  | 8        |
| Comparison Modules             | C4-64~C4-95              | L4-00~L4-07                 | 8        |
| Binary Selector                | C5-00~C5-23              | L3-04~L3-11                 | 8        |
| Word Selector                  | C5-24~C5-35              | L7-41~L7-44                 | 4        |
| DW Selector                    | C5-36~C5-47              | L9-04~L9-07                 | 4        |
| Floating point number Selector | C5-48~C5-71              | LD-00~LD-07                 | 8        |
| Filter Modules                 | C6-00~C6-17              | LD-23~LD-26<br>L9-17~L9-18  | 6        |
| Level-to-Pulse conversion      | C6-24~C6-35              | L3-84~L3-87                 | 4        |
| Limiting Modules               | C6-36~C6-53              | LD-27~LD-30<br>L9-19~L9-20  | 6        |
| Input of logic delay           | C6-54~C6-85              | L3-20~L3-27                 | 8        |
| Multi-point Curve              | C7-00~C7-41              | LD-46~LD-47                 | 2        |
| Constant Value                 | C8-00~C8-41              | LD-65~LD-85<br>L7-00~L7-20  | 10       |

## 6.2 WORD-BIT CONVERSION

### 6.2.1 WORD-BIT CONVERSION MODULES (A-H)

#### a. Illustration

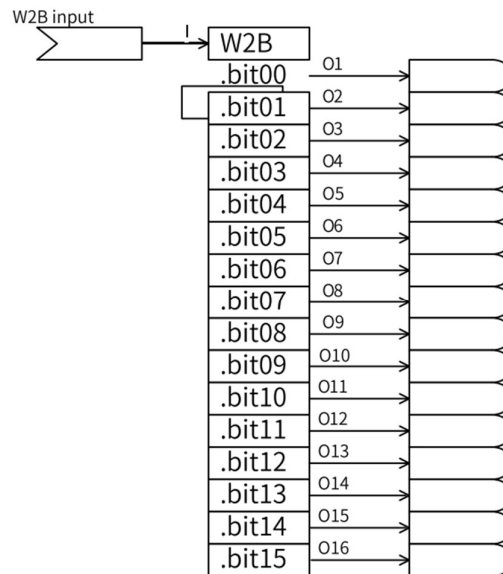


Figure 1. W2B module.

#### b. Operation

When the input I is a word, the outputs O1 to O16 correspond to bit00 to bit15 of input I.

When the input I is a DWord, the outputs O1 to O16 correspond to bit00 to bit15 from the high-order 16 bits of input I (low-order 16 bits are not used).

## c. Connection

- Input I: word connector, DWord connector.
- Outputs O1 to O16: bit connector.

| W2B Module |                | A     | B     | C     | D     | E     | F     | G     | H     |
|------------|----------------|-------|-------|-------|-------|-------|-------|-------|-------|
| Inputs     | I              | C1-00 | C1-01 | C1-02 | C1-03 | C1-04 | C1-05 | C1-06 | C1-07 |
| Outputs    | O1<br>(bit00)  | L1-76 | L1-92 | L2-08 | L2-24 | L2-40 | L2-56 | L2-72 | L2-88 |
|            | O2<br>(bit01)  | L1-77 | L1-93 | L2-09 | L2-25 | L2-41 | L2-57 | L2-73 | L2-89 |
|            | O3<br>(bit02)  | L1-78 | L1-94 | L2-10 | L2-26 | L2-42 | L2-58 | L2-74 | L2-90 |
|            | O4<br>(bit03)  | L1-79 | L1-95 | L2-11 | L2-27 | L2-43 | L2-59 | L2-75 | L2-91 |
|            | O5<br>(bit04)  | L1-80 | L1-96 | L2-12 | L2-28 | L2-44 | L2-60 | L2-76 | L2-92 |
|            | O6<br>(bit05)  | L1-81 | L1-97 | L2-13 | L2-29 | L2-45 | L2-61 | L2-77 | L2-93 |
|            | O7<br>(bit06)  | L1-82 | L1-98 | L2-14 | L2-30 | L2-46 | L2-62 | L2-78 | L2-94 |
|            | O8<br>(bit07)  | L1-83 | L1-99 | L2-15 | L2-31 | L2-47 | L2-63 | L2-79 | L2-95 |
|            | O9<br>(bit08)  | L1-84 | L2-00 | L2-16 | L2-32 | L2-48 | L2-64 | L2-80 | L2-96 |
|            | O10<br>(bit09) | L1-85 | L2-01 | L2-17 | L2-33 | L2-49 | L2-65 | L2-81 | L2-97 |
|            | O11<br>(bit10) | L1-86 | L2-02 | L2-18 | L2-34 | L2-50 | L2-66 | L2-2  | L2-98 |
|            | O12<br>(bit11) | L1-87 | L2-03 | L2-19 | L2-35 | L2-51 | L2-67 | L2-83 | L2-99 |
|            | O13<br>(bit12) | L1-88 | L2-04 | L2-20 | L2-36 | L2-52 | L2-68 | L2-84 | L3-00 |
|            | O14<br>(bit13) | L1-89 | L2-05 | L2-21 | L2-37 | L2-53 | L2-69 | L2-85 | L3-01 |
|            | O15<br>(bit14) | L1-90 | L2-06 | L2-22 | L2-38 | L2-54 | L2-70 | L2-86 | L3-02 |
|            | O16<br>(bit15) | L1-91 | L2-07 | L2-23 | L2-39 | L2-55 | L2-71 | L2-87 | L3-03 |

## 6.2.2 BIT TO WORD CONVERSION MODULES (A-D)

### a. Illustration

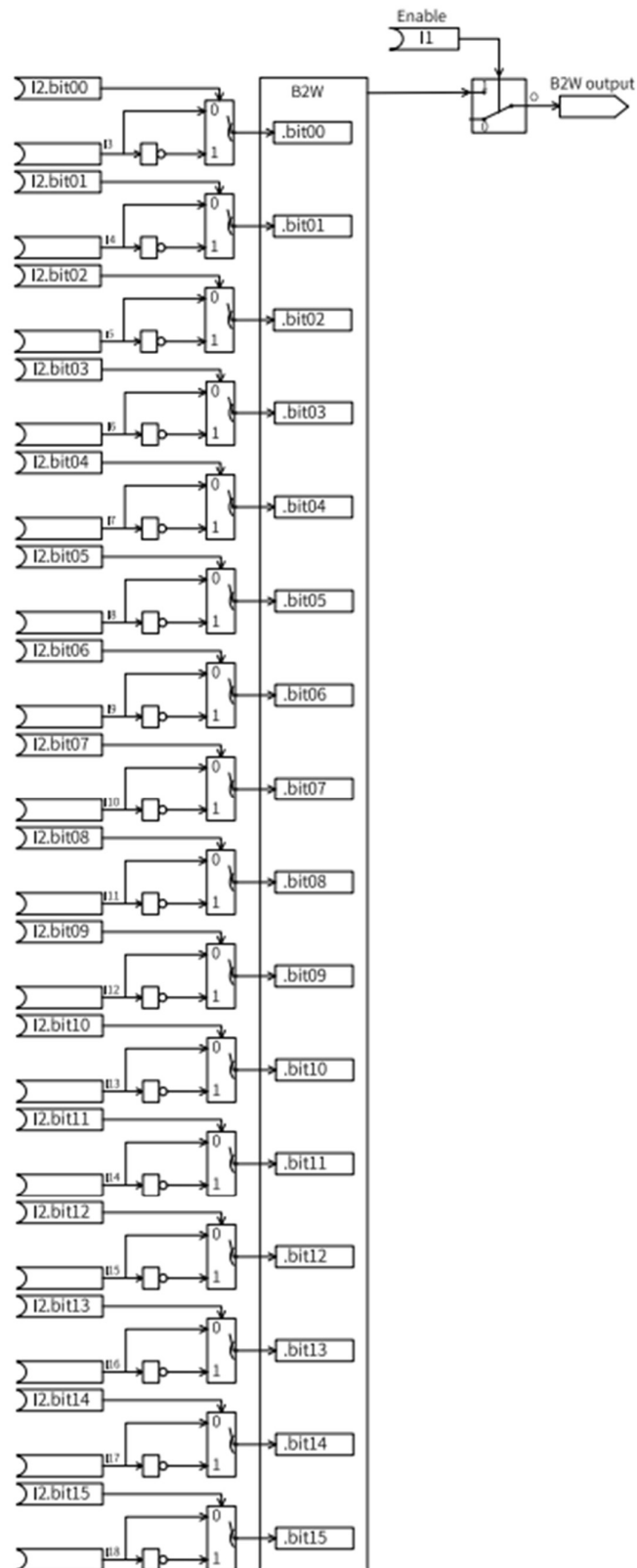


Figure 2. B2W module.

## b. Operation

When input I1 is set to 0-[disabled], the module is disabled, and the output O is 0.

Bit00 to bit15 of I2 are the inversion flags of I3 to I18. The value 1 indicates that the corresponding I3 to I18 input is inverted. The inverted I3 to I18 are assigned to bit00 to bit15 of the hexadecimal number and output to O.

## c. Connection

- Input I1: 0 indicates disabled, and 1 indicates enabled.

|       |                                    |              |              |
|-------|------------------------------------|--------------|--------------|
| C1-12 | B2W module A enable                |              | 0[ Disabled] |
| C1-13 | Bit inversion flag of B2W module A | 0[ Disabled] | 0            |
| C1-14 | B2W module A - Bit00               | 1[ Enabled]  | 0[ 0]        |

- Input I2: 16-bit unsigned data Input.
- I3 to I18: 0, 1, DI input, or bit connector input.
- Output O: word connector.

| B2W Module |              | A     | B     | C     | D     |
|------------|--------------|-------|-------|-------|-------|
| Inputs     | I1           | C1-12 | C1-30 | C1-48 | C1-66 |
|            | I2           | C1-13 | C1-31 | C1-49 | C1-67 |
|            | I3 (bit 00)  | C1-14 | C1-32 | C1-50 | C1-68 |
|            | I4 (bit 01)  | C1-15 | C1-33 | C1-51 | C1-69 |
|            | I5 (bit 02)  | C1-16 | C1-34 | C1-52 | C1-70 |
|            | I6 (bit 03)  | C1-17 | C1-35 | C1-53 | C1-71 |
|            | I7 (bit 04)  | C1-18 | C1-36 | C1-54 | C1-72 |
|            | I8 (bit 05)  | C1-19 | C1-37 | C1-55 | C1-73 |
|            | I9 (bit 06)  | C1-20 | C1-38 | C1-56 | C1-74 |
|            | I10 (bit 07) | C1-21 | C1-39 | C1-57 | C1-75 |
|            | I11 (bit 8)  | C1-22 | C1-40 | C1-58 | C1-76 |
|            | I12 (bit 9)  | C1-23 | C1-41 | C1-59 | C1-77 |
|            | I13 (bit 10) | C1-24 | C1-42 | C1-60 | C1-78 |
|            | I14 (bit 11) | C1-25 | C1-43 | C1-61 | C1-79 |
|            | I15 (bit 12) | C1-26 | C1-44 | C1-62 | C1-80 |
|            | I16 (bit 13) | C1-27 | C1-45 | C1-63 | C1-81 |
|            | I17 (bit 14) | C1-28 | C1-46 | C1-64 | C1-82 |
|            | I18 (bit 15) | C1-29 | C1-47 | C1-65 | C1-83 |
| Outputs    | O            | L7-21 | L7-22 | L7-23 | L2-24 |

## 6.3 WORD TO DOUBLE WORD CONVERSION

### 6.3.1 WORD TO DOUBLE WORD CONVERSION MODULES (A-D)

#### a. Operation

$$O = \begin{cases} O1: \frac{I1 \times 65535 + I2}{I3 \times 65535 + I4}, I3 \times 65535 + I4 \neq 0 \\ O2: I1 \times 65535 + I2, I3 \times 65535 + I4 = 0 \end{cases}$$

When the base value I3 as the high-order 16 bits and I4 as the low-order 16 bits is a non-zero value, the output is the result of DWord with I1 as the high-order 16 bits and I2 as the low-order 16 bits divided by the base value, which is output to O1.

When the base value with I3 as the high-order 16 bits and I4 as the low-order 16 bits is 0, the output is the Dword with I1 as the high-order 16 bits and I2 as the low-order 16 bits, which is directly output to O2.

#### b. Connection

- Inputs I1 and I2: word connector, DWord connector.
- Inputs I3 and I4: 16-bit unsigned data.
- Output O1: floating-point connector.
- Output O2: DWord connector.

| W-DW Modules | Inputs |       |       |       | Outputs |       |
|--------------|--------|-------|-------|-------|---------|-------|
|              | I1     | I2    | I3    | I4    | O1      | O2    |
| A            | C2-00  | C2-01 | C2-02 | C2-03 | LD-31   | L9-00 |
| B            | C2-04  | C2-05 | C2-07 | C2-08 | LD-32   | L9-01 |
| C            | C2-08  | C2-09 | C2-10 | C2-11 | LD-33   | L9-02 |
| D            | C2-12  | C2-13 | C2-14 | C2-15 | LD-34   | L9-03 |



## 6.4 LOGIC OPERATIONS

### 6.4.1 LOGIC AND-OR MODULES (A-L)

#### a. Illustration

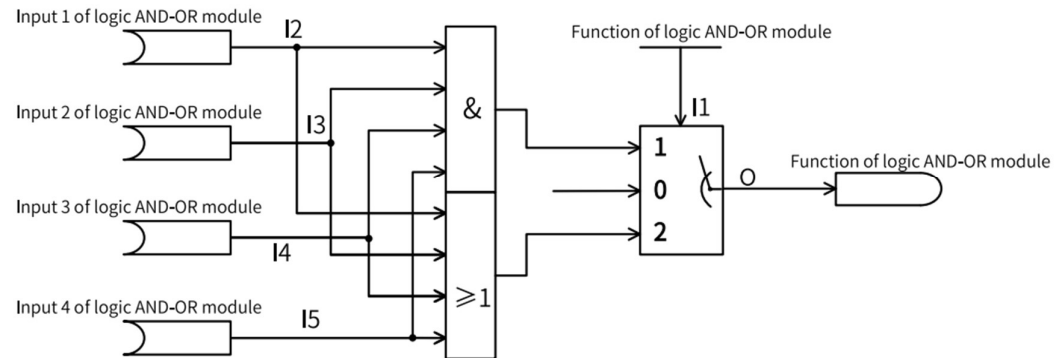


Figure 4. Logic AND-OR Modules.

#### b. Operation

When the logic AND-OR module enable selection I1 is set to 0, the module is disabled, and the output O is 0.

When the logic AND-OR module enable selection is set to 1, logic AND is active and the output O is I1 & I2 & I3 & I4.

If the inputs I1, I2, I3 and I4 are all true, the output O is true; otherwise, the output O is false. The truth table is described below.

| Inputs |    |    |    | Output |
|--------|----|----|----|--------|
| I1     | I2 | I3 | I4 | O      |
| 0      | X  | X  | X  | 0      |
| X      | 0  | X  | X  | 0      |
| X      | X  | 0  | X  | 0      |
| X      | X  | X  | 0  | 0      |
| 1      | 1  | 1  | 1  | 1      |

If any of the inputs parameters are not going to be used, they have to be set on 1 to avoid getting always a 0 on the output.

When the logic AND-OR module enable selection I1 is set to 2, logic OR is active, and the output O is I1 | I2 | I3 | I4.

If the inputs I1, I2, I3, and I4 are all false, the output O is false; otherwise, the output O is true. The truth table is described below.

| Inputs |    |    |    | Output |
|--------|----|----|----|--------|
| I1     | I2 | I3 | I4 | O      |
| 1      | X  | X  | X  | 1      |
| X      | 1  | X  | X  | 1      |
| X      | X  | 1  | X  | 1      |
| X      | X  | X  | 1  | 1      |
| 0      | 0  | 0  | 0  | 0      |

If any of the inputs parameters are not going to be used, they have to be set on 0 to avoid getting always a 1 on the output.

The module enable selection I1 can only be set to the values mentioned above, it cannot be switched by a bit-connector or a digital input, so only one mode of the module can be used at the same time.

## c. Connection

- Input I1: 0 indicates module disabled, 1 indicates logic AND, and 2 indicates logic OR.

|       |                                   |              |
|-------|-----------------------------------|--------------|
| C3-00 | Function of logic AND-OR module A | 1[ AND]      |
| C3-01 | Input 1 of logic AND-OR module A  | 0[ Disabled] |
| C3-02 | Input 2 of logic AND-OR module A  | 1[ AND]      |
| C3-03 | Input 3 of logic AND-OR module A  | 2[ OR]       |

- Inputs I2, I3, I4, and I5: 0, 1, DI input, and bit connector input.
- Output O: bit connector.

| Logic AND-OR Modules | Inputs |       |       |       |       | Output |
|----------------------|--------|-------|-------|-------|-------|--------|
|                      | I1     | I2    | I3    | I4    | I5    | O      |
| A                    | C3-00  | C3-01 | C3-02 | C3-03 | C3-04 | L3-36  |
| B                    | C3-05  | C3-06 | C3-07 | C3-08 | C3-09 | L3-37  |
| C                    | C3-10  | C3-11 | C3-12 | C3-13 | C3-14 | L3-38  |
| D                    | C3-15  | C3-16 | C3-17 | C3-18 | C3-19 | L3-39  |
| E                    | C3-20  | C3-21 | C3-22 | C3-23 | -     | L3-40  |
| F                    | C3-24  | C3-25 | C3-26 | C3-27 | -     | L3-41  |
| G                    | C3-28  | C3-29 | C3-31 | C3-32 | -     | L3-42  |
| H                    | C3-32  | C3-33 | C3-34 | C3-35 | -     | L3-43  |
| I                    | C3-36  | C3-37 | C3-38 | C3-39 | -     | L3-44  |
| J                    | C3-40  | C3-41 | C3-42 | C3-43 | -     | L3-45  |
| K                    | C3-44  | C3-45 | C3-46 | C3-47 | -     | L3-46  |
| L                    | C3-48  | C3-49 | C3-50 | C3-51 | -     | L3-47  |

Logic AND-OR modules A to D have four inputs (I2 to I5), and modules E to L have three inputs (I2 to I4).

## 6.4.2 LOGIC NOT MODULES (A-P)

### a. Illustration

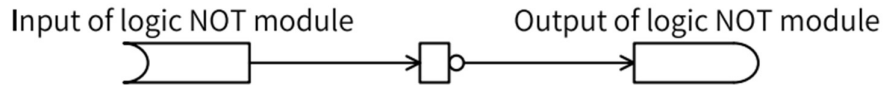


Figure 5. Logic NOT module

### b. Operation

- When input I is set to 0 - [ Disabled ], the module is disabled, and the output is 0.  
 $O = 0;$
- When input I is not set to 0 - [Disabled], the output is the inversion of the input I configured.  
 $O = \bar{I};$

The truth table is described below.

| Input | Output |
|-------|--------|
| I     | O      |
| 0     | 1      |
| 1     | 0      |

### c. Connection

- Input I: 0-[Disabled], 0-[logic], 1-[logic], Digital input, and bit-connector input.

|       |                                     |                       |
|-------|-------------------------------------|-----------------------|
| C3-56 | Input of logic NOT module A         | 0 [ Disabled ]        |
| C3-57 | Input of logic NOT module B         | 1 [ Logic 1 ]         |
| C3-58 | Input of logic NOT module C         | 2 [ Logic 0 ]         |
| C3-59 | Input of logic NOT module D         | 3 [ DI1 ]             |
| C3-60 | Input of logic NOT module E         | 4 [ DI2 ]             |
| C3-61 | Input of logic NOT module F         | 5 [ DI3 ]             |
| C3-62 | Input of logic NOT module G         | 6 [ DI4 ]             |
| C3-63 | Input of logic NOT module H         | 7 [ DI5 ]             |
| C3-64 | Input of logic NOT module I         | 8 [ DI6 ]             |
| C3-65 | Input of logic NOT module J         | 9 [ DI7 ]             |
| C3-66 | Input of logic NOT module K         | 10 [ DI8 ]            |
| C3-67 | Input of logic NOT module L         | 11 [ DI9 ]            |
| C3-68 | Input of logic NOT module M         | 12 [ DI10 ]           |
| C3-69 | Input of logic NOT module N         | 13 [ DI11 ]           |
| C3-70 | Input of logic NOT module O         | 14 [ DI12 ]           |
| C3-71 | Input of logic NOT module P         | 15 [ DI13 ]           |
| C3-72 | Function of logic XOR/XNOR module A | 16 [ DI14 ]           |
|       |                                     | 17 [ DI15 ]           |
|       |                                     | 18 [ DI16 ]           |
|       |                                     | Other [ B-connector ] |

- Output O: bit-connector.

| Logic NOT Modules | Input<br>I | Output<br>O |
|-------------------|------------|-------------|
| A                 | C3-56      | L3-52       |
| B                 | C3-57      | L3-53       |
| C                 | C3-58      | L3-54       |
| D                 | C3-59      | L3-55       |
| E                 | C3-60      | L3-56       |
| F                 | C3-61      | L3-57       |
| G                 | C3-62      | L3-58       |
| H                 | C3-63      | L3-59       |
| I                 | C3-64      | L3-60       |
| J                 | C3-65      | L3-61       |
| K                 | C3-66      | L3-62       |
| L                 | C3-67      | L3-63       |
| M                 | C3-68      | L3-64       |
| N                 | C3-69      | L3-65       |
| O                 | C3-70      | L3-66       |
| P                 | C3-71      | L3-67       |

## 6.4.3 LOGIC XOR/XNOR MODULES (A-H)

### a. Illustration

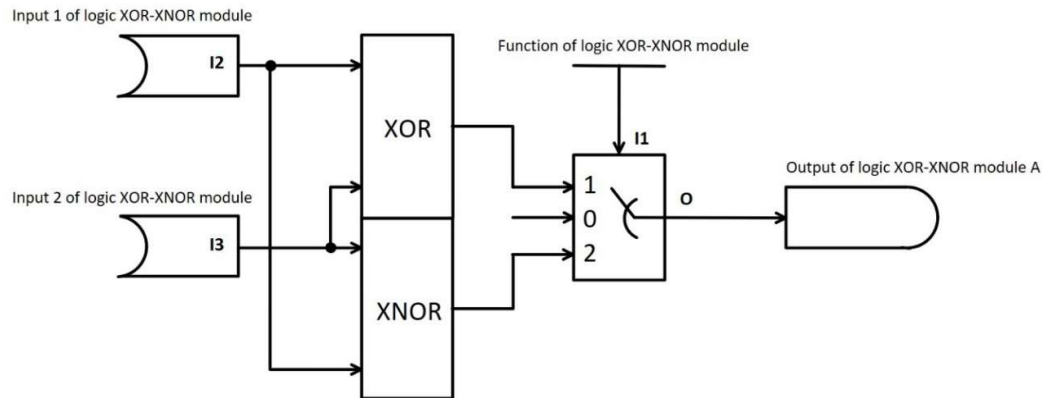


Figure 6. Logic XOR/XNOR module.

### b. Operation

- When the logic XOR/XNOR module enable election I1 is set to 0, the module is disabled.

$$O = 0;$$

- When the logic XOR/XNOR module enable selection I1 is set to 1, logic XOR is active.

$$O = (\bar{I2} \& I3) \mid (I2 \& \bar{I3});$$

When the I1 and I2 are the same, the output is 0; when I1 and I2 are different, the output is 1. The following is the truth table:

| Inputs |    | Output |
|--------|----|--------|
| I2     | I3 | O      |
| 0      | 0  | 0      |
| 1      | 0  | 1      |
| 0      | 1  | 1      |
| 1      | 1  | 0      |

- When the logic XOR/XNOR module enable selection I1 is set to 2, logic XNOR is active.

$$O = (I2 \& I3) \mid (\bar{I2} \& \bar{I3});$$

When the I1 and I2 are the same, the output is 1; when I1 and I2 are different, the output is 0. The following is the truth table:

| Inputs |    | Output |
|--------|----|--------|
| I2     | I3 | O      |
| 0      | 0  | 1      |
| 1      | 0  | 0      |
| 0      | 1  | 0      |
| 1      | 1  | 1      |

## c. Connection

- Input I1: 0 indicates module disabled, 1 indicates XOR, and 2 indicates XNOR.
- Inputs I2 and I3: 0, 1, DI Input, and bit connector input.
- Output O: bit-connector.

| Logic AND-OR Modules | Inputs |       |       | Output |
|----------------------|--------|-------|-------|--------|
|                      | I1     | I2    | I3    | O      |
| A                    | C3-72  | C3-80 | C3-88 | L3-68  |
| B                    | C3-73  | C3-81 | C3-89 | L3-69  |
| C                    | C3-74  | C3-82 | C3-90 | L3-70  |
| D                    | C3-75  | C3-83 | C3-91 | L3-71  |
| E                    | C3-76  | C3-84 | C3-92 | L3-72  |
| F                    | C3-77  | C3-85 | C3-93 | L3-73  |
| G                    | C3-78  | C3-86 | C3-94 | L3-74  |
| H                    | C3-79  | C3-87 | C3-95 | L3-75  |

The module enable selection I1 can only be set on the values mentioned before, it cannot be switched by a bit-connector or a digital input, so only one mode of the module can be used at the same time.

## 6.5 ARITHMETIC OPERATIONS

### 6.5.1 ABSOLUTE VALUE MODULES (A-H)

#### a. Operation

$$O = |I|$$

$$SN = \begin{cases} 1, & I < 0 \\ 0, & I \geq 0 \end{cases}$$

The output O is the absolute value of input I. When input I is negative value, SN is 1; otherwise, SN is 0.

#### b. Connection

- Input I: AI, HDI, Aim, motor-driven potentiometer, PID, word connector, Dword connector, and floating-point connector.

|                                                 |                                  |
|-------------------------------------------------|----------------------------------|
| Input of floating-point absolute value module A |                                  |
| Input of floating-point absolute value module B | 0 [ Disabled ]                   |
| Input of floating-point absolute value module C | 1 [ AI1 ]                        |
| Input of floating-point absolute value module D | 2 [ AI2 ]                        |
| Input of floating-point absolute value module E | 3 [ AI3 ]                        |
| Input of fixed-point absolute value module F    | 4 [ HDI ]                        |
| Input of fixed-point absolute value module G    | 5 [ Aim ]                        |
| Input of fixed-point absolute value module H    | 6 [ Multi-reference ]            |
| Input 1 of floating-point ADD/SUBTRACT module A | 7 [ Motor-driven potentiometer ] |
|                                                 | 8 [ PID ]                        |
|                                                 | Other [ F-connector ]            |

- Output O: word connector, Dword connector, and floating-point connector.
- Output SN: bit connector.

| Absolute Value Modules | Input | Outputs |       |
|------------------------|-------|---------|-------|
|                        | I     | O       | SN    |
| A                      | C4-00 | LD-08   | L4-16 |
| B                      | C4-01 | LD-09   | L4-17 |
| C                      | C4-02 | LD-10   | L4-18 |
| D                      | C4-03 | LD-11   | L4-19 |
| E                      | C4-04 | LD-12   | L4-20 |
| F                      | C4-05 | L9-08   | L4-21 |
| G                      | C4-06 | L9-09   | L4-22 |
| H                      | C4-07 | L9-10   | L4-23 |

The modules A-E are floating-point absolute value modules, and the modules F-G are fixed-point absolute value modules.

## 6.5.2 ADD/SUBTRACT MODULES (A-H)

### a. Illustration

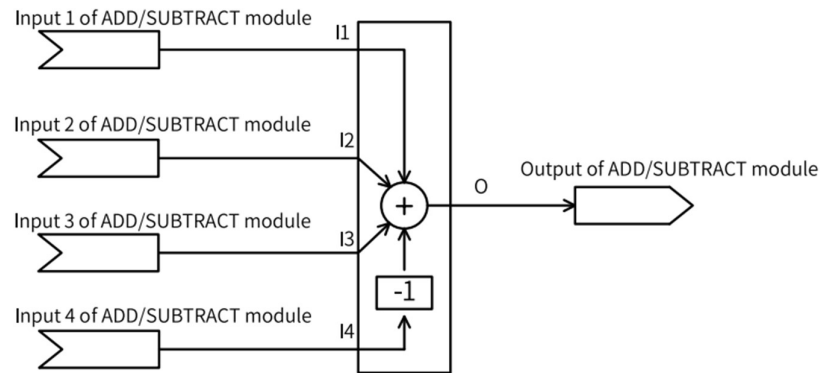


Figure 7. ADD/SUBTRACT module.

### b. Operation

$$O = I1 + I2 + I3$$

The output O is the sum of inputs I1, I2, and I3 minus I4.

### c. Connection

- Inputs I1, I2, I3, and I4: AI, HDI, Aim, motor-driven potentiometer, PID, word connector, and floatingpoint connector.

|       |                                                 |                                  |
|-------|-------------------------------------------------|----------------------------------|
| C4-08 | Input 1 of floating-point ADD/SUBTRACT module A | 0 [ Disabled ]                   |
| C4-09 | Input 2 of ADD/SUBTRACT module A (ADD)          | 1 [ AI1 ]                        |
| C4-10 | Input 3 of ADD/SUBTRACT module A (ADD)          | 2 [ AI2 ]                        |
| C4-11 | Input 4 of ADD/SUBTRACT module A (SUBTRACT)     | 3 [ AI3 ]                        |
| C4-12 | Input 1 of floating-point ADD/SUBTRACT module B | 4 [ HDI ]                        |
| C4-13 | Input 2 of ADD/SUBTRACT module B (ADD)          | 5 [ Aim ]                        |
| C4-14 | Input 3 of ADD/SUBTRACT module B (ADD)          | 6 [ Multi-reference ]            |
| C4-15 | Input 4 of ADD/SUBTRACT module B (SUBTRACT)     | 7 [ Motor-driven potentiometer ] |
| C4-16 | Input 1 of floating-point ADD/SUBTRACT module C | 8 [ PID ]                        |
|       |                                                 | Other [ F-connector ]            |

- Output O: DWord connector and floating-point connector.

| Add/Subtract Modules | Inputs |       |       |       | Output |
|----------------------|--------|-------|-------|-------|--------|
|                      | I1     | I2    | I3    | I4    | O      |
| A                    | C4-08  | C4-09 | C4-10 | C4-11 | LD-13  |
| B                    | C4-12  | C4-13 | C4-14 | C4-15 | LD-14  |
| C                    | C4-16  | C4-7  | C4-18 | C4-19 | LD-15  |
| D                    | C4-20  | C4-21 | C4-22 | C4-23 | LD-16  |
| E                    | C4-24  | C4-25 | C4-26 | C4-27 | LD-17  |
| F                    | C4-28  | C4-29 | C4-30 | C4-31 | L9-11  |
| G                    | C4-32  | C4-33 | C4-34 | C4-35 | L9-12  |
| H                    | C4-36  | C4-37 | C4-38 | C4-39 | L9-13  |

The modules A-E are floating-point ADD/SUBTRACT modules, and the modules F-H are fixed-point ADD/SUBTRACT modules.

## 6.5.3 MULTIPLY/DIVIDE MODULES (A-H)

### a. Illustration

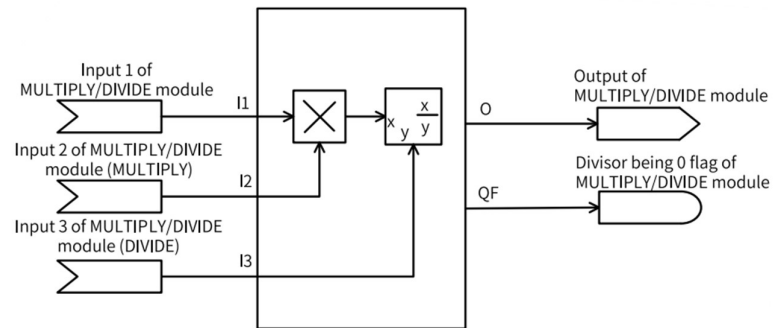


Figure 8. MULTIPLY/DIVIDE module.

### b. Operation

$$O = \begin{cases} I1 \times I2, I3 = 0 - [Disabled] \\ \frac{I1 \times I2}{I3}, I3 \neq 0 \\ 0, I3 = 0 \end{cases}$$

$$QF = \begin{cases} 1, I3 = 0 \\ 0, I3 \neq 0 \end{cases}$$

When I3 is set to 0-[Disabled], the output is the product of I1 and I2.

When I3 is set to others, if the I3 input value is 0, the output is 0, and the divisor being 0 flag is 1; if the I3 input value is not 0, the output is the product of I1 and I2 divided by I3, and the divisor being 0 flag is 0.

### c. Connection

- Inputs I1, I2 and I3: AI, HDI, Aim, motor-driven potentiometer, PID, word connector, Dword connector, and floating-point connector.

|       |                                                    |                                |
|-------|----------------------------------------------------|--------------------------------|
| C4-40 | Input 1 of floating-point MULTIPLY/DIVIDE module A | 0 [Disabled]                   |
| C4-41 | Input 2 of MULTIPLY/DIVIDE module A (MULTIPLY)     | 1 [AI1]                        |
| C4-42 | Input 3 of MULTIPLY/DIVIDE module A (DIVIDE)       | 2 [AI2]                        |
| C4-43 | Input 1 of floating-point MULTIPLY/DIVIDE module B | 3 [AI3]                        |
| C4-44 | Input 2 of MULTIPLY/DIVIDE module B (MULTIPLY)     | 4 [HDI]                        |
| C4-45 | Input 3 of MULTIPLY/DIVIDE module B (DIVIDE)       | 5 [Aim]                        |
| C4-46 | Input 1 of floating-point MULTIPLY/DIVIDE module C | 6 [Multi-reference]            |
| C4-47 | Input 2 of MULTIPLY/DIVIDE module C (MULTIPLY)     | 7 [Motor-driven potentiometer] |
| C4-48 | Input 3 of MULTIPLY/DIVIDE module C (DIVIDE)       | 8 [PID]                        |
|       |                                                    | Other [ F-connector]           |

- Output O: Dword connector and floating-point connector.

| Multiply/Divide modules | Inputs |       |       | Output |
|-------------------------|--------|-------|-------|--------|
|                         | I1     | I2    | I3    | O      |
| A                       | C4-40  | C4-41 | C4-42 | LD-18  |
| B                       | C4-43  | C4-44 | C4-45 | LD-19  |
| C                       | C4-46  | C4-47 | C4-48 | LD-20  |
| D                       | C4-49  | C4-50 | C4-51 | LD-21  |
| E                       | C4-52  | C4-53 | C4-54 | LD-22  |
| F                       | C4-55  | C4-56 | C4-57 | L9-14  |
| G                       | C4-58  | C4-59 | C4-60 | L9-15  |
| H                       | C4-61  | C4-62 | C4-63 | L9-16  |

The modules A-E are floating-point MULTIPLY/DIVIDE modules, and the modules F-H are the byte MULTIPLY/DIVIDE modules.

## 6.5.4 COMPARISON MODULES (A-H)

### a. Illustration

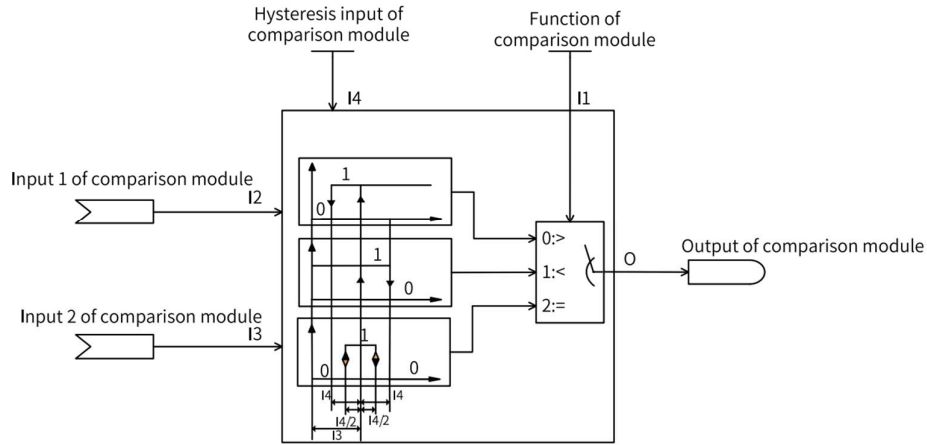


Figure 9. COMPARISON module.

### b. Operation

The hysteresis input I4 implements suppression of frequent on-off. It is always referenced to the maximum value of I3. The operation of the comparison module depending on the value of I1 is as follows:

- If the comparison module function selection I1 is set to 0, the comparison module will be disabled.
- If the comparison module function selection I1 is set to 1, the output O keeps low level when I2 increases from 0 toward I3 in the positive direction **(1)**; it changes from low level to high level when I2 increases to a value greater than I3 **(2)**; and it remains high when I2 continues to increase. When I2 decreases, the output O remains high as long I2 is greater than I3 minus I4 **(3)**; it changes from high level to low level only when I2 is equal or smaller than I3 minus I4 **(4)**.

$$I1 = 1 \rightarrow O = \begin{cases} 0, \uparrow I2 < I3 & (1) \\ 1, \uparrow I2 > I3 & (2) \\ 1, \downarrow I2 > I3 - I4 & (3) \\ 0, \downarrow I2 \leq I3 - I4 & (4) \end{cases}$$

↑ = increasing; ↓ = decreasing.

- If the comparison module function selection I1 is set to 2, the output O keeps high level when I2 increases from 0 toward the sum of I3 and I4 in the positive direction **(1)**; it changes from high level to low level when I2 increases to a value greater than the sum of I3 and I4 **(2)**; and it remains low when I2 continues to increase. When I2 decreases, the output O remains low as long as I2 is greater than I3 **(3)**; it changes from low level to high level only when I2 is smaller than I3 **(4)**.

$$I1 = 2 \rightarrow O = \begin{cases} 1, \uparrow I2 < I3 + I4 & (1) \\ 0, \uparrow I2 \geq I3 + I4 & (2) \\ 0, \downarrow I2 > I3 & (3) \\ 1, \downarrow I2 < I3 & (4) \end{cases}$$

↑ = increasing; ↓ = decreasing.

- If the comparison module function selection I1 is set to 3, the output is high level when I2 is between  $(I3 - I4/2)$  and  $(I3 + I4/2)$  **(1)**; otherwise, it is low level **(2)(3)**.

$$I1 = 3 \rightarrow O = \begin{cases} 1, & I3 - I4 \leq I2 \leq I3 + I4 & (1) \\ 0, & I2 < I3 - I4 & (2) \\ 0, & I2 > I3 + I4 & (3) \end{cases}$$

## c. Connection

- Input I1: 0: Module disabled; 1: Input 1 > Input 2; 2: Input 1 < Input 2; 3: Input 1 = Input 2.

|       |                                                        |                        |
|-------|--------------------------------------------------------|------------------------|
| C4-64 | Function of floating-point comparison module A         | 0 [ Module disabled]   |
| C4-65 | Input 1 of floating-point comparison module A          | 1 [ Input 1 > Input 2] |
| C4-66 | Input 2 of floating-point comparison module A          | 2 [ Input 1 < Input 2] |
| C4-67 | Hysteresis input of floating-point comparison module A | 3 [ Input 1 = Input 2] |

- Inputs I2 and I3: AI, HDI, Aim, motor-driven potentiometer, PID, word connector, DWord connector, and floating-point connector.
- Input I4: floating-point number with two decimal places.
- Output O: bit connector.

| Comparison Modules | Inputs |       |       |       | Output |
|--------------------|--------|-------|-------|-------|--------|
|                    | I1     | I2    | I3    | I4    | O      |
| A                  | C4-64  | C4-65 | C4-66 | C4-67 | L4-00  |
| B                  | C4-68  | C4-69 | C4-70 | C4-71 | L4-01  |
| C                  | C4-72  | C4-73 | C4-74 | C4-75 | L4-02  |
| D                  | C4-76  | C4-77 | C4-78 | C4-79 | L4-03  |
| E                  | C4-80  | C4-81 | C4-82 | C4-83 | L4-04  |
| F                  | C4-84  | C4-85 | C4-86 | C4-87 | L4-05  |
| G                  | C4-88  | C4-89 | C4-90 | C4-91 | L4-06  |
| H                  | C4-92  | C4-93 | C4-94 | C4-95 | L4-07  |

The modules A-E are floating-point comparison modules, and the modules F-H are fixed-point comparison modules.

## 6.6 SWITCH FUNCTIONS

### 6.6.1 BINARY SELECTOR MODULES (A-H)

#### a. Illustration

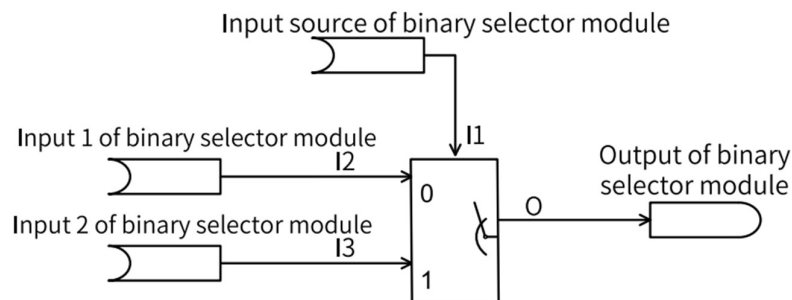


Figure 10. Binary Selector module.

#### b. Operation

$$O = \begin{cases} I2, & I1 = 0 \text{ (1)} \\ I3, & I1 = 1 \text{ (2)} \end{cases}$$

When the input I1 of the binary selector module is set to 0, the output is I2 **(1)**; when the input I1 is set to 1, the output O is I3 **(2)**.

#### c. Connection

- Inputs I1, I2, and I3: 0, 1, DI input, Dword connector input, and bit-connector input.

|        |                                           |                |
|--------|-------------------------------------------|----------------|
| C5-00  | Input source of binary selector module A  | 0 [ Disabled ] |
| C5-01  | Input 1 of binary selector module A       | 1 [ Logic 1 ]  |
| C5-02  | Input 2 of binary selector module A       | 2 [ Logic 0 ]  |
| C5-03  | Input source of binary selector module B  | 3 [ DI1 ]      |
| C5-04  | Input 1 of binary selector module B       | 4 [ DI2 ]      |
| C5-05  | Input 2 of binary selector module B       | 5 [ DI3 ]      |
| C5-06  | Input source of binary selector module C  | 6 [ DI4 ]      |
| C5-07  | Input 1 of binary selector module C       | 7 [ DI5 ]      |
| C5-08  | Input 2 of binary selector module C       | 8 [ DI6 ]      |
| C5-09  | Input source of binary selector module D  | 9 [ DI7 ]      |
| C5-10  | Input 1 of binary selector module D       | 10 [ DI8 ]     |
| C5-11  | Input 2 of binary selector module D       | 11 [ DI9 ]     |
| C5-12  | Input source of binary selector module E  | 12 [ DI10 ]    |
| C5-13  | Input 1 of binary selector module E       | 13 [ DI11 ]    |
| C5-14  | Input 2 of binary selector module E       | 14 [ DI12 ]    |
| C5-15  | Input source of binary selector module F  | 15 [ DI13 ]    |
| C5-16  | Input 1 of binary selector module F       | 16 [ DI14 ]    |
| C5-17  | Input 2 of binary selector module F       | 17 [ DI15 ]    |
| C5-18  | Input source of binary selector module G  | 18 [ DI16 ]    |
| C5-19  | Input 1 of binary selector module G       | 19 [ DI17 ]    |
| C5-20  | Input 2 of binary selector module G       | 20 [ DI18 ]    |
| C5-21  | Input source of binary selector module H  | 21 [ DI19 ]    |
| C5-22  | Input 1 of binary selector module H       | 22 [ DI20 ]    |
| C5-23  | Input 2 of binary selector module H       | 23 [ DI21 ]    |
| C5-24  | Input source of binary selector module I  | 24 [ DI22 ]    |
| C5-25  | Input 1 of binary selector module I       | 25 [ DI23 ]    |
| C5-26  | Input 2 of binary selector module I       | 26 [ DI24 ]    |
| C5-27  | Input source of binary selector module J  | 27 [ DI25 ]    |
| C5-28  | Input 1 of binary selector module J       | 28 [ DI26 ]    |
| C5-29  | Input 2 of binary selector module J       | 29 [ DI27 ]    |
| C5-30  | Input source of binary selector module K  | 30 [ DI28 ]    |
| C5-31  | Input 1 of binary selector module K       | 31 [ DI29 ]    |
| C5-32  | Input 2 of binary selector module K       | 32 [ DI30 ]    |
| C5-33  | Input source of binary selector module L  | 33 [ DI31 ]    |
| C5-34  | Input 1 of binary selector module L       | 34 [ DI32 ]    |
| C5-35  | Input 2 of binary selector module L       | 35 [ DI33 ]    |
| C5-36  | Input source of binary selector module M  | 36 [ DI34 ]    |
| C5-37  | Input 1 of binary selector module M       | 37 [ DI35 ]    |
| C5-38  | Input 2 of binary selector module M       | 38 [ DI36 ]    |
| C5-39  | Input source of binary selector module N  | 39 [ DI37 ]    |
| C5-40  | Input 1 of binary selector module N       | 40 [ DI38 ]    |
| C5-41  | Input 2 of binary selector module N       | 41 [ DI39 ]    |
| C5-42  | Input source of binary selector module O  | 42 [ DI40 ]    |
| C5-43  | Input 1 of binary selector module O       | 43 [ DI41 ]    |
| C5-44  | Input 2 of binary selector module O       | 44 [ DI42 ]    |
| C5-45  | Input source of binary selector module P  | 45 [ DI43 ]    |
| C5-46  | Input 1 of binary selector module P       | 46 [ DI44 ]    |
| C5-47  | Input 2 of binary selector module P       | 47 [ DI45 ]    |
| C5-48  | Input source of binary selector module Q  | 48 [ DI46 ]    |
| C5-49  | Input 1 of binary selector module Q       | 49 [ DI47 ]    |
| C5-50  | Input 2 of binary selector module Q       | 50 [ DI48 ]    |
| C5-51  | Input source of binary selector module R  | 51 [ DI49 ]    |
| C5-52  | Input 1 of binary selector module R       | 52 [ DI50 ]    |
| C5-53  | Input 2 of binary selector module R       | 53 [ DI51 ]    |
| C5-54  | Input source of binary selector module S  | 54 [ DI52 ]    |
| C5-55  | Input 1 of binary selector module S       | 55 [ DI53 ]    |
| C5-56  | Input 2 of binary selector module S       | 56 [ DI54 ]    |
| C5-57  | Input source of binary selector module T  | 57 [ DI55 ]    |
| C5-58  | Input 1 of binary selector module T       | 58 [ DI56 ]    |
| C5-59  | Input 2 of binary selector module T       | 59 [ DI57 ]    |
| C5-60  | Input source of binary selector module U  | 60 [ DI58 ]    |
| C5-61  | Input 1 of binary selector module U       | 61 [ DI59 ]    |
| C5-62  | Input 2 of binary selector module U       | 62 [ DI60 ]    |
| C5-63  | Input source of binary selector module V  | 63 [ DI61 ]    |
| C5-64  | Input 1 of binary selector module V       | 64 [ DI62 ]    |
| C5-65  | Input 2 of binary selector module V       | 65 [ DI63 ]    |
| C5-66  | Input source of binary selector module W  | 66 [ DI64 ]    |
| C5-67  | Input 1 of binary selector module W       | 67 [ DI65 ]    |
| C5-68  | Input 2 of binary selector module W       | 68 [ DI66 ]    |
| C5-69  | Input source of binary selector module X  | 69 [ DI67 ]    |
| C5-70  | Input 1 of binary selector module X       | 70 [ DI68 ]    |
| C5-71  | Input 2 of binary selector module X       | 71 [ DI69 ]    |
| C5-72  | Input source of binary selector module Y  | 72 [ DI70 ]    |
| C5-73  | Input 1 of binary selector module Y       | 73 [ DI71 ]    |
| C5-74  | Input 2 of binary selector module Y       | 74 [ DI72 ]    |
| C5-75  | Input source of binary selector module Z  | 75 [ DI73 ]    |
| C5-76  | Input 1 of binary selector module Z       | 76 [ DI74 ]    |
| C5-77  | Input 2 of binary selector module Z       | 77 [ DI75 ]    |
| C5-78  | Input source of binary selector module AA | 78 [ DI76 ]    |
| C5-79  | Input 1 of binary selector module AA      | 79 [ DI77 ]    |
| C5-80  | Input 2 of binary selector module AA      | 80 [ DI78 ]    |
| C5-81  | Input source of binary selector module AB | 81 [ DI79 ]    |
| C5-82  | Input 1 of binary selector module AB      | 82 [ DI80 ]    |
| C5-83  | Input 2 of binary selector module AB      | 83 [ DI81 ]    |
| C5-84  | Input source of binary selector module AC | 84 [ DI82 ]    |
| C5-85  | Input 1 of binary selector module AC      | 85 [ DI83 ]    |
| C5-86  | Input 2 of binary selector module AC      | 86 [ DI84 ]    |
| C5-87  | Input source of binary selector module AD | 87 [ DI85 ]    |
| C5-88  | Input 1 of binary selector module AD      | 88 [ DI86 ]    |
| C5-89  | Input 2 of binary selector module AD      | 89 [ DI87 ]    |
| C5-90  | Input source of binary selector module AE | 90 [ DI88 ]    |
| C5-91  | Input 1 of binary selector module AE      | 91 [ DI89 ]    |
| C5-92  | Input 2 of binary selector module AE      | 92 [ DI90 ]    |
| C5-93  | Input source of binary selector module AF | 93 [ DI91 ]    |
| C5-94  | Input 1 of binary selector module AF      | 94 [ DI92 ]    |
| C5-95  | Input 2 of binary selector module AF      | 95 [ DI93 ]    |
| C5-96  | Input source of binary selector module AG | 96 [ DI94 ]    |
| C5-97  | Input 1 of binary selector module AG      | 97 [ DI95 ]    |
| C5-98  | Input 2 of binary selector module AG      | 98 [ DI96 ]    |
| C5-99  | Input source of binary selector module AH | 99 [ DI97 ]    |
| C5-100 | Input 1 of binary selector module AH      | 100 [ DI98 ]   |
| C5-101 | Input 2 of binary selector module AH      | 101 [ DI99 ]   |

- Output O: bit-connector.

| Binary Selector Modules | Inputs |       |       | Output |
|-------------------------|--------|-------|-------|--------|
|                         | I1     | I2    | I3    | O      |
| A                       | C5-00  | C5-01 | C5-02 | L3-04  |
| B                       | C5-03  | C5-04 | C5-05 | L3-05  |
| C                       | C5-06  | C5-07 | C5-08 | L3-06  |
| D                       | C5-09  | C5-10 | C5-11 | L3-07  |
| E                       | C5-12  | C5-13 | C5-14 | L3-08  |
| F                       | C5-15  | C5-16 | C5-17 | L3-09  |
| G                       | C5-18  | C5-19 | C5-20 | L3-10  |
| H                       | C5-21  | C5-22 | C5-23 | L3-11  |

## 6.6.2 WORD SELECTOR MODULES (A-D)

### a. Illustration

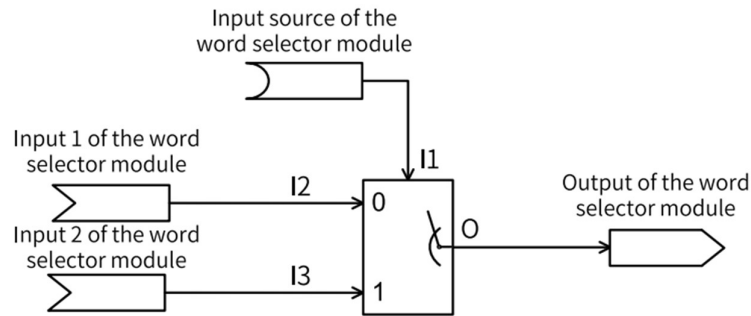


Figure 11. Word Selector module.

### b. Operation

$$O = \begin{cases} I2, & I1 = 0 \text{ (1)} \\ I3, & I1 = 1 \text{ (2)} \end{cases}$$

When input selection I1 of the word selector module is set to 0, the putput O i I2 **(1)**; when I1 is set to 1, the output O is I3 **(2)**.

### c. Connection

- Input I1: 0, 1, DI input, and bit-connector input.

|       |                                         |                     |
|-------|-----------------------------------------|---------------------|
| C5-24 | Input source of word selector module A  | 0[ Disabled]        |
| C5-25 | Input 1 of word selector module A       | 1[ Logic 1]         |
| C5-26 | Input 2 of word selector module A       | 2[ Logic 0]         |
| C5-27 | Input source of word selector module B  | 3[ DI1]             |
| C5-28 | Input 1 of word selector module B       | 4[ DI2]             |
| C5-29 | Input 2 of word selector module B       | 5[ DI3]             |
| C5-30 | Input source of word selector module C  | 6[ DI4]             |
| C5-31 | Input 1 of word selector module C       | 7[ DI5]             |
| C5-32 | Input 2 of word selector module C       | 8[ DI6]             |
| C5-33 | Input source of word selector module D  | 9[ DI7]             |
| C5-34 | Input 1 of word selector module D       | 10[ DI8]            |
| C5-35 | Input 2 of word selector module D       | 11[ DI9]            |
| C5-36 | Input source of DWord selector module A | 12[ DI10]           |
| C5-37 | Input 1 of DWord selector module A      | 13[ DI11]           |
| C5-38 | Input 2 of DWord selector module A      | 14[ DI12]           |
| C5-39 | Input source of DWord selector module B | 15[ DI13]           |
| C5-40 | Input 1 of DWord selector module B      | 16[ DI14]           |
| C5-41 | Input 2 of DWord selector module B      | 17[ DI15]           |
| C5-42 | Input source of DWord selector module C | 18[ DI16]           |
| C5-43 | Input 1 of DWord selector module C      | Other[ B-connector] |
| C5-44 | Input 2 of DWord selector module C      |                     |

- Inputs I1 and I2: word connector, Dword connector.
- Output O: word connector.

| Word Selector Modules | Inputs |       |       | Output |
|-----------------------|--------|-------|-------|--------|
|                       | I1     | I2    | I3    | O      |
| A                     | C5-24  | C5-25 | C5-26 | L7-41  |
| B                     | C5-27  | C5-28 | C5-29 | L7-42  |
| C                     | C5-30  | C5-31 | C5-32 | L7-43  |
| D                     | C5-33  | C5-34 | C5-35 | L7-44  |

## 6.6.3 DWord SELECTOR MODULES (A-D)

### a. Illustration

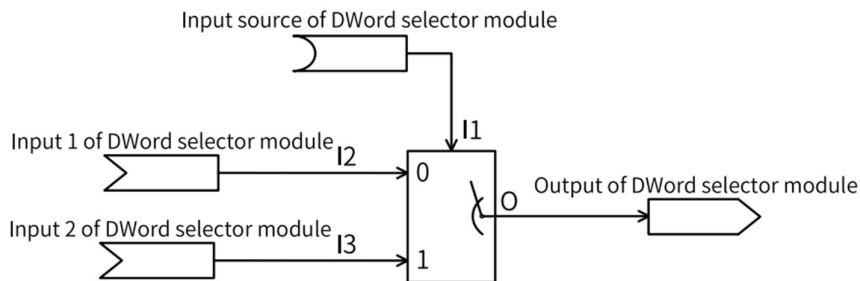


Figure 12. DWord Selector module.

### b. Operation

$$O = \begin{cases} I2, & I1 = 0 \text{ (1)} \\ I3, & I1 = 1 \text{ (2)} \end{cases}$$

When input selection I1 of the word selector module is set to 0, the output O is I2 **(1)**; when I1 is set to 1, the output O is I3 **(2)**.

### c. Connection

- Input I1: 0, 1, DI input, and bit-connector input.

|       |                                                         |                     |
|-------|---------------------------------------------------------|---------------------|
| C5-36 | Input source of DWord selector module A                 | 0[ Disabled]        |
| C5-37 | Input 1 of DWord selector module A                      | 1[ Logic 1]         |
| C5-38 | Input 2 of DWord selector module A                      | 2[ Logic 0]         |
| C5-39 | Input source of DWord selector module B                 | 3[ DI1]             |
| C5-40 | Input 1 of DWord selector module B                      | 4[ DI2]             |
| C5-41 | Input 2 of DWord selector module B                      | 5[ DI3]             |
| C5-42 | Input source of DWord selector module C                 | 6[ DI4]             |
| C5-43 | Input 1 of DWord selector module C                      | 7[ DI5]             |
| C5-44 | Input 2 of DWord selector module C                      | 8[ DI6]             |
| C5-45 | Input source of DWord selector module D                 | 9[ DI7]             |
| C5-46 | Input 1 of DWord selector module D                      | 10[ DI8]            |
| C5-47 | Input 2 of DWord selector module D                      | 11[ DI9]            |
| C5-48 | Input source of floating-point number selector module A | 12[ DI10]           |
| C5-49 | Input 1 of floating-point number selector module A      | 13[ DI11]           |
| C5-50 | Input 2 of floating-point number selector module A      | 14[ DI12]           |
| C5-51 | Input source of floating-point number selector module B | 15[ DI13]           |
| C5-52 | Input 1 of floating-point number selector module B      | 16[ DI14]           |
| C5-53 | Input 2 of floating-point number selector module B      | 17[ DI15]           |
| C5-54 | Input source of floating-point number selector module C | 18[ DI16]           |
| C5-55 | Input 1 of floating-point number selector module C      | Other[ E-connector] |
| C5-56 | Input 2 of floating-point number selector module C      |                     |

- Inputs I2 and I3: word connector, Dword connector.
- Output O: Dword connector.

| DWord Selector Modules | Inputs |       |       | Output |
|------------------------|--------|-------|-------|--------|
|                        | I1     | I2    | I3    | O      |
| A                      | C5-36  | C5-37 | C5-38 | L9-04  |
| B                      | C5-39  | C5-40 | C5-41 | L9-05  |
| C                      | C5-42  | C5-43 | C5-44 | L9-06  |
| D                      | C5-45  | C5-46 | C5-47 | L9-07  |

## 6.6.4 FLOATING-POINT NUMBER SELECTOR MODULES (A-H)

### a. Illustration

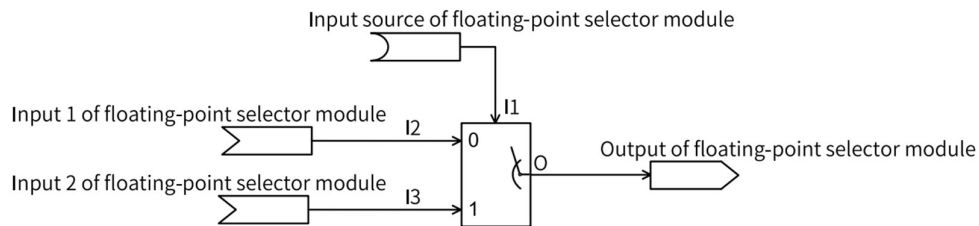


Figure 13. Floating-point Number Selector module.

### b. Operation

$$O = \begin{cases} I2, & I1 = 0 \text{ (1)} \\ I3, & I1 = 1 \text{ (2)} \end{cases}$$

When input selection I1 of the word selector module is set to 0, the output O is I2 **(1)**; when I1 is set to 1, the output O is I3 **(2)**.

### c. Connection

- Input I1: 0, 1, DI input, and bit-connector input.

|       |                                                     |                       |
|-------|-----------------------------------------------------|-----------------------|
| C5-48 | Input source of floating-point number selector m... | 0 [ Disabled ]        |
| C5-49 | Input 1 of floating-point number selector module A  | 1 [ Logic 1 ]         |
| C5-50 | Input 2 of floating-point number selector module A  | 2 [ Logic 0 ]         |
| C5-51 | Input source of floating-point number selector m... | 3 [ DI1 ]             |
| C5-52 | Input 1 of floating-point number selector module B  | 4 [ DI2 ]             |
| C5-53 | Input 2 of floating-point number selector module B  | 5 [ DI3 ]             |
| C5-54 | Input source of floating-point number selector m... | 6 [ DI4 ]             |
| C5-55 | Input 1 of floating-point number selector module C  | 7 [ DI5 ]             |
| C5-56 | Input 2 of floating-point number selector module C  | 8 [ DI6 ]             |
| C5-57 | Input source of floating-point number selector m... | 9 [ DI7 ]             |
| C5-58 | Input 1 of floating-point number selector module D  | 10 [ DI8 ]            |
| C5-59 | Input 2 of floating-point number selector module D  | 11 [ DI9 ]            |
| C5-60 | Input source of floating-point number selector m... | 12 [ DI10 ]           |
| C5-61 | Input 1 of floating-point number selector module E  | 13 [ DI11 ]           |
| C5-62 | Input 2 of floating-point number selector module E  | 14 [ DI12 ]           |
| C5-63 | Input source of floating-point number selector m... | 15 [ DI13 ]           |
| C5-64 | Input 1 of floating-point number selector module F  | 16 [ DI14 ]           |
|       |                                                     | 17 [ DI15 ]           |
|       |                                                     | 18 [ DI16 ]           |
|       |                                                     | Other [ B-connector ] |

- Inputs I2 and I3: AI, HDI, Aim, motor-driven potentiometer, PID, and floating-point connector.
- Output O: floating-point connector.

| Floating-point Number Selector Modules | Inputs |       |       | Output |
|----------------------------------------|--------|-------|-------|--------|
|                                        | I1     | I2    | I3    | O      |
| A                                      | C5-48  | C5-49 | C5-50 | LD-00  |
| B                                      | C5-51  | C5-52 | C5-53 | LD-01  |
| C                                      | C5-54  | C5-55 | C5-56 | LD-02  |
| D                                      | C5-57  | C5-58 | C5-59 | LD-03  |
| E                                      | C5-60  | C5-61 | C5-62 | LD-04  |
| F                                      | C5-63  | C5-64 | C5-65 | LD-05  |
| G                                      | C5-66  | C5-67 | C5-68 | LD-06  |
| H                                      | C5-69  | C5-70 | C5-71 | LD-07  |

## 6.7 CONTROL FUNCTIONS

### 6.7.1 FILTER MODULES (A-F)

#### a. Illustration

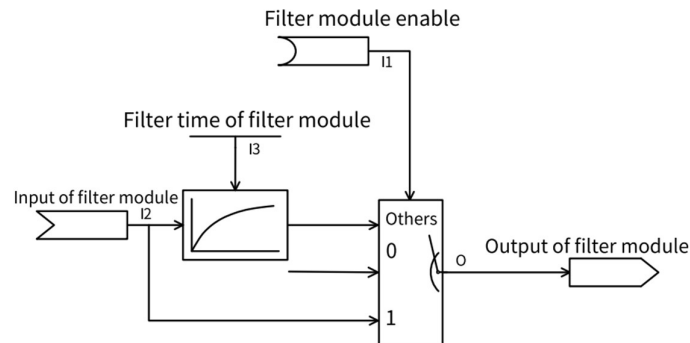


Figure 14. Filter module.

#### b. Operation

$$O = \begin{cases} I1 = 0[\text{Disable}], & 0 \\ I1 = 1, & I2 \\ I1 = 2, & \text{filtered } I2 \end{cases}$$

If module enable selection I1 is set to 0-[disable], the module is disabled, and the output is 0. If module enable selection I1 is not 0, and the input value is 1, the filter is disabled, and the output O is I2; if the input value is 2, the output O is the filtered value of input I.

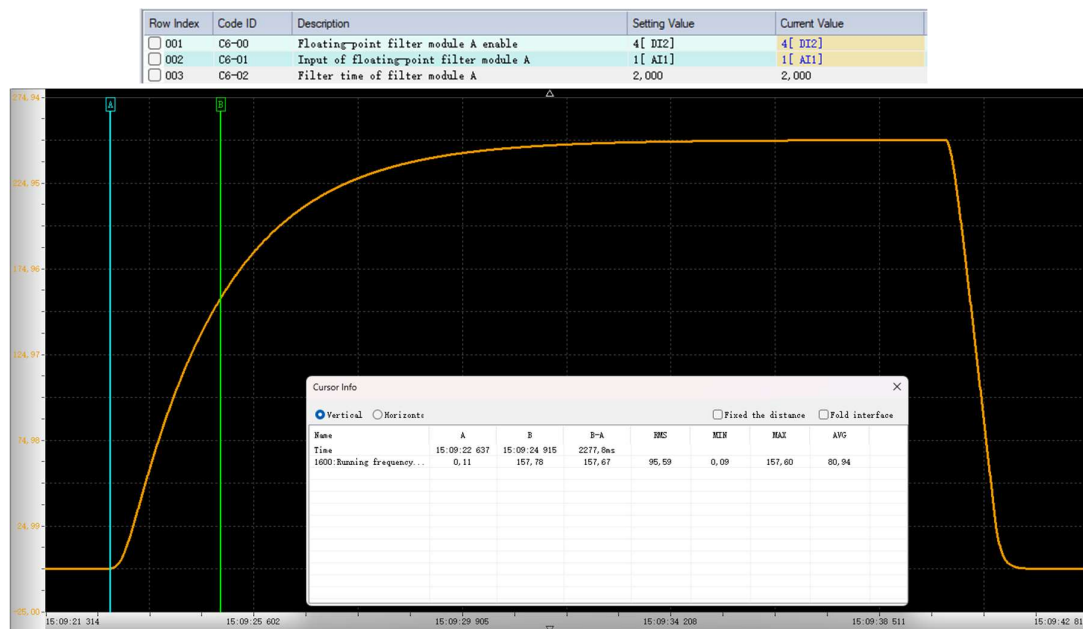


Figure 15. Scope of filter curve (Frequency from 0-250 Hz according to the value of AI1).

As can be seen on the graph, I3 corresponds to the time the filter lasts on reaching 63% of the value set on I2.

## c. Connection

- Input I1: 0 = Module disabled; 1 = Filter disabled; 2 = Filter Enabled.

DI input, bit-connector.

|       |                                            |                     |
|-------|--------------------------------------------|---------------------|
| C6-00 | Floating-point filter module A enable      |                     |
| C6-01 | Input of floating-point filter module A    | 0[ Module disabled] |
| C6-02 | Filter time of filter module A             | 1[ Filter disabled] |
| C6-03 | Floating-point filter module B enable      | 2[ Filter enabled]  |
| C6-04 | Input of floating-point filter module B    | 3[ DI1]             |
| C6-05 | Filter time of filter module B             | 4[ DI2]             |
| C6-06 | Floating-point filter module C enable      | 5[ DI3]             |
| C6-07 | Input of floating-point filter module C    | 6[ DI4]             |
| C6-08 | Filter time of filter module C             | 7[ DI5]             |
| C6-09 | Floating-point filter module D enable      | 8[ DI6]             |
| C6-10 | Input of floating-point filter module D    | 9[ DI7]             |
| C6-11 | Filter time of filter module D             | 10[ DI8]            |
| C6-12 | Fixed-point filter module E enable         | 11[ DI9]            |
| C6-13 | Input of fixed-point filter module E       | 12[ DI10]           |
| C6-14 | Filter time of fixed-point filter module E | 13[ DI11]           |
| C6-15 | Fixed-point filter module F enable         | 14[ DI12]           |
|       |                                            | 15[ DI13]           |
|       |                                            | 16[ DI14]           |
|       |                                            | 17[ DI15]           |
|       |                                            | 18[ DI16]           |
|       |                                            | Other[ B-connector] |

- Input I2: AI, HDI, Aim, motor-driven potentiometer, PID, word connector and floating-connector.
- Input I3: floating-point number with three decimal places.
- Output O: Dword connector and floating-point connector.

| Filter Modules | Inputs |       |       | Output |
|----------------|--------|-------|-------|--------|
|                | I1     | I2    | I3    | O      |
| A              | C6-00  | C6-01 | C6-02 | LD-23  |
| B              | C6-03  | C6-04 | C6-05 | LD-24  |
| C              | C6-06  | C6-07 | C6-08 | LD-25  |
| D              | C6-09  | C6-10 | C6-11 | LD-26  |
| E              | C6-12  | C6-13 | C6-14 | L9-17  |
| F              | C6-15  | C6-16 | C6-17 | L9-18  |

The modules A-D are floating-point filter modules, and the modules E-F are fixed-point filter modules.

## 6.7.2 LEVEL-TO-PULSE CONVERSION MODULES (A-D)

### a. Illustration

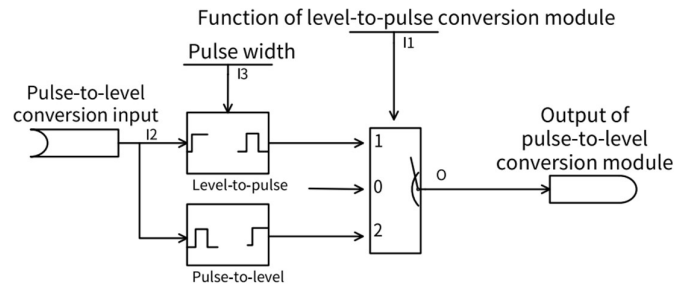


Figure 16. Level-to-Pulse Conversion module.

### b. Operation

When module enable selection I1 is set to 0, the module is disabled, and the output is 0.

When module enable selection I1 is set to 1, level-to-pulse conversion is active, and the output is set to high level within the pulse time I3 on the rising edge of the input I2.

If input I2 is 0, the output becomes 0 immediately, regardless of whether the pulse duration is reached.

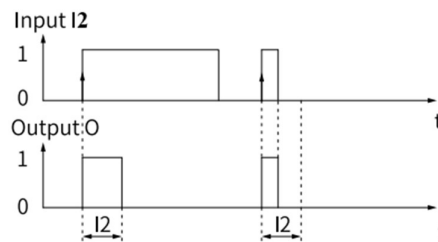


Figure 17. Time-graph of Level-to-Pulse Conversion mode.

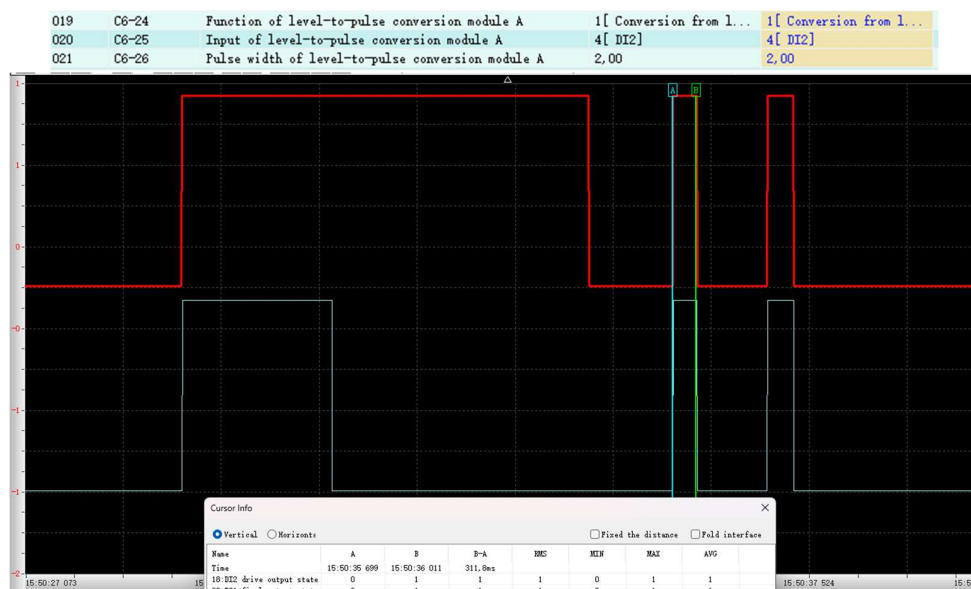


Figure 18. Scope of Level-to-Pulse Conversion mode (Time of the pulse set to 2s).

When module enable selection I1 is set to 2, pulse-to-level conversion is active. The output is set to high level on the first rising edge and low level on the second rising edge of the input I2. Then the output is set to high level on every odd-numbered rising edge and low level on every even numbered rising edges.

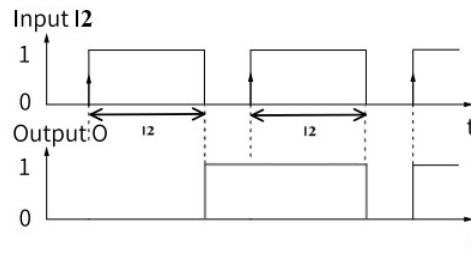


Figure 19. Time-graph of Pulse-to-Level Conversion mode.

|                              |       |                                                   |                         |                         |
|------------------------------|-------|---------------------------------------------------|-------------------------|-------------------------|
| <input type="checkbox"/> 019 | C6-24 | Function of level-to-pulse conversion module A    | 2[ Conversion from p... | 2[ Conversion from p... |
| <input type="checkbox"/> 020 | C6-25 | Input of level-to-pulse conversion module A       | 4[ DI2]                 | 4[ DI2]                 |
| <input type="checkbox"/> 021 | C6-26 | Pulse width of level-to-pulse conversion module A | 2,00                    | 2,00                    |

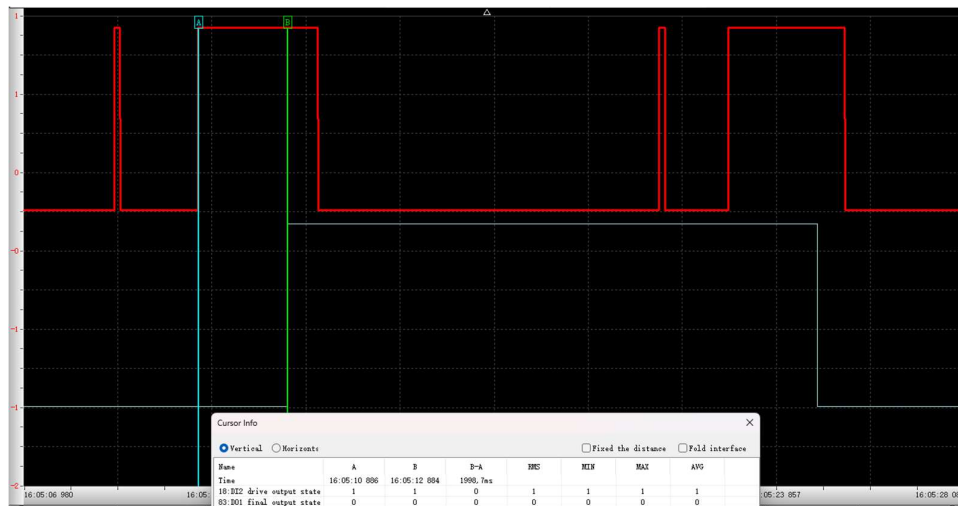


Figure 20. Scope of Pulse-to-Level Conversion mode (Time of the pulse set to 2s).

## c. Connection

- Input I1: 0: Module disabled; 1: Conversion from level to pulse; 2: Conversion from pulse to level.

|       |                                                   |                                    |
|-------|---------------------------------------------------|------------------------------------|
| C6-24 | Function of level-to-pulse conversion module A    | 1[ Conversion from level to pulse] |
| C6-25 | Input of level-to-pulse conversion module A       | 0[ Disabled]                       |
| C6-26 | Pulse width of level-to-pulse conversion module A | 1[ Conversion from level to pulse] |
| C6-27 | Function of level-to-pulse conversion module B    | 2[ Conversion from pulse to level] |

- Input I2: 0, 1, DI input, and bit connector input.
- Input I3: floating-point number with two decimal places.
- Output O: bit connector.

| Level-to-Pulse Conversion Modules | Inputs |       |       | Output |
|-----------------------------------|--------|-------|-------|--------|
|                                   | I1     | I2    | I3    | O      |
| A                                 | C6-24  | C6-25 | C6-26 | L3-84  |
| B                                 | C6-27  | C6-28 | C6-29 | L3-85  |
| C                                 | C6-30  | C6-31 | C6-32 | L3-86  |
| D                                 | C6-33  | C6-34 | C6-35 | L3-87  |

## 6.7.3 LIMITING MODULES (A-F)

### a. Illustration

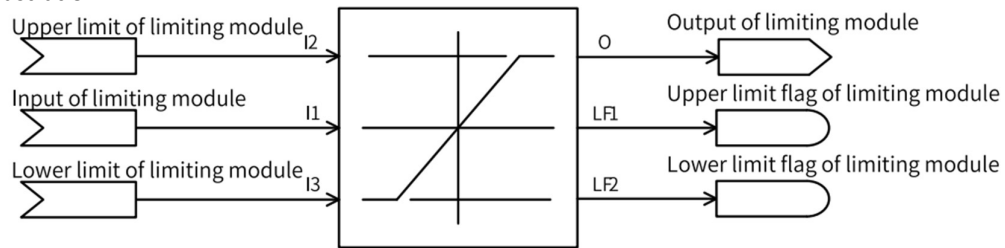


Figure 21. Limiting Module.

### b. Operation

$$O = \begin{cases} I1, & I3 \leq I1 \leq I2 \\ I2, & I1 \geq I2 \\ I3, & I1 \leq I3 \end{cases}$$

$$LF1 = \begin{cases} 0, & I3 \leq I1 \leq I2 \\ 1, & I1 \geq I2 \end{cases}$$

$$LF2 = \begin{cases} 0, & I3 \leq I1 \leq I2 \\ 1, & I1 \leq I3 \end{cases}$$

When the input I1 is greater than the upper limit I2, the output O is I2, and the upper limit flag LF1 is set to 1; when the input I1 is less than the lower limit I3, the output O is I3, and the lower limit flag LF2 is set to 1; when the input I1 is between the upper and lower limits, the output is the input value and the limit flags LF1 and LF2 are set to 0.

### c. Connection

- Inputs I1, I2, and I3: AI, HDI, Aim, motor-driven potentiometer, PID, word connector, and floatingpoint connector.

|       |                                                 |                                |
|-------|-------------------------------------------------|--------------------------------|
| C6-36 | Input of floating-point limiting module A       | 0 [Disabled]                   |
| C6-37 | Upper limit of floating-point limiting module A | 1 [AI1]                        |
| C6-38 | Lower limit of floating-point limiting module A | 2 [AI2]                        |
| C6-39 | Input of floating-point limiting module B       | 3 [AI3]                        |
| C6-40 | Upper limit of floating-point limiting module B | 4 [HDI]                        |
| C6-41 | Lower limit of floating-point limiting module B | 5 [Aim]                        |
| C6-42 | Input of floating-point limiting module C       | 6 [Multi-reference]            |
| C6-43 | Upper limit of floating-point limiting module C | 7 [Motor-driven potentiometer] |
| C6-44 | Lower limit of floating-point limiting module C | 8 [PID]                        |
|       |                                                 | Other [F-connector]            |

- Output O: DWord connector and floating-point connector.
- Outputs LF1 and LF2: bit connector.

| Limiting Modules | Inputs |       |       | Outputs |       |       |
|------------------|--------|-------|-------|---------|-------|-------|
|                  | I1     | I2    | I3    | O       | LF1   | LF2   |
| A                | C6-36  | C6-37 | C6-38 | LD-27   | L4-48 | L4-49 |
| B                | C6-39  | C6-40 | C6-41 | LD-28   | L4-50 | L4-51 |
| C                | C6-42  | C6-43 | C6-44 | LD-29   | L4-53 | L4-53 |
| D                | C6-45  | C6-46 | C6-47 | LD-30   | L4-54 | L4-55 |
| E                | C6-48  | C6-49 | C6-50 | L9-19   | L4-56 | L4-57 |
| F                | C6-51  | C6-52 | C6-53 | L9-20   | L4-58 | L4-59 |

## 6.7.4 LOGIC DELAY MODULES (A-H)

### a. Illustration

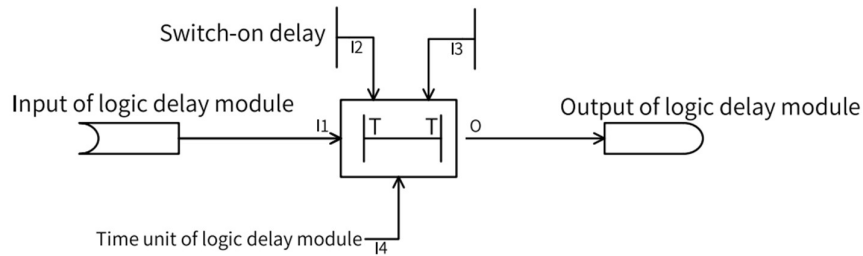


Figure 22. Logic Delay Module.

### b. Operation

The output O has a switch-on delay when the input I1 changes from low level to high level, and the delay time is determined by the switch-on delay time I2 and the time unit I4. It also has switch-off delay when the input I1 changes from high level to low level, and the delay time is determined by the switch-off delay time I3 and the time unit I4. During the delay, the pulse signals less than the delay time will be filtered out. See the following figure.

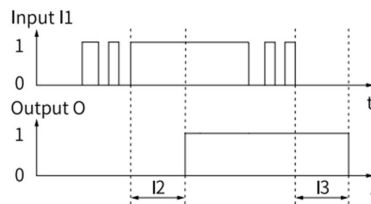


Figure 23. Time-graph of Logic Delay Module.

|     |       |                                          |          |          |
|-----|-------|------------------------------------------|----------|----------|
| 049 | C6-54 | Input of logic delay module A            | 4[ DI2]  | 4[ DI2]  |
| 050 | C6-55 | Switch-on delay of logic delay module A  | 2        | 2        |
| 051 | C6-56 | Switch-off delay of logic delay module A | 4        | 4        |
| 052 | C6-57 | Delay time unit of logic delay module A  | 100[ 1s] | 100[ 1s] |

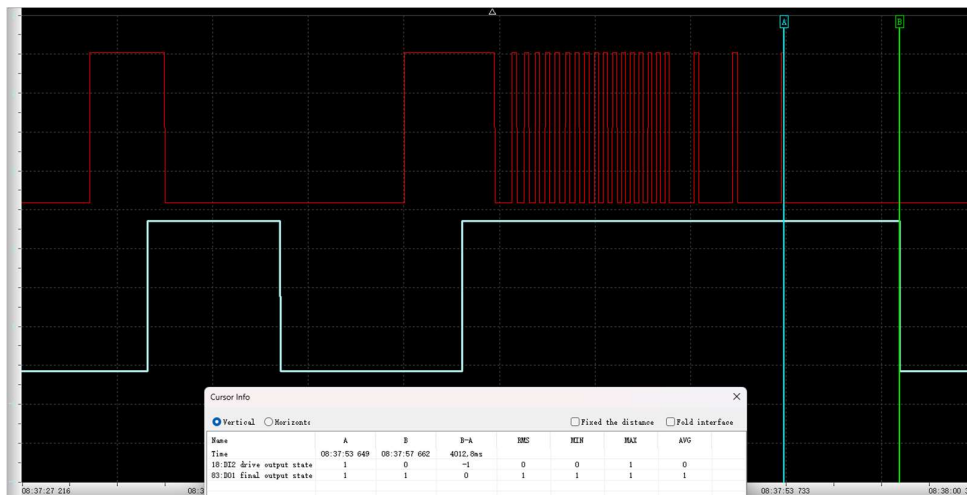


Figure 24. Scope of Logic Delay Module.

As can be seen on the scope, the Logic Delay module does not give an output until the input signal I1 reaches a high level during a period equal to I2 (time unit determined by I4). Once the input signal drops, the Logic Delay Module maintains the output during the period defined on the switch-off delay (I3). If there is a high state signal on the input while this period, it will restart the switch-off delay.

## c. Connection

- Input I1: 0, 1, DI input, and bit connector input.

|       |                                          |                       |
|-------|------------------------------------------|-----------------------|
| C6-54 | Input of logic delay module A            | 0 [ Disabled ]        |
| C6-55 | Switch-on delay of logic delay module A  | 1 [ Logic 1 ]         |
| C6-56 | Switch-off delay of logic delay module A | 2 [ Logic 0 ]         |
| C6-57 | Delay time unit of logic delay module A  | 3 [ DI1 ]             |
| C6-58 | Input of logic delay module B            | 4 [ DI2 ]             |
| C6-59 | Switch-on delay of logic delay module B  | 5 [ DI3 ]             |
| C6-60 | Switch-off delay of logic delay module B | 6 [ DI4 ]             |
| C6-61 | Delay time unit of logic delay module B  | 7 [ DI5 ]             |
| C6-62 | Input of logic delay module C            | 8 [ DI6 ]             |
| C6-63 | Switch-on delay of logic delay module C  | 9 [ DI7 ]             |
| C6-64 | Switch-off delay of logic delay module C | 10 [ DI8 ]            |
| C6-65 | Delay time unit of logic delay module C  | 11 [ DI9 ]            |
| C6-66 | Input of logic delay module D            | 12 [ DI10 ]           |
| C6-67 | Switch-on delay of logic delay module D  | 13 [ DI11 ]           |
| C6-68 | Switch-off delay of logic delay module D | 14 [ DI12 ]           |
| C6-69 | Delay time unit of logic delay module D  | 15 [ DI13 ]           |
| C6-70 | Input of logic delay module E            | 16 [ DI14 ]           |
|       |                                          | 17 [ DI15 ]           |
|       |                                          | 18 [ DI16 ]           |
|       |                                          | Other [ B-connector ] |

- Inputs I2 and I3: unsigned data.
- Input I4: 0: No delay; 1: 10 ms; 10: 100 ms; 100: 1s; 1000: 10s; 6000: 1 min; 12000: 2 min.
- Output O: bit connector.

| Logic Delay Modules | Inputs |       |       |       | Output |
|---------------------|--------|-------|-------|-------|--------|
|                     | I1     | I2    | I3    | I4    | O      |
| A                   | C6-54  | C6-55 | C6-56 | C6-57 | L3-20  |
| B                   | C6-58  | C6-59 | C6-60 | C6-61 | L3-21  |
| C                   | C6-62  | C6-63 | C6-64 | C6-65 | L3-22  |
| D                   | C6-66  | C6-67 | C6-68 | C6-69 | L3-23  |
| E                   | C6-70  | C6-71 | C6-72 | C6-73 | L3-24  |
| F                   | C6-74  | C6-75 | C6-76 | C6-77 | L3-25  |
| G                   | C6-78  | C6-79 | C6-80 | C6-81 | L3-26  |
| H                   | C6-82  | C6-83 | C6-84 | C6-85 | L3-27  |

## 6.8 MULTI-POINT CURVE MODULES (A-B)

### a. Illustration

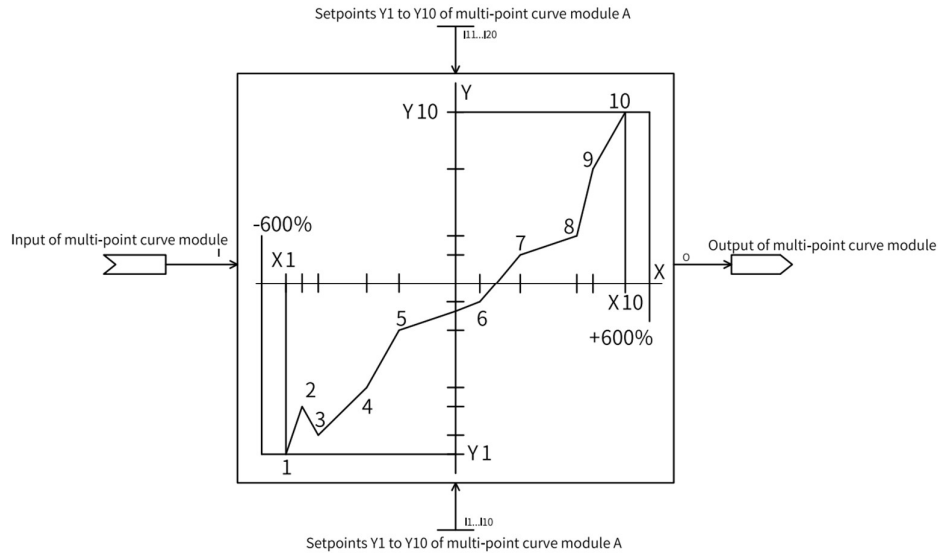


Figure 25. Multi-point Curve Module.

### b. Operation

The set coordinates are valid only when the following conditions are met:  $X1 \leq X2 \leq \dots \leq X10$ . When the input is beyond the valid coordinate points, the output is the ordinate of the adjacent valid coordinate point; when the input is within the valid coordinate points, the ordinate corresponding to the output is calculated based on the curve. When the input coordinates meet the condition and the quantity is less than 10 coordinates, if the last input abscissa is a negative value, the last negative abscissa and the abscissa with the value of 0 after it are retained, and the other coordinate values after it are discarded. If the last input abscissa is a positive value, the last positive abscissa is retained, and other coordinate values after it are discarded.

If the condition  $X1 \leq X2 \leq \dots \leq X10$  is not met, the AC drive reports L32.4. If two points have the same X coordinate but different Y coordinates, the AC drive also reports L32.4.

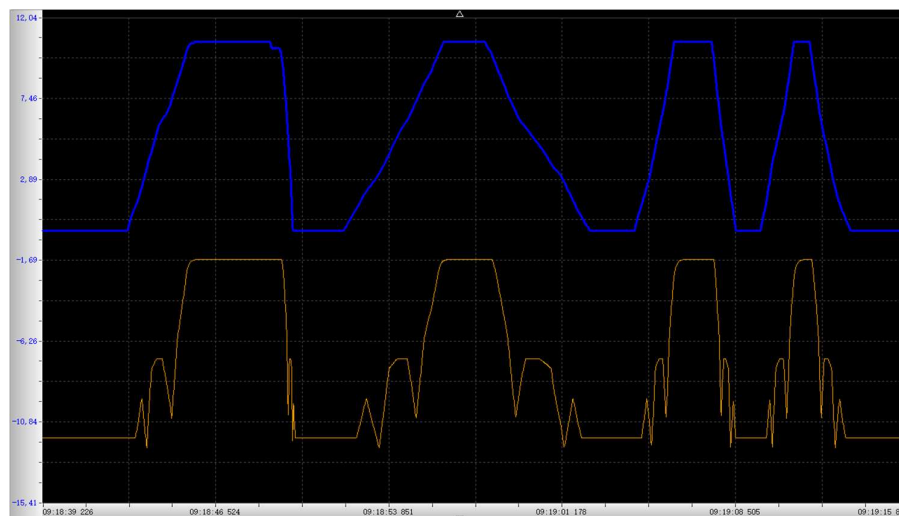


Figure 26. Scope of Multi-point Curve Module (Blue: A11; Orange: Output of Multi-Point Curve Module).

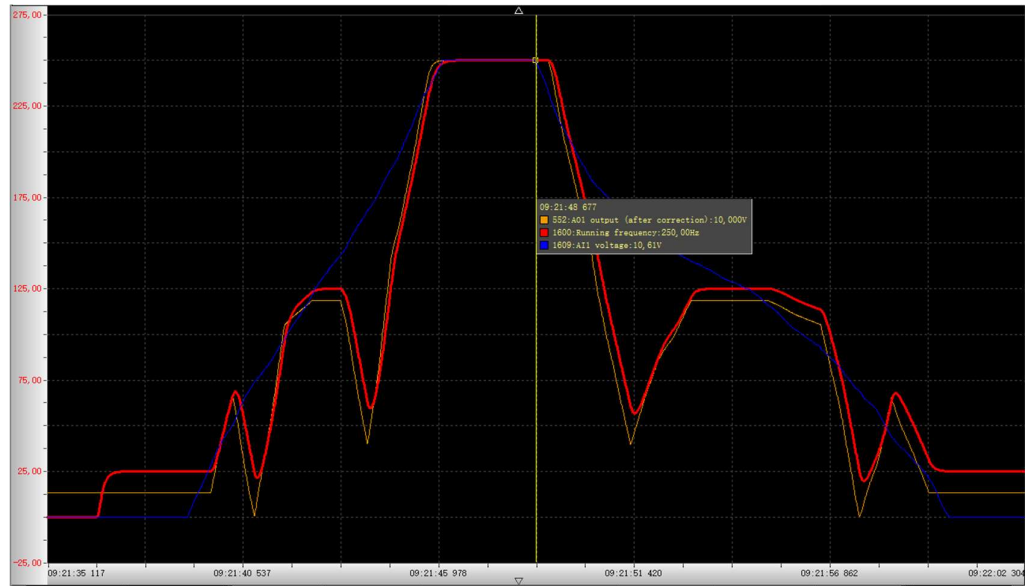


Figure 27. Scope of Multi-point Curve Module with running frequency.

## c. Connection

- Input I: floating-point connector.

|       |                                           |                     |
|-------|-------------------------------------------|---------------------|
| C7-00 | Input of multi-point curve module A       |                     |
| C7-01 | Setpoint X1 of multi-point curve module A | 0[ Disabled]        |
| C7-02 | Setpoint X2 of multi-point curve module A | Other[ F-connector] |

- Inputs I1 to I20: floating-point number with one decimal place.
- Output O: floating-point connector.

| B2W Module |           | A     | B     |
|------------|-----------|-------|-------|
| Inputs     | I         | C7-00 | C7-21 |
|            | I1 (X1)   | C7-01 | C7-22 |
|            | I2 (X2)   | C7-02 | C7-23 |
|            | I3 (X3)   | C7-03 | C7-24 |
|            | I4 (X4)   | C7-04 | C7-25 |
|            | I5 (X5)   | C7-05 | C7-26 |
|            | I6 (X6)   | C7-06 | C7-27 |
|            | I7 (X7)   | C7-07 | C7-28 |
|            | I8 (X8)   | C7-08 | C7-29 |
|            | I9 (X9)   | C7-09 | C7-30 |
|            | I10 (X10) | C7-10 | C7-31 |
|            | I11 (Y1)  | C7-11 | C7-32 |
|            | I12 (Y2)  | C7-12 | C7-33 |
|            | I13 (Y3)  | C7-13 | C7-34 |
|            | I14 (Y4)  | C7-14 | C7-35 |
|            | I15 (Y5)  | C7-15 | C7-36 |
|            | I16 (Y6)  | C7-16 | C7-37 |
|            | I17 (Y7)  | C7-17 | C7-38 |
|            | I18 (Y8)  | C7-18 | C7-39 |
|            | I19 (Y9)  | C7-19 | C7-40 |
|            | I20 (Y10) | C7-20 | C7-41 |
| Output     | O         | LD-46 | LD-47 |

## 6.9 CONSTANT VALUE

### 6.9.1 CONSTANT VALUE SETPOINTS (1-42)

#### a. Illustration

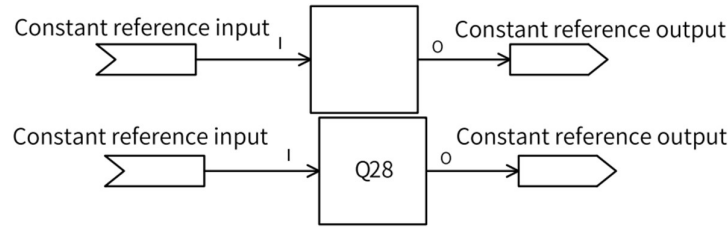


Figure 28. Constant Value Setpoints module.

#### b. Operation

$$O = I$$

The output O is equal to the input I.

Constant value setpoints 1–5 are floating-point numbers with two decimal places, and the value range is -300.00 to +300.00.

Constant value setpoints 6–21 are floating-point numbers with one decimal place, and the value range is -3000.0 to +3000.0.

Constant value setpoints 22–26 are floating-point numbers with two decimal places, which are converted into Q28 fixed-point numbers for output, and the value range is -300.00 to +300.00.

Constant value setpoints 27–42 are fixed-point numbers, and the value range is 0 to 65535.

#### c. Connection

- Input I: unsigned number, floating-point number with one decimal place, and floating-point number with two decimal places.
- Output O: word connector and floating-point connector.

| Constant Value Settings | Input | Output | Remarks                                       |
|-------------------------|-------|--------|-----------------------------------------------|
|                         | I     | O      |                                               |
| 1                       | C8-00 | LD-65  | Floating-point number with two decimal places |
| 2                       | C8-01 | LD-66  | Floating-point number with two decimal places |
| 3                       | C8-02 | LD-67  | Floating-point number with two decimal places |
| 4                       | C8-03 | LD-68  | Floating-point number with two decimal places |
| 5                       | C8-04 | LD-69  | Floating-point number with two decimal places |
| 6                       | C8-05 | LD-70  | Floating-point number with one decimal place  |
| 7                       | C8-06 | LD-71  | Floating-point number with one decimal place  |
| 8                       | C8-07 | LD-72  | Floating-point number with one decimal place  |
| 9                       | C8-08 | LD-73  | Floating-point number with one decimal place  |
| 10                      | C8-09 | LD-74  | Floating-point number with one decimal place  |

| Constant Value Settings | Input | Output | Constant Value Setting                                      |
|-------------------------|-------|--------|-------------------------------------------------------------|
|                         | I     | O      |                                                             |
| 11                      | C8-10 | LD-75  | Floating-point number with one decimal place                |
| 12                      | C8-11 | LD-76  | Floating-point number with one decimal place                |
| 13                      | C8-12 | LD-77  | Floating-point number with one decimal place                |
| 14                      | C8-13 | LD-78  | Floating-point number with one decimal place                |
| 15                      | C8-14 | LD-79  | Floating-point number with one decimal place                |
| 16                      | C8-15 | LD-80  | Floating-point number with one decimal place                |
| 17                      | C8-16 | LD-81  | Floating-point number with one decimal place                |
| 18                      | C8-17 | LD-82  | Floating-point number with one decimal place                |
| 19                      | C8-18 | LD-83  | Floating-point number with one decimal place                |
| 20                      | C8-19 | LD-84  | Floating-point number with one decimal place                |
| 21                      | C8-20 | LD-85  | Floating-point number with one decimal place                |
| 22                      | C8-21 | L7-00  | Floating-point number converted into Q28 fixed-point number |
| 23                      | C8-22 | L7-01  | Floating-point number converted into Q28 fixed-point number |
| 24                      | C8-23 | L7-02  | Floating-point number converted into Q28 fixed-point number |
| 25                      | C8-24 | L7-03  | Floating-point number converted into Q28 fixed-point number |
| 26                      | C8-25 | L7-04  | Floating-point number converted into Q28 fixed-point number |
| 27                      | C8-26 | L7-05  | Fixed-point number                                          |
| 28                      | C8-27 | L7-06  | Fixed-point number                                          |
| 29                      | C8-28 | L7-07  | Fixed-point number                                          |
| 30                      | C8-29 | L7-08  | Fixed-point number                                          |
| 31                      | C8-30 | L7-09  | Fixed-point number                                          |
| 32                      | C8-31 | L7-10  | Fixed-point number                                          |
| 33                      | C8-32 | L7-11  | Fixed-point number                                          |
| 34                      | C8-33 | L7-12  | Fixed-point number                                          |
| 35                      | C8-34 | L7-13  | Fixed-point number                                          |
| 36                      | C8-35 | L7-14  | Fixed-point number                                          |
| 37                      | C8-36 | L7-15  | Fixed-point number                                          |
| 38                      | C8-37 | L7-16  | Fixed-point number                                          |
| 39                      | C8-38 | L7-17  | Fixed-point number                                          |
| 40                      | C8-39 | L7-18  | Fixed-point number                                          |
| 41                      | C8-40 | L7-19  | Fixed-point number                                          |
| 42                      | C8-41 | L7-20  | Fixed-point number                                          |

## 6.10 ANY PARAMETER CONTROL

### 6.10.1 ANY 16-BIT DATA ADDRESS MONITORING (1-5)

#### a. Illustration

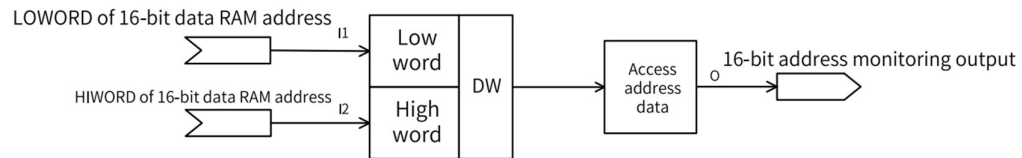


Figure 29. Any 16-bit Data Address Monitoring module.

#### b. Operation

The 32-bit address with I1 as the LOWORD and I2 as the HIWORD is used to locate the data for output. The range of addresses that can be monitored is as follows:

0x20000000 to 0x2001FFFE

0x24000000 to 0x2404FFFE

#### c. Connection

- Inputs I1 and I2: hexadecimal unsigned data.
- Output O: word connector

| 16-Bit Data Address Monitoring | Inputs |       | Output |
|--------------------------------|--------|-------|--------|
|                                | I1     | I2    | O      |
| 1                              | C9-00  | C9-01 | L7-36  |
| 2                              | C9-02  | C9-03 | L7-37  |
| 3                              | C9-04  | C9-05 | L7-38  |
| 4                              | C9-06  | C9-07 | L7-39  |
| 5                              | C9-08  | C9-09 | L7-40  |

## 6.10.2 ANY 32-BIT DATA ADDRESS MONITORING (1-5)

### a. Illustration

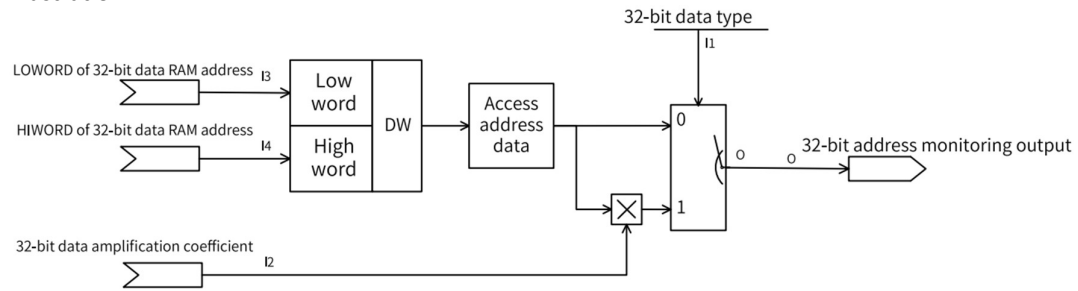


Figure 30. Any 16-bit Data Address Monitoring module.

### b. Operation

The 32-bit address with I1 as the LOWORD and I2 as the HIWORD is used to allocate the data for output. If data type selection I3 is set to 0, the data is directly output to O; if I3 is set to 1, the data is multiplied by the amplification factor I4 and then output to O.

The range of addresses that can be monitored is as follows:

0x20000000 to 0x2001FFFC.

0x24000000 to 0x2404FFFC.

### c. Connection

- Inputs I1 and I2: Unsigned data.
- Inputs I3 and I4: Hexadecimal unsigned data.
- Output O: Word connector

| 32-Bit Data Address Monitoring | Inputs |       |       |       | Output |
|--------------------------------|--------|-------|-------|-------|--------|
|                                | I1     | I2    | I3    | I4    | O      |
| 1                              | C9-10  | C9-11 | C9-12 | C9-13 | L9-21  |
| 2                              | C9-14  | C9-15 | C9-16 | C9-17 | L9-22  |
| 3                              | C9-18  | C9-19 | C9-20 | C9-21 | L9-23  |
| 4                              | C9-22  | C9-23 | C9-24 | C9-25 | L9-24  |
| 5                              | C9-26  | C9-27 | C9-28 | C9-29 | L9-25  |

## 6.11 MOTOR-DRIVEN POTENTIOMETER

### a. Illustration

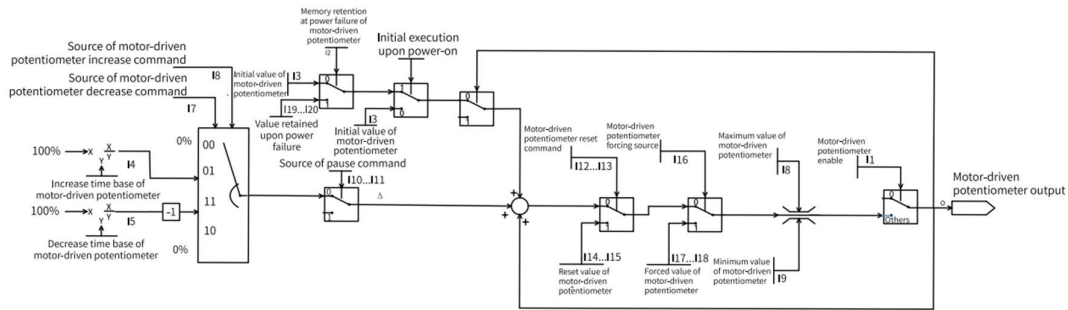


Figure 31. Motor-driven Potentiometer module.

### b. Operation

When I1 is set to 0, the motor-driven potentiometer is disabled, and the output O is 0; when I1 is set to 1, the motor-driven potentiometer is enabled.

When I2 is set to 1, the motor-driven potentiometer restores the values retained upon power failure (I19 and I20) upon first power-on; when I2 is set to 0, the motor-driven potentiometer restores the initial value (I3) upon first power-on.

When I1 is enabled, if the values retained upon power failure are not restored, the output O of the motor-driven potentiometer is the initial value I3.

When the increase command source I5 is 1, the motor-driven potentiometer increases the output O at the speed of the increase time base I4; when the increase command source I6 is 1, the motor-driven potentiometer increases the output O at the speed of the increase time base I7.

When the value of the motor-driven potentiometer increases, the maximum output O is the maximum output value I8; when the value of the motor-driven potentiometer decreases, the minimum output O is the minimum output value I9.

When I10 and I11 are 1, the output O stops changing; when I10 and I11 become 0, the output O continues to change.

When I12 and I13 are 1, the output O is reset to a specified value: if the reset value source I14 is 0, the output O is reset to the reset value digital setting I15; if the reset value source I14 is others, the output O is reset to the value specified by I14.

When I16 is 1, the output O is forcibly set to a specified value: if the force value source I17 is 0, the output O is forcibly set to the forced value digital setting I18; if the force value source I17 is others, the output O is forced to be the value specified by I17.

I19 and I20 are the per-unit values of the retained output values of the motor-driven potentiometer after Q28 conversion.

## c. Connection

- Input I: unsigned number, floating-point number with one decimal place, and floating-point number with two decimal places.

|       |                                                     |                     |
|-------|-----------------------------------------------------|---------------------|
| FB-20 | Motor-driven potentiometer enable                   | 0 [Disabled]        |
| FB-21 | Memory retention at power failure of motor-drive... | 1 [Enabled]         |
| FB-22 | Initial value of motor-driven potentiometer         | 3 [DI1]             |
| FB-23 | Value increase time base of motor-driven potenti... | 4 [DI2]             |
| FB-24 | Value decrease time base of motor-driven potenti... | 5 [DI3]             |
| FB-25 | Source of motor-driven potentiometer increase co... | 6 [DI4]             |
| FB-26 | Source of motor-driven potentiometer decrease co... | 7 [DI5]             |
| FB-27 | Maximum output value of motor-driven potentiometer  | 8 [DI6]             |
| FB-28 | Minimum output value of motor-driven potentiometer  | 9 [DI7]             |
| FB-29 | Source 1 of motor-driven potentiometer pause com... | 10 [DI8]            |
| FB-30 | Source 2 of motor-driven potentiometer pause com... | 11 [DI9]            |
| FB-31 | Source 1 of motor-driven potentiometer reset com... | 12 [DI10]           |
| FB-32 | Source 2 of motor-driven potentiometer reset com... | 13 [DI11]           |
| FB-33 | Source of motor-driven potentiometer reset value    | 14 [DI12]           |
| FB-34 | Reset value of motor-driven potentiometer           | 15 [DI13]           |
| FB-35 | Source of motor-driven potentiometer force command  | 16 [DI14]           |
|       |                                                     | 17 [DI15]           |
|       |                                                     | 18 [DI16]           |
|       |                                                     | Other [B=connector] |

- Output O: word connector and floating-point connector.

| Motor-driven Potentiometer |                |       | Remarks                                                                                                             |
|----------------------------|----------------|-------|---------------------------------------------------------------------------------------------------------------------|
| Inputs                     | I1             | FB-20 | Motor-driven potentiometer enable.                                                                                  |
|                            | I2             | FB-21 | Retentive Upon power failure enable.                                                                                |
|                            | I3             | FB-22 | Initial value after power-on.                                                                                       |
|                            | I4             | FB-23 | Increase speed.                                                                                                     |
|                            | I5             | FB-24 | Decrease speed.                                                                                                     |
|                            | I6             | FB-25 | Increase or decrease according to the set rate when the increase or decrease command is active.                     |
|                            | I7             | FB-26 | The output value remains unchanged when the increase and decrease commands are active or inactive at the same time. |
|                            | I8             | FB-27 | Maximum value.                                                                                                      |
|                            | I9             | FB-28 | Minimum value.                                                                                                      |
|                            | I10            | FB-29 | High level indicates pause and low level indicates continue.                                                        |
|                            | I11            | FB-30 | -                                                                                                                   |
|                            | I12            | FB-31 | Reset is triggered on the rising edge of the reset command. The motor-driven potentiometer reset to the set value.  |
|                            | I13            | FB-32 | -                                                                                                                   |
|                            | I14            | FB-33 | -                                                                                                                   |
|                            | I15            | FB-34 | -                                                                                                                   |
|                            | I16            | FB-35 | High level indicates forcing enabled and low level indicates forcing disabled.                                      |
|                            | I17            | FB-36 | -                                                                                                                   |
|                            | I18            | FB-37 | -                                                                                                                   |
|                            | I19            | FB-38 | Per-unit value of the value retained upon power failure after Q28 conversion.                                       |
|                            | I20            | FB-39 | -                                                                                                                   |
| Outputs                    | O              | LD-45 | Final output.                                                                                                       |
|                            | ForceVal       | LD-39 | Force value of motor-driven potentiometer.                                                                          |
|                            | ResetVal       | LD-40 | Reset value of motor-driven potentiometer.                                                                          |
|                            | MaxVal         | LD-41 | Maximum value of motor-driven potentiometer.                                                                        |
|                            | MinVal         | LD-42 | Minimum value of motor-driven potentiometer.                                                                        |
|                            | InitialVal     | LD-43 | Initial value of motor-driven potentiometer.                                                                        |
|                            | Process Output | LD-44 | Process operation output.                                                                                           |

## 6.12 MULTI-REFERENCE

### 6.12.1 MULTI-REFERENCE MODULE

#### a. Illustration

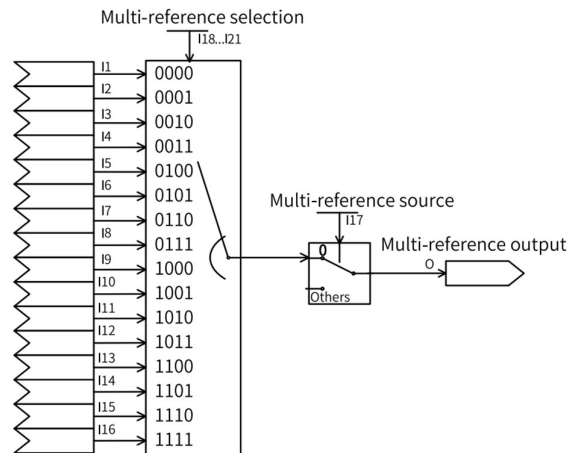


Figure 32. Multi-reference module.

#### b. Operation

When the multi-reference source I17 is set to 0, the 4-bit binary number of multi.reference selection I18 to I21 map to multi-reference I1 to I16, and the corresponding multi-reference value is output to O.

When the multi-reference source I17 is set to others, the multi-reference value selected by using the corresponding method is output to O.

| Multi-references   | I21 (BIT3) | I20 (BIT2) | I19 (BIT1) | I18 (BIT0) | Actual Effective Value |
|--------------------|------------|------------|------------|------------|------------------------|
| Multi-reference 1  | 0          | 0          | 0          | 0          | I1                     |
| Multi-reference 2  | 0          | 0          | 0          | 1          | I2                     |
| Multi-reference 3  | 0          | 0          | 1          | 0          | I3                     |
| Multi-reference 4  | 0          | 0          | 1          | 1          | I4                     |
| Multi-reference 5  | 0          | 1          | 0          | 0          | I5                     |
| Multi-reference 6  | 0          | 1          | 0          | 1          | I6                     |
| Multi-reference 7  | 0          | 1          | 1          | 0          | I7                     |
| Multi-reference 8  | 0          | 1          | 1          | 1          | I8                     |
| Multi-reference 9  | 1          | 0          | 0          | 0          | I9                     |
| Multi-reference 10 | 1          | 0          | 0          | 1          | I10                    |

| Multi-references   | I21 (BIT3) | I20 (BIT2) | I19 (BIT1) | I18 (BIT0) | Actual Effective Value |
|--------------------|------------|------------|------------|------------|------------------------|
| Multi-reference 11 | 1          | 0          | 1          | 0          | I11                    |
| Multi-reference 12 | 1          | 0          | 1          | 1          | I12                    |
| Multi-reference 13 | 1          | 1          | 0          | 0          | I13                    |
| Multi-reference 14 | 1          | 1          | 0          | 1          | I14                    |
| Multi-reference 15 | 1          | 1          | 1          | 0          | I15                    |
| Multi-reference 16 | 1          | 1          | 1          | 1          | I16                    |

## c. Connection

- Inputs I1 to I16: floating-point number with one decimal place.
- Input I17: AI, pulse, PID, preset frequency, and floating-point connector.
- Inputs I18 to I21: 0, 1, DI input, and bit connector input.
- Output O: floating-point connector and system information

| Multi-reference |     |                   | Output Connector |             |
|-----------------|-----|-------------------|------------------|-------------|
| Input           | I1  | FC-00             | SetVal1          | LD-49       |
|                 | I2  | FC-01             | SetVal2          | LD-50       |
|                 | I3  | FC-02             | SetVal3          | LD-51       |
|                 | I4  | FC-03             | SetVal4          | LD-52       |
|                 | I5  | FC-04             | SetVal5          | LD-53       |
|                 | I6  | FC-05             | SetVal6          | LD-54       |
|                 | I7  | FC-06             | SetVal7          | LD-55       |
|                 | I8  | FC-07             | SetVal8          | LD-56       |
|                 | I9  | FC-08             | SetVal9          | LD-57       |
|                 | I10 | FC-09             | SetVal10         | LD-58       |
|                 | I11 | FC-10             | SetVal11         | LD-59       |
|                 | I12 | FC-11             | SetVal12         | LD-60       |
|                 | I13 | FC-12             | SetVal13         | LD-61       |
|                 | I14 | FC-13             | SetVal14         | LD-62       |
|                 | I15 | FC-14             | SetVal15         | LD-63       |
|                 | I16 | FC-15             | SetVal16         | LD-64       |
|                 | I17 | FC-51             | -                | -           |
|                 | I18 | FC-55             | -                | -           |
|                 | I19 | FC-56             | -                | -           |
|                 | I20 | FC-57             | -                | -           |
|                 | I21 | FC-58             | CurSel           | FC-52/U2-05 |
| Output          | O   | LD-48/FC-53/U2-06 | -                | -           |

## 7 FREE PROGRAMMING EXAMPLES

### 7.1 USING TWO DI (DI2 & DI3) TO TRIGGER SELF-DEFINED OFF (STOP)

With this application we are capable of stopping the drive by different modes without having to change parameter F6-10.

On the group parameter A4 (password and SuperAdmin mode needed), the parameters A4-01, A4-02 and A4-03 allow to make a control of the stop command of the drive through custom channel:

- **OFF1:** Start stop command (the rising edge corresponds to the start command, and the low-level corresponds to stop). If OFF1=0, a stop command is executed, and the drive will exit the operation state and enter the stop state according to F6-10 [Stop Mode].
- **OFF2:** Coast to stop command (valid at low level). After receiving the command, unconditionally block IGBT output.
- **OFF3:** Emergency stop command (valid at low level, when the value is 0, execute the action). The emergency stop command is valid at low level. When the corresponding valid function code value is 0, the emergency stop action is executed. AC DRIVE will decelerate to stop according to the shortest time allowed, and then block the IGBT output.

To enable these parameters, the parameter F0-02 (command source) has to be 3-[Customization].

|                              |       |                |                   |                   |
|------------------------------|-------|----------------|-------------------|-------------------|
| <input type="checkbox"/> 003 | F0-02 | Command source | 3[ Customization] | 3[ Customization] |
|------------------------------|-------|----------------|-------------------|-------------------|

OFF1 will be controlled by the output of an AND gate with DI2 and DI3 as inputs. To set the AND gate module A, parameters from C3-00 to C3-04 must be set as follows:

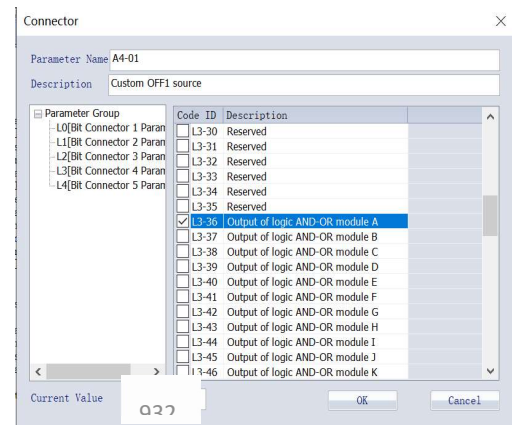
|                              |       |                                   |   |             |
|------------------------------|-------|-----------------------------------|---|-------------|
| <input type="checkbox"/> 001 | C3-00 | Function of logic AND-OR module A | — | 1[ AND]     |
| <input type="checkbox"/> 002 | C3-01 | Input 1 of logic AND-OR module A  | — | 4[ DI2]     |
| <input type="checkbox"/> 003 | C3-02 | Input 2 of logic AND-OR module A  | — | 5[ DI3]     |
| <input type="checkbox"/> 004 | C3-03 | Input 3 of logic AND-OR module A  | — | 1[ Logic 1] |
| <input type="checkbox"/> 005 | C3-04 | Input 4 of logic AND-OR module A  | — | 1[ Logic 1] |

When C3-00 is set with the value 1, the AND/OR gate is set as AND and the inputs work as I1&I2&I3&I4, so on C3-01 and C3-02 will be the inputs of the gate controlled by the DIs and the other gates must be set with a logic 1 to not disturb with the DIs. Digital inputs must not have any function set by the group of parameters F4.

This module is explained in detail on chapter 6.4.1.

To control OFF1 with the AND gate, the output of the gate must be the source of OFF1:

| Row...                       | Code ID | Description                          | Setting Value     | C |
|------------------------------|---------|--------------------------------------|-------------------|---|
| <input type="checkbox"/> 001 | A4-00   | Control channel                      | ---               | 0 |
| <input type="checkbox"/> 002 | A4-01   | Custom OFF1 source                   | ---               | 0 |
| <input type="checkbox"/> 003 | A4-02   | Custom OFF2 source 1                 | 0[ Inactive]      | 0 |
| <input type="checkbox"/> 004 | A4-03   | Custom OFF3 source 1                 | 3[ DI1]           | 0 |
| <input type="checkbox"/> 005 | A4-04   | Custom running permission source     | 4[ DI2]           | 0 |
| <input type="checkbox"/> 006 | A4-05   | Custom fault reset source 1          | 5[ DI3]           | 0 |
| <input type="checkbox"/> 007 | A4-06   | Custom JOG1 source                   | 6[ DI4]           | 0 |
| <input type="checkbox"/> 008 | A4-07   | Custom JOG2 source                   | 7[ DI5]           | 0 |
| <input type="checkbox"/> 009 | A4-08   | Custom speed negation source         | 8[ DI6]           | 0 |
| <input type="checkbox"/> 010 | A4-10   | OFF2 source 2                        | 9[ DI7]           | 0 |
| <input type="checkbox"/> 011 | A4-11   | OFF2 source 3                        | 10[ DI8]          | 0 |
| <input type="checkbox"/> 012 | A4-12   | OFF3 source 2                        | 11[ DI9]          | 0 |
| <input type="checkbox"/> 013 | A4-13   | OFF3 source 3                        | 12[ DI10]         | 0 |
| <input type="checkbox"/> 014 | A4-14   | Fault reset source 2                 | 13[ DI11]         | 0 |
| <input type="checkbox"/> 015 | A4-15   | Fault reset source 3                 | 14[ DI12]         | 0 |
| <input type="checkbox"/> 016 | A4-16   | RFG prohibition source               | 15[ DI13]         | 0 |
| <input type="checkbox"/> 017 | A4-17   | RFG pause source                     | 16[ DI14]         | 0 |
| <input type="checkbox"/> 018 | A4-18   | Source of setting RFG reference to 0 | 17[ DI15]         | 0 |
| <input type="checkbox"/> 019 | A4-19   | Source of setting RFG reference to 1 | 18[ DI16]         | 0 |
| <input type="checkbox"/> 020 | A4-20   | Source of setting RFG reference to 2 | Other[ B-connecto | 0 |



OFF2 and OFF3 can be controlled with other digital inputs or other module to add more control to the application.

## 7.2 USING COMPARISON MODULE TO REALIZE AI DISCONNECTION DETECTION

Connectors can be used to add fault detections. With the group of parameters H2 new fault detections can be set. In this example, AI disconnection will be detected when the value of the analog input falls under a constant value. To do this, the floating-point comparison module must be set:

|     |       |                                                |                                         |                       |
|-----|-------|------------------------------------------------|-----------------------------------------|-----------------------|
| 065 | C4-64 | Function of floating-point comparison module A | 2[ Input 1 < Input 2]                   | 2[ Input 1 < Input 2] |
| 066 | C4-65 | Input 1 of floating-point comparison module A  | LB-00[AI1 input per-unit value]         | 2100                  |
| 067 | C4-66 | Input 2 of floating-point comparison module A  | LD-49[Multi-reference selection output] | 2349                  |

|     |       |                                                        |                                         |                       |
|-----|-------|--------------------------------------------------------|-----------------------------------------|-----------------------|
| 065 | C4-64 | Function of floating-point comparison module A         | 2[ Input 1 < Input 2]                   | 2[ Input 1 < Input 2] |
| 066 | C4-65 | Input 1 of floating-point comparison module A          | LB-00[AI1 input per-unit value]         | 2100                  |
| 067 | C4-66 | Input 2 of floating-point comparison module A          | LD-49[Multi-reference selection output] | 2349                  |
| 068 | C4-67 | Hysteresis input of floating-point comparison module A | 0[ Inactive]                            | 0[ Inactive]          |
| 069 | C4-68 | Function of floating-point comparison module B         | 2[ AI1]                                 | 2[ AI1]               |
| 070 | C4-69 | Input 1 of floating-point comparison module B          | 2[ AI2]                                 | 2[ AI2]               |
| 071 | C4-70 | Input 2 of floating-point comparison module B          | 2[ AI3]                                 | 2[ AI3]               |
| 072 | C4-71 | Hysteresis input of floating-point comparison module B | 2[ AI4]                                 | 2[ AI4]               |
| 073 | C4-72 | Function of floating-point comparison module C         | 2[ AI5]                                 | 2[ AI5]               |
| 074 | C4-73 | Input 1 of floating-point comparison module C          | 2[ AI6]                                 | 2[ AI6]               |

| Row Index | Code ID | Description       | Setting Value | Current Value |
|-----------|---------|-------------------|---------------|---------------|
| 001       | FC-00   | Multi-reference 1 | 30.0          | 30.0          |

The multi-reference module can be used as a multiplexer, or each input of the module can also be used as constant values. To use the multi-reference inputs directly as outputs, the f-connector Multi-reference X (1,2,3,4,5...) Outputs (LD49 to LD64 connectors) have to be used. Instead, to use the multi-reference module (multiplexer functionality), parameters FC-51, FC-55, FC-56, FC-57 and FC-58 must be set to control the multiplexer, as explained before in chapter 6.12.1.

To set the fault detection, parameter H2-04 must be set as follows:

|     |       |                          |                     |              |
|-----|-------|--------------------------|---------------------|--------------|
| 005 | H2-04 | Source of custom fault 1 | 1400                | 1400         |
| 006 | H2-05 | Source of custom fault 2 | 0[ Inactive]        | 0[ Inactive] |
| 007 | H2-06 | Source of custom fault 3 | 1[ Active]          | 0[ Reserved] |
| 008 | H2-07 | Source of custom fault 4 | Other[ B-connector] | 0[ Reserved] |

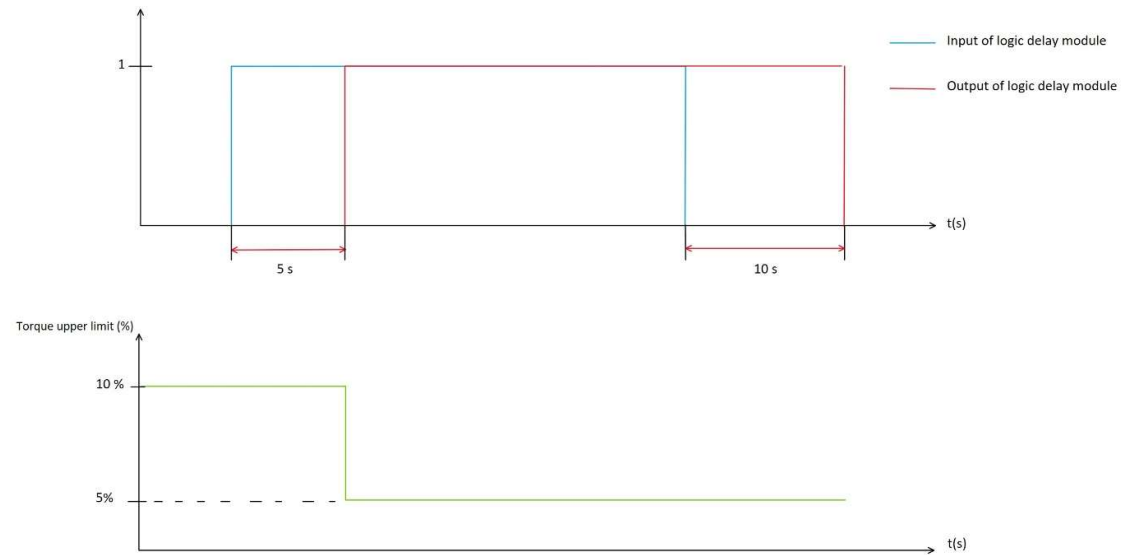
With this configuration, when AI drops under the value set on multi-reference 1, fault error E027.1 will trigger.

To be able to reset the fault, the value of AI must be higher than the reference value, or the drive won't be able to start.

## 7.3 CONTROLLING TORQUE UPPER LIMIT WITH A LOGIC DELAY AND A SELECTOR MODULES

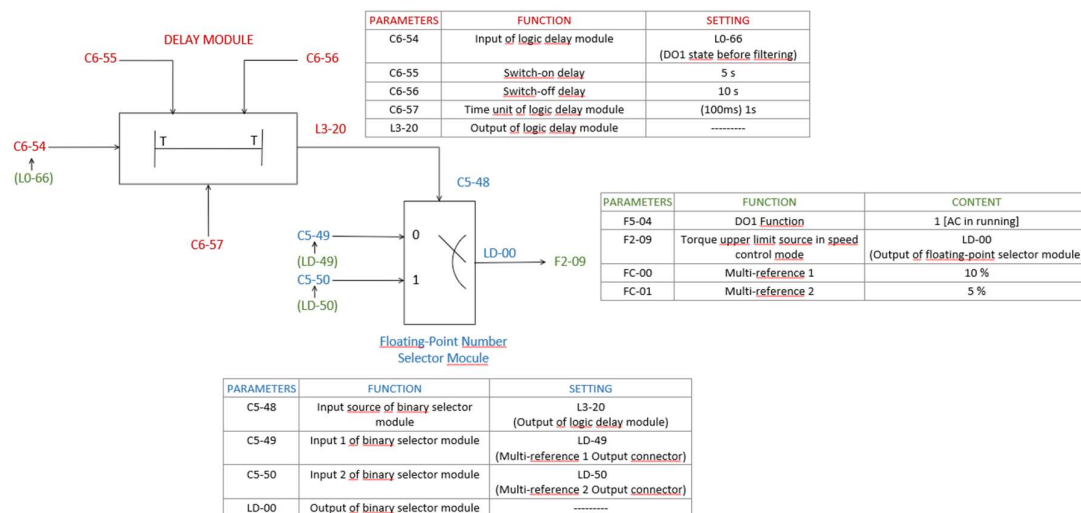
Logic modules can be connected one after the other in order to have more complex control applications.

In this case, a logic delay module will control the floating-point selector module output according to the RUN signal of the drive and the time since the RUN command has been given and since the STOP command is given (RUN signal OFF).

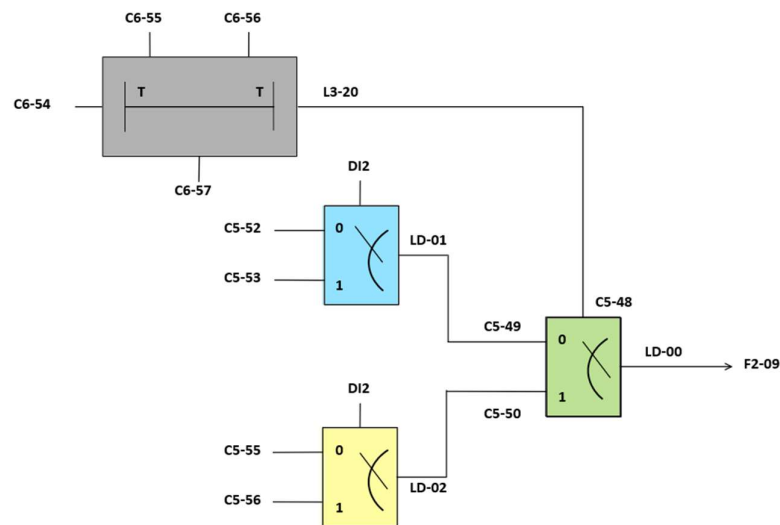


The previous time graph shows how torque upper limit values are selected. These two values switch with the other according to which delay is counting on the logic delay module. When the RUN command is ON, the torque upper limit stays with the first value (10 % for example as shown on the graph) while the time set on switch-on delay (5 s for example as shown on the graph) is counting and the output of the logic delay module is 0. Once it ends, the output of the logic delay module goes 1 and the torque upper limit switches to the second value (5 % for example as shown on the graph).

When the switch-off delay ends, the torque upper limit will change to the first value again. The following image shows the interconnection between both modules, with all the parameters needed to set and its settings.



This application can be expanded adding another floating-point selector module on each input of the current floating-point selector module. This adds the possibility of control the torque upper limit for each direction of the drive (FWD: forward, REV: reverse):



On the inputs of the selectors will go the Multi-reference values, (4 in total for this example). On the last selector will output the value selected from one of the other selectors and according to the delay running at that moment. The values on the new selectors will be selected by DI2, which also changes the direction of the drive, so on the top new selector we will set the **maximum** values of torque upper limit for forward and reverse directions and, on the other selector, we will set the **minimum** values of the upper torque limit for forward and reverse directions.

This same application can be controlled by a function of MD520 called frequency reach, where when the value of threshold set is reached, gives an output. With this function we can also control the torque upper limit but using the running frequency instead of the time passed.