DO139

1. General Information

The electrically isolated 8-channel DO139 digital output module can be wired either as highside or lowside or as a push/pull output for controlling DC motors with a nominal voltage of 12 - 24 VDC at nominal current up to 0.5 A.

Normal and TPU mode operation is possible (see section 9 "Operating Modes" on Page 6).

2. Order Data

Model Number	Short Description	Image
7DO139.70	2003 digital output module, 8 outputs 12 - 24 VDC, 0.5 A, short-circuit protection, thermal overload protection, screw-in module. Order 1 x TB712 terminal block separately.	
7TB712.9	Accessory terminal block, 12-pin, screw clamp, 1.5 mm²	
7TB712.91	Accessory terminal block, 12-pin, cage clamp, 1.5 mm²	
7TB712:90-02	Accessory terminal block, 12-pin , 20 pieces, screw clamp, 1.5 mm²	
7TB712:91-02	Accessory terminal block, 12-pin, 20 pieces, cage clamp, 1.5 mm²	
Not included in delivery is the 1 x TB712 terminal block.		

Table 1: DO139 order data

3. Technical Data

Product ID	7DO139.70
General Information	
C-UL-US Listed	Yes
Module Type	B&R 2003 screw-in module
Slot	Adapter module, CP interface Power Panel interface

Table 2: DO139 technical data

Product ID	7DO139.70
B&R ID Code	$52
Static Characteristics	
Number of Outputs	8
Type	FET
Design	Highside • Lowside • Push/Pull
Status Display	No

Diagnostics Status
   Voltage Monitoring
   Output Monitoring
	11.5 V < supply voltage < 30 V
	Output OK

Switching Voltage/Supply
   Minimum
   Nominal
   Maximum
	11.5 VDC
	12 -24 VDC
	30 VDC

Continuous Current per
   Output
   Module
	Max. 0.5 A
	Max. 4 A

Leakage Current when Switched Off @ 24 VDC	<40 µA
Residual Voltage	0.2 V @ 0.5 A
Short Circuit Current	Typ. 4 A
Switching On after Overload Cutoff	Automatic within seconds (depending on the module temperature)

Power Consumption
   Internal
   24 VDC supply voltage
	Max. 0.25 W
	Max. 1.8 W

Protection	Thermal cutoff Integrated protection for switching inductances Reverse polarity protection 24 VDC supply voltage for digital outputs - Maximum current 5 A (blow-out fuse)
Dynamic Characteristics	

Switching Delay
   Log. 0 - Log. 1
   Log. 1 - Log. 0
	Max. 450 µs
	Max. 450 µs

Switching Frequency Resistive Load	Max. 100 Hz
Operating Characteristics	

Electrical Isolation
   Output - PLC
   Output - Output
	Yes
	No

Mechanical Characteristics	
Dimensions	B&R 2003 screw-in module

Table 2: DO139 technical data (cont.)

4. Pin Assignments

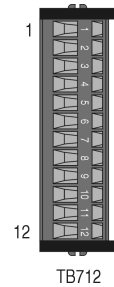| DO139 Pin Assignment		
Terminal	**Assignment**	
1	Output 1	
2	Output 2	
3	Output 3	
4	Output 4	
5	Output 5	
6	Output 6	
7	Output 7	
8	Output 8	
9	NC	
10	NC	
11	+12 to +24 VDC	
12	GND	

Table 3: DO139 pin assignment

5. Connection Example

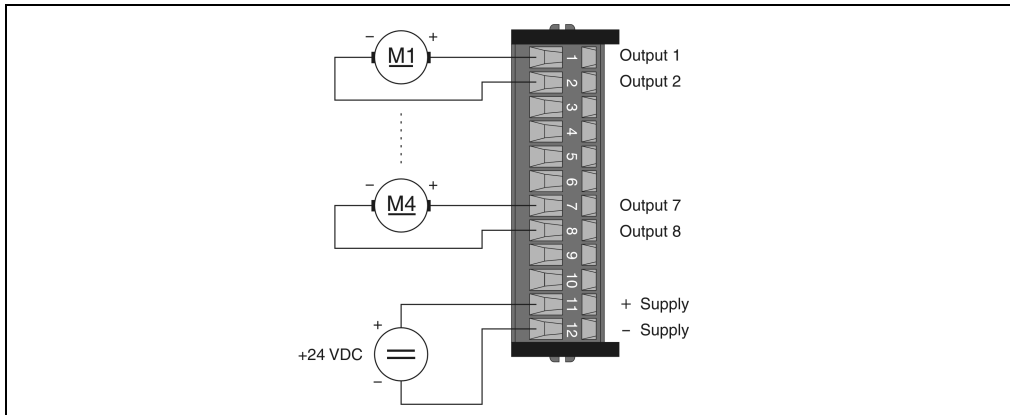## 5.1 Full-bridge Operation

Figure 1: DO139 full-bridge operation
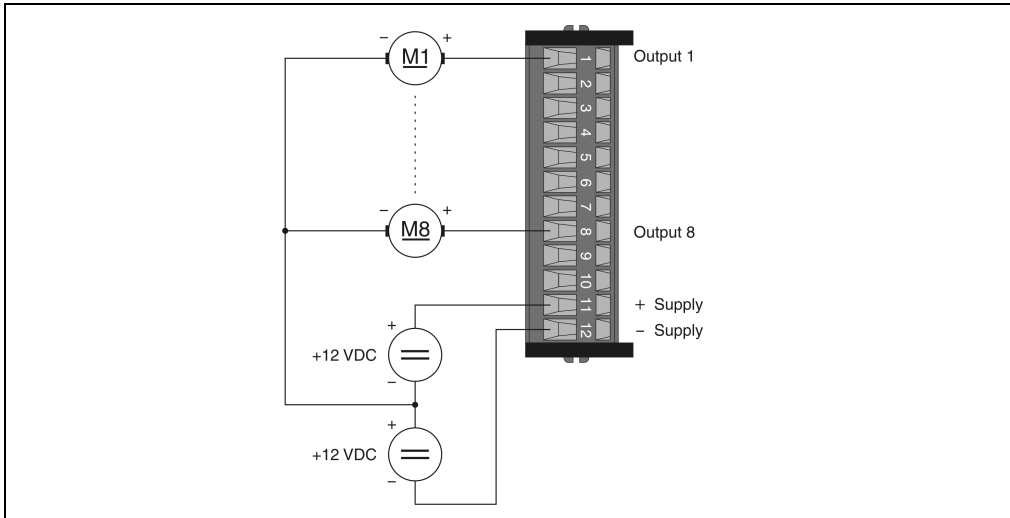
5.2 Half-bridge Operation

Figure 2: DO139 half-bridge operation

5.3 Highside or Lowside Operation
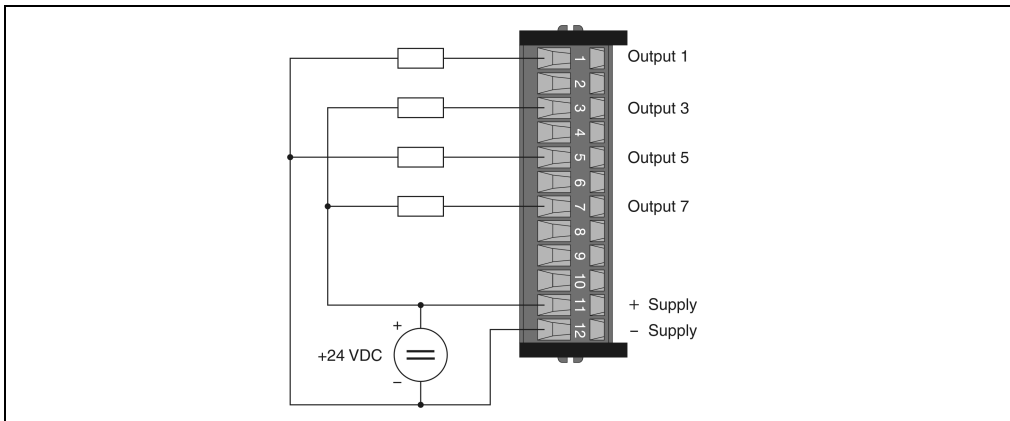

Figure 3: DO139 highside or lowside operation
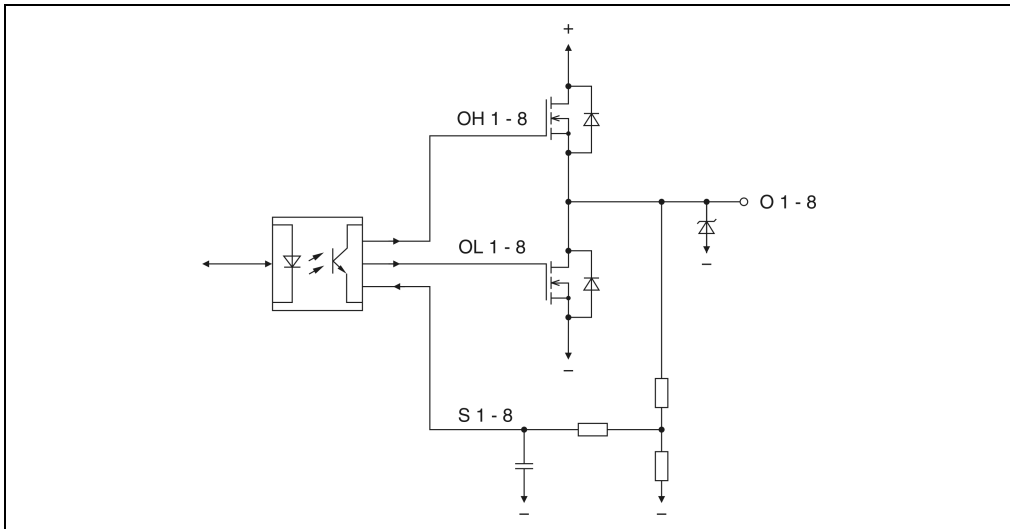
6. Output Circuit Diagram

Figure 4: DO139 output circuit diagram

7. Monitoring the Supply Voltage
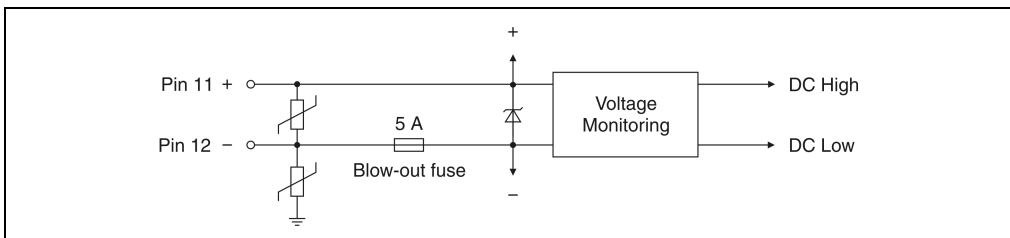
Figure 5: DO139 monitoring the supply voltage

8. Output Monitoring

The output states are compared to the set values during each I/O cycle. The status can be read using a register. An accumulative bit for output monitoring is created in the module status. Individual channels can be masked, allowing an alarm to be supressed.

Due to the possible low operating voltage of 11.5 V, the LOW level for the output reading is only given at an output voltage of <2.5 V.

9. Operating Modes

9.1 Normal Mode

The module is in normal mode after being switched-on or after a reset. Data access takes place cyclically using data and configuration words.

9.2 TPU Mode

To speed up operation of the digital outputs and output states which have been read back, the module can be switched to TPU mode.

I/O operation takes place using a serial protocol (I²C) via the TPU pins, which are operated using LTX functions.

- TPU functionality can be activated using configuration word 14 (see section 10.2.5 "Configuration Word 14 (write)" on Page 13).
- Operation takes place using I²C LTX functions
- TPU functionality is available on slots 1 to 3 when using a Power Panel.
- TPU functionality is available on slots 1 to 4 when using the B&R SYSTEM 2003.
- Maximum switching frequency should be observed

10. Variable Declaration

The variable declaration is valid for the following controllers:

- CPU for the PLC 2003
- ETHERNET Powerlink bus controller
- CAN bus controller

B&R Automation Studio™ Support: See B&R Automation Studio™ Help starting with V 1.40

After booting, the DO139 digital module logically corresponds to an analog module. Communication takes place using shovel instructions from data and configuration words.

Addressing screw-in modules is also explained in the B&R SYSTEM 2003 User's Manual in sections "AF101" and "CPUs".

The following table provides an overview of the data and configuration words that are used for this module.

Data Access	VD Data Type	VD Module Type	VD Channel	R	W	Description
Data Word 0	UINT	Transp. In	0	●		Read-back output states and output monitoring for single channel evaluation
	UINT	Transp. Out	0		●	Switches output states and output driver to active/inactive
Configuration Word 12	UINT	Transp. In	24	●		Module status
Configuration Word 14	UINT	Transp. In	28	●		Module type
	UINT	Transp. Out	28		●	Module configuration

Table 4: DO139 data and configuration words

10.1 Access using CAN Identifiers

Access via CAN identifiers is used if the slave is being controlled by a device from another manufacturer. Access via CAN identifiers is described in an example in B&R SYSTEM 2003 User's Manual, Chapter 4 "Module Addressing" . The transfer modes are explained in Chapter 5, "CAN Bus Controller Functions".

10.1.1 Input Data (output states which have been read back)

The output states which have been read back can be transferred in packed or unpacked mode. CAN objects can only be sent back in packed mode.

CAN ID [1]	Slot 1		Slot 2		Slot 3		Slot 4	
542	ScrM 1L	ScrM 1H	ScrM 2L	ScrM 2H	ScrM 3L	ScrM 3H	ScrM 4L	ScrM 4H
543	Free							
544	Free							
545	Free							

Table 5: DO139 input data packed

1) CAN ID = 542 + (nn - 1) x 16 + (ma - 1) x 4
 nn .... Node number of the CAN slave = 1
 ma ... Module address of the AF101 = 1

Four CAN objects can be sent back in unpacked mode.

Slot	CAN ID [1]	Word 1		Word 2	Word 3	Word 4
1	542	ScrM 1L	ScrM 1H	Not used (2 byte objects)		
2	543	ScrM 2L	ScrM 2H	Not used (2 byte objects)		
3	544	ScrM 3L	ScrM 3H	Not used (2 byte objects)		
4	545	ScrM 4L	ScrM 4H	Not used (2 byte objects)		

Table 6: DO139 input data unpacked

1) CAN ID = 542 + (nn - 1) x 16 + (ma - 1) x 4 + (sl - 1)
 nn .... Node number of the CAN slave = 1
 ma ... Module address of the AF101 = 1
 sl ..... Slot number of the screw-in module on the AF101 (1 - 4)

Note:

B&R 2000 users have to exchange the data so that the high data is first (Motorola format)!

For more information on ID allocation, please refer to the B&R SYSTEM 2003 User's Manual, Chapter 5 "CAN Bus Controller Functions".

10.1.2 Output Data

The output states can be transferred in packed or unpacked mode. CAN objects can only be transferred in packed mode.

CAN ID [1]	Slot 1		Slot 2		Slot 3		Slot 4	
1054	ScrM 1L	ScrM 1H	ScrM 2L	ScrM 2H	ScrM 3L	ScrM 3H	ScrM 4L	ScrM 4H
1055	Free							
1056	Free							
1057	Free							

Table 7: DO139 output data packed

1) CAN ID = 1054 + (nn - 1) x 16 + (ma - 1) x 4
nn .... Node number of the CAN slave = 1
ma ... Module address of the AF101 = 1

Four CAN objects can be transferred in unpacked mode.

Slot	CAN ID [1]	Word 1		Word 2	Word 3	Word 4
1	1054	ScrM 1L	ScrM 1H	Not used (2 byte objects)		
2	1055	ScrM 2L	ScrM 2H	Not used (2 byte objects)		
3	1056	ScrM 3L	ScrM 3H	Not used (2 byte objects)		
4	1057	ScrM 4L	ScrM 4H	Not used (2 byte objects)		

Table 8: DO139 output data unpacked

1) CAN ID = 1054 + (nn - 1) x 16 + (ma - 1) x 4 + (sl - 1)
nn .... Node number of the CAN slave = 1
ma ... Module address of the AF101 = 1
sl ..... Slot number of the screw-in module on the AF101 (1 - 4)

Note:

B&R 2000 users have to exchange the data so that the high data is first (Motorola format)!

For more information on ID allocation, please refer to the B&R SYSTEM 2003 User's Manual, Chapter 5 "CAN Bus Controller Functions".

10.2 Description of Data and Configuration Words

10.2.1 Data Word 0 (read)

Bits 0 - 7 contain output states which have been read back.

Bits 8 - 15 contain the status for output monitoring.

Bit	Description
0	Output 1 Status
1	Output Status 2
2	Output 3 Status
3	Output Status 4
4	Output 5 Status
5	Output Status 6
6	Output 7 Status
7	Output Status 8
8	0 ... Output 1 OK 1 ... Short circuit on output 1
9	0 ... Output 2 OK 1 ... Short circuit on output 2
10	0 ... Output 3 OK 1 ... Short circuit on output 3
11	0 ... Output 4 OK 1 ... Short circuit on output 4
12	0 ... Output 5 OK 1 ... Short circuit on output 5
13	0 ... Output 6 OK 1 ... Short circuit on output 6
14	0 ... Output 7 OK 1 ... Short circuit on output 7
15	0 ... Output 8 OK 1 ... Short circuit on output 8

10.2.2 Data Word 0 (write)

Bits 0 - 7 define the output status:

State	Description
0	Output switched off
1	Output switched on

Table 9: DO139 definition for output states

Bits 8 - 15 switch the output driver to active or inactive:

State	Description
0	Output driver inactive (high-resistance = tristate)
1	Output driver active (the level is defined by bits 0 - 7)

Table 10: DO139 - output driver switched to active or inactive

Bit	Description
0	Output 1
1	Output 2
2	Output 3
3	Output 4
4	Output 5
5	Output 6
6	Output 7
7	Output 8
8	Switches output driver 1 to active or inactive (high-resistance = tristate)
9	Switches output driver 2 to active or inactive (high-resistance = tristate)
10	Switches output driver 3 to active or inactive (high-resistance = tristate)
11	Switches output driver 4 to active or inactive (high-resistance = tristate)
12	Switches output driver 5 to active or inactive (high-resistance = tristate)
13	Switches output driver 6 to active or inactive (high-resistance = tristate)
14	Switches output driver 7 to active or inactive (high-resistance = tristate)
15	Switches output driver 8 to active or inactive (high-resistance = tristate)

10.2.3 Configuration Word 12 (reading)

Configuration word 12 contains the module status.

Bit	Description
0	Group monitoring for the outputs. 0 ... Outputs OK 1 ... Output monitoring for a channel has been accessed. Single channel evaluation using data word 0 (read).
1 - 7	Not defined, masked out
8	0 ... Supply voltage is in the valid range (11.5 V < supply voltage < 30 V) 1 ... Supply voltage too low ($\leq$11.5 V)
9	0 ... Supply voltage is in the valid range (11.5 V < supply voltage < 30 V) 1 ... Supply voltage too high ($\geq$30 V)
10 - 15	Not defined, masked out

10.2.4 Configuration Word 14 (reading)

The high byte of configuration word 14 defines the module code.

Bit	Description
0 - 7	Not defined, masked out
8 - 15	Module Code: $52

10.2.5 Configuration Word 14 (write)

The module is configured using configuration word 14.

Bit	Description
0	The outputs are monitored by the module. The status of this group monitoring is shown by the module status in bit 0 and can be evaluated by the user.
	If a CAN bus controller is used, an alarm message is automatically generated by the bus controller on one of the digital outputs when an error has been recognized. It corresponds to the alarm message "Open Connection or Sensor Open" (see Appendix B "CAN Bus Controller Error Messages" in the B&R SYSTEM 2003 User's Manual). The generation of this alarm message can be deactivated by setting bit 0. The bit in the module status is processed further.
	0 ... Alarm message of group monitoring for outputs is activated (when used with a CAN bus controller)
	1 ... Alarm message of group monitoring for outputs is deactivated (when used with a CAN bus controller)
1 - 7	0
8	The supply voltage of the digital outputs is monitored by the module for the lower threshold value. The status is shown by the module status in bit 8 and can be evaluated by the user.
	If a CAN bus controller is used, an alarm message is automatically generated by the bus controller when the permitted supply voltage range has not been reached. It corresponds to the alarm message "Measurement Range not Reached" (see Appendix B "CAN Bus Controller Error Messages" in the B&R SYSTEM 2003 User's Manual). The generation of this alarm message can be deactivated by setting bit 8. The bit in the module status is processed further.
	0 ... Supply voltage monitoring alarm message for outputs to the lower threshold value is activated (when used with a CAN bus controller)
	1 ... Supply voltage monitoring alarm message for outputs to the lower threshold value is deactivated (when used with a CAN bus controller)
9	The supply voltage of the digital outputs is monitored by the module for the upper threshold value. The status is shown by the module status in bit 9 and can be evaluated by the user.
	If a CAN bus controller is used, an alarm message is automatically generated by the bus controller when the permitted supply voltage range has been exceeded. It corresponds to the alarm message "Measurement Range Exceeded" (see Appendix B "CAN Bus Controller Error Messages" in the B&R SYSTEM 2003 User's Manual). The generation of this alarm message can be deactivated by setting bit 9. The bit in the module status is processed further.
	0 ... Supply voltage monitoring alarm message for outputs to the upper threshold value is activated (when used with a CAN bus controller)
	1 ... Supply voltage monitoring alarm message for outputs to the upper threshold value is deactivated (when used with a CAN bus controller)
10 - 14	0
15	0 ... Normal mode
	1 ... Switches to TPU mode