1.1 MM432

1.1.1 General Information

The motor bridge module MM432 is used to control two DC motors with a nominal voltage of 10 - 24 VDC at a nominal current up to 4 A. The module is also equipped with two ABR channels as well as six normal digital inputs for creating positioning tasks which are not too complex.

Each motor is controlled with a full-bridge (H-bridge). Therefore, the motors can be moved in both directions. Each bridge branch has its own supply voltage allowing two different motors with different voltages to be used. Each channel has current measurement, supply voltage measurement, and short circuit recognition to ground and to the positive supply voltage. Motor control takes place using a 16 kHz PWM signal and is therefore mostly noise-free.

A local processor provides the required intelligence and is used for communication with the higher level CPU. It handles the preparation of the ABR inputs and normal digital inputs, the control of both motors (each with a PWM signal) and the analog measurements.

1.1.2 Order Data

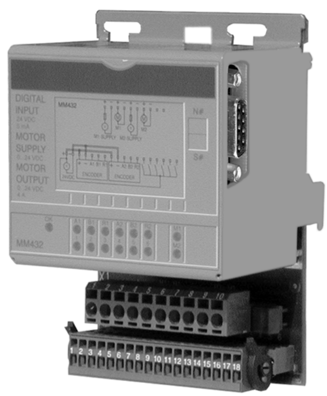
Model Number	Short Description	Image
7MM432.70-1	2003 motor bridge module, two motor (H) bridges, 10 - 30 VDC @ 4 A, peak current up to 8 A (max. 2 s), integrated current controller, electronic overcurrent protection, 12 digital 24 V inputs, can be optionally used for limit and position detection (counter functions, 20 kHz A/B/R evaluation), status LEDs, terminal blocks should be ordered separately.	
7TB710.9	Terminal block, 10 pin, screw clamps	
7TB710.91	Terminal block, 10 pin, cage clamps	
7TB710:90-01	Terminal block, 10 pin, 30 pcs., screw clamps	
7TB710:91-01	Terminal block, 10 pin, 30 pcs., cage clamps	
7TB718.9	Terminal block, 18 pin, screw clamps	
7TB718.91	Terminal block, 18 pin, cage clamps	
7TB718:90-02	Terminal block, 18 pin, 20 pcs., screw clamps	
7TB718:91-02	Terminal block, 18 pin, 20 pcs., cage clamps	
Terminal blocks are not included in the delivery.		

Table 1: MM432 order data

1.1.3 Technical Data

Description	MM432
General Information	
C-UL-US Listed	In preparation
B&R ID Code	$C4
Module Type	B&R 2003 I/O module
Number EX270 CP430, EX470, EX770 CP470, CP770, CP474, CP476, CP774 EX477, EX777	 1 2 4
Status Display	LEDs
Power Consumption	Max. 2.5 W
Environment Temperature during Operation	0 to 55 °C
Standard Inputs	
Amount	6
Design	Sink
Nominal Voltage	24 VDC
Maximum Input Voltage	30 VDC
Switching Threshold Low range Switching range High range	 < 5 V 5 - 15 V > 15 V
Input Impedance	Approx. 5 kΩ
Input Current	Approx. 5 mA @ 24 VDC
Input Delay	Max. 1 ms
Isolation	No electrical isolation
ABR Inputs	
Amount	6
Design	Sink
Nominal Voltage	24 VDC
Maximum Input Voltage	30 VDC
Switching Threshold Low range Switching range High range	 < 5 V 5 - 15 V > 15 V
Input Impedance	Approx. 5 kΩ
Input Current	Approx. 5 mA @ 24 VDC
Max. Input Frequency	20 kHz
Input Delay	Max. 6.5 µs
Operating Modes	Control inputs, incremental (4-fold evaluation)
Isolation	No electrical isolation

Table 2: MM432 technical data

Description	MM432
Motor Bridge - Power Element	
Amount	2
Supply Voltage	10 - 30 VDC
Max. Overvoltage	35 VDC
Nominal Current	4 A
Max. Current (electr. limited)	8 A (max. 2 s)
PWM Frequency	16 kHz
Protection	Ext. fuse 6.3 AT required, short circuit protection to ground and positive voltage per channel
Short Circuit Recognition	< 2.5 ms
Max. Short Circuit Current to Positive Voltage (lower bridge branch to positive voltage)	25 A ±25 %
Max. Short Circuit Current to Positive Voltage (upper bridge branch to GND)	50 A
Max. Short Circuit Current between Motor Lines (M+ to M-)	25 A ±25 %
Motor Bridge - Current Measurement	
Amount	2
Measurement Range	-0.1 to +8 A
Resolution	50 mA
Mechanical Characteristics	
Dimensions	B&R 2003 single width

Table 2: MM432 technical data

1.1.4 Status LEDs

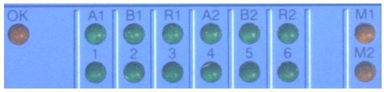
<table>
<tr><th colspan="3">Status LEDs</th></tr>
<tr><td colspan="3">
</td></tr>
<tr><th>LED</th><th colspan="2">Description</th></tr>
<tr><td>DCOK</td><td colspan="2">Lit as long as input supply is within the defined range.</td></tr>
<tr><td>LED Green (Ax, Bx, Rx, 1 - 6)</td><td colspan="2">Input state of the corresponding inputs.</td></tr>
<tr><td rowspan="7">LED Yellow (Mx)</td><td colspan="2">Control status of the corresponding output:</td></tr>
<tr><th>Control Status</th><th>Description</th></tr>
<tr><td>Static "On"</td><td>Output activiated, no error</td></tr>
<tr><td>Static "Off"</td><td>Output deactivated</td></tr>
<tr><td>Blinking (256 ms time-span)</td><td>Short circuit recognition activated</td></tr>
<tr><td>Blinking (512 ms time-span)</td><td>Over-current warning activated</td></tr>
<tr><td>Blinking (2 sec time-span)</td><td>Supply for inputs and electronics activated</td></tr>
</table>

Table 3: MM432 status LEDs

1.1.5 Pin Assignments

Power Element

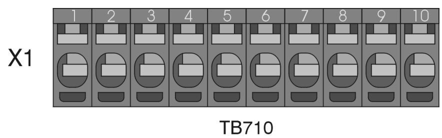
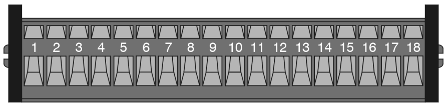
<table>
<tr><th colspan="3">Terminal Block X1</th></tr>
<tr><th>Terminal</th><th>Assignment</th><td rowspan="11">
</td></tr>
<tr><td>1</td><td>+ DC supply for motor 1</td></tr>
<tr><td>2</td><td>- DC supply for motor 1</td></tr>
<tr><td>3</td><td>+ Motor output motor 1</td></tr>
<tr><td>4</td><td>- Motor output motor 1</td></tr>
<tr><td>5</td><td>+ DC supply for motor 2</td></tr>
<tr><td>6</td><td>- DC supply for motor 2</td></tr>
<tr><td>7</td><td>+ Motor output motor 2</td></tr>
<tr><td>8</td><td>- Motor output motor 2</td></tr>
<tr><td>9</td><td>Not assigned</td></tr>
<tr><td>10</td><td>Not assigned</td></tr>
</table>

Table 4: MM432 pin assignment power element

Digital Inputs

Terminal Block X2	
Terminal	**Assignment**
1	+24 VDC supply for inputs and incremental encoder
2	GND
3	ABR encoder 1: +24 VDC supply
4	ABR encoder 1: GND
5	ABR encoder 1: A-Signal
6	ABR encoder 1: B-Signal
7	ABR encoder 1: R-Signal
8	ABR encoder 2: +24 VDC supply
9	ABR encoder 2: GND
10	ABR encoder 2: A-Signal
11	ABR encoder 2: B-Signal
12	ABR encoder 2: R-Signal
13	Digital input 1 (reference enable 1)
14	Digital input 2 (limit switch 1 left)
15	Digital input 3 (limit switch 1 right)
16	Digital input 4 (reference enable 2)
17	Digital input 5 (limit switch 2 left)
18	Digital input 6 (limit switch 2 right)

X2



TB718

Table 5: MM432 pin assignment digital inputs

1.1.6 Connection Example

Power Element

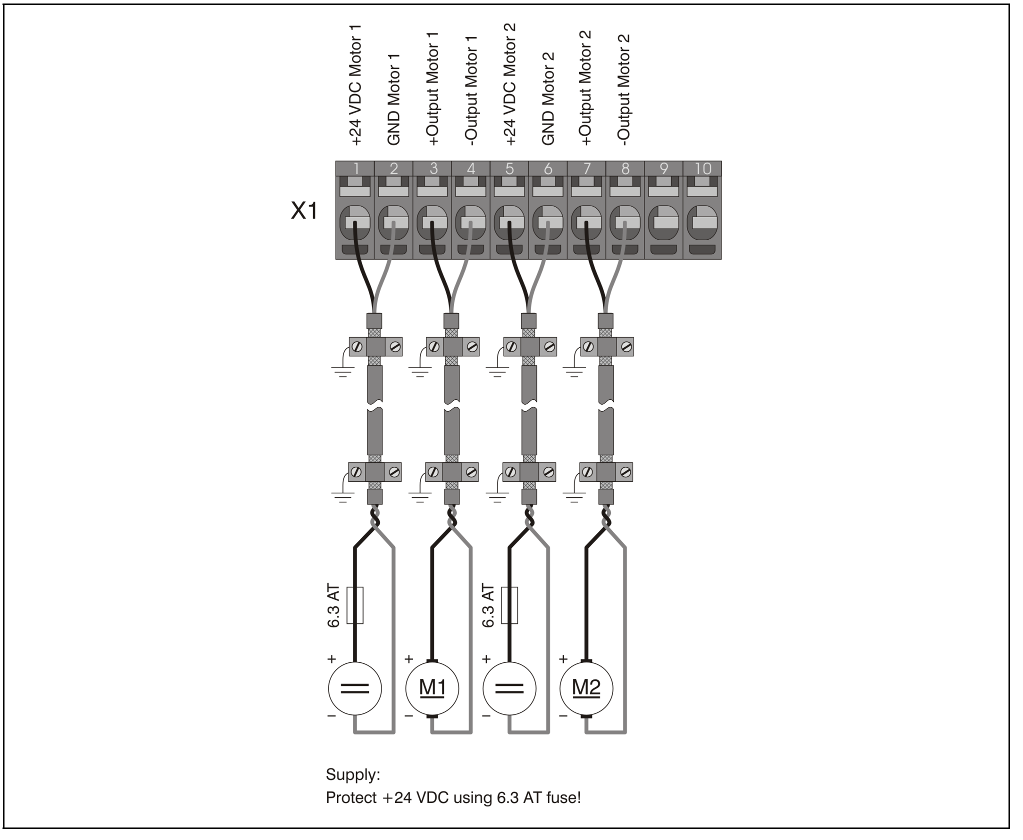


Figure 1: MM432 connection example for power element

Digital Inputs

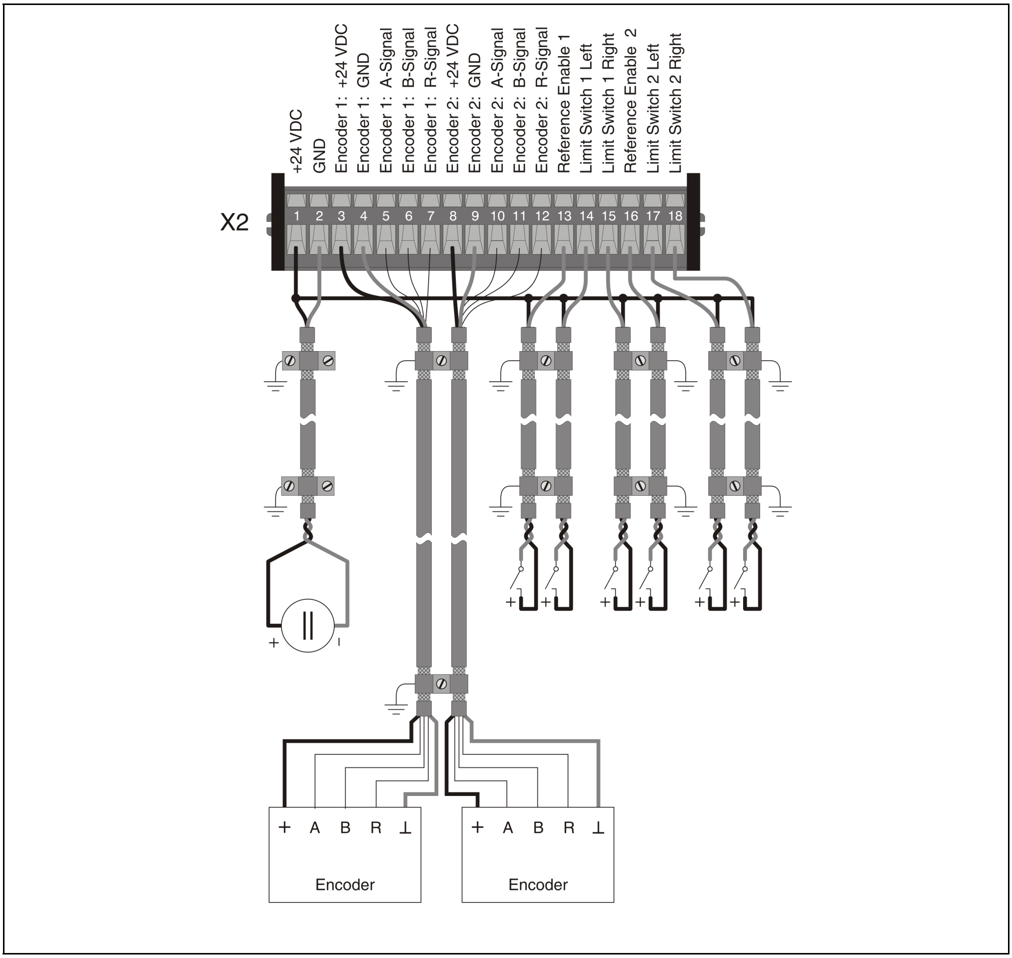


Figure 2: MM432 connection example for digital inputs

1.1.7 Input Circuit Diagram

Standard Inputs

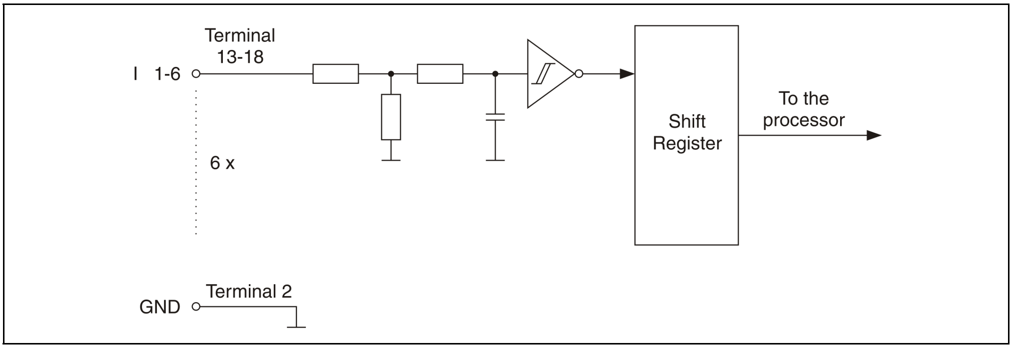


Figure 3: MM432 input circuit diagram for standard inputs

ABR Inputs

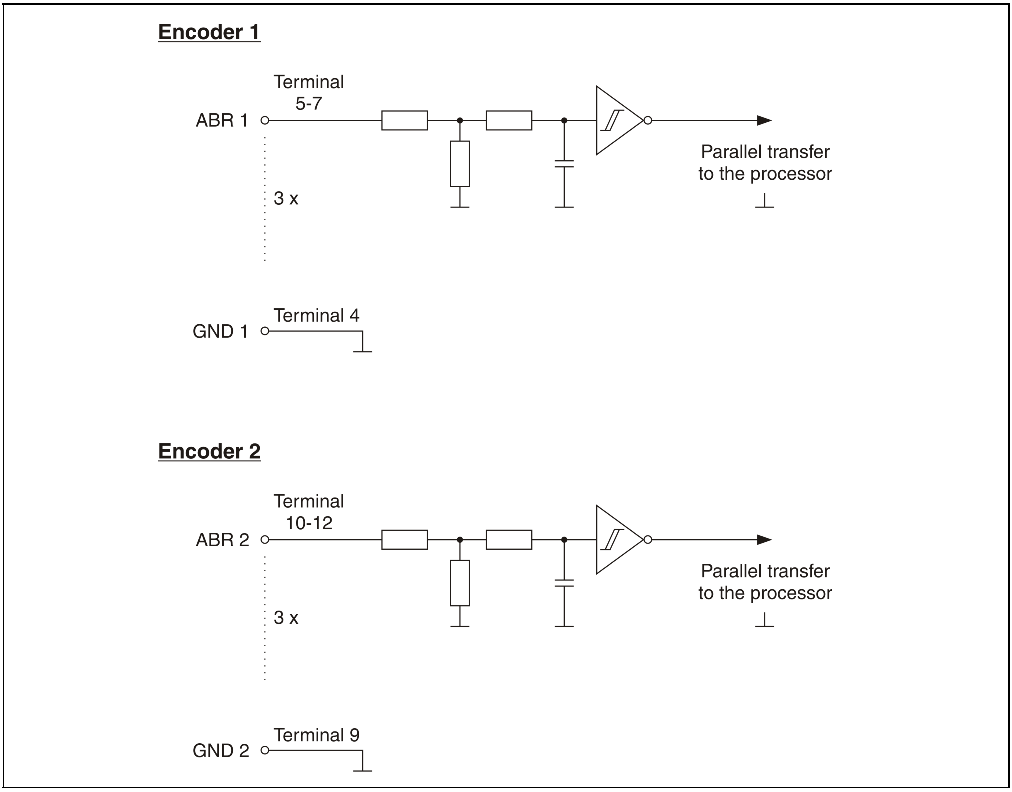


Figure 4: MM432 input circuit diagram for ABR inputs

1.1.8 Area of Use

General Information

The MM432 motor bridge module is designed for control of DC motors in the lower power range (typ. 80 W). Both directions are possible.

The main areas of use for the module are in those areas where frictional torque and its compensation play a decisive role. The module is less suited for dynamic control of acceleration torque (speed, position). The reason for this lies in the structure of a controller for the MM432.

Current and Torque Control

An electronic current controller is implemented on the MM432 module, which is configured by the PLC CPU. Since the current with the torque is proportional, the module treats torque control independently.

Acceleration and deceleration of currents ramps can also be configured, and executed using the module. The current must be monitored by the application so that the motor is not operated in generator mode. The current value is read and checked to see whether it lies within the negative range. The module does not have braking resistors.

Another integrated functionality which is possible is configuring a direction dependent motor cutoff, triggered using the limit switch.

RPM Control

RPM control is also available in addition to current and torque control. It must be performed by the CPU of the PLC. Data transfer times via the 2003 bus and the resulting jitter must be taken into consideration here.

Application Examples

- Drive controller for sliding doors
- Pump control for 2 components mixture

1.1.9 Limits for Area of Use

The areas of use are limited by both performance data and the controller properties (see Section 1.1.3 "Technical Data", on page 2 and Section 1.1.8 "Area of Use", on page 10). The following response times must be considered:

Timing	
Controller Cycle Time on the MM432 (current control)	1 ms (in comparison to ACOPOS: 50 µs)
PLC CPU Access Time to MM432 Data	Approximately 2.5 ms (configuration: CPU + MM432)
Recommended Task Classes	4 ms

Table 6: MM432 response time

It is important to ensure that data refresh for the MM432 proceeds asynchronously with loop control.

1.1.10 Module Structure

General Information

The design of the motor bridge module MM432 corresponds to an adapter module AF101 with four screw-in modules installed and a digital mixed module.

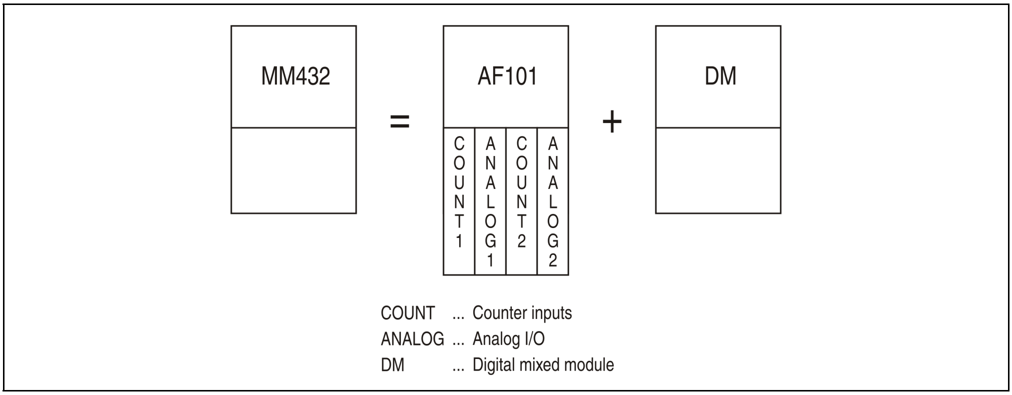


Figure 5: MM432 module deisgn

Module Addresses

Because of this special module design, the motor bridge module MM432 requires two module addresses.

A CPU, a motor bridge module MM432 and a digital input module DI435 are used in the example shown below. Module address assignments are to be made as shown in the diagram.

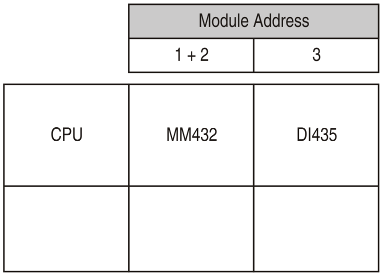


Figure 6: MM432 module addresses

Variable Declaration

To avoid conflicts in the register, the settings listed below must be used in the variable declaration for the module address and for the slot. In this case, the module is accessed with module addresses 1 and 2.

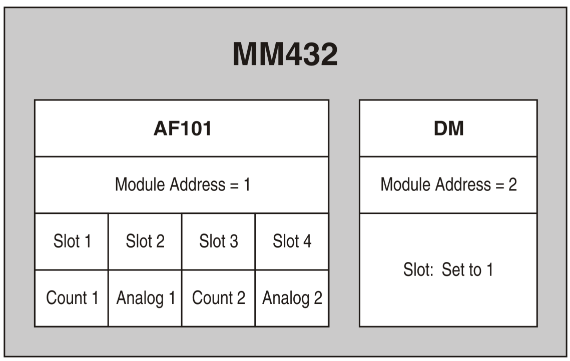


Figure 7: MM432 variable declaration

1.1.11 Timing

The following three factors must be taken into consideration for timing when a B&R 2003 CPU is used as the controller:

- Internal bus cycle
- I/O AF cycle
- I/O CPU load

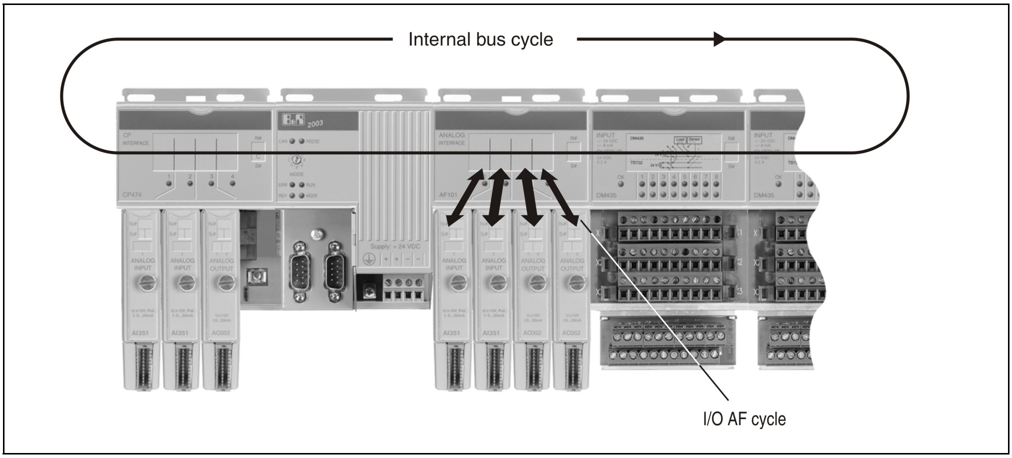


Figure 8: MM432 response time

Internal Bus Cycle

All motor bridge modules, combination modules, AF modules and digital I/O modules are processed during this time. The internal bus cycle for a MM432 is calculated as follows:

<u>There is no AF101 adapter module on the bus</u>

t_{int_cycle} = n * 36 µs * 8 +8 * 120 µs +1200 µs = 2448 µs (n = 1)

n ... Number of MM432 modules
36 µs ... Time for a motor bridge module MM432
8 ... Number of data words for a MM432
120 µs ... Motor bridge module MM432 busy
1200 µs ... Offset

There is an AF101 adapter module on the bus or a CPx74 is used as CPU

t_{int_cycle} = n * 36 µs * 8 +8 * 200 µs +1200 µs = 3088 µs   (n = 1)

n ... Number of MM432 modules
36 µs ... Time for a motor bridge module MM432
8 ... Number of data words for a MM432
200 µs ... AF101 or CPx74 busy
1200 µs ... Offset

I/O AF Cycle for Digital and Analog Data Points

During this time, all digital and analog data points on the motor bridge module MM432 are updated or read in internally.

$t_{dig\_IO\_AF} \leq$ 1 ms

$t_{an\_IO\_AF} \leq$ 1 ms

I/O CPU Load

This time determines how long the CPU requires to process the I/O data passed on by the motor bridge module MM432. The CPU is loaded considerably by the analog I/O data.

A CP430 or CPx70 is used as CPU

t_{IO_CPU} = 8 * 100 µs = 800 µs

8 ... Number of data words for a MM432
100 µs ... Analog data point on CP430 or CPx70

A CPx74 is used as CPU

t_{IO_CPU} = 8 * 70 µs = 560 µs

8 ... Number of data words for a MM432
70 µs ... Analog data point on CPx74

A CP476 is used as CPU

t_{IO_CPU} = 8 * 50 µs = 400 µs

8 ... Number of data words for a MM432
50 µs ... Analog data point on CP476

Task Class

Fastest Task Class Recommended: 4 ms

1.1.12 Variable Declaration for Incremental Encoder Operation

The variable declaration is valid for the following controllers:

- CPU for the PLC 2003
- Remote I/O bus controller
- CAN bus controller

Addressing screw-in modules is also explained in sections "AF101" and "CPU".

The module MM432 is equipped with two incremental encoders. The incremental encoders are on slots 1 and 3 (bridges 1 and 2). Operation is identical.

Incremental Encoder Operation with PLC 2003 CPU and Remote Slave

Data access takes place using data and configuration words. 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 Chan.	R	W	Description
Data Word 0	UINT	Analog In	0	●		Module status
Data Word 1	DINT	Analog In	2	●		Counter value
Configuration Word 12	UINT	Transp. In	24	●		Module status (current status unlatched)
Configuration Word 14	UINT	Transp. In	28	●		Module type
	UINT	Transp. Out	28		●	Module configuration

Table 7: MM432 data and configuration words incremental encoder operation with CPU and remote slave

Incremental Encoder Operation with CAN Slaves

Data access takes place using data and configuration words. 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 Chan.	R	W	Description
Data Word 0	DINT	Analog In	0	●		Counter value
Data Word 2	UINT	Analog In	4	●		Module status
Configuration Word 12	UINT	Transp. In	24	●		Module status (current status unlatched)
Configuration Word 14	UINT	Transp. In	28	●		Module type
	UINT	Transp. Out	28		●	Module configuration

Table 8: MM432 data and configuration words incremental encoder operation with CAN slave

Note:

B&R 2000 users have to exchange the two counter status words so that the high word is first (Motorola format)!

Access using CAN IDs

Access via CAN IDs is used if the slave is being controlled by a device from another manufacturer. Access via CAN IDs is described in an example in section "Module Addressing" . The transfer modes are explained in section "CAN Bus Controller".

Note:

For both incremental encoders, B&R 2000 users must exchange the data so that the high data is first (Motorola format)!

Incremental Encoder 1

In the example below, the motor bridge module MM432 is accessed with module addresses 1 and 2.

Slot	CAN-ID [1)]	Word 1		Word 2		Word 3		Word 4
1	542	Counter LL	Counter ML	Counter MH	Counter HH	Status L	Status H	Not used
2	543	Not used						
3	544	Not used						
4	545	Not used						

Table 9: MM432 access using CAN IDs, incremental encoder 1

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

For more information on ID allocation, see section "CAN Bus Controller".

Incremental Encoder 2

In the example below, the motor bridge module MM432 is accessed with module addresses 1 and 2.

Slot	CAN-ID [1)]	Word 1		Word 2		Word 3		Word 4
1	542	Not used						
2	543	Not used						
3	544	Counter LL	Counter ML	Counter MH	Counter HH	Status L	Status H	Not used
4	545	Not used						

Table 10: MM432 access using CAN IDs, incremental encoder 2

1) CAN-ID = 542 + (nn - 1) x 16 + (ma - 1) x 4 + (sl - 1)
   nn .... Node number of the CAN slaves = 1
   ma ... Module address = 1
   sl ..... Slot number = 3

For more information on ID allocation, see section "CAN Bus Controller".

Description of Data and Configuration Words

Data Word 0 (read)

Data word 0 includes the module status time constant for the counter value.

Bit	Description
0	Level of the reference pulse
1	Level of the reference enable switch
2	Level of encoder input B
3	Level of encoder input A
4	Not defined, masked out
5	0 ... Supply voltage for the incremental encoder< 18 V 1 ... Supply voltage for the incremental encoder> 18 V
6	Changes state each time referencing takes place
7	0 ... Referencing is taking place 1 ... Counter is referenced (resetting takes place when the reference command is received)
8 - 15	Not defined, masked out

Data Word 1 (read)

Counter value MSW.

Data Word 2 (read)

Counter value LSW.

Configuration Word 12 (read)

Configuration word 12 contains the module status (current status unlatched). The module status is written to data word 0.

Configuration Word 14 (read)

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

Bit	Description
0 - 7	Not defined, masked out
8 - 15	Module code: $42

Configuration Word 14 (write)

The module is configured using configuration word 14.

Bit	Description
0 - 3	0
4	0 ... No effect on counter 1 ... Clear counter (reference)
5	0 ... Ignore reference enable switch (referencing using reference pulse). Setting refers to bit 4 1 ... Actively switch reference enable switch (referencing using reference pulse and reference enable switch)
6	0 ... Set counter immediately to 0. In data word 0 (module status), bit 7 is immediately set to 1 and the counter is cleared. 1 ... Counter remains functioning. In data word 0 (module status), bit 7 is immediately set to 0 (referencing required).
7	0 ... No effect on reference pulse 1 ... Reference pulse is inverted. This setting is used for encoders with a high pulse.
8 - 10	0
11	0 ... No effect on count direction 1 ... Count direction inverted as compared to counter wiring
12 - 14	0
15	This function is only available in configuration word 14 for incremental encoder 1! The inputs for limit switch and reference enable for each standard setting are filtered with a software filter of 4 ms. This filtering can be switched on or off for both bridges with this bit. 0 ... Software filter switched on 1 ... Software filter switched off

1.1.13 Variable Declaration for Analog Input Data

The variable declaration is valid for the following controllers:

- CPU for the PLC 2003
- Remote I/O bus controller
- CAN bus controller

Addressing screw-in modules is also explained in sections "AF101" and "CPU".

The analog input data is divided on slots 2 and 4 (bridges 1 and 2) with the module MM432. Operation is identical.

Data access takes place using data and configuration words. 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 Chan.	R	W	Description
Data Word 0	INT	Analog In	0	●		Actual value for the output current
Configuration Word 8	INT	Transp. In	16	●		Supply voltage for the PWM channel
Configuration Word 9	UINT	Transp. In	18	●		Digital signals
Configuration Word 11	UINT	Transp. In	22	●		Acknowledgment for special functions (only on slot 2)
Configuration Word 12	UINT	Transp. In	24	●		Module status
Configuration Word 13	UINT	Transp. Out	26		●	Commands for special functions (only on slot 2)

Table 11: MM432 data and configuration words for analog input data

Access using CAN IDs

Access via CAN IDs is used if the slave is being controlled by a device from another manufacturer. Access via CAN IDs is described in an example in section "Module Addressing" . The transfer modes are explained in section "CAN Bus Controller".

Note:

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

Analog Input Data 1

In the example below, the motor bridge module MM432 is accessed with module addresses 1 and 2.

Analog input data cannot be packed. Only the second object from this group of four will be created and sent.

Slot	CAN-ID 1)	Word 1	Word 2	Word 3	Word 4
1	542	Not used			
2	543	Channel 1L Channel 1H	Not used		
3	544	Not used			
4	545	Not used			

Table 12: MM432 access using CAN IDs, analog input data 1

1) CAN-ID = 542 + (nn - 1) x 16 + (ma - 1) x 4 + (sl - 1)
nn .... Node number of the CAN slaves = 1
ma ... Module address = 1
sl ..... Slot number = 2

For more information on ID allocation, see section "CAN Bus Controller".

Analog Input Data 2

In the example below, the motor bridge module MM432 is accessed with module addresses 1 and 2.

Analog input data cannot be packed. Only the fourth object from this group of four will be created and sent.

Slot	CAN-ID 1)	Word 1	Word 2	Word 3	Word 4
1	542	Not used			
2	543	Not used			
3	544	Not used			
4	545	Channel 1L Channel 1H	Not used		

Table 13: MM432 access using CAN IDs, analog input data 2

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

For more information on ID allocation, see section "CAN Bus Controller".

Description of Data and Configuration Words

Data Word 0 (read)

Data word 0 includes the internally measured actual value in the module for the output current. The value is standardized with the unit [mA] to 16 bit.

Configuration Word 8 (read)

Configuration word 8 contains the supply voltage for the PWM channel. The value is standardized with the unit [V] to 16 bit.

Configuration Word 9 (read)

Configuration word 9 contains an image of the digital signals.

Bit	Description
0	Level of encoder input A
1	Level of encoder input B
2	Level of the reference pulse
3	Level of the reference enable switch
4	Level for the left limit (for limiting the negative set value)
5	Level for the right limit (for limiting the postive set value)
6	Not defined, masked out
7	Cumulative Report : Limit left/right 0 ... No limit reached 1 ... The left or right limit switch has responded
8	Cumulative Report: Error on the bridge 0 ... No error occured 1 ... An error has occured on the bridge
9	Short circuit monitoring for the upper bridge branch to GND 0 ... No short circuit has occured 1 ... A short circuit has occured on the bridge in the upper bridge branch
10	Short circuit monitoring for the lower bridge branch to positive voltage 0 ... No short circuit has occured 1 ... A short circuit has occured on the bridge in the lower bridge branch
11 - 15	Not defined, masked out

Configuration Word 12 (read)

Configuration word 12 contains the module status.

Bit	Description
0	0 ... Measurement of the motor bridges supply voltage is OK 1 ... Error during measurement of the motor bridges supply voltage
1	0 ... Measurement of the output current actual value OK 1 ... Error when measuring the output current actual value
2 - 10	Not defined, masked out
11	0 ... Converter value ready 1 ... Converter value not yet ready
12 - 15	Not defined, masked out

1.1.14 Variable Declaration for Analog Output Data

The variable declaration is valid for the following controllers:

- CPU for the PLC 2003
- Remote I/O bus controller
- CAN bus controller

Addressing screw-in modules is also explained in sections "AF101" and "CPU".

The analog output data is divided on slots 2 and 4 (bridges 1 and 2) with the module MM432. Operation is identical.

Data access takes place using data and configuration words. 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 Chan.	R	W	Description
Data Word 0	INT	Analog Out	0		●	PWM: Pulse Width Ratio Current Controller Op.: Current set value
Configuration Word 6	DINT	Transp. Out	12		●	Current Controller Op.: Controller proportional factor
Configuration Word 8	UINT	Transp. Out	16		●	Current Controller Op.: Integral action time for contoller
Configuration Word 9	INT	Transp. Out	18		●	Current Controller Op.: Standardization of the current
Configuration Word 10	INT	Transp. Out	20		●	Limit value
Configuration Word 11	UINT	Transp. Out	22		●	Ramp slope for the set value ramp
Configuration Word 12	UINT	Transp. Out	24		●	Set value for the limit switch input
Configuration Word 14	UINT	Transp. In	28	●		Module type
	UINT	Transp. Out	28		●	Module configuration

Table 14: MM432 data and configuration words for analog output data

Access using CAN IDs

Access via CAN IDs is used if the slave is being controlled by a device from another manufacturer. Access via CAN IDs is described in an example in section "Module Addressing" . The transfer modes are explained in section "CAN Bus Controller".

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

<u>Analog Output Data 1</u>

In the example below, the motor bridge module MM432 is accessed with module addresses 1 and 2.

Analog output data cannot be packed. Only the second object from this group of four will be created and sent.

<table>
<tr><th>Slot</th><th>CAN-ID [1)]</th><th colspan="2">Word 1</th><th>Word 2</th><th>Word 3</th><th>Word 4</th></tr>
<tr><td>1</td><td>1054</td><td colspan="5">Not used</td></tr>
<tr><td>2</td><td>1055</td><td>Channel 1L</td><td>Channel 1H</td><td colspan="3">Not used</td></tr>
<tr><td>3</td><td>1056</td><td colspan="5">Not used</td></tr>
<tr><td>4</td><td>1057</td><td colspan="5">Not used</td></tr>
</table>

Table 15: MM432 access using CAN IDs, analog output data 1

1) CAN-ID = 1054 + (nn - 1) x 16 + (ma - 1) x 4 + (sl - 1)
nn .... Node number of the CAN slaves = 1
ma ... Module address = 1
sl ..... Slot number = 2

For more information on ID allocation, see section "CAN Bus Controller".

Analog Output Data 2

In the example below, the motor bridge module MM432 is accessed with module addresses 1 and 2.

Analog output data cannot be packed. Only the fourth object from this group of four will be created and sent.

Slot	CAN-ID [1]	Word 1		Word 2	Word 3	Word 4
1	1054	Not used				
2	1055	Not used				
3	1056	Not used				
4	1057	Channel 1L	Channel 1H	Not used		

Table 16: MM432 access using CAN IDs, analog output data 2

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

For more information on ID allocation, see section "CAN Bus Controller".

Description of Data and Configuration Words

Data Word 0 (write)

The use of data word 0 is dependent on the operating mode.

Operating Mode	Description
PWM	In data word 0, the pulse width ratio of 0 - 100 % is set. Value range: 0 ... 0 % / ±1000 ... ±100.0 %
Current Controller Operation	In data word 0, the current set value of 0 - 4000 mA is set. Value range: 0 ... 0 mA / ±4000 ... ±4000 mA

Configuration Word 6 (write)

Configuration word 6 defines the proportional factor KP in current controller operation for the P-element. A proportional factor of KP = 1.0 corresponds to a value of $00010000.

$$P = (set - act) \cdot KP$$

Configuration Word 8 (write)

Configuration word 8 defines the integral action time in the current controller operation referring to 1 ms scan time for the I-element:

$$I_{new} = I_{old} + \frac{P}{T_N}$$

T_N	Description
0	I-share switched off
1 - 65535	I_{new} is calculated corresponding to the formula

Configuration Word 9 (write)

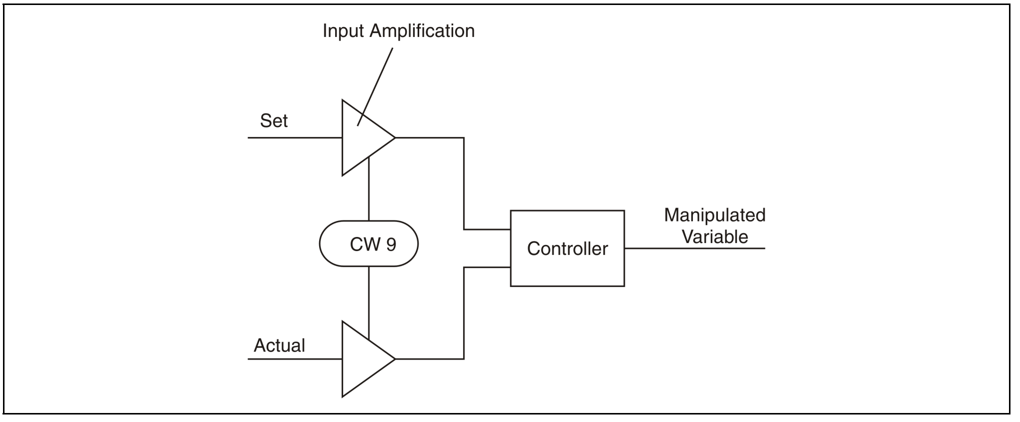


Figure 9: MM432 adjusting the input amplification

Configuration word 9 is used to adjust the input amplification for the controller. The specified value is used for standardizing the current in the current controller operation. The value correpsonds to the nominal current for the motor being controlled (0 - 4000 mA corresponds to 0 - 4000).

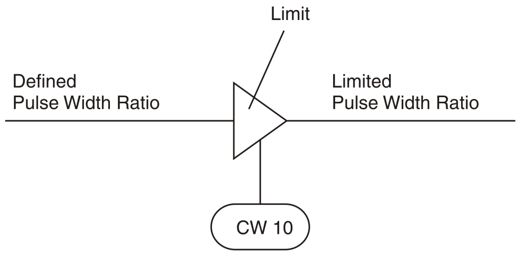
The set value and the actual value are standardized 100 % to this value. Therefore, the controller can always be operated using the full operating range, whereby the highest possible calculation accuracy can be achieved internally. The manipulated variable is standardized again on the actual value before output.

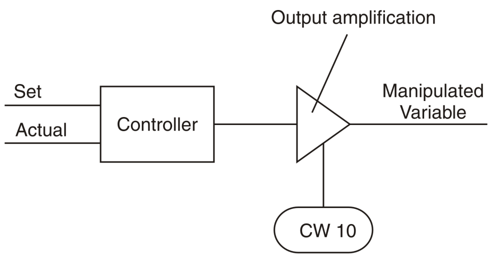
Example: Motor with a nominal current of 2 A
Standardization value in configuration word 9 = 2000

That means, an actual value of 1000 (1 A) corresponds to 50 % of the controller operating range.

Configuration Word 10 (write)

Configuration word 10 is used to adjust the output amplification for the controller. Usage is dependent on the operating mode.

<table>
<tr><th>Operating Mode</th><th>Description</th></tr>
<tr><td>PWM</td><td>Limit value for pulse width ratio (value range: 0 ... 0 % / 1000 ... 100.0 %)


Using the specified limit value of 0 - 100 %, the defined pulse width ratio in data word 0 is converted to the limit value. The actual PWM value is obtained in this way.
$$PWM = SetValue \times \frac{LimitValue}{100}$$
Example: Set value = 50 %
Limit value = 80 %
⇒ PWM value = 40 %</td></tr>
<tr><td>Current Controller Operation</td><td>Limit value for manipulated variable (value range: 0 ... 0 % / 1000 ... 100.0 %)


Using the specified limit value of 0 - 100 %, the defined manipulated variable from the control processes is converted to the limit value. The actual manipulated variable is obtained in this way.
$$ManipulatedVariable = ManipulatedVariable \times \frac{LimitValue}{100}$$
Example: Manipulated variable = 70 %
Limit value = 90 %
⇒ Manipulated variable = 63 %</td></tr>
</table>

Configuration Word 11 (write)

Configuration word 11 defines the ramp slope for the set value ramp. The calculation formula is as follows:

$$RampSlope = \frac{100}{RampValue} \qquad [Percent]$$

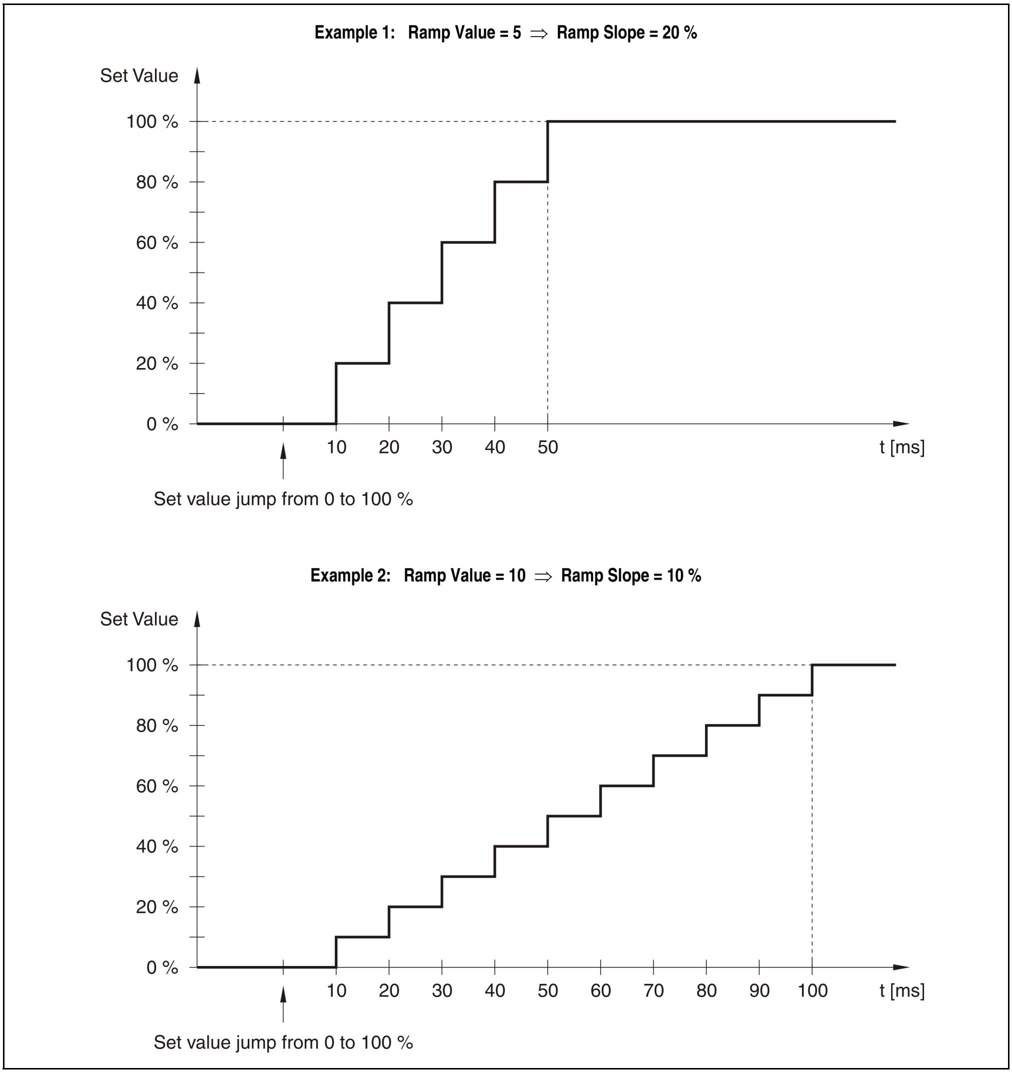
The ramp slope is defined by the ramp value. There is both a ramp value for the positive and for the negative set value ramp.

Ramp Value	Configuration Word 11
Positive Ramp	High byte
Negative Ramp	Low byte

Value Range for the Ramp Value	Description
0	The set value is used directly.
1 - 255	The set value is used according to to the ramp slope.

After any change, the set value is linked to the new set value along to the set value ramp in a 10 ms cycle.

Example: The set value changes from 0 to 100 %. The following curve shows the set value ramp for a ramp value of 5 and 10.



Configuration Word 12 (write)

Configuration word 12 contains the set value which is used when a limit switch signal is triggered. If a limit switch is triggered (without ramp) during operation, this value is immediately used as the set value.

The limit position is retained using this relatively small value. In order to exit from the limit position, a new set value must be defined using inverted signs:

Normal Operation		Limit Position Reached	
Direction	Set Value	Limit Position Retain	Exit from the Limit Position
Left	Negative	The value in configuration Word 12 is used as a negative set value. The left limit position is retained using this relatively small value.	A positive set value must be transferred. This value has a higher priority than the defined set value in configuration word 12 for retaining the position.
Right	Positive	The value in configuration word 12 is used as a positive set value. The right limit position is retained using this relatively small value.	A negative set value must be transferred. This value has a higher priority than the defined set value in configuration word 12 for retaining the position.

Configuration Word 14 (read)

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

Bit	Description
0 - 7	Not defined, masked out
8 - 15	Module code: $42

Configuration Word 14 (write)

The module is configured using configuration word 14.

<table>
<tr><th>Bit</th><th colspan="3">Description</th></tr>
<tr><td rowspan="6">0 - 1</td><td colspan="3">This function is only available in configuration word 14 for analog output data 1.
The filter for measuring the current is configured with a frequency of 16 kHz. The current controller should therefore not be operated at a slower rate. If the output is used as a PWM output, then a lower frequency can be set.
Setting the frequency takes place for both bridges using these two bits:</td></tr>
<tr><th>Bit Combination</th><th>PWM Frequency</th><th>Description</th></tr>
<tr><td>00</td><td>16 kHz</td><td>Default Setting</td></tr>
<tr><td>01</td><td>8 kHz</td><td>Only for PWM, not for current controller</td></tr>
<tr><td>10</td><td>4 kHz</td><td>Only for PWM, not for current controller</td></tr>
<tr><td>11</td><td>2 kHz</td><td>Only for PWM, not for current controller</td></tr>
<tr><td>2 - 7</td><td colspan="3">0</td></tr>
<tr><td>8</td><td colspan="3">0 ... No effect on the left limit switch
1 ... Left limit switch is inverted</td></tr>
<tr><td>9</td><td colspan="3">0 ... No effect on the right limit switch
1 ... Right limit switch is inverted</td></tr>
<tr><td>10</td><td colspan="3">0 ... No effect on the direction of rotation
1 ... Direction of rotation is inverted
Note:
The bit is only allowed to manipulated in the following exceptions:
• If the motor is incorrectly connected at start-up, the error can be easily corrected by setting bit 10. Otherwise, this bit must always remain at the value 0!
• Bit 10 is only allowed to be set or reset when the motor is shut down!</td></tr>
<tr><td>11</td><td colspan="3">0 ... Limit switch function is activated
1 ... Limit switch function is deactivated Digital inputs for the limit switch can be freely chosen.</td></tr>
<tr><td>12 - 13</td><td colspan="3">0</td></tr>
<tr><td>14</td><td colspan="3">0 ... PWM output operation (standard setting)
1 ... Current controller operation</td></tr>
<tr><td>15</td><td colspan="3">0 ... PWM output or current controller is switched off
1 ... PWM output or current controller is enabled. Enable is allowed to take place only after the configuration has been made !</td></tr>
</table>

1.1.15 Variable Declaration for Digital Inputs/Outputs

The variable declaration is valid for the following controllers:

- CPU for the PLC 2003
- Remote I/O bus controller
- CAN bus controller

Variable Declaration with PLC 2003 CPU and Remote Slaves

Function	Variable Declaration				
	Scope	Data Type	Length	Module Type	Chan.
Single Digital Input (Channel x)	tc_global	BIT	1	Digit. In	1 ... 8
Single Digital Output (channel x)	tc_global	BIT	1	Digit. Out	1 ... 8
Module Status	tc_global	BYTE	1	Status In	0

Table 17: MM432 variable declaration digital I/O with CPU and remote slaves

Variable Declaration with CAN Slaves

Function	Variable Declaration				
	Scope	Data Type	Length	Module Type	Chan.
Single Digital Input (channel x)	tc_global	BIT	1	Digit. In	1 ... 8
Single Digital Output (channel x)	tc_global	BIT	1	Digit. Out	1 ... 8

Table 18: MM432 variable declaration digital I/O with CPU and CAN slaves

<u>Module Status</u>

The module status for CAN slaves can only be read using command codes. The command codes are explained in section "CAN Bus Controller Functions", under "Command Codes and Parameters". An example is provided in section "Module Addressing".

Access using CAN IDs

Access via CAN IDs is used if the slave is being controlled by a device from another manufacturer. Access via CAN IDs is described in an example in section "Module Addressing" . The transfer modes are explained in section "CAN Bus Controller".

Digital Inputs

A maximum of eight digital I/O modules can be run in packed mode.

The MM432 modules uses two module addresses. If two MM432 modules are used, only four additional digital I/O modules can be used.

The following example shows the structure of the CAN object if two MM432 and four DI435 modules are used.

CAN-ID [1)]	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
286	MM432 Not used	MM432 I 1 - 8	MM432 Not used	MM432 I 1 - 8	DI435	DI435	DI435	DI435

Table 19: MM432 access using CAN IDs, digital inputs, packed

1) CAN-ID = 286 + (nn - 1) x 4
nn ... Node number of the CAN slave = 1

A maximum of four digital I/O module can be run in unpacked mode.

The following example shows the structure of the CAN object if one MM432 and two DI435 modules are used.

Module	CAN-ID [1)]	Bytes
MM432	286	Not used
	287	Inputs 1 - 8
DI435	288	Inputs 1 - 8
DI435	289	Inputs 1 - 8

Table 20: MM432 access using CAN IDs, digital inputs, unpacked

1) CAN-ID = 286 + (nn - 1) x 4 + (ma - 1)
nn .... Node number of the CAN slaves = 1
ma ... Module address of digital IO modules = 1 - 4

Digital Outputs

A maximum of eight digital I/O modules can be run in packed mode.

The MM432 modules uses two module addresses. If two MM432 modules are used, only four additional digital I/O modules can be used.

The following example shows the structure of the CAN object if two MM432 and four DO722 modules are used.

CAN-ID 1)	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7v	Byte 8
414	MM432 Not used	MM432 O 1 - 8	MM432 Not used	MM432 O 1 - 8	DO722	DO722	DO722	DO722

Table 21: MM432 access using CAN IDs, digital outputs, packed

1) CAN-ID = 414 + (nn - 1) x 4
nn ... Node number of the CAN slave = 1

A maximum of four digital I/O module can be run in unpacked mode.

The following example shows the structure of the CAN object if one MM432 and two DO722 modules are used.

Module	CAN-ID 1)	Bytes
MM432	414	Not used
	415	Outputs 1 -8
DO722	416	Outputs 1 -8
DO722	417	Outputs 1 -8

Table 22: MM432 access using CAN IDs, digital outputs, unpacked

1) CAN-ID = 414 + (nn - 1) x 4 + (ma - 1)
nn .... Node number of the CAN slaves = 1
ma ... Module address of digital IO modules = 1 - 4

For more information on ID allocation, see section "CAN Bus Controller".

Digital Inputs

The limit switch and reference enable inputs for each standard setting are filtered with a 4 ms software filter. This filter can be switched off for both bridges (see Section "Configuration Word 14 (write)", on page 19).

After either the controller has been switched on, or after a reset, the channels are assigned the following inputs:

Chan.	Standard Assignement
1	Reference pulse 1
2	Reference enable 1
3	Left limit switch 1
4	Right limit switch 1
5	Reference pulse 2
6	Reference enable 2
7	Left limit switch 2
8	Right limit switch 2

To ensure the greatest possible flexibility, any signal can be assigned to the eight input channels. The signal can be be any physical input or any internal logic function. An internal logic function is, for example, a cumulative report or short circuit monitoring.

The following signals can be assigned to the eight channels:

Signal	Signal Number			
	Bridge 1		Bridge 2	
	Decimal	Hexadecimal	Decimal	Hexadecimal
Encoder Input A	00	$00	16	$10
Encoder Input B	01	$01	17	$11
Reference Pulse	02	$02	18	$12
Reference Enable	03	$03	19	$13
Left Limit Switch	04	$04	20	$14
Right Limit Switch	05	$05	21	$15
Cumulative Report: Limit Left/Right	07	$07	23	$17
Cumulative Report: Error on the Bridge	08	$08	24	$18
Short Circuit Monitoring for the Upper Bridge Branch to GND	09	$09	25	$19
Short Circuit Monitoring for the Lower Bridge Branch to Positive Voltage	10	$A	26	$1A

Table 23: MM432 the signals that can be assigned to the input channels

Assignment takes place with configuration words 11 and 13 on slot 2 (analog input data 1).

Configuration Word 11 (read)

Executing the commands is acknowledged by the reading of configuration word 11.

If the content of configuration word 11 corresponds to the last command executed, then the command was executed properly. If an error occurs, bit 15 is set.

Error Number	Description
$8000	Unknown command

Configuration Word 13 (write)

Various signals can be assigned to the digital input channels using commands. After each command, configuration word 11 must be read out. If the content of the register corresponds to the last command recorded, then the command was properly executed. If an error occurs, then the error number $8000 is output.

Once all signals have been assigned, all signals configured up this point of time are accepted using the command $1800.

Note:

The assignments disappear after the controller has been switched off or after a reset! The assignments must be made again after switching on the controller or after a reset .

Commands are made up of two areas:

$ | aa | bb

Place Holder	Description	
aa	Indicates the digital input channel.	
	Channel Number	**Digital Input Channel**
	$10	1
	$11	2
	$12	3
	$13	4
	$14	5
	$15	6
	$16	7
	$17	8
bb	Signal number as a hexadecimal code (see Table 23 "MM432 the signals that can be assigned to the input channels", on page 35).	
$1800	Completes the assignment of the signals. The signals assigned up this point are used.	

Table 24: MM432 commands for assigning signals to the digital input channels

<u>Example</u>

The input channels 1 and 5 are assigned the internal logic function "Cumulative Report: Error on bridge 1/2" instead of the "Reference pulse 1/2"

The input channels are then assigned as follows:

Chan.	Assignment
1	Cumulative Report: Error on the bridge 1
2	Reference enable 1
3	Left limit switch 1
4	Right limit switch 1
5	Cumulative Report: Error on the bridge 2
6	Reference enable 2
7	Left limit switch 2
8	Right limit switch 2

The command for assigning the signals consists of the channel number (see Table 24 "MM432 commands for assigning signals to the digital input channels", on page 37) and the signal number (see Table 23 "MM432 the signals that can be assigned to the input channels", on page 35).

Digital Input Channel	Assigned Signal	Channel Number	Signal Number	Command
1	Cumulative Report: Error on the bridge 1	$10	$08	$1008
5	Cumulative Report: Error on the bridge 2	$14	$18	$1418

Procedure for assigning the signals:

1) Write command $1008 in configuration word 13.
2) Ackowledge the command by reading from configuration word 11.
3) Write command $1418 in configuration word 13.
4) Ackowledge the command by reading from configuration word 11.
5) Accept the assigned signals by writing the command $1800 in configuration word 13.
6) Ackowledge the command by reading from configuration word 11.

Digital Outputs

Output channels and their functions:

Chan.	Function
1	Motor 1: Enabling of the output bridge 0 ... The set value is set without ramp delay to zero. As soon as the actual value has fallen below 1%, the bridge is turned off. 1 ... The motor outputs are enabled.
2	Motor 1: Emergency stop 0 ... The set value is set without ramp delay to zero. The controller remains activated. 1 ... Normal operation
3	Motor 1: Acknowledges the short circuit cutoff 0 ... No effect on motor 1 1 ... Acknowldges the short circuit cutoff (with positive edges)
4	0
5	Motor 2: Enabling of the output bridge 0 ... The set value is set without ramp delay to zero. As soon as the actual value has fallen below 1%, the bridge is turned off. 1 ... The motor outputs are enabled.
6	Motor 2: Emergency stop 0 ... The set value is set without ramp delay to zero. The controller remains activated. 1 ... Normal operation
7	Motor 2: Acknowledges the short circuit cutoff 0 ... No effect on motor 2 1 ... Acknowldges the short circuit cutoff (with positive edges)
8	0

Module Status

Evaluation of the module status is explained using an example in section "Module Addressing".

Bit	Description
0 - 4	Module code: $17
5	Not defined, masked out
6	Digital module: 0
7	0 ... No supply voltage or supply voltage too low for digital inputs 1 ... Supply voltage for digital inputs in the valid range

1.1.16 General Information for PWM Output

Event	Description
Acessing Short Circuit Monitoring	The set value and the ramps are set to 0, the controller is deactivated, the I-element is cleared, the bridges are locked, error signals and status bits are set, the status LED begins to blink and changes to the set value are ignored. Acknowledgement takes place using a positive edge on output channel 1 and 5 of the digital component.
Accessing the Limit Switch	The set value and the ramps are set to the parameters of the value. The manipulated variable follows the controller parameters that have been configured. Through the set value impact it can be navigated using a configurable holding torque in a limit.
Emergency Stop	An emergency stop can be activated on the respective bridge by resetting digital output channels 2 and 6. Output Cleared: The set value and the ramps are set to 0, the manipulated variable follows configured controller parameters, and the bridges remain activated. Output Set: The last specified set value is activated.
Enable for PWM Output or Current Controller	The PWM output or the current controller is enabled by setting bit 15 in configuration word 14. Enable Set: All parameters must be configured. The I element that has accumulated up to now is cleared. The last specified set value is activated. The controller algorithm runs through and the bridges are switched on. Enable Cleared: The set value and the ramps are set to 0. The manipulated value follows configured controller parameters and the bridges remain activated until the current falls below 1%.
Electronic Current Limitation	The maximum current is electronically limited to the nominal current(4 A) only in current controller operation. In PWM operation, the current limitation should be guaranteed by the application. Therefore, the maximum peak current of 8 A is allowed to be queued for a maximum of 2 s.

Table 25: MM432 general information for PWM output

1.1.17 Notes for the Application

- Short circuit monitoring fails when there is an under-voltage for power elements.
- If a short circuit occurs, then this must be ackowledged on the MM432 by the application using software.
- Rapid sucession of acceleration with over-current and deceleration braking can cause an overload. In this case, protection must be provided for the application. If the starting current is over 4 A then a holding pause (I = 0 A) must be set for the duration of the over-current.
- The current must be monitored by the application so that the motor is not operated in generator mode. The current value is read and checked to see whether it lies within the negative range. The module does not have braking resistors.
- The AC401 converter can be used for converting 5 V differential encoder signal levels to 24 V (model number: 0AC401.9).