

User Manual

Keypads **MO 405.HXX**

SAE J1939 Interface



Contents

1	Introduction.....	3
2	Safety Instructions	4
2.1	General Instructions.....	4
2.2	Device Specific Instructions.....	4
2.3	Intended Use	4
3	Product Features	5
4	Installation.....	6
4.1	Mounting.....	6
4.2	Electrical Connection	6
4.3	Bus Termination.....	6
4.4	Status Displays	6
5	SAE J1939 Interface	7
5.1	J1939 Message Structure.....	7
5.2	Address Claiming.....	7
5.3	Software Configuration	7
5.4	Configuration Commands	8
5.4.1	CMD0 Temporarily Enable/Disable Transmission and Get Device Status	8
5.4.2	CMD1 Get/Set Communication Parameters For Button Status Message	9
5.4.3	CMD2 Get/Set Communication Parameters For LED Indicator Control Messages.....	9
5.4.4	CMD3 Get/Set Other Communication Parameters	9
5.4.5	CMD4 Get/Set Indicator Data.....	10
5.4.6	CMD5 Get/Set Other Parameters	10
5.4.7	CMD250 Reset to Factory Defaults.....	11
5.5	Process Data Messages.....	11
5.5.1	Button Status Message	11
5.5.2	LED Indicator Control Message 1	12
5.5.3	LED Indicator Control Message 2	13
6	Parameters	14
6.1	Communication Parameters	14
6.2	Application Parameters.....	14
6.3	J1939 Name Fields.....	14
7	Appendix	15
7.1	Definitions.....	15

7.2	References	15
7.3	Disposal	15

1 Introduction

This document contains information on how to install, configure and operate the device “MO 405 Keypad”. It describes the product functions and parameters used for operation.

Read through this document and related documents before use to become familiar with the device.

The following symbols may appear throughout this document.



This symbol indicates a warning that may cause personal injury, death or damage to machine by means other than electrical if the symbol is omitted.



This symbol indicates a warning that may cause personal injury, death or damage to machine if the symbol is omitted.

NOTE: Indicates additional information on the subject.

CAUTION: Indicates that the reader must pay special attention to a particular issue on the subject.

The information contained herein is subject to change. Makersan reserves the right to make corrections, enhancements, improvements and other changes to its products at any time and without notice.

2 Safety Instructions

2.1 General Instructions

Installation, configuration and commissioning of the device must be performed by trained specialists only. These specialists must consider all the components in the system. Care must be taken to ensure that all the devices operate properly and safely together.

If a device fails to operate properly in the system, the malfunctioning device must be replaced.

Opening or modifying the device is dangerous and will void warranty.

2.2 Device Specific Instructions

Please refer to product datasheet for device specific safety instructions. They must be read and observed before installation and use.

2.3 Intended Use

The device can be used in many applications with no limitation. But all the operating conditions specified in the product datasheet must not be exceeded during product life in order to ensure part reliability.

Always follow the instructions described in this document and product datasheet to install, configure and operate the device properly. Also observe the general rules and regulations on low voltage devices.

Use outside these conditions may result in personal injury, death or damage to machine.

3 Product Features

The “MO 405 Keypads” are versatile and compact control solution that operate from CAN bus. They can be used in industrial and off-highway machines, construction equipment, and many other areas.

Some of the key features of these devices are listed below:

- Up to 3 LED indicators per key
- Dimmable LED indicators and backlight
- Programmable parameters
- Rugged and compact design

The device communicates over CAN bus according to the SAE J1939 protocol. It transmits key states cyclically or on request and/or on state change. The LED indicators are controlled via CAN bus.

Baud rate: 250 kbit/s

Arbitrary Address Capable: Yes

Node ID:	144 (90h)
PGN used by button status message:	65285 (FF05h)
PGN used by LED indicator control message 1:	42752 (A700h)
PGN used by LED indicator control message 2:	42496 (A600h)
Transmission type for button status message:	Cyclic
Transmission rate for button status message:	100 ms

NOTE: The device parameters may differ from the values above when the device pre-configured according to customer requirements.

NOTE: All hexadecimal numbers are denoted by a ‘h’ suffix in this document.

4 Installation

4.1 Mounting

Do not mount the device while the power is being applied.

The device must be mounted away from heat sources.

Fasten the unit on a flat surface.


Refer to the technical drawings in the product datasheet for dimensions.

Do not use a hammer or crowbar to assemble the unit.

Do not expose the unit to electrical or mechanical stress. It may lead to degrade in device performance or damage of device.

4.2 Electrical Connection

The device is connected via 4 pin Deutsch DT connector. The pin assignment for the connector is shown below. Please refer to product datasheet for mating connector information.

	Pin	Assignment
	1	+Vs
	2	GND
	3	CAN_H
	4	CAN_L

4.3 Bus Termination

CAN bus must be terminated at both ends by a resistor of 120 Ω in order to prevent signal reflections. The device doesn't have an internal termination resistor. Therefore termination must be done externally if the device is connected at one end.

4.4 Status Displays

If a serious fault (e.g: eeprom error, software error etc.) is detected by the device, all LED indicators will blink fast (approximately 2 Hz) to warn the user.

5 SAE J1939 Interface

5.1 J1939 Message Structure

SAE J1939 uses extended frame format (CAN2.0B) with 29 bit CAN identifier. The identifier consists of priority field, Parameter Group Number (PGN) and source address. The PGN indicates which parameter group is being transmitted in the message. Each parameter group has a unique PGN and defines priority of the message, transmission rate and assignment of each parameter within the 8 byte data field.

The mapping of identifier is shown below.

Priority	Ext. Data Page	Data Page	PDU Format	PDU Specific	Source Address
3 bits	1 bit	1 bit	8 bit	8 bit	8 bit

The priority field indicates the message priority during arbitration process. A value of 0 is the highest priority and a value of 7 is the lowest priority.

Extended data page field is set to 0 for J1939 devices.

Data page field allows to define a second page so increases the number of possible PGNs. Its value is currently 0 and 1 is reserved for future use.

PDU format identifies that if the message will be sent to a specific destination or broadcasted to all devices on the network. If the value in PDU format field is between 0 and 239, the PGN is in the PDU1 format. In this format the PDU specific field contains the destination address (peer to peer). If the value in PDU format field is 240 or greater, the PDU specific field interpreted as a Group Extension (GE) and the message is sent to all devices (broadcast). The Group Extension field allows to define more PGNs for broadcast messages. This format is referred to as PDU2.

The source address is the address of the device transmitting the message.

J1939 defines a standard set of PGNs for various applications. In addition to these PGNs, there are some PGNs available for manufacturer specific use (proprietary). For peer to peer communication, the Proprietary A PGN (EF00h) can be used. For broadcast messages, the Proprietary B PGNs ranging from FF00h to FFFFh are available.

5.2 Address Claiming

Each device on the network has to have a unique address (1 to 253, 254 null). For the most devices, these addresses are preassigned. However J1939 supports dynamic addressing. If a device supports this feature, it sends an Address Claim message with the address it wants to use. All devices must compare this address with their address. If there is a conflict (the address is used by another device), the device having the same address also sends an Address Claim message. In this case the device with higher priority uses the claimed address. The other device may claim a new address. The priority of a device is determined by its NAME. The NAME is 64 bit long and lower value of NAME means higher priority when claiming addresses.

5.3 Software Configuration

The device parameters can be adjusted over CAN bus using peer to peer communication. The Proprietary A PGN (EF00h) is used for the configuration of the device.

Users can configure the device by sending predefined commands. The command structure is shown below. It allows adjustment of several parameters within a message quickly and efficiently. If a parameter value must be retained, set all bits of the parameter to 1 in the message which means data not available in terms of SAE J1939. This provides great flexibility for configuration.

Request Format (ECU → Sensor)

PGN		D0	D1	D2	D3	D4	D5	D6	D7
EFh	Node ID	CMD	R/W	X	X	X	X	X	X

Response Format (ECU ← Sensor)

PGN		D0	D1	D2	D3	D4	D5	D6	D7
EFh	Node ID	CMD	Status	X	X	X	X	X	X

R/W operation codes:

- 0 : write operation
- 1 : read operation

Status codes:

- 0 : Success
- 1 : Invalid command
- 2 : Invalid parameter
- 3 : Store parameter failed

When sending data from a controller unit to the device, the first data byte is command followed by read/write request. The device will respond back with a status code indicating that the requested operation succeeded or failed. If the operation succeeded, the parameters will be saved to the nonvolatile memory of the device automatically.



While configuring the device, the machine or vehicle may react unexpectedly and may cause personal injury or death. Ensure that man and machine in safe condition!

5.4 Configuration Commands

5.4.1 CMD0 Temporarily Enable/Disable Transmission and Get Device Status

PGN		D0	D1	D2	D3	D4	D5	D6	D7
EFh	Node ID	00h	R/W	AAh	55h	AAh	55h	Device Status	TX Disable / Enable

Device Status: Indicates operating status of the device. If a fault occurred, it will hold a value other than zero. It is readonly.

TX Disable/Enable: Writing a value of 1 disables transmission of the process data message temporarily. To reenble the transmission, write zero to this field.

Example: To read the device status, send the following message to a device having a node ID of 10h (assuming that the controller which sends this message has an ID of 01h).

Message ID	D0	D1	D2	D3	D4	D5	D6	D7
18EF1001h	00h	01h	X	X	X	X	X	X

5.4.2 CMD1 Get/Set Communication Parameters For Button Status Message

PGN		D0	D1	D2	D3	D4	D5	D6	D7
EFh	Node ID	01h	R/W	PGN (LSB)	PGN (MSB)	Destination Address for PDU1	Priority	Repetition Rate (LSB)	Repetition Rate (MSB)

PGN: This value holds the PGN used by the button status message. Both PDU1 and PDU2 formats are supported.

Destination Address for PDU1: If a PGN with PDU1 format is used, this value specifies the destination address. Data range 1 to 253.

Priority: Sets the priority used by the message. Data range 0 to 7.

Repetition Rate: This value controls the transmission rate of the message. It ranges from 20 to 10000 ms. A value of zero disables periodic transmission; the message is sent only on request. In that case use the request PGN to obtain data.

Example: Sending the following message to a device having a node ID of 10h will adjust the priority of the message to 6 and set the repetition rate to 100ms while leaving other parameters unchanged.

Message ID	D0	D1	D2	D3	D4	D5	D6	D7
18EF1001h	01h	00h	FFh	FFh	FFh	06h	64h	00h

5.4.3 CMD2 Get/Set Communication Parameters For LED Indicator Control Messages

PGN		D0	D1	D2	D3	D4	D5	D6	D7
EFh	Node ID	02h	R/W	0Bh	Receive Timeout	PGN LED1 (LSB)	PGN LED1 (MSB)	PGN LED2 (LSB)	PGN LED2 (MSB)

Receive Timeout: This value defines the timeout for LED indicator control messages. It has a resolution of 100 ms. If the device doesn't receive a LED indicator message within this time, all LED indicators will blink fast in order to indicate this error. A value of 0 disables this feature.

PGN LED1: This parameter holds the PGN of the message that is used to control the indicator groups 1 to 10. Each group has three LED indicators.

PGN LED2: This parameter holds the PGN of the message for the indicator groups 11 to 20.

5.4.4 CMD3 Get/Set Other Communication Parameters

PGN		D0	D1	D2	D3	D4	D5	D6	D7
EFh	Node ID	03h	R/W	AAh	FAh	33h	FFh	Node ID	Send On Button Event

Node ID: Sets the source address of the device. Since the device is arbitrary address capable, the actual node ID may differ from this value on the network. Data range 1 to 253.

Send On Button Event: Writing a value of 1 to this field enables transmission of the button status message on a button event (state change).

CAUTION: After this command, a reset is performed by the device automatically.

5.4.5 CMD4 Get/Set Indicator Data

PGN		D0	D1	D2	D3	D4	D5	D6	D7
EFh	Node ID	04h	R/W	26h	55h	Indicator Group No	Left Indicator	Center Indicator	Right Indicator

Indicator Group No: This parameter is the number of the indicator group which will be configured. Each button has three LED indicators associated with it. Data range 1 to total number of buttons.

Left Indicator: This parameter controls the state of the left indicator in the selected indicator group. The table below shows the available states for this field.

Value	Description
0	Off
1	On
2	Blink Medium (1 Hz)
3	Blink Slow (1/2 Hz)
4	Blink Fast (2 Hz)

Center Indicator: This parameter controls the state of the center indicator in the selected indicator group. The valid states are same as above.

Right Indicator: This parameter controls the state of the right indicator in the selected indicator group. The valid states are same as above.

5.4.6 CMD5 Get/Set Other Parameters

PGN		D0	D1	D2	D3	D4	D5	D6	D7
EFh	Node ID	05h	R/W	FCh	0Bh	Intensity Adjustment via Buttons	LED Diagnostic	Indicator Intensity	Backlight Intensity

Intensity Adjustment via Buttons: When this parameter is set, it enables adjustment of LED indicator and backlight intensity via the buttons on the keypad. To enter into the configuration mode, press and hold the buttons 1 and 2 when the device powers up. The LEDs will blink on and off when entering configuration mode. In this mode pressing the button 1 will increase the backlight intensity by 5 percent. Pressing the button 2 will decrease the backlight intensity by 5 percent. Pressing the button 3 will set the backlight intensity to maximum level (full brightness). Pressing the button 4 will turn off the backlight. Pressing the button 5 will increase the LED indicator intensity by 5 percent. Pressing the button 6 will decrease the LED indicator intensity by 5 percent. Pressing the button 7 will set the LED indicator intensity to maximum level (full brightness). Pressing the button 8 will turn off the LED indicators. In order to save the current setting and return to normal operation, press the button 1 and 2 simultaneously. Data range 0 to 1.

LED Diagnostic: Setting this parameter enables LED diagnostic mode. In this mode all LEDs and backlight will blink for one second at device startup. Data range 0 to 1.

Indicator Intensity: This parameter allows adjustment of the indicator intensity via CAN bus. Data range 0 to 250.

Backlight Intensity: This parameter allows adjustment of the backlight intensity via CAN bus. Data range 0 to 250.

5.4.7 CMD250 Reset to Factory Defaults

PGN		D0	D1	D2	D3	D4	D5	D6	D7
EFh	Node ID	FAh	W	12h	ABh	FFh	33h	CCh	FFh

This command is used to reset all parameters including node id to factory defaults. It is write only.

5.5 Process Data Messages

5.5.1 Button Status Message

This message contains information about status of each button. Using the default values, the device sends the following process data message:

Message ID	D0	D1	D2	D3	D4	D5	D6	D7
18FF0590h	Button 1-4 Status	Button 5-8 Status	Button 9-12 Status	Button 13-16 Status	Button 17-20 Status	FFh	FFh	FFh



The message above is only valid when the corresponding button data is available (not equal to 3 (3h)). In case of a fault the device sends 2 (2h) in the data field. These values must be identified by the user and special actions must be taken for these cases.

The mapping of the button status message is shown below:

Start position (Byte/Bit)	Length	Description
1.1	2 bits	Button 1 Status
1.3	2 bits	Button 2 Status
1.5	2 bits	Button 3 Status
1.7	2 bits	Button 4 Status
2.1	2 bits	Button 5 Status
2.3	2 bits	Button 6 Status
2.5	2 bits	Button 7 Status
2.7	2 bits	Button 8 Status
3.1	2 bits	Button 9 Status
3.3	2 bits	Button 10 Status
3.5	2 bits	Button 11 Status
3.7	2 bits	Button 12 Status
4.1	2 bits	Button 13 Status
4.3	2 bits	Button 14 Status
4.5	2 bits	Button 15 Status
4.7	2 bits	Button 16 Status
5.1	2 bits	Button 17 Status
5.3	2 bits	Button 18 Status
5.5	2 bits	Button 19 Status
5.7	2 bits	Button 20 Status

The status information of a button is transmitted in the following format:

Value(bits)	Description
00	Button not pressed
01	Button pressed
10	Error indicator
11	Not available

5.5.2 LED Indicator Control Message 1

This message is used to control the state of the LED indicators group 1 to 10. The default value for the PGN used by this message is 42752 (A700h). The mapping of this message is shown below:

Start position (Byte/Bit)	Length	Description
1.1	2 bits	Button 1 left LED state
1.3	2 bits	Button 1 center LED state
1.5	2 bits	Button 1 right LED state
1.7	2 bits	Button 2 left LED state
2.1	2 bits	Button 2 center LED state
2.3	2 bits	Button 2 right LED state
2.5	2 bits	Button 3 left LED state
2.7	2 bits	Button 3 center LED state
3.1	2 bits	Button 3 right LED state
3.3	2 bits	Button 4 left LED state
3.5	2 bits	Button 4 center LED state
3.7	2 bits	Button 4 right LED state
4.1	2 bits	Button 5 left LED state
4.3	2 bits	Button 5 center LED state
4.5	2 bits	Button 5 right LED state
4.7	2 bits	Button 6 left LED state
5.1	2 bits	Button 6 center LED state
5.3	2 bits	Button 6 right LED state
5.5	2 bits	Button 7 left LED state
5.7	2 bits	Button 7 center LED state
6.1	2 bits	Button 7 right LED state
6.3	2 bits	Button 8 left LED state
6.5	2 bits	Button 8 center LED state
6.7	2 bits	Button 8 right LED state
7.1	2 bits	Button 9 left LED state
7.3	2 bits	Button 9 center LED state
7.5	2 bits	Button 9 right LED state
7.7	2 bits	Button 10 left LED state
8.1	2 bits	Button 10 center LED state
8.3	2 bits	Button 10 right LED state

5.5.3 LED Indicator Control Message 2

This message is used to control the state of the LED indicators group 11 to 20. The default value for the PGN used by this message is 42496 (A600h). The mapping of this message is shown below:

Start position (Byte/Bit)	Length	Description
1.1	2 bits	Button 11 left LED state
1.3	2 bits	Button 11 center LED state
1.5	2 bits	Button 11 right LED state
1.7	2 bits	Button 12 left LED state
2.1	2 bits	Button 12 center LED state
2.3	2 bits	Button 12 right LED state
2.5	2 bits	Button 13 left LED state
2.7	2 bits	Button 13 center LED state
3.1	2 bits	Button 13 right LED state
3.3	2 bits	Button 14 left LED state
3.5	2 bits	Button 14 center LED state
3.7	2 bits	Button 14 right LED state
4.1	2 bits	Button 15 left LED state
4.3	2 bits	Button 15 center LED state
4.5	2 bits	Button 15 right LED state
4.7	2 bits	Button 16 left LED state
5.1	2 bits	Button 16 center LED state
5.3	2 bits	Button 16 right LED state
5.5	2 bits	Button 17 left LED state
5.7	2 bits	Button 17 center LED state
6.1	2 bits	Button 17 right LED state
6.3	2 bits	Button 18 left LED state
6.5	2 bits	Button 18 center LED state
6.7	2 bits	Button 18 right LED state
7.1	2 bits	Button 19 left LED state
7.3	2 bits	Button 19 center LED state
7.5	2 bits	Button 19 right LED state
7.7	2 bits	Button 20 left LED state
8.1	2 bits	Button 20 center LED state
8.3	2 bits	Button 20 right LED state

The table below shows the available states for each field.

Value (bits)	Description
00	Off
01	On
10	Blink Medium (1 Hz)
11	Not available

6 Parameters

6.1 Communication Parameters

Parameter	Range	Default	Unit	Comment
Node ID	1...253	144		
Send On Button Event	0, 1	0		False
Button Status Message				
PGN		65285		
Priority	0...7	6		
Destination address	1...253			Only used for PDU 1
Repetition rate	0 or 20...10000	100	ms	0:on request, otherwise cyclic
LED Indicator Control Messages				
PGN LED indicators group 1 to 10		42752		
PGN LED indicators group 11 to 20		42496		
Receive Timeout	0 or multiply of 100 ms	0	ms	0: disabled

6.2 Application Parameters

Parameter	Range	Default	Unit	Comment
Intensity adjustment via buttons	0, 1	0		0: disabled
LED diagnostic	0, 1	1		1: enabled
LED indicators intensity	0...250			250: Full brightness
Backlight intensity	0...250			250: Full brightness

6.3 J1939 Name Fields

Field	Default Value	Comment
Arbitrary address capable	1	Yes
Industry group	0	Global
Vehicle system	0	Non-specific system
Vehicle system instance	0	
Function	135	Keypad
Function instance	0	
ECU instance	0	
Manufacturer	568	Makersan Co.
Identity number	X	Serial number

7 Appendix

7.1 Definitions

PDU	Protocol Data Unit
PGN	Parameter Group Number
LSB	Least Significant Bit (or Byte)
MSB	Most Significant Bit (or Byte)

7.2 References

SAE J1939/21	Data Link Layer
SAE J1939/71	Vehicle Application Layer
SAE J1939/81	Network Management

7.3 Disposal

Please observe the national regulations for your country when disposing of the device.

Our Products

- Controller & I/O
- HMI Display
- Keypads
- Buttons
- Sensors
- Accelerator Pedals
- Control Levers
- DC/DC Regulators
- Door Access Systems

Our Applications

- Automotive & Engine
- Trucks & Buses
- Agriculture & Construction
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