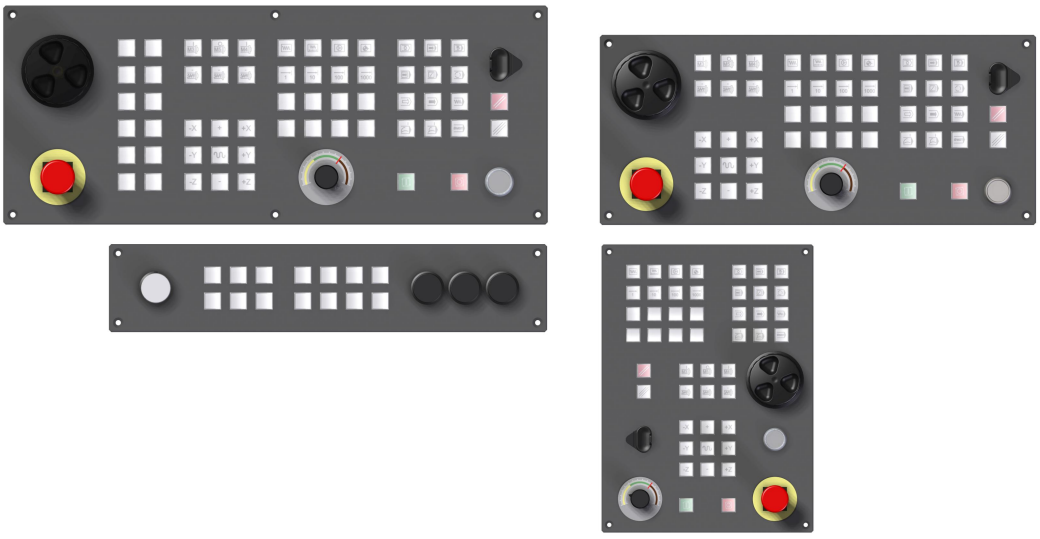
MK19, MK15 and MK15V
EtherCAT Communication-interface
Machine Keyboards

Technical Description

2023



Contents

1. Scope of the description

This technical description contains electrical, communication and installation features of the MK19, MK15 and MK15V machine keyboards made by NCT Ipari Elektronikai Ltd.

2. General features

The NCT-made MK19, MK15 and MK15V machine keyboards are slave units designed primarily to be HMI input units of machine tools and connectable to EtherCAT network. These keyboards are available in three physical constructions, all three can be built in panel; the MK19 and MK15 ones can easily be fitted to 19” or 15” displays, while MKV15 one is designed to 15” display, but with a form lengthened vertically.

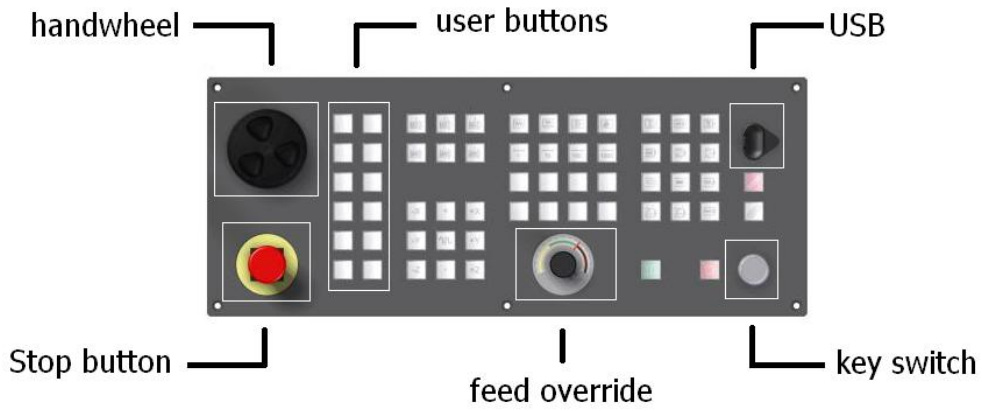


Fig. 1 19” machine keyboard and its parts

On the machine operating panels there are LED illuminated key characters number of which depends on the type of keyboard. The keyboards contain built-in input units usual on machine tools, or they enable users to build in or connect their own devices (Fig. 1). The built-in input units contained in all three constructions are the following: a feed override switch, an emergency stop button and a key switch. The NCT-made magnetic handwheel is optional. The operating devices built-in or that can be built-in are not always connected to the electronic control unit of the keyboard and in some cases there is a building-in possibility only; operation of them should be ensured particularly and this will be detailed in any case.

To implement spindle override function, the keyboard provides an internal variable (MainSpindle) that can be read-out through an EtherCAT and that is increased, decreased or reset automatically by the keyboard after pushing the suitable keys without intervention of the control unit or the PLC.

3. Connectable devices and connector assignment

There are keys and connectors in different number on the keyboard of three kinds but the electronic unit in all three of keyboards is identical and joins keyboard through a 50-pin D-sub connector, thus connectors on the electronic unit are identical in all three versions. Specifications of the certain version can be found at the description of the given type in tabular form.

The power-supply voltage required by the electronics of the operating panel is 24 VDC and the supply connector is located on the electronic unit. Besides, there is a power-supply output for transmitting voltage of 24 VDC what makes voltage cabling easier (Fig. 2).

a.) **b.)**

Fig. 2 Power-supply connectors: a.) power-supply output, b.) power-supply input

The electronic unit has two standard Ethernet RJ45 connectors (EtherCAT IN and OUT) for EtherCAT communications. Besides EtherCAT connectors, in accordance with standard there are the following LEDs: Run, Link/Act In, Link/Act Out. These LEDs can be found on the electronic unit of the keyboard, therefore they cannot be seen when the keyboard is built in.

a.) **b.)**

Fig. 3 Connectors of the machine keyboard handwheel: a.) CAN bus handwheel connector, b.) incremental handwheel connector

CAN bus and TTL (incremental) handwheels can be connected to the machine keyboard and the keyboard can manage external handwheels too. One TTL and four CAN bus handwheels can be connected to a machine keyboard, and both external and built-in handwheels can be either CAN or TTL. Connection configuration of the TTL handwheel is as follows: in the case of the built-in handwheel the signals A, B, 5VDC, GND should be connected to the handwheel connector; the axis and the size of the step are selected from the machine keyboard. In the case of the external handwheel incremental signals should be

connected to the handwheel connector too; but signals of selection of axis and incremental – to the external handwheel connector. The external handwheel connector is capable to receive signals of 24 V, but the maximum input voltage the handwheel connector withstands is 5 V! The type of the handwheel and its steps number should be selected during the keyboard configuration set up. The external handwheel connector on the keyboard is uniquely assigned to the iHDW-B-D-A-6-S-I-M type external handwheel.

The CAN bus handwheel should be connected to the CAN connector; as far as communication of CAN handwheel produced by NCT Ltd. is concerned, please ask for our help.

The connector of the built-in feed override switch is uniquely assigned to the override switch of magnetic arrest produced by NCT Ltd.

On the keyboards there is a key switch which should be connected to suitable connector on the keyboard. Instead of the key switch a Maxim iButton® electronic key can be used, which can be connected to the keyboard electronics; the unique identifier of the key can be read-out through the EtherCAT interface. The USB connector is not connected to the keyboard electronics; it can be used when it is connected to one of the USB sockets of a central unit only. Neither the emergency stop switch is connected to the electronics; it needs to be connected independently from the electronics.

3.1. MK19 machine keyboard

The connector assignment of the MK19 keyboard is illustrated by the Fig. 4; its characteristics are contained in the Table I.

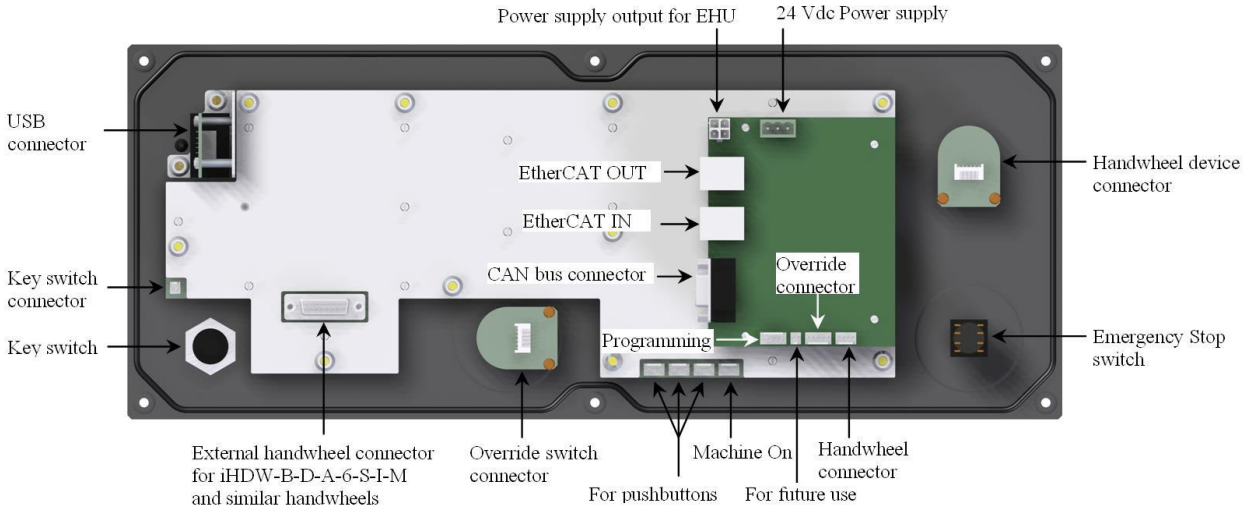


Fig. 4 The connector assignment of the MK19 machine keyboard

Table I Specifications of the MK19 machine keyboard

Description	MK19
Number of pushbuttons	59
Durability of pushbuttons / Manufacturer	10^7 pressing / ALPS
LED illumination	All of the pushbuttons
Mounted buttons	Emergency Stop, Key switch
Handwheel connection	TTL, CAN BUS, External
Installation mode	For panel mounting
Power supply voltage/input current	24 VDC/200 mA
Built-in handwheel	Optional
EtherCAT	RJ45 IN/OUT 100 Mbit
Operating/storing temperature/relative humidity (without condensation)	0…+55 °C/-24…+85 °C/95%
Weight	3.0 kg
IP protection rating	IP20
IP protection rating of the built in version of the unit	IP54

3.2. MK15 machine keyboard

It is a smaller version of the MK19 keyboard, there is no place for freely usable pushbuttons, and thus it contains pushbuttons fewer by 12. The MK15OP optional panel can be connected to it. Its connector assignment is illustrated by the Fig. 5; its characteristics are contained in the Table II.

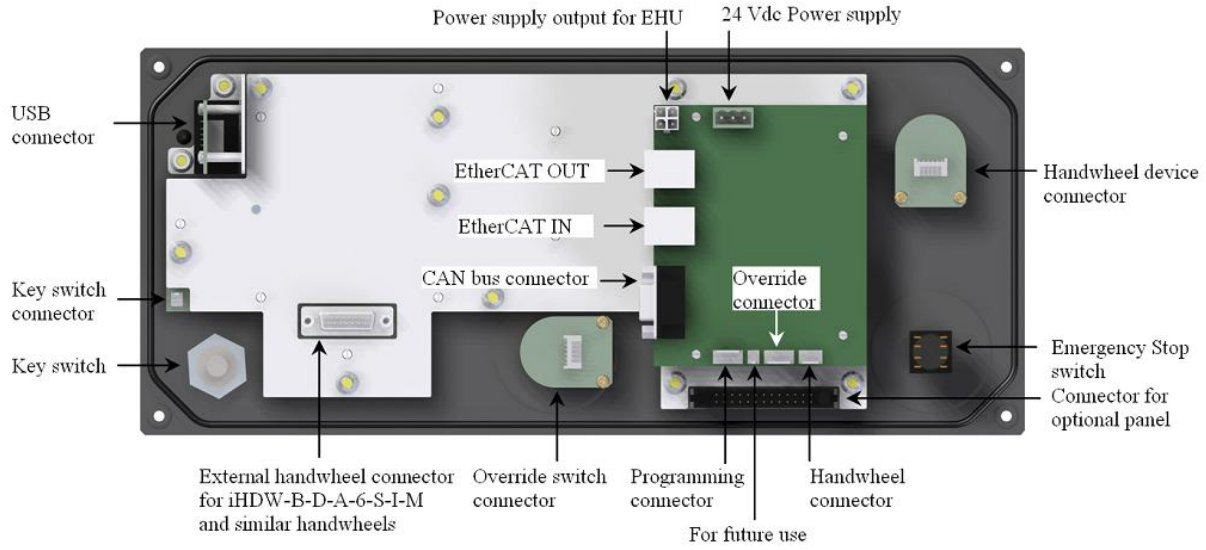


Fig. 5 The connector assignment of the MK15 machine keyboard

Table II Specifications of the MK15 machine keyboard

Description	MK15
Number of pushbuttons	47
Durability of pushbuttons / Manufacturer	10^7 pressing / ALPS
LED illumination	All of the pushbuttons
Mounted buttons	Emergency Stop, Key switch
Handwheel connection	TTL, CAN BUS, External
Installation mode	For panel mounting
Power supply voltage/input current	24 VDC/200 mA
Built-in handwheel	Optional

Description	MK15
EtherCAT	RJ45 IN/OUT 100 Mbit
Operating/storing temperature/relative humidity (without condensation)	0…+55 °C/-24…+85 °C/95%
Weight	2.35 kg
IP protection rating	IP20
IP protection rating of the built in version of the unit	IP54

3.3. MK15V machine keyboard

This is a vertically lengthened version of the MK15 keyboard, with the same number of pushbutton. It can be used with built-in handwheel (there is no possibility to connect external incremental handwheel) and NCT CAN bus handwheel only. The MK15OP optional panel cannot be connected to it. Its connector assignment is illustrated by the Fig. 6; its characteristics are contained in the Table III.

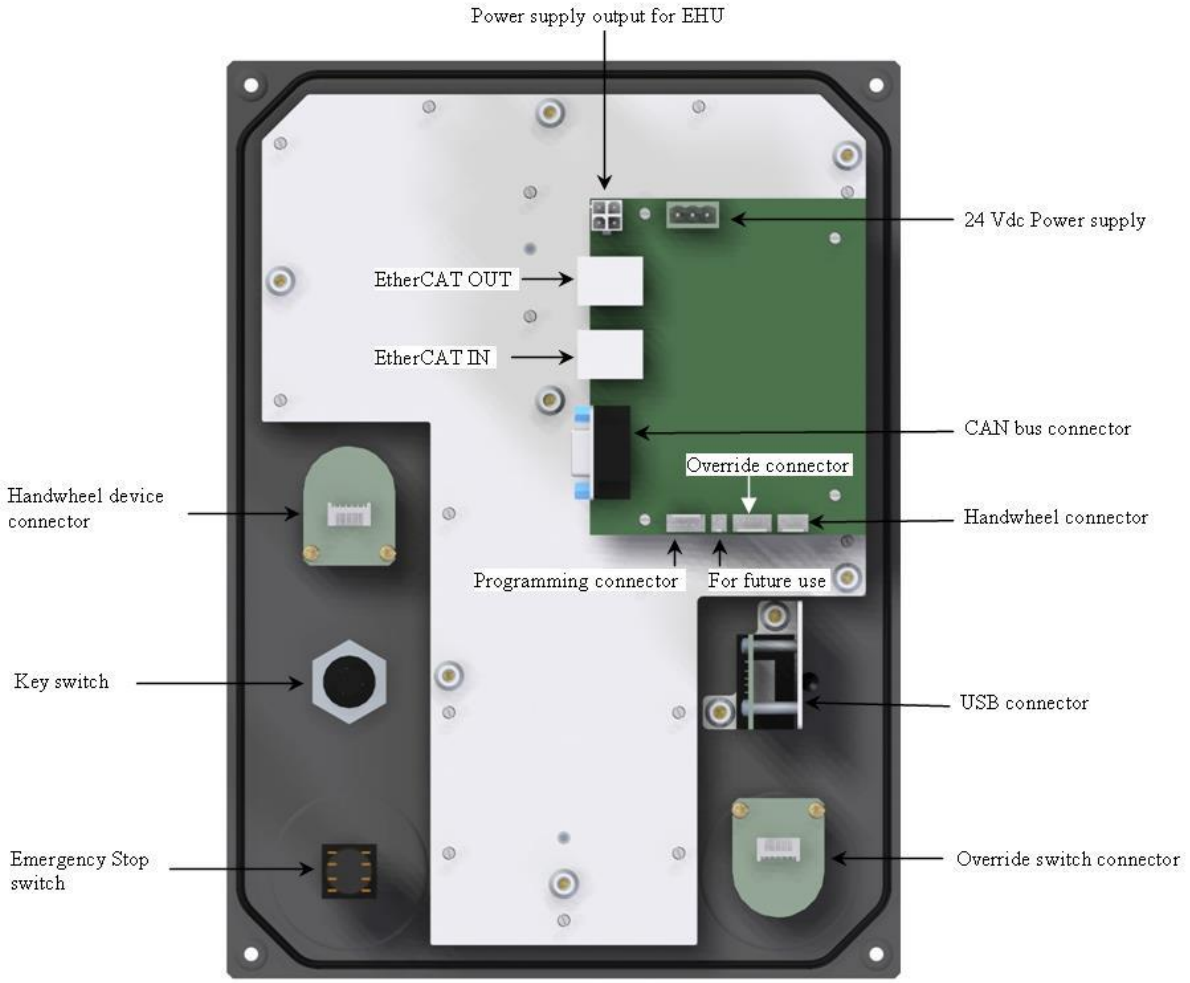


Fig. 6 The connector assignment of the MK15V machine keyboard

Table III Specifications of the MK15V machine keyboard

Description	MK15V
Number of pushbuttons	47
Durability of pushbuttons / Manufacturer	10^7 pressing / ALPS
LED illumination	All of the pushbuttons
Mounted buttons	Emergency Stop, Key switch
Handwheel connection	TTL, CAN BUS
Installation mode	For panel mounting
Power supply voltage/input current	24 VDC/0,4 A
Built-in handwheel	Optional
EtherCAT	RJ45 IN/OUT 100 Mbit
Operating/storing temperature/relative humidity (without condensation)	0…+55°C/-24…+85°C / 95%
Weight	2.5 kg
IP protection rating	IP20
IP protection rating of the built in version of the unit	IP54

3.4. MK15OP optional panel

This is an add-on panel for the MK15 machine keyboard to increase number of buttons. It contains four large buttons and fourteen standard pushbuttons. All of the pushbuttons are LED-illuminated. The mounted buttons should be connected to the connectors on the panel. The panel is connected to the electronics of the MK15 machine keyboard with a ribbon cable and the power-supply voltage for illumination of pushbuttons is provided through this cable too. Its connector assignment is illustrated by the Fig. 7; its characteristics are contained in the Table IV.

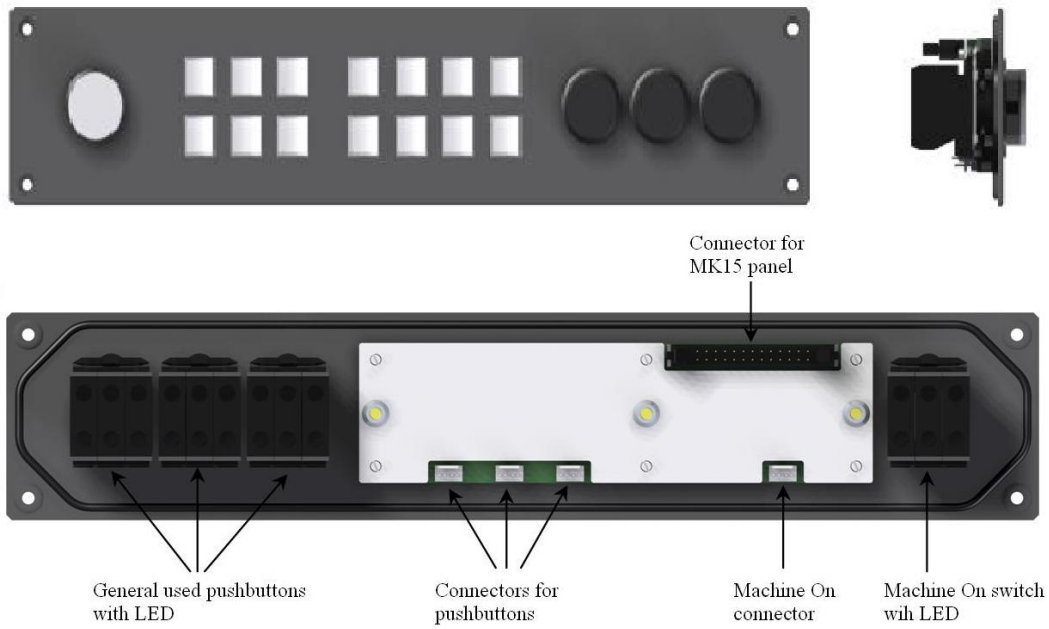


Fig. 7 The front board, side view and connector assignment of the MK15OP optional panel

Table IV Specifications of the MK15OP optional panel

Description	MK15OP
Number of pushbuttons	18
Durability of pushbuttons / Manufacturer	10^7 pressing / ALPS
LED illumination	All of the pushbuttons
Mounted buttons (4 pieces)	General (e.g. Machine ON, Start/Stop)
Installation mode	For panel mounting
Operating/storing temperature/relative humidity (without condensation)	0…+55°C/-24…+85°C / 95%
Weight	0.9 kg
IP protection rating	IP20
IP protection rating of the built in version of the unit	IP54

4. Description of Communication

The NCT-made MK19, MK15 and MK15V keyboards are slave devices connectable to EtherCAT network; communication settings of a device are contained in the standard XML description provided by the NCT Ltd. Knowledge of basic elements of the EtherCAT communication are assumed, they are not the subject of this description.

4.1. Input and output data of the keyboard

Communication between the NCT-made machine keyboards and the EtherCAT master is implemented by input and output variables (entries) through process data interface. In the cases of all three versions the number and type of the variables are the same, the difference shows itself during their use; this will be mentioned at detailed description of variables. The machine keyboard-related input variables (read by the EtherCAT master) are shown in the Table V, and the output variables (written by the EtherCAT master) are shown in the Table VI. The name, type and bit length of the variables are given. The name and the type given in the table are equal with the name and the type contained in the XML file.

Table V Keyboard-related input variables

Name of variable	Type	Bit length	Remark
MachinePushbuttons	ULINT	64 bit	-
Yaxley	USINT	8 bit	-
MainSpindle	USINT	8 bit	-
HwMove	USINT	8 bit	-
HandwheelMove0	USINT	8 bit	-
HandwheelMove1	USINT	8 bit	-
HandwheelMove2	USINT	8 bit	-
HandwheelMove3	USINT	8 bit	-
HandwheelAxis0	USINT	8 bit	-
HandwheelAxis1	USINT	8 bit	-
HandwheelAxis2	USINT	8 bit	-
HandwheelAxis3	USINT	8 bit	-

Name of variable	Type	Bit length	Remark
HandwheelIncr0	USINT	8 bit	-
HandwheelIncr1	USINT	8 bit	-
HandwheelIncr2	USINT	8 bit	-
HandwheelIncr3	USINT	8 bit	-
Beep	USINT	8 bit	-
iButtonSerialNumber	ULINT	64 bit	From revision 3 only!
GpIn1	BIT	1 bit	-
GpIn2	BIT	1 bit	-
GpIn3	BIT	1 bit	From revision 3 only!
GpIn4	BIT	1 bit	From revision 3 only!

Table VI Keyboard-related output variables

Name of variable	Type	Bit length	Remark
LEDs	ULINT	64 bit	-
NcReady	USINT	8 bit	-
GpOut1	BIT	1 bit	-
GpOut2	BIT	1 bit	-
GpOut3	BIT	1 bit	From revision 3 only!
GpOut4	BIT	1 bit	From revision 3 only!

4.2. Detailed description of the variables

LEDs: This variable is used for switching on or off bias lighting of the pushbuttons on the keyboard. Giving value 1 to the correspondent bit will switch the adherent LED on. Association of given bits and LEDs can be found in bitmaps. In the case of MK15-type keyboard the bits of the MK15OP optional panel can also be accessed in this variable.

NcReady: This variable is not used at present status of the keyboard.

GpOut1, GpOut2, GpOut3, GpOut4: General-purpose outputs on the keyboard. The LEDs of the mounted pushbuttons on the MK15OP optional panel joinable MK15 keyboard can be connected to them. The variables GpOut3 and GpOut4 exist from revision number 3 only.

MachinePushbuttons: The status of the pushbuttons on the machine keyboard can be read-out on this variable. If the pushbutton is in pressed down status the value of the correspondent bit is 1. As long as the pushbutton is pressed down the value of the bit remains 1. Association of given bits and pushbuttons can be found in bitmaps. In the case of MK15-type keyboard the bits of the MK15OP optional panel can also be asked for in this variable.

Yaxley: The value of the feed override can be read-out on this variable. The value is an integer number between 0 and 30.

MainSpindle: The value of the spindle override can be read-out on this variable. The variable MainSpindle is the special internal variable of the keyboard, its value is an integer number between 0 and 10. Pressing down the SMIN pushbutton its value decreases by 1, pressing down the SMAX pushbutton its value increases by 1, and pressing down the S100 pushbutton its value will be 5. On switching on its value starts from 5; on increasing or decreasing it does not overflow. The pushbuttons are illustrated in the Fig. 8.

HwMove: The position change of the built-in handwheel compared to the previous EtherCAT cycle can be read-out on this variable, in increment unit. Its actual value depends on the type of the handwheel built-in.

HandwheelMove0, HandwheelMove1, HandwheelMove2, HandwheelMove3: The position change of one of the four connectable external handwheels compared to the previous EtherCAT cycle can be read-out on this variable, in increment unit. Its actual value depends on the type of the external handwheel connected.

HandwheelAxis0, HandwheelAxis1, HandwheelAxis2, HandwheelAxis3: The axis selected on the handwheel (one of the connectable four external ones) of given number can be read-out on this variable.

HandwheelIncr0, HandwheelIncr1, HandwheelIncr2, HandwheelIncr3: The value of increment selected on the handwheel (one of the connectable four external ones) of given number can be read-out on this variable.

Beep: On this variable the keyboard indicates if a pushbutton has been pressed down. Its value is 1 up to one cycle; then it resets to zero automatically, even if the pushbutton is kept pressed down.

iButtonSerialNumber: On this variable, the unique identifier of the iButton electronic key (instead of the key switch) connected to the keyboard optionally, can be read-out. It exists from revision number 3 only.

GpIn1, GpIn2, GpIn3, GpIn4: General-purpose inputs on the keyboard. The mounted pushbuttons on the MK15OP optional panel joinable MK15 keyboard can be connected to them. The variable is of inverted operation (see sub-para 4.4). The variables GpIn3 and GpIn4 exist from revision number 3 only.

4.3. Machine Keyboard Bitmap

The keyboard allocation on the Fig. 8 and the Table VII determine the mutual assignment between physical location of the pushbuttons and LEDs of the machine keyboard and the bit value of the variables.

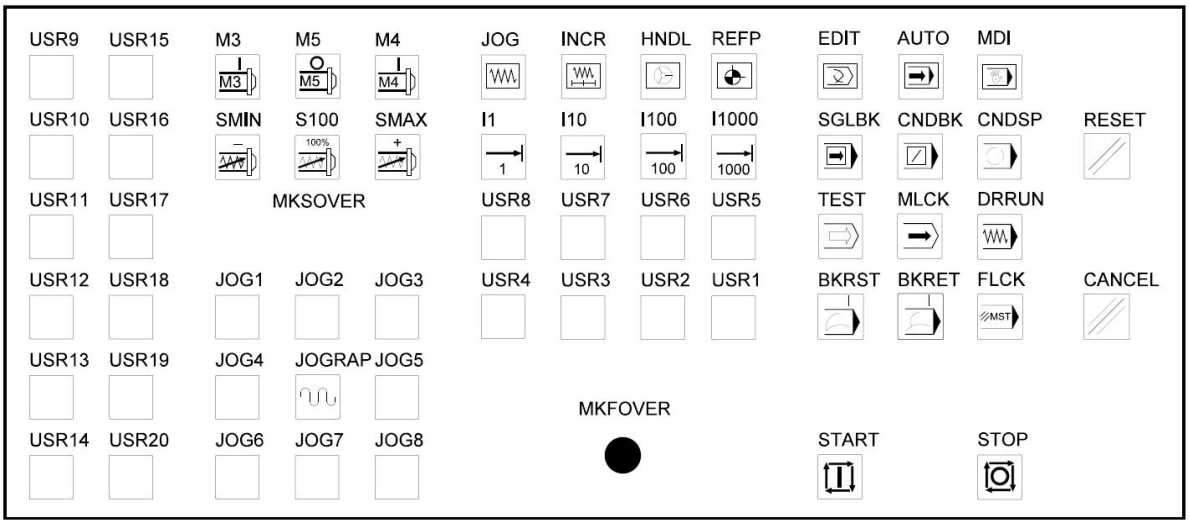


Fig. 8 Keyboard allocation on the 19" machine keyboard

Table VII Mutual assignment between pushbuttons, LEDs and bits

Symbol	Bit	Symbol	Bit	Symbol	Bit
START	0	**MDI**	21	**USR3**	42
STOP	1	**AUTO**	22	**USR4**	43
FLCK	2	**EDIT**	23	**USR5**	44
USR22 (MK15OP)	3	**TEST**	24	**USR6**	45
M3	4	**MLCK**	25	**USR7**	46
M4	5	**DRRUN**	26	**USR8**	47
M5	6	**BKRST**	27	**USR9**	48
USR21 (MK15OP)	7	**BKRET**	28	**USR10**	49
JOG1	8	**CNDSP**	29	**USR11**	50
JOG2	9	**CNDBK**	30	**USR12**	51
JOG3	10	**SGLBK**	31	**USR13**	52
JOG4	11	**I1**	32	**USR14**	53
JOG5	12	**I10**	33	**RESET**	54
JOG6	13	**I100**	34	**CANCEL**	55
JOG7	14	**I1000**	35	**USR15**	56
JOG8	15	**SMAX**	36	**USR16**	57
REFP	16	**S100**	37	**USR17**	58
HNDL	17	**SMIN**	38	**USR18**	59
INCR	18	**JOGRAP**	39	**USR19**	60
JOG	19	**USR1**	40	**USR20**	61
-	20	**USR2**	41	***KEY***	62
				-	63

Each pushbutton and LED on the keyboard has a bit in the **MachinePushbuttons** and **LEDs** variable of the keyboard. The Table VII shows relation between symbols and bit numbers. The bit number in the abovementioned variables is the bit number relating to the given pushbutton or LED, starting from 0 in the range of 0 – 63; the Symbol column identifies pushbuttons shown in the Fig. 8. The status of a given pushbutton and the LED related to it can be found at the same bit position. The ***KEY*** bit indicates the status of the key switch which is not illustrated in the Fig. 8; the **USR21** and **USR22** symbols are related to the add-on panel MK15OP.

4.4. Bitmap of the MK15OP optional panel

The standard pushbuttons of the MK15OP panel can be accessed in the **MachinePushbuttons** and **LEDs** variables of the keyboard. The bit – pushbutton relation can be determined on the basis of the Table VII too. The symbols on the Fig. 9 and Fig. 8 have the same bit number, with the exception of the **USR21** and **USR22** pushbuttons which are not in the keyboard allocation. The **GpIn1**, **GpIn2**, **GpIn3**, **GpIn4** bit variables are assigned to the BTN1, BTN2, BTN3, BTN4 mounted pushbuttons, while the **GpOut1**, **GpOut2**, **GpOut3**, **GpOut4** bit variables are assigned to the LEDs relating to the mentioned mounted pushbuttons. The input (GpIn...) bit variables are of inverted operation, therefore their default value is 1; their value will be 0 at the moment of pressing the pushbutton down and while the pushbutton is kept pressed down.

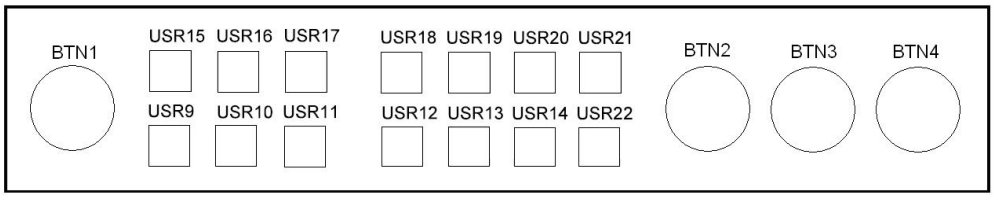


Fig. 9 Keyboard allocation of the MK15OP optional panel

5. Commissioning

There are many machine keyboards' functions facilitating commissioning, troubleshooting and servicing. These functions are, inter alia, the self-testing, the test operation mode and the machine keyboard configuration; the latter can be implemented without external device. During configuration of the keyboard, the type of the handwheel should be set up, and the feed override switch could be calibrated.

During its self-testing, the keyboard checks status of every pushbutton. If there are pushbuttons jammed or shorted somehow, the keyboard falls into error state, and all the

pushbuttons are illuminated. In case of jammed button the newer keyboards cyclically illuminate all the buttons, than the properly working buttons are turned off and only the jammed buttons are illuminated. This informs us not only about the fact of jamming but

the jammed buttons are shown.On the electronics of the keyboard there is a red LED titled with ERR which also indicates the error state of the keyboard. To get knowledge of test operation mode and configuration of the keyboard, a video is available which illustrates each function separately (http://www.youtube.com/watch?v=croWiZEc0Ig).

Handwheels are needed connect before the keyboard is switched on or if the handwheel is connected before switch on, a power cycle is required.

5.1. Test Operation Mode

The machine keyboard has a test operation mode facilitating comissioning during production, and on-site troubleshooting and servicing. In test operation mode the following checks can be carried out:

- testing proper function of the pushbuttons
- testing LED illumination of the pushbuttons
- testing proper function of the handwheel and the feed override
- testing the key switch

To enter into the test operation mode, the three pushbuttons indicated in the Fig.10 should be kept pressed down continuously, while the keyboard turns on (voltage is applied). To leave the test operation mode, the power-supply voltage of the keyboard should be switched off.

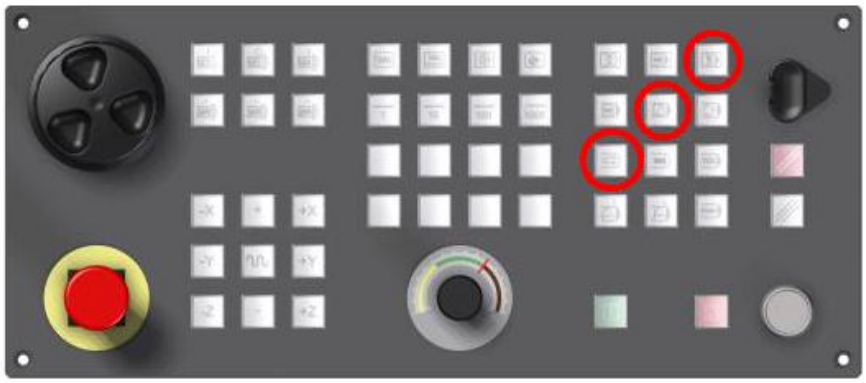


Fig. 10 Pushbuttons for entering into the test operation mode

5.2. Configuration of the machine keyboard

Configuration of the machine keyboard can be carried out in test operation mode too. During configuration, the step number and the type of the handwheel (e.g. NCT magnetic handwheel) can be set up, and the NCT feed override magnetic switch can be calibrated.