NUMmonitor

User manual

M00062EN-01

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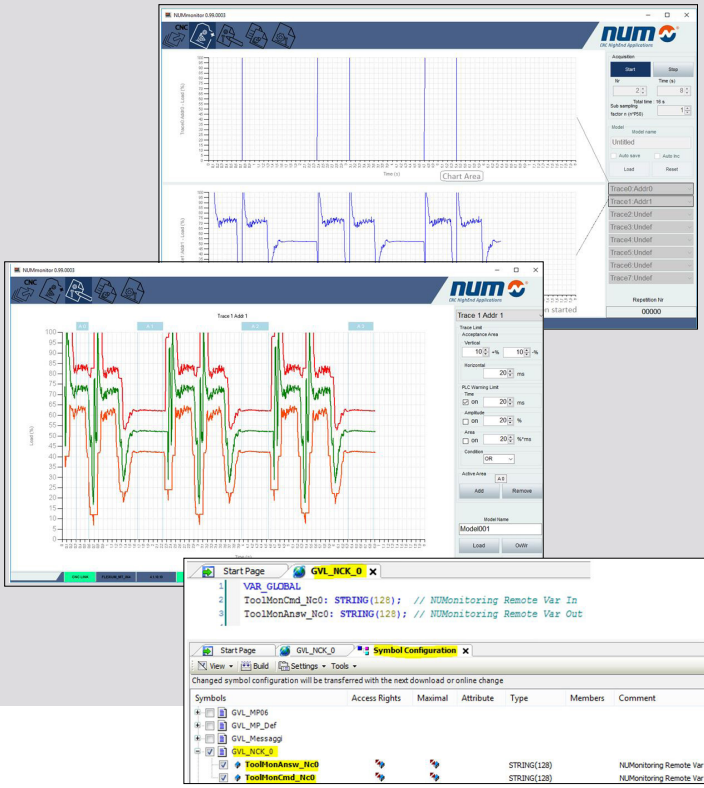

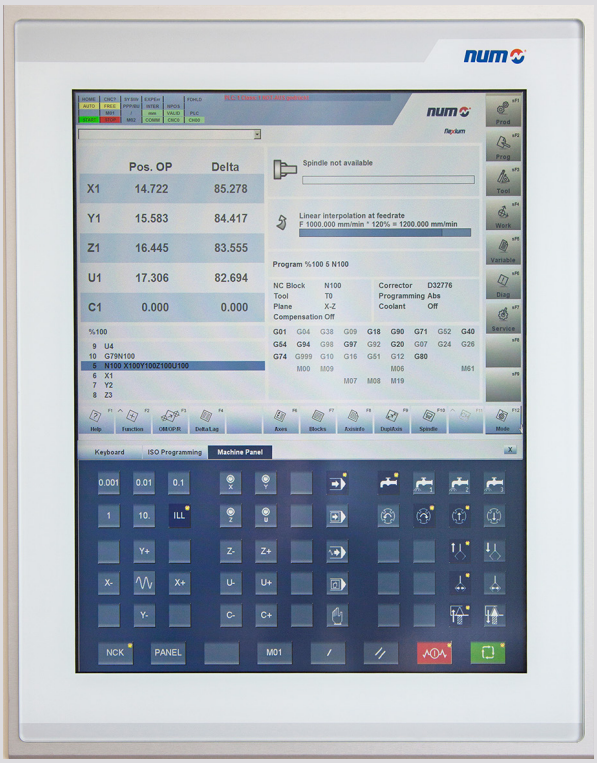

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CNC HighEnd Applications

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The physical, technical and functional characteristics of the hardware and software products and the services described in this document are subject to modification and cannot under any circumstances be regarded as contractual.

The programming examples described in this manual are intended for guidance only. They must be specially adapted before they can be used in programs with an industrial application, according to the automated system used and the safety levels required.

Summary

Summary

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1 Foreword

1.1 Field of application and requirements

- NUMmonitor is a Microsoft Windows operating system application designed to perform an active control during workpiece machining using a CNC NUM system.
- NUMmonitor allows the CNC system to exchange information about machining process and make it possible for the PLC to take actions.
- NUMmonitor finds particular utility in high productivity machines such as transfer machine and in any case where it's necessary to have control of the tool during processing, where measuring wear or interception of tool breakage play a role of primary importance.
- No additional sensors are required on the motors nor any acquisition cards to acquire the measures to be monitored.
- NUMmonitor finds application indiscriminately in applications that use motors controlled with vector system or motors controlled in V/f mode.

1.2 Use of the manual

This manual is for use by qualified personnel only.

To reduce the risk due to an improper use of the product, do not perform any servicing other than that contained in this manual unless you are qualified to do so.

To ensure proper use of these products, please always read this User's manual carefully and retain for future reference. Should the unit require maintenance, please contact a NUM authorized service center only.

How to read the manual

This manual gives information about the use of NUMmonitor and its customization.

Chapter	Description
1	**Foreword** This chapter introduces: - Field of application and requirements. - Use of the manual. - Document revisions. - NUM Agencies.
2	**Features description** This chapter introduces: - NUMmonitor general information and requirements. - Database data storing. - CNC interface. - PLC remote interface. - GENERAL SETTINGS configuration. - MODEL CREATION parameters - MODEL SETTINGS parameters - MONITORING parameters
3	**NUMmonitor Installation and Preliminary configurations** This chapter introduces: - NUMmonitor Installation - Preliminary configurations - E Trigger management variable - Selection of exchange variables between NUMmonitor and PLC - Link to a database file - CNC CONNECTION
4	**Creating a machining model** This chapter introduces: - Model creation configuration - Start recording - Model settings
5	**PLC Configuration** This chapter introduces: - Model creation commands - Monitoring commands - NUMmonitor special control - ToolMonFunc description - Application example

1.3 Document revisions

Date	Index	Reason for revision	See chapter
09 - 2020	00	Document creation	-
03 - 2021	01	NUMmonitor general informations and requirements updating	2.1
		V/f Motor List parameters - Scale factor	2.5.5
		Image update	2 and 4
		CNC part program example (Ability to copy and paste text)	5
		What to check if NUMmonitor is not ready	5.4.3
		CNC part program example - Programming command improvement	5.5.5

1.4 NUM Agencies

The list of NUM agencies is given click here http://www.num.com

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Summary

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2 Features description

NUMmonitor could be managed mainly in two ways:

- **NUMmonitor managing without PLC Remote Control**
  In this operating mode, all operations are handled by the operator in the PC where NUMmonitor is running.
  The only synchronization with the CNC is due to the state of E Trigger variable as explained in chapter "3.3".

- **NUMmonitor managing with PLC Remote Control**
  In this operating mode, the PLC can remote NUMmonitor operations to allow automatic monitoring.
  Details for configuring NUMmonitor are explained in the chapter "2.5.2".
  For the PLC configuration, refer to the chapter "5".

2.1 NUMmonitor general information and requirements

- NUMmonitor is a tool that requires a dedicated licence installed on the CNC system with which it will work, otherwise all the windows will be locked. This means that the licence must be present into the licence file of the CNC.
- Two licence types for NUMmonitor are offered:
  - **NUMmonitor Basic** where the max number of traces (measure points) that could be monitored is limited to two and interaction with the PLC is not allowed. (See chapter "3.6.1" for NUMmonitor status bar detection).
  - **NUMmonitor Full** where the max number of traces (measure points) that could be monitored is eight and the remote control from the PLC is allowed. Allowed doesn't meas must be, if you need monitoring more the two traces without PLC remote control, this is feasible with this licence type. (See chapter "3.6.1" for NUMmonitor status bar detection).
- NUMmonitor could be installed in every PC with Windows Operative system >= 8.1 or 10
- NUMmonitor is an application designed to interface exclusively with the Flexium+ CNC with software version >= 4.1.10.10 (CNC oscilloscope function is required)
- NUMmonitor uses functions integrated into NUM FXserver and NUM GatewayService, these functions must be loaded, in advance, into the PC where NUMmonitor will run. The easiest way is to install NUM HMI on that PC also without using NUM HMI on that PC.
- NUMmonitor can be connected to one CNC at time, this means that monitoring operations cannot be performed with motors connected to different CNCs simultaneously, but exclusively with those referred to the associated CNC. If you have more process to monitoring in different CNCs you can open more instances of NUMmonitor on the same PC, but you need an high power PC with a lot of RAM, or you use more PCs. Depending on the amount of the information you will decide to manage, the bottleneck could be found in different stage of the system, but for a standard use we don't foreseen problem.
- NUMmonitor allows the monitor up to 8 simultaneous traces, which correspond to a maximum of 8 motors at a time during the machining verification.
- The minimum sampling time is CNC P50 value, but this will give a big amount of data not always useful.
- The maximum monitoring time strictly depends on the resources of the computer on which the application runs because the waveforms created during monitoring are allocated in the RAM memory of the computer.
- The data of the configurations of the models is stored in a database using the LiteDb open source library, consult the relative documentation to know its characteristics and limits.
- NUMmonitor allows the connections to one database file at time, model configurations that are in two separate database files cannot be viewed and used simultaneously.

- NUMmonitor does not store the data of the traces in the database during the monitoring phase, but only carries out an analysis to intercept any emergency conditions.
- NUMmonitor uses date transferred by means of Drive Quick Measure Points.
- The user must be sure that no other applications such as: HMI, FlexiumTools, PLC program will not access to the same quick measure point defined to be used with NUMmonitor.

If PLC programs are downloaded with monitoring in progress, the monitoring functionality can be compromised.

2.2 Database data storing

An appropriately configured reference model must be created for each type of machining that needs to be monitored. All the information necessary for the definition of each model is stored in a database file.

It's possible to manage multiple database files, for example to group the models that refer to the machining of a specific piece.

2.3 CNC interface

NUMmonitor performs the monitoring of the machining by exchanging information from CNC.

These information can indicate status information such as the execution status of a machining or motor current measurement. The part program of each machining must be modified to send the appropriate information to NUMmonitor.

A proper configuration of the parameters of the drives connected to the motors is necessary for the correct setting of the measurement information that is transmitted to the CNC and NUMmonitor.

2.4 PLC remote interface

NUMmonitor allows most of the commands available for the user interface to be sent remotely by the PLC.

NUMmonitor, in this operating mode, sends messages to the PLC about the status of the program and about any emergency conditions that may arise during monitoring.

A fully integrated system is used to perform automatic monitoring by using data exchange with the PLC.

2.5 GENERAL SETTINGS configuration

The GENERAL SETTINGS configuration of NUMmonitor allows the modification of some parameters to perform correct operation relative to the specific application, it is also possible to configure the parameters to adapt the program to the different needs or preferences of the user.

The changed value are automatically saved when *"Enter*" button has been pushed.

Fig. 1 GENERAL SETTINGS - *Parameters divided by category.*

2.5.1 Database parameters

DB Name	Indicates the name of the existing or new database that you want to use. This parameter can be changed if the database connection is not active.
DB Location	Indicates the path where the database file is located or where you want to create the new database file. This parameter can be changed if the database connection is not active.

2.5.2 PLC parameters

Remote Control	Enables or disables PLC remote control. Activation of the PLC remote control is only possible when **Remote Var In** and **Remote Var Out** are assigned to a variable name. This parameter can be changed if the connection to the CNC is not active.
Remote Var In	Indicates the name of the data receive variable sent by the PLC to NUMmonitor when remote control from PLC is active. The variable name must contain the complete path depending from the PLC application installed on the machine to be monitored, as in the picture below. This parameter can be changed if the connection to the CNC is not active.
Remote Var Out	Indicates the name of the data send variable from NUMmonitor to PLC when remote control from PLC is active. The variable name must contain the complete path depending from the PLC application installed on the machine to be monitored, as in the picture below. This parameter can be changed if the connection to the CNC is not active.

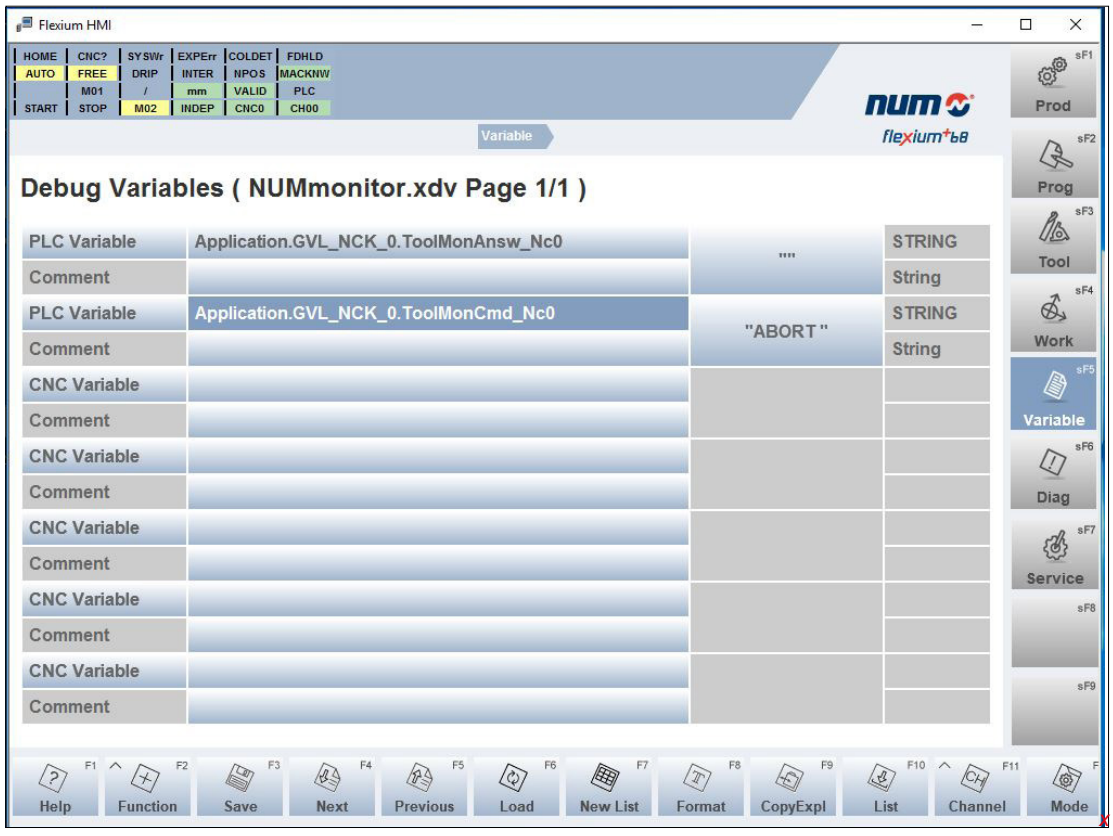

Fig. 2 Flexium+ HMI - Window for debug variables.

2.5.3 CNC parameters

E Trigger	It indicates the E parameter where the CNC informs NUMmonitor the start or end of an acquisition session. This parameter can be changed if acquisition during model creation or monitoring is not active. This parameter must be of global use (Refer to M00040EN Flexium+ Programming manual).
E Tp Base Address	Indicates the E parameter which represents the base address of the Drive Quick Measure Point defined for the acquisition of trace data during acquisition. (Refer to M00040EN Flexium+ Programming manual and M00055EN Flexium+ Extended programming manual) This parameter can be changed if acquisition during model creation / monitoring is not active.
CNC Address	Indicates the CNC address of the connection. It must be the same selected on the address rotary switch located on the NCK box (Refer to M00009EN Flexium systems Installation manual). This parameter can be changed if the connection to the CNC is not active.

2.5.4 MODEL CREATION parameters

These parameters are used to configure limits and defaults when creating the machining model.

Fig. 3 GENERAL SETTINGS - *MODEL CREATION - Parameters.*

Max Drive Addr Nr	This parameter configures the maximum number of drive addresses that can be associated to a trace for model creation and monitoring. This parameter requires restarting the application to make the change active.
Default Name	This parameter indicates the name proposed when creating the model. This parameter requires restarting the application to make the change active.
Default Acq Time	This parameter indicates the time in seconds that is proposed when creating the model. This value is set if the model is not created from an existing model. This parameter requires restarting the application to make the change active.
Defaut Acq Nr	This parameter indicates the number of machining repetition that must be performed during the learning phase and that is proposed when creating the model.
Default Auto Save	This parameter enables or disables the default enable state of the model auto save when the model is created. This value is set if the model is not created from an existing model. This parameter requires restarting the application to make the change active.
Default Auto Inc	This parameter activates or deactivates the default enabling status of the auto increment function of the model name when the model is created. This value is set if the model is not created from an existing model. This parameter requires restarting the application to make the change active.
Default H Range	This parameter defines the default value of the value in ms of the horizontal acceptance limit when the model is created. This value is set if the model is not created from an existing model. This parameter can be changed if the acquisition in the MODEL SETTINGS or MONITORING window is not active.
Default V Range Pos	This parameter defines the default value of the value in % of the positive acceptance vertical limit. This value is set if the model is not created from an existing model. This parameter can be changed if the acquisition in the MODEL SETTINGS or MONITORING window is not active.

Default V Range Neg	This parameter defines the default value of the value in % of the negative acceptance vertical limit. This value is set if the model is not created from an existing model. This parameter can be changed if the acquisition in the MODEL SETTINGS or MONITORING window is not active.
Default Amplitude Lim En	This parameter enables or disables the default enable status of the amplitude limit verification function. This value is set if the model is not created from an existing model. This parameter can be changed if the acquisition in the MODEL SETTINGS or MONITORING window is not active.
Default Amplitude Lim	This parameter defines the default limit in % of exceeding amplitude value compared to the acceptance area. This value is set if the model is not created from an existing model. This parameter can be changed if the acquisition in the MODEL SETTINGS or MONITORING window is not active.
Default Time Lim En	This parameter activates or deactivates the default enable status of the time limit check function. This value is set if the model is not created from an existing model. This parameter can be changed if the acquisition in the MODEL SETTINGS or MONITORING window is not active.
Default Time Lim	This parameter defines the default limit in ms of exceeding time compared to the acceptance area. This value is set if the model is not created from an existing model. This parameter can be changed if the acquisition in the MODEL SETTINGS or MONITORING window is not active.
Default Area Lim En	This parameter activates or deactivates the default enable status of the area limit check function. This value is set if the model is not created from an existing model. This parameter can be changed if the acquisition in the MODEL SETTINGS or MONITORING window is not active.
Default Area Lim	This parameter defines the default limit in %*ms of exceeding area compared to the acceptance area. This value is set if the model is not created from an existing model. This parameter can be changed if the acquisition in the MODEL SETTINGS or MONITORING window is not active.
Default Lim OP	This parameter defines the default value of the logical association between the Amp / Time / Area limits activated to define the final alarm status. This value is set if the model is not created from an existing model. This parameter can be changed if the acquisition in the MODEL SETTINGS or MONITORING window is not active.

2.5.5 V/f Motor List parameters

These parameters define the measurement point scaling factors for the motors controlled in V/f mode as shown in the below figure.

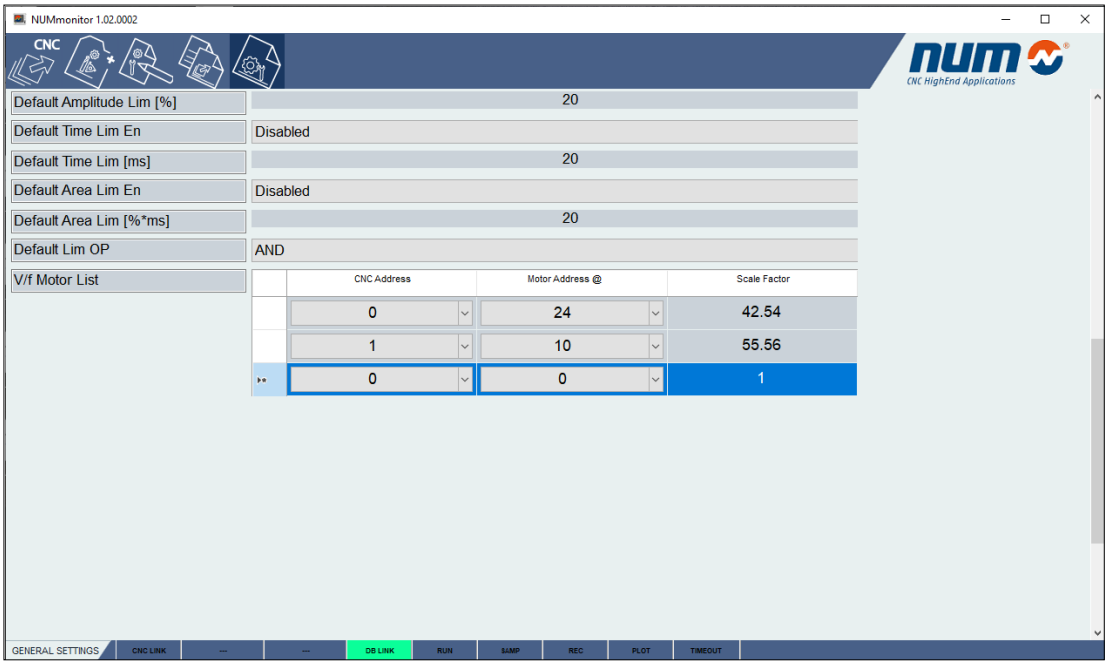

Fig. 4 GENERAL SETTINGS - *MODEL CREATION - V/f Motor List parameters.*

CNC Address	This parameter defines the CNC Address associated with the motor. This parameter can be changed if the acquisition in the MODEL SETTINGS or MONITORING window is not active.
Motor Address @	This parameter defines the address (@) of the drive associated with the motor. This address could be read into the Diag/CNCfg window of the Flexium HMI. This parameter can be changed if the acquisition in the MODEL SETTINGS or MONITORING window is not active.
Scale Factor	This parameter defines the calculated scale factor. This parameter can be changed if the acquisition in the MODEL SETTINGS or MONITORING window is not active. For the calculation of this scale factor it is necessary to apply the following formula: $\text{ScaleFactor} = \frac{856100 * \text{Motor Nominal Power [kW]}}{\text{Drive Size[Apk]}}$ For example, with a drive with a peak current of 50Apk and a motor with a rated output of 10kW we will have: $\text{ScaleFactor} = \frac{856100 * 10}{50} = 171220$ This scale factor matches the value read from MP6, that must be selected in case of V/f asynchronous motor application. Remember that MP6 shows the used motor power in Watt, the value traced from NUMmonitor will be in percentage respect to the motor nominal power. (see also chapter "3.2.1")

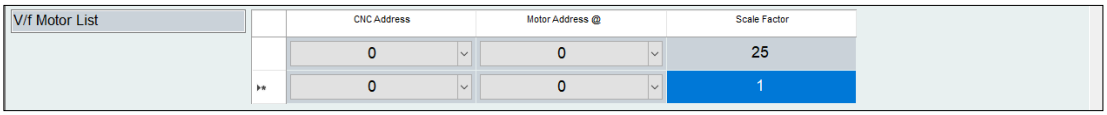

Fig. 5 V/f Motor List - *Add new Scale Factor row*

To add a new Scale Factor row you must select CNC Address and Motor Address @ and write the Scale Factor value into the last row where * is present into the first left column.

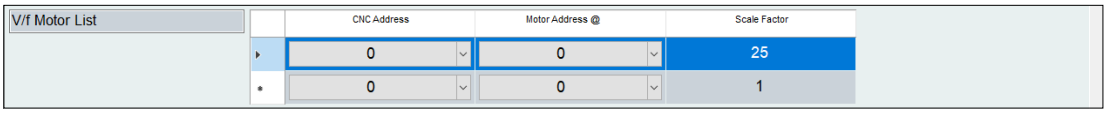

Fig. 6 V/f Motor List - *Delete Scale Factor row*

To delete a Scale Factor row you must select it pushing into the first left column or using window up or window down keyboard button till the row will be highlighted in blu. Then you will push Del (Canc) button on the keyboard

2.5.6 MONITORING Parameter

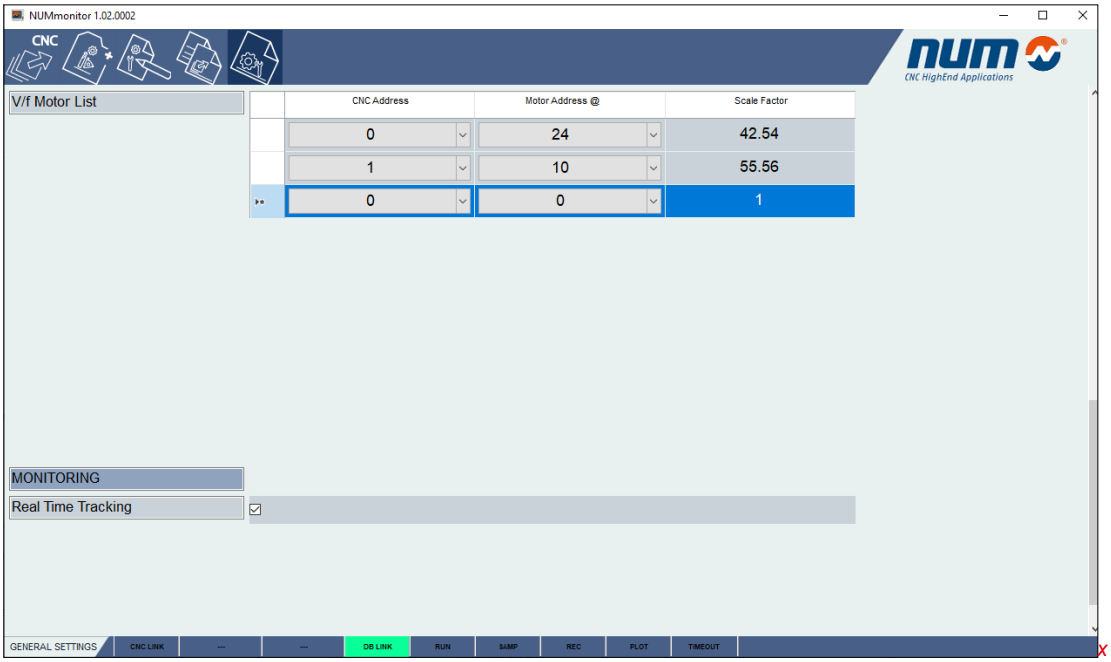

Fig. 7 GENERAL SETTINGS - *MONITORING - Real Time Tracking*

Real Time Tracking	This control enables or disables plotting of the graphs during monitoring. The machining graph will be displayed at the end of the plot if this control is deactivated.

2.6 MODEL CREATION parameters

For the creation of the model, a learning phase is required where the motor machining data are recorded.

The model creation is possible only if the CNC and the Database are connected and the NUMmonitor licence is integrated into the CNC licence file.

These condition are true when in the status bar the *'CNC LINK'* and *'DB LINK'* indicators in the status bar are light on and green and indicator where appears the name of the computer where RTS is running to which NUMmonitor has been connected is not red.

Next phase is the configuration needed to characterize the type of monitoring to be carried out.

The creation of the model takes place in two phases, the learning of the machining waveforms and the limits configuration.

Fig. 8 MODEL CREATION - *Creation of the model in the learning phase.*

The main program status information is displayed in the status bar at the bottom of the windows.

During the learning phase it is necessary to wait until the state of the acquisition system to be ready for the recording to start.

To start learning, press the *'Start'* button and wait for the three *'RUN', 'SAMP', 'REC'* indicators to change color to light blue and '*PLOT*' in orange.

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Fig. 9 *Status bar presentation waiting for 'PLOT' start trigger.*

At the end of the learning phase, the system will automatically display the MODEL SETTINGS window if the '*Auto Save'* parameter is deactivated. In this case it's possible to configure the limit configuration before saving the model.

If the indicator '*PLOT*' don't change color from orange to light blue, check the partprogram to verify where the 'E trigger' variable is set to 1 and if the 'E trigger' variable number is the same choosen into the GENERAL SETTINGS window.

The model is automatically saved if the parameter *'Auto Save'* is activated. In this case if the model was created from scratch, the configuration values of the limits will be the default values defined in the GENERAL SETTINGS window in the *MODEL CREATION* item, otherwise the configuration will be the one inherited from the loaded model.

The field marked with ① displays the name of the computer where RTS is running to which NUMmonitor has been connected while field marked with ② displays the Flexium⁺ System version where RTS is running to which NUMmonitor has been connected.

2.6.1 Acquisition parameters

The parameters related to the acquisition make it possible to set up the learning system according to the characteristics of the machining program to be monitored.

These parameters are configurable until the registration of the model is started.

Time	This parameter defines the estimated time in seconds of working process to be monitored.
Nr	This parameter defines the number of machining repetitions that must be performed during the learning phase. NUMmonitor creates a model based on the average of acquisitions. To avoid averages as a result of acquisitions set this parameter with the value 1. The indicator below the parametric Time and Nr indicates the total estimated time of the learning phase.
Sub sampling factor n (n*P50)	This parameter defines the sampling time factor to set a sampling time of the acquisition as a multiple of that set in the CNC task (parameter P50). This allowes reducing the amount of samples transferred from CNC to PC in case of limited performance of the system: PC, RAM PC, Network speed, free time disposable between CNC time consuming and CNC P50, etc.
Start	This button starts the learning phase of the model. These conditions are necessary to start learning: • The CNC is connected. • The database is connected. • At least one trace in the trace selector has been assigned to an address. NUMmonitor is ready to acquire machining data when in the status bar the three indicators labeled as '*RUN*', '*SAMP*' and '*REC*' are light blue and '*PLOT*' in orange.
Stop	This button interrupts the learning phase of the model. The interruption invalidates the creation of the model, so it will not be possible to use the recorded data stored until the intentional interruption of the registration.

2.6.2 Model parameters

These parameters define how to generate a model and the possibility to create it by inheriting the configuration from an existing model.

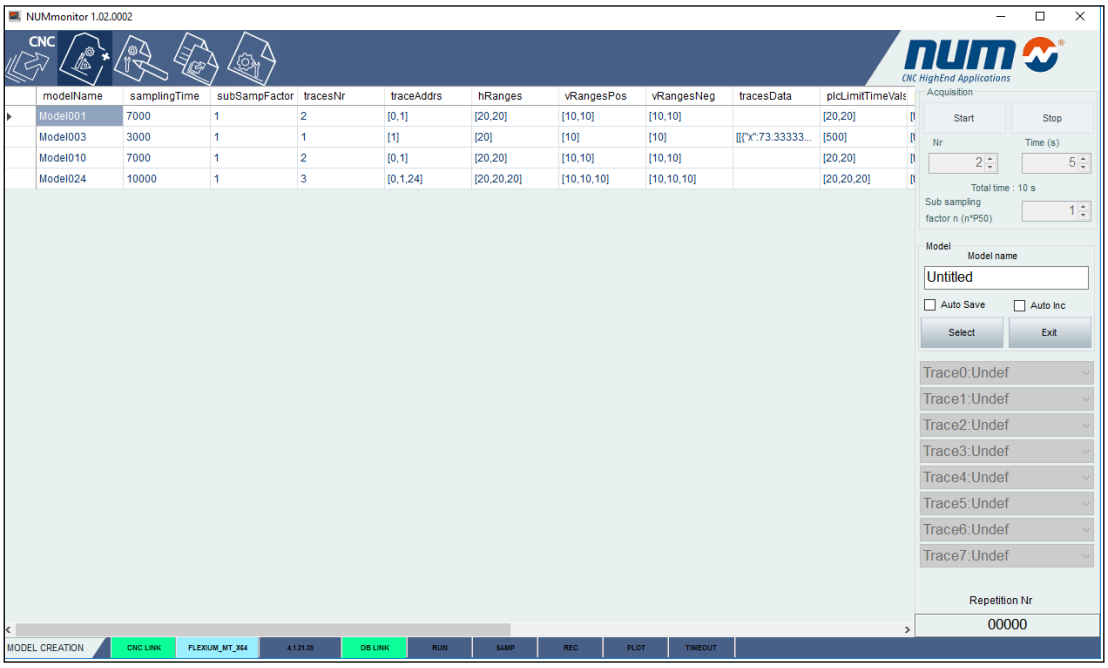
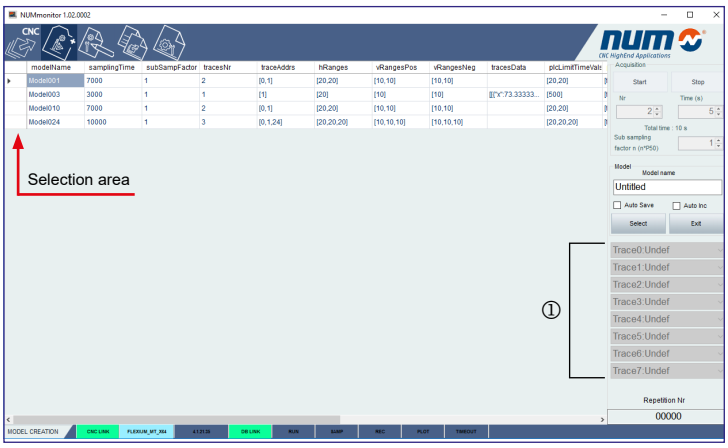
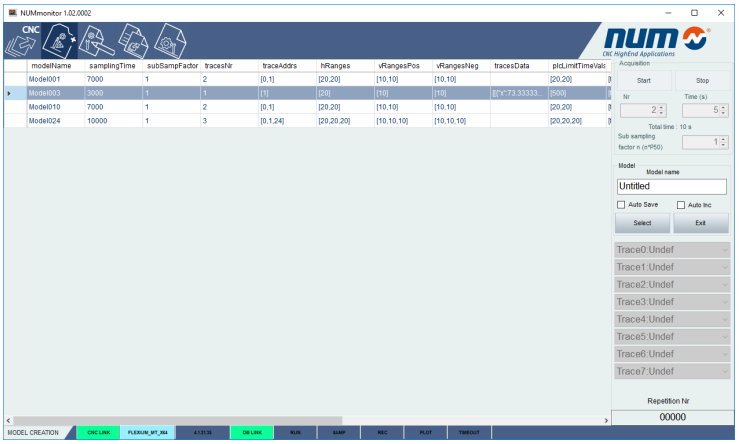


Fig. 10 MODEL CREATION - *Parameters*

Model name	This field indicates the name of the model to be stored or the base name in case of use of auto increment function.
Auto Save	This control allows the activation or deactivation of the auto-save function. At the end of the learning phase, if this control is enabled, the model is saved. See chapter "4.1" for more information.
Auto Inc	This control allows the activation or deactivation of the auto increment function of the numeric postfix appended to the model name in the case of the presence of the name in the database. See chapter "4.1" for more information.
Reset	This control allows the initialization of the monitoring window to its initial state.
Load	This button allows the loading of the configuration of an existing model for new model creation. The following parameters will be imported: • Acquisition parameters: - Nr - Time • Model parameters: - Model Name • Traces address configuration • Limits parameters configuration (as explained in chapter "2.7")

Select	 The figure shows the window for loading the configuration of a model from an existing model. This window displays a tabular list of models in the connected database. The first field named *'Model name'* is the name of the model from which the import of the configuration will be made. To select a model it is necessary to click with the mouse in the area called *'Selection Area'*, a blue bar highlights all the fields of the selected model.  This button allows the loading of the model that has been selected positioning the left arrow on the model row.
Exit	This button allows the exit from the model loading mode, in this way the loading of the configuration from the existing model is aborted.
Trace Selector ①	This control allows the assignment of the traces involved to the creation of the model as explained in the chapter "4.1".
Repetition Nr	This indicator displays the number of repetitions performed during model creation. The number of repetitions is increased by one at the end of each recording.

2.7 MODEL SETTINGS parameters

At the end of the motor values learning phase, if the status of the *'Auto Save'* control is disabled, the window for the model limits configuration is showed.

The figure here under shows the window in which the model limits are configured.

Fig. 11 MODEL SETTINGS - *Model limits configuration*

The MODEL SETTINGS window, unlike the MODEL CREATION window, allows the display and modification of the parameters one trace at a time, in order to allow a clearer and faster customization.

The configuration of the limits for each model can also be made from a model previously saved in the database.

It is also possible to clone an existing model to create a new one to have a copy with a different configuration of the limits.

Trace Selector ①	This control allows you to select the trace of the model to be configured. All the controls in the *'Trace Limit'* box and the chart area graph refer to the trace selected with the *Trace Selector* control.

2.7.1 Active Area parameters

These parameters are used to set time areas of the model trace where both the monitoring and the configured alarm detectors are activated. This allows to isolate the temporal areas not interested in monitoring and which could limit the possibility of intercepting real problems during machining.

The active areas are shown in the graph with blue vertical lines, labeled with *Ax* where *'x'* is the progressive number of the area.

The time areas are linked to the trace in which has been defined. In the MODEL for each trace the time areas are defined in independent way.

Fig. 12 MODEL SETTINGS - *Active Area parameters*

In this figure the time areas that will be subject to controls during the monitoring are highlighted in blue on top.

These areas can be modified to increase or decrease the affected area in question. To do that move the mouse over the chart till to see the "move cursor" on the vertical line that define the area limit you like moving, then pushing and old the left button of the mouse you can move the limit.

It is possible to have an indefinite number of areas per trace up to the saturation of the available time area.

Active Area - Add	This control allows the addition of a new activation time band. The new bands are created starting from the first available area with priority of insertion from left to right. This control is disabled when NUMmonitor detects that there is no more time availability for inserting a new band.
Active Area - Remove	This control allows the removal of the existing time bands. The time band subject to removal is the one displayed in the active band indicator above the *'Add'* and *'Remove'* controls. To select a band it is necessary to click with the mouse on the vertical bar at the beginning or end of the band concerned. At the end of the removal, the first available antecedent band in time order is selected.

Every time a new time band is inserted or removed, the band labels are renamed so that the progressive number Ax is sorted in ascending order, where x is the increasing number associated with each band.
On the right of the Active area number is displayed its time width.

2.7.2 Acceptance Area parameters

The parameters of the *'Acceptance Area'* box are used to manage the acceptance area of the selected trace. It is possible to modify the dimensions of this area by acting on its horizontal part (time) and on the vertical part (amplitude).

The reference trace represents the trace generated and calculated during the learning phase of the model and is visualized through a green trace.

The acceptance area represents the reference limit within which the trace must remain during the monitoring and is displayed graphically in the chart area with two red traces.

Vertical +%	This control allows you to set the maximum positive acceptance value as a percentage of the reference trace.
Vertical -%	This control allows you to set the maximum negative acceptance value as a percentage of the reference trace.
Horizontal	This control allows to set the antecedent and subsequent acceptance time value in ms compared to the reference trace.

2.7.3 Alarm Detectors Limit parameters

The Alarm Detectors Limit parameters allow the configuration of NUMmonitor to generate alarms during the monitoring phase under certain conditions. These alarms are sent to the PLC if NUMmonitor is configured appropriately.

The purpose of configuring these parameters is to allow NUMmonitor to intercept critical conditions such as tool breakage.

Time - on	This control allows you to activate the out-of-limit time alarm detector during monitoring.
Time - ms	This control allows to set the maximum acceptance of out-of-limit time related to the acceptance area as indicated in chapter "4.3.2". Obviuosly this time value must be less then the time width of each Acceptance area.
Amplitude - on	This control allows you to activate the out-of-limit amplitude alarm detector during monitoring.
Amplitude - %	This control allows to set the maximum acceptance of out-of-limit amplitude in percentage of the acceptance area as indicated in chapter "4.3.2".
Area - on	This control allows you to activate the out-of-limit area alarm detector during monitoring.
Area - %*ms	This control allows to set the maximum acceptance of the area out of limits in %*ms in relation to the acceptance area as indicated in chapter "4.3.2".
Condition	This parameter performs a logical operation between the status of the active alarm detectors (Time / Amplitude / Area) to generate the logic status of the alarm. If the 'OR' item is selected, it is sufficient that only one active alarm detector is in alarm condition. If the 'AND' item is selected, all active alarm detectors must detect an alarm to generate the alarm.

2.7.4 Model management parameters

Models including configurations are stored in the selected and active database.

Model Name	This field displays and allows the typing of the model name.
Load	This control allows the selection of a model from a list of models in the database in the same way it is done when loading a template model to create a new model.
Save/OvWr	This control allows the saving or updating of a model in the database.The label associated with this control can vary depending on whether the model name is present in the database or not. If the model name is not present in the database, the label associated with this check will be *'Save'*. If the model name is part of the database records, the label associated with this control will be *'OvWr'*.
Delete	This control allows the deletion of a model from the database. The deletion is permanent, it will not be possible to retrieve a model in the database after its removal.

2.8 MONITORING parameters

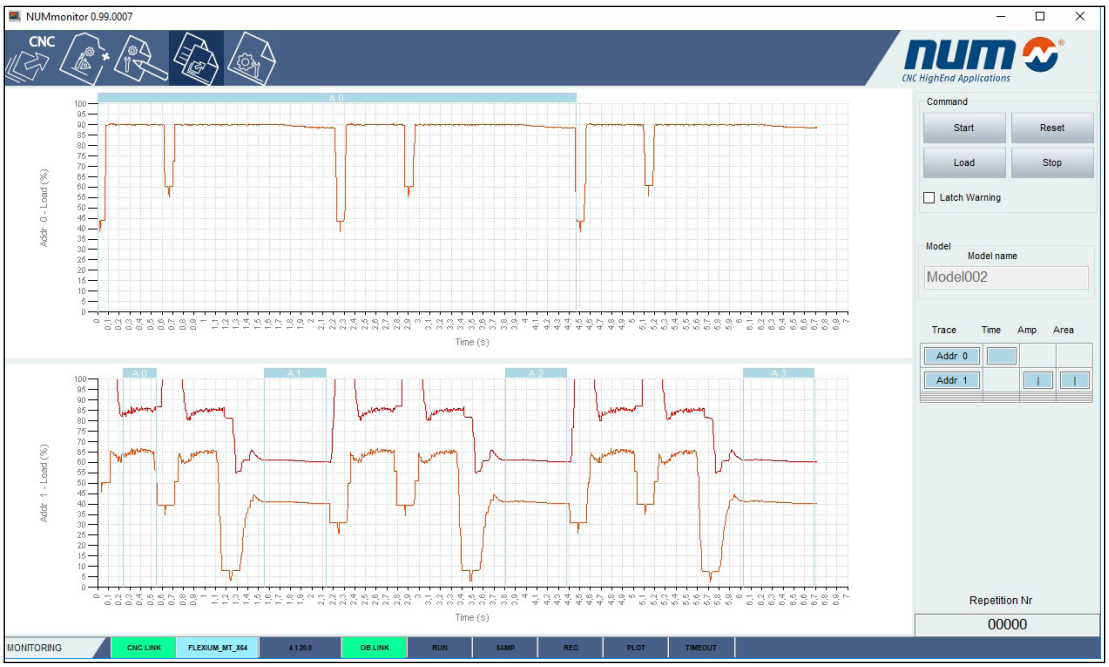


Fig. 13 MONITORING - *window*

2.8.1 Commands

Load	This control allows the selection of a model from the list of models in the database in the same way it is done when loading a template model during the creation phase of a new model. When the chart area is loaded, the graphic representation of the active alarm detectors for each trace is displayed. The red traces represent the amplitude limits set in the acceptance area and the vertical blue lines indicate the set activation phases. It is possible to select a model only if the database is connected.
Reset	This control allows the initialization of the monitoring window to its initial state.
Start	This control allows the start of monitoring. Monitoring can be started if the CNC is connected. NUMmonitor is ready to acquire machining data when in the status bar the three indicators indicated with the labels *'RUN'*, *'SAMP'*, *'REC'* are colored light blue. When the monitoring starts, the color of the indicator with the *'PLOT'* label on the status bar turns orange, waiting for E Trigger 0->1 transition (see chapter "2.5.3"). 
Stop	This control allows the interruption of the monitoring. This control could executed if the CNC is connected.
Latch Warning	This control activates the freezing mode of the alert status display of the alarm detectors in the display grid, as explained below.

2.8.2 Monitoring status display grid

During monitoring, this grid displays the trace status with the display of the alarm detectors set in the loaded model. Each row represents a trace that is monitored.

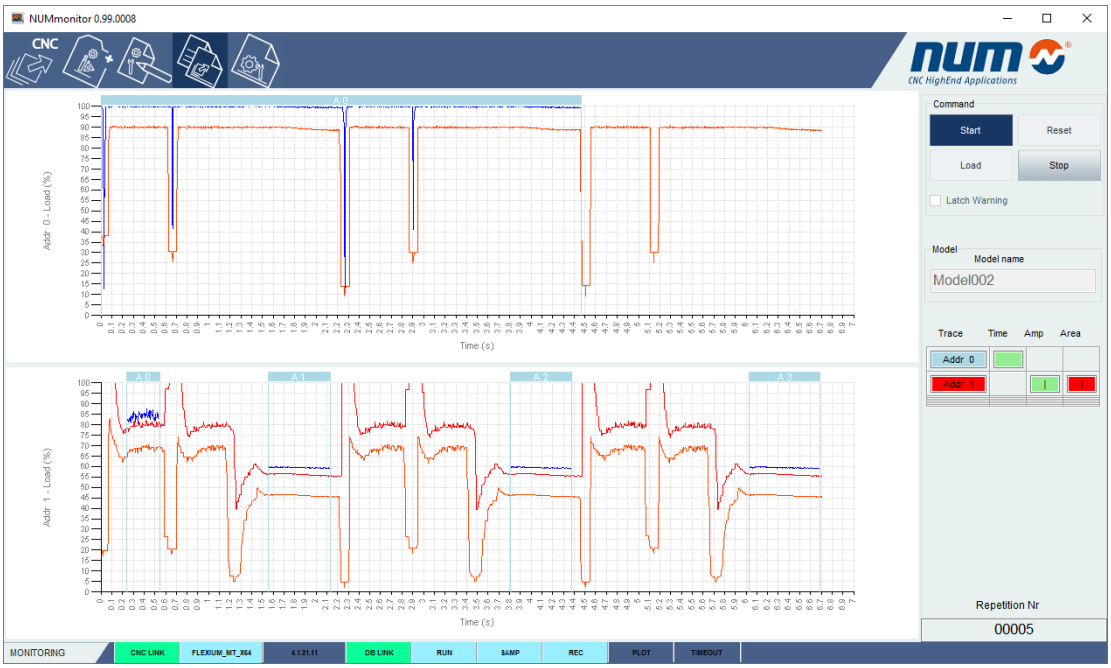


Fig. 14 MONITORING - *status window*

Trace	This column displays the addresses of the traces that will be monitored. The color of this indicator can be: • White if the trace is not active. • Blue if the trace is active and is not in alarm. • Red if the trace is active and is in an alarm state.
Time	This column displays the time alarm detector information as set in the model configuration. The color of this indicator can be: • White if the detector is not active. • Green if the detector is active. • Yellow if the detector is active and in an alert state. • Red if the detector is active and in an alarm state. See chapter "4.3.2" for detailed information.
Amp	This column indicates if the amplitude alarm detector is active as set in the model configuration. The background color of this indicator can be: • White if the detector is not active. • Green if the detector is active. • Red if the detector is active and in an alarm state. See chapter "4.3.2" for detailed information.
Area	This check indicates if the area alarm detector is active as set in the model configuration. The background color of this indicator can be: • White if the detector is not active. • Green if the detector is active. • Yellow if the detector is active and in an alert state. • Red if the detector is active and in an alarm state. See chapter "4.3.2" for detailed information. If more than one trace alarm detector is present, a symbol of association of the logical operator between the state of the detectors is displayed within the rectangle that represents the active detectors as set in the model configuration. If the *'&'* symbol is present, the logical operation between the detectors of each trace is of type *AND*, the alarm on the trace will be active when all the active limit detectors of the trace are in alarm status. If the symbol *'|'* is present, the logical operation between the limits is of *OR* type, the alarm on the trace will be active when at least one of the alarm detectors of the active trace is in alarm status.

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3 NUMmonitor Installation and Prelimary configurations

3.1 NUMmonitor Installation

- Run the *setup.exe* file contained in the installation folder:

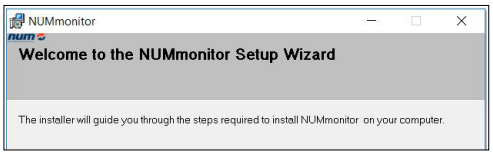

Fig. 15 Welcome to the NUMmonitor Setup Wizard

- Click on the *Next button* in the window:

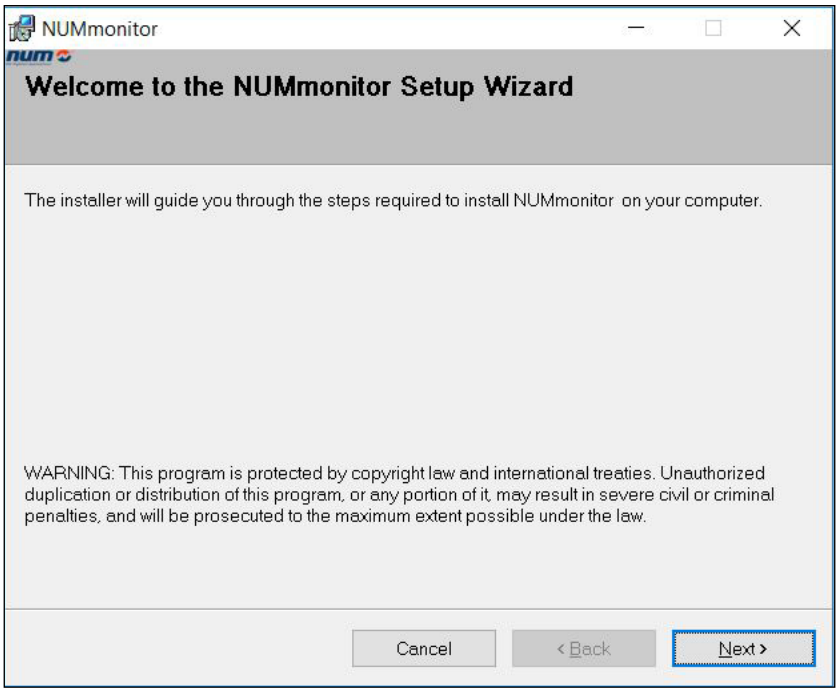

Fig. 16 Welcome to the NUMmonitor Setup Wizard *Warning.*

- Select an installation folder and click on the *Next button* in the window:

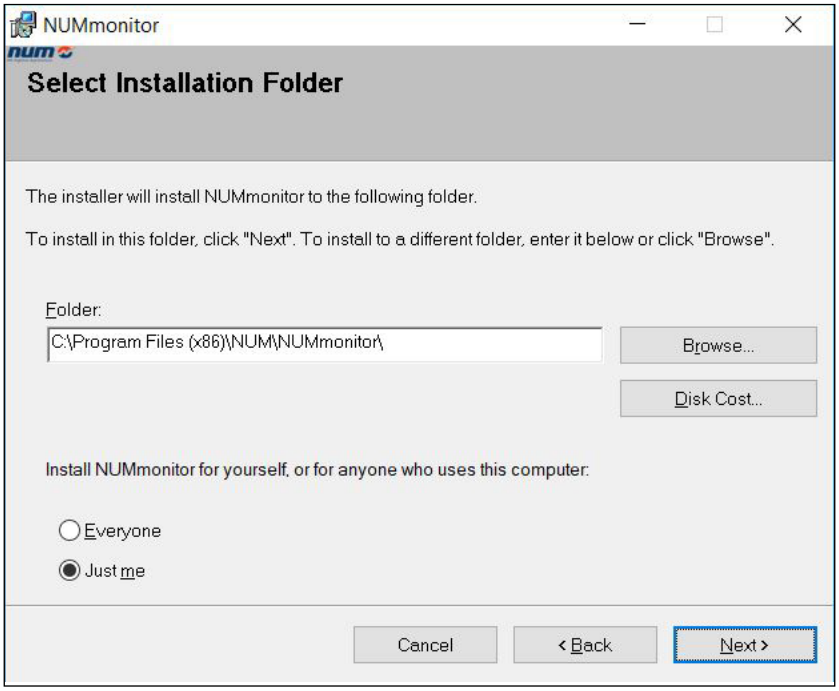

Fig. 17 NUMmonitor *Setup Installation Folder*

- Confirm the start of the installation by clicking on the *Next button* in the window:

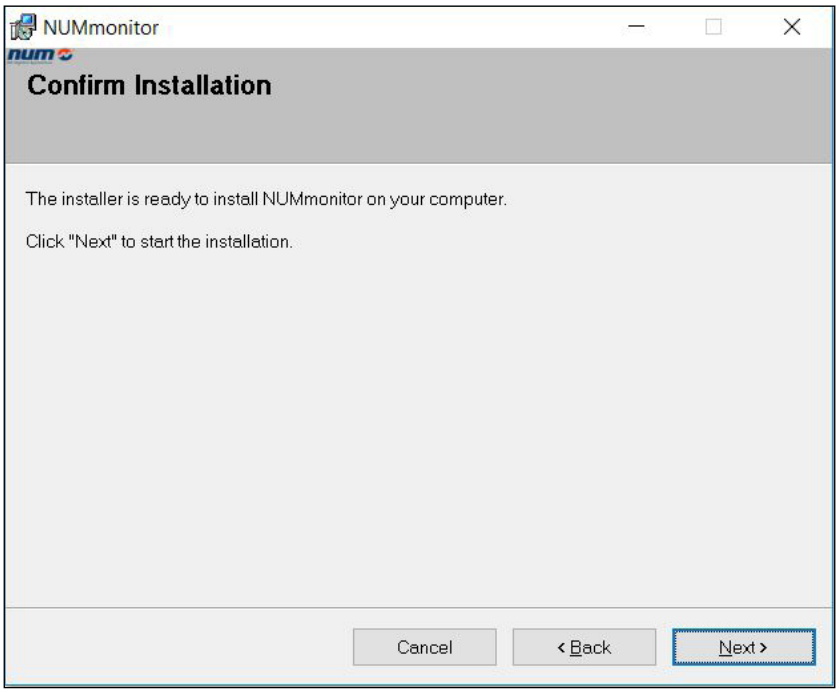

Fig. 18 NUMmonitor *Setup Confirm Installation*

- Wait for the installation to finish click on the *Close button* in the window:

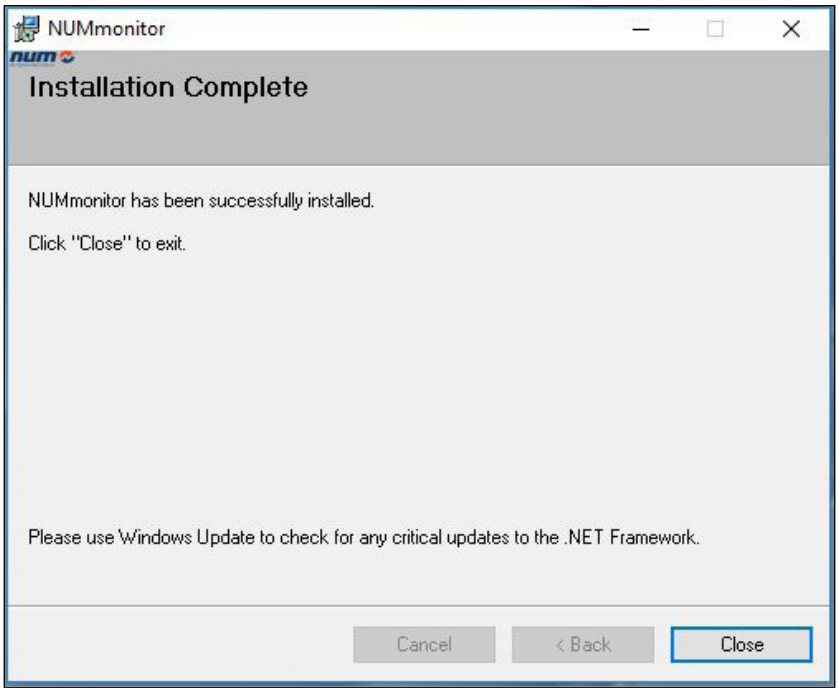

Fig. 19 NUMmonitor *Installation Complete*

- Click on the *NUMmonitor icon* in the taskbar to run the application as shown:

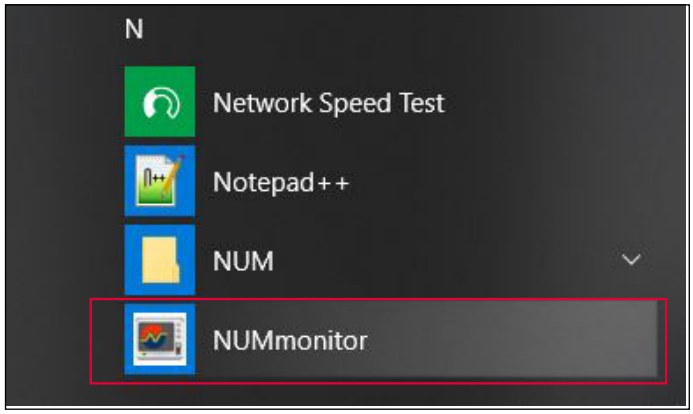

Fig. 20 Run NUMmonitor

3.2 Preliminary configurations

To create a model and perform the monitoring it is necessary to configure the drives appropriately and insert instructions in the part program as well as to configure NUMmonitor appropriately.

3.2.1 Drive configuration

E35232=11 (select MP11 for TP2 axis X@0)
E35233=11 (select MP11 for TP2 axis Z@1)
E35254=11 (select MP11 for TP2 spindle @24)

For each axis of each drive it is necessary to modify the type of measurement associated with the test point 2 through modification of parameter V131 as follows:

- Select measurement point 11 (MP11 - Load) for synchronous motor (axis motor) or asynchronous motor controlled in vector mode (spindles). It is possible to select the full scale in parameter V30 of the drive by changing the status of bit 7 (V30.7) as indicated in the reference NUMDrive X parameters manual.
- Select measurement point 6 (MP6 - Delivered Power) for asynchronous motor controlled in V/f mode.
- The measure point selection for TP2 could be performed also into the part program by means of E35232+@.

3.2.2 Scale factor setting in NUMmonitor

Calculate the scale factor for the asynchronous motors controlled in V/f as indicated in the chapter "2.5.5".

For axes controlled in vector mode, no scale factor setting must be present.

3.2.3 Quick test point activation

The part program and the %11000 program must be edited to manage the quick test points activation for the measurement of the drives, by changing the parameters from the E35264 to the E35295 according to the addresses of the drives we want to activate with the value 1.

It's suggested to deactivate quick TP into %11000 and then activate them into the part program.

```
%11000. l (Reset NUMonitor) (CH00)
E83123=0 (Disable recording)
E35264=0 (Disable quick TP axis X@0)
E35265=0 (Disable quick TP axis Z@1)
E35288=0 (Disable quick TP spindle @24)
```

Example code with quick test points activation

```
%20 .l(NUMonitor test) (CH00)
E35264=1 (axis X@0 quick TP activation)
E35265=1 (axis Z@1 quick TP activation)
E35288=1 (spindle @24 quick TP activation)
```

3.3 E Trigger management variable

It is necessary to identify, inside the part program, the part of the processing code subject to monitoring, by inserting an E83xxx variable with value = 1 to activate monitoring and = 0 to deactivate it.

This variable can be chosen arbitrarily but must be the same identified in the field *'E Trigger'* explained in the chapter "2.5.3".

The figure shows an example code with E Trigger variable activation and deactivation.

```
M201 G1 Z0 F10000
N20 G4 F1

N25

E83123=1  (recording activation)

(start movement)

M3 S1000
N30 G1 Z-100
S0
N40 G1 Z0
M4 S2000
N50 G4 F1

E83123=0  (recording deactivation)

M5
G4 F1
M01
G79 N25
```

3.4 Selection of exchange variables between NUMmonitor and PLC

The **Remote Var In** and **Remote Var Out** variables explained in chapter "2.5.2" must be defined into the PLC program and shared with FX server as shown in the figures here under.

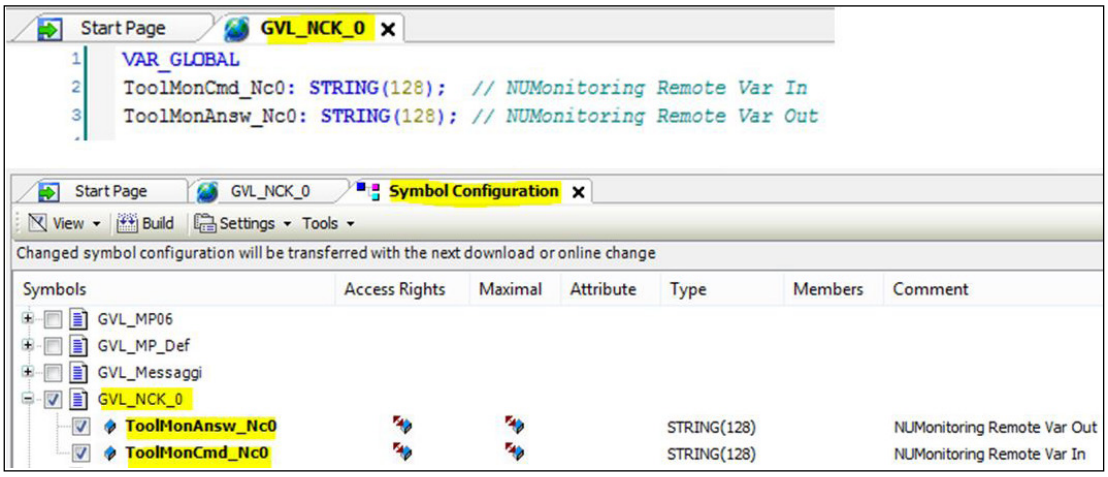

Fig. 21 **Remote Var In** *and* **Remote Var Out** *configuration in* PLC *"Symbol Configuration" folder*

3.5 Link to a database file

NUMmonitor requires connection with the database to store the machining models.

The connection to the configured database is automatically performed when the application starts.

The status of the database connection is displayed on the CONNECTION window and can be changed.

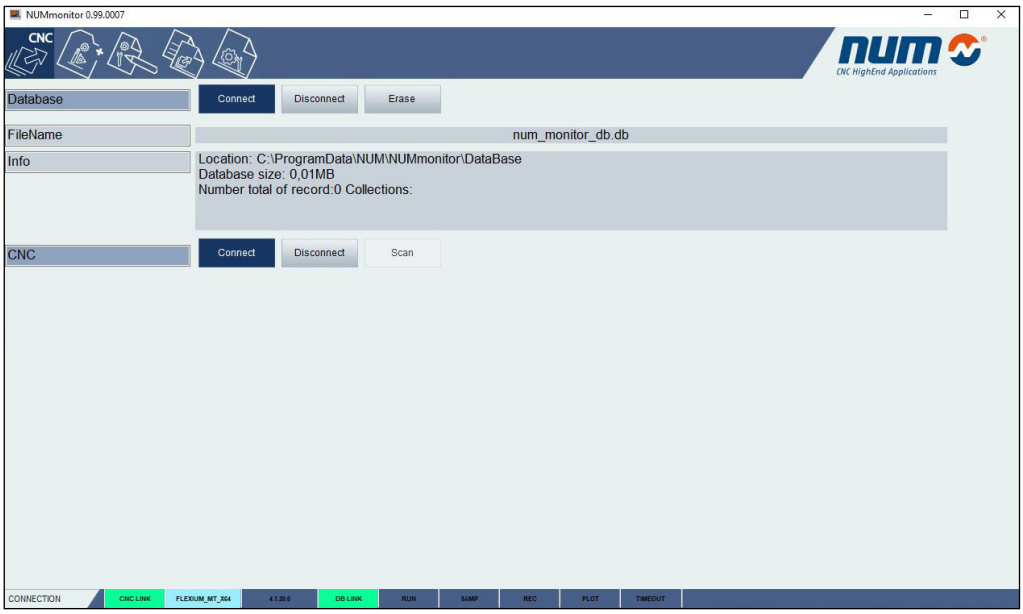

Fig. 22 CONNECTION - *window*

The figure shows the CONNECTION *window*, the operations that can be performed with the database are the connection, disconnection and deletion of the content.

It also displays information about the database name, the database path, the size in MB, and the total number of machining models contained in it.

To change database files it is necessary to disconnect the current database and then select the *'Settings'* window to change the file name and relative path.

The successful connection to the database is displayed in the status bar, the green *'DB LINK'* indicator means connection occurred.

NUMmonitor creates a new database in case the entered database file name does not exist in the specified folder. Click on the *Erase button* to delete the contents of a database; at the end of the deletion, an automatically disconnection to the database is made.

3.6 CNC CONNECTION

The *CONNECTION* window also allows the operations of connection to a numerical control to be performed.

The connection to the configured CNC is automatically performed when the application starts.

The operations that can be performed with the numerical control are the connection, disconnection and configuration.

The *Disconnection* is necessary to change the associated number of the numerical control, the parameters *'CNC Number'* and *'Axis Group'* in the GENERAL SETTINGS window can be modified only when the CNC is disconnected.

The *Scan* button allows scanning and connection to a numeric control in the network.

By clicking on the *Scan* button, the numeric controls scan window is displayed as shown in figure.

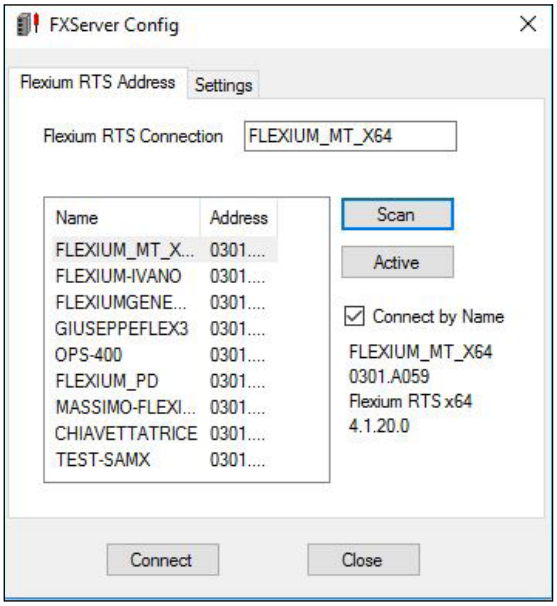

Fig. 23 SCAN to search Flexium+ devices

- To scan the numeric controls on the network, click on the *Scan* button, wait for the end of loading (the window returns active).
- Select a numerical control by clicking with the mouse, select the checkmark *Connect by Name*, click on *Active* and then on *Close* to return to the main window.
- The successful connection to the numerical control is displayed in the status bar, the *'CNC LINK'* indicator green means connection has been completed.

3.6.1 CNC connection status bar

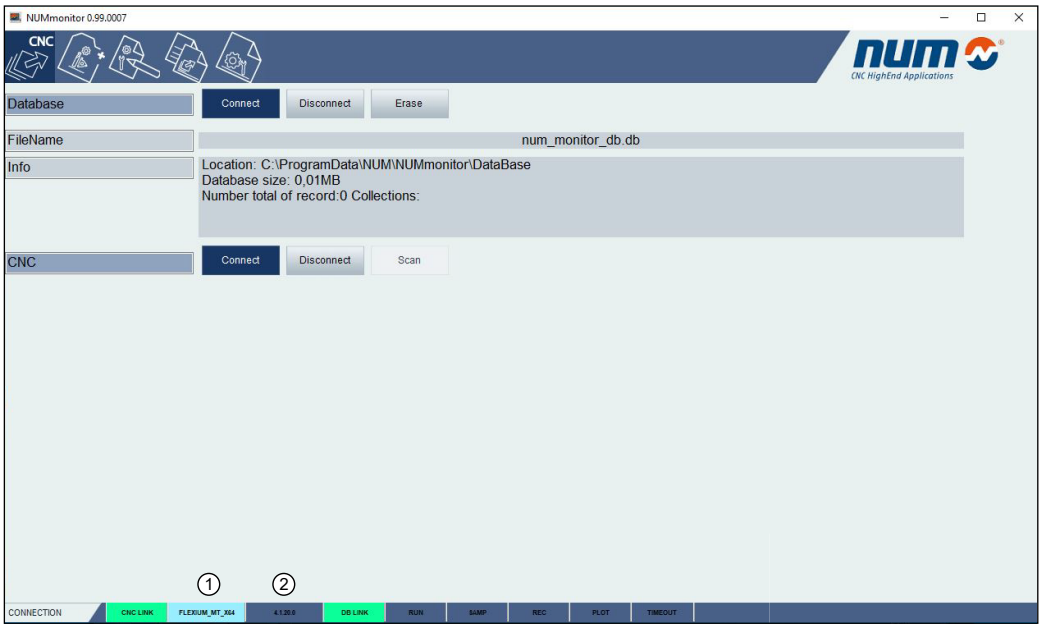

Fig. 24 CONNECTION - *window with connections active and NUMmonitor Full licence installed.*

If the CNC LINK indicator is red, it means that the connection has not been made, the control can no longer be present on the network or the CNC number shown in the settings window does not exist.

If the CNC LINK indicator is yellow, it means that RTS is restarting.

The field marked with ① displays the name of the computer where RTS is running to which NUMmonitor has been connected.

- If the indicator is red it means that the NUMmonitor licence is not installed on the CNC belong the RTS.
- If the indicator is light blue it means that the NUMmonitor Full licence is installed on the CNC belong the RTS.
- If the indicator is green it means that the NUMmonitor Basic licence is installed on the CNC belong the RTS, the max number of traces to be monitored is limited to two and the remote control from the PLC is not enabled.

The field marked with ② displays the Flexium⁺ System version where RTS is running to which NUMmonitor has been connected.

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4 Creating a machining model

Creating a model can be done starting from scratch or from an existing model.

The main difference is that starting from scratch you can define the traces to be monitored, starting from a model this is not allowed.

To start from scratch in case you have previuosly started from an existing model you must push the **Reset** button.

The creation of a model starting from an existing model can be done manually pushing LOAD button, then selecting a model clicking with the mouse on the first column where there is an arrow in the row corresponding to the model we want to select until the whole row is highlighted with a blue bar, otherwise it can also be carried out through PLC.

All the data that make up the model are loaded and stored in the selected database.

The reference window for creating the model is MODEL CREATION.

The requirement for creating a model is that the numerical control and the database are connected.

The model is created by registering ,during the machine working process, Measure Point value selected into the drive and associated to the Quick Measure Point defined in GENERAL SETTING window by the drives connected to the CNC.

Each model can be composed of up to 8 traces (or 2 in case of NUMmonitor Basic licence).

Each trace is associated with the address of the drive connected to the CNC.

The controls to configure for creating a model are shown in figure.

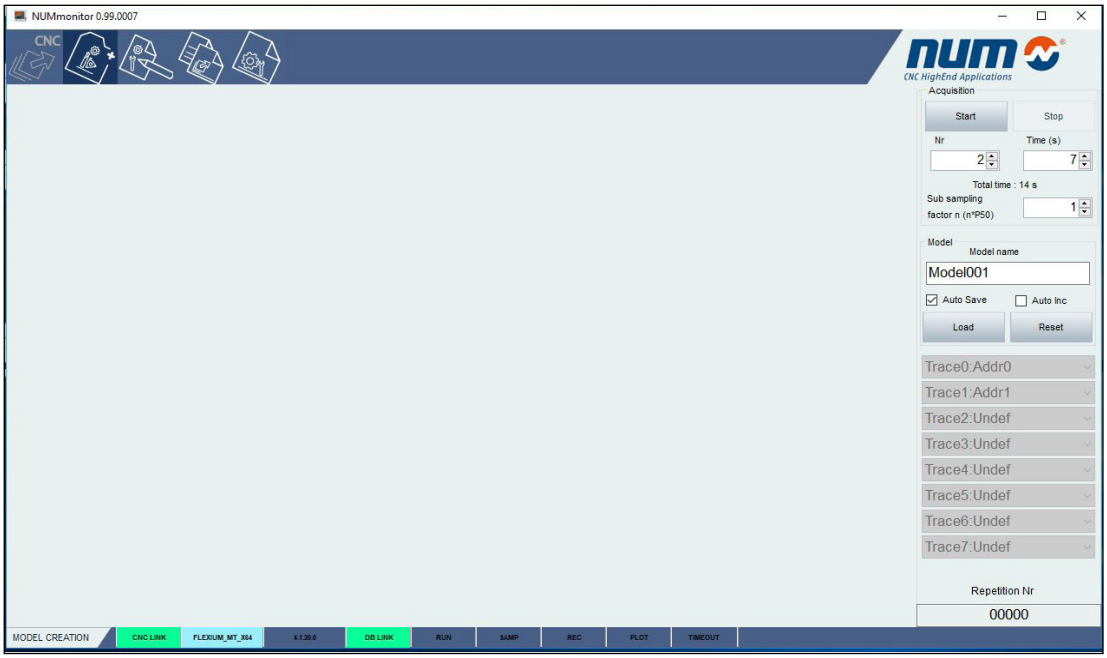

Fig. 25 MODEL CREATION - *window*

Deletion of a model present into the database could be done from MODEL SETTING window (See chapter "4.3.4")

4.1 Model creation configuration

By default it is possible to associate to the trace selector a number of drive addresses from 0 to 31.

To change this setting the value associated with the *'Max Drive Addr Nr'* parameter (see chapter "2.5.4") must be changed under the MODEL CREATION item on the GENERAL SETTINGS window and restart the application.

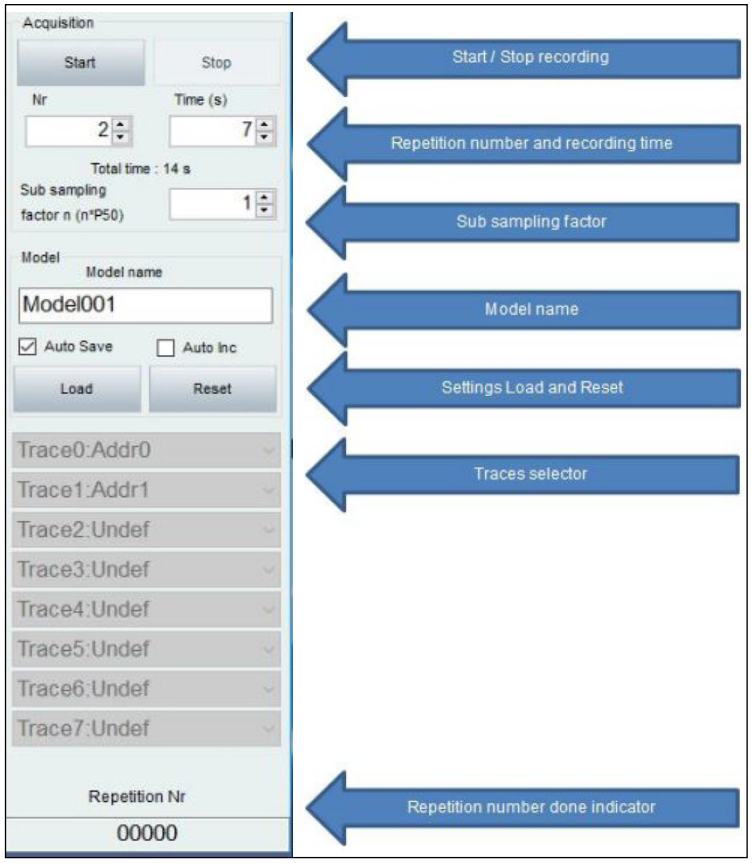

Fig. 26 MODEL CREATION - *configuration*

Trace selector	Once the addresses of the drives to be associated to the traces have been identified, they are set by the trace selector. The trace selector consists of eight vertically aligned fields where each trace is associated with the trace number and the address of the drive. The label associated with each field indicates this association, the trace number on the left and the address of the drive on the right are displayed between the *":"* field separator character. A drop-down menu containing the list of available addresses is displayed by clicking on the control of each trace with the mouse. It is possible to associate the same address with several traces. The first item of the drop-down menu labelled with *'Undef'* means no association, selecting this item, no recording of that trace will be made. Model registration is enabled when at least one trace is associated with an address of the drive in the trace selector.
Time	An estimate of the processing time in seconds is required to fill this field. A value greater than the estimated value is advisable to enter in this field. If the value shown in this field is lower than the actual duration of the part program, when the set time is exceeded, the model creation is interrupted. The red *'TIMEOUT'* indicator in the status bar indicates the occurrence of the above condition. An increase in the time value and a new recording are necessary if the timeout condition comes true. 

Nr	The *'Nr'* field represents the number of records that will be made during the creation of the model for the same machining, the reference traces that will be generated at the end of the model creation will be the result of the average machining values for each trace.
Sub sampling factor n	Sub sampling factor allows the configuration of the acquisition sampling time as a multiple of the CNC sampling period. For example, if the value of this parameter is 1, the sampling time will be identical to that of the CNC sampling period, if instead the value 2 is assigned the sampling time will be double compared to that of the CNC sampling period.
Total time	Below *'Nr'* and *'Time'* fields the total estimated time in seconds, that will be necessary for the creation of the model is displayed. The value shown in this indicator is the result of the multiplication of these two fields.
Model name	The name associated with the model being created is indicated in the *'Model name'* field. The content of this field can be changed. The name proposed in this field is indicated in the *'Default Name'* field under the *MODEL CREATION* item in the GENERAL SETTING *window*. The default value of this field is 'Untitled', restarting the application is necessary to make the change active.
Auto Save	The *'Auto Save'* checkmark enables or disables the automatic saving of the model at the end of its creation, the default status of this field is disabled and can be changed in the *'Default Auto Save'* field under the *MODEL CREATION* item in the GENERAL SETTINGS window. To make the default value active, an application restart is necessary.
Auto Inc	If enabled, the *'Auto Inc'* control allows to create a series of indexed models starting from the basic model. A four-digit progressive index is appended to the model name at the end of the model creation. At the end of the model creation, the model name will be named as *'ModelName_0001'*, where *'Model Name'* is the model base name and *'0001'* is the associated index. The numerical index is generated by analyzing the existing indices associated with the corresponding model names in the database, increasing the index by one unit with respect to the largest index. The default status of this field is disabled and can be changed in the *'Default Auto Inc'* field under the *MODEL CREATION* item on the *GENERAL SETTINGS window*. To make the default value active, an application restart is necessary.
Reset	The *'Reset'* button is used when a setting of the window controls for model creation to default values is required.
Load	The *'Load'* button allows the loading of the configuration for the registration of the model by loading the configuration from an existing model.
Start	The *'Start'* button allows the start of the recording.
Stop	The *'Stop'* button interrupts the recording. Stopping the model registration invalidates its creation.

4.2 Start recording

- After entering the configuration parameters, start recording using the *'Start'* button. Configuration parameters cannot be changed when recording started.
- When the *'RUN'*, *'SAMP'*, *'REC'* indicators on the status bar are colored light blue and '*PLOT*' in orange the recording system is ready. When this event occurs, the CNC program for the registration of the model can be started.
- The acquisition of trace information takes place when the *'E Trigger'* variable defined in the CNC GENERAL SETTINGS window is set to 1 during the part program execution.
- The acquisition starts when the value of the variable *'E Trigger'* passes from the value 0 to the value 1. The acquisition system pauses when after the start of the recording this value is 0, and will be executed at the next transition of the value from 0 to 1.
- The orange colored '*PLOT*' indicator in status bar means that the variable *'E trigger'* has not the value 1, check the partprogram to verify where the '*E trigger*' variable is set to 1 and if the *'E trigger'* variable number is the same choosen into the GENERAL SETTINGS window.
- The light blue colored *'PLOT'* indicator in the status bar means that the acquisition has started, the graphs in the chart area are drawn according to the selected traces as shown in figure below.

Fig. 27 MODEL CREATION - *window*

- The blue color of the *'RUN'*, *'SAMP'*, *'REC'*, *'PLOT'* indicators on the status bar indicates that the recording is complete.
- When registration is complete, the MODEL SETTING window for the model configuration will be displayed if the *'Auto save'* control is disabled. In this way it is possible to customize the configuration parameters of the model before saving it in the database.
- If the *'Auto save'* control is enabled, the model is automatically saved when the recording is completed. In this case, if the model was created from scratch, the default limits and alarm settings (fields from *'Default H Range'* to *'Default Lim OP'* under the *MODEL CREATION* item in the GENERAL SETTING window) are stored, otherwise the settings of the limits and the alarms inherited from he model loaded through the *'Load'* button are memorized.
- At the end of the registration of the model, if the *'Auto save'* control is disabled, the MODEL SETTING *window* is displayed (see chapter "4.3").
-

4.2.1 MODEL CREATION window with REC indicator in alarm

If during the registration the REC indicator becomes red it means that the CNC oscilloscope buffer has not been downloaded on time and the traces are corrupted, so the registration is aborted.

This could happens if the PC, on which NUMmonitor is running, is not fast enought to download the CNC oscilloscope buffer because the oscilloscope buffer is filling a great quantity of samples. You can reduce the amount of samples increasing the 'Sub sampling factor n (n*P50)'

4.3 Model settings

Fig. 28 MODEL SETTING - *window*

This window displays the graph of the recording with the acceptance limits and alarm detectors setting.

In this window, data is displayed one trace at a time. Via the trace selector, the trace to be configured is selected.

- Three graphs per trace are displayed in the chart area.
- The green graph represents the reference trace for the creation of the model limits and is the result of the average of the values measured based on the repetitions set.
- The red graphs represent the area of acceptance of the model that can be modified by modifying the appropriate parameters.
- The configuration values set in the model correspond to the default values under the *MODEL CREATION* item in the GENERAL SETTINGS window if the model has been created from scratch, otherwise
  these values are identical to those of the loaded model.
- The blue band above the graph, named with A0 in the figure, represents the time band where the trace is monitored.
- The default time band is set to the entire duration of the trace to be monitored in a model created from scratch.

It is possible to modify the point in time of activation and deactivation of the monitored time band, dropping with the mouse the two vertical bars that delimit the temporal band at its ends.

To activate monitoring on different areas of the trace, multiple time bands can be created.

The configuration of the temporal bands of the loaded model is inherited in the case of creating a model starting from an existing model.

4.3.1 Controls for the MODEL SETTINGS

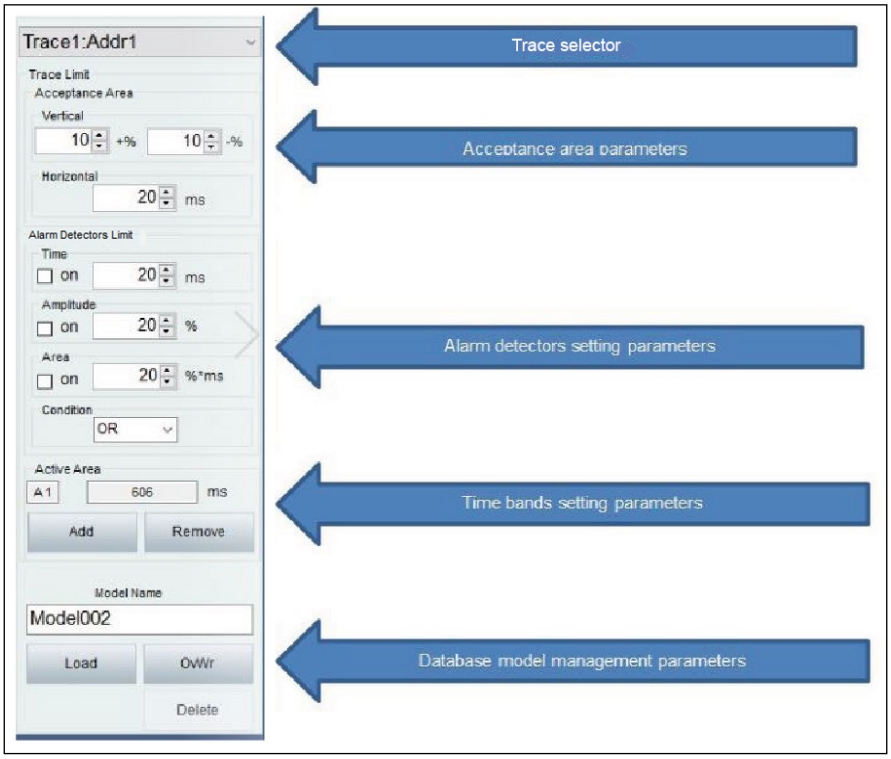

Fig. 29 MODEL SETTING - *controls*

Trace selector	The trace selector is a control for selecting and displaying the trace number to be edited. The text associated with the field displays the trace number and the address of the source drive used to create the model. By clicking on this control with the mouse, a list of the available traces of the model is displayed in a drop-down menu sorted by trace number.
Acceptance area parameters	These parameters allow the definition of a limit area for the verification of the trace to be monitored. By setting these limits, an analysis of the deviation for the calculation of tool wear in % is performed. The modification of these parameters corresponds to the recalculation of the limits displayed by the red graphs for the redefinition of the acceptance area boundary.
Vertical parameters	These parameters allow the configuration of the width of the acceptance area, it is possible to independently modify the upper and lower limit as percentage of deviation of the reference trace.
Horizontal parameter	This parameter allows to set the time deviation of the acceptance area in ms from the reference trace. The value of this parameter is applied both as an advance and as a time delay.

4.3.2 Alarm Detectors Limit setting

Setting these parameters allows the PLC to receive alarm information during monitoring (remote control with PLC must be active). Through these parameters it is possible to set the error detection criteria that allows the generation of the alarm to the PLC.

The parameters for the limit settings are divided into three groups, each group is dedicated to a separate alarm detector. The alarm detector can be activated or deactivated individually.

A logical operator of the state of the alarm detectors allows the generation of the final alarm status.

The analisys of the measured value compared to the Acceptance Area is performed for each sampled value within each time band.

Time	This detector allows to measure the time in which the trace amplitude exceeds the limits indicated in the Acceptance Area during monitoring within the time bands. The detector signals the alarm if the measured overflow time exceeds the set limit (Time band) as shown in following figures. If the measured amplitude value returns within the Acceptance Area values before the set **Time**, the alarm detector resets its status. When the amplitude limit is exceeded, the detector sets its state on alert and calculates the trace overrun time; if this time exceeds the set **Time**, the detector changes its status in alarm, while if the amplitude of the trace returns to the inside of the limits of the acceptance area, before exceeding the set **Time**, the detector resets its status. Outside the time band, the alarm detector resets its status if it is not in an alarm state. This detector measures the amplitude value of the trace compared to the corresponding value in the Acceptance Area within the time band. When the amplitude value of the trace exceeds the limit indicated in the set parameter, the detector sets its state in alarm as shown in figure. The amplitude value set corresponds to the percentage in amplitude of the value of the acceptance area. Outside the time bands, the alarm detector resets its status if it is not in an alarm state.

Fig. 30 MODEL SETTING - *with trace reference*

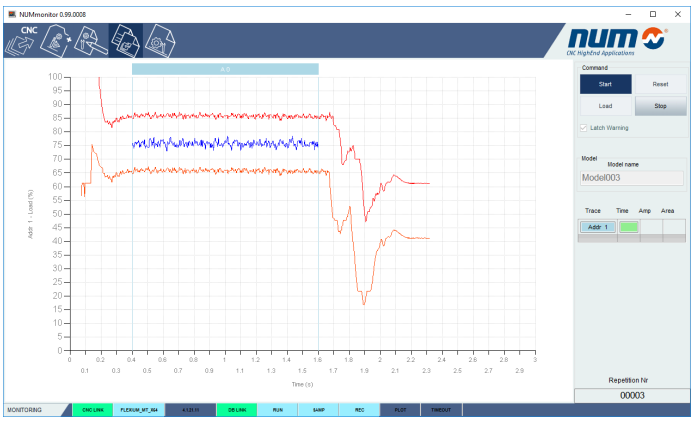

Fig. 31 MONITORING - *with trace within Acceptance Area*

Fig. 32 MONITORING - *with trace exceeding Vertical +%, Alert state*

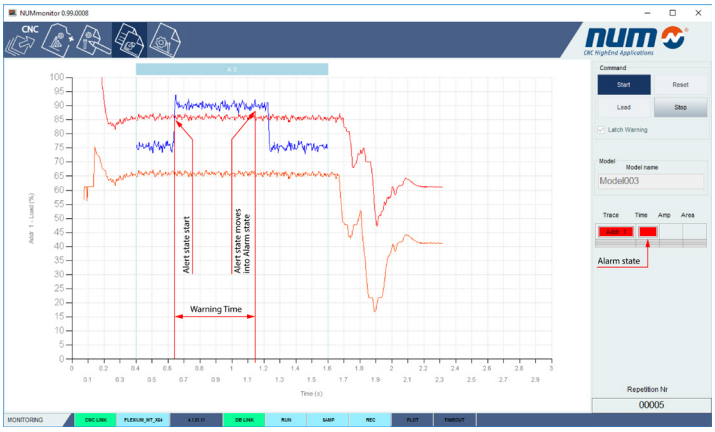

Fig. 33 MONITORING - *with trace exceeding Vertical +% and exceeding Warning Time too, Alarm state*

Amplitude	This detector measures the amplitude value of the trace compared to the corresponding value in the acceptance area within the time bands. When the amplitude value of the trace exceeds the limit indicated in the set parameter, the detector sets its state in alarm as shown in figure 36. The amplitude value set corresponds to the percentage in amplitude of the value of the acceptance area. Outside the time bands, the alarm detector resets its status if it is not in an alarm state.

Fig. 34 MODEL SETTING - *with trace reference*

Fig. 35 MONITORING - *with trace within Alarm Amplitude limit*

Fig. 36 MONITORING - *with trace exceeding Alarm Amplitude limit, Alarm state.*

Area

This detector measures the overflow value of the trace area outside the acceptance area within the time band.
If the measured amplitude value returns within the Acceptance Area before the value of the calculated area exceeds the Warning Area Limit, the alarm detector resets its status. The **Area** set value is set in **%*ms** where **%** is the percentage in amplitude and **ms** is the time width.
When the Trace value exceeds the Acceptance Area Limit, the detector changes its status in alert state and calculates the overflow area.
If the area exceeds the Trace value exceed, the detector changes its status in alarm, if the Trace value returns inside of the Acceptance Area Limit, before exceeding the Acceptance Area Limit, the detector changes its status in reset state.
Outside the time band, the alarm detector resets its status if it is not in an alarm state.

Fig. 37 MODEL SETTING - *with trace reference*

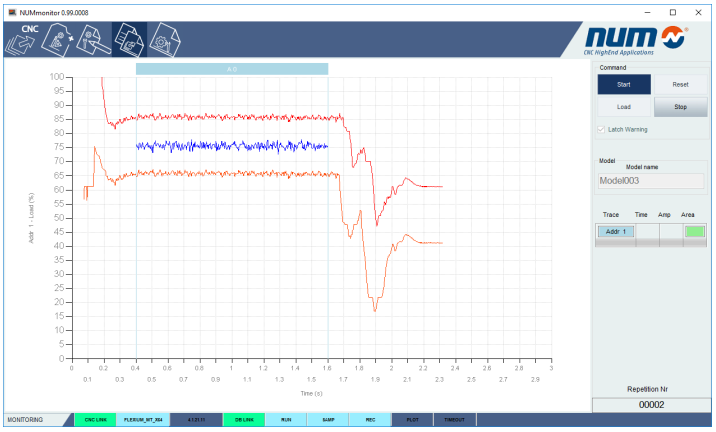

Fig. 38 MONITORING - *with trace within Acceptance Area*

Fig. 39 MONITORING - *with trace within Area limit, Alert state.*

Fig. 40 MONITORING - *with trace exceeding Warning Area limit, Alarm state.*

Fig. 41 MONITORING - *with trace exceeding Warning Area limit, Alarm state.*

Condition

This control allows to perform a logical operation between the alarm detectors to determine the alarm global condition, the one that will be transmitted to the PLC when it occurs. This control is a drop-down menu and it is possible to select between two types of logical operators: AND or OR.
In case it is necessary to apply different criteria in the selected areas of the same motor address, it is possible to create a model where the same motor address is assigned on several traces.

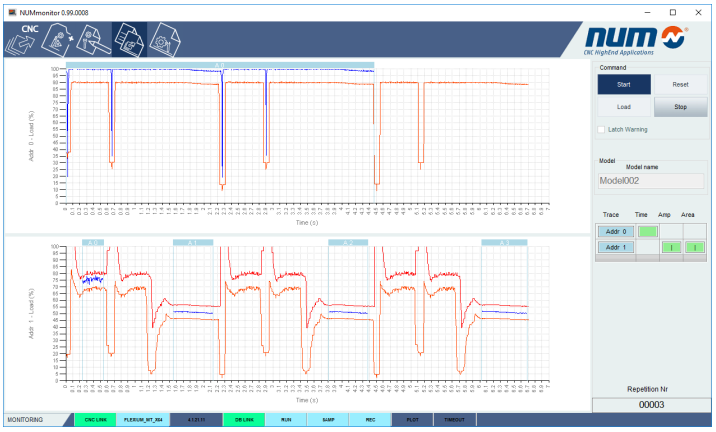

Fig. 42 MONITORING - *Trace Addr1, Warning Amplitude Limit OR Warning Area Limit (Trace not in alarm)*

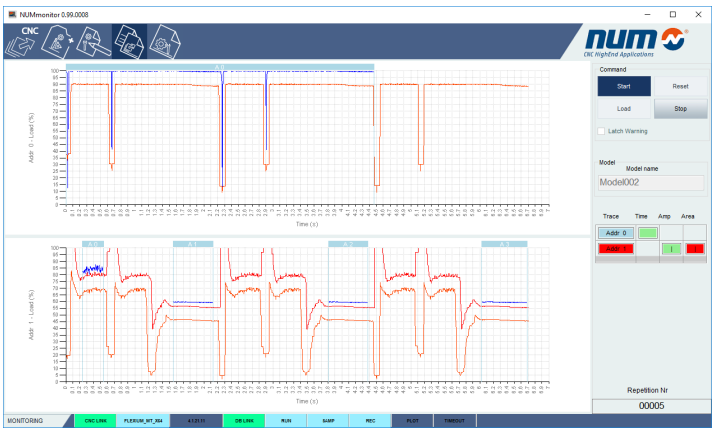

Fig. 43 MONITORING - *Trace Addr1, Warning Amplitude Limit not in alarm state OR Warning Area Limit in alarm state (Trace in alarm)*

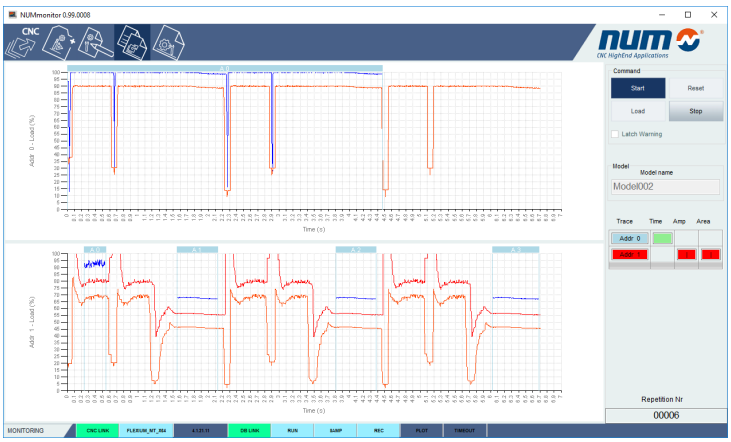

Fig. 44 MONITORING - *Trace Addr1, Warning Amplitude Limit in alarm state OR Warning Area Limit in alarm state (Trace in alarm)*

4.3.3 Time bands parameters

These parameters allow the time bands management.

Within the time bands two measurement and verification systems are activated:

- Alarm detectors (for example for tool breakage warning).
- Acceptance area deviation check (tool wear measurement).

An unlimited number of time bands for each trace are possible within the model. The minimum number of time bands is one.

A time band is automatically created with a time extension of the entire period of the trace created if the model has been created from scratch.

By dragging with the mouse on the vertical lines that delimit the time band it is possible to change the point in time of activation and deactivation.

All the active time bands are taken into consideration for the calculation of the acceptance area deviation check. At the beginning of each time band every alarm detector is initialized in the reset state if the alarm status is not already present.

Add	This button inserts a new time band. Before the insertion, an analysis of the availability of areas to insert a time band is performed. A new time band is inserted with priority of insertion on the left with respect to the last band inserted, if it is not possible then it is inserted in the first available area on the left. This button is deactivated if a free area is not detected during the analysis, and is reactivated when the conditions of availability of areas allow it. Each time band is identified through a label placed above the graph with the name *Ax*, where *x* is the number of the temporal band present in the graph. The association of the label of each band is assigned automatically, ordering the indices in increasing way starting from left to right.
Remove	This button allows the elimination of a time band. Click on one of the *two vertical delimiting bars* with the mouse to remove a time band, until the label corresponding to the selected band to be deleted appears on the display above the *Add* and *Remove* buttons, then press the *Remove* button. When a time band is deleted, if necessary, the labels associated to the bands are automatically renamed, sorted by index in increasing order from left to right. This button is disabled when the number of activation time bands is one.

4.3.4 Database models management

These parameters allow the management of the models within a database.

Model Name	This parameter displays or inserts the model name in the database.
Load	Models created and saved in the database can be viewed and edited after their creation. This button displays the model management window in the database as shown in figure here under.
Save/OvWr	This button allows saving or overwriting the model in the database. The function associated with this button depends on the name assigned to the *'Model Name'* field. The *'Save'* label appears in the button if the name associated with the *'Model Name'* field does not correspond to the name of a model in the database; its function corresponds to saving the model in the database. The *'OvWr'* label is displayed in the button if the name associated with the *'Model Name'* field corresponds to the name of a model in the database; its function corresponds to the overwriting of the model in the database.
Delete	This button is active only when the model management window in the database is displayed. It deletes a model from the database. To perform the operations on a model it is necessary: push **Load** button to show the list of the model present into the database, then select the model we like to remove from the database, clicking with the mouse on the first column where there is an arrow in the row corresponding to the model we want to delete and wait until the whole row is highlighted with a blue bar, then push the **Delete** button.

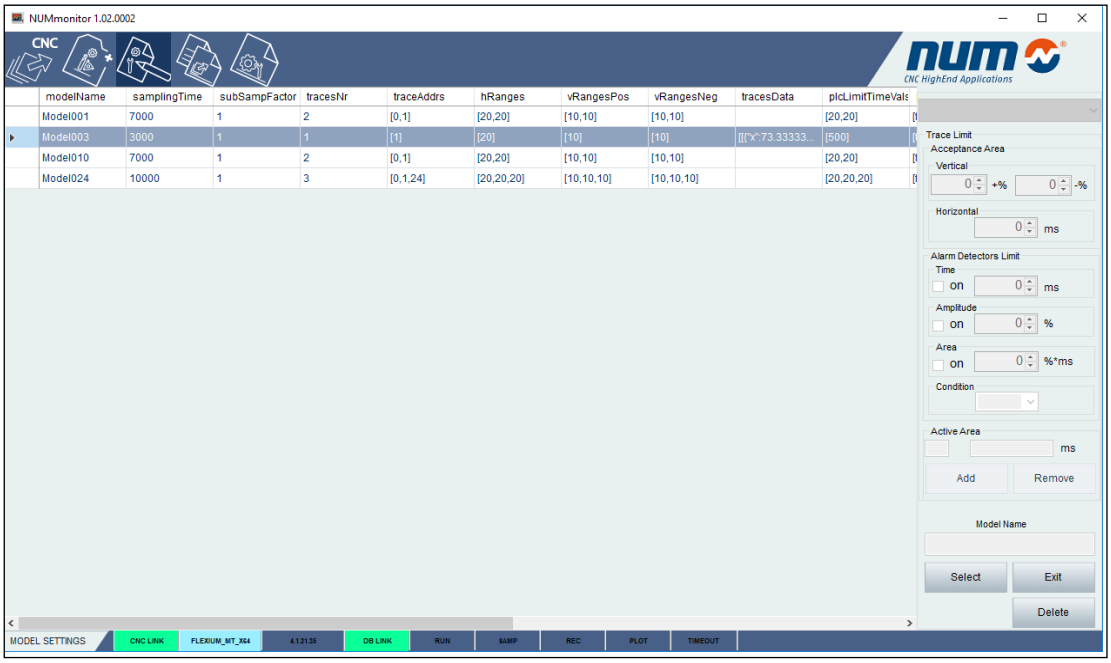

Fig. 45 MODEL SETTING - Model management window

This window displays the list of models present in the database represented in a table where each row represents a model, the second column named *'Model Name'* indicates the name of the model.

To perform the operations on a model it is necessary to select it, clicking with the mouse on the first column where there is an arrow in the row corresponding to the model we want to select until the whole row is highlighted with a blue bar.

- The selected model is loaded by pressing the *'Select'* button.
- To return to the MODEL SETTINGS window without performing any operation press the *'Exit'* button.
- To delete the selected model from the database press the *'Delete'* button, the deletion is permanent and it is not possible to retrieve the data of a deleted model.

Page deliberately empty

Summary

Window deliberately empty

5 PLC Configuration

For helping the OEM on integrating the NUMmonitor into his system, has been developed a function used to manage the **Remote Var In** and **Remote Var Out** of NUMmonitor.

This function will be integrated into the *Flexium⁺ library*.

As already described it's necessary to define two strings to share with NUMmonitor via FXserver, for example: *ToolMonCmd_Nc0 and ToolMonAnsw_Nc0 .*

Fig. 46 PLC Global Variable definition

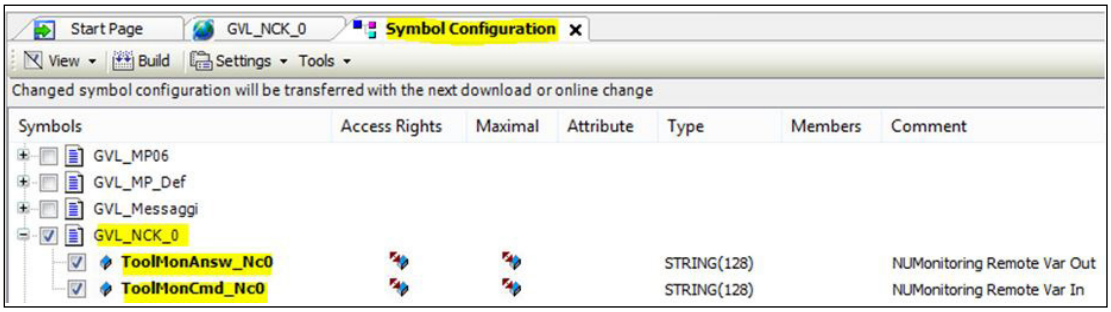

Fig. 47 PLC Global Variable Sharing

The PLC function *"ToolMonFunc"* and *"ModelNameCheck"* (distributed with this document) must be loaded into the PLC project.

The figure above represents the I/O list.

```
FUNCTION_BLOCK ToolMonFunc
VAR_ INPUT
   TMAnsw: STRING (128 );
   MC-St art: BOOL;
   TestMCLoopEnd: BOOL;
   MNStart: BOOL;
   TestMNEnd: BOOL;
   Abort: BOOL;
   ModelName: STRING (35 );
   nMCLoops: BYTE;
END_VAR
VAR_OUTPUT
   TMCmd: STRING (128);
   Busy: BooL;
   MCReady: BOOL;
   MCLoopEnd: BOOL;
   MCDone: BOOL;
   MCOn: BOOL;
   MCLoop: INT;
   MNReady: BOOL;
   MNDone: BOOL;
   MNAlarm: BOOL;
   MNOn: BOOL;
   MNCycles: DINT;
   MNDefect: DINT;
   MNconsDefect: DINT;
   ErrCode: INT;
   MNAnswStr: STRING (128);
   TracesNumber: USINT;
   Trace0Addr: USINT;
   Trace0PctDev: INT;
   Trace1Addr: USINT;
   Trace1PctDev: INT;
   Trace2Addr: USINT;
   Trace2PctDev: INT;
   Trace3Addr: USINT;
   Trace3PctDev: INT;
   Trace4Addr: USINT;
   Trace4PctDev: INT;
   Trace5Addr: USINT;
   Trace5PctDev: INT;
   Trace6Addr: USINT;
   Trace6PctDev: INT;
   Trace7Addr: USINT;
   Trace7PctDev: INT;
END_VAR
```

With *PLC Remote Control* the *Model Name* selection could be done via *PLC Remote Control* but the *job START* (model creation or model monitoring) can be done only via *PLC Remote Control*.

5.1 Model creation commands

MC	Command without *ModelName* definition, the NUMmonitor will use the selected Model Name done on the tool and the associated repetition number.
MC<b><ModelName>	Command with *ModelName* definition, the NUMmonitor will use the selected Model Name sent via remote control, that must be present into the NUMmonitor data base and repetition number used will be taken from the model characteristic.
MC<b><ModelName><b><Nr>	Command with *ModelName* definition, the NUMmonitor will use the selected Model Name sent via remote control, which must be present into the NUM-monitor data base and the repetition sent with the *Nr* command.
Note. <b> means space character.	

5.2 Monitoring commands

MN	Command without *ModelName* definition, the NUMmonitor will use the selected *ModelName* done on the tool.
MN<b><ModelName>	Command with *ModelName* definition, the NUMmonitor will use the selected Model Name sent via remote control, which must be present into the NUM-monitor data.

5.3 NUMmonitor special control

The only free command are the *'Reset' (*button on NUMmonitor tool - MONITORING window*)* and "ABORT" from PLC remote control that will interrupt the tool job in execution in any instant they will be sent.

5.4 ToolMonFunc description

5.4.1 ToolMonFunc Inputs

TMAnsw: STRING(128)	It must be linked to NUMmonitor **Remote Var Out** .
MCStart: BOOL	When *TRUE* a *START* command is sent to NUMmonitor to place it in waiting for strobe signal to start the model recording phase. It must be put to *FALSE* when the signal **MCReady** will become *TRUE*. **MCStart** command is taken in charge only when the signal **Busy** is *FALSE*.
TestMCLoopEnd: BOOL	When *TRUE* is used to wait **MCLoopEnd** or **MCDone** signal that inform that the end of a recording phase cycle has been reached. This signal must be put to *FALSE* when **MCLoopEnd** or **MCDone** become *TRUE*. **MCDone** inform that the last recording phase cycle has been completed.
MNStart: BOOL	When *TRUE* a *START* command is sent to NUMmonitor to place it in waiting for strobe signal = 1 to start monitoring job (in other words the comparison between the data of the selected model and the data coming from the machining in execution on the CNC. It must be put to *FALSE* when the signal **MNReady** will become *TRUE*. **MNStart** command is taken in charge only when the signal **Busy** is *FALSE*.
TestMNEnd: BOOL	When *TRUE* is used to wait the end of the monitoring (strobe signal = 0). This signal must be put to *FALSE* when **MNDone** or **MNAlarm** become TRUE.
Abort: BOOL	When *TRUE* abruptly interrupts Model creation or Monitoring phase.
ModelName: STRING(35)	In this variable could be written the *'Model Name'* who must be selected into the NUMmonitor data base to which *Model Creation* or *Monitoring* will be applied. This *'Model Name'* must be present into NUMmonitor data base. The *'Model Name'* is an ASCII string with maximum length of 35 characters where are admitted only characters in small or capitol letter, numbers and underscore (_). Other symbols are not admitted otherwise an error will occur. Special case: If *'Model Name'* is equal to only one space it will be treated like an empty string (No name definition). If *'Model Name'* is an empty string the used model will be model selected into the NUMmonitor tool. If any model is selected in NUMmonitor an error code will occur: - **13** in case of use with **MCStart.** - **23** in case of use with **MNStart**. Same error code will occur in case the model is present into the NUMmonitor data base, but the model creation has not been completed. If the *'Model Name'* contains not admitted characters an error code will occur: - **6** in case of use with **MCStart**. - **7** in case of use with **MNStart**.
nMCLoops: BYTE	Admitted value range from 1 to 99. Special case: If **nMCLoops = 0** it will be used the value set for the chosen *"Model Name"* model present into the NUMmonitor data base. The **nMCLoops** value (1…99) is taken in charge only in case of **MCStart** and **ModelName** different from empty string. If **nMCLoops** exceeds the admitted range, the error **code 5** will occur or if **nMCLoops** will be in the admitted range but ModelName equal to empty string, the error **code 4** will occur.

5.4.2 ToolMonFunc Ouputs

TMCmd: STRING(128)	It must be linked to NUMmonitor **Remote Var In**.
Busy: BOOL	When *TRUE* means that the function is waiting the answer to a sent NUMmonitor command.
MCReady: BOOL	When *TRUE* means that NUMmonitor is ready to record the data of the selected model. This signal could be *TRUE* only with ***MCStart*** = *TRUE*.
MCLoopEnd: BOOL	When *TRUE* means that the one sampling of the selected model has been completed. In conjunction with the status of the signal **MCDone** could be used to distinguish if a new piece must be machined to make a new record of date for the model or not. **MCLoopEnd** could be *TRUE* only **TestMCLoopEnd** = *TRUE*.
MCDone: BOOL	When *TRUE* means that the end of the model recording phase has been reached. **MCDone** could be *TRUE* only **TestMCLoopEnd** = TRUE.
MCOn: BOOL	Set to *TRUE* when **MCReady** = *TRUE* and set to *FALSE* when **MCDone** = *TRUE* or **ABORT** = *TRUE* or error code = **12** or **15**.
MCLoop: INT	It is the recording cycle number (pieces to be machined) needed to complete the model creation job. It starts with the total required cycle number when **MCReady** = *TRUE*, decreases by one when **MCLoopEnd** = *TRUE* and becomes zero when **MCDone** = *TRUE*.
MNReady: BOOL	When *TRUE* means that NUMmonitor is ready to start the monitoring job, comparing the data of the selected model with the data received from the field (piece machining). This signal could be *TRUE* only with **MNStart** = *TRUE*.
MNDone: BOOL	When *TRUE* means that the end of the monitoring job has been reached and the result is: good piece machined. This signal could be *TRUE* only with **TestMNEnd** = *TRUE*.
MNAlarm: BOOL	When TRUE means that during the piece machining at one monitored parameter has been exceeded. The piece is bad. This signal is set to *TRUE* immediately when the parameter is exceeded during the piece machining and stay *TRUE* till the falling edge of **TestMNEnd**. Due to this behavior, the OEM could decide in which way react on the working process: immediately or at the end of the machining.
MNOn: BOOL	Set to *TRUE* when **MNReady** = *TRUE* and set to *FALSE* when **ABORT** = *TRUE* or error code = **22** or **25**.
MNCycles: DINT	This is the machined pieces counter (good + bad). It is put to zero when **MNReady** = *TRUE* and increased with the raising edge of **MNDone** or **MNAlarm**.
MNDefect: DINT	This is the machined bad pieces counter. It is put to zero when **MNReady** = *TRUE* and increased with the raising edge of **MNAlarm** (This could happen during the piece machining).
MNconsDefect: DINT	This is the consecutive machined bad pieces counter. It is put to zero when **MNReady** = *TRUE* or **MNDone** = *TRUE* and increased with the raising edge of **MNAlarm** (This could happen during the piece machining). It could be used to stop the working process at the end of the piece machining when a threshold value as been reached.
ErrCode: INT	Error code if different from 0. See chapter "5.4.3".

AnswStr: STRING(128)	This is the copy of the NUMmonitor answer message and contains all the wear information of each monitored trace. These information are also decoded into the following *ToolMonFunc Outputs variables*. This string is stored on rising edge of **MNDone** or **MNAlarm** and its content changes on the next rising edge of **MNDone** or **MNAlarm**. The content is cleared (empty string) by **MCStart** = *TRUE* o **MNStart** = *TRUE* or **MNReady** = *TRUE*.
TracesNumber: USINT	Number of monitored traces. This value is stored on rising edge of **MNDone** or **MNAlarm** and its value changes on the next rising edge of **MNDone** or **MNAlarm**. The value is cleared (= 0) by **MCStart** = *TRUE* o **MNStart** = *TRUE* or **MNReady** = *TRUE*.
Trace0Addr: USINT	Drive address which data are monitored on **Trace0** of NUMmonitor. This value is stored on rising edge of **MNDone** or **MNAlarm** and its value changes on the next rising edge of **MNDone** or **MNAlarm**. The value is cleared (= 0) by **MCStart** = *TRUE* o **MNStart** = *TRUE* or **MNReady** = *TRUE*.
Trace0PctDev: INT	Percentage deviation (tool wear %) of **Trace0** referred to the comparing limits stored into the model used as reference for the monitoring job. The possible values are between -255 and 255 while the value of 256 is sent in case of an error signaled by the alarm detectors. This value is stored on rising edge of **MNDone** or **MNAlarm** and its value changes on the next rising edge of **MNDone** or **MNAlarm**. The value is cleared (= 0) by **MCStart** = *TRUE* o **MNStart** = *TRUE* or **MNReady** = *TRUE*.
Trace1Addr: USINT	As for **Trace0Addr**.
Trace1PctDev: INT	As for **Trace0PctDev**.
Trace2Addr: USINT	As for **Trace0Addr**.
Trace2PctDev: INT	As for **Trace0PctDev**.
Trace3Addr: USINT	As for **Trace0Addr.**
Trace3PctDev: INT	As for **Trace0PctDev**.
Trace4Addr: USINT	As for **Trace0Addr**.
Trace4PctDev: INT	As for **Trace0PctDev**.
Trace5Addr: USINT	As for **Trace0Addr**.
Trace5PctDev: INT	As for **Trace0PctDev**.
Trace6Addr: USINT	As for **Trace0Addr**.
Trace6PctDev: INT	As for **Trace0PctDev**.
Trace7Addr: USINT	As for **Trace0Addr**.
Trace7PctDev: INT	As for **Trace0PctDev**.

5.4.3 ToolMonFunc ErrCode

ErrCode	Description.
1	NUMmonitor not ready. Check: - NUMmonitor running but not connected to the CNC - NUMmonitor GENERAL SETTING "Remote Var In" not defined - NUMmonitor GENERAL SETTING "Remote Var Out" not defined - NUMmonitor GENERAL SETTING "Remote Control" not enabled
2	Syntax error in NUMmonitor Answer.
3	NUMmonitor Answer: unknown code.
4	ModelCreation: Repetition number not admitted (number <> 0).
5	ModelCreation: Repetition number out of range (number < 0 or number > 99).
6	ModelCreation: Model Name contains not admitted characters.
7	Monitoring: Model Name contains not admitted characters.
10	ModelCreation: Syntax error in NUMmonitor Answer.
11	ModelCreation: Model Name in NUMmonitor Answer different from the requested.
12	ModelCreation: Creation aborted by NUMmonitor.
13	ModelCreation: Model Name not present into NUMmonitor database.
14	ModelCreation: Syntax error in Command to NUMmonitor
15	ModelCreation: NUMmonitor error during model recording.
16	ModelCreation: Not executable command because PLC remote control not enabled on NUMmonitor.
17	ModelCreation: Model configuration incomplete.
18	ModelCreation: Waiting for trigger start Exxxxx 0/1 transition.
20	Monitoring: Syntax error in NUMmonitor Answer.
21	Monitoring: Model Name in NUMmonitor Answer different from the requested.
22	Monitoring: Monitoring aborted by NUMmonitor.
23	Monitoring: Model Name not present into NUMmonitor database.
24	Monitoring: Syntax error in Command to NUMmonitor.
25	Monitoring: NUMmonitor error during model monitoring.
26	Monitoring: Not executable command because PLC remote control not enabled on NUMmonitor.
28	Monitoring: Waiting for trigger start Exxxxx 0/1 transition.
30	ABORT: Not executable command because PLC remote control not enabled on NUMmonitor. Check 'Remote Control' in GENERAL SETTING window (see chapter "2.5") or NUMmonitor Full licence type is not present (see chapter "2.1", "3.6.1")

5.5 Application example

5.5.1 PLC program example

```
PROGRAM ToolMon_0
VAR
ToolMonFunc_Nc0: ToolMonFunc;
CodiceErrore: INT;
mMF150Ch1_0: BOOL;
MNAnswStr_0: STRING(128);
mCodiceErrore: INT;
END_VAR
-------------------------
IF ResetCh1_0 THEN
    E47000_0:= 0;
    E20000_0 := FALSE;
END_IF

IF MF150Ch1_0 AND NOT mMF150Ch1_0 THEN
    E47000_0:= 0;
    mMF150Ch1_0:= TRUE;
END_IF
IF MF150Ch1_0 AND mMF150Ch1_0 AND ((E47000_0= 1) OR (E47000_0= 2)) THEN
    MF150Ch1_0:= mMF150Ch1_0:= FALSE;
END_IF

IF btnRecord THEN
    E47000_0:= 1;
END_IF
IF btnMonitoring THEN
    E47000_0:= 2;
END_IF

IF MF151Ch1_0 OR MF153Ch1_0 THEN
    ToolMonFunc_Nc0.ModelName:= Flexium_CNC_0.RCNC.PLCString;
    E47000_0:= 0;
    E20000_0 := FALSE;
END_IF
IF MF151Ch1_0 THEN
    ToolMonFunc_Nc0.nMCLoops:= E33010_0:= Flexium_CNC_0.RCNC.E33000[10];
END_IF

ToolMonFunc_Nc0(
    TMAnsw:= ToolMonAnsw_Nc0,
    MCStart:= MF151Ch1_0,
    TestMCLoopEnd:= MF152Ch1_0,
    MNStart:= MF153Ch1_0,
    TestMNEnd:= MF154Ch1_0,
    Abort:= ResetCh1_0,
    TMCmd => ToolMonCmd_Nc0,
    MNAlarm => MSG427,
    MNCycles => E40000_0,
    MNDefect => E40001_0,
    MNconsDefect => E40002_0,
    ErrCode => CodiceErrore,
    MNAnswStr => MNAnswStr_0,
    TracesNumber => E47002_0,
    Trace0Addr => E47003_0,
    Trace0PctDev => E40003_0,
    Trace1Addr => E47004_0,
    Trace1PctDev => E40004_0,
    Trace2Addr => E47005_0,
    Trace2PctDev => E40005_0,
    Trace3Addr => E47006_0,
    Trace3PctDev => E40006_0,
    Trace4Addr => E47007_0,
    Trace4PctDev => E40007_0,
```

```
    Trace5Addr => E47008_0,
    Trace5PctDev => E40008_0,
    Trace6Addr => E47009_0,
    Trace6PctDev => E40009_0,
    Trace7Addr => E47010_0,
    Trace7PctDev => E40010_0);

IF MF151Ch1_0 AND ToolMonFunc_Nc0.MCReady THEN
    MF151Ch1_0:= FALSE;
END_IF

IF MF152Ch1_0 AND (ToolMonFunc_Nc0.MCdone OR ToolMonFunc_Nc0.MCLoopEnd) THEN
    E20000_0 := ToolMonFunc_Nc0.MCdone;
    MF152Ch1_0:= FALSE;
END_IF

IF MF153Ch1_0 AND ToolMonFunc_Nc0.MNReady THEN
    MF153Ch1_0:= FALSE;
END_IF

IF MF154Ch1_0 AND (ToolMonFunc_Nc0.MNDone OR ToolMonFunc_Nc0.MNAlarm) THEN
    MF154Ch1_0:= FALSE;
END_IF

Flexium_CNC_0.WCNC.E20000[0]:= E20000_0;
Flexium_CNC_0.WCNC.E40000[0]:= E40000_0;
Flexium_CNC_0.WCNC.E40000[1]:= E40001_0;
Flexium_CNC_0.WCNC.E40000[2]:= E40002_0;
Flexium_CNC_0.WCNC.E40000[3]:= E40003_0;
Flexium_CNC_0.WCNC.E40000[4]:= E40004_0;
Flexium_CNC_0.WCNC.E40000[5]:= E40005_0;
Flexium_CNC_0.WCNC.E40000[6]:= E40006_0;
Flexium_CNC_0.WCNC.E40000[7]:= E40007_0;
Flexium_CNC_0.WCNC.E40000[8]:= E40008_0;
Flexium_CNC_0.WCNC.E40000[9]:= E40009_0;
Flexium_CNC_0.WCNC.E40000[10]:= E40010_0;

Flexium_CNC_0.WCNC.E47000[0]:= E47000_0;
Flexium_CNC_0.WCNC.E47000[2]:= E47002_0;
Flexium_CNC_0.WCNC.E47000[3]:= E47003_0;
Flexium_CNC_0.WCNC.E47000[4]:= E47004_0;
Flexium_CNC_0.WCNC.E47000[5]:= E47005_0;
Flexium_CNC_0.WCNC.E47000[6]:= E47006_0;
Flexium_CNC_0.WCNC.E47000[7]:= E47007_0;
Flexium_CNC_0.WCNC.E47000[8]:= E47008_0;
Flexium_CNC_0.WCNC.E47000[9]:= E47009_0;
Flexium_CNC_0.WCNC.E47000[10]:= E47010_0;

LedRecord_Nc0:= ((((E47000_0 = 1) OR MF150Ch1_0) AND Lamp2Hz.OUT) OR
ToolMonFunc_Nc0.MCOn) AND HMI_Nc0;
LedMonitoring_Nc0:= ((((E47000_0 = 2) OR MF150Ch1_0) AND Lamp2Hz.OUT) OR ToolMonFunc_Nc0.MNOn) AND HMI_
Nc0;
IF CodiceErrore <> mCodiceErrore AND mCodiceErrore <> 0 THEN
CodiceErrore:=0;
END_IF

CASE CodiceErrore OF
 1:
    MSG401:= TRUE; // NUMmonitor not ready
 2:
    MSG402:= TRUE; // Syntax error in NUMmonitor Answer
 3:
    MSG403:= TRUE; // NUMmonitor Answer: unknown code
 4:
    MSG404:= TRUE; // ModelCreation: Repetition number not admitted (number <> 0)
```

```
 5:
      MSG405:= TRUE; // ModelCreation: Repetition number out of range (number < 0 or number > 99)
 6:
      MSG406:= TRUE; // ModelCreation: Model Name contains not admitted characters
 7:
      MSG407:= TRUE; // Monitoring: Model Name contains not admitted characters
10:
      MSG410:= TRUE; // ModelCreation: Syntax error in NUMmonitor Answer
11:
      MSG411:= TRUE; // ModelCreation: Model Name in NUMmonitor Answer different from the requested
12:
      MSG412:= TRUE; // ModelCreation: Creation aborted by NUMmonitor
13:
      MSG413:= TRUE; // ModelCreation: Model Name not present into NUMmonitor database
14:
      MSG414:= TRUE; // ModelCreation: Syntax error in Command to NUMmonitor
15:
      MSG415:= TRUE; // ModelCreation: NUMmonitor error during model recording
16:
      MSG416:= TRUE; // ModelCreation: Not executable command because PLC remote control not enabled on NUMmonitor
17:
      MSG417:= TRUE; // ModelCreation: Model configuration incomplete
18:
      MSG418:= TRUE; // ModelCreation: Waiting for trigger start Exxxxx 0/1 transition
20:
      MSG420:= TRUE; // Monitoring: Syntax error in NUMmonitor Answer
21:
      MSG421:= TRUE; // Monitoring: Model Name in NUMmonitor Answer different from the requested
22:
      MSG422:= TRUE; // Monitoring: Monitoring aborted by NUMmonitor
23:
      MSG423:= TRUE; // Monitoring: Model Name not present into NUMmonitor database
24:
      MSG424:= TRUE; // Monitoring: Syntax error in Command to NUMmonitor
25:
      MSG425:= TRUE; // Monitoring: NUMmonitor error during model monitoring
26:
      MSG426:= TRUE; // Monitoring: Not executable command because PLC remote control not enabled on NUMmonitor
28:
      MSG428:= TRUE; // Monitoring: Waiting for trigger start Exxxxx 0/1 transition
30:
      MSG430:= TRUE; // ABORT: Not executable command because PLC remote control not enabled on NUMmonitor
ELSE
      MSG401:= MSG402:= MSG403:= MSG404:= MSG405:= MSG406:= MSG407:= FALSE;
      MSG410:= MSG411:= MSG412:= MSG413:= MSG414:= MSG415:= MSG416:= MSG417:= MSG418:= FALSE;
      MSG420:= MSG421:= MSG422:= MSG423:= MSG424:= MSG425:= MSG426:= MSG428:= FALSE;
      MSG430:= FALSE;
END_CASE

mCodiceErrore:= CodiceErrore;
IF ClrMsg THEN
  CodiceErrore:= 0;
END_IF
```

5.5.2 PLC Variables description

btnRecord	Bool
btnMonitoring	Bool
LedRecord	Bool
LedMonitoring	Bool

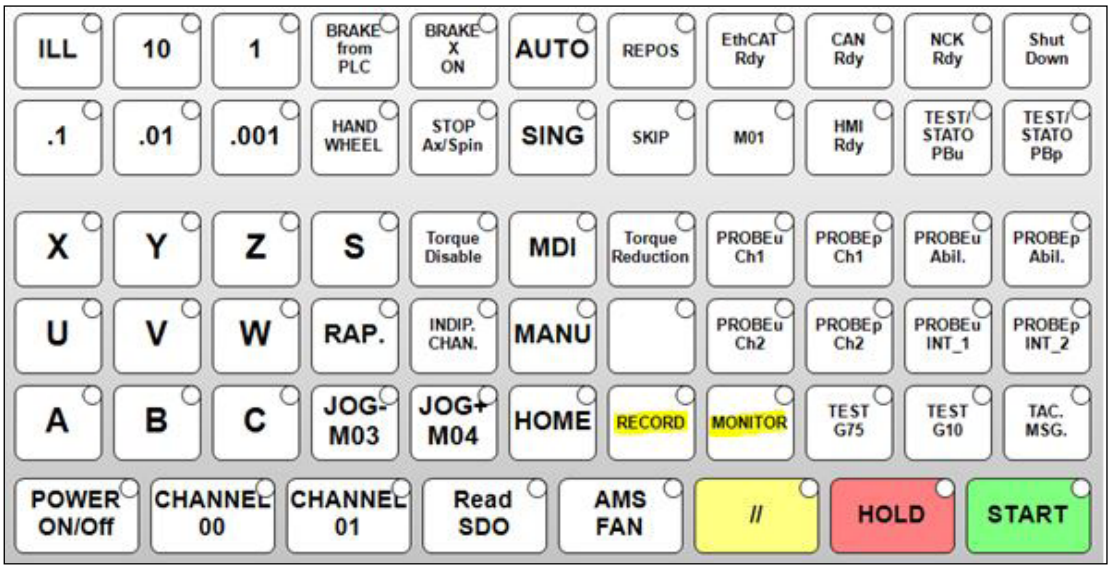

Fig. 48 MP06 configuration example

```
VAR_GLOBAL

E20000_0: BOOL; // TRUE = MCDone, FALSE = Loop to another piece machining

E33000_0: USINT; // Axis address
E33001_0: USINT; // Drive current reduction 1..127
E33010_0: USINT; // Model Acquisition Loops

E40000_0: LREAL; // Monitoring cycles counter
E40001_0: LREAL; // Rejected pieces counter
E40002_0: LREAL; // Rejected pieces in succession counter

E40003_0: LREAL; // Trace 0 percentage deviation (Tool wear %)
E40004_0: LREAL; // Trace 1 percentage deviation (Tool wear %)
E40005_0: LREAL; // Trace 2 percentage deviation (Tool wear %)
E40006_0: LREAL; // Trace 3 percentage deviation (Tool wear %)
E40007_0: LREAL; // Trace 4 percentage deviation (Tool wear %)
E40008_0: LREAL; // Trace 5 percentage deviation (Tool wear %)
E40009_0: LREAL; // Trace 6 percentage deviation (Tool wear %)
E40010_0: LREAL; // Trace 7 percentage deviation (Tool wear %)

E47000_0: BYTE;   // =1 RECORD ModelName selected by PLC, =2 Monitoring ModelName selected by PLC,
                  // =3 RECORD ModelName selected by PC, =4 Monitoring ModelName selected by PC

E47002_0: BYTE;   // Number of monitored traces
E47003_0: BYTE;   // Trace 0 address number
E47004_0: BYTE;   // Trace 1 address number
E47005_0: BYTE;   // Trace 2 address number
E47006_0: BYTE;   // Trace 3 address number
E47007_0: BYTE;   // Trace 4 address number
E47008_0: BYTE;   // Trace 5 address number
```

```
E47009_0: BYTE;   // Trace 6 address number
E47010_0: BYTE;   // Trace 7 address number

MF150Ch1_0: BOOL; // Wait for NUMmonitor job selection, if not already done by PC
MF151Ch1_0: BOOL; // Start NUMmonitor Acquisition job
MF152Ch1_0: BOOL; // Check NUMmonitor Acquisition job end (Last repetition end)
MF153Ch1_0: BOOL; // Start NUMmonitor Monitoring job
MF154Ch1_0: BOOL; // Check NUMmonitor Monitoring job end (Last repetition end)

END_VAR
```

5.5.3 PLC note

What we have to do in case of NUMmonitor alarms/errors or exceeding a threshold of the consecutive machined bad pieces counter is deputed to the OEM PLC integrator.

- Stop immediately or in any case at the end of the machined piece, depend from the machine type.
- The analysis of the warning message for each monitored trace is not done in this example, but the message sent by NUMmonitor at the end of each monitoring phase is disposable into *ToolMon Funct.AnswStr output*.

The M function used into the example must be decoded by the OEM PLC program, as also the management of the channel M function acknowledge.

```
MF150Ch1_0:= Flexium_CNC_0.RCNC.Channel [1].MFunctionAck = 150;
MF151Ch1_0:= Flexium_CNC_0.RCNC.Channel [1].MFunctionAck = 151;
MF152Ch1_0:= Flexium_CNC_0.RCNC.Channel [1].MFunctionAck = 152;
MF153Ch1_0:= Flexium_CNC_0.RCNC.Channel [1].MFunctionAck = 153;
MF154Ch1_0:= Flexium_CNC_0.RCNC.Channel [1].MFunctionAck = 154;
```

Fig. 49 M function decoding

```
//Reset funzioni M
IF Flexium_CNC_0.RCNC.Channel [1].Reset OR GenReset_Nc0 THEN
   MF150Ch1_0:= MF151Ch1_0:= MF152Ch1_0:= MF153Ch1_0:= MF154Ch1_0:= FALSE;
END_IF

//Abilitazione CH1
S1nack_Ch1_0:= (MF5S1Ch1_0 AND NOT SCh1_0fermo);
MFnack_Ch1_0:= MF150Ch1_0 OR MF151Ch1_0 OR MF152Ch1_0 OR MF153Ch1_0 OR MF154Ch1_0;
Flexium_CNC_0.WCNC.Channel [1].AckMFunction:= NOT (MFnack_Ch1_0 OR S1nack_Ch1_0) OR
Flexium_CNC_0.RCNC.Channel [1].Reset OR Flexium_CNC_0.RCNC.General.Reset;
```

Fig. 50 Decoded M function: Reset and M function acknowledge interlock

5.5.4 PLC Message

MSG401: BOOL; // NUMmonitor not ready
MSG402: BOOL; // Syntax error in NUMmonitor Answer
MSG403: BOOL; // NUMmonitor Answer: unknown code
MSG404: BOOL; // ModelCreation: Repetition number not admitted (number <> 0)
MSG405: BOOL; // ModelCreation: Repetition number out of range (number < 0 or number > 99)
MSG406: BOOL; // ModelCreation: Model Name contains not admitted characters
MSG407: BOOL; // Monitoring: Model Name contains not admitted characters
MSG410: BOOL; // ModelCreation: Syntax error in NUMmonitor Answer
MSG411: BOOL; // ModelCreation: Model Name in NUMmonitor Answer different from the requested
MSG412: BOOL; // ModelCreation: Creation aborted by NUMmonitor
MSG413: BOOL; // ModelCreation: Model Name not present into NUMmonitor database
MSG414: BOOL; // ModelCreation: Syntax error in Command to NUMmonitor
MSG415: BOOL; // ModelCreation: NUMmonitor error during model recording
MSG416: BOOL; // ModelCreation: Not executable command because PLC remote control not enabled on NUMmonitor
MSG417: BOOL; // ModelCreation: Model configuration incomplete
MSG418: BOOL; // ModelCreation: Waiting for trigger start Exxxxx 0/1 transition
MSG420: BOOL; // Monitoring: Syntax error in NUMmonitor Answer
MSG421: BOOL; // Monitoring: Model Name in NUMmonitor Answer different from the requested
MSG422: BOOL; // Monitoring: Monitoring aborted by NUMmonitor
MSG423: BOOL; // Monitoring: Model Name not present into NUMmonitor database
MSG424: BOOL; // Monitoring: Syntax error in Command to NUMmonitor
MSG425: BOOL; // Monitoring: NUMmonitor error during model monitoring
MSG426: BOOL; // Monitoring: Not executable command because PLC remote control not enabled on NUMmonitor
MSG427: BOOL; // Monitoring: Allarm during monitoring
MSG428: BOOL; // Monitoring: Waiting for trigger start Exxxxx 0/1 transition
MSG430: BOOL; // ABORT: Not executable command because PLC remote control not enabled on NUMmonitor

5.5.5 CNC part program example

```
%19.1(test NUMmonitor)(CH00)

(Before to run the part program the NUMmonitor must be activated on the PC where it is loaded)
(and the fields CNC LINK, DB LINK must be green and the PLC Remote Control must be selected)


VAR
[i] [MODEL(10)]
ENDV

(M142 remove torque reduction to drive E33000=@)
(M143 torque reduction E33001=1..127 to drive E33000=@)
(M144 torque enable to drive E33000=@)
(M145 torque disable to drive E33000=@)
(M150 Wait NUMmonitor job selection)
(M151 Start NUMmonitor Model Acquisition)
(M152 Wait NUMmonitor Model Acquisition end)
(M153 Start NUMmonitor Monitoring)
(M154 Wait NUMmonitor Monitoring end)
(E40000 Monitoring cycles counter)
(E40001 Bad pieces counter increased each time an alarm is detected by NUMmonitor during monitoring)
(E40002 Consecutive bad pieces counter put to 0 when the machined piece is good)
(The counters are set to 0 when a new M151 or M153 is executed)
\\------------------

E35232=11 (select MP11 for TP2 axis X@0)
E35233=11 (select MP11 for TP2 axis Z@1)
E35254=11 (select MP11 for TP2 spindle @24)

E35264=1 (Enable quick TP axis X@0)
E35265=1 (Enable quick TP axis Z@1)
E35288=1 (Enable quick TP spindle @24)

E83000=0 E83001=0 E83002=0

N10
 M143 E33000=0 E33001=110
 M144 E33000=0 (torque enable to drive @0)
 M144 E33000=1 (torque enable to drive @1)

 M201 G1 Z0 F10000
 G4 F1

N20
 $0 Push button RECORD o MONITOR
 M150
 G79 E47000 = 1 N100 (RECORDING MODEL)
 G79 E47000 = 2 N200 (MONITORING)
 G79 N500
N100 (RECORDING MODEL)
(If the input Model name is one blank character, because it is not possible to confirm an input without characters)
(the model name is not sent to NUMmonitor, the PLC library transform the blank input into an empty field)
(This means that instead of choosing the model name via part program input, you use the model already selected on NUMmonitor).
(At the opposite if the Model name is valid it must be already present into the NUMmonitor data base otherwise an error will occur)
(If the input Model name is one blank character, the following LOOP NUMBERs value is not taken into account because it is used)
(the value associated to the Model selected on NUMmonitor)
```

```
N101 $0 MODEL NAME ?
N102 _GETSTR [MODEL]
N110 $0 LOOP NUMBERs ?
N111 E33010= $
N120 _SETSPLC [MODEL]
N121 $0
N130 M151
N140 G77 N400 N499 (Piece machining)
N150 M152
N160 G79 E20000 = 0 N140
N170 G79 N20

N200 (MONITORING)
(If the Model name is one blank character, because it is not possible to confirm an input without characters)
(the model name is not sent to NUMmonitor, the PLC library transform the blank input into an empty field)
(This means that instead of choosing the model name via part program input, you use the model already selected on NUMmonitor,)
(in this case the LOOP NUMBERs must be equal 0)
(At the opposite if the Model name is valid it must be already present into the NUMmonitor data base otherwise an error will occur)
N201 $0 MODEL NAME ?
N202 _GETSTR [MODEL]
N210 _SETSPLC [MODEL]
N211 $0
N220 M153
N230 G77 N400 N499 (Piece machining)
N240 M154
N241 G4 F0.2
(Copy to E8300x only to make easier the reading by HMI/variable window)
N250 E83000=E40000 E83001=E40001 E83002=E40002
N260 M01
N270 G79 N230

N400
  \\ G4F Delay >= (Sub sampling factor +1) * P50 in seconds
  G4F{{n+1}*E41005/1000000}
  E83123=1  (Enable data recording)
  (start machining)
  FOR [i]=1 TO 3 DO (the loop is only to enlarge the job execution time)
    M3 S1000
    G1 Z-100
    S0
    G1 Z0
    M4 S2000
    G4 F1
  ENDF
  M5
  G4 F1
  E83123=0  (Stop data recording)
N499

N500
M143 E33000=0 E33001=127
M145 E33000=0 (torque disable to drive @0)
M145 E33000=1 (torque disable to drive @1)
E35264=0 (Disable quick TP axis X@0)
E35265=0 (Disable quick TP axis Z@1)
E35288=0 (Disable quick TP spindle @24)

M2
```

Window deliberately empty

Window deliberately empty

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