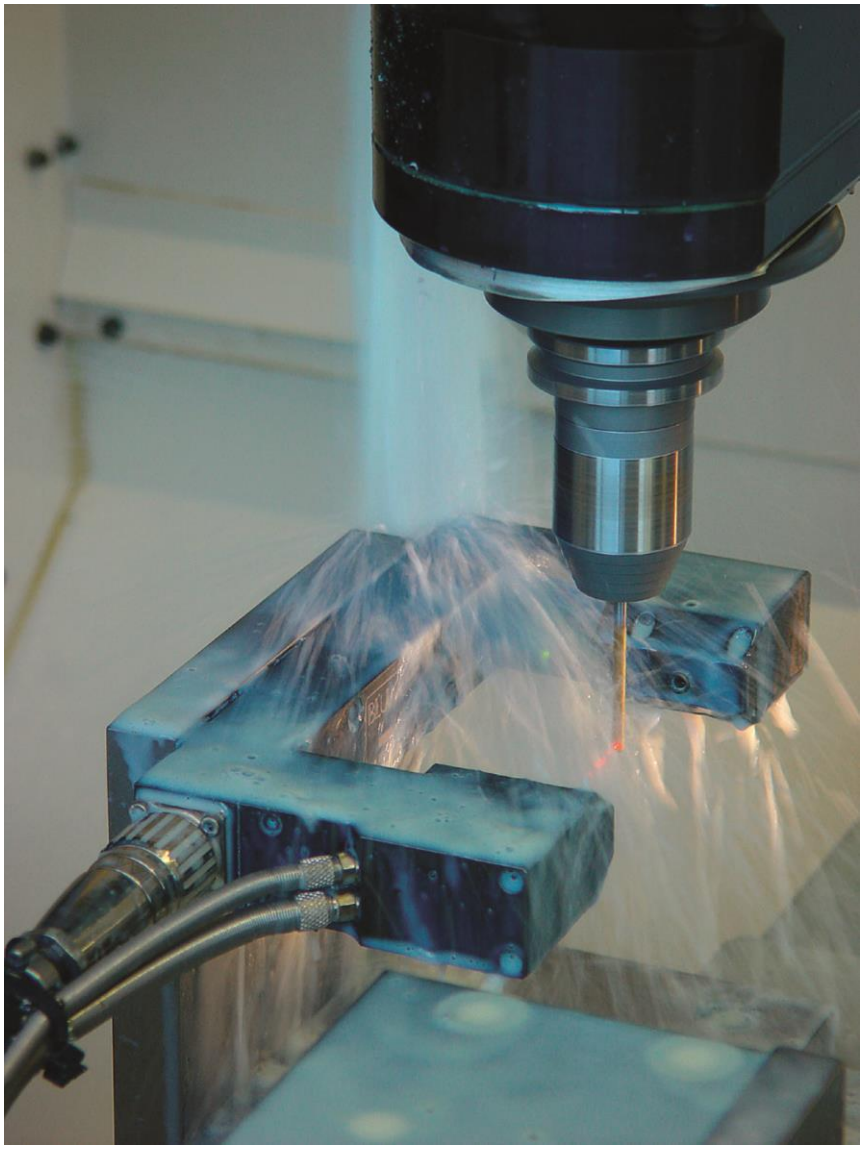


- **for Laser Systems**
- Tool Measurement
- NT Technology
- Tool Length Measurement
- Tool Radius Measurement
- Tool Breakage Detection
- Tool Form Monitoring
- Tool Form Measurement
- Single Cutting Edge Monitoring
- Axes Compensation

Installation instructions	**English**
Software	148844
Version	V5F
Control	Okuma OSP-P200M, P300M

Copyright

We always supply the latest software version. If another version is requested, please contact our Service Department / Hotline.

Prior to the start up procedure it is mandatory to check if the parameters and the software range are already used by other programmes. If so, the cycles must be adapted because overwriting of used parameters and data can have unpredictable influence on the machine and could cause damage.
After finishing the installation, the used parameters and the performed changes to programme and machine must be documented.
Blum-Novotest GmbH is not liable for damages to the machine due to programming errors or faulty application of the measuring cycles. Installing the measuring cycles, the mentioned warranty exclusions are accepted.
We reserve the right for technical modifications which improve the product. All suggestions for improvement are gladly accepted.
Decisive for the technical contents is the language version of the manufacturer (DE/EN).
Original operating instructions

Please read the manual carefully first, then start up the measuring system and the measuring cycles!

Order number Software until 03-2018: P87.0634-030.315
Order number Software as from 04-2018: 148844

Content

1. Description of the laser measuring system

1.1 Introduction

The BLUM laser measuring system is a highly accurate optical measuring device for automated tool measurement in a machining centre under operating conditions. The measuring results are the basis for tool setting and adjustments of tool wear as well as a criterion for tool change in due time. The increased process safety improves manufacturing quality while reducing waste parts.
In order to ensure a smooth manufacturing process in an automated flexible manufacturing system, it is essential to check the dimensions of the cutting tools, which are to be used.
By measuring the tool geometry, it is possible to recognise incorrectly loaded tools or inaccurately pre-set tools in time, as well as worn or damaged tools. Using an optimised strategy for tool compensation or tool change will avoid further damages to the tool or to the workpiece.
The tools are measured without contact at nominal rpm. The measuring signal is directly processed in the CNC and evaluated in the NC-programme.

Reasons for tool measurement without contact at nominal rpm:

- High spindle rpm on milling machines (from 10 000 min^{-1}) result in length variations of the spindle.
- Measuring at nominal rpm includes radial spindle run-out, which determines the accuracy of the machined bore/surface.
- Measuring tools at rotating spindle helps to detect and to compensate incorrect clamping, spindle and tool run-out.
- Chips and/or cooling lubricant are removed by centrifugal force at high nominal rpm.
- Time is saved by avoiding stopping of the CNC-axes or reducing the spindle rpm when using tactile measuring systems.
- Damages caused to the machine and to the tool, due to direct contact with a tactile measuring system, will be avoided by non-tactile measuring in the laser beam.

Correctable errors:	**Error magnitude:**
Spindle offset on high-frequency spindles	(approx. $\pm$ 0.15 mm)
Length offset due to varying clamping forces	(approx. $\pm$ 0.10 mm)
Radius offset due to radial spindle run-out	(approx. $\pm$ 0.05 mm)
Contour offset due to wear or grinding errors	(approx. $\pm$ 0.08 mm)

1.2 Literature references

The following manuals can be ordered from Blum-Novotest GmbH:

1. Laser system
2. Pneumatic unit
3. Programming instructions
4. Programming instructions measuring cycle extension for diverse special functions

For further information about the machine, please refer to the machine documentation supplied by the machine manufacturer.

1.3 Commissioning procedure

For quick and correct operation, the following order is recommended:

1. Mechanical installation (→ chapter 2.1)
2. Installation of the pneumatic (→ chapter 2.2)
3. Electrical installation (→ chapter 2.3)
4. Adaptation of the machine data (→ chapter 2.5)
5. Adaptation of the PLC-programme (→ chapter 2.7)
6. Machine-specific software adaptation (→ chapter 3.2)
7. Installation of error texts (→chapter 3.2.8)
8. Installation of data for a graphical operator guidance (option) (→ chapter 3.3)
9. Function test (→ chapter 3.4.1)
10. Determination of the axial run-out error / run-out error (→ chapter 3.4.2)
11. Calibration of laser measuring system (→ programming instruction)
12. Testing cycles by the example programmes (→ programming instructions)
13. Testing cycles by the graphical operator guidance (→ programming instructions)

1.4 Structure and function of the laser measuring system

The complete laser measuring system consists of transmitter, receiver, pneumatic unit as well as cables and mounting systems. Transmitter and receiver, together with their corresponding electronic system, are located in rigid housings. The measuring system is designed for operation in machining centres. The necessary protection of the optical components is guaranteed by pneumatic operated shutters. In addition to this, the openings of the shutters are protected by barrier air. Shutters and barrier air are both controlled by the pneumatic unit.
Transmitter and receiver are fixed on the machine in an appropriate location by means of mounting systems. They are linked to the machine control unit by means of cables.
The laser system works like a highly accurate light barrier. The transmitter is sending a laser beam, which directly hits the receiver, if it is adjusted correctly. If a tool interrupts the laser beam, the output signals change.
The operating voltage for the measuring system is 24 VDC. There are inputs for switching the system on and off as well as the outputs for an evaluation of the conditions. All inputs and outputs have a 24V signal level and can be connected directly to the PLC or CNC. If other signal levels are required by the CNC, the concerned signals must be additionally wired via optocoupler.
The built-in LED´s on the receiver indicate the status of the laser system. Further information can be found in the operating manual.
Each time the laser beam is interrupted or released by the tool, the receiver generates a so-called dynamic output signal, a high-active rectangular pulse of defined length on each light-dark or dark-light change. This signal is linked to the measuring input of the CNC. Therefore, the actual position of the travelling axis at the trigger point can be generated. Additionally, a second so-called static signal is generated, which corresponds directly to the status of the light barrier: Low = dark or interrupted, high = light or not interrupted.

Input signals of the laser measuring system:	**"ENABLE0"**
	"ENABLE1"
	"ENABLE2" (Option)
Output signals of the laser measuring system:	**"LASER OK"**
	"STATIC"
	"DYNAMIC"
	"ANALOG" (Option)
Serial interface:	**"RS232 Interface" (Option)**

1.5 Description of signals and modes

The operation mode of the laser measuring system results from the signals ***"ENABLE0"***, ***"ENABLE1"*** and ***"ENABLE2"***. In order to use all modes, each signal must have a separate PLC output.

With ***"ENABLE0"*** the transmitter is switched on, i.e. the laser beam is visible - with open shutter. Measurement or cutting edge monitoring is impossible if the transmitter is switched off. To enhance lifetime, the ***"ENABLE0"*** should be set only during the measuring cycle.
Following operating mode of the receiver is possible (24 V = High, 0 V = Low):

"ENABLE0"	"ENABLE1"	"ENABLE2"	Operating mode	Comment
24 V	0 V	0 V	MODE0 / LED off	Single cutting edge monitoring 0
24 V	24 V	0 V	MODE1 / LED green	Measuring 1
24 V	0 V	24 V	MODE2 / LED red	Single cutting edge monitoring 2 or measuring 2
24 V	24 V	24 V	MODE3 / LED yellow	Measuring 3

MODE0: Each light-dark variation, caused by the cutting edges of the rotating tool (light → dark), generates a high-impulse at the output ***"DYNAMIC"***. If, within a defined period of time, no cutting edge is detected, the Output ***"DYNAMIC"*** generates a low-signal, which is stored until the next switch-over of the modes. At the end of the control cycle, the status of this output can be evaluated by the control. Thereby, the signal levels have the following meaning: low = error, high = all edges are present. A patented process filters interferences, caused by coolant drops. If this filtering process has been successfully completed, there is a high-signal at the output ***"LASER OK"***. A low signal indicates an error.

MODE1: Each change (light → dark) or (dark → light) generates a high-impulse at the output ***"DYNAMIC"***. This signal is evaluated as a trigger point by the measuring input of the control. This mode is used for measurement of stationary or rotating tools from light to dark (=measuring direction "pushing", which means, the tool is moved into the laser beam). Additionally, it is used for calibrating and measuring stationary tools from dark to light (=measuring direction "pulling", which means the tool is moved out of the laser beam).

MODE3: After expiration of the time constant at the last change (dark → light) at the output ***"DYNAMIC"*** a high-impulse will be generated. This signal is evaluated as a trigger point by the measuring input of the control. This mode is used to measure rotating tools from dark to light (=measuring direction "pulling", which means the tool is moved out of the laser beam). A minimum rpm, resulting from a programmed time constant, must be set for the measuring operation. Attention: Measurement has to be performed at the correct minimum speed, otherwise the results will be incorrect.

MODE2: Depending on version (P87.0634-…): Customer specific special function (...Z0) or same functionality as **MODE0** (-Z1-1) or **MODE3** (-Z1-2), however, at a different basic rpm.

The output ***"LASER OK"*** generates in **MODE1** the signal level low (light below threshold) or high (light over threshold), depending on the captured light. The triggering thresholds are 25% higher than those of the output ***"STATIC"***. It will be used for monitoring the operational safety of the laser measuring system.
The output ***"DYNAMIC"*** is sending a signal in **MODE1** with a defined impulse length at each change light → dark and dark → light. The impulse duration is pre-set by the manufacturer (e.g. 0.020 sec) and can only be reprogrammed at NT-devices at any time. This output is connected as a trigger signal to the measuring input of the control.
The output ***"STATIC"*** in the operating mode **MODE1** gives the signal level Low (incidence of light under switching threshold) or High (incidence of light over switching threshold) depending on the light received. The switching threshold depends on diverse factors and is typically between 80% and 95% of the maximum of the incidence of light. This output should not be connected with the measuring input of the control as rapidly rotating tools are generating extremely short needle impulse, which is not recognized by the control.
The output ***"ANALOG"*** is available as an option. It is only used for special measuring tasks, e.g. detection of the position of an edge. The output signal has a voltage of 0-10 V (or 0-5 V at LaserControl NT), depending on the quantity of light that reaches the receiver and also the shading degree of the laser beam. The signal may have to be shaped to be linear (e.g. depending on the extent to which the laser is shaded by a specific tool). The output is not used by the standard measuring cycles.
Optionally, the **"RS232-interface"** is usable. Through it, parameter may be transcribed. Additionally, further functions can be applied. This requires a serial link on the control, which can be called by the NC-programme. It will not be used by the standard measuring cycles.

2. Installation of the laser measuring system

2.1 Mechanical installation

For the mechanical installation of the laser measuring system, the following steps have to be considered:

- The laser measuring system should be mounted in a suitable place inside the working area and within the axis strokes by means of a support- or mounting system. It can be fixed on or next to the machine table. Ideally, the mounting location is chosen as near as possible to the tool magazine in order to reduce the traverse path.
- The fixture must be stable to prevent the system from vibrating by the moves of the CNC-axes. Otherwise, the repeatability will deteriorate. Furthermore, a minimum distance must be kept between the laser beam and the end of the traversing area (software limit switch), long enough to allow for radial approach with the reference tool from both sides.
- Transmitter and receiver should always be located in a way, depending on the side of approach for radius measuring (positive or negative end of axis), that the laser beam is always directed towards the rotating cutting edge. This will avoid disturbing reflections and deviations.
- The electrical wires must be in compliance with the requirements for cables of measuring systems. Use flexible conduits to protect the cables against coolant and glowing chips.
- Okuma OSP controls need an impulse time > 25.4ms to process the skip signal. Requirement laser system: **Impuls time 100 ms** (order parameter **t100 Z0-x**). An impulse time of 20 ms is inadmissible.

Please refer to the supplied operating manual for more information.

2.2 Installation of the pneumatic unit

Please take notice of the following recommendations for the installation of the pneumatic unit:

- The pneumatic unit must be fixed at an appropriate location outside the working area and must be connected to the air pressure line of the machine. The pneumatic pipes must be laid with due care and should be protected by flexible conduits inside the working area. It is essential that the air pipes are kept free from pollution (coolant, oil, water and dust). This is the only way to protect the optical parts from pollution.
- The air pressure for the shutter and the barrier air must be set to the recommended values.

For more information, refer to the data sheets supplied with the pneumatic unit.

2.3 Electrical connection

Connection with input and output

The laser measuring system will be connected to the PLC inputs and outputs of the control. The machine manufacturer defines the connection. The connection to the NC-programme is made by the PLC-programme. In any case, a measurement input of the control (SE1 at the SSU unit) has to be connected with the measuring system. For the usage of all functions, 6 outputs and 2 inputs are needed.

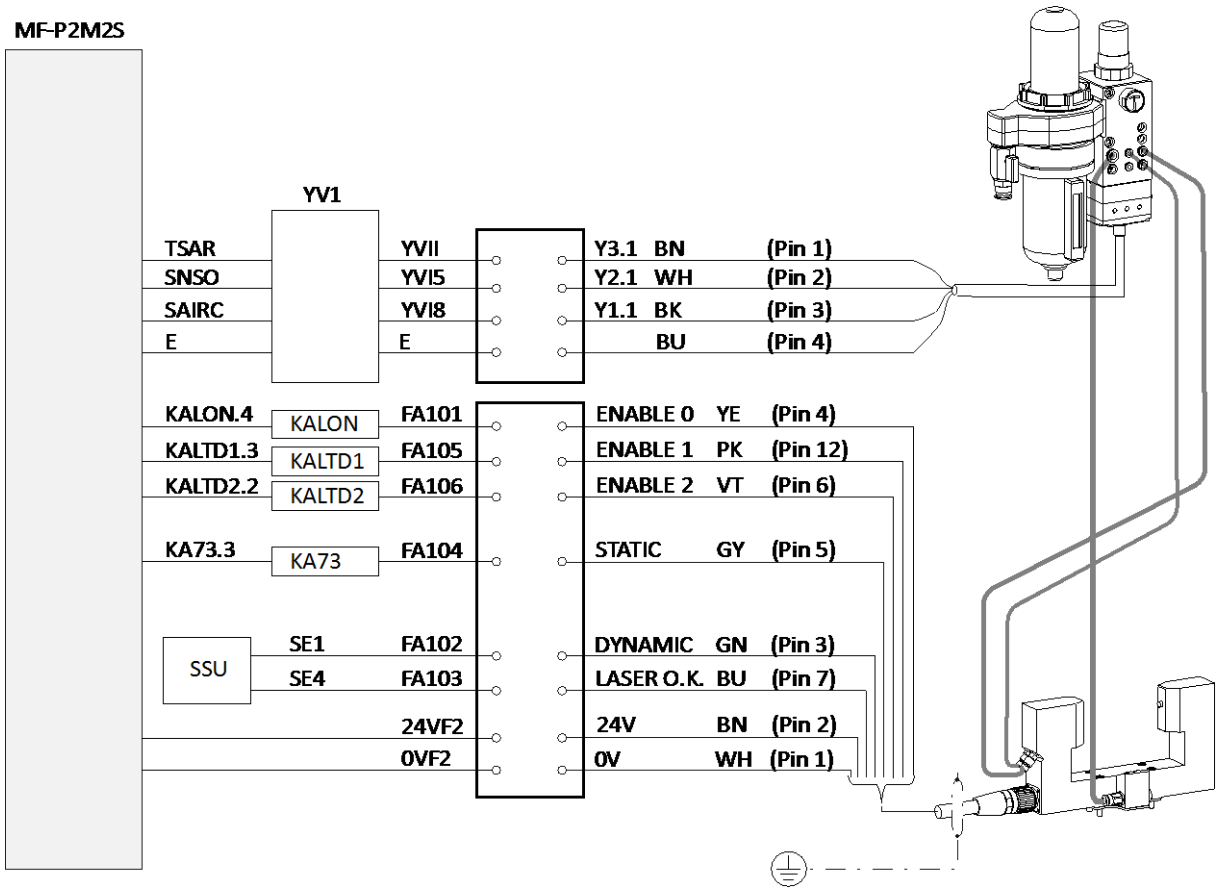
⚠ CAUTION!

Damage to the laser measuring system by short circuit possible.

▶ Connect each individual wire to its own terminal.

For particular application, additional options "serial interface" as well as the output ***"ANALOG"*** may be used. More information concerning the connection and the extended functions are available upon request.

2.3.1 Connecting diagram to NC/PLC



Y3.1	Tool cleaning nozzle
Y2.1	Shutter
Y1.1	Barrier air

Inputs/Outputs:

1. If there are not enough outputs available, the signals ***"Y2.1 shutter"*** and ***"ENABLE0"***can be operated by a conjointly output. The diagnostic programme O9699 (T_SIGNAL) can not be used then!
2. Only with standard laser (without NT-function): The signal ***"LASER OK"*** or ***"STATIC"*** can be dispensed if there are not enough inputs available. However, the diagnostic programme O9699 (T_SIGNAL) will not work properly.
3. A protection sleeve without end position control can be connected with the signal***"Y2.1 shutter"*** as long as movement of the protection sleeve is possible without collision. When actuating "Reset" during the cycle, manual retraction is necessary before closing the protection hood.
4. A linear unit with end position control may be connected with the signals ***"move-out linear unit"***, ***"move-in linear unit"***, ***"linear unit in work position"*** and ***"linear unit in initial position"***. When actuating "Reset" during the cycle, manual retraction is necessary before closing the protection hood.

2.3.2 Connection with IF70 serially (option)

See separate instruction P87.0634-030.315-EN_V5F_SETUP_IF70.docx

2.4 Linear unit (option)

The laser measuring system can be mounted on a linear unit or swivel unit. The measuring cycles are already prepared for this. The linear unit will be controlled simultaneously when opening and closing the shutters at set option (VC154 bit 2).
The output **"move-out linear unit"** is controlled for move-out. The output **"move-in linear unit"** is controlled for move-in. The end position is called with the inputs **"linear unit in work position"** and **"linear unit in initial position"**.

Note:
There is danger of collision at the time optimised cycles O9685 and O9688 at the set option (VC154 bit 2). Therefore, they are locked for safety reasons. When calling, error "20 FUNCTION NOT POSSIBLE" will be set.

2.5 Adaptation of machine data

The following machine specifications must be checked and adapted if required.

- During automatic operation with the single block ON, a block of a control statement such as IF, GOTO or CALL usually does not come to a stop until the next block is executed. This bit is intended to select a stop or a non- stop in the particular control statement block.
  - Configuration in NC: Optional parameter 2 bit (0) must be set to 1= Stop or 0=Non-Stop
- Set the DYNAMIC signal.
  - Configuration in NC: Optional parameter 61 bit (0) must be set to 0=normally open (A-contact Default).
- Set the LASEROK signal (not necessary with IF70 connection).
  - Configuration in NC: Optional parameter 61 bit (3) must be set to 1=normally close (B-contact).

2.6 Compatibility with former NCU-software versions

The software version V5F can be used on controls OSP200M. Due to the size of programme and the slow block processing time, the cycle takes longer.

2.7 Adaptation of the PLC programme

At the beginning of a measuring cycle the laser system is switched on and is ready for operation. Depending on the measuring task, different modes can be set on the laser system (measuring with/without barrier air, measuring inside/outside, single cutting edge monitoring, ...). At the end of a cycle, the system is switched off and tight protection against coolant and chips is re-established. All NC/PLC-control bits and their corresponding outputs, which are connected to the laser system, should be set to 0 in case of "RESET" and "EMERGENCY STOP", in order to switch off the system. There is no need for a link with the safety door.
These functions are made by means of a PLC programme, which is adapted to the NC-programme. The GUD variables determine, which measuring input, which analogue input and output or PLC-words will be used. The assignment of a signal within a data word has been determined and must not be modified.

Output signals:	Bit 0: ENABLE0 (transmitter)
	Bit 1: ENABLE1 (receiver)
	Bit 2: Valve shutter Y2.1
	Bit 3: Valve barrier air Y1.1
	Bit 4: ENABLE2 (receiver, only for NT, option)
	Bit 5: Value tool cleaning nozzle Y3.1 (option)
	Bit 6: Move out linear unit (option)
	Bit 7: Move in linear unit (option)
Input signals:	Bit 0: LASER OK
	Bit 1: DYNAMIC
	Bit 2: STATIC
	Bit 3: Linear unit in working position (option)
	Bit 4: Linear unit in initial position (option)
	Bit 5: reserved
	Bit 6: reserved
	Bit 7: reserved

Notes:

Addressing as byte (VC170=18 or VC176=18):

- The complete output byte will be written or the complete input byte will be read from cycle. The machine specific outputs must be set in the PLC.
- If the signal ***"STATIC"*** is not connected with a separate PLC-input, bit 0 and bit 2 of the input word must be strapped within the PLC (not permitted for LaserControl NT).

Addressing as bit (VC170 .. VC179):

- If a single PLC-input or output is used for each signal,**VC170 .. VC178** must be set.
- The end position control of a linear unit is not supported with addressing as bit and must be carried out within the PLC.

Beside the laser measuring system, additional measuring systems (e.g. measuring probe) may be connected. As initial state (default-state) the machine data should be defined so that it could be measured with the measuring probe.
At the beginning of a measuring cycle with the laser measuring system, the DYNAMIC must be configured so that the entrance for the LaserControl is active. Activation will be made in programme O9670. Deactivation will be made in programme O9679 at the end of the measuring cycle.
As a measuring cycle may not be finished completely and therefore, the default state will not be established, the PLC-programme must always establish the default state in the reset-state.

3. Installation of the software

3.1 Installation of the measuring cycles

The measuring cycles are divided into different categories (V5Fx stands for the version number):

- *Main programmes:* These programmes are examples and should demonstrate the definition of the parameter and the call for the measuring cycles. The cycle call with the transfer parameters might be taken over in a part programme. They are available in different languages (xx=language abbreviation were inch=en).
  They are saved in archive **Standard/Fast/S_Runout/T_Signal.xx.spf**.
  The .spf files have to be divided from O6xx to M30 and be saved as O6xx.MIN in ANSI encoding format before be copied on the control.
- *Sub-routines:* These programmes contain the actual measuring procedure.
  They are saved in the archive **BLUM-LASER-STD.SSB** (standard cycles), which needs to be copied on the control in any case.
- *Auxiliary programmes:* These programmes constitute the basic structure for the machine-specific adaption. They have to be adapted to the particular machine or rather control when operating.
  They are saved in the archive **BLUM-LASER-USER.SSB** (→ chapter 3.2).
- Probably, further archives must be loaded (e.g. for time optimised tool control or for measurement of turning tools).
- The archives contain 50 programme numbers and will be copied on the control D:\MD1 folder.
  - If the memory store space is not enough for install the whole packet a smaller 31 programme package can be installed. Keep the necessary language text programme O96(VC180) and delete the remaining programmes from O9650 to O9669.
- The .SSB files have to be registered in the control.
  - With the machine in Auto Mode, press the right arrow button until the menu option “Library Program” is shown.
  - Press the “Library Program” Button and the Library Register will appear on the screen.
  - You will now need to create a library buffer large enough to register all of the .SSB files. Do this by pressing the “Buffer Size” button and typing in a memory amount (Normally start with 250000) and press “OK”.
  - Next, press the “REGIS.” button and the list of compatible .SSB files in MD1 will be shown. Select the file you wish to register and press “OK”. Repeat this step to register all the files needed in the Library Register.
    - If an error message appears, then the library buffer is too small. You will need to start over and set a larger buffer size.
  - Once all the files are registered, press the “CLOSE” button to return to the AUTO mode screen.

Note:

Figures and texts are available in different languages for the graphical programme support (Blum GUI) and for the error messages. Further information can be found in the supplementary instructions on request.

3.1.1 Global variables

As standard, the following common variables will be used in the measuring cycles.
Default cycles, turning tools: VC77, VC78, VC100..VC200
Calibration values: e.g. VC90..VC99 (permanent)
NT-H: VC50..VC69 (option)
Angle heads: VC70..VC79 (option)
In particular cases, the variables can be transferred to other areas.

If the calibration and temperature compensations values must be stored in different blocks (e.g. for several spindles or attachment heads), additional variables must be used, e.g. VC90..VC99 for the first spindle and VC80..VC89 for the second spindle.

3.2 Machine-specific software adaptations

3.2.1 General

The measuring cycles are in modular design. Some of the sub-routines have been reserved for the machine manufacturer or end user. These programmes **must** be completed when commissioning the measuring cycles and adapted to the machine. Otherwise the cycles will not function and there is risk of collision with the laser measuring system!
When installing the measuring cycles, parts of the software can be relinquished, i.e. just the tool wear control with the corresponding auxiliary programme will be installed.

O9670 (USERSTARTPROG)	preliminary actions, approach strategy, skip axis limit switch
O967x (USERPARATABx)	machine-specific definitions, axes assignment, basic adaptions
O9678 (USERSETOFFS)	set zero point offset at temperature compensation
O9679 (USERENDPROG)	final operations, retracting strategy, fault management, tool change

With the large variety of machines, mounting possibilities, measuring tasks and strategies before and after measuring, there is an infinite number of programming options. The following explanations can only describe a small part of all the possibilities without being beyond the scope of a start-up manual.

Attention:

- All dimensions, stored in the common variables in O967x (USERPARATABx), will be displayed in mm.
- Incorrect information concerning mounting direction, respectively measuring position of the laser measuring system, can cause collisions.
- In case of an incorrect association of the in- and outputs, the laser system will not be addressed correctly. Perhaps other machine components will be controlled.
- A misstatement of retraction plane can cause collisions.
- If the tool limit data is defined incorrectly, collisions may occur. Furthermore, very short tools may not be measured and the radius of very big tools is measured incorrectly.
- An incorrect specification for the time constants results in a single cutting edge cycle or (at LaserControl NT systems) pulling measuring block at incorrect spindle rpm. To avoid incorrect measurement, all programmes should be executed by 100% feed and rpm (exception: commissioning, function test).

Flexible programming
The common variable VC181 (value<10) can be set before the call of a measuring cycle to realise customer-specific requirements. Therefore, for example, for a laser measuring system with a long distance (Laser single), the control of very small tools is carried out in the focus point and the control of the remaining tools is carried out at the current laser beam position at optimum time. The evaluation of the variable and the necessary adaptation can be effected in O9670 (USERSTARTPROG) or at the beginning of O967x (USERPARATABx).
A solution for multi-spindle machines is also realised in this way.

If needed, please contact our service.

Schematical programme run

	Call of:	Contains:	In case of error: Skip to:
O96xx ...			
	O9630 PM=1	Initialising variables (e.g. VC144)	
	O9670	Start programme with adaptation by OEM	O965x
	O967x		
	O9630 PM=2	mm/inch conversion of the internal variables	O9679
	O9644 PM=1 PS=0	Read spindle status	
	O9633 PM=1	Read tool data	O9679
		Check call parameter	O9679
	O9633 PM=3	Check tool data	O9679
	O9634 PM=9	Turn-on laser	
	O9639 PM=1	Approaching strategy to the laser	
	O9634 PM=1	Turn-on laser with check "Laser OK"	O9633 PM=2
		Starting point of the loop	
	O9640 …	Position axis partially with examination on position within VC150..VC153	
	O9634 PM=..	Navigation of the nozzle and checking start situation	
	O9632 …	Measuring block with examination on trigger point	O9633 PM=2
		End of the loop	
	O9633 PM=2	at measuring cycles: Edit tool data	
	O9639 PM=2	Retracting strategy from the laser	
	O9634 PM=2	Turn-off laser	
	O9644 PM=2 PS=0	Restore spindle status	
	O9679	End programme with adaptation by OEM	
	O965x	Error output	

3.2.2 Switching the unit of measurement mm/inch

📖 Read the documentation of the control manufacturer.

⚠ CAUTION!

Measuring error

After switching over the dimension unit from mm to inch (or vice versa), the system must be recalibrated (see programming instruction).

⚠ CAUTION!

Malfunction

To activate the set parameter, the machine must be switched off and back on again.

3.2.3 Auxiliary programme O9670 (USERSTARTPROG)

Before each measuring cycle, the first auxiliary programme O9670 (USERSTARTPROG) will be called. The following actions should be programmed in O9670 (USERSTARTPROG):

- Sometimes rotary axes have to be moved to defined positions.
- Coolant must be switched off (e.g. with M9) for all measuring tasks.
- Sometimes the laser measuring system must be swivelled into measuring position by M-function.
- The laser system is often located in the area of the tool magazine. In order to reach the measuring position without any collision, the door of the tool changer has to be opened before.
- In case of long bed or twin spindle machines, it is possible to install several laser systems. Furthermore, there are machines, where the tool has to be checked or measured in an angle of 0° and 90°. The variables **VC129** (value 1..7) have access to various data blocks, which are stored in the auxiliary programmes O9671 ... O9677. Generally, (one laser system, one spindle, tool orientation) VC129=1 has to be set, as the data will be read from O9671 (USERPARATAB1).
- Active transformations have to be deactivated. This will be done by the command G10 for example.
- To prevent tool offset calling errors two Caution stops are set by M0 in line NC191 and NC192. In case of use different T-Code, PH-Code and PD-Code for the tool offset; the program stops with a M0 a comment is shown in parenthesis and it waits to the confirmation of the operator to continue the cycles with a M3 command. In case of intentional use of different T-Code, PH-Code and PD-Code, the M0 and M3 could be deleted by the user.

Example:

```
O9670(USERSTARTPROG)
...
VC129=1 (LASER SYSTEM x, DEFINED IN USERPARATABx)
VC200=1 (SSU UNIT CONNECTOR USED FOR DYNAMIC SIGNAL)
...
NC191
M0 (CAUTION: H-CODE AND D-CODE DON'T MATCH)
M3
GOTO N30
NC192
M0 (CAUTION: H/D-CODE AND ACTIVE TOOL NUMBER DON'T MATCH)
M3
GOTO N30
...
N999 RTS
```

3.2.4 Auxiliary programme O9679 (USERENDPROG)

After each measuring cycle, the last auxiliary programme O9679 (USERENDPROG) will be called. The following actions should be programmed in O9679:

- The skip signal is deactivated disabling in the PLC all sensors inputs.
- Sometimes the laser measuring system must be swivelled into initial position by M-function, for example.
- Frequently, the laser measuring system is mounted in the area of the tool changer and the cover can only be closed after leaving the measuring position. The travel movement of the axis and the auxiliary function for closing the cover should be programmed here.
- Depending on the machine and measuring task, a specific retracting strategy can be realised.
- In case of error, the variable **VC100** contains an error number (VC100>0). During the programme run, O965x or O966x is called as the last programme after O9679 at a positive error number. There, the associated text is chosen and shown. At a positive error number, the programme run is interrupted with an alarm message or an endless loop. It is possible to react on the error condition customer-specifically by negating assigned error numbers in programme O9679. In the case of negative error numbers, the programme sequence will not be interrupted. The requested reaction, e.g. to out-feed the pallet, can be integrated in O9679. Is possible to call to the programme OEDLA, which generates an error diagnostic file where all the common variables values are stored.
- For multi-spindle machines, the strategy is saved here, e.g. saving the error status.
- At detected tool errors (VC100=15, 16, 19), the tool is locked, if possible.
- The measuring results would be printed in the Gauging Results Screen with OGRxx calling.

- Now, deactivated transformations can be activated again.

Example (standard):

```
O9679
...
N8 IF[[[VC100-15]*[VC100-16]*[VC100-19]] EQ 0]GOTO N990
GOTO N998
N990 VTLD3[VTLCN]=64 (NG2 FLAG,NEVER ATTEMPT TO CHANGE)
VTLD4[VTLCN]=32 (TOOL LIFE FLAG BREAKAGE)
N998 CALL OGR1 (DISPLAY GAUGING RESULTS)
N999 RTS
```

Example (with optimised error management):

```
O9679
...
N8 IF[[[VC100-15]*[VC100-16]*[VC100-19]] EQ 0]GOTO N990
GOTO N998
N990 (M CODE TO LOCK TOOL)
VC100=-VC100 (SUPRESS STANDARD ERROR)
(ADD HERE USER OPTIMIZED ERROR HANDLING)
N998 CALL OGR1 (DISPLAY GAUGING RESULTS)
N999 RTS
```

3.2.5 Auxiliary programme O967x (USERPARATABx)

At the beginning of each measuring cycle, a machine-specific programme O967x (USERPARATABx) is called, in which the definitions for the laser measuring system will be loaded. By the variable **VC129** = 1,2,3,..7 (defined in O9670), O9671 ... O9677 will be called. At least one programme O967x is needed. The included variables **must** be written with applicable values when commissioning. All values are entered as **radius values**, also at diameter axes (lathes). Positions and measurements are entered in metric dimensions (mm), the necessary conversion into inch is affected automatically during the cycle.
After each alteration of the variables in the O967x, the programme calibration has to be run (O9601, O9611 or O9621). Thereby, a plausibility check of the variables will take place.

General variables

VC200	**SSU unit connector** SSU unit connector used for "DYNAMIC" input signal Example: SE2 - VC200=2 Default value: VC200 = 1 (SE1)
VC180	**Language code** In case of error, malfunction will be issued. VC180 contains the offset number of the auxiliary programme O[9650+x] 0=English, 1=German, 2=French, 3=Italian, 4=Spanish, 5=Dutch, 6=Swedish, 7=Polish, 8=Danish, 9=Czech, 10=Portuguese, 11=Hungarian, 12=Japanese, 13=Korean, 14=Chinese..., 19=reserved for the manufacturer. Default value: VC180=0
VC141	**Number of trials** In case of errors during measuring cycles of tool measurement (e.g. by coolant drops) several trials are performed, before the cycle is finished due to an error. This parameter defines the max. number of repeated trials. Default value: VC141 = 4
VC140	**Start address for calibration parameter (10 global, subsequently following common variables)** The calibration values must be stored in variables, which will be obtained when switching off the machine. Generally, (one laser system, one spindle, one tool orientation) **one** start address is used. Several laser measuring systems can be integrated in one machine. Sometimes the tools must be measured with 0° and 90° (e.g. angle head). The related calibration values are different and are stored as parameter block. In this case **different** start addresses have to be defined. Example: VC140=90 → calibration values are stored in VC90..VC99

Beam alignment

Definition of the axis assignment (here: Laser beam in X/Y-level parallely to Y-axis).

VC101 **Axis assignment**

If the axes X, Y and Z are used with the defined axis numbers, a 3 digits assignment is sufficient, as VC101 will be extended internally to 6 digits.

Definition for milling machines (X=1, Y=2, Z=3:

1 digit	=	type of axis, in which radial measurements are performed, e.g. 1 = "X"
10 digits	=	type of axis, which is parallel to the laser beam, e.g. 2 = "Y". The movement of this axis can be repressed with set option VC157 bit 1.
100 digits	=	type of the axis, in which the length measurement will be executed, e.g. 3 = "Z"

As a type of the axis, only the values 1, 2 and 3 are valid at milling machines!

Example: VC101=321 (tool vertical to X/Y-level, laser parallel to Y-axis)

Definition for turning machines (X=6, Y=9, Z=7):

1 digit	=	type of axis, in which radial measurements are performed, e.g. 6 = "X"
10 digits	=	type of axis, which is parallel to the laser beam, e.g. 9 = "Y". The movement of this axis can be repressed with set option VC157 bit 1.
100 digits	=	type of the axis, in which the length measurement will be executed, e.g. 7 = "Z"

Note: As type of the axis, only the values 6, 7 and 9 are valid on turning machines!

Example: VC101=796 (tool vertical to X/Y-level, laser parallel to Y-axis)

Note: At other axis names (e.g. "W" instead of "Z"), an adaption to the other cycles is necessary.

VC102 **Approach side in the length axis**

Depending on the mounting position of the laser measuring system, the tool is located on the positive or negative axis side with reference to the laser beam. For 3-axis-machines, the value +1 is valid generally.

VC102=+1 → length measurement is carried out on the positive axis side relating to the laser beam

VC102=−1 → length measurement is carried out on the negative axis side relating to the laser beam

VC103 **Approach side in the radius axis**

Radius measurement and positioning for eccentrical length measurement is made on the positive or the negative axis side with respect to the laser beam depending on the mounting position of the laser measuring system and the possible axis travel. The laser beam should be directed preferably against the rotating tool cutting edge during measurement. This will avoid disturbing reflections and deviations. Radius measurements may also be carried out from both sides.

VC103=+1 → one-sided radius measuring on the positive side of the axis regarding laser beam

VC103=−1 → one-sided radius measuring on the negative side of the axis regarding laser beam

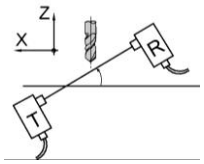
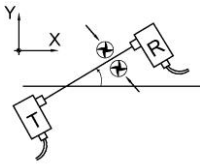
VC103=+2 → radius measurement on the positive axis side regarding the laser beam and then on the negative axis side

VC103=−2 → at first, radius measurement on the negative axis side of the laser beam and then on the positive axis side

Note:

Radius measurement on both sides is only possible with VC103=+/-2!

Definitions of angles

VC162 	**Only for cycles O961x: Angle between laser beam and laser axis** (=deviation to the perpendicular line between laser beam and length axis) At some machines, the laser beam can not be reached by the tool length axis. By an angular extension, the tool can be measured "indirectly" by moving the laser axis. The tool inspection is executed at different positions along the laser beam depending on the tool length. The software limit switch and the angle determine the tool limits (max./min. length). At commission, the angle must be determined. Default value (for cycles O960x, O962x, O968x): VC162=0 (laser beam is oriented perpendicularly to the length axis)
VC163 	**Angle between laser beam and laser axis** (=deviation to the perpendicular line between laser beam and radius axis) If is not possible to align the laser beam perpendicularly to the tool radius axis because of mounting difficulties, this angle must be determined and entered when commissioning. It must be in the range of +/-45 degrees and is used for compensation of the arising error in measurement during radius measurement and positioning. Default value: VC163=0 (laser beam is oriented perpendicularly to the length axis)

Retraction level

In the measuring cycles, the tool is brought to a retract position in the tool length axis. This position must be chosen in a way that the laser measuring system can be reached without any collision. Therefore, the variables **VC120** for the start position and **VC121** for the end position are used. Both variables **must** be occupied with valid values, e.g. the software limit switch of the tool length axis or the tool change position. Both of the retract positions may be different. Depending on the measuring task, a specific approach strategy may be programmed. The variable **VC137** (will be set at the beginning of cycle) contains the current programme number. This way, e.g. the approach or retracting movement during tool measuring control (VC137=5, 7, 8) can be performed at the effective position of the tool length axis, unless there is no danger of collision. At the other programmes, positioning is made on the software limit switch of the tool length axis. The variables **VC120**, **VC121** must be supplied accordingly.

VC120	**Start-up positions level before measuring cycle** The tool length axis will be brought to this position before the measuring cycle. The data is shown as machine coordinates.
VC121	**Retract level after the measuring cycle** On this position, the tool length axis will be reached after the measuring cycle. The data is shown as machine coordinates.

Note:
The variables **VC120** and **VC121** will not be used at cycles O9685 or O9688!

Measuring position

VC104	**Measuring position of the radius axis (axis for radius measurement)** Rough position of the laser beam
VC105	**Measuring position of the laser axis (measuring position between transmitter and receiver)** Generally, the centre is between transmitter and receiver or on focus of focused systems (accuracy < 1 mm). If the tool can not be displaced in the laser axis, a value will be entered here, on which the axis is positioned, enabling measurement without collision. **Note:** The movement of this axis can be repressed with set option VC157 bit 1.
VC106	**Measuring position of the length axis (axis for length measurement)** Rough position of the laser beam

Notes:

1. Input the measuring positions in machine coordinates.
2. When calibrating, the exact position of the centre of the laser beam will be saved in the calibration values VC[VC140+5] and VC[VC140+4]. The default values VC104 and VC106 can be corrected thereby.
3. Error "14 WRONG CALIBRAT.-/TC-PARA" will be sent, if VC[VC140+4] of VC106 or VC[VC140+5] of VC104 deviates exceeding 2 mm.

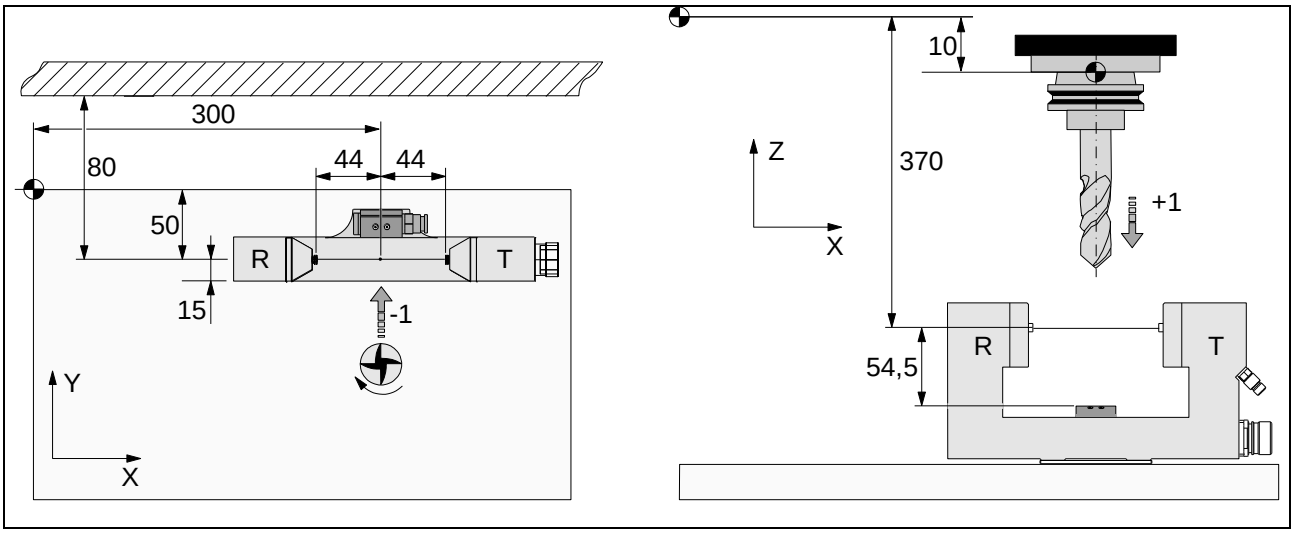
Interfering contours

The collision-free area from the laser beam to interference contours is restricted. By entering the correct distances, collisions with the tool are preventable.

VC107	**Distance between laser beam and interference contour behind the laser beam in tool radius axis** If no interference contour is existing, the maximum tool radius is entered here. Note: At O9603 and O9609, the one-sided radius measurement will be checked automatically at call parameter PM=±2, if the tool on the other side can be measured without collision. The measurement on the second side will only be executed, if all four conditions are fulfilled: PM = ±2 VC103 = ±2 (measured radius of the first side + VC123) <= VC107 measured radius of the first side <= VC108
VC108	**Distance between measuring position and interference contour in laser beam axis** The distance between measuring position and transmitter or receiver could be smaller than the maximum tool radius. In this variable, the distance between measuring position VC105 and interfering contours (e.g. shutters) is entered.
VC109	**Distance between laser beam and interference contour in tool length axis** Note: If the value is too low, the length of a multi-staged tool may no longer be measurable. Default value: 20 mm at "LaserControl Nano", 55 mm at "LaserControl Micro Compact"
VC182	**Distance between laser beam and interference contour in front of laser beam in tool radius axis** When positioning oversized tools, the interfering contour of the laser housing is considered. In this variable, the distance between laser beam and interfering contours is entered. At vertical mounting (e.g. the tool axis is directed to the basic carrier of the laser measuring system Micro Compact), half of the housing width is entered generally. Default value: 17 mm at vertical mounting, 20 mm at horizontal mounting

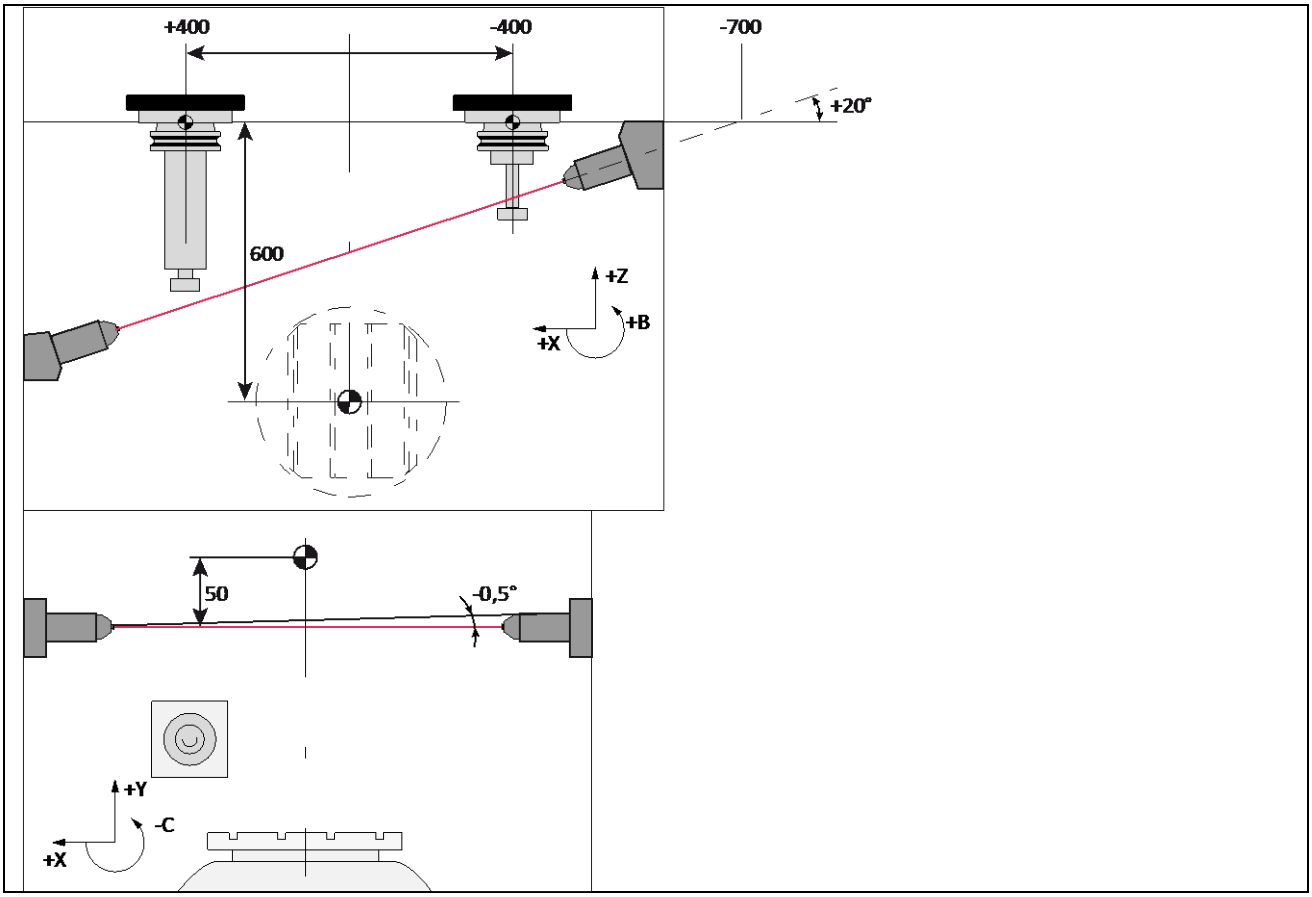
Example 1: Laser beam parallely to X-axis, perpendicularly towards tool length axis

```
VC101=100*3 + 10*1 + 1*2
VC102=1  VC103=-1
VC162=0  VC163=0
VC120=-10  VC121=-10
VC104=-50  VC105=300  VC106=-370
VC107=80-2  VC108=44-2  VC109=54.5-7  VC182=15+2
```



Example 2: Laser beam "parallel" to X-axis, not perpendicularly towards tool length axis, cycles O961x

```
VC101=100*3 + 10*1 + 1*2
VC102=1  VC103=-1
VC162=+20  VC163=-0.5
VC120=+400  VC121=+400
VC104=-50  VC105=600  VC106=-700
VC107=400  VC108=400  VC109=400  VC182=15+2
```



Software limit switch of the axes

During tool measurement, calculation of the start position and final position, the software limit switch of the tool length- and tool radius axis have to be considered.

VC150	**Positive software limit switch of the tool length axis** The positive software limit switch or a constant value is entered.
VC151	**Negative software limit switch of the tool length axis** The negative software limit switch or a constant value is entered.
VC152	**Positive software limit switch of the tool radius axis** The positive software limit switch or a constant value is entered.
VC153	**Negative software limit switch of the tool radius axis** The negative software limit switch or a constant value is entered.

Notes:

1. In case of trouble-shooting, it may be helpful to enter unattainable positions (e.g. VC150=99999.999, VC151=-99999.999) instead of the software limit switch of the machine.
2. The beam axis (tens of VC101) is used for cycles O961x in VC150 and VC151.
3. The positive software limit switch will be read in User parameter P Program limit (Machine) and the negative software limit switch will be read in User parameter N Program limit (Machine).
   VC150 .. VC153 must be converted in mm (e.g. by multiplication with VC144)!

Connecting laser measuring system with control

Definition of inputs/outputs:

VC170	Output signal for "ENABLE0", at M-function: VC170=660.659
VC171	Output signal for "ENABLE1", at M-function: VC171=445.444
VC172	Output signal for "Valve Shutter", at M-function: VC172=662.661
VC173	Output signal for "Valve Barrier Air", at M-function: VC173=443.442
VC174	Output signal for "ENABLE2", at M-function: VC174=447.446
VC175	Output signal for "Tool cleaning nozzle", at M-function: VC175=155.154
VC179	Output signal for "Linear unit", at M-function: VC179=144.145
	When using standard M-functions, the following applies: VC17x=xxx.yyy (xxx=ON, yyy=OFF)
	Addressing as bit: VC17x = 0, 1..16
	Addressing as byte (VDOUT[18]), the following applies:
	VC170=18, VC171=0, VC172=0, VC173=0, VC174=0, VC175=0, VC179=0
VC176	Input signal for "LASER OK"
VC177	Input signal for "DYNAMIC"
VC178	Input signal for "STATIC"
	When using standard OEM connection, the following applies:
	VC176=8888, VC177=0, VC178=0
	Addressing as bit: VC17x = 0, 1..16
	Addressing as byte (VDIN[18]), the following applies:
	VC176=18, VC177=0, VC178=0

Information for addressing in bit form:

1. In- or outputs not in use, are defined with VC17x=0.
2. If the signal **“STATIC“** is not connected with a separate PLC-input, the same input number must be set in **VC176** and **VC178** (not permitted for LaserControl NT).
3. For reducing the number of outputs, probably ***"valve shutter", "valve barrier air"*** and ***"tool cleaning nozzle"*** can be bridged. In this case, VC173=0 and VC175=0 is defined. However, the diagnostic programme O9699 (T_SIGNAL) will not work properly.
4. If the signals **“valve shutter“** and **“ENABLE0“** are hooked up to the same PLC-output, the same output number must be specified in **VC170** and **VC172**. However, the diagnostic programme O9699 (T_SIGNAL) will not work properly.
5. If the signal **“valve barrier air“** is not connected with a separate PLC-output, **VC175=0** must be defined.

Information for addressing in M code:

1. Outputs can be programmed as pair of M-function
   VC170..VC175,VC179 VC170=xxx.yyy with xxx=M-function for "Signal ON", yyy= M-function for "Signal OFF"

Further information:

1. When using an IF70, special definitions shall apply. Please refer to instruction **P87.0634-030.315-EN_V5F_SETUP_IF70**.
2. The delay time of a measuring input (e.g. 0.008 seconds) can be considered when measuring. The delay time is between 0...0.020 seconds and will be added to the number of the measuring input (e.g. VC177=7), e.g. VC177=7.008.

Laser measuring system: Constants

VC132	**Impulse time laser measuring system** Impulse length of signal "DYNAMIC". **Attention:** The measuring input requires a signal length of 100ms, shorter signals are ignored! Default value: VC132 = 0.100 s
VC133	**Basic spindle speed of the laser measuring system for MODE0 (only for LaserControl NT)** The spindle speed for the single cutting monitoring depends on the number of cutters and the basic spindle speed. An overlapping of 20% (for safety reasons) will be considered in this parameter. Default value: VC133 = 3750 min^{-1}
VC134	**Basic spindle speed of the laser measuring system for MODE1 (only for LaserControl NT)** Default value: VC134 = 0 min^{-1}
VC135	**Basic spindle speed of the laser measuring system for MODE2 (only for LaserControl NT)** Depending on the version of the system, MODE2 as well as MODE0 or MODE3 is reacting, however, with another basic spindle speed. Z...–0 (not used), default value: VC135 = 0 min^{-1} Z...–1 (as MODE0), default value: VC135 = 42000 min^{-1} Z...–2 (as MODE3), default value: VC135 = 600 min^{-1}
VC136	**Basic spindle speed of the laser measuring system for MODE3 (only for LaserControl NT)** For measurement of the tool while pulling out of the beam, a minimum spindle speed is necessary (safety 10%). Default value: VC136 = 3000 min^{-1}

Note:
Equipment-specific details can be found on the label on the back of the equipment

Laser measuring system: Options

VC154	**Option bits for laser system**		
	Bit number	**Value**	**Function**
	Bit0 (1)	(0)	no Laser NT
		(1)	LaserNT
	Bit1 (2)	(0)	Cycles for single cutting monitoring possible
		(2)	locked
	Bit2 (4)	(0)	no linear unit
		(4)	linear unit available
	Bit3 (8)	(0)	only Laser
		(8)	Hybrid-Laser with probe for temperature compensation
	Bit4 (16)	(0)	No option Z...–1
		(16)	Option Z...–1 (MODE2 as MODE0), but with a different basic spindle speed
	Bit5 (32)	(0)	No option Z...–2
		(32)	Option Z...–2 (MODE2 as MODE3), but with a different basic spindle speed
	Bit6 (64)	(0)	only Laser
		(64)	Hybrid-Laser with probe for length measurement
	Bit7 (128)		reserved for options
	Add required options, standard value: VC154=0		
VC155	**Option bits for measuring cycles (I)**		
	Bit0 (1)		Start position for eccentrical measuring block at O9603, O9606 will be calculated from:
		(0)	Trigger point of centrical measuring block
		(1)	Length from tool memory
	Bit1 (2)		Measurement of non-rotating, inside turning tools at O9603, O9609:
		(0)	locked
		(2)	possible
	Bit2 (4)		Speed control in cycle
		(0)	executing
		(4)	not executing
	Bit3 (8)		reserved for O9609
	Bit4 (16)		Check in O9608 with PM=0 and PM=2 is possible:
		(0)	No
		(16)	Yes
	Bit5 (32)		Positioning on retraction level at measuring cycle end:
		(0)	Yes
		(32)	No
	Bit6 (64)		Repetition of whole cycle:
		(0)	No
		(64)	Yes
	Bit7 (128)		Error message:
		(0)	Standard
		(128)	MSG: which symbol must be highlighted in SPEC CODE No.10 Bit 5
	Bit8 (256)		Calling signal "LASER OK" at the beginning of cycle? only if: O9604, O9605, O9607, O9608, O9615, O9618, O9624, O9685, O9688 (caution: The call is necessary at a retractable unit, because the end switch will be called, too).
		(0)	Yes
		(256)	No

VC155 **Option bits for measuring cycles (l)**

Bit number	Value	Function
Bit9 (512)		Reducing barrier air after calling of signal "LASER OK"? only if: O9604, O9605, O9607, O9608, O9615, O9618, O9624, O9685, O9688
	(0)	No
	(512)	Yes
Bit10 (1024)		Search O9901, O9911, O9921 when calibrating:
	(0)	Search run/measuring block
	(1024)	Positioning
Bit11 (2048)		Spindle indexing (M19 RS=..) at double-sided radius measurement only if: O9603, O9609
	(0)	Skip spindle positioning
	(2048)	Execute spindle positioning
Bit12 (4096)		reserved for options
Bit13 (8192)		reserved for options
Bit14 (16384)		reserved for options
Bit15 (32768)		reserved for options

Add required options, standard value: VC155=0

VC156 **Option bits for calibration, temperature compensation, allocation of tool correction and functions in accordance with the tool data**

Bit0 (1)		Length measurement at calibration/TC locked
	(0)	No
	(1)	Yes
Bit1 (2)		Radius measurement at calibration/TC locked
	(0)	No
	(2)	Yes
Bit2 (4)		reserved (compatibility of other controls)
Bit3 (8)		Execute measuring cycle with
	(0)	current H-number
	(8)	H0
Bit4 (16)		Condition at the end of the measuring cycles:
	(0)	current H-number
	(16)	H0
Bit5 (32)		Measurement at PB=-3,-2,-1:
	(0)	Positioning
	(32)	Search run, then NT
Bit6 (64)		Target point of the measuring path at central measuring block, calculated of:
	(0)	Current tool length
	(64)	Minimum tool length
Bit7 (128)		Radius in tool memory:
	(0)	Radius values
	(128)	Diameter values
Bit8 (256)		Length in tool memory:
	(0)	Radius values
	(256)	Diameter values
Bit9 (512)		Write tool data / send tool status or diverse errors:
	(0)	writing / sending
	(512)	repress (e.g. for virtual machines)

VC156 **Option bits for calibration, temperature compensation, allocation of tool correction and functions in accordance with the tool data**

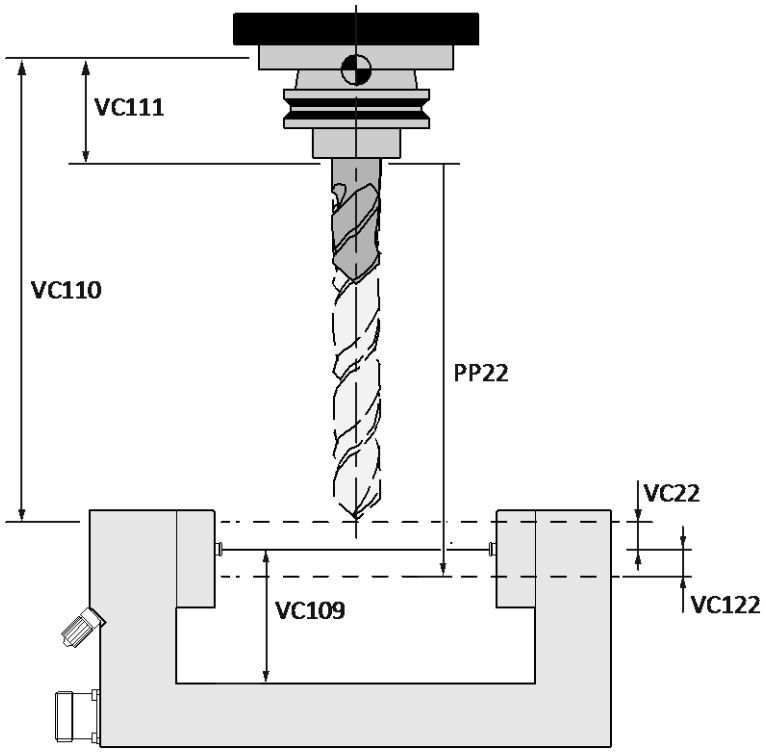
Bit number	Value	Function
Bit10 (1024)		Tool data:
	(0)	Standard
	(1024)	Data transfer in USER-programmes
Bit11 (2048)		centric search run:
	(0)	as measuring block
	(2048)	as incremental positioning (step by step)
Bit12 (4096)		in case of error during search run:
	(0)	Repeat measuring block from the beginning
	(4096)	Remaining path from current position as incremental positioning (step by step)
Bit13 (8192)		Length in tool memory:
	(0)	positive
	(8192)	negative
Bit14 (16384)		reserved for options
Bit15 (32768)		reserved for options

Add required options, standard value: VC156=0

Note:

The step width is calculated in the start position. The whole measuring distance (DTG) is divided in 10 steps. The maximum step width for safety reasons is VC109/4.
On an interrupted measuring block (only bit12 set) by a coolant drop the search function is continued from the current position. After recognition of the "dark" situation on measuring mode +3 the positioning is done further into dark by VC123. With measuring mode 0,+1,+2 the positioning is taken to the last "light" position. From here, measurement is continued as usual.

The step width is calculated with set VC156 bit11/ bit12. The entire measuring1 path will be divided into 10 steps, however, the maximum step width is VC109/4 because of safety reasons.



VC157	Option bits for measuring cycles (II)		
	Bit number	**Value**	**Function**
	Bit0 (1)		only at VC163≠0:
		(0)	Radius measurement parallel to radius axis
		(1)	Radius measurement is perpendicularly towards laser beam
	Bit1 (2)		Laser axis is existing:
		(0)	Yes
		(2)	No (e.g. at lathes)
	Bit2 (4)		Laser system is turned-on during cycle:
		(0)	Yes
		(4)	No
	Bit3 (8)		Laser system is turned-off during cycle:
		(0)	Yes
		(8)	No
	Bit4 (16)		Management of the measuring mode NT (-1, -2, -3, +3) is set internally:
		(0)	For milling tools (Mode LED is yellow/red)
		(16)	For grinding tools (Mode LED is green)
	Bit5 (32)		reserved (compatibility of other controls)
	Bit6 (64)		reserved (compatibility of other controls)
	Bit7 (128)		Activating functionality "Anglehead-measurement with swivelled tool axis" (option -AH): (an additional option code is necessary at activated function!)
		(0)	No
		(128)	Yes
	Bit8 (256)		Swivel head axis is existing:
		(0)	No
		(256)	Yes
	Bit9 (512)		Only at O9686 spindle as:
		(0)	Positioning (M19 RS=..)
		(512)	Rotation axis (G31)
	Bit10 (1024)		reserved (compatibility of other controls)
	Bit11 (2048)		reserved (compatibility of other controls)
	Bit12 (4096)		reserved for options
	Bit13 (8192)		reserved for options
	Bit14 (16384)		reserved for options
	Bit15 (32768)		reserved for options
	Add required options, standard value: VC157=0		

Note:
The retractable unit will not be controlled with set VC157 bit 2/ bit 3.

VC181	**Option tool cleaning nozzle** In order to clean the tool from coolant it can be blown off in the cycle and cleaned. This procedure is used at all cycles. It is valid VC181=DCBA, with: D = Waiting time in seconds in start position before the first rough measuring block (0..9), C = Blowing during search run/rough measuring block (0=off,1=on), B = Waiting time in seconds in start position before the first fine measuring block (0..9), A = Blowing during fine measuring block (0=off,1=on). Recommendations: Less coolant exposure, drop formation → VC181=1110 Intense coolant exposure, internal coolant → VC181=2101 Default value or option is not existing: VC181=0
VC185	Extended option
VC186	Extended option
VC187	Extended option
VC188	Extended option
VC189	Extended option
VC190	Extended option
VC191	Extended option
VC192	Extended option

Return strokes during measurement

VC122	**Distance from tool edge** This value should be changed slightly in exceptional cases only. Value range: 2.000 mm <= VC122 <= 6.000 mm Default value: VC122 = 6.000 mm
VC123	**Retracting travel after first measuring block** This value is not allowed to be decreased. It can be increased just slightly in exceptional cases only (→ longer measuring time). Default value: VC123 = 1.800 mm
VC124	**Retracting travel after second measuring block** This value is not allowed to be decreased. It can be increased just slightly in exceptional cases only (→ longer measuring time). Default value: VC124 = 0.050 mm
VC125	**Retracting travel after the following measuring blocks** This value is not allowed to be decreased. It can be increased just slightly in exceptional cases only (→ longer measuring time). Default value: VC125 = 0.020 mm

Velocities during measurement

VC117	**Rapid speed** By the given velocity, the pre-positioning of the tool in the laser beam will be executed (G1 F=VC117). The pre-positioning at rapid traverse (with G0) will be effected at VC117=0. Default value: VC117 = 0
VC118	**Positioning speed** By the given velocity, the positioning of the tool in the laser beam will be executed after the first measuring block (G1 F=VC118). The positioning in rapid traverse (with G0) will be effected at VC118=0. Default value: VC118 = 5000 mm/min
VC119	**Maximum measuring speed** The maximum measuring speed must be adapted, so that the axis comes to a stop without collision if a measuring signal has been detected. Value will be restricted internally on a maximum value of 10000 mm/min. Default value: VC119 = 5000 mm/min
VC142	**Feed for G1 at the end of cycle** The given speed will be chosen at the end of the cycle. Generally, the current speed will be re-established. Default value: VC142 = VFCOD*VC144
VC130	**Measuring speed 1** reserved Default value: VC130 = 1000 mm/min
VC131	**Measuring speed 2** The measuring speed 2 is used for measurement of turning tools in the cycles O962x. The measuring speed 2 will also be used for cycles O9603 and O9606 during length measurement, if there is a theoretical risk of collision by an eccentrical measuring block, at C=1 or tool radius greater than VC107 or VC108. The top of the tool cutting edge may not interrupt the beam in case of a feed/speed-rate that is too big and therefore could be missed. Default value: VC131 = 500 mm/min (for O962x) Default value: VC131 = 200 mm/min (for O9603 and O9606)

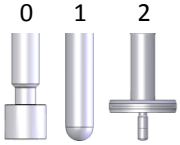
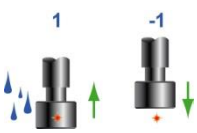
Spindle data

VC143	**Spindle speed and spindle status** At machines with spindle transmitter, the spindle speed is read automatically. It is not possible with analogue spindles, here, the spindle speed has to be defined over these variables. Pre-decimal position: Spindle speed Position after decimal point: Status 0.03 → M3, 0.04 → M4, 0.19 → M19 Examples: VC143=0: Speed rate with M3 → will be read automatically in O9644 VC143>0: Speed rate with M3/M4, e.g.: S20000, M4 → VC143=20000.045 Default value: VC143=0

Tool data

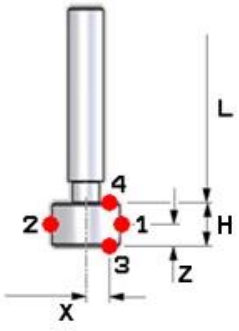
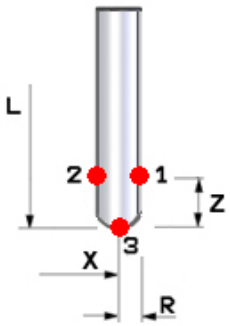
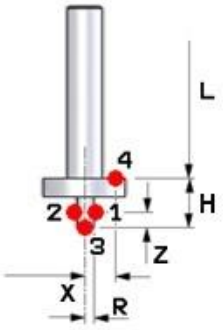
VC110	**Maximum tool length** Value to calculate the start position at tool length measurement.
VC111	**Minimum tool length** Value to calculate the final position for tool length measurement.
VC112	**Maximum tool radius** Value to calculate the start position at tool radius measurement.
VC113	**Minimum tool radius** Value for calculation of the final position at measurement of turning tools.
VC114	**Tool length correction value** On some programmes, which are generated from a post-processor, a defined tool length is used for programming. The used theoretical tool length will be entered here. Default value: VC114 = 0.0 mm
VC115	**Tool radius correction value** On certain programmes, e.g. those, generated by a post processor, a defined tool radius is used for programming. The theoretically used tool radius will be entered here. Default value: VC115 = 0.0 mm
VC116	**Tool length of zero tool** Some companies are working with tool lengths which are referring to a zero tool. The real tool length of the zero tool is inserted here. Default value: VC116 = 0.0 mm
VC160	**Tool memory** VC160=122: Tool data with tool wear VC160=122.5: Tool data without tool wear Value automatically set by the programme

Mode for calibration and temperature compensation

VC138	**Type of reference tool, extent of calibration (radius one-sided/double-sided)** When calibrating, the laser beam will be shaded from 4 directions and therefore, the elliptic form of the laser beam and the laser beam centre in length and radius axis is determined accurately. Therefore, a standard reference tool (type 0) will be used. For easy measuring tasks, a cylindrical pin (type 1) can also be used. For NT-H3D-applications, a special reference tool (type 2) will be used.  **VC138 = 0** → type 0, both-sided length and radius calibration VC138 = 1 → type 1, one-sided length and both-sided radius calibration VC138 = 2 → type 0, both-sided length and one-sided radius calibration VC138 = 3 → type 1, one-sided length and radius calibration **VC138 = 4** → type 2, both-sided length and radius calibration VC138 = 5 → type 2, both-sided length and one-sided radius calibration Note: The both-sided radius calibration should be preferred as therefore, the width of the laser beam can be determined. The same applies at length calibration with type 0 or type 2.
VC139	**Measuring direction for calibration and temperature compensation measurement**  The movement of the reference tool at the measuring block will be affected either out of the beam (pulling) or into the beam (pushing). The pulling measuring direction is preferred because of the increased interference resistance compared with coolant influences and pollution at the reference tool. **VC139 = +1** → Measurement pulling out of the beam (light transitions dark → light) VC139 = –1 → Measurement pushing into the beam (light transitions light → dark)

Data of reference tool

VC126	**Length of reference tool (L+H)** The length L is the µm-precisely measured distance of the tool holder reference point (spindle nose) and the lower edge of the reference tool. For highly accurate measurements, the axial run-out (DL) inside the spindle will be measured and considered when entering, e.g. ignoring at pulling calibration (VC139=+1), added to the length at pushing calibration (VC139=-1). With VC126=0 the data of the reference tool will be read from the tool memory. The measurement (L-H) will be entered as length in the tool memory. VC126 = reference tool length + 0/axial run-out errors
VC127	**Radius of reference tool (R)** The radius R is the µm-precisely measured radius of the reference tool. For highly accurate measurements, the concentricity (DR) inside the spindle will be measured and considered when entering, e.g. subtracted from the diameter at pulling calibration (VC139=+1), added to the diameter at pushing calibration (VC139=-1). With VC127=0 the data of the reference tool will be read from the tool memory. The measurement R will be entered as radius in the tool memory. VC127 = (reference tool diameter +/– radial run-out errors)/2
VC128	**Height of reference tool (H)** The height H is the accurately measured distance in µm between the top edge and lower edge of the detached checking diameter. With VC128=0 the data of the reference tool will be read from the tool memory. The measurement H will be entered in tool memory as wear length. At type 1, VC128 = 0 mm or wear length=0 will be entered.

Typ0	Typ1	Typ2
		
A. Entry in tool memory:		
Length: L Wear length: H Radius: R	Length: L Wear length: 0 Radius: R	Length: L Wear length: H Radius: R
B. Entry in USERPARATAB:		
VC126=L+H VC127=R VC128=H	VC126=L VC127=R VC128=0	VC126=L+H VC127=R VC128=H
Recommended call parameters:		
X = R – 0.5 mm Z = H / 2	X = 0 Z >= R + 0.5 mm	X = 6.3 mm Z = 2.0 mm

3.2.6 Auxiliary programme O9678 (SET ZERO POINT OFFSET)

At the temperature compensation, the drift of machine axes will be determined, which result from the thermally offset of the spindle and the axes. The measured values for the drift of both axes will be transferred to the auxiliary programme O9678 (SET ZERO POINT OFFSET). The customer- and user-specific evaluation takes place there.

Example:

```
O9678(SET ZERO POINT OFFSET)
...
PP17=FIX[VC101/1000]
PP12=FIX[PP17/100]
PP11=FIX[PP17/10]-10*PP12
PP10=PP17-100*PP12-10*PP11
N10 IF[[VC156 AND 1] NE 0]GOTO N20
N12 IF[[[PP12-1]*[PP12-6]] NE 0]GOTO N14
VZOFX[VACOD]=VZOFX[VACOD]+0.0001*FIX[10000*[PP26/PP23]]
N14 IF[[[PP12-2]*[PP12-9]] NE 0]GOTO N16
VZOFY[VACOD]=VZOFY[VACOD]+0.0001*FIX[10000*[PP26/PP23]]
N16 IF[[[PP12-3]*[PP12-7]] NE 0]GOTO N20
VZOFZ[VACOD]=VZOFZ[VACOD]+0.0001*FIX[10000*[PP26/PP23]]
N20 IF[[VC156 AND 2] NE 0]GOTO N30
...
N30 IF[[VC154 AND 8] EQ 0]GOTO N40
...
```

This control doesn’t have an external zero offset option. If this option is activated **only the actual zero offset** is going to be modified.
0.0001*FIX[10000*[PP4/PP6]]= determined drift of the tool length/radius in x axis.

3.2.7 Auxiliary programme O967x, block USERTOOLDATA (option)

Generally, the tool data is read and written in O9633 (TOOL DATA). In special cases, it can be read in the programme O967x (USERPARATABx) in block N3100 or written in block N3200. By this, the variables VC146, VC147, VC148, VC149, VC158, VC159 and VC161 must be supplied accordingly.

VC156 bit10 (1024) must be set, so that O967x (USERPARATABx) will be called.

- At the beginning of the measuring cycle, the tool data must be written in the common variables. The measuring mode (measuring, check, verification) is available in VC138, the measuring scope (length + radius, only length, only radius) is available in VC139.
- At the end of a measuring cycle, the measured data of the common variables must be read. The measuring mode (measuring, check, verification) is available in VC138, the measuring scope (length + radius, only length, only radius) is available in VC139.

3.2.8 Subroutine O9644 (spindle function)

Usually, the spindle is programmed with M3, M4, M5 and M19 in combination with the spindle speed (S-word). If additional programming is necessary, this programme has to be adapted.

3.2.9 Alarm- and masc texts (option)

Firstly the error will be eliminated if possible with an error strategy. If this does not lead to success, an error message is given. This will be carried out with VUACM[1]="error text" plus VDOUT[992]=VC100 and is integrated into the auxiliary programme O9650 .. O9668 (depending on the language). O9669 is reserved to call error messages by manufacturer-specified error numbers.

3.3 Cycle support (option)

For user-friendly programming, a graphical support can be integrated by the machine manufacturer. The measuring cycles can also fully be used without graphical support.

Further notes → programming instructions graphical operator guidance

3.4 Diagnostic programme

3.4.1 O9699 (T_SIGNAL) / function test of the laser measuring system

After loading the PLC-programmes into the control, the correct function of the laser measuring system must be tested. This will be done by using the programme O699 (T_SIGNAL). O699 is calling O9699 in which the test routine is set.

Therefore, the following preparations are necessary:

- The pneumatic unit must be connected, the pollution protectors must be mounted.
- The variable VC129=x (x=1..7) must be set in programme O9670 (USERSTARTPROG). The associated O967x (USERPARATABx) must contain valid values for the variables VC170 .. VC178.
- The laser system must be swivelled in the working area, if necessary. The corresponding command can be integrated into the programme O9670 (USERSTARTPROG).
- The LED´s at the receiver must be observed. If this is not possible, a mirror can be used.
- When testing, the Z-axis is moving a measuring block with a slow feed rate about 0.999 mm (0.999 inch respectively) towards Z-. Collision should be avoided in the traversing area. The measuring block will be stopped by interrupting the light route

During the programme run, the following topics will be checked:

- Verification of the output and input signals of the laser measuring system and the pneumatic unit. Incorrect data in O967x (USERPARATABx) regarding the input and output signals and the wiring errors will be recognized. (Attention: The adjustment of the operation pressure for the barrier air and the outlet at the bypass valve must be checked separately).
- Correct function of the measuring input (by a measuring block). A wiring error or a wrong signal evaluation of the measuring input will be recognized.
- Correct installation of the language files (by an error message). At the end of a programme, the error message "E0 Language Version V5xx" will be given.

During the programme sequence, the diagnostic messages will be displayed as comments (...). The programme awaits the key <NC-Start> actuated by the operator.
The measuring cycles may not be used until this programme was finished free from error.

NOTICE

O9699 (T_SIGNAL) is NOT working with IF70!

3.4.2 O9698 (S_RUNOUT) / determination of run-out error and axial run-out error

The programme O698 (S_RUNOUT) determines the run-out error and axial run-out error of the reference tool at the current spindle speed. The determined values will be sent for diagnostic reasons in the common variables VC40..VC45.

Therefore, the following preparations are necessary:

- Carry out machine-specific adaptations in the auxiliary programme O967x (USERPARATABx).
- Clean reference tool carefully, insert into the spindle and register the correct tool data in the auxiliary programme O967x (USERPARATABx) in the variables VC126, VC127 and VC128. Change to operation "automatic" and start programme O698.
- Firstly, the calibration cycle O9601 "pulling" will be executed, i. e. the measurement dark → light (→ determination of the smallest length and the smallest radius) will be made. The calibration values will be saved in the common variables VC40..VC45.
- Afterwards, the calibration cycle O9601 "pressing" is going to be executed, i.e. the measurement light → dark will follow. (→ Determination of the largest length and the largest radius). The calibration values will be saved in the common variables VC[VC140+0]..VC[VC140+9].
- The difference of VC40/VC[VC140+0] or VC41/VC[VC140+1] results in axial run-out error (→VC46) and the deviation (→VC47).
- The difference of VC42/VC[VC140+2] or VC43/VC[VC140+3] results in the run-out error (→ VC48) and the deviation (→ VC49).
- The axial run-out error and run-out error, as well as the deviation of the measuring values, will be monitored in compliance with the limit values (0.02 mm/0.0008inch).

Subsequently, VC127 in O967x (USERPARATABx) (or maybe in the tool data) must be adapted by half of the run-out error and an usual calibration has to be done with the updated data of the reference tool.

3.4.3 OEDLA (ERROR DIAGNOSIS) / generate in case of error the file “BLUMDIAGNOSIS.CVS”, were are stored all the used variables values.

In case of error, this programme generate in MDI folder the BLUMDIAGNOSIS.CSV file. In this file are written all the used common variables values and calibration results continually. After the values, the date and hour of the storing are written.

Therefore, the following preparations are necessary:

- Set the CALL OEDLA in the programme O9679(USERENDPROG) line N6+1.

NOTICE

Facilitate BLUMDIAGNOSIS.CVS file to the Blum technical service in case of need assistance.
Due to the continuous stored process the available control memory could be reduced; delete the file if is needed.

3.4.4 OGRxx (DISPLAY GAUGING RESULTS yy) / print in Gauging Result Screen measuring results

This programme prints different measuring results in the Gauging Result Screen. Were xx=VC180 (Language code for NC error messages) and yy=language name in English.
Standard: xx=0 , yy=ENGLISH

Therefore, the following preparations are necessary:

- Set the CALL OGRxx in the programme O9679(USERENDPROG) line N998.

3.5 Programme overview

Main programme or example application

O601	Main programme 2-axes calibration (length and radius)
O602	Main programme length measurement of centric tools (drills)
O603	Main programme length and radius measurement of non-centric tools (mills)
O604	Main programme thermal 2-axes compensation (length and radius)
O605	Main programme single cutting edge monitoring on straight cutting edges
O606	Main programme length-, radius and cutting edge radius measurement
O607	Main programme contour monitoring on round cutting edges (ball nose mills)
O608	Main programme tool breakage detection (shaft breakage)
O685	Main programme fast single cutting edge monitoring
O688	Main programme fast tool breakage detection (shaft breakage)

Sub-routines

O9601	Sub-routine 2-axes calibration (length and radius)
O9602	Sub-routine length measurement of centric tools (drills)
O9603	Sub-routine length and radius measurement of non-centric tools (mills)
O9604	Sub-routine thermal 2-axes temperature compensation (length and radius)
O9605	Sub-routine single cutting edge monitoring on straight cutting edges
O9606	Sub-routine length-, radius and cutting edge radius measurement
O9607	Sub-routine contour monitoring on round cutting edges (ball nose mills)
O9608	Sub-routine tool breakage detection (shaft breakage)
O9685	Sub-routine fast single cutting edge monitoring
O9688	Sub-routine fast tool breakage detection (shaft breakage)

User-specific auxiliary programmes

O9670	Preliminary actions, approach strategy, skip axes limit switch
O9671... O9677	Machine-specific definitions, axes attribution, basic settings, configuration for calibrating programme
O9678	Setting of zero point offset
O9679	Final operations, retracting strategy, error strategy, tool change

General auxiliary programmes

O9639	Positioning motions towards the laser, retracting from the laser
O9637	Verification of the variables of O967x
O9636	Definition of the measuring direction, call by O9606, O9607, O9626, O9629
O9642	Arc with 2 axes (at VC133 ≠ 0 also 3 axes)
O9634	Laser on / off and further actions
O9632	Measuring block with check for position behind software limit switch
O9646	Calculation of arc from measuring values with LeasSquareFit, call by O9606, O9626
O9630	Conversion of reference value from O967x (USERPARATABx) and safety checks
O9640	Positioning of one axis with verification of position behind the software limit switch and maybe tool axis (at VC133 ≠ 0 also 2 axes)
O9641	Interpolating positioning of two axes with verification of position behind the software limit switch and maybe tool axis (at VC133 ≠ 0 also 3 axes)
O9643	Interpolating positioning of three axes without verification of software limit switch and tool axis.
O9644	read/send spindle function
O9650 ... O9669	Edits error messages in different languages: CZ=czech, DK=danish, FR=french, GR=german, IT=italian, PL=polish, PO=portuguese, NL=dutch, SP=spanish, SW=swedish, UK=english
O9633	Reading and writing of tool data

Following programmes must always be loaded:
O9639, O9634, O9632, O9630, O9640, O9644, O9650 .. O9669 (one language), O9633, O9679, O967x (at least one configuration), O9670

Following programmes will be needed for calibration:
O9601, O9637 (additionally at NT-H1 or NT-H6: O9691)

Following programmes will be needed for tool control:
O9605, O9607, O9608, O9636, O9642, O9641

Following programmes will be needed for tool measurement:
O9602, O9603, O9606, O9636, O9646 (additionally at NT-H6: modified O9602, O9692)

Following programmes will be needed for temperature compensation:
O9604, O9678 (additionally at NT-H: O9694)

Following programmes will be needed for faster tool control:
O9685, O9688, O9643

3.6 Used call parameter

The cycles use the following call parameter (also see programming instruction):

Standard mounting:
O9601 PH=.. PD=.. PA=.. PR=.. PZ=.. PX=..
O9602 PH=.. PD=.. PB=.. PS=.. PW=.. PA=.. PR=.., maybe additionally PX=.. PI=..
O9603 PH=.. PD=.. PB=.. PE=.. PM=.. PZ=.. PX=.. PS=.. PT=.. PC=.. PQ=.. PW=.. PU=.. PA=.. PR=..
O9604 PH=.. PD=.. PB=.. PA=.. PR=.. PZ=.. PX=.. PS=.. PT=..
O9605 PH=.. PD=.. PC=.. PQ=.. PZ=.. PV=.. PA=.. PF=..
O9606 PH=.. PD=.. PB=.. PI=.. PK=.. PC=.. PM=.. PJ=.. PX=.. PZ=.. PQ=.. PS=.. PT=.. PW=.. PU=.. PA=.. PR=..
O9607 PH=.. PD=.. PC=.. PQ=.. PX=.. PI=.. PJ=.. PK=.. PV=.. PF=.. PM=..
O9608 PH=.. PD=.. PX=.. PM=.. PQ=.. PW=..
O9685 PH=.. PD=.. PC=.. PQ=.. PZ=.. PV=.. PA=.. PF=.. PB=..
O9688 PH=.. PD=.. PX=.. PM=.. PQ=.. PW=.. PB=..

Auxiliary programmes:
O9639 PM=..
O9637
O9636 PM=..
O9642 PR=.. PF=.. PM=..
O9634 PM=..
O9632 PA=.. PF=.. PB=.. PC=..
O9646 PM=.. PR=.. PX=.. PZ=..
O9630 PM=..
O9640 PA=.. PF=.. PM=..
O9641 PF=.. PM=..
O9643 PF=.. PM=..
O9644 PM=.. PS=..
O9650 .. O9669
O6633 PM=..
O9679
O967x (PM=..)
O9678 PB=.. PS=.. PT=..
O9670
OEDLA
OGRxx

Auxiliary programmes for Laser NT-H / NT-H6:
O9691 PZ=..
O9692
O9694 PB=.. PZ=.. PT=..

Functional expansion -EA (boring tool):
O9609 PH=.. PD=.. PB=.. PQ=.. PE=.. PM=.. PS=.. PT=.. PW=.. PU=.. PA=.. PR=..

Functional expansion -EB (diagonal mounting):
O9611 PH=.. PD=.. PA=.. PR=.. PZ=.. PX=..
O9615 PH=.. PD=.. PC=.. PQ=.. PZ=.. PV=.. PA=.. PF=..
O9618 PH=.. PD=.. PX=.. PM=.. PQ=.. PW=..

Functional expansion -ED (turning tools/lathes):
O9621 PH=.. PD=.. PA=.. PR=.. PZ=.. PX=..
O9624 PH=.. PD=.. PB=.. PA=.. PR=.. PZ=.. PX=.. PS=.. PT=..
O9626 PH=.. PD=.. PB=.. PI=.. PK=.. PC=.. PM=.. PQ=.. PS=.. PT=.. PW=.. PU=.. PA=.. PR=..
O9629 PH=.. PD=.. PB=.. PQ=.. PR=.. PM=.. PS=.. PT=.. PW=.. PU=..

Functional expansion -EH6 (highly accurate length measurement):
O9602 PH=.. PD=.. PB=.. PS=.. PW=.. PA=.. PR=.. PX=.. PI=.. PJ=..

Functional expansion -EK (control KIG-milling tool):
O9605 PH=.. PD=.. PC=.. PQ=.. PZ=.. PV=.. PA=.. PF=.. PI=..

Functional expansion -ES (spindle orientation):
O9686 PH=.. PD=.. PZ=.. PX=.. PC=..

3.7 List of common variables

Common variables, which have to be defined in O9670 (USERSTARTPROG):

VC129	Choose between O9671 (USERPARATAB) (=1) ... O9677 (USERPARATAB) (=7)

Common variables, which have to be defined in O967x (USERPARATABx):

VC101, 1 digit	Axis number for tool radius measurement
VC101, 10 digits	Axis number of laser beam axis
VC101, 100 digits	Axis number for tool length measurement
VC102	Side of approach in the length axis (+1 or -1)
VC103	Side of approach in the radius axis (+2,+1 or –1, –2)
VC104	Measuring position of the axis for tool radius measurement
VC105	Measuring position of the laser axis (position between transmitter and receiver)
VC106	Measuring position of the axis for tool length measurement
VC107	Distance between laser beam and interfering contour in tool radius axis
VC108	Distance between laser beam and interfering contours in laser beam axis
VC109	Distance between laser beam and interference contour in tool length axis
VC110	Maximum tool length
VC111	Minimum tool length
VC112	Maximum tool radius
VC113	reserved
VC114	Tool length offset (option for post processor applications)
VC115	Tool radius offset (option for post processor applications)
VC116	Real length of “zero tool”
VC117	Rapid speed
VC118	Positioning speed
VC119	Maximum measuring speed
VC120	Retraction level in the tool length axis prior measuring cycle
VC121	Retraction level in the tool length axis after measuring cycle
VC122	Distance before tool edge
VC123	Retracting travel after first measuring block
VC124	Retracting travel after second measuring block
VC125	Retracting travel after the following measuring blocks
VC126	Length of reference tool (L+H) or measured length for diagnosis
VC127	Radius of reference tool (R) or measured radius for diagnosis
VC128	Height of reference tool (H) or measured 2nd radius for diagnosis
VC130	Measuring speed1
VC131	Measuring speed2
VC132	Pulse time of “Output DYNAMIC” of the laser system
VC133	Basic speed of laser system for MODE0
VC134	Basic speed of laser system for MODE1
VC135	Basic speed of laser system for MODE2
VC136	Basic speed of laser system for MODE3
VC138	Type of reference tool (type 0, type 1, type 2), performing radial measurements of the reference tool one-sided/both-sided or measuring mode for diagnosis
VC139	Measuring direction for calibration and temperature compensation measurement

Common variables, which have to be defined in O967x (USERPARATABx):

VC140	Basic address for calibration parameter block
VC141	Number of trials (2, .., 10)
VC142	Feed rate at the end of cycle
VC150	Positive software limit switch of the tool length axis
VC151	Negative software limit switch of the tool length axis
VC152	Positive software limit switch of the tool radius axis
VC153	Negative software limit switch of the tool radius axis
VC154	Option bits for laser system
VC155	Option bits for measuring cycles
VC156	Option bits for temperature compensation, allocation of tool correction
VC157	Option bits (reserved)
VC162	Angle deviation laser beam to tool length axis
VC163	Angle deviation laser beam to tool radius axis
VC170	Number of PLC output for signal "ENABLE0" or M-Code
VC171	Number of PLC output for signal "ENABLE1" or M-Code
VC172	Number of PLC output for signal "Valve Shutter" or M-Code
VC173	Number of PLC output for signal "Valve barrier air" or M-Code
VC174	Number of PLC output for signal "ENABLE2" or M-Code
VC175	Number of PLC output for signal "Valve tool cleaning nozzle" or M-Code
VC176	Number of PLC input for signal "LASER OK"
VC177	Number of PLC input for signal "DYNAMIC"
VC178	Number of PLC input for signal "STATIC"
VC180	Language code for NC error messages
VC181	Definition of mode of nozzle usage
VC182	Distance between laser beam and interfering contour in front of laser beam in tool radius axis
VC200	SSU unit connector used for "DYNAMIC" input signal

Common variables, which are automatically set by the program:

VC77	Parameter to enable the sensor
VC78	Parameter to check the sensor status
VC100	Error text number, 0=no error
VC137	Current programme number (1..29,81..89.99)
VC[VC140+0]	1st calibrating value of tool length axis (front edge)
VC[VC140+1]	2nd calibrating value of tool length axis (rear edge)
VC[VC140+2]	1st calibrating value of tool radius axis (standard side)
VC[VC140+3]	2nd calibrating value of tool radius axis (option side)
VC[VC140+4]	Mean value of calibrating values in tool length axis
VC[VC140+5]	Mean value of calibrating values in tool radius axis
VC[VC140+6]	TC-reference value in tool length axis
VC[VC140+7]	TC-reference value in tool radius axis
VC[VC140+8]	Angle ≙ VC162
VC[VC140+9]	Angle ≙ VC163 / position laser axis (≙VC105)
VC143	Spindle rpm and rotation direction at programme call
VC144	Scaling factor, depending on unit system of the machine 1=mm, 25.4=inch
VC145	Tool offset code=H*1000+D*1
VC146	Length (drilling or milling tool) or length L1 (turning tool)
VC147	Length wear (drilling / milling tool) or wear L1 (turning tool)
VC148	Radius
VC149	Wear radius
VC158	Tool length L2 (turning tool)
VC159	Wear L2 (turning tool)
VC161	Tool cutting edge position
VC164	Radius position in tool coordinates
VC165	Laser position in tool coordinates
VC166	Length position in tool coordinates
VC168	Trigger-point of measuring axis
VC169	Active tool length for internal calculation of position
VC185..VC192	Internal variables (e.g. for circle calculation)
VC193	Counter for temperature compensation values (option)
VC194	1st temperature compensation value of tool length axis (Option)
VC195	1st temperature compensation value of tool radius axis (Option)
VC196	2nd temperature compensation value of tool length axis (Option)
VC197	2nd temperature compensation value of tool radius axis (Option)
VC198	3rd temperature compensation value of tool length axis (Option)
VC199	3rd temperature compensation value of tool radius axis (Option)

Common variables, which have to be defined in O967x (USERPARATAB)
(Only at measurement with angle head not equal to 0°)

VC70	Distance in radius direction from laser beam to positioning of the swivel axis
VC71	Transformation angle
VC72	Angle of swivel head after measurement
VC73	Angle of swivel head to measurement
VC74	Head kinematics radius axis
VC75	Head kinematics laser axis
VC76	Head kinematics length axis
VC79	Axis number of swivel head

4. Service

focus on productivity

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