



## M-SHAFT Shaft Controller

Cyclically recurring production sequences mostly includes several associated motion axes. These actuators are operated here in a precisely defined sequence. Mechanical cams were previously used for synchronization tasks. M-SHAFT makes it possible to create a virtual form of this rigid coupling. The production of an individual workpiece corresponds here to a rotation of the virtual shaft. The positioning of the individual motion axes is linked to this rotation. This transformation of the motion sequence from a time base to a rotation angle base offers an essential benefit: Even with a varying production speed, the set motion sequence is always performed automatically. The tedious work involved in manually changing the motion profiles thus becomes a thing of the past.

Item	Item-No.
M-SHAFT Download	00017168-90
M-SHAFT RT	00017168-63

- Software module for coordinating cyclically recurring motion sequences
- A shaft controller synchronizes up to 32 motion axes
- Position profile is set individually for each axis
- Production speed (speed of the shaft controller) can be changed during operation
- Configuration and diagnostic via the SolutionCenter
- Commissioning user interface (SHAFT-Monitor)
- Library for IEC 61131-3 PLC programs

The screenshot displays the SolutionCenter software interface. The main window shows a PLC program editor with the following code:

```

27 (* constantes *)
28 VAR CONSTANT
29 END_VAR
30
31
32 (* call the PGU's *)
33
34 IF ( NOT g_bo_init_OK ) THEN
35 (* program init *)
36   prg_Init();
37 ELSE
38 (* check if the axis are O.K. *)
39   prg_SftCheckReadyForOperation();
40
41 (* if the number of axis > 0 *)

```

The right side of the interface shows a graph titled 'production' with the following data series:

shaft angle [°]	displacement [mm]
0	0
50	80
100	60
150	20
200	80
250	40
300	0
350	140

The 'Profile parameter' dialog box is open, showing the following data:

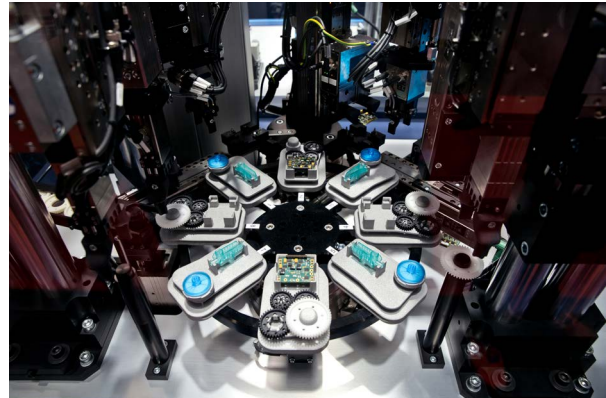
Step	Pos. [mm]	Movement
40	80.0	Linear
40	80.0	Sinus²
60	80.0	Sinusoide
80	80.0	Mod. Sinus
		Restriehern
		Poly 6. Dgr
		Trapezoid
		Time

The bottom right of the interface shows a file tree with the following structure:

- Solution
  - My Templates
  - Press\_at75 [10.04.01.32]
    - Online Device (TCP)
      - /ctc0 (Boot device)
      - /flash0
      - /nvram0
      - /nvram1
      - /ram0
    - Offline Device

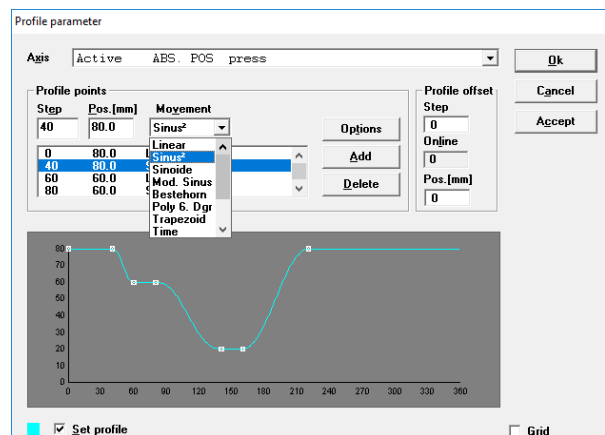
### Synchronized motion sequence despite changing production speed

A virtual shaft is the core of M-SHAFT. It rotates precisely 360° for the production of a workpiece. All the associated motion axes therefore complete their set profile exactly once during this cycle. Attaching these profiles relatively to the shaft position offers an inherently key benefit: The sequence maintains even with a changing production speed. Higher quantities per time unit automatically lead to axes motion in shorter time frames. Thus, even complex applications can be designed and implemented in shortest possible time.



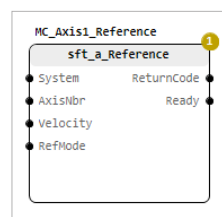
### Motion paths individually designed

Characteristic positions of the individual axes are defined by means of individual support locations distributed over the 360°. M-SHAFT interpolates between these points and forms a continuous motion path. The provided interpolation types make it possible to focus on high production performance or keeping any jerks to a minimum. The system can also be automatically optimized to maximum production speed. Therefore, M-SHAFT Table Interpreter calculates the optimum distribution of the defined support locations over the 360° and relieves engineers of this task.

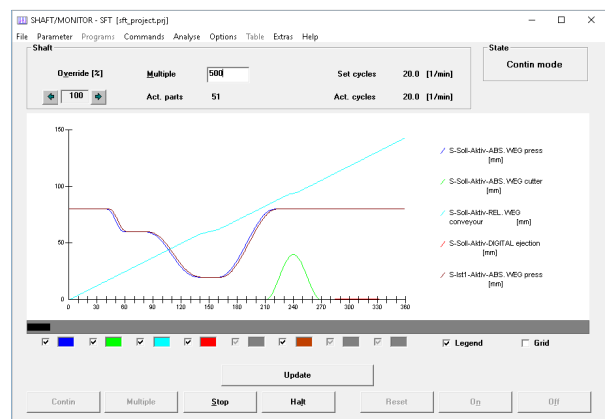


### Creating applications easily

A high-level sequence program mostly takes over the coordination of M-SHAFT and the loading and removal systems. M-SHAFT is integrated directly in this application via the IEC 61131-3 library. This enables starting a plant up to required production speed from one central location.



The »SHAFT Monitor« commissioning user interface enables the complete parameter assignment and manual operation of the M-SHAFT. Highly dynamic processes are recorded directly on the controller by the Scope 3 software oscilloscope and fully visualized on the PC. In this way, a complete overview is always ensured. This not only shortens the time required for the initial commissioning, but also enables fast troubleshooting during operation.



M-SHAFT	
General	
Controller representation	Software module on the M1 controller
Configuration	SolutionCenter
Parameterization	SHAFT-Monitor
Operation	SHAFT-Monitor, Application integration via library for IEC 61131-3
Product Features	
Number of available axes	32 axes per M-SHAFT module
Number of M-SHAFT modules on one M1 controller	No limit Multiple instances can be linked as master/slave systems
Sampling time	100 µs to 5 ms
General Functions	
Shaft structure	One shaft rotation is divided into 360 support locations. The set position of the linked axes is defined at these points.
Operating modes of the shaft	<ul style="list-style-type: none"> <li>• Multiple: Production of a specified number of parts</li> <li>• Continuous: Production of an unlimited number of parts</li> <li>• Handwheel: Setting of the shaft position via a handwheel</li> </ul>
Shaft start	Different interpolation types are provided for the approach to the set speed.
Shaft stop	The shaft stops: <ul style="list-style-type: none"> <li>• After reaching the specified number of parts</li> <li>• At a set rotation angle in degrees</li> <li>• Directly on the Stop command</li> </ul>
Available axis types	<ul style="list-style-type: none"> <li>• Absolute position axes (e.g. cam discs)</li> <li>• Relative position axes (also continuous axes, e.g. conveyor belt, feeds)</li> <li>• Analog axes (e.g. proportional valves)</li> <li>• Digital axes (e.g. switch cams)</li> </ul>
Profile definition of the individual axes	360 support locations are provided for defining the set profile. Extensive interpolation methods connect these support points.
Axis coupling to the shaft	<ul style="list-style-type: none"> <li>• The coupling is based on the profile setting by means of the support locations</li> <li>• A gear ratio can be selected for each axis</li> <li>• Start and stop of the individual axes possible during operation</li> </ul>
Parameter of the axes	Characteristic parameters such as maximum speed, acceleration and travel path are defined for each axis.
Position setting and control	Depending on the motion axis M-SHAFT performs various tasks: <ul style="list-style-type: none"> <li>• M-SHAFT performs the calculation of the set position and set speed including closed-loop control</li> <li>• M-SHAFT performs the calculation of the set position and set speed, the closed-loop control is carried out in the drive</li> </ul>
Controller structure	PID controller with feed forward control as <ul style="list-style-type: none"> <li>• Velocity controller</li> <li>• Position controller with / without minor velocity controller</li> </ul>
Referencing of the axes	Various methods are available depending on the drive, sensor and encoder used.
Monitoring of the movement range	Checking of the actual axis position in relation to the defined travel range
Blocking range definition for reset drives	In a reset drive, all axes are moved to an initial position. With rotary tables, the blocking range allows the definition of the collision-free rotation direction to the initial position.
Monitoring of the drag errors	Checks whether the motion axis actually follows its set value
Diagnostics	<ul style="list-style-type: none"> <li>• SHAFT-Monitor commissioning user interface</li> <li>• Software oscilloscope Scope 3</li> </ul>

M-SHAFT		
<b>Special Functions</b>		
Profile lowering / -raising	The position profile of an axis can either be raised or lowered at specific points or overall.	
Profile shift	The entire position profile of an axis can be shifted by a required angle of the shaft.	
Matching set and actual position	A correction between position set value and actual value of a relative axis can be triggered in a defined rotational window by an initiator.	
Variable duty cycle	Some motors must be operated at the rated speed. If the speed of the shaft is reduced, the drive continues to run at the rated speed, however the switch off time is selected variably by M-SHAFT as required.	
Actuation of external devices	For triggering external devices, an output is switched at a defined rotation angle of the shaft.	
Synchronization with external systems	The shaft is stopped at a specific rotation angle. If the synchronization signal reaches the defined level, the shaft continues rotating.	
Additional function using CNC commands	This is used for example to query end position switches, if the shaft is stopped for a defined period or if a specific table section is repeated several times.	
Optimization of the motion profile	With this approach all individual axis set positions are set at several identical support locations. The M-SHAFT Table Interpreter calculates the minimum achievable travel speed of all axes between these support locations. As a result it optimally distributes the support locations over the 360°. In this way the maximum possible shaft speed is achieved.	
<b>Drive Interface</b>		
Analog	Via Bachmann hardware modules (e.g. ISI222, GIO212)	
Fieldbus	By means of DriveMiddleware or another user-specific drive integration	
<b>Position Detection</b>		
By M1 via rotary encoder	The actual position is determined with Bachmann hardware modules (e.g. ISI222, CNT204).	
By the drive via rotary encoder	The actual position is determined in the drive and transferred to M-SHAFT via the fieldbus.	
<b>Software Interfaces</b>		
Process communication	Internal values are provided as SVI variables and are directly available for other applications or the visualization.	
Application interface	IEC 61131-3 library for parameter assignment, operation and diagnostics of the M-SHAFT software module	
<b>Installation</b>		
Installation medium for engineering PC	Installer, available by download	
License protection on the M1 controller	Hardware-dependent license file	
<b>System Requirements</b>		
Engineering PC	Microsoft Windows 7 or higher, hard disk 50 MB free memory M1 real-time system	
M1 real-time system	Bachmann M1 processor modules of the series MH, MC, MX; M-Base from V3.75R	

Order Codes M-SHAFT		
Item	Item-No.	Description
M-SHAFT Download	00017168-90	Software, PLC library, commissioning tool and user documentation for M-Shaft. Requires M-Base.
M-SHAFT RT	00017168-63	License file to operate the M-Shaft software module on a M1 controller