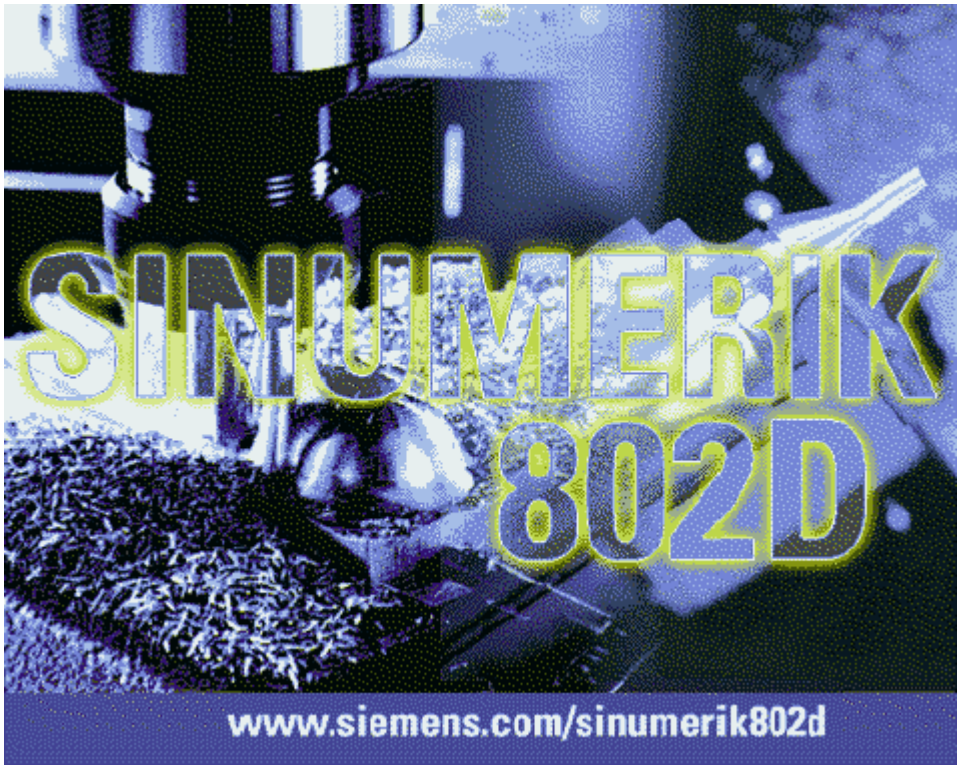
SIEMENS

Automation & Drives

Description of PLC Subroutine Library V01.06.00 for **SINUMERIK 802D**



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Change Log

V 01.05.00:

New functions

- Measuring in JOG mode
  (usable with Version SINUMERIK 802D SW 01.01.05 or higher)
  MEAS_JOG (SBR43) V1.0
  Needs: PLC_INI (SBR32) V1.4, MCP_NCK (SBR38) V1.4

- Tool Magazine
  MGZ_INI (SBR49) V1.0, MGZ_SRCH (SBR50) V1.0, MGZ_RNEW (SBR51) V1.0

Improvements

- Data exchange to PLC User Interface improved
  TURRET1 (SBR46) V1.4, EMG_STOP (SBR33) V1.4 , MCP_NCK (SBR38) V1.4

- Signal names have been changed :
  V10000004.0 ... V10000005.6 from CK0 ... CK5 to CK1 ... CK6 now.
  V16002000.3 from EMG_STOP to EMGY_STOP

- Functionality of spindle keys has been changed. The trigger mode of CCW and CW keys can choose with MD 14512[19] Bit0 (momentary or continuous).
  MCP_802D (SBR34) V1.4

V 01.06.00:

Improvements

- Signal names have been changed :
  V10000001.0 and V11000001.0 from not used to CONTINUOUSLY (CONT) now.
  MCP_802D(SBR34)

- M133.5 is continuously traversing and M133.6 most significant Bit of INC buffer now.
  MCP_802D(SBR34) V1.5, MCP_SIMU(SBR37) V1.4, MCP_NCK(SBR38) V1.5

1. General Description

SINUMERIK 802D is a compact numerical control system with profibusdrive interface,Idaelly suited for turning and milling machines.

To adapt the SINUMERIK 802D to machine tools, machine control logic must be designed with the *PLC Programming Tool. The tool used is PLC 802* Version 3.0 or higher, The PLC tool contains STEP7-Micro / WIN32 V3.0 programming language..

This document describes the PLC Subroutine Library V01.05.00 & is designed for Machine Tool Builders who have basic knowledge of CNC and PLC functioning & programming.

Please, refer to following documents for more detailed information on 802D :

- *SINUMERIK 802D Start-up and installation Guide*
- *SINUMERIK 802D Function description*
- *611U planning guide*

1.1.Purpose of the library PLC application programs

To acquaint the users with PLC programming tool, 4 PLC projects are provided in the Internet site: http://www.siemens.com/sinumerik802d.

SUBR_LIBRARY.PTP	Library program with all subroutines provided and an empty main program (OB1)
SIMULATION.PTP	Simulation program
SAMPLE_TURN.PTP	Sample program for turning (lathe) machine
SAMPLE_MILL.PTP	Sample program for milling machine

In project file SUBR_LIBRARY.PTP a variety of subroutines are provided for basic functions such as emergency stop control, axes control, coolant control, lubrication control and turret control for turning machines.

The project SIMULATION.PTP is an application PLC program for testing your 802D without Machine control panel. The other 2 project files can be used as samples to show how to make use of the subroutines in the project file SUBR_LIBRARY.PTP for turning or milling machines.

Customers can just download the project files from the Internet and read these samples to understand how a subroutine is programmed and how the subroutine is called. These files can be saved (SUBR_LIBRARY.PTP) in a new project.By organizing the subroutines, modifying or adding the necessary networks most of the machine tool requirements can be met or addressed.

Just download your PLC application program into SINUMERIK802D and test it until all the functions work.

1.2. Pre-condition

The subroutine library and the sample PLC application programs are designed for standard axis configurations. By downloading one of the initialization files from toolbox (path: \Data\Setup), the standard axis configurations can be completed. The file **SETUP_T.INI** is for turning machine and file **SETUP_M.INI** is for milling machine.

By downloading the configuration file **SETUP_T.INI** from toolbox, the axes configuration can be changed to a **turning machine** with 2 feed axes and 1 spindle.

Axis number	Axis Name	Axis interface address
1st axis	X1	V3800 xxxx
2nd axis	Z1	V3801 xxxx
3rd axis	SP	V3802 xxxx

By downloading the configuration file **SETUP_M.INI** from toolbox, the axes configuration can be changed to a **milling machine** with 4 feed axes and one spindle:

Axis number	Axis Name	Axis interface address
1st axis	X1	V3800 xxxx
2nd axis	Y1	V3801 xxxx
3rd axis	Z1	V3802 xxxx
4th axis	SP	V3803 xxxx
5th axis	A1	V3804 xxxx

To understand the subroutines in the library, the following preconditions must be taken into consideration.

1.2.1. Division of the System Resources

The system resources can be divided into 3 parts. They are PLC system, NCK, and PLC programming tool. In this chapter, these available resources are listed and further, divided & described into resources for sample program and resources free for user.

1.2.2. Resources

1.2.2.1. Resource of **PLC**

Inputs:	I0.0 … I8.7 (72 inputs on 1st PP module with address 9)
	I9.0 … I17.7 (72 inputs on 2nd PP module with address 8)
Outputs:	Q0.0 … Q5.7 (48 outputs on 1st PP module)
	Q6.0 … Q11.7 (48 outputs on 2nd PP module)
Global Memory:	M0.0 … M255.7
Retentive Memory:	V14000000.0 … V14000127.7 (128 bytes)
User Alarm:	V16000000.0 … V16000003.7 (32 user alarms)
Timers:	T0 … T15 (16x100ms timers),
	T16 … T31 (16x10ms timers)
Counters:	C0 … C31 (32 counters)

1.2.2.2. Resource of **NC**

PLC Machine Data: MD14510 / MD14512 / MD14514

MD14510 User Data INT: V45000000 … V45000062 (32 words)
MD14512 User Data HEX: V45001000 … V45001032 (32 bytes)
MD14514 User Data Real: V45002000 … V45002028 (8 Dword)

1.2.2.3. Resource of Programming Tool

Symbol tables: SYM1 … SYM32
Subroutines: SBR0 … SBR63

1.2.3. Resource free for customers

1.2.3.1. **Resource of PLC**

Inputs: I0.0 … I17.7 (144 inputs)
Outputs: Q0.0 … Q11.7 (96 outputs)
Global Memory: M0.0 … M127.7
Retentive Memory: V14000000.0 … V14000063.7 (64 bytes)
User Alarm: V16000000.0 … V16000001.7 (16 user alarms)
Timers: T0 … T15 (16x100ms timers)
T16 … T23 (8x10ms timers)
Counters: C0 … C23 (24x counters)

Resource of NC

PLC Machine Data: MD14510 / MD14512 / MD14514

MD14510 User Data INT: V45000000 … V45000030 (16 words)
MD14512 User Data HEX: V45001000 … V45001015 (16 bytes)
MD14514 User Data Real: V45002000 … V45002028 (8 Dword)

Resource of Programming Tool

Symbol tables: SYM1 … SYM15 (15 symbol tables)
Subroutines: SBR0 … SBR31 (32 subroutines)

1.2.3.2. Resource reserved for sample programs

Resource of PLC

Inputs: -
Outputs: -
Global Memory: M128.0 … M255.7
Retentive Memory: V14000064.0 … V14000127.7 (64 bytes) (for machining center, V14000000.0 to V14000040.7 are reserved)
User Alarm: V16000002.0 … V16000003.7 (16 user alarms)
Timers: no 100ms timers reserved
T16 … T31 (16x10ms timers)
Counters: C24 … C31 (8x counters)

Resource of NC

PLC Machine Data: MD14510 / MD14512 / MD14514
MD14510 User Data INT: V45000032 … V45000062 (16 words)
MD14512 User Data HEX: V45001016 … V45001031 (16 bytes)
MD14514 User Data Real: no

Resource of Programming Tool

Symbol tables: SYM16 … SYM32 (17 symbol tables)
Subroutines: SBR32 … SBR63 (32 subroutines)

1.3. Arrangement of symbol table

SYM	Name	Content of the symbol table
1	PP_1	I/O of PP module 1 will be defined by customers
2	PP_2	I/O of PP module 2 will be defined by customers
3 ~ 15		Reserved for customer
16	IS_MCP	Interface signal from and/or to MCP
17	IS_HMI	Interface signal from and/or to HMI
18	IS_AUX	Interface signal of auxiliary function from NCK
19	IS_NCK	Interface signal from and/or to NCK
20	IS_CHA	Interface signal from and/or to CHANNEL
21	IS_AX1	Interface signal from and/or to AXIS 1
22	IS_AX2	Interface signal from and/or to AXIS 2
23	IS_AX3	Interface signal from and/or to AXIS 3
24	IS_AX4	Interface signal from and/or to AXIS 4
25	IS_AX5	Interface signal from and/or to AXIS 5
26	MD_PLC	PLC Machine Data for Siemens Subroutine
27	ALARM	User Alarms
28	NV_MEM	Retentive data area (None Volatile Memory)
29	SPC_MEM	Special Memory Bit
30	SBR_MEM	Definition of Memory for library PLC application program
31 ~ 32		Reserved for library PLC application program

1.4. Arrangement of subroutine library

SBR	Name	Subroutine description
0 ~ 30	-	Free for customer application
31	**USR_INI**	Reserved for user initializing (called by SBR32 PLC_INI)
32	**PLC_INI**	Initialization of the control
33	**EMG_STOP**	Emergency Stop (including drive power on and power off sequence)
34	**MCP_802D**	Transfer I/O of 802D MCP to interfaceV1000xxxx and V1100xxxx
35	**SPD_OVR**	Spindle override code generator (gray code) to interface V1000 0008
36		Reserved
37	**MCP_SIMU**	Simulating override switches and acknowledging the active signals
38	**MCP_NCK**	MCP_HMI signal (from V1000 000x) to NCK
39	**HANDWHL**	Handwheel(s) for 3 axis (MCS and WCS) selected from PLC
40	**AXIS_CTL**	Enable control for 4 Feed Axis and spindle Control (hardware limit switch, and brake release if necessary)
41 ~ 42		Reserved
43	**MEAS_JOG**	Measuring in Jog
44	**COOLING**	Coolant control
45	**LUBRICAT**	Lubrication control (interval and time)
46	**TURRET1**	Turret control 1 (Hall effect device sensor turret with 4 or 6 position)
47	**TURRET2**	Turret control 2 (encoder sensor turret like SAUTER turret)
48	**TOOL_DIR**	Make out the direction of tool change
49	**MGZ_INI**	Initialization of holder table of tool magazine (max. 40 tools)
50	**MGZ_SRCH**	Search holder position of programmed tool from magazine
51	**MGZ_RNEW**	Refresh holder table
52 ~ 62		Reserved for library PLC application programs
63	**TOGGLE**	Toggle switch K1 ~ K6; Delay Switch K7, K8

1.5. MCP Interface Description (refer to Chapter 18.2.1 and 18.2.2 in Functional Description)

1000	Signals from MCP [w/r] Interface MCP to PLC							
Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
10000000	NC-STOP				Single block	Operating Mode JOG	MDA	AUTOM
10000001	NC-START	Spindle function Spindle CW	Spindle STOP	Spindle CCW	Protec-tion level 7	Machine function REF	REPOS	CONT
10000002	Feed START	STOP	Var. INC	Protec-tion level 4	INC1000	Machine function INC100	INC10	INC1
10000003	RESET	Protection level 6	5	E	D	Feed override C	B	A
10000004	Axis Traverse keys 4th Axis -	4th Axis +	Rapid overlay	CK5	Optional Customer keys (CK) CK4	CK3	CK2	CK1
10000005	free	CK6	3rd Axis -	3rd Axis +	Axis Traverse keys 2nd Axis -	2nd Axis +	1st Axis -	1st Axis +
10000006	free	Free customer free	free	free		Free customer keys free	free	free
10000007	free	Free customer keys free	free	free	free	free	free	free
10000008	“0”	“0”	“0”	Spindle Override E	D	C	B	A

1100	Signals to MCP [w/r] Interface MCP to PLC							
Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
11000000	NC-STOP				Single block	Operating Mode JOG	MDA	AUTOM
11000001	NC-START	Spindle function Spindle CW	Spindle STOP	Spindle CCW	free	Machine function REF	REPOS	CONT
11000002	Feed START	STOP	Var. INC	free	INC1000	Machine function INC100	INC10	INC1
11000003	free	free	free	free	free	free	free	free
11000004	Axis Traverse keys 4th Axis -	4th Axis +	Rapid overlay	Customer keys LED`s CLED5	CLED4	CLED3	CLED2	CLED1
11000005	free	CLED6	3rd Axis -	3rd Axis +	Axis Traverse keys 2nd Axis -	2nd Axis +	1st Axis -	1st Axis +
11000006	free	Free customer keys free	free	free		Free customer keys free	free	free
11000007	free	Free customer keys free	free	free	free	free	free	free

2. Assignment of the symbol tables

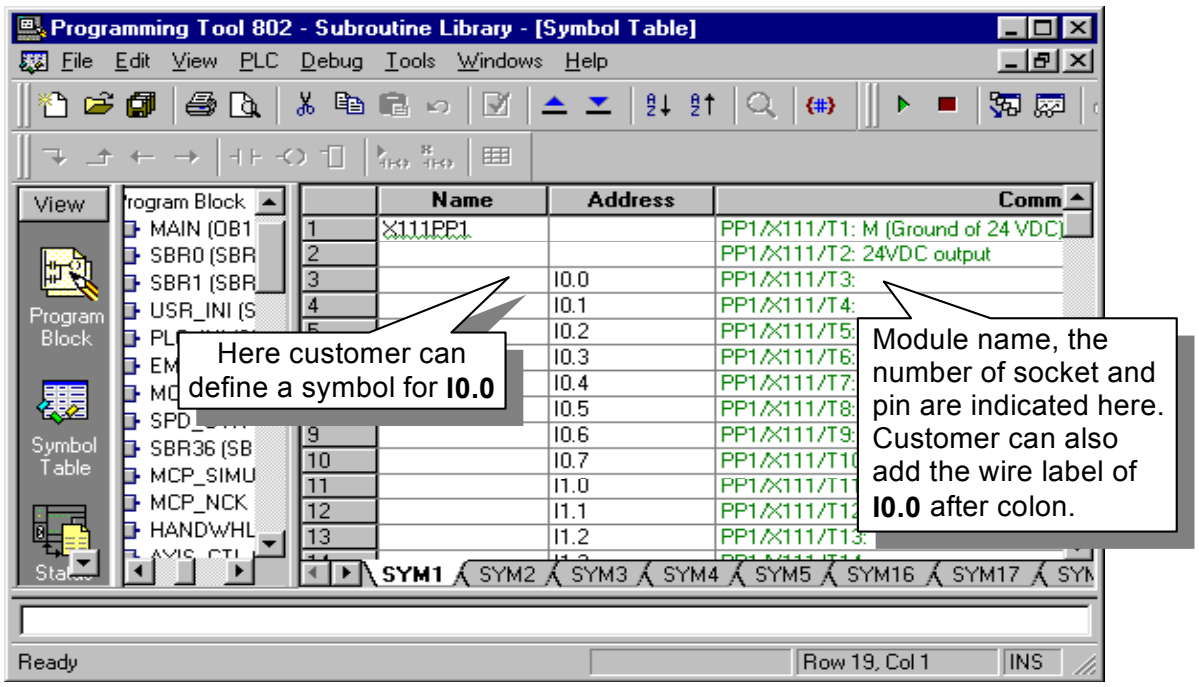
- List of Symbols used in the subroutine library obey the same convention:

1. Leading characters are for destinations:
   - P_ - to PLC interface
   - H_ - to HMI interface
   - N_ - to NCK interface
   - M_ - to MCP interface
2. subsequent characters are for areas:
   - C_ - Channel
   - 1_ - Axes
   - M_ - MCP

   Other short forms in the symbols:
   - HWL - Hardware Limit
   - HW - Handwheel
   - RT - Rapid Traverse
   - TK - Traverse Key
   - ACT - active
   - SEL - selected (activated)
3. Max. 11 upper case character to compose a symbol (include the leading character). No special characters such as =, +, -, [,] etc. are allowed except underscore.

2.1. Symbol table 1

For 1st PP module
With this symbol table, all the physical inputs and outputs of PP module can be defined by the customers according to their specific application.



2.2. Symbol table 2

For 2nd PP module
With this symbol table, all the physical inputs and outputs of PP module can be defined by the customers according to their specific application.

2.3. Symbol table 3 - Symbol table15

These symbol tables are reserved for the application programs of customers.

CAUTION

If the color of your symbol is changes automatically to RED, the symbol is not accepted the programming tool. Check if special character is used or if leading character is a digit.

CAUTION

If a waved underscore appears under your symbol, the symbol is duplicated. Check duplicate name or address.

2.4. Symbol table 16: IS_MCP

User Data Interface is defined and symbolized for MCP in this symbol table, i.e.

V1000 xxxx: Signals from MCP to PLC
V1100 xxxx: Signals to MCP

All main programs (OB1) and subroutines in the library PLC application programs access the signals from MCP which are symbolized here in this table.

The signals from MCP should be transferred to this interface signal area in a subroutine. In case 802D MCP is used, Subroutine 34 can be used to convey the signals from inputs / outputs of MCP to the interface. In a similar way, if a customer has his own MCP, he is only required to write a subroutine to transfer the signals from MCP to this User Data Interface. Then all the subroutines in the library are available for application.

2.5. Symbol table 17: IS_HMI

Interface Signals from and to HMI are symbolized in this symbol table, i.e.

V1700 0xxx: Signal from HMI – Program Control (retentive, read only)
V1900 0xxx: Signal from HMI – Simulation active (retentive read only)
V1900 1xxx: Signal from HMI – Handwheel selection (retentive read only)
V1900 5xxx: Signal to HMI – Operator key lock (retentive read/write)

2.6. Symbol table 18: IS_AUX

Interface Signals from NCK channel are listed in this symbol table, i.e.

V2500 0xxx: Signal from NCK channel – Auxiliary function (read only)
V2500 1xxx: Signal from NCK channel – decoded M functions (read only)
V2500 2xxx: Signal from NCK channel – T function transferred (read only)
V2500 3xxx: Signal from NCK channel – M function transferred (read only)
V2500 5xxx: Signal from NCK channel – D function transferred (read only)
V2500 6xxx: Signal from NCK channel – H function transferred (read only)

2.7. Symbol table 19: IS_NCK

Interface Signals to and from NCK are listed in this symbol table, i.e.

V2600 xxxx: General signal to NCK (read/write)
V2700 xxxx: General signal from NCK (read only)

2.8. Symbol table 20: IS_CHA

Interface Signals to and from NCK are listed in this symbol table, i.e.

V3000 xxxx: Mode signal to NCK (read/write)
V3100 xxxx: Mode signal from NCK (read only)
V3200 xxxx: Control signal to NCK (read/write)
V3300 xxxx: Control signal from NCK (read only)

2.9. Symbol table 21, 22, 23, 24, 25: IS_AX1, IS_AX2, IS_AX3, IS_AX4, IS_AX5

Interface Signals to and from NCK are listed in this symbol table, i.e.

V380x xxxx: Axis control signals to NCK (read/write)
V390x xxxx: Axis control signals from NCK (read only)

2.10. Symbol table 26: MD_PLC

PLC Machine Data from NCK are listed in this symbol table, i.e.

V4500 0xxx: reflected MD14510 USER_DATA_INT (read only)
V4500 1xxx: reflected MD14512 USER_DATA_HEX (read only)
V4500 2xxx: reflected MD14514 USER_DATA_FLOAT (read only)

There are 32 Machine Data in each area. The last 16 Machine Data of each area are reserved for the library PLC application program.

2.11. Symbol table 27: ALARM

Activating BIT of PLC Alarms of NCK (V1600 000x) are listed in this symbol table. There are 32 User Alarms which can be activated by PLC application. The last 16 alarms are reserved for the library PLC application program.

2.12. Symbol table 28: NV_MEM

There are 128 bytes in this retentive data area and the data used in the library are listed (V1400 xxxx). The last 64 bytes are reserved for the library PLC application program.

2.13. Symbol table 29: SPC_MEM

There are 7 special memory bits in 802D (SM0.0 … SM0.6).

2.14. Symbol table 30: SBR_MEM

All the memory used in the Subroutines Library are listed in this table. These are used as global variables for diagnosis purpose and arranged in the order of subroutines.

2.15. Symbol table 31 and 32: reserved for library program

3. Description of the subroutines library

The PLC machine data used for the subroutines in the library are listed here to have an overview:

USER_DATA_INT:

MD14510[16] - Machine type
0: not defined (Initializing according to MD14512[16])
1: Turning machine
2: Milling machine

MD14510[22] - Turret clamping time (unit: 0.01s)
MD14510[24] - Lubrication interval (unit: 1min)
MD14510[25] - Lubrication duration (unit: 0.01s)

USER_DATA_HEX:

MD14512[16] Axis configuration (in case MD14510[16]=0)
Bit 0 - 1st axis is configured.
Bit 1 - 2nd axis is configured
Bit 2 - 3rd axis is configured
Bit 3 - 4th axis is configured
Bit 4 - 5th axis is configured

MD14512[18] special configuration of the machine tool
Bit 0 - Spindle without override switch
Bit 1 - Drive Optimization
Bit 2 - Lubrication at first power on
Bit 3 - When 802D MCP used, User Key1 is Feed Enable toggle key
Bit 4 - External spindle stop signal
Bit 6 - Hardware limits independent from PLC
Bit 7 - Only one hardware limit switch for each axis (with Bit6=0)

MD14512[19] Bit 0 = 0 Spindle key CW and CCW work as momentary trigger mode
Bit 0 = 1 Spindle key CW and CCW work as continuous trigger mode

3.1. Subroutine 32 - PLC_INI (PLC Initializing)

3.1.1. Purpose of Subroutine 32

This subroutine is executed at the 1st PLC cycle to set some interface signals according to the configuration defined by PLC machine data. In this subroutine the following interface signals are set:

V32000006.7 - feed override active for NCK channel
V380x0001.5 - Measuring system 1 for the axes defined
V380x0001.7 - feed override active for the axes defined

And also the Machine Data MD14512[18] Bit0 will be evaluated in the program to determine whether the spindle override switch is installed.

At end of Subroutine 32, Subroutine 31: USR_INI is called. The initialization of customer PLC project should be programmed in this subroutine.

3.1.2. Local Variable Definition – no local variable defined

3.1.3. Global Memory occupied

24 bytes are defined in the retentive data area and are assigned in this subroutine with gray code values for applications of rotary gray code switches to select axis, operation mode etc. See symbol table SYM28 (NV_MEM), from VB14000101 ~ VB14000124.

3.1.4. Corresponding PLC Machine Data

One WORD PLC machine data is defined for the machine type.

MD14510[16] - Machine type
0: not defined (Initializing according to MD14512[16])
1:Turning machine
2: Milling machine

I.e. for turning machine the axes is configured as below:

1st axis	X axis
2nd axis	Z axis
3rd axis	Spindle

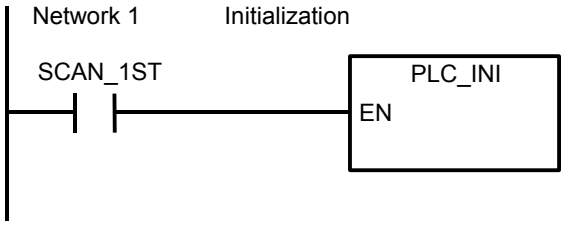
And for milling machine the axes is configured as below:

1st axis	X axis
2nd axis	Y axis
3rd axis	Z axis
4th axis	Spindle
5th axis	A axis

MD14512[16] Axis configuration (in case MD14510[16]=0)
Bit0 - 1st axis is configured.
Bit1 - 2nd axis is configured
Bit2 - 3rd axis is configured
Bit3 - 4th axis is configured
Bit4 - 5th axis is configured

MD14512[18] special configuration of the machine tool
Bit0 - Spindle without override switch

3.1.5. Sample of Subroutine Call



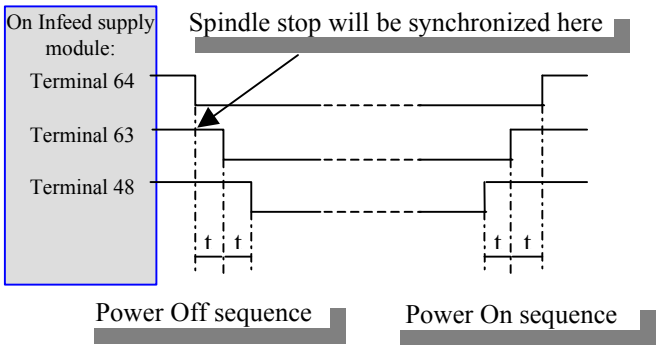
3.2. Subroutine 33 - EMG_STOP (Emergency Stop)

CAUTION

Please check whether this subroutine complies with all the relevant safety requirements.

3.2.1. Purpose of Subroutine 33

This subroutine handles the emergency stop sequence according to the timing diagram described in “Function Description”, as well as the power on and off sequence of the Supply Infeed module. For detailed information about Supply Infeed module please refer to 611U start-up guide.



The precondition of this subroutine is that the standard configuration of turning and milling machine are used. When the enable on the drive is off, i.e. when Terminal 64 is reset to zero, axes and spindle are braking to standstill. This subroutine evaluates a feedback signal from V390X0001.4 – $n<n_{min}$, or an external spindle stop signal (e.g. an analog spindle without encoder) according to MD14510[16].

MD14510[16]=0 means non standard configuration. In this case an external spindle stop signal (for example, zero speed signal from a frequency converter) must be connected to the subroutine to detect a spindle zero speed.

Drive Enable and Disable signal come from User Data area V1000 xxxx.

2 alarms may be activated from this subroutine:

Alarm 700016 – DRIVE NOT READY
Alarm 700017 – I^2/T ALARM FOR INFEED MODULE

Feed Stop to channel will be activated by any alarms from the subroutine library. The cancellation Feed Stop is RESET after alarm condition is cleared.

Important ! For machine tools with neither digital or analog spindle used, the PLC machine data should be specified like following table. Otherwise the emergency can not be released.

For turning machine	For milling machine
MD14510[16]=0 MD14512[16] Bit 0 = 1 Bit 1 = 1	MD14510[16]=0 MD14512[16] Bit 0 = 1 Bit 1 = 1 Bit 2 = 1

3.2.2. Local Variable Definition

Inputs:

DELAY	WORD	Power on / off sequence delay (Unit:10ms)
E_KEY	BOOL	Emergency Stop Key (NC)
T_72	BOOL	Terminal 72 of Infeed module: Drive ready (NO)
T_52	BOOL	Terminal 52 of Infeed module: I^2t monitoring (NO)
HWL_ON	BOOL	any of the hardware-limit switches is active (NO) [1)]
SpStop	BOOL	Spindle Stop (NO) [2)]

[1)] From subroutine 40 (AXIS_CTL) an output signal is set to "1" when any of the hardware limit switch active. The signal can be connected to this subroutine to trigger emergency stop in case of over limit.

[2)] By Emergency Stop, spindle standstill signal from NCK will be evaluated before disable the drive system to make sure that spindle can be stopped if PLC machine data MD14510[16] = 1 or 2 (i.e. by turning or milling machine tools). If MD14510[16]=0, this external signal will then be evaluated .

[3)] NO – Normal Open; NC – Normal Close

Outputs:

T_48	BOOL	To Terminal 48 of Infeed module: Contactor control
T_63	BOOL	To Terminal 63 of Infeed module: Pulse enable
T_64	BOOL	To Terminal 64 of Infeed module: Controller enable

3.2.3. Global Memory occupied

T_48m	M130.0	Status of Terminal 48 of the power module
T_63m	M130.1	Status of Terminal 63 of the power module
T_64m	M130.2	Status of Terminal 64 of the power module
D_T64m	M130.6	Delay for Terminal 64 before verify ready signal
SP_STOPm	M130.4	Spindle comes to standstill
PO_END	M130.7	Power Up procedure ended

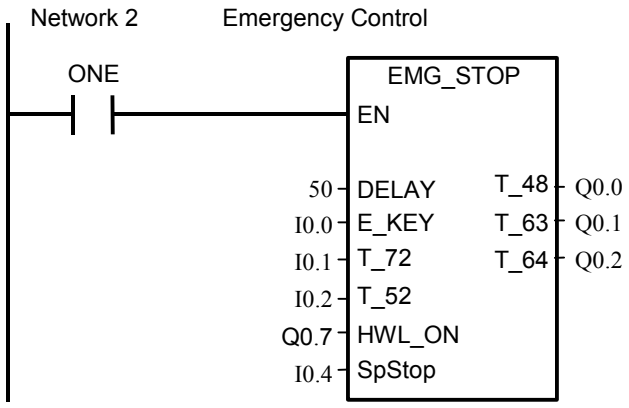
Three 10ms timer are used in this subroutine:

D_T64_T63	T24	Delay from Terminal 64 is off till Terminal 63 off
D_T63_T48	T25	Delay from Terminal 63 is off till Terminal 48 off
D_PON	T26	Delay after Power On

3.2.4. Corresponding PLC Machine Data

MD14510[16] – Machine type is evaluated in this subroutine

3.2.5. Sample of Subroutine Call



3.3. Subroutine 34 - MCP_802D (802D MCP signal transferring)

3.3.1. Purpose of Subroutine 34

Subroutine34 transferring the input signals from 802D MCP to interface area for further processing. The key layout is shown in the figure below and the key assignment can be found in the following table:

X1201

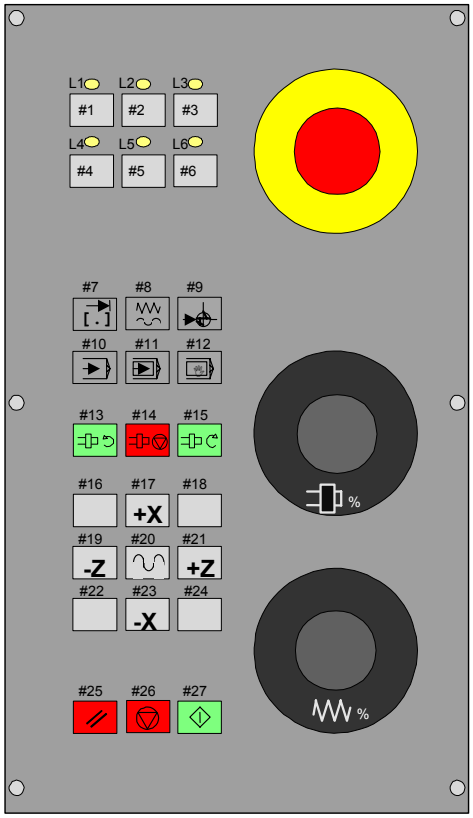
Pin	Signal	Type	Description	Pin	Signal	Type	Description
1	M	Output	GND	2	L+	Output	+24V
3	Im+0.0	Input	#1	4	Im+0.1	Input	#2
5	Im+0.2	Input	#3	6	Im+0.3	Input	#4
7	Im+0.4	Input	#5	8	Im+0.5	Input	#6
9	Im+0.6	Input	#7	10	Im+0.7	Input	#8
11	Im+1.0	Input	#9	12	Im+1.1	Input	#10
13	Im+1.2	Input	#11	14	Im+1.3	Input	#12
15	Im+1.4	Input	#13	16	Im+1.5	Input	#14
17	Im+1.6	Input	#15	18	Im+1.7	Input	#16
19	Im+2.0	Input	#17	20	Im+2.1	Input	#18
21	Im+2.2	Input	#19	22	Im+2.3	Input	#20
23	Im+2.4	Input	#21	24	Im+2.5	Input	#22
25	Im+2.6	Input	#23	26	Im+2.7	Input	#24
27		not connected		28		not connected	
29		not connected		30		not connected	
31	On+0.0	Output	LED1	32	On+0.1	Output	LED2
33	On+0.2	Output	LED3	34	On+0.3	Output	LED4
35	On+0.4	Output	LED5	36	On+0.5	Output	LED6
37	On+0.6	Output		38	On+0.7	Output	
39	On+1.0	Output		40	On+1.1	Output	
41	On+1.2	Output		42	On+1.3	Output	
43	On+1.4	Output		44	On+1.5	Output	
45	On+1.6	Output		46	On+1.7	Output	
47	DOCOM1	Input	24VDC	48	DOCOM1	Input	24VDC
49	DOCOM1	Input	24VDC	50	DOCOM1	Input	24VDC

X1202

Pin	Signal	Type	Description	Pin	Signal	Type	Description
1	M	Output	GND	2	L+	Output	+24V
3	Im+3.0	Input	#25	4	Im+3.1	Input	#26
5	Im+3.2	Input	#27	6	Im+3.3	Input	
7	Im+3.4	Input		8	Im+3.5	Input	
9	Im+3.6	Input		10	Im+3.7	Input	
11	Im+4.0	Input	Feed_OV_A	12	Im+4.1	Input	Feed_OV_B
13	Im+4.2	Input	Feed_OV_C	14	Im+4.3	Input	Feed_OV_D
15	Im+4.4	Input	Feed_OV_E	16	Im+4.5	Input	
17	Im+4.6	Input		18	Im+4.7	Input	
19	Im+5.0	Input	Sp_OV_A	20	Im+5.1	Input	Sp_OV_B
21	Im+5.2	Input	Sp_OV_C	22	Im+5.3	Input	Sp_OV_D
23	Im+5.4	Input	Sp_OV_E	24	Im+5.5	Input	
25	Im+5.6	Input		26	Im+5.7	Input	
27		not connected		28		not connected	
29		not connected		30		not connected	
31	On+2.0	Output		32	On+2.1	Output	
33	On+2.2	Output		34	On+2.3	Output	
35	On+2.4	Output		36	On+2.5	Output	
37	On+2.6	Output		38	On+2.7	Output	
39	On+3.0	Output		40	On+3.1	Output	
41	On+3.2	Output		42	On+3.3	Output	
43	On+3.4	Output		44	On+3.5	Output	
45	On+3.6	Output		46	On+3.7	Output	
47	DOCOM2	Input	24VDC	48	DOCOM2	Input	24VDC
49	DOCOM2	Input	24VDC	50	DOCOM2	Input	24VDC

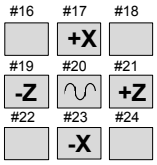
In this subroutine the physical inputs of axis traverse keys are transferred to the logic address in the interface (V1000 xxxx). Key cross may be different according to variety of machine tool structure. In this subroutine only 5 different key crosses are available.

802D MCP layout

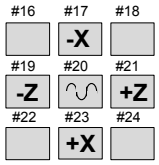


Traverse key layout

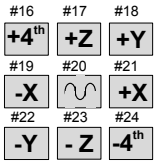
For inclined bed turning machine



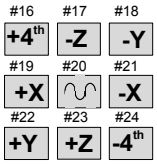
For horizontal bed turning machine



For vertical milling machine



For knee-type milling machine



Note: In this subroutine the feed override signals of 802D MCP are checked to be sure that MCP is available. Otherwise an alarm will be triggered.

Alarm 700024 – 802D MACHINE CONTROL PANEL DEFECT

3.3.2. Local Variable Definition

Inputs:

PB_0	BYTE	Parameter buffer for K1 … K8
PB_1	BYTE	Parameter buffer for K9 … K15 and K20
PB_2	BYTE	Parameter buffer for K16… K19 and 21...K24
PB_3	BYTE	Parameter buffer for K25… K27
Fov	BYTE	Parameter buffer for Feed override
Sov	BYTE	Parameter buffer for Spindle override
Drv_En	BOOL	Parameter feed enable key (holding signal: 1- enable; 0: disable. See Machine data MD14512[18] bit 3)
I_En	BOOL	Parameter condition for NC start
Xcross	WORD	Parameter definition for layout of traverse axis keys. 0: traverse key not processed in the subroutine 1: traverse key layout for inclined bed turning machine 2: traverse key layout for horizontal bed turning machine 3: traverse key layout for vertical milling machine 4: traverse key layout for knee-type milling machine 5: traverse key sequentially arranged (for variable Xcross)

Key number	I/O Addr.*	Local Var.	Xcross =1	Xcross =2	Xcross =3	Xcross =4
#16	Im 1.7	L1.7			+ 4th	+ 4th
#17	Im 1.8	L2.0	+ X	- X	+ Z	- Z
#18	Im 1.9	L2.1			+ Y	- Y
#19	Im 2.0	L2.2	- Z	- Z	- X	+ X
#20	Im 2.1	L2.3	Rapid	Rapid	Rapid	Rapid
#21	Im 2.2	L2.4	+ Z	+ Z	+ X	- X
#22	Im 2.3	L2.5			- Y	+ Y
#23	Im 2.4	L2.6	- X	+ X	- Z	+ Z
#24	Im 2.5	L2.7			- 4th	- 4th

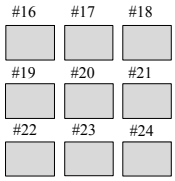
- not absolute input address. The absolute address is in accordance with the interface port on PP module.

Outputs: send out the signals from User Data to V1100 xxxx “signal for User Keys” to

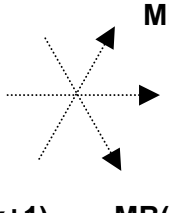
LEDs	BYTE	Output for L1 to L6 MCP

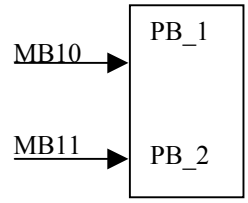
If other traverse key cross is required than those in previous samples , than use the configuration **Xcross**=5 (variable key arrangement).

variable key arrangement



Key number	I/O Addr.*	Bit transfer [*written by customer]	Parameter MCP_802D	Xcross =5	MCP_802D
#16	Im 1.7	IBx MBx	PB_2 Bit 0	+4. axis	
#17	Im 1.8		PB_2 Bit 1	-4. axis	
#18	Im 1.9		PB_2 Bit 2	+1. axis	
#19	Im 2.0		PB_2 Bit 3	-1. axis	
#20	Im 2.1		PB_1 Bit 7	Rapid	
#21	Im 2.2		PB_2 Bit 4	+2. axis	
#22	Im 2.3		PB_2 Bit 5	-2. axis	
#23	Im 2.4		PB_2 Bit 6	+3. axis	
#24	Im 2.5	IB(x+1) MB(x+1)	PB_2 Bit 7	-3. axis	

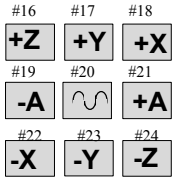




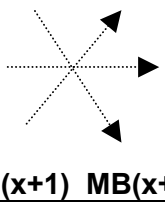
Manufactures can connect their physical I/O addresses in such way that they get their required **Xcross** by adding some networks for converting.
The Xcross configuration will be realised by bit wise connection between Ibx (IBx+1) and MBx (MBx+1) and be transferred to PB_1 Bit7 and PB_2. This program part is written by the customer.

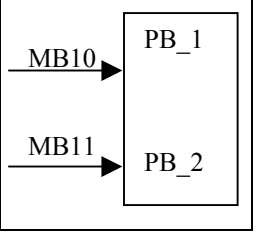
***The absolute address is in accordance with the interface port on PP module**.

Example:



Key number	I/O Addr.*	Bit transfer [*written by customer]	MB10 MB11	Parameter MCP_802D	Xcross =5	MCP_802D
#16	Im 1.7	IBx MBx	M11.6	PB_2 Bit 0	+4. axis	
	Im 1.8		M11.4	PB_2 Bit 1	- 4. axis	
	Im 1.9		M11.1	PB_2 Bit 2	+1. axis	
	Im 2.0		M11.0	PB_2 Bit 3	- 1. axis	
	Im 2.1		M11.3	PB_1 Bit 7	Rapid	
	Im 2.2		M10.7	PB_2 Bit 4	+2. axis	
	Im 2.3		M11.2	PB_2 Bit 5	- 2. axis	
	Im 2.4		M11.5	PB_2 Bit 6	+3. axis	
	Im 2.5	IB(x+1) MB(x+1)	M11.7	PB_2 Bit 7	- 3. axis	





In above example MB10 and MB11 are used, which represent the keys for MCP_802D.

3.3.3. Global Memory occupied

Two Bytes are used in this subroutine for toggle keys as Single Block and Feed Enable:

MB 133
MB 134

3.3.4. Corresponding PLC Machine Data

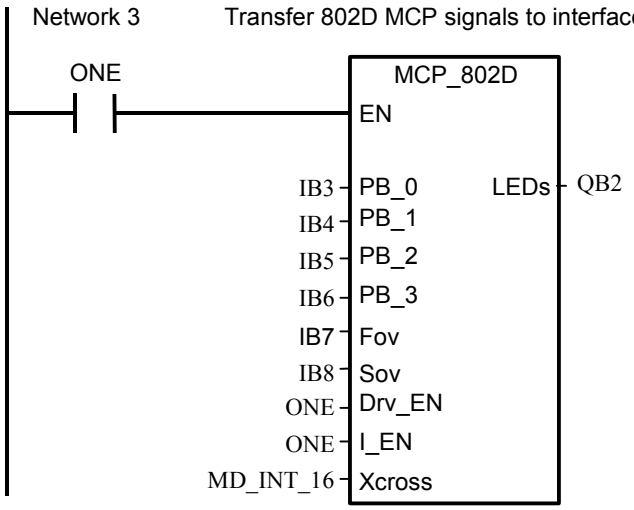
While there are no feed enable and feed disable keys on 802D MCP, two possibilities are provided by this subroutine, either using User Key 1 as toggle switch for feed enable and disable or using external key via an input to PP module. Therefore one PLC machine data bit is defined in MD14512[18] for this special requirement:

If MD14512[18] bit 3=1 Customer Key 1 on 802D MCP is used as toggle key for Feed Enable or disable
If MD14512[18] bit 3=0 an external key can be connect to the subroutine. The key should be with holding signal, i.e. 1 – feed enable; 0 – feed disable.

The Spindle key function depends on PLC machine data MD14512[19]:

If MD14512[19] bit 0=0 Spindle key CW and CCW work as momentary trigger mode
If MD14512[18] bit 0=1 Spindle key CW and CCW work as continuous trigger mode

3.3.5. Sample of Subroutine Call



3.4. Subroutine 35 - SPD_OVR (Spindle override with toggle keys)

3.4.1. Purpose of Subroutine 35

The purpose of this subroutine is to provide an alternative way to change spindle override value using toggle keys instead of using rotary gray code switch. Some customers would like to simplify their design of their own MCPs, using 3 toggle keys for spindle override to increase or decrease the override value of the spindle and with a toggle key to get override of 100%. The generated spindle override code is output to MCP interface VB10000008.

If Gcode=1, the gray code override is selected in steps of 1 not depending on the value of STEPi. For gray coding, 15 codes are available corresponding to the 15 positions of a rotary switch.

If Gcode=0, binary override code will be generated.

If binary code is selected for spindle, one machine data must be set:

MD12060 OVR_SPIND_IS_GRAY_CODE = 0 (0: Binary code; 1: Gray code)

3.4.2. Local Variable Definition

Inputs:

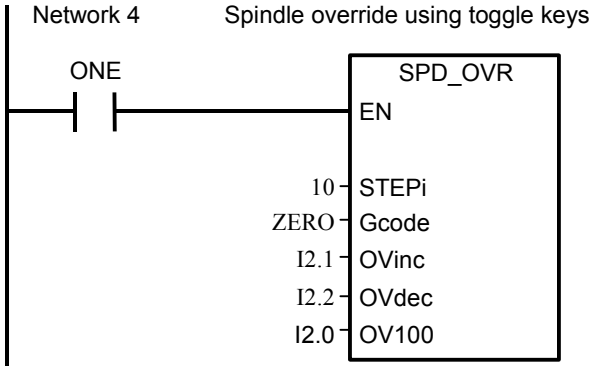
STEPi	WORD	Step for increasing or decreasing the override value with the range from 1 to 10 for binary code
Gcode	BOOL	1 - gray code override is selected; 0 – binary code;
OVinc	BOOL	toggle key for override increasing
OVdec	BYTE	toggle key for override decreasing
OV100	BYTE	toggle key for override 100%

3.4.3. Global Memory occupied

OV_CNT	WORD	MW242	buffer for override code.

3.4.4. Corresponding PLC Machine Data – no PLC machine defined

3.4.5. Sample of Subroutine Call



3.5. Subroutine 37 - MCP_SIMU (MCP simulation)

3.5.1. Purpose of Subroutine 37

The purpose of this subroutine is to provide a way to operate the 802D without MCP. With the help of Status Chart of Micro/WIN, most of the MCP functions, such as selection of operating mode or reference point approach, NC start, stop etc., can be simulated. The application of this subroutine can be found in chapter 5.1.

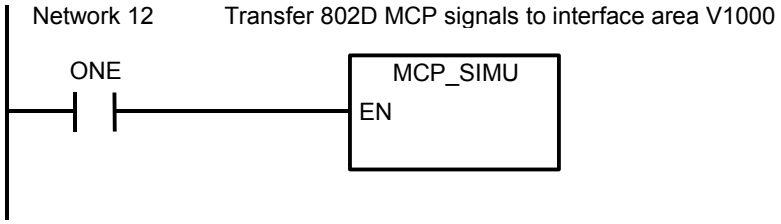
3.5.2. Local Variable Definition – no local variable is used in the subroutine

3.5.3. Global Memory used

SIM_CAM1	M249.0	Reference CAM axis 1 for simulation
SIM_CAM2	M249.1	Reference CAM axis 2 for simulation
SIM_CAM3	M249.2	Reference CAM axis 3 for simulation
SIM_T63	M249.3	for simulation of terminal 63 of drive
SIM_T64	M249.4	for simulation of terminal 64 of drive
FOV_P	M250.0	Feed override increment
FOV100	M250.1	Feed override 100%
FOV_N	M250.2	Feed override decrement
SOV_P	M250.3	Spindle override increment
SOV100	M250.4	Spindle override 100%
SOV_N	M250.5	Spindle override decrement
SIM_INC	M250.7	Increment selection
FOV_POS	C25	simulating feed rate override switch
SOV_POS	C26	simulating spindle override switch

3.5.4. Corresponding PLC Machine Data – no machine data defined

3.5.5. Sample of Subroutine Call



3.6. Subroutine 38 - MCP_NCK (MCP signal processing)

3.6.1. Purpose of Subroutine 38

The purpose of this subroutine is to transfer MCP signals in the interface V1000xxxx to NCK interface to activate operation mode and control sequences. The main functions in the subroutine are:

1. Selection of operation mode
2. Selection of increment
3. HMI signals to NCK channel interface

4. AXIS traversing signal to NCK axis interface with condition of no exceeding any hardware limits.

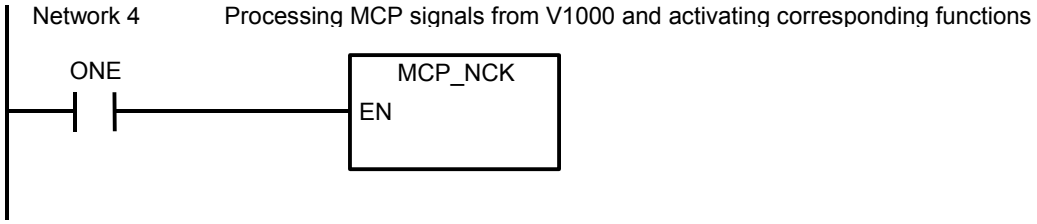
3.6.2. Local Variable Definition – no local variable is used in the subroutine

3.6.3. Global Memory occupied – no global memory used.

3.6.4. Corresponding PLC Machine Data

MD14510[16] – Machine data is used to decide the axis number for traversing. For example, if a turning machine is selected, the Z axis is the second axis and spindle is third, therefore the signal of traverse key of Z axis on the MCP should be sent to 2nd axis interface and spindle to 3rd axis interface.

3.6.5. Sample of Subroutine Call



3.7. Subroutine 39 - HANDWHL (Handwheel selection)

3.7.1. Purpose of Subroutine 39

The purpose of this subroutine is to select handwheel in MCS or WCS according HMI interface V1900 1xxx.

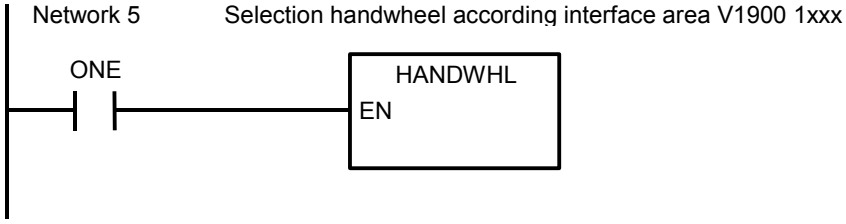
3.7.2. Local Variable Definition – no local variables are defined

3.7.3. Global Memory occupied – no memory used

3.7.4. Corresponding PLC Machine Data

MD14510[16] – Machine type is evaluated in this subroutine

3.7.5. Sample of Subroutine Call



3.8. Subroutine 40 - AXES_CTL (Feed axes and Spindle control)

3.8.1. Purpose of Subroutine 40

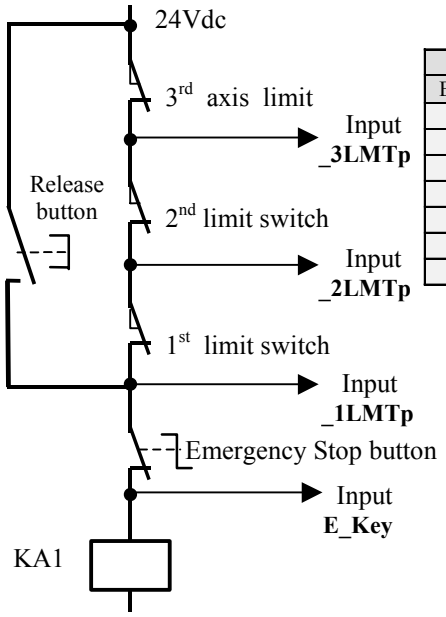
The purpose of this subroutine is to control the interface signals of “Impulse enable” - V380x4001.7 and “controller enable” (V380x0002.1), to monitor hardware limits and reference cam signals of all axes. For spindle, the enable signal will be activated by any of the spindle command, like Spindle CW and CCW, M03, M04, SPOS.

Motor brake will be released with the condition that no emergency stop and position controller is active.

Two different ways are provided by the subroutine for hardware limit control. One is PLC solution (MD14512[18] bit 6=0) and the other is hardware solution (MD14512[18] bit 6=1).

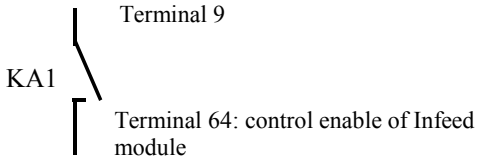
By PLC solution, the hardware limit signals, either 2 hardware limit switches (MD14512[18] bit 7=0) or only one hardware limit switch (MD14512[18] bit 7=1) can be configured for each axis. These signals will be sent to NCK interface V380x1000.0 or V380x1000.1 and a feed stop will be generated by NCK according to these interface signals. It is also possible to trigger a EMERGENCY STOP by connecting the output signal **OVImt** (subroutine parameter) to the input parameter **HWL_ON** of subroutine 33 EMG_STOP.

The hardware solution is actually PLC independent for more safety, see the figure below:



Encoding of HW limit switch					Hardware limit Reached
E_Key	_1LMTp	_2LMTp	_3LMTp	Direction	
0	1	1	1	-	Only Emg. Stop
0	0	1	1	V39000004.7	1st + over limit
0	0	1	1	V39000004.6	1st - over limit
0	0	0	1	V39010004.7	2nd + over limit
0	0	0	1	V39010004.6	2nd - over limit
0	0	0	0	V39020004.7	3rd + over limit
0	0	0	0	V39020004.6	3rd - over limit

Note: In case of EMERGENCY STOP or any of the hardware limits are reached, Terminal 64 switches and Terminal 9 are disconnected by hardware.



With above solution, the feed stop of all axes (i.e. disable Supply Infeed module by disconnecting TERMINAL64 and T9 via a relay) will be activated by any active hardware limit switches or Emergency Stop button by means of hardware. The Inputs signals to PLC shown in above figure are for diagnosis purpose and to provide more information for PLC, e.g. the feed stop of Supply Infeed module is caused by either Emergency Stop button or by one of hardware limit switches.

Note: Some precondition should be considered when this solution is used:

1. The axes should be configured one next to the other, e.g. X, Z, spindle or X, Y, Z, spindle; This subroutine does not support the configuration like X, Y, Spindle, Z;
2. The inputs to the subroutine for hardware limit of unused axis should be assigned with SM0.0. Otherwise the hardware limit can not be detected.

3.8.2. Local Variable Definition

Inputs:

NODEF	WORD	reserved word
T_64	BOOL	Status of terminal 64 of infeed module
T_63	BOOL	Status of terminal 63 of infeed module
OPTM	BOOL	input for brake release during drive optimization (NO)
_1LMTp	BOOL	1st axis hardware limit plus (NC)
_1LMTn	BOOL	1st axis hardware limit minus (NC)
_1REF	BOOL	1st axis reference point cam (NO)
_2LMTp	BOOL	2nd axis hardware limit plus (NC)
_2LMTn	BOOL	2nd axis hardware limit minus (NC)
_2REF	BOOL	2nd axis reference point cam (NO)
_3LMTp	BOOL	3rd axis hardware limit plus (NC)
_3LMTn	BOOL	3rd axis hardware limit minus (NC)
_3REF	BOOL	3rd axis reference point cam (NO)
_4REF	BOOL	4th axis reference point cam (NO)
_5REF	BOOL	5th axis reference point cam (NO)

Note: NO – Normal Open;
NC – Normal Close

Outputs:

_1BRK	BOOL	Brake release output for 1st axis (high effective)
_2BRK	BOOL	Brake release output for 2nd axis (high effective)
_3BRK	BOOL	Brake release output for 3rd axis (high effective)
OVlmt	BOOL	Over limit output (any of HW limit is active, also high effective)

If only one HW limit switch (with 2 cams) is installed on the machine tool for each axis, the local variable for positive limit switch is used for this switch signal. In the PLC program the traversing direction is evaluated to decide the over limit direction.

3.8.3. Global Memory occupied

SP_CMD	M138.1	Spindle start command (CW or CCW)

3.8.4. Corresponding PLC Machine Data

MD14510[16] – machine type 0: not defined;
1: turning machine; 2: milling machine

MD14512[16] - axes configuration (valid only if MD14510[16]=0)
Bit 0 – 1: 1st axis is selected
Bit 1 – 1: 2nd axis is selected
Bit 2 – 1: 3rd axis is selected
Bit 3 – 1: 4th axis is selected
Bit 4 – 1: 5th axis is selected

MD14512[18] Bit 6 – 1: Hardware solution for over limit monitoring;
0: PLC solution with the condition defined by:

MD14512[18] Bit 7 – 1: only one hardware limit switch for each axis or
0: 2 hardware limit switches for both directions of an axis;

MD14512[18] Bit 1 – 1: Switch #OPTM for brake release by drive optimization;
0: Switch #OPTM is not valid.

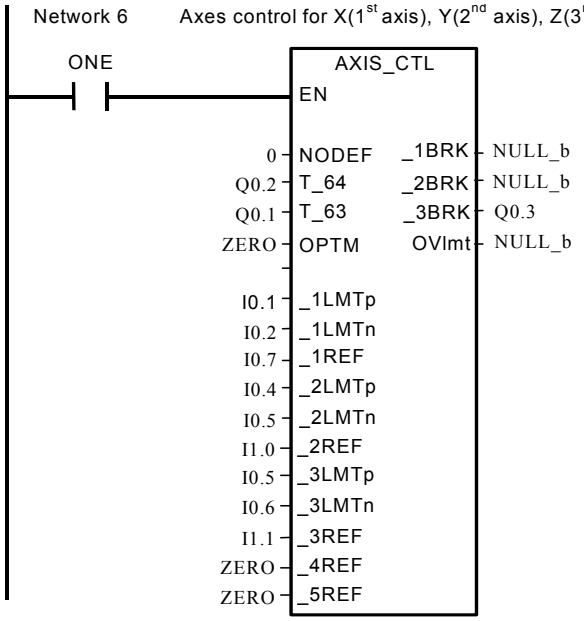
Note: The motor brake must be released by optimization, which is controlled by SimoCom U via RS232 interface. In this case it is necessary to install a switch for optimization. If MD14512[18] bit1=1, the condition for brake release is no emergency stop (V27000000.1=0) and switch #OPTM=on.

Note: an PLC alarm will be generated to provide a message that brake is released for optimization.

Alarm 700026 – BRAKE RELEASED FOR DRIVE OPTIMIZATION

Important: After drive optimization, MD14512[18] Bit 1 should be set to "0" .

3.8.5. Sample of Subroutine Call



3.9. Subroutine 43 - MEAS_JOG (Measuring in Jog mode)

3.9.1. Purpose of Subroutine 43

This subroutine handles the information of the probe and realizes the function "Measurement in Jog Mode". With this subroutine it is possible to calibrate the probe and measure the tools.
To use this subroutine, it is necessary to call up the subroutine MCP_NCK (SBR38) in the OB1.
In case if there is any change the operating area while function "Measurement in Jog Mode" is active, this function will be stopped automatically.

Following message will be activated in this subroutine:
700031 – MEASUREMENT IN JOG IS ACTIVE

3.9.2. Local Variable Definition

Inputs:

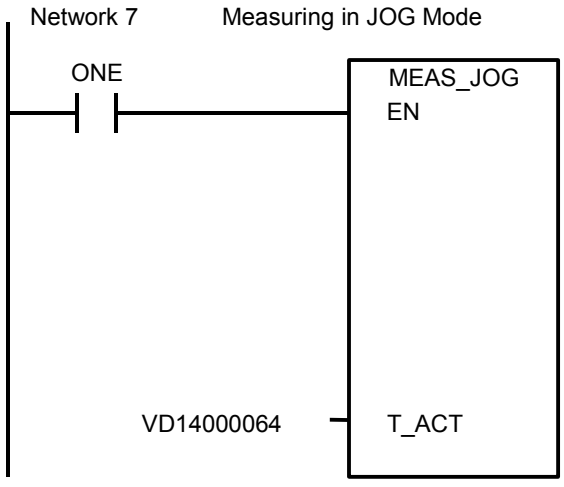
Meas_Enable	BOOL	Enable MEAS_JOG
VD14000064	DWORD	Active tool number

3.9.3. Global Memory occupied

MEAS_OPAUT	M240.0	Meas in operating mode automatic
MEAS_OPJOG	M240.1	Meas in operating mode jog
CHL_HMI	M240.2	Meas in operating mode change look from HMI
NO_KEY	M240.3	no traversing keys in the axis
OUT_HMI	M240.4	operating mode automatic from HMI
FDI_MEASJOG	M240.5	feed disable in Meas_JOG
ON_MEASJOG	M240.6	start Meas_JOG
PROBE_ON	M240.7	probe signal has released
JOG_MEASJOG	M241.0	output operation mode jog in Meas_JOG
AUT_MEASJOG	M241.1	output operation mode auto in Meas_JOG
CHL_MEASJOG	M241.2	operation mode change look in Meas_JOG
KEY_MEASJOG	M241.3	traversing keys in Meas_JOG
RES_MEASJOG	M241.4	reset in Meas_JOG
ESC_MEASJOG	M241.5	abort Meas_JOG
DRY_MEASJOG	M241.6	dry run feed in Meas_JOG
SBL_MEASJOG	M241.7	single block in Meas_JOG

3.9.4. Corresponding PLC Machine Data – no machine data defined

3.9.5. Sample of Subroutine Call



3.10. Subroutine 44 - COOLING (coolant control)

3.10.1. Purpose of Subroutine 44

The coolant is controlled under JOG mode by a key on MCP and in AUTO/MDA mode by M07/M08 for coolant on and M09 for coolant off in part program. In case of emergency stop, coolant motor overload, or by active functions like Program Test or simulation, coolant will be inhibited.

2 alarms will be activated from this subroutine:

Alarm 700018 – COOLING MOTOR OVERLOAD
Alarm 700019 – COOLANT LEVEL LOW

3.10.2. Local Variable Definition

Inputs:

C_key	BOOL	Manual operating key (trigger signal required)
OVload	BOOL	Coolant motor overload (NC)
C_low	BOOL	Coolant level low (NC)

Outputs:

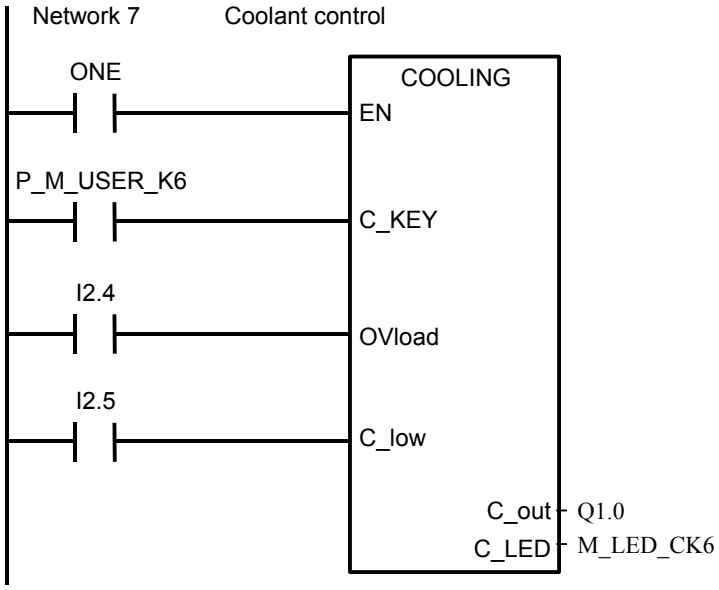
C_out	BOOL	Coolant output
C_LED	BOOL	output for status display

3.10.3. Global Memory occupied

COOLon	M150.0	Status of coolant on

3.10.4. Corresponding PLC Machine Data – no PLC machine data related

3.10.5. Sample of Subroutine Call



3.11. Subroutine 45 - LUBRICAT (Lubricating control)

3.11.1. Purpose of Subroutine 45

Lubrication is controlled according a specified time interval for a specified duration (not distance related). A manual key is available to start lubricating, and during power on of the machine tool it is also possible to start lubrication. Normally the lubrication will be started periodically in the time interval defined by input parameter **Lintv**. The lubrication lasts for the duration specified by another input parameter **Ltime**. In case of emergency stop, lubrication motor overload, lubrication will be not started.

2 alarms will be activated in this subroutine:

Alarm 700020 – LUBRICATING MOTOR OVERLOAD
Alarm 700021 – LUBRICANT LEVEL LOW

3.11.2. Local Variable Definition

Inputs:

Lintv	WORD	Lubrication time interval (unit: 1 min)
Ltime	WORD	Lubrication duration (unit: 0.01s, max. 327.67s)
L_key	BOOL	manual lubrication key (trigger signal required)
L1st	BOOL	Lubrication by first PLC cycle (power on)
Ovload	BOOL	lubrication motor overload
L_low	BOOL	lubricant level low

Outputs:

L_out	BOOL	Lubrication output
L_LED	BOOL	output for status display

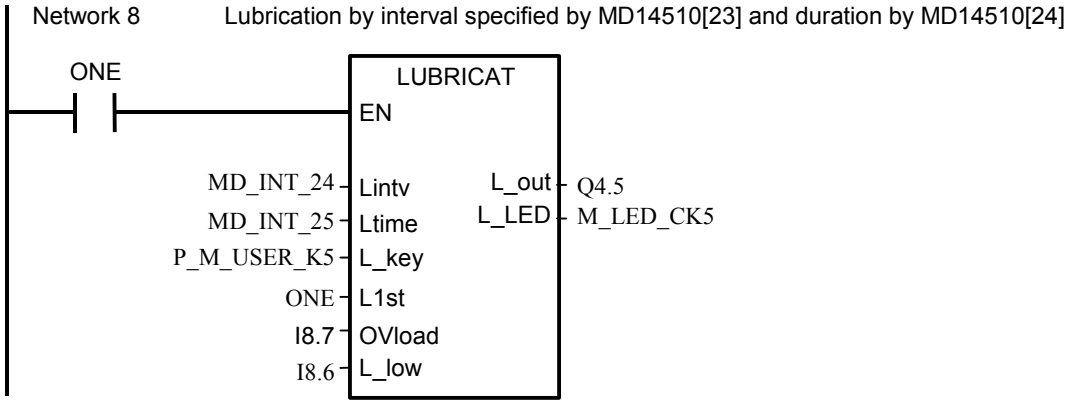
3.11.3. Global Memory occupied

L_cmd	M152.0	lubrication command
L_interval	C24	used to calculate lubrication interval (unit: 1 minute)
L_time	T27	used to calculate lubrication time (unit: 0.01s, max. 327,67s Approx. 5 min)

3.11.4. Corresponding PLC Machine Data

MD 14510 [24]:	Lubrication time interval (unit: 1 min)
MD 14510 [25]:	Lubrication duration (unit: 0,01 s, max. 327.67s)

3.11.5. Sample of Subroutine Call



3.12. Subroutine 46 - TURRET1 (Turret with Hall Effect Device position sensor)

3.12.1. Purpose of Subroutine 46

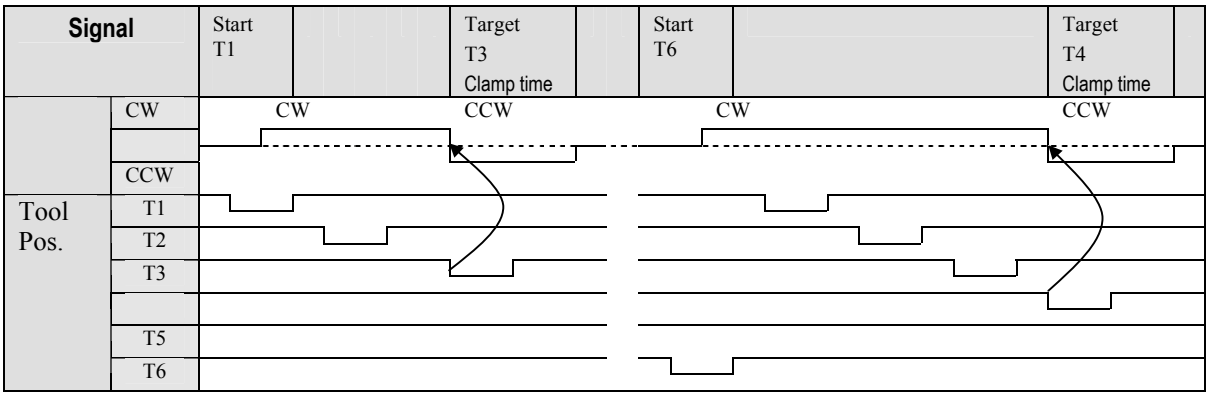
This subroutine controls the kind of turret with Hall Effect Device sensor (HED).Turret motor is controlled by PLC output. During tool search the motor turns clockwise. When the desired tool is in-position, turret motor runs counter clockwise for a specified duration for clamping. The subroutine verifies the parameter for turret CCW to limit the value within 3 seconds in order to avoid the damage of the turret motor.

T function from NCK will start turret change in AUTO and MDA mode and a short strike on the manual key will change one turret position and long press for more position turret change in JOG mode.

During time of turret change one interface signal (V32000006.1 “Read-in disable”) is set, so that a part program will be stopped waiting for the turret change.

In case of emergency stop, turret motor overload, or by active functions like Program Test or simulation, turret will be inhibited.

The timing diagram for this kind of turret is shown below:



3 alarms will be activated in this subroutine:

Alarm 700022 – TURRET MOTOR OVERLOAD
Alarm 700023 – PROGRAMMED TOOL NUM. > MAX. TURRET NUMBER
Alarm 700026 – NO POSITION SIGNALS FROM TURRET

3.12.2. Local Variable Definition

Inputs:

Tmax	WORD	max. number of tool on the turret
T_01 … T_06	BOOL	tool position sensors (low effective)
T_key	BOOL	manual lubricating key (trigger signal required)
OVload	BOOL	lubricating motor overload

Outputs:

T_cw	BOOL	turret positioning
T_ccw	BOOL	turret clamping
T_LED	BOOL	output for status display

3.12.3. Global Memory occupied

T_CURRENT	VD14000064	Current tool (retentive data)
ClampTime	MW154	Turret clamping time
T_cw_m	M156.0	Turret CW flag
T_ccw_m	M156.1	Turret CCW flag
CcwDelay	M156.2	Turret CCW delay
K_active	M156.3	Manual key is active
TC_end	M156.4	Tool Change complete
Tp_ne_Tc	M156.5	Programmed Tool number not equal current tool
T__P_INDX	MD160	Buffer to monitor the change of the turret by JOG mode
T_CHL	M168.4	Operation mode change look
T1clamp	T28	Turret1 clamping timer.

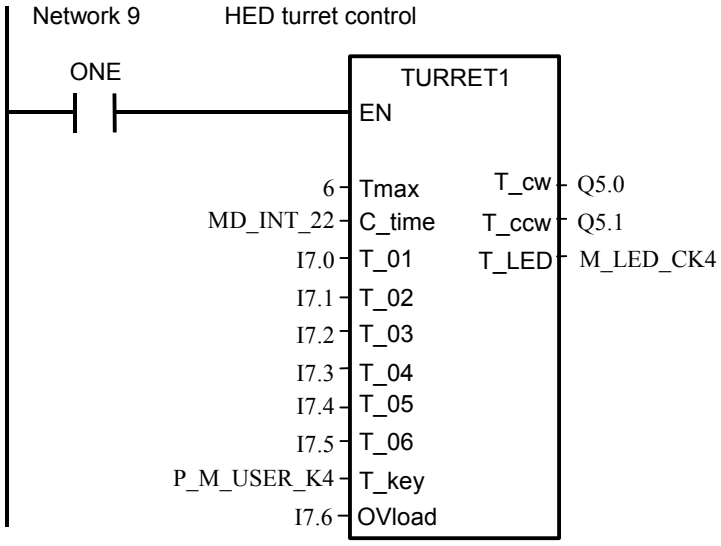
3.12.4. Corresponding PLC Machine Data

MD14510[22]: Turret clamping time (unit: 0.01s max. 300 unit)

By PLC initialization if MD14510[16]=1 (turning machine), the value of MD14510[22] will be automatically evaluated and the result will be saved in memory word MW154 which is used by subroutine 46 for turret change.

IF MD14510[22]=0 THEN MW154= 50 (default)
IF MD14510[22]>300 THEN MW154=300 (max.)

3.12.5. Sample of Subroutine Call



3.13. Subroutine 47 - TURRET2 (Control of a turret with binary encoder)

3.13.1. Purpose of Subroutine 47

This subroutine is used to control turret with encoder. The encoder is installed in this kind of turret, with the capability to index in 2 directions in order to have a shorter tool change time. For the timing diagram and the principle, please refer turret description.

During time of turret change one interface signal (V32000006.1 “Read-in disable”) is set, so that a part program will be stopped waiting for the turret change.

In case of emergency stop, turret motor overload, or during Program Test active or simulation active, turret will be inhibited.

2 alarms will be activated in this subroutine:

Alarm 700022 – TURRET MOTOR OVERLOAD
Alarm 700023 – PROGRAMMED TOOL NUM. > MAX. TURRET NUMBER

3.13.2. Local Variable Definition

Inputs:

Tmax	DWORD	max. tool number on turret
T_1	BOOL	T code A
T_2	BOOL	T code B
T_3	BOOL	T code C
T_4	BOOL	T code D
Parity	BOOL	parity
Strobe	BOOL	signal strobe
OVload	BOOL	turret motor overload
T_key	BOOL	manual change key

Outputs:

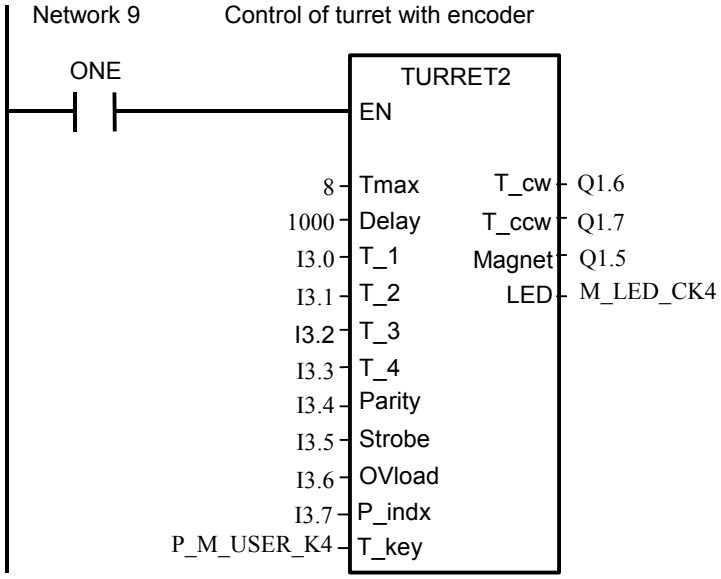
T_cw	BOOL	turret CW
T_ccw	BOOL	turret CCW

3.13.3. Global Memory occupied

T_CURRENT	VD14000064	Current tool number (retentive data)
T_cw_m	M156.0	Turret CW flag
T_ccw_m	M156.1	Turret CCW flag
T__P_INDX	MD160	Buffer to monitor the change of the turret by JOG mode
T_DES	MD164	Destination tool number
T_DIR	M168.0	Turret change direction
T_POS	M168.1	Turret in-positioning
T_LOCK	M168.2	Turret clamping command
T_MAG	M168.3	Turret solenoid for clamping

3.13.4. Corresponding PLC Machine Data – no machine data related

3.13.5. Sample of Subroutine Call



3.14. Subroutine 48 - TOOL_DIR (Tool change direction)

3.14.1. Purpose of Subroutine 48

The purpose is to identify the direction and pre-indexing position of the turret or tool chain according to the maximum tool number and programmed tool number. In subroutine library this subroutine is called by subroutine 47 - TURRET2 for turrets like from SAUTER Company. Tool number should be limited between 2 and 64.

3.14.2. Local Variable Definition

Inputs:

Tmax	DWORD	max. tool number on turret
Pnum	DWORD	programmed tool number
Pcurr	DWORD	current turret position

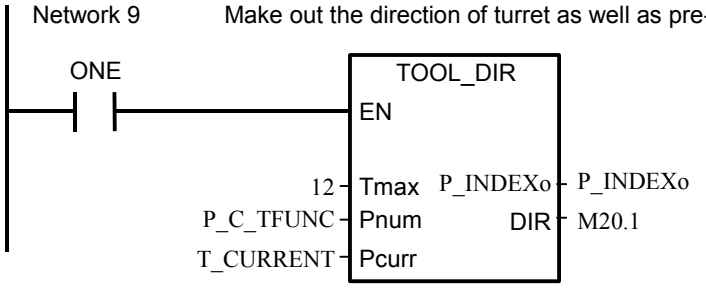
Outputs:

P_INDXo	DWORD	pre-indexing position; one position before the destination in direction of shortest way.
DIR	BOOL	tool change direction: 1 - CW; 0 - CCW

3.14.3. Global Memory occupied – no global memory defined

3.14.4. Corresponding PLC Machine Data – no PLC machine data related

3.14.5. Sample of Subroutine Call



3.15. Subroutine 49 - MGZ_INI (Initialization on tool magazine table)

3.15.1. Purpose of Subroutine 49

In order to realize tool magazine control for machining center, which requires random access of tools from magazine, PLC library provides some subroutines for magazine management. These subroutines include initialization,searching for position of the destination tool, refreshing holder table.

It is defined in the library that the number of tool holders of a magazine must not exceed 40. Initialization is to establish a table in retentive data area VB14000000 to VB14000040 representing up to 40 tools on the magazine.

After initialization, the tool holders on the magazine contain the same number of tools as holders and no tool in the spindle.

In tool change, the holder with programmed tool should be allocated first. The number of the holder is used to control the magazine to turn clockwise or counter clockwise to exchanging position.

After ATC exchanges the tools on the holder and spindle, the holder table should be refreshed. The programmed tool is on the spindle and existing tool on spindle, should be put back into empty holder. Please refer the following table for principal.

The control logic for magazine as well as ATC is hardware dependent, therefore should be designed by machine tool builders.

TOOL on	Table	After ini.	T5 M06	T8 M06	T16 M6	T0 M06	T15 M06	T10 M06
SPINDLE	VB14000000	0	5	8	16	0	15	10
T_HOLDER_1	VB14000001	1	1	1	1	1	1	1
T_HOLDER_2	VB14000002	2	2	2	2	2	2	2
T_HOLDER_3	VB14000003	3	3	3	3	3	3	3
T_HOLDER_4	VB14000004	4	4	4	4	4	4	4
T_HOLDER_5	VB14000005	5	0	0	0	16	16	16
T_HOLDER_6	VB14000006	6	6	6	6	6	6	6
T_HOLDER_7	VB14000007	7	7	7	7	7	7	7
T_HOLDER_8	VB14000008	8	8	5	5	5	5	5
T_HOLDER_9	VB14000009	9	9	9	9	9	9	9
T_HOLDER_10	VB14000010	10	10	10	10	10	10	15
T_HOLDER_11	VB14000011	11	11	11	11	11	11	11
T_HOLDER_12	VB14000012	12	12	12	12	12	12	12
T_HOLDER_13	VB14000013	13	13	13	13	13	13	13
T_HOLDER_14	VB14000014	14	14	14	14	14	14	14
T_HOLDER_15	VB14000015	15	15	15	15	15	0	0
T_HOLDER_16	VB14000016	16	16	16	8	8	8	8

The purpose of this subroutine is to establish a table for tool magazine representing the positions of the tools on the magazine. After initialization the table is arranged in the following way:

Number of Tool Holder	Tool number on the holder
1	1
2	2
…	…
39	39
40	40

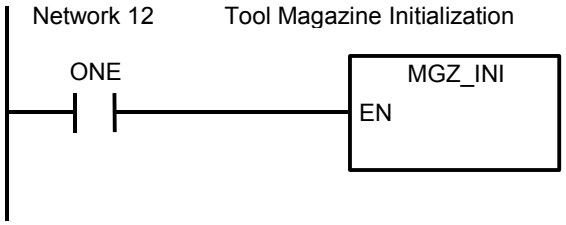
It is possible to have 64 tools for SINUMERIK802D. But in subroutine library, only 40 tools are permitted. For magazine more than 40 tool, the following subroutine should be modified before application: SBR49–MGZ_INI, SBR50–MGZ_SRCH, and SBR51–MGZ_RNEW.

3.15.2. Local Variable Definition – no local variable defined

3.15.3. Global Memory occupied – no global memory defined

3.15.4. Corresponding PLC Machine Data – no PLC machine data related

3.15.5. Sample of Subroutine Call



3.16. Subroutine 50 - MGZ_SRCH (Search tool from magazine)

3.16.1. Purpose of Subroutine 50

The purpose of this subroutine is to find the holder location from magazine, which contains the wanted tool.

3.16.2. Local Variable Definition

Inputs:

P_TOOL	DWORD	Programmed tool number

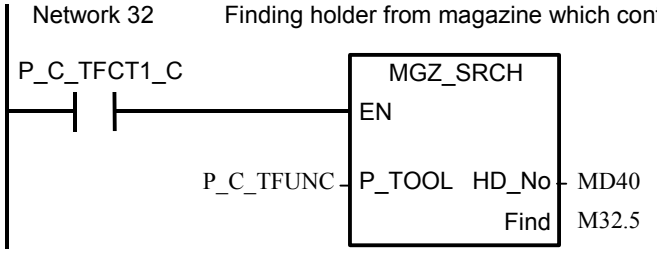
Outputs:

HD_No	DWORD	Holder number with programmed tool
Find	BOOL	1: tool is found, 0: not found

3.16.3. Global Memory occupied - no global memory defined

3.16.4. Corresponding PLC Machine Data - no

3.16.5. Sample of Subroutine Call



3.17. Subroutine 51 - MGZ_RNEW (Refresh magazine table)

3.17.1. Purpose of Subroutine 51

The purpose of this subroutine is to refresh magazine table after tool exchange, in order to have a correct magazine table, the subroutine actually exchanges the tool number on the spindle (located in VB14000000) with tool number in the holder which contains programmed tool.

3.17.2. Local Variable Definition

Inputs:

P_TOOL	DWORD	Programmed tool number

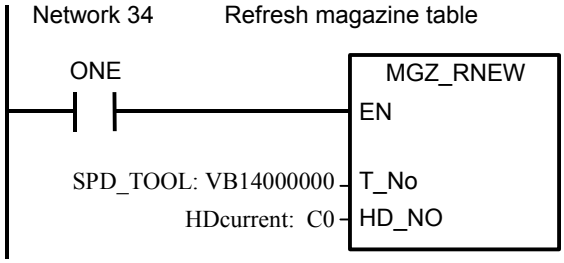
Outputs:

HD_No	DWORD	Holder number with programmed tool
Find	BOOL	1: tool is found, 0: not found

3.17.3. Global Memory occupied - no global memory defined

3.17.4. Corresponding PLC Machine Data - no

3.17.5. Sample of Subroutine Call



3.18. Subroutine 36, 41, 42 and Subroutine 52 ... 62 are reserved for subroutine library

3.19. Subroutine 63 - TOGGLE

3.19.1. Purpose of Subroutine 63

Toggle switch is a kind of switch with one push of the key (input of the subroutine) to turn the output on and second push to turn the output off.

Delayed-switch is a kind of switch, with which once the key (input of the subroutine) is pressed, the output will be on for the time interval defined by parameter “Delay7” (for key 7) and “Delay 8” for key 8.

There are 6 toggle switches and 2 delayed-switches are available in this subroutine to simplify the PLC application program of the customers. This subroutine can put in the main program.

The bit parameter for key inputs and outputs can be connected to physical input or output or to any memory bits. All the unused bit inputs can be connected to “ZERO” (M251.0), all the unused byte inputs connected to byte constant “0”, all unused bit outputs connected to “NULL_b” (M255.7).

3.19.2. Local Variable Definition

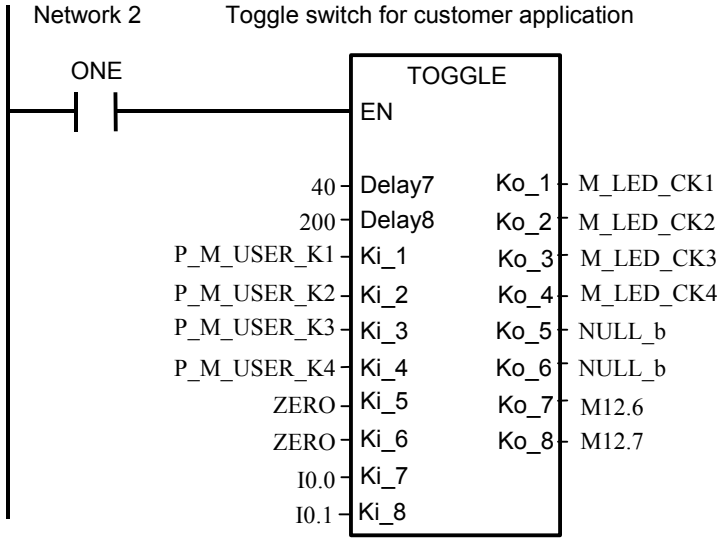
Symbol	Var. Type	Data type	Comment
Delay 7	IN	WORD	Delay time of switch 7 (unit 10 ms)
Delay 8	IN	WORD	Delay time of switch 8 (unit 10 ms)
Ki_1	IN	BOOL	Toggle key 1
Ki_2	IN	BOOL	Toggle key 2
Ki_3	IN	BOOL	Toggle key 3
Ki_4	IN	BOOL	Toggle key 4
Ki_5	IN	BOOL	Toggle key 5
Ki_6	IN	BOOL	Toggle key 6
Ki_7	IN	BOOL	Delayed key 7 (delay switch)
Ki_8	IN	BOOL	Delayed key 8 (delay switch)
Ko_1	OUT	BOOL	Switch 1 output
Ko_2	OUT	BOOL	Switch 2 output
Ko_3	OUT	BOOL	Switch 3 output
Ko_4	OUT	BOOL	Switch 4 output
Ko_5	OUT	BOOL	Switch 5 output
Ko_6	OUT	BOOL	Switch 6 output
Ko_7	OUT	BOOL	Switch 7 output (delayed)
Ko_8	OUT	BOOL	Switch 8 output (delayed)

3.19.3. Global Memory used

Symbol	Address	Comment
K1st1 … K8st1	MB245	Toggle key status 1
K1st2 … K8st2	MB246	Toggle key status 2
K1on … K8on	MB247	Toggle key status ON

3.19.4. Corresponding PLC Machine Data – no PLC machine data related

3.19.5. Sample of Subroutine Call



4. PLC User Alarms used in Subroutine Library

There are several user alarms activated in the subroutines. In the table below the alarms are listed. In case an alarm comes, please pay attention to this table to know from which subroutine the alarm is activated.

Alarm Number	Interface Address	Alarm Description	Activated in Subroutine
700016	V16000002.0	DRIVES NOT READY	SBR33: EMG_STOP
700017	V16000002.1	I^2/T ALARM FOR INFEED MODULE	
700018	V16000002.2	COOLANT MOTOR OVERLOAD	SBR44: COOLING
700019	V16000002.3	COOLANT LEVEL LOW	
700020	V16000002.4	LUBRICATING MOTOR OVERLOAD	SBR45: LUBRICAT
700021	V16000002.5	LUBRICANT LEVEL LOW	
700022	V16000002.6	TURRET MOTOR OVERLOAD	SBR46: TURRET1
700023	V16000002.7	PROGRAMMED TOOL NUM. > MAX. TURRET NUMBER	SBR47: TURRET2
700024	V16000003.0	802D MACHINE CONTROL PANEL DEFECT	SBR34: CP_802D
700025	V16000003.1	BRAKE RELEASED FOR DRIVE OPTIMIZATION	SBR40: AXES_CTL
700026	V16000003.2	NO POSITION SIGNALS FROM TURRET	SBR46: TURRET1
700031	V16000003.7	MEASURING IN JOG IS ACTIVE	SBR43: MEAS_JOG

Feed stop to channel (V32000006.0) will be activated by any alarms from the subroutine library. To remove the feed stop, clear the alarm condition first and then RESET.

5. Sample PLC Application Programs

There are some special flags that will used in the project files:
SM0.0 - always “1” symbolized as ONE
M251.0 - always “0” (cleared every cycle in subroutine 33), symbolized as ZERO.
(Note: these two bits will finally be replaced with bit constant later)

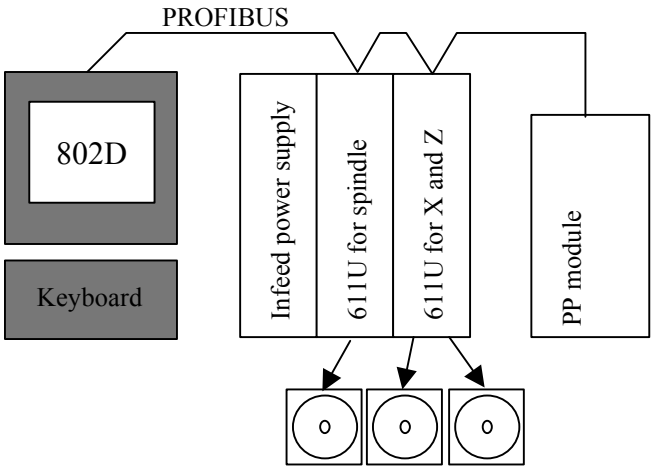
M255.7 - for unused output bit, symbolized as NULL_b
MB255 - for unused output byte, symbolized as NULL_B
MW254 - for unused output word, symbolized as NULL_W
MD252 - for unused output double word, symbolized as NULL_D

5.1. PLC Application Program for simulation

5.1.1. Purpose of the Simulation Program

The purpose of the simulation program is to provide a way to test the system without MCP before all 802D components are installed on the machine tool. This simulation program works with the help of Status Chart of the programming tool. Customers can simulate the MCP to traverse the axes and spindle, change override, and select increment, etc.

Hardware connected:



Note: here all enable signals on the drive unit in the case of simulation are connected to Terminal 9**.**
But these enable signals must be controlled by PLC when application on the machine tools

Subroutine 37 SIMU_MCP monitors the status such as mode change, NC start, stop, etc. acknowledges mode changes, generates the override value and also simulates reference cams via global memory bits for feed axis and spindle. The change of feed and spindle overrides is carried out via Status Chart. (Refer to chapter 3.4)

Program organization (OB1)

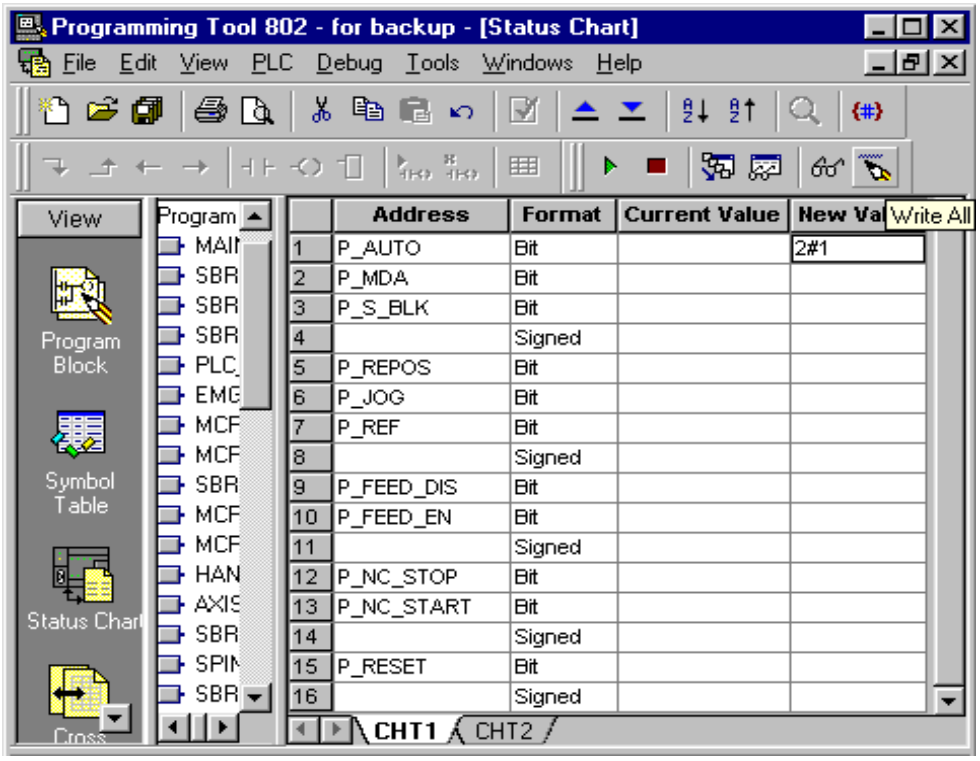
Call condition	Subroutine name	Description
1st PLC cycle (SM0.1)	PLC_INI (SBR32)	Initializing
Every cycle (SM0.0)	EMG_STOP (SBR33)	For enable drives
Every cycle (SM0.0)	MCP_SIMU (SBR37)	Simulating MCP
Every cycle (SM0.0)	MCP_NCK (SBR38)	Transferring MCP to NCK interface
Every cycle (SM0.0)	AXES_CTL (SBR39)	Enabling NCK interface signals

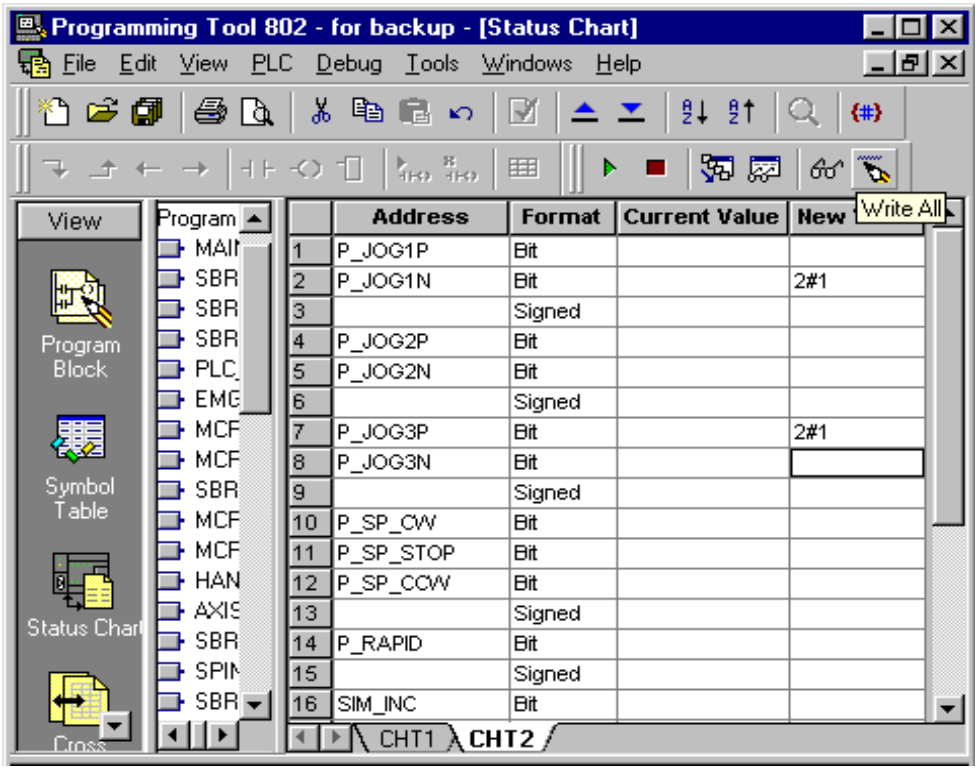
5.1.2. PLC Machine Data related

The related PLC MD is MD14510[16] for machine type.

5.1.3. Application

1. Connect hardware component according to the *Start-up and Installation Manual* as the figure above.
2. Power on the NC and drives. Set RS232 interface to “STEP7-Connect” on 802D.
3. Start *Programming Tool PLC V3.0* and set Communication parameter to match the setting in NC.
4. Open the project file: SIMULATION.PTP and download it to 802D. Start PLC.
5. Open the “Status Chart” of the programming tool and give a “1” to the mask in the *new value* column of the desired function, and then click the icon  with mouse key to write the value to the 802D.





5.2. Sample PLC Application Program for a Turning Machine

5.2.1. Purpose of the sample turning machine

SAMPLE_TURN.PTP is an application program for turning machine. Through this sample 802D customers can learn how an application is composed using subroutine library, and how to make use of the subroutines in the library. Another purpose for this sample is that for turning machines with similar configuration can be used directly, or make simply modification to build a PLC application program quickly.

This sample program is suitable for turning machines with following configuration:

- 2 Feed axes: X and Z; 2 HW limit switches for each axis
- Turret (with HED sensor) of 6 tools
- Lubrication system (Interval and duration are controlled by PLC)
- Cooling system
- 802D: 1 digital spindle: SP
  One PP module (2 connector X111 and X222 are reserved 802D MCP).

Input / Output assignment:

Terminal Block X333

Signal	Terminal	Description	Note
M	1	Ground of 24VDC	
L+	2	Output 24VDC as Common for all inputs in X333	
I 6.0	3	Emergency stop button	Button: NC
I 6.1	4	Limit switch X+	NC
I 6.2	5	Limit switch X-	NC
I 6.3	6	Limit switch Z+	NC
I 6.4	7	Limit switch Z-	NC
I 6.5	8	Reference Cam X	NO
I 6.6	9	Reference Cam Z	NO
I 6.7	10		
I 7.0	11	T1	Sensor NC
I 7.1	12	T2	Sensor NC
I 7.2	13	T3	Sensor NC
I 7.3	14	T4	Sensor NC
I 7.4	15	T5	Sensor NC
I 7.5	16	T6	Sensor NC
I 7.6	17	Turret motor overload	Thermal relay NC
I 7.7	18		
I 8.0	19	T72 Supply Infeed module ready	NO
I 8.1	20	T52 I^2t monitoring	NO
I 8.2	21		
I 8.3	22		
I 8.4	23	Coolant level low	NC
I 8.5	24	Coolant motor overload	NC
I 8.6	25	Lubricant level low	NC
I 8.7	26	Lubricating motor overload	NC
	27,28,29,30	Not connected	
Q 4.0	31	TERMINAL48 control contactor of Supply Infeed module	
Q 4.1	32	TERMINAL63 pulse enable	
Q 4.2	33	TERMINAL64 control enable	
Q 4.3	34	X axis motor brake release	
Q 4.4	35	Coolant output	
Q 4.5	36	Lubrication output	
Q 4.6	37		
Q 4.7	38		
Q 5.0	39	Turret CW	
Q 5.1	40	Turret CCW	
Q 5.2	41		
Q 5.3	42		
Q 5.4	43		
Q 5.5	44		
Q 5.6	45		
Q 5.7	46		
L+	47, 48	Input 24VDC for all outputs	
L+	49, 50	Input 24VDC for all outputs	

- 802D MCP installed

  Terminal Block X111 for MCP X1201

  Terminal Block X222 for MCP X1202

  Note: the connecting of MCP and PP is different from SAMPLE_MILL.PTP

Definition of User keys on MCP

Customer Key 1	Drive enable (toggle key)
Customer Key 2	
Customer Key 3	
Customer Key 4	Tool change key
Customer Key 5	Manual lubricating key
Customer Key 6	Manual cooling key

5.2.2. Program Organization (OB1)

Call condition	Subroutine name	Description
1st PLC cycle (SM0.1)	PLC_INI (SBR32)	Initializing
Every cycle (SM0.0)	EMG_STOP (SBR33)	For enable drives
Every cycle (SM0.0)	MCP_802D (SBR34)	802D MCP signals to MCP interface
Every cycle (SM0.0)	MCP_NCK (SBR38)	Transferring MCP to NCK interface
Every cycle (SM0.0)	AXES_CTL (SBR40)	Enabling NCK interface signals
Every cycle (SM0.0)	COOLING (SBR44)	Cooling control
Every cycle (SM0.0)	LUBRICAT (SBR45)	Lubricating control
Every cycle (SM0.0)	TURRET1 (SBR44)	Turret of HED sensors

5.2.3. PLC Machine Data related

The related PLC MD are:

MD14510[16] = 1 - for turning machine.
MD14510[22] = value - turret clamping time (unit: 0.01S)
MD14510[24] = value - Lubrication interval (unit: 1.0 Min.).
MD14510[25] = value - Lubrication duration (unit: 0.01S).

5.3. Sample PLC Application Program for a Milling Machine

5.3.1. Purpose of the sample milling machine

SAMPLE_MILL.PTP is an application program for milling machine. Through this sample 802D customers can learn how an application is composed using subroutine library, and how to make use of the subroutines in the library. Another purpose for this sample is that for milling machines with similar configuration can be used directly, or make simply modification to build a PLC application program quickly.

This sample program is suitable for milling machines with following configuration:

- 3 Feed axes: X, Y and Z; 2 HW limit switches for each axis
- Lubrication system (interval and duration are controlled by PLC)
- Cooling system
- One PP module (2 connector X222 and X333 are reserved 802D MCP)
- 802D:
  One digital spindle: SP (4th axis)
  1 PP72/48
  One PP module (2 connector X222 and X333 are reserved 802D MCP).

Input / Output assignment:

Terminal Block X111

Signal	Terminal	Description	Note
M	1	Ground of 24VDC	
L+	2	Output 24VDC as Common for all inputs in X111	
I 0.0	3	Emergency stop button	Button: NC
I 0.1	4	Limit switch X+	NC
I 0.2	5	Limit switch X-	NC
I 0.3	6	Limit switch Y+	NC
I 0.4	7	Limit switch Y-	NC
I 0.5	8	Limit switch Z+	NC
I 0.6	9	Limit switch Z-	NC
I 0.7	10	Reference Cam X	NO
I 1.0	11	Reference Cam Y	NO
I 1.1	12	Reference Cam Z	NO
I 1.2	13		
I 1.3	14		
I 1.4	15		
I 1.5	16		
I 1.6	17		
I 1.7	18		
I 2.0	19	T72 Supply Infeed module ready	NO
I 2.1	20	T52 I^2t monitoring	NO
I 2.2	21		
I 2.3	22		
I 2.4	23	Coolant level low	NC
I 2.5	24	Coolant motor overload	NC
I 2.6	25	Lubricant level low	NC
I 2.7	26	Lubricating motor overload	NC
	27,28,29,30	Not connected	
Q 0.0	31	Terminal 48: control contactor of Supply module	
Q 0.1	32	Terminal 63 pulse enable	
Q 0.2	33	Terminal 64 control enable	
Q 0.3	34	Z axis motor brake release	
Q 0.4	35	Coolant output	
Q 0.5	36	Lubrication output	
Q 0.6	37		
Q 0.7	38		
Q 1.0	39		
Q 1.1	40		
Q 1.2	41		
Q 1.3	42		
Q 1.4	43		
Q 1.5	44		
Q 1.6	45		
Q 1.7	46		
L+	47, 48	Input 24VDC for all outputs	
L+	49, 50	Input 24VDC for all outputs	

- 802D MCP installed

  Terminal Block X222 for MCP X1201

  Terminal Block X333 for MCP X1202

Definition of User keys on MCP

Customer Key 1	Drive enable (toggle key)
Customer Key 2	
Customer Key 3	
Customer Key 4	
Customer Key 5	Manual lubricating key
Customer Key 6	Manual cooling key

5.3.2. Program Organization (OB1)

Call condition	Subroutine name	Description
1st PLC cycle (SM0.1)	PLC_INI (SBR32)	Initializing
Every cycle (SM0.0)	EMG_STOP (SBR33)	For enable drives
Every cycle (SM0.0)	MCP_802D (SBR34)	802D MCP signals to MCP interface
Every cycle (SM0.0)	MCP_NCK (SBR38)	Transferring MCP to NCK interface
Every cycle (SM0.0)	AXES_CTL (SBR40)	Enabling NCK interface signals
Every cycle (SM0.0)	COOLING (SBR44)	Cooling control
Every cycle (SM0.0)	LUBRICAT (SBR45)	Lubricating control

5.3.3. PLC Machine Data related

The related PLC MD are:

MD14510[16] = 2 - for milling machine.
MD14510[24] = value - Lubrication interval (unit: 1.0 Min.).
MD14510[25] = value - Lubrication duration (unit: 0.01S).

Note:

Load initialization file **setup_M.ini** to PCU. Standard milling configuration is for 4 feed axes and one spindle, so it is necessary to modify the setting. Machine data MD20070[5]=0 will cancel axis A1.