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MT-CNC / MTC200
Gear Speed Selection
V15

Description of Functions

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Purpose of the document This document describes the 'Gear speed selection' function and the related requirements.

Configuration control

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Contents

1 Introduction

Machine tool applications frequently require a speed and torque range to be covered that exceeds the capacity of the main spindle drives.

Using changeable gears significantly enhance those ranges. Each gear step, however, only covers a specific speed and torque range.

If the required speed is lower or higher that it would be tolerated by the currently selected gear step, changing to another gear step is necessary.

2 Gear Speed Selection - Scope of Functions

2.1 Gear Speed Selection from the NC User's Perspective

Usually, automatic gear speed selection (M40) is used for milling machines. Programming the auxiliary functions for direct gear speed selection (M41 through M44) is the exception.

With lathes, in contrast, direct gear speed selection is preferred because the selected gear stage has a stronger effect on the workpiece surface quality. Usually, the speed ranges of the individual gear steps overlap more than the gear steps of milling machines.

As a function of the spindle index ('Sx'; x Ɛ {' ', '1', '2', '3'}), the following auxiliary functions may be programmed for gear speed selection:

- Mx40: Automatic gear speed selection for spindle x
- Mx41: 1st gear step for spindle x
- Mx42: 2nd gear step for spindle x
- Mx43: 3rd gear step for spindle x
- Mx44: 4th gear step for spindle x

If there is no multi-step gearbox ('number of gear steps' axis parameter = 1), the auxiliary function for gear speed selection may also be used for other purposes.

The NC executes the auxiliary functions M40 through M41, like any other auxiliary function, at the end of the block. If automatic gear speed selection (M40) is active, the NC commands a necessary gear shift before the NC actually performs the commanded speed.

2.2 Automatic Gear Speed Selection

Automatic gear speed selection (Mx40) only comes into effect if there is a gearbox with at least two stages. Using the 'automatic gear speed selection' axis parameter, the operator can select whether,

- after power-on,
- during jogging in manual mode,
- after a BST/RET command, and
- after the Control-Reset key has been pressed,

automatic gear speed selection(Mx40) or the auxiliary function (Mx41 through Mx44) that is related to the currently selected gear step is active.

With Mx40, the NC employs the speed limits of the individual gear steps that are stored in the parameters, and automatically calculates, for each specified speed, the required gear step. Using the auxiliary functions Mx41 through Mx44, it transmits the gear step to the SPS that performs the necessary selection.

If gear steps overlap in automatic gear speed selection, the NC always selects the step with the lower speed (higher torque).

Programming S0 does not cause the gear step to be changed.

In automatic mode and in MDI mode, the NC employs the S value that has been programmed in conjunction with Mx03, Mx04 or Mx05 for computing the gear step (see Appendix).

The S value that has been programmed for 'constant surface speed' is not taken into account when the gear speed is selected. With G96, the currently selected gear step is retained until one of the auxiliary functions

Mx41 through Mx44 changes the gear step and, consequently, de-selects automatic gear speed selection.

In manual mode, the currently selected gear step is retained, even if Mx40 is active.

If a different gear step is required in manual mode, it can be selected by changing over to MDI mode and entering the corresponding auxiliary function.

The gear step is retained when the mode changes.

2.3 Monitoring and Limiting the Speed

If, while one of the auxiliary functions Mx41 through Mx44 is active, a speed value is commanded that cannot be reached with the currently selected gear step, the NC outputs the minimum and/or maximum speed of the step concerned. This applies to automatic mode, MDI mode, and manual mode.

The NC monitors and delimits the speed values with respect to the minimum and the maximum speed not only after a speed value has been specified, but also when the spindle speed is influenced by a spindle override or the ‘constant surface speed’ function (G96).

Thus, the SPS may only permit the spindle to be jogged in manual mode if the necessary gear step is selected. If this is not the case, the spindle rotates at the minimum speed of the step if too high a gear step has been selected.

In such a case, the SPS should not permit the spindle to be jogged, and issue a message that prompts the operator to change gear in MDI mode.

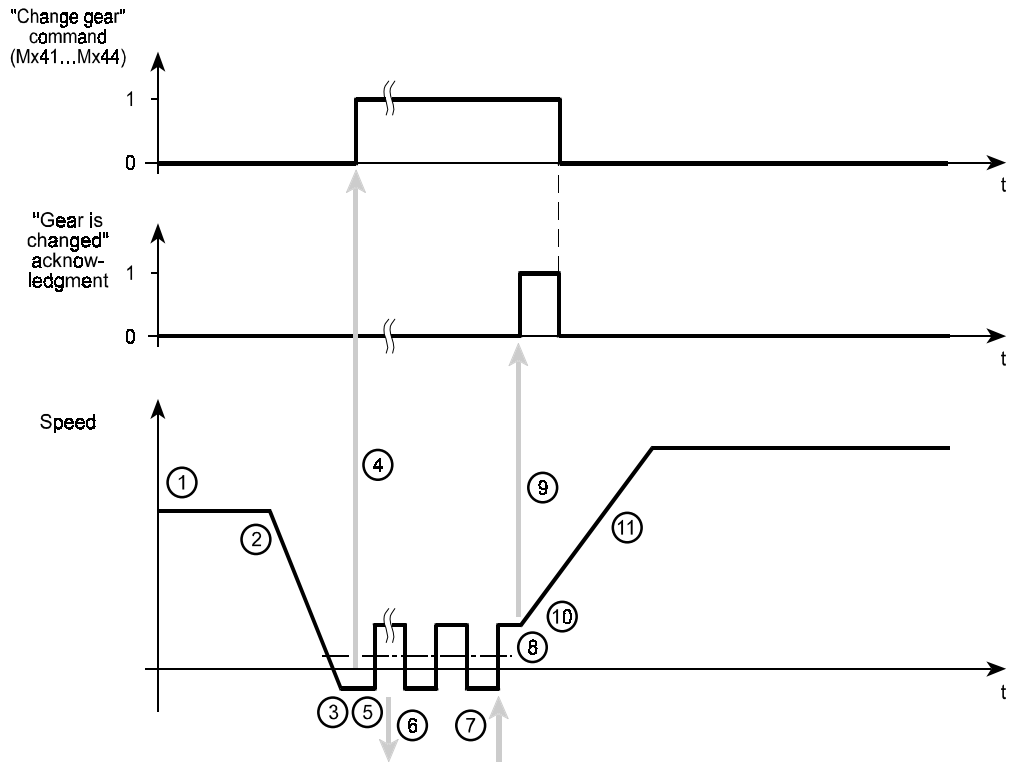
2.4 Status Display

If automatic gear step selection is not active, the currently pending M functions show the currently selected gear step and/or the gear step that should newly be selected.

As soon as automatic gear step selection (Mx40) is active, the status display of M functions always shows Mx40, irrespective of the currently selected gear step or the gear step that is going to be selected.

Irrespective of the M functions, the status display always shows the current gear step (1-4) is a multi-step gearbox exists for the spindle concerned. An undefined gear state is indicated by a ‘?’.

3 Gear Speed Selection Sequence



① Gear speed selection in the NC program
② Decelerate spindle
③ Change the parameter record of the drive
④ 'Change gear' command by outputting auxiliary function M41 through M46 (NC → SPS)
⑤ Initiate hunting, drifting or positioning
⑥ Initiate gear change
⑦ Terminate gear change
⑧ Terminate hunting, drifting or positioning
⑨ 'Gear is shifted' acknowledgment by acknowledging the auxiliary function (SPS → NC)
⑩ Specifying the new speed to the drive
⑪ Accelerate to new programmed speed

Fig. 3-1: Sequence of automatic gear speed selection

3.1 Selecting the Gear Step in the NC Program

With Mx40, the NC automatically selects the gear step that is required for the commanded speed. If one of the auxiliary functions Mx41 through Mx44 has been programmed, that auxiliary function directly selects the gear step.

3.2 Decelerating the Spindle

Irrespective of the gear speed selection method, the NC initiates gear speed selection by at first decelerating the spindle.

3.3 Changing the Parameter Record of the Drive

Once the spindle has stopped, the NC selects, in the drive, the parameter record that belongs to the gear step.

3.4 'Change Gear' Command (NC → SPS)

The SPS monitors the auxiliary functions Mx41 through Mx44. As soon as one of those auxiliary functions is active, the SPS recognizes that a new gear step must be selected.

3.5 Initiating Hunting, Drifting, or Positioning

The SPS employs the AXD_WR and AXD_RD function blocks to start hunting, drifting, or positioning. Using the APR SERCOS parameter 'spindle functions' (ident number 65012 for the SPS or P-7-3572 for the NC), the required functions may be started, and their current state can be interrogated.

Bit	State	Function	Comment
0	0 1	- Hunting	 with KDA, RAC and TDA only
1	0 1	- Positioning	 with KDA, RAC and TDA only
2	0 1	- Drifting	 for analog drives too
8	0 1	- Hunting active	 with KDA, RAC and TDA only
9	0 1	- Positioning active	 with KDA, RAC and TDA only
10	0 1	- Drifting active	 for analog drives too

The following APR SERCOS parameters permit different speed, acceleration, and position values for the drifting and positioning functions to be selected.

SPS ID	NC ID	Function	Unit	Comment
65013	P-7-3573	Speed for drifting	0.0001 1/min	Value can be modified when function is active;; max. speed = 1000 rpm
65014	P-7-3574	Acceleration for drifting	rad/s^2	
65015	P-7-3575	Position for positioning	degrees	0 degrees ≤ position ≤ 360 degrees; speed and acceleration must be entered in the drive via the SERCOS parameters.

Note: To access the corresponding data, the SPS ident numbers (SPS ID) must be used in the SPS, and the NC ident numbers (NC ID) must be used in the NC.

Hunting can be influenced by the following SERCOS parameters:

NC ID	Function	Unit
S-0-0213	Hunting speed	0.0001 rpm
S-0-0214	Hunting offset speed	0.0001 rpm
S-0-0215	Hunting cycle time	0.1 ms

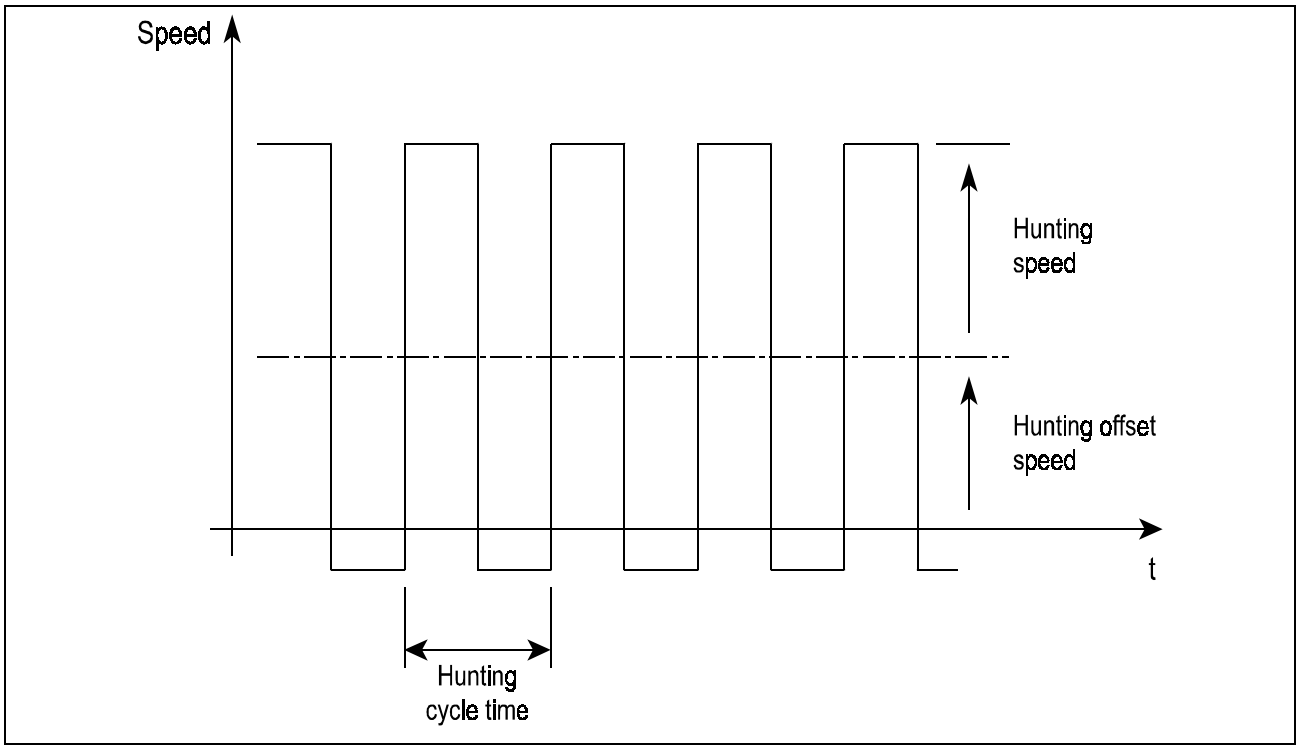


Fig. 3-2: Hunting

As long as different hunting movements are not required, the related parameters may be entered in the SERCOS parameters during commissioning.

Note: Hunting and positioning is only available with digital INDRAMAT drives (KDA, RAC and TDA).

3.6 Initiating Gear Change

In the SPS, performing the gear changing process proper must take all machine- and gear-related peculiarities into account.

The SPS may set the ‘change gear’ output, for example, to initiate a gear change.

3.7 Terminating Gear Change

As soon as the gearbox is engaged, this state is reported to the SPS via a ‘gear is engaged’ input. The SPS then reports the selected gear step to the NC, using the ‘actual gear step’ interface signals.

Several attempts may be necessary if the required gear step does not engage. The SPS issues a message and does not acknowledge the related auxiliary function if changing gears is not successful after several attempts and/or after a specific time has elapsed.

Note: There is a standard function block for gear speed selection available in the SPS (see Chapter 6). This standard function

block permits a specific gear change to be performed swiftly by connecting existing inputs.

3.8 Terminating Hunting, Drifting, or Positioning

The SPS terminates the hunting, drifting, or positioning process as soon as the selected gear step has engaged.

3.9 'Gear is shifted' Acknowledgment (SPS → NC)

The SPS acknowledges a successfully completed gear change by acknowledging the pending auxiliary function.

3.10 Specifying the New Speed to the Drive

The NC transmits the new programmed spindle speed to the drive. According to the current parameter record, the drive takes the transmission ratio of the gear step into account.

3.11 Accelerating to the New Programmed Speed

The NC transitions to the next NC block after the drive has accelerated to the new programmed command speed and the block has been completed.

4 Setting the Parameter Values

The MT-CNC takes gear drives only into account in conjunction with digital primary spindles or with digital spindles with rotary axis capability.

4.1 Number of Gear Steps

A value between 1 and 4 may be entered for the ‘number of gear steps’ axis parameter.

The axis parameter must be set to ’1’ if a gear drive does not exist.

An existing transmission ratio can be taken into account via the SERCOS parameters ‘gearbox revolutions, input’ and ‘gearbox revolutions, output’.

According to the value entered for the number of gear steps, the user interface only displays the parameters of the existing gear steps.

4.2 Automatic Gear Step Selection

Automatic gear step selection is active

- after power-on,
- during jogging in manual mode,
- after a BST/RET command, and
- after the Control-Reset key has been pressed,

if the ‘automatic gear step selection’ parameter has been set to ‘Yes’.

If the axis parameter is set to ‘No’, merely the auxiliary function (Mx41 through Mx44) is active that belongs to the currently selected gear step.

While the direct gear step selection is frequently employed for lathes, the automatic gear step selection is preferred for milling machines.

4.3 Parameters for the Individual Gear Steps

For each gear step of a main spindle, a maximum speed value, a minimum speed value, and a maximum acceleration value must be entered in the axis parameters.

The NC uses the maximum and minimum speed values of the individual gear steps as a database for automatic gear changes and for speed monitoring.

Parameter name	Valid range	Default
Min. speed of gear step 1	0 - 500000 rpm	0 rpm
Max. speed of gear step 1	0 - 500000 rpm	200 rpm
Max. acceleration of gear step 1	0 - 100000 rad/s²	100 mm/s²
Min. speed of gear step 2	0 - 500000 rpm	0 rpm
Max. speed of gear step 2	0 - 500000 rpm	200 rpm
Max. acceleration of gear step 2	0 - 100000 rad/s²	100 mm/s²
Min. speed of gear step 3	0 - 500000 rpm	0 rpm
Max. speed of gear step 3	0 - 500000 rpm	200 rpm
Max. acceleration of gear step 3	0 - 100000 rad/s²	100 mm/s²
Min. speed of gear step 4	0 - 500000 rpm	0 rpm
Max. speed of gear step 4	0 - 500000 rpm	200 rpm
Max. acceleration of gear step 4	0 - 100000 rad/s²	100 mm/s²

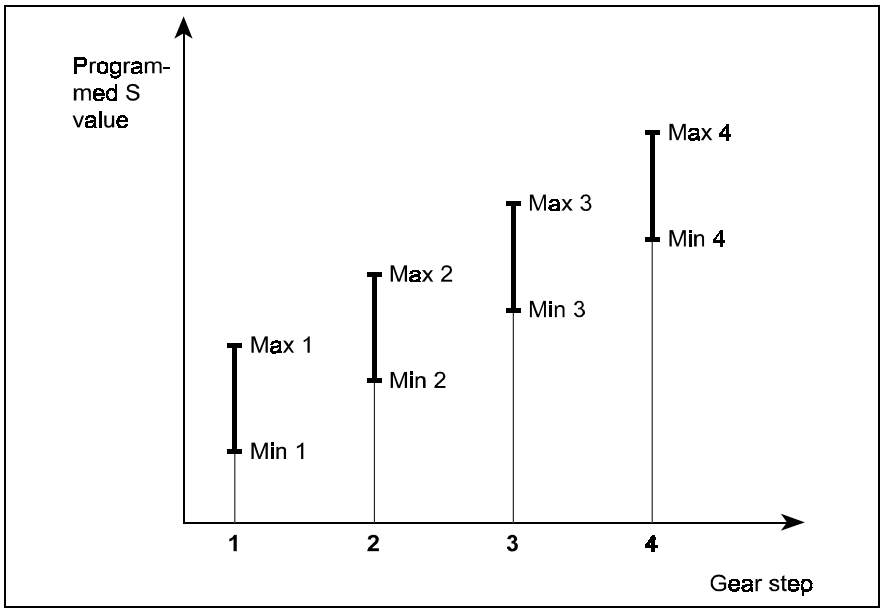


Fig. 4-1: Limit values and speed ranges of the individual gear steps

5 Interface Signals

The auxiliary functions Mx40 through Mx44 are reserved for gear speed selection if a gear drive with at least two stages is available. Out of the auxiliary functions Mx40 through Mx44, the NC only passes the auxiliary functions Mx41 through Mx44 on to the SPS.

5.1 Command: 'Change Gear'

The NC sets one of the auxiliary functions Mx41 through Mx44 if changing gear is necessary. This is done irrespective of whether the gear change has been determined by the automatic gear step selection (Mx40) or has directly been selected in the NC program by one of the auxiliary functions Mx41 through Mx44.

The number of the gear step that must be set corresponds to the last digit of the currently active auxiliary function (Mx41 through Mx44).

5.2 Acknowledgment: 'Gear Speed Selection Is Terminated'

Whenever gear speed selection could successfully be completed, the auxiliary functions Mx41 through Mx44 must be acknowledged by the SPS.

Gear speed selection is only considered as being completed if no more auxiliary functions are pending and the SPS has set the acknowledgment.

Together with the acknowledgment, the SPS must return the selected gear step to the NC.

Note: The NC checks the actual gear step only after the auxiliary functions Mx41 through Mx44 have been acknowledged.

5.3 Actual Gear Step

The ‘actual gear step' (AxxCGEAR1, AxxCGEAR2, AxxCGEAR3) interface signals exist for each axis:

Actual gear step	AxxCGEAR3	AxxCGEAR2	AxxCGEAR1
1	0	0	0
2	0	0	1
3	0	1	0
4	0	1	1
not defined	1	1	1

Based on the actual gear step, the SPS informs the NC about the currently selected gear step. The NC only takes the ‘actual gear step’ interface signals into account if there is a gear drive with at least two stages.

The NC must always know the current gear step in order to be able to control gear speed selection, to initiate a necessary gear change, and/or to avoid a change to an existing gear step.

Note: The SPS must continually update the ‘actual gear step’ interface signals; in particular upon each gear step change and whenever the controller is switched on.

6 SPS Programming for Gear Speed Selection

6.1 General Information About Gear Speed Selection

Besides generally triggering the valves that control the gear speed selection, the SPS must ensure that the currently selected gear stage is reported to the NC.

To exchange that request between SPS and NC, there are three interface signals in the axis interfaces available.

According on the requested gear step, the SPS performs the selection, interprets the feedback signals from the initiators of the gear steps, reports them via the axis interface signals to the NC, and acknowledges the requests from the NC.

The SPS recognizes the requests for gear change via M functions that are invariably assigned to the gear steps.

The M functions that must be used in this process are:

- Mx41,
- Mx42,
- Mx43 and
- Mx44.

<x> stands for the spindle index (", 1, 2 or 3).

6.2 Gear Speed Selection Block Diagram

The block diagram on the next page shows the execution of a gear speed selection. The figure does not show the interrogation of enabling signals and other safety equipment.

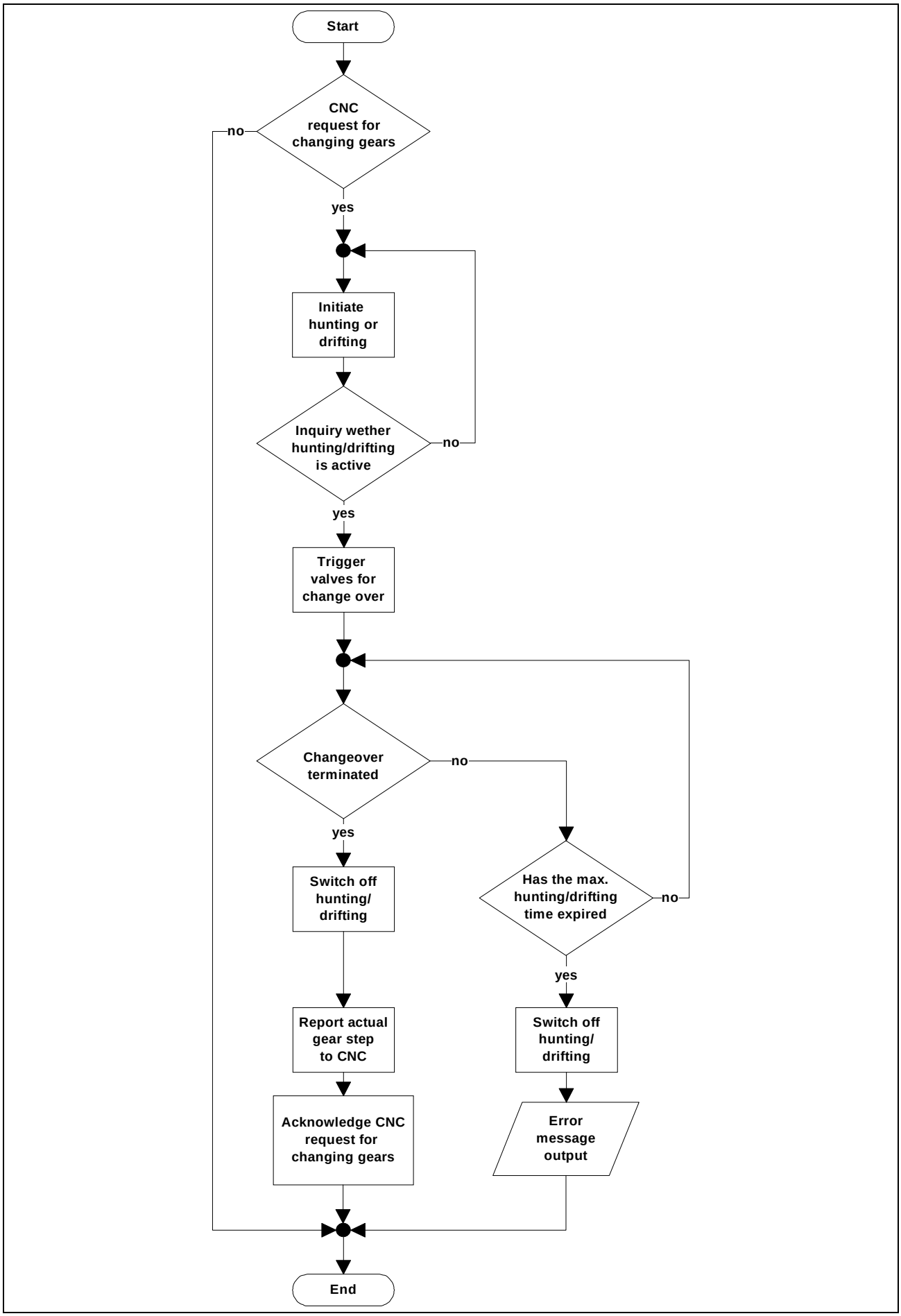


Fig. 6-1: Gear speed selection block diagram

6.3 To Be Noted

Switching On the Controller

When the controller is switched on, the CNC must immediately (i.e. within the first SPS cycle) have the actual gear step reported via the axis interface signals between SPS and CNC (AxxCGEAR1, AxxCGEAR2, AxxCGEAR3).

Consequently, the assignment to the actual gear step bits must be programmed in the first step (initialization step) of the SFC structure.

The assignment to the CNC may be programmed once in the initialization step while the further process of gear speed selection (changing gear, acknowledgment, etc.) is executed in the program step. Alternatively, the complete sequence may continually be processed as a SETTING ACTION in the initialization step.

Using Structured Axis Data Types

If structured axis data types are used within the SPS program (in this case special types inside of employed function blocks), is must be ensured that the output signals do not overwrite each other.

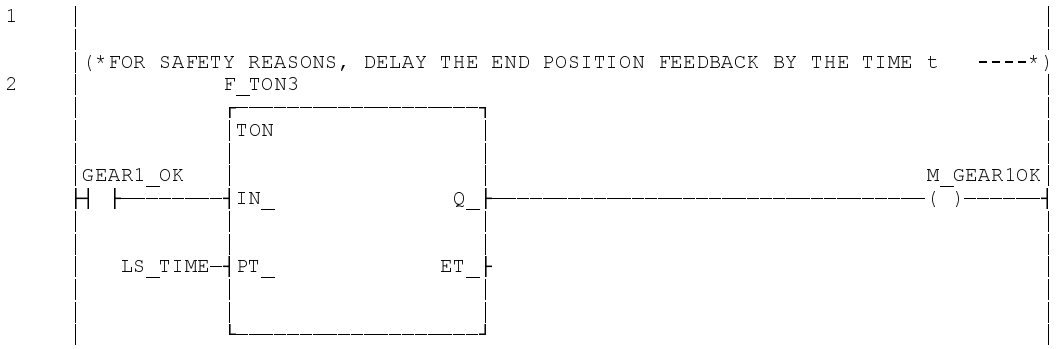
This may happen if a complete axis data type is processed within an employed function block, and has been connected as an output, without entering the current states of the outputs in the function blocks.

This means for the transfer of the actual gear step bits to the CNC that such a function block may, depending on the sequence of execution, overwrite the output signals.

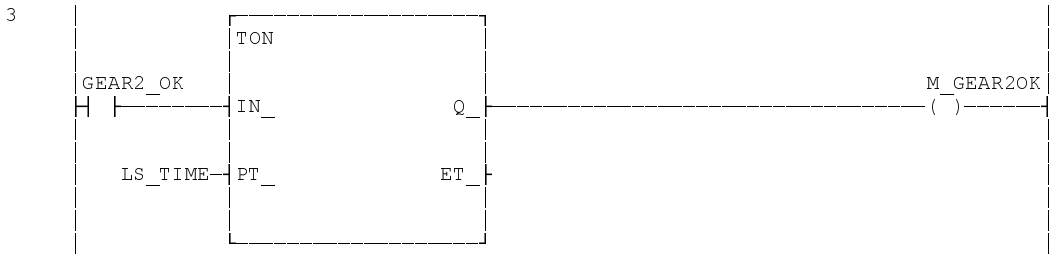
Within an SFC structure, it must be noted that only one step is processed in each SPS cycle

6.4 Typical SPS Program

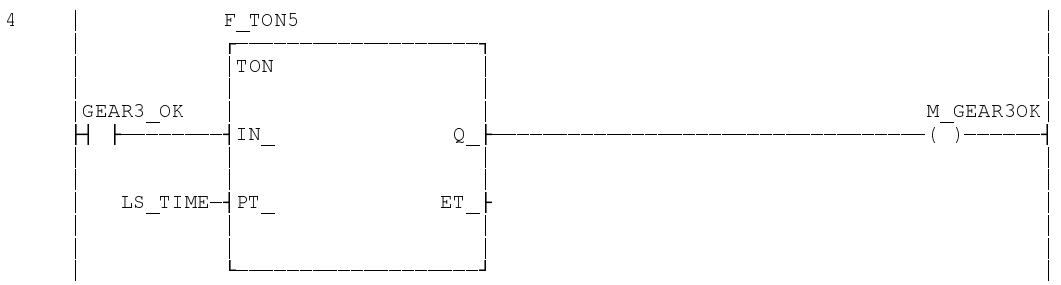
The following is a typical SPS program for gear speed selection:



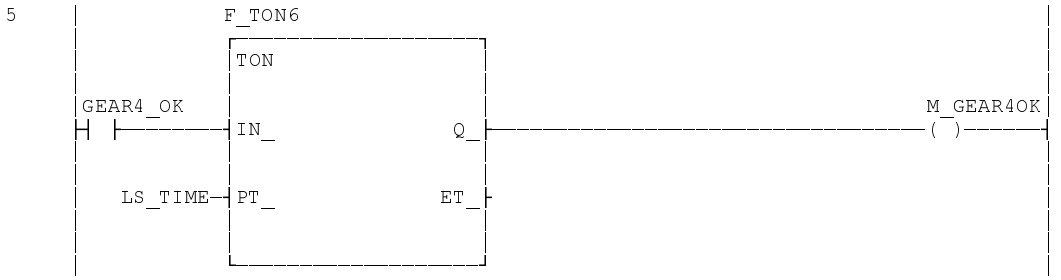
F_TON3..... DELAY END POSITION VALVE 1..... ..... TON
GEAR1_OK..... GEAR STEP 1 ENGAGED..... VAR_INPUT. BOOL
M_GEAR1OK..... TIMER 3 EXPIRED .... BOOL
LS_TIME..... END POSITION DELAY TIME ..... VAR_INPUT. TIME



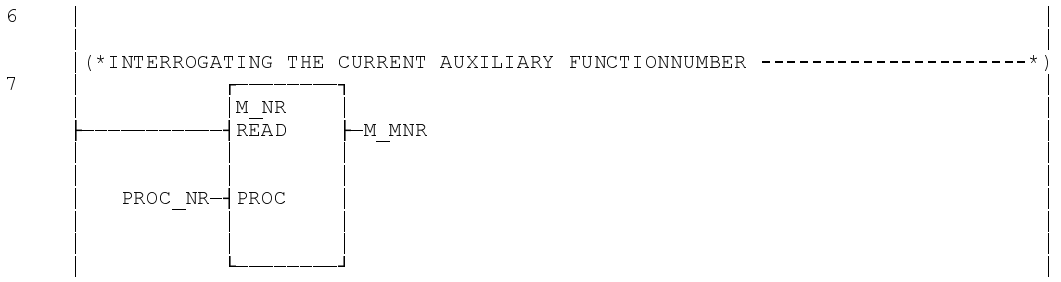
F_TON4..... DELAY END POSITION VALVE 2..... ..... TON
GEAR2_OK..... GEAR STEP 2 ENGAGED ..... VAR_INPUT. BOOL
M_GEAR2OK..... TIMER 4 EXPIRED .... BOOL
LS_TIME..... END POSITION DELAY TIME ..... VAR_INPUT. TIME



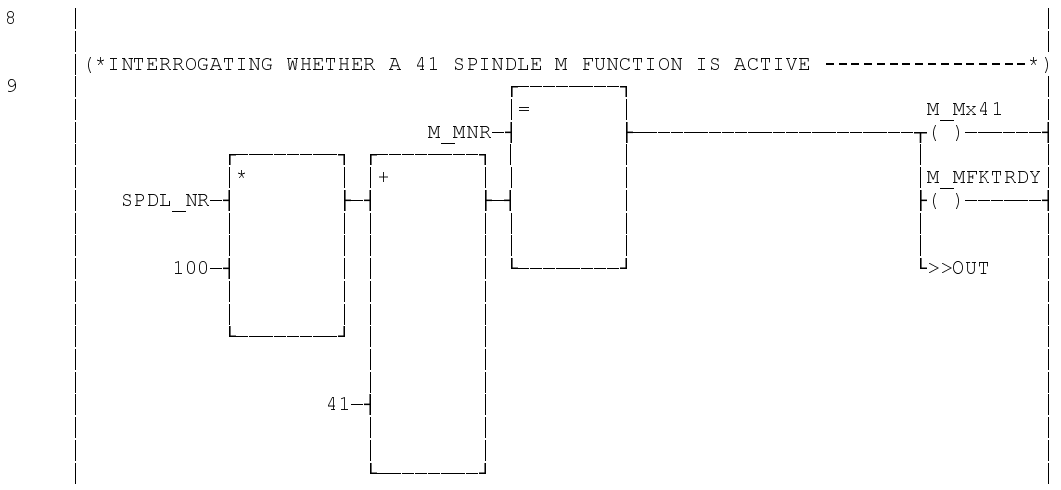
F_TON5..... DELAY END POSITION VALVE 3..... ..... TON
GEAR3_OK..... GEAR STEP 3 ENGAGED ..... VAR_INPUT. BOOL
M_GEAR3OK..... TIMER 5 EXPIRED .... BOOL
LS_TIME..... END POSITION DELAY TIME ..... VAR_INPUT. TIME



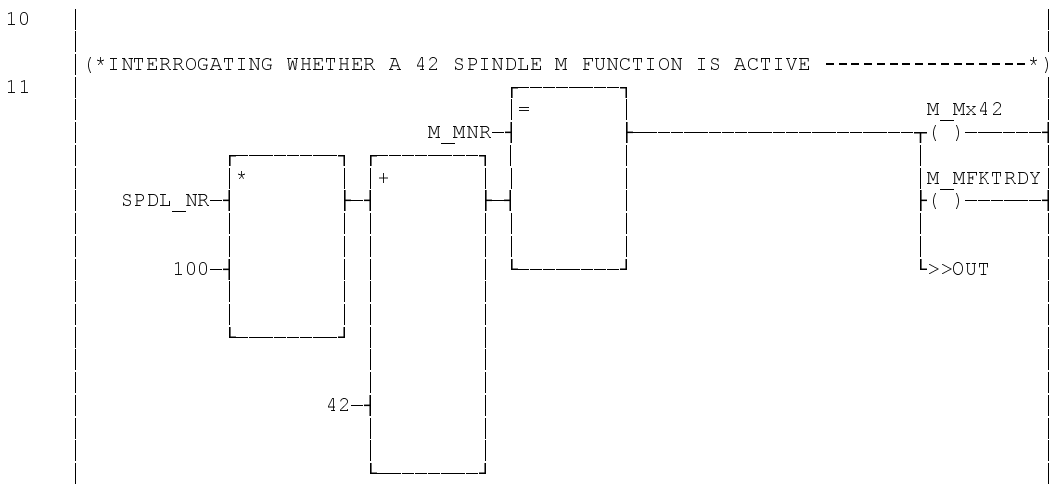
F_TON6..... DELAY END POSITION VALVE 4..... ..... TON
GEAR4_OK..... GEAR STEP 4 ENGAGED ..... VAR_INPUT. BOOL
M_GEAR4OK..... TIMER 6 EXPIRED .... BOOL
LS_TIME..... END POSITION DELAY TIME ..... VAR_INPUT. TIME



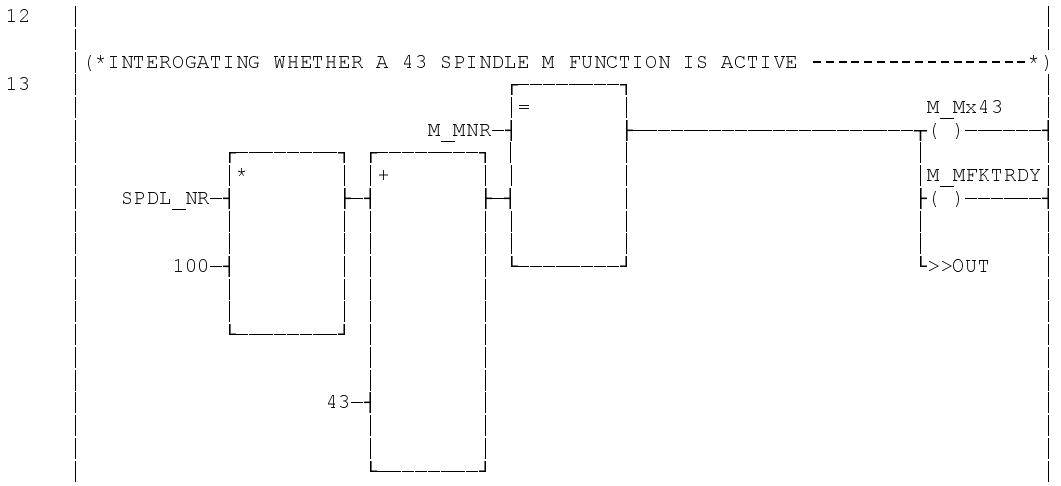
M_NR	.....	.....	M_NR
M_MNR	FLAG FOR M FUNCTION NO.	.....	INT
PROC_NR	PROCESS NUMBER	VAR_INPUT.	INT



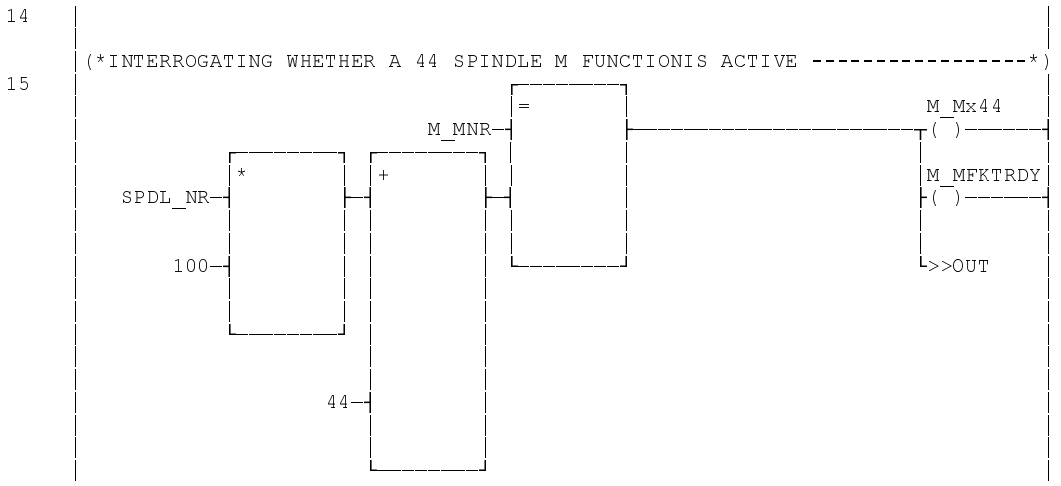
M_MNR	FLAG FOR M FUNCTION NO.	.....	INT
M_Mx41	Mx41 IS ACTIVE.....	.....	BOOL
SPDL_NR	NUMBER OF THE SPINDLE	VAR_INPUT.	INT
M_MFKTRDY	M FUNCTION DETECTED	.....	BOOL
100	.....	.....	ANY_INT
OUT	.....	.....	LABEL
41	.....	.....	ANY_INT



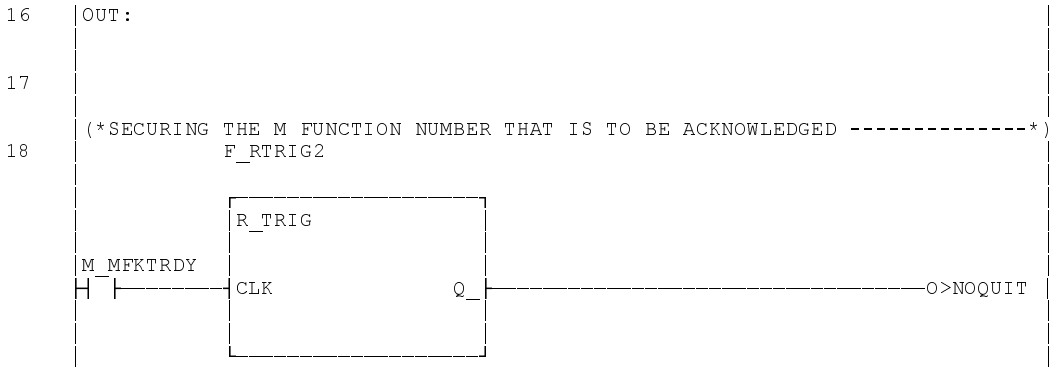
M_MNR	FLAG FOR M FUNCTION NO.	.....	INT
M_Mx42	Mx42 IS ACTIVE	.....	BOOL
SPDL_NR	NUMBER OF THE SPINDLE	VAR_INPUT.	INT
M_MFKTRDY	M FUNCTION DETECTED	.....	BOOL
100	.....	.....	ANY_INT
OUT	.....	.....	LABEL
42	.....	.....	ANY_INT



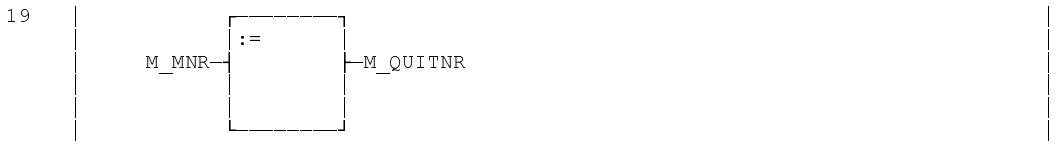
M_MNR	FLAG FOR M FUNCTION NO.	INT
M_Mx43	Mx43 IS ACTIVE	BOOL
SPDL_NR	NUMBER OF THE SPINDLE	VAR_INPUT. INT
M_MFKTRDY	M FUNCTION DETECTED	BOOL
100		ANY_INT
OUT		LABEL
43		ANY_INT



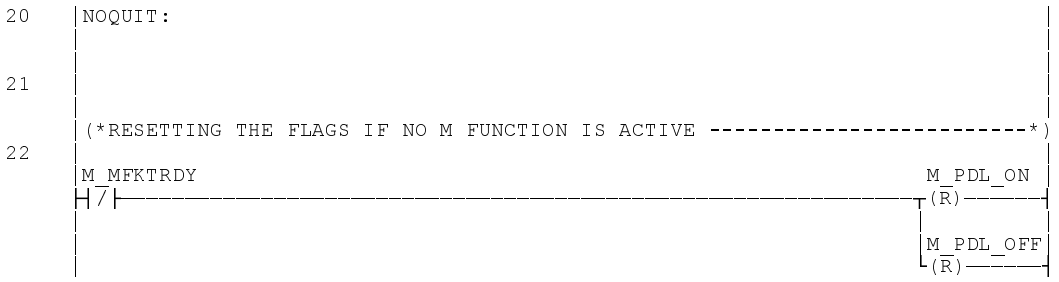
M_MNR	FLAG FOR M FUNCTION NO.	INT
M_Mx44	Mx44 IS ACTIVE	BOOL
SPDL_NR	NUMBER OF THE SPINDLE	VAR_INPUT. INT
M_MFKTRDY	M FUNCTION DETECTED	BOOL
100		ANY_INT
OUT		LABEL
44		ANY_INT



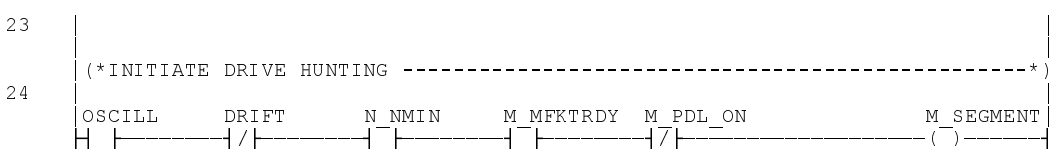
F_RTRIG2	SECURE M FUNCTION NO.	R_TRIG
M_MFKTRDY	M FUNCTION DETECTED	BOOL
NOQUIT		LABEL



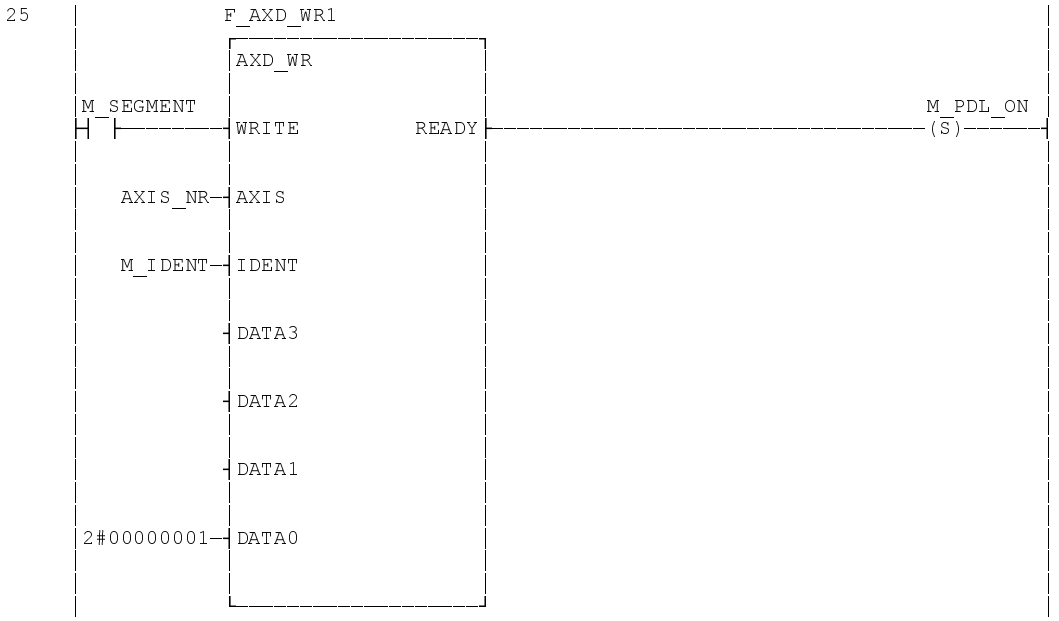
M_MNR..... FLAG FOR M FUNCTION NO. .... INT
M_QUITNR..... SECURE M FUNCTION NUMBER .... INT



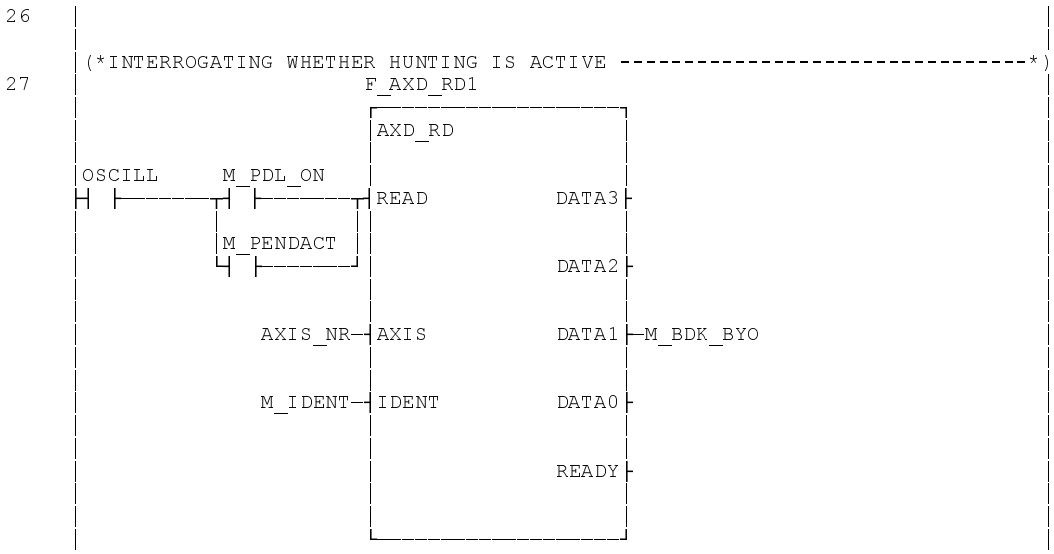
M_MFKTRDY..... M FUNCTION DETECTED .... BOOL
M_PDL_ON..... ACTIVATE HUNTING .... BOOL
M_PDL_OFF..... DE-ACTIVATE HUNTING .... BOOL



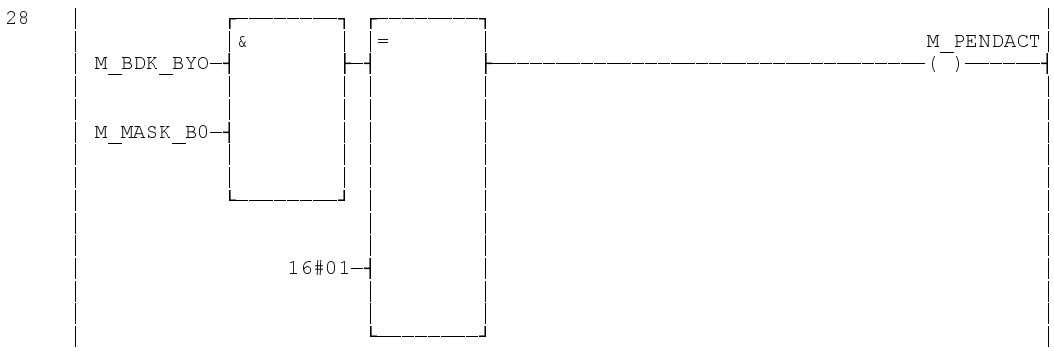
OSCILL..... ACTIVATE HUNTING ..... VAR_INPUT. BOOL
DRIFT..... ACTIVATE DRIFTING ..... VAR_INPUT. BOOL
N_NMIN..... N<Nmin MESSAGE ..... VAR_INPUT. BOOL
M_MFKTRDY..... M FUNCTION DETECTED .... BOOL
M_PDL_ON..... ACTIVATE HUNTING .... BOOL
M_SEGMENT..... INTERMEDIATE FLAG SEGMENT .... BOOL



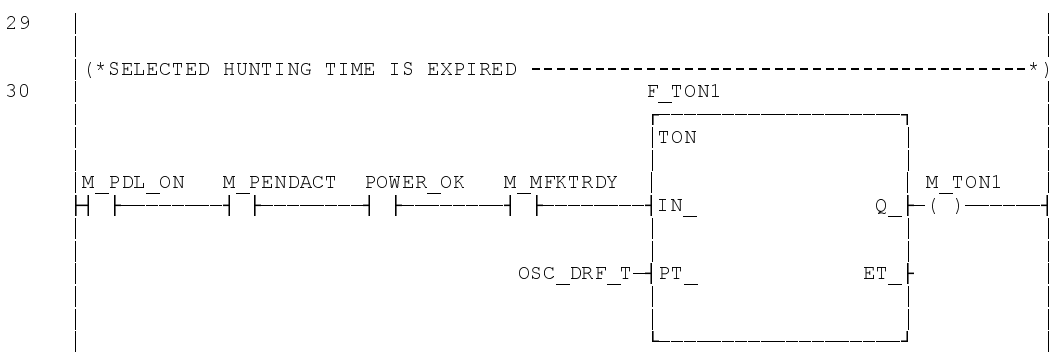
F_AXD_WR1..... ACTIVATE HUNTING .... AXD_WR
M_SEGMENT..... INTERMEDIATE FLAG SEGMENT..... ..... BOOL
M_PDL_ON..... ACTIVATE HUNTING .... BOOL
AXIS_NR..... NUMBER OF THE AXIS ..... VAR_INPUT. INT
M_IDENT..... IDENT NO. OF SERCOS PARAMETER .... UINT
2#00000001..... .... Binary



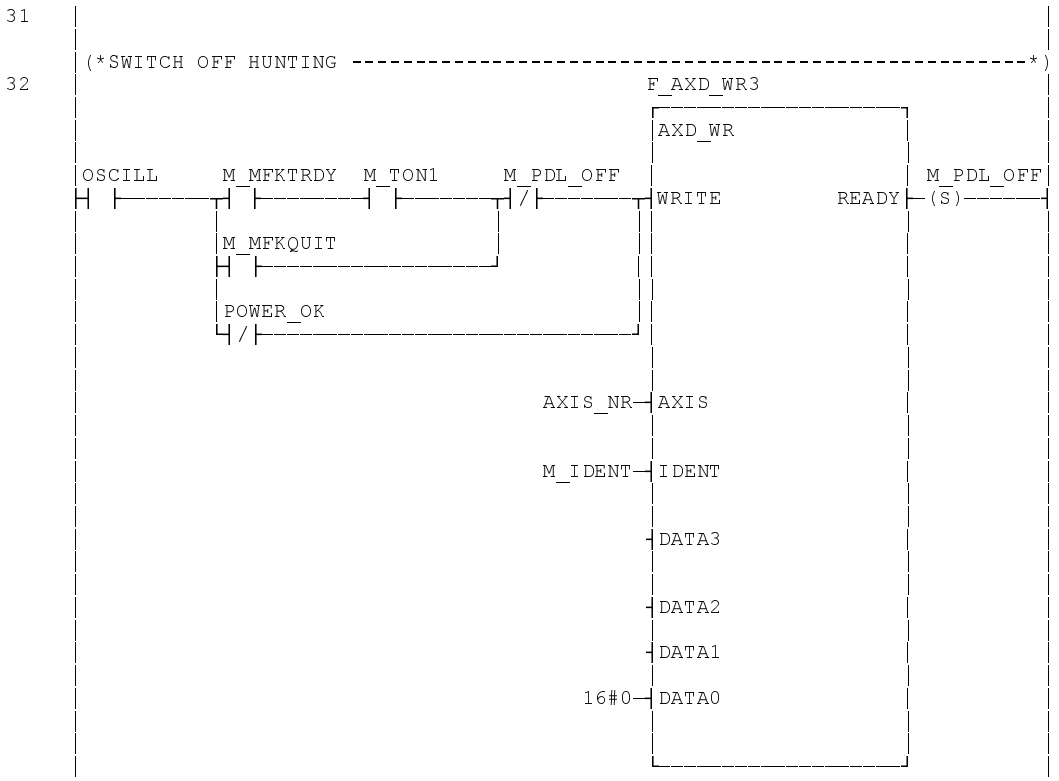
F_AXD_RD1..... IS HUNTING ACTIVE ? .... AXD_RD
OSCILL..... ACTIVATE HUNTING ..... VAR_INPUT. BOOL
M_PDL_ON..... ACTIVATE HUNTING .... BOOL
M_PENDACT..... HUNTING IS ACTIVE .... BOOL
AXIS_NR..... NUMBER OF THE AXIS ..... VAR_INPUT. INT
M_BDK_BYO..... BYTE HUNTING BDK..... ..... BYTE
M_IDENT..... IDENT NO. OF SERCOS PARAMETER .... UINT



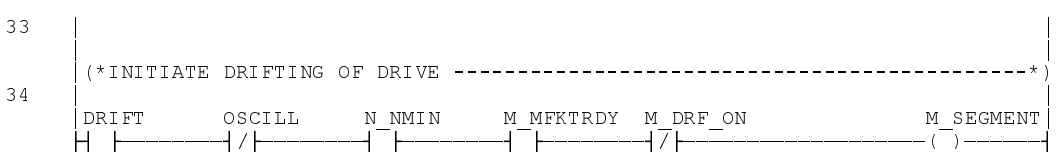
M_BDK_BYO..... BYTE HUNTING BDK..... ..... BYTE
M_PENDACT..... HUNTING IS ACTIVE .... BOOL
M_MASK_B0..... MASK FOR BIT 0 .... BYTE
16#01..... .... Hexadec



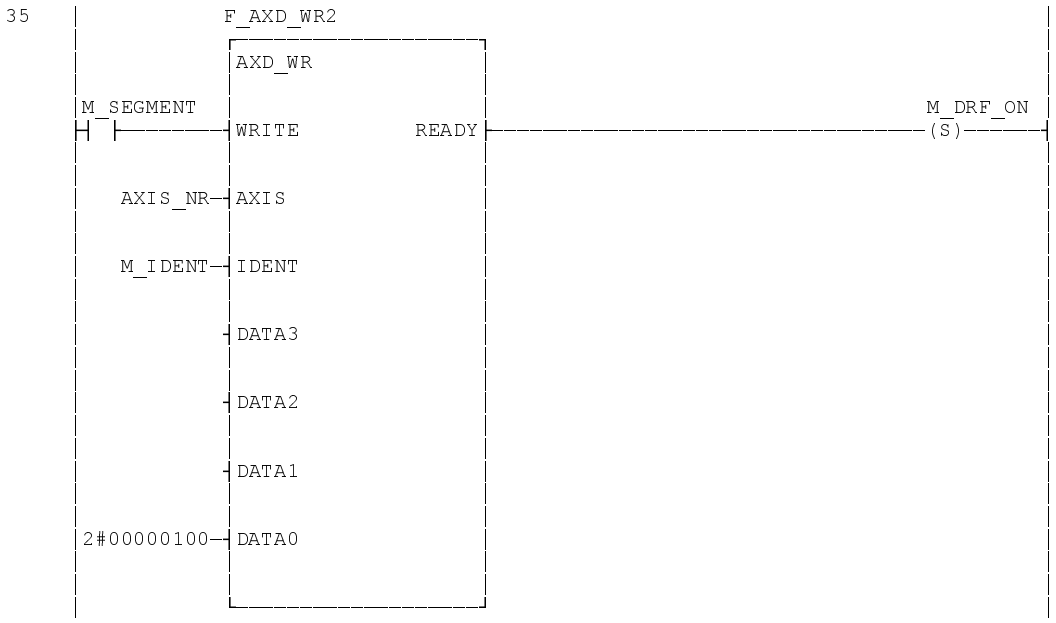
F_TON1..... LET HUNTING TIME EXPIRE .... TON
M_PDL_ON..... ACTIVATE HUNTING .... BOOL
M_PENDACT..... HUNTING IS ACTIVE .... BOOL
POWER_OK..... POWER IS APPLIED ..... VAR_INPUT. BOOL
M_MFKTRDY..... M FUNCTION DETECTED .... BOOL
M_TON1..... TIMER 1 EXPIRED .... BOOL
OSC_DRF_T..... HUNTING/DRIFT TIME ..... VAR_INPUT. TIME



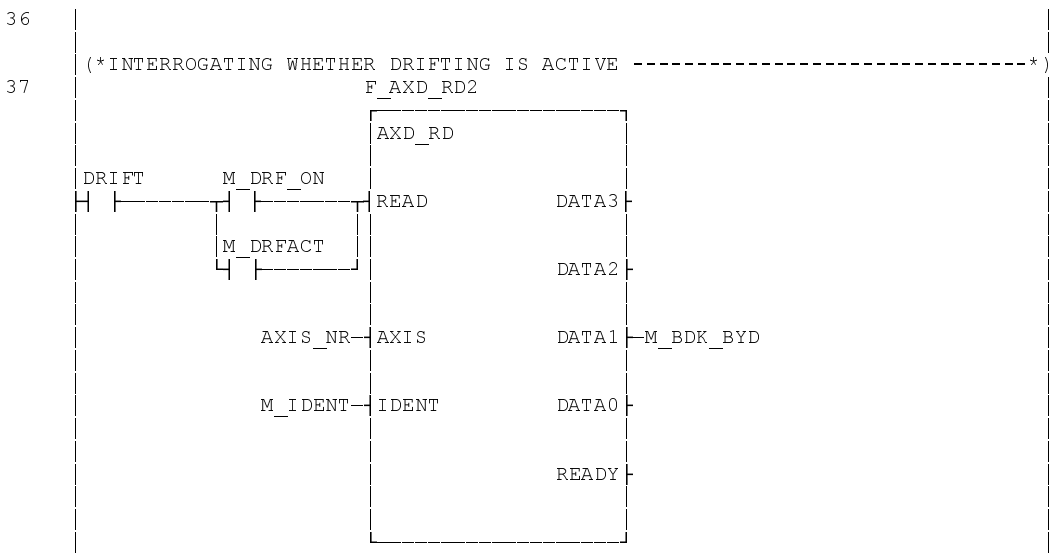

```
F_AXD_WR3..................... SWITCH OFF HUNTING ..................... .......... AXD_WR
OSCILL........................ ACTIVATE HUNTING ....................... VAR_INPUT. BOOL
M_MFKTRDY..................... M FUNCTION DETECTED .................... .......... BOOL
M_TON1........................ TIMER 1 EXPIRED ........................ .......... BOOL
M_PDL_OFF..................... SWITCH OFF HUNTING ..................... .......... BOOL
M_PDL_OFF..................... SWITCH OFF HUNTING...................... .......... BOOL
M_MFKQUIT..................... ACKNOWLEDGE M FUNCTION .................. .......... BOOL
POWER_OK...................... POWER IS APPLIED ....................... VAR_INPUT. BOOL
AXIS_NR....................... NUMBER OF THE AXIS ..................... VAR_INPUT. INT
M_IDENT....................... IDENT NO. OF SERCOS PARAMETER........... .......... UINT
16#0.......................... ....................................... .......... Hexadec
```



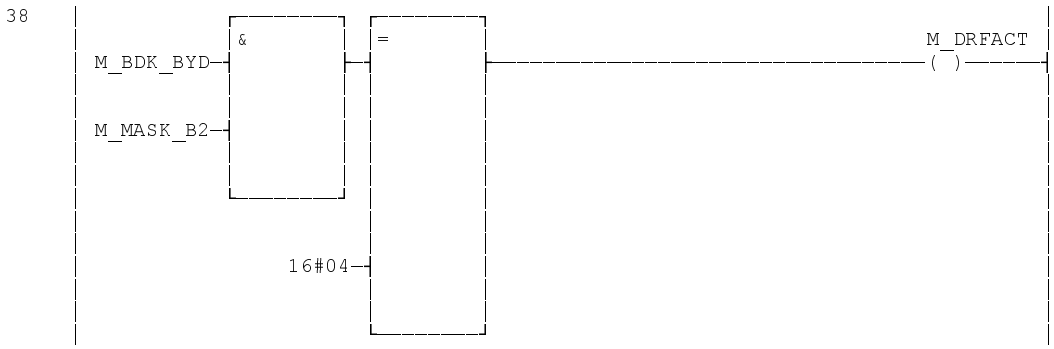

```
DRIFT......................... ACTIVATE DRIFTING ...................... VAR_INPUT. BOOL
OSCILL........................ ACTIVATE HUNTING ....................... VAR_INPUT. BOOL
N_NMIN........................ N<Nmin MESSAGE ......................... VAR_INPUT. BOOL
M_MFKTRDY..................... M FUNCTION DETECTED .................... .......... BOOL
M_DRF_ON...................... ACTIVATE DRIFTING ...................... .......... BOOL
M_SEGMENT..................... INTERMEDIATE FLAG SEGMENT............... .......... BOOL
```



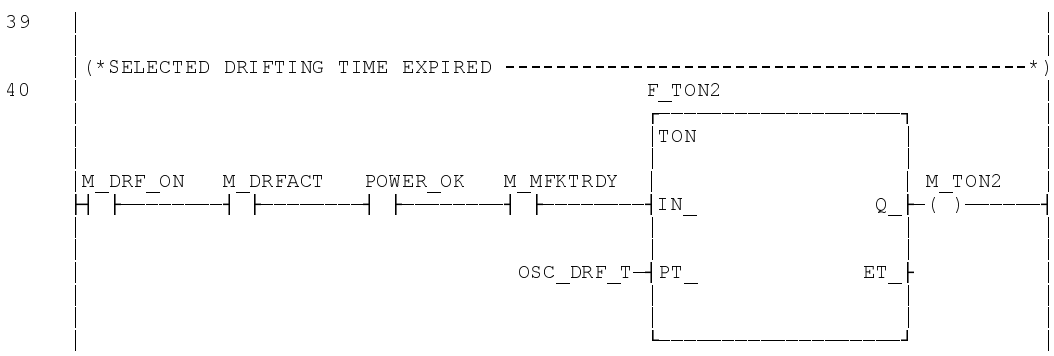

```
F_AXD_WR2..................... INITIATE DRIFTING ..................... .......... AXD_WR
M_SEGMENT..................... INTERMEDIATE FLAG SEGMENT ............. .......... BOOL
M_DRF_ON...................... ACTIVATE DRIFTING ..................... .......... BOOL
AXIS_NR....................... NUMBER OF AXIS ........................ VAR_INPUT. INT
M_IDENT....................... IDENT NO. OF SERCOS PARAMETER .......... .......... UINT
2#00000100.................... ....................................... .......... Binary
```



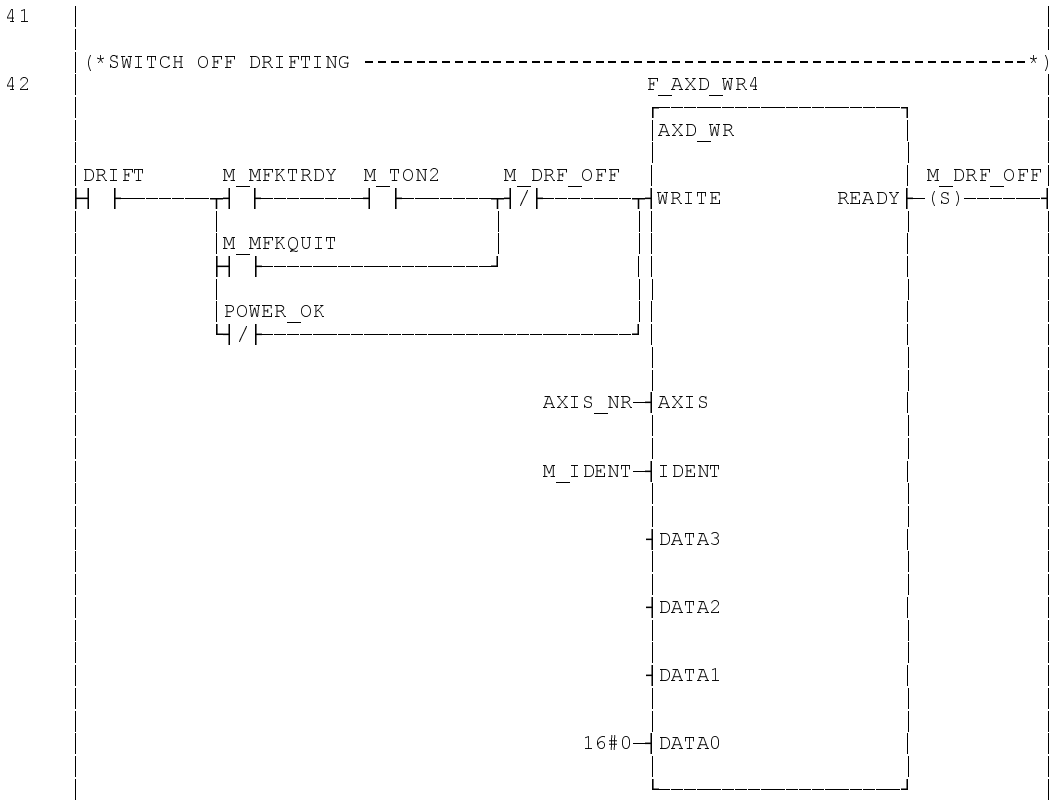

```
F_AXD_RD2..................... IS DRIFTINGACTIVE ? ................... .......... AXD_RD
DRIFT......................... ACTIVATE DRIFTING ..................... VAR_INPUT. BOOL
M_DRF_ON...................... ACTIVATE DRIFTING ..................... .......... BOOL
M_DRFACT...................... DRIFTING IS ACTIVE..................... .......... BOOL
AXIS_NR....................... NUMBER OF THE AXIS .................... VAR_INPUT. INT
M_BDK_BYD..................... BYTE DRIFTING BDK...................... .......... BYTE
M_IDENT....................... IDENT NO. OF SERCOS PARAMETER .......... .......... UINT
```



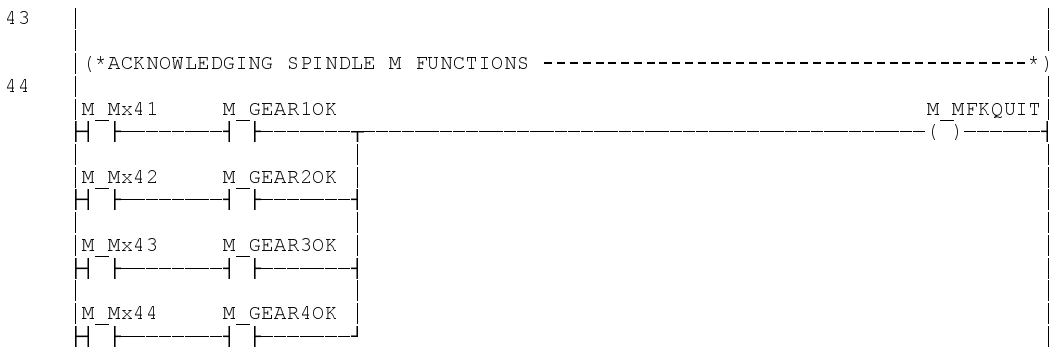

```
M_BDK_BYD..................... BYTE DRIFTING BDK..................... .......... BYTE
M_DRFACT...................... DRIFTING IS ACTIVE ................... .......... BOOL
M_MASK_B2..................... MASK FOR BIT 2 ....................... .......... BYTE
16#04......................... ..................................... .......... Hexadec
```




```
F_TON2........................ LET DRIFTING TIME EXPIRE .............. .......... TON
M_DRF_ON...................... ACTIVATE DRIFTING ..................... .......... BOOL
M_DRFACT...................... DRIFTING IS ACTIVE .................... .......... BOOL
POWER_OK...................... POWER IS APPLIED ...................... VAR_INPUT. BOOL
M_MFKTRDY..................... M FUNCTION DETECTED ................... .......... BOOL
M_TON2........................ TIMER 2 EXPIRED ...................... .......... BOOL
OSC_DRF_T..................... HUNTING/DRIFTING TIME ................. VAR_INPUT. TIME
```



F_AXD_WR4	SWITCHOFF DRIFTING	.....	.....	AXD_WR
DRIFT	ACTIVATE DRIFTING	.....	VAR_INPUT.	BOOL
M_MFKTRDY	M FUNCTION DETECTED	.....	.....	BOOL
M_TON2	TIMER 2 EXPIRED	.....	.....	BOOL
M_DRF_OFF	SWITCH OFF DRIFTING	.....	.....	BOOL
M_DRF_OFF	SWITCH OFF DRIFTING	.....	.....	BOOL
M_MFKQUIT	ACKNOWLEDGE M FUNCTION	.....	.....	BOOL
POWER_OK	POWER IS APPLIOED	.....	VAR_INPUT.	BOOL
AXIS_NR	NUMBER OF THE AXIS	.....	VAR_INPUT.	INT
M_IDENT	IDENT NO. OF SERCOS PARAMETER	.....	.....	UINT
16#0	.....	.....	.....	Hexadec



M_Mx41	Mx41 IS ACTIVE	.....	.....	BOOL
M_GEAR1OK	TIMER 3 EXPIRED	.....	.....	BOOL
M_MFKQUIT	ACKNOWLEDGE M FUNCTION	.....	.....	BOOL
M_Mx42	Mx42 IS ACTIVE	.....	.....	BOOL
M_GEAR2OK	TIMER 4 EXPIRED	.....	.....	BOOL
M_Mx43	Mx43 IS ACTIVE	.....	.....	BOOL
M_GEAR3OK	TIMER 5 EXPIRED	.....	.....	BOOL
M_Mx44	Mx44 IS ACTIVE	.....	.....	BOOL
M_GEAR4OK	TIMER 6 EXPIRED	.....	.....	BOOL

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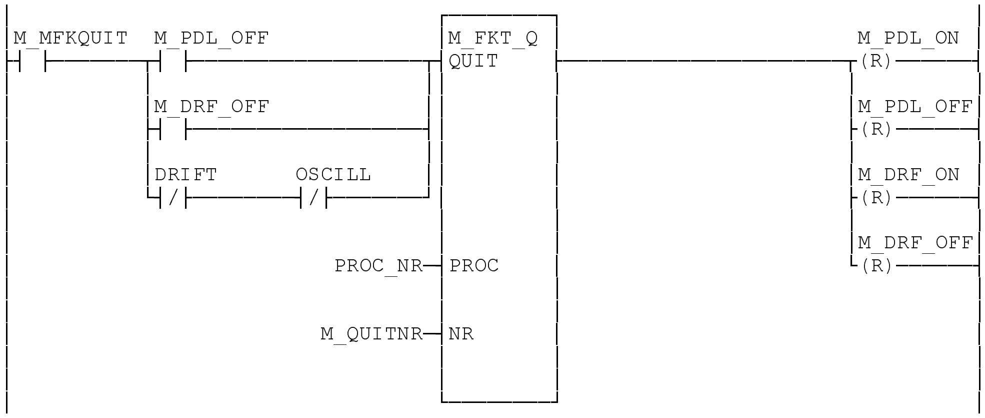


```
M_MFKQUIT.................... ACKNOWLEDGE M FUNCTION ................. .......... BOOL
M_PDL_OFF.................... SWITCH OFF HUNTING ..................... .......... BOOL
M_FKT_Q...................... ........................................ .......... M_FKT_Q
M_PDL_ON..................... ACTIVATE HUNTING ....................... .......... BOOL
M_DRF_OFF.................... SWITCH OFF DRIFTING .................... .......... BOOL
M_PDL_OFF.................... SWITCH OFF HUNTING ..................... .......... BOOL
DRIFT........................ ACTIVATE DRIFTING ...................... VAR_INPUT. BOOL
OSCILL....................... ACTIVATE HUNTING ....................... VAR_INPUT. BOOL
M_DRF_ON..................... ACTIVATE DRIFTING....................... .......... BOOL
PROC_NR...................... PROCESS NUMBER ......................... VAR_INPUT. INT
M_DRF_OFF.................... SWITCHOFF DRIFTING ..................... .......... BOOL
M_QUITNR..................... SECURE M FUNCTION NUMBER ............... .......... INT
```

46 MQQUIT:

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(*VALVES FOR SELECTING THE GEAR STEP -------------------------------------*)

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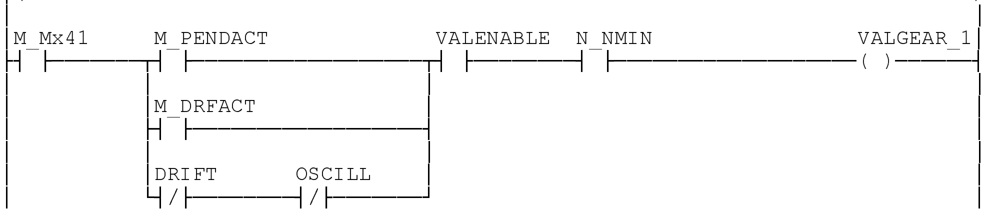


```
M_Mx41....................... Mx41 IS ACTIVE ......................... .......... BOOL
M_PENDACT.................... HUNTING IS ACTIVE ...................... .......... BOOL
VALENABLE.................... ENABLING THE VALVES .................... VAR_INPUT. BOOL
N_NMIN....................... N<Nmin MESSAGE ......................... VAR_INPUT. BOOL
VALGEAR_1.................... VALVE GEAR STEP 1 ...................... VAR_OUTPUT BOOL
M_DRFACT..................... DRIFTING IS ACTIVE ..................... .......... BOOL
DRIFT........................ ACTIVATE DRIFTING ...................... VAR_INPUT. BOOL
OSCILL....................... ACTIVATE HUNTING ....................... VAR_INPUT. BOOL
```

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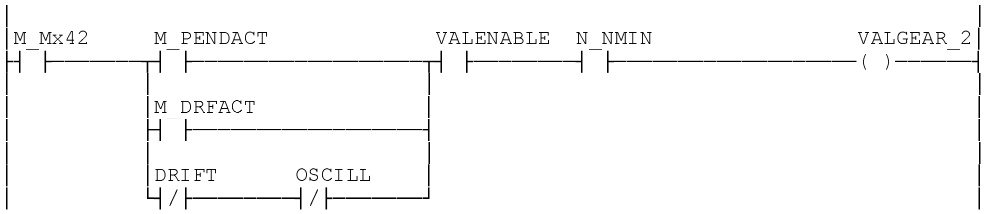
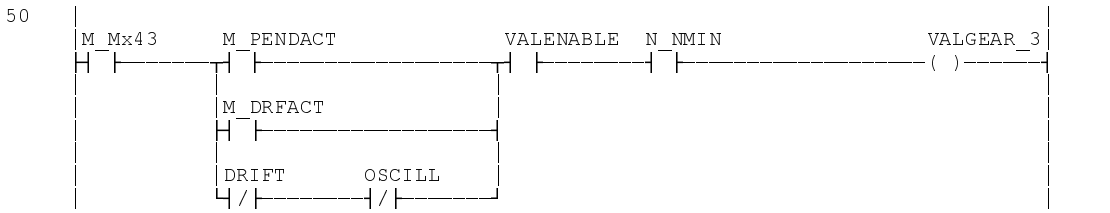
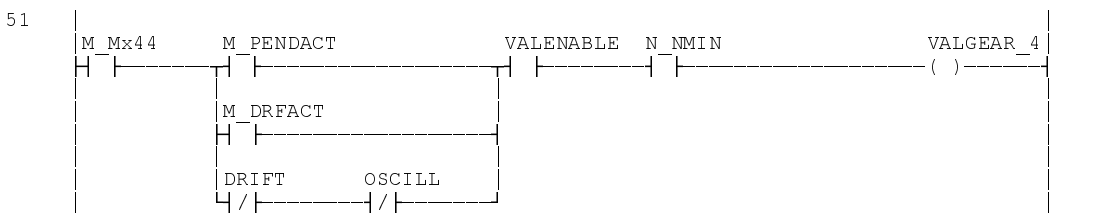


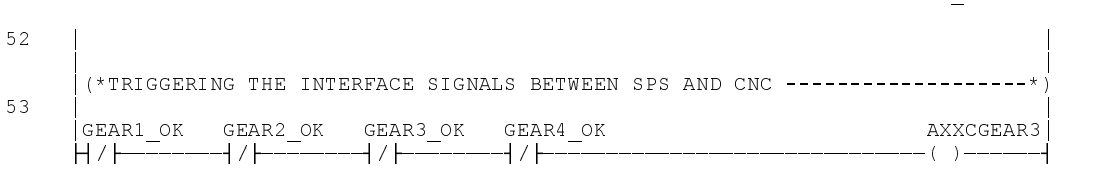

```
M_Mx42....................... Mx42 IS ACTIVE ......................... .......... BOOL
M_PENDACT.................... HUNTING IS ACTIVE ...................... .......... BOOL
VALENABLE.................... ENABLING THE VALVES .................... VAR_INPUT. BOOL
N_NMIN....................... N<Nmin MESSAGE ......................... VAR_INPUT. BOOL
VALGEAR_2.................... VALVE GEAR STEP 2 ...................... VAR_OUTPUT BOOL
M_DRFACT..................... DRIFTING IS ACTIVE ..................... .......... BOOL
DRIFT........................ ACTIVATE DRIFTING ...................... VAR_INPUT. BOOL
OSCILL....................... ACTIVATE HUNTING ....................... VAR_INPUT. BOOL
```



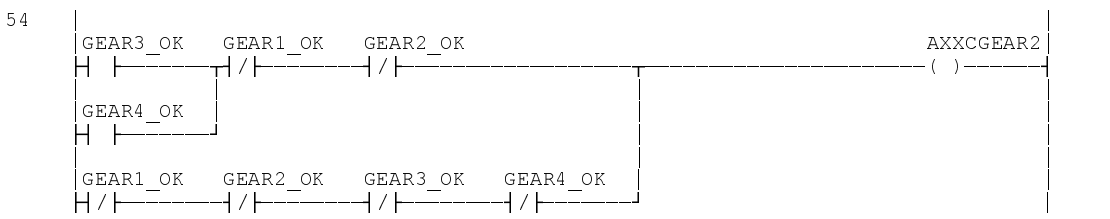
M_Mx43..... Mx43 IS ACTIVE .... BOOL
M_PENDACT..... HUNTING IS ACTIVE .... BOOL
VALENABLE..... ENABLING THE VALVES ..... VAR_INPUT. BOOL
N_NMIN..... N<Nmin MESSAGE ..... VAR_INPUT. BOOL
VALGEAR_3..... VALVE OF GEAR STEP 3 ..... VAR_OUTPUT BOOL
M_DRFACT..... DRIFTING IS ACTIVE .... BOOL
DRIFT..... ACTIVATE DRIFTING ..... VAR_INPUT. BOOL
OSCILL..... ACTIVATE HUNTING ..... VAR_INPUT. BOOL



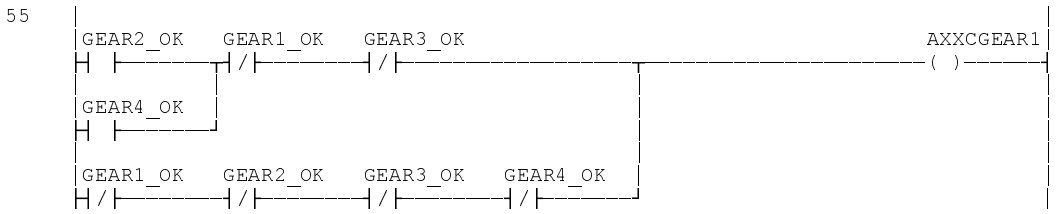
M_Mx44..... Mx44 IS ACTIVE .... BOOL
M_PENDACT..... HUNTING IS ACTIVE .... BOOL
VALENABLE..... ENABLING THE VALVES ..... VAR_INPUT. BOOL
N_NMIN..... N<Nmin MESSAGE ..... VAR_INPUT. BOOL
VALGEAR_4..... VALVE OF GEAR STEP 4 ..... VAR_OUTPUT BOOL
M_DRFACT..... DRIFTING IS ACTIVE .... BOOL
DRIFT..... ACTIVATE DRIFTING ..... VAR_INPUT. BOOL
OSCILL..... ACTIVATE HUNTING ..... VAR_INPUT. BOOL



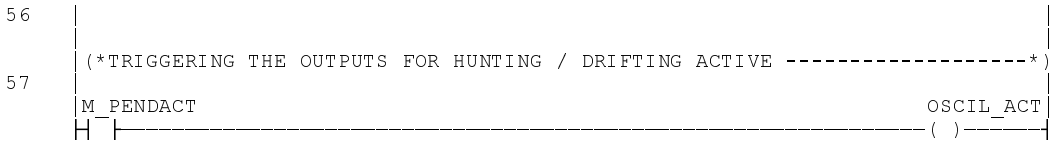
GEAR1_OK..... GEAR STEP 1 ENGAGED..... VAR_INPUT. BOOL
GEAR2_OK..... GEAR STEP 2 ENGAGED..... VAR_INPUT. BOOL
GEAR3_OK..... GEAR STEP 3 ENGAGED..... VAR_INPUT. BOOL
GEAR4_OK..... GEAR STEP 4 ENGAGED..... VAR_INPUT. BOOL
AXXCGEAR3..... BIT 3 GEAR SPEED SELECTION ..... VAR_OUTPUT BOOL



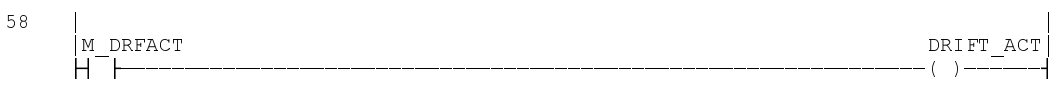
GEAR3_OK..... GEAR STEP 3 ENGAGED..... VAR_INPUT. BOOL
GEAR1_OK..... GEAR STEP 1 ENGAGED..... VAR_INPUT. BOOL
GEAR2_OK..... GEAR STEP 2 ENGAGED..... VAR_INPUT. BOOL
AXXCGEAR2..... BIT 2 GEAR SPEED SELECTION ..... VAR_OUTPUT BOOL
GEAR4_OK..... GEAR STEP 4 ENGAGED..... VAR_INPUT. BOOL
GEAR1_OK..... GEAR STEP 1 ENGAGED..... VAR_INPUT. BOOL
GEAR2_OK..... GEAR STEP 2 ENGAGED..... VAR_INPUT. BOOL
GEAR3_OK..... GEAR STEP 3 ENGAGED..... VAR_INPUT. BOOL
GEAR4_OK..... GEAR STEP 4 ENGAGED..... VAR_INPUT. BOOL



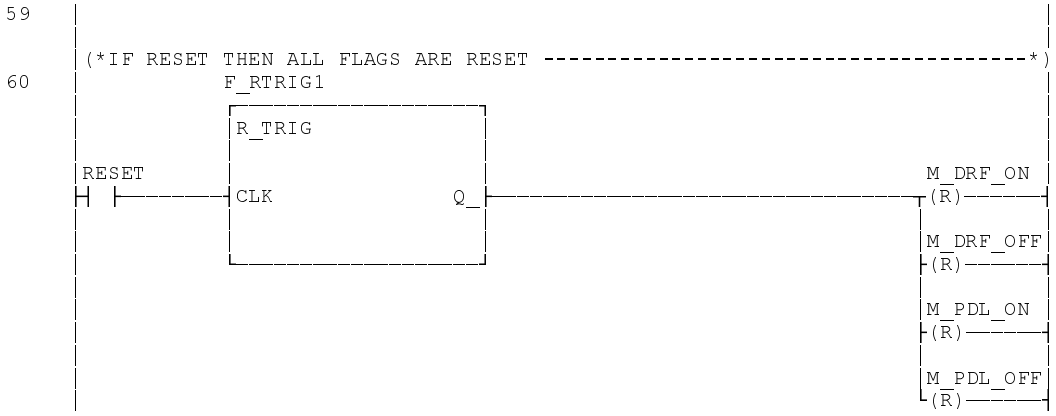
GEAR2_OK..... GEAR STEP 2 ENGAGED..... VAR_INPUT. BOOL
GEAR1_OK..... GEAR STEP 1 ENGAGED..... VAR_INPUT. BOOL
GEAR3_OK..... GEAR STEP 3 ENGAGED..... VAR_INPUT. BOOL
AXXCGEAR1..... BIT 1 GEAR SPEED SELECTION ..... VAR_OUTPUT BOOL
GEAR4_OK..... GEAR STEP 4 ENGAGED..... VAR_INPUT. BOOL
GEAR1_OK..... GEAR STEP 1 ENGAGED..... VAR_INPUT. BOOL
GEAR2_OK..... GEAR STEP 2 ENGAGED..... VAR_INPUT. BOOL
GEAR3_OK..... GEAR STEP 3 ENGAGED..... VAR_INPUT. BOOL
GEAR4_OK..... GEAR STEP 4 ENGAGED..... VAR_INPUT. BOOL



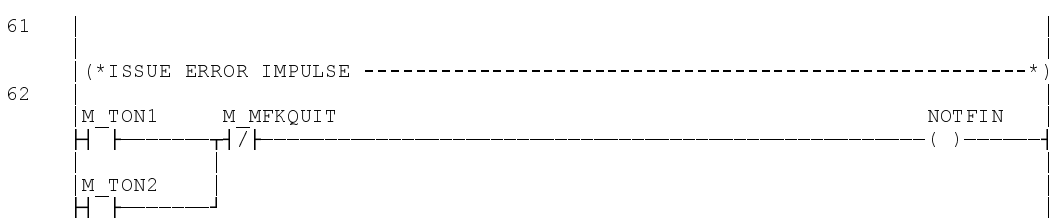
M_PENDACT..... HUNTING IS ACTIVE .... BOOL
OSCIL_ACT..... HUNTING IS ACTIVE ..... VAR_OUTPUT BOOL



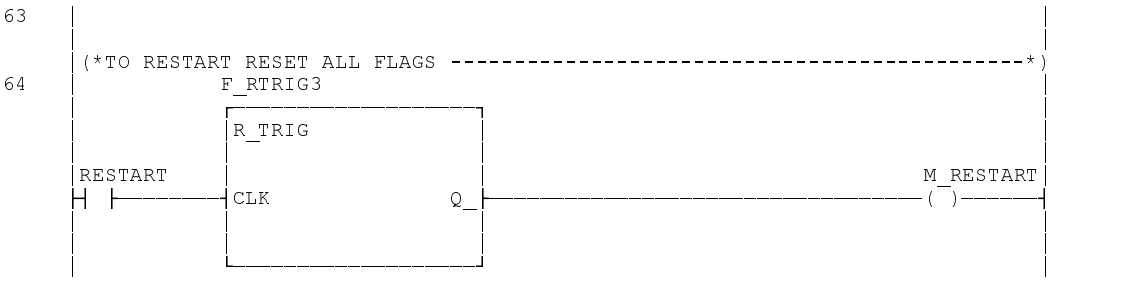
M_DRFACT..... DRIFTING IS ACTIVE .... BOOL
DRIFT_ACT..... DRIFTING IS ACTIVE ..... VAR_OUTPUT BOOL



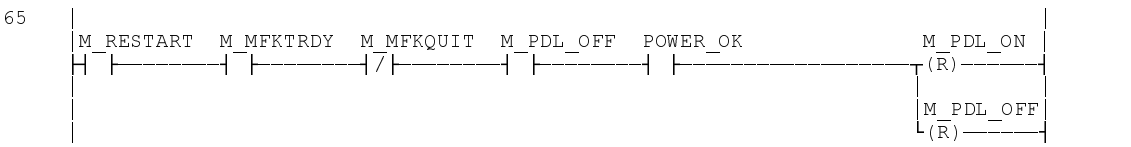
F_RTRIG1..... POSITIVE EDGE AT RESET .... R_TRIG
RESET..... RESET INPUT ..... VAR_INPUT. BOOL
M_DRF_ON..... ACTIVATE DRIFTING .... BOOL
M_DRF_OFF..... SWITCH OFF DRIFTING .... BOOL
M_PDL_ON..... ACTIVATE HUNTING .... BOOL
M_PDL_OFF..... SWITCH OFF HUNTING..... ..... BOOL



M_TON1..... TIMER 1 EXPIRED .... BOOL
M_MFKQUIT..... ACKNOWLEDGE M FUNCTION .... BOOL
NOTFIN..... CHANGEOVER NOT TERMINATED ..... VAR_OUTPUT BOOL
M_TON2..... TIMER 2 EXPIRED .... BOOL



F_RTRIG3..... DETECT RESTART .... R_TRIG
RESTART..... RESTART FOR HUNTING ..... VAR_INPUT. BOOL
M_RESTART..... EDGE AT RESTART .... BOOL



M_RESTART..... EDGE AT RESTART .... BOOL
M_MFKTRDY..... M FUNCTION DETECTED .... BOOL
M_MFKQUIT..... ACKNOWLEDGE M FUNCTION .... BOOL
M_PDL_OFF..... SWITCH OFF HUNTING .... BOOL
POWER_OK..... POWER IS APPLIED ..... VAR_INPUT. BOOL
M_PDL_ON..... ACTIVATE HUNTING .... BOOL
M_PDL_OFF..... SWITCH OFF HUNTING .... BOOL

7 Appendix

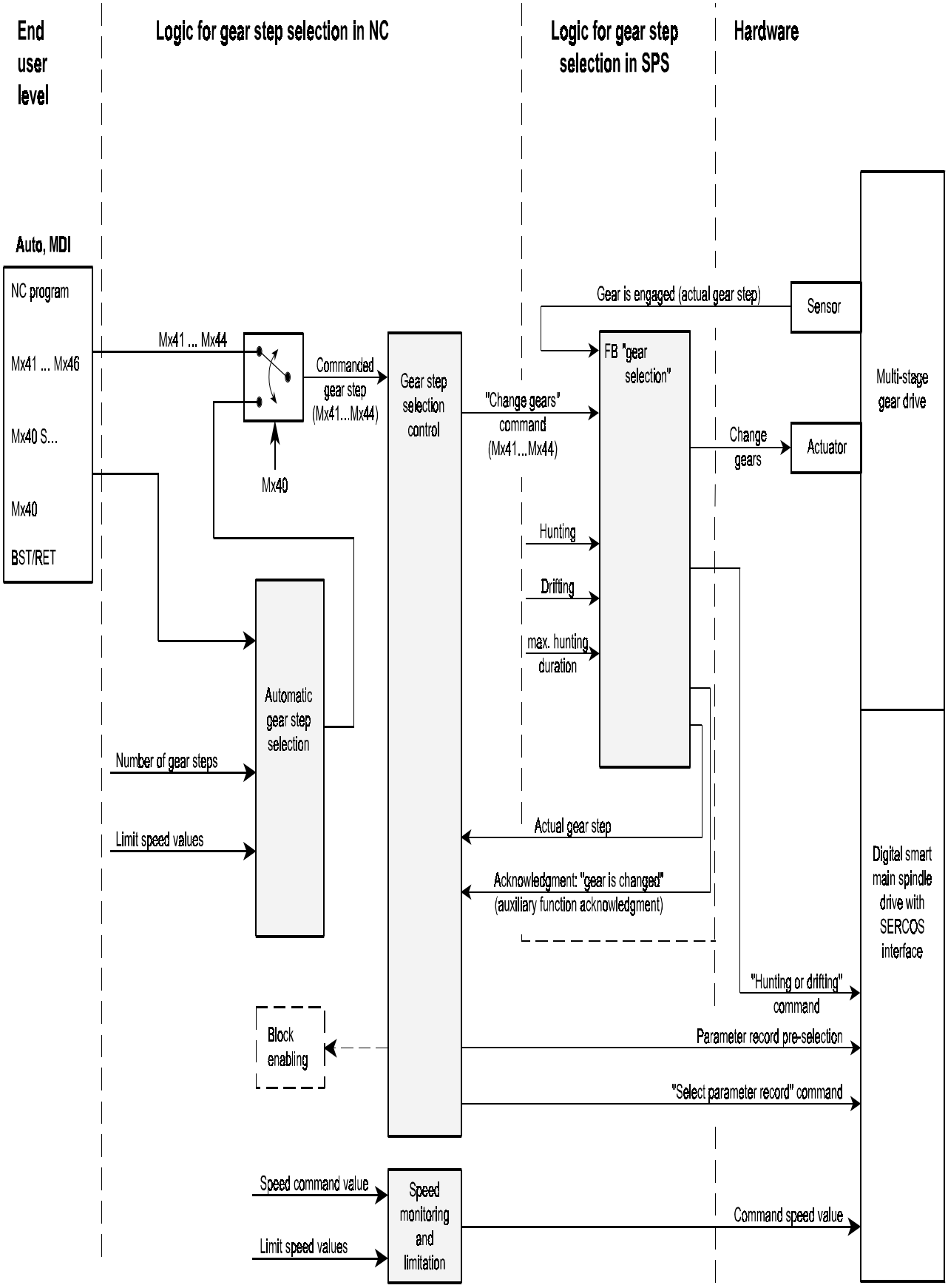


Fig. 7-1: Gear speed selection function diagram

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T

9 Figures

List of Customer Service Points

Germany

Sales area Center	Sales area East	Sales area West	Sales area North
INDRAMAT GmbH D-97816 Lohr am Main Bgm.-Dr.-Nebel-Str. 2 Phone: 09352/40-0 Fax: 09352/40-4885	INDRAMAT GmbH D-09120 Chemnitz Beckerstraße 31 Phone: 0371/3555-0 Fax: 0371/3555-230	INDRAMAT GmbH D-40849 Ratingen Hansastraße 25 Phone: 02102/4318-0 Fax: 02102/41315	INDRAMAT GmbH D-22085 Hamburg Fährhausstraße 11 Phone: 040/227126-16 Fax: 040/227126-15
Sales area South	**Sales area South-West**		**INDRAMAT Service Hotline**
INDRAMAT GmbH D-80339 München Ridlerstraße 75 Phone: 089/540138-30 Fax: 089/540138-10	INDRAMAT GmbH D-71229 Leonberg Böblinger Straße 25 Phone: 07152/972-6 Fax: 07152/972-727		INDRAMAT GmbH Phone: D-0172/660 040 6 -or- Phone: D-0171/333 882 6

Customer service points in Germany

Europe

Austria	Austria	Belgium	Denmark
G.L.Rexroth Ges.m.b.H. Geschäftsbereich INDRAMAT A-1140 Wien Hägelingasse 3 Phone: 1/9852540-400 Fax:1/9852540-93	G.L.Rexroth Ges.m.b.H. Geschäftsbereich INDRAMAT A-4061 Pasching Randlstraße 14 Phone: 07229/64401-36 Fax: 07229/64401-80	Mannesmann Rexroth N.V.-S.A. Geschäftsbereich INDRAMAT B-1740 Ternat Industrielaan 8 Phone: 02/5823180 Fax: 02/5824310	BEC Elektronik AS DK-8900 Randers Zinkvej 6 Phone: 086/447866 Fax: 086/447160
United Kingdom	**Finland**	**France**	**France**
Mannesmann Rexroth Ltd. INDRAMAT Division Cirencester, Glos GL7 1YG 4 Esland Place, Love Lane Phone: 01285/658671 Fax: 01285/654991	Rexroth Mecman OY SF-01720 Vantaa Riihimiehentie 3 Phone: 0/848511 Fax: 0/846387	Rexroth - Sigma S.A. Division INDRAMAT F-92632 Gennevilliers Cedex Parc des Barbanniers 4, Place du Village Phone: 1/41475430 Fax: 1/47946941	Rexroth - Sigma S.A. Division INDRAMAT F-69634 Venissieux - Cx 91, Bd 1 Joliot Curie Phone: 78785256 Fax: 78785231
France	**Italy**	**Italy**	**Netherlands**
Rexroth - Sigma S.A. Division INDRAMAT F-31100 Toulouse 270, Avenue de lardenne Phone: 61499519 Fax: 61310041	Rexroth S.p.A. Divisione INDRAMAT I-20063 Cernusco S/N.MI Via G. Di Vittoria, 1 Phone: 02/92365-270 Fax: 02/92108069	Rexroth S.p.A. Divisione INDRAMAT Via Borgomanero, 11 I-10145 Torino Phone: 011/7712230 Fax: 011/7710190	Hydraudyne Hydrauliek B.V. Kruisbroeksestraat 1a P.O. Box 32 NL-5280 AA Boxtel Phone: 04116/51951 Fax: 04116/51483
Spain	**Spain**	**Sweden**	**Switzerland**
Rexroth S.A. Centro Industrial Santiago Obradors s/n E-08130 Santa Perpetua de Mogoda (Barcelona) Phone: 03/718 68 51 Telex: 591 81 Fax: 03/718 98 62	Goimendi S.A. División Indramat Jolastokieta (Herrera) Apartado 11 37 San Sebastion, 20017 Phone: 043/40 01 63 Telex: 361 72 Fax: 043/39 93 95	AB Rexroth Mecman INDRAMAT Division Varuvägen 7 S-125 81 Stockholm Phone: 08/727 92 00 Fax: 08/64 73 277	Rexroth SA Département INDRAMAT Chemin de l`Ecole 6 CH-1036 Sullens Phone: 021/731 43 77 Fax: 021/731 46 78
Switzerland	**Russia**		
Rexroth AG Geschäftsbereich INDRAMAT Gewerbestraße 3 CH-8500 Frauenfeld Phone: 052/720 21 00 Fax: 052/720 21 11	Tschudnenko E.B. Arsenia 22 153000 Ivanovo Rußland Phone: 093/22 39 633		

European customer service points without Germany

Outside Europe

Argentina Mannesmann Rexroth S.A.I.C. Division INDRAMAT Acassusso 48 41/7 1605 Munro (Buenos Aires) Argentina Phone: 01/756 01 40 01/756 02 40 Telex: 262 66 rexro ar Fax: 01/756 01 36	Argentina Nakase Asesoramiento Tecnico Diaz Velez 2929 1636 Olivos (Provincia de Buenos Aires) Argentina Argentina Telefon 01/790 52 30	Australia Australian Industrial Machenery Services Pty. Ltd. Unit 3/45 Horne ST Campbellfield VIC 2061 Australia Phone: 03/93 59 0228 Fax: 03/93 59 02886	Brazil Mannesmann Rexroth Automação Ltda. Divisão INDRAMAT Rua Georg Rexroth, 609 Vila Padre Anchieta BR-09.951-250 Diadema-SP Caixa Postal 377 BR-09.901-970 Diadema-SP Phone: 011/745 90 65 011/745 90 70 Fax: 011/745 90 50
Canada Basic Technologies Corporation Burlington Division 3426 Mainway Drive Burlington, Ontario Canada L7M 1A8 Phone: 905/335-55 11 Fax: 905/335-41 84	China Rexroth (China) Ldt. Shanghai Office Room 206 Shanghai Intern. Trade Centre 2200 Yanan Xi Lu Shanghai 200335 P.R. China Phone: 021/627 55 333 Fax: 021/627 55 666	China Rexroth (China) Ldt. Shanghai Parts & Service Centre 199 Wu Cao Road, Hua Cao Minhang District Shanghai 201 103 P.R. China Phone: 021/622 00 058 Fax: 021/622 00 068	China Rexroth (China) Ldt. 1430 China World Trade Centre 1, Jianguomenwai Avenue Beijing 100004 P.R. China Phone: 010/50 50 380 Fax: 010/50 50 379
China Rexroth (China) Ldt. A-5F., 123 Lian Shan Street Sha He Kou District Dalian 116 023 P.R. China Phone: 0411/46 78 930 Fax: 0411/46 78 932	Hong Kong Rexroth (China) Ldt. 19 Cheung Shun Street 1st Floor, Cheung Sha Wan, Kowloon, Hong Kong Phone: 741 13 51/-54 and 741 14 30 Telex: 3346 17 GL REX HX Fax: 786 40 19 786 07 33	India Mannesmann Rexroth (India) Ltd. INDRAMAT Division Plot. 96, Phase III Peenya Industrial Area Bangalore - 560058 Phone: 80/839 21 01 80/839 73 74 Telex: 845 5028 RexB Fax: 80/839 43 45	Japan Rexroth Co., Ltd. INDRAMAT Division I.R. Building Nakamachidai 4-26-44 Tsuzuki-ku, Yokohama 226 Japan Phone: 045/942-72 10 Fax: 045/942-03 41
Korea Rexroth-Seki Co Ltd. 1500-12 Da-Dae-Dong Saha-Gu, Pusan, 604-050 Phone: 051/264 90 01 Fax: 051/264 90 10	Korea Seo Chang Corporation Ltd. Room 903, Jeail Building 44-35 Yoido-Dong Youngdeungpo-Ku Seoul, Korea Phone: 02/780-82 07 ~9 Fax: 02/784-54 08	Mexico Motorización y Diseño de Controles, S.A. de C.V. Av. Dr. Gustavo Baz No. 288 Col. Parque Industrial la loma Apartado Postal No. 318 54060 Tlalnepantla Estado de Mexico Phone: 5/397 86 44 Fax: 5/398 98 88	
USA Rexroth Corporation INDRAMAT Division 5150 Prairie Stone Parkway Hoffman Estates, Illinois 60192 Phone: 847/645-36 00 Fax: 857/645-62 01	USA Rexroth Corporation INDRAMAT Division 2110 Austin Avenue Rochester Hills, Michigan 48309 Phone: 810/853-82 90 Fax: 810/853-82 90		

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