5.8 RETRACE

M

Overview

The tool can retrace the path along which the tool has moved so far (reverse execution). Furthermore, the tool can move along the retraced path in the forward direction (forward reexecution). After forward reexecution is performed until the tool reaches the position at which reverse execution started, machining is continued as programmed.

NOTE
This function is optional.

Procedure

- Forward execution → reverse execution

To perform forward execution of a program, set the reverse execution signal RVS to 0, then perform a cycle start operation. If the reverse execution signal RVS is set to 1, reverse execution or the end of reverse execution results.
To perform reverse execution of a program, use one of the following methods:

1) Set the reverse execution signal RVS to 1 during forward execution of a block.
2) Perform a single block stop operation during forward execution, then set the reverse execution signal RVS to 1.
3) Perform a feed hold stop operation during forward execution, then set the reverse execution signal RVS to 1.

When method 1) is used, reverse execution starts after the end of the block being executed (after execution up to the single block stop position). Reverse execution does not start as soon as the reverse execution signal RVS is set to on.

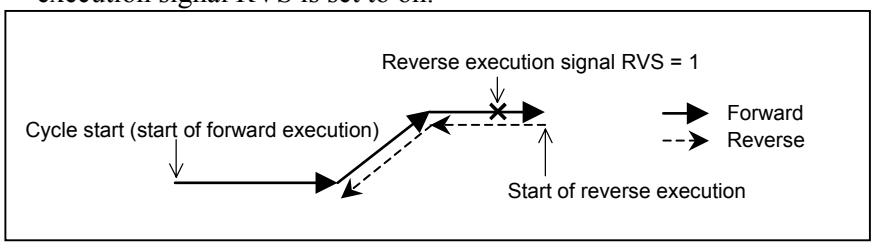


Fig. 5.8 (a)

If functions for gas cutting machine are enabled, however, only when linear interpolation (G01), circular interpolation (G02, G03), or skip function (G31) is specified, reverse execution starts at the position at which the reverse execution signal RVS is set to on.

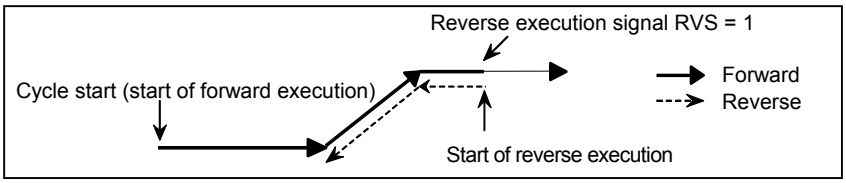


Fig. 5.8 (b)

When method 2) is used, performing a cycle start operation starts reverse execution from the position at which a single block stop takes place.

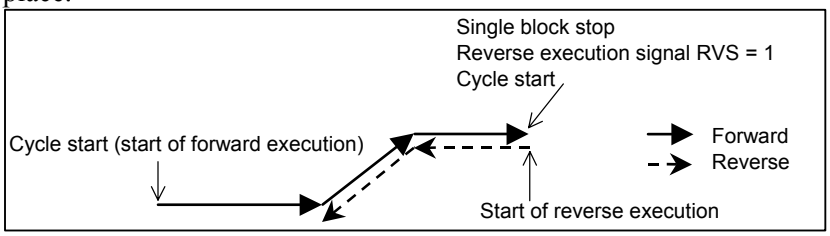


Fig. 5.8 (c)

When method 3) is used, performing a cycle start operation starts reverse execution from the position at which a feed hold stop takes place.

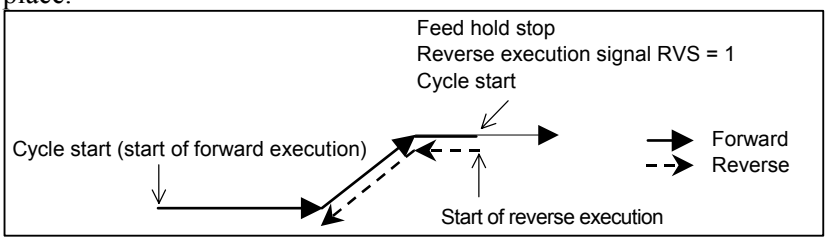


Fig. 5.8 (d)

- Reverse execution → forward reexecution

To perform forward reexecution of a program, use one of the following three methods:

1) Set the reverse execution signal RVS to 0 during reverse execution of a block.
2) Set the reverse execution signal RVS to 0 after a single block stop takes place during reverse execution.
3) Set the reverse execution signal RVS to 0 after a feed hold stop takes place during reverse execution.

When method 1) is used, forward reexecution starts after the block being executed ends (after execution up to the position at which a single block stop takes place). Forward reexecution does not start as soon as the reverse execution signal RVS is set to 0.

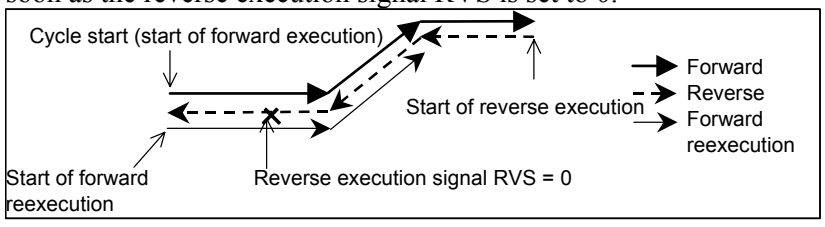


Fig. 5.8 (e)

If functions for gas cutting machine are enabled, however, only when linear interpolation (G01), circular interpolation (G02, G03), or skip function (G31) is specified, forward reexecution starts at the position at which the reverse execution signal RVS is set to 0.

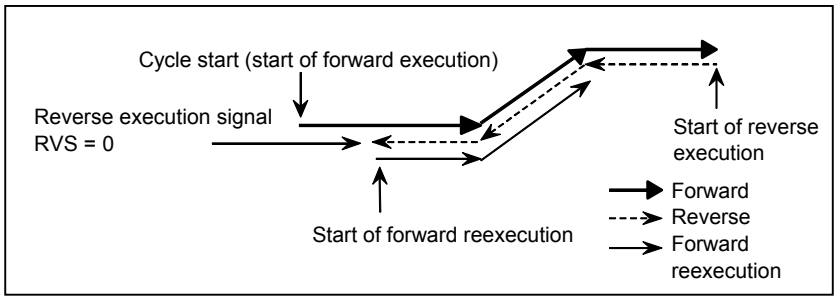


Fig. 5.8 (f)

When method 2) is used, performing a cycle start operation starts forward reexecution from the position at which a single block stop takes place.

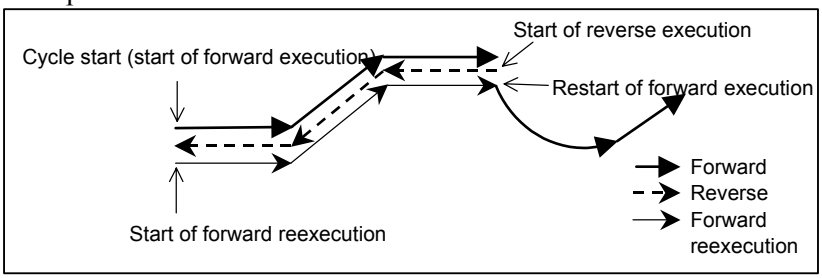


Fig. 5.8 (g)

When method 3) is used, performing a cycle start operation starts forward reexecution from the position at which a feed hold stop takes place.

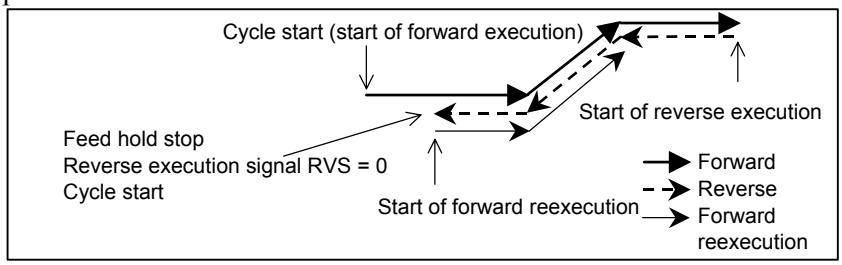


Fig. 5.8 (h)

- Reverse execution → end of reverse execution → forward reexecution

When a block to be executed is no longer present during reverse execution (when reverse execution has been performed up to the block where forward execution started, or when forward execution has not yet been performed), the reverse execution end state is entered, and operation stops.

Even when a cycle start operation is performed while the reverse execution signal RVS is held 1, operation is not performed, and the reverse execution end state is maintained. Forward reexecution (or forward execution) is started by setting the reverse execution signal RVS to 0 then performing a cycle start operation.

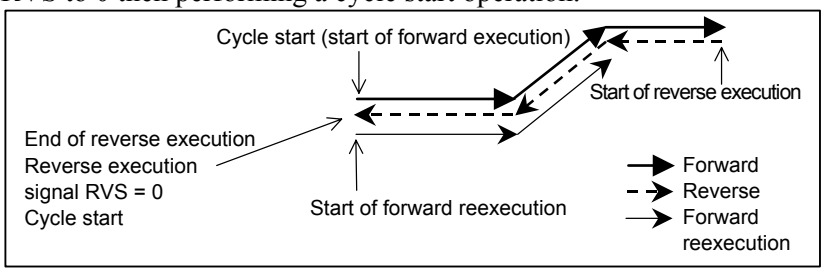


Fig. 5.8 (i)

- Forward reexecution → forward execution

After forward reexecution is performed up to the block at which reverse execution started, forward execution starts automatically, and commands are read from the program again and executed. No particular operation is required.

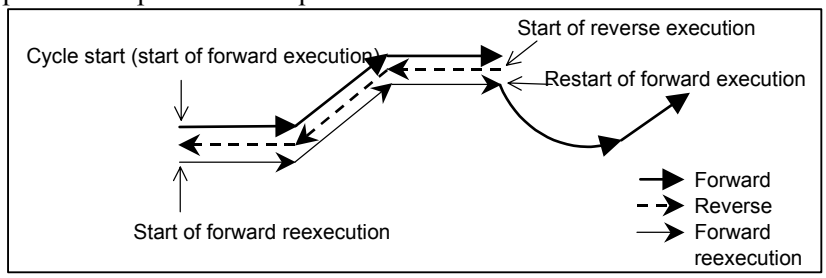


Fig. 5.8 (j)

If reverse execution was performed after feed hold stop, forward reexecution ends when the feed hold stop position is reached, then forward execution is performed. Also if single block operation was performed, forward reexecution ends at the single block stop position.

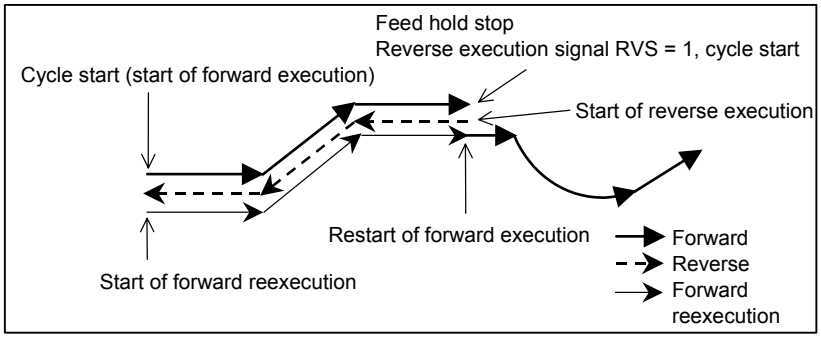


Fig. 5.8 (k)

Description

- Reverse execution and forward execution

Usually in automatic operation, a program is executed in the programmed order. This is called forward execution. This function allows a program executed by forward execution to be executed in the reverse direction. This is called reverse execution. Reverse execution allows the tool to retrace the path along which the tool has moved during forward execution.
Reverse execution of a program can be performed only for blocks that have been executed by forward execution.
Furthermore, in single block operation, reverse execution can also be performed on a block-by-block basis .

- Forward reexecution

Blocks that have been executed by reverse execution can be reexecuted in the forward direction up to the block from which reverse execution started. This is called forward reexecution. Forward reexecution allows the tool to retrace the same tool path as in forward execution until the position at which reverse execution started is reached.
After the block from which reverse execution started is reached, the program is executed again in the programmed order (forward execution).
Furthermore, in single block operation, forward reexecution can also be performed on a block-by-block basis.

- End of reverse execution

When a block to be executed is no longer present during reverse execution (when stored blocks have all been executed during reverse execution, or when forward execution has not yet been performed), operation stops. This is called the end of reverse execution.

- Status indication

During reverse execution, characters "RVRS" blink on the screen. During forward reexecution, characters "RTRY" blink to indicate that forward reexecution is in progress. The "RTRY" indication is kept blinking until the block at which reverse execution started is reached and normal operation starts (until forward execution is restarted).
When a block to be executed is no longer present during reverse execution, or if an attempt is made to perform reverse execution for a block that cannot be executed by reverse execution, characters "RVED" blink, notifying the user that reverse execution can no longer be performed.

- Number of blocks that can be executed by reverse execution

Up to about 100 blocks can be executed by reverse execution. Depending on the specified program, the maximum number of executable blocks may decrease.

- Reset

A reset operation (the reset button on the MDI panel, the external reset signal, or the reset & wind signal) clears the blocks stored for reverse execution.

- Feedrate

A feedrate to be applied during reverse execution can be specified in parameter No. 1414. If this parameter is set to 0, the feedrate in reverse execution is assumed to be the same as that in forward execution. Rapid traverse, however, is performed always at the rapid traverse rate, regardless of the setting of this parameter.
The feedrate in forward reexecution is always the same as that in forward execution.
In reverse execution or forward reexecution, feedrate override, rapid traverse override, and dry run are allowed.

- Start of reverse execution or forward reexecution after the end of a block

In a block for rapid traverse (G00), linear interpolation (G01), circular interpolation (G02, G03), dwelling (G04), skip cutting (G31), or an auxiliary function in an automatic operation mode (memory operation, part program operation, or MDI operation), reverse execution or forward reexecution can be started. However, reverse execution and forward reexecution do not start as soon as the reverse execution signal status is changed. When the block has ended, that is, after a movement, dwelling, or an auxiliary function is completed, reverse execution or forward reexecution starts.

Start of reverse execution or forward reexecution after feed hold stop

When a feed hold stop operation is performed during execution of rapid traverse (G00), linear interpolation (G01), circular interpolation (G02, G03), or skip cutting (G31), then the reverse execution signal status is changed and operation is restarted, reverse execution or forward reexecution can be started immediately from the stop position. This cannot be performed when dwelling (G04) or an auxiliary function is being executed.

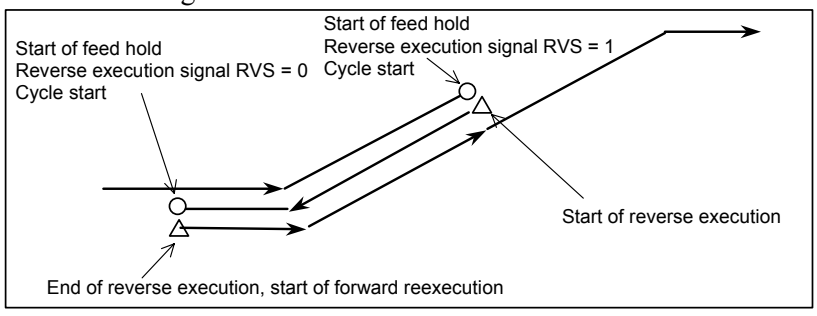


Fig. 5.8 (l)

When reverse execution is started after feed hold stop operation, the part from the start point of that block to the feed hold stop position is stored as one block. Therefore, when forward reexecution is performed with the single block switch set to 1, a single block stop takes place as soon as the position at which reverse execution started is reached.

Start of reverse execution or forward reexecution after single block stop

After a single block stop takes place, reverse execution or forward reexecution can be started immediately when the reverse execution signal status is changed and restart operation is performed.

Limitation

- Blocks that cannot be executed by reverse execution

In the modes listed below, reverse execution cannot be performed.
When one of these commands appears during reverse execution, reverse execution ends immediately and "RVED" is displayed.

- Involute interpolation (G02.2, G03.2)
- Exponential interpolation (G02.3, G03.3)
- Three-dimensional circular interpolation (G02.4, G03.4)
- NURBS interpolation (G06.2)
- Cylindrical interpolation (G07.1,G107)
- Polar coordinate interpolation (G12.1, G13.1,G112,G113)
- Polar coordinate command (G16)
- Functions related thread cutting (G33,G34,G35,G36)
- 3-dimensional cutter compensation (G41.2, G41.3, G42.2, G42.3)
- Tool length compensation in tool axis direction (G43.1)
- Tool center point control (G43.4, G43.5)
- Polygon turning (G50.2, G51.2)
- Tool axis direction control (G53.1)
- Single direction positioning (G60)
- Tapping mode (G63)
- Tapping cycle (G84,G74)
- Rigid tapping cycle (G84,G74,G84.2,G84.3)
- Fine boring ccyle (G76)
- Back boring ccyle (G87)

It is impossible to perform reverse execution for blocks specifying the commands listed below. If one of these commands appears during reverse execution, reverse execution ends immediately and "RVED" is displayed.
Some of these commands turn a mode on and off. It is possible to start reverse execution and perform forward reexecution in a mode set by such a command. However, if a block that turns the mode on or off is reached during reverse execution, the reverse execution ends at that block, and "RVED" is displayed.

- Functions related AI contour control (G05,G05.1,G08)
- HRV3 on/off (G05.4)
- Hypothetical axis interpolation (G07)
- Inch/metric conversion (G20, G21)
- Stored stroke check on/off (G22, G23)
- Functions related referece position return (G27, G28, G29, G30)
- Floating referece position return (G30.1)
- 3-dimensional coordinate system conversion (G68, G69)
- Feature coordinate system (G68.2)
- Figure copying (G72.1,G72.2)

- Chopping (G81.1)
- Index table indexing
- Cs contouring control
- Spindle positioning

- Switching of automatic operation mode

When a single block stop operation is performed during reverse execution or forward reexecution and the mode is changed from memory operation to MDI operation or vice versa, it becomes impossible to perform reverse execution, forward reexecution, and forward execution. To restart operation, restore the original mode, then perform a cycle start operation.

- Single block stop position

A block that is internally generated by the control unit is also treated as one block during reverse execution.

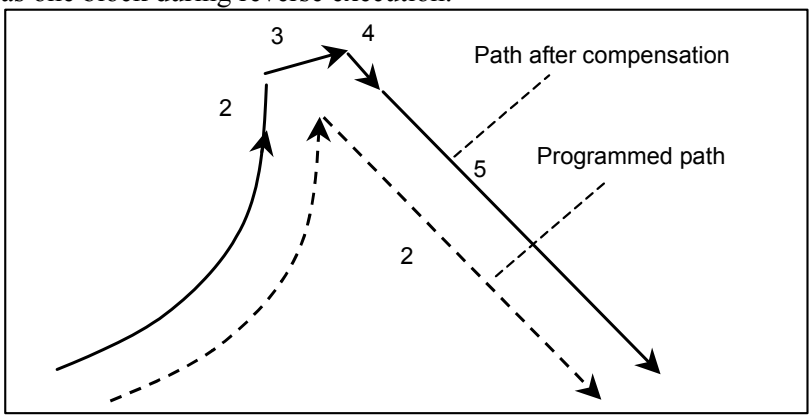


Fig. 5.8 (m) Path when cutter compensation is applied

In the above example, the program specifies two blocks, but in actual operation, move commands for five blocks are generated.
In such a case, positions at which a single block stop takes place may differ between forward execution and reverse execution.

- Positioning (G00)

When non-linear type positioning is performed (bit 1 (LRP) of parameter No. 1401 is set to 0), the tool path in reverse execution and that in forward execution do not match. The tool path in forward reexecution is the same as that in forward execution.
When linear type positioning is performed (bit 1 (LRP) of parameter No. 1401 is set to 1), the tool path in reverse execution is the same as that in forward execution.

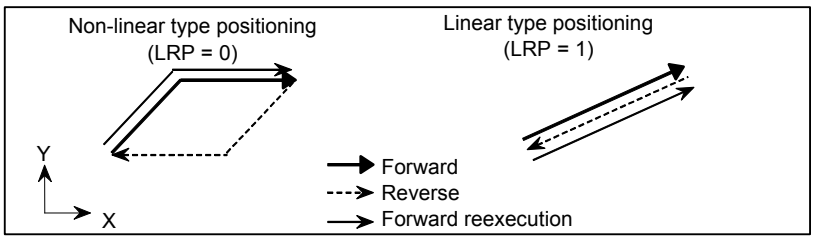


Fig. 5.8 (n)

- Dwell command (G04)

During reverse execution or forward reexecution, the dwell command (G04) is executed in the same way as in normal operation.

- Programmable data input (G10)

Tool compensation values, parameters, pitch error data, workpiece origin offsets, and tool life management values set or modified by programmable data input (G10) are ignored during reverse execution and forward reexecution.

- Skip function (G31) and automatic tool length compensation (G37)

The skip signal and the automatic tool length measurement signal are ignored during reverse execution and forward reexecution. During reverse execution and forward reexecution, the tool moves along the path that the tool has actually passed during forward execution.

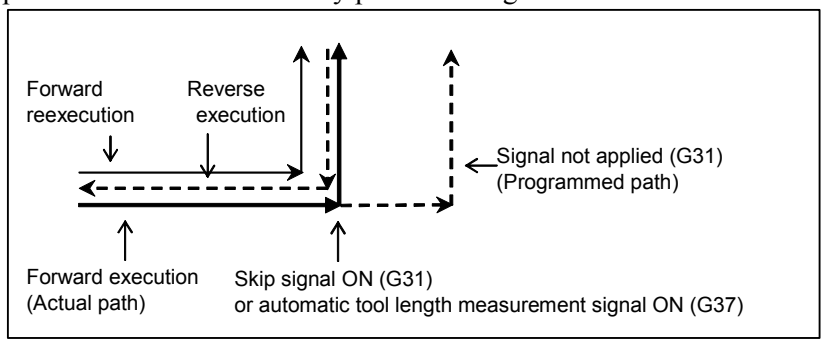


Fig. 5.8 (o)

- Setup of a coordinate system (G92, G54 to G59, G54.1P_, G52, and G92.1)

When setup of a coordinate system (G92, G54 to G59, G54.1P_, and G52) is specified during reverse execution, the indicated current position may differ from the position indicated during forward execution. However, the actual machine position does not differ.

- Mirror image

When a block to which a mirror image is applied by programmable mirror image (G50.1, G51.1) is executed during reverse execution, the tool moves along the actual path resulting from the application of a mirror image in the reverse direction.

When a mirror image is applied to a block by setting or a machine signal, the block with the mirror image not applied is stored. Mirror image application by setting or a machine signal is enabled also during reverse execution and forward reexecution. Therefore, during reverse execution and forward reexecution, the mirror image by setting data or machine signal must be turned on and off so that this on/off status and the on/off status during forward execution match.

- Changing offsets

Even when cutter compensation data or tool length offsets are changed during reverse execution or forward reexecution, the change in compensation or offset data does not become valid until forward reexecution ends and normal operation starts. Until then, the tool moves with the offset data that was applied when the block was executed for the first time during forward execution.

- Interrupt type custom macro

(1) Do not initiate any interrupt during reverse execution.
(2) Do not execute an interrupted block and the interrupt program in reverse execution.

- Tool management function

The tool life is not counted during reverse execution and forward reexecution.

- Inverse time feed (G93)

If a nonzero value is set as the feedrate to be applied during reverse execution in parameter No. 1414, a block that moves the tool by inverse time feed during forward execution is executed at the parameter-set feedrate (feed per minute) during reverse execution.
If the feedrate during reverse execution (parameter No. 1414) is not set (= 0), the same feedrate as applied during forward execution is used.

- Maximum spindle speed clamp (G92Sxxxx)

Clamping at a maximum spindle speed specified during reverse execution becomes valid. This means that if G92Sxxxx appears during reverse execution, the spindle speed is clamped at Sxxxx in the subsequent reverse execution. As a result, the clamp speed may differ between reverse execution and forward execution even when the same block is executed. The spindle speed is clamped when the G96 mode is set.

- Auxiliary functions

M, S, T, and the second auxiliary function (B function) are output directly also during reverse execution and forward reexecution.
When specified together with a move command in the same block, M, S, T, and the second auxiliary function (B function) are output with the move command at the same time during forward execution, reverse execution, and forward reexecution. Therefore, the output positions of M, S, T, and the second auxiliary function (B function) during reverse execution differ from those during forward execution and forward reexecution.

- Custom macro operation

Custom macro operations are ignored during reverse execution and forward reexecution.

- Tool retract and recover function

For retract operation and repositioning operation by the tool retract and recover function, reverse execution cannot be performed. Retract operation and repositioning operation are ignored during reverse execution and forward reexecution.

- AI contour control

During reverse execution and forward reexecution, the feedrate clamp function by acceleration under AI contour control is disabled.

- Display

During reverse execution and forward reexecution, the modal display and the display of the currently executed program are not updated; information obtained at the start of reverse execution is maintained.

Signal

Reverse execution signal RVS<Gn007.0>

[Classification] Input signal

[Function] Requests the control unit during automatic operation (DNC operation and MDI operation except memory operation and binary operation) to return the tool by retracing the path the tool has passed so far.

[Operation] When this signal is set to 1 during forward execution, the machining path along which the tool has moved so far is retraced. Note that, however, reverse execution does not start as soon as this signal is set to 1; reverse execution starts after the forward execution of the current block ends. When this signal is set to 0 during reverse execution, switching from reverse execution to forward reexecution takes place. Also in this case, forward reexecution does not start as soon as the signal is set to 0, but forward reexecution starts after the reverse execution of the current block is completed.

To make swift switching from forward execution to reverse execution or from reverse execution to forward reexecution, set the automatic operation stop signal *SP to 0 to stop automatic operation, and after the automatic operation in-progress signal STL becomes 0 and the automatic operation stop state is entered, change the RVS signal status. Subsequently, after the automatic operation stop signal *SP is set to 1 and the status of the automatic operation in-progress signal ST is changed from 1 to 0 to start automatic operation, it becomes possible to change the execution mode to reverse execution or forward reexecution in the middle of a block.

Reverse execution in-progress signal RVSL<Fn082.2>

[Classification] Output signal

[Function] Posts that reverse execution is being performed.

[Output condition] This signal is set to 1 when:

- The reverse execution signal RVS is set to 1 and reverse execution is being performed.

This sigal is set to 0 when:

- The reverse execution signal RVS is set to 0 and forward reexecution or forward execution is being performed.
- Blocks to be executed are no longer present during reverse execution, and so execution is stopped.

During reverse execution, the M, S, T, and second auxiliary functions are executed in the same way as during forward execution. When these functions are not to be performed in the same way as during forward execution, use this signal to allow the PMC to perform appropriate processing.

In particular, when the M, S, T, or second auxiliary function and a move command are specified in the same block, the positions at which the code signal and strobe signal are output differ between forward execution and reverse execution. Therefore, use this signal and distribution completion signal DEN to allow the PMC to perform appropriate processing as necessary.

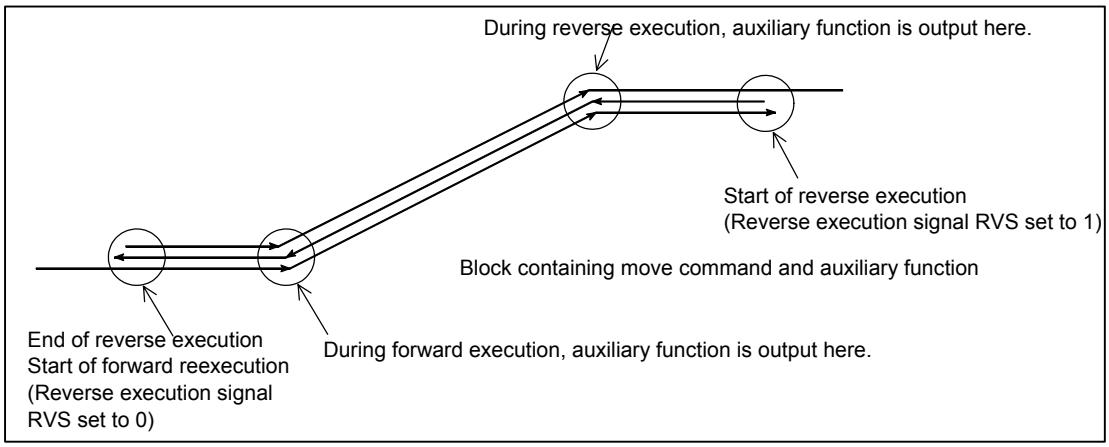


Fig. 5.8 (p)

Signal address

	#7	#6	#5	#4	#3	#2	#1	#0
Gn007								RVS

	#7	#6	#5	#4	#3	#2	#1	#0
Fn082						RVSL		

Parameter

1414	Feedrate for retrace

[Input type] Parameter input
[Data type] Real path
[Unit of data] mm/min, inch/min, degree/min (machine unit)
[Minimum unit of data] Depend on the increment system of the reference axis
[Valid data range] Refer to the standard parameter setting table (C)
(When the increment system is IS-B, 0.0 to +999000.0)
Set a cutting feedrate for retrace operation. When 0 is set, a retrace operation is performed at a programmed feedrate.

NOTE
This parameter has no effect on blocks that are in rapid traverse mode during reverse execution.

Warning

⚠ WARNING

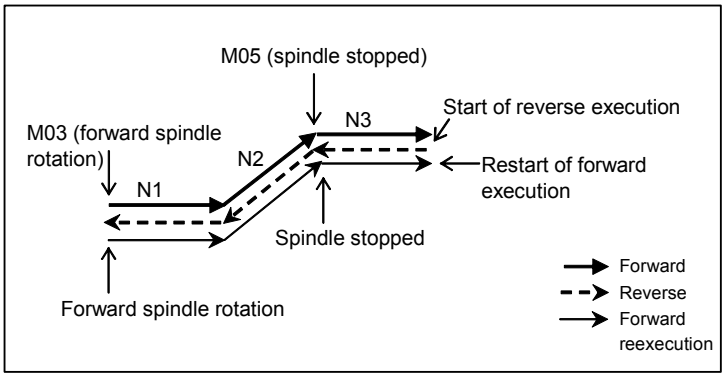
1 Auxiliary functions are output directly even during reverse execution and forward reexecution. Accordingly, the execution status of an auxiliary function during forward execution may be reversed during reverse execution.

Example:

When forward rotation of the spindle(M03) and stop (M05) are specified.

When N3 is executed during reverse execution, M05 is output. So, when N2 and N1 are executed during reverse execution, operation is performed with the spindle stopped.

When N1 is executed during forward reexecution, M03 is output. So, when N1 and N2 are executed during forward reexecution, operation is performed with the spindle rotating in the forward direction.



2 To perform reverse execution after a feed hold stop or single block stop operation, be sure to restore the original position if manual intervention has been performed after the stop , then set the reverse execution signal to 1. Movements made by manual intervention are ignored during reverse execution and forward reexecution. (The same operation as in the manual absolute off state takes place.)

Reference item

Manual name	Item name
USER'S MANUAL (B-63944EN)	Retrace