Changes for the Better

MITSUBISHI
ELECTRIC

CNC
MELDAS AC SERVO

SERVO ADJUSTMENT MANUAL

BNP-B2334B(ENG)

1 PROLOGUE

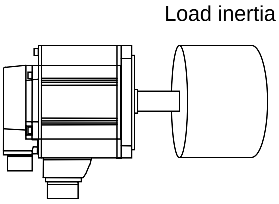
1-1 Servo Adjustment

1-1-1 Basic knowledge on machines

It is important to have basic knowledge on machine characteristics. It is required to comprehend the characteristics of the machine and set the appropriate parameters. Especially, the 2 items mentioned below have to be fully understood.

(1) Load inertia

Inertia is physical quantity to express load amount. In servo control, load inertia converted into motor axis is more important than load weight. Servo response is in proportion to speed loop gain (VGN) and in inverse proportion to load inertia. It is essential to know the load inertia amount when determining appropriate VGN.



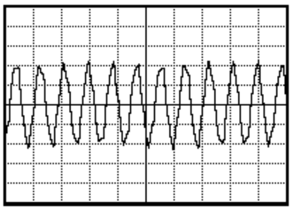
$$\text{Servo response} \underset{\text{(Proportion)}}{\propto} \frac{\text{Speed loop gain (VGN)}}{\text{Load inertia}}$$

(2) Resonance frequency

All machines have a resonance point and the resonance of ball screw is a serious problem for general machine tools. Resonance has to be suppressed as it prevents VGN from being raised.

Notch filter is installed on servo and it suppresses the resonance. However, resonance frequency has to be set for each machine to set parameters.

The clue to the efficient servo adjustment is recognizing resonance frequency, suppressing resonance and raising VGN as much as possible.

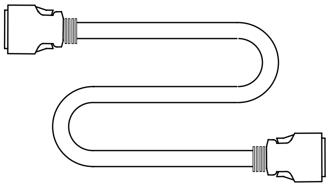


Vibration waveform

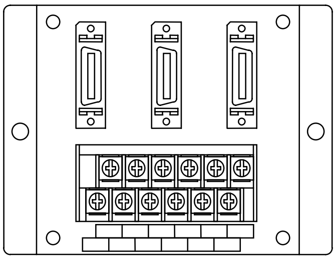
1-1-2 How to use a high-coder

Before adjusting servo, it is required to understand the servo condition. Measure the D/A output (analogue output) mounted on the servo drive unit with a high-coder etc. Get used to using a high-coder before starting servo adjustment.

Prepare the cable SH21 (NC bus cable, etc.) and the tools shown below in advance. Relay terminal (MR-J2CN3TM) is a tool designated for MDS-B-SVJ2 and MR-J2-CT. In case that DO output has already been used, let the signal go through to encourage the D/A output by using a relay terminal as the D/A output, contactor and DO output for break control shares the same connector.

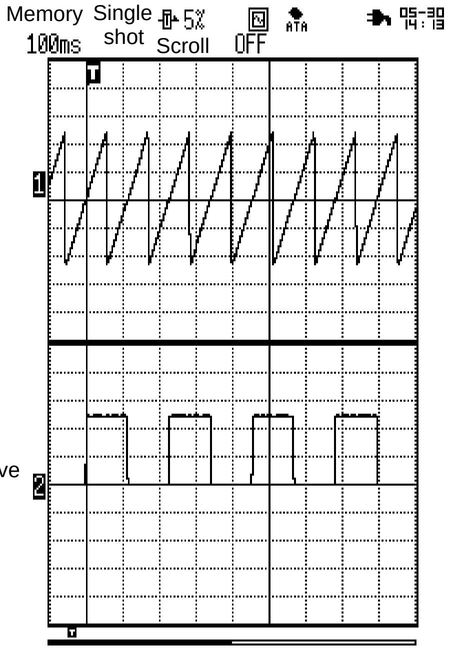


SH21
(NC bus cable)



MR-J2CN3TM
(Relay terminal)

Have a look at the trial output in the display when finished connecting high-coder. An example of MDS-B-SVJ2 is shown the right.



Ch.1 Trial output of saw-tooth wave
SV061=101
SV063=0

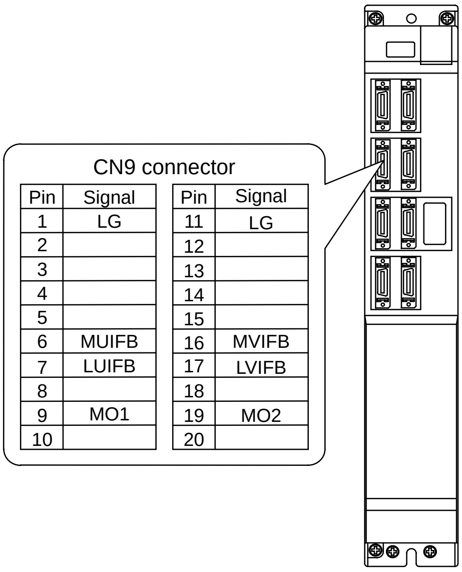
Ch.2. Trial output of rectangular wave
SV062=102
SV064=0

Waveform of MDS-B-SVJ2 trial output result

1-1-3 D/A Output specifications for MDS-C1/CH-Vx

(1) D/A Output specifications

Item	Explanation
No. of channels	2ch
Output cycle	888 µsec (minimum value)
Output precision	8bit
Output voltage	0V to 2.5V to +5V
Output scale setting	±1/256 to ±128 times
Output pins	CN9 connector MO1 = pin 9 MO2 = pin 19 GND = pin 1, 11
Function	Phase current feed back output function L-axis U-phase current FB : pin 7 L-axis V-phase current FB : pin 17 M-axis U-phase current FB : pin 6 M-axis V-phase current FB : pin 16
Option	A drive unit with 2 axes (MDS-C1/CH-V2) also has 2 channels for D/A output. Therefore, set the output data of the axis (SV061,62), which is not observed, to “-1”.



CN9 connector

Pin	Signal	Pin	Signal
1	LG	11	LG
2		12	
3		13	
4		14	
5		15	
6	MUIFB	16	MVIFB
7	LUIFB	17	LVIFB
8		18	
9	MO1	19	MO2
10		20	

(2) Setting the output data

No.	Abbrev	Parameter name	Explanation
SV061	DA1NO	D/A output channel 1 data No.	Input the No. of the data to be outputted to each data D/A output channel.
SV062	DA2NO	D/A output channel 2 data No.	

No.	Output data	Standard output unit	Standard setting value of output scale (Setting values in SV063, SV064)	Standard output unit	Output cycle
-1	D/A output non-selected	For an Amp. with 2 axes (MDS-C1/CH-V2). Set for the parameter of the axis which is not used.			
0	ch1: Speed feedback	r/min	13 (in case of 2000r/min)	1000r/min / V	3.55ms
			9 (in case of 3000r/min)	1500r/min / V	3.55ms
	ch2: Current command	Stall%	131	Stall 100% / V	
1	Current command	Stall%	131	Stall 100% / V	3.55ms
2	–				
3	Current feedback	Stall%	131	Stall 100% / V	3.55ms
4	–				
5	–				
6	Position droop	NC display unit / 2	328 (When the display unit=1µm)	10µm / 0.5V	3.55ms
7	–				
8	Feedrate (FΔT)	(NC display unit / 2) / communication cycle	55 (When 1µm,3.5ms)	1000(mm/min) / 0.5V	3.55ms
9	–				
10	Position command	NC display unit / 2	328 (When the display unit=1µm)	10µm / 0.5V	3.55ms
11	–				
12	Position feedback	NC display unit / 2	328 (When the display unit=1µm)	10µm / 0.5V	3.55ms
13	–				
14	Collision detection estimated torque	Stall%	131	Stall 100% / V	3.55ms
15	Collision detection disturbance torque	Stall%	131	Stall 100% / V	3.55ms
64	Current command (High-speed)	Internal unit	8 (adjustment required)	–	888µs
65	Current feedback (High-speed)	Internal unit	8 (adjustment required)	–	888µs
77	Estimated disturbance torque	Internal unit	8 (adjustment required)	–	888µs
125	Saw-tooth wave test output	0V to 5V	0 (256)	Cycle: 227.5ms	888µs
126	Rectangular wave test output	0V to 5V	0 (256)	Cycle: 1.7ms	888µs
127	2.5V (data 0) test output	2.5V	0 (256)	–	888µs

(3) Setting the output scale

Usually, the standard setting value is set for the output scale (SV063, SV064). When “0” is set, the output will be made as well as when “256” is set.

$$\text{DATA} \times \frac{\text{SV063}}{256} \times \frac{5\ [\text{V}]}{256\ \ (8\text{bit})} + 2.5\ [\text{V}]\ (\text{offset}) = \text{Output voltage [V]}$$

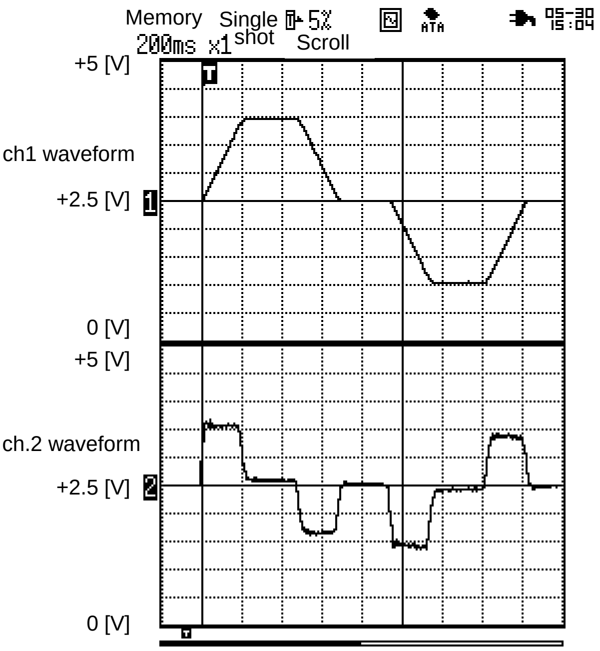
(Example) When outputting the current FB with 100%/V–stall (SV061=3, SV063=131)

$$100 \times \frac{131}{256} \times \frac{5}{256} + 2.5 = 3.499\ [\text{V}]$$

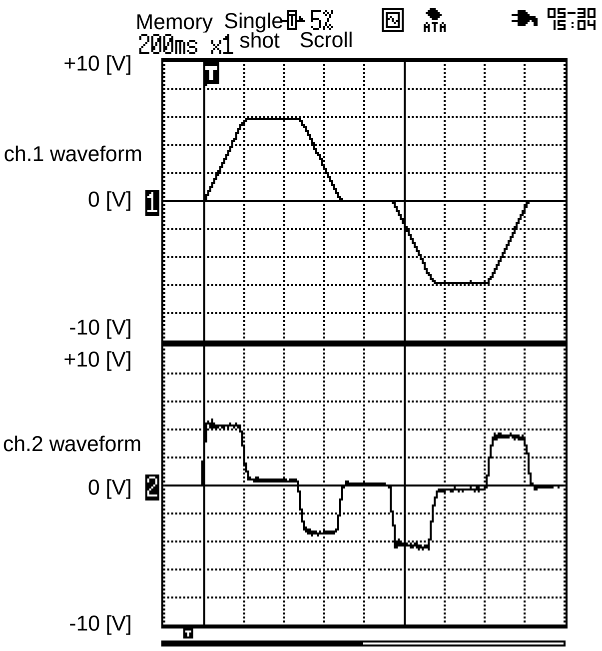
No.	Abbrev.	Parameter name	Explanation	Normal setting range
SV063	DA1MPY	D/A output channel 1 output scale	The standard setting value is specified usually. (When “0” is set, the output will be made as well as when “256” is set)	-32768 to 32767
SV064	DA2MPY	D/A output channel 2 output scale		

(4) Output voltage range and offset

The output voltage range for MDS-C1/CH-Vx series is different from MDS-B-SVJ2 series. When using MDS-C1/CH-Vx series, adjust the zero level on Hi-coder side because of 2.5V offset voltage. (When the data is “0”, 2.5V)



Output waveform of MDS-C1/CH-Vx

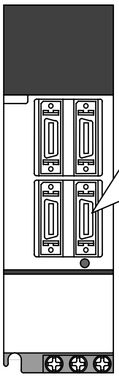


Output waveform of MDS-B-SVJ2

1-1-4 D/A Output specifications for MDS-B-SVJ2

(1) D/A output specifications

Item	Explanation
No. of channels	2ch
Output cycle	888µsec (min. value)
Output precision	8bit
Output voltage range	-10V to 0 to +10V
Output scale setting	±1/256 to ±128 times
Output pins	CN3 connector MO1 = pin 4 MO2 = pin 14 GND = pin 1, 11
Function	Offset amount adjustment function Output clamp function Low path filter function
Option	Relay terminal: MR-J2CN3TM Connect from the CN3 connector using the SH21 cable as a lead-in wire.



CN3 Connector

Pin	Signal	Pin	Signal
1	LG	11	LG
2		12	
3	SG	13	MBR
4	MO1	14	MO2
5	COM	15	MC
6		16	
7		17	
8		18	
9		19	
10	VDD	20	EMGX

(2) Setting the output data

No.	Abbrev	Parameter name	Explanation
SV061	DA1NO	D/A output channel 1 data No.	Input the No. of the data to be outputted to each D/A output channel. (Channel No.9, 10, 29 and 30 correspond to C1 and subsequent versions of software.) (Channel No.8 and 28 correspond to C3 and subsequent versions of software)
SV062	DA2NO	D/A output channel 2 data No.	

No.	Output data	Standard output unit	Output cycle	No.	Output data	Standard output unit	Output cycle
0	0V test output	For offset amount adjustment					
1	Speed feedback	1000r/min / 2V	888µsec	21	Motor load level	100% / 5V	113.7ms
2	Current feedback	Rated(stall) 100% / 2V	888µsec	22	Amplifier load level	100% / 5V	113.7ms
3	Speed command	1000r/min / 2V	888µsec	23	Regenerative load level	100% / 5V	910.2ms
4	Current command	Rated(stall) 100% / 2V	888µsec	24	PN bus wire voltage	50V / V (1/50)	888µsec
5	V-phase current value	10A / V	888µsec	25	Speed cumulative item	–	888µsec
6	W-phase current-value	10A / V	888µsec	26	Cycle counter	0-5V (Regardless of resolution)	888µsec
7	Estimated disturbance torque	Rated(stall) 100% / 2V	888µsec	27	Excessive error detection amount	mm / V	3.55ms
8	Collision detection disturbance torque	Rated(stall) 100% / 2V	888µsec	28	Collision detection estimated torque	Rated (stall) 100% / 2V	888µsec
9	Position feedback (stroke)	100mm / V	3.55ms	29	Position command (stroke)	100mm / V	3.55ms
10	Position feedback (pulse)	10µm / V	3.55ms	30	Position command (pulse)	10µm / V	3.55ms
11	Position droop	mm / V	3.55ms	31 to 99	–		
12	Position droop (×10)	100µm / V	3.55ms				
13	Position droop (×100)	10µm / V	3.55ms				
14	Feedrate (FΔT)	10000(mm/min) / V	888µsec	100	5V test output		
15	Feedrate (FΔT × 10)	1000(mm/min) / V	888µsec	101	Saw-tooth wave test output	-5 to 5V Cycle: 113.7ms	888µsec
16	Model position droop	mm / V	3.55ms				
17	Model position droop (×10)	100µm / V	3.55ms	102	Rectangular wave test output	0 to 5V Cycle: 227.5ms	888µsec
18	Model position droop (×100)	10µm / V	3.55ms				
19	q-axis current cumulative value	–	888µsec	103 to	Setting prohibited		
20	d-axis current cumulative value	–	888µsec				

(3) Setting the output scale

This is set when an output is to be made with a unit other than the standard output unit.

(Example 1) When SV061 = 5, SV063 = 2560
The V-phase current value will be output with 1 A/V unit to D/A output ch.1.

(Example 2) When SV063 = 11, SV064 = 128
The position droop will be output with a 2mm/Vunit to D/A output ch.2.

No.	Abbrev.	Parameter name	Explanation	Normal setting range
SV063	DA1MPY	D/A output channel 1 output scale	When “0” is set, the output will be made with the standard output unit. To change the output unit, set a value other than 0. The scale is set with a 1/256 unit. When 256 is set, the unit will be the same as the standard output.	-32768 to 32767
SV064	DA2MPY	D/A output channel 2 output scale		

(4) Setting the offset amount

This is used when the zero level of the output voltage is to be finely adjusted. The output scale when the data No. is “0” will be the offset amount. After setting the offset, set the data No. to a value other than “0”, and do not set it to “0” again. Because the offset amount is saved in the drive unit memory, it does not need to be set again when the drive unit power is turned ON next.

No.	Abbrev.	Parameter name	Explanation	Normal setting range
SV061	DA1NO	D/A output channel 1 data No.	Set “0”. After setting the offset amount in SV063 and SV064, change the data No. to a value other than “0”.	0 to 102
SV062	DA2NO	D/A output channel 2 data No.		
SV063	DA1MPY	D/A output channel 1 offset amount	The amount can be set with the output precision unit. Observe the output value and set so that the output value is 0V. Because the offset amount is saved in the drive unit memory, it does not need to be set again when the drive unit power is turned ON next.	-10 to 10
SV064	DA2MPY	D/A output channel 2 offset amount		

1-1-5 Parameters Concerning with Acceleration/Deceleration Processing

As for acceleration/deceleration control with NC, there are 4 types of processing. The setting of acceleration/deceleration time constant is based on “constant time”, which means that the inclination changes in accordance with the speed. (cf. constant inclination)

(1) Exponential (primary delay) acceleration/deceleration

Acceleration/deceleration is made according to exponential function. This acceleration/deceleration control has been used for a long time as the way it is controlled is very simple. However, it takes longer time to complete positioning and it is not used for rapid traverse feed any more. This is occasionally used for cutting feed.

(2) Exponential acceleration - linear deceleration

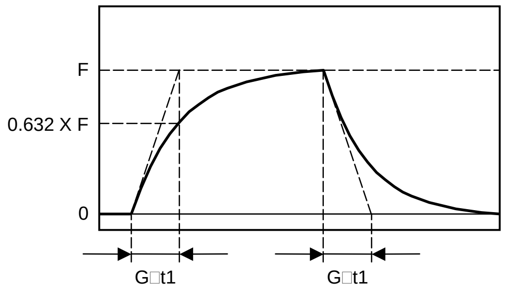
This acceleration/deceleration control enabled to shorten the time to complete positioning by improving the exponential acceleration/deceleration control.

(3) Linear acceleration/deceleration

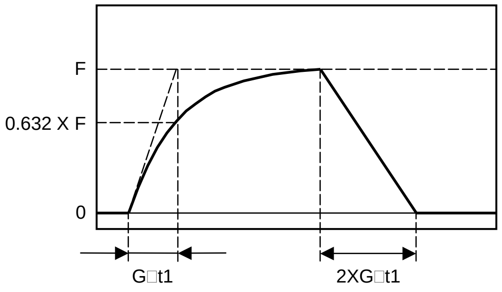
This acceleration/deceleration control is most commonly used. Comparing with exponential acceleration/ deceleration control, the motor torque output is more ideal and the time to complete positioning can be reduced. This acceleration/deceleration control requires the memory capacity, therefore, it was limited when using conventional NC though the present NC has been relieved from such a limitation. Use linear acceleration/deceleration for rapid traverse feed. Use also for the cutting feed.

(4) S-pattern (Soft) acceleration/deceleration

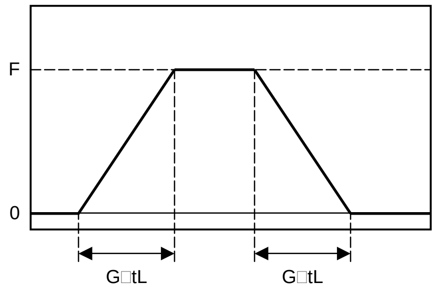
Use this acceleration/deceleration control in case that the shock at the start of acceleration when using linear acceleration/deceleration, or in case that the torque output efficiency is not good enough as the acceleration/deceleration torque is not constant (the protrusion can be observed in the torque waveform) in the axis with a large inertia (acceleration/deceleration time constant ≥300ms). However, this acceleration/deceleration type cannot be used for the cutting feed in interpolation axis because the synchronization between axes is not available.



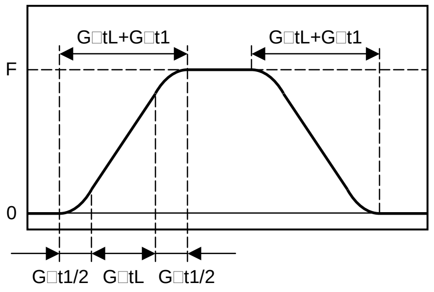
(1) Exponential (primary delay) acceleration/deceleration



(2) Exponential acceleration-linear deceleration



(3) Linear acceleration/deceleration



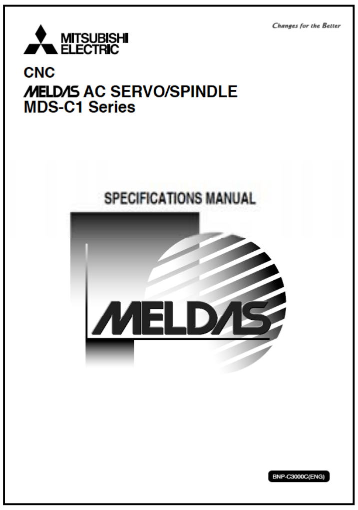
(4) S-pattern (Soft) acceleration/deceleration

Axis specification parameters (M60S series) concerning with acceleration/deceleration control.

<table>
<tr><th>M60S</th><th>Abbrev.</th><th>Parameter name</th><th>Unit</th><th>Explanation</th><th>Setting range</th></tr>
<tr><td>#2001</td><td>rapid</td><td>Rapid traverse rate</td><td>mm/min</td><td>Set rapid traverse rate for each axis.
The setting value has to be less than the maximum spindle speed of the motor.</td><td>1 to 999,999</td></tr>
<tr><td>#2002</td><td>clamp</td><td>Cutting feed clamp speed</td><td>mm/min</td><td>Set the cutting feed (G1 feed) clamp speed.
The programmed speed is restricted by this parameter.</td><td>1 to 999,999</td></tr>
<tr><td>#2003</td><td>smgst</td><td>Acceleration/ deceleration mode</td><td colspan="3">Designate modes for acceleration/deceleration (smoothing) control;
<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set.</th><th>Meaning when “1” is set.</th></tr>
<tr><td>0</td><td>LR</td><td rowspan="4">Set the G0 feed (rapid traverse) acceleration/deceleration type.</td><td rowspan="4">1: Linear acceleration/deceleration
2: Exponential (primary delay) acceleration/deceleration
8: Exponential acceleration, linear deceleration
F: S-pattern (soft) acceleration/deceleration</td></tr>
<tr><td>1</td><td>R1</td></tr>
<tr><td>2</td><td></td></tr>
<tr><td>3</td><td>R3</td></tr>
<tr><td>4</td><td>LC</td><td rowspan="4">Set the G1 feed (cutting feed) Acceleration/deceleration type.</td><td rowspan="4">1: Linear acceleration/deceleration
2: Exponential (primary delay) acceleration/deceleration
8: Exponential acceleration, linear deceleration
F: S-pattern (soft) acceleration/deceleration</td></tr>
<tr><td>5</td><td>C1</td></tr>
<tr><td>6</td><td></td></tr>
<tr><td>7</td><td>C3</td></tr>
<tr><td>8</td><td>OT1</td><td>Stroke end stop time constant G0tl</td><td>Stroke end stop time constant G0tl×2</td></tr>
<tr><td>9</td><td>OT2</td><td>Stroke end stop type: linear deceleration</td><td>Position loop step stop</td></tr>
<tr><td>10</td><td>OT3</td><td></td><td>(Speed loop step stop)</td></tr>
<tr><td>11</td><td></td><td colspan="2">(Note) Set this parameter(bit8-10) with a limit switch (H/W).</td></tr>
<tr><td>12</td><td></td><td></td><td></td></tr>
<tr><td>13</td><td></td><td></td><td></td></tr>
<tr><td>14</td><td></td><td></td><td></td></tr>
<tr><td>15</td><td></td><td></td><td></td></tr>
</table>
Set “0” in bits with no particular description.</td></tr>
<tr><td>#2004</td><td>G0tL</td><td>G0 time constant (linear)</td><td>ms</td><td>Set time constant for linear control with G0 feed (rapid traverse) acceleration/deceleration, or time constant at the 1st step of S-pattern acceleration/deceleration control</td><td>1 to 4000</td></tr>
<tr><td>#2005</td><td>G0t1</td><td>G0 time constant (exponential)</td><td>ms</td><td>Set the exponential time constant with G0 feed (rapid traverse) acceleration/deceleration, exponential acceleration-linear deceleration time constant, or time constant at the 2nd step of S-pattern time constant.</td><td>1 to 5000</td></tr>
<tr><td>#2006</td><td>G0t2</td><td></td><td></td><td>Not used.</td><td>0</td></tr>
<tr><td>#2007</td><td>G1tL</td><td>G1 time constant (linear)</td><td>ms</td><td>Set time constant for linear control with G1 (cutting feed) acceleration/deceleration, or time constant at the 1st step of S-pattern time constant.</td><td>1 to 4000</td></tr>
<tr><td>#2008</td><td>G1t1</td><td>G1 time constant (exponential)</td><td>ms</td><td>Set the exponential time constant with G1 feed (cutting feed) acceleration/deceleration, exponential acceleration-linear deceleration time constant, or time constant at the 2nd step of S-pattern time constant.</td><td>1 to 5000</td></tr>
<tr><td>#2009</td><td>G1t2</td><td></td><td>ms</td><td>Not used</td><td>0</td></tr>
<tr><td>#2013
#2014</td><td>OT–
OT+</td><td>Soft limit I –
Soft limit I +</td><td>mm</td><td>These set the soft limit area with zero point of basic machine coordinate system as reference point. When the inputted value exceeds this parameter, the machine cannot move. When #2013 is set to the same value as #2014 except for “0”, this function is disabled. (For maker setup)</td><td>-99999.999 to 99999.999</td></tr>
</table>

2 MDS-C1/CH-Vx ADJUSTMENT PROCEDURES

Prepare the following manuals when adjusting the MDS-C1-Vx Series (200V series) and MDS-CH-Vx Series (400V series) servo parameters in accordance with this manual.



MITSUBISHI ELECTRIC

Changes for the Better

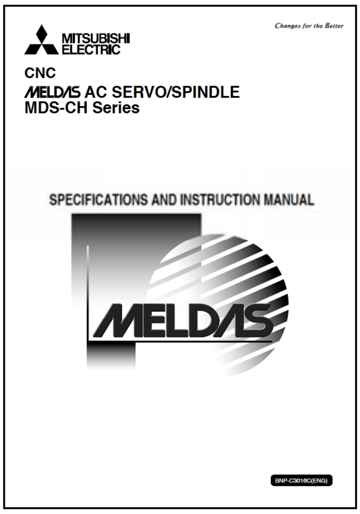
CNC
MELDAS AC SERVO/SPINDLE
MDS-C1 Series

SPECIFICATIONS MANUAL

MELDAS

BNP-C3000C(ENG)

“MDS-C1 SERIES SPECIFICATIONS MANUAL” BNP-C3000



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Changes for the Better

CNC
MELDAS AC SERVO/SPINDLE
MDS-CH Series

SPECIFICATIONS AND INSTRUCTION MANUAL

MELDAS

BNP-C3016C(ENG)

“MDS-CH SERIES SPECIFICATIONS AND INSTRUCTION MANUAL ” BNP-C3016

When adjusting the servo for the first time (primary adjustment), set and adjust the following items in order from 2-1 to 2-4. “2-5 Procedures for adjusting each function” are set and adjusted only when required.

- 2-1 Setting initial parameters
- 2-2 Gain adjustment
- 2-3 Adjusting acceleration/deceleration time constant
- 2-4 Initial adjustment for the servo functions

As for the primary adjustment, set and adjust the items in order from 2-1 to 2-4.

In this manual, [Normal setting range] of parameters are shown instead of [Setting range]. [Normal setting range] means the range of the values used in actual parameter adjustment (though [Setting range] means the range of values that does not cause an error).

<Example of parameter explanation>

No.	Abbrev.	Parameter name	Explanation	Normal setting range
SV008	VIA	Speed loop leading compensation	“1364” is set as a standard. ”1900” is set as a standard during SHG control. Adjust in increments of approx. 100 at a time.	700 to 2500

⚠ **CAUTION** This manual explains only in case of high gain mode of MDS-C1-Vx.

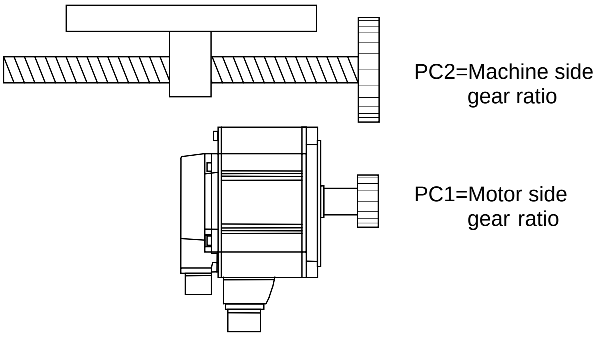
2-1 Setting Initial Parameters

Input the setting values listed in the "Standard Parameter list per motor" in the specifications manual for the initial parameters before adjusting the servo. If a wrong value is input, the initial parameter error (ALM37) will occur. In this case, the parameter number causing an error is displayed on the NC screen. Some parameters are determined by the machine specification and they are explained below.

2-1-1 Setting the gear ratio

Input the ratio of gear tooth. When initial parameter error (ALM37) –error parameter number 101– occurs, reconsider the specification as electric gear must be overflowing.

When the machine specification is “rack and pinion”, π is included in the deceleration ratio. In this case, the accurate positioning is impossible to be made. Express the π with a rough fractional number when calculating the gear ratio.



No.	Abbrev	Parameter name	Explanation
SV001	PC1	Motor side gear ratio	Calculate the reducible number of each gear tooth and set the result. When PC1 < PC2, deceleration is set. In case that π is included as well as “rack and pinion”, the accurate positioning is impossible to be made as π is calculated into a rough fractional number when calculating the gear ratio. For accurate positioning, the full-closed loop control using a linear scale is required.
SV002	PC2	Machine side gear ratio	

2-1-2 Setting detector specifications

When using the linear scale, refer to the linear scale instruction manual, and set the parameters correctly.

No.	Abbrev	Parameter name	Explanation
SV019	RNG1	Position detector resolution	For semi-closed loop (using the detector at the motor end only), set the same value as SV020. For full-closed loop, set in accordance with the linear scale specification.
SV020	RNG2	Speed detector resolution	Set the motor detector resolution with kp/rev (1000 pulse/1 rotation) unit.
SV025	MTYP	Motor/detector type	The 2 high-order digits have to be set in accordance with the specification of the detector at the motor end and linear scale. Refer to the "2-7 List of MDS-C1/CH-Vx Parameters" in addition.

2-1-3 Confirming the machine specifications value

Confirm the following machine specifications value to be set in axis specification parameters.

M60S Series	Abbrev.	Parameter name	Explanation
#2001	rapid	Rapid traverse rate	Set the rapid traverse rate. Confirm the maximum rotation speed of the motor.
#2002	clamp	Cutting feed clamp speed	Specify the maximum speed of the cutting feedrate. Even though the feedrate for G01 exceeds this value, clamped with this speed.
#2003	smgst	Acceleration/deceleration mode	Set in accordance with machine specifications. In machine tools, rapid traverse feed is generally set to “Linear acceleration/deceleration” mode and cutting feed is generally set to “Exponent acceleration/deceleration” mode. S-pattern (soft) acceleration/deceleration function is occasionally used for the machine with a large inertia.

2-2 Gain Adjustment

2-2-1 Preparation before operation

(1) Confirming the safety

The servo is ready to be operated when the initial parameter settings are completed. Confirm the safety by checking the following items before operation.

Cancel the emergency stop and make READY ON.	Is any alarm occurring?
⇩	
Confirm the axis movement by using a manual pulse generator.	Are there any vibration or strange sound? Is the load too large? (Is the current too large?)
⇩	
Confirm the soft limit movement by using a manual pulse generator.	Does the axis stop before hitting the machine? Confirm the soft limit (over travel) protection.
⇩	
Make a program taking account of axis movement range.	Make a program taking account of soft limit position. (Refer to the sample program.)
⇩	
Specify the single block operation and set the rapid traverse override to less than 25%.	Move slowly at first confirming the program.
⇩	
Move axis forward and backward by memory operation (program operation). If there is no problem, cancel the single block and raise the override up to 100% gradually.	If the acceleration current is too large, make acceleration/deceleration time constant longer. If there is more than 100% of acceleration current, that will be enough.

(Sample program of rapid traverse feed for reciprocating operation.)

G28 X0;	X axis zero return
N01 G90 G0 X-200.;	Move X axis to X= -200 with rapid traverse feed by absolute position command (the line N01).
G4 X1.0;	Dwell for 1 second. (1-second pause) Use “X” even for Y axis and Z axis.
G0 X0;	Make X axis move to X=0 by rapid traverse feed.
G4 X1.0;	Dwell for 1 second. (1-second pause) Use “X” even for Y axis and Z axis.
GOTO 01	Back to “N01”

Make sure not collide.
No “.” means 200µm,
do not fail to add “.”.

⚠ CAUTION

Do not fail to confirm the soft limit movement (over travel) to prevent collision.
Be careful of the position of other axes and pay attention when the cutter has already mounted as the collision possibly occurs before the soft limit.

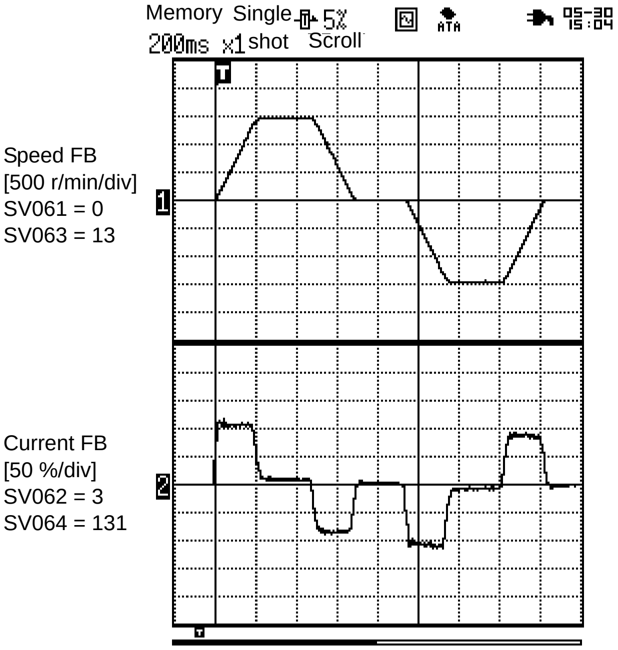
(2) Confirming the acceleration/deceleration waveform with a Hi-coder

Measure speed FB waveform and current waveform during acceleration/deceleration after connecting a Hi-coder. **Zero level adjustment on Hi-coder side is required** to obtain the waveform shown right because of 2.5V offset.

(Items to be checked)

1) Voltage output level (ch.1, ch.2)
2) Zero level (ch.1, ch.2)
3) Output polarity of the current FB

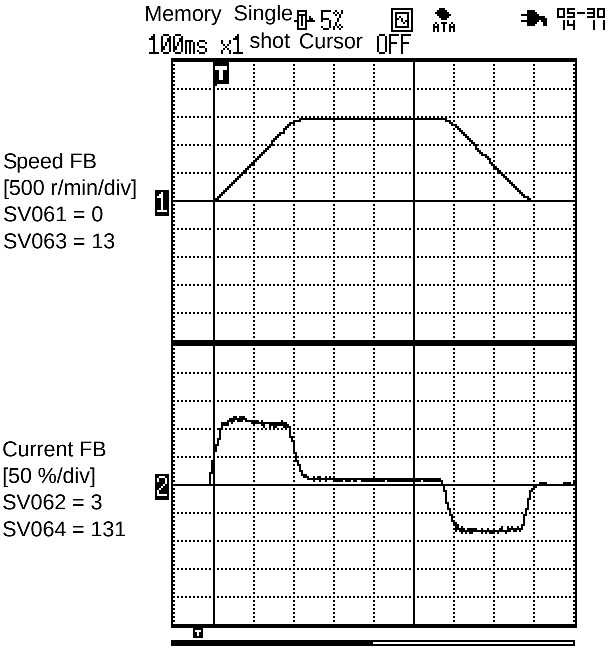
Make sure that the hi-code data is reliable as the rest of the servo adjustment procedures which will be done later depend on this Hi-coder data.



Acceleration/deceleration waveform of reciprocating operation

When measuring repeatedly, set the trigger for starting Hi-coder measurement at the start of speed FB. When measuring the data later, change the data of ch.2 only and leave ch.1 at speed FB, so that the measurement is always executed at the same timing. Set the timing of the measurement, and the data can be compared easily in case that the operation conditions including parameters are changed.
The waveforms shown in this manual are measured at one acceleration/deceleration as the reciprocating operation includes the same waveform which has different polarity. In case of the waveform shown the right, the trigger level is set as follows;

ch.1: 100mV ↑direction



Determine the measuring timing by setting the trigger

No.	Abbrev.	Parameter name	Explanation	Normal setting range
SV061	DA1NO	D/A output channel 1 data No.	The data No. to be output each D/A output channel is output.	-1 to 12, 64, 65, 77, 125 to 127
SV062	DA2NO	D/A output channel 2 data No.		
SV063	DA1MPY	D/A output channel 1 output scale	The output will be made with a standard output unit normally. The scale is set with a 1/256 unit. Refer to "1-2-3 D/A Output Specifications for MDS-C1/CH-Vx ".	-32768 to 32767
SV064	DA2MPY	D/A output channel 2 output scale		

2-2-2 Measuring the inertia rate

Measure the load inertia by using the disturbance observer function of a servo drive unit to determine the standard speed loop gain (standard VGN). Set the measured load inertia rate in the servo parameter SV037.

Measure the unbalance torque and set it in SV032.

In case of horizontal axis, set “SV032=0”.
In case of vertical axis, refer to “2-4-1 (1) unbalance torque and frictional torque ”.

⇩

Set “SV037=100”, “SV043=600” and “SV044=0”.

No need to compensate the disturbance observer itself.
Therefore, set gain (SV044) to “0”.

⇩

Set “SV061=0”, “SV062=77”, “SV063=13”, and “SV064=8”.

Output the estimated disturbance torque to D/A output ch.2.
(In case that 3000r/min is specified, set SV063 to “9”.)

⇩

Accelerate/decelerate and then adjust the output scale of ch.2.

Adjust the output scale (SV064) so that the disturbance torque waveform in case of SV037=100 becomes as shown below.
(Adjust so that the inertia rate can be judged.)

⇩

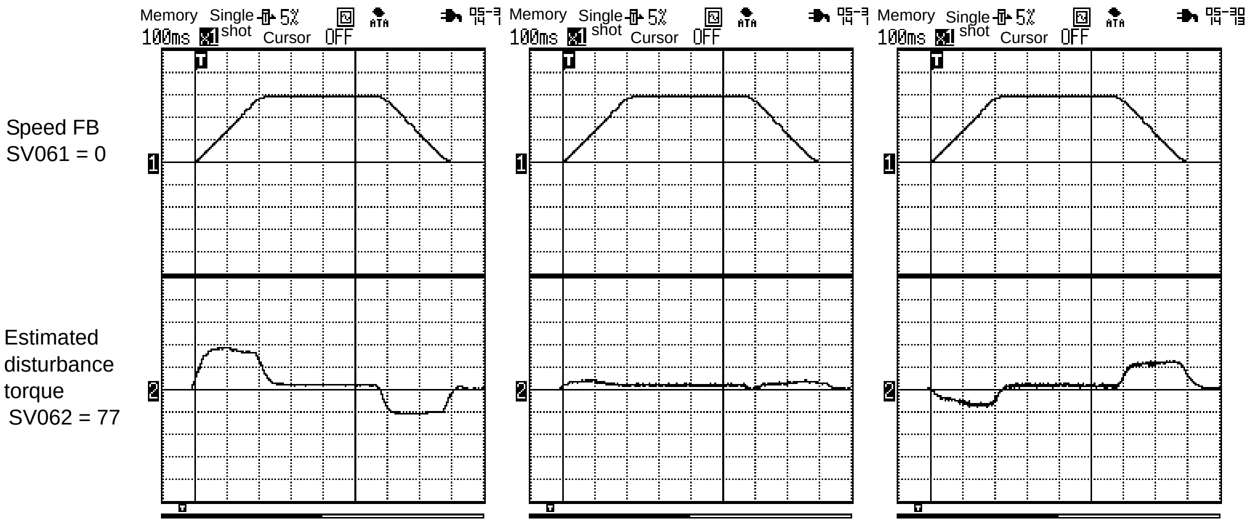
Change SV037 during acceleration/deceleration so that the estimated disturbance torque becomes flat.

Make a program taking account of the soft limit position.
(Refer to the sample program.)

⇩

Designate the load inertia scale as the value of SV037 at which the estimated disturbance torque becomes the flattest.

The load inertia rate of the following example including the motor itself is JL = 3.4 x JM.
(Set SV043 back to “0” and take a note of SV037.)



SV037 = 100
(Too low)

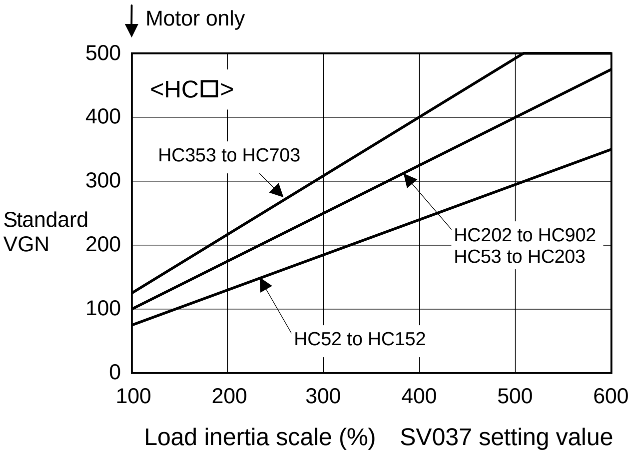
SV037 = 340
(Optimum)

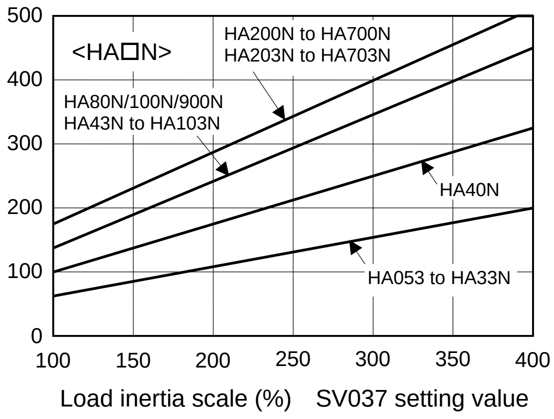
SV037 = 500
(Too high)

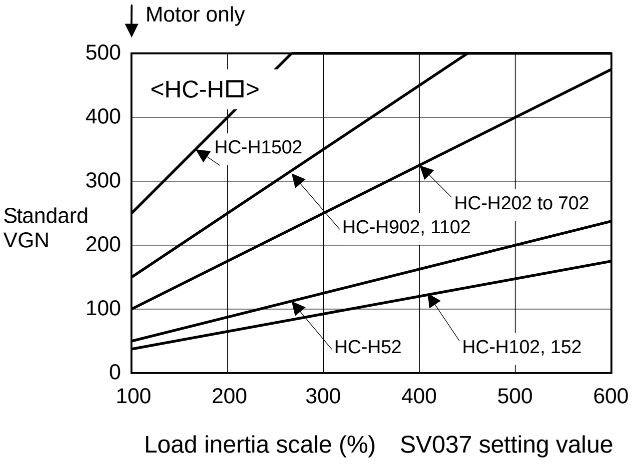
2-2-3 Determining the standard speed loop gain

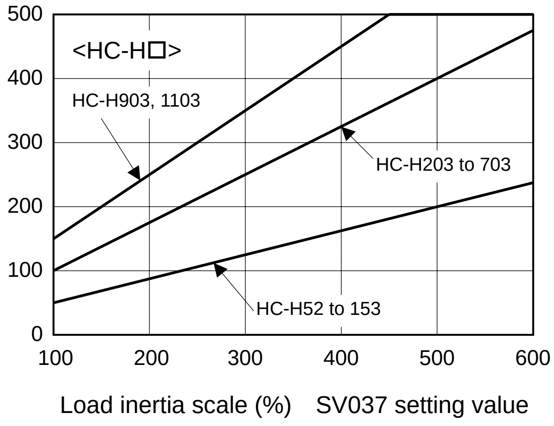
The standard speed loop gain (standard VGN) is determined referring to the respective load inertia rate in the following table. If the standard VGN is set as it is, vibration would occur in most models; so at this point, keep this value in mind as the target value for adjusting the gain.

No.	Abbrev.	Parameter name	Explanation	Normal setting range
SV005	VGN1	Speed loop gain 1	Determine the standard setting value by measuring load inertia scale and referring to the graph below.	100 to 400









2-2-4 Explanation of notch filter

Machine resonance occurs when the speed loop gain is increased to improve the control accuracy. The machine resonance is a phenomenon that occurs when the servo's speed loop control acts on the machine's specific frequency (characteristic resonance frequency). When adjusting the speed loop gain, a notch filter must be set to suppress this machine resonance (vibration) resulting in an increase of vibration. The notch filter functions to suppress the servo response at the set frequency, and thereby suppress the occurrence of vibration. Always understand the methods of setting the notch filter before adjusting the speed loop gain. Refer to section "2-2-5 Adjusting the speed loop gain" for details on setting the notch filter.

(1) Notch filter specifications

Mainly the following two notch filters are used with the MDS-C1/CH-Vx series.

MDS-C1/CH-Vx filters

	Frequency range	Frequency settings	Depth compensation settings
Notch filter 1	100Hz to 2250Hz	SV038	SV033.bit1 to 3
Notch filter 2	100Hz to 2250Hz	SV046	SV033.bit5 to 7

The operation frequency parameter can be set in 1Hz increments, but the internal control will function at the frequency shown below which is the closest to the setting value. Set the setting frequency shown below in the parameter when adjusting the notch filter.

The depth compensation is a function that sets the notch filter at a low frequency. A stable notch filter can be set even at a low frequency. Usually, the standard value that matches the setting frequency is set as shown below.

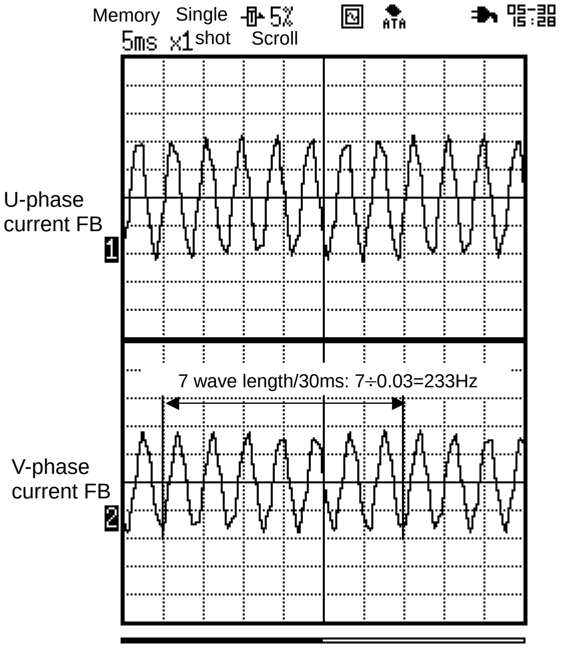
Setting frequency and standard filter depth for notch filter 1 and 2

Setting frequency	Standard filter depth	Setting frequency	Standard filter depth	Setting frequency	Standard filter depth
2250Hz	0	562Hz	0	281Hz	4
1800Hz	0	529Hz	0	250Hz	4
1500Hz	0	500Hz	0	225Hz	4
1285Hz	0	474Hz	0	204Hz	4
1125Hz	0	450Hz	0	187Hz	8
1000Hz	0	429Hz	0	173Hz	8
900Hz	0	409Hz	0	160Hz	8
818Hz	0	391Hz	4	150Hz	8
750Hz	0	375Hz	4	132Hz	8
692Hz	0	346Hz	4	125Hz	8
642Hz	0	321Hz	4	112Hz	8
600Hz	0	300Hz	4	100Hz	C

(Note) The depth compensation setting above shows a HEX setting value when the bit0 or bit4 setting is 0.

<table>
<tr><td>bit</td><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>SV033 setting</td><td colspan="4">*</td><td colspan="4">*</td><td colspan="3">Notch filter 2 depth compensation</td><td>*</td><td colspan="3">Notch filter 2 depth compensation</td><td>*</td></tr>
<tr><td>When bit0, 4 = 0</td><td colspan="4">Does not change</td><td colspan="4">Does not change</td><td colspan="4">0, 4, 8, C</td><td colspan="4">0, 4, 8, C</td></tr>
<tr><td>When bit0, 4 = 0</td><td colspan="4">Does not change</td><td colspan="4">Does not change</td><td colspan="4">1, 5, 9, D</td><td colspan="4">1, 5, 9, D</td></tr>
</table>

(2) Measuring the resonance frequency



Measuring vibration frequency (233Hz)
(Measure manually when vibration occurs.)

The resonance frequency must be measured before setting the notch filter frequency. To measure, gradually increase the speed loop gain to generate vibration, and measure the current waveform with a Hi-corder.

The phase current feedback output function is used to measure the resonance frequency of the MDS-C1/CH-Vx. (Refer to the following table) Output the U-phase current feedback to Ch. 1 of the Hi-corder, and the V-phase feedback to Ch. 2 as shown on the right. Then measure the two phase current feedbacks simultaneously. Depending on the motor rotation angle, there may be cases where vibration cannot be measured at either one of the current phases; however, if measuring the two phases simultaneously, the vibration can always be measured.

Once the resonance frequency has been measured, immediately apply emergency stop and stop the vibration.

To calculate the vibration frequency, select an easy-to-view range in the Hi-corder grid, and calculate the number of waves generated in one second. (The unit is [Hz] at this time.)

Phase current feedback output function (CN9)

MDS-C1/CH-V1	MDS-C1/CH-V2	Signal	Output pin	GND pin
L axis	L axis (No. 1 axis)	U-phase current FB	7 pins	1, 11 pins (Common for each signal)
		V-phase current FB	17 pins	
	M axis (No. 2 axis)	U-phase current FB	6 pins	
		V-phase current FB	16 pins	

POINT

1. Measure the Y-phase current feedback and V-phase current feedback simultaneously so that the measurement can be completed without being affected by the motor angle.
2. The phase current feedback is used, so when the motor is rotating, a SIN wave that is 4-fold the speed (for HC motor) can be measured.
3. If a "squeak" is heard at the instant when acceleration/deceleration is started, the machine is vibrating at a high frequency exceeding 700Hz. The 750Hz or 1125Hz filter is effective in this case.

CAUTION

When generating resonance, make sure that the speed loop gain is not increased too far resulting in a large vibration. After measuring the resonance frequency, immediately apply emergency stop to stop the vibration. The machine or servo amplifier could fail if vibration is generated for a long time.

(3) Setting the notch filter frequency

After measuring the resonance frequency, refer to the "Setting frequency and standard filter depth for notch filter 1 and 2". Select the setting frequency larger than but closest to the resonance frequency and set the parameter. Set the depth compensation parameter to the standard filter depth that matches the frequency.

In the example of measurement on the previous page, the measured resonance frequency is 233Hz. Thus, set the following:

Filter setting frequency = 250Hz, Filter depth = 4

POINT

The notch filter easily becomes unstable when a low frequency is set. Even when set, only the resonance frequency may change (the vibration tone changes), and the resonance may not be completely removed. If the state is unstable, try using a higher frequency.

Basically, all resonance can be removed by setting the notch filter. The MDS-C1/CH-Vx series has the following functions in addition to the notch filter. Use those as necessary.

(4) Jitter compensation

Jitter compensation is effective to eliminate the vibration occurring when the axis motor whose backlash is comparatively large or whose linear movement object is heavy stops rotating. Set from 1 pulse by turn and confirm how it works.

Jitter compensation is effective only in case that the vibration occurs due to the backlash, thus, it does not work when the vibration is caused by other factors. (Even when set, only the vibration tone changes.) If the jitter compensation is not effective, remove the vibration with the notch filter.

Jitter compensation

Parameter setting	No jitter compensation	Compensation 1 pulse	Compensation 2 pulses	Compensation 3 pulses
SV027. bit4	0	1	0	1
SV027. bit5	0	0	1	1

(5) Other filters

The notch filter 3 with an operation frequency fixed at 1125Hz, and the speed feedback filter fixed at 2250Hz are the other notch filters available. The usage methods are the same as notch filter 1 and 2. Set them as necessary such as when treating with the third frequency.

Other MDS-C1/CH-Vx filters

	Frequency range	Frequency settings	Depth compensation settings
Notch filter 3	1125 Hz fixed	SV033. bit4	None
Speed feedback filter	2250 Hz fixed	SV017. bit3	None

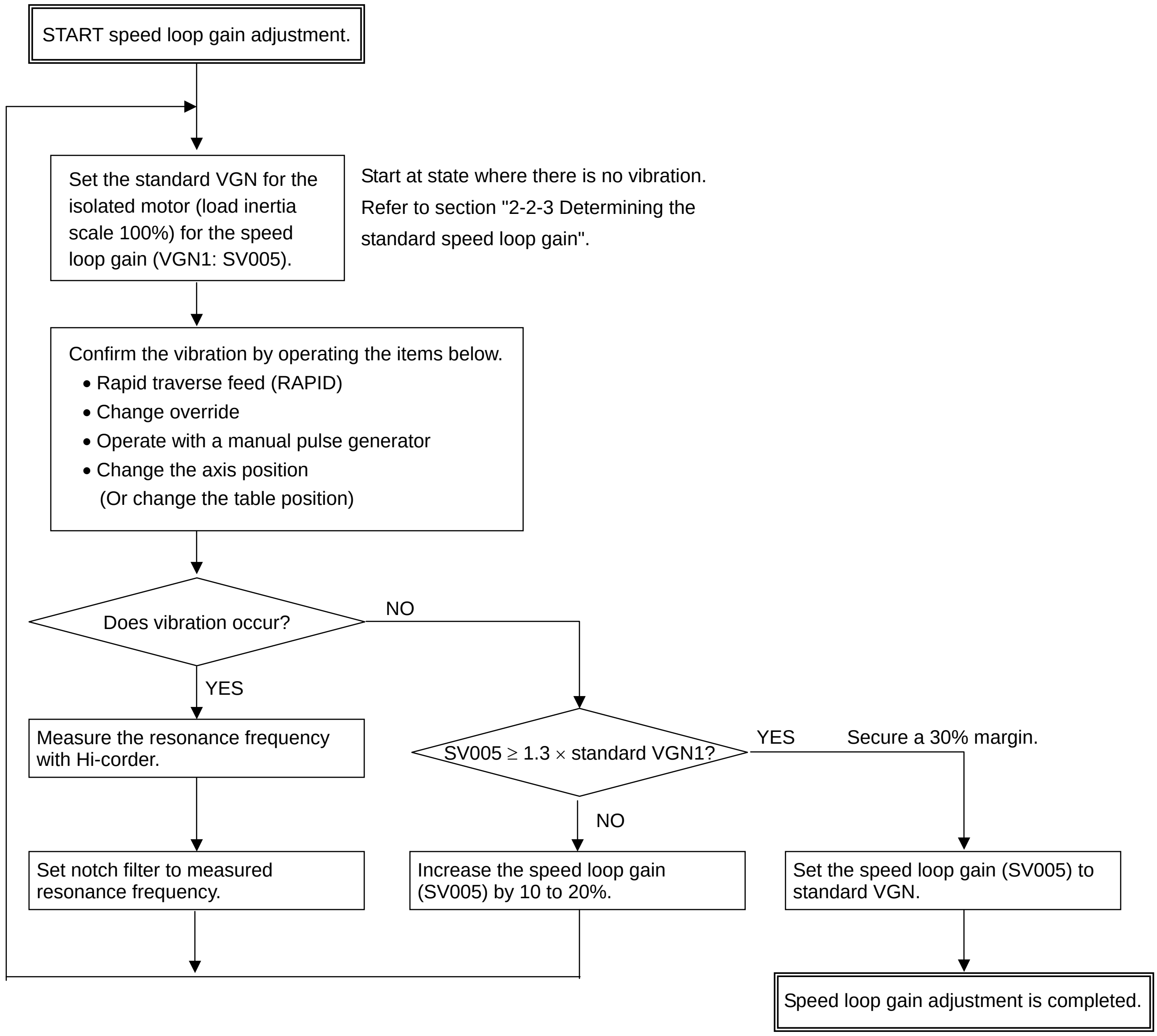
Parameter settings related to resonance removing filter

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Unit</th><th>Explanation</th><th>Normal setting range</th></tr>
<tr><td>SV038</td><td>FHz1</td><td>Notch filter frequency 1</td><td>Hz</td><td>Set the resonance frequency to be suppressed. (Valid at 36 or more.)
Set “0” when the filter is not be used.</td><td>150 to 1125</td></tr>
<tr><td>SV046</td><td>FHz2</td><td>Notch filter frequency 2</td><td>Hz</td><td>Set the resonance frequency to be suppressed. (Valid at 36 or more.)
Set “0” when the filter is not to be used.</td><td>150 to 1125</td></tr>
<tr><td>SV017</td><td>SPEC*</td><td>Servo specification selection</td><td colspan="3">
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="4">mtr</td><td>drva</td><td>drvu</td><td>mpt</td><td>mp</td><td>abs</td><td></td><td>vdir</td><td>fdir</td><td>vfb</td><td>qro</td><td>dfbx</td><td>fdir2</td></tr>
</table>
<Start speed feedback filter> Eliminate the high frequency vibration of a motor and a detector.
<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set</th><th>Meaning when “1” is set</th></tr>
<tr><td>3</td><td>vfb</td><td>Speed FB filter stop</td><td>Speed FB filter start (2250Hz fixed)</td></tr>
</table>
</td></tr>
<tr><td>SV027</td><td>SSF1</td><td>Servo function selection 1</td><td colspan="3">
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>aflt</td><td>Zrn2</td><td colspan="2">afse</td><td colspan="2">ovs</td><td colspan="2">lmc</td><td>omr</td><td>zrn3</td><td colspan="2">vfct</td><td></td><td>upc</td><td colspan="2">vcnt</td></tr>
</table>
<Start jitter compensation> Eliminate the vibration while the motor is stopping.
<table>
<tr><th colspan="2">bit</th><th>No jitter compensation</th><th>Pulse of compensation type1</th><th>Pulse of compensation type2</th><th>Pulse of compensation type3</th></tr>
<tr><td>4</td><td rowspan="2">vfct</td><td>0</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>5</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
</table>
<Active adaptive filter>
<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set</th><th>Meaning when “1” is set</th></tr>
<tr><td>C
D</td><td>afse</td><td colspan="2">Raise the sensitivity of the adaptive filter.
00: Standard sensitivity 11: high-sensitivity of vibration detector
(Set 2 bit at the same time.)</td></tr>
<tr><td>E</td><td>zrn2</td><td colspan="2">Set to “1”</td></tr>
<tr><td>F</td><td>aflt</td><td>Adaptive filter stopped</td><td>Adaptive filter activated</td></tr>
</table>
</td></tr>
<tr><td>SV033</td><td>SSF2</td><td>Servo function selection 2</td><td colspan="3">
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="4">dos</td><td colspan="2">dis</td><td></td><td></td><td colspan="3">nfd2</td><td>nf3</td><td colspan="3">nfd1</td><td>zck</td></tr>
</table>
<Depth compensation for the notch filter 1>
<table>
<tr><th colspan="2">bit</th><th>Explanation</th></tr>
<tr><td>1 to 3</td><td>nfd1</td><td>When bit0 (zck) = 0 (Standard), set the first digit of SV033 to even numbers such as 0, 2, 4…A, C, and E. 0 is the deepest. The higher the setting value is, the shallower the filter is.</td></tr>
</table>
<Activate notch filter 3> Eliminate the high frequency vibration.
<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set</th><th>Meaning when “1” is set</th></tr>
<tr><td>4</td><td>nf3</td><td>Notch filter 3 stopped</td><td>Notch filter 3 stopped (fixed to1125Hz)</td></tr>
</table>
<Depth compensation for notch filter 2>
<table>
<tr><th colspan="2">bit</th><th>Explanation</th></tr>
<tr><td>5 to 7</td><td>nfd2</td><td>Set the same as the depth compensation for notch filter 1.
Set shallowly to make control stable and prevent other vibrations apart from the filter frequency though the effective vibration elimination can not be expected.</td></tr>
</table>
</td></tr>
</table>

2-2-5 Adjusting the speed loop gain

The speed loop gain (SV005) is gradually increased from the state where resonance does not occur. Once resonance starts, set the notch filter to remove the resonance. Next, increase the speed loop gain while removing the vibration with the notch filter, and adjust the speed loop gain targeting the standard VGN determined from the load inertia. A 30% margin must be secured to ultimately set the standard VGN value, so set a standard VGN x 1.3 value and confirm that resonance does not occur.

If the resonance cannot be eliminated even when the notch filter is set, the speed loop gain setting will be limited. Set a value 30% lower than the maximum value at which resonance does not occur.



⚠ **CAUTION**	Do not set the notch filters to the frequency where vibration does not occur as a means of insurance. Setting many notch filters does not necessarily guarantee a better effect.

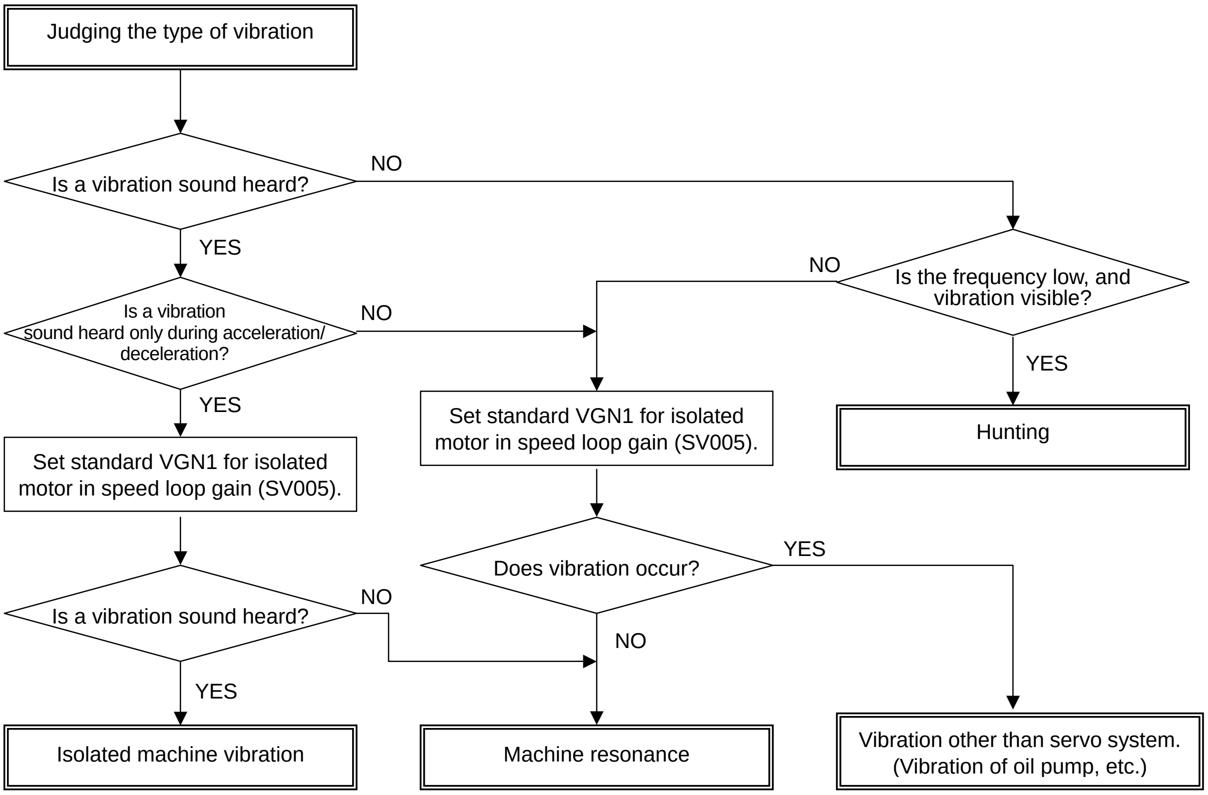
POINT

1. The final SV005 (VGN1) setting value is 70% of the maximum value at which machine resonance does not occur. If the resonance is suppressed and the SV005 setting is increased by using a vibration suppression function, such as a notch filter, the servo can be adjusted easier later on.
2. If the vibration is caused by resonance (mutual action of servo control and machine characteristics), the vibration can always be stopped by lowering SV005 (VGN1). If the vibration does not change even when SV005 is lowered, there may be a problem in the machine. The notch filter is not effective when there is a problem in the machine.

<<Reference material>>

Machine resonance is not the only vibration that occurs at the servo shaft. Types of vibration that occur at the servo shaft are listed below.

Types of vibration	Cause	Vibration frequency	Measures	Explanation
Machine resonance	Delay in servo control response	150Hz to 1kHz	• Set the notch filter • Lower VGN1 (SV005)	There may be several resonance points. The vibration can always be stopped by lowering VGN1.
Hunting	The speed loop PI gain (VGN, VIA) is unbalanced	Several Hz	• Lower VIA (SV008) • Raise VGN1 (SV005) • Use the disturbance observer	Visually apparent that the shaft vibrates during acceleration, or the shaft trembles when stopped.
Isolated machine vibration	Insufficient machine rigidity	10 to 20Hz	• Lower PGN1 (SV003) • Use S-pattern (soft) acceleration/deceleration	The machine vibrates due to impact during acceleration/deceleration. A "clonk" sound may be heard during acceleration.



2-2-6 Adjusting the position droop waveform

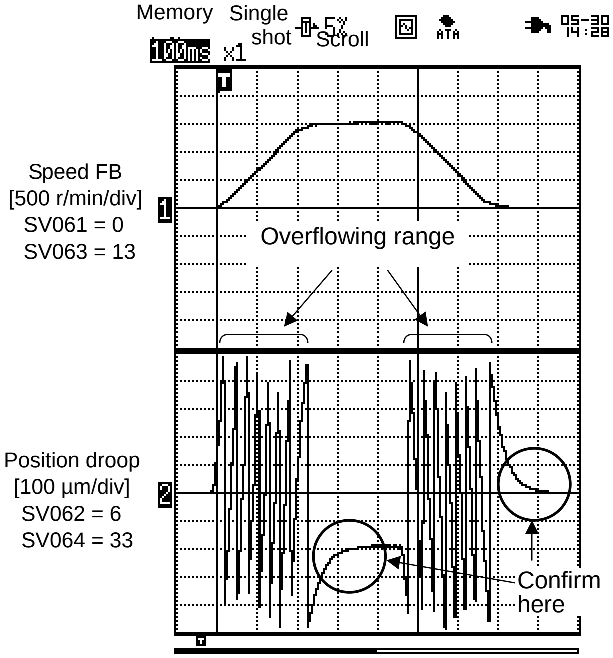
After adjusting the filter and determining the optimal speed loop gain (VGN1), adjust the speed loop leading compensation (VIA) and position loop gain (PGN) observing the position droop waveform.

(1) Measuring the position droop

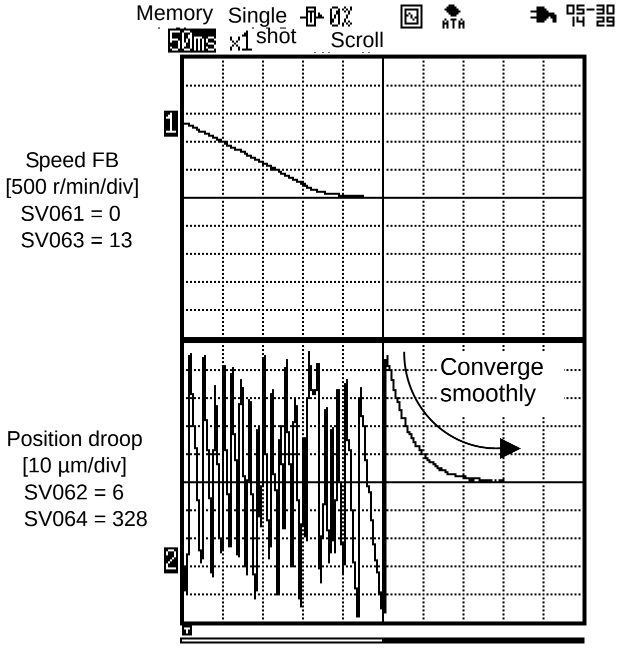
During rapid traverse feed, position droop takes a few millimeters. However, the unit of the waveform to be observed is "µm" and the overflowing waveform is displayed on the Hi-coder. Before adjusting, make the waveform as shown right appear on the Hi-coder.

Smooth convergence is the most important thing about position droop waveform. The position droop have to converge smoothly when the speed becomes constant or when positioning is completed and position droop becomes "0". Both of the waveforms enclosed with circles can be used for gain adjustment, however, the waveform at when positioning is completed is normally used because it enables to confirm the overshooting at the same time when adjusting servo.

It is necessary to confirm that the waveform of the positioning converges smoothly (approaches to "0") at the range of 10µm/0.5V because accurate control is required for the feed axis of machine tools.



Position droop waveform



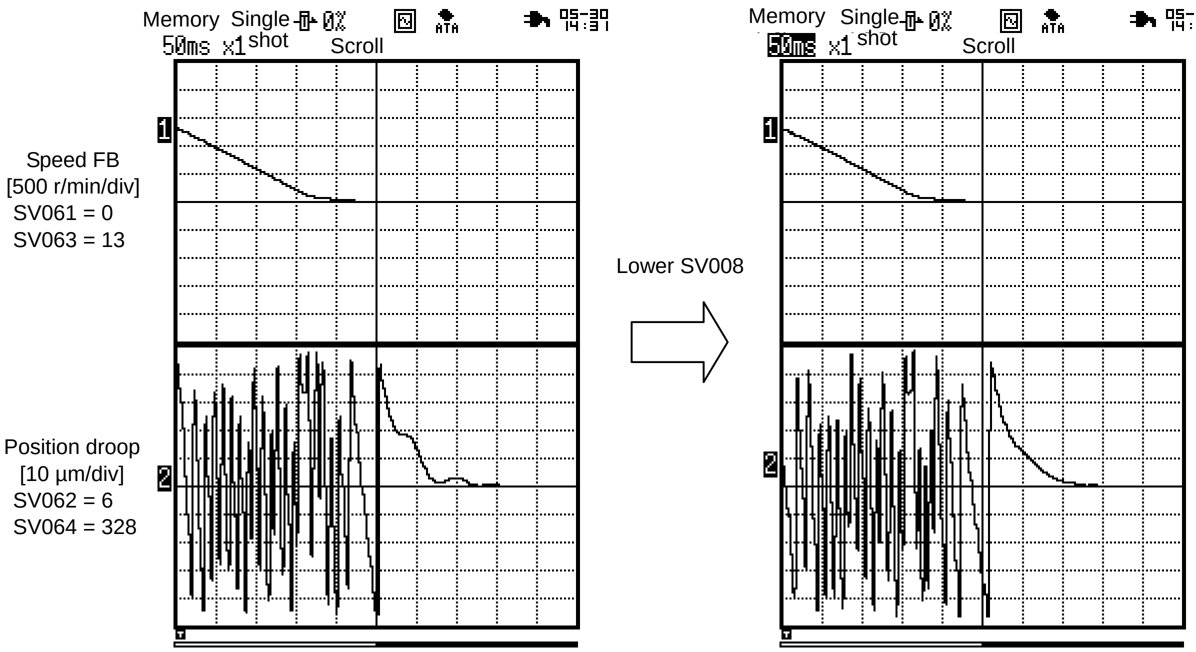
Confirm the waveform
when positioning is completed

(2) Adjusting speed loop leading compensation

There may be no problem when used at a normal load inertia scale. However, if used at a load inertia scale exceeding 500% with an insufficient speed loop gain (SV005) set, the position droop waveform may vibrate just before the motor stops. If the speed loop gain is small, and the shaft has relatively low wear, the motor may repeatedly reciprocate just before stopping resulting in hunting.

If vibration of the position droop is not improved much even when the position loop gain (SV003) is lowered, the leading compensation (SV008) value set for the proportional gain (SV005) is too large, so lower SV008 by approx. 100.

No.	Abbrev.	Parameter name	Explanation	Normal setting range
SV008	VIA	Speed loop leading compensation	1364 is set as a standard. 1900 is set as a standard during SHG control. Adjust in increments of approx. 100.	700 to 2500



Insufficient speed loop gain

After adjusting speed loop leading compensation (SV008)

POINT

1. The vibration can be eliminated by lowering VIA (SV008); however, VIA only adjusts the gain balance for the speed loop's PI control. As long as VGN1 (SV005) is set lower than the standard value, high-accuracy control cannot be expected.
2. Disturbance observer can also suppress the vibration.
   (Refer to “2-5-1 Disturbance observer”.)

(3) Adjusting position loop gain

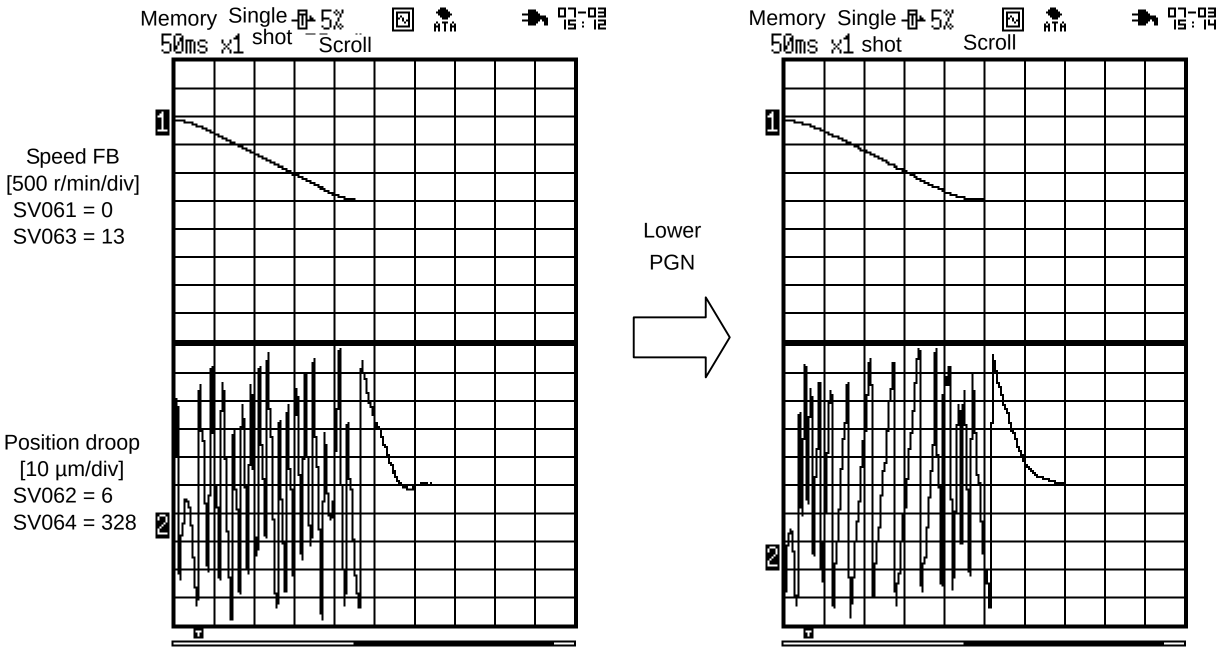
When raising the position loop gain, the responsiveness of the position and cutting accuracy is improved. Setting time is shortened and the cycle time can also be reduced. However, be aware of the limit value determined by the speed loop characteristics and machine characteristics.

The same position gain has to be set in both interpolation axes (the axes to perform synchronous control with). Set the position loop gain of the all axes to the lowest limit value of all.

No.	Abbrev.	Parameter name	Explanation	Normal setting range
SV003	PGN1	Position loop gain 1	Set 33 as a standard. Adjust in increments of approx. 3. If PGN is increased, cutting precision will be improved and the setting time will be shortened.	18 to 70

Limit of the position loop gain

Limit of PGN	Phenomenon	Cause	Remedy
Limit of speed loop characteristics	Position droop waveform vibrates during positioning. Overshooting occurs during positioning.	Insufficient speed loop gain (VGN1)	Suppress the resonance more and raise VGN. Use disturbance observer.
Limit of machine characteristics	Machine vibrates or makes strange noise during acceleration/deceleration. When feeding with the maximum scale by a pulse generator, machine vibrates or makes strange noise.	Insufficient machine rigidity	Use SHG control function. Use S-pattern acceleration/deceleration function when vibration occurs in rapid traverse feed. (NC function)



PGN is too high (33SHG)

After adjusting PGN (23SHG)

CAUTION

Set the same position loop gain (PGN) to all the interpolation axes.
(For the PGN of X, Y, Z axes, set the smallest value of the three to all of X, Y, Z axis.)

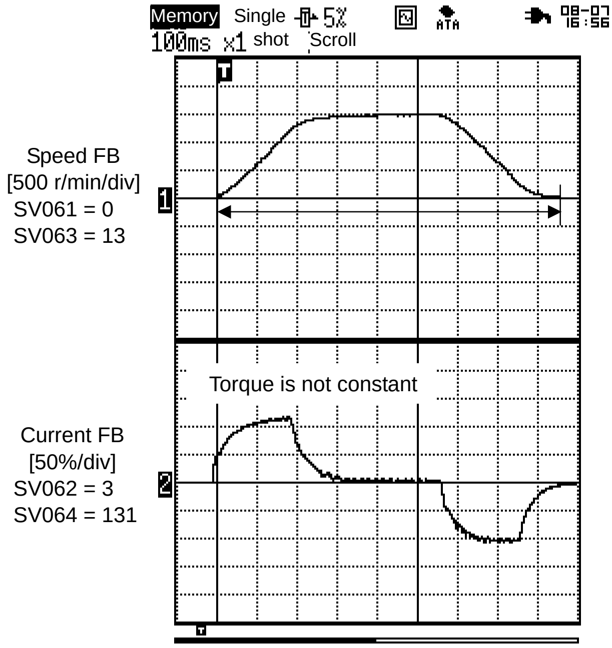
(4) SHG (Smooth High Gain) control

A high-response control and smooth control (reduced impact on machine) were conventionally conflicting elements; however, SHG control enables the two elements to function simultaneously by controlling the motor torque (current GB) with an ideal waveform during acceleration/deceleration.

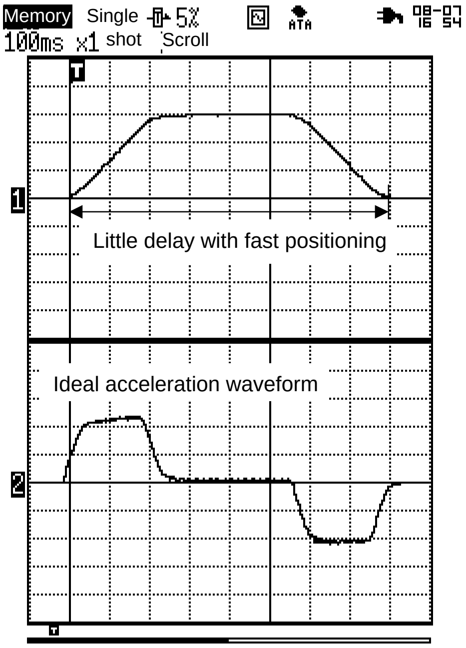
Start the adjustment with PGN1=23 (hereinafter referred to as 23SHG) for the feed axis of a machine tool at first. Try to adjust the SHG value so that it become as close to 47SHG as possible. If more than 33SHG can be set, this machine tool is a precision machine. If more than 23SHG can be set, the machine tool precision is good enough. SHG control function is efficient for feed axes of machine tools (X axis, Y axis or Z axis of the machining center etc.) to meet the demand of high-speed and high-accuracy cutting.

When changing normal control to SHG control, start adjusting, by setting PGN1 to "1/2". SHG control is as effective as when PGN1 is doubled. SHG control also can shorten the cycle time as it reduces the setting time.

No.	Abbrev.	Parameter name	Setting ratio	Setting example									Normal setting range
SV003	PGN1	Position loop gain 1	1	18	21	23	26	33	38	47	60	70	18 to 70
SV004	PGN2	Position loop gain 2	$\frac{8}{3}$	48	56	62	70	86	102	125	160	186	48 to 186
SV057	SHGC	SHG control gain	6	108	126	140	160	187	225	281	360	420	108 to 420
SV008	VIA	Speed loop leading compensation	Set 1900 as a standard for SHG control.										700 to 2500
SV015	FFC	Acceleration feed forward gain	Set 100 as a standard for SHG control.										0 to 300



Normal control (PGN = 26)



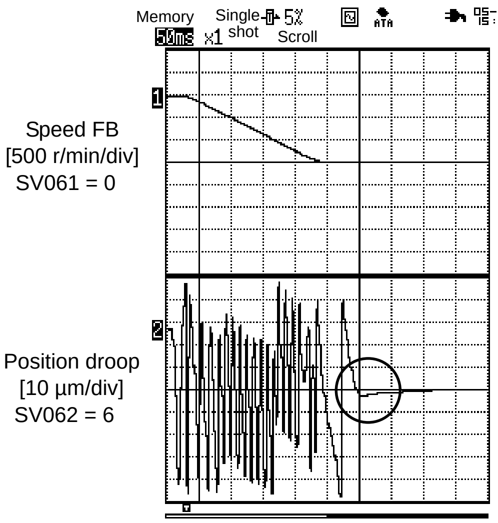
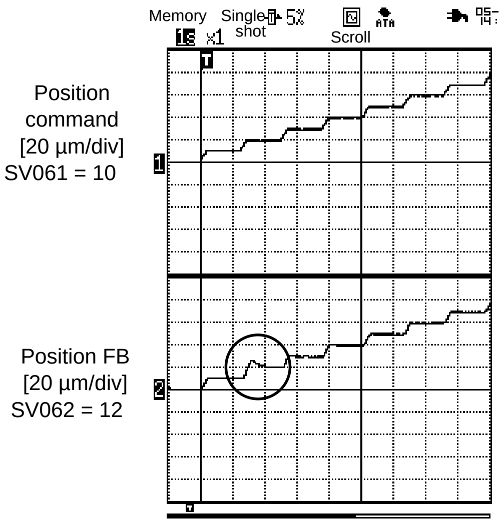
SHG control (PGN = 26SHG)

⚠ CAUTION The SHG control is an optional function. Confirm if the option is set in the NC with a System Specification Order List.

(5) Confirming overshooting

Adjust to make overshooting amount become less than 1 µm.

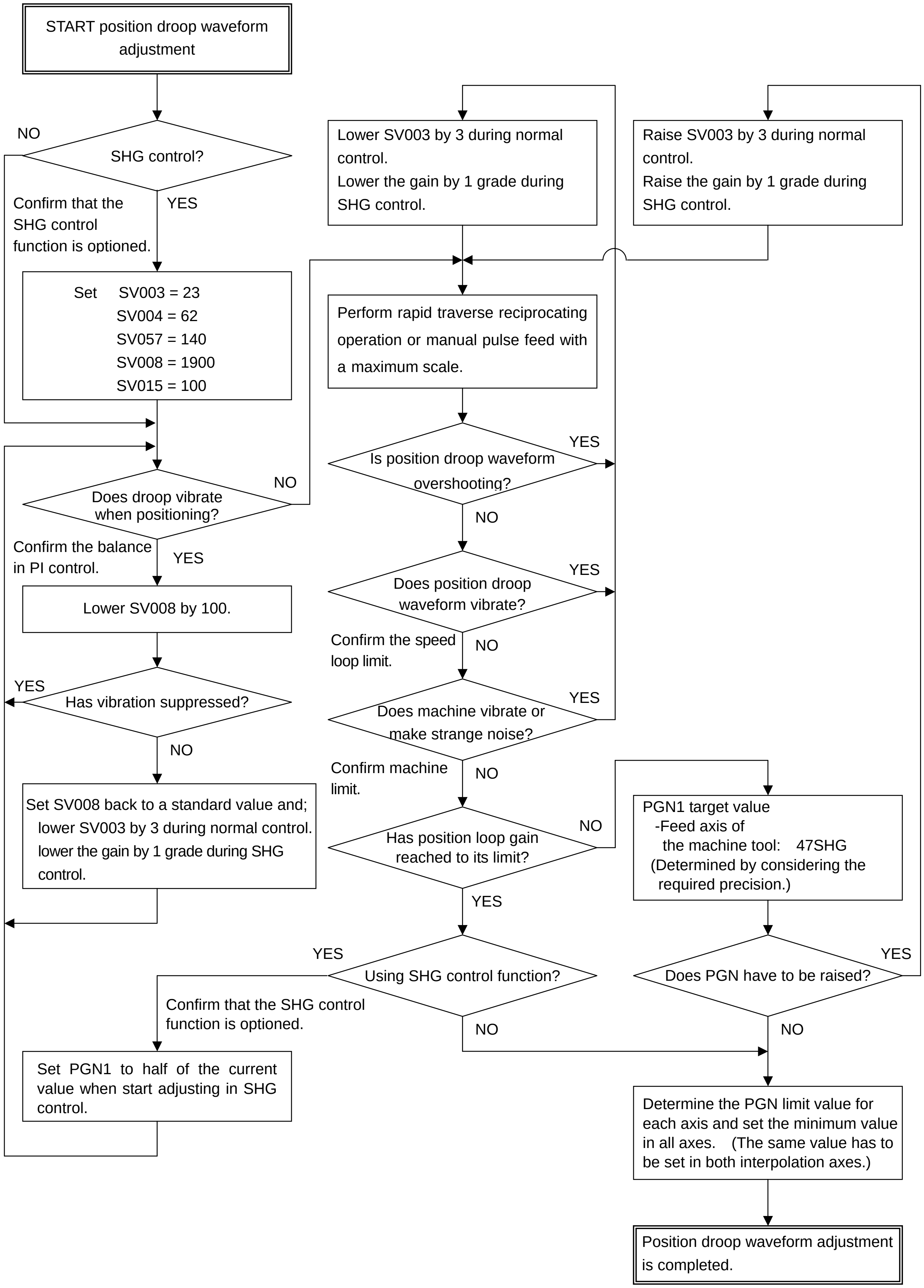
Cause and remedy of overshooting

	During rapid traverse feed	During pulse feed
Waveforms		
Cause	-Position loop gain is too high. -Acceleration feed forward gain (SV015) is too high. -Torsion of the machine system is too large. If a machine has a torsion factor, overshooting is easily caused as the axis is pushed to a stop when positioning.	-Position loop gain is too high. -Friction of the machine system is too large. If the machine static friction is too large, overshooting is easily caused as a large torque is maintained when the machine starts operation. -If the general motion of the machine is unstable, possibly caused by the machine-side problem.
Remedy	-Lower the position loop gain -When acceleration feed forward gain (SV015) is set to more than “100”, lower it. -Try the speed loop delay compensation during full closed loop control (when using linear scale). (Refer to [2-6-2 Speed loop delay compensation].) -If nothing has improved after lowering gain parameter, use overshooting compensation as the cause seems to be on machine side. Overshooting can be resolved by 1% to 3% of compensation. (Refer to “2-5-2 Overshooting compensation” in this manual.)	

POINT

If more than “100” is set in acceleration feed forward gain (SV015) during SHG control, overshooting will be caused easily.

(6) Adjusting the position droop waveform



2-3 Adjusting Acceleration/Deceleration Time Constant

2-3-1 Rapid traverse feed (G0 feed)

For rapid traverse feed, linear acceleration/deceleration function is normally used. Occasionally, S-pattern (soft) acceleration/deceleration function is used to ease the collision against machines.

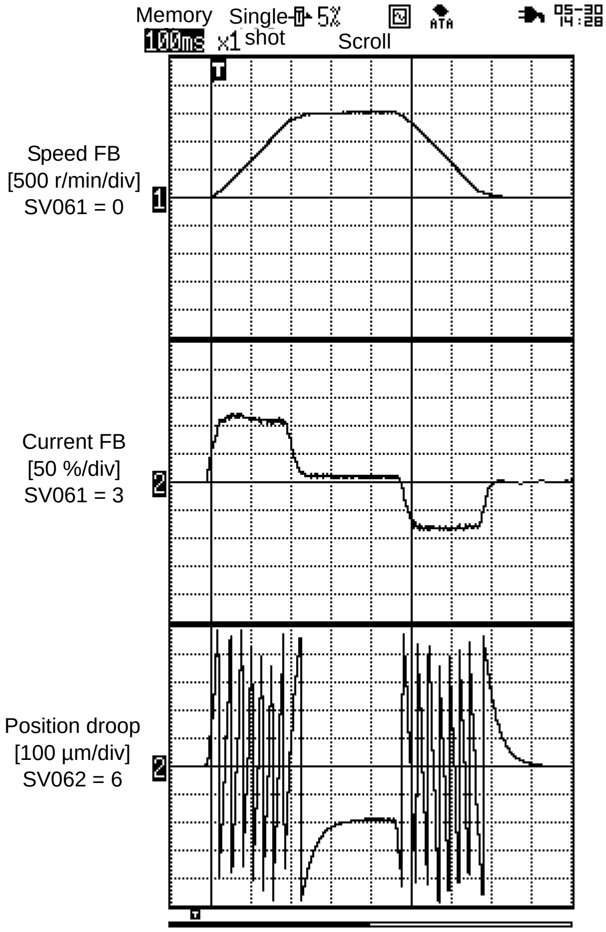
(1) Confirm that the rapid traverse rate ≤ max. rotation speed

Fist of all, confirm that the rapid traverse rate is less than the maximum rotation speed of the servo motor.

(2) Adjust acceleration/deceleration time constant by the maximum current command value

Perform the rapid traverse reciprocating operation confirming in NC servo monitor screen and adjust acceleration/deceleration time constant (with NC axis specification parameter) so that the maximum current command value during acceleration/deceleration becomes less than the range of the table shown below.

(Acceleration/deceleration time constant is not judged by current FB but by current command)



Waveforms during rapid traverse feed

(3) Confirm the rapid traverse feed

Confirm: 1) if the machine does not vibrate or make strange noise.
2) if the waveforms during acceleration/deceleration are not disturbed when observing current FB waveform and position droop waveform.
3) if the friction torque is normal.
4) 1) to 3) with the override changing.

Max. current command value when adjusting acceleration/deceleration time constant (MDS-C1/CH-Vx)

Motor type	Max. current command value	Motor type	Max. current command value	Motor type	Max. current command value
HC52	Within 388%	HA40N	Within 400%	HC-H52	Within 400%
HC102	Within 340%	HA80N	Within 365%	HC-H102	Within 340%
HC152	Within 380%	HA100N	Within 260%	HC-H152	Within 500%
HC202	Within 275%	HA200N	Within 225%	HC-H202	Within 340%
HC352	Within 251%	HA300N	Within 200%	HC-H352	Within 260%
HC452	Within 189%	HA700N	Within 205%	HC-H452	Within 270%
HC702	Within 221%	HA900N	Within 220%	HC-H702	Within 280%
HC902	Within 227%			HC-H902	Within 215%
		HA053N	Within 240%	HC-H1102	Within 200%
HC53	Within 264%	HA13N	Within 240%	HC-H1502	Within 190%
HC103	Within 257%	HA23N	Within 230%	HC-H53	Within 290%
HC153	Within 266%	HA33N	Within 230%	HC-H103	Within 280%
HC203	Within 257%	HA43N	Within 295%	HC-H153	Within 350%
HC353	Within 230%	HA83N	Within 275%	HC-H203	Within 320%
HC453	Within 177%	HA103N	Within 245%	HC-H353	Within 240%
HC703	Within 189%	HA203N	Within 210%	HC-H453	Within 240%
		HA303N	Within 180%	HC-H703	Within 195%
HA-LF11K2	Within 215%	HA703N	Within 180%	HC-H903	Within 230%
HA-LF15K2	Within 240%			HC-H1103	Within 190%

2-3-2 Cutting feed (G1)

For cutting feed, exponent acceleration/deceleration function is normally used. S-pattern acceleration/ deceleration cannot be used as it disables synchronous interpolation.

(1) Reciprocating operation without dwell

During cutting feed, no confirmation of in-position is made before going on to the next step. Adjust the acceleration/deceleration time constant during acceleration/deceleration by reciprocating operation without dwell. Set the feedrate at the maximum (clamp: axis specification parameter) and confirm the maximum current command during the turn without swell.

```
(Cutting feed reciprocating operation    Sample program)

  G28 X0;                           X axis zero return
  N01 G90 G1 X-200. F8000;          Move X axis to X=-200 with F5000 cutting feed by absolute position command.
  G1 X0;                 ↑          Turn without dwell and move to X=0 with F5000 cutting feed.
  G4 X1.0;               |          Dwell for a second.   (Pause for a second)   Use “X” even for Y axis and Z axis.
  GOTO 01  Max. cutting feedrate    Go back to the line N01.
```

(2) Adjust acceleration/deceleration time constant by max. current command value

Confirm the maximum current command value in the servo monitor and adjust acceleration/deceleration time constant (with NC axis specification parameter) so that the maximum current command value becomes less than the range of the table shown in the chapter “2-3-1 Rapid traverse feed (G0)”.

(3) Set all the interpolation axes to the same value as the axis with the longest time constant

For example, set the same value for the cutting feed time constant of X axis, Y axis and Z axis in machining center because interpolation control is required.

(4) Confirm the cutting feed

Confirm : 1) if the machine does not vibrate or make strange noise.
2) if the waveforms during acceleration/deceleration are not disturbed when observing current FB waveform and position droop waveform.
3) 1) and 2) with the override changing.

POINT

Perform reciprocating operation without dwell when adjusting cutting feed (G1) time constant.

⚠ CAUTION

1. Set the same value for the cutting feed time constant in both interpolation axes and for the position loop gain (PGN).
2. For vertical axis, perform from downward stop to upward start without dwell and confirm the current command.

2-4 Initial Adjustment for the Servo Functions

2-4-1 Standard settings for the lost motion compensation

(1) Unbalance torque and frictional torque

As for the initial adjustment of lost motion compensation, set the standard compensation amount. Measure the unbalance torque and the frictional torque to calculate the standard compensation amount. During a stop, the static frictional torque may effect. Feed slowly by about F1000, measure the load current in the servo monitor screen of NC and calculate by the following expression.

$$\text{Unbalance torque} = \frac{(+\text{ Feed load current\%}) + (-\text{ Feed load current\%})}{2}$$

$$\text{Frictional torque} = \left| \frac{(+\text{ Feed load current\%}) - (-\text{ Feed load current\%})}{2} \right|$$

Unbalance torque and frictional torque

	Horizontal axis	Unbalance axis
In machine tools	Lathe: Z axis Vertical machining center: X axis, Y axis Horizontal machining center: X axis, Z axis etc.	Lathe: X axis Vertical machining center: Z axis Horizontal machining center: Y axis etc.
Unbalance torque	0	The average of the load torque when feeding to both + and – direction by about F1000.
Frictional torque	The load torque when feeding by about F1000.	The difference between load torque and unbalance torque when feeding by about F1000.

(2) Setting the standard compensation amount

As for lost motion compensation type, use type 2 (SV027.bit9). Set the unbalance torque in SV032 and set the doubled frictional torque in SV016 as a standard compensation amount. (Set SV041 to “0”.) To adjust the compensation amount more accurately, determine the value to be set in SV016 and SV041 by measuring the roundness.

How to set the standard lost motion compensation amount

Setting item	Parameter setting
(1) Start lost motion compensation type 2	SV027.bit9 = 1 (SV027.bit8 = 0)
(2) Unbalance torque setting	SV032 = unbalance torque [%]
(3) Lost motion compensation standard amount	SV016 = 2 x frictional torque [%] (SV041 = 0)

⚠ **CAUTION**

When using the disturbance observer, further adjustment by roundness measurement is required because the lost motion compensation amount (SV016) calculated as mentioned above will become over compensation.

(Example)

In case that the load current% is -25% in + direction and -65% in – direction when performing JOG feed by about F1000,

$$\text{Unbalance torque} = \frac{-25 + (-65)}{2} = -45\% \qquad \text{Frictional torque} = \left| \frac{-25 - (-65)}{2} \right| = 20\%$$

Therefore, set SV032 = -45, SV016 = 40.

<table>
<tr><th>No.</th><th>Abbrev</th><th>Parameter name</th><th>Explanation</th></tr>
<tr><td>SV027</td><td>SSF1</td><td>Servo function selection 1</td><td>Normally type 2 is used for the lost motion compensation.
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>aflt</td><td>zrn2</td><td colspan="2">afse</td><td colspan="2">ovs</td><td colspan="2">lmc</td><td>omr</td><td>zrn3</td><td colspan="2">vfct</td><td></td><td>upc</td><td colspan="2">vcnt</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Explanation</th></tr>
<tr><td>8
9</td><td>lmc</td><td>00: lost motion compensation stop 10: lost motion compensation type 2
01: lost motion compensation type 1 11: Setting prohibited</td></tr>
</table>
</td></tr>
</table>

No.	Abbrev.	Parameter name	Unit	Explanation	Normal setting range
SV032	TOF	Torque offset	Stall%	Set the unbalance torque amount.	-60 to 60
SV016	LMC1	Lost motion compensation 1	Stall%	Set “2 × (frictional torque)” as an initial value. When using disturbance observer, further adjustment by roundness measurement is required.	0 to 60
SV041	LMC2	Lost motion compensation 2	Stall%	Set “0” as a standard (initial adjustment value). When “0” is set, compensate the value set in SV016 in both + and – direction.	0 to 60

2-4-2 Excessive error width detection

In most cases, no problem will occur with the standard setting values.

No.	Abbrev.	Parameter name	Unit	Explanation	Normal setting range
SV023	OD1	Excessive error detection width during servo ON	mm	Calculate as follows by using rapid traverse rate and position loop gain (PGN1). When “0” is set, the excessive error alarm will not be detected. <Standard setting value> $\text{OD1=OD2=} \frac{\text{Rapid traverse rate (mm/min)}}{60 \times \text{PGN1}} \div 2 \text{ (mm)}$ (Round fractions off.)	3 to 15
SV026	OD2	Excessive error detection width during servo OFF	mm		

2-4-3 Vertical axis drop prevention control

Vertical axis drop prevention control is performed for the unbalance axis which equips a motor brake. Set the time to delay the servo ready OFF confirming the drop amount when an emergency stop occurs.

(1) Parameter settings

Set the 3 parameters (SV048, SV055 and SV056) at the same time to enable vertical axis drop prevention control. For MDS-C1/CH-Vx series, set the parameters of the axes which does not perform the vertical axis drop prevention control because the converter unit of MDS-C1 series are in common with other servo axes and spindles. (Refer to “2-4-3(3) Parameter settings in each system” in this manual)

<How to set>

1) Adjust the vertical axis drop prevention time (SV048) and set the minimum value at which the axis does not drop when the Emergency stop is inputted.
2) Set the same value as the adjusted vertical axis drop prevention time (SV048) for the max. gate off delay time after emergency stop (SV055).
3) Set the same axis as the acceleration/deceleration time constant in the deceleration time constant at emergency stop (SV056) is set for the axis that controls the drop prevention.
4) If the vertical axis is MDS-C1/CH-V2 (drive unit with 2 axes), set the servo parameter of the other axis.
   SV048 = the same value as SV048 of the vertical axis
   SV055 = the same value as SV055 of the vertical axis
   SV056 = the same value as rapid traverse acceleration/deceleration time constant of the identical axis
5) If the converter which supplies the PN power to the vertical axis is controlled by a spindle drive unit, set the spindle parameter SP033.bit15 = 1.
6) If the converter which supplies the PN converter to the vertical axis is controlled by the other servo drive unit, set the servo parameters of the axis. (as mentioned in (4))

No.	Abbrev.	Parameter name	Unit	Explanation	Normal setting range
SV048	EMGrt	Vertical axis drop prevention time	ms	Increase the setting by 100 ms at a time and set the minimum value where the axis does not drop.	0 to 300
SV055	EMGx	Max. Gate off delay time after emergency stop	ms	Set the time from emergency stop input to compulsory ready OFF. When performing vertical axis drop prevention control, set the same value as SV048.	0 to 300
SV056	EMGt	Deceleration time constant at emergency stop	ms	When performing vertical axis drop prevention control, set the deceleration control. Set the same value as the rapid traverse acceleration/deceleration time constant.	0 to 300

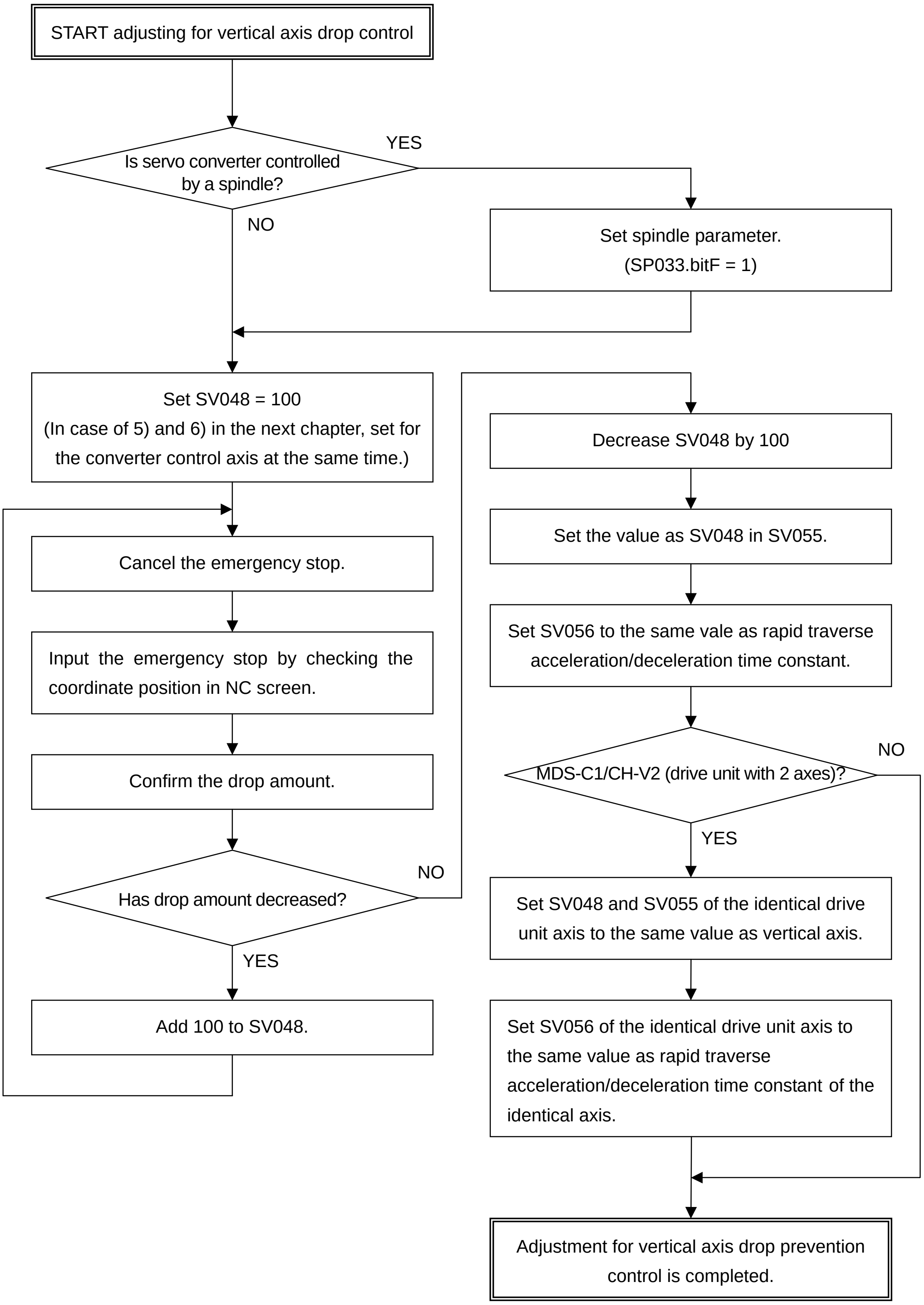
POINT

1. SV048 and SV055 are set individually in each axis. However, when using MDS-C1/CH-V2 (drive unit with 2 axes), both axes are controlled at the same time with the larger setting value of these 2 parameters.
2. This control will not function if an alarm for which dynamic brakes are set as the stopping method occurs in an axis where the vertical axis drop prevention control is being carried out.
3. A drop amount of several µm to 10µm) will remain due to the brake play.

⚠CAUTION

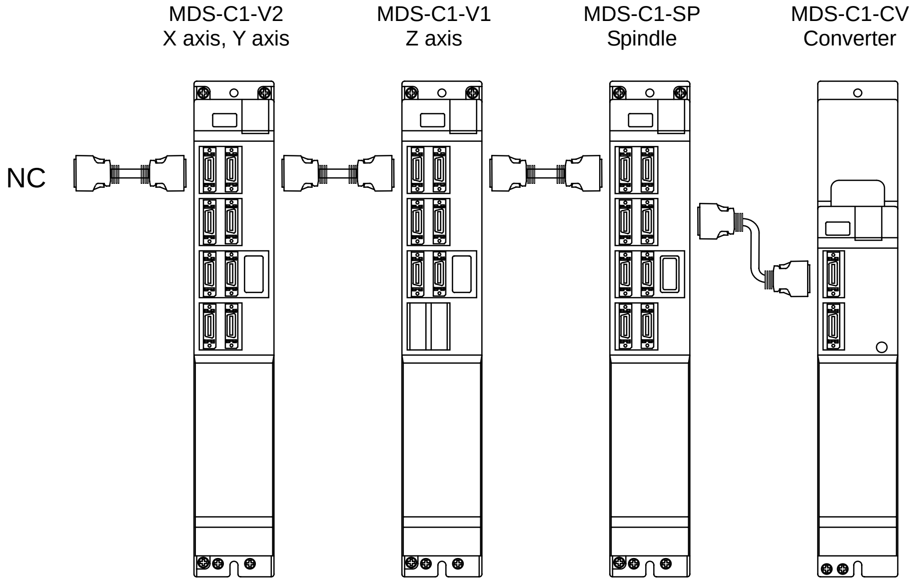
When only SV048 and SV055 are set and SV056=0, machine will occasionally come into collision because stopping method is changed from “decelerating to a stop” to “Steps to a stop”.

(2) Adjustment procedures for vertical axis drop prevention control



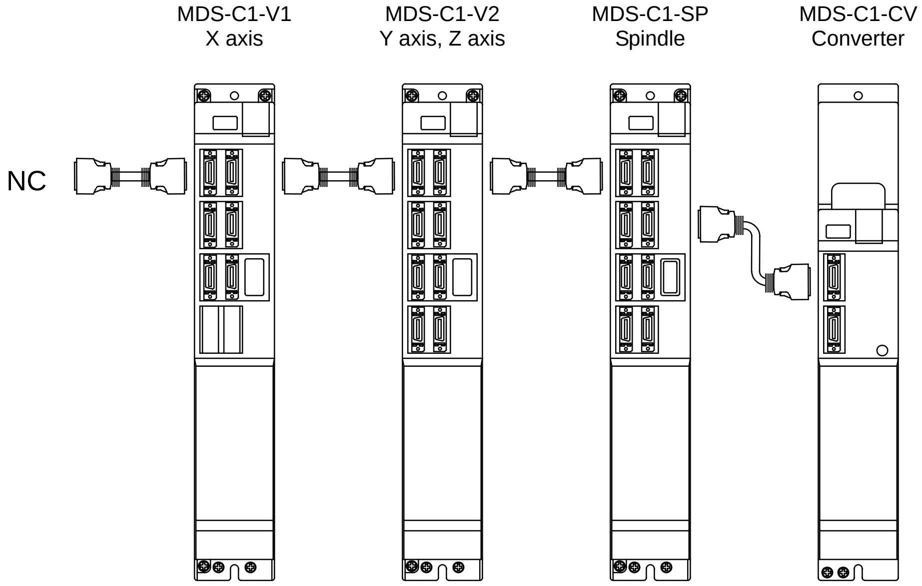
(3) Parameter settings in each system

1) In case that a spindle controls the converter, Z axis = drive unit with 1 axis. (Z axis: Vertical axis)



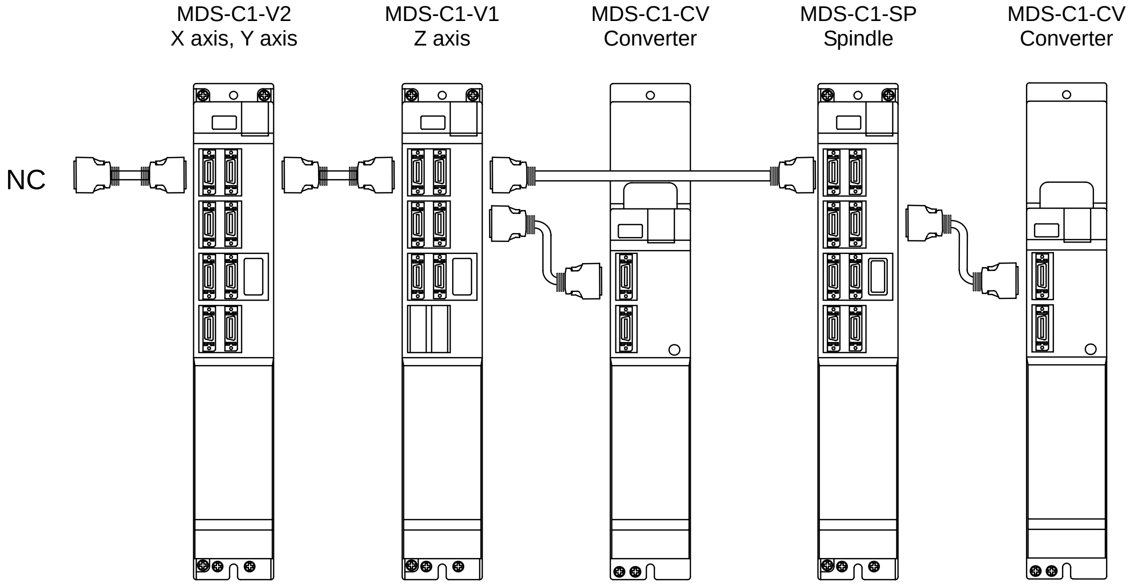
Axis	X axis	Y axis	Z axis (Vertical axis)	Spindle
Parameters	MDS-C1/CH-V2		MDS-C1/CH -V1	MDS-C1/CH -SP
SV048	–	–	Set after adjustment.	Spindle parameter SP033.bitF = 1
SV055	–	–	The same value as SV048.	
SV056	–	–	The same value as rapid traverse time constant of Z axis.	

2) In case that a spindle control the converter, Z axis = drive unit with 2 axes (Z axis: Vertical axis)



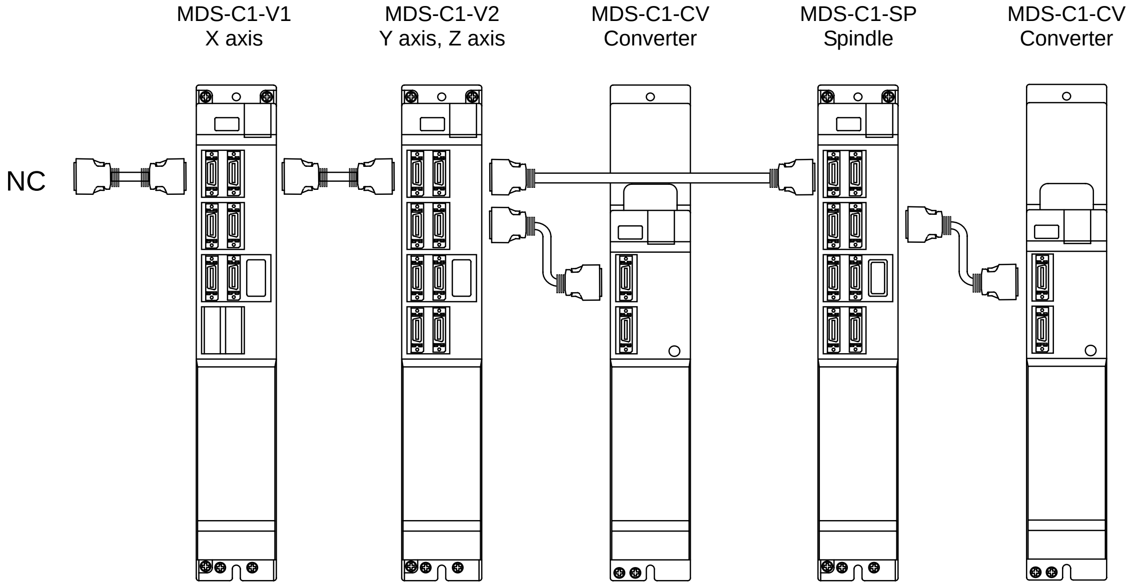
Axis	X axis	Y axis	Z axis (Vertical axis)	Spindle
Parameter	MDS-C1/CH -V1	MDS-C1/CH -V2		MDS-C1/CH -SP
SV048	–	The same value as Z axis.	Set after the adjustment.	Spindle parameter SP033.bitF = 1
SV055	–	The same value as Z axis.	The same value as SV048.	
SV056	–	The same value as rapid traverse time constant of Y axis.	The same value as rapid traverse time constant of Z axis.	

(3) In case that Z axis controls the converter, Z axis = drive unit with 1 axis (Z axis: Vertical axis).



Axis / Parameter	X axis	Y axis	Z axis (Vertical axis)	Spindle
	MDS-C1/CH -V2		MDS-C1/CH -V1	MDS-C1/CH -SP
SV048	–	–	Set after the adjustment.	Spindle parameter No need to set
SV055	–	–	The same value as SV048.	
SV056	–	–	The same value as rapid traverse time constant of Z axis.	

(4) In case that Z axis controls the converter, Z axis = drive unit with 2 axes (Z axis: Vertical axis).



Axis / Parameter	X axis	Y axis	Z axis (Vertical axis)	Spindle
	MDS-C1/CH -V1	MDS-C1/CH -V2		MDS-C1/CH -SP
SV048	–	The same value as Z axis.	Set after the adjustment.	Spindle parameter No need to set
SV055	–	The same value as Z axis.	Set the same value as SV048.	
SV056	–	The same value as rapid traverse time constant of Y axis.	Set the same value as rapid traverse time constant of Z axis.	

2-5 Procedures for Adjusting Each Functions

2-5-1 Disturbance observer function

(1) When to use

1) When improving cutting accuracy

Disturbance observer function is efficient to improve the cutting accuracy. For roundness measurement, cutting accuracy can be improved especially at around 45 degrees.

2) When suppressing the vibration of position droop waveform

Disturbance observer function can suppress the vibration of position droop waveform caused by the insufficient speed loop gain (VGN) without lowering speed loop leading compensation (VIA).

3) When suppressing the collision sound during lost motion compensation

When the lost motion compensation amount is increased, the collision sound is occasionally caused. The compensation amount can be made smaller by using disturbance observer function, and it also suppresses the collision sound.

(2) Precautions

1) Vibration (resonance) is easily caused

Disturbance observer is hardly used for some machine characteristics.

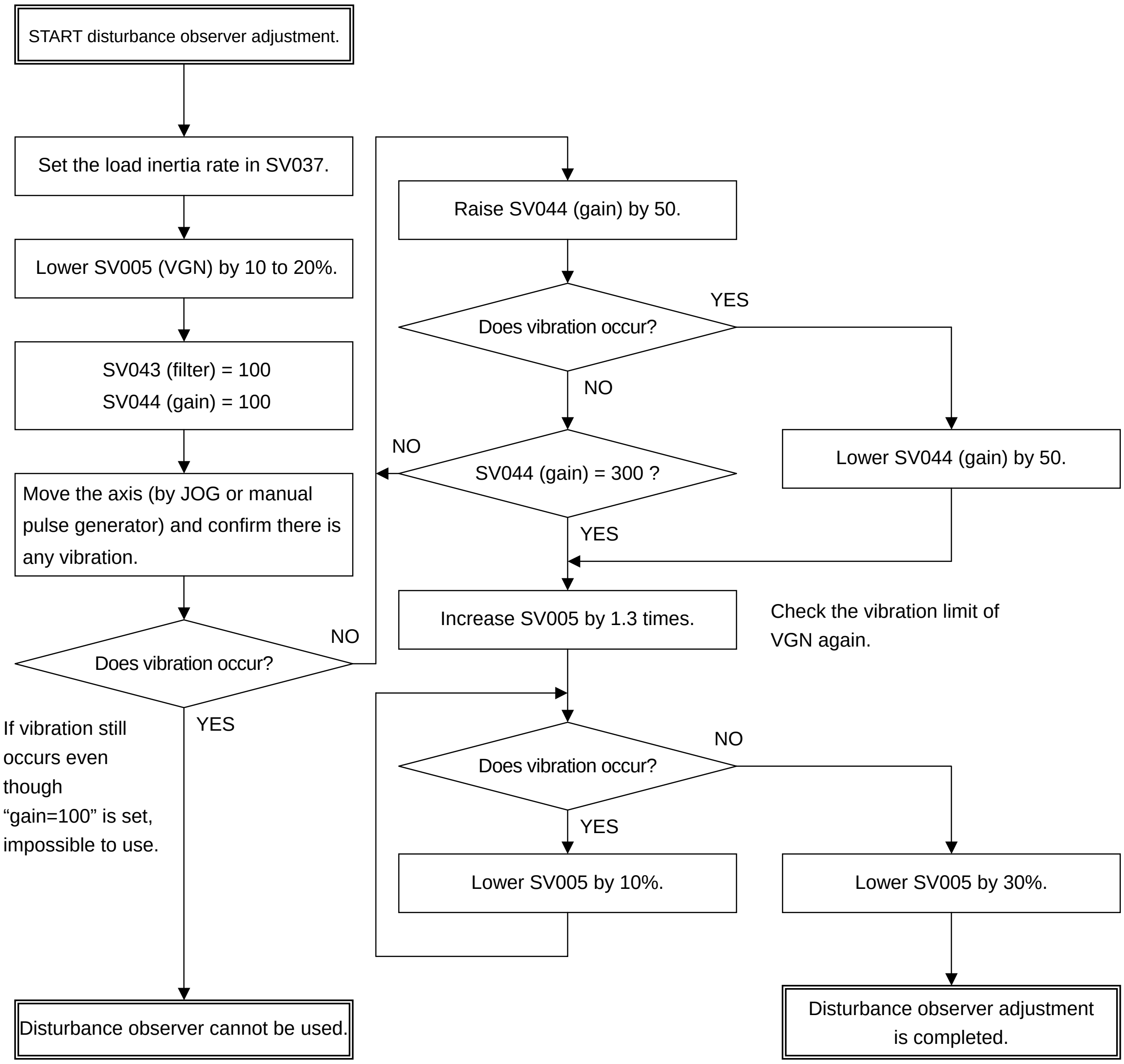
2) Lost motion compensation has to be readjusted

The optimum lost motion compensation amount (SV016, SV041) changes when the disturbance observer's filter frequency (SV043) and gain (SV044) are changed.

⚠ **CAUTION**

When starting disturbance observer, lost motion compensation has to be adjusted again.

(3) Procedures for disturbance observer adjustment



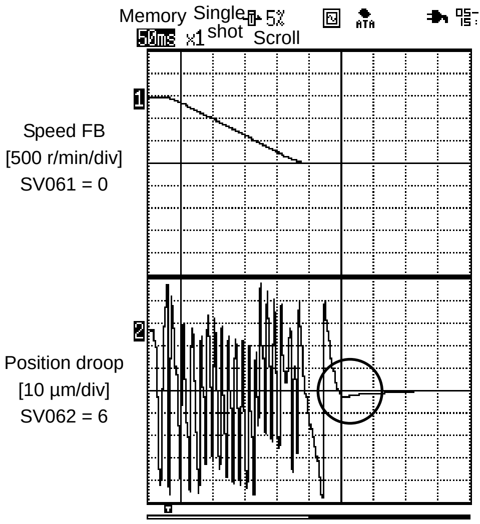
No.	Abbrev.	Parameter name	Unit	Explanation	Normal setting range
SV037	JL	Load inertia scale	%	Set the value calculated in the way explained in "2-2-2 Measuring the inertia rate".	150 to 600
SV043	OBS1	Disturbance observer filter frequency	rad/sec	Set the disturbance observer filter band. Set "100" as a standard. The setting is enabled at more than 100.	100
SV044	OBS2	Disturbance observer gain	%	Set the disturbance observer compensation gain. As a standard, set between 100 and 300. Lower the setting if vibration occurs.	100 to 300

2-5-2 Overshooting compensation

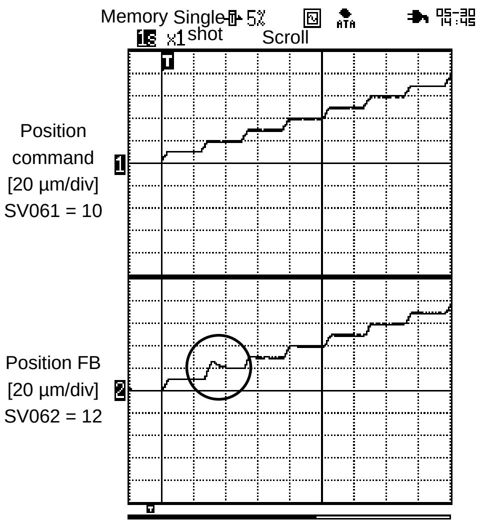
(1) When to use

1) When compensating overshooting

Both overshooting during rapid traverse positioning and during pulse feed can be improved.



Overshooting during rapid traverse positioning



Overshooting during pulse feed

(2) Precautions

1) Do not use overshooting compensation function to solve the problem caused by gain adjustment

Overshooting can occur when position loop gain (SV003) and acceleration feed forward gain (SV015) is too high. Adjust the gain at first whenever overshooting is found. In case that the overshooting cannot be solved by gain adjustment, use overshooting compensation function as it seems to be caused by machine-side factors including torsion and friction. The overshooting can be suppressed with overshooting compensation by 1% to 3%.

In the full closed system using a linear scale, adjust with [2-6-2 Speed loop delay compensation] (SV007) at first.

2) If the compensation amount is too much, the roundness precision will be worsened

When the overshooting compensation amount is too much, the roundness precision is occasionally worsened. Be careful when setting the value which is more than 5% in SV031 (compensation amount).

3) The overshooting which is more than 1µm has to be suppressed

Normally the overshooting which is more than 1µm is considered as a problem. If it is less than 1 µm is hardly suppressed due to the control resolution.

(3) Details of overshooting compensation

1) Overshooting compensation type 1

This is an old compatible type and not used for an initial adjustment.

2) Overshooting compensation type 2

This is an old compatible type and not used for an initial adjustment.

3) Overshooting compensation type 3

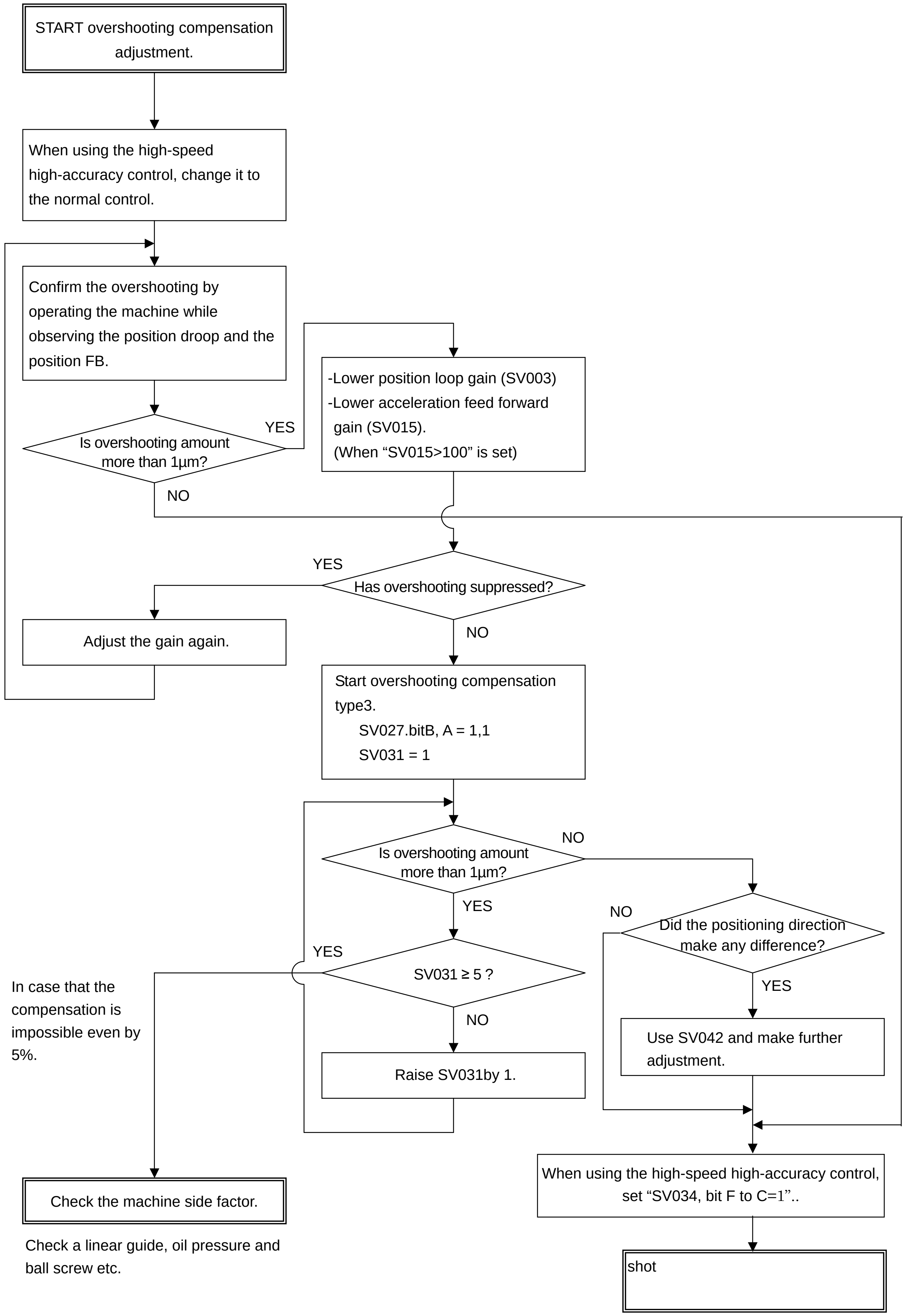
This is compatible with the standard specifications. The offset amount is set based on the motor's stall current. Determine the amount that is free from overshoot by adjusting the compensation gain (SV031, SV042) while increasing its value in increments of 1%. This adjustment is usually made within the range from 1% to 3%.

During the feed forward control (the high-speed high-accuracy control), an overshoot may be occurred due to inappropriate adjustment of the feed forward gain. So, when adjusting the compensation gain (SV031, SV042), stop the feed forward control, or set "fwd_g" to "0". After adjusting, set the range of the non-sensitive zone for the overshooting compensation "SV034(SSF3)/bit F to C" (ovsn) to "1" (2 μ m).

If overshoot occurs in the feed forward control mode only (no overshoot occurs in the normal control mode), adjust the feed forward gain (fwd_g).

POINT	In the full closed system using a linear scale, adjust with [2-6-2 Speed loop delay compensation] (SV007) at first.

(4) Procedures for overshooting compensation



In case that the compensation is impossible even by 5%.

Check a linear guide, oil pressure and ball screw etc.

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th></tr>
<tr><td>SV027</td><td>SSF1</td><td>Servo function selection 1</td><td>The overshooting compensation starts with the following parameter.
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>aflt</td><td>zrn2</td><td colspan="2">afse</td><td colspan="2">ovs</td><td colspan="2">lmc</td><td>omr</td><td>zrn3</td><td colspan="2">vfct</td><td></td><td>upc</td><td colspan="2">vcnt</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Explanation</th></tr>
<tr><td>A
B</td><td>ovs</td><td>00: Overshooting compensation stop
01: Overshoot compensation type1
10: Overshooting compensation type2
11: Overshoot compensation type3</td></tr>
</table></td></tr>
<tr><td>SV034</td><td>SSF3</td><td>Servo function selection 3</td><td>When using the feed forward control (the high-speed high-accuracy control), set the range of the non-sensitive zone.
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="4">ovsn</td><td></td><td></td><td></td><td></td><td></td><td>os2</td><td>zeg</td><td></td><td></td><td>mohn</td><td>has2</td><td>has1</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Explanation</th></tr>
<tr><td>C
D
E
F</td><td>ovsn</td><td>Set the non-sensitive zone for the overshooting compensation type 3 in increments of 2µm. During the feed forward control, set the non-sensitive zone of the model position droop and ignore overshoot of the model. Set it to the standard 2µm (0001).</td></tr>
</table></td></tr>
</table>

No.	Abbrev.	Parameter name	Unit	Explanation	Normal setting range
SV031	OVS1	Overshooting compensation 1	Stall% (rated current%)	Increase the value by 1% at a time and find the value where overshooting dose not occur. When OVS2 is “0”, the setting value will be applied in both the + and – directions.	-1 to 3
SV042	OVS2	Overshooting compensation 2	Stall% (rated current%)	Set “0” as a standard. Set this when the compensation amount is to be changed according to the direction.	-1 to 3

POINT

1. When either parameter SV031:OVS1 or SV042:OVS2 is set to “0”, the same amount of compensation is carried out in both + and – direction, using the setting value of the other parameter (the parameter which is not set to “0”).
2. To compensate in only one direction, set -1 in the parameter (OVS1 or OVS2) for the direction in which compensation is prohibited.

2-5-3 Collision detection function

(1) When to use

1) To ease an impact when a machine collides

Collision detection function can ease the impact to the machine by detecting the alarm at the collision as soon as possible when collision occurs and by causing the pullback torque.

2) To keep the alarm history separating collision alarms from over load alarms

Collision alarms are conventionally detected as over load alarms. Collision detection function enables to keep the collision alarm history with special alarm numbers only for collision alarms.

(2) Precautions

1) Collision detection function does not guarantee the machine precision

As before, prevent the machine collision when operating a machine.

2) Alarm can be detected incorrectly

Collision is detected by detecting the disturbance torque, therefore, frictional torque or cutting torque can be incorrectly taken for a collision depending on condition of the machine or operation.

(3) Details of collision detection method 1

The required torque is estimated by considering the position command issued by the NC. The disturbance torque is calculated by the difference from the actual torque. When this disturbance torque exceeds the collision detection level set by the parameters, a collision is detected.

As soon as a collision is detected, pullback torque (which is adjustable with a parameter) is commanded and ease the impact. After the motor stopped, alarm 58 (during G0 command) or 59 (during G1 command) will occur, the system will be stopped.

	Collision detection level setting parameter	Detection alarm
During rapid traverse (during G0 feed)	SV060	Alarm 58
During cutting feed (during G1 feed)	SV060 × clG1 (SV035.bitC to E)	Alarm 59

(4) Details of collision detection method 2

When the current command reaches the motor’s maximum current, collision is detected. As soon as the collision is detected, pullback torque (which can be adjusted by a parameter) is commanded. After the motor stopped, the alarm 5A will occur and the system will stop. If the acceleration/deceleration time constant is short, and if detections are easily made incorrectly during normal operation, make the acceleration/deceleration time constant longer and adjust so that the current during acceleration is not saturated (so that the current does not reach the maximum value). Or, turn the parameter SV035.bitB ON and ignore the collision detection method 2.

(5) Torque estimated gain (SV059)

In SHG control mode, when the rapid traverse reciprocating operation is carried out after setting the unbalance torque (SV032), frictional torque (SV045) and “SV035.bitF=1”, the value to be set in SV059 is displayed in MPOS (MP scale offset amount) in NC servo monitor screen. (Refer to [2-4-1 (1) Unbalance torque and frictional torque].) When accelerating, the value converges gradually. Set the convergence value to torque estimate gain (SV059).

(6) Collision detection level (SV60)

Collision detection level during G0/G1 feed

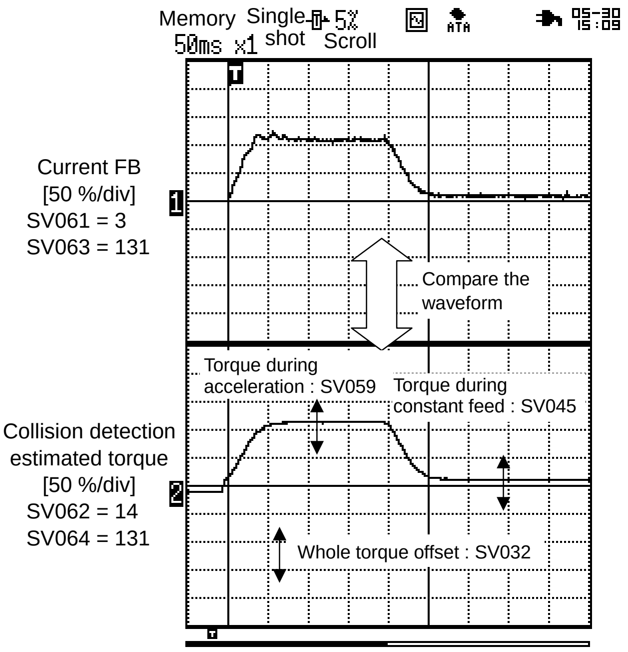
Feed	Detection level setting	How to adjust
G0	SV060	First, set “SV060: TLEV= 100”, and carry out no-load operation at the maximum rapid traverse feed rate. If an alarm does not occur, lower the setting by “10”, and if an alarm occurs, raise the setting by “20”. Set the value which is in increment of the limit value at which the alarm does not occur by 1.5 times. If SV035.bitA (clet)=1 is set, the maximum disturbance torque will appear in MPOS in the NC servo monitor. When setting, refer to the value shown in MPOS.
G1	SV060 x clG1 (SV035)	The detection level during G1 feed is set as an inter-fold of the detection level during G0 feed. Calculate the maximum cutting load, and adjust the SV035.bitC to E (clG1) setting value so that the detection level becomes larger than the maximum cutting load.

(7) Confirming parameter settings

Calculate the estimated torque abstracting acceleration factors from position command to detect the collision. It is required to obtain the following items to detect collision correctly.

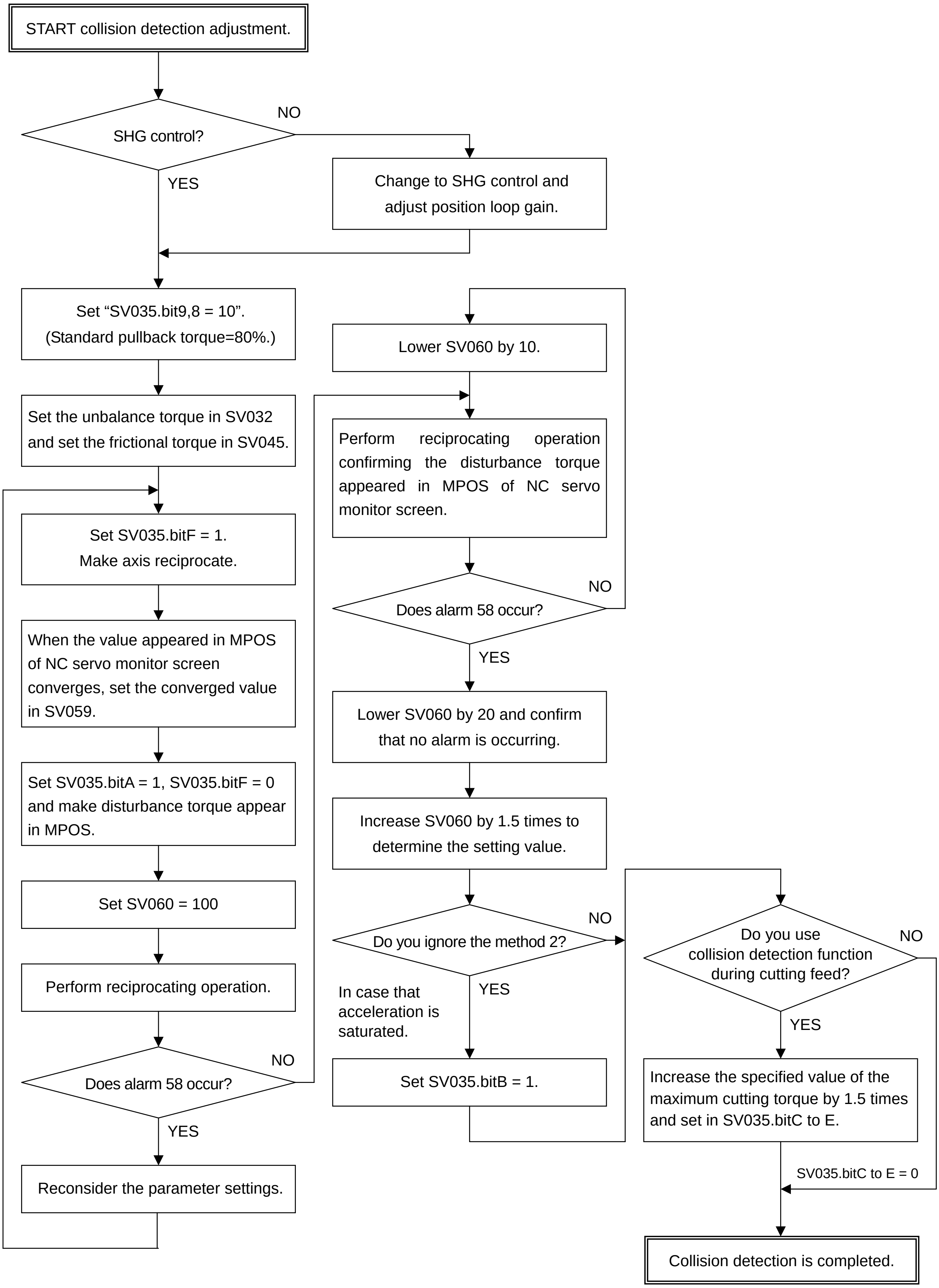
1) Torque estimated gain (SV059)
2) Frictional torque (SV045)
3) Unbalance torque (SV032)

When confirming the setting values of above–mentioned parameters, output current FB and collision detection estimated torque at the same time as shown the right and adjust so that they both forms the same waveform.



How to confirm collision detection parameters

(8) Procedures for collision detection adjustment



<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th></tr>
<tr><td>SV035</td><td>SSF4</td><td>Servo function selection 4</td><td>
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>clt</td><td colspan="3">clG1</td><td>cl2n</td><td>clet</td><td colspan="2">cltq</td><td></td><td>iup</td><td colspan="6">tdt</td></tr>
</table>

<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set</th><th>Meaning when “1” is set</th></tr>
<tr><td>8
9</td><td>cltq</td><td colspan="2">Set the pullback torque during collision detection with a ratio of maximum motor torque.
00:100%　 01:90%　 10:80% (Standard)　 11:70%</td></tr>
<tr><td>A</td><td>clet</td><td>Setting for normal use</td><td>The peak value of disturbance torque in the last 2 seconds appears in MPOS on servo monitor screen.</td></tr>
<tr><td>B</td><td>cl2n</td><td>Collision detection method 2 is enabled.</td><td>Collision detection method 1 is disabled.</td></tr>
<tr><td>C
D
E</td><td>clG1</td><td colspan="2">Set the collision detection level for the collision detection method 1 cutting (G1) feed. G1 collision detection level will be SV060 × clG1.
When clG1=0, the collision detection method 1 will not function during cutting feed.</td></tr>
<tr><td>F</td><td>clt</td><td>Setting for normal use</td><td>The setting value of SV059 is appeared in MPOS on servo monitor screen.</td></tr>
</table>
</td></tr>
</table>

No.	Abbrev.	Parameter name	Unit	Explanation	Normal setting range
SV032	TOF	Torque offset	Stall%	Set the unbalance torque amount. The amount is the same as the value set when lost motion compensation was adjusted.	-60 to 60
SV045 (8 low-order digit bit)	TRUB	Frictional torque	Stall%	Set the frictional torque amount. Refer to [2-4-1 (1) Unbalance torque and frictional torque].	10 to 30
SV059	TCNV	Collision detection torque estimating gain	–	When SV035.bitF (clt) = 1 is set and axis performs reciprocating operation, the value to be set is appeared in MPOS on servo monitor screen.　Set the converged value after a few reciprocating operations. When operating as above, set SHG control function, SV032 and SV045 in advance or set SV060 = 0	0 to 32767
SV060	TLMT	Collision detection level	Stall%	Set the collision detection level of method 1 G0 feed when using the collision detection function. When “0” is set, all collision detection function will not function.	70 to 150

(Note) 8 low-order digit bit: The 16 bit-length parameter is divided into 8 high-order digit bit and 8 low-order digit bit.　If high-order digit bit are set to “0” and low-order digit bit are set to “-128 to 127”, set as well as normal parameters.

POINT

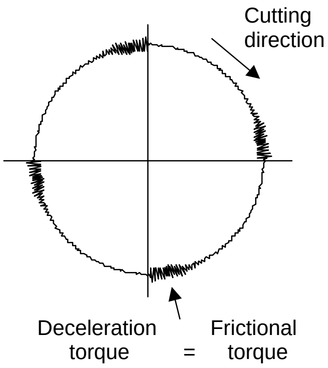
1. SHG control has to be enabled for using the collision detection function or for performing SV059 setting value calculating operation.
2. Set the detection level with an allowance to avoid incorrect detections.
3. When SV060=0 is set, all collision detection functions will be disabled.
4. Collision detection method 2 is enabled when the value except for “0” is set.　Set the parameter (SV035.bitB) to ignore the collision.
5. Adjust the torque estimated gain (SV059) again when detection resolution was changed because of detector change and when position loop gain (PGN) or the setting of position control system is changed (when closed loop control is changed to semi-closed loop control).

2-5-4 Voltage non-sensitive zone (Td) compensation

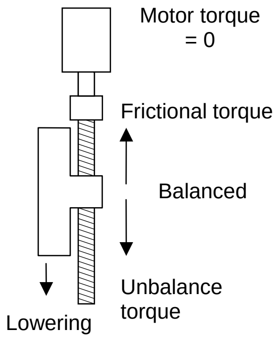
(1) When to use

1) When improving the cutting precision

Voltage non–sensitive zone compensation is effectual when the cutting accuracy is worsened before passing the quadrants during circle cutting or when the cutting accuracy while unbalance axis is lowering is worse than while it is rising. In short, voltage non–sensitive zone compensation improves the control precision when the control speed is slow and the output torque is controlled with nearly “0”.



For circle cutting



For unbalance torque

(2) Precautions

1) Vibration (resonance) easily occurs

Vibration can be inducted as voltage non–sensitive zone compensation can make the same effect as when the current loop gain is raised.

2) The drive sound during the motor rotation becomes noisier

If setting 100% (as a standard), the sound during the motor rotation will be noisier. However, the cutting precision is improved as long as vibration does not occur.

(3) Adjustment procedures

Set the value from 50 to 100% observing the vibration or noise occurrence.

No.	Abbrev.	Parameter name	Unit	Explanation	Normal setting range
SV030 (8 low-order digits)	IVC1	Voltage non -sensitive band compensation	%	When 100% is set, the voltage equivalent to the logical non-energized time will be compensated. Compensation equivalent to 100% is possible even when 0 is set. If vibration or vibration sound occurs because of over-compensation, adjust the value to 100% or less.	0 to 100

(Note) 8 low-order digit bit: The 16bit-length parameter is divided into 8 high-order digit bit and 8 low-order digit bit. If high-order digit bit are set to “0” and low-order digit bit are set to “-128 to 127”, set as well as normal parameters.

2-6 Full Closed System

2-6-1 Basic knowledge

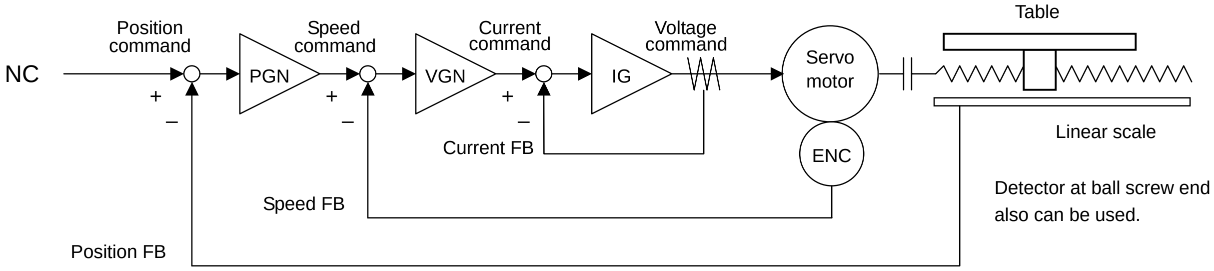
(1) Full closed loop control

All the servo control performs closed loop control which uses a feedback from the detector. "Full closed loop control" means the system which directly detects the machine position by using a linear scale mainly and it is distinguished from "Semi-closed loop control" which detects the motor position.

In the machine which drives the table with a ball screw,

1) coupling or backlash of the connecting point between a table and a ball screw
2) pitch error of a ball screw

exist and they worsen the precision. The high-accuracy position control, which is not affected by a backlash nor pitch error, is enabled by detecting the table position directly as the table position means the machine end.



Full closed loop control

However, the precision can be worse than we expected as the non-linear factors such as backlash and the torsion of ball screw prevent the position loop gain from being raised. The reason why this is caused is that the machine system is included in control loop in full closed loop. In other words, even though using the full closed loop to prevent the influence from the backlash etc., the high-accuracy cannot be obtained if the machine rigidity is not high enough. It does not mean that the precision can be improved by adding a linear scale to a conventional machine. Additionally, not only the parameter adjustment but also the machine side factors including the position where the linear scale is attached are very important to improve the precision.

Semi-closed loop is widely used because of its stability. It is stable as it does not includes the non-linear factors of the machine system in its control loop. NC has backlash compensation function and pitch error compensation function, the high-accuracy control is enabled by issuing a command in the direction which cancels the machine error.

POINT In full closed system, the machine system is directly included in the position loop control. Therefore, the precision is not improved as the gain cannot be raised if the machine rigidity is not high enough.

(2) Servo adjustment

How to adjust the servo in full closed system is the same as in semi-closed system. However, the position loop gain is generally lower than that in semi-closed system as the vibration and overshooting is easily caused. Some functions are enabled only in full closed loop control (Refer to 2-6-2 and subsequent chapters). Set those functions if necessary.

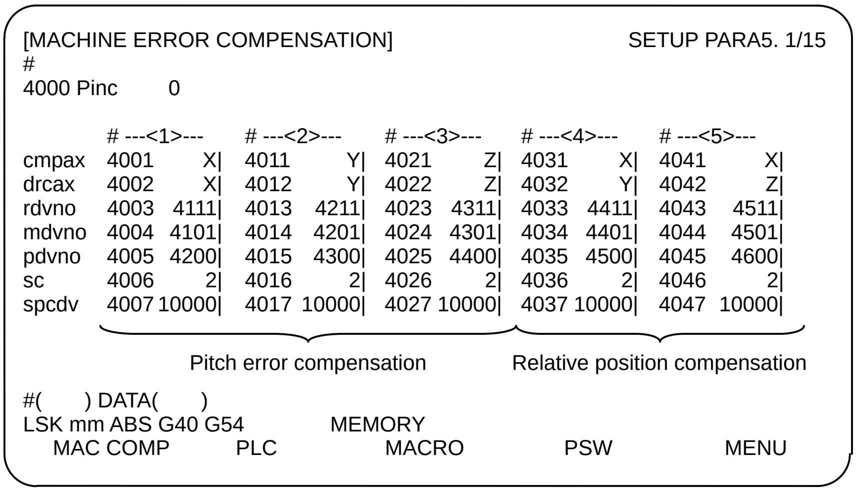
In full closed system, the way that the machine error compensation is used is different from semi-closed loop control. Confirm the parameter settings referring to the table below.

Machine error compensation in full closed loop control

Machine error compensation	Parameter	Use	Necessity	Details
Backlash compensation	Axis specification parameter	This compensates the machine backlash.	X (Partly O)	Normally set "0" as machine backlash can be compensated by a linear scale. Occasionally, this parameter is used for compensating the backlash of a linear scale itself.
Pitch error compensation	Machine error compensation parameter	This compensates the scale parallelism. (This originally compensates the pitch error of the ball screw.)	O	Use this parameter for as it is almost impossible to attach a linear scale to a ball screw completely. (The pitch error can be compensated by linear scale FB.)
Relative position compensation	Machine error compensation parameter	This compensates the orthogonality between axes.	O	A linear scale cannot compensate the orthogonality between axes, therefore, this parameter has to be set as well as in semi-closed loop control.

M60S Series	Abbrev.	Parameter name	Unit	Explanation	Setting range
#2011	G0back	Backlash during G0 (rapid traverse) feed	Command unit / 2	Normally set "0" in full closed system.	-9999 to 9999
#2012	G1back	Backlash during G1 (cutting) feed			
#40 1	cmpax	Machine error compensation / base axis		In case that the base axis is a compensation axis, pitch error will be compensated. In case that the base axis is not a compensation axis, relative position will be compensated.	Axis name
#40 2	drcax	Machine error compensation / compensation axis			
#40 6	sc	Machine error compensation / compensation scale		When "0" is set in this parameter, nothing will be compensated.	0 to 99

(Note) Set the axis number in the shown in above parameter list as follows; Set "0" for the 1st axis, "1" for the 2nd axis and "2" for the 3rd axis.



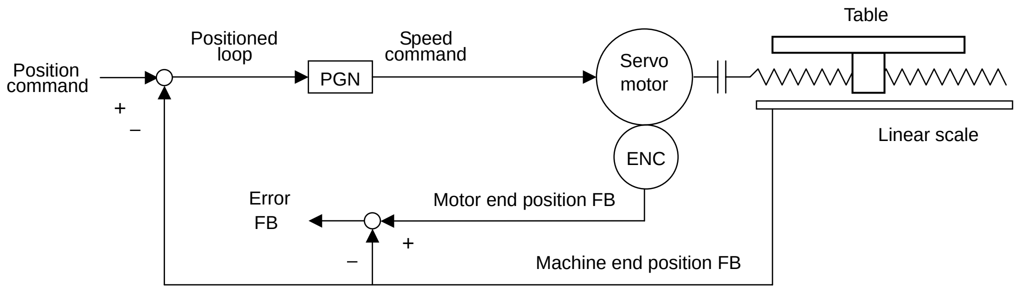
```
[MACHINE ERROR COMPENSATION]                          SETUP PARA5. 1/15
#
4000 Pinc       0

        # ---<1>---     # ---<2>---     # ---<3>---     # ---<4>---     # ---<5>---
cmpax   4001      X|    4011      Y|    4021      Z|    4031      X|    4041      X|
drcax   4002      X|    4012      Y|    4022      Z|    4032      Y|    4042      Z|
rdvno   4003   4111|    4013   4211|    4023   4311|    4033   4411|    4043   4511|
mdvno   4004   4101|    4014   4201|    4024   4301|    4034   4401|    4044   4501|
pdvno   4005   4200|    4015   4300|    4025   4400|    4035   4500|    4045   4600|
sc      4006      2|    4016      2|    4026      2|    4036      2|    4046      2|
spcdv   4007  10000|    4017  10000|    4027  10000|    4037  10000|    4047  10000|

                  Pitch error compensation          Relative position compensation

#(      ) DATA(      )
LSK mm ABS G40 G54           MEMORY
   MAC COMP       PLC          MACRO          PSW          MENU
```

Machine error compensation screen on NC (M60S Series)

(3) Overrun detection

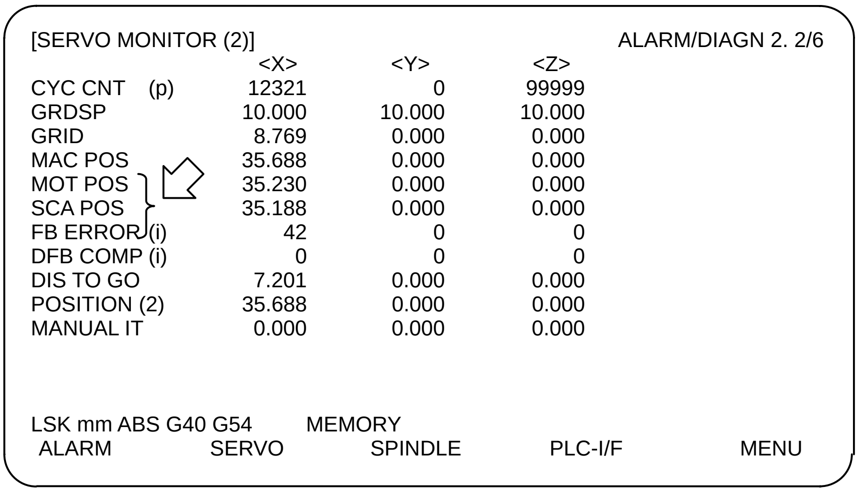
In full closed system, the machine end position FB detected with a linear scale is used for position control, and at the same time, the motor end position FB is also detected and the difference between both FBs is observed. In case that the error amount, which means the difference between machine end position FB and motor end position FB, exceeds the servo parameter SV054, alarm 43 occurs and the system is stopped to prevent the overrun due to scale FB error.

The error amount during acceleration/deceleration is normally less than 100µm, therefore, setting “2mm” as a standard (parameter setting “0”) has no problem.



No.	Abbrev.	Parameter name	Unit	Explanation	Normal setting range
SV054	ORE	Closed loop overrun detection width	mm	When the difference between the motor end detector and the linear scale (position detector) exceeds SV054, it is considered as overrun and alarm 43 will occur. If “-1” is set, alarms will not be detected. If “0” is set, overrun will be detected by 2mm.	0

The FB position mentioned above can be confirmed on the NC servo monitor screen.



```
[SERVO MONITOR (2)]                                    ALARM/DIAGN 2. 2/6
                    <X>          <Y>          <Z>
CYC CNT    (p)    12321            0        99999
GRDSP            10.000       10.000       10.000
GRID              8.769        0.000        0.000
MAC POS          35.688        0.000        0.000
MOT POS          35.230        0.000        0.000
SCA POS          35.188        0.000        0.000
FB ERROR (i)         42            0            0
DFB COMP (i)          0            0            0
DIS TO GO         7.201        0.000        0.000
POSITION (2)     35.688        0.000        0.000
MANUAL IT         0.000        0.000        0.000



LSK mm ABS G40 G54      MEMORY
 ALARM          SERVO         SPINDLE         PLC-I/F          MENU
```

Servo monitor screen on NC (M60S Series)

2-6-2 Speed loop delay compensation

(1) When to use

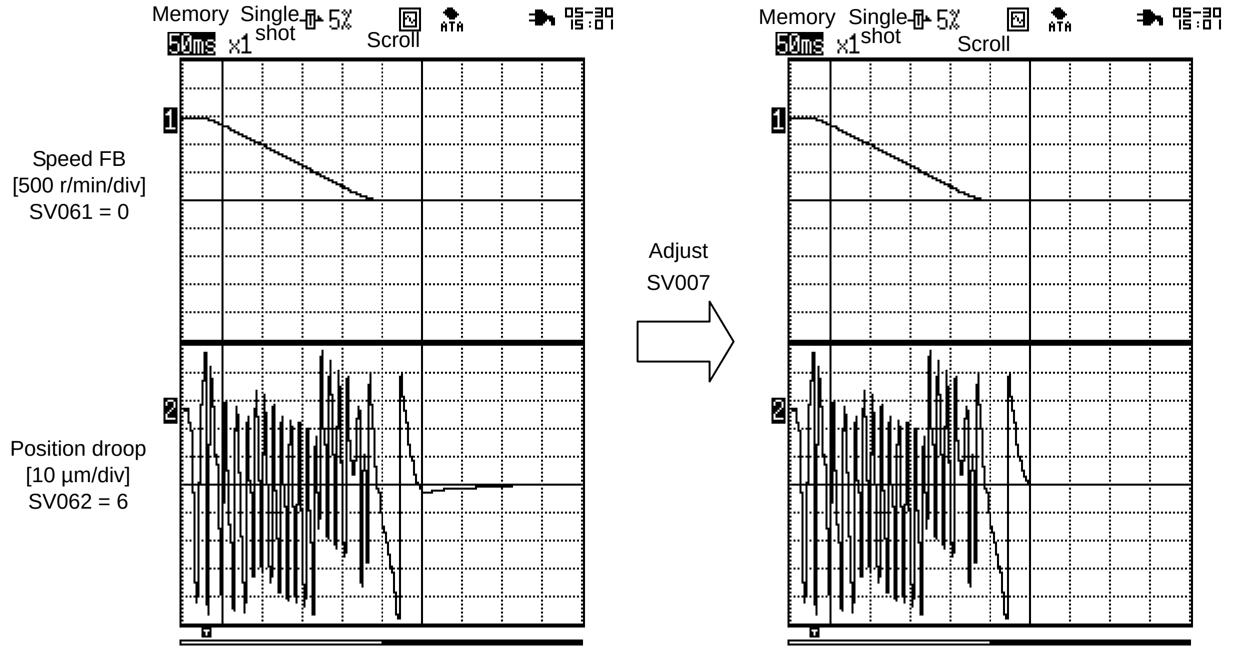
1) In case that the overshooting is caused when positioning or during pulse feed

Generally, machine end is positioned delaying from the motor end positioning. In position loop control of full closed loop, the machine end position is used as the position feedback. Therefore, the machine end position easily causes overshooting as the motor end position leads too much. Speed loop delay compensation function (type 2) prevents the overshooting by weakening the speed loop PI control after positioned loop has become “0”. (Weakening the lead compensation means delaying.)

(2) Precautions

1) If the setting value is too large, the positioned loop falls into arrears

Speed loop delay compensation function weakens the leads compensation (PI control), as a result, it takes longer time to complete positioning. If the setting value is too large, positioning will not be performed and position droop will fall into arrears.



When overshooting is occurring

After adjusting speed loop delay compensation (SV007)

⚠ CAUTION If the setting value is too large, the positioned loop falls into arrears.

(3) Procedures for speed loop delay compensation

1) Start delay compensation control

Start delay compensation selection type 2 with SV027.bit1,0.

2) Set torque offset (SV032)

Set the unbalance torque of the axis in SV032 (TOF). (For how to measure the unbalance torque, refer to [2-4-1(1) Unbalance torque and frictional torque].)

3) Adjust speed loop delay compensation

Measure the position droop waveform and confirm the overshooting. Raise SV007 (VIL) by 5 at a time so that the overshooting will be eliminated. Do not raise too much, or position droop will fall into arrears after the axis has stopped.

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Unit</th><th>Explanation</th><th>Normal setting range</th></tr>
<tr><td>SV027</td><td>SSF1</td><td>Servo function selection 1</td><td colspan="3">Use type 2 for delay compensation. (Type 1 is an old compatible type.)
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>aflt</td><td>zrn2</td><td colspan="2">afse</td><td colspan="2">ovs</td><td colspan="2">lmc</td><td>omr</td><td>zrn3</td><td colspan="2">vfct</td><td></td><td>upc</td><td colspan="2">vcnt</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set</th><th>Meaning when “1” is set</th></tr>
<tr><td>0
1</td><td>vcnt</td><td>00: Delay compensation selection disabled
01: Delay compensation selection type 1</td><td>10: Delay compensation selection type 2
11: Setting prohibited</td></tr>
</table>
</td></tr>
<tr><td>SV007</td><td>VIL</td><td>Speed loop delay compensation</td><td></td><td>Set this when limit cycle occurs, or when overshooting occurs during positioning.</td><td>0 to 30</td></tr>
<tr><td>SV032</td><td>TOF</td><td>Torque offset</td><td>Stall%</td><td>Set the unbalance torque.
Set the same value as that is set when adjusting the lost motion compensation.</td><td>-60 to 60</td></tr>
</table>

2-6-3 Dual feedback control

(1) When to use

1) When the precision of the surface cut by deep cuts function is not good

When using a linear scale, the feedback will be returned sensitively until the cutting load collides as it directly detects the machine end position including a table etc. As a result, the position loop control becomes unstable, and the cut surface may have undulation. Dual feedback control enables the stable control and also the cutting precision is improved as the high frequency factors included in the machine end FB is eliminated.

2) When position droop vibrates during acceleration/deceleration

In case that the rigidity of machine system is low in the full closed system of a larger machine etc., position loop gain cannot be raised occasionally as the response at acceleration/deceleration becomes vibrative and overshooting is caused. By using dual feedback control, the vibration limit of the position loop gain (PGN) can be raised as it enables the stable position loop control.

(2) Precautions

1) Optional functions

Dual feedback control is an optional function. In case that the initial parameter error (error No. 103, error No. 2303 in M60S series) occurs, option parameter does not exist.

2) Do not raise the control time constant (SV051) too much

When raising the control time constant (SV051), the limit of position loop gain can be raised up to the level of semi-closed loop control, however, it affects interpolation precision and the quadrant protrusion cannot be compensated completely by lost motion compensation. (In case that the machine backlash is large,) this phenomenon occurs remarkably especially in the machine whose cutting feedrate is very fast. When raising time constant, the position loop control becomes stable as it becomes similar to the semi-closed loop control, however, it means that the machine end (linear scale) FB is not used.

3) Positioning time is postponed

In dual feedback control, positioning is performed according to the motor end FB position, and then moved to the machine end FB position according to control time constant (SV051). If the control time constant is small (less than about 20ms), it will not affect. However, if the difference between motor end FB and machine end FB is large and the control time constant is also large, it takes longer time to carry out the final positioning.

(3) Procedures for dual feedback control adjustment

1) Start dual feedback control

Set SV017.bit1 to “1” and turn OFF/ON the power again.

2) Confirm the effect

A certain effect can be obtained just by starting dual feedback control. If the effect is enough, set SV051 to “1” to make it clear that this function is being used and finish adjusting.

If the effect is not enough, following adjustment is required.

3) Set control voltage non–sensitive zone (SV052)

Set the machine backlash amount in SV052. Set the value which is equivalent to #2012:G1back, the axis specification parameter of NC (M60S series), in semi–closed loop control. (Note: The setting unit for G1back is normally [0.5µm].)

4) Adjust the control time constant

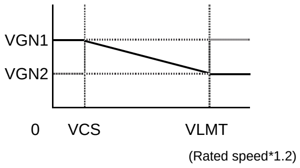
Raise SV051 by 5ms at a time from “0”, adjust the time constant so that the precision of cut surface is improved and overshooting is suppressed, increase the adjusted time constant by 1.5 times to double to allow a margin, and finally set the resulted value.

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Unit</th><th>Explanation</th><th>Normal setting range</th></tr>
<tr><td>SV017</td><td>SPEC*</td><td>Servo specification selection</td><td colspan="3">Dual feedback control is started with the following parameters.
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="4">mtr</td><td>drva</td><td>drvu</td><td>mpt</td><td>mp</td><td>abs</td><td></td><td>vdir</td><td>fdir</td><td>vfb</td><td>qro</td><td>dfbx</td><td>fdir2</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set</th><th>Meaning when “1” is set</th></tr>
<tr><td>1</td><td>dfbx</td><td>Dual feedback control stop</td><td>Dual feedback control start</td></tr>
</table>
</td></tr>
<tr><td>SV051</td><td>DFBT</td><td>Dual feedback control time constant</td><td>ms</td><td>Set the dual feedback control time constant.
When “0” is set, the control is performed by 1ms.</td><td>0 to 20</td></tr>
<tr><td>SV052</td><td>DFBN</td><td>Dual feedback control voltage dead zone</td><td>µm</td><td>Set the machine backlash amount.
Set the value which is equivalent to the NC parameter G1back.</td><td>0 to 10</td></tr>
</table>

POINT

1. Dual feedback control is for compensating the phenomenon caused by the insufficient rigidity of the machine. If there are any other items to be improved in the machine side (for example, the position where the scale is attached etc.), improve them at first.
2. Before using dual feedback control function, complete the servo adjustment in normal control (which means the full closed loop control without dual feed back control) and confirm the position loop gain (PGN).
3. Lower the position loop gain if overshooting or vibration occurs during acceleration/deceleration even though control time constant (SV051) is set to “10ms”.

2-7 MDS-C1/CH-Vx Parameter List

No.	Abbrev.	Parameter name	Explanation	Setting range	Reference
SV001	PC1*	Motor side gear ratio	Set the motor side and machine side gear ratio. For the rotary axis, set the total deceleration (acceleration) ratio. Even if the gear ratio is within the setting range, the electronic gears may overflow and cause an alarm.	1 to 32767	2-1-1
SV002	PC2*	Machine side gear ratio		1 to 32767	
SV003	PGN1	Position loop gain 1	Set the position loop gain. The standard setting is “33”. The higher the setting value is, the more precisely the command can be followed and the shorter the positioning time gets, however, note that a bigger shock is applied to the machine during acceleration/ deceleration. When using the SHG control, also set SV004 (PGN2) and SV057 (SHGC). (If “201” or bigger is set, the SHG control cannot be used.)	1 to 200	2-2-6 (3) 2-2-6 (4)
SV004	PGN2	Position loop gain 2	When using the SHG control, also set SV003 (PGN1) and SV057 (SHGC). When not using the SHG control, set to “0”.	0 to 999 (rad/s)	
SV005	VGN1	Speed loop gain 1	Set the speed loop gain. Set this according to the load inertia size. The higher the setting value is, the more accurate the control will be, however, vibration tends to occur. If vibration occurs, adjust by lowering by 20 to 30%. The value should be determined to be 70 to 80% of the value at the time when the vibration stops.	1 to 999	2-2-3 2-2-5
SV006	VGN2	Speed loop gain 2	If the noise is bothersome at high speed during rapid traverse, etc, lower the speed loop gain. As in the right figure, set the speed loop gain of the speed 1.2 times as fast as the motor’s rated speed, and use this with SV029 (VCS). When not using, set to “0”. 	-1000 to 1000	–
SV007	VIL	Speed loop delay compensation	Set this when the limit cycle occurs in the full-closed loop, or overshooting occurs in positioning. Select the control method with SV027 (SSF1)/bit1, 0 (vcnt). Normally, use “Changeover type 2”. When you set this parameter, make sure to set the torque offset (SV032 (TOF)). When not using, set to “0”. No changeover When SV027 (SSF1)/ bit1, 0 (vcnt)=00 The delay compensation control is always valid. Changeover type 1 When SV027 (SSF1)/ bit1, 0 (vcnt)=01 The delay compensation control works when the command from the NC is “0”. Overshooting that occurs during pulse feeding can be suppressed. Changeover type 2 When SV027 (SSF1)/ bit1, 0 (vcnt)=10 The delay compensation control works when the command from the NC is “0” and the position droop is “0”. Overshooting or the limit cycle that occurs during pulse feeding or positioning can be suppressed.	0 to 32767	2-6-2
SV008	VIA	Speed loop lead compensation	Set the gain of the speed loop integration control. The standard setting is “1364”. During the SHG control, the standard setting is “1900”. Adjust the value by increasing/decreasing it by about 100 at a time. Raise this value to improve contour tracking precision in high-speed cutting. Lower this value when the position droop vibrates (10 to 20Hz).	1 to 9999	2-2-6 (2) 2-2-6 (4)
SV009	IQA	Current loop q axis lead compensation	Set the gain of current loop. As this setting is determined by the motor’s electrical characteristics, the setting is fixed for each type of motor. Set the standard values for all the parameters depending on each motor type.	1 to 20480	–
SV010	IDA	Current loop d axis lead compensation			
SV011	IQG	Current loop q axis gain		1 to 4096	
SV012	IDG	Current loop d axis gain			

The parameters marked with * such as PC1* are the parameters enabled when the NC power is turned ON again.

No.	Abbrev.	Parameter name	Explanation	Setting range	Reference
SV013	ILMT	Current limit value	Set the normal current (torque) limit value. (Limit values for both + and - direction.) When the value is "500" (a standard setting), the maximum torque is determined by the specification of the motor.	0 to 999 (Stall [rated] current %)	–
SV014	ILMTsp	Current limit value in special control	Set the current (torque) limit value in a special control (initial absolute position setting, stopper control, etc). (Limit values for both of the + and - directions.) Set to "500" when not using.	0 to 999 (Stall [rated] current %)	–
SV015	FFC	Acceleration rate feed forward gain	When a relative error in the synchronous control is large, apply this parameter to the axis that is delaying. The standard setting value is "0". For the SHG control, set to "100". To adjust a relative error in acceleration/deceleration, increase the value by 50 to 100 at a time.	0 to 999 (%)	2-2-6 (4)
SV016	LMC1	Lost motion compensation 1	Set this when the protrusion (that occurs due to the non-sensitive band by friction, torsion, backlash, etc) at quadrant change is too large. This compensates the torque at quadrant change. This is valid only when the lost motion compensation (SV027 (SSF1/ lmc)) is selected.		2-4-1
			Type 1: When SV027 (SSF1)/ bit9, 8 (lmc)=01 Set the compensation amount based on the motor torque before the quadrant change. The standard setting is "100". Setting to "0" means the compensation amount is zero. Normally, use Type 2.	-1 to 200 (%)	
			Type 2: When SV027 (SSF1)/ bit9, 8 (lmc)=10 Set the compensation amount based on the stall (rated) current of the motor. The standard setting is double of the friction torque. Setting to "0" means the compensation amount is zero.	-1 to 100 (Stall [rated] current %)	
			When you wish different compensation amount depending on the direction When SV041 (LMC2) is "0", compensate with the value of SV016 (LMC1) in both of the + and -directions. If you wish to change the compensation amount depending on the command direction, set this and SV041 (LMC2). (SV016: + direction, SV041: - direction. However, the directions may be opposite depending on other settings.) When "-1" is set, the compensation won't be performed in the direction of the command.		

The parameters marked with * such as PC1* are the parameters enabled when the NC power is turned ON again.

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th colspan="2">Explanation</th><th>Setting range</th><th>Reference</th></tr>
<tr><td>SV017</td><td>SPEC*</td><td>Servo specification selection</td><td colspan="4">
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="4">spm</td><td></td><td></td><td>mpt3</td><td>mp</td><td>abs</td><td></td><td>vdir</td><td>fdir</td><td>vfd</td><td>seqh</td><td>dfbx</td><td>fdir2</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set</th><th>Meaning when “1” is set</th><th>Reference</th></tr>
<tr><td>0</td><td>fdir2</td><td>Speed feedback forward polarity</td><td>Speed feedback reverse polarity</td><td>–</td></tr>
<tr><td>1</td><td>dfbx</td><td>Dual feedback control stop</td><td>Dual feedback control start</td><td>2-6-3</td></tr>
<tr><td>2</td><td>seqh</td><td>READY/Servo ON time normal</td><td>READY/Servo ON time high speed</td><td>–</td></tr>
<tr><td>3</td><td>vfb</td><td>Speed feedback filter stop</td><td>Speed feedback filter stop (2250Hz)</td><td>2-2-4 (5)</td></tr>
<tr><td>4</td><td>fdir</td><td>Position feedback forward polarity</td><td>Position feedback reverse polarity</td><td>–</td></tr>
<tr><td>5</td><td>vdir</td><td>Standard setting</td><td>HA motor (4 pole motor)
Detector installation position 90 degrees (B, D)</td><td>–</td></tr>
<tr><td>6</td><td></td><td></td><td></td><td></td></tr>
<tr><td>7</td><td>abs</td><td>Incremental control</td><td>Absolute position control</td><td>–</td></tr>
<tr><td>8</td><td>mp</td><td>MP scale 360P (2mm pitch)</td><td>MP scale 720P (1mm pitch)</td><td>–</td></tr>
<tr><td>9</td><td>mpt3</td><td>MP scale ABS detection NC control</td><td>MP scale ABS detection automatic (Standard setting)</td><td>–</td></tr>
<tr><td>A</td><td></td><td></td><td></td><td></td></tr>
<tr><td>B</td><td></td><td></td><td></td><td></td></tr>
<tr><td>C
D
E
F</td><td>spm</td><td colspan="2">0 : Setting for normal use
1 : When using the S type drive unit of the MDS-C1-Vx (200V type)
2 : Setting for MDS-CH-Vx (400V type)
3 to F Setting prohibited</td><td></td></tr>
</table>
(Note) Set to “0” for bits with no particular description.
</td></tr>
<tr><td>SV018</td><td>PIT*</td><td>Ball screw pitch</td><td colspan="2">Set the ball screw pitch. Set to “360” for the rotary axis.</td><td>1 to 32767
(mm/rev)</td><td>–</td></tr>
</table>

The parameters marked with * such as PC1* are the parameters enabled when the NC power is turned ON again.

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range</th><th>Reference</th></tr>
<tr><td rowspan="2">SV019</td><td rowspan="2">RNG1*</td><td rowspan="2">Position detector resolution</td><td>In the case of the semi-closed loop control
Set the same value as SV020 (RNG2). (Refer to the explanation of SV020.)</td><td>1 to 9999
(kp/rev)</td><td rowspan="3">2-1-2</td></tr>
<tr><td>In the case of the full-closed loop control
Set the number of pulses per ball screw pitch.
<table>
<tr><th>Detector model name</th><th>Resolution</th><th>SV019 setting</th></tr>
<tr><td>OHE25K-ET, OHA25K-ET</td><td>100,000 (p/rev)</td><td>100</td></tr>
<tr><td>OSE104-ET, OSA104-ET</td><td>100,000 (p/rev)</td><td>100</td></tr>
<tr><td>OSE105-ET, OSA105-ET</td><td>1,000,000 (p/rev)</td><td>1000</td></tr>
<tr><td>RCN723 (Heidenhain)</td><td>8,000,000 (p/rev)</td><td>8000</td></tr>
<tr><td>Relative position detection scale</td><td>Refer to specification manual for each detector</td><td>PIT/Resolution (µm)</td></tr>
<tr><td>AT41 (Mitsutoyo)</td><td>1 (µm/p)</td><td>The same as SV018 (PIT)</td></tr>
<tr><td>FME type, FLE type (Futaba)</td><td>Refer to specification manual for each detector</td><td>PIT/Resolution (µm)</td></tr>
<tr><td>MP type (Mitsubishi Heavy Industries)</td><td>Refer to specification manual for each detector</td><td>PIT/Resolution (µm)</td></tr>
<tr><td>AT342 (Mitsutoyo)</td><td>0.5 (µm/p)</td><td>Twice as big as SV018 (PIT)</td></tr>
<tr><td>AT343 (Mitsutoyo)</td><td>0.05 (µm/p)</td><td>20 times as big as SV018 (PIT)</td></tr>
<tr><td>LC191M (Heidenhain)</td><td>Refer to specification manual for each detector</td><td>PIT/Resolution (µm)</td></tr>
<tr><td>LC491M (Heidenhain)</td><td>Refer to specification manual for each detector</td><td>PIT/Resolution (µm)</td></tr>
</table></td><td>1 to 9999
(kp/pit)</td></tr>
<tr><td>SV020</td><td>RNG2*</td><td>Speed detector resolution</td><td>Set the number of pulses per one revolution of the motor end detector.
<table>
<tr><th>Detector model name</th><th>SV020 setting</th></tr>
<tr><td>OSE104, OSA104</td><td>100</td></tr>
<tr><td>OSE105, OSA105</td><td>1000</td></tr>
</table></td><td>1 to 9999
(kp/rev)</td></tr>
<tr><td>SV021</td><td>OLT</td><td>Overload detection time constant</td><td>Set the detection time constant of Overload 1 (Alarm 50).
Set to “60” as a standard. (For machine tool builder adjustment.)</td><td>1 to 999
(s)</td><td>–</td></tr>
<tr><td>SV022</td><td>OLL</td><td>Overload detection level</td><td>Set the current detection level of Overload 1 (Alarm 50) in respect to the stall (rated) current. Set to “150” as a standard. (For machine tool builder adjustment.)</td><td>110 to 500
(Stall [rated] current %)</td><td>–</td></tr>
<tr><td>SV023</td><td>OD1</td><td>Excessive error detection width during servo ON</td><td>Set the excessive error detection width when servo ON.
<Standard setting value> OD1=OD2= $\frac{\text{Rapid traverse rate (mm/min)}}{60*PGN1}$ /2 (mm)
When “0” is set, the excessive error detection will not be performed.</td><td>0 to 32767
(mm)</td><td>2-4-2</td></tr>
<tr><td>SV024</td><td>INP</td><td>In-position detection width</td><td>Set the in-position detection width.
Set the accuracy required for the machine.
The lower the setting is, the higher the positioning accuracy gets, however, the cycle time (setting time) becomes longer. The standard setting is “50”.</td><td>0 to 32767
(µm)</td><td>–</td></tr>
</table>

The parameters marked with * such as PC1* are the parameters enabled when the NC power is turned ON again.

No.	Abbrev.	Parameter name	Explanation	Reference
SV025	MTYP*	Motor/Detector type	*When using MDS-C1-Vx Series (200V type)	

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
pen				ent				mtyp							

bit		Explanation	Reference
0	mtyp	Set the motor type. Set this along with SV017 (SPEC)/spm.	—
1		1) When SV017/spm=0 (Normal drive unit)	
2			
3			
4			
5			
6			
7			

Setting	0x	1x	2x	3x	4x	5x	6x	7x
x0	HA40N		HA50L	HA53L				
x1	HA80N		HA100L	HA103L				
x2	HA100N		HA200L	HA203L				
x3	HA200N		HA300L	HA303L				
x4	HA300N		HA500L	HA503L				
x5	HA700N							
x6	HA900N							
x7			HA-LH11K2					
x8			HA-LH15K2					
x9								
xA			HA150L	HA153L				
xB								
xC								
xD								
xE			HA-LF11K2					
xF			HA-LF15K2					

Setting	8x	9x	Ax	Bx	Cx	Dx	Ex	Fx
x0	HA43N			HC52	HC53			
x1	HA83N			HC102	HC103		HC103R	
x2	HA103N			HC152	HC153		HC153R	
x3	HA203N			HC202	HC203		HC203R	
x4	HA303N			HC352	HC353		HC353R	
x5	HA703N			HC452	HC453		HC503R	
x6				HC702	HC703			
x7				HC902				
x8								
x9								
xA	HA93N							
xB								
xC	HA053N							
xD	HA13N							
xE	HA23N							
xF	HA33N							

2) When SV017/spm=1 (S type drive unit)

Setting	8x	9x	Ax	Bx	Cx	Dx	Ex	Fx
x0								
x1								
x2								
x3								
x4			HC353					
x5		HC452	HC453					
x6		HC702						
x7								
x8								
x9								
xA								
xB								
xC								
xD								
xE								
xF								

The parameters marked with * such as PC1* are the parameters enabled when the NC power is turned ON again.

No.	Abbrev.	Parameter name	Explanation	Reference
SV025	MTYP*	Motor/Detector type	When using MDS-CH-Vx Series (400V type)	

bit		Explanation	Reference
0 1 2 3 4 5 6 7	mtyp	Set the motor type.　Set this along with SV017 (SPEC)/spm. Set SV017(SPEC)/spm to 2.	—

Setting	0x	1x	2x	3x	4x	5x	6x	7x
x0								
x1								
x2								
x3								
x4								
x5								
x6								
x7								
x8								
x9								
xA								
xB								
xC								
xD								
xE								
xF								

Setting	8x	9x	Ax	Bx	Cx	Dx	Ex	Fx
x0				HC-H52	HC-H53			
x1				HC-H102	HC-H103			
x2				HC-H152	HC-H153			
x3				HC-H202	HC-H203			
x4				HC-H352	HC-H353			
x5				HC-H452	HC-H453			
x6				HC-H702	HC-H703			
x7				HC-H902	HC-H903			
x8				HC-H1102	HC-H1103			
x9				HC-H1502				
xA								
xB								
xC								
xD								
xE								
xF								

The parameters marked with * such as PC1* are the parameters enabled when the NC power is turned ON again.

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range</th><th>Reference</th></tr>
<tr><td>SV025</td><td>MTYP*</td><td>Motor/Detector type</td><td colspan="3">Continuing from the previous page.
<table>
<tr><th colspan="2">bit</th><th>Explanation</th><th>Reference</th></tr>
<tr><td>8</td><td rowspan="4">ent</td><td rowspan="8">Set the detector type.
Set the position detector type for “pen”, and the speed detector type for “ent”. In the case of the semi-closed loop control, set the same value for “pen” and “ent”.
<table>
<tr><th>pen setting</th><th>ent setting</th><th>Detector model name</th></tr>
<tr><td>0</td><td>0</td><td>OSE104</td></tr>
<tr><td>1</td><td>1</td><td>OSA104</td></tr>
<tr><td>2</td><td>2</td><td>OSE105, OSA105</td></tr>
<tr><td>3</td><td>3</td><td></td></tr>
<tr><td>4</td><td>Setting impossible</td><td>OHE25K-ET, OSE104-ET</td></tr>
<tr><td>5</td><td>Setting impossible</td><td>OHA25K-ET, OSA104-ET</td></tr>
<tr><td>6</td><td>Setting impossible</td><td>OSE105-ET, OSA105-ET, RCN723 (Heidenhain)</td></tr>
<tr><td>7</td><td>Setting impossible</td><td></td></tr>
<tr><td>8</td><td>Setting impossible</td><td>Relative position detection scale, MP type (Mitsubishi Heavy Industries)</td></tr>
<tr><td>9</td><td>Setting impossible</td><td>AT41 (Mitsutoyo), FME type, FLE type (Futaba)</td></tr>
<tr><td>A</td><td>Setting impossible</td><td>AT342,AT343 (Mitsutoyo), LC191M/491M (Heidenhain), MDS-B-HR</td></tr>
<tr><td>B</td><td>Setting impossible</td><td></td></tr>
<tr><td>C</td><td>C (Current synchronization)</td><td>The setting of the slave axis in the speed/current synchronization control. When the master axis is the semi-closed control.</td></tr>
<tr><td>D</td><td>E (Current synchronization)</td><td>The setting of the slave axis in the speed/current synchronization control. When the master axis is the full-closed control.
(Current synchronization control is only for MDS-C1-V2.)</td></tr>
<tr><td>E</td><td>Setting impossible</td><td></td></tr>
<tr><td>F</td><td>Setting impossible</td><td></td></tr>
</table>
</td><td rowspan="8">—</td></tr>
<tr><td>9</td></tr>
<tr><td>A</td></tr>
<tr><td>B</td></tr>
<tr><td>C</td><td rowspan="4">pen</td></tr>
<tr><td>D</td></tr>
<tr><td>E</td></tr>
<tr><td>F</td></tr>
</table>
</td></tr>
<tr><td>SV026</td><td>OD2</td><td>Excessive error detection width during servo OFF</td><td>Set the excessive error detection width when servo ON.
For the standard setting, refer to the explanation of SV023 (OD1).
When “0” is set, the excessive error detection will not be performed.</td><td>0 to 32767 (mm)</td><td>2-4-2</td></tr>
</table>

The parameters marked with * such as PC1* are the parameters enabled when the NC power is turned ON again.

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range</th><th>Reference</th></tr>
<tr><td>SV027</td><td>SSF1</td><td>Servo function selection 1</td><td colspan="3">
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>aflt</td><td>zrn2</td><td colspan="2">afse</td><td colspan="2">ovs</td><td colspan="2">lmc</td><td>omr</td><td>zrn3</td><td colspan="2">vfct</td><td></td><td>upc</td><td colspan="2">vcnt</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set</th><th>Meaning when “1” is set</th><th>Reference</th></tr>
<tr><td>0
1</td><td>vcnt</td><td colspan="2">Set the execution changeover type of the speed loop delay compensation.
00: Delay compensation changeover invalid
01: Delay compensation changeover type 1
10: Delay compensation type 2
11: Setting prohibited</td><td>2-6-2</td></tr>
<tr><td>2</td><td>upc</td><td>Start torque compensation invalid</td><td>Start torque compensation valid</td><td>—</td></tr>
<tr><td>3</td><td></td><td></td><td></td><td></td></tr>
<tr><td>4
5</td><td>vfct</td><td colspan="2">Set the number of compensation pulses of the jitter compensation.
00: Jitter compensation invalid
01: Jitter compensation 1 pulse
10: Jitter compensation 2 pulses
11: Jitter compensation 3 pulses</td><td>2-2-4 (4)</td></tr>
<tr><td>6</td><td>zrn3</td><td colspan="2">ABS scale: Set to “1” in using AT342, AT343, LC191M/491M.</td><td>—</td></tr>
<tr><td>7</td><td>omr</td><td>Machine end compensation invalid</td><td>Machine end compensation valid</td><td>—</td></tr>
<tr><td>8
9</td><td>lmc</td><td colspan="2">Set the compensation amount with SV016 (LMC1) and SV041 (LMC2).
00: Lost motion compensation stop
01: Lost motion compensation type 1
10: Lost motion compensation type 2
11: Setting prohibited</td><td>2-4-1</td></tr>
<tr><td>A
B</td><td>ovs</td><td colspan="2">Set the compensation amount with SV031 (OVS1) and SV042 (OVS2).
00: Overshooting compensation stop
01: Overshooting compensation type 1
10: Overshooting compensation type 2
11: Overshooting compensation type 3</td><td>2-5-2</td></tr>
<tr><td>C
D</td><td>afse</td><td colspan="2">00: Adoptive filter sensitivity standard
11: Adoptive filter sensitivity increase (Set 2 bits at a time)</td><td>—</td></tr>
<tr><td>E</td><td>zrn2</td><td colspan="2">Set to “1”.</td><td></td></tr>
<tr><td>F</td><td>aflt</td><td>Adoptive filter stop</td><td>Adoptive filter start</td><td>—</td></tr>
</table>
(Note) Set to “0” for bits with no particular description.</td></tr>
<tr><td>SV028</td><td></td><td></td><td>Not used. Set to “0”.</td><td>0</td><td>–</td></tr>
<tr><td>SV029</td><td>VCS</td><td>Speed at the change of speed loop gain</td><td>If the noise is bothersome at high speed during rapid traverse, etc, lower the speed loop gain.
Set the speed at which the speed loop gain changes, and use this with SV006 (VGN2). (Refer to SV006.)
When not using, set to “0”..</td><td>0 to 9999
(r/min)</td><td>–</td></tr>
<tr><td>SV030</td><td colspan="5">The higher order 8bits and lower order 8bits are used for different functions.
“The setting value of SV030” = (Icx*256) + IVC
<table>
<tr><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range</th><th>Reference</th></tr>
<tr><td>IVC
(Low order)</td><td>Voltage dead time compensation</td><td>When 100% is set, the voltage equivalent to the logical non-energized time will be compensated.
When “0” is set, a 100% compensation will be performed.
Adjust in increments of 10% from the default value 100%.
If increased too much, vibration or vibration noise may be generated.</td><td>0 to 255
(%)</td><td>2-5-4</td></tr>
<tr><td>Icx
(High order)</td><td>Current bias 1</td><td>Set to “0” as a standard.
Use this in combination with SV040 and the high order 8bits of SV045.</td><td>0 to 127</td><td></td></tr>
</table></td></tr>
</table>

The parameters marked with * such as PC1* are the parameters enabled when the NC power is turned ON again.

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range</th><th>Reference</th></tr>
<tr><td>SV031</td><td>OVS1</td><td>Overshooting compensation 1</td><td>Set this if overshooting occurs during positioning. This compensates the motor torque during positioning.
This is valid only when the overshooting compensation SV027 (SSF1/ovs) is selected.
Type 1: When SV027 (SSF1)/ bitB, A (ovs)=01
Set the compensation amount based on the motor’s stall current.
Normally, use Type 3 as this is an old compatible type.
Type 2: When SV027 (SSF1)/ bitB, A (ovs)=10
Set the compensation amount based on the motor’s stall current.
Normally, use Type 3 as this is an old compatible type.
Type 3: When SV027 (SSF1)/ bitB, A (ovs)=11
This is compatible with the standard specifications. The offset amount is set based on the motor’s stall current. Determine the amount that is free from overshoot by adjusting the compensation gain (SV031, SV042) while increasing its value in increments of 1%. In the feed forward control mode, set “SV034(SSF3)/bit F to C” (ovsn), as well.
When you wish different compensation amount depending on the direction
When SV042 (OVS2) is “0”, compensate with the value of SV031 (OVS1) in both of the + and -directions.
If you wish to change the compensation amount depending on the command direction, set this and SV042 (OVS2). (SV031: + direction, SV042: - direction. However, the directions may be opposite depending on other settings.)
When “-1” is set, the compensation won’t be performed in the direction of the command.</td><td>-1 to 100 (Stall [rated] current %)</td><td>2-5-2</td></tr>
<tr><td>SV032</td><td>TOF</td><td>Torque offset</td><td>Set the unbalance torque of vertical axis and inclined axis.</td><td>-100 to 100 (Stall [rated] current %)</td><td>2-4-1 (1)
2-5-3
2-6-2</td></tr>
<tr><td>SV033</td><td>SSF2</td><td>Servo function selection 2</td><td colspan="3">
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="4">dos</td><td></td><td></td><td>hvx</td><td>svx</td><td colspan="3">nfd2</td><td>nf3</td><td colspan="3">nfd1</td><td>zck</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set</th><th>Meaning when “1” is set</th><th>Reference</th></tr>
<tr><td>0</td><td>zck</td><td>Z phase check valid (Alarm 42)</td><td>Z phase check invalid</td><td>–</td></tr>
<tr><td>1
2
3</td><td>nfd1</td><td colspan="2">Set the filter depth for Notch filter 1 (SV038).
<table>
<tr><td>Value</td><td>000</td><td>001</td><td>010</td><td>011</td><td>100</td><td>101</td><td>110</td><td>111</td></tr>
<tr><td>Depth (dB)</td><td>Infntly deep</td><td>-18.1</td><td>-12.0</td><td>-8.5</td><td>-6.0</td><td>-4.1</td><td>-2.5</td><td>-1.2</td></tr>
</table>
Deep← Shallow→</td><td>2-2-4 (1)
2-2-4 (6)</td></tr>
<tr><td>4</td><td>nf3</td><td>Notch filter 3 stop</td><td>Notch filter 3 start (1125Hz)</td><td>2-2-4 (5)</td></tr>
<tr><td>5
6
7</td><td>nfd2</td><td colspan="2">Set the operation frequency of Notch filter 2 (SV046).
<table>
<tr><td>Value</td><td>000</td><td>001</td><td>010</td><td>011</td><td>100</td><td>101</td><td>110</td><td>111</td></tr>
<tr><td>Depth (dB)</td><td>Infntly deep</td><td>-18.1</td><td>-12.0</td><td>-8.5</td><td>-6.0</td><td>-4.1</td><td>-2.5</td><td>-1.2</td></tr>
</table>
Deep← Shallow→</td><td>2-2-4 (1)
2-2-4 (6)</td></tr>
<tr><td>8
9</td><td>svx
hvx</td><td colspan="2">Set the performance mode of the servo control. (Only for MDS-C1-Vx)
00: By current loop gain
01: MDS-B-Vx compatible mode selected
10: High gain mode selected
11: High gain mode selected</td><td>–</td></tr>
<tr><td>A</td><td></td><td></td><td></td><td></td></tr>
<tr><td>B</td><td></td><td></td><td></td><td></td></tr>
<tr><td>C
D
E
F</td><td>dos</td><td colspan="2">Digital signal output selection
0 : MP scale absolute position detection, offset demand signal output
1 : Specified speed signal output
2 to F : Setting prohibited</td><td>–</td></tr>
</table>
(Note) Set to “0” for bits with no particular description</td></tr>
</table>

The parameters marked with * such as PC1* are the parameters enabled when the NC power is turned ON again.

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range</th><th>Reference</th></tr>
<tr><td>SV034</td><td>SSF3</td><td>Servo function selection 3</td><td colspan="3">
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="4">osvn</td><td></td><td></td><td></td><td></td><td></td><td>os2</td><td>zeg</td><td></td><td></td><td>mohn</td><td>has2</td><td>has1</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set</th><th>Meaning when “1” is set</th><th>Reference</th></tr>
<tr><td>0</td><td>has1</td><td>Setting for normal use (Except for HC)</td><td>HAS control 1 valid
(HC: High acceleration rate support)</td><td>–</td></tr>
<tr><td>1</td><td>has2</td><td>Setting for normal use (Except for HC)</td><td>HAS control 2 valid
(HC: Overshooting support)</td><td>–</td></tr>
<tr><td>2</td><td>mohn</td><td>MDS-B-HR motor thermal valid</td><td>MDS-B-HR motor thermal ignored</td><td>–</td></tr>
<tr><td>3</td><td></td><td></td><td></td><td></td></tr>
<tr><td>4</td><td></td><td></td><td></td><td></td></tr>
<tr><td>5</td><td>zeg</td><td>Z phase normal edge detection
(Setting for normal use)</td><td>Z phase reverse edge detection
(Valid only when SV027/bit6=1)</td><td>–</td></tr>
<tr><td>6</td><td>os2</td><td>Setting for normal use</td><td>Overspeed detection level changeover</td><td>–</td></tr>
<tr><td>7</td><td></td><td></td><td></td><td></td></tr>
<tr><td>8</td><td></td><td></td><td></td><td></td></tr>
<tr><td>9</td><td></td><td></td><td></td><td></td></tr>
<tr><td>A</td><td></td><td></td><td></td><td></td></tr>
<tr><td>B</td><td></td><td></td><td></td><td></td></tr>
<tr><td>C</td><td rowspan="4">ovsn</td><td colspan="2" rowspan="4">Set the non-sensitive band of the overshooting compensation type 3 in increments of 2µm at a time.
In the feed forward control, the non-sensitive band of the model position droop is set, and overshooting of the model is ignored. Set the standard 2µm (0001).</td><td rowspan="4">–</td></tr>
<tr><td>D</td></tr>
<tr><td>E</td></tr>
<tr><td>F</td></tr>
</table>
(Note) Set to “0” for bits with no particular description.
</td></tr>
<tr><td>SV035</td><td>SSF4</td><td>Servo function selection 4</td><td colspan="3">
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>clt</td><td colspan="3">clG1</td><td>cl2n</td><td>clet</td><td colspan="2">cltq</td><td>ckab</td><td>iup</td><td colspan="6">tdt</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set</th><th>Meaning when “1” is set</th><th>Reference</th></tr>
<tr><td>0</td><td rowspan="6">tdt</td><td colspan="2" rowspan="6">Td creation time setting
Set to “0”. (For machine tool builder adjustment)</td><td rowspan="6">–</td></tr>
<tr><td>1</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td><td>iup</td><td colspan="2">*When using MDS-C1-Vx Series (200V type):
Set to “1” when using any of motors from HC152 to HC702 and from HC153 to HC453.</td><td>–</td></tr>
<tr><td>7</td><td>ckab</td><td>Setting for normal use</td><td>No signal 2 (Alarm 21) special detection</td><td>–</td></tr>
<tr><td>8</td><td rowspan="2">cltq</td><td colspan="2" rowspan="2">Set the retracting torque for collision detection in respect to the maximum torque of the motor.
00: 100% 01: 90% 10: 80% (Standard) 11: 70%</td><td rowspan="8">2-5-3</td></tr>
<tr><td>9</td></tr>
<tr><td>A</td><td>clet</td><td>Setting for normal use</td><td>The disturbance torque peak of the latest two seconds is displayed in MPOS of the servo monitor screen.</td></tr>
<tr><td>B</td><td>cl2n</td><td>Collision detection method 2 valid</td><td>Collision detection method 2 invalid</td></tr>
<tr><td>C</td><td rowspan="3">clG1</td><td colspan="2" rowspan="3">Collision detection method 1
Set the collision detection level during cutting feed (G1).
The G1 collision detection level=SV060*clG1.
When clG1=0, the collision detection method 1 during cutting feed won’t function.</td></tr>
<tr><td>D</td></tr>
<tr><td>E</td></tr>
<tr><td>F</td><td>clt</td><td>Setting for normal use</td><td>The guide value of the SV059 setting value is displayed in MPOS of the servo monitor screen.</td></tr>
</table>
</td></tr>
</table>

No.	Abbrev.	Parameter name	Explanation	Setting range	Reference
SV036	PTYP*	Power supply type			

F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
amp				rtyp				ptyp							

bit		Explanation	Reference
0 1 2 3 4 5 6 7	ptyp	When the CN4 connector of the drive unit and the power supply are connected, setting below is necessary. To validate the external emergency stop function, add 40h.	–

Setting	0x	1x	2x	3x	4x	5x	6x	7x	8x
x0	Not used			CV-300					
x1		CV-110							CR-10
x2			CV-220						CR-15
x3									CR-22
x4	CV-37								CR-37
x5		CV-150			CV-450	CV-550			
x6	CV-55		CV-260						CR-55
x7				CV-370					
x8	CV-75								CR-75
x9		CV-185							CR-90

bit		Explanation	Reference
8 9 A B	rtyp	*When using MDS-C1-Vx Series (200V type): Set the regenerative resistor type when MDS-A-CR is used.	–

Setting	Regenerative resistor model name	Resistance value	Capacity
0	MDS-C1-CV (Setting when using power supply regeneration)		
1	GZG200W260HMJ	26Ω	80W
2	GZG300W130HMJ × 2	26Ω	150W
3	MR-RB30	13Ω	300W
4	MR-RB50	13Ω	500W
5	GZG200W200HMJ × 3	6.7Ω	350W
6	GZG300W200HMJ × 3	6.7Ω	500W
7	R-UNIT-1	30Ω	700W
8	R-UNIT-2	15Ω	700W
9	R-UNIT-3	15Ω	2100W
A to F	No setting		

(Note) The “rtyp” setting is required only for MDS-A-CR Series.

*When using MDS-CH-Vx Series (400V type)
Set to “1” when MDS-CH-V1-185 is used.

bit		Explanation	Reference
C D E F	amp	Always set to “0”.	–

No.	Abbrev.	Parameter name	Explanation	Setting range	Reference
SV037	JL	Load inertia scale	Set “the motor inertia + motor axis conversion load inertia” in respect to the motor inertia. SV037 (JL) = $\frac{Jl + Jm}{Jm}$ *100 Jm : Motor inertia Jl : Motor axis conversion load inertia	0 to 5000 (%)	2-2-2 2-5-1
SV038	FHz1	Notch filter frequency 1	Set the vibration frequency to suppress if machine vibration occurs. (Valid at 36 or more) When not using, set to “0”.	0 to 9000 (Hz)	2-2-4
SV039	LMCD	Lost motion compensation timing	Set this when the lost motion compensation timing doest not match. Adjust by increasing the value by 10 at a time.	0 to 2000 (ms)	–

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<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range</th><th>Reference</th></tr>
<tr><td rowspan="4">SV040</td><td colspan="5">The higher order 8bits and lower order 8bits are used for different functions.
"Setting value of SV040" = (Icy*256) + LMCT</td></tr>
<tr><td>Abbrev.</td><td>Parameter name</td><td>Explanation</td><td>Setting range</td><td>Reference</td></tr>
<tr><td>LMCT (Low order)</td><td>Lost motion compensation non-sensitive band</td><td>Set the non-sensitive band of the lost motion compensation in the feed forward control.
When "0" is set, the actual value that is set is 2μm. Adjust by increasing by 1μm at a time.</td><td>0 to 100 (μm)</td><td rowspan="2">–</td></tr>
<tr><td>Icy (High order)</td><td>Current bias 2</td><td>Normally, set to "40" if you use HC202 to HC902, HC203 to HC703.
Use this in combination with SV030 and the high order 8bits of SV045.</td><td>0 to 127</td></tr>
<tr><td>SV041</td><td>LMC2</td><td>Lost motion compensation 2</td><td>Set this with SV016 (LMC1) only when you wish to set the lost motion compensation amount to be different depending on the command directions.
Set to "0" as a standard.</td><td>-1 to 200 (Stall [rated] current %)</td><td>–</td></tr>
<tr><td>SV042</td><td>OVS2</td><td>Overshooting compensation 2</td><td>Set this with SV031 (OVS1) only when you wish to set the overshooting compensation amount to be different depending on the command directions.
Set to "0" as a standard.</td><td>-1 to 100 (Stall [rated] current %)</td><td>2-5-2</td></tr>
<tr><td>SV043</td><td>OBS1</td><td>Disturbance observer filter frequency</td><td>Set the disturbance observer filter band.
Set to "100" as a standard.
To use the disturbance observer, also set SV037 (JL) and SV044 (OBS2). When not using, set to "0".</td><td>0 to 1000 (rad/s)</td><td rowspan="2">2-5-1</td></tr>
<tr><td>SV044</td><td>OBS2</td><td>Disturbance observer gain</td><td>Set the disturbance observer gain. The standard setting is "100" to "300". To use the disturbance observer, also set SV037 (JL) and SV043 (OBS1). When not using, set to "0".</td><td>0 to 500 (%)</td></tr>
<tr><td rowspan="4">SV045</td><td colspan="5">The higher order 8bits and lower order 8bits are used for different functions.
"Setting value of SV045" = (Icy*256) + LMCT</td></tr>
<tr><td>Abbrev.</td><td>Parameter name</td><td>Explanation</td><td>Setting range</td><td>Reference</td></tr>
<tr><td>TRUB (Low order)</td><td>Frictional torque</td><td>When you use the collision detection function, set the frictional torque.</td><td>0 to 100 (Stall [rated] current %)</td><td>2-4-1 (1)
2-5-3</td></tr>
<tr><td>Ib1 (High order)</td><td>Current bias 3</td><td>Set to "0" as a standard.
Use this in combination with SV030 and the high order 8bits of SV040.</td><td>0 to 127</td><td>–</td></tr>
<tr><td>SV046</td><td>FHz2</td><td>Notch filter frequency 2</td><td>Set the vibration frequency to suppress if machine vibration occurs.
(Valid at 36 or more) When not using, set to "0".</td><td>0 to 9000 (Hz)</td><td>2-2-4</td></tr>
<tr><td>SV047</td><td>EC</td><td>Inductive voltage compensation gain</td><td>Set the inductive voltage compensation gain. Set to "100" as a standard. If the current FB peak exceeds the current command peak, lower the gain.</td><td>0 to 200 (%)</td><td>–</td></tr>
<tr><td>SV048</td><td>EMGrt</td><td>Vertical axis drop prevention time</td><td>Input a length of time to prevent the vertical axis from dropping by delaying Ready OFF until the brake works when the emergency stop occurs. Increase the setting by 100ms at a time and set the value where the axis does not drop.</td><td>0 to 20000 (ms)</td><td>2-4-3</td></tr>
<tr><td>SV049</td><td>PGN1sp</td><td>Position loop gain 1 in spindle synchronous control</td><td>Set the position loop gain during the spindle synchronous control (synchronous tapping, synchronous control with spindle/C axis).
Set the same value as the value of the spindle parameter, position loop gain in synchronous control.
When performing the SHG control, set this with SV050 (PGN2sp) and SV058 (SHGCsp).</td><td>1 to 200 (rad/s)</td><td rowspan="2">–</td></tr>
<tr><td>SV050</td><td>PGN2sp</td><td>Position loop gain 2 in spindle synchronous control</td><td>Set this with SV049 (PGN1sp) and SV058 (SHGCsp) if you wish to perform the SHG control in the spindle synchronous control (synchronous tapping, synchronous control with spindle/C axis).
When not performing the SHG control, set to "0".</td><td>0 to 999 (rad/s)</td></tr>
<tr><td>SV051</td><td>DFBT</td><td>Dual feed back control time constant</td><td>Set the control time constant in dual feed back.
When "0" is set, the actual value that is set is 1ms.
The higher the time constant is, the closer it gets to the semi-closed control, so the limit of the position loop gain is raised.</td><td>0 to 9999 (ms)</td><td rowspan="2">2-6-3</td></tr>
<tr><td>SV052</td><td>DFBN</td><td>Dual feedback control non-sensitive band</td><td>Set the non-sensitive band in the dual feedback control.
Set to "0" as a standard.</td><td>0 to 9999 (μm)</td></tr>
<tr><td>SV053</td><td>OD3</td><td>Excessive error detection width in special control</td><td>Set the excessive error detection width when servo ON in a special control (initial absolute position setting, stopper control, etc.).
If "0" is set, excessive error detection won't be performed when servo ON during a special control.</td><td>0 to 32767 (mm)</td><td>–</td></tr>
</table>

No.	Abbrev.	Parameter name	Explanation	Setting range	Reference
SV054	When SV035 (SSF4)/ bit7 (ckab)=0				
	Abbrev	Parameter name	Explanation	Setting range	Reference
	ORE	Overrun detection width in closed loop control	Set the overrun detection width in the full-closed loop control. If the gap between the motor end detector and the linear scale (machine end detector) exceeds the value set by this parameter, it is judged to be overrun and Alarm 43 will be detected. When "-1" is set, the alarm detection won't be performed. When "0" is set, overrun is detected with a 2mm width.	-1 to 32767 (mm)	2-6-1 (3)
	When SV035 (SSF4)/ bit7 (ckab)=1 (Note) This applies to only MDS-C1-Vx Series. The higher order 8bits and lower order 8bits are used for different functions. "Setting value of SV054" =(NSE*256)+ORE				
	Abbrev.	Parameter name	Explanation	Setting range	Reference
	ORE (Low order)	Overrun detection width in closed loop control	Set the overrun detection width in the full- closed loop control. If the gap between the motor end detector and the linear scale (machine end detector) exceeds the value set by this parameter, it is judged to be overrun and Alarm 43 will be detected. When "255" is set, the alarm detection won't be performed. When "0" is set, overrun is detected with a 2mm width.	0 to 255 (mm)	2-6-1 (3)
	NSE (High order)	Special detection width for No signal 2	When SV035 (SSF4)/ bit7 (ckab), this setting is valid. Set the special detection width for No signal 2 (Alarm 21). When "0" is set, overrun is detected with a 15µm width.	0 to 127 (µm)	–
SV055	EMGx	Max. gate off delay time after emergency stop	Set a length of time from the point when the emergency stop is input to the point when READY OFF is compulsorily executed. Normally, set the same value as the absolute value of SV056. In preventing the vertical axis from dropping, the gate off is delayed for the length of time set by SV048 if SV055's value is smaller than that of SV048.	0 to 20000 (ms)	2-4-3
SV056	EMGt	Deceleration time constant at emergency stop	In the vertical axis drop prevention time control, set the time constant used for the deceleration control at emergency stop. Set a length of time that takes from rapid traverse rate (rapid) to stopping. Normally, set the same value as the rapid traverse acceleration/ deceleration time constant. When executing the synchronous operation, put the minus sign to the settings of both of the master axis and slave axis.	-20000 to 20000 (ms)	2-4-3
SV057	SHGC	SHG control gain	When performing the SHG control, set this with S003 (PGN1) and SV004 (PGN2). When not performing the SHG control, set to "0".	0 to 1200 (rad/s)	2-2-6 (4)
SV058	SHGCsp	SHG control gain in spindle synchronous control	Set this with SV049 (PGN1sp) and SV050 (PGN2sp) if you wish to perform the SHG control in the spindle synchronous control (synchronous tapping, synchronous control with spindle/C axis). When not performing the SHG control, set to "0".	0 to 1200 (rad/s)	–
SV059	TCNV	Collision detection torque estimating gain	Set the torque estimating gain when using the collision detection function. After setting as SV035/bitF(clt)=1 and performing acceleration/ deceleration, set the value displayed in MPOS of the NC servo monitor screen. Set to "0" when not using the collision detection function.	-32768 to 32767	2-5-3
SV060	TLMT	Collision detection level	When using the collision detection function, set the collision detection level during the G0 feeding. If "0" is set, none of the collision detection function will work.	0 to 999 (Stall [rated] current %)	
SV061	DA1NO	D/A output ch. 1 data No.	Input the data number you wish to output to D/A output channel. In the case of MDS-C1-V2, set the axis on the side to which the data will not be output to "-1".	-1 to 127	1-1-3
SV062	DA2NO	D/A output ch. 2 data No.			
SV063	DA1MPY	D/A output ch. 1 output scale	Set the scale with a 1/256 unit. When "0" is set, output is done with the standard output unit.	-32768 to 32767 (Unit: 1/256)	
SV064	DA2MPY	D/A output ch. 2 output scale			
SV065	TLC	Tool end compensation spring constant	Set the spring constant of the tool end compensation. In the semi-closed loop control, the tool end compensation amount is calculated with the following equation. Compensation amount= $\frac{F(mm/min)^2 *SV065}{R (mm) *10^9}$ (µm) F: Commanded speed R: Radius When not using, set to "0".	-32768 to 32767	–

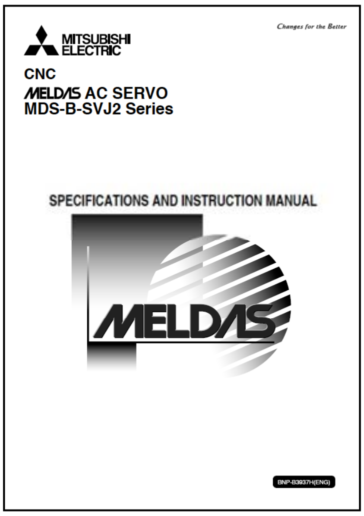
3 MDS-B-SVJ2 ADJUSTMENT PROCEDURES

3 MDS-B-SVJ2 ADJUSTMENT PROCEDURES

Prepare the following manual when adjusting the servo parameters for MDS-B-SVJ2 in accordance with this manual.

SPECIFICATIONS AND INSTRUCTION MANUAL

Hereinafter referred to as “Instruction Manual”



Changes for the Better

MITSUBISHI
ELECTRIC

CNC
MELDAS AC SERVO
MDS-B-SVJ2 Series

SPECIFICATIONS AND INSTRUCTION MANUAL

MELDAS

BNP-B3937H(ENG)

“MDS-B-SVJ2 Series SPECIFICATIONS AND INSTRUCTION MANUAL“ BNP-B3937

When adjusting the servo for the first time (primary adjustment), set and adjust the following items in order from 3-1 to 3-4.
“3-5 Procedures for adjusting each function” are set and adjusted only when required.

3-1 Setting initial parameters
3-2 Gain adjustment
3-3 Adjusting acceleration/deceleration time constant
3-4 Initial adjustment for the servo functions

As for the primary adjustment, set and adjust the items in order from 3-1 to 3-4.

In this manual, [Normal setting range] of parameters are shown instead of [Setting range]. [Normal setting range] means the range of the value used in actual parameter adjustment (though [Setting range] means the range of the values that does not cause an error).

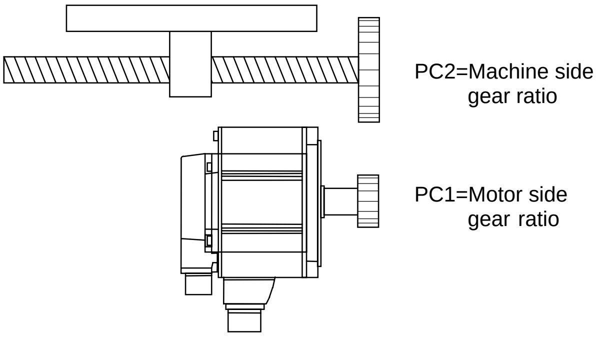
<Example of parameter explanation>

No.	Abbrev.	Parameter name	Explanation	Normal setting range
SV008	VIA	Speed loop leading compensation	“1364” is set as a standard. “1900” is set as standard during SHG control. Adjust in increment of approx. 100 at a time.	700 to 2500

3-1 Setting Initial Parameters

Input the setting values shown in “4-3 Standard parameter list according to motor” in the instruction manual as for initial parameters before adjusting servo. If a wrong value is inputted, the initial parameter error (ALM37) will occur. In this case, the parameter number causing an error is displayed on the NC screen. Some parameters are determined by the machine specification and they are explained below.

3-1-1 Setting the gear ratio



Input the ratio of gear tooth. When initial parameter error (ALM37) -error parameter number 101 occurs, reconsider the specification as electric gear must be overflowing.
(Refer to “4.2.2 Limitations to electric gear setting value” in the specifications manual.)
When the machine specification is “rack and pinion” , π is included in the deceleration ratio. In this case, the accurate positioning is impossible to be made. Express the π with a rough fractional number when calculating the gear ratio.

No.	Abbrev.	Parameter name	Explanation
SV001	PC1	Motor side gear ratio	Calculate the reducible number of each gear tooth and set the result. When PC1 < PC2, it is set as deceleration is set. In case that π is included as well as “rack and pinion”, the accurate positioning is impossible to be made as π is calculated into a rough fractional number when calculating the gear ratio.
SV002	PC2	Machine side gear ratio	

3-1-2 Initial settings of speed loop gain

The standard value of speed loop gain (VGN1) is determined by load inertia. If the adjustment has not been done yet, set the standard value of JL=100% (motor only) to JL=200%. Do not set the too large value, or the vibration occurs. Set the value which does not cause a vibration but large enough to perform rapid traverse feed.

No.	Abbrev.	Parameter name	Explanation
SV005	VGN1	Speed loop gain	Set JL=100% (motor only) to JL=200% as a standard.
SV008	VIA	Speed loop leading compensation	Set 1364 as a standard.

3-1-3 Confirming the machine specifications value

Confirm the following machine specifications value to be set in axis specifications parameters.

M60S Series	Abbrev.	Parameter name	Explanation
#2001	rapid	Rapid traverse rate	Set the rapid traverse rate. Confirm the maximum rotation speed of the motor.
#2002	clamp	Cutting feed clamp speed	Specify the maximum speed of the cutting feedrate. Even though the feedrate for G01 exceeds this value, clamped with this speed.
#2003	smgst	Acceleration/ deceleration mode	Set in accordance with machine specifications. In machine tools, rapid traverse feed is generally set to “Linear acceleration/deceleration” mode and cutting feed is generally set to “Exponent acceleration/deceleration” mode. S-pattern (soft) acceleration/deceleration function is occasionally used for the machine with a large inertia.

3-2 Gain Adjustment

3-2-1 Preparation Before Operation

(1) Confirming the safety

The servo is ready to be operated when the initial parameter settings are completed. Confirm the safety by checking the following items before operation.

Cancel the emergency stop and make READY ON.	Is any alarm occurring?
⇩	
Confirm the axis movement by using a manual pulse generator.	Are there any vibration or strange sound? Is the load too large? (Is the current too large?)
⇩	
Confirm the soft limit movement by using a manual pulse generator.	Does the axis stop before hitting the machine? Confirm the soft limit (over travel) protection.
⇩	
Make a program taking account of axis movement range.	Make a program taking account of soft limit position. (Refer to the sample program.)
⇩	
Specify the single block operation and set the rapid traverse override to less than 25%.	Move slowly at first confirming the program.
⇩	
Move axis forward and backward by memory operation (program operation). If there is no problem, cancel the single block and raise the override up to 100% gradually.	If the acceleration current is too large, make acceleration/deceleration time constant longer. If there is more than 100% of acceleration current, that will be enough.

(Sample program of rapid traverse feed for reciprocating operation)

```
G28 X0;                X axis zero return
N01 G90 G0 X-200.;     Move X axis to X= -200 with rapid traverse feed by absolute position command (the line N01).
G4 X1.0;               Dwell for 1 second. (1-second pause)  Use "X" even for Y axis and Z axis.
G0 X0;                 Make X axis move to X=0 by rapid traverse feed.
G4 X1.0;               Dwell for 1 second. (1-second pause)  Use "X" even for Y axis and Z axis.
GOTO 01                Back to "N01"
```

Make sure not collide. No "." means 200μm, do not fail to add ".".

⚠ CAUTION

Do not fail to confirm the soft limit movement (over travel) to prevent collision.
Be careful of the position of other axes and pay attention when the cutter has already mounted as the collision possibly occurs before the soft limit.

(2) Confirm the acceleration/deceleration waveform with a Hi-coder

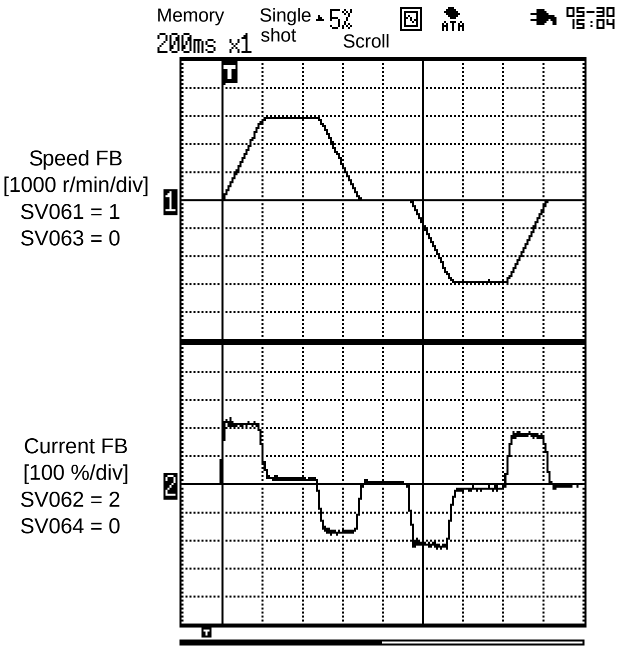
Measure the speed FB waveform and current FB waveform during acceleration/deceleration after connecting a Hi-coder.

(Items to be checked)

1) Voltage output level (ch.1, ch.2)
2) Zero level (ch.1, ch.2)
3) Output polarity of the current FB

Make sure that the Hi-coder data is reliable as the rest of the servo adjustment procedures which will be done later depend on this Hi-coder data.

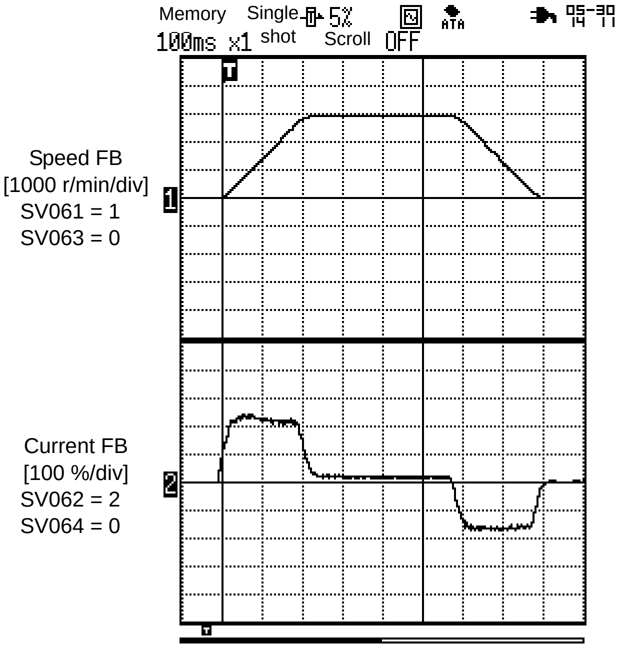
Output zero level can be adjusted on servo side. (Refer to [1-2-4 (4) Setting the offset amount] in this manual.)



Acceleration/deceleration waveform of reciprocating operation

When measuring repeatedly, set the trigger for starting Hi-coder measurement at the start of speed FB. When measuring the data later, change the data of ch.2 only and leave ch.1 at speed FB so that the measurement is always executed at the same timing.
Set the timing of the measurement, and the data can be compared easily in case that the operation conditions including parameters are changed.

The waveforms shown in this manual are measured at one acceleration/deceleration as the reciprocating operation includes the same waveform which has different polarity. In case of the waveform shown the right, the trigger level is set as follows;



Determine the measuring timing by setting the trigger

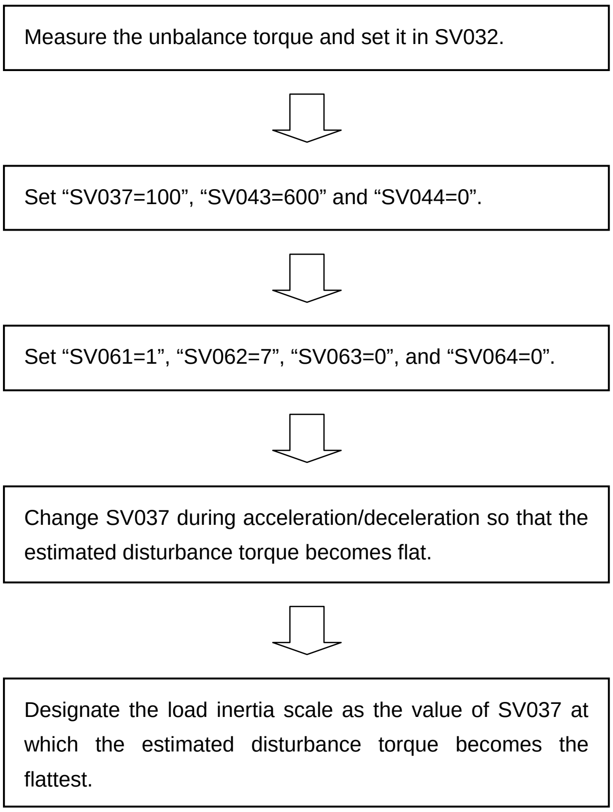
ch.1: 100mV ↑direction

No.	Abbrev.	Parameter name	Explanation	Normal setting range
SV061	DA1NO	D/A output channel 1 data No.	The data No. to be output each D/A output channel is output.	0 to 30
SV062	DA2NO	D/A output channel 2 data No.		100 to 102
SV063	DA1MPY	D/A output channel 1 output scale	When "0" is set, the output will be made with the standard output unit. To change the output unit, set a value other than "0". The scale is set with a 1/256 unit.	-32768 to 32767
SV064	DA2MPY	D/A output channel 1 output scale		

3-2-2 Measuring the inertia rate

Measure the load inertia by using a servo drive unit to determine the standard speed loop gain (standard VGN1). Set the measured load inertia rate in the servo parameter SV 037.

(1) Measuring the inertia with the disturbance observer



Measure the unbalance torque and set it in SV032.

In case of horizontal axis, set “SV032=0”.
In case of vertical axis, refer to “3-4-1 (1) unbalance torque and frictional torque ”.

Set “SV037=100”, “SV043=600” and “SV044=0”.

No need to compensate the disturbance observer itself. Therefore, set gain (SV044) to “0”.

Set “SV061=1”, “SV062=7”, “SV063=0”, and “SV064=0”.

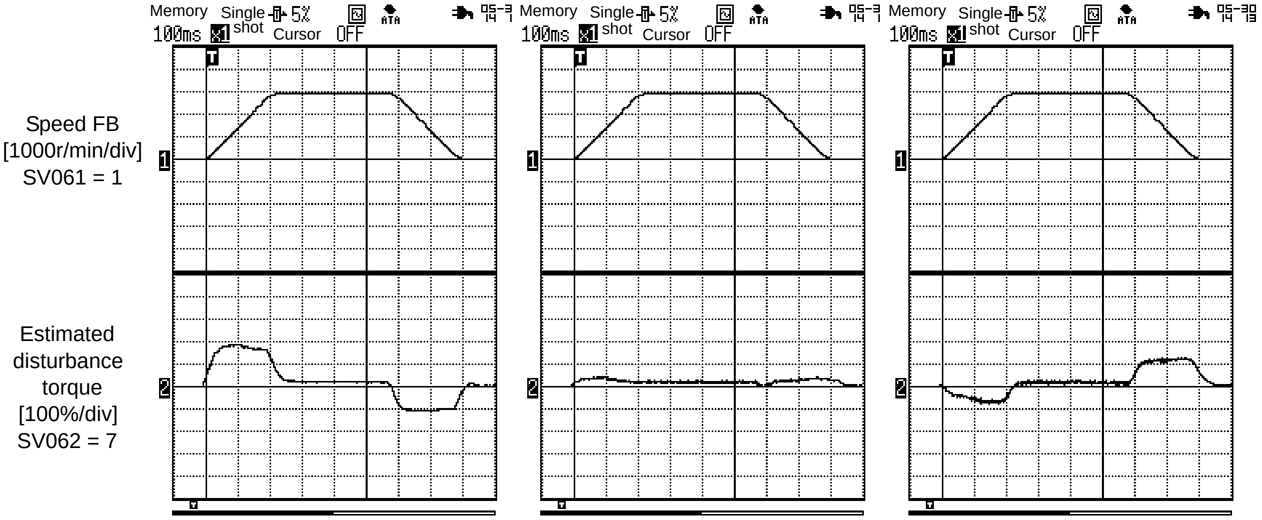
Output the estimated disturbance torque to D/A output ch.2.

Change SV037 during acceleration/deceleration so that the estimated disturbance torque becomes flat.

Make a program taking account of the soft limit position. (Refer to the sample program)

Designate the load inertia scale as the value of SV037 at which the estimated disturbance torque becomes the flattest.

The load inertia rate of the following example including the motor itself is JL = 3.4 × JM.
(Set SV043 back to “0” and take a note of SV037)



SV037 = 100
(Too low)

SV037 = 340
(Optimum)

SV037 = 500
(Too high)

(2) Measuring the inertia with collision detection

The load inertia measured by a servo drive unit can be displayed in the NC monitoring screen.

Measure the unbalance torque and set it in SV032

In case of horizontal axis, set “SV032=0”.
In case of vertical axis, refer to “3-4-1 (1) Unbalance torque and frictional torque”.

⇩

Measure the frictional torque and set it in SV045.

Refer to “3-4-1 (1) Unbalance torque and frictional torque” for the details of frictional torque measurement.

⇩

Set to SHG control.
(SV003=33, SV004=86, SV057=187)

Refer to [3-2-8 (4) SHG control] for the details of SHG control.

⇩

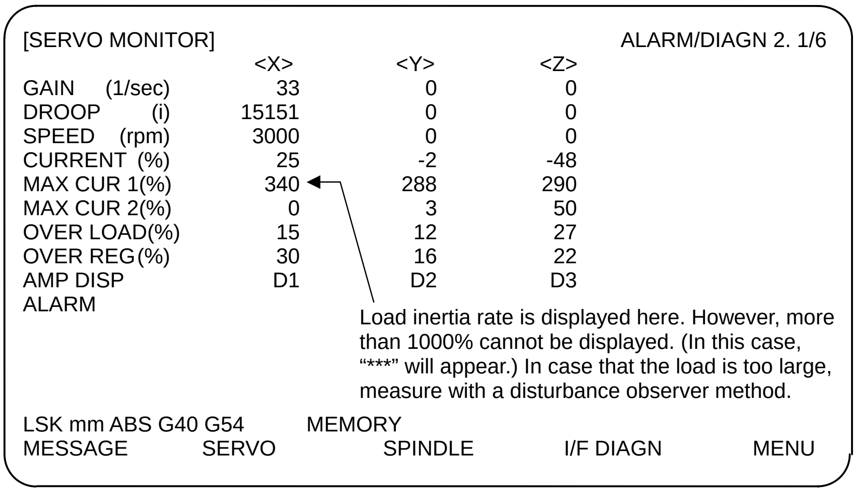
Set “SV034=0003”, “SV060=0”.

[MAX CURRENT] in NC servo monitoring screen is changed to the load inertia.

⇩

Accelerate/decelerate, and the load inertia rate (%) will be displayed in [MAX CURRENT 1] in NC SERVO MONITOR screen.
The displayed value is the converged value after performing acceleration/deceleration a couple of times.

Acceleration/deceleration is performed with the time constant at which the acceleration/deceleration exceeds 100%.
When setting to READY OFF, the calculation result is reset.



```
[SERVO MONITOR]                                      ALARM/DIAGN 2. 1/6
                     <X>          <Y>          <Z>
GAIN     (1/sec)      33            0            0
DROOP        (i)   15151            0            0
SPEED      (rpm)    3000            0            0
CURRENT  (%)          25           -2          -48
MAX CUR 1(%)         340 ◄        288          290
MAX CUR 2(%)           0            3           50
OVER LOAD(%)          15           12           27
OVER REG(%)           30           16           22
AMP DISP              D1           D2           D3
ALARM

LSK mm ABS G40 G54         MEMORY
MESSAGE        SERVO          SPINDLE          I/F DIAGN          MENU
```

Load inertia rate is displayed here. However, more than 1000% cannot be displayed. (In this case, “***” will appear.) In case that the load is too large, measure with a disturbance observer method.

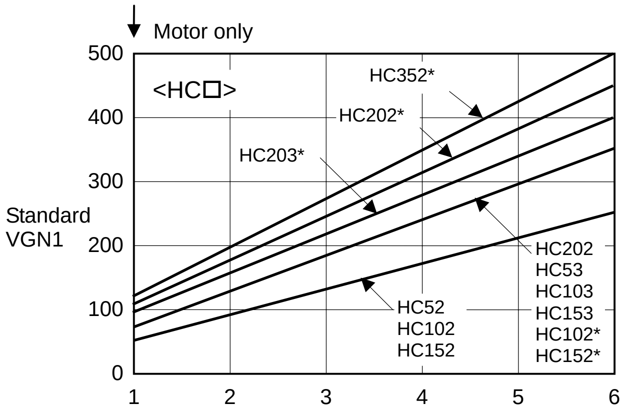
Screen of M64S when load inertia rate of X axis is set to be displayed

⚠ **CAUTION**	When measuring the load inertia with collision detection, the result of measurement will be changed if the setting valued of unbalance torque (SV032) or frictional torque (SV045) is changed. Set the exact frictional torque to measure the load inertia as precisely as possible.

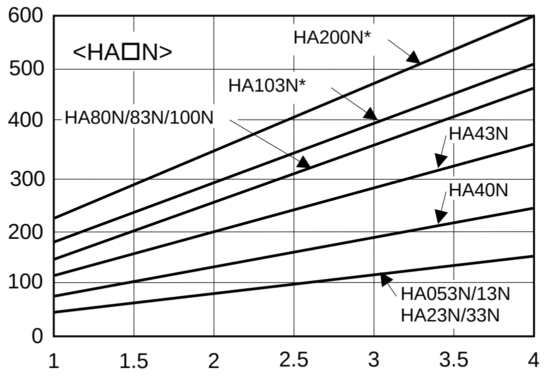
3-2-3 Determining the standard speed loop gain

The standard speed loop gain (standard VGN) is determined referring to the respective load inertia rate in the following table. With most models, vibration will occur if the standard VGN is set, so at this point, use this as the target value for adjusting the gain.

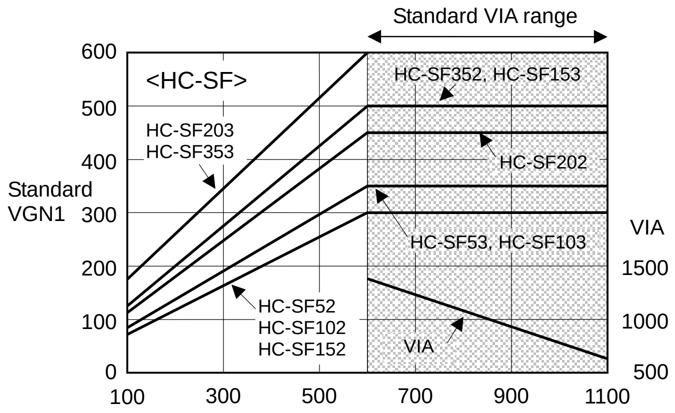
No.	Abbrev.	Parameter name	Explanation	Normal setting range
SV005	VGN1	Speed loop gain	Determine the standard setting value by measuring load inertia scale and referring to the graph below.	10 to 600



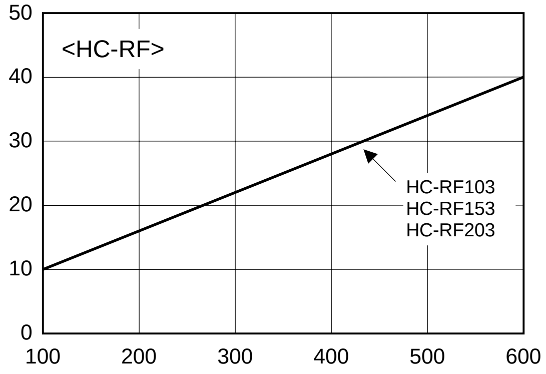
Load inertia scale (%) Setting value for SV037



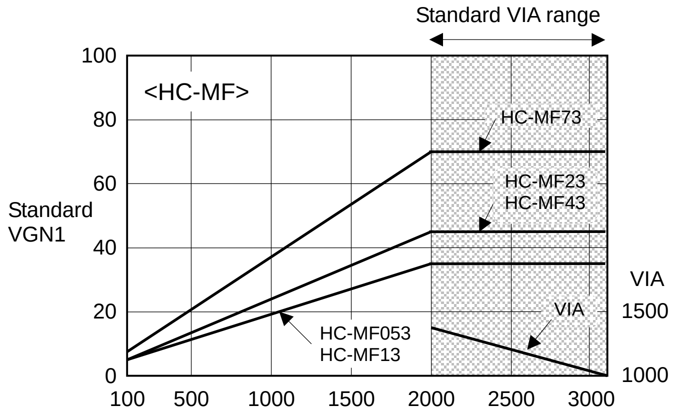
Load inertia scale (%) Setting value for SV037



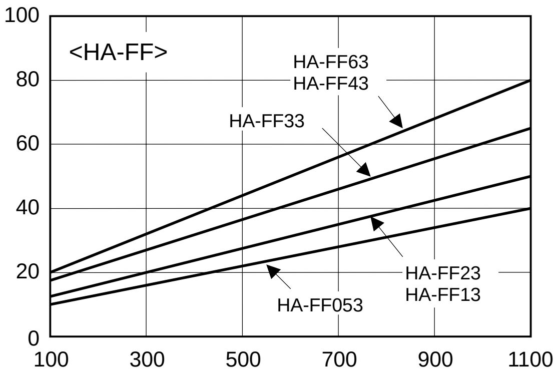
Load inertia scale (%) Setting value for SV037



Load inertia scale (%) Setting value for SV037



Load inertia scale (%) Setting value for SV037



Load inertia scale (%) Setting value for SV037

3-2-4 Explanation of resonance suppression filter

Machine resonance occurs when the speed loop gain is increased to improve the control accuracy. The machine resonance is a phenomenon that occurs when the servo's speed loop control acts on the machine's specific frequency (characteristic resonance frequency), resulting in an increase of vibration. When adjusting the speed loop gain, a notch filter must be set to suppress this machine resonance (vibration). Always understand the methods of setting the notch filter before adjusting the speed loop gain.

(1) Resonance suppression filter specifications

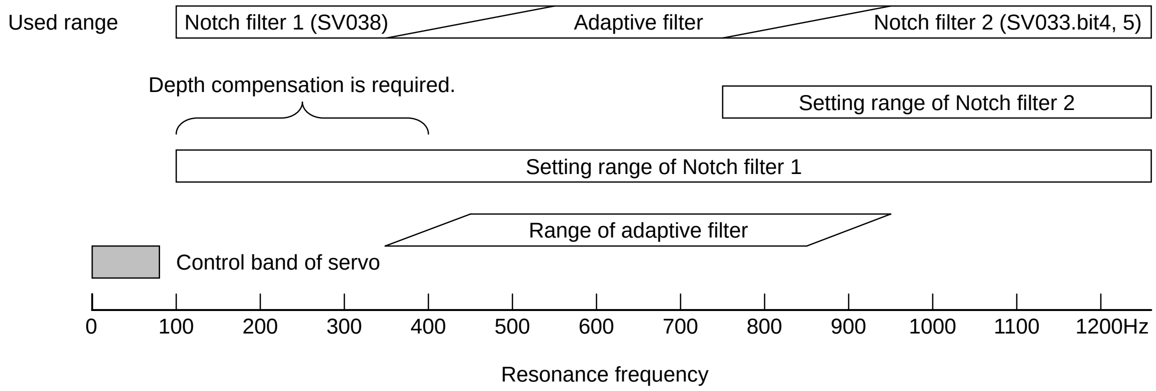
The following three resonance suppression filters are used with the MDS-B-SVJ2 series.

MDS-B-SVJ2 resonance suppression filters

	Frequency range	Frequency settings	Depth compensation settings
Adaptive filter	Approx. 400Hz to 900Hz	Automatically set	Adjust filter sensitivity
Notch filter 1	100Hz to 2250Hz	SV038	SV033.bit0 to 3
Notch filter 2	750Hz to 2250Hz	SV033.bit4, 5	None

(2) Filter setting frequency

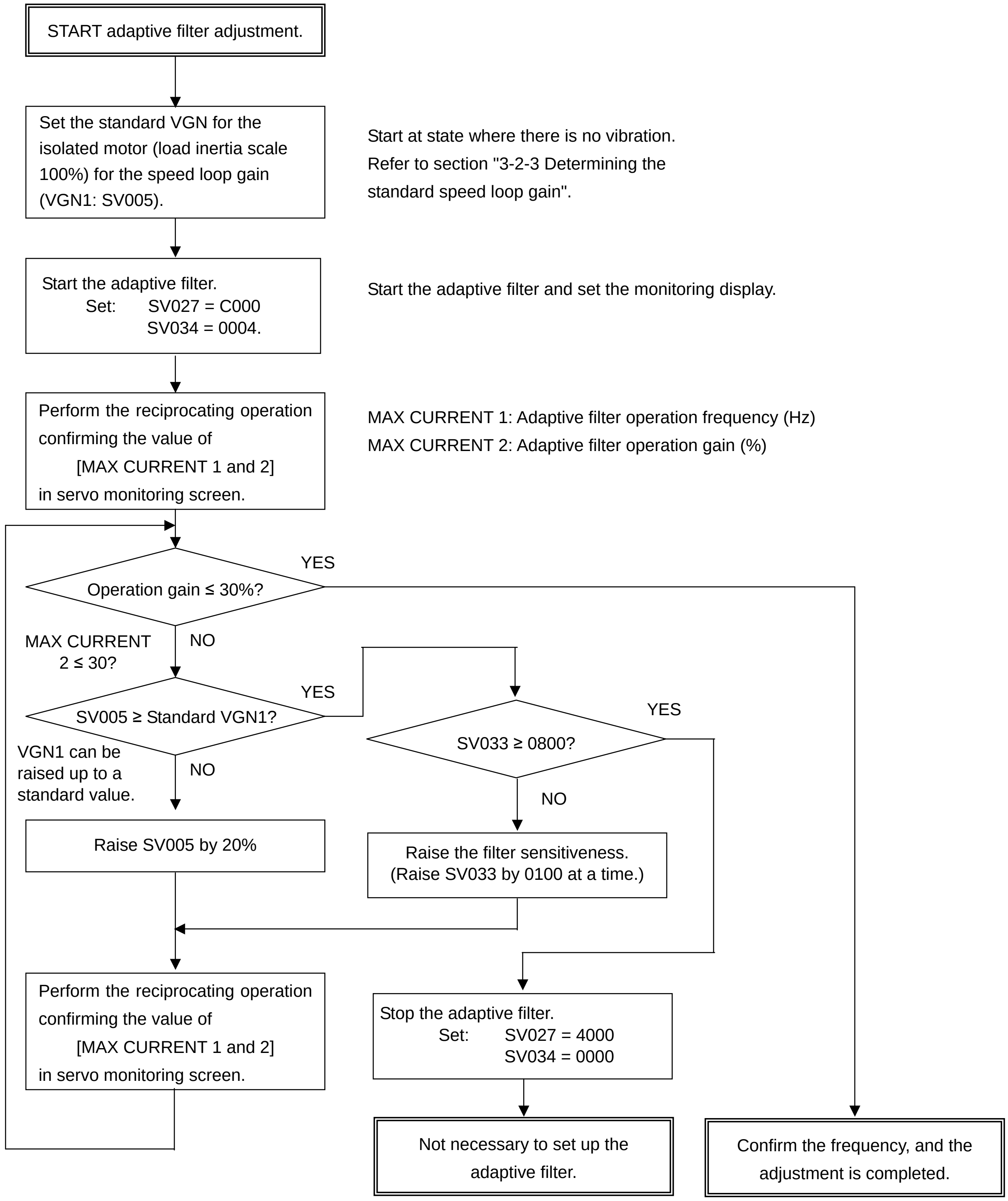
There may be several machine resonances, so three types of filters are used according to the resonance frequency. The adaptive filter automatically sets the resonance frequency, but since the resonance point is easily converged to approx. 600Hz, notch filters are used at the other frequencies. In other words, notch filter 1 is used for resonance at frequencies lower than the adaptive filter, and notch filter 2 is used for resonance at frequencies higher than the adaptive filter. This supports the entire range between 100 and 1200Hz where machine resonance occurs.



POINT The adaptive filter is easily converged to somewhere between 500 and 700Hz, so use notch filters to remove the resonance at other areas.

3-2-5 Adjusting the adaptive filter

For the MDS-B-SVJ2, the machine resonance is first removed with the adaptive filter. The frequency does not need to be set for the adaptive filter, but the filter sensitivity must be adjusted. If the operation gain (filter depth) is not sufficient, raise the filter sensitivity, and carry out acceleration/deceleration to fully converge the filter coefficient. (Target filter gain 30% or less)



Start at state where there is no vibration.
Refer to section "3-2-3 Determining the standard speed loop gain".

Start the adaptive filter and set the monitoring display.

MAX CURRENT 1: Adaptive filter operation frequency (Hz)
MAX CURRENT 2: Adaptive filter operation gain (%)

POINT For MDS-B-SVJ2, adjust the adaptive filter first.

3-2-6 Explanation of notch filter

The resonance that cannot be removed with the adaptive filter is removed with the notch filters. The notch filter is set when the speed loop gain is adjusted. The methods for setting the notch filter are explained here first. The notch filter is set with the methods explained in "3-2-7 Adjusting the speed loop gain".

(1) Setting notch filter 1

Check the operation frequency of the adaptive filter adjusted before, and make sure that the filter frequencies are not overlapped.

The operating frequency parameter can be set in 1Hz increments, but the internal control will function at the frequency shown below which is the closest to the setting value. Set the setting frequency shown below in the parameter when adjusting the notch filter.

The depth compensation is a function that sets the notch filter at a low frequency. A stable notch filter can be set even at a low frequency. Usually, the standard value that matches the setting frequency is set as shown below.

Setting frequency and standard filter depth for notch filter 1

Setting frequency	Standard filter depth	Setting frequency	Standard filter depth	Setting frequency	Standard filter depth
2250Hz	0	281Hz	4	150Hz	8
1125Hz	0	250Hz	4	141Hz	8
750Hz	0	225Hz	4	132Hz	8
563Hz	0	205Hz	4	125Hz	8
450 Hz	0	188Hz	8	118Hz	8
375Hz	4	173Hz	8	113Hz	8
321Hz	4	161Hz	8	107Hz	8

(2) Setting notch filter 2

Notch filter 2 is set with two bits as shown below. There is no depth compensation. The function is the same as when using notch filter 1 with a filter depth of 0.

Setting frequency for notch filter 2

Parameter setting	No filter	2250Hz	1125Hz	750Hz
SV033. bit4	0	1	0	1
SV033. bit5	0	0	1	1

POINT

1. If the notch filter is set to a low frequency of 400Hz or less, vibration could recur at a frequency lower than the lower frequency. In this case, use depth compensation so that the filter functions at a shallower (weaker) level and suppress the vibration.
2. The adaptive filter functions rather gradually, so there may be cases when the resonance cannot be completely removed. Use the notch filter in this case.
3. Jitter compensation is also effective for a shaft with large backlash. Note that this is effective only for vibration that occurs when the motor is stopped.

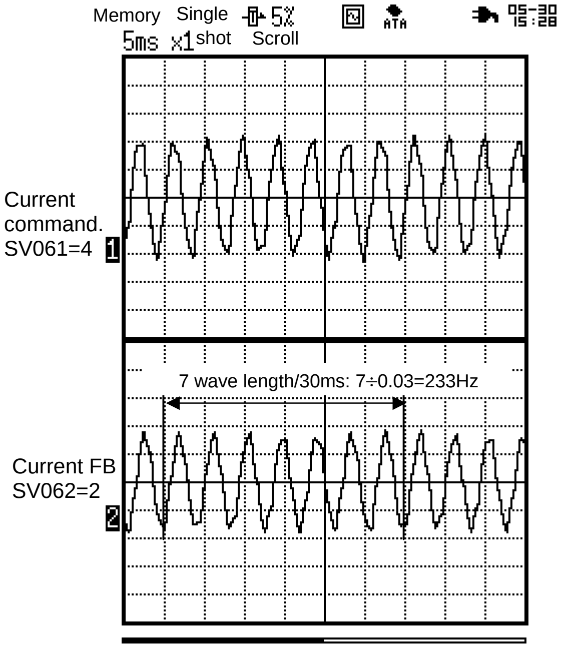
(3) Measuring the resonance frequency

The resonance frequency must be measured before setting the notch filter frequency. To measure, gradually increase the speed loop gain to generate vibration, and measure the current waveform with a Hi-corder.

It can be measured either the current command or the current feedback; the measured frequency will be the same. The scale setting (SV063, SV064) should be set higher than the standard level so that even minute vibrations can be measured.

Once the resonance frequency has been measured, immediately apply emergency stop and stop the vibration.

To calculate the vibration frequency, select an easy-to-view range in the Hi-corder grid, and calculate the number of waves generated in one second.



Measuring vibration frequency (233Hz)
(Measure manually when vibration occurs.)

POINT If a "squeak" is heard at the instant when acceleration/deceleration is started, the machine is vibrating at a high frequency exceeding 700Hz. The 750Hz or 1125Hz filter is effective in this case.

⚠ **CAUTION** When generating resonance, make sure that the speed loop gain is not increased too far resulting in a large vibration. After measuring the resonance frequency, immediately apply emergency stop to stop the vibration. The machine or servo amplifier could fail if vibration is generated for a long time.

(4) Setting the notch filter frequency

After measuring the resonance frequency, refer to the "Setting frequency and standard filter depth for notch filter 1 and 2". Select the setting frequency larger than but closest to the resonance frequency, and set the parameter. Set the depth compensation parameter to the standard filter that matches the frequency.

In the example measured on the previous page, the measured resonance frequency is 233Hz. Thus, set the following:

Filter setting frequency = 250Hz, Filter depth = 4

POINT The notch filter easily becomes unstable when a low frequency is set. Even when set, if the resonance frequency changes (the vibration tone changes), the resonance may not be completely removed. If the state is unstable, try using a higher frequency.
Basically, all resonance can be removed by setting the notch filter. The MDS-C1/CH-Vx series has the following functions in addition to the notch filter. Use those as necessary.

Basically, all resonance can be removed with the notch filter settings. The MDS-B-SVJ2 has the following functions in addition to the notch filter and adaptive filter. Use those as necessary.

(5) Adjusting jitter compensation

Jitter compensation is effective to eliminate the vibration occurring when the axis motor whose backlash is comparatively large or whose liner movement object is heavy stops. Set (SV027.bit4, 5) from 1 pulse by turn and confirm how it works.

Jitter compensation is effective only in case that the vibration is occurred because of the backlash, thus, it does not work when the vibration is caused by other factors. (Even when set, only the vibration tone changes.) If the jitter compensation is not effective, remove the vibration with the notch filter.

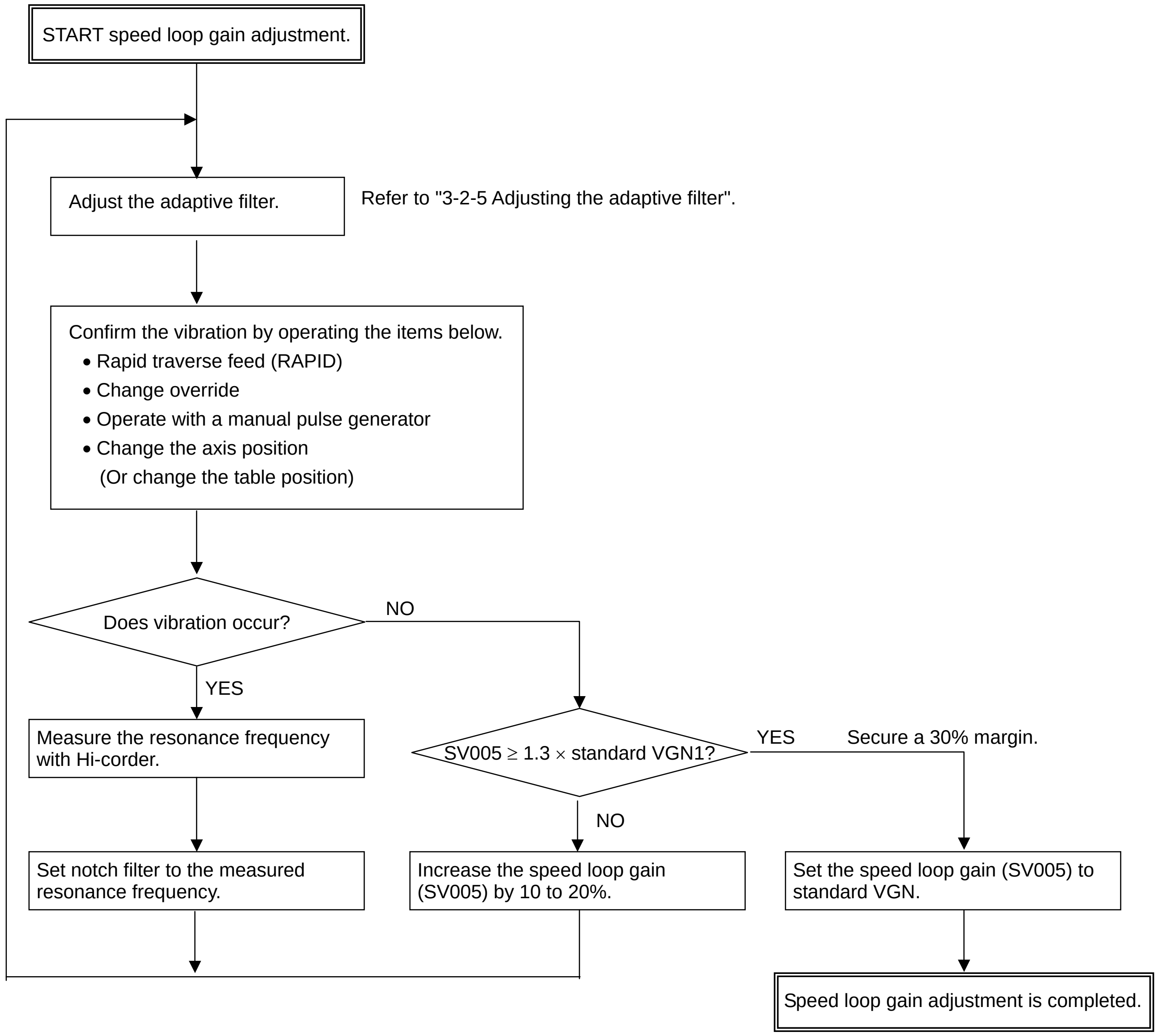
Parameter settings related to resonance removing filter

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Unit</th><th>Explanation</th><th>Normal setting range</th></tr>
<tr><td>SV038</td><td>FHz</td><td>Notch filter frequency 1</td><td>Hz</td><td>Set the resonance frequency to be suppressed. (Valid at 72 or more). Set “0” when the filter is not used.</td><td>150 to 1125</td></tr>
<tr><td>SV027</td><td>SSF1</td><td>Servo function selection 1</td><td colspan="3">
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>aflt</td><td>zrn2</td><td></td><td></td><td colspan="2">ovs</td><td colspan="2">lmc</td><td></td><td></td><td colspan="2">vfct</td><td></td><td></td><td></td><td>zup</td></tr>
</table>
<Start jitter compensation> Eliminate the vibration when a motor is stopping.
<table>
<tr><th colspan="2">bit</th><th>No jitter compensation</th><th>Compensation pulse 1</th><th>Compensation pulse 2</th><th>Compensation pulse 3</th></tr>
<tr><td>4</td><td rowspan="2">vfct</td><td>0</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>5</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
</table>
<Start adaptive compensation>
<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set</th><th>Meaning when “1” is set</th></tr>
<tr><td>F</td><td>aflt</td><td>Stop adaptive stop.</td><td>Stop adaptive start.</td></tr>
</table>
</td></tr>
<tr><td>SV033</td><td>SSF2</td><td>Servo function selection 2</td><td colspan="3">
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="4">afs</td><td></td><td></td><td colspan="2">fhz2</td><td colspan="4">nfd</td></tr>
</table>
<Notch filter 1 depth compensation>
<table>
<tr><th colspan="2">bit</th><th>Explanation</th></tr>
<tr><td>0
to
3</td><td>nfd</td><td>The more the setting value is raised, the shallower the filter becomes.
When “0” is set, the filter is set the shallowest.
When setting the filter shallower, the vibration is not suppressed well, however, the control is stabilized and the vibration caused by other factor except for the filter frequency can be prevented.</td></tr>
</table>
<Set the frequency of notch filter 2>
<table>
<tr><th colspan="2">bit</th><th>No filter</th><th>2250Hz</th><th>1125Hz</th><th>750Hz</th></tr>
<tr><td>4</td><td rowspan="2">fhz2</td><td>0</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>5</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
</table>
(Note) Notch filter 2 does not have depth compensation function.
<Compensate the adaptive filter sensitiveness>
<table>
<tr><th colspan="2">bit</th><th>Explanation</th></tr>
<tr><td>8
to
B</td><td>afs</td><td>When “0” is set, the sensitivity is set to the standard.
The more the setting value is raised, the more the sensitivity to detect the vibration element is raised.</td></tr>
</table>
</td></tr>
</table>

3-2-7 Adjusting the speed loop gain

After adjusting the adaptive filter, further raise the speed loop gain (SV005). When the machine starts resonating, set the notch filter to remove the resonance, and adjust the speed loop gain targeting the standard VGN determined from the load inertia. A 30% margin must be secured to ultimately set the standard VGN value, so set a standard VGN x 1.3 value and confirm that resonance does not occur.

If the resonance cannot be eliminated even when the notch filter is set, the speed loop gain setting is limited. Set a value 30% lower than the maximum value at which resonance does not occur.



POINT Set so that the adaptive filter's operation frequency and notch filter's set frequency are not overlapped.

CAUTION Do not set the notch filters to the frequency that vibration does not occur as a means of insurance. Setting many notch filters is not a complete safety measure.

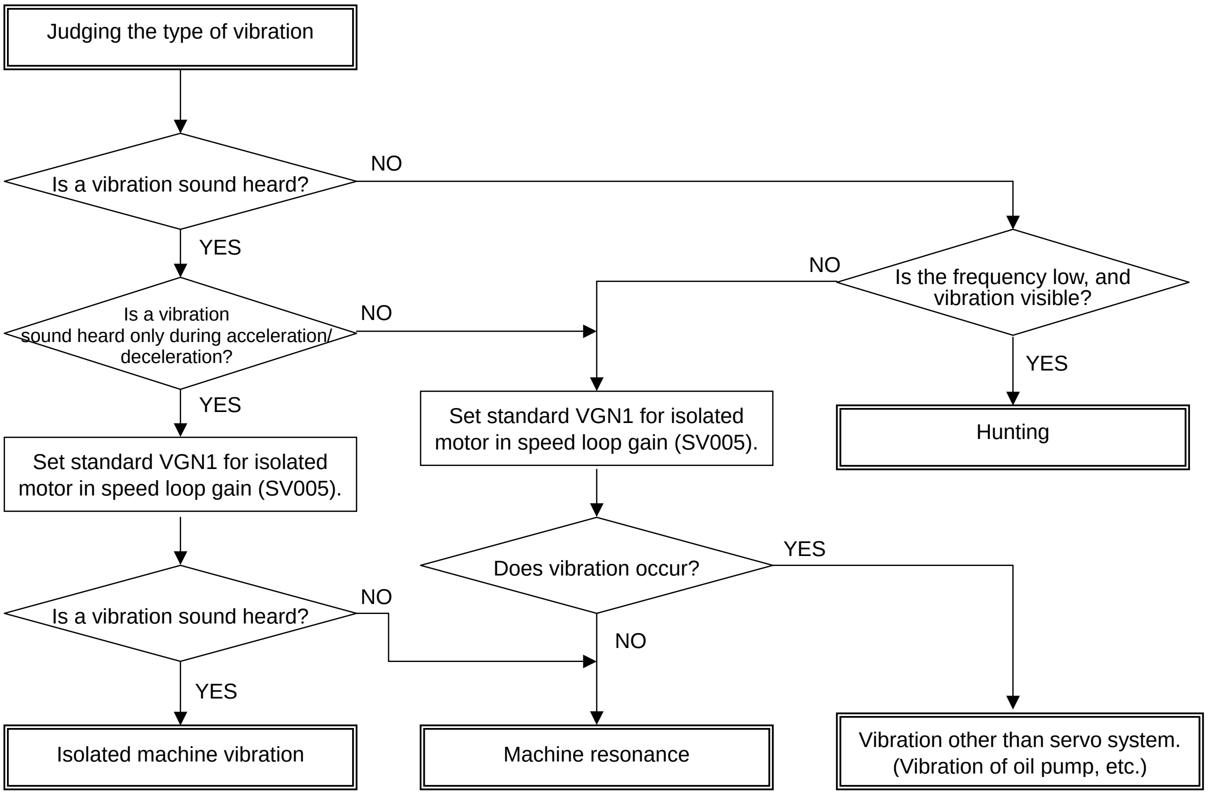
POINT

1. The final SV005 (VGN1) setting value is 70% of the maximum value at which machine resonance does not occur. If the resonance is suppressed and the SV005 setting is increased by using a vibration suppression function, such as a notch filter, the servo can be adjusted easier later on.
2. If the vibration is caused by resonance (mutual action of servo control and machine characteristics), the vibration can always be stopped by lowering SV005 (VGN1). If the vibration does not change even when SV005 is lowered, there may be a problem in the machine. The notch filter is not effective when there is a problem in the machine.

<<Reference material>>

Machine resonance is not the only vibration that occurs at the servo shaft. Types of vibration that occur at the servo shaft are listed below.

Types of vibration	Cause	Vibration frequency	Measures	Explanation
Machine resonance	Delay in servo control response	150Hz to 1kHz	• Set the notch filter • Lower VGN1 (SV005)	There may be several resonance points. The vibration can always be stopped by lowering VGN1.
Hunting	The speed loop PI gain (VGN, VIA) is unbalanced	Several Hz	• Lower VIA (SV008) • Raise VGN1 (SV005) • Use the disturbance observer	Visually apparent that the shaft vibrates during acceleration, or the shaft trembles when stopped.
Isolated machine vibration	Insufficient machine rigidity	10 to 20Hz	• Lower PGN1 (SV003) • Use S-pattern (soft) acceleration/deceleration	The machine vibrates due to impact during acceleration/deceleration. A "clonk" sound may be heard during acceleration.



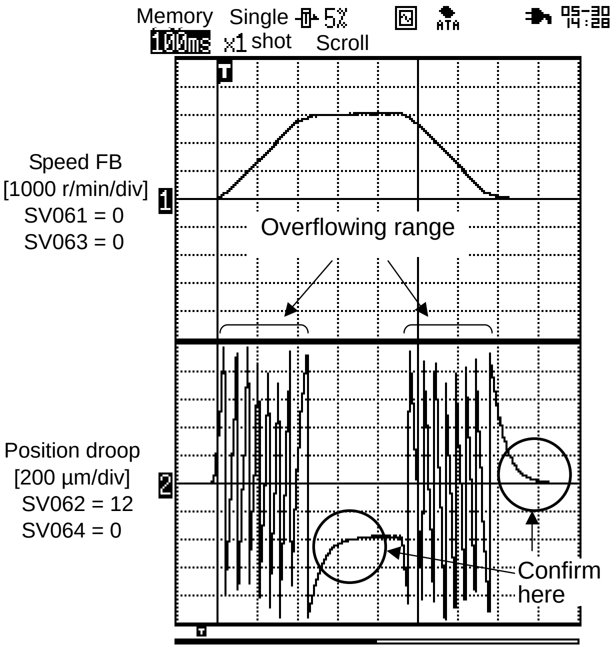
3-2-8 Adjusting the position droop waveform

After adjusting the filter and determining the optimal speed loop gain (VGN1), adjust the speed loop leading compensation (VIA) and position loop gain (PGN) observing the position droop waveform.

(1) Measuring the position droop

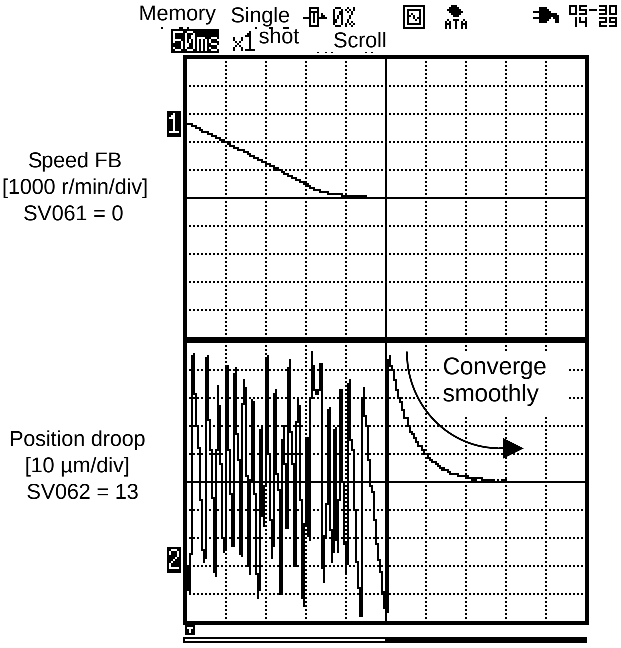
During rapid traverse feed, position droop takes a few millimeters. However, the unit of the waveform to be observed is µm and the overflowing waveform is displayed on the Hi-coder. Before adjusting, make the waveform as shown the right display on the Hi-coder.

Smooth convergence is the most important thing about position droop waveform. The position droop have to converge smoothly when the speed becomes constant or when positioning is completed and position droop becomes "0". Both of the waveforms enclosed with circles can be used for gain adjustment, however, the waveform at when positioning is completed is normally used because it enables to confirm the overshooting at the same time when adjusting servo.



Position droop waveform

When the axis is used for a simple positioning as well as magazine or tool changer, all we have to confirm is the data number 12 (100µm/V). However, it is necessary to confirm that the waveform of the positioning converges smoothly (approaches to "0") at the data number 13 (10µm/V) in the feed axis of machine tools which requires precision.



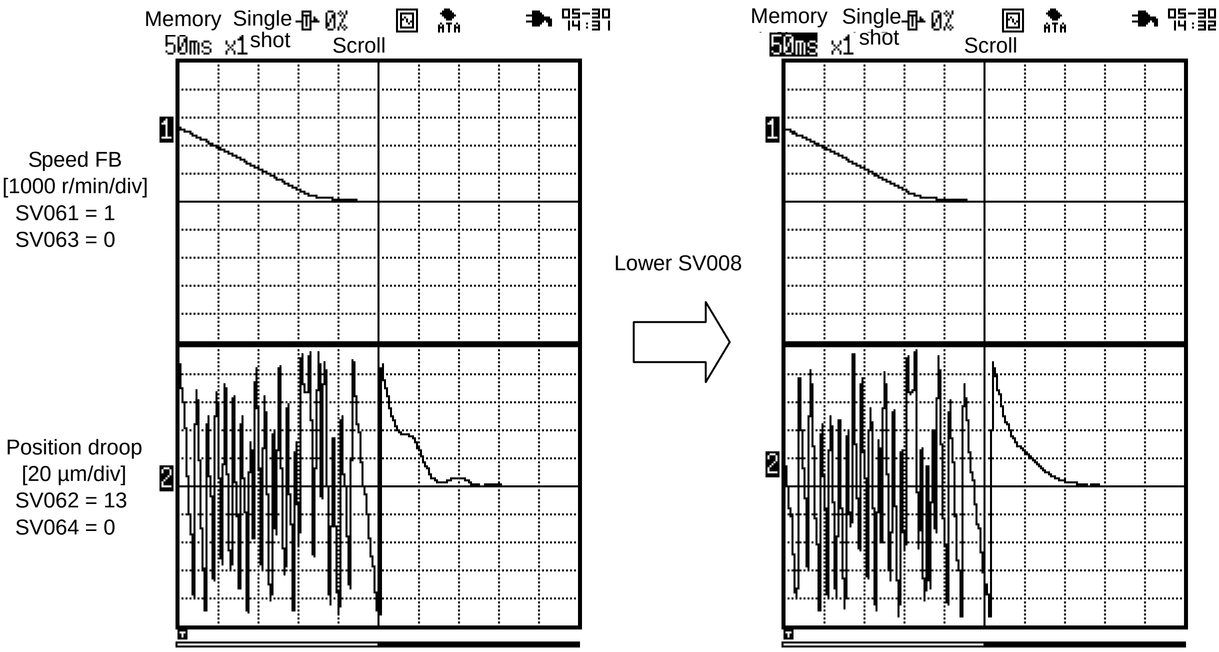
Confirm the waveform
when positioning is completed

(2) Adjusting speed loop leading compensation

There may be no problem when used at a normal load inertia scale. However, if used at a load inertia scale exceeding 500% with an insufficient speed loop gain (SV005) set, the position droop waveform may vibrate just before the motor stops. If the speed loop gain is small, and the shaft has relatively low wear, the motor may repeatedly reciprocate around the stop position resulting in hunting.

If vibration of the position droop is not improved much even when the position loop gain (SV003) is lowered, the leading compensation (SV008) value set for the proportional gain (SV005) is too large, so lower SV008 by approx. 100.

No.	Abbrev.	Parameter name	Explanation	Normal setting range
SV008	VIA	Speed loop leading compensation	1364 is set as a standard. 1900 is set as a standard during SHG control. Adjust in increments of approx. 100.	700 to 2500



Insufficient speed loop gain

After adjusting speed loop leading compensation (SV008)

POINT

1. The vibration can be eliminated by lowering VIA (SV008); however, VIA is only effective for balancing with proportion gain (VGN1) in this case. As long as SV005 (VGN1) is set lower than the standard value, high–accuracy control cannot be expected.
2. Disturbance observer can also suppress the vibration. (Refer to “3-5-2 Disturbance observer.”)

(3) Adjusting position loop gain

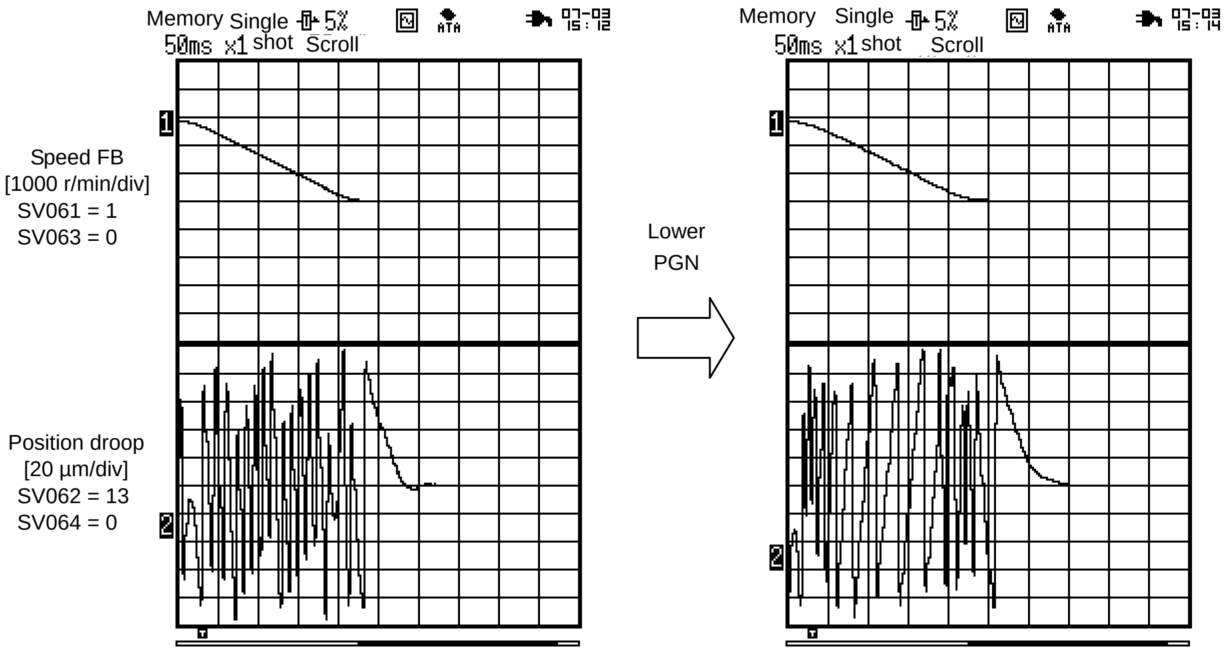
When raising the position loop gain, the responsiveness of the position and cutting accuracy is improved. Setting time is shortened and the cycle time can also be reduced. However, be aware of the limit value determined by the speed loop characteristics and machine characteristics.

The same position gain has to be set in both interpolation axes (the axes to perform synchronous control with). Set the position loop gain of the all axes to the lowest limit value of all.

No.	Abbrev.	Parameter name	Explanation	Normal setting range
SV003	PGN1	Position loop gain 1	Set 33 as a standard. Adjust in increments of approx. 3. If PGN is increased, cutting precision will be improved and the setting time will be shortened.	12 to 47

Limit of the position loop gain

Limit of PGN	Phenomenon	Cause	Remedy
Limit of speed loop characteristics	Position droop waveform vibrates during positioning. Overshooting occurs during positioning.	Insufficient speed loop gain (VGN1)	Suppress the resonance more and raise VGN. Use disturbance observer.
Limit of machine characteristics	Machine vibrates or makes strange noise during acceleration/deceleration. When feeding with the maximum scale by a pulse generator, machine vibrates or makes strange noise.	Insufficient machine rigidity	Use SHG control function. Use S-pattern acceleration/deceleration function when vibration occurs in rapid traverse feed. (NC function)



PGN is too high (33SHG)

After adjusting PGN (23SHG)

⚠ CAUTION

Set the same position loop gain (PGN) to all the interpolation axes.
(For the PGN of X, Y, Z axes, set the smallest value of the three to all of X, Y, Z axis.)

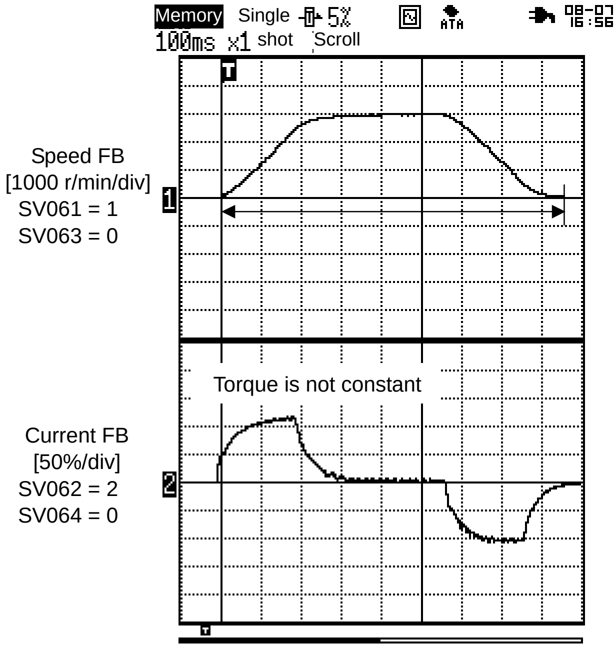
(4) SHG (Smooth High Gain) control

A high-response control and smooth control (reduced impact on machine) were conventionally conflicting elements; however, SHG control enables the two elements to function simultaneously by controlling the motor torque (current GB) with an ideal waveform during acceleration/deceleration.

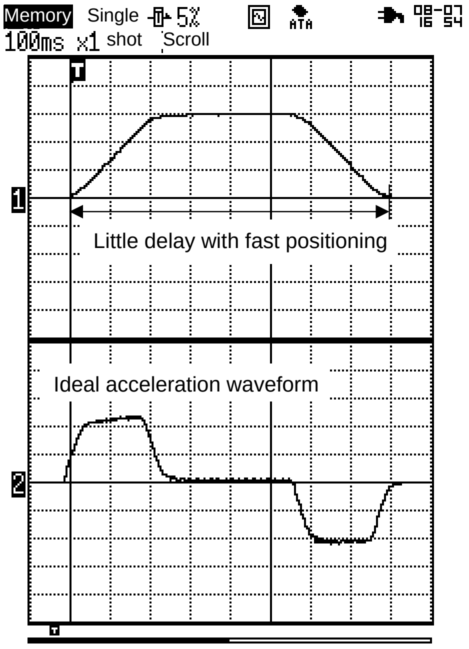
Start the adjustment with PGN1=23 (hereinafter referred to as 23SHG) for the feed axis of a machine tool at first. Try to adjust the SHG value so that it become as close to 33SHG as possible. If more than 33SHG can be set, this machine tool is a precision machine. If more than 23SHG can be set, the machine tool precision is good enough. SHG control function is efficient for feed axes of machine tools (X axis, Y axis or Z axis of the machining center etc.) to meet the demand of high-speed and high–accuracy cutting.

When changing normal control to SHG control, start adjusting, by setting PGN1 to “1/2”. SHG control is as effective as when PGN1 is doubled. SHG control also can shorten the cycle time as it reduces the setting time.

No.	Abbrev.	Parameter name	Setting ratio	Setting example									Normal setting range
SV003	PGN1	Position loop gain 1	1	12	15	18	21	23	26	33	38	47	12 to 47
SV004	PGN2	Position loop gain 2	$\frac{8}{3}$	32	40	48	56	62	70	86	102	125	32 to 125
SV057	SHGC	SHG control gain	6	72	90	108	126	140	160	187	225	281	72 to 281
SV008	VIA	Speed loop leading compensation	Set 1900 as a standard for SHG control.										700 to 2500
SV015	FFC	Acceleration feed forward gain	Set 100 as a standard for SHG control.										0 to 300



Normal control (PGN=26)



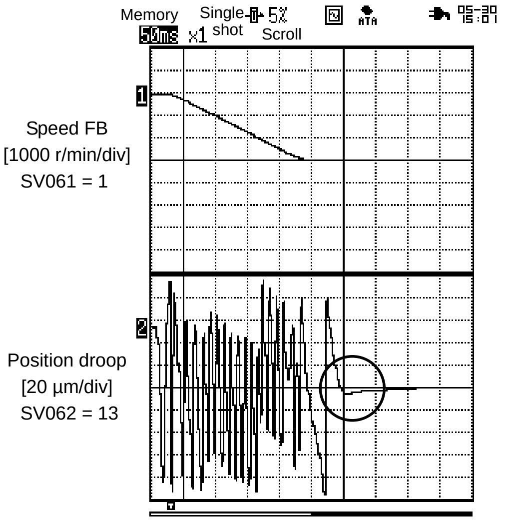
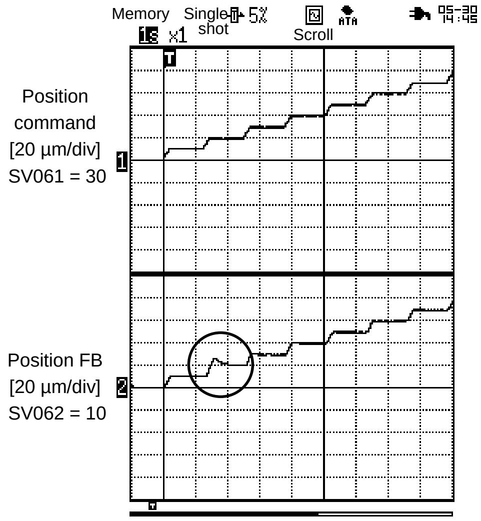
SHG control (PGN = 26SHG)

CAUTION The SHG control is an optional function. Confirm if the option is set in the NC with a System Specification Order List.

(5) Confirming overshooting

Adjust to make overshooting amount become less than 1 μm.

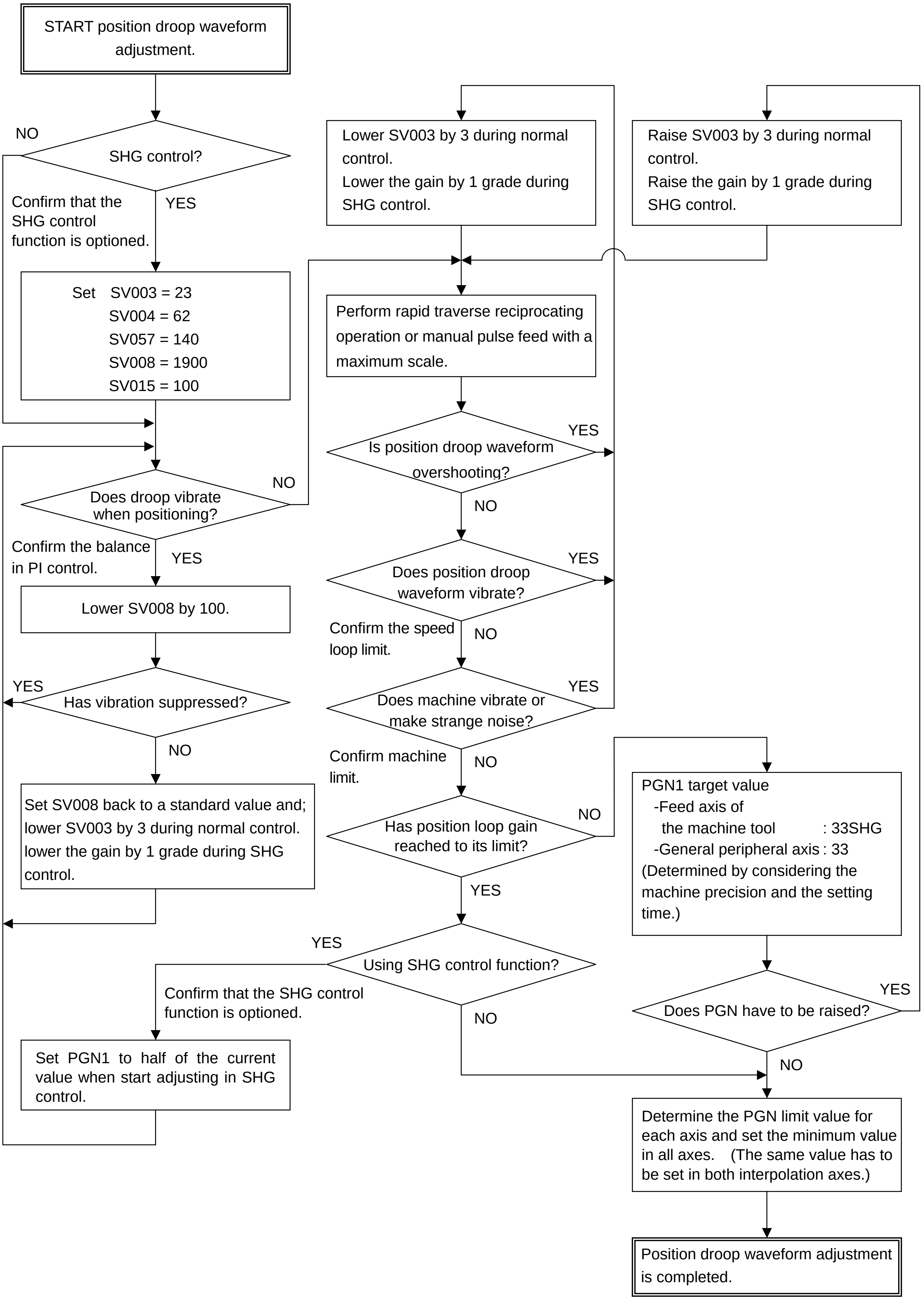
Cause and remedy of overshooting

	During rapid traverse feed	During pulse feed
Waveforms		
Cause	-Position loop gain is too high. -Acceleration feed forward gain (SV015) is too high. -Torsion of the machine system is too large. If a machine has a torsion factor, overshooting is easily caused as the axis is pushed to a stop when positioning.	-Position loop gain is too high. -Friction of the machine system is too large. If the machine static friction is too large, overshooting is easily caused as a large torque is maintained when the machine starts operation. -If the general motion of the machine is unstable, possibly caused by the machine-side problem.
Remedy	-Lower the position loop gain -When acceleration feed forward gain (SV015) is set to more than "100", lower it. -If nothing has improved after lowering gain parameter, use overshooting compensation as the cause seems to be on machine side. Overshooting can be resolved by 1% to 3% of compensation. (Refer to "3-5-3 Overshooting compensation" in this manual)	

POINT

If more than "100" is set in acceleration feed forward gain (SV015) during SHG control, overshooting will be caused easily.

(6) Adjusting the position droop waveform



3-3 Adjusting Acceleration/Deceleration Time Constant

3-3-1 Rapid traverse feed (G0 feed)

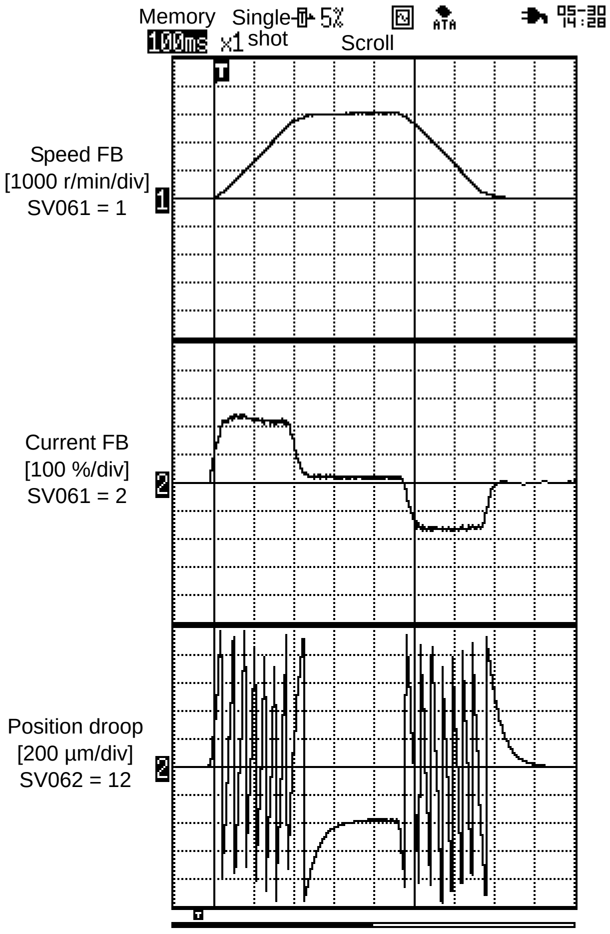
For rapid traverse feed, linear acceleration /deceleration function is normally used. Occasionally, S-pattern (soft) acceleration /deceleration function is used to ease the collision against machines.

(1) Confirm that the rapid traverse rate ≤ max. rotation speed

Fist of all, confirm that the rapid traverse rate is less than the maximum rotation speed of the servomotor. Although the maximum rotation speed is faster than the rated rotation speed in general-purpose motor, try not to exceed the rated rotation speed. If the maximum rotation speed exceeds the rated rotation speed when accelerating, the output torque will be limited.

(2) Adjust acceleration/deceleration time constant by the maximum current command value

Perform the rapid traverse reciprocating operation confirming in NC servo monitor screen and adjust acceleration/deceleration time constant so that the maximum current command value during acceleration/deceleration becomes less than the range of the table shown below.
(Acceleration/deceleration time constant is not judged by current FB but by current command.)



Waveforms during rapid traverse feed

(3) Confirm the rapid traverse feed

Confirm that; 1) the machine does not vibrate or make strange noise.
2) the waveforms during acceleration/ deceleration are not disturbed when observing current FB waveform and position droop waveform.
3) the friction torque is normal.
4) confirm 1) to 3) by changing override.

Max. current command value when adjusting acceleration/deceleration time constant (MDS-B-SVJ2)

Motor type	Max. current command value	Motor type	Max. current command value	Motor type	Max. current command value
HC52	Within 390%			HA40N	Within 420%
HC102	Within 340%	HA102*	Within 270%	HA80N	Within 370%
HC152	Within 380%	HA152*	Within 270%	HA100N	Within 270%
HC202	Within 275%	HA202*	Within 270%	HA200N*	Within 270%
HC352*	Within 270%			HA053N/13N	Within 240%
HC53	Within 265%	HA103R	Within 225%	HA23N/33N	Within 235%
HC103	Within 260%	HA153R	Within 225%	HA43N	Within 300%
HC153	Within 265%	HA203R	Within 225%	HA83N	Within 280%
HC203*	Within 270%			HA103N*	Within 270%

(Note 1) The asterisk "*" after the motor model refers to the combination with a one capacity smaller servo amplifier.
(Note 2) Refer to the instruction manual “5-3-1 (1) Adjusting the rapid traverse feed” for other motors.

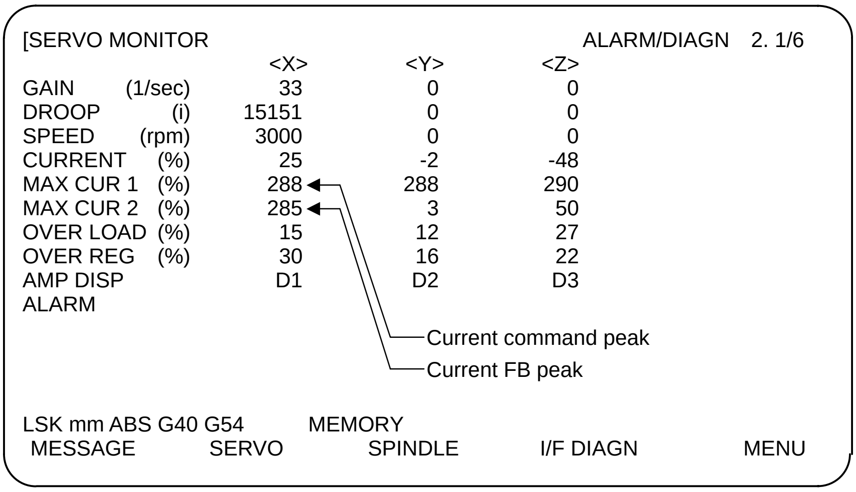
(4) Confirm the current command and the current FB

If the current FB peak becomes larger than the current command peak (over compensation), an overcurrent (alarm 3A) will occur easily. In this case, lower the inductive voltage compensation gain. If the load inertia is large, an adjustment is definitely required.

<How to adjust>

1) Set “1” in SV034.mon and make current command and current FB to NC servo monitor screen.
2) Adjust the inductive voltage compensation gain (SV047) so that the current FB peak becomes smaller than current command peak by 3% during rapid traverse acceleration/deceleration.

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Unit</th><th>Explanation</th><th>Normal setting range</th></tr>
<tr><td>SV047</td><td>EC</td><td>Inductive voltage compensation gain</td><td>%</td><td>Set “100” as a standard. Lower the gain if the current FB peak exceeds the current command peak.</td><td>70 to 100</td></tr>
<tr><td>SV034</td><td>SSF3</td><td>Servo function selection 3</td><td colspan="3">
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>daf2</td><td>daf1</td><td>dac2</td><td>dac1</td><td colspan="4">mon</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>MAX current 1</th><th>MAX current 2</th></tr>
<tr><td rowspan="9">0
to
3</td><td>0</td><td>Max. current command value (%) when power is turned ON.</td><td>Max. current value (%) for 1 second.</td></tr>
<tr><td>1</td><td>Max. current command value (%) for 1 second.</td><td>Max. current command FB value (%) for 1 second.</td></tr>
<tr><td>2</td><td>Max current FB value (%) when power is turned ON.</td><td>Max. current command value (%) for 1 second.</td></tr>
<tr><td>3</td><td>Load inertia rate (SV059 setting value)</td><td>–</td></tr>
<tr><td>4</td><td>Adaptive filter operation frequency (Hz)</td><td>Adaptive filter operation gain (%)</td></tr>
<tr><td>5</td><td>PN bus voltage (V)</td><td>Regenerative operation frequency monitor (times/sec)</td></tr>
<tr><td>6</td><td>Maximum estimated torque (%) for 1 second</td><td>Max. current FB value (%) for 1 second</td></tr>
<tr><td>7</td><td>Maximum estimated torque (%) for 1 second</td><td>Max. disturbance torque (%) for 2 seconds (%)</td></tr>
<tr><td>8toF</td><td colspan="2">Setting prohibited.</td></tr>
</table>
</td></tr>
</table>



```
[SERVO MONITOR                                    ALARM/DIAGN   2. 1/6
                       <X>          <Y>          <Z>
GAIN      (1/sec)       33            0            0
DROOP         (i)    15151            0            0
SPEED       (rpm)     3000            0            0
CURRENT       (%)       25           -2          -48
MAX CUR 1     (%)      288          288          290
MAX CUR 2     (%)      285            3           50
OVER LOAD     (%)       15           12           27
OVER REG      (%)       30           16           22
AMP DISP                D1           D2           D3
ALARM

LSK mm ABS G40 G54       MEMORY
 MESSAGE        SERVO         SPINDLE        I/F DIAGN        MENU
```

Current command peak

Current FB peak

Screen of M64S when current FB peak of X axis is set to be displayed

3-3-2 Cutting feed (G1)

For cutting feed, exponent acceleration/deceleration function is normally used. S-pattern acceleration / deceleration cannot be used as it disables synchronous interpolation.

(1) Reciprocating operation without dwell

During cutting feed, no confirmation of in-position is made before going on to the next step. Adjust acceleration/deceleration time constant during acceleration/deceleration by performing reciprocating operation without dwell. Set the feedrate at the maximum (with “clamp”: axis specification parameter) and confirm the maximum current command during the turn without dwell.

(Cutting feed reciprocating operation Sample program)

```
G28 X0;                       X axis zero return
N01 G90 G1 X-200. F8000;      Move X axis to X=-200 with F5000 cutting feed by absolute position command.
G1 X0;               ↑        Turn without dwell and move to X=0 with F5000 cutting feed.
G4 X1.0;                      Dwell for a second. (Pause for a second).  Use “X” even for Y axis and Z axis.
GOTO 01         Max. cutting  Go back to the line N01
                feedrate
```

(2) Adjust acceleration/deceleration time constant by max. current command value

Confirm the maximum current command value in the servo monitor and adjust acceleration/deceleration time constant so that the maximum current command value becomes less than the range of the table shown in the chapter “3-3-1 Rapid traverse feed (G0 feed) ”.

(3) Set all the interpolation axes to the same value as the axis with the longest time constant

For example, set the same value for the cutting feed time constant of X axis, Y axis and Z axis in machining center because interpolation control is required.

(4) Confirm the cutting feed

Confirm:
1) if the machine does not vibrate or make strange noise.
2) if the waveforms during acceleration/deceleration are not disturbed when observing current FB waveform and position droop waveform.
3) 1) and 2) with the override changing.

POINT

Perform reciprocating operation without dwell when adjusting cutting feed (G1) time constant.

⚠ CAUTION

1. Set the same value for both the cutting feed time constant and the position loop gain (PGN) between the interpolation axes.
2. With the vertical axis, start with an upward direction from a stop in a downward position without using dwell, and check the current command.

3-4 Initial Adjustment for the Servo Functions

3-4-1 Standard settings for the lost motion compensation

(1) Unbalance torque and frictional torque

As for the initial adjustment of lost motion compensation, set the standard compensation amount. Measure the unbalance torque and the frictional torque to calculate the standard compensation amount. During a stop, the static frictional torque may effect. Feed slowly by about F1000, measure the load current in the servo monitor screen of NC and calculate by the following expression.

$$\text{Unbalance torque} = \frac{(+\text{ Feed load current\%}) + (-\text{ Feed load current\%})}{2}$$

$$\text{Frictional torque} = \left| \frac{(+\text{ Feed load current\%}) - (-\text{ Feed load current\%})}{2} \right|$$

Unbalance torque and frictional torque

	Horizontal axis	Unbalance axis
In machine tools	Lathe: Z axis Vertical machining center: X axis, Y axis Horizontal machining center: X axis, Z axis etc.	Lathe: X axis Vertical machining center: Z axis Horizontal machining center: Y axis etc.
Unbalance torque	0	The average of the load torque when feeding to both + and – direction by about F1000.
Frictional torque	The load torque when feeding by about F1000.	The difference between load torque and unbalance torque when feeding by about F1000.

(2) Setting the standard compensation amount

As for lost motion compensation type, use type 2 (SV027.bit9). Set the unbalance torque in SV032 and set the doubled frictional torque in SV016 as a standard compensation amount. (Set SV041 to “0”.) To adjust the compensation amount more accurately, determine the value to be set in SV016 and SV041 by measuring the roundness.

How to set the standard lost motion compensation amount

Setting item	Parameter setting
(1) Start lost motion compensation type 2	SV027.bit9=1 (SV027.bit8=0)
(2) Unbalance torque setting	SV032 = unbalance torque [%]
(3) Lost motion compensation standard amount	SV016 = 2 x frictional torque [%] (SV041=0)

⚠ **CAUTION**

When using the disturbance observer, further adjustment by roundness measurement is required because the lost motion compensation amount (SV016) calculated as mentioned above will become over compensation.

(Example)

In case that the load current% is -25% in + direction and -65% in – direction when performing JOG feed by about F1000,

$$\text{Unbalance torque} = \frac{-25+(-65)}{2} = -45\% \qquad \text{Frictional torque} = \left|\frac{-25-(-65)}{2}\right| = 20\%$$

Therefore, set SV032 = -45, SV016 = 40.

<table>
<tr><th>No.</th><th>Abbrev</th><th>Parameter name</th><th>Explanation</th></tr>
<tr><td>SV027</td><td>SSF1</td><td>Servo function selection1</td><td>Normally type2 is used for the lost motion compensation.
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>aflt</td><td>zrn2</td><td></td><td></td><td colspan="2">ovs</td><td colspan="2">lmc</td><td></td><td></td><td colspan="2">vfct</td><td></td><td></td><td></td><td>zup</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th colspan="2">Explanation</th></tr>
<tr><td>8</td><td rowspan="2">lmc</td><td>00: lost motion compensation stop</td><td>10: lost motion compensation type2</td></tr>
<tr><td>9</td><td>01: lost motion compensation type1</td><td>11: Setting prohibited</td></tr>
</table>
</td></tr>
</table>

No.	Abbrev.	Parameter name	Unit	Explanation	Normal setting range
SV032	TOF	Torque offset	Stall% (rated current %)	Set the unbalance torque amount.	-60 to 60
SV016	LMC1	Lost motion compensation 1	Stall% (rated current %)	Set "2 x (frictional torque)" as an initial value. When using disturbance observer, further adjustment by roundness measurement is required.	0 to 60
SV041	LMC2	Lost motion compensation 2	Stall% (rated current %)	Set "0" as a standard (initial adjustment value). When "0" is set, compensate the value set in SV016 in both + and – direction.	0 to 60

3-4-2 Excessive error width detection

In most cases, no problem will occur with the standard setting values.

No.	Abbrev.	Parameter name	Unit	Explanation	Normal setting range
SV023	OD1	Excessive error detection width during servo ON	mm	Calculate as follows by using rapid traverse rate and position loop gain (PGN1). When "0" is set, the excessive error alarm will not be detected. <Standard setting value> $\text{OD1=OD2=} \dfrac{\text{Rapid traverse rate (mm/min)}}{60 \times \text{PGN1}} \div 2 \text{ (mm)}$ (Round fractions off.)	3 to 15
SV026	OD2	Excessive error detection width during servo OFF	mm		

3-4-3 Setting deceleration control time constant

Set the same value as the rapid traverse acceleration/deceleration time constant of each axis. For MDS-B-SVJ2, use the deceleration control as a standard stopping method when emergency stop is inputted.

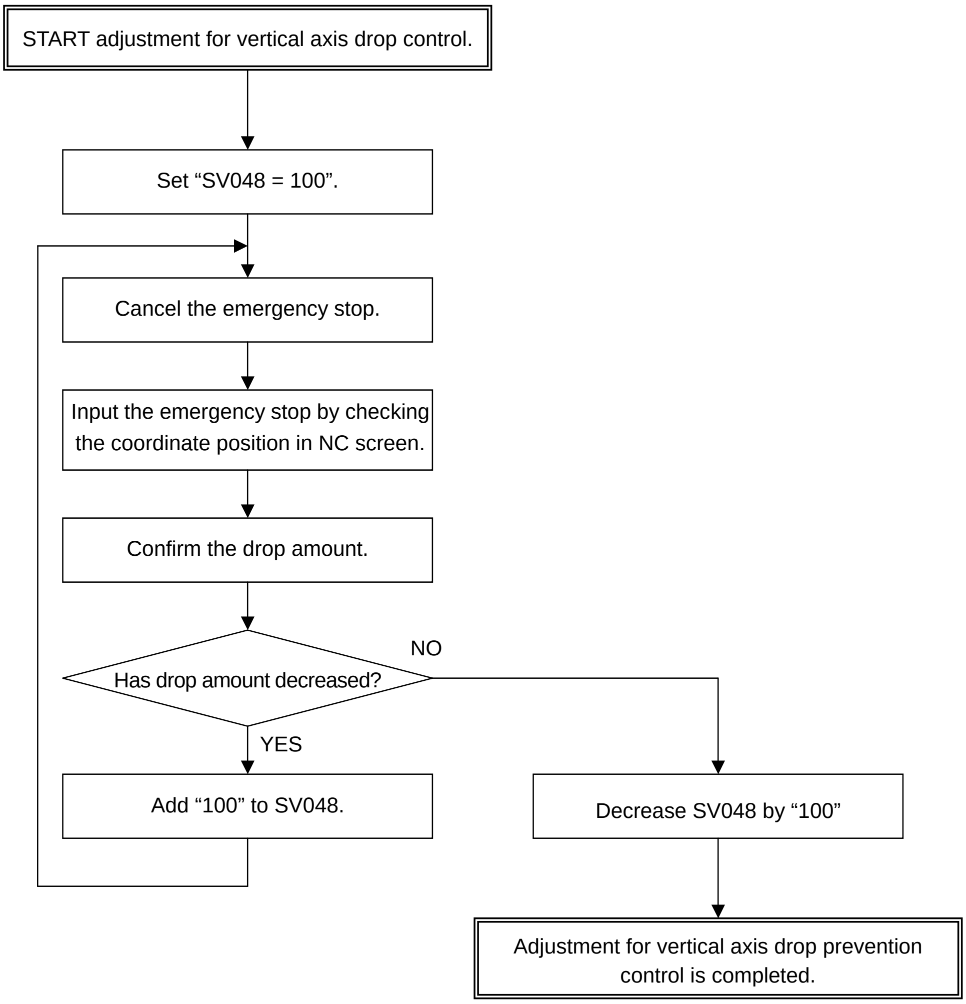
No.	Abbrev.	Parameter name	Unit	Explanation	Normal setting range
SV056	EMGt	Deceleration time constant at emergency stop	ms	Set the same value as the rapid traverse acceleration /deceleration time constant.	0 to 300

⚠ CAUTION

If the deceleration control time constant (EMGt) is set longer than the acceleration/deceleration time constant, the over-travel point (stroke end point) could be exceeded. Note that the axis could collide with the machine end.

3-4-4 Adjustment procedures for vertical axis drop prevention control

Execute the following procedures to the unbalance axis which has a motor brake. Set the shortest required time by confirming the drop amount when the emergency stop is inputted.



No.	Abbrev.	Parameter name	Unit	Explanation	Normal setting range
SV048	EMGrt	Vertical axis drop prevention type	ms	Increase the setting by 100ms at a time and set the value where the axis does not drop.	0 to 300

POINT

1. This control will not function if the dynamic brake stop is selected with the servo specifications (SV017: SPEC).
2. This control will not function if an alarm for which the dynamic brakes are set as the stopping method occurs in an axis where vertical axis drop prevention control is being carried out.
3. To compensate the drop amount by another several µm to several 10µm, use section "3-5-5 Vertical axis pull up control during emergency stop".

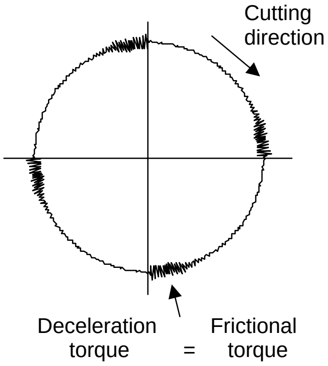
3-5 Procedures for Adjusting Each Functions

3-5-1 Voltage non-sensitive zone (Td) compensation

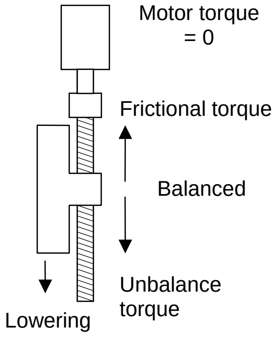
(1) When to use

1) When improving the cutting precision

Voltage non-sensitive zone compensation is effectual when the cutting accuracy is worsened before passing the quadrants during circle cutting or when the cutting accuracy while unbalance axis is lowering is worse than while it is rising. In short, voltage non-sensitive zone compensation improves the control precision when the control speed is slow and the output torque is controlled with nearly “0”.



For circle cutting



For unbalance torque

(2) Precautions

1) Vibration (resonance) easily occurs

Vibration can be inducted as voltage non-sensitive zone compensation can make the same effect as when the current loop gain is raised.

2) The drive sound during the motor rotation becomes noisier

If setting 100% (as a standard), the sound during the motor rotation will be noisier. However, the cutting precision is improved as long as vibration does not occur.

(3) Adjustment procedures

Set the value from 0 to 100% observing the vibration or noise occurrence.

No.	Abbrev.	Parameter name	Unit	Explanation	Normal setting range
SV030	IVC1	Voltage non-sensitive band compensation	%	When 100% is set, the voltage equivalent to the logical non-energized time will be compensated. Adjust in increments of 10% from the default value 100%. If increased too much, vibration or vibration noise may be generated.	0 to 100

3-5-2 Disturbance observer function

(1) When to use

1) When improving cutting precision

Disturbance observer function is efficient to improve the cutting accuracy. For roundness measurement, cutting accuracy can be improved especially at around 45 degrees.

2) When suppressing the vibration of position droop waveform

Disturbance observer function can suppress the vibration of position droop waveform caused by the insufficient speed loop gain (VGN) without lowering the speed loop leading compensation (VIA).

3) When suppressing the collision sound during lost motion compensation

When the lost motion compensation amount is increased, the collision sound is occasionally caused. The compensation amount can be made smaller by using disturbance observer function, and it also suppresses the collision sound.

(2) Other precautions

1) Vibration (resonance) is easily caused

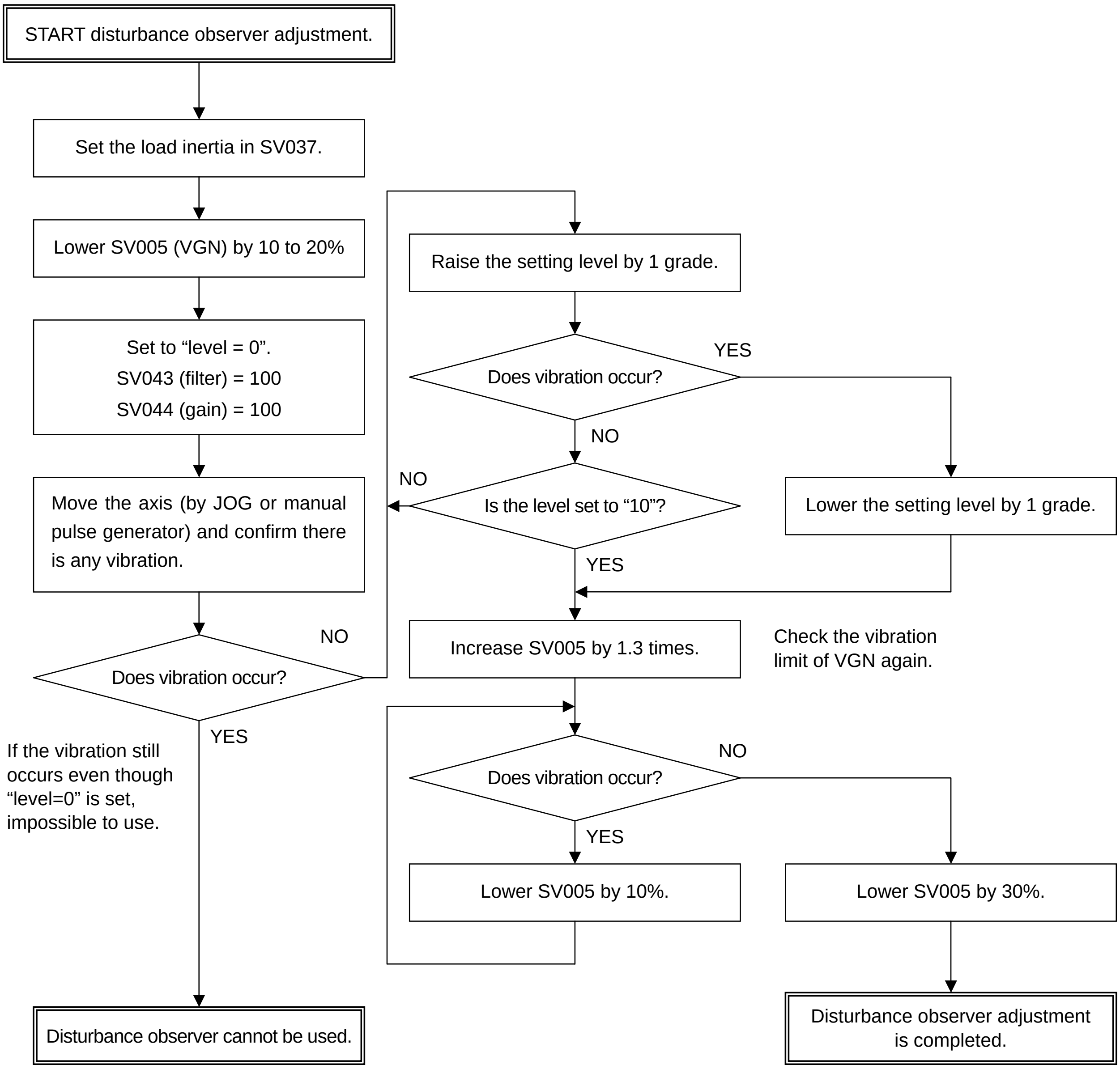
Disturbance observer is hardly used for some machine characteristics.

2) Lost motion compensation has to be adjusted again

When changing observer filter pole (SV043) and gain (SV044), the optimal lost motion amount (SV016, SV041) is also changed.

⚠ **CAUTION**	When starting disturbance observer, lost motion compensation has to be adjusted again.

(3) Procedures for disturbance observer adjustment



No.	Item	Setting level										
		0	1	2	3	4	5	6	7	8	9	10
SV043	Filter frequency	100	200	200	300	300	200	200	300	200	300	300
SV044	Observer gain	100	100	150	100	150	200	250	200	300	250	300

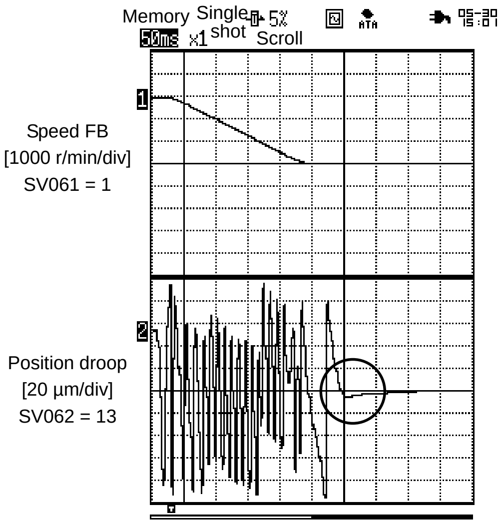
No.	Abbrev.	Parameter name	Unit	Explanation	Normal setting range
SV037	JL	Load inertia scale	%	Set the value calculated in the way explained in “3-2-2 Measuring the inertia rate”.	150 to 600
SV043	OBS1	Disturbance observer filter frequency	rad/s/2π	Set the disturbance observer filter band. Set “300” as a standard. If any vibration occurs, lower by 100 at a time. If the setting value is lowered, the compensation will be less effective.	200 to 300
SV044	OBS2	Disturbance observer gain	%	Set the disturbance observer gain. Set “100” to “300” as a standard, and lower the setting if vibration occurs.	100 to 300

3-5-3 Overshooting compensation

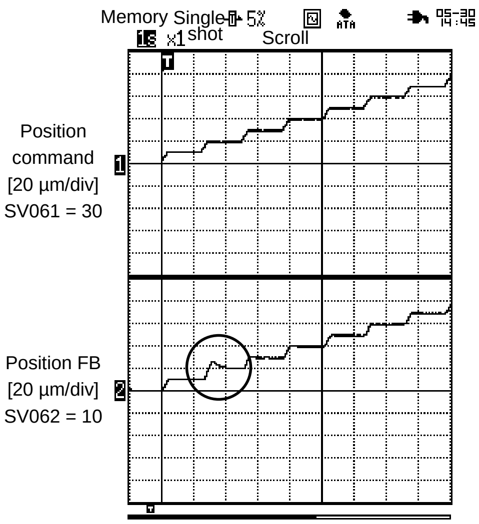
(1) When to use

1) When compensating overshooting

Both overshooting during rapid traverse positioning and during pulse feed can be improved.



Overshooting during rapid traverse positioning



Overshooting during pulse feed

(2) Precautions

1) Do not use overshooting compensation function to solve the problem caused by gain adjustment

Overshooting can occur when position loop gain (SV003) and acceleration feed forward gain (SV015) is too high. Adjust the gain at first whenever overshooting is found. In case that the overshooting cannot be solved by gain adjustment, use overshooting compensation function as it seems to be caused by machine-side factors including torsion and friction. The overshooting can be suppressed with overshooting compensation by 1% to 3%.

2) If the compensation amount is too much, the roundness precision will be deteriorated

When the overshooting compensation amount is too much, the roundness precision is occasionally deteriorated. Be careful when setting the value which is more than 5% in SV031 (compensation amount).

3) The overshooting which is more than 1µm has to be suppressed

Normally the overshooting which is more than 1µm is considered as a problem. If it is less than 1µm is hardly suppressed due to the control resolution.

(3) Details of overshooting compensation method

1) Overshooting compensation type 1

This is compatible with the standard specifications. The offset amount is set based on the motor's stall current. Determine the amount that is free from overshoot by adjusting the compensation gain (SV031, SV042) while increasing its value in increments of 1%. This adjustment is usually made within the range from 1% to 3%.

Compensation will not be performed if the next feed command has been issued before the motor completes positioning (before position droop becomes "0"). Therefore, no compensation will be performed during circle cutting, and this prevents the precision of the roundness from being deteriorated. Also, compensation will not be performed in the high-speed high-accuracy control (the feed forward control) mode.

2) Overshooting compensation type 2 (Equivalent to the type 3 of MDS-C1-Vx)

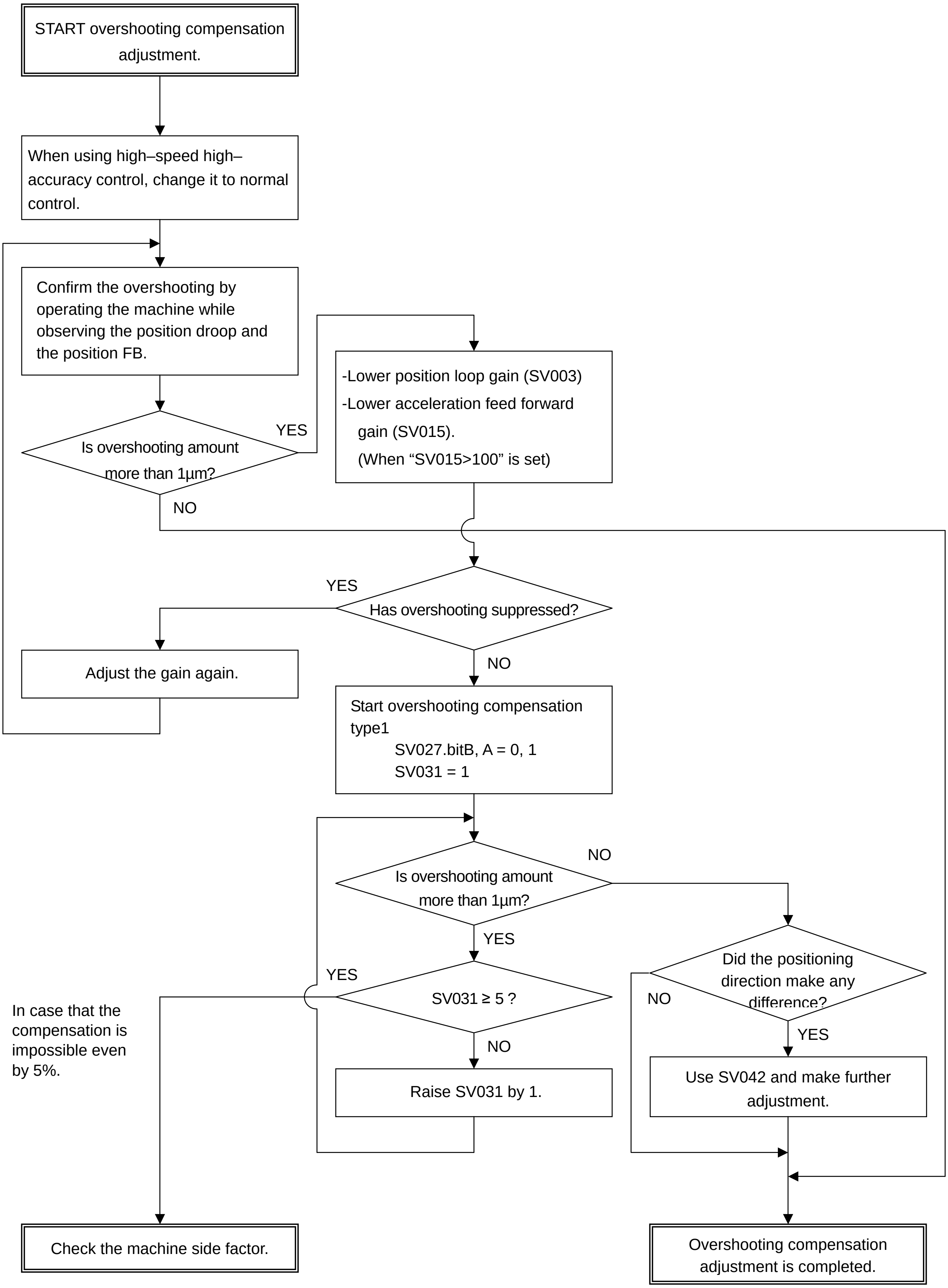
This is used when overshooting compensation is required even during the feed forward control (the high-speed high-accuracy control). During the feed forward control (the high-speed high-accuracy control), an overshoot may be occurred due to inappropriate adjustment of the feed forward gain. So, when adjusting the compensation gain (SV031, SV042), stop the feed forward control, or set "fwd_g" to "0". If overshoot occurs in the feed forward control mode only (no overshoot occurs in the normal control mode), adjust the feed forward gain (fwd_g).

POINT

When using overshooting compensation type 1,

1. Compensation will not be performed if the next feed command has been issued before the motor completes positioning (or stops). (Therefore, no compensation will be performed during circle cutting.)
2. Compensation is not made when performing the feed forward control (the high-speed high-accuracy control).

(4) Procedures for overshooting compensation adjustment



In case that the compensation is impossible even by 5%.

Check a linear guide, oil pressure and ball screw etc.

<table>
<tr><th>No.</th><th>Abbrev</th><th>Parameter name</th><th>Explanation</th></tr>
<tr><td>SV027</td><td>SSF1</td><td>Servo function selection1</td><td>The overshooting compensation starts with the following parameter.
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>aflt</td><td>zm2</td><td></td><td></td><td colspan="2">ovs</td><td colspan="2">lmc</td><td></td><td></td><td colspan="2">vfct</td><td></td><td></td><td></td><td>zup</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Explanation</th></tr>
<tr><td>A
B</td><td>ovs</td><td>00: Overshooting compensation stop
01: Overshoot compensation type 1
10: Overshoot compensation type 2
11: Setting prohibited</td></tr>
</table>
</td></tr>
</table>

No.	Abbrev.	Parameter name	Unit	Explanation	Normal setting range
SV031	OVS1	Overshooting compensation 1	Stall% (rated current%)	Increase the value by 1% at a time and find the value where overshooting dose not occur. When OVS2=0, the setting value will be applied in both the + and – directions.	-1 to 3
SV042	OVS2	Overshooting compensation 2	Stall% (rated current%)	Set “0” as a standard. Set this when the compensation amount is to be changed according to the direction.	-1 to 3

POINT

1. When either parameter SV031:OVS1 or SV042:OVS2 is set to “0”, the same amount of compensation is carried out in both + and – direction, using the setting value of the other parameter (the parameter not set to “0”).
2. To compensate in only one direction, set -1 in the parameter (OVS1 or OVS2) for the direction in which compensation is prohibited.

3-5-4 Collision detection function

(1) When to use

1) To ease an impact when a machine collides

Collision detection function can ease the impact to the machine by detecting the alarm as soon as possible when collision occurs and by causing the pullback torque.

2) To keep the alarm history separating collision alarms from over load alarms

Collision alarms are conventionally detected as over load alarms. Collision detection function enables to keep the collision alarm history with special alarm numbers only for collision alarms.

(2) Precautions

1) Collision detection function does not guarantee the machine precision

Prevent the machine collision when operating a machine as before.

2) Alarm can be detected incorrectly

Collision is detected by detecting the disturbance torque, therefore, frictional torque or cutting torque can be incorrectly taken for a collision depending on condition of the machine or operation.

(3) Details of collision detection method 1

The required torque is estimated by considering the position command issued by the NC. The disturbance torque is calculated by the difference from the actual torque. When this disturbance torque exceeds the collision detection level set by the parameters, a collision is detected.

As soon as a collision is detected, pullback torque is commanded at 80% of the maximum motor torque and the impact is eased. After the motor has stopped, alarm 58 (during G0 command) or 59 (during G1 command) occurs, and the system is stopped.

	Collision detection level setting parameter	Detection alarm
During rapid traverse (during G0 feed)	SV060	Alarm 58
During cutting feed (during G1 feed)	SV060 x clG1 (SV035.bitC to E)	Alarm 59

(4) Details of collision detection method 2

When the current command reaches the motor’s maximum current, collision is detected. As soon as the collision is detected, pullback torque is commanded at 80% of the maximum motor torque. After the motor has stopped, the alarm 5A occurs and the system stops. If the acceleration/deceleration time constant is short, and if detections are easily made incorrectly during normal operation, make the acceleration/deceleration time constant longer and adjust so that the current during acceleration is not saturated (so that the current does not reached the maximum value). Or, turn the parameter SV035.bitF “ON” and ignore the collision detection method 2.

(5) Torque estimated gain (SV059)

With MDS-B-SVJ2, the torque estimated gain (SV059) is the same value as the load inertia scale (SV037). Set the load inertia measured at [3-2-2 Measuring the inertia rate] in SV059.

(6) Collision detection level (SV060)

Collision detection level during G0/G1 feed

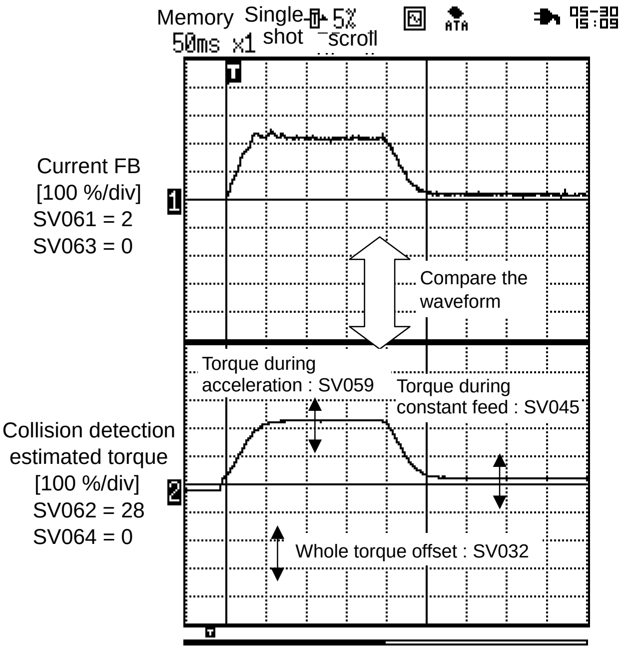
Feed	Detection level setting	How to adjust
G0	SV060	First, set “SV060: TLEV=100”, and carry out no-load operation at the maximum rapid traverse feed rate. If an alarm does not occur, lower the setting by “10”, and if an alarm occurs, raise the setting by “20”. Set the value which is in increment of the limit value at which the alarm does not occur by 1.5 times. If “SV034.bit0 to 3 (mon)=7” is set, the maximum disturbance torque will appear on the NC servo monitor. Refer to this value.
G1	SV060 x clG1 (SV035)	The detection level during G1 feed is set as an inter-fold of the detection level during G0 feed. Calculate the maximum cutting load, and adjust the SV035.bitC to E (clG1) setting value so that the detection level becomes larger than the maximum cutting load.

(7) Confirm the parameter settings

Calculate the estimated torque abstracting acceleration factors from position command to detect the collision. It is required to obtain the following items to detect collision correctly.

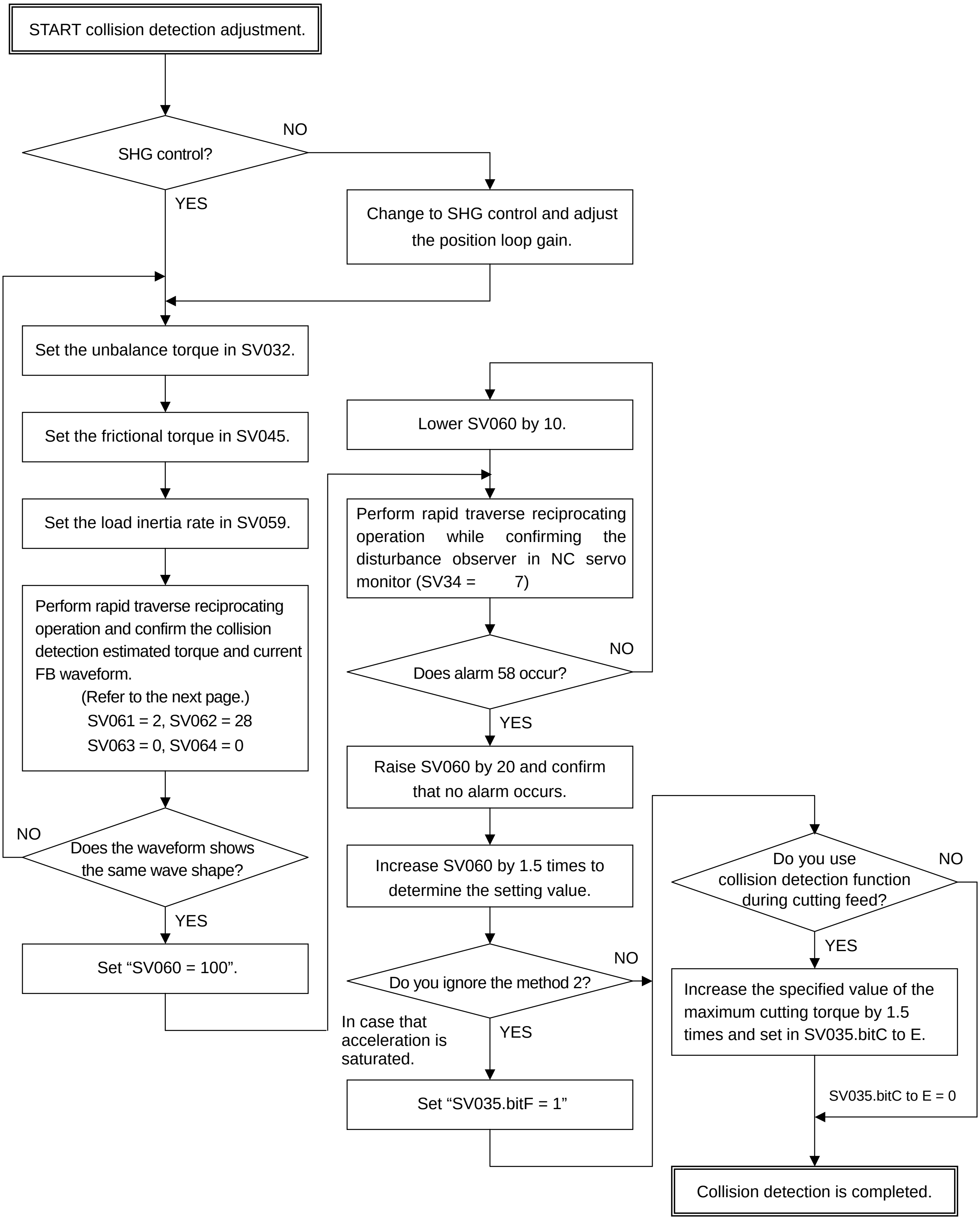
1) Torque estimated gain (SV059)
2) Frictional torque (SV045)
3) Unbalance torque (SV032)

When confirming the setting values of above-mentioned parameters, output current FB and collision detection estimated torque at the same time as shown the right and adjust so that they both forms the same waveform.



How to confirm collision detection parameters

(8) Procedures for detecting collision adjustment



<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th></tr>
<tr><td>SV034</td><td>SSF3</td><td>Servo function selection 3</td><td>The data concerning with the collision detection function is set with following parameters.
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>daf2</td><td>daf1</td><td>dac2</td><td>dac1</td><td colspan="4">mon</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>MAX current 1</th><th>MAX current 2</th></tr>
<tr><td rowspan="9">0
to
3</td><td>0</td><td>Max. current command value (%) when power is turned ON.</td><td>Max. current command value (%) for 1 second.</td></tr>
<tr><td>1</td><td>Max. current command value (%) for 1 second.</td><td>Max. current FB value (%) for 1 second.</td></tr>
<tr><td>2</td><td>Max current FB value (%) when power is turned ON.</td><td>Max. current FB value (%) for 1 second.</td></tr>
<tr><td>3</td><td>Load inertia rate
(SV059 setting value)</td><td>–</td></tr>
<tr><td>4</td><td>Adaptive filter operation frequency (Hz)</td><td>Adaptive filter operation gain (%)</td></tr>
<tr><td>5</td><td>PN bus voltage (V)</td><td>Regenerative operation frequency monitor (times/sec)</td></tr>
<tr><td>6</td><td>Estimated maximum torque (%) for 1 second</td><td>Max. current FB value (%) for 1 second</td></tr>
<tr><td>7</td><td>Estimated maximum torque (%) for 1 second</td><td>Max. disturbance torque for 2 seconds (%)</td></tr>
<tr><td>8toF</td><td colspan="2">Setting prohibited.</td></tr>
</table>
</td></tr>
<tr><td>SV035</td><td>SSF4</td><td>Special servo function selection 4</td><td>The following parameters are used for the collision detection function.
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>cl2n</td><td colspan="3">clG1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set.</th><th>Meaning when “1” is set.</th></tr>
<tr><td>C
to
E</td><td>clG1</td><td colspan="2">Set the collision detection level for the collision detection method 1 cutting (G1) feed.
G1 collision detection level will be SV060 × clG1.
When “clG1 = 0” is set, the collision detection method 1 will not function during cutting feed.</td></tr>
<tr><td>F</td><td>cl2n</td><td>Collision detection method 2 is available.</td><td>Collision detection method 2 is not available.</td></tr>
</table>
</td></tr>
</table>

No.	Abbrev.	Parameter name	Unit	Explanation	Normal setting range
SV032	TOF	Torque offset	Stall% (Rated current %)	Set the unbalance torque amount. The amount is the same as the value set when lost motion compensation was adjusted.	-60 to 60
SV045	TRUB	Frictional torque	Stall% (Rated current%)	Set the frictional torque amount. Refer to “3-4-1 (1) Unbalance torque and frictional torque”.	10 to 30
SV059	TCNV	Collision detection torque estimating gain (load inertia rate)	%	Set the torque estimated gain. In MDS-B-SVJ2, the value is the same as the load inertia rate including the motor inertia (SV037). Refer to [3-2-2 Measuring the inertia rate] of this manual.	150 to 600
SV060	TLMT	Collision detection level	Stall% (Rated current%)	Set the collision detection level of method 1 G0 feed when using the collision detection function. When “0” is set, all collision detection function will not function.	70 to 150

POINT

1. SHG control has to be enabled for using the collision detection function.
2. Set the detection level with an allowance to avoid incorrect detections.
3. When “SV060=0” is set, all collision detection functions will be disabled.
4. Collision detection method 2 is enabled when the value except for “0” is set. Set the parameter (SV035.bitF) to ignore the collision.

3-5-5 Vertical axis lifting control

(1) When to use

1) This function is used for preventing the workpiece from being damaged when emergency stop is inputted during cutting feed or during power failure.

The drop amount as much as the brake lash (a few µm to ten-odd µm), which could not be compensated by the conventional vertical axis drop prevention control function, can be compensated.

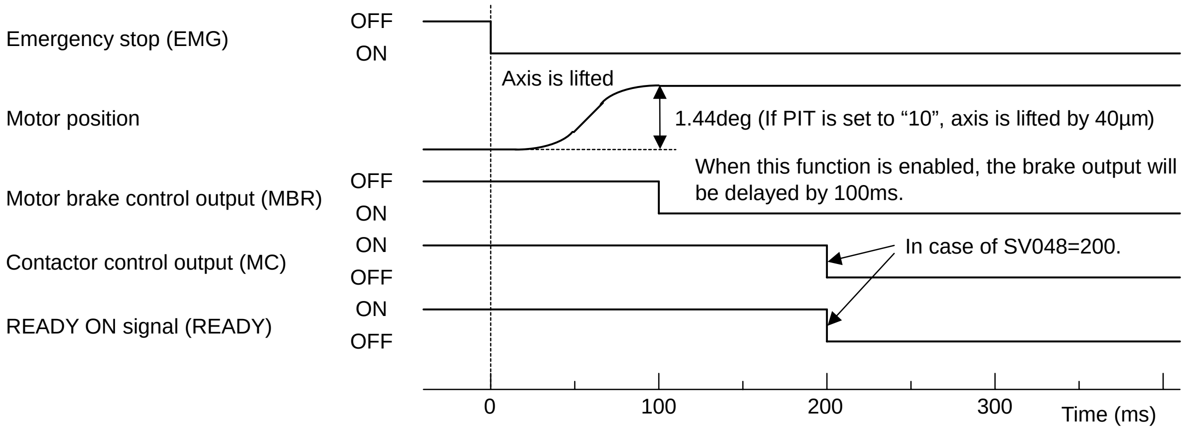
(2) Precautions

1) This function is available only for a vertical machining center only

If this function is used for a lathe or a horizontal machining center, the workpiece and tool will be damaged.

(3) Details of vertical axis lifting control function

Even though using the vertical axis drop prevention control function, the vertical axis drops by a few µm due to the mechanical backlash of the motor brake. This function enables to make a vertical axis move upward during emergency stop or power failure by lifting the axis by 1.44deg (motor degrees) before braking.



Operation sequence of the vertical axis lifting control

(4) Procedures for the vertical axis lifting control

1) Adjust the vertical axis drop prevention control referring to “3-4-4 Vertical axis drop prevention control” in this manual.
2) Add 100ms to the vertical axis drop prevention time (SV048) which is adjusted in 1.
3) Turn SV027.bit0 ON.
4) Set the unbalance torque. (Set the same value as when lost motion compensation is adjusted.) Confirm the coordinate position when emergency stop is inputted in NC screen.

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Unit</th><th>Explanation</th><th>Normal setting range</th></tr>
<tr><td>SV027</td><td>SSF1</td><td>Servo function selection1</td><td colspan="3">The following parameters are used for starting the vertical axis lifting control.
<table>
<tr><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>aflt</td><td>zrn2</td><td></td><td></td><td colspan="2">ovs</td><td colspan="2">lmc</td><td></td><td></td><td colspan="2">vfct</td><td></td><td></td><td></td><td>zup</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set.</th><th>Meaning when “1” is set.</th></tr>
<tr><td>0</td><td>zup</td><td>Stop the vertical axis lifting control.</td><td>Start the vertical axis lifting control.</td></tr>
</table></td></tr>
<tr><td>SV032</td><td>TOF</td><td>Torque offset</td><td>Stall%
(Rated current %)</td><td>Set the unbalance torque amount.
The compensation direction is determined by the + or – of this parameter.
When “0” is set, the vertical axis lifting control is not performed.</td><td>-60 to 60</td></tr>
<tr><td>SV048</td><td>EMGrt</td><td>Vertical axis drop prevention time</td><td>ms</td><td>Set the value which is more than 200ms as the brake delays by 100ms comparing with the normal operation.</td><td>0 to 400</td></tr>
</table>

⚠ **CAUTION**

1. This function is available for Z axis of the vertical machining center, however, not available for Y axis of the horizontal machining center and X axis of the lathe etc. as the collision will occur. Confirm the working condition of the machine before using this function.
2. In case that the motor brake is controlled by the external sequence, make it output in 100ms after emergency stop is inputted as well as servo drive unit output signal (MBR).

3-6 MDS-B-SVJ2 Parameter List

No.	Abbrev.	Parameter name	Explanation	Setting range (Unit)	Reference
SV001	PC1*	Motor side gear ratio	Set the motor side and machine side gear ratio. For the rotary axis, set the total deceleration (acceleration) ratio. Even if the gear ratio is within the setting range, the electronic gears may overflow and cause an alarm.	1 to 32767	3-1-1
SV002	PC2*	Machine side gear ratio		1 to 32767	
SV003	PGN1	Position loop gain 1	Set the position loop gain. The standard setting is "33". The higher the setting value is, the more precisely the command can be followed and the shorter the positioning time gets, however, note that a bigger shock is applied to the machine during acceleration/deceleration. When using the SHG control, also set SV004 (PGN2) and SV057 (SHGC).	1 to 200 (rad/s)	3-2-8 (3) 3-2-8 (4)
SV004	PGN2	Position loop gain 2	When using the SHG control, also set SV003 (PGN1) and SV057 (SHGC). When not using the SHG control, set to "0".	0 to 999 (rad/s)	
SV005	VGN1	Speed loop gain	Set the speed loop gain. Set this according to the load inertia size. The higher the setting value is, the more accurate the control will be, however, vibration tends to occur. If vibration occurs, adjust by lowering by 20 to 30%. The value should be determined to be 70 to 80% of the value at the time when the vibration stops.	1 to 999	3-2-3 3-2-7
SV006			Not used. Set to "0".	0	
SV007			Not used. Set to "0".	0	
SV008	VIA	Speed loop lead compensation	Set the gain of the speed loop integration control. The standard setting is "1364". During the SHG control, the standard setting is "1900". Adjust the value by increasing/decreasing it by about 100 at a time. Raise this value to improve contour tracking precision in high-speed cutting. Lower this value when the position droop vibrates (10 to 20Hz).	1 to 9999	3-2-8 (2) 3-2-8 (4)
SV009	IQA	Current loop q axis lead compensation	Set the gain of current loop. As this setting is determined by the motor's electrical characteristics, the setting is fixed for each type of motor. Set the standard values for all the parameters depending on each motor type.	1 to 20480	—
SV010	IDA	Current loop d axis lead compensation		1 to 20480	
SV011	IQG	Current loop q axis gain		1 to 2560	
SV012	IDG	Current loop d axis gain		1 to 2560	
SV013	ILMT	Current limit value	Set the normal current (torque) limit value. (Limit values for both + and - direction.) When the value is "500" (a standard setting), the maximum torque is determined by the specification of the motor.	0 to 500 (Stall [rated] current %)	—
SV014	ILMTsp	Current limit value in special control	Set the current (torque) limit value in a special control (initial absolute position setting, stopper control, etc). (Limit values for both of the + and - directions.) Set to "500" when not using.	0 to 500 (Stall [rated] current %)	—
SV015	FFC	Acceleration rate feed forward gain	When a relative error in the synchronous control is large, apply this parameter to the axis that is delaying. The standard setting value is "0". For the SHG control, set to "100". To adjust a relative error in acceleration/deceleration, increase the value by 50 to 100 at a time.	0 to 999 (%)	3-2-8 (4)

Parameters with an asterisk * in the abbreviation, such as PC1*, are validated when the NC power is turned ON again.

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range (Unit)</th><th>Reference</th></tr>
<tr><td rowspan="4">SV016</td><td rowspan="4">LMC1</td><td rowspan="4">Lost motion compensation 1</td><td>Set this when the protrusion (that occurs due to the non-sensitive band by friction, torsion, backlash, etc) at quadrant change is too large.
This compensates the torque at quadrant change.
This is valid only when the lost motion compensation (SV027 (SSF1/ lmc)) is selected.</td><td></td><td rowspan="4">3-4-1
4-3-2 (3)
4-2-4 (1)
4-2-4 (7)
4-3-4 (4)</td></tr>
<tr><td>Type 1: When SV027 (SSF1)/ bit9, 8 (lmc)=01
Set the compensation amount based on the motor torque before the quadrant change.
The standard setting is “100”. Setting to “0” means the compensation amount is zero.
Normally, use Type 2.</td><td>-1 to 200
(%)</td></tr>
<tr><td>Type 2: When SV027 (SSF1)/ bit9, 8 (lmc)=10
Set the compensation amount based on the stall (rated) current of the motor.
The standard setting is double of the friction torque. Setting to “0” means the compensation amount is zero.</td><td>-1 to 100
(Stall [rated] current %)</td></tr>
<tr><td>When you wish different compensation amount depending on the direction
When SV041 (LMC2) is “0”, compensate with the value of SV016 (LMC1) in both of the + and -directions.
If you wish to change the compensation amount depending on the command direction, set this and SV041 (LMC2). (SV016: + direction, SV041: - direction. However, the directions may be opposite depending on other settings.)
When “-1” is set, the compensation won’t be performed in the direction of the command.</td><td></td></tr>
<tr><td>SV017</td><td>SPEC*</td><td>Servo specification selection</td><td colspan="3">
<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>abs</td><td></td><td>vdir</td><td></td><td>mc</td><td></td><td></td><td>dmk</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set</th><th>Meaning when “1” is set</th><th>Reference</th></tr>
<tr><td>0</td><td>dmk</td><td>Deceleration control stop (SVJ2 standard)</td><td>Dynamic brake stop</td><td>–</td></tr>
<tr><td>1</td><td></td><td></td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td><td></td><td></td></tr>
<tr><td>3</td><td>mc</td><td>Contactor control output invalid</td><td>Contactor control output valid</td><td>–</td></tr>
<tr><td>4</td><td></td><td></td><td></td><td></td></tr>
<tr><td>5</td><td>vdr</td><td>HA053N to HA33N motor
Detector installation position standard (A, C)</td><td>HA053N to HA33N motor
Detector installation position 90 degrees (B, D)</td><td>–</td></tr>
<tr><td>6</td><td></td><td></td><td></td><td></td></tr>
<tr><td>7</td><td>abs</td><td>Incremental control</td><td>Absolute position control</td><td>–</td></tr>
<tr><td>8</td><td></td><td></td><td></td><td></td></tr>
<tr><td>9</td><td></td><td></td><td></td><td></td></tr>
<tr><td>10</td><td></td><td></td><td></td><td></td></tr>
<tr><td>11</td><td></td><td></td><td></td><td></td></tr>
<tr><td>12</td><td></td><td></td><td></td><td></td></tr>
<tr><td>13</td><td></td><td></td><td></td><td></td></tr>
<tr><td>14</td><td></td><td></td><td></td><td></td></tr>
<tr><td>15</td><td></td><td></td><td></td><td></td></tr>
</table>
(Note) Set to “0” for bits with no particular description.</td></tr>
<tr><td>SV018</td><td>PIT*</td><td>Ball screw pitch</td><td>Set the ball screw pitch. Set to “360” for the rotary axis.</td><td>1 to 32767
(mm/rev)</td><td>—</td></tr>
</table>

Parameters with an asterisk * in the abbreviation, such as PC1*, are validated when the NC power is turned ON again.

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range (Unit)</th><th>Reference</th></tr>
<tr><td>SV019</td><td>RNG1*</td><td>Position detector resolution</td><td rowspan="2">For both parameters, set the number of pulses per one revolution of the motor detector.
<table>
<tr><th rowspan="2">Motor model name</th><th colspan="2">Setting value</th></tr>
<tr><th>SV019</th><th>SV020</th></tr>
<tr><td>HC*-E42/A42/A47, HC*R-E42/A42/A47
HA*N-E42/A42</td><td>100</td><td>100</td></tr>
<tr><td>HC*-E33/A33, HC*R-E33/A33
HA*N-E33/A33</td><td>25</td><td>25</td></tr>
<tr><td>HC-SF, HC-RF</td><td>16</td><td>16</td></tr>
<tr><td>HA-FF, HC-MF</td><td>8</td><td>8</td></tr>
</table></td><td>8 to 100 (kp/rev)</td><td>—</td></tr>
<tr><td>SV020</td><td>RNG2*</td><td>Speed detector resolution</td><td>8 to 100 (kp/rev)</td><td>—</td></tr>
<tr><td>SV021</td><td>OLT</td><td>Overload detection time constant</td><td>Set the detection time constant of Overload 1 (Alarm 50).
Set to “60” as a standard. (For machine tool builder adjustment.)</td><td>1 to 300 (s)</td><td>—</td></tr>
<tr><td>SV022</td><td>OLL</td><td>Overload detection level</td><td>Set the current detection level of Overload 1 (Alarm 50) in respect to the stall (rated) current. Set to “150” as a standard. (For machine tool builder adjustment.)</td><td>50 to 180 (Stall [rated] current %)</td><td>—</td></tr>
<tr><td>SV023</td><td>OD1</td><td>Excessive error detection width during servo ON</td><td>Set the excessive error detection width when servo ON.
<Standard setting value> $\mathrm{OD1}=\mathrm{OD2}=\frac{\text{Rapid traverse rate (mm/min)}}{60*\mathrm{PGN1}}/2$ (mm)
When “0” is set, the excessive error detection will not be performed.</td><td>0 to 32767 (mm)</td><td>3-4-2</td></tr>
<tr><td>SV024</td><td>INP</td><td>In-position detection width</td><td>Set the in-position detection width.
Set the accuracy required for the machine.
The lower the setting is, the higher the positioning accuracy gets, however, the cycle time (setting time) becomes longer. The standard setting is “50”.</td><td>0 to 32767 (μm)</td><td>—</td></tr>
</table>

Parameters with an asterisk * in the abbreviation, such as PC1*, are validated when the NC power is turned ON again.

No.	Abbrev.	Parameter name	Explanation	Reference
SV025	MTYP*	Motor/Detector type		—

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
pen				ent				mtyp							

bit		Explanation	Reference
0 1 2 3 4 5 6 7	mtyp	Set the motor type.	

Setting	0x	1x	2x	3x	4x	5x	6x	7x	8x
x0	HA40N							HA-FF43	HA43N
x1	HA80N							HA-FF63	HA83N
x2	HA100N								HA103N
x3	HA200N								
x4									
x5									
x6									
x7									
x8									
x9									
xA									HA93N
xB									
xC								HA-FF053	HA053N
xD								HA-FF13	HA13N
xE								HA-FF23	HA23N
xF								HA-FF33	HA33N

Setting	9x	Ax	Bx	Cx	Dx	Ex	Fx
x0	HC-MF43		HC52 or HC-SF52	HC53 or HC-SF53			
x1	HC-MF73		HC102 or HC-SF102	HC103 or HC-SF103		HC103R or HC-RF103	
x2			HC152 or HC-SF152	HC153 or HC-SF153		HC153R or HC-RF153	
x3			HC202 or HC-SF202	HC203 or HC-SF203		HC203R or HC-RF203	
x4			HC352 or HC-SF352	HC-SF353			
x5							
x6							
x7							
x8							
x9							
xA							
xB							
xC	HC-MF053						
xD	HC-MF13						
xE	HC-MF23						
xF							

bit		Explanation	Reference
8 9 10 11	ent	Set the speed detector type. Set to “2”.	
12 13 14 15	pen	Set the position detector type. Set to “2”.	

Parameters with an asterisk * in the abbreviation, such as PC1*, are validated when the NC power is turned ON again.

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range (Unit)</th><th>Reference</th></tr>
<tr><td>SV026</td><td>OD2</td><td>Excessive error detection width during servo OFF</td><td>Set the excessive error detection width when servo ON.
For the standard setting, refer to the explanation of SV023 (OD1).
When “0” is set, the excessive error detection will not be performed.</td><td>0 to 32767 (mm)</td><td>3-4-2</td></tr>
<tr><td>SV027</td><td>SSF1</td><td>Servo function selection 1</td><td colspan="3">
<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>aflt</td><td>zrn2</td><td></td><td></td><td colspan="2">ovs</td><td colspan="2">imc</td><td></td><td></td><td colspan="2">vfct</td><td></td><td></td><td></td><td>zup</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set</th><th>Meaning when “1” is set</th><th>Reference</th></tr>
<tr><td>0</td><td>zup</td><td>Vertical axis lift-up control stop</td><td>Vertical axis lift-up control start</td><td>3-5-5</td></tr>
<tr><td>1</td><td></td><td></td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td><td></td><td></td></tr>
<tr><td>3</td><td></td><td></td><td></td><td></td></tr>
<tr><td>4
5</td><td>vfct</td><td colspan="2">Set the number of compensation pulses of the jitter compensation.
00: Jitter compensation invalid 10: Jitter compensation 2 pulses
01: Jitter compensation 1 pulse 11: Jitter compensation 3 pulses</td><td>3-2-6 (5)</td></tr>
<tr><td>6</td><td></td><td></td><td></td><td></td></tr>
<tr><td>7</td><td></td><td></td><td></td><td></td></tr>
<tr><td>8
9</td><td>lmc</td><td colspan="2">Set the compensation amount with SV016 (LMC1) and SV041 (LMC2).
00: Lost motion compensation stop 10: Lost motion compensation type 2
01: Lost motion compensation type 1 11: Setting prohibited</td><td>3-4-1</td></tr>
<tr><td>10
11</td><td>ovs</td><td colspan="2">Set the compensation amount with SV031 (OVS1) and SV042 (OVS2).
00: Overshooting compensation stop 10: Overshooting compensation type 2
01: Overshooting compensation type 1 11: Setting prohibited</td><td>3-5-3</td></tr>
<tr><td>12</td><td></td><td></td><td></td><td></td></tr>
<tr><td>13</td><td></td><td></td><td></td><td></td></tr>
<tr><td>14</td><td>zrn2</td><td colspan="2">Set to “1”.</td><td>–</td></tr>
<tr><td>15</td><td>aflt</td><td>Adoptive filter stops</td><td>Adoptive filter starts</td><td>3-2-5</td></tr>
</table>
(Note) Set to “0” for bits with no particular description.</td></tr>
<tr><td>SV028</td><td></td><td></td><td>Not used. Set to “0”.</td><td>0</td><td></td></tr>
<tr><td>SV029</td><td></td><td></td><td>Not used. Set to “0”.</td><td>0</td><td></td></tr>
<tr><td>SV030</td><td>IVC</td><td>Voltage dead time compensation</td><td>When 100% is set, the voltage equivalent to the logical non-energized time will be compensated.
Adjust in increments of 10% from the default value 100%.
If increased too much, vibration or vibration noise may be generated.
When not using, set to “0”.</td><td>0 to 200 (%)</td><td>3-5-1</td></tr>
<tr><td>SV031</td><td>OVS1</td><td>Overshooting compensation 1</td><td>Set this if overshooting occurs during positioning. This compensates the motor torque during positioning.
This is valid only when the overshooting compensation SV027 (SSF1/ ovs) is selected.
Type 1: When SV027 (SSF1)/ bit11, 10 (ovs)=01
Set the compensation amount based on the motor’s stall (rated) current.
Increase by 1% and determine the amount that is free from overshooting.
Compensation will not be performed in the feed forward control mode during circular cutting.
Type 2: When SV027 (SSF1)/ bit11, 10 (ovs)=10
Use this to perform the overshooting compensation in the feed forward control mode during circular cutting. The setting method is the same in Type 1.
When you wish different compensation amount depending on the direction
When SV042 (OVS2) is “0”, compensate with the value of SV031 (OVS1) in both of the + and -directions.
If you wish to change the compensation amount depending on the command direction, set this and SV042 (OVS2). (SV031: + direction, SV042: - direction. However, the directions may be opposite depending on other settings.)
When “-1” is set, the compensation won’t be performed in the direction of the command.</td><td>-1 to 100 (Stall [rated] current %)</td><td>3-5-3</td></tr>
</table>

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Setting range (Unit)</th><th>Reference</th></tr>
<tr><td>SV032</td><td>TOF</td><td>Torque offset</td><td>Set the unbalance torque of vertical axis and inclined axis.</td><td>-100 to 100
(Stall [rated] current %)</td><td>3-2-2 (2)
3-4-1
3-5-4
3-5-5</td></tr>
<tr><td>SV033</td><td>SSF2</td><td>Servo function selection 2</td><td colspan="3">
<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="4">afs</td><td></td><td></td><td colspan="2">fhz2</td><td colspan="4">nfd</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set</th><th>Meaning when “1” is set</th><th>Reference</th></tr>
<tr><td>0
1
2
3</td><td>nfd</td><td colspan="2">Set the filter depth for Notch filter (SV038: FHz1).
The control is stabilized by making the filter shallower.
<table>
<tr><td>Value</td><td>0</td><td>2</td><td>4</td><td>6</td><td>8</td><td>A</td><td>C</td><td>E</td></tr>
<tr><td>Depth (dB)</td><td>Infntly deep</td><td>-18.1</td><td>-12.0</td><td>-8.5</td><td>-6.0</td><td>-4.1</td><td>-2.5</td><td>-1.2</td></tr>
</table>
Deep ← → Shallow</td><td>3-2-6 (1)</td></tr>
<tr><td>4
5</td><td>fhz2</td><td colspan="2">Set the operation frequency of Notch filter 2.
00: No operation 01: 2250Hz 10: 1125Hz 11: 750Hz</td><td>3-2-6 (2)</td></tr>
<tr><td>6</td><td></td><td></td><td></td><td></td></tr>
<tr><td>7</td><td></td><td></td><td></td><td></td></tr>
<tr><td>8
9
10
11</td><td>afs</td><td colspan="2">Set the vibration sensitivity of the adaptive filter.
If the filter depth is not deep enough (generally 70% or more) and the vibration cannot be sufficiently eliminated, raise the value.</td><td>3-2-5</td></tr>
<tr><td>12</td><td></td><td></td><td></td><td></td></tr>
<tr><td>13</td><td></td><td></td><td></td><td></td></tr>
<tr><td>14</td><td></td><td></td><td></td><td></td></tr>
<tr><td>15</td><td></td><td></td><td></td><td></td></tr>
</table>
(Note) Set to “0” for bits with no particular description.</td></tr>
<tr><td>SV034</td><td>SSF3</td><td>Servo function selection 3</td><td colspan="3">
<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>daf2</td><td>daf1</td><td>dac2</td><td>dac1</td><td colspan="4">mon</td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set</th><th>Meaning when “1” is set</th><th>Reference</th></tr>
<tr><td>0
1
2
3</td><td>mon</td><td colspan="2">NC servo monitor MAX current display data changeover
<table>
<tr><th>Setting</th><th>MAX current 1</th><th>MAX current 2</th></tr>
<tr><td>0</td><td>Max. current command value after turning the power ON (%)</td><td>Max. current command value for one second (%)</td></tr>
<tr><td>1</td><td>Max. current command value for one second (%)</td><td>Max. current FB value for one second (%)</td></tr>
<tr><td>2</td><td>Max. current FB value after turning the power ON (%)</td><td>Max. current FB value for one second (%)</td></tr>
<tr><td>3</td><td>Load inertia rate (%)</td><td>-</td></tr>
<tr><td>4</td><td>Adaptive filter operation frequency (Hz)</td><td>Adaptive filter operation gain (%)</td></tr>
<tr><td>5</td><td>PN bus voltage (V)</td><td>Regenerative operation frequency monitor (The number of times/sec)</td></tr>
<tr><td>6</td><td>Estimated max. torque for one second (%)</td><td>Max. current FB value for one second (%)</td></tr>
<tr><td>7</td><td>Estimated max. torque for one second (%)</td><td>Max. disturbance torque for two seconds (%)</td></tr>
<tr><td>8~F</td><td colspan="2">Setting prohibited</td></tr>
</table></td><td>3-2-2 (2)
3-2-5
3-3-1 (4)
3-5-4</td></tr>
<tr><td>4</td><td>dac1</td><td>D/A output ch.1 overflow setting</td><td>D/A output ch.1 clamp setting</td><td rowspan="2">–</td></tr>
<tr><td>5</td><td>dac2</td><td>D/A output ch.2 overflow setting</td><td>D/A output ch.2 clamp setting</td></tr>
<tr><td>6</td><td>daf1</td><td>D/A output ch.1 no filter</td><td>D/A output ch.1 filter setting</td><td rowspan="2">–</td></tr>
<tr><td>7</td><td>daf2</td><td>D/A output ch.2 no filter</td><td>D/A output ch.2 filter setting</td></tr>
<tr><td>8</td><td></td><td></td><td></td><td></td></tr>
<tr><td>9</td><td></td><td></td><td></td><td></td></tr>
<tr><td>10</td><td></td><td></td><td></td><td></td></tr>
<tr><td>11</td><td></td><td></td><td></td><td></td></tr>
<tr><td>12</td><td></td><td></td><td></td><td></td></tr>
<tr><td>13</td><td></td><td></td><td></td><td></td></tr>
<tr><td>14</td><td></td><td></td><td></td><td></td></tr>
<tr><td>15</td><td></td><td></td><td></td><td></td></tr>
</table>
(Note) Set to “0” for bits with no particular description.</td></tr>
</table>

<table>
<tr><th>No.</th><th>Abbrev.</th><th>Parameter name</th><th>Explanation</th><th>Reference</th></tr>
<tr><td>SV035</td><td>SSF4</td><td>Servo function selection 4</td><td colspan="2">
<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>cl2n</td><td colspan="3">clG1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set</th><th>Meaning when “1” is set</th><th>Reference</th></tr>
<tr><td>0</td><td></td><td></td><td></td><td></td></tr>
<tr><td>1</td><td></td><td></td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td><td></td><td></td></tr>
<tr><td>3</td><td></td><td></td><td></td><td></td></tr>
<tr><td>4</td><td></td><td></td><td></td><td></td></tr>
<tr><td>5</td><td></td><td></td><td></td><td></td></tr>
<tr><td>6</td><td></td><td></td><td></td><td></td></tr>
<tr><td>7</td><td></td><td></td><td></td><td></td></tr>
<tr><td>8</td><td></td><td></td><td></td><td></td></tr>
<tr><td>9</td><td></td><td></td><td></td><td></td></tr>
<tr><td>10</td><td></td><td></td><td></td><td></td></tr>
<tr><td>11</td><td></td><td></td><td></td><td></td></tr>
<tr><td>12</td><td rowspan="3">clG1</td><td rowspan="3" colspan="2">Collision detection method 1
Set the collision detection level during cutting feed (G1).
The G1 collision detection level=SV060*clG1.
When clG1=0, the collision detection method 1 during cutting feed won’t function.</td><td rowspan="4">3-5-4</td></tr>
<tr><td>13</td></tr>
<tr><td>14</td></tr>
<tr><td>15</td><td>cl2n</td><td>Collision detection method 2 valid</td><td>Collision detection method 2 invalid</td></tr>
</table>
(Note) Set to “0” for bits with no particular description.
</td></tr>
<tr><td>SV036</td><td>PTYP*</td><td>Regenerative resistor type</td><td colspan="2">
<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="4">amp</td><td colspan="4">rtyp</td><td colspan="4">emgx</td><td></td><td></td><td></td><td></td></tr>
</table>
<table>
<tr><th colspan="2">bit</th><th>Meaning when “0” is set</th><th>Meaning when “1” is set</th><th>Reference</th></tr>
<tr><td>0</td><td></td><td rowspan="4" colspan="2">Always set to “0(0000)”.</td><td rowspan="4"></td></tr>
<tr><td>1</td><td></td></tr>
<tr><td>2</td><td></td></tr>
<tr><td>3</td><td></td></tr>
<tr><td>4</td><td rowspan="4">emgx</td><td rowspan="4" colspan="2">Set the external emergency stop function. (Setting is prohibited for values with no description.)
<table>
<tr><th>Setting</th><th>Explanation</th></tr>
<tr><td>0</td><td>External emergency stop invalid</td></tr>
<tr><td>4</td><td>External emergency stop valid</td></tr>
</table>
</td><td rowspan="4">–</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td><td rowspan="4">rtyp</td><td rowspan="4" colspan="2">Set the regenerative resistor type.
<table>
<tr><th>Setting</th><th>Explanation</th></tr>
<tr><td>0</td><td>Drive unit standard built-in resistor (SVJ2-01 doesn’t have a built-in resistor)</td></tr>
<tr><td>1</td><td>Setting prohibited</td></tr>
<tr><td>2</td><td>MR-RB032</td></tr>
<tr><td>3</td><td>MR-RB12 or GZG200W390HMK</td></tr>
<tr><td>4</td><td>MR-RB32 or GZG200W1200HMK: 3 units connected in parallel</td></tr>
<tr><td>5</td><td>MR-RB30 or GZG200W390HMK: 3 units connected in parallel</td></tr>
<tr><td>6</td><td>MR-RB50 or GZG300W390HMK: 3 units connected in parallel</td></tr>
<tr><td>7 to F</td><td>Setting prohibited</td></tr>
</table>
</td><td rowspan="4">–</td></tr>
<tr><td>9</td></tr>
<tr><td>10</td></tr>
<tr><td>11</td></tr>
<tr><td>12</td><td rowspan="4">amp</td><td rowspan="4" colspan="2">Always set to “1(0000)”.</td><td rowspan="4">–</td></tr>
<tr><td>13</td></tr>
<tr><td>14</td></tr>
<tr><td>15</td></tr>
</table>
</td></tr>
</table>

Parameters with an asterisk * in the abbreviation, such as PC1*, are validated when the NC power is turned ON again.

No.	Abbrev.	Parameter name	Explanation	Setting range (Unit)	Reference
SV037	JL	Load inertia scale	Set “the motor inertia + motor axis conversion load inertia” in respect to the motor inertia. SV037 (JL) = $\frac{Jl + Jm}{Jm}$ *100 Jm: Motor inertia Jl : Motor axis conversion load inertia	0 to 5000 (%)	3-2-2 (1) 3-5-2
SV038	FHz1	Notch filter frequency 1	Set the vibration frequency to suppress if machine vibration occurs. (Valid at 72 or more) When not using, set to “0”.	0 to 3000 (Hz)	3-2-6 (1)
SV039	LMCD	Lost motion compensation timing	Set this when the lost motion compensation timing doest not match. Adjust by increasing the value by 10 at a time.	0 to 2000 (ms)	—
SV040	LMCT	Non-sensitive band in feed forward control	Set the non-sensitive bad of the lost motion compensation and overshooting compensation during the feed forward control. When “0” is set, the actual value that will be set is 2μm. Adjust by increasing by 1μm.	0 to 100 (μm)	—
SV041	LMC2	Lost motion compensation 2	Set this with SV016 (LMC1) only when you wish to set the lost motion compensation amount to be different depending on the command directions. Set to “0” as a standard.	-1 to 200 (Stall [rated] current %)	—
SV042	OVS2	Overshooting compensation 2	Set this with SV031 (OVS1) only when you wish to set the overshooting compensation amount to be different depending on the command directions. Set to “0” as a standard.	-1 to 100 (Stall [rated] current %)	3-5-3
SV043	OBS1	Disturbance observer filter frequency	Set the disturbance observer filter band. The standard setting is “300”. Lower the setting by 50 at a time if vibration occurs. To use the disturbance observer, also set SV037 (JL) and SV044 (OBS2). When not using, set to “0”.	0 to 1000 (rad/s)	3-5-2
SV044	OBS2	Disturbance observer gain	Set the disturbance observer gain. The standard setting is “100” to “300”. To use the disturbance observer, also set SV037 (JL) and SV043 (OBS1). When not using, set to “0”.	0 to 1000 (%)	
SV045	TRUB	Frictional torque	Set the frictional torque when using the collision detection function.	0 to 100 (Stall [rated] current %)	3-2-2 (2) 3-4-1 (1) 3-5-4
SV046			Not used. Set to “0”.	0	
SV047	EC	Inductive voltage compensation gain	Set the inductive voltage compensation gain. Set to “100” as a standard. If the current FB peak exceeds the current command peak, lower the gain.	0 to 200 (%)	3-3-1 (4)
SV048	EMGrt	Vertical axis drop prevention time	Input a length of time to prevent the vertical axis from dropping by delaying Ready OFF until the brake works when the emergency stop occurs. Increase the setting by 100ms at a time and set the value where the axis does not drop.	0 to 2000 (ms)	3-4-4 3-5-5
SV049	PGN1sp	Position loop gain 1 in spindle synchronous control	Set the position loop gain during the spindle synchronous control (synchronous tapping, synchronous control with spindle/C axis). Set the same value as the value of the spindle parameter, position loop gain in synchronous control. When performing the SHG control, set this with SV050 (PGN2sp) and SV058 (SHGCsp).	1 to 200 (rad/s)	—
SV050	PGN2sp	Position loop gain 2 in spindle synchronous control	Set this with SV049 (PGN1sp) and SV058 (SHGCsp) if you wish to perform the SHG control in the spindle synchronous control (synchronous tapping, synchronous control with spindle/C axis). When not performing the SHG control, set to “0”.	0 to 999 (rad/s)	
SV051			Not used. Set to “0”.	0	
SV052			Not used. Set to “0”.	0	
SV053	OD3	Excessive error detection width in special control	Set the excessive error detection width when servo ON in a special control (initial absolute position setting, stopper control, etc.). If “0” is set, excessive error detection won’t be performed when servo ON during a special control.	0 to 32767 (mm)	—
SV054			Not used. Set to “0”.	0	
SV055			Not used. Set to “0”.	0	

No.	Abbrev.	Parameter name	Explanation	Setting range (Unit)	Reference
SV056	EMGt	Deceleration time constant at emergency stop	Set the time constant used for the deceleration control at emergency stop. Set a length of time that takes from rapid traverse rate (rapid) to stopping. Normally, set the same value as the rapid traverse acceleration/ deceleration time constant.	0 to 5000 (ms)	3-4-3
SV057	SHGC	SHG control gain	When performing the SHG control, set this with S003 (PGN1) and SV004 (PGN2). When not performing the SHG control, set to “0”.	0 to 999 (rad/s)	3-2-8 (4)
SV058	SHGCsp	SHG control gain in spindle synchronous control	Set this with SV049 (PGN1sp) and SV050 (PGN2sp) if you wish to perform the SHG control in the spindle synchronous control (synchronous tapping, synchronous control with spindle/C axis). When not performing the SHG control, set to “0”.	0 to 999 (rad/s)	—
SV059	TCNV	Collision detection torque estimating gain	To use the collision detection function, set the torque estimating gain. In the case of MDS-B-SVJ2, the value is the same as the load inertia ratio that includes the motor inertia. (=SV037:JL) If acceleration/deceleration is performed after setting SV034.mon=3 and SV060=0, the load inertia ratio will be displayed on the NC monitor screen.	0 to 5000 (%)	3-5-4
SV060	TLMT	Collision detection level	When using the collision detection function, set the collision detection level during the G0 feeding. If “0” is set, none of the collision detection function will work.	0 to 200 (Stall [rated] current %)	
SV061	DA1NO	D/A output ch. 1 data No.	Input the data number you wish to output to D/A output channel.	0 to 102	1-1-4
SV062	DA2NO	D/A output ch. 2 data No.			
SV063	DA1MPY	D/A output ch. 1 output scale	When “0” is set, output is done with the standard output unit. Set other than “0” when you wish to change the unit. Set the scale with a 1/256 unit. When “256” is set, the output unit will be the same as the standard output unit.	-32768 to 32767 (Unit: 1/256)	
SV064	DA2MPY	D/A output ch. 2 output scale			
SV065			Not used. Set to “0”.	0	

Revision History

Printing Date	Manual No.	Revision details
Jul.,2002	BNP-B2334A(ENG)	First Edition
Feb.,2004	BNP-B2334B(ENG)	Explanation on the MDS-CH-Vx series was added. Font size of explanations and inserted drawings was increased. Chapter 2 Modified MDS-C1/CH-Vx series adjustment procedures. Chapter 2 (beginning) MDS-CH manual was added. Section 2-1-3 Parameter numbers were added. Section 2-2-3 Explanations were changed. MDS-CH-Vx series standard VNG graph was added. Section 2-2-4 Title was changed from "Adjusting the notch filter" to "Explanation of notch filter". Explanations were completely reviewed. Adjustment flow was deleted. Changed Hi-corder measurement data for measuring the vibration frequency to U-phase and V-phase current FB. Explanation on the adaptive filter was deleted. Section 2-2-5 Explanations and adjustment flows were completely reviewed. Explanation of types of vibration was added for reference. Section 2-2-6 (2) Explanations were completely reviewed. Points were revised. Section 2-2-6 (4) Explanation was added. SHG control measurement waveform was added. Section 2-3-1 Method of current value indication was changed in table of maximum current command values for adjustment. Section 2-4-3 (3) Items 5 and 6 were deleted since vertical axis required converter control. Section 2-5-2 Overshooting compensation type 3 was changed to be complied with the standard specifications. Non-sensitive zone setting is added. Explanation of SV034 is added. Section 2-7 MDS-CH-Vx was added, and explanations were changed to unified specifications. Section 3-1-3 Parameter numbers were added. Section 3-2-3 Standard VGN1 for combination with one rank smaller servo amplifier was added. Section 3-2-4 Items were added. Section 3-2-5 Flow chart for the adaptive filter adjustment was changed. Section 3-2-6 Explanations were completely reviewed. Adjustment flow was deleted. Section 3-2-7 Explanations and adjustment flows were completely reviewed. Explanation of types of vibration was added for reference. Section 3-2-8 (4) Explanation was added. SHG control measurement waveform was added. Section 3-3-1 Maximum current command value for combination with one rank smaller servo amplifier was added. Section 3-5-3 Explanations for compensation methods were modified. Section 3-6 Explanations were changed to unified specifications.

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