

TOSVERT VF-AS3

Torque Control Instruction Manual

TOSHIBA INDUSTRIAL PRODUCTS AND SYSTEMS CORPORATION

Note

1. Read this manual carefully before using the inverter. After reading, the user should keep this manual at hand to use it for maintenance and inspection in the future.
2. Please be informed that the contents of this document may be changed without notice.

1. Torque control function

■ Function

VF-AS3 has speed control that controls the rotation of a motor and torque control that controls a power necessary for constant tension control such as winding control.

Torque control can be used with a motor speed sensor or without it. For a machine requiring torque accuracy, use the control with sensor.

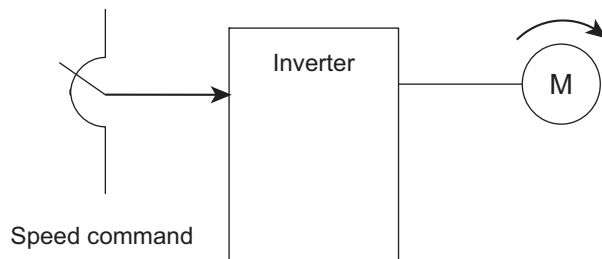
Note 1) For torque control with sensor, an encoder feedback option "VEC008Z" is required.

■ Difference from speed control

1. What is speed control

Inverter control generally uses speed control.

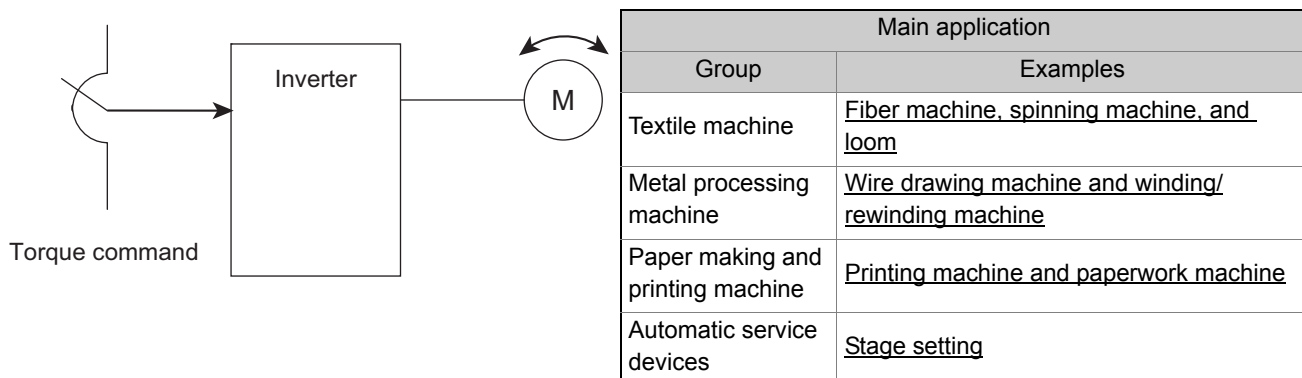
It gives an inverter a command of a desired rotational speed so that the inverter can control the motor to rotate at the speed as commanded. Therefore, the speed becomes constant regardless of the size of load.



Main application	
Group	Examples
Wind/water power machines and compress machine	Fan, blower, pump, air-conditioning system, clean room, dryer, and compressor
Distribution, conveyance, and transport machines	Crane, hoist, conveyor, 3-dimensional automatic warehouse, and 3-dimensional parking
Construction machines related	Rock crusher, tunnel boring machine, and paving machine
Textile machine	<u>Fiber machine, spinning machine, loom, dyeing machine, and industrial sewing machine</u>
Food processing machine	Blender, slicer, rice/wheat cleaning machine, bakery equipment, noodle making machine, tea manufacturing machine, and commercial oven
Packing machine	Wrapping machine, packing machine, and bag-filling machine
Wood processing machine	Woodwork machine, sawing lumbering machine, and woodwork milling machine,
Metal handicraft machine	Lathe, drilling machine, milling machine, and grinding machine
Metal processing machine	<u>Wire drawing machine</u> , press machine, and <u>winding/rewinding machine</u>
Paper making and printing machine	<u>Printing machine, and paperwork machine</u>
Automatic service devices	Health care tool (running machine and so on), medical appliance (X-ray equipment and so on), and <u>stage setting</u>
Environment and life-related machine	Business-purpose washing machine, car-wash machine, shutter, and dust collector

2. What is torque control

Torque control gives the inverter a command of a torque to be applied to a load machine, and the inverter controls so that this torque command and the load torque should match. Therefore, the speed is decreased with a larger load and increased with a smaller load.



■ **Parameter setting**

Torque control

Title	Parameter name	Adjustment range	Unit	Default setting
Pt	V/f Pattern	0: V/f constant 1: Variable torque 2: Automatic torque boost 3: Vector control 1 4: Energy savings 5: Dynamic energy savings (for fan and pump) 6: PM motor control 7: V/f 5-point setting 8: - 9: Vector control 2 10: PG feedback control 11: PG feedback vector control (speed/torque) 12: -	-	0
F420	Torque command selection	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5 - 11: - 12: F725 13 - 19: - 20: Embedded Ethernet 21: RS485 communication (connector 1) 22: RS485 communication (connector 2) 23: Communication option	-	2
F421	Torque command filter	0 - 1000	ms	0
F423	Tension control torque bias input	Same as [F420]	-	0
F424	Load sharing gain input	Same as [F420]	-	0

Title	Parameter name	Adjustment range	Unit	Default setting
F425	Fwd speed limit input	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5 - 11: - 12: F426	-	0
F426	Fwd speed limit level	0.0 - UL	Hz	50.0/60.0
F427	Rev speed limit input	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5 - 11: - 12: F428	-	0
F428	Rev speed limit level	0.0 - UL	Hz	50.0/60.0
F430	Speed limit center value input select	0: - 1: Terminal RR 2: Terminal RX 3: Terminal II 4: Terminal AI4 (option) 5 - 11: - 12: F431	-	0
F431	Speed limit center value	0.0 - FH	Hz	0.0
F432	Speed limit band	0.0 - FH	Hz	0.0
F435	Rotation direction limit during torque control	0: Fwd/Rev permit 1: Command direction permit	-	0
F441	Power running torque limit level 1	0.0 - 249.9 250.0: Disabled	%	250.0
F443	Regenerative torque limit level 1	0.0 - 249.9 250.0: Disabled	%	250.0
F444	Power running torque limit level 2	0.0 - 249.9 250.0: Disabled	%	250.0
F445	Regenerative torque limit level 2	0.0 - 249.9 250.0: Disabled	%	250.0
F446	Power running torque limit level 3	0.0 - 249.9 250.0: Disabled	%	250.0
F447	Regenerative torque limit level 3	0.0 - 249.9 250.0: Disabled	%	250.0
F448	Power running torque limit level 4	0.0 - 249.9 250.0: Disabled	%	250.0
F449	Regenerative torque limit level 4	0.0 - 249.9 250.0: Disabled	%	250.0
F455	Torque command polarity at Rev	0: Regeneration at positive torque command 1: Power running at positive torque command	-	0
F725	Panel torque command	-250 - 250	%	0
F727	Panel tension torque bias	-250 - 250	%	0
F728	Panel load sharing gain	0 - 250	%	100

Analog input

Title	Parameter name	Adjustment range	Unit	Default setting
F201	RR point 1 input value	0 - 100	%	0
F202	RR point 1 frequency	0.0 - 590.0	Hz	0.0
F203	RR point 2 input value	0 - 100	%	100
F204	RR point 2 frequency	0.0 - 590.0	Hz	50.0/60.0
F205	RR point 1 rate	0 - 250	%	0
F206	RR point 2 rate	0 - 250	%	100
F210	RX point 1 input value	-100 - 100	%	0
F211	RX point 1 frequency	0.0 - 590.0	Hz	0.0
F212	RX point 2 input value	-100 - 100	%	100
F213	RX point 2 frequency	0.0 - 590.0	Hz	50.0/60.0
F214	RX point 1 rate	-250 - 250	%	0
F215	RX point 2 rate	-250 - 250	%	100
F216	II point 1 input value	0 - 100	%	20
F217	II point 1 frequency	0.0 - 590.0	Hz	0.0
F218	II point 2 input value	0 - 100	%	100
F219	II point 2 frequency	0.0 - 590.0	Hz	50.0/60.0
F220	II point 1 rate	0 - 250	%	0
F221	II point 2 rate	0 - 250	%	100
F222	AI4 point 1 input value	-100 - 100	%	0
F223	AI4 point 1 frequency	0.0 - 590.0	Hz	0.0
F224	AI4 point 2 input value	-100 - 100	%	100
F225	AI4 point 2 frequency	0.0 - 590.0	Hz	50.0/60.0
F226	AI4 point 1 rate	-250 - 250	%	0
F227	AI4 point 2 rate	-250 - 250	%	100

2. How to set parameters

2.1 Basic settings and procedures for torque control

(1) Setting torque control with control methods

Set with [Pt: V/f Pattern]. Set as follows depending on whether or not the motor speed sensor exists.

Without sensor: [Pt] = "9: Vector control 2 (speed/torque)"

With sensor: [Pt] = "11: PG feedback vector control (speed/torque)"

- For torque control, setting of parameters for motor is required. For details, refer to [6.23] in the instruction manual (E6582062) of the inverter.
- For torque control with sensor, an encoder feedback option "VEC008Z" is required. For details, refer to the instruction manual "E6582148."

(2) Setting parameters to execute torque control

With setting of [CMOd: Run command select], speed control and torque control can be switched with ON/OFF of an input terminal or communication. They can be switched also during operation.

When [CMOd] = "1: Operation panel/extension panel", torque control is not available.

1) When switching with ON/OFF of the input terminal

Set [CMOd] = "0: Terminal."

Assign "112/113: Speed control/Torque control switching" to an unused input terminal.

Setting example [F116: S3 terminal function] = "112"

Torque control with [S3] terminal ON, speed control with [S3] terminal OFF

For constant torque control, set to a parameter of always active function.

Setting example [F127: Always active function 2] = "112"

2) When switching with communication

With setting of [CMOd], set as follows with communication.

"2: Embedded Ethernet"

FA38: Set bit0 = ON.

"3: RS485 communication (connector 1)"

FA20: Set bit0 = ON.

"4: RS485 communication (connector 2)"

FA22: Set bit0 = ON.

"5: Communication option"

FA23: Set bit0 = ON.

(3) Setting a mode of torque command

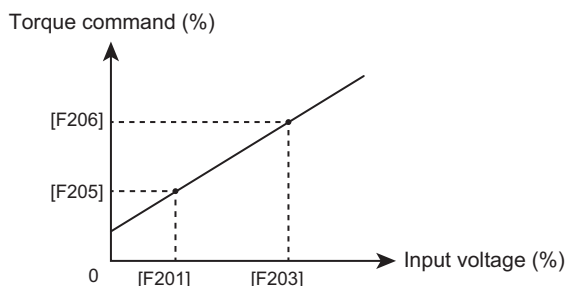
For torque control, the inverter controls so that the torque command and the load torque match.

Set a mode to enter the torque command with [F420: Torque command selection].

- For the motor speed sensor, use the two-phase input type.
- For sensorless torque control, "forward power running ⇔ reverse regeneration" and "forward regeneration ⇔ reverse power running" cannot be operated. Use torque control with sensor if necessary.

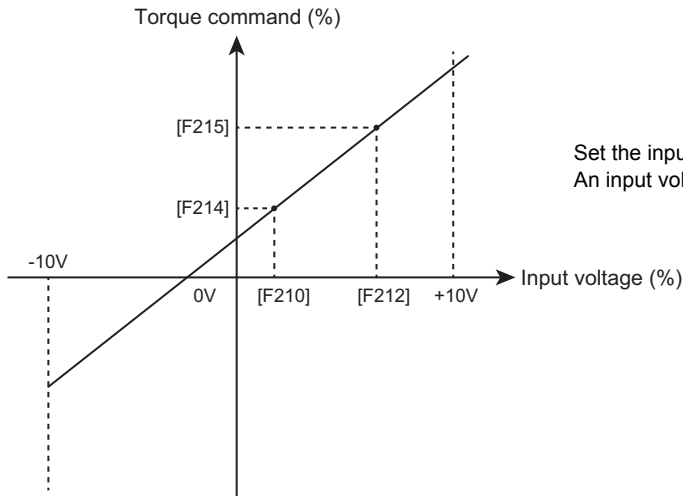
1) When setting analog input in [F420]

(a) When setting to "1: Terminal RR" and entering the torque command with 0 to10V



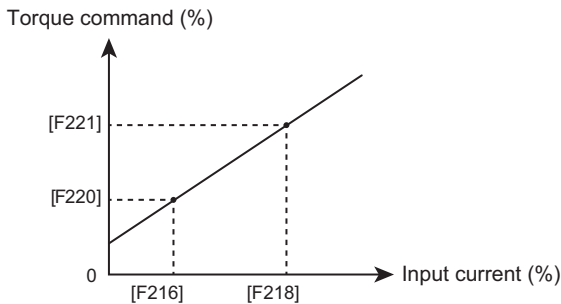
Set the input characteristics according to the load.
An input voltage of 10V is equivalent to 100%.

(b) When setting to "2: Terminal RX" and entering the torque command with -10 to +10V



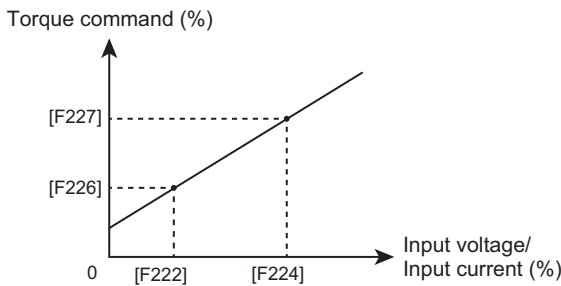
Set the input characteristics according to the load.
An input voltage of 10V is equivalent to 100%.

(c) When setting to "3: Terminal II" and entering the torque command with 4 to 20mA



Set the input characteristics according to the load.
An input current of 20mA is equivalent to 100%.

(d) When setting to "4: Terminal AI4 (option)" and entering the torque command with -10 to +10V, 0 to 10V, and 4 to 20mA



Set the input characteristics according to the load.
An input voltage of 10V or input current of 20mA is equivalent to 100%.

2) When setting the torque command as a value

Set [F420] = "12: F725" and set the torque command value in [F725: Panel torque command].

3) When setting communication in [F420]

"20: Embedded Ethernet"

Set the torque command to FA40.

"21: RS485 communication (connector 1)"

Set the torque command to FA30.

"22: RS485 communication (connector 2)"

Set the torque command to FA32.

"23: Communication option"

Set the torque command to FA33.

(4) Starting torque control

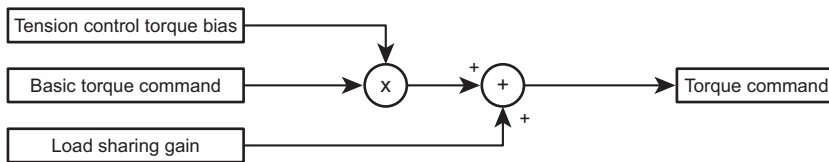
Switch speed control and torque control according to the setting of [CMOD].

- "0: Terminal"
Turn on the input terminal to which "112: Speed control/Torque control switching" is assigned.
- "2: Embedded Ethernet"
FA36: Set bit0 = ON.
- "3: RS485 communication (connector 1)"
FA00: Set bit0 = ON.
- "4: RS485 communication (connector 2)"
FA04: Set bit0 = ON.
- "5: Communication option"
FA06: Set bit0 = ON.

2.2 Setting a gain and a bias for torque command

You can multiply the torque command by a gain and add a bias to the torque command.

Torque command = Basic torque command x Tension torque bias + Load sharing gain



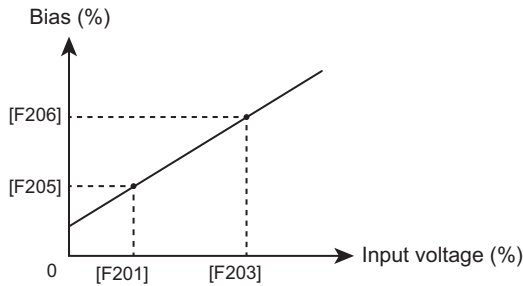
(1) Setting a mode of bias

Set a mode to enter the bias with [F423].

When [F423] = "0" and [F424] = "0", the gain = 1 and the bias = 0.

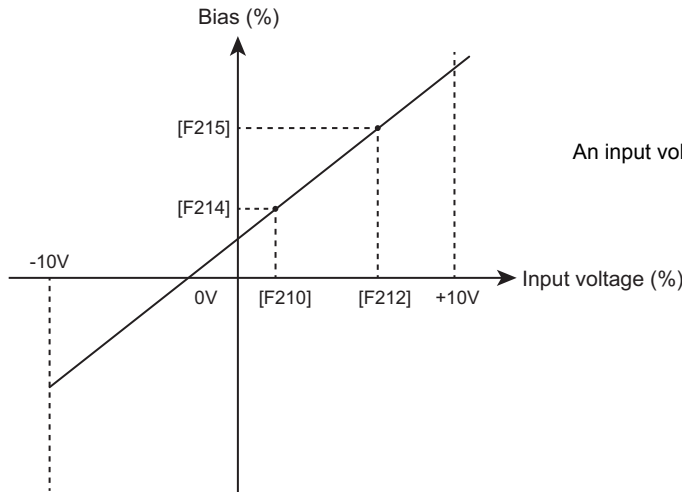
1) When setting analog input in [F423]

(a) When setting to "1: Terminal RR" and entering the bias with 0 to 10V



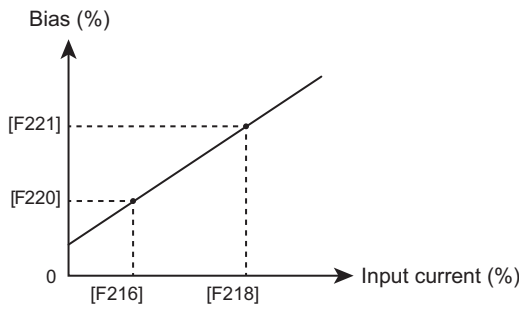
An input voltage of 10V is equivalent to 100%.

(b) When setting to "2: Terminal RX" and entering the bias with -10 to +10V



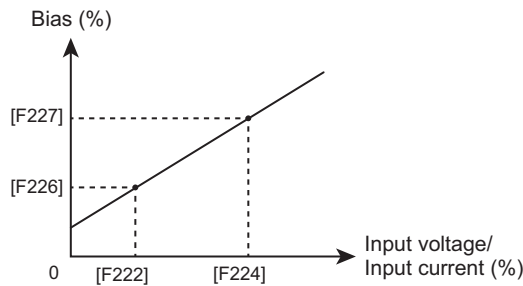
An input voltage of 10V is equivalent to 100%.

(c) When setting to "3: Terminal II" and entering the bias with 4 to 20mA



An input current of 20mA is equivalent to 100%.

(d) When setting to "4: Terminal AI4 (option)" and entering the bias with -10 to +10V, 0 to 10V, and 4 to 20mA



An input voltage of 10V or input current of 20mA is equivalent to 100%.

2) When setting the bias as a value

Set [F423] = "12: F727" and set the bias in [F727: Operation panel tension torque bias].

3) When setting communication in [F423]

"20: Embedded Ethernet"

Set the bias to FA40.

"21: RS485 communication (connector 1)"

Set the bias to FA30.

"22: RS485 communication (connector 2)"

Set the bias to FA32.

"23: Communication option"

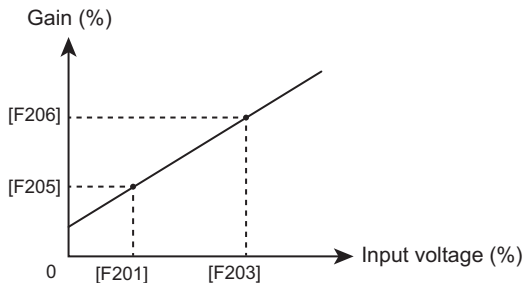
Set the bias to FA33.

(2) Setting a mode of gain

Set a mode to enter the gain with [F424].

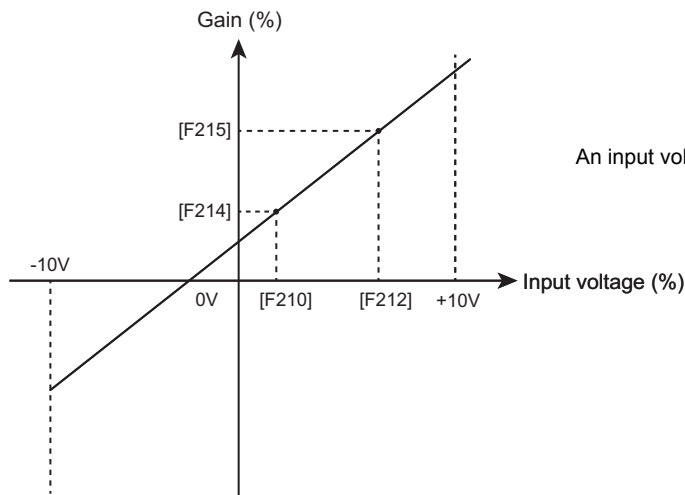
1) When setting analog input in [F424]

(a) When setting to "1: Terminal RR" and entering the gain with 0 to10V



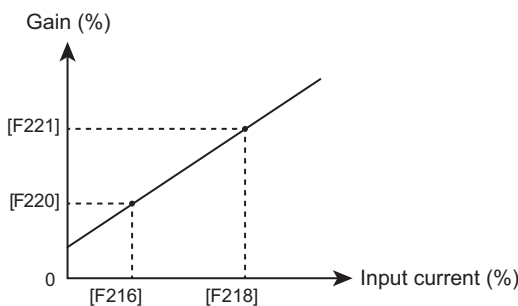
An input voltage of 10V is equivalent to 100%.

(b) When setting to "2: Terminal RX" and entering the gain with -10 to +10V



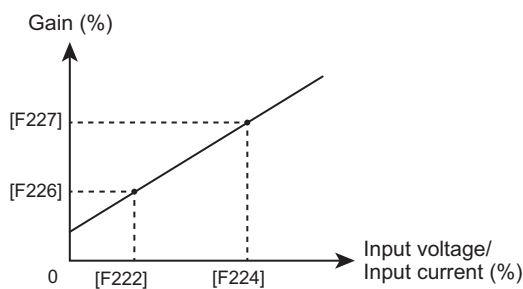
An input voltage of 10V is equivalent to 100%.

(c) When setting to "3: Terminal II" and entering the gain with 4 to 20mA



An input current of 20mA is equivalent to 100%.

(d) When setting to "4: Terminal AI4 (option)" and entering the gain with -10 to +10V, 0 to 10V, and 4 to 20mA



An input voltage of 10V or input current of 20mA is equivalent to 100%.

2) When setting the gain as a value

Set [F424] = "12: F728" and set the gain in [F728: Operation panel load sharing gain].

3) When setting communication in [F424]

"20: Embedded Ethernet"

Set the gain to FA40.

"21: RS485 communication (connector 1)"

Set the gain to FA30.

"22: RS485 communication (connector 2)"

Set the gain to FA32.

"23: Communication option"

Set the gain to FA33.

2.3 Setting a torque command filter

The torque command can be filtered.

Set the time in [F421: Torque command filter].

3. Setting of speed limits during torque control

When the load torque decreases during operation in torque control mode, the output frequency (speed) of the inverter increases. You can set speed limits to protect your machine.

There are two methods to limit the frequency.

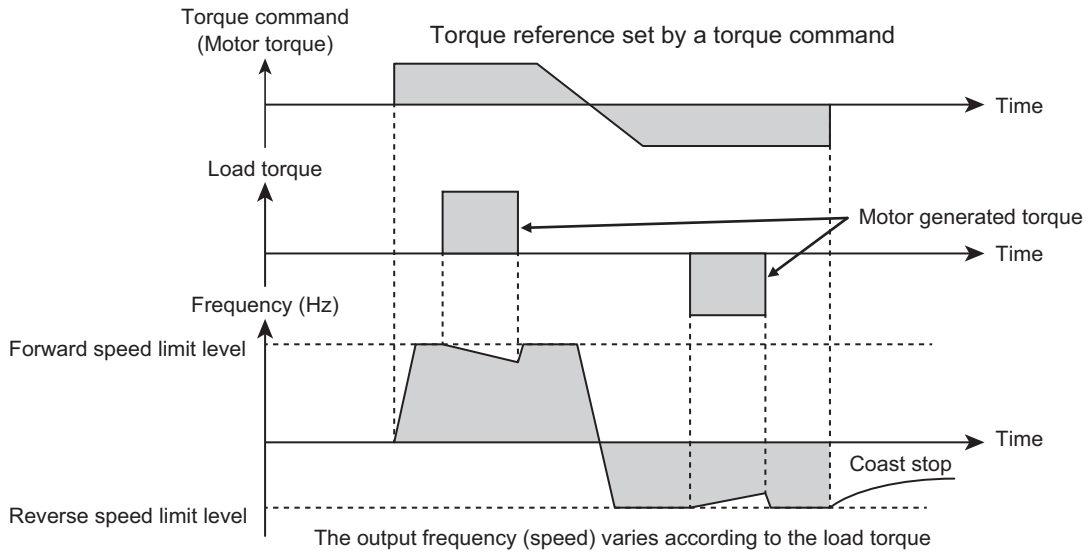
- Setting the forward and reverse speed limits
 - Setting the center value of speed limits and setting the speed limit band in positive and negative directions from the center value
- In addition, you can set limits not to rotate in direction opposite to the command direction.

3.1 Setting the forward and reverse speed limits

(1) Motions with speed limits

When torque command > load torque, the speed increases to reach the speed limit level.

When torque command < load torque, the speed decreases.



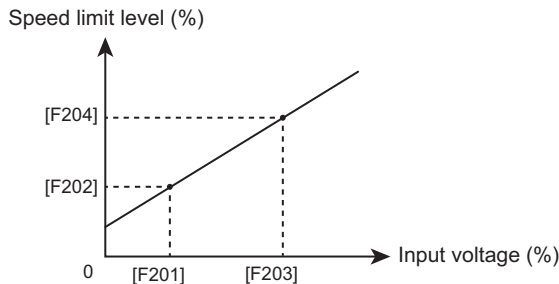
(2) Setting a mode of speed limit level

Set a mode to enter the speed limit level.

Set in [F425: Fwd speed limit input] for forward run and in [F427: Rev speed limit input] for reverse run.

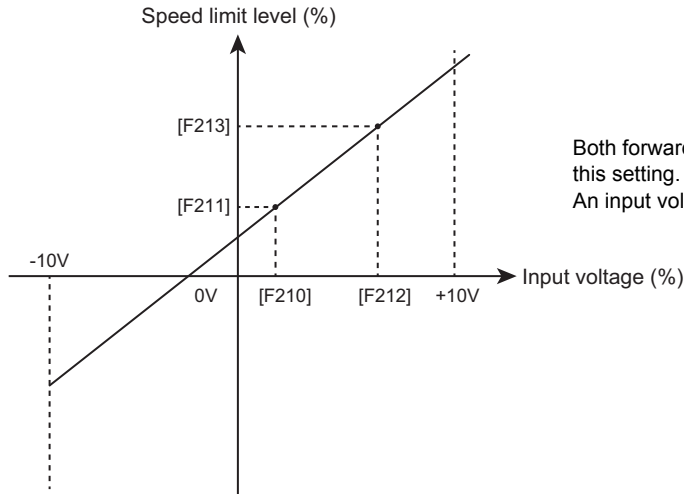
1) When setting analog input in [F425] and [F427]

(a) When setting to "1: Terminal RR" and entering the speed limit level with 0 to10V



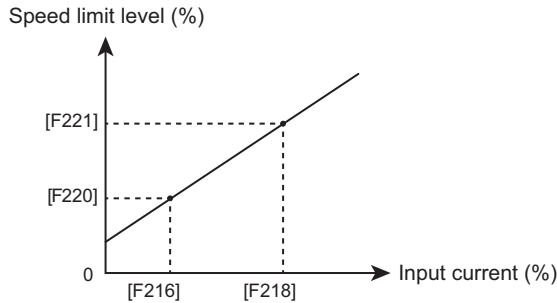
Both forward run and reverse run are performed according to this setting.
An input voltage of 10V is equivalent to 100%.

(b) When setting to "2: Terminal RX" and entering the speed limit level with -10 to +10V



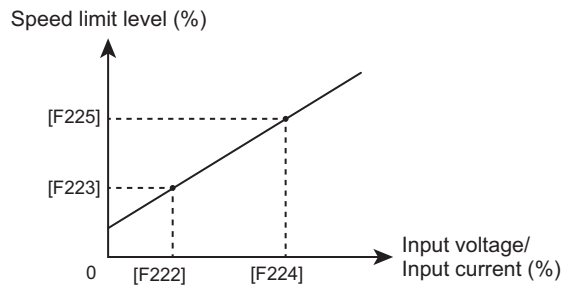
Both forward run and reverse run are performed according to this setting.
An input voltage of 10V is equivalent to 100%.

(c) When setting to "3: Terminal II" and entering the speed limit level with 4 to 20mA



Both forward run and reverse run are performed according to this setting.
An input current of 20mA is equivalent to 100%.

(d) When setting to "4: Terminal AI4 (option)" and entering the speed limit level with -10 to +10V, 0 to 10V, and 4 to 20mA



Both forward run and reverse run are performed according to this setting.
An input voltage of 10V or input current of 20mA is equivalent to 100%.

2) When setting the speed limit level with a value

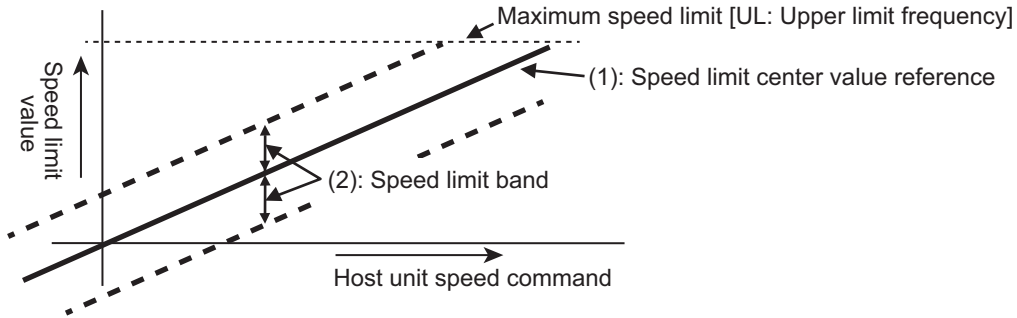
For forward run, set [F425] = "12: F426" and set a value in [F426: Fwd speed limit level].

For reverse run, set [F427] = "12: F428" and set a value in [F428: Rev speed limit level].

3.2 Setting the center value of speed limits and setting the speed limit band in positive and negative directions from the center value

(1) Motions with speed limits

Generally, this setting is applied when operating a slave unit that follows the speed of the host unit. By setting the speed limit band with the speed command of the host unit as the speed limit center value, the speed of the slave unit can be limited with \pm speed limit band against the speed of the host unit.

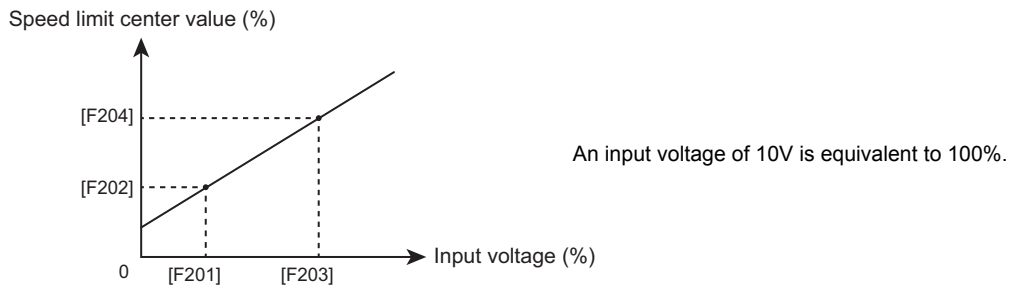


(2) Setting the speed limit level

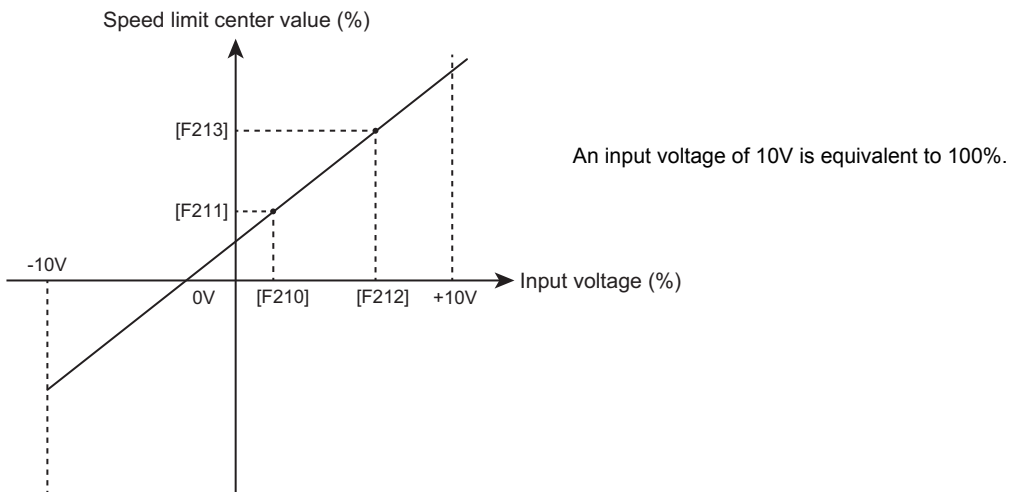
The speed limit can be set between "center value - speed limit band" and "center value + speed limit band." Set a mode to enter the speed limit center value with [F430: Speed limit center value input select]. Set the speed limit band for the center value in [F432: Speed limit band].

1) When setting analog input in [F430]

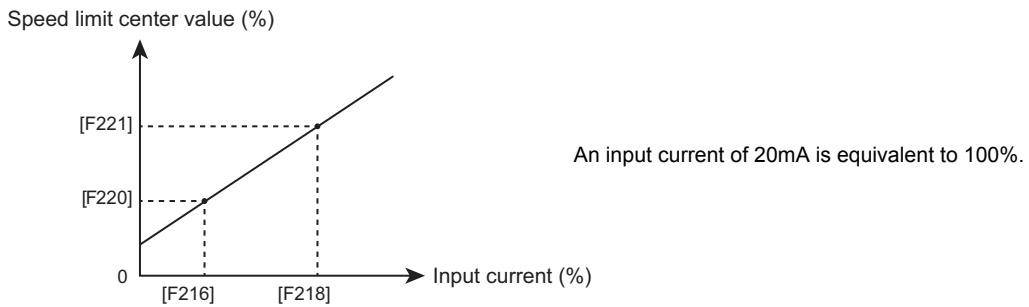
(a) When setting to "1: Terminal RR" and entering the speed limit center value with 0 to 10V



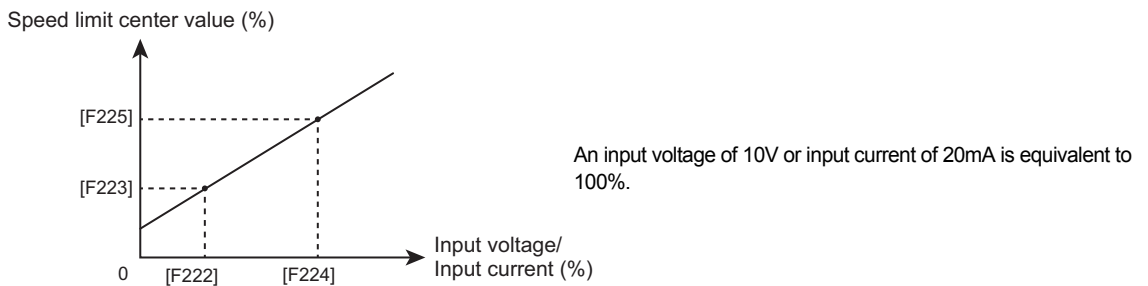
(b) When setting to "2: Terminal RX" and entering the speed limit center value with -10 to +10V



(c) When setting to "3: Terminal II" and entering the speed limit center value with 4 to 20mA



(d) When setting to "4: Terminal AI4 (option)" and entering the speed limit center value with -10 to +10V, 0 to 10V, and 4 to 20mA



2) When setting the speed limit level with a value

Set [F430] = "12: F431" and set a value in "F431: Speed limit center value].

3.3 Limiting not to rotate in the direction opposite to the command direction

Set [F435: Rotation direction limit during torque control] = "1: Command direction permit."

Define the command direction as follows with the setting of [CMOd: Run command selection].

"0: Terminal"

Forward run with Terminal F (input terminal function "2: Fwd run") ON, reverse run with Terminal R (input terminal function "4: Rev run") ON

"2: Embedded Ethernet"

FA36: Forward run when bit9 = OFF, reverse run when bit9 = ON

"3: RS485 communication (connector 1)"

FA00: Forward run when bit9 = OFF, reverse run when bit9 = ON

"4: RS485 communication (connector 2)"

FA04: Forward run when bit9 = OFF, reverse run when bit9 = ON

"5: Communication option"

FA06: Forward run when bit9 = OFF, reverse run when bit9 = ON

4. Application of torque control

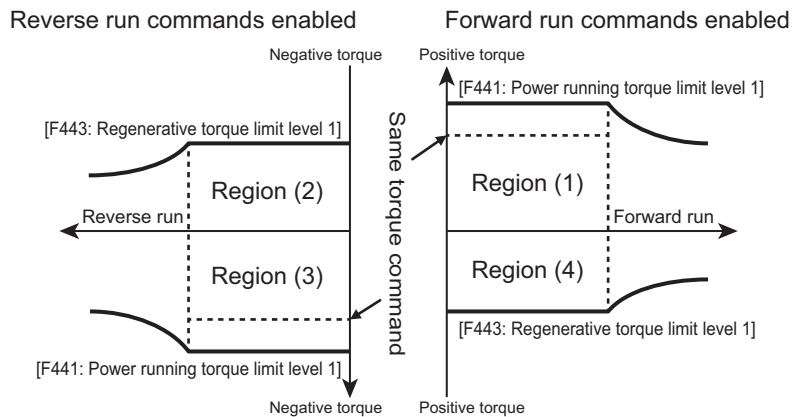
4.1 Applied to application where the direction of rotation does not change

If the direction of rotation does not change continuously because of the machine characteristics, set [F455: Torque command polarity at Rev] = "0: Regeneration at positive torque command."

As shown in the figure below, the power running torque command is positive (+) and the regenerative torque command is negative (+).

Limit the power running torque in [F441: Power running torque limit level 1] and the regenerative torque in [F443: Regenerative torque limit level 1].

This setting is used for applications where the rotation direction is determined.



For the torque limit level, Power running/Regenerative torque limit 1 - 4 can be switched with ON/OFF of input terminals. Assign "32: Stall prevention switching/Torque limit switching 1" and "34: Torque limit switching 2" to two unused input terminals.

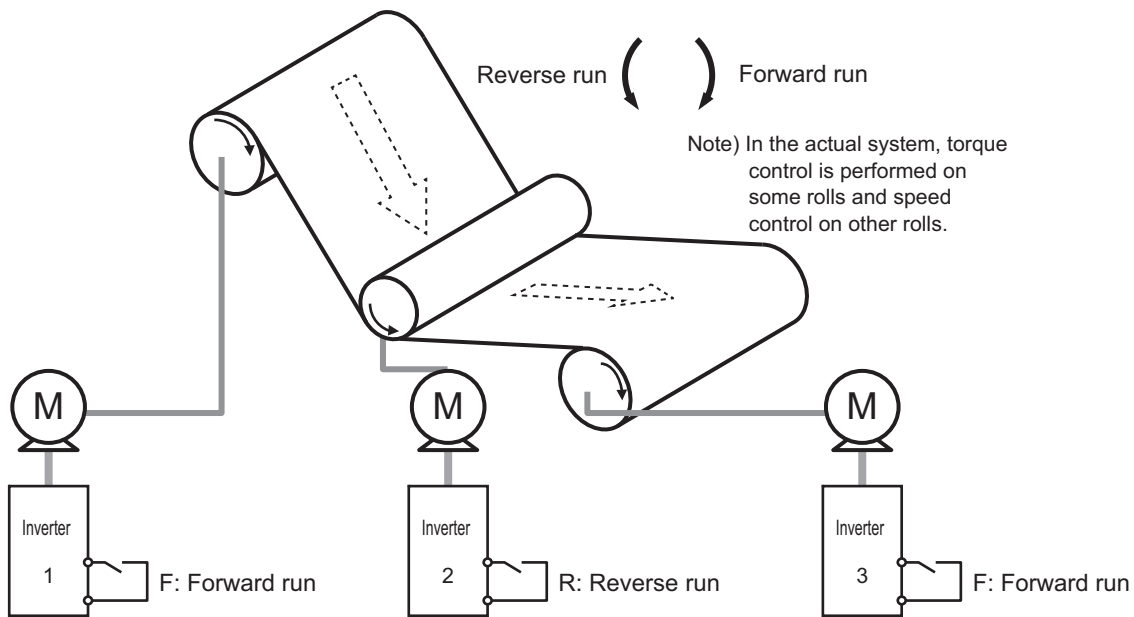
	32: Stall prevention switching/ Torque limit switching 1	34: Torque limit switching 2
Torque limit level 1	OFF	OFF
Torque limit level 2	ON	OFF
Torque limit level 3	OFF	ON
Torque limit level 4	ON	ON

Example of application:

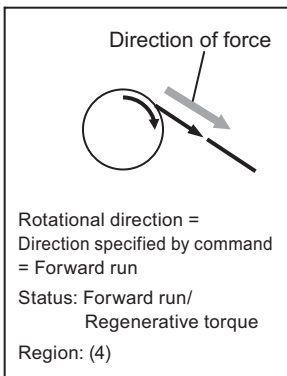
In paper manufacturing lines and so on, once machines have been set up, the directions of rotation of their motors are fixed and forward run and reverse run are not switched in succession. When controlling the system, the torque produced in the direction specified by a rotation command is assumed to be positive torque and the torque produced in the direction opposite to that specified by the rotation command is assumed to be negative torque.

As shown in the figure below, the directions of rotation of the motors that drive rolls arranged in a line and rotate to send materials in one direction along the manufacturing line differ according to whether they are placed on this side or other side of the rolls that they drive. Since the product is sent in a fixed direction, the direction of rotation of each motor is determined by the command from the inverter, regardless of the operating status: power running or regenerative braking. In this case, a forward run command is selected for inverter 1 and a reverse run command for inverter 2. Set [F455: Torque command polarity at Rev] to prevent a motor from rotating in the direction opposite to that specified by a command.

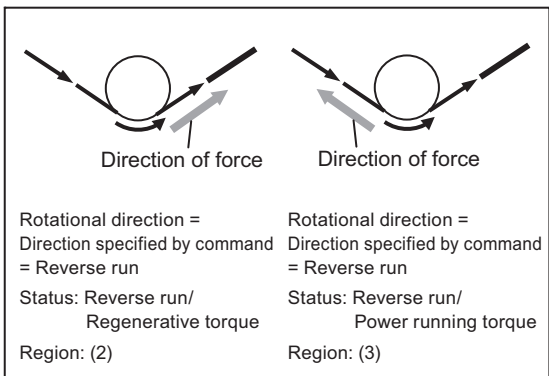
This setting is also used for fixing the side from which a rewinder sends out the material: upper or lower side.



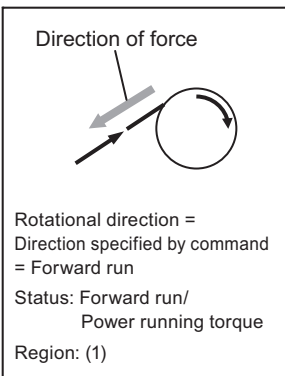
When torque control is performed by inverter 1



When torque control is performed by inverter 2



When torque control is performed by inverter 3



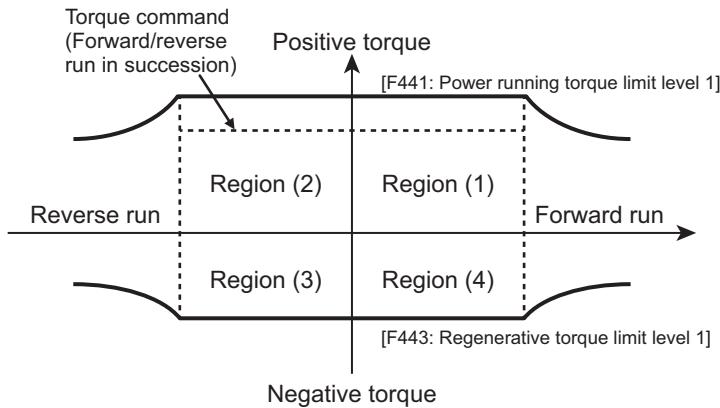
4.2 Applied to application where the direction of rotation changes

If the direction of rotation of the motor changes continuously while the direction in which a force is applied does not change, set [F455: Torque command polarity at Rev] = [1: Power running at positive torque command].

As shown in the figure below, the torque command on the positive side is positive (+), and the torque command on the negative side is negative (-).

Limit the torque on the positive side in [F441: Power running torque limit level 1] and the torque on the negative side in [F443: Regenerative torque limit level 1]. For the torque limit level, Power running/Regenerative torque limit 1 - 4 can be switched with ON/OFF of input terminals.

This setting is used for applications where the rotation direction is not determined.



Example of application:

This setting is used for controlling a motor whose direction of rotation (power running or regenerative braking) is determined regardless of the command (F or R command) from the inverter. As shown in the figures below, it is used for applications where the direction of rotation of the motor and its operating status (power running or regenerative braking) may change in succession according to the load torque even with the same command.

