

VF-nC3

Motor Control instruction manual

(basic edition)

Confidential 秘

This manual is the engineering fortune of
Toshiba Schneider Inverter Corporation.

All of the release, reproduction, diversion
and alteration of contents are strictly
prohibited.

This manual is deals with firmware "Ver110".
The firmware will be updated without any notice.

CONTENTS

| | | |
|----------|--|----------|
| 1 | FOR THE BEST PERFORMANCE OF MOTOR DRIVE | 2 |
| 1.1 | THE SELECTION OF V/F CONTROL MODE..... | 2 |
| 1.2 | V/F PARAMETER SETTING..... | 2 |
| 1.3 | EXECUTION OF AUTO-TUNING | 3 |
| 2 | TROUBLE SHOOTING..... | 6 |
| 2.1 | TROUBLE AT ACCELERATION / DECELERATION | 6 |
| 2.2 | TROUBLE AT CONSTANT SPEED | 8 |
| 2.3 | TROUBLE AT FIELD WEAKENING AREA (OVER THE MOTOR RATED SPEED) | 10 |
| 2.4 | TROUBLE AT POWER RIDE THROUGH | 10 |
| 2.5 | TROUBLE AT CATCH ON FLY..... | 11 |
| 2.6 | TROUBLE AT DC INJECTION | 11 |

1 FOR THE BEST PERFORMANCE OF MOTOR DRIVE

VF-nC3 has several motor control mode as V/f (for standard drive), variable torque (for fan and pump), automatic torque boost (for high starting torque), vector control (for constant speed even at high torque), and energy saving (for high efficiency drive) .

The parameter setting for the best performance for each control mode

1.1 the selection of V/f control mode

| Name | Com. No. | function | unit | minimum unit Panel / com | values | factory setting |
|------|----------|----------------------------|------|-----------------------------|---|--------------------|
| pt | 0015 | V/f control mode selection | — | — | 0: V/f constant 1: variable torque 2: Automatic torque boost 3: Vector control 4: Energy saving | 0 |

- V/f constant (PT=0)
The output voltage is proportional to the frequency. It is the standard control for various uses.
- Variable torque (PT=1)
The output voltage is proportional to the square of frequency. It is for the fan and pump to save the energy.
- Automatic torque boost (PT=2)
It is better to use the case that needs high starting torque.
- Vector control (PT=3)
It is better to use the case that needs high torque at low speed, or reduces the speed fluctuation with load.
- Energy saving (PT=4)
The motor flux is automatically adjusted to the point of highest efficiency.
Big energy saving effect is achieved in case of the frequently light load driving.

1.2 V/f parameter setting

It is necessary to set these 2 parameters below.

| Name | Com. No. | function | unit | minimum unit Panel / com | values | factory setting |
|------|----------|--------------------------|------|-----------------------------|--------------|-----------------|
| vl | 0014 | base frequency 1 | Hz | 0.1/0.01 | 20.00-400.00 | *1 |
| vlv | 0409 | base frequency voltage 1 | V | 0.1/0.1 | 50.0-330.0 | *1 |

*1 depends on the setting of "Set up menu". Please refer to the instruction manual 11.5.

1.3 Execution of Auto-tuning

It is necessary to adjust F402 in case PT=2(automatic torque boost), 3(vector control), 4(energy saving) are selected. To adjust F402, it is convenient to use Auto-tuning function.

Here after is the step of the auto-tuning.

Step1: To set motor name-plate information

| Name | Com. No. | function | unit | minimum unit Panel / com | values | factory setting |
|------|----------|---------------------|-------|-----------------------------|-----------|-----------------|
| f405 | 0405 | motor rated power | kW | 0.01/0.01 | 0.01-5.50 | *2 |
| f415 | 0415 | motor rated current | A | 0.1/0.1 | 0.1-30.0 | *2 |
| f417 | 0417 | motor rated speed | min-1 | 1/1 | 100-32000 | *1 |

*1 depends on the setting of "Set up menu". Please refer to the instruction manual 11.5.

*2 depends on product range. Please refer to the instruction manual 11.4.

Step2: To execute auto-tuning function

Auto-tuning is performed at the beginning of the running just after F400 is set to 2. It is finished less than 3 seconds.

After auto-tuning is performed, F402 is automatically set to appropriate value.

Auto-tuning is recommended to be executed in case motor is in cold state (around 0 – 40 degree C.)

In case there is a fault during auto-tuning, ETN1 trip appears in the LED display. In this case F402 is not changed.

The trouble shooting for ETN1 trip is described in the section 13 of instruction manual.

| Name | Com. No. | function | unit | minimum unit Panel / com | values | factory setting |
|------|----------|-------------|------|-----------------------------|--------|-----------------|
| f400 | 0400 | Auto tuning | - | 1/1 | 0 - 2 | 0 |

That's all for the motor parameter setting.

If any trouble occurs, please refer to the section 2 "trouble shooting" in this manual, and set proper parameters.

The list of the motor parameters is attached to the next page.

nC3 motor parameter list

| | parameter | function | P _L control law | | | | | Accessible during running ? | For what ? | Default setting | Parameter range |
|-----------------------------|------------------|--|----------------------------|-----------------|------------------------|----------------|---------------|-----------------------------|---|-----------------|-----------------|
| | | | 0 | 1 | 2 | 3 | 4 | | | | |
| | | | V/f constant | Variable torque | Automatic torque boost | Vector control | Energy saving | | | | |
| Basic parameter | ωL [Hz] | Basic frequency 1 | ★ | ★ | ★ | ★ | ★ | Yes | V/f ratio (rotor flux) | *2 | 20.0~400.0 |
| | $\omega L U$ [V] | Basic voltage 1 | ★ | ★ | ★ | ★ | ★ | Yes | V/f ratio (rotor flux) | *2 | 50~330 |
| | F405 [kW] | Motor rated power | — | — | ★ | ★ | ★ | No | Motor power | *1 | 0.01~5.50 |
| | F412 [%] | motor coefficient 1 | △ | △ | ○ | ○ | ○ | No | Leakage coefficient | 5.0 | 0.0~20.0 |
| | F415 [A] | Motor rated current | △ | △ | ★ | ★ | ★ | No | Motor rated current | *1 | 0.1~30.0 |
| | F416 [%] | Motor no load current | △ | △ | ○ | ○ | ○ | No | Magnetizing current | *1 | 10~90 |
| | F417 [rpm] | Motor rated speed | △ | △ | ★ | ★ | ★ | No | -Rated speed -Rotor time constant | *2 | 100~32000 |
| | ωb [%] | Torque boost 1 | ○ | ○ | — | — | — | Yes | Stator resistance compensation | *1 | 0.0~30.0 |
| | F402 [%] | Automatic torque boost | — | — | ☆ | ☆ | ☆ | Yes | Stator resistance compensation | *1 | 0.0~30.0 |
| Adjust parameter | F401 [%] | Slip gain | — | — | — | ○ | — | Yes | Slip gain | 50 | 0~150 |
| | F480 [%] | motor coefficient 7 | — | — | ○ | ○ | ○ | No | Increasing flux at low speed | 120 | 100~150 |
| | F485 [%] | motor coefficient 8 | ○ | ○ | ○ | ○ | ○ | No | Current limit at field weakening | 100 | 10~250 |
| | F495 [%] | motor coefficient 9 | ○ | ○ | ○ | ○ | ○ | No | Over-modulation rate | 104 | 90~110 |
| | F491 or F657 [%] | motor coefficient 10 | ○ | ○ | ○ | ○ | ○ | No | Ramp rate for speed search | 133 | 10~200 |
| Speed loop adjust parameter | F459 | Load inertia | — | — | — | ○ | ○ | Yes | Load inertia | 1.0 | 0.1~100.0 |
| | F460 [Hz] | Motor special constant 3 | — | — | — | ○ | ○ | Yes | Speed loop gain | 0.0 | 0.0~25.0 |
| | F461 | Motor special constant 4 | — | — | — | ○ | ○ | Yes | Speed loop dumping coefficient | 1.00 | 0.50~2.50 |
| | F462 | Motor special constant 5 | — | — | — | ○ | ○ | Yes | Speed loop filter | 35 | 0~100 |
| | F467 | Motor special constant 6 | ○ | ○ | ○ | — | — | Yes | Current differential gain | 10 | 0~100 |
| | F652 [Hz] | OP stall gain | ○ | ○ | ○ | ○ | ○ | No | OP stall gain | 0.0 | 0.0~25.0 |
| | F654 [Hz] | Current differential time constant (inverse) | ○ | ○ | ○ | — | — | No | Current differential time constant (inverse) (Hz) | 20 | 1~250 |
| Current loop gain | F458 [Hz] | Current loop gain | ○ | ○ | ○ | ○ | ○ | No | Current loop gain | 0 | 0~100 |
| | F649 | Current loop dumping coefficient | ○ | ○ | ○ | ○ | ○ | No | Current loop dumping coefficient | 0.00 | 0.00~2.55 |

*1 depends on the setting of "Set up menu". Please refer to the instruction manual 11.5.

*2 depends on product range. Please refer to the instruction manual 11.4.

- ★ : the parameter to be set mandatory
- ☆ : the parameter to be set automatically by auto-tuning
- : the parameter to be set if necessary
- △ : the parameter no need to be set
- : the parameter not to be used

2 TROUBLE SHOOTING

In this section, it is described how to solve the trouble at each trouble.

2.1 trouble at acceleration / deceleration

| Trouble contents | Solution | Note |
|---|---|---|
| <ul style="list-style-type: none"> - Motor speed is overshoot after acceleration is finished. - Motor speed is undershoot (goes round to opposite direction) before deceleration stop | <p>PT=0,1,2</p> <ul style="list-style-type: none"> - The current differential gain is too high even if load inertia is big. To decrease F467 every 5. <p>PT=3,4</p> <ul style="list-style-type: none"> -To adjust F459 (factory setting is 1.0) as follows <in case the GD2 of the motor and load are known> To set correct value of F459 by "F459 calculation tool" (*3). <in case the GD2 of the motor or load is unknown> First, to set F459 the approximate value "(The total GD2 of load and motor) / (motor GD2)" . Then, in case the trouble is not solved, increase F459 every 0.5 . -To increase F461(factory setting is 1.00) every 0.1 up to 1.30. | <p>PT=0,1,2 refer to the "detail manual for IM" section 3</p> <p>PT=3,4 refer to the "detail manual for IM" section 2</p> |
| <ul style="list-style-type: none"> - "P" alarm is displayed, or OP trip occurs after acceleration is finished. <p>PT=3,4</p> | <ul style="list-style-type: none"> -To adjust F459 (factory setting is 1.0) as follows <in case the GD2 of the motor and load are known> To set correct value of F459 by "F459 calculation tool" (*3). <in case the GD2 of the motor or load is unknown> First, to set F459 the approximate value "(The total GD2 of load and motor) / (motor GD2)" . Then, in case the trouble is not solved, increase F459 every 0.5 . -To increase F461(factory setting is 1.00) every 0.1 up to 1.30. | <p>refer to the "detail manual for IM" section 2</p> |
| <ul style="list-style-type: none"> - Motor is vibrating during acceleration and deceleration. <p>PT=0,1,2</p> | <ul style="list-style-type: none"> - The current differential gain is too low even if load inertia is small. To increase F467 every 5. | <p>refer to the "detail manual for IM" section 3</p> |
| <ul style="list-style-type: none"> - There is some delay when motor speed reaches to speed command after acceleration if finished. <p>PT=3,4</p> | <ul style="list-style-type: none"> -To adjust F459 (factory setting is 1.0) as follows <in case the GD2 of the motor and load are known> To set correct value of F459 by "F459 calculation tool" (*3). <in case the GD2 of the motor or load is unknown> First, to set F459 the approximate value "(The total GD2 of load and motor) / (motor GD2)" . Then, in case the trouble is not solved, decrease F459 every 0.5 . -To decrease F461(factory setting is 1.00) every 0.1 up to 0.80. | <p>refer to the "detail manual for IM" section 2</p> |
| <ul style="list-style-type: none"> - After recovery from current(torque) limitation state, speed is not rapidly recovered. (want to recover the speed as fast as possible) | <ul style="list-style-type: none"> - To set FB81 to 32768.(*4) | <p>refer to the "detail manual for IM" section 13</p> |

| | | |
|---|--|--|
| <p>- In case of small inertia, deceleration time (deceleration distance) can not be shorten.</p> | <p>- To set F307=2(no voltage compensation) in case PT=0. - To set F305=3(dynamic over flux dec.) in case PT=2,3 - To change PT to 0,2,3 in case PT=1,4</p> | <p>refer to the "detail manual for IM" section 4</p> |
| <p>- OP trip occurs during normal deceleration in case F307=0 (no voltage compensation, with voltage limitation) PT=0,1</p> | <p>- Because of "no voltage compensation", there is far from theoretical circuit equation in case Vbus is increased. Furthermore, output voltage is not properly controlled in case output frequency is high, because output voltage is limited. To change F307 as below. (1) in case output voltage must be limited, to set F307=1 , and confirm VL and VLV. (2) In case to keep compatibility to commercial power drive, to set F307=2.</p> | |

(*4) FB81 is super user parameter. It can be changed only by our corporate engineer.
 In case super user parameter is changed, modification record must be clearly made.

2.2 trouble at constant speed

| Trouble contents | Solution | Note |
|--|--|--|
| - Motor speed is reduced in case load is increased. PT=3 | - To increase F401(slip gain) up to 100. In case F401 is too big, motor speed is increased in case load is increased. | |
| - E-20 trip occurs at start and stop. PT=2,3,4 | - To confirm motor parameters from name plate, and do the auto-tuning again. (to follow the section 1.1 – 1.3) | |
| - Start up torque is not enough even if auto-tuning is done. PT=2,3,4 | - To increase F480 every 5. | refer to the "detail manual for IM" section 5 |
| - In case motor cable is long, Start up torque is not enough even if auto-tuning is done. PT=2,3,4 | - In case of long cable (more than 30m : shielded cable, 60m: non-shielded cable), start up torque is not enough in some case. To increase F402 up to 110% of present value. | |
| - Motor is vibrated against external disturbance. PT=0,1,2 | - The current differential gain is too low even if load inertia is small. To increase F467 every 5. | refer to the "detail manual for IM" section 3 |
| - Speed is overshoot against the disturbance PT=3,4 | -To adjust F459 (factory setting is 1.0) as follows <in case the GD2 of the motor and load are known> To set correct value of F459 by "F459 calculation tool" (*3). <in case the GD2 of the motor or load is unknown> First, to set F459 the approximate value “(The total GD2 of load and motor) / (motor GD2)” . Then, in case the trouble is not solved, increase F459 every 0.5 . -To increase F461(factory setting is 1.00) every 0.1 up to 1.30. | refer to the "detail manual for IM" section 2 |
| - There is some delay motor speed is recovered after the disturbance PT=3,4 | -To adjust F459 (factory setting is 1.0) as follows <in case the GD2 of the motor and load are known> To set correct value of F459 by "F459 calculation tool" (*3). <in case the GD2 of the motor or load is unknown> First, to set F459 the approximate value “(The total GD2 of load and motor) / (motor GD2)” . Then, in case the trouble is not solved, decrease F459 every 0.5 . -To decrease F461(factory setting is 1.00) every 0.1 up to 0.80. | refer to the "detail manual for IM" section 2 |
| - Speed monitor increases around 1Hz at instant power break down. | - To set FB52=3.0. If the problem is not improved, to decrease FB52 every 1.0. In case FB52 is small, the possibility of OP trip is increased. (*4) | |
| - Motor acoustic noise is larger than nC1 at the area that the modulation rate is 30-50%. | - To set F315 . (motor noise is as same as that of nC1) BUT, it has a risk described in the "section 10.2 in the detailed manual for IM" to modify F315. Before to set F315, you HAVE TO discuss with (TSIJ) design team to confirm whether it is possible or not to set F315. | refer to the "detail manual for IM" section 10 |

(*4) FB52 is super user parameter. It can be changed only by our corporate engineer.
In case super user parameter is changed, modification record must be clearly made.

*3 F459 calculation tool

The calculation tool by Excel as below.

F459 is automatically calculated when user input several needed value.

The calculation for the setting value of F459

1 To set the inverter rated power and voltage(refer to the name plate) to the cell [] in table 1.

| | |
|----------------------------|-----|
| inverter rated voltage (V) | 200 |
| inverter rated power (kW) | 3.7 |

2 To set the motor rated power, current and pole number (refer to the name plate) to the cell [] in table 2.

| | |
|-------------------------|-----|
| motor rated current (A) | 10 |
| motor rated power (kW) | 2.2 |
| motor pole number | 4 |

3 To set the motor inertia (motor only) to the cell [] in table 3.

| | |
|-----------------------------------|-------|
| Jm: motor GD2 (kgm ²) | 0.006 |
|-----------------------------------|-------|

(how to set table 3)

In case of Toshiba standard motor (FBKA(W)21 / FBKK(W)8)

A: to set motor type form to the cell [] in table 3-A

B: When push the button "Jm calculation", the value of "motor GD2" is set to the cell [] in the table 3.

| | | |
|-----------------|---|--|
| motor type-form | 2 | (To set 1 in case of FBKK(W)8, 2 in case of FBKA(W)21) |
|-----------------|---|--|

Jm calculation

In case motor GD2 is already known

To set the value "Jm =GD2 /4" to the cell [] in the table 3

4 To set the load GD2 to the cell [] in table 4.

| | |
|------------------------------------|---|
| Jload: load GD2(kgm ²) | 0 |
|------------------------------------|---|

(how to set table 4)

In case load GD2 is already known

To set the value "Jload =GD2 /4" to the cell [] in the table 4

5 To push the button "F459 calculation"

the value of F459 setting is displayed on the cell [] in the table 5.

| | | | |
|--------------------|------|------------------|-------------------------|
| F459 setting value | 1.14 | F459 calculation | calculation is finished |
|--------------------|------|------------------|-------------------------|

2.3 trouble at field weakening area (over the motor rated speed)

| Trouble contents | Solution | Note |
|--|--|---|
| - Speed stall occurs at field weakening area | - To reduce F485(factory setting is 100) every 10. it means that current limitation level for field weakening area is reduced by decrease F485. | refer to the "detail manual for IM" section 6 |
| - Motor current is large at field weakening area | - To increase F495(factory setting is 104) up to 110. it means to increase the output voltage at field weakening area. (therefore current is reduced) But, in case motor oscillation is increased, to keep F495 to the default value. | refer to the "detail manual for IM" section 7 |
| - Motor oscillation occurs at field weakening area | - To decrease F495(factory setting is 104) up to 90. The output voltage is not sinusoidal wave at over modulation area. It causes motor oscillation. | refer to the "detail manual for IM" section 7 |
| - E-13 trip occurs at torque disturbance or load is off at field weakening area PT=3,4 | -To adjust F459 (factory setting is 1.0) as follows <in case the GD2 of the motor and load are known> To set correct value of F459 by "F459 calculation tool" (*3). <in case the GD2 of the motor or load is unknown> First, to set F459 the approximate value “(The total GD2 of load and motor) / (motor GD2)” . Then, in case the trouble is not solved, increase F459 every 0.5 . -To increase F460 (factory setting is 0.0) up to 10.0 . -To increase F461(factory setting is 1.00) every 0.1 up to 1.30. -To increase FH every 10Hz in case FH and speed command are same. (it is in the case the problem still occurs even if these adjustment above are already done) | refer to the "detail manual for IM" section 2 |

2.4 trouble at power ride through

| Trouble contents | Solution | Note |
|--|---|---|
| - OP trip occurs during "ramp stop" | - To set F412=10.0 - To decrease FB54 every 5 (*5) | refer to the "detail manual for IM" section 8 |
| - Motor is vibrating and MOFF occurs during "bus-maintain" | - To set F412=10.0 - To decrease FB54 every 5 (*5) | refer to the "detail manual for IM" section 8 |

(*4) FB54 is super user parameter. It can be changed only by our corporate engineer.
In case super user parameter is changed, modification record must be clearly made.

2.5 trouble at catch on fly

| Trouble contents | Solution | Note |
|---|---|---|
| - Motor speed can not be detected and start to 0Hz. | - To set FB57=70 in case FB57=0. - To reduce FB57 every 5 in case FB57 is not 0 | refer to the "detail manual for IM" section 9 |
| - Motor is little bit rotated during catch on fly | - NO countermeasure in case FB57=0. - To increase FB57 every 5 in case FB57 is not 0 | refer to the "detail manual for IM" section 9 |
| - Motor speed can not be detected only at speed upper limit(UL) | - To set F415(motor rated current) correctly | refer to the "detail manual for IM" section 9 |

* After Software version V108, F491(FP) was added, and it corresponds to FB57.(FB57 still remains.)

So, please read FB57 as F491 in this table. Moreover, the factory setting of the parameter was set to 133 for all models.

2.6 trouble at DC injection

| Trouble contents | Solution | Note |
|---|--|--|
| - Motor is little bit rotated to opposite direction | - To increase F250 every 0.5Hz up to rated slip frequency (in case F250 is small) - To reduce F467 every 5 (in case PT=0,1,2) | refer to the "detail manual for IM" section 12 |