



SAFTRONICS

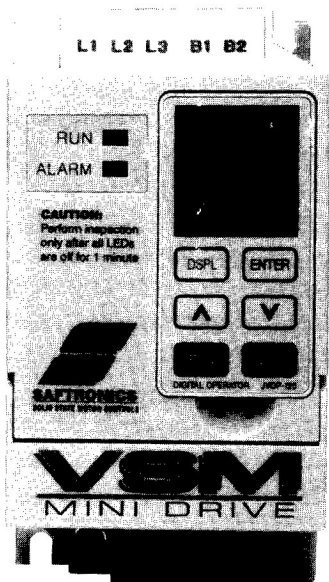
SOLID STATE MOTOR CONTROLS

VSM mini

Ultra-compact Mini-inverter

User's Manual

230V, 3-phase: 0.1kW to 1.5kW



▲ DANGER

PRECAUTIONS

- 1) Do not connect or disconnect wiring, or perform signal checks while the power supply is turned ON.
- 2) The VSM series internal capacitor is still charged even after the power supply is turned OFF. To prevent electrical shock, disconnect all power before servicing the inverter, then wait at least one minute after the power supply is disconnected and all LED's are extinguished.
- 3) Do not perform a withstand voltage test or a megger test on any part of the VSM. This electronic equipment uses semiconductors and is vulnerable to high voltage.
- 4) Do not remove the operator unless the power supply is turned OFF. Never touch the printed circuit board while the power supply is turned ON.

Failure to observe these and other precautions highlighted in this manual will expose the user to high voltages, resulting in equipment damage, serious injury or death.

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1.1 INTRODUCTION

The VSM is a series of ultra-compact, all digital micro-inverters. With a power range of 0.1 to 2 HP (0.1 to 1.5 kW), it provides all the functionality of its larger, general-purpose counterparts. This functionality includes patented features like full-range automatic torque boost, electronic thermal motor overload, speed search, stall prevention, low-noise operation and various other features. Utilizing the latest microprocessor technology, members of the design team have collaborated to make the VSM the smallest 3-phase AC inverter in the world.

This manual details installation, start-up and operating procedures for the VSM series adjustable frequency drive controller. Descriptions of diagnostic and troubleshooting procedures are also included herein.

1.2 SPECIFICATIONS

| Model | XCBU | 230V 3-phase | 20P1 | 20P2 | 20P4 | 20P7 | 21P5 |
|---|---------------------------------------|--|------------|-----------|----------|---------|------|
| Output characteristics | Max. applicable motor output HP (kW)* | 0.13 (0.1) | 0.25 (0.2) | 0.5 (0.4) | 1 (0.75) | 2 (1.5) | |
| | Inverter capacity (kVA) | 0.3 | 0.6 | 1.1 | 1.9 | 2.6 | |
| | Rated output current (A) | 0.8 | 1.5 | 3.0 | 5.0 | 7.0 | |
| Max. output voltage (V) | 230V 3-phase | 200 to 230V (proportional to input voltage) | | | | | |
| | 240V single/3-phase | 200 to 240V (proportional to input voltage) | | | | | |
| Max. output frequency (Hz) | | 400Hz (programmable) | | | | | |
| Rated input voltage and frequency | 230V 3-phase | 3-phase: 200 to 230V, 50/60Hz | | | | | |
| | 240V single/3-phase | single-phase: 200 to 240V, 50/60Hz 3-phase: 200 to 230V, 50/60Hz | | | | | |
| Allowable voltage fluctuation | | -15% to +10% | | | | | |
| Allowable frequency fluctuation | | ±5% | | | | | |
| Control method | | Sine wave PWM w/ full-range automatic torque boost | | | | | |
| Frequency control range | | 0.5 to 400Hz | | | | | |
| Frequency accuracy (temperature change) | | Digital command: ±0.01% (14 to 122°F, -10 to +50°C) | | | | | |
| | | Analog command: ±1% (77°F ± 18°F, 25°C ± 10°C) | | | | | |
| Frequency setting resolution | | Digital operator reference: 0.1Hz (< 100Hz), 1Hz (100Hz or more) | | | | | |
| | | Analog reference: 0.06Hz/60Hz (1/1000) | | | | | |
| Output frequency resolution | | 0.1Hz | | | | | |
| Overload capacity | | 150% of rated output current for 1 minute | | | | | |
| Frequency reference signal | | 0 to +10VDC (20kΩ), 4 to 20mA (250kΩ) selectable | | | | | |
| Accel/decel time | | 0.1 to 999 sec (accel/decel times are set independently) | | | | | |
| Braking torque | | Short-term average deceleration torque:** 0.13HP; 0.25HP (0.1kW, 0.2kW): 150% | | | | | |
| | | 0.5HP; 1HP (0.4kW, 0.75kW): 100% 2HP (1.5kW): 50% or more Continuous regenerative torque: approximately 20% (150% w/ optional braking resistor, braking resistor built-in) | | | | | |
| V/f characteristics | | Custom V/f pattern is possible | | | | | |
| Motor overload protection | | Electronic thermal overload relay | | | | | |
| Instantaneous overcurrent | | Motor coasts to a stop at approx. 250% of inverter rated current | | | | | |
| Overload | | Motor coasts to a stop after 1 min. at 150% inverter rated output current | | | | | |
| Overvoltage | | Motor coasts to a stop if DC bus voltage exceeds 410V. | | | | | |
| Undervoltage | | Motor coasts to a stop when DC bus voltage is 200V or less (approx. 160V or less for single/3-phase series) | | | | | |
| Momentary power loss | | The following operations are selectable: Not provided (stops if power loss is 15ms or longer) Automatic restart at recovery from 0.5s power loss Automatic restart | | | | | |
| | | Protected by electronic circuit | | | | | |
| Heatsink overheat | | Protected by electronic circuit | | | | | |
| Current limit level (stall prevention) | | Independently programmable during accel and constant-speed running. Provided/not provided selectable during decel. | | | | | |
| Ground fault | | Protected by electronic circuit (overcurrent level) | | | | | |
| Power charge indication | | Run LED stays ON or digital operator LED stays ON. | | | | | |

| Model | XCBU | 230V 3-phase | 20P1 | 20P2 | 20P4 | 20P7 | 21P5 |
|--|-----------------------------|---|------|------|------|------|------|
| Input signals | Run/stop input | Two signals (forward run/stop, reverse run/stop) | | | | | |
| | Multi-function input | Three of the following Input signals are selectable: forward/reverse run (3-wire control), fault reset, external fault (N.O./N.C. contact input), multi-step speed operation, jog command, alternate accel/decel time selection, external baseblock (N.O./N.C. contact input), speed search command, accel/decel hold command, LOCAL/REMOTE selection, UP/DOWN command | | | | | |
| Output signals | Multi-function output | Two of the following output signals are selectable (1 N.O./N.C. contact output, 1 photo-coupler output): fault, running at frequency, zero speed, frequency detection (output frequency ≤ or ≥ set value), during overtorque detection, during baseblock, during undervoltage detection, during speed search, operation mode | | | | | |
| | Analog monitor | 0 to +10VDC output, programmable for output frequency or output current | | | | | |
| Standard functions | | Full-range automatic torque boost, fault retry, upper/lower frequency limit, DC injection braking current/time at start/stop, frequency reference gain/bias, jump frequency, analog meter calibrating gain, S-curve accel/decel, slip com- | | | | | |
| Display | Status Indicator LED | Run and ALARM LED's provided as standard | | | | | |
| | Digital operator (JVOP-120) | Monitors frequency reference, output frequency, output current, FWD/REV selection | | | | | |
| Terminals | | Screw terminals for both main circuit and control circuit | | | | | |
| Wiring distance between inverter and motor | | 100m or less | | | | | |
| Enclosure | | Open chassis (IP 20) | | | | | |
| Cooling method | | Self-cooling | | | | | |
| Environmental cond. | Ambient temperature | 14 to 122°F (-10 to 50°C) | | | | | |
| | Humidity | 95% RH or less (non-condensing) | | | | | |
| | Storage temperature*** | -4 to 140°F (-20 to 60°C) | | | | | |
| | Location | Indoor (free from corrosive gases or dust) | | | | | |
| | Elevation | 3,280 ft (1,000m) or less | | | | | |
| Vibration | | Up to 9.8m/s ² (1G) at less than 20Hz, up to 1m/s ² (0.2G) at 20 to 50Hz | | | | | |

* Based on a standard 4-pole motor for max. applicable motor output.

** Shows deceleration torque for an uncoupled motor decelerating from 60Hz w/ shortest time.

*** Temperature during shipping (for short periods of time)

1.3 PRELIMINARY INSPECTION

Receiving

After unpacking the VSM:

Verify that the part numbers on the drive nameplate match the numbers on your purchase order or packing slip.

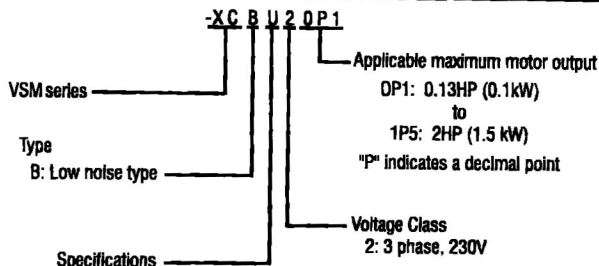
Check the unit for physical damage which may have occurred during shipping. If any part of the drive is missing or damaged, notify the carrier and your Safronics representative immediately.

If the drive will be stored after receiving, place it in its original packaging and store according to temperature specifications on page 3.

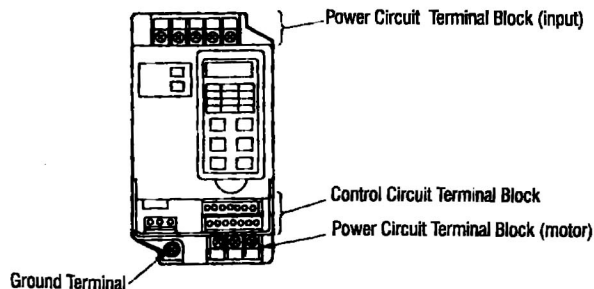
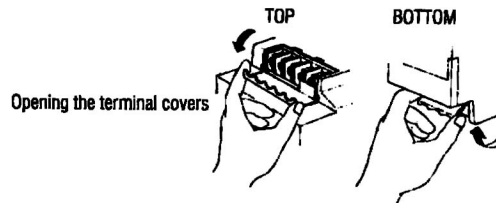
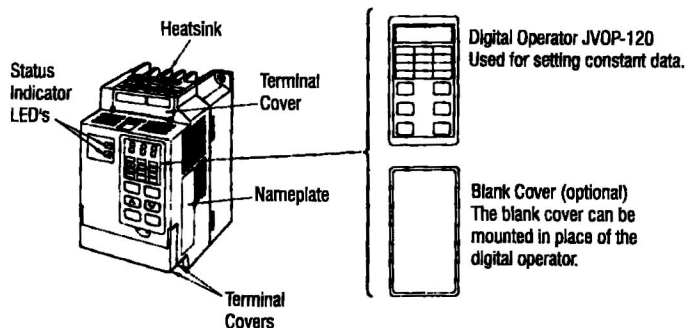
Checking the Nameplate

For Domestic Standards for 3-phase, 200VAC, 0.13HP (0.1kW)

| | |
|--------------|---------------------------------------|
| Inverter | MODEL : XCBU 20P1 SPEC : |
| model | INPUT : AC 3PH 200-230V 50/60 Hz 0.9A |
| Input spec. | OUTPUT : AC 3PH 0-230V 0.3kVA 0.8A |
| Output spec. | LOT NO : MASS 0.5 kg |
| Lot no. | SER NO : PRG : |
| Serial no. | |



Identifying the Parts



1.4 MOUNTING

Precautions

- 1) When preparing to mount the VSM, hold it by the heatsink.
- 2) The VSM generates heat. For the most effective cooling possible, mount it vertically. For more details, refer to "Dimensions" and "Clearances" on page 7.

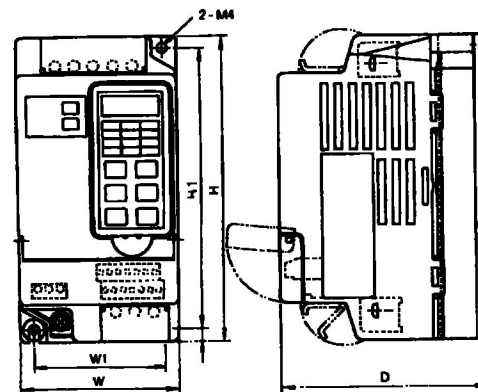
Choosing a Location

Be sure that the inverter is mounted in a location protected against the following conditions:

- Extreme cold and heat. Use only within the ambient temperature range: 14 to 122°F (-10 to 50°C).
- Rain, moisture
- Oil sprays, splashes
- Salt spray
- Direct sunlight (not for use outdoors)
- Corrosive gases (e.g. sulfurized gas) or liquids
- Dust or metallic particles in the air
- Physical shock, vibration
- Magnetic noise (e.g. welding machines, power devices, etc.)
- High humidity
- Radioactive substances
- Combustibles (e.g. thinner, solvents, etc.)

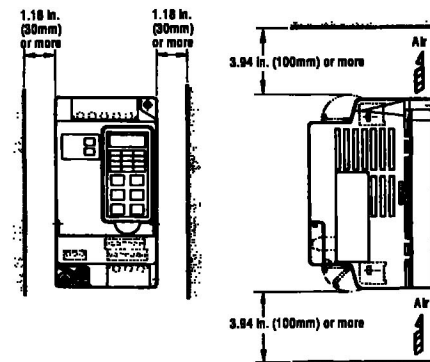
Dimensions

| Model | | Low-noise Type (dimensions in inches, mass in lbs.) | | | | | |
|------------------------|------|---|------|------|------|------|-----|
| Capacity(kW) | W | H | D | W1 | H1 | Mass | |
| 3-phase, 230V input | 0.1 | 2.68 | 5.04 | 2.76 | 2.20 | 4.65 | 1.1 |
| | 0.2 | 2.68 | | 2.95 | 2.20 | | |
| | 0.4 | 2.68 | | 3.46 | 2.20 | | |
| | 0.75 | 2.68 | | 5.12 | 2.20 | | |
| | 1.5 | 4.25 | | 6.10 | 3.78 | | |



Clearances

When mounting the VSM, observe clearances as shown below:



▲ CAUTION

When mounting units in an enclosure, install a fan or other cooling device to limit the air temperature within the inverter to below 122°F (50°C).

1.5 WIRING

Wiring Instructions

- 1) Connect the power supply wiring to terminals L1 (R), L2 (S) and L3 (T) on the main circuit input section (at the top of the inverter).

Inverter Power Supply Specifications

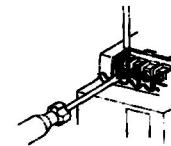
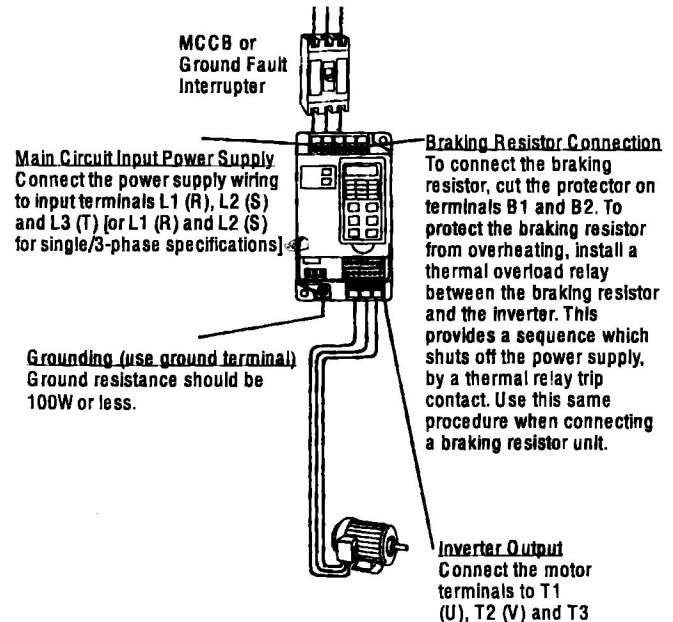
| | |
|---|---|
| 3-phase Input Power Supply CIMR-XC 2 | Single/3-phase Input Power Specification Product CIMR-XC B |
| Connect to L1 (R), L2 (S), L3 (T) | 3-phase input : Connect to L1 (R), L2 (S), L3 (T) Single-phase input : Connect to L1 (R), L2 (S) |

- 2) Connect the motor wiring to terminals T1 (U), T2 (V) and T3 (W) on the main circuit output section (at the bottom of the inverter).
- 3) The motor wiring must be less than 100m in length, and it is recommended that it be in a separate conduit from the power wiring.
- 4) Control wiring must be less than 50m in length and in a separate conduit from the power wiring.
- 5) Tighten the screws on the main circuit and control circuit terminals.
- 6) Do not connect or disconnect wiring, or perform signal checks while the power supply is turned ON.
- 7) Please observe all local and national electrical codes when wiring electrical devices.

Wire and Terminal Screw Sizes

| Circuit | Model | Terminal | Screw | Wire | |
|-----------------|----------------------|--|-------|---|--|
| | | Symbol | | Size (mm ²) | Type |
| Main Circuit | Common to all models | L1 (R), L2 (S), L3 (T), B1, B2, T1 (U), T2 (V), T3 (W) | M3.5 | 0.75 to 2 | 600V vinyl-sheathed wire or equivalent |
| | | SF, SR, S1, S2, S3, SC, FS, FR, FC, AM, AC, PA, PC | | | |
| Control Circuit | Common to all models | MA, MB, MC | -- | Twisted: 0.5 to 0.75 Single: 0.5 to 1.25 | Shielded wire or equivalent |
| | | | | | |

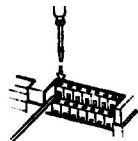
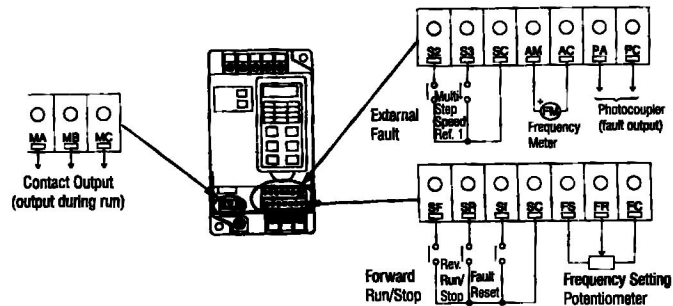
Main Circuit Wiring



Connect with a Phillips screwdriver.

Control Circuit Wiring

Terminal functions described below are based on factory settings.

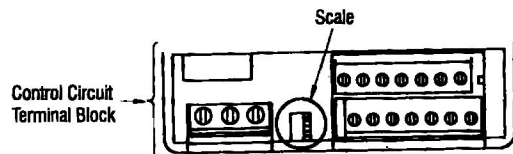


Screwdriver Blade Width
0.4mm Max. 2.5mm Max.

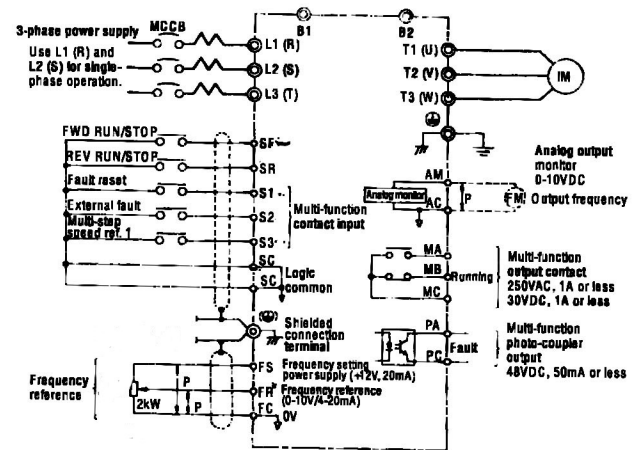
Insert the wire into the lower part of the terminal block and connect it tightly with a screwdriver.



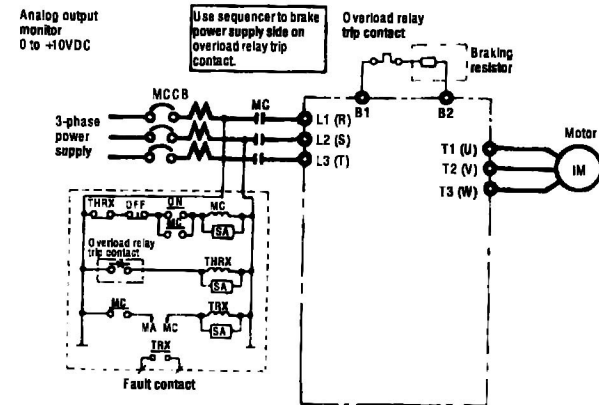
Open the control circuit terminal cover and verify that the strip length is 5.5mm.



Standard Connection Diagram



Braking Resistor Connection Example



Terminal Description

| Type | Terminal | Terminal Name | Terminal Function (Signal Level) | | | |
|-----------------|-----------------------|-----------------------------|--|--|---|--|
| Main Circuit | L1(R), L2 (S), L3 (T) | AC power supply input | L1 (R) and L2 (S) for single-phase power supply | | | |
| | T1(U), T2 (V), T3 (W) | Inverter output | For inverter output | | | |
| | B1, B2 | Braking resistor connection | For braking resistor connection | | | |
| | E (G) | Ground | For grounding (Class 3 grounding - 100W or less) | | | |
| Control Circuit | Input | Sequence | SF | Forward Run/Stop | Runs when "closed", stops when "open" | Photocoupler insulation input: 24VDC 8mA |
| | | | SR | Reverse Run/Stop | Runs when "closed", stops when "open" | |
| | | | S1 | Multi-function contact input 1 | Factory preset is "fault reset" | |
| | | | S2 | Multi-function contact input 2 | Factory preset is "external fault (NO contact) input" | |
| | | | S3 | Multi-function contact input 3 | Factory preset is "multi-step speed reference 1" | |
| | | | SC | Sequence common | Common terminal for sequence input | |
| | Frequency Reference | FR | Frequency setting power supply | +12V (allowable current 20mA maximum) | | |
| | | FR | Frequency reference input | 0 to 10VDC (20kW) or 4 to 20mA (250W) | | |
| | | FC | Frequency reference input common | 0V | | |
| | Output | AM | Analog monitor output | Factory preset is "output frequency" | 0 to 10VDC, 2mA or less | |
| | | AC | Analog monitor output common | 0V | | |
| | | MA | N.O. contact output | Factory preset is "during running" | Contact capacity: 250VAC, 1A or less | |
| | | MB | N.C. contact output | | | |
| MC | | Contact output common | | | | |
| PA | | Photocoupler output | Factory preset is "fault" | Photocoupler output: 48VDC, 50mA or less | | |
| PC | | Photocoupler output common | | | | |

Inspection

After wiring is complete, verify that:

All wiring is correctly installed.

Excess screws and wire clippings are removed from inside of the unit.

Screws are securely tightened.

Exposed wire has no contact with other wiring or terminals.

▲CAUTION


If a FWD or REV run command is given from the control circuit terminal when the operation method selection function (*n02*) is set to "1", "3" or "5", the motor will start automatically as soon as power is applied to the main circuit.

2.1 TRIAL RUN

The inverter will operate after receiving a frequency reference. There are two operation modes for the VSM:

- 1) Run command from the digital operator.
- 2) Run command from the control circuit terminal.

Prior to shipping, the drive is set up to receive a run command and frequency reference from the digital operator. Below are instructions for running the VSM using the digital operator. For instructions on using the control circuit terminals, refer to "Inputs & Outputs" on page 48.

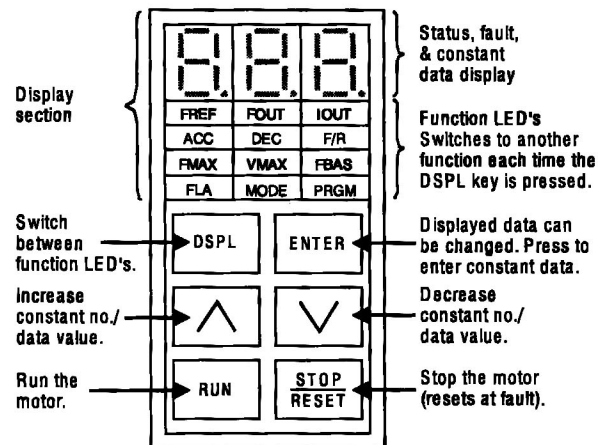
| Operation Steps | Operator Display | 12-LED Display | Status Indicator LED's |
|--|------------------|---|--|
| 1) Turn ON the power supply. Frequency reference (6.0Hz) is displayed. | 6.0 | FREF lights. | RUN <i>blinking</i> ALARM <i>off</i> (operation ready) |
| 2) Depress the RUN button. The inverter runs at 6.0Hz (the LED's rotate in a clockwise direction when a FWD RUN command is given). | |  | RUN <i>on</i> ALARM <i>off</i> (Normal operation) |
| 3) Depress the STOP/RESET button to stop motor rotation. | 6.0 | LED's rotate in direction of motor. | |

Operation Checkpoints:

- Motor rotates smoothly.
- Motor rotates in the correct direction.
- Motor has no abnormal vibration nor noise.
- Acceleration and deceleration are smooth.
- Unit is not overloaded.
- Status indicator LED's and digital operator display are correct.

2.2 DIGITAL OPERATOR DISPLAY

All functions of the VSM are accessed using the digital operator. Below are descriptions of the display and keypad sections.



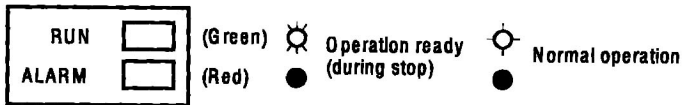
| | | |
|--|---|--|
| FREF Frequency reference setting/monitoring | FOUT Output frequency monitor | IOUT Output current monitor |
| ACC Acceleration time 1 | DEC Deceleration time 1 | F/R Operator RUN command FWD/REV selection |
| FMAX Maximum frequency | VMAX Maximum voltage | FBAS Maximum voltage output frequency (base frequency) |
| FLA Electronic thermal reference current (motor rated current) | MODE Operation mode selection | PRGM Constant no./data |

2.3 LED DESCRIPTION

Description of Status Indicator LED's

There are two LED's on the upper left corner of the face cover of the VSM. The inverter status is indicated by various combinations of ON, BLINKING and OFF LED's.

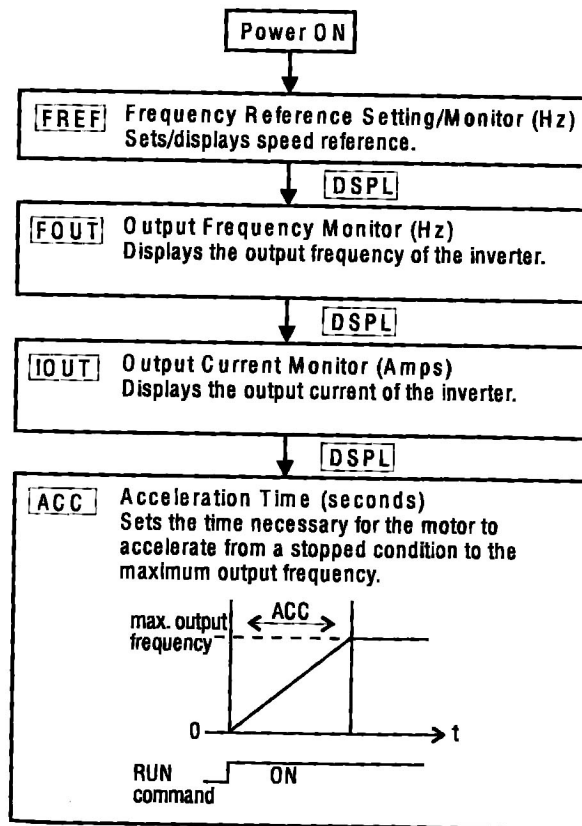
○ : ON ◐ : Blinking ● : OFF

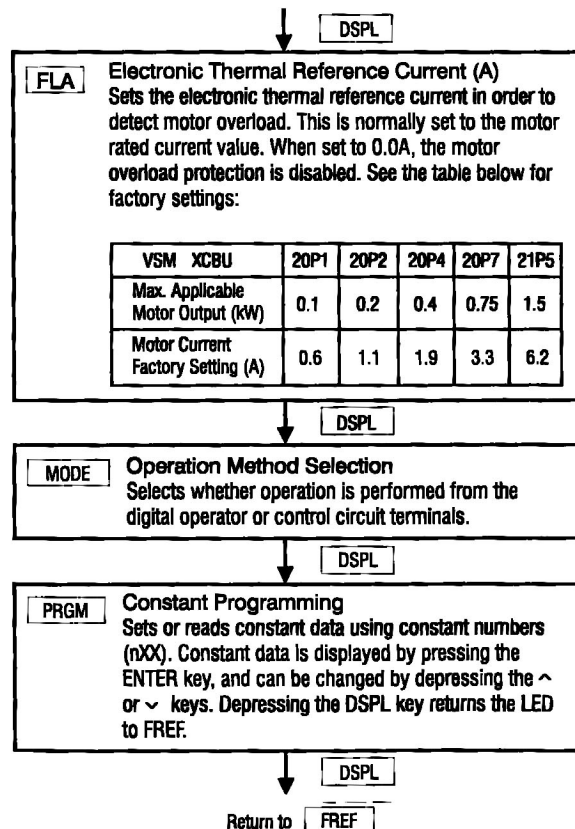
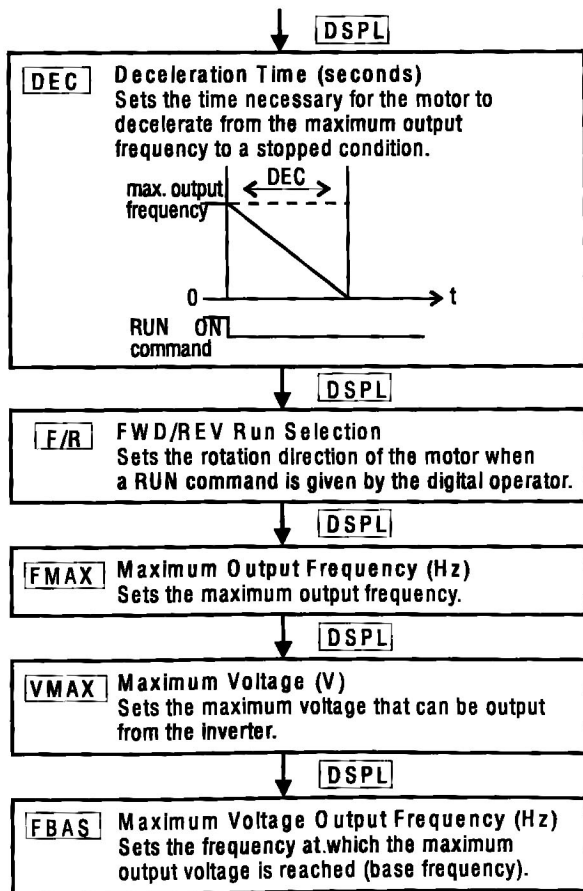


For details on how the status indicator LED's function during an invert-er fault, refer to "Alarm & Fault Displays", on page 54.

Description of Function LED's

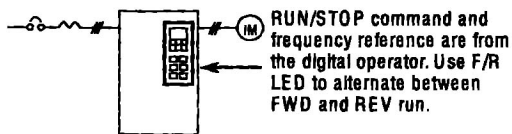
By pressing the DSPL key on the digital operator, each of the function LED's can be selected. The following flowchart describes each function LED:



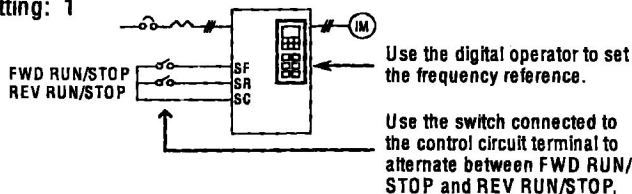


Detailed Description of Mode Function Selection

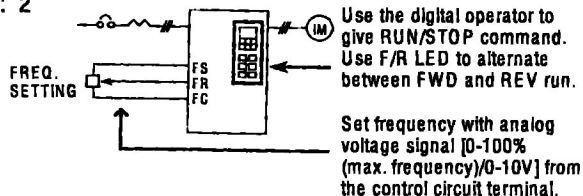
Setting: 0



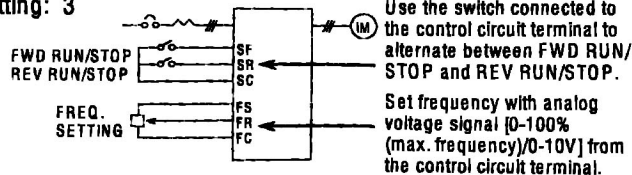
Setting: 1



Setting: 2



Setting: 3



Note: To set frequency reference with a potentiometer, it will be 100% at a rotation ratio of 80%. To set frequency reference to 100% at a rotation ratio of 100%, set constant $n39$ (frequency reference gain) to approximately "1.2".

Setting: "4" or "5"

For details, refer to "Current Reference Input" on page 52.

2.4 SIMPLE PROGRAMMING

By using the function LED's on the digital operator, simple accel/decel operation of the VSM is possible. Following are two methods for setting the acceleration time ($n20$). The first example shows how to set the acceleration time utilizing the **ACC** LED, and the second example shows how to access the constant number ($n20$) through the **PRGM** LED, and change the data.

Example 1: **ACC** LED

- | | <u>Display</u> |
|---|----------------|
| • Depress the DSPL key until the ACC LED is illuminated. | 10.0 |
| • To set the acceleration time to 5 seconds, depress the \vee key until the operator display reads 5.0. | 5.0 |
| • Depress ENTER key. | 5.0 |

Example 2: **PRGM** LED

- | | |
|---|-------|
| • Depress the DSPL key until the PRGM LED is illuminated. | $n01$ |
| • Depress the \wedge key to access constant $n20$. | $n20$ |
| • Depress the ENTER key. The current set value is displayed. | 10.0 |
| • To set the acceleration time to 15 seconds, depress the \wedge key until the operator display reads 15.0. | 15.0 |
| • Depress the ENTER key. | $n20$ |
| • Depress the DSPL key until the FREF LED is illuminated. | 0.0 |

3.1 VSM CONSTANTS (n01~n69)

| No. (nXX) | Name | Setting Range | Setting Unit | Initial Setting | User Setting | Ref. Page |
|--------------|---|-------------------|---|--------------------|-----------------|--------------|
| 01 | Constant selection/ initialization | 0, 1, 8, 9 | 1 | 1 | | 27 |
| 02 | Operation method selection | 0~5 | 1 | 0 | | 20 |
| 03 | Stopping method selection | 0, 1 | 1 | 0 | | 42 |
| 04 | FWD/REV run selection | For: FWD rEv: REV | | For | | 17 |
| 05 | REV run prohibit selection | 0, 1 | 1 | 0 | | 40 |
| 06 | Multi-function input selection 1 (terminal S1) | 0~14 | 1 | 1 | | 48 |
| 07 | Multi-function input selection 2 (terminal S2) | 1~14 | 1 | 2 | | |
| 08 | Multi-function input selection 3 (terminal S3) | 1~15 | 1 | 4 | | |
| 09 | Multi-function output selection 1 (terminal MA/MB) | 0~10 | 1 | 1 | | 51 |
| 10 | Multi-function output selection 2 (terminal PA) | 0~10 | 1 | 0 | | |
| 11 | Frequency reference 1 | 0.0~400Hz | 0.1Hz (less than 100Hz)/ 1Hz (100Hz or more) | 6.0Hz | | 39 |
| 12 | Frequency reference 2 | | | 0.0Hz | | |
| 13 | Frequency reference 3 | | | 0.0Hz | | |
| 14 | Frequency reference 4 | | | 0.0Hz | | |
| 15 | Frequency reference 5 | | | 0.0Hz | | |
| 16 | Frequency reference 6 | | | 0.0Hz | | |
| 17 | Frequency reference 7 | | | 0.0Hz | | |
| 18 | Frequency reference 8 | | | 0.0Hz | | |
| 19 | Jog frequency reference | | | 6.0Hz | | |
| 20 | Acceleration time 1 | 0.0~999sec | 0.0sec (less than 100sec)/ 1sec (100sec or more) | 10.0sec | | 17, 28 |
| 21 | Deceleration time 1 | | | 10.0sec | | |
| 22 | Acceleration time 2 | | | 10.0sec | | |
| 23 | Deceleration time 2 | | | 10.0sec | | |

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| No. (nXX) | Name | Setting Range | Setting Unit | Initial Setting | User Setting | Ref. Page |
|-----------|---|---------------------------|--------------------------------|-----------------|--------------|-----------|
| 24 | Maximum output frequency | 50.0-400Hz | 0.1Hz (<100Hz) 1Hz (≥100Hz) | 60.0Hz | | 18, 46 |
| 25 | Maximum voltage | 1-255V | 1V | 230V | | |
| 26 | Maximum voltage output frequency | 0.6-400Hz | 0.1Hz (<100Hz) 1Hz (≥100Hz) | 60.0Hz | | 48 |
| 27 | Mid. output frequency | 0.5-399Hz | | 1.5Hz | | |
| 28 | Mid. output frequency voltage | 1-255V | 1V | 12V | | |
| 29 | Minimum output frequency | 0.5-10.0Hz | 0.1Hz | 1.5Hz | | |
| 30 | Minimum output frequency voltage | 1-50V | 1V | 12V | | |
| 31 | Electronic thermal reference current | 0-120% inv. rated current | 0.1A | varies | | |
| 32 | Electronic thermal motor protection | 0-4 | 1 | 0 | | 37 |
| 33 | Current limit during deceleration | 0, 1 | 1 | 0 | | 32 |
| 34 | Current limit level during acceleration | 30-200% | 1% | 170% | | 31 |
| 35 | Current limit level during running | 30-200% | 1% | 160% | | 32 |
| 36 | Operation after momentary power loss | 0-2 | 1 | 0 | | 30 |
| 37 | Carrier frequency | 1-4 | 1=2.5kHz | 4 | | 30 |
| 38 | Automatic torque boost gain | 0.0-3.0 | 0.1 | 1.0 | | 43 |
| 39 | Frequency reference gain | 0.10-2.00 | 0.01 | 1.00 | | 35 |
| 40 | Frequency reference bias | -99-99% | 1% | 0% | | |
| 41 | Frequency reference upper limit | 0-110% | 1% | 100% | | 42 |
| 42 | Frequency reference lower limit | 0-110% | 1% | 0% | | |
| 43 | Control circuit terminal FR function | 0, 1 | 1 | 0 | | 39 |
| 44 | Analog monitor selection | 0, 1 | 1 | 0 | | 34 |

| No. (nXX) | Name | Setting Range | Setting Unit | Initial Setting | User Setting | Ref. Page |
|-----------|------------------------------------|--|--------------------------------|-----------------|--------------|-----------|
| 45 | Analog monitor gain | 0.00-2.00 | 0.01 | 1.00 | | 34 |
| 46 | DC injection braking current | 0-100% | 1% | 50% | | 33 |
| 47 | DC injection braking time at stop | 0.0-5.0sec | 0.1sec | 0.0sec | | |
| 48 | DC injection braking time at start | 0.0-5.0sec | 0.1sec | 0.5sec | | |
| 49 | S-curve accel/decel selection | 0-3 | 1 | 0 | | 41 |
| 50 | Overtorque detection | 0-4 | 1 | 0 | | 44 |
| 51 | Overtorque detection level | 30-200% | 1% | 160% | | |
| 52 | Overtorque detection time | 0-9.9sec | 0.1sec | 0.1sec | | 33 |
| 53 | Frequency detection level | 0.0-400Hz | 0.1Hz (<100Hz) 1Hz (≥100Hz) | 0.0Hz | | |
| 54 | Slip compensation gain | 0.0-9.9% | 0.1% | 0.0% | | 40 |
| 55 | Motor no-load current | 0-99% | 1% | 40% | | 40 |
| 56 | Jump frequency 1 | 0.0-400Hz | 0.1Hz (<100Hz) 1Hz (≥100Hz) | 0.0Hz | | 36 |
| 57 | Jump frequency 2 | | | | | |
| 58 | Jump frequency 3 | | | | | |
| 59 | Jump frequency bandwidth | 0.0-25.5Hz | 0.1Hz | 1.0Hz | | |
| 60 | Fault retry attempts | 0-10 times | 1 time | 0 | | 29 |
| 68 | Fault record | Stores, displays most recent alarm (setting disabled). | | | | - |
| 69 | PROM number | Displays last 3 digits of the PROM number NSP600 (setting disabled). | | | | - |

Note: constants n61 -n67 are reserved for future use.

3.2 CONSTANT SET-UP & INITIALIZATION**Constant Selection/Initialization (n01)**

The following table describes data which can be set or read when *n01* is set.

| Setting | Programmable Constants | Accessible Constants |
|-------------------------------------|--|--------------------------|
| 0 (constant setting disabled) | <i>n01</i> | <i>n02</i> to <i>n69</i> |
| 1 | <i>n02</i> to <i>n60</i> | <i>n01</i> to <i>n69</i> |
| 2 to 7 | Disabled | |
| 8 9 (constant initialization) | Initialize Initialize (3-wire sequence) | |

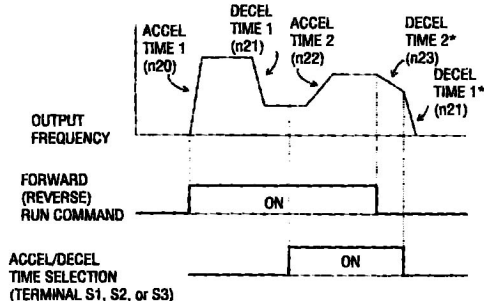
Note: "Er" appears on the LED display for one second and the set data returns to its initial value in the following cases:

- 1) The set values of input terminal function selections 1, 2 and 3 (*n06*, *n07* and *n08*) are the same.
- 2) The following conditions are not satisfied when setting the V/f pattern:
 $\text{Max. output frequency (n24)} \geq \text{Max. voltage output frequency (n26)}$
 $\geq \text{Mid. output frequency (n27)}$
 $\geq \text{Min. output frequency (n29)}$
 For details, refer to "Torque Adjustment" on page 43.
- 3) The following conditions are not satisfied when setting jump frequency:
 $\text{Jump frequency 3 (n58)} \leq \text{Jump frequency 2 (n57)}$
 $\leq \text{Jump frequency 1 (n56)}$
- 4) $\text{Freq. reference lower limit (n42)} \leq \text{Freq. reference upper limit (n41)}$.
- 5) $\text{Electronic thermal reference current (n31)} \leq 120\% \text{ of inverter rated current}$.

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3.3 VSM OPERATION

Accel/Decel Time Adjustment



* When "deceleration to a stop" is selected ($n03 = "0"$)

When either of the input terminal function selections ($n06$, $n07$ or $n08$) are set to "8", accel/decel times can then be selected by turning ON/OFF the accel/decel time selection (terminal S1, S2 or S3).

At OFF: $n20$ (accel time 1) $n21$ (decel time 1)
At ON: $n22$ (accel time 2) $n23$ (decel time 2)

| No. | Name | Unit | Setting Range | Initial Setting |
|-------|--------------|------|---------------|-----------------|
| $n20$ | Accel time 1 | 0.1s | 0.0 to 999s | 10s |
| $n21$ | Decel time 1 | 0.1s | 0.0 to 999s | 10s |
| $n22$ | Accel time 2 | 0.1s | 0.0 to 999s | 10s |
| $n23$ | Decel time 2 | 0.1s | 0.0 to 999s | 10s |

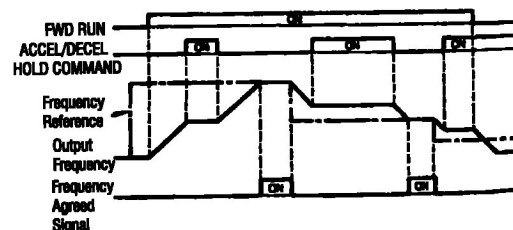
- **Accel time**
Set the time needed for the output frequency to reach 100% from 0%.
- **Decel time**
Set the time needed for the output frequency to reach 0% from 100%

Accel/Decel Hold

In order to temporarily hold acceleration or deceleration, input an accel/decel hold command. The output frequency is maintained during acceleration or deceleration when the accel/decel hold command is input. The stop command releases the accel/decel hold and then operation ramps to a stop.

Set input terminal function selection ($n06$, $n07$ or $n08$) to "13", which is the accel/decel hold command selection.

Time chart at accel/decel hold command input



Note: When the FWD (REV) run command is input along with the accel/decel hold command, the motor does not operate. However, when the frequency reference lower limit ($n42$) is set greater than or equal to the minimum output frequency ($n29$), the motor operates at the frequency reference lower limit.

Automatic Fault Retry ($n60$)

After a fault occurs, the inverter and its fault detection circuit are reset. The number of retry attempts and self-diagnostic tests can be set up to 10 times in $n60$. The inverter will automatically restart after the following faults occur:

- Overcurrent (OC)
- Overvoltage (OV)

The number of retry attempts are cleared to "0" in the following cases:

- 1) If no other fault occurs within 10 minutes after retry.
- 2) After the fault is checked if the fault reset signal is ON.
- 3) Power supply is turned OFF.

Automatic Restart After Power Loss

When momentary power loss occurs, operation restarts automatically.

| Setting | Description |
|---------|--|
| 0 | Continuous operation after momentary power loss not provided. |
| 1* | Continuous operation after power recovery within 0.5 second. |
| 2** | Continuous operation after power recovery (fault output not provided). |



* Holds the operation signal to continue operation after recovery from momentary power loss.

** When "2" is selected, operation restarts if power supply voltage reaches its normal level.

No fault signal is output.

Carrier Frequency (n37)

This function sets the inverter output transistor switching frequency (carrier frequency). This used to reduce motor noise and current leakage.

| Setting | Carrier Frequency (kHz) | Metallic noise from motor | Leakage Current |
|---------|-------------------------|--|--|
| 1 | 2.5 | Louder  Inaudible | Smaller  Larger |
| 2 | 5.0 | | |
| 3 | 7.5 | | |
| 4 | 10.0 | | |
| 5 | 12.5 | | |
| 6 | 15.0 | | |

Factory setting: "4"

Current Limit/Stall Prevention

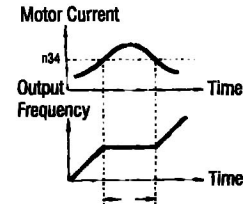
This function automatically adjusts the output frequency and and thus output current according to the load, to continue operation without stalling the motor.

• Stall Prevention/Current limit level during acceleration (n34)

The current limit level during acceleration can be set in increments of 1% (inverter rated current = 100%).

Factory setting: 170%

A setting of 200% disables current limit during acceleration. During acceleration, if the output current exceeds the value set for n34, acceleration stops and frequency is maintained. When the output current goes down to the value set for n34, acceleration starts.



Controls the acceleration rate to prevent the motor from stalling.

In the constant output area [output frequency \geq max. voltage output frequency (n26)], the current limit level during acceleration is changed by the following equation:

Current limit level during accel
(constant output)

Stall Prevention/Current limit level

$$= \text{Current limit level during accel} \times \frac{\text{Max. voltage output frequency}}{\text{Output frequency}}$$

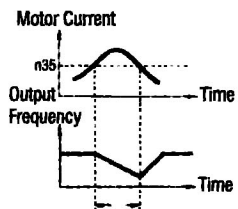
during running (*n35*)

The current limit level during running can be set in increments of 1% (inverter rated current = 100%).

Factory setting: 160%

A setting of 200% disables current limit during running. During speed agree, if the output current exceeds the value set for *n35*, then deceleration starts.

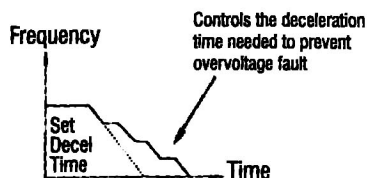
When the output current exceeds the value set for *n35*, deceleration continues. When the output current goes down to the value set for *n35*, acceleration starts, up to the set frequency.



Decreases frequency to prevent the motor from stalling.

· Stall Prevention/Current limit during deceleration (*n33*)

To prevent overvoltage during deceleration, the inverter automatically extends the deceleration time according to the value of main circuit DC voltage. When using an optional braking resistor, set *n33* to "1".



DC Injection Braking

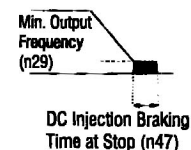
· DC injection braking current (*n46*)

DC injection braking current can be set in increments of 1%. (inverter rated current = 100%)

· DC injection braking time at stop (*n47*)

DC injection braking time at stop can be set in increments of 0.1 second.

When *n46* is set to "0", DC injection braking is disabled, so the inverter output shuts OFF at DC injection braking start.

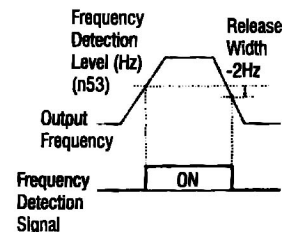


When coasting to a stop is selected in the stopping method selection (*n03*), DC injection braking at stop is disabled.

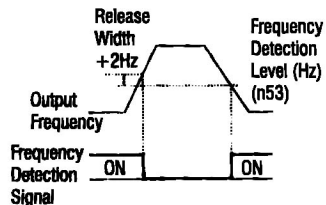
Frequency Detection (*n53*)

When output terminal function selection *n09* or *n10* is set to "4" or "5", frequency detection is enabled. This function turns ON when the output frequency is higher or lower than the frequency detection level (*n53*).

· Frequency detection (output frequency \geq frequency detection level)
Set *n09* or *n10* to "4".



- Frequency detection (output frequency \leq frequency detection level)
Set *n09* or *n10* to "5".

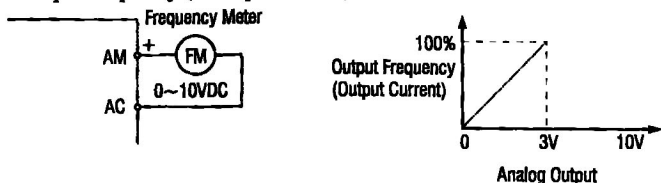


Frequency Meter or Ammeter (*n44*)

This function selects between outputting either output frequency or output current to analog output terminals AM and AC for monitoring.

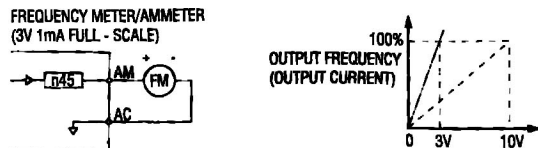
| Setting | Description |
|---------|------------------|
| 0 | Output frequency |
| 1 | Output current |

In the initial setting, an analog voltage of approximately 3V is output when the output frequency (or output current) is 100%.



Frequency Meter or Ammeter Calibration (*n45*)

This function is used to adjust the analog output gain.



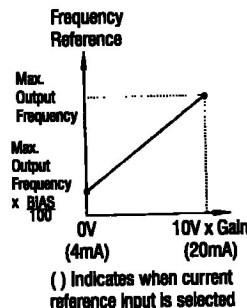
Set the analog output voltage to 100% of output frequency (or output current). The frequency meter displays 0 to 60Hz at 0 to 3V.

$$10V \times \boxed{\begin{matrix} n45 \text{ setting} \\ 1.00 \end{matrix}} = 3V$$

Output frequency becomes 100% at this value.

Frequency Signal Adjustment

When the frequency reference is given by an analog signal at control circuit terminals FR and FC, the relation between analog voltage and frequency reference can be set.



- Frequency reference gain (*n39*)
The analog input voltage value for the maximum output frequency (*n24*) can be set in increments of 0.01.
Factory setting: 1.00

- Frequency reference bias (*n40*)
The frequency reference provided when the analog input is 0V (4mA) can be set in increments of 1%. (*n24*: maximum output frequency = 100%)
Factory setting: 0%

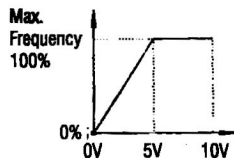
$$n39 = \frac{AV}{10V}, \text{ where } A = \text{factory setting.}$$

Gain: Outputs 100% (max. output frequency: **FMAX**, *n24*) at AV.
Bias: Outputs B% (ratio to max. output frequency) at 0V.

$$n40 = B\%, \text{ where "B" = factory setting.}$$

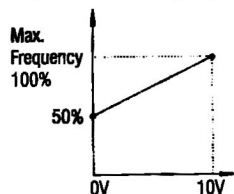
Examples

0 to 5V input



Gain: $n39 = "0.50"$
Bias: $n40 = "0"$

0 to 10V input, 50 to 100% frequency reference



Gain: $n39 = "1.00"$
Bias: $n40 = "50"$

Jog Operation

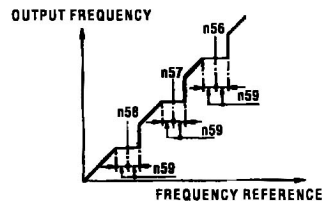
By inputting a jog command and then a forward (or reverse) run command, operation is enabled at the jog frequency set in $n19$. When multi-step speed references 1, 2 or 3 are input simultaneously with the jog command, the jog command has priority.

| Name | Constant No. | Setting |
|-------------------------|-----------------|-----------------------------|
| Jog frequency reference | $n19$ | Factory setting |
| Jog command | $n06, n07, n08$ | Set to "7" for any constant |

Jump Frequencies ($n56$ to $n59$)

This function allows the prohibition or "jumping" of critical frequencies so that the motor can operate without resonant vibrations caused by machine systems. This function is also used for deadband control. Setting the value to 0.0Hz disables this function.

Set jump frequency 1, 2 or 3 according to the following figure:



$n56 \geq n57 \geq n58$
If this condition is not satisfied, the inverter displays "Err" for 1 minute and resets the data to original settings.

Motor Overload Detection

The VSM protects against motor overload with a UL-recognized built-in electronic thermal overload relay.

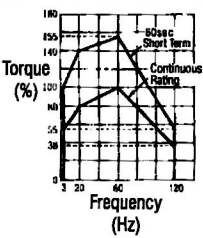
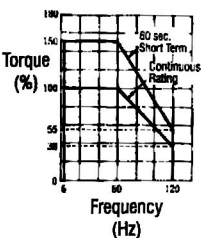
- Electronic thermal reference current ($n31$)
Set to the rated current value shown on the motor nameplate.
Note: setting to 0.0A disables the motor overload protection function.
- Motor overload protection selection ($n32$)

| Setting | Electronic Thermal Characteristics |
|---------|--|
| 0 | Applied to general-purpose motor, standard ratings |
| 1 | Applied to general-purpose motor, short-term ratings |
| 2 | Applied to inverter-duty motor, standard ratings |
| 3 | Applied to inverter-duty motor, short-term ratings |
| 4 | Electronic thermal overload protection not provided |

The electronic thermal overload function monitors motor temperature, based on inverter output current and time, to protect the motor from overheating. When the electronic thermal overload relay is enabled, an "OL1" error occurs, shutting OFF the inverter output and preventing excessive overheating in the motor. When operating with one inverter connected to one motor, an external thermal relay is not needed. When operating several motors with one inverter, install a thermal relay on each motor.

General-purpose and inverter-duty motors

Induction motors are classified as general-purpose or inverter-duty motors, based on their cooling capabilities. Hence, the motor overload detection function operates differently for each of these two motor types.

| | Cooling Effectiveness | Torque characteristics | Electronic thermal overload |
|-----------------|---|---|---|
| General-purpose | Effective when operated at 50/60 Hz from commercial power supply. |  <p>Base Frequency 60Hz</p> <p>During operation at low speeds, torque must be limited in order to stop motor temperature rise.</p> | "OL1" error (motor overload protection is enabled when motor is continuously operated at 50/60 Hz or less at 100% load. |
| Inverter-duty | Effective when operated at low speeds (approx. 6Hz). |  <p>Base Frequency 60Hz</p> <p>Use inverter-duty motor for continuous operation at low speeds.</p> | Effective when operated at low speeds (approx. 6Hz). |

Multi-Step Speed Selection

This function allows the programming of up to 8 preset speeds, through input terminal function selections.

8-step speed selection

n02 = "1" (operation mode selection)

n11 = 25.0Hz

n12 = 30.0Hz

n13 = 35.0Hz

n14 = 40.0Hz

n15 = 45.0Hz

n16 = 50.0Hz

n17 = 55.0Hz

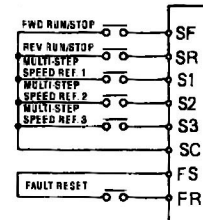
n18 = 60.0Hz

n06 = 4 (multi-function contact input terminal)

n07 = 5 (multi-function contact input terminal)

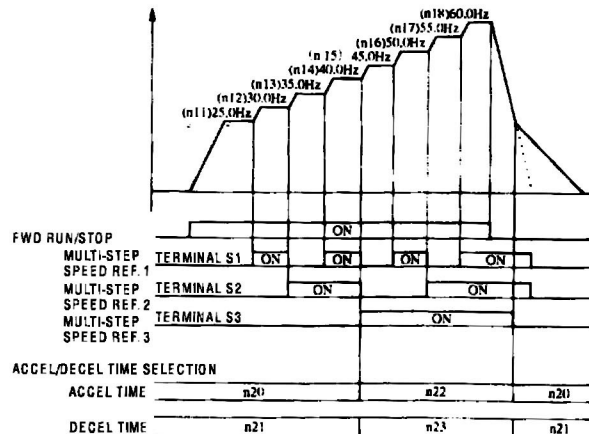
n08 = 6 (multi-function contact input terminal)

n43 = 1 (terminal FR function selection)



Note: When n02 is set to "2", "3", "4" or "5", frequency reference 1 (n11) becomes disabled. To output a reference from control circuit terminal FR, set n43 to "0".

Multi-step speed reference 3 is used together with the accel/decel time selection. When multi-step speed reference 3 is turned OFF, accel/decel time 1 (n20, n21) is selected. When it is turned ON, accel/decel time 2 (n22, n23) is selected.



Reverse Run Prohibit (n05)

A "reverse run disabled" setting does not accept a reverse run command from the control circuit terminal nor the digital operator. This setting is used in applications where a reverse run command can cause problems.

| Setting | Description |
|---------|----------------------|
| 0 | Reverse run enabled. |
| 1 | Reverse run disabled |

Slip Compensation

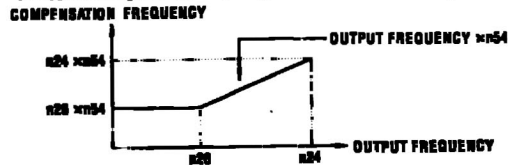
As the load becomes larger, the motor speed is reduced and the motor slip value increases. The slip compensation function controls the motor speed at a constant value even if the load varies. When the inverter output current is equal to the electronic thermal reference current (motor rated current), the compensation frequency is added to the output frequency.

| No. | Name | Unit | Setting range | Default |
|-----|--|-------|-------------------------------------|---------|
| n24 | Max. output frequency | 0.1Hz | 50.0 to 400Hz | 60.0Hz |
| n26 | Max. voltage output frequency (base frequency) | 0.1Hz | 0.6 to 400Hz | 60.0Hz |
| n31 | Electronic thermal reference current | 0.1A | 0 to 120% of inverter-rated current | * |
| n54 | Slip compensation gain | 0.1% | 0.0 to 9.9% | 0.0% |
| n55 | Motor no-load current | 1% | 0 to 90% | 40% |

* Varies depending on inverter capacity

Notes: 1) Slip compensation is disabled during the following conditions:

- Output frequency < minimum output frequency (n29)
 - During regeneration
 - Setting electronic thermal reference current (n31) to 0.0A
- 2) In the constant output area [output frequency \geq max. voltage output frequency (n26)], the compensation frequency is increased automatically as described below.

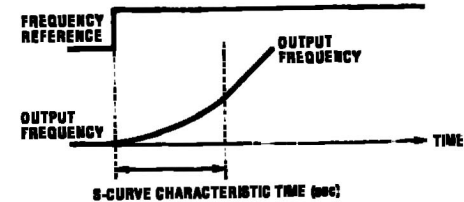


Soft-Start Characteristics (n49)

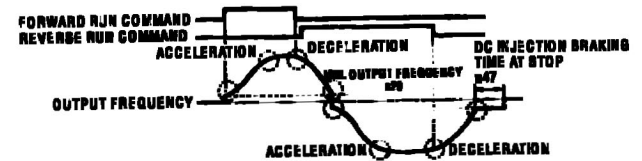
An S-curve pattern is used to reduce shock and provide smooth transitions during machine acceleration and deceleration.

| Setting | Description |
|---------|--------------|
| 0 | Not provided |
| 1 | 0.2 second |
| 2 | 0.5 second |
| 3 | 1.0 second |

Note: S-curve characteristic time is the time from current frequency to the set accel/decel time.

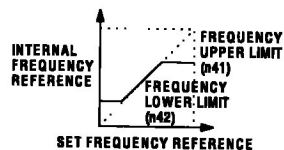


The following figure shows FWD/REV run switching during deceleration to a stop.



S-curve characteristics at

Speed Limit Adjustment



- Frequency reference upper limit (n41)
The upper limit of the frequency reference can be set in increments of 1%. (n24: maximum output frequency = 100%)
Factory setting: 100%
- Frequency reference lower limit (n42)
The lower limit of the frequency reference can be set in increments of 1%. (n24: maximum output frequency = 100%)
Factory setting: 0%

When operating at a frequency reference of 0, operation continues at the frequency reference lower limit. However, when the lower limit is set to less than the minimum output frequency (n29), operation discontinues.

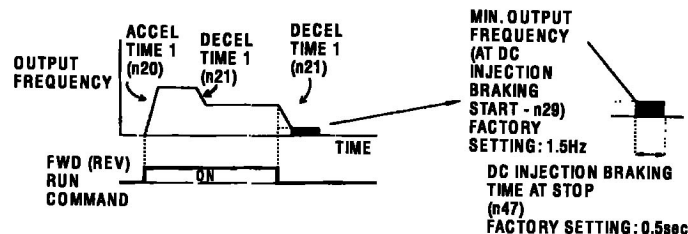
Stopping Method (n03)

This function selects the stopping method suitable for the particular application.

| Setting | Description |
|---------|------------------------|
| 0 | Deceleration to a stop |
| 1 | Coast to a stop |

- Deceleration to a stop

Example when accel/decel time 1 is selected

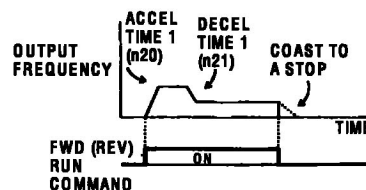


Upon removal of the FWD (REV) run command, the motor decelerates at a decel rate determined by the time set at decel time 1 (n21) and DC injection braking is applied immediately before stop. If the decel time is short or the load inertia is large, an overvoltage fault (OV) may occur during deceleration. In this case increase the decel time or install an optional braking resistor.

Braking torque: w/out braking resistor, approx. 20% of motor rated torque with braking resistor, approx. 150% of motor rated torque

- Coasting to a stop

Example when accel/decel time 1 is selected



Upon removal of the FWD (REV) run command, the motor starts to coast.

Torque Adjustment (n38)

Motor torque can be adjusted by changing the V/f pattern and with full-range automatic torque boost. For details on setting the V/f pattern, see "V/f Pattern Adjustment", on page 46.

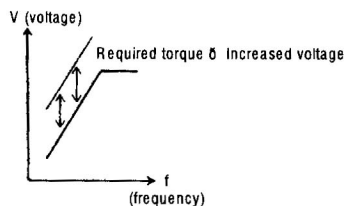
- Full-range automatic torque boost

The motor torque requirement changes according to load conditions. Full-range automatic torque boost adjusts the voltage of the V/f pattern according to the required torque. The VSM automatically adjusts the voltage during constant-speed operation as well as during acceleration.

The required torque is calculated by the inverter. This ensures tripliss operation and power savings.

$$\text{Output voltage} \propto \text{Automatic torque boost gain} \times \text{Required torque}$$

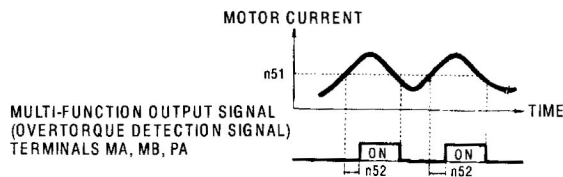
· Operation



Normally, no adjustment is necessary for automatic torque boost gain (*n38*, factory setting: “1.0”). When the wiring distance between the inverter and the motor is long, or when the motor generates vibration, change the automatic torque boost gain, and set the V/f pattern (*n24* to *n30*).

Torque Detection

If an excessive load is applied to the machine, an increase in output current is detected and alarm signals are sent to multi-function output terminals MA, MB and PA.



To output an overtorque detection signal, set output terminal function selection *n09* or *n10* to “6”.

· Overtorque detection function selection (*n50*)

| Setting | Description |
|---------|---|
| 0 | Overtorque detection not provided. |
| 1 | Detection during constant speed operation, but operation continues. |
| 2 | Detection during constant speed operation, and operation stops. |
| 3 | Detection during running, but operation continues. |
| 4 | Detection during running, but operation stops. |

Notes:

- 1) For overtorque detection during accel or decel, set to “3” or “4”.
- 2) For continuous operation after overtorque detection, set to “1” or “3”. During detection, the operator displays an “OL3” alarm (blinking).
- 3) To stop the inverter at an overtorque detection fault, set to “2” or “4”. At detection, the operator displays an “OL3” fault.

· Overtorque detection level (*n51*)

The overtorque detection current level can be set in increments of 1%.
(Inverter rated current = 100%)
Factory setting: 160%

· Overtorque detection time (*n52*)

If the time during which motor current exceeds the overtorque detection level (*n51*) is longer than the overtorque detection time (*n52*), the overtorque detection function is enabled.

Triplex Operation

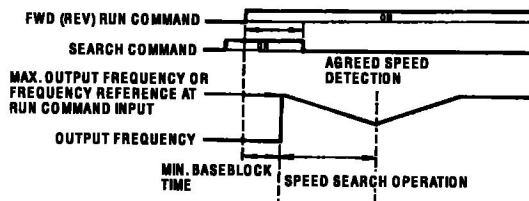
When starting into a coasting motor, use the speed search command or DC injection braking at start, to prevent a drive trip and motor burnout.

· Speed search

This function allows the restart of a coasting motor without the necessity to stop. It is useful during inverter bypass operation, when switching between the motor receiving power directly from the line and from the inverter. Set the input terminal function selection (*n06*, *n07* or *n08*) to “11” (start search command from maximum output frequency) or “12” (start search command from the set frequency).

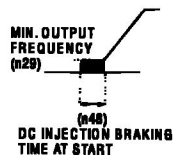
Build a sequence so that the FWD (REV) run command is input at the same time as the search command, or after the search command. If the run command is input before the search command, the search command is disabled.

Time chart at search command input



DC injection braking at starting (n46, n48)

This function restarts a coasting motor after first stopping it. DC injection braking time at start (n48) is set in units of 0.1 second. DC injection braking current is set in n46. When n48 is set to "0", DC injection braking is disabled and acceleration starts from the minimum output frequency.



V/f Pattern Adjustment

Set the V/f pattern using constants n24 to n30 as described below. It may be necessary to change the V/f pattern when using a high-speed motor, or when special torque adjustment is required in the application.

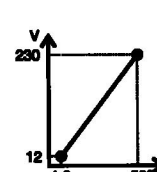
| No. | Name | Unit | Setting range | Default |
|-----|--|-------|---------------|---------|
| n24 | Max. output frequency | 0.1Hz | 50.0 to 400Hz | 60.0Hz |
| n25 | Max. voltage | 1V | 1 to 255V | 230V |
| n26 | Max. voltage output frequency (base frequency) | 0.1Hz | 0.6 to 400Hz | 60.0Hz |
| n27 | Mid. output frequency | 0.1Hz | 0.5 to 399Hz | 1.5Hz |
| n28 | Mid. output frequency voltage | 1V | 1 to 255V | 12V |
| n29 | Min. output frequency | 0.1Hz | 0.5 to 10.0Hz | 1.5Hz |
| n30 | Min. output frequency voltage | 1V | 1 to 50V | 12V |

Examples of V/f pattern setting

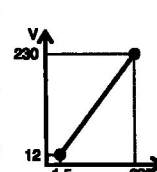
Set the V/f pattern according to the applications described below. When running at a frequency exceeding 50/60Hz, change the maximum output frequency (n24).

Note: Be sure to set the maximum output frequency according to the motor characteristics.

1) General-purpose applications

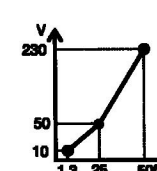


| Constant | Setting |
|----------|---------|
| n24 | 50.0 |
| n25 | 230.0 |
| n26 | 50.0 |
| n27 | 1.3 |
| n28 | 12.0 |
| n29 | 1.3 |
| n30 | 12.0 |

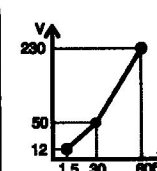


| Constant | Setting |
|----------|---------|
| n24 | 60.0 |
| n25 | 230.0 |
| n26 | 60.0 |
| n27 | 1.5 |
| n28 | 12.0 |
| n29 | 1.5 |
| n30 | 12.0 |

2) Fans/pumps

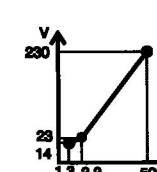


| Constant | Setting |
|----------|---------|
| n24 | 50.0 |
| n25 | 230.0 |
| n26 | 50.0 |
| n27 | 25.0 |
| n28 | 50.0 |
| n29 | 1.3 |
| n30 | 10.0 |

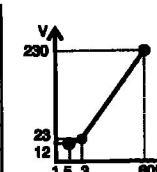


| Constant | Setting |
|----------|---------|
| n24 | 60.0 |
| n25 | 230.0 |
| n26 | 60.0 |
| n27 | 30.0 |
| n28 | 50.0 |
| n29 | 1.5 |
| n30 | 10.0 |

3) Applications requiring high starting torque



| Constant | Setting |
|----------|---------|
| n24 | 50.0 |
| n25 | 230.0 |
| n26 | 50.0 |
| n27 | 2.2 |
| n28 | 23.0 |
| n29 | 1.3 |
| n30 | 14.0 |



| Constant | Setting |
|----------|---------|
| n24 | 60.0 |
| n25 | 230.0 |
| n26 | 60.0 |
| n27 | 3.0 |
| n28 | 23.0 |
| n29 | 1.5 |
| n30 | 18.0 |

Increasing the voltage of the V/f pattern increases motor torque, but an excessive increase may cause motor excitation, overheat or vibration.

Note: set n25 to the motor rated voltage.

3.4 INPUTS & OUTPUTS

Multi-function Input Signals (*n06, n07, n08*)

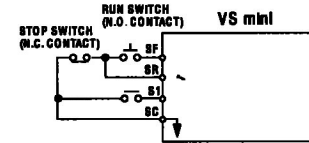
Multi-function input terminal S1, S2 and S3 functions can be changed when necessary by setting constants *n06, n07 & n08*, respectively. Neither of these constants can receive a setting common with the other.

- Terminal S1 function: set to *n06*
- Terminal S2 function: set to *n07*
- Terminal S3 function: set to *n08*

| Setting | Name | Description | Ref. |
|---------|---|---|------|
| 0 | FWD/REV run command (3-wire sequence selection) | Setting enabled only for <i>n06</i> | 49 |
| 1 | Fault reset | -- | -- |
| 2 | External fault (N.O. contact input) | Inverter stops by external fault signal input. Digital operator displays "EF" * | -- |
| 3 | External fault (N.C. contact input) | | |
| 4 | Multi-step speed reference 1 | -- | 39 |
| 5 | Multi-step speed reference 2 | -- | |
| 6 | Multi-step speed reference 3 | -- | |
| 7 | JOG command | -- | 36 |
| 8 | Accel/decel time selection | -- | 28 |
| 9 | External baseblock (N.O. contact input) | Motor coasts to a stop at this input signal. Digital operator displays "bb" (blinking). | -- |
| 10 | External baseblock (N.C. contact input) | | |
| 11 | Search command from maximum frequency | Speed search command signal | 45 |
| 12 | Search command from set frequency | | |
| 13 | Accel/decel hold command | -- | 29 |
| 14 | LOCAL/REMOTE selection | -- | 49 |
| 15 | UP/DOWN command | -- | 49 |

* 1, 2 or 3 is displayed in corresponding to S1, S2 and S3, respectively.
Factory settings: *n06* = "1", *n07* = "2", *n08* = "4"

Terminal function at 3-wire sequence selection



- Local/Remote selection (setting: "14")

Selects whether an operation reference is received from the digital operator or the control circuit terminal.

Local/Remote selection is available only while the inverter is stopped.
Open: run according to the setting of operation mode selection (*n02*).
Closed: run by frequency reference and run command from the digital operator.

Example: Set *n02* to "3" or "5".

Open: run by frequency reference from control circuit terminal FR and run command from control circuit terminals SF and SR.

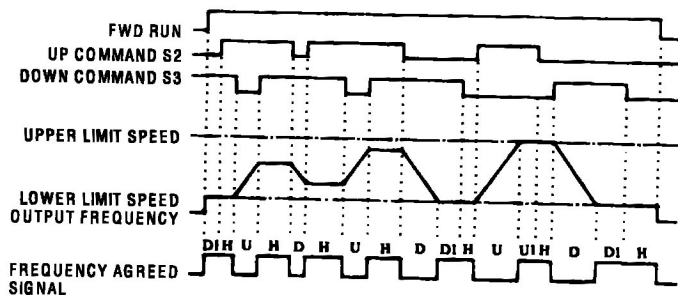
Closed: run by frequency reference and run command from the digital operator.

- Up/Down command (setting: *n08* = "15")

With the FWD (REV) run command entered, accel/decel is enabled by inputting the Up or Down signals to control circuit terminals S2 and S3 without changing the frequency reference, so that operation can be performed at the desired speed. When Up/Down commands are specified by *n08*, any function set to *n07* becomes disabled; terminal S2 becomes an input terminal for the Up command and terminal S3 an input terminal for the Down command.

| | | | | |
|--|--------|--------|------|--------|
| Control Circuit Terminal S2 (UP command) | Closed | Open | Open | Closed |
| Control Circuit Terminal S3 (DOWN command) | Open | Closed | Open | Closed |
| Operation Status | Accel | Decel | Hold | Hold |

Time Chart at Up/Down Command Input



- U: Up (accelerating) status
- D: Down (decelerating) status
- H: Hold (constant speed) status
- UI: Up status, with clamping at upper limit speed
- DI: Down status, with clamping at lower limit speed

Notes:

- 1) When Up/Down command is selected, the upper limit speed is set regardless of frequency reference.
Upper limit speed = maximum output frequency (n24) × frequency reference upper limit (n41) / 100
- 2) The lower limit value is either the minimum output frequency (n29) or the frequency reference lower limit (n42), whichever is larger.
- 3) When the FWD (REV) run command is input, operation starts at the lower limit speed without an Up/Down command.
- 4) If the jog command is input while the drive is running by the Up/Down command, the jog command has priority.

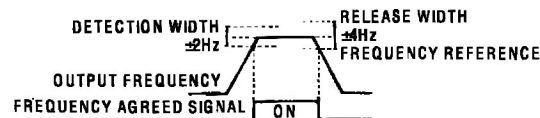
Multi-function Output Signals (n09, n10)

Multi-function output terminal MA, MB and PA functions can be changed when necessary by setting constants n09 and n10.

- Terminal MA and MB functions: set to n09
- Terminal PA functions: set to n10

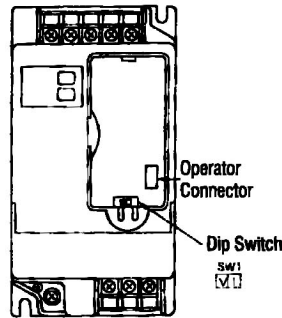
| Setting | Name | Description | Ref. |
|---------|--|--|------|
| 0 | Fault | "Closed" when inverter fault occurs. | -- |
| 1 | In operation | "Closed" when FWD or REV run command is input, or when the inverter outputs voltage. | -- |
| 2 | Agreed frequency | -- | 51 |
| 3 | Zero speed | "Closed" when the inverter output frequency is less than the min. output frequency. | -- |
| 4 | Frequency detection (output frequency ≥ frequency detection level) | -- | 33 |
| 5 | Frequency detection (output frequency ≤ frequency detection level) | -- | |
| 6 | Overtorque detection | -- | 44 |
| 7 | Baseblock | "Closed" when the inverter output shuts off. | -- |
| 8 | Undervoltage detection | "Closed" when the inverter detects low voltage. | -- |
| 9 | Speed search | "Closed" when the inverter is searching for the speed. | -- |
| 10 | Operation mode | "Closed" when LOCAL/REMOTE selection is set to "LOCAL". | -- |

Factory settings: n09 = "1", n10 = "0"



Current Reference Input

When setting frequency by inputting a current reference (4-20mA) from the control circuit terminal FR, switch dipswitch SW1 on the printed circuit board to the "I" side. SW1 is accessed by removing the digital operator.

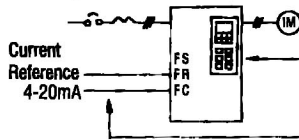


CAUTION

Do not remove the digital operator to access the dipswitch unless the power supply is turned OFF.

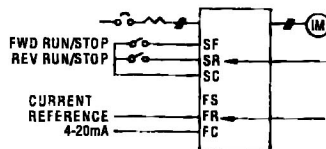
After switching SW1, set the **MODE** function LED to "4" or "5".

• Setting: "4"



Depress the digital operator keys to run or stop the inverter. Switch run and stop direction by setting the F/R function LED. Set frequency by the analog current signal [0-100% (max. frequency) / 4-20mA] connected to the control circuit terminal.

• Setting: "5"



Switch run/stop direction and FWD/REV run with switching device connected to the control circuit terminal. Set frequency by the analog current signal [0-100% (max. frequency) / 4-20mA] connected to the control circuit terminal.

Frequency reference gain and bias (*n39*, *n40*) can be set even when current reference input is selected. For details, refer to "Frequency Signal Adjustment" on page 35.

4.1 MAINTENANCE & INSPECTION

Periodically inspect the inverter as described in the following table to prevent accidents and to ensure high performance with high reliability.

| Location | Check for | Solution |
|--------------------------------------|---|--|
| Terminals, unit mounting bolts, etc. | Loose or misaligned connection hardware | Properly seat and securely tighten all connection hardware. |
| Heatsink | Built-up dust, dirt and debris | Blow with dry, compressed air; 39.2×10^4 to 58.8×10^4 Pa, 57 to 85psi (4 to 6kg/cm ²) pressure |
| Printed circuit board | Accumulation of conductive material or oil mist | If dust or oil cannot be removed, replace the inverter. |
| Power elements, smoothing capacitor | Abnormal odor or discoloration | Replace the inverter. |

DANGER

To prevent electrical shock, disconnect all power before servicing the inverter. Then wait at least one minute after the power supply is disconnected and all LED's are extinguished.

4.2 ALARM & FAULT DISPLAYS

This section describes the alarm and fault displays, explanations for fault conditions, and corrective actions to be taken if the VSM malfunctions.

- Corrective actions for models with blank covers (no operator)
- 1) Input a fault reset or cycle the power supply OFF and ON.
- 2) When a fault cannot be corrected:
 - Turn the power supply OFF and check the wiring and control logic.
 - Turn the power supply OFF and replace the blank cover with the digital operator to display faults.

Alarm Display

| Digital Operator Display | Status LED's | | Description | Possible Causes/ Corrective Actions |
|--------------------------|--------------|-------------|---|---|
| | RUN (green) | ALARM (red) | | |
| EF blinks | On or Blinks | Blinks | Simultaneous input of FWD and REV commands - when both commands are closed for 0.5sec or longer, inverter stops according to <i>n03</i> . | Check SF and SR input terminals. |
| bb blinks | | | External baseblock - when inverter receives external baseblock signal, its output shuts off. Operation restarts after signal is released. | |
| STP blinks | | | Operator stop function - STOP key is depressed when the run command is from control input terminals SF and SR. | |
| oL3 blinks | On | Blinks | Overtorque detection - motor current exceeds the set value as a result of machine fault or overload. Operation continues. | Check the driven machine and remove the cause of the fault, or increase the value in <i>n51</i> to the machine's allowable value. |
| SEr blinks | | | Sequence error - LOCAL/REMOTE command is changed during running. | Check multi-function contact inputs S1, S2 and S3. |

Alarm Display (continued)

| Digital Operator Display | Status LED's | | Description | Possible Causes/ Corrective Actions |
|--------------------------|--------------|-------------|---|---|
| | RUN (green) | ALARM (red) | | |
| UU blinks | Blinks | Blinks | Main circuit low voltage - DC bus voltage drops below the undervoltage detection level when the inverter is not outputting. | Check the voltage, verify that the main circuit power supply wiring is connected, and terminal screws are securely tightened. |
| oU blinks | | | Main circuit overvoltage - DC bus voltage exceeds the overvoltage detection level when the inverter is not outputting. | Check the power supply voltage. |
| oH blinks | | | Heatsink overheat - intake air temperature rises when the inverter is not outputting. | Check the intake air temperature. |

Fault Display

| Digital Operator Display | Status LED's | | Description | Possible Causes/ Corrective Actions |
|--------------------------|--------------|-------------|---|--|
| | RUN (green) | ALARM (red) | | |
| oC | Off | On | Overcurrent - inverter output current momentarily exceeds approximately 250% of rated current. | Consider the following causes: <ul style="list-style-type: none"> Short circuit at inverter output Excessive load inertia (GD2) Extremely rapid accel/decel time (<i>n20</i> to <i>n23</i>) Special motor use Motor start during coasting Motor start w/ capacity larger than inverter Magnetic contactor at inverter output is ON/OFF Reset after finding the cause. |
| ou | | | Main circuit overvoltage - when DC voltage exceeds the overvoltage protection level, because of excessive regenerative energy from the motor (over 410V). | When decel time is too small, or a negative load is decreased (e.g. crane, elevator, etc.), increase decel time (<i>n21</i> & <i>n23</i>) or connect a braking resistor. |
| Uu1 | | | Main circuit low voltage - DC voltage falls below 210V (3-phase) or 170V (single-phase). | Input power supply voltage is reduced, phases are opened or momentary power loss occurs. Check the voltage, verify that main circuit power supply wiring is connected and terminal screws are securely tightened. |
| Uu2 | | | IGBT module control power supply fault - fault is detected. | Turn off the power supply once, then turn it on again. If the fault remains, replace the inverter. |
| | | | | |

* During protective operations, the inverter output shuts off and the motor coasts to a stop.

Fault Display (continued)

| Digital Operator Display | Status LED's | | Description | Possible Causes/ Corrective Actions |
|--------------------------|--------------|-------------|---|---|
| | RUN (green) | ALARM (red) | | |
| oH | Off | On* | Heatsink overheat - temperature increases because of inverter over-load operation or intake air temperature increase. | Load is too large, V/f characteristics are improper, accel setting may be too small, or intake air temperature exceeds 113°F (45°C). Check the size of the load, the V/f setting (<i>n24</i> to <i>n30</i>) the intake air temperature, or the cooling fan. |
| oL1 | | | Motor overload - protection is enabled because of electronic thermal overload detection. | Check the size of the load, the operation pattern, or the V/f setting (<i>n24</i> to <i>n30</i>). Set motor rated current value (<i>n31</i>) according to motor nameplate value. |
| oL2 | | | Inverter overload - protection is enabled because of electronic thermal overload detection. | Check the size of the load, the operation pattern, or the V/f setting (<i>n24</i> to <i>n30</i>). Re-check the inverter capacity. |
| oL3 | | | Overtorque detection - motor current exceeds the set value as a result of a machine fault or overload. | Check the driven machine and remove the cause of the fault, or increase the value in <i>n51</i> to the machine's allowable value. |
| EF1 EF2 EF3 | | | External faults - inverter receives an external fault input from external circuit. | Check multi-function input terminals S1, S2 and S3. |
| | | | | |

* During protective operations, the inverter output shuts off and the motor coasts to a stop.

Fault Display (continued)

| Digital Operator Display | Status LED's | | Description | Possible Causes/ Corrective Actions |
|--------------------------|--------------|-------------|--|---|
| | RUN (green) | ALARM (red) | | |
| F00 | Off | On* | CPF-00 - initial memory fault is detected. | Turn off the power supply once, then turn it on again. If the fault remains, replace the inverter. |
| F01 | | | CPF-01 - ROM fault is detected. | |
| F04 | | | CPF-04 - constant fault is detected. | Record all constant data and reinitialize the constants. Turn off the power supply once, then turn it on again. If the fault remains, replace the inverter. |
| F05 | | | CPF-05 - AD converter fault is detected. | Turn off the power supply once, then turn it on again. If the fault remains, replace the inverter. |
| F06 | | | CPF-06 - a prohibited option is detected. | Turn off the power supply once and remove the option. Then turn on the power supply again. |
| — (OFF) | | | Off | Off |

* During protective operations, the inverter output shuts off and the motor coasts to a stop.

PERIPHERAL DEVICES

It is recommended that the following peripheral devices should be mounted between the AC main circuit power supply and VSM input terminals L1 (R), L2 (S) and L3 (T).

- Molded-case circuit breaker (MCCB):
Be sure to connect it for wiring protection.

- Magnetic contactor:

Mount a surge suppressor on the coil (refer to the table below). When using a magnetic contactor to start and stop the inverter, do not exceed one start per hour.

Recommended MCCB Specifications

- 230V 3-phase

| VSM Model XCBU | 20P1 | 20P2 | 20P4 | 20P7 | 21P5 |
|-----------------------------|------|------|------|------|------|
| Capacity (kVA) | 0.3 | 0.6 | 1.1 | 1.9 | 2.6 |
| Rated output current (A) | 0.8 | 1.5 | 3 | 5 | 7 |
| MCCB type NF30 (Mitsubishi) | 5A | 5A | 5A | 10A | 20A |

Recommended Surge Suppressors

| Surge suppressors | | Model | Specifications | Code No. |
|--------------------|---|--------|------------------------------------|----------|
| Coils and relays | | DCR2- | | |
| 200V to 230V | Large magnetic contactors | 50A22E | 250VAC 0.5 μ F 200 Ω | C002417 |
| | Control relays MY-2, -3 (Omron) HH-22, -23 (Fuji) MM-2, -4 (Omron) | 10A25C | 250VAC 0.1 μ F 100 Ω | C002482 |

• Ground fault interrupter

Select a ground fault interrupter not affected by high frequencies. To prevent malfunctions, the current should be 200mA or more and the operating time 0.1 second or more.

Examples:

NV series manufactured by Mitsubishi Electric Co., Ltd. (1988 and later)
EGSG series manufactured by Fuji Electric Co., Ltd. (1984 and later)

• AC reactor

Install an AC reactor to connect to a power supply transformer of large capacity (600kVA or more) or to improve the power factor on the power supply side.

• Noise filter

Use a noise filter exclusively for the inverter if radio noise generated from the inverter causes other control devices to malfunction.

▲CAUTION

- 1) Never connect a general LC/RC noise filter to the inverter output circuit.
- 2) Do not connect a phase-advancing capacitor to the input/output sides or a surge suppressor to the output side.
- 3) When a magnetic contactor is installed between the inverter and the motor, do not turn it ON/OFF during operation.

For more details on peripheral devices, refer to the VSM catalog, or contact your Safronics representative.

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