# Varispeed-505WII <br> INDUSTRIAL USE THYRISTOR CONVERTER UNITS 



Before initial operation, read these instructions thoroughly, and retain for future reference.


When properly installed, operated and maintained, this unit will provide a lifetime of optimum operation. It is mandatory that the person who operates, inspects, and maintains this equipment thoroughly reads and understands this manual and has in his possession at all time.

## IMPORTANT

- Make no withstand voltage test on the VS-505WII because it incorporates semi-conductor electronic circuits.
- If insulation resistance tests are neccessary, make them only in accordance with the instructions given in this manual.
- Do not tamper with potentiometers of the power units since they were preset at the factory before shipment.

Varispeed-505WII (VS-505WII) is a thyristor converter unit for varispeed reversible operation of industrial DC motors.

For correct operation of VS-505WII, users must thoroughly read these instructions. This manual is also necessary for maintenance and troubleshooting, and threfore should be kept filed for ready reference.

For details on DC motors, refer to "Instructions for Industrial DC Motors" (TOE-C435-3B).


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## RECEIVING

The equipment has been put through severe tests at the factory before shipped. After unpacking, however, check and see the following.

- Its nameplate data meets your requirements.
- It has sustained no damage while in transit.
- Fastening bolts and screws are not loosened.
- Devices built in the cabinet are not damaged or missing.


## STORAGE

If the equipment is temporarily stored or machine stops for an extended length of time, the following precautions should be taken.

## LOCATION

Store the equipment under the following conditions.

- Free from rainfall and drops of water
- Clean and dry

(a) Control Circuit
- Free from corrosive gas and liquid
- Ambient temperature: $0^{\circ} \mathrm{C}$ to $40^{\circ} \mathrm{C}$
- Less vibration


## INSTALLATION

Select a location described in STORAGE and install the equipment by proper procedure in keeping the equipment in good working condition.

## WIRING

Make wiring in reference to the interconnection diagram furnished on your order and the following.

## COMPONENT ARRANGEMENT IN VS-505 W II

Figs. 1 to 3 show component arrangement in the VS-505WII.

(b) Main Circuit

Fig. 1 Type CDMR-WII, $-\mathrm{S}(460 \mathrm{~V}, 115 \mathrm{~A}$ )


Fig. 2 Type CDMR-WII, $-\mathrm{M}(230 \mathrm{~V}, 260 \mathrm{~A})$


Fig. 3 Type CDMR-WII, -L ( $460 \mathrm{~V}, 420 \mathrm{~A}$ )

## terininal sizes and carrying currents

Table 1 shows the size and the current carring capacities of the terminals of VS-505WII. Select leads with sufficient current carrying capacity. Refer to "Cautions when Wiring".

Table 1 Terminal Size and Current Capacity

| CDMR | -WII | AC Circ | Main <br> cuit | $\begin{gathered} \mathrm{DC} \\ \mathrm{Cir} \end{gathered}$ | Main cuit | $\begin{gathered} \text { Fie } \\ \text { Cir } \end{gathered}$ | eld cuit |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Rated <br> Volt- <br> age <br> V | Rated <br> Out- <br> put <br> kW | Terminal Size | Carrying Current A | Terminal Size | Carrying Current A | Terminal Size | Carrying Current A |
|  | 25 | M4 | 21 | M5 | 25 |  |  |
|  | 35 | M8 | 29 | M8 | 35 |  |  |
|  | 45 | M8 | 37 | M8 | 45 | M4 | 12 |
|  | 90 | M8 | 74 | M8 | 90 |  |  |
| 230 | 105 | M8 | 86 | M8 | 105 |  |  |
|  | 180 | M10 | 147 | M10 | 180 | M4 | 22 |
|  | 260 | M10 | 213 | M10 | 260 | M4 |  |
|  | 420 | M12 | 343 | M12 | 420 | M4 | 25 |
|  | 550 | M12 | 449 | M12 | 550 | M4 | 25 |
| 460 | 50 | M8 | 41 | M8 | 50 | M4 | 12 |
|  | 90 | M8 | 74 | M8 | 90 |  |  |
|  | 105 | M8 | 86 | M8 | 105 |  |  |
|  | 180 | M10 | 147 | M10 | 180 | M4 | 22 |
|  | 260 | M10 | 213 | M10 | 260 |  |  |
|  | 420 | M12 | 343 | M12 | 420 | M4 | 25 |
|  | 550 | M12 | 449 | M12 | 550 |  |  |

Notes :

- Terminal size other than listed above is M4 and current capacity is 2 A or below.
Rule of thumb of AC main circuit power capacity
$1.2 \times \sqrt{3} \times \mathrm{E} \times \mathrm{I}$ (VA)
E : Supply voltage
I : AC main circuit current


## INTERCONNECTIONS

Make connections of VS-505WII with associate units according to the interconnection diagram separately furnished.

## CAUTIONS WHEN WIRING

Main Circuits
Use 600 V PVC insulated wires or cabtyre cables with the current carrying capacities of the combined DC motor for AC main circuit terminals ( $\mathrm{U}, \mathrm{V}, \mathrm{W}$ ) and DC main circuit terminals ( $\mathrm{P}, \mathrm{N}$ ).

## Field Circuits

Use 600 V PVC insulated wires or cabtyre cables with the current carrying capacities of the combined DC motor for field power circuit terminals ( $\mathrm{U}_{0}, \mathrm{~W}_{0}, \mathrm{U}_{1}, \mathrm{~W}_{1}$ ) and field circuit terminals ( J , K ). Use stranded wires of cross-section 5.5 $\mathrm{mm}^{2}$ or larger for field circuit terminals ( $\mathrm{J}, \mathrm{K}$ ).

## Signal Circuits

Use shielded wires or twisted wires of twisting pitches 20 mm or smaller for the speed setting circuit terminals ( 6 to 10 ), speed feedback terminals ( 2,3 ), tachometer circuit terminals ( 50 to 52).


Fig. 4 Pitch of Twisted Wire

Separation of Signal Cables from Main Circuit Cables

To avoid inductive interference from other cables, run the shielded or twisted wires ( 1 to 55)
separate from main circuit cables ( $\mathrm{U}, \mathrm{V}, \mathrm{W}$; $\mathrm{U}_{0}, \mathrm{~W}_{0}$; $\mathrm{U}_{1}, \mathrm{~W}_{1} ; \mathrm{P}, \mathrm{N} ; \mathrm{J}, \mathrm{K}$ ) in a bundle or thru a duct.

## CAUTION

After wiring, check interconnections. Make insulation resistance tests using a 500 V megger. Connect VS-505WII main circuit terminals ( $\mathrm{U}, \mathrm{V}$, $\mathrm{W} ; \mathrm{U}_{0}, \mathrm{~W}_{0} ; \mathrm{U}_{1}, \mathrm{~W}_{1} ; \mathrm{P}, \mathrm{N} ; \mathrm{J}, \mathrm{K}$ ) with common lead. Measure the insulation resistance between common lead and the ground. When the test result is $2 \mathrm{M} \Omega$ or more, it means that wiring is good.

## TEST RUN

When the VS-505WII has been correctly installed and wired, the unit shall be tested through a test run as follows.

If trouble is found during the test run, refer to "Check Before Test Run" and "Troubleshooting Guide" for necessary measures. If the cause of the trouble cannot be located, or repair is impossible, notify our service station, giving the details of trouble conditions.

## CHECK BEFORE TEST RUN

Make the following checks prior to the test run.

Table 2 Check before Test Run

| Check Pomts | Check Items |
| :---: | :---: |
| Interconnections between VS-505WII and Associate Units | - Correct wiring <br> - Tightening of terminal screws |
| DC Motor | - Disconnection from the driven machine <br> - Removal of thrust block <br> - Remove inspection covers and blow out with air to clean commutator. (Fig. 5) |
| VS-505WII | - Adhesion of dirt or dust on the enclosure <br> - Smooth hand rotation of thyristor cooling fan * <br> - Check items in "Cautions in Operation" on the back of the control board door <br> - Correct connection of the shunt connector to the voltage selecting tap (Fig. 6) <br> - Correct setting of the frequency selector switch (Fig. 7) <br> - Correct adjustment of potentiometers on the control board (1PCB) Refer to red paint |
| Supply Voltage at Input Terminals of VS-505WII | - Voltages of any two of phases U, V, W are within the values on Table 3. Check with a tester. <br> - Terminals $U_{0}$ and $U_{1}$, and $W_{0}$ and $W_{1}$ are connected. <br> - Rotating direction of the motor blower meets with the arrow marked on the blower. |

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Fig. 5 Inspection Window of DC Motor


Fig. 6 Tap Selection of Control Supply Voltage


Fig. 7 Power Frequency Selector Switch

Table 3 Supply Voltage Allowable Range

| Nominal <br> Supply <br> Voltage | Supply <br> Frequency | Permissible <br> Voltage <br> Variation | Voltage <br> Selector <br> Tap |
| :---: | :---: | :---: | :---: |
| 200 V | $50 / 60 \mathrm{~Hz}$ | $170-220 \mathrm{~V}$ | 200 V |
| 220 V | $50 / 60 \mathrm{~Hz}$ | $187-242 \mathrm{~V}$ | 220 V |
| 400 V | $50 / 60 \mathrm{~Hz}$ | $340-440 \mathrm{~V}$ | 400 V |
| 440 V | $50 / 60 \mathrm{~Hz}$ | $374-484 \mathrm{~V}$ | 440 V |

## TEST RUN (Cont'd)

## NO-LOAD OPERATION

After making the checks specified before test run, thoroughly check the environment of the system for safety.

Check the polarity of DC tachometer generator feedback voltage. When the motor is running forward, the polarity of VS-505WII signal terminal $2(3: 0 \mathrm{~V})$ is minus and it is plus during reverse running of the motor.

Then, run the motor without load according to Table 4.

## FULL-LOAD OPERATION

Before starting full-load operation, stop the power supply, couple the DC motor to the driven machine, and check the motor and the driven machine for safe and obstruction-free conditions. Table 5 gives full-load operation procedure.

Table 4 No-load Operation

| Order | Operation | Check Items |
| :---: | :---: | :---: |
| 1 | Set the speed reference at zero. |  |
| 2 | Turn on main circuit power suppy. | Smooth rotation of the thyristor cooling fan.* |
|  |  | Smooth rotation of the blower for DC motor. |
|  |  | Rotating direction of the blower meets with the marking on the blower. |
| 3 | Make an operational sequence and check to be sure that operation is ready. (Turn on ready signal, motor cooling fan ON /OFF signal.) | Indication light "PREP" on the control board (1PCB) turns on. |
| 4 | Turn-on the operation signal. |  |
| 5 | Gradually, increase the speed setting value. | Smooth acceleration of DC motor. |
|  |  | No abnormal odor, smoke, vibration and noise on DC motor. |
| 6 | Remove the hand-hole cover and check the commutator. | No brush chattering and sparking at the brushes. |
|  | To avord excessive temperature rise of DC motor winding in frame 112, 132, reclose the window within 5 minutes. |  |
| 7 | Gradually, turn the speed setting potentiometer clockwise. | Smooth acceleration of DC motor . |
| 8 | Increase the speed setting value to the maximum. | DC motor rotates at the maximum speed. Check with a speedometer. |
| 9 | Change the speed to various values. | DC motor speed corresponds with the set values. |
| 10 | Turn off the operation signal. | DC motor suddenly stops. |
| 11 | Turn off the main circuit power supply. | - |

[^1]
## ADJUSTMENT

Do not tamper unnecessarily with the potentiometers on the control circuit board since they have been adjusted at the factory before shipped.

## Adjuster Locations and Functions

Adjuster locations on the control circuit board and functions are shown in rig. 8 and Table 6. The characteristics of control circuit board check terminals are shown in Fig. 9 and Table 7.


Fig. 8 Adjuster Locations on Control Circuit Board

Table 5 Full-load Operation

| Order | Operation |
| :---: | :--- |
| 1 | Set the speed at zero. |
| 2 | Turn on the main circuit power supply. |
| 3 | Turn on operation signal and gradually <br> increase the speed. Check to be sure <br> that the motor and driven machine are <br> correctly running. |
| 4 | Turn off the operation signal. |
| 5 | Turn off main circuit power supply. |

Table 6 Control Circuit Board Adjuster Locations and Functions

| Type of Adjusters | Adjuster Location | Adjuster Name | Adjuster Function | Adj | usting Method | Specifications |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Potentiometers | 1 | $\oplus$ RATE | Accel tume adjustment at fwd run. (Decel time adjustment at rvs run.) | Clockwise rotation increases accel time. |  | 3-75 sec |
|  | 2 | $\Theta$ RATE | Decel time adjustment at fwd run (Accel ume adjustment at rvs run.) | Clockwise rotation increases decel time. |  | 3-75 sec |
|  | 3 | NGAIN | ASR Gain adjustment. | Clockwise rotation increases GAIN |  |  |
|  | 4 | NMAX | Speed feedback adjustment. | Clockwise rotation decreases speed. |  | $\pm 6 \mathrm{~V} / 100 \%$ speed |
|  | 5 | IGAIN | ACR Gain adjustment. | Clockwise rotation increases gan. |  |  |
|  | 6 | IFB | Man circuit current feedback adjustment. | Clockwise rotation decreases current. |  | +3 V/100\% current |
|  | 7 | F LIMIT | Speed and current himit value at forward run. | Clockwise rotation increases limit value. |  | 150\% (Standard) |
|  | 8 | R LIMIT | Speed and current limit value at reverse run. | Clockwise rotation increases limit value. |  | 150\% (Standard) |
|  | 9 | CEMF | Counter electromotive force compensation. | Clockwise rotation increases gain. |  | 0.17-0.84 times |
|  | 10 | SM | Speedometer adjustment. | Clockwise rotation increases pointer swing. |  | 1 mADC max |
|  | 11 | AM | Ammeter adjustment. | Clockwise rotation increases pointer swing. |  | 1 mADC max |
|  | 12 | NOFS | ASR offset adjustment. | $\Theta$ voltage $\oplus$ voltage |  |  |
|  | 13 | IOFS | ACR offset adjustment. | $\Theta$ voltage $\oplus$ voltage |  | - |
|  | 14 | KIPP | Phase shift lag limit adjustment | Clockwise rotation advances shlft lag 11 mlt . |  | $155^{\circ} \mathrm{e}$ ¢ (Standard) |
|  | 15 | PSB | Adjustment of phase shifter operation point. | Clockwise rotation advances phase. |  | $\begin{aligned} & 90^{\circ} e \ell-160^{\circ} \mathrm{el} \\ & \text { (Adjustable) } \end{aligned}$ |
|  | 16 | OL\% | Setting overload detection start point. | Clockwise rotation increases overload detection start point. |  | 110\% (Standard) |
|  | 17 | OLT | Selting overload detection time. | Clockwise rotation increases operation time. |  | 150\%, 60 sec (Standard) |
|  | 18 | ZCD | Setting zero current detection level. | Clockwise rotation increases detection level. |  | $\begin{aligned} & \text { 0\% - 10\% (Adjustable) } \\ & 7 \% \text { (Standard) } \\ & \hline \end{aligned}$ |
|  | 19 | IREF | Setting field current. | Clockwrise rotation increases field current. |  | - |
| Resistor Selection (Open) | 20 | $\begin{aligned} & \text { lFBR - } \\ & \text { 4FBR } \\ & \hline \end{aligned}$ | Rough adjustment of field current detection voltage level. | Open the resistor according to specifications. |  | Refer to motor specifications. |
|  | 21 | $\begin{aligned} & 5 \mathrm{FBR}- \\ & 9 \mathrm{FBR} \\ & \hline \end{aligned}$ | Rough adjustment of main circuit current detection voltage level. |  |  |  |
| Slide Switch | 22 | 1SW | Control Method selector | (Speed <br> control)$\mathrm{N}=-1$(Current <br> control) |  | - |
|  | 23 | 2SW | Supply frequency selector. | 50 H | \% -60 Hz |  |
| Plug Selection | 24 | A - D | Rough adjustment of speed detection voltage level. | Selection according and motor | of the voltage level to type of tach-gen rated speed. | - |
|  | 25 | E | Selection of soft start operation | and motor rated speed. |  | - |
|  |  |  |  | E2 Soft s | start | - |
|  | 26 | F | Selection of PI or P control by ACR control method | F1 PI con | trol | - |
|  |  |  |  | F2 ${ }^{\text {P }}$ P cont |  | $\underline{ }$ |
|  | 27 | H | Selection of P.I or P control by ASR control method | H1 P P contr |  | - |
|  |  |  |  | H2 ${ }^{\text {Hi contr }}$ |  | 二 |
|  | 28 | J | Selection of zero-speed condition at motor overheat. | J1 Gate <br> reach <br> stop <br> J2 Immed | block after motor ed zero speed by operation. <br> diate gate block. | - |
|  | 29 | K | Selection of start interlock zero-speed condition. | K1 With |  |  |
|  |  |  |  | K2 Without |  | - |
|  | 30 | L | Selection of zero-speed condition at motor blower stop. | L1 Field ha <br> motor z <br> operati <br>  El | alf-reduced after zero-speed by stop on. (Gate block) | - |
|  |  |  |  | L2 Field ha <br> (Gate bl | alf-reduced immediately. lock) | - |
|  | 31 | M | Selection of exciter according | M1 ${ }^{\text {M }}$ Exciter | er used. | - |
|  | 31 | M | to type of motor field. | M2 Excite | er not used. | $\cdots$ |
| Shortcircuit Jumper | 32 | OPN | [-_ | Open | - Speed control by voltage detection. <br> - Speed control by AC tach-gen. | - |
|  |  |  |  | Short circuited | Other than the above. | - |
|  | 33 | OPS |  | Open | Special application. | $\underline{\square}$ |
|  |  |  |  | Short- circuited | Other than the above. | - |

## TEST RUN (Cont'd)



Fig. 9 Control Circuit Check Terminals

## Adjustment Procedure

## NMAX (Speed feedback adjustment)

To adjust the DC motor speed exactly to the reference speed, proceed as follows.

1. Prepare the tachometer having the required accuracy.
2. Operate the $D C$ motor at no load (or less variation).
3. Measure the speed reference voltage with a voltmeter. Correct the voltage to that of desired motor speed.
4. Measure the motor speed with a tachometer.
5. If the speed does not reach the desired speed, turn NMAX counterclockwise to increase the speed.

Table 7 Control Board Check Terminals

|  | Signal Name |  | Check <br> Terminals | Normal Value |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Stable power supply |  | CH22 | OV (SG) |  |
|  |  |  | CH24 | $+15 \mathrm{~V}$ |  |
|  |  |  | CH25 | -15 V |  |
|  | Unstable power supply |  | CH19 | +24 V | Allowable voltage function range: $\pm 20$ \% |
|  |  |  | CH2O | -24 V |  |
|  |  |  | CH23 | +24 V (Pulse amplifier supply) |  |
|  | Speed reference |  | CH4 | ¥6 V/100\% command ( $\odot$ Forward, ( $\dagger$ Reverse) |  |
|  |  |  | CH5 | $\pm 6$ V/100\% command ( $\dagger$ Forward, $\Theta$ Reverse) |  |
|  | Speed feedback |  | CH3 | $76 \mathrm{~V} / 100 \%$ speed ( $\odot$ Forward, $\dagger$ Reverse) |  |
|  | Current command | Forward | CH9 | -3 V/1008 command |  |
|  |  | Reverse | CH8 |  |  |  |
|  | Current limit (Speed limit) | Forward | CH7 | +3 V/ $100 \%$ current limit ( +6 V/100\% speed limit) |  |
|  |  | Reverse | CH6 |  |  |  |
| Main | Current feedback |  | CH18 | +3 V/100\% current |  |
| Circuit <br> Power | Current limiter output |  | CH2 | Approx. -1 V at gate block | 0 to +6 V when controlling |
|  | Phase shifter input |  | CH16 | Approx. +5.5 V at 60 Hz , +6.5 V at 50 Hz at gate block. | +1 to +5.5 V at 60 Hz , +1 to +6.5 V at 50 Hz when controlling. |
|  | Counter electromotive force input |  | CH1 | 0- $\pm 5$ V |  |
|  | Overload detection start point |  | CH21 | 110\% (Approx, -1.65 V) |  |
|  | Zero-current detection |  | CH15 | 0 V at load current conduction, approx. +12 V at 0 A of load current. |  |
|  | Pulse amplifier power supply | Forward | CH12 | 0 V at reverse operation. | Approx. +24 V at forward operation. |
|  |  | Reverse | CH13 | 0 V at forward operation. | Approx. +24 V at reverse operation. |
|  | Gate block (at failure) |  | CH14 | 0 V normal, approx. -12 V at gate block. |  |
|  | Phase shifter synchronization power supply |  | $\mathbf{u}$ $\mathbf{v}$ $\mathbf{w}$ |  <br> U, V, W: Main circuit input power supply. |  |
| Field <br> Power | Current command |  | CH11 | Voltage according to field current. | Ex. ${ }^{-6} \mathrm{~F} / 5 / 5 \mathrm{~A}$ |
|  | Current feedback |  | CH17 |  | - +3 V/5 A |
|  | Phase shifter input |  | CH10 | Approx. +5 V at 60 Hz . +6 V at 50 Hz at field block. | ```+1 to +5 V at 60 Hz. +1 to +6 V at }50\textrm{Hz when controlling.``` |

6. If the speed exceeds the desired speed, turn NMAX clockwise to decrease the speed.

FLIMIT (Forward limit value adjustment)
RLIMIT (Reverse limit value adjustment)

1. Current limitation (Speed control)

Slide the control method selector switch (1SW) on the control circuit board to N . When the voltages at CH 7 (forward) and CH6 (reverse) are +3 V , $100 \%$ current limit value is obtained. Current limit value can be set within the range of $0 \%$ to $250 \%$ by F LIMIT and R LIMIT.

## 2. Speed limitation (Current control)

Slide the control method selector switch (1SW) on the control circuit board to I. When the voltages at CH7 (forward) and CH6 (reverse) are +6 V , $100 \%$ speed limit value is obtained. Speed limit value can be set within the range of $0 \%$ to $250 \%$ by F LIMIT and R LIMIT.

PSB (Phase shifter operating point adjustment)
PSB sets the phase shifter operating point.

1. When the current controller (ACR) is inte-gral-controlled
Connect the plug selector F on the control circuit board at Fl. Turn PSB fully counterclockwise.
2. When the current controller (ACR) is ratiocontrolled

Connect the plug selector F on the control circuit board at F2. Turn PSB clockwise gradually with reference current at $0 \mathrm{~V}(0 \mathrm{~V}$ at CH 2$)$, and set at the position where main circuit current is ready to start.

## CEMF (Counter electromotive force compensation)

Current loop is vulnerable to counter electromotive force. In order to obtain optimum performance, a compensating electromotive force has to be biased on the phase shifter, depending on the control mode.

1. When the current controller (ACR) is ratiocontrolled
Adjust CEMF, observing the motor acceleration current with a synchroscope. Turn CEMF fully counterclockwise, and turn CEMF clockwise gradually until optimum value shown in Fig. 10 is obtained.
2. When the current controller (ACR) is inte-gral-controlled


Fig. 10 CEMF Adjustment

CEMF compensation reduces the loss time due to Forward/Reverse selection to as the same level as the integral control of ACR. Turn CEMF fully counterclockwise, and during motor acceleration by current limit gradually turn it clockwise until the voltage at CH 2 on the control circuit board stabilizes.

## Field Current Adjustment

Field current adjustment is required for checking the setting at the factory or for fine adjustment. To change the setting, selection of resistors (IFBR to $4 F B R$ ) on the control circuit board is required.

## l. For constant field current

a. Connect a DC ammeter to the field circuit.
b. Adjust so that the ammeter indicates the rated field current with IREF on the control circuit board. (Refer to the test report or nameplate data.)

## 2. For field weakening control

Field weakening control is made for the VS-505WII combined with field weakening control unit type JGSM-51-
a. Connect DC ammeter to the field circuit and DC voltmeter to output terminals $\mathrm{P}, \mathrm{N}$.
b. Turn IREF on the control circuit board and FORCE FLD and V LIMIT of field controller fully counterclockwise.
c. Set the minimum field weakening current by IREF. In this case, set the current at $80 \%$ field weakening current at maximum speed. (See the test report.)
d. Set the rated field current (field intensifying by FORCE FLD. (See the test report or nameplate data.)
e. A fter the motor starts, gradual increasing the speed reference increases the voltage across $P$ and $N$ and governs it at some value. Turn $V$ LIMIT clockwise gradually so that the governed value is the rated voltage.

## MAINTENANCE

VS-505WII requires almost no daily inspection. To keep the correct and successful operation, periodic maintenance operations should be performed. The users should prepare their own maintenance programs based on the following guidelines.

## PERIODIC INSPECTION

Table 8 shows the minimum inspection items and the procedures.

Table 8 Periodic Inspection

| Inspection Part | Inspection Item | Inspection Procedure | What to do | Remarks |
| :---: | :---: | :---: | :---: | :---: |
| Thyristor cooling fan | Noise <br> - Vibration | - Check for any intermittent or unusual noise. <br> - Feel by hand. | Replace. | Rule of thumb for cooling fan replacement: 15,000 hours of operation. |
| General | - Dust or dirt <br> - Loose terminal screws or nuts | - Check for dust clogging or dirt adhesion. <br> - Check for loose screws or nuts. | - Clean with an electracal cleaner <br> - Tighten. | $\square$ |

## PARTS REPLACEMENT

- Replace the parts required after checking the trouble and correcting it according to TROUBLESHOOTING GUIDE.
- Turn off the power before part removal or mounting.


Fig. 11 Field Thyrsitor Assembly

## Field Thyristor Replacement

With all the Models, thyristor modules consisting of a thyristor and a diode are used as the field thyristor. Replace them as follows.

1. Remove the four mounting screws of field snubber board (3PCB), lead clamping screws, control power connector. Then, remove snubber board. See Fig. 11.
2. Remove lead clamping screws connecting to thyristor, and remove the leads from thyristor. In this case, mark all terminals for identification. See Fig. 12.
3. Remove thyristor mounting screws (2) and remove thyristor module.
4. Check the type and capacity of new thyristor module against the requirements. Install it by reversing the removal procedure, making connections to the terminals identified by the marks made before removing the old thyristor module. Coat the thyristor mounting surface with joint compound, JOINTAL Z made by Nippon Light Metal Co., Ltd.

Main Circuit Thyristor Replacement
VS-505 W II, 230 V at 25 A
The unit uses a thyristor module consisting of two thyristors. Replace it as follows.

1. Remove snubber board (4PCB) mounting screws (5) and lead clamping screws. Remove snubber board. (Fig. 13)
2. Remove bus bar mounting screws and lead clamping screws connected to thyristor. Remove bus bar and leads. (Fig. 14) In this case, mark the terminals for identification.
3. Remove two thyristor clamping screws and thyristor.
4. Check the replacement module for type and capacity, and reinstall it by reversing the disassembly procedure, identifying the terminals by means of the marks made prior to disassembling.


Fig. 12 With Snubber Board Removed

## Main Circuit Thyristor Replacement

VS-505W II, 230 V at 35 to $105 \mathrm{~A}, 460 \mathrm{~V}$ at 50 to 105 A
The unit uses a thyristor module consisting of two thyristors. Replace it as follows.

1. Remove snubber board (4PCB) mounting screws (5) and remove snubber board. (Fig. 15)
2. Remove bus bar mounting screws and lead clamping screws connected to thyristor. Remove bus bar and leads. (Fig. 16). In this case, mark the terminals for identification.
3. Remove two thyristor clamping screws and thyristor.
4. Check the replacement module for type and capacity, and reinstall it by reversing the disassembly procedure, identifying the terminals by means of the marks made prior to disassembling. Coat the thyristor mounting surface with joint compound, JOINTAL Z made by Nippon Light Metal Co., Ltd.


Fig. 13 Field Thyristor Assembly ( 230 V, 25 A)

## Main Circuit Thyristor Replacement

VS-505 W II, 230 V at 180 to $550 \mathrm{~A}, 460 \mathrm{~V}$ at 180 to 550 A

The VS-505WII uses a flat thyristor module as a power module. For 180 A and 260 A , one power module is employed, and for 420 A , and 550 A , three power modules are employed. Proceed as follows.

1. Remove the clamping screws for thyristor gate (G) and cathode (K) terminals ( 24 for 260 A or below, and 8 for 420 A or more), and free the leads. Remove fuse mounting bolt(s) ( 3 for 260 A or below and 1 for 420 A or more). (Fig. 17)
2. Loosen power module mounting bolts ( 7 for 260 A or below, 8 for 420 A or more), and remove the power module.


Fig. 15 Main Circuit Thyristor Assembly ( $460 \mathrm{~V}, 105 \mathrm{~A}$ )


Fig. 16 With Snubber Board Removed
3. Place the main circuit thyristor module on a work bench. Remove the snubber board (4PCBU, V, W) mounting screws ( 3 for 260 A or below, 4 for 420 A or more), and take out the snubber board. (Fig. 18)
4. Loosen the fin mounting nuts alternately, turning $1 / 4$ turn at a time. Then, remove the leaf spring.
5. Remove the fin and take out the leaf spring.
6. Clean the contact surfaces of the new thyristor and the fin, and thinly coat these surfaces with joint compound, JOINTAL Z made by Nippon Light Metal Co., Ltd.
7. Align the fin locating pin and the thyristor locating hole, after making sure that the polarity of the thyristor is correct.
8. Keeping the leaf spring and the fin in parallel, finger-tighten the clamping nuts. Then, tighten them alternately through $1 / 4$ turn at a time, three times each with a socket wrench. Now, the thyristor fin has been installed.

(a) With Thyristor Removed
9. Tighten the snubber board mounting screws. Then, mount the thyristor module by reversing the disassembling procedure, tightening the screws firmly.


Fig. 17 Main Circuit Thyristor ( $460 \mathrm{~V}, 420 \mathrm{~A}$ )

(b) Thyristor

Fig. 18 Thyristor Replacement

## Thyristor Protective Fuse Replacement

VS-505 W II, 230 V at 25 to $105 \mathrm{~A}, 460 \mathrm{~V}$ at 50 to 105 A

1. Pull up the fuse blown indicating microswitch with the leads connected. (Fig. 19)
2. Remove the two fuse mounting bolts.
3. Mount the replacement fuse by reversing the removing procedure, after checking it for model and capacity.


Fig. 19 Main Circuit Fuse Assembly ( $460 \mathrm{~V}, 105 \mathrm{~A}$ )

## Thyristor Protective Fuse Replacement

VS-505 W II, 230 V at 180 to $550 \mathrm{~A}, 460 \mathrm{~V}$ at 180 to 550 A

1. Remove the two lead clamping screws of the fuse-blown indicating mocroswitch and free the leads. (Fig. 20)
2. Remove the two fuse mounting bolts, and remove the fuse together with the fuse-blown indicating microswitch.
3. Check the replacement fuse for model and capacity, and install it by reversing the disassembling procedure.


Fig. 20 Main Circuit Fuse Assembly ( $460 \mathrm{~V}, 420 \mathrm{~A}$ )

## Surge Absorber Fuse Replacement

1. Pull the fuse element and remove it. (Fig. 21)
2. Mount the replacement fuse, after checking its model and capacity.


Fig. 21 Surge Absorber Fuse

## Surge Absorber Replacement

1. Remove three surge absorber mounting screws and remove surge absorber.
2. Check the replacement surge absorber for model and capacity. Mount three surge absorbers after connecting M4 pressure terminals to their leads as shown in Fig. 22.


Fig. 22 Surge Absorber with Pressure Terminals Connected to Leads

## Thyristor Cooling Fan Replacement

To replace a thyristor cooling fan with a new one, proceed as follows. (Fig. 23) The VS-505WII units rated $230 \mathrm{~V}, 25 \mathrm{~A}$; $460 \mathrm{~V}, 50 \mathrm{~A}$ are selfcooled type.

1. Remove the cooling fan power lead.
2. Unscrew the two fan mounting screws and dismount the fan.
3. Remove the fan by reversing the disassembling procedure.

(a) $230 \mathrm{~V}, 45$ to 105 A ; $460 \mathrm{~V}, 90 / 105 \mathrm{~A}$

(b) $230 \mathrm{~V}, 180 / 260 \mathrm{~A} ; 460 \mathrm{~V}, 180 / 260 \mathrm{~A}$

(c) $230 \mathrm{~V}, 420 / 550 \mathrm{~A}$; $460 \mathrm{~V}, 420 / 550 \mathrm{~A}$ Fig. 23 Thyristor Cooling Fan

## MAINTENANCE (Cont'd)

## Control Circuit Board Replacement

Disconnect all the leads from the terminals.
Then, unplug the connectors shown in Fig. 24, and remove the 6 control circuit board mounting screws.

Mount the new board by reversing the disassembling procedure. Plug-in the connectors firmly.

## CAUTIONS IN REPLACING CONTROL CIRCUIT BOARD

Make sure that the type of the new control circuit board agrees with the nameplate and potentiometer settings of new control circuit board are the same as the old one. Refer to the nameplate "Cautions in Operation" posted on the inside of the control clrcuit board door of VS-505WII. See Table 6 "Adjuster Locations on the Control Circuit Board and Functions".


Fig. 24 Control Board

## TROUBLESHOOTING GUIDE

Table 9 Troubleshooting Guide


[^2]
## SPARE PARTS

Table 9 lists the recommended spare parts for one VS-505WII, keep always minimum insurance spare parts on hand to protect the unit against costly downtime. When ordering spare parts,
specify complete nameplate rating and description (type, code no., etc.) of the parts required, and quantity desired.

Table 10 Spare Parts for Control Panel

| Thyristor Converter Unit Type CDMIR-W II |  | Main circuit Thyristor |  | Thyristor Protective fuse |  | Surge Absorber Fuse |  | Fan |  | Ficld <br> Thyristor Diode |  | Surge Absorber |  | Control Circuit Board |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Type (Code No) | Q'ty | Type (Code No ) | Q'ty | Type (Code No ) | Q'ty | 'Type (Code No.) | Q'ty | Type (Code No ) | Q'ty | Type (Code No.) | Q'ty | $\begin{gathered} \text { Type } \\ \text { (CodeNo) Nit } \end{gathered}$ |
| Type SS | $\begin{array}{r} 230 \mathrm{~V} \\ 25 \mathrm{~A} \end{array}$ | TM20DA-II (SCR195) | 6 | $\begin{aligned} & \text { 60FHS-55 } \\ & \text { (FU642) } \end{aligned}$ | 2 | FCF2-20 <br> (FU599) | 2 |  | 1 | TM20RA-H (SCR192) | 2 | $\begin{aligned} & \text { TNR23G471K } \\ & \text { (XX110) } \end{aligned}$ | 3 | $\begin{aligned} & \text { JPDC-C041 } \\ & \text { (ETC5472) } \end{aligned}$ |
| Type S | $\begin{array}{r} 230 \mathrm{~V} \\ 35 \mathrm{~A} \end{array}$ | $\begin{aligned} & \text { TM25DZ-H } \\ & \text { (SCR196) } \end{aligned}$ |  |  |  |  |  |  |  |  |  |  |  |  |
|  | $\begin{array}{r} 230 \mathrm{~V} \\ 45 \mathrm{~A} \end{array}$ |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | $\begin{array}{r} 230 \mathrm{~V} \\ 90 \mathrm{~A} \end{array}$ | $\begin{aligned} & \text { TM55DZ-H } \\ & \text { (SCR197) } \end{aligned}$ |  | 60F1IS-110 (FU644) |  |  |  | $\left\lvert\, \begin{aligned} & 4715 \mathrm{P}^{2} \mathrm{C}-22 \mathrm{~T} \\ & -\mathrm{B} 30-\mathrm{B} 00 \end{aligned}\right.$ (FAN130) |  |  |  |  |  |  |
|  | $\begin{aligned} & 230 \mathrm{~V} \\ & 105 \mathrm{~A} \end{aligned}$ | TM90DZ-H (SCR198) |  | 60FIIS-150 <br> (FU615) |  |  |  |  |  |  |  |  |  |  |
| Type M | $\begin{aligned} & 230 \mathrm{~V} \\ & 180 \mathrm{~A} \end{aligned}$ | $\begin{aligned} & \mathrm{N} 105 \mathrm{CH} 1 \mathrm{O} \\ & \text { (SCIR259) } \end{aligned}$ | 12 | CS51-200 <br> (FU609) |  | FCF2-30 <br> (FU600) |  | $\begin{aligned} & 5915 \mathrm{P} \mathrm{C}-22 \mathrm{~T} \\ & -\mathrm{B} 30-1300 \\ & \text { (FANI31) } \end{aligned}$ |  |  |  |  |  |  |
|  | $\begin{aligned} & 230 \mathrm{~V} \\ & 260 \mathrm{~A} \end{aligned}$ | N195CH08 <br> (SCR261) |  | $\begin{aligned} & \text { CS5F-350 } \\ & \text { (FU612) } \end{aligned}$ |  |  |  |  |  |  |  |  |  |  |
| Type L | $\begin{array}{\|l\|} \hline 230 \mathrm{~V} \\ 420 \mathrm{~A} \\ \hline \end{array}$ |  |  | $\begin{aligned} & \text { CS5F-450 } \\ & \text { (FU614) } \\ & \hline \end{aligned}$ |  |  |  | MIRW'18DTA |  |  |  |  |  |  |
|  | $\begin{aligned} & 230 \mathrm{~V} \\ & 550 \mathrm{~A} \end{aligned}$ | 553PA80 (SCR263) |  | CS5F-600 <br> (FU616) |  |  |  | (FAN107) |  |  |  |  |  |  |
| Type S | $\begin{array}{r} 460 \mathrm{~V} \\ 50 \mathrm{~A} \end{array}$ | $\begin{aligned} & \text { PK55IIB-160 } \\ & \text { (SCR244) } \\ & \binom{\text { TM55DZ-2H }}{(\text { SCR201) }} \end{aligned}$ | ${ }^{6}$ | 60FHS-110 (FU644) |  | $\begin{aligned} & \text { FCF2-20 } \\ & \text { (FU599) } \end{aligned}$ | 2 | - | 1 | $\begin{aligned} & \text { TM20R^-H } \\ & \text { (SCR192) } \end{aligned}$ | 2 | $\begin{aligned} & \text { TNR23G102K } \\ & \text { (XX167) } \end{aligned}$ | 3 | , |
|  | $\begin{array}{r} 460 \mathrm{~V} \\ 90 \mathrm{~A} \end{array}$ |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | $\begin{aligned} & 460 \mathrm{~V} \\ & 105 \mathrm{~A} \end{aligned}$ | $\begin{aligned} & \text { PK90HB-160 } \\ & \text { (SCIR245) } \\ & \binom{\text { TM90D7-2LI }}{\text { (SClR202) }} \end{aligned}$ |  | 60FIIS-150 <br> (FU645) |  |  |  | HN4556MV (FAN110) |  |  |  |  |  | DC-C0 |
| Type M | $\begin{aligned} & 460 \mathrm{~V} \\ & 180 \mathrm{~A} \end{aligned}$ | N105ClH16 (SCI260) | 12 | $\begin{aligned} & \text { CS5F-200) } \\ & \text { (FU609) } \end{aligned}$ | 3 | FCF2-30 <br> (FU600) |  | 7556MXV |  |  |  |  |  | (E'TC5172) |
|  | $\begin{aligned} & 460 \mathrm{~V} \\ & 260 \mathrm{~A} \\ & \hline \end{aligned}$ | N195CH16(SCR262) |  | $\begin{aligned} & \text { CS5F-350 } \\ & \text { (FU612) } \\ & \hline \end{aligned}$ |  |  |  | (FAN111) |  |  |  |  |  | 1 |
| Type L | $\begin{aligned} & 460 \mathrm{~V} \\ & 420 \mathrm{~A} \end{aligned}$ |  |  | $\begin{aligned} & \text { CS5F-450 } \\ & \text { (FU614) } \end{aligned}$ |  |  |  | MRW18DTA |  |  |  |  |  | 1 |
|  | $\begin{aligned} & 460 \mathrm{~V} \\ & 550 \mathrm{~A} \end{aligned}$ | 553PA160 <br> (SCR264) |  | $\begin{aligned} & \text { CS5F-600 } \\ & \text { (FU616) } \end{aligned}$ |  |  |  | (FAN107) |  |  |  |  |  |  |

## 〈REFERENCE 〉

## ROUGH CHECK OF THYRISTORS

Where thyristors normally function, the following values are obtained.

More than several hundreds of kiloohms across (A) and (K).

Several ohms to several hundreds of ohms across (G) and (K).

(a) Resistance across thyristor terminals ( A ) and ( K )

(b) Resistance across thyristor terminals (G) and (K)

Fig. 25 Rough Check of Thyristors

## ELEMENTARY DIAGRAM OF THYRISTOR CONVERTER UNIT (TYPE CDMR-W II, $230 \mathrm{~V}, 90 \mathrm{~A}$ )



Fig. 26 Main Circuit


Fig. 27 Control Circuit

## 〈REFERENCE〉(Cont'd)

## FUNCTIONS OF EXTERNAL CONTROL TERMINALS

Table 11 Functions of External Control Terminals for Input

|  | Signal Name |  | Terminal No. | Function |
| :---: | :---: | :---: | :---: | :---: |
| 1 | Ready signal | $\bigcirc$ | 30 | "Close" --- Field intensifying. "Open" --- Gate block $\rightarrow$ Field half-reduced. |
| 2 | Operation signal | $\cdots$ | 29 | ```"Close" --- Speed reference "ON" + Acceleration to speed reference value. "Open" --- Speed reference "OFF" > Stop by regenerative braking -> Gate block.``` |
|  |  |  | 29 28 | $\begin{aligned} & \text { "RUN" --- Speed reference "ON" } \rightarrow \text { Acceleration to speed } \\ & \text { reference value. } \\ & \text { "STOP" --- Speed reference "OFF" } \rightarrow \text { Stop by regenerative } \\ & \text { braking } \rightarrow \text { Gate block. } \end{aligned}$ |
| 3 | Quick stop signal | $\cdots$ | 27 | Quick stop at "Close" in case of soft start operation. "Close" --- Speed reference "OFF" $\rightarrow$ Stop by regenerative braking + Gate block. |
| 4 | Main circuit M input answer back signal | $\bigcirc$ | 26 | Close <br> released. Terminals 26 and 35 (or 36) <br> short-circuited unless used. |
| 5 | Motor overheat signal | --9 | 33 | "Open" --- Gate block. "Close" -- Normally. |
| 6 | Field block signal | $\bigcirc$ | 32 | "Close" phase. |
| 7 | Motor blower ON /OFF signal | $\bigcirc$ | 31 | "Close" --- Field intensifying. <br> "Open" --- Gate block $\rightarrow$ Field current half-reduced. |
| 8 | External gate block signal | $\bigcirc$ | 46-47 | "Close" --- Gate block. |
| 9 | External (OCL) failure reset | $\bigcirc$ | 45-46 | "Close" --- Normally. <br> "Open" --- Reset.Terminals 45 and 46 short- <br> circuited when reset button in <br> the unit is used. |
| 10 | Fuse blown detection signal (inside) | $\square$ | R1-R2 | "Open" --- Normally. <br> "Close" --- Gate block. |
| 11 | Thyristor cooling fan stop signal (inside) | $\bigcirc$ | R3-R4 | With failure detection cooling fan (option). <br> "Open" --- Normally. <br> "Close" --- Gate block. |
| 12 | Speed reference ( $\oplus$ Forward, $\Theta$ Reverse) |  | 6 | - Soft start command possible. <br> - 3 to 75 sec . (Variable) <br> - Accel. time, decel. time adjustable independently. <br> Terminals 11 and 12 short- |
|  |  |  | 7 |  |
|  |  |  | 8 |  |
|  |  |  | 10 |  |
|  |  |  | 12 |  |
|  |  |  | 13 | $\pm 6 \mathrm{~V} / 100 \% \mathrm{~N}$ |
| 13 | External current reference ( ${ }^{\oplus}$ |  | 14 | $\pm 3 \mathrm{~V} / 100 \% \mathrm{Ia}$ |
|  | $\Theta$ Reverse torque) |  | 15 | 0 V (SG) |
| 14 | Speed feedback signal |  | 2-3 | DCTG $2(-), 3(+)$ |
| 15 | CEMF compensation |  | 48 | Forward: $-6 \mathrm{~V} / 100 \% \mathrm{Va}$ Reverse: $+6 \mathrm{~V} / 100 \% \mathrm{Va}$ |
| 16 | Automatic field weakening current command |  | 1 | Output received from field controller Type JGSM-51. |
| 17 | Speed feedback (Voltage feedback) |  | 5 | - Output from Type JGSM-55 <br> When reversible operation by ACTG. (OPN: Open) <br> - Output from type JGSM-53 <br> When speed controlled by voltage detection. <br> (OPN: Open) |

## Notes:

1. Use highly reliable contact for input interface signal considering that the load is $48 \mathrm{VDC}, 10 \mathrm{~mA}$.
2. Provide a noise killer at both ends of coil when relays, contactors, etc. are used.

Table 12 Functions of External Control Terminals for Output

|  | Signal Name |  |  | Terminal No. | Function |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | Ready signal |  | $\cdots$ | 24-25 | Contact signal closed when operation is ready. <br> (PREP light ON.) | Allowable contact capacity :$\begin{gathered} 220 \text { VAC, } 2 \text { A } \\ 24 \text { VDC, } 2 \text { A } \end{gathered}$ |
| 2 | Operation signal |  | ${ }^{22}-\frac{0^{-21}}{0^{23}}$ | 21-22-23 | NO contact --- For $M$ input command. |  |
| 3 | Failure | signal | 19 | 18-19-20 | Contact signal closed (or opened) when failure occurs |  |
| 4 | $\begin{aligned} & \text { Zero-s } \\ & \text { detecti } \end{aligned}$ | eed n signal | - | 44 | "ON" at motor speed 1\% or below ( $\pm 6 \mathrm{~V} / 100 \% \mathrm{~N}_{\text {PB }}$ ). |  |
| 5 | Main circuit current detection signal |  |  | 49 | $\begin{aligned} & \pm 6 \mathrm{~V} / 100 \% \text { Ia } \\ & \text { (Allowable load impedance: } 3 \mathrm{k} \Omega \text { ) } \\ & \pm 12 \mathrm{~V} \text { Max } \end{aligned}$ |  |
| 6 | Speed reference signal |  |  | 11 | $\pm 6 \mathrm{~V} / 100 \% \mathrm{~N}$ | Terminals 11 and 12 short-circuited. |
| 7 | Speed feedback signal |  |  | 4 | Input from Type JGSM- 55 when reversible operation by ACTG. (OPN: Open) |  |
| 8 | Individual failure detection signal | Thyristor cooling fan stop |  | 39 | "ON" by thyristor cooling fan stop. | $-F_{7}^{*}$ |
|  |  | Thyristor overcurrent and overload |  | 40 | "ON" by thy ristor overcurrent overload. |  |
|  |  | Field lost |  | 41 | "ON" by field loss. |  |
|  |  | Motor overheat |  | 42 | "ON" by motor overheat. |  |
|  |  | Fuse blown |  | 43 | "ON" by fuse-blown. <br> Connected to 1 mA DC meter <br> (Full scale at maximum speed) |  |
| 9 | Speedometer |  |  | 50-51 |  |  |  |
| 10 | Main circuit ammeter |  |  | 52-51 | Connected to 1 mA DC meter ( $2 \mathrm{k} \Omega$ or below). |  |
| 11 | Control power supply |  |  | 53 | (Full scale at $150 \%$ load) |  |
|  |  |  |  | 54 | 0 V (SG) |  |
|  |  |  |  | 55 | +15 V |  |
|  |  |  |  | 38 | +24 V |  |
|  |  |  |  | 37 | OV(POWER 0 V ) |  |
|  |  |  |  | 35, 36 | +48 V | Isolated from other control power supply. |
|  |  |  |  | 34 | OV (POWER 0 V) |  |

*Allowable rating $24 \mathrm{VDC}, 50 \mathrm{~mA}$. ( 24 VDC power supply required externally.)

## Varispeed-505WII

INDUSTRIAL USE THYRISTOR CONVERTER UNITS

TOKYO OFFICE Ohtemachı Bldg, 1-6-1 Ohtemachı, Chıyoda-ku, Tokyc, 100 Japan Phone (03) 3284-9111 Telex YASKAWA J33530 Fax (03) 3284-9034
SEOUL OFFICE Seoul Center Bldg, 91-1, So Kong-Dong, Chung-ku, Seoul, Korea
Phone (02) 776-7844 Fax (02) 753-2639
TAIPEI OFFICE Shen Hsıang Tang Sung Chiang Building 10F 146 Sung Chiang Road, Taipeı, Taıwan
Phone (02) 563-0010, -7732 Fax (02) 567-4677
YASKAWA ELECTRIC AMERICA, INC. • SUBSIDIARY
Chicago-Corporate Headquarters 2942 MacArthur Blvd Northbrook, Illinois 60062-2028, U S A
Phone (708) 291-2340 Fax (708) 498-2430
Chicago-Technical Center 3160 MacArthur Blvd Northbrook, Hlinois 60062-1917, U S A
Phone (758) 291-0411 Fax (708) 291-1028
Los Angeles Office 5626 Corporate Averue Cypress, CA 90630 . U S A
Phone (714) 828-9692 Telex (230) 678396 YASKAWAUS TSTN Fax (714) 828-1 165
New Jersey Office Riverdale One, 44 Route 23 North, Suite 5 Riverdale, NJ 07457-1619
Phone (201) 835-9512 Fax (201) 835-9511
YASKAWA ELECTRIC EUROPE GmbH SUBSIDIARY
Niederhochstadter Strape 73, W 61476 Kronberg-Oberhochstadt, Germany
Phone (06173) 938-0 Telex 415660 YASE D Fax (06173) 68421
YASKAWA ELETRICO DO BRASIL COMERCIO LTDA. SUBSIDIARY
Rua Conde Do Pinhal 8-5", Andar Sala 51 CEP 01501-São Paulo-SP. Bresil
Phone (011) 35-1911 Fax (011) 37-7375
YASKAWA ELECTRIC (SINGAPORE) PTE. LTD.
CPF Bidg, 79 Robinson Road No 13-05, Singapore 0106
Phone 2217530 Telex (87) 24890 YASKAWA RS Fax (65) 224-5854

YASKAWA ELECTRIC CORPORATION


[^0]:    * VS-505WII of larger capacity than $230 \mathrm{~V}, 45 \mathrm{~A}$ or $460 \mathrm{~V}, 90$ A are provided with a thyristor cooling fan.

[^1]:    * VS-505WII, rated 220 V. 45 A and above and 460 V. 90 A and above are provided with a thyristor cooling fan.

[^2]:    Note: If the reading is not $\infty$, accurate measurement with a 500 V megger is required. Reading must be $\mathbf{3}$ megohms or above.

