INVERTER

Series L2000

M A N U A L

NB596XA

MANUAL

These two manuals provide you with the general information how to use L2000 frequency converters and how to apply, if needed, special applications.

L2000 Installationmanual provides you with the information necessary to install, start-up and operate the L2000 frequency converters. It is recommended that this manual is read thoroughly before powering up the frequency converter for the first time.

If any problem occurs, please contact your local distributors. WATT DRIVE Antriebstechnik GmbH is not responsible of the use of the frequency converters against the instructions.

WATT DRIVE WORLDWIDE

WATT DRIVE Antriebstechnik GmbH
Tel.: +43/2633/404-0 Fax: +43/2633/404-220
Internet: http:\\www.wattdrive.com
A-2753 Markt Piesting
Wöllersdorferstraße 68
e-mail: watt@wattdrive.com

WATT DRIVE Nord GmbH
Tel.: +49/2932/9681-0 Fax: +49/2932/9681-81
D-59759 Arnsberg
e-mail: watt-arnsberg@t-online.de

WATT DRIVE Süd GmbH
Tel.: +49/7471/9685-0 Fax: +49/7471/9865-29
D-72379 Hechingen
e-mail: watt-sued@t-online.de

WATT DRIVE Nord GmbH
Vertriebs- und Servicecenter Köln
Tel.: +49/2204/84-2800 Fax: +49/2204/84-2819
D-51429 Bergisch Gladbach
e-mail: watt-koeln@t-online.de

WATT DRIVE
Vertriebs- und Servicecenter Max LAMB KG
Tel.: +49/931/2794-0 Fax: +49/931/27455
D-97044 Würzburg
e-mail: ant@lamb.de

WATT EURO DRIVE (Far East) PTE LT
Tel.: +65/86 23 220 Fax: +65/86 23 33
SGP-629082 Singapore
e-mail: watteuro@pacific.net.sg

WATT EURO DRIVE (Malaysia) SDN BH
Tel: +603/736 89 81 Fax: +603/736 89 76
40400 Selangor, Malaysia
e-mail: cmfoo98@tm.net.my

Version: BA-FBE_UR.002.R001.06_00
File: H: L2000 Kurzanleitung_englisch.doc
Date: 14th of June 2000 / DE

Please read this manual carefully before you install and operate an L2000 series inverter and observe all of the instructions given in there. This manual may also serve as a reference guide and therefore should always be kept at hand.

Symbols used

There are several safety instructions in this manual which are marked with a special hazard alert symbol (flash or exclamation mark in the center of a triangle). Additionally, either the word CAUTION or WARNING is added following the triangle with the exclamation mark.

⚠ This symbol means hazardous high voltage. It is used to call your attention to items or operations that could be dangerous to your or other persons life. Please read the safety message carefully and follow all the instructions given.

⚠ This symbol is used to call your attention to situations which are potentially dangerous to persons. Please read the safety message carefully and follow all the instructions given.
The safety messages given following this symbol are further divided into two categories:

⚠ **WARNING**

This message indicates a situation which may lead to serious injury or even death if the instruction is not observed.

⚠ **CAUTION**

This message indicates a situation which may lead to minor or moderate injury, or damage of product.

⚠ **HAZARDOUS HIGH VOLTAGE**

Motor control equipment or electronic controllers are connected to hazardous line voltages. When servicing drives and electronic controllers there might exist exposed components with cases or protrusions at or above line potential. Extreme care should be taken to protect against shock.

For these reasons, the following safety guidelines should be observed:
Stand on an insulating pad and make it a habit to use only one hand when checking components. Disconnect power before checking controllers or performing maintenance. Be sure that equipment is grounded properly. Wear safety glasses whenever working on an electronic controller or rotating electrical equipment.

⚠ **WARNING**

This equipment should be installed, adjusted and serviced only by qualified electrical maintenace personel familiar with the construction and operation of the equipment and the hazards involved. Failure to observe this precaution could result in bodily injury.

⚠ **WARNING**

The user is responsible that all driven machinery, drive train mechanism not supplied by WATT Drive Antriebstechnik GmbH and process line material are capable of safe operation at an applied frequency of 150% of the maximum selected frequency range to the AC motor. Failure to do so can result in destruction of equipment and injury to personnel should a single point failure occur.

⚠ **WARNING**

HAZARD OF ELECTRICAL SHOCK. DISCONNECT INCOMING POWER BEFORE WORKING ON THIS CONTROL.

⚠ **WARNING**

SEPERATE MOTOR OVERLOAD AND OVERCURRENT PROTECTION DEVICES ARE REQUIRED TO BE PROVIDED IN ACCORDANCE WITH THE SAFETY CODES REQUIRED BY JURISDICTIONAL AUTHORITIES.

⚠ **CAUTION**

These instructions should be read and clearly understood before working on L2000 series equipment.

⚠ **CAUTION**

Proper grounds, disconnecting devices (e.g. fuses) and other safety devices and their location are the responsibility of the user and are not provided by WATT Drive GmbH

⚠ **CAUTION**

DANGEROUS VOLTAGE EXISTS UNTIL THE POWER LIGHT ON THE DIGITAL OPERATOR IS OFF.

⚠ **CAUTION**

Rotating shafts and electrical potentials above ground level can be hazardous. Therefore it is strongly recommended that all electrical work conform to the national electrical codes and local regulations. Installation, maintenance and alignment should be performed by qualified personnel only.

Factory recommended test procedures included in this instruction manual should be followed. Always disconnect electrical power before working on the unit.

⚠ **WARNING**

a) Any motor used must be of suitable rating.
b) Motors may have hazardous moving parts so that suitable protection must be provided in order to avoid injury.

⚠ **CAUTION**

Alarm connections may have hazardous live voltages even when the inverter is disconnected. In case of removing the front cover for maintenance or inspection, confirm that incoming power for alarm connections is surely disconnected.

⚠ **CAUTION**

Main terminals or other hazardous terminals for any interconnection (terminals for connecting the motor, contact breaker, filter etc.) must be inaccessible in end installation.

All of the above instructions, together with any other requirements, reccommendations, and safety messages highlighted in this manual must be strictly complied with.

NOTES ON EMC (ELECTRO MAGNETICAL COMPATIBILITY)

⚠ **WARNING**

This equipment should be installed, adjusted and serviced by qualified personnel familiar with construction and operation of the equipment and the hazards involved. Failure to observe this precaution could result in bodily injury.

When using L2000 series inverters in EU countries, the EMC directive 89/336/EEC must be observed. To satisfy the EMC directive and to comply with the standard, the following provisions should be obeyed:

A) Environmental conditions for the inverter:
- Ambient temperature: -10°C to 40°C.
- Relative Humidity: 20% to 90% (no dew condensation)
- Vibrations: max. 5,9m/s^2 (0.6 g) at 10–55Hz.
- Location: 1000 meter or less altitude, indoors (no corrosive gas or dust).

B) The power supply to the L2000 inverter must conform to the conditions stated below. If one of the conditions mentioned is not satisfied then an appropriate L2000 AC reactor will have to be installed.
- Voltage fluctuation +/-10% or less
- Voltage unbalance +/-3% or less
- Frequency variation +/-4% or less

C) Wiring

- Shielded wiring (screened cable) is required for motor wiring, and total length has to be kept to less than 50m. When using motor cables longer than 50m, L2000 motor filters should be installed. Directions for installing filters can be found in the L2000 installation manual.
- Seperate the mains circuit wiring from the wiring used for signals or process circuit. Please refer to the L2000 installation manual.

D) Installation

- For L2000 series inverters, the filters described hereafter have to be used and the installation notes have to be observed.

If installed according to the following directions, the frequency inverters comply with the following standards:

Emmissions: EN 61800-3 (EN 55011 group 1, class B)
Immunity: EN 61800-3, industrial environments

For the best possible damping of interference, special line filters have been developed which guarantee you easy assembly and installation along with the necessary electrical reliability. However, effective EMC is only ensured if the suitable filter is selected for the particular drive and installed in accordance with these EMC recommendations. Please choose the appropriate filter using the table below:

Inverter type	Input voltage	Filter type
L2000-002 NFE	1 ~ 220V -10% thru 240V +5%	UHZNF-E-1-007
L2000-004 NFE		UHZNF-E-1-007
L2000-005 NFE		UHZNF-E-1-012
L2000-007 NFE		UHZNF-E-1-012
L2000-011 NFE		UHZNF-E-1-024
L2000-015 NFE		UHZNF-E-1-024
L2000-022 NFE		UHZNF-E-1-024
L2000-004 HFE	3 ~ 380 V -10% thru 460V +10%	UHZNF-F-3-007
L2000-007 HFE		UHZNF-F-3-007
L2000-015 HFE		UHZNF-F-3-007
L2000-022 HFE		UHZNF-F-3-011
L2000-030 HFE		UHZNF-F-3-011
L2000-040 HFE		UHZNF-F-3-011
L2000-055 HFE		UHZNF-F-3-020
L2000-075 HFE		UHZNF-F-3-020

Note: All filters are designed for 50Hz/60Hz +/-5%.

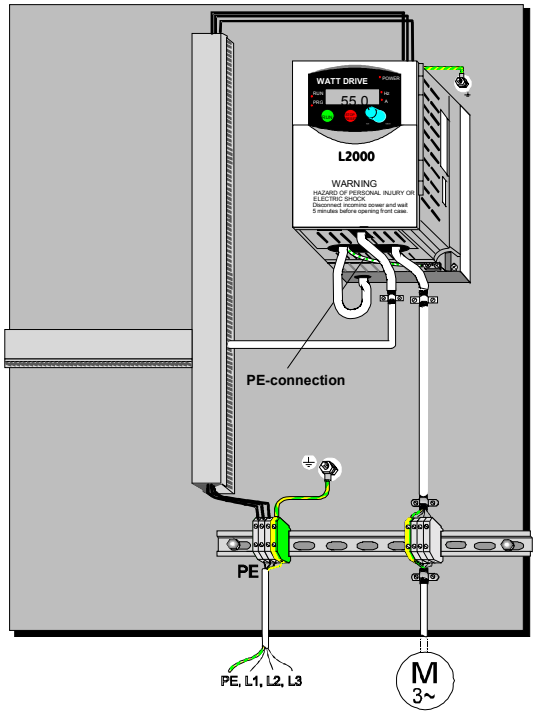
The amount of line-conducted interference also increases as motor cable length increases. Adherence to the interference limits for line-conducted interference is guaranteed on following way:

- If maximum motor cable length is 10 m at maximum elementary frequency:
  Class „B“.
- If maximum motor cable length is 20 m at elementary frequency 5 kHz:
  Class „B“.
- If maximum motor cable length is 50 m at maximum elementary frequency:
  Class „A“.

Observe the following provisions for an electromagnetically compatible setup of your drive system:

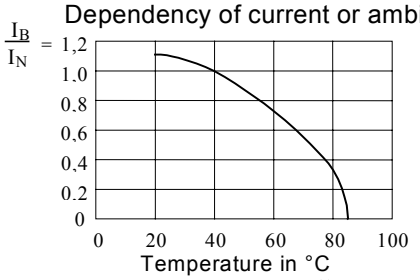
1. As user you must ensure that the HF impedance between frequency inverter, filter and ground is as small as possible.
   - Take care it that the connections are metallic and have the largest possible areas (zink-plated mounting plates)
2. Conductor loops act like antennas, especially when they encompass large areas. Consequently:
   - Avoid unnecessary conductor loops
   - Avoid parallel arrangement of „clean“ and interference-prone conductors
3. Lay the motor cable and all analog and digital control lines shielded.
   - You should allow the effective shield area of these lines to remain as large as possible; i.e., do not move the shield further away than absolutely necessary.
   - With compact systems, if for example the frequency inverter is communicating with the steering unit, in the same control cabinet connected at the same PE-potential, the screen of control lines should be put on, on both sides with PE. With branch systems, if for example the communicating steering unit is not in the same control cabinet and there is a distance between the systems, we recommend to put on the screen of control lines only on the side of the frequency inverter. If it is possible, direct in the cable entry section of the steering unit. The screen of Motor cabels always must be put on, on both sides with PE.
   - The large area contact between shield and PE-potential you can realise with a metal PG screw connection or a metallic mounting clip.
   - Use only copper mesh cable (CY) with 85% coverage
   - The shielding should not be interrupted at any point in the cable. If the use of reactors, contactors, terminals or safety switches in the motor output is necessary, the unshielded section should be kept as small as possible.
   - Some motors have a rubber gasket between terminal box and motor housing. Very often, the terminal boxes, and particularly the threads for the metal PG screw connections, are painted. Make sure there is always a good metallic connection between the shielding of the motor cable, the metal PG screw connection, the terminal box and the motor housing, and carefully remove this paint if necessary.
4. Very frequently, interference is coupled in through installation cables. This influence you can minimize:
   - Lay interfering cables separately, a minimum of 0.25 m from cables susceptible to interference.
   - A particularly critical point is laying cables parallel over larger distances. If two cables intersect, the interference is smallest if they intersect at an angle of 90°. Cables susceptible to interference should therefore only intersect motor cables, intermediate circuit cables, or the wiring of a rheostat at right angles and never be laid parallel to them over larger distances.
5. The distance between an interference source and an interference sink (interference-threatened device) essentially determines the effects of the emitted interference on the interference sink.
   - You should use only interference-free devices and maintain a minimum distance of 0.25 m from the drive.
6. Safety measures
   - Ensure that the protective conductor terminal (PE) of the filter is properly connected with the protective conductor terminal of the frequency inverter. An HF ground connection via metal contact between the housings of the filter and the frequency inverter, or solely via cable shield, is not permitted ***as*** protective conductor connection. The filter must be solidly and permanently connected with the ground potential so as to preclude the danger of electric shock upon touching the filter if a fault occurs. You can achieve this by connecting it with a grounding conductor of at least 10 mm² or connecting a second grounding conductor, connected with a separate grounding terminal, parallel to the protective conductor (the cross section of each single protective conductor terminal must be designed for the required nominal load).

Technical specifications and dimensions of L2000 foot print filter:

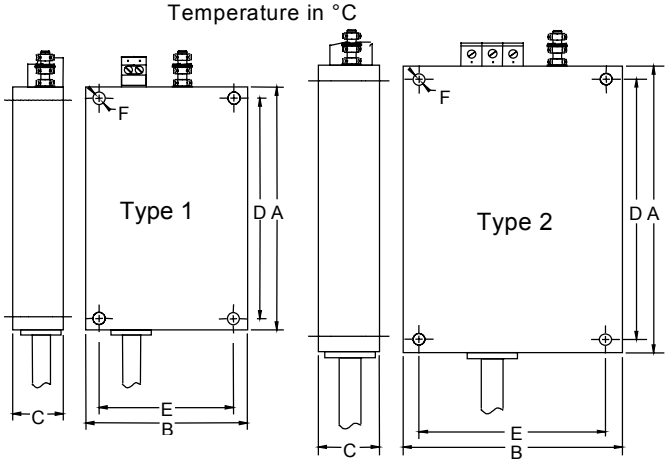


Current	at 40°C ambient temperature
Overload	1.5 x I_N for 10min
Frequency	50 / 60 Hz
Material	Steel, surface refined
Humidity class	C
Operation height	< 1000 m without derating; > 1000 m, I_N-2%, for each 1000m
Temperature range	-25°C through +85°C
Enclosure	Input terminals IP 20 and PE-holder M5. Load side: cable, unshielded.

Dependency of current or ambient temperature:



Dimensions (in mm)							
Model: UHZNF-	Typ	A	B	C	D	E	F
E-1-007	1	120	80	25	110	67	2x6
E-1-012	1	130	110	27	118	98	4x6
E-1-024	1	180	140	29	168	128	4x6
F-3-007	2	130	110	27	118	98	4x6
F-3-011	2	180	140	29	168	128	4x6
F-3-020	2	257	182	35	236	160	4x7



Type: UHZNF- / Specification:	E-1-007	E-1-012	E-1-024	F-3-007	F-3-011	F-3-020
Voltage in V	240 +5%	240 +5%	240 +5%	460 +10%	460 +10%	460 + 10%
Current in A at 40°C	2 x 6A	2 x 10A	2 x 23A	3 x 6A	3 x 11A	3 x 20A
Leak. Current in mA/Phase, 50Hz, worst case [1])	-	-	-	32	62	120
Leakage current in mA/ Phase, 50Hz, Un [2])	< 3.5	< 3.5	< 10	< 3.5	< 3.5	<10
Test voltage in V DC, 2s ph./ph., ph./ground	1400 / 2800	1400 / 2800	1400 / 1400	1978 / 2800	1978 / 2800	1978 / 1978
Dimensions single wire / litze	4 / 4 mm²	4 / 4 mm²	4 / 4 mm²	4 / 4 mm²	4 / 4 mm²	4 / 4 mm²
Output cable	3x1.5mm²	3x1.5mm²	3x2.5mm²	4x1.5mm²	4x2.5mm²	4x2.5mm²
Weight in kg (approx.)	0.5	0.6	1.0	0.7	1.1	2.4
Heat dissip. in W (approx.)	6	7	9	7	10	14

[1]) “Worst case” states the leakage current for three-phase filters in the worst of cases. That means one phase is live and two phases of the feed-line lead-in are interrupted. These maximum values are based on an operating voltage of 460 V (ph./ph.).

[2]) The normal leakage current for three-phase filters is stated. This means the filter is operating on 460 V (ph./.ph.). The stated values are adhered to up to a neutral voltage of 5V to ground caused by line unbalance.

C O N T E N T S

1. SAFETY PRECAUTIONS 10
INSTALLATION 10
WIRING 10
CONTROL AND OPERATION 11
MAINTENANCE AND INSPECTION 12
OTHERS 12
2. INSPECTION UPON UNPACKING 14
3. TECHNICAL SPECIFICATIONS 15
4. APPEARANCE AND NAMES OF PARTS 19
5. INSTALLATION 21
6. WIRING 22
WIRING THE POWER SUPPLY AND MOTOR 22
WIRING THE CONTROL TERMINALS 23
GENERAL REMARKS 24
WIRING EQUIPMENT AND OPTIONS 26
TERMINALS 28
7. GENERAL OPERATION NOTES 31
BEFORE STARTING OPERATION 31
TEST RUN 31
8. CONTROL CIRCUIT TERMINAL FUNCTIONS 33
OVERVIEW 33
9. USING THE DIGITAL OPERATOR 35
THE DIGITAL OPERATOR CONTROL PANEL 35
OPERATING PROCEDURE EXAMPLE 35
DIGITAL OPERATOR KEYS 37
BASIC FUNCTIONS 38
EXTENDED FUNCTIONS OF GROUP A 38
EXTENDED FUNCTIONS OF GROUP B 44
EXTENDED FUNCTIONS OF GROUP C 47
10. MESSAGES 49
TRIP MESSAGES 49
OTHER MESSAGES 50
11. TROUBLE SHOOTING 51

1. Safety precautions

Installation

The following safety precautions are to be observed when installing the frequency inverter:

⚠ CAUTION Be sure to install the inverter on flame resistant material such as metal. Otherwise, there is a danger of fire.

⚠ CAUTION Be shure not to place anything inflammable in the vicinity. Otherwise, there is a danger of fire.

⚠ CAUTION Be sure not to let foreign matter (such as cut wire refuse, spatter from welding, iron refuse, wires, dust etc.) enter the inverter. Otherwise, there is a danger of fire.

⚠ CAUTION Install the inverter in a room which is not exposed to direct sunlight and is well ventilated. Avoid environments which tend to be high in temperature, high in humidity or which have dew condensation, as well as places with dust, corrosive gas, explosive or inflammable gas, grinding-fluid mist, salt damage etc. Otherwise, there is a danger of fire.

⚠ CAUTION The wall surface on which the inverter is mounted must be of a nonflammable material, such as a steel plate.

Wiring

⚠ WARNING The inverter has to be grounded properly. Otherwise, there is a danger of fire.

⚠ WARNING Wiring work must only be carried out when the power supply is off. Otherwise, there is a danger of electric shock and/or fire.

⚠ WARNING Before carrying out the wiring work, the inverter has to be mounted properly. Otherwise, there is a danger of electric shock or injury.

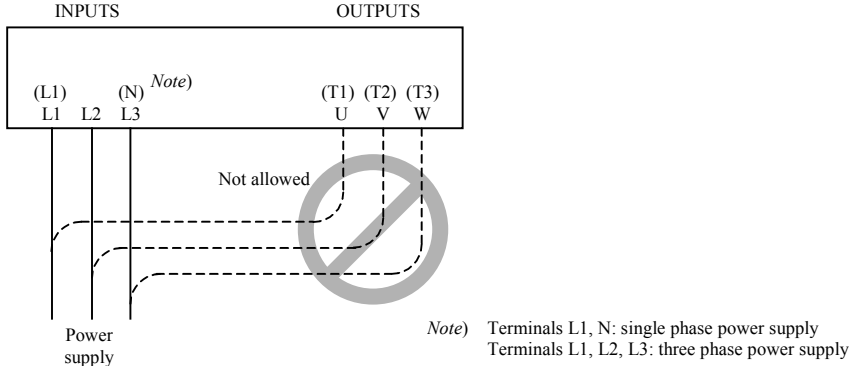
⚠ CAUTION Make shure that the input voltage is as follows (please also refer to chapter 11):

Single/three phase: 200~240V, 50/60Hz (models up to 2,2kW)

Three phase: 200~240V, 50/60Hz

Three phase: 380~460V, 50/60Hz

⚠ CAUTION Don´t connect AC power supply to the inverter output terminals U, V, and W. Otherwise, there is a danger of injury and/or fire.



⚠ CAUTION Remarks for using earth leakage circuit breakers in the mains supply:

Frequency inverters with CE-filters (RFI-filter) and screened motor cables have a higher leakage current against earth. Especially in the moment of switching this can cause unintentional triggering of earth leakage circuit breakers. Because of the rectifier on the input side of the inverter there is the possibility to stall the switch-off function through amounts of DC current. For these reasons, the following items should be observed:

Only pulse current sensitive earth leakage circuit breakers which have a short term delay and a higher trigger current (500mA) should be used. Other components should be secured with separate earth leakage circuit breakers. Earth leakage circuit breakers in front of an inverter´s rectifier are not an absolute protection against direct touching.

⚠ CAUTION Each phase of the power supply has to be provided with a fuse. Otherwise, there is a danger of fire.

Control and operation

⚠ WARNING Be sure to turn on the input power supply only after closing the front case. While being energized, don´t open the front case. Otherwise, there is a danger of electric shock.

⚠ WARNING Never operate the switches with wet hands. Otherwise, there is a danger of electric shock.

⚠ WARNING If the retry mode is selected, the inverter may suddenly restart during a stop which was caused by a trip. In such a case, be sure not to approach the machine. Provisions have to be taken that the driven motor or machine does not endanger personnel even in the case of a sudden restart. Otherwise, there is a danger of injury.

⚠ WARNING Even if the power supply is cut off for a short period of time, the inverter may restart operation after the power supply has recovered if the operation command is given. If this may incur danger to personnel, provisions have to be made in order to prevent a restart after power recovery. Otherwise, there is a danger of injury.

⚠ WARNING The STOP key is effective only if the corresponding parameters have been set. Otherwise, there is a danger of injury.

⚠ WARNING If a reset is carried out following a trip condition the motor will restart if the operation command has been given. Be sure to acknowledge this trip condition with a reset only after confirming that no operation command is active. Otherwise, there is a danger of injury.

⚠ WARNING When the power to the inverter is turned on while the operation command is active the motor starts immediately. So before turning power supply on be sure to confirm that no operation command is active.

⚠ WARNING If the inverter has been configured for the stop command not to be given using the STOP key, pressing the STOP key does not stop the motor. In this case a separate emergency stop switch is necessary.

⚠ CAUTION Operate the motor and machine connected to the inverter only within the manufacturer´s speed specifications. Otherwise, there is a danger of injury.

⚠ CAUTION If a motor is to be operated at a frequency higher than the standard setting value of 50 or 60Hz, be sure to check the allowable speed of the motor and the machine with each manufacturer, and operate them only after getting their consent.

⚠ CAUTION Check the following during and after the test run. Otherwise, there is a danger of machine breakage:

Was the short cut bar between terminals +1 and + removed by mistake?

Was the running direction of the motor correct?

Was the inverter tripped during acceleration or deceleration?

Were the indications of the rpm and the frequency meter correct?

Were there any abnormal motor vibrations or noise?

Maintenance and inspection

⚠ WARNING Before carrying out maintenance and inspection wait for at least five minutes after having turned off the input power supply. Otherwise, there is a danger of electric shock.

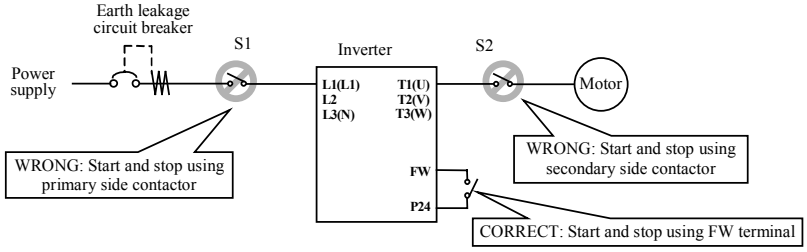
⚠ WARNING When removing connectors (e.g. from fans and printed circuit boards) never pull the attached wires. Otherwise, there is a danger of fire due to wire breakage and/or injury.

Others

⚠ CAUTION Withstand voltage tests and insulation resistance tests (megger tests) are executed before the units are shipped, so that there is no need to conduct these tests before operation.

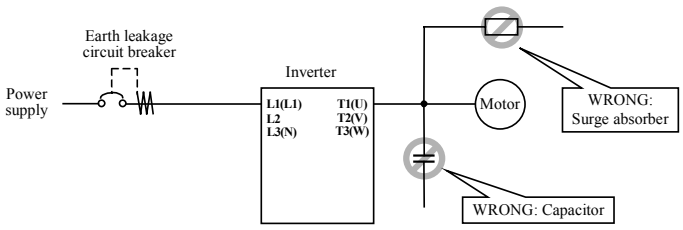
⚠ CAUTION Do not attach or remove wiring or connectors when power is applied. Also, do not check signals (e.g. using a multimeter) during operation.

⚠ CAUTION Never stop motor operation by switching off the electromagnetic contactors on the primary or secondary side of the inverter.



When there has been an instantaneous power failure, and if an operation instruction has been given, then the inverter may restart operation after the power failure has ended. If there is a possibility that such an occurrence may harm humans, then install an electromagnetic contactor on the primary (power supply) side of the inverter, so that the circuit does not allow automatic restarting after the power supply has recoverd. If the optional remote operator is used and the retry function has been selected, this will also cause automatic restarting when an operation instruction has been input, so please be careful.

⚠ CAUTION Do not insert leading power factor capacitors or surge absorbers between the output terminals of the inverter and the motor.

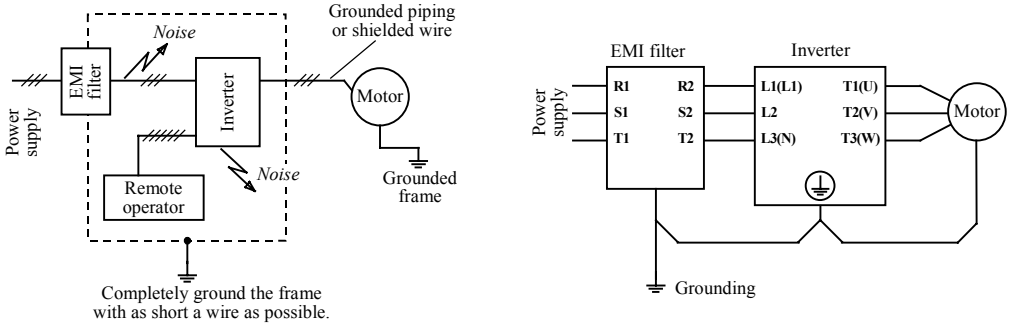


⚠ CAUTION Be sure to ground the grounding terminal ⏚ properly.

⚠ CAUTION Before inspecting the unit wait at least five minutes before opening the inverter .

⚠ CAUTION PROTECTION AGAINST NOISE INTERFERENCE FROM THE INVERTER

L2000 series inverters use many semiconductor switching elements such as transistors and IGBTs. For this reason, a radio set or measuring instrument located near the inverter is susceptible to noise interference. To protect the instruments from erreneous operation due to noise interference produced by the inverter, they should be installed well apart from the inverter. It is also effective to shield the whole inverter structure (refer to figure below, left part).



Addition of an EMI filter on the input side of the inverter also reduces the effect of noise from commercial power lines on external devices (refer to figure above).

⚠ CAUTION EFFECTS OF DISTRIBUTER LINES ON INVERTERS

In the cases mentioned below involving a general purpose inverter, a large peak current flows on the power supply side, sometimes destroying the converter module:

A) The unbalance factor of the power supply is 3% or higher.

B) The power supply capacity is set at least ten times greater than the inverter capacity (i.e. 500kVA or more)

C) When abrupt power supply changes are to be expected. Some examples:

1) Several inverters are interconnected using a short bus to the same power supply.

2) A thyristor converter and an inverter are interconnected using a short bus.

3) An installed power factor compensating device is connected or disconnected.

In the cases mentioned above we recommend installing an AC reactor of 3% voltage drop at rated current with respect to the supply voltage on the power supply side.

⚠ CAUTION When an EEPROM error occurs (trip *E 08*) all parameter values have to be checked for correctness (especially the RS input).

⚠ CAUTION When the intelligent digital inputs FW or RV are configured as normally closed contact (standard setting is normally open), then the inverter starts automatically. Do not configure these inputs as normally closed inputs unless absolutely necessary.

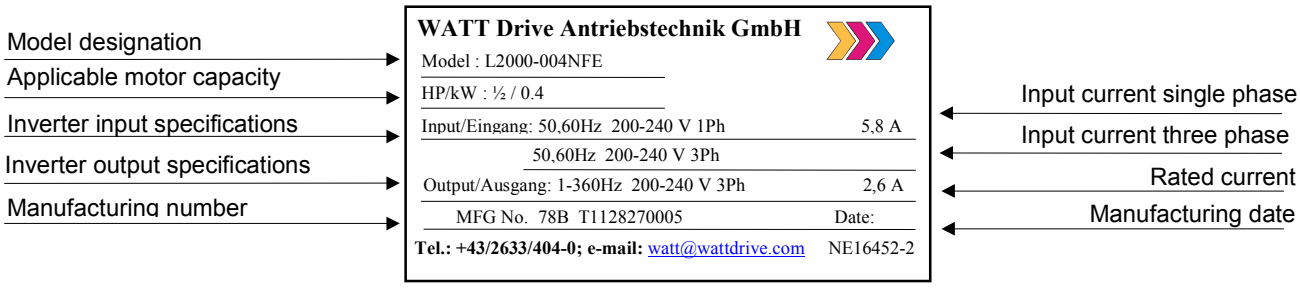
⚠ GENERAL NOTICE

In all the illustrations and figures in this manual, covers and safety devices are occasionally omitted in order to better describe the details. When the inverter is operated make shure that all the covers and safety devices are placed in their correct positions.

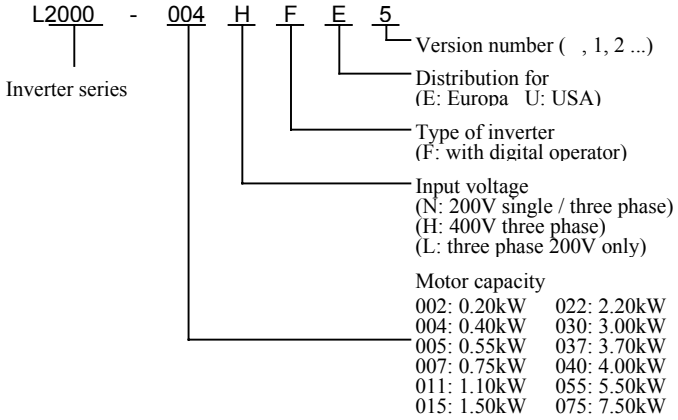
2. Inspection upon unpacking

Please check the shipment by the time of delivery for damages and completeness. Check that the inverter and the accompanying instruction manual has been provided. Using the specification label attached to the side of inverter make sure that the inverter model delivered is the one you ordered.

The specifications included on the specification label are described below:



In the illustration below, the contents of the model designation used for L2000 series inverters is explained:



3. Technical specifications

Inverter L2000- (200V series)			002 NFE	004 NFE	005 NFE	007 NFE	011 NFE	015 NFE	022 NFE			
Protective structure (*Note 1*)			IP20									
Overvoltage category			III									
Maximum motor size (4P) in kW (*Note 2*)			0.2	0.4	0.55	0.75	1.1	1.5	2.2	3.7	5.5	7.5
Maximum capacity in kVA		230V	0.5	1.0	1.1	1.5	1.9	2.8	3.9	6.3	9.5	12.7
		240V	0.5	1.0	1.2	1.6	2.0	2.9	4.1	6.6	9.9	13.3
Input supply phase			002 ~ 022NFE/U: Single phase / 3 phase 037 ~ 075LFU: 3 phase									
Rated input voltage			200VAC –10% ~ 240VAC +5% 50/60Hz +/-5%									
Rated output voltage (*Note 3*)			Three phase 200 ~ 240VAC (Corresponds to input voltage)									
Rated input current in A Single phase (Three phase)			3.1 (1.8)	5.8 (3.4)	6.7 (3.9)	9.0 (5.2)	11.2 (6.5)	16.0 (9.3)	22.5 (13.0)	- (20.0)	- (30.0)	- (40.0)
Rated output current in A (*Note 4a*)			1.4	2.6	3.0	4.0	5.0	7.1	10.0	15.9	24.0	32.0
Output frequency range			0.5 ~ 360 Hz (*Note 5*)									
Frequency accuracy (at 25°C +/-10°C)			Digital command: +/-0.01% of maximum frequency Analog command: +/-0.2% of maximum frequency									
Frequency setting resolution			Digital setting: 0.1 Hz Analog setting: maximum frequency /1000									
Voltage/frequency characterist.			Constant or reduced torque with any variable voltage/frequency									
Overload current capacity			150% during 60 seconds (once per 10 minutes)									
Acceleration/deceleration time			0.1 ~ 3000 s in selectable linear and non-linear mode (second acceleration/deceleration usable)									
Starting torque			100% or more (when torque boost has been set)									
Braking torque	Dynam. braking, feedback to capacitor (*Note 6*)		ca. 100%				ca. 70%		ca. 20%			
	DC injection braking		Braking is on at the minimum frequency or less (minimum frequency, braking time and braking force can be set)									
Inputs	Frequency setting	Dig. operator	Settings using keys ▲▼ or potentiometer									
		External signals	0-10VDC (input impedance 10k Ohm); 4-20mA (input impedance 250 Ohm); Potentiometer 1k-2k Ohm, 1W									
	Forward / Reverse run (Start/Stop)	Dig. operator	Via keys RUN (for start) and STOP/RESET (for stop) (Default setting: forward run)									
		Ext. signals	Intelligent input terminals configurable as FW and RV									
	Intelligent input terminals programmable as		FW: Forward run start/stop CF1–CF4: Multistage speed AT: Analog current input selection FRS: Free run stop USP: USP function SFT: Software lock RV: Reverse run start/stop JG: Jogging command 2CH: 2.Accel./decel. time EXT: External trip RS: Reset PTC: Thermal protection									
Outputs	Intelligent output terminals programmable as		FA1/FA2: Frequ. arrival signal RUN: Motor running signal OL: Overload signal OD: PID deviation signal AL: Alarm signal									
	Frequency and current monitoring		Connection of external analog meter (0-10VDC, max. 1mA) for frequency or current; connection of external digital frequency meter									
Fault alarm contact			On when the inverter trips (1c contact)									
Other functions			Automatic voltage regulation, retry; analog gain/vias adjustment, frequency jump, upper/lower limiter, output frequency display, trip history monitoring, carrier frequency setting, PID control, automatic torque boost, and many more									
Protection functions			Overcurrent, overvoltage, undervoltage, electronic thermal, temperature abnormality, ground fault upon starting, overload limit									
Environmental	Ambient temp. (*Note 7*)		-10 ~ 50°C									
	Storage temperature and humidity		-25 ~ 70°C (during short term transportation period only) 20 ~ 90% RH (no dew condensation)									
	Vibration		Max. 5.9m/s^2 (=0.6g) at 10-55Hz									
	Installation location		1000m or less altitude indoors (IP54 or equivalent)									
External color			Blue									
Options			Remote operator, copy unit, cable for digital operator, reactor for improving power factor, noise filter									
Overall weight (approx.)			0.85		1.3		2.2		2.8		5.5	5.7

Inverter L2000- (400V series)			004 HFE	007 HFE	015 HFE	022 HFE	030 HFE	040 HFE	055 HFE	075 HFE
Protective structure (*Note 1*)			IP20							
Overvoltage category			III							
Maximum motor size (4P) in kW (*Note 2*)			0.4	0.75	1.5	2.2	3.0	4.0	5.5	7.5
Maximum capacity in kVA		460V	1.1	1.9	3.0	4.3	6.2	6.8	10.3	12.7
Input supply phase			004 ~ 075HF: 3 phase							
Rated input voltage			380VAC –10% ~ 460VAC +10% 50/60Hz +/-5%							
Rated output voltage (*Note 3*)			Three phase 380 ~ 460VAC (Corresponds to input voltage)							
Rated input current in A			2.0	3.3	5.0	7.0	10.0	11.0	16.5	20.0
Rated output current in A (*Note 4b*)			1.5	2.5	3.8	5.5	7.8	8.6	13.0	16.0
Output frequency range			0.5 ~ 360 Hz (*Note 5*)							
Frequency accuracy (at 25°C +/-10°C)			Digital command: +/-0.01% of maximum frequency Analog command: +/-0.2% of maximum frequency							
Frequency setting resolution			Digital setting: 0.1 Hz Analog setting: maximum frequency /1000							
Voltage/frequency characterist.			Constant or reduced torque with any variable voltage/frequency							
Overload current capacity			150% during 60 seconds (once per 10 minutes)							
Acceleration/deceleration time			0.1 ~ 3000 s in selectable linear and non-linear mode (second acceleration/deceleration usable)							
Starting torque			100% ore more (when torque boost has been set)							
Braking torque	Dynam. braking, feedback to capacitor (*Note 6*)		ca. 100%		ca. 70%	ca. 20%				
	DC injection braking		Braking is on at the minimum frequency or less (minimum frequency, braking time and braking force can be set)							
Inputs	Frequency setting	Dig. operator	Settings using keys ▲ ▼ or potentiometer							
		External signals	0-10VDC (input impedance 10k Ohm) 4-20mA (input impedance 250 Ohm) Potentiometer 1k-2k Ohm, 1W							
	Forward / Reverse run (Start/Stop)	Dig. operator	Via keys RUN (for start) and STOP/RESET (for stop) (Default setting: forward run)							
		Ext. signals	Intelligent input terminals configurable as FW and RV							
	Intelligent input terminals programmable as		FW: Forward run start/stop CF1–CF4: Multistage speed AT: Analog current input selection FRS: Free run stop USP: USP function SFT: Software lock				RV: Reverse run start/stop JG: Jogging command 2CH: 2.Accel./decel. time EXT: External trip RS: Reset PTC: Thermal protection			
Outputs	Intelligent output terminals programmable as		FA1/FA2: Frequ. arrival signal RUN: Motor running signal OL: Overload signal OD: PID deviation signal AL: Alarm signal							
	Frequency and current monitoring		Connection of external analog meter (0-10VDC, max. 1mA) for frequency or current; connection of external digital frequency meter							
Fault alarm contact			On when the inverter trips (1c contact)							
Other functions			Automatic voltage regulation, retry; analog gain/vias adjustment, frequency jump, upper/lower limiter, output frequency display, trip history monitoring, carrier frequency setting, PID control, automatic torque boost, and many more							
Protection functions			Overcurrent, overvoltage, undervoltage, electronic thermal, temperature abnormality, ground fault upon starting, overload limit							
Environmental.	Ambient temperature (*Note 7*)		-10 ~ 50°C							
	Storage temperature and humidity		-25 ~ 70°C (during short term transportation period only) 20 ~ 90% RH (no dew condensation)							
	Vibration		Max. 5.9m/s² (=0.6g) at 10-55Hz							
	Installation location		1000m or less altitude indoors (IP54 or equivalent)							
External color			Blue							
Options			Remote operator, copy unit, cable for digital operator, reactor for improving power factor, noise filter							
Overall weight (approx.)			1.3	1.7		2.8			5.5	5.7

Notes on technical specifications:

Note 1: Protective structure is based upon EN60529

Note 2: The applicable motor is a WATT DRIVE standard four-pole motor. When using another motor, make sure that the rated motor current does not exceed the rated inverter current.

Note 3: The output voltage will decrease if input voltage decreases.

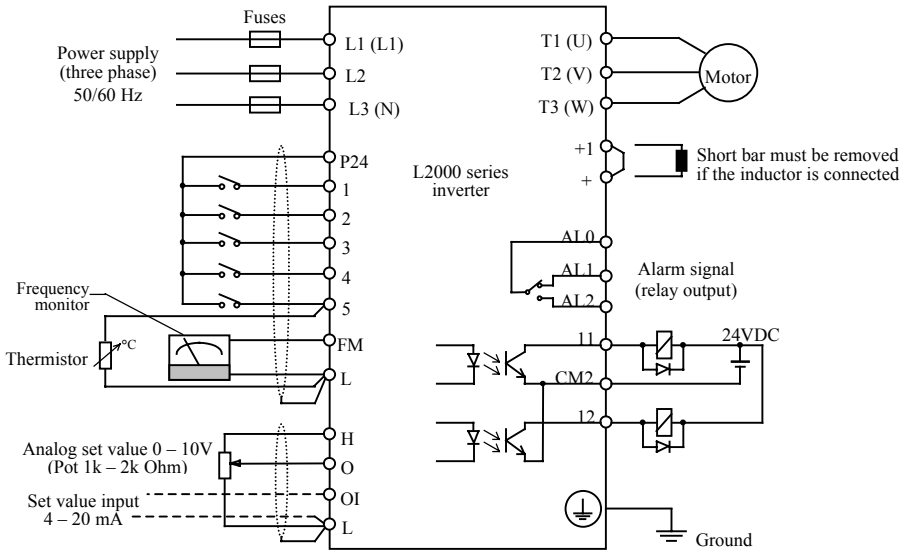
Note 4a: The initial data setting values of 005N/011N are same as 007N/015N. So be sure to set the correct values under *b 12* and *b 22* of 005N/007N for each motor first.

Note 4b: The initial data setting value of 030H is same as 040H. So be sure to set the values under *b 12* and *b 22* of 030H for the motor first.

Note 5: Confirm with the motor manufacturer the motors maximum rpm when using a motor running at frequencies higher than 50/60Hz

Note 6: Torque will be reduced when the base frequency exceeds 50Hz.

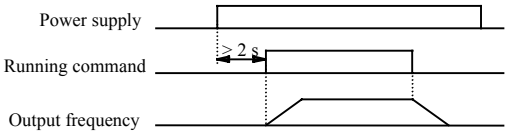
Note 7: In the range of 40 to 50°C reduce the carrier frequency to 2kHz and derate the output current to 80% of the rated current, and remove the top cover.



Notes:

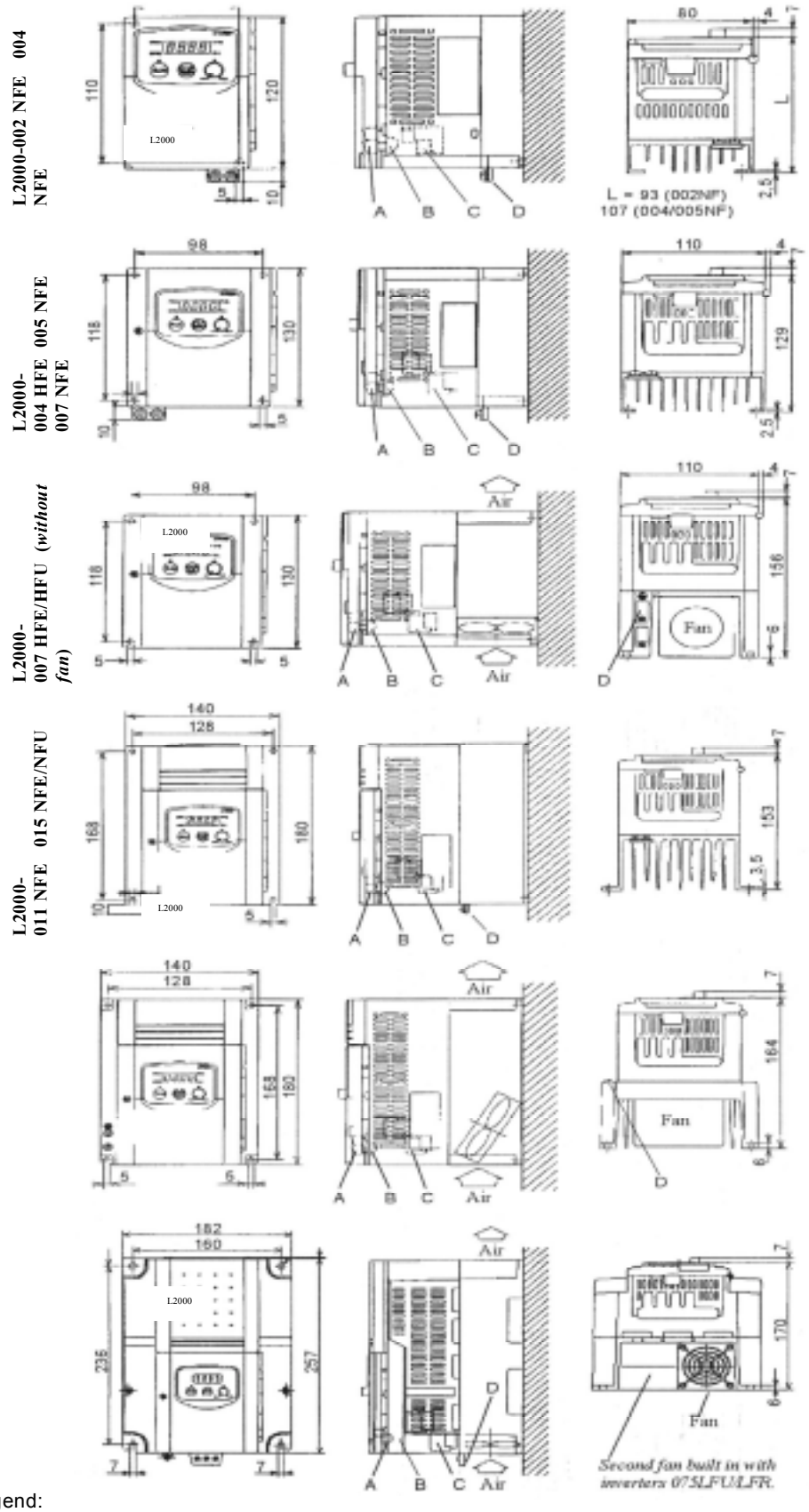
The common potential depends on the terminals used:

Terminals	Common potential
1, 2, 3, 4, 5	P24
FM, H, O, OI	L
11, 12	CM2



A trip will occur when a running command is active at the time the power supply is switched on. The power supply should not be switched on simultaneously with the running command; instead there should be a time delay of about 2 seconds from the time the power supply is switched on until the running command is activated (refer to time diagram). Also the power supply must not be switched off while the running command is being active (motor is running).

External dimensions and terminal positions of L2000 series inverters

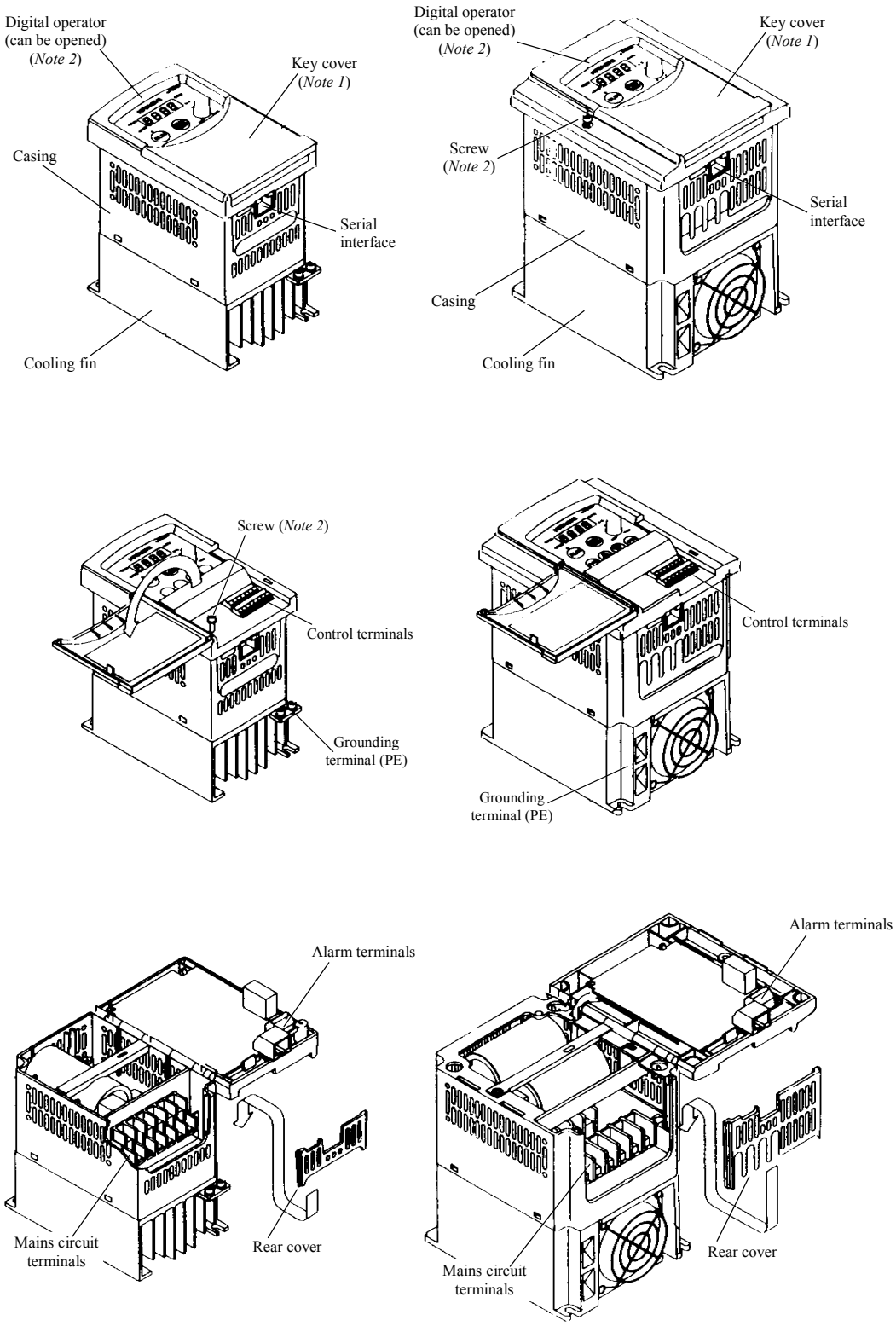


Legend:

A Control terminals
B Alarm terminals
C Main terminals
D Grounding terminals

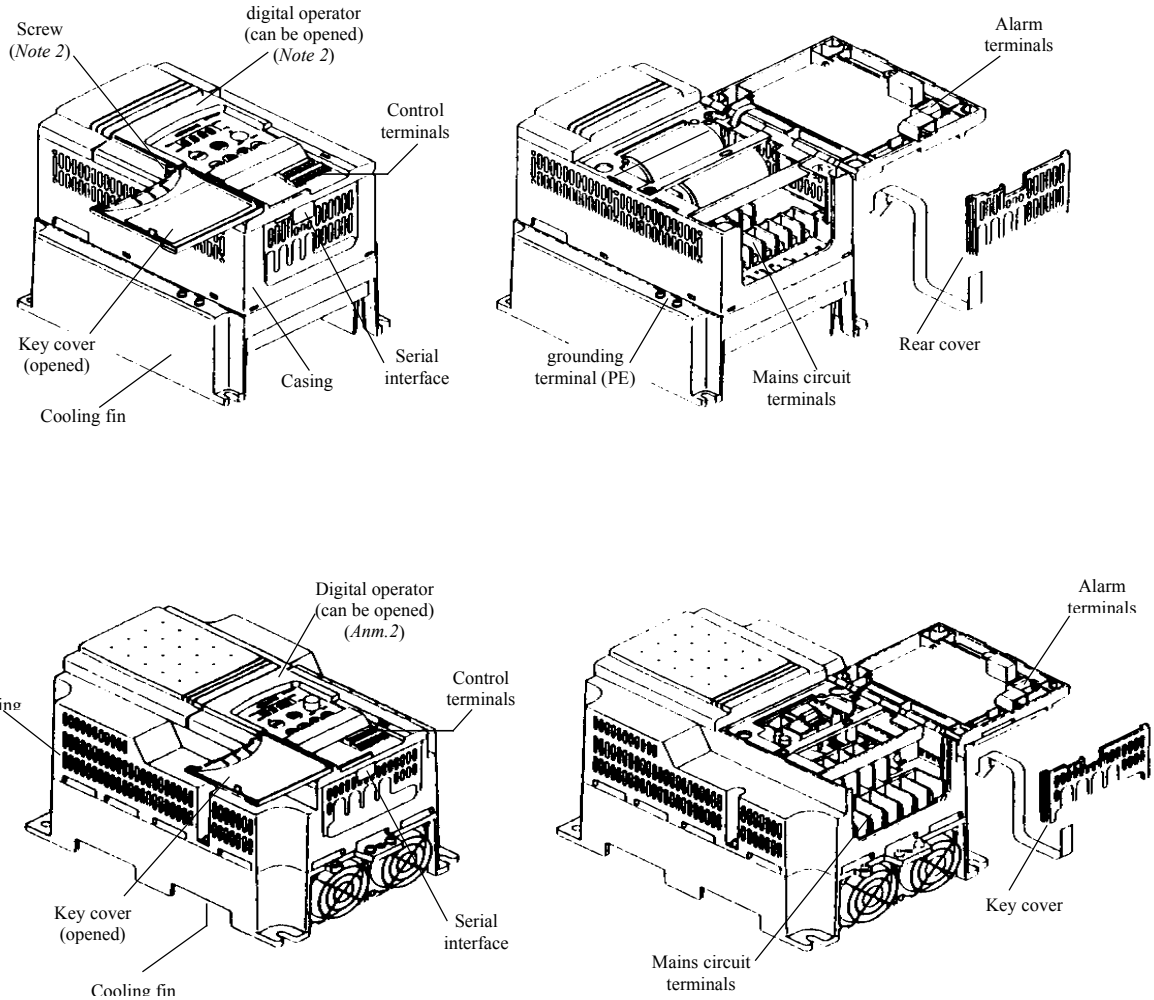
(All dimensions are in millimeters)

4. Appearance and names of parts



Note 1: The key cover can be opened by hand without any additional tool.

Note 2: The screw must be loosened before the digital operator can be opened.

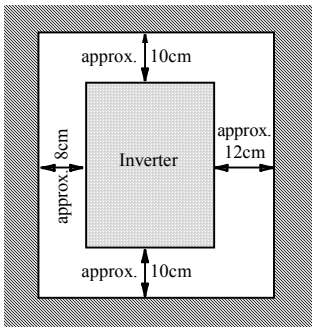


Note 1: The key cover can be opened by hand without any additional tool.
Note 2: The screw must be loosened before the digital operator can be opened.

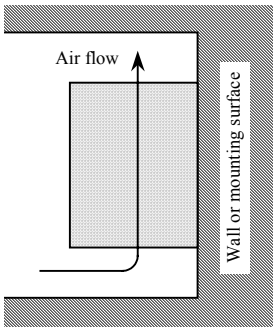
5. Installation

The inverter must be mounted vertically on a non-flammable wall in order to prevent from overheating and fire. The minimum clearances to the surrounding walls shown in the figure below must be complied with to ensure a good ventilation. Foreign matter (especially conductive objects) must nut be dropped into the inverter since they not only cause malfunction and damage but may also lead to electrical and fire hazards.

Cover all ventilation holes on the inverter during installation so that no foreign objects can enter the inverter. Be sure to remove those covers from the inverter before you put the inverter to work.



The inverter must be installed vertically
(do not install it on the floor or horizontally)



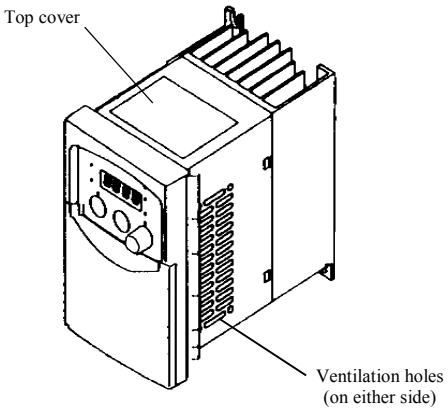
⚠ The mounting base must be a non-flammable material (e.g. metal)

The minimum clearances to the surrounding walls shown in the figure are only meant for reference. A more compact installation (back to back) may well be possible and should be discussed with WATT DRIVE. Please always leave enough room for the key cover to be opened without problems in order to connect wires to the control terminals.

The ambient temperature should be in the range of -10°C to 50°C. At a temperature of 40~50°C the carrier frequency has to be reduced to 2kHz, the output current must be kept below 80% of the rated current, and the top cover (see figure below) has to be removed. Higher ambient temperature causes shorter inverter life. So if there is hot equipment in the vicinity of the inverter, keep it away from the inverter as far as possible.

If the inverter is to be installed in a cabinet, ambient temperature is considered to be the temperature prevailing withing this cabinet. Fans have to be provided if necessary so that ambient temperature remains within the limits specified above.

For safety reasons the digital operator must be closed and not be opened during inverter operation. The end application must be in accordance with the BS EN 60204-1 standard.



6. Wiring

⚠ CAUTION Fasten the screws with the specified fastening torque so that they will not loosen unintentionally. Check all terminals for loose screws. Otherwise there is a danger of fire.

⚠ CAUTION Use 60/75 deg C Cu wire or equivalent only.

⚠ CAUTION Open type equipment

⚠ CAUTION A class 2 circuit wired with class 1 wire or equivalent

⚠ CAUTION Suitable for use on a circuit capable of delivering not more than 5,000 rms symmetrical amperes, 240V maximum. For model with NFE.

⚠ CAUTION Suitable for use on a circuit capable of delivering not more than 5,000 rms symmetrical amperes, 480V maximum. for model with HFE.

⚠ CAUTION <u>Remarks for using earth leakage circuit breakers in the mains supply</u>

Frequency inverters with CE-filters (RFI-filter) and screened motor cables have a higher leakage current against earth. Especially in the moment of switching this can cause unintentional triggering of earth leakage circuit breakers. Because of the rectifier on the input side of the inverter there is the possibility to stall the switch-off function through amounts of DC current. For these reasons, the following items should be observed:

Only pulse current sensitive earth leakage circuit breakers which have a short term delay and a higher trigger current (500mA) should be used. Other components should be secured with separate earth leakage circuit breakers. Earth leakage circuit breakers in front of an inverter´s rectifier are not an absolute protection against direct touching.

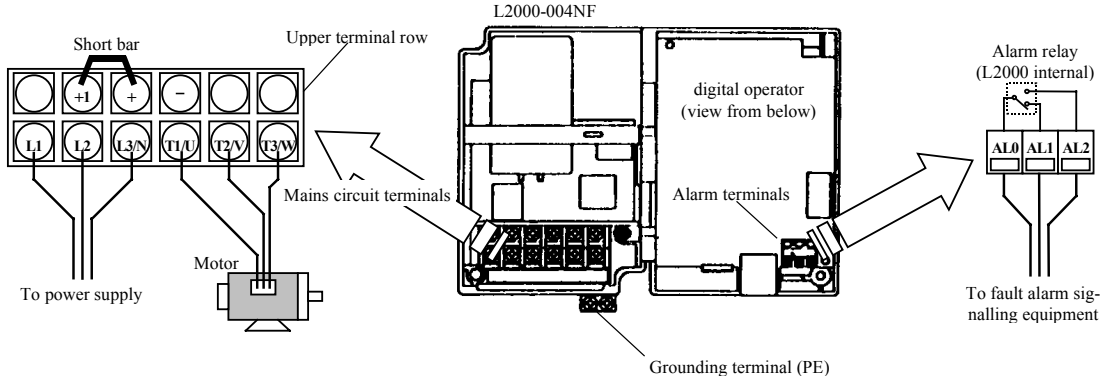
⚠ CAUTION Each phase of the power supply has to be provided with a fuse. Otherwise, there is a danger of fire.

⚠ CAUTION As for motor leads, earth leakage breakers, and electromagnetic contactors, be sure to use the ones that have the correct rating. Otherwise, there is a danger of fire.

⚠ CAUTION Make sure that the mains supply leads are reliably fixed.

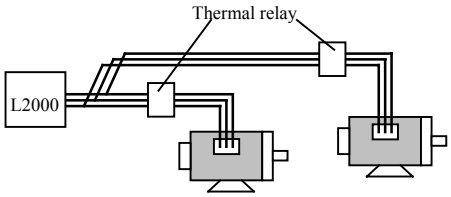
Wiring the power supply and motor

In order to connect cables to the power supply or alarm terminals the digital operator has to be opened. For this, first of all the corresponding screw has to be loosened. The location of the terminals is depicted in the figure below:



When connecting cables, the following details have to be considered:

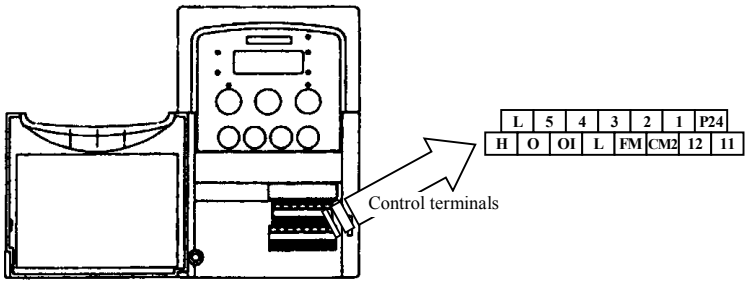
1) Power supply cables must only be connected to the terminals L1, L2, and L3/N.
2) Do not connect any cables to the non-designated terminals in the upper terminal row (refer to figure above) as these terminals are reserved for L2000 internal purposes.
3) If more than one motor is to be driven by a single inverter, thermal relays have to be provided for each motor.



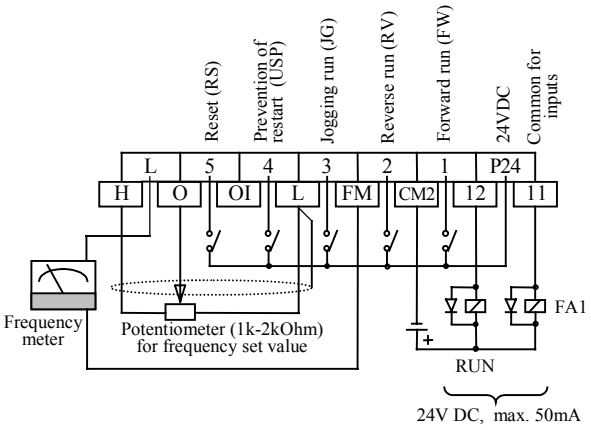
4) The leads from the power supply must be connected to the mains circuit terminals as follows:
   Connect single phase power supply (50/60Hz) to terminals L1, L3/N.
   Connect three phase power supply (50/60Hz) to terminals L1, L2, L3/N.
5) Don´t remove the short bar between the terminals +1 and +.

Wiring the control terminals

The following figure shows the location of the control terminals. The exact use of each of the control terminals is described later in this chapter.



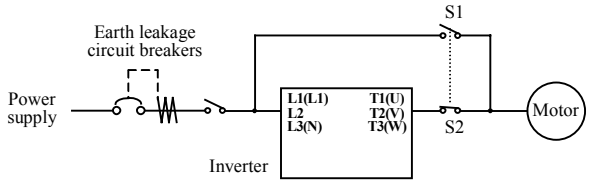
The figure below contains an example for control terminal wiring:



General remarks

When connecting cables, the following items must be observed:

- When changing the power supply of the motor between the inverter and commercial power line, be sure to install mechanically interlocked switches (S1 and S2) as shown in the figure below:

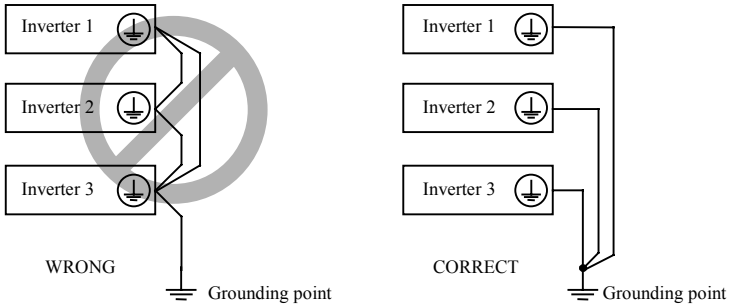


- Install an earth leakage breaker at the input of the inverter. Select an earth leakage breaker which has a short term delay and a higher trigger current.

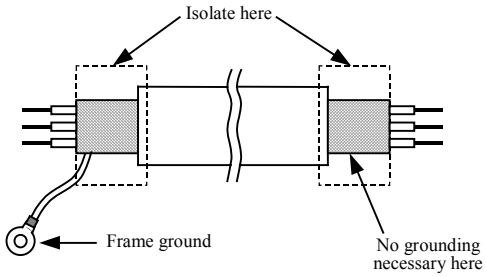
  When the cable between the inverter and the motor is more than 10 meters long, the thermal relay may malfunction due to high-frequency waves. To prevent this, install an AC reactor on the output side of the inverter or use a current sensor rather than a thermal relay.

- In case a relay is connected to the digital output terminals 11 or 12 be sure to install a surge absorbing diode in parallel to the relay. Otherwise the surge voltage created when the relay goes on or off may damage the output circuit.

- Be sure that the specified grounding is carried out. Separate the inverter´s grounding pole from those of other heavy electric machinery and avoid using common grounding poles when multiple inverters are employed.

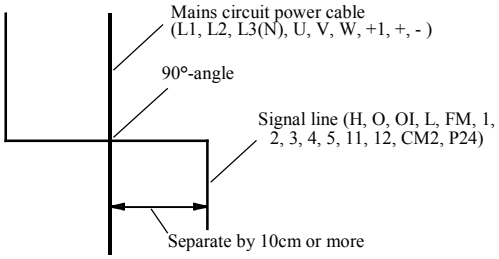


- Use a twisted and shielded wire when connecting signal lines to the control terminals and cut the shielded covering as shown in the figure below. Make sure that the length of the signal line is 20 m or less. If the line must be longer than 20 m then an appropriate signal amplifier should be used.



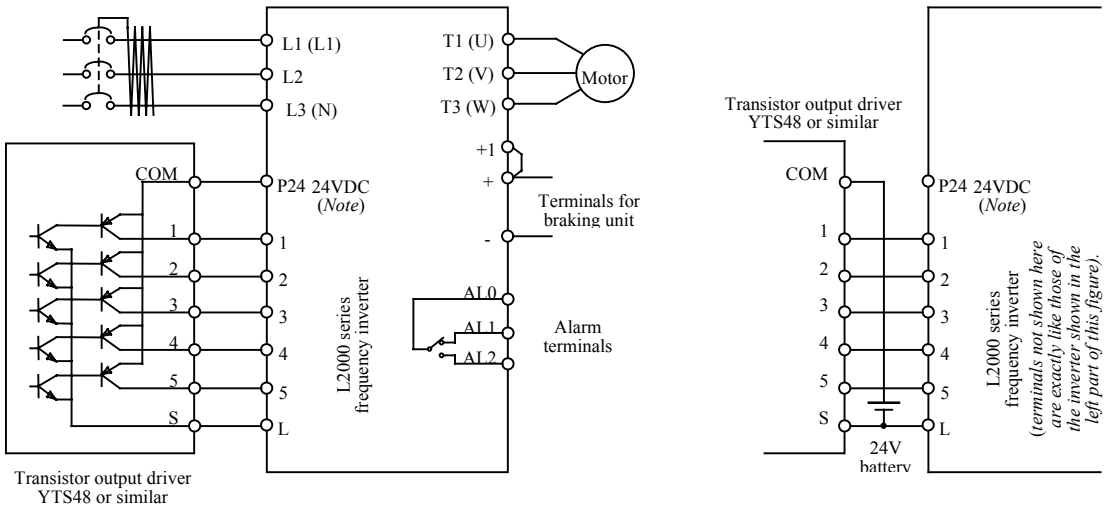
- Use relays which are capable of reliably switching at a voltage of 24VDC and a current of 3mA.

- Install the mains circuit cables at a safe distance from the control circuit cables. If the mains circuit cables and the control circuit cables have to cross each other, this should be done at an angle of 90 degrees because interference can be minimized in this case.



- Do not short circuit the terminals P24 and L, H, OI, or FM by mistake, because this may cause a malfunction.
- Do not short circuit the terminals H and L because this may cause a malfunction.

The following figure shows an example for connecting a driver-IC to the digital inputs when using the inverter´s internal 24VDC power supply terminal (left half of figure below) and when using a separate external 24VDC power supply (right half of figure below).



Note: Do not short circuit the terminals P24 and L by mistake because this may lead to a malfunction.

Wiring equipment and options

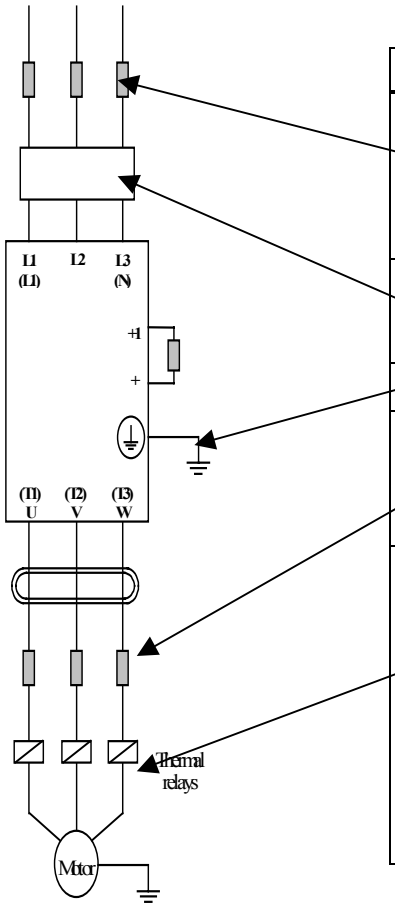
⚠ CAUTION Provide the wiring equipment in accordance with the safety codes required by jurisdictional authorities. If specified in standards or laws and regulations, follow their istructions. In the following table some guidelines for choosing an appropriate wire gauge are presented:

Motor output (kW)	Inverter model	Cable specifications		600V fuse to be used (rated current / A)
		Power lines	Signal lines	
0.2	L2000-002NFE	1.5 mm² (AWG 15)	Shielded wire (max. 0.75mm²) *)	10 A
0.4	L2000-004NFE			
0.55	L2000-005NFE			
0.75	L2000-007NFE	2.5 mm² (AWG 13)		16 A
1.1	L2000-011NFE			
1.5	L2000-015NFE	4.0 mm² (AWG 11)		25 A (single phase) 16 A (three phase)
2.2	L2000-022NFE	4.0 mm² (AWG 11)		40 A (single phase) 25 A (three phase)
0.4	L2000-004HFE	1.5 mm² (AWG 15)		10 A
0.75	L2000-007HFE	1.5 mm² (AWG 15) 2.5 mm² (AWG 13)		10 A 16 A
1.5	L2000-015HFE	1.5 mm² (AWG 15) 2.5 mm² (AWG 13) 2.5 mm² (AWG 13) 4.0 mm² (AWG 11)		10 A 16 A 16 A 25 A
2.2	L2000-022HFE	1.5 mm² (AWG 15) 2.5 mm² (AWG 13) 2.5 mm² (AWG 13) 4.0 mm² (AWG 11)		10 A 16 A 16 A 25 A
3.0	L2000-030HFE			16 A 25 A
4.0	L2000-040HFE			25 A
5.5	L2000-055HFE	2.5 mm² (AWG 13) 4.0 mm² (AWG 11) 4.0 mm² (AWG 11)		16 A 25 A 25 A
7.5	L2000-075HFE	2.5 mm² (AWG 13) 4.0 mm² (AWG 11) 4.0 mm² (AWG 11) 4.0 mm² (AWG 11)		16 A 25 A 25 A 25 A
		4.0 mm² (AWG 11)		25 A

Notes:

- Field wiring connections must be made by a UL listed and CSA certified closed-loop terminal connector sized for the wire gauge involved. The connector must be fixed using the crimp tool specified by the connector manufacturer.
- Only use a fuse that has the appropriate rated current.
- Be sure to use bigger wires for mains circuit cables and motor cables if the distance exceeds 20m.

*) Use 0,75mm^2 for the alarm signal wire. The wire stripping length should be approximately 5–6 mm. The wire sleeve diameter except for the alarm signal wire should not be greater than 2mm.

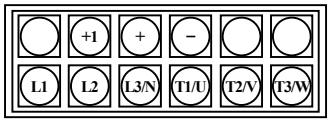
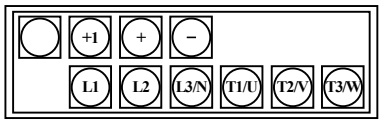
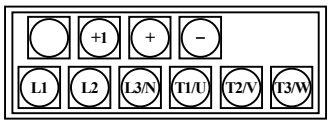


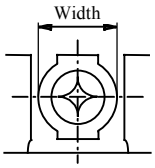
Part description	Function
AC reactor	This part is used when the unbalance ratio is 3% or more and the power supply is 500kVA or more, and there are rapid changes in the power supply. This part also improves the power factor.
EMI filter (*Note*)	This part is used to conform with the applicable EMC standards.
DC reactor	This part is used to improve the power factor.
Radio noise filter	This part reduces noise generated at the output of the inverter (this type of filter supplies an almost perfect sine shaped output voltage between phase-pase and phase-PE).
Motor filter	Motors that are driven by an inverter are to a larger extent subject to voltage fluctuations than motors directly driven (without inverter) by power lines. An AC reactor installed between inverter output and motor smoothens motor run and so reduces torque ripple. When the cable between the inverter and the motor is too long, this part also forces the voltage dv/dt to be limited and so protects the isolation of the motor.

Note: Usage of an EMI filter (e.g. one from the UHZNF series) is necessary for the European EMC directive, for the Australian C-TICK and others. In comparison, the other parts mentioned in the table above are not intended for this special use.

Terminals

In the table below the location and dimensions of the power terminals (terminals for power supply and motor) are listed:

Location of power terminals	Inverter model	Screw size	Width in mm
	002NFE 004NFE	M3,5	7,1
	007NFE~ 022NFE 004HFE~ 040HFE	M4	9
	055HFE, 075HFE	M5	13



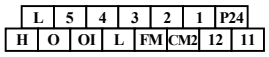
View of power terminals

View of grounding terminal

The following table shows the location and dimensions of all terminals:

Terminal type	002NFE, 004NFE		007NFE~022NFE 004HFE~040HFE		075HFE	
	Screw	Width (in mm)	Screw	Width (in mm)	Screw	Width (in mm)
Power terminal	M3.5	7.1	M4	9	M5	13
Control terminal	M2	-	M2	-	M2	-
Alarm terminal	M3	-	M3	-	M3	-
Grounding terminal	M4	-	M4	-	M5	-

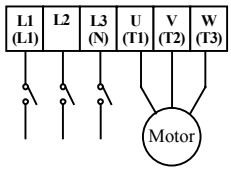
Location of control terminals



Location of alarm terminals

In the following table the purpose of the power terminals is shown:

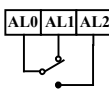
Terminal symbol	Purpose	Description
L1(L1), L2, L3(N)	Mains supply	Single phase supply: connect to L1, N Three phase supply: connect to: L1, L2, L3
U, V, W bzw. T1, T2, T3	Inverter output	Connect a three phase motor
+1, +	External DC reactor	Normally a short bar is attached between terminals +1 and +. When a DC reactor is to be connected, remove the short bar first.
+, -	Braking unit	Connect the optional braking unit (when high braking torque is required).
⏚	Grounding	Ground must be connected to prevent electric shock should the inverter case carry dangerous voltages due to a malfunction.



The following table lists the tightening torque values for tightening the screws:

Screw	Torque in Nm
M2	Typ. 0.20 Max. 0.25
M3	Typ. 0.50 Max. 0.60
M3.5	Typ. 0.80 Max. 0.90
M4	Typ. 1.20 Max. 1.30
M5	Typ. 2.00 Max. 2.20

The next table describes the purpose of each control terminal: (*To be continued on next page*)

Terminal categorie	Symbol	Purpose	Initial setting	Remarks
Digital Inputs	5	These inputs have different purposes depending on the user programmed configuration: Forward and reverse running command, up to 4 multistage speed settings, jogging run, 2nd stage acceleration/decel., free run stop, external trip, USP function, terminal software lock, reset, PTC, input for choosing current as analog set value	Reset input	Input closed (ON): Function active Input opened (OFF): Function not active Input must be ON for a minimum of 12ms
	4		Multistage frequency input / USP function	
	3		Multistage frequency input / use 4-20mA input	
	2		Reverse run	
	1		Forward run	
	P24	Common for input signals		24V DC; max. 30mA
Monitor signal	FM	Connection of an analog or digital meter for measuring frequency; connection of an analog meter for current measurement	Frequency monitor (analog)	
	L	Common for monitor signal		
Frequency command input	H	Reference for frequency command input		10V DC; max. 10mA
	O	Voltage frequency command		Set value 0-10V; Input impedance 10k Ohm
	OI	Current frequency command		Set value 4-20mA; Input impedance 250 Ohm
	L	Common for frequency command input		
Digital output	11	The digital outputs can be user programmed to provide different signals for the following situations: Signal when reaching set value or passing a configurable frequency; signal during motor run; overload signal; PID deviation signal; alarm signal	Frequency arrival signal (signal when reaching set value)	Outputs of open collector type for connection to a relay (max. 27V DC and max. 50mA)
	12		Signal during motor run	
	CM2	Common for digital outputs		
Fault alarm output	AL0	 Initial setting: During normal operation AL0-AL1 is closed; during a trip condition or cut off power supply AL0-AL1 is opened (i.e. AL0-AL2 is closed). Ratings of relay contacts: Max. 250VAC / 2.5A (resistive) or 0.2A (cos phi = 0.4); Min. 100VAC / 10mA Max. 30VDC / 3.0A (resistive) or 0.7A (cos phi = 0.4); Min. 5VDC / 100mA		
	AL1			
	AL2			

7. General operation notes

Before starting operation

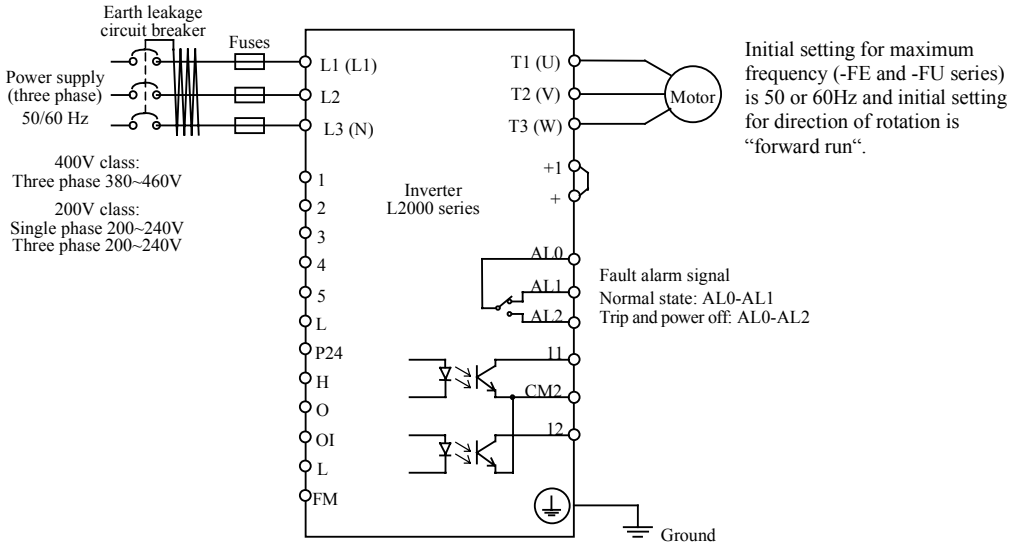
Prior to the test run, the following items should be checked:

1) Make sure that the power lines (input power supply terminals L1(L1), L2, and L3(N)) and output terminals (U(T1), V(T2) und W(T3)) are connected correctly.
2) Make sure that there are no mistakes in the signal line connections.
3) The grounding terminal must be grounded.
4) Terminals other than those marked as grounding terminals must not be grounded.
5) The inverter must be installed vertically on a non-flammable mounting surface (e.g. steel).
6) Remove any residue from wiring work like stray pieces of wire and others. Also, make sure that no tolls are left behind.
7) Make sure that the wires connected to the output terminals are not short-circuited or grounded.
8) All the terminal screws must be sufficiently tightened.
9) The configurable maximum output frequency parameter must be chosen in accordance with the maximum frequency of the connected motor and machine.
10) Do not operate the inverter with the front case opened. Make sure the front case is completely closed and locked with the screw.

Do not carry out any withstand voltage tests because the inverter has a surge absorber between the mains circuit terminals and the ground.

Test run

Below an example for an inverter connection is shown. For the initial tests, frequency adjustment and forward and reverse running commands should be carried out via the digital operator in order to check the inverter's correct functioning.



In order to test the inverter, follow the procedure described below:

1) Turn on power supply to the inverter. The power LED on the digital operator will light up.
2) Set function *A 02* to 02.
3) Set function *A 01* to 00. Now the inverter can be operated using the built in potentiometer which is indicated by the lit lamp above the potentiometer.
4) After pressing the RUN key the motor starts to run and the RUN lamp lights up.
5) The actual frequency can be monitored using function *d 01*.
6) You can stop the test run by pressing the STOP key.

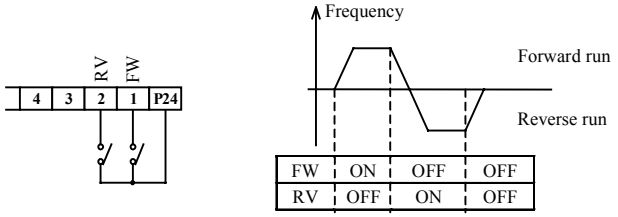
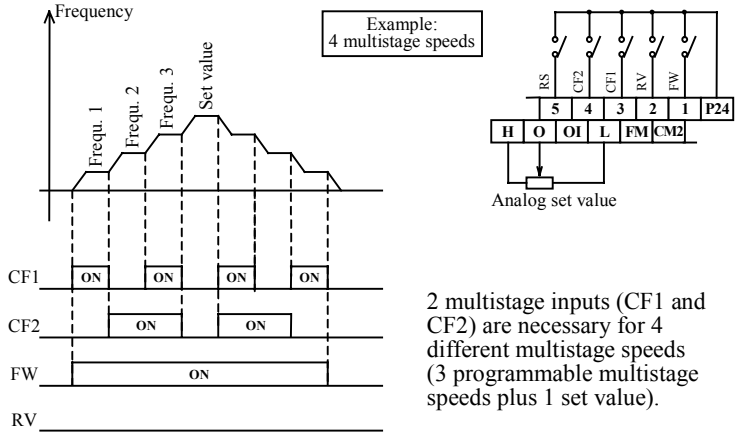
⚠ CAUTION After the test run has been completed, check the following items to ensure that the motor will not be damaged:

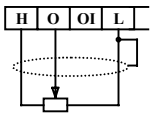
Was the direction of the motor run correct? Was there any trip condition during acceleration or deceleration? Were there any unusual motor sounds or vibrations?

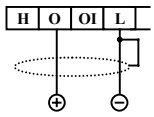
When a trip occured during the test run due to overcurrent or overvoltage, increase acceleration or deceleration time.

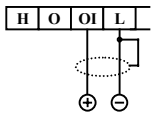
8. Control circuit terminal functions

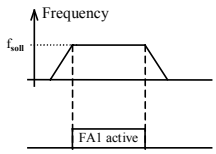
Overview

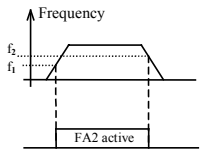
Terminal symbol		Terminal function		Description
Programmable digital inputs 1 through 5	FW (00)	Forward run (Start/Stop)		 Input FW closed: Motor starts with forward running direction. Input FW open: Motor decelerates from forward running. (same for reverse run using input RV) Inputs FW and RV both closed: motor decelerates.
	RV (01)	Reverse run (Start/Stop)		
	CF1 (02)	Programmable multistage speeds	1	 2 multistage inputs (CF1 and CF2) are necessary for 4 different multistage speeds (3 programmable multistage speeds plus 1 set value).
	CF2 (03)		2	
	CF3 (04)		3	
	CF4 (05)		4	
	JG (06)	Jogging run		The jogging run activated using the terminal JG may serve for setting up a machine in manual operation mode. When a forward or reverse run command is given, the frequency configured using *A 38* is then sent to the motor. For motor stop, one of three operating modes can be chosen by configuring *A 39*.
	PTC (19)	Connection of external PTC thermistor		Only digital input 5 can be programmed as a PTC thermistor input (using *C 05*). The terminal L serves as common for the thermistor input.
	AT (16)	Activate input OI (current set value 4-20mA)		When the AT input is activated, then the set value will be a 4-20mA current that has to be supplied at the terminals OI and L.
	2CH (09)	2. stage acceleration/deceleration		Using this input the second stage acceleration and deceleration time configured using *A 92* and *A 93* is activated.
	FRS (11)	Free run stop function		When the terminal FRS is turned on, frequency to the motor is switched off and the motor runs free.
	EXT (12)	External trip		When the terminal EXT is turned on, the inverter enters the trip state, stops output to the motor, and displays *E 12*. The trip condition can be acknowledged, among others, using the RS input.
	USP (13)	Prevention of restart		When the USP input is on, the motor does not restart when power supply recovers following a power supply failure and a running command is active at the same time.
	RS (18)	Reset		A trip can be acknowledged by activating the RS input. If a reset is given during normal inverter operation, the motor runs free. The RS input is always a normally open contact and cannot be configured as normally closed input.
	SFT (15)	Software lock		When the SFT input is turned on, the configured parameters are protected from being overwritten.

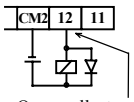
<table>
<tr><th colspan="2">Terminal symbol</th><th>Terminal function</th><th>Description</th></tr>
<tr><td colspan="2">P24</td><td>24V DC common for digital inputs</td><td>Common terminal for the intelligent digital inputs</td></tr>
<tr><td rowspan="4">Frequency command</td><td>H</td><td>10V reference voltage for analog set value (using potentiometer)</td><td rowspan="4">Set value configured using potentiometer:
 

Pot (1k – 2K)
Set value configured using voltage input:
 

0 - 9,6V DC (rated value 10V)
Input impedance 10k Ohms
Set value configured using current input:
 

4 - 19,6mA DC (rated value 20mA)
Input impedance 250 Ohms
The OI input (set value using analog current 4..20mA) will only be used if the input configured as AT has been closed before. If no digital input has been configured as an AT input then the set values that are present at terminals O and OI will be added.</td></tr>
<tr><td>O</td><td>Frequency set value analog input (0-10V)</td></tr>
<tr><td>OI</td><td>Frequency set value analog input (4-20mA)</td></tr>
<tr><td>L</td><td>Common terminal for analog set value inputs</td></tr>
<tr><td rowspan="2">Monitor</td><td>FM</td><td>Frequency monitor</td><td>Using the FM output the output frequency can be monitored and displayed using
an external analog or digital meter. If needed, the motor current can be displayed instead of the frequency.</td></tr>
<tr><td>L</td><td>0V</td><td>Common terminal for the FM output</td></tr>
<tr><td rowspan="5">Programmable digital outputs 11 and 12</td><td>FA1 (01)
FA2 (02)</td><td>Frequency arrival signals</td><td> 

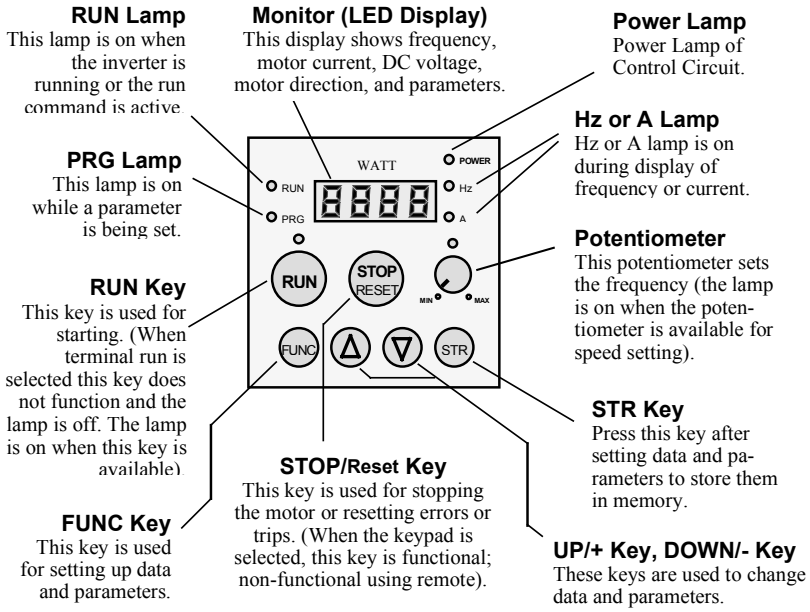
When a digital output is configured as FA1 then a signal is output as long as the output frequency is held constant at set value. With a digital output being configured as FA2, a signal will be output as long as the actual output frequency is above the values set under C 42 and C 43.</td><td rowspan="5">Connection of a signal relay to digital output 11 or 12:
 

Open collector type output (max. 27VDC, 50mA)</td></tr>
<tr><td>RUN (00)</td><td>RUN signal</td><td>The RUN signal is active as long as the motor is running.</td></tr>
<tr><td>OL (03)</td><td>Overload signal</td><td>The OL signal will be output when the actual motor current
is above the threshold set under C 41.</td></tr>
<tr><td>OD (04)</td><td>PID deviation signal</td><td>The OD signal will be output when the threshold set under C 44 (level of PID deviation) is being passed.</td></tr>
<tr><td>AL (05)</td><td>Alarm signal</td><td>The alarm signal is output in case a trip condition occurs.</td></tr>
<tr><td colspan="2">CM2</td><td>0V</td><td>This is the 0V common for the programmable digital outputs 11 and 12. These
open collector type outputs are isolated using photocouplers and are separated
from L common.</td></tr>
<tr><td colspan="2">AL0</td><td rowspan="3">Alarm terminals</td><td rowspan="3">During normal trouble-free operation the terminals AL0 and AL1 are shorted. During a trip condition or while power to the inverter is off the terminals AL0 and AL2 are shorted instead.
Absolute maximum relay contact ratings:
250VAC; max. load of 2.5A (purely resistive) or 0.2A (at an cos phi of 0.4)
30VDC; max. load of 3.0A (purely resistive) or 0.7A (at an cos phi of 0.4)
Minimum relay contact ratings:
100VAC at a load of 10mA or 5VDC at a load of 100mA</td></tr>
<tr><td colspan="2">AL1</td></tr>
<tr><td colspan="2">AL2</td></tr>
</table>

9. Using the digital operator

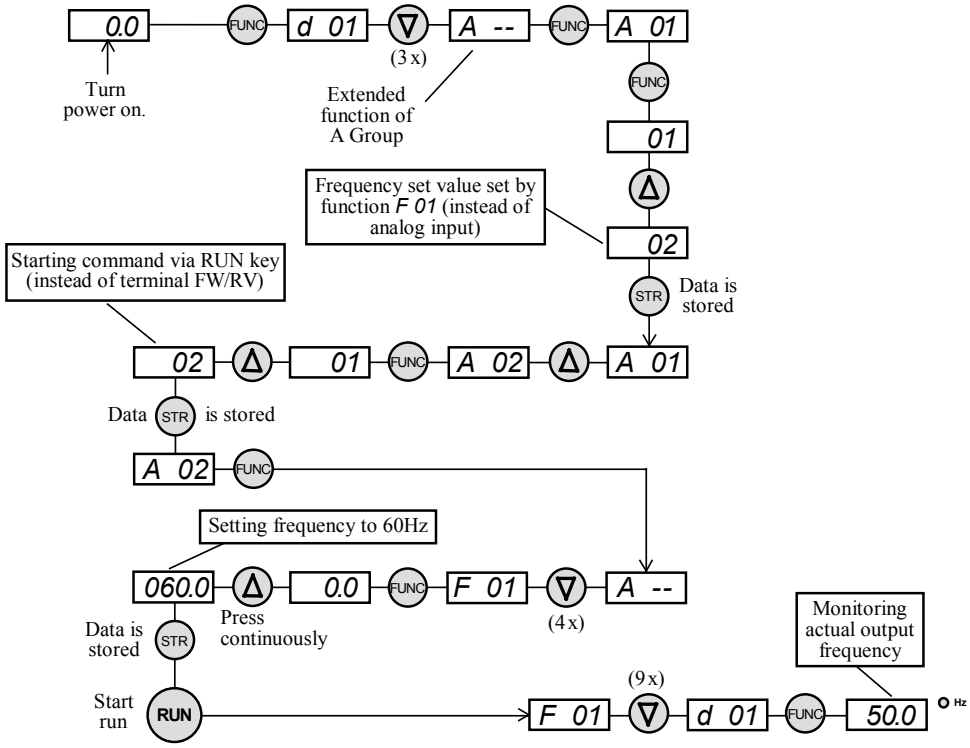
The digital operator control panel

The following figure shows the digital operator of an L2000 series inverter. The keys and displays (lamps and LED display) are shown with the names that are used throughout this manual:

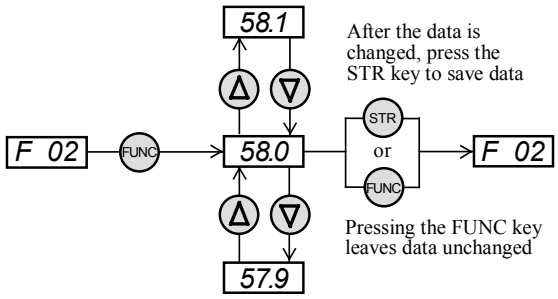


Operating procedure example

The following figure shows an operation sequence using the digital operator for changing several inverter parameters:

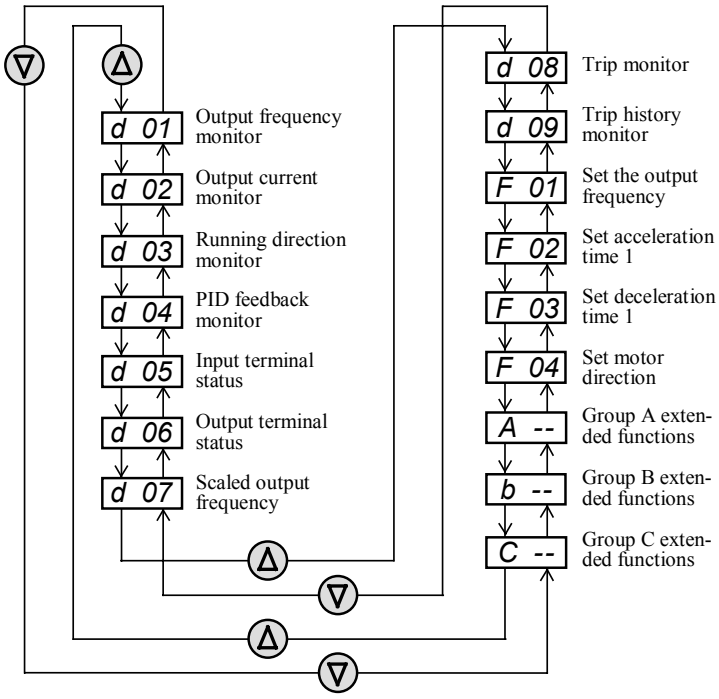

0.0
FUNC
d 01
(3 x)
A --
FUNC
A 01
Turn power on.
Extended function of A Group
FUNC
01
Frequency set value set by function F 01 (instead of analog input)
02
Starting command via RUN key (instead of terminal FW/RV)
STR
Data is stored
02
01
FUNC
A 02
A 01
Data
STR
is stored
A 02
FUNC
Setting frequency to 60Hz
060.0
0.0
FUNC
F 01
A --
(4 x)
Data is stored
STR
Press continuously
Monitoring actual output frequency
(9 x)
Start run
RUN
F 01
d 01
FUNC
50.0
Hz

Digital operator keys



[UP key, DOWN key] ... These keys change parameter values.

[FUNC key] ... This key switches between the parameter area and extended function area.



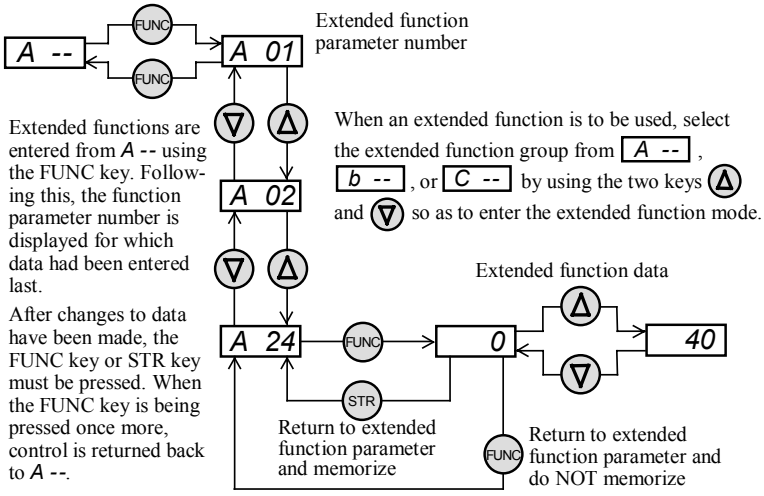
[START key] ... This key starts the L100 inverter.

The set value of *F 04* determines forward or reverse run.

[STOP key] ... This key stops the L100 inverter.

When a trip occurs, this key becomes the RESET key

Setting parameters for extended functions (example for extended functions of group A):



Explanation of display after power on:

When the inverter is turned on, the display returns to what was displayed when the power was last turned off (except in the extended function mode).

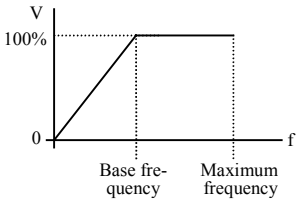
Basic functions

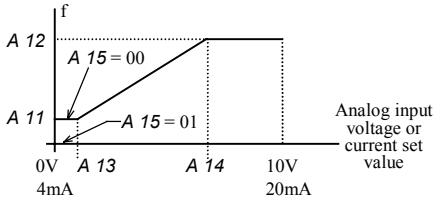
Function	Display	*)	Function description / parameter setting range	Standard setting	Set values
Set / display frequency set value	*F 01*	Y	Setting range 0.5Hz–360Hz (resolution +/-0.1Hz). The frequency can be set using the following methods: Using *F 01* and *A 20*: Enter the parameter 02 under *A 01*. Using the potentiometer on the digital operator. Enter the parameter 00 under *A 01*. By means of a voltage of 0–10 V or a current of 4–20mA at input terminals O or OI. Enter the parameter 01 under *A 01*. Using the digital input terminals configured as CF1–CF4. After selecting the desired frequency stage by applying logic levels to the digital inputs, the frequency for the selected stage can be entered. (Note: Multistage speed settings can also be entered using *A21-A35*). The frequency set value display is independent of the method with which the set value was entered.	0.0	
Acceleration time 1	*F 02*	Y	Setting range 0.1s–3000s. (Resolution 0.1s in the range of 0.1 through 999.9. Resolution 1s in the range of 1000 through 3000).	10.0	
Deceleration time 1	*F 03*	Y	Setting range 0.1s–3000s. (Resolution 0.1s in the range of 0.1 through 999.9. Resolution 1s in the range of 1000 through 3000).	10.0	
Motor direction	*F 04*	N	After pressing the RUN key the motor starts in forward running mode (parameter 00) or in reverse running mode (parameter 01).	00	

Extended functions of group A

Group A comprises a variety of functions, among them functions for adjusting the frequency set value, functions for setting up multistage speed settings, as well as functions for configuring parameters for a DC brake, etc.

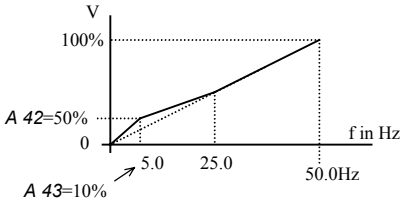
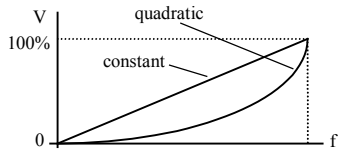
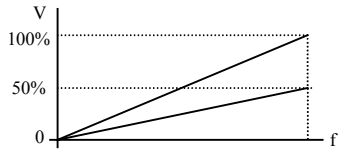
Function	Display	*)	Function description / parameter setting range	Standard setting	Set values
Main functions					
Frequency source	*A 01*	N	There are three different ways to set the output frequency: 00: using the potentiometer on the digital operator 01: using analog input terminals O (0-10V) or OI (4-20mA) 02: using functions *F 01* or *A 20*	01	
Run command source	*A 02*	N	The command for starting the motor can be issued via: 01: the digital inputs configured as FW or RV 02: the RUN key on the digital operator	01	
Base frequency	*A 03*	N	The base frequency is the frequency where the output voltage has its maximum value. Setting range 50Hz–360Hz.	50	

Maximum frequency	*A 04*	N		50	

Function	Display	*)	Function description / parameter setting range	Standard setting	Set values
Analog set value adjustment 					
External frequency start point	*A 11*	N	Here the frequency is set that corresponds to the external frequency start point bias set under *A 13*. Setting range 0Hz–360Hz.	0.0	
External frequency end point	*A 12*	N	Here the frequency is set that corresponds to the external frequency end point bias set under *A 13*. Setting range 0Hz–360Hz.	0.0	
External frequency start point bias	*A 13*	N	The value enterd here is based on the maximum voltage set value or current set value of 10V or 20mA, respectively. Setting range 0%–100%.	0	
External frequency end point bias	*A 14*	N	The value enterd here is based on the maximum voltage set value or current set value of 10V or 20mA, respectively. Setting range 0%–100%.	100	
External frequency start pattern	*A 15*	N	Inverter behaviour for set values < external frequency start point: 00: The frequency configured under *A 11* is sent to the motor 01: A frequency of 0Hz is sent to the motor	01	
Analog input filter time constant	*A 16*	N	A value between 1 and 8 can be entered to configure the inverter's reaction speed to changes in analog set value at the O or OI terminal and thus determine the amount of filtering for harmonics that may be present with the analog signal: 1: Little filtering / fast reaction to changes in set value 8: Extensive filtering / slow reaction to changes in set value	8	

Function	Display	*)	Function description / parameter setting range	Standard setting	Set values
Multistage frequency settings and jogging mode Up to 15 multistage frequency settings can be selected using the digital inputs configured as CF1 through CF4. Alternatively to setting the multistage frequencies under functions *A 21* through *A 35* they can be set using function *F 01*. Jogging mode can be used to set up a machine manually and is activated using a digital input configured as JG. Since the acceleration ramp is not active during jogging mode, there might be an overcurrent trip (especially when a too high jogging frequency is chosen). Jogging mode can not be used when the jogging frequency is smaller than the start frequency configured under *b 82*. Multistage frequency settings have a higher priority than other frequency set values. Only the jogging frequency's priority is even higher.					
Frequency set value	*A 20*	Y	A frequency set value between 0.5Hz and 360Hz can be entered here (a 02 must have been configured under *A 01* beforehand).	0	
Multistage frequency settings	*A 21* thru *A 35*	Y	Anyone of the 15 multistage frequency settings from *A 21* through *A 35* can be assigned a frequency in the range of 0.5Hz to 360Hz.	0 (any one)	
Jogging frequency	*A 38*	Y	The frequency that is sent to the motor when jogging mode is activated can be chosen from 0.5Hz to 9.99Hz.	1.0	

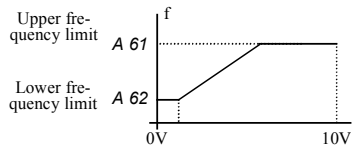
Jogging stop mode	*A 39*	N	When a stop command is issued during activated jogging mode, the motor stops by: 00: running free 01: decelerating using configured deceleration time 02: decelerating using DC brake	00	

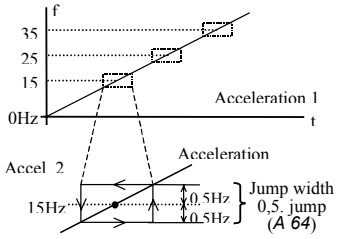
Function	Display	*)	Function description / parameter setting range	Standard setting	Set values
Voltage/frequency characteristics, boost  Parameter settings: *A 41*=00 *A 42*=50 *A 43*=10.0 *A 44*=00 *A 45*=100					
Boost selection method	*A 41*	N	Selection of: 00: manual boost or 01: automatic boost	00	
Voltage rise, manual boost	*A 42*	Y	The amount of voltage rise in manual boost mode can be set in the range of 0% to 99%.	11	
Manual boost frequency adjustment	*A 43*	Y	The frequency where the highest voltage rise exists can be set in the range of 0% to 50% of the base frequency.	10.0	
Voltage/frequency characteristic	*A 44*	N	 	00	
Output voltage gain	*A 45*	Y	 	100	

Function	Display	*)	Function description / parameter setting range	Standard setting	Set values
DC braking L2000 series inverters have a configurable DC brake that is activated as soon as the stop command is issued. By applying a strobed DC voltage to the motor's stator a braking torque is induced into the rotor that effectively works against the rotation of the motor. Usage of the DC brake makes possible high registration accuracy when carrying out positioning work. ⚠ CAUTION Usage of the DC brake causes an additional heating of the motor. For this reason the DC brake should be configured with as short a braking torque and braking time as possible.					
DC brake active / not active	*A 51*	N	00: DC brake is not used (not) 01: DC brake is used (active)	00	
DC brake frequency	*A 52*	N	The DC brake will be activated as soon as the actual output frequency falls below the frequency entered here. Setting range 0.5Hz–10Hz.	0.5	
DC brake waiting time	*A 53*	N	When the frequency set under *A 52* is reached the motor runs free for the duration entered here. Only after this duration the DC brake is activated. Setting range 0.0s–5s.	0.0	
DC brake braking torque	*A 54*	N	The amount of braking force can be entered here. Setting 0%–100%.	0	

DC brake braking time	*A 55*	N	The time during which the DC brake is activated can be configured from 0.0s through 60s.	0.0	

Function	Display	*)	Function description / parameter setting range	Standard setting	Set values
Upper/lower limiter, jump frequency					
Frequency upper limit	*A 61*	N	Setting range 0.5Hz–360Hz. (When 0.0 is entered, this function is not active).	0.0	
Frequency lower limit	*A 62*	N	Setting range 0.5Hz–360Hz (When 0.0 is entered, this function is not active).	0.0	
1. jump frequency	*A 63*	N	Setting range 0.1Hz–360Hz (When 0.0 is entered, this function is not active).	0.0	
1. jump frequency width	*A 64*	N	Setting range 0.1Hz–10Hz (When 0.0 is entered, this function is not active).	0.5	
2. jump frequency	*A 65*	N	Setting range 0.1Hz–360Hz (When 0.0 is entered, this function is not active).	0.0	
2. jump frequency width	*A 66*	N	Setting range 0.1Hz–10Hz (When 0.0 is entered, this function is not active).	0.5	
3. jump frequency	*A 67*	N	Setting range 0.1Hz–360Hz (When 0.0 is entered, this function is not active).	0.0	
3. jump frequency width	*A 68*	N	Setting range 0.1Hz–10Hz (When 0.0 is entered, this function is not active).	0.5	





Function	Display	*)	Function description / parameter setting range	Standard setting	Set values

PID control

Introduction

The PID closed loop control has been designed with a control variable of “frequency in Hz” where the proportional gain (k**p**), the integral gain (T**N**), and the differential gain (T**V**) of the control algorithm can be set independently from each other. The set value and the actual value are scaled in % (setting range 0–100%). For a better presentation of these values they can be scaled and displayed in the desired physical engineering unit (e.g. flow or throughput of 0 to 30l/h).

The PID control output is limited to a lower limit of 0 Hz (or the frequency set under *A 62*) and to the frequency set under *A 04* (or *A 61*, respectively) as an upper limit. This ensures that the motor running direction will not be reversed when a negative deviation is present.

In order to optimize the PID control’s behaviour it is advisable to keep acceleration and deceleration times as short as possible.

Set value

Function *A 01* is used to configure the method by which the set value is input and also the terminal where it is input:

Set value	Parameter	Scaling
Built-in potentiometer	00	0–100%
Function *F 01*	02	(0–100%) * (parameter value of function *A 75*)
Multistage frequencies *A 20... A 35*	-	(0–100%) * (parameter value of function *A 75*)
Analog input O (0–10V)	01	0–100% (independant of *A 11* thru *A 14*)
Analog input OI (4–20mA)	01	0–100% (independant of *A 11* thru *A 14*)

Actual value

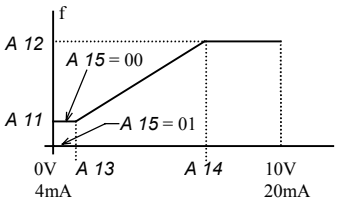
For input of the actual value, one of the two analog inputs available (O or OI) can be used. The adjustment of the actual value is done using functions *A 11* through *A 14*. (This adjustment of the actual value has already been described as “set value adjustment” earlier in this manual. However, this description is only correct when the PID

(*To be continued on next page*)

Function	Display	*)	Function description / parameter setting range	Standard setting	Set values

(*Continued from previous page*)

control is not used, in this case it is really the set value that gets adjusted. So when the PID control is activated, the functions *A 11* through *A 14* do not adjust the set value but the actual value instead).



x axis:
Voltage or current **actual** value into analog input (when PID control is used)
Voltage or current **set** value into analog input (when PID control is not used)

The parameters of functions *A 11* through *A 14* are changed from Hz to % due to the PID control's activation (done using *A 71*) and to engineering units by setting function *A 75*. For this reason, function *A 71* must be set to 01 ***before*** the other functions are configured.

Displayed values

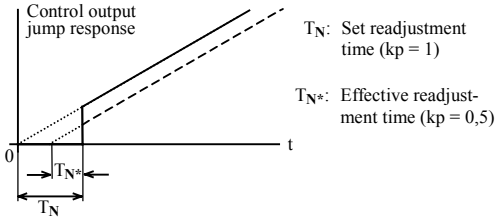
Function *d 04* enables the display of the actual value while *F 01* enables the display of the set value. These values can be displayed in engineering units by setting function *A 75*.

When function *F 01* is activated the PID set value will be displayed, but there is no permanent update of the displayed value. When function *d 04* is activated the actual value will be displayed which in contrast to the set value does get permanently updated.

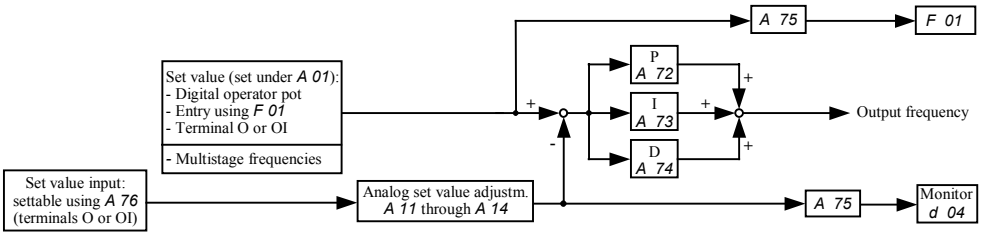
P, I and D gain

Although these gains can be set independently of each other, there are interactions between them. When the P gain (k_P) is changed, the effective I gain changes (T_{N*}) also. Only when $k_P = 1$, the effective I gain (T_{N*}) is equal to the I gain that had been entered (T_N). When k_P is not equal to 1, T_{N*} can be calculated as follows:

$T_{N*} = T_N * k_P$ (refer to the figure on the right).

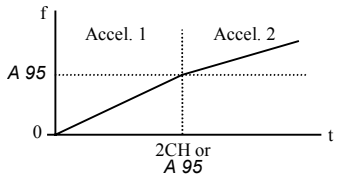
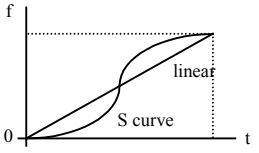


PID block diagram



PID control active / not active	*A 71*	N	00: PID control is not used (not active) 01: PID control is used (active)	00	
P (proportional) gain of PID control	*A 72*	Y	The proportional gain of PID control can be set in the range of 0.2 through 5.0.	1.0	
I (integral) gain of PID control	*A 73*	Y	The integral gain of PID control can be set in the range of 0.0s through 150s.	1.0	
D (differential) gain of PID control	*A 74*	Y	The differential gain of PID control can be set in the range of 0.0s through 100s.	0.0	
Scale conversion of PID control	*A 75*	N	The set value or actual value to be displayed on the LED display can be multiplied by a factor in the range of 0.01 through 99.99 so that engineering units (e.g. flow or throughput) can be displayed instead of the frequency.	1.00	
Feedback signal location	*A 76*	N	The set value can be fed into one of two different analog inputs: 00: analog input OI 01: analog input O (The set value can also be set using the potentiometer or the multistage frequencies).	00	

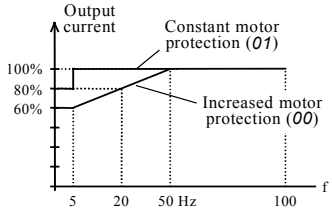
Function	Display	*)	Function description / parameter setting range	Standard setting	Set values
Automatic Voltage Regulation (AVR) The AVR function causes motor voltage stabilization when DC voltage is fluctuating (e.g. due to an instable mains supply or a dropping or excessive DC voltage as a result of too short acceleration or deceleration times) and thus ensures a high torque (especially during acceleration). Dynamic braking (without the use of the AVR function) causes a rise in DC voltage during deceleration (especially when very short deceleration times have been set) which in turn causes a rise in motor voltage. This raised motor voltage causes a higher braking torque. For this reason, the AVR function can be deactivated for deceleration using *A 81*.					
Charcteristics of AVR function	*A 81*	N	00: AVR function active in every operation mode 01: AVR function is not active 02: AVR function is active in all operation modes except deceleration	02	
Motor voltage for AVR function	*A 82*	N	The settable parameters depend on the inverter model used: 200V models: 200, 220, 230, 240 V 400V models: 380, 400, 415, 440, 460 V If the mains supply voltage is higher than the rated motor voltage, then the supply voltage must be entered here and the output voltage must be reduced under *A 45* to the rated motor voltage. Example: With a mains supply voltage of 440V and a motor rated voltage of 400V the parameter 440 has to be entered under *A 82* and 91 (=400/440*100%) has to be entered under *A 45*.	FE models 230/400 FU models 230/460	

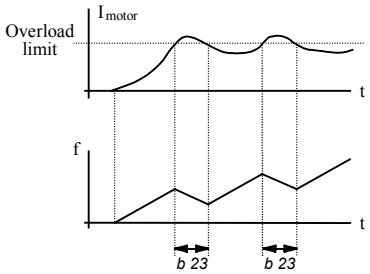
Function	Display	*)	Function description / parameter setting range	Standard setting	Set values
Time ramps 					
2. Acceleration time	*A 92*	Y	Setting range: 0.1s–999,9s (Resolution 0.1s) 1000s–3000s (Resolution 1s)	15.0	
2. Deceleration time	*A 93*	Y	Setting range: 0.1s–999,9s (Resolution 0.1s) 1000s–3000s (Resolution 1s)	15.0	
Method to switch over from 1. to 2. accel/decel time	*A 94*	N	The switchover from the 1. acceleration / deceleration time to the 2. acceleration / deceleration time is initiated by: 00: an active signal at a digital input configured as 2CH 01: the reaching of the frequencies set under *A 95* or *A 96*	00	
Accel.1 / Accel.2 switchover frequency	*A 95*	N	Here the frequency is set at which the switchover from 1. to 2. acceleration time must take place. Setting range: 0.0Hz–360.0Hz.	0.0	
Decel.1 / Decel.2 switchover frequency	*A 96*	N	Here the frequency is set at which the switchover from 1. to 2. deceleration time must take place. Setting range: 0.0Hz–360.0Hz.	0.0	
Acceleration characteristic	*A 97*	N		00	
Deceleration characteristic	*A 98*	N	A linear or an S curve characteristic can be chosen for motor deceleration (1. and 2. deceleration times): 00: Linear 01: S curve (also refer to *A 97*)	00	

Extended functions of group B

Most of the functions of group B serve safety purposes or are used to protect the inverter from damages.

Function	Display	*)	Function description / parameter setting range	Standard setting	Set values
Automatic restart after inverter trip ⚠ WARNING On occurance of a trip condition this function causes an automatic inverter restart if a running command is being active at the same time. Additional precautions must be taken for personnel not to get endangered in case of a motor restart. In standard setting any inverter failure will cause a trip condition. An automatic motor restart following an inverter trip is possible with: Overcurrent (*E 01 – E 04*, with a maximum of 4 retries within 10 minutes, after 4 retries the inverter trips); Overvoltage (*E 07*, *E 15*, with a maximum of 3 retries within 10 minutes, after 3 retries the inverter trips); Undervoltage (*E 09*, with a maximum of 16 retries within 10 minutes, after 16 retries the inverter trips)					
Restart mode	*b 01*	N	Here the inverter reaction to trips *E 01* through *E 04*, *E 07*, *E 09*, and *E 15* is selected: 00: Trip messages are displayed on occurrance of the above trips (retry is not active). 01: Restart with start frequency after the time set under *b 03* has elapsed. 02: After the time set under *b 03* has elapsed the inverter synchronizes to the motor's current speed and the motor is accelerated using the configured acceleration time. 03: After the time set under *b 03* has elapsed the inverter synchronizes to the motor's current speed and the motor is decelerated using the configured deceleration time. Afterwards the corresponding trip will be displayed.	00	
Allowable under-voltage failure time	*b 02*	N	Here the time is entered during which the undervoltage condition is met while the corresponding trip *E 09* is not being displayed. Setting range: 0.3s–25s.	1.0	
Waiting time until retry	*b 03*	N	Here the time is entered that must elapse following one of the above mentioned trip conditions before automatic retry is initiated. During the waiting time the message ▫▫▫▫ is displayed on the LED display. Setting range: 0.3s–100s.	1.0	

Function	Display	*)	Function description / parameter setting range	Standard setting	Set values
Electronic motor protection The L2000 series inverters have a an electronic facility that is able to monitor the driven motor's thermal load. This electronic thermal motor protection facility is matched to the motor's rated current using function *b 12*. However, the motor temperature can not be monitored if values are entered that are above the rated current of the motor. In this case you will have to install PTC thermistors or thermo contacts into the motor windings.					
Electronic thermal protection current	*b 12*	N	The setting range lies between 0.5 times and 1.2 times of the inverter rated current (i.e. the entered value has a unit of A).	Inverter rated current	
Electronic thermal characteristic	*b 13*	N		01	

Function	Display	*)	Function description / parameter setting range	Standard setting	Set values
Overload restriction 					
Overload limit characteristic	*b 21*	N	Three different overload limit characteristics are available that can be chosen from: 00: Overload limit is not active 01: Overload limit is active in any state of operation 02: Overload limit is not active during acceleration	01	
Overload limit current	*b 22*	N	The setting range lies between 0.5 times and 1.2 times of the inverter rated current (i.e. the value is entered with a unit of A).	1,25* inverter rated current	
Deceleration time	*b 23*	N	When the configured overload limit is reached the frequency will be reduced within the time entered here (setting range: 0.1s/Hz–30s/Hz). Important note: Do not enter values below 0.3 !	1.0	

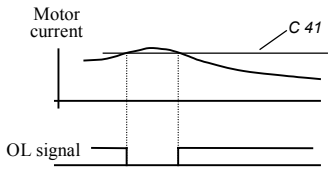
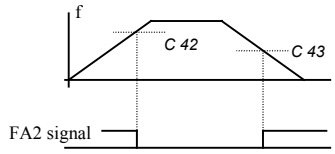
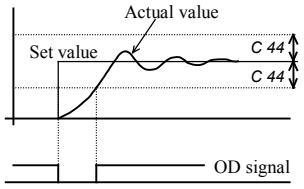
Function	Display	*)	Function description / parameter setting range	Standard setting	Set values
Software lock mode; magnetizing current					
Software lock mode	*b 31*	N	The following 4 methods of locking entered parameters are available: 00: Software lock initiated by input SFT; all functions locked 01: Software lock initiated by input SFT; function *F 01* still usable 02: Software lock; all functions locked 03: Software lock; function *F 01* still usable	01	
Magnetizing current	*b 32*	N	*This function will be available from July 1998.* *(The date on the name plate must read „9807“ or later.)* Magnetizing current can be configured when smaller motors are used or when driving multiple motors.	0.58 * inverter rated current	

Function	Display	*)	Function description / parameter setting range	Standard setting	Set values
Other functions					
Analog meter adjustment	*b 81*	Y	The analog signal output on terminal FM (representing frequency set value or output current) can be adjusted using this function. However, adjustment of the pulse signal (digital frequency set value) is not possible here. (Setting range: 0–255).	80	
Start frequency adjustment	*b 82*	N	A higher start frequency results in shorter acceleration and deceleration times (e.g. for overcoming increased static friction). When a too high frequency is configured here this may result in the trip *E 02*. (Setting range: 0.5Hz–9,9Hz).	0.5	
Carrier frequency	*b 83*	N	High carrier frequencies result in less motor noise and less motor power dissipation but on the other hand cause higher dissipation within the power amplifier and more noise in the motor and mains supply cables. For this reasons the carrier frequency should be configured as small as possible. (Note: During DC braking the carrier frequency will automatically be reduced to 1kHz). (Setting range: 0.5kHz–16kHz).	5	
Initializing mode	*b 84*	N	Two different methods for initializing the inverter can be chosen from: 00: Clearing the trip history register 01: Reinstalling the factory standard settings For clearing the trip history register or reinstalling the factory standard settings do the following: - Make sure that the parameter 01 has been entered under function *b 85* (European version). - Enter 00 or 01 under *b 84*. - On the digital operator, press the two arrow keys and the FUNC key simultaneously. - While holding down the keys mentioned above press the STOP key shortly and wait about 3 seconds for the LED display to show the message *d 00* in a blinking manner. - Now release the keys again. The initialization has now been completed. Note: This function can not be configured while the remote operator is being connected.	00	
National version	*b 85*	N	The national parameter set that will be loaded during initialization (also refer to *b 84*) can be selected. The L2000-...NFE/HFE inverter series models need the parameter 01 to be configured here. 00: Japan 01: Europe 02: USA 03: not used yet	FE models: 01 FU models: 02	
Frequency value for display using *d 07*	*b 86*	Y	The product of the value displayed under *d 01* and the factor configured here will be displayed using *d 07*. (Setting range: 0.1–99.9).	1.0	
STOP key locking	*b 87*	N	Using this function the STOP key on the digital operator or the remote operator can be locked. 00: STOP key always active 01: STOP key not active when terminals FW/RV are used	00	
Operation method when FRS signal is cancelled	*b 88*	N	Activating a digital input configured as FRS causes the inverter to be shutdown and the motor to run free. Two methods are available for deactivating the FRS input: 00: 0Hz restart after FRS has been deactivated 01: Motor synchronization to the current motor speed following the waiting time configured under *b 03*.	00	
Remote display contents	*b 89*	Y	When using a remote operator OPE-J one of the following values can be displayed externally: 01: Current frequency 02: Motor current 03: Running direction 04: PID actual value 05: State of digital inputs 06: State of digital outputs 07: Scaled actual frequency With the exception of the STOP key, all keys of the OPE-J are inactive.	01	

Extended functions of group C

The functions of group C are used for configuring the programmable digital inputs and outputs.

Function	Display	*)	Function description / parameter setting range	Standard setting	Set values
Programmable digital inputs Digital inputs 1, 2, 3, 4, and 5 can be assigned 15 different input functions. Every input can be assigned to any of the 15 input functions with the exception of the thermistor input function (parameter 19) which can only be assigned to input 5. However, two different digital inputs can not be assigned the same input function. The inputs can be programmed either as normally closed contacts or as normally open contacts (the only exception is the digital input configured as RS, this input can not be programmed as normally closed contact).					
Function of digital input 1	*C 01*	N	The programmable digital inputs (control terminals 1 through 5) can be assigned one of the following functions: 00: FW (start/stop forward run) 01: RV (start/stop reverse run) 02: CF1 (1. multistage frequency input) 03: CF2 (2. multistage frequency input) 04: CF3 (3. multistage frequency input) 05: CF4 (4. multistage frequency input) 06: JG (jogging run) 09: 2CH (2. acceleration/deceleration) 11: FRS (free run stop) 12: EXT (external trip) 13: USP (restart prevention function) 15: SFT (software lock) 16: AT (use input OI) 18: RS (reset) 19: PTC thermistor input (only digital input 5)	00	
Function of digital input 2	*C 02*	N	Refer to *C 01* for possible parameters	01	
Function of digital input 3	*C 03*	N	Refer to *C 01* for possible parameters	FE model 02 FU model 16	
Function of digital input 4	*C 04*	N	Refer to *C 01* for possible parameters	FE model 03 FU model 13	
Function of digital input 5	*C 05*	N	Refer to *C 01* for possible parameters	18	
Type of digital input 1	*C 11*	N	00: Normally open contact 01: Normally closed contact	00	
Type of digital input 2	*C 12*	N	Refer to *C 11* for possible parameters	00	
Type of digital input 3	*C 13*	N	Refer to *C 11* for possible parameters	00	
Type of digital input 4	*C 14*	N	Refer to *C 11* for possible parameters	FE model 00 FU model 01	
Type of digital input 5	*C 15*	N	Refer to *C 11* for possible parameters	00	

Function	Display	*)	Function description / parameter setting range	Standard setting	Set values
Programmable digital outputs Digital outputs can be assigned one of 6 different signalling functions. Both outputs may also be assigned to the same function. The outputs can be programmed either as normally closed contacts or as normally open contacts.					
Function of digital output 11	*C 21*	N	One of the following signalling functions can be assigned: 00: RUN signal (signal active during motor run) 01: FA1 signal (frequency arrival) 02: FA2 signal (frequency exceeded) 03: OL signal (overload) 04: OD signal (PID-deviation exceeded) 05: AL signal (alarm signal)	01	
Function of digital output 12	*C 22*	N	Refer to *C 21* for possible parameters	00	
Function of FM terminal	*C 23*	N	The FM output terminal can be used to output one of the following values: 00: Output frequency display (analog signal 0–10VDC) 01: Motor current display (analog signal 0–10VDC; 100% of the rated current corresponds to 5VDC) 02: Output frequency (digital pulse signal)	00	
Digital output 11 type	*C 31*	N	00: Normally open contact 01: Normally closed contact	01	
Digital output 12 type	*C 32*	N	Refer to *C 31* for possible parameters	01	
Type of alarm relay output	*C 33*	N	Refer to *C 31* for possible parameters	01	
Level for overload signal	*C 41*	N		Inverter rated current	
Arrival frequency FA2 for acceleration	*C 42*	N		0.0	
Arrival frequency FA2 for deceleration	*C 43*	N	(The digital output terminal 11 or 12 configured as FA2 will remain activated during deceleration as long as the actual frequency is above the frequency entered here (also refer to the figure under *C 42*). (Setting range: 0Hz–360Hz)	0.0	
Level of PID deviation	*C 44*	N		3.0	

10. Messages

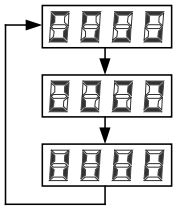
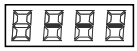
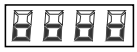
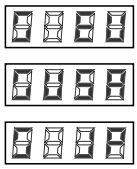
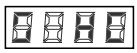
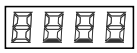
Trip messages

L2000 series inverters will trip on overcurrent, overvoltage and undervoltage to protect the inverter.The output is shut down and the motor runs free. This condition is held until the trip state is reset using the RESET key or the RS input.

Type of trip	Description	Trip display
Overcurrent protection	When the output of the inverter is short circuited, the motor is locked, or a heavy load is suddenly applied, and the inverter output current exceeds a predetermined level, the inverter is shut off.	During constant speed: *E 01* At decele-ration: *E 02* At accele-ration: *E 03* at the others: *E 04*
Overload protection	When a motor overload is detected by the electronic thermal function, the inverter is shut off.	*E 05*
Overvoltage protection	When the inverter DC bus voltage exceeds a predetermined level due to regenerative energy from the motor, this trip occures and the inverter is shut off.	*E 07*
EEPROM error (*Note*)	When the inverter memory has a problem due to noise or excessive temperature rise, this trip occurs and the inverter is shut off.	*E 08*
Undervoltage protection	A decrease of DC bus voltage may result in improper function of the control unit. It may also cause motor heating and low torque. The inverter is shut off when the DC bus voltage goes below a certain level.	*E 09*
CPU error	Malfunction or abnormality of the CPU. The inverter is shut off.	*E 11* *E 22*
External trip	A trip signal from external equipment shuts off the inverter. It is necessary to assign the external trip to an intelligent terminal.	*E 12*
USP error	Indicates an error when power is turned on while the inverter run is enabled (when USP function is selected).	*E 13*
Ground fault protection	The inverter is protected by detection of ground faults between the drive output and the motor at power on. Protection is for the inverter only and not for humans.	*E 14*
Input overvoltage	When the input voltage is higher than a specified value, it is detected and 100 seconds after power is turned on, the inverter is shut off.	*E 15*
Thermal protection	When the temperature of the inverter module is beyond specification, the thermal sensor in the inverter module detects the temperature and the inverter is shut off.	*E 21*
PTC error	When the resistance value of the external thermistor is too large, the equipment detects the abnormal condition of the thermistor and then shuts off the inverter (when PTC function is selected).	*E 35*

Note: If an EEPROM error occurs, be sure to observe its value. If power is turned off while the RS input terminal is held ON, the EEPROM error occurs when power is turned back on.

Other messages

Cause	Display
The inverter is currently in standby mode or There is an active reset signal.	
The mains power supply has been switched off.	
The waiting time prior to automatic inverter restart is coming to an end (refer to functions *b 01* and *b 03*).	
The factory standard settings have been selected and the inverter currently is in its initializing phase (refer to functions *b 84* and *b 85*). The parameters for the European market (EU) are loaded. For non-European inverter models there are versions for North America (USA) and Japan (JP).	
The trip history register is being initialized.	
The copy unit is carrying out a copy operation.	
No data available (this may be displayed under functions *d 08* and *d 09* when the trip history register is empty, or under *d 04* when PID control is not active).	

11. Trouble shooting

Error	Condition	Possible cause	Remedy
The motor won't start	No voltage can be measured at outputs U, V, and W	Does a voltage exist at the terminals L1, N (NFE models) or L1, L2 and L3 (HFE models)? If this is the case, is the power lamp also lit?	Check terminals L1, L2, L3 (U, V, W). Switch on the power supply afterwards.
		Does the LED display on the digital operator show a trip message (*E _ _*)?	Analyze the cause of the trip message (also refer to chapter 9 - Messages). Acknowledge the trip condition by re-setting the inverter (e.g. by pressing the RESET key).
		Has a run command been issued?	Issue a run command by using the RUN key or the digital inputs FW or RV.
		Has a frequency set value been entered using function *F 01* (only when inverter is operated using the digital operator)?	Enter a frequency set value under *F 01*.
		Have the terminals H, O, and L been wired correctly when set value is given by means of a potentiometer?	Check for errors in potentiometer wiring.
		Have the terminals O and OI been wired correctly if an external set value is used?	Check for correct connection of the wires carrying the set value signal.
		Are the digital inputs configured as RS or FRS still active?	Deactivate RS or FRS. Check the signal on digital input 5 (standard setting = RS).
		Has the correct frequency set value source (*A 01*) been selected? Has the correct source for the running command (*A 02*) been selected?	Correct the *A 01* parameter setting, if necessary. Correct the *A 02* parameter setting, if necessary.
	No voltage can be measured at outputs U, V, and W	Is the motor blocked or is the motor load too high?	Reduce the load that the motor drives. Operate the motor without any load for testing purposes.
The motor runs in the wrong direction		Have the output terminals U, V, and W been wired correctly? Does the connection scheme of the terminals U, V, and W match the motor's running direction?	Connect the output terminals U, V, and W to the motor corresponding to the desired running direction (generally U, V, and W in this order cause the motor to run in forward direction).
		Have the control terminals been wired correctly?	Use terminal FW for forward run and RV for reverse run.
		Has the function *F 04* been configured correctly?	Configure the desired running direction under *F 04*.
The motor won't reach its normal speed		No set value signal is present on terminals O and OI.	Check the potentiometer or the external set value origin and if necessary replace them.
		Is one of the multistage frequency settings being activated?	Note that there is a priority order with the multistage frequency settings having higher priority than the set value at inputs O and OI.
		Is the motor load too high?	Reduce the motor load because the overload restriction functions prevents the motor from reaching its normal speed in case an overload exists.

Error	Condition	Possible cause	Remedy
The motor run is unstable		Are the motor load fluctuations too great?	Choose an inverter and motor of a higher rating. Reduce load fluctuations to a minimum.
		Are there motor resonating frequencies?	Avoid critical frequencies by using jump frequencies (*A 63 – A 68*) or change the carrier frequency (*b 83*).
The motor's rpm does not match frequency.		Has the correct maximum frequency been set?	Check the configured operating frequency range and the V/F characteristics.
		Have the nominal rpm of the motor and the gear reduction ratio been set correctly?	Check the nominal rpm of the motor and the gear reduction ratio.
The saved parameters are not the same as the parameters that had been entered.	The entered parameters have not been saved.	The inverter power supply had been shut off before the entered parameter settings were saved by pressing the STR key.	Enter the parameter settings once more and save each input made.
		After switching off the power supply the entered values are copied into the internal EEPROM. The power off duration should at least be 6 seconds or more.	Enter the parameter settings once more and then turn off the power supply for more than 6 seconds.
	The copy unit parameter settings have not been copied to the inverter.	After copying the parameters from the copy unit SRW into the inverter the power supply was left in the on state for only less than 6 seconds.	Copy the parameter settings once more and then keep the power supply turned on for more than 6 seconds.
No data entries can be made.	The motor won't start or stop and also no set value can be entered.	Have the functions *A 01* and *A 02* been configured correctly?	Check if the settings made under *A 01* and *A 02* are correct.
	Parameters can neither be set nor changed.	Has the software lock function been activated?	Deactivate the software lock using *b 31* so that all parameters can be changed again.
		Has the hardware lock been activated?	Deactivate the digital input configured as SFT.
		Has position 4 of the dip switch (on the back of the copy unit) been set to ON?	Set position 4 of the dip switch to OFF so that the remote operator can be read out.
The electronic thermal protection is activated (trip *E 05*).		Has a too high manual boost been configured? Have the correct settings been made in conjunction with the electronic thermal protection function?	Check the settings for boost and electronic thermal protection.

Important note for saving changed parameters:

After changed parameters have been saved with the STR key (when parameters are changed using the L2000 digital operator) or with the COPY key (when parameters are copied into the inverter using the SRW copy unit) no entry must be made using the inverter's digital operator for at least 6 seconds. However, when a key is pressed within this time, or a reset command is issued, or the inverter is switched off, the data may not be saved correctly.