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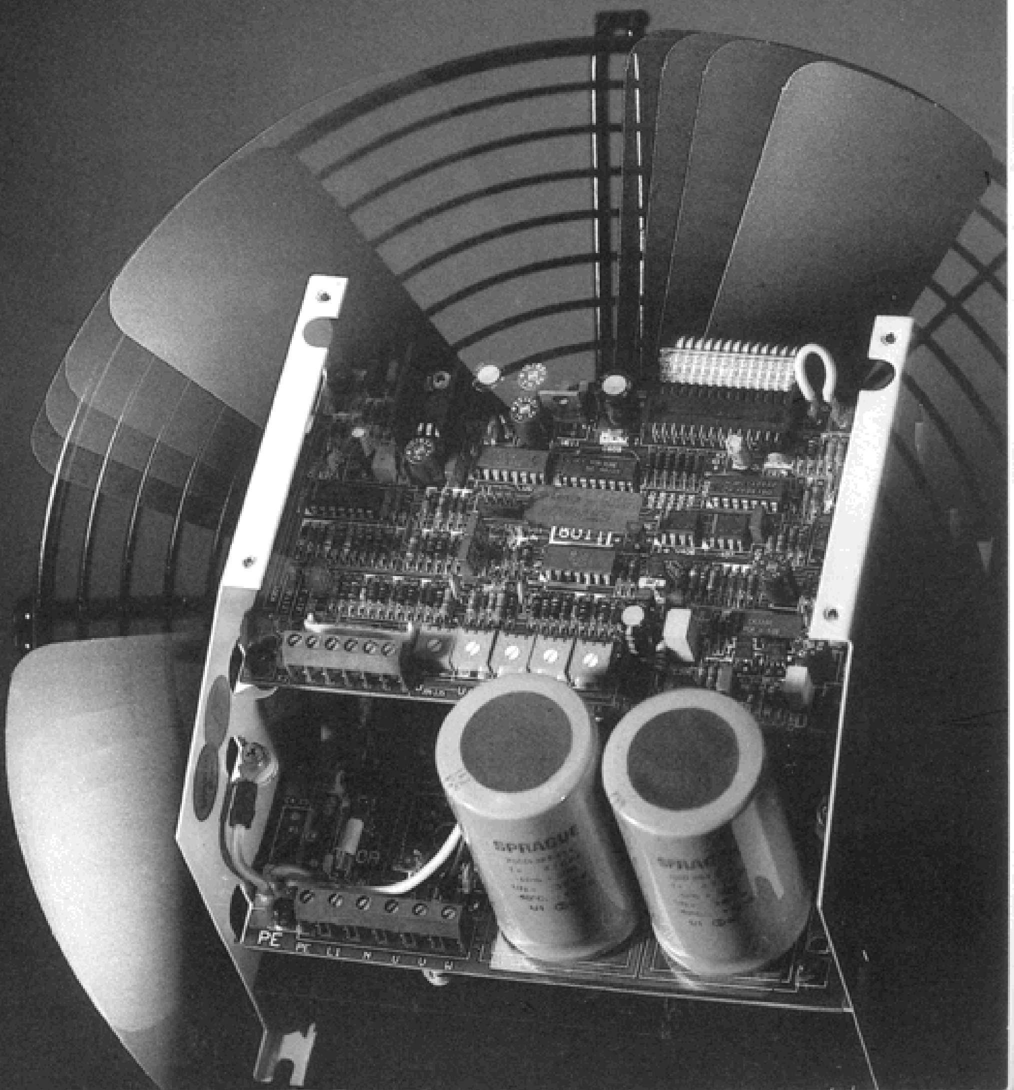
Lenze
Power Transmission

Technical Description

Inverter drives Range 610



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Contents **page**

1.	General description	2
2.	Controller concept	2
3.	Features	2
4.	Technical data	3
5.	Connection diagrams and operating conditions	4
5.1	Connection diagram for the power boards 6011A, 6012A und 6013A	4
5.2	Connection diagram for the control board 6011	4
5.3	Operating conditions	5
6.	Setting instructions	6
6.1	Trimmers and LED display	6
6.2	Factory setting of the trimmers	6
6.3	Control inhibit LED	7
6.4	Speed limitation values n_{min} and n_{max}	7
6.5	U/f characteristic setting	7
6.6	Voltage boost U_{min} in the lower frequency	8
6.7	Acceleration and deceleration time T_i	9
7.	Control functions	9
7.1	Control release RFR	9
7.2	Rotation direction R/L	9
7.3	D. C. injection braking GSB	10
8.	Speed set value	11 - 13
9.	Y-capacitor	13
10.	Dimensions	14
11.	Installation instructions	14
12.	Option 6012 (galvanic isolation)	15
12.1	Technical features	16
12.2	Installation and connection information	16
13.	Delivery programme	17
14.	Accessories	17

1. General description

The Lenze inverter range 610 comprises 3 models for the stepless speed control of three-phase motors from 0.37 ... 0,75 kW nominal power. 220V/380V three-phase motors are to be connected in delta arrangement.

When supplying motors from inverters it must generally be observed that for thermal reasons the continuous shaft power of the motor as compared to its nominal name plate power has to be reduced by approximately 15%. The available peak power of the recommended motor driven by a 610 range inverter is approx. 20% higher than the nominal power of that motor.

2. Controller concept

PWM frequency inverter with constant d. c. link voltage designed as a standard inverter for speed control tasks in enclosure IP 00.

3. Features

The 610 frequency inverters are speed controllers for three-phase motors with

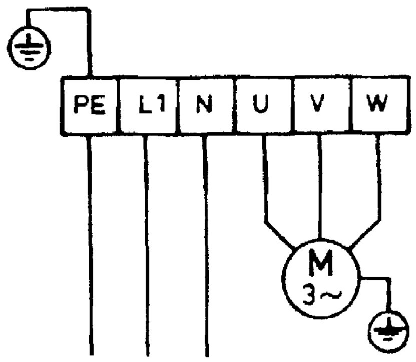
- Pulse-width modulation of the output voltage
- Torque boost facility U_{min} in the lower frequency range
- U/f characteristic control
- Set value integrator T_i
- Trimmers for U_{min}, U/f, Ti, n_{min}, n_{max}
- Control release delay at mains switch-on of approx. 400 ms
- Current limitation at mains switch-on
- Compensation of mains voltage fluctuations
- Monitoring of the d. c. link voltage $U_{d\,min}$ and $U_{d\,max}$
- Direct reversing
- D. C. injection braking
- Speed provision by isolated master voltage or master current or highly isolated potentiometer
- Isolated control inputs with option board 6012 available

	611	612	613
Nominal current I_N	2,6 A	3,2 A	4,0 A
Nominal power S_N	1,0 kVA	1,2 kVA	1,5 kVA
Recommended motor power P_M	0,37 kW	0,55 kW	0,75 kW
Typical current at peak motor torque I_K	3,0 A	3,7 A	4,7 A
Breaking current I_{GSB} when using d.c. injection braking	0 ...4,5 A	0...5,5 A	0...7,5 A
Typical power loss P_V at I_N	30 W	45 W	60 W
Mains voltage U_L	190 ... 260 V~ ± 0 %; 50 - 60 Hz		
Mains current I_L at I_N, U_L = 220 V~ and f_d = 50 Hz	5,0 A	7,0 A	9,0 A
Ouput frequency f_d	2,5 ... 110 Hz		
Master voltage U_{Leit}	0 ... 10 V		
Control current I_{Leit} instead of master voltage U_{Leit}	0 ... 20 mA or 4 ... 20 mA		
Permissible ambient temperature ϑ_a	0 ... 45° C		
Dimensions H x W x L	135 x 170 x 180 mm		
Weight m	1,4 kg	1,8 kg	1,8 kg
Lenze Part No. Simplatroll Stock No.	326 476 K3-77736	326 477 K3-94279	326 478 K3-94260

Table 1

5. Connection diagrams and operating conditions

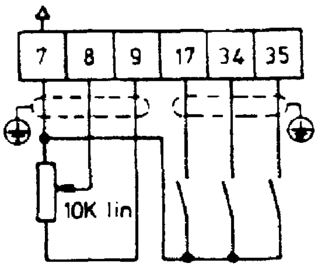
5.1 Connection diagram for the power boards 6011A, 6012A and 6013A

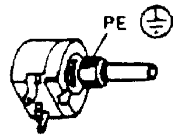


U_{mains}: 190V ... 260V~ 3-phase motor
50 ... 60 Hz delta connected

Fig. 1

5.2 Connection diagram for the control board 6011





Speed set value RFR R/L GSB

- GSB → Close switch for d.c. injection braking
- R/L → With the switch open field rotation is clockwise, with the switch closed field rotation is anticlockwise.
- RFR → Close the switch for controller release

Control inputs are not isolated.
Use highly isolated potentiometers.
Use 250 V~rated cables.

Fig. 2

5.3 Operating conditions

The mains connection, the earth connection and the motor connection have to be in accordance with fig. 1. Standard three-phase 380/220 V~ motors are to be connected in delta. The mains voltage range given (260 $V\sim_{max}$) must not be exceeded. The connecting cables have to be 1,5 to 2,5 mm^2 and for 250 V~ nominal insualtion.

The control cables have to be connected according to fig. 2. It is advisable to use double or multiwire twisted cables. The cables must be rated for 250 V~ nominal insulation voltage, the control signals themselbes must be isolated.

If only signals carrying potential are available for the drive galvanic isolation can be carried out using option 6012. Additional auxiliary voltages are not necesssary for this. Option 6012 can be installed inside the controller (see also ch. 12).

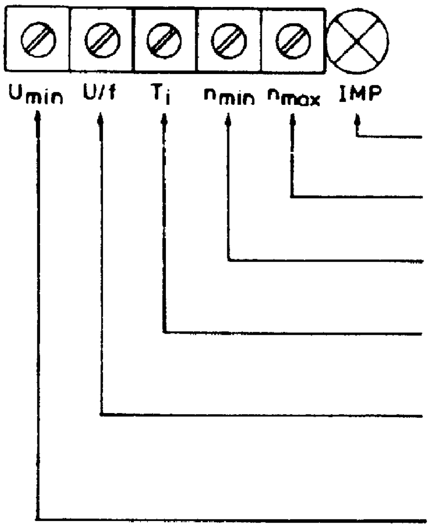
All the controllers in the 610 range are fitted with an NTC-resistor to reduce the current peak at mains switch-on. After only short-time operation of the controller the resistance value of the NTC-resistor falls considerably due to heating and its permanent power loss is correspondingly small. If the controller is disconnected from the mains after operation the cooling time of the NTC-resistor to its full cold resistance value can take up to 10 minutes.

If the mains is switched on again after a shorter disconnection time the mains in-rush current can be increased since the NTC-resistor may still be hot. For this reason a mains disconnection time of at least 3 minutes is recommended in the case of periodic mains switching. However, occasional switching after very short disconnection times does not cause any damage to the controllers in the 610 range.

Caution: The controller carries voltage for up to 30 s after disconnection from the mains.

6. Setting instructions

6.1 Trimmers and LED display



LED lights up:	control inhibit
min. speed:	0,05...0,6 n_N
max speed:	0,6...2,2 n_N
acceleration and deceleration time:	1...20 s
rated voltage point:	max. output voltage at 45...110 Hz

Voltage boost in the frequency range up to 0,5 $f_{d\,max}$

fig. 3

6.2 Factory setting of the trimmers

U_{min}:	current intake of an idle running motor at f_d = 5 Hz is ca. 0,8 I_N
U/f:	max. output voltage is at f_d = 50 Hz
Ti:	acceleration and deceleration time is ca. 5 s
n_{min}:	min. speed is ca. 0,1 n_N
n_{max}:	max. speed is ca. n_N

6.3 Control inhibit LED

The LED lights up for

- control inhibit
- mains switch on delay
- undervoltage
- overvoltage
- excess temperature of the heatsink (only for 613), reset via mains disconnection

6.4 Speed limitation values n_{min} and n_{max}

The trimmers marked n_{min} and n_{max} can be used to set the minimum and maximum values of the output frequency f_d of the inverter and therefore also the min. and max. speed of the motor.

n_{min}-trimmer fully anticlockwise:	f_{dmin} = 2,5 Hz
n_{min}-trimmer fully clockwise:	f_{dmin} = 30 Hz
n_{max}-trimmer fully anticlockwise:	f_{dmax} = 30 Hz
n_{max}-trimmer fully clockwise:	f_{dmax} = 110 Hz

The settings of the trimmers are independent of each other.

6.5 U/f characteristic setting

By using the U/f-trimmer the output voltage of the inverter can be set in relation to the output frequency. The factory settting for the U/f characteristic is such that the inverter reaches its maximum output at 50 Hz.

U/f-trimmer fully clockwise:	max. output voltage is reached at 45 Hz
U/f-trimmer fully anti-clockwise:	max. output voltage is reached at 110 Hz

By choosing the U/f characteristic the excitation of the motor is largely determinded. The U/f characteristic setting facility should be used if the nominal frequency of the motor is different from 50 Hz or when its nominal voltage is different from the nominal voltage connected to the inverter.

The terminal voltage in the rated operating point at 50/60 Hz can be measured ba rectifying the terminal voltage externally and using a moving coil instrument set to dc.

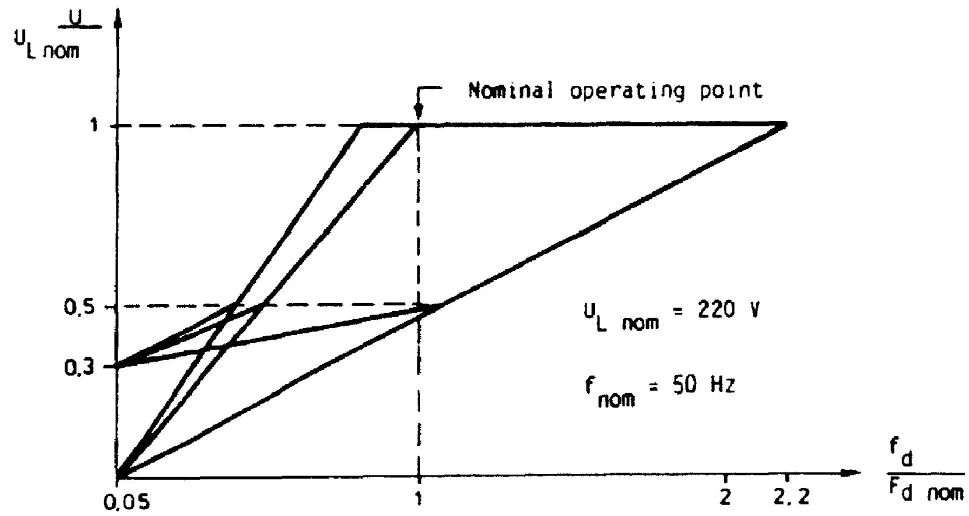
6.6 Voltage boost U_{min} in the lower frequency range

By using the U_{min}-trimmer the output voltage of the inverter can be raised in the lower frequency range. The factory setting is such that a 4-pole motor of the recommended power draws ca. 80 % nominal current at load-free speed (5 Hz).

Clockwise rotation of the U_{min}-trimmer increases the voltage supplied to the motor, anti-clockwise rotation reduces it.

Voltage increase in the lower frequency range is necessary when the drive system requires increased starting torque. When the U_{min}-trimmer is turned fully clockwise the available starting torque is in the range of the rated torque of the motor used. Voltage increase normally causes increased motor noise and increased motor losses. This mode of operation is therefore only permitted for a short time. Lowering the voltage reduces the noise and leads to smoother motor rotation.

The positions of the U_{min}- and U/f-trimmers influence the voltage/frequency characteristics as shown in fig. 4.



6.7 Acceleration and deceleration time T_i

By using the trimmer T_i the acceleration and deceleration time of the set value integrator can be adjusted.

T_i-trimmer fully anti-clockwise: T_i = 1 s

T_i-trimmer fully clockwise: T_i = 20 s

For optimum acceleration and braking the integrating time T_i has to be set according to the torque and total inertia of the drive system. If the setting time of T_i is too short the motor stalls during acceleration and the acceleration torque is reduced.

7. Control functions

7.1 Control release RFR

The release of the control pulses for the inverter output stages is obtained by switching terminal 17 (RFR input) to terminal 7 (electronics ground GND). This can be switched by relay contact, open collector transistor, opto-coupler or similar. With the terminals open the voltage between terminals 17 and 7 is ca. 15 V, with the terminals closed the signal current is ca. 5 mA.

7.2 Rotation direction R/L

With control terminal 34 open the voltage sequence at the output terminals U, V, W of the inverter rotates clockwise, in other words, the timing sequence of the voltage curves is identical to the alphabetical sequence of the terminals. Therefore, a motor connected to the inverter is rotating clockwise as viewed from the shaft end when the motor terminals are connected in the sequence U1, V1, W1 to the inverter terminals U. V, W.

Switching terminal 34 to terminal 7 results in anti-clockwise rotation. The switching possibilities are as in 7.1.

In connection with the current limitation inherent in the 610 controllers the R/L change-over feature allows the well-known three-phase motor plug braking mode to be used. If the direction of the rotating field is reversed during continuous motor operation by switching at the R/L-terminal, the rotor and the field ratate in opposite directions, at first with slip $s \approx 2$. This causes a braking torque to be applied to the rotor and the kinetic energy of the rotating masses is dissipated as heat in the motor. This may cause non-permissible heating up of the motor especially with large inertias and frequent speed reversals. For this reason load cycles with plug braking have to be carefully checked regarding the cooling conditions of the motor.

7.3 D.C. injection braking

By short-circuiting terminal 33 to terminal 7 the drive system is put into the "d.c. injection braking" operating mode. With this operating mode the rotating field frequency is immediately set to zero and a d.c. current is supplied to the motor. This causes the rotor to be actively braked to standstill. Due to remanence effects there is usually a small standstill torque even at zero speed. Standstill operation can lead to non-permissible heating-up of the motor depending on the d.c. braking current set and the cooling characteristics of the motor. After releasing the d.c. injection braking operation the drive re-accelerates with the integrating time T_i towards the set speed.

The amount of d.c. current supplied to the motor can be set by using the U_{min}-trimmer. At fully anti-clockwise setting of the trimmer the d.c. current is zero. Clockwise rotation of the trimmer increases the value of the d.c. current up to a maximum value given by the internal current limitation ($\approx$1,5 ... 2 I_N) which is reached in the range between the middle and the fully clockwise position of the trimmer.

If it is required to adjust the braking current independently of the setting of the U_{min}-trimmer, additional soldering in of diodes V_{01}, V_{02} and resistor R_{01} can be carried out at the corresponding soldering points in the middle of the control board 6011 as shown in fig. 7.

Additional components

V_{01}, V_{02}: small signal diodes 1N4148 (observe correct polarity!).

$R_{01} \approx$ 1,8 MΩ for maximum braking current.

The exact value of R_{01} has to be adjusted to the particular motor connected and the braking effect which is required. Increasing R_{01} reduces the value of the braking current supplied. The pack supplied with the controller includes some resistors with values $\geq$ 1,8 MΩ for this application.

As was the case with plug braking, in d.c. injection braking operation the kinetic energy of the inertias is converted to heat in the motor. The load cycles have therefore to be checked carefully with regard to the cooling conditions of the motor. With large inertias successive use of the plug braking and d.c. injection braking may be advantageous.

8. Speed set value

Important: Terminals 7, 8 and 9 for setting the output frequency of the inverter f_d are not isolated. The provision of the set value must only be by a highly

isolated potentiometer or an isolated master voltage or an isolated current control loop. The control cables must be rated for a nominal insulation voltage of 250 V.~

a) Speed signal by highly isolated 10-k -potentiometer, 1 W (Lenze part no.: 332 194). The holding screw of the potentiometer must be earthed. Connection according to fig. 2.

Slider position towards terminal 7: $f_d = f_{dmin}$

Slider position towards terminal 9: $f_d = f_{dmax}$

The values f_{dmin} and f_{dmax} are set by trimmer potentiometers (see section 6,4).

Non-linearity $\leq$ 2 %
Temperature drift $\leq$ 2 %

b) Speed signal by isolated master voltage. Terminals 8 and 7 can be used to connect an isolated master voltage 0 ... 10 V in accordance with fig. 5.

U_{Leit} = 0 V : $f_d = f_{dmin}$

U_{Leit} = 10 V : $f_d = f_{dmax}$

The linearity and temperature drift are as in a).

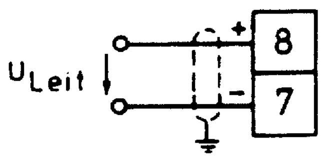


Fig. 5

c) Speed signal by isolated current loop. Terminals 8 and 7 can be used to feed in an isolated control current in accordance with fig. 6 provided that control board 6011 is modified as fallows:

Control current 0...20 mA. Solder in R_{201} = 511 Ω , 1 % , 0,5 W MS-restistor.

I_{Leit} = 0 mA: $f_d = f_{dmin}$

I_{Leit} = 20 mA: $f_d = f_{dmax}$

Control current 4...20 mA. Solder in R_{201} = 750 Ω and R_{202} = 53,6 kΩ , each 1 %, 0,5 W MS-resistors.

I_{Leit} = 4 mA $f_d = f_{dmin}$

I_{Leit} = 20 mA $f_d = f_{dmax}$

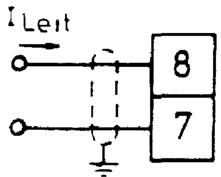


Fig. 6

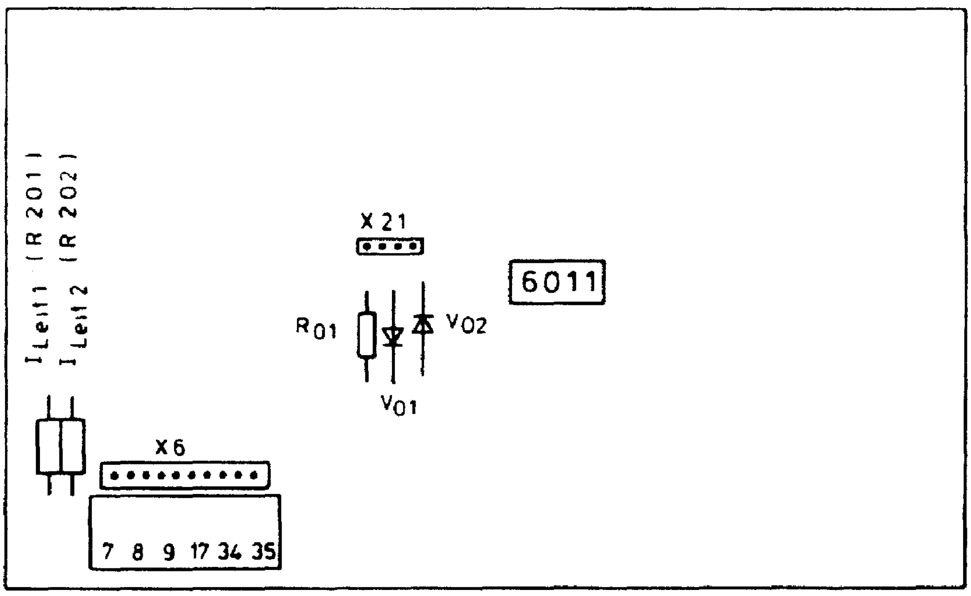
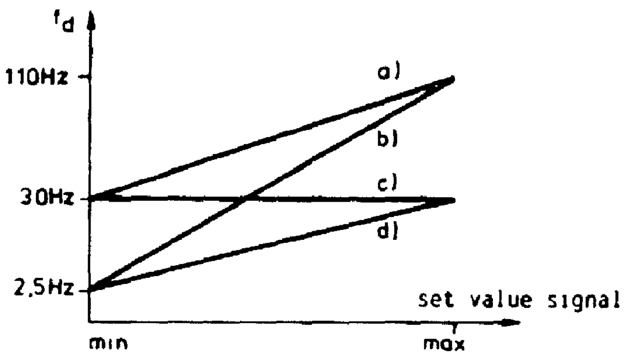


Fig- 7

Fig. 8 shows the relationship between the output frequency f_d of the inverter and the set value signal and the n_{min} - and n_{max} - trimmer positions.



Set value signal

a) n_{min}-trimmer fully clockwise
   n_{max}-trimmer fully clockwise

b) n_{min}-trimmer fully anti-clockwise
   n_{max}-trimmer fully clockwise

c) n_{min}-trimmer fully clockwise
   n_{max}-trimmer fully anti-clockwise

d) n_{min}-trimmer fully anti-clockwise
   n_{max}-trimmer fully anti-clockwise

fig. 8

9. Y-capacitor

In order to reduce possible interference levels, particularly on longer control cables, the 610 controllers can be fitted with a Y-capacitor (interference suppression capacitor).

However, according to VDE 0160 and VDE 0560, this is permissible only when the controller is used as a permanently connected power electronics device and either an FI-safety-switch or other protective means in accordance with VDE 0160 are present.

The y-capacitor can be soldered in on the power boards 6011A, 6012A and 6013A as C3 at the soldering points provided (on the left next to the fuse). A Y-capacitor 6,8 nFY, 250V is available as an accessory (see ch. 14).

10. Dimensions

Attachment borings for option 6012

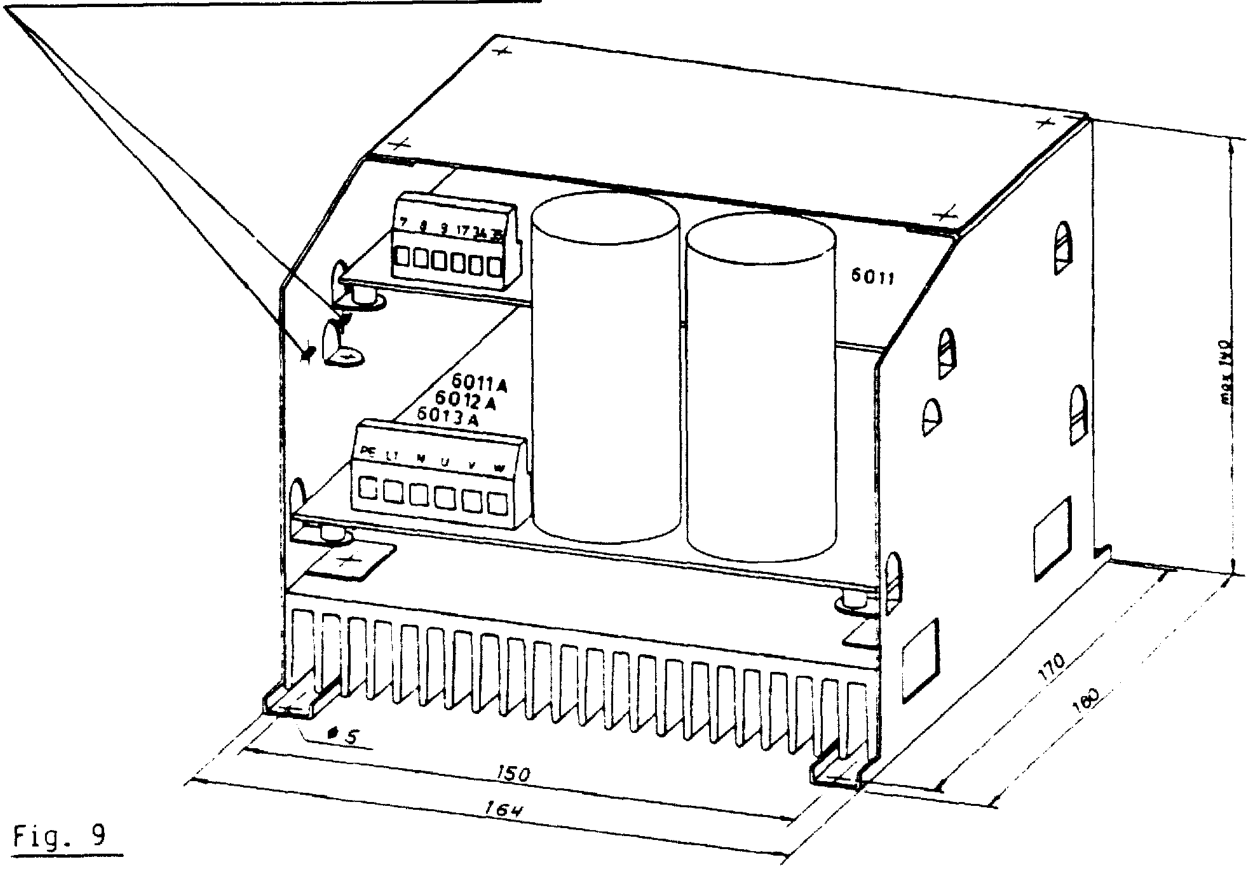


Fig. 9

11. Installation instructions

Install the inverter vertically with the terminal strip at the bottom. Ensure that there is a free space of 100 mm at the top and bottom and 50 mm at the sides in order to maintain the flow of air through the heatsink and the inverter (fig. 10).

When installing the inverter in a housing, ensure that there is adequate ventilation. The power loss of the inverter given in Table 1 and the power losses of other devices in that housing must be considered here. The ambient temperature of the inverter must not exceed +45° C.

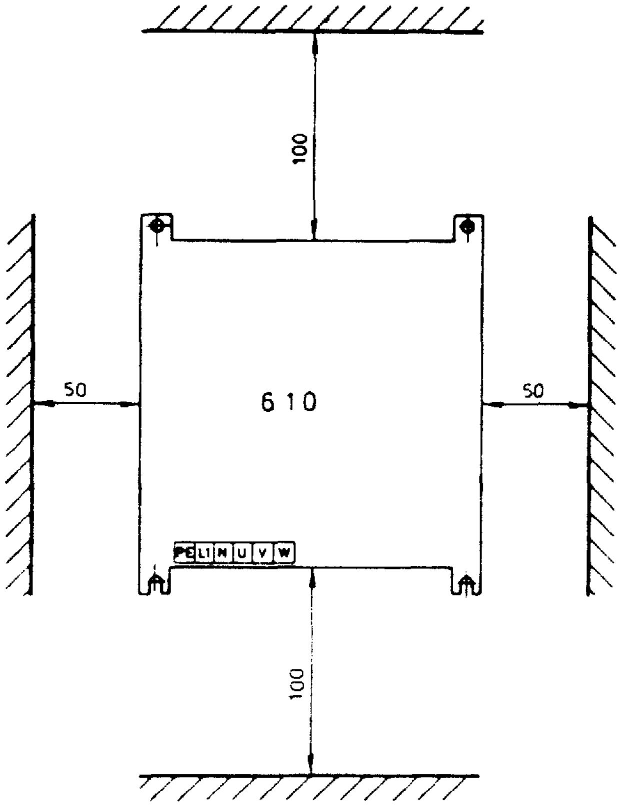


Fig. 10

12. Option 6012 (galvanic isolation)

The option 6012 makes complete galvanic isolation between the drive signals and the control board 6011 possible. The option must be used when only non-isolated signals are available to control the inverter. The option should also be used in the case of isolated signals when the control cables are laid in a high interference environment or when the ground-capacitance of an external control circuitry is large and an existing input interference is not improved sufficiently by simple means such as the installation of a Y-capacitor (see ch. 9).

12.1 Technical features

- Isolation of the logical signals RFR, R/L, GSB
- Isolation of the speed set value signal n_{soll}

  Set value provided by

  a) 10-k -potentiometer or

  b) master voltage 0 ... 10 V or

  c) control current 0 ... 20 mA. In this case a resistor R = 511 has to be wired permanently between terminals 7 and 8 of option 6012.
- Inversion of the logical RFR, R/L and GSB by means of jumper programming.

  a) Jumper J1 attached (jumper pins bridged):
  Activation of the function RFR (terminal 17), R/L (terminal 34) or GSB (terminal 35) by L-signal of 0V (short circuiting the respective terminal with terminal 7).

  b) Jumper J1 removed:
  Activation of the function RFR, R/L or GSB by H-signal of 18 ... 30 V at the respective terminal w.r.t. terminal 7.

The factory supplies the option with the jumper attached.

12.2 Installation and connection information

The option 6012 is supplied complete with holder and flat cable connector in order to install it in the standard inverter.

Installation is carried out according to fig. 11 by screwing the holder against the left side part of the inverter. The electrical connection is made by attaching the flat cable connecter to the 10-pin strip X6 on board 6011. The flat cable connecter must be pushed completely onto the pin-type strip. A Check should be made before start-up to see that no component of the option print has been damaged or bent during installation.

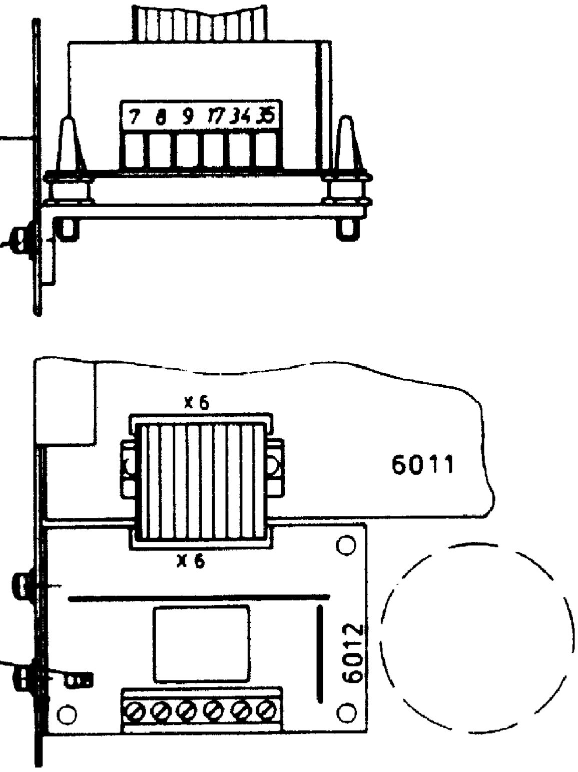


Fig. 11

The terminal arrangement for option 6012 is identical with that of board 6011 except for the fact that the terminals on the option are isolated. Therefore, the connection diagram fig. 2 can be used as a guide when connecting the control signals to the option. The control signals RFR, R/L and GSB are described in ch. 7, the possibilties of setting the speed signal in ch. 8.

As has been explained in section 12.1, after removing the jumper J1 positive H-signals of 18 ... 30 V lead to an activation of the functions RFR, R/L, and GBR as is customary for memory programmed controls (MPCs). In the case of supplying the speed set value by means of current loop only the control current range 0 ... 20 mA is permissible. In this case the resistor R_{01} = 511 Ω , 1 % , 0,5 W has to be connected externally between terminals 7 and 8.

13. Delivery programme

Inverter with fuse, ready to be installed	part no.: see table 1
Technical specifications 610	part no.: 326 875
Set value potentiometer 10 k Ω , 1 W, lin.	part no.: 322 194
Enclosed pack for control current an d.c. injection braking	part no.: 329 067

14. Accessories

Fuse F10A, 80 A^2 s	part no.: 328 536
Y-capacitor 6,8 nFY, 250 V	part no.: 329 066
Mains choke 5 mH, 9 A	part no.: 323 330
Option 6012 (galvanic isolation)	part no.: 326 874

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