PowerWAVE EL 100
(4–12 kVA)

User Manual

KOHLER POWER
uninterruptible

KOHLER POWER uninterruptible

IMPORTANT NOTICES

1. Read instructions carefully before installing and starting the Emergency Lighting Inverter
2. All warnings in the manual should be adhered to.
3. All operating instructions should be followed.
4. The unit should be supplied by a grounded outlet. Do not operate the unit without a ground source.
5. Power cord of the EL-Inverter should be routed carefully so that they are not to be walked on.
6. Please save this manual.
7. Please save or recycle the packaging materials.

WARNING

Do not insert any object into ventilation holes or other openings.
To reduce the risk of fire or electric shock, install in temperature and humidity controlled indoor area free of conductive contaminants.
To reduce the risk of fire, replace fuses with the same type and rating when necessary.

CAUTION

Only qualified personnel should install or service EL-Inverter/batteries.

Risk of electric shock, do not remove cover. No user serviceable parts inside, refer servicing to qualified service personnel.

The output may be energised when the unit is not connected to a mains supply.

Risk of electric shock. Hazardous live parts inside. This unit is energised from the battery supply even when the input AC power is disconnected.

To reduce the risk of electric shock, disconnect the EL-Inverter from the mains supply before installing a computer interface signal cable. Reconnect the power cord only after signalling interconnections have been made.

ABOUT THE BATTERIES

CAUTION: RISK OF ELECTRIC SHOCK

The battery circuit is not isolated from the mains voltage. Hazardous voltages may occur between the battery terminals and the ground

A battery can present a risk of electric shock or burn from high short circuit currents. The following precautions should be taken when working on batteries:

* Remove watches, rings or other metal objects.
* Use tools with insulated handles.

The batteries of the EL-Inverter are recyclable. Batteries must be disposed of according to local environmental laws. The batteries contain lead and pose a hazard to the environment and human health if not disposed of properly.

Do not dispose of batteries in a fire. The batteries may explode. Do not open or mutilate the batteries. They contain an electrolyte which is toxic and harmful to the skin and eyes. If electrolyte comes into contact with the skin the affected area should be washed immediately.

The internal energy source (the battery) cannot be de-energised by the user. When

changing batteries, install the same number and same type of batteries.

I. GENERAL DESCRIPTION

Introduction

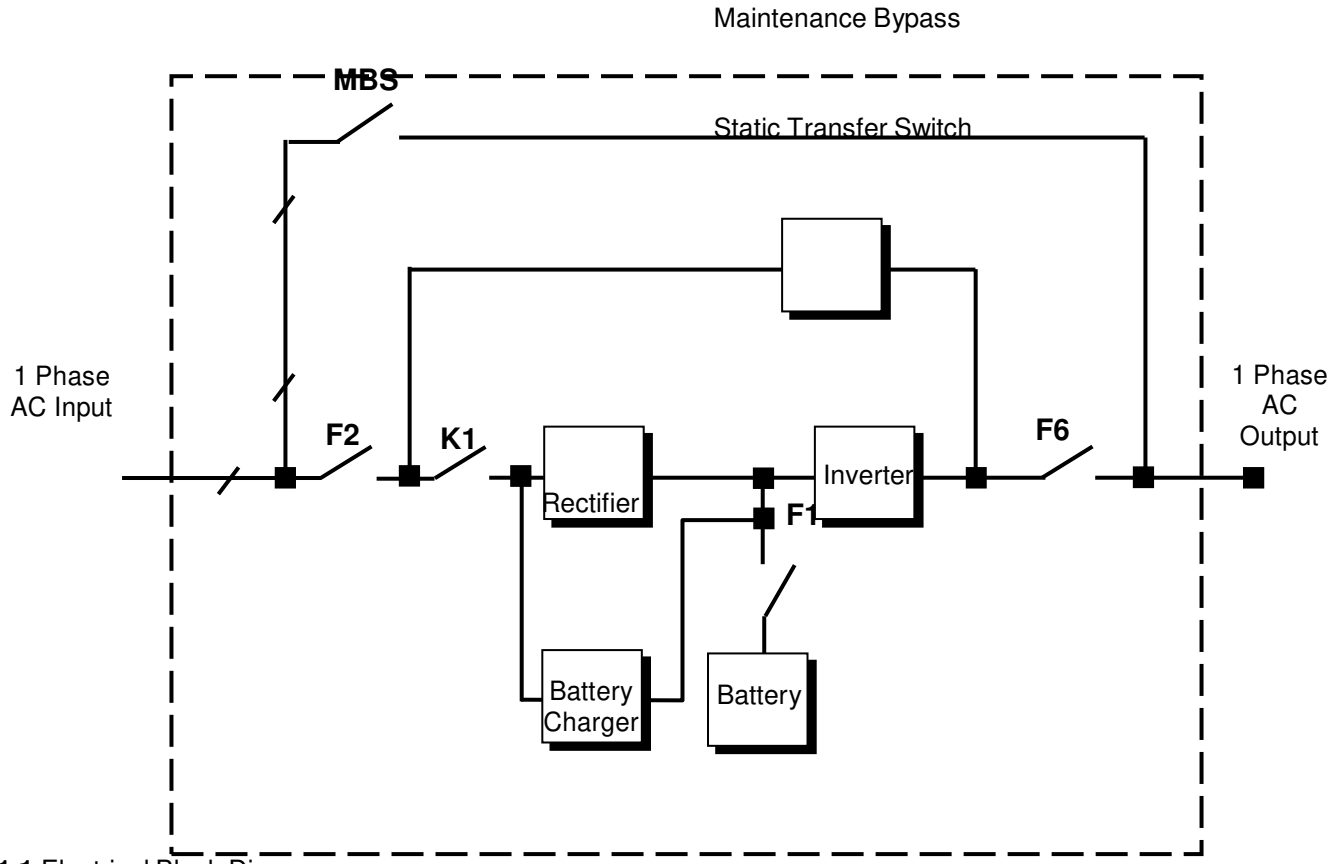
EL-100 Series Emergency Lighting Inverters (EL-Inverter) are double conversion power supplies manufactured with the latest IGBT and PWM technology, to produce a reliable, microprocessor controlled pure sine wave output to Emergency Lighting equipment.

EL-100 Series units are 1-phase in / 1-phase out devices and they are installed between a single phase emergency lighting distribution system and a single phase+N mains supply.

Basic Features

- Microprocessor Controlled
- Double-Conversion
- IGBT Inverter
- Sinusoidal output Waveform.
- Low output Voltage THD
- High overload capacity
- Overload and short circuit Protection
- Overtemperature protection
- Two different operation modes. (CHANGEOVER and INVERTER)
  Static Bypass Switch
- Maintenance Bypass Switch
- LCD Display
- Alarm History (Up to 128 Alarms)
- Real time clock (date and time)
- Emergency Power off (EPO)
- System and battery test ability (TEST1 and TEST2)
- Boost charge for batteries
- High battery recharging current
- Battery current-limit
- Deep discharge protection
- Alarm relay contacts
- RS232 communication port
- Remote monitoring Panel (Optional)
  SNMP Adapter (Optional)
- MODBUS Adapter (Optional)

Design Concept:



1.1 Electrical Block Diagram

F1	: Battery switch & fuse.
F2	: AC Input switch & fuse.
MBS	: Maintenance By Pass Switch.
F6	: Output fuse.
K1	: Input Contactor

DESCRIPTION OF BLOCKS:

RECTIFIER: The first conversion stage (from AC to DC) uses a single phase uncontrolled rectifier to convert the incoming mains supply into a DC bus voltage. The DC voltage supplied by the rectifier provides power to the inverter section.

BATTERY CHARGER: It produces a well-regulated DC voltage suitable for charging the batteries.

BATTERIES: Batteries are used as reserve DC power supply for the Inverter in case of mains failure. Batteries are discharged by the inverter during mains failure. The discharged batteries are recharged by the battery charger on a constant current / constant voltage basis, if AC mains power is available.

INVERTER: It is manufactured by using the latest IGBT technology and Pulse Width Modulation (PWM) technique. The inverter converts the DC bus voltage supplied by the rectifier and / or the batteries into a well-regulated AC voltage with stable voltage and frequency.
The output of the inverter is used to supply the Emergency Lighting Equipment in case of a mains failure.

STATIC TRANSFER SWITCH (STATIC BY-PASS): This is an electronically controlled transfer switch which enables the load (Emergency Lighting Equipment) to be connected either to inverter output or to a by-pass power source (mains power).

MAINTENANCE BY-PASS SWITCH (MBS): This is a manually controlled mechanical switch, which is used to supply the load, using the mains supply, when the EL-Inverter is shut down for maintenance or service purposes.

1.2.1 OPERATING MODES OF EL-INVERTER:

A. Normal Operation (If mains supply is available)

The normal operation mode of EL-INVERTER is CHANGEOVER mode. In this mode, 1-phase mains supply (bypass supply) is available at the output terminals of the unit and the load is supplied by mains voltage. On the other hand, Inverter keeps running and is ready to supply the load. During normal operation, the rectifier supplies DC power to the Inverter and charges the batteries at the same time.

B. Battery Operation

The batteries are connected to the rectifier output. In case of mains failure, the rectifier stops operating and the DC voltage necessary for the inverter operation is supplied by the batteries. As soon as the mains failure is sensed by the control circuitry, the load is transferred to Inverter which is already running. Therefore, the AC voltage output supplying the loads connected to the output is not interrupted.
This way. It is possible to keep the lights energised which have already been turned on (MAINTAINED Operation). It is also possible to turn on the Emergency Lighting system only if the mains voltage is not available (NONE-MAINTAINED Operation). For this purpose, a NC contactor should be added to the output of the EL-Inverter as will be explained later in section 4.1.3

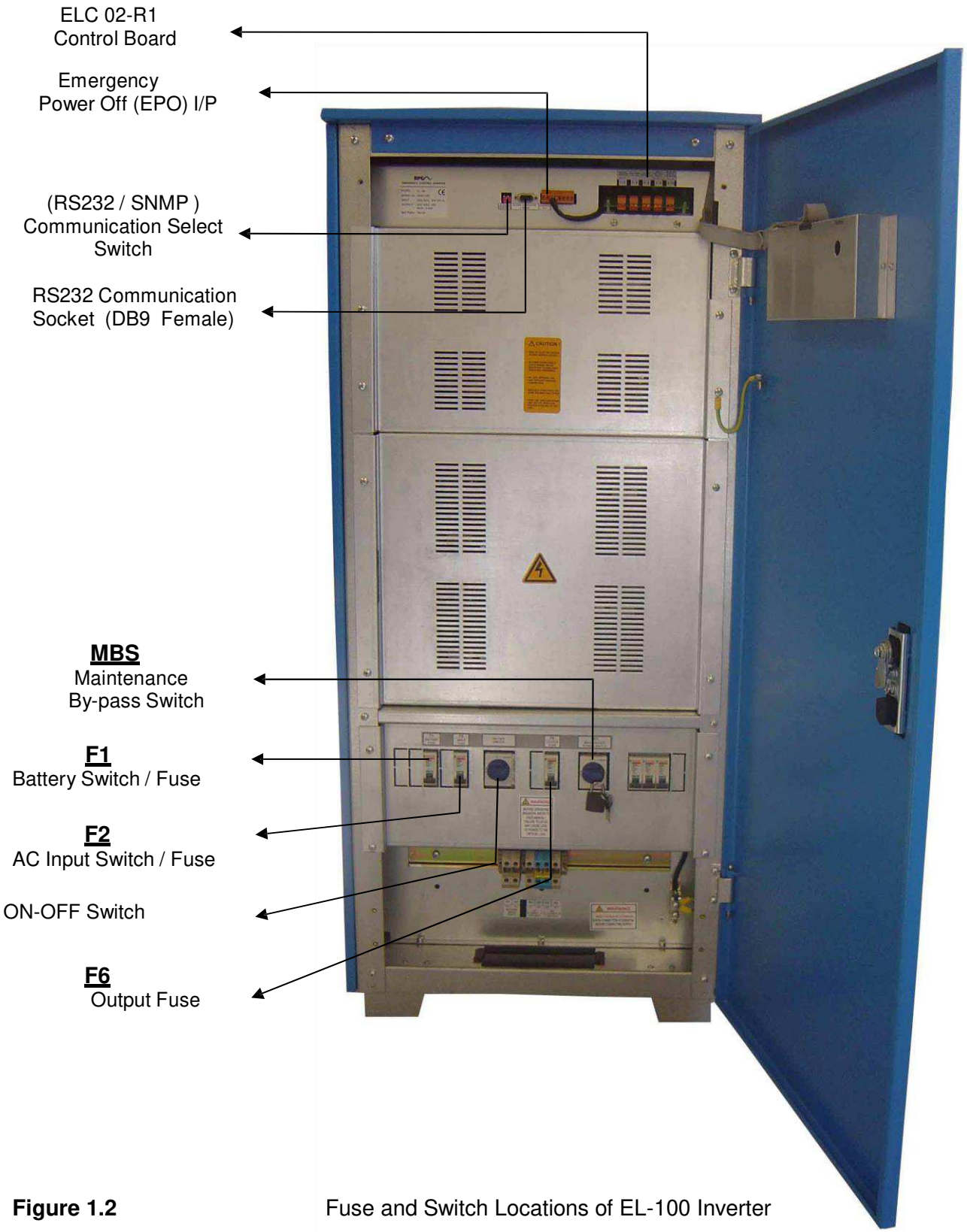


Figure 1.2 Fuse and Switch Locations of EL-100 Inverter

1.3 Technical Specifications

MODEL	EL-104	EL-104	EL-105	EL-106	EL-108	EL-112
Output kVA	2	4	5	6	8	12.5
Output kW	1.7	2.7	3.5	4.4	5.8	8.75
Serial Communication	RS232 (optional SNMP, RS485 or MODBUS)					
INPUT						
Input voltage	230 Vac + N					
Voltage tolerance	15%					
By-Pass voltage	230 Vac, N					
Input frequency	50 Hz / 5%					
RFI Level	EN 50091					
OUTPUT						
Nominal output voltage	230 Vac, N					
Voltage regulation tolerance	2 %					
Nominal output frequency	50 Hz.					
Output frequency tolerance (Line syncron)	2%					
Output frequency tolerance (Free running)	0,2%					
Efficiency (100% Load)	87-88%					
Load Crest factor	3:1					
Overload	<120% Continuous 120%-150% load 10 min. 150%-180% load 1 min. > 180% by-pass					
Total Harmonic Distortion (THD)	<%3					
BATTERY						
Number of	14	16	18	18	20	20
Float charge voltage	189 Vdc	216 Vdc	243 Vdc	243 Vdc	270 Vdc	270 Vdc
End of discharge voltage	140 Vdc	160 Vdc	180 Vdc	180 Vdc	200 Vdc	200 Vdc
ENVIRONMENT						
Maximum Temperature	0 C - 40 C					
Audible noise	<60dBA					
Dimensions (HxWxD) (mm)	1210 x 570 x 370					
OTHER						
Serial communication	RS232 (standard) RS485 (optional)					
Alarm contacts	Standard					
SNMP Adaptor	Optional					
Remote Monitoring Panel	Optional					

II. EL-INVERTER INSTALLATION

2.1 Introduction

WARNING

Do not apply electrical power to the EL-Inverter equipment before the arrival of authorized service personnel.

The EL-Inverter equipment should be installed by a qualified service personnel.

The connection of the batteries and the maintenance should be done by the qualified service personnel.

Do not make short- circuit to the battery's poles. Because of the high short-circuit current, it has the danger of electrical shock or burn.

Eye protection should be worn to prevent injury from accidental electrical arcs. Remove rings, watches and all metal objects. Only use tools with insulated handles. Wear rubber gloves.

This chapter contains location installation information of the EL-Inverter and the batteries. All the establishments have their own specialties and needs. So, in this part the installation procedure is not being explain step by step. Instead general procedure and the applications are explained for the technical personnel.
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2.2 Unpacking

The EL-Inverter is packed and enclosed in a structural cardboard carton to protect it from damage.
1) Inspect for damage that may have occurred during the shipment If any damage is noted, call the shipper immediately and retain the shipping carton and the EL-Inverter.
2) Carefully open the carton and take the EL-Inverter out.
3) Retain the carton and packing material for future use.

Unit package contents:
1) A user manual and Guarantee certificate.
2) Battery cabinet and/or shelf (Optional)
3) Battery connection cables.
4) Battery Circuit Breaker (Optional)

2.3 Equipment Positioning

1) The equipment's installation place must be an easy serving place.
2) Install the EL-Inverter in a protected area with adequate air flow and free of excessive dust.
3) You must therefore allow for a minimum gap of 250 mm behind the unit to allow adequate air flow
4) Select a suitable place (temperature is between 0°C and 40°C) and the relative humidity (%90 max)
5) It is recommended to air-conditioned the room (24°C)
6) Temperature is a major factor in determining the battery life and capacity. Battery manufacturers quote figures for an operating temperature of 20°C. On a normal installation the battery temperature is maintained between 15°C and 25°C. Keep batteries away from main heat sources or main air inlets etc.
7) In case of an operating the EL-Inverter in a dusty place, clean the air with a suitable air filtration system.
8) Keep out of your equipment from the explosive and flammable items.
9) Avoid direct sunlight, rain, and high humidity.

WARNING Check the capacity of the forklift if it is available for lifting.
DO NOT MOVE THE BATTERY CABINET WHILE THE BATTERIES ARE INSTALLED.

2.4 Connecting The EL-Inverter Power Cables

WARNING A separate line should be used to supply the EL-Inverter AC input. Do not use any additional cable to increase the length of the EL-Inverter's input cable. It is advised to use an MCCB suit- able for the input current on the EL-Inverter's input line.

The connection of the electrical panel should be supplied by a grounded outlet. Other- wise, the EL-Inverter and the load connected to the output will be left ungrounded. The grounding system must be controlled and must be strengthened if required. Potential difference between ground and neutral must be less than 3V AC.

Descriptions of the EL-Inverter input output cable connection terminals are shown in figure 2.1

Recommended input line cable and fuse ratings are given in the table below.

EL-INVERTER Power (kVA)	**NOMINAL CURRENT: Amperes / Recommended cable cross-section (mm^2)**		
	AC Input line (Full capacity recharge)	**Output** (At full load)	**Battery**
	230V	230V	
	A / mm^2	A / mm^2	A / mm^2
2	20A / 6mm^2	9A / 4mm^2	16A / 6mm^2
4	25A / 6mm^2	20A / 6mm^2	20A / 6mm^2
5	30A / 10mm^2	25A / 10mm^2	20A / 6mm^2
6	38A / 16mm^2	30A / 10mm^2	25A / 10mm^2
8	52A / 16mm^2	35A / 10mm^2	30A / 10mm^2
12,5	74A / 25mm^2	55A / 16mm^2	45A / 16mm^2

NOTES: The neutral conductor should be sized for 1.5 times the output/bypass phase current. The Earth conductor should be sized at 2 times the output/bypass conductor (this is dependent on the fault rating, cable lengths, type of protection etc.) These recommendations are for guideline purposes only and are superseded by local regulations and codes of practice.

2.4.1 Safety Earth

The safety earth cable must be connected to the earth BUS BAR and bonded to each cabinet in the system and also the earthing and neutral bonding arrangements must be in accordance with the local laws.

ATTENTION Failure to follow adequate earthing procedures can result in electric shock hazard to personnel, or the risk of fire.

2.4.2 Cable connection procedure

WARNING All connections of the EL-INVERTER must be done by qualified service personnel.

After positioning the EL-Inverter, the cables must be connected as described below:

1. Verify all switches of the EL-Inverter in **"0"** position.

2. Connect the AC input coming from the mains distribution panel to the AC input terminals.

3. Connect the output of the EL-Inverter to the load distribution panel.

4. Connect the battery group. Refer to battery installation section.

WARNING: DO NOT TURN ON THE BATTERY FUSE (F1) BEFORE STARTING THE EL-INVERTER

5. Make all the earth connections on the copper earth bus of the unit.

Note: The earth and the neutral connections must be in accordance to the local rules.

2.4.3 Description of connection terminals of the EL-Inverter:

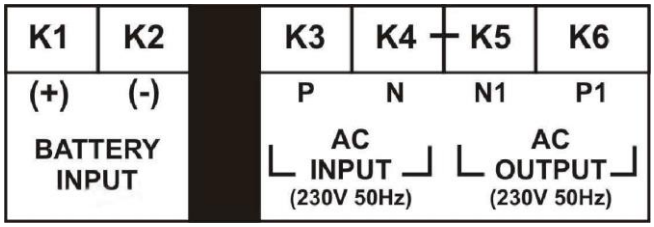

Figure-2.1 Cable Connection Label

2.4.4 Battery Installation

WARNING Be careful while connecting batteries.

ATTENTION Remove the battery fuse before making the connection of the battery circuit breaker box during the battery installation.

The batteries associated with the EL-Inverter equipment are usually contained in a purpose-built battery cabinet, which sits alongside the main EL-Inverter equipment. Sealed, maintenance-free batteries are normally used in this type of installations.

Where battery racks are used, they should be sited and assembled in accordance with the battery manufacturer's recommendations. In general, batteries require a well-ventilated, clean and dry environment at reasonable temperatures to obtain efficient battery operation.

In general, a minimum space of 10 mm must be left on all vertical sides of the battery block. A minimum clearance of 20 mm should be allowed between the cell surface and any walls. A clearance of minimum150 mm should be allowed between the top of the cells and the underside of the shelf above (this is necessary for monitoring and servicing the cells). All metal racks and cabinets must be earthed. All live cell connections must be shrouded.

1. Unpack each battery and check its terminal voltage. If any battery has terminal voltage less than 10.5V it must be charged before continuing.

2. Please check the battery connecting hardware.

3. Please locate suitable number of batteries at each rack.

4. Start locating the batteries from top to the bottom on the racks.

5. Be careful about the connection between the racks and polarities.

6. After interconnecting the batteries, connect the (+) and (-) poles to the battery input terminals on the EL-Inverter. Be careful to connect the batteries correctly and do not turn on (F1) before checking all connections and turn F1 on only after starting the EL-Inverter.

III. FRONT PANEL

3.1 Introduction

The front panel of EL-Inverter, consisting of a 2 lines alphanumeric display, 2 status lamps, plus 4 function keys, allows the complete monitoring of the EL-Inverter status. The mimic flow diagram helps to comprehend the operating status of the EL-Inverter. By using the function keys operator can move on menus and change some parameters.

L1 : If lamp is lit static bypass is active and load is connected to mains voltage
L2 : If lamp is lit inverter supplies the load

There are 4 function keys on front panel these are ENTER, UP, DOWN and (↔).
UP and DOWN keys help moving on menus, (↔) key selects options, ENTER key means the selected option or menu is valid.

NOTE: During parameter settings, "+" sign will change into "—" sign if "↔" button is pressed for 3 seconds and the parameter values will start decreasing.

3.2 Front Panel Menu Descriptions

By using menu buttons on the front panel you can move on main menu functions. You can enter the submenu of the item seen on the LCD panel (MEASURES, ALARMS, INFORMATION) and navigate within it by using again ↓, ↑, ↵ **(Enter)** buttons.

The Main Menu items are listed below. You can choose any requested menu using (↑) and (↓) keys. By pressing ENTER key, you can choose that menu and you can reach all submenu items using (↑) and (↓) keys again. At the end of submenus of each Menu an <ENTER> EXIT message is seen, and if you press ENTER, you exit from the selected menu and go back to the beginning of the MAIN MENU.

Main menu items	Function
STATUS	The status message which shows the EL-Inverter status
COMMAND MENU	→ Enter "go to Command submenu"
MEASURES MENU	→ Enter "go to Measures submenu"
ALARMS MENU	→ Enter "go to Alarms submenu"
USER OPTIONS	→ Enter "go to User Option submenu"
TIME MENU	→ Enter "go to Time submenu"
CALIBRATION MENU	→ Enter "go to Calibration submenu"
ADJUST MENU	→ Enter "go to Adjust submenu"
INFORMATION MENU	→ Enter "go to Information submenu"
Go to STATUS MENU	

3.2.1 COMMAND Menu items

This menu is used to give various commands to the EL-Inverter or perform tests on it.

	Submenu item	Function
1	**SOUND: ON/OFF**	Used for turning on/off the audible alarm. If you press ENTER key the option will change (push ON, push OFF). If the OFF option is selected audible alarm is turned off but in case of a new alarm, EL-Inverter changes the option to ON state.
2	**<ENTER> TEST1**	If you press ENTER key for 3 seconds, the load of the EL-Inverter is transferred to Inverter for about 8 seconds, even if the EL-Inverter is in CHANGEOVER Mode, for test purposes. At the end of this test, normal operation is resumed automatically.
3	**<ENTER> TEST2**	If you press ENTER key for 3 seconds, the Rectifier is turned off and the load is transferred to inverter. This is an autonomy test and lasts until you press ENTER key again.
4	**ENTER <BOOST>**	If you press ENTER key for 3 seconds boost charge starts. The given time for boost charge is 10 hours. At the end of this time EL-Inverter stops the boost charge. If the boost charge is active this submenu item changes to **STOP BOOST> 005H** message the 005H shows that boost charge is going on for 5 hours. If the number is 10 boost charge stops. If you press ENTER key boost charge stops immediately. Boost charge starting and boost charge end times are recorded to log event menu. If boost is active EL-Inverter beeps each 15 seconds
5	**SIMULATION OFF**	The purpose of this submenu to check dry contact connections. Normally to check line failure contact you must turn off mains power. This is not necessary with this utility. 3 options are available. **SIMULATION OFF** simulation mode is off **SIM:LINE FAILURE** if you press ENTER key for 3 seconds the line failure relay on the interface board is energised. **SIM:LINF+BT.LOW** if you press enter key for 3 seconds the line failure and battery low relays on the interface board are energised. **SIM:BYPASS** if you press ENTER key for 3 seconds the bypass relay on the interface board is energised. So you can check dry contact connections
6	**<ENTER> EXIT**	→ Enter (↵) exit from submenu
	Go to MAIN MENU	

3.2.2 MEASURES Menu items

Many EL-Inverter parameters can be monitored in this menu. Navigation through the items is performed using ( ) and ( ) keys.

	Submenu item	Function
1	**LD%: 060**	Output load percentage
2	**OP CURR : 011A**	Output current
3	**OPV: 230**	Output voltage
4	**IPV: 230**	1 Phase input voltages
5	**BATT: 270 V**	Battery voltage
6	**BYP: 230**	By-pass voltage
7	**FREQU: 50.0 Hz 50.0 Hz**	Input frequency – Output frequency
8	**TEMP: 030 c**	Ambient temperature.
9	**<ENTER> EXIT**	→ Enter **(↵)** exit from submenu
	Go to MAIN MENU	

3.2.3 ALARMS Menu items

The last 128 events can be monitored in this menu.

	Submenu item	Function
1	**EL-INVERTER STATUS**	Alarm status at that instant.
2	**000>311201 23:15**	Monitoring past alarms: First 3-digit number indicates the event number, 000 event is the last one. Date is in ddmmyy and time is in hh:mm format. On the second line, the alarm events on the first line are listed. Using button 128 events can be viewed.
3	**PARR.ERR.NR : 017**	Parallel controller board error (If parallel hardware exists) If this value is 0 then the parallel is OK
4	**<ENTER> EXIT**	→ Enter **(↵)** exit from submenu
	Go to MAIN MENU	

3.2.4 USER OPTIONS Menu items

From this menu the user selects some important parameters and apply them.

	Submenu item	Function
1	**MODE: CHANGEOVER**	Two different operating modes can be selected using UP and DOWN keys. **CHANGEOVER**: In this mode the load is normally supplied by the utility supply, and in case of a utility supply failure, the load is transferred to inverter without any interruption. **INVERTER:** In this mode the load is normally supplied by the inverter, whether the utility power supply (line voltage) is good or not. The load is bypassed to utility supply in case of a failure in the inverter. Press ENTER for 3 seconds and the selection is valid
2	**INV No: 001**	By using PLUS and MINUS keys you can change number 0 to 7. ese numbers are important for parallel operation, if exists. → press ENTER for 3 seconds and then the selection is valid

3	**RESTART: ON/OFF**	By using key you can change on and off options. **ON:** during mains failure at the end of battery discharge Inverter shut-downs, after mains restoration Inverter starts again. **OFF**: after mains restoration Inverter doesn't start by itself again. You must urn off and then turn on the EL-Inverter. (battery trip out is off) press ENTER for 3 seconds and then the selection is valid

	Submenu item	**Function**
4	**REMOTE: ON**	By using ↔ key, you can ON enable and OFF options. **ON**: remote battery test, shutdown and bypass functions are enabled through RS232 **OFF**: these functions are disabled → press ENTER for 3 seconds and then the selection is valid
5	**BOOST TIME**	Boost charge period of 1-15 hours is set. Boost charge is disabled if 0 is entered during boost charging.
6	**BOOST**	Manual – automatic modes are selected using +/- key. In automatic mode, if the line is off, each time input line voltage is restored the boost charge starts automatically.
7	**DIRECT START: ON**	ON: Inverter starts automatically. When the EL-Inverter is turned on. OFF: The inverter stays in standby mode when the EL-Inverter is turned on. The inverter starts when ENTER key is pressed. Until this moment the load is supplied by the by-pass line.
8	**XFER MOD: RELAY**	CURRENT: Switches into bypass without delay when the load current is zero DELAY: If the EL-Inverter is not synchronized to the bypass voltage, switching to bypass is performed with a 15msec. delay.
9	**RELAY: DC LOW**	DC LOW or COMMON (The function of the relay is selectable).
10	**RL5: COMMON**	Alarms: COMMON, BATT. LOW, OUTPUT HIGH, OVERLOAD, LINE FAILURE, OVER TEMP. OVER CURRENT, OUTPUT LOW, BATTERY HIGH, BATT. FAULT, BY-PASS BAD, BOOST CHARGE, MANUEL BYP, ROT. PHASE, OUTP. OFF, EL-INVERTER FAILURE. RL5 relay can be defined for any desired alarm.
11	**<ENTER> EXIT**	→ Enter **(↵)** exit from submenu
	Go to MAIN MENU	

3.2.5 TIME Menu items

You can see date and time of RTC (real time clock) on EL-Inverter. And you can adjust date and time.

	Submenu item	**Function**
1	**TIME: 23 :15**	time
2	**DATE: 11-10-2001**	date
3	**SET HOURS: 11**	(+) and (-) adjust hours (0-23)
4	**SET MINS: 38**	(+) and (-) adjust minutes (0-59)
5	**SET DAY: 21**	(+) and (-) adjust day (1-31)
6	**SET MONTH: 06**	(+) and (-) adjust month (1-12)
7	**SET YEAR: 2001**	(+) and (-) adjust year (2000-2099)
8	**<ENTER> UPDATE**	→ Enter update new date and time
9	**<ENTER> EXIT**	→ Enter **(↵)** exit from submenu
	Go to MAIN MENU	

3.2.6 CALIBRATION Menu items

	Submenu item	**Function**
1	(Password required)	System adjustments.
	<ENTER> EXIT	→ Enter **(↵)** exit from submenu
	Go to MAIN MENU	

3.2.7 ADJUST MODE submenu

This menu is used to adjust time and date of the EL-Inverter operation.

	Submenu item	Function
1	(Password required)	System adjustments.
	<ENTER> EXIT	→ Enter **(↵)** exit from submenu
	Go to MAIN MENU	

3.2.8 INFORMATION Menu items

This menu gives information about the EL-Inverter operation.

	Submenu item	Function
1	**COMM: OK SYNC: OK**	If the EL-Inverter is operating in syncron to mains SYNC:OK ,if not syncron SYNC:-- If communication is active COMM:OK ,if not active COMM:--
2	**POWER: 5000 VA**	The maximum power rating of the EL-Inverter
3	**VERSION: Y11P-LT1**	Shows the EL-Inverter software version
4	**<ENTER> EXIT**	→ Enter **(↵)** exit from submenu
	Go to MAIN MENU	

3.3 STATUS Messages

This message group simply shows the EL-Inverter STATUS on the upper line of LCD PANEL.

RECTIFIER START: Rectifier is started.
ENTER START: Press ENTER to start the EL-Inverter.
INVERTER START: Inverter is started.
MAINT SWITCH ON: Maintenance bypass switch is on
STATUS NORMAL: EL-Inverter is operating normally.
EMERGENCY STOP: External emergency stop signal is applied to the EL-Inverter.
WAITING SYNC: Inverter started waiting for mains synchronization.
STATUS FAULT: Fault status

RECTIFIER START:
At start up the EL-Inverter controller board checks for input voltage, frequency, battery voltage for starting, if these parameters normal, it starts up.

INVERTER START:
If the inverter stops by any reason, controller board tries to restart the inverter. Each time the inverter is started, this message appears on first line of LCD PANEL

MAINT SW
SWITCH ON:
Maintenance bypass switch is connected from bypass input to the output of EL-Inverter directly. If the maintenance bypass switch is on (1 position) controller stops the inverter against any accidental short circuits be- tween mains voltage and inverter output. If the user turns off the maintenance bypass switch, inverter starts again.

EMERGENCY STOP:
If an external EPO switch is installed to system (connected to interface board), it is possible to stop all EL- Inverter parts (rectifier, static bypass, inverter, etc…). After pressing EPO switch the rectifier and inverter are turned off and the power to the critical load is turned off. To start again, turn off the ON/OFF switch and turn it on again.

FAULT STATUS:
In some cases, controller checks events but cannot find solutions, in this case controller decide to stop system, for restarting the user must turn off the ON/OFF switch and turn it on again.

3.4 SHUTDOWN Messages:

EL-100 series Emergency Lighting inverters can operate interactive with the operating system. You can send commands to the Inverter from operating system by using some software. EL-Inverter takes these commands and produces some messages listed below:

WAITING SHUTDOWN : Shutdown command is performed by the operating system and the Inverter is waiting for a certain delay for shutdown.
EL-INVERTER SHUTDOWN : EL-Inverter is in shutdown status
WAITING RESTART : EL-Inverter is shutdown but it is waiting for a certain delay for restart
PAR.SHUTDOWN : In parallel systems the other EL-Inverter sends shutdown command and it is in shutdown status.
CANCEL SHUTDOWN : Shutdown command is cancelled.

Only operating system or a PC computer can send these commands.
If the shutdown command is performed during line failure, the Inverter shutdowns and if the mains is okay it starts again automatically.

3.5 Fault Messages and Quick Troubleshooting

All alarms contained in the control software are listed in the following table.

ALARM	POSSIBLE CAUSE
A1 BYPASS FAILURE	Bypass system failure. Bypass elements may be faulty.
A2 INVERTER FAILURE	Inverter digital start system is failed. Call the service.
A3 3 OVERTEMP	Overtemperature in EL-Inverter repeated 3 times in the last 30 mins. 1) Check for air inlets and outlets for any blocking by dust etc. 2) Fan failure 3) Bad location 4) Check for Overload
A4 OUT FAILURE	Inverter output voltage is out of tolerance for 3 times in the last 30 min. Call the service.
A5 BATT AUT END	Batteries are completely discharged; wait for restoration of electric power input. This message occurs only during a line failure
A6 CHARGER FAULT	Rectifier could not produce DC bus voltage.
A7 BATTERY LOW	Battery voltage is low. 1) Inverter operation for a long time when line out 2) Charger system failure
A8 OUTPUT HIGH	Inverter output voltage is higher than the max. tolerated value. Inverter is stopped 1) Inverter failure
A9 OVERLOAD	EL-Inverter loaded more than 100% of nominal power rating.
A10 LINE FAILURE	Line failure. 1) Mains may be off. 2) Check all three input phases. 3) Check input fuses.
A11 HIGH TEMPER	Overtemperature. 1) Overload for inverter 2) Excessive ambient temperature. 3) Fan failure or dirty air inlets 4) Bad location (not enough ventilation)
A12 OVERCURRENT	Inverter output system failure 1) Internal overcurrent 2) Output short circuit. 3) Inverter failure. Call the service.
A13 OUTPUT LOW	Inverter output voltage is lower than the min tolerated value. Inverter is stopped.

ALARM	POSSIBLE CAUSE
A14 BATTERY HIGH	Battery voltage is higher than max. tolerated value. Rectifier fault, call the service.
A16 BYP INPUT BAD	During normal (inverter) operation sometimes you can see this message. During bypass if the bypass protection option is ON, and if the bypass source is out of tolerance, EL-Inverter turns off the static bypass for load protection. 2) Check the bypass fuse
A19 REPLACE BATT	Battery test aborted. And batteries are not OKAY EL-Inverter gives beep sound every 15 sec You can clear this message by pressing the ENTER key for 3 seconds. 1) Rectifier fault 2) Damaged battery cells 3) Poor battery connections
A20 BOOST CHARGE	Boost charge is active. At the end of the boost charging time EL-Inverter stops the boost charge. EL-Inverter gives beep sound every 15 sec during boost charge
A21 ROTATE PHASE	EL-Inverter input phases sequence is not correct 1) Turn off the EL-Inverter and rotate phase sequence 2) Turn on EL-Inverter again
A22 OUTPUT OFF	Output OFF alarm - No bypass or inverter output voltage at the output. - A fault may be in the output. Check the output components.
A23 MODE FAILURE	In parallel operation the slave device tries to operate as the same mode as the master device, If the modes are different this message will appear. Change the mode of the slave from USER OPTION MENU. Press ENTER button for 3 seconds after mode selection, then restart the Inverter.
A24 P.FAILURE 10	RS485 failure
A25 PAR. PSP FAIL	Power supply error in parallel controller board.
A26 4 CABLE FAIL	Master-Slave digital cable connection error.
A27 P.FAILURE 13	Parallel controller board failure.
A28 PLUG IN DIG.	Digital connection cable plug in failure
A31 DUBL EL-INVERTER NUMBER	Parallel Inverter numbers are the same. Change one of them
A40 CAN'T FIND PR	Parallel mode is selected but main controller could not find parallel control board. Select ONLINE mode from SETTING MENU. Turn off the ups and turn on again.
A41 P.BAL.FAILURE	In parallel operation current sharing is not okay
A42 BATTERY TEST	Performing battery test
A43 P.SYNC.FAIL	In parallel system SLAVE UPS is not synchronized to MASTER
A48 STATIC BYPS.	Load is transferred to static bypass.
A50 EMERGE. STOP	Emergency stop button is pressed.
A51 MAINT SW. ON	Maintenance bypass switch is ON.
A52 MANUAL BYPASS	The load is transferred to bypass manually.
A53 CHECK +6V	Check +6V on the supply main controller board.
A54 CHECK DC1	Battery voltage is below the lower limit.
A55 PDLY FAIL	Parallel delay fault
A59 REF FAILURE	2.5 V ADC reference voltage on the main controller board exceeds predefined tolerances.

IV. OPERATING INSTRUCTIONS

Introduction

The operating instructions will be considered in two parts:
1- CHANGEOVER MODE
2- INVERTER MODE

4.1 OPERATION INSTRUCTIONS FOR CHANGEOVER MODE

4.1.1 Power ON :

1. Battery switch must be off. (“0” position)
2. MBS (Maintenance by-pass) switch must be in “0” position.
3. Turn F2 into “1” position.
4. Turn F6 (Output) switch into “1” position.
5. Turn on ON/ OFF switch to “1” position. (The front panel will run)

WARNING: Energy will form at the output through the static by-pass.
RECTIF START message will appear on the front panel.

6. When START message appears on the front panel, turn F1 battery switch into “1” position.
7. Press enter button in the front panel, INVERTER START message will appear.

Inverter starts operating and static bypass input continues to supply the output.
The EL-Inverter is ready when STATUS NORMAL/CHANGEOVER MODE message appears on the front panel.

(NOTES: Make sure that “Changeover Mode” has been selected in the USER OPTIONS MENU)

4.1.2 Power OFF:

1. Turn F6 output switch into “0” position.
2. Turn F1 battery switch into “0” position.
3. Turn off ON/OFF switch into “0” position.
4. Turn F2 into “0” position.

4.1.3 OPERATION AND TEST OPTIONS OF THE UNIT IN THE CHANGEOVER MODE IN AN EMERGENCY LIGHTING SYSTEM

If the EL-Inverter is in “CHANGEOVER MODE” the output is supplied by incoming utility supply. In case of a failure in this supply, the output is connected to the static inverter output. This transfer operation is performed internally by the control logic of the Inverter.

The operation of the EL-Inverter can be controlled externally, through the terminals on the inner front panel of the unit. These terminals are located on the Emergency Lighting Controller Board (ELCO2-R1) shown below:

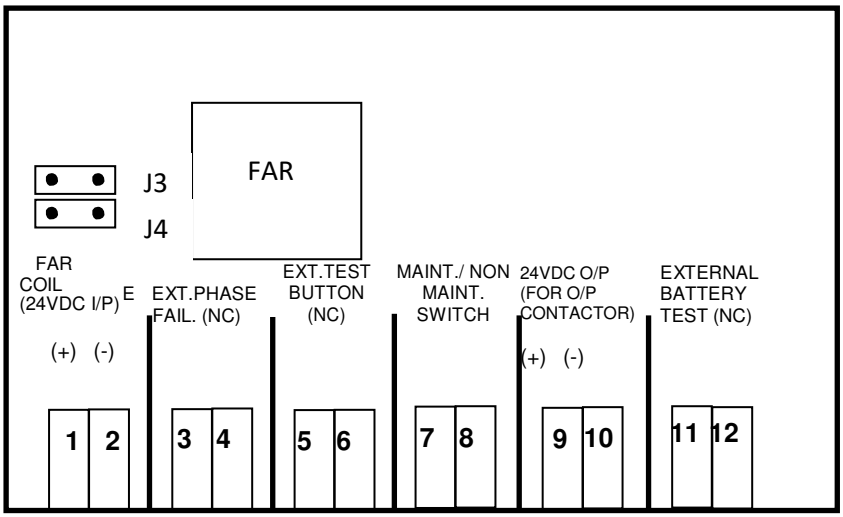

Fig 4.1 Emergency Lighting Inverter Control Board (ELC02-R1)

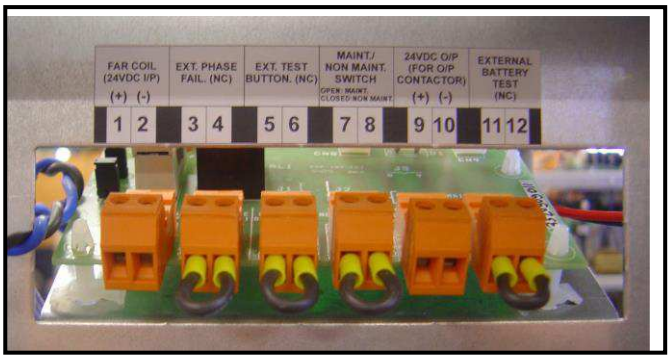

Figure 4.2 Control Terminals

1) Terminals 1 & 2:

A fire Alarm Relay (FAR), with a 24V DC coil is mounted on the ELC02-R1 board and its coil is connected via terminals 1 and 2, to the 24V DC control output of the remote Fire Alarm Panel. Under normal operating conditions this relay is energised and if the external 24V DC supply to terminals 1 and 2 is lost (in case of a fire alarm) the FAR will be de-energised by forcing the load on to the inverter and de- energising the none-maintained contactor , regardless of the position of the switch connected across terminals 7 and 8. That means under fire alarm conditions the load is turned on, anyway. FAR can be kept energised, for test purposes by inserting jumpers J3(-) and J4 (+) on the ELC02-R1 board.

2) Terminals 3 & 4:

An external phase failure device, via external phase fail terminals (Terminals "3" and "4" on the ELC02-R1 Board) can also be used to externally monitor a phase which is not supplying the machine. Terminals 3 and 4 should normally be kept shorted under normal operating conditions. When the external phase failure device opens these terminals, the output is switched to inverter.

3) Terminals 5 & 6:

A N/C momentary test button can be connected across the terminals "5" and "6" on the ELC02-R1 board , providing an immediate test that the system is working OK by forcing the load on to the inverter and de-energising the none-maintained contactor if fitted. (The NC contacts of the contactor should be used for connecting the load to the Inverter outputs.) The operation of the external test switch is indicated on the LCD with "A17 TEST EXT." Message.

4) Terminals 7 & 8:

Terminals 7 and 8 on the ELC02-R1 Board are for connection to an external switch so the end user can control the output of the system (i.e. the lights are on or off) if a NC none-maintained contactor is used in series with the Inverter output. For maintained operation this switch (connected across 7 and 8) should be "open" and for non-maintained operation it should be "closed".

If the EL-Inverter operates in MAINTAINED lighting mode, the emergency lighting equipment is al- ready energised and kept energised by the Inverter during a mains failure.

If the EL-Inverter operates in NONE-MAINTAINED mode, the emergency lighting equipment is energised only if there is a mains failure. For this operation, a NC DC-Contactor (None-Maintained Contactor) should be used in series with the output of the EL-Inverter.

Even if this switch is closed for non-maintained operation, the non-maintained contactor is deenergised and the lights are turned on in case of power failure.

5) Terminals 9 & 10:

The none maintained contactor mentioned above should have a coil voltage of 24V DC, and this voltage is available across the terminals 9 and 10 on the ELC02-R1 Board (max 3 Amps).

6) Terminals 11 & 12:

Terminals 11 and 12 on the ELC02-R1 Board are for connection to an external battery test switch so the end user can control the batteries of the system (i.e. batteries are empty or charged) by external battery test option.

7) There are also two more test options (TEST1 and TEST2) which can be performed using the buttons on the LCD panel.

a) TEST1:

- Choose and enter the COMMAND menu on the LCD panel.
- Choose "ENTER" TEST1 and press ENTER button. In this case the load is transferred to inverter and the Inverter stays in this position for a fixed period of time (Approx. 8 seconds) and then transferred back to utility supply (normal changeover mode) Each time the ENTER button is pressed this test is repeated.

b) TEST2:

- Choose "ENTER" TEST2 in the COMMAND Menu,
- And press the ENTER Button.

In this case, a line failure is simulated for test purposes (autonomy test). In other words, the rectifier is turned off and the load is transferred to inverter, with batteries supplying the system. This test will go on until you press the ENTER button again, when you see" ENTER" TEST END on the first line of LCD. This process is indicated on the panel by A20 TEST2. Test 2 is reset automatically if a BAT AUT END (Battery autonomy end) alarm is produced.

4.2 OPERATING INSTRUCTIONS FOR "INVERTER" MODE

Follow the same procedure given in section 3.1.1, only make sure that the "INVERTER Mode" has been selected in USER OPTIONS menu.

MODE SELECTION:

Using the UP-DOWN buttons on the front panel, select "USER OPTIONS MENU" on LCD and press " ENTER" When you see "MODE" display select either "CHANGEOVER" or "INVERTER" mode using (+) and (-) buttons.

After selecting the desired operation mode, press "ENTER" until you hear the beep sound.

Turn off the EL-Inverter and after a few seconds, turn it on again. Now the unit will start operating in the selected mode.

V. MAINTENANCE

WARNING DO NOT OPEN the cover of the EL-Inverter because there is no part that can be maintained by the user. DO NOT TOUCH battery leads. There is high voltage even if the EL-Inverter is off. Therefore no one should open the cover of the EL-Inverter except the service personnel. Otherwise, serious injuries may occur.

5.1 Scheduled Maintenance

Some semiconductor devices inside the EL-Inverter do not require any maintenance. Only cooling fans are moving parts. If the environment is clean and cool enough, the planned maintenance program will be at minimum level. Even though, periodic check and maintenance based on a well-prepared documents (a good guide) will increase the performance of the EL-Inverter and prevent some small faults (errors) to become unhandlable ones.
The equipment was designed to require little amount of maintenance numbers. The user should do the following instructions.

5.2 Daily checks

Check the EL-Inverter every day and be careful about the following:

1. Check the operator control panel. Verify that all LEDs and parameter measurements are normal and there is no alarm message on the indicator panel.
2. Check if the device is overheated.
3. Check the cooling fans' rotations.
4. Check if there is any change in the equipment's noise level.
5. Check if there is any stoppage on the ventilation path. If so, clean the dust using a vacuum cleaner.
6. Make sure that there is nothing placed on the EL-Inverter.

5.3 Weekly checks

1. Record the results on the indicator panel.
2. Measure and record voltages on each phase.
3. Measure and record currents on the output of the EL-Inverter.
4. Check battery status by performing a manual battery test. Use a dry humid gland to clean the cover of the EL-Inverter.

Record the observations if possible. Check if there is any difference with the previous records (observations). If the last recorded values are significantly different from previous records, please check If the load has been changed, and if so, please record the type, size, and position of this load. This information will be very valuable in helping the service personnel in determining any probable errors.
If there is a significant change in the parameter values without any reason, please immediately call the qualified service personnel.

5.4 Annual maintenance

To get reliable and efficient performance from the EL-Inverter, please call the qualified service personnel once a year.

5.5 EL-Inverter Storage and transportation

1. Check the batteries charge by performing manual battery test before storage. If the charge is not enough then charge the batteries at least for 12 hours.

2. Qualified service personnel should disconnect the connections.

3. Batteries should be charged every six months during storage period.

4. Keep the EL-Inverter and batteries in dry and cool place.
EL-Inverter ideal storage temp.: 0 ^{0}C ~ 40 ^{0}C max.
Battery ideal storage temp.: 10 ^{0}C ~ 35 ^{0}C max.

5. The EL-Inverter must be placed on a suitable palette for transportation purposes.

VI. FAULTS AND TROUBLESHOOTING

6.1 General procedure for fault checking and troubleshooting

EL-Inverter contains complicated electronic control circuits. In order to locate any fault occurring circuits, an advanced knowledge about the circuitry and its operation principles must be known. The aim of this section is to give the knowledge required at the first intervention.

There is no practical way to locate any possible fault. Most of the faults do not occur as a performance decrement. Generally, the EL-Inverter operates normally or switches into by-pass mode. But in order to determine any change in load or the system the parameters must be recorded regularly as mentioned previously.

Generally, the output voltage can deviate 2% from the predefined values. If values differ more than this percentage then reasons must be investigated.

The following general structure must be systematically followed while trying to indicate the error:

Fault determination: First step is to record the messages, indicator panel LEDs, operating parameter values and last status of switches. This must be done before attempting to press any button.

Fixing interventions: After recording all indications, check the meaning of the fault and alarm messages using “The operator control indicator panel”. If anything related, follow the related procedure.

Reporting the fault: Service personnel must clearly report the work done. Hence, if any other error occurs there will be enough information to fix it.

VII. EL-INVERTER's REMOTE CONTROL CONNECTION

Following external connections are available in EL-100 series

Communication By serial port connection
Dry contacts (interface board) connection.

7.1 Using Serial Port

A standard Serial communication port is installed to all EL-100 series UPS, by using this port user can take all information about UPS. All measured parameters, alarms can be monitored by this port. This port is interactive and some commands for UPS operation are available. These commands are listed below:

- Switch to BYPASS
- Switch to INVERTER SOUND on/off
- Adjust time and date
- Start SIMULATION mode
- Quick BATTERY TEST
- BATTERY TEST until battery low alarm
- CANCEL battery test
- Turn off EL-Inverter output voltage immediately (SHUTDOWN)
- Turn off EL-Inverter output voltage after delay (WAITING SHUTDOWN)
- Turn off EL-Inverter output voltage (SHUTDOWN) and turn on EL-Inverter output voltage (WAITING RESTART)
- CANCEL SHUTDOWN
- RENAME EL-Inverter

Special software is required to use the serial port. Some of the commands above are special functions. These can be used only with TMON software.

7.2 The external communication and alarm relay connections are shown below:

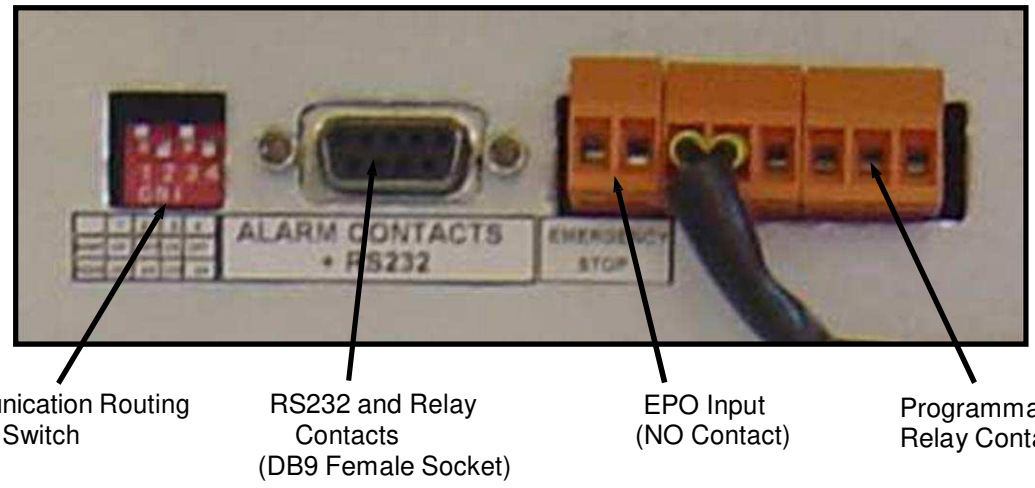

Figure 7.

7.2.1 Communication Routing Switch:

RS232 Communication of the EL-Inverter can be routed either to an internal (e.g ML100 port multiplexer, MD1 MODBUS adapter, SNMP unit etc.) or to an external device.

There are two sets of DIP switch positions:

	1	2	3	4
INTERNAL (e.g. SNMP)	ON	OFF	ON	OFF
RS232 (EXTERNAL)	OFF	ON	OFF	ON

In “RS232” position of DIP switches, RS232 communication with an external device is performed through the standard DB9 socket shown above. If DIP switches are in “INTERNAL” position, communication through the standard socket is turned off and routed to an internally connected device. For example, if an ML100 Port Multiplexer has been installed in the EL-Inverter, standard DB9 socket is not used for RS232 communication, instead, the two ports, COM1 and COM2 on the ML100 can be used for external communication simultaneously.

7.2.2 The pin configuration of the standard DB9 socket is as follows:

Pin no.	Function
1	Not Connected
2	Line Failure Alarm Relay Contact (N0)
3	Not Connected
4	Common Contact for all Alarm Relays (C)
5	Battery Low Alarm Relay Contact (N0)
6	RXD (RS232)
7	Signal Ground
8	Bypass Alarm Relay Contact (N0)
9	TXD (RS232)

7.2.3 Emergency Power off (EPO) input:

This is a contact input and EPO is activated when the contacts of this input are short-circuited by an external EPO switch.

7.3 Serial port connection cable

RS485 cables connections are as follows:

EL-Inverter Side	Panel Side
9 Tx	2 Rx
7 Gnd	5 Gnd
6 Rx	3 Tx

7.4 Remote control/connection with a modem

The EL-Inverter can be connected to a phone line using its RS232 port and a modem. The operator connects to the EL-Inverter by a computer containing TMON program and a modem. By this way a modem can be monitored using a telephone line.

7.4.1 Hardware Configuration

All requirements for modem connection are as follows:
PC with modem
WINDOWS 98
Available EL-Inverter control software
DUMP modem which is connected to EL-Inverter

The EL-Inverter has AT command set to switch the DUMP modem into auto – answer mode. To perform this process, go to COMMAND MENU and then go to ENTER: MODEM INIT subitem and press enter button for 3 seconds after installing the hardware. A short warning beep will be heard after pressing the button. Modem's RX and TX LEDs will start operating. Then, the modem will be configured to answer incoming calls. To test this, calls the phone number connected to the modem and hear modem's voice.

7.4.2 Functioning Principle

The remote operator, by means of a PC and a modem device and using the remote connection function of the control software, calls the EL-Inverter through the number to which this is connected.
The dumb modem device, connected to the EL-Inverter, will answer the call and convert the data coming from EL-Inverter serial on the telephone line. This way all measures and controls allowed by the RS232 serial port can be carried out.

7.4.3 Modem programming procedure

Smart modem (SM) is the one connected to PC, and (DUMB) DM is the one connected to the EL-Inverter. Standard Hayes AT programming language is the suitable language for modems. In applications a modem which uses AT command set must be selected.

The NULL modem connected to the EL-Inverter by connecting to a PC should be programmed, Connect the null modem to the PC's modem using a standard modem connection cable, then run Hyperterminal program and send AT commend group to the modem, the AT command set used in configuration is given in the following table:

AT Command	**Description**
ATS0=1	Modem will auto-answer after one ring.
AT&K0	Flow control disable in some modem models (Check for equivalents in other types)
AT&D0	DTR signal usage.
AT&Y0	Load 0^{th} setting values at the modem start.
Speed configuration string	**Look for speed configuration table (Below)**
AT&W0	Save the values in table as 0^{th} setting.

Different modem models can use different command sets. Below communication speed configuration of some modem models are given. Select the one suitable for your mode, if your modem's model is not listed then try each command one by one. If your modem supports the command you will receive <OK> answer from the NULL modem in the hyperterminal, otherwise you will get <ERROR>

Speed configuration table	
Modem model	**Speed configuration string**
US ROBOTICS sportster voice	AT&N3
APACHE AE56SP-R	ATN0S37=6
BOCAMODEM V.32 BIS	ATN0S37=6

The configuration flow in Hyperteminal will be as follows:

ATS0=1 <enter>
OK answer from the modem
AT&K0 <enter>
OK answer from the modem
AT&D0 <enter>
OK answer from the modem
AT&Y0 <enter>
OK answer from the modem
AT&N3 <enter> (US ROBOTICS ICIN) OK answer from the modem
AT&W0 <enter>
OK answer from the modem

7.4.3.1 Smart Modem (SM) configuration (programming)

Smart modem will configure itself from the program when using TMON. The default settings are as follows:

B0 E1 F1 M1 Q0 V1 X3
BAUD = 2400 PARITY = N WORDLEN = 8
DIAL = PULSE (TONE which can be programmed)

&A3 &B1 &C1 &D0 &H1 &I0 &K1 &M4
&N0 &R2 &S0 &T5 &Y1

This configuration is done by TMON program.

7.4.4 Modem connection cables

A standard modem connection cable is used to connect SM to a PC. This cable is required if an external modem is used, but instead if an internal modem is used then no need for this cable.

The connection cable between the EL-Inverter and DM must as follows:

EL-Inverter DB9 Pin	MODEM DB25 Male
6	3
7	7
9	2

7.5 EL-INVERTER Remote monitoring panel connection

Remote monitoring panel is used to monitor the EL-Inverter from 400m distance. This panel is installed to control/monitor room. If the distance is less than 25m then RS232 cable is used, and RS485 for larger distances. Additional adaptor is required for RS485.

The remote monitoring panel transfers the data to the user from the EL-Inverter. The remote monitoring panel requires 230Vac 50 Hz AC voltages to operate, and it is better to use the output of the EL-Inverter as a power supply.