

EBBETT

INVERTER

OWNERS MANUAL

Section 1:

SCOPE

The scope of the hand book is to provide the user with sufficient information to be able to engineer and carry out the installation of an Ebbett Inverter in such a way as to be able to maximise the features and benefits of the unit, and achieve a convenient and reliable power supply system within the battery charging capability. Sufficient information is also provided to establish the origin of any problems with the system, or faults with a unit, and refer back to the seller for repair or replacement.

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Section 3:

THEORY OF OPERATION

Power supplied by the utility company is usually 230 (115) volts, in the form of a current, alternating sinusoidally at 50 (60) Hz.

In order to produce similar power, the basic "static inverter" electronically "chops" the direct current (DC) of a battery, into a current alternating in polarity (AC) at the rate of 50-60 cycles per second (50-60 Hz), and feeds this current into a step-up transformer which produces the high output voltage. However, output is in the form of a square-wave, of uncontrolled output voltage, that would vary drastically with load and battery condition, and be too crude for most applications.

In the Ebbett Inverter, output voltage and waveform is controlled by turning the power devices on for varying lengths of time during every conduction half-cycle. This technique is called pulse-width modulation (PWM). In sine-wave models the length of each pulse in a series, is varied throughout the cycle, and the resultant output current when filtered, appears very close to the normal mains supply. Step square-wave models use fewer pulses, in steps. This allows higher efficiency. Special digital phase-correction techniques are used to ensure sinusoidal currents flow in inductive loads. In all models output voltage is controlled to tolerances even closer than normal mains, under all circumstances.

The inverter/battery combination represents what is called a "current-limited" source of power:

- The battery by way of its inherent discharge curve characteristic and internal resistance, loses terminal voltage as output load is increased. This limits the amount of current that can be drawn by the inverter.
- The inverter is designed so that as nameplate-load is exceeded, output voltage is reduced, and current limited to safe levels. Also, as semiconductor temperature rises, current-limiting is biased towards further reduction.

Overall performance and load-handling ability is therefore determined primarily by battery condition, and secondly by inverter temperature.

Despite changing conditions, the electronic logic of the unit monitors, adjusts, and continues to maintain output to specification. When control limits are reached, it activates one or more of its many protection circuits, and locks out until reset.

The biggest difference between "mains" and "inverter" is the current limit. The mains can take short surges of thousands of amps. The inverter system can't. When you short-circuit the mains, you blow a fuse. When you short-circuit the inverter, it shuts down.

Read the directions. Check the specifications.

Section 4:

LOAD RATING

(1) Battery

Automotive batteries are now rated by a "Reserve Capacity" rating which is defined as the time in minutes a new fully-charged battery can deliver 25 amps continuously before the voltage falls to a specified end point. Most manufacturers specify 1.68 to 1.7 volts per cell (10.08 to 10.2 battery volts) and the low voltage trip of the inverter is factory-set to this. For a battery with "Reserve Capacity of 90 minutes", an inverter drawing 25 amps would sustain load for 90 minutes. If the battery was charged at the same time by a 40 amp alternator, then the load discharge would be less than the charging capability, and the battery would last indefinitely.

Other types of battery are rated in ampere-hours capacity (AH) at given discharge rates.

For example, specification curves show a battery to have a capacity of 40 AH if discharged at the rate of 10 amps.

The battery will last for, 40 AH divided by 10 amps = 4 Hours

To establish the battery current drawn by an inverter on a given load, the rough rule of thumb is:-

(12 volt system); inverter output load + 10 = battery amps

(24 volt system); inverter output load + 20 = battery amps

For example, a 12 volt inverter running on 100VA (Watt) television.

$$100VA + 10 = \underline{10 \text{ amps battery current}}$$

Therefore for a combination of 12v inverter, on the 40AH battery, running the 100VA TV, the battery would last for 4 hours.

In marine and automotive systems, operation of an electric starter motor requires a battery almost fully charged. It is important therefore, that either the inverter be powered by an auxiliary battery not required for essential use such as motor starting, or that it be run only while an alternator of sufficient current is charging the battery.

The life of automotive batteries is limited by low discharge, and specially-designed marine, industrial standby, and deep-cycle batteries are available from most manufacturers.

The inverter continually monitors battery voltage under load; so overall system operation depends primarily on the battery's ability to maintain terminal voltage while supplying current.

A good battery is essential.

In practice it will be observed that the inverter will trip on "Low Battery" for say full load, but if reset, will continue to run for some hours on a light load. Conversely, a load increase after it has been running for some time on a light load, may be sufficient to drop the terminal voltage and actuate "Low Battery Trip".

In the event of accidental reverse polarity connection or other fault, the battery must be capable of supplying sufficient current to trip circuit breakers instantaneously; otherwise, heating, explosion, or serious damage to battery and inverter, may occur.

As a general rule, at least twice the name-plate-maximum of the inverter, is sufficient.

(2) Inverter

The maximum rating for the inverter is a 30 min maximum (plus allowance for surges), such as would be required to run a typical appliance.

I.e. a 400VA inverter will run a power tool rated at 400VA, with start surges from 500 to 1000VA.

A continuous rating (24 hr at battery float voltage) is determined by long term thermal build up. At 20 deg C, and without fan cooling, this rating will be approx 50% of the nameplate maximum. Performance curves for specific models show details.

If cycled on heavier loads it will be observed that temperature compensation in protection circuits, and thermal trip, reduce the inverter's ability to handle surges.

Make sure the inverter will be large enough for your load surges.

This is especially important for induction motors (fridges, pumps, etc) which typically require 4-6 times run-current, on start-up.

Section 5:

OPERATION

On-Off-Reset:

No power is used until the switch is operated. The switch turns on the electronic controller, which in turn, powers up the main semi-conductors to provide an output. On start up, the unit ramps-up to provide a "soft start" to external loads. Appliances can then be plugged-in, started, and stopped at whim. Resetting of the fault-latches is achieved by the following procedure: (a) Turn off. (b) Pause. (c) Turn on again. A remote switch option is available. Fault-reset is also achieved by disconnection of the battery supply.

If the MCB or battery disconnection is used, the required pause is approximately 30 seconds. Reset using the remote switch option is instantaneous.

Power On:

When the Inverter is switched on, the two "Power On" lights indicate that the electronic output-drivers are functioning. Both must be lit to the same intensity for correct operation.

Overload:

Multi-function Indicator of all solid state load-monitoring protection circuits.

- (1) Maximum Current: Factory set at 100% of name plate load. As the current is limited, output voltage is reduced. Current-limiting and spike-suppression circuits accept overloads, but in general, the unit will trip on any load with start surges (motors etc.) in excess of 250% of name plate rating.
- (2) Thermal Protection: Electronic monitoring of heat-sink temperatures reduces the current limit as temperature rises. Long term rating is limited primarily by thermal rise of the transformers. A temperature sensor in the windings shuts the inverter down, and is reset by turning the inverter off and on again. After a thermal trip, the inverter cannot be restarted until it has cooled sufficiently.
- (3) Output Voltage Monitor: The unit continually monitors its own output. From start up, a minimum voltage of at least 195-205 (97-103) volts must be detected or lockout will occur.

During normal operation, should the output voltage drop as a result of overload, component failure etc, lockout will occur. Allowance is made for brief overloads during motor starting.

The output monitor remains active even when "Low Battery" has tripped, so any "Low Battery" lockout is always immediately followed by an "Overload" lockout 3-5 seconds later.

Low Battery:

Primarily employed to protect the inverter. Factory-set to suit the minimum battery voltage requirements of an automotive lead acid battery under light load. (12v set 10v, 24v set 20v).

Under normal operation then, the two "Power On" lights will operate. If a fault occurs, they will extinguish. If overloaded, the "Overload Trip" alone will operate. If the battery is flat, both "Battery Low" and "Overload Trip" lights will operate.

Section 6:

INSTALLATION

Unpack, and examine for any signs of in-transit damage due to impact, vibration or moisture. Select a dry, well ventilated place, and position the unit, preferably vertically.

Before connection note warnings and special notes section 7.

Portable Unit:

Supplied as standard. With multi-purpose inverters, merely clip leads onto correct battery polarity and turn on (red positive, black negative). Rubber feet are fitted to the base for free standing use.

Permanent Installation:

Large inverters are not supplied with clip leads. This is because they require very high currents to trip protection circuits and it is desirable to reduce the possibility of incorrect connection (Ref Battery Section 4:1). The unit can be wall-mounted by using the four holes provided in the back plate. These holes are threaded to enable fastening by way of 6mm metric bolts from the rear, or by removing the cover and using 8 gauge x 1 inch wood or PK screws from the front. A 5mm spacer should be used behind the cabinet. The recommended method is to use standard aluminium mounting straps, purchased as an option and screwed to the rear of the cabinet first.

All permanent installations should have a circuit breaker or fuse and battery isolator to avoid the risk of fire, in the unlikely event of component failure. The small portable inverter models require the addition of this equipment externally. All models above 400VA do not, as they come fitted with an electromechanical circuit-breaker fitted in the front panel.

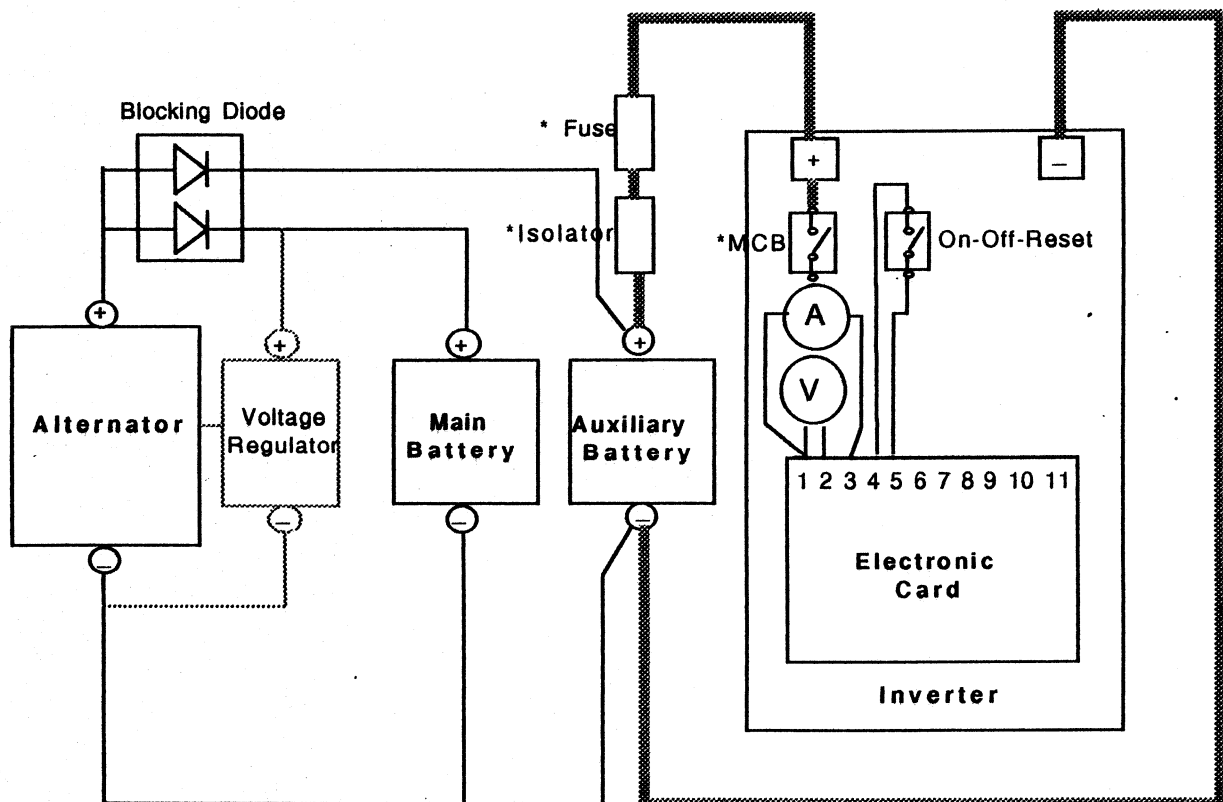
Remote on-off-reset can be installed by removal of the existing wires from terminals 4 and 5 of the electronic card, and substitution of a normally-open contact switch (100 milliamps).

Optional ammeter and voltmeter are connected as shown.

Do not disconnect other wires, serious damage to the inverter may result and invalidate the guarantee.

The suggested automotive or marine installation uses an auxiliary battery and blocking diode. The auxiliary battery is automatically charged with the main battery, but can be flattened without affecting the essential power source. Battery lead length must be as short as possible and no longer than one and a half times that supplied. (Volt drop causes "Low Battery" to trip early). Alternatively, up to three twin metres of 266/0.3 mm cable can be used, but a separate low-current control wire must be run from the battery positive terminal to terminal 2 of the electronic control card. However any increase in lead length will compromise performance, especially on surge loads. Longer leads are not recommended on larger 12v inverters.

RECOMMENDED BATTERY CONNECTION - AUTOMOTIVE/MARINE INSTALLATION



***Note: External fuse and isolator not required on models with built-in MCB**

In some installations the inverter may have to be ordered with an optional extra input filter if it is to share a common battery with other measurement or communications equipment sensitive to HF ripple. This is not normally the case with most domestic, automotive or marine installations, but care must always be taken to ensure the inverter or cabling is at least 1 metre away from aerials or other radio equipment. If this distance cannot be achieved, battery cables may have to be screened or installed in an earthed metal trucking.

For Telecom Installation of 48V Special Models.

- An extra input filter is fitted.
- Input cables should be as short as possible, less than 0.2 ohm & screened or ducted away from communication cables.
- Output cables should be screened if load is a non-linear, pulse-current load (personal computer etc) in a sensitive communications environment.
- Floating output may be best connected to MEN neutral system for safety. (otherwise remains as an isolating transformer).
- Case & one battery terminal should be earthed.

Section 7:

WARNING AND SPECIAL NOTES

- * - The inverter is a high voltage apparatus that must be used in accordance with local electrical wiring regulations and treated with the same respect as other 230V (115V) appliances.
- * - Under no circumstances should the front cover be removed while the inverter is connected to the battery.
Turn inverter on, then off, after disconnection from the battery, to dissipate dangerous charges retained in capacitors.
- * - The inverter must be connected, only to the specified battery voltage. Connection to a higher voltage can cause serious damage to electronic components and invalidate the warranty.
- * - Ensure the battery is of sufficient size to supply maximum inverter current.
- * - Ensure correct polarity battery-connection. Incorrect connection of models without protection will cause battery or inverter damage and invalidate the warranty.
- * - Turn the inverter off while connecting and disconnecting to avoid sparking and minimise risk of explosion of hydrogen gas from battery.
- * - Ventilation is required for cooling. Also, house the unit in a separate compartment from batteries, to avoid risk of a hydrogen explosion.
- * - Keep battery leads as short as possible.
- * - Battery should be floated from earth in marine installations to avoid electrolysis problems with the hull.

Detection devices are built into the design to tell us if any failure is a result of abuse that would invalidate the warranty.

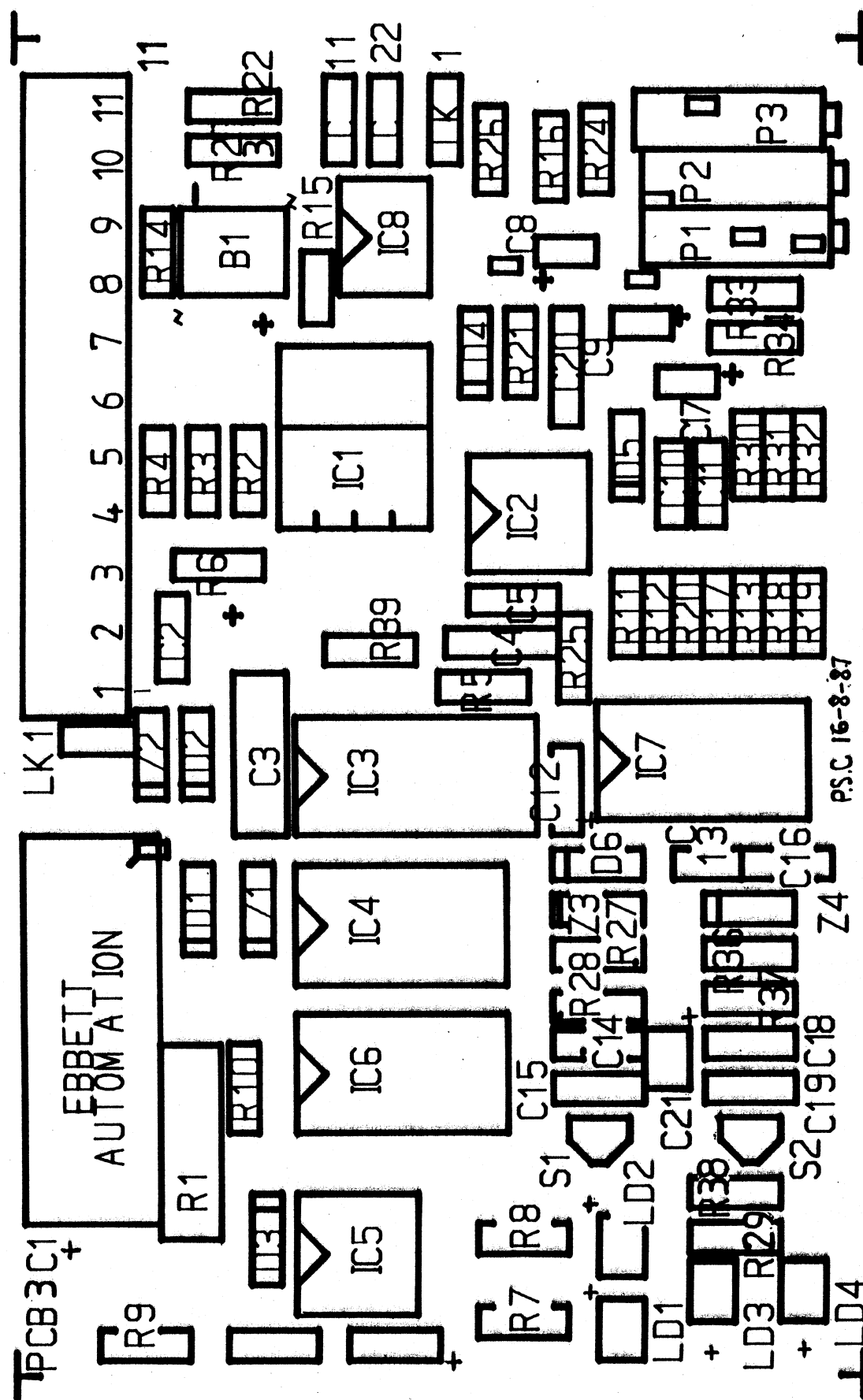
Section 8(1):

ADJUSTMENTS

All on electronic control card, are factory-set, and should require no field adjustment.

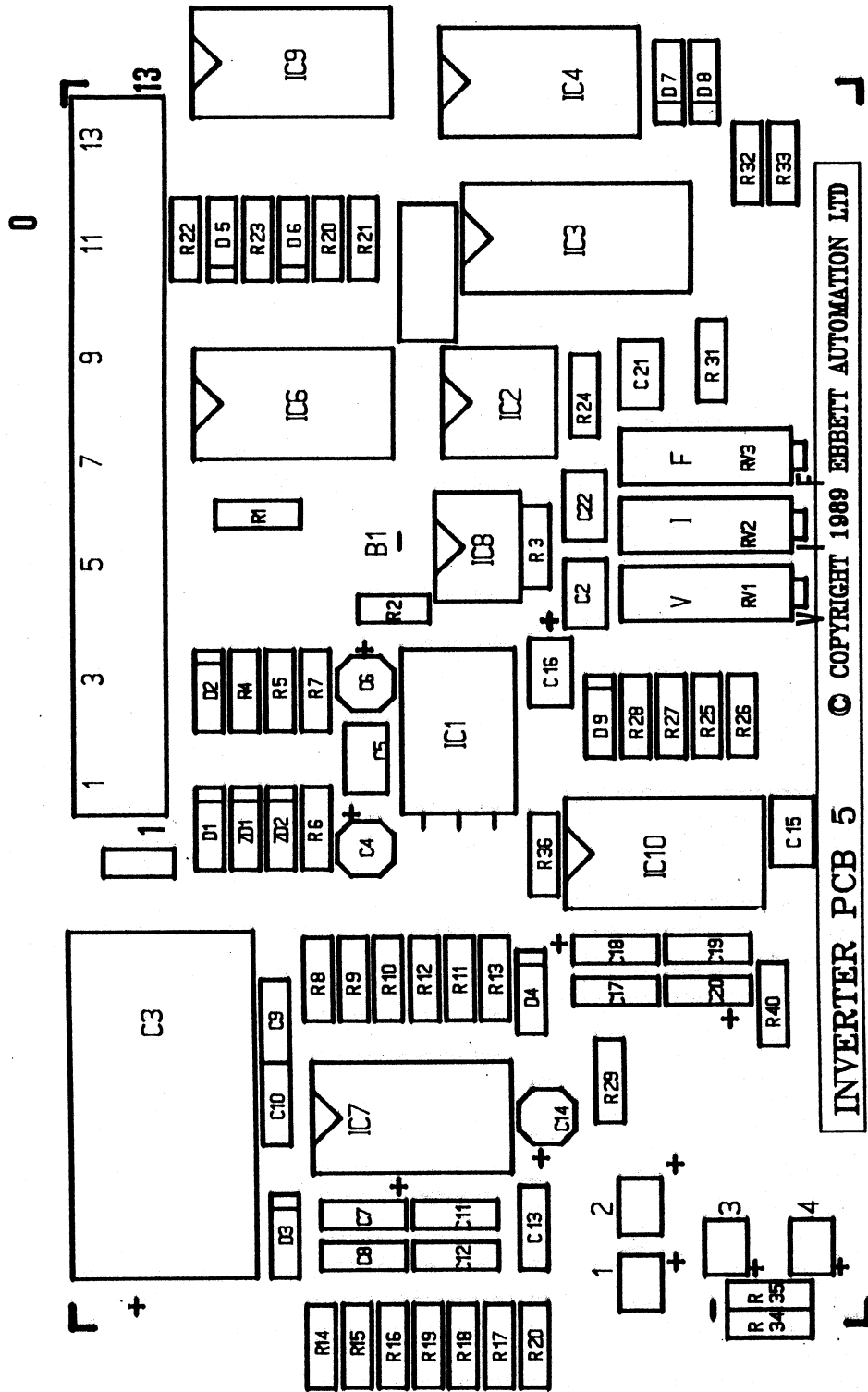
P1 - Output Voltage	-	Factory set 230 (115) volts.
P2 - Maximum Current	-	Factory set 100 percent, must not be altered. Breaking of seal will render warranty invalid.
P3 - Frequency	-	Factory set 50 (60) Hz.

NOTE - Comparisons of voltage and current using standard multimeters are only valid on perfect sine-wave Inverter models.
For precise measurements on other models, true RMS-reading meters must be used.



Section 8(2b):

ELECTRONIC CONTROL CARD LAYOUT - PCB5



INVERTER PCB 5 © COPYRIGHT 1989 EBBETT AUTOMATION LTD

Section 9:

FAULT FINDING CHART

<u>Problem</u>	<u>Cause</u>	<u>Remedy</u>
(1) Output failure; no indicator lights.	No battery connection.	Clean, reclamp terminals.
	Circuit breaker turned off.	Operate upwards for "on".
	Circuit breaker faulty.	Refer seller, repair / replacement.
	On-off switch (if fitted) turned off.	Operate switch.
	Battery connected reverse polarity (small inverter).	Connect correctly.
	Remote switch (if installed) not turned on.	Operate switch.
	Remote option terminals 4-5 not linked.	Connect link.
	Electronics failure.	Refer seller, repair/replacement.
(2) Output failure; circuit-breaker trips immediately.	Battery connected reverse polarity.	Correct connection.
	Electronics failure.	Refer seller, repair/replacement.
(3) Low battery lockout (followed by overload lockout); (a) - Immediately.	Power-supply not reset.	Turn off, wait 30 secs, turn on again.
	Faulty battery connection.	Clean, reclamp terminals.
	Battery dead-flat or faulty.	Recharge/replace battery.
	Battery discharged.	Recharge battery.
	Load too great for battery condition.	Recharge or replace battery.
	Battery too small.	Replace with larger battery.
	Battery affected by another surge load (eg starter motor).	Install auxiliary battery / blocking diode arrangement for inverter.
(4) Overload lockout; (a) - Immediately.	Power-supply not reset.	Turn off, wait 30 secs, turn on again.
	Unit overheated.	Reset, when cooled down
	Electronics failure.	Refer seller, repair/replacement.
	Load short-circuited.	Disconnect load, repair fault.
	Load too heavy.	Reduce load, or obtain larger unit.
	Electronics failure.	Refer seller repair/replacement.
(b) - after 3-5 secs.		
(5) Unit making abnormal audible noise or power-on lights not lit to same intensity. repair/replacement.	Electronics failure.	Turn off, refer seller

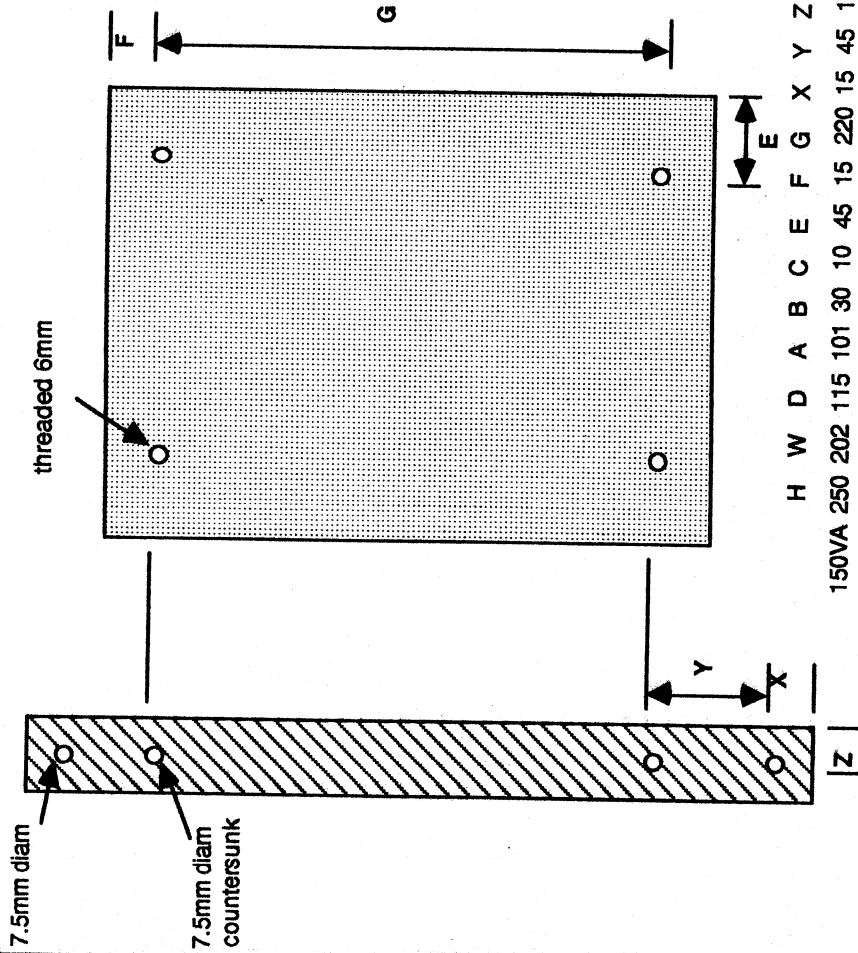
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EBBETT INVERTER

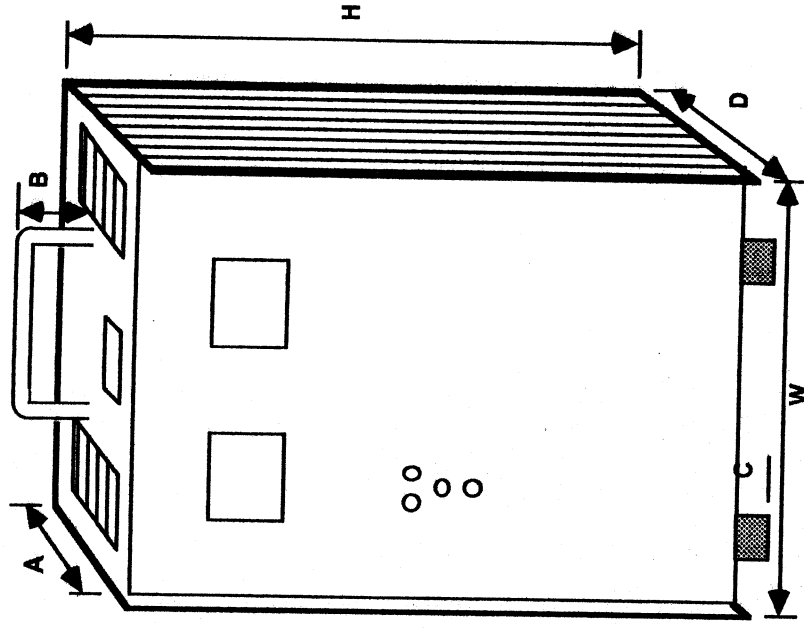
Mounting Strap

(2 off aluminium strap 40x4mm)

Rear Mounting



	H	W	D	A	B	C	E	F	G	X	Y	Z
150VA	250	202	115	101	30	10	45	15	220	15	45	19
400VA	293	214	115	101	30	10	50	25	240	15	55	19
800VA	313	256	122	116	30	10	50	25	260	15	55	19
1500VA	353	345	155	145	30	10	75	25	300	15	55	19
3000VA	353	345	200	189	30	10	75	25	300	15	55	19

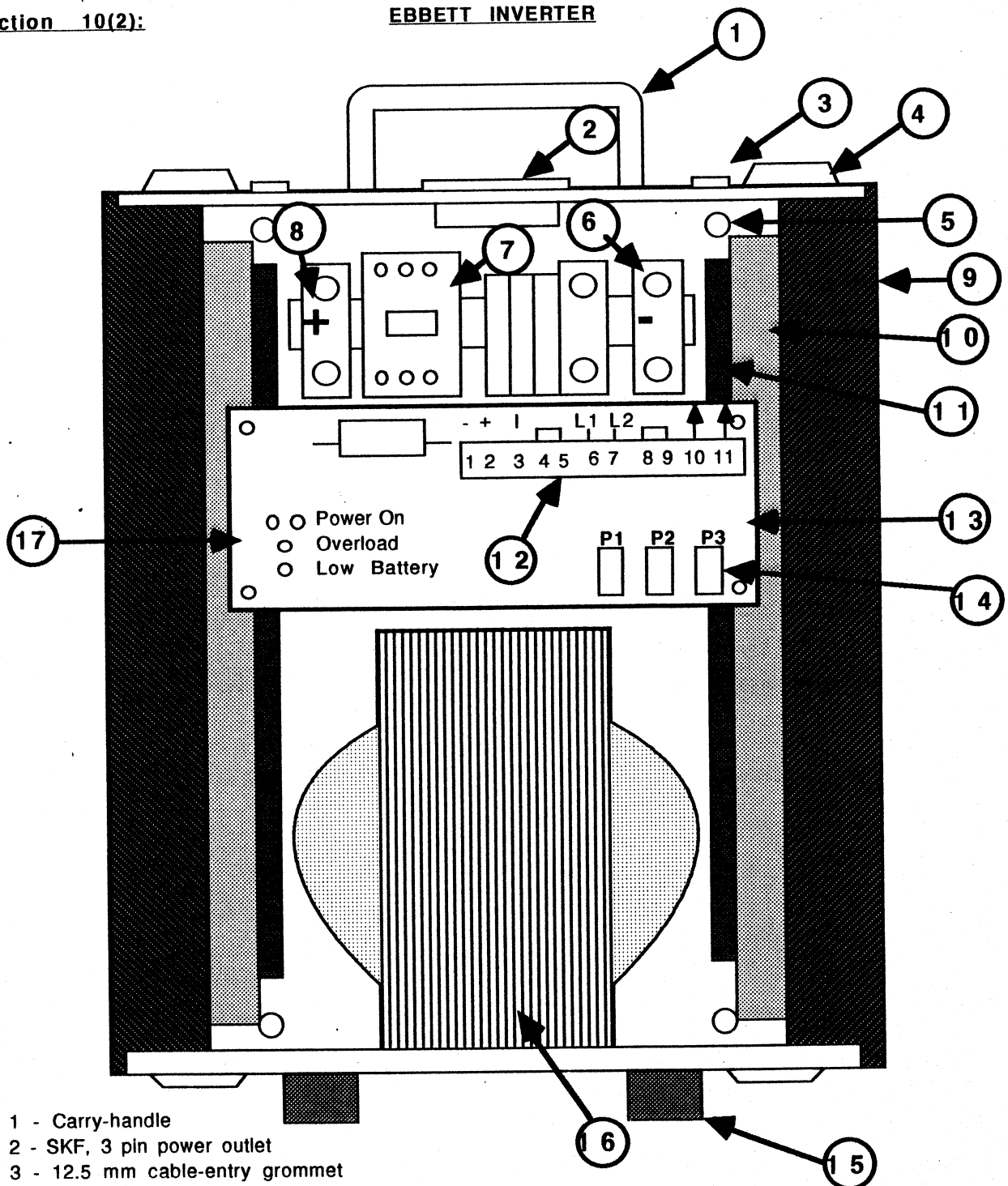


TITLE: Inverter mounting & dimensions

SCALE: Not to scale

DRAWN BY: GAE

DATE: 17/12/97



- 1 - Carry-handle
- 2 - SKF, 3 pin power outlet
- 3 - 12.5 mm cable-entry grommet
- 4 - Air-flow louvre
- 5 - 6mm mounting hole
- 6 - TM1, battery negative terminal
- 7 - MCB, battery circuit breaker (on/off)
- 8 - TM1, battery positive terminal
- 9 - Heat-sink
- 10- Power transistor mounting bracket
- 11- Power circuit board
- 12- Remote on/off option link
- 13- PCB, control circuit board
- 14- Adjustment potentiometers
- 15- Rubber foot
- 16- INV, power transformer
- 17- Indicator LEDs

TITLE: Physical Layout

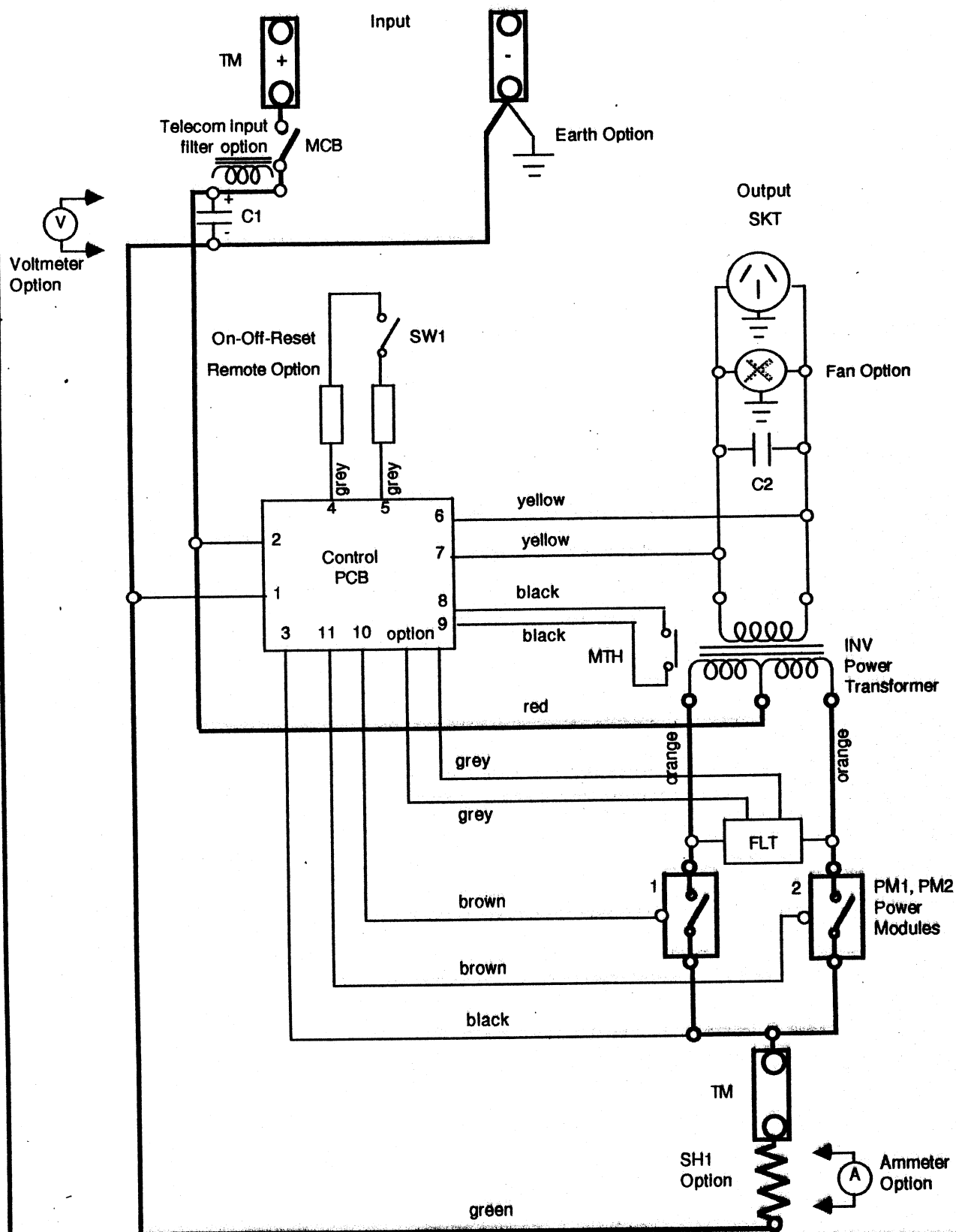
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Section 11:

EBBETT INVERTER



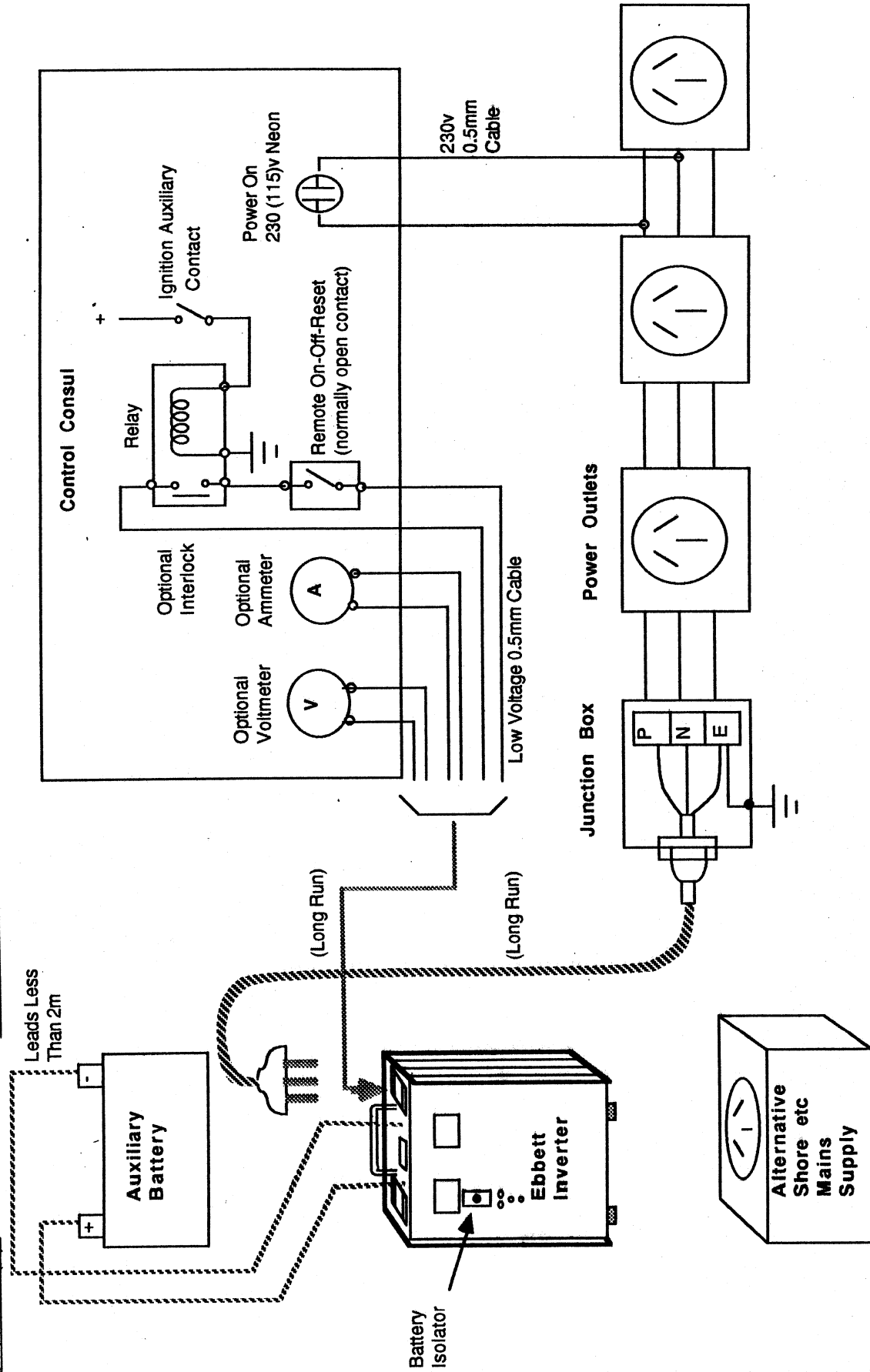
TITLE: Electrical Schematic

SCALE: Not to scale

DRAWN BY: GAE

DATE: 10/6/94

Section 12(1): **AUTOMOTIVE OR MARINE SYSTEM - SUGGESTED EXTERNAL ELECTRICAL WIRING**



TITLE: External Wiring
SCALE: Not to scale
DRAWN BY: GAE
DATE: 10/9/97

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EBBETT AUTOMATION - CONDITIONS OF SALE

Warranty: The Company warrants that the equipment shall remain free from defect in material and workmanship for 12 months from date of dispatch from the Seller's factory.

In the event of any such defect occurring, the Seller, at his option, will repair, or replace free of charge and F.O.B. his factory, the part of the equipment found to be defective, provided that the Purchaser, at his own cost, shall have previously returned to the Seller's factory for examination, the part alleged to be defective, and the Seller agrees that such part of the equipment has been supplied by the Seller and is in fact defective.

This warranty shall not apply to defects in the equipment caused by or resulting from fair wear and tear, wilful damage, negligent or unskilled use in operation or storage, or storage or use in unsuitable conditions by the Purchaser or any third party after delivery by the Seller.

The Seller shall not be liable for any consequential losses, damages or expenses whatsoever incurred by or resulting from defects in the equipment supplied by the Seller.

Prices: Current prices are subject to change without notice.

Sales Tax: Unless stated otherwise, all prices quoted are not inclusive of sales tax where applicable.

Payment: Unless otherwise agreed in writing, all sales are on a basis of cash prior to delivery.

For credit arrangements, all goods remain the property of the Seller until full and final payment is received, and until that time, the Seller reserves the right to take back into his possession any goods held by the buyer or any third party.

Freight: Freight is extra.