T25000

BROADCAST EQUIPMENT

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The constructor reserves the right to modify the information in this manual at any time without advising update.

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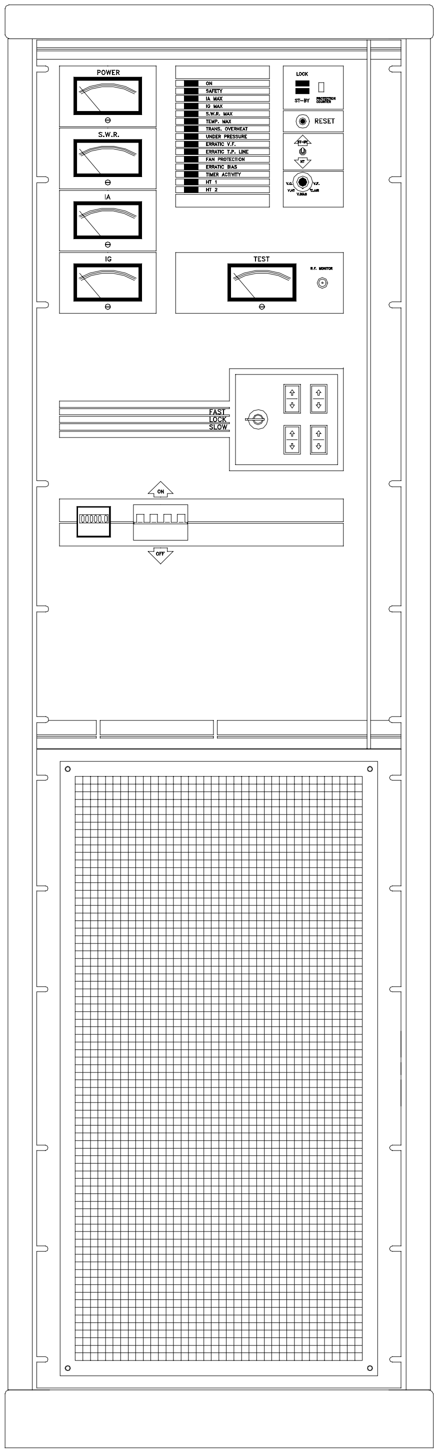
SUMMARY

DESCRIPTION

The T25000 is an amplifier for the transmission of frequency modulation (total deviation 150 KHz) using a thermionic tube in an amplifying cavity with adjustable input and output frequency tuning. Conceived as the final stage in a transmission system, it requires a modulator and other intermediate stages of amplification housed in the same or separate mechanical structure.


POWER
S.W.R.
IA
IG
ON
SAFETY
IA MAX
IG MAX
S.W.R. MAX
TEMP. MAX
TRANS. OVERHEAT
UNDER PRESSURE
ERRATIC V.F.
ERRATIC T.P. LINE
FAN PROTECTION
ERRATIC BIAS
TIMER ACTIVITY
HT 1
HT 2
LOCK
ST-BY
PROTECTION COUNTER
RESET
ST-BY
HT
V.C.
V.F.
V.HT
C.AIR
V.BIAS
TEST
R.F. MONITOR
FAST
LOCK
SLOW
ON
OFF

TECHNICAL FEATURES

DESCRIPTION		10000W OUT	25000W OUT
THERMOIONICS TUBE TYPE		TRIODE EIMAC 3CX15000	
EXPECTED TUBE	TYP	20000 HOURS	10000 HOURS
POWER OUTPUT	MAX	25000 WATT	
EXCITATION POWER		650W	1700W
REFLECTED POWER		750W	300W
S.W.R.	MAX	750 WATT	
POWER GAIN		Ca. 10.2 dB	
R.F. HARMONIC COMPONENT	MIN	-82 dBC	
SYNCHRONOUS A.M.		0.05 dBC	
HIGH TENSION	TYP	V.HT.=8000V	
ANODE EFFICENCY		70%	77%
ANODE CURRENT {IA}	TYP	1.9A	4A
ANODE CURRENT {IA}	MAX	4.3A	
GRID CURRENT {IG}	TYP	200 Ma	500 mA
GRID CURRENT {IG}	MAX	1A	
BIAS VOLTAGE	TYP	V.BIAS=35-200V	
FILAMENT VOLTAGE	range	V.FIL.=6.1-6.4V	
R.F. CAVITY TEMPERATURE	TYP	70 °C	
R.F. CAVITY TEMPERATURE	MAX	95 °C	
INSTALLATION ALTITUDE	MAX	3000 mt. on sea level	
AMBIENT HUMIDITY	MAX	90 %	
OPERATING TEMPERATURE	range	0°C-45°C	
INPUT CONNECTIONS		50 OHM 7/8” TYPE CONNECTOR	
OUTPUT CONNECTIONS		50 OHM 3+1/8” TYPE CONNECTOR	
STAR TYPE SUPPLY		3x380V + N	
STAR TYPE ABSORPTION	3L+N	54A, 52A, 54A, 5.9A	
TRIANGLE TYPE SUPPLY		3x220V - 3x240V 50-60 Hz	
TRIANGLE TYPE ABSORPTION	3L	90A, 93A, 93A	
GENERAL POWER SUPPLY		16.5 KVA	36.5 KVA
POWER FACTOR		COS § = 0.9	

TECHNICAL DESCRIPTION

The T25000 unit is composed of various functional elements: power amplifying cavity which houses the thermionic tube, (this is a triode with direct cathode heating, configured in common grid mode with input signal to the cathode and output from the anode); low-pass output filter for the suppression of harmonic components of the carrier frequency; analog filter connected to the input circuit; three phase high voltage power supply for the thermionic tube's anode; cathode bias circuit; AC stabilised power supply circuit for the filament/cathode; safety circuits for the protection of the unit and service personnel; power supply for the motors which control the amplifying cavity's tuning. The unit is designed to function with the thermionic tube at full power in class C mode, at lower powers in class B and very low powers in class AB. The cathode bias circuit (see card E20123.x) is automatic and senses cathode current. The cathode/grid voltage is obtained via a chain of power diodes connected in series with each other. The very high voltage gain of the thermionic tube allows the class of amplification to be changed with small changes in bias voltage. The tube filament AC supply is kept constant by a phase-angle switching power supply with stability of better than 1.5% (see cards E20127.x and E20128.x). Activation of the filament power supply is conditional upon the pressure of cooling air within the amplifying cavity; if regular, the filament supply is enabled. The working voltage is reached progressively to avoid overcurrent to the tube's socket. A regulator circuit is available on card E20127.x which allows the filament voltage/power to be varied in order to extend the life of the thermionic tube if the RF power required is less than the nominal value (see technical notes on the filament). The high voltage anode power supply (7500 volts DC) is generated by a six phase rectifier (see card E20144.x) with an inductive filter followed by a capacitive filter. A high power, insulated resistor is connected in series with the tube's anode supply output in order to limit the energy dissipated in the event of accidental electric arc within the amplifying cavity or the thermionic tube. The high power transformer is inserted electrically in 2 steps, the first connects a series resistor to limit overcurrent, the second connects the transformer directly to the line supply. This avoids inadvertent power loss due to the action of the local supply's safety cut-outs. The principal electronic circuit card (E20127.x) contains all the user interface circuits (see also card E20131.x) and the circuits which monitor all the important variables of the amplifier. Control of the unit includes the facility to disable operation in the event of variables exceeding their safety limits, with various automatic reset modes. For a detailed description of the unit's protection logic, consult the chapter entitled "user interface". The low-pass output filter is housed within the unit, above the amplifying cavity. It is essential that this filter is both connected and functioning perfectly; in case of malfunction it is not possible to guarantee the suppression of spurious, out-of-band RF frequencies and, furthermore, dangerous internal overheating of the equipment may be caused. The control of the RF tuning of the cavity is performed by 2-speed electric motors. This technique , besides being convenient, ensures the safety of personnel responsible for tuning the equipment. There are two amplifier cavity adjustment controls for the input and two for the output; one of the two matches impedance, the other tunes the frequency.

USER INTERFACE AND LOGIC OF OPERATION

The display of all controls and operational parameters are situated on the unit's front panel. Any suspension of operation, whether temporary or indefinite, results in the thermionic tube's HT anode supply being shut down and the disabling of the modulator's supply. The shutting down of the equipment as a result of a fault condition will be refer hereafter as the protection state. The most frequent causes of each anomaly indicated are also displayed, assuming the unit is not faulty.

Four of the five meters simultaneously display the following operational parameters:

1) the RF power output (P.W.R.) 25KW f.s.d.

2) the reflected RF power present at the radiating system connector (S.W.R.), 2.5KW f.s.d.

3) the thermionic tube's anode current (I.A.) 5A f.s.d.

4) the thermionic tube's grid control current (I.G.) 2A f.s.d.

The fifth meter (TEST) can be switched to five different functions via a rotary selector switch situated above it:

1) (V.C.) calibration of all meters. With the selector in this position, all the meters will display full scale deflection (f.s.d.) to allow the operator to calibrate the scales and identify a faulty meter. Adjustment of the meters is via 5 pre-set potentiometers located on the card E20131.x behind the front panel (see circuit diagrams).

2) (V.HT) selects the reading of the anode supply voltage, 10KV f.s.d. DC.

3) (V.BIAS) selects the reading of the cathode/grid bias voltage of the thermionic tube, 200Vdc f.s.d.

4) (C.AIR) selects the reading of the temperature of the amplifying cavity's hot air exit, 100°C f.s.d.

5) (V.F.) selects the reading of filament voltage, 10V f.s.d. AC

The lever switch located above the rotary selector, described above, allows operation to be suspended by the operator (ST.BY) or restored (H.T.). In the ST.BY position, the thermionic tube's anode voltage is removed and the modulators supply is cut as in a "protection state".

The ST.BY indicator light identifies the position of the switch described above.

The RESET switch allows the operator to disable the automatic shutdown of the transmitter which follows when the maximum number of automatic resets has been reached (8) for various parameters being monitored: reflected power, anode current, grid control current and amplifier cavity cooling air exit temperature. The number of resets that have taken place is displayed on the front panel alphanumeric display (PROTECTION COUNTER). When the electronic logic has reached the limit of automatic resets permitted, the unit will shutdown indefinitely and the front panel LOCK indicator will light. The attempts at automatic reset are cumulative and will increment the counter even if they result from different causes.

The ON indicator light indicates that the T25000 is powered by the line supply.

The flashing SAFETY light indicates that the equipment is not in a safe condition to operate at high voltage and is thus in a protection state. This happens when a panel is open or an important electrical connector is not inserted correctly.

The IA MAX indicator indicates that the maximum permitted anode current (3.3A) has been exceeded. The amplifier is in the protection state. The protection logic attempts a reset after about 3 seconds and increments the counter. The most probable causes of this anomaly are an excessive demand of RF power from the output, or incorrect tuning (the impedance seen by the anode circuits is too low). If the impedance of the radiating system is incorrect or unstable it is possible that large fluctuations of anode current will be experienced with likely intervention of the protection mechanism. Variations of line voltage will have an significant influence on anode current if the preceding RF stages maintain stable power levels; in particular if the line voltage reduces but the excitation power remains unchanged, anode current will increase appreciably. When the thermionic tube is at the end of its life, it is possible for this fault to occur often.

The flashing IG MAX light indicates that the maximum permitted grid current (1A) has been exceeded. The amplifier is in the protection state. The protection logic attempts a reset after about 3 seconds and increments the counter. The most probable causes of this anomaly are an excessive RF power input, or incorrect tuning (the impedance seen by the anode circuits is too high). If the impedance of the radiating system is incorrect or unstable it is possible that large fluctuations of grid current will be experienced with likely intervention of the protection mechanism. Variations of line voltage will have an significant influence on grid current if the preceding RF stages maintain stable power levels; in particular if the line voltage reduces but the excitation power remains unchanged, grid current will increase appreciably. When the thermionic tube is at the end of its life, it is possible for this fault to occur often, with problems of matching RF impedance with preceding stages.

The flashing SWR MAX light indicates that the maximum permitted reflected power (750W) at the power output connector has been exceeded. The amplifier is in the protection state. The protection logic attempts a reset after about 3 seconds and increments the counter. The most probable cause of this anomaly is an incorrect value of impedance of the radiating system connected to the output of the transmitter. Very often the cause of the protection state can seem inexplicable; this can occur when there is a temporary collapse of the radiating system without permanent damage.

The flashing TEMP MAX light indicates that the maximum permitted temperature (85°C) of the hot air output from the amplifying cavity has been exceeded. The amplifier is in the protection state. The protection logic attempts a reset when normal temperatures have been restored and increments the counter. The most probable causes of this anomaly are excessive ambient temperatures, inefficient air filters or incorrect tuning (the impedance seen by the anode circuits is too high).

The flashing TRANS. OVERHEAT light indicates that the anode power supply transformer is overheating. The amplifier is in the protection state. The protection logic attempts a reset when the transformer sensor detects that normal temperatures have been restored. The most probable causes of this anomaly are excessive ambient temperatures, or inefficient air filters.

The flashing UNDER PRESSURE light indicates that the pressure of cooling air within the amplifying cavity is insufficient. The amplifier is in the protection state. The protection logic attempts a reset when the pressure sensor detects that normal pressures have been restored. In this protection state, the power amplifier will disable the filament supply as indicated by the ERRATIC VF light. The principle cause of this fault is the inefficient condition of the cooling air filters or an insufficient circulation of air in the room where the equipment is located. When the cooling fan is damaged or not incorrectly powered, this protection state can arise sporadically.

The flashing ERRATIC VF light indicates that the filament voltage at the thermionic tube's socket is incorrect. The amplifier is in the protection state. The protection logic resets operation when the value returns to within a 5% tolerance. In the first phase of switching on, it is normal for this indication to remain lit for up to ten seconds; this is due to the time taken for the filament power supply to reach its operating value. This indication remains active if the UNDER PRESSURE indicator is lit at the same time. When the filament voltage is at normal levels, the timer is activated to ensure a period of 300-400 seconds elapses before the anode supply and the RF EXCITER supply are restored. In the event of a loss of power lasting more than 1.5 seconds, the protection logic puts the transmitter into the ERRATIC VF protection state and repeats the preheating cycle (TIMER ACTIVITY) before restoring normal operation. The principle causes of anomalies can be related to problems of air pressure within the amplifying cavity (see relevant paragraph) or caused by brief losses of power from the line supply.

The flashing ERRATIC T.P. LINE light indicates that the protection mechanism connected to the anode power supply has intervened. The amplifier is in the protection state. The protection logic will not automatically reset the unit; operator intervention is necessary. The principal causes of this anomaly are short circuits, temporary or permanent, to any part of the anode supply circuit or chassis. In many cases, it is a sign that the thermionic tube is at the end of its life or defective. Another cause of this fault is high line voltage or an unbalanced three phase supply.

The flashing FAN PROTECTION light indicates that the protection mechanism connected to the main amplifying cavity cooling fan has intervened. The amplifier is in the protection state. The protection logic will not automatically reset the unit; operator intervention is necessary. The principal cause of this fault is high line voltage or an unbalanced three phase supply.

The flashing ERRATIC BIAS light indicates that the cathode/grid bias voltage is incorrect. The amplifier is in the protection state. The protection logic will not automatically reset the unit; operator intervention is necessary: the only way to clear this fault and its effect is to remove electrical power from the unit for at least ten seconds. The principal causes of this anomaly are short circuits, temporary or permanent, to any part of the anode or cathode supply circuit or chassis. In many cases, it is a sign that the thermionic tube is at the end of its life or defective.

The TIMER ACTIVITY light indicates that the timer is counting down during the pre-heating phase required by the filament before the anode supply is enabled and RF excitation is applied to the input. The amplifier is in the protection state even if no malfunction is present. When the timer has finished its count, the indicator light goes out. Consult the paragraphs regarding ERRATIC VF, HT1 and HT2.

The HT1 light indicates when the TIMER ACTIVITY cycle has ended, but only if the unit is not in the protection state due to any fault. This light indicates the first step of activating the anode power supply at which point the transformer is connected to the line supply via a series resistance to limit overcurrent. This phase is always followed, after about a second, by a second and final phase when the HT2 indicator is lit. HT1 remains lit even when HT2 is lit. In this final phase, the unit is fully activated: the anode transformer is connected directly to the line supply and the interlock enables the modulator. The modulator is enabled if both indicators, HT1 and HT2 are lit; furthermore, both these must be permanently lit when the transmission system is ready to go on-air. They will be extinguished when the T25000 power stage is faulty or has been shutdown by the operator.

An hour counter is located on the front panel which registers the number of hours that the unit has been connected to the line supply. This provides useful information for the purpose of periodic maintenance.

A switch on the front panel controls the supply of power to all the internal circuits of the amplifier. WARNING! The entire transmission system MUST BE DISCONNECTED from the line supply before any internal work is carried out.

Actuators located on the front panel allow adjustment of tuning of the amplifying cavity (see chapter on tuning adjustments). The three position key: FAST, LOCK and SLOW allows selection of the most suitable motor speed for tuning. In the LOCK position all motors are inactive. Moving the key to the FAST position selects a fast adjustment speed. SLOW provides a fine adjustment speed. The four 2-position switches activate the motors for tuning the amplifying cavity and have the following functions:

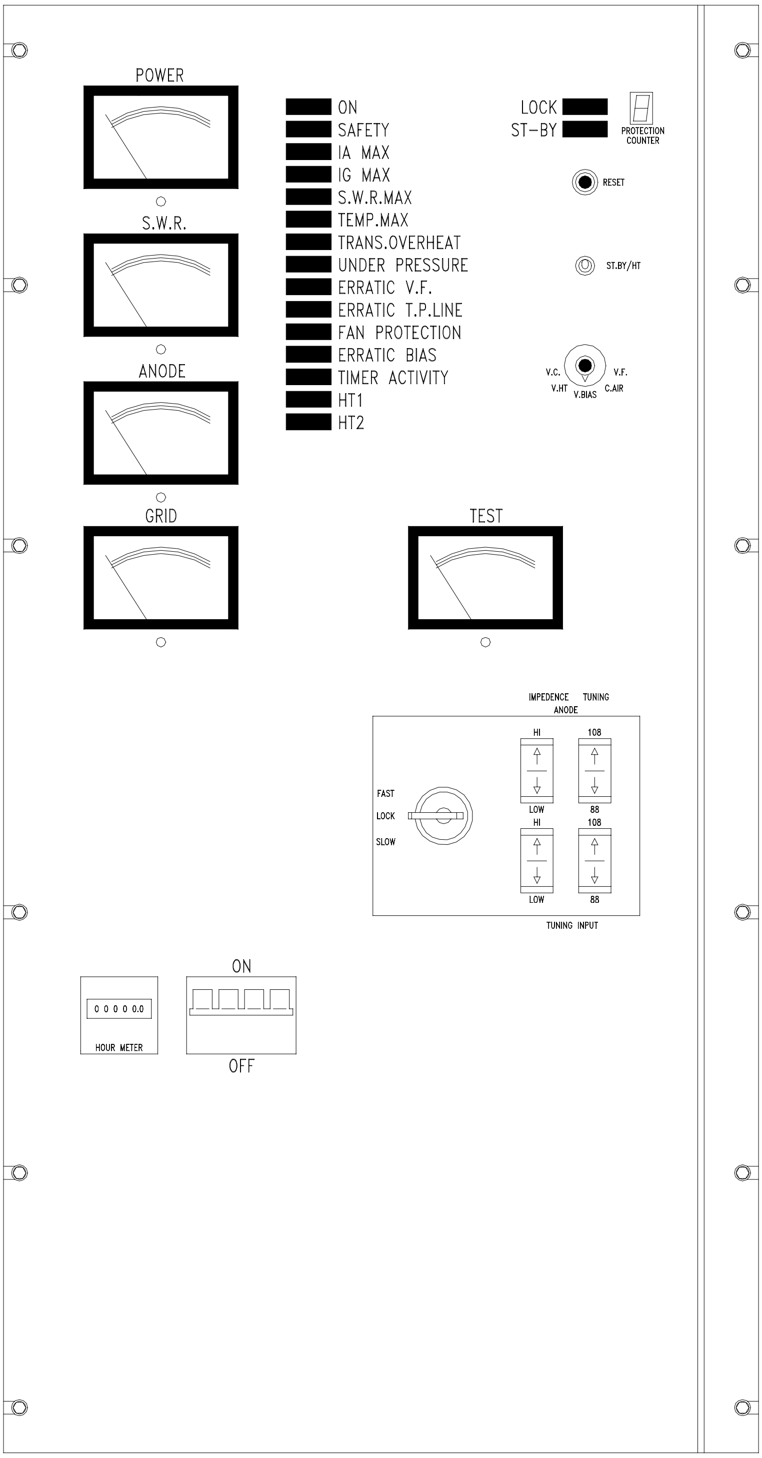
1) ANODE IMPEDANCE (top left). Adjusts the matching impedance between the thermionic tube's anode and the radiating system. When pushed up, the anode impedance is increased and vice versa.

2) ANODE TUNING (top right). Adjusts the tuned frequency of the anode output circuit. When pushed up the tuned frequency increases and vice versa.

3) INPUT IMPEDANCE (bottom left). Adjusts the matching impedance between the thermionic tube's cathode and the exciter stage. When pushed up the impedance is increased and vice versa.

4) INPUT TUNING (bottom right) Adjusts the tuned frequency of the cathode input circuit. When pushed up the tuned frequency increases and vice versa.

FRONT PANEL


POWER
S.W.R.
ANODE
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IA MAX
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S.W.R.MAX
TEMP.MAX
TRANS.OVERHEAT
UNDER PRESSURE
ERRATIC V.F.
ERRATIC T.P.LINE
FAN PROTECTION
ERRATIC BIAS
TIMER ACTIVITY
HT1
HT2
LOCK
ST-BY
PROTECTION COUNTER
RESET
ST.BY/HT
V.C.
V.F.
V.HT
V.BIAS
C.AIR
IMPEDENCE
TUNING
ANODE
FAST
LOCK
SLOW
HI
LOW
108
88
HI
LOW
108
88
TUNING INPUT
HOUR METER
ON
OFF

FIRST PHASE OF INSTALLATION

Before describing the operational phases of the installation procedure, an indication of the ambiental requirements of the location where the equipment is to be installed will be given. In the room designated for installation, a means of removing the hot air generated by all the equipment should be fitted. If the T25000 is the largest source of heat of the entire system, and if the ambient temperature is 25°C, at least 2000m³ per hour should be removed. If the temperature is 45°C then at least 3000m³ per hour should be evacuated. Clearly, it is necessary to provide an equal amount of fresh air from outside which must be filtered appropriately to avoid ingress of insects, dust, smoke and organic material. The equipment can function normally at ambient temperatures between -5 and 45°C with a relative humidity of 95%, non-condensing at 45°C. The line supply should be three phase with a voltage of 208/240 volts for delta connection (without neutral) and 380/415 volts for star connection (with neutral). The power required to supply the T25000 is at least 24 KVA, taking account of the power factor produced by the powerful anode rectifier. An efficient earth system must be provided to cater for loss of current that can involve the chassis of the unit and other equipment in contact. Particular attention should be paid to the connection with the radiating system which is especially prone to electrical atmospheric phenomena. Before the antenna cable is fed to any enclosed space, an electrical conductor with a section of at least 150mm² must be connected from the external conductor of the antenna cable to a low impedance earth point dedicated to the antenna structure. Given the very low values of parasitic inductance of the connections to the T25000, the amount of electrical energy of atmospheric origin can only be partially controlled, in terms of personal safety, by earth connections. To maximise safety of personnel, it is very important that the equipment is installed in a room which is only entered by personnel on a temporary basis for reasons of maintenance, repairs or short checks. If the installation room is entered frequently by personnel for reasons other than occasional service operations on the transmitter, it is imperative that a metal grid, connected to an efficient earth, is used to enclose the equipment in order to isolate it from the personnel. Having taken account of the precautions previously detailed, the installation phase may now proceed. Remove all packing pieces from the equipment used for transport and take care not to mislay any items included. Remove the anode supply transformer from its transport case, taking care not to damage its windings and connection terminals. Open all the equipment's panels and check the integrity of electrical connections and the mechanical components of the RF connections; if any damage has been incurred in transit, contact ELENOS for information regarding the guarantee. Remove the fixing bracket of the anode power supply inductor which is no longer required for transport and is now dangerous!

Locate the rectangular plastic PVC tablet, supplied with the equipment, within the unit and place the anode transformer on top, in the place clearly intended. The transformer is not fixed with bolts inside the unit to avoid extra currents flowing between its external parts and the base of the equipment in which it is located. Should the installation be made in seismic zones, the transformer should be lashed to the internal structure of the unit using cord made of insulating material. The external body of the transformer MUST be connected to the electrical earth of the unit, AT ONE POINT ONLY of its body. Make absolutely certain that this earth conductor is connected to the earth terminal of the whole T25000 unit. Do not connect the central node of the star of the transformer primary to the neutral of the line supply. Connect the anode transformer primary to the intended, heavy-section cables with the terminals best suited for high voltage operation (see the diagram for three-phase connection). Connect the anode transformer secondary to the intended, heavily insulated cable (see identification labels). Connect the two wires from the front, right-hand spar (see identification labels) to the thermal probe socket of the anode transformer. WARNING! Malfunctions occuring during the first few hours of operation are frequently caused by the passage of connection cables, using ordinary insulation, close to parts of the anode transformer which present a risk. Take care to prevent loose cables from making contact with the high voltage terminals of the anode transformer. The T25000 can be connected in two ways to the line supply: star connection for line voltages of 380/415V with neutral connection (4 wire + earth); delta connection for line voltages of 208/240V without neutral connection (3wire + earth). The entry for the main electrical supply cables is located on the rear of the unit where a series of holes are available for the cables to enter. Inside the unit, near the two high-power contactors, a terminal block is provided for the connection of the electrical supply cables. The section of the cables is different for the two types of connection and can be determined from the technical table defining values of current absorption of the line supply. Each country has its regulations concerning the section of cable connected to the line supply which MUST be respected. In the absence of precise indications the section of cable should allow for a current density of not greater than 4A per square millimetre of conductor. (for example: a 50A current will require a cable of section of $50/4 = 12.5mm^2$). In the event of a three phase star connection, do not swap the neutral line for any of the phases; this will do permanent damage to the equipment. The neutral terminal can be readily identified by its label inside the unit. For delta connection do not connect neutral to the terminal inside the unit; this has been intentionally short-circuited to one of the three phases. IT IS ESSENTIAL THAT THE EQUIPMENT IS CONNECTED TO THE EARTHING POINT of the system on site. Inside the unit is a terminal which can be identified by its yellow/green colours; its dimension is the same as those of the three phases. The earth connection is essential to ensure the safety of personnel who have occasion to make physical contact with the apparatus or any mechanical structure or electrical conductor which are in electrical contact with the apparatus. The earth connection is useful for minimising damage to the equipment or other nearby equipment, in the event of high voltage discharges of an atmospheric nature, or caused by the equipment itself. Connection to the three phases is NOT arbitrary and determines the direction of rotation of the fan, which clearly must be correct. Testing for correct rotation of the cooling fan must only be performed once the unit is fully closed to ensure operator safety. The electrical supply system which supplies the unit and all other equipment with power, MUST be fitted with a CIRCUIT BREAKER with a current calibration not greater than 30% of the current drawn by the whole transmitter. When the equipment is connected to the electrical supply, it exposes personnel to the risk of coming into contact with high voltage lines; for this reason it is ABSOLUTELY ESSENTIAL THAT THE CIRCUIT BREAKER IS IN THE OFF POSITION, whilst any equipment panel remains open. Maintaining the unit's on/off switch in the off position IS NOT

SUFFICIENT! DO NOT SUPPLY ELECTRICAL POWER TO THE EQUIPMENT UNTIL ALL PANELS ARE SHUT AND IT IS CONNECTED TO AN EARTHING POINT. An isolating transformer between the equipment and the line supply significantly reduces the incidence of damage incurred by atmospheric causes, greatly increases reliability and reduces the costs of faults caused by overvoltage of the line supply. It is useful to construct a winding of about 25 turns, diameter 25-35 cm (about 1 foot) with the line supply cables of the 3 phases and neutral before they enter the equipment. UNDER NO CIRCUMSTANCES CONSTRUCT A WINDING WITH THE EARTH CABLE WHICH MUST BE OF HEAVY SECTION (100mm²) AND MUST CONNECT THE EQUIPMENT TO EARTH DIRECTLY AND WITH THE SHORTEST POSSIBLE LENGTH. The final power apparatus is always connected to other excitation equipment which, in the majority of cases, comprises one or more intermediate driver stages and an FM "exciter" modulator. The connections to the preceding amplification stages and the modulator are of two types: radio frequency connections and electrical line supply connections with a safety interlock system. The RF connections are as follows: the RF output of the modulator is connected to the RF input of the first intermediate stage; the RF output of the first intermediate stage is connected to the RF input of any second intermediate stage. The RF output of the unit preceding the final T25000 amplifier is connected to the input of the low-pass filter which finally supplies the input of the final amplifying cavity. The RF connection is complete when the power output of the T25000 is connected to the radiating system. Connection to the radiating system will determine the final positioning of the equipment which, for convenience, ought to be left free until the final phase of installation. The connection of the electrical supply is more complex and can vary according to the configuration of the transmission system components. For this reason a series of diagrams has been supplied (see the reciprocal safety interlock connections between units) which illustrates how the installation connections of all the equipment can be completed. Note that the T25000 does not supply electrical power but only disconnects it via an interlock switch with a 10A capacity. The connection scheme must satisfy two crucial constraints: if either the final power stage or an intermediate stage fall into the protection state, the modulator must shutdown the RF output.

INSTALLATION OF THE THERMIONIC TUBE

When the T25000 amplifier is in its final position, installation of the thermionic tube may proceed. The directions which follow are also valid for periodic replacement of the thermionic tube; for this reason it is a good idea to leave a copy of the technical manual available nearby. The electrical circuit breaker supplying the whole transmission system must be open before performing this operation so that the system is ISOLATED from electrical power. The T25000 must also be ISOLATED from the radiating system. WARNING! During the installation of the thermionic tube, the hands of the operator will be in physical contact with parts normally functioning at HIGH VOLTAGE. Even if the equipment has been inactive for some time, it is ESSENTIAL that a conductor be used to electrically connect the high voltage supply to the chassis of the unit. WARNING! In order to discharge the high voltage capacitor, connect the solid conductor to the unit's chassis at the point INTENDED for this operation: the electrical junction connecting the overcurrent-limiting series power resistor with the anode of the thermionic tube. If the high voltage capacitor is discharged at a point other than that previously described, it is possible to cause permanent damage to the equipment. Remove the top panel of the unit. Remove the hot air exit flue above the amplifying cavity after having disconnected the thermal probe tied to the flue. Take the thermionic tube out of its packing and check that it is whole and fit for operation. The thermionic tube should not show any signs of smearing with pollutants on any part; if this is not the case, contact the supplier. Introduce the thermionic tube into the amplifying cavity keeping the tube VERTICAL and CENTRAL and rotated so that its "handles" are turned towards the side walls of the amplifying cavity. WARNING! It is possible to damage the socket during installation of the thermionic tube, in particular the spring "finger" contacts of the control grid electrode. Proceed with care and caution, do not force and, in particular, AVOID ROTATION and TORSION to the vertical axis of the thermionic tube. To ensure that the thermionic tube is correctly positioned in its socket use a small mirror and torch to verify that the circular control grid contact is well inserted into the "fingers". WARNING! Exciting the unit with RF when the tube is not correctly inserted will probably cause damage to both the tube and the equipment. The installation of the thermionic tube is concluded when the hot air exit flue is refitted, the thermal probe reconnected and the top panel closed. WARNING! Do not forget to remove the safety shorting cable between the high voltage contact and the unit's chassis before re-fitting the panels.

SECOND PHASE OF INSTALLATION

When all the phases of electrical connection are complete and checked, it is possible to close all the panels of the equipment. Arrange all the other transmission system apparatus in their final positions. Included with the T25000 unit is a kit of sleeves made from material which are used to close the three wide access points which correspond to the entrance and exits of the RF cables and the hot air exit. The application of the three sleeves is clear, their function is to prevent the ingress of insects or organic vegetable material into the equipment. WARNING! Particular care should be taken with the connection to the radiating system as the principal cause of functional problems within the first few hours of operation is caused by an inefficient RF load. The connection phase of the radiating system is particularly hazardous for the operator since he is not aided by an earth connection; the efficiency of the earth connection can never be relied upon at radio frequency. The above information is very important if the transmitter being installed is connected to a multiport radiating system (duplexer, triplexer, etc...). In this case IT IS NECESSARY TO DISACTIVATE ALL THE TRANSMITTERS CONNECTED TO THE SAME RADIATING SYSTEM. As in any installation of electronic apparatus, the final operation is to check that all connections are correct, in particular with this unit it is essential to ensure that the short-circuit safety connection has been removed from the high voltage circuit.

ACTIVATION OF THE TRANSMISSION SYSTEM

Before supplying electrical power to the transmission system, check that all equipment components have there on/off switches switched OFF. Check that the frequency of the modulator has been correctly programmed and that it has been adjusted for zero RF power. Activate the circuit breaker which supplies power to the transmission system. Move the small switch on the panel of the T25000 to the ST BY position (advised). Switch on the three phase equipment to check for correct rotation of the three phase cooling fans. In the case of the T25000, if the connection of the three phases is correct, 3 seconds after switch-on, the UNDER PRESSURE indicator, located on the front panel, will go out. WARNING! If the phases are not correctly connected, carry out the following procedure: SWITCH OFF the main circuit breaker of the electrical installation so as to remove electrical power from the whole transmission system. Remove the rear panel of the T25000 to access the terminal connector block. Invert two of the phases. If other equipment has to be reconnected, consult their respective technical manuals. Close the rear panel of the T25000 and all other transmission equipment. Switch on the installation's main circuit breaker. Switch on the power on/off switches of all the transmitter components of the system. At this point the T25000 is ready to operate and follows the following start-up sequence: the following front panel indicators will light: ON, TIMER ACTIVITY, ST BY (if selected), UNDER PRESSURE (for about 3 seconds) and ERRATIC V.F. (for about 10 seconds). Each stage of the system has a start-up sequence and only when concluded will that stage operate at radio frequency. The modulator will remain inactive until the start-up phase of all the system equipment is concluded. After about 300/400 seconds the TIMER ACTIVITY indicator, located on the front panel of the T25000 "final" amplifier will go out. This signifies that the pre-heating cycle of the thermionic tube's filament has ended. Move the switch on the front panel of the T25000 to the H.T. position; the ST BY indicator will now go out, the H.T.1 indicator will light and, after about a second, the H.T.2 indicator will also light. When all the components of the transmission system have concluded their respective initial phases, the modulator is also enabled. The modulator has its own preliminary phase; when this has terminated, the whole transmission system is ready for the frequency tuning operations. All other components of the transmission system, both active and passive must be tuned before the T25000 amplifier is ready for frequency tuning. It is essential that the modulator, in the first phase, is adjusted for zero power output when it concludes its preparatory cycle (for other equipment, consult the technical manual supplied).

TUNING INSTRUCTIONS

NOTE: The T25000 unit is factory-adjusted (if no other request has been made) to operate at 98MHz. The tuning adjustments are motorised and controlled by 4 controls (UP/DOWN) on a switchboard located on the front panel. Two choices are available: FAST adjustment and SLOW adjustment, depending on the position of the selector key on the front panel. The four switches vary the following parameters: ANODE IMPEDANCE, top left; ANODE TUNING, top right; INPUT TUNING, bottom right; INPUT IMPEDANCE, bottom left. If one of the four switches is lifted up, the parameter is increased and vice versa. Adjust the modulator power for an anode current consumption of about 500-600mA on the T25000. Move the selector key to the FAST position and simultaneously move the ANODE TUNING switch (top right) in one of the two positions: up, to tune to a frequency greater than 98MHz; down, to tune to a frequency of less than 98MHz. Continue with this adjustment to obtain a maximum reading on the P.W.R. meter located on the front panel. Increment the excitation power of the modulator, keeping under control the reflected power reading of the preceding driver stage; this should be less than the threshold at which the protection mechanism intervenes to allow other adjustments to be made. With the key in the SLOW position, adjust alternately the two input tuning adjustments of the final stage; first INPUT TUNING (bottom right), then INPUT IMPEDANCE (bottom left) in order to minimise the reflected power reading of the preceding driver stage. Increment again the modulator power, keeping under control the I.A. and I.G. values of the final stage and the driver's reflected power value. Make adjustments to obtain the maximum relative power output of the final stage using the ANODE TUNING control (top right) and, if necessary, adjust the two controls INPUT TUNING and INPUT IMPEDANCE to optimise matching with the driver stage. If neither the I.A. or I.G readings of the final stage approach the threshold of protection intervention, proceed with the same sequence of operations until a final power output greater than 50% of the maximum is obtained. At this point evaluate the tendency of the tuning characteristics which can be of two types: the I.A. value tends to be too high with low values of I.G.; or the value of I.G. tends to be too high with I.A. relatively low and low power output. The two tendencies can be normalised with the ANODE IMPEDANCE control (top left). This adjustment is important to obtain equilibrium between the I.A. and I.G. parameters but must be adjusted in small steps IMMEDIATELY FOLLOWED by a compensating adjustment of the ANODE TUNING control to maximise the relative output power reading of the T25000 P.W.R. meter. The rule is as follows: if incrementing exciter power results in excessive anode current (I.A.), increase ANODE IMPEDANCE by lifting the corresponding switch (top left) (simultaneously compensating ANODE TUNING). In this way the output power will increase, reducing I.A. and compensating I.G. Otherwise, if increasing exciter power results in excessive levels of grid current (I.G.), reduce ANODE IMPEDANCE (top left) by pushing the dedicated switch down (simultaneously compensate ANODE TUNING). This last adjustment, for the same exciter power, will not increase output power (it may decrease it) but the saturation effect will disappear and the final stage will accept the higher level of input power to achieve maximum performance. WARNING! It is worth repeating that each adjustment of ANODE IMPEDANCE must be made in small steps and immediately followed by compensatory adjustments of ANODE TUNING (top right) to maximise the relative power output and thus the electrical efficiency of the T25000. These instructions refer to output tuning, however it will be necessary, during this procedure, to also optimise the input tuning in order to minimise the reflected power reading of the driver stage.

OPERATIONAL LIMITS

The T25000 power amplifier can function at full power if the ambient conditions fall within the limits defined in the chapter entitled "First Phase of Installation". The maximum altitude of the installation must not exceed 2000m above sea level to guarantee maximum RF power output. If the altitude of the installation does exceed 2000m, the specified RF power output must be reduced, also in correlation with the ambient temperature. The limits of the working output power in this case have to be found experimentally, the performance of the unit is not readily definable under these conditions. It is not however possible for the equipment to conform to conditions of safety and the guarantee if the site has an atmospheric pressure equivalent to an altitude in excess of 3500 m above sea level. The ambient humidity is very important in relation to the high voltage circuits; a value of up to 95% can be tolerated at a temperature of 45°C, but only if variations in atmospheric pressure do not provoke condensation. The equipment cannot function under any condition if the ambient humidity is condensing. If fluctuations in line voltage are very large, the whole system should be adjusted taking account that the RF power output can exceed the safety limits of the equipment or the radiating system. If the only unit dependant on line voltage is the T25000, the voltage/power characteristics are as follows:

A 2% variation of line voltage implies a 5% variation of RF power output

A 5% variation of line voltage implies a 15% variation of RF power output

A 10% variation of line voltage implies a 25% variation of RF power output

The equipment will not operate however if line voltage exceeds 15% of nominal or is 20% less than nominal. The thermionic tube is subject to wear through use. After a year of operation, the performance of the T25000 will most certainly have been degraded, but not necessarily terminated. The thermionic tube must be changed when the gain of the amplifier falls below 9dB.

The radiating system must present an electrical impedance of 50Ω. The T25000 amplifier can function normally if the standing wave ratio (S.W.R. or R.O.S) is less than 1.6. When the radiating system exceeds this figure permanently, it is possible for the protection mechanism to trigger due to standing waves. Operation at reduced power levels is useful to avoid loss of service but does not guarantee that, due to variations of electrical or ambient conditions, loss of service will be avoided.

PERIODIC MAINTENANCE

Each time a new thermionic tube is installed, certain safety precautions should be observed in order to maintain the rights of the guarantee of the equipment or the tube itself. For the first 200 hours of operation, power output should be limited to 70% of the nominal maximum level. After the thermionic tube has been operating for 200 hours, full RF power may be developed. At this point certain adjustments should be performed to the stabilised filament power supply in order to prolong the life of the thermionic tube (see chapter regarding filament voltage adjustment). Every three months, periodic alignment of the amplifier tuning is necessary to compensate for consumption of the thermionic tube. This is essential mainly if the radiating system is suffering adversely from the external ambient conditions. Several parts of the T25000 are employed in the filtering of the cooling air; depending on the relative ambient conditions, the anti-dust filters will need replacing at intervals dependant on the quality of air in the area. The thermionic tube is subject to wear and has an operating life of about 10,000 hours under normal conditions. If the performance demanded of the equipment is less than nominal, and if the filament voltage is regularly adjusted, an operating life of 15,000 hours or more can be obtained.

ADJUSTMENT OF THE FILAMENT VOLTAGE

The filament of the thermionic tube installed in the T25000 is powered by an AC stabilised circuit with a precision of better than 1.5%. The filament voltage has a very important influence on the operational life of the thermionic tube, that is, the lower the voltage, the longer the life of the tube. However, if the thermionic tube is working with the filament underheated (voltage too low for the working cathode voltage) the tube life will be reduced by cathode pollution. There therefore exists an ideal filament voltage for the power at which the thermionic tube is operating. Adjustments of the filament voltage should be performed with the equipment operating at the desired RF power level; for this reason personnel making these adjustments must be fully prepared technically in order to carry out this task with the equipment open.

The sequence of operations to follow is:

1) Prepare the unit so that it is operating at the desired power level with the front panel open to allow adjustment of the low-power trimmer potentiometer located on card E20127.x (reference P6).

2) Rotate the trimmer clockwise for 3 or 4 turns (this will reduce the voltage) keeping the front panel voltage reading under observation. Continue with small steps until it is possible to detect the smallest variation of anode current (I.A.) or RF power output (P.W.R.).

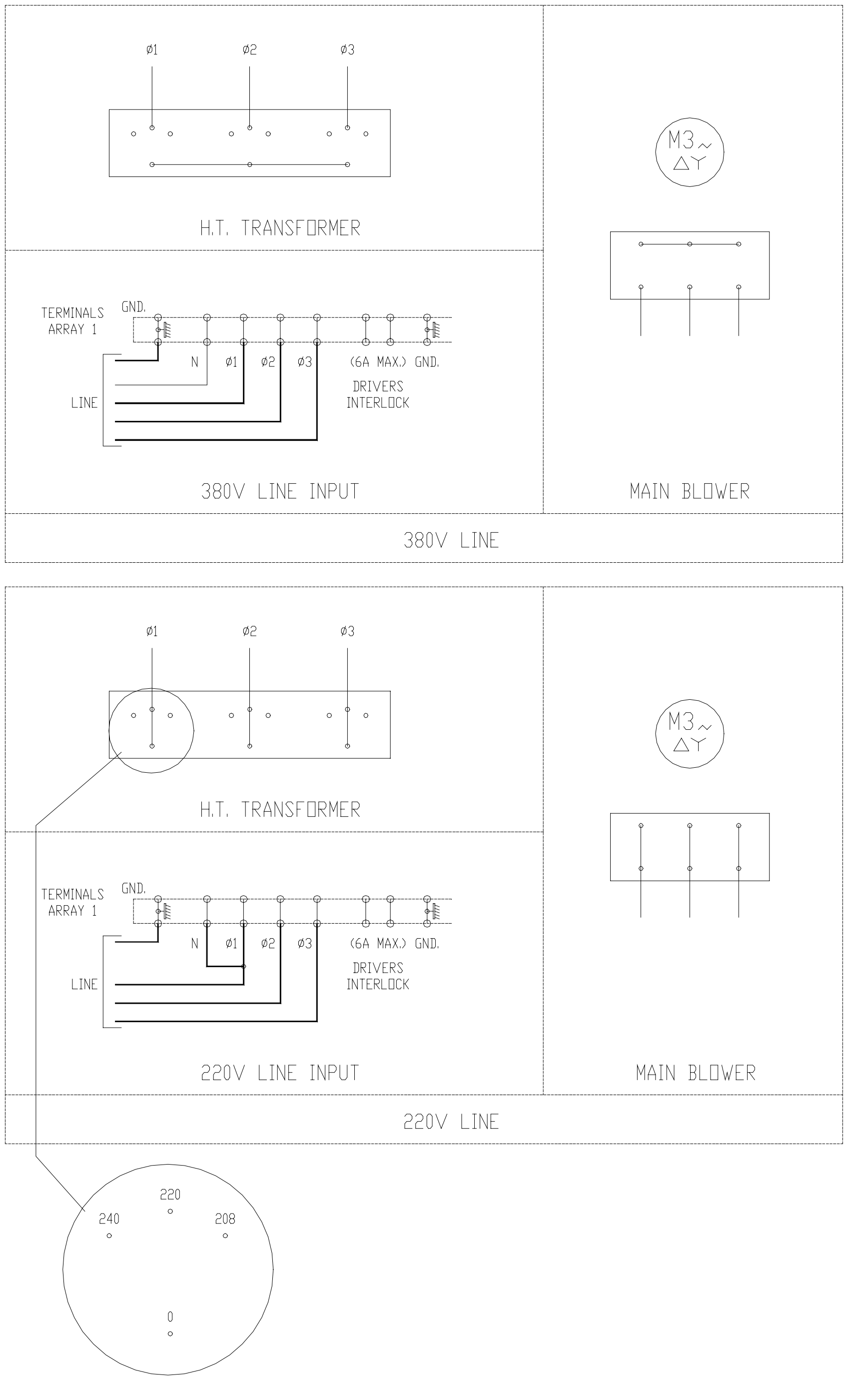
3) Rotate the trimmer very carefully in the opposite direction until the filament voltage is just beyond the point at which the variations of the performance of the tube begin.

The final value of filament voltage obtained will be unique and will vary from tube to tube. The voltage should not be reduced within the first 200 hours of operation of the thermionic tube; adjustments after 4000 hours are of no use. It is necessary to correct the filament voltage with a slight increase every three months, in order to compensate for consumption of the thermionic tube's cathode. For this operation it is necessary to first return to the nominal value and then repeat the three steps described above. WARNING! Ensure that the safety precautions described at the beginning of the chapter are complied whenever maintenance is carried out on the equipment.

REMARKS ON ELECTRICAL DIAGRAMS

We in these notes explain how interpret the electrical schemes that follows this page. All electronic components are installed on various mechanical panels, a drawing shows their positions with a reference label. A special drawing represents the frontal panel and helps to find the various warning indications and status conditions of the machinery. This draft is useful also in order to trace the position of the driving in order to activate / disarm the machinery and in order to tune the radio frequency amplifier cavity. The electrical schemes have split up in two categories: connection schemes between different unity and relative schemes of electronic boards. The connection schemes between different electrical unity have distributed in more sheets with needed cross references between draft and draft, it that's why is present a symbology a little bit special but effective. Inside of a box it is present a text-row that like this: 1A-> 3C, this means that lines connections inside the box with its respective identification numeration depart from the draft #1 label A to arrive to draft #3 label C. Each draft collects a distinctive functional theme in order to facilitate the breakdowns research.

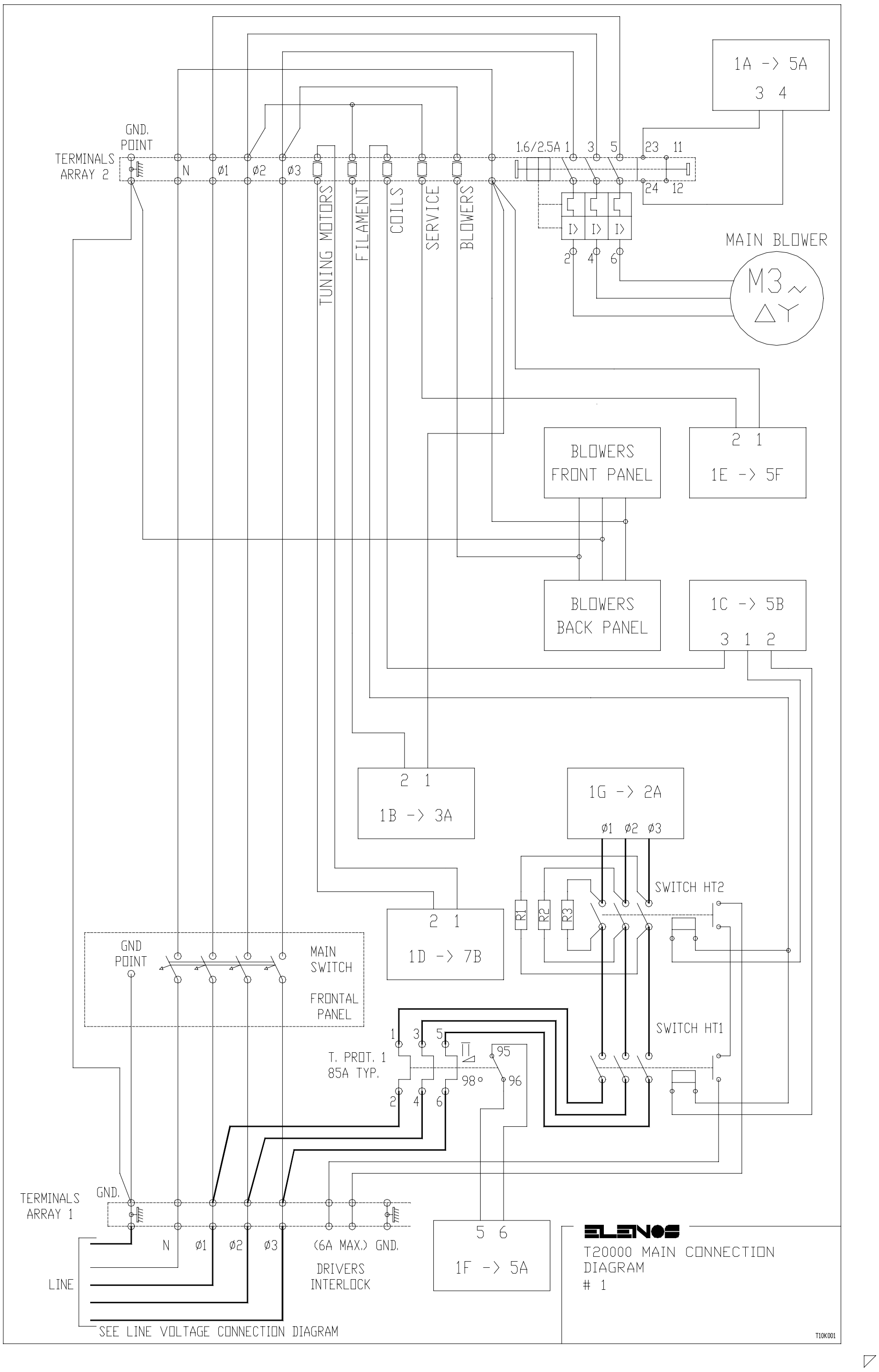
LINE VOLTAGE DIAGRAM CONNECTION



PART LIST TRANSMITTER 20K

Sheet # 1	Part List of Sheet # 1
Sheet # 2	Part List of Sheet # 2
Sheet # 3	Part List of Sheet # 3
Sheet # 4	Part List of Sheet # 4
Sheet # 5	Part List of Sheet # 5
Sheet # 6	Part List of Sheet # 6
Sheet # 7	Part List of Sheet # 7
E20123	Part List of E20123
E20127	Part List of E20127
E20128	Part List of E20128
E20131	Part List of E20131
E20138	Part List of E20138
E20144	Part List of E20144

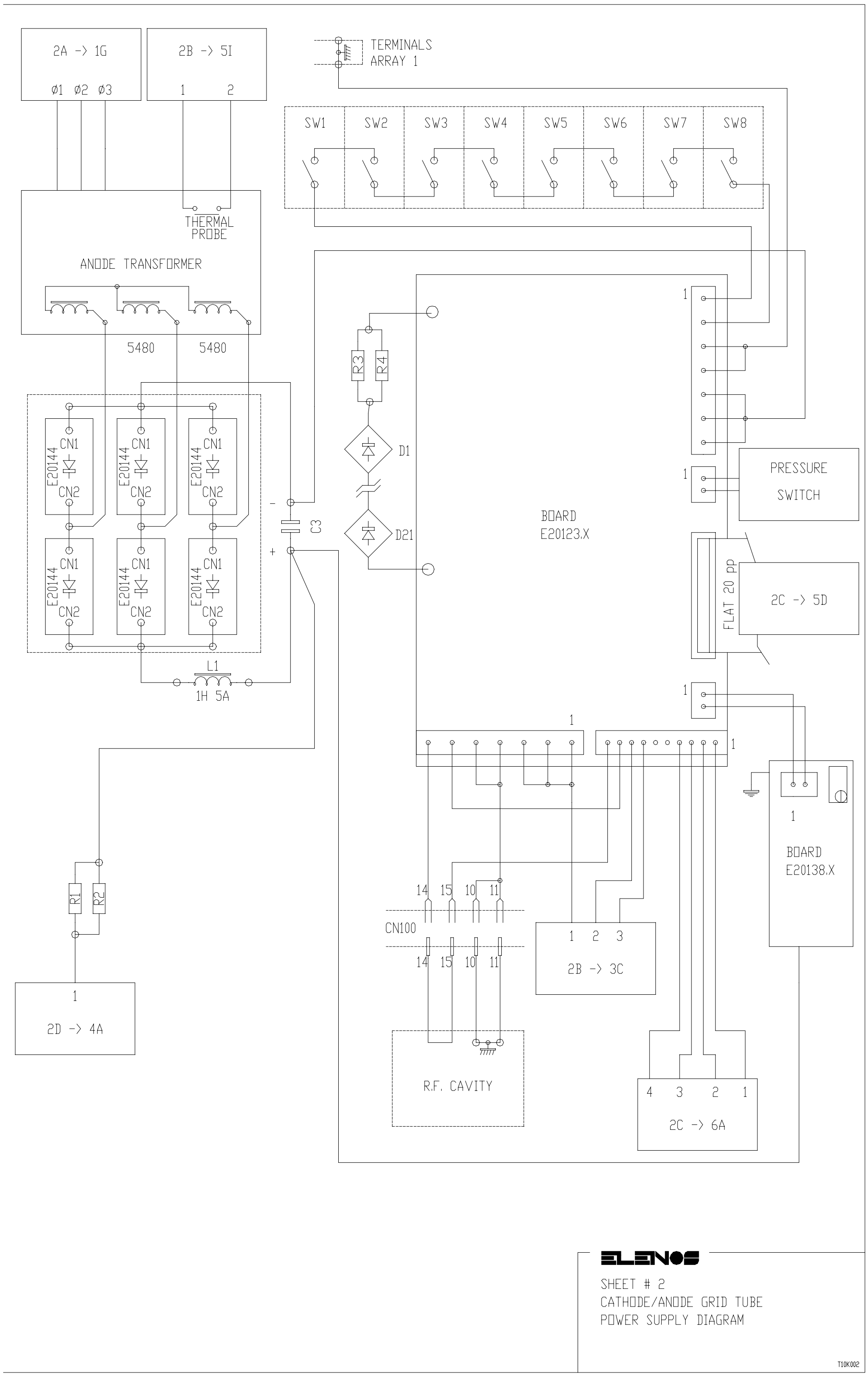
Sheet # 1


1A -> 5A
3 4
GND.
POINT
TERMINALS
ARRAY 2
N
Ø1
Ø2
Ø3
1.6/2.5A 1
3
5
23
11
24
12
TUNING MOTORS
FILAMENT
COILS
SERVICE
BLOWERS
MAIN BLOWER
M3~
ΔY
2
4
6
BLOWERS
FRONT PANEL
2 1
1E -> 5F
BLOWERS
BACK PANEL
1C -> 5B
3 1 2
2 1
1B -> 3A
1G -> 2A
Ø1 Ø2 Ø3
SWITCH HT2
R1
R2
R3
2 1
1D -> 7B
GND
POINT
MAIN
SWITCH
FRONTAL
PANEL
T. PROT. 1
85A TYP.
95
96
98
SWITCH HT1
TERMINALS
ARRAY 1
GND.
N
Ø1
Ø2
Ø3
(6A MAX.) GND.
DRIVERS
INTERLOCK
LINE
SEE LINE VOLTAGE CONNECTION DIAGRAM
5 6
1F -> 5A
ELENOS
T20000 MAIN CONNECTION
DIAGRAM
1

Part list of Sheet # 1

Terminals array 1	6 contact + 5 with fuse		
Terminals array 1	8 contact		
Main Switch	380 V 25 A		
Switch HT 1	400V 3-Phase 45 KW		
Switch HT 2	400V 3-Phase 45 KW		
T. PROT. 1	Thermal Protection	29A-380V	50A-220V
Blower switch	380V 3-Phase	Prot. 1.5-2.6A	
Main Blower	0.75HP 380V 1.6A		

Sheet # 2

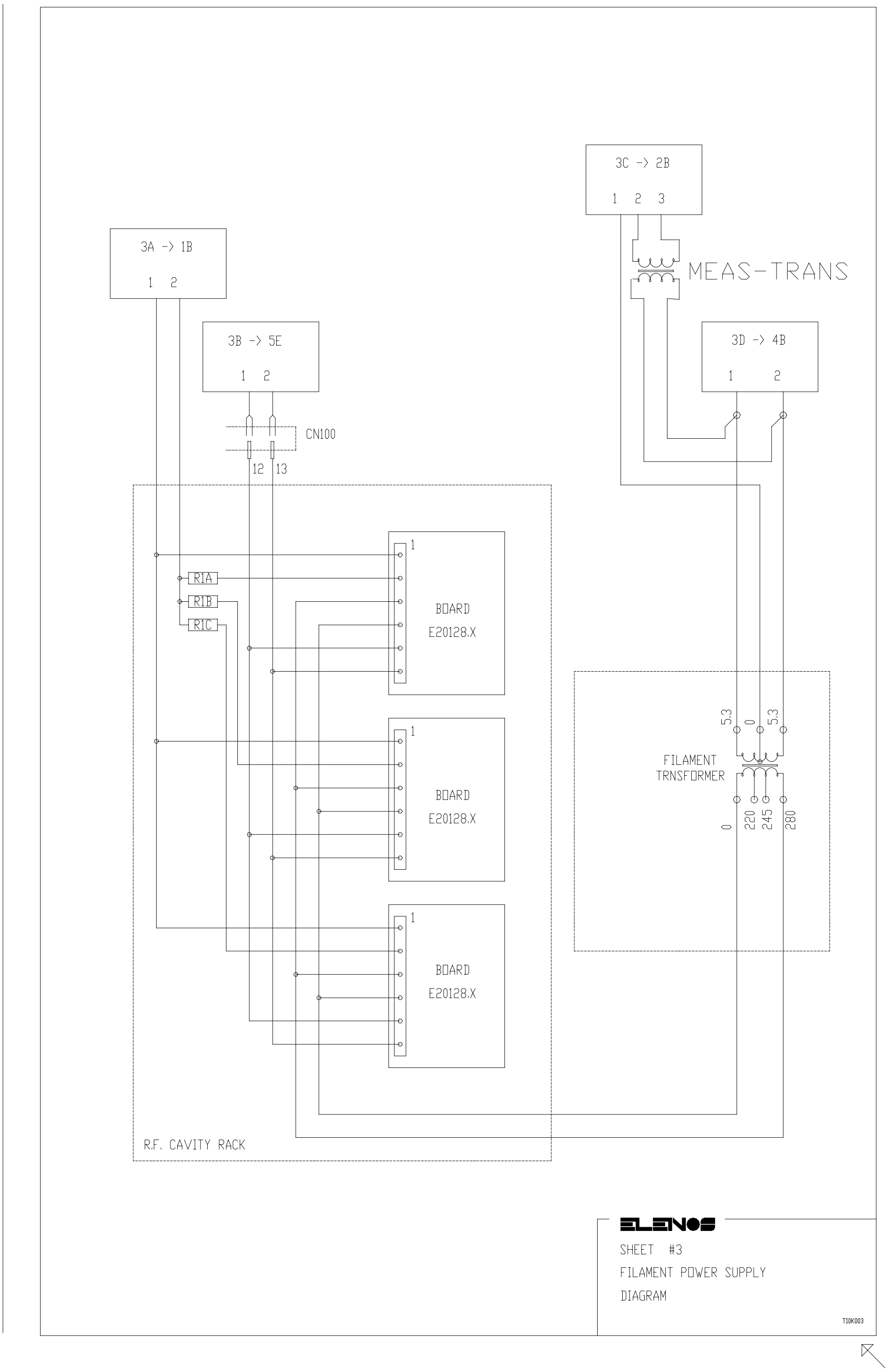


2A -> 1G
Ø1 Ø2 Ø3
2B -> 5I
1 2
TERMINALS
ARRAY 1
SW1
SW2
SW3
SW4
SW5
SW6
SW7
SW8
THERMAL
PROBE
ANODE TRANSFORMER
5480
5480
E20144
CN1
CN2
C3
R3
R4
D1
D21
L1
1H 5A
BOARD
E20123.X
PRESSURE
SWITCH
FLAT 20 pp
2C -> 5D
BOARD
E20138.X
R1
R2
2D -> 4A
CN100
14 15 10 11
R.F. CAVITY
1 2 3
2B -> 3C
4 3 2 1
2C -> 6A
SHEET # 2
CATHODE/ANODE GRID TUBE
POWER SUPPLY DIAGRAM

Part list of Sheet # 2

Therminals Array 1	1 Contat
SW1 ..... SW8	Connector Security
R1	Wire Resistor 50x400 60 ohm
R2	Wire Resistor 50x400 60 ohm
R3	Wire Resistor 50x400 60 ohm
R4	Wire Resistor 50x400 60 ohm
L1	Inductor 1H 5A
D1	Bridge type KBPC250G
D2	Bridge type KBPC250G
D3	Bridge type KBPC250G
D4	Bridge type KBPC250G
D5	Bridge type KBPC250G
D6	Bridge type KBPC250G
D7	Bridge type KBPC250G
D8	Bridge type KBPC250G
D9	Bridge type KBPC250G
D10	Bridge type KBPC250G
D11	Bridge type KBPC250G
D12	Bridge type KBPC250G
D13	Bridge type KBPC250G
D14	Bridge type KBPC250G
D15	Bridge type KBPC250G
D16	Bridge type KBPC250G
D17	Bridge type KBPC250G
D18	Bridge type KBPC250G
D19	Bridge type KBPC250G
D20	Bridge type KBPC250G
D21	Bridge type KBPC250G
Anode Transformer	28.5 KVA

Sheet # 3

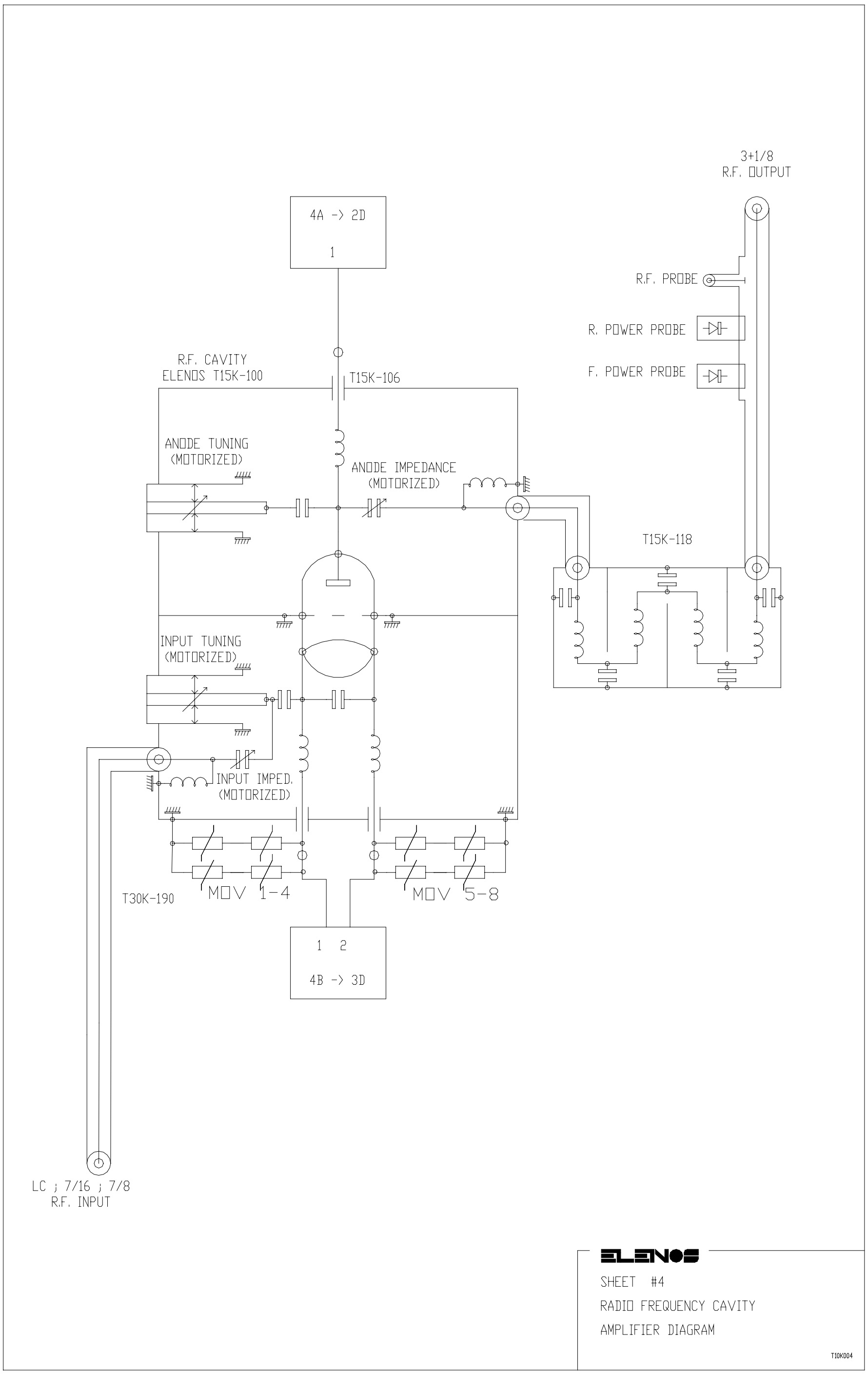


3C -> 2B
1 2 3
MEAS-TRANS
3A -> 1B
1 2
3B -> 5E
1 2
3D -> 4B
1 2
CN100
12 13
R1A
R1B
R1C
BOARD
E20128.X
BOARD
E20128.X
BOARD
E20128.X
FILAMENT
TRNSFORMER
5.3
0
5.3
0
220
245
280
R.F. CAVITY RACK
SHEET #3
FILAMENT POWER SUPPLY
DIAGRAM

Part list sheet # 3

R1A	Wire Resistor 35x100 20 ohm
R1B	Wire Resistor 35x100 20 ohm
R1C	Wire Resistor 35x100 20 ohm
Meas-Tranf	Transformer 1:1 {20V/20V}
Filament Transformer	2 KVA
CN100	AMP cylinder connector 24 pin

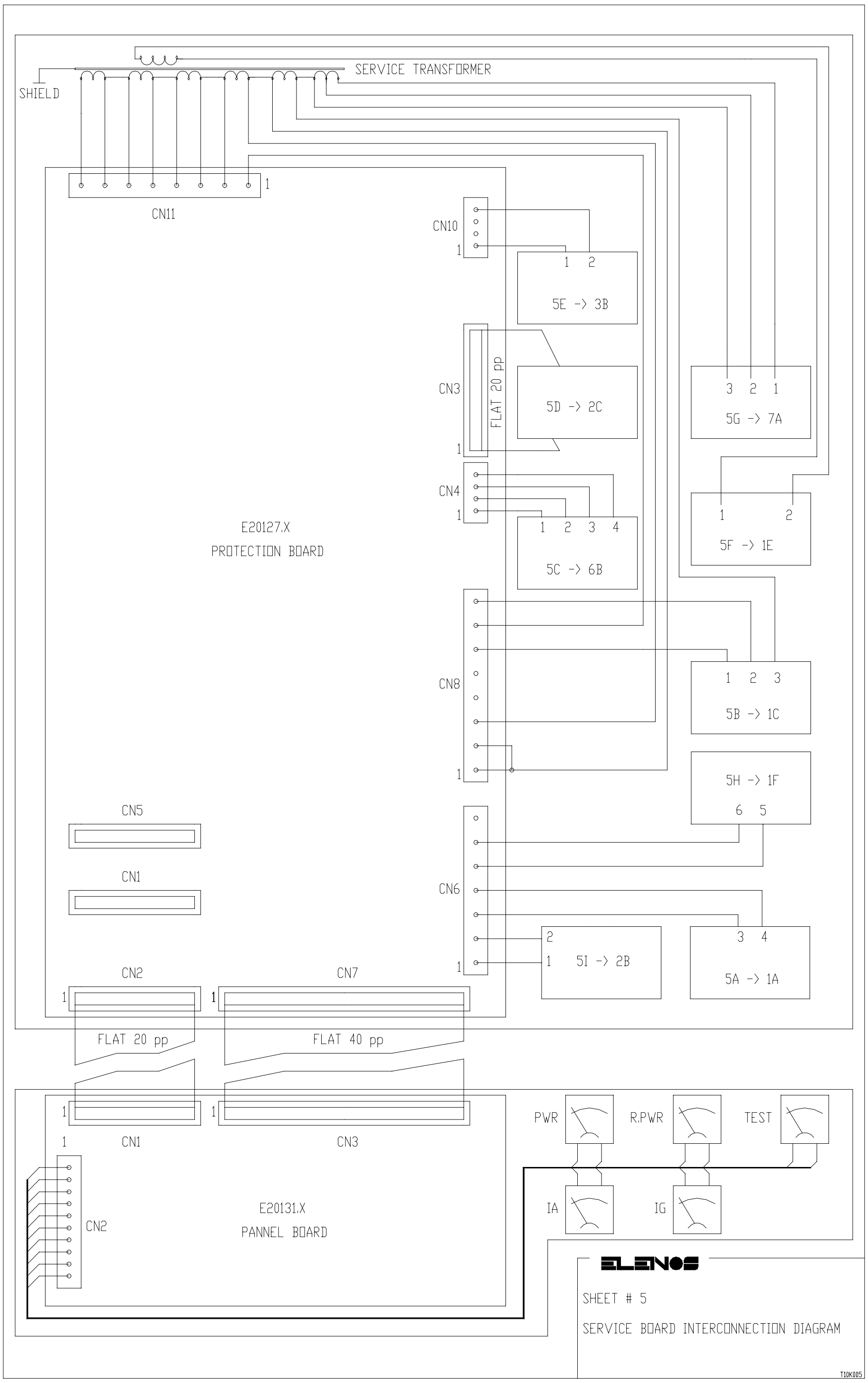
Sheet # 4


3+1/8
R.F. OUTPUT
4A -> 2D
1
R.F. PROBE
R. POWER PROBE
F. POWER PROBE
R.F. CAVITY
ELENOS T15K-100
T15K-106
ANODE TUNING
(MOTORIZED)
ANODE IMPEDANCE
(MOTORIZED)
T15K-118
INPUT TUNING
(MOTORIZED)
INPUT IMPED.
(MOTORIZED)
T30K-190
MOV 1-4
MOV 5-8
1 2
4B -> 3D
LC ; 7/16 ; 7/8
R.F. INPUT
SHEET #4
RADIO FREQUENCY CAVITY
AMPLIFIER DIAGRAM

Part list sheet # 4

MOV 1	MOV type S20K-275
MOV 2	MOV type S20K-275
MOV 3	MOV type S20K-275
MOV 4	MOV type S20K-275
MOV 5	MOV type S20K-275
MOV 6	MOV type S20K-275
MOV 7	MOV type S20K-275
MOV 8	MOV type S20K-275
R.F. CAVITY	ELENOS 15K-100 + ELENOS 15K-106
OUTPUT FILTER	ELENOS T15K-118

Sheet # 5

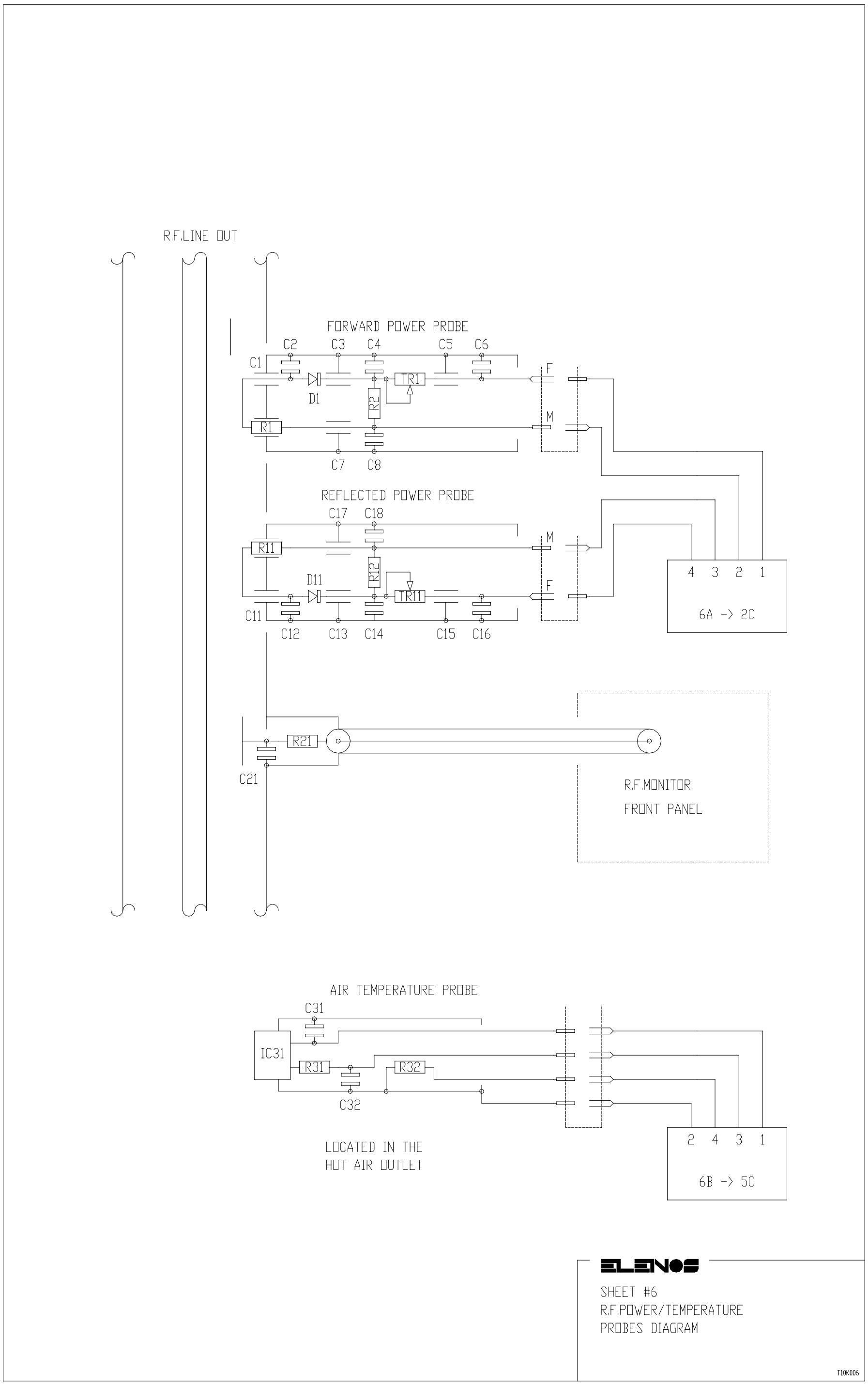


SERVICE TRANSFORMER
SHIELD
CN11
CN10
1 2
5E -> 3B
CN3
FLAT 20 pp
5D -> 2C
3 2 1
5G -> 7A
CN4
1 2 3 4
5C -> 6B
1 2
5F -> 1E
E20127.X
PROTECTION BOARD
CN8
1 2 3
5B -> 1C
5H -> 1F
6 5
CN5
CN1
CN6
2
1
5I -> 2B
3 4
5A -> 1A
CN2
CN7
FLAT 20 pp
FLAT 40 pp
CN1
CN3
PWR
R.PWR
TEST
IA
IG
CN2
E20131.X
PANNEL BOARD
SHEET # 5
SERVICE BOARD INTERCONNECTION DIAGRAM

Part list sheet # 5

PWR	Meter 100uA f.s. M3D
R.PWR	Meter 100uA f.s. M3D
TEST	Meter 100uA f.s. M3D
IA	Meter 100uA f.s. M3D
IG	Meter 100uA f.s. M3D
S.T.	220-8/14/24/11/16 V

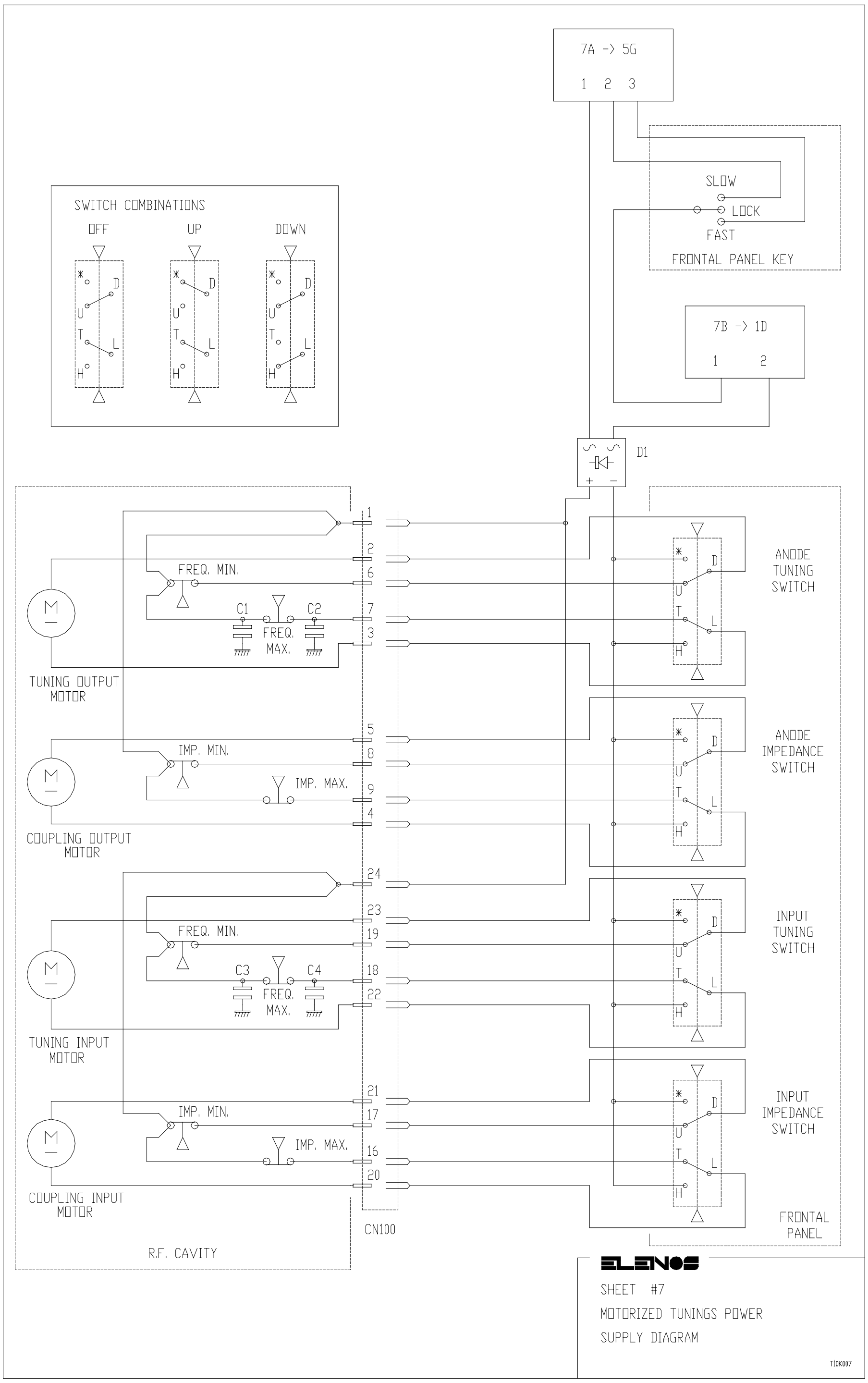
Sheet # 6


R.F.LINE OUT
FORWARD POWER PROBE
C1
C2
C3
C4
C5
C6
D1
TR1
R2
R1
F
M
C7
C8
REFLECTED POWER PROBE
C17
C18
R11
R12
D11
TR11
M
F
C11
C12
C13
C14
C15
C16
4 3 2 1
6A -> 2C
R21
C21
R.F.MONITOR
FRONT PANEL
AIR TEMPERATURE PROBE
C31
IC31
R31
R32
C32
LOCATED IN THE
HOT AIR OUTLET
2 4 3 1
6B -> 5C
ELENOS
SHEET #6
R.F.POWER/TEMPERATURE
PROBES DIAGRAM

Part list sheet # 6

R1	Resistor	0.25W	180	1%
R2	Resistor	0.25W	2700	1%
R11	Resistor	0.25W	180	1%
R12	Resistor	0.25W	18 K	1%
R21	Resistor	0.25W	49.9	1%
R31	Resistor	0.25W	6980	1%
R32	Resistor	0.25W	6980	1%
TR1	Trimmer type 67WR200K			
TR11	Trimmer type 67WR20K			
C1	Ceramic F.P. Capacitor	3 pF		
C2	Ceramic Capacitor	22 pF		
C3	Ceramic F.P. Capacitor	1000 pF		
C4	Ceramic Capacitor	4700 pF		
C5	Ceramic F.P. Capacitor	1000 pF		
C6	Ceramic Capacitor	4700 pF		
C7	Ceramic F.P. Capacitor	1000 pF		
C8	Ceramic Capacitor	4700 pF		
C11	Ceramic F.P. Capacitor	3 pF		
C12	Ceramic Capacitor	22 pF		
C13	Ceramic F.P. Capacitor	1000 pF		
C14	Ceramic Capacitor	4700 pF		
C15	Ceramic F.P. Capacitor	1000 pF		
C16	Ceramic Capacitor	4700 pF		
C17	Ceramic F.P. Capacitor	1000 pF		
C18	Ceramic Capacitor	4700 pF		
C21	Ceramic Capacitor	22 pF		
C31	Ceramic Capacitor	4700 pF		
C32	Ceramic Capacitor	4700 pF		
D1	Diode type AA118			
D11	Diode type AA118			

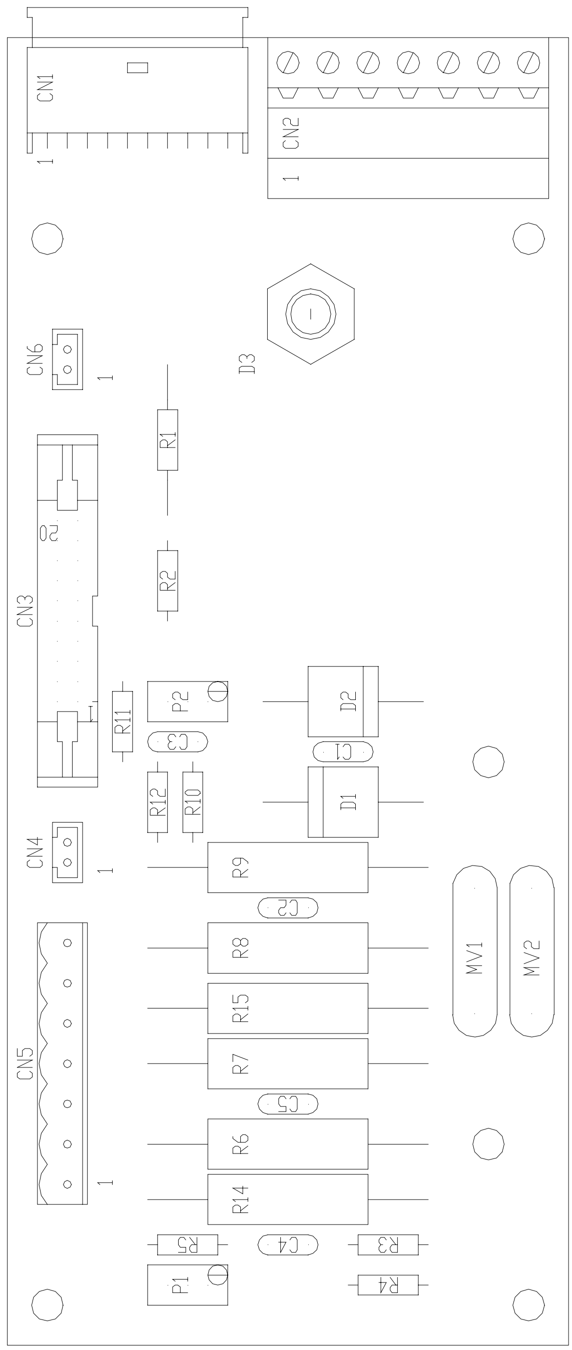
Sheet # 7


7A -> 5G
1 2 3
SLOW
LOCK
FAST
FRONTAL PANEL KEY
SWITCH COMBINATIONS
OFF
UP
DOWN
7B -> 1D
1 2
D1
FREQ. MIN.
C1
C2
FREQ. MAX.
TUNING OUTPUT MOTOR
IMP. MIN.
IMP. MAX.
COUPLING OUTPUT MOTOR
C3
C4
TUNING INPUT MOTOR
COUPLING INPUT MOTOR
R.F. CAVITY
CN100
ANODE TUNING SWITCH
ANODE IMPEDANCE SWITCH
INPUT TUNING SWITCH
INPUT IMPEDANCE SWITCH
FRONTAL PANEL
ELENOS
SHEET #7
MOTORIZED TUNINGS POWER
SUPPLY DIAGRAM
T10K007

Part list Sheet # 7

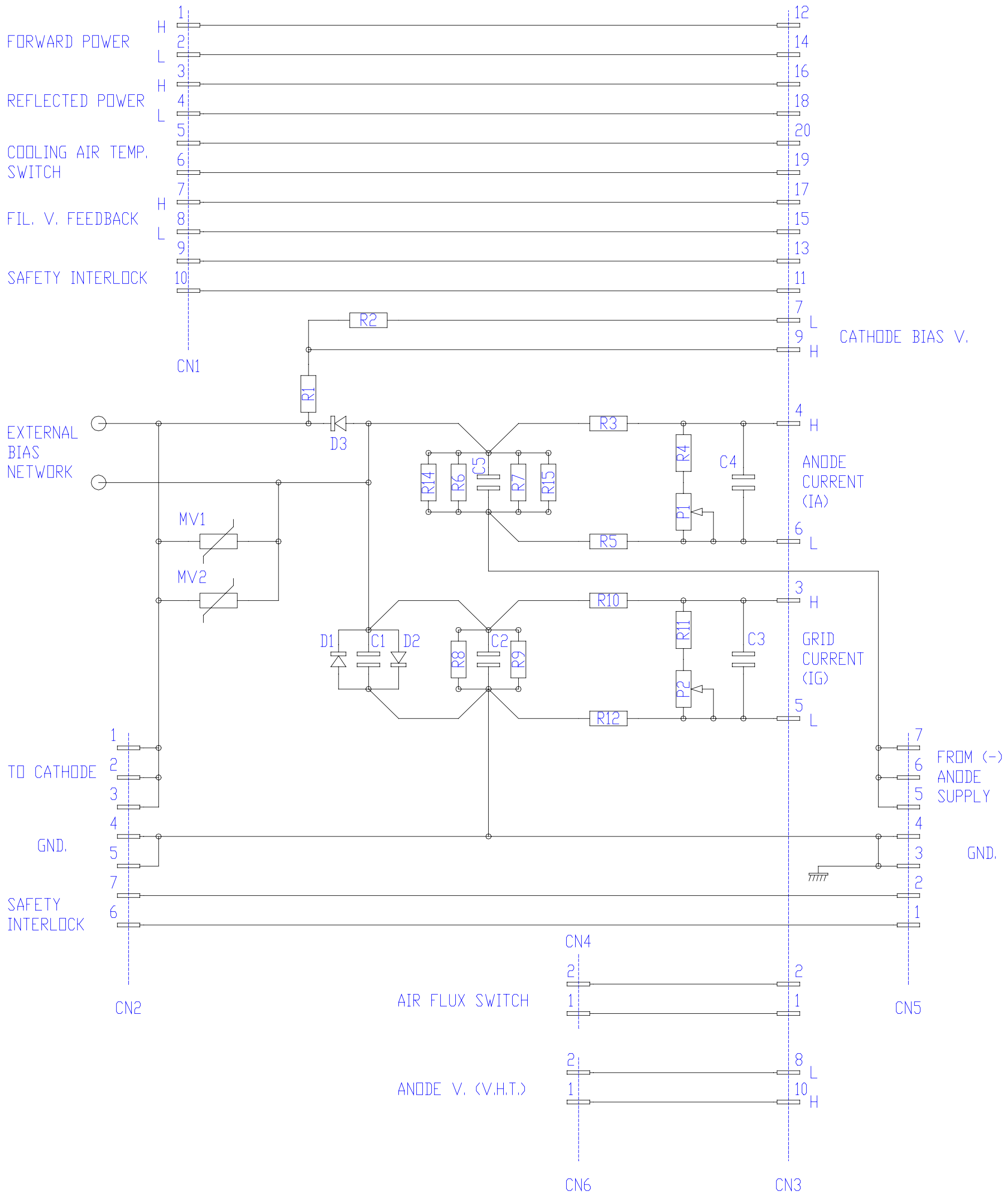
D1	Bridge type KBPC250G
Tuning Output Motor	Motor type 36.10.5
Coupling Output Motor	Motor type 36.10.5
Tuning Input Motor	Motor type 36.10.5
Coupling Input Motor	Motor type 1.61.013.325
Anode Tuning Switch	Switch Togle 2-Way 3-Pos. 131FL
Anode Impedance Switch	Switch Togle 2-Way 3-Pos. 131FL
Input Tuning Switch	Switch Togle 2-Way 3-Pos. 131FL
Input Impedance Switch	Switch Togle 2-Way 3-Pos. 131FL
F. P. Key	Selector 3-pos with Key

Layout E20123.3



Cathode bias and signals conveyor board

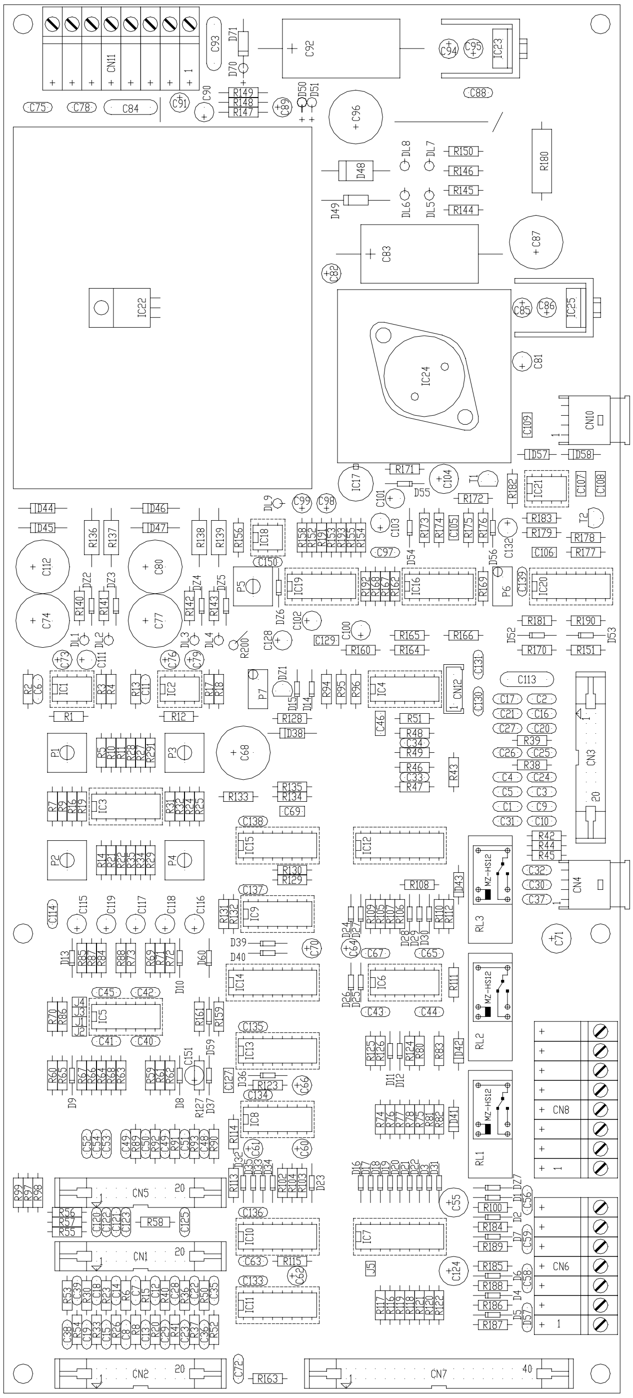
Electrical diagram E20123.3



Part list E20123.3

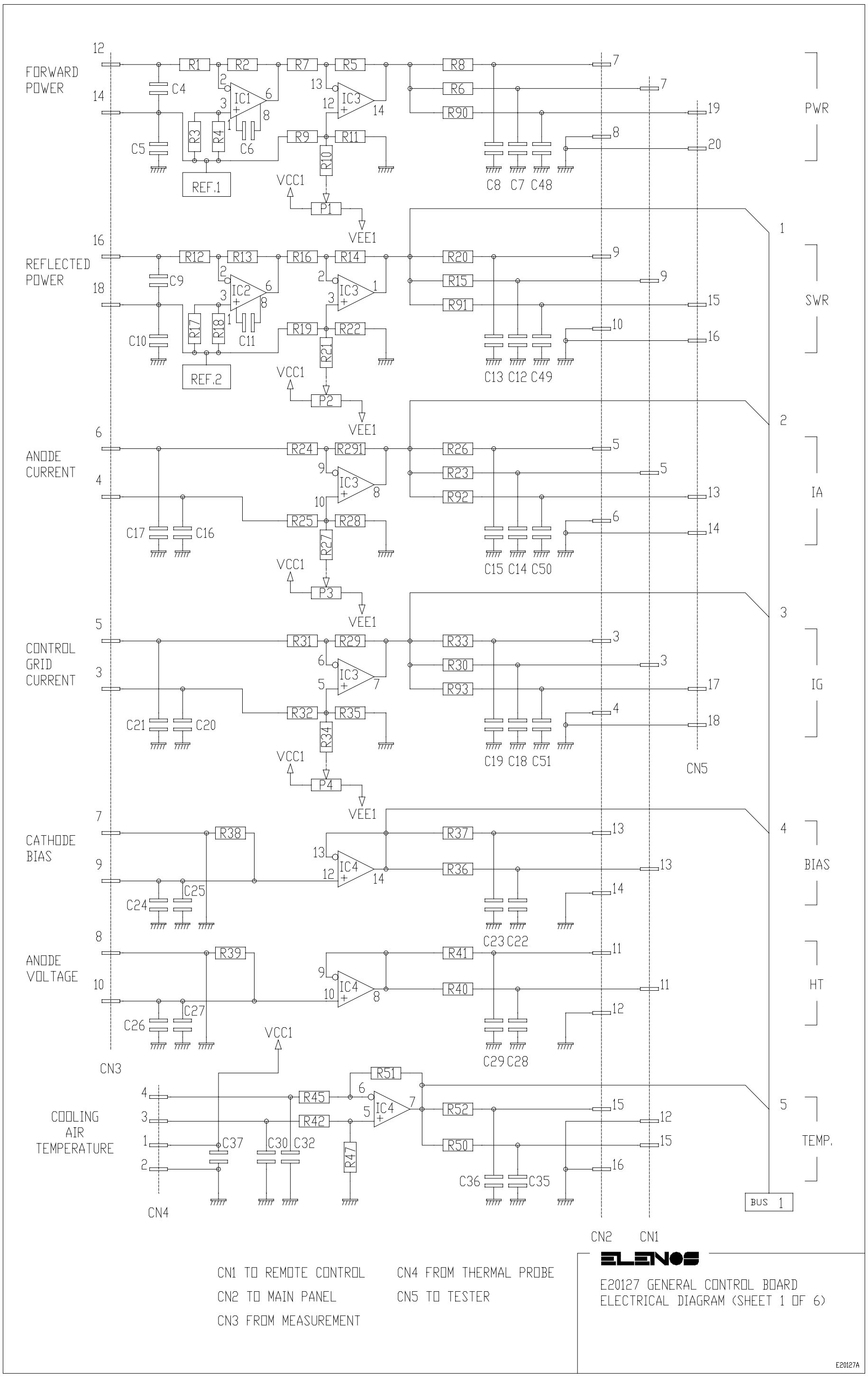
R1	Resistor	0.25W	100K	5%
R2	Resistor	0.25W	1k	1%
R3	Resistor	0.25W	49.9	1%
R4	Resistor	0.25W	49.9	1%
R5	Resistor	0.25W	49.9	1%
R6	Resistor	5W	0.12	1%
R7	Resistor	5W	0.12	1%
R8	Resistor	5W	0.12	1%
R9	Resistor	5W	0.12	1%
R10	Resistor	0.25W	49.9	1%
R11	Resistor	0.25W	100	1%
R12	Resistor	0.25W	49.9	1%
R14	Resistor	5W	0.12	1%
R15	Resistor	5W	0.12	1%
P1	Trimmer type 67WR100			
P2	Trimmer type 67WR100			
C1	Ceramic Capacitor	100nF	63V	
C2	Ceramic Capacitor	100nF	63V	
C3	Ceramic Capacitor	100nF	63V	
C4	Ceramic Capacitor	100nF	63V	
C5	Ceramic Capacitor	100nF	63V	
D1	Diode type P600			
D2	Diode type P600			
D3	Diode type 16F120			
MV1	MOV type S20K-275			
MV2	MOV type S20K-275			
CN1	AMP connector 10 pin 90 deg.			
CN2	PHOENIX connector 7 pin 90 deg.			
CN3	ANSLEY connector 2x10 pin			
CN4	AMP connector 2 pin			
CN5	PHOENIX connector 7 pin 90 deg.			
CN6	AMP connector 2 pin			

Layout E20127

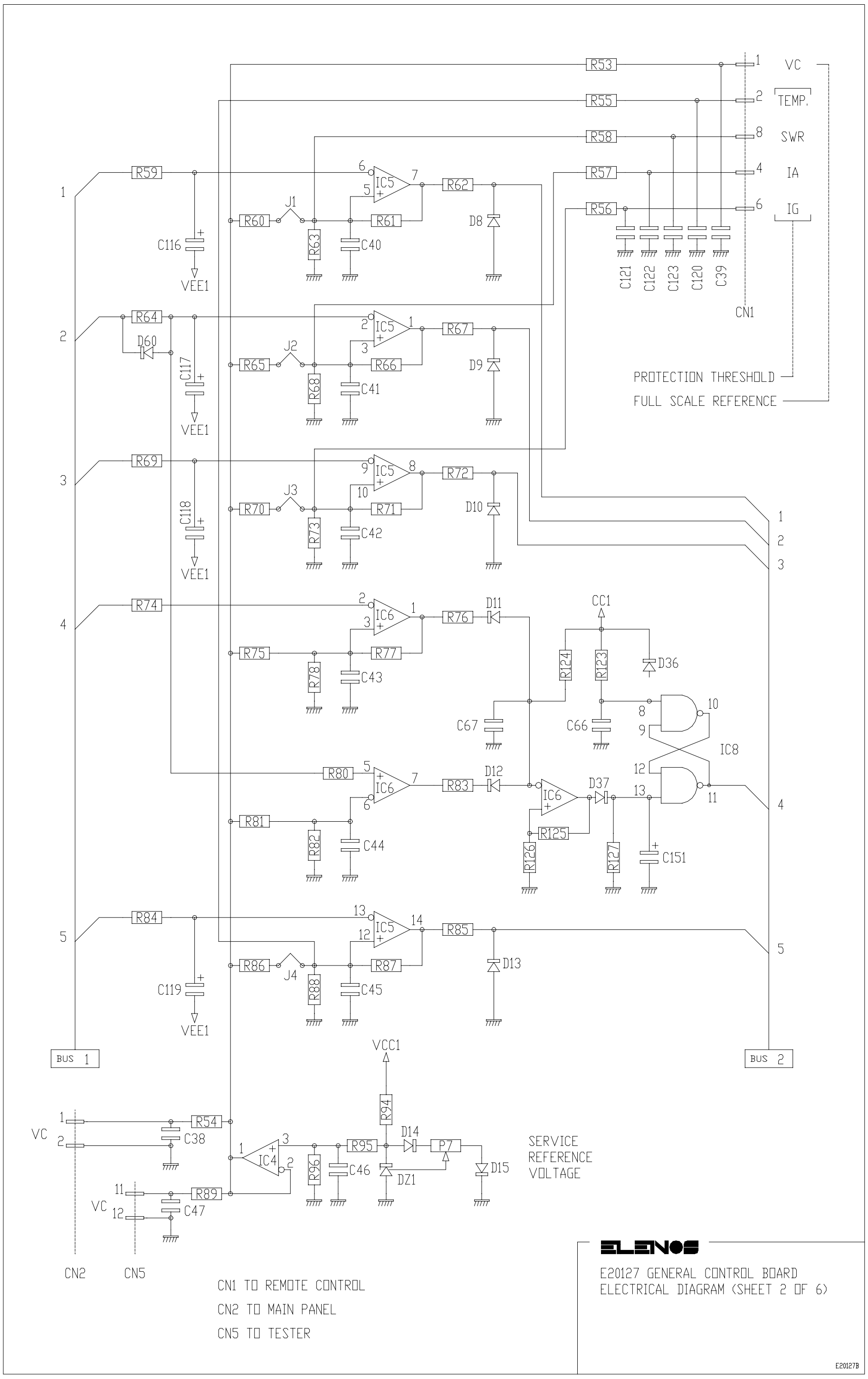


General control board layout

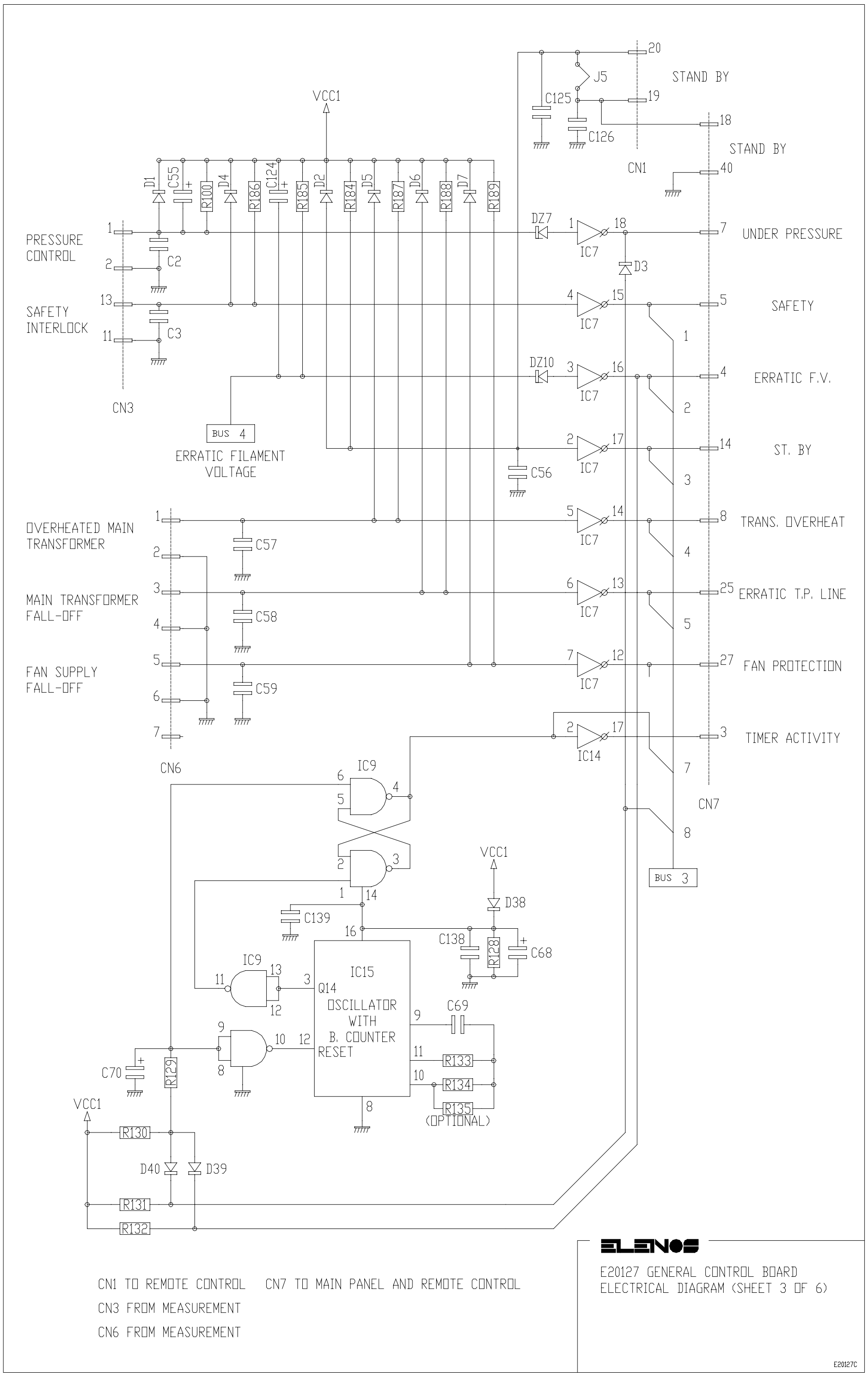
Electrical diagram E20127 (1 of 6)



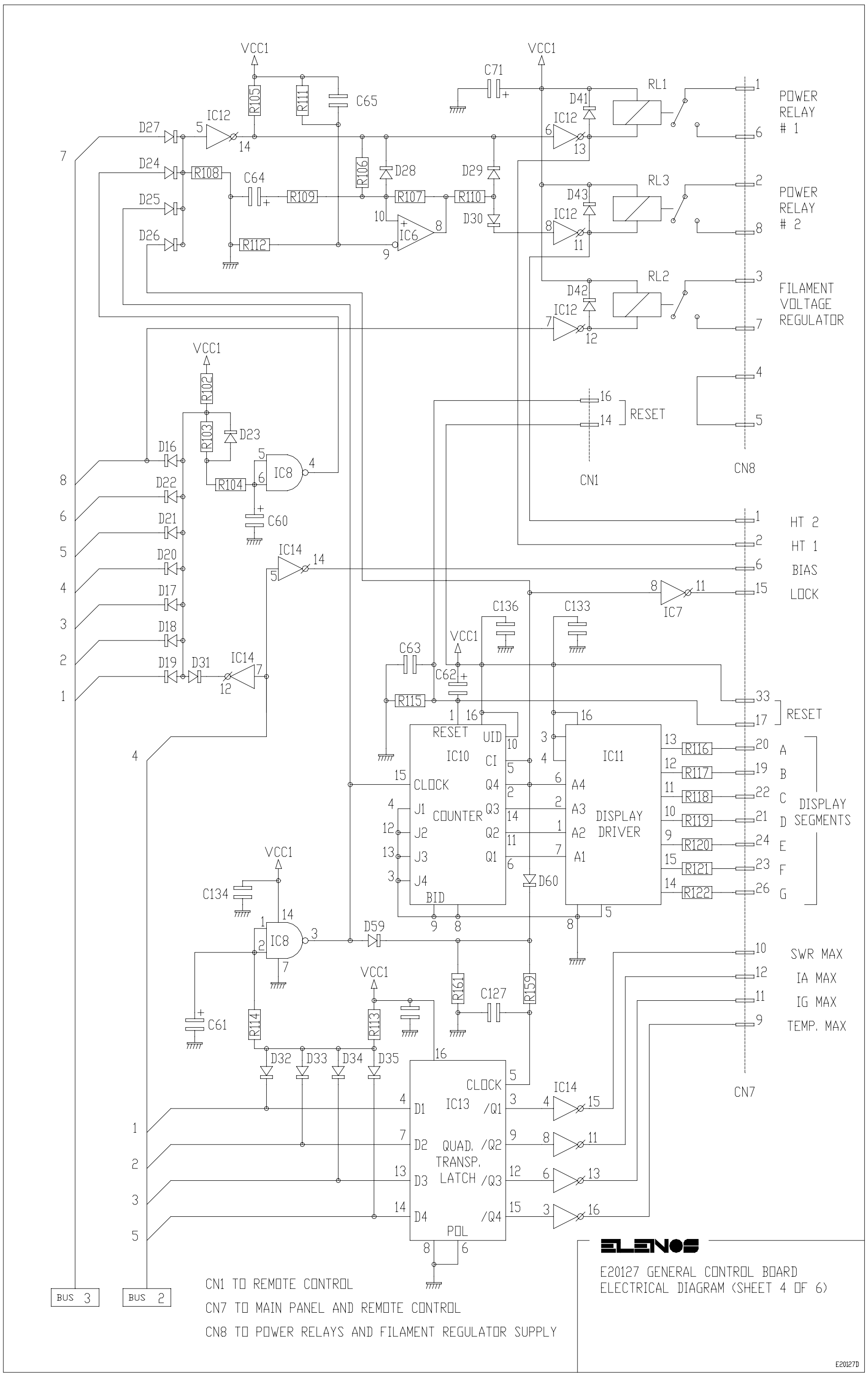
Electrical diagram E20127 (2 of 6)



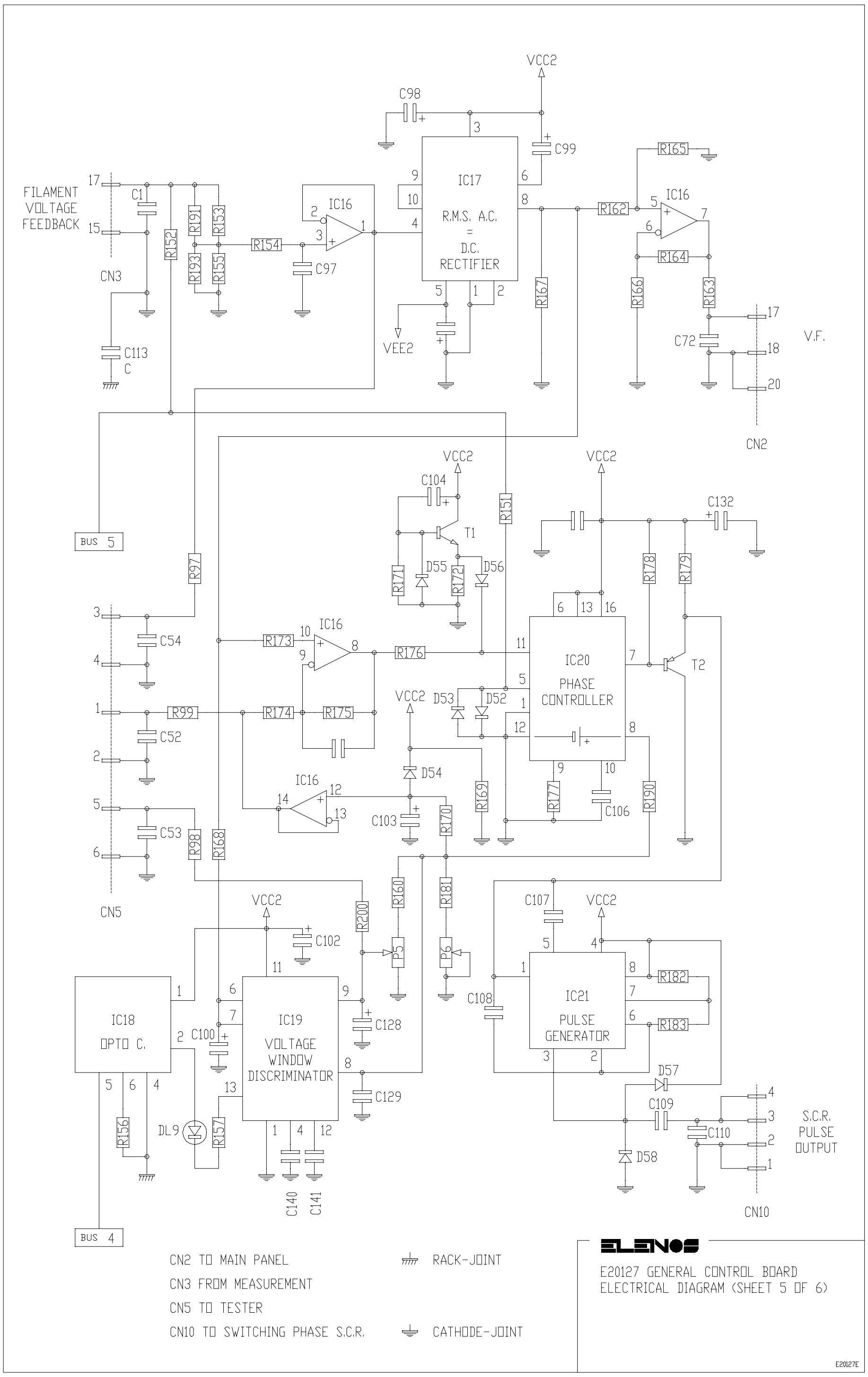
Electrical diagram E20127 (3 of 6)



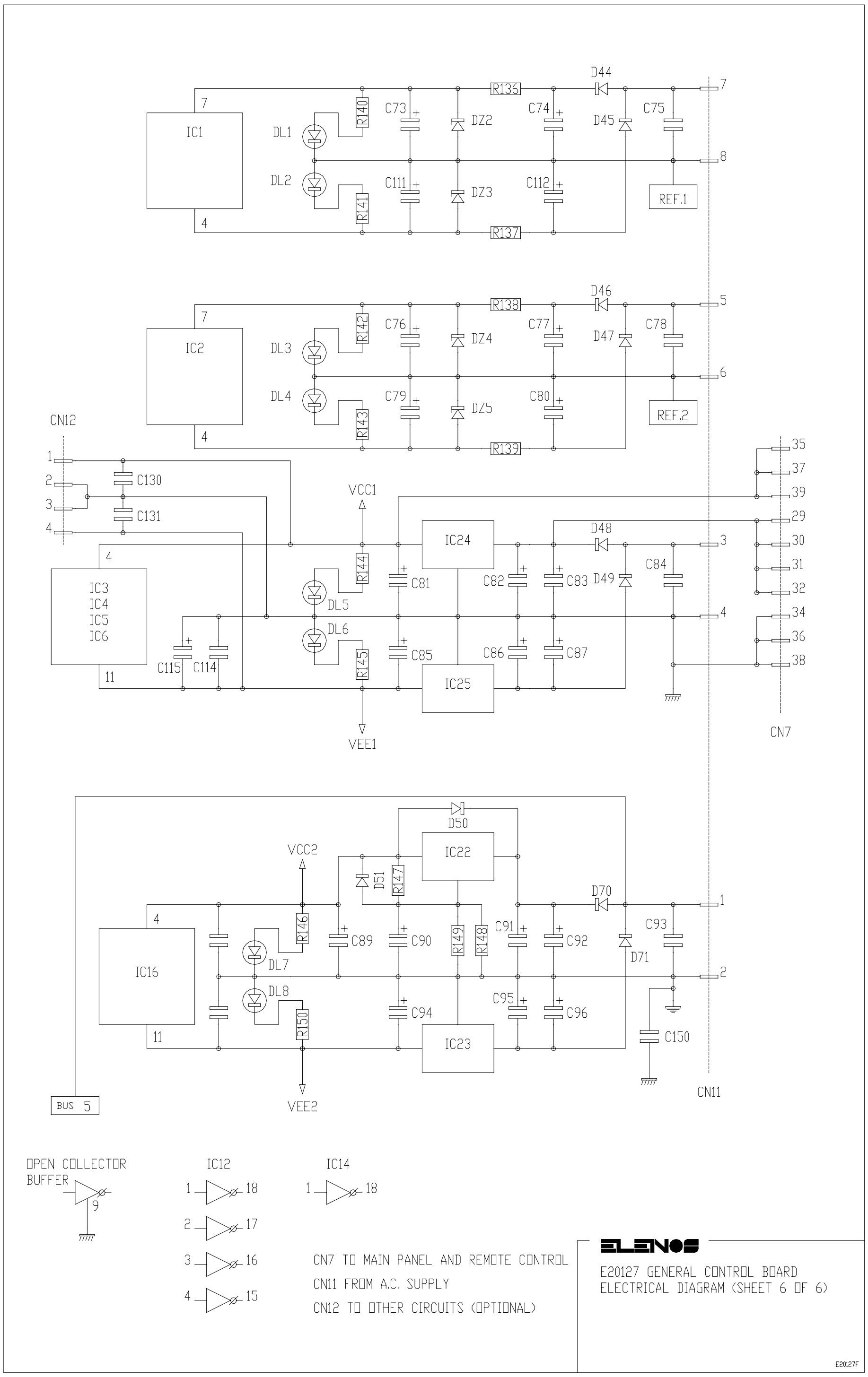
Electrical diagram E20127 (4 of 6)



Electrical diagram E20127 (5 of 6)



Electrical diagram E20127 (6 of 6)



Part list E20127

R1	Resistor	1300	0.25 W	1%
R2	Resistor	2000	0.25 W	1%
R3	Resistor	1300	0.25 W	1%
R4	Resistor	2000	0.25 W	1%
R5	Resistor	34 K	0.25 W	1%
R6	Resistor	100	0.25 W	1%
R7	Resistor	1020	0.25 W	1%
R8	Resistor	100	0.25 W	1%
R9	Resistor	1020	0.25 W	1%
R10	Resistor	1 M	0.25 W	1%
R11	Resistor	34 K	0.25 W	1%
R12	Resistor	1300	0.25 W	1%
R13	Resistor	2000	0.25 W	1%
R14	Resistor	34 K	0.25 W	1%
R15	Resistor	100	0.25 W	1%
R16	Resistor	1020	0.25 W	1%
R17	Resistor	1300	0.25 W	1%
R18	Resistor	2000	0.25 W	1%
R19	Resistor	1020	0.25 W	1%
R20	Resistor	100	0.25 W	1%
R21	Resistor	1 M	0.25 W	1%
R22	Resistor	34 K	0.25 W	1%
R23	Resistor	100	0.25 W	1%
R24	Resistor	1020	0.25 W	1%
R25	Resistor	1020	0.25 W	1%
R26	Resistor	100	0.25 W	1%
R27	Resistor	1 M	0.25 W	1%
R28	Resistor	34 K	0.25 W	1%
R29	Resistor	34 K	0.25 W	1%
R30	Resistor	100	0.25 W	1%
R31	Resistor	1020	0.25 W	1%
R32	Resistor	1020	0.25 W	1%
R33	Resistor	100	0.25 W	1%
R34	Resistor	1 M	0.25 W	1%
R35	Resistor	34 K	0.25 W	1%
R36	Resistor	100	0.25 W	1%
R37	Resistor	100	0.25 W	1%
R38	Resistor	34 K	0.25 W	1%
R39	Resistor	34 K	0.25 W	1%
R40	Resistor	100	0.25 W	1%
R41	Resistor	100	0.25 W	1%
R42	Resistor	10 K	0.25 W	1%
R45	Resistor	10 K	0.25 W	1%
R47	Resistor	34 K	0.25 W	1%
R50	Resistor	100	0.25 W	1%
R51	Resistor	34 K	0.25 W	1%
R52	Resistor	100	0.25 W	1%
R53	Resistor	100	0.25 W	1%
R54	Resistor	27	0.25 W	1%
R55	Resistor	100	0.25 W	1%

Part list E20127

R56	Resistor	100	0.25 W	1%
R57	Resistor	100	0.25 W	1%
R58	Resistor	100	0.25 W	1%
R59	Resistor	10K	0.25 W	1%
R60	Resistor	15K	0.25 W	1%
R61	Resistor	10 M	0.25 W	1%
R62	Resistor	10K	0.25 W	1%
R63	Resistor	10K	0.25 W	1%
R65	Resistor	3.3K	0.25 W	1%
R66	Resistor	10 M	0.25 W	1%
R67	Resistor	10K	0.25 W	1%
R68	Resistor	1 K	0.25 W	1%
R69	Resistor	100 K	0.25 W	1%
R70	Resistor	10 K	0.25 W	1%
R71	Resistor	10 M	0.25 W	1%
R72	Resistor	10K	0.25 W	1%
R73	Resistor	10K	0.25 W	1%
R74	Resistor	10 K	0.25 W	1%
R75	Resistor	100 K	0.25 W	1%
R76	Resistor	10 K	0.25 W	1%
R77	Resistor	10 M	0.25 W	1%
R78	Resistor	10 K	0.25 W	1%
R80	Resistor	1 K	0.25 W	1%
R81	Resistor	4750	0.25 W	1%
R82	Resistor	10 K	0.25 W	1%
R83	Resistor	10 K	0.25 W	1%
R84	Resistor	10 K	0.25 W	1%
R85	Resistor	10 K	0.25 W	1%
R86	Resistor	1.8 K	0.25 W	5%
R87	Resistor	10 M	0.25 W	1%
R88	Resistor	10 K	0.25 W	1%
R89	Resistor	100	0.25 W	1%
R90	Resistor	100	0.25 W	1%
R91	Resistor	100	0.25 W	1%
R92	Resistor	100	0.25 W	1%
R93	Resistor	100	0.25 W	1%
R94	Resistor	6810	0.25 W	1%
R95	Resistor	34 K	0.25 W	1%
R96	Resistor	137 K	0.25 W	1%
R97	Resistor	100	0.25 W	1%
R98	Resistor	100	0.25 W	1%
R99	Resistor	100	0.25 W	1%
R100	Resistor	10 K	0.25 W	1%
R102	Resistor	1K	0.25 W	1%
R103	Resistor	100 K	0.25 W	1%
R104	Resistor	10 K	0.25 W	1%
R105	Resistor	10 K	0.25 W	1%
R106	Resistor	100 K	0.25 W	1%
R107	Resistor	10 M	0.25 W	1%
R108	Resistor	10 K	0.25 W	1%

Part list E20127

R109	Resistor	100	0.25 W	1%
R110	Resistor	10 K	0.25 W	1%
R111	Resistor	10 K	0.25 W	1%
R112	Resistor	10 K	0.25 W	1%
R113	Resistor	100 K	0.25 W	1%
R114	Resistor	100	0.25 W	1%
R115	Resistor	10 K	0.25 W	1%
R116	Resistor	1K	0.25 W	1%
R117	Resistor	1K	0.25 W	1%
R118	Resistor	1 K	0.25 W	1%
R119	Resistor	1 K	0.25 W	1%
R120	Resistor	1 K	0.25 W	1%
R121	Resistor	1 K	0.25 W	1%
R122	Resistor	1 K	0.25 W	1%
R123	Resistor	100 K	0.25 W	1%
R124	Resistor	100 K	0.25 W	1%
R125	Resistor	10 M	0.25 W	1%
R126	Resistor	10 K	0.25 W	1%
R127	Resistor	4750	0.25 W	1%
R128	Resistor	1 K	0.25 W	1%
R129	Resistor	100 K	0.25 W	1%
R130	Resistor	10 K	0.25 W	1%
R131	Resistor	10 K	0.25 W	1%
R132	Resistor	10 K	0.25 W	1%
R133	Resistor	475 K	0.25 W	1%
R134	Resistor	150 K	0.25 W	1%
R136	Resistor	150	0.5 W	5%
R137	Resistor	150	0.5 W	5%
R138	Resistor	150	0.5 W	5%
R139	Resistor	150	0.5 W	5%
R140	Resistor	100	0.25 W	1%
R141	Resistor	100	0.25 W	1%
R142	Resistor	100	0.25 W	1%
R143	Resistor	100	0.25 W	1%
R144	Resistor	1 K	0.25 W	1%
R145	Resistor	1 K	0.25 W	1%
R146	Resistor	1 K	0.25 W	1%
R147	Resistor	1 K	0.25 W	1%
R148	Resistor	15 K	0.25 W	1%
R149	Resistor	22 K	0.25 W	1%
R150	Resistor	1 K	0.25 W	1%
R151	Resistor	15 K	0.25 W	1%
R152	Resistor	2.2 K	0.25 W	1%
R153	Resistor	2870	0.25 W	1%
R154	Resistor	10 K	0.25 W	1%
R155	Resistor	1 K	0.25 W	1%
R156	Resistor	150 K	0.25 W	1%
R158	Resistor	1 K	0.25 W	1%
R159	Resistor	100 K	0.25 W	1%
R160	Resistor	100 K	0.25 W	1%

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R161	Resistor	100 K	0.25 W	1%
R162	Resistor	10 K	0.25 W	1%
R163	Resistor	100	0.25 W	1%
R164	Resistor	15 K	0.25 W	1%
R165	Resistor	15 K	0.25 W	1%
R166	Resistor	10 K	0.25 W	1%
R167	Resistor	10 K	0.25 W	1%
R168	Resistor	10 K	0.25 W	1%
R169	Resistor	10 K	0.25 W	1%
R170	Resistor	475 K	0.25 W	1%
R171	Resistor	475 K	0.25 W	1%
R172	Resistor	475 K	0.25 W	1%
R173	Resistor	6810	0.25 W	1%
R174	Resistor	1 K	0.25 W	1%
R175	Resistor	475 K	0.25 W	1%
R176	Resistor	2.2 K	0.25 W	5%
R177	Resistor	82 K	0.25 W	5%
R178	Resistor	10 K	0.25 W	1%
R179	Resistor	10 K	0.25 W	1%
R180	Resistor	270	2 W	5%
R181	Resistor	10 K	0.25 W	1%
R182	Resistor	6810	0.25 W	1%
R183	Resistor	6810	0.25 W	1%
R184	Resistor	10 K	0.25 W	1%
R185	Resistor	10 K	0.25 W	1%
R186	Resistor	10 K	0.25 W	1%
R187	Resistor	10 K	0.25 W	1%
R188	Resistor	10 K	0.25 W	1%
R189	Resistor	10 K	0.25 W	1%
R190	Resistor	6810	0.25 W	1%
R191	Resistor	10 K	0.25 W	1%
R200	Resistor	1 K	0.25 W	1%
R291	Resistor	34 K	0.25 W	1%
P1	Trimmer type 72P100K			
P2	Trimmer type 72P100K			
P3	Trimmer type 72P100K			
P4	Trimmer type 72P100K			
P5	Trimmer type 72P10K			
P6	Trimmer type 67W10K			
P7	Trimmer type 67W10K			
C1	Ceramic Capacitor	4.7 nF	50V	
C2	Ceramic Capacitor	4.7 nF	50V	
C3	Ceramic Capacitor	4.7 nF	50V	
C4	Ceramic Capacitor	4.7 nF	50V	
C5	Ceramic Capacitor	4.7 nF	50V	
C6	Ceramic Capacitor	33 pF	50V	
C7	Ceramic Capacitor	4.7 nF	50V	
C8	Ceramic Capacitor	4.7 nF	50V	
C9	Ceramic Capacitor	4.7 nF	50V	
C10	Ceramic Capacitor	4.7 nF	50V	

Part list E20127

C11	Ceramic Capacitor	33 pF	50V
C12	Ceramic Capacitor	4.7 nF	50V
C13	Ceramic Capacitor	4.7 nF	50V
C14	Ceramic Capacitor	4.7 nF	50V
C15	Ceramic Capacitor	4.7 nF	50V
C16	Ceramic Capacitor	4.7 nF	50V
C17	Ceramic Capacitor	4.7 nF	50V
C18	Ceramic Capacitor	4.7 nF	50V
C19	Ceramic Capacitor	4.7 nF	50V
C20	Ceramic Capacitor	4.7 nF	50V
C21	Ceramic Capacitor	4.7 nF	50V
C22	Ceramic Capacitor	4.7 nF	50V
C23	Ceramic Capacitor	4.7 nF	50V
C24	Ceramic Capacitor	4.7 nF	50V
C25	Mylar Capacitor	4.7 nF	50V
C26	Ceramic Capacitor	220 nF	63V
C27	Mylar Capacitor	100 nF	63V
C28	Ceramic Capacitor	4.7 nF	50V
C29	Ceramic Capacitor	4.7 nF	50V
C30	Ceramic Capacitor	4.7 nF	50V
C31	Ceramic Capacitor	4.7 nF	50V
C32	Ceramic Capacitor	4.7 nF	50V
C35	Ceramic Capacitor	4.7 nF	50V
C36	Ceramic Capacitor	4.7 nF	50V
C37	Ceramic Capacitor	4.7 nF	50V
C38	Ceramic Capacitor	4.7 nF	50V
C39	Ceramic Capacitor	4.7 nF	50V
C40	Ceramic Capacitor	100 nF	63V
C41	Ceramic Capacitor	100 nF	63V
C42	Ceramic Capacitor	100 nF	63V
C43	Ceramic Capacitor	100 nF	63V
C44	Ceramic Capacitor	100 nF	63V
C45	Ceramic Capacitor	100 nF	63V
C46	Mylar Capacitor	100 nF	63V
C47	Ceramic Capacitor	4.7 nF	50V
C48	Ceramic Capacitor	4.7 nF	50V
C49	Ceramic Capacitor	4.7 nF	50V
C50	Ceramic Capacitor	4.7 nF	50V
C51	Ceramic Capacitor	4.7 nF	50V
C52	Ceramic Capacitor	4.7 nF	50V
C53	Ceramic Capacitor	4.7 nF	50V
C54	Ceramic Capacitor	4.7 nF	50V
C55	Electr. Vert. Capacitor	100 uF	35V
C56	Ceramic Capacitor	4.7 nF	50V
C57	Ceramic Capacitor	4.7 nF	50V
C58	Ceramic Capacitor	4.7 nF	50V
C59	Ceramic Capacitor	4.7 nF	50V
C60	Electr. Vert. Capacitor	10 uF	35V
C61	Electr. Vert. Capacitor	10 uF	35V
C62	Electr. Vert. Capacitor	10 uF	35V

Part list E20127

C63	Ceramic Capacitor	4.7 nF	50V
C64	Electr. Vert. Capacitor	10 uF	35V
C65	Ceramic Capacitor	100 nF	63V
C66	Electr. Vert. Capacitor	10 uF	35V
C67	Ceramic Capacitor	100 nF	63V
C68	Electr. Vert. Capacitor	1000 uF	40V
C69	Mylar Capacitor	100 nF	63V
C70	Electr. Vert. Capacitor	10 uF	35V
C71	Electr. Vert. Capacitor	100 uF	35V
C72	Ceramic Capacitor	4.7 nF	50V
C73	Electr. Vert. Capacitor	10 uF	35V
C74	Electr. Vert. Capacitor	470 uF	40V
C75	Ceramic Capacitor	4.7 nF	50V
C76	Electr. Vert. Capacitor	10 uF	35V
C77	Electr. Vert. Capacitor	470 uF	40V
C78	Ceramic Capacitor	4.7 nF	50V
C79	Electr. Vert. Capacitor	10 uF	35V
C80	Electr. Vert. Capacitor	470 uF	40V
C81	Electr. Vert. Capacitor	10 uF	35V
C82	Electr. Vert. Capacitor	10 uF	35V
C83	Electr. Axial Capacitor	2200 uF	63V
C84	Ceramic Capacitor	4.7 nF	2KV
C85	Electr. Vert. Capacitor	10 uF	35V
C86	Electr. Vert. Capacitor	10 uF	35V
C87	Electr. Vert. Capacitor	1000 uF	40V
C88	Ceramic Capacitor	4.7 nF	50V
C89	Electr. Vert. Capacitor	10 uF	35V
C90	Electr. Vert. Capacitor	10 uF	35V
C91	Electr. Vert. Capacitor	10 uF	35V
C92	Electr. Axial Capacitor	2200 uF	63V
C93	Ceramic Capacitor	4.7 nF	2KV
C94	Electr. Vert. Capacitor	10 uF	35V
C95	Electr. Vert. Capacitor	10 uF	35V
C96	Electr. Vert. Capacitor	1000 uF	40V
C97	Ceramic Capacitor	4.7 nF	50V
C98	Electr. Vert. Capacitor	10 uF	35V
C99	Electr. Vert. Capacitor	10 uF	35V
C100	Electr. Vert. Capacitor	10 uF	35V
C101	Electr. Vert. Capacitor	10 uF	35V
C102	Electr. Vert. Capacitor	10 uF	35V
C103	Tantalum Capacitor	10 uF	35V
C104	Electr. Vert. Capacitor	47 uF	35V
C105	Mylar Capacitor	470 nF	63V
C106	Mylar Capacitor	47 nF	63V
C107	Mylar Capacitor	10 nF	63V
C108	Mylar Capacitor	4.7 nF	63V
C109	Mylar Capacitor	470 nF	63V
C111	Electr. Vert. Capacitor	10 uF	35V
C112	Electr. Vert. Capacitor	470 uF	40V
C113	Ceramic Capacitor	4.7 nF	2KV

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C114	Ceramic Capacitor	100 nF	63V
C115	Electr. Vert. Capacitor	10 uF	35V
C116	Electr. Vert. Capacitor	10 uF	35V
C117	Electr. Vert. Capacitor	10 uF	35V
C118	Electr. Vert. Capacitor	10 uF	35V
C119	Electr. Vert. Capacitor	10 uF	35V
C120	Ceramic Capacitor	4.7 nF	50V
C121	Ceramic Capacitor	4.7 nF	50V
C122	Ceramic Capacitor	4.7 nF	50V
C123	Ceramic Capacitor	4.7 nF	50V
C124	Electr. Vert. Capacitor	100 uF	35V
C125	Ceramic Capacitor	4.7 nF	50V
C127	Mylar Capacitor	100 nF	63V
C128	Electr. Vert. Capacitor	10 uF	35V
C129	Mylar Capacitor	470 nF	63V
C132	Electr. Vert. Capacitor	10 uF	35V
C133	Ceramic Capacitor	100 nF	63V
C134	Ceramic Capacitor	100 nF	63V
C135	Ceramic Capacitor	100 nF	63V
C136	Ceramic Capacitor	100 nF	63V
C137	Ceramic Capacitor	100 nF	63V
C138	Ceramic Capacitor	100 nF	63V
C150	Ceramic Capacitor	4.7 nF	2KV
D1	Diode type 1N4148		
D2	Diode type 1N4148		
D3	Diode type 1N4148		
D4	Diode type 1N4148		
D5	Diode type 1N4148		
D6	Diode type 1N4148		
D7	Diode type 1N4148		
D8	Diode type 1N4148		
D9	Diode type 1N4148		
D10	Diode type 1N4148		
D11	Diode type 1N4148		
D12	Diode type 1N4148		
D13	Diode type 1N4148		
D14	Diode type 1N4148		
D15	Diode type 1N4148		
D16	Diode type 1N4148		
D17	Diode type 1N4148		
D18	Diode type 1N4148		
D19	Diode type 1N4148		
D20	Diode type 1N4148		
D21	Diode type 1N4148		
D22	Diode type 1N4148		
D23	Diode type 1N4148		
D24	Diode type 1N4148		
D25	Diode type 1N4148		
D26	Diode type 1N4148		
D27	Diode type 1N4148		

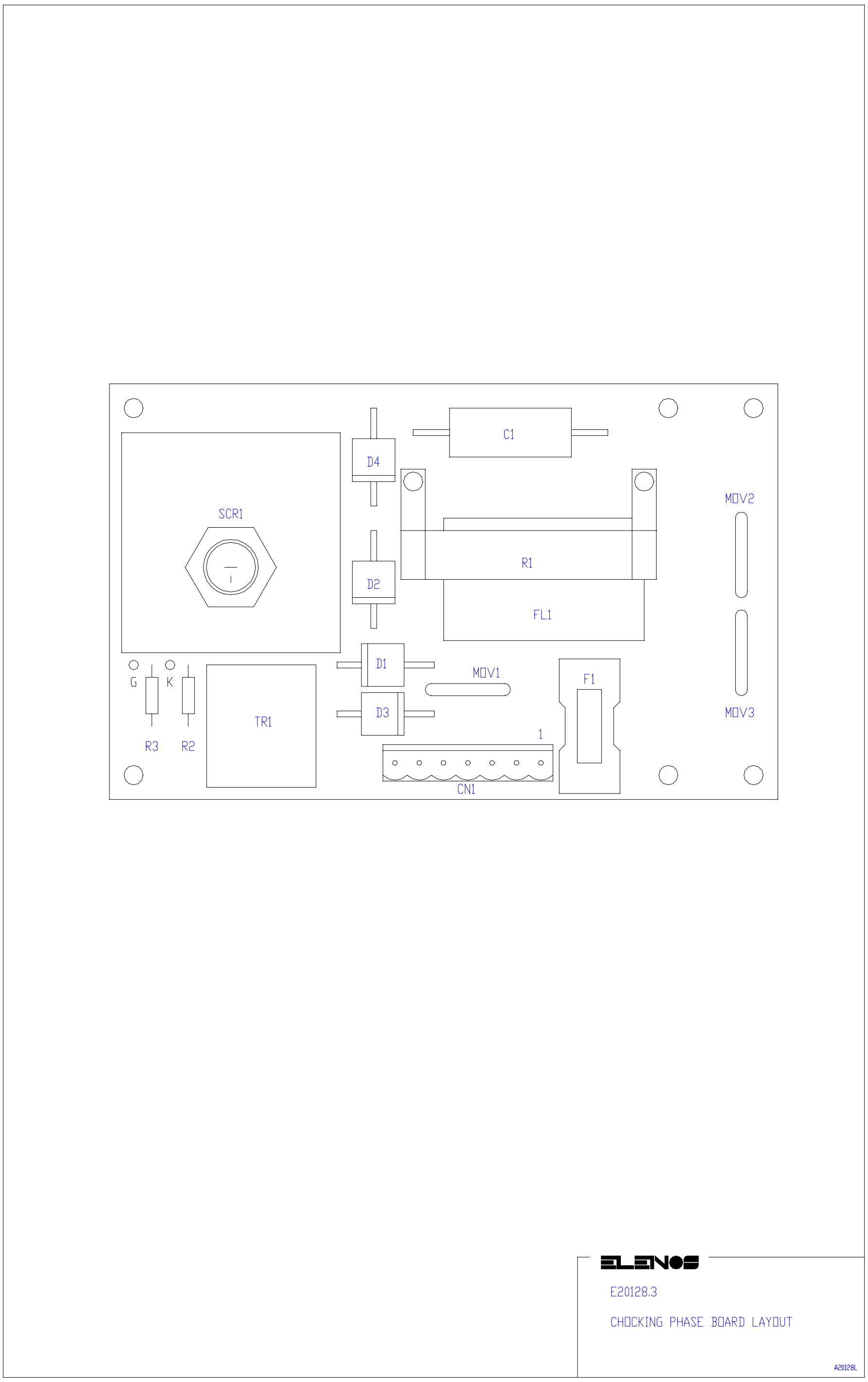
Part list E20127

D28	Diode type 1N4148		
D29	Diode type 1N4148		
D30	Diode type 1N4148		
D31	Diode type 1N4148		
D32	Diode type 1N4148		
D33	Diode type 1N4148		
D34	Diode type 1N4148		
D35	Diode type 1N4148		
D36	Diode type 1N4148		
D37	Diode type 1N4148		
D38	Diode type 1N4007		
D39	Diode type 1N4148		
D40	Diode type 1N4148		
D41	Diode type 1N4007		
D42	Diode type 1N4007		
D43	Diode type 1N4007		
D44	Diode type 1N4007		
D45	Diode type 1N4007		
D46	Diode type 1N4007		
D47	Diode type 1N4007		
D48	Diode type BY255		
D49	Diode type 1N4007		
D50	Diode type 1N4007		
D51	Diode type 1N4007		
D52	Diode type 1N4148		
D53	Diode type 1N4148		
D54	Diode type 1N4148		
D55	Diode type 1N4148		
D56	Diode type 1N4148		
D57	Diode type 1N4007		
D58	Diode type 1N4007		
D59	Diode type 1N4148		
D60	Diode type 1N4148		
D70	Diode type 1N4007		
D71	Diode type 1N4007		
DL1	Led rosso 3 mm.		
DL2	Led rosso 3 mm.		
DL3	Led rosso 3 mm.		
DL4	Led rosso 3 mm.		
DL5	Led rosso 3 mm.		
DL6	Led rosso 3 mm.		
DL7	Led rosso 3 mm.		
DL8	Led rosso 3 mm.		
DL9	Led rosso 3 mm.		
DZ1	I.C. type LM336	2.5 V	
DZ2	Zener Diode	9.1 V	0.5 W
DZ3	Zener Diode	9.1 V	0.5 W
DZ4	Zener Diode	9.1 V	0.5 W
DZ5	Zener Diode	9.1 V	0.5 W
DZ7	Zener Diode	5.1 V	0.5 W

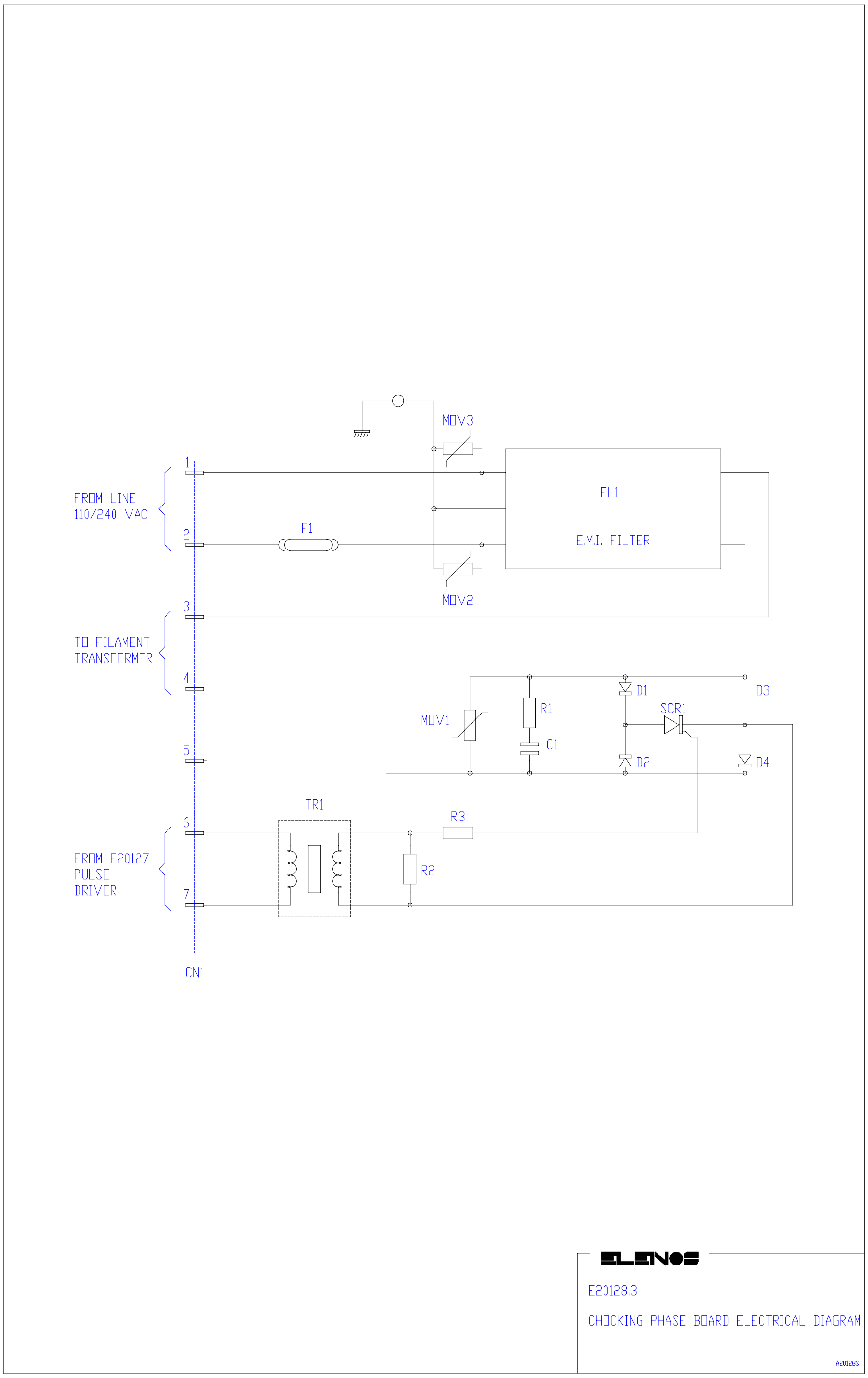
Part list E20127

IC25	I.C. type LM7912 case TO220 + Heatsink 21C / W		
J1	Jumper 2 pin		
J2	Jumper 2 pin		
J3	Jumper 2 pin		
J4	Jumper 2 pin		
J5	Jumper 2 pin		
RL1	Relay Finder type 40.31		
RL2	Relay Finder type 40.31		
RL3	Relay Finder type 40.31		
CN1	ANSLEY connector 2x10 pin		
CN2	ANSLEY connector 2x10 pin		
CN3	ANSLEY connector 2x10 pin		
CN4	AMP connector 4 pin 90 deg.		
CN5	ANSLEY connector 2x10 pin		
CN6	PHOENIX connector 7 pin 90 deg.		
CN7	ANSLEY connector 2x20 pin		
CN8	PHOENIX connector 8 pin 90 deg.		
CN10	AMP connector 4 pin 90 deg.		
CN11	PHOENIX connector 8 pin 90 deg.		

Layout E20128



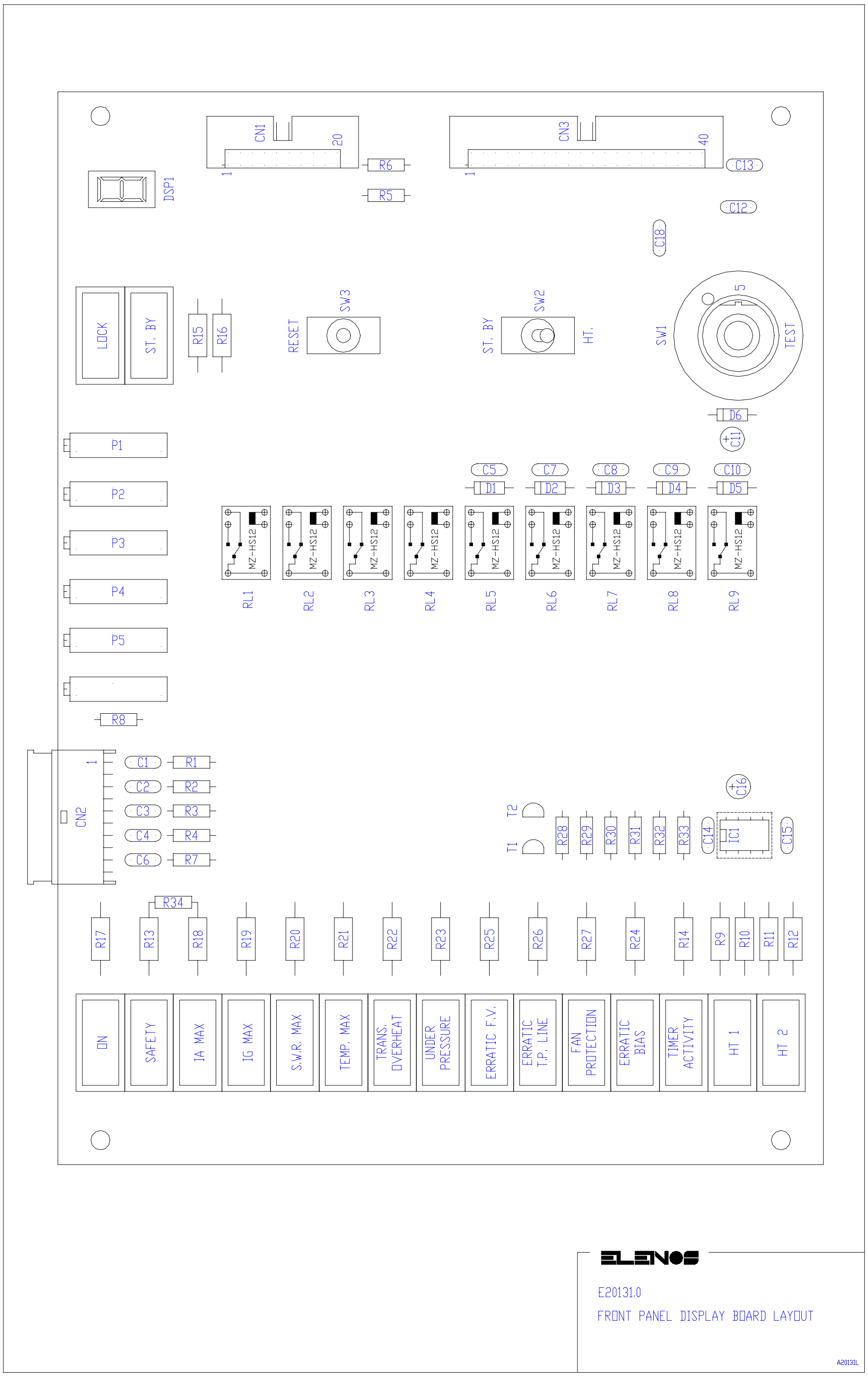
Electric diagram E20128



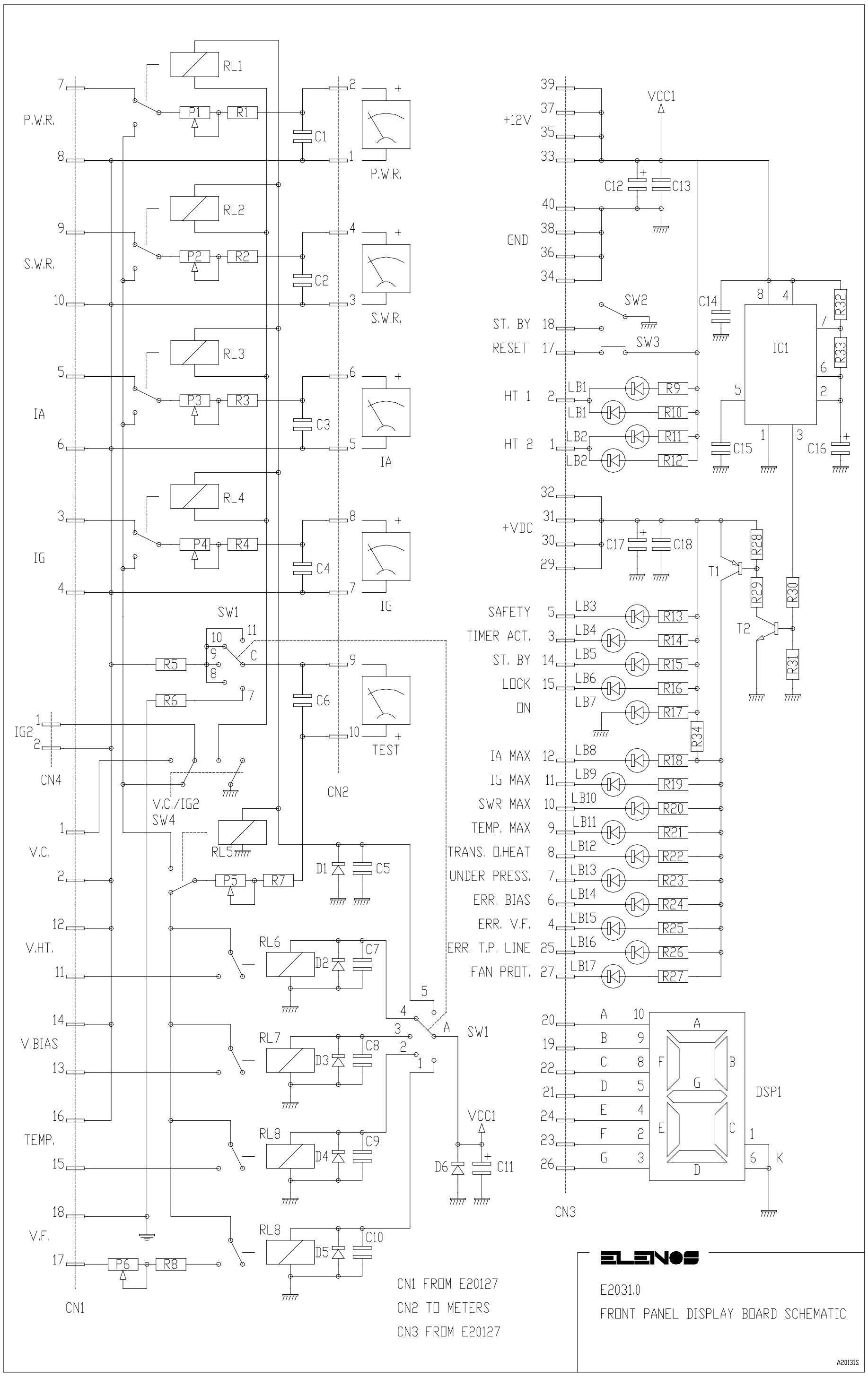
Part list E20128

PCB1	Board E20128.3			
R1	Resistor	50	ELENOS	5%
R2	Resistor	1 K	0.25 W	1%
R3	Resistor	49.9	0.25 W	1%
C1	Paper Capacitor	0.1 uF	1000 V	+/- 5%
MOV1	MOV type S20K-275			
MOV2	MOV type S20K-275			
MOV3	MOV type S20K-275			
D1	Diode type P600K			
D2	Diode type P600K			
D3	Diode type P600K			
D4	Diode type P600K			
SCR1	SCR type R16RIA120 + Heatsink 7.7 C / W			
TR1	Transformer type TI1539449			
F1	Fuse 10A 250V + Portafuse			
CN1	PHOENIX connector 7 pin			

Layout E20131



Electric diagram E20131



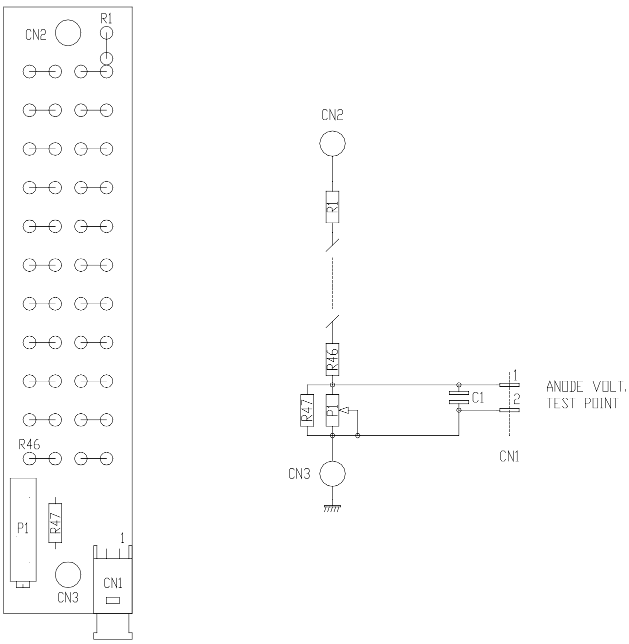
Part list E20131

PCB1	Print Board type E20131			
R1	Resistor	0.25W	15K	1%
R2	Resistor	0.25W	15K	1%
R3	Resistor	0.25W	15K	1%
R4	Resistor	0.25W	15K	1%
R5	Resistor	0.25W	10K	1%
R6	Resistor	0.25W	10K	1%
R7	Resistor	0.25W	6K8	1%
R8	Resistor	0.25W	10K	1%
R9	Resistor	0.5W	150	5%
R10	Resistor	0.5W	150	5%
R11	Resistor	0.5W	150	5%
R12	Resistor	0.5W	150	5%
R13	Resistor	0.5W	330	5%
R14	Resistor	0.5W	330	5%
R15	Resistor	0.5W	330	5%
R16	Resistor	0.5W	330	5%
R17	Resistor	0.5W	330	5%
R18	Resistor	0.5W	330	5%
R19	Resistor	0.5W	330	5%
R20	Resistor	0.5W	330	5%
R21	Resistor	0.5W	330	5%
R22	Resistor	0.5W	330	5%
R23	Resistor	0.5W	330	5%
R24	Resistor	0.5W	330	5%
R25	Resistor	0.5W	330	5%
R26	Resistor	0.5W	330	5%
R27	Resistor	0.5W	330	5%
R28	Resistor	0.25W	10K	1%
R29	Resistor	0.25W	10K	1%
R30	Resistor	0.25W	10K	1%
R31	Resistor	0.25W	10K	1%
R32	Resistor	0.25W	2K2	5%
R33	Resistor	0.25W	47K	5%
R34	Resistor	0.25W	47K	5%
P1	Trimmer type 89PR10K			
P2	Trimmer type 89PR10K			
P3	Trimmer type 89PR10K			
P4	Trimmer type 89PR10K			
P5	Trimmer type 89PR10K			
P6	Trimmer type 89PR10K			
C1	Ceramic Capacitor	4.7nF	63V	
C2	Ceramic Capacitor	4.7nF	63V	
C3	Ceramic Capacitor	4.7nF	63V	
C4	Ceramic Capacitor	4.7nF	63V	
C5	Ceramic Capacitor	100nF	63V	
C6	Ceramic Capacitor	4.7nF	63V	
C7	Ceramic Capacitor	100nF	63V	
C8	Ceramic Capacitor	100nF	63V	
C9	Ceramic Capacitor	100nF	63V	

Part list E20131

C10	Ceramic Capacitor	100nF	63V	
C11	Vert. Electr. Capacitor	10uF	63V	
C12	Ceramic Capacitor	4.7nF	63V	
C14	Ceramic Capacitor	100nF	63V	
C15	Ceramic Capacitor	100nF	63V	
C16	Vert. Electr. Capacitor	10uF	63V	
C18	Ceramic Capacitor	4.7nF	63V	
D1	Diode type 1N4007			
D2	Diode type 1N4007			
D3	Diode type 1N4007			
D4	Diode type 1N4007			
D5	Diode type 1N4007			
D6	Diode type 1N4007			
DL1	Led type HLMP-2685			
DL2	Led type HLMP-2685			
DL3	Led type HLMP-2685			
DL4	Led type HLMP-2685			
DL5	Led type HLMP-2685			
DL6	Led type HLMP-2685			
DL7	Led type HLMP-2685			
DL8	Led type HLMP-2685			
DL9	Led type HLMP-2685			
DL10	Led type HLMP-2685			
DL11	Led type HLMP-2685			
DL12	Led type HLMP-2685			
DL13	Led type HLMP-2685			
DL14	Led type HLMP-2685			
DL15	Led type HLMP-2685			
DL16	Led type HLMP-2685			
DL17	Led type HLMP-2685			
DSP1	Diplay type HDSP-7303			
T1	Transistor type BC327			
T2	Transistor type BC327			
SW1	2-way 6-pos. rotate switch			
SW2	2-pos switch 25A-250 VAC			
SW3	Push-botton			
CN1	ANSLEY connector 2x10 pin			
CN2	AMP connector 10 pin			
CN3	ANSLEY connector 2x20 pin			

E20138



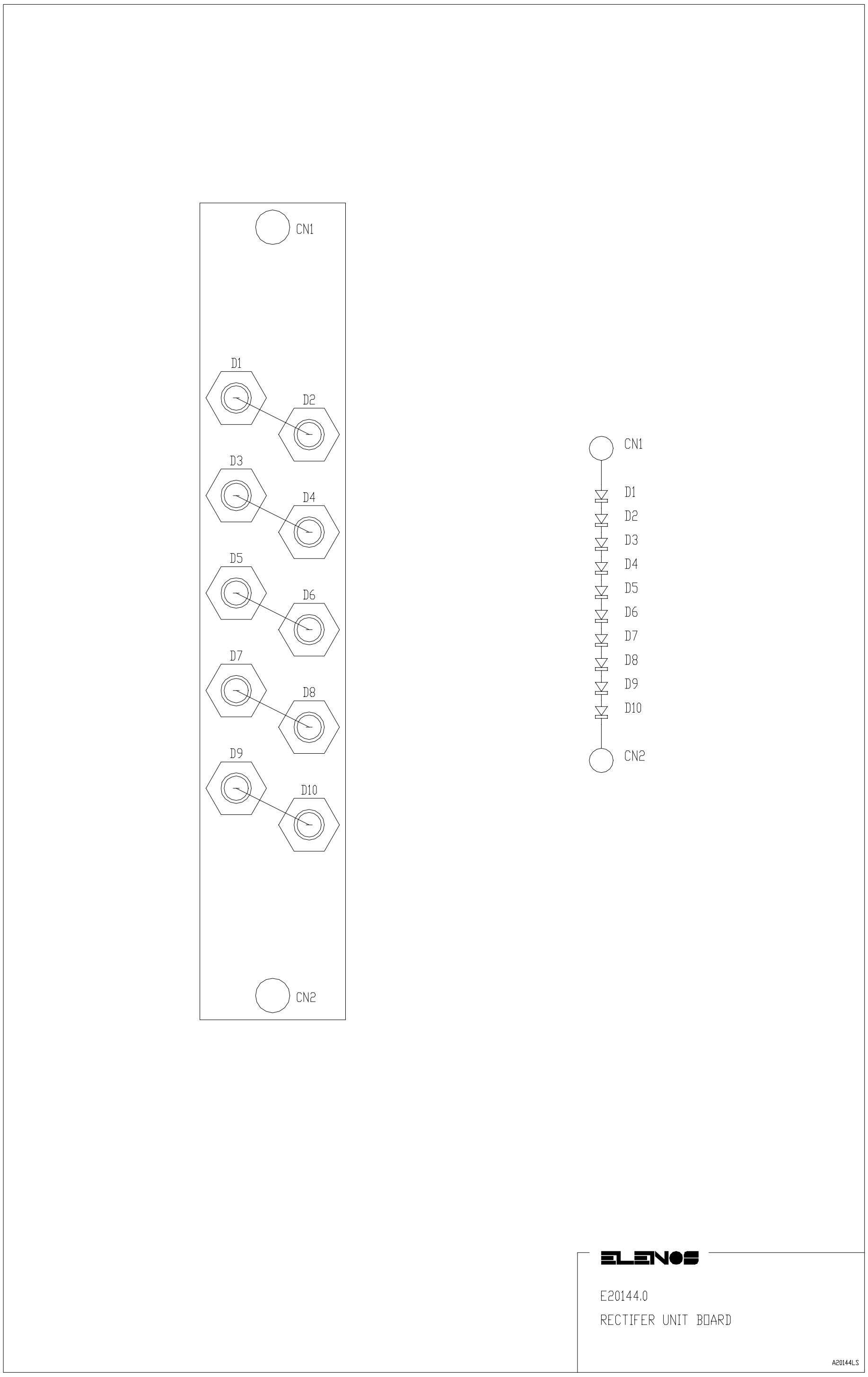
E20138

VOLTAGE DIVIDER BOARD

ELECTRICAL DIAGRAM AND LAYOUT

Part list E20138

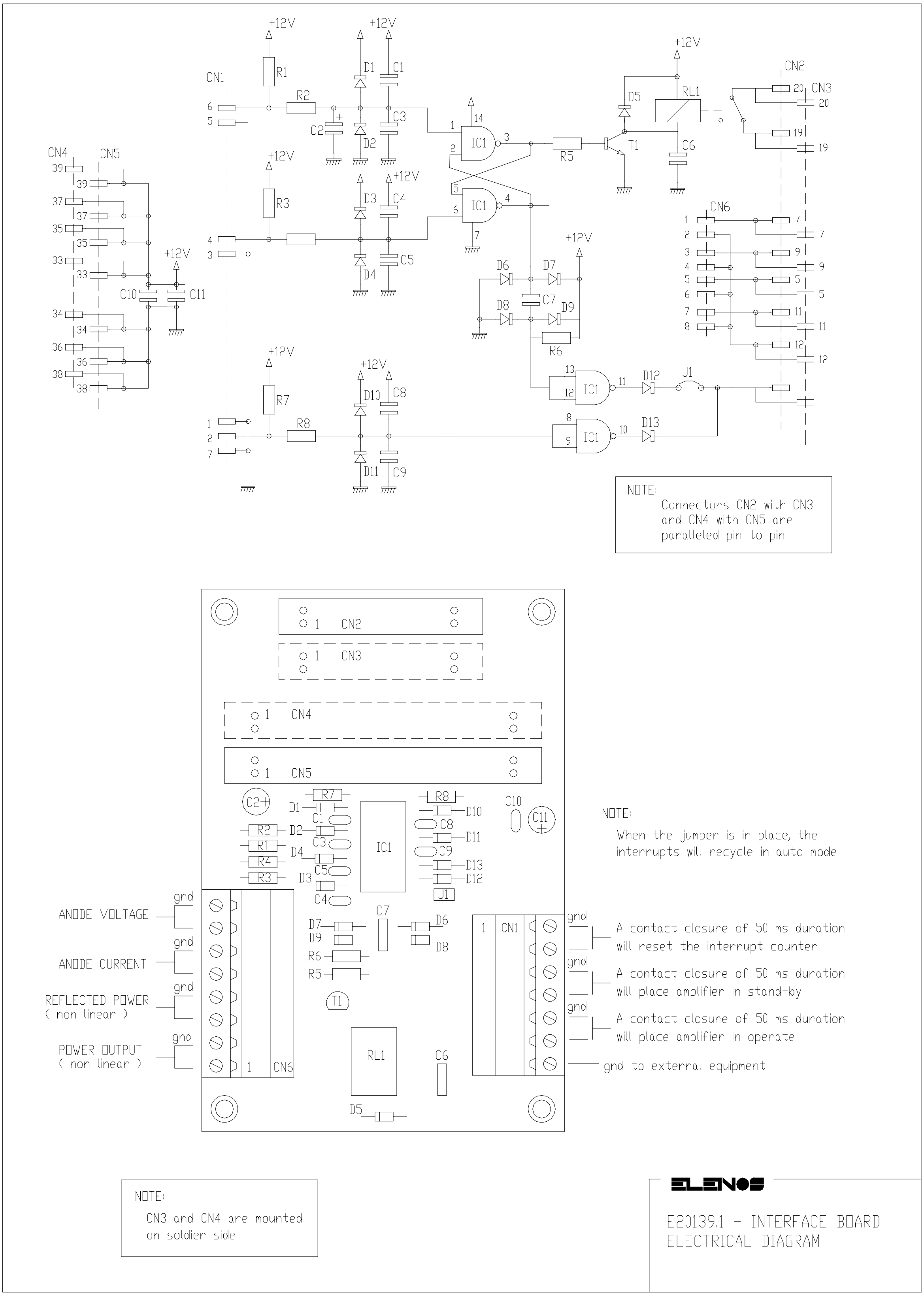
E20144


CN1
D1
D2
D3
D4
D5
D6
D7
D8
D9
D10
CN2
CN1
D1
D2
D3
D4
D5
D6
D7
D8
D9
D10
CN2
E20144.0
RECTIFER UNIT BOARD
A20144LS

Part list E20144

PCB1	Board E20144.0
D3	Diode type A12FR120
D4	Diode type A12F120
D5	Diode type A12FR120
D6	Diode type A12F120
D7	Diode type A12FR120
D8	Diode type A12F120
D9	Diode type A12FR120
D10	Diode type A12F120
D11	Diode type A12FR120
D12	Diode type A12F120

E20139 - Interface board (optional)



Part List of E20139.1 Board

Rif.	Description	Value	Remarks
PCB	Board Code 2PCB0177		
R1 - R8	Resistor	10K	0.25 W 1%
C1	Ceramic Capacitor 5mm	4.7 nF	50V
C2	Electrolytic vert. Capacitor	10 uF	35V
C3,C4,C5	Ceramic Capacitor 5mm	4.7 nF	50V
C6, C7	Mylar capacitor 5mm	100 nF	63V
C8,C9,C10	Ceramic Capacitor 5mm	4.7 nF	50V
C11	Electrolytic vert. capacitor	10 uF	35V
D1 - D4	Diode type 1N4148		
D5	Diode type 1N4007		
D6 - D13	Diode type 1N4148		
T1	Transistor type BC547		
IC1	IC type 4093 + socket 14 pin		
RL1	Relay SIEMENS V23101 D0106 B201		
J1	Jumper		
CN1	PHOENIX conn. 7 pin angled		
CN2, CN3	ANSLEY conn. 10+10 pin male with extractors		
CN4, CN5	ANSLEY conn. 20+20 pin male with extractors		
CN6	PHOENIX conn. 8 pin male with extractors		