TEST REPORT

AS 3100:2009

General requirements for electrical equipment

Report reference No .....:	09TH0459-AS3100_2	
Tested by (printed name and signature) .....:	Georg Loritz	Georg Loritz
Approved by (printed name and signature) .....:	Frank Hesmer	F. Hesmer
Date of issue .....:	2011-03-02	
Testing Laboratory Name .....:	**Bureau Veritas Consumer Products Services Germany GmbH**	DAkkS Deutsche Akkreditierungsstelle **D-PL-12024-03-01**
Address .....:	Businesspark A96, 86842 Tuerkheim, Germany	
Testing location .....:	**same as above**	
Applicant's Name .....:	**Ablerex Electronics Co., Ltd**	
Address .....:	1F, No. 3, Lane 7, Paokao Road Hsintien 23114, Taiwan	
Test specification		
Standard.....:	AS 3100:2009	
Test procedure .....:	Safety verification report	
Non-standard test method .....:	None	
Test Report Form No.....:	AS3100_A	
Master TRF .....:	Bureau Veritas Consumer Products Services Germany GmbH	

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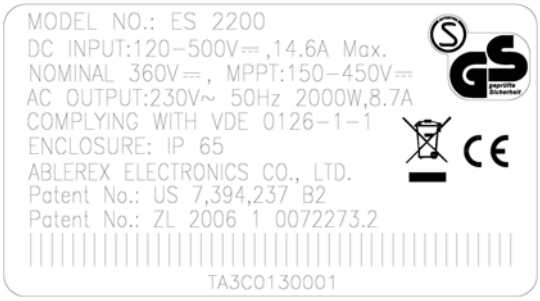
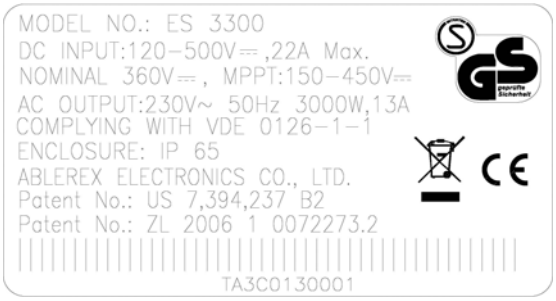
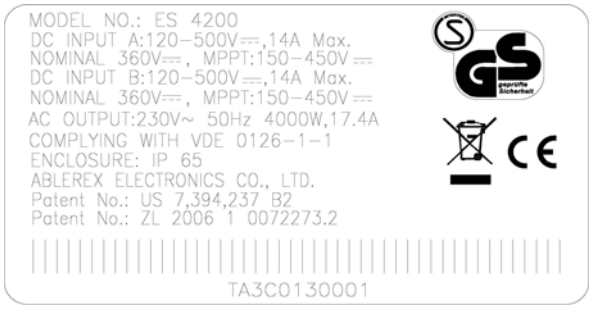
Test item description .....:	Solar Inverter					
Trademark .....:	Ablerex					
Model and/or type reference .....:	ES1650, ES2200, ES3300, ES4200, ES5000					
Ratings .....:	ES1650	ES2200	ES3300	ES4200		ES5000
Input Voltage:	120 – 500V (150V – 450V MPP)					
Input current:	10,5A	14,6A	22A	14A	14A	17,6 A / 17,6 A
Output Voltage:	230V / 50Hz					
Output current:	6,5A	8,7A	13A	17,4A		21,7A
Output power:	nom 1500W	nom 2000W	nom 3000W	nom 4000W		nom 5000W

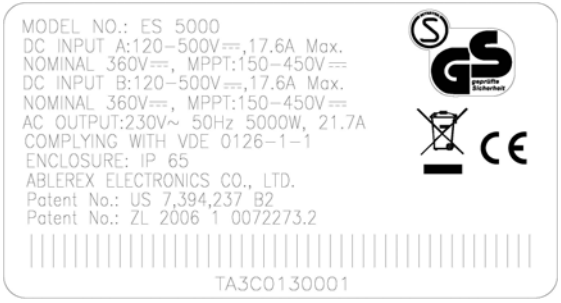
Marking:


MODEL NO.: ES1650
DC INPUT: 120 - 500V ⎓, 10.5A Max.
NOMINAL: 360V ⎓, MPPT: 150 - 450V ⎓
AC OUTPUT: 230V ~ 50Hz 1500W, 6.5A
COMPLYING WITH VDE 0126 - 1 - 1
AS / NZS3100 & AS4777
ENCLOSURE: IP 65
MA3C0130001


MODEL NO.: ES 2200
DC INPUT:120-500V⎓,14.6A Max.
NOMINAL 360V⎓, MPPT:150-450V⎓
AC OUTPUT:230V~ 50Hz 2000W,8.7A
COMPLYING WITH VDE 0126-1-1
ENCLOSURE: IP 65
ABLEREX ELECTRONICS CO., LTD.
Patent No.: US 7,394,237 B2
Patent No.: ZL 2006 1 0072273.2
TA3C0130001


MODEL NO.: ES 3300
DC INPUT:120-500V⎓,22A Max.
NOMINAL 360V⎓, MPPT:150-450V⎓
AC OUTPUT:230V~ 50Hz 3000W,13A
COMPLYING WITH VDE 0126-1-1
ENCLOSURE: IP 65
ABLEREX ELECTRONICS CO., LTD.
Patent No.: US 7,394,237 B2
Patent No.: ZL 2006 1 0072273.2
TA3C0130001


MODEL NO.: ES 4200
DC INPUT A:120-500V⎓,14A Max.
NOMINAL 360V⎓, MPPT:150-450V⎓
DC INPUT B:120-500V⎓,14A Max.
NOMINAL 360V⎓, MPPT:150-450V⎓
AC OUTPUT:230V~ 50Hz 4000W,17.4A
COMPLYING WITH VDE 0126-1-1
ENCLOSURE: IP 65
ABLEREX ELECTRONICS CO., LTD.
Patent No.: US 7,394,237 B2
Patent No.: ZL 2006 1 0072273.2
TA3C0130001


MODEL NO.: ES 5000
DC INPUT A:120-500V⎓,17.6A Max.
NOMINAL 360V⎓, MPPT:150-450V⎓
DC INPUT B:120-500V⎓,17.6A Max.
NOMINAL 360V⎓, MPPT:150-450V⎓
AC OUTPUT:230V~ 50Hz 5000W, 21.7A
COMPLYING WITH VDE 0126-1-1
ENCLOSURE: IP 65
ABLEREX ELECTRONICS CO., LTD.
Patent No.: US 7,394,237 B2
Patent No.: ZL 2006 1 0072273.2
TA3C0130001

History Sheet:			
Georg Loritz	2010-09-14	Initial report was written	Rev. 0
Georg Loritz	2010-09-28	Report reference number adapted Clarified temperature measurement in 8.11 Photos of cable entry glads and earth connection added	Rev. 1
Georg Loritz	2010-03-02	New inverter model ES1650 included	Rev. 2

Address of the manufacturer sites:
Ablerex Electronics (SUZHOU) Co., Ltd. No. 36, Wangwu Road, Wuzhong District, Shuzhou City, Jiangsu Province, P.R. China

Summary of testing:

The Product was tested to the standard AS 3100:2009

1. The ES1650, ES2200 was tested on a 16A (IEC) branch circuit, the ES 3300, ES4400 and the ES5000 on a 32A (IEC) branch circuit. The safety of the unit relies on the branch circuit of building installation. If used on a branch circuit greater than this, additional testing may be necessary.

2. The input connector and output connector are fixed connected inside of the enclosure.

3. The solar inverters are rated class I.

4. The unit is permanently connected to mains and to DC (photovoltaic).

5. The unit is specified for outdoor and indoor (unconditioned) use. See IP report.

6. The magnetic device T1 has an electrical reinforced insulation system and is rated 100°C. Compliance of T1 was checked by applying clause 4.1.3 Clearance and creepage and 8.4 Electric Strength of AS 3100:2009. An additional transformer winding analysis is included in Annex No. 4.

7. The product was evaluated for a maximum ambient of 50°C. The temperature test was performed without forced air cooling.

8. EMC testing and IP testing was performed by an independent test house.

9. Marking – The Unit needs the following marking:

Marking needed, refer to user manual

Particulars: test item vs. test requirements	
Equipment mobility ..... :	Fixed (wall mounted), wires detachable
Operating condition..... :	Continuous
Mains supply tolerance (%)..... :	According to the specification:
Tested for IT power systems ..... :	N/A
IT testing, phase-phase voltage (V) ..... :	N/A
Class of equipment ..... :	Class I
Protection against ingress of water ..... :	IP65 according to IEC 60529
Test case verdicts	
Test case does not apply to the test object :	N/A
Test item does meet the requirement ..... :	P(ass)
Test item does not meet the requirement .. :	F(ail)
Testing	
Date of receipt of test item ..... :	2010-05-17, 2010-01-10, 2010-01-13
Date(s) of performance of test ..... :	2010-06-28 till 2010-08-31

The test result presented in this report relate only to the object(s) tested.
This report shall not be reproduced, except in full, without the written approval of the applicant.
Throughout this report a comma is used as the decimal separator.

This Test Report consists of the following documents:

1. Test Report
2. EMC Test Report – Annex No. 1
3. IP Test Report – Annex No. 2
4. Schematics, Layouts, Transformer drawings - Annex No. 3
5. Pictures of the unit – Annex No. 4
6. Test Equipment list – Annex No. 5

General product information:

The Solar Inverter converts DC voltage into AC voltage.

The input and output are protected by Varistors to Earth. The unit is providing EMC filtering at the output towards mains. The unit does not provide galvanic separation from input to output. The output is switched off redundantly by the high power switching bridge and two relays in series. This assures that the opening of the output circuit will also operate in case of one error.

The voltage and frequency measurement is performed with resistors in serial which are connected directly to line and neutral. Both controllers get these signals and analyze the data.

With the sensor CT1 the current is measured so that two independent signals are created. These two signals are linked to both controllers.

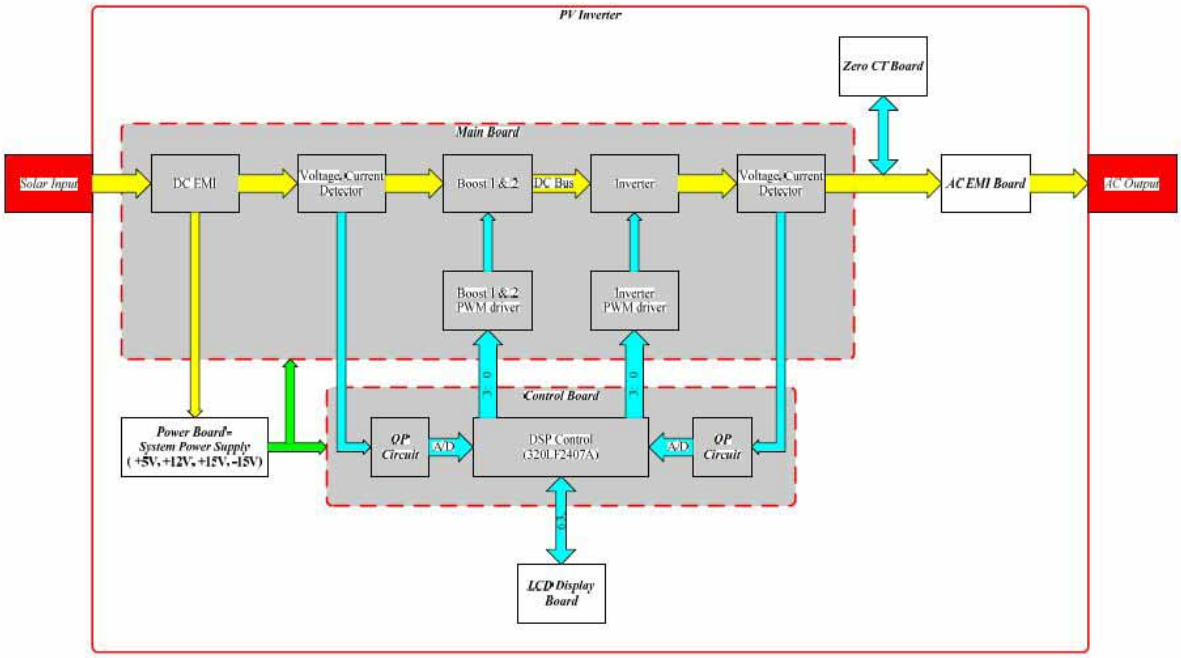
The main controller and redundant controller communicate with each other.

There are two relays in serial on each path (L1 and N). Each controls one pair of relays (one relay at each path). In addition the power bridge can be stopped by both controller.

Before start-up, the inverter measures the insulation resistance of DC+/- to GND. If the value is smaller than the intern configured value, the inverter will not connect to the grid.

The measurements had been performed with two Units, one of each series. The Series are devided in the ES5000 / ES4400 and the ES3300 / ES2200 / ES1650. All the results are applicable to the other unit of the series.

Blockdiagramm:



Information for Production testing:

Visual Inspection

Dielectric Testing:
AC to PE: 1,1kVac or 1,6kVdc, 1s
AC/DC to USER: 1,35kVac or 1,9kVdc, 1s
DC to PE: 1,35kVac or 1,9kVdc, 1s
AC to DC: 1,35kVac or 1,9kVdc, 1s

Performance test

Not required explicit by the standard, but recommended by Bureau Veritas.

Ground Continuity Testing:
25A, 1 Min. from PE to Enclosure

AS 3100:2009			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 3: DESIGN AND CONSTRUCTION			
3.1	**General** All equipment shall comply with the provisions of this Standard in respect of selection of materials, design, and construction, and with the tests specified herein. The selection and application of materials, and the design and construction of all equipment shall be such as will ensure, as far as is reasonably possible and economically practicable, that when the equipment is standing, supported, or fixed in a normal position and operating in a normal manner, and account being taken of ordinary wear and tear and other depreciating factors that can reasonably be anticipated, no person will be exposed to risk of injury or electric shock, and there will be no unwarrantable risk of fire either (a) through the functioning of the equipment under conditions required by its use at rated loading; or (b) through the mechanical or electrical failure of any material or of the equipment itself or of any part thereof. This Standard does not, in general, take into account the use of equipment by young children or infirm persons without supervision, or playing with the equipment by young children.	Noticed	P
3.2	**Equipment to be suitable for conditions of use** All equipment shall be of a type, design, and construction that will enable it to be installed in accordance with the National Wiring Rules and will provide protection against mechanical and electrical failure which can reasonably be expected to result from mechanical failure, or from exposure to weather, water or dampness, corrosive fumes, dust, steam, oil, high temperature or any other deleterious influences to which it will be exposed under the conditions of its use. Non-hygroscopic insulating materials shall be used where required in individual Standards. In other cases, hygroscopic materials may be used for insulation, provided that the materials are suitably impregnated or treated if liable to exposure to dampness. The position and fixing of the insulation shall be such as will maintain creepage distances and clearances during the normal life of the equipment. In general, timber shall not be acceptable as an insulating material except that it may be recognized in special cases where a particular grade is used for a specific purpose. NOTE Non-hygroscopic material is taken to be material that does not, after being conditioned in an oven at 50°C ± 5°C for 24h ± 1h and then cooled in a desiccators, absorb greater than 5% by weight of moisture during a 48 hour treatment in a humidity of 95% at a temperature of 20°C ± 5°C.	Noticed	P

AS 3100:2009			
Clause	Requirement – Test	Result – Remark	Verdict
3.3	**Selection of materials and parts** Any material or part used in, or in the construction of, any equipment shall comply with any specific requirements set out in respect thereto in this Standard or in an individual Approval and test specification dealing with such materials or parts. Where any standard prescribes, for or in any equipment, the use of a particular kind of material or part, a material or part of another kind may be used instead, provided that its use will not introduce any risk of electric shock or fire and will not render the equipment less resistant to mechanical or electrical failure than would the use of a material or part of the kind prescribed.	See list of critical components, Annex No. 1, Table 3.3	P
3.4	**Selection of components** Any component part that is used in or in the construction of any equipment and which is depended upon for safety shall comply with the appropriate requirements of any relevant individual Approval and test specification.	See list of critical components, Annex No. 1, Table 3.3	P
3.5	**Workmanship** All fabrication and construction shall be carried out in a thoroughly workmanlike fashion complying with the appropriate requirements of this Standard and the generally accepted principles of sound and safe practice.		P
3.6	**Fuses**		N/A
3.6.1	**Accessibility and shrouding** This Clause shall not apply to internal fuses where the arrangement and enclosure of the fuses is such that they are not intended and are unlikely to be replaced other than by appropriate servicing personnel. For all other fuses, the following provisions shall apply: (a) Every fuse incorporated in equipment shall be exposed to view or have its location clearly indicated by suitable visible marking or by instructional literature provided with the equipment. (b) Every fuse shall be in an accessible position. (c) Every fuse shall be so arranged that a person is not subject to the risk of inadvertent contact with (i) any part of a fuse that is mounted in a compartment accessible for normal routine cleaning; or (ii) live parts, when covers are removed to gain access to any fuse. Fuse carriers shall remain in position for the purpose of assessing this requirement. (d) Fuse-links, fuse-contacts and fixed contacts shall be so shielded as to protect a person from accidental contact with live metal while the fuse-carrier is being inserted or withdrawn in the normal manner.	Just internal fuses	N/A
3.6.2	**Mounting** A semi-enclosed fuse that is incorporated in equipment and is marked with the letter 'R' shall be mounted in such a manner that no earthed metal is introduced in, or adjacent to, the fusing chamber.		N/A

AS 3100:2009			
Clause	Requirement – Test	Result – Remark	Verdict
3.7	**Identification of wiring** For equipment other than that having a Type Z attachment insulated or covered conductors used as earthing conductors shall be coloured (a) green; or (b) green and yellow in the proportions specified in AS/NZS 3191. The colour green in combination with colours other than yellow shall be acceptable for live conductors, provided that the other colour covers not less than 30% of the surface of the conductor in any 15 mm length. The single colour green shall not be used to identify any live conductor except (i) at the discretion of a regulatory authority, where the conductor forms portion of the complex wiring of equipment; or (ii) where it is specified by an individual Approval and test specification.	Verified	P
3.8.	**Regulating devices and switches**		P
3.8.1	**Fixing and mounting** All regulating devices and switches shall be securely fixed in position. Rotary regulating devices and rotary switches shall be so fixed or located that they cannot turn bodily during operation. No regulating device or switch shall be mounted in a position or be marked in such a manner as to incorrectly indicate the intended contact position. NOTE See Clause 5.2.2 concerning clearances between terminals and exposed conductive parts.	Verified	P
3.8.2	**Visual indications of positions** Notwithstanding the requirements of an individual Approval and test specification, the different positions of regulating devices and the different positions of switches may be indicated by figures, letters or other visual means which clearly indicate the intent. If figures are used for indicating the different positions, the 'off' position shall be indicated by the figure '0' or 'OFF' and the position of any energized state shall be indicated by a higher figure. The figure '0' shall not be used for any other indication. NOTE It is intended that individual Approval and test specifications be amended to line up with the requirements of the above paragraph as the opportunity arises. Any marking provided to indicate the position of a regulating device or switch shall be visible when the device or switch is in the corresponding position.		N/A
3.8.3	**Voltage and current limitation** No regulating device or switch shall control a normal operating Voltage or current when the Voltage with which the device or switch is supplied is more than 15% in excess of the voltage at which the device or switch is rated.		N/A
3.8.4	**Switches for transportable machinery** Transportable machinery, with moving parts that may cause injury to persons, shall be fitted with a switch that operates in all live conductors so that it isolates the entire equipment from the supply.	No transportable machinery	N/A

AS 3100:2009			
Clause	Requirement – Test	Result – Remark	Verdict
3.8.5	**Switches** Any switch incorporated in equipment shall be a Category 1, 2 or 3 switches, as appropriate or comply with AS/NZS 61058 series, in accordance with the conditions occurring in the appliance. A Category 1 switch shall comply with the relevant requirements of AS/NZS 3133, and its 'off' position shall be marked in accordance with Clause 3.8.2 herein. A Category 2 switch shall comply with the relevant requirements of AS/NZS 3133, and its 'off' position need not be marked. A Category 3 switch shall satisfy the test requirements of Clauses 13.1(j), 13.3 and 13.4 of AS/NZS 3133, and its 'off' position need not be marked. In addition it shall be subjected to 50 operations of making and breaking the normal load current of the circuit it controls, in accordance with Clause 13.5.4 and Table 3 of AS/NZS 3133, except that where appropriate for circuits including motors, the test current and power factor shall be the equivalent current and power factor of the circuit which the switch controls, with the rotors locked. The rate of operation shall be in accordance with Clause 13.3 of AS/NZS 3133. In addition, where Category 1 and 2 switches control circuits containing motors, these switches shall be subjected to a further 50 operations. The test current and power factor shall be equivalent to the current and power factor of the circuit with rotors locked and the rate of operation shall be in accordance with Clause 12.8 of AS/NZS 3133. A Category 1 switch shall be used when (a) the equipment is intended for connection to the supply by a plug and flexible cord; (b) notwithstanding Clause 5.1, it is not usual or possible to guard live parts completely against personal contact, because of the intended use and generally accepted practice with any particular equipment; and (c) the equipment is of a type that is usually left connected to the outlet socket indefinitely, and which has not been provided with a means to indicate whether it is energized or not. NOTE 1 The specification of a particular category of switch in an individual Standard does not necessarily preclude the use of a switch with a lower category number. NOTE 2 A Category 3 switch, tested to the above requirements, would not automatically qualify for an 'M' rating in accordance with AS/NZS 3133.		N/A
3.8.6	**Electronic regulating devices and switches** Electronic thermostats and electronic switches without a mechanical switch in the main circuit may not provide a reliable off-state. Therefore the circuit on the load side shall be considered to be live.		N/A

AS 3100:2009			
Clause	Requirement – Test	Result – Remark	Verdict
3.9	**Socket-outlets** Socket-outlets shall not be permitted in equipment intended for connection by flexible cord except in the following circumstances: (a) Where specifically accepted by an approvals authority in those cases where there is little likelihood of cascading of similar equipment which could result in circuit overloading and extension of fault conditions. (b) Where permitted by an individual Approval and test specification or by National Wiring Rules. (c) Where the equipment is basically providing a switching or control function. This does not preclude the use of socket-outlets or other facilities for connections within the equipment.	No socket outlets.	N/A
3.10	**Equipment intended to be supported by contacts of socket-outlets** Appliances having integral pins for insertion into socket outlets shall comply with Appendix J of AS/NZS 3112.1		N/A
3.11	**Static charge in equipment** Attention is drawn to the hazard of shocks caused by the build-up of electrostatic charge in equipment such as hand-held tools. AS/NZS 1020 gives guidance on the control of undesirable static electricity.		N/A
3.12	**Control methods** For equipment suitable for connection to the supply mains, asymmetrical control of the input current is prohibited in normal use. However, half-wave rectification directly on the supply mains may be used where the controlled active input power does not exceed 100W or, where the controlled equipment is class II, portable equipment which, in normal use, is only operated for short periods of time and for which the rated power input does not exceed 1200W. NOTE Asymmetrical control means control by a device designed to operate in a different manner on the positive and negative half cycles of an alternating voltage or current Compliance is checked by inspection and by measurement.	Unit intended for feeding in to the public low-voltage mains. Asymetrical, abnormal operation causes a disconnection of the unit	P
3.13	**Stability** Freestanding equipment intended to be used on a surface such as a floor or a table shall have adequate stability and shall be tested in accordance with Clause 8.14.	Wall mounting equipment	N/A

AS 3100:2009			
Clause	Requirement – Test	Result – Remark	Verdict
3.14	**Equipment connected to supply by a plug** Equipment intended to be connected to the supply mains by means of a plug shall be constructed so that in normal use there is no risk of electric shock from charged capacitors having a rated capacitance exceeding 0,1 µF, when the pins of the plug are touched. Compliance is checked by the following test. The equipment is supplied at rated voltage. Any switch is then placed in the off position and the equipment is disconnected from the supply mains at the instant of voltage peak. One second after disconnection, the voltage between the pins of the plug is measured with an instrument that does not appreciably affect the value to be measured. The voltage shall not exceed 34 V.	Permanetly connected equipment with fixed AC wiring and lockable DC connectors which are safe to touch	P

AS 3100:2009			
Clause	Requirement – Test	Result – Remark	Verdict
SECTION 4: PROTECTION AGAINST MECHANICAL AND ELECTRICAL FAILURE			
4.1	**Prevention of short-circuit and arcing**		P
4.1.1	**General** All terminals, contacts and other live parts shall be so arranged that short-circuit or destructive arcing, either between live parts or between any live part and other conductive material, cannot take place, and that no part other than an easily replaceable contact can be appreciably damaged by an arc or overheating arising from the normal operation of the equipment. Holes for fixing screws shall be so placed that no such short-circuit or arcing can occur when the screws are in position.	Noticed	P
4.1.2	**Segregation of internal wiring** Where extra-low voltage (see Clause 5.5) and low voltage equipment wiring is within the one enclosure and the extra-low voltage wiring or parts connected thereto are accessible to the standard test finger without the use of tools, either of the following requirements, or a combination thereof, shall apply: (a) The extra-low voltage wiring and associated connections shall be effectively separated from low voltage wiring by means of rigidly fixed screens or barriers or by other effective means such as lacing or enclosure in insulating sleeving. (b) The extra-low voltage wiring and exposed parts shall be insulated for the highest voltage present in any low voltage conductor and shall be so arranged or fixed that, in the event of a conductor breaking away or becoming detached from a terminal, bare extra-low voltage parts cannot come into contact with uninsulated low voltage parts or vice versa. Parts of one voltage system provided with basic insulation shall not come into contact with live parts of other systems. The requirements of Clauses 5.1, 5.2 and 5.3 shall not be applicable to extra-low voltage wiring complying with the requirements of this Clause. Where separate external equipment, operating at extra-low voltage, is supplied from the enclosure in which cables and wiring of different systems are terminated, the extra-low voltage wiring and connections shall be effectively separated from low voltage wiring as in Item (a), unless all parts of external equipment and associated wiring are installed and protected in accordance with the low voltage requirements of the National Wiring Rules.	Verified	P

AS 3100:2009			
Clause	Requirement – Test	Result – Remark	Verdict
4.1.3	**Creepage distances and clearances for appliances** Creepage distances and clearances for appliances shall be not less than the values in millimetres shown in Table 4.1. The way in which creepage distances and clearances are measured is indicated in Annex C. If a resonance voltage occurs between the point where a winding and a capacitor are connected together, and metal parts separated from live parts by basic insulation only, the creepage distance and clearance shall be not less than the values specified for the value of the voltage imposed by the resonance, these values being increased by 4 mm in the case of reinforced insulation. Compliance is checked by inspection and if necessary by measurement. For appliances provided with an appliance inlet, the measurements are made with an appropriate connector inserted; for appliances with Type X attachment, they are made with supply conductors of the appropriate current rating, and also without conductors; for otherequipment, they are made on the equipment as delivered. For appliances provided with belts, the measurements are made with the belts in place and the devices intended for varying the belt tension adjusted to the most unfavourable position within their range of adjustment, and also with the belts removed. Movable parts are placed in the most unfavourable position; nuts and screws with non-circular heads are assumed to be tightened in the most unfavourable position. The clearances between terminals and accessible metal parts are also measured with the screws or nuts unscrewed as far as possible, but the clearances shall then be not less than 50% of the values shown in Table 4.1. Distances through slots or openings in external parts of insulating material are measured to metal foil in contact with the accessible surface; the foil is pushed into corners and the like by means of the standard test finger shown in Figure 8.10 but it is not pressed into openings. If necessary, a force is applied to any point on bare conductors, other than those of heating elements, on uninsulated capillary tubes of thermostats and similar devices and to the outside of metal enclosures, in an endeavour to reduce the creepage distances and clearances while taking the measurements. The force is applied by means of a test finger having a tip as shown in Figure 8.10 and has a value of (a) for bare conductors and for uninsulated capillary tubes of thermostats and similar devices..... 2 N; and (b) for enclosures.....30 N NOTE 1 If a barrier is interposed and if it is in two parts that are not cemented together, the creepage distance is also measured through the joint. NOTE 2 For appliances having parts with double insulation where there is no metal between basic insulation and supplementary insulation, the measurements are made as though a metal foil were present between the two insulations.	See table 4.1.3 in Annex No. 1	P

AS 3100:2009			
Clause	Requirement – Test	Result – Remark	Verdict
	NOTE 3 If a barrier is interposed, clearances are measured over the barrier or, if the barrier is in two parts with mating surfaces that are not connected together, through the joint. NOTE 4 When assessing creepage distances and clearances, the effect of insulating linings of metal enclosures or covers is taken into consideration. NOTE 5 Internal conductors are considered to be bare conductors, unless their insulation withstands an electric strength test made between the conductor and metal foil wrapped round the insulation, a test voltage of 2000Vbeing applied for 15 min. NOTE 6 Means provided for fixing the equipment to a support are considered to be accessible. NOTE 7 A component incorporated in an appliance and which may comply with an individual Approval and test specification is to also comply with the creepage distances and clearance specified in this Clause.		
4.1.4	**Additional requirements for appliances**		P
4.1.4.1	**General** The requirements in Clauses 4.1.4.2 to 4.1.4.5 are applicable only to appliances.	Noticed	P
4.1.4.2	**Printed circuit boards** For conductive patterns on printed circuit boards, except at their edges, the values in Table 4.1 between parts of different potential may be reduced as long as the peak value of the voltage stress does not exceed either (a) 150V per millimetre with a minimum distance of 0.2mm, if protected against the deposition of dirt; or (b) 100V per millimetre with a minimum distance of 0.5mm, if not protected against the deposition of dirt. For peak voltages exceeding 50V, the reduced creepage distances apply only if the proof tracking index (PTI) of the printed circuit board is greater than 175 when measured in accordance with Paragraph B4, Annex B. These distances may be reduced further provided that the appliance complies with the requirements of Clause 8.15 when the distances are short-circuited in turn. NOTE When the limits specified above lead to higher values than those of Table 4.1, the values of the table apply. Creepage distances and clearances within optocouplers are not measured. For live parts of different potential separated by basic insulation only, creepage distances and clearances smaller than those specified in Table 4.1 are allowed provided the requirements of Clause 8.15 are met if these creepage distances and clearances are short-circuited in turn.	No reduction on PCBs	N/A
4.1.4.3	**Distances through insulation** The distance through insulation between metal parts for working voltages up to an including 250V shall be not less than 1.0mm if they are separated by supplementary insulation and be not less than 2.0mm if they are separated by reinforced insulation. Compliance is checked by inspection and by measurement. NOTE 1 This does not imply that the distance has to be through solid insulation only. The insulation may consist of solid material plus one or more air layers. NOTE 2 For appliances having parts with double insulation where there is no metal between basic insulation and supplementary insulation, the measurements are made as though there is a metal foil between the two insulations NOTE 3 The specified distances through insulation do not apply to	Noticed	P

AS 3100:2009			
Clause	Requirement – Test	Result – Remark	Verdict
	the insulation of internal wiring.		
4.1.4.4	**Insulation in sheet form** The requirement in Clause 4.1.4.3 does not apply if the insulation is applied in thin sheet form, other than mica or similar scaly material, and (a) for supplementary insulation, consists of at least two layers, provided that each of the layers withstands the electric strength test of Clause 8.4 for supplementary insulation; or (b) for reinforced insulation, consists of at least three layers, provided that any two layers together withstand the electric strength test of Clause 8.4 for reinforced insulation. Compliance is checked by inspection.	Noticed	P
4.1.4.5	**Supplementary insulation and reinforced insulation** The requirement in Clause 4.1.4.3 does not apply if the supplementary insulation or the reinforced insulation is inaccessible and meets one of the following conditions: (a) The maximum temperature rise determined during the tests of Clause 8.15 does not exceed the value specified in Table 5.7. (b) The insulation, after having been conditioned for 168 h in an oven maintained at a temperature equal to 75°C in excess of the maximum temperature rise determined during the tests of Clause 8.15, withstands the electric strength test of Clause 8.4, this test being made on the insulation both at the temperature occurring in the oven and after cooling to approximately room temperature. Compliance is checked by inspection and by test. For optocouplers the conditioning procedure is carried out at a temperature of 50 °C in excess of the maximum temperature rise measured on the optocoupler during the tests of Clauses 8.12 or 8.15, the optocoupler being operated under the most unfavourable conditions which occur during these tests.	Noticed	P
4.2	**Mechanical protection of conductors and cables**		P
4.2.1	**General** All conductors and cables shall be of such a type or be so located or protected that mechanical or electrical failure is not likely to occur under the conditions to which they may reasonably be subjected in service.		P
4.2.2	**Adjacent material** All material immediately adjacent to or in contact with a conductor shall be so shaped that it will not cause such abrasion of the conductor or its insulation, braiding or sheathing as could lead to its mechanical or electrical failure.		P
4.2.3	**Passage for conductors** Where conductors and cables (including flexible cables and flexible cords) are to be threaded through tubes or channels or passed through openings formed in metal work, the tubes, channels or openings shall be of ample size and, if not bushed, shall have no sharp angles or projecting edges which would be likely to damage a conductor or the insulation, braiding, or sheathing of a cable. Conduit ends and other open ends through which cables pass shall be bushed or so		P

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Clause	Requirement – Test	Result – Remark	Verdict
	shaped that they will not cause abrasion of conductors or the insulation, braiding, or sheathing of the cables. Where bushes are used, they shall be fixed securely in position.		
4.2.4	**Protection near moving parts** Equipment wiring near moving parts shall be so located or arranged as to guard against the possibility of abrasion of the conductor, or its insulation, braiding or sheathing.	Cords are arranged accordingly	P
4.2.5	**Unprotected conductors with fibrous insulation** Fibrous insulated cables, which are defined as 'unprotected' in AS 3158 shall be used only where they can be installed without damage, will not be subjected to undue bending and abrasion, and are protected from mechanical damage and other deleterious effects by virtue of their location and the general design of the equipment in which they are incorporated.		N/A
4.3	**Terminals and connecting facilities for supply conductors**		P
4.3.1	**Connecting facilities required** All equipment shall be provided with facilities for the connection of supply conductors in one of the following forms (a) Terminals. (b) Contact pins or spring contacts intended to engage with the corresponding contacts of a connector, socket-outlet or cord extension socket. For socket-outlets, the requirements of Clause 3.10 shall apply. (c) Connection of the conductors, flexible cord or flexible cable to internal leads, terminals, lugs or the like, by crimping or other similar suitable devices. This form of connection shall be permitted only in the following cases: (i) Where equipment is connected by a Type Y attachment. (ii) A Type Z attachment, where specifically allowed in an individual Approval and test specification. However, in the absence of an Approval and test specification, a Type Z attachment may be permitted where it is used to provide an essential safety feature and where replacement during the economic life of the equipment is unlikely. (iii) Where equipment has Type Y or Type Z attachments in accordance with Clause 4.5.1 of this Standard. (iv) For equipment not covered by individual Approval and test specifications, where the replacement of the flexible cord or cable by the user of the equipment is not intended or is unlikely having regard to the type of flexible cord and the method of use of the equipment, for example whether it is fixed or portable and the degree to which the supply cable or cord will be subjected to flexure and mechanical damage in service. Twist-on connectors with suitable metal inserts may be used for live conductors but shall not be used for earthing connections. (d) Soldering may be used (i) for Type X attachments in equipment having a rated	DC side: a) Connectors (appliance inlet) AC side: b) terminals (terminal type Y)	P

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Clause	Requirement – Test	Result – Remark	Verdict
	input not exceeding 250W; and (ii) for Type Y and Type Z attachments; and shall comply with Clause 4.3.5. No portable equipment shall be provided with facilities for the connection of more than one supply flexible cord, unless permitted in an individual Approval and test specification. Any equipment intended for permanent connection to fixed wiring shall be provided with terminals as specified in Item (a).		
4.3.2	**Design and construction of terminals** All terminals shall be inherently corrosion-resistant or suitably protected against corrosion, and shall be so designed and proportioned that a connection made thereto will not loosen or overheat under normal conditions of use. NOTE For equipment that will be subjected to severe vibration in service, for example a percussion tool, it is generally necessary for special precautions to be taken to ensure that the connections made to the terminals will not slacken off under normal conditions of use. Devices such as self-locking nuts, self-clamping terminals, spring washers or reusable locking compounds are acceptable for the purpose. All terminals shall be so designed that the conductors connected thereto can be rigidly and effectively clamped between metal surfaces and shall comply with Clause 4.6.1. Connecting plates associated with terminals and forming internal connections shall be in effective electrical contact with the associated terminal in accordance with Clause 4.6.1. Terminals shall be either securely fixed in position within a terminal box or enclosure, or so arranged that movement of the connections is limited by location in a suitable enclosure, recess, housing or the like, provision being made for maintaining adequate clearance between live parts and exposed metal parts. Other arrangements are not precluded, provided that the terminals are suitably restrained. Screws of tunnel-type terminals and other clamping devices, which are intended to clamp directly onto conductors, shall be so shaped and finished that strands of the conductor are not likely to be severed when the screw is tightened to the extent necessary to provide a satisfactory termination. The surfaces against which the terminated conductor is to be clamped shall have no sharp angles or projecting edges that would be likely to damage the conductor and, for tunnel-type terminals, the hole for any pinching screw shall not extend through the conductor-way beneath the clamped conductor. Aluminium conductors shall not be clamped directly by screws in tunnel-type terminals other than special types designed to evenly distribute stress and to break the oxide film on the conductors. Indirect clamping by means of suitable ferrules, plates and the like shall be acceptable, provided that the clamping means breaks the oxide film on the conductors. In general, a self-tapping screw shall not be used as a terminal screw for conductors; the acceptability of self-	Noticed	P

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Clause	Requirement – Test	Result – Remark	Verdict
	tapping screws as terminal screws in any particular application will be judged on the circumstances of the case in accordance with Clause 4.8. Die-cast terminal blocks made from zinc-base alloy shall not be used. Terminals provided for direct connection to fixed wiring of an installation shall be so designed and located as to permit the supply cables (other than flexible cables and cables having fewer than seven strands) to be connected in accordance with one of the following methods: (a) Soldered into a cable-socket of appropriate size. (b) Clamped in a terminal or binding post. (c) Terminated in an approved solderless tag or terminating device.		
4.3.3	**Location of terminals** The live terminals shall be within a terminal box or an enclosure, and shall be grouped together. The earthing terminal, if any, shall be either within the terminal box or enclosure or on the external surface of the equipment adjacent to the terminal box or enclosure. If the earthing terminal is on the external surface of the equipment, provision shall be made for the earthing conductor of the supply flexible cord or cable to pass through an opening in the terminal box or enclosure to the earthing terminal. An earthing terminal of the quick-connect type shall not be acceptable on the external surface of the equipment. In equipment, except for those which have Type Y or Type Z attachments in accordance with Clause 4.5.1, the terminal box or enclosure shall be such as will allow access to the terminals and replacement of the flexible cord without dismantling the equipment to such an extent as will disturb the assembly of internal wiring and internal live parts. This does not preclude the terminals of a switch being used as the supply terminals of an equipment, provided that if it is necessary to move the switch for the purpose of connecting the supply flexible cord, the equipment shall incorporate a suitable recess, channel, or space so that the switch and any associated internal wiring will readily return to their correct positions. NOTE See Clause 5.2.2 concerning clearances between terminals and exposed conductive parts.	DC terminals grouped together, AC terminals grouped together, PE terminal clearly marked	P
4.3.4	**Terminal arrangements** Except for equipment that is provided with a Type Y or Type Z attachment, the following provisions shall apply: (a) The arrangement of the terminals shall be such as will allow the supply flexible cord or flexible cable to be disconnected and replaced without removing any internal wiring or connections from the terminals. (b) The clamping of the supply conductor at a terminal shall be independent of the clamping of any internal lead at that terminal. This does not apply where the internal lead is effectively anchored to the terminal by means other than the terminal screw or where the replacement of the flexible cord or flexible cable by the user of the equipment is not intended or is unlikely having regard to the type of flexible cord and the	Verified	P

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Clause	Requirement – Test	Result – Remark	Verdict
	method of use of the equipment, for example whether it is fixed or portable and the degree to which the supply cable or cord will be subjected to flexure and mechanical damage in service. (c) Screwless terminals that require special preparation of the conductors shall not be acceptable for the connection of supply flexible cords.		
4.3.5	**Soldered connections** Where facilities for soldered connections are provided, they shall comply with the following requirements: (a) The soldering terminals, lugs or the like shall be so designed that the conductors are held in position independently of the soldering. (b) They shall be so located and arranged as to minimize the likelihood of insulation being bridged by excess solder and so that essential insulation will not be damaged during soldering. NOTE See Clause 4.5.3 and Clause 4.6.		N/A
4.3.6	**Prevention of slipping or spreading of conductors** All terminals shall be of a form that will prevent slipping or spreading of conductors or conductor strands; for example, by providing for the clamping of conductors either in a cylindrical hole by means of a suitable binding screw or screws, or between the head of a screw and a base so arranged that it will prevent the conductors from slipping or spreading, or by providing solderless tags or washers or other suitable devices to prevent such slipping or spreading. Except for equipment with Type Y or Type Z attachments, a device shall not be acceptable as a means of preventing spreading of conductor strands on the terminals of portable equipment, unless it can be readily re-used when connection of the supply flexible cord is renewed. NOTE Terminal washers and lugs having sections such as claws that are intended to fold over and contain strands of a flexible cord or conductor, or a device in which the conductors are held by clinching the shank of a solderless terminal lug, are not deemed to be readily re-usable. The requirement is not applicable to connections made in equipment with Type Y or Type Z attachment.	Verified	P
4.3.7	**Earthing conductors** Where the equipment includes an earthing terminal, provision shall be made by means of space within the terminal enclosure, the disposition of the terminals, a separate conductor way, suitable shielding, or other suitable means, to ensure that when correctly wired the connection is made without the earthing conductor of the flexible cord being held or pressed against live terminals or other live parts. In addition, where the equipment is intended to accommodate a supplementary earthing conductor of a supply flexible cord as part of an earth-circuit-monitoring arrangement, provision shall be made for adequate basic insulation of the supplementary earthing conductor. NOTE Earth-monitoring equipment should be supplied with instructions describing how the equipment is to be correctly connected, including reference to the provision of basic insulation for supplementary earthing conductors, and a statement that the connection should be made by a suitably qualified person.		P
4.3.8	**Conductors and terminals not to be stressed**	Strain relief provided for	P

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Clause	Requirement – Test	Result – Remark	Verdict
	All conductors shall be so supported and connected that there will be no undue mechanical stress on either the conductors or the terminals to which they are connected.	the AC wire	
4.3.9	**Temperature at terminals** The terminals on all equipment shall be so placed, arranged and ventilated that any conductors or cables connected thereto will not be liable to be exposed to temperatures in excess of those permissible for the conductor material and the class of insulation of the conductors or cables, where such insulation is relied upon to prevent short-circuit or contact with material through which leakage may occur. Where temperature conditions are such as will require the use of connecting cables of heat-resisting type, prominent marking shall be provided adjacent to the terminals to indicate the type of connecting cable necessary. For terminals for the connection of supply flexible cords to portable equipment, the temperature rises, in general, shall not exceed 50°C (to allow the connection of flexible cords having maximum operating temperature of 75°C) except under the circumstances covered by Footnote h to Table 5.7, which allows a higher operating temperature.	See temperature test table 8.11 in Annex No. 1	P
4.3.10	**Access to terminal devices** Terminal devices shall not be accessible without the aid of a tool, even if their live parts are not accessible.		P
4.4	**Flexible cord and connecting plug**	Stationary equipment with industrial PV-plug connection on DC side and fixed connection on AC side	N/A
4.4.1	**When required** Any portable equipment having a rating not exceeding 20A at low voltage shall be provided with a supply flexible cord, except that such flexible cord need not be provided for equipment intended for direct insertion into a socket-outlet, or incorporating a Group 3 appliance inlet, or a Group 2 appliance inlet intended to accommodate a connector with thermal control. The flexible cord shall (a) comply with AS/NZS 3191; (b) unless varied in the individual Approval and test specification, have a length of not less than (i) 0.9m for table top or bench mounted equipment; or (ii) 1.8m for other equipment; which length shall be measured from the body of the equipment at the point where the cord or appliance connector enters the body, irrespective of the length of any cord protector, to the centre of the live pins on the face of the plug. (c) unless varied in the individual Approval and test specification, be not less than (i) if elastomer insulated, ordinary duty sheathed flexible cord; or (ii) if polyvinyl chloride insulated (A) for equipment having a mass not exceeding 3 kg, light duty sheathed flexible cord; or		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	(B) for equipment having a mass exceeding 3 kg, ordinary duty sheathed flexible cord; (d) be of the appropriate current rating; (e) be correctly wired to a plug of appropriate type complying with AS/NZS 3112 or alternatively, for equipment with a rating not exceeding 600 W, with a plug socket adaptor complying with AS/NZS 3122; (f) be correctly connected to a connector of appropriate type if the equipment incorporates an appliance inlet or be correctly connected to terminals of the equipment; (g) incorporate an earthing conductor where the equipment has earthing facilities; and (h) not incorporate an earthing conductor where the equipment is of the double-insulated type. NOTE Item (c) refers to the provision of an 'appropriate' type of flexible cord. The permissible applications of the various types of flexible cord are specified in general terms in the National Wiring Rules. Specific application requirements relating to equipment are specified within the individual Approval and test specifications. Polyvinyl chloride insulated flexible cords shall not be used for equipment having external metal parts, the temperature rise of which exceeds 75 K during the test of Clause 8.12, unless the design of the equipment is such that the power supply cord is not likely to touch such metal parts in normal use. Tinsel flexible cords and flexible cords with conductors having a nominal cross-sectional area of 0.5mm$_2$ shall not be used for earthing purposes. Tinsel flexible cord is recognized only for the connection of equipment of small current rating where extreme flexibility is required. For items that have no individual Approval and test specification, the type of flexible cord permitted in published individual Approval and test specifications should be used as the basis for evaluating whether a particular type of cord is an appropriate type for the item in question. In the selection of cords, consideration should be given to the following conditions: (i) Physical conditions. (ii) Environment. (iii) Exposure to oils, grease, or solvents. ower supply cords shall have a nominal cross-sectional area not less than those given in Table 4.4.		
4.4.2	**Warning notice** Any equipment with a current rating above 10A but not exceeding 20A, and which is intended for connection by flexible cord and plug to a socket-outlet, shall have a prominent and durable notice affixed adjacent to the flexible cord entry of the equipment to indicate that it must be connected only to a socket-outlet of appropriate current rating.		N/A
4.5	**Supply connection and external flexible cables and cords**		P
4.5.1	**General** Where a supply flexible cord or supply flexible cable is to be connected directly to equipment (that is, not through a connector or the like), the facilities for the connection of the supply flexible cord or cable shall, in addition to complying with Clause 4.3, comply with this	Noticed, type Y attachment.	P

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Clause	Requirement – Test	Result – Remark	Verdict
	Clause. Power supply cords shall be assembled with the equipment by one of the following methods: (a) Type X attachment. (b) Type Y attachment. (c) Type Z attachment. For equipment not covered by an individual Approval and test specification, Type Y or Type Z attachments may be provided in the following circumstances: (i) Where sealing or encapsulation provides an essential safety feature such as waterproofing or avoidance of tampering with adjustments. (ii) In all other cases where the replacement of the flexible cord or flexible cable by the user of the equipment is not intended or is unlikely, having regard to the type of flexible cord and the method of use of the equipment, for example whether it is fixed or portable and the degree to which the supply cable or cord will be subjected to flexure and mechanical damage in service. Riveting, or the use of special screws that are not removable or that are intended to be removed only with the aid of a special single-purpose tool, shall be regarded as an acceptable method of sealing; screws of the conventional straight slot, Phillips head, Allen key type and the like are not acceptable, unless access to their heads is prevented by a plug which is non-removable without irreparable damage.		
4.5.2	**Provision for entry of flexible cord** The equipment shall include provision for entry of the flexible cord or cable within its protective covering or sheath. The opening through which the flexible cord or cable passes shall be bushed or shaped so as to minimize abrasion of the protective covering and insulation. A sleeve, guard or other device provided to prevent sharp bending of the supply flexible cord shall not be integral with the cord where a Type X attachment is used, unless it forms part of a specially prepared cord available from the manufacturer or its service agent. It shall be fixed in a reliable manner and not incorporated in the cord anchorage device, unless the anchorage device will clamp the cord effectively with the sleeve removed.	Verified	P
4.5.3	**Cord anchorage** All equipment intended for connection by means of a flexible cord or flexible cable shall be provided with a saddle, grip, tortuous path or other suitable means so that when the device is connected in the correct manner the stress on the connecting terminals shall be definitely and substantially reduced, and the arrangement shall comply with the test specified in Clause 8.6. For Type X attachment where a tortuous path (labyrinth) is used, it shall be clear how the cord is to be fitted and how the relief from strain and the prevention of twisting are obtained. Where cord anchorage is obtained by means of a screw bearing on the sheathing of a flexible cord, the assembly shall be such that in no way will it damage	Cord anchorage or self-locking inlet provide suitable location in position	P

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Clause	Requirement – Test	Result – Remark	Verdict
	the flexible cord when correctly applied nor shall it loosen in service. The screw shall (a) be made of suitable insulating material; (b) have a nominal diameter not less than that of the aperture for the flexible cord; and (c) be so shaped as not to damage the flexible cord. The method used for reducing the stress shall be such as will ensure that necessary insulation will not be damaged. The knotting of a flexible cord shall not be deemed an acceptable means of cord anchorage. A floating-type cord anchorage shall not be acceptable unless it is suitably located in position within the terminal compartment, independent of the flexible cord. The cord anchorage shall be capable of accommodating a flexible cord of size and type appropriate∗ to the equipment that is to be connected. For equipment having an earthing terminal, any cord anchorage designed to embrace the complete flexible cord shall be capable of accommodating a flexible cord that includes an earthing conductor. * See Note to Clause 4.4.1 Item (h). If the effectiveness of the cord anchorage of a connecting device is dependent on the relative location of component parts of the device, the arrangement shall be such as will prevent inadvertent assembly of the component parts in the wrong position. NOTE Wherever possible, a device that provides for anchorage of the complete flexible cord within its braid or sheathing is to be used. Such a device may take the form of a clamp or saddle-type grip. Where it is impracticable to anchor a flexible cord or flexible cable that includes an earthing conductor in this way, the wiring facilities should be such as will permit sufficient slack to be left in the earthing conductor to ensure that any stress is taken up by the live conductors before the earthing conductor becomes taut. Devices such as those in the form of a crimped-on metal ring, which are either not located in position or are incapable of being used more than once, are not acceptable for equipment with Type X attachments. Floating devices, whether clamps or disks having holes for separate conductors, may be used only where the design of the equipment provides a space in which such devices naturally fit and which locates them in position. They may, however, be accepted without such location where space available is limited and there is little room for them to move; in such a case the device shall not be of metal if there is a possibility of the clamp coming into contact with live terminals. Split devices are acceptable only if they are of such a type that there is no possibility of damage to the flexible cord and they may be removed and replaced without undue difficulty.		
4.5.4	**Protection of supply flexible cord** Porcelain beads, heat-resistant sleeving, tubing, taping or the like on supply flexible cords shall not be accepted as providing insulation or protection on that flexible cord for equipment with Type X attachment. Beads and similar ceramic insulators on live wires shall be so fixed or supported that they cannot change their position; they shall not rest on sharp edges. The equipment shall include provision for guarding the supply flexible cord against damage from internal moving parts, and internal surfaces having normal operating temperatures in excess of that permissible for the supply flexible cord.		P
4.5.5	**Interconnection cables and cords** Facilities for the connection of detachable and non-		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	detachable interconnection flexible cables or cords shall comply with the requirements for the supply cable or cord, except that (a) connectors and appliance inlets used for the interconnection flexible cable or cord shall not be interchangeable with the connectors and appliance inlets used for the power supply cord, if this might impair compliance with this Standard; and (b) the cross-sectional area of the conductors of the interconnection flexible cable or cord is determined on the basis of the maximum current carried by the conductor during the normal operation tests. NOTE 1 An interconnection flexible cable or cord is considered to be a flexible cable or cord provided as part of the complete equipment for purposes other than supply; for example a remote hand-held switching device, an exposed interconnection between two parts of the equipment, or a separate signalling circuit. NOTE 2 Socket-outlets that are not accessible to the user and which are used for the interconnection of various parts of equipment are not considered to be general purpose outlets.		
4.6	**Joints and connections**		N/A
4.6.1	**Joints and insulation** Where insulation is required on joints or connections in equipment wiring, the thickness need only be equivalent to that required by Clause 5.2.3. All joints and connections, the failure of which could cause a hazard, shall utilize materials and forms of construction that will avoid deterioration or loss of contact pressure in service. Insulating materials which may shrink or deform in service in such a manner as to cause loss of contact pressure at a joint or connection shall not be used unless they are suitably treated or proofed to prevent such shrinkage or deformation, or unless the metallic parts of the joint or connection have sufficient resiliency to compensate for any such shrinkage or deformation and to retain adequate contact pressure in service. Stranded conductors shall not be consolidated by lead-tin soldering where they are subject to contact pressure, unless the clamping means is so designed that there is no risk of bad contact due to cold flow of the solder. NOTE 1 Some thermoplastic materials are regarded as liable to shrink or deform at temperatures normally associated with terminal block applications. NOTE 2 Consolidation of stranded conductors by lead-tin soldering is allowed if spring terminals are used; securing the clamping screws alone is not considered adequate. NOTE 3 Soldering of the tip of a stranded conductor is allowed.		N/A
4.6.2	**Soldered joints** Soldered joints shall be made without the use of fluxes containing corrosive substances.		N/A
4.6.3	**Limitations of soldered joints** Soft-soldered joints and soft soldering shall not be used for the connection of conductors or in the construction of any equipment where the temperature of the soldered joint is likely to exceed 120°C in normal operation. NOTE: It is recommended that the soft solder used in electrical work be that listed as 50 Sn in AS 1834.1 and AS 1834.2, this being the grade primarily intended for general electrical purposes.		N/A
4.6.4	**Joints and connections in lighting fittings**		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	No joint or connection shall be made within a lighting fitting except in a space incorporated therein for the purpose.		
4.6.5	**Solderless joints** The attachment of conductors by crimped or similar forms of solderless pressure joints shall be made only with the use of the appropriate attaching tools.		N/A
4.6.6	**Cascading of adaptors** Two-way quick-connect tab and receptacle adaptors and the like shall not be cascaded.		N/A
4.7	**Strength of screw threads and fixings** Components that have screw threads, and which will be removed or loosened with the aid of a tool for the purpose of connecting supply conductors to the equipment, together with their fixings, shall be capable of withstanding the test specified in Clause 8.7. Where a number of identical threaded components are involved, tests may be conducted on a representative number at the discretion of the testing laboratory. If one failure occurs and the omission of this component does not prevent the equipment from complying with the remaining requirements of the specification, this shall not in itself constitute non-compliance with this Clause, but all of the remaining represented components shall withstand the test. Where the screwed component or its fixing is of thermoplastic material, the length of engagement of a thermoplastic screw into a tapped hole in metal or in plastic material shall be not less than the nominal diameter of such screw. Testing to the requirements of this Clause shall not be required for equipment with Type Y or Type Z attachments.	See table 8.7 in Annex No. 1	P
4.8	**Space-threaded and thread-cutting screws** Space-threaded (sheet metal) screws shall not be used for the connection of current-carrying parts, unless they clamp these parts directly in contact with each other and are provided with a suitable means of locking. Thread-cutting (self-tapping) screws shall not be used for the electrical connection of current-carrying parts, unless they generate a full-form standard machine screw thread. Unless the thread is formed by a swaging action such screws shall not, however, be used if they are likely to be removed or replaced during installation or servicing. Thread-cutting and space-threaded screws may be used to provide earthing continuity, provided that it is not necessary to disturb the connection in normal use and that at least two screws are used for each connection.	Verified	P
4.9	**Direct connection to fixed wiring** Equipment designed for direct connection to the supply circuit wiring shall comply with the following: (a) Provision shall be made for the entry of insulated conductors within their conduit, sheathing or other protective covering. (b) Terminals suitable for the connection of the supply conductors and an earthing conductor (if required) shall be provided; the terminals shall be fixed in position and	DC and AC inlets grouped, PE terminal clearly marked	P

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Clause	Requirement – Test	Result – Remark	Verdict
	shall be grouped together either in a terminal box or within the equipment enclosure, except that the earthing terminal may be located adjacent to the terminal box or enclosure. (c) Where identification is necessary, live terminals shall be marked in accordance with Clause 7.6. (d) Terminals of a heating element or thermostat shall not be used as a means for the connection of supply conductors.		
4.10	**Mechanical strength** Equipment shall have adequate mechanical strength and be so constructed as to withstand such rough handling as may be expected in normal use. Compliance is checked by inspection and, if necessary, by the test of Clause 8.8.		P
4.11	**Degree of protection (IP classification)** Where the equipment is marked to classify it as having a specified degree of protection, the equipment shall comply with the appropriate requirements of AS 60529. The tests of AS 60529 shall be carried out after the test of Clause 4.10 if applicable. For equipment assigned with a second characteristic numeral greater than 0, the equipment shall then withstand the tests of Clause 8.4.	IP 65, see Annex no. 3	P

SECTION 5: PROTECTION AGAINST RISK OF ELECTRIC SHOCK			
5.1	**Guarding of live parts** Except for equipment intended for use only in a position not accessible to unauthorized persons, all equipment shall be so designed and constructed that, when the equipment is standing, supported, or fixed, in a normal manner, no person can inadvertently come into contact with any live part (see also Clause 8.10). If a hole giving access to preset controls is marked as such on the enclosure or reference made to it in the instructions and the setting of this control requires a screwdriver or other tool, the adjustment of the control shall not allow contact with any live parts. A metal test pin having a diameter of 2 mm and a length of 100 mm shall not become live when it is inserted through the hole in every position with a force of 10 N. Covers of equipment, other than accessories, relied upon to prevent inadvertent personal contact with live parts shall be fixed in position in such a manner that a tool is necessary to remove them; wing nuts, knurled nuts and the like are not deemed to comply with this requirement. A slot that will accept a coin is regarded as intended to accommodate a tool for the purpose of this Clause. In addition, the opening or removal of any cover or component, with or without tools, where such opening or removal is necessary as a normal operation of the equipment as distinct from maintenance, repairs, or adjustment, shall not expose live parts to inadvertent personal contact. If a manufacturer instructs the user to remove any covers or components for maintenance, repairs or adjustments, this shall not expose live parts to inadvertent personal contact. Any metal cover or casing enclosing live parts shall be of a strength sufficient to ensure that it cannot be deformed readily so as to come into contact with live parts. Edison-type screw lampholders incorporated in equipment shall be provided with adequate shielding facilities appropriate to the type of lamp with which they may be used.	Guarantedd also due to IP65	P
5.1.1	**Class II construction** Class II appliances and class II constructions shall be constructed and enclosed so that there is adequate protection against accidental contact with basic insulation and metal parts separated from live parts by basic insulation only. It shall only be possible to touch parts which are separated from live parts by double insulation or reinforced insulation. Compliance is checked by inspection and by applying the test finger of figure 8.10, as described in clause 8.10. NOTE 1 This requirement applies for all positions of the appliance when it is operated as in normal use, even after opening lids and doors and removal of detachable parts. NOTE 2 Built-in appliances and fixed appliances are tested after installation.		N/A
5.2	**Insulation of live parts**		P
5.2.1	**General**	See table 8.3.1, 8.3.2	P

	Live parts of electrical equipment shall be adequately insulated and supported and shall comply with the following: (a) Clauses 8.3 and 8.4 of this Standard. (b) Any specified requirements for insulation thickness. Unless otherwise specified in a particular clause herein or in an individual Approval and test specification, any specified thickness of insulation shall be regarded as applicable at the thinnest point of the insulation, for example at the bottom of a screwdriver slot in a brush holder cap.	and 8.4 in Annex No. 1 below	
5.2.2	**Separation of live parts from non-current-carrying conductive parts** The support and insulation of every live part shall be such as will ensure that no live part can make contact with any non-current-carrying conductive part exposed to personal contact. In respect of terminals of components such as switches, adequate clearances shall be maintained or insulation shall be provided to prevent contact of the terminals, or loose strands of flexible cords intended to be terminated therein, with exposed conductive parts. Where necessary, provision shall be made to ensure that conductors protruding through terminals, when normally connected, will not contact exposed conductive parts.	Noticed	P
5.2.3	**Equipment wiring** NOTE This Clause deals only with requirements for electrical insulation. In some instances further mechanical protection of equipment wiring may be necessary such as by providing a braiding, covering, sheathing or sleeving, or by location of the wiring in order to comply with Clauses 3.1, 3.2 and 4.2.		P
5.2.3.1	**General requirements** Where equipment wiring is insulated in order to comply with Clauses 5.1, 5.2.1 and 5.2.2, such insulation shall be of a grade appropriate to the voltage to which it will be subjected in ordinary use. Insulants covered by this Standard shall comply with (a) the thickness requirements of Clauses 5.2.3.2 or 5.2.3.3; or (b) the thickness requirements of AS/NZS 3191. However, for other insulation the suitability of the insulant is assessed and an electric strength test shall be made between the conductor and metal foil wrapped around the insulation, a test voltage of 2000V being applied for 15 min. NOTE Where the insulant is adequately specified and compliance with this test is obvious, the test need not be conducted. Where equipment incorporates a component, such as a pilot lamp, which is connected to the supply terminals of the equipment but operates at a lower voltage than at those terminals, the wiring to such component shall have a grade of insulation appropriate to the rated voltage of the equipment. If, however, the reduced voltage is obtained from the potential drop across a shunt (other than a section of an element or winding) and if the conductors are separated from exposed metal parts by adequate spacing or by effective insulating means appropriate to the rated voltage of the equipment, then the insulation between the conductors need only be appropriate for the voltage of the component. Where the equipment wiring is in the form of a cable it		P

	shall comply with the relevant Approval and test specification except as provided in Clauses 5.2.3.2 and 5.2.3.3.		
5.2.3.2	**Specific requirements – PVC insulation** Specific requirements for wiring with PVC insulation are as follows: (a) For internal equipment wiring and accessible equipment wiring not subject to flexing or damage, the following shall apply: (i) *General* Insulation of internal equipment wiring of 250 V grade shall have an average aggregate thickness between any two live conductors and between any live conductor and exposed metal of not less than 0.5mm, and in no case shall the minimum aggregate thickness at any point be less than 0.35mm. Where insulating sleeving is used, it shall be a close fit over the conductor or other sleeving or otherwise shall be securely fixed in position. (ii) *Maximum operating temperature* Flexible cords with V60, V75 and V90 insulants may have a maximum operating temperature of 80°C, 95°C and 100°C, respectively, when used as internal equipment wiring in such a manner as to be not subjected to flexing. (b) For accessible equipment wiring subject to flexing or damage, or external equipment wiring of 250V grade, insulation shall have an average aggregate thickness of not less than 0.8mm, and the minimum thickness at any point shall be not less than 0.6mm except as otherwise provided for a specific type of cable in the appropriate Approval and test specification, for example, parallel 2 core unsheathed.		P
5.2.3.3	**Specific requirements – fibrous insulation** The thickness of 250V grade fibrous insulation for internal, accessible and external equipment wiring shall comply with AS 3158 or AS/NZS 3191, as appropriate. Fibrous insulation used for accessible or external equipment wiring shall be so treated or covered as to render it impervious to moisture; a cable complying with AS 3158 shall be regarded as satisfactory in this respect.		N/A
5.2.4	**Arrangement of equipment wiring** Precautions shall be taken in the support and fixing of equipment wiring to ensure that live parts, including any one conductor that may become detached from its termination, cannot become exposed to personal contact by protruding through an opening without coming into contact with exposed metal. In the determination of compliance with this requirement, the dimensions and disposition of the opening shall be taken into consideration. Attachment of one conductor to another by tying, lacing, clipping, or the like, is regarded as a satisfactory means of fixing and support, provided that any one conductor detached from its termination is so retained in position as to comply with this Clause.	External clip terminals on DC side; AC side: internal screw terminals, external wiring is attached upon installation and secured via strain-relief; each exposed metal part is earthed	P
5.3	**Earthing facilities**		P
5.3.1	**Exposed metal parts to have means of earthing** If equipment includes any exposed metal parts, then all such exposed metal parts shall be in good electrical contact with each other, and the equipment shall be provided with a common earthing facility by means of	All exposed metal parts are earthed	P

	which all the exposed metal parts may be effectively earthed. For combination gas-electric equipment, the main metallic gas pipe of the equipment to which the incoming gas supply is to be directly connected shall be bonded to the earthing terminal of the equipment. Metal parts that are coated with porcelain enamel, paint or similar insulating finishes, shall not be deemed to have been brought into good electrical contact with other parts merely by contact with the coated surface or by screws or bolts passing through those portions of the parts that are coated. The coating of metal parts with porcelain enamel is not acceptable alone as justification of absence of earthing of such parts. Flexible metallic conduit or tubing enclosing the conductors between movable component parts of an equipment shall not be relied upon for earthing purposes.		
5.3.2	**Method of making the earth connection** Facilities for earthing shall take one of the following forms: (a) A terminal suitable for the attachment of an earthing conductor. (b) The earthing contact of an appliance inlet. (c) Other approved means. A constructional bolt, stud, or screw may be used as the earthing terminal on equipment having exposed metal parts only if all the following conditions are observed: (i) The earthing conductor can be removed from the terminal without in any way reducing the effectiveness of the bolt, stud or screw as a constructional medium, or causing any parts of the equipment to lose their relative rigidity. NOTE This provision does not preclude the use, as an earthing terminal, of a stud which also serves for securing a terminal cover provided that it complies with Items (ii) and (iii). (ii) The removal of any covers, or parts of which are likely to be removed in obtaining access to terminals or in adjusting the equipment or parts thereof, shall not disturb or reduce the effectiveness of the earthing connection. (iii) The bolt, stud or screw is not used for fixing the equipment in position or for adjusting the position of the equipment or any part of it.	Earthing terminal provided and clearly marked	P
5.3.3	**Design and construction of earthing terminal** The earthing terminal provided on any equipment shall be capable of accommodating an appropriate internal earthing conductor and a supply earthing conductor of the size required by the National Wiring Rules. The current-carrying capacity of any earthing terminal shall be not less than that of the earthing conductors to be connected.	Noticed	P
5.3.4	**Resistance of earthing connection** The resistance between the earthing facility and any exposed metal parts shall not exceed 1Ω for readily accessible exposed metal parts that rotate, reciprocate or oscillate continuously, and 0.1Ω in all other cases, when tested in accordance with Clause 8.4.	See table 8.4 in Annex No. 1	P
5.3.5	**Printed conductors** The printed conductors of printed circuit boards shall	No hand-held equipment	N/A

	not be used to provide earthing continuity in hand-held equipment. They may be used to provide earthing continuity in other equipment if at least two tracks are used with independent soldering points and the equipment complies with the requirement of Clause 8.4 for each circuit.		
5.4	**Equipment with double insulation**		P
5.4.1	**General** Equipment may be accepted as having double insulation only if it complies with Clause 5.4 and is capable of passing the tests prescribed herein. NOTE 1 See Annex D for information on the design of electrical equipment having double insulation. NOTE 2 Sheathed-type flexible cords that comply with AS/NZS 3191 are regarded as affording double insulation between conductors and any metal in contact with the sheathing. In addition, the following forms of construction are considered as acceptable: (a) Equipment having metal parts that can be touched and that are separated from live parts by insulation that is considered to be the equivalent of double insulation. NOTE 3 An example of this form of construction is the use of optocouplers. (b) Equipment having metal parts that can be touched, and which are intentionally connected to live parts through an impedance which is designed to preserve the appropriate level of safety. Parts connected by protective impedances shall be separated by double insulation or reinforced insulation.		P
5.4.2	**Supplementary insulation** Supplementary insulation shall consist of suitable non-hygroscopic insulating materials possessing adequate mechanical strength, and shall comply with the test requirements specified in Clause 8.4.3. Any supplementary insulation in the form of coverings, linings and the like shall be securely fixed in position and shall be such as it will maintain its position and insulating properties under any conditions of normal wear and tear, or other deteriorating factors that can be reasonably expected in service. The arrangements of the supplementary insulation shall be such that in the event of failure of the basic insulation due to a fault condition, the effectiveness of the supplementary insulation shall not be impaired.		N/A
5.4.3	**Basic insulation** Basic insulation shall consist of suitable material possessing adequate mechanical strength and shall comply with the test requirements specified in Clause 8.4.3.	Basic insulation between live parts to PE.	P
5.4.4	**Reinforced insulation** Instead of double insulation, the use, in equipment, of a single layer of insulation may be accepted as affording equivalent protection under the following conditions: (a) The single layer of reinforced insulation shall be of non-hygroscopic insulating material possessing adequate mechanical strength. (b) The insulation shall be suitable for the particular application involved and shall not give rise to danger, either (i) through the functioning of the equipment under conditions required by its use at rated loading; or (ii) through the mechanical or electrical failure of the	Reinforced insulation between live parts and accessible communication interface	P

	equipment, or of any part thereof. (c) Precautions shall be taken to guard against the accidental bridging of the insulation by metal or partially conducting material such as carbon dust or moisture, which can be reasonably anticipated to accumulate under normal conditions of use. (d) The insulation shall comply with the test requirements specified in Clause 8.4.3.		
5.4.5	**External metal parts** The equipment shall have no external metal other than the parts listed in Items (b) to (d) of Clause 2.1.23 (the definition for exposed metal.)		P
5.4.6	**Detachable covers** The removal of any covers that are detachable without the use of tools shall not expose to personal contact (a) live parts; (b) metal parts separated from live parts by basic insulation; or (c) the surface of basic insulation. Exposure of such parts due to the removal of a lamp from a lampholder shall not be a cause for rejection in terms of this requirement. Accessible or external equipment wiring that complies with Clause 5.2.3.2 (b) is deemed to comply with this Clause.	No removal without the use of tools	P
5.4.7	**Arrangement of equipment wiring** Precautions shall be taken in the support and fixing of equipment wiring to ensure compliance with the following requirements: (a) Live parts, including any one conductor that may become detached from its termination, cannot come into contact with either supplementary insulation or external metal parts or become exposed to personal contact by protruding through an opening. (b) Basic insulation cannot come into contact with external metal parts. (c) Basic insulation cannot become exposed to personal contact by protruding through an opening. Attachment of one conductor to another by tying, lacing, clipping, or the like, is regarded as a satisfactory means of fixing and support, provided that any one conductor detached, from its termination is thus so retained in position as to comply with this Clause. Where a single layer of reinforced insulation is accepted as the equivalent of double insulation in accordance with Clause 5.4.4, a live part in contact with the reinforced insulation is not precluded by the above requirements.	Verified	P
5.4.8	**Insulation of internal wiring** The average aggregate thickness of basic insulation between any two live conductors and between any live conductor and supplementary insulation shall be not less than 0.5mm. The average aggregate thickness of supplementary insulation shall be not less than 0.6mm. The aggregate thickness of insulation at any point shall be not less than 0.35 mm and 0.44mm for basic and supplementary insulation respectively. A regulatory authority may, however, accept a lesser aggregate thickness of certain types of insulation where satisfied that the insulation is superior to those that are generally used for similar applications and has	Verified	P

	the requisite mechanical and electrical strength. Where insulating sleeving is used, it shall be a close fit over the conductor or other sleeving, or otherwise shall be securely fixed in position. Notwithstanding the requirements of this Clause, insulation thickness complying with AS/NZS 3191 is deemed to be satisfactory. For appliances, the requirements of Clause 4.1.4.3 are not applicable to the insulation of internal wiring complying with AS/NZS 3191.		
5.4.9	**Openings in external metal walls** Where a flexible cord or other conductor passes through an external metal wall, a substantial insulating bush shall be securely fixed in the opening and shall comply with the test requirements specified in Clause 8.4.3 for supplementary insulation.	Strain relieves provided	P
5.4.10	**Radio interference suppression devices** No radio interference suppression device shall be connected between live parts and external metal parts of double-insulated equipment. Any radio interference suppression capacitor connected between live parts and internal metal parts (for example, in parallel with the basic insulation) shall have a capacitance not exceeding 0.05µF.		N/A
5.5	**Extra-low voltage equipment** Clauses 5.1, 5.2 and 5.3 shall not apply to equipment rated at extra-low voltage, except that DC equipment rated above 50V shall be capable of withstanding the high voltage test specified in Clause 8.4. If extra-low voltage wiring or parts connected thereto are accessibleto the standard test finger without the use of tools, they shall be connected to a safety extra-low voltage supply.		N/A
5.6	**Switches in portable heating appliances** For portable heating appliances, any switch controlling an element that is accessible to personal contact (see Clause 8.10) shall open all live conductors connected to the element; however, a single-pole switch may be used under the following conditions: (a) If it controls only a portion of the element, the remaining portion of which is not controlled by any switch on the appliance and is open to view and is luminous when energized. (b) If it controls only a portion of the element, the whole of which is under the control of a switch opening all live conductors connected thereto and if the portion not controlled by the single-pole switch is open to view and is luminous when energized.		N/A
5.7	**Temperature rises for components and insulating material** The temperature rises of components and of electrical insulating materials used in the construction of electrical equipment shall not exceed the values specified in Table 5.7 when tested in accordance with Clause 8.12. The reference ambient temperature shall be as specified in Clause 8.1.	See table 8.12 in Annex No. 1	P
5.8	**Fault-indicating devices** Any device, other than a circuit-interrupting device, intended to indicate to the user that a fault exists in equipment, shall be so designed and constructed that a defect in the fault-indicating device itself shall not give rise to a false indication.	Fault indication just for grid conditions and DC insulation resistance	N/A

	NOTE Defect in this context is intended to mean any fault or failure such as failure of a lamp or other component, which may reasonably be anticipated in service (see Clause 3.1). Any such device intended to indicate that a dangerous potential exists on any external metal parts of equipment shall indicate when the potential difference between such external metal parts and earth (or other reference point where an isolated system is used) reaches a predetermined voltage which shall not exceed 32Vr.m.s. Any external metal parts of such devices that are connected to internal wiring shall be so arranged that under no circumstances can they reach a potential exceeding 32Vr.m.s, or shall be so arranged that under no circumstances can a leakage current in excess of 2mA flow when the external metal part is connected directly to earth (or other reference point where an isolated system is used) through a conductor having a negligible impedance.		
5.9	**Fixing of handles, knobs, or the like** Handles, knobs, grips, levers, or the like, shall be fixed in a reliable manner so that they will not work loose in normal use if loosening might result in a hazard. If handles, knobs, or the like, are used to indicate the position of switches or similar components, it shall not be possible to fix them in a wrong position if this might result in a hazard. Compliance is checked by inspection, by manual test and by trying to remove the handle, knob, grip or lever by applying for 1min. an axial force of a value as follows: (a) If the shape of these parts is such that an axial pull is unlikely to be applied in normal use, the force is (i) 15 N for actuating members of electrical components; and (ii) 20 N in other cases. (b) If the shape is such that an axial pull is likely to be applied, the force is (i) 30 N for actuating members of electrical components; and (ii) 50 N in other cases. NOTE Sealing compounds and the like, other than self-hardening resins, are not considered to be adequate to prevent loosening.		P

SECTION 6: RESISTANCE TO HEAT, FIRE AND TRACKING			
6.1	**General** This Section applies only to equipment designated 'attended' or 'unattended' in a particular Approval and test specification. For particular Approval and test specifications that do not designate equipment as 'attended' or 'unattended' the requirements of Annex A apply.	Noticed	P
6.2	**Resistance to heat** External parts of non-metallic material, parts of insulating material supporting live parts including connections, and parts of thermoplastic material providing supplementary or reinforced insulation, the deterioration of which might cause the equipment to fail to comply with this Standard, shall be sufficiently resistant to heat. Compliance is checked, if required, by Footnote[e] to Table 5.7 and by Footnote† to Table 8.15.9, using the test of Paragraph B2, Annex B.	See list of critical components on Table B 2 in Annex No.1	P
6.3	**Resistance to fire** Parts of non-metallic material shall be resistant to ignition and spread of fire. Compliance is checked by the tests of Paragraph B3, Annex B. This requirement does not apply to decorative trims, knobs, wiring insulation and other parts not likely to be ignited or to propagate flames originating from inside the equipment. Alternatively, compliance may be checked as specified in Clause 30.2 of AS/NZS 60335.1.	Noticed, see Table B3.3 and B3.4 in Annex No.1	P
6.4	**Resistance to tracking** Insulating material across which a tracking path may occur shall have adequate resistance to tracking, taking into account the severity of its duty conditions. Compliance is checked by the tests of Paragraph B4, Annex B.		N/A

SECTION 7: MARKING			
7.1	**Information to be marked** All equipment shall be marked with the following information: (a) The name or registered trade name or mark of the manufacturer or of the responsible vendor. NOTE In every state and territory of Australia and in New Zealand legislation has been enacted which requires that electrical equipment of a declared class or type should not be marketed unless approved by the relevant regulatory authority. It may be essential in terms of the legislation that certain classes or types of article be marked with the approvals marking allotted by the relevant authority. (b) The operating voltage and the rating in amperes or loading in watts or volt-amperes. For equipment other than class III equipment, that is intended for connection to the supply mains the marking of the operating voltage for single phase equipment shall be at least 230V and for polyphase equipment at least 400V or a rated voltage range that includes 230V for single phase equipment and 400V for polyphase equipment. (c) Where the use of equipment is limited either by its own nature or by the nature of any component to a particular system, it shall be marked with those details of the system (such as DC, AC, phases, frequency) to which the use of the equipment or any component thereof is limited. (d) Where a manufacturer or responsible vendor markets a number of different types of the same article, each article shall be marked with the catalogue number, type number or name, or other marking that will distinguish it from any other type of the same article. (e) If applicable, designation for degree of protection against moisture including any pressure, head or time. NOTE Information on degrees of protection is contained in AS 60529. (f) If compliance with this Standard depends upon the operation of a replaceable thermal link or fuse link, the reference number or other means for identifying the link shall be marked at a place so that it is clearly visible when the appliance has been dismantled to the extent necessary for replacing the link. NOTE Marking on the link is allowed as long as the marking is legible after the link has failed. This requirement does not apply to links that can only be replaced together with a part of the appliance. Where abbreviations or symbols are used in lieu of the appropriate wording, the following shall apply; however, other abbreviations that clearly convey the intention may be accepted: The numerical value of the frequency and the number of phases may be coupled with the alternating current abbreviation or symbol. Notwithstanding the requirements of an individual Approval and test specification, the following requirements shall apply: (i) Th above marking, viz: 'alternating current' or 'a.c. or " shall be acceptable for designating equipment intended for operation on a.c. only. In addition, the presence of a marking that indicates the frequency of the supply voltage shall render the marking 'alternating current' or 'a.c. or " unnecessary. (ii) Any marking required shall be expressed in SI units, unless otherwise specified in an individual Approval	See type label	P

	and test specification.		
7.2	**Method of marking** Unless provision for a special form of marking is made in an individual specification, marking required under Items (a), (b), (c), (d), (e) and (f) of Clause 7.1 shall be legible and except where permissible under Paragraph four below, indelible, and shall be made either on the equipment itself or on a nameplate securely fixed thereto. Adhesive metallic labels shall not be fixed in locations where, if they become detached, they may readily touch live parts or bridge insulation. Nameplates incorporating a durable surface finish, including those with particulars printed photographically in conjunction with anodizing, shall be regarded as indelible. Where marking is by adhesive non-metallic labels, surface transfers, painting, silk-screening, printing with etching dyes or similar means, the marking shall be sufficiently durable for its purpose and located where it will not be subjected to conditions that may lead to its deterioration, having regard to the quality of marking, the surface to which it is applied, and service conditions such as temperature, moisture, abrasion and handling. The marking of fixed equipment shall be clearly discernible from the outside after the equipment has been fixed as in normal use, but, if necessary, after removal of a cover. The marking of other equipment shall be clearly discernible from the outside, if necessary, after removal of a cover; for portable equipment, the removal of this cover shall not require the use of a tool. Indications for switches, thermostats, thermal cut-outs and other control devices shall be placed in the vicinity of these components; they shall not be placed on removable parts if these parts can be replaced in such a way that the marking is misleading.	Verified	P
7.3	**Double marking** If any equipment is to be marked with its load in watts and is marked with more than one voltage but only one wattage, then the marked wattage shall correspond to the wattage measured at the highest marked voltage.		N/A
7.4	**Marking of earth connections** The provisions of this Clause shall apply to all equipment except that which has a Type Z attachment. The earthing terminal of any equipment shall be identified by means of the word 'earth' or the letter 'E' or the international earth symbol, viz. ⏚, or any combination thereof, marked in a legible and indelible manner on or adjacent to the terminal; however, for equipment arranged only for direct connection to fixed wiring of an installation (a) the earthing terminal need not be marked if its function is clearly evident, for example where the earthing terminal stud or screw is obviously attached to a metal frame or enclosure; or (b) if the earthing terminal is within a terminal box or enclosure, any marking which is required may be effected in a durable manner by means such as painting or a suitable transfer.	Earthing is applied via screw connectior and is clearly marked with E on the enclosure	P

	Lettering used for the marking of the earthing terminal shall be of such a size, or so indented or embossed, as to be conspicuous. The marking required by this Clause may be supplemented by other identifying features, such as plating or green colouring of earth connections, or the word 'green'. In any equipment the marking required by this Clause shall not be used to identify anything other than an earthing terminal or facility.		
7.5	**Marking of class II equipment** All Class II equipment, other than accessories, shall be identified by means of the international symbol for double-insulated equipment, viz. ⧈ , or the words 'DOUBLE INSULATED'. Such markings shall be legible and indelible and shall be made either on the equipment itself or on a nameplate securely fixed thereto. The dimensions of the symbol for Class II construction shall be such that the length of the sides of the outer square is about twice the length of the sides of the inner square. The length of the sides of the outer square shall be not less than 5mm, unless the largest dimension of the appliance does not exceed 150mm, in which case the dimensions of the symbol may be reduced, but the length of the sides of the outer square shall be not less than 3mm. The symbol for Class II construction shall be so placed that it will be obvious that it is a part of the technical information and is unlikely to be confused with any other marking.		N/A
7.6	**Marking of live supply connections** Where it is necessary to mark and identify live supply connections, the following system shall be used unless otherwise specified in an individual Approval and test specification: (a) For active connections, any marking or abbreviation which clearly indicates the intent. (b) For neutral connections, N (or Neutral). In any equipment, marking as above shall not be used other than to indicate live connections.	L for line, N for neutral used	P
7.7	**Additional marking of multi-rated equipment** Where an equipment is provided with facilities for supply by flexible cord and plug and is designed for conversion to a rating which exceeds that at which the equipment is initially intended to operate, the equipment shall be marked with the following information: (a) Instructions which clearly indicate how the equipment is to be converted to any higher rating. (b) Details for fitting the correct type of supply flexible cord and plug and the appropriate socket-outlet to be used for each rating which exceeds 10A. Such marking shall be legible and indelible, and shall be made either on the equipment itself or on a nameplate securely fixed thereto.		N/A
7.8	**Equipment with type X, type Y and type Z attachments** The instructions shall contain the substance of the following: (a) For equipment with Type X attachment having a specially prepared cord, if the supply cord is damaged,	Wiring defined in the manual. The cords (AC: Y type) is not provided by the manufacturer.	P

	it shall be replaced by a special cord or assembly available from the manufacturer or its service agent. (b) For equipment with Type Y attachment, if the supply cord is damaged, it shall be replaced by the manufacturer or its service agent or similarly qualified person in order to avoid a hazard. (c) For equipment with Type Z attachment, the supply cord cannot be replaced. If the cord is damaged the equipment should be scrapped.		
7.9	**Legibility of marking** The marking required by Section 7 shall comply with Clause 8.13.	See table 8.13 in Annex No. 1	P
7.10	**Instructions for installation and use** If it is necessary to take special precautions when installing or using equipment, details shall be given in an instruction sheet, which shall accompany the equipment.	Warning instructions are provided in the manual which is shipped with the units	P

SECTION 8: TESTS			
8.1	**General** In general, the tests specified in this Section shall be carried out on equipment as received. A test of this Standard, or any individual Approval and test specification, that is not appropriate to any particular equipment because of the method of its construction or the technology of its design shall not be conducted. In such cases, a regulatory authority may substitute tests, which it considers to be appropriate. In any equipment a component that is not depended upon for safety*, and the failure or malfunction of which would not introduce a hazard, need not be tested for compliance withany relevant Approval and test specification. Where equipment is marked with a rated voltage of 230V a.c. or a voltage range that includes 230V a.c. for single phase equipment, the rated voltage is equal to 240V a.c. in Australia and 230V a.c. in New Zealand or the highest marked voltage which ever is greater. Where equipment is marked with a rated voltage of 400 V a.c or a voltage range that includes 400V a.c. for polyphase equipment, the rated voltage is equal to 415V a.c. in Australia and 400V a.c. in New Zealand or the highest marked voltage which ever is greater. In all other cases, such tests shall be carried out at the highest marked voltage. In Australia, for equipment other than class III equipment, that is intended for connection to the supply mains and that is not marked with an operating voltage of at least 240V for singlephase equipment and at least 415V for three-phase equipment, for testing purposes the rating in amperes or loading in watts or volt-amperes is equal to the calculated value corresponding to 240V for single-phase equipment and 415V for three-phase equipment as appropriate. The frequency of the test (supply) voltage shall be 50Hz, unless the equipment is intended for operation at some other particular frequency. If any equipment incorporates provision for adjustment of loading about any marked voltage, tests shall be conducted with the equipment adjusted so as to give maximum loading. Where tests in this Standard or in any individual Approval and test specification are to be conducted with alternating current at a lagging power factor, the test circuit shall, unless otherwise specified, be a series circuit of an inductor and resistor. The reference ambient temperature shall be 25°C unless it is clear by virtue of the design, application or marking that the equipment will usually operate in an ambient temperature higher than 25°C, in which case it shall be 40°C. Notwithstanding the foregoing, where an individual specification requires a test to be conducted under specified temperature shall be required to withstand all tests relevant to the failure.	Noticed	P
8.2	**Void**		N/A
8.3	**Insulation resistance and leakage current**		P

8.3.1	**Insulation resistance** Insulation resistance shall be measured with a d.c. voltage of approximately 500V applied, the measurement being made 1min after application of the voltage (a) between live parts and internal metal parts; (b) between live parts and the case, frame, or exposed metal parts; (c) between live parts and external metal parts; (d) between live parts and a flexible electrode applied to non-conductive parts normally handled in service; and (e) through supplementary insulation. The insulation resistance so measured shall not be less than 1MΩ between parts as detailed above in Items (a), (b) and (c) and not less than 10MΩ in all other cases.	See table 8.3.1 in Annex No. 1	P
8.3.2	**Leakage current test** The leakage current of equipment shall not be excessive when assessed according to the following test. The leakage current is measured between any pole of the supply and accessible metal parts and metal foil having dimensions not exceeding 200mm × 100mm in contact with accessible surfaces of insulating material, connected together. After the equipment has been operated until steady state conditions are established, the leakage current to accessible metal parts and metal foil shall not exceed the values given in the standard	See table 8.3.2 in Annex No. 1	P
8.4	**High voltage (electric strength) test**	See table 8.4 in Annex No. 1	P
8.4.1	**Between live parts** All equipment shall withstand the application between live parts of an a.c. voltage of the value indicated in Table 8.4, according to the working voltage between the parts to which the test is being applied.	Noticed	P
8.4.2	**Equipment with earthing facilities** All equipment with earthing facilities shall withstand the application between live parts and exposed metal or earth, of an a.c. voltage of the value indicated in Table 8.4, according to the working voltage between the live parts and exposed metal or earth.	Noticed	P
8.4.3	**Equipment with double insulation** This test shall not apply to insulation that encloses only conductors or live parts operating at extra-low voltage supplied from a transformer complying with AS/NZS 61558.2.6. The insulation between live parts and external metal, or live parts and a flexible electrode applied to the surface of the insulation, shall withstand high voltages applied as follows: (a) Across basic insulation..... 1250V. (b) Across supplementary insulation..... 2500V. Where it is not possible to test the basic and supplementary insulation separately, or where a single layer of insulation is provided as the equivalent of separate layers of basic and supplementary insulation, a test voltage of 3750V shall be applied between live parts and external metal or live parts and a flexible electrode applied to the outer surface of the insulation.		N/A

8.4.4	**Non-conducting external parts** An a.c. voltage of 3750V shall be applied between live parts and a flexible electrode applied to non-conducting parts normally handled in service.		N/A
8.4.5	**Method of applying test** Any radio interference suppression devices shall remain connected during the following high voltage test. The test equipment and the test method shall be generally in accordance with AS 1931.1 and AS 1931.2, as detailed below. To prevent overvoltages due to switching surges, the initial voltage shall not exceed 30% of the full test voltage and shall be increased uniformly to the full voltage in a time of not more than 30s. The full test voltage shall be maintained for 1 min after which the test voltage shall be diminished rapidly to 30% of its full value before switching off. The specified test voltage shall be maintained for the 1 min duration of the test within ±3%. The test voltage shall be alternating, of any frequency between 25Hz and 100Hz, and approximately of sine waveform. There shall be no disruptive discharges, that is, flashovers or insulation punctures, during any high voltage tests. The high voltage transformer used for the test shall be so designed that when the output terminals are short-circuited, after the output voltage has been adjusted to the appropriate test voltage, the output current shall be greater than 180mA. The overcurrent relay shall not trip when the output current is less than 100mA.	Noticed	P
8.4.6	**Number of samples** In cases where high voltage tests specified in any Specification would require the same insulation to be stressed more than once, the person submitting the equipment may submit, at the person's discretion, a sufficient number of samples to permit each such test to be made on a separate sample.	Noticed	P
8.5	**Test of earthing connection** The connection between the earthing terminal or earthing contact, and parts required to be connected thereto, shall be of low resistance. Compliance is checked by an earthing connection test, whereby a current derived from an a.c. source having a no-load voltage not exceeding 12V, and equal to 1.5 times rated current of the equipment or 25A, whichever is the greater, is passed between the earthing terminal or earthing contact, and each of the accessible metal parts in turn. The voltage drop between the earthing terminal of the equipment or the earthing contact of the appliance inlet and the accessible metal part is measured, and the resistance calculated from the current and this voltage drop. The resistance shall not exceed (a) for readily accessible exposed parts which rotate, reciprocate or oscillate continuously.....1Ω. (b) in all other cases..... 0.1 Ω.	See table 8.5 in Annex No. 1	P

8.6	**Cord anchorage** For the purpose of testing the cord anchorage, the equipment shall be wired in the normal manner with a flexible cord of the appropriate type. If the equipment is provided with an earthing terminal, the flexible cord shall include an earthing conductor. For Type X attachment, the conductors are introduced into the terminals, the terminal screws, if any, being tightened just sufficiently to prevent the conductors from easily changing their position. The cord anchorage is used in the normal way, its clamping screws being tightened with a torque equal to two-thirds of that specified in Table 8.7. The flexible cord shall be PVC-sheathed, unless otherwise specified in an individual Approval and test specification. Any sleeving or packing around the cord where it passes through the cord anchorage device shall be removed before the test is applied. The equipment is tested with the cord as delivered. It shall not be possible to push the cord into the equipment to such an extent that the cable or cord, or internal parts of the equipment, could be damaged. After the equipment has been correctly wired with all the strands intact, it shall be held fixed in position. The cord shall then be subjected 25 times to a pull of the value shown in Table 8.6. The pulls are applied in the most unfavourable direction without jerks, each time for 1s. Unless varied in an individual specification, accessories shall be subjected to a pull of 65 N. Immediately afterwards, the cord is subjected for 1 min to a torque of the value shown in Table 8.6. For Type X attachments having a specially prepared cord and Type Y and Z attachments, any additional sleeving used for cord protection purposes shall not be totally displaced from its anchorage point when tested. The sleeving shall be tested separately after the cord anchorage test in accordance with the method specified in this Clause; however, the pull shall be 30 N and the torque test shall not be applied. During the tests, the cord shall not be damaged. After the tests, the cord shall not have been longitudinally displaced by more than 2mm and the conductors shall not have moved over a distance of more than 1 mm in the terminals, nor shall there be appreciable strain at the connection. For the measurement of the longitudinal displacement, a mark is made on the cord while it is subjected to the pull, at a distance of approximately 20mm from the cord anchorage or other suitable point before starting the tests. After the tests, the displacement of the mark on the cord in relation to the cord anchorage or other point is measured while the cord is subjected to the pull.	See table 8.6 in Annex No. 1	P
8.7	**Test for screw threads and fixings (See Clause 4.7)**		P

8.7.1	**Threaded fastenings of metal in metal or thermosetting plastic or wood, or the like** The screwed component shall be tightened and loosened in a steady and uniform manner the following number of times, by means of a suitable test screwdriver or other appropriate device applying a torque of appropriate value given in Table 8.7: (a) Where it operates in a thread in metal..... 5 times. (b) Where it operates in a thread in insulating material ..... 10 times. Screwed components operating in a thread in insulating material shall be completely removed and re-inserted for each operation. The shape of the blade of any test screwdriver shall be compatible with the slot of the screw to be tested. Threads of the screwed component and its fixing shall not strip, insulating material shall not crack, nor shall there be any other failure which would render the screwed component non-reusable. Where a screw is intended to secure a conductor, the test shall be carried out so that the stress is applied to the working section of the thread. Where applicable, the test shall be conducted with the appropriate conductor inserted in the terminal. For terminals that may be used for looping purposes, the test shall be conducted with the maximum and minimum number of conductors respectively which the terminal is intended to accommodate.	See table 8.7 in Annex No. 1	P
8.7.2	**Threaded fastenings with any component of thermoplastic material** The length of thread engagement shall be measured and shall comply with Clause 4.7. The screwed components shall be tightened and loosened as described in Clause 8.7.1, except that the following procedure shall be used instead of the application of the specified torque values. The tightening shall be effected by first taking the screw up to the point where it bottoms and then tightening by a further 180°C of turning or to the required torque in Table 8.7, whichever is reached first. Threads of the fastening shall not jump or strip, insulating material shall not crack, nor shall there be any other failure which would render either component of the fastening non-reusable. Where a screw is intended to secure a conductor, the test shall be carried out so that the stress is applied to the working section of the thread.		N/A
8.8	**Mechanical strength test**		P
8.8.1	**General** Equipment shall be subjected to blows, with an impact energy of 0.5 ± 0.05Nm, by any means having the same performances as the spring-operated impact-test apparatus described in Clauses 8.8.2 to 8.8.4.	See table 8.8 in Annex No. 1	P

8.8.2	**Spring-operated impact-test apparatus** The apparatus consists of three main parts, the body, the striking elements and the spring-loaded release cone as shown in Figure 8.8.2. The body comprises the housing, the striking element guide, the release mechanism and all parts rigidly fixed thereto. The mass of this assembly is 1250g. The striking element comprises the hammer head, the hammer shaft and the cocking knob. The mass of this assembly is 250g. The hammer head has a hemispherical face of polyamide having a Rockwell hardness of HR 100, with a radius of 10mm; it is fixed to the hammer shaft in such a way that the distance from its tip to the plane of the front of the cone when the striking element is on the point of release is 20mm. The cone has a mass of 60g and the cone spring is such that it exerts a force of 20N when the release jaws are on the point of releasing the striking element. The hammer spring is adjusted so that the product of the compression, in millimetres, and the force exerted, in newtons, equals 1000, the compression being approximately 20mm. With this adjustment, the impact energy is 0.5 ± 0.05Nm. he release mechanism springs are adjusted so that they exert just sufficient pressure to keep the release jaws in the engaged position. The apparatus is cocked by pulling the cocking knob until the release jaws engage with the groove in the hammer shaft. The blows are applied by pushing the release cone against the sample in a direction perpendicular to the surface at the point to be tested. The pressure is slowly increased so that the cone moves back until it is in contact with the release bars, which then move to operate the release mechanism and allow the hammer to strike.	Noticed	P
8.8.3	**Procedure** The sample as a whole is rigidly supported against a plane surface and three blows are applied to every point of the enclosure that is likely to be weak. To ensure that the sample is rigidly supported, it may be necessary to place it against a solid wall of brick, concrete or the like, covered by a sheet of polyamide which is tightly fixed to the wall, care being taken that there is no appreciable air gap between the sheet and the wall. The sheet shall have a Rockwell hardness of HR 100, a thickness of at least 8mm and a surface area such that no part of the sample is mechanically overstressed due to insufficient supporting area. If necessary, the blows are also applied to handles, levers, knobs and the like, and to signal lamps and their covers, but only if the lamps or covers protrude from the enclosure by more than 10mm or if their surface area exceeds 400mm². Lamps within the equipment, and their covers, are only tested if they are likely to be damaged in normal use.	Noticed	P

8.8.4	**Criteria** After the test, the sample shall show no damage within the meaning of this Specification; in particular, live parts shall not have become exposed so as to impair compliance with Clauses 5.1 and 5.2, and there shall not have been such distortion as to impair compliance with Clause 4.1.3. In case of doubt, supplementary insulation is subjected to an electric strength test as specified in Clause 8.4.3. If there is a doubt as to whether a defect has been promoted by the application of preceding blows, this defect is neglected and the group of three blows which led to the defect is applied to the same place on a new sample, which shall then withstand the test.		P
8.9	**Standard electrodes for electric strength tests** Where the electric strength of a material in sheet form is to be tested, the electrodes used shall be constructed of solid brass. The electrodes shall be in the form of solid brass cylinders, one of 75mm diameter by 25mm depth, and the other of 38mm diameter by 38mm depth. Where the electric strength over a surface is to be tested, the same pair of electrodes, or two of the latter size, may be used.	Noticed	P
8.10	**Standard test finger and protective impedance**		N/A
8.10.1	**General** For the purpose of determining whether or not either live parts (see Clause 5.1) or non-current-carrying conductive parts are exposed to personal contact, use shall be made of the standard test finger.	Noticed	N/A
8.10.2	**Design and construction** The standard test finger, as shown in Figure 8.10, shall be so designed that each of the jointed sections can be turned through an angle of 90°C with respect to the axis of the finger in the same direction only. The tip of the finger shall be made of copper or copper alloy; the handle shall be made of insulating material. The finger shall be provided with two joints operating in the same plane and so constructed that they will remain in any desired position. A terminal or other equivalent means shall be provided to permit attachment of a flexible wire lead to the finger.	Noticed	N/A

8.10.3	**Method of use** The standard test finger may be applied directly to the live or non-current-carrying conductive part in question and a visual examination made to determine whether or not the finger is in contact with the part under test. The test finger shall be applied in every possible position, making use of the joints incorporated, provided that where bending takes place at both joints the direction of bending at each joint shall be the same, either clockwise or anti-clockwise. Where, however, there is any doubt as to whether contact is made or whether a given part is live, the flexible wire lead from the test finger shall be connected through a high-resistance voltmeter having a resistance of not less than 1000Ω/V of the scale reading, or other convenient indicator of equivalent current sensitivity, to one pole of a battery (6V to 12V) the other pole of which shall be connected to the supply terminals or points of the inner wiring of the equipment, which shall be entirely disconnected from the supply mains during this test.	No openings in the enclosure, IP65 protection.	N/A
8.10.4	**Protective impedance** Protective impedance shall consist of at least two separate components, the impedances of which are unlikely to change significantly throughout the life of the equipment. If any one of the components is short-circuited or open-circuited, the current between the part and the supply source shall not exceed 2mA for d.c. and its peak value shall not exceed 0.7mA for a.c., and also the following shall apply: (a) For potentials not exceeding 450V peak, the capacitance shall not exceed 0.1μF. (b) For potentials not exceeding 15 000V peak, the quantity of electricity in the discharge shall not exceed 45μC. (c) For potentials exceeding 15 000V peak, the energy in the discharge shall not exceed 350mJ. Voltage, current and capacitance are measured between the relevant part and either pole ofthe supply source, the equipment being supplied at rated voltage. Discharge parameters are measured immediately after interruption of the supply, ensuring that the method of interruption of the supply does not break the connection to earth of one of the poles of the supply source. The circuit for measuring the steady-state current shall have a total resistance of 1750Ω ± 250Ω shunted by a capacitor such that the time constant of the circuit is 225μs ± 15μs. The quantity of electricity or energy in the discharge shall be measured into a load consisting of a non-inductive resistor of 2000Ω. Resistors or capacitors used as protective impedances shall comply with Clause 14.1(a), or Clause 14.2 of AS/NZS 60065, as appropriate.		N/A
8.11	**Temperature measurements**	See table 8.11 in Annex No. 1	P

8.11.1	**Methods of measurement** Three methods of measuring temperatures are recognized, (a) thermometer method; (b) thermocouple method; and (c) increase-of-resistance method.	Thermocouple method used	P
8.11.2	**Thermometer method** Three types of thermometer may be employed, viz. bulb thermometers containing either mercury or alcohol, and resistance thermometers. Where bulb thermometers are used to measure the temperature of a surface, one or other of the following procedures shall be adopted, whichever is appropriate to the particular case: (a) The bulb shall be surrounded by a single wrapping of tinfoil having a thickness of not less than 0.03mm. The foil shall be turned up at the end to form a complete covering for the bulb, which shall then be secured in contact with the surface under test. The exposed part of the wrapped bulb shall be completely covered with a pad of heat-insulating material without unduly shielding the test surface from normal cooling. (b) The bulb, except at the point of contact, shall be covered with a pad of felt, cotton wool, or other non-conducting material 3mm thick, extending at least 19.0mm in every other direction from the bulb and pressed into contact with the surface to which it is applied to prevent loss of heat by radiation and convection from the bulb. Any thermometers used shall be of marked immersion and known accuracy.		N/A
8.11.3	**Thermocouple method** The two conductors between which the thermo-electric effect is produced shall be welded or hard-soldered at both the hot and the cold junctions, care being taken to ensure that the wires at the junction make contact at one point only, and are not twisted together. The standard No. 1 thermocouple shall be a base metal couple made up of wires not smaller than 0.213mm and not larger than 0.315mm.The standard No. 2 thermocouple shall be a base metal couple made up of wires not smaller than 0.457mm and not larger than 0.559mm and with insulation suitable for use at 350°C. Thermocouples shall be affixed in a manner appropriate to the case, for example by tying, clamping, wedging, or soldering. Where a thermocouple is soldered to a portion of the article under test, care shall be taken to avoid appreciable modification of the physical characteristics of the article by the temperature or the fluxes used in the soldering process. Measurements of the thermal e.m.f. should be made with suitable equipment (potentiometer or direct-reading instrument). If the test equipment is not provided with cold-junction compensation, the cold-junction should be contained in a vacuum flask containing crushed ice.	Noticed	P

8.11.4	**Increase-of-resistance method** he increase-of-resistance method is suitable for the measurement of the average temperature of coils or windings. The appropriate equations to be used are contained in Note 2 to Table 5.7. An approximate method is to calculate the temperature rise of the conductor on the basis of 1°C for each 0.4% increase of resistance. It should be noted that this method provides no indication of any points of temperature higher than average.		N/A
8.11.5	**Measurement of ambient temperature** The temperature of the ambient air shall be measured by at least two thermometers protected against radiation from the object under test. For the purpose of the Standard, ambient temperature shall be considered as the average of readings recorded at 10min intervals during the final 30min of the test.		P
8.11.6	**Maximum temperature rise** The maximum temperature rise shall be taken to have been reached when for one 30min period the mean temperature curve for the object under test retains the same nominal temperature difference above ambient temperature.		P
8.12	**Temperature and fire risk test** Any material or insulation of equipment and the surfaces of the test surroundings referred to below shall not attain excessive temperatures in normal use. Except for hand-held tools, compliance shall be checked by determining the temperature of the surrounds, and material or insulation, where appropriate, under the normal conditions as given in 8.12		P
8.13	**Test of marking** Nameplates, transfers and paintings used to provide the information required in accordance with Clause 7.1 shall be checked by inspection and by rubbing by hand for 15 s with a piece of cloth soaked with water and again with a piece of cloth soaked with petroleum spirit. At the completion of these tests, the marking shall comply with Clause 7.2. This test does not apply to any marking provided on the container in which the article is supplied.	Verified	P

8.14	**Stability test** Freestanding equipment intended for use on a surface such as a floor or a table shall have adequate stability. Compliance is checked by a stability test, equipment provided with an appliance inlet being fitted with an appropriate connector and flexible cord. The equipment is placed, with the motor switched off, in any normal position of use on a plane inclined at an angle of 10°C to the horizontal, the cord resting on the inclined plane in the most unfavourable position. If, however, the equipment is such that, were it to be tilted through an angle of 10°C when standing on a horizontal plane, a part of it not normally in contact with the supporting surface would touch the horizontal plane, the equipment is placed on a horizontal support and tilted in the most unfavourable direction through an angle of 10°C. Equipment with doors is tested with the doors open or closed, whichever is the more unfavourable. Equipment intended to be filled with liquid by the user in normal use is tested empty or filled with the most unfavourable quantity of water up to the rated capacity. The equipment shall not overturn.	Wall mounted equipment	N/A
8.15	**Abnormal operation**	See table 8.15 in Annex No. 1	P
8.15.1	**General** Equipment shall be so designed that the risk of fire, mechanical damage impairing safety or the protection against electric shock as a result of abnormal or careless operation is obviated as far as is practicable. Compliance is checked as follows and by the tests of Clauses 8.15.2 to 8.15.8, as appropriate, all thermostats and temperature limiters being short-circuited or otherwise rendered inoperative and the equipment shall then comply with the tests of Clause 8.15.9; and the tests shall be conducted under the general test conditions specified in Clause 8.12	Noticed	P
8.15.2	**Heating equipment test** Equipment with heating elements is tested under the conditions specified in Clause 8.12, the supply voltage being such that the input is equal to rated input. If a non-self-resetting thermal cut-out operates, or if the current is otherwise interrupted in a non-self-resetting way before steady conditions are established, the operating period is considered to be ended. If interruption of the current does not occur, the equipment is operated until steady conditions are established. For equipment for short-term operation, the duration of the test is equal to the rated operating time.		N/A

8.15.3	**Locked-rotor test** A locked-rotor test is made by locking moving parts if the equipment (a) has moving parts liable to be jammed; (b) has motors with a locked rotor torque smaller than the full-load torque; (c) has motors to be started by hand; (d) is intended to be remotely or automatically controlled; or (e) is liable to be operated while unattended. Equipment incorporating motors having capacitors in the circuit of an auxiliary winding is operated with the rotor locked, the capacitors, one at a time, being short-circuited or open-circuited, whichever is the more unfavourable, unless the equipment is not intended for use unattended and the motor is provided with a capacitor complying with IEC 60252-1. For each of the tests, the equipment, starting from room temperature, is operated at rated voltage or at the upper limit of the rated voltage range for a period of (i) 30s for (A) hand-held equipment; (B) equipment that has to be kept switched on by hand; and (C) equipment that is continuously loaded by hand; or (ii) 5 min or, if a timer is provided, equal to the max. period allowed by the timer, for other equipment that is not intended for use unattended; or (iii) as long as necessary to establish steady conditions or, if a timer is provided, equal to the maximum period allowed by the timer for the remaining equipment. At the end of the test period specified, or at the instant of operation of fuses, thermal cut-outs, motor protection devices and the like, the temperature of the windings shall not exceed the values shown in Table 8.15.3.		N/A
8.15.4	**Equipment with three-phase motors** Equipment incorporating three-phase motors is operated under normal load, with one phase disconnected, for a period as specified in Clause 8.15.3.		N/A

8.15.5	**Running overload test** A running overload test is made on equipment incorporating motors that are either intended to be remotely or automatically controlled, or liable to be operated continuously while unattended, the equipment being operated under normal load, at rated voltage or at the upper limit of the rated voltage range, until steady conditions are established. The load is then increased in appropriate steps so that the current through the motor windings is raised, the supply voltage being maintained at its original value. When new steady conditions are established, the load is again increased. This operation is repeated until the overload protection device operates or until the motor stalls. The winding temperature is continuously measured and noted during each period of steady conditions, and the maximum temperature value recorded shall not exceed (a) for Class 105 (A) material 140°C (b) for Class 120 (E) material 155°C (c) for Class 130 (B) material 165°C (d) for Class 155 (F) material 180°C (e) for Class 180 (H) material 200°C (f) for Class 200 material 220°C (g) for Class 220 material 240°C (h) for Class 250 material 270°C	Noticed	N/A
8.15.6	**Equipment for short-time or intermittent operation** Equipment for short-time or intermittent operation, other than hand-held equipment, equipment that has to be kept switched on by hand, equipment that is continuously loaded by hand, or equipment with a timer, is operated under normal load and at rated voltage or at the upper limit of the rated voltage range, until steady conditions are established, or until the thermal cut-out operates. When steady conditions are established, or immediately before the operation of the thermal cut-out, the temperature of the windings shall not exceed the values specified in Clause 8.15.5.		N/A
8.15.7	**Equipment with series motors** Equipment incorporating series motors is operated at a voltage equal to 1.3 times rated voltage, for 1min, with the lowest possible load. Any heating elements shall be disconnected for this test. After this test, the safety of the equipment shall not have been impaired; in particular, windings and connections shall not have worked loose.		N/A

8.15.8	**Equipment incorporating electronic components** The equipment is operated at a supply voltage so that the input is equal to rated input. Components such as semiconductor devices, capacitors, resistors or inductors, the failure of which might cause a hazard, are short-circuited or disconnected, whichever is the more unfavourable. If a non-self-resetting thermal cut-out operates or if the current is otherwise interrupted in a non-self-resetting way before steady conditions are established, the operating period is considered to be ended. If interruption of the current does not occur, the equipment is operated until steady conditions are established. For equipment for short-term operation, the duration of the test is equal to the rated operating time. Positive temperature coefficient resistors (PTCs), negative temperature coefficient resistors (NTCs) and voltage dependent resistors (VDRs) are not short-circuited if they are used within their manufacturer's declared Specification.		P
8.15.9	**Test results** During the tests of Clauses 8.15.2 to 8.15.8, the equipment shall not emit flames or molten metal, or poisonous or ignitable gas in hazardous amounts, enclosures shall not deform to such an extent as will impair compliance with this Specification and temperature rises shall not exceed the values shown in Table 8.15.9. After the tests, the insulation of equipment other than that of Class III, when cooled down to approximately room temperature, shall withstand an electric strength test as specified in Clause 8.4 the test voltage being (a) for basic insulation 1000V; (b) for supplementary insulation 2750V; (c) for reinforced insulation 3750V. For equipment that is to be immersed in or filled with conducting liquid in normal use, the sample is immersed in or filled with water, as appropriate, for 24h before the electric strength test is made.	Noticed	P
Annex A (Normative) **Requirements from the 1994 edition**			
The following requirements, taken from the 1994 edition of AS 3100, are applicable to equipment that is not designated as 'attended' or 'unattended'.			
SECTION 5: PROTECTION AGAINST RISK OF ELECTRIC SHOCK FOOTNOTES TO TABLE 5.7 There is no specific limit for thermoplastic material.			
SECTION 6: PROTECTION AGAINST HEAT AND FIRE			
A 6.1	**Resistance to fire**		P

A 6.1.1	**General requirements for compliance of solid insulating materials and non metallic enclosures** Compliance of solid insulating materials and non metallic materials of electrical accessories is checked by the tests detailed in A 6.1.2 to A 6.1.7. Guidance for the selection and sequence of tests is given in the flow chart figure A1. Glow-wire test apparatus and common test procedure is given in AS/NZS 60695.2.10. Glow-wire flammability test method for end-products is given in AS/NZS 60695.2.11. This includes guidance for the test temperature, a definition of small parts and evaluation of test results. In addition to the evaluation requirements of AS/NZS 60695.2.11 the complete product has failed to comply with the glow-wire tests if burning droplets or glowing particles escape from the equipment and ignite the tissue paper or scorch the particle board underlay beneath the specimen. The glow-wire test temperature' T' is required to be specified in each product specification. The test method for Needle-Flame Test is given in AS/NZS 4695.2.2. This includes an evaluation of test results.		P
A 6.1.2	**Materials and tests** The tests are carried out on solid insulating materials and non metallic enclosure whilst assembled on a complete end product. The tests are not carried out on decorative trims, insulation of wires, knobs and other small parts unlikely to be ignited or to propagate flames originating from inside the equipment.		P
A 6.1.3	**Glow-wire tests on relevant parts** Relevant parts, other than those in A 6.1.4 are subjected to the glow-wire test of AS/NZS 60695.2.11, which is carried out at 650°C, unless otherwise specified in the relevant product standard. Note The majority of thermoplastic materials are capable of complying with the 550₀C GWT and consequently where the material is adequately specified and certified this test may be waived with the agreement of the test authority. The glow-wire test is not carried out on parts of material classified at least HB40 according to AS/NZS 60695.11.10, provided that the test sample was no thicker than the relevant part.		P
A 6.1.4	**Glow–wire tests on retaining parts** Parts of insulating material retaining current carrying parts carrying more than 0.2amps in position, are subjected to the glow-wire test of AS/NZS 60695.2.11 which is carried out at the glow-wire test temperature 'T ' specified in the product standard. NOTE Where no product standard exists the appropriate test temperature may be obtained from the guidance for glow-wire tests given in Annex A of AS/NZS 60695.2.11. If parts tested withstand the glow-wire test, but during the test produce a flame that persists for longer than 2s, then the consequential needle flame test of A 6.1.5 applies.		P

A 6.1.5	**Consequential needle flame test** a) The needle-flame test of A 6.1.7 is applied to all parts of non-metallic material (including barriers and enclosures) that are likely to be ignited by and are positioned within a distance of 50mm of those parts that flamed during the glow-wire test of A 6.1.4. Note The needle flame test should be applied, wherever possible from inside the enclosure. b) The needle-flame test of A 6.1.7 is also applied to those parts, outside the 50 mm specified above, that were contacted by the flame, subjected to burning droplets or glowing particles when the glow-wire test was conducted in accordance with A 6.1.4. c) The needle-flame test of A.6.1.7 is also applied to those parts that were contacted by the flame or subjected to burning droplets or glowing particles when the needle-flame test was conducted in accordance with A 6.1.5 b) above. The needle-flame test is not carried out on parts of material classified as V-0 or V-1 according to AS/NZS 60695.11.10, provided that the test sample was no thicker than the relevant part.		P
A 6.1.6	**Needle flame tests on printed circuit boards** The base material of printed circuit boards is subjected to the needle-flame test of A 6.1.7. The 12mm flame is applied to an edge of the board not less than 10mm from a corner. If the board is horizontal in the normal position of use, the board is tested in the horizontal position, the flame being applied to the edge that has the lowest heat sink. For all other board mounting positions, the board shall be tested vertically with the flame applied to the lower edge. The test is not carried out: i) on the printed circuit boards in a metal enclosure that confines flames or burning droplets; ii) if the material is classified as V-0 according to AS/NZS 60695.11.10, provided that the test sample was no thicker than the printed circuit board. NOTE 1 For this test, the printed circuit board may be tested without circuit components, if the submitter wishes. This is a more onerous test condition but this would permit a change of component without necessitating a retest. NOTE.2 If the printed circuit board is tested with components mounted and a component ignites during the test, this would not constitute a failure of the board, unless the component ignites the board.		P

A 6.1.7	**Needle-flame test method** The needle-flame test shall be carried out in accordance with AS/NZS 4695.2.2 with the following modifications. a) for the purpose of Clause 5 of AS/NZS 4695.2.2, the duration of application of the test flame is 30s ± 1s; b) for the purpose of Clause 8.2 of AS/NZS 4695.2.2, the specimen is arranged so that the flame can be applied to a vertical or horizontal edge; c) for the purpose of Clause 8.4 of AS/NZS 4695.2.2, the first paragraph of 8.4 does not apply. If possible, the flame is applied at least 10mm from a corner; d) for the purpose of Clause 8.5 of AS/NZS 4695.2.2, the test is carried out on one specimen. If the specimen does not withstand the test, the test may be repeated on two further specimens, both of which shall then withstand the test; e) for the purpose of Clause 10 of AS/NZS 4695.2.2, the duration of burning (tb) shall not exceed 30s. However, for printed circuit boards, it shall not exceed 15s. Slight discolouration of the particle board is ignored.		P
A 6.2	**Temperatures of surfaces to be handled** The temperature rise of surfaces intended to be touched, when tested in accordance with Clause 8.12, shall not exceed the values specified in Table 5.7.		P
A 6.3	**Resistance to tracking** Insulating material across which a tracking path may occur between live parts of different polarity or between live parts and earthed metal parts, and insulating material of commutators and brush-caps, shall have adequate resistance to tracking, taking into account the severity of its duty conditions. For parts of insulating material other than ceramic, compliance is checked by the proof tracking test specified in AS/NZS 60112. For parts of insulating material used under severe duty conditions, the test voltage is 175V. If the specimens do not withstand this test and there is no hazard other than fire, surrounding parts are subjected to the needle-flame test referred to in Clause 6.1.1.3. For parts of insulating material used under extra-severe duty conditions, the test voltage is 250V. If the specimens do not withstand this test, but withstand the test made with a test voltage of 175V, and there is no hazard other than fire, surrounding parts are subjected to the needle-flame test referred to in Clause 6.1.1.3. The needle-flame test is made on all parts of non-metallic material positioned within a distance of 50mm from any place where a tracking path may occur, unless these parts are shielded by a separate barrier or enclosure from that tracking path, in which case the barrier or enclosure is subjected to the needle flame test. NOTE 1 Guidelines for the duty conditions are given in Annex P of AS/NZS 3350.1. NOTE 2 There are no tracking requirements for insulation considered to be subjected to normal duty conditions. NOTE 3 Unless otherwise varied in the particular Standard, the severity will be considered as normal duty.		N/A

Annex B (Normative) Tests of resistance to heat, fire and tracking			
B 1	**Introduction** The tests in this Annex shall be used to determine resistance to heat, fire and tracking.	Noticed	P
B 2	**Resistance to heat test** Unless varied in a particular specification, compliance is checked by subjecting the relevant part to the ball pressure test by means of the apparatus shown typically in Figure B2. Before starting the test, the relevant part is maintained for 24h in an atmosphere having a temperature between 15°C and 35°C and a relative humidity between 45% and 75%. The part is supported so that its upper surface is horizontal and the spherical part of the apparatus is pressed against this surface with a force of 20 N. The thickness of the part under test shall be at least 2.5mm. NOTE: If necessary, the required thickness may be obtained by using two or more sections of the part. The test is made in a heating cabinet at a temperature of 40°C ± 2°C plus the maximum temperature rise determined during the test of Clause 8.12, but it shall be at least (a) for external parts..... 75°C ± 2°C; (b) for parts supporting live parts..... 125°C ± 2°C. However, for parts of thermoplastic material providing supplementary insulation or reinforced insulation, the test is made at a temperature of 25°C ± 2°C plus the maximum temperature rise determined during the tests of Clause 8.15, if this is higher. The temperature rises of Clause 8.15.1 are not taken into account if the test of Clause 8.15 is terminated by the operation of a non-self-resetting protective device and it is necessary to remove a cover or to use a tool to reset it. Before the test is started, the test apparatus is brought to the temperature determined above. After 1h the apparatus is removed and the part is immediately immersed in cold water so that it is cooled to approximately room temperature within 10s. The diameter of the impression shall not exceed 2mm.	See table B2 in Annex No.1	P
B 3	**Resistance to fire tests**		P
B 3.1	**General** Unless varied in a particular specification, compliance is checked by the tests of Paragraph B3.2 and the applicable parts of Paragraph B3.3. Guidance on the application of glow-wire and needle-flame tests is given in Figure B3.		P

B 3.2	**Materials and tests** Relevant parts of non-metallic material are subjected to the glow-wire test of AS/NZS 60695.2.10, on the appropriate part of the equipment, the test being made at a temperature of 550°C. Insulating materials of winding bobbins and formers are subjected to the glow-wire test of AS/NZS 60695.2.10, the test being made at a temperature of 650°C. Base material of printed wiring boards together with any coating or encapsulation shall comply with the needle-flame test of Paragraph B3.4; however, flames shall have extinguished within 15s of removal of the test flame. The flame shall be applied to an edge of the board having the lowest heat sink effect, with the board orientated in its normal position of use and at a point, if possible, not less than 10mm from a corner.		P
B 3.3	**Glow-wire test** For equipment that is operated while attended, parts of insulating material supporting, in contact with or within 3mm to current-carrying connections, other than those in low-power circuits determined as described in Clause 19.11.1 of AS/NZS 3350.1, are subject to the glow-wire test of AS/NZS 60695.2.10, the test being made at a temperature of 650°C. However, parts of insulating material supporting, in contact with or within 3mm to screw connections that carry a current exceeding 0.5A during normal operation and which are likely to be made or remade during installation, user maintenance or when replacing a supply cord assembled with the appliance by a Type X attachment, are subject to the glow-wire test of AS/NZS 60695.2.10, the test being made at a temperature of 750°C. For equipment that is operated while unattended, parts of insulating material supporting, in contact with or within 3 mm to current carrying connections, other than those in low-power circuits determined as described in Clause 19.11.1 of AS/NZS 3350.1, are subject to the glow-wire test of AS/NZS 60695.2.10, the test being made at a temperature of 750°C. However, parts of insulating material supporting, in contact with or within 3mm to screw connections, which carry a current exceeding 0.5A during normal operation and which are likely to be made or remade during installation, user maintenance or when replacing a supply cord assembled with the appliance by a Type X attachment, are subject to the glow-wire test of AS/NZS 60695.2.10, the test being made at a temperature of 850°C.		P
B 3.4	**Needle-flame test** The needle-flame test shall be carried out in accordance with AS/NZS 4695.2.2 except that (a) accidentally applied ignition sources, as referred to in Clause 8.4 of AS/NZS 4695.2.2, are not applicable; and (b) for the purpose of Clause 10 of AS/NZS 4695.2.2, slight discolouration of the particle board is ignored.		P

B 4	**Resistance to tracking test** Insulating material across which a tracking path may occur shall have adequate resistance to tracking, taking into account the severity of its duty condition. A tracking path is considered likely to occur between live parts of different potential, live parts and earthed metal parts, and across insulating material of commutators and brush-caps. The needle-flame test is made on all parts of non-metallic material positioned within a distance of 50mm from any place where a tracking path may occur, unless these parts are shielded by a separate barrier or enclosure from that tracking path, in which case the barrier or enclosure is subjected to the needle-flame test.		P
Annex C (Normative) **Measurement of creepage distances and clearances**			
C	The methods of measuring creepage distances and clearances to be used in interpreting the requirements of Clause 4.1.3 are indicated in Cases 1 to 10 of this Annex. These cases do not differentiate between gaps and grooves or between types of insulation. The following assumptions are made: a) A groove may have parallel, converging or diverging sides. (b) Any groove having diverging sides, a min. width exceeding 0.25mm, a depth exceeding 1.5mm and a width at the bottom equal to or greater than 1mm, is regarded as an air gap (see Case 8). (c) Any corner including an angle less than 80°C is assumed to be bridged with an insulating link of 1mm width (0.25mm for dirt-free situations) moved into the most unfavourable position (see Case 3). (d) Where the distance across the top of a groove is 1mm (0.25mm for dirt-free situations) or more, no creepage distance exists across the air space (see Case 2). (e) A creepage path is assumed not to exist if there is an air gap as defined in Item (b) exceeding 0.25mm. (f) Creepage distances and clearances measured between parts moving relative to each other are measured when these parts are in their most unfavourable stationary positions. (g) A computed creepage distance is never less than a measured clearance. (h) Any air gap less than 1mm wide (0.25mm for dirt-free situations) is ignored in computing the total creepage distance.	Noticed	P
Annex D (Informative) **Information on the safety principles of the design and testing of electrical equipment including insulation-encased and metal-encased class II construction**			

D 1	**The risk of electric shock** Since the human body is to some extent a conductor of electricity, a current will flow through the tissues when contact is made simultaneously with two objects that are at different potentials. Thus, if the two terminals of a source of electricity are grasped, one in each hand, current will flow through the body. The current that flows may be imperceptible at very low voltages, but lethal at higher voltages. A similar effect will be produced if only one terminal of a supply is touched, provided that, as is usual, the power supply is tied to earth and the person is standing on a floor that is not well-insulated from earth. Voltages below 32V are usually considered to be harmless to ordinarily healthy people under normal circumstances. Consequently, no precautions are taken generally to prevent a userfrom coming into contact with the conducting parts of a safety-extra-low-voltage system. Public supply systems, however, are of the order of 250V (relative to earth potential) and a shock from them can be dangerous. Hence, it is necessary to prevent the user of electrical equipment from making contact with any 'live' part of the system, that is to say, any part whose potential is, or may become, different from earth potential. It might be thought that safety would be ensured if no part of the supply system were connected to earth; while this would be so as long as the insulation were adequately maintained, the system would not, in practice, be safe, because the potential might fortuitously rise to any value above earth. By deliberately earthing one point of the system, the maximum potential to earth that can occur is limited to a value that is known and can be guarded against. In Australia and New Zealand all low voltage supply systems are required to be earthed and the most commonly used method of earthing electrical installations is the multiple earthed neutral (MEN) system. This system is a variant of the TN-C-S system used in some other parts of the world.		P
D 2	**Protection of live parts** In the interests of safety, no equipment for connection to electricity supply mains should have any live parts accessible to the user. The protective screen or case may be of insulating material, or of metal if it is insulated from the current-carrying parts. Any such apertures should be so arranged in the form of baffled louvers or the like so that there is no possibility of a finger passing through them and coming into contact with live parts or unearthed metal.		P

D 3	**Earthing of class I equipment** If the protective case is of metal, a failure of the protection, which might occur through breakdown of the insulating material or bridging of insulation, such as the escape of a strand of flexible cord from under a clamping screw to bridge the gap to the case, could raise the potential of the case to a hazardous voltage above earth. This would be an extremely dangerous condition, because persons touching the case would be likely to receive a dangerous shock if they were making partial contact with earth, or a fatal shock if they were in good contact with earth through standing on a wet floor or touching water pipes, gas pipes, or other earthed metal. It is therefore desirable in the interests of safety to provide a second line of defence, and the National Wiring Rules requires, generally, that any metal in an electrical installation that can be touched shall be 'earthed'; that is to say, electrically connected to the general mass of earth and to the earthed point of the supply system by conductors of low resistance. So long as this condition is maintained, there can be no danger in touching the metal, for even in the event of failure of insulation, no appreciable potential can exist between it and persons who are also making contact with earth. If the failure of insulation is partial, a small current will flow through the earth wire harmlessly to earth, while if it is complete, a heavy current will flow, which will operate protective devices (fuses or circuit-breakers) in the live conductors and disconnect the power supply. If earthing is to be relied upon for protection, it is essential that portable equipment should be connected to the mains by means of plugs and sockets that incorporate an earthing connection. If two-pin plugs and sockets or lampholder adaptors are used, no such protection is afforded. Equipment having metal cases that are not earthed are not allowed in Australia or New Zealand (Class 0 and Class 0I equipment), unless the equipment is of Class II construction as described in Paragraphs D5 and D6.		P
D 4	**Monitored earthing connections** There are in existence systems for detecting the presence of leakage current to earth or a rise in potential of accessible metal, and which disconnects the supply to minimize the risk of electric shock. Other systems may activate alarms or switch off the power supply to the equipment, unless the earth circuit is complete.		P

D 5	**Insulation-encased class II construction** In this form of Class II construction, the equipment is totally enclosed in a casing made of insulating material, having no external metal whatever, and having no apertures through which a probe can be inserted to touch live metal or basic insulation. Where the insulating case is made strong enough to withstand service conditions without fracture or deterioration, and when the equipment is suitable for conditions of use, such as wet or dry conditions, this is probably the safest form of construction. The principles of design of insulation-encased Class II equipment are simple and should require no explanation. Such equipment should not forfeit the description 'insulation encased' because it has relatively small metal parts accessible from the outside of the enclosure, such as screws, name plates, or guards, separated from live parts by insulation that is thick, and by visible creepage paths that are so long, that the chance of their becoming live through failure of the insulating path is extremely remote. Such insulation and creepage paths should, as a minimum, comply with the requirements for reinforced insulation. Not all equipment can be manufactured using the 'insulation-encased' form of construction, for example electric hair clippers, hedge clippers and portable tools, which require some external metal in order to perform their proper function. Accordingly, a form of construction known as double insulation has been devised.		N/A
D 6	**Metal-encased class II construction**		N/A
D 6.1	**Principles of double insulation** As its name implies, double insulation involves the provision of two completely separate sets of insulation between the current-carrying parts and any metal accessible to the user. If either set of insulation breaks down, or accidentally becomes short-circuited by conductor strands or by other metal, it will not result in risk to the user, who will be protected by the second set of insulation. The accessible metal parts will become live only in the event of breakdown of both sets, and the chances of this occurring are much less than the chances of the breakdown of either set alone.		N/A

D 6.2	**Design of metal-encased Class II equipment** Metal-encased equipment should be so designed that, in general, failure of two independent sections of insulation must occur before any external surface can become electrically connected with live conductors.* Each section of insulation should alone be amply sufficient to withstand the normal working voltage of the equipment without breakdown or appreciable leakage, even under damp conditions, so that if either section fails, safety is assured by the second section. The insulation adjacent to the live conductors is referred to as 'basic insulation', and the second layer as 'supplementary insulation'. Alternatively, the supplementary insulation may be in the form of a maintained air gap of adequate dimension. It is not always possible or indeed necessary to comply fully with this ideal of two independent sections of insulation in order to achieve an adequate measure of safety. In certain circumstances, a single layer of insulation is sometimes used where the principles of two distinct layers of insulation cannot be applied reasonably in equipment intended to be double insulated. This single layer of insulation has to be of a special nature, both in respect of quality and in the method of incorporation in the equipment, to be accepted as affording protection equivalent to that provided by the two independent layers of insulation. This single layer is referred to as reinforced insulation. In addition to passing the test specified for double insulation, the continued effectiveness of the single layer of insulation under normal conditions of use should be assessed having regard to such factors as a) mechanical strength, resistance to shrinking and warping, and the like; (b) resistance to moisture; (c) security of mounting and fixing in the equipment; (d) accidental bridging of the insulation by extraneous metal objects; (e) resistance to tracking due to deposits of foreign matter (for example, carbon dust and the like) (see Clause 5.4.4); and (f) protection against heat and fire (see Section 6). * Failure of insulation in this context is taken to include the accidental bridging of an insulating gap by metal or partially conducting material such as carbon dust or moisture, as well as electrical breakdown in the conventional sense.		N/A

D 6.3	**Methods of achieving double insulation** The following are different forms of construction in which the principle of double insulation can be incorporated: (a) A continuous and substantial layer of metal is interposed between basic and supplementary insulation, illustrated diagrammatically in Figure D1(a). A defect starting in the basic insulation, whether it be an electrical puncture or a mechanical fracture, may grow until it reaches the metal layer but is unlikely to spread into the supplementary insulation. It is necessary to arrange that the supplementary insulation has electric strength and insulation resistance substantially greater than the minimum required for the basic insulation. The required degree of safety is proved by testing the insulation between live metal and the metal layer and the insulation between the metal layer and exposed metal, and ensuring that each is adequate by itself. (b) There is a metal layer interposed between the basic insulation and the supplementary insulation, but this layer and the basic insulation are not complete and some bare live conductors are left separated only by air from the supplementary insulation. This is shown in Figure D1(b). (c) The live parts are completely enclosed in basic insulation, which is itself enclosed in supplementary insulation without the interposition of any metal layer as shown in Figure D1(d). In this case, in order to comply with the principle of 'double improbability', the supplementary and basic insulations should be of such mechanical and electrical characteristics that a failure of either is unlikely to spread to the other. If they have to be of the same material, they should at least be mechanically distinct, so that there is a surface of discontinuity to prevent the spread of deterioration from one to another. Each section of insulation should be designed so that by itself it would be capable of withstanding the tests applicable to basic or supplementary insulation, as appropriate. (d) A variation of the type in Item (c) is shown in Figures D1(c) and D1(e), where the live conductors are not completely surrounded by solid basic insulation, but are partly separated by air from the supplementary insulation. The supplementary insulation may have a hole through it as in Figure D1(e). It is also possible that metal work connected to neither live conductors nor accessible metal is embedded in the supplementary insulation, as shown in Figure D1(f). Inspection and tests on the supplementary insulation as a whole should be made to ensure that the presence of the metal inclusions does not reduce the effectiveness of the supplementary insulation below the limit of acceptance.		N/A

D 6.4	**Connection to the power supply** In designing double-insulated equipment it is important to remember that the principle should be extended to auxiliary items such as switches, plugs and sockets, and also to any apertures through which the supply cord may be led in. If, in portable equipment, the flexible cord is a two-core cord sheathed with elastomer or PVC compound, it might be thought that since the insulation around the conductors and that comprising the sheath were of mechanically and electrically different characteristics, the conductor could pass through a hole in unearthed external metal without breaking the principle of double insulation. However, in view of the fact that the cord is particularly vulnerable at the point of entry into portable equipment, because of the repeated bending that occurs there, this is not considered to be safe and equipment may well fail to qualify for classification as double-insulated, unless the flexible cord enters either through a hole in insulating material as shown in Figure D1(g) or through a properly secured insulating bush if the case is of metal as in Figure D1(h).		N/A
D 7	**Classification of the tests involved**		P
D 7.1	**General** To ensure that electrical equipment is safe when it leaves the factory, tests are necessary to establish the following general requirements: (a) The design is such that there is no likelihood of danger to the user or surroundings in normal use or in the event of such careless use as may occur in normal service, and that the materials used will not deteriorate to such an extent that the equipment becomes unsafe (see Paragraph D7.2). (b) During the course of production, no unapproved changes in design have been made (see Paragraph D7.3). (c) Each item of equipment has been assembled correctly and that no significant departure from the component or materials specifications has occurred (see Paragraph D7.4).		P
D 7.2	**Type tests** To ensure the first general requirement is being met, a comprehensive series of tests is required. These tests are known as 'type tests'. A type test is a test, or a series of tests, that is made on a sample of one or more specimens for the purpose of checking compliance of the design of a given product with the requirements of the Standard concerned. It is not necessary to repeat this series of tests, unless and until the manufacturer decides to make a change. Such tests are contained in the main body of this Standard and in particular Approval and test specifications.		P
D 7.3	**Surveillance tests** To ensure that the second of the general requirements is being met, manufacturers, testing organizations or purchasers should select samples at random and at a frequency according to their own discretion. Such samples should then be subjected to some or all of the tests specified in the relevant Standard, as considered necessary.		P

D 7.4	**Production tests** To satisfy the third of the general requirements, it is necessary for the manufacturer to undertake production tests. These tests will in general comprise routine tests, but if it is not possible or practicable to carry out all the tests that might be considered desirable on each individual item of equipment, reliance may be placed on sampling tests. The frequency of sampling will depend upon the extent to which the production process is likely to vary. Production tests are made as follows: (a) Routine tests Routine tests are made on each item of equipment. Details of routine tests are given in Paragraph D8. (b) Sampling tests Sampling tests are not made on each item of equipment, but on a proportion diverted from the production line for this purpose. If the manufacturer requires such tests or if they are specified, the way in which the tests are to be applied and the action to be taken in the event of a departure from the requirements should be documented.		P
D 8	**Requirements for routine tests**		P
D 8.1	**General** To ascertain that the equipment has been correctly assembled, routine tests should be made on every individual item, usually at one or more suitable testing points on the production line. Such tests should not therefore damage any product that is in accordance with the typetested sample, in any way. For this reason, the tests may often have to be less stringent than the type tests. Usually, routine tests are made as part of the final inspection procedure. It is not, however, always possible or practicable to apply the tests after complete assembly. In these cases, an intermediate test position should be set up, as near as is reasonable to the last point in the assembly line, when access to the necessary parts can still be obtained. No one series of tests will be universally applicable, but tests to determine the following are suggested as a basis where specific tests are not laid down for particular equipment: (a) The insulation is effective. (b) The earthing of Class I equipment has good continuity. (c) Cord anchorage and terminal connections are properly assembled. (d) Wiring and components are correctly fitted and positioned. (e) The equipment functions correctly. The tests necessary to check these items are described in Paragraphs D8.2 to D8.6.		P

D 8.2	**Effectiveness of insulation** The effectiveness of insulation is checked by an electric strength test. However, as the purpose of the test is mainly to check correctness of assembly, it is not necessary to apply such high voltage for such times as are called for in the type test specified in the relevant Standard. Indeed, it is essential that there should be no risk of deterioration or premature failure due to overstress. This is particularly important when applying the test voltage between live parts and accessible metal parts to test reinforced insulation in Class II equipment. The way in which the stress is apportioned between live parts, intermediate metal parts and accessible metal, where there is true double insulation, depends upon the relative impedance of basic insulation and supplementary insulation. A decision should be made whether the test is to be made by applying the original test voltage for a shorter time, by reducing the test voltage, or by impulse testing; the latter may involve higher voltages.		P
D 8.3	**Continuity of earthing of Class I equipment** The continuity of earthing can be checked by the test described in the relevant Standard; the check is to see that necessary connections have been made. To avoid the possibility of deterioration due to local overheating, a lower current than that called for in the type test may be passed for a shorter time.		P
D 8.4	**Assembly of cord anchorage and terminal connections** An inspection is necessary to ensure that all screws have been tightened and that snap-on, crimped or similar connections have been correctly assembled.		P
D 8.5	**Correct position of wiring and components** The correct positioning and retention of wiring and components should be checked by inspection.		P
D 8.6	**Correct functioning of the equipment** The test program should include appropriate tests for the correct functioning of the equipment and safety devices.		P
D 8.7	**Selection of tests** It may not always be necessary to examine all of the criteria mentioned above. For example, it might be possible to dispense with the electric strength test in Paragraph D8.2 in favour of adequate inspection of creepage distances while inspection in Paragraph D8.5 would in general only be applied in cases where inadequate retention or incorrect positioning could lead to danger. The tests in Paragraph D8.6 apply in general only to equipment such as motor-operated appliances and heating appliances. In some cases additional tests may be necessary. A decision should be made whether the production tests are to be routine tests or sampling tests.		P
D 8.8	**Segregation of defective products** It is essential that all defective items are segregated from production until the items have been repaired and retested or destroyed.		P

D 9	**Production test equipment** The following applies to production test equipment: (a) The manufacturer should be able to demonstrate (i) that the equipment, apparatus and instruments for the tests are suitable for their purpose; and (ii) that checks are made at sufficiently frequent intervals to ensure that their accuracy is maintained. (b) Essential operating instructions for test equipment should be maintained and should be readily available to the operator. (c) Adequate records should be maintained for the test equipment showing (i) means of identification (where appropriate); and (ii) frequency of check tests and details of repairs.		P
Annex E (Informative) **Circuit for measuring leakage currents**			
E 1	**General** A suitable circuit for measuring leakage currents in accordance with Clause 8.3.2 is shown in Figure E1.		P
E 2	**Circuit components** The circuit comprises two basic parts (a) a resistance, capacitance shunt whose impedance changes with frequency; and (b) a high impedance r.m.s. responding a.c. voltmeter whose indication is virtually independent of frequency over the range 20Hz to 5000Hz. The shunt consists of a parallel combination of a resistance of 1750Ω ±250Ω and a capacitor such that the time constant of the circuit is 225μs ±15μs. The resistor has a tapping of 1000Ω from one end for connection to the voltmeter. The voltmeter, of internal resistance not less than 1MΩ, and an error of ±5% or less over the frequency range of 20Hz to 5000Hz is to be connected across the 1000Ω portion of the shunt resistance so that its indication in volts r.m.s. will be a direct measure of leakage current in milliamperes r.m.s. at 50Hz. Suitable overload protection may be provided for the voltmeter to prevent damage to the instrument due to excessive leakage current. A resolution of at least 0.01V is required for the voltmeter. A typical circuit of the arrangement is shown in Figure E1.		P
Annex F (Normative) **Heat behaviour test**			
F 1	**General** Where required by a particular Standard the heat behaviour test shall be applied to the complete equipment to determine whether all insulating materials adequately maintain minimum safety requirements on exposure to elevated temperatures for a specified time. Where this is not practicable the test shall be applied to a sub- assembly or component.		P

F 2	**Test specimen** The test specimen shall be the complete equipment, except that when this is not practicable for test purposes it shall be a complete sub-assembly or component mounted in such a way as to simulate intended use. If not otherwise specified, the test specimen should be stored at 25°C ± 10°C and a relative humidity of 60% ± 15% for 24h immediately before the test. The test specimen shall be placed in an oven and heated at a predetermined temperature for a period of time.		P
F 3	**Test apparatus** The test apparatus shall consist of an air-circulating oven capable of maintaining the temperature of its test space within ± 3°C of the test temperature specified in Paragraph F4.		P
F 4	**Test method** The test method shall be as follows: a) The oven control shall be adjusted to a setting which produces a test temperature 10K higher than the highest temperature attained during conditions of normal use or 70°C, whichever is the higher. The oven shall be maintained at that setting for the duration of the test. b) The test specimen shall be positioned within the heated oven in the most unfavourable position likely to occur in normal use. The test specimen shall not be energized during the test. c) During the test, temperatures of external surfaces of the insulating enclosure shall be measured and temperatures of surfaces of components or sub-assemblies shall be measured within the equipment. Where the test is applied to sub-assemblies or components the temperature of the surfaces of the sub-assembly or component shall be measured. d) The test specimen shall be allowed to remain in the oven for 7h after the measured temperature has reached the lower limit of the test temperature. The test specimen shall then be carefully removed and allowed to cool to room temperature.		P
F 5	**Tests results** After the tests, inspection of the specimen shall be carried out. The following shall apply: a) There shall be no exposure of live parts or bridging of live parts to accessible conductive parts. b) There shall be no change to the acceptable mechanical protection to internal parts of the equipment. c) There shall be no impairment of the normal operation of the equipment to the extent that the equipment fails the requirements of other tests of the appropriate Standard, for example IR, HV and tests of leakage current.		P

3.3 3.4	Selection of materials and parts Selection of components (list of critical components)	P

Object/Part No.	Manufacturer/Trademark	Type/Model	Technical data	Standard	Mark(s) of conformity
Enclosure	+ Ablerex	ES1650 ES2200 ES3300	Steel cover one; overall approx. dimension: 430mm by 453mm by 170mm min. 1,5mm thickness Provided with four 9mm holes for pushbuttons, three 4mm holes for LEDs and a 68mm by 26mm opening on front for the display covered with plastic Steel cover two; overall approx. dimension: 425mm by 450mm by 150mm min. 1,5mm thickness Provided with four 9mm holes for pushbuttons, three 4mm holes for LEDs and a 68mm by 26mm opening on front for the display covered with plastic Steel chassis; overall approx. dimension: 429mm by 449mm by 164mm min. 1,5mm thickness		Accepted
Gasket of main enclosure	Shin-Etsu Silicone Taiwan	KE-961U	Flame Class: RTI = 150°C; Class HB	(QMFZ2)	URus E48923
Enclosure Heat sink	+ Ablerex	Aluminium	overall approx. dimension: 425mm by 300mm by 40mm mounted to enclosure chassis		Accepted
Case of control card	Grand Pacific Petrochemical Corp	D-1000 A	Flame Class: 94V-0; RTI = 60°C	(QMFZ2)	cURus E88637
Connector DC Male 3 provided	Multi –Contact AG Basel	PV-ADSP4/2,5	1000V; 22,5A; 90°C	(ECBT2)	URus E229145
Connector DC Female	Multi –Contact AG Basel	PV-ADBP4/2,5	1000V; 22,5A; 90°C	(ECBT2)	URus E229145
Connector AC	Adels-CONTACT	1500/3DS	300V; 40A; 85°C; FW2; AWG18-8 Flame Class: 94V-2	(XCFR2)	URus E63492
Internal wiring from AC terminal to AC Board and from AC Board to Main Board	+ Ancheer Cable	1015	10 AWG; 600Vac; 105°C Provided with Ferrite Core	(AVLV2)	cURus E328778
Internal wiring from AC terminal to AC Board and from AC Board to	+ Wonderful Hi-Tech	1015	10 AWG; 600Vac; 105°C Provided with Ferrite Core	(AVLV2)	cURus E77981

Object/Part No.	Manufacturer/Trademark	Type/Model	Technical data	Standard	Mark(s) of conformity
Main Board					
Internal wiring from DC terminal to Main Board	+ Sin Yu Technology Inc	1015	10 AWG; 600Vac; 105°C	(AVLV2)	cURus E191346
Tubing shrink for DC wires	+ Shenzhen	RSFR	Temp. Class: 125°C; VW-1; min. 0,8mm thickness	(YDPU2)	cURus E203950
Tubing shrink for internal wiring control panel and internal wiring display	+ Shenzhen	RSFR	Temp. Class: 125°C; VW-1; min.0,25mm thickness	(YDPU2)	cURus E203950
Tubing shrink for internal wiring between the terminals AC, DC power and EMI Board	+ Shenzhen	RSFR	Temp. Class: 125°C; VW-1; min. 0,3mm thickness	(YDPU2)	cURus E203950
PCB PVAD010	+ JIANGSU DIFEIDA	DFD-2	overall approx. dimension: 330mm by 270mm by 1,6mm Flame Class: 94V-0; RTI = 130°C	(ZPMV2)	cURus E213009
PCB PVAD010	+ Hung Chin Electronic Co Ltd	96	overall approx. dimension: 330mm by 270mm by min. 1,6mm thickness Flame Class: 94V-0; RTI = 130°C	(ZPMV2)	URus E211578
Diode (D26, D27)	+ Diotec Semiconductors	P1000J	10A; 600V		Accepted
Inductor (L2) C.M.	Lion Electronics	L06S01-06	Open type construction with overall approx. dimension: 33mm by 38mm by 18mm measured Rating: 2,0mH Core: Ferrite; R-47x27x15A-MA055-C Coil: Enamelled copper Magnet wire wound on Core Base plate: 26mm by 18mm by min. 1,6mm thickness for 1PCB or 26mm by 18mm by min. 0,8mm for 2PCB´s (NF-77) Flame Class: 94V-0		Accepted
Varistor (RT1, RT2)	Brightking Inc	621KD20	Climate Category: 40/085/56, 6500A max peak current, 100A Class current, Varistor Voltage: 620Vdc	(XGPU2) IEC61051-2 IEC61051-2-2 CECC 42000 CECC 42200 CECC 42201	VDE
Capacitor (C28, C30, C31, C34, C35, C37, C50, C51)	+ Nippon Chemi-Con	KMH	500V; 470µF; 105°C		Accepted

Object/Part No.	Manufacturer/Trademark	Type/Model	Technical data	Standard	Mark(s) of conformity
Electrolytic Bulk					
Capacitor (C28, C30, C31, C34, C35, C37, C50, C51) Electrolytic Bulk	+ Lelon Electronics Corp	LSG	500V; 470µF; 105°C		Accepted
Capacitor (C28, C30, C31, C34, C35, C37, C50, C51) Electrolytic Bulk	+ Samwha Electronic co., Ltd.	SAMWHA	500V; 470µF; 105°C		Accepted
Capacitor (C28, C30, C31, C34, C35, C37, C50, C51) Electrolytic Bulk	+ Nichicon Corporation	NICHICON	500V; 470µF; 105°C		Accepted
Capacitor (C28, C30, C31, C34, C35, C37, C50, C51) Electrolytic Bulk	+ Hitachi	Hitachi	500V; 470µF; 105°C		Accepted
Inductor 3 provided	Top Coil Technology	T100-77439A7*3-700µH	Open type construction with overall approx. dimension: 57mm by 57mm by 57mm Rating: 700µH; 180°C Core: Ferrite; 77439-A7 by Magnetics Coil: Enamelled copper Magnet wire with tubed outlets wound on Core Tubing: RTI = 125°C; min. 0,4mm thickness by DONGGUAN; UL E209436 Mounted to Enclosure Heat sink		Accepted
Heat sink for Inductor T100	+ Ablerex	Steel	overall approx. dimension: 82mm by 73mm by 66mm by min. 1,2mm thickness		Accepted
Insulation between Inductor T100 and Heat sink	+ PIONEER CONDUCTOR RUBBER INDUSTRY	Silicone Molding Resin	Overall approx. dimension: 64mm by 60mm by min. 4mm thickness Flame Class: 94V-0; RTI = 150°C	(QMFZ2)	cURus E153203
Current sensor (CT2, CT1)	LEM	HX15-P HX25-P	Galvanic isolation between primary and secondary circuit Hall effect measuring principle Isolation voltage 3000V	(NMTR2)	cURus E189713

Object/Part No.	Manufacturer/Trademark	Type/Model	Technical data	Standard	Mark(s) of conformity
			Current rating 15A		
Transistor (Q11, Q7, Q8, Q9, Q10) IGBT	+ Fairchild	HGTG30N60A4	60A; Tc=110°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate		Accepted
Transistor (Q11, Q7, Q8, Q9, Q10) IGBT	+ Advanced Power Technology	APT50GN60BG	64A; Tc=110°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate		Accepted
Transistor (Q11, Q7, Q8, Q9, Q10) IGBT	+ Fairchild	HGTG40N60A4	63A; Tc=110°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate		Accepted
Transistor (Q11, Q7, Q8, Q9, Q10) IGBT	+ IR	IRG4PSC71U	60A; Tc=100°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate		Accepted
Transistor (Q11, Q7, Q8, Q9, Q10) IGBT	+ Infineon	IKW75N60T	75A; Tc=100°C; 600V Screwed with metal clamp to enclosure heat sink enclosure heat sink		Accepted
Transistor (Q11, Q7, Q8, Q9, Q10) IGBT	+ Infineon	IGW75N60T	75A; Tc=100°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate		Accepted
Transistor (Q11, Q7, Q8, Q9, Q10) IGBT	+ IR	IRG4PSC71KD	60A; Tc=100°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate		Accepted
Diode (D3, D4, D5, D6, D7)	+ IXYS	DSEP 30-06A	30A; Tc=135°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate	IEC 62103/EN 50178	Accepted
Diode (D3, D4, D5, D6, D7)	+ IXYS	DSEI 30-06A	I=37A; Tc=85°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate	IEC 62103/EN 50178	Accepted
Diode (D3, D4, D5, D6, D7)	+ Fairchild	RHRG5060	I=50A; Tc=93°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate	IEC 62103/EN 50178	Accepted
Diode (D3, D4, D5, D6, D7)	+ Fairchild	RURG8060	I=80A; Tc=72°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate	IEC 62103/EN 50178	Accepted
Diode (D3, D4, D5, D6, D7)	+ IXYS	DSEP 60-06A	60A; Tc=110°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate	IEC 62103/EN 50178	Accepted
Diode (D3, D4, D5, D6, D7)	+ IXYS	DSEI 60-06A	60A;Tc=70°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate	IEC 62103/EN 50178	Accepted
Relay	Song Chuan	841-P-2A-C-H	Coil: 12Vdc	(NLDX2)	cURus E88991

Object/Part No.	Manufacturer/Trademark	Type/Model	Technical data	Standard	Mark(s) of conformity
(RY1, RY2)			Contact: 25A; 250Vac Insulation: Class F	EN60255	VDE
Capacitor (C26, C90) AC-Capacitor	+ Shihlin Electric	RM	350Vac; 10µF; 105°C	(CZDS2)	cURus E202431
PCB PVBF000	+ JIANGSU DIFEIDA	DFD-2	overall approx. dimension: 283mm by 82,5mm by 1,6mm Flame Class: 94V-0; RTI = 130°C	(ZPMV2)	cURus E213009
PCB PVBF000	+ Hung Chin Electronic Co Ltd	96	overall approx. dimension: 283mm by 82,5mm by 1,6mm Flame Class: 94V-0; RTI = 130°C	(ZPMV2)	URus E211578
Fuse (F1)	Conquer Electronics	AFE	6,35mm by 31,8mm 250Vac; 30A; Fast Acting	(JDYX2)	URus E82636
Fuse (F1)	Littelfuse	314	6,35mm by 31,8mm 250Vac; 30A; Fast Acting	(JDYX2)	E10480
Capacitor (C4) Line to Line	+ Cheng Tung Industrial Co Ltd	CTX	300V; max. 1µF; 100°C; X	(FOKY2) IEC60384-14	cURus E211230 VDE
Induction (L1, L2, L3, L4) C.M.	Cormex Electronics Industry Co., Ltd.	E-13447	Open type construction with overall approx. dimension: 60mm by 40mm by 55mm Rating: 2mH; 15A Core: Ferrite Coil: Enamelled copper Magnet wire wound on Core Base Plate: 26mm by 18mm by min. 1,6mm thickness for 1PCB or 26mm by 18mm by min. 0,8mm for 2PCB´s (NF-77) Flame Class: 94V-0		Accepted
Capacitor (C3)	+ Cheng Tung Industrial Co Ltd	CTX	300V; max. 0,68µF; 100°C; X	(FOKY2) IEC60384-14	cURus E211230 VDE
Varistor (RV1, RV2, RV3)	+ Brightking Inc.	471KD20	Diameter 20mm 300Vac; 385Vdc 6500A max peak current, 100A Class current, Varistor Voltage: 470Vdc	(XGPU2) IEC61643-331	URus E244500 19280010
Tubing shrink for RV1	+ EVREFAME	HST-2	Temp. Class: RTI = 125°C; min. 0,4mm thickness		CSA LR97595
Capacitor (C5, C6) Line to Ground	+ Success Electronics Co., Ltd.	SE	250Vac; 4700pF; 125°C; Y2	(FOWX2) IEC60384-14	URus E114280 VDE
Capacitor (C5, C6) Line to Ground	+ Shantou High-New Technology	CE	250Vac; 4700pF; 125°C; Y2	(FOWX2) IEC60384-14	URus 208107 VDE
Capacitor (C1, C2) Line to Line	+ Cheng Tung Industrial Co Ltd	CTX	300Vac; 3,3nF; 100°C; X	(FOKY2) IEC60384-14	cURus E211230 VDE
PCB PVAP211	+ JIANGSU DIFEIDA	DFD-2	overall approx. dimension: 133mm by 69mm by	(ZPMV2)	cURus E213009

Object/Part No.	Manufacturer/Trademark	Type/Model	Technical data	Standard	Mark(s) of conformity
			1,6mm thickness Flame Class: 94V-0; RTI = 130°C		
PCB PVAP211	+ Hung Chin Electronic Co Ltd	96	overall approx. dimension: 133mm by 69mm by 1,6mm thickness Flame Class: 94V-0; RTI = 130°C	(ZPMV2)	URus E211578
NTC (NTC1)	THINKING Electronic Industries Co Ltd	NP19L-Y1	4A; 5Ohm; 25°C	(XGPU8)	cURus E138827
Fuse (F1)	CONQUER	PTP-A	3,6mm by 10mm 250Vac; 3A	(JDYX) CSA C22.2 No 248.1/248.14	cURus E82636
Capacitor (C3)	+ Yi Shuo E-tech	PDF103M3A5TCY	1kV; 0,01µF;		Accepted
Capacitor (C2, C61) Electrolytic 2 in Series	+ Capxon	KM	250Vac; 47µF; 105°C		Accepted
Capacitor (C2, C61) Electrolytic 2 in Series	+ HER MEI	HT	250Vac; 47µF; 105°C		Accepted
Capacitor (C2, C61) Electrolytic 2 in Series	+ LUXON	SM	250Vac; 47µF; 105°C		Accepted
Capacitor (C2, C61) Electrolytic 2 in Series	+ Aishi	RH	250Vac; 47µF; 105°C		Accepted
Capacitor (C19, C22)	+ Yi Shuo E-tech	PDB222K3A5TCY	1kV; 2200pF		Accepted
Transistor (Q27)	+ Toshiba	K4115	900Vdc; 7A		Accepted
Transformer (TX1)	Cormex Electronics Ind. Co., Ltd	PVA-HPTS-001 EI-28 E-14177A	Open type construction with overall approx. dimension: 30mm by 29mm by 29mm Rating: Input: 500V;0.1A Output: 12V;3A Switching Frequency: 40kHz Core: Ferrite; EI-28/20-JPP-4 or DMR40 or NC-2H or LP3 Coil: Enamelled copper Magnet wire wound on Bobbin Bobbin: BH-B-2802-1 or P-2807 or SW-28A or TF-2801(BOEI280100) or T375J Insulation Tape: NO.35660 by Symbio Inc.		Accepted

Object/Part No.	Manufacturer/Trademark	Type/Model	Technical data	Standard	Mark(s) of conformity
			or NO.1350F-1 by 3M Company or NO.CT by Jingjiang Yahua Margin Tape: NO.35661 by Symbio Inc. or NO.44 by 3M Company or NO.WF by Jingjiang Yahua		
Transistor (U2, U3, U5, U10)	+ STMicroelectronics	L7805CV	5V; 1.5A Screwed to Heat sink H1, H2, H3, H4		Accepted 15020035
PCB PVAI030	+ JIANGSU DIFEIDA	DFD-2	overall approx. dimension: 215mm by 75mm by min. 1,6mm thickness Flame Class: 94V-0; RTI = 130°C	(ZPMV2)	cURus E213009
PCB PVAI030	+ Hung Chin Electronic Co Ltd	96	overall approx. dimension: 215mm by 75mm by min. 1,6mm thickness Flame Class: 94V-0; RTI = 130°C	(ZPMV2)	URus E211578
Transformer (T1)	Lion Electronics	MSL-HPTS-002 EE16	Open type construction with overall approx. dimension: 17,5mm by 15mm by 21,3mm Rating: Input: 12V;1A Output: 12V;1A Switching Frequency: 40KHz Core: EE16; Ferrite Coil: PACIFIC-THAI ELECTRICWIRE&CABLE CO .,LTD; UL E142108; 130°C Bobbin: PHENOLIC T375J; EE-16 10PIN; CHANG CHUN PLASTICS CO., LTD UL E59481; 150°C Insulation System: Insulation Class B; 130°C Applicable parts of IEC 62103/EN 50178		Accepted
Optical Isolator (U1, U15, U16, U17, U20)	Cosmo Electronic	K1010	Diameter Clamping Voltage 5000Vac	(FPQU2) VDE 0884	cURus E169586 VDE
PCB PVBH010	+ JIANGSU DIFEIDA	DFD-2	overall approx. dimension: 50,5mm by 72mm by min. 1,6mm thickness Flame Class: 94V-0; RTI = 130°C	(ZPMV2)	cURus E213009

Object/Part No.	Manufacturer/Trademark	Type/Model	Technical data	Standard	Mark(s) of conformity
			Provided with Ferrite Core		
PCB PVBH010	+ Hung Chin Electronic Co Ltd	96	overall approx. dimension: 50,5mm by 75mm by min. 1,6mm thickness Flame Class: 94V-0; RTI = 130°C Provided with Ferrite Core	(ZPMV2)	URus E211578
PCB PVAN210	+ JIANGSU DIFEIDA	DFD-2	overall approx. dimension: 31mm by 35mm by min. 1,6mm thickness Flame Class: 94V-0; RTI = 130°C	(ZPMV2)	cURus E213009
PCB PVAN210	+ Hung Chin Electronic Co Ltd	96	overall approx. dimension: 31mm by 35mm by min. 1,6mm thickness Flame Class: 94V-0; RTI = 130°C	(ZPMV2)	URus E211578
PCB PVAM210	+ JIANGSU DIFEIDA	DFD-2	overall approx. dimension: 107mm by 75mm by min. 1,6mm thickness Flame Class: 94V-0; RTI = 130°C Provided with Display	(ZPMV2)	cURus E213009
PCB PVAM210	+ Hung Chin Electronic Co Ltd	96	overall approx. dimension: 107mm by 75mm by min. 1,6mm thickness Flame Class: 94V-0; RTI = 130°C Provided with Display	(ZPMV2)	URus E211578
Diode (D28, D29)	+ Diotec Semiconductors	P1000J	10A; 600V		Accepted
Inductor (L3) C.M.	Lion Electronics	L06S01-06	Open type construction with overall approx. dimension: 33mm by 38mm by 18mm measured Rating: 2,0mH Core: Ferrite; R-47x27x15A-MA055-C Coil: Enamelled copper Magnet wire wound on Core Base plate: 26mm by 18mm by min. 1,6mm thickness for 1PCB or 26mm by 18mm by min. 0,8mm for 2PCB´s (NF-77) Flame Class: 94V-0		Accepted
Varistor (RT3, RT4)	Brightking Inc	621KD20	Climate Category: 40/085/56, 6500A max peak current, 100A Class current, Varistor Voltage: 560Vdc	(XGPU2) IEC61643-331	URus E223465

Object/Part No.	Manufacturer/Trademark	Type/Model	Technical data	Standard	Mark(s) of conformity
Capacitor (C53, C52) Electrolytic Bulk	+ Nippon Chemi-Con	KMH	500V; 470µF; 105°C		Accepted
Current sensor (CT3)	LEM	HX15-P HX25-P	Galvanic isolation between primary and secondary circuit Hall effect measuring principle Isolation voltage 3000V Current rating 15A	(NMTR2)	cURus E189713
Diode (D8)	+ IXYS	DSEP 30-06A	30A; Tc=135°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate	IEC 62103/EN 50178	Accepted
Diode (D8)	+ IXYS	DSEI 30-06A	I=37A; Tc=85°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate	IEC 62103/EN 50178	Accepted
Diode (D8)	+ Fairchild	RHRG5060	I=50A; Tc=93°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate	IEC 62103/EN 50178	Accepted
Diode (D8)	+ Fairchild	RURG8060	I=80A; Tc=72°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate	IEC 62103/EN 50178	Accepted
Diode (D8)	+ IXYS	DSEP 60-06A	60A; Tc=110°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate	IEC 62103/EN 50178	Accepted
Diode (D8)	+ IXYS	DSEI 60-06A	60A;Tc=70°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate	IEC 62103/EN 50178	Accepted
Transistor (Q12) IGBT	+ Fairchild	HGTG30N60A4	60A; Tc=110°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate		Accepted
Transistor (Q12) IGBT	+ Advanced Power Technology	APT50GN60BG	64A; Tc=110°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate		Accepted
Transistor (Q12) IGBT	+ Fairchild	HGTG40N60A4	63A; Tc=110°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate		Accepted
Transistor (Q12) IGBT	+ IR	IRG4PSC71U	60A; Tc=100°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate		Accepted
Transistor (Q12) IGBT	+ Infineon	IKW75N60T	75A; Tc=100°C; 600V Screwed with metal clamp to enclosure heat sink enclosure heat sink		Accepted
Transistor	+ Infineon	IGW75N60T	75A; Tc=100°C; 600V		Accepted

Object/Part No.	Manufacturer/Trademark	Type/Model	Technical data	Standard	Mark(s) of conformity
(Q12) IGBT			Screwed with metal clamp to enclosure heat sink provided with ceramic plate		
Transistor (Q12) IGBT	+ IR	IRG4PSC71KD	60A; Tc=100°C; 600V Screwed with metal clamp to enclosure heat sink provided with ceramic plate		Accepted
Comments: 1) an asterisk indicates a mark which assures the agreed level of surveillance 2) + means, that components from other vendor and other model number, but with the same rating and equivalent approvals are accepted.					

3.14	Equipment connected to supply by a plug	N/A

Measurement location	Initial voltage (peak) (V)	Measured voltage after 1s (V)	Conditions
Appliance inlet terminals			

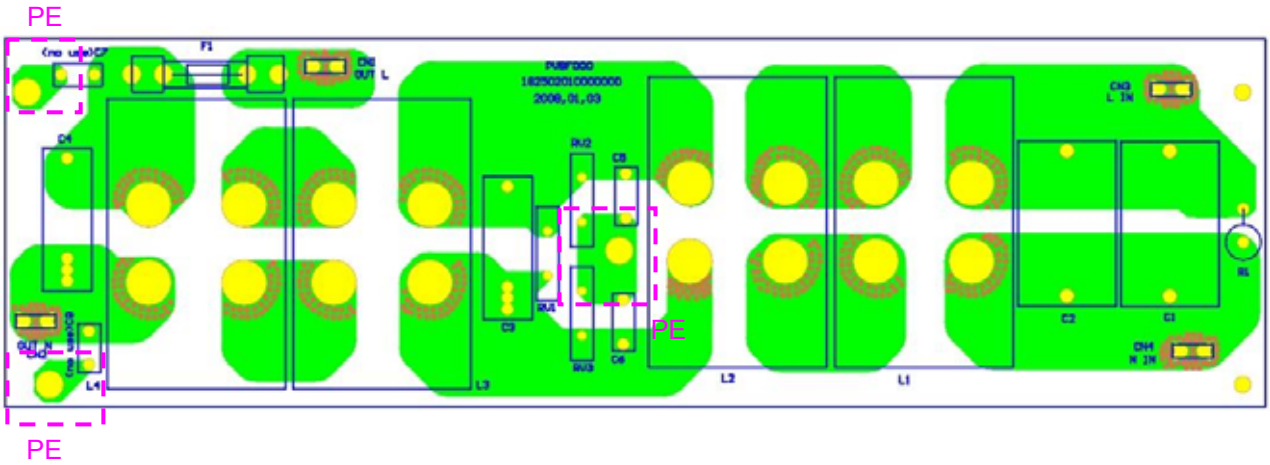
Comments:
The voltage across the line capacitor decayed to less than 34V of it's original value after 1 second.

4.1.3	Creepage distances and clearance distances for appliances	P

PCB EMI PVBF000

Clearance and creepage distance	Up (V)	U r.m.s. (V)	required cl (mm)	cl (mm)	required dcr (mm)	dcr (mm)
Hazard* to earth (basic)	500	500	2,5*	3,5	3,0*	3,5

Layout PCB EMI PVBF000 (Top Side):

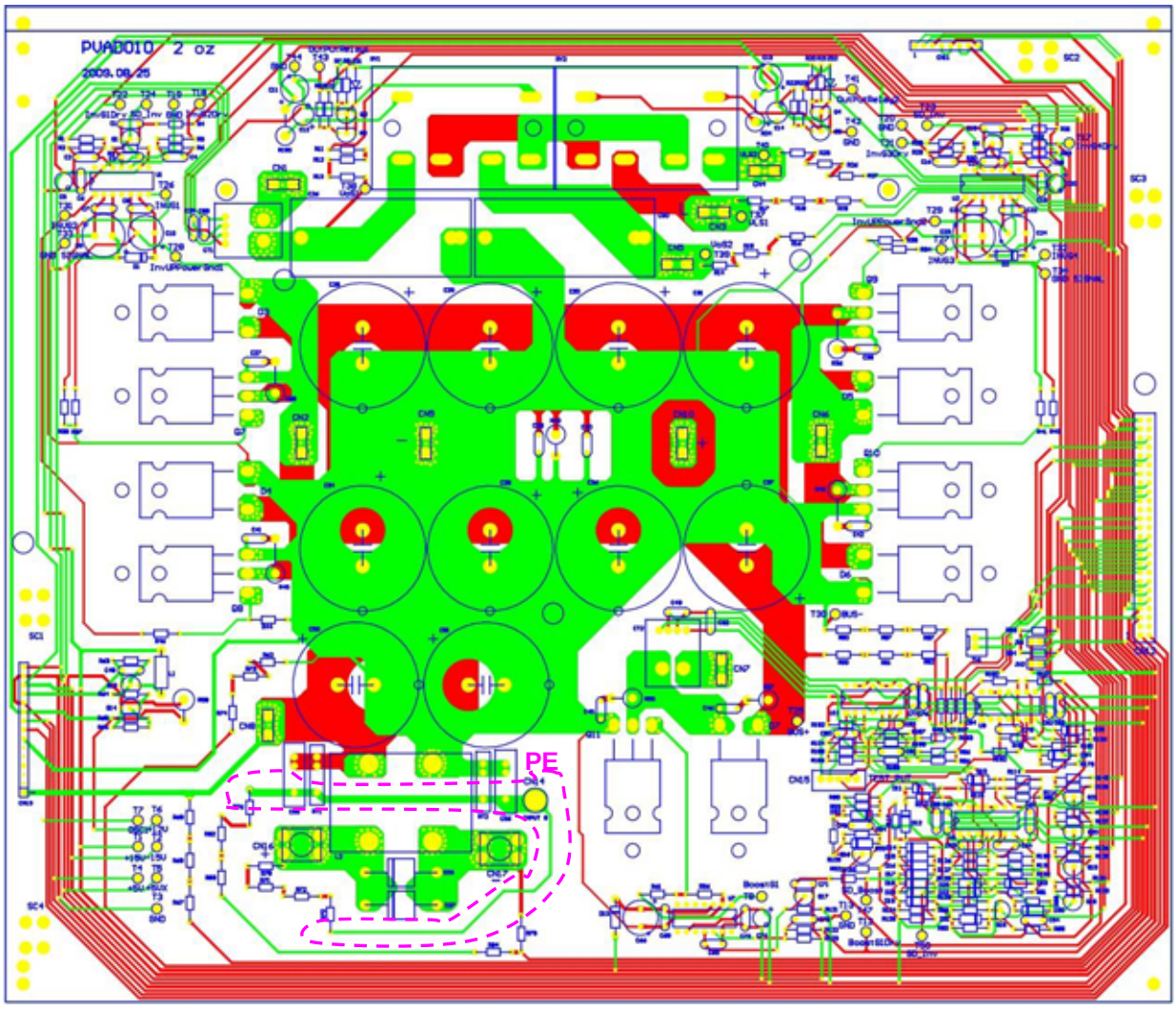


Comment:

* DC and AC are considered Hazard potential.

PCB Mainboard PVAD010 (ES2200 and ES3300)						
Clearance and creepage distance	Up (V)	U r.m.s. (V)	required cl (mm)	cl (mm)	required dcr (mm)	dcr (mm)
Hazard* to earth (basic)	500	500	2,5*	5,2	3,0*	5,2

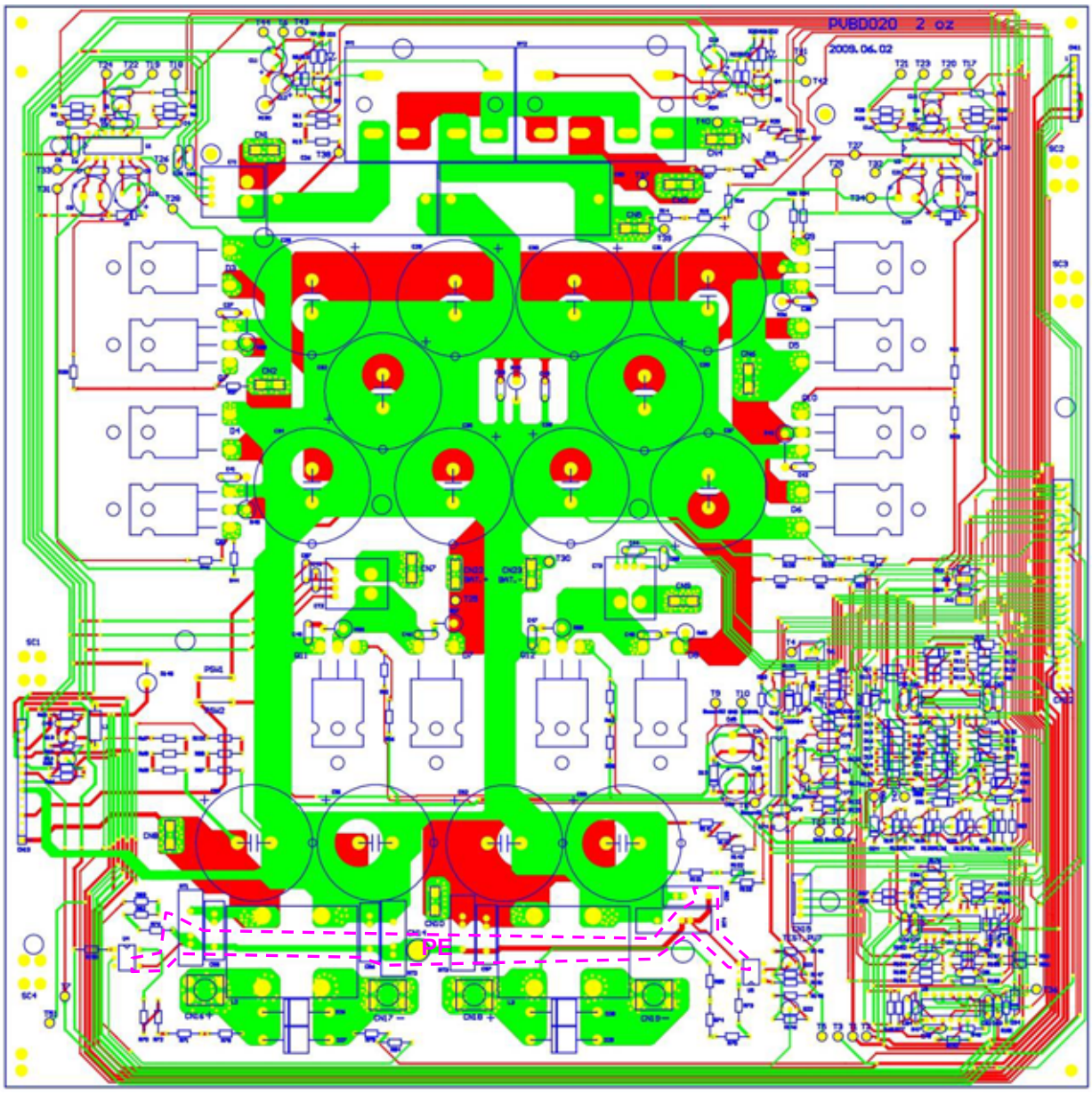
Layout PCB PVAD010 (Top Side):



Comment:
* DC and AC are considered Hazard potential.

PCB Mainboard PVBD020 (ES4400 and ES5000)						
Clearance and creepage distance	Up (V)	U r.m.s. (V)	required cl (mm)	cl (mm)	required dcr (mm)	dcr (mm)
Hazard* to earth (basic)	500	500	2,5*	5,2	3,0*	5,2

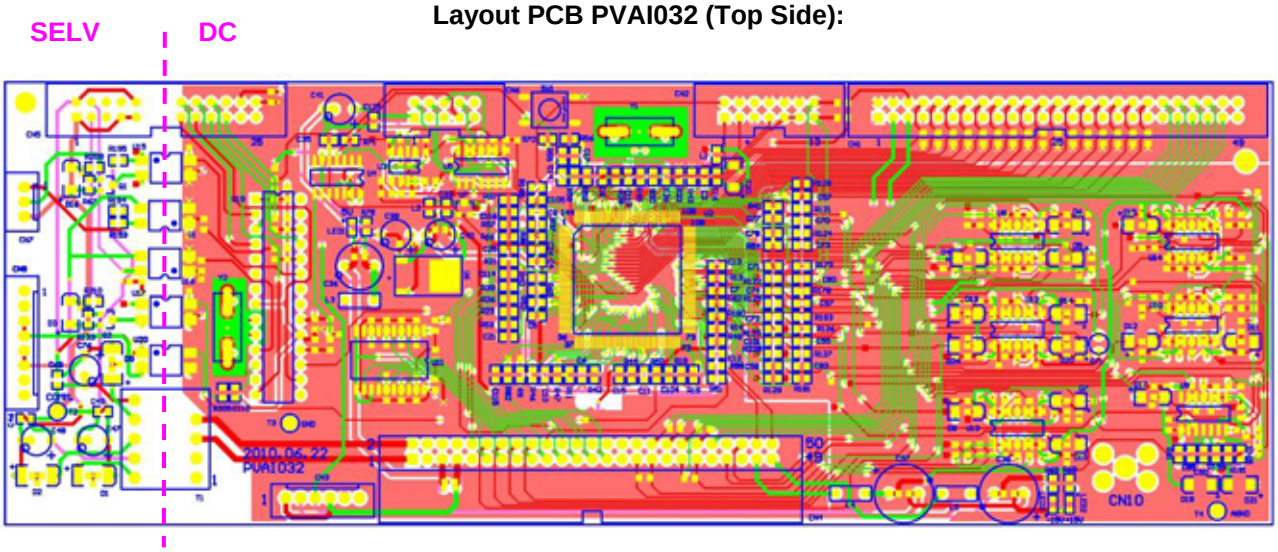
Layout PCB PVBD020 (Top Side):



Comment:
* DC and AC are considered Hazard potential.

PCB Control Board PVAI032						
Clearance and creepage distance	Up (V)	U r.m.s. (V)	required cl (mm)	cl (mm)	required dcr (mm)	dcr (mm)
DC to SELV (reinforced)	500	500	6,0*	6,0	6,0*	6,0

Layout PCB PVAI032 (Top Side):



Comment:
* DC and AC are considered Hazard potential.

8.3.1	**Insulation resistance Testing**	**P**

A 500Vdc voltage was applied to the two locations. The current flowing was measured and the resistance was calculated.

ES3300			
Location (from to)	Insulation type	Potential used	Insulation resistance
AC to enclosure	Basic	$500V_{DC}$	7,8MΩ
DC to enclosure	Basic	$500V_{DC}$	2,5MΩ
AC to secondary	Reinforced	$500V_{DC}$	180MΩ
DC to secondary	Reinforced	$500V_{DC}$	90MΩ
ES5000			
Location (from to)	Location (from to)	Location (from to)	Location (from to)
AC to enclosure	Basic	$500V_{DC}$	7,8MΩ
DC to enclosure	Basic	$500V_{DC}$	2,5MΩ
AC to secondary	Reinforced	$500V_{DC}$	180MΩ
DC to secondary	Reinforced	$500V_{DC}$	90MΩ

Note:
The insulation resistance must be >1MΩ in case of primary to enclosure and >10MΩ in case of primary to secondary.

* Secondary is grounded to enclosure. So the primary to enclosure criterium applies.

8.3.2	**TABLE: Leakage current and fault current**	**P**

The outputs were loaded to the rated value. The current measuring circuit according to Figure 4 of IEC 60990 was taken.

Star mains equipment

Parts tested	Measured voltage (U2)	Calculated current (mA)	Comments
L to PE	N/A	540μA	Normal condition
N to PE	N/A	540μA	Normal condition

Comments:
Where a PCE has a continuous leakage current of more than $5mA_{AC}$ in normal use, a fixed connection is required for protection; this shall be stated in the installation manuals (according to IEC 60950-1).

8.4	High voltage (electric strength)	P

test voltage applied between:	Measured working voltage	test voltage (V) a.c. / d.c.	breakdown Yes / No
AC to enclosure	230V	2000VAC	No
DC to enclosure	500V	2000VAC	No
AC to SELV	230V	3800VAC	No
DC to SELV	500V	3800VAC	No

Note:

If a defect occurred during abnormal operation (8.15), the high voltage test was applied to assure that there is no hazard to the user.

8.5	Test of earthing connection	P

Using a maximum 12 Vac power source, a current of 1,5 times rated current or 25A (whichever is greater) is passed between the equipment earthing terminal and the part in the equipment that is required by 8.5 to be earthed listed below. The voltage drop from the earthing terminal to the accessible metal part required to be earthed was recorded and the resistance was calculated. The resistance shall not exceed 0,1Ω.

ES3300

Accessible conductive part	Test current in (A_{AC})	Measured Voltage in (V)	Calculated Resistance in (Ω)
PE – terminal to enclosure cover 1	26,1A	1,9V	72mΩ
PE – terminal to enclosure cover 2	26,1A	2,1V	80mΩ
PE – terminal to enclosure heatsink	26,1A	1,9V	72mΩ
PE – terminal to enclosure side	26,1A	2,0V	77mΩ

ES 5000

Accessible conductive part	Test current in (A_{AC})	Measured Voltage in (V)	Calculated Resistance in (Ω)
PE – terminal to enclosure cover 1	32,5A	1,8V	55mΩ
PE – terminal to enclosure cover 2	32,5A	2,1V	65mΩ
PE – terminal to enclosure heatsink	32,5A	1,8V	55mΩ
PE – terminal to enclosure side	32,5A	2,0V	62mΩ

Note:
After 2 min applying the current the voltage was measured.

8.6	Cord anchorage	P

The cord is subjected 25 times to a steady pull, each time for a duration of 1s.

Force value:

	m<1kg	30N	0,1Nm
	1kg<m<4kg	60N	0,25Nm
x	m>4kg	100N	0,35Nm

ES5000

Test	Condition	Verdict	Comment
Power supply cord damaged ?	---	P	No effect on the cord
Longitudinal displacement:	<1mm	1,3mm	max. 2mm

8.7	Test for screw threads and fixings	P

Screwed components shall be tightened and loosened in a steady and uniform manner the following number of times:

a) where it operates in a thread in metal…….5 times
b) where it operates in a thread in insulating material……10 times

Torque dependent on the diameter, see 8.7.2

ES5000

Tested screw/location	Condition (a or b)	Verdict	Comment (torque)
Screws for enclosure (front panel side)	a	P	0,25Nm
Screws for enclosure (upper side)	a	P	0,25Nm
Screws for fixing PCB	a	P	0,7Nm
Screws for connector terminal	a	P	0,7Nm

8.8	Mechanical strength test	P
Equipment shall be subjected to blows, with an impact energy of 0,5 +/- 0,05Nm, by the impact-test apparatus, see clause 8.8.2		

ES5000	
Part	Observation
Enclosure side	No damage, no effect on the aluminium enclosure
Enclosure top	No damage, no effect on the aluminium enclosure
Display	No damage
Connectors	No damage
Buttons	No damage

8.10.4	**Protective Impedance**	**N/A**
A 2000 Ohms non-inductive resistor and a switch were connected between the user accessible part of a limited current circuit and either pole of the limited current circuit or earth. A storage oscilloscope was connected across the points under consideration. The switch was closed and voltages on resistor were measured.		
Limit values		
Circuit(s) tested		
Measured working voltage:		
Measured frequency		
Measured current through 2000Ohm		
Measured capacitance		

8.11	Temperature measurement, ES5000							P
	Test voltage (Vdc) ..... :	180[1]	180[1]	184[1]	402[1]	406[1]	406[1]	-
	Test current (Idc) ..... :	12[1]	13[1]	12[1]	6[1]	6[1]	6.1[1]	-
	Test voltage (Vac) ..... :	218	230	252	219	230	246	-
	Test current (Iac) ..... :	20	19	16,6	23	19	19,2	-
	t_{amb1} (°C) ..... :	29,4	29	30	28,8	29,8	28.5	-
	t_{amb2} (°C) ..... :	50	50	50	50	50	50	-

maximum temperature T of part/at::	T (°C)						T_{max} (°C)
1. DC terminal	48,8	48,9	49,3	49,5	50,8	49,3	90
2. AC Terminal	54,9	55,3	54,2	52,6	49,9	50,9	85
3. Diode D28 PCB	73,4	74,4	73,7	61,7	59,3	59,9	130
4. Terminal CN18 PCB	81,9	81,7	79,2	57,5	54,6	55,7	130
5. Coil L3	77,2	78,9	79,2	67,6	64,0	70,4	155
6. Condensator C51	74,4	75,7	76,9	56,4	54,0	52,0	105
7. Q11 an PCB	78,0	79,5	80,5	65,1	62,3	60,5	130
8. Currentsensor CT2	78,8	79,5	83,4	77,0	74,6	71,7	85
9. Condensator C30	80,2	81,3	83,8	80,7	78,5	74,5	105
10. Condensator C26	85,1	86,3	87,2	85,7	83,9	80,2	105
11. Relay RY1	86,8	88,6	89,3	89,8	70,3	87,7	90
12. Condensator C61	72,2	73,9	74,8	81,9	79,7	79,7	105
13. Condensator C65	81,4	83,0	83,8	81,4	79,3	78,9	105
14. H1 PCB	86,2	87,2	88,0	80,7	79,0	78,7	130
15. Wiring Choke	70,3	73,2	75,0	64,2	64,0	59,9	105
16. Choke	93,7	94,4	92,8	98,2	92,9	89,5	125
17. Condensator C1 PB	80,9	82,7	81,2	86,3	92,3	78,8	100
18. Coil L2 PB	87,1	88,7	89,1	86,4	85,1	83,6	155
19. Condensator C3 PB	83,8	85,3	85,7	82,8	82,4	80,9	100
20. Transformer T1 CB	70,2	71,6	72,4	69,5	66,4	67,0	100[2]
21. Housing	62,0	61,7	62,6	61,5	61,7	61,5	85
22. Housing near LCD	58,4	58,6	59,6	57,3	56,9	56,2	85
23. cooling fins	82,4	84,9	85,8	79,0	77,1	74,2	85
24. Transformator TX1	53,1	52,7	54	51,9	51,4	51,7	100[2]

The above temperatures are recorded at $t_{amb1.}$ The values measured are subtracted with t_{amb1} and t_{amb2} (°C) added. Therefore above measured temperatures are the absolute temperatures in °C at maximum ambient.

The printed circuit board is rated 130°C.

[1] applied test voltage and test current for each of the two DC-strings

[2] reliability test (heat resistance: no evidence of mechanical damage shall occur after expose to 100°C for 96h)

8.13	Test of marking	P
Nameplates, transfers and paintings used to provide the information required in accordance with Clause 7.1 shall be checked by inspection and by rubbing by hand for 15 s with a piece of cloth soaked with water and again with a piece of cloth soaked with petroleum spirits.		
Requirement	Observation	
Legible?	Yes	
Marking easily removable?	No	
Curling?	No	

8.14	Stability test	N/A
Under conditions of normal use, freestanding units and equipment shall not become physically unstable to the degree that they could become a hazard to operators and service personnel.		
a) The unit is tilted to an angle of 10° from its normal upright position. Doors, drawers etc. are opened.		
Result:	Equipment overbalanced	

8.15	Abnormal operation		P
	ambient temperature (°C) .....:	25°C	—
	model/type of power supply .....:	AC: CROMA DC: 3x 300-40	—
	manufacturer of power supply .....:	AC: CROMA DC:	—
	rated markings of power supply .....:	AC: 10kW, 300V, 3x 15A DC: 900V, 40A;	—

Component No.	Fault	Test condition		Test time	fuse No. (AC)	Fault condition		Result
		AC	DC			AC	DC	
DC input Diode D26	Short	230V 16A	500V 8A	10min	32A	230V 0A	4V 26,4A	Unit switched off immediately. No hazard, no defect
DC input Diode D27	Short	230V 16A	500V 8A	10min	32A	230V 0A	4V 26,4A	Unit switched off immediately. No hazard, no defect
DC input capacitor C50	Short	230V 16A	500V 8A	2h	32A	230V 0A	4V 26,4A	Unit switched off immediately. L3: 136,5°C Ambient: 25°C No hazard, no defect
DC input capacitor C51	Short	230V 16A	500V 8A	2h	32A	230V 0A	4V 26,4A	Unit switched off immediately. L3: 136,5°C Ambient: 25°C No hazard, no defect
Current Sensor CT2	R189 open	230V 16A	500V 8A	2h	32A	230V 16A	500V 8A	No effect on function. Output power limited. No hazard, no defect
Current Sensor CT2	C64 short	230V 16A	500V 8A	2h	32A	230V 16A	500V 8A	No effect on function. Output power limited. No hazard, no defect
Transistor Q11	Short	230V 16A	500V 8A	2h	32A	230V 0A	4V 26,4A	Unit switched off immediately. L2: 136,5°C L3: 136,5°C CT2: 54,1°C CT3: 54,1°C Ambient: 25°C No hazard, no defect
DC input Diode D28	Short	230V 16A	500V 8A	10min	32A	230V 0A	4V 26,4A	Unit switched off immediately. No hazard, no defect
DC input Diode D29	Short	230V 16A	500V 8A	10min	32A	230V 0A	4V 26,4A	Unit switched off immediately. No hazard, no defect

Component No.	Fault	Test condition		Test time	fuse No. (AC)	Fault condition		Result
		AC	DC			AC	DC	
DC input capacitor C52	Short	230V 16A	500V 8A	2h	32A	230V 0A	4V 26,4A	Unit switched off immediately. L3: 136,5°C Ambient: 25°C No hazard, no defect
DC input capacitor C53	Short	230V 16A	500V 8A	2h	32A	230V 0A	4V 26,4A	Unit switched off immediately. L3: 136,5°C Ambient: 25°C No hazard, no defect
Current Sensor CT3	R178 open	230V 16A	500V 8A	2h	32A	230V 16A	500V 8A	No effect on function. Output power limited. No hazard, no defect
Current Sensor CT3	C61 short	230V 16A	500V 8A	2h	32A	230V 16A	500V 8A	No effect on function. Output power limited. No hazard, no defect
Transistor Q12	Short	230V 16A	500V 8A	2h	32A	230V 0A	4V 26,4A	Unit switched off immediately. L2: 136,5°C L3: 136,5°C CT2: 54,1°C CT3: 54,1°C Ambient: 25°C No hazard, no defect
Capacitor C28	Short	230V 16A	500V 8A	2h	32A	230V 0A	4V 26,4A	Unit switched off immediately. L2: 136,5°C L3: 136,5°C CT2: 54,1°C CT3: 54,1°C Ambient: 25°C No hazard, no defect
Capacitor C29	Short	230V 16A	500V 8A	2h	32A	230V 0A	4V 26,4A	Unit switched off immediately. L2: 136,5°C L3: 136,5°C CT2: 54,1°C CT3: 54,1°C Ambient: 25°C No hazard, no defect

Component No.	Fault	Test condition		Test time	fuse No. (AC)	Fault condition		Result
		AC	DC			AC	DC	
Capacitor C30	Short	230V 16A	500V 8A	2h	32A	230V 0A	4V 26,4A	Unit switched off immediately. L2: 136,5°C L3: 136,5°C CT2: 54,1°C CT3: 54,1°C Ambient: 25°C No hazard, no defect
Capacitor C31	Short	230V 16A	500V 8A	2h	32A	230V 0A	4V 26,4A	Unit switched off immediately. L2: 136,5°C L3: 136,5°C CT2: 54,1°C CT3: 54,1°C Ambient: 25°C No hazard, no defect
Capacitor C32	Short	230V 16A	500V 8A	2h	32A	230V 0A	4V 26,4A	Unit switched off immediately. L2: 136,5°C L3: 136,5°C CT2: 54,1°C CT3: 54,1°C Ambient: 25°C No hazard, no defect
Capacitor C33	Short	230V 16A	500V 8A	2h	32A	230V 0A	4V 26,4A	Unit switched off immediately. L2: 136,5°C L3: 136,5°C CT2: 54,1°C CT3: 54,1°C Ambient: 25°C No hazard, no defect
Capacitor C34	Short	230V 16A	500V 8A	2h	32A	230V 0A	4V 26,4A	Unit switched off immediately. L2: 136,5°C L3: 136,5°C CT2: 54,1°C CT3: 54,1°C Ambient: 25°C No hazard, no defect
Capacitor C35	Short	230V 16A	500V 8A	2h	32A	230V 0A	4V 26,4A	Unit switched off immediately. L2: 136,5°C L3: 136,5°C CT2: 54,1°C CT3: 54,1°C Ambient: 25°C no defect, No hazard

Component No.	Fault	Test condition		Test time	fuse No. (AC)	Fault condition		Result
		AC	DC			AC	DC	
Capacitor C36	Short	230V 16A	500V 8A	2h	32A	230V 0A	4V 26,4A	Unit switched off immediately. L2: 136,5°C L3: 136,5°C CT2: 54,1°C CT3: 54,1°C Ambient: 25°C No hazard, no defect
Capacitor C37	Short	230V 16A	500V 8A	2h	32A	230V 0A	4V 26,4A	Unit switched off immediately. L2: 136,5°C L3: 136,5°C CT2: 54,1°C CT3: 54,1°C Ambient: 25°C No hazard, no defect
Capacitor C39	Short	230V 16A	500V 8A	2h	32A	230V 0A	4V 26,4A	Unit switched off immediately. L2: 136,5°C L3: 136,5°C CT2: 54,1°C CT3: 54,1°C Ambient: 25°C no defect, No hazard
Resistor R40	Short	230V 16A	500V 8A	2h	32A	230V 0A	4V 26,4A	Unit switched off immediately. L2: 136,5°C L3: 136,5°C CT2: 54,1°C CT3: 54,1°C Ambient: 25°C No hazard, no defect
Capacitor C40	Short	230V 16A	500V 8A	2h	32A	230V 0A	4V 26,4A	Unit switched off immediately. L2: 136,5°C L3: 136,5°C CT2: 54,1°C CT3: 54,1°C Ambient: 25°C No hazard, no defect
Transistor Q7	Short	230V 16A	500V 8A	10min	32A	230V 0A	4V 26,4A	Unit switched off immediately, unit defect, HiPot-Test passed, no hazard
Transistor Q8	Short	230V 16A	500V 8A	10min	32A	230V 0A	4V 26,4A	Unit switched off immediately, unit defect, HiPot-Test passed, no hazard

Component No.	Fault	Test condition		Test time	fuse No. (AC)	Fault condition		Result
		AC	DC			AC	DC	
Transistor Q9	Short	230V 16A	500V 8A	10min	32A	230V 0A	4V 26,4A	Unit switched off immediately, unit defect, HiPot-Test passed, no hazard
Transistor Q10	Short	230V 16A	500V 8A	10min	32A	230V 0A	4V 26,4A	Unit switched off immediately, unit defect, HiPot-Test passed, no hazard
Diode D3	Short	230V 16A	500V 8A	10min	32A	230V 0A	4V 26,4A	Unit switched off immediately, unit defect, HiPot-Test passed, no hazard
Diode D4	Short	230V 16A	500V 8A	10min	32A	230V 0A	4V 26,4A	Unit switched off immediately, unit defect, HiPot-Test passed, no hazard
Diode D5	Short	230V 16A	500V 8A	10min	32A	230V 0A	4V 26,4A	Unit switched off immediately. Unit defect, No hazard
Diode D6	Short	230V 16A	500V 8A	10min	32A	230V 0A	4V 26,4A	Unit switched off immediately, unit defect, HiPot-Test passed, no hazard
Current Sensor CT1	R180 open	230V 16A	500V 8A	2h	32A	230V 16A	500V 8A	No effect on function. Output power limited. No hazard, no defect
Current Sensor CT1	R152 short	230V 16A	500V 8A	2h	32A	230V 16A	500V 8A	No effect on function. Output power limited. No hazard, no defect
Capacitor C26 short	Short	230V 16A	500V 8A	10min	32A	230V 0A	4V 26,4A	Unit switched off immediately, internal fuse F1 30A defect, unit defect, HiPot-Test passed, no hazard
Relay RY1	Short Pin1 to Pin2 and Pin3 to Pin4	230V 16A	500V 8A	10min	32A	230V 0A	500V 0A	Unit does not connect to grid
Relay RY2	Short Pin1 to Pin2 and Pin3 to Pin4	230V 16A	500V 8A	10min	32A	230V 0A	500V 0A	Unit does not connect to grid
AC output Resistor R1	Short	230V 16A	500V 8A	10min	32A	230V 0A	4V 26,4A	Unit switched off immediately, internal fuse F1 30A defect, unit defect, HiPot-Test passed, no hazard
AC output Capacitor C1	Short	230V 16A	500V 8A	10min	32A	230V 0A	4V 26,4A	Unit switched off immediately, internal fuse F1 30A defect, unit defect, HiPot-Test passed, no hazard

Component No.	Fault	Test condition		Test time	fuse No. (AC)	Fault condition		Result
		AC	DC			AC	DC	
AC output Capacitor C2	Short	230V 16A	500V 8A	10min	32A	230V 0A	4V 26,4A	Unit switched off immediately, internal fuse F1 30A defect, unit defect, HiPot-Test passed, no hazard
AC output Varistor RV1	Short	230V 16A	500V 8A	10min	32A	230V 0A	4V 26,4A	Unit switched off immediately, internal fuse F1 30A defect, unit defect, HiPot-Test passed, no hazard
AC output Capacitor C3	Short	230V 16A	500V 8A	10min	32A	230V 0A	4V 26,4A	Unit switched off immediately, internal fuse F1 30A defect, unit defect, HiPot-Test passed, no hazard
AC output Capacitor C4	Short	230V 16A	500V 8A	10min	32A	230V 0A	4V 26,4A	Unit switched off immediately, internal fuse F1 30A defect, unit defect, HiPot-Test passed, no hazard
Thermal Sensor	Open	230V 16A	500V 8A	10min	32A	230V 0A	500V 0A	Unit switched off immediately, display message Er18, no hazard, no defect
Thermal Sensor	Short	230V 16A	500V 8A	5h	32A	230V 0A	4V 26,4A	No effect on function, no derating, temperature rising on IBGT, unit defect, HiPot-Test passed, no hazard
Transformer short / overload								
Power-Board Transformer TX1	Pin1 to Pin5 short	230V 16A	500V 8A	10min	32A	230V 0A	500V 0A	Unit switched off immediately, unit defect, HiPot-Test passed, no hazard
Power-Board Transformer TX1	Pin6 to Pin7 short	230V 16A	500V 8A	10min	32A	230V 0A	500V 0A	Unit switched off immediately, unit defect, HiPot-Test passed, no hazard
Power-Board Transformer TX1	Pin8 to Pin9 short	230V 16A	500V 8A	10min	32A	230V 0A	500V 0A	Unit switched off immediately, unit defect, HiPot-Test passed, no hazard
Power-Board Transformer TX1	Pin9 to Pin10 short	230V 16A	500V 8A	10min	32A	230V 0A	500V 0A	Unit switched off immediately, unit defect, HiPot-Test passed, no hazard
Controlle-Board Transformer T1	Pin3 to Pin4 short	230V 16A	500V 8A	2h	32A	230V 16A	500V 8A	No effect T1: 38°C Ambient: 25°C no hazard, no defect

Component No.	Fault	Test condition		Test time	fuse No. (AC)	Fault condition		Result
		AC	DC			AC	DC	
Controlle-Board Transformer T1	Pin6 to Pin7 short	230V 16A	500V 8A	2h	32A	230V 0A	4V 26,4A	Unit switched off immediately T1: 116°C Ambient: 25°C unit defect, HiPot-Test passed, no hazard
Controlle-Board Transformer T1	Pin8 to Pin9 short	230V 16A	500V 8A	2h	32A	230V 16A	500V 8A	No effect T1: 95°C Ambient: 25°C no hazard, no defect
Controlle-Board Transformer T1	Pin9 to Pin10 short	230V 16A	500V 8A	2h	32A	230V 16A	500V 8A	No effect T1: 95°C Ambient: 25°C no hazard, no defect
Controlle-Board Transformer T1	Pin6 to Pin7 overload	230V 16A	500V 8A	2h	32A	230V 0A	4V 26,4A	Unit switched off immediately T1: 116°C Ambient: 25°C unit defect, HiPot-Test passed, no hazard
Controlle-Board Transformer T1	Pin8 to Pin9 overload	230V 16A	500V 8A	2h	32A	230V 16A	500V 8A	No effect T1: 95°C Ambient: 25°C no hazard, no defect
Controlle-Board Transformer T1	Pin9 to Pin10 overload	230V 16A	500V 8A	2h	32A	230V 16A	500V 8A	No effect T1: 95°C Ambient: 25°C no hazard, no defect
Misuse								
Input DC voltage	Mismatch before startup	230V 0A	500V 0A	10min	32A	230V 0A	4V 26,4A	Unit defect, HiPot-Test passed, no hazard
Output AC voltage	Mismatch before startup	230V 0A	500V 0A	10min	32A	230V 0A	500V 0A	Unit does not connect to grid, no hazard, no defect

Comment:

Fault conditions are to be applied only one at a time and shall be applied in turn in any convenient order. The equipment shall be operated until further change as a result of the applied fault is unlikely. Each test is normally limited to 1 h since a HAZARD arising from the fault will usually manifest itself within that time. If there is an indication that a HAZARD may result after the 1 h period, the test shall be continued until the ultimate result is obtained or until temperatures stabilize, whichever happens first.

The tests were performed on the unit mentioned in the bracket. Only differences are the input voltage range and the power transformer. The behaviour in case of a fault is identical.

B 2	Resistance to heat test		P
	allowed impression diameter (mm) .....:	≤ 2 mm	—

Part	Test temperature (°C)	Impression diameter (mm)
Bobbin T1	125°C	0,95mm
Bobbin TX1	125°C	0,95mm

B 3.3	Glow wire test					P
Part tested	Temperature in °C	Flame height in cm	Duration of flame in s			Result
			t_i	t_e	t_a	
AC connector	850°C	8,0cm	0s	3s	30s	P
DC connector	850°C	2,0cm	0s	30s	30s	P
L2 insulation plate (main)	750°C	2,5cm	0s	6s	30s	P
L3 insulation plate (main)	750°C	2,5cm	0s	6s	30s	P
CT1 housing (main)	750°C	2,0cm	0s	5s	30s	P
CT2 housing (main)	750°C	2,0cm	0s	5s	30s	P
CT3 housing (main)	750°C	2,0cm	0s	5s	30s	P
L1 insulation plate wire (EMI)	750°C	0,0cm	N/A	N/A	30s	P
L1 insulation plate bottom (EMI)	750°C	0,0cm	N/A	N/A	30s	P
L2 insulation plate wire (EMI)	750°C	0,0cm	N/A	N/A	30s	P
L2 insulation plate bottom (EMI)	750°C	0,0cm	N/A	N/A	30s	P
L3 insulation plate wire (EMI)	750°C	0,0cm	N/A	N/A	30s	P
L3 insulation plate bottom (EMI)	750°C	0,0cm	N/A	N/A	30s	P
L4 insulation plate wire (EMI)	750°C	0,0cm	N/A	N/A	30s	P
L4 insulation plate bottom (EMI)	750°C	0,0cm	N/A	N/A	30s	P
Storage throttle isolation[1]	750°C	0,0cm	N/A	N/A	30s	P
Storage throttle wire cloth[1]	750°C	0,0cm	N/A	N/A	30s	P
Relay Y1	750°C	0,0cm	N/A	N/A	30s	P
Relay Y2	750°C	0,0cm	N/A	N/A	30s	P
Connector CN12[2]	750°C	2,0cm	0s	15s	30s	P
Connector CN3[3]	750°C	8,0cm	0s	15s	30s	P
TX1 bobbin (main)	650°C	0,0cm	N/A	N/A	30s	P
TX1 foil (main)	650°C	0,0cm	N/A	N/A	30s	P
T1 bobbin (control)	650°C	0,0cm	N/A	N/A	30s	P
T1 foil (control)	650°C	0,0cm	N/A	N/A	30s	P

Comment:

[1] the result is applicable on all three storage trottles

[2] the result is applicable on CN2, CN4, CN5, CN6, CN11, CN12, CN13

[3] the result is applicable on CN1, CN3, CN7, CN8, CN9, CN10, CN15

* Only the listed connectors are tested in B 3.3. Male and female parts are of the same material, thus they were not tested each.

B 3.4	Needle-flame test	P

Part tested	Duration of flame t_b (s)	Application of flame t_a (s)	Result
Capacitor C26 (Main)	0s	30s	P
Capacitor C34, C36, C37, C50, C51, C52, C53 (Main)	0s	30s	P
Inductor L4 (Control)	0s	30s	P
Capacitor C41 (Control)	0s	30s	P

Note:
The test specimens were pre-conditioned in the laboratory environment.
One sample of each specimen was tested.
The needle-flame was applied to one point at each specimen.
A wrapping tissue was used as burning indicator.

The needle-flame test was conducted as consequential test to the glow-wire testing in B3.3.

Annex No. 1
EMC Test Report

The whole report is stored at
Bureau Veritas Consumer Products Services Germany GmbH, Türkheim
Project 09TH0459

Verification of Compliance

Product Name	:	**PV Inverter**
Main Model Number	:	**ES5000**
Series Model Number	:	**ES4200**
Applicant	:	**GE Industrial Belgium BVBA**
Address	:	**Nieuwevaart 51 B 9000 Gent Belgium**
Report Number	:	**S2C-U030-0803-055**
Issue Date	:	**May 15, 2009**
Applicable Standards	:	**EN 61000-6-3:2007** **EN 61000-6-4:2007** **EN 62040-2:2006 Category C2** **EN 61000-6-1:2007** **EN 55022: 2006 Class B** **EN 61000-6-2:2005** - IEC 61000-4-2:2001 - IEC 61000-4-3:2006 - IEC 61000-4-4:2004 - IEC 61000-4-5:2005 - IEC 61000-4-6:2006 - IEC 61000-4-8:2001 - IEC 61000-4-11:2004

Based on the EMC Directive 2004/108/EC and the specifications of the customer, one sample of the designated product has been tested in our laboratory and found to be in compliance with the EMC standards cited above.

CE

TAF 0905
FCC CAB Code TW1053
NVLAP Lab Code 200575-0
IC Code 4699A
VCCI Accep. No. R-1527, C-1609, T-131, T-1441

Central Research Technology Co.
EMC Test Laboratory
11, Lane41, Fushuen St., Jungshan Chiu,
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Tel : 886-2-25984568
Fax: 886-2-25984546

J. Y. Shih

(Tsun-Yu Shih/ General Manager)

Date: May 15, 2009

Annex No. 2
IP Test Report

The whole report is stored at
Bureau Veritas Consumer Products Services Germany GmbH, Türkheim
Project 09TH0459

Intertek

Report No.: TP10090079-ETS
Date: September 10, 2010
Page 1 of 8

TEST REPORT

Applicant:	Ablerex Electronics Co., Ltd. 1F, No.3, Lane 7, Paokao Rd., Hsintien, 23114 Taipei Hsien, Taiwan
Product:	Power Inverter for PV
Model:	ES2200, ES3300, ES4200, ES5000
Brand Name:	Ablerex
Rating:	ES2200: Input: 360Vdc, Output: 230V / 8.7A ES3300: Input: 360Vdc, Output: 230V / 13A ES4200: Input: 360Vdc, Output: 230V / 17.4A ES5000: Input: 360Vdc, Output: 230V / 21.7A
Model Similarity:	All models are identical except for the output rating difference, the details see Page 3

Date of Receipt of Test: September 3, 2010

Date of Performance of Test: September 3, 2010 - September 9, 2010

Sample Description:	The product covered by this report is a Power Inverter for PV for use under dust-tight and water jets conditions.
Testing Standard:	Sub-clauses 13.4, 13.6 and 14.2.5, 14.3 of IEC 60529: 1989 +A1: 1999 degrees of protection provided by enclosures (IP65).
Conclusion:	From the results of our testing on the submitted sample(s), we are of the opinion that the submitted sample(s) **COMPLY WITH** the above testing standard.

Prepared by:

Godfrey Lee
Project Engineer

Reviewed by:

Gary Yunn
Assistant Manager

Intertek Testing Services Taiwan Ltd.
5F, No. 423, Ruiguang Rd., Neihu District, Taipei 114, Taiwan
Tel: (886-2) 66022888; Fax: (886-2) 66022415

Note:

1) The testing results relate only to the items tested.
2) The test report shall not be reproduced except in full, without written approval of the laboratory.
3) This test report only allows to be revised within three years from its original issued date unless a further updating to the standard or requirement is noticed.
4) This report is for the exclusive use of Intertek's Client and is provided pursuant to the agreement between Intertek and its Client. Intertek's responsibility and liability are limited to the terms and conditions of the agreement. Intertek assumes no liability to any party, other than to the Client in accordance with the agreement, for any loss, expense or damage occasioned by the use of this report. Only the Client is authorized to permit copying or distribution of this report and then only in its entirety. Any use of the Intertek name or one of its marks for the sale or advertisement of the tested material, product or service must first be approved in writing by Intertek. The observations and test results in this report are relevant only to the sample tested. This report by itself does not imply that the material, product, or service is or has ever been under an Intertek certification program.
5) When determining the test conclusion, the Measurement Uncertainty of test has been considered.

Intertek

Report No.: TP10090079-ETS
Date: September 10, 2010
Page 3 of 8

Technical information:

Explanation of model designation of ES2200, ES3300, ES4200, ES5000

Rating:

Model Name	ES2200	ES3300	ES4200	ES5000
Nominal DC Voltage	360Vdc	360 Vdc	360 Vdc	360 Vdc
Max. DC input Voltage	500 Vdc	500 Vdc	500 Vdc	500 Vdc
Working range	120 ~ 500Vdc	120 ~ 500 Vdc	120 ~ 500 Vdc	120 ~ 500 Vdc
MPPT Range	150 ~ 450Vdc	150 ~ 450Vdc	150 ~ 500Vdc	150 ~ 450Vdc
Max. DC input Current	14.6A	22A	14.7A / 14.7A	18.3A / 18.3A
MPPT Tracker	1	1	2	3
Rate Output Power	2K	3K	4K	5K
Rate Voltage / Current	230V / 8.7A	230V / 13A	230V / 17.4A	230V / 21.7A

Intertek

Report No.: TP10090079-ETS
Date: September 10, 2010
Page 4 of 8

IP6X Test (sub-clause 13.4 and 13.6 of IEC 60529):

Test Method:

1. The test is made using a dust chamber incorporating the basic principles shown in figure 2 whereby the powder circulation pump may be replaced by other means suitable tomaintain the talcum powder in suspension in a closed test chamber. The talcum powder used shall be able to pass through a square-meshed sieve the nominal wire diameter of which is 50 μm and the nominal width of a gap between wires 75 μm. The amount of talcum powder to be used is 2 kg per cubic metre of the test chamber volume. It shall not have been used for more than 20 tests.
2. Category 2: Enclosures where no pressure difference relative to the surrounding air is present.
3. If it is impracticable to make a special hole, the suction connection shall be made to the cable inlet hole. If there are other holes (for example, more cable inlet holes or drain-holes) these shall be treated as intended for normal use on site.
4. The object of the test is to draw into the enclosure, by means of depression, a volume of air 80 times the volume of the sample enclosure tested without exceeding the extraction rate of 60 volumes per hour. In no event shall the depression exceed 2 kPa (20 mbar) on the manometer shown in figure 2.
5. If an extraction rate of 40 to 60 volumes per hour is obtained the duration of the test is 2 h. If, with a maximum depression of 2 kPa (20 mbar), the extraction rate is less than 40 volumes per hour, the test is continued until 80 volumes have been drawn through, or a period of 8 h has elapsed.
6. The enclosure under test is supported in its normal operating position inside the test chamber, but is not connected to a vacuum pump. Any drain-hole normally open shall be left open for the duration of the test. The test shall be continued for a period of 8 h.
7. If it is impracticable to test the complete enclosure in the test chamber, one of the following procedures shall be applied:
   - Testing of individually enclosed sections of the enclosure;
   - Testing of representative parts of the enclosure, comprising components such as doors, ventilation openings, joints, shaft seals, etc., in position during test;
   - Testing of a smaller enclosure having the same full-scale design details.

   In the last two cases, the volume of air to be drawn through the enclosure under test shall be the same as for the whole enclosure in full scale.

IP6X Test (sub-clause 13.4 and 13.6 of IEC 60529):

Test Method (cont):

8. The enclosure shall be deemed category 1, whether reductions in pressure below the atmospheric pressure are present or not.

Compliance criteria:

1. The protection is satisfactory if no deposit of dust is observable inside the enclosure at the end of the test.

IPX5 Test (sub-clause 14.2.5 and 14.3 of IEC 60529):

Test Method:

1. The test is made by spraying the enclosure from all practicable directions with a stream of water from a standard test nozzle as shown in figure 6.
   The conditions to be observed are as follows:
   – internal diameter of the nozzle: 6,3 mm;
   – delivery rate: 12,5 l/min ± 5 %;
   – water pressure: to be adjusted to achieve the specified delivery rate;
   – core of the substantial stream: circle of approximately 40 mm diameter at 2,5 m distance from nozzle;
   – test duration per square metre of enclosure surface area likely to be sprayed: 1 min;
   – minimum test duration: 3 min;
   – distance from nozzle to enclosure surface: between 2,5 m and 3 m.

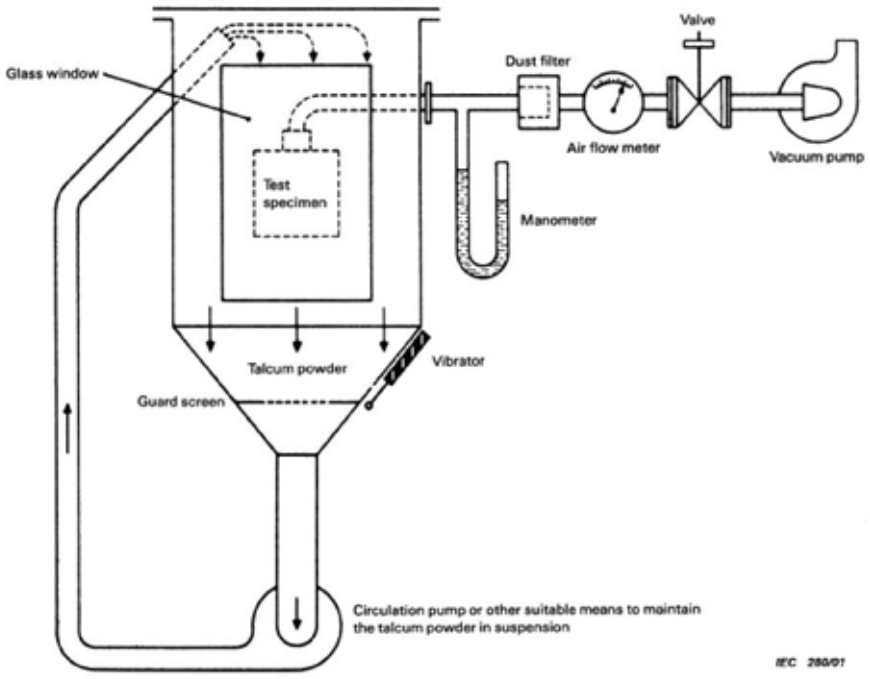
Compliance criteria:

1. After the test, the enclosure shall comply with the requirements of sub-clause 14.3. The enclosure shall be inspected for ingress of water. If any water has entered, it shall not:
   – Be sufficient to interfere with the correct operation of the equipment or impair safety;
   – Deposit on insulation parts where it could lead to tracking along the creepage distances;
   – Reach live parts or windings not designed to operate when wet;
   – Accumulate near the cable end or enter the cable if any.

Test Result:

13.4, 13.6, 14.2.5, 14.3	**IP65 Test**	**Pass**
Result		
After the test, the function of the Sample is functioning as normal.		

APPENDIX 1:



NOTE See IEC 60068-2-68, figure 2 valid for La2 only.

Figure 2 – Test device to verify protection against dust (dust chamber)

Intertek

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Date: September 10, 2010
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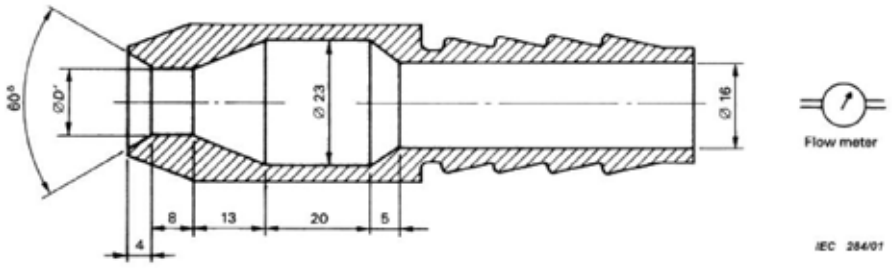
APPENDIX 1:



Dimensions in millimetres

D' = 6,3 for the test of 14.2.5 (second characteristic numeral 5)
D' = 12,5 for the test of 14.2.6 (second characteristic numeral 6)

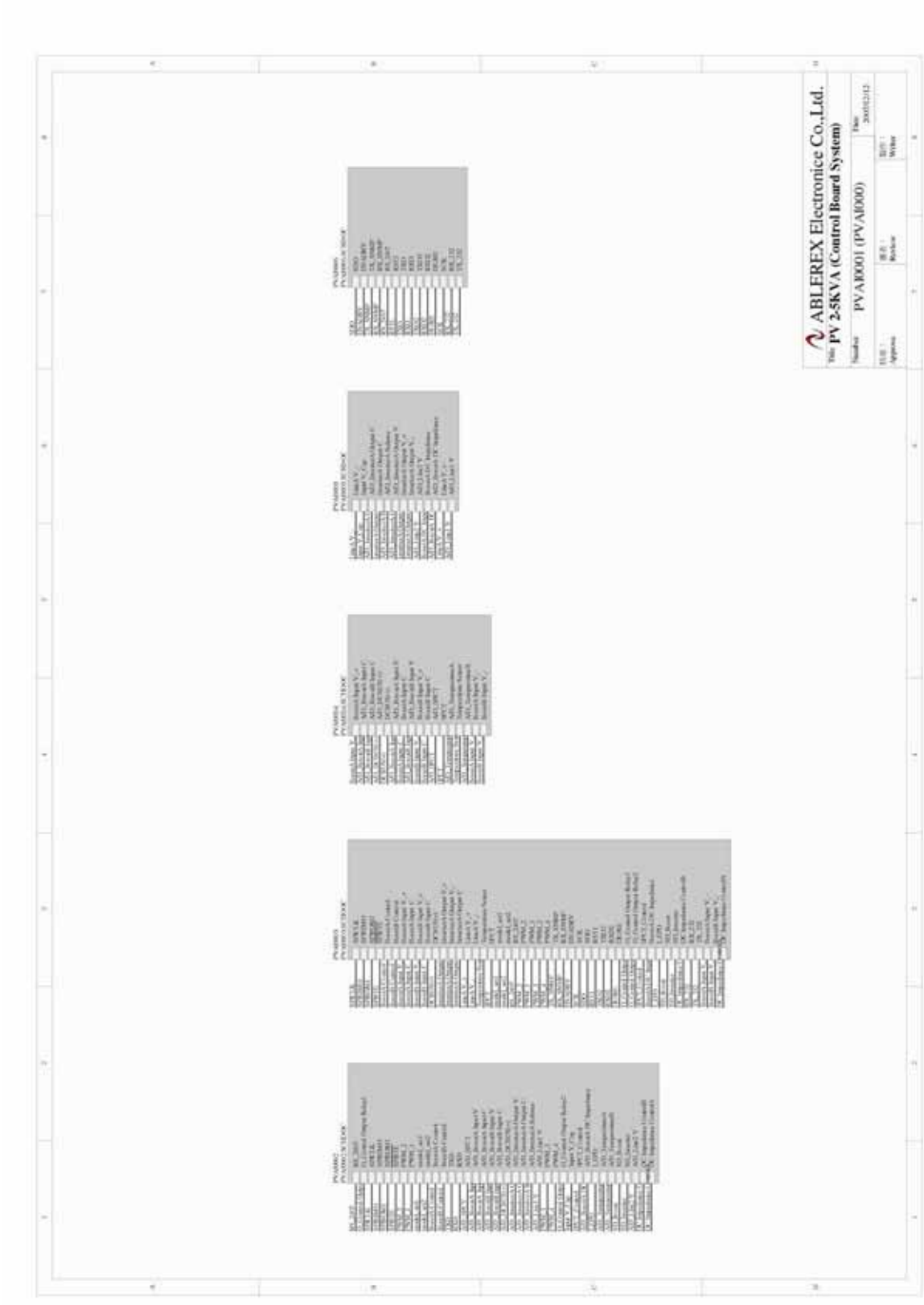
Figure 6 – Test device to verify protection against water jets (hose nozzle)

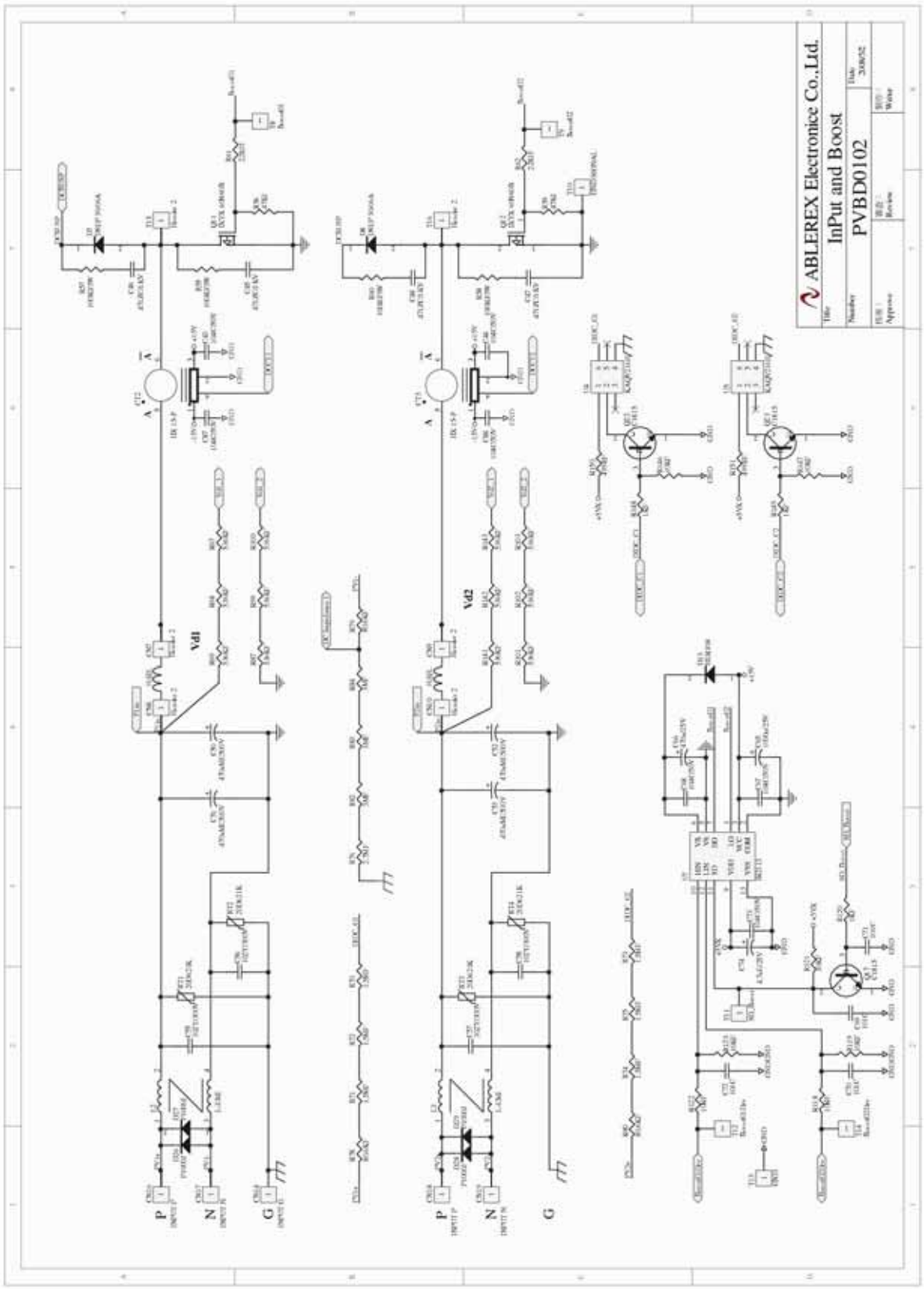
Annex No. 3
Schematics, Layouts, Transformer drawings

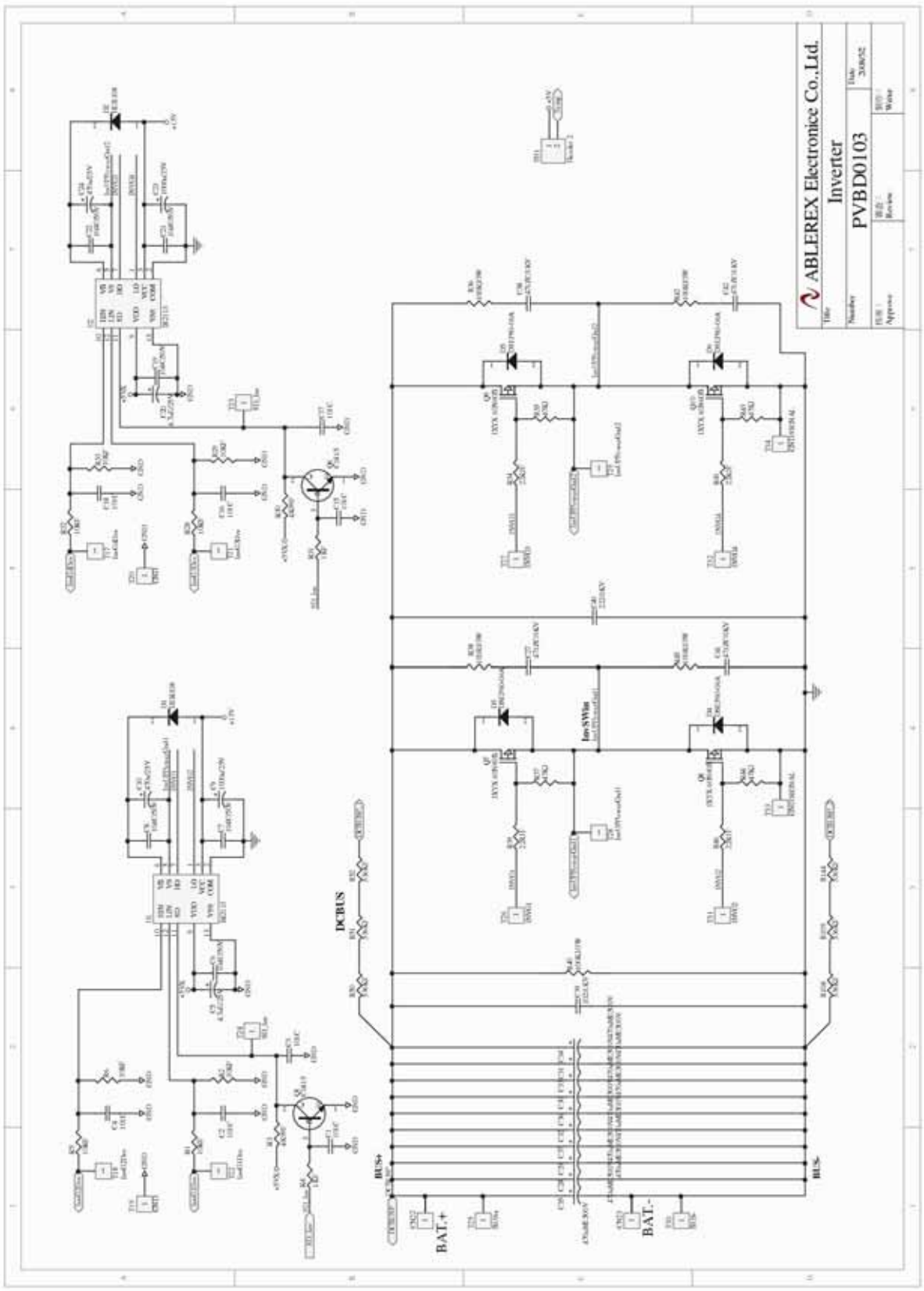
ES2200 / ES3300 / ES4400 / ES5000

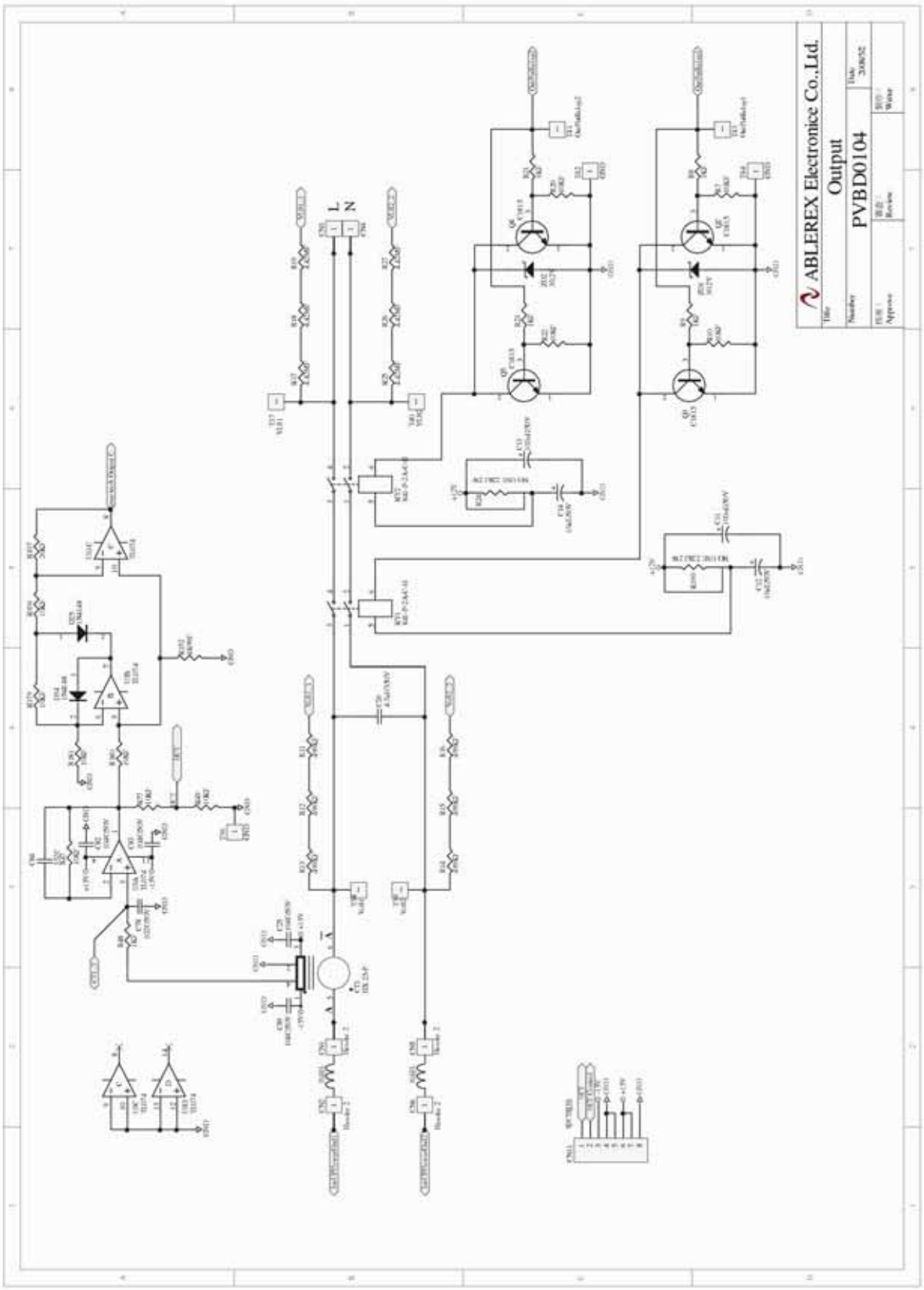
Schematic

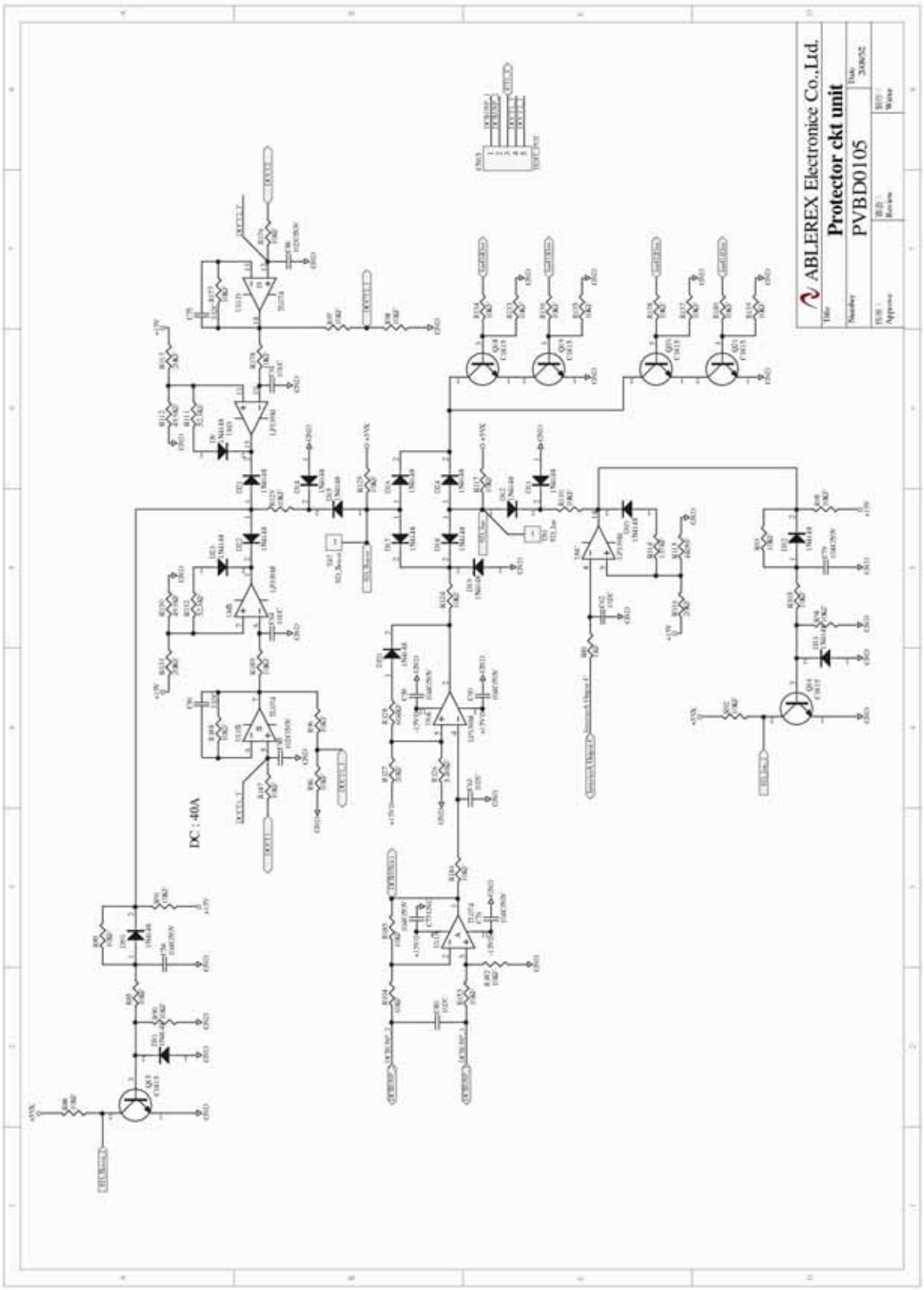
Main Board



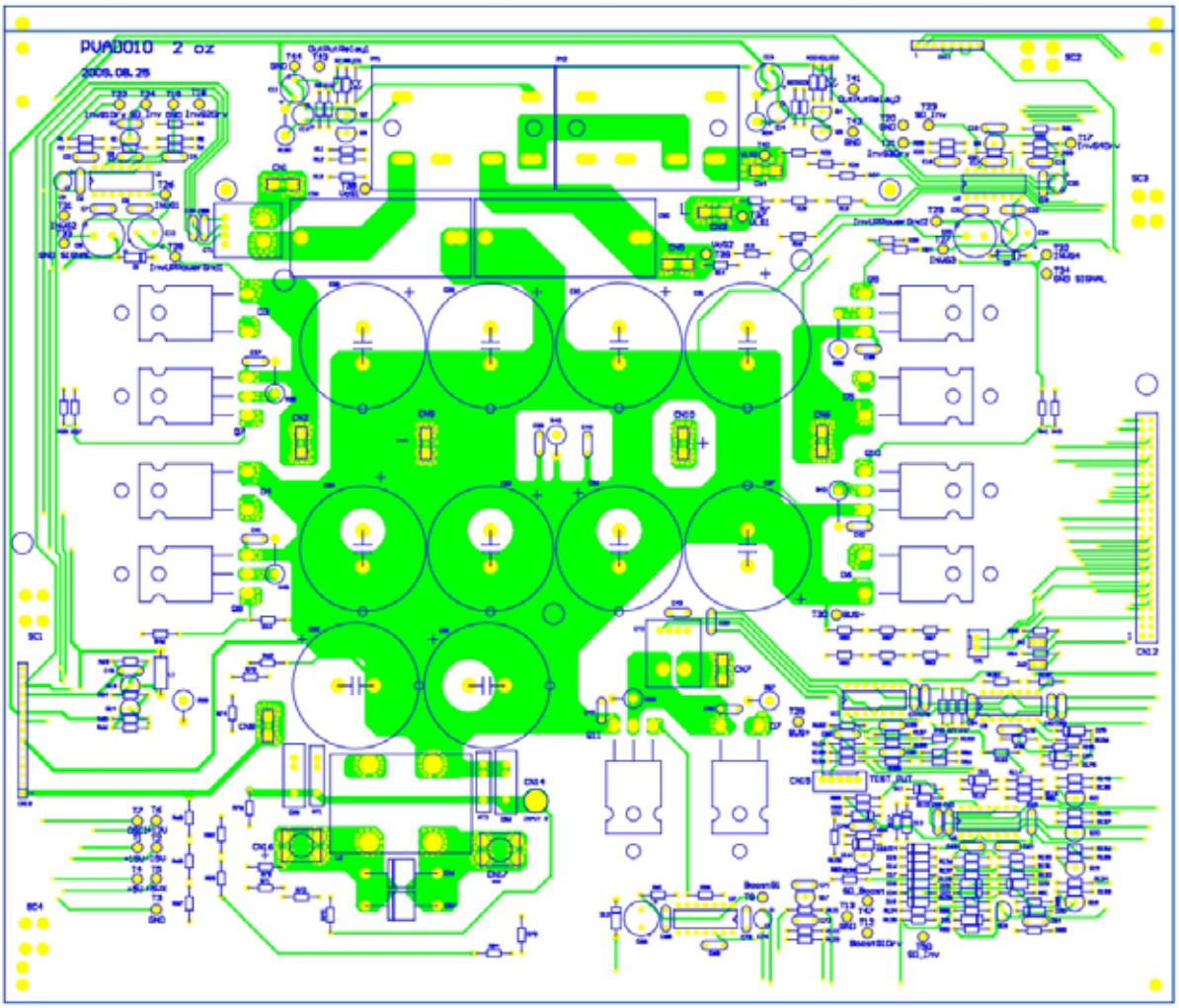

ABLEREX Electronics Co.,Ltd.
InPut and Boost
PVBD0102
Vd1
Vd2
P
N
G


ABLEREX Electronics Co.,Ltd.
Inverter
PVBD0103
DCBUS
BAT.+
BAT.-

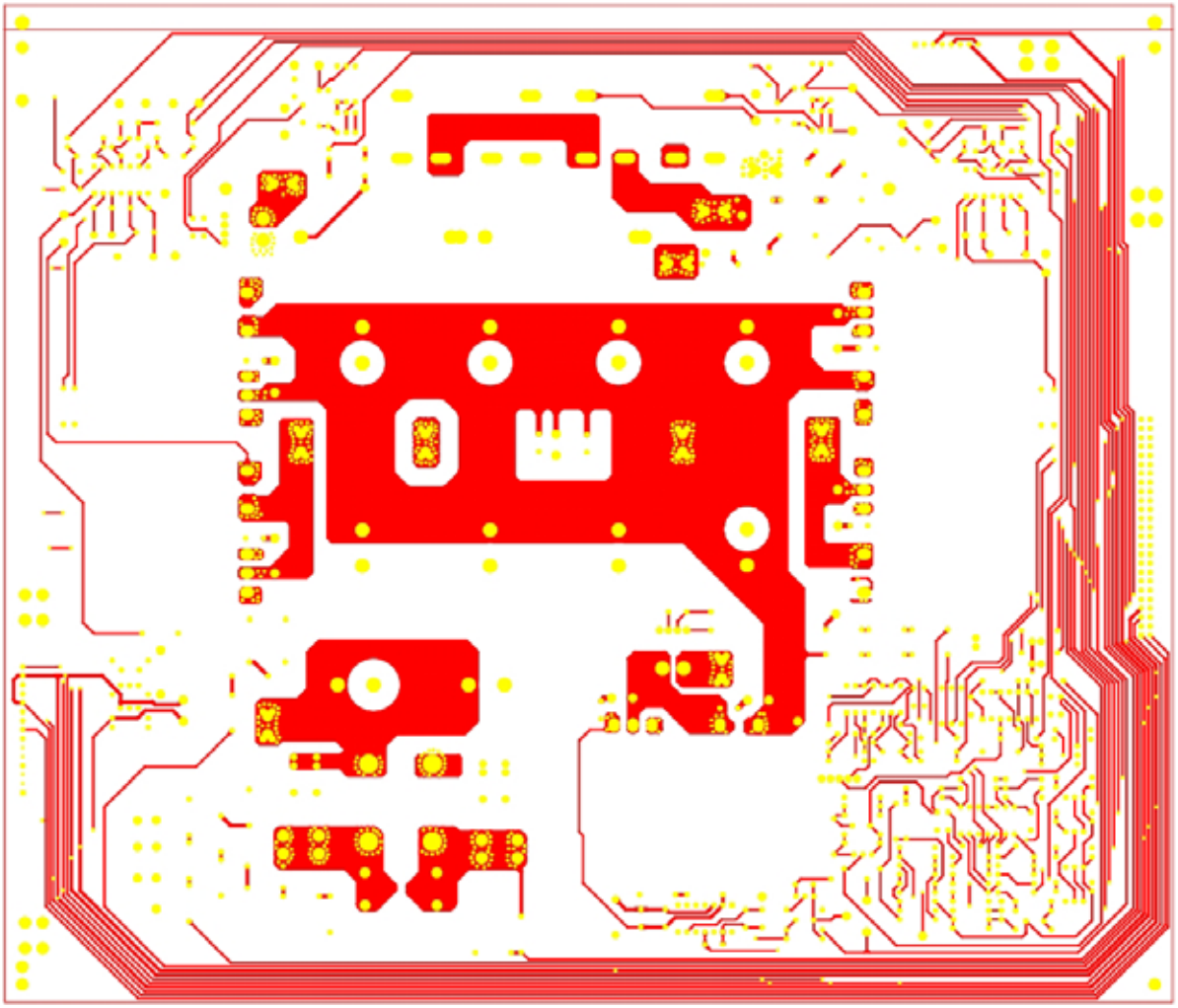

ABLEREX Electronics Co.,Ltd.
Output
PVBD0104
L
N


ABLEREX Electronics Co.,Ltd.
Protector ckt unit
PVBD0105
DC : 40A

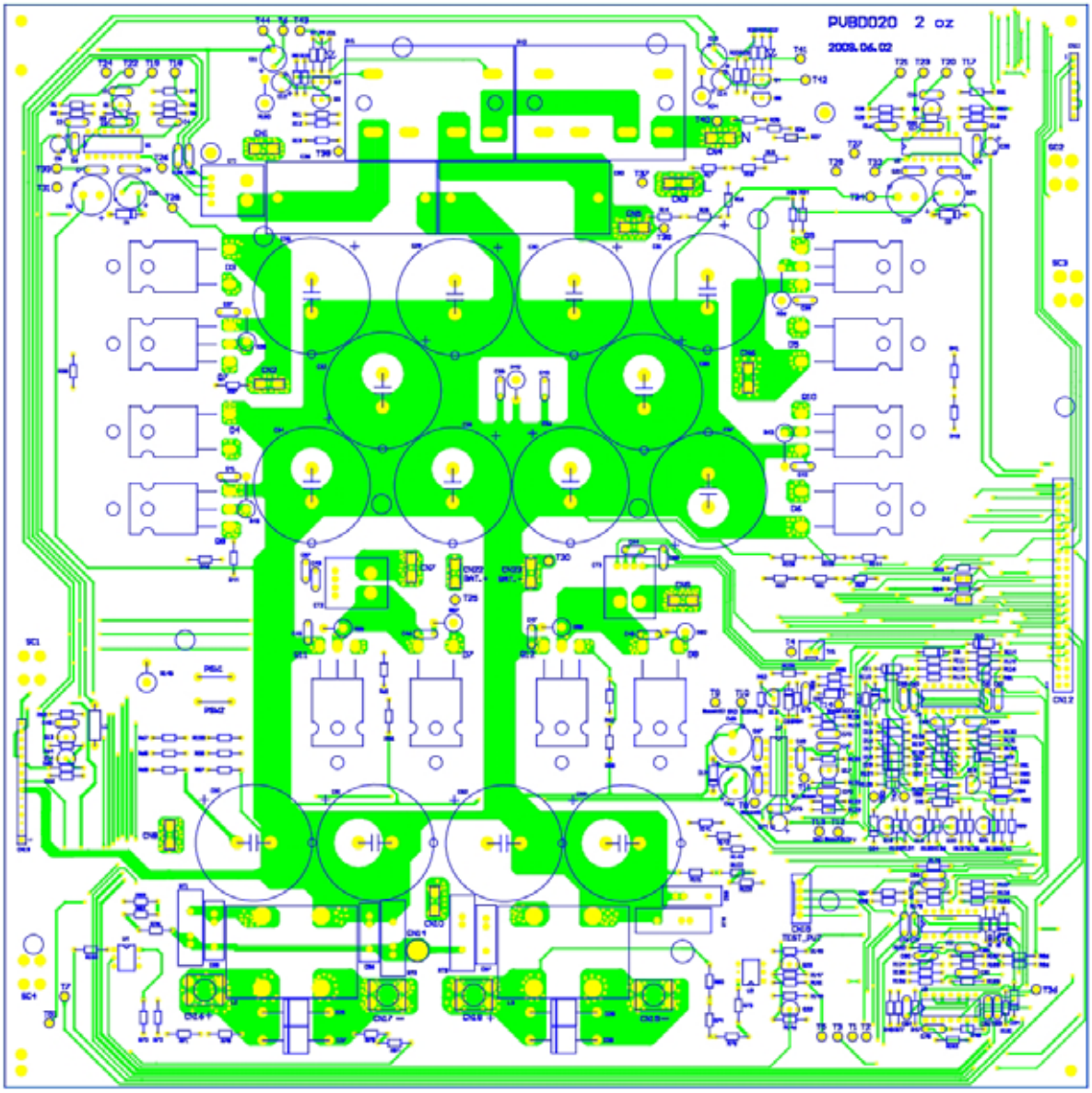
ES2200 / ES3300
Top Side (PVAD010)



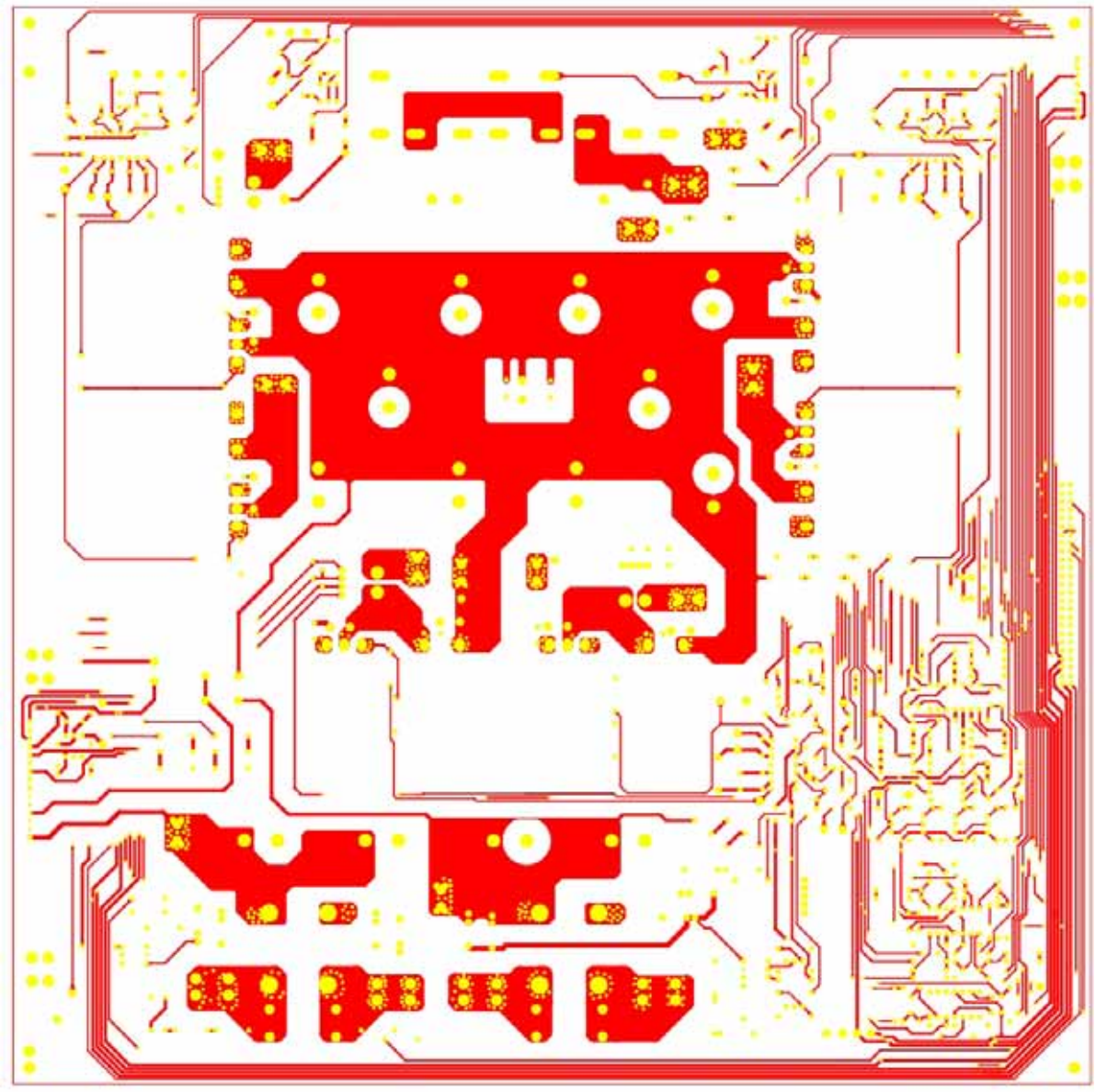
Bottom Side (PVAD010)



ES4400 / ES5000
Top Side (PVBD020)

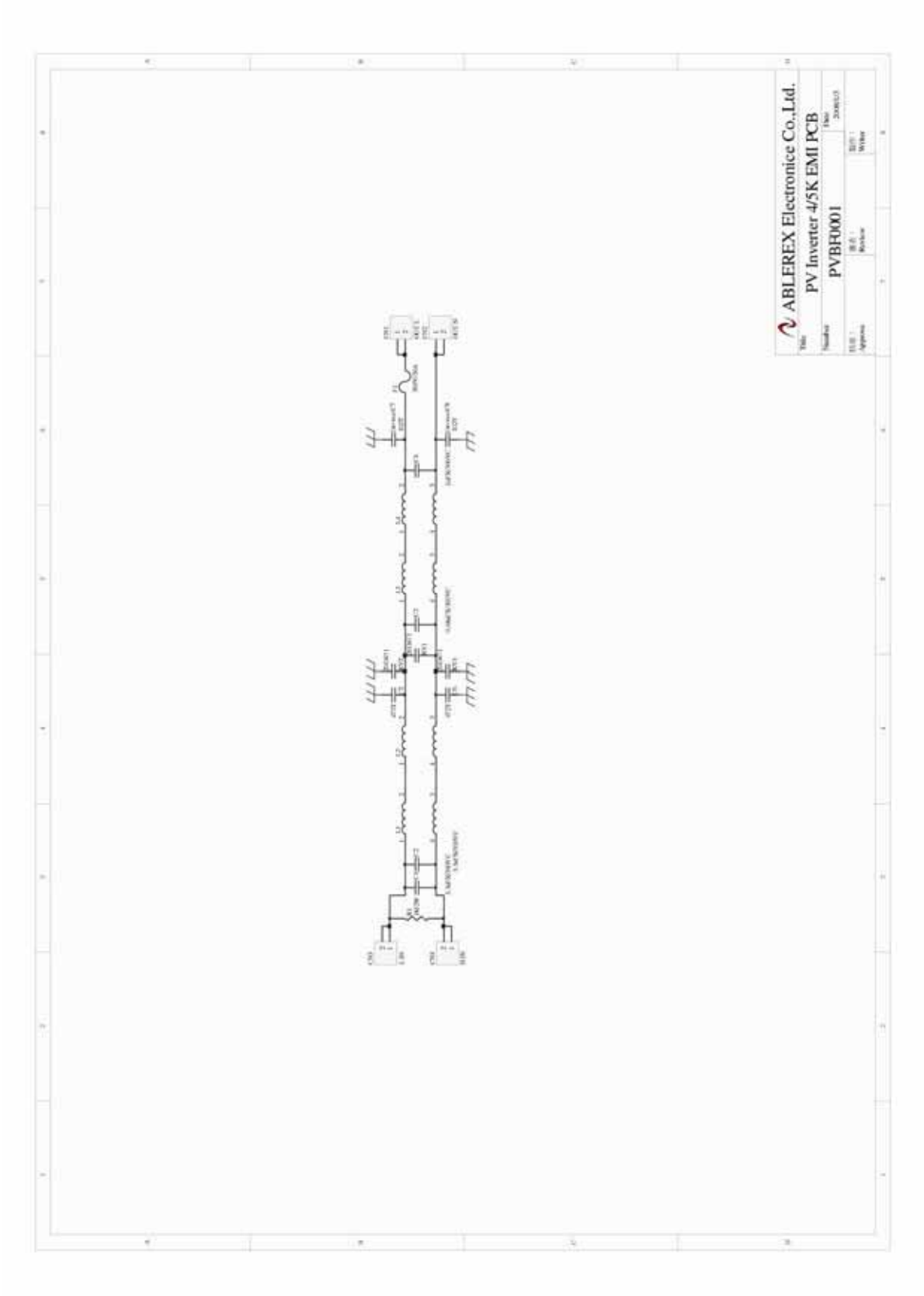


Bottom Side (PVBD020)

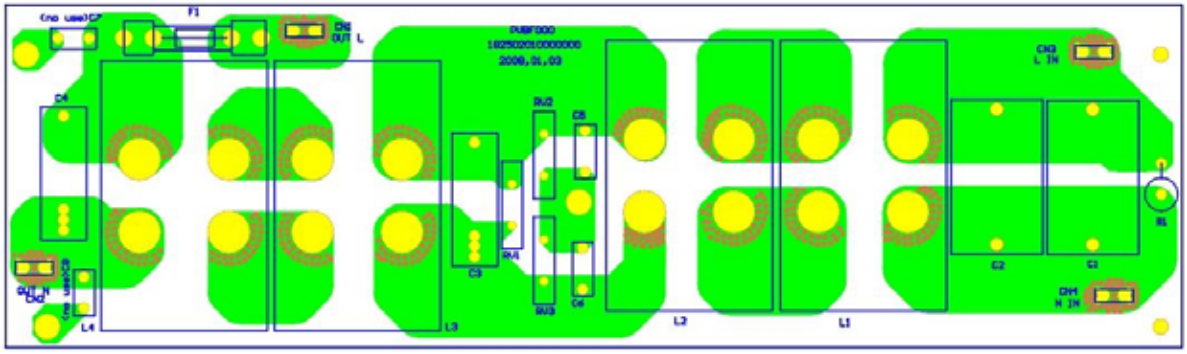


ES2200 / ES3300 / ES4400 / ES5000

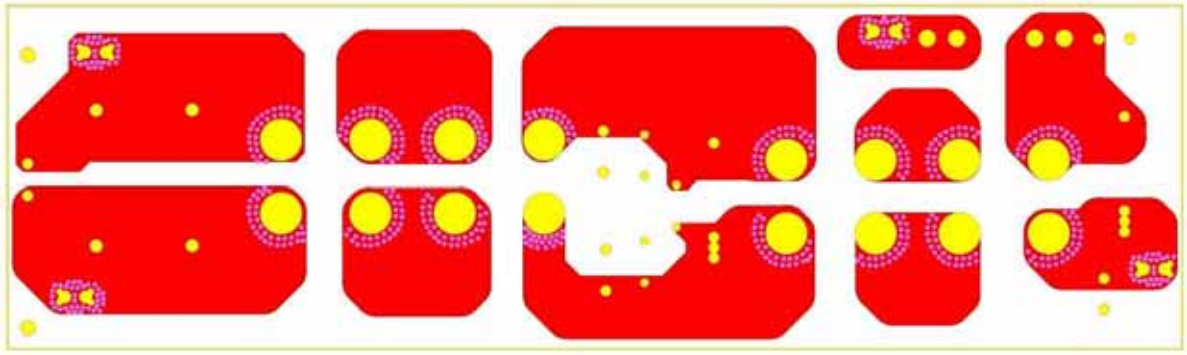
EMI Board (PVBF000)



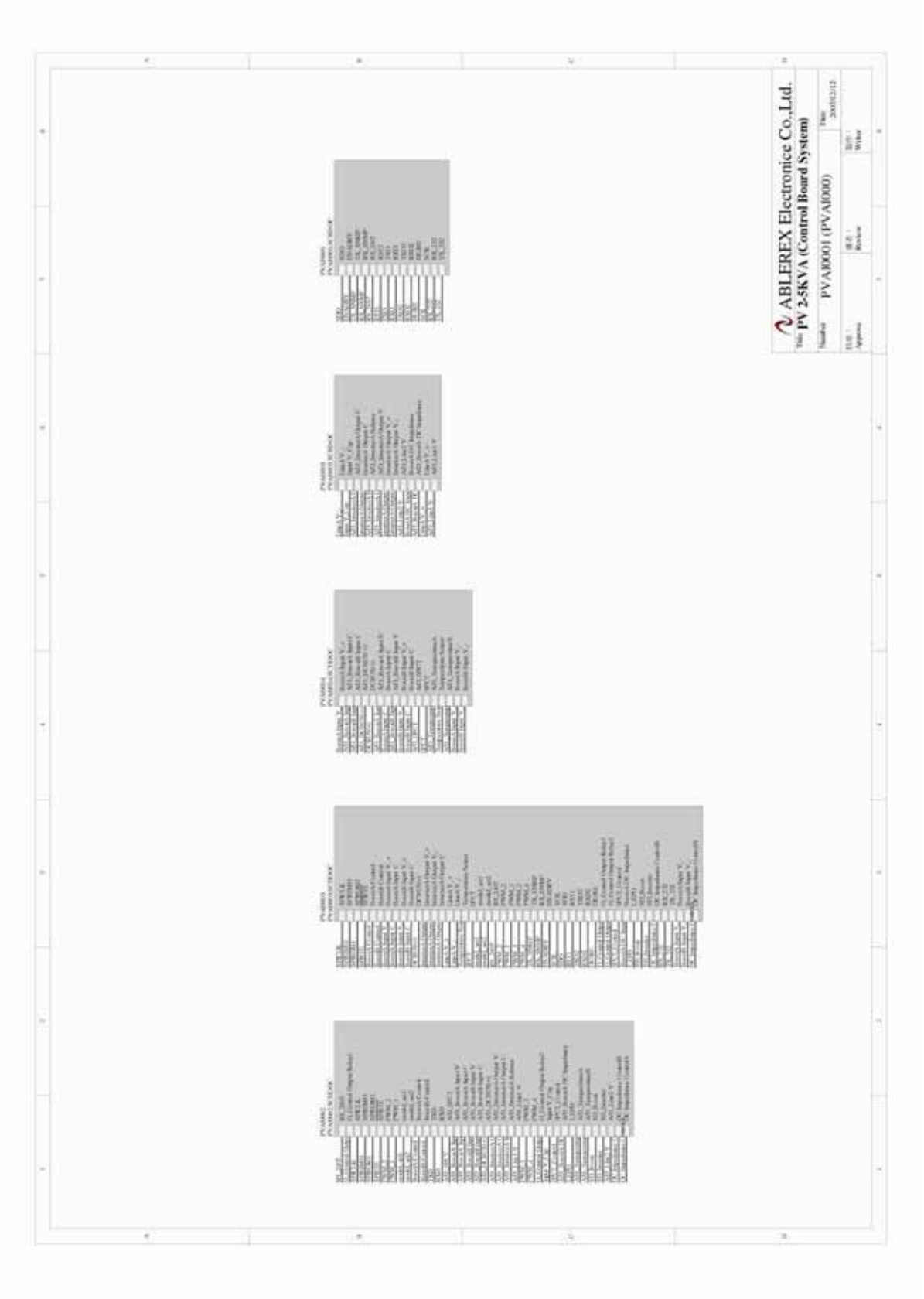
Top Side (PVBF000)

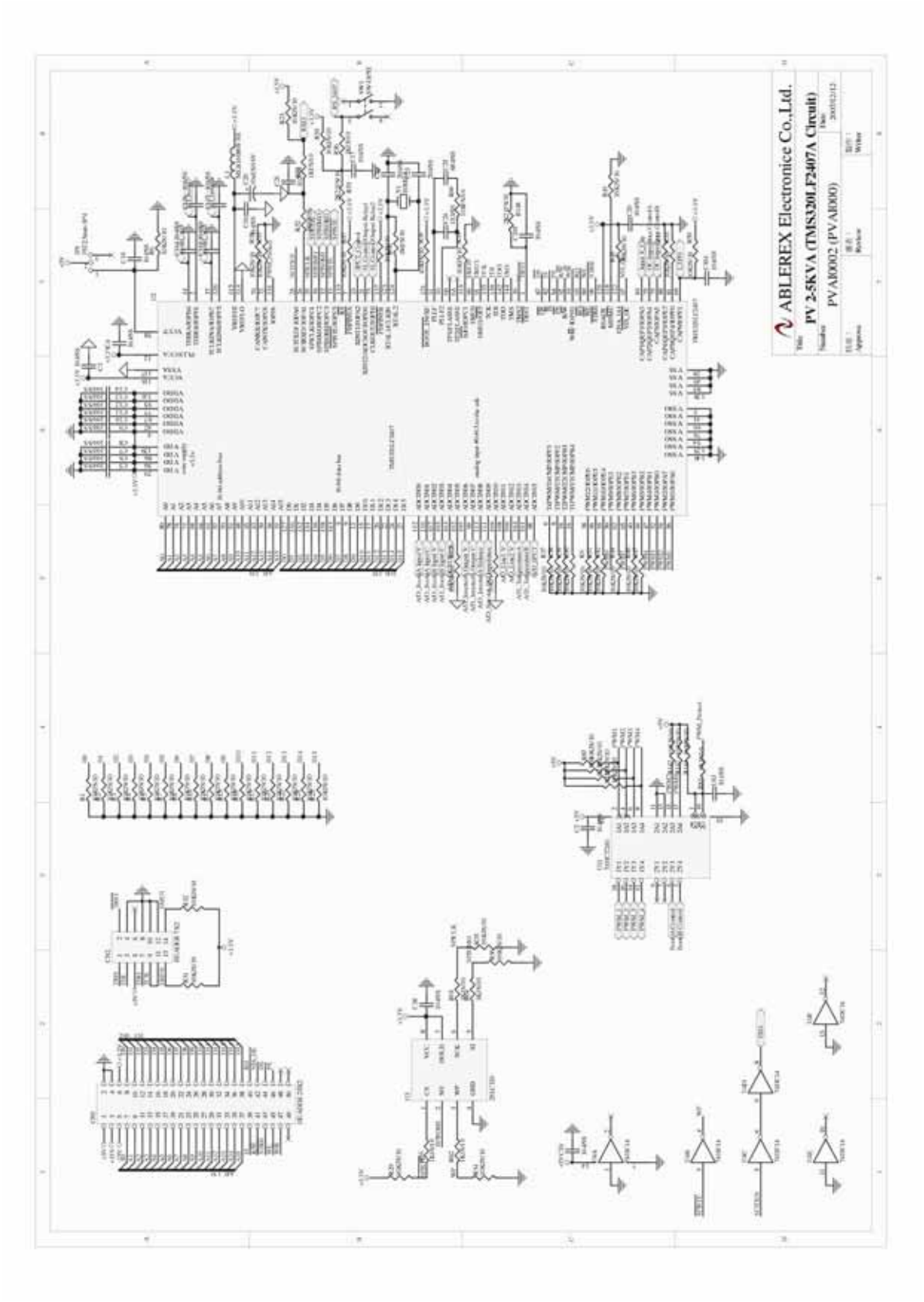


Bottom Side (PVBF000)



Control Board (PVAI032)

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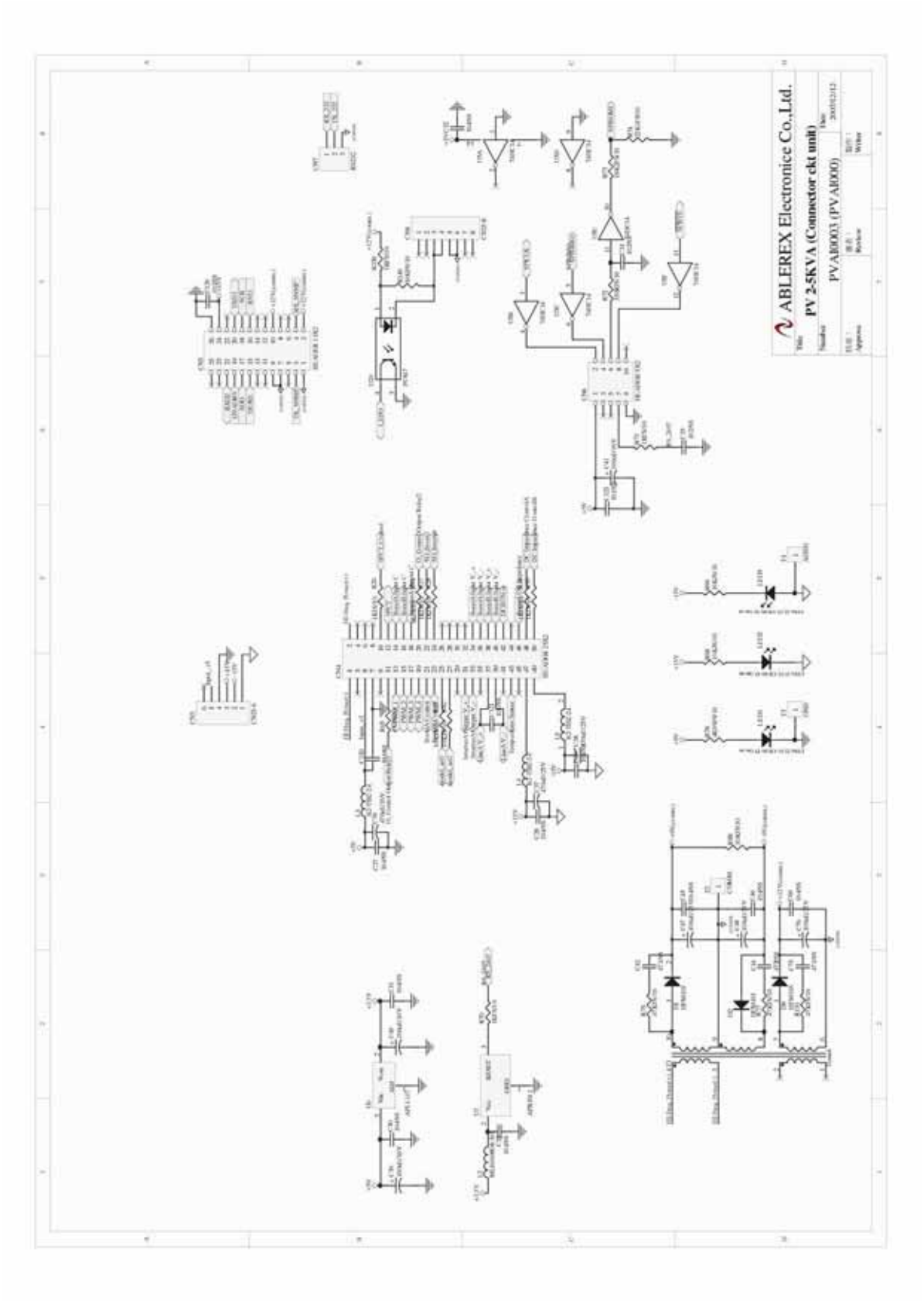
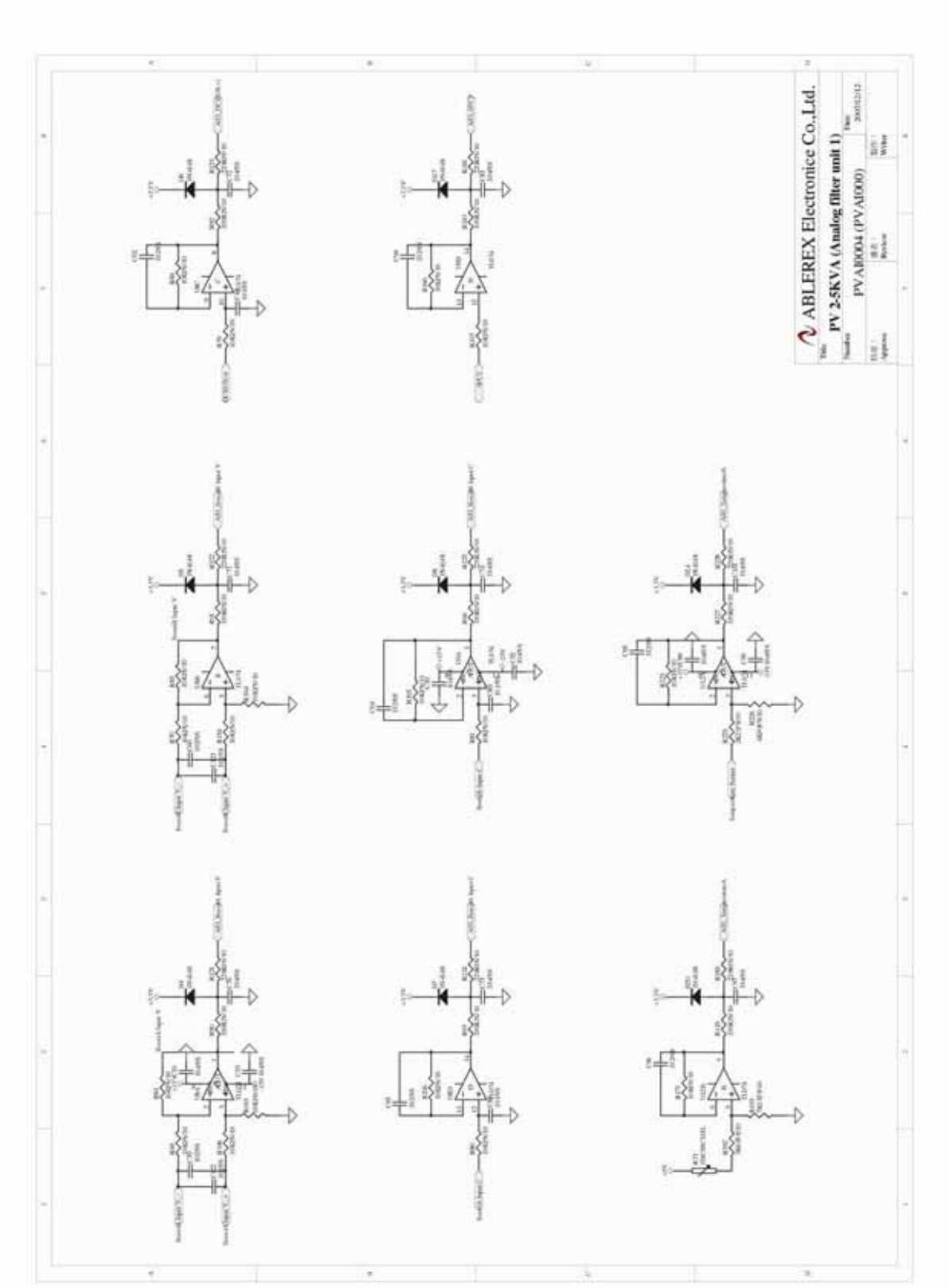
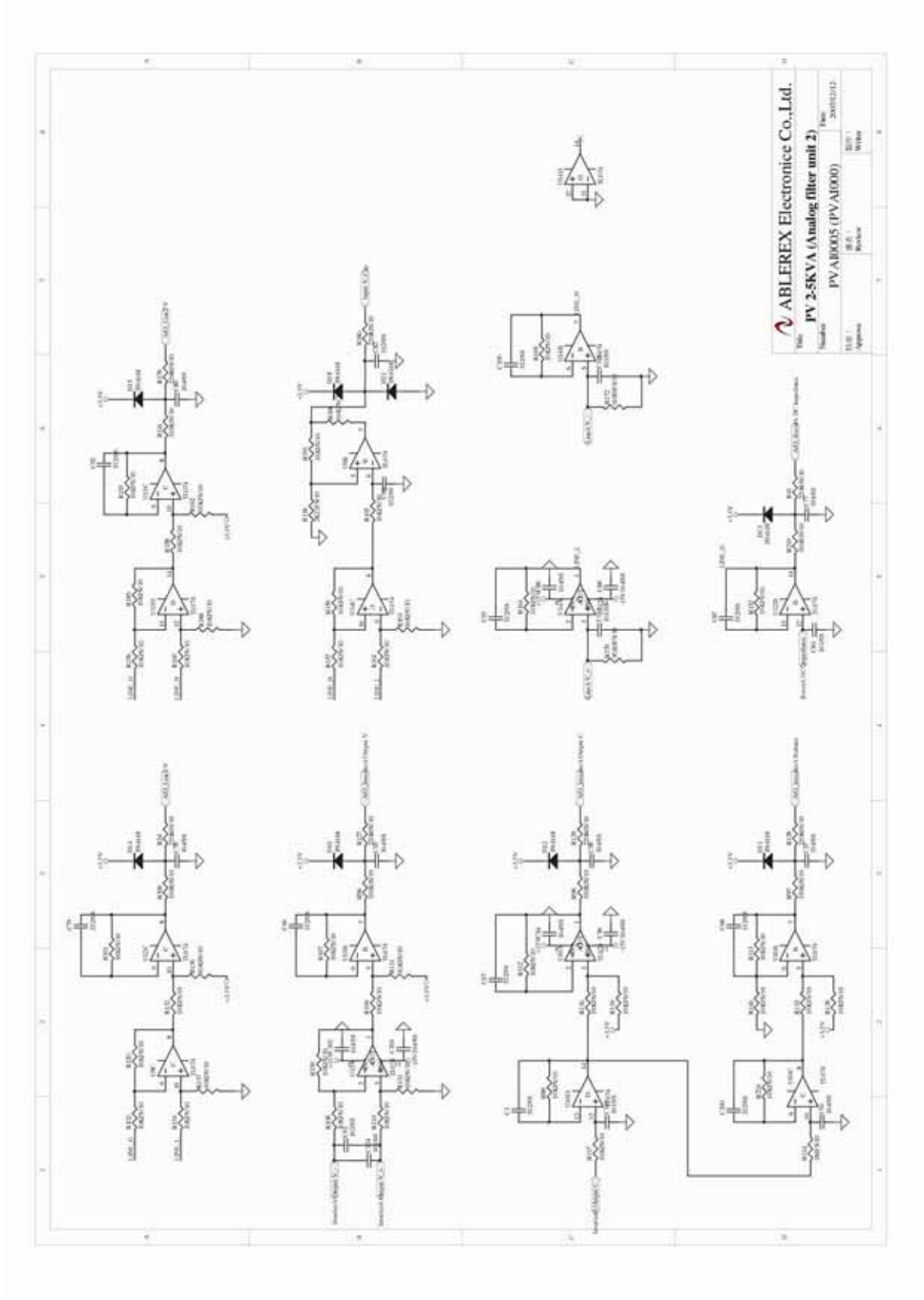
PV 2-5KVA (TMS320LF2407A Circuit)
PVA0002 (PVA0000)


ABLEREX Electronice Co.,Ltd.
PV 2-5KVA (Connector ckt unit)
PVAB003 (PVAB000)


ABLEREX Electronice Co.,Ltd.
PV 2-5KVA (Analog filter unit 1)
PVAB004 (PVAI000)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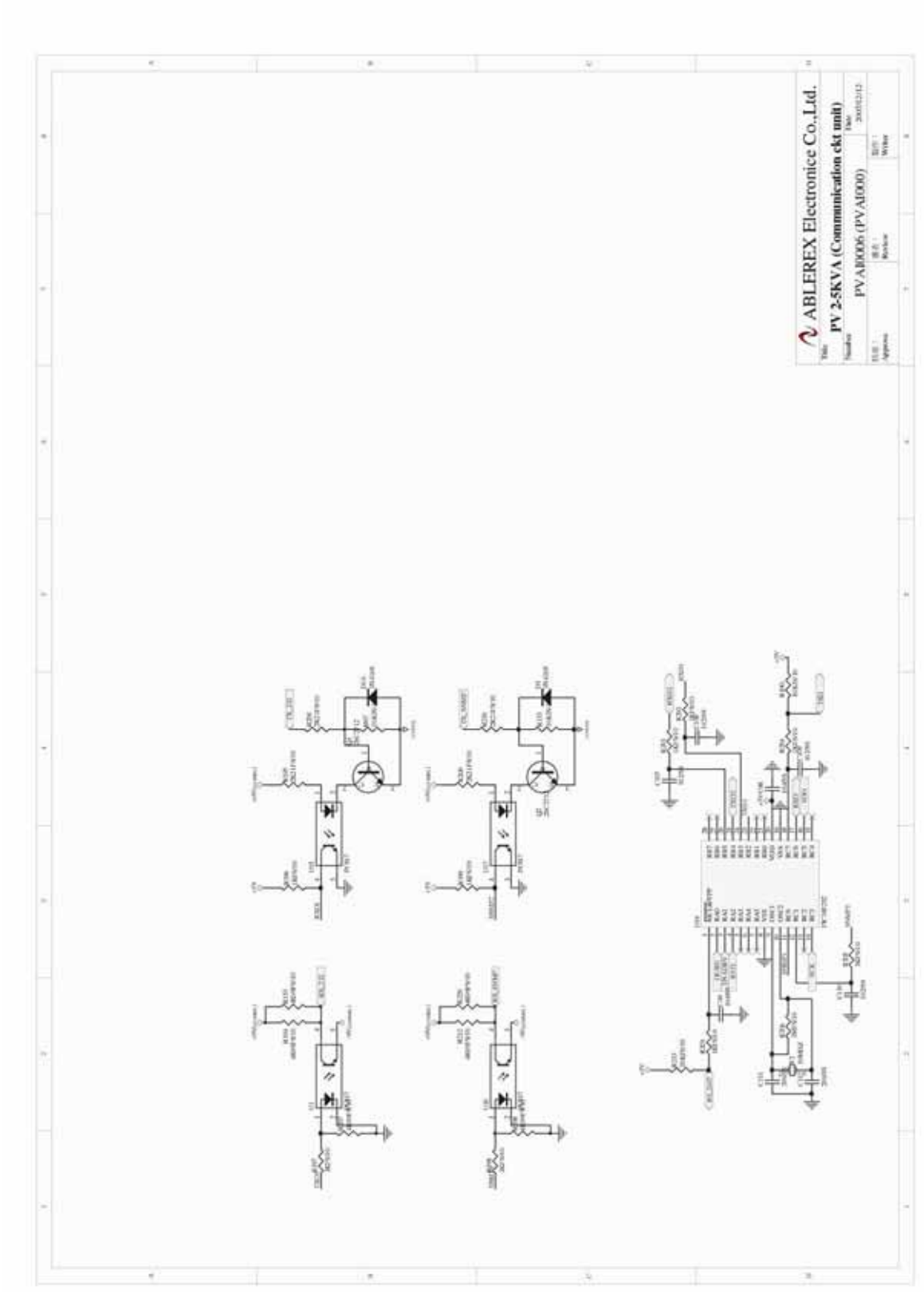
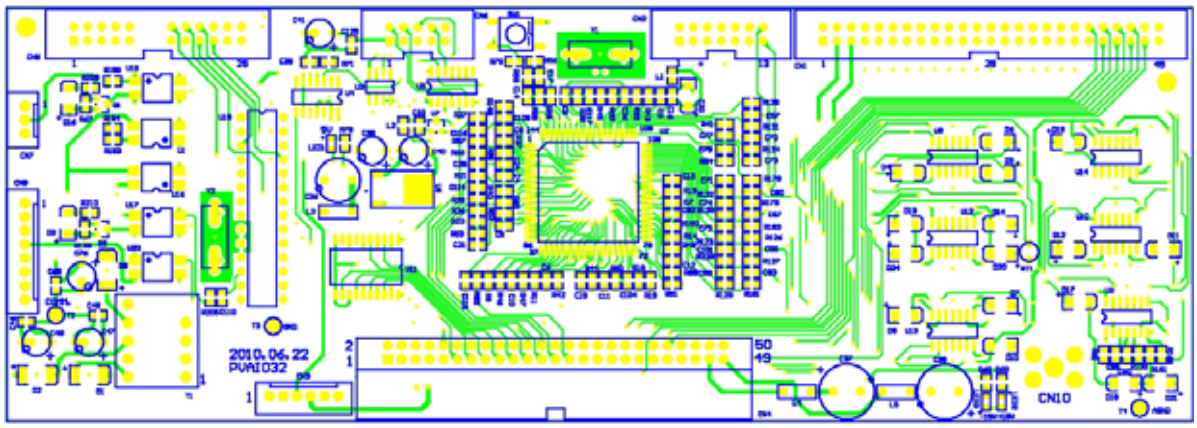
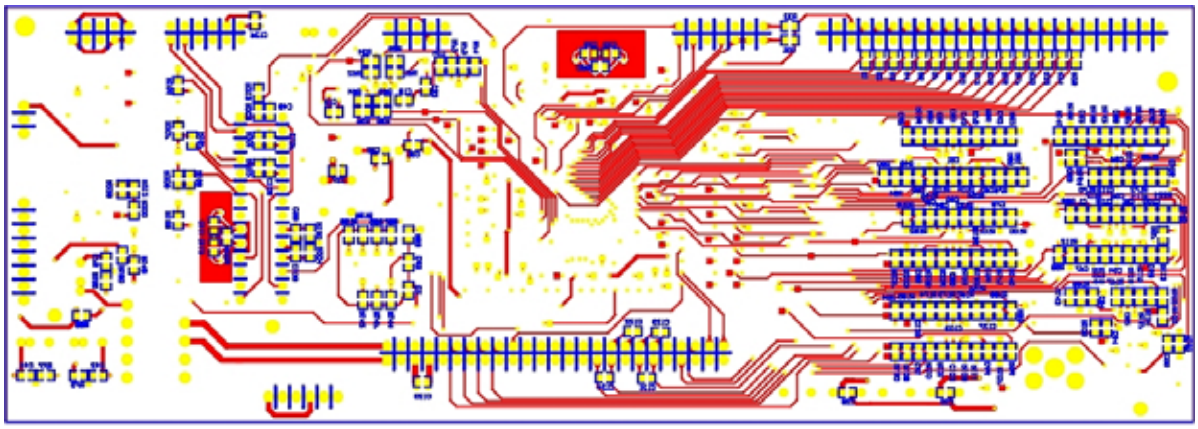
PV 2-5KVA (Analog filter unit 2)
PVAB0005 (PVAI000)


ABLEREX Electronice Co.,Ltd.
PV 2-5KVA (Communication ckt unit)
PVAB0006 (PVAI000)

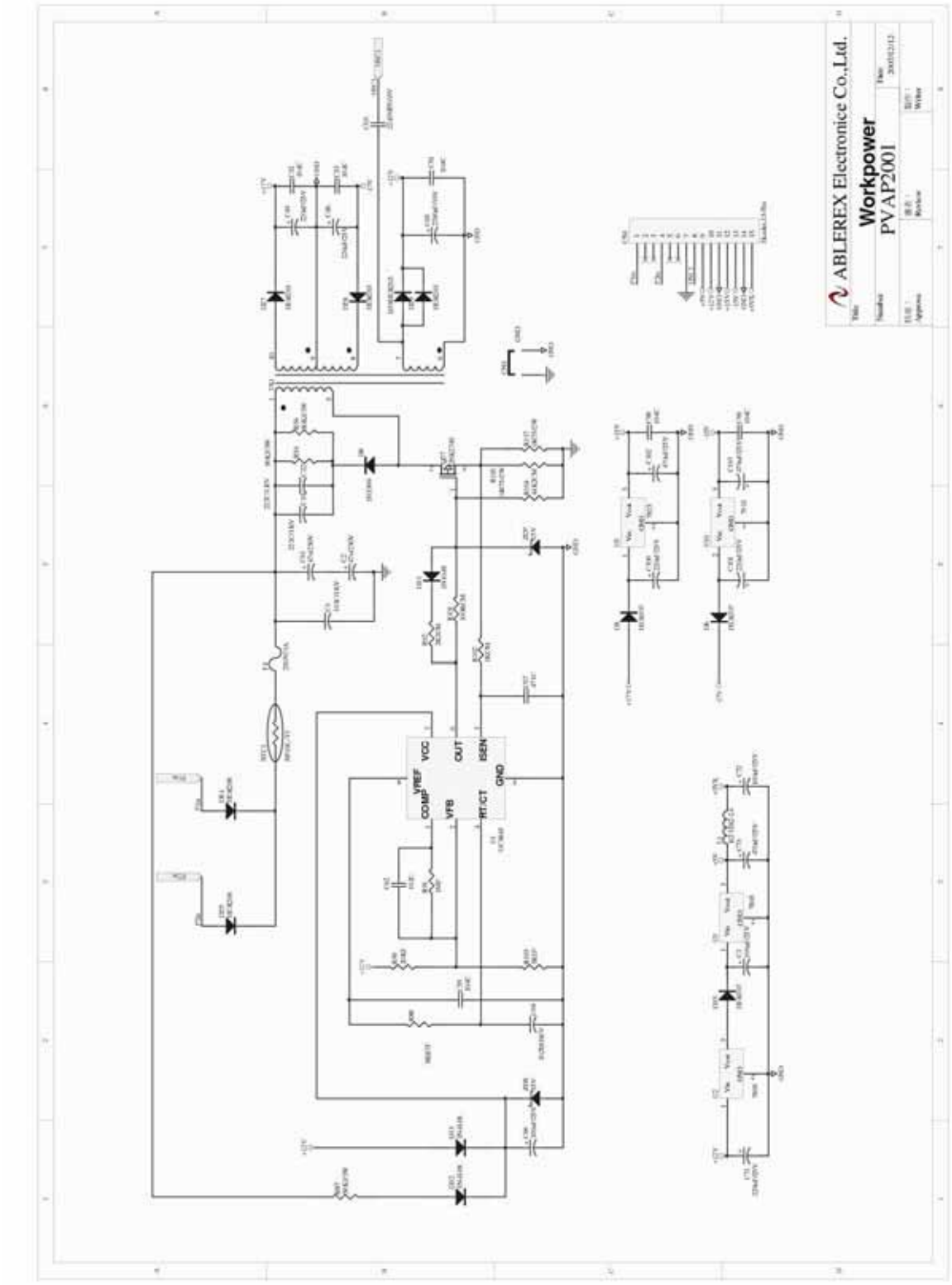
Top Side (PVAI032)



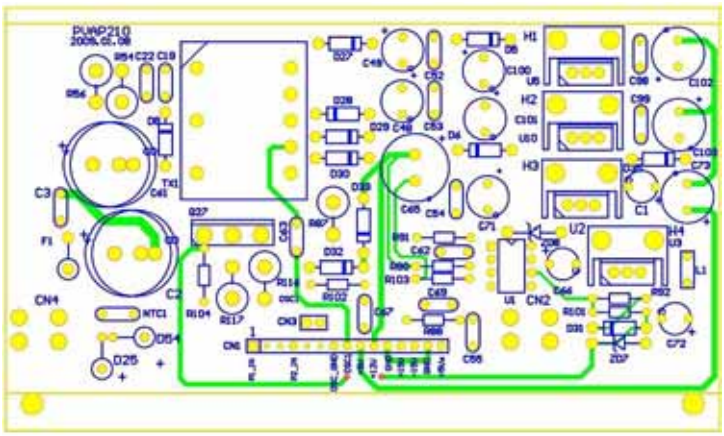
Bottom Side (PVAI032)



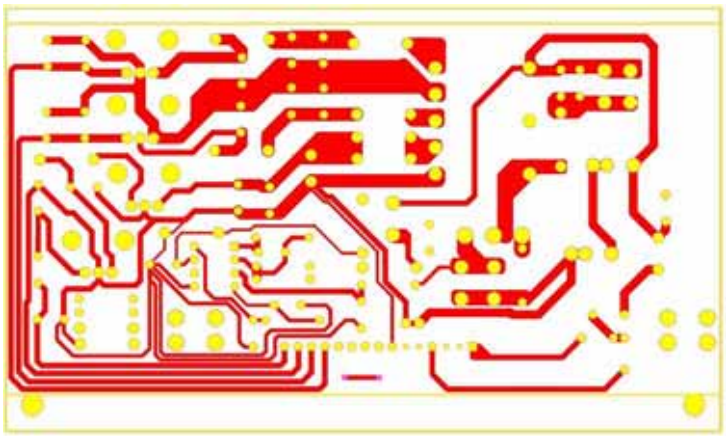
Workpower Board (PVAP210)



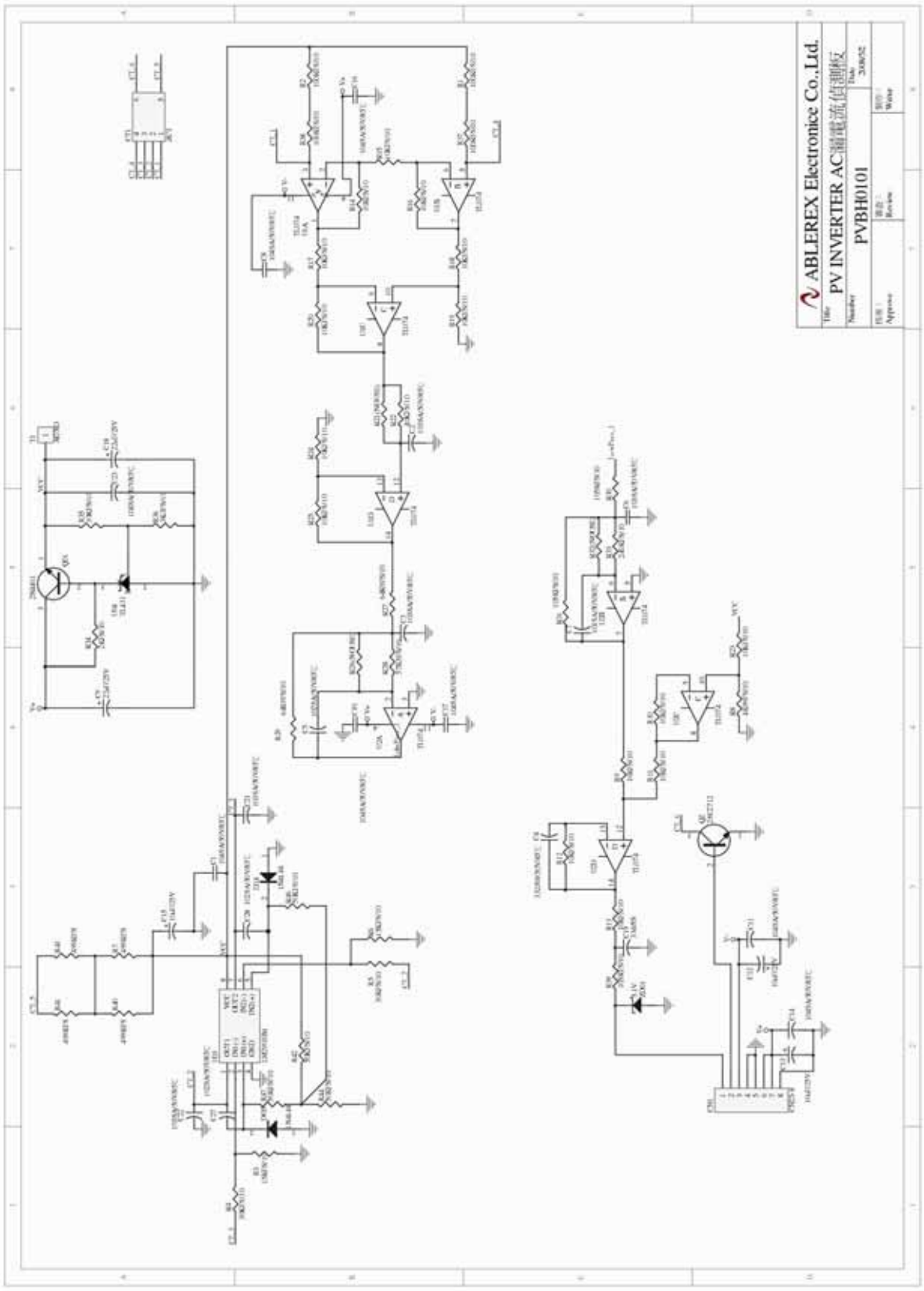
Top Side (PVAP210)



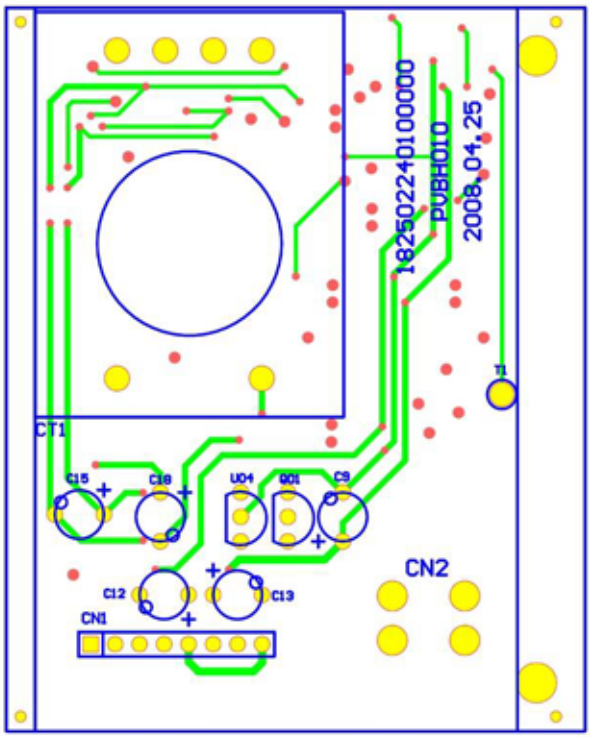
Bottom Side (PVAP210)



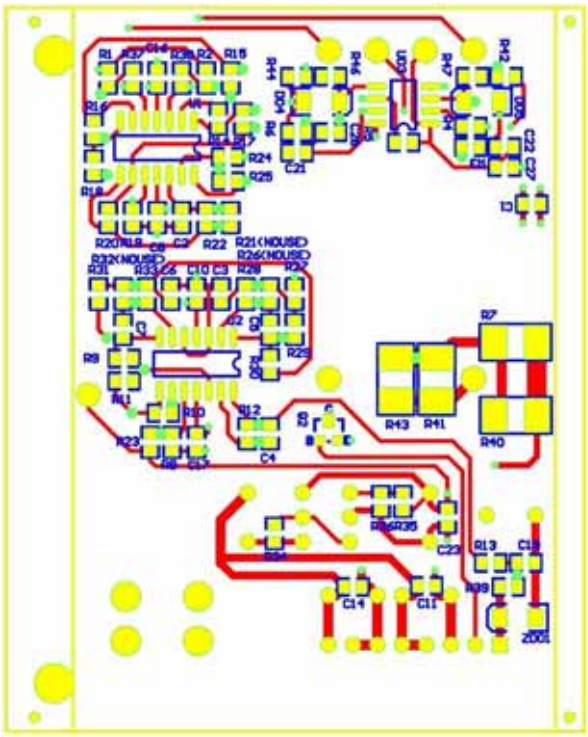
Zero Control Board (PVBH010)



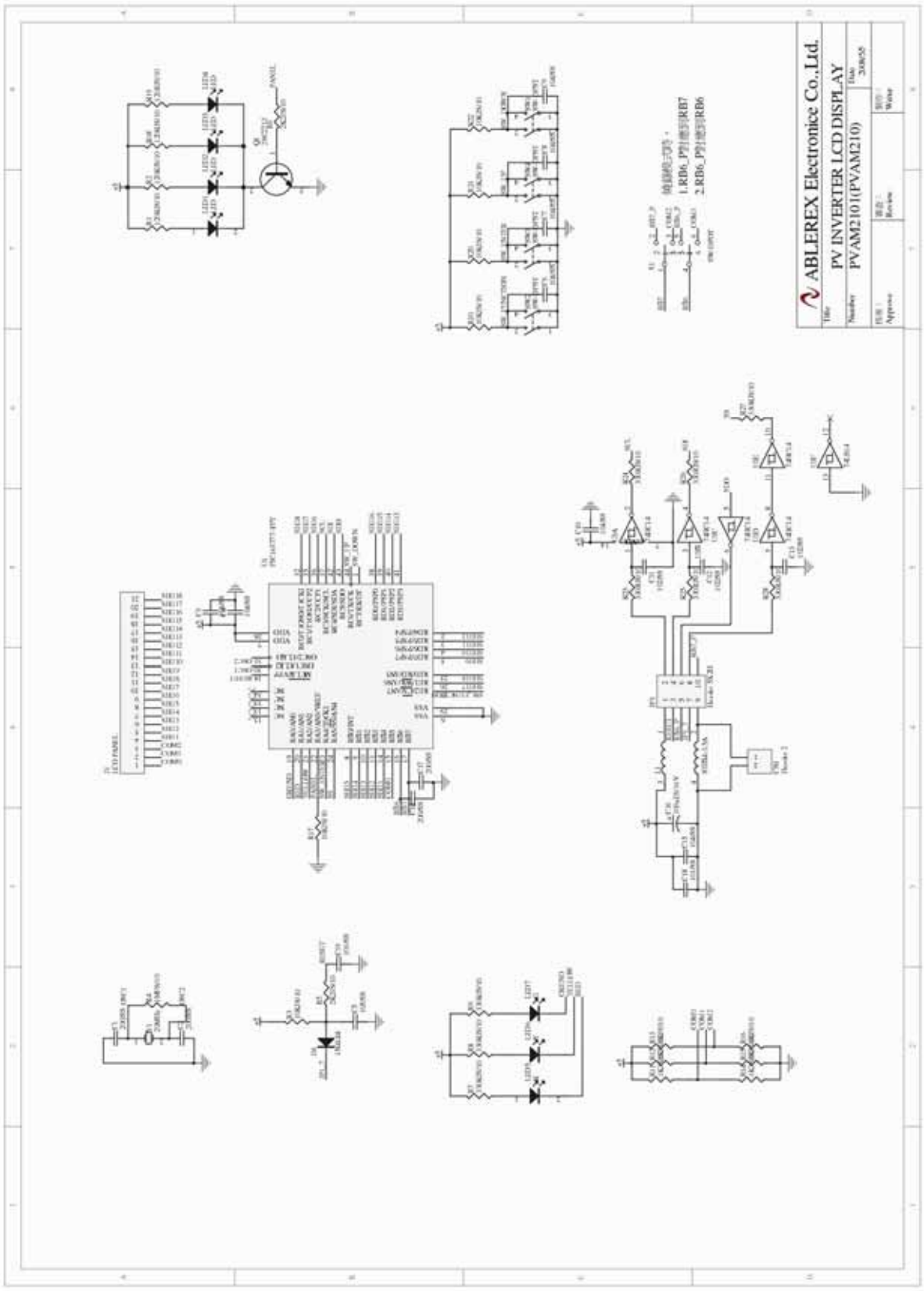
Top Side (PVBH010)



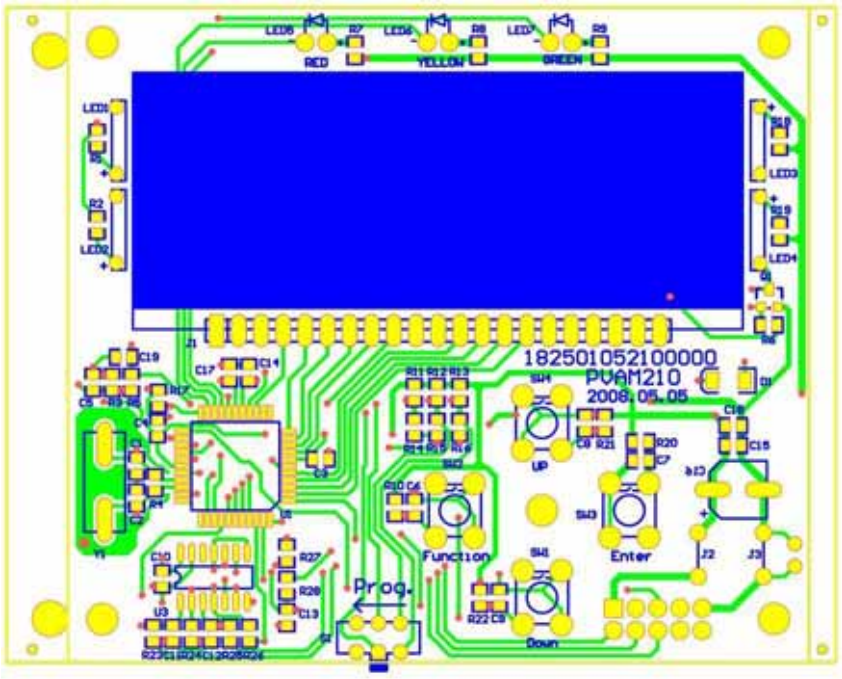
Bottom Side (PVBH010)



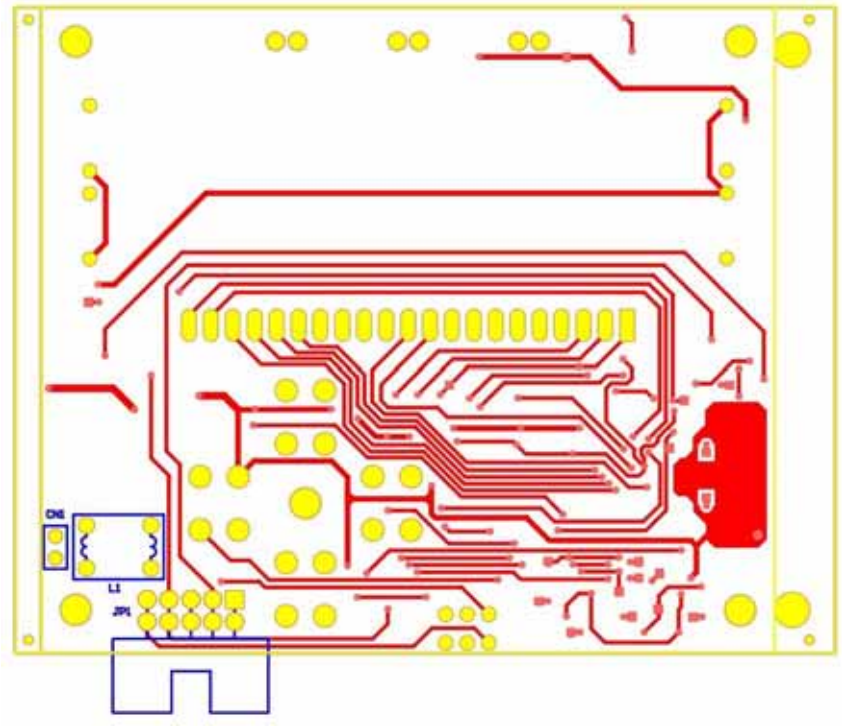
Display Board (PVAM210)



Top Side (PVAM210)



Bottom Side (PVAM210)



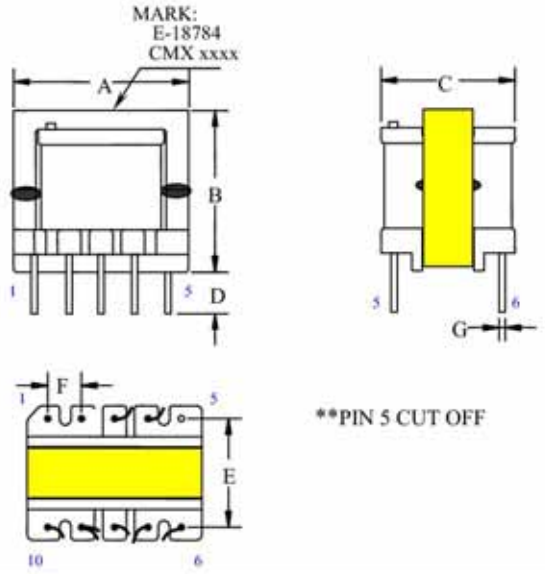
Tramsformer T1

Datasheet

SPECIFICATION FOR APPROVAL

CUSTOMER：盈 正 豫 順	ITEM： EE-16 X'FMR	P/N：

Mechanical Assembly：



A	17.5 MAX	mm
B	17.5 MAX	mm
C	15.0 MAX	mm
D	3.8 +/- 0.5	mm
E	10.4 +/-0.5	mm
F	3.25 +/-0.5	mm
G	0.6ϕ +/- 0.5	mm
H		mm
I		mm
J		mm
L		mm
W		mm

ELECTRICAL REQUIREMENTS

	L(uH)	DCR(Ω)
L(4– 3)	300 +/- 5 %	2 .2 MAX
L(7-6)	268 uH REF	2.5 MAX
L(9-8)	83.4uH REF	3.1 MAX
L(10-9)	192 uH REF	4.8 MAX

TEST INSTRUMENTS：
(1) HP- 4284A
HP- 42841A
@ 40KHz/1V AT 25℃
(2) ZT-301A
ZT-9072A

APPROVED BY	MODEL NO.
Wu Hong Xi	
CHECKEED BY	
Chen Shiming	CORMEX NO.
REPORTED BY	E-18784
Song Degen	(XE18784000)

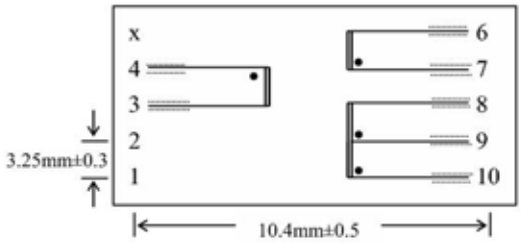
CORMEX ELECTRONICS IND. CO., LTD.

CUSTOMER: 盈正豫順

P/N: D/N: E-18784 (XE18784000) DATE: JUL. 21, 2010 GAP:0.1mm REF

1. CORE：EE-16-NH2B, EE-16/14- JPP4 , FEE-16-NC-2H
   EE-16-DMR40 ,EE1614-LP3,EE16-ZP40,EE-16-M2.3K
2. BOBBIN： BOEI160400
3. SCHEMATIC：

(BOTTOM VIEW)



(PIN 5 CUT OFF)

4. WINDING FIGURE：

PLOYESTER FILM TAPE (LAYERS)

xx	10 – 9：CU-0.1 ψ(2UEW-Y) x 1P x 44 Ts 并 9 – 8：CU-0.1 ψ(2UEW-R) x 1P x 29 Ts 繞	xx	x3
xx	7 – 6：CU-0.14(2UEW-Y) x 1P x 52 Ts	xx	x1
xx	4 – 3：CU-0.14 ψ(2UEW-Y) x 1P x 55 Ts	xx	x3
	BOBBIN		
3.0mm		3.0mm	

** 引線均套 Teflon Tube，且套管長度需 6mm MIN

** "xx"表示 R44-3.0mm

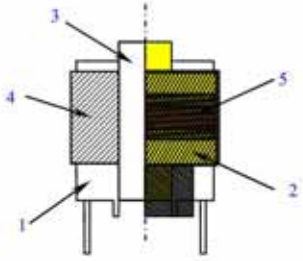
5. CHARACTER ISTICS： @ 40KHZ/1V（25℃）
   Lp(4 – 3)：300uH+/-5% DCR(4 – 3)： 2.2Ω MAX

6. HI-POT TEST：
   (1) PRI(3) TO SEC(7,10)： 3000Vac, 60Hz,3mA, 1MIN
   (2) WINDING (3) TO CORE： 1500Vac, 60Hz, 3mA, 1MIN
   (3) WINDING (7,10) TO CORE ： 1000Vac, 60Hz, 3mA, 1MIN
   (4) WINDING (7) TO WINDING (10) ： 500Vac, 60Hz, 3mA, 1MIN

MATERIAL LIST

Component	Manufacturer	Material	Note	UL File No
Core (Mn-Zn)	A-CORE ELECTRICAL CO.,LTD. DONG YANG DMEGC MAGNETICS CO.,LTD. Nippon Ceramic Co., Ltd. ZHEJIANG HAINING LIANFENG MAGNET INDUSTRY CO. , LTD NAN TONG ZHONGXING MAGNETIC INDUSTRIAL CO.,LTD New Conda Magnetic Industrial Co ., Ltd Su ZhouTian MingMagnetic Co . Ltd.	EE16/14-JPP-4 EE-16-DMR40 FEE-16-NC-2H EE16-NH2B EE16-ZP40 EE1614-LP3 EE-16-M2.3K		
Magnet Wire	PACIFIC ELECTRIC WIRE & CABLE CO LTD TAI-I ELECTRIC WIRE & CABLE CO LTD FENG CHING METAL CORP JUNG SHING WIRE CO LTD	MW75C(DD) MW75C(UEW) MW75-C(UEW , UEW-2) MW75C(UEW-4#)	130℃ 130℃ 130℃ 130℃	E84081 E85640 E172395 E174837
Bobbin	CHANG CHUN PLASTICS CO LTD	T375J	150℃	E59481
Insulating Tape	3M COMPANY ELECTRICAL MARKETS DIV (EMD) JINGJIANG YAHUA PRESSURE SENSITIVE GLUE CO LTD	NO.1350F-1 NO.CT(yellow)	130℃ 130℃	E17385 E165111
Margin Tape	3M COMPANY ELECTRICAL MARKETS DIV (EMD) JINGJIANG YAHUA PRESSURE SENSITIVE GLUE CO LTD	NO.44 NO.WF	130℃ 130℃	E17385 E165111
Tube	CHANGYUAN ELECTRONICS (SHENZHEN) CO LTD	PTFE CB —TT-S	200℃	E180908
Epoxy	DONGGUAN EATTO ELECTRONIC MATERIAL CO LTD	3300A-1/3300B-1 94V-0	130℃	E218090
Varnishes	JOHN C DOLPH CO WU JIANG TAIHU INSULATING MATERIAL CO LTD	BC-359 ET-90(a) MW28 ET-90(a) MW24	130℃ 130℃ 155℃	E317427 E228349

1. THE LEADWIRE TENSILE STRENGTH OF THE PRODUCTS SHALL BE WITHSTAND THE STATIC FORCE OF 1.0KG.
2. INSULATION RESISTANCE [I.R.] : 500V DC , 100M OHM MIN . BETWEEN WINDING TO CORE.
3. ISSECTION :
   - (1). BOBBIN
   - (2). INSULATING TAPE
   - (3). CORE
   - (4). MAGNET WIRE
   - (5). COPPER FOIL



檢 驗 記 錄 表

□IQC □PQC □OQC
□PRO □RD

檢驗編號：

第 1 次送樣

廠商/單位	盈正豫順	批 量	5PCS	檢驗時間	9:30	檢驗日期	10.07.17
料 號	E-18784	抽樣數	5PCS	允收水準	CRI.MAJ.MIN.	溫 度	25℃
品 名		單據編號		AC / RE	0/1	濕 度	70%

項 目	L (4-3)	L (7-6)	L (9-8)	L (10-9)	DCR(4-3)	DCR(7-6)	DCR(9-8)	DCR(10-9)
規 格	300uH±5%	268uH	83.4uH	192uH	2.2Ω	2.5Ω	3.1Ω	4.8Ω
上下限范圍	285-315	REF	REF	REF	MAX	MAX	MAX	MAX
測試條件	40KHz/V							
1	294.7	284.8	94.55	217.10	1.65	1.93	2.42	3.83
2	295.6	287.2	95.1	219.8	1.73	1.95	2.45	3.85
3	294.4	288.4	94.8	220.0	1.66	1.94	2.42	3.84
4	294.2	282.1	92.88	215.3	1.68	1.95	2.43	3.85
5	298.3	289.1	96.2	220.4	1.66	1.95	2.43	3.85
6								
7								
8								
9								
10								
$\overline{X}$	295.44	286.32	94.71	218.52	1.68	1.94	2.43	3.84
R	4.10	7.00	3.32	5.10	0.08	0.02	0.03	0.02

檢驗項目	檢驗數	不良數	不 良 內 容	判 定		處 理
				合 格	不合格	□ 允 收
電氣特性	5PCS	0		OK		□ 拒 收
相位	5PCS	0		OK		
耐壓	5PCS	0		OK		

備注：

1:ZT-1320 HP-4284A @40KHZ/1V
2:CORE:EE16-NH2B
3:BOBBIN:BOEI160400
4:WIRE: CU-0.1ϕ,0.14ϕ(2UEW-Y),0.1ϕ(2UEW-R)

核 准	審 核	檢驗員
吳鴻禧	陳詩明	宋德根

檢 驗 記 錄 表

□IQC □PQC □OQC
□PRO □RD

檢驗編號：

第 1 次送樣

廠商/單位	盈正豫順	批 量	5PCS	檢驗時間	9:30	檢驗日期	10.07.17
料 號	E-18784	抽樣數	5PCS	允收水準	CRI.MAJ.MIN.	溫 度	25℃
品 名		單據編號		AC / RE	0/1	濕 度	70%

項 目	A mm	B mm	C mm	D mm	E mm	F mm	G mm	
規 格	17.5	17.5	15.0	3.8±0.5	10.4±0.5	3.25±0.5	0.6ϕ±0.5	
上下限范圍	MAX	MAX	MAX	3.3-4.3	9.9-10.9	2.75-3.75	0.55-0.65	
測試條件								
1	17.11	15.28	13.97	3.86	10.38	3.26	0.58	
2	16.48	16.14	13.54	3.87	10.42	3.27	0.57	
3	17.14	15.30	13.90	3.85	10.42	3.25	0.58	
4	17.20	16.15	13.98	3.86	10.39	3.24	0.57	
5	16.53	16.18	13.96	3.87	10.40	3.26	0.57	
6								
7								
8								
9								
10								
$\overline{X}$	16.89	15.81	13.87	3.86	10.40	3.26	0.57	
R	0.72	0.90	0.44	0.02	0.04	0.03	0.01	

檢驗項目	檢驗數	不良數	不 良 內 容	判 定		處 理
				合 格	不合格	□ 允 收
外觀尺寸	5PCS	0		OK		□ 拒 收

備注：（測試儀器）
卡尺

核 准	審 核	檢 驗 員
吳鴻猷	陳詩明	宋德根

Construction Analysis

	Transformer Construction Analysis Form	Dok. F 10.0.-06. doc Date 02/07	Page 1/1 Rev. C

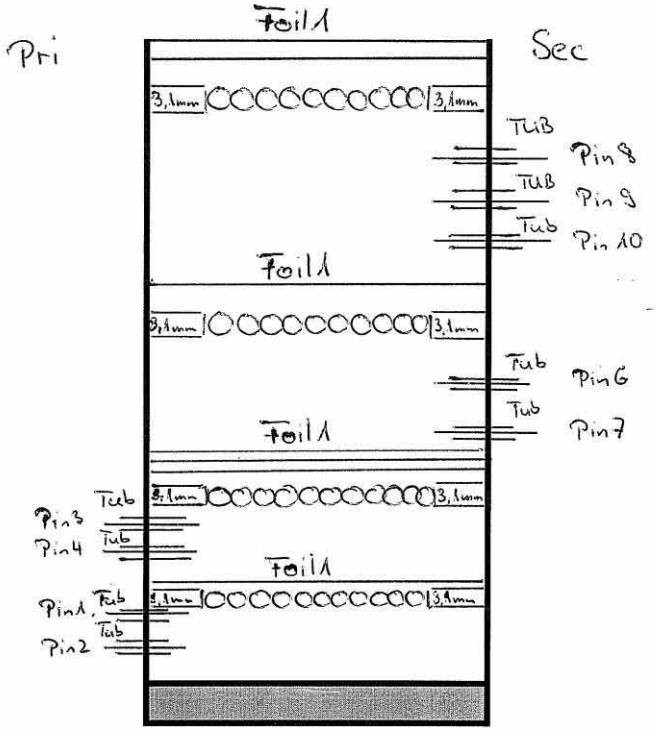
Engineer: Georg Loritz	Date : 19.08.10	Verdict	
Signature : G.Loritz	Project No : 09TH0459	Pass P	
		Fail ___	

Transformer Name: E-1878 18 Picture(s) filed

Transformer No.: T1 Mounted on: Control Board PWA1

Overall size: 20,7 by 16,5 by 13,6 mm

Ferrite size: 14,6 by 16,5 by 4,9 mm



Foil 1:
Thickness: 0,006 mm

Foil 2: margin tape
Thickness: 0,025 mm

Foil 3:
Thickness: / mm

Bobbin:
Min. thickness: 6,5 mm

Tubing of wires:
Reaches min.: 4 mm
into windings
Thickness: 0,1 mm

Min. Clearance : 6,2 mm (required: 6 mm)

Min. Creepage : 6,2 mm (required: 6 mm)

Shortcuts :

PRI = primary windings SEC = secondary windings MEW = multi-extruded wire
TUB = wire tubed M = margin tape 2L = insulation foil

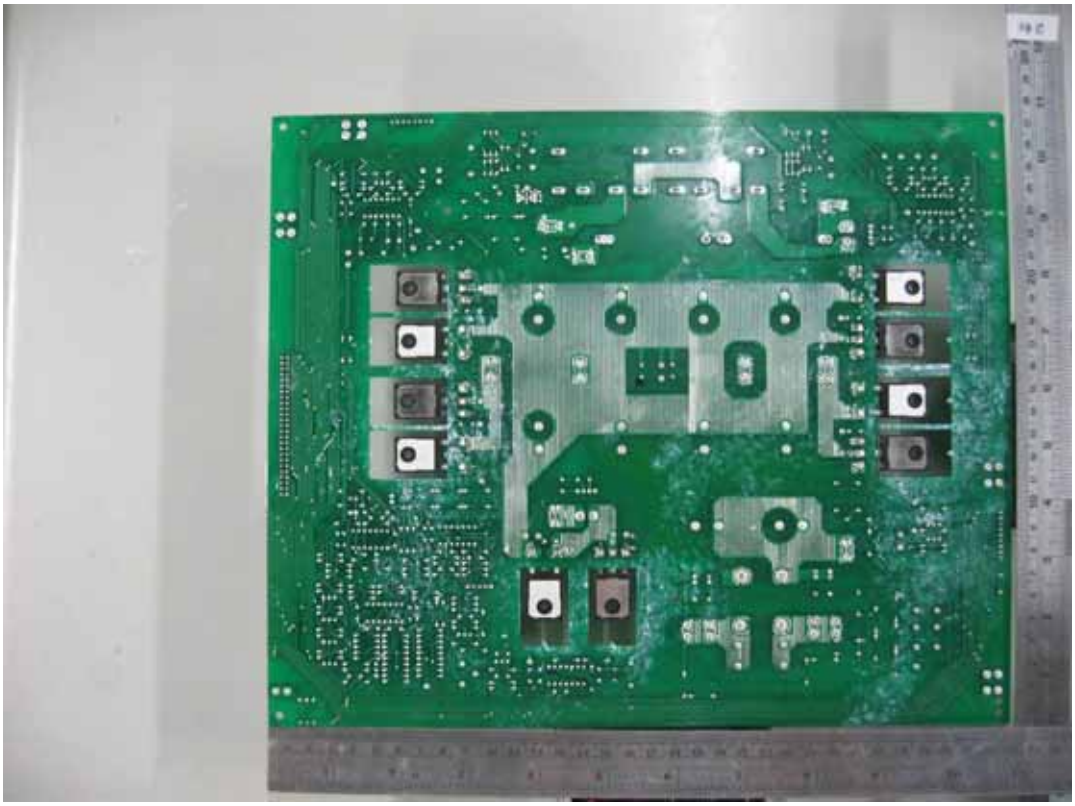
Annex No. 4
Pictures of the unit

ES2200 / ES3300

ES2200 / ES3300 inside

ES2200 / ES3300 mainboard top

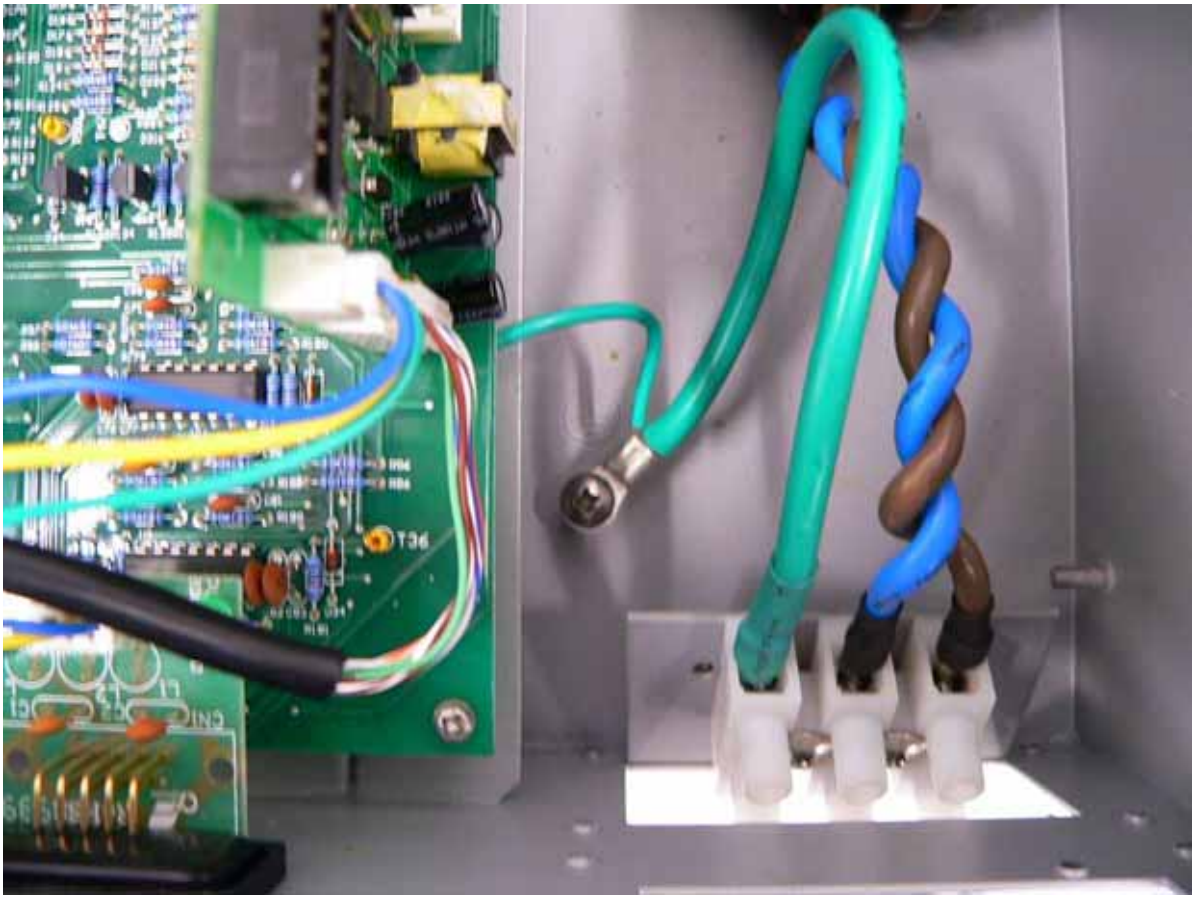
ES2200 / ES3300 mainboard bottom

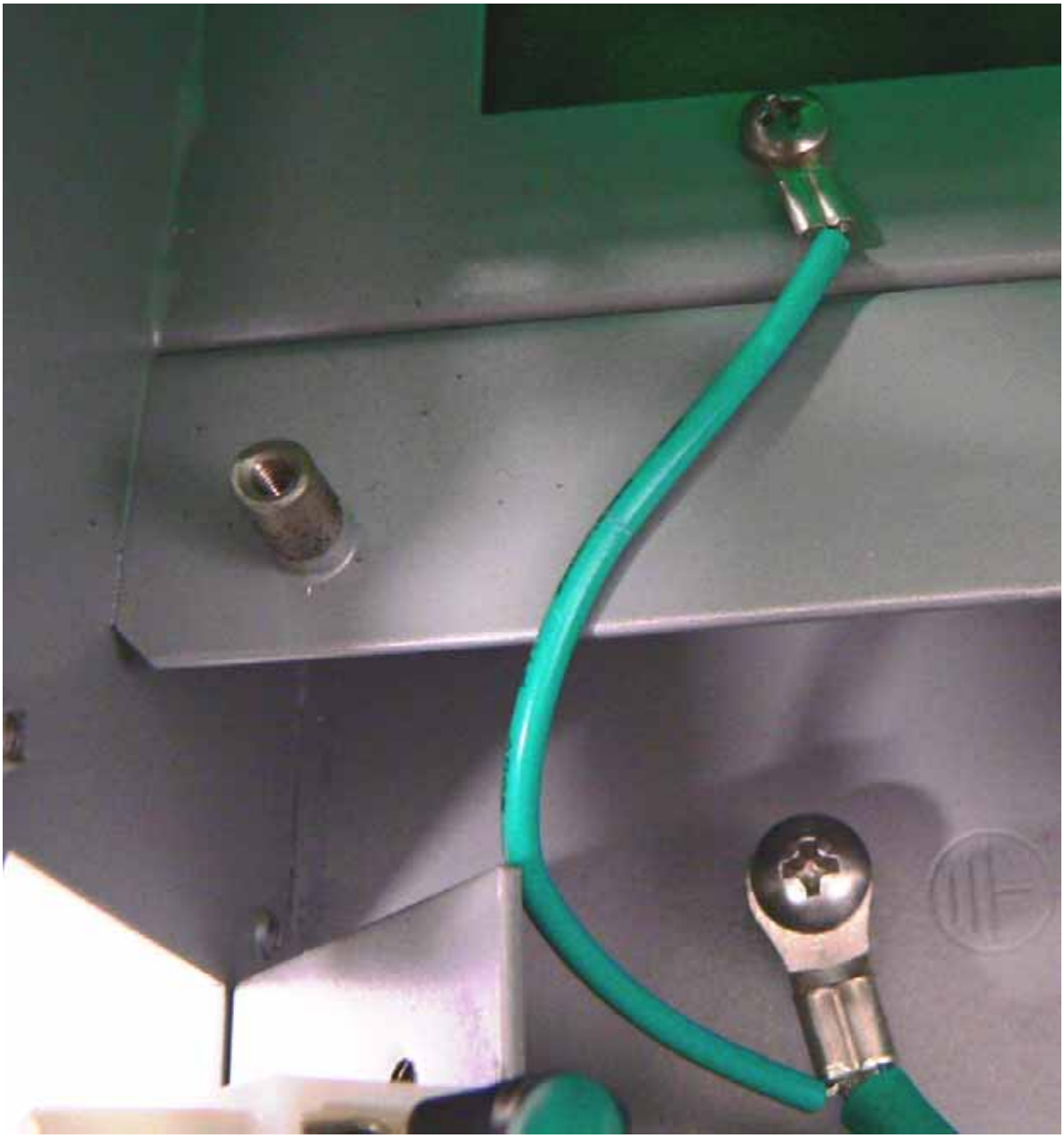


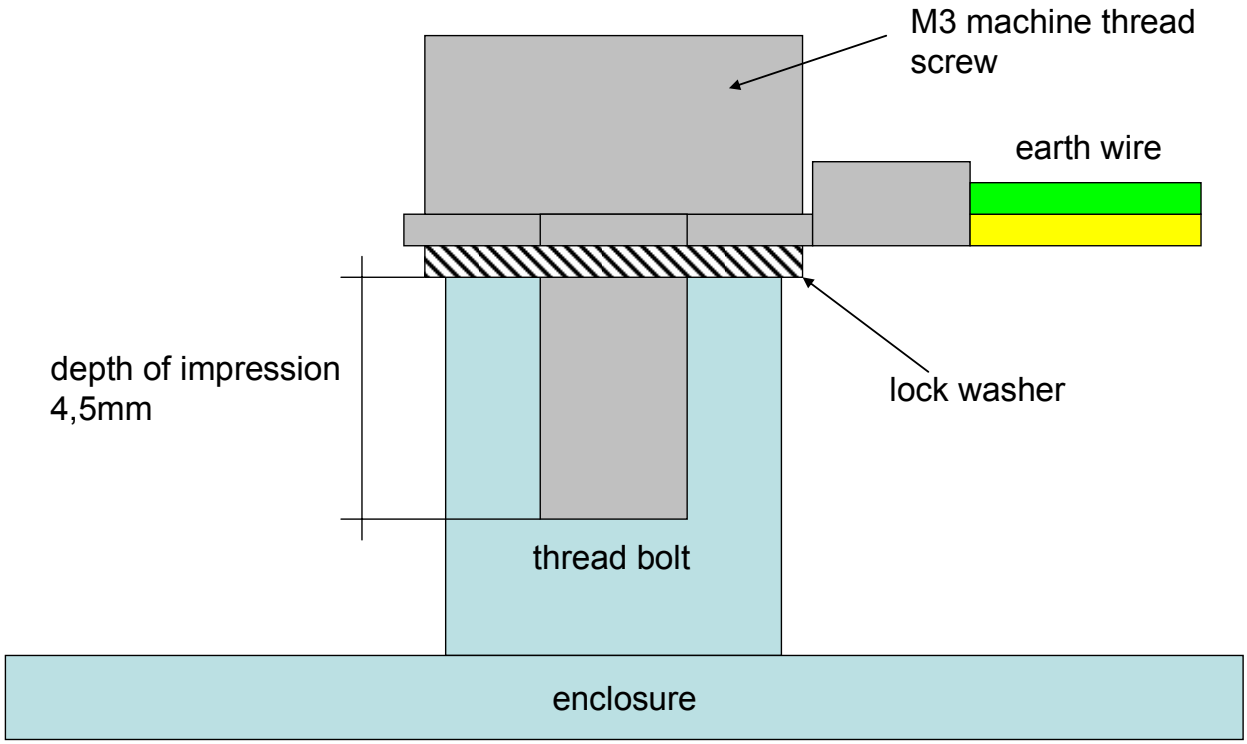
ES4400 / ES5000

ES4400/ES5000 inside

Earth connection

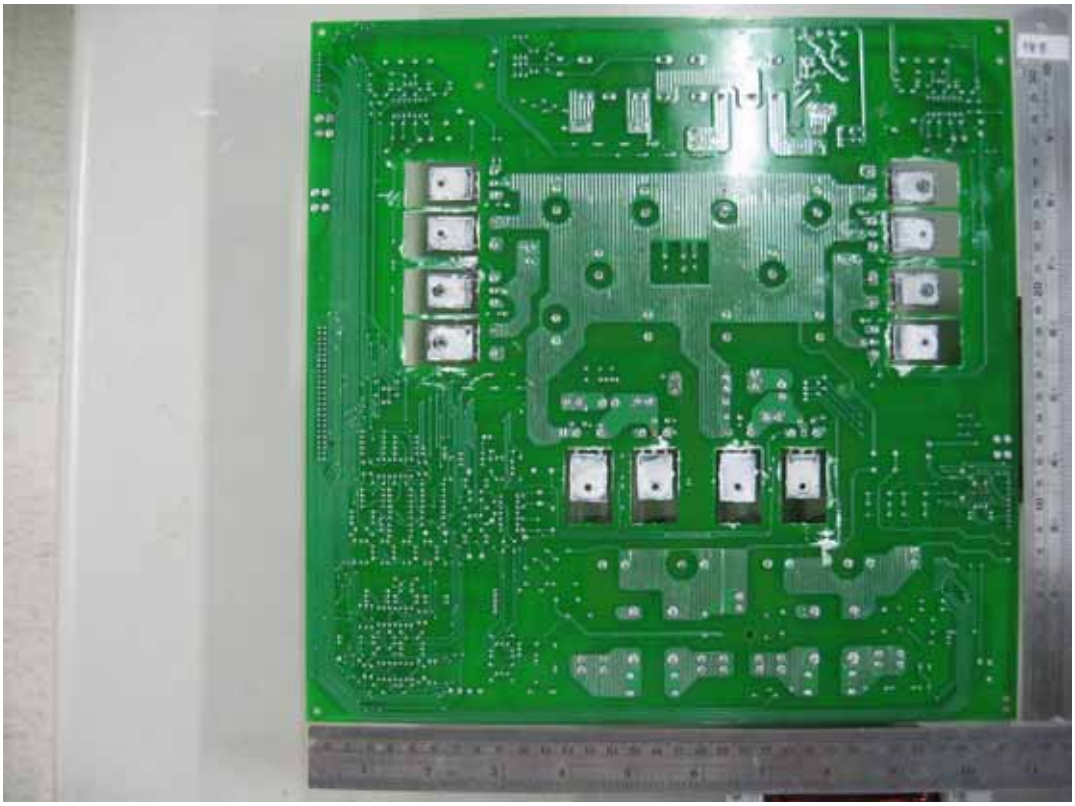





M3 machine thread screw
earth wire
depth of impression 4,5mm
lock washer
thread bolt
enclosure

ES4400/ES5000 mainboard top

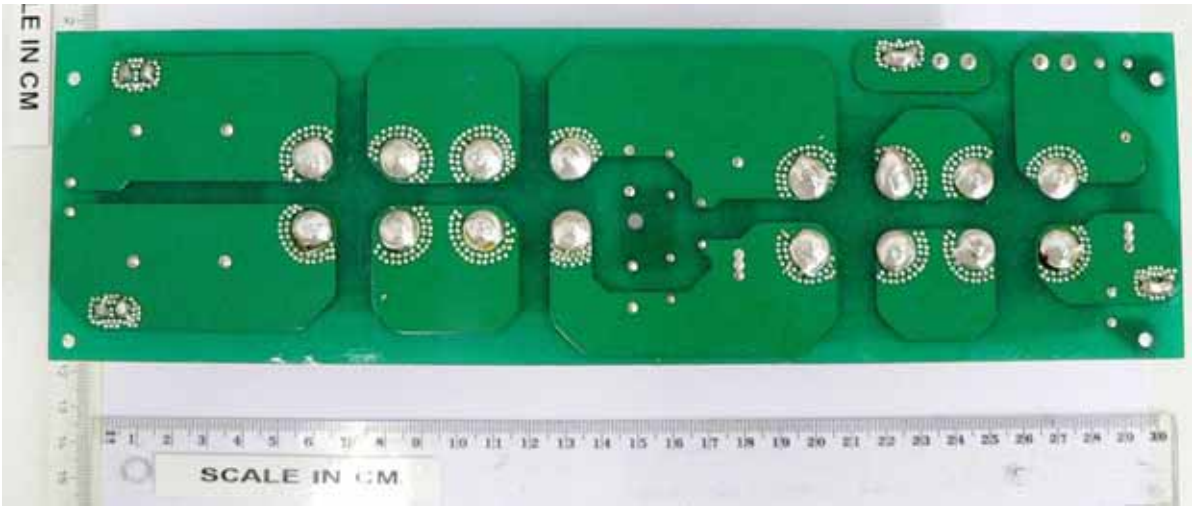
ES4400/ES5000 mainboard bottom



ES2200 / ES3300 / ES4400 / ES5000

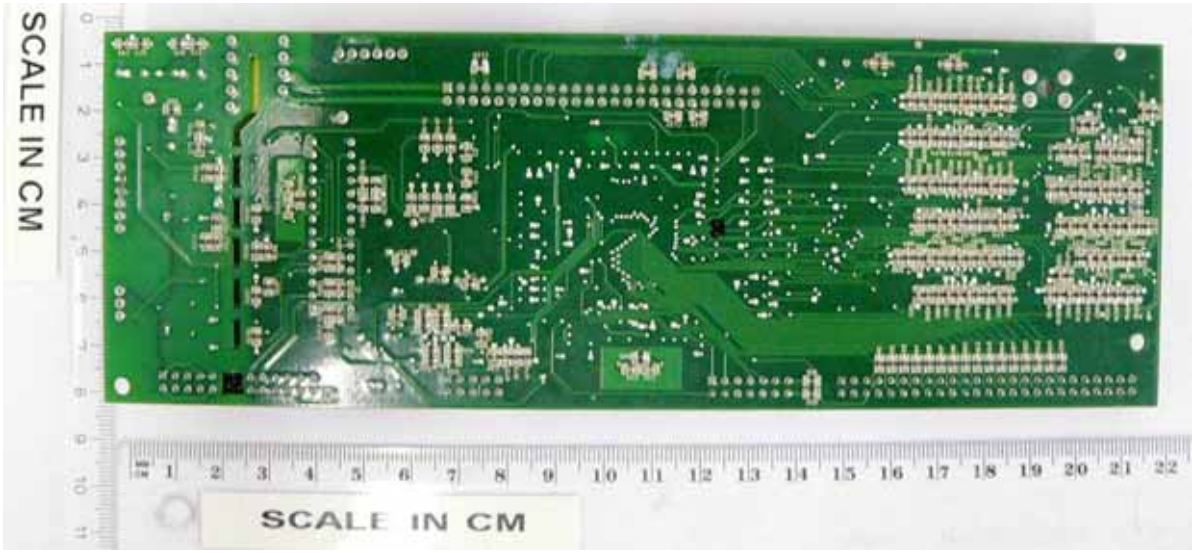
EMI Board (top side)

EMI Board (bottom view)



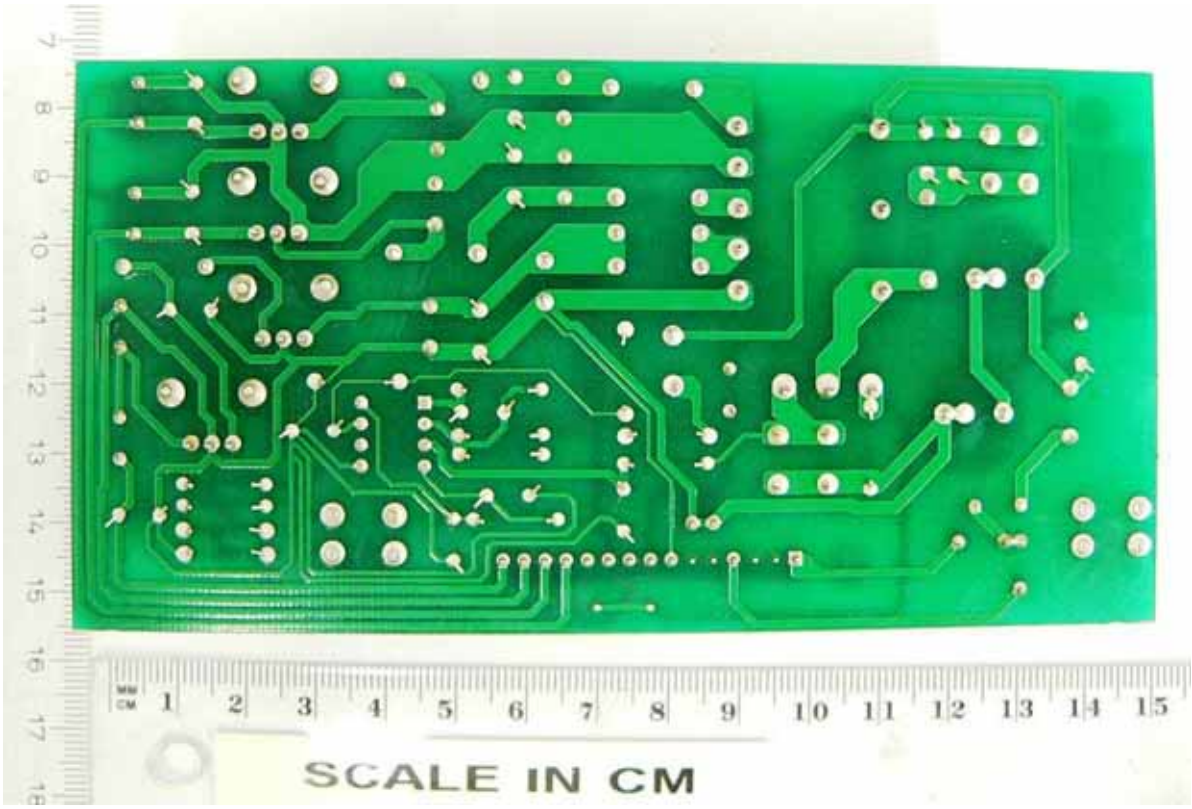
Control Board (top side)

Control Board (bottom view)

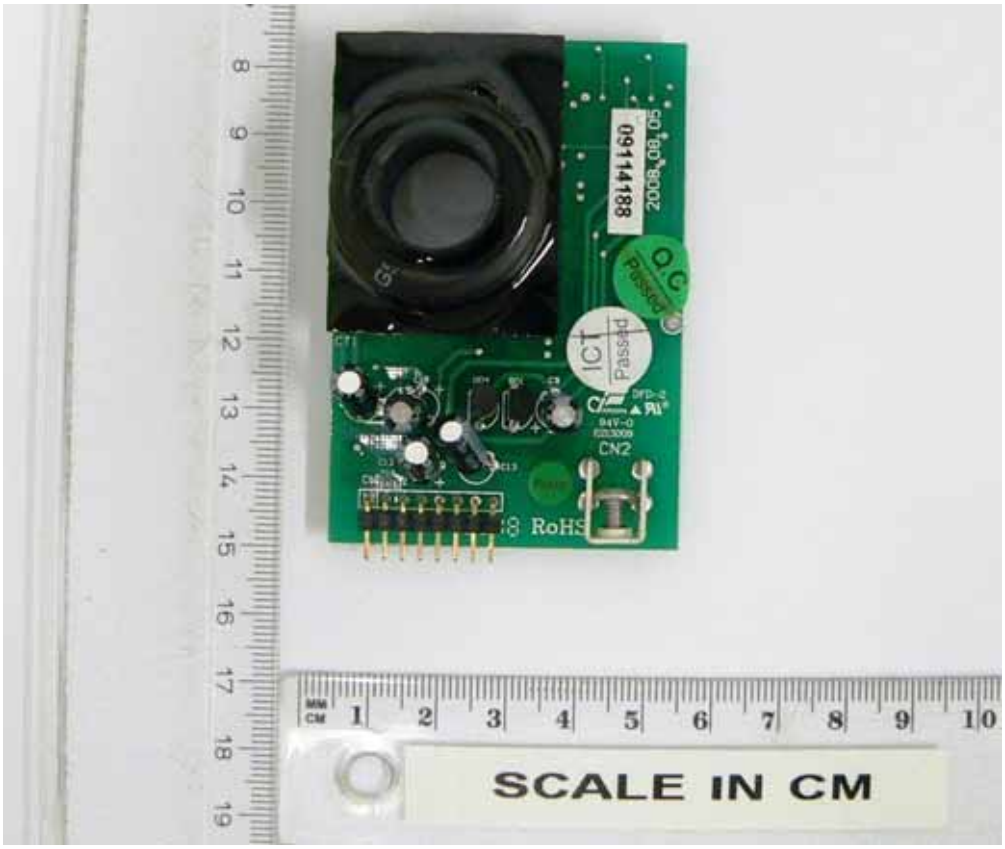


Workpower Board (top side)

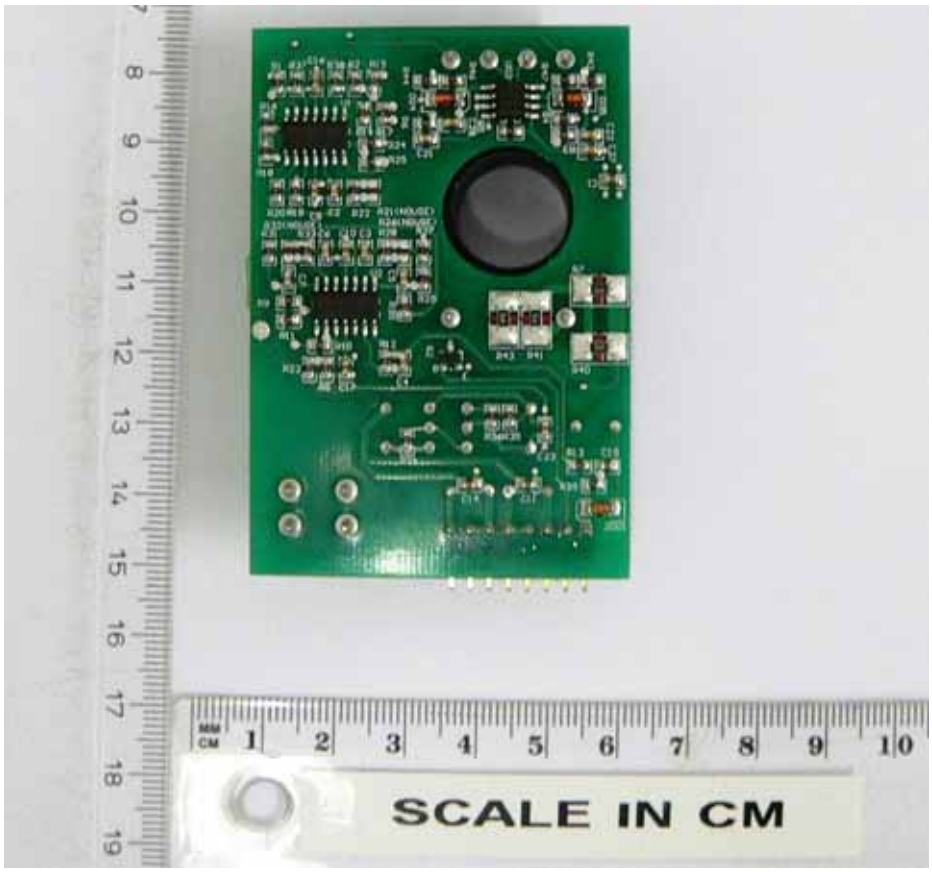
Workpower Board (bottom view)



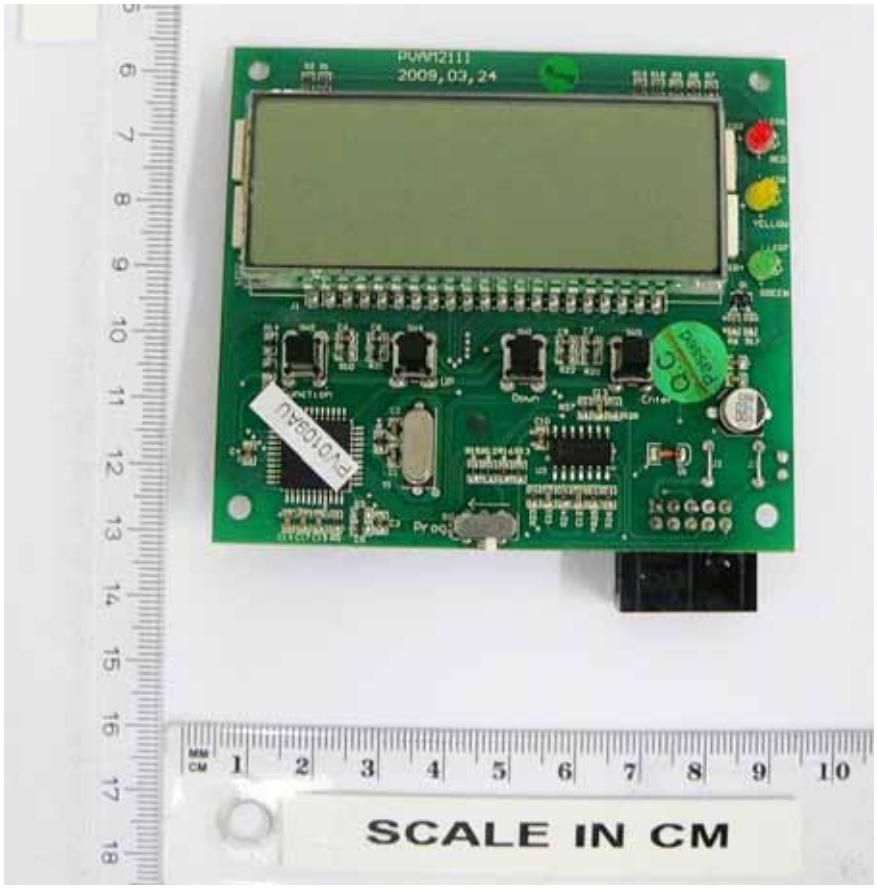
Zero Control Board (top side)



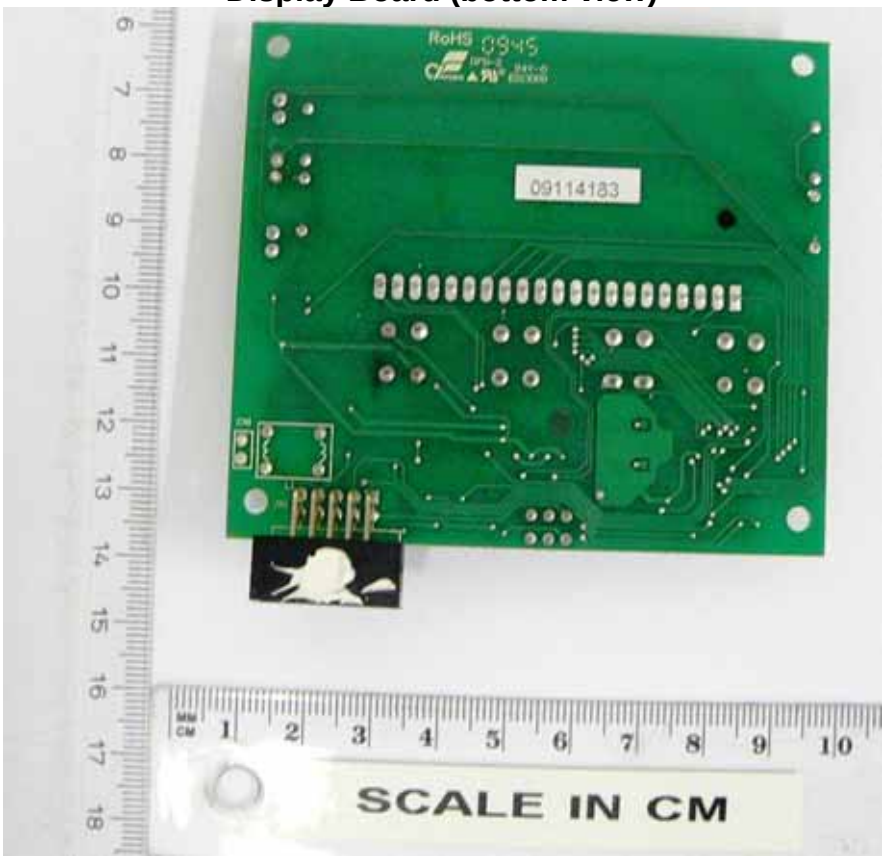
Zero Control Board (bottom view)



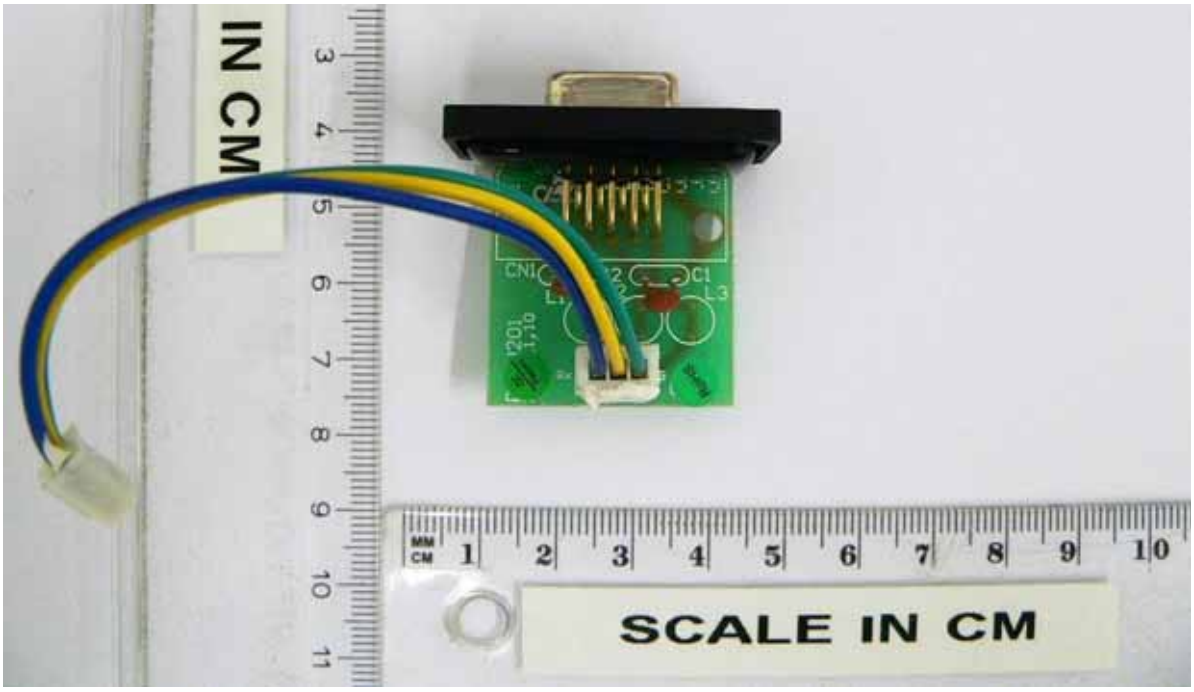
Display Board (top side)



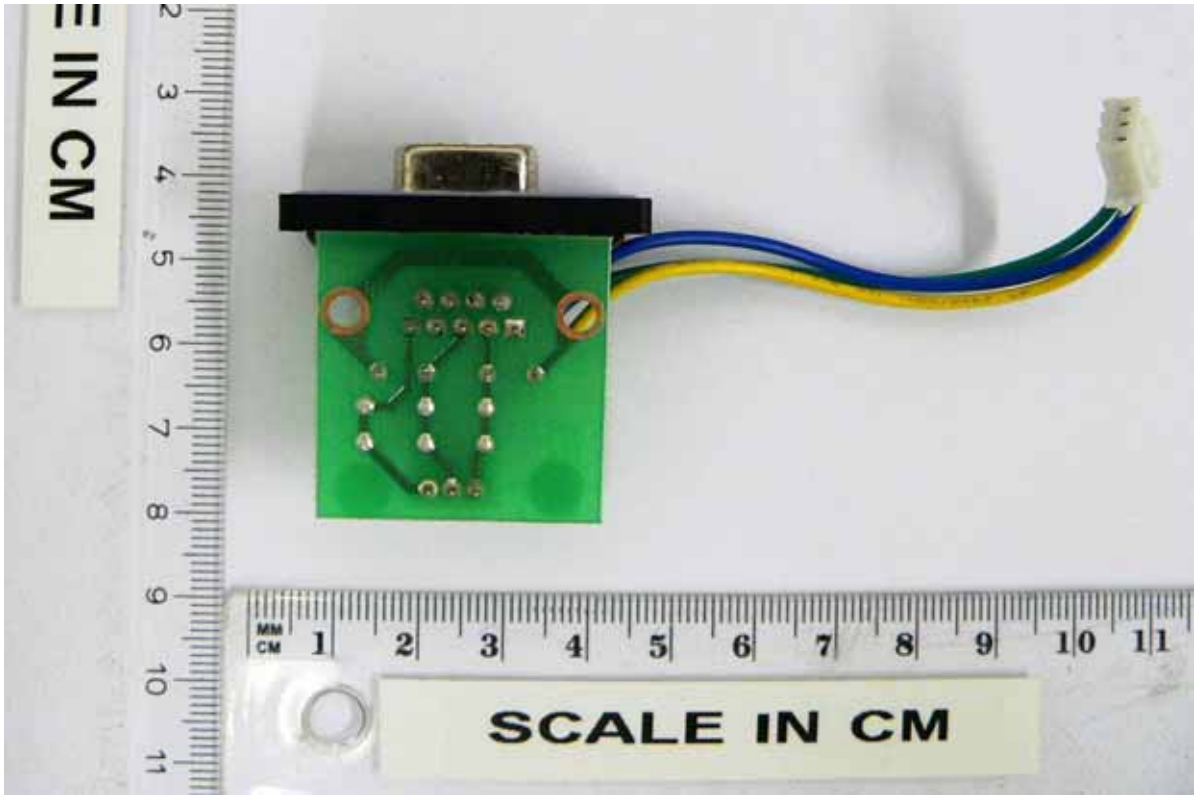
Display Board (bottom view)



RS232 Board (top side)



RS232 Board (bottom view)



Annex No. 5
Test Equipment List

Device	Internal No.	Manufacturer	Type	Serial No.	Last Calibration	Next Calibration
Multimeter	329	Keithley	2701/E	1092554	Jun 2010	Jun 2011
Digital Multimeter	663	GMC-I Gossen-Metrawatt GmbH	METRAHit 29S	SF4220	Aug 2009	Aug 2010
Variable Resistor	49	Heine Spezial-widerst. GmbH	ESG 4 19.4 Ω, 3 A	-		
Insulation Tester	61	Unitest	93406	IE 0167SE	Aug 2009	Aug 2010
Transformer	93	TTH	ETR 250 V	-		
DC-Power Supply	224	Power Control	PCE A6KW eco 150-41	E00084278		
DC-Power Supply	225	Power Control	PCE A6KW eco 150-41			
DC-Power Supply	226	Power Control	PCE A6KW eco 150-41	E00084297		
DC Power Supply	363	PCE	A12KW	E00126314		
DC Power Supply	364	PCE	A12KW	E00126318		
3-Phasen Trenntrafo	446	Statron	5316.1	9507001		
3 phase transformer	596	Ruhstrat	TIDMT	a27468		
Oscilloscope	333	Yokogawa	DL 1620	91F424384	Jun 2008	Jun 2010
Dielectric tester	730	SPS electronic	HA 2201G	04032304	Feb 2010	Feb 2011
leakage current meter	812	Kikusui	TOS3200	NK003303	Dez 2009	Dez 2010
Glow wire testapparatus	75	LGA				
Thermometer	223	Greisinger	GMH3250		Aug 2010	Aug 2011
Needle flame tester	748	ED&D Inc.	BTA-01			
Spring hammer	63	PTL	F 22.50	5001449	Jun 2008	Jun 2010
Digital force instrument	715	Chatillon Ametek, Inc.	50LBF	S/N W00717	Aug 2009	Aug 2010
Dual channel digital multimeter	485	Greisinger	GMH	-	Jun 2010	Jun 2011
Heating chamber	580	Heraus	UT6060	8903742		
Steel Ball	505	A.Pfeifer	500g	-		
Steel Ball	509	A.Pfeifer	500g	-		
Torquet screwdriver	842	Proxxon	II	2560		
Digital caliper rule	430	TESA	31172150	2E059206	Jun 2010	Jun 11