EUROPEAN DIRECTIVES

Manual DA-EU-M *Third edition*

Contents

Introduction

Purpose of this manual

Advanced programmable logic controllers are finding uses in an ever expanding range of applications. While they fulfil their classical role as machinery controllers, with advanced processing and operator facilities, they are also to be found in instrumentation and analysis systems, data logging systems, and even on transport systems.

This manual deals with the new requirements for equipment sold into Europe that contains Automation Direct.com (ADC) products, and explains the requirements attached to the CE labelling of ADC equipment, so that conformity can be assured to the now legally binding requirements of the EEC directives and their associated harmonised standards.

Where appropriate the reference to standard will be shown in the right hand margin.

The directives

Europe is in the process of harmonising all national standards in order to remove barriers to trade between EU countries, and this process may easily take 10 - 20 years. Each area of trade will eventually be controlled by a directive, and within each directive is a set of applicable standards.

Directives and the standards within them are being constantly revised over this introductory period. In order to determine which standard issues are applicable at any one time it is necessary to consult the official journal of the European community, which lists all standards and directives as they become legally applicable. Harmonised standards released in the OJ are prefixed by the letters EN. Particular countries may still continue to insist on additional compliance to their own national standards, and specific industries or particular customers may have their own specific requirements.

Three directives have been issued at present that relate to programmable logic controllers.

- Machinery directive - 89/392/EEC
- EMC directive - 89/336/EEC
- Low voltage directive - 73/23/EEC

CE marking of machinery or electrical equipment reflects conformity of a product to all applicable directives.

Every piece of equipment bearing the CE mark must have a declaration of conformity that states which standards applicable to the CE mark it complies

with. This document doesn't have to accompany the product, however in most cases, the manufacturer does so.

The CE mark

A typical situation for example in an industrial machine which is built of components from different manufacturers, would be to have:

1 A CE label as part of the nameplate relating to the complete machine, and with the declaration of conformity specifying compliance with either fundamental safety standards (type A), or specific machinery group safety standards (type C), within the machinery directive.

2 CE labels on individual safety components, such as emergency stop or guards forming part of the machine, with compliance indicated on the separate declarations of conformity to the specific group safety standards applying to the particular safety device (type B).

3 CE labels on electrical components which do not have an intrinsic function, such as contactors, transformers and motors, which have their own declarations of conformity to the low voltage directive, or to specific non generic standards.

4 CE labels on complex components such as PLC's with declarations of conformity to EMC and low voltage directives, with the applicable standards.

The standards, directives and their amendments that legally apply are listed in the OJ (official journal).

This manual is based on the current legal position, with attention given to expected amendments that will effect the situation over the short to medium term future. This is the second edition of the manual and there will be future issues plus amendment notices as legislation changes.

Automation Direct.com

ADC are members of the ERA (Electrical Research Association), who inform of changes to current EMC and safety standards.

ADC has invested in its own certifications facility, which is based in the UK and incorporates a premises dedicated solely for the purpose of CE and occasionally UL certification of ADC's products.

The premises is equipped with an extensive EMC testing facility as well as dedicated office space for management and procedures.

Programmable logic controllers have a product specific standard, EN 61131-2 that became mandatory in mid 1998. Before this date, ADC's's certifications department had been using appropriate generic standards. To approve the existing product range to EN 61131-2 would have been economically unviable. Therefore a decision was made in May 2000 to approve new products to the product specific standard, while continuing to use the generic standards for existing products. A formal department statement can be found in the appendix.

Enforcement agencies

Minimum generic standard levels exist for EMC and safety of equipment. The relevant EU directives are known as the EMC and low voltage directives. The directives simply state that manufacturers and their agents must act responsibly, using good engineering practice to ensure that CE marked equipment does not cause interference to other equipment, exhibits a minimum specified level of EMC immunity and operates safely.

Each European country has translated the EU directives into national law, and differences occur in the interpretation and implementation of these directives.

Local enforcement agencies are under increasing political pressure, over and above their legal responsibilities, to show that their country is actively enforcing the directives. In the UK alone there are 182 local enforcement agencies, each with their own interpretation of the law, method of working, local budget and political pressures for or against membership of the EU.

The UK and France utilise their own local trading standards departments to enforce the legislation, who view this as a very small part of their responsibilities. Activities in the UK started by identifying local electronic manufacturers and agents and judging the response by asking them if they are aware of the directives. More recently local trading standards departments have identified manufacturers and importers, and purchased their products for the purpose of testing through approved bodies. A number of prosecutions have already taken place.

Germany operates differently to the rest of Europe. They have a dedicated CE marking enforcement agency that actively random tests electronic equipment.

ADC's group policy

Documentation is provided for systems builders and end users as to the standards, classes and environments that suit each item in the PLC product ranges, so that final product designs and systems may be constructed to comply with the requirements of the directives.

The ADC group has its own in-house test facilities, and has joined the ERA (electrical research association) in the UK, who provides a consultation and approval of procedures applied within the group. PLC equipment is designed and manufactured using good engineering practices to ensure safety and reliability.

The selection of ADC products for a particular application is the final responsibility of the system designer and end user, and this document is only intended to provide awareness of possible working methods for system design departments. Many industries have special hazards and it is the combined responsibility of the system designer and end user to ensure that equipment operates safely and within the law.

The situation onsite

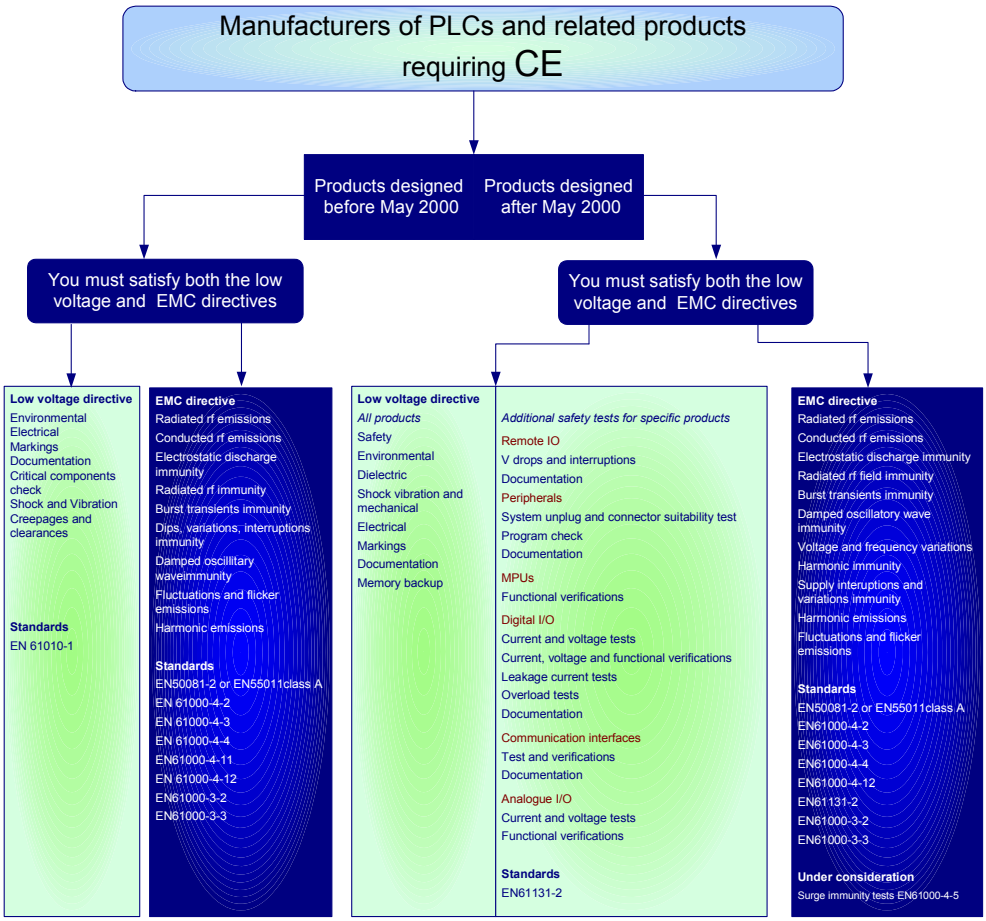
All end users within the EU must by law perform various basic electrical safety checks before equipment is taken into service, which are repeated annually. These tests are designed to ensure continued reliability of the safety earth bond to any accessible metal parts, and the integrity of the insulation. Electrical safety and the EMC characteristics of equipment and installations rely heavily on good earthing, and ADC equipment has been designed assuming that the installation recommendations detailed in IEC 1000-5-1, IEC 1000-5-2, and EN 61131-2 have been followed. Some sites may not be suitable for modern electronic equipment, and if a system design engineer is aware of this then subsequent accident or financial loss will be his or her direct responsibility.

Determination of the operating environment

The OEM panel designer or systems designer, must always ensure that there are no special electrical requirements to be met within a particular project design, and the questionnaire included within Annex B of the machinery directive electrical safety standard EN60204-1:1993 is a responsible method to ensure compliance.

Once the environment has been accurately specified in the contract or product design specification, and the type of personnel identified who have access to the interior of the control enclosure, an analysis must be performed by the system designer of each electrical circuit in the system to determine degrees of insulation required between hazardous circuits and accessible parts, relative to installation categories, pollution levels, etc.

Directives and standards incorporating the May 2000 decision



The Machinery Directive

This section should be read in conjunction with the standard EN 60204-1:1992 and relates directly to each section and clause within that standard while using the same nomenclature.

Definition

If an ADC programmable logic controller forms part of a system involving moving parts, control and power circuits, the machinery directive becomes the prime directive to be considered. The term machinery also covers an assembly of machines or system, arranged and controlled so that they function as an integral whole.

If an ADC PLC is integrated into a device such as an analyser system or data logging system, which does not posses any powered moving parts, then the EMC and low voltage directives become the prime directives covering the apparatus.

The machinery directive also includes a requirement for compliance to the EMC directive, and the safety aspects of the product specific standard EN61131 which covers programmable logic controllers.

Applicable standards

The standard listed in the machinery directive which covers PLCs and electrical components, is:

EN 60204-1:1992 Safety of machinery - Electrical equipment of machines: part 1: General requirements.

The above standard is a category B1 application standard used in the production of group C product standards, and includes a requirement for compliance to the EMC directive. It also considers all the requirements of the low voltage directive.

It is intended as the first part of a series of standards relating to the electrical equipment of machines.

Essential reading

The mechanical group of BSI (British standards institute) have produced an overview of the machinery directive, which is essential reading for manufacturers wishing to sell machinery into Europe. The part number of this publication is: TH 42073: February 1996.

All standards, and the above publication are available from:

BSI, Linford Wood, Milton Keynes, MK14 6LE, England, or your local BSI agent.

Hazard analysis

A hazard analysis must be performed by the machine builder or systems integrator. EN 60204-1:1992 4.1

It is a requirement in this standard that the PLC equipment must be installed in a standard industrial steel cabinet which must provide the required protection against shock. Fuses must be fitted to power input lines weather AC or DC, in order to limit the energy into all unlimited circuits even with power line reversal, and thus providing electrical fire protection. 6.2.1

Control circuits can fail in any state, which could conceivably cause a hazard, and it is the responsibility of the machine designer to utilise redundancy and diversity in the design of output circuit arrangements that control hazardous actions. 9.4.2.2 9.4.2.3

Disruptions in external power to PLC systems should cause an output drive to be removed temporarily from all output states in a specified and controlled manner. It is the responsibility of the design engineer to select a non-hazardous restart mode after power failure in the program design. Disturbances in common external power could, in an extreme case cause complete destruction of all PLC systems, so that even redundant, diverse systems could fail. The design engineer should consider alternative redundant, diverse systems such as separate emergency shut down systems, watchdog timers etc., and with their own backup supplies where the hazards are extreme. 9.4

All ADC PLCs comply with the generic immunity requirements of the EMC directive, when correctly installed to their individual installation manuals. However it is the responsibility of the design engineer to ensure that adverse electrical interference which might cause destruction or disruption of the PLC, will not give rise to a hazardous condition within the machine. For example, the stored electrical energy in the lithium CMOS memory backup batteries within each PLC, can not cause a shock hazard, but could cause a fire under adverse conditions outside the limits of this specification.

Only the replacement battery assemblies manufactured and approved by ADC should be fitted, and note should be made to this effect in the spare parts or routine maintenance section of the machines technical manual.

For maintenance purposes, PLCs may be operated without backup batteries in the case of hazardous environments and the PLCs are mounted in explosion proof enclosures. It is left to the design engineer to consider the hazards associated with each application. All PLC CPUs contain super capacitors in order to maintain CMOS memory during battery change.

There are no acoustic noise problems associated with PLCs.

Selection of equipment

ADC PLCs are designed to be used in heavy industrial environments, provided the equipment is installed correctly in a standard industrial steel enclosure, maintaining the requirements of each individual product user manual. Certain products can also be used in commercial and domestic environments, see the product manual and declaration of conformity. Equipment can be AC powered from all industrial or domestic mains supplies so long as appropriate filters are used where applicable and that isolation transformers are always used. Consult the declaration of conformity for a particular product, to find out these special requirements.

EN 60204-1:1992 4.2

4.3.2

Electrical supply

Operational Requirements

EN 60204-1:1992 4.3

The below table illustrates voltage requirements for the ADC product range. Tolerance withstand of incoming voltage for AC powered models, is stated in the manuals, whilst the voltage markings on the product reflect this. The standards do not require this tolerance to be included within the stated voltage range for DC powered models.

PLC Range	Markings	Manual
05 AC	100-240V AC	100 - 240 +10% -15%
05DC	12-24V DC	10.8 - 26.4 VDC
06AC	100-240VAC 50-60Hz	100 - 240 +10% -15%
06DC	12-24V DC 20W	10.8 - 26.4 VDC
205 AC	100-240V AC	100 - 240 +10% -15%
205 DC-1	24V DC	10.2 - 28.8 VDC
205 DC-2	125-240V	125-240V +10% -15%
305 AC	100-240V AC	100 - 240 +10% -15%
305 DC (05BDC, and 10BDC)	24V DC	20.5 – 30 VDC <10% ripple
405 AC	100-120 and 196-240V AC	100 - 120 and 196-240 +10% -15%
405 DC-1	20–28V DC	20 – 29 VDC (24VDC) less than 10% ripple
405 DC -2	100-132V	100-132V +10% -15%, <10% ripple
Terminator AC	100-240V AC	100 - 240 +10% -15%
Terminator DC	12-24V DC	10.8 – 26.4VDC
FA 24PS	100-240V AC	100 - 240 +10% -15%

Hold mode

When the mains power to an ADC PLC turns off, the internal power supply sends a PF (power fail) signal to the cpu. Once the cpu receives the PF signal, it stops accessing the memory, enters the 'hold' mode, and waits for system reset. The system reset is generated by a device which monitors the

voltage of the 5Vdc supply . If the voltage drops to less than 4.25Vdc, the device outputs a system reset signal.

If the mains power turns off for only a short time (< 900ms , such as in a flicker of the mains), the internal power supply sends the PF signal to the cpu. However, in this case, the 5Vdc might not drop to less than 4.25Vdc. The cpu then waits for system reset without accessing the memory, and the PLC appears to freeze. The cpu must be reset by removing the mains power.

Frequency

All PLC ranges operate over the frequency range 47 - 63Hz.

Harmonic Distortion

Range specified as <10% of total RMS value for 2nd through 5th, <2% for 6th - 30th.

Voltage Impulses

Specified as 1.5mS pulses with 500nS - 500uS rise/fall time and peak value of 460v on top of nominal 230vAC mains.

It is the responsibility of the machinery designer to fit transient voltage suppressers, such as metal oxide varistors, of rating 275v AC working voltage and high energy capacity (e.g. 140 joules), across the power input connections of the PLC. Transient suppressers must be protected by 3 amp anti surge (long time lag) fuses, in both line and neutral circuits, to comply with the requirements of the LV directive. The capacity of the transient suppresser must be greater than the blow characteristics of the fuses or circuit breakers.

A recommended AC supply input arrangement for ADC PLCs is to use twin 3 amp anti surge fused terminals with fuse blown indication, such as Klippon SAKSI. An alternative arrangement would be to use two circuit breakers wired to a Schaffner FN 2070, or equivalent mains filter, with a high energy transient suppresser soldered directly across the output terminals of the filter.

PLC system inputs should be protected from voltage impulses by deriving their power from the same fused, filtered, and surge suppressed supply.

All AC output modules in the DL305 and DL405 ranges contain internal transient suppressers and fuses, with the exceptions of:

DL305 series	D3-16TR suppressers but no fuses F3-08TRS-1, F3-08TRS-2
DL405 series	F4-08TRS-1, F4-08TRS-2

Supply interruption

Specified as 3mS random total interruption of power.

All ADC AC powered bases, PSUs, or system assemblies, can withstand a full half cycle (10mS) power interruption without effect. Response times of individual AC input modules are detailed in the main product catalogue, and all AC input modules comply with this requirement.

Voltage dips

Specified as 20% of nominal supply for one cycle.

All AC powered PLC systems and I/O modules meet this requirement.

DC voltage

DL 05 series	10.2 – 28.8v DC (<10% max ripple)	EN60204-1 :1992 4.3.2
DL 06 series	10.2 – 28.8v DC (<10% max ripple)	
DL 205 series	10.2 - 28.8vDC (<10% max ripple)	
DL 305 series	20.5 - 30vDC (<10% max ripple)	
DL 405 series	20 - 29vDC (<10% max ripple)	

All four PLC ranges are suitable for use on machinery with 24v DC supplies in Europe, while the DL 205, DL 05 and DL 06 series are also suitable for use on 12v DC supplies. Care must be taken to ensure that the chosen analogue modules accept the power supply tolerance.

DC Supplies

From batteries

Voltage	0.85 to 1.15 of nominal voltage (10.2-13.8v and 20.4-27.6v) 0.7 to 1.2 of nominal voltage in the case of battery-operated vehicles
Voltage interruption	Not exceeding 5ms

From converting equipment

Voltage	0.9 to 1.1 of nominal voltage (10.8-13.2v and 21.6-26.4v)
Voltage interruption	Not exceeding 20ms. There shall be more than 1 second between successive interruptions

Ripple (peak to peak) must not exceed 0.05 of nominal voltage.

Physical environment and operating conditions

EMC compatibility

EN 60204-1:1992 4.4

All ADC PLCs comply with the requirements of the EMC directive, for use in industrial environments The following standards are applicable to the 05, 06, 205, 305 and 405 PLC ranges, however please refer to the chapter on EMC for further details.

EN50081-2:1994 Generic emissions standard for industrial environments

EN 50082-2:1995 Generic immunity standard for industrial environments

The products comply with the above standards only when the equipment is installed to the requirements of the individual product installation manuals.

It should be stressed in the machinery installation manual that it is the responsibility of the end user to provide adequate earthing of the framework of individual machinery, and that earth continuity must be <0.1 ohms when tested at 10 amps AC to an adjacent earth rod, or matrix earth connection point to that used for the protective grounding (see section 20.2).

Furthermore, equi-potential bonding between machinery must be provided alongside serial data and signal lines, with data and signal lines of screened twisted pair construction, and where the cable screens are connected to the machinery frame at both ends.

End users must be made aware in the machinery technical manual, that the extensive use of mains filters and screened cables within machinery will cause electrical interference to be channelled onto the protective earthing point of each machine.

Therefore if adequate site earthing is not provided, interaction between control system components will occur, and it will be the legal responsibility of the end user to improve site grounding. Some factory sites situated on dry soils may be unsuitable for modern electronic equipment to operate reliably and safely.

See draft Installation guidelines IEC 1000-5-1, and IEC 1000-5-2 for site installation requirements.

Ambient air temperature

EN 60204-1:1992 4.4.2

Specified as 5 - 40°C in an enclosed cubicle or 35°C average over 24 hours. The installation manuals for each PLC product series include details on the mounting orientation and spacing for each base in a control system for optimum heat dissipation.

The low voltage directive safety standard, EN 61010-1 specifies the maximum size of openings allowed, and the machinery directive standard, EN60204-2, specifies that the enclosure must be sealed to suit the particular environment (e.g. the wash down of machinery at night).

All of the above requirements preclude ventilation, and therefore for the correct design of a control cubicle for operation in ambient temperatures up to 40°C the design engineer must assess or test for temperature rise at the top of the control cubicle. This is to be no greater than 20°C above ambient, to allow for the maximum PLC operating temperature of 60°C or 55°C for the DL 205 and DL 05 series.

All operator interfaces have a maximum operating temperature of 50°C, and the FA-UNICON has a maximum of 45°C when operating from 24vDC power. This must be taken into account when measuring temperature rise above ambient in the enclosed fully loaded cubicle.

Therefore the cubicle size should allow sufficient cooling in free air, and operator interfaces should not be mounted near the top of a cubicle where the heat rise is at a maximum.

Some FA-UNICON signal converters should be mounted near the bottom of a cubicle, preferably on an industry standard DIN rail mounting 25 pin 'D' to terminal converter module. This is due to the limited upper temperature limit.

ADC PLC equipment will operate at temperatures as low as 0°C, which is ideal for indoor applications covered by the machinery directive. Where the ambient temperature can drop below zero, cubicle heaters must be fitted. They must be wired for continuous independent operation, or with a time delayed start of several hours to allow for the drying out of all electronic apparatus.

Humidity

EN 60204-1:1992 4.4.3

Specified as 30% - 95% RH (non-condensing)

DL 05, DL 06, DL305 and DL405 PLC systems operate over a

5% - 95% RH range.

DL205 PLC systems operate over 30% - 95% RH range.

The standard suggests measures that should be applied if the equipment is operated outside the above humidity limits.

In the case of high humidity or early morning condensation, as is very often found in northern climates, small thermostatically controlled cubicle heaters are often used. Alternatively a permanently wired light bulb (typically 60 watt), will often overcome early start failures due to condensation.

ADC DL 05, DL 06, DL405 and DL305 PLC systems are specified for operation at humidity levels as low as 5% RH, and most problems experienced at this level are normally caused by static discharge.

All ADC PLCs have been tested for ESD up to 8Kv while mounted within a grounded standard industrial cubicle. If operation in very low humidity is required, the hazards associated with operation of the equipment by maintenance personnel while the cubicle door is open should be considered. Either power to mechanical actuating equipment should be cut, or total system shutdown, or static wrist straps should be provided while the door is open. Warnings on the outside of the control cubicle should also be considered.

Altitude

EN 60204-1:1992 4.4.4

Specified as operational up to 1000m above sea level. ADC PLC equipment can operate at altitudes over 1000m above mean sea level.

Contaminants

EN 60204-1:1992 4.4.5

ADC PLC equipment contains IC sockets and electrical connectors. The operational life of the PLC equipment can be shortened if corrosive gases, etc. are allowed to permeate into the cubicle.

Adequate measures must be taken by the machinery designer. The corrosive atmosphere can be controlled either by filtering, sealing out, or locating the main control equipment in safer atmospheric conditions. Distributed I/O in sealed cubicles can also be considered.

Radiation

EN 60204-1:1992 4.4.6

Ionising or non-ionising radiation could cause memory loss in ADC PLC systems. Measures must be taken to eliminate this radiation by the design engineer.

Vibration shock and bump

EN 60204-1:1992 4.4.7

All PLC families are tested to MIL STD 810C, Method 514.2 (vibration),

MIL STD 810C, Method 516.2 (shock), NEMA (ICS3-304) (noise).

Transportation and storage

EN 60204-1:1992 4.5

Specified as -25°C to +70°C transport and storage temperature range. All PLC equipment and operator interfaces are specified for a storage range of -20°C to 70°C. Programmer and operator interface devices with LCD displays must be removed from machinery during transportation and storage, to avoid damage if temperatures as low as -25°C are to be encountered.

All other PLC equipment can withstand storage and transportation temperatures as low as -25°C.

Provisions for handling

EN 60204-1:1992 4.6

No special provisions required.

Installation and operation

EN 60204-1:1992 4.7

Control cubicles should be accessible for maintenance, and operator interfaces should be mounted at the eye level, which is consistent with the average height of operators in the end users country.

This section deals with the requirements of equipment, terminals, and wiring associated with the PLC system inside the control cubicle. The design engineer is responsible for the incorporation of these measures.

Incoming supply terminations

If circuit breakers are used as the supply disconnection device then two CBs must be fitted, one for each supply line, in order to limit currents in unlimited supply circuits, as required by the Low Voltage directive.

EN 60204-1:1992 5.0

Protection against electric shock

Protection by enclosure

Over voltage surge suppressers that are wired to the power input terminals of each item of PLC equipment (section 4.3.1), must be capable of withstanding the blow characteristics of the fuses or circuit breakers. This section calls for all live parts to be located inside enclosures, and the low voltage directive safety standard EN 61010-1 also specifies that enclosures should be metal, but not magnesium, for protection against fire.

EN 60204-1:1992 6.0

Protection of equipment

All ADC output modules have their ratings indicated in the technical manual and on each module label. Input module current requirements are indicated in the module specifications, and the total input requirement should be estimated based on the percentage of inputs likely to be active, so that adequate protective fusing can be determined.

EN 60204-1:1992-7.0

AC and DC control circuits to input and output modules should have both sides of the control circuit supply fused, to EN 61010-1 for the low voltage directive, and fuse values should never exceed the capacity of the circuit cabling used.

EN 60204-1:1992-7.2.9

Fast blow fuses can also be used to protect individual DC transistor outputs, and anti-surge (long time lag) fuses can be used to protect individual relay and AC output channels. Fuse ratings should be as low as possible to provide best protection and should never be greater than each output channel switching capacity.

Under voltage protection

Controlled operation of the PLC by turning OFF outputs and storing machine operational status in non-volatile memory, ensures reliable operation in the event of under voltage conditions in all ADC PLCs.

EN 60204-1:1992 7.5

Equi-potential bonding

The machine design engineer must consider hazardous operations that can occur if actuators fail to operate due to insufficient power, and under voltage detection may be necessary in these instances.

The requirements of this section are essential for the reliable operation of modern electronic control equipment.

EN 60204-1:1992 8.0

Control circuits and control functions

Transformers

Control circuit transformers are not mandatory in small fully enclosed machines, or those having a rated power of less than 3Kw. Control circuit isolation transformers however may be preferred for the reduction of voltage risk to personnel. The practice of earthing the centre tap of 120v isolation transformers to provide a maximum voltage of 60vAC above earth, is no

EN 60204-1:1992 9.0

longer allowable as one side of each input or output circuit must be connected to the protective bonding circuit.

ADC equipment is rated for installation over voltage category 1, as specified in EN 61010-1, provided an isolation transformer is used to supply the AC power to the control equipment.

Emergency stop

EN 60204-1:1992 9.2.5.4

Emergency stop functions should be wired so as to directly remove power from all actuators, and an electromechanical drop-out relay may be used for this function, but the PLC power should not be removed.

The PLC should be informed of this action by using and input circuit via a secondary contact on the Emergency Stop.

See PLC installation manuals for suggested circuit arrangements.

Circuit redundancy and diversity

EN 60204-1:1992 9.4.2.2

Redundancy and diversity can be used in various ways to provide manual or automatic protection, depending upon the hazards present.

The simple duplication of series or parallel connected output modules, with a mixture of single channel relay and DC or AC output devices to provide diversity.

The addition of input channels to monitor output voltage application, and limit switch detection of the operation of actuators within set times.

Change-over relay contacts used to select duplicate output channels.

The use of manually selected duplicate, duty standby systems with paralleled inputs, and utilising standard diode isolation modules for parallel connection of DC output channels and power line selector.

Automatic duty standby parallel systems controlled by a third watchdog system of diverse design.

Emergency shutdown fail safe systems, using a mixture of solid state and relay output devices.

All the above circuit arrangements can be constructed from within the ADC families, with diversity of output control provided by a wide range of solid state and electro-mechanical relay output modules.

All ADC PLC systems incorporate non-volatile memory, with the choice of battery backed CMOS RAM, EEPROM, or UVPROM.

Control interfaces

Protection

Many panel mounting operator interfaces are protected to IP65, and contain sealed membrane key pads, however they are usually not sealed at the back and must always be mounted in an enclosure sealed to suit the environment. EN 60204-1:1992 10.1.2

The DV1000 operator terminal is not sealed to any specific standard and should only be used in control cubicles with protective sealed doors, or in a suitable environment, specified in the machinery technical manual.

Due to their complexity, **operator interfaces must not be used as emergency stop devices.**

A choice of output module types are available in all ADC ranges, where single channel outputs with individual commons, or multiple output channels sharing commons, can be selected to suit the application. EN 60204-1:1992 11.2

Where modules with shared commons are used, it is recommended that separate, bus connected DIN rail mounting terminals be used, to provide the single point control and common return connections.

Inputs

All ADC PLC input modules utilise opto-isolation, with the exception of two modules in the DL 05 and DL 06 range: F0 04AD-1 and F0 4AD2DA1 EN 60204-1:1992 11.2.1

The standard requires that the common supply terminals of each input module circuit must be connected to the protective bonding circuit, at the single common terminal point of the supply.

Outputs

The standard requires that the common supply terminal of each output which is load switched by the PLC must be connected to the protective bonding circuit. For compliance it will be necessary to choose complimentary sinking output and sourcing input module styles. Many ADC input modules can be sink or source configured, and it is the responsibility of the machine designer to ensure that any earthing requirements of loads or auxiliary equipment that are switched by the PLC output modules are complied with. If a conflict occurs then separate isolation transformer windings must be used. EN 60204-1:1992 11.2.2

Requirements for the suppression of interference caused by the switching of inductive loads are detailed in each PLC user manual.

Switched output rates of less than 5 times per minute are outside the requirements of the EMC directive, but if rates exceed 5 per minute, then special consideration should be given to the suppression of electrical noise at source, preferably using capacitive, resistive and inductive components to avoid the fire hazard of un fused transient suppressers.

A 100 ohm resistor and 0.1uf suppresser, wired directly across the switching element, is normally adequate suppression for most inductive PLC loads on 230vAC 50Hz supplies.

Servo drive interfaces

EN 60204-1:1992 11.3.1

Differential analogue outputs and inputs are required for signals between motor drive units. ADC PLC systems offer opto-isolated, low source impedance, current loop input and output modules, in several configurations and combinations. Opto-isolation ensures immunity to common mode signals between I/O lines and frame. The low impedance of current loop signals ensures good overall noise immunity.

Hydraulic, servo and velocity drives

EN 60204-1:1992 11.3.2/3

All industrial standard, current and voltage interface levels, including ±10v, are available in each range.

Communications

EN 60204-1:1992 11.5

A key-operated switch, with a label marked "isolate communications if operating machinery during maintenance" must be provided in any networked PLC control cubicle. Special products are under development.

Electronic equipment

I/O status

EN 60204-1:1992 12.2.1

All ADC PLC input and output channels contain LED indication of their operational state.

Equi-potential bonding

EN 60204-1:1992 12.2.3

As per the requirements of this section, all control cubicles in a network, utilising communications or remote I/O, must be equi potentially bonded by cables in excess of 6mm^2. Communication cables must have twisted pairs with foil and 60% braid screening with the braiding connected to the machinery frame at both cable ends.

See draft Installation guidelines IEC 1000-5-1, and IEC 1000-5-2 for site installation requirements.

PLCs

EN 60204-1:1992 12.3.1

ADC programmable controllers comply with the sections of EN 61131-2:1995 that are applicable to the machinery directive.

Memory retention and protection

EN 60204-1:1992 12.3.2

Non-volatile memory is provided. Programs may be password protected, and special programming devices or software systems are required for memory alteration.

Programming equipment

EN 60204-1:1992 12.3.3

The machinery manufacturer can withhold access to control programs by password protection and fixing programs into UVPROM memory.

Operator interfaces and programming devices can operate without interaction, on all CPUs with two or more serial ports.

Where communications, networking or operator interfaces are required on a machine, dual port CPUs only, must be utilised.

Verification

EN 60204-1:1992 12.3.4

Software project titles and revision levels must be accurately maintained so that hard copies of a project's title page, using the DirectSOFT programming software, will ensure verification of documentation and software on disc.

Testing

Insulation resistance

EN 60204-1:1992 20.3

ADC PLC equipment has been tested to >10M ohm at 500v DC. This is well in excess of the requirements.

Voltage test

EN 60204-1:1992 20.4

ADC PLC equipment has been tested to withstand in excess of 1000v AC for 1 minute.

Residual test

EN 60204-1:1992 20.5

There are no hazardous residual voltages, as switched mode power supply capacitors are discharged.

EMC

EN 60204-1:1992 20.6

ADC equipment complies with the generic heavy industrial requirements of the EMC directive, including IEC 801.

The Low Voltage Directive

Introduction

The low voltage directive simply states that electrical equipment must be safe. It states that following the guidelines detailed in the applicable standards within the directive, will in most cases satisfy the safety requirements. EN 61010-1:1993

Compliance with standards does not however, exonerate all further responsibility and in the case of an accident or dispute, enforcement agencies will look to the end user and manufacturing chain of the electrical apparatus, for evidence of irresponsible design or use.

The most relevant generic safety standard under the low voltage directive is:

EN61010-1:1993 Safety requirements of electrical equipment for measurement, control, and laboratory use.

However the standard EN 61131-2 is a combined standard (product specific) which has a large section on safety, and encompasses both the low voltage and the EMC directives. Equipment that fully complies with EN 61131-2 is covered in the eyes of the low voltage directive, as long as all the manufacturer's guidelines and the guidelines of this document are adhered to.

Classification for CE marking by the operating environment

Confusion can arise as the low voltage directive applies only to equipment operating on voltages greater than 50v RMS and modules which allow higher voltages may be inserted. For this reason, all items in the ranges are considered individually.

Installation category

Electrical equipment may fall into one of three installation categories, which declare the level of over voltage within an environment.

Likewise equipment may fall into one of two categories of pollution degree, which stipulate allowable levels of environmental pollution in an environment.

If equipment is CE marked as suitable for a particular category, then over voltages must be limited by suitable devices (transient suppressers etc) to the level specified in that category; see the following table.

Category 3 equipment connected directly to the power distribution system within a factory or work place is closest to the source of over voltages caused by the switching of large inductive loads, and motor over runs, etc.

Category 2 equipment connected to a local AC power outlet is deemed to experience a lower level of over voltage from the same sources as above due to natural damping in the electrical distribution system.

Category 1 equipment is deemed as being operated via an isolation transformer, or isolating power supply, within a control cubicle.

All ADC PLCs are rated as basic insulation. This is the insulation offered by the manufacturer between the live side of the power supply and the I/O and comms ports.

Installation Category		Overvoltage Category	
Level	Description	Peak impulse withstand voltage from 230vac power.	
		Basic Insulation	Double Insulation
1	Signal level, special equipment or parts of equipment, telecommunications, electronics, etc.	1500v	2550v
2	Local AC power level, appliances, portable equipment, etc.	2500v	4250v
3	Distribution power level, fixed installations, etc.	4000v	6800v

Pollution level

Two levels of pollution are specified, across terminals and printed circuit boards.

Pollution degree 1: No pollution, or only dry, non-conductive pollution occurs. The pollution has no influence.

Pollution degree 2: Normally only non-conductive pollution occurs.

Occasionally, however, a temporary conductivity caused by condensation must be expected.

Classification with regard to protection against electric shock

The definition of Class, which designates the means by which electric shock protection is maintained in normal use, and likely fault conditions.

Class 1: All accessible parts of the PLC equipment are earthed to a protective earth terminal, so that only basic insulation is required in the external circuits of the installation.

Class 2: Accessible parts of the PLC equipment are not earthed, so that double or reinforced insulation will be required in the external circuits of the installation.

Safety requirements for installations

All ADC PLC equipment designed after May 2000 is compliant with the product specific standard EN61131-2. All PLC equipment designed before this date, complies with the generic standards as outlined earlier on in this document and in the chart in the annex. Therefore the DL 05, DL 06, DL 205, DL 305 and DL 405 PLC ranges, all comply with the generic standards, but not to the product specific standard EN 61131-2

In the case of future modules for existing PLC ranges, they will be certified to the generic standards.

EN61131-2 stipulates a minimum installation (over voltage) category of 2, and that over voltages are controlled to less than 1500vDC by suitable devices (transient suppressers etc). It also stipulates minimum creepage and clearance distances across PCBs that are larger than those required by EN61010-1 (the low voltage directive safety standard).

All ADC equipment is suitable for installation (over voltage) category 1, and to pollution degree 1, when the safety requirements of the manufacturer, the low voltage directive and the machinery directives are met. They state that PLC equipment must be housed in a protective steel enclosure, sealed against the ingress of moisture and polluting gases, and that with access by operators is limited for safety reasons, by lock and power breaker.

The declaration of conformity (associated with CE marking), of ADC equipment states that if access is required by operators or untrained personnel, then the PLC equipment must be installed inside an internal cover or secondary enclosure.

Furthermore the safety requirements of the machinery directive standard EN60204-1, state that all control circuits and PLC power circuits must be via isolation transformers or an isolating power supply, and one side of all AC or DC control circuits must be earthed. This is the same as installation category 1 of the standard EN61010-1 (low voltage directive).

For fire safety hazard reasons both power input connections to a PLC must be separately fused using 3 amp T type anti-surge fuses. Also a transient suppresser must be fitted to limit PLC supply and control circuit over voltages to 1500v maximum. This ensures that the stipulations of over voltage category 1 are met.

Accessible parts that may become hazardous live in a control system

PLC's are complex components, that are mounted within enclosures. The only accessible parts in a PLC system are the control circuit and power wiring, and the braid of screened cables outside the control cubicle.

Operator interface (MMI, HMI) products are mounted on enclosure fronts and hence accessible. The thickness of membrane keypad overlays, and the plastic cases has been considered when CE marking operator interface products.

Control and power circuits are required by the machinery directive to be earthed, and ADC products have been CE marked on this basis and installation requirement.

The new installation standards IEC 1000-5-1, IEC 1000-5-2, and EN 61131-4 state that the braid of screened cables must not be used for connection of the signal 0v within networks. Braiding must be earthed to the cubicle frame, and substantial equi-potential bond wires must be wired alongside serial cables between each node of a network purposely forming complex ground loops in order to reduce the overall impedance of a grid style ground plane in a factory or office.

It is the responsibility of the system designer to ensure that control and power circuitry connected to the PLC is earthed, as previously specified, and that screened cable braiding is earthed with equi-potential bonds between nodes of a network.

Correct observance of these requirements will ensure that there are no accessible un-earthed circuits or parts associated with a PLC system.

Single fault test conditions

The system designer must also be aware of the further requirements of the low voltage directive safety standard EN 61010-1, section 4.4. which requires design of the control system to accommodate the following single fault test conditions to test for protection against the spread of fire:

A TCF (technical construction file) should be kept for each project or product that demonstrates how hazards have been avoided in the following sections.

Each test is applied one at a time for an hour, and there must be no effect on operation after resetting of fuses, etc. No hazardous live voltages or excessive temperatures that may cause fire are allowed.

Protective impedance

EN61010-1 4.4.2.1

If the system designer uses series resistors or voltage clamps to ensure that an accessible part does not become hazardous live, then no hazard should be created when these are shorted out or removed under normal conditions. This is not normally part of an industrial control system design.

Protective conductor

EN61010-1 4.4.2.2.

The ground terminal of the PLC system must be open circuited and the system run for one hour to ensure that hazardous live situations cannot occur on accessible parts, or the electrical noise from filters cause destruction and a fire hazard in sensitive electronics.

Actuators

EN61010-1 4.4.2.3

Actuators driven from output modules designed for short term or intermittent operation in the system must be operated continuously, or it must be demonstrated in the TCF how this condition is protected.

Motors

Motors must be stalled for an hour while fully energised, or it must be demonstrated in the TCF how this condition is protected. EN61010-1 4.4.2.4

Capacitors

Capacitors in the auxiliary windings of motors (except self healing capacitors), must be short circuited for one hour while the motor is fully energised, or it must be demonstrated in the TCF how this condition is protected. EN61010-1 4.4.2.5

Transformers

Mains and control voltage isolation transformers must have each winding short-circuited or subjected to worst case overloads for one hour, or it must be demonstrated in the TCF how this condition is protected. EN61010-1 4.4.2.6

Outputs

Each output from the PLC must be short circuited one at a time, for one hour on full output, or it must be demonstrated in the TCF how this condition is protected. The ADC product literature details which modules are fitted with safety fuses, and their ratings. EN61010-1 4.4.2.7

Multiple supplies

Equipment designed to operate from more than one supply must be connected to both supplies simultaneously for one hour, or it must be demonstrated in the TCF how this condition is prevented. EN61010-1 4.4.2.8

Cooling

Equipment cooling must be restricted as follows, one fault at a time, for one hour each: EN61010-1 4.4.2.9

- Air holes in cubicles, with filters shall be closed.
- Forced cooling by motor driven fans must be stopped.
- Cooling by circulation of water or other coolant must be stopped.

Heating

Equipment with heating devices must have the following faults applied one at a time. EN61010-1 4.4.2.10

- PLC timers that limit the heating shall be over ridden to run continuously.
- Temperature controllers, (except for over temperature control devices which have special requirements under section 14.3. of standard), must be overridden to energise the heaters continuously.

Insulation

Insulation between all circuits and accessible parts must be short circuited. This is a test to ensure that any live control or power lines shorted to any other circuit or part will blow a fuse. EN61010-1 4.4.2.11

Alternatively the protection means can be demonstrated in the TCF.

Interlocks for the protection of operators must be high integrity components as detailed under sections 14.6. and 15.3. of the standard, and type approved for the application under an IEC standard. EN61010-1 4.4.2.12

Tests and other requirements

Compliance

EN61010-1 4.4.3

Compliance must be met as detailed in the standard EN61010-1:1993, or latest issue as released in the OJ.

All other aspects of the standard are also applicable, and must be checked by the system designer.

Earthing

PLC-Direct equipment must be installed and operated with one side of all control and power circuits, and the braid of screened cables adequately earthed. This ensures that there are no unearthed parts or circuits accessible to operators, and that basic insulation is adequate when used in external circuits of the control system as per table D1 in annex D of the standard.

Earth bond

If both sides of the power supply are fused then the earth bond impedance of the control panel earth circuit must be checked by applying a test current of twice the fuse or circuit breaker rating for the control and power circuit for 1 minute. The voltage between the protective bond terminal on the PLC and earth must not exceed 10vDC or AC RMS. If only one side is fused then 25 amps test current is required, and checked to 0.1 ohm impedance.

Double insulation

If an external circuit controlled by the PLC equipment needs to be isolated from earth, and hazardous voltages occur on this external circuit, then double insulation must be provided. This can be achieved by using a relay on the output circuit of the PLC system, which will provide double insulation rating between adjacent output channels, and to the logic supply powering the output device on the output module.

This requirement may be the main contributing factor when choosing a PLC range, and output module type. It is the responsibility of the system designer to assess the hazard and select the correct module for the task.

Hazardous live parts in the form of terminals and sockets are permitted to be protected by basic insulation in the external circuits of the control system so long as the system designer ensures that terminal sockets and connectors have no accessible live parts by utilising good engineering practice.

The system designer must not compromise the basic insulation requirements of the PLC or system by using inferior quality connectors and terminals or by mixing different circuits within the wiring of those connectors.

The EMC Directive

Introduction

All PLC equipment supplied by ADC, must be configured by competent engineers, and the resultant control system must be housed in a steel enclosure to comply with the safety requirements of other directives.

The many possible configurations of control equipment, and differing cable arrangements both inside and outside the control cubicle, will always result in control systems with differing EMC characteristics.

The tests covered by this document are conducted by ADC and have been designed to simulate actual operational configurations.

Types of PLC user

EMC compliance must be designed into control panels by all personnel associated with their manufacture.

The decision on whether to self certify the final product or system, or to use an official test house to approve the product, or a TCF (technical construction file), depends on the product produced.

There is no legal requirement in the directives, which state that only an official test house can be used for official approval, and there is also no such thing as a pre-compliance test. The end user, OEM, or system builder can conduct their own in-house tests using purchased or hired equipment, or hire time in a test laboratory to conduct their own tests.

If the product is designed to be EMC compliant, the design engineer can utilise good engineering judgement to decide whether testing is required before applying the CE label. The EMC directive simply states that the equipment must not cause interference, and must have a reasonable level of immunity to EMC phenomena.

In the case of a dispute however, a design engineer or company that does not conduct any tests may find itself liable to civil or legal action.

Manufacturers of standard machinery placed on the open market (OEMs)

Machinery or equipment containing PLC's, placed on the open market must show compliance to the EMC directive. The manufacturer can choose to self certify to harmonised standards, or to use a test house to approve a TCF.

The results from the test report should provide sufficient information for the system to be approved by a test house.

Manufacturers of special purpose machinery for a single end user's own use

In this case the machine or product specification will have been constructed and approved by both the final end user and the special machine manufacturer. Use should be made of the questionnaire in the standard EN60204-1 (machinery directive), to ensure that the EMC environment is consistent with the product or machine design. Utilising the results obtained in this report, and providing proof of EMC measures taken will assure compliance.

Integrators of individual machinery into systems for one end user

A systems integrator must obtain from the final user, adequate information regarding the operating environment, usually by means of the questionnaire associated with EN60204-1, and these requirements must be included in the contract and project specification.

The systems integrator can then utilise the EMC test data contained in this report to configure EMC compliant systems, with the EMC design measures documented in the technical manual for the product.

EMC compliant panels can be designed, and manufactured in-house, or contracted out to a panel builder.

If however the end user specifically states in the purchase contract that CE approval is the responsibility of the systems integrator, a TCF must be compiled. This must include the data from this report, and official approval for the TCF must be obtained from a test house.

Panel builders working to constructional drawings, and end users constructing their own systems

The panel designer must utilise this test report to determine EMC characteristics for each panel design. This will normally control the layout of components, power line filtering, and cable style and layout with regard to other susceptible components within the same panel. EMC compliant panels can then be built to order.

Environments applicable to the PLC system under test

AC powered equipment for use in domestic, light and heavy industrial environments.

DC powered equipment for use in the domestic, light and heavy industrial environments.

Battery powered equipment where the power leads are less than 3 metres in length.

EMC standards applicable to PLC manufacturers

Please see the May 2000 decision in the annex for explanation of the standards applied by ADC. The standards chart, also in the annex will give an overall guide to which standards ADC applies to which products.

Product specific standard

EN 61131-2 : 1995 and amendment AMD 9441-Programmable controllers part 2. Equipment requirements and tests

The standard EN 61131-2 is a combined product specific standard, which encompasses both the low voltage and the EMC directives. However equipment that complies with EN 61131-2 only, is not fully covered in the eyes of the EMC directive, as other EMC standards are required. However in the eyes of the low voltage directive, EN 61131-2 covers all aspects, as it is recognised as a safety standard under the low voltage directive.

EN 61131-2 covers EMC immunity for which it calls up various standards from the EN 61000 series, but it does not reference other standards for rf emissions. It simply states:

'Due to differing national regulations, emission levels cannot be specified. Equipment shall meet the levels specified in every country of concern'. EN 61131-2 3.9.3

Therefore ADC applies the generic rf emissions standard EN 50081-2 for industrial environments.

EN50081-1	or EN 55011 class B. Rf emissions for domestic environments. Domestic accreditation is not normally necessary as PLCs are industrial products. Although a PLC may not pass rf emissions limits to domestic environments, special external modifications and conditions can be made in certain circumstances.
EN50081-2	or EN55011 class A. Rf emissions for heavy industrial environments.
EN61000-4-2.	Electrostatic discharge, immunity.
EN61000-4-3	Radiated electromagnetic field immunity.
EN61000-4-4	Fast transients, immunity.
EN61000-4-12	Damped oscillatory wave immunity.
EN 61131-2	Programmable controllers (product specific). Voltage and frequency variations.
EN 61131-2	Programmable controllers (product specific). Third harmonic immunity.
EN 61131-2	Programmable controllers (product specific). Supply interruptions and variations, immunity.
EN61000-3-2.	Harmonic emissions.
EN61000-3-3	Voltage fluctuations and flicker, emissions.

Generic standards

EN50081-1 or EN55011class B. Rf emissions for domestic environments. Domestic accreditation is not normally necessary as PLCs are industrial products. Although a PLC may not pass rf emissions limits to domestic environments, special external modifications and conditions can be made in certain circumstances.

EN50081-2 or EN55011class A. Rf emissions for heavy industrial environments.

EN61000-4-2. Electrostatic discharge, immunity.

EN61000-4-3 Radiated electromagnetic field immunity.

EN61000-4-4. Fast transients, immunity.

EN61000-4-11 Voltage dips, interruptions and variations, immunity.

EN61000-4-12 Damped oscillatory wave immunity.

EN61000-3-2. Harmonic emissions.

EN61000-3-3. Voltage fluctuations and flicker, emissions.

With regards to immunity for industrial environments, the new standard EN61000-6-2 –Generic immunity standard for industrial environments, replaces for earlier generic standard EN 50082-2:1995. This new standard includes new tests, which are not necessarily directly applicable to PLCs, as the product specific standard EN61131-2 does not call them up. Although at ADC we are only certifying all new products to this standard, we also intend to lean toward it with the when testing and retesting the existing equipment. We have therefore also included the standard EN 61000-4-12 –Damped oscillatory wave immunity, that EN61131-2 calls up, for use on equipment designed before May 2000, (see May 2000 decision in annex).

Tests limits applicable to the EMC directive

Generic domestic and light industrial environments, emission

EN50081-1:1995

Port	Frequency MHz	Limits	Basic Standard
Enclosure	30 - 230	30dBuV @ 10m peak. (40dBuV @ 3m)	EN55022 Class B
	230 - 1000	37dBuV @ 10m peak. (47dBuV @ 3m)	EN55022 Class B
AC mains	0.15 - 0.5	66 - 56 dB(uV) quasi-peak	EN55022 Class B and EN55014
		56 - 46 dB(uV) average	EN55022 Class B and EN55014
	0.5 - 5	56 dB(uV) quasi-peak	EN55022 Class B and EN55014
		46 dB(uV) average	EN55022 Class B and EN55014
	5 - 30	60 dB(uV) quasi-peak	EN55022 Class B and EN55014
		50 dB(uV) average	EN55022 Class B and EN55014

Generic heavy industrial environments, emission

EN50081-2:1994

Port	Frequency MHz	Limits	Basic Standard
Enclosure	30 - 230	30 dBuV @ 30m quasi-peak. (40dBuv/m@10m, 50 dBuV@3m)	EN55011 Class A
	230 - 1000MHz	37dBuV @ 30m quasi-peak. (47dBuv/m@10m, 57 dBuV @ 3m)	:
AC mains	0.15 - 0.5MHz	79 dB(uV) quasi-peak	:
		66 dB(uV) average	:
	0.5 - 30MHz	73 dB(uV) quasi-peak	:
		60 dB(uV) average	:

Generic domestic and light industrial environments, immunity

EN50082-1:1992

Test	Levels	Basic Standard
Enclosure		
RF field	27 - 500Mhz, 3v/m unmodulated	EN 61000-4-3
ESD	8kv air discharge	EN 61000-4-2
Signal and control lines, and DC input/output power ports		
Fast transients	500v peak, 5/50nS, 5khz	EN 61000-4-4
AC power ports		
Fast transients	1kv peak, 5/50nS, 5khz	EN 61000-4-4

Generic heavy industrial environment, immunity

EN50082-2:1995

Test	Levels	Basic Standard
Enclosure		
RF field	80 - 1000Mhz, 10v/m, 80% AM at 1khz 900Mhz, 10v/m, 50% PM at 200hz	EN 61000-4-3
ESD	8kv air discharge, 4kv contact	EN61000-4-2
Signal and bus lines		
Fast transients	1kv peak, 5/50nS, 5khz	EN61000-4-4 criteria B
Process, measurement, control lines, AC and DC input and output power lines		
Fast transients	2kv peak, 5/50nS, 5khz	EN61000-4-4 criteria B

Product specific

For PLCs conforming to the product specific standard EN61131-1, the following immunity requirements are met. Emissions for this category are covered by the generic standards as detailed above.

Noise tests		Noise severity levels		
	Maximum surge energy/ minimum source impedance	All power supplies	Digital I/O, ext supply ≥ 24v	Digital I/O, ext supply < 24v, analogue and communication I/O
ESD	150 pf/150Ω	15Kv	15Kv	15Kv
Rf field		10v/m	10v/m	10v/m
Conducted noise Common mode fast transients	mj/ spike at 2kv on 50Ω	2Kv	1Kv	0.25Kv
Damped oscillatory wave, series mode.	200Ω	1Kv	1Kv	-

Other immunity tests within the product specific standard

The following tests are specified by EN 61131-2. The standard does not reference any other standard, but instead provides details for the these tests within.

- Voltage and frequency range
- Third harmonic
- Momentary interruption
- Gradual and sudden shut down and start up
- Gradual supply variation
- Improper supply connection, polarity and voltage level

Future additions to standards

Surge

These tests simulate indirect lighting strikes. The PLC product specific standard EN 61131-2 in section 3.9.1, table 16, note 5, states 'Revision of these requirements is under consideration in order to take EN 61000-4-5 into account'. EN 61000-4-5 is about surge immunity tests.

Emissions

None in the relatively near future

Evaluation of EMC characteristics

When testing to the European standards three thinking methodigies are utilised. Firstly, the PLC equipment must be setup in as true to life a situation as reasonably possible, secondly the procedures as detailed in the applied standards are followed as closely as reasonably possible. Thirdly, and because of the vast complexity of rf emissions and the possible combinations of system builds, the product is tested at building block level. Hence for emissions testing, the system is separated down to each module and base, and tested separately.

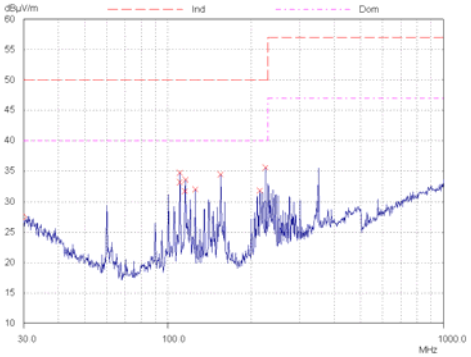
The rf emission characteristics of a modular PLC system are affected directly by control cubicle type, layout, quantity of orifices to the cubicle, the equipment within the cubicle, and the cabling arrangement utilised, to mention but a few. Therefore there is a virtually infinite number of possibilities and combinations of final system build, in terms of rf emissions. This is the reason that when testing for rf emissions, each module, base etc is tested individually.

The evaluation of the rf emissions of PLC components is conducted with the equipment mounted on an industry standard cubicle or enclosure. This is placed on a 0.8m non conductive table.

Immunity tests are conducted with the PLC equipment mounted within an industry standard cubicle, within the anechoic chamber. This ensures there are no external EMC influences, which would affect the products whilst undergoing testing. A capacitive clamp is used to couple fast transients on I/O, control and comms lines, whilst power inputs and outputs are injected directly or via capacitive networks as detailed in the emissions standard.

Radiated emissions

This is a very important test as it produces more failures than any other. Rf emissions in region of 30-1000MHz are observed. The products are set up in a real life situation, with appropriate cables, industrial enclosure etc. To the left is an example of a radiated emissions scan. The two limit lines shown are domestic and industrial, and are only relevant to a test distance of 3 metres. Although the accuracy of a good anechoic chamber is high, the standards still stipulate the use of an OATS (open area test site). Therefore once a scan is performed in the anechoic chamber, the highest emissions are observed and individual measurements are taken on the OATS.



Emissions test equipment

The emissions are measured with an EMCO hybrid conical, log period antenna. The test receiver is Rhode & Schwarz, which is the preferred choice of major test houses worldwide.

Anechoic chamber

Testing is carried out initially in the anechoic chamber. This performs two main tasks. Firstly it reduces ambient signals by 100dB to negligible levels across the range of 30-1000MHz, and secondly it virtually eliminates internal reflections from rf signals from the product under test. This means that the signal received at the antenna is the direct signal only, as there is negligible influence from reflected signals.

Guard band

If the measured signals on the scan rise to 15dBuv/m below the industrial limit line, the product is taken to the outside test site, (or OATS). At the OATS, a guard band of 5dBuV/m is used. Any emission falling 5dBuV/m below the limit line is considered a failure.

The OATS is the final word in accuracy, and ADC have built theirs very closely around the ideal as specified in CISPR 16, which is the EU standard, covering requirements for official test sites.

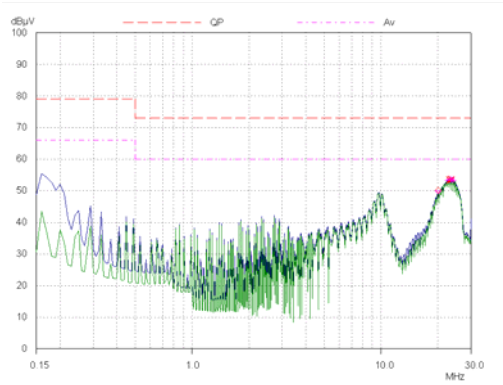
OATS

At the OATS the normal EU EMC procedure is utilised. The antenna is raised from 1 – 4 metres and the product is rotated through 360 degrees. An automated antenna mast and recessed turntable are used to do this. The test distance is 10m and the product is placed 0.8m in height over the turntable.

The galvanised steel ground plane is 10m x 3 m, and is perforated so as to avoid buckling with temperature change.

Conducted emissions

This is applicable to ac powered units only and testing is carried out in the range of 150KHz – 30MHz.



The test is carried out within the anechoic chamber, and a LISN (line impedance stabilisation network) is used to couple the product to the mains supply. The LISN has an rf pickup socket which is used to output the rf signal to the test receiver, where a scan is run. Two scans are run, one between line and earth and the other between neutral to earth. To the left is an example of a conducted emissions scan, between line and earth. The green plot illustrates the plot for the average measurement, and the blue represents the quasi peak measurement. The two limit lines are average and quasi peak.

Guard band

If the measured signals on the scan rise to 3dBuv below the industrial limit lines, the product is considered to have failed this test. Further tests will then be carried out, including tests using in line power filters.

Radiated immunity

This test is similar to radiated emissions tests, but the antenna is used to transmit a signal from 80-1000MHz with 80% amplitude modulation at a field strength of 10v/m. ADC outsources this test as it is fairly quick, and it is very rare that further investigation is required or that failures occur.

Fast transients, ESD, surge and dips

ADC uses a generator, by Schaffner, which is the preferred choice of major test houses worldwide. The generator is fully compliant with current EU standards for test equipment specification.

Fast transients are injected up to 4.4kv, ESD to 16kv, surge to 4.4kv, and simulated voltage dips and dropouts, at various specifications and levels are applied.

Harmonics, voltage fluctuations and flicker

These tests come under the emissions category, not immunity as one might expect. These tests are outsourced as they are quick, and it is unusual for a failure to occur.

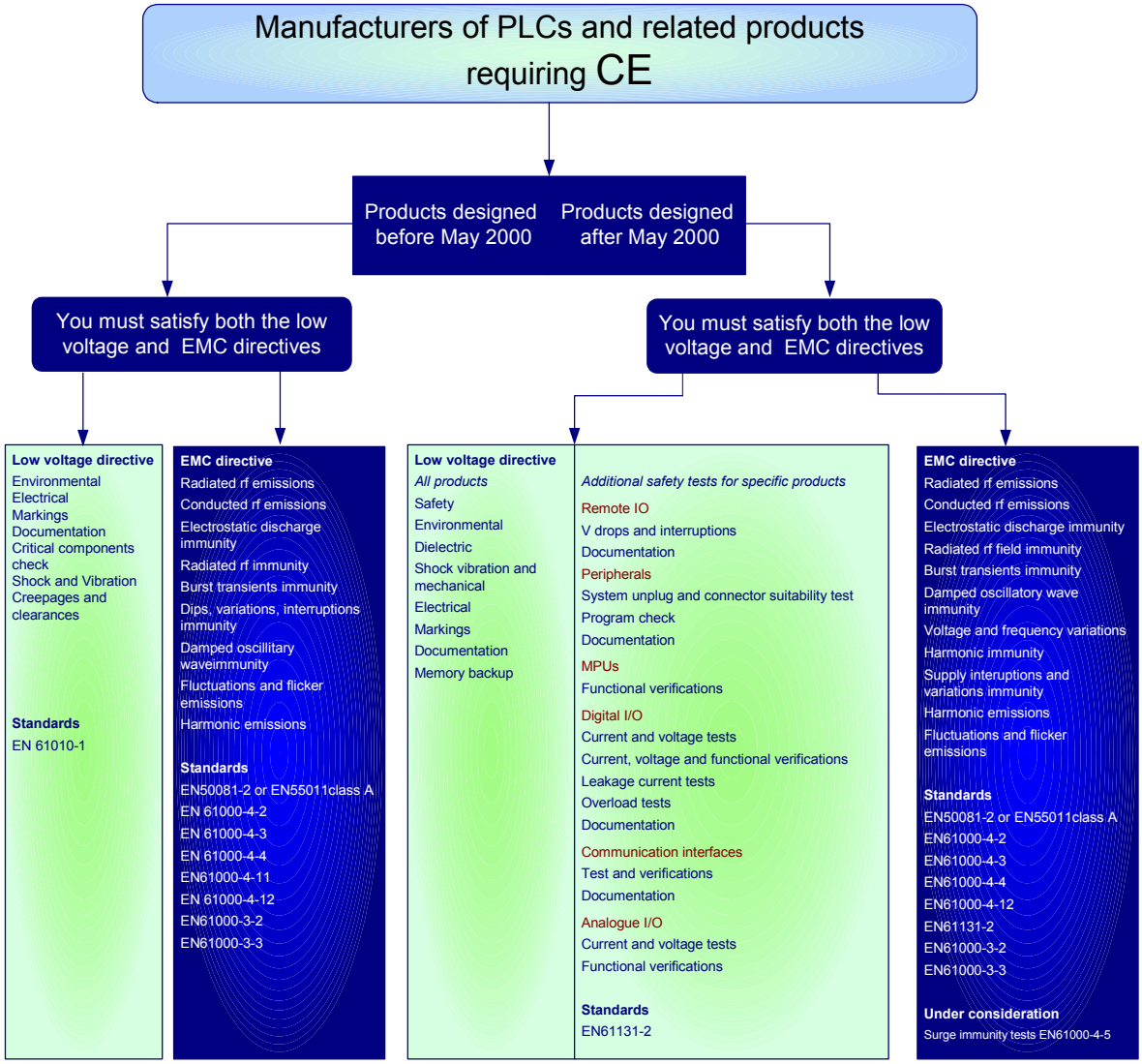
Appendices

Annex A

Statement on May 2000 decision

Annex B

ADC standards chart



Annex C

Extract of machinery directive questionnaire form EN60204-1:1993

Enquiry form for the electrical equipment of machines

The following information is required from the end user of the equipment to ensure proper design, application and utilisation of the electrical equipment of the machine, system or apparatus.

Name of Manufacturer or Supplier:
……..…….

Name of End User: ……..……..……..…

Tender/Order No. ……..…..…..…… Date
….……..…..

Type of Machine/Serial number: ……...……..……

1. Are there to be modifications as allowed for within EN60204-1:1992. Yes No

Operating Conditions - Special Requirements (section 4.4. of EN60204-1:1992)

2. Ambient Temperature Range ……..

3. Humidity Range ……..

4. Altitude ……..….

5. Environmental (e.g. corrosive atmospheres, particulate matter, special EMC characteristics)……

6. Radiation ……...……

7. Vibration, Shock ……..

8. Special installation and operation requirements ……

Power Supply(ies) and Related Conditions (section 4.3. of EN60204-1:1992)

9. Anticipated voltage fluctuations (if greater than ± 10%) ……

10. Anticipated frequency fluctuations (if greater than ± 1%) …….

Specification of the short-time value ……

11. Indicate possible future changes in electrical equipment that will require an increase in the electrical supply requirements ……

12. Indicate for each source of electrical supply required

Nominal voltage (V)		AC			DC
If AC, number of phases			Frequency		Hz
Nominal voltage (V)		AC			DC
If AC, number of phases			Frequency		Hz
Nominal voltage (V)		AC			DC
If AC, number of phases			Frequency		Hz

13. Type of power supply earthing: TN TT IT

TN (System with one point directly earthed, with a protective conductor (PE) connected to that point)
TT (System with one point directly earthed, but the protective conductor (PE) not connected to that earth point
of the system)
IT (System which is not directly earthed)

14. Is the electrical equipment to be connected to a neutral (N) supply conductor? (section 5.1. of EN60204-1:1992) Yes No

15. Does the user or the supplier provide the over current protection of the supply conductors?

(section 7.2. 1.of EN60204-1:1992)……..

Type and rating of over current protective devices ……

16. Supply disconnecting device

- Is the disconnection of the neutral (N) conductor required? Yes No

- Is a link for the neutral (N) permissible? Yes No

17. Type of disconnecting device to be provided……..……

18. Limit of power up to which 3-phase motors may be started directly across the incoming supply lines……..…kW

19. May the number of motor overloads on 3-phase motors be reduced to 2 ?

(section 7.3. of EN60204-1:1992) Yes No

20. Where the machine is equipped with local lighting:

- highest permissible voltage ……V

- if lighting circuit voltage is not obtained directly from the power supply, state preferred voltage ……V

21. Functional identification ……..(section 18.3 of EN60204-1:1992)

22. Inscriptions/Special markings ……

23. Mark of Certification? Yes No

- If YES, which one? ……

- On electrical equipment? ……

- In which language? …….

24. Technical documentation (section 19.1. of EN60204-1:1992)

On what media? ……

In which language? ……

25. Size, location and purpose of ducts, open cable trays or cable supports to be provided by the user: (section 19.5. of EN60204-1:1992) - (additional sheets to be provided where necessary.)

26. For which of the following classes of persons is access to the interior of enclosures required during normal operation of the equipment?

    - Skilled persons: ……

    - Instructed persons ……

27. Are locks with removable keys to be provided for fastening doors or covers? ……

28. If "two-hand control" is to be provided, state the type ……

29. Indicate if special limitations on the size or weight may affect the transport of a particular machine or control gear assembly to the installation site

    - Maximum dimensions: ……

    - Maximum weight: ……

30. In the case of machines with frequent repetitive cycles of operation dependant on manual control, how often is it expected that cycles of operation will be repeated?
    …… per hour.

31. For what length of time is it expected that this maximum rate of repetition will be repeated without subsequent pause? ……minutes.

32. In the case of specially built machines, is a certificate of operating type tests with the loaded machine to be supplied? Yes No

33. In the case of other machines, is a certificate of operating type tests on a loaded prototype machine to be supplied? Yes No