ETN008 EN July 2013	Electrotechnical design of equipment	ETO GRUPPE JOINTLY INNOVATIVE

Contents

DOC-VER.	CHANGE NO.	EDITED	CHECKED	RELEASED
01	500000009972	2018-03-06 D.CONZELMANN	2018-03-08 A.KUENSTLE	2018-03-08 U.KAMPHAUS

DOCUMENT NO.

100011086_Z25_001_01

REPLACEMENT FOR DOCUMENT NO

-

1 Purpose and Scope

This company standard is currently valid for ETO MAGNETIC GmbH.

This equipment specification (ES) is a guideline for the electrical and electronic design of facilities and machines. This equipment specification shall be applicable to all orders placed by ETO. The technical design is examined during machine acceptance testing using a checklist.

In case of contradiction between this equipment specification and the specifications sheet, the design in the specifications sheet shall be applicable.

If special agreements are made, these shall only apply to the relevant order and shall be documented in writing. Oral agreements shall not apply.

If during acceptance testing, deviations from the equipment specification are detected, the observance of which would have been possible, a modification at supplier´s expense may be requested.

The aim of this equipment specification is the following:

- High availability (operational availability) of the machine
- Minimum spares inventory and short downtimes in case of repairs due to the use of suitable preferred components
- Avoid additional work and costs during start-up
- Ensure safety for the operating and service personnel
- Ensure use of modern technology in respect of cost effectiveness, maintenance and set-up times
- Due to the standardization forming the basis of the equipment specification, ETO personnel can familiarize themselves quickly with new machines and facilities.

2 Change history

Issue	Change Description
November 2014	Translation of the German version July 2013

3 Project Organization and Project Management

At ETO, the relevant technical department is responsible for the technical assessment and the electrotechnical design of machines during procurement.

All drawings and planning documents shall be presented to ETO for viewing and approval purposes on the occasion of the design discussion. The approval only relates to the design principle. However, this shall not release the supplier from their obligation to produce a fully functional machine which meets the technical specification as well as the applicable standards and laws.

Project planning documents include:

- Machine / system concept
  - electrical
  - controls
  - safety
  - arrangement diagram of electrical components
- Operation chart
- NOK strategy

Technical modifications arising during production and project planning shall be agreed upon with ETO.

The supplier acts as general contractor. The supplier is also responsible for all interfaces and processes.

The supplier shall find out about the local conditions. ETO may assist in providing information on the conditions such as e.g. how the machine may be installed, energy supply as well as arrangement and configuration of assemblies such as e.g. electrical enclosures and control panels.

Acceptance testing of the electrotechnical equipment as well as the installation is performed according to the specifications sheet. The supplier shall complete the Equipment Acceptance - Electrical Engineering checklist and document the results. ETO will perform random sampling.

4 Specifications and Standards

4.1 General Information

The Directive 2006/42/EC on Machinery shall be applicable. The current version of the EC Low Voltage Directive shall be complied with accordingly.

The supplier shall be responsible for the safe operation of electrical facilities and compliance with the occupational health and safety standards and guidelines applicable at the time of operation acceptance.

4.2 VDE specifications

The EN 60204-1 including the recommendations and additional requirements specified therein shall be complied with.

In case of electrical equipment located in Ex areas, the specifications for electrical systems in explosive atmospheres shall be complied with.

4.3 Accident prevention regulations

In addition to the requirements specified in the machine standards, the requirements specified in BGV A3 shall be complied with.

Troubleshooting works or works for restoring equipment to its specified condition have to be performed on energized machine components. Electrical machines and equipment shall therefore be designed such that when above mentioned works are performed, during which protection against direct contact has to be suspended or disabled (e.g. by opening the doors of the electrical enclosure) for imperative reasons, the energized parts are protected against direct contact by additional measures taking into account voltage, frequency, application and location of operation.

The ready-to-use or connected electrical system shall be tested for its proper condition prior to start-up. The supplier shall confirm in writing that the electrical system complies with the specifications of BGV A3.

5 Nominal voltages

5.1 Supply voltage

Production location	Germany	Poland	China	USA
Electric grid system:	TN-C-S system **Three-phase current** L1, L2, L3, N, PE (400V, 50 Hz) **Alternating current** L, N, PE (230 V, 50 Hz)	TN-C-S system **Three-phase current** L1, L2, L3, N, PE (400V, 50 Hz) **Alternating current** L, N, PE (230 V, 50 Hz)	TN-C-S system **Three-phase current** L1, L2, L3, N, PE (400V, 50 Hz) **Alternating current** L, N, PE (230 V, 50 Hz)	TN-C-S system **Three-phase current** L1, L2, L3, PE (480V, 60 Hz) **Alternating current** L, N, PE (120 V, 60 Hz)

Symmetrical load distribution shall be ensured. The grid voltage fluctuation is +/- 10%.

If the connected load is greater than or equal to 30 kW, the short circuit current shall be limited to 50 kA eff.

5.2 Auxiliary voltages (control voltage)

For general controls, signal lamps and solenoid valves, stabilized 24V DC shall be used. The power supply unit shall have a minimum reserve of 30%. A PELV system (single-ended) shall be used for protection.

Control voltage and test voltage shall be galvanically isolated.

6 EMERGENCY STOP equipment, main switch and guards

Every safety equipment of a machine, as well as the separation of the EMERGENCY STOP circuits between individual machines, shall be agreed upon with ETO. In case of linked facilities or machines, the supplier shall prepare a safety concept which shall be agreed upon with ETO.

6.1 Emergency actions

All operators of EMERGENCY STOP control devices shall be reset (unlocked) manually after use. All risks shall be examined in the risk assessment. The EMERGENCY STOP concept and safe switching shall be laid out according to the results of the risk assessment.

6.2 Position of EMERGENCY STOP push-button switches

The position of EMERGENCY STOP control devices shall be selected such that the EMERGENCY STOP switch is easily accessible. It shall also be ensured that the EMERGENCY STOP switch is not operated inadvertently. The position of the EMERGENCY STOP push-button switches shall be agreed upon with ETO.

6.3 EMERGENCY STOP interface - partly completed machine or machine components

In case of partly completed machines or machine components, which are connected to a completed machine, the relevant EMERGENCY STOP circuits shall be connected.

6.4 EMERGENCY STOP interface - linked machines

When designing a machine, an unlinked machine concept according to the EC Directive on Machinery (e.g. the machine consists of several independent cabinets) shall be preferred to one integrated machine cabinet for all processes.

A linkage between the individual EMERGENCY STOP circuits is required if there is a risk for persons at the transfer points between linked facilities or machines.

6.5 Supply circuit disconnect

The supply circuit disconnect shall only be lockable in OFF position. The supply circuit disconnect shall be lockable with at least one padlock having a shackle diameter of up to 8 mm. Every equipment shall be provided with a supply circuit disconnect. In case of a fully-automated machine, the supply circuit disconnect shall be installed in the central electrical enclosure.

The installation height of 0.6 - 1.7 m for the supply circuit disconnect shall be observed. When the disconnect is to be installed in the door of the electrical enclosure, ETO shall be consulted. In case of a "connected facility", deactivation of the main switch must not cause an EMERGENCY STOP for the connected machine parts.

6.6 Guards / guard doors

The selection of safety measures shall be made according to the risk assessment of the machine.

Any hazardous areas shall be protected by means of guards with guard locking such that operation and monitoring is not made more complicated. The machine shall be protected such that operation without guard is not possible.

Opening a guard shall cause shut down of all hazardous energies.

Adjustment works with open guard door shall be possible without any limitations and manipulations regarding safety. Walk-in areas within safety enclosures shall be evaluated in the risk assessment and suitable (technical, organizational) measures shall be derived from the results.

It shall be possible to fill and empty palletizers, graders and bunkers outside of the protection equipment in order to prevent production interruptions and/or machine idle time.

7 Technical Documentation

7.1 General Information

Electrotechnical documents shall be compiled in folders or ring binders and provided with a table of contents.

The following documents shall be provided by the supplier not later than for operation acceptance:

- Operating manual as simple hardcopy as well as in electronic form including, amongst others
  Specifications of the equipment
  Machine layout / installation plan including dimensions
  Packaging, transport and installation instruction
  Operating manual
  Electric circuit diagrams
  Data sheets, technical documents and/or operating manuals for the components and parts used
  Spare parts and wearing parts lists
  Complete list of parts of the supplier
- Electric circuit diagrams in the electrical enclosure (in a folder)
- Project plan for electrical devices (in electronic form as ePLAN data incl. project data)
- EC declaration of conformity / EC set-up declaration
- Risk assessment according to machine specification
- Documentation of safety element configuration.

The supplier shall include any changes in the documentation.

Every document shall comply with the current status of the machine. The paper size for wire diagrams and connection diagrams shall be DIN A4 in landscape orientation. This also applies to all internal wiring diagrams, if these are not displayed in a broken down manner in the circuit diagram. All other documents shall be provided in DIN A4 format.

If documents are subject to authority approval (e.g. for facilities requiring reporting and monitoring such as pressure tanks, etc.) the supplier is obligated to obtain the test certificate from the relevant authority prior to handing over the machine to ETO and present them to ETO upon delivery.

7.2 Wiring diagrams

The wiring diagram shall include the following:

- Voltage, frequency and number of phases of the current supply
- Nominal values of current and output of machine (connected load)
- Nominal values of current and output of all individual drive units
- Nominal currents of fuses
- Lead or target designation
- Connection designation
- Settings of set-up switches
- Bus addresses
- Overview of interchangeable parts including the respective codes
- Contact assignment of contactors or relays
- Reference descriptions for finding the target location
- Explanations regarding the current paths (function)
- Set values of releases, pressure controllers, time relays and the like
- Set values of control devices, frequency converters and the like
- Set values of current, voltage and resistance
- Connection diagrams (terminal diagrams) including internal and external connections as well as wire numbers, cross sections and number of leads.

8 Design specifications

The electrical system shall be separated entirely from other types of energy (e.g. no pneumatic systems in electrical enclosures).

8.1 Electrical enclosure design

	Description
Types, dimensions, etc.	See company standard for preferred components
Cable feed	See chapter Cable Inlet
Color of enclosure	RAL 7035
IP Code	IP 54 (even with electrical enclosure cooling)
Ambient temperature	Up to +40 °C for continuous operation
Relative air humidity	Max. 90 %
Enclosure cooling	Via filter ventilators in the doors or air / air-heat exchangers of the cooling attachments

On the inside of every enclosure door a plastic pocket for documents in DIN A4 in landscape orientation, at least 40 mm deep, shall be attached. If several electrical enclosures are screwed together, every single electrical enclosure shall have a separate circuit diagram pocket.

Doors that can be unhinged having an angle of aperture of at least 130° shall be provided. The door stops (left / right) shall be agreed upon with the responsible ETO Electrical Engineering Project Manager in advance.

The electrical enclosure shall be equipped with a lock (cam lock with double-bit insert).

Isolated electrical enclosures shall be equipped with eyelets for transporting the assembled units.

Assembled electrical enclosures shall be mounted at least 100 mm above the installation area and must not present any obstacle to the transport of the machine. A design with rolls may be suitable.

8.1.1 Cooling and ventilation

The maximum permissible ambient temperature for the used parts must by no means be exceeded. Suitable ventilation of the electrical enclosure shall be always ensured. If during series operation, malfunctions of the machine / equipment occur caused by increased temperatures in the enclosure, the supplier is obliged to retrofit a sufficient cooling / ventilation system.

The housing temperature of electric drives (pump, motor, etc.) must not exceed 45°C.

The cooling or ventilation systems shall be operated depending on the temperature. (Energy efficiency)

8.1.2 Cable inlet

The cable inlets must not change the IP rating.

Generally, the cables shall be provided with a strain relief at the inlet, preferably by means of using screw connections with strain relief clamps. Screw connections shall be able to withstand the ambient conditions and in particular be oil-resistant. It shall additionally be ensured that only plastic screw connections are used when cables are let in plastic housings.

Cable runs from / to the electrical enclosure shall be selected such that these are not damaged during transport. No cables must be installed below the lowest frame part of the base frame.

8.1.3 Electrical enclosure illumination and sockets

An illumination for the electrical enclosure shall be provided for enclosures sized 600 mm x 1.800 mm and up. The illumination shall include interior lamps with door contacts for every compartment as well as a Schuko socket. The enclosure illumination as well as the Schuko sockets (yellow) in the enclosure shall be connected in front of the main switch and have a separate circuit. The corresponding installation shall be guided via distribution boxes or separately covered terminal blocks ("yellow" color of cables and wires and/or protective hose).

8.2 Terminal boxes

Terminal boxes shall have an IP rating of at least IP 54 and be installed at locations easily accessible from outside.

8.3 Arrangement of electric equipment / reserve

The installation height of indicating and operable measuring and control devices as well as an external control panel shall be 1200 mm min. and 1600 mm max. above finished floor level.

The arrangement of control components shall be presented to the responsible project manager for approval.

The electrical enclosures shall be sufficiently dimensioned such that at least 30% reserve space is available for later upgrades of standard machines. The reserve space shall be provided for the devices of individual functional groups as well as the terminal blocks, cable ducts, swing frames, slots and program storage devices.

8.4 Programmable logic controllers

The number of slots for input / output assemblies shall be selected such that 30%, but at least 1 slot for every input or output assembly, remains unused or 1 slot for a combined input/output card.

8.5 Service sockets, network outlets

If housings and installation spaces contain electronic equipment, such as e.g. programmable logic controllers (PLC), at least one Schuko socket shall be installed for service purposes outside of the electrical enclosure.

For providing a connecting to the machine network, network outlets shall be installed on the machine front and back of larger assembly machines for service purposes.

On larger assembly machines, two service sockets per station shall generally be provided outside of the electrical enclosure on the machine front and back.

The positions shall be agreed upon with ETO during the design stage.

8.6 Remote maintenance access

For all devices, which allow for remote maintenance by the supplier, this feature shall be implemented. The machine suppliers have access to the entire facility via VPN. Remote maintenance access shall be agreed upon with ETO-EDV. Subordinate devices shall be included in the remote maintenance (e.g. welding laser) and the access at the respective machine location be tested.

8.7 Wires and cables

All wires shall be installed non-stop from connection point to connection point without any connection links. Junctions are only permissible at easily accessible but enclosed connection or junction boxes.

All wires shall be protected against excess current. The control wires shall be flexible and at least have fine wire strands. Multicore cables shall be used for the installation outside of electrical enclosures and control panels. Cores (strands) are not permitted. This does not apply to additional earth or equipotential bonding conductors. Cables which are subject to movement during operation, shall be highly flexible (suitable for drag chains). Cables installed in drag chains shall have plug-in connectors on both ends. In the wet area of oils, emulsions or similar materials, PUR cables or cables having at least equivalent properties shall be used.

Cables in cable ducts shall be installed such that they are easily accessible. Opening the cable duct shall be possible without disassembling machine parts. Bundled cables longer than approx. 30 cm shall preferably be installed in a cable duct.

8.8 Wiring

Core coloring specifications for machines used within the EU:

	Description
Main circuits	black 1.5 mm^2 and up
Control circuits AC	red 1 / 1.5 mm²
Control circuits DC	blue 0.5 mm^2 and up
External voltages AC / DC	orange or yellow 1 / 1.5 mm²

For the locations China and U.S., the relevant country-specific guidelines shall be observed.

Different colors for the phases of control circuits are not wanted.

Control circuits which are energized by external voltage, i.e. energized from outside or are energized even with the main switch turned off, shall have an "orange" core color. The wiring of the electrical enclosure shall be guided in plastic ducts. Only conductors with fine strands shall be used for the wiring.

Every cable coming from outside and going to the terminal and/or junction boxes, control panels and/or electrical enclosures shall be guided on terminal strips.

On every terminal strip, only one wire may be connected per connection point. In the wiring ducts no equipment, terminals or terminal connections must be installed.

The wiring shall comply with the wiring diagram.

8.9 Profibus / Profinet system

Machines and facilities shall have a rational, easy to be maintained and fail-safe design. For this reason, the use of decentralized technology and field bus systems is preferred at ETO.

During the planning stage it shall be verified, whether the use of a Profibus system is reasonable with regard to cost-effectiveness and technology. It shall also be verified, whether in the lower field level the use of a bus system for the transmission of digital I/Os is reasonable with regard to cost-effectiveness and technology. If this is the case, ETO specifies the use of the Profibus/Profinet system. Pneumatic valve terminals shall preferably be actuated via a Profibus/Profinet system.

The following shall be observed:

- Passive branch lines are not acceptable.
- Extensive and low impedance connection of the shield shall be ensured.
- Different Profibus cable types within one segment shall be avoided due to expectable reflections.
- If repeaters are used, a bus cable of 1 m min. length shall be installed between bus station and repeater.
- A maximum of 29 stations is permitted per bus segment. The segments are separated by repeaters. Per segment, two terminating resistors shall be placed at both ends of the cable.
- Bus and analogue cables shall be installed separately from the main circuits in a suitable fashion.
- A level measurement shall be performed and documented on the ready-to-use machine.

8.10 Solenoids

In order to prevent overvoltages when switching off inductances - such as e.g. solenoid valves - limit elements shall be used which limit the voltage to an acceptable value for electronic control units and windings.

All solenoids shall be designed for a duty cycle of 100%.

Solenoids shall be energized by 24V DC. They shall at least meet an IP rating of IP65. Solenoids shall be connected via plug connectors. The status of the signal shall be displayed via an LED light at the plug.

8.11 Electric motors

8.11.1 General Information

Special motors (also DC motors) may only be used if it is indispensable. Their use requires written approval of the customer.

As a rule, antifriction bearings with permanent lubrication shall be used.

The insulation of electric motors in rectifier operation shall at least meet insulation class "F".

The output of the electric motors shall be adapted to the mechanical power requirements of the machine. If due to a power graduation a larger motor has to be used, overdimensioning must not exceed 30%.

Pictograms or instruction plates, e.g. rotation arrow, OPEN / CLOSE, shall be attached permanently to the outside of the machine, be protected against accidental inversion and be well visible even with installed enclosures.

The power rating plate shall preferably be attached on the same side as the terminal box, however not on removable parts. If the plate is hidden, a second power rating plate shall be attached on a well visible location.

IP rating of motors: IP 44

8.11.2 Design of three-phase ac motors

Three-phase ac motors shall preferably be of the 4-pole type (1500 min^{-1}). Deviations from this specification are only permissible in exceptional cases. These require approval of the customer.

Three-phase ac motors having a power of more than 3 kW shall be designed for a nominal voltage for delta connections so that they are suitable for star-delta starting.

8.12 Electronic control units, signal columns and signal lamps

All electronic control units, signal columns and signal lamps shall be permanently labeled. The respective function shall be obvious from the label.

The function of the signal lamps shall be verifiable using a "lamp test" function.

The colors of the signal lamps regarding the machine status are specified in the style of DIN EN 60204-1:

Color from top to bottom	**Significance**		
	Safety of persons	**Machine / process status**	**Example**
RED	Danger, prohibition	Emergency	EMERGENCY STOP
YELLOW	Caution	Abnormal	Malfunction and / or fault acknowledgment
BLUE	Command	Lack of material, operator intervention	Refill material, maintenance counter reached specified limit
GREEN	Safety	Normal	Start, operating state
WHITE	No special significance assigned		

The composition is performed individually depending on the requirements of the machine.

8.13 Connection of sensors

The voltage supply for the sensors shall be protected by a separate automatic circuit breaker. If in case of a malfunction, the automatic circuit breaker is activated, this must not cause the control device to be switched off and a diagnosis of the activation shall be made.

The sensors shall preferably be connected using plug distributors with LED and M8 screws. Switching statuses shall be well visible from outside. If this is not the case, female connectors with LED and switching status display shall be used.

All proximity switches shall be plug-in switches for fast replacement during operation. Cable sockets shall be installed near the proximity switch / actuator using mounting clips. Bundling of cable sockets in a cable harness is not permitted.

If sensor wires are inserted in drag chains or protective hoses, which are moved during operation, both ends shall have a plug-in design. The wire shall be suitable for use in drag chains.

The plug couplings shall, wherever feasible, be installed separately, in order to ensure fast access to the coupling.

Plug connections of proximity switches shall be installed in separate terminal holders (e.g. by Festo). Installation of the plug connectors in a cable / hose harness is not permitted.

For teachable sensors, separate holders shall be installed such that they are easily accessible and well visible.

8.14 Connection of actuators

The voltage supply for the actuators shall be protected by a separate automatic circuit breaker. If in case of a malfunction, the automatic circuit breaker is activated, this must not cause the control device to be switched off and a diagnosis of the activation shall be made.

All actuators shall be plug-in actuators for fast replacement during operation. Cable sockets shall be installed near the actuator. Bundling of cable sockets in a cable harness is not permitted.

If actuator cables are inserted in drag chains or protective hoses, which are moved during operation, both ends shall have a plug-in design. The cable shall be suitable for use in drag chains.

8.15 Control devices and vibration conveyors

See Equipment Specification for the mechanical, pneumatic and hydraulic design of machines.

8.16 Control components at manual workstations

The start of the automatic procedure is initiated by a mushroom actuator.

Every station shall be equipped with the following control components:

- 1 Malfunction signal
- 1 Text signal for displaying operation conditions, malfunction messages and for entering time and count values.
- Control component for switching on as well as for the EMERGENCY STOP shut off.
- Control component for selecting automatic, manual or step mode
- Station-related piece counter
- (total number of pieces [not resettable], shift counter [resettable], number of good parts and bad parts [resettable]) (see also Equipment Specification - Design of Equipment Control Systems)
- Maintenance counter (if required, see also Equipment Specification - Design of Equipment Control Systems, as well as additional counters)

8.17 Control components on every individual automatic station / cabinet

Every individual station shall be equipped with the following control components:

- 1 Malfunction signal
- 1 Text signal for displaying operation conditions, malfunction messages and for entering time and count values.
- Control component for switching on as well as for the EMERGENCY STOP shut off.
- Control component for selecting automatic, manual or step mode
- Station-related piece counter
- (total number of pieces [not resettable], shift counter [resettable], number of good parts and bad parts [resettable]) (see also Equipment Specification - Design of Equipment Control Systems)
- Maintenance counter (if required, see also Equipment Specification - Design of Equipment Control Systems, as well as additional counters)

8.18 Main circuits

Main circuits shall be secured according to the best available technology.

Selectivity to mains fuses (supply) shall be ensured.

8.19 Permanently energized circuits (in front of the main switch)

Power supply terminals, service sockets (yellow), etc. which is permanently energized shall be clearly and permanently labeled. The label must not be on the cable ducts.

The terminals shall be covered or have a "finger-safe" design. The cables shall be installed separately and the specified core colors shall be adhered to.

8.20 Additional equipment, UPS

All industrial computers shall be connected to an uninterrupted power supply (UPS). For this purpose, uniquely marked sockets and terminal blocks shall be provided in the electrical enclosure. (External voltage - energized even with switched off main switch!!)

In case of a voltage breakdown, the UPS shall shut down the machine in a controlled manner. No data must be lost.

9 Reference designation

The reference designation shall be performed according to ETN007 Equipment Specification - Mechanical, Pneumatic and Hydraulic Design.

The reference designation shall be visible from outside.