



MARKUP: Sections struck through are NOT APPLICABLE for LV Soft Starter.



GENERAL SPECIFICATION

ELECTRICAL

GS EP ELE 123

Low Voltage ~~Variable Speed Drive~~

Please refer to pages 45 ~ 46 of Specification for Main Electrical Equipment for the detail amendments of this document.

02	11/2020	Harmonisation and digitalisation
01	11/2018	Revision
00	12/2017	First issue
Rev.	Date	Purpose of the revision

Owning entity: DSO/IP/TEC	Managing entity: DSO/IP/TEC/EIS
Other Approving entity(ies):	



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1. Scope

This General Specification defines the minimum requirements for the design, manufacture, inspection and testing of low voltage ~~variable speed drives~~ (VSD).

Each VSD is linked to a low voltage asynchronous motor to form a seamless and compatible assembly.

This specification shall be supplemented by a project specification and/or a data sheet defining the characteristics of each VSD.

DC ~~variable speed drive~~ are outside the scope of this specification.

2. Reference documents

This document is the TOTAL E&P transposition of the TOTAL S.E. Harmonized GS GR ELE 123.

The reference documents listed below form an integral part of this General Specification.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published at the effective date of this document.

Reference	Title
EN 50495	Safety devices required for the safe functioning of equipment with respect to explosion risks
EN 50598 2	Ecodesign for power drive systems, motor starters, power electronics and their driven applications - Part 2: Energy efficiency indicators for power drive systems and motor starters
European Directive 2011/65/EU	Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment
European Directive 2014/30/EU	Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility
IEC 60079 (Parts 1; 2; 14)	Explosive atmospheres - Parts 1; 2; 14

Reference	Title
IEC 60146 (All parts)	Semiconductor converters - General requirements and line commutated converters - All parts
IEC 60204-1	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
IEC 60269-4	Low-voltage fuses - Part 4: Supplementary requirements for fuse-links for the protection of semiconductor devices
IEC 60332-3-24	Tests on electric and optical fibre cables under fire conditions - Part 3-24: Test for vertical flame spread of vertically-mounted bunched wires or cables - Category C
IEC 60445	Basic and safety principles for man-machine interface, marking and identification - Identification of equipment terminals, conductor terminations and conductors
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 61800 (Parts 2; 3; 5-1)	Adjustable speed electrical power drive systems - Parts 2; 3; 5-1
IEC 62262	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
IEC TS 60034-25	Rotating electrical machines - Part 25: AC electrical machines used in power drive systems - Application guide
ISO 4628-3	Paints and varnishes - Evaluation of degradation of coatings - Designation of quantity and size of defects, and of intensity of uniform changes in appearance - Part 3: Assessment of degree of rusting
ISO 12944-2	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 2: Classification of environments



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Reference	Title
GS EP ELE 079 Electrical Apparatus for Potentially Explosive Gas Atmospheres	
GS EP INS 101 Instrumentation Design	
GS EP INS 158 I/O Assignment Principles	
GS EP ELE 116 LV Induction Motor	

3. Applicability

This specification is applicable for all VSD installed in cabinet or wall mounted, which can be installed:

- **Onshore**
- Safe or hazardous areas,
- Outdoor or indoor.

For each case, the specific requirements and location will be defined in the relevant data sheet.

4. Definitions of terms

For the Project Definitions and Abbreviations refer to the document Project Description, Definitions and Abbreviations document no. AZ-AB1-70-SK02-360003.



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5. Scope of supply

The scope of supply is defined in the Requisition document attached in the Purchase Order and shall contain as a minimum:

- All documents listed in the chapter 12.
- One or several VSD fully equipped and tested in accordance to the content required into this document, project particular specification and project data sheets (See Appendix 1 - DS EP ELE 123 filled up with project requirements).

6. Design

6.1 Service conditions

The equipment shall be designed to operate in an industrial environment.

VSD and all associated equipment shall be suitable for the specified place of installation.

6.1.1 Installation inside electrical rooms

Unless otherwise specified, indoor electrical equipment shall be able to operate without damage or derating of performance as long as room temperature does not exceed 40°C.

The room's humidity level shall be defined in the project specification or data sheet.

6.1.2 Installation outside electrical rooms

Outdoor electrical equipment shall be designed to operate continuously in environmental conditions as defined in the project specification or data sheet.



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6.1.3 Service life, life cycle and maintenance frequency

The Manufacturer shall guarantee a service life of 25 years, integrating the serial manufacturing period and follow up service (software and spare parts).

The Manufacturer shall guarantee operation of the equipment for a period of 6 years without needing any maintenance that entails shutting it down.

6.2 Definition of the equipment

The installation includes:

- A drawer or withdrawable circuit breaker located in an LV switchboard according to schematic diagram provided by Company or Engineering Contractor (outside the Manufacturer's scope).
- A cabinet containing the VSD or wall mounted VSD unit, with the power and command control circuits according to schematic diagrams provided by Company or Engineering Contractor.
- A by-pass system, in a separate cabinet that allows VSD troubleshooting without affecting the operation through the by-pass, if requested by Company in the project particular specification or/and data sheet. The by-pass system shall allow direct on line starting of the motor and continuous operation at full speed.

6.3 System voltage

6.3.1 Voltages and neutral earthing

The VSD shall be designed to power a low voltage asynchronous motor.

Unless otherwise specified in Project particular specification and/or data sheet, the voltages and neutral earthing system provided by the Company for electrical equipment will be:

- **Power Supply: 690 V or 400 V AC, 50 Hz – 3 phases, 3 wires (IT system earthed through a 150 mA high impedance)**
- **UPS Distribution: 230 VAC – 1 phase IT system (Neutral not distributed)**
- **DC Distribution: 110 VDC unearthed system**

Use of voltage levels and/or frequencies not herein recommended is subject to written Company approval.

Any other voltage required (control circuit, safety control voltage, etc.) shall be generated by the VSD supplied by the Manufacturer from UPS or DC distribution provided by Company.

The voltage converter provided by Manufacturer if any, shall comply with EMC requirements.



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If a backed-up or uninterrupted voltage is required for the VSD operation, the Manufacturer shall clearly mention it.

6.3.2 Electrical system variations

Unless otherwise specified, electrical equipment shall operate satisfactorily with the following simultaneous variations, from their nominal value, when measured at the consumer input terminals.

Voltage:

- Steady state variations: $\pm 10\%$,
- Transient variations: $+20\%$, -20% , Recovery within 1.5 seconds.

Frequency:

- Steady state variations: $\pm 5\%$,
- Transient variations: $\pm 10\%$ Recovery time: within 5 seconds.

~~6.3.3 Output voltage of the VSD~~

The output voltage of the VSD shall be specified in the project specification and/or the data sheets.

6.4 Technical requirements

The VSD and its motor shall be sized to ensure permanent service at full load under the conditions of the present general specification completed by the particular specification.

VSD and motor shall form an assembly of compatible equipment, suited to the variations of torque of the driven machine, in all phases of operation, from start-up to maximum speed within the specified variation range.

Special attention shall be given to the minimum speed of the variation range, corresponding to minimum effectiveness of the cooling fan mounted on the motor's shaft.

In cases where very slow speeds are likely, forced ventilation may be installed on the motor under Company's written approval.

The Manufacturer shall verify that the upstream protection and switching device is compatible with the technical characteristics of the VSD.

VSD shall be protected by fuses as per [IEC 60269-4](#) or current limiting circuit breaker.

The current-limiting fuses or circuit breaker shall be selected and sized following the VSD Manufacturer's instructions.



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For wall mounted VSD, unless otherwise specified, the current-limiting fuses or circuit breaker will be provided and installed in the motor drawer by LV Switchboard Manufacturer (see Appendix 3).

In addition, the supporting wall and the floor surface under the VSD shall be of non-flammable material.

The total harmonic current distortion (THDi) of the VSD shall not exceed 5% for rated power motor ≥ 110 kW and $\leq 35\%$ for rated power motor < 110 kW.

The Manufacturer shall provide a table of the harmonic currents generated per frequency level in accordance with the characteristics of the upstream network.

The degree of protection of equipment shall be at least IP 31 for indoor cabinet (IP20 when door is open) and IP 55 for outdoor, as per IEC 60529.

The VSD Manufacturer shall take the initiative to install and size the filters (dV/dt limitation, sine filter, other) to ensure the protection of the motor insulation and bearings depending on power cable length, network rated voltage, motor coil type and the motor insulation voltage.

The use of a motor with reinforced insulation instead of filters installation may be proposed.

In this latest case, it allows to reduce the thermal dissipation in the electrical room.

The VSD Manufacturer shall coordinate with motor Manufacturer for the appropriate choice of Motor and VSD.

The interface parameters and interactions between the motor and the converter, including installation guidance as part of a power drive system, shall meet the requirements of IEC TS 60034-25.

The requirements for the performance of all semiconductor power converters and semiconductor power switches using controllable and/or non-controllable electronics devices are specified in IEC 60146 (all parts).

The VSD shall be IE2 class as per EN 50598-2.

VSD shall meet an overvoltage category III and the safety requirements as per IEC 61800-5-1.

Unless otherwise specified, VSD shall be designed for pollution degree 2 as a minimum and climatic condition class 3K3 as per IEC 61800-2.

Equipment weighing more than 25 kg shall be fitted with lifting rings.

6.5 Performance requirements

The VSD equipment shall satisfy the following requirements:

- Remote start/stop,
- All interfaces as defined in the data-sheets and the typical schematics in appendixes,
- Only one operating quadrant, unless otherwise specified,
- Design of the VSD by the VSD manufacturer from speed / torque curve and starting time of machine driven by the motor either 150% or 110% of overload for 60 seconds,
- A supply voltage variation of $\pm 10\%$ without causing, under any circumstances, a speed variation greater than $\pm 1\%$ at the rated operating point,
- A frequency variation range at the VSD output suited to the driven machine's operating criteria,
- A linear acceleration curve adjustable from 1.5 to 30 seconds, unless otherwise stipulated in the project specification,
- Adjustable transient torques overload capability in the start-up phase,
- A voltage/frequency ratio adjustment capability,
- A ~~remote speed adjustment~~ by transmission of a 4-20 mA signal,
- A minimum power factor of 0.9 for the VSD-motor assembly.

The VSD shall be able to power the motor under 70% of main supply rated voltage during at least 250 msec.

The Manufacturer shall specify the limit values for admissible voltage dips and the conditions for restoring normal operation at rated load in case of voltage interruption.

The VSD shall be ready to restart after a momentary loss of power > 250 msec.

6.6 Power Cables

In order to limit electromagnetic disturbances emitted by the VSD, cables shall be shielded.

The type and length of cable between the motor and the VSD shall be stipulated in the VSD data sheet. Beyond a certain cable length, waveform reflection and voltage signal distortion phenomena can occur.

A dV/dt filter may then be needed at the VSD output, in which case the Manufacturer shall take the initiative to install an appropriately sized filter (See § 6.4).

The manufacturer shall provide the instructions manual for cabling, screening and grounding of power cables.

Provision shall be made for a serial interface with ECS and ICSS. The VSD shall be provided with digital communication capability to allow direct control and status communication with ICSS. For further interface and I/O details, refer to Section 26 of this document, Electrical Control System (ECS) – Addendum to GS EP ELE 221, Electrical I/O Lists [AZ-AB1-70-SK02-160011, 160012] & Instrument Electrical Interface Specification [AZ-AB1-70-SK02-240012].



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6.7 Temperature sensors

Motors associated with VSDs are fitted with 1 set of 3 PTC sensors in series, placed in the stator windings.

When the sensor exceeds its temperature threshold, the safety function of VSD shall shutdown the motor.

For VSD driven motor installed within potentially hazardous areas, the motor/VSD association shall comply with the requirements of [IEC 60079-14](#) and safety function of VSD certified ATEX as per [EN 50495](#).

6.8 Protection devices and information

The protection system shall be electronic and have a dialogue interface capable, in the event of system faults, of providing sufficiently detailed information for trained personnel to repair the VSD equipment.

For process ESD (Emergency shutdown) purpose, VSD shall be fitted with a stop function category 0 as per [IEC 60204-1](#) and SIL 2 safety integrated level, if requested by risk analysis.

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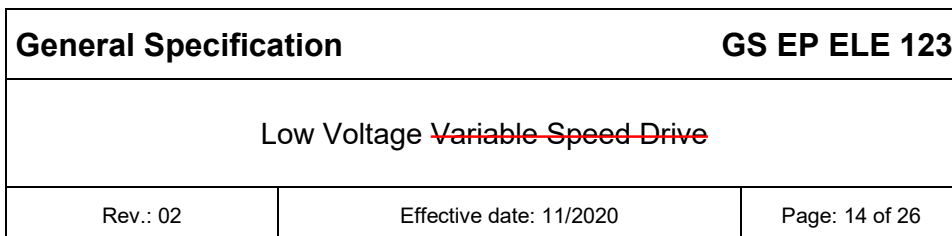
The following minimum protection functions shall be provided/displayed:

	Trip
Motor	
• Short circuit	X
• Overload	X
• Stator overheating (PTC sensor)	X
• Unbalance current	X
• Earth fault	X
Variable Speed Drive	
• Line over voltage	X
• DC Bus over voltage	X
• Rectifier over current	X
• Inverter over current	X
• Inverter overvoltage	X
• Inverter overload	X
• Converter ground fault	X
• Converter cooling fault	X
• Converter over temperature	X
• Emergency stop	X
• Loss of control voltage	X

A general trip contact shall be connected to terminals for immediate action on the upstream breaking device.

The following minimum information shall be available on the front panel face of the VSD cabinet:

- Output current,
- ~~Output frequency,~~
- ~~Speed reference,~~
- ~~Output speed,~~
- Output active power,





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7. General construction requirements

7.1 Metal-enclosed cabinet

The VSD shall be installed in one or more free-standing metal cabinets designed for indoor operation.

The equipment shall be arranged so as to provide access inside the cabinet without shutting down the VSD.

Each cabinet shall be designed to allow front access for normal maintenance operations.

Removable side panels may be provided, but rear access should not be needed.

Access to the equipment shall be designed for ease of maintenance.

The thickness of the steel plates shall be sufficient to ensure excellent overall rigidity.

Each cabinet shall have a degree of protection of at least IK 08 as per standard [IEC 62262](#) and a key-lockable handle for opening and closing it.

The key-locks will be defined in the particular specification.

Lifting rings shall be provided.

7.2 Outdoor VSD in hazardous areas

Outdoor VSD installed in potentially hazardous area shall be suitable certified category 2G with either Ex"d" or Ex "px" protection mode as per [IEC 60079-1](#) or [IEC 60079-2](#), respectively.

7.3 Cooling

Cooling by natural convection shall be preferred.

However, if forced ventilation is needed, the fans shall offer high reliability, a lifetime ≥ 55.000 hours and their operation be permanently monitored.

Indicator lights and alarm contacts shall be provided for fan faults and for clogged filters.

7.4 Accessibility

The location and grouping of the components and auxiliary equipment shall allow easy identification and easy front access for operation, maintenance and repair purposes.

Appropriate partitioning between the different functional units shall be provided, to allow adjustments and verifications to be carried out in total safety.



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All exposed busbars and live equipment parts located inside the cabinet shall have at least IP 20 protection.

7.5 Wiring and terminal blocks

The wiring inside the cabinet shall be single-core with class 5 copper conductors.

The minimum cross-section of the wiring shall be 1.0 mm² (2.5 mm² for power cables), except for connections to printed circuit boards, where the minimum cross-section may be 0.75 mm².

The wiring shall be halogen-free and comply with category C of standard [IEC 60332-3-24](#).

The wiring shall be held in place by insulating supports such as sleeves, ducting, plastic ties or strips and be arranged such as to prevent any mechanical damage.

Wiring between fixed parts and hinged doors shall be mechanically protected.

All components such as ducting, wiring, cable ties, etc. shall be made of flame-retardant materials.

Each wire shall be identified at each end as per the Manufacturer's wiring diagrams.

Terminal blocks shall be provided for all outside connections.

They shall be installed on standardized rails, be easily accessible and available with either spring or screw terminals.

Only one conductor shall be connected per terminal.

The cables shall enter from the bottom.

The terminals shall correspond to the cable type and cross-section determined in the data sheet or particular specification.

The manufacturer shall provide the instructions manual for cabling, screening and earthing of control cables.

7.6 Earthing

An Earthing dispatcher with a minimum cross-section between 16 and 35 mm² according to VSD rated power, and a sufficient number of connections shall be installed near the cable entries to facilitate the bonding of cable armor and earthing conductors.



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All exposed metallic parts, which might accidentally be energized, shall be connected to the earth bar

The earth bar shall be linked to the main earth circuit via a connection terminal provided by the Manufacturer.

All earth connections shall be individual.

All removable metallic parts shall be connected to the frame and hinged doors earthed via flexible connections.

7.7 Identification

All external devices used for operation, measurement or indication shall be clearly identified by an indelible functional label, to facilitate identification by the operator.

All the components shall be identified by a tag in accordance with the identification system used by the Manufacturer, and marked on the diagrams and reference documents.

All indoor tags and labels shall be made from a corrosion resistant material, and indelibly marked (white dilophane or gravoply labels with black etching).

Identification by tag shall be installed with glue and plastic rivet.

All outdoor tags and labels shall be stainless steel etching.

Identification by tag shall be installed with stainless steel rivet.

The identification and marking of terminals, and general rules for the use of colours or alphanumeric notations to identify conductors, shall meet requirement of [IEC 60445](#).

All High risk Electrical MV and HV equipment shall be labelled in English and Azerbaijani Language.

7.8 Painting

For indoor equipment, the surface treatment and protection of the steel plates shall comply with the Manufacturer's standard, but include cleaning, degreasing, and application of an anti-rust primer and a finishing coat, so as to provide effective protection against corrosion under the specified climatic and operating conditions.

Colour shall be of Manufacturer's standard, unless otherwise specified in the project specification.

For outdoor equipment, the painting system shall be, according to ISO 12944-2 and category C4 Medium for onshore area.

The Manufacturer shall submit his coating system for protection against external corrosion for Company approval.



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For outdoor applications, Manufacturer shall provide a warranty of 5 years - with a rusting degree Ri = 2, as per [ISO 4628-3](#).

7.9 Human-Machine Interface (HMI)

The VSD shall have an HMI on its front, for configuration purposes and to display the measurements and operating status.

If there is a fault, the alarm message describing the fault shall appear automatically on the display.

VSD Manufacturer shall provide a software tools for programming and graphic representation of signals and alarms.

7.10 Anti-condensation heating element

If requested by Company in the data sheet, hygrostat controlled anti-condensation heating element, shall be supplied at 230 VAC – 50 or 60 Hz single phase (external power supply provided by Contractor).

7.11 Manufacturer's nameplate.

A Manufacturer's nameplate shall be provided with each part of the equipment, showing the following information:

- Manufacturer's name and address,
- Manufacturer's identification reference,
- Rated input and output voltages,
- Rated output power (kW),
- Serial number and year of manufacture.

8. Inspection and testing

8.1 Factory Acceptance Tests

Each VSD shall be tested for compliance with the specifications attached to the order, with standards, applicable regulations and Manufacturer documents.

As a minimum, the routine tests defined in [IEC 61800-2](#) and [IEC 61800-5-1](#) shall be performed.

The type test certificates, as per [IEC 61800-2](#) or [IEC 61800-5-1](#), shall be provided.

Unless otherwise specified, the factory tests shall be done in the presence of a Company representative with a minimum 2 weeks prior notice.

8.2 On-site checks and tests

After installation and connection have been completed by the Construction Contractor and unless otherwise specified in the data sheet, the Manufacturer shall assist Company in configuring, on-site testing and commissioning of the equipment.

8.3 Test and inspection report

The Manufacturer shall issue a complete report of the factory acceptance tests as defined in the applicable standards.

Inspection reports shall also be issued.

On-site tests shall also be recorded in a test report.

The VSDS Supplier's scope shall include coordination meetings, test sessions with Contractor, Company and Vendor consultation in finalizing the requirements to support VSDS-ECS interface validation related activities to be carried out at the early stage of VSD-ECS interface design. Furthermore, VSDS shall be offered for full system integration tests, following a successful completion of VSD electrical tests. All interfaces between VSDS and ECS shall be tested at the VSDS Supplier's works during iFAT. The VSDS Supplier shall ensure that sufficient resources (personnel, hardware and software) are available to support the VSDS-ECS integration tests.

8.4 List of tests and inspections to be carried out

Description of the test or inspection	Factory	On-site
Verification of compliance with the specifications of the order, standards and supplier documents	X	
Visual inspection	X	X
Routine tests as per IEC 61800-2 or IEC 61800-5-1	X	
Adjustment and functional tests of the VSD coupled with the motor		X

9. Packaging and shipment

Special conditions regarding packaging, transportation and storage are stipulated in the documents "General Purchasing Conditions" or "Particular Purchasing Conditions".

After the tests and inspection, any traces of humidity shall be removed from the equipment before commencing packaging and shipment.

The equipment, accessories and consumables shall be clearly tagged to facilitate assembly and installation on site.

Any consumables, special tools or equipment required for assembly, commissioning and maintenance shall be shipped with the equipment.



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A complete set of installation, operation and maintenance instructions shall be placed in the packages with the equipment.

Appropriate protection against mechanical damage and the effects of corrosion shall be applied for transportation and throughout storage on site.

10. Installation

The VSD installation shall respect installation, operation, storage preservation and maintenance instructions/manuals supplied in the language of the country.

For wall mounted VSD, a dedicated frame shall be used to support the VSD in case of finishing wall/partition.

11. Spare parts

11.1 Commissioning and Start-Up

The Manufacturer shall include in its bid all the spare parts needed for testing and starting up the installation. Company reserves the right to request certain additional parts it considers critical.

The spare parts shall be delivered at the same time as the main equipment.

The list of spare parts is appended to the order.

The Manufacturer shall provide "Plug and Play" spare parts and/or all special tools to make spare parts "Plug and Play" on site (example for an electronic board: Software and Firmware, laptop, programming adapter and operating manual).

Packaged spare parts shall be clearly identified (storage).

11.2 Five and ten years operation

The Manufacturer shall include with its bid a price list of all the tools and spare parts required for five and ten years operation of the equipment.

The list of spare parts is appended to the order.

Packaged spare parts shall be clearly identified (storage).

12. Documentation

Refer to Appendix 1 for typical list.



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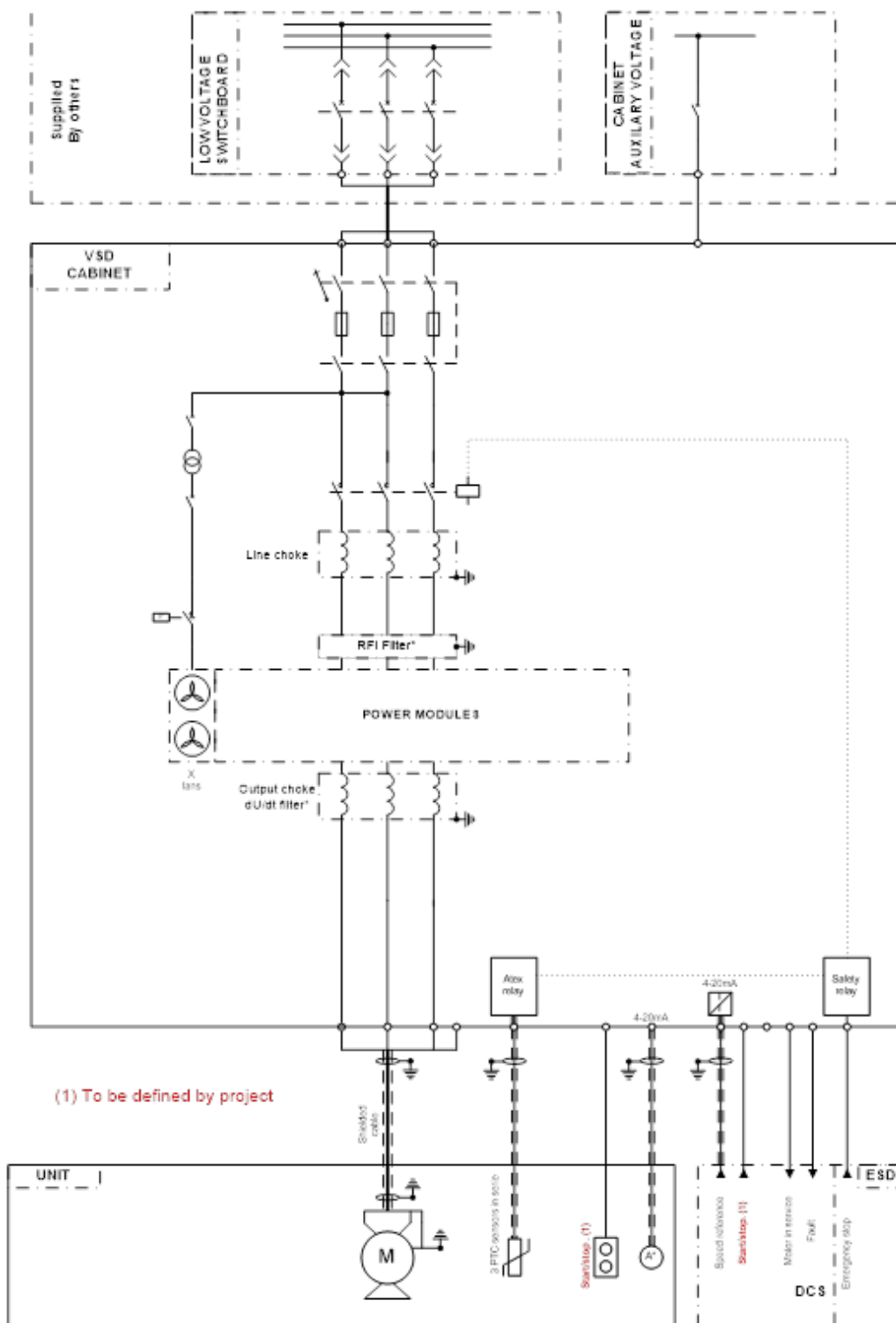
13. Appendix 1: Documentation list

A separate specification shall list all the documents to be provided by the Manufacturer.

It shall include at least the documents below:

Description of the test or inspection	With the bid	After order
Deviation list to project specifications	X	
Completed data sheets	X	X
Preliminary harmonic study at line side. Only if included in the scope of work	X	
Description and guarantee of control hardware and software support during the expected lifetime of the VSD	X	X
VSD torque-speed curve in all speed range superimposed to load curve	X	X
Thermal dissipation expressed in watts	X	X
Technical manual	X	X
Wiring schematics	X	
General layout drawing, indicating the dimensions and weight	X	X
List of spare parts required for testing and commissioning	X	X
The price list of spare parts for two years of operation	X	X
The installation, use and maintenance manuals		X
Detailed wiring diagrams		X
ATEX certificate as an equipment associated to control system of a ATEX motor located in hazardous area		X
List of equipment parts		X
Type test certificates according to § 8.1	X	
Test and inspection reports		X

~~14. Appendix 2: Schematic VSD in cabinet without bypass~~



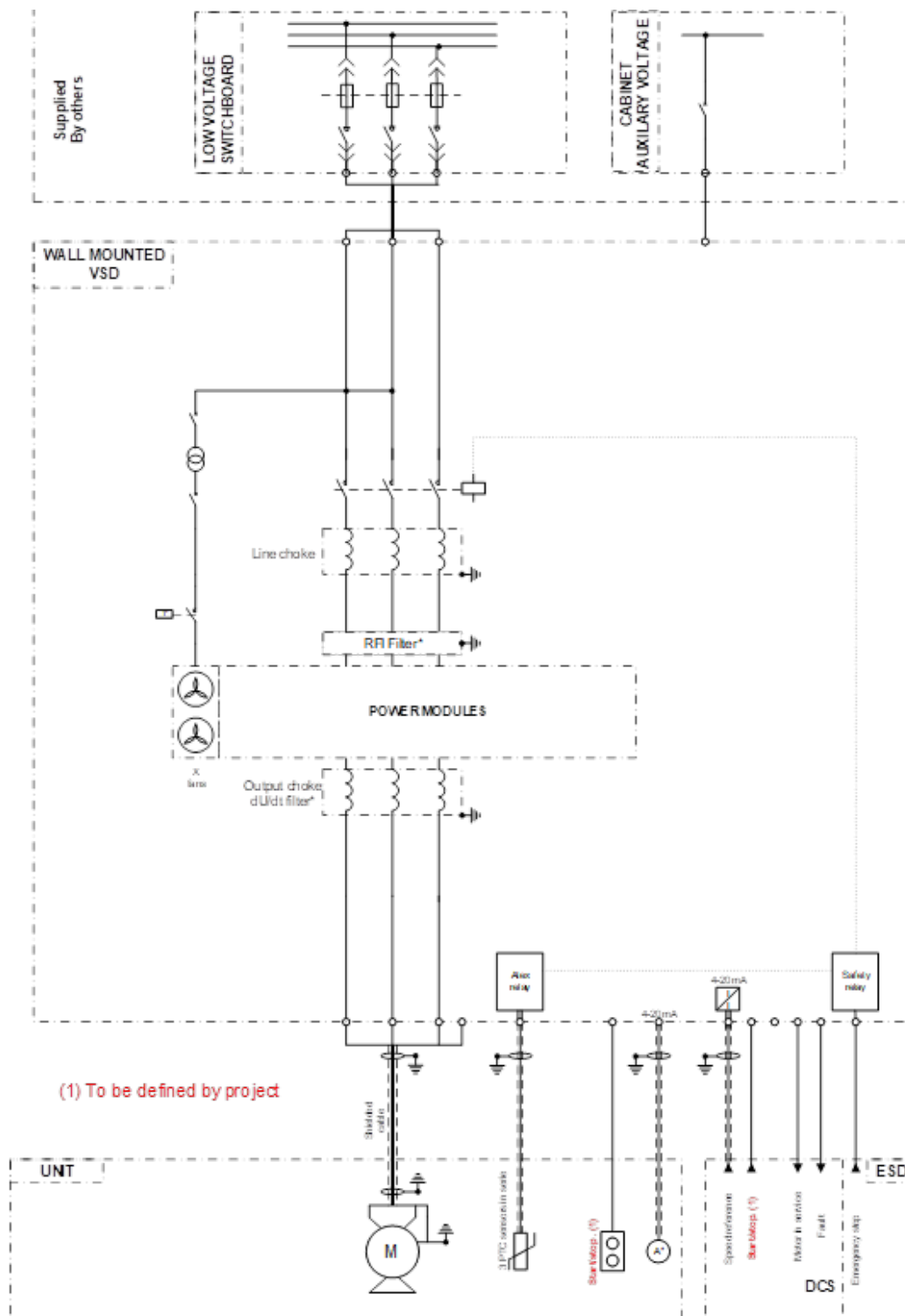
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15. Appendix 3: Schematic VSD wall mounted



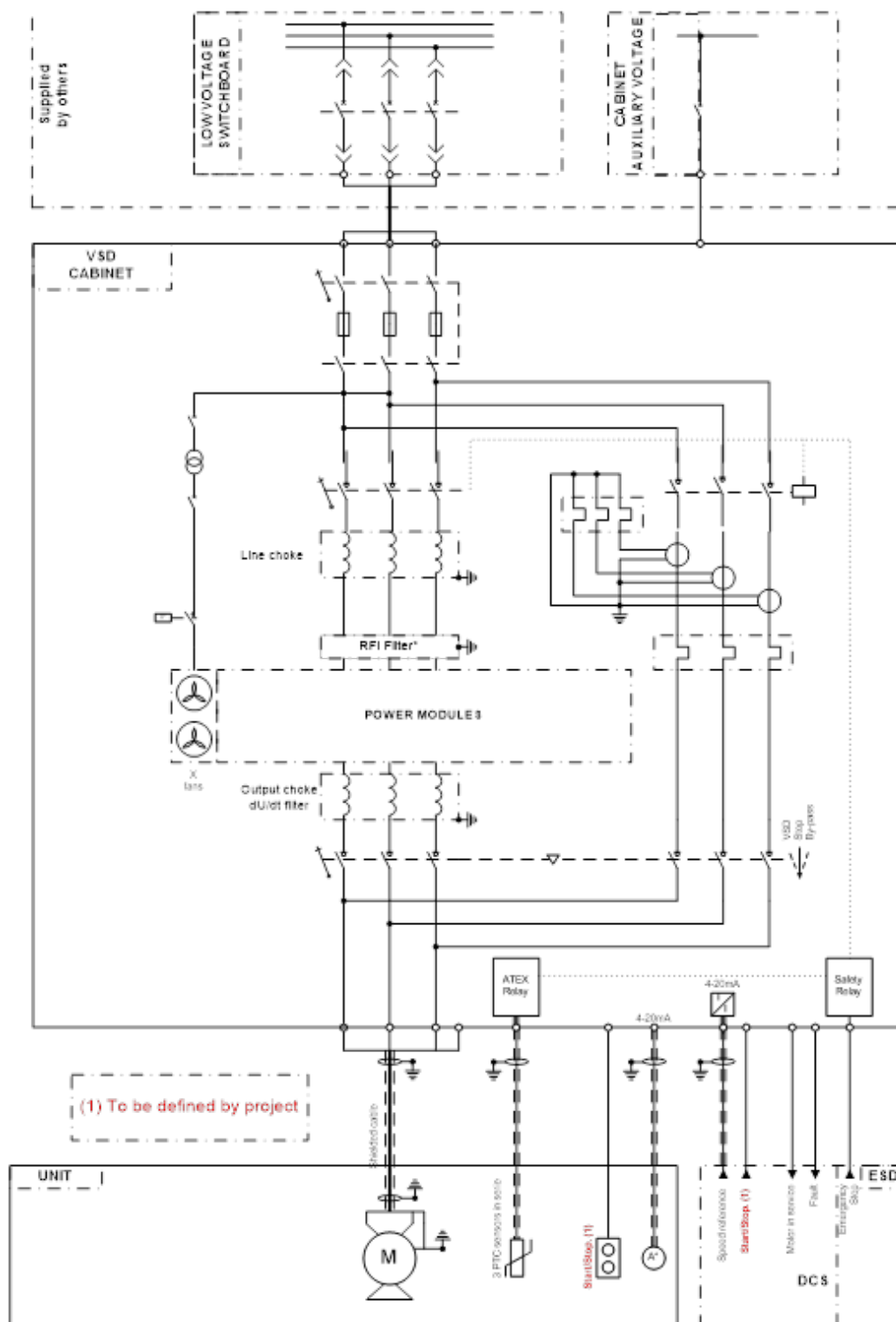
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16. Appendix 4: Schematic VSD in cabinet with bypass





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