


INTER PLANT STANDARD – STEEL INDUSTRY		
 IPSS	VARIABLE FREQUENCY DRIVE (VFD) UP TO 690 V Part 1 - General (FIRST REVISION)	IPSS: 1-10-035-15
	Corresponding IS does not exist	

0. FOREWORD

- 0.1 This interplant standard has been prepared by the Standard Committee on Electrical Components and equipment, 1:10 with the active participation of the representatives of the Steel Plants, major consultancy organizations and established manufacturers of VFD (variable frequency drive) and was adopted in September 2015.
- 0.2 Inter plant Standard for steel industry primarily aim at achieving rationalization and unification of parts and assemblies used in steel plant equipment and accessories, and provide guidance in indenting stores or equipment (or while placing orders for additional requirement) by individual steel plants. For experience effective control on inventories, it is advisable to select a fewer number of sizes/types from those mentioned in this standard, for the purpose of company standard of individual steel plants. It is not desirable to make deviations in technical requirements.
- 0.3 While formulating this standard, assistance has been drawn from the following publications.
 i) IEC/146-1-1 (1991-04) ii) IEEE Standard 444(Part-I):1973 iii) EN 61800-3(2nd environment) / IEC 1800-3 industrial environment / IEEE 519.

1. SCOPE

- 1.1 This interplant standard covers the requirements of Variable Frequency Drive (VFD) system used for ac drives up to 690 V. VFD system is used for controlling the speed / torque of an ac motor by controlling the voltage and frequency of the power supply to the motor. VFD are also termed as VFD drive, AFD, VSD, VVVF drives, ASD, ac drives, Inverter drives.

2. TERMINOLOGY

For the purpose of this standard, the definitions in IS1885 (part 17): 1979 “Electro technical Vocabulary” shall apply.

3. SITE CONDITIONS.

3.1 The following shall constitute the normal site conditions for the purpose of this standard:

3.1.1 *Ambient temperature* - The reference ambient temperature shall be 50°C. Derating factors for the temperature is to be specified by the supplier.

3.1.2 *Altitude* - The altitude shall not exceed 1000m above sea level.

3.1.3 *Relative humidity* - The maximum relative humidity shall be 95%. However, the maximum ambient temperature and 95% relative humidity may not occur simultaneously. Equipment shall also withstand saline atmospheric condition.

Note: However, maximum temperature and maximum relative humidity may not occur simultaneously.

3.1.4 *Ambient air* - The ambient air may contain a fair amount of conductive & heavy dust laden steel plant environment.

3.1.5 *Noise* – Noise shall conform to IEC 61000.

3.1.6 *Vibration* – Vibration shall conform to IEC 60068-2-6.

4. ENCLOSURE

4.1 The VFD module shall conform to IP20.

5. POWER SUPPLY SYSTEM.

5.1 The VFD equipment shall be suitable for operation from the following power supply system.

a) *Rated Voltage:*

- 3 Phase 690V ac, 50 Hz± 5%
- OR
- 3 Phase 415Vac, 50 Hz± 5%
- OR
- 1 Phase 240Vac, 50 Hz± 5%

b) *Voltage variation:* +10%, -15%

c) *Frequency variation:* 50 Hz+6%, -6%

5.2 External AC input choke of suitable rating shall be provided to limit THD as per IEEE 519 & also THD at the motor terminal should be limited to 5%. In case of grounded neutral system, additional filter is to be provided.

VFD suppliers shall also provide THD details of harmonics at motor terminals which should be limited to 5%

5.3 ACB/MCCB with 50 kA rating with positive isolation feature

5.4 AC line surge suppressor network

6. EQUIPMENT DETAILS

6.1 Rating

6.1.1 Rating is based on current and shall be rounded off to the higher integer value.

6.1.2 VFD system shall be selected based on heavy duty current (I_{hd}) and shall be rated for 150% of the motor rated current.

Overload capacity of VFD shall be 150% for one minute for constant torque & 115% for variable torque for one-minute.

6.1.3 Output frequency range shall be minimum 0 to 50 Hz at constant torque and above 50 Hz at constant power.

6.1.4 Efficiency of VFD shall be minimum 96% at 100% load

6.1.5 Switching frequency shall be in the range of 1-16 kHz

6.1.6 Peak output voltage at motor terminals shall be less than 3.15 times rated voltage with pulse rise time of ≥ 0.1 micro second.

6.1.7 Maximum recommended cable length from VFD to motor without requirement of choke shall be indicated by the drive suppliers (Max 3.15 times bus voltage or 1600 V).

6.1.8 Converter duty Isolation transformer of adequate rating at input side shall be provided for drive rated 200 kW and above.

6.2 Diagnostic Check :

6.2.1 Controller logic circuit diagnostic shall be performed on application of power to prove functionality and viability of microcontroller logic circuits.

6.2.2 Memory Cyclic Redundancy Check(CRC) to be performed on application of power to prove integrity of EEPROM & UVROM memory.

6.3 Upgradeability of CPU & Firmware-

6.3.1 Controller logic circuits shall be of latest design CPU with adjustable frequency drive specific circuitry & firmware and upgradeable features.

6.4 Hot /Cold Standby Provision:

6.4.1 Provision of changeover & communication, data/programme transfer shall be made available in the panel as required for Hot/cold standby facility, by the indenter.

6.4.2 Communication module shall have the facility(selectable) to act like Master or slave.

6.5 VFD system for ac drives shall mainly comprise of the following.

- ac power circuit with choke / filters etc.
- Converter bridge
- Inverter
- Control & regulation equipment including protection, indication & annunciation

6.6 Basic Features required in VFD drive: -

6.3.1 Converters & inverters for VFD shall be with microprocessor based digital regulation & control. VFD regulation & control shall be compatible to PLC/ICS/DDC etc. through standard communication protocol.

6.3.2 Inverter shall be fully microprocessor based, in design having 3 phase uncontrolled (unless specified otherwise) and IGBT based inverter with pulse width modulation (PWM) power section, suitable for constant /variable torque application. It shall be complete with programming unit.

6.3.3 The control section of the drive (controller, pulse/gate drive, power supply etc.) shall be interfaced to the power section (rectifier and inverter) with the help of screws, bus bars or flexible cables/wires and isolation of control & power section shall not require any desoldering / soldering of the components/ wires.

6.3.4 *Drive* - shall have following provisions to be operated from key pads :

- i) Forward inching

- ii) Reverse inching
- iii) Forward run
- iv) Reverse run
- v) Stop
- vi) Speed increase
- vii) Speed decrease
- viii) Provision to stop the motor quickly from running condition and quick reversal of the drive shall be provided.

6.3.5 Control features:

- i) Speed ratio of the motor shall be adjustable from 0 Hz to 50 Hz in continuous mode.
- ii) Slip compensation shall be provided to 1% speed regulation from no load to full load.
- iii) Ramp stoppage/coast to stop features.
- iv) Minimum braking torque of 30% shall be available. However, for higher braking torque requirement braking resistors shall be provided suitably (This is applicable to crane duty).
- v) Normal jogging and threading facilities (as per requirement)
- vi) System shall accept digital and analog signal from other drives wherever required
- vii) System shall give digital and analog signal to other drives wherever required.
- viii) Provision for checking system in manual regime.
- ix) Current and speed feed back facility.

6.3.6 Minimum Control-function modules to be provided in digital regulation system.

- Reference speed setter.
- Ramp generator.
- Current feed back controller.
- Pulse transformer trigger module.
- Logic control and sequence module.
- V/F control module.
- Slip compensation control.
- Current limiter.
- Counter current braking.

6.3.7 *System shall have minimum:*

- - Digital inputs: 3 Nos.
- - Digital outputs 3 Nos.
- - Relay O/P 2 Nos. (programmable)
- - Analogue inputs: 2 Nos.
- - Analogue outputs 2 No.

6.3.8 *Communication* - Drive shall have following features:

RS 232 / RS 485 Modbus / Ethernet / Profibus / Device net /
Control net / Profinet

6.4 Control supply and power components shall be so arranged that they do not cause any heating to the controller and allied section of the inverter.

6.4.1 Panel mounted or integrated type backlit display unit shall be desirable feature. The same unit shall be used for programming, fault messaging and running status. Display of the fault message will be in English text form.

6.4.2 Acceleration and de-acceleration time with adjustable setting shall be provided which will be independently programmable.

6.4.3 Adjustable Torque boost facility shall be provided.

6.4.5 In order to prevent resonance between motor and coupled machines multiple point skip frequency settings shall be provided.

6.4.6 Programmable automatic restart / flying re-start (start on fly) in case of momentary power failure during operation shall be provided. Programmable power ride-through feature shall be provided

6.4.7. Suitable bypass provision on VFD failure shall be provided if required by the purchaser.

6.4.8 Adjustable current limit setting shall be provided.

6.4.9 Over loaded capacity shall be 150% of drive rated current or 110% for 1 minute (Variable Torque) repeated every 300 seconds. These overload capacities shall such that unit is shutdown safely at the end of the envisaged overload period without causing any failure to control and power section of the inverter.

6.5.1 Self-diagnostic facility shall be provided.

6.5.2 Isolation arrangement for input and out put along with status monitoring device and shunt trip coil (240 Vac) shall be provided.

- 6.5.3 The device shall be protected by semiconductor fuse at ac side.
- 6.5.4 In case of power failure, drive shall be able to store and memorize set parameters and software blocks.
- 6.5.5 It shall have electromagnetic compatibility with EMC filter as per EN-61800-3/ IEC-1800-3.
- 6.5.6 Provision of storing & down loading configuration.
- 6.5.7 IGBT initialization testing by control section on each power up & run command.
- 6.5.8 Suitable earthing provision to be provided.
- 6.5.9 For individual inverter drive feeding multiple motors (group drive application), individual isolating device to be provided between VFD and motor.

6.6 Protection

- 6.6.1 The unit shall be capable of protecting the device (itself) and the motor both in case of faults. Following minimum protections are required :
 - i) Protection against input & output phase loss/phase short circuit.
 - ii) Under voltage and over voltage protection.
 - iii) Over voltage and under voltage in dc bus.
 - iv) Over current in dc bus.
 - v) dc Short circuit
 - vi) dc earth leakage /earth fault.
 - vii) Wrong phase sequence.
 - viii) Transients and surges over voltage.
 - ix) Over current and short circuit at any point of the system
 - x) Under load.
 - xi) Control power supply failure.
 - xiii) Inversion fault
 - xiv) di/dt. Protection
 - xv) Earth fault of motor
 - xvi) Fan failure
 - xvii) Stalling of motor.
 - xviii) Over speed
 - xix) Display and data logging as per requirement
 - xx) Any other protection as per purchaser's requirement.
 - xxi) Lightning & surge protection
 - xxii) Heat sink temperature protection is desirable to safeguard the drive
 - xxiii) Microcontroller monitored thermal sensor on heat sinks for thermal protection.

xxiv) IGBTs shall have soft recovery free wheeling diodes to prevent IGBT failure when subjected to motor discharge spikes. This shall apply to DB circuit also.

6.6.2 Power removal safety function shall be there to prevent motor from unintentionally restarting conforming to standard EN954-1 : cat : 3 and IEC/EN61800-5-2.

6.7 Alarm and Annunciation – Minimum 5 alarms for faults shall be stored preferably with the time stamping.

7. PANEL FOR DRIVES, SWITCHGEAR COMPONENTS AND ACCESSORIES

7.1 IP42 and above with test certificate.

7.2 Sheet steel used for fabrication of metal cabinet for control panel shall be of cold rolled type and of thickness not less than 2 mm. Non-load bearing side may be of 1.6 mm thick sheet. The gland plate thickness shall be minimum 3mm and the material shall be CRCA.

7.3 The cabinet shall be floor-mounting type and shall be provided with lockable-hinged door at front and back with handle.

7.4 The panel shall be accessible both from front and back.

7.5 Durable gasket shall be provided for all doors and covers and for all partitions between adjacent units. The gasket shall be of sponge rubber synthetic rubber and shall be adequately secured. Barrier shall be provided/between power equipment and control equipment.

7.6 Internal control & power wiring shall be routed separately to have better noise immunity.

7.7 The control and power terminals shall be such that each and individual terminal shall be accessible for maintenance without effecting the wiring at any other terminal.

9.0 TEST

9.1 The equipment shall be fully tested in accordance with the relevant clauses of applicable standards.

9.2 Type test certificates shall be submitted for all equipment as stipulated in the relevant standards.

9.3 All routine test at site.

9.4 Tests as per approved QAP.

8. INFORMATION TO BE FURNISHED

8.1 **Name Plate** - Each control panel shall be provided with one or more name plates containing the following information:

- a) Original Equipment Manufacturer's name
- b) Type designation or identification number and year of manufacture
- c) Reference to this Interplant Standard
- d) Rated voltage of the main circuit, ac/dc
- e) Rated voltage of the control circuit, ac/dc
- f) Rated current
- g) Rated short circuit current (See clause 4.5 of IPSS:1-04-042-03)
- h) Degree of protection
- i) Dimensions, and
- j) Weight of panel

8.2 **Marking** - Inside the control panel, it shall be possible to identify individual circuits and their protective devices. For this purpose, metal engraved marking shall be permanently fixed on the mounting base of the components.

8.2.1 An identification, name-plate/markings by inscription indicating the panel designation, that is the operation of the crane for which it is intended, shall be provided approximately at the centre of the panel. The inscription shall be in English and Hindi languages with the height of letters not less than 10 mm.

8.2.2 Each component or apparatus inside the panel shall be properly identified and marked on the base mounting. The marking or the symbol given shall tally with those used in the circuit diagrams. The size of the marking used shall be suited to the component and shall be clearly visible.

8.2.3 The manufacturer shall also provide circuit/wiring diagrams with complete cable and component specifications along with instructions for installation, operation and maintenance.

8.2.4 An instruction manual shall be provided, containing schematic and wiring diagram with step by step operational explanation of the circuit, and component specifications in detail.

8.2.5 A schematic diagram for different schemes shall be provided on respective panels preferably metallographed or printed.

APPENDIX – A

STANDARD INFORMATION TO BE FURNISHED BY SUPPLIER

SL. NO.	VENDOR'S NAME	CUSTOMER DATA	SUPPLIER DATA OR CONFIRMATION	REFERENCE
1	Drive type			
1.1	ac Drive specification for application			
1.2	Make			
1.3	Model no.			
1.4	Control technology – VFD vector control / torque control			
2	Application requirement			
2.1	Application			
2.2	Normal duty/Light overload/High overload			
2.3	Speed range			
2.4	Cable length			
2.5	Small write up about application			
3	Motor data			
3.1	Motor voltage			
3.2	Full load current			
3.3	Frequency			
3.4	Nominal speed			
4	Ambient data			
4.1	Ambient temperature			
4.2	Humidity level			
4.3	Environment			
5.1	Drive data			
5.2	Temperature range for derating			
5.3	Offered drive continuous current for mentioned duty at 50°C			

5.4	Over load time			
5.5	Overload repeatability			
5.6	Drive over temperature limit			
6	Supply voltage			
6.1	Supply voltage limit			
6.2	Efficiency			
6.3	dc over voltage tripping limit			
6.4	dc under voltage tripping limit			
7.1	Switching frequency			
7.2	Available maximum limit			
7.3	Derating factor for quoted module on maximum switching frequency			
7.4	You have quoted Offer compliance considering			
7.4.1	Cable length			
7.4.2	Cable length allowed for Switching frequency considered			
7.4.3	Cable length between motor and drive output terminal			
7.4.4	Maximum permissible cable length			
7.4.5	With output choke			
7.4.6	Without output choke			
7.4.7	Communication requirement			
7.4.8	Communication protocol			
7.4.9	EMC Filter			
7.4.10	EMC Filter required			
7.4.11	Permissible cable length with offered EMC Filter			
7.4.12	Input choke			
7.4.13	Output choke			
8.0	Storage procedure and starting and start up procedure (Operation & Maintenance Manual)			
9.0	Human Interface module			

9.1	HMI name			
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10.0	Text line display (Back lid LCD display in full plane English text message for grouping, parameter description, programming and fault message display. It shall display the description of parameter/fault etc.			
10.3	Fault history			
10.4	Maximum parameters available on 1 screen			
11	I/O			
11.1	Digital Input			
11.2	Digital output/Relay output			
11.3	Analog input (0-10 V or 4-20 ma and number)			
11.4	Analog output (0-10 V or 4-20 ma and number)			
12	Protection			
12.1	Over voltage			
12.2	Under voltage			
12.3	I ² t protection (over temperature protection of motor)			
12.4	Short circuit			
12.5	Output earth fault			
12.6	Drive over temperature			
12.7	Drive under load			
12.8	Adjustable overload)			
12.9	Single phasing			
12.10	Under load			
12.11	Stall			
13	Protection of module			
14	Built in chopper (W/O resistance) for dynamic braking			
15	Earthing Provision			
16	IGBT Device Make & Particulars			

Note:

1. Please give the specific detail and page number of supporting documents/catalogue
2. For all the fields' supplier is supposed to confirm or give the data as applicable
3. Please use extra paper for clarification of specific points, if any.
4. The supplier shall fill this document with exception listed out clearly.