


INTER PLANT STANDARD – STEEL INDUSTRY		
 IPSS	ac VARIABLE FREQUENCY DRIVE FOR STEEL MILL DUTY EOT CRANES	IPSS: 1-10-044-12
	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 October 2012.
- 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) IEE Standard 444(Part-I):1973 iii) EN 61800-3(2nd environment) / IEC 1800-3 industrial environment.iii

1. SCOPE

- 1.1 This interplant standard covers the requirements of VFD drive used for low voltage ac drives up to 690 V for EOT cranes.

2. TERMINOLOGY

For the purpose of this standard, the definitions in IS: 1885 (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 minimum 50°C unless specified otherwise. 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%.

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 ac VFD converters, which shall be used for speed control of crane motors shall be stand alone units having IP20 degree of protection or as per the requirement of the purchaser.

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
- OR
- 3 Phase 415Vac, 50 Hz

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

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

5.2 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%

6. EQUIPMENT DETAILS

6.1 VFD system selection

6.1.1 The VFD drive selected for crane application shall be Insulated gate bipolar transistor (IGBT) based, PWM (Pulse Width Modulation), closed loop vector control with encoder feedback.

6.1.2 Due consideration of the following shall be given for selection & sizing the VFD drive for cranes: :

- Starting torque requirement
- Speed range.
- Maximum torque & power requirement.
- Acceleration & deceleration requirements
- Compatibility with power supply through down shop leads(DSL)
- Environmental conditions
- Duty cycle, including no. of starts & stops per hour
- Reliability requirement

6.1.3 VFD drive shall be selected based on the current rating (rated current) mentioned in the manufacturer's catalogue at the base switching frequency.

Minimum base switching frequency should be considered to achieve low switching losses and hence best efficiency. In case of dual current rating mentioned in the catalogue, the current rating corresponding to "Constant Torque" or "Heavy duty" shall be selected for Crane applications.

6.1.4 The continuous current rating of the VFD drive shall be at least equal to the 1.5 times the motor rated current. For common dc bus configuration, the rating of rectifier module shall be sum of the rating of invertors of two largest mechanisms unless otherwise specified.

6.1.5 One of the following configurations shall be adopted for VFDs for steel mill duty crane :

- a) Separate converter panels for individual motions shall be provided with either resistive type dynamic braking function or fully regenerative capability. However, For steel melting shop cranes, the rectifier section for Hoist motion shall be PWM-type controlled (Active Front End) 4Q regenerative type (IGBT based) rectifier. The travel drives may be operated with dynamic braking resistors.

- b) Common dc Bus configuration with two sets (one working and one emergency) of fully regenerative , active front end type , IGBT based rectifier units along with inverter units for individual motions
- 6.1.6 For Cranes under operation in Steel melting shop having ambient temperature of more than 50°C as well as dusty condition e.g. Charging crane, Ladle crane, Hot slab handling cranes, VFDs should be provided with A/C unit or Fan / Blower with filter arrangement and be suitably protected with proper enclosure having IP54 degree of protection or shall be housed inside crane girder or air conditioned Electrical room on crane platform
- 6.1.7 In case VFD is offered with dynamic braking function, a dynamic braking module consisting of power electronic switch (IGBT) and discharge/braking resistor shall be provided..The braking resistor of a hoisting drive shall be selected considering the possible lowering height of the load being lowered at the maximum speed. The sizing of the braking resistor shall take into consideration the regenerative energy due to overhauling load and the lowering time The Hoisting drive should preferably have the flexibility of connecting external Dynamic braking module. For cross traverse and long travel motions, the braking resistor shall be capable of absorbing the regenerative energy during deceleration of the motion also taking into account the possibility of a swinging load (the load and load attachment included).The braking resistor shall be thermally capable to absorb the regenerative energy during successive drive cycles of the application.
- 6.1.8 Range of switching frequency shall be 1-16 kHz.
- 6.2 Power circuit for the vector converter for cranes shall mainly comprise of the following :
- 4Q regenerative PWM-type controlled rectifier bridge with IGBTs or 6-pulse diode rectifier bridge on the input (based on application and Purchaser's requirement)
 - 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.
 - In case of power failure, drive shall be able to store and memorize set parameters and software blocks.
 - IGBT semi-converter inverter bridge to convert the dc to a PWM VFD output suitable for a crane duty induction motor

- Microprocessor based digital Control & regulation equipment protection, indication & annunciation devices

6.3 Basic Features required in VFD :

- 6.3.1 Converters & inverters for VFD shall be with microprocessor based digital regulation & control. VFD system regulation & control shall be compatible to PLC/DCS etc. through standard communication protocol. This should agree with dc bus configuration and stand alone configuration.
- 6.3.2 Inverter shall be fully microprocessor based, in design having 3 phase controlled rectification and IGBT based inverter with pulse width modulation (PWM) power section, suitable for constant 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 inter phased 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 Crane Software Features:

- a) Quick Lift
 - To allow a lightly loaded or empty hoist to move up and down faster than the base speed of the motor
- b) Reverse Plug Simulation
 - When reversing directions, the inverter will decelerate at a faster rate than the normal deceleration rate..
- c) Load Hold (Hang Time)
 - To hold a load aloft at zero speed without setting the brake. Permit precise positioning of the load without delays normally associated with mechanical operation of the brake
- d) Motor and Brake Torque Proving

- Precise coordination between motor and brake to extends brake life and lower maintenance costs.
- The drive shall completely control motor torque, a brake shall be required only for holding and emergency stopping in case of power outages or faults.
- An adjustable load float time to further minimize brake wear.
- Brake failure alarm output. (indication and alarm)

e) Fast Stop

- To Rapidly decelerate the drive when the run command is removed i.e. when back-up limit switch is tripped

f) Speed Control

- To accommodate five-speed cabin/pendant control, infinitely variable speed control, and a bi-polar voltage or analog current input speed command

g) Microspeed Positioning Control

- To Permit extremely slow movements for greater positioning accuracy

h) Dual Upper and Lower Limit Switch Inputs

- To accommodate limit-switch inputs on both the upper and lower travel of the hoist.
- Operation of the rotary /spindle limit switch in either direction shall stop the hook motion; operation of the counter weight limit switch will be considered as emergency stop and a fault message shall be displayed. Further movement in hoist direction is prevented.

i) Torque Limits

- Two sets of Fwd and rev torque limits are provided.

j) Torque Limited Acceleration / Deceleration Times

- For smooth starts and stops to prevent load sway

k) Stepless Acceleration / Deceleration

- Ensure smooth variable velocity control

l) Mechanical Resonance Filters

- Prevents operation at speeds which excite mechanical resonance and vibration.

m) Hoist Overload Protection

- Prevents operators from picking up loads in excess of crane capacity.

n) Slack Cable Detection

- Digital input which prevents hoist from paying out rope to far and rewinding in reverse direction which will damage rope _

o) Uncommanded Motion Detection

- If the drive detects that the motor is still moving for some time interval after the drive has issued command to stop the motor, then

the drive will fault out with a motor runaway fault. The time interval shall be computed internally from the tuning parameters

p) Automatic Self-tuning to AC Motor and Load

- To Optimize motor operation by determining::
 - * Motor pole count
 - * Motor phase sequence
 - * Motor stator resistance
 - * Motor field current
 - * Motor slip frequency

q) Keypad Security Lockout

- To Prevent unauthorized modification of drive controller data.

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.
- Current limiter.
- Counter current braking.

6.3.7 *System shall have:*

- - Digital inputs: 3 Nos.
- - Digital outputs 3 Nos.
- - Relay O/P 2 Nos. (programmable)
- - Analogue inputs: 2 Nos.
- - Analogue outputs 2 Nos.

6.3.8 *Communication* - Drive shall have following minimum 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 Shall have panel mounted or integrated type backlit LCD display unit. The same unit shall be used for programming, fault messaging and running status. Display of the fault message will 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.
- 6.4.4 In order to prevent resonance between motor and coupled machines multiple point skip frequency settings shall be provided.
- 6.4.5 Adjustable current limit setting shall be provided.
- 6.4.6 Over load capacity shall be 150% of drive rated currents (Constant Torque) repeated every 5 minutes. These overload capacities shall be 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 Forced air cooling arrangement shall be provided.
 - 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. Suitable inbuilt dc choke shall be provided.
 - 6.5.3 The device shall be protected by semiconductor fuse at ac side.
 - 6.5.4 Suitable choke (with mH rating, 3 phase) at input side shall be provided to meet the following In case of choke the same shall have following minimum requirement.
 - i) Nominal operating voltage = Rated voltage of the drive.
 - ii) Maximum current $I_{max} = 2x I_{rated}$ for 1 minute.
 - iii) Grade of core material CRGO.
 - iv) Temperature rise at $I_{rated} = 95 \text{ deg C}$.
 - v) Insulation class H
 - Vi) Insulation resistance at 1100 V dc, between winding to core more than 100 M Ohms.
 - 6.5.5 In case of power failure, drive shall be able to store and memorize set parameters and software blocks.
 - 6.5.6 It shall have electromagnetic compatibility (EMC) with EMC filter EN-61800-3/ IEC-1800-3.
 - 6.5.7 Suitable earthing provision to be provided. A separate earth conductor between the ac converter and the ac motor shall be provided for safety and noise attenuation

6.5.8 Earth Fault

6.6 Protection

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.

6.7 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 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. Height limitation shall be limited by the customer.

7.2 For stand alone VFD, enclosure shall be IP 42 with ac provision.

- 7.3 The cabinet shall be floor-mounting type and shall be provided with lockable-hinged door at front with handle. Hinges should be of stainless steel or alloy steel.
- 7.4 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.
- 7.5 Internal control & power wiring shall be routed separately to have better noise immunity.
- 7.6 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

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) Manufacturer's name or trade mark
- 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			
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	De-rating factors for higher amb. temp.& higher switching frequencies			
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	Switching frequency			
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 considering			
8	Cable length			
8.1	Cable length allowed for Switching frequency considered			
8.2	Cable length between motor and drive output terminal			
8.3	Maximum permissible cable length			
8.3A	With output choke			
8.3B	Without output choke			
9	Communication requirement			
9.1	Communication protocol			
10	EMC Filter			
10.1	EMC Filter required			
10.2	Permissible cable length with offered EMC Filter			
10.3	Input choke			
10.4	Output choke			
11	Human Interface module			
11.1	HMI name			

11.2	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.			
11.3	Fault history			
11.4	Maximum parameters available on 1 screen			
12	I/O			
12.1	Digital Input			
12.2	Digital output/Relay output			
12.3	Analog input (0-10 V or 4-20 ma and number)			
12.4	Analog output (0-10 V or 4-20 ma and number)			
13	Protection			
13.1	Over voltage			
13.2	Under voltage			
13.3	I ² R protection (over temperature protection of motor)			
13.4	Short circuit			
13.5	Output earth fault			
13.6	Drive over temperature			
13.7	Drive under load			
13.8	Adjustable overload)			
13.9	Single phasing			
13.10	Under load			
13.11	Stall			
14	Protection of module			
15	dynamic braking module			

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.