HIND RECTIFIERS LIMITED

Address : Lake Road, Bhandup (W), Mumbai - 400078.
Tel. : +91-22-25696789
Email : corporate@hirect.com / marketing@hirect.com
CIN : L28900MH1958PLC011077
Website : www.hirect.com

TECHNICAL SPECS FOR AUXILIARY POWER SUPPLY
Type – Mumbai Monorail

Date: 09-10-2019

Sr	Description		Specification
1.	**Input Power Source:**		
a)	Nominal DC Voltage	:	750Volts
b)	Working DC Voltage Range		600Vdc to 865Vdc
c)	Working Short Tem Voltage Range	:	525Vdc to 900Vdc
d)	Rated DC Current	:	55Amps
e)	Rated Frequency	:	NA
f)	Variation of DC supply Voltage	:	- 20%+ 15% of Nominal Voltage
	Variation of Frequency	:	NA
	No. of Phases		NA
2.	**Output Specifications:**		
a)	Output – 1		AC output power – 23kVA, 415Vac, 32A, 3Phase, 50Hz, Sine wave with Galvanic Isolation
	Zigzag Transformer N Current	:	10Amps (Unbalance/ Single Phase Load)
b)	Output – 2		12kW, 24Vdc, 500A, Galvanic Isolated Output adjustable: 24V to 27V ± 1%, Ripple < 1%
c)	Output -3		0.8kW, 27Vdc, 30A Settable, Electrically Isolated Output: 24V to 30V, Ripple < 1%
d)	Rating Class	:	Continuous
3	**Control Characteristics:**		
a)	Rectifying Circuit System	:	First Stage: 3 Level modified PSFB
b)	Output Adjusting System	:	Close Loop Control with set REF
c)	Control Range	:	NA
d)	Operating Range: Voltage	:	22Vdc to 27Vdc
	Battery-Charging Current		30 Amps
e)	Regulation	:	±1.5% of rated voltage (control characteristics – as a constant voltage source with current limit)
4	**Setting and Calibration:**	:	operators through GUI
5	**Protections:**	:	dv/dt protection Unit Fuses (Line side) Thermostat for over temperature protection of devices.
6	**Controls on Control Cubicle**	:	Unit Start Push Button (manual/Bypass mode) Unit Stop Mushroom type push to lock Push button (manual mode). Fault Acknowledge/Reset Push Button. Hooter for Audible annunciation. Auto/Manual control key selection.
7	**Operating Conditions**		
a)	Max. Ambient Temperature	:	45° C (113 ^{0}F)
b)	Max. Humidity	:	90% (Non-condensing with max. Ambient Temperature not occurring together.
c)	Altitude	:	Less than 1000mts above MSL
8	**Cooling Method**		Forced Air cooled.
9	**Construction**	:	The cubicle similar to existing Unit, W-1210 X H-1090 X D-305
10	**Input & output terminals**	:	Similar to existing Unit

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11	**Wiring**	:	Soft electrolytic annealed copper busbars / cables of adequate rating to be used. Control wires will be PVC insulated flexible multi-strand copper cable of 1.5 / 0.5mm^2 of 660V/1100V grade.
12	**Earthing**	:	A copper Plate of Suitable size for ground to be provided inside the panel. All metal parts will be earthed to this ground point with visual double earth. The common earthing point will be brought out of the panel by bolt.
13	**Painting**	:	Powder coating. RAL 7032 OR As per Customer Requirement
14	**Input & Output Cables**	:	Not in HIRECT scope.
15	**Place of Installation**	:	Indoor
16	**Mass and Dimensions**		Approximate same as Existing System
17	**Control System / Technique**		
18	**Interface to the train control system**		The 24 VDC and 415 VAC lines shall be connected via terminals in the device
19	**Interface to the Line Voltage**		The 600/750 VDC lines shall be connected via terminals in the device
20	**Start-up time**		For establishing the readiness for service (time between presence of the input voltage and the operability), the auxiliary converter shall not need more than 15 seconds
21	**Interfacing**		Through RS-485 and Ethernet communication

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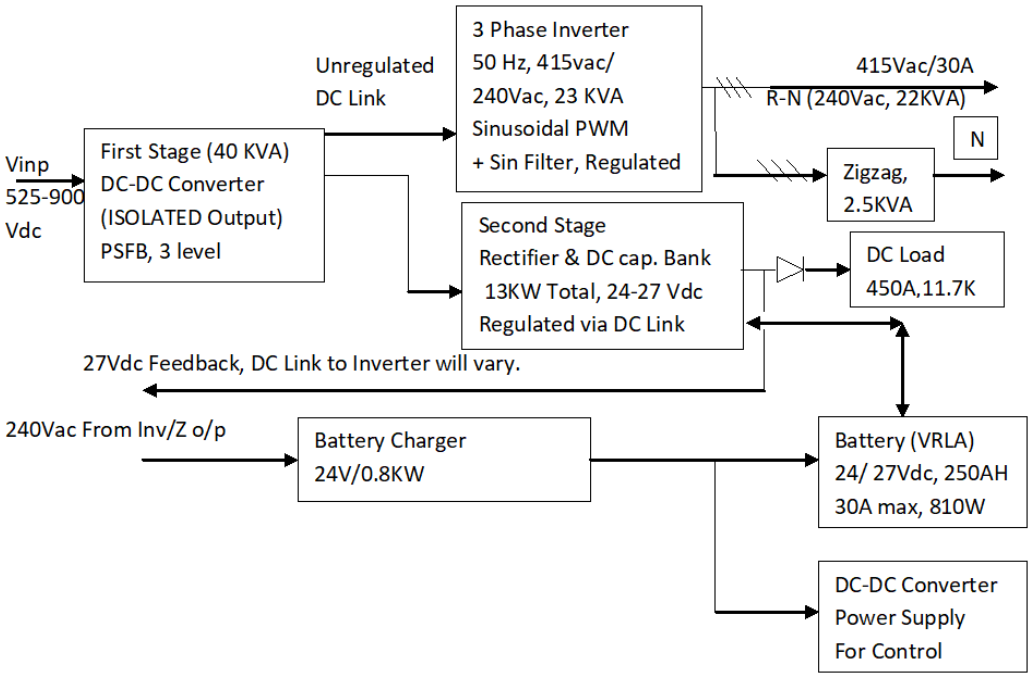
22 Block Diagram of Proposed APS

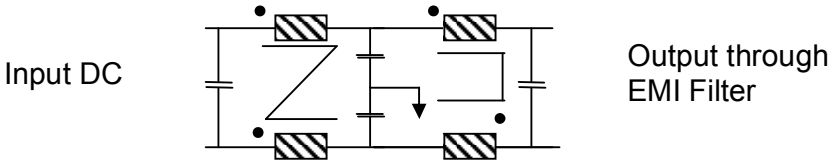
First stage: 40KW DC-DC Converter. The new topology for creating the inverter DC link and regulated 24Vdc Power Supply **fully isolated** from input DC source. This will reduce Conduction losses on the primary side of the converter. The form-factor (FF) had to be made closest to unity and also switching losses minimized.
The isolated buck-boost topology with high conversion efficiency.

The two full bridge inverters, both square waves; phase shifting with respect to each other to achieve regulation, and the size of output filter had to be reduced substantially.
Two inverter secondary added, either in series when both polarities are identical giving 2Vs.



23 Input Section of Proposed APS

DC Voltage is the input DC voltage from Sub Station Rectifier
DC-DC converter input passes thought EMI Filter which will also protect surge votlage



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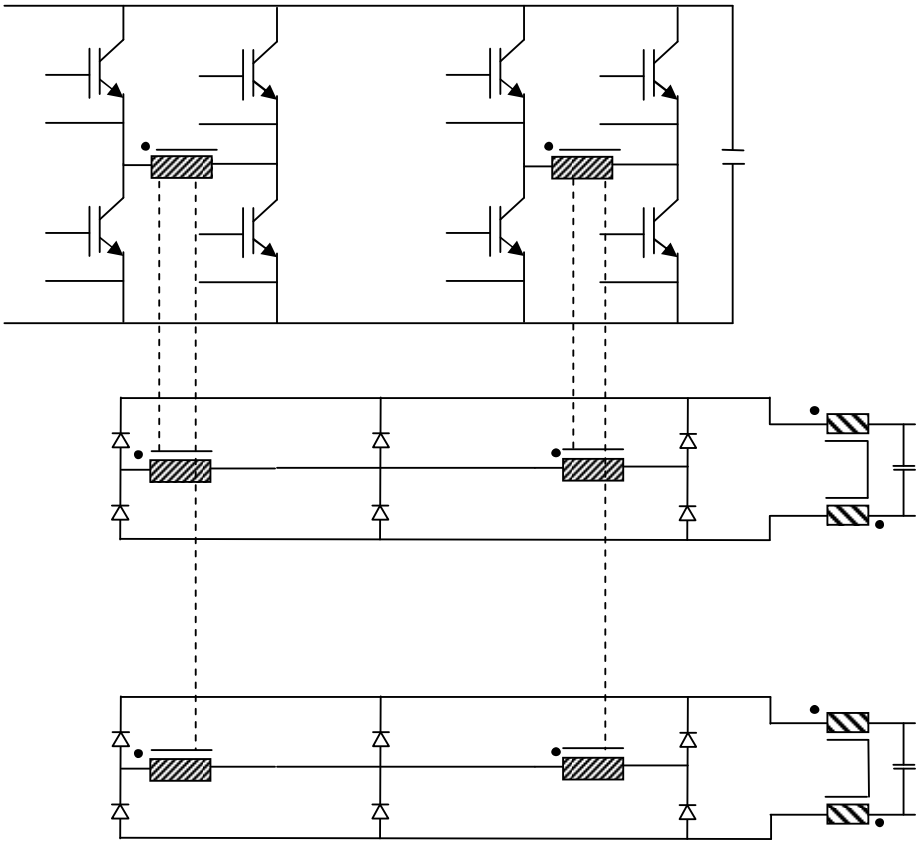
24 Input DC-DC Section of Proposed APS

When minimum input DC is supplied 525Vdc = 0° Phase shift, the phase shift should be minimum, which will cause the output to be 2V since both 1Ts and 2Ts are vectored in same direction (series connection), therefore voltage across 1Ts will add up with 2Ts giving output 2V while the diodes D1 and D6 conduct for +ve Cycle and D2 and D5 for the negative cycle. (Set point will be defined later)
When maximum input voltage DC is supplied (900Vdc) 1000Vdc= 180° Phase shift, the phase shift is maximum, which will cause the output to be 1V since 1Ts and 2Ts are vectored in opposite direction (parallel connection), therefore voltage across 1Ts and 2Ts giving output 1V while the diodes D1, D4 and D5 conduct for +ve Cycle and D2, D3 and D6 for the negative cycle.
During intermediate input levels of DC voltage and phase shifts, the control have combination of series and parallel voltage sources within the same cycle. The sample waveforms are shown in below figure.
The unit will generate two DC bus
Outputs – 1: DC link Voltage (700Vdc/750Vdc) for 3ph Inverter.
Outputs – 2: 24Vdc Output, this output is taken as feedback to adjust phase shift and Regulate.

DC-DC converter Switching Frequency= 10 KHz, 300A/ 1700V IGBTs used,



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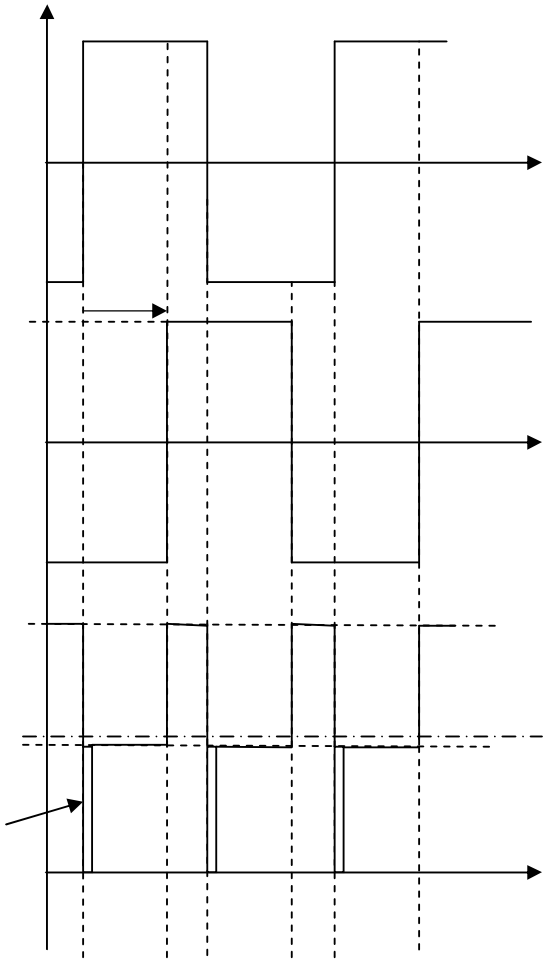
25 Input DC-DC Section Waveform of Proposed APS

IGBT Control Waveform for DC-DC Converter
Inverter 2 is Lagging Inverter 1 during control operation:



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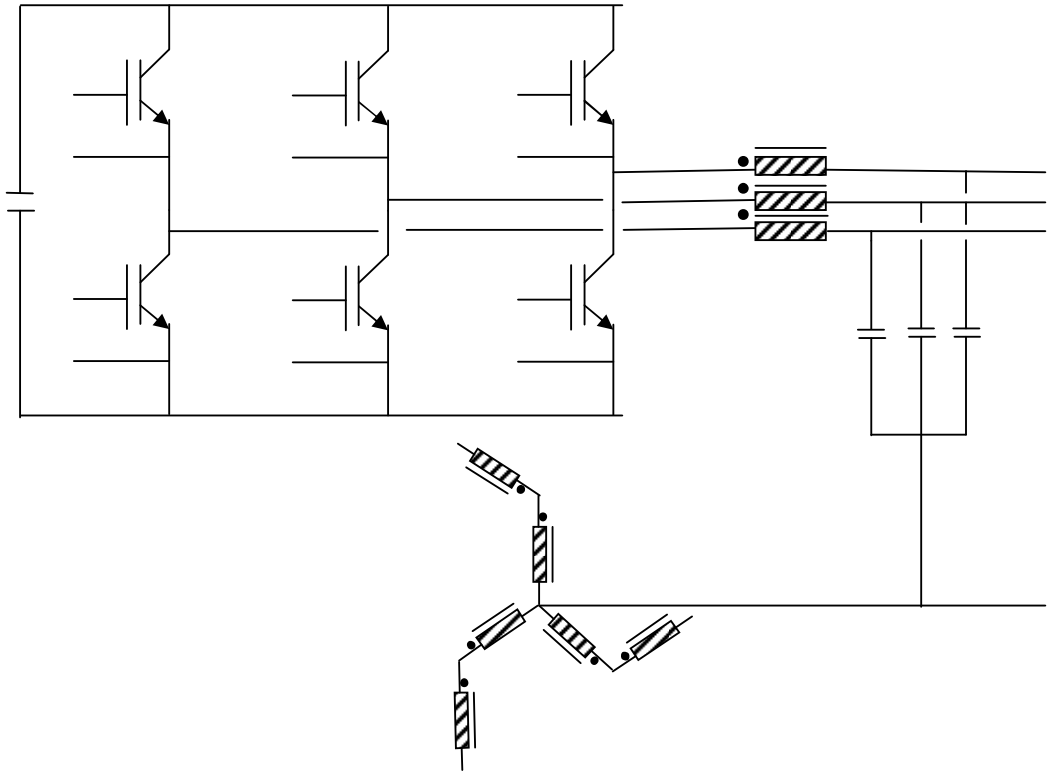
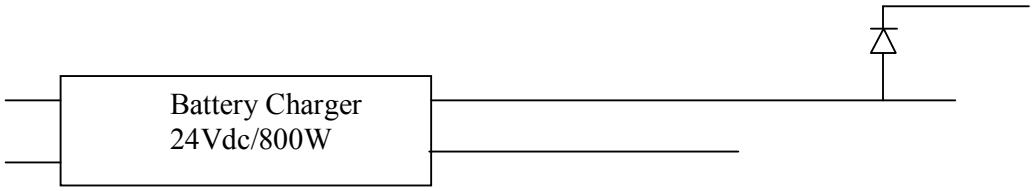
25 Output DC-AC Inverter Section with Zigzag Transformer of Proposed APS

3 Phase 50Hz Sine wave Inverter (fundamental Frequency)
Inverter Switching frequency - 3.0 KHz
DC Link - 700Vdc / 750Vdc,
IGBT Module - 300A/ 1700V



Due to sufficiently high DC link voltage, Inverter will work on sinusoidal modulation instead of Space Vector Modulation which can work at higher modulation index.
The sinusoidal waveform has low THD value, it is easier to filter and it offers smaller footprint.
The inverter is closed loop voltage regulated using d-q frame vector control.

26 Battery Charger Section of Proposed APS



The 800W Battery input will take from Inverter output. Due to separate input and control, the main 24Vdc supply voltage will be constant during Battery current limit.