Technical Memorandum

SMCSD Headworks, Primary and Secondary Treatment Pre-Design

Subject:	**TM 8: Electrical and Instrumentation**
Prepared For:	SMCSD
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The purpose of this technical memorandum (TM) is to present the preliminary design of the headworks and primary treatment processes to be implemented at the Sausalito-Marin City Sanitary District (SMCSD) Wastewater Treatment Plant (WWTP). This TM is intended to be included as an appendix to Recommend Project Summary and will provide the major recommendations. The TM is organized as follows:

1. Electrical, Instrumentation and Control Design Criteria
2. Equipment List
3. Instrumentation Index
4. I/O List
5. FFR Pump VFD Technical Memorandum

The electrical and instrumentation technical memorandums were developed based on preliminary concepts reviewed during the pre-design phase. The information presented will be updated during final design.

1 Purpose

These design criteria should be used as the guidelines for detailed design of electrical and instrumentation and control (I&C) system for the project. It should be noted that it is SMCSD's goal to standardize major equipment such as switchboards, MCCs, motors etc… and thus like equipment and parts should be specified and installed for all District's facilities including the new Headworks.

1.1 Criteria Changes

These criteria establish the guidelines to be used in the final preparation of detailed design electrical, I&C drawings and specifications and any other document required for this project encompassing power and control systems including lighting and communications and controls. These guidelines are subject to changes approved SMCSD as required.

2 Codes and Standards

The work should be performed in accordance with the latest revisions of codes and standards published by the following organizations:

American National Standards Institute (ANSI)

Institute of Electrical and Electronics Engineers (IEEE)

American Society for Testing and Materials (ASTM)

Insulated Cable Engineers Association (ICEA)

International Society for Automation (ISA)

National Fire Protection Association (NFPA)

National Electrical Code (NFPA-70)

National Electrical Manufacturers Association (NEMA)

National Electrical Safety Code (ANSI C2)

Illuminating Engineering Society (IES)

Underwriters Laboratories (UL) where applicable.

Pacific Gas and Electric Company (PG&E)

International Building Code

California Electrical Code

California Fire Code
Fire Protection in Wastewater Treatment and Collection Facilities (NFPA 820)

3 Drawings

All project drawings should be prepared following SMCSD standard drawings symbols, identification system, equipment tagging systems, and abbreviations.

3.1 Site Plans

Site plans drawing should show facility locations, roadways lighting, duct banks, pull boxes, manholes, switchgear, motor control centers, distribution panels, and other major equipment. Site plans should use civil drawing backgrounds based on existing as-built drawings provided by the SMCSD and supplemented with data obtained during site visits.

In general, underground duct banks should be run parallel to buildings, and roads. Diagonal runs should be avoided as much as possible. Runs should be straight without horizontal bends. Change in duct bank direction should be done at manholes or pull boxes. Manholes and pull boxes should be numbered and reference to duct bank sections details should be included.

Duct bank sections should show conduit arrangement. All conduits should be labeled including spares. Spares conduits should be located in the upper sections of the duct bank to facilitate the installation of future cables.

Grounding cable should be indicated in all duct bank sections. Reinforcing steel when required should be referenced to typical detail.

Manholes and pull boxes should be provided as required and should be sized based on the NEC requirements and per typical detail. Low voltage (600V) ductbank system and Instrument (data highway, communications) ductbank should be separate.

Low voltage and communications duct bank runs should be separated from each other by a minimum distance of 12 inches and run through different pull boxes

3.2 Standard Electrical and I&C Details

Standard Electrical, I&C Details drawing should show typical equipment installation details for panel mounting equipment, conduit penetrations, conduit stub-ups, mounting pedestals, lighting fixtures mounting, manholes, pull boxes construction, instrument mounting, control panel and supports.

3.3 Main Single Line Diagram

A main single line diagram drawing should show the main electrical components where power is fed from for this pump station. It should include a pull section, metering section, main breaker and branch breakers. The main service switchboard should follow requirements from Pacific Gas & Electric Company.

Information on the single line diagram should include voltage, number of phases, and frequency for all systems. Ampere (current) capacity and short circuit rating for all buses should also be shown. Data such as circuit breaker frame and trip settings, metering and relaying, current and voltage transformers and their ratios, KVA rating, voltages, phases, winding connections, type of cooling and impedance for all major transformers should be shown.

Number, type and size of cables including rating and conduits for all incoming services and feeders should be shown.

Minimum short circuit rating should be shown on the single-line diagram for all electrical components.

Space heaters will be considered for the Main Switchboard or Motor Control Center for locations where they are needed to prevent condensation inside switchboard or MCC.

3.4 Motor Control Center (MCC) Single Line Diagram

A separate drawing should be prepared to show the MCC single line diagram and its front view elevation. (Front and back if back-to-back arrangement). The drawing should show a horizontal bus with ampere rating, short circuit rating, and number of phases, frequency, and number and size of wires.

Circuit arrangement should be identified in a MCC manufacturer's standard designation to cubicle numbers. Circuits should include circuit breakers, motor- starter's type and overloads. Motor starters should be sized based on NEMA standards. NEMA starter size should be shown for each starter. Motor horsepower and equipment identification should be shown on the bottom of the single line. For solid-state reduced voltage starters, internal shunt contactors should be shown.

Number, size of wire including grounding conductor, conduit size, lighting transformer rating, and motor control devices should be shown on the single line. Spare breakers and starters should be specified for future use. Loose spare parts such as fuses, CPTs, switches, lights etc. should also be specified.

Standard short circuit rating of 65kA symmetrical bracing should be specified for the MCC.

Space heaters will be considered for the MCC for locations where they are needed to prevent condensation inside the MCC.

3.5 Panelboard Schedule

A panelboard schedule should be prepared for each panelboard. The panelboard schedule should be three-phase as required. Panelboard schedule should show name of panel.

Panelboard schedule should include the panelboard location, number of branch circuits, main circuit breaker or main lugs, panelboard enclosure type, number of poles and trip rating for all circuits, description of circuit assignment, connected load (VA) for each circuit, connected load for each bus, subtotal connected loads and total panelboard connected load. A 200 VA load should be allowed for each duplex-type convenience receptacle. The total VA per bus should balance within ten percent. GFI breakers should be used for loads having potential of ground faults.

The panelboard should include 20% spare circuit breakers and spaces for future loads.

An * along the circuit breaker number should be used to indicate a ground-fault circuit interrupter type breaker.

A note addressing conduit and wire size should be added at the bottom of the panelboard schedule.

3.6 Control Schematics

Control schematic drawings should show all control devices associated with specific equipment. Motor control schematic should show control devices located in the motor control center as well as remotely located devices. The diagrams should follow ladder type representation with rung numbers on the left hand side of the diagram and rung description on the right hand side.

One spare normally open contact and one spare normally close contact should be provided as a minimum for each control relay. Push-to-test indicating lights should be used and should be identified as such on the diagrams.

All connections to existing SCADA RTU should be dry contact type signals powered by SCADA 24VDC circuits.

Process Instrumentation (P&IDs) drawings and control descriptions or strategies (narratives) should be the basis for the development of control schematics and software configuration.

3.7 Power, Control, and Instrumentation Layout Plans

Drawings for power, control and instrumentation layout plans should show the location of and connection to all equipment that requires raceways and conductors.

Generally, layout drawings scales should be 1/4 inch = 1 foot. Mechanical, civil, structural, or architectural layout drawings should be used for electrical background layout drawings, as applicable.

Embedded in slab and exposed conduit runs should be shown on the same drawing. Grounding layout may be shown with the power layout unless the drawing is too crowded.

No building dimensions should be shown on drawings. Building column lines should be shown. Sections should be shown only when needed to clarify installation.

Conduit work should be shown by heavy lines with background and equipment outlines shown screened. Conduit should be identified on plans at each end of a run.

4 General Power System Design Considerations

The design of the power system should consider the latest state of the art in the design of industrial power system with emphasis in safety as the main goal for the operating and maintenance personnel and service reliability for plant operation.

Electrical equipment should be specified to meet the area classification where the equipment should be installed. Equipment enclosures should have the degree of protection for the location, weather indoors or outdoors. Protective relays should be multi-function solid state type with programmable settings

Motor control center should be provided with 15 % installed spare components to allow for future load growth.

Short circuit calculations and arc flash calculations will be considered in the power system design. Short circuit calculations will be used to determine the proper short circuit rating of the equipment. Arc flash calculations will be used to determine the Flash Protection Boundary and the personal protective equipment (PPE) that people within the Flash Protection Boundary should use. Both short circuit calculations and arc flash calculations are required by the current (2005) National Electrical Code.

5 Voltage Level and Equipment Utilization Criteria

The following voltage levels and utilization equipment should be used in the power system design.

Voltage Level	Equipment utilization
480 Volts	Motor Control Centers Power Distribution Panelboards Low voltage 3-Phase Motors Power (Welding) Receptacles
120/208 Volts	Lighting Panelboards Lighting Systems and Convenience Receptacles Single Phase Motors (fractional horse power) Special Receptacles

Bus voltage drop due to motor start should be limited to 20 percent or less.
Considerations should be given to the design and installation of equipment to allow for easy of additions without modifications to the original installation.

6 Classification Of Areas

Wastewater process area classification should be unclassified, general purpose area. All areas within the Headworks shall be classified as hazardous class I Div 1 NEMA 7 location. All equipment located within this area shall be classified as such and shall be suitable to be installed and to operate safely in this hazardous location.

All indoors areas other than the Headworks shall be non-classified, general purpose NEMA 12 areas. However, because the plant is located on the shoreline with corrosive salt air, all outdoor areas shall be considered as corrosive NEMA 4X areas.

7 Power Distribution

7.1 Normal Power Supply:

In 2008, the District had a major modification to its existing electrical system which presently included a new PG&E service, 2005 new main electric service switchboard, new distribution panel and miscellaneous re-wirings of several other existing load centers. See single-line diagram on electrical drawing. (See Figure 7.1.1 for photo of this service transformer).

Figure 7.1.1 – PG&E Service Transformer T-1417

This secondary circuit is then connected to a main service switchboard rated at 600 Amperes, 480/277V AC, three-phase, and four-wire. This switchboard has two vertical sections: a pull section and metering/main service breaker section. (See Figure 7.1.2 for details of this existing main service switchboard.)

Figure 7.1.2 – Existing Main Service Switchboard (Section 1 and Section 2 ONLY. Third section on the right is a separate distribution panel fed by existing distribution panel H-2)

From this main service circuit breaker, power is fed to another 400A circuit breaker located inside the existing generator building where the entire plant loads can be transferred to an emergency (Diesel) generator. The new ATS is rated for 600 Amperes and was manufactured by General Electric. The existing emergency generator is rated for 250 kW, 480/277VAC, 3-phase, 4-wire and was manufactured by Kohler.

For the Headworks, an existing 250A 480V 3 pole spare breaker in the existing distribution system will be used to feed the new MCC-HW serving the headworks equipment.

7.2 Standby Power Supply:

The plant currently has a 250 KW Diesel generator which provides standby power for the entire plant via a new 600A Automatic Transfer Switch recently installed. The plant is in the process of implementing a RTU-based load shed system which will inhibit non-essential loads and shed loads if necessary to prevent overloading the standby generator. The existing generator set should be capable over provide service for essential loads from the upgrades.

8 Conduit Requirements

Power distribution at 480 volts and 120/208 volts should be single conductors in separate metal or non-metallic raceways from the distribution equipment or switchboard to the loads.

All conduits for power, control, instrumentation and lighting feeder circuits for exposed indoors, general purpose locations, installation should be rigid galvanized steel with threaded fittings. Minimum conduit size should be 3/4 – inch.

For outdoors exposed installations and in classified hazardous location PVC coated rigid galvanized steel conduit shall be used. In addition, conduit "EYS" seals shall be used for any conduit entering or leaving classified hazardous locations.

Non-metallic PVC schedule 40 conduit should be used in concrete encased steel reinforced duct banks or routings below the floor slab.

Flexible metal conduit should be used for connection to lighting fixtures.

PVC jacketed liquid-tight flexible metal conduit should be used for connection to motors and instruments.

In general, low voltage 480-volt power cables and 120-volt control cables both rated for 600-volt insulation should be run in the same conduit, provided that the cable insulation voltage rating is the same. Conductors No. 6 AWG and larger should be run in separate conduits from control circuits.

9 Cable and Wire

In general 600–volt conductors should be used for power, lighting and control circuits. Conductors should be stranded copper with moisture and heat resistance thermoplastic, meeting the requirements of ICEA Standard S-61-402 for type THHN/THWN 75ºC, 600V wire and cable.

All conductors for lighting circuits should be solid single copper conductor; maximum conductor size should be No. 10 AWG.

The minimum size of conductor should be No. 12 AWG for power, lighting and control circuits. Panel wiring should be MTW or SIS minimum size No.14 AWG.

600-volt conductors should be color coded as follows:

480 V Power	120/240 Lighting and Receptacles
Phase A – Brown	Phase A – Black Black
Phase B – Red	Phase B – Red Red
Phase C – Yellow	Phase C – Blue Blue
Neutral – White	Neutral – White
Ground – Green	Ground – Green

24V DC Power

Violet

Instrumentation cables should be single and multi-pair twisted shielded pairs or triad No. 18 copper PVC jacket, individually shielded with an overall shield, insulated for 600 volts 90ºC for dry locations and 75ºC for wet locations.

ETHERNET data highway cables where used should be CAT6e

Bare copper conductors should be used for grounding application.

10 Motors and Motor Control

For 460-volt motors up to 100 horsepower for outdoor installation should be totally enclosed fan cooled (TEFC) type. Motors larger than 100 horsepower should be either TEFC or weather protected NEMA II. For indoor installation, motors 100 horsepower to 500 horsepower should be Open drip-proof.

All motors ½ horsepower up to and including 500 horsepower should be 460-volt, 3-phase, 60 Hz. Motors below ½ horsepower should be 120-volt, single-phase, 60 HZ.

All 3-phase motors should be specified with locked-rotor Code Letter “G”.

460-volt motor insulation should be NEMA class F with class B temperature rise at full load. Service factor should be 1.15 at 300 feet and 40 º C ambient temperatures.

Motors 75 horsepower and larger should be provided with winding thermal sensors to protect the motor against winding over temperature. Motor larger than 1000 horsepower should be medium voltage (4160-volt) and should be provided with resistance type temperature detectors (RTD) in the windings and in the bearings.

Motors 20 horsepower and larger located indoors and outdoors should be provided with space heaters.

Motor control components should be standardized and located in draw-out units. Additional control relays when required, should be located in separate relay compartments in the MCC.

Motors equipped with thermal sensors embedded in the windings or in the bearings should have the control relay contact interlock with the stop control circuit.

For motor equipped with space heaters, provisions should be included in the control circuit to turn the heater “ON” when the motor is stopped. Power for the space heater should be derived from the motor circuit control power transformer.

All motor control circuits should be provided with a lock-out stop pushbutton located on the respective motor starter. A power 600V heavy duty disconnect switch shall be provided at each motor.

In general 460-volt motors should be started across the line. Motors 100 horsepower and larger should be started with solid state reduced voltage starters with internal shunt contactors. Solid-state reduced voltage starters should have acceleration and deceleration functions with adjustable

time delays. An electronic control keypad as well as control pushbutton station type should be provided for each solid-state starter.

Motor control center shall bear **arc flash** label as per NEC and NFPA 70E. Arc flash label shall be produced by a power system study performed by a licensed electrical engineer. (See Figure 10.1 for sample of arc flash label on typical MCC)

Figure 10.1 – Arc Flash Label on MCC

11 Enclosure for Electrical Equipment

Equipment enclosures located outdoors should be NEMA 4X and enclosures located indoors general purpose area should be NEMA 12. For Headworks enclosures should be NEMA 7 explosion proof as required by NFPA 820 and NEC.

12 Lighting System and Outlets

Lighting system should be designed based on the guidelines established by the Illumination Engineering Society (IES). Lighting should be designed and installed to ensure a safe working environment for plant personnel. Emergency lighting should be provided for ease of egress of pump station personnel on an emergency condition.

Lighting circuits should originate from 120/208 three phase lighting panelboards.

Industrial fluorescent, ceiling mounted light fixtures should be designed for the Headworks interior. HPS, HID type should be designed for the exterior. For classified hazardous locations, the light fixtures shall be explosion proof.

120 volt grounding type convenience receptacles should be provided throughout the pump station, several 50-amp 480V 3phase welding receptacles should also be provided at the facility.

13 Grounding System

A grounding grid should be designed around all electrical equipment rooms or substations with copper ground conductors and ground rods. All ground connections should be made by exothermic welding process or approved compression type connectors.

All non-current carrying metal parts of electrical equipment should be grounded. All wye connected transformer neutrals should be solidly grounded.

All motors should be grounded through the ground conductor enclosed in the power feeder conduit to the ground bus in the motor control center.

All receptacles should be grounded by means of the ground conductor run in the circuit feeder.

All outdoors and indoors wet location 120-volt receptacles should have ground fault interrupter protection.

All instruments wiring shielded cable should be grounded at only one point in the control panel.

Metal equipment platforms and supports, metal tanks, fences, and railings should be grounded.

Ground cables stubbed up through floors should be protected by non-magnetic sleeves or steel conduit to which the ground cable should be solidly bonded.

Building structural steel should be grounded.

14 Communication System

No additional telephone or any other communication system is provided for the pump station as the District staff normally carries personal (cellular) phone. The existing telephone service presently used for the SCADA system should remain.

15 Instrumentation and Control System

15.1 Control System (SCADA):

The Plant presently has a wireless SCADA System with distributed PLCs manufactured by KOYO DirectLOGIC Series. This SCADA system primarily provides all control and data monitoring functions for most of the existing process equipment at the plant. (See Figures 15.1.1 and 15.1.2)

Figure 15.1.1 – Main PLC at existing Operations Bldg (DirectLOGIC 405 model)

Figure 15.1.2 – Master Antenna Operations Bldg

These PLCs then communicate with the Operator Interface Stations (computers) located at the Control Room of the Operations Building. All process parameters such as pump running, pump failure, sludge flow, etc… are displayed on these computers using HMI software package manufactured by Citect. The existing HMI software shall be modified to include all new I/O points from the Headworks project.

Figure 15.1.3 – SCADA Operator Interface Stations (Computers) in Operations Bldg.

To match existing installation, the Headworks will be provided with a new SCADA node with a KOYO DirectLOGIC PLC and Automation Direct EZTouch OIT to match with the existing installation. This new SCADA node will communicate with the SCADA via a new radio XStream and a YAGI antenna as shown on P&ID drawing.

15.2 Field Instruments

Field instruments will be as required per process requirements. Main instrument for this project are flowmeters. For best accuracies and suited application, magnetic flowmeters will be utilized. They should be flanged type, NEMA 4X, microprocessor based manufactured by Siemens to match existing installation. Other misc. field instruments such as pressure transmitters, gauges etc. as required will be specified to match existing installation.

15.3 Miscellaneous Monitoring Functions:

The new main service switchboard should be specified with multifunction, electronic digital power meter having MODBUS communication capable to be connected to the PLC network. Similarly the solid-state reduced voltage starters should have same MODBUS communication port. The communication ports of these equipment available as standard feature can be connected to SCADA system if desired by the SMCSD.

16 Headworks Location Impacts

The tentative location of the Headworks structure will require relocation of several major power feeds including the main service feeder to the existing service transformer. During detailed design phase, a detailed plan will be developed to permanently relocate these feeders early during construction phase of the project.

17 Technical Specifications Outlines

Technical electrical specifications Division 16 and instrumentation specifications Division 13 should be prepared following CSI Standard Specification format.

The table below is a preliminary list of specifications for this project. Other sections may be added as the job progress.

Specification Number	Description
13400	Instrumentation and control system
13470	SCADA Remote Terminal Unit
13475	Control strategies
13480	I/O list
13482	Instrument index
16000	Requirements for electrical work
16145	Cabinet and Enclosures
16148	Disconnect Switches
16153	Low Voltage Circuit Breakers
16155	Motors Controls
16159	Panelboards
16160	Lighting System
16222	Motors
16920	600 V Motor Control Center
16940	Electrical Tests

18 Preliminary Drawings

E-1 Legend and Symbols
E-2 Plant Single-Line Diagram and MCC HW Elevation
E-3 Single-Line Diagram MCC-HW
I-1 Instrumentation Legend
I-2 SCADA System Diagram

SMCSD HEADWORKS

Prepare by: DTN Engineers, Inc.
Date: 08-26-2011
DTN Project #: 286

EQUIPMENT REQUIRING POWER AND/OR CONTROLS

No.	Building/ Structure Process Name	EQPT TAG No.	EQUIPMENT DESCRIPTION	Process Code	LOCATION	DWG No.	HP or KVA	Voltage & Phase	Continuous Load	Notes
1	Tertiary Process	ME- 930	Disk Filter No. 1				4.75	460 3∅	*	
2	Tertiary Process	ME- 931	Disk Filter No. 2				4.75	460 3∅	*	
3	Screening	ME- 932	Screenings Discharge Screw No. 1				2.00	460 3∅		
4	Flow equalization	ME- 933	Return Pump No. 1				15.00	460 3∅	*	
5	Flow equalization	ME- 934	Return Pump No. 2				15.00	460 3∅	*	
6	Screening	ME- 935	Screenings Discharge Screw No. 2				2.00	460 3∅		
7	Screening	ME- 936	Screenings Conveyor				5.00	460 3∅		
8	Grit	P- 937	Grit Tank Paddle Mixer No. 1				0.75	460 3∅	*	
9	Grit	P- 938	Grit Tank Paddle Mixer No. 2				0.75	460 3∅	*	
10	Grit	P- 939	Grit Pump No. 1				10.00	460 3∅		
11	Grit	P- 940	Grit Pump No. 2				10.00	460 3∅		
12	Grit	ME- 941	Grit Washer Paddle No. 1				0.75	460 3∅	*	
13	Grit	ME- 942	Grit Washer Paddle No. 2				0.75	460 3∅	*	
14	Grit	ME- 943	Grit Washer Discharge Screw No. 1				1.50	460 3∅	*	
15	Grit	ME- 944	Grit Washer Discharge Screw No. 2				1.50	460 3∅	*	
16	Primary Clarification	ME- 950	Primary Clarifier No. 2				1.50	460 3∅	*	VFD
17	Material Handling	ME- 951	Turntable				2.00	460 3∅		
18	Primary Clarification	P- 952	Primary Sludge Pumps				5.00	460 3∅	*	VFD
19	Primary Clarification	P- 953	Primary Sludge Pumps				5.00	460 3∅		VFD
20	Headworks Building	ME- 954	Ventilation Unit				20.00	460 3∅	*	
21	Utility		Lighting and Conventional Outlet				15.00	460 3∅	*	
22	Primary Clarification		Control Panel				-	460 3∅	*	
23	Screening	ME- 955	Washer Compactor				3.00	460 3∅		
24	Screening	ME- 956	Washer Grinder				10.00	460 3∅		

Note: Existing FFR Feed Pumps will be upgraded from 50Hp to 75Hp each. They are fed from existing MCC.

Total Load: 136.00 HP=163.66A at 480V 3∅

Demand Load: 87.00 HP= 104.7A at 480V 3∅

SMCSD HEADWORKS

INSTRUMENT INDEX

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Item	INSTRUMENTS DESCRIPTION	NAME	AREA	LOOP No.	RANGE	SET POINT	SPECS	DWG No.	NOTES
1	Flowmeter	FIT		945					
2	Flowmeter	FIT		946					
3	Flowmeter	FIT		947					
4	Flammable Gas Detector	AIT		948					
4	Energy/Power Meter	JIT		949					Packaged Equipment

SMCSD HEADWORKS

I/O LIST

Prepare by: DTN Engineers, Inc.
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ITEM No.	EQUIPMENT DESCRIPTION	EQUIP. NO.	TAG NAME	LOOP No.	SIGNAL FUNCTION	TYPE	DWG No.	COMMENTS
	Disk Filter No. 1	ME-930	YSA	930	In Auto Mode	DI		
	Disk Filter No. 1	ME-930	YSR	930	Run	DI		
	Disk Filter No. 1	ME-930	YSF	930	Fail	DI		
	Disk Filter No. 2	ME-931	YSA	931	In Auto Mode	DI		
	Disk Filter No. 2	ME-931	YSR	931	Run	DI		
	Disk Filter No. 2	ME-931	YSF	931	Fail	DI		
	Screenings Discharge Screw No. 1	ME-932	YSA	932	In Auto Mode	DI		
	Screenings Discharge Screw No. 1	ME-932	YSR	932	Run	DI		
	Screenings Discharge Screw No. 1	ME-932	YSF	932	Fail	DI		
	Equalization Return Pump No. 1	ME-933	YSA	933	In Auto Mode	DI		
	Equalization Return Pump No. 1	ME-933	YSR	933	Run	DI		
	Equalization Return Pump No. 1	ME-933	YSF	933	Fail	DI		
	Equalization Return Pump No. 2	ME-934	YSA	934	In Auto Mode	DI		
	Equalization Return Pump No. 2	ME-934	YSR	934	Run	DI		
	Equalization Return Pump No. 2	ME-934	YSF	934	Fail	DI		
	Screenings Discharge Screw No. 2	ME-935	YSA	935	In Auto Mode	DI		
	Screenings Discharge Screw No. 2	ME-935	YSR	935	Run	DI		
	Screenings Discharge Screw No. 2	ME-935	YSF	935	Fail	DI		
	Screenings Conveyor	ME-936	YSA	936	In Auto Mode	DI		
	Screenings Conveyor	ME-936	YSR	936	Run	DI		
	Screenings Conveyor	ME-936	YSF	936	Fail	DI		
	Grit Tank Paddle Mixer No. 1	P-937	YSA	937	In Auto Mode	DI		
	Grit Tank Paddle Mixer No. 1	P-937	YSR	937	Run	DI		
	Grit Tank Paddle Mixer No. 1	P-937	YSF	937	Fail	DI		
	Grit Tank Paddle Mixer No. 2	P-938	YSA	938	In Auto Mode	DI		
	Grit Tank Paddle Mixer No. 2	P-938	YSR	938	Run	DI		
	Grit Tank Paddle Mixer No. 2	P-938	YSF	938	Fail	DI		
	Grit Pump No. 1	P-939	YSA	939	In Auto Mode	DI		
	Grit Pump No. 1	P-939	YSR	939	Run	DI		

ITEM No.	EQUIPMENT DESCRIPTION	EQUIP. NO.	TAG NAME	LOOP No.	SIGNAL FUNCTION	TYPE	DWG No.	COMMENTS
	Grit Pump No. 1	P-939	YSF	939	Fail	DI		
	Grit Pump No. 2	P-940	YSA	940	In Auto Mode	DI		
	Grit Pump No. 2	P-940	YSR	940	Run	DI		
	Grit Pump No. 2	P-940	YSF	940	Fail	DI		
	Grit Washer Paddle No. 1	ME-941	YSA	941	In Auto Mode	DI		
	Grit Washer Paddle No. 1	ME-941	YSR	941	Run	DI		
	Grit Washer Paddle No. 1	ME-941	YSF	941	Fail	DI		
	Grit Washer Paddle No. 2	ME-942	YSA	942	In Auto Mode	DI		
	Grit Washer Paddle No. 2	ME-942	YSR	942	Run	DI		
	Grit Washer Paddle No. 2	ME-942	YSF	942	Fail	DI		
	Grit Washer Discharge Screw No. 1	ME-943	YSA	943	In Auto Mode	DI		
	Grit Washer Discharge Screw No. 1	ME-943	YSR	943	Run	DI		
	Grit Washer Discharge Screw No. 1	ME-943	YSF	943	Fail	DI		
	Grit Washer Discharge Screw No. 2	ME-944	YSA	944	In Auto Mode	DI		
	Grit Washer Discharge Screw No. 2	ME-944	YSR	944	Run	DI		
	Grit Washer Discharge Screw No. 2	ME-944	YSF	944	Fail	DI		
	Primary Clarifier No 2	ME-950	YSA	950	In Auto Mode	DI		
	Primary Clarifier No 2	ME-950	YSR	950	Run	DI		
	Primary Clarifier No 2	ME-950	YSF	950	Fail	DI		
	Turntable	ME-951	YSA	951	In Auto Mode	DI		
	Turntable	ME-951	YSR	951	Run	DI		
	Turntable	ME-951	YSF	951	Fail	DI		
	Primary Sludge Pump No. 1	P-952	YSA	952	In Auto Mode	DI		
	Primary Sludge Pump No. 1	P-952	YSR	952	Run	DI		
	Primary Sludge Pump No. 1	P-952	YSF	952	Fail	DI		
	Primary Sludge Pump No. 2	P-953	YSA	953	In Auto Mode	DI		
	Primary Sludge Pump No. 2	P-953	YSR	953	Run	DI		
	Primary Sludge Pump No. 2	P-953	YSF	953	Fail	DI		
	Ventilation Unit	ME-954	YSA	954	In Auto Mode	DI		
	Ventilation Unit	ME-954	YSR	954	Run	DI		
	Ventilation Unit	ME-954	YSF	954	Fail	DI		
	Washer Compactor	ME-955	YSA	955	In Auto Mode	DI		
	Washer Compactor	ME-955	YSR	955	Run	DI		
	Washer Compactor	ME-955	YSF	955	Fail	DI		

ITEM No.	EQUIPMENT DESCRIPTION	EQUIP. NO.	TAG NAME	LOOP No.	SIGNAL FUNCTION	TYPE	DWG No.	COMMENTS

INTEROFFICE MEMO

Memo from: Diep Nguyen, DTN Engineers Inc.

Memo to: Mark Takemoto, PE, PM, RMC

CC: Kevin Rahman, PE, SMCSD

Date: July 19, 2011

Subject: Technical Report- Replacement of existing FFR pumps/VFDs

Dear Mark,

Per our discussions by phone and emails, we visited the Plant on Friday July 15, 2011 and have been collaborating with Kevin Rahman of the District regarding the referenced subject. Here is our Technical Report.

I INTRODUCTION/BACKGROUND

Sausalito Marin City Sanitation District (SMCSD) has been operating three Fixed Film Reactor (FFR) pumps rated @ 50HP 480V three phase at their main wastewater treatment facility since 1982. Each of these pumps is driven by a Variable Frequency Drive (VFD) manufactured by Cutler- Hammer (Eaton) which is also rated for 50HP. As part of the planned Headworks Project, RMC team is considering to change these FFR pumps from 50HP to 75HP or 100HP units also driven by new VFD's. This memo is written to address impacts of these changes and to recommend a resolution to accommodate the increased in horsepower for these pumps.

II. FIELD INVESTIGATION

Record Drawings dated Jan 29, 1981 were reviewed, followed by a site visit by RMC team (DTN) reveal the following facts:

1. Existing FFR VFDs:
   These existing FFR VFDs are presently wall-mounted in the electrical room of the control building. (See photo no. 1)

Photo 1 – Existing FFR VFDs

The electrical room is very much built to its maximum capacity physically. The new FFR VFDs with larger capacity must have same physical dimensions or smaller as the existing VFDs to make the changes feasible concerning installation costs and switch-over during construction.

2. Temporary Control Panel with new VFDs:
   The District presently installed a temporary control panel with three new VFDs driving three 35hp Flygt pumps. (See photo no. 2 and photo no. 3)

Photo 2 – Temporary Control Panel with three ABB VFDs

Photo 3 – Existing Flygt Pumps

The temporary VFDs are manufactured by ABB assembled in a common NEMA 3R enclosure with a programmable logic controller for automatic control of the pumps. These VFDs are standard ABB ACS550 Series 6-pulse type, each rated at 100HP 480V three phase. While these units are designed with additional components to reduce harmonics, they do not meet the required maximum harmonic distortions (voltage and current limits) as per IEEE 519 Standards for harmonics at the drive input terminals.

It was also noted that the temporary control panel has three circuit breakers feeding the VFD. Each of these three 70A 480V 3-pole circuit breaker has a low short circuit rating of 14,000 ampere @480V. This rating is considerably much lower than the recommended 42KA or 65KA values established since new PG&E service transformer was replaced several years ago. However, it is clearly understood that this setup is only temporary, and because the temporary pumps are rated for only 35HP, and thus 70A is correct size breaker. For 75hp or 100hp pumps, correct size of the feeding circuit breaker is 200 ampere.

III. ANALYSIS AND AVAILABLE OPTIONS

As stated earlier in this memo, the best option to replace the existing FFR VFDs with new units to accommodate increased motor horsepower is to utilize new VFDs that meet the following constraints:

A. Harmonic limits per IEEE 519 Standard.
B. Physically smaller than 25” wide by 78” high by 16 ½” depth and must be wall-mounted.

It has been known for many years that without proper measures or corrections, harmonics can cause dielectric thermal and voltage stress which creates overheating to motors and malfunction of the sensitive electronic equipment such as field instruments and control system components. IEEE 519 Standard issued in 1993 dictates that harmonic generators such as VFDs must have a maximum voltage and current harmonics of 5% or less at the drive input terminals. To comply with this requirement, the drive industry presently has two types of drives known as clean power VFDs that will meet IEEE 519 Standard: Multi-pulse, phase-shifting VFDs and active front-end harmonic filter VFDs. Most often, the phase shifting VFDs require a transformer, and thus are normally free-standing for 75HP and larger. On the other hand, active front-end harmonic filter drives are smaller in foot print although they have built-in, active harmonic filter which cancels out the harmful harmonics internally to the drives. These two types of clean power VFDs have been accepted by the wastewater and water industries in last 8 years.

There are four options available to accomplish the increased horsepower for FFR pumps as follows:

Option 1: Use of existing (temporary) ABB ACS550 Series drives installed in electrical room and install external harmonic filter to limit harmonics per IEEE 519 Standard.

Option 2: Use of free-standing, phase shifting VFD installed in the electrical room. (Existing electrical equipment has to be rearranged to make room for much larger enclosure).

Option 3: Use of free-standing, phase shifting VFD installed remotely from electrical room in NEMA 4X enclosure located outdoor.

Option 4: Use active front-end harmonic filter VFDs installed in electrical room. Provided these VFDs have to be wall-mounted, and smaller than existing VFDs.

The advantages and disadvantages of these four options are provided in the following summary:

Option	Advantages	Disadvantages
Option 1: Reuse of existing temporary 100hp VFDs and install external harmonic filter. **Installed cost: $50K**	1. These ABB CS550 VFDs will fit in the electrical room. 2. District already paid for these drives. Only auxiliary enclosures are needed.	1. These VFDs do not meet IEEE 519 Standard. 2. External Harmonic Filter is required and has to be installed outdoor unless existing equipment is rearranged
Option 2: Use clean power VFDs (phase shifting type) free standing, installed in electrical room. **Installed cost: $65K**	1. Meets IEEE 519 Standard.	1. These VFDs do not easily fit the available space. 2. Switchover is a big challenge and costly. 3. Existing electrical equipment must be re-arranged.
Option 3: Use clean power VFDs (phase shifting type) free standing installed remotely from existing electrical room. **Installed cost: $85K**	1. Meets IEEE 519 Standard.	1. Must be located outside in NEMA 4x enclosure. 2. Highest installation cost as compared to installation in electrical room.
Option 4: Use clean power VFDs (active front-end filter) wall-mounted at same locations as existing VFDs. **Installed cost: $55K**	1. Meets IEEE 519 Standard. 2. Can fit in the electrical room in spaces vacated by VFDs. 3. Overall, it is best for switch-over	1. A little higher initial cost for the VFDs installation as compared to Option 1.

Major VFD manufacturers such as Robicon, Cutler-Hammer and ABB were contacted, and dimensions of these clean power drives (phase shifting and active harmonic filter) have been obtained. Some literatures of these products can be found in the Appendix of this memo.

IV. CONCLUSION AND RECOMMENDATION

Accordingly, it is our professional opinion and recommendation that the District implement **Option 4** by using active front-end harmonic filter VFDs also manufactured by ABB to fit in with the existing available spaces vacated by removal of existing Cutler-Hammer VFDs, and meet IEEE 519 Standard. These clean power VFDs have been utilized in many past years to avoid and prevent potential damages cause by unwanted system harmonics. These drives have higher initial costs compared to regular VFDs, however in considering installation costs and simplification during construction for switch-over they, 100hp ABB clean power ACS800 VFDs, should be used. The existing temporary ACS550 VFDs can be salvaged and utilized in future remote pumping stations with additional harmonic filter(s).

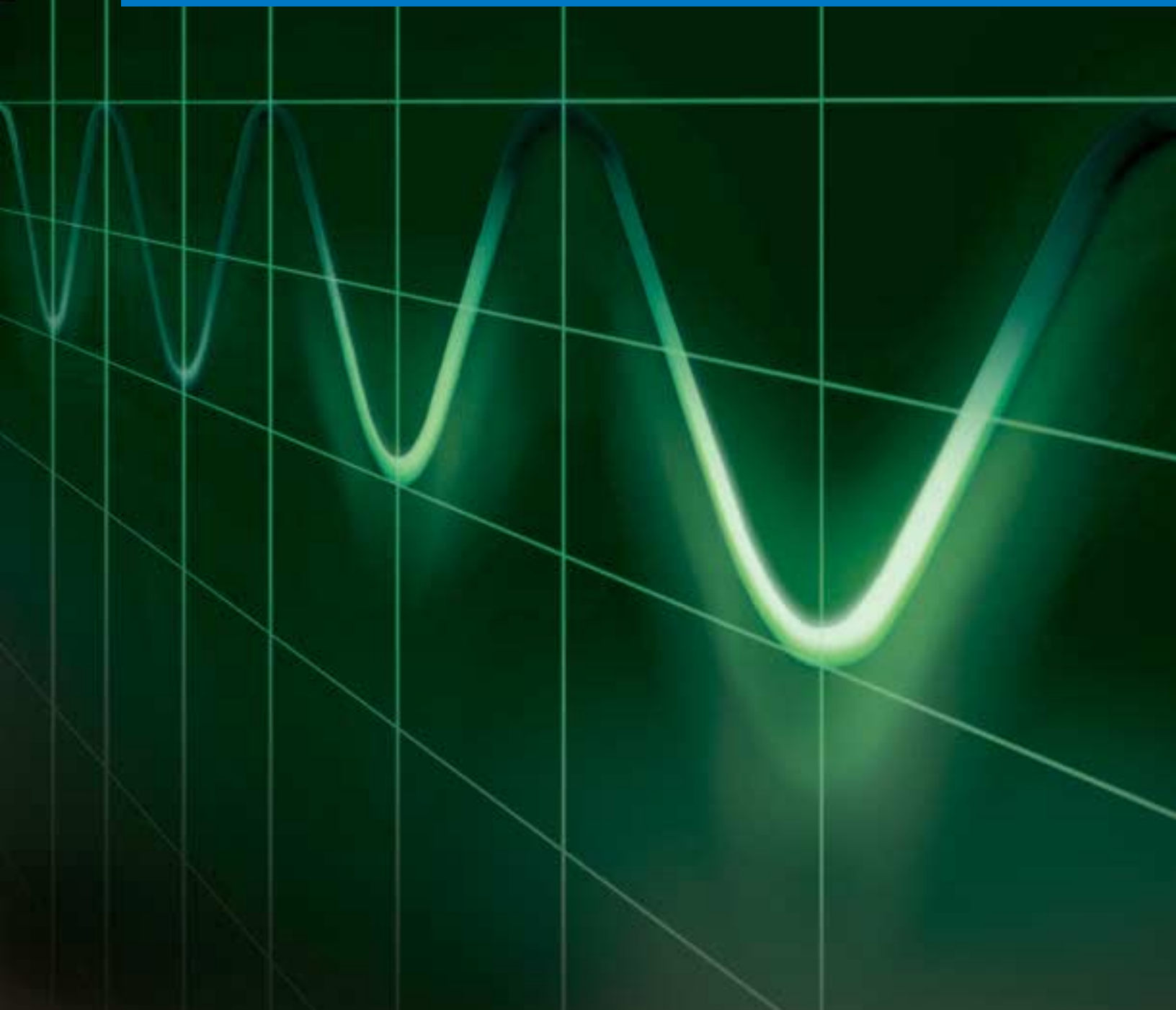
VI. APPENDIX

A. Cutler-Hammer clean-power VFDs (phase shifting type)
B. Robicon clean power VFD (multi-pulse type)
C. ABB ACS800 active front end harmonic filter VFDs
D. External TCI active harmonic filter

EATON | Cutler-Hammer

CPX9000 Clean Power Solution

Product Focus



CPX9000 The Best Solution for Clean Power.

The new CPX9000 is the most advanced Clean Power Solution.
Based on Cutler-Hammer's high-tech and highly successful 9000 Series of adjustable frequency drives, the CPX9000 uses advanced 18-pulse, Clean Power technology to significantly reduce line harmonics at the drive input terminals, resulting in one of the purest sinusoidal waveforms available.

The CPX9000 delivers "True Power Factor," so in addition to reducing harmonic distortion, the CPX9000 prevents overheating of transformers and the overloading of breakers and feeders. It allows adjustable frequency drives to be applied to generators and other high impedance power systems.

Designed to exceed the IEEE 519-1992 requirements for harmonic distortion, the CPX9000 is the clear choice for applications in the Water, Wastewater, HVAC, Industrial, and Process industries where harmonics are a concern.

Facility analysis simulations and services.
While utilities may deliver relatively clean power (pure sinusoidal waveforms), nonlinear loads such as computers, drives, and electronic ballasts can introduce undesirable harmonic currents into the power system.

Many facilities demand the IEEE 519-1992 standard for minimizing harmonic distortion be met to eliminate the potential for equipment failures which lead to increased downtime and costs.

The first step in developing a Clean Power Solution is a facility analysis. Cutler-Hammer performs facility simulations for existing facilities and during the design and construction phase of new facilities. In addition to providing Clean Power with the CPX9000, the Cutler-Hammer Engineering Services organization is equipped to measure, analyze, and correct harmonic and other power quality issues. Contact Cutler-Hammer to get started on improving your power quality and power management.

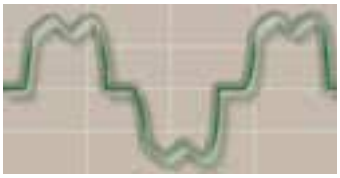
Ensuring IEEE Compliance.
After the simulation is complete, a number of steps can be taken to ensure IEEE 519-1992 compliance. The major technologies are passive filters, active filters, additional inductive reactance, phase-shifted sources, 12-pulse rectifiers and the CPX9000 Clean Power drive. While all of technologies are viable, the CPX9000 is selected most often because unlike the other technologies, it meets IEEE 529-1992 in every case at the drive input connection even if power system conditions change. This means no re-tuning, no adjustments and no new system analysis.

Cutler-Hammer offers a wide range of power quality and power management tools that allow you to take control of your power. This ranges from high-tech harmonic analyzers to sophisticated facility-wide PowerNet monitoring and management systems.

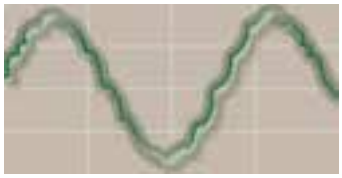
The 18-Pulse rectifier assembly is modular, compact and uses diode packs to eliminate bulky external charging circuitry.

A full range of configuration options includes a variety of bypass contactors and cutting edge starters, such as Eaton Cutler-Hammer's *IT.* reduced voltage soft starters.

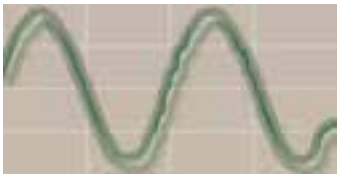
Designed to exceed IEEE 519-1992 requirements for harmonic distortion, the CPX9000 is the clear choice for applications in the water, wastewater, HVAC, industrial and process industries where power quality and harmonics are a concern.



6-Pulse drives typically have distortion with steep current rises.



12-Pulse drives typically produce a rough sinusoidal waveform.



The CPX9000 Clean Power Solution dramatically reduces harmonic distortion for a clean waveform.

18-pulse drives exceed the IEEE standard of 5% THD. The chart illustrates differences between 6-, 12- and 18-Pulse solutions. For sensitive medical and electronic equipment, Eaton's CPX9000 is unsurpassed.

CPX9000 Standard Features:

- SVMulti-Line,™ easy-to-use operator control panel
- SVDrive,™ windows-based programming software
- Selectable sensorless vector
- Input fuses and MOV for input protection
- Pre-engineered compact NEMA1 or dust-resistant enclosures

Options include integration of PanelMate® operator interface stations and automation PCs.

Communications Capabilities:

- Devicenet
- Profibus DP
- Ethernet
- Modbus-RTU
- Lonworks & key HVAC protocols

Eaton's electrical business is a global leader in electrical control, power distribution, and industrial automation products and services. Through advanced product development, world-class manufacturing methods, and global engineering services and support, Eaton's electrical business provides customer-driven solutions under brand names such as Cutler-Hammer®, Powerware®, Durant®, Heinemann®, Holec® and MEM®, which globally serve the changing needs of the industrial, utility, light commercial, residential, and OEM markets. For more information, visit www.EatonElectrical.com.

Eaton Corporation is a diversified industrial manufacturer with 2005 sales of $11.1 billion. Eaton is a global leader in electrical systems and components for power quality, distribution and control; fluid power systems and services for industrial, mobile and aircraft equipment; intelligent truck drivetrain systems for safety and fuel economy; and automotive engine air management systems, powertrain solutions and specialty controls for performance, fuel economy and safety. Eaton has 59,000 employees and sells products to customers in more than 125 countries. For more information, visit www.eaton.com.

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Moon Township, PA 15108
United States
tel: 1-800-525-2000
www.EatonElectrical.com

Cutler-Hammer

Printed in USA
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January 2006

ROBICON W120CP clean power drive 50 HP to 200 HP

Introduction

This technical data sheet provides a short overview of the most important characteristics of the ROBICON W120CP (clean power) 18-pulse low harmonics drive from Siemens, developed specifically to meet specifications in the municipal water and waste water market.

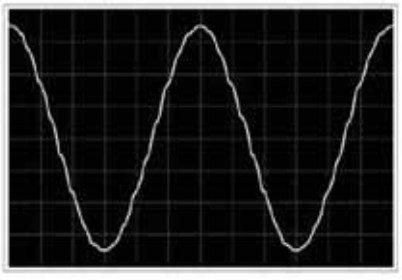
A result of the powerful combination of SINAMICS®, the most advanced drives technology platform, and the ROBICON legacy of more than 20 years of quality and expertise in the water and waste water industry, the W120CP makes the best even better.

The compact and quiet ROBICON W120CP utilizes the well proven, simple yet effective, 18-pulse technology to provide clean power to meet the low harmonic requirements of IEEE 519-1992 at the VFD input terminals, combined with a state-of-the-art power module with IGBT power semiconductors. The drive can be operated in either Volts/Hertz, sensorless vector, or closed loop vector with encoder control modes.

Standard features

The standard drive enclosure is a floor standing cabinet, which can be equipped with a wide variety of pre-engineered and custom options. The ROBICON W120CP has the following standard features:

- NEMA 1 enclosure, with blowers (optional NEMA 12 ventilated with air filters)
- Circuit breaker disconnect with flange mount operator handle, mechanically interlocked with the enclosure door
- Short circuit current rating (SCCR) 65 kA
- Clean power 18-pulse front end with patented phase shifting autotransformer and input line reactor
- Intelligent operator panel (IOP), door mounted for easy start-up and operation
- UL listing per UL508C
- Windows based STARTER software – common to all models of the SINAMICS family.



December 2010

SINAMICS Drives

www.usa.siemens.com/drives

SIEMENS

Product Specifications

Light Overload		High Overload					
Output (at 460V, 60 Hz)	Base load current for 110% overload	Output (at 460V, 60 Hz)	Base load current for 150% overload	Rated output current	Approx. max. input current [1]	Power module frame size	ROBICON W120CP enclosed drive
HP	A	HP	A	A	A		Model No.
50	68	**40**	60	68	64	E	**6SL3710-3BJ27-5AR0**
60	80	**50**	75	80	74	E	**6SL3710-3BJ29-0AR0**
75	100	**60**	90	100	91	F	**6SL3710-3BJ31-1AR0**
100	130	**75**	110	130	118	F	**6SL3710-3BJ31-5AR0**
125	160	**100**	145	160	143	F	**6SL3710-3BJ31-8AR0**
150	186	**125**	178	186	170	F+	**6SL3710-3BJ32-0AR0**
200	240	**150**	205	240	217	F+	**6SL3710-3BJ32-5AR0**

[1] The input current is based on the input current of the power module and includes an allowance of 10 A for auxiliary circuits.

The standard ROBICON W120CP base enclosed drive includes:

- NEMA 1 enclosure
- UL508C listing (file no. E319311)
- Short circuit current rating (SCCR) 65 kA
- Power module PM240 (standard 6-pulse), unfiltered
- 18-pulse diode rectifier
- Circuit breaker disconnect with mechanical door interlock
- Patented phase-shifting autotransformer with matched input line reactor for clean power input meeting the requirements of IEEE 519-1992 at the VFD input terminals under all conditions
- Intelligent operator panel (IOP), door mounted and wired
- Integral braking chopper
- Cable entry top or bottom, line and motor side

Controller CU230P-2 HVAC with:

- RS485 serial communications port USS / Modbus RTU / BACnet MS/TP
- 6 digital inputs, 24V 15 mA, optically isolated (group)
- 3 relay outputs, 2x form C 250 VAC 2 A or 30VDC 5 A, 1x NO 30 VDC 0.5 A
- 4 analog inputs, 2x differential -10V to +10V or 0/4 to 20mA, 1x 0/4 to 20mA or temperature sensor, 1x temperature sensor input for Ni1000/Pt1000 sensor
- Input for temperature sensor KTY84, PTC thermistor or thermostat
- 2 analog outputs, 0 to +10V or 0/4mA to 20mA, 1x 0/4mA to 20mA, non-isolated

NOTE: Some of the control unit inputs and/or outputs may be used for options.

Standard Options

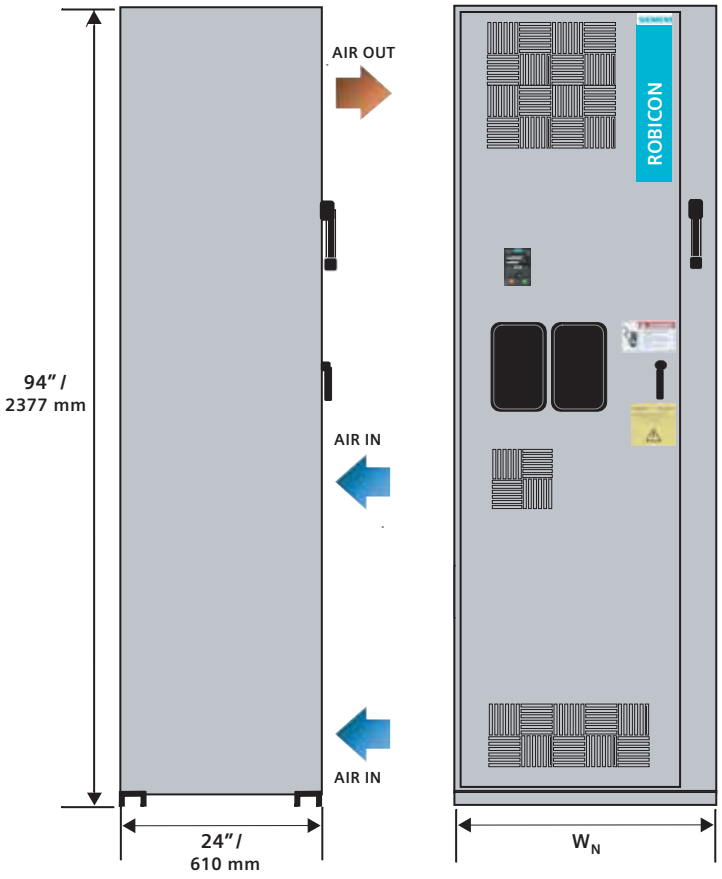
Option Code	Description
Enclosure Options	
M12	NEMA12 filters
L50	Cabinet light and outlet
L55	Cabinet space heaters (120VAC)
L56	Motor space heater supply
Y09	Special enclosure paint color [specify color]
Power Circuit and Protection Options	
L08	Output reactor
L13	Input isolation contactor
L28	2 contactor manual bypass (output/bypass contactors with o/l)
L32	Output isolation contactor
L63	Braking resistor
L96	Input surge protective device
L98	Motor thermal overload relay (already included in L28)
L99	Motor protection relay (Multilin 369)
P10	Input voltage monitor (Siemens type 3UG4)

Option Code	Description	
Control Options		
E86	Isolation Amplifier for one analog input	
E87	Isolation Amplifier for two analog outputs	
K20	Pilot lights (qty. 3), door mounted – Ready, Run, Fault	
K21	Additional local controls (L-R & H-O-A, speed pot, Start/Stop p/b)	
K22	Elapsed time (hour) meter, door mounted, non-resettable	
K23	AOP3R operator panel (replaces IOP) with CU240S controller	
N55	ALL STOP mushroom pushbutton, latching, coast to stop	
L87	Ground fault monitor for ungrounded supplies	
L97	RTD monitor for 8x Pt100 temperature sensors	
Communication Bus Options		
G21	Modbus Plus	(with option K23 only)
G22	Modbus RTU	(with option K23 only - standard in base)
G23	DeviceNet	(with option K23 only)
G24	PROFIBUS	
G26	EtherNet/IP	(with option K23 only)
G27	Modbus TCP/IP	(with option K23 only)
G33	PROFINET	(with option K23 only)

Note: Please consult factory for additional/custom options.

Design Data

FLOOR MOUNT ENCLOSURE



Note:
Dimensions are nominal for enclosure, tolerance 0.5" (12 mm), excluding protruding components. Please refer to drawings for exact details.

ROBICON W120CP Enclosed drive	Output (Light Overload) (at 460V, 60 Hz)	Noise level L_{pA} (1m) at 60 Hz	Cooling air flow demand	Heat loss	Weight approx.		Drive enclosure Nominal size W_N x D_N x H_N	
Model No.	HP	dB(A)	cfm	kW	lb	kg	inch	mm
Floor standing enclosure								
6SL3710-3BJ27-5AR0	**50**	70	591	1.55	**930**	422	**30 x 24 x 94**	762 x 610 x 2377
6SL3710-3BJ29-0AR0	**60**	70	591	1.95	**930**	422	**30 x 24 x 94**	762 x 610 x 2377
6SL3710-3BJ31-1AR0	**75**	70	866	2.47	**1120**	508	**36 x 24 x 94**	914 x 610 x 2377
6SL3710-3BJ31-5AR0	**100**	70	866	3.27	**1160**	526	**36 x 24 x 94**	914 x 610 x 2377
6SL3710-3BJ31-8AR0	**125**	70	866	3.91	**1260**	572	**36 x 24 x 94**	914 x 610 x 2377
6SL3710-3BJ32-0AR0	**150**	70	866	4.78	**1460**	662	**36 x 24 x 94**	914 x 610 x 2377
6SL3710-3BJ32-5AR0	**200**	70	866	5.41	**1660**	753	**36 x 24 x 94**	914 x 610 x 2377

Technical Data

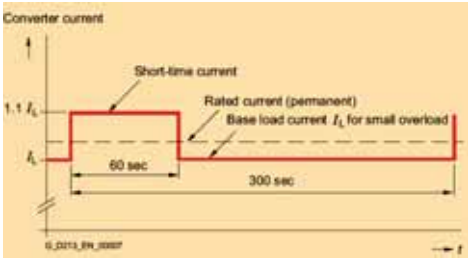
Electrical data			
Supply voltages and output ranges	460 V to 480 V 3 ph AC, ±10%, 1 to 200 HP		
Supply systems	Grounded or ungrounded supplies		
Line frequency	47 Hz to 63 Hz		
Output frequency	0 Hz to 266 Hz (650 Hz with derating)		
Power factor approx.	0.95		
Drive efficiency	94 to 96%		
Short circuit current rating	SCCR 65kA		
Control method	V/Hz control, V/Hz with flux current control (FCC), Vector control, sensorless or (with CU240) closed loop with encoder		
Fixed speeds	16 fixed frequencies		
Skipped frequency ranges	4, programmable		
Braking operation	Integral brake chopper for dynamic braking, with CU240 DC and compound braking		
Meachnical data			
Type of enclosure	NEMA 1, optionally NEMA 12 (ventilated), ANSI 61 gray		
Type of cooling	Forced air ventilation		
Noise level L_{pA} (1 m)	70 dB(A) at 60 Hz line frequency		
Environmental protection	Nickel plated busbars, varnish coated electronic boards		
Compliance with standards			
UL listing	Listed to UL508C, file no. E319311		
Ambient conditions	**Operation**	**Storage**	**Transport**
Ambient temperature	32°F to 104°F (0°C to +40°C) Up to +122°F/+50°C with derating	-13°F (-25°C) to 131°F (+55°C)	-13°F (-25°C) to 158°F (+70°C) Down to -40°F (-40 °C) for 24 hours
Relative humidity (non-condensing)	5% to 95%	5% to 95%	5% to 95% at 40°C
Installation altitude	Up to 3,300 ft (1000 m) above sea level without reduction in performance, > 3,300 ft see derating data		

Engineering Information

Overload ratings

The W120CP drive may be operated with both variable torque and constant torque loads at either light or high overload duties. The criterion for overload is that the drive is operated with its base load current before and after the overload occurs.

Light overload duty is based on 110% base load current for 60 sec or 150% for 3 sec, repeated every 300 sec.



Light overload

High overload duty is based on 150% base load current for 60 sec or 200% for 3 sec, repeated every 300 sec.

Motor and drive sizing

Service Factor must be considered for motors operating at Service Factors beyond 1.0. Please consult factory for assistance sizing the drive.

For motors with ratings larger than the drive, please consult factory as nuisance tripping may occur if drive is not properly sized.

In sensorless vector control, the rated motor current (FLA) must be at least 1/4 of the rated drive output current. With lower motor currents, operation is possible in Volts/Hz control mode only.

Intelligent operator panel (IOP)

The SINAMICS IOP makes it easy to operate, commission and diagnose faults on the drive. Up to two process values can be displayed on the screen either graphically or numerically. Process values can be displayed in the appropriate technological units. The user language can be selected.

Due to the large plain text display, menu prompting and application wizards, commissioning of drives is very quick.

Parameters are displayed in plain text, explanatory help texts are provided and there is a parameter filter function. The user is interactively navigated through commissioning of common applications such as pumps, fans, compressors and conveyors using application wizards.

The IOP has a dedicated key to toggle between local (from IOP) and remote control.

Fault diagnosis is in a user-friendly fashion using plain text display of faults and alarms. Explanatory help texts are provided by pressing the INFO key.

Siemens Industry, Inc.
Drive Technologies
3333 Old Milton Parkway
Alpharetta, GA 30005
1-800-241-4453

info.us@siemens.com

www.usa.siemens.com/drives

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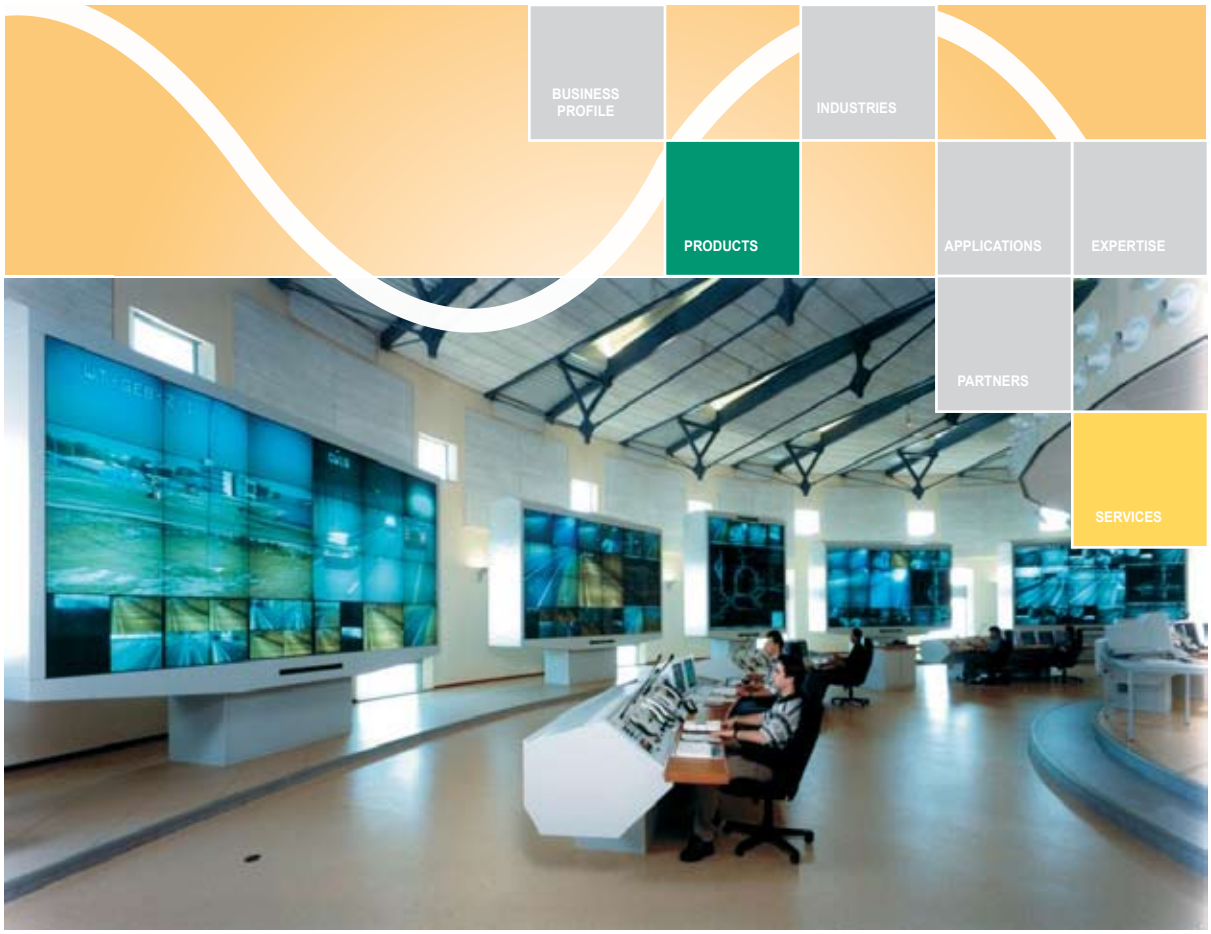
Order No. LDFL-00105-1210
Printed in USA

Low Harmonic Drive Solutions

Reducing the Harmonic Footprint of Variable Speed Drives

Product Brochure



Managing Power Quality

The Importance of Understanding the Effects of Harmonic Distortion

Any distorted voltage and current waveform that deviates from the ideal sinusoidal waveform presents the potential to harm electrical components, which can result in costly repairs and equipment downtime. Non-linear loads connected to the electrical supply in industrial and commercial facilities insert harmonics (waveform distortions) on the power distribution system. Common non-linear loads include solid state motor soft starters, variable speed drives, computers, electronic lighting, welding supplies and uninterruptible power supplies.

The impact of harmonic distortion can appear in many ways: it can cause distribution transformers and supply cables to overheat, resulting in insulation breakdown and failure; electronic displays and lighting may flicker; nuisance tripping of circuit breakers is possible; and damage can occur to electronic equipment, and may even distort readings provided by metering equipment.

The effects of harmonic distortion are not limited to the facilities where electrical equipment is installed. Situations where electrical equipment is installed in residential areas (pumping stations, waste water treatment plans, cooling towers, HVAC Systems) present the potential for equipment in residential and commercial buildings to be impacted -- and even damaged. The Institute of Electrical and Electronics Engineers (IEEE) has established a recommended practice -- IEEE 519-1992 -- which sets reasonable limits for harmonic current and voltage distortion for electrical power systems. This recommended practice provides the foundation for evaluating the level of harmonic distortion in a power distribution system, and the level of action required to mitigate the risks.

Industries such as water and waste water treatment, and HVAC, must meet local requirements to achieve low harmonic levels; this prevents disturbances to equipment in nearby residential properties. Typically, such electrical users need to meet the IEEE 519-1992.

Taking action to deal with harmonic distortion provides many benefits beyond those related to managing risk. Industries with high power consumption, like pulp and paper, metals, oil and gas refineries, cement and chemicals processing, have the opportunity to optimize the quality of power in the facilities by managing disturbances and losses caused by harmonics.

Drives with Harmonic Reduction Solutions Built In

It is very important that professionals responsible for designing and maintaining electrical systems be aware of the potential issues related to harmonic distortion of their power distribution systems -- and know how to manage them in the most efficient and cost effective manner.

There are many factors and components that impact the overall quality of a power distribution system. Variable speed drives are among the many electrical devices included in that group. Manufacturers of variable speed drives offer a variety of answers to the question of how to reduce the level of distortion these devices produce. Most of these solutions involve adding large components like line reactors and special transformers to the variable speed drive installation that help to reduce the level of harmonic distortion. A brief overview of the available solutions is included on page 4.

ABB offers a broad range of harmonic reduction solutions as well. The most recent addition to this offering is the ACS800 Ultra-low Harmonic variable speed drive – providing the best combination of harmonic reduction, package size and weight, and range of available features.

Ultra-low Harmonic drive

What is an Ultra-low Harmonic Drive?

An Ultra-low Harmonic (ULH) drive has switching IGBT semiconductors in the supply side, instead of a conventional diode bridge. The drive is able to control the line current to sinusoidal waveform. Additionally, the line filter used in an ultra-low harmonic drive typically is designed to attenuate high-order voltage harmonics to reach very low total distortion of both current and voltage.

Benefits

Harmonic mitigation is built right into the ULH drive - - eliminating the need for additional expensive and space-consuming components like line reactors and transformers. This concept ensures the drive meets the IEEE 519-1992 standard at the input terminals of the drive. *The harmonic performance is independent of supply imbalance, unlike 12- and 18-pulse solutions, and avoids any concern related to network resonances.* Total harmonic distortion of the drive is typically 3.5 – 4.5% of the nominal rating and the drive always operates with power factor of 1.

Features

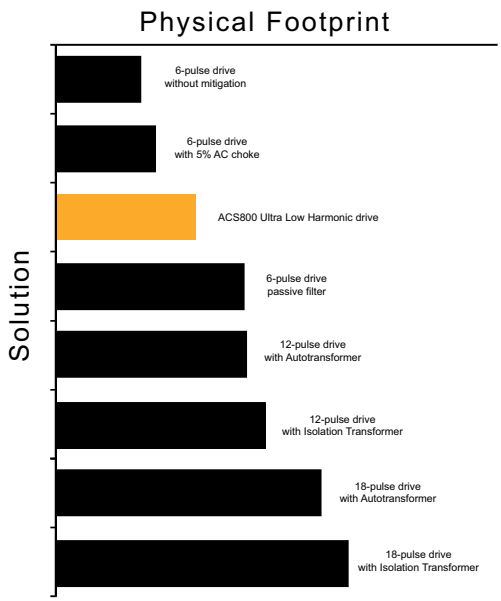
The ULH drive is available in both wall-mounted package and enclosed cabinet-built versions (depending on ratings and options selected).

The power ratings of the wall-mounted type start from 7.5 hp heavy-duty rating and go up to 125 hp normal-duty rating. It is available in the NEMA 1 protection class. The cabinet-built drive is available in the power range of 40 hp up to 2,800 hp, and with NEMA 1, NEMA 1 filtered and NEMA 12 protection class – easily configured and ordered using our standard product catalogs.

Where it can be used

The ABB ACS800 ULH drive is the ideal solution for those drive installations where low harmonic content is desired or mandated. Its performance and simplicity of installation make it suitable to a wide range of industries and applications. Typical industries include HVAC, water and wastewater treatment, mining, metals, and pulp and paper mills. The most common applications for these drives are pumps, fans, compressors and conveyors.

Solution vs. Physical Footprint Chart

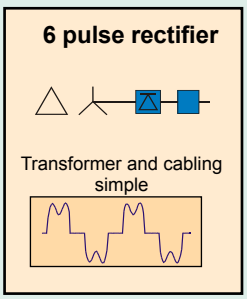


Comparison of the overall footprint of the ACS800 ULH drives vs. other available harmonic reduction solutions.

Solution Comparison

Many Options; One Real Solution

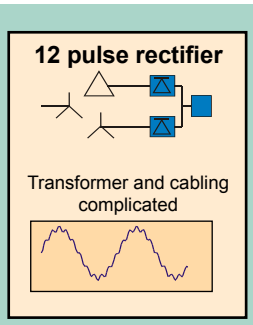
Each of the popular methods of harmonic-reducing variable speed drive packages is described below, including information about standard 6-pulse drives without any harmonic reduction. Most manufacturers of variable speed drives offer each of the solutions provided, with the exception of the Ultra-low Harmonic solution. ABB is unique in offering this version of our popular ACS800 product specifically designed to optimize the harmonic reduction solution.



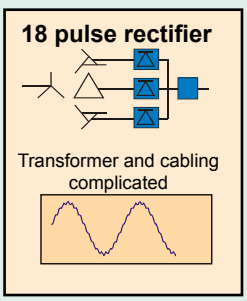
6-pulse drive, no harmonic reduction – 6-pulse drive without any reactors is the cheapest and simplest drive configuration; can produce 50 – 90% total distortion.

6-pulse drive with reactors – Reactors may be located either at AC side in the input, or in DC link of the drive; typical harmonic distortion is 25 – 35%.

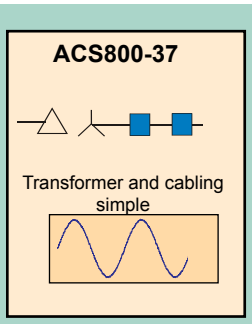
6-pulse drives with passive filter – This solution adds a low-pass filter in series with the drive. This is a low-cost solution, but can cause load-dependent voltage drop and may reduce available power.



12-pulse drive – In 12-pulse drives, two rectifiers are connected parallel and are fed by a phase shifting transformer. Phase-shifted 6-pulse line currents of each rectifier sum up on the primary side of the transformer and, as a result, certain harmonic components are cancelled through the primary winding connection. The level of harmonic performance is impacted by line imbalance. The transformer can be either an isolating transformer or autotransformer.



18-pulse drive – Same operation principle as the 12-pulse drive, but the design has a higher part count and greater complexity. Harmonic performance is better than in 12-pulse drive but still sensitive to network voltage imbalance. This solution will typically meet the requirements of IEEE 519, if the supply voltage phases are balanced to within 1% - which may be difficult to achieve.



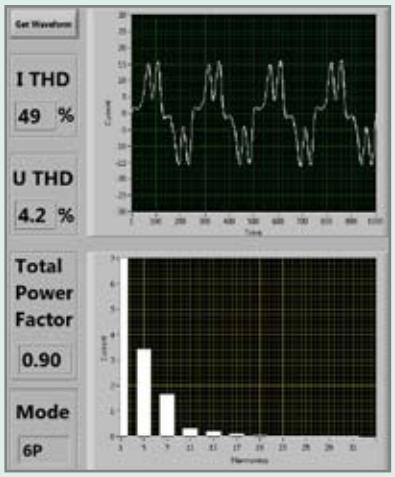
Ultra-low Harmonic drive – This solution is configured to enable the drive to control the line current to near sinusoidal waveform quality. The line filter used in the Ultra-low harmonic drive is designed to attenuate high-order voltage harmonics to reach very low total distortion of both current and voltage. In this case, the drive package meets the IEEE 519 standard at the input terminals, and is not susceptible to unbalanced supply voltages (which is an issue for the 18-pulse solution).

Measurement results

The Analysis is Done – We Have a Winner!

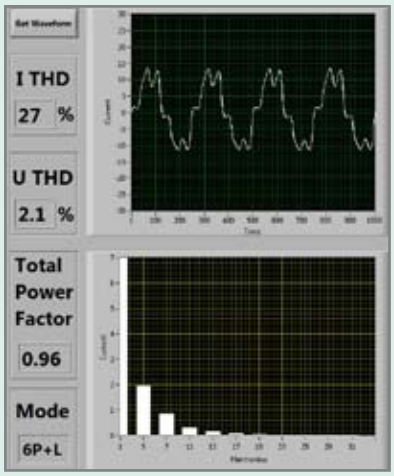
The following graphics indicate the actual level of harmonic distortion produced by the variable speed drive type mentioned. The results speak for themselves – the ACS800 ULH produces the least harmonic distortion of all solutions tested. Note that the actual level of harmonic distortion will vary from installation to installation due to the variety of distribution system configurations and components connected. However, the relative difference between each of these variable speed drive types on the same system will be the same.

6-pulse drive, no harmonic reduction



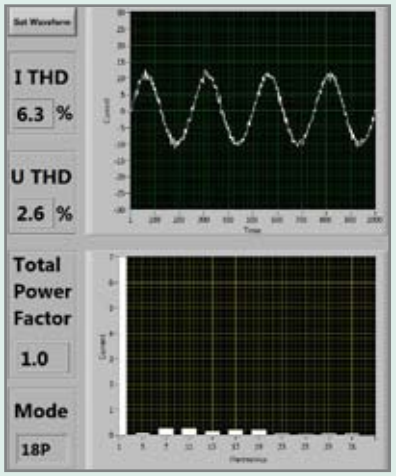
6-pulse drives without any harmonic reduction have dramatic impact on the power distribution system – in this case the level of distortion is 49% and reduces the power factor to .90.

6-pulse drive with reactors

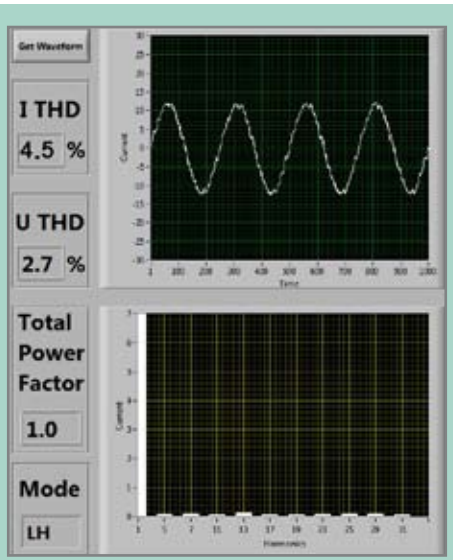


The level of harmonic distortion is reduced when reactors are added to 6-pulse drives, but is still significant. Power factor is also impacted.

18-pulse drive



The 18-pulse solution offers very good reduction of harmonic distortion. The problem with this solution is the size and weight of the package due to the special transformers used. Unbalanced supply voltages are also an issue. A relatively small percentage of voltage imbalance can cause an 18-pulse drive solution to fail to meet IEEE519.



ACS800 Ultra-low Harmonic drive

The ACS800 Ultra-low Harmonic drive solution provides the best overall management of harmonic distortion of all solutions tested. There is no need for additional reactors or transformers which makes it more compact than the 18-pulse solution and is not impacted by unbalanced supply voltages and retains IEEE519 levels of harmonic reduction.

Ultra-low Harmonic drive, wall mounted

ACS800-U31, 7.5 to 125 Hp

Simple low-harmonic solution

There is an increasing concern among end users and power companies about the harmful effects of harmonics. Harmonic distortion may disturb or even damage sensitive equipment connected in the same environment. Harmonic standards thus are becoming stricter and there is a growing demand for low harmonic solutions.

The ACS800-U31 drive offers an easy solution to the problem of harmonics. The solution itself is incorporated in the drive, eliminating the need for any additional filtering equipment or complicated and large multi-pulse transformer arrangements.

Meets the strictest standards

The ACS800-U31 eliminates low-order harmonics with the active converter controlled with DTC, and high order harmonics with an LCL line filter. The result is exceptionally low-harmonic content in the network-- exceeding the requirements set by standard IEEE519 at the drive input terminals, even on the weakest AC line network. The ACS800-U31 provides you with a simple, compact and complete solution to meet stringent power quality standards.

Beats external solutions

The ACS800-U31 does not require a dedicated multi-pulse transformer and thus eases installation, in terms of cabling arrangements; the drive also requires less floor space. Harmonic performance is better than with 12- and 18-pulse solutions. Passive or active external filtering devices are avoided with the ACS800-U31, making the solution compact and simple. Other advantages of the ACS800-U31 are that it always operates with unity power factor 1, and is impervious to AC line voltage imbalances up to and over 3%. The system efficiency also is better than 12- and 18-pulse solutions, since no phase-shifting transformer is required.

Main standard features

- Meets IEEE519-1992 at Drive input terminals
- Wall mounting
- Compact design
- UL Type 1 protection class
- Built in low harmonic LCL filter
- Coated boards
- Extensive, programmable I/O
- Long lifetime cooling fan and capacitors
- Inputs galvanically isolated
- 3 I/O and fieldbus extension slots inside
- Alphanumeric multilingual control panel with a start-up assistant feature

Options for ACS800-U31

- Braking chopper
- EMC filter for 1st environment, restricted distribution according to EN 61800-3
- EMC filter for 2nd environment, unrestricted distribution according to EN 61800-3
- Analog and digital I/O extension modules
- Fieldbus modules
- Pulse encoder interface module
- Resolver interface

Ratings and dimensions

ACS800-U31

ACS800 - U31 - XXXX - 25 + XXXX

Type code	Frame size	Input A	I_{max} A	Normal Duty I_{2N} A	Normal Duty P_N Hp	Heavy-duty use I_{2HD} A	Heavy-duty use P_{HD} Hp	Noise Level dBA	Air flow ft³/min	Heat Dissipation BTU/hr
3-phase supply voltage 208, 220, 230, 240. The power ratings are valid at nominal voltage, 240Vac (50 & 60Hz)										
ACS800-U31-0011-2	R5	32	52	32	10	26	7.5	70	206	1730
ACS800-U31-0016-2	R5	44	68	45	15	38	10	70	206	2380
ACS800-U31-0020-2	R5	55	90	56	20	45	10	70	206	3110
ACS800-U31-0025-2	R5	70	118	69	25	59	15	70	206	3760
ACS800-U31-0030-2	R5	82	144	83	30	72	20	70	206	4500
ACS800-U31-0040-2	R6	112	168	114	40	84	25	73	238	5420
ACS800-U31-0050-2	R6	140	234	143	50	117	30	73	238	7260
ACS800-U31-0060-2	R6	157	264	157	60	132	40	73	238	8650
3-phase supply voltage 380, 400, 415, 460, 480, 500. The power ratings are valid at nominal voltage, 480Vac 60Hz										
ACS800-U31-0020-5	R5	29	52	29	20	25	15	70	206	2240
ACS800-U31-0025-5	R5	33	61	34	25	30	20	70	206	2600
ACS800-U31-0030-5	R5	44	68	45	30	37	25	70	206	3420
ACS800-U31-0040-5	R5	54	90	55	40	47	30	70	206	4140
ACS800-U31-0050-5	R5	65	118	67	50	57	40	70	206	4960
ACS800-U31-0060-5	R5	76	144	78	60	62	50	70	206	5980
ACS800-U31-0070-5	R6	112	168	114	75	88	60	73	238	8030
ACS800-U31-0100-5	R6	129	234	132	100	114	75	73	238	9570
ACS800-U31-0120-5	R6	145	264	156	125	125	100	73	238	11620
3-phase supply voltage 525, 575, 600. The power ratings are valid at nominal voltage, 575Vac 60Hz										
ACS800-U31-0060-7	R6	53	62	54	50	43	40	73	238	5980
ACS800-U31-0070-7	R6	73	79	75	60	60	50	73	238	8030
ACS800-U11-0100-7	R6	86	99	88	75	71	60	73	238	9570

Frame size	UL Type 1 Height (in)	Width (in)	Depth (in)	Weight (lbs)
R5	32.1	10.4	15.4	143
R6	38.2	11.8	17.3	220.5

Enclosure

Degree of Protection:
UL Type 1(Standard)
Paint color:
NCS 1502-Y (RAL 90021/PMS 420C)

NOTES:

- I_{max} current available for 10 seconds at start.
- I_{2N} continuous base current at 40°C (104°F). Overload cycle 110% I_{2N} for 1 minute / 5 minutes allowed.
- I_{2hd} continuous base current at 40°C (104°F). Overload cycle 150% I_{2hd} for 1 minute / 5 minutes allowed.

- Current ratings do not change with different supply voltages.
- Horsepower ratings are based on NEMA motor ratings for typical 4-pole motors (1800 rpm). Check motor nameplate current for compatibility.

Ultra-low Harmonic drive, cabinet-built

ACS800-37, 125 to 2800 Hp

Simple low harmonic solution

There is increasing concern among end users and power companies about the harmful effects of harmonics. Harmonic distortion may disturb or even damage sensitive equipment connected in the same environment. Harmonic standards thus are becoming stricter and there is a growing demand for low harmonic solutions.

The ACS800-37 drive offers an easy solution to the problem of harmonics. The solution itself is incorporated in the drive, eliminating the need for any additional filtering equipment or complicated and large multi-pulse transformer arrangements.

Meets the strictest standards

The ACS800-37 eliminates low-order harmonics with the active converter controlled with DTC, and high order harmonics with an LCL line filter. The result is exceptionally low-harmonic content in the network--exceeding the requirements set by standard IEEE519 at the drive input terminals, even on the weakest AC line network. The ACS800-37 provides you with a simple, compact, and complete solution to meet stringent power quality standards.

Beats external solutions

The ACS800-37 does not require a dedicated multi-pulse transformer and thus eases installation in terms of cabling arrangements; the drive also requires less floor space. Harmonic performance is better than both 12- and 18-pulse solutions. Passive or active external filtering devices are avoided with the ACS800-37, making the solution compact and simple. Other advantages of the ACS800-37 are that it always operates with unity power factor 1, and is impervious to AC line voltage imbalances up to and over 3%. The system efficiency also is better than 12- and 18-pulse solutions, since no phase-shifting transformer is required.

Extensive range of features

In line with other ACS800 cabinet-built drives, the ACS800-37 offers a wide variety of standardized configurations to adapt to different application requirements. The smart module concept enables easy maintenance and redundancy in the high power range where multiple identical power modules make one power structure. If one power module fails, the drive may be operated at reduced capacity.

Main standard features

- Meets IEEE519-1992 at Drive input terminals
- Compact design
- UL Type 1 protection class
- Built in low harmonic LCL filter
- EMC filter for 2nd environment, unrestricted distribution according to EN 61800-3
- Main switch with IR fuses
- Line contactor
- Removable air circuit breaker (in frame size nxR8i)
- Du/dt filters (in frame size nxR8i)
- Coated boards
- Extensive, programmable I/O
- Long lifetime cooling fan and capacitors
- Inputs galvanically isolated
- 3 I/O and fieldbus extension slots inside
- Alphanumeric multilingual control panel with a start-up assistant feature

Options for ACS800-37

- Analog and digital I/O extension modules
- Braking chopper and resistor
- Cabinet heater
- Customer terminal block
- Du/dt filters (in frame sizes R7i-R8i)
- Grounding monitoring for ungrounded network
- EMC filter for 1st environment, restricted distribution according to EN 61800-3
- Fieldbus modules
- UL Type 1 Filtered or UL Type 12 enclosure classes
- Emergency stop, category 0 or 1
- Output for motor fan
- Pulse encoder interface module
- Prevention of unexpected start up of motor
- Bottom entry and exit of cables
- 1 or 2 thermistor relays
- 3, 5 or 8 PT100 relays

Plus, tailormade accessories through ABB's application engineering.

Ratings and dimensions

ACS800-37

ACS800	-	37	-	XXXX	-	5 7	+	XXXX

Type code	Frame size	Input	I_{max}	Normal Duty		Heavy-duty use		Noise Level	Air flow	Heat Dissipation
				I_{2N}	P_N	I_{2HD}	P_{HD}			
		A	A	A	Hp	A	Hp	dBA	ft³/min	BTU/Hr
3-phase supply voltage 380, 400, 415, 460, 480, 500. The power ratings are valid at nominal voltage, 480Vac 60Hz										
ACS800-37-0070-5+C129	R6	112	168	114	75	88	60	73	295	8200
ACS800-37-0100-5+C129	R6	129	234	132	100	114	75	73	295	9600
ACS800-37-0120-5+C129	R6	145	264	156	125	125	100	73	295	11600
ACS800-37-0170-5+C129	R7i	180	291	192	150	156	125	74	765	20500
ACS800-37-0210-5+C129	R7i	220	355	240	200	183	150	74	765	27300
ACS800-37-0260-5+C129	R8i	270	438	302	250	226	150	75	1860	30700
ACS800-37-0320-5+C129	R8i	329	530	361	300	273	200	75	1860	37600
ACS800-37-0400-5+C129	R8i	410	660	437	350	340	250	75	1860	47800
ACS800-37-0460-5+C129	R8i	473	762	504	400	393	300	75	1860	54700
ACS800-37-0510-5+C129	R8i	536	863	571	450	445	350	75	1860	61500
ACS800-37-0610-5+C129	R8i	630	1016	672	550	524	400	75	1860	78600
ACS800-37-0780-5+C129+H359	2xR8i	803	1294	856	700	667	550	77	3770	88800
ACS800-37-0870-5+C129+H359	2xR8i	900	1458	965	800	752	650	77	3770	109000
ACS800-37-1160-5+C129+H359	2xR8i	1200	1941	1284	1050	1001	850	77	3770	150000
ACS800-37-1330-5+C129+H359	3xR8i	1376	2217	1467	1250	1143	1000	78	6030	157000
ACS800-37-1820-5+C129+H359	3xR8i	1888	2956	1956	1650	1524	1300	78	6030	229000
ACS800-37-2200-5+C129+H359	4xR8i	2344	3670	2428	2050	1892	1600	79	7530	277000
3-phase supply voltage 525, 550, 575, 600, 690. The power ratings are valid at nominal voltage, 575Vac 60Hz										
ACS800-37-0060-7+C129	R6	53	86	54	50	43	40	73	294	6142
ACS800-37-0070-7+C129	R6	73	120	75	60	60	50	73	294	8190
ACS800-37-0100-7+C129	R6	86	142	88	75	71	60	73	294	9554
ACS800-37-0170-7+C129	R7i	125	202	133	125	104	100	74	765	27300
ACS800-37-0210-7+C129	R7i	146	235	156	150	121	100	74	765	30700
ACS800-37-0260-7+C129	R8i	180	301	193	200	150	150	75	1860	41000
ACS800-37-0320-7+C129	R8i	250	417	268	250	209	200	75	1860	51200
ACS800-37-0400-7+C129	R8i	300	502	322	300	251	250	75	1860	61500
ACS800-37-0440-7+C129	R8i	344	571	367	350	286	300	75	1860	64900
ACS800-37-0540-7+C129	R8i	400	668	429	450	334	350	75	1860	71700
ACS800-37-0790-7+C129+H359	2xR8i	593	985	632	650	493	500	77	3770	120000
ACS800-37-0870-7+C129+H359	2xR8i	657	1091	700	750	545	600	77	3770	126000
ACS800-37-1160-7+C129+H359	2xR8i	853	1425	914	1000	713	750	77	3770	157000
ACS800-37-1330-7+C129+H359	3xR8i	1001	1663	1067	1150	831	900	78	6030	185000
ACS800-37-1510-7+C129+H359	3xR8i	1164	1879	1206	1300	940	1050	78	6030	212000
ACS800-37-2320-7+C129+H359	4xR8i	1729	2791	1791	2000	1396	1500	79	7530	304000
ACS800-37-2780-7+C129+H359	5xR8i	2091	3472	2228	2450	1736	1900	79	10550	362000
ACS800-37-3310-7+C129+H359	6xR8i	2470	3987	2559	2800	1999	2200	79	11300	413000

Frame size	Width	Height UL Type 1	Height UL Type 12	Depth top entry/exit [B]	Weight
	in	in	in	in	lb
R6	16.9	83.9	91.1	25.4	550
R7i	24.8	83.9	91.1	25.4	880
R8i	48.4[A]	83.9	91.1	25.4	2646
2xR8i	107.5	83.9	91.1	25.4	4982
3xR8i	139.0	83.9	91.1	25.4	6746
4xR8i	178.3	83.9	91.1	25.4	7937
5xR8i	225.6	83.9	91.1	25.4	10538
6xR8i	243.4	83.9	91.1	25.4	10869

[A] 60.2 in if equipped with 1st environment filter and common motor terminal.

[B] The depth without the handle.

NOTES:

I_{max} current available for 10 seconds at start.

I_{2N} continuous base current at 40°C (104°F). Overload cycle 110% I_{2N} for 1 minute / 5 minutes allowed.

I_{2hd} continuous base current at 40°C (104°F). Overload cycle 150% I_{2hd} for 1 minute / 5 minutes allowed.

- Current ratings do not change with different supply voltages.
- The rated current of the ACS800 must be greater than or equal to the rated motor current to achieve the rated motor power given in the table.
- Horsepower ratings are based on NEMA motor ratings for typical 4-pole motors (1800 rpm). Check motor nameplate current for compatibility.

Enclosure

Degree of Protection:
UL Type 1 (Standard)
UL Type 1 Filtered and UL Type 12 (opt)
Paint color:
Light beige RAL 7035 semi-gloss

Communications options
Fieldbus control

ABB industrial drives have connectivity to most major automation systems. This is achieved with a dedicated gateway concept between the fieldbus systems and ABB drives.

The fieldbus gateway module easily can be mounted inside the drive. Because of the wide range of fieldbus gateways, your choice of automation system is independent of your decision to use first-class ABB AC drives!

Manufacturing flexibility

Drive control
The drive control word (16 bit) provides a wide variety of functions from start, stop and reset to ramp generator control. Typical setpoint values such as speed, torque and position can be transmitted to the drive with 15 bit accuracy.

Drive monitoring
A set of drive parameters and/or actual signals, such as torque, speed, position, current etc., can be selected for cyclic data transfer, providing fast data for operators and the manufacturing process.

Drive diagnostics
Accurate and reliable diagnostic information can be obtained via the alarm, limit and fault words, reducing drive and production downtime.

Drive parameter handling
Total integration of the drives in the production process is achieved by single parameter read/write, up to complete parameter set-up or download.

Reduced installation and engineering effort

Cabling
Substituting the large amount of conventional drive control cabling with a single communication cable reduces costs and increases system reliability.

Design
The use of fieldbus control reduces engineering time at installation, due to the modular structure of the hardware and software.

Commissioning and assembly
The modular machine configuration allows pre-commissioning of single machine sections and provides easy and fast assembly of the complete installation.

Currently available modules

- PROFIBUS (+K454)
- DeviceNet (+K451)
- ControlNet (+K462)
- Modbus (+K458)
- Ethernet (+K466)
- CANopen (+K457)
- InterBUS-S (+K453)

NOTE: Additional Fieldbus module options are available. Contact your local ABB representative for more information.

Additional I/O options

Standard I/O can be extended by using analog and digital extension modules or pulse encoder interface modules which are mounted in the slots on the ASC800 control board. The control board has two slots available for extension modules. More extension modules can be added with the I/O extension adapter, which has three additional slots. The available number and combination of I/O's depends on the control software used. The standard application software supports 2 analog, 2 digital extension modules, and 1 encoder interface module.

Optional I/O

Analog I/O extension module RAIO-01 (+L500)
- **2 analog inputs:** galvanically isolated from 24 V supply and ground
  - ±0(2)...10 V, 0(4)... 20 mA or ±0...2 V, resolution 12 bits
- **2 analog outputs:** galvanically isolated from 24 V supply and ground
  - 0(4)...20 mA, resolution 12 bit

Digital I/O extension module RDIO-01 (+L501)
- **3 digital inputs:** individually galvanically isolated
  - Signal level 24 to 250 V DC or 115/230 V AC
- **2 relay (digital) outputs:**
  - Form C contacts
  - 24 V or 115/230 V AC
  - Max. 2 A

Technical specification

Mains connection

Voltage and power range	3-phase, U_{2IN} = 208 to 240 V, ± 10%, except -37 3-phase, U_{5IN} = 380 to 500 V, ± 10% 3-phase, U_{7IN} = 525 to 690 V, ± 10% (600 V UL, CSA)
Short Circuit Current Rating (SCCR)	ACS800-U1,-U31 = 65ka ACS800-U2,-37 = 100ka
Frequency	48 to 63 Hz
Power factor ACS800-U31,-37	$\cos\varphi_1$ = 1 (fundamental) $\cos\varphi$ = 0.99 (total)
Efficiency (at nominal power) 97%	

Motor connection

Voltage for > 500 V units	3-phase output voltage 0...U_{2IN}/U_{5IN}/U_{7IN}
Frequency	0...±300 Hz
Field weakening point	8...300 Hz
Motor control	ABB's exclusive Direct Torque Control (DTC)
Torque control Open loop Closed loop Open loop Closed loop	Torque step rise time <5 ms with nominal torque <5 ms with nominal torque Non-linearity: ±4% with nominal torque ±1% with nominal torque
Speed control Open loop Closed loop Open loop Closed loop	Static accuracy 10% of motor slip 0.01% of nominal speed Dynamic accuracy 0.3...0.4% sec. with 100% torque step 0.1...0.2% sec. with 100% torque step

Environmental

Ambient temperature Transport Storage Operation	 -40...+70°C -40...+70°C -15...+50°C, no frost allowed 40...50°C at reduced output current (1% / 1°C)
Cooling method	Dry clean air
Altitude 0...1000 m 1000...4000 m	 without derating with derating ~ (1% / 100 m) (600 V units 1000...2000 m with derating)
Relative humidity	5 to 95%, no condensation allowed
Protection class UL Type 1 UL Type 1 filtered UL Type 12	 standard for -37 option for -37 option for -37
Paint color	-37: RAL 7035 -U31: NCS 1502-Y (RAL 90021, PMS 420 C)
Contamination levels Storage	No conductive dust allowed IEC60721-3-1, Class 1C2 (chemical gases), Class 1S2 (solid particles)
Transportation	IEC60721-3-2, Class 2C2 (chemical gases), Class 2S2 (solid particles)
Operation	IEC60721-3-3, Class 3C1/3C2* (chemical gases), Class 3S2 (solid particles)

C = chemically active substances
S = mechanically active substances
* coated circuit boards

Product compliance

UL & cUL (508A or 508C) and CSA C22.2 NO.14-95, C-Tick, GOST R
NEC 430.126(A)(2) Motor Overtemperature Protection
Quality assurance system ISO 9001 and
Environmental system ISO 14001
CE (Available)
Low Voltage Directive 73/23/EEC with amendment 93/68/EEC
Machinery Directive 98/37/EC
EMC Directive 89/336/EEC with amendment 93/68/EEC

EMC (according to EN 61800-3)

2nd environment, unrestricted distribution category C3 as standard in -37 (frame sizes R7i-nxR8i), option in the others
1st environment, restricted distribution category C2 as option up to 1000 A input current

Drive Services

Through its large variety of drive lifecycle services and worldwide service network ABB aims for high drive availability and long lifetime.

Training and learning

The ABB University provides eLearning and hands-on classroom training for its ACS800 drives. Look for the training courses on www.abb.com/abbuniversity.

Installation and commissioning

ABB's professional installation and commissioning service uses certified engineers to install and adjust ABB drives according to the application requirements as well as to instruct the user on how to operate the drive.

Support line services

The support line network provides fast and efficient support for ABB drive users. The service is available via e-mail and telephone: 1-800-HELP365 option #4.

Maintenance and repair

ABB recommends regular preventative maintenance for AC drives throughout their lifetime.

Maintaining drives in accordance with the maintenance schedules ensures drive maximum availability, minimum repair costs, optimized performance and extended lifetime. Maintenance can be performed on a contract basis.

Drive preventative maintenance (PM) consists of annual drive inspections and component replacements according to the product specific maintenance schedules, using PM kits which contain all the service parts and materials specified for a certain preventative maintenance.

ABB's certified engineers provide maintenance and repair services on site and in ABB authorized workshops.

Work services include e.g.:

- Module maintenance and repair services - instead of performing module maintenance or repair on site, modules can be sent to an ABB workshop. It is often practical to carry out preventive maintenance at the same time.
- Exchange unit service - a convenient and fast way to fix a problem with a drive is to order an exchange module. A refurbished drive is immediately shipped to the customer (subject to availability). The defective but repairable unit will be returned to ABB.

Spare part services

Genuine ABB factory-certified drive parts are delivered quickly worldwide. They guarantee full compatibility and are available throughout the drive's lifetime.

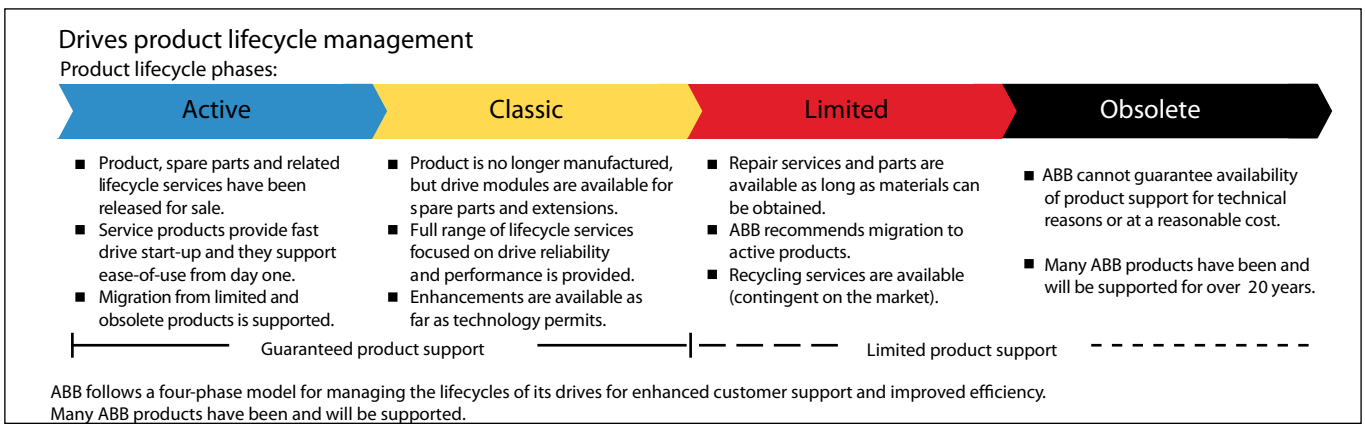


ABB follows a four-phase model for managing the lifecycles of its drives for enhanced customer support and improved efficiency. Many ABB products have been and will be supported.

Contact and web information

For US support www.abb.us/drives
For Global support www.abb.com/motors&drives

ABB's worldwide presence is built on strong local companies working together with the local distributor and channel partner network across borders to achieve a uniform level of services for all our customers. By combining the experience and know-how gained in local and global markets, we ensure that our customers in all industries can gain the full benefit from our products.

For further details about all our variable speed drive products and services please contact your nearest ABB office or visit the ABB website: http:// www.abb.us/drives

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Fax: +55 11 3684 1991

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ABB Inc.
Drives & LVC Canada
3299 J.B. Deschamps Blvd.
Lachine, Quebec
H8T 3E4
Telephone (800) 215-3006
Fax (514) 420-3137
Internet http://www.abb.com/motors&drives

TCI H5

H5 Active Line Conditioner

c UL us

Performance and Protection for Drives

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Active Harmonic Mitigation and Power Factor Correction

TCI introduces the H5® Active Line Conditioner for overall system efficiency improvement. The H5 actively monitors the load current, reacting to changes in load almost instantaneously, while returning the true power factor to near unity. This dual duty product accomplishes both objectives immediately upon installation without the need for a special commissioning process. The filter's ability to adjust to a dynamic load also means that an expensive harmonic study is not necessary prior to the installation of an H5. The ease of installation plus the superior performance of this filter makes the H5 the ultimate choice in harmonic mitigation solutions.

Typical Problems, Superior Solutions with H5 Filters

Harmonics and Power Quality

Variable frequency drives and other types of non-linear loads take the incoming power from the utility and modify it for more efficient use within a wide range of applications. Since this conversion process is not using the power efficiently as it is supplied from the utility, distortion of both the current waveform and voltage waveform occurs. This distortion is a set of frequencies that combine with the fundamental to create a new waveform. If non-linear loads represent a significant portion of the entire installed load, this distortion begins to cause problems throughout the electrical system. These problems range from transformer and distribution equipment overheating to random breaker tripping. Harmonics may even cause sensitive equipment to fail completely.

Another by-product of this distortion is poor power factor. Unity power factor is achieved when the voltage waveform and the current waveform are truly synchronized and sinusoidal. The combination of reactive power and harmonic distortion contribute to voltage and current waveforms that are not providing true load KW.

The H5 Active Line Conditioner

By actively monitoring the load current, the H5 determines the proper current waveform for injection into the system to maintain an acceptable level of harmonic distortion. A state of the art, high-speed DSP Controller allows for virtual real time correction of the non-linear current demanded by loads such as variable frequency drives. This inherent injection portion of the design of the H5 also allows the filter to control the synchronization of the current and voltage waveforms. This means that the H5 is always attempting to achieve unity power, while never allowing for leading power factor. Another aspect of the H5 design is that in order to maintain optimum system efficiency, the filter will allow the current distortion to rise as the load is decreased. This occurs because the non-linear load is now less of a draw on the entire system and mitigation requirements are no longer the same, all while still driving towards unity power factor.

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Versatility

The H5 is one of the most versatile filters available on the market today. The ability of the filter to adjust to varying loads means that it can be applied to different types of loads without the need of an expensive harmonic study. The H5 filter cannot be overloaded by harmonic currents. If there is more corrective current needed than the H5 can accommodate, the unit will go into current limit and the line distortion will rise. If additional harmonic mitigation is required, several H5 units can be paralleled and desired distortion levels can be reached. Typical applications for the H5 filter include:

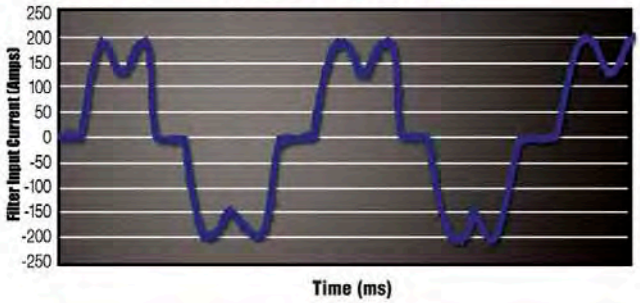
- Oil and Gas
- Waste Water Treatment
- HVAC Systems
- Down Hole Pumping
- Extruders
- Pulp & Paper
- Uninterruptible Power Supplies (UPS)
- AC Variable Frequency Drives
- Fans

Product Features

- **Meets IEEE-519 1992**
- **TDD Reduction to 5% or better at Full Load**
- **Power Factor Correction to .98 lagging (programmable)**
- **Power Factor never goes leading**
- **Response time is less than 8 ms to step load changes**
- **Harmonic Currents cannot overload the H5**
- **Additional filters can be added in parallel to increase correction capability**
- **Self-Commissioning Installation, no start-up required**
- **Modular design**
- **Harmonic Cancellation to the 50th harmonic**
- **ANSI C62.16 surge protection**
- **UL / CUL**
- **NEMA 1 and Open Chassis available**

Unfiltered Application

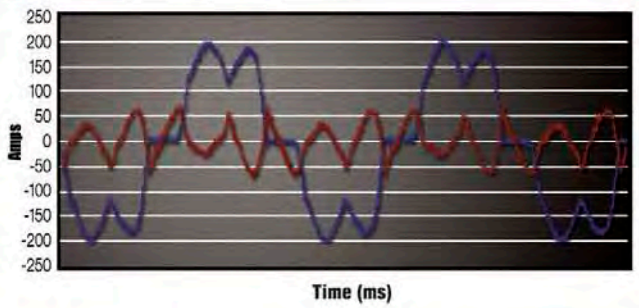
Typical Non-Linear Load Waveform without Filtering



Waveforms

Harmonic distortion occurs as a set of frequencies combine with the fundamental waveform to create a new, distorted waveform. Harmonic distortion can cause damage to sensitive equipment and poor power factor. To address this problem, IEEE-519 1992 set forth distortion limits for power users.

Injection Waveform

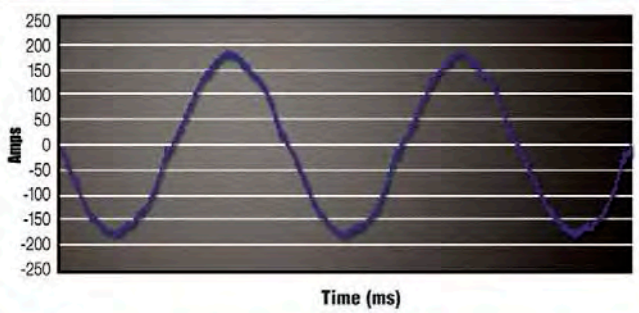


Load Current

H5 Injection Current

The H5 reduces distortion to meet IEEE-519 limits. The H5 actively monitors the load current and injects equal compensating currents, opposite in phase, to maintain an acceptable level of harmonic distortion. All of this is done in near real time.

Resultant Line Current Waveform



This inherent injection portion of the design of the H5 also allows the filter to control the synchronization of the current and voltage waveforms.

The H5 is always attempting to achieve unity power, while never allowing for leading power factor, resulting in current waveforms that are close to sinusoidal.

H5IM: Interface Module included standard with every unit

The door mounted H5IM Operator Interface Module is an easy to use device that allows for operation and system adjustments for all the H5's setup and operating parameters. The password protected keypad/LED display is also a convenient way to communicate with the filter without the hassle of using an externally connected device.

Functions such as Power Factor, Line Voltage, % of output current and injected harmonics per phase can all be displayed on the easy to read module. A wide variety of status and fault conditions can also be monitored. For example:

- Over Current
- Phase loss (ALC)
- IGBT Failure
- Over Temperature
- Phase unbalance
- Bus Over voltage

H5 Filter Configurations

TCI has designed the H5 filter to be the most versatile filter in the marketplace. Multiple design options allow for the selection of the proper filter for the application.

Bus-Applied

The Bus-Applied Filter combines TCI's Digital Filter Technology with existing system impedance to provide the harmonic and power factor correction solution. This traditional active filter design can be directly connected to the power bus in standard MCC configurations. As with other bus-applied designs, impedance must be installed on the load side of the H5 filter. The small size and superior performance make this design perfect for integration into most applications.

H5 Selection Charts

Active Line Conditioner

Open

Active Line Conditioner				
Open Part Number	Corrective RMS Current	Watts Loss	Dimensions (Inches) Height x Width x Depth	Wt. (lbs.)
ALC50A00H	50	4330	56.00 x 17.00 x 14.36	256
ALC50A00S	50	4330	56.00 x 17.00 x 14.36	256
ALC90A00H	90	4812	56.00 x 17.00 x 14.36	285
ALC90A00S	90	4812	56.00 x 17.00 x 14.36	285
ALC170A00H	170	9624	64.13 x 31.80 x 19.09	554
ALC170A00S	170	9624	64.13 x 31.80 x 19.09	554

NEMA 1

Active Line Conditioner				
NEMA 1 Part Number	Corrective RMS Current	Watts Loss	Dimensions (Inches) Height x Width x Depth	Wt. (lbs.)
ALC50A01H	50	4330	56.11 x 17.52 x 16.39	335
ALC50A01S	50	4330	56.11 x 17.52 x 16.39	335
ALC90A01H	90	4812	56.11 x 17.52 x 16.39	372
ALC90A01S	90	4812	56.11 x 17.52 x 16.39	372
ALC170A01H	170	9624	64.13 x 32.52 x 21.32	794
ALC170A01S	170	9624	64.13 x 32.52 x 21.32	794

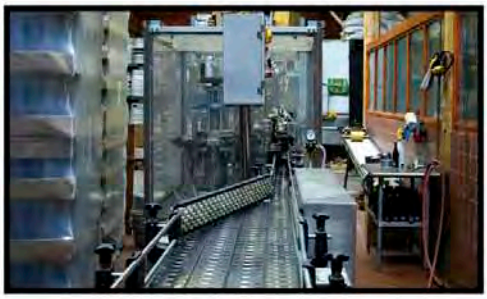
Part Numbering System

ALC 90 A 01 H

- H5 Series
- Panel Current
- Voltage Rating
  - A = 480 V B = 240 V D = 208 V
  - H = 440 V J = 415 V K = 220 V
- Enclosure
  - 00 - Open
  - 01 - NEMA 1
- Package Option
  - H - H5IM Interface Module
  - S - Option Package

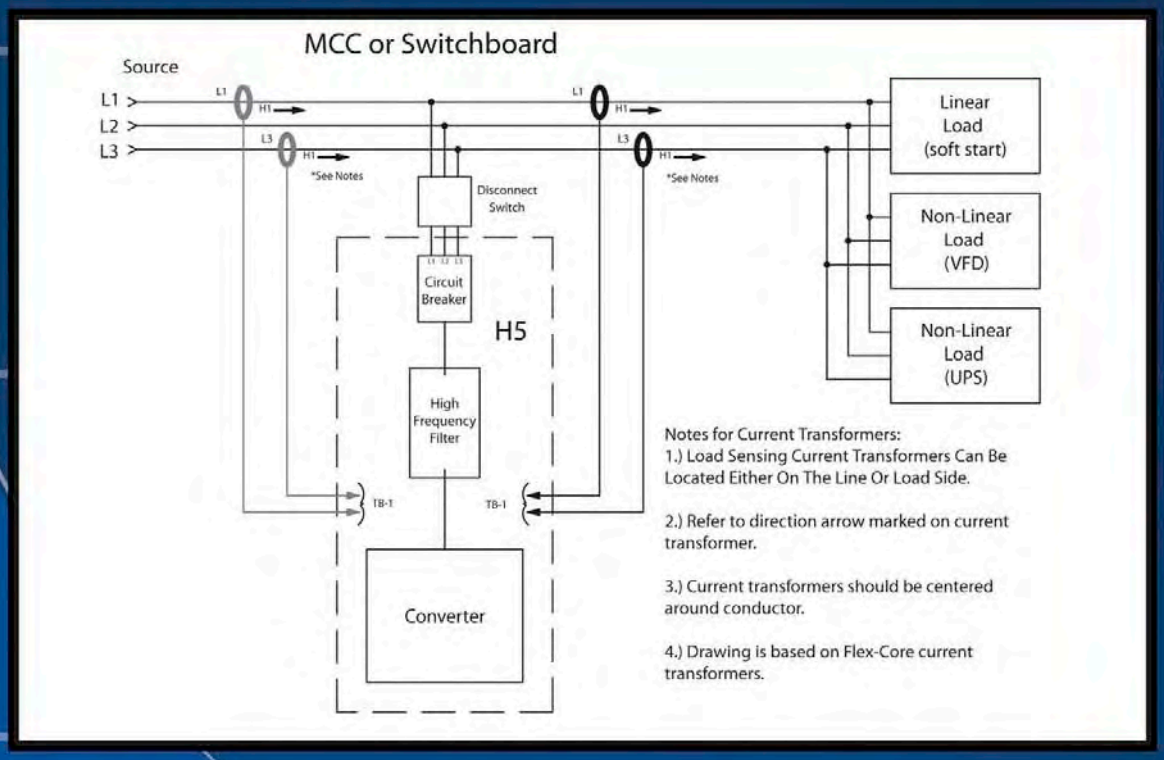
H5 Sizing

When sizing an Active Line Conditioner many factors need to be considered: the size and number of variable frequency drives, desired power factor correction level, future system growth expectations, etc. Also, depending on the use of individual line reactors or DC bus chokes with the VFDs, the amount of corrective current required to meet IEEE-519 and/or specific power factor correction levels can vary greatly. Therefore, please contact your nearest TCI Sales Representative who will help you determine the best solution for today and into the future.



System	
Voltage	208/220/240/380/400/415/440/480V 3 ph, 50/60 Hz, three wire systems
Operating Frequency	45 Hz to 70 Hz
Performance	
Harmonic Reduction	≤ 5% TDD (Full Load)
Power Factor Correction	≤ .98 Lagging (Programmable), Never Leading
Response Time	< 8 ms to step load changes
Protection	Internal circuit breaker
Agency Approvals	UL/cUL
Enclosure Options	Open Chassis NEMA 1
Physical Environment	
Storage Temperature	-40° to 60° C
Operating Temperature	-20° to 40° C
Maximum Humidity	95%, non-condensing
Elevation	1,000m (3,300 ft) derate > 1,000m

Typical Unit Diagram



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