HALLIBURTON

Summit ESP ACS®-15 variable speed drives

Reliable, flexible, and accurate multilevel protection

Summit ESP ACS®-15 active front end variable speed drives

Optimize performance of ESP or HPS equipment

Summit ESP® – A Halliburton Service presents the Summit ESP Adaptive Control System (Summit ESP ACS®-15), the newest generation of variable speed drives (VSDs) featuring proven technology to ensure ultimate performance for your electric submersible pumping (ESP) or horizontal pumping system (HPS) equipment. With their rugged outdoor rated design, proprietary software, and plug-and-play capabilities, the Summit ESP ACS-15 active front end (AFE) drives offer reliability, flexibility, accuracy, and multilevel protection. The SummitView™ color touchscreen operator interface enables user-friendly operation.

The family of Summit ESP ACS-15 AFE drives is the ideal choice whenever input power quality needs to be maintained or when power provider constraints arise. Phase shift transformers or passive input filters are unnecessary, thus reducing installation footprint requirements.

The Summit ESP ACS-15 AFE system's robust design provides assurance for harsh-environment operations in all climates. State-of-the-art circuit boards feature a conformal coating, and all drive components reside in enclosures with cam-locking perimeter latches. This ensures door-seal integrity and ingress protection from unwanted contaminants.

Summit ESP ACS-15 AFE drives perform active harmonic cancellation. These drives, which are always IEEE-519 compliant under normal operating conditions, provide a power factor (PF) of .99 to unity (1.0) compared to other topologies that provide PFs of .95 to .98. The drives are not influenced by changes in harmonic spectrum, system impedance imbalances, or typical voltage variations.

Summit ESP ACS®-15 drives provide quick response and adaptability to dynamic operating conditions attendant with your application. They also deliver asset protection, optimized production, reduced operating costs, and increased equipment life cycles.

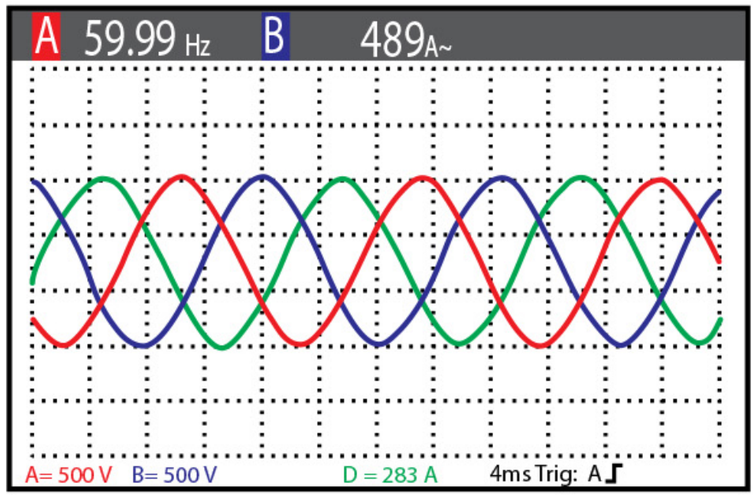
Less reactive power (kVAR) is used as PF increases, thus reducing the amount of apparent power that the utility must provide to operate your equipment. This PF improvement helps reduce your operating costs.

From an electrical network viewpoint, reactive power is basically wasted power. Less apparent power demand may allow your power system to accommodate additional loading without more costs. Utility fuel factor costs may also decrease.

Extra savings with the use of Summit ESP® ACS®-15 AFE drives are realized on installation and wiring costs. The drives are three wires in and three wires out, and do not require additional harmonic mitigation devices such as phase-shift transformers or harmonic input filters. Therefore, the total drive solution requires less space; additionally, equipment is online quicker, installation costs decline, and revenue occurs faster.

The waveform snapshots shown below demonstrate how ACS-15 AFE VSDs provide significantly improved voltage and current sinusoidal waveforms compared to other drive topologies. As waveforms become more sine wave shaped, harmonic content declines and fewer harmonics are reflected into the power grid. Operating power costs are greatly influenced by the amount of input harmonics resident on the system.

Waveform comparison of Summit ESP ACS®-15 drive input vs. 6-pulse inputs



Voltage snapshot of Summit ESP ACS®-15 AFE drive

IMPROVE POWER COST

Power costs are usually the largest expenditure for an oil-producing field. Summit ESP ACS®-15 AFE drives offer several operational benefits, depending upon the characteristics of your field's electrical distribution system.

These benefits include:

- Less kilowatt (kW) consumption
- Lower fuel-factor costs
- No PF penalties
- Fewer power system losses
- Additional power system capacity
- Cooler operating equipment

Use of the Summit ESP ACS-15 AFE drives provides:

- Lower electrical system losses
- Better voltage levels
- Cooler operation
- Extended runlife

Summit ESP ACS-15 AFE drives offer:

- High power factors
- Increased system efficiency
- Possible elimination of PF penalties

Less than 4% THD for voltage and current

BENEFITS OF POWER FACTOR IMPROVEMENT

Lower utility fees/fines

- Fewer kVAR requirements – more efficient use of consumed power
- High PF requires less utility power and increases generating site efficiency
- May alleviate PF penalties

Decreased electrical system losses

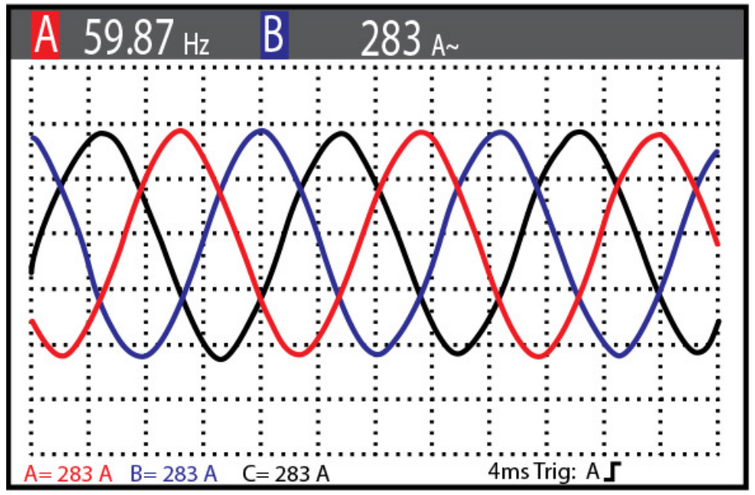
- High PF decreases electrical system losses
- As electrical system losses decrease, network capacity increases
- Electrical costs (power bills) are the largest expenditure for an oil production field

Increased voltage level in electrical system

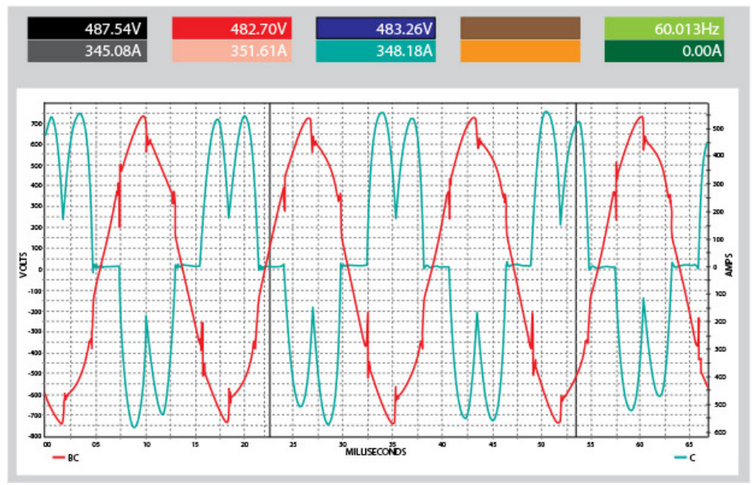
- High PF loads decrease electrical losses and voltage drops
- Equipment operates at lower temperatures, thus increasing efficiency
- Overall system efficiency increases

Other benefits of increased power factor

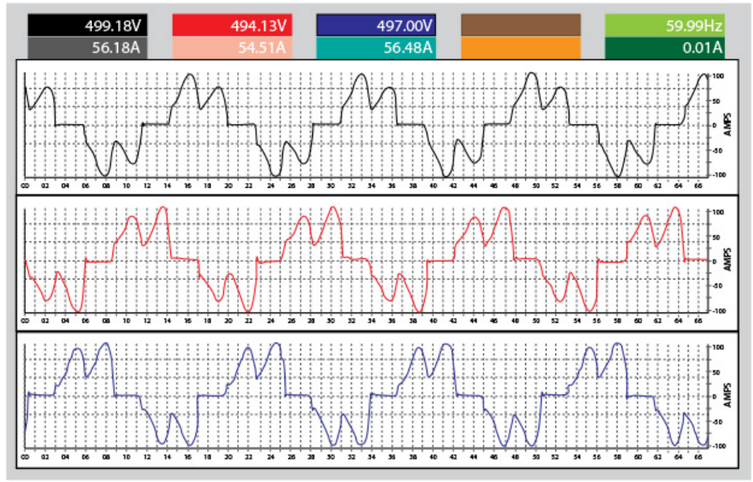
- Fewer peak demand changes
- Lower fuel surcharges
- Lower operating expenses (OPEX)



Current snapshot of Summit ESP ACS®-15 AFE drive



VSD with 6-pulse front end – Six-step variable voltage inverter (WI) voltage and current snapshot

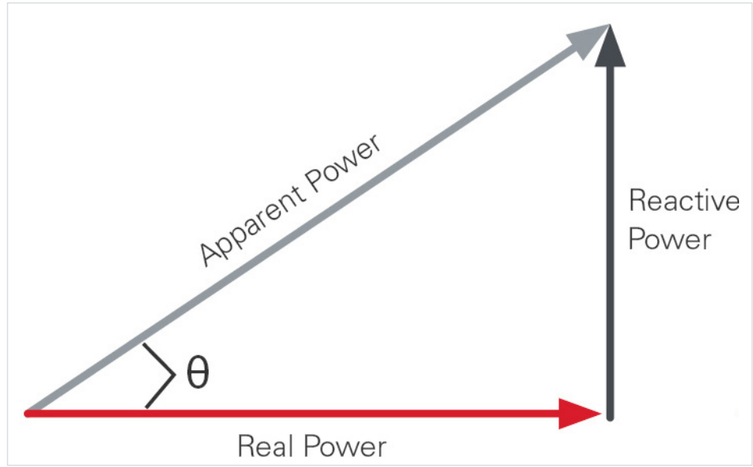


VSD with 6-pulse front end and passive harmonic input filter – current snapshot

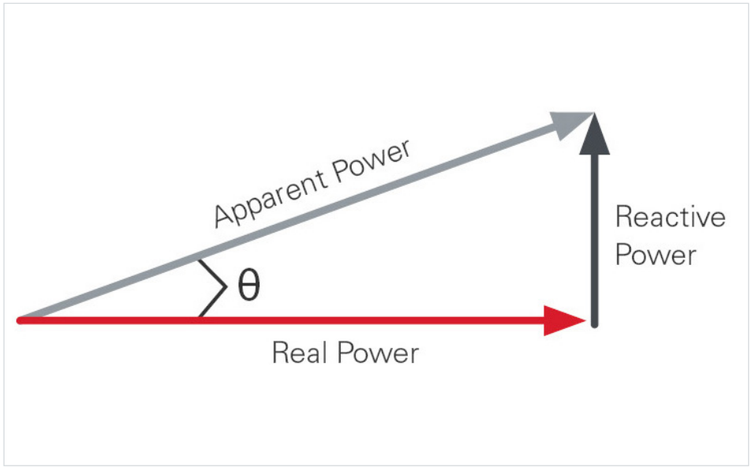
Improve power cost

Summit ESP ACS®-15 AFE drives consistently provide a 0.99 to unity power factor under normal operating conditions. This is an important consideration in areas where utility rates are based in part on power factor and PF penalty assessment. PF values under 0.9 may have a penalty associated with them, and the cost of operation increases along with a decrease in system load capability. Many electric companies bill their commercial accounts not only on the basis of kilowatt hours used but also on PF and peak demand. A reduced power factor increases the cost for utilities to supply power. Likewise, peak demand requires the utility to provide capability to meet that demand event, although normal demand for power may be much less.

Power Factor (PF) = cos θ = Real Power/Apparent Power



As Power Factor decreases, the ratio of Real Power to Apparent Power also decreases; Reactive Power increases as angle θ increases.



As Power Factor increases, the ratio of Real Power to Apparent Power increases. Angle θ decreases and Reactive Power decreases, allowing the ratio to approach unity. Therefore, less power is consumed.

Low-PF equipment draws increased amounts of current compared to high-PF equipment for an equal amount of useful power. Distribution system losses increase with these high current draw loads and require larger conductors than other equipment. Power providers charge higher fees and penalties where low PF exists because of wasted energy and decreased generating capability. High-PF loads require less kVAR and permit the utility to have less demand on its generators. Subsequently, the additional generating margin allows for increased customer base and revenue.

Minimize harmonic distortion

In many areas, power providers are invoking power quality constraints and penalties for noncompliance when excessive harmonics and low PF occur. The threshold limits vary from region to region and also by utility needs for maintaining consistent generation performance, customer demand, operational cost, and maximized generation capacity.

Typically, enforced harmonic thresholds range from 5 percent to 10 percent, and PF enforcement/penalties occur below .85 or .9. As a result, the importance of drive selection versus utility threshold limits is becoming more of a consideration for a given application. Summit ESP's ACS-15 family of AFE drives offers many advantages over other VSD topologies with the best PF (.99 to unity).

Optimum performance (low harmonics) for 6-, 12-, 18-, and 24-pulse drives requires power entering the drive system impedances in the three phases to be balanced within limits not practical in typical oil production field environments. Harmonic mitigation performance of these topologies can be significantly reduced by very small changes in phase impedance. Drives with single or multiple converter bridges operate best at or near 100 percent loading. Production wells, especially in nonconventional areas, normally have initial operation at about 85 percent full load for a period of time followed by a production decline, causing pumps to operate at approximately 60 percent of full load design. Typically, the surface equipment is not optimized, and high harmonic levels attendant with low PF become the new normal operating condition.

Historical harmonic mitigation in an ESP VSD installation is to use a 6-pulse drive with a harmonic filter, a 12-pulse drive with a phase-shift transformer (auto-transformer), an 18-pulse drive with phase-shift transformer, and, in large kVA applications, a 24-pulse drive with a phase-shift transformer. As the number of pulses increases, the harmonic distortion decreases. However, there is little effect on PF, or on considerations for cost and footprint.

Our Summit ESP® ACS®-15 AFE drives use input rectifiers based on insulated-gate bipolar transistors (IGBTs). This active rectifier minimizes the amount of harmonic distortion that the VSD injects into the power grid by drawing nearly sinusoidal current. Standard 6-pulse rectifiers (SCR/diodes) used in most drives create harmful odd-numbered voltage and current harmonics (e.g., 5th, 7th, 9th, 11th, etc.) that can generate anywhere from 30 percent to 100 percent current distortion (THDi) and up to 30 percent voltage distortion (THDv). Active harmonic cancellation ensures that IEEE-519 harmonic levels are maintained throughout the normal VSD operating range. Input harmonic mitigation of 97 percent to 98 percent are typical of our AFE VSDs.

Input harmonics can greatly diminish quality of an electrical network and increase operating costs. Summit ESP's ACS-15 AFE drives can help maintain the quality of a "clean power" system, improve power quality of existing electrical networks, and help reduce OPEX. Critical applications demand higher-performance equipment. Our preeminent Summit ESP ACS-15 AFE drives give improved performance not only under ideal operating conditions but also under adverse field operating conditions typical of most oil production power networks.

Active harmonic cancellation is performed on each individual phase thousands of times per cycle, compensating for the harmonics spectrum generated by the nonlinear current of the drive. The drive's IGBT active front end virtually eliminates harmonics, irrespective of harmonic profile, system impedances, voltage variations, and drive loading when operated within normal operating conditions.

OPEX influenced by drive type and power factor

DRIVE TYPE	AUXILIARY EQUIPMENT NEEDED	PF UNDER NORMAL OPERATING CONDITIONS[1]
AFE	None	PF ~ 0.99 to 1.0 – Not Load Dependent
Multi-Pulse	Phase-Shift Transformer	Typically = 0.96 to -0.98
6-Pulse	Passive Input Filter[2]	PF ~ 0.65 to 0.96 – Can Be Load Dependent

[1]Power provider penalties typically begin at PF = .9
[2]Required for input harmonic reduction – not normal operation of drive

Ease of Operation

Summit ESP® ACS®-15 AFE VSDs offer user-friendly operation with many inherent features provided to customers without any additional charge. Intuitive high-contrast color touchscreens with quick-start menus, embedded help screens, and exclusive Tri-Tap® touchscreen technology provide effortless access to any desired item within the menu structure in three taps or fewer for easy drive reconfigurability or data acquisition. Our SummitView™ operator interface allows quicker access than mechanical key commands common in competitors' operator panels that require a centralized push of the key.

Proprietary AFE startup software ensures equipment startup without line sync complications or faults. Auto calculation of basic variables entered for your equipment provides:

- Expedited startup
- Protective operating parameters

Cold-weather startup software ensures VSD startup during temperatures down to -40°C (-40°F).

Other software routines reside in the operator panel for proportional–integral–derivative (PID) control, gassy wells, locked pumps (two modes available), and reservoir drawdown protection.

All Summit ESP ACS-15 AFE drives are "plug and play" for SCADA systems and downhole sensors. A mast-mounted 360° tower beacon is standard on all drives, and provides operational status from a distance. Additional drive input filters, phase-shift transformers, or standalone sine wave filters are not required.

Overview

Software features

Automated Startup of AFE/Main Drive
Prevents line sync and startup faults
BENEFIT: Faster equipment startup

Auto Calculations
Provides automatic population of inherent equipment protection variables based upon basic input parameters
BENEFITS: Faster startup time; greater revenue

Drawdown Mode
Protects reservoir from overproduction
BENEFIT: Prevents formation damage

Gas Lock Software
Provides ability to maintain gassy well production
BENEFITS: Less downtime; more revenue

Locked Pump Software
Provides controlled startup routines for the releasing or freeing of locked pump
BENEFIT: Less downtime; more revenue

Cold-Weather Software
Offers automated IGBT "warm-up" for easy startup at temperatures below -20°C (-5°F)
BENEFITS: Reliable equipment startup

Cost-saving features

Integrated Sine Wave Filter (SWF)
External SWF not required
BENEFITS: Fewer equipment costs; better reliability

No Phase Shift Transformers Required
Less space required
BENEFIT: Fewer equipment costs

No Passive Input Filters Required
Less space required
BENEFIT: Fewer equipment costs

SCADA Ready
Plug-and-play interfaces
BENEFIT: Easy remote asset monitoring integration

Operational feature

360° Mast-Mounted LED Beacon
Light Indicates drive status from a distance
BENEFIT: Requires less field time to check VSD status

Display features

Touchscreen Display
Quick parameter/information access
BENEFITS: No mechanical keys; more robust

Intuitive Operator Panel
Easy-to-understand descriptions in English
BENEFIT: Simple to use

Quick-Start Menus
Pre-defined start up template
BENEFIT: Faster startup time

Tri-Tap® Touchscreen Menu Access
Three taps to access desired function
BENEFIT: Fast movement or information access

Embedded Help Screens
Provides immediate access when assistance is needed
BENEFIT: Easy access to online assistance

Dedicated Input/Output (I/O) Screen
User-configured digital I/O and analog I/O programming, scaling, and alarms
BENEFIT: Easy reconfigurability

Multiple Analog/Digital I/O
User configuration assignments with scaling selectivity
BENEFIT: I/O configured to customers' specific needs

Downhole Sensor (DHS) Ready
Plug-and-play pre-defined DHS sensors
BENEFITS: Greater choice of DHS uses; faster startup

Dedicated DHS Screens
Easy status and data acquisition without menu scrolling
BENEFIT: Quick information access

Fault Data Log
Provides quick reference for fault history
BENEFIT: Easy historical analysis

SUMMIT ESP ACS®-15 VARIABLE SPEED DRIVES

PRIMARY DESIGN FEATURES	
Output KVA @ 3/60/480 VAC*	43–1,500 KVA
Input Voltage Rating, 3-Phase**	380–480 VAC
Output AC Volts Maximum	Input Voltage Base
Output Frequency (Hz) Range	0–90
Initial Output Current	200% for 2 seconds
Overload for 1 Minute	110%
SummitView™ Color Display with Tri-Tap® Screen	Standard
45–66 Hz Input Frequency	Standard
Oversize Enclosure with Sun Shield	Standard
VSD Enclosure with Heat Exhaust System	Standard
Enclosure Door Cam Locking Latches	Standard
Operator Access Door	Standard
High-Intensity LED Status Beacon	Standard
Enclosure Space Heater	Optional
Output Contractor	Optional
Bypass Motor Starter	Optional
UL, cUL Certifications	Optional
Maximum Motor Cable Length	15,000 Ft

* AFE drives available from 141 kVA to 1,500 kVA
** Other voltages and single-phase units available

STANDARD OPERATING CONDITIONS	
Operating Ambient Temperature*	0–40°C
Storage Temperature	Minus 40°C–60° C
Humidity (Max.) Non-Condensing	95%
Altitude (Max. Without Derate)	3,300 ft (1,000 m)
Line Voltage Variation	Plus 10% – Minus 15%
Line Frequency Variation	45–66 Hz
Efficiency	> 96%
Power Factor (Displacement)	0.98

* 0–50° C Operating Ambient Temperature Optional

STANDARD PROTECTION FEATURES

- Semi-Conductor Fuses
- AC Input Circuit Breaker
- Input Line Reactors – 3%
- Phase Rotation Insensitivity
- Electromagnetic Interference (EMI) Filter
- Input Phase Loss Protection
- Input Over-Voltage Protection
- Output Short Circuit Protection
- Output Ground Fault Protection
- Output Phase Protection
- Over-Temperature Protection
- Drive Under-Speed Protection
- Drive Overload Protection
- Motor Overload Protection
- Local/Remote Keypad
- SummitView Operator Interface with Tri-Tap Touchscreen Technology
- Multilevel Password Protection
- Keypad Lockout
- Fault Alarm Output
- Pulse-Width Modulated (PWM) Filter Monitor Technology

I/O FEATURES	
6 Each Digital Inputs – Programmable	120 VAC ± 10%
1 Each Digital Output – Run	Form C Relay 250 VAC or 30 VDC, 2 Amp Resistive
1 Each Digital Output – Programmable	Open Collector 48 VDA, 50 mA
2 Each Analog Inputs – Configurable	Voltage 0 – ±10 V, R > 200 kΩ
1 Each Analog Output – Programmable	0–20 mA, Impedance 500 Ω, Resolution 106 ± 3%
Additional Expandable I/O	Optional

INPUT/OUTPUT INTERFACES	
OPERATOR CONTROL FEATURES	
SummitView™ Color Display	Standard
Drive-Mounted Display	Standard
Conventional Control Elements	Standard
Serial Communications	Standard
115 VAC Control Circuit	Optional
SPEED SETTING INPUTS	
SummitView Color Display	Standard
PID Control for Downhole Sensor	Standard
2 Each 4–20 mA Isolated	Standard
3 Each 4–20 mA Isolated	Optional
4–20 mA Differential	Configurable
ANALOG OUTPUTS	
Speed/Frequency	Standard
0–20 mA / 4–20 mA	Standard
Isolated Signals	Optional
0–10 VDC Signals	Configurable
Torque/Load/Current	Programmable
Motor Voltage	Programmable
Kilowatts	Programmable
DISCRETE OUTPUTS	
Fault Alarm	Standard
Drive Running	Standard
Additional Discrete Outputs	Optional
Open Collector Outputs	1 Each
Drive at Set Speed	Programmable
Dry Contacts – 2 Each	Programmable, Relay Form C, NO/NC Contact
Dry Contacts – 3 Each	Run Relay: 1 Each Relay Form C, NO/NC Contact

SUMMIT ESP ACS®-15 VARIABLE SPEED DRIVES

COMMUNICATIONS FEATURES	
RS-232	Standard
ModBus RTU	Standard
RS-485	Optional

PERFORMANCE FEATURES	
Sinusoidal Wave Form (Filtered PWM)	Standard
Volts/Hertz Control	Standard
IR and Slip Compensation	Standard
Adjustable Acceleration/Deceleration	Standard
Current Torque Limit	Standard
Linear or S-Curve Acceleration/Deceleration	Standard
Coast to Stop	Standard
DC Injection Braking	Optional
PID Setpoint Controller	Programmable

For more information, contact your local Halliburton representative or visit us on the web at www.halliburton.com

Sales of Halliburton products and services will be in accord solely with the terms and conditions contained in the contract between Halliburton and the customer that is applicable to the sale.

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