Spellman®
High Voltage Electronics Corporation

Next Generation in Land-Based/Shipborne Power Feed Equipment

spellmanhv.com

Spellman is proud to offer the Next Generation in Power Feed Equipment

Downtime is costly, so high reliability in Telecom equipment is mandatory. High reliability in Spellman's Power Feed Equipment is achieved via a combination of redundancy, high derating, and increased clearance spacing of all critical HV components.

Background

A submarine cable system is fed power from Power Feed Equipment (PFE). The PFE supplies constant current tothe fiber optic repeaters. There are longstanding, historical requirements for PFE including; stable output (constant current), high reliability (even through an earthquake), safety, and high levels of control/diagnostics provided. In the years of "recovery" after 2002, there were other requirements added; low-cost, and less complexity (smaller footprint). Fast forward to 2006 where the first Spellman designed, Single-Bay complete PFE (Gen3) started shipping out to sites.

The Need for More

Spellman's Gen3 system is rated for 5kV, which limits the length of cable that can be powered. It is not suitable for longer cable runs (>2000km). Increasing needs for long cable runs drives the voltage requirement higher, and advancements in repeater design drive the current higher. The higher current for the repeaters then increases the PFE voltage requirement even further because this increases the cable losses (voltage drop). Based on those needs, the next generation of PFE, Gen4, was designed to provide higher voltage, higher current and higher power for long-haul systems.

Spellman®
High Voltage Electronics Corporation

Gen4 PFE

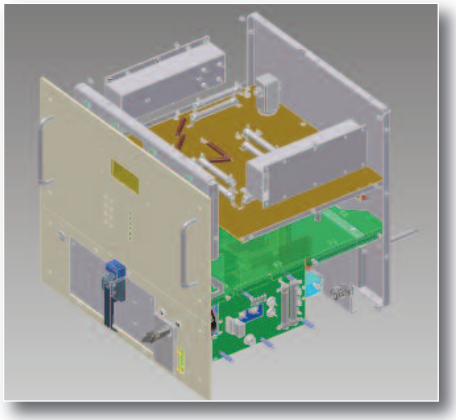
The Gen4 PFE has a nominal rating of 15kV, 1.5A. This is a substantial increase in voltage (3x), current (1.5x) and power (4.5x) as compared to Gen3. The Gen4 PFE is a 3-cabinet design.The 3 cabinets (from left to right) are as follows:

PFE Output/Control Bay

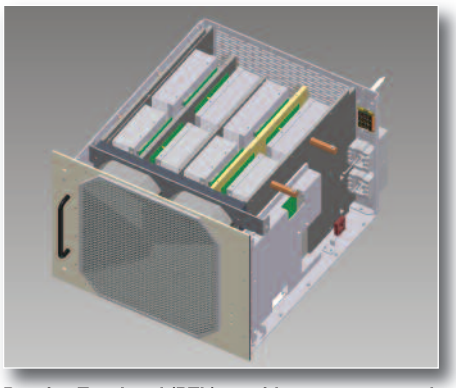
Contains the Local Control Unit (LCU) and Network Switch Unit (NSU) which work together to unify the Ethernet communications amongst all the internal elements of the PFE, as well as externally, to a Network Management System for remote diagnostics and monitoring. Also within this bay are the sophisticated PFE specific functions for output monitoring, protection, configuration, and polarity setting.

Converter Bay

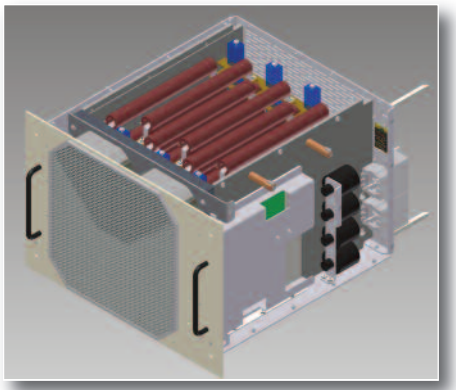
Contains 6 identical High Voltage Power Converters in an n+1 configuration. Only 5 Converters are needed for full voltage/current. If less than that is required, less converters are needed to satisfy the requirements.



Output Monitor Unit (OMU).
Part of PFE Output/Control Bay



Passive Test Load (PTL) provides course control



Active Test Load (ATL) provides fine control

Test Load Bay

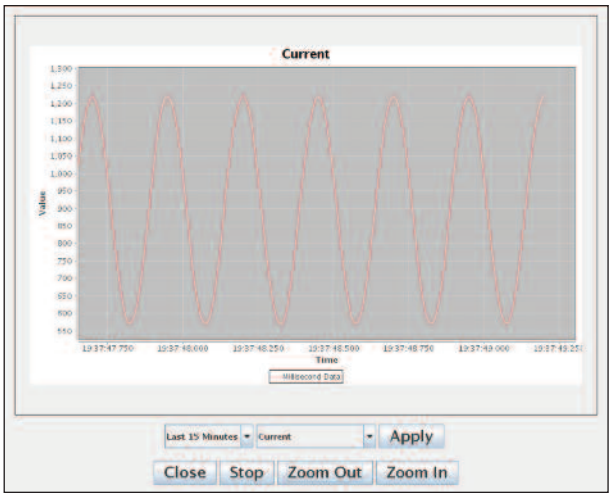
Contains a mixture of 1 Active Test Load (ATL) module and 4 Passive Test Load (PTL) modules. The ATL is a variable electronic load utilizing an array of MOSFET transistors operated in their active region. The PTL is comprised of fixed resistors, combined with high voltage relays. The ATL provides the fine control and the PTL provides the coarse control. These modules work together to provide a variable load capable of dissipating 22.5kW continuously. Similar to the Gen3 PFE, most of the Field Replaceable Units (FRU) within the PFE are blind-mating which allows quick replacement in case of failure.

Additional Features

During the design process, it is often the time to consider additional features based on customer requests in previous versions. Below are some features added during the Gen4 PFE design. These features are not available in the Gen3 PFE.

Data Acquisition

The Gen4 PFE is constantly recording critical parameters; PFE Voltage, PFE Current, Ocean Ground Voltage, Station Ground Current, every 10ms. The LCU integrated within the PFE has the ability to plot this data locally or it can be sent up stream (externally) to the Network Management system. The internal memory within the PFE allows a rolling queue of about 1 week of data.



LCU Data Acquisition Graphical Interface

Redundant Ocean Ground connections

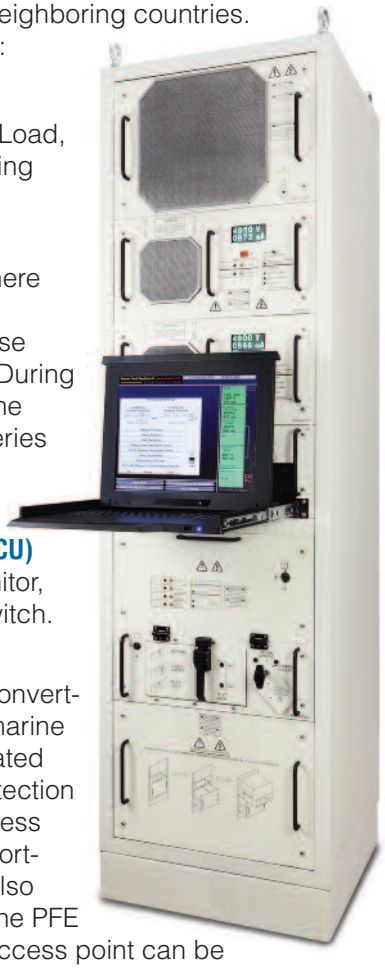
More and more customers are requesting this option. It allows redundancy in the critical connection to Ocean Ground (OG). The current is monitored in both OG connections. Normally, those currents should be equal. If they aren't, it likely indicates a connection issue on one of them, which alerts the user that service is required before it affects operation of the PFE.

Configurable for multiple voltage ranges

The Gen4 PFE has a maximum voltage of 15kV, but it can be configured (at the factory) for lower voltage, while keeping the same current rating (1.5A). Options of 6kV, 9kV, 12kV, in addition to 15kV are available. This is accommodated simply by installing less Converter and Passive Test Load (PTL) modules (1 converter and 1 PTL less for each 3kV reduction). The system always contains 3 cabinets. Covering from 6-15kV, it picks up nicely from where the Gen3 PFE leaves off (at 5kV).

Gen3 PFE

The Gen3 PFE was designed to accommodate shorter cable runs at a lower price, while still achieving high levels of safety, diagnostics, reliability and availability. To date, over 90 Gen3 PFE systems are in service, providing reliable power to fiber optic repeaters all over the globe. The Gen3 PFE has nominal ratings of 5kV and 1A. This is adequate for +1000km cable installations and many times is used to power cables that hop across several landing sites across the shores of neighboring countries. Starting at the top, we have:



Test Load

Variable Electronic Load, capable of dissipating 5kW continuously.

Converters (2)

2n configuration,where each converter can run at 5kV, 1A in case the other one fails. During normal operation, the converters are in series and share the total PFE voltage.

Local Control Unit (LCU)

PC, Keyboard, Monitor, Mouse, Ethernet switch.

PFE Output Module

The output of the Converters power the submarine cable via sophisticated monitoring and protection devices. Cable access and termination (shorting or opening) is also being provided at the PFE output point. This access point can be used to insert other ancillary cable testing devices into the cable path. Due to the dangers of High Voltage being present, significant safety features need to be incorporated at this point, and through out the PFE.

Gen3 to Gen4 Comparison

	Gen3	Gen4
# of cabinets	1	3
Converter Redundancy	2n	n +1
Voltage	5kV	15kV
Current	1.0A	1.5A
Power	5kW	22.5kW
Data Acquisition	No	Yes

PFE for Cable Laying Ships

In addition to advancements in landbased PFE, there also have been some advances in ship-based PFE. The cable laying by ships is a costly and time consuming process in the deployment of a new or repaired cable and as such it is important that the ship's cable engineers know that the cable they are laying is operating correctly. This could be powered from the land base PFE at the landing station, but this would be a very hazardous for the crew on the ship for the repair as the control of when the HV is ON or OFF is not on the ship where the cable engineers and handlers could be exposed to the HV on the cable being deployed.

Ship board PFE is used to power the cable during these operations whilst keeping the control of the HV at the ship so the safety of the crew can be maintained. Because cable laying ships can work on many difference cables the Ship Board PFE is typically capable of around 12kV at around 2A.

These shipboard PFE systems are functionally very similar to standard land based PFE, only with reduced functionality and requirements, (and a substantially lower price).

Part of the similarity is the control for powering the cable up and down. Because the cable is an enormous inductor and capacitor it needs to have the current changes controlled very slowly so as not to cause any transients or oscillations that could damage the repeaters.

System Management Terminal

The Ship Board PFE has a new System Management Terminal (SMT) that allows the parameters needed to be set and the alarms and ramp rates for powering up and down to be controlled safely. The SMT replaces the original System Control Unit (SCU) which is now obsolete.

The Ship Board PFE can operate from the AC supplied from ship generators, and generally can use more "Off the Shelf" High Voltage power supply units. (No need to carry all those batteries on board and hopefully no seismic events while out at sea). But reliability is still paramount for the shipboard PFE, as a PFE failure out at sea would stop cable deployment until help arrives.

Conclusion

Highly advanced PFE solutions have been designed and deployed and have proved to meet and even exceed customer requirements and expectations. With the Gen3 and Gen4 PFE systems, most, if not all, land-based needs are met for powering Subsea Fiber Optic communications around the globe. Future advancements and solutions are in the works, which have the possibility of providing significantly smaller systems with higher voltage capabilities, as well as low-cost, lower-voltage units (e.g. for branching power requirements).

The Authors

Paul Treglia

Director of Product Development
Spellman High Voltage Electronics Corporation

Clive McNamara

UK Regional Sales Manager
Spellman High Voltage Electronics, Ltd.

Reprinted with the permission of Submarine Telecom Forum;
this updated article originally appeared in STF #73 November 2013.

Spellman®
High Voltage Electronics Corporation

Spellman USA and Corporate HQ
475 Wireless Blvd.
Hauppauge, NY 11788
United States
tel: +1-631-630-3000
fax: +1-631-435-1620
email: sales@spellmanhv.com

Spellman Valhalla NY USA
One Commerce Park
Valhalla, NY 10595
United States
tel: +1-914-686-3600
fax: +1-914-686-5424

Spellman UK
Broomers Hill Park #14, Broomers Hill
Pulborough, West Sussex,
United Kingdom RH20 2RY
tel: +44 (0) 1798 877000
fax: +44 (0) 1798 872479

Spellman Japan
4-3-1 Kamitoda,
Toda-shi, Saitama-ken,
Japan 335-0022
tel: +81 (0) 48-447-6535
fax: +81 (0) 48-445-7280

Spellman China
Spellman High Voltage Electronics (SIP) Co Ltd.
Block D, No.16 SuTong Road,
Suzhou Industrial Park 215021 China
tel: +(86)-512-69006010
fax: +(86)-512-67630030

Spellman High Voltage Korea Co.,Ltd.
#B-720, BRC Smart Valley,
Song Do Mirae-ro 30,
Yeonsu-Gu, Incheon, Korea 406-081
tel: +82-32-719-2300
fax: +82-32-720-4300

Spellman de Mexico – Plant 2
Avenida Pedregal # 2 Esquina
Avenida Chapultepec
Parque Industrial FINSA Oriente
Matamoros, Tamps., Mexico 87340
tel. +52 868 150-1200

Spellman de Mexico – Plant 3
Avenida Chapultepec # 101 Esquina
Avenida Horizonte
Parque Industrial FINSA Oriente
Matamoros, Tamps., Mexico 87340
tel. +52 868 150-1200

Spellman High Voltage GmbH
Josef-Baumann-Straße 23
44805 Bochum
Germany
tel: +49 (0) 234 87906-0
fax: +49 (0) 234 87906-11

Spellman®
High Voltage Electronics Corporation

spellmanhv.com