RigPower, LLC

Creating New Industry Standards

- 2000 Volt Rated
- IP-68 Ingress Protection
- Continuous 360 degree shielding

RigPower, LLC's mission is to create new industry standards in industrial electrical connectors by combining appropriate technological advances, quality production methods and dependable customer support.

Background

Previous onshore drilling rig designs used DC motors and control systems, mostly derived from 1940-1950 era technology originally developed for diesel-electric locomotives. While these systems have proven to be reliable, many operators desire the benefits available only with Variable Frequency Drive (VFDs) systems. As these drive systems are rapidly being applied to land based drilling rigs, the unique needs of a VFD equipped mobile land rig cannot be met with standard connectors.

Variable Frequency Drives require special considerations for the proper installation and operation of the drive system as well as the proper operation of nearby or adjacent systems. The VFD-1® is the only connector both designed for the unique requirements of single conductor shielded VFD cables and rugged enough to survive in the harsh conditions of the drilling industry.

VFD Cable

Land rig VFD installations require the use of shielded single conductor cable rather than the shielded three conductor cable normally sold for VFD applications. The use of single conductor cable allows for two major advantages:

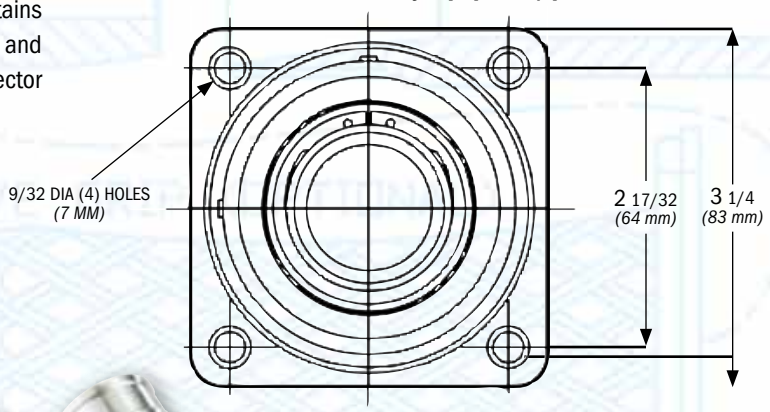
- The first advantage is the ease of manually installing and removing the cable. Each single conductor cable will obviously be lighter than a three conductor cable and, when handled individually, will be much easier to install and remove.
- The second advantage of using single conductor cables is that they only require single pole connectors. No, this isn't trivial. The VFD-1® is commercially available, rated for 1135 amps at 2000 volts, maintains the integrity of the cable shield, is field repairable, and is safe and reliable to connect in the field. There is NO three pole connector available for shielded VFD cable.

Any multi-pole connector developed for shielded high power systems will have several intrinsic weaknesses as compared to the VFD-1® single pole connector.

- **SIZE –** The space necessary inside a conductor for three separate power connections, plus ground connections, makes for an extremely large connector. The VFD-1® connector, even with 777 cable, fits into a standard size 24 shell.
- **SAFETY –** Should a three conductor connector be accidentally disconnected under load, there will be severe phase to phase arcing. Unfortunately the arc path will have enough resistance that the breaker may not rapidly recognize the fault and current will continue to flow for several seconds, producing a spectacular fireball.
- **EMI PROTECTION –** A multi-conductor cable has only one braid shield enclosing all three phase leads and the ground(s). Often connections are made by breaking out short sections of the individual phase leads. These short segments of unshielded cable serve as almost perfect antennas for the EM noise inherent in the waveforms produced by VFD systems.

RigPower has solved these problems with the VFD-1® Series:

- **Service Ratings: 1135 Amps, 2000 Volts**
- **Small #24 Shell Size Footprint**
- **Contact Technology provides self-adjusting (Multilam) contact force for resistance to the severe load variations and vibration encountered in drilling service**
- **The conductivity of the cable shield braid is carried completely through the connector to ensure uninterrupted 360 degree protection of EMI radiation**
- **IP68 Level ingress protection to prevent moisture intrusion into cable system**
- **Cable-Receptacle mating pairs**
- **Available in nine colors for easy equipment/phase identification**



VFD-1® Female Receptacle

VFD-1® Male Receptacle

Description and Design Features

All electrical carrying components on the VFD-1® series are made from Sn plated high conductivity copper. The receptacle lugs and plug contacts are designed to use the standard Hex crimp seen on all RigPower, LLC products. This standard crimp design provides a more robust and durable crimp and standardizes on the tools needed. One set of four hex die sizes will accommodate all RigPower contacts from 4/0 to 777 MCM cables.

VFD-1® 90°/45° Female Receptacle Internal

All electrical carrying components on the VFD-1® series are made from Sn plated high conductivity copper. The receptacle lugs and plug contacts are designed to use the standard Hex crimp seen on all RigPower, LLC products. This standard crimp design provides a more robust and durable crimp and standardizes on the tools needed. One set of four hex die sizes will accommodate all RigPower contacts from 4/0 to 777 MCM cables.

Each insulator has an O-Ring Seal designed into the body which offers improved mounting between the insulator and receptacle shell. Additionally, the O-Ring provides a water tight seal so that the component won't have the propensity to short or burn out, even when the cap is not installed.

90°/45° Stainless Steel Alignment Screw provides a secure attachment to the receptacle contact by way of a stainless steel Helicoil.

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The Female connectors come with a Multilam Louver Strip and the RigPower patented (U.S. Patent No. 7442,096) Dead Front Delrin® Ring which provides increased safety by helping to prevent accidental contact.

VFD-1® Flexible Electromagnetic Shield

VFD-1® Flexible Rubber Insulators

The Flexible Rubber Insulation and the Flexible Electromagnetic Shield connect to the back end of the receptacle shell after installation. Once installed the ground contact band provides current carrying capability for EMI shielding.

Bal Seal Canted Coil Springs® are versatile electrical springs that offer improved contact performance and can provide longer service life in demanding environments. The small coil size and the number of independent coils make the springs suitable for a wide variety of electrical connector designs, with maximum contact points for optimal current-carrying capability in electrical and/or EMI shielding uses.

VFD-1® 90°/45° Male Receptacle Internal

All electrical carrying components on the VFD-1® series are made from Sn plated high conductivity copper. The receptacle lugs and plug contacts are designed to use the standard Hex crimp seen on all RigPower, LLC products. This standard crimp design provides a more robust and durable crimp and standardizes on the tools needed. One set of four hex die sizes will accommodate all RigPower contacts from 4/0 to 777 MCM cables.

The dead front tip design is on both male and female contacts which increases personnel safety.

90°/45° Stainless Steel Alignment Screw provides a secure attachment to the receptacle contact by way of a stainless steel Helicoil.

Each insulator has an O-Ring Seal designed into the body which offers improved mounting between the insulator and receptacle shell. Additionally, the O-Ring provides a water tight seal so that the component won't have the propensity to short or burn out, even when the cap is not installed.

VFD-1® Male Receptacle

Patent Pending self-aligning 90/45 degree style lug reduces cable bend radius and saves valuable space behind panel wall.

Self-aligning lugs standard in 4/0, 313, 444, 535, 646 and 777 cable sizes. Metric sizes available on special order.

Male Receptacle Insulator is designed to insert into the female plug providing a double insulator layer thus allowing for increased voltage

Large robust safety cap allows easy operation by personnel wearing work gloves.

Quick acting double lead ACME threads for rapid yet secure connections.

Dead front tip design on both male and female contacts increases personnel safety.

Bal Seal Canted Coil Springs® are versatile electrical springs that offer improved contact performance, and can provide longer service life in demanding environments. The small coil size and the number of independent coils make the springs suitable for a wide variety of electrical connector designs, with maximum contact points for optimal current-carrying capability in electrical and/or EMI shielding uses.

VFD-1® Female Receptacle

Neoprene gasket is provided.

Large robust safety cap allows easy operation by personnel wearing work gloves.

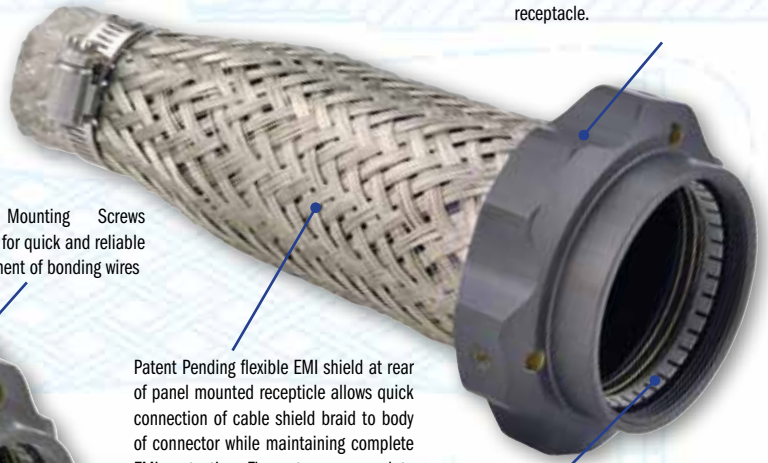
The dead front tip design is on both male and female contacts which increases personnel safety.

The VFD-1® series female receptacles are available with the Multilam Contact System. The Multilam Louver Strip allows electrical contact to be made via a large number of defined, current carrying contact points.

- High resistance to heat
- High electrical and thermal conductivity
- Sufficiently high contact forces
- High number of contact cycles
- Excellent resistance to corrosion
- Resistance to vibration
- Long product life

Female Receptacle Insulator is designed to overlap the insulator of the male plug providing a double insulator layer thus allowing for increased voltage

VFD-1® Flexible Electromagnetic Shield



Large robust Gland Nut provides for an easy and safe connection to the receptacle.

Patent Pending flexible EMI shield at rear of panel mounted recepticle allows quick connection of cable shield braid to body of connector while maintaining complete EMI protection. Flexes to accommodate 45 degree style lug.

VFD-1® Flexible Rubber Insulator

Large robust Gland Nut provides for an easy and safe connection to the receptacle.

Rear Mounting Screws provide for quick and reliable attachment of bonding wires

Patent Pending flexible rubber boot for using non-shielded cable inside enclosure. Flexes to accommodate 45 degree design lug.

Ground Contact System provides the required grounding connection to/from the receptacle housing

VFD-1® Description and Design Benefits

Braid Shield Trap

Cable Shield is trapped between the cone-shaped rim of the Insulator and the EMI Braid Shield.

VFD-1® Male Contact w/Braid Shield Trap

Patent Pending EMI Braid/Shield trap allows quick connection on cable shield braid to body of connector while maintaining complete EMI protection.

Both the Male and Female contacts have an O-Ring Seal designed into the body which provides a water tight seal with the plug insulator so that the component won't have the propensity to short or burn out, even when the cap is not installed.

Braid Shield Trap Insulator

The dead front tip design is on both male and female contacts which increases personnel safety.

Male contacts standard in 4/0, 313, 444, 535, 646 and 777 cable sizes.

VFD-1® Female Contact w/Braid Shield Trap

Braid Shield Trap Insulator

Female contacts standard in 4/0, 313, 444, 535, 646 and 777 cable sizes.

Patent Pending EMI Braid/Shield trap allows quick connection on cable shield braid to body of connector while maintaining complete EMI protection.

The patented (U.S. Patent No. 7442,096) Dead Front Delrin® Ring provides increased safety by helping to prevent accidental contact.

VFD-1® Female Plug Shell Insulator

Bal Seal Canted Coil Springs® mates to the Conductive Ring located on outside of the male and female plug insulator. This contact point allows the electromagnetic current to pass from/to the VFD-1® plug and receptacle uninterrupted.

Male and Female Plug Shell Insulator overlaps the Braid Shield Trap Insulator to create a double insulated environment which allows for increased voltage

Each plug shell insulator has an O-Ring Seal designed into the body which offers improved mounting between the insulator and shell body. Additionally, the O-Ring provides a water tight seal so that the component won't have the propensity to short or burn out, even when the cap is not installed.

VFD-1® Female Plug w/Cable Clamp—Black

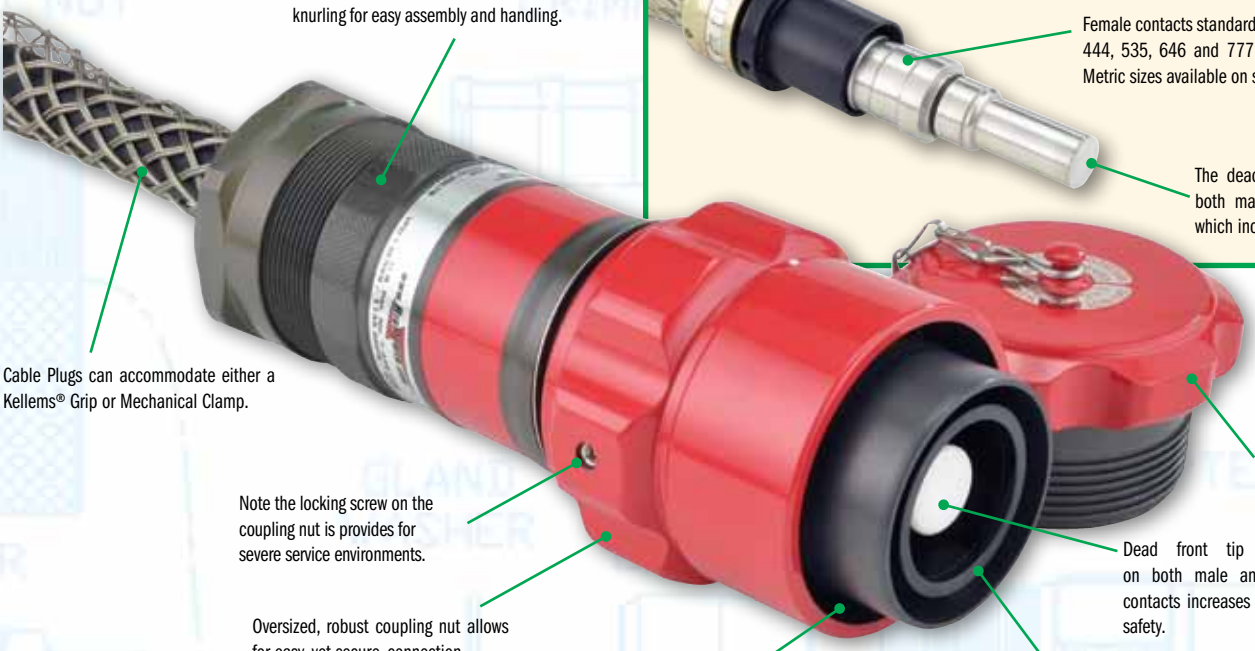
VFD-1® Male Plug w/Kellems Grip—Red

INDUSTRY EXCLUSIVE

All RigPower, LLC Contacts have a Double Crimp Style base that is longer than other manufacturers, which provides a more complete and secure connection between the cable and contact.

- Termination method is double crimp style for cable mounted plug and receptacles
- Crimping locators are designed into the base for ease of installation
- Made from Sn plated high conductivity copper
- Uses the same crimping die sets as the RigPower, LLC "RMP®II, Secure Mount®, Safe Stab®, MCC-1, HP20 and MC20" series connectors

VFD-1® Male Plug w/Kellems® Grip



INDUSTRY EXCLUSIVE
Cable Adapter – Robust grip with knurling for easy assembly and handling.

Cable Plugs can accommodate either a Kellems® Grip or Mechanical Clamp.

Note the locking screw on the coupling nut is provides for severe service environments.

Oversized, robust coupling nut allows for easy, yet secure, connection.

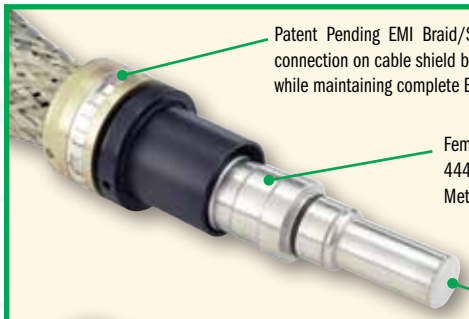
Quick acting double lead ACME threads are machined inside each coupling nut for rapid yet secure connections.

Large robust safety cap allows easy installation by personnel wearing work gloves.

Dead front tip designed on both male and female contacts increases personnel safety.

The Male Insulator is designed to insert into the female plug providing a double insulator layer thus allowing for increased voltage

VFD-1® Male Contact w/Braid Shield Tap



Patent Pending EMI Braid/Shield Trap allows quick connection on cable shield braid to body of connector while maintaining complete EMI protection.

Female contacts standard in 4/0, 313, 444, 535, 646 and 777 cable sizes. Metric sizes available on special order.

The dead front tip design is on both male and female contacts which increases personnel safety.

VFD-1® Female Plug w/Mechanical Clamp

Cable Plugs can accommodate either a Mechanical Clamp or Kellems® Grip.

Oversized, robust coupling nut allows for easy, yet secure, connection.

INDUSTRY EXCLUSIVE
Cable Adapter – Robust grip with knurling for easy assembly and handling.

Note the locking screw on the coupling nut provides for severe service environments.

Quick acting double lead ACME threads are machined inside each coupling nut for rapid yet secure connections.

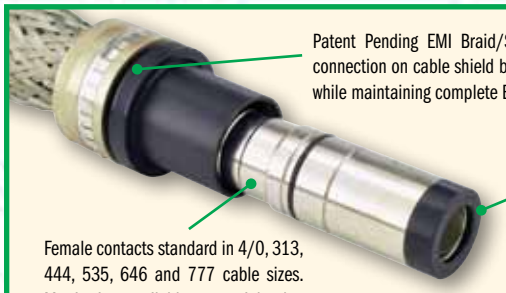
The Female Insulator is designed to overlap the insulator of the male plug providing a double insulator layer thus allowing for increased voltage

Large robust safety cap allows easy installation by personnel wearing work gloves.

The VFD-1® series female receptacles are available with the Multilam Contact System. The Multilam Louver Strip allows electrical contact to be made via a large number of defined, current carrying contact points.

- High resistance to heat
- Sufficiently high contact forces
- High number of contact cycles
- Excellent resistance to corrosion
- Resistance to vibration
- Long product life
- High electrical and thermal conductivity

VFD-1® Female Contact w/Braid Shield Tap



Patent Pending EMI Braid/Shield Trap allows quick connection on cable shield braid to body of connector while maintaining complete EMI protection.

Female contacts standard in 4/0, 313, 444, 535, 646 and 777 cable sizes. Metric sizes available on special order.

The patented (U.S. Patent No. 7442,096) Dead Front Delrin® Ring provides increased safety by helping to prevent accidental contact.

Ordering Table for VFD-1® Connectors and Spare Parts (Rated for 2000 Volts / 1135 Amps)		
VFD-1® Panel Mount Receptacles Ordering Format: VFD1-(1)-(2)-(3)		
(1) Receptacle Gender & Rear Insulator Style	**(2) 45° Cable Lug Select Size**	**(3) Color**
MALE Receptacles	4/0L = 4/0 MCM	BK = Black
	3L = 313 MCM	BL = Blue
M1 = Male Bar w/45° Lug and Rear Flexible Braided Shield	4L = 444 MCM	BR = Brown
M2 = Male Bar w/45° Lug and Rear Flexible Shield	5L = 535 MCM	GY = Gray
	6L = 646 MCM	OR = Orange
FEMALE Receptacles	7L = 777 MCM	P = Purple
		R = Red
F1 = Female Bar w/45° Lug and Rear Flexible Braided Shield		W = White
F2 = Female Bar w/45° Lug and Rear Flexible Insulator		Y = Yellow

VFD-1® Male or Female Plugs Ordering Format: FD1-(1)-(2)-(3)-(4)			
(1) Contact Size & Gender	**(3) Cable OD for Grommet**	**(2) Style of Cable Retention**	**(4) Color**
Female	14 = 0.750 - 0.875	M = Mechanical Clamp	BK = Black
4/0F = 4/0 Female Contact	16 = 0.870 - 1.000		BL = Blue
3F = 313 Female Contact	18 = 1.000 - 1.125	OR	BR = Brown
4F = 444 Female Contact	20 = 1.125 - 1.250		GY = Gray
5F = 535 Female Contact	22 = 1.250 - 1.375	K16 = #16 (0.875 - 1.000)	OR = Orange
6F = 646 Female Contact	24 = 1.375 - 1.500	K20 = #20 (1.000 - 1.250)	P = Purple
7F = 777 Female Contact	26 = 1.500 - 1.625	K24 = #24 (1.250 - 1.500)	R = Red
Male	28 = 1.625 - 1.750	K28 = #28 (1.500 - 1.750)	W = White
4/0M = 4/0 Male Contact	30 = 1.750 - 1.875	K30 = #30 (1.750 - 1.875)	Y = Yellow
3M = 313 Male Contact	32 = 1.875 - 2.000	K32 = #32 (1.875 - 2.125)	
4M = 444 Male Contact	34 = 2.000 - 2.125	K36 = #36 (2.125 - 2.273)	
5M = 535 Male Contact	36 = 2.125 - 2.250	K39 = #39 (2.273 - 2.437)	
6M = 646 Male Contact	38 = 2.250 - 2.373		
7M = 777 Male Contact	39 = 2.375 - 2.437		

VFD-1® Spare Part Descriptions and Part Numbers

VFD-1® Plugs Contacts and Retention Clips		VFD-1® Plugs & In-Line Receptacle Spare Parts	
Part Number	**Part Description**	**Part Number**	**Part Description**
	Female	G14	Grommet 14 (0.750 - 0.875)
VFD1-4/0F	4/0 Female Contact	G16	Grommet 16 (0.870 - 1.000)
VFD1-3F	313 Female Contact	G18	Grommet 18 (1.000 - 1.125)
VFD1-4F	444 Female Contact	G20	Grommet 20 (1.125 - 1.250)
VFD1-5F	535 Female Contact	G22	Grommet 22 (1.250 - 1.375)
VFD1-6F	646 Female Contact	G24	Grommet 24 (1.375 - 1.500)
VFD1-7F	777 Female Contact	G26	Grommet 26 (1.500 - 1.625)
FRC	Female Retaining Ring	G28	Grommet 28 (1.625 - 1.750)
FRCW	Female Retaining Ring Washer	G30	Grommet 30 (1.750 - 1.875)
	Male	G32	Grommet 30 (1.875 - 2.000)
VFD1-4/0M	4/0 Male Contact	G34	Grommet 34 (2.000 - 2.125)
VFD1-3M	313 Male Contact	G36	Grommet 36 (2.125 - 2.250)
VFD1-4M	444 Male Contact	G38	Grommet 38 (2.250 - 2.273)
VFD1-5M	535 Male Contact	G39	Grommet 39 (2.273 - 2.437)
VFD1-6M	646 Male Contact	GW16	Grommet Washer 16 (0.870 - 1.125)
VFD1-7M	777 Male Contact	GW20	Grommet Washer 20 (1.125 - 1.375)
MRC	Male Retaining Ring	GW24	Grommet Washer 24 (1.375 - 1.625)
MRCW	Male Retaining Ring Washer	GW28	Grommet Washer 28 (1.625 - 1.875)
VFD Panel Mount Receptacle Spare Parts		GW32	Grommet Washer 32 (1.875 - 2.125)
		GW36	Grommet Washer 32 (2.125 - 2.273)
Part Number	**Part Description**	GW39	Grommet Washer 39 (2.273 - 2.437)
VFD1-4/0L	4/0 - 45° Cable Lug	KG16	Kellems Grip 16 (0.875 - 1.000)
VFD1-3L	313 - 45° Cable Lug	KG20	Kellems Grip 20 (1.000 - 1.250)
VFD1-4L	444 - 45° Cable Lug	KG24	Kellems Grp 24 (1.250 - 1.500)
VFD1-5L	535 - 45° Cable Lug	KG28	Kellems Grip 28 (1.500 - 1.750)
VFD1-6L	646 - 45° Cable Lug	KG32	Kellems Grip 32 (1.750 - 2.000)
VFD1-7L	777 - 45° Cable Lug	KG36	Kellems Grip 36 (2.000 - 2.250)
VFD1-RI	VFD Receptacle Flexable Insulator	KG39	Kellems Grip 39 (2.250 - 2.437)
VFD1-RS	VFD Receptacle Flexable Braided Shield	KN24	Kellems Grip Nut #24
VFD1-RC-XX	VFD Receptacle Cap w/Chain	MC24	Mechanical Clamp #24
HC	Hose Clamp	VFD1-MPI	VFD1 Male Plug Insulator
Additional VFD Support Items		VD1-FPI	VFD1 Female Plug Insulator
		VFD1-BT	VFD1 Braid Trap
VFD1-FT	Female Plug Assembly Tool Set (3 piece)	VFD1-PC-XX	VFD1 Plug Cap w/Chain
VFD1-MT	Male Plug Assembly Tool Set (2 piece)	VFD1-CA-XX	VFD1 Cable Adapter
		VFD1-CN-XX	VFD1 Coupling Nut

VFD-1® Female Assembly Tool

- Complete Three Piece Set
- Allows quick and easy installation of both front and rear retaining rings.
- Made of 316 Stainless Steel for Durability
- Allows field repair of VFD cables

VFD-1® Male Assembly Tool

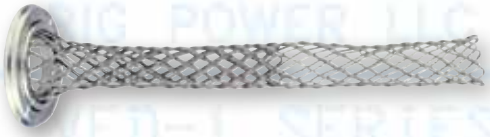
- Complete Two Piece Set
- Allows quick and easy installation of retaining rings.
- Made of 316 Stainless Steel for Durability
- Allows field repair of VFD cables

Mechanical Clamp

Has a dual holding pattern. One size for larger cables, reverse it and it accommodates smaller cables more effectively.

Kellems® Grip

Provides extra protection from high tensile loads on cables.



*Kellems®, is a Registered Trademark of Hubbell Inc.

The VFD-1® Series:

- 2000 Volt Rated
- IP-68 Ingress Protection
- Continuous 360 degree shielding

Single Pole High-Amperage Connectors for Use with VFD systems on Land-Based and Off-Shore Oil Drilling Rigs and Other High-Amperage Power Generation Applications

For Use With Single Conductor Cables 4/0 MCM to 777 MCM

If You Want The Very Best Single Pole Electrical Connectors

Demand Genuine RigPower, LLC Electrical Parts

Look for these other fine products from RigPower, LLC:

RMP® II Series, Secure Mount® Series, Safe Stab®, Quick Stab®, Quad Stab Series, MCC-1 Series, HP20 Series, MC20 Series and **The Phase-Lock® Sequential Locking System**

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10345 South Perdue Avenue
Baton Rouge, Louisiana 70814 USA
phone: (225) 272-8800
fax: (225) 272-8830
www.rigpower.com