RFS' HYBRIFLEX[®] Remote Radio Head (RRH) hybrid feeder cabling solution combines optical fiber and DC power for RRHs in a single lightweight aluminum corrugated cable, making it the world's most innovative solution for RRH deployments. It was developed to reduce installation complexity and costs at Cellular sites. HYBRIFLEX[®] allows mobile operators deploying RRH architecture to standardize the RRH installation process. HYBRIFLEX[®] combines optical fiber (multi-mode or single-mode) and DC power wire in a single corrugated cable and can connect multiple RRHs with a single feeder.

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HYBRIFLEX[®] cables are manufactured, pre-terminated, with various types of termination and are cut to specific lengths. The aluminium outer conductor facilitates easy transportation (because it is lightweight) and handling. Moreover this cable is easier to bend than other optic / power solutions using a steel outer conductor.



Click or scan to learn more about RFS HYBRIFLEX®



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3

RFS RADIO FREQUENCY SYSTEMS The Clear Choice®

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Non-OVP HYBRIFLEX® feeder assembly (using ODC (top) & LC (bottom) connectors)

4



HYBRIFLEX[®] trunk cable assemblies are factory constructed specifically to suit modern RRH networks, ensuring perfect compatibility and trouble-free installation. Additional features that ease installation and ensure durability service include:

- Robust breakout design with coloring fibers and power conductors
- Stranded construction for easy bending and maximum fiber protection
- Orrugated aluminum shield protects from crush and animal damage
- Integrated rip cords for length management
- Factory test certificate included with every cable assembly
- Robust ODC connector with solid protective caps
- Water-proofing seal for DC wire end caps

Model Structure

HB	078/114/158	05/13/21/33	U	6	S or M	12	XX	КІТ
Hybrid	Over jacket Diameter	10, 6, 4 and 2	unshielded	6 pairs DC	Single or	12	Assembly	Include
	7/8", 1-1/4", 1-5/8"	gauge		conductor	Multi-mode	pairs	Length (in	Grounding kit and
					(only single)	of	meters)	Hoist grip
						fiber		



Non-OVP HYBRIFLEX® Generation 2 Design Enhancements

Customers have requested several product enhancements to the **HYBRIFLEX**[®] trunk cable designs. This was due to recent attacks from animals that would permanently damage the fiber optic break-outs at the top of the assembly, and to shielding power wires to additional transient voltages from lightning strikes. RFS was able to accommodate these requests by Engineering new features into the existing models:

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Shielded power cables

- Solution Each power conductor pair is wrapped with a tinned copper braid, layered with protective jackets
- Braid can be "pony-tailed" to a common ground for additional EMI protection
- Round profile allows water-tight seal to power connector



Fully-armored fiber optic cable breakouts

- Helically-wrapped stainless steel prevents crushing, animal bite damage and over-bending
- Armor is layered inside larger corrugation junctions to provide 100% mechanical coverage





6x12 HYBRIFLEX® configurations

Cable type	HB078-05U6S12-	HB114-13U6S12-	HB158-21U6S12-	
Cable brand	HYBRIFLEX®	HYBRIFLEX®	HYBRIFLEX®	
Conductor gauge	10 AWG	6 AWG	4 AWG	
Number of conductor	6 pairs, shielded	6 pairs, shielded	6 pairs, shielded	
Number of fibers	12 pairs, armored	12 pairs, armored	12 pairs, armored	
Hybrid armor type	Corrugated aluminum	Corrugated aluminum	Corrugated aluminum	
Hybrid fiber mode	single	single	single	
Hybrid termination	Top: ODC	Top: ODC	Top: ODC	
	Bottom: LC	Bottom: LC	Bottom: LC	
Hybrid weight (kg/m (lb/ft))	1.39 0.93	2.24 1.51	2.8 2	
Max over jacket diameter	28.6mm 1.13"	39mm 1.54"	51mm 2″	
Breakout fiber length, top	0.5m 20″	0.5m 20″	0.5m 20″	
Breakout fiber length, bottom	1350mm 53"	1350mm 53"	1350mm 53"	
Breakout power length, top	4m 157"	4m 157"	4m 157"	
Breakout power length, bottom	150mm 6"	150mm 6"	150mm 6"	
Hybrid minimum bend radius	125mm 5"	152mm 6"	250mm 10"	

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9x18 HYBRIFLEX® configurations

Cable type	HB114-05U9S18-	
Cable brand	HYBRIFLEX®	
Conductor gauge	10 AWG	
Number of conductor	9 pairs, shielded	
Number of fibers	18 pairs, armored	
Hybrid armor type	Corrugated aluminum	
Hybrid fiber mode	single	
Hybrid termination	Top: ODC	
	Bottom: LC	
Hybrid weight (kg/m (lb/ft))	2.24 1.51	
Max over jacket diameter	39mm 1.54"	
Breakout fiber length, top	0.5m 20″	
Breakout fiber length, bottom	1350mm 53″	
Breakout power length, top	4m 157″	
Breakout power length, bottom	150mm 6"	
Hybrid minimum bend radius	152mm 6"	





3x6 HYBRIFLEX® configurations

Cable type	HB078-13U3S6-	HB114-21U3S6-
Cable brand	HYBRIFLEX®	HYBRIFLEX®
Conductor gauge	6 AWG	4 AWG
Number of conductor	3 pairs, shielded	3 pairs, shielded
Number of fibers	6 pairs, armored	6 pairs, armored
Hybrid armor type	Corrugated Aluminum	Corrugated aluminum
Hybrid fiber mode	single	single
Hybrid termination	Top: ODC	Top: ODC
	Bottom: LC	Bottom: LC
Hybrid weight (kg/m (lb/ft))	1.03 0.7	2.24 1.51
Max over jacket diameter	28.6mm 1.13"	39mm 1.54"
Breakout fiber length, top	0.5m 20″	0.5m 20"
Breakout fiber length, bottom	1350mm 53″	1350mm 53"
Breakout power length, top	4m 157"	4m 157"
Breakout power length, bottom	150mm 6"	150mm 6"
Hybrid minimum bend radius	125mm 5"	152mm 6"

8



LC termination ODC termination



HYBRIFLEX® tower accessories and installation tools

Although RFS suggests that hangers and hoisting grips be part of the hybrid kits, which includes the main trunk assembly, RFS can offer these items to be ordered separately if need be.

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Caution! Only use approved accessories and tools. Also note: RFS HYBRIFLEX[®] does not require the use of grommets.

Note: Hangers are sold in kits of 10 with hardware included (three options available)

	Cable size	Model number	Short description
	HB058 HB078 HB114 HB158	GKFROM60-58 GKFORM60-78 GKFORM60-114 GKFORM60-158	60 inch grounding kit
S.A.A	HB058 HB078 HB114 HB158	CLAMP-58 or SNAP-58 or SNAP-ST-58 CLAMP-105 or SNAP-58 or SNAP-ST-78 CLAMP-114 or SNAP-114 or SNAP-ST-114 CLAMP-158 or SNAP-158 or SNAP-ST-158	Standard clamp bolt- on hanger; Snap-in hanger; Stackable snap-in hanger
	HB058 HB078 HB114 HB158	HOIST1-58L HOIST1-78L HOSIT1-114-L HOSIT1-158L	Hoisting grip, lace up
	Any size	ANGLE-UI ANGLE-CLPI	Universal angle adapter, snap-in or 3/8" (kit of 10) Angle member adapter kit 3/8" (SS) (Kit of 10)
Shacp Blade	HB078 HB114 HB158	JSTRIP-78 JSTRIP-114 JSTRIP-158	Manual jacket stripping tool



IEC standard fiber inspection

Non-OVP Hybriflex optical interface connectors

In addition to the LC and ODC connectors on the main trunk, jumpers with ODC plug and socket connectors attach the RRH to the main trunk.

Tools and test equipment

Use only approved test equipment recommended by RFS.

Note: It is recommended that the main feeder be tested using ODC to LC test adapters and not the actual HYBRIFLEX[®] jumper.

Safety Caution!

Operator should always assume fiber optic cables are live; laser radiation can cause irreversible damage or injury to the human eyes.

Optical end-face Inspection

It is industry standard as per the IEC document 61300-3-25 1.0 that all optical fiber end-face are inspected and cleaned before mating. Please refer to the cleaning procedure within this document if need be.



ODC Plug

ODC Socket







Fiber interface zones, per IEC Template 613000-3-3 (for single-mode fiber)



Zone	Description	Diameter	Allowable defect diameter	Allowable size scratches
Α	Core zone	25µm	None @200x	None @200x
В	Cladding zone	25-120μm	Less than 2-5μm, none > 10μm	No greater than 3µm
С	Adhesive zone	120-130µm	None >10µm	Any scratch ok
D	Contact zone	130-250µm	None> 10μm	Any scratches ok



LC connector inspection

 Inspect the LC fiber end-face using approved test equipment probe and the appropriate LC fiber tips. If the test fails due to too much debris, clean end-face accordingly and retest.



LC end-face inspection

ODC connector inspection

- 2. Inspect the ODC fiber end-face using the approved test equipment probe and the appropriated ODC plug and ODC socket fiber tips. *If the test fails due to too much dirt clean end-face accordingly and re-test.*
- a. Unscrew the ODC cap (Caution! Protect cap against dust during the testing process).
- *b.* Insert ODC plug or socket tips into the ODC plug or socket connector as shown in figure A, B and inspect each connector (*Caution!* Make sure that tip is inserting fully into the connector to prevent any false image or damage).
- c. Adjust inspection probe zoom until image can be viewed clearly.





Important Note: In the event of failure, clean connectors as shown below, refer to optical fiber cleaning section within this document for additional cleaning suggestions.

Cleaning ODC plug and socket connector

If the ODC plug or socket end-face shows any particles or debris, clean the end-face using the following 1.25mm one click cleaning or swab stick.



Swab stick (Use as recommended)



One-click cleaner used on the appropriate tip for plug and socket



Cleaning ODC plug using the one-click cleaner



1.25mm one-click cleaner

Clean the ODC socket using the Swab stick, gently moisten the cleaning swab tip with a alcohol or Electro-Wash pen wet solution and gently clean each connector



Non-OVP optical testing

Note: OTDR uni-directional measurements lead to inaccuracies when fibers with different Mode Field Diameters (MFD) are connected. The inaccuracies usually are in the form of "gainers" or "exaggerated losses". At MFD mismatched connection OTDR backscattered light is greater or smaller, depending on the direction. Specifically, the capture fraction in an optical fiber is inversely proportional to the mode-field diameter squared. Thus, when two fibers of dissimilar mode field diameter are connected together, measurable differences in back reflected signal will occur that will add additional 0.1 to 0.5dB per IL connection. This is an OTDR testing issue only and does not affect cable performance and actual optical loss. In order to avoid this issue OTDR testing must be done bi-directionally per FOTP-61

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RFS suggests that all Hybriflex cables be tested using Loopback loss method -

- Use only RFS-approved test equipment and loopback patch cords
- Perform only recommended tests
- Keep all cleaners, adapters and calibration items clean & free of any contamination
- Replace any old, worn adapters and test cables
- Test all individual components before mating
- Used only single-mode fiber accessories. Do not mix-match adapter or loopback devices.

Typical system insertion loss table (using power meter only to measure insertion loss)

Fiber characteristic	Single-mode
Light propagation mode	1310 and 1550 nm
IL per connector one way	0.25 dB
Reflectance	Min 50 dB
Max system fiber loss allowed	4 dB (2 dB up and 2 dB down)

Field Jumpers testing

Connect the HYBRIFLEX[®] jumper cable to the ODC plug test lead as shown below, and follow test equipment instructions. Refer to the system insertion loss table for pass/fail criteria when recording results.

Note: ODC plug and socket can be mated securely by hand but if need be use, approved torque wrench with the applicable torque of 1 N-m to firmly secure the connection. Test equipment and reference cables should be reset prior to each measurement.



System loss measurement (sector jumper connected to main assembly)



HYBRIFLEX handling and installation procedures

HYBRIFLEX[®] cable should be handled and installed according to the same rules, instructions and regulations as typical coaxial cables.



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These short instructions were written for qualified and experienced installers. They describe, in short, the main points that have to be noted during the installation, without any claim of completeness. Any liability or warranty for results of improper or unsafe use is disclaimed!

General remarks:

In principle, care must be taken to avoid any strain that may cause permanent deformation on the armor and exposed fiber end-face, like exceeding bending radii, kinking, applying too high tensile stress or forcible deformation of the corrugated outer conductor (e.g. pulling over sharp edges, over tightening of clamps, etc.).

Transport/shipment & handling of the drum

Drums have to be handled carefully, in order to avoid any damage to the drum and/or the cable.

- O NOT remove protective wooden covering until ready to install cable at final location.
- If the drum will be shipped by van or truck, the drum has to be secured against rolling. Pay special attention to careful loading and unloading. Do not roll the drum from high levels (load floor) of the vehicle without protective measures. Roll the drum from the vehicle by using planks or ramp. Do not drop the drum!
- If forklifts are used, the forks must be long enough to engage both flanges of the drum at the same time to avoid cable damage.
- If a crane is used, a special hanger is necessary to ensure proper dispersion of weight and thus avoiding damage of the drum flanges and the cable.
- Do not lay the drum on its side. Reels must be transported and handled in their up-right position only (the cable could be deformed due to its own weight).
- Make sure that the cable end is always secured and fixed as close as possible to the drum core.
- *Note* the required rotation direction of the drum, which is shown by an arrow on the drum flange.







Handling of HYBRIFLEX[®] cable

Upon receiving the HYBRIFLEX[®] shipment, it is highly recommended that the drum be inspected for any physical damage and all fiber connection points be tested.

- Do not drag the cable over sharp edges. If it can't be avoided, protective measures must be taken, such as positioning additional rigging at those critical places.
- If cables have to be pulled in horizontal runs, use pipe rollers, wooden planks or similar devices.
- Prevent any pinches to the DC wires, which may cause electrical spikes and short-circuits.



HYBRIFLEX[®] cable, with aluminium outer conductor, is easy to bend, but must be handled carefully.

- Do not twist the cable, e.g. if changing from vertical to horizontal run. The minimum bend radius should be strictly observed (see product spec sheet for details).
- HYBRIFLEX[®] cable should be bent manually with a force evenly distributed. While applying, carefully slide your hand slides along the cable [see Diagram 1 below]. Avoid sharp motions.



While pressing, slide your hand





HYBRIFLEX® hoisting and pulling

- Note: when hoisting and pulling HYBRIFLEX[®] always uses caution.
- Do not remove the protective sock. If removed during pre-test, re-attach securely before hoisting
- Do not attach hosting grip over protective sock
- Hoisting grips should be attached no less than 5 feet from breakout point





HYBRIFLEX® Cable is supplied in specific cut length, with fully terminated factory connectors.

a winch is recommended. Provide a pulley high enough on the tower to enable the HYBRIFLEX[®] line to be raised sufficiently. Attach the approved supplied hoisting grip, use tie back rope or additional electrical tape if needed to prevent any stress or force to the fiber and protective sock. Only use the approved lace up hoist grip included with the main trunk HYBRIFLEX® cable. Do not use closed lacing hoisting grips! For very long vertical runs of cable, additional hoisting grips should be Protective attached at 50 – 60m (150 – 180 ft) intervals. sock: Add the hoist line to the hoisting grip or ropes sling; protect the Do not hoist Minimum HYBRIFLEX[®] against shackles. without sock 18.12 FT Make certain to allow slack in the cable between the hoisting grips in case more than one is used, so each one can carry weight, and ensure the slack is maintained during hoisting. Hoist the cable slowly. Caution! Pay-out must be resistive to prevent buckling of the cable. When unspooling, keep reel secure so it does not accidentally come loose. If it is necessary to drag the cable over sharp edges of buildings and tower members, protective measures must be taken. Careless handling can damage the protective layers and eventually Hoisting grip: causing damage to fiber strands or end-faces which may render the entire HYBRIFLEX[®] line length useless. Always secured with electrical If the cable is hoisted inside the tower, feed it into the tower base and tape or tie wrap keep it from hitting any tower steel work. before applying Caution! Protective sock should not be removed until installation is tension complete.



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Short lengths of small HYBRIFLEX[®] can be hoisted manually, otherwise



HYBRIFLEX[®] bending guidelines and parameters



• Avoid any tight bends near the fiber connector boot as micro-bends can cause broken fibers or increase insertion loss (see diagram 2 & 3 below).



 Do not leave the cable hanging in a long free space, e.g. during the installation under a platform. In adverse conditions additional protective measures may have to be taken, like temporarily anchoring the cable.





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Fixation / Mounting of the cable

The crush resistance of aluminium is lower than copper, which should be considered when tightening the clamps (especially if these clamps have not been approved by RFS).

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A number of different clamps may be used, and we recommend using the SNAP-series products. The SNAP hanger is suitable for all fixing situations as well as being the safest (most failure proof) clamp, offering a large number of exceptional advantages.

In any case the recommended and maximum clamp spacing shown in table 1 must always be considered. The small spacing applies to severe site conditions (wind load, icing etc.); whereas the greater/recommended spacing can be used for less exposed cable runs (e.g. indoor applications).

Table 1

HYBRIFLEX [®] Size	Spacing (recommended – max)
HB058 [5/8"]	0.7 - 1m (28 - 36")
HB078 [7/8"]	0.9 – 1.5m (3 - 5ft)
HB114 [1-1/4"]	1 - 1.3m (3 - 4.5ft)
HB158 [1-5/8"]	1 - 1.2m (3 - 4ft)

Grounding kit installation



Note: to avoid any corrosion problems, the contact element of the grounding kit below are tin plated copper. The tin plating allows compatibility with both aluminum and copper conductors.

Warning! Due to the electro-chemical potential differences between copper and aluminium do not use the un-plated grounding kits, which are designed only for copper cables!

Please follow the included installation instruction carefully.

For Grounding purpose we also strongly recommend the use of a manual jacket stripping tool, model JSTRIP-xxx.



Available JSTRIP tool



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1. Set the JSTRIP onto a straight part of cable at desired point of the grounding kit (figure a).

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2. Insert a screwdriver into the two support holes and begin turning, maintaining a straight line – do not push in any lateral directions and do not twist or leave the right angle line. Continue turning by hand (the screwdriver is needed for the start only) until the jacket is cut completely around, still maintaining a straight line (figure b, c, and d).

3. Make a mark onto the cable jacket in a distance of 70mm (2.75in) from the beginning of the first cut. 50mm (2.0in) is needed for the grounding kit installation (figure e).

4. Put the tool onto the cable again with the blade edge close to the mark (some of the tool should cover some of the stripped area). Start again, while pushing the tool slowly toward the marking. The jacket will be cut in a spiral. Turn further by pushing the tool very slowly until reaching the marking. If the tool is on the mark, turn further, but now push a little bit in the reverse direction in order to finish the cut in straight line.

Note: If the tool has been started to cut in a spiral, the tool will move continuously by itself in the same direction. If the marked area is reached, this movement has to be stopped by pushing carefully in the opposite direction. To develop the proper technique, we recommend testing on a part of cable, which is not needed for the installation. If this process is not easy enough or not acceptable, a clamp (e.g. hanger clamp) may be placed on the mark. (Figure f, g, and h)





5. Put the body of the grounding kit very carefully around the cable, in order to prevent damaging the outer conductor, and then carefully tighten the nuts (Figure k)

Figure k



6. Finally use the supplied sealing materials as described in the grounding kits installation instruction to perform a proper sealing of the complete kit. Place the remaining third 50 mm (2") piece of butyl mastic carefully over the ground wire. (as shown in diagram 5) We recommend bending it with overlapping on both sides when placing over the ground wire. Afterwards mould it in a straight line to the coaxial cable to avoid gaps where water could enter (see Diagram 5).

RFS RRH jumper with IP-RC connector installation guide

Use the following instruction to properly install/attach the IP-RC connector. Failure to follow these procedures entirely may cause damage to the Fiber or Connector. For factory pre-installed assembly, skip to step 4a:













HYBRIFLEX® bulkhead connector fitting installation

The HYBRIFLEX[®] bulkhead fitting Kit is designed to be used with HYBRIFLEX[®] Cable to secure the transmission line to the equipment cabinet. No additional boot is required. It forms a mechanical and water-tight connection, and provides ground continuity (for metal types) between the cable's armor and the metal enclosure used. These HYBRIFLEX[®] connectors are UL listed for ordinary wet location use in accordance with UL Standard 514B. Prepare the junction box per bulkhead fitting size. Refer to the specific fitting instruction sheet (attached to the cable) for the punch-hole dimension and torque specifications.

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Installation required tools:

Tape, Ruler, specific bulkhead fitting size open ended wrench, Jacket removal tool and ripcord removal kit

HYBRIFLEX[®] cable bulkhead fitting kit is shipped hand tightened on all trunk cable. In the event of a complete field installation, follow the entire instruction, otherwise skip to step 7a.



Note if armor is to be removed: If additional breakout length is needed, loosen the bulkhead and slide it down over jacket. Refer to the rip cord removal process. Once ripcord removal is completed, prep the end of the cable using the jacket removal tool or knife and remove 2.6" of the jacket to expose the aluminium outer armor.



Instruction steps:

1) Remove the connector from the package and inspect it to ensure there are no missing pieces or damage. DO NOT DISASSEMBLE OR TIGHTEN THREAD (Figure 1).

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- 2) Prep the cable by removing 2.6" of the jacket using the jacket stripping tools or knife to expose the aluminum outer armor (Figure 8).
- 3) Carefully feed ESD taped bag with fiber terminations into the connector and slide over DC power. Caution! When sliding bulkhead over fiber splitter fan-out (Figure 3 and 4).
- 4) Feed cable assembly until the aluminum armor reaches the center stop of the bulkhead. Hold the intermediate body (with open ended wrench) and tighten the back-nut using the appropriate torque wrench and specific torque. See torque table
- 5) Tighten the front end body and front end to the specific torque see torque table. Cut and remove the excess blue filler and clear Mylar flush with the connector face (see figure 9 and 10). 5a) For 6 gauge assembly, tighten body sealing nut at this time.
- 6) Connector is now installed on the cable assembly and it is ready to be mounting into the junction box (See figure 10).
- 7) To assemble the HYBRIFLEX[®] cable into the junction box, loosen fitting, unwrap the lock-nut, adjust bulkhead as needed.
- 8) Carefully insert the fiber and DC wires into the junction box punch hole, then slowly guide the HYBRIFLEX[®] connector (and reducer if applicable) into the fitting hole. Note: Be careful not to cut any wires.
- 9) Slide capture lock-nut until it reaches the reducer thread and secured to the box, a flat screw driver can be used for additional tightening (see Figure 11).







Figure 6









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Figure 10

Figure 8

Figure 9



(Plastic fitting)



Figure 11

(Metal fitting)



Additional installation guidelines for all HYBRIFLEX[®] products



Fiber cleaning introduction

Warning: Before attempting to clean or inspect fiber optics it is strongly recommended that technician have a good understand of the IEC 61300-3-35 fiber optics standard procedure. This document can be obtained simply by performing a google search for IEC 61300-3-35.

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It is important that every fiber connector be inspected and cleaned prior to mating. This document describes inspection and cleaning processes for fiber optic connections. The procedures in this document describe basic inspection techniques and processes of cleaning for fiber optic cables, bulkheads, and adapters used in fiber Optics connections.

Note: This document is intended for use by service personnel, field service technicians, and hardware installers.

Inspection and cleaning are critical

Clean fiber optic components are a requirement for quality connections between fiber optic equipment. One of the most basic and important procedures for the maintenance of fiber optic systems is to clean the fiber optic equipment.



Any contamination in the fiber connection can cause failure of the component or failure of the whole system. Even microscopic dust particles can cause a variety of problems for optical connections. A particle that partially or completely blocks the core generates strong back reflections, which can cause instability in the laser system. Dust particles trapped between two fiber faces can scratch the glass surfaces. Even if a particle is only situated on the cladding or the edge of the end face, it can cause an air gap or misalignment between the fiber cores which significantly degrades the optical signal.

In addition to dust, other types of contamination must also be cleaned off the end face. Such materials include:

- Oils, frequently from human hands
- Film residues, condensed from vapors in the air
- Powdery coatings, left after water or other solvents evaporate away

These contaminants can be more difficult to remove than dust particles and can also cause damage to equipment if not removed. When you clean fiber components, always complete the steps in the procedures carefully. The goal is to eliminate any dust or contamination and to provide a clean environment for the fiber-optic connection. Remember that inspection, cleaning and re-inspection are critical steps which must be done before you make any fiber-optic connection.



General reminders and warnings

Review these reminders and warnings before you inspect and clean your fiber-optic connections.

Reminders:

• Always turn off any laser sources before you inspect fiber connectors, optical components, or bulkheads.

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- Always make sure that the cable is disconnected at both ends.
- Always wear the appropriate safety glasses when required in your area.
- Always inspect the connectors or adapters before you clean.
- Always inspect and clean the connectors before you make a connection.
- Always use the connector housing to plug or unplug a fiber connector.
- Always keep a protective cap on unplugged fiber connectors.
- Always store unused protective caps in a re-sealable container in order to prevent the possibility of the transfer of dust to the fiber. Locate the containers near the connectors for easy access.
- Always discard used tissues and swabs properly.

Warnings

- Never look into a fiber while the system lasers are on.
- Never use alcohol or wet cleaning without a way to ensure that it does not leave residue on the end-face. It can cause damage to the equipment.
- Never clean bulkheads or receptacle devices without a way to inspect them.
- Never connect a fiber to a fiberscope while the system lasers are on.
- Never touch the end face of the fiber connectors.
- Never twist or pull forcefully on the fiber cable.
- Never reuse any tissue, swab or cleaning cassette reel.
- Never touch the clean area of a tissue, swab, or cleaning fabric.
- Never touch any portion of a tissue or swab where alcohol was applied.
- Never touch the dispensing tip of an alcohol bottle.
- Never use alcohol around an open flame or spark; alcohol is very flammable.

Best practices

• Re-sealable containers should be used to store all cleaning tool, and store end caps in a separate container.

The inside of these containers must be kept very clean and the lid should be kept tightly closed to avoid contamination of the contents during fiber connection.

• Never allow cleaning alcohol to evaporate slowly off the ferrule as it can leave residual material on the cladding and fiber core. This is extremely difficult to clean off without another wet cleaning and usually more difficult to remove than the original contaminant. Liquid alcohol can also remain in small crevices or cavities where it might re-emerge.



General inspection and cleaning procedures

This section describes the connector cleaning process. Additional sections provide more detail on specific inspection and cleaning techniques.

General Cleaning Process



Complete the following steps:

1. Inspect the fiber connector, component, or bulkhead with a fiberscope.

2. If the connector is dirty, clean it with a dry cleaning technique. Using hand tool such as one-clik cleaner, etc.

- 3. Inspect the connector.
- 4. If the connector is still dirty, repeat the dry cleaning technique.
- 5. Inspect the connector.

6. If the connector is still dirty, clean it with a wet cleaning technique followed immediately with a dry clean in order to ensure no residue is left on the end-face.

Note: Wet cleaning is not recommended for bulkheads and receptacles. Damage to equipment can occur.

7. Inspect the connector again.

8. If the contaminate still cannot be removed, repeat the cleaning procedure until the end-face is clean.

Note: Never use alcohol or wet cleaning without a way to ensure that it does not leave residue on the end-face. It can cause equipment damage.

Connector inspection technique

This inspection technique is done with the use of fiberscopes in order to view the end-face.

A fiberscope is a customized microscope used in order to inspect optical fiber components. The fiberscope should provide 200x-400x total magnification. Specific adapters are needed to properly inspect the end-face of most connector types, for example: 1.25 mm, 2.5 mm.

Tools

- Clean, re-sealable container for the end-caps
- Fiberscope
- Bulkhead probe





Cleaning techniques for pigtails and patch cords

This section describes cleaning techniques for pigtails and patch cords.

Note: No known cleaning methods are 100% effective; therefore, it is imperative that inspection is included as part of the cleaning process. Improper cleaning can cause damage to the equipment.

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Dry cleaning technique: cartridge and pocket style cleaners

This section describes dry cleaning techniques with the use of cartridge and pocket style cleaners.

Tools

- Cartridge Cleaning Tools:
- Pocket Style Cleaning Tools:

Note: Make sure that the lasers are turned off before you begin the inspection.

Caution: Invisible laser radiation might be emitted from disconnected fibers or connectors. Do not stare into beams or view directly with optical instruments.

1. Remove the protective end-cap and store it in a small re-sealable container.

2. Inspect the connector with a fiberscope.

3. If the connector is dirty, clean it with a cartridge or pocket cleaner.

- For cartridge cleaners, press down and hold the thumb lever. The shutter slides back and exposes a new cleaning area, then go to step 5.
- For pocket cleaners, peel back protective film for one cleaning surface, and then go to step 5.
- For manual advance cleaners, pull on the cleaning material from the bottom of the device until a new strip appears in the cleaning window, and then go to step 5.

4. Hold the Ferrule tip lightly against the cleaning area and rotate one quarter turn.

5. Pull the ferrule tip lightly down the exposed cleaning area in the direction of the arrow or from top to bottom.

Caution: Do not scrub the fiber against the fabric or clean over the same surface more than once. This can potentially contaminate or damage your connector.

- 6. Release the thumb lever to close the cleaning window, if you use cartridge type cleaners.
- 7. Inspect the connector again with the fiberscope.
- 8. Repeat the inspection and cleaning processes, as necessary.

Caution: Throwaway any used cleaning material, either cards or material cartridges, after use.



Dry clean technique: lint-free wipes

This section describes dry cleaning techniques that use lint-free wipes.

Tools

• Lint-free wipes, preferably clean room quality

Note: Make sure that the lasers are turned off before you begin the inspection.

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- 1. Remove the protective end-cap and store it in a small re-sealable container.
- 2. Fold the wipe into a square about 4 to 8 layers thick.
- 3. Inspect the connector with a fiberscope.

If the connector is dirty, clean it with a lint-free wipe.

Caution: Be careful not to contaminate the cleaning area of the wipe with your hands or on a surface during folding.

4. Lightly wipe the ferrule tip in the central portion of the wipe with a figure-8 motion.

Caution: Do not scrub the fiber against the wipe. If you do it, it can cause scratches and more contamination.

- 5. Repeat the figure 8 wiping action on another clean section of the wipe.
- 6. Properly dispose of the wipe.
- 7. Inspect the connector again with the fiberscope.
- 8. Repeat this process as necessary.

Wet cleaning technique: lint-free wipes

If a dry cleaning procedure does not remove the dirt from the fiber end-face, then precede the wet cleaning method.

Caution: Improper cleaning can cause damage to the equipment. The primary concern with the use of isopropyl alcohol is that it can be removed completely from the connector or adapter. Residual liquid alcohol acts as a transport mechanism for loose dirt on the end face. **If** the alcohol is allowed to evaporate slowly off the ferrule, it can leave residual material on the cladding and fiber core. This is extremely difficult to clean off without another wet cleaning and usually more difficult to remove than the original contaminant. Liquid alcohol can also remain in small crevices or cavities where it can re-emerge during fiber connection.

Tools

- 99% isopropyl alcohol
- Lint-free wipes



Caution: Read the reminders and warnings before you begin this process.

Note: Make sure that the lasers are turned off before you begin the inspection.

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- 1. Remove the protective end-cap and store it in a small re-sealable container.
- 2. Inspect the connector with a fiberscope.
- 3. Fold the wipe into a square, about 4 to 8 layers thick.
- 4. Moisten one section of the wipe with one drop of 99% alcohol. Be sure that a portion of the wipe remains dry.
- Lightly wipe the ferrule tip in the alcohol moistened portion of the wipe with a figure- 8 motion. Immediately repeat the figure 8 wiping action on the dry section of wipe to remove any residual alcohol.

Caution: Do not scrub the fiber against the wipe, doing so can cause scratches.

- 6. Properly dispose of the wipe. <u>Never reuse a wipe.</u>
- 7. Inspect the connector again with a fiberscope.
- 8. Repeat the process as necessary.

HYBRIFLEX® jacket removal tools instruction

Note: These instructions are written for qualified and experienced personal. Please study them carefully before starting any work. Any liability or responsibility for the result of improper or unsafe practices is disclaimed. Please respect valid environmental regulations for assembly and was disposal. Always make sure to use appropriate protection.

Also, this user instruction is applicable for all size of HYBRIFLEX[®]. Use caution when handling the jacket removal tool to avoid any accidental contact with the cutter blade.



Part Number	HYBRIFLEX [®] size
HTPT-1-058	5/8"
HTPT-1-078	7/8"
HTPT-1-114	1-1/4"
HTPT-1-158	1-5/8″





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Armor cutting tool instruction for 1-1/4" and 1-5/8" inch

The following instructions can be use for 1-1/4 and 1-5/8" HYBRIFLEX[®]'s cable. Note, the cutting tool are special design, an off the shelf pipe cutter from local hardware should not be use. Do not use a knife.

Note: Although both tool design are identical, the size are different, to prevent any damage use only the appropriate cutting tool size for the respective cable size. HYBRIFLEX[®] cutting tool is a special design; an 'off the shelf' pipe cutter from a local hardware store should not be used.





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- 1) Using the jacket striping tool remove the jacket off the cutting section
- 2) Turn the turning knob counter clockwise all the way until the tool is completely open (Figure 2). Warning! Do not try to release the latch, it is locked in place. The blade can only be move in and out by tuning the knob.
- Insert the cable between roller 1 and 2 as shown in Figure 2a.
- Grasp cable and tool together with one hand as shown in Figure 2a.
- 5) Slowly spin tool around the cable while tightening the knob. Continue until the aluminum armor is cut through as shown in Figures 3, 3a.

These instructions are written for qualified and experienced personal. Please study them carefully before starting any work. Any liability or responsibility for the result of improper or unsafe practices is disclaimed. Please respect valid environmental regulations for assembly and was disposal. Always make sure to use appropriate protection.







Armor cutting tool instruction for 5/8 and 7/8 inch

The following instructions are designed for use with the 5/8 HYBRIFLEX[®] cable.

Note: HYBRIFLEX[®] Cutting tool is a special design. Knives or 'off the shelf' pipe cutters should not be used.

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Note: Do not unscrew the roller guide. HTP-1-078 is strictly design for 7/8" cable.

1) Using the jacket removal tool remove the jacket off the cutting section.

2) Hold the tool body and turn the handle counter clockwise and adjust it to fit the 7/8" cable (Figure 2).

3) Grasp the handle and body of the tool together with one hand as shown (Figure 2a).

4) While holding the tool body and handle with one hand as shown (Figure 2a), insert the cable as you grasp the tool body and cable together with the other hand as shown (Figure 3).

5) Turn handle clockwise until the blade contacts the cable armor. *Note*: Ensure that the blade is seated properly on the high end of the corrugation.

6) Slowly spin the tool around the cable and tighten the handle as needed. Continue until the armor is cut through as shown in Figure 4, 4a.





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Armor removal instruction





Figure 1

Figure 1a

Figure 2

Figure 2a







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HYBRIFLEX[®] is constructed with ripcord for ease of armor cut back.

Follow these steps to remove the armor:

Safety: Caution! Use hand protection and safety glasses, the sharp aluminum edges and flying particles can be dangerous. This procedure should be executed with the fiber protection as received in place.

Note: The armor cutting tools are special and unique, regular pipe cutters from your local hardware store (Lowe's, Home depot etc.) should not be used. Although a knife can be used to remove the jacket, the jacket removal tool is strongly recommended to avoid damage to the fiber and power wires. Also, only the referenced mandrel should be used to remove the ripcord. A hex drive or other means should not be used.

- 1) Measure and mark the length of the armor to be removed (suggested max. 15ft per cut).
- 2) Using the jacket removal tool, strip 3" off the jacket as shown in Figure 1 & 1a.



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- 3) Place the cutting tool over the 3" exposed aluminum armor; slowly turn the cutter handle clockwise until the blade is fully engaged with the aluminum armor (Figure 2) *Note:* Armor should be cut on the high end (peak) of the corrugation, not in the valley (see Figure 2b). Rotate cutting tool and tighten handle as needed until the aluminum armor cut as shown in Figure 2a.
- 4) Insert stop collar at the edge of the aluminum armor as shown in Figure 3.
- 5) Remove the electrical tape, shown in Figure 4. *Note:* 7/8" cables have one ripcord. (6" of the ripcord is exposed from the factory under the electrical tape).

Note: If ripcord is not exposed or too short due to previous armor removal, stop and complete steps 12-18 first.

- 6) Locate ripcord and place a knot at the end of it as shown in Figure 5.
 - Insert the mandrel into the drill tool as shown in Figure 6 and insert the ripcord into the mandrel slot and start winding the ripcord around the mandrel in the ripping direction (towards the stop collar), at minimal speed to slice both jacket and aluminum armor. The mandrel should be centered on the cable and in contact with the jacket surface (see Figure 7).
 - 2) After the ripcord reaches the stop collar, remove the ripcord from the mandrel by running the drill in reverse. Cut the excess ripcord leaving 6" exposed.
 - Now that the armor and jacket has been sliced, peel open the jacket, remove and discard. See Figure 8.
- 7) Caution! Due to the sharp edges of the aluminum armor DO NOT start this step without proper gloves. Use nose plier and flare open the aluminum armor ensure that sides and bottom are flare open as shown Figure 9-9b. Peel open the aluminum armor as shown Figure 10, if need be use shoulder to support fiber and wires during peeling Figure 10a.
- 8) Now that the armor is peeled off, slide the Mylar tape all the way towards the stop collar until it forms a small bundle. Use scissors to cut off the Mylar.

Caution: Be careful not damage the fiber or power wires.

- 9) Pull filler away from fiber and DC conductor, cut and discard. Caution! Do not score the DC conductor. (See Figure 11)
- 10) Untwist fiber and DC conductors and cut excess filler cord.
- 11) Continue with the installation process.



