

*FEMTO LAB : GUIDELINES AND AUTHORIZED USER LIST*

*SEPTEMBER 2012*

## MANDATORY TRAINING

Some equipment requires extra training before you will be allowed to use it. You are responsible for knowing whether or not you need training on a particular piece of equipment.

<i>EQUIPMENT</i>	<i>PERSON IN CHARGE</i>	<i>APPROVED USERS</i>
40Gbps BERT Manufacturer: Centellax		
Lightwave component Analyzer* Manufacturer: Agilent	Molly Piels	Sudha Sid
PNA-X (4 port network analyzer)* Manufacturer: Agilent	Molly Piels	
Wirebonder Manufacturer: Westbond	Jon Peters Siddharth Jain	<b>NO USERS CAN BE APPROVED TO USE THIS EQUIPMENT</b>
PM Splicer Manufacturer: Fujikara	Molly Piels	Kim Nguyen Mike Davenport Wenzao John Garcia
50GHz Spectrum Analyzer Manufacturer: R&S	Molly Piels	Mike Davenport Martijn Heck
Polishing Station	Sudha	many
MLLs	Mike Davenport Martijn Heck	Many

OBR	Jared Bauters	many
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\* Equipment is password protected

## GENERAL LAB GUIDELINES

### Equipment with optical inputs

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- Check max. power specs before inserting optical power into any device. Measure the optical input you intend to insert on a hand-held power meter before making the connection.
- Note that when using optical pulses, the average power is much lower than the peak pulse power. It is important in this case to also calculate the peak power and compare to the specified value on the datasheet.

### Equipment with moving parts

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#### Spectrum analyzers (both optical and electrical)

- Do not leave running continuous sweep – set to single sweep before leaving the lab or turn off.

### High power optical equipment

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Koheras Laser, IPG EDFAs, Agilent automatic power control attenuator etc. These rules apply even when you are not operating at high power levels.

- Make sure connectors are absolutely clean (see cleaning techniques below)
  - For safety, never inspect a connector while the laser is on
- DO NOT mate Angled polished connectors (APCs) with straight Connectors (SC/UPC)
- Make sure equipment has adequate ventilation when mounted on rack
- Turn experimental setups on “back to front”: e.g. if you have a laser put in to an EDFA, turn on the laser before the EDFA. Otherwise, the EDFA pump laser may be operating at a far-too-high level, which can result in huge amounts of optical power coming out of the EDFA when the laser is turned on.
- Remember to turn off after use

### Fiber optic connector care

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- Always clean and inspect connectors prior to making a connection (turn the laser off first). We have several fiber scopes for inspection, and cleaning is explained below. If you do not know what a clean fiber looks like, please ask someone who does.

Please see below on how to care for fiber optic connectors. \*\*This is something that is really important\*\*

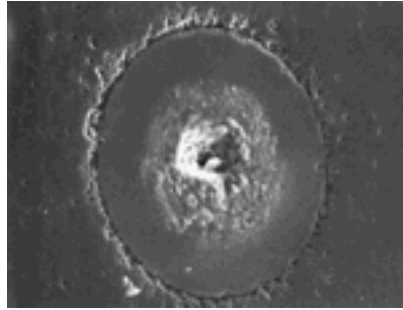


Fig 1. Optical connector damaged due to high optical power

### **When not to clean the connectors**

One should never clean an optical connector attached to a fiber that is carrying light. Optical power levels as low as +15 dBm, or 32 milliwatts, may cause an explosive ignition of the cleaning material when it contacts the end of the optical connector, destroying the connector. Typical cleaning materials, such as tissues saturated with alcohol, will combust almost instantaneously when exposed to optical power levels of +15 dBm or higher. The micro-explosions at the tip of the connector can leave pits in the end of the connector and crack the connector's surface, destroying its ability to carry light with low loss. Figure 5 shows an optical connector that has been heavily damaged by high optical power levels. Usually the damage is limited to less severe pitting.

### **The importance of cleaning**

Another important thing to remember in handling fiber optic connectors is that the fiber end face and ferrule must be absolutely clean before it is inserted into a transmitter or receiver. Dust, lint, oil (from touching the fiber end face), or other foreign particles obscure the end face, compromising the integrity of the optical signal being sent over the fiber. From the optical signal's point-of-view, dirty connections are like dirty windows. Less light gets through a dirty window than a clean one. It is hard to conceive of the size of a fiber optic connector core. Single-mode fibers have cores that are only 8-9  $\mu\text{m}$  in diameter. As a point of reference, a typical human hair is 50-75  $\mu\text{m}$  in diameter, approximately 6-9 times larger! Dust particles can be 20  $\mu\text{m}$  or larger in diameter. Dust particles smaller than 1  $\mu\text{m}$  can be suspended almost indefinitely in the air. A 1  $\mu\text{m}$  dust particle landing on the core of a single-mode fiber can cause up to 1 dB of loss. Larger dust particles (9  $\mu\text{m}$  or larger) can completely obscure the core of a single-mode fiber. Fiber optic connectors need to be cleaned every time they are mated and unmated; it is essential that fiber optics users develop the necessary discipline to always clean the connectors before they are mated. It is also important to cover a fiber optic connector when it is not in use. Unprotected connector ends are most often damaged by impact, such as hitting the floor. Most connector manufacturers provide some sort of protection boot. The best protectors cover the entire connector end, but they are generally simple closed-end plastic tubes that fit snugly over the ferrule only. These boots will protect the connector's polished ferrule end from impact damage that might crack or chip the polished surface. Many of the tight fitting plastic tubes contain jelly-like contamination (most likely mold release) that adheres to the sides of the ferrule. A blast of cleaning air

or a quick dunk in alcohol will not remove this residue. This jelly-like residue can combine with common dirt to form a sticky mess that causes the connector ferrule to stick in the mating adapter. Often, the stuck ferrule will break off as one attempts to remove it. The moral of the story is always thoroughly clean the connector before mating, even if it was cleaned previously before the protection boot was installed.

### **Cleaning Technique**

Required Equipment: • Kimwipes<sup>®</sup> or any lens-grade, lint-free tissue. The type sold for eyeglasses work quite well. • Denatured alcohol. Note: Use only industrial grade 99% pure isopropyl alcohol. Commercially available isopropyl alcohol is for medicinal use and is diluted with water and a light mineral oil. Industrial grade isopropyl alcohol should be used exclusively. • 30X microscope. • Canned dry air. 1. Fold the tissue twice so it is four layers thick. 2. Saturate the tissue with alcohol. 3. First clean the sides of the connector ferrule. Place the connector ferrule in the tissue, and apply pressure to the sides of the ferrule. Rotate the ferrule several times to remove all contamination from the ferrule sides. 4. Now move to a clean part of the tissue. Be sure it is still saturated with alcohol and that it is still four layers thick. Put the tissue against the end of the connector ferrule. Put your fingernail against the tissue so that it is directly over the ferrule. Now scrape the end of the connector until it squeaks. It will sound like a crystal glass that has been rubbed when it is wet. 5. Use the microscope to verify the quality of the cleaning. If it isn't completely clean, repeat the steps with a clean tissue. Repeat until you have a cleaning technique that yields good, reproducible results. 6. Mate the connector immediately! Don't let the connector lie around and collect dust before mating. 7. Air can be used to remove lint or loose dust from the port of a transmitter or receiver to be mated with the connector. Never insert any liquid into the ports.

### **Handling**

1. Never touch the fiber end face of the connector. 2. Connectors not in use should be covered over the ferrule by a plastic dust cap. It is important to note that inside of the ferrule dust caps contain a sticky residue that is a by-product of making the dust cap. This residue will remain on the ferrule end after the cap is removed. 3. The use of index-matching gel, a gelatinous substance that has a refractive index close to that of the optical fiber, is a point of contention between connector manufacturers. Glycerin, available in any drug store, is a low-cost, effective index-matching gel. Using glycerin will reduce connector loss and reflection, often dramatically. However, the index-matching gel may collect dust or abrasives that can damage the fiber end faces. It may also leak out over time, causing reflections to increase.

### **RF EQUIPMENT (INCLUDING HIGH-SPEED PHOTODETECTORS)**

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- Many of the input ports cannot handle high powers. Check to make sure you know what the maximum allowable input RF power is before making a connection. Check to make sure that the amount of power you are applying falls

below that value. This may have to be calculated. Do not turn on amplifiers until the connection is made. When in doubt, use an attenuator.

- These are static sensitive devices, so observe appropriate ESD precautions (use grounding strap when touching them etc.)
- The lab has several versions of u2t high-speed detectors (bandwidth>40GHz). Please check data sheet to determine if they are AC coupled or DC coupled and if AC coupled use DC block before inserting into subsequent block (RF Spectrum Analyzer or Amplifier).
- In general, make sure you are not applying DC to an RF port by checking the appropriate datasheets.
- Check bias polarity prior to applying bias. If using a Keithley (any DC power supply with a fast front-end), slowly turn the bias up from 0V to the desired bias rather than turning the output on and off.
- Connectors are especially fragile: follow connector care guidelines outlined below.

### Connector types

There are four common types of RF connector in the lab. Below is the list ranging from low to high frequency.



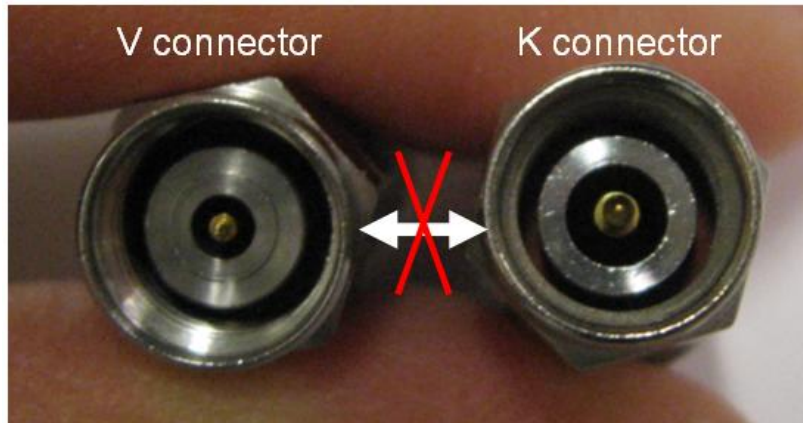


1) SMA connectors

- Frequency range : DC to 18 GHz
- SMA connectors are compatible with K connectors, but it is not recommended due to possible damage to K connectors.

2) 2.92mm connectors (K connectors)

- Frequency range : DC to 40 GHz
- 2.92mm is the diameter of the signal core
- Air gap between inner core and outer ground







3) 2.4mm connector

- Frequency range : DC to 50 GHz
- Not compatible with K connector. Any connection between K and 2.4 mm will damage the connector
- Mates with v connector

4) 1.8mm connector (V connector), mates with 2.4mm connectors

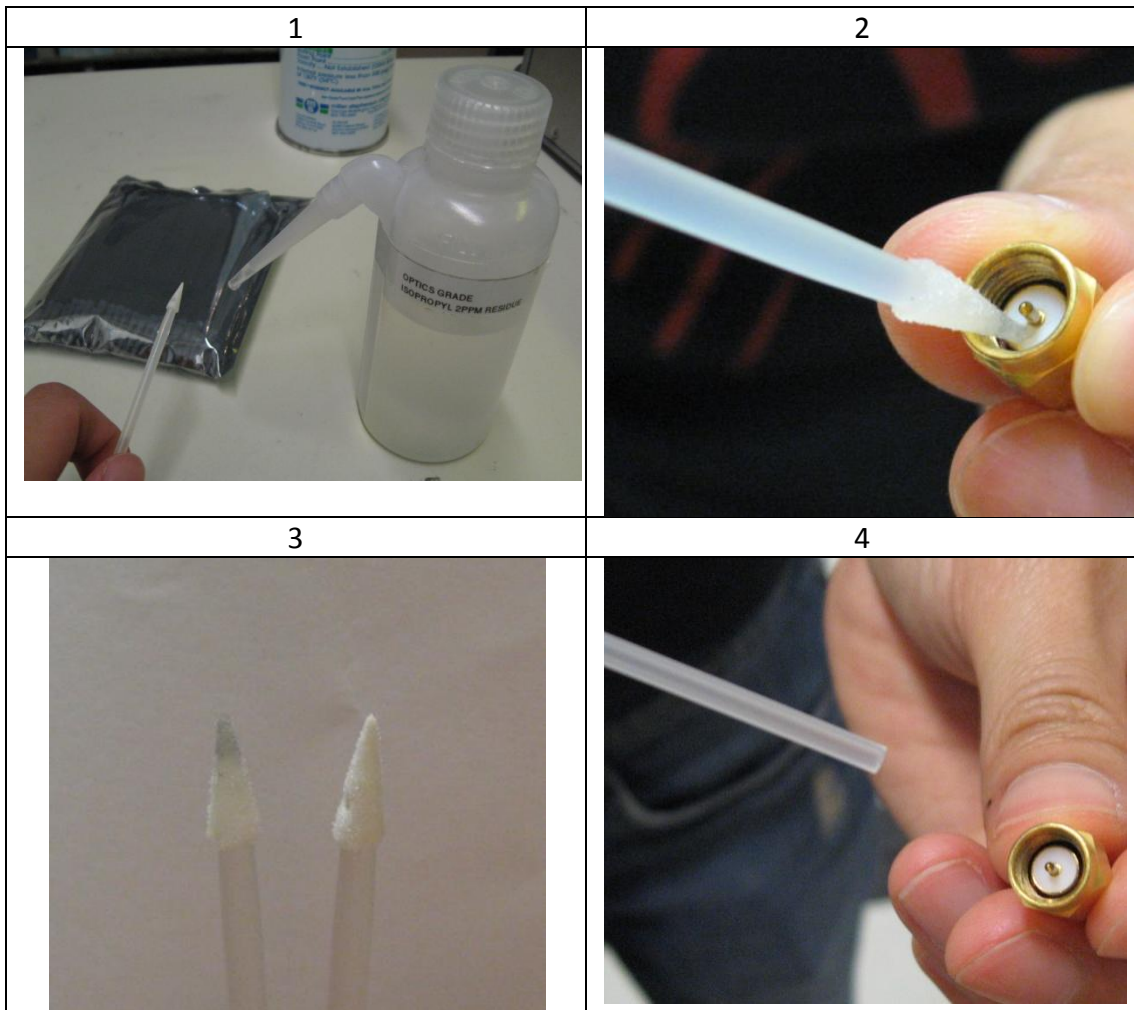
- Frequency range : DC to 60 GHz
- Not compatible with K connector. Any connection between K and 1.8mm will damage the connector
- Mates with v connector

**Storage of connectors**

There are two boxes for the storage of these high speed connectors. One is for SMA, and the other one is for K and V connectors. Please put all the connectors back into the boxes once you are done. All the connectors have really sensitive pins so improper storage (like shown in the figure) might damage the connectors!!



### Cleaning connectors



1. Spray ISO on the special static proof wipe (Fig.1).
2. Wipe the connector gently (Fig.2). Sometimes the wipe will look pretty dirty

(Fig.3)

3. DO NOT put pressure on the center pin. It might damage the connector!! V connectors are especially sensitive.
4. Blow dry the connector to avoid any residue (Fig.4)

#### GENERAL LAB ETIQUETTE

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- Please report all broken equipment to the lab manager and concerned student in charge. This includes probes, connectors etc. It is not acceptable to put back broken equipment without labeling the equipment with what is wrong, when it happened and who noticed it.
- Please replace supplies when they are running low or missing. General supplies include but are not limited to: Batteries, Kim-Wipes, Lens Tissues, Fiber Optic dry cleaning cartridges, Soldering station supplies etc.
- Please ASK before removing equipment from anyone's setup. Put a note on your own setup when in use to remind others to do the same.
- Please clean up after yourself. This is especially critical when using common areas such as the soldering station, splicer, polishing station and wire bonder.
- Please turn off all non-essential equipment at the end of the day to reduce energy consumption.

#### EQUIPMENT OWNERSHIP AND DOCUMENTATION

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- When you purchase new equipment for the lab, you must put a Bowers group property sticker on it (stickers are located in the office supplies drawer)
- Any equipment with a Bowers group tag on it to leave the lab must be signed out on the sheet posted on the door
- Please store any users' manuals in the bookshelf in the back corner of the lab. Post any electronic documentation on the group wiki. If the item you have purchased does not have its function printed on it, please label it (e.g. if you purchase lensed fibers, add a label with the spot size; if you purchase a butterfly packaged laser, write laser and the wavelength on it).