

Camera Training Center Breda The Netherlands



grass valley

A **BELDEN** BRAND

Jan Paul Campman

- ▢ **Your Host for this session**
- ▢ *Training Manager*
- ▢ *Trainer*
- ▢ *Acceptance Engineer*
- ▢ *Demo specialist*
- ▢ *Web master*

- your guide for this INTERACTIVE session.
- **Welcome to the LDX Series WEB-Training**



3G Triax / Fiber / 10G Fiber (basics)

This part gives you some more details about the
Connection between Camera and XCU

In this session:

- ◆ **Triax or Fiber basics**
- ◆ **3 G Triax Technical**
- ◆ **Fiber Technical**
- ◆ **Diagnostics**



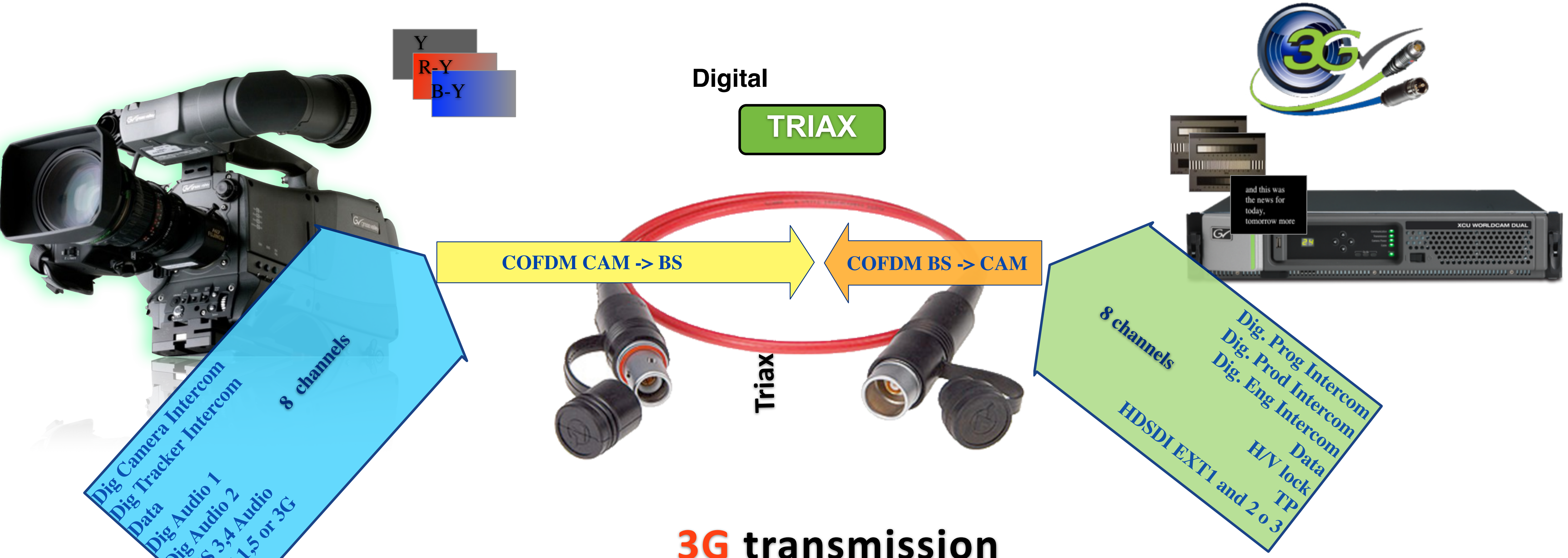
◆Analog Triax
◆3G Triax
◆Fiber

differences

| | | Analog | Digital | Digital |
|----|------------------------------|---|---|--|
| | | HD Triax | 3G Triax | HD FIBER |
| 1 | 720p | 23.98 / 25 / 29.97 / 50 / 59.94 Hz | 23.98 / 25 / 29.97 / 50 / 59.94 Hz | 23.98 / 25 / 29.97 / 50 / 59.94 Hz |
| 2 | 1080i | 50 / 59.94 Hz | 50 / 59.94 Hz | 50 / 59.94 Hz |
| 3 | 1080p (WorldCam) | 23.98 / 24 / 25 / 29.97 Hz | 23.98 / 24 / 25 / 29.97 / 50 / 59.94 Hz | 23.98 / 24 / 25 / 29.97 / 50 / 59.94 Hz |
| 4 | Future feature | | Transmission is 3D ready. | |
| 5 | S/N ratio in Y signal | 58dB typical | 61dB typical | 61dB typical |
| 6 | Typical Cable length Fiber | Triax cable (supports standard Triax cable up to 3,900ft (1200m)) | 1500m 14mm, with no degradation 25% more vs HD Triax | Hybrid Fiber upto 2500m full config. ; upto 4000 ENG config |
| 7 | Audio (Cam -> BS) | yes, 2x analog | yes, 2x analog + digital AES-EBU output | yes, 2x analog + digital AES-EBU output |
| 8 | Intercom (Cam -> BS) | Camera, Tracker | Camera, Tracker | Camera, Tracker |
| 9 | Intercom (BS -> Cam) | Eng, Production, floor | Eng, Production, floor | Eng, Production, floor |
| 10 | Private data | yes, RS232 48kb but sacrificing Tracker and floor channels | yes, RS-232, 115kb | yes, RS232, 115kB |
| 11 | Digital Audio | no | yes, 2x digital AES-EBU in & out | yes, 2x digital AES-EBU in & out |
| 12 | Digital Embedded Audio | no | yes, complete digital (4 channels) | yes, complete digital (4 channels) |
| 13 | HD-SDI out (BS) | 3x (1.5G) | 6x (3G or 1.5G) | 6x (3G or 1.5G) |
| 14 | HD-SDI out (live / effect) | No | 2x 1.5G | 2x 1.5G |
| 15 | Monitoring out | CVBS | CVBS + HDSDI | CVBS + HDSDI |
| 16 | Menu text output | CVBS | CVBS | CVBS |
| 17 | SD-SDI output (OPTION BOARD) | Yes | yes | yes |
| 18 | External Video in | 2x SDI or 2xCVBS | 3x HDSDI / SDI | 3x HDSDI / SDI |
| 19 | External video out | 1x selectable 1 or 2 | 2x selectable 1,2 or 3, VF + HDSDI out | 2x selectable 1,2 or 3, VF + HDSDI out |
| 20 | Teleprompter | CVBS, up to 20% of the cable length | CVBS, full cable length | CVBS, full cable length |
| 21 | Repeater possible | Yes (extending cable length to 2 km) | Not planned, existing repeater is incompatible | No |

3G Triax / Fiber / 10G Fiber (basics)

3G adaptors **Triax** and Fiber

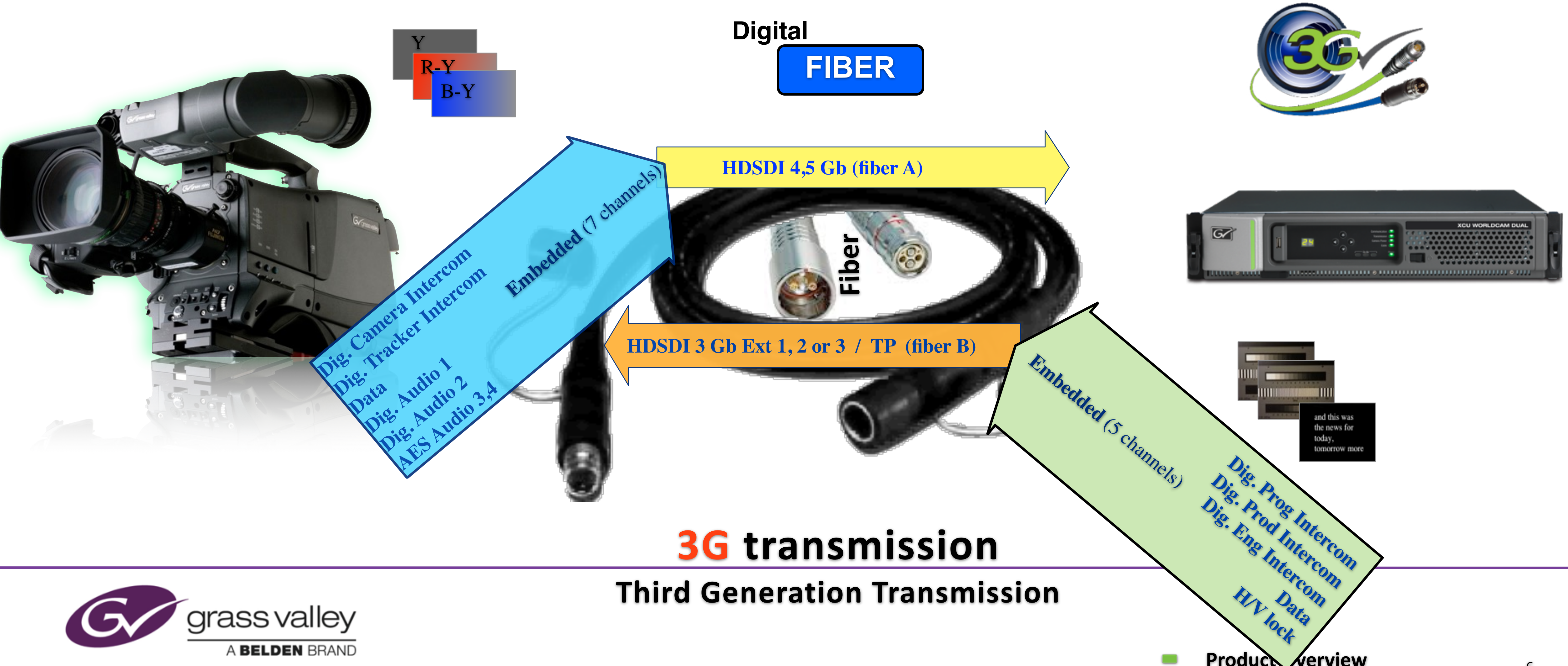


3G transmission

Third Generation Transmission

3G Triax / Fiber / 10G Fiber (basics)

3G adaptors **Fiber** and Triax



3G Triax / Fiber / 10G Fiber (basics)

10G adaptors **Fiber**



ST 2022-6: “Transport of High Bit Rate Media Signals over IP Networks (HBRMT)”

3G Triax / Fiber / 10G Fiber (basics)

10G adaptors **Fiber** ()

Hybride
FIBER
XS

Power



10G over IP (SMPTE 2022-6) (fiber A)

10G over IP (SMPTE 2022-6) (fiber B)

3G Triax / Fiber / 10G Fiber (basics)

products for **2011/2012**

Basestation



SXP LDK 4475

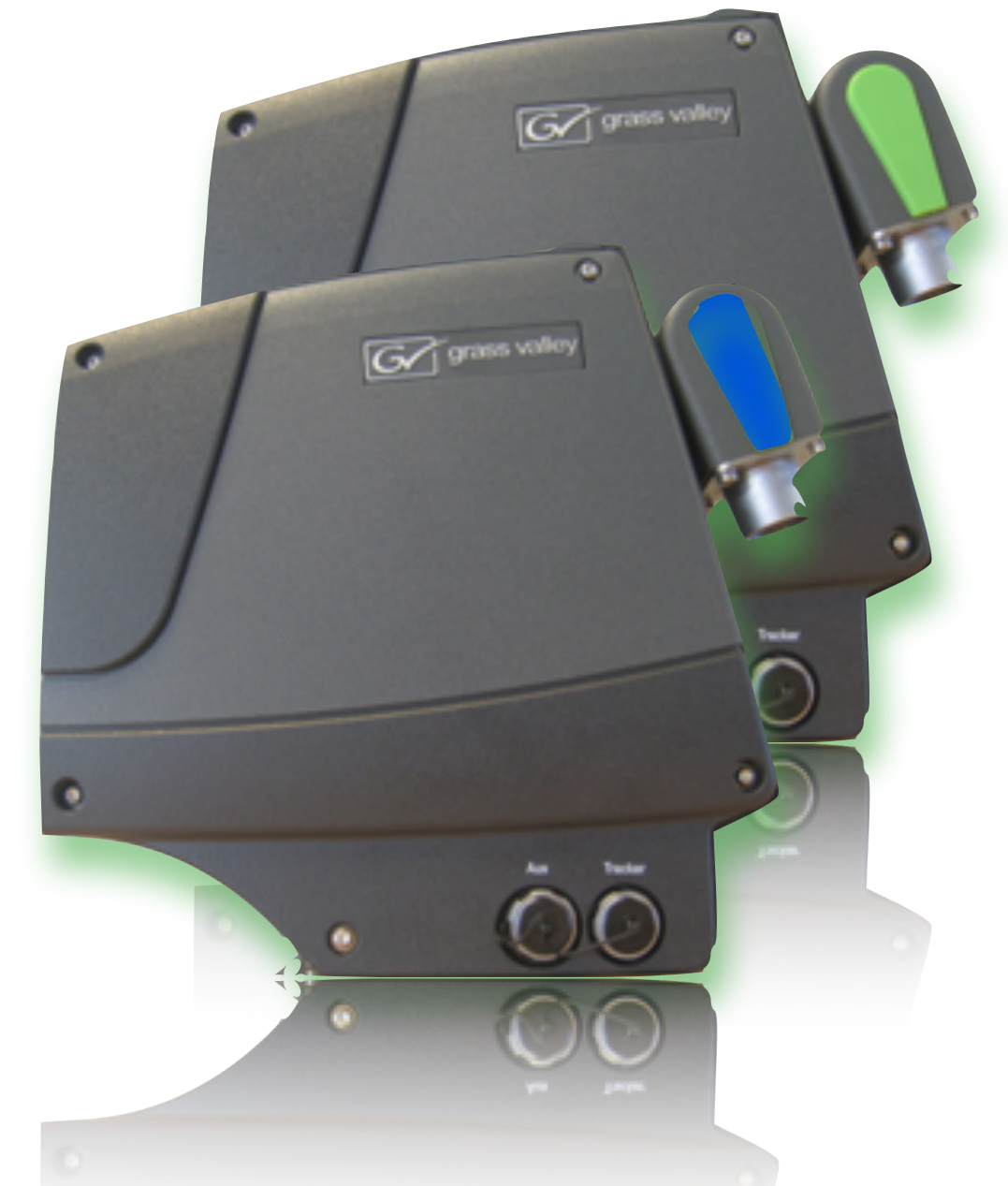


LDK4400 Triax

LDK4410 Fiber

LDK4420 Twin

LDK4430 3 speed



3G Triax Adaptor LDK 5418/19
3G Fiber Adaptor LDK 5420/21

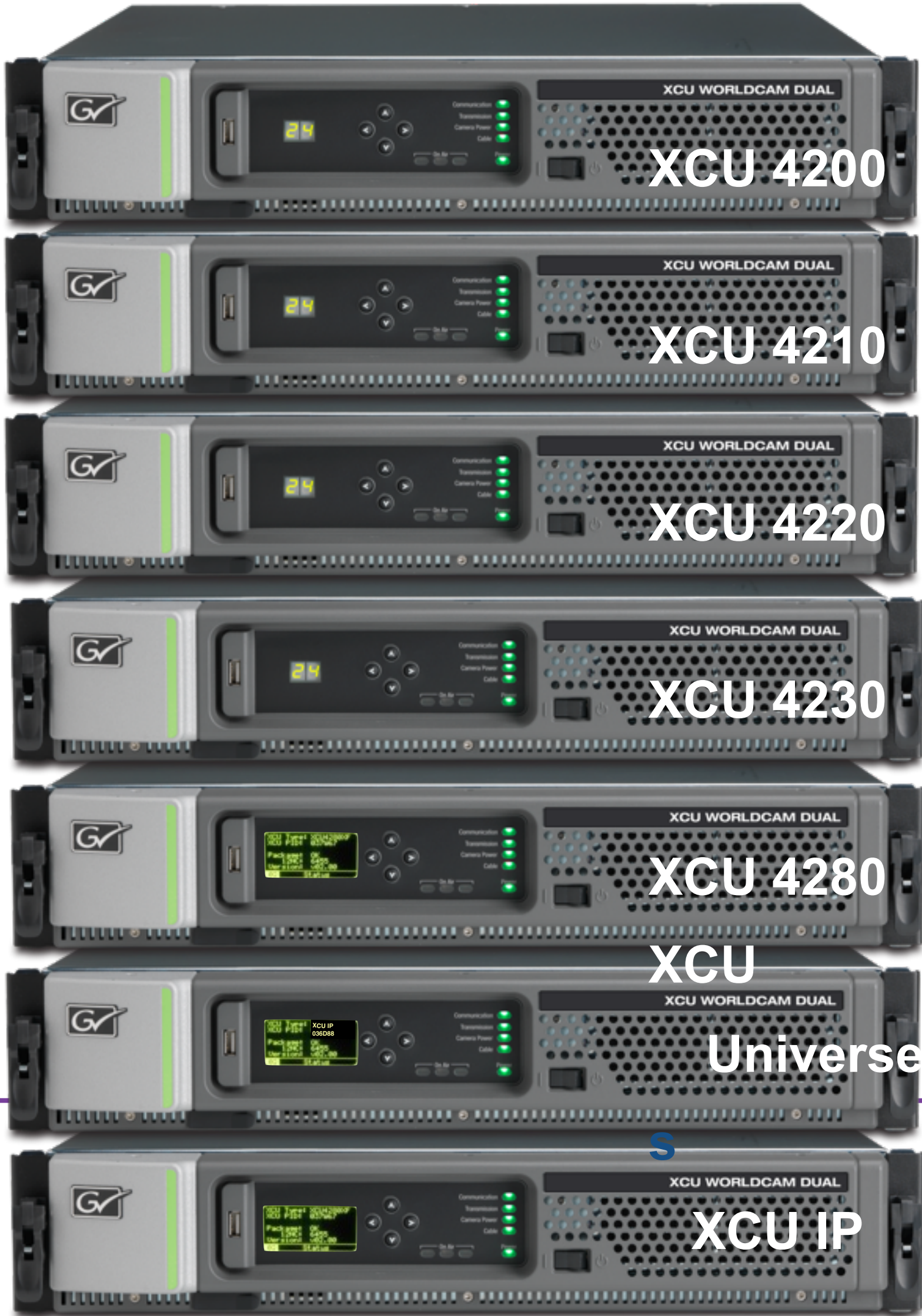
/ for LDX

3G Triax / Fiber / 10G Fiber (basics)

products for 2013/2014/2015



SXP LDK 4475



XCU 4200

Triax

XCU 4210

Fiber

XCU 4220

Dual

XCU 4230

Twin

XCU 4280

XF Fiber

XCU

Universe

XF Fiber

XCU IP

XF Fiber



3G Triax Adaptor LDX 5640

3G Fiber Adaptor LDX 5650

10G Fiber Adaptor LDX 5680



3G Triax / Fiber / 10G Fiber (basics)

products for **2013/2014**



LDK 4425/26/27/29

3G Triax / Fiber / 10G Fiber (basics)

3G adaptors Fiber and Triax (3th Generation)

3G Transmission

- ◆ NO MORE differences between Fiber and Triax
- ◆ Supporting ALL HD video formats (incl. 1080p50/60)
- ◆ Longer cable runs for 3G Fiber
- ◆ Having maximum reliability & robustness in the field for 3G Triax (25% longer cable runs)
- ◆ Having full transmission diagnostics under all conditions (this is a must)
- ◆ Conversion from Triax > Fiber > Triax available



No longer, the transmission choice you make at the moment of purchase, will limit the productions you can say 'yes' to.

3G Triax / Fiber / 10G Fiber (basics)

10G adaptors Fiber (*introduced 2015*)

10G Adaptor for LDX

XF Transmission

- ✦ New **Transmission** system between Camera Adapter and XCU
- ✦ **10Gb Fiber** only transmission, using standard SMPTE cables
- ✦ **Xtreme Flexible** transmission offers required bandwidth for high frame rates
- ✦ Direct Frame Transmission from Camera head to XCU output
NO frame storage in camera head needed
- ✦ “Future-proof” transmission system ; Support of different protocols
 - **3G (4,5Gb) format** (pending)
 - **10G HDSDI/SDSDI over IP** Supporting SMPTE 2022-6 based on standard protocol



3G Triax / Fiber / 10G Fiber (basics)

Adaptors Fiber and Triax

3G & 10G Adaptor for LDX only

- ◆ Triax (**Green**) - LDX 5640
- ◆ Fiber (**Blue**) - LDX 5650
- ◆ Fiber (**Yellow**) - LDX 5660
- ◆ New docking connector type used for LDX
- ◆ New mounting method for LDX

With LDX

3G is Third Generation Transmission

- | | |
|-------------------------|-----------|
| 1: Analog RGB | 1990-2000 |
| 2: Analog component | 2000-2013 |
| 3: Digital Transmission | 2013- now |

With LDX

3G is Third Generation Transmission

4,5 G fiber for 1080i or 1080p
3 speed LDK8300

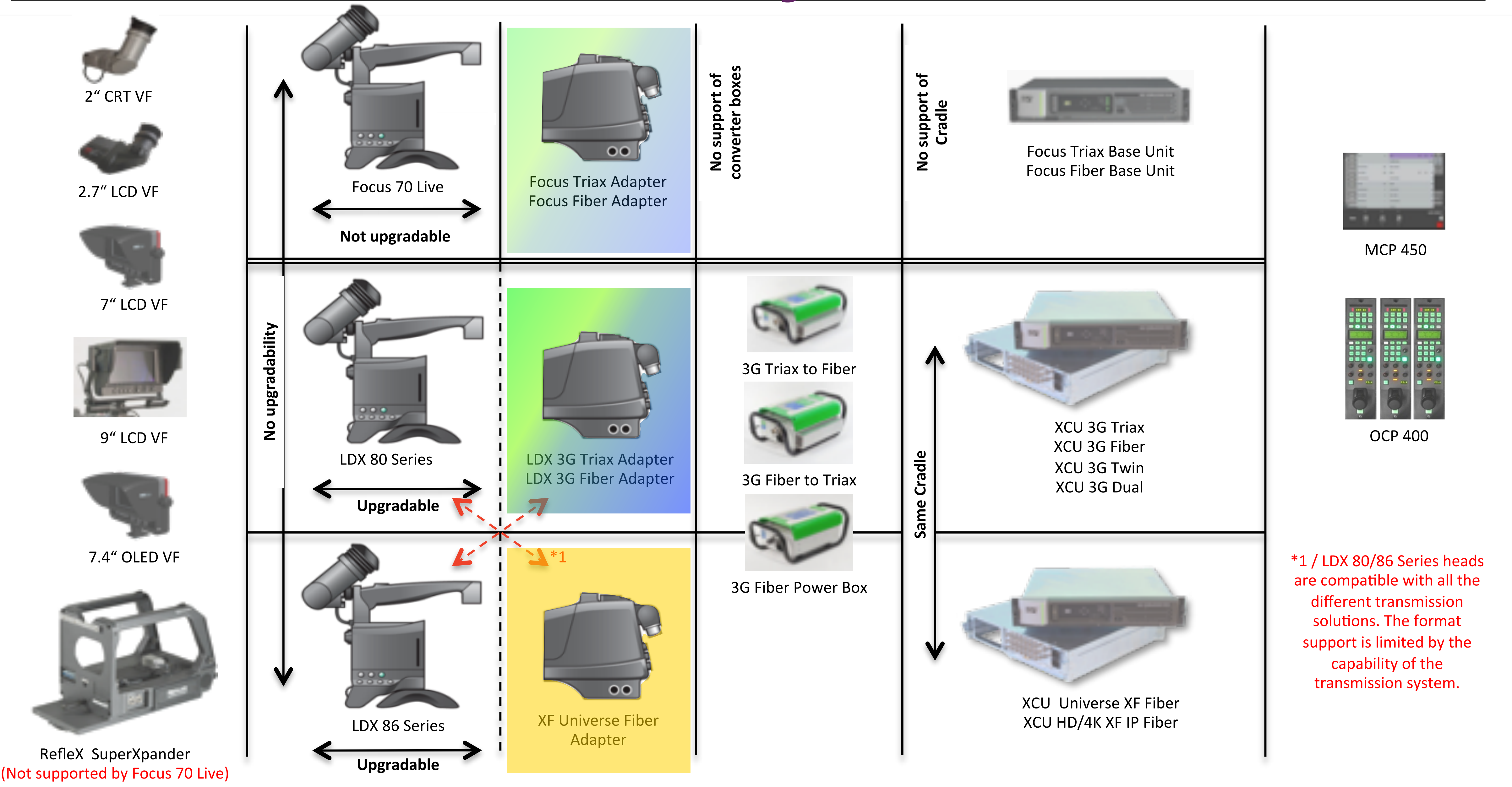
With LDX 86

10G XF adaptor

- 1: for 1 , 3 , 6 speed
- 2: for 4K
- 3: for XDR



LDXseries GrassValley (Compatibility)



3G Triax / Fiber / 10G Fiber (basics)

| Transmission | Named | | Connections | Mode | Power | Formats |
|---------------|--------------------|--|-------------|---------------------|---------|---------------------------------------|
| Digital Triax | 3G (Third Gen.) | | one core | COFDM | 300V DC | 1080i/p 720p |
| | | | | | | |
| Fiber | 3G | | Fiber A/B | HDSDI (4,5Gb) | 300V DC | 1080i/p 720p (3 speed for 8300) |
| Fiber | 10G | | Fiber A/B | SMPTE 2022 or 3G | 300V DC | All + 3/6 speed |

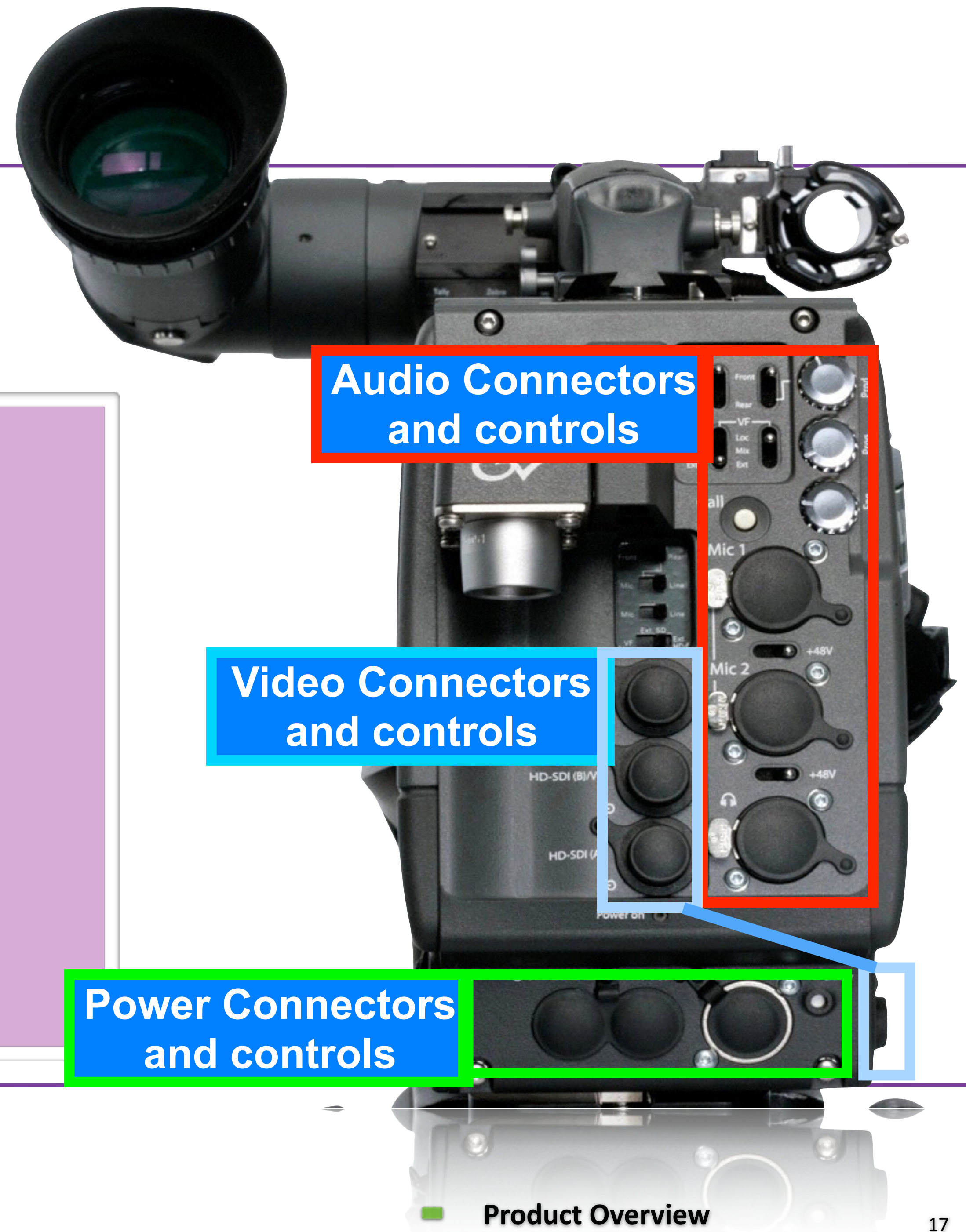


3G Triax / Fiber / 10G Fiber (basics)

3G adaptors Triax and Fiber LDK5419 / 5421

3G Adaptor

- ◆ Audio
XLR Audio channel 1, 2 / AES Audio channel 3, 4
- ◆ Video
BNC for HDSDI live or live+VF and Ext, analog TP out
- ◆ Power
Scriptboard, power TP unit (+ ON air pin)
- ◆ Controls
Ext/Y mix, Intercom select ENG/Prod. Fantom power

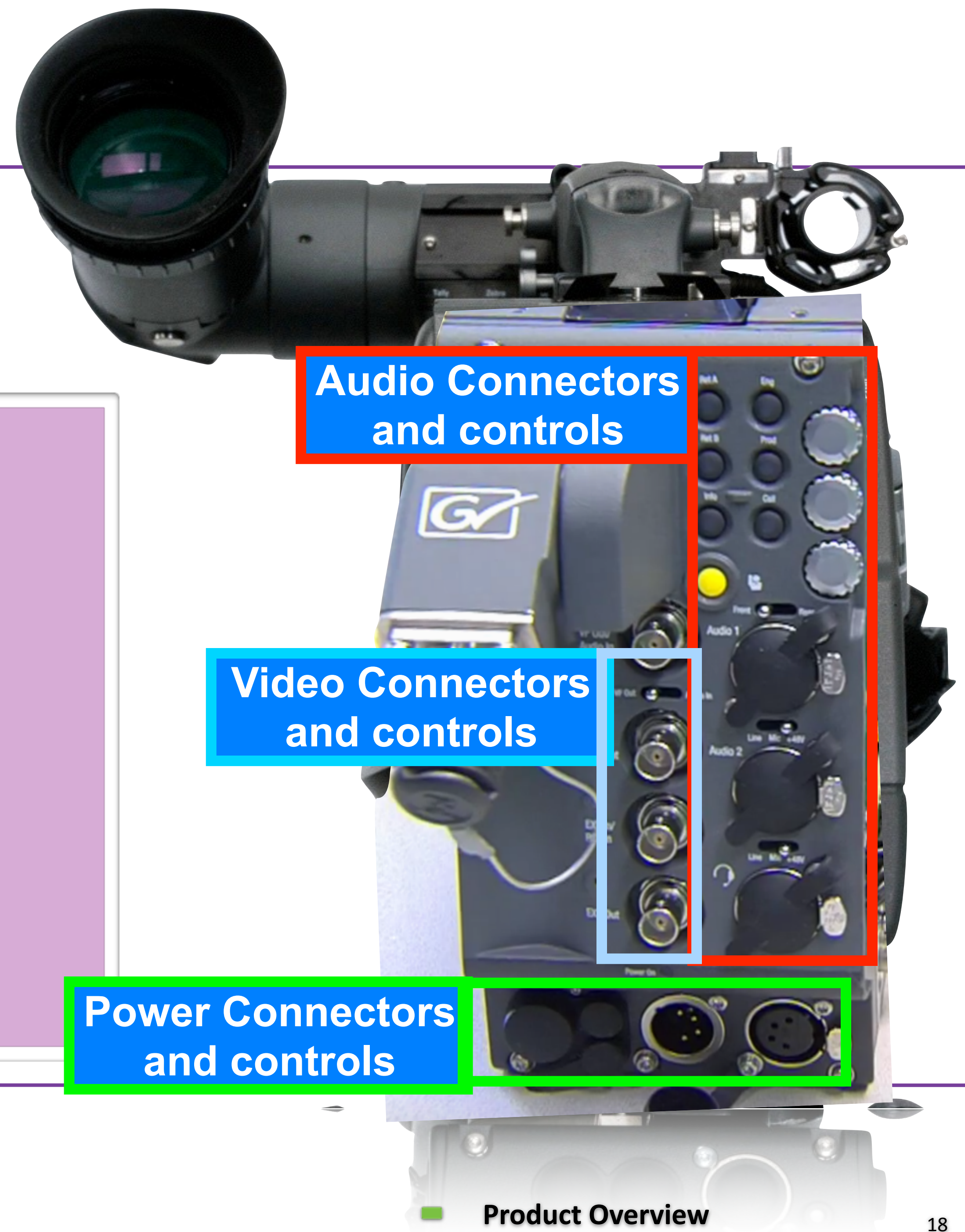


3G Triax / Fiber / 10G Fiber (basics)

3G or 10G adaptors **Fiber** LDX 5640/50/60

3G/10G Adaptor

- ◆ Audio
XLR Audio channel 1, 2 / AES Audio channel 3, 4
- ◆ Video
BNC for HDSDI live or live+VF and Ext, analog TP out
- ◆ Power
Scriptboard, power TP unit (+ ON air pin)
- ◆ Controls
Ext/Y mix, Intercom select ENG/Prod. Fantom power



3G Triax / Fiber / 10G Fiber (basics)

This part gives you some more details about the
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In this session:

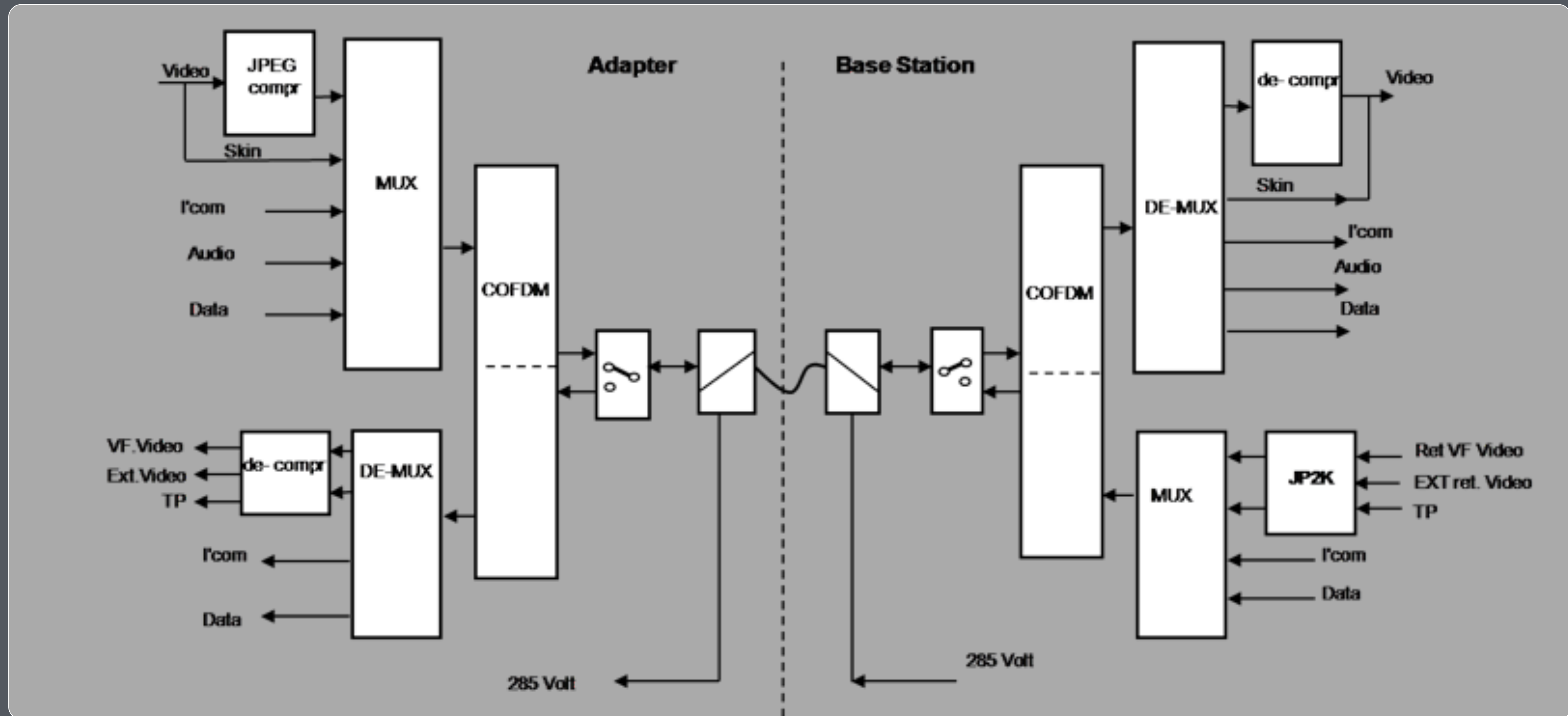
- ◆ **Triax or Fiber basics**
- ◆ **3G Triax Technical**
- ◆ **Fiber Technical**
- ◆ **Diagnostics**

Ask the
Expert!



3G basics Triax

Technical part
Only for Service experts

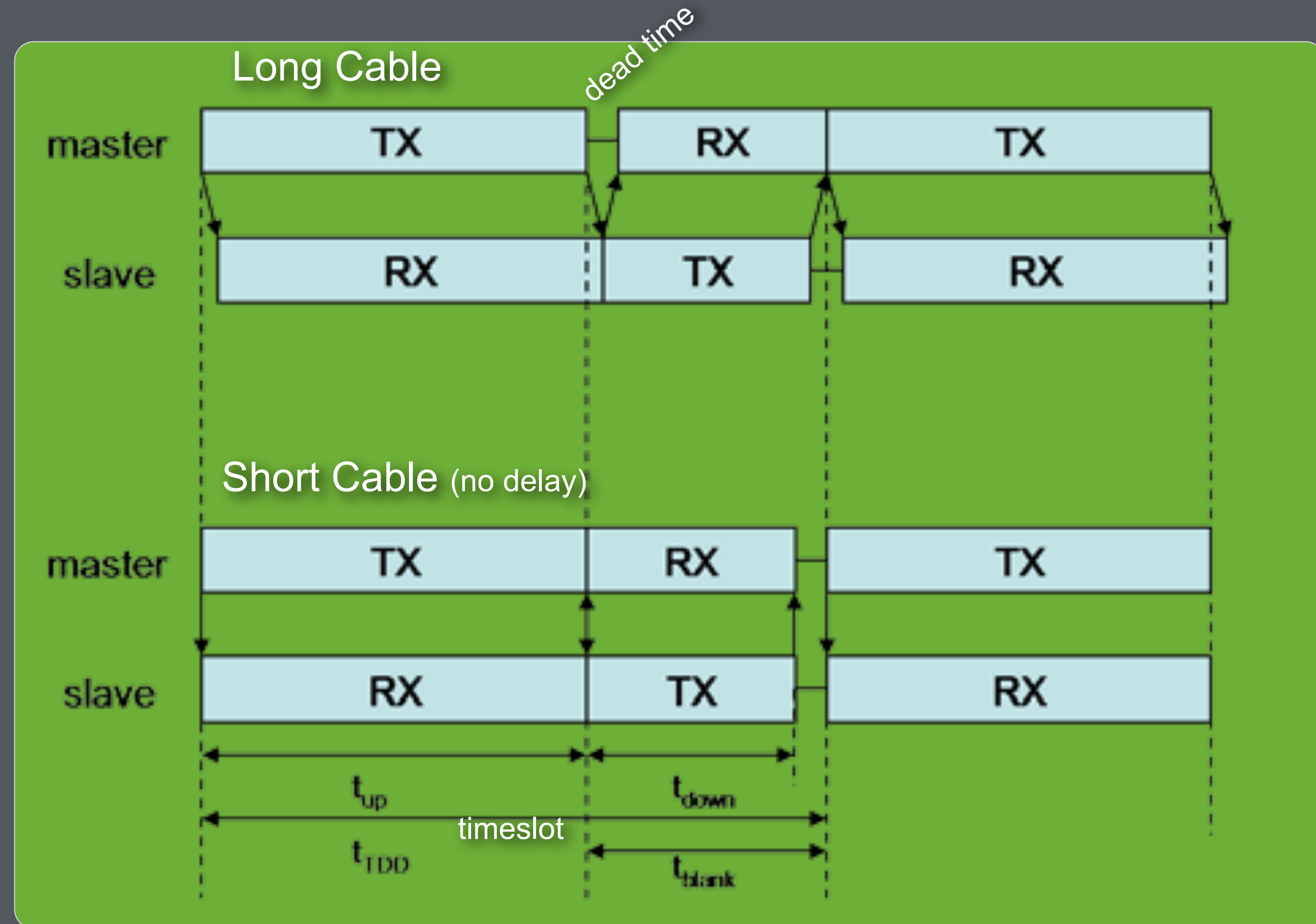


3G basics Triax

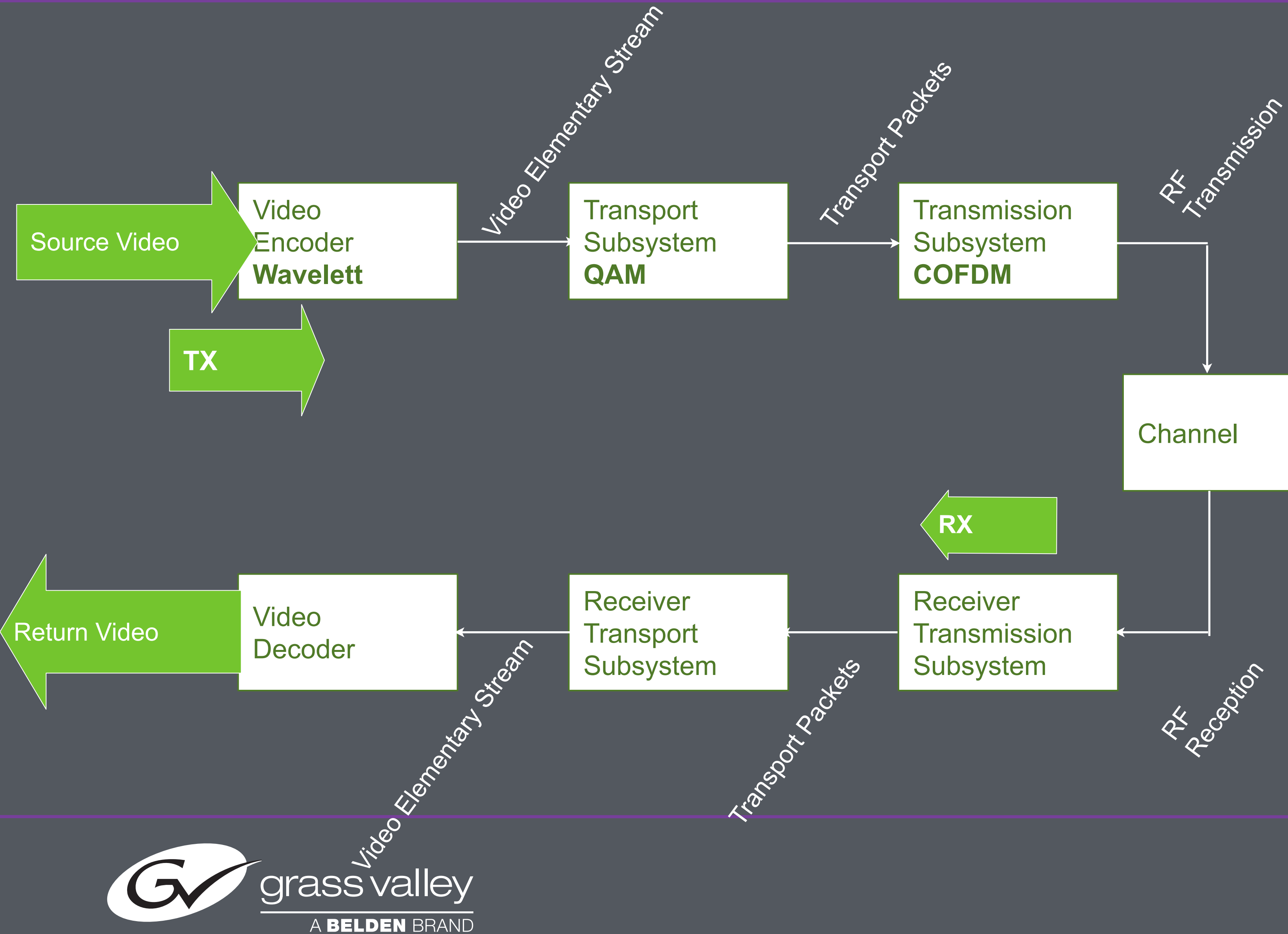
Compression is done segmented to reduce delay

Time Division Multiplex:

- ♦ Camera and Basestation do not send at same time but in multiplex
- ♦ Camera is master, Slave (Basestation) only sends when master is finished.
- ♦ Multiplex switch is controlled by FPGA
- ♦ Camera/Adaptor sends symbols and Basestation returns with symbols (data blocks).
- ♦ To control delays in the triax cable a dead time is used.



3G basics Triax



- Digital Video source (HDSDI)
- Encoded into Wavelet and stream
- Multiplexed with Video/Data streams
- Modulated on QAM
- OFDM created
- Broadcast via RF triax

- Received via RX triax
- Demodulated from QAM
- Demultiplexed Video/Data streams
- Decoded into Wavelet and stream
- Digital Video source (HDSI)

3G basics Triax

Wavelett JPEG2000 10bit 4.2.2 compression

QAM – higher numbers require more sensitive equipment

- ◆ 16 – 16 symbols (or phases)
- ◆ 64 – 64 symbols
- ◆ 256 – 256 symbols

OFDM Orthogonal frequency-division multiplexing

Digital data signals are transmitted over radio frequency (RF) carrier signals on a cable (triax) system

For two-way communication

"downstream" direction is from the camera to the basestation

"upstream" direction is from the basestation to the camera

Digital data must be encoded into RF waveforms (OFDM)

Technology derived from early modem work on Telephone systems

Triax transmission bandwidth over 100 MHz range

3G basics Triax

Compression: Near Lossless !

- ◆ Lossless data compression is a class of data compression algorithms that allows the exact original data to be reconstructed from the compressed data. The term lossless is in contrast to lossy data compression, which only allows an approximation of the original data to be reconstructed, in exchange for better compression rates.
- ◆ Lossless data compression is used in many applications. For example, it is used in the ZIP file format and in the Unix tool gzip. It is also often used as a component within lossy data compression technologies (e.g. lossless mid/side joint stereo preprocessing by the LAME MP3 encoder and other lossy audio encoders).
- ◆ Lossless compression is used in cases where it is important that the original and the decompressed data be identical, or where deviations from the original data could be deleterious. Typical examples are executable programs, text documents and source code. Some image file formats, like PNG or GIF, use only lossless compression, while others like TIFF and MNG may use either lossless or lossy methods. Lossless audio formats are most often used for archiving or production purposes, with smaller lossy audio files being typically used on portable players and in other cases where storage space is limited and/or exact replication of the audio is unnecessary.

3G basics Triax

Compression:

◆ Main channel:

Wavelett (JPEG2000) encoder compresses 10 bit video, 4:2:2, full resolution. Up to 1080p60 (current status).

◆ Steps of the encoding / compression:

A wavelet transform is done twice on the image. This results in 3 resolution levels.

The video fields are then split up into precincts (blocks of 512x128), quantized and encoded in a bitstream. As soon as a precinct is complete, it can be transmitted.

◆ Return channels:

2x HD, 1xSD. The HD channel is downsampled horizontally in the FPGA and send to a dedicated IC for compression (ADV212) The compression works similar as the main channel, but on a complete field instead of precincts. This results in a higher delay for the compression (2 fields encoding, 2 fields decoding). High bitrate is used for the HD channels is and for the SD channel (teleprompter) . At the decoder side (camera adapter) the HD video is upscaled to full resolution again.

Warning

3G basics Triax

QAM: (quadrature amplitude modulation)

QAM (quadrature amplitude modulation) is a method of combining two amplitude-modulated (AM) signals into a single channel, thereby doubling the effective bandwidth. QAM is used with pulse amplitude modulation (PAM) in digital systems, especially in wireless applications.

In a QAM signal, there are two carriers, each having the same frequency but differing in phase by 90 degrees (one quarter of a cycle, from which the term quadrature arises). One signal is called the I signal, and the other is called the Q signal. Mathematically, one of the signals can be represented by a sine wave, and the other by a cosine wave. The two modulated carriers are combined at the source for transmission. At the destination, the carriers are separated, the data is extracted from each, and then the data is combined into the original modulating information.

3G basics Triax

QAM transport *(Explained QAM 4)* (Quadrature-Amplitude-Modulation)

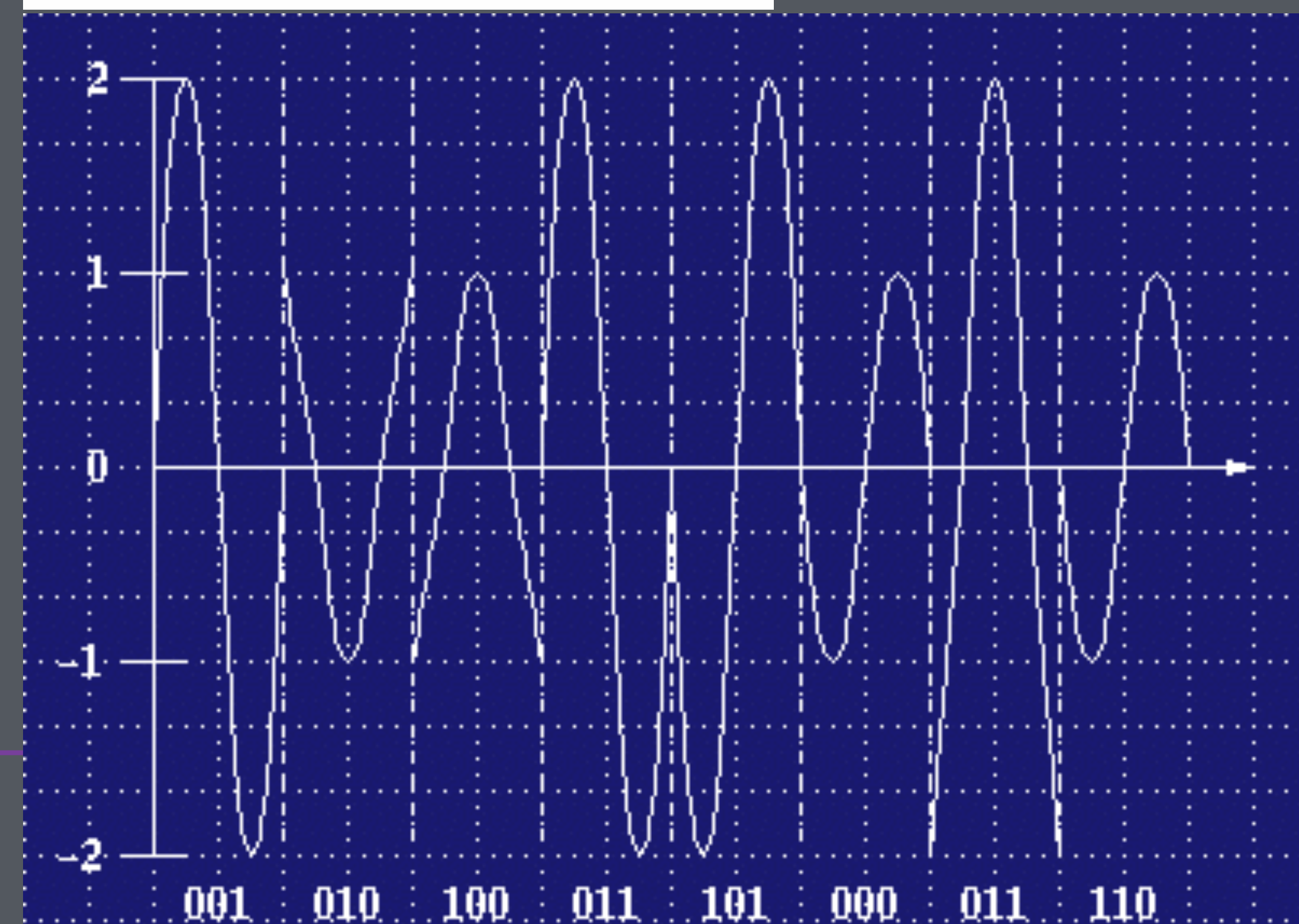
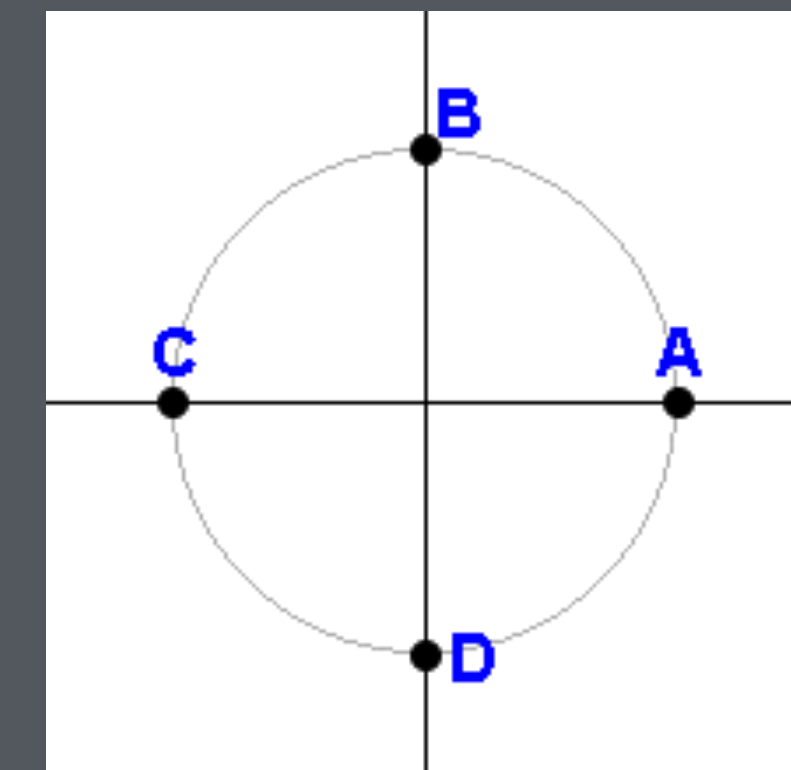
- ✦ Quadrature => 4 symbol (phase) states (A,B,C,D)
- ✦ Represent bit values as a combination of amplitude modulation and phase shift keying

- ✦ Example: *(QAM 4)*

001010100011101000011110

| | | | | | | | |
|------|-------------------|-------------------|-------------------|-------------------|------|-------------------|-------------------|
| 001 | 010 | 100 | 011 | 101 | 000 | 011 | 110 |
| 2A n | 1A ^{1/4} | 1A ^{1/2} | 2A ^{1/4} | 2A ^{1/2} | 1A n | 2A ^{1/4} | 1A ^{3/4} |

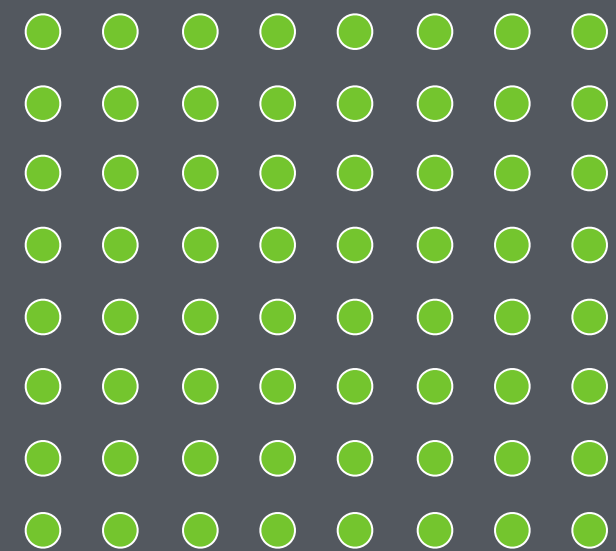
| Bit value | Amplitude | Phase shift |
|-----------|-----------|-------------|
| 000 | 1 | None |
| 001 | 2 | None |
| 010 | 1 | 1/4 |
| 011 | 2 | 1/4 |
| 100 | 1 | 1/2 |
| 101 | 2 | 1/2 |
| 110 | 1 | 3/4 |
| 111 | 2 | 3/4 |



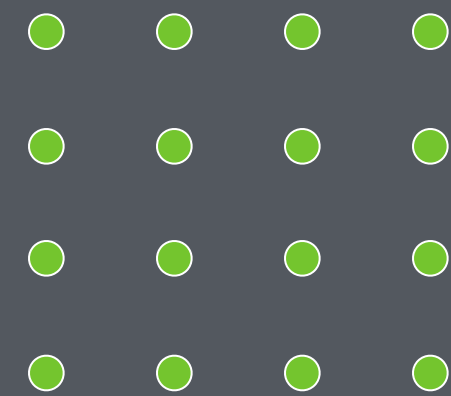
3G basics Triax

QAM256

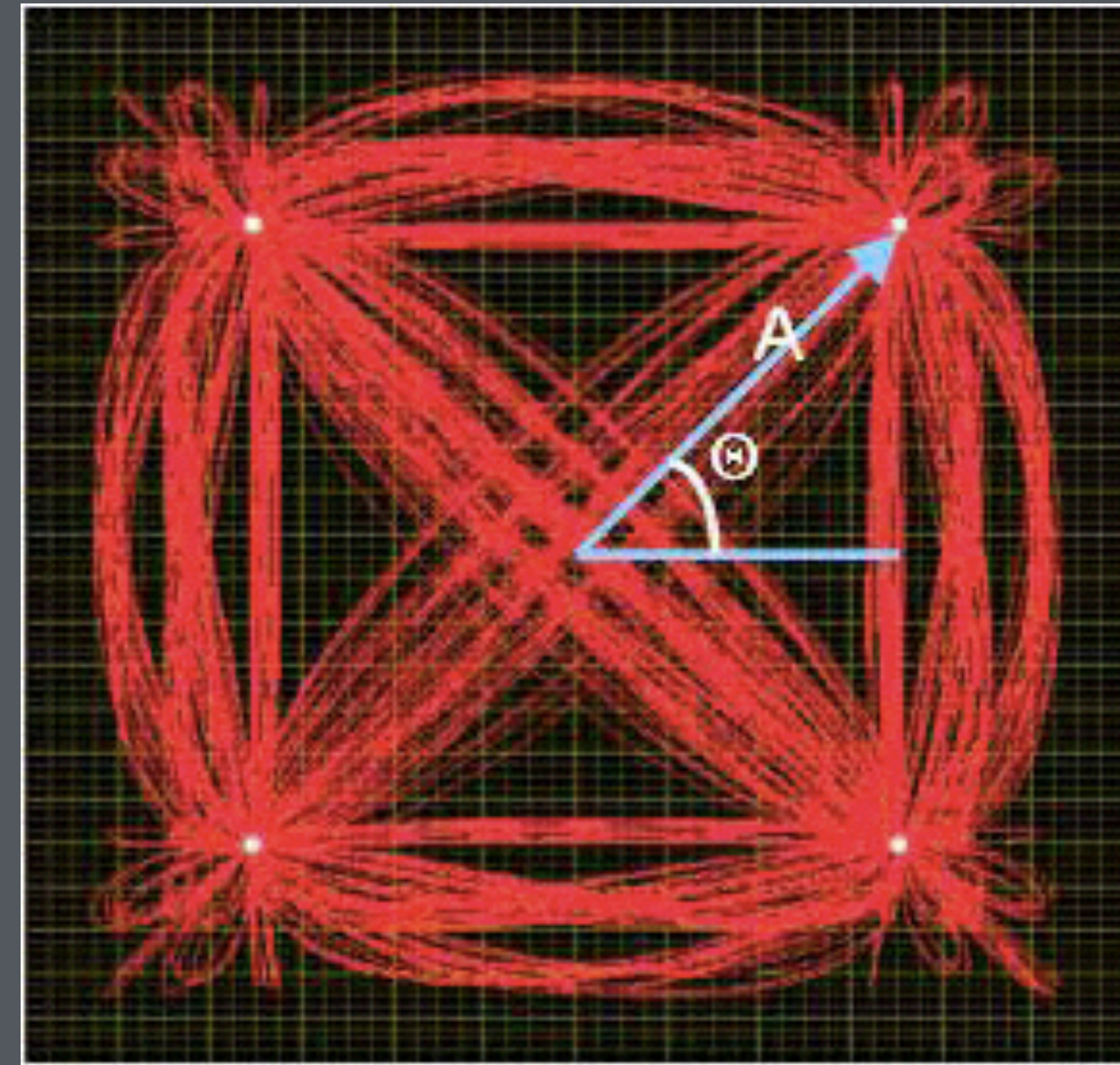
QAM64



QAM16

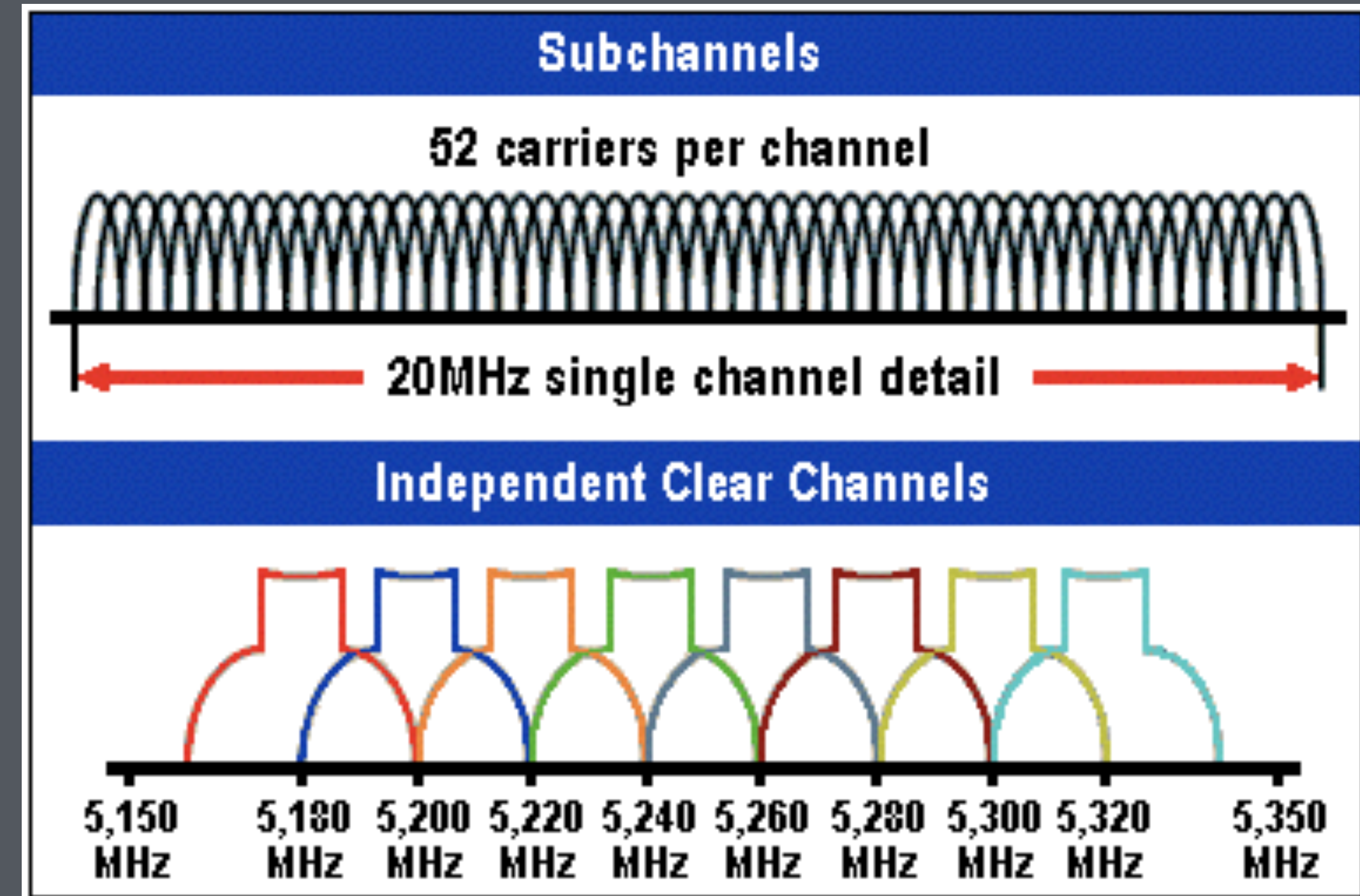


QAM4



3G basics Triax

- ◆ Orthogonal frequency-division multiplexing (OFDM), essentially identical to coded OFDM (COFDM) and discrete multi-tone modulation (DMT),
- ◆ Frequency-division multiplexing (FDM) scheme utilized as a digital multi-carrier modulation method.
- ◆ A large number of closely-spaced orthogonal sub-carriers are used to carry data.
- ◆ The data is divided into several parallel data streams or channels, one for each sub-carrier.
- ◆ Each sub-carrier is modulated with a conventional modulation scheme (such as quadrature amplitude modulation QAM) at a low symbol rate, maintaining total data rates similar to conventional single-carrier modulation schemes in the same bandwidth.



3G basics Triax

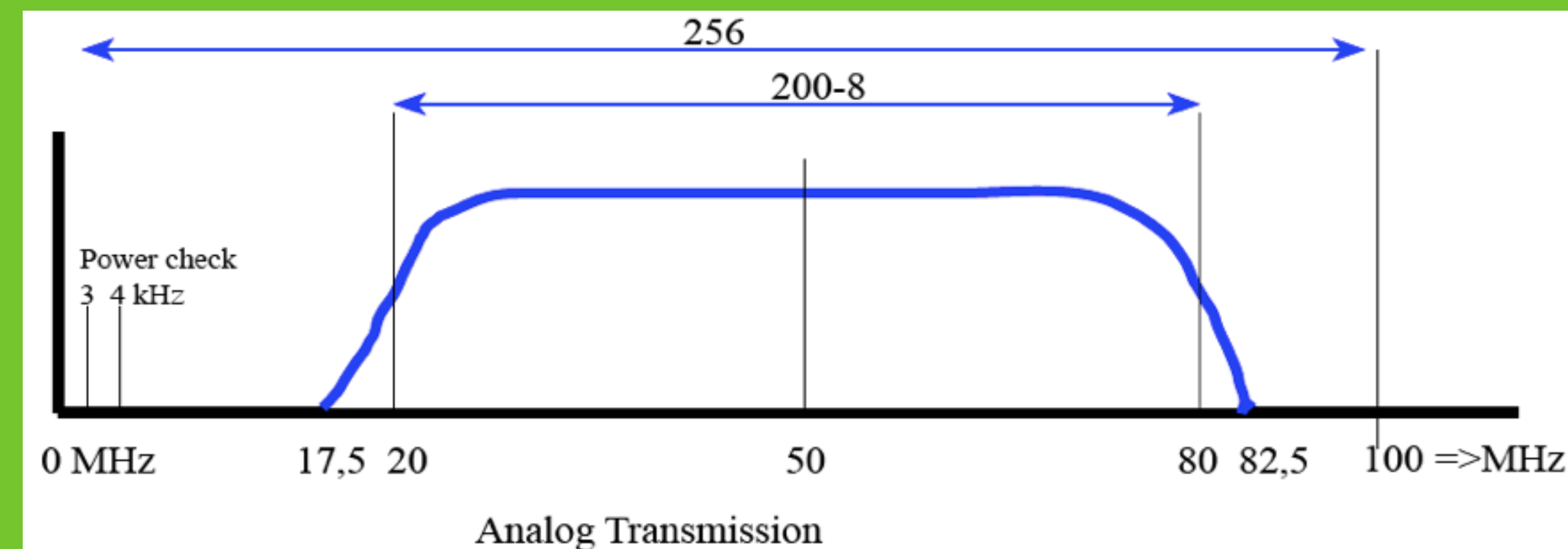
Signal Transmission:

from Camera to Base Station:

Live signal (raw 1,5 of 3 Gb) : 280 Mb
Audio (4 x) : 4 Mb/sec (sample rate 48 khz, 24 bits)
Intercom (2x) : 2 Mb/sec (sample rate 48 khz, 24 bits)
Control data : 0.1 Mb/sec
Private data : 0.1 Mb/sec One stream
Synchronisation : 0.1 Mb/sec

from BS to Camera:

Ret vid. 1 (raw 0.75Gb =1/2 HD) : 35 Mb
Ret vid. 2 (raw 0.75Gb =1/2 HD) : 35 Mb
TP-video (raw 270 Mb =SD) : 15 Mb
Intercom (3x) : 3 Mb/sec (sample rate 48 khz, 16 bits)
Control data : 0.1 Mb/sec
Private data : 0.1 Mb/sec One stream
Synchronisation : 0.1 Mb/sec

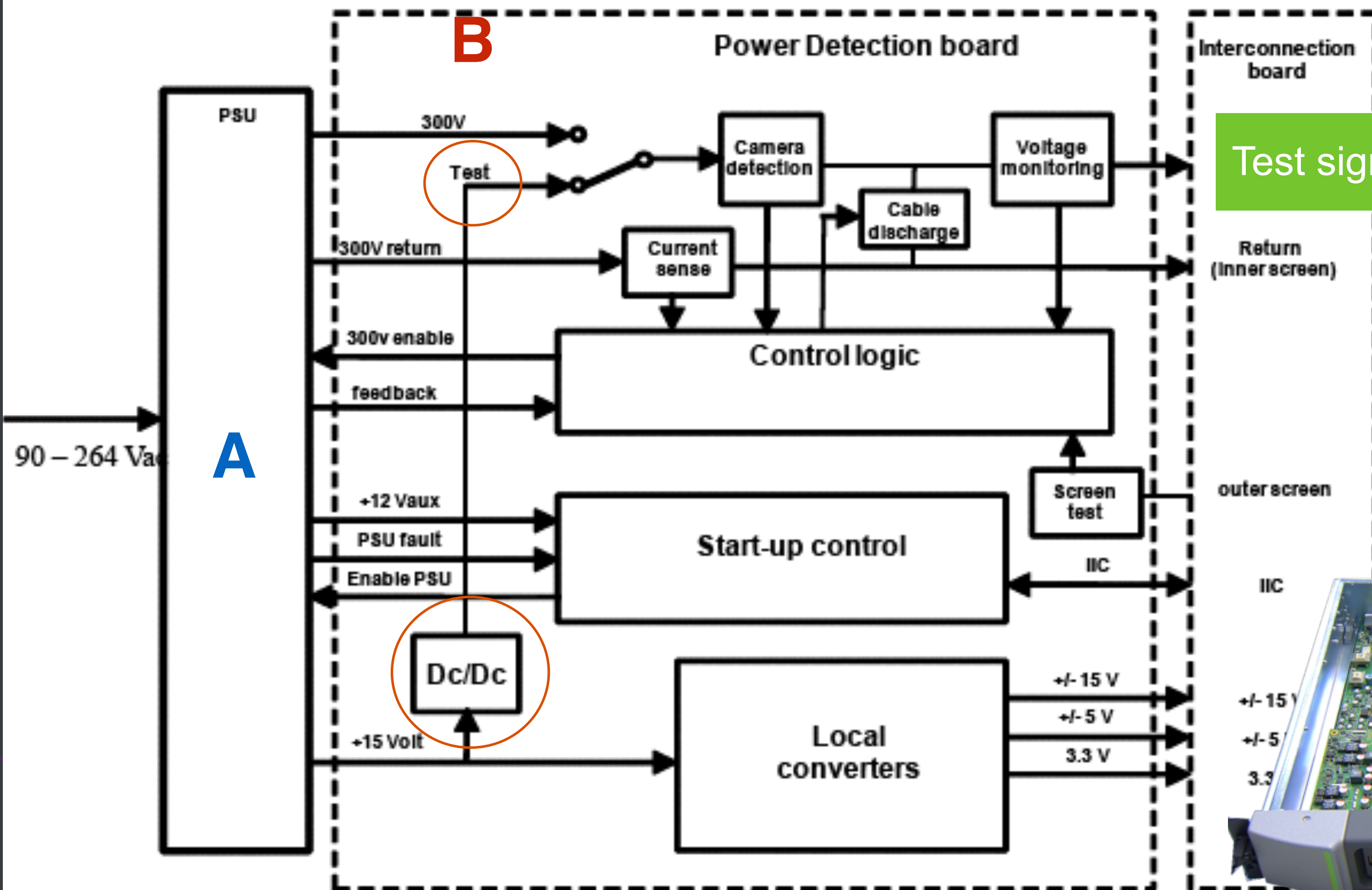


Transmission Control:

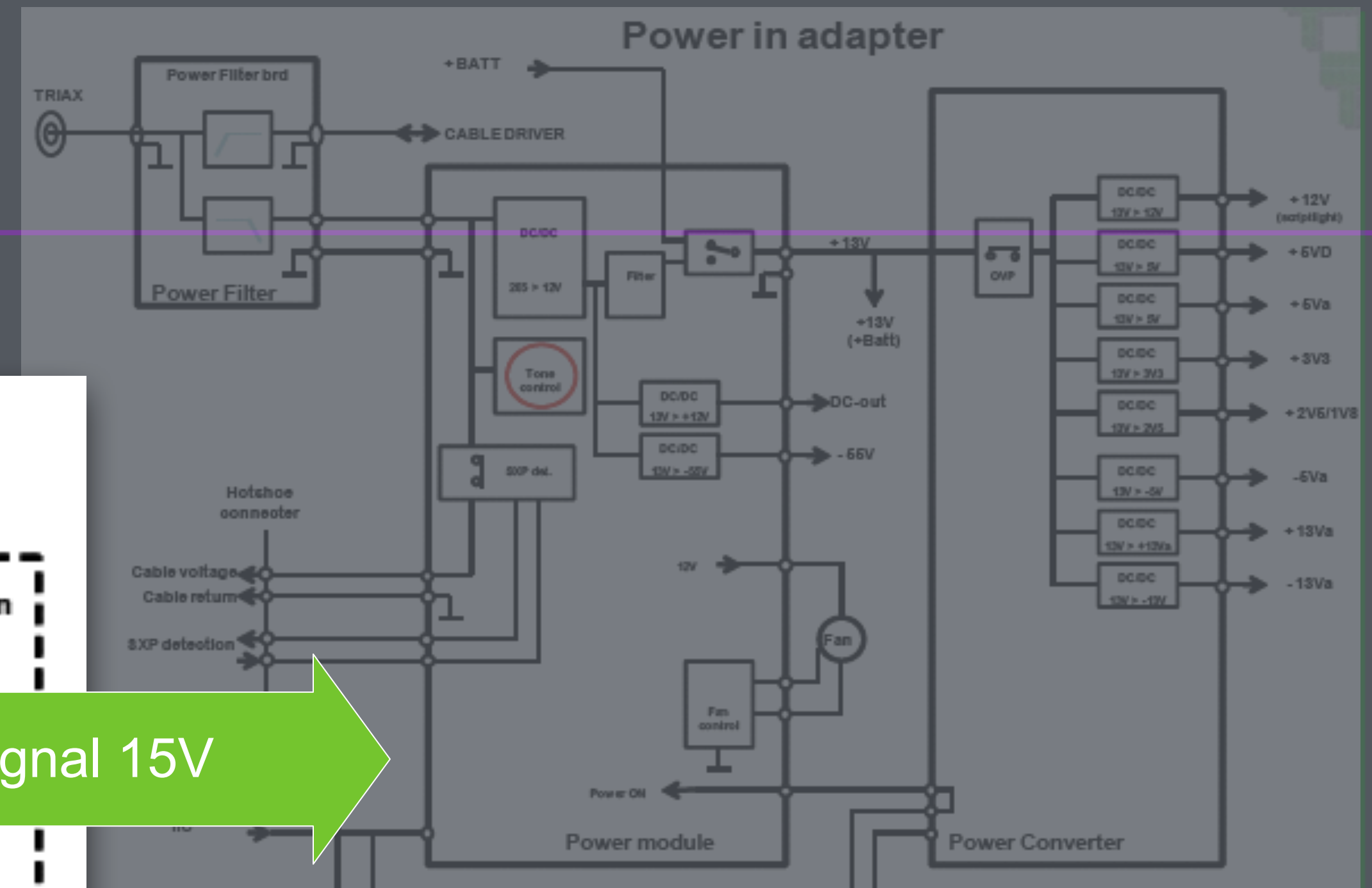
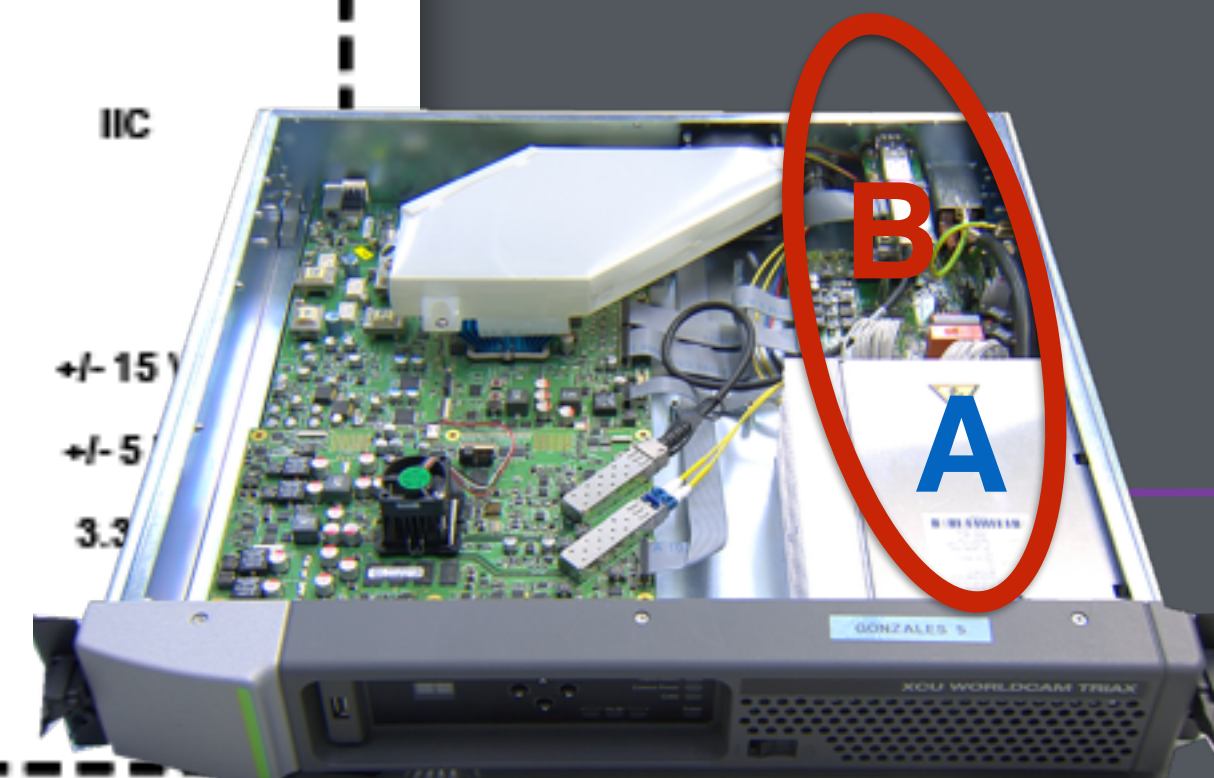
- **Transmission from Camera \Leftrightarrow Basestation is an Digital (Analog) signal.**
- A COFDM modulation is used to send data though the Triax.
- Cable driver has switchable and variable gain amplifiers and pre-emphasis.
Internal in the FPGA a controllable (Analog and Digital) pre-emphasis is created.

3G basics Power

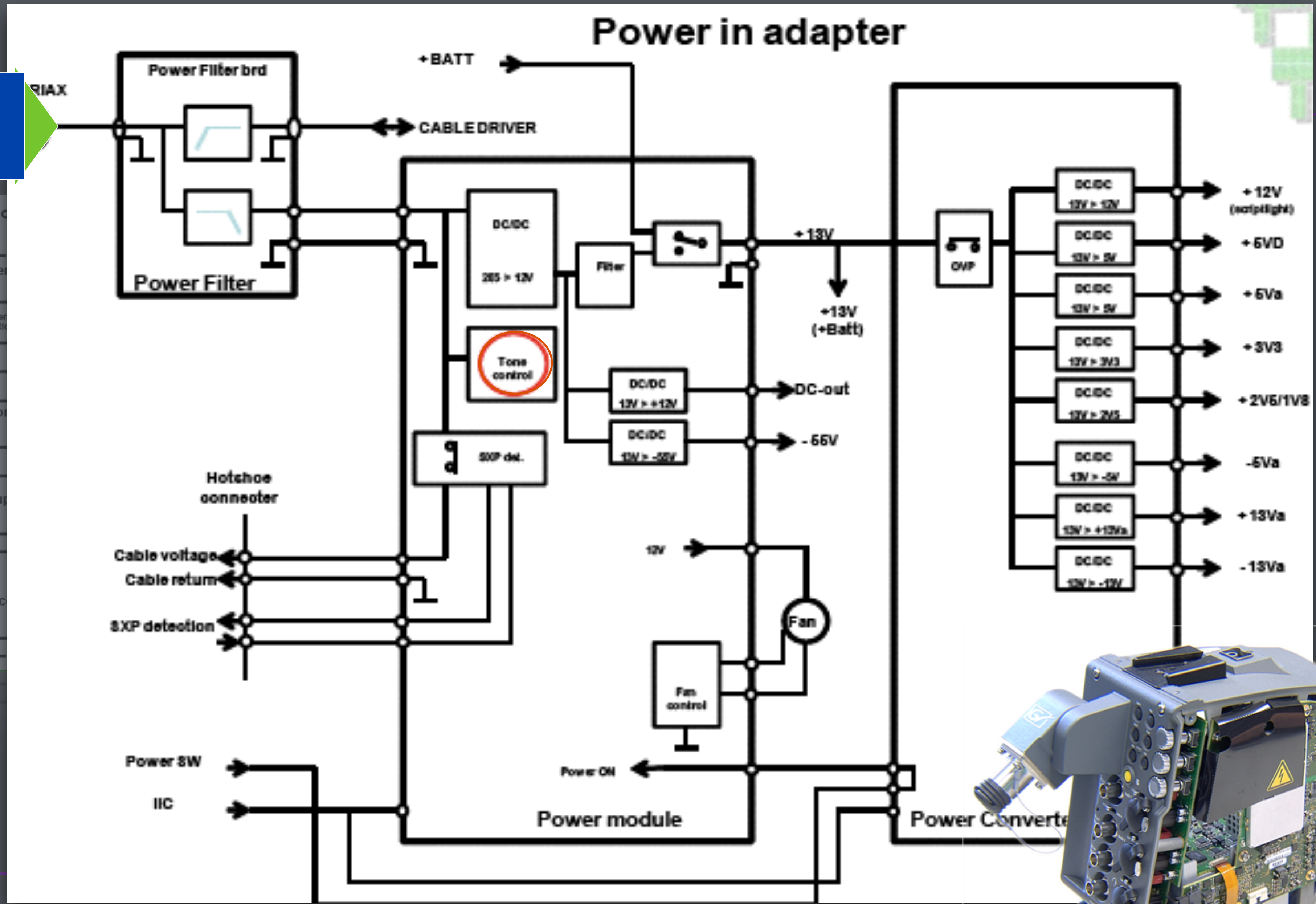
Base Station Power



Test signal 15V

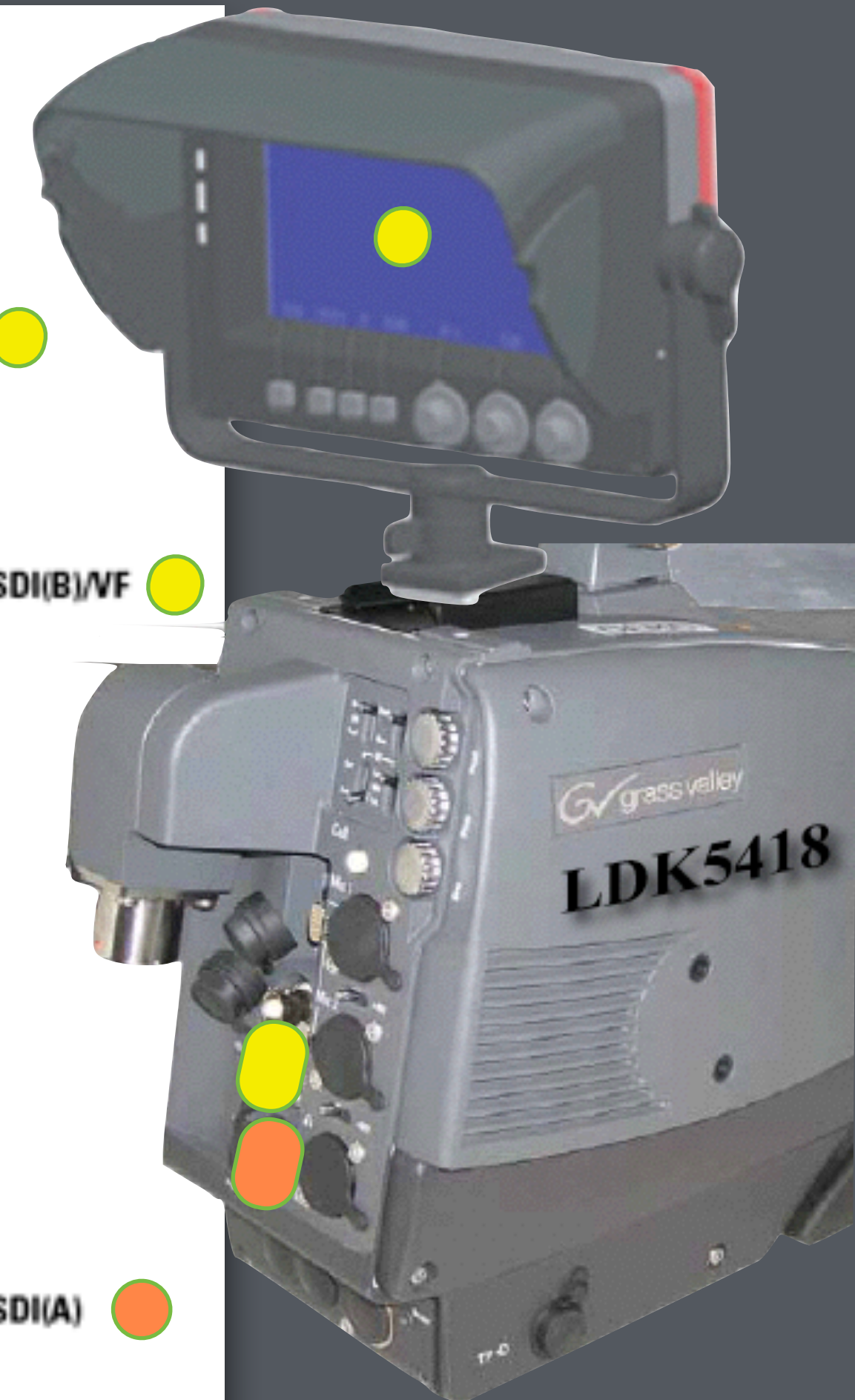
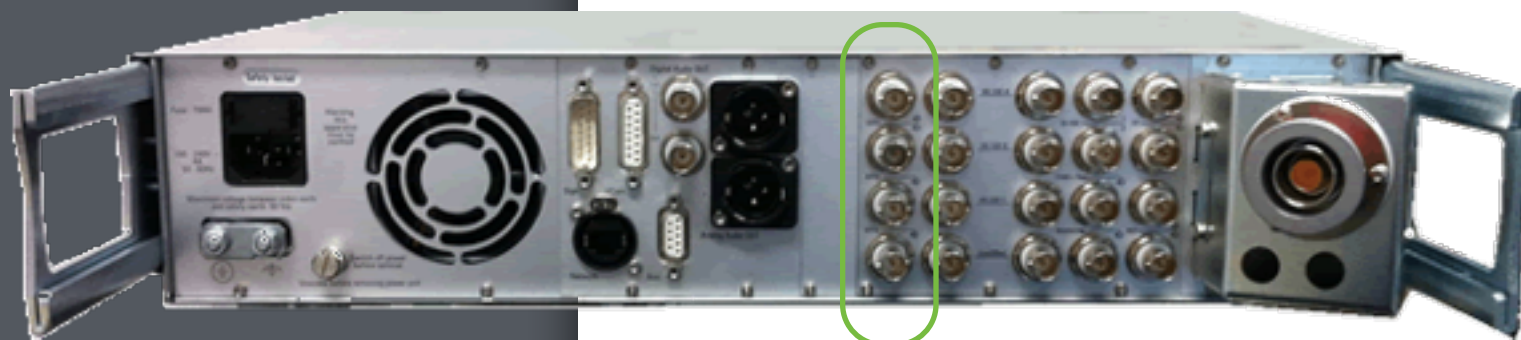
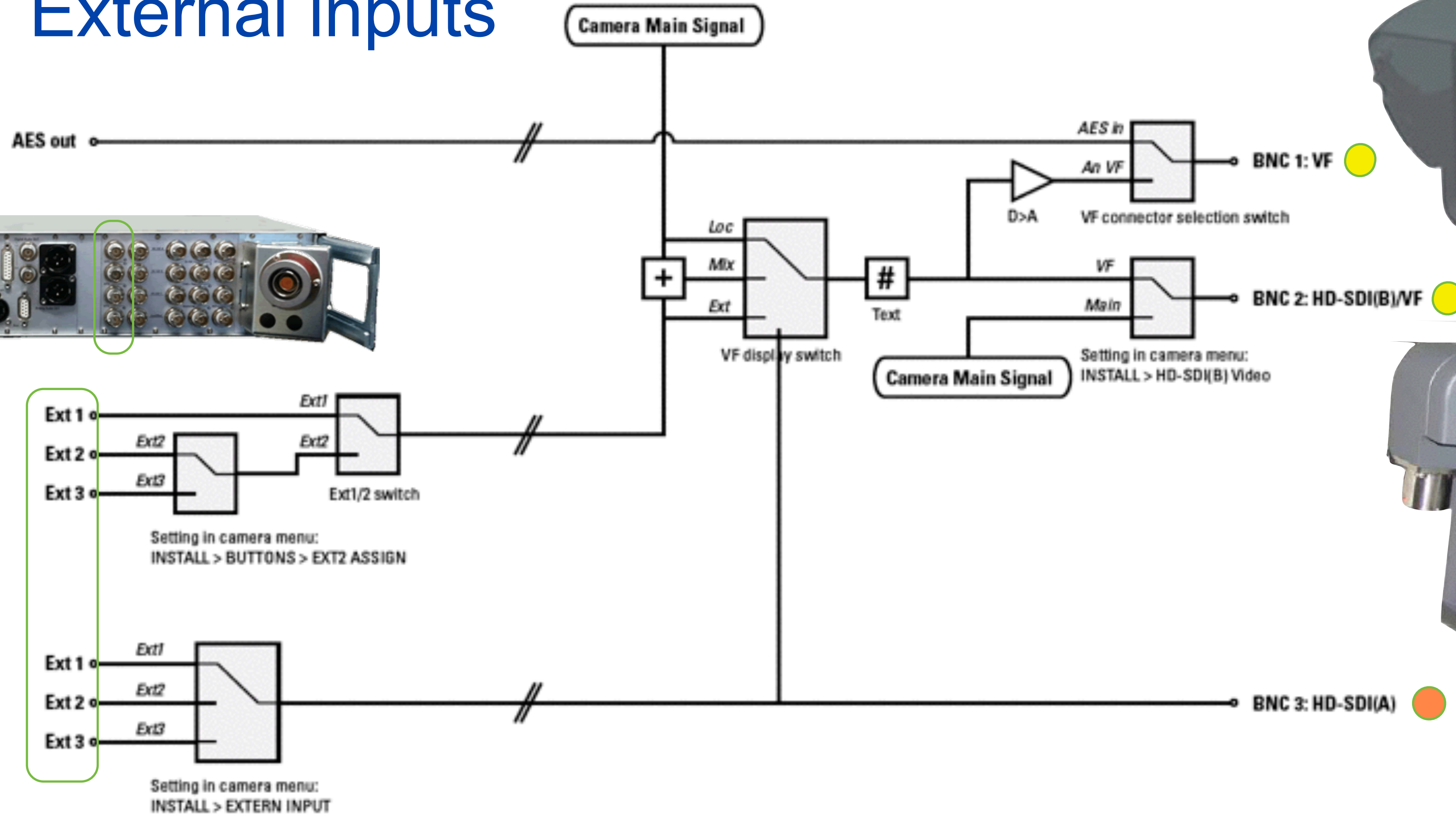


Te Tones 2x



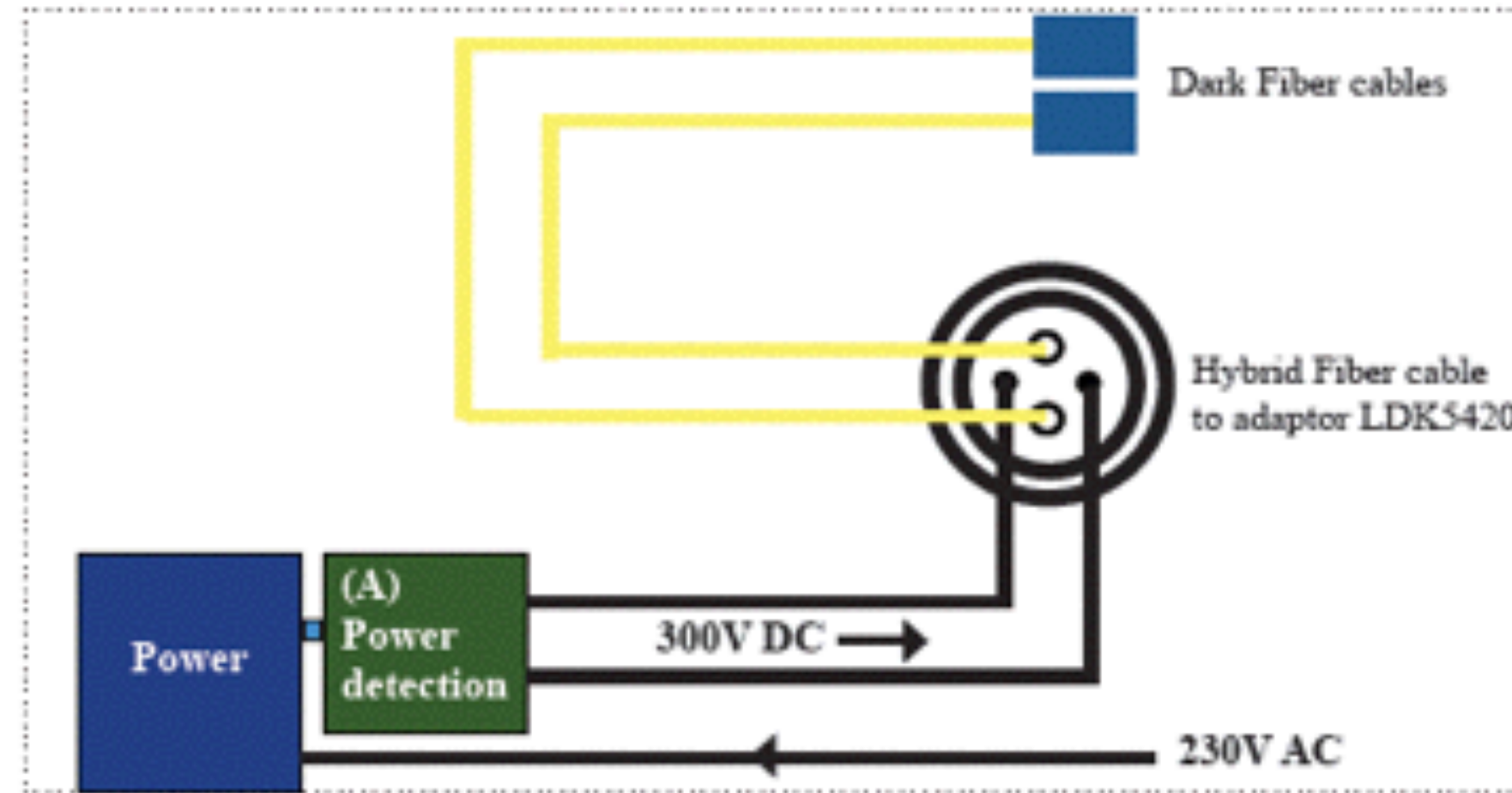
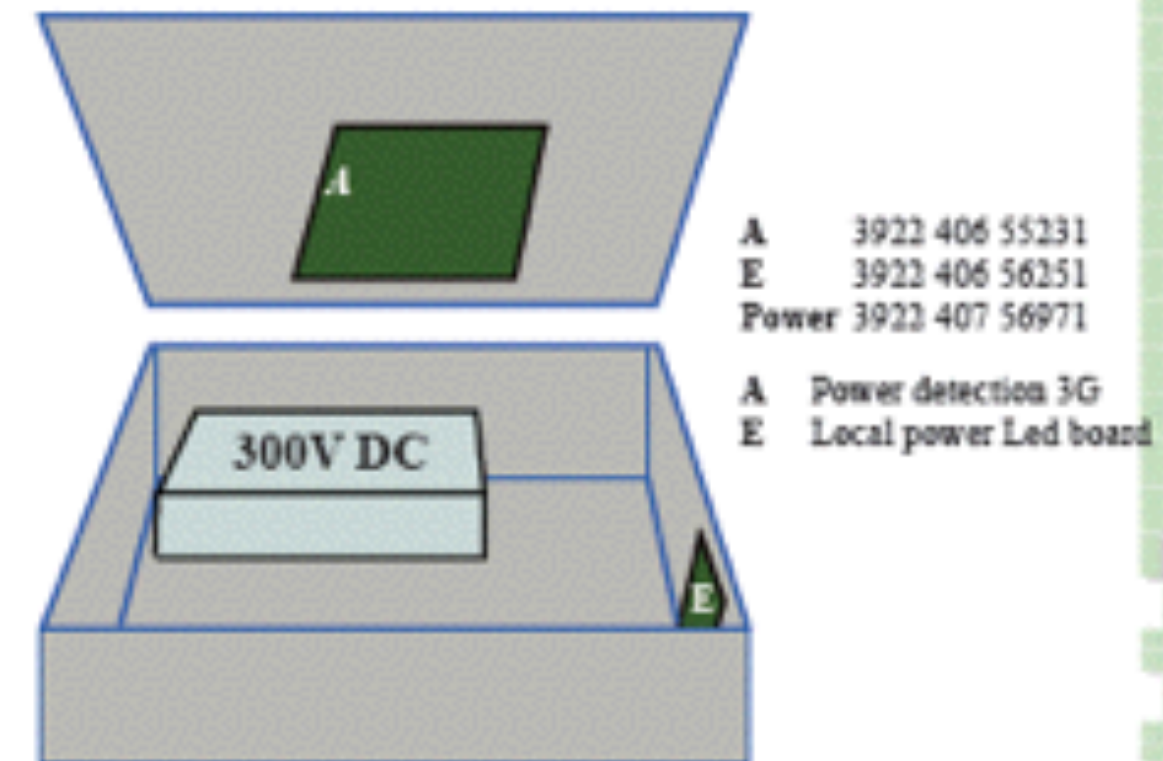
3G basics Ext 1,2,3

External inputs





Mixing Triax < --- > Fiber

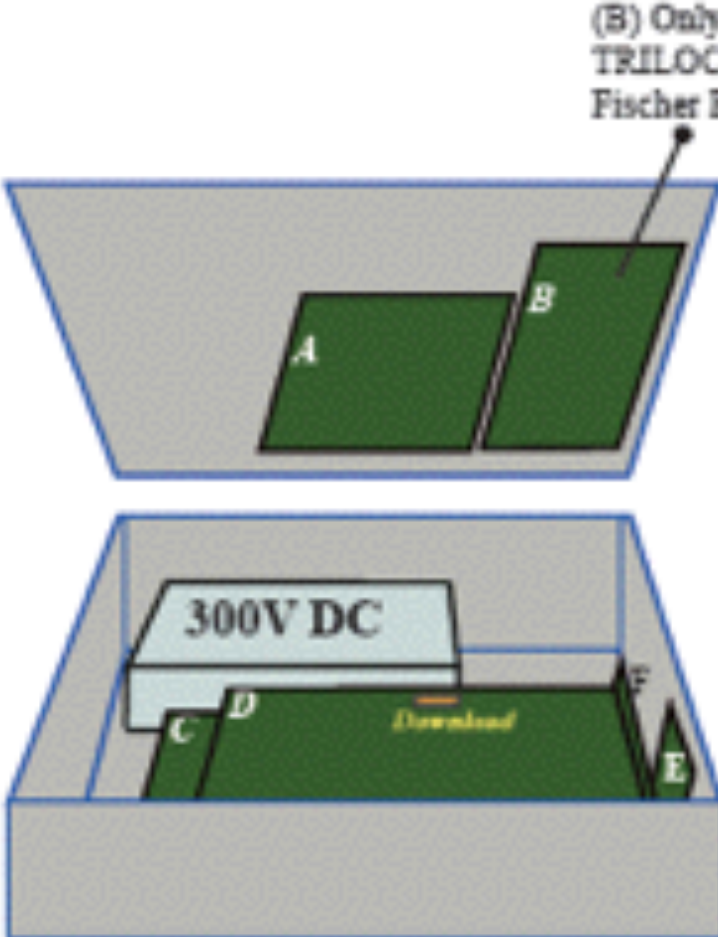
3G LDK 4425
Fiber Power Convertor



Mixing Triax < --- > Fiber

3G LDK 4426
Triax Cam to Fiber Convertor




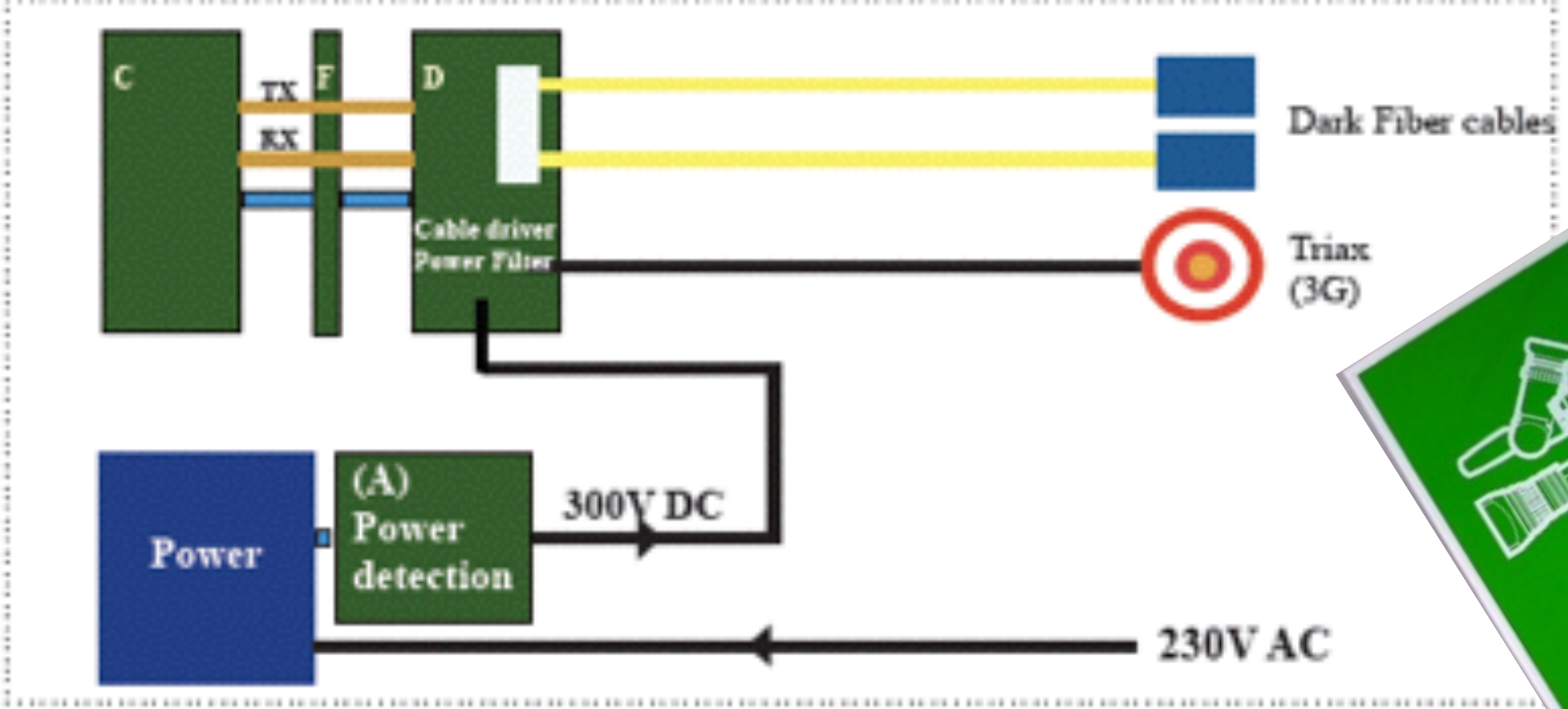
(B) Only Used with TRILOCK or Fischer Hybrid fiber

| | |
|-------|----------------|
| A | 3922 406 55231 |
| B | 3922 406 56101 |
| C | 3922 406 54211 |
| D | 3922 406 56081 |
| E | 3922 406 56111 |
| F | 3922 406 56091 |
| Power | 3922 407 56971 |

A Power Detection 3G
 B Power Switching Reflex
 C 3G Transmission Board
 D Transmission IF Reflex
 E LED board Reflex
 F Interface

No Service items available !





The diagram shows the internal components and their connections:

- Power** (blue box) connects to **(A) Power detection** (green box).
- (A) Power detection** outputs **300V DC** to the **Cable driver Power Filter** (green box).
- 230V AC** is also connected to the **Cable driver Power Filter**.
- The **Cable driver Power Filter** outputs to the **Triax (3G)** (red target icon).
- The **Triax (3G)** outputs to **Dark Fiber cables** (blue box).
- The **Triax (3G)** also outputs to the **3G TRIAX CAMERA** (green box).
- The **3G TRIAX CAMERA** outputs to the **3G FIBER BASESTATION** (blue box).

3G basics Triax Connections

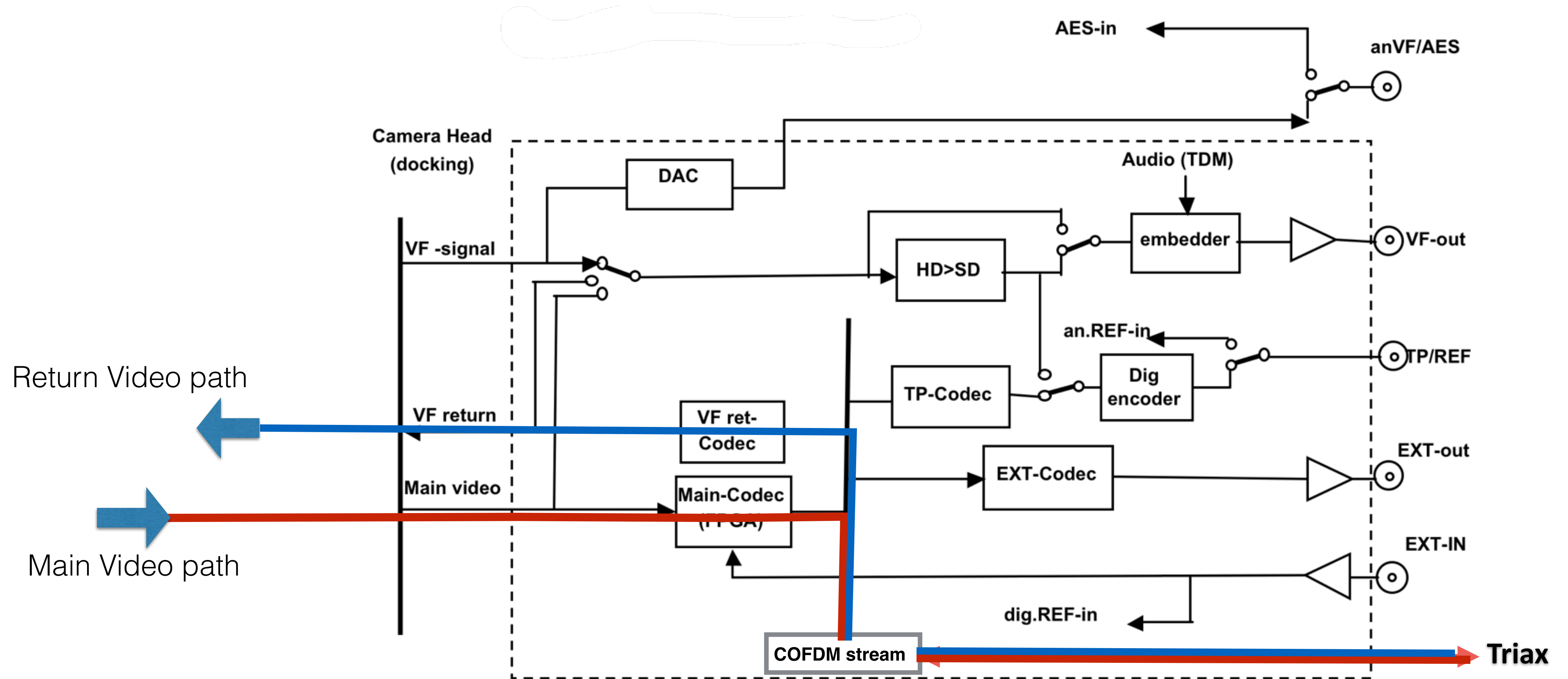


Figure 3

3G Triax / Fiber / 10G Fiber (basics)

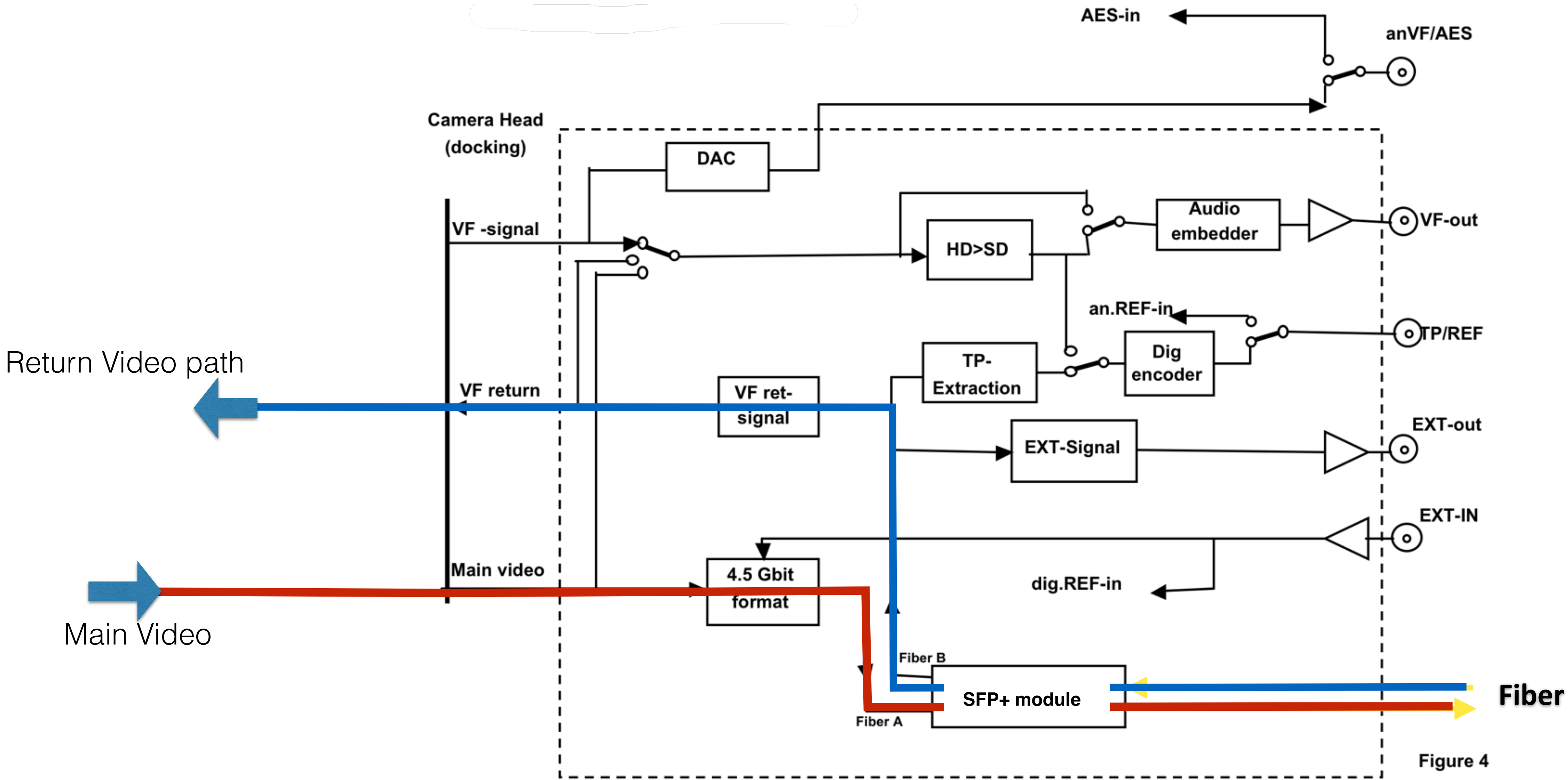
This part gives you some more details about the
Connection between Camera and XCU

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- ◆ Triax or Fiber basics
- ◆ 3 G Triax Technical
- ◆ **Fiber Technical**
- ◆ Diagnostics



3G basics Fiber Connections



XCU HD/4K IP – Connections

SFP+ modules *Small Form Factor*

Integrated I2C functionality
with following details:

- Type number
- Light indication (yes/no)
- Send and Receive power level
- Temperature

Most SFP+ modules use transceivers with less than 1 Watt (Power level II)

SFP+ module maximum power consumption shall meet one of the following power classes:

Power Level I modules - Up to 1.0 W

Power Level II modules - Up to 1.5 W

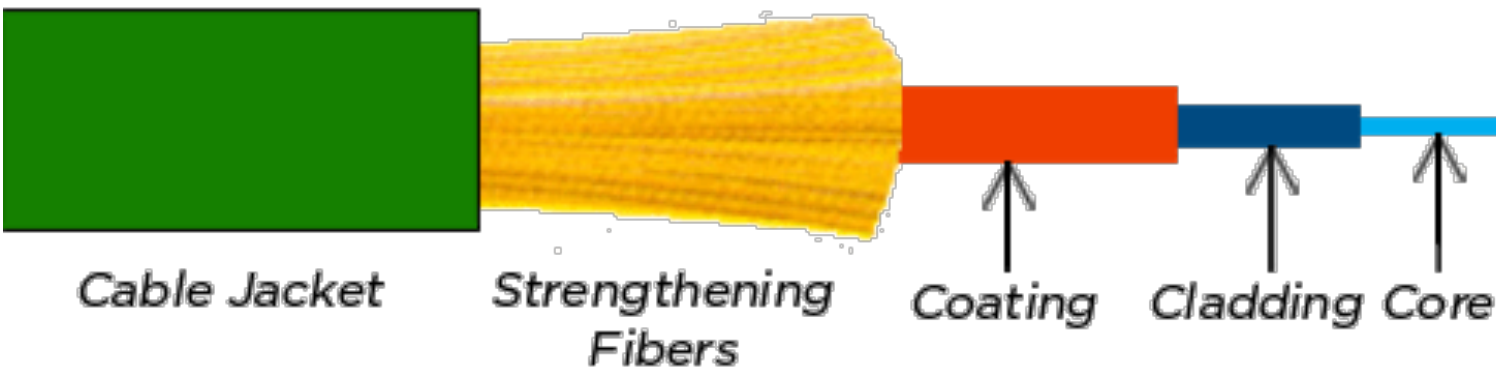
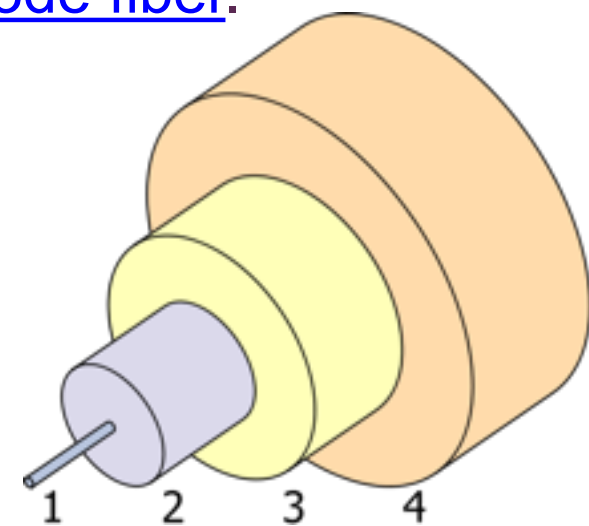
Power Level III modules - Up to 2.0 W



XCU HD/4K IP Multi-Mode Vs. Single Mode Fiber

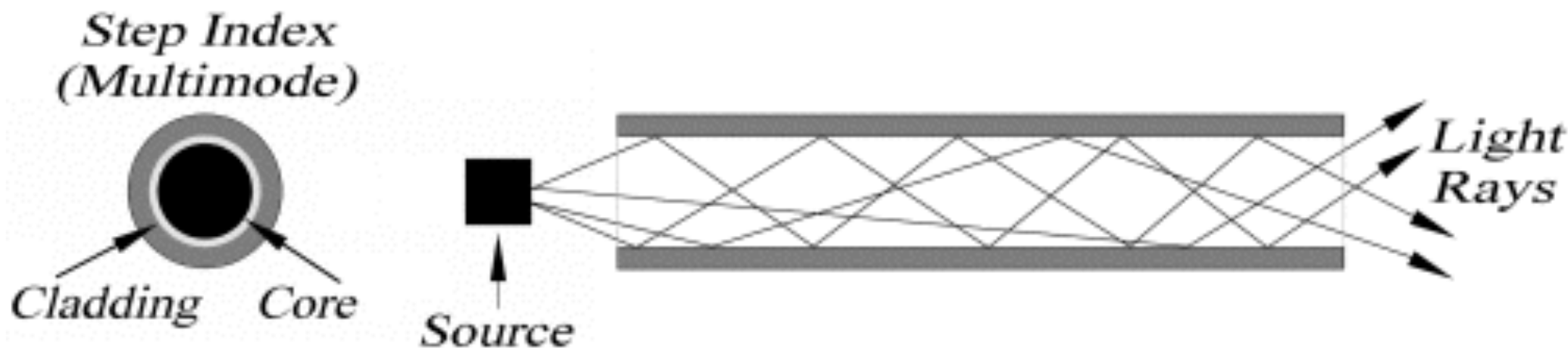
The structure of a typical [single-mode fiber](#).

- 1. Core 8 μm diameter
- 2. Cladding 125 μm dia.
- 3. Buffer 250 μm dia.
- 4. Jacket 400 μm dia.



Multi-Mode Fiber

62.5 Micron
50 Micron



Single Mode Fiber

8 Micron
The thickness of a human hair



3G Triax / Fiber / 10G Fiber (basics)

This part gives you some more details about the
Connection between Camera and XCU

In this session:

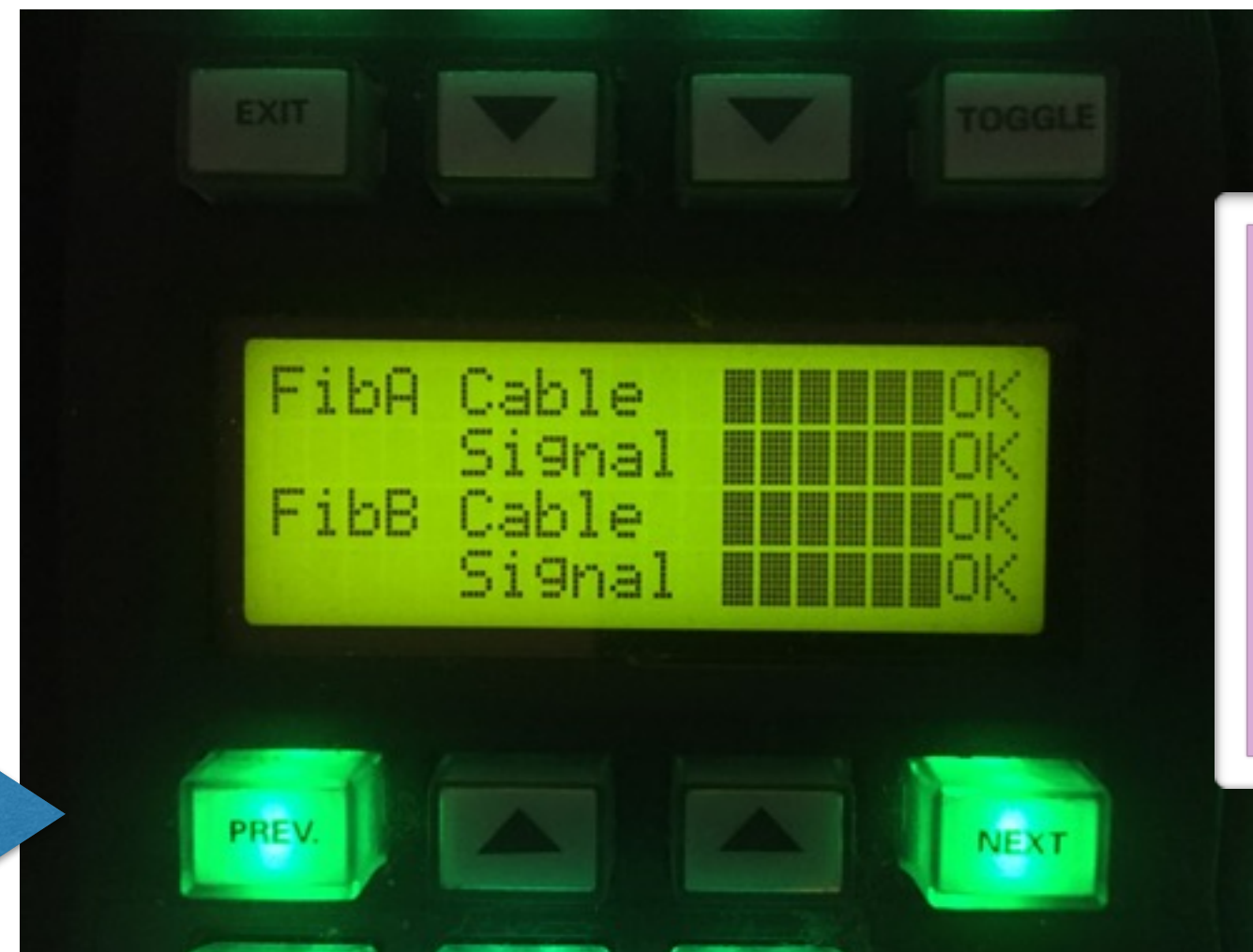
- ◆ Triax or Fiber basics
- ◆ 3 G Triax Technical
- ◆ Fiber Technical
- ◆ **Diagnostics**



3G / 10G Triax / Fiber Diagnostics

With help of the following items
it is possible to check the
performance from the connection
between Camera and XCU

- ◆ OCP 400
- ◆ MCP 400 / 450
- ◆ Camera Connect
- ◆ Menu Camera (Diagnostics)
- ◆ Menu XCU (Diagnostics)



Fiber system:

FibA/B Cable = Optical bandwidth
Signal = Data performance indicator



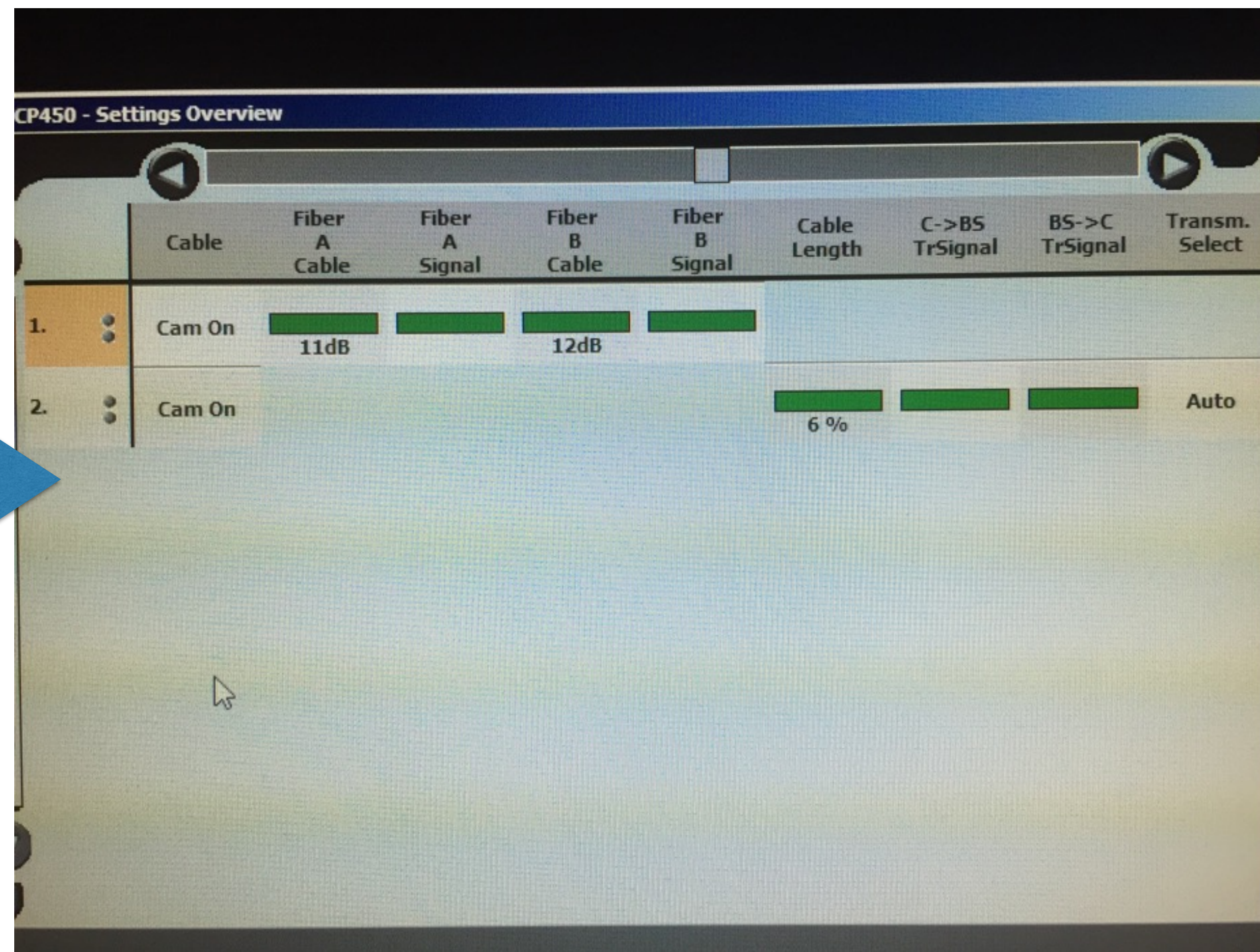
Triax system:

Cable = Cable loss indicator
C->BS Signal = Data performance indicator
C->BS Camera -> XCU

3G / 10G Triax / Fiber Diagnostics

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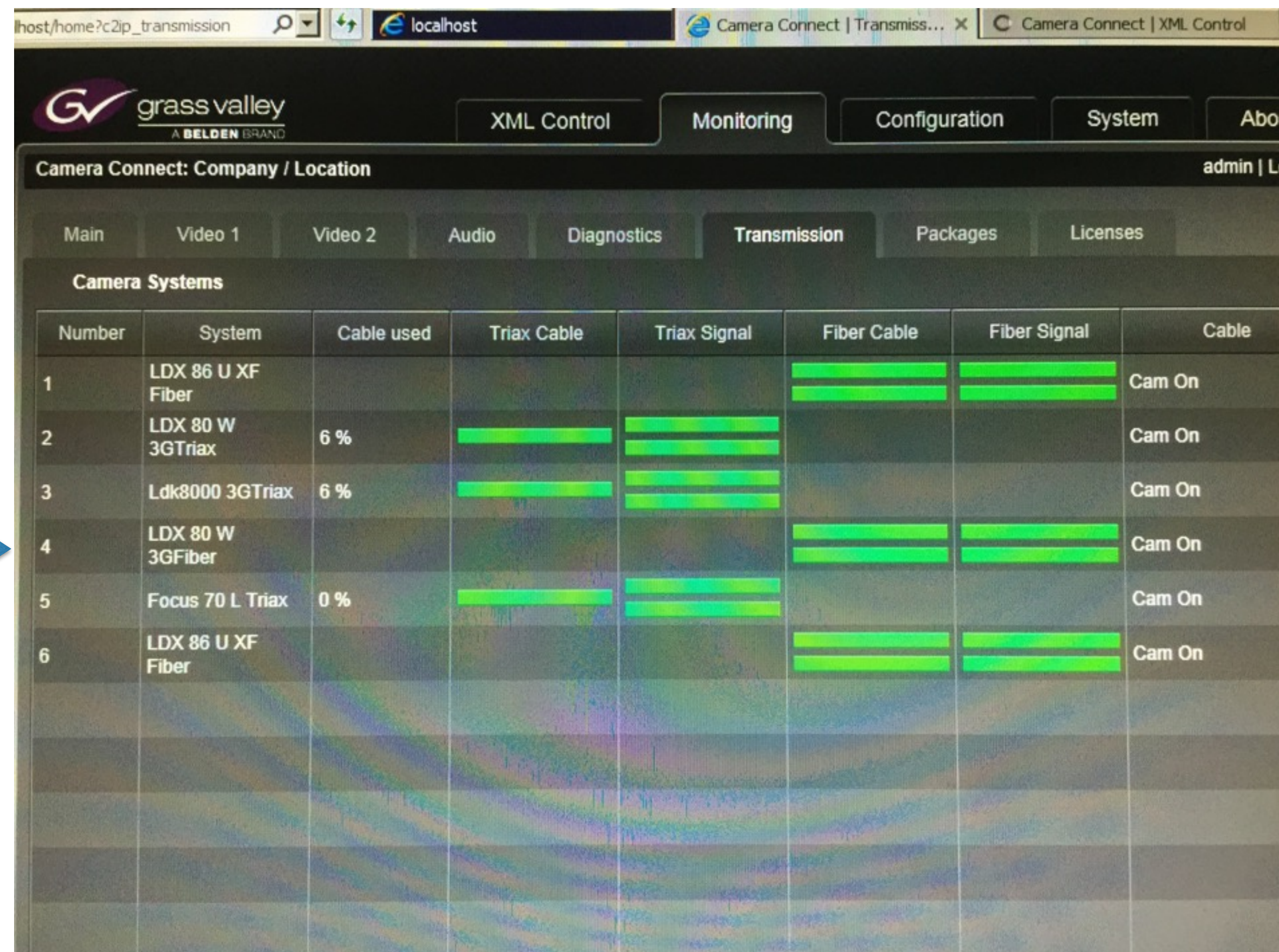
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3G / 10G Triax / Fiber Diagnostics

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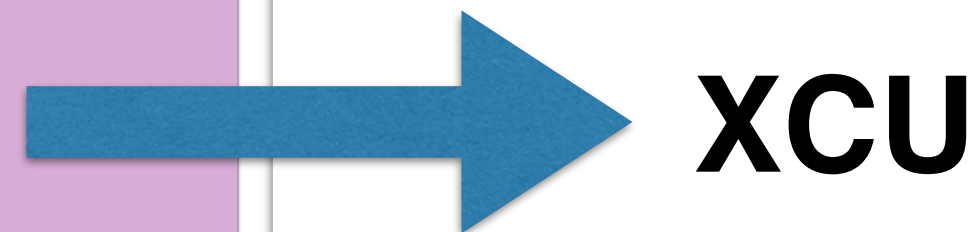
The screenshot shows the 'Camera Connect' web interface with the 'Transmission' tab selected. The page displays a table of camera systems with their respective cable types and signal status. The table has columns for Number, System, Cable used, Triax Cable, Triax Signal, Fiber Cable, Fiber Signal, and Cable. The status 'Cam On' is shown for all systems.

| Number | System | Cable used | Triax Cable | Triax Signal | Fiber Cable | Fiber Signal | Cable |
|--------|-------------------|------------|-------------|--------------|-------------|--------------|--------|
| 1 | LDX 86 U XF Fiber | | | | | | Cam On |
| 2 | LDX 80 W 3GTriax | 6 % | | | | | Cam On |
| 3 | Ldk8000 3GTriax | 6 % | | | | | Cam On |
| 4 | LDX 80 W 3GFiber | | | | | | Cam On |
| 5 | Focus 70 L Triax | 0 % | | | | | Cam On |
| 6 | LDX 86 U XF Fiber | | | | | | Cam On |

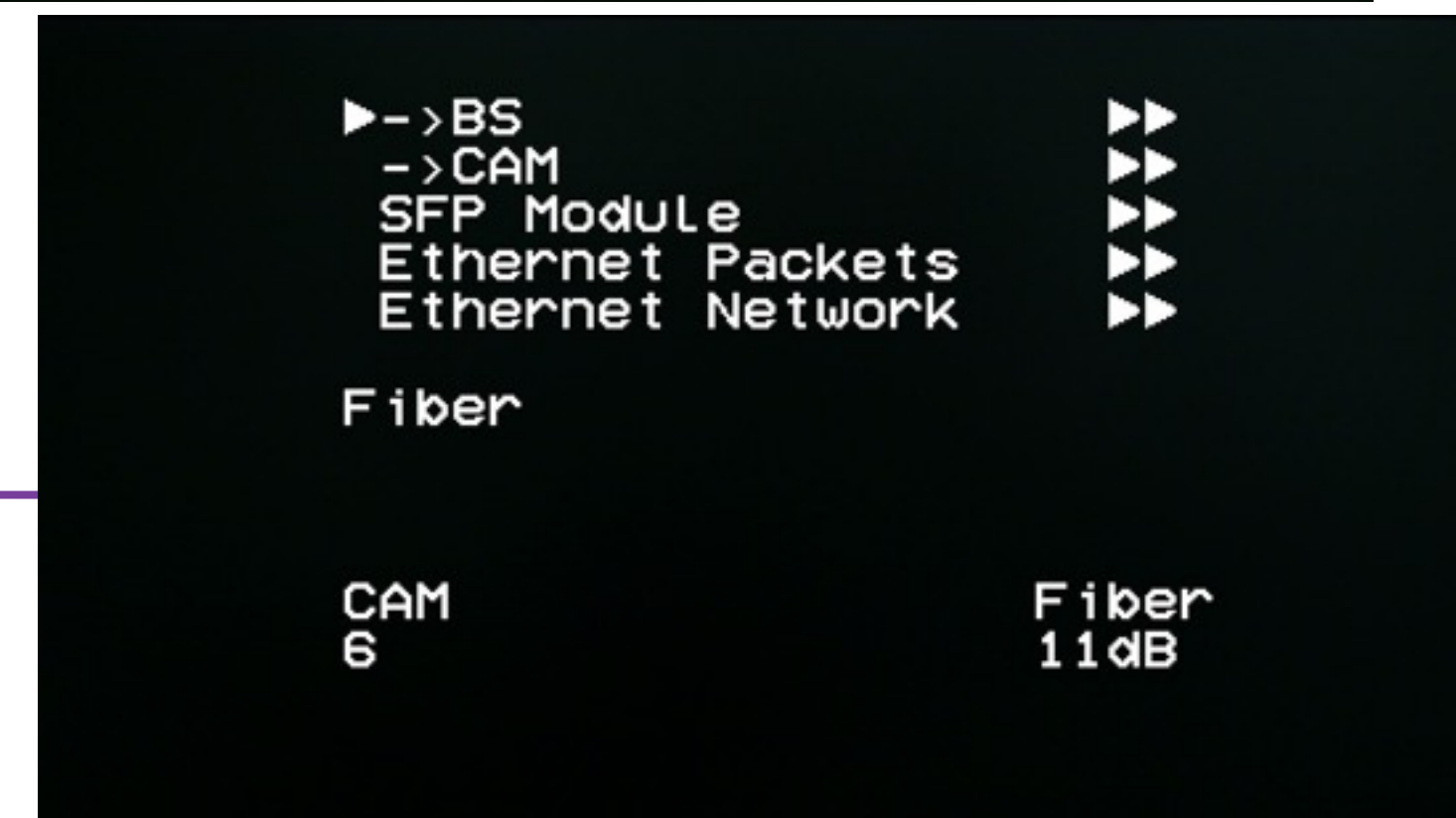
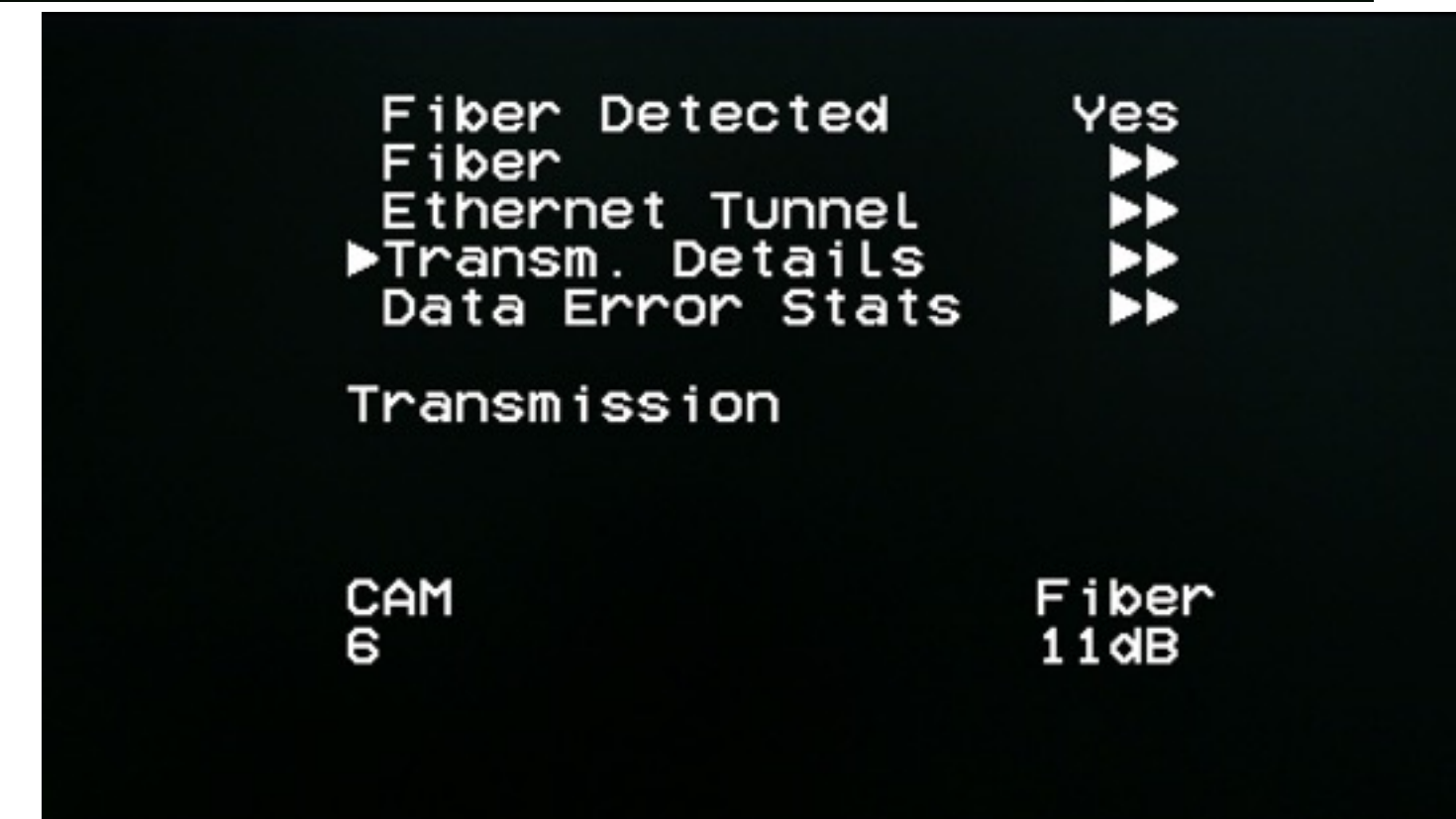
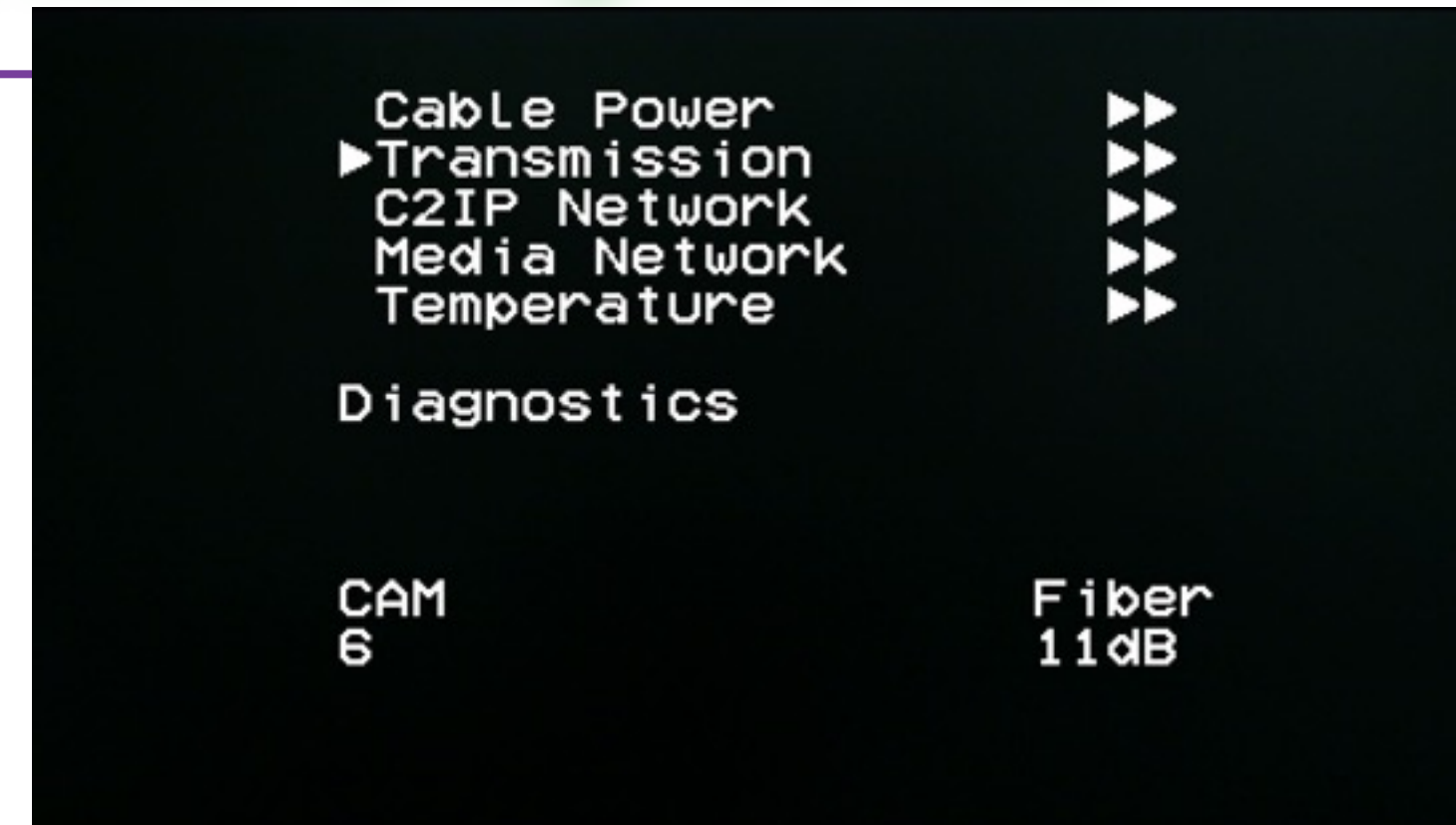
3G / 10G Triax / Fiber Diagnostics

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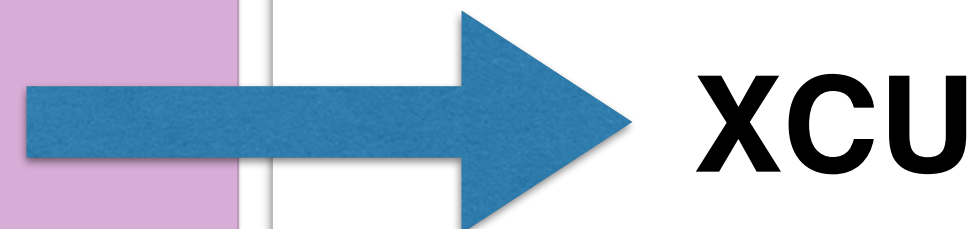
XCU



3G / 10G Triax / Fiber Diagnostics

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```
►RX Margin      11 dB
Signal Err Count 0
Ethernet Err/sec 0
EYE value       32
```

->BS

CAM
6

Fiber
11dB

```
►Opt. Module    EOLP1396
RX Power        -5 dB
TX Power        -2 dB
Temp            34 C
Loss Count      1
```

SFP Module

CAM
6

Fiber
11dB

```
SFP Module
►Ethernet Packets
Ethernet Network
Video
Streams
```



Fiber

CAM
6

Fiber
11dB

Keep it Clean!



Keep it Clean!



Close Cover!

Particle Migration:

- Repeated matings cause large particles break apart and migrate
- Dirt can spread from the cladding to the core after successive matings
- Dirt mated between connectors can be permanently embedded in the glass, making cleaning impossible
- Major loss of optical budget



Fiber Maintenance

Number 1 Field Issue with Fiber = DIRT

- Clean all connectors and connection points
- Many cleaning tools and fiber cleaning products
- Wet / Dry Cleaning
- Wet Cleaning
- Dry Cleaning



Wet / Dry Solution Cleaning Kit



Electro-Wash Wipes



IBC Click Cleaning Tool

1. Simplex or Duplex
2. ST, SC
3. LC
4. SMPTE 304M

Fiber Troubleshooting Tools

Tools for troubleshooting on set fiber issues

- An **optical power meter (OPM)** is a device used to measure the power in an optical signal. Many cleaning tools and fiber cleaning products
- **Visual Fault Locator** works as an end-to-end cable continuity tester that helps you diagnose and repair fiber link problems
- An **optical time-domain reflectometer (OTDR)** is an instrument used to characterize an optical fiber.



Optical Power Meter



Optical Fault Locator



OTDR- optical time-domain reflectometer

THANK YOU

GRACIAS
ARIGATO
SHUKURIA
JUSPAXAR
DANKSCHEEN
TASHAKKUR ATU
YAQHANYELAY
SUKSAMA
EKHMET
GRASIO
BENKRUJA
HONACHALUYA
GRAZIE
MEHRBANI
PALDIES
BOLZİN
MERCİ
BİYAN
SHUKRIA
TINGKI
KOMAPSUNIDA
MAKE
GOZAIMASHITA
EFCHARISTO