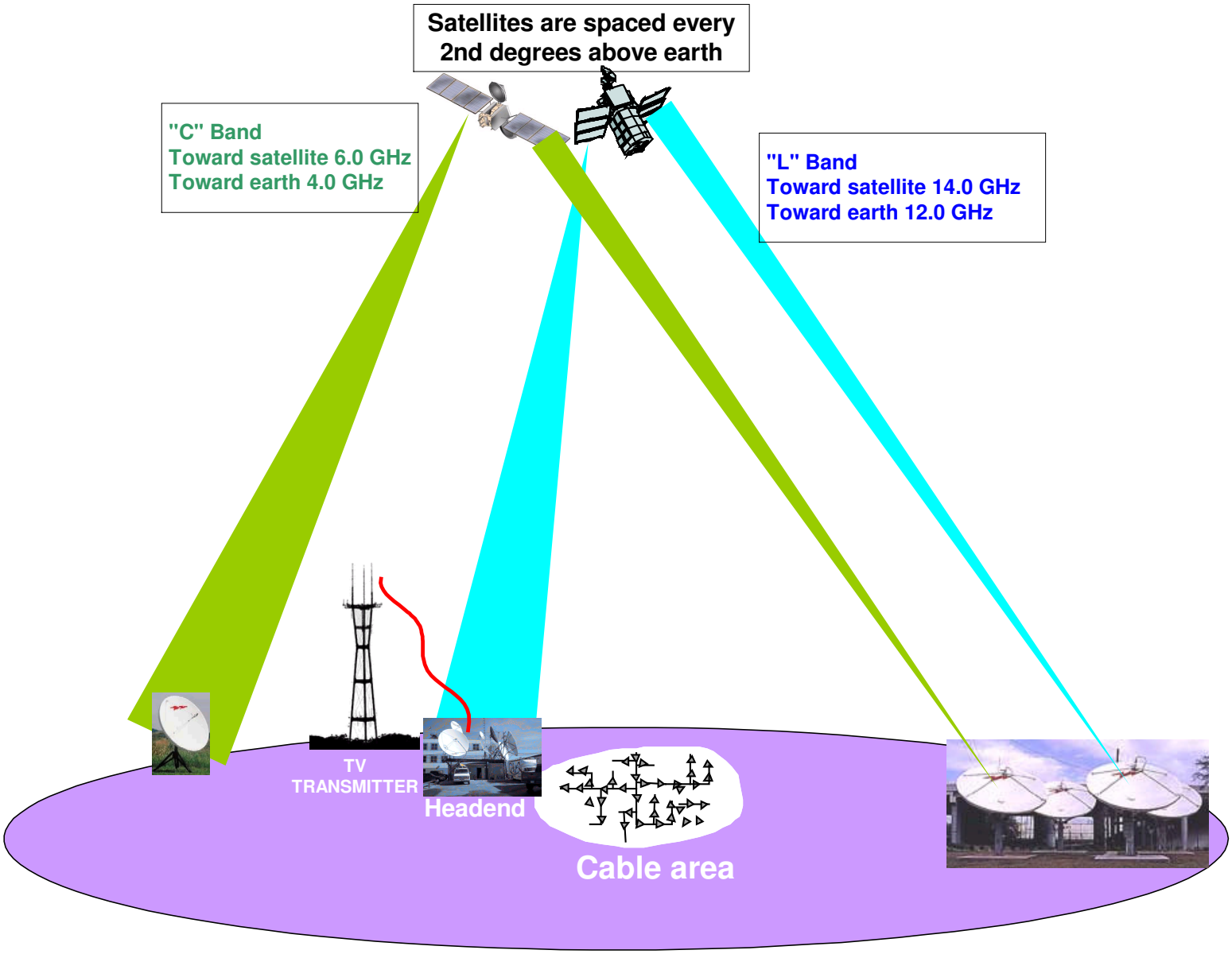
Broadband System - N



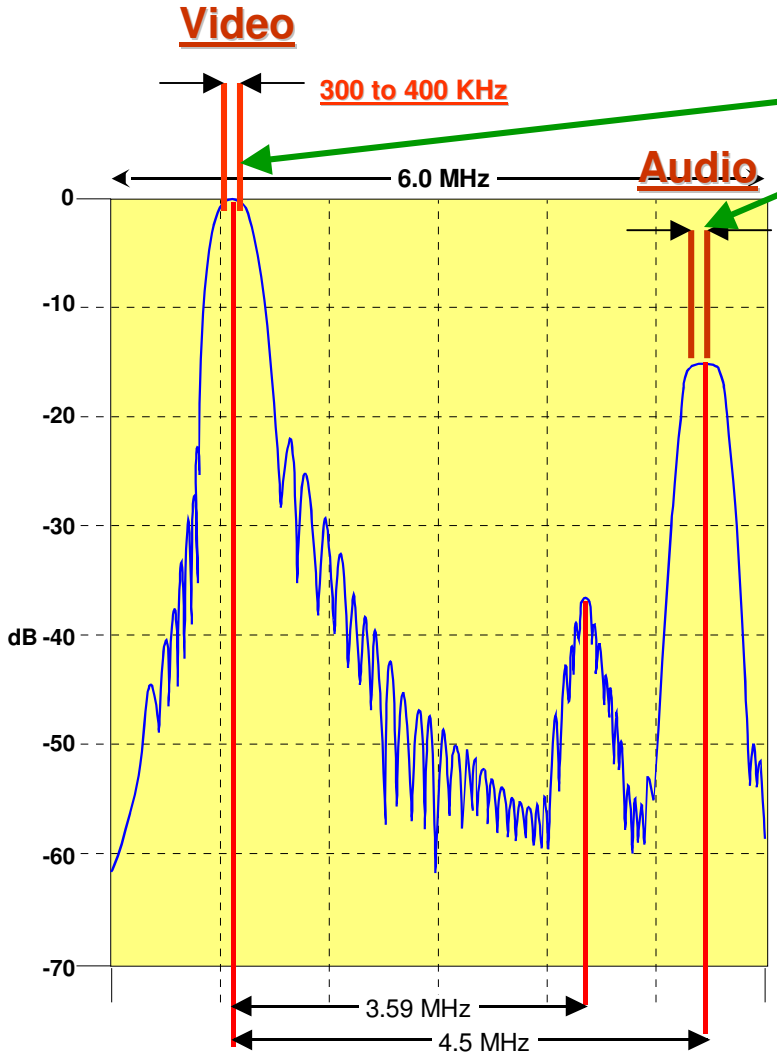
RF test equipment can be divided in two sections.

- Single equipment capable of reading the strength of a Television Channels.
- Multi function meter, capable of reading;
  - TV channel signal strength
  - Digital signal (Power meter)
  - Multi channel reading (Slope or Tilt)
  - Spectral view of all the channels carried by an HFC system
  - C/N measurement.
  - Distortion measuring (C-N, CTB and CSO)
  - Frequency Response (Peak & Valley response)
  - QAM reading (BER, MER and FEC)
  - Return alignment tool. (Response and Ingress)
  - Ingress reading (Leakage)

Filed Strength Meter capable of reading Television Channels.

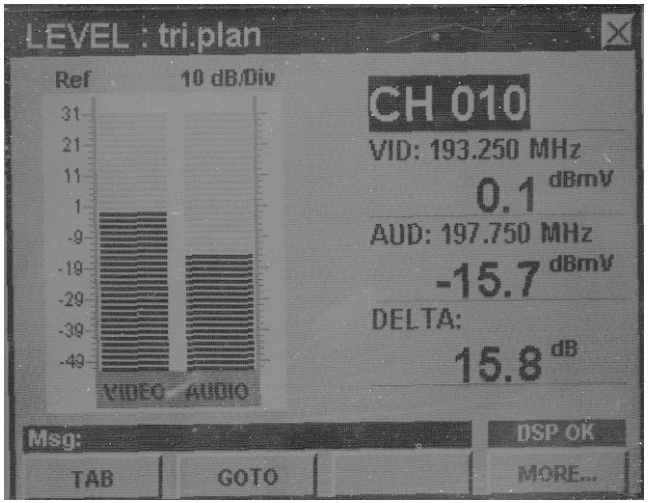
This equipment read the level of a single TV channel or a single FM music channel. These level can be read as TV channel or Frequency. They also give you the difference in level between the Video and Audio of TV channel. They can usually read signal from: 5 to 870 MHz.

Field Strength Meter



Most FSM read between 300 to 400 KHz of band width.

How it is display on the Field Strength Meter



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Multi Function FSM

Multi function meter can be classified in two types;

- **Meter for customer installation**
- **Meter for complete system verification.**

Installation FSM

Multifunction HFC Analyzer

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Multi Function FSM

Installation FSM

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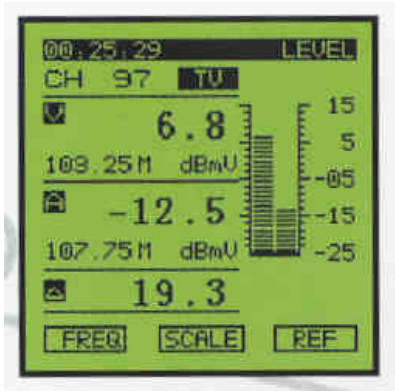
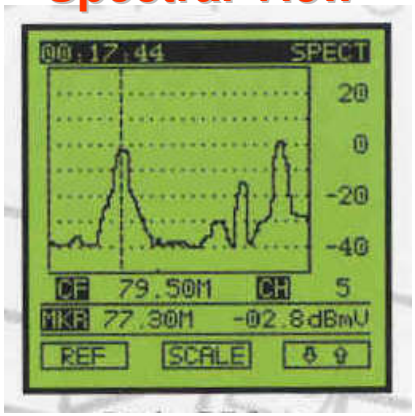
Installation FSM

The Model One from Trilithic is an installation meter that can perform the following functions.

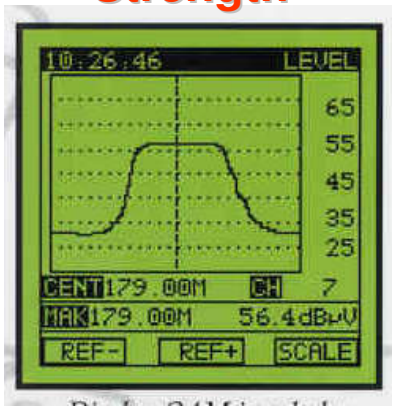
Single channel reading



Single channel Spectral View



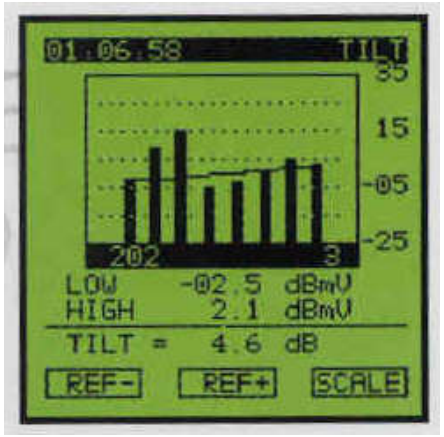
Digital signal Strength



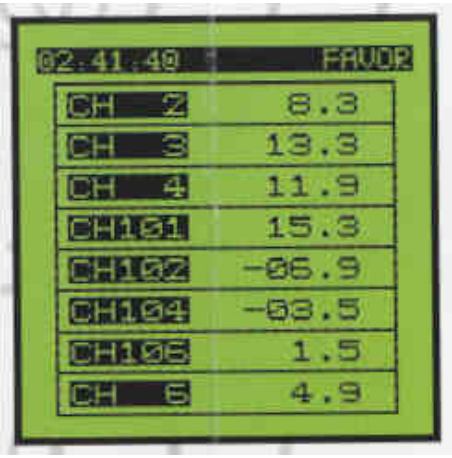
Installation FSM

The Model One from Trilithic is an installation meter that can perform the following functions.

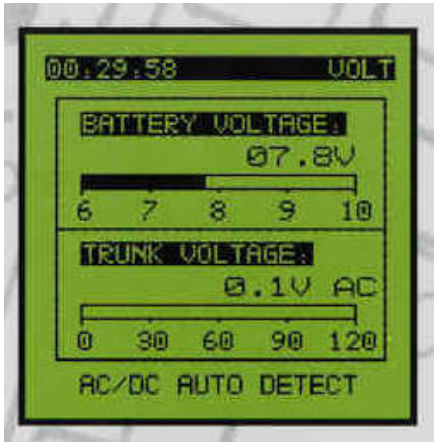
Tilt View



Favourites channels View



AC – DC Reading



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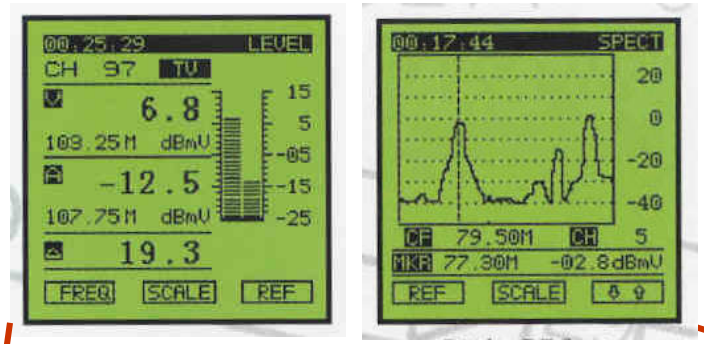
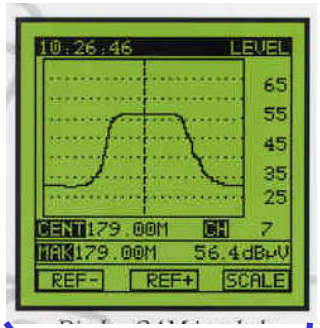
Installation FSM

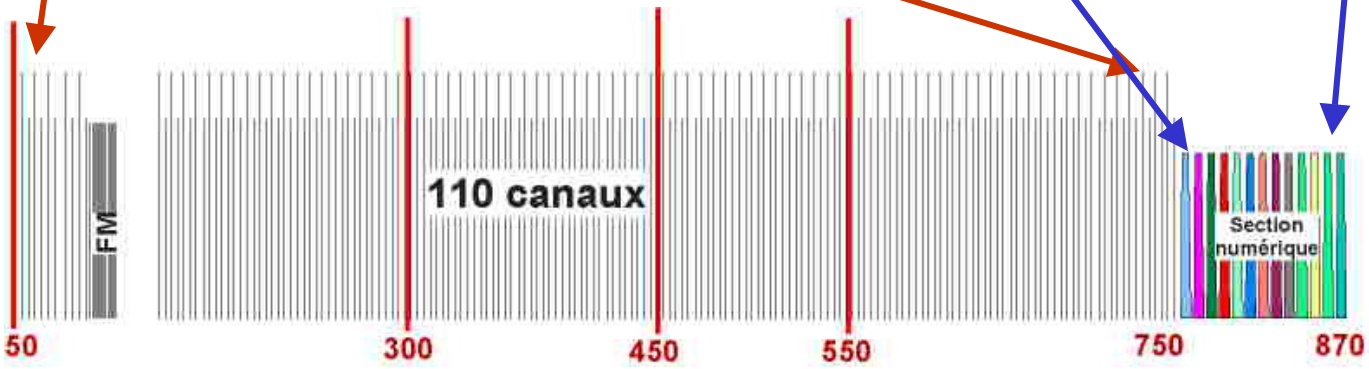
Below are examples of a signal been read by the Model One F.S.M.

Analog TV channel



QAM TV channel





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Multifunction HFC Analyzer

860 DSPi

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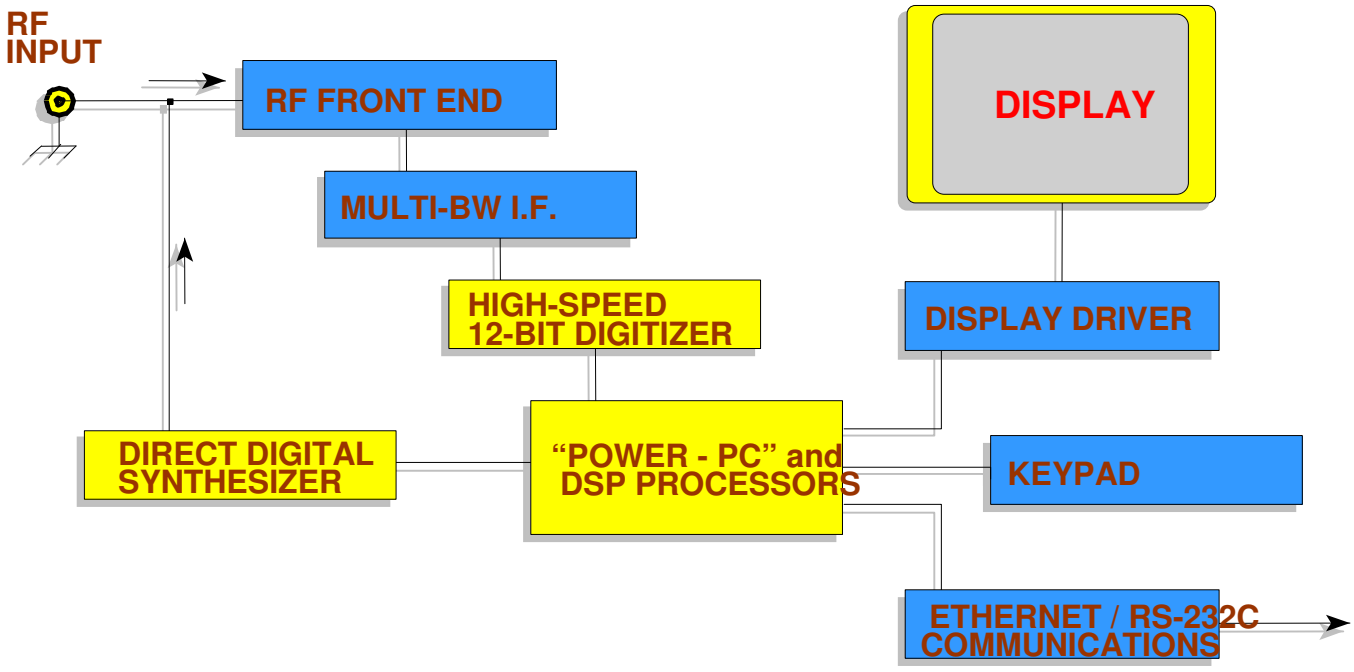
Meter for complete system verification.

BLOCK DIAGRAM

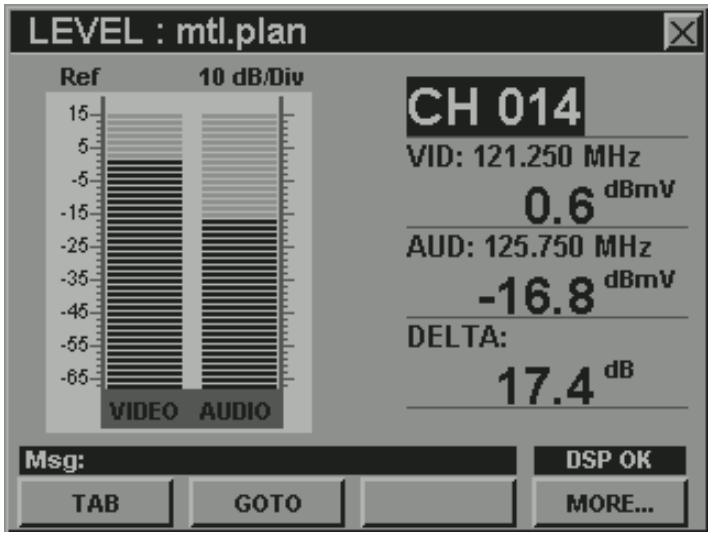


Meter for complete system verification.

Standard functions.

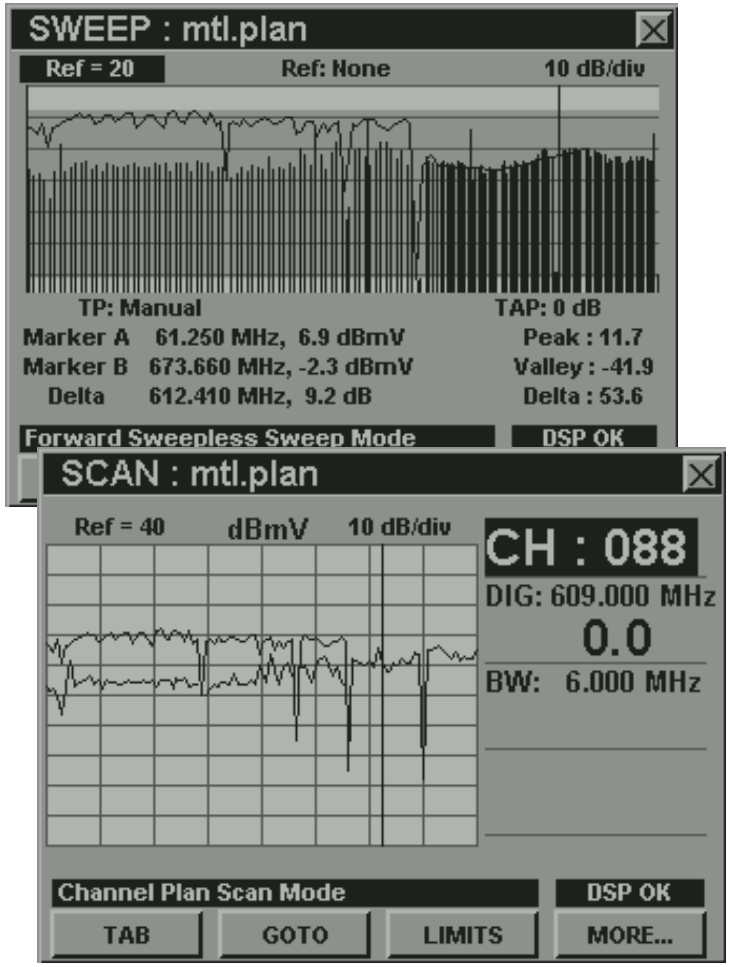
Single Channel Measurement

- NTSC or PAL video, audio, SAP.
- Audio demodulation.
- Hum (50/60Hz, 100/120Hz, 1KHz L.P.)
- C/N on active channel channels.
- CTB, CSO.
- Depth of Modulation.
- QAM Haystack with power.
- Toggle to 1-chan. spectrum mode.



Meter for complete system verification.

- **Full Plan Measurement.**
  - Level, CTB, CSO, Hum and C/N on designated channels - all if possible
- **Tilt / 8 Channel Plan**
  - Auto Gain and Tilt calculation
- **FCC Test**
  - Drop, Block and Tap
    - 24 hour tests
    - Spectrum Monitor Mode
    - "Sweepless" Sweep



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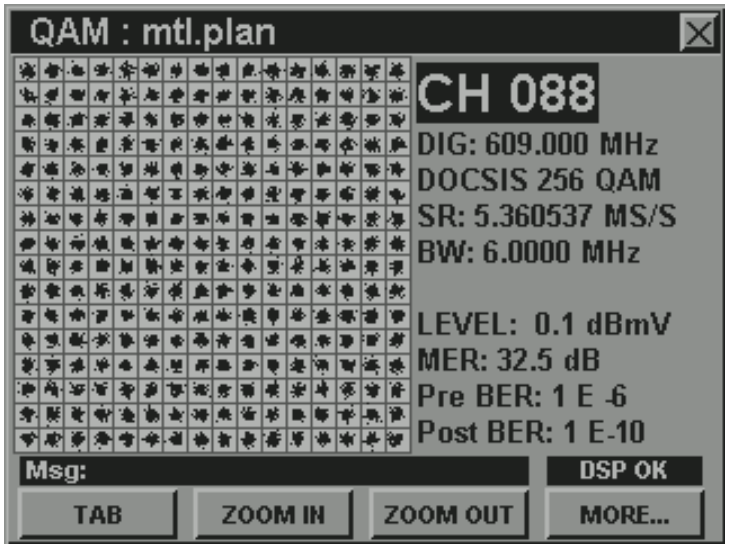
Meter for complete system verification.

Digital Analyzer Option

- QAM, QPSK

- Constellation, MER, pre and post BER, C/(N+I)?

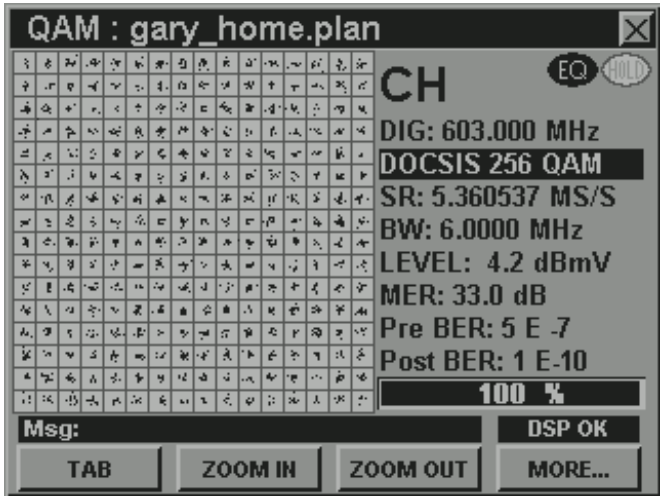
- Spectrum under active signal



Meter for complete system verification.

QAM-DOCSIS channel, measuring; Level, MER and BER.

64 QAM DOCSIS signal.

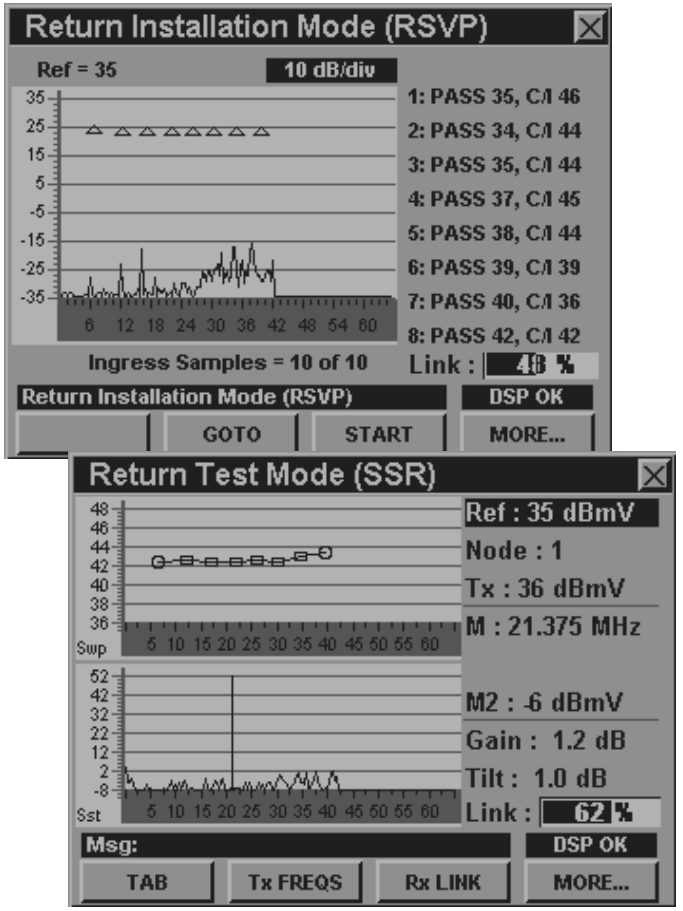


256 QAM DOCSIS signal.

Meter for complete system verification.

Return Test Option

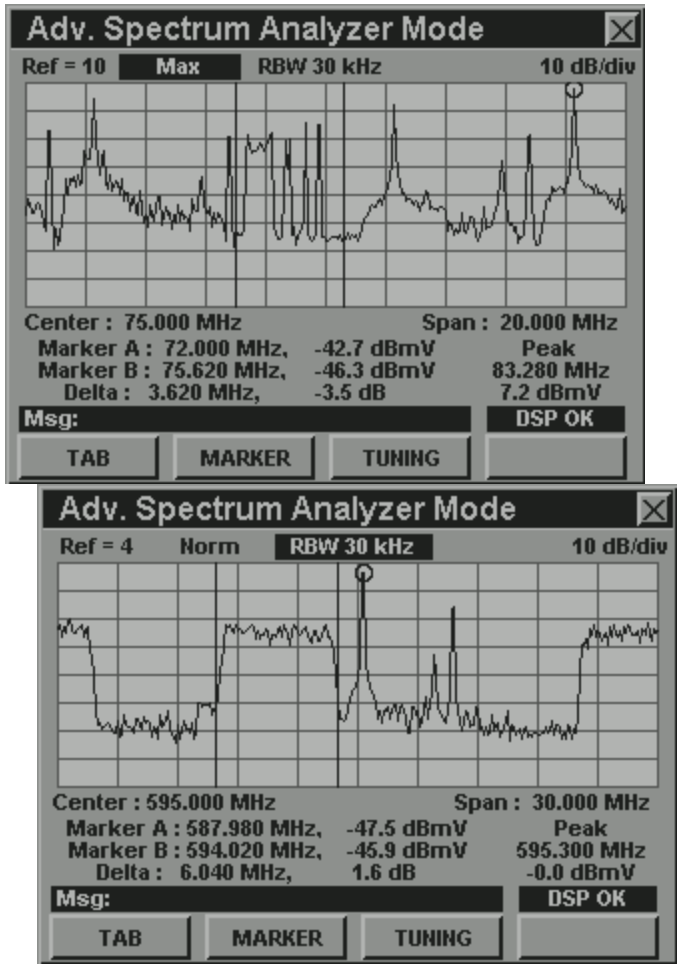
- **RSVP**
  - Up to 8 frequencies
- **SSR**
  - New combined displays
- **Ingress comparison:**
  - SST vs. current location



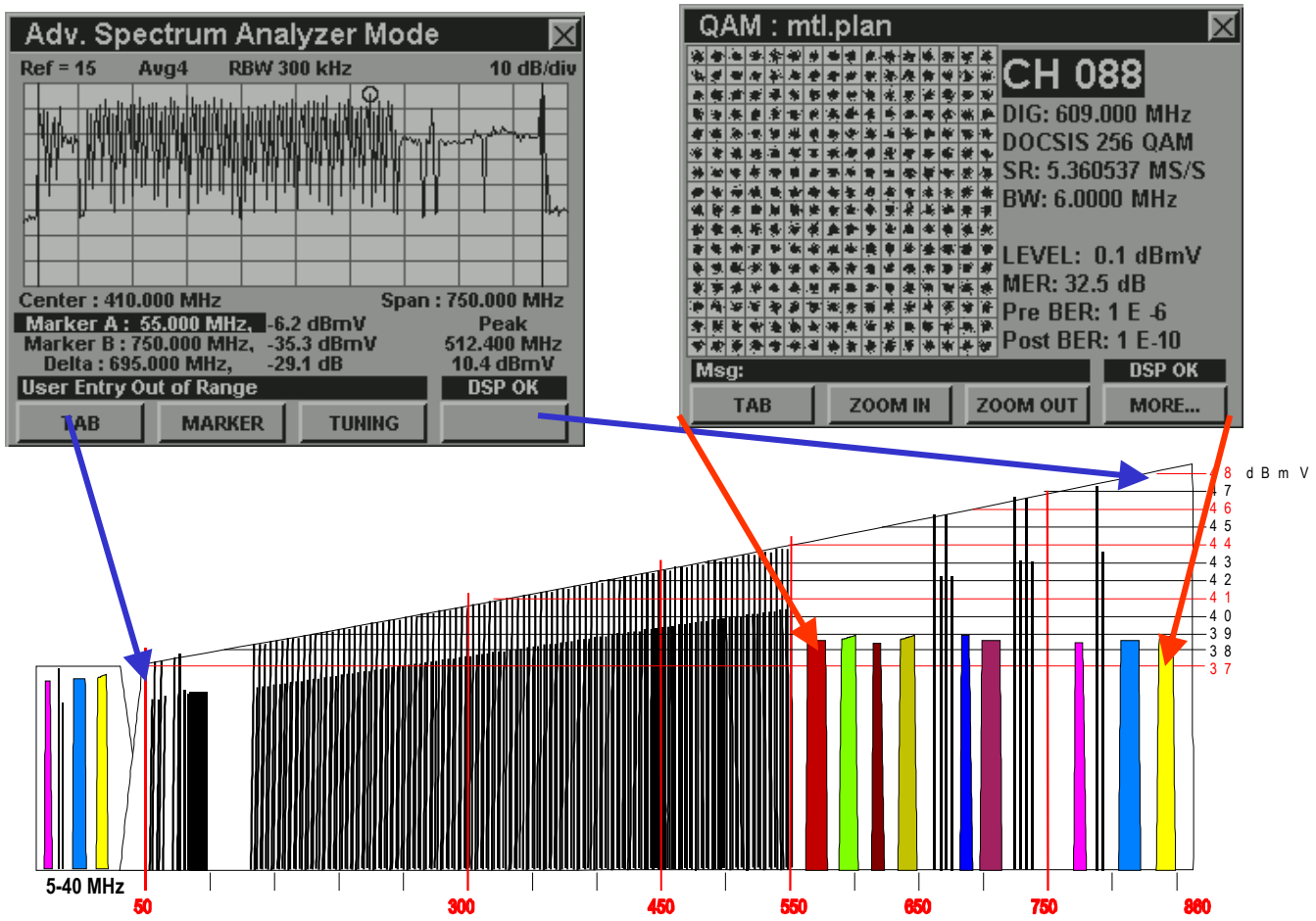
Meter for complete system verification.

Spectrum Analyzer Option:

- Span 0, 100 KHz to 860 MHz
- Resolution Bandwidth 10 KHz to 3 MHz in 1,3 format
- Video Bandwidth 100 Hz to 3 MHz in 1,3 format
- Spur free Display Range 60 dB
- Noise floor -50 dBmV in 10 KHz resolution
- Display smoothed to approximate an analog analyzer

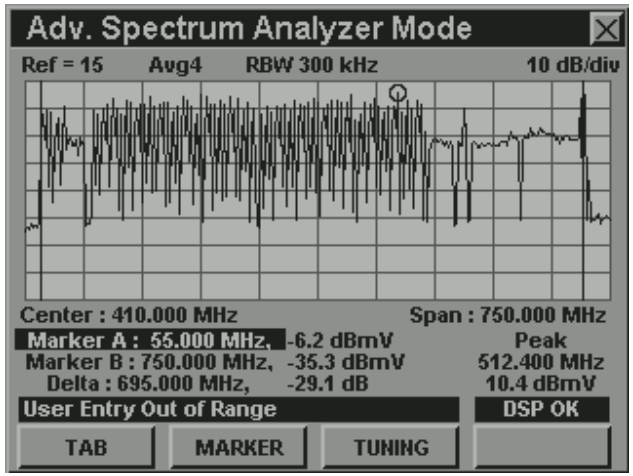


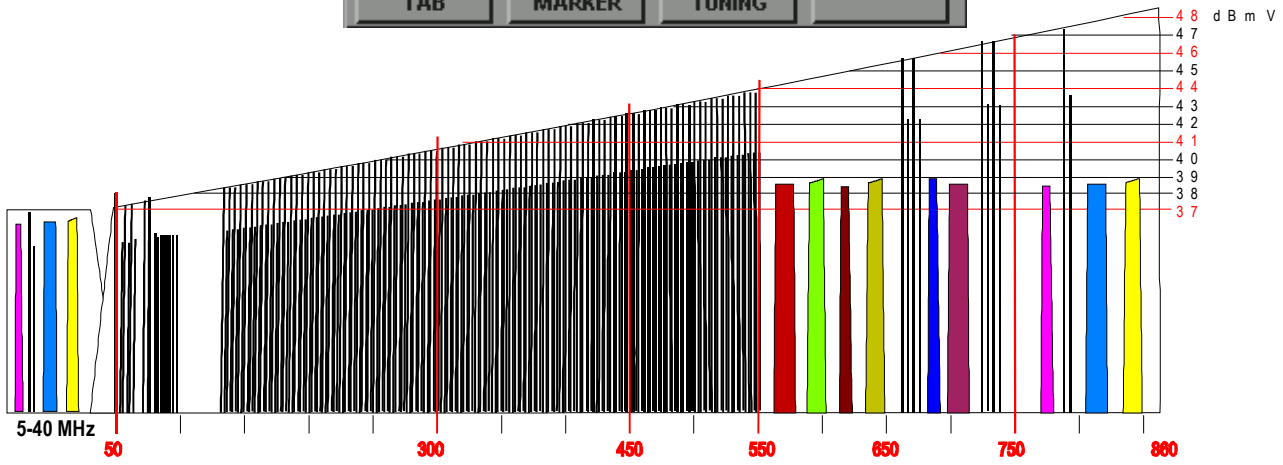
Meter for complete system verification.



Meter for complete system verification.

Spectrum Analyzer Measurement.





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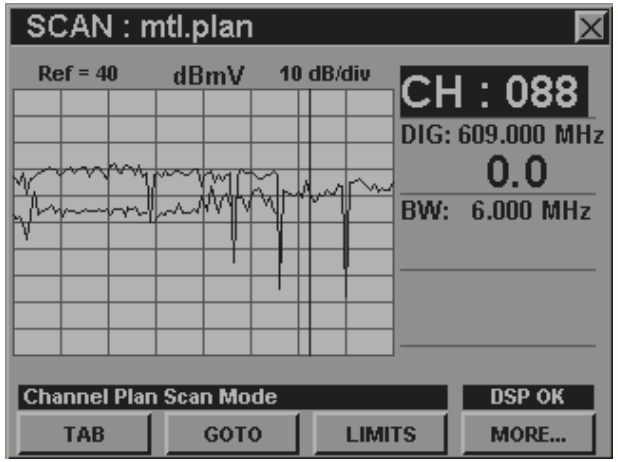
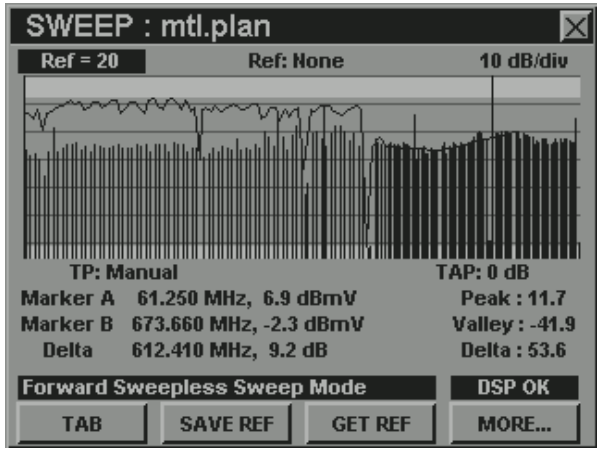
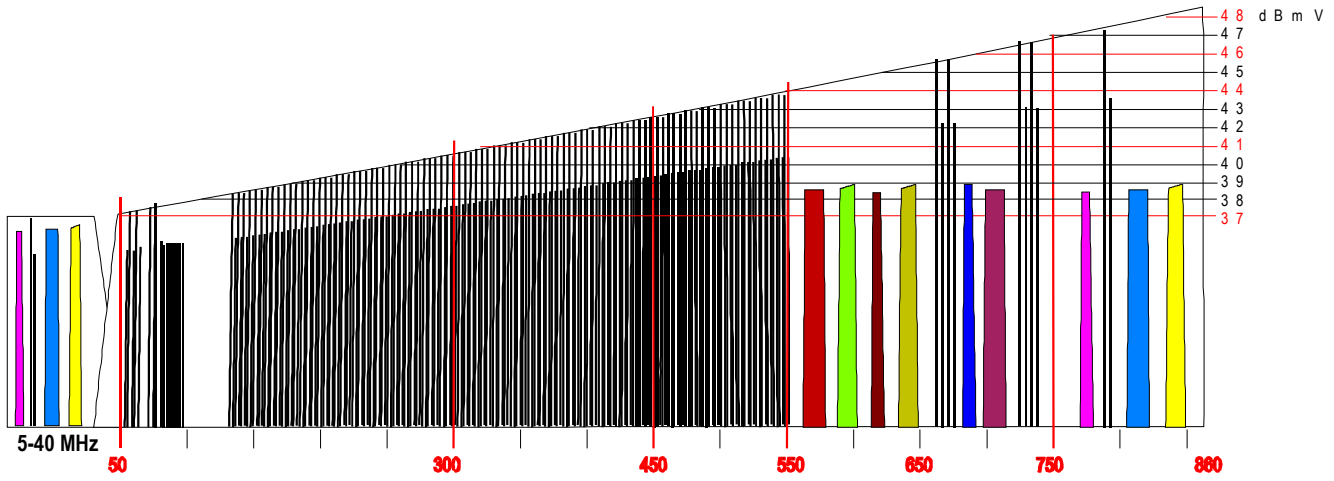
Meter for complete system verification.







Fiber Optic Test Equipments

HFC System

Since a HFC system requires two types of communications, one type been fiber optic and the other one been coaxial cable, two type of test equipments are require to test both sections of a system.

- **Test equipment for coaxial cable distribution.**

- **Test equipment for fiber optic communication.**

Test equipments for fiber optic communication

Test equipments required for the fiber optic section are the following;

- Power meter.
- Light Source.
- OTDR (Optical Time Domain Reflectometer).
- OSA (Optical Spectrum Analyser).
- Talk Set.
- Visual Fault Locator
- Optical Fiber Identifier.
- Optical Scope.
- PMD Analyzer.

Power meter.

Power meter are required to measure the power output of the optic transmitting equipment, the input of the receiving equipment and the actual loss of a fiber optic link.

GN-6025

Freq.: 800 to 1700 nm.

+5 to – 70 dBm

GN-6025C *

Freq.: 800 to 1700 nm.

+20 to – 60 dBm

*** Best for HFC system.**

Light Source.

Optical Light Source gives a calibrated light output that can be used for testing a fiber link, when no other light signal are available.

GN-6250 *

1310-1550 nm.

- 8.0 dBm

GN-6260

1550-1625 nm

- 8.0 / - 5.0 dBm

***Best for HFC system.**

OTDR (Optical Time Domain Reflectometer)

OTDR are used to check continuity and signal loss on fiber optic link.

CMA-4000-MDK-1

- 8.4” Colour Matrix Display.
- 30/28 dB 1310/1550 nm.
- Dual Single Opt. Module.
- Hard Transit Case.
- Network VisionNet Plus Software.

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OTDR (Optical Time Domain Reflectometer)

OTDR are used to check continuity and signal loss on fiber optic link.

CMA-4000-DK-2-X

- 8.4” Colour Matrix Display.
- 36/34 dB 1310/1550 nm.
- Built-in-Hard drive.
- Built in Light Source.
- Dual Single Opt. Module.
- Hard Transit Case.
- Network VisionNet Plus Software.

OTDR (Optical Time Domain Reflectometer)

OTDR are used to check continuity and signal loss on fiber optic link.

CMA-4000-DK-3-X

- 8.4” Colour Matrix Display.
- 40 dB 1310/1550 nm.
- Built-in-Hard drive.
- Dual Single Opt. Module.
- Built in Light Source.
- Hard Transit Case.
- Network VisionNet Plus Software.

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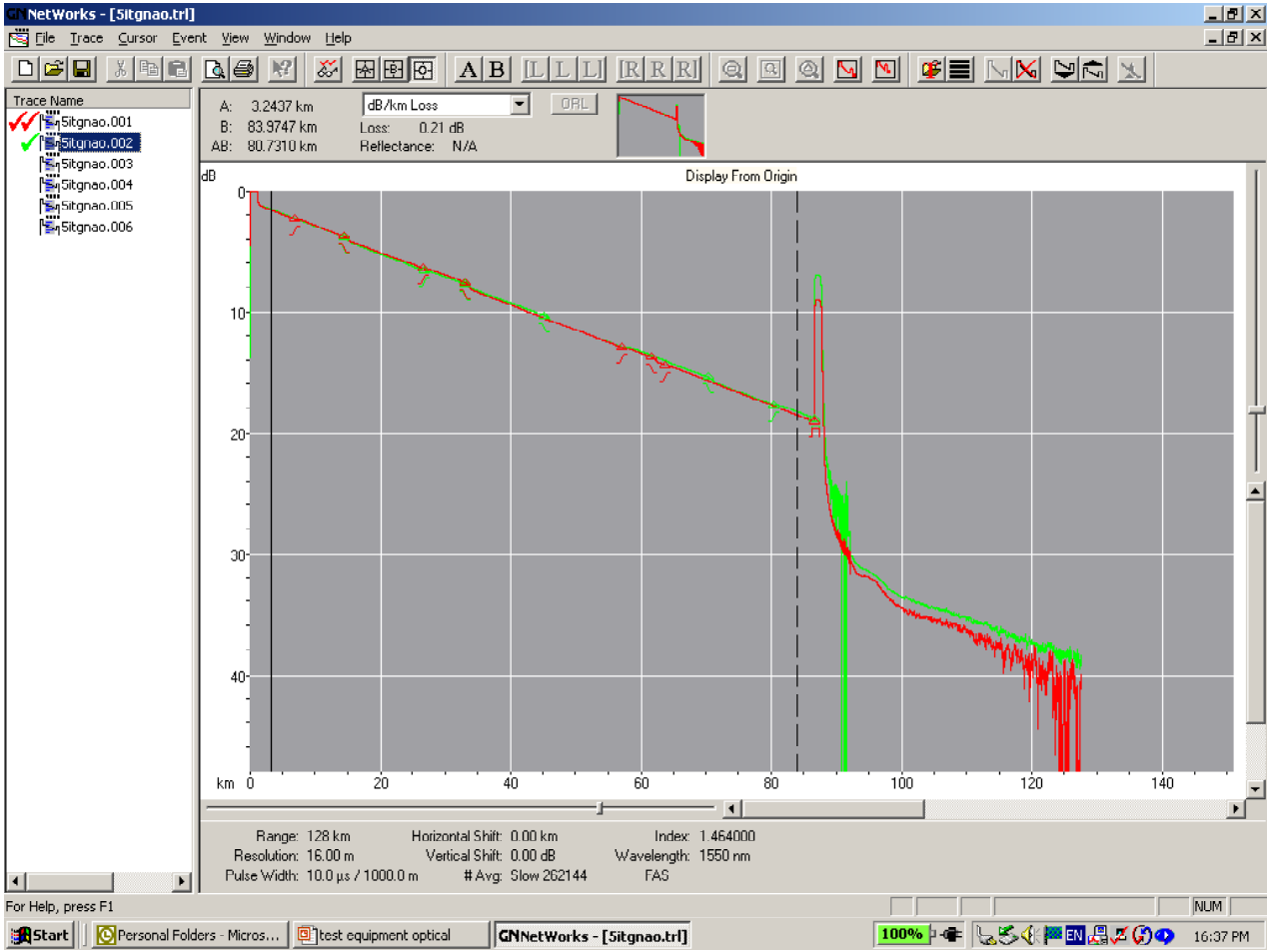
OTDR (Optical Time Domain Reflectometer)

Printed view of two fiber optic links measurements.



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The Growing Demand for Data Transport

It is clear, as we approach the 21th century the remarkable evolution in information services in our society. This revolution in information has been promoted by;

- **Higher number of long distance phone call**
- **Internet traffic**
- **Multimedia services**
- **Transport of medical picture at high speed**
- **Financial exchanges (Credit card, Direct payments etc.)**
- **Demand for more television signal**

These are the reason, why information services need increase in capacity

Capacity of a fiber optic network

Since to-day, the capacity of a fiber optic network is limited to 10 Gbps, soon to be 40 Gbps, we must find other way to increase the fiber optic's capacity

Let have a look at the possibility of augmenting the capacity of the network.

Ways of Increasing the Capacity of a Fiber Optic System.

* By installing more fiber.
* By augmenting the fiber optic capacity.
* By using the technology of CWDM or DWDM.

Installing New Fiber Optic

Installing new fiber optic can be very expensive and difficult in areas like;

- **Big city.**
- **Submarine cable.**
- **Underground duck been completely full.**
- **Lack of space in CO (Central Office)**

SONET transmission capacity

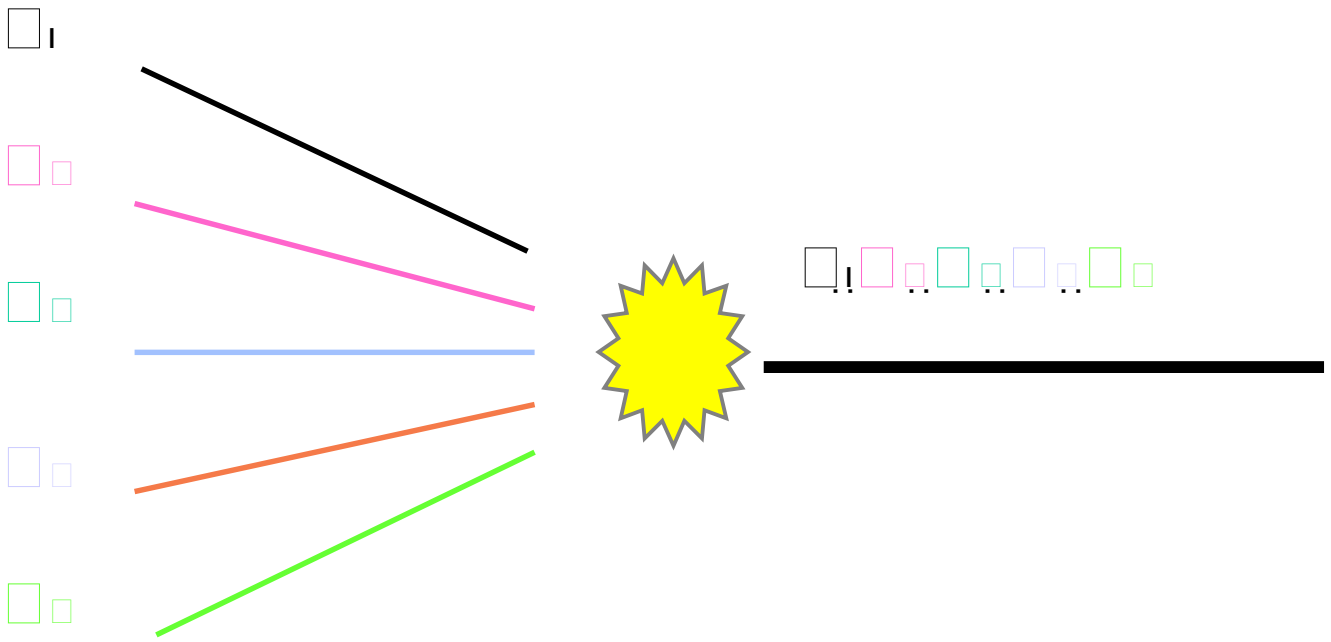
Optic	Mb/s	Tel. Conv.	TV ch.
DS0	0.064	1	*
T1	1.54	24	*
DS3	44.74	672	*
OC-3	155.52	2,016	2
OC-12	622.08	8,064	12
OC-48	2,488.32	32,256	48
OC-96	4,976.64	77,760	55
OC-192	9,953.28	155,520	111

* Only slow scan picture.

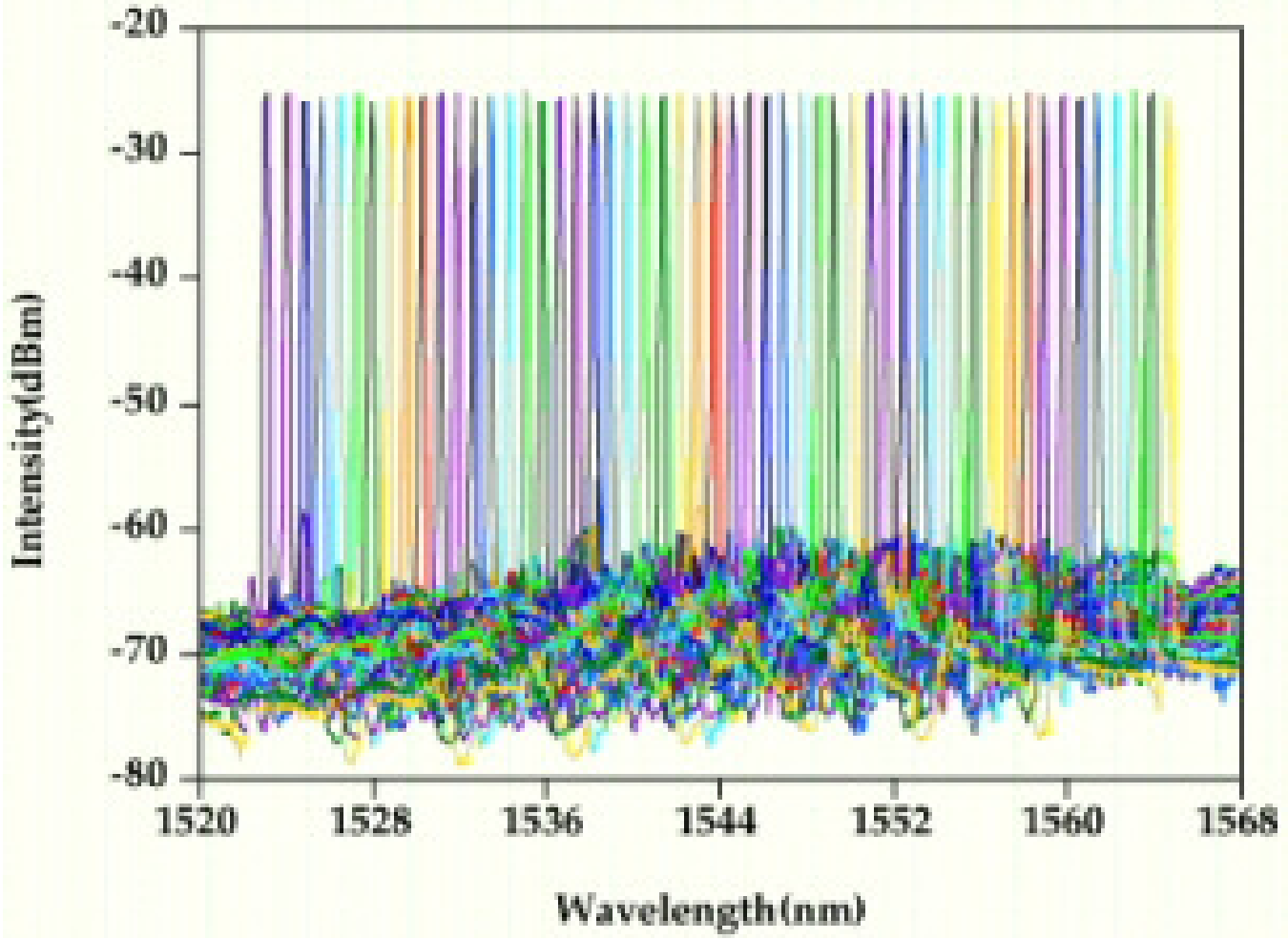
The DWDM Technology

The DWDM technology, consist on transmitting many optical waves on the same fiber optic.

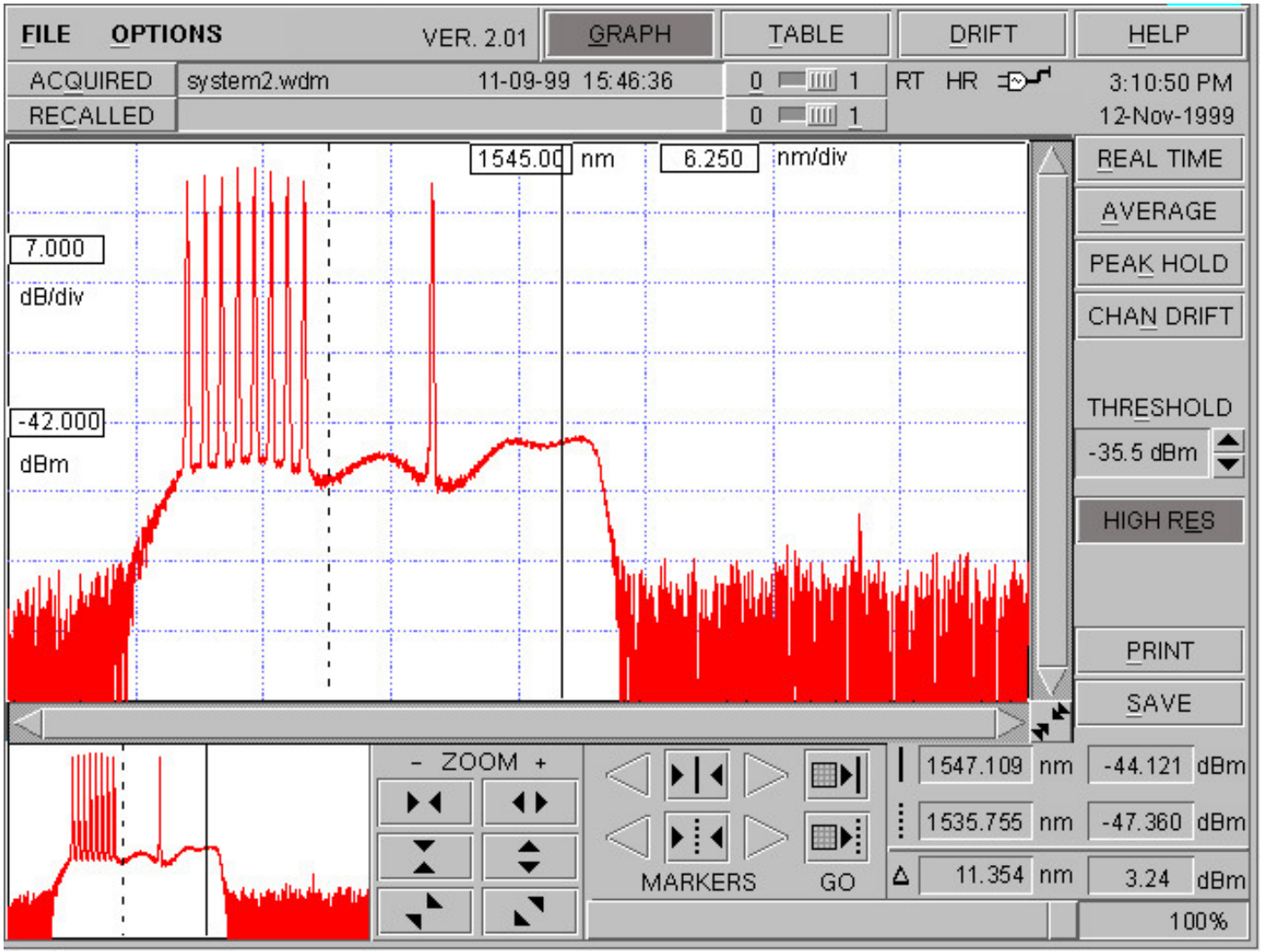
Dense Wave Division Multiplexing



Thirty Two Wavelengths DWDM Frequencies.



OSA (Optical Spectrum Analyser).



OSA (Optical Spectrum Analyser).

OSA are used to measure Carrier to Noise, Signal amplitude, EDFA's flatness and bandwidth response and signal frequency.

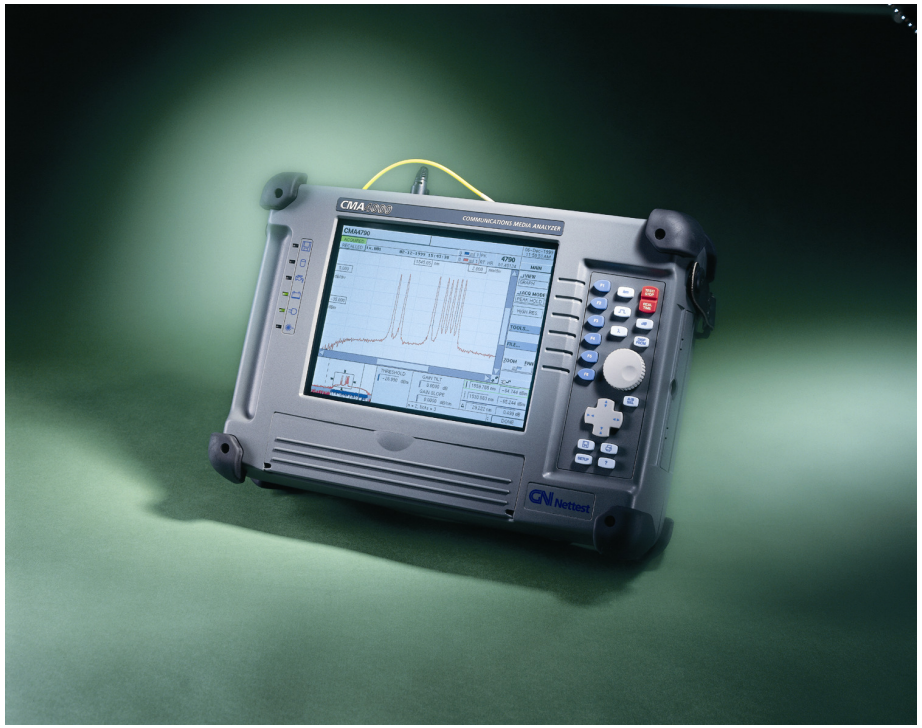
Model CMA4791

Wavelength: 1520 - 1570 nm

Power Range: +20 to –60 dBm

Power Range: +10 to –70 dBm opt.

Channel table: 256 channels.



Talk Set.

Talk set are used to communicates between the field technician and the central office people over fiber optic.

Optical Specifications

For Full-duplex

OVS-6000

1310 nm

Range: >30 dB

OVS-6100

1310 nm

Range: >50 dB

Above on single-mode fiber.

Visual Fault Locator

The VFL-670 works at 670 nm with an output of –4.0 dBm. It is capable of a distance of 2 kilometres. It give a RED visible light, where there is a break or a bad connected installed. The unit work for multimode and single mode fiber optic.

Optical Fiber Connector Inspection.

The FS-X00 Fiberscope is ideal for inspecting optic connector. This unit will give a 200X or 400X view for multimode and single mode fiber connector. You need one of the following ADAPTER: FC-APC, ST, SC-APC, or D4.

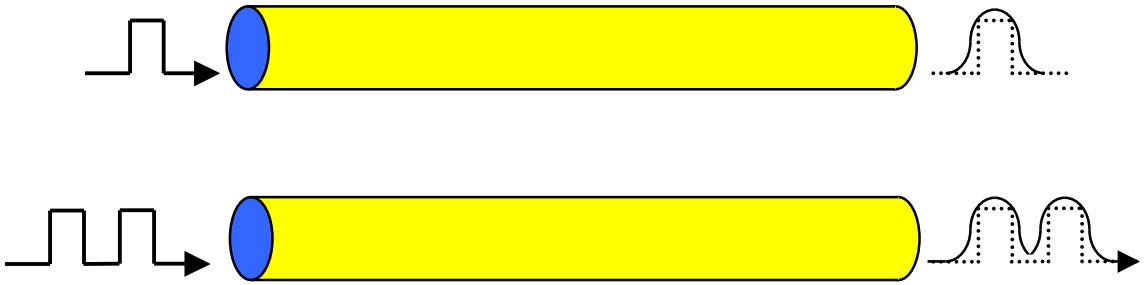
Problems with Fiber Optic Transport System.

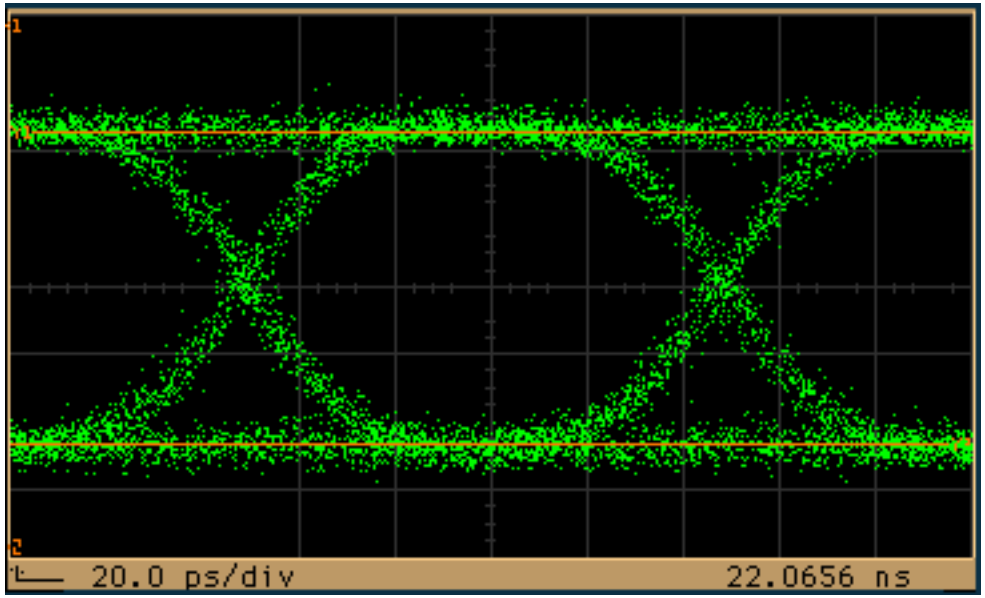
Two majors problems with Fiber optic transport System

- **Chromatic Dispersion.**
- **Polarization Mode Dispersion.**

What is Dispersion.

The spreading or broadening of light pulses as they propagate through the fiber





Digital Communication Bit Times

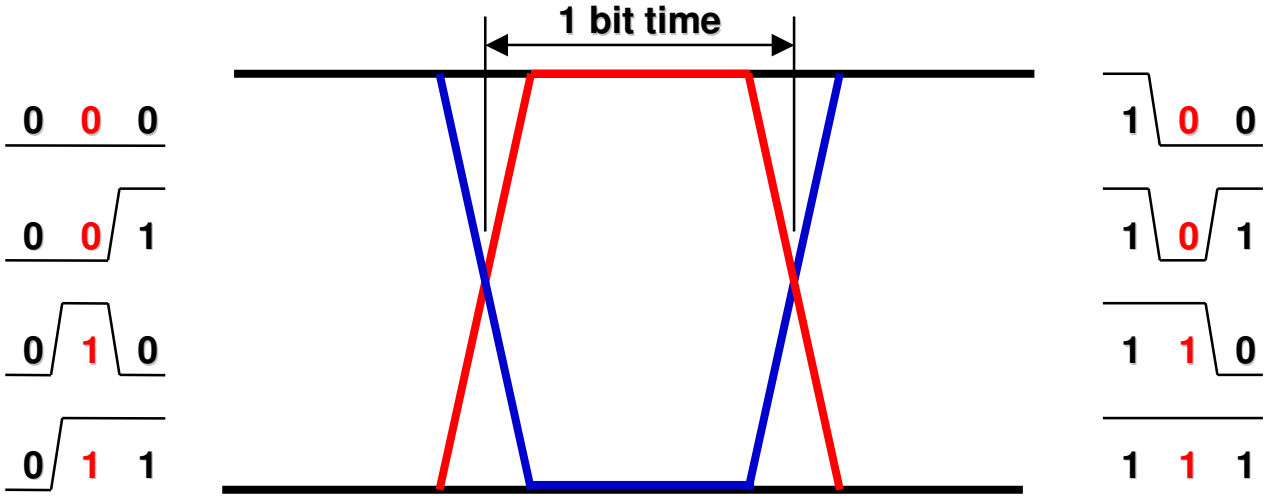
SONET	SDH	Transmission Rate	Bit Time	Dispersion Limit
OC-1		51.84 Mb	19.29 ns	2 ns
OC-3	STM-1	155.52 Mb	6.43 ns	640 ps
OC-12	STM-4	622.08 Mb	1.61 ns	160 ps
OC-24		1244.16 Mb (1.2 Gb)	803.76 ps	80 ps
OC-48	STM-16	2488.32 Mb (2.4 Gb)	401.88 ps	40 ps
OC-192	STM-64	9953.28 Mb (10 Gb)	100.47 ps	10 ps
OC-768	STM-256	39,813.12 Mb (40 Gb)	25.12 ps	2 ps

Above are SONET

- Transmission Rate
- Bit Time
- Dispersion Limit

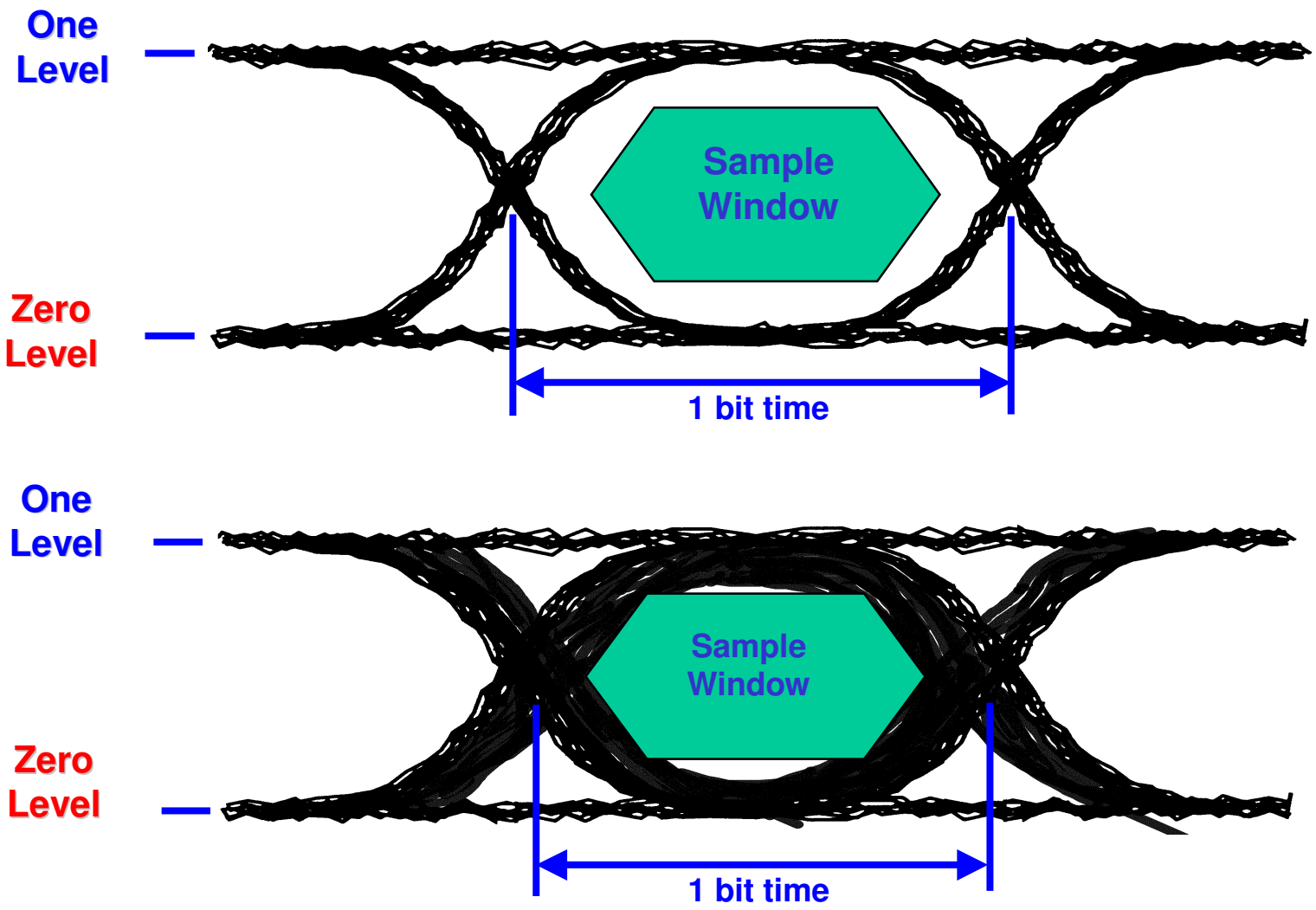
Eye Diagrams - What They Are

- For each bit time, there are 8 possibles conditions:



- Combine (overlap) them for an eye diagram

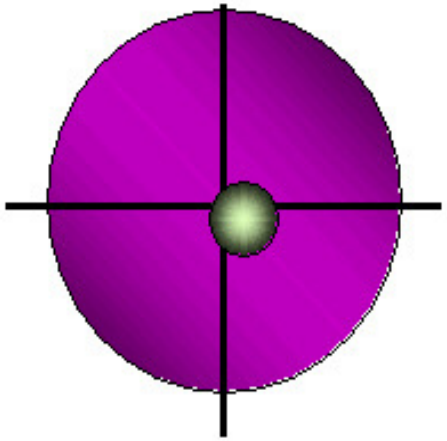
Typical Good and Bad Eye Diagram (High Bit Error Rate)



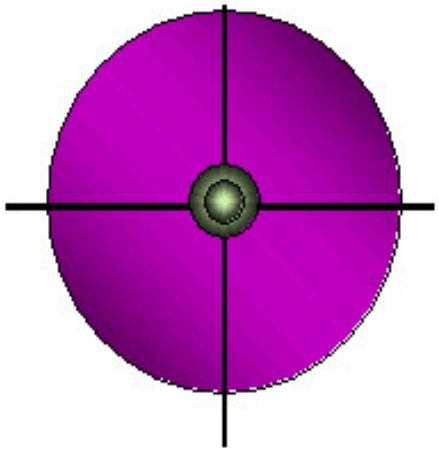
What is Polarization Mode Dispersion

Polarization Mode Dispersion is basically due to the fact that different polarizations of light travel at different speeds.

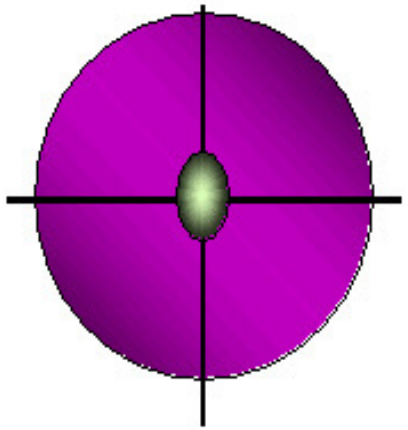
Off Center



Different Size



Non-Circular



Above are some the majors causes of PMD.

Differential Delay

The difference in speed between the two cars (or two wavelengths of light) causes them to arrive at the end at different times. The longer the distance, the more time difference between them.

65 mph

55 mph

Start
0 sec. diff

65 mph

55 mph

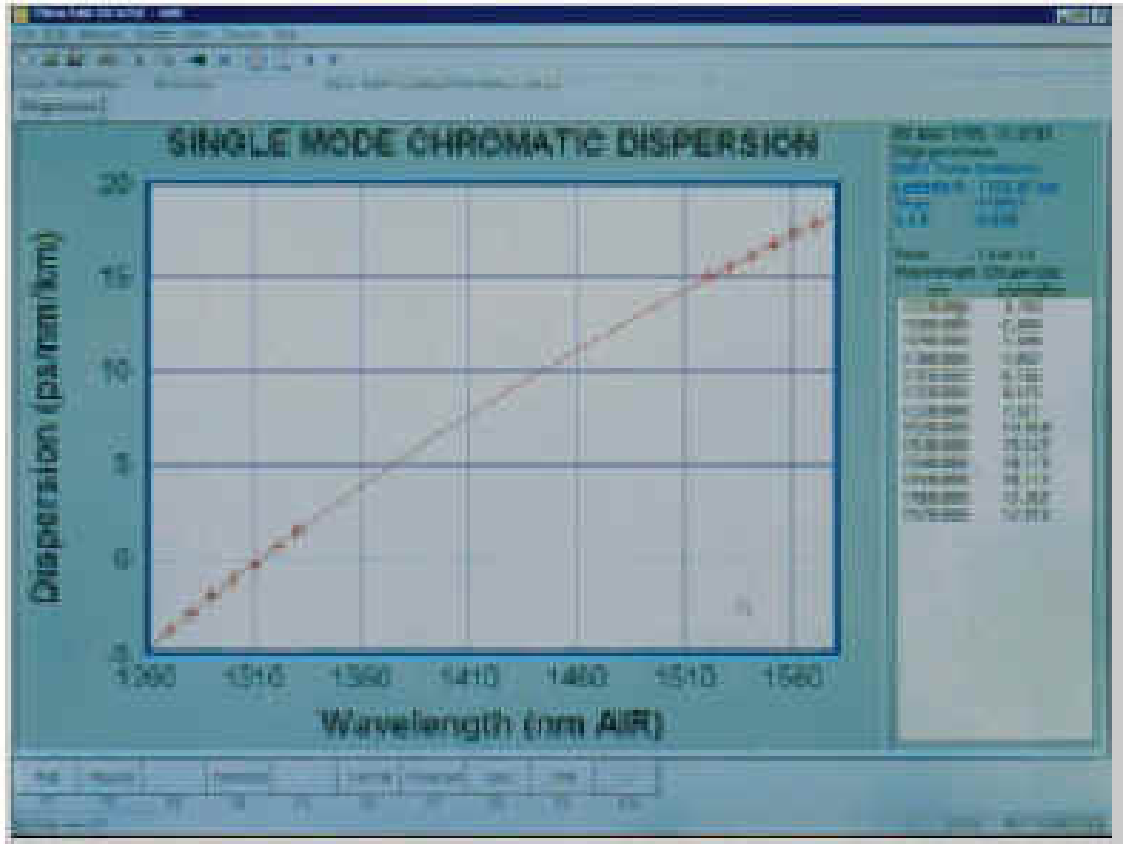
After 1 mille
10 sec. diff

65 mph

55 mph

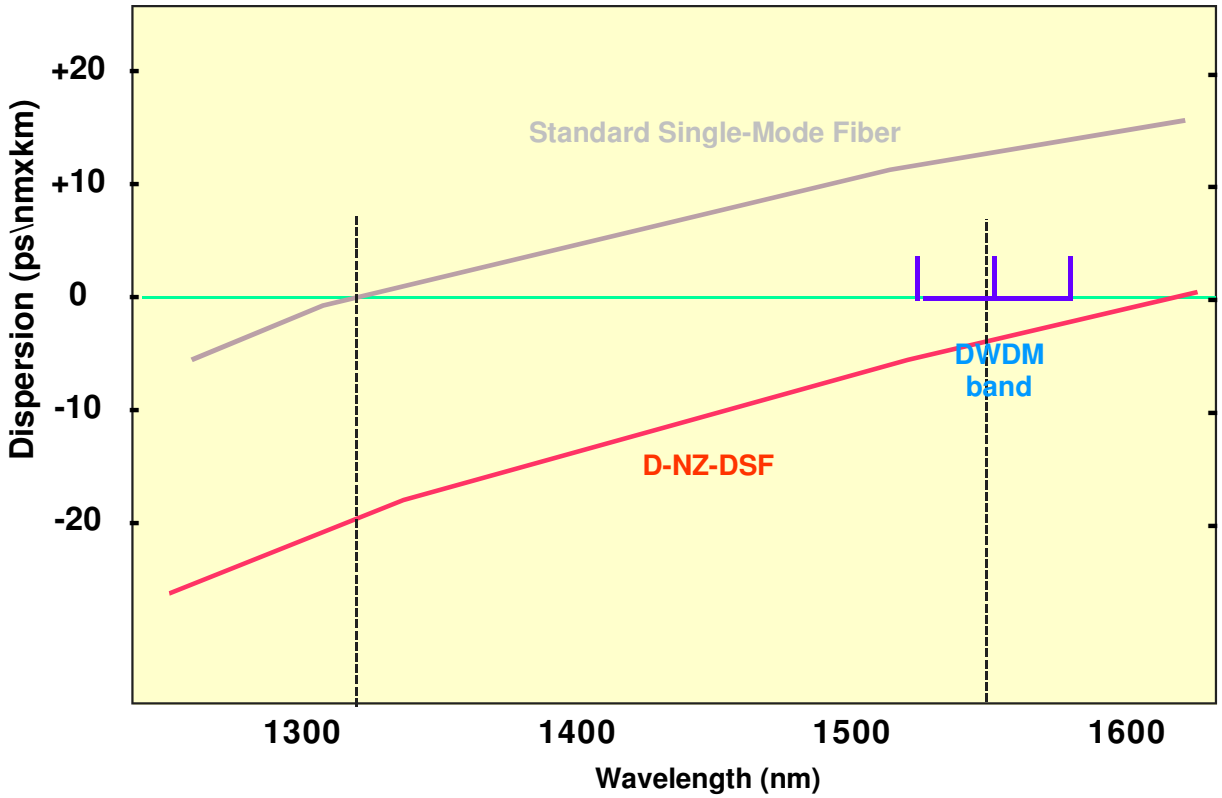
After 20 mille
200 sec. diff

Reading of Chromatic Dispersion.



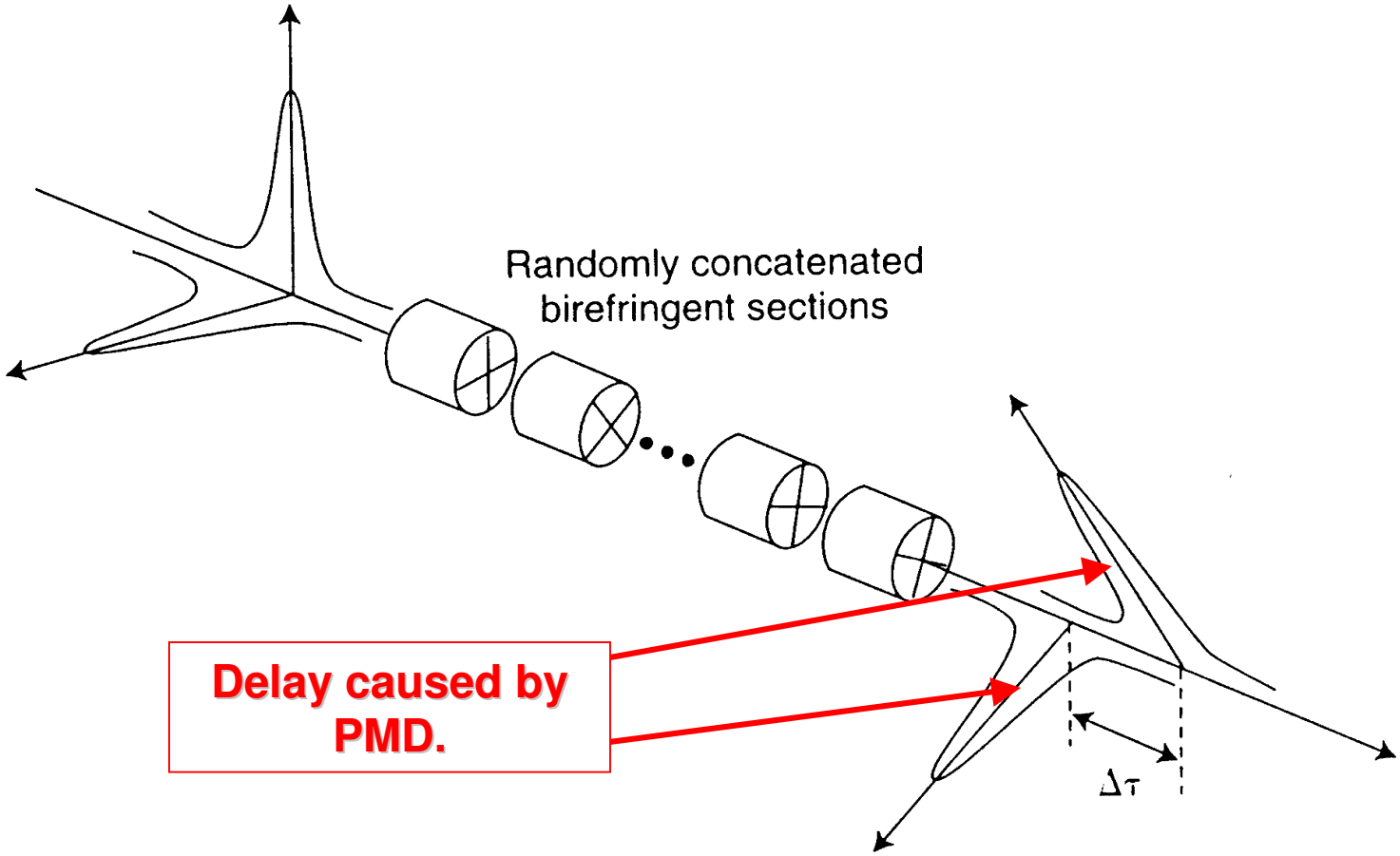
Above are reading of Chromatic Dispersion between 1260 to 1560 nanometre.

Chromatic Dispersion.



As there are two types of fiber optic with different type of Chromatic Dispersion. Above is the Chromatic Dispersion for standard fiber and NZ-DSF (None Zero Chromatic Dispersion). This type a\of fiber optic is used for long distance transport and utilized the 1550 nm light frequency.

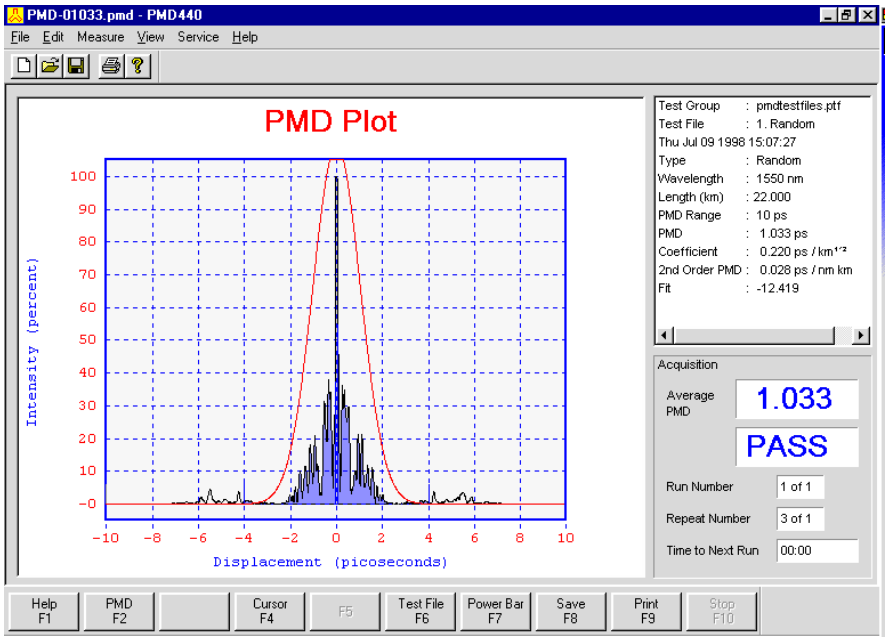
The Results of PMD.

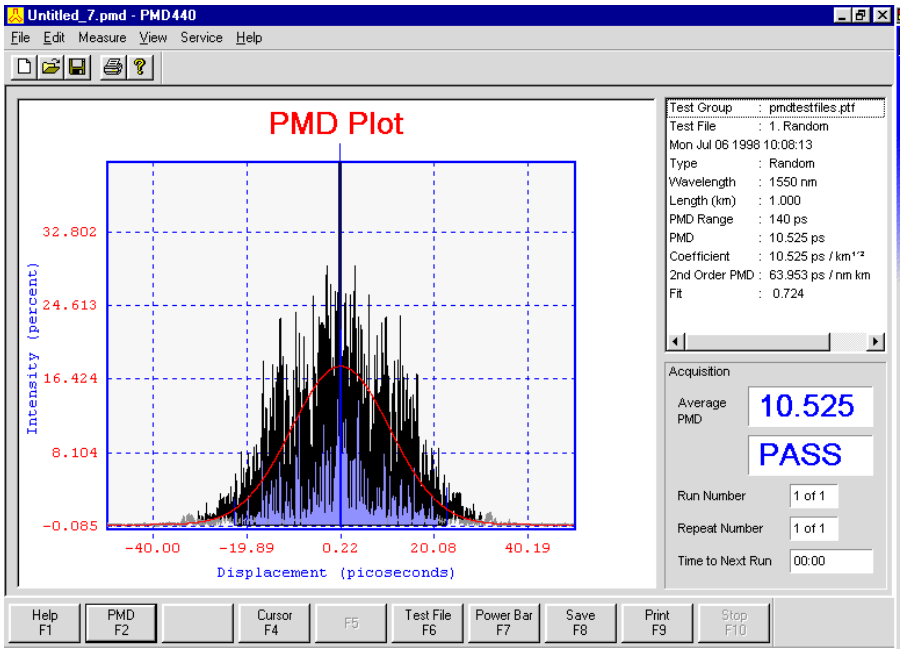


PMD Analyzer

The PMD440 is capable of measuring PMD (Polarisation Mode Dispersion). PMD can occur at 1310 and 1550 nm. PMD will be one of the major problem with fiber optic for long distance and high speed data transmission.

Reading PMD Results.





Good PMD Measurement

Bad PMD Measurement

PMD and HFC System.

A HFC system requires the following PMD requirements:

For 1310 nm is: 0.5 ps sk-km.

For 1550 nm is: 0.2 ps sk-km.

Any worse PMD readings than the above, would cause a bad CSO (Composite Second Order) reading at the NODE.

The end of this session.