M2 Optics, Inc.

RF Optics, Inc.

FOS 860A

Standard Optical Receiver

This brief discussion was written because many users initially review the instrument specs and say; *"I don't really need this instrument".* In the end, customers who do purchase it say; *"I don't know how we got along without it".*

The primary factors in the performance of optical communications systems are optical power and optical modulation index (OMI). The OMI must be set properly to achieve optimum Carrier to Noise Ratio (CNR) while avoiding unacceptably large non-linear distortions and threshold clipping effects. Static clipping behavior increases the lasers non-linear distortions and imposes an upper limit on its channel capacity.

The mathematical calculation of CNR for a multi-channel carrier system is a statistical calculation that is comprised of a number of variables such as OMI (m), video noise BW (B), receiver photocurrent (I), receiver noise equivalent current (N) and laser Relative Intensity Noise (RIN).

$$CNR = (\mathbf{m} \cdot I)^2 / [2B(2qi + N + (RIN \cdot I^2)]$$

As you can see from the above equation for CNR, the OMI or **m** is a key variable along with optical power (as they are squared) in the CNR calculation. Therefore, it is vital to get as much optical power from a laser as possible as the result of setting the OMI to the optimum level for the system to perform optimally. The FOS 860A OMI/Standard Optical Node is used to accurately set the laser OMI for optimum system performance in a real system, with real carriers and transport media. The FOS 860A also acts as a standard node with distortion performance that is much better than a node. It can be used as a substitute for a node in the field and will quickly find if the node or the received optical signal is causing problems.

Many manufacturers use the FOS 860A in their manufacturing test and alignment processes. But as stated earlier, they typically set up their transmitters with un-modulated carriers and therefore do not achieve the best performance when duplicated in the field with real modulated carriers. Performance is usually better with modulated carriers.

The FOS 860A is used in laboratories, manufacturing locations, head ends and in field sites. It does double duty as a standard receiver and can be used extensively to verify performance of transmitters and optical nodes anywhere in the system. In addition, it is used as an OMI monitor and or a tool in setting the optimum OMI in a system. It is quite an achievement to squeak out an additional one or two dB in system CNR performance by optimizing the OMI setting.

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Before a laser or transmitter is employed in a system, it goes through a number of processes and specification setting procedures. All of these procedures are prone to inaccuracies that in the end may add up to a major shift in performance.

- Laser OMI is determined and specified by the laser manufacturer.
  - They typically use un-modulated carriers. (Variable introduced)
  - They set the specification using a specific number of channels (Variable introduced)
- Lasers are purchased and installed by the transmitter manufacturer.
  - Laser driver circuits are introduced between the input and the laser. (Variable introduced)
  - TX manufacturers typically use un-modulated carriers. (Variable introduced)
  - TX manufacturers typically do not divulge the OMI for their TX's. They usually tell the user the RF per channel level necessary to drive the transmitter. This way the manufacturer can provide for the variations normally encountered in manufacturing optical equipment. (Variable introduced)
- Transmitters sometimes have front panel "set up" indicators. An example may be that a green light goes on when the levels are in a certain range.
  - The circuit tolerances can cause the OMI setting window to shift, become smaller or larger thereby allowing the OMI setting to have a fairly wide range. (Variable introduced)

The final result is that the user sets the RF input level for the number of channels used. This may be a change from the original OMI/channel setting. And with modulated carriers, and all the other above variables, the setting is certain to be non-optimum. If the FOS 860A is not used to set OMI, a lot of other expensive equipment, time, and math calculations are required to set the total and per channel OMI percentage. And this procedure must be repeated each time any variable in the set up is changed. Not an easy task.

In summary, the FOS 860 allows the user to set the transmitter OMI with all of the many variables taken into account. Most users don't know how they got along without this instrument after they use it for a period of time. They initially review it, don't think they need it, try it, improve their system performance and troubleshooting ability, and buy it. Whenever customers review system performance issues, they realize the importance of owning the instrument.

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