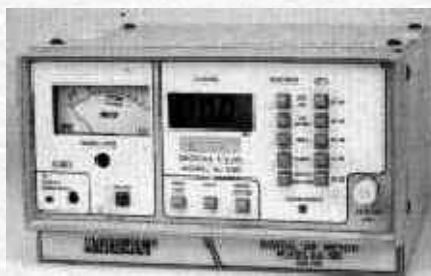


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AN INTRODUCTION TO SIGNAL LEVEL METERS

The Signal Level Meter is probably the single most essential piece of instrumentation required for a CATV network. The signal level meter is often referred to as a Field Strength Meter (FSM). As we will see later the FSM is really a misnomer. However, the term is so commonly used that even in this article we will refer to the signal strength meter as an FSM.



The FSM is used for both installation of new equipment in a network as well as for fault finding and routine maintenance. The Bureau of Indian Standards (BIS) has laid down that every cable subscriber must receive a minimum signal level of 60 dBm and the signal level should not exceed 80 dBm for any channel. These levels ensure that a TV set connected at the subscriber outlet would receive a good picture. A signal level meter is used to measure and ensure that signal levels are delivered as required.

Further, the distortion performance of an Amplifier is closely related to the output signal level. The amplifier distortion increases by 2 dB for every 1 dB increase in the output level. Hence it is critical to adjust amplifier levels appropriately. This can be done using a signal level meter that is accurate and has been calibrated recently.

Both the above cases show that a calibrated and accurate FSM is not just a convenience but an absolutely essential item for any CATV network. A wide variety of FSMs are available locally. These include products from India, China, Taiwan, Japan, Italy and USA. The Indian CATV Network Owner probably has the widest choice in this category of products. To help take a decision on the most appropriate product for their specific needs, let's take a detailed look at each of the features offered.

DIGITAL AND ANALOG DISPLAY



The most popular and obvious categorisation is by the display used. Broadly, the meters can be classified as those utilising an analog meter or a digital display.

FSMs utilising an analog meter, are usually low cost units. These typically incorporate attenuators that need to be manually switched in or out of the circuit before obtaining a final measurement which is within the range of the analog display (meter).

A major drawback of these instruments is that the meter needs to be "tuned" to obtain the highest / peak reading. The reading could easily vary by as much as 5 to 10 dB and hence particular attention must be paid to precisely tune the instrument before obtaining a reading. Some manufacturers build in a digital display that merely indicates the tuned frequency. The digital display does not indicate the measured signal level. A simple digital frequency display serves little purpose and is probably added by the manufacturers so as to (misleadingly ?) market their products as a digital meter.

The digital display meter typically indicates the signal level and other measured parameters, as text on an LCD display. The LCD display is preferred to an LED display since it consumes very little power. However the LCD display is visible only in external light and hence some manufacturers include internal back lighting to illuminate the LCD when measurements are made in the field, under insufficient light.

AUTOMATIC ATTENUATION



Most digital meters include electronics that automatically switches in the appropriate amount of external attenuation so as to make an accurate reading. This is a major user convenience.

Further many digital meters are pre-programmed with the standard PAL-B/G audio and video frequencies, for each of the channels. Hence the



user simply increments to the channel to be measured and directly obtains a reading without having to tune the meter or manually activate attenuators.

AUTOMATIC TUNNING

A word of caution. Meters that are pre-programmed for standard PAL-B/G frequencies can often yield gross errors in reading actual signal levels, though their performance in their laboratory would seem perfect. This is because in practice, modulator frequencies some times drift and the peak video and audio frequencies may not be at the precise frequency indicated by the channel look up table. Such meters could indicated readings that are off by 4 to 5 dB or even more for certain channels where there has been a frequency drift.

The ideal solution for this is to provide an automatic tuning facility within the meter. The meter therefore scans the frequency neighbourhood of this specified channel for the highest signal level and measures and displays this result.

FREQUENCY RANGE FORWARD PATH

Ideally an FSM should measure all frequencies that are employed in a CATV network. Most CATV networks currently employ 48 MHz to 550 MHz in the forward path. 750 MHz equipment is now available in the country. Hence keeping in mind future upgrades and growth, it would be prudent to buy a meter which can measure forward path CATV signals for all frequencies from 48 MHz to 890 MHz, including all skip channels.

REVERSE PATH

The reverse path is being increasingly used by CATV networks for relaying live programmes and for exchange of channels between Headends. The advent of Internet and Computer connectivity through CATV networks will further push the use of the reverse path on CATV networks. It would therefore seem prudent to buy a unit which is capable of measuring signals in the reverse path (5 MHz to 30 MHz). Measurement of reverse path signals would also help identify strong signal ingress at particular frequencies which would, as a result not permit use of that particular reverse path channel.

A local manufacturer - Signet, offers an external reverse path adapter. This stand alone unit has its own power supply and can be fitted onto any meter capable of measuring forward path signals, to adapt it for reverse path measurement. The reverse path adapter simply up converts the input frequency by 100 MHz. Hence signals in the 5 to 30 MHz range would be up converted to a frequency range of 105 MHz to 130 MHz, which can then be measured on any meter with a frequency mode.

MEASUREMENT RANGE

A CATV network typically carries signals ranging in level, from around 50 dBm to 100 dBm. Most signal level meters have the capability to measure signals ranging from 40 dBm to 120 dBm. This range should be adequate for most applications. Some products can even measures signals down to 20 dBm.

The capability to measure low level signals of around 25 dBm are ideally suited for measuring stray or radiated signals in free space using a dipole antenna. The antenna, through a cable is directly connected to a meter. Such a setup measures the radiated signal or the signal field in free space. This has led to signal level meters often (but incorrectly) referred to as Field Strength Meters. The strength of an external field can only be measured when the meter is connected to an antenna of known gain. When the meter is connected directly to a CATV cable, it measures the signal strength within the cable and hence its true function is that of a signal level measurement meter.

ACCURACY

Accuracy is the extent to which the meters reading varies from the actual reading. Hence a meter with an accuracy of ± 2 dB could read anything between 98 dBm or 102 dBm when the actual signal level is 100 dBm.

Further, two meters with an accuracy of ± 2 dB may actually have readings of 98 dBm and 102 dBm i.e. a variation of 4 dBm between their readings and still meet specifications. Similarly two meters with an accuracy of ± 4 dBm can have a variation in their readings of upto 8 dBm !

RESOLUTION

The resolution indicates the smallest difference in level that the meter can detect. A meter with a resolution of 0.1 dBm would show changes in its inputs of as low as 0.1 dBm. However do not be misled by this specification. Typically the same meter would have an accuracy of ± 2 dBm. Hence the reading indicated on the display could be upto 2 dBm of the true level, even though the meter indicates a signal level of 98.3 dBm. The resolution specification can only help compare two signals without necessarily providing information of their true levels.

SIGNAL AVERAGING



Anyone using a signal level meter would have realised that the signal level of a channel carrying a picture is not constant but varies by approximately 2 dBm, varying with the picture content. This 2 dB represents a very large signal variation specially when compared to typical resolutions of 0.1 to 0.2 dB. Manufacturers therefore typically average out the readings over a couple of seconds before displaying the reading. The averaging can simply be done by the use of

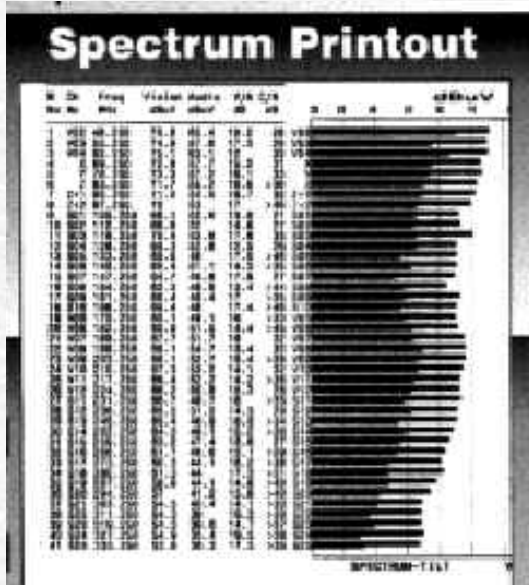
resistor and capacitor combination which builds in an appropriate time constant.

CALIBRATION

A signal level meter, after manufacture is calibrated by comparing it to a known reference. Calibration indicates the variation in reading, at different frequencies, compared to the ideal value. As the electronic components age, their values drift over a period of time. The meter then no longer is as accurate as before. Its accuracy may no longer be ± 2 dBm specified when the meter was purchased new. Manufacturers usually specify a period after which it is recommended that the meter be re-calibrated. Usually it is recommended that a meter be calibrated every 12 months to 36 months (1 to 3 years). Calibration cannot be done by the user. The instrument must be sent back to the factory where its readings are compared with a known reference.

I have often been approached by CATV networks who indicate that readings between two different meters owned by them, varies as much as 5 dBm to 8 dBm. Clearly one or both units need to be calibrated, particularly if their initially specified accuracy was ± 2 dB (which would permit reading variations of upto 4 dB max).

SOFTWARE COMPENSATION



Since the actual signal measured by a meter will vary from the true value at different frequencies, its readings need to be compensated by different amounts over a wide range of frequencies. If this is done, the instrument's accuracy would improve substantially. Certain manufacturers such as Ro.Ve.R. Sat, Italy, incorporate a memory chip in each meter. The memory chip records the amount of correction that needs to be applied for that particular meter, over its entire frequency range. The information is written into the memory at the calibration process at the factory and helps improve the instrument accuracy, over the full measurement frequency range. However, discussions with other Signal Level Meter manufacturers such as Signet, indicate that they prefer an approach of using tighter tolerance components for higher accuracy & lower drift, thereby alleviating the need for software compensation.

PRACTICAL PITFALLS

Often meters yield poor readings even though they may have been purchased a year ago. The problem can usually be traced to a damaged female connector on the instrument panel. Often, the line technician inserts a thick center conductor, RG11 cable into the female F Connector which has not been designed to accommodate such thick wires. The spring contacts in the female F connector remain permanently parted. As a result proper contact is not made thereafter and reading accuracy, particularly at lower frequencies suffers significantly.



POWER PASS VOLTAGE

Most CATV networks remotely power line amplifiers. The line amplifier should receive an input AC voltage in the range of 30 VAC to 60

VAC. If an FSM can measure both the RF signal levels as well powerpass voltages, it would be an

ideal solution. Hence most digital display based signal level meters provide the capabilities to measure powerpass AC voltages upto atleast 60 VAC. It would be prudent and safe if the meter could actually measure or atleast withstand without damage, 100 VAC input voltage.

CONVENIENCE FEATURES

Sophisticated signal level meters often include a variety of facilities and convenience features, in addition to the basic functions of signal measurement. These include:

SPECTRUM DISPLAY

Typically a signal level meter measures levels at spot frequencies only. Often, it is necessary to know the signal levels and more importantly the changes in signal levels over the entire CATV bandwidth. This facility is provided by signal level meters that provide a bar graph display covering the entire useful CATV Spectrum. This is shown in Figure 1. The bar graph display indicates, at a glance whether all channels are being transmitted at approximately equal levels.

TILT / SLOPE MEASUREMENT

The BIS specifies that the slope at any consumers premise should not exceed 9 dB over a frequency range of 300 MHz and permits a maximum slope of 15 dB at any frequency. The slope can be deduced from the spectrum display. However this usually requires a large LCD display panel which tend to increase the instrument cost. Some instruments offer a tilt or slope feature which measures the signal at 2 extreme frequencies and a third frequency midway.

MEMORIES

Some products include a memory chip in the meter. The built in memory is capable of storing up 100 readings from the same location or even measured at different locations in the CATV network. The memorised readings can then be printed out for a permanent record or for review and fault finding purpose.

PRINTER INTERFACE

Some sophisticated signal level meters include the facility to attach a printer and obtain printouts of readings or even an entire spectrum bar chart display.

The meter usually interfaces with the printer using either a serial (RS-232) port or a parallel port. These are standard computer interfaces. However, the buyer should bear in mind that most of the popular commercial printers provide only a parallel port. Hence a signal level meter with a parallel port interface will link to a wider variety of printers compared to a unit that provides a serial interface.

COMPUTER INTERFACE

As the level of sophistication increases, a signal level meter's capabilities can be substantially enhanced by inter connecting it to a computer. The computer can then be loaded with software that would process readings obtained from the meter and present it graphically. An excellent example of this is the product from Signet. When used with a personal computer, the unit provides the functionality of a spectrum analyser that can be used for testing coaxial cable, by cable manufacturers or even for other applications.

AUDIO MONITORING

It is often convenient to identify a channel by monitoring its audio content. Most signal level meters now offer a built in speaker which provides demodulated audio of the channel being measured.

C/N MEASUREMENT

The BIS specifies that each CATV subscriber must receive a signal at the outlet, not only of a signal level between 60 dBm and 80 dBm, for any channel, but the signal's Carrier to Noise ratio (C/N) should be atleast 43 dB. It is therefore necessary, for proof of performance, to measure the C/N ratio not only at the Headend but also in the field, and at the customers premises. Conventionally C/N is measured using a spectrum analyser. Clearly this is not a convenient solution. Ro.Ve.R. Sat amongst others, offers a signal level meter that can measure the C/N ratio, WITHOUT DISTURBING THE SYSTEM. Lets take a closer look.

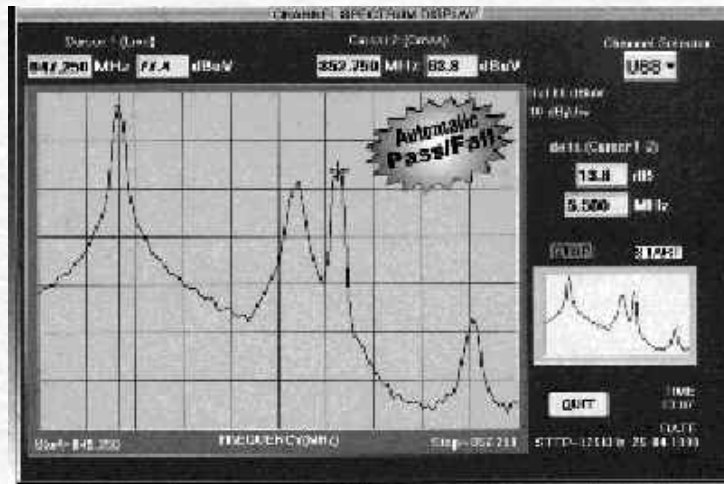
The C/N ratio is simply the ratio of the Carrier (Video Carrier) level compared to the Noise in that channel. A very simple way of measuring this for any channel, is to measure the Carrier level (say 75 dBm). Then for the same channel, switch off the modulator at the Headend and then again measure the signal (say 35 dBm). The C/N ratio is then simply $75 \text{ dBm} - 35 \text{ dBm} = 40 \text{ dBm}$. While this method is simple, in most cases it is not practical since a modulator at the Headend is to be shut off for each reading. This would disturb viewers watching that programme on the entire network.

Signet meters offer the capability to measure the C/N ratio, without switching off the Modulator, but require that the video i/p be disconnected when making measurements. They however provide an auto-scan feature that can scan the entire spectrum in approx. 2 minutes, say at 2 am, when all

video signal can be temporarily disconnected, for provide an C/N measurement over the entire spectrum.

As one can expect, the most accurate results would be obtained at high signal levels. Signal Level Meters offering this facility almost universally employ automatic electronic switching of the input level. In such meters the input signal is directly fed to the next stage for all signals upto 80 dBm. For signals beyond 80 dBm an attenuation network is switched into the circuit, thereby reducing the effective input to the second stage. Once the external attenuator is in place the effective signal to the second stage falls substantially. Hence the most accurate C/N measurement would be made for input levels above 70 dBm but below 80 dBm. Ro.Ve.R. Sat utilise a proprietary method for measuring the C/N ratio with their FSM without switching off the Modulator. Clearly this feature is essential if the signal level meter is to be used to verify the performance of the instrument at any point, from the Headend to the subscriber's home.

BATTERY LIFE



Since the signal level meter is a portable instrument, it is designed to have minimum weight. This restricts the size of the battery that can be included with the product. Given the extensive use of the FSM throughout a working day, it is almost essential that an FSM be provided with a rechargeable battery and charger failing this, the cost of frequent replacement of new batteries would be prohibitive. There are 2 popular types of rechargeable batteries provided by equipment manufacturers viz.

SEALED LEAD ACID BATTERIES

These batteries are similar in construction to a car battery. They are relatively heavy and are designed (unlike the car battery) to be sealed. Hence it is not necessary to top them up periodically with electrolyte. They are also built to endure vibration and bumps during operation. These batteries provide very good power capacity for their size and weight. The key disadvantage for these batteries is that the battery life is severely affected if the battery is completely discharged and left in this discharged state, even overnight. Care should be taken to ensure that the battery is never deep discharged and weak batteries should immediately be put to charge. Most signal level meters incorporate these batteries. They are also fairly low cost.

Ni-Cd BATTERIES



These rechargeable batteries are almost similar in appearance to disposable dry cells. The batteries use Nickel and Cadmium, hence their name Ni-Cd. These batteries are rechargeable, theoretically to 10,000 cycles. The batteries are prone to a "memory effect". The memory effect reduces the battery capacity to the extent that it is used. Therefore a fully charged Ni-Cd that is used to barely 10% of its capacity between recharged cycles will soon be able to deliver only 10% of its rated power. In recent times, Ni-Cd manufacturers claim to have overcome the memory effect. In summary, Ni-Cds are small and lighter than Lead acid cells but are more expensive.

AUTO POWER OFF

To conserve battery life, many signal level meters offer an auto power off feature. This feature automatically shuts off the instrument if it is not used for a specified period of time e.g. 5 minutes. This is a genuinely useful feature and avoids unnecessary battery drain. Some meters also include a mechanical facility that physically moves the power switch to the off position when the meter case is closed. This feature was common in the older Leader instruments but is not as effective as an auto power off facility.

CONCLUSION

A wide variety of signal level meters are now available in the Indian market. The CATV professional has a choice of locally manufactured as well as imported products. The buyer should always keep in mind after sales service that would be available to him if required. Most foreign brands now support their products with after sales service in India, through their authorised service centers. In an effort to list most of the reputed products available in the country, SCA T has conducted the

country's first survey for these products. The following pages indicate various features and price for each of these products.
It is hoped that this article and the following survey will help readers make a considered decision when buying their next Signal Level Meter.

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