

FIBRE-OPTICS MONITOR

INSTRUCTION MANUAL

The logo for ELLMAX ELECTRONICS is centered on the page. It consists of a white, horizontally-oriented hexagonal shape with a thin black border. Inside the hexagon, the word "ELLMAX" is written in a large, bold, black, sans-serif font. Below it, the word "ELECTRONICS" is written in a smaller, bold, black, sans-serif font. Two horizontal lines extend from the left and right sides of the hexagon, passing through the page.

FIBRE-OPTICS MONITOR

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Version 2.1

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The **FIBRE-OPTICS MONITOR** contains the following items:

FIBRE-OPTICS MONITOR TRANSMITTER UNIT

FIBRE-OPTICS MONITOR RECEIVER UNIT

2 x 2.5mm FREE CONNECTORS

CABLE WITH 2 x 3.5mm CONNECTORS

3.5mm FREE CONNECTOR

CABLE WITH 3.5mm CONNECTOR TO CROC. CLIPS

MICROPHONE

BATTERIES FOR Tx AND Rx

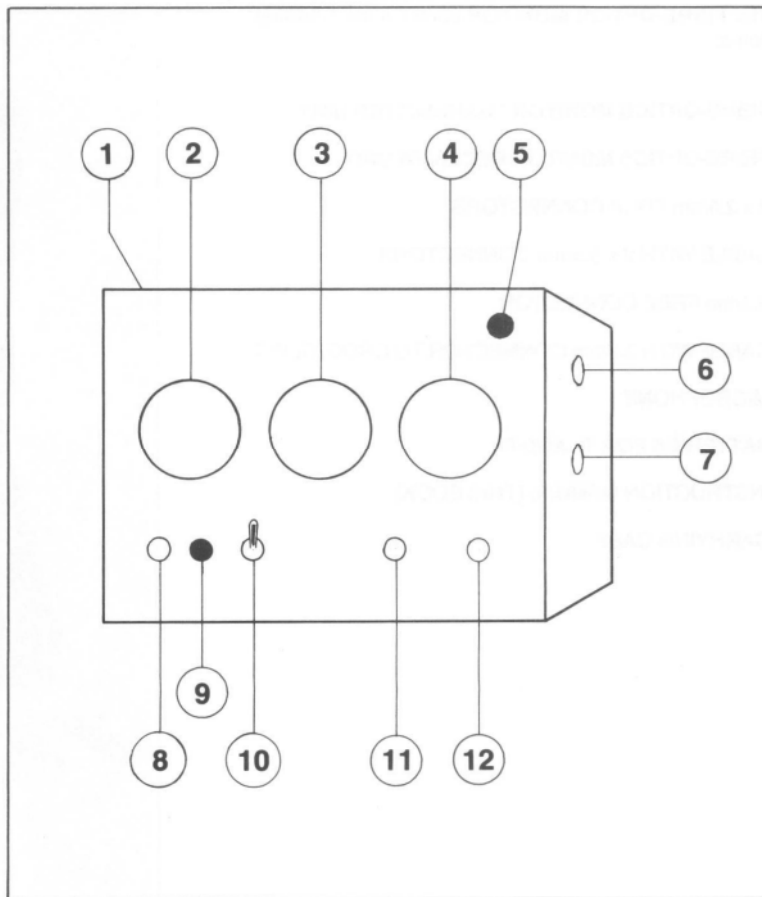
INSTRUCTION MANUAL (THIS BOOK)

CARRYING CASE



TRANSMITTER UNIT

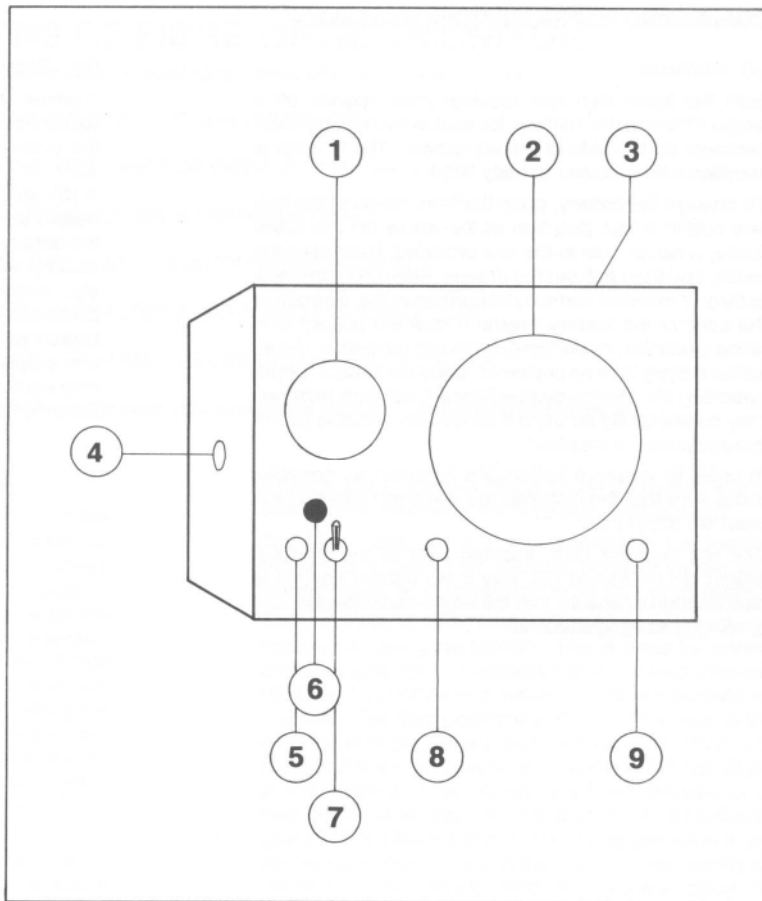
1. Battery holder for 9V 'radio' battery.
2. Switches between analogue, digital, variable tone and fixed tone modes.
3. Controls frequency of the variable tone generator (100Hz to 5kHz).
4. Controls output intensity of high radiance infra-red l.e.d., unhoused infra-red l.e.d., and output indicator (approx. 20dB range).
5. Gives a visible indication of the output of the transmitting diodes.
6. High-radiance infra-red l.e.d. (820nm) in S.M.A.* socket.
7. Unhoused infra-red l.e.d. (880nm) window.
8. 2.5mm socket for optional external power supply of +9V to +15V d.c.
9. L.e.d. indicating adequate supply voltage.
10. ON/OFF switch for battery. Does not control optional external supply.
11. Analogue input, 20k Ω impedance, a.c. coupled, 3.5mm socket.
12. Digital input, 1.2V to 1.6V Schmitt thresholds. Also acts as output monitor for tone generator. B.N.C. socket.



*SMA or other connector option

RECEIVER UNIT

1. Controls the gain of the amplifier.
2. Loudspeaker output of analogue circuit.
3. Battery holder for 9V 'radio' battery.
4. Receive diode (Si) in S.M.A.* socket.
5. 2.5mm socket for optional external power supply of +9V to +15V d.c.
6. L.e.d. indicating adequate supply voltage.
7. ON/OFF switch for battery. Does not control optional external supply.
8. Mean power monitor, 150k Ω output impedance, connected passively to receive diode (i.e. not through amplifier). 3.5mm socket.
9. Analogue output, impedance less than 1 Ω . Connection to this socket automatically disconnects the loudspeaker. 3.5mm socket.



*SMA or other connector option

CONNECTING POWER SUPPLIES TO MONITOR

a) Batteries

Both the transmitter and receiver units operate off a single PP3-type 9V battery, located in the battery compartment on the side of the equipment. The Monitor is supplied with batteries already fitted.

To change the battery, push the front cover of the battery holder in the direction of the arrow on this cover (using a nail or coin in the slot provided) to release the catch, and then pull out the drawer. Make sure the new battery is inserted correctly according to the diagram in the base of the battery drawer. Once the battery is in place, push the drawer firmly back into the holder. An alkaline battery is to be preferred, because it has a longer operating life. Rechargeable batteries may conveniently be used if prolonged portable use of the equipment is required.

In order to preserve battery life as much as possible, make sure that the batteries are switched off when the units are not in use.

The red indicator l.e.d. situated near to the ON/OFF switch will be turned ON only if the battery voltage is high enough to ensure that the equipment operates according to its specifications.

(b) External Power Supplies

A power supply socket (2.5mm) is provided on the front panels for applications which require prolonged use of the units. The supply voltage should be in the range +9V to +15V d.c. — IT IS IMPORTANT THAT THE +15V MAXIMUM IS NOT EXCEEDED. Diodes are connected in series from the supply socket and also from the battery supply to the circuitry, ensuring that reverse polarity will not damage the equipment. These diodes also ensure that current cannot flow between power sources, and that the equipment draws current from the source with the maximum supply voltage if more than one supply is connected up. The battery ON/OFF switch only controls the connection to the battery, and not to the external supply socket.

APPLICATIONS OF FIBRE-OPTICS MONITOR

The Fibre-Optics Monitor may be used for a variety of applications, including:

- OPTICAL CABLE/FIBRE CONTINUITY TESTING
- DETECTING PRESENCE OF INFRA-RED RADIATION
- ANALOGUE DATA TRANSMISSION
- OPTICAL CABLE ATTENUATION MEASUREMENTS
- TESTING OUT OPTICAL RECEIVERS AND TRANSMITTERS
- OPTICAL ABSORPTION AND REFLECTION MEASUREMENTS

These applications together with the associated procedures are described in the following sections.

a. Optical Cable/Fibre Continuity Testing

For continuity testing, the output power control of the transmitter and the analogue gain of the receiver should both be set to maximum, and the transmitter's rotary switch should be turned to FIXED TONE. In order to check that the units are operating correctly, line up the transmitter's emitting diodes with the receiver's detecting diode, switch on both units, and a loud tone should then be heard at the receiver. If a different tone frequency is required, this may be achieved by setting the transmitter's switch to VARIABLE TONE, and then adjusting the tone frequency control until the desired frequency is obtained. The frequency of this internal generator may be monitored at the DIGITAL INPUT/ TONE MONITOR socket.

To test a cable terminated with SMA* connectors for continuity, simply connect one end into the transmitter's SMA* I.e.d. housing, and the other end into the receiver's SMA* receive diode housing. A

tone will be heard at the receiver if the fibre path is continuous.

The high radiance I.e.d. incorporated in the Monitor transmitter's connector housing enables cables with graded index, 50µm core fibre to be effectively tested.

The continuity of bare, unterminated fibres may also be determined using the Monitor. This is done by placing one fibre end right up against the un-housed infra-red I.e.d., and the other end inside the receive diode's receptacle. The fibre positioning is not critical due to the wide beam angle, large area of emission, and high output power of the un-housed I.e.d., and the high sensitivity of the receiver. Alternatively, the SMA*-housed I.e.d. may be found to give the best output with a particular type of fibre. Mains lighting, which may generate a low frequency audible output in the receiver, can readily be prevented from falling onto the receive diode by screening the light as the fibre is inserted into the re-

*SMA or other connector option

ceiver's receptacle. In order to achieve best signal conditions, the fibre ends should be cut so that they are optically flat.

Step-index fibres with core diameters of 100µm or greater are best suited for continuity testing of bare, unterminated fibres. 50µm graded-index fibre may be used, but then the received power is considerably reduced, and the range of the instrument is correspondingly smaller.

Optical cables terminated with non-SMA* connectors may be tested by using appropriate interface cables, or by implementing the above procedure for unterminated fibres.

b. Detecting presence of Infra-red Radiation

The Monitor receiver may be used to give an audible indication of the presence of infra-red radiation at locations such as the remote ends of optical links, cable breaks, bad joints and "lossy" optical coupling arrangements, if audio tones, such as those produced by the transmitter, are present in the signal. A short length of large core optical cable would act as a convenient probe, although the signal may be detected by simply pointing the receive diode towards the source of the radiation.

D.C. (i.e. unmodulated) optical radiation may be detected by connecting a DVM (set to d.c.) to the MEAN POWER MONITOR socket. At 850nm, the reading will be approximately 50mV per µW of incident radiation, up to a maximum of 0.5V. This measurement is most suitable for conditions where ambient light is not present, for example at the end of an SMA* terminated cable which may be connected up to the receiver, thus screening off the ambient light.

c. Analogue Data Transmission

Analogue signals in the bandwidth of 25Hz to 20kHz may be transmitted over free-space or optical fibre, with very little distortion, using the Monitor units.

Electrical interfacing to both terminals is via 3.5mm audio sockets, and the signal may be heard directly at the receiver's loudspeaker. The input impedance at the transmitter is 20kΩ and the receiver's output impedance is less than 1Ω. For analogue transmission, the transmitter's rotary switch should be set to ANALOGUE mode.

A possible application of the audio transmission system is communicating verbal instructions during cable joining operations, using spare fibres in the cable to carry the voice signals. These fibres may be connected to each unit by a temporary joint to a short length of similar fibre already terminated in an SMA* connector. For this application, a microphone is included as an accessory. It is not necessary to carry out the detailed procedures given below if the equipment is used for speech transmission. Even with 50µm graded index fibre, the high radiance i.e.d. in the connector socket enables voice transmission over a route of more than 35dB attenuation.

When analogue voltage signals are being transmitted, the input voltage amplitude at the transmitter should be kept below 50mVpp, to ensure that there is no 'clipping'. Slight distortion of the optical signal due to the i.e.d. response not being exactly linear may be decreased by reducing the analogue signal size. Also, the i.e.d. output increases in linearity as the output power is increased. At the receiver, the optical power must not be high enough to overload the circuitry. To ensure this, the voltage at the MEAN POWER MONITOR should be less than 0.5V d.c., and the signal at the ANALOGUE OUTPUT should be less than 3Vpp. The signal at the ANALOGUE OUTPUT may be reduced by turning down the optical gain of the receiver, while the signals at both outputs may be reduced by turning down the output power of the transmitter.

*SMA or other connector option

d. Optical Cable Attenuation Measurements

The Fibre-Optics Monitor, in conjunction with an a.c. voltmeter, can be used to measure or monitor (over a period of time) the attenuation of an optical route, which is terminated in SMA* connectors (See Section d3 for other terminations). The various procedures are given in the following paragraphs:

(d1) Standard Measurement Method

1. Set the transmitter to FIXED TONE, and turn the analogue gain of the receiver to a **minimum**.
2. Connect an a.c. voltmeter which can measure a.c. values down to, or below, a tenth of a millivolt, to the **ANALOGUE OUTPUT** socket of the receiver. A DVM with a 200mV a.c. scale is ideal for this purpose. (The Mean Power Monitor socket should be left unconnected for best measurement accuracy).
3. Connect a short length (about a metre) of optical cable (of the same type as the route to be measured) between the transmitter and receiver. This reference length of cable must have flat, clean ends in order to achieve a good measurement accuracy. To ensure there is no optical overload at the receiver, reduce the transmitted output level (turn the OUTPUT POWER control anti-clockwise) until the voltmeter reading is just below 1.00V (RMS or sine—RMS—equivalent). [Refer to d4 for optical power levels which cannot be reduced to below this value]. Then take the voltmeter reading (= V_{REF}). For optimum accuracy, it is best to take this initial reading after the units have been switched on for five minutes or more, so that equilibrium conditions are reached.

Check the electrical noise level by switching off the transmitter and noting the voltmeter reading

(=V_A). V_A will normally be zero if the DVM specified in Step 2 is used.

4. Connect up the route to be measured between the transmitter and receiver, in place of the short length, and take the voltmeter reading (=V₀).
5. The attenuation (or insertion loss) of the route is calculated using the following formula:

$$\text{attenuation} = 10 \log_{10} \frac{V_{\text{REF}}}{\sqrt{(V_0^2 - V_A^2)}} \text{ dB,}$$

$$\text{which approximates to } 10 \log_{10} \frac{V_{\text{REF}}}{V_0} \text{ dB}$$

when V_A is small compared to V₀.

For measurement of a number of routes, only the final two Steps 4 and 5 need be repeated. If the output power level of the transmitter is altered, however, Step 3 must be repeated to re-set a suitable level. After measuring a number of routes, check that V_{REF} is essentially the same as the original value.

The attenuation range using the above procedure is 30dB, when a 0.1mV sensitivity voltmeter is used, and the accuracy is within ± 0.2dB.

(d2) High Loss Method

In order to increase the attenuation range capability of the Monitor, Steps 4 and 5 of the procedure described in d1 are replaced by the following (which may be used to measure losses of greater than 15dB):

Connect up the route to be measured between the transmitter and receiver, in place of the short reference length. Then, increase the receiver analogue gain to maximum by turning the control fully clockwise. Take the voltmeter reading (= V₁).

Measure the electrical noise by switching off the transmitter, and note the voltmeter reading ($=V_B$).

The attenuation of the route is given by the formula:

$$\text{attenuation} = 10 \log_{10} \frac{V_{REF}}{\sqrt{(V_1^2 - V_B^2)}} + k \text{ dB},$$

where the approximate value of $k = 15$.

(k is derived from the ratio of the maximum to minimum gain of the receiver).

Remember to turn the receiver analogue gain back down to minimum if re-measurement of V_{REF} is required.

The range of the instrument using this method is 45dB, while the accuracy is ± 2 dB. In order to increase the accuracy of this method, the constant k may be determined by equating the measurement results of a route with a loss between 15 and 25dB, using the Standard and High Loss Methods. A precise value of k leads to an accuracy of ± 0.5 dB for this High Loss Method.

(d3) Measurement with non SMA*-terminated Cable

The attenuation of a cable route with end connectors other than SMA (US Standard)* may also be measured using the Fibre-Optics Monitor. Identical methods to those described above are used, but with short (one metre or less) interface cables connecting the Monitor to the route and reference cables.

(d4) Measurement using Mean Power Monitor Output

The loss of a route may also be determined by measuring the d.c. voltage at the MEAN POWER MONITOR socket of the receiver. This d.c. signal, which is proportional to the average optical input

power, is present whatever the nature of modulation of the optical input, and therefore may be used with transmitters that have a constant d.c. output. This method is also most appropriate for very high optical signal levels, which may overload the analogue circuitry. (Refer to Section d1, Step 3). The measurement procedure parallels that described in Section d1, Steps 3, 4 and 5, while the reference signal level should be kept below 0.5V d.c. to avoid overload. A high input impedance meter such as a DVM must be used at the MEAN POWER MONITOR socket, since its output impedance is 150k Ω , (as opposed to less than 1 Ω for the analogue output). A 3.5mm plug may be inserted in the ANALOGUE OUTPUT socket to turn off the loudspeaker during these measurements.

For some experimental set-ups, it may be useful to use the fact that the mean transmitted output power is exactly halved in switching the transmitter from DIGITAL (with no input connected) to TONE.

(d5) Attenuation Monitoring Procedure

Due to the high stability of the Fibre-Optics Monitor units with variations in temperature and supply voltage, the equipment may be used to monitor continuously the insertion loss of an optical route. The measurement procedures are the same as those described in d1 to d4 above, with the route measurements being taken over a period of time.

Changes in route attenuation may of course be calculated without recourse to the reference signal level, using the following formula:

$$\text{change in attenuation} = 10 \log_{10} \sqrt{\frac{(V_1^2 - V_N^2)}{(V_2^2 - V_N^2)}} \text{ dB},$$

which approximates to $10 \log_{10} \frac{V_1}{V_2}$ dB when V_N

*SMA or other connector option

is small compared to V_1 and V_2 ,

where V_1 and V_2 are two separate readings with the route connected up

V_N is the electrical noise level.

The above formula applies to both the Standard and High Loss measurement methods.

For measurements taken during changes in the ambient temperature, the accuracy of the results decreases by typically $\pm 0.01 \text{ dB}/^\circ\text{C}$.

The high stability of the Monitor circuitry depends on adequate power supply voltage levels, the presence of which is shown by the Supply Voltage Indicating L.e.d.s being ON.

(d6) Additional notes for all attenuation measurements

For highly accurate attenuation measurements of small core fibres, it may be necessary to maintain the same launching conditions at the transmitter for both route and reference readings. This is achieved by first measuring the route loss, and then cutting back the fibre close to the transmitter and measuring the signal at the receiver for this reference length, preferably by connecting the cut fibre end into a low loss temporary joint, the other end of which is a similar fibre terminated in a connector at the receiver. If this method is used, then the optical power output should have previously been set using a similar reference path to ensure that optical overload is not occurring.

It should also be noted that in order to measure the loss per unit length of a route without including the effects of a non-equilibrium light distribution at the reference fibre, then a reference length of a few hundred metres should be used, and the **difference** in length between the route and reference fibres

must be taken into account in the loss per unit length calculation. Alternatively, an equilibrium mode simulator and a cladding mode stripper may be used at the transmitting end to artificially produce an equilibrium distribution in the reference fibre.

e. Testing Out Optical Receivers and Transmitters

The Monitor transmitter may be used as a versatile optical source for testing out optical digital receivers. Any data train up to a rate of 0.5 MBit/s may be produced by connecting an external signal generator to the DIGITAL INPUT socket, and setting the rotary switch to DIGITAL. It is also possible to test out audio frequency analogue receivers by setting the transmitter's rotary switch to ANALOGUE, and connecting an audio generator to the ANALOGUE INPUT socket. In both of the above test configurations, the output power control, which has a range of approximately 20dB, provides a useful feature for receiver sensitivity testing.

The Monitor receiver may be used for testing out audio frequency analogue optical transmitters. By also monitoring the mean power output voltage, the modulation depth of the optical signal may be determined.

Equipment terminated with connectors other than SMA* may also be tested by using an appropriate interface cable between the Fibre-Optics Monitor and the equipment under test, or by utilising the un-housed l.e.d. for receiver testing.

f. Optical Absorption and Reflection Measurements

It is possible to measure the optical absorption or reflection properties of various materials at the wavelengths of the emitting devices by detecting the level of radiation at the receiver, with the transmitter set on FIXED TONE acting as the source. The material to be tested is in-

*SMA or other connector option

serted between the transmitter and receiver units (or between the ends of the cables attached to these) for transmission experiments, and at a suitable angle for reflection measurements. A DVM set to a.c. may be used to accurately measure the signal at the ANALOGUE OUTPUT socket. As in Step 3 of Section d1, the received optical power level must never be high enough to overload the receiver, and so the signal at the ANALOGUE OUTPUT socket should not exceed 1.00V RMS. The measurement procedure is analogous to that described in Section d1, with the reference set-up being that which is most appropriate for any particular experiment.

For accurate measurements over free-space, it is important to minimise the contribution to the signal of ambient light from mains lighting. Also, when very small signal levels are being measured, the effect of electrical noise of the receiver may be taken into account by using the square root of the difference of the squares formula, which has been used in Step 5 of Section d1, i.e. Signal Voltage = $[(\text{Total Voltage})^2 - (\text{Noise Voltage})^2]^{1/2}$.

g. Other Applications

Besides those described above, a number of applications or experiments may be carried out with the Monitor equipment. Examples are:

1. "listening" directly to light sources, since any audio modulation of detected light will be converted into sound by the Monitor receiver. An optical cable acts as a convenient probe for detecting the optical radiation;
2. measurement of the frequency of a rotating disc or a vibrating object using light reflection or transmission, by connecting a frequency meter to the ANALOGUE OUTPUT socket;
3. utilising the numerous applications of the Monitor as a training aid in a course on fibre-optics or general optics.

MONITOR TRANSMITTER — BRIEF TECHNICAL DESCRIPTION

Exhibit 1 shows a block diagram of the Fibre-Optics Monitor Transmitter circuitry.

The I.e.d. driver section produces a current through the emitting diodes that is proportional to the input voltage. This is achieved using an emitter follower configuration, with the diodes connected in series in the collector of the output transistor.

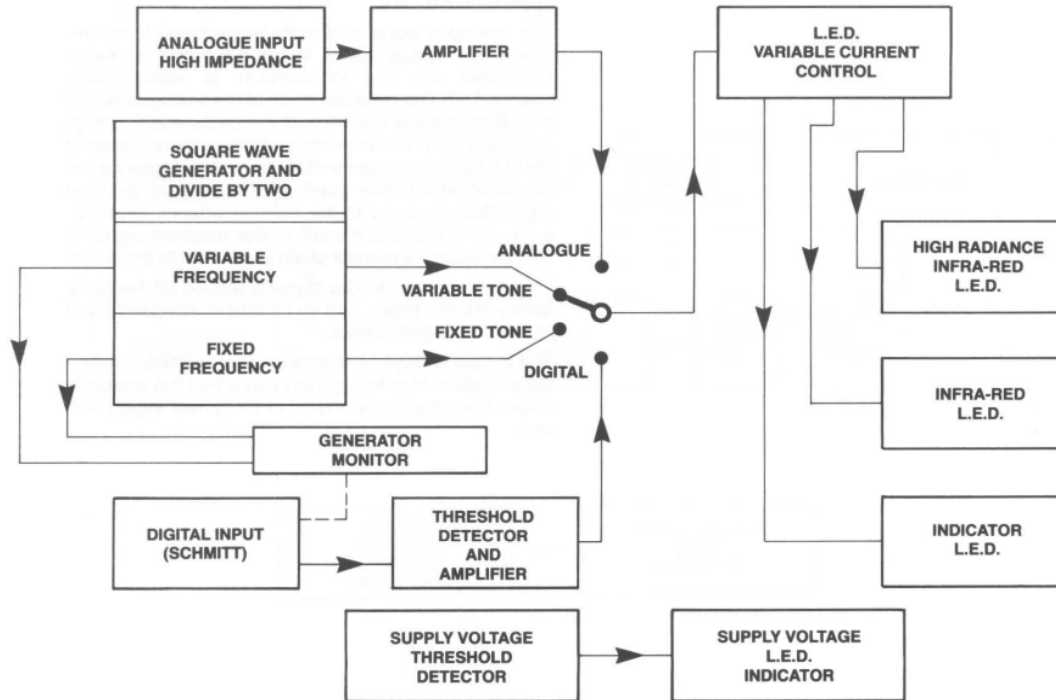
A frequency divider (divide by two) follows the square wave generator to ensure a mark to space ratio of exactly 50 : 50.

When the transmitter is in the digital mode, the optical output is either ON (input low), or OFF (input high). In the threshold detector circuitry, a fraction of the output is fed back to the positive input to provide some hysteresis, i.e. a Schmitt input, so that the digital output will be clean even if the input signal is varying slowly.

Analogue amplification is provided by a MOS operational amplifier, powered by a single supply voltage. When the transmitter is in the analogue mode, the light intensity of the emitting diodes is directly proportional to the input voltage signal (plus a d.c. bias).

The supply voltage I.e.d. indicator goes ON only when the voltage is high enough to ensure that the emitted optical intensity becomes independent of the power supply voltage.

Exhibit 1 FIBRE-OPTICS MONITOR TRANSMITTER – BLOCK DIAGRAM



MONITOR RECEIVER — BRIEF TECHNICAL DESCRIPTION

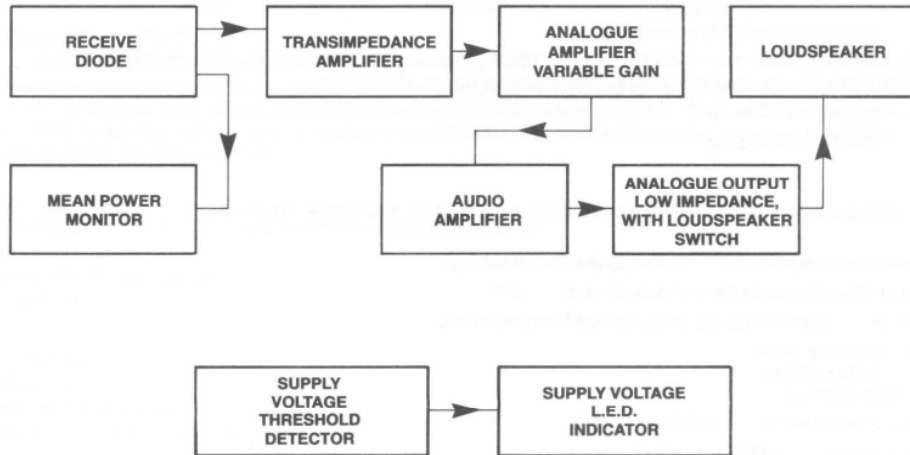
A block diagram of the Fibre-Optics Monitor Receiver appears in Exhibit 2.

The analogue signal is directly proportional to the received a.c. optical signal. When the output socket is connected up, the loudspeaker is automatically switched off. The electrical noise at the analogue output (resulting in a low level hiss at the loudspeaker at high analogue gain) is due primarily to the thermal noise of the $5M\Omega$ transimpedance resistor. In order to reduce the likelihood of receiver overload, the receive diode is capacitively coupled to the transimpedance amplifier, so that the d.c. component of the received signal is channelled into a resistor chain in series with the diode.

The mean power monitor signal is tapped off the diode series resistor chain, and so its size is independent of the analogue gain control.

The supply voltage l.e.d. indicator goes ON only when the voltage is high enough to ensure that the analogue output becomes independent of the power supply voltage.

Exhibit 2 FIBRE-OPTICS MONITOR RECEIVER – BLOCK DIAGRAM



MONITOR SPECIFICATIONS

a) Transmitter/Receiver Combination

Attenuation measurement range:

Standard Method: 30dB
High Loss Method: 45dB

Attenuation measurement accuracy:

Standard Method: ± 0.2 dB
High Loss Method: ± 0.5 dB, or ± 2 dB if K not determined.

Temperature dependence of above accuracy figures: ± 0.01 dB/°C typical

Analogue Bandwidth: 25Hz to 20kHz (3db points)

Range for analogue transmission (better than 40dB S.N.R.): 25dB (This range is for a fibre link, with the high radiance I.e.d. being used to launch light into a graded index fibre, core diameter 50 μ m, N.A. 0.21)

Operating Temperature Range: 0°C to 70°C

Optical Connectors: SMA (U.S. Standard)*

b) Transmitter

Typical power launched into graded index fibre, core diameter 50 μ m, N.A. 0.21, from SMA*-housed I.e.d: 5 μ W peak (at maximum setting)

Typical output power from un-housed I.e.d.: 3mW (at maximum setting)

Angle between half power intensity points for un-housed I.e.d: 24°

Variable I.e.d. drive control: 20dB range (± 3 dB), for SMA*-housed I.e.d.

Peak Output Wavelength/Spectral Width

SMA*-housed I.e.d: 820nm/35nm
Un-housed I.e.d: 880nm/80nm

Schmitt threshold levels on digital input: 1.2V and 1.65V

Input impedance at digital input: 100k Ω to ground

Phase of digital signal:

Input 'mark' (1) gives **no** light at output
Input 'space' (0) gives light at output

Tone generator frequency (typical):

fixed: 400Hz
variable: 100Hz to 5kHz

*SMA or other connector option

Tone generator output: square wave, 50:50 mark : space ratio to within 1%
 Maximum transmitted digital data rate for less than 15% pulse width distortion: 0.5 MBit/s for SMA*-housed I.e.d.
 Optical rise and fall times (typical):
 SMA*-housed I.e.d: 200nS
 Un-housed I.e.d: 1.5 μ S
 Signal generator monitor:
 Voltage amplitude: (Supply Voltage - 1)Vpp approx.
 Output impedance: 25k Ω
 Maximum analogue input signal for no clipping: 50mVpp
 Input impedance at analogue socket: 20k Ω , capacitively coupled. Optical output is inverted relative to input.
 Analogue frequency response: 10Hz to 35kHz
 Power Supply:
 9V PP3-type battery
 Optional external d.c. supply: + 9V to + 15V (current is 25mA typical at 9V)
 Physical characteristics
 Dimensions: 128 x 97 x 75mm approx.
 Weight: 500gm approx.

c) Receiver

Photodiode type: Silicon p-i-n
 Analogue frequency response:
 for output impedance greater than 36 Ω : 20Hz to 25kHz
 for 8 Ω output impedance: 90Hz to 25kHz
 Analogue output impedance: less than 1 Ω
 Maximum power into 8 Ω (and at loudspeaker) from analogue output: 0.25W with 15V power supply
 Maximum signal at analogue output at zero load current: 3Vpp
 Typical response at 850nm wavelength at analogue output: 2.5V/ μ W to 82V/ μ W (over analogue gain range),
 inverted signal relative to optical input.
 Analogue gain range: 30dB
 Maximum optical power for 40dB Signal to Noise ratio: 12nWpp at 850nm

Mean power monitor:

Output impedance: 150k Ω Typical response at 850nm: 50mV/ μ W

Phase of signal: non-inverted relative to optical input

Frequency response: d.c. response, 0.1s time constant

Maximum signal without overload: 0.5V d.c.

Optical overload at 850nm:

a.c. overload: 1.5 μ Wppd.c. overload: 10 μ W

(at overload, the noise level increases significantly).

Power Supply:

9V PP3-type battery

Optional external d.c. supply: + 9V to + 15V (current is 25mA typical at 9V)

Physical characteristics:

Dimensions: 128 x 97 x 75mm approx.

Weight: 500gm approx.

While the information is true at the time of printing, small production changes in the course of the company's policy of improvement through research and design might not be indicated in the specifications.



FIBRE-OPTICS AND OPTO-ELECTRONICS

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This fibre-optics equipment complies with the EMC (Electromagnetic Compatibility) directive of the European Community and meets or exceeds the following technical standards:

- EN 50081-1 - "Electromagnetic compatibility generic emission standard Part 1: residential, commercial and light industry."

- EN 50082-1 - "Electromagnetic compatibility generic immunity standard Part 1: residential, commercial and light industry."

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