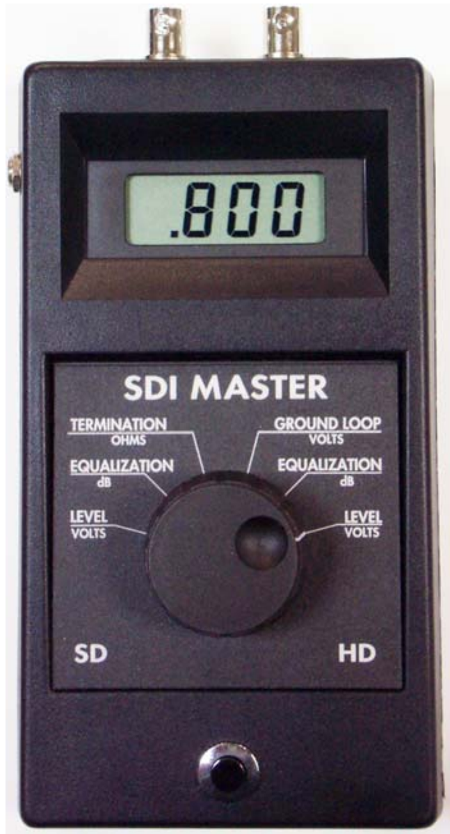
SDI-1



SDI MASTER

INSTRUCTION BOOK

IB-6374-01

SDI MASTER
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1.0 SHIPPING INSPECTION

Remove the unit from the shipping container and inspect for shipping damage. If any damage is found contact the shipping carrier for further instructions. The SDI-1 is shipped fully tested and ready for use. You should have the SDI-1 meter with a 9V battery in the battery compartment, **(<u>Note the battery will not be attached to the snap-on battery clip for shipping reasons</u>).** Open the slide-off lid then snap the battery connector onto the battery and replace the cover. The meter is now ready to use.

1.1 DESCRIPTION

The SDI-1 MASTER is a hand-held, battery operated, digital meter that measures the signal strength and necessary cable equalization required by SD and HD Television Signals when transmitting these digital signals over coaxial cable or other transmission facilities that may cause level or high frequency loss and consequent data loss.

In addition to measuring signal strength and cable equalization requirements, this meter can also measure inaccuracy of CABLE TERMINATIONS and the resultant RETURN LOSS that can introduce data error. Inaccurate cable termination will result in some part of the data signal being reflected back down the cable. If the sending end termination is the same as the characteristic impedance of the coaxial cable, the entire reflected energy will be absorbed at the sending end and no data errors will result. However, if the sending end does not accurately match the characteristic impedance of the cable, some of the data will be re-reflected back toward the data receiver, mangling the pulses by mixing with the subsequently arriving pulses. Data errors will be reduced by insuring that all cables are accurately terminated to avoid the return loss condition that is a major cause of data errors.

The SDI-1 meter will also measure 60 Hz. common mode interference (also known as Ground Loop interference) introduced by unbalances in AC Power Distribution that can also introduce data errors when the amplitude of the interfering 60 Hertz signal exceeds the linearity limitations of the data receiver. Since Unbalanced power loads are endemic to all business locations and the Data Signal uses the same grounds as the Power Industry, these power unbalances are directly injected into the Data Channel. Since the amplitude of this common mode interference will vary with time, it must be checked by regular measurement of the cable facilities to insure that excess common mode interference is not present. It is possible for AC Power to create as much as several volts of potential between different grounds that are only a few feet apart, particularly if supplied by the opposing phase from the power source, while the Data Signal in only 0.8 Volts in amplitude at the best, and may well be much lower after traversing a long cable. It does not require much Common Mode interference to compress a data signal out of existence. Furthermore, this type of interference comes and goes with time, and can be very hard to establish what is causing the problem without some method for measuring this trouble condition.

2.0 DIGITAL TELEVISION DATA SIGNALS THIS METER WILL MEASURE.

This meter is designed to measure Standard Definition (SDTV) and High Definition (HDTV) digital television signals, such as the 270 Megabit signals used to transmit SDTV using the 525i/59.4 and 625/50 formats, and the 1.485 Gigabit signal used to transmit HDTV using the 1080p/24, 1080p23.98, 1080PsF/24, 1080PsF/23.98, 720p/60, 720p/59.94, 720p/50, 720p/30, 720p/29.97, 720p/25, 720p/24, 720p/23.98 formats.

3.0 HOW TO MEASURE SIGNAL STRENGTH ON (SD) TELEVISION SIGNALS.

Disconnect the coaxial cable from the receiving data terminal. Connect the coaxial cable to be measured to the input coaxial connector marked (INPUT) on the SDI MASTER. Connecting the SDI MASTER to a distribution amplifier that in turn is connected to the cable is OK, IF the distribution amplifier does not correct frequency response or amplify the signal in any way (as some distribution amplifiers do). In order to use a D.A., it must simply repeat the exact signal received from the cable in order to obtain meaningful results from this measurement. If a unity gain D.A. is not available, then the cable must be removed from the receiving terminal and connected to the SDI MASTER directly.

Rotate the selector switch on the SDI-1 meter to "SD LEVEL" (on the left-hand side of the switch). Depress and hold down the button at the bottom of the meter to observe the meter reading. The reading is in Volts peak to peak. Since the decimal point is in front of the number, the actual number reads in milliVolts, peak to peak. When the reading is complete, release the button to conserve battery power.

A reading of 0.800 volts peak-to-peak indicates that you are measuring the direct nominal output of a digital video source. As the SDTV signal traverses the coaxial cable, this voltage will be reduced with distance traveled. A cable that is commonly used by the Television Broadcast Industry is the Belden 1694A Precision Video Cable. When this cable is used, the signal strength can be expected to drop by a constant percentage for each 100 meters of cable. Since the maximum data rate for SDTV is 270 megabits, the highest fundamental frequency of interest is 135 MHz. This corresponds to a 100 meter loss of 6.89 dB, which is a reduction of the signal voltage to .4524 times the original 0.800 Volts peak to peak, or a voltage of 361.9 milliVolts peak-to-peak. Since this is the voltage at the highest frequency of the SDTV signal, and not at all frequencies, the actual signal will not be reduced that much. An indication of the expected signal strength at various lengths of cable can be found in the table below.

SIGNAL STRENGTH OF SDTV SIGNALS

FEET OF CABLE	METERS OF CABLE	MILLIVOLTS
0	0	800
164	50	566
328	100	413
492	150	307
656	200	236
820	250	188
984	300	147
1,148	350	127
1,312	400	107
1,476	450	99

The signal strength of a data generator is supposed to be 800 milliVolts at the output, but it may vary as much as +/- 10% from this value, so expect that the meter reading may vary at least that much when estimating cable length using the signal strength that is measured.

4.0 MEASURE THE FREQUENCY RESPONSE EQUALIZATION ON SD TV SIGNALS.

Coaxial cable losses are greatest at the highest frequencies and lower at low frequencies and all frequencies must arrive at the data receiving location at nearly the same amplitude, therefore the signal must be "equalized" prior to delivery to the data terminal if the amplitude discrepancy between the highest and lowest frequencies are too great. The SDI MASTER measures this differential signal amplitude with frequency and reads out this differential amplitude between the high and low frequency amplitudes in dB. This reading is the total amount of equalization that must be provided by in-line equalizers to reduce data errors to a minimum. Failure to provide these equalizers will increase the number of data errors and program outages.

To make this measurement, disconnect the receiving end of the coaxial cable from the data receiver and connect the cable to the "INPUT" coaxial connector of the SDI MASTER. Rotate the selector switch to SD EQUALIZQATION (on the left side of the switch). Depress and hold down the power button for the duration of the measurement. The read-out will be in decibels. This displays the total amount of equalization that must be applied between the cable and the data receiver to obtain optimum data transmission and reduce data errors.

Occasionally a data source may be encountered that is transmitting at a higher level than 0.800 Volts. In this case, an equalization measurement made near the data source may indicate a negative deciBell equalization reading. This does not constitute an error, it merely indicates that a level exists in excess of 0.800 Volts at that point in the cable. Farther away, down the cable, the reading will become positive again to indicate the amount of equalization to be provided.

5.0 HOW TO MEASURE SIGNAL STRENGTH OF HD TELEVISION SIGNALS

Disconnect the coaxial cable from the receiving data terminal. Connect the coaxial cable to be measured to the "INPUT" coaxial connecter on the SDI MASTER. Rotate the selector switch on the SDI MASTER to HD LEVEL (on the right hand side of the switch), and depress and hold down the button on the bottom of the meter to observe the meter reading. The reading is in Volts peak-to-peak. Since the decimal point is in front of the number, the actual number reads in milliVolts peak-to-peak. When the reading is complete, release the button to conserve battery power.

A reading of 0.800 volts peak-to-peak indicates you are measuring the direct nominal output of a digital video source. As the HDTV signal traverses the coaxial cable, this voltage will be reduced with distance traveled. A cable that is commonly used by the Television Broadcast Industry is the Belden 1694A Precision Video Cable. When this cable is used, the signal strength of the highest frequency of interest in HDTV can be expected to drop 84.9 % percent for each 100 Meters of cable. Since signal strength is the sum of the amplitude of all of the harmonics, the actual signal strength to be expected at various lengths of cable is shown in the table below.

SIGNAL STRENGTH OF HDTV SIGNALS

FEET OF CABLE	METERS OF CABLE	MILLIVOLTS
0	0	800
164	50	408
328	100	249
492	150	167
656	200	123
820	250	99

The signal strength of the data generators is supposed to be 800 milliVolts at the output, but it may vary as much as +/- 10% from this value, so expect that the meter reading may vary at least that much when estimating the cable length using the signal strength that is measured.

6.0 MEASURE THE FREQUENCY RESPONSE EQUALIZATION ON HD TV SIGNALS.

Coaxial cable losses are greatest at the highest frequencies and lower at low frequencies and all frequencies must arrive at the data receiving location at nearly the same amplitude, therefore the signal must be "equalized" prior to delivery to the data terminal if the amplitude discrepancy between the highest and lowest frequencies are too great. The SDI MASTER measures this differential signal amplitude with frequency and reads out this differential amplitude between the high and low frequency amplitudes in dB. This reading is the total amount of equalization that must be provided by in-line equalizers to reduce data errors to a minimum. Failure to provide these equalizers will increase the number of data errors and program outages.

To make this measurement, disconnect the receiving end of the coaxial cable from the receiving data receiver and connect the cable to the "INPUT" coaxial connector on the SDI MASTER. Rotate the selector switch to HD EQUALIZATION (on the right side of the switch). Depress and hold down the power button for the duration of the measurement. The read-out is in decibels. This is the total amount of equalization that must be applied between the end of the cable and the data receiver input to obtain optimum data transmission and to reduce data errors.

Occasionally a data source may be encountered that is transmitting at a higher level than 0.800 Volts. In this case the equalization measurement made near the data source may indicate a negative deciBell equalization reading. This does not constitute an error, it merely indicates that a level exists in excess of 0.800 Volts at that point in the cable. Farther away, down the cable, the reading will become positive again to indicate the amount of equalization to be provided.

7.0 HOW TO MEASURE CABLE TERMINATION IMPEDANCE.

The measurement of terminations must be made as close as possible to the termination to be measured, or cable resistance errors will skew the result. The SDI MASTER must be connected to the termination to be measured by the shortest patch cord available, preferably no longer than one foot.

To make the termination test, disconnect the coaxial cable at the input of the data receiver. Connect a short patch cord (about one foot long) from the BNC connector labeled "LOAD" on the SDI MASTER to the input of the data receiver to be tested. Rotate the selector switch on the SDI MASTER to TERMINATION, and depress and hold the power button to read the termination value. This meter can read any value of termination from 000.0 to 199.9 Ohms with an accuracy of +/- 0.1 Ohms.

8.0 HOW TO MEASURE CABLE TERMINATION RETURN LOSS.

When the receiving terminations do not have the same resistive value as the characteristic impedance of the coaxial cable, some of the arriving energy is reflected back to the sending end of the cable. This reflection is called "Return Loss" and is measured in deciBells, it is a measure of the amplitude of the reflected data and thus the potential for the reflected signal to directly interfere with subsequent data pulses. In effect the reflections "close the eye" of the data pulses and cancel out data making this a prime source of data loss.

If the source is terminated to the same impedance as the characteristic impedance of the coaxial cable, no secondary reflection can occur. However, if the sending-end termination is not exactly correct, or if there are other discontinuities in the cable that would cause reflections, then data being carried by these reflection will interfere with the data being received and data errors could result. Note that cable connectors and patch panel connectors are also able to introduce reflections due to impedance mismatches. A few low level reflections will not rise to the level of creating data errors, but given enough of these reflections, then the reflected energy may begin to introduce errors. Since the total sum of all the reflected energy in a system can cause data errors, each individual termination must be measured closely.

The measurement may be made with some cable between the termination to be measured and the SDI-1, but you must subtract the loop resistance of the intervening cable to arrive at the termination resistance of that cable. The loop resistance of Belden 1694A coaxial cable is 9.2 Ohms per 1000 feet of cable, therefore 0.0092 Ohms will be added to each foot of cable between the termination and the SDI-1 measuring device. Even 10 feet of cable between the SDI-1 and the termination to be measured can add a significant error to a termination measurement in terms of implied RETURN LOSS. For accurate TERMINATION and RETURN LOSS measurements, use patch cords about one foot long. Note that a 0.1 % accuracy termination resistor must be within +/- 0.075 Ohms, while a one foot coaxial cable loop is 0.092 Ohms. The following table indicates the return loss engendered by varying degrees of termination errors.

TERMINATION RETURN LOSS TABLE 1

OHMS		RETURN LOSS	TERMINATION ACCURACY	OHMS		RETURN LOSS
75 +/- .05		69.5 dB	0.1%	75 +/- .05		69.5 dB
74.9	=	63.5 dB	1%	75.1	=	63.5 dB
74.8	=	57.5 dB	1%	75.2	=	57.5 dB
74.7	=	54.0 dB	1%	75.3	=	54.0 dB
74.6	=	51.5 dB	1%	75.4	=	51.5 dB
74.5	=	49.6 dB	1%	75.5	=	49.6 dB
74.4	=	48.0 dB	1%	75.6	=	48.0 dB
74.3	=	47.0 dB	1%	75.7	=	47.0 dB
74.2	=	45.5 dB	2%	75.8	=	45.5 dB
74.1	=	44.5 dB	2%	75.9	=	44.5 dB
74.0	=	43.6 dB	2%	76.0	=	43.6 dB
73.5	=	40.1 dB	2%	76.5	=	40.1 dB
73.0	=	37.6 dB	5%	77.0	=	37.6 dB
72.5	=	35.7 dB	5%	77.5	=	35.7 dB
72.0	=	34.2 dB	5%	78.0	=	34.2 dB
71.5	=	32.8 dB	5%	78.5	=	32.8 dB
71.0	=	31.7 dB	10%	79.0	=	31.7 dB
70.5	=	30.7 dB	10%	79.5	=	30.7 dB
70.0	=	29.8 dB	10%	80.0	=	29.8 dB
69.0	=	28.3 dB	10%	81.0	=	28.3 dB
68.0	=	27.0 dB	10%	82.0	=	27.0 dB
67.0	=	25.9 dB		83.0	=	25.9 dB
66.0	=	24.9 dB		84.0	=	24.9 dB
65.0	=	24.1 dB		85.0	=	24.1 dB

The formula for calculating the Return Loss created by any discontinuity in a 75 Ohm transmission system follows:

$$\text{Return Loss} = 20 \log \frac{Zt - Zo}{Zt + Zo}$$

Zt = Terminating impedance

Zo= Cable characteristic impedance = 75 Ohms

TERMINATION RETURN-LOSS TABLE 2

TERMINATION ACCURACY	75 OHM TERMINATION LOWER	UPPER	RETURN LOSS	SIGNAL REFLECTION
+/- 0.1 %	74.925	75.075	66.0 dB	0.05 %
+/- 1.0 %	74.26	75.75	46.1 dB	0.5 %
+/- 2.0 %	73.53	76.50	40.1 dB	1.0 %
+/- 5.0 %	71.43	78.75	32.3 dB	2.4 %
+/- 10.0 %	68.18	82.50	26.4 dB	4.8 %
+/- 20.0 %	62.5	90.00	20.8 dB	9.1 %
+/- 30.0 %	57.69	97.50	17.7 dB	13.0 %
+/- 40.0 %	53.57	105.00	15.6 dB	16.7 %
+/- 50.0 %	50.00	112.50	14.0 dB	20.0 %

9.0 HOW TO MEASURE 60 Hz COMMON-MODE INTERFERENCE.

The POWER INDUSTRY and the BROADCAST INDUSTRY use exactly the same ground, but for very different purposes and this does cause a particular kind of problem for the broadcast industry. This problem is called Common Mode Interference (also known as Ground-Loop Interference). The Power Industry distribution system uses three phases of power to render different voltages, the power they distribute to non industrial customers is 220 Volts, with a center tap grounded. The power plug in the wall can be connected to one side of the 220 Volt system, thus deriving the 110 Volts. The other side of the 220 Volt system then delivers 110 Volts to another load. If these two loads are not equal (and they never are quite equal), then the unequal portion flows into the local ground. Of course this flow into the ground occurs in both phases.

The Power Industry depends on this to balance the total load over a large number of loads. Of course when currents flow through the ground to balance the load for the Power Industry, they also have voltage drop through the resistance of the ground. This ground resistance is very low, but the amperage drawn by these loads are very high. The result is that several volts may exist between different grounds. That can happen between adjacent power plugs. The Power Industry sees no problem with only a few volts between grounds, but in the Television Industry, where the signal is typically one volt or less, several volts of interference is disastrous.

The worst part is that you cannot reasonably predict what amplitude to expect and when to expect it, it changes from moment to moment, depending on elevators and motors that turn on and off at random. The sending end data terminal will likely be at one ground potential and the receiving data terminal is very likely connected to another ground. This will cause a 60 Hz potential to exist between the sending and receiving equipment. The data transmission system can tolerate some 60 Hz interference, but it is only a matter of exceeding this tolerance level when serious data compression and data loss can occur.

The SDI MASTER will measure the 60 Hz Common-Mode interference (also called Ground Loop interference) that exists between any two pieces of equipment that are connected with a coaxial cable. It may be necessary to test for 60 Hz at various times of day to see if the common-mode interference is excessive, or may be reaching the degree of interference that indicates that some remediation must by attempted.

If excess 60 Hz exists between the data source and the data receiver, then there are several possible solutions. One is to plug one end or the other into another power plug (especially into a plug carrying the opposite phase of the 60 Hz and retesting to see if the voltage is thereby reduced. Another solution is to place a 60 Hz cancellation distribution amplifier between the cable and the receiving data terminal. Probably the best solution is to bond the rack containing the data source and data receiver together with a very heavy duty copper ground bar (not wire, because the resistance and inductance of the wire is much too high to do any good.)

The procedure for making this test is to connect the source coaxial cable to the" INPUT" connector on the SDI MASTER, then connect the receiving data terminal to the "LOAD" coaxial connector on the SDI MASTER, rotate the front selector knob to the "GROUND LOOP" position, then depress and hold down the power button until the test is completed. The result will be displayed on the LCD. The read-out on the LCD is in Volts RMS. Remember that the data signal is measured in terms of peak-to-peak, so multiply the 60 Hz voltage reading by 2.83 to see what the interference potential is. As an example, if the meter reads 1.8 volts, the actual interfering signal will be 1.8 X 2.83 or 5.1 volts peak-to-peak. That is enough to engulf a 0.8 volt peak-to-peak video data signal, unless some process is used to reduce the affect of the interfering signal.

Different data receivers have different input circuits, so it is impossible to predict exactly how much 60 Hz common mode interference will actually cause trouble in a given installation. While this form of interference is generally fairly low within a broadcast studio, because grounding procedures are carefully attended to, remote locations are another matter, and can require remediation to reduce the 60 Hz interference to tolerable levels.

9.1 CARE AND MAINTENANCE

The SDI-1 is a precision measuring instrument and should be treated accordingly. While it can withstand ordinary everyday indoor use, it should not be left outside in the rain or otherwise mistreated. It is not waterproof. The battery should be removed if it is placed into storage to prevent leakage of corrosive fluids from batteries as they discharge and age.

Replace non-rechargeable batteries at least once a year even if ordinary use does not discharge the battery because old batteries may leak and cause corrosion damage. No routine maintenance or test procedures are required other than battery replacement. Attempts at field repair or adjustment will void the warranty. If the SDI-1 fails to operate properly, even after battery replacement, or does not read a known SDI signal correctly, call the factory at 1-800-235-6960 for a Return Authorization Number and return it to the factory for repair.

9.2 BATTERIES

One alkaline 9 Volt "transistor" battery is used. These batteries must not be used with the optional battery-charger as the alkaline battery is not designed to be charged and may leak and cause damage to the internal electronics. End of the battery life is indicated by a display of all the decimal points on the LCD when the meter is turned on.

If all the decimal points turn on during use, replace the 9Volt battery with a fresh battery immediately. Be aware that a dead battery can read 9VDC on a Voltmeter, if the battery is not under load. To correctly measure the battery Voltage, leave it connected to the load (SDI-1) and turn on the SDI-1 while reading the Voltmeter with the "load on". This will give you a correct reading of the battery Voltage. SDI-1 Meter Reading taken with all the decimal points illuminated (dead battery) are not valid.

The battery is located in the case, under the digital meter, with access provided by a sliding plastic cover plate that has the word OPEN printed on it. Slide in the direction of the arrow to open. When replacing the cover, place it flat into the grooves so that both ends engage and slide the lid closed.

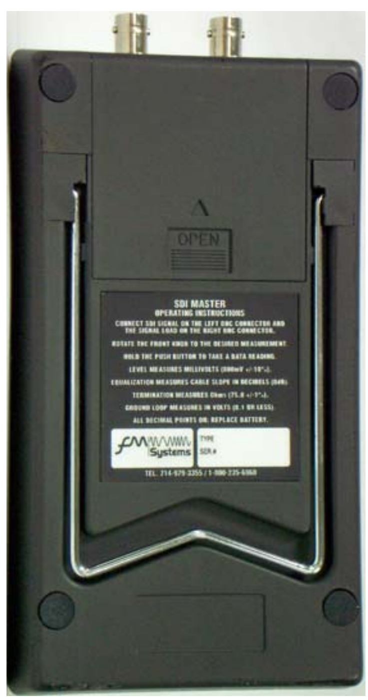
9.3 OPTIONAL CHARGER

An optional charger may be ordered. In this case, a "9 Volt" nickel-cadmium battery must be installed in the battery compartment. The initial charge of the nickel-cadmium battery requires 24 hours. Plug the charger into the 115 Volt AC power source and connect the plug on the end of the 9 Volt cord into the connector on the side of the case to the left of the meter face. After the initial charge, operate the meter as needed until the LCD displays all decimal points on before re-charging. Re-charging after every use builds a "discharge memory" into the battery that will reduce battery capacity.

The charging current is low to minimize over-charging. When re-charging is required, leave the charger on overnight, but do not charge day after day continuously. The SDI-1 will not operate on the charger without the battery because the charger will not supply enough current by itself. Always fully charge the battery, and remove the charging cord before starting measurements.

9.4 AUXILIARY EQUIPMENT

The MC1 is a Protective Carry Case to house and protect the SDI-1 meter while it is being transported. This is a very rugged ABS cases with a foam lined interior suitable for transporting the meter safely.



An abbreviated instruction manual is printed on the back of the SDI-1
and a phone number to call if you have any questions.