EM34-3 & EM34-3XL

OPERATING INSTRUCTIONS

(For Model With Two Digital Meters)

February 2009

NOTE TO EM34-3 USERS

CAUTION

1. If your system is non-rechargeable, use only alkaline batteries. If it is rechargeable, it is safe to use non-rechargeable alkaline batteries, however, do not attempt to recharge them.

   One of the most common problems with the instrument is the contamination of the connector and battery contacts. To clean connector contacts on the cables, receiver and transmitter use contact cleaning aerosol (e.g. WD40), which is available in most electronic components stores. To clean battery contacts use fine sand paper (#400 or higher) and wipe several times over the contacts. Ensure that the spring action of the battery holders is maintained. Bend holder slightly if necessary. Keep protective cap over connectors when cables not in use.

EM34-3XL

2. The EM34-3 is more susceptible to power line and atmospheric noise at 40m coil separation than at the 10m and 20m separation. For those who frequently survey with the 40m separation in noisy environments, **Geonics** offers an alternative system, the EM34-3XL. With 10 times the signal to noise capability at 40m separation and 4 times greater signal to noise at 10m and 20m separations; the XL system offers improved performance under noisy conditions. The EM34-3XL is available as either a new system or your current EM34-3 can be modified to an XL system. The XL coil has a diameter of approximately 1.0 m and is 1.5 kg heavier than the standard EM34-3 coil.

EM34-3 & EM34-3XL OPERATING INSTRUCTIONS

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EM34-3 & EM34-3XL OPERATING INSTRUCTIONS
(For Model with Digital Readout)

The following is the set-up and operating procedure for the EM34-3 Terrain Conductivity Meter.

1.

INITIAL SET-UP

At the beginning of the survey select an area free of "cultural interference" and man-made conductors such as buried pipes, buildings, power lines, steel reinforced concrete, etc.

1.1_ Having determined the coil separation to be used for the survey, lay the instrument out on the ground accordingly. Connect the reference cable (10, 20 or 40 meters) - one end to the 8-pin connector on the transmitter (Tx) coil and the other end to the **"REFERENCE"** connector on the receiver console. See attached sketch (page 17) for proper use of thimbles and snaps on the cable.

1.2 Connect the transmitter console to the transmitter coil using the appropriate short cable.

1.3 Put the **"LEVEL"** switch on the transmitter console to the **"NORMAL"** position. (See Section 6).

1.4 Set the receiver and transmitter coils to the selected coil separation with red circles on the coils both facing in the same direction.

1.5 Set transmitter **"SEPARATION"** switch to selected value <u>and turn on transmitter</u> (**"POWER/ON"** switch to **"ON"** position).

1.6 Check to see that Battery Monitor Meter indicator on the transmitter console is in the green area of the scale. If not, batteries are low or are not making proper contact to the battery clips. During the transmitter battery check transmitter coil has to be far from metal objects including concrete floor.

1.7 To check receiver battery switch the **"SEPARATION"** switch to **"BATT±"** positions and power switch to **"POWER ON"** position. The digital meter, on the right side of the front panel, will indicate the condition of the two sets of receiver batteries. If the reading is below the ± 4.5 (V) check that the battery contacts are clean and rigid. Replace contacts and/or batteries if required.

With new batteries, meter reading should be in the range of ± 6.00 (V).

For instruments with rechargeable batteries refer to section 5.5.

If after replacement of set of receiver batteries, or check of the battery holder contacts, digital meter still does not register battery level, it is possible that the digital meter or associated components are malfunctioning.

1.8 Set receiver **"SEPARATION"** switch to selected value.

2.

ELECTRONIC NULLING

To remove any offsets in the output (DC) circuitry.

2.1 Leave equipment set up and transmitter on as in Section 1. For the nulling, set coils at the largest separation (10, 20 or 40 m) at which the instrument will be used at the site.

2.2 Turn on receiver (**"POWER/ON"** switch to **"ON"** position).

2.3 With receiver coil disconnected and **"SENSITIVITY RANGE"** switch set to 1000mS/m depress **"NULL"** push button switch. Both meter readings should go to zero.

2.4 If either meter is not at zero reading, release the lock on the appropriate **"NULL"** control potentiometer, by turning the lock nut on the **"NULL"** control anti-clockwise for one turn. Keeping the **"NULL"** switch depressed adjust the **"NULL"** control to zero the meter.

2.5 Lock the **"NULL"** control.

2.6 Connect the receiver coil to the receiver console **"COIL"** connector via the appropriate short cable.

3.

RECEIVER COMPENSATION AND GAIN CHECK

3.1 Maintaining the receiver and transmitter coils in the same plane adjust the coil separation to obtain approximately zero reading (zero ± 300) on the **"SEPARATION"** meter (the meter on the left side of the front panel). (Insure that red circles on coils face in the same direction). The coil separation should now be at the selected value.

3.2 With the **"SENSITIVITY RANGE"** switch set to the 1000 mS/m position move the receiver coil toward the transmitter until the **"SEPARATION"** meter reads to 1 000.

3.3 Measure the distance that the receiver coil has moved. This distance should be 24.2% of intercoil spacing.

4.

TAKING A READING

The instrument is now operational, reading apparent terrain conductivity directly in mS/m in either the horizontal or vertical dipole mode.

4.1 At each measurement station the transmitter operator positions himself and remains stationary. The receiver operator should position the receiver coil such that the **"SEPARATION"** meter is approximately zero reading (zero ± 300).

4.2 The **"SENSITIVITY RANGE"** switch should be set such that the **"CONDUCTIVITY"** reading (the meter on the right side of the front panel) is in the upper 70% of the full scale. The meter reading should then be recorded in mS/m. (The **"SENSITIVITY RANGE"** switch setting indicates full scale meter reading).

NOTE: In order to minimize reading errors particularly on the most sensitive settings it is necessary to keep the receiver and transmitter consoles separated from their respective coils by 0.7 - 1.0 meter.

5.

PERIODIC DAILY CHECKS

5.1 Nulling: To make sure that any possible drift is kept under control, we suggest that you repeat the electronic nulling procedure (steps 2.1 to 2.6) at least once per day during the survey.

5.2 Receiver Battery: The receiver battery test is done simply by switching the **"SEPARATION"** switch to **"BATT±"** positions and power switch to **"POWER ON"** position. The digital meter will indicate the condition of the two sets of receiver batteries. If the reading is below the ± 4.5 (V) check that the battery contacts are clean and rigid. Replace contacts and/or batteries if required.

With new batteries, meter reading should be in the range of ± 6.00 (V).

For instruments with rechargeable batteries refer to section 5.5.

5.3 EM34-3 Transmitter Batteries: With the Tx coil connected and the **"LEVEL"** switch in the **"HIGH"** position, needle of the Battery Monitor Meter should be in the black area of the scale. Keeping the transmitter batteries warm in cold weather will improve battery lifetime.

5.4 EM34-3XL Transmitter Batteries: With the Tx coil connected and the **"LEVEL"** switch in the **"NORMAL"** position, needle of the Battery Monitor Meter should be in the black area of the scale. This procedure is valid for 10 m, 20 m of High Power or Normal Power operation and 40 m - Normal Power operation. For 40 m High Power operation **"LEVEL"** switch has to be in **"HIGH"** position. Keeping the transmitter batteries warm in cold weather will improve battery lifetime.

5.5 The receiver and transmitter **"CHARGER"** connectors are used for charging of the optional rechargeable set of batteries. Do not try to charge non-rechargeable batteries normally supplied with the instrument.

6.

TRANSMITTER OUTPUT POWER

As mentioned earlier, transmitter output power should be kept at the **"NORMAL"** level for increased battery life. Under very noisy conditions (power line or spherics) the transmitter power should be increased by switching the **"LEVEL"** switch to **"HIGH"** position.

7.

INSTRUMENT CALIBRATION

Prior to leaving the factory, the instrument is calibrated to read correctly, but due to its high sensitivity, fine adjustment of the instrument in the field may be helpful, particularly in regions of low conductivity and where the conductivity values are known to a good degree of confidence.

NOTE: As a precautionary measure the readings and exact location should be recorded prior to making any adjustments so that if the correction is found to be unsatisfactory the original settings can be recovered without returning the instrument to the factory.

7.1 Having decided what the new reading should be, the instrument **"zero"** can be adjusted by controls inside the receiver console. To gain access to these controls remove the receiver chassis from its metal cover by removing the two side screws and battery lid.

7.2 The **"zero"** adjustment potentiometers are located on printed circuit board No. 5 - one potentiometer for each coil separation.

10 meters - R15
20 meters - R14
40 meters - R13

7.3 The appropriate potentiometer should then be adjusted to give the desired meter reading.

NOTE: Each control should be adjusted only with the corresponding coil separation.

7.4 After adjusting any of the **"zero"** controls check the Electronic Null (Section 2).
Re-Null if necessary and repeat **"zero"** adjustment.

8.

MISCELLANEOUS

8.1 The switch marked **"HD/VD"** is used to give information to the optional external data logger about orientation of the coils; **"HD"** position for horizontal dipole (coils in the vertical

coplanar mode) and **"VD"** position for vertical dipole (coils in the horizontal coplanar mode).

8.2 The **"RECORD"** push button activates recording of data on the digital logger.

8.3 The **"RECORDER"** connector is the output connector for the digital data logger.

Multiple coil separation surveys

8.4 It is possible to use one cable for multiple coil spacing surveys, however, a simple calibration procedure is required. For a 10m and 20m coil separation set up procedure is as follows:

i. Set up the instrument with the 10m cable, take and note the reading.

ii. Without moving the coils, carefully remove the 10m cable and replace it with the 20m cable.

iii. Take another reading at 10m separation with the 20m cable and note the reading. It will likely be different from the reading with the 10m cable. Do not forget to adjust **"SEPARATION"** on receiver.

iv. The difference between the two readings is now your calibration constant to be either added to or subtracted from all your 10m readings. 20m reading are taken normally.

V. The procedure is the same for 20m and 40m separations.

9.0

NOTES ON INSTRUMENT OPERATION

9.1 Coil misalignment and Spacing Errors: It was noted in **Geonics** Technical Note TN-6 that in the horizontal dipole mode (plane of the coils vertical) the measurement was relatively insensitive to coil misorientation: in this mode the secondary (quadraturephase) magnetic field is perpendicular to the plane of the receiver coil and a small error θ in coil misalignment produces a $(1-\cos\theta)$ error in the apparent conductivity. When used in the vertical dipole mode (coil planes horizontal), however, the secondary field is approximately 45° to the horizontal and points away from the

transmitter. In this case a small error θ causes an error of the order of cos (θ + 45°), resulting in greater sensitivity to misalignment. The aim of the operators should be to maintain the two coils as close to coplanar as possible at all times, in either mode of operation.

It will be observed that the left-hand meter (indicating intercoil spacing) is relatively much more sensitive to intercoil spacing than the right-hand meter, which indicates conductivity. Small variations in intercoil spacing will have no effect on the measured value of conductivity.

9.2 Electrical Interference: Occasionally electrical interference will be encountered, either from cultural sources (50/60 Hz power lines, industrial noise) or from atmospheric electricity (spherics). Noise from cultural sources will often manifest itself as a slow variation in the output meter reading and these variations must be averaged out by the receiver operator. The amplitude of the excursions may be a function of coil orientation and also of the intercoil spacing since the operating frequency of the EM34-3 varies with the intercoil spacing: the excursions will usually be largest at the 40m spacing. They will also, of course, be largest on the most sensitive (low conductivity) ranges.

In regions where intense cultural noise is suspected (near large power lines, etc.) it is often a good idea to check for instrumental overloading by reducing the sensitivity by one switch position (i.e. going to the next higher conductivity range) and checking that the indicated conductivity still reads the same. To give an example: suppose we are working on the 10mS/m scale and the instrument reads 8mS/m near a power line. If the reading is not 8mS/m on the 100mS/m scale, overload is present. Suppose, however, that at the same location the instrument reads 10mS/m on both the 100 and the 1000mS/m scales. Then the overload is not affecting these less sensitive ranges and must be used in the vicinity of the interference, although the readings will be somewhat less accurate as a result of employing a less sensitive scale.

Atmospheric noise will often show itself as sporadic variation of the meter reading which are usually most severe in the horizontal dipole mode. The receiver operator must either average out the noise or wait for a quieter period.

10.

NOTES ON SURVEY INTERPRETATION

10.1 Linearity of Response: As stated in TN6, at high values of terrain conductivity the indicated conductivity is no longer linearly proportional to the actual conductivity. This effect is more severe for the vertical dipole mode of operation as

shown in Fig. 1 which illustrates indicated vs true ground conductivity for both operating configurations.

The curves of Fig. 1 apply to any of the three intercoil spacings. They indicate that for ground conductivity in excess of 700mmho/m the indicated conductivity in the vertical dipole mode falls to zero, and in fact for greater conductivity it becomes negative. In those instances where the ground is known to be reasonably uniform with depth the graph can be used to approximately correct the data.

10.2 Relative Response with Depth: TN6 discusses in detail the fact that it is possible to calculate the relative response from material at different depths for either operating coil configuration. The results for the EM34-3 are shown in Fig. 2 where it should be noted that the x-axis is the depth divided by the (variable) intercoil spacing. The great difference in the response to near surface material from the two coil configurations is important; the horizontal dipole mode will be relatively sensitive to variations in the near surface material whereas the vertical dipole mode will be relatively insensitive to such changes.

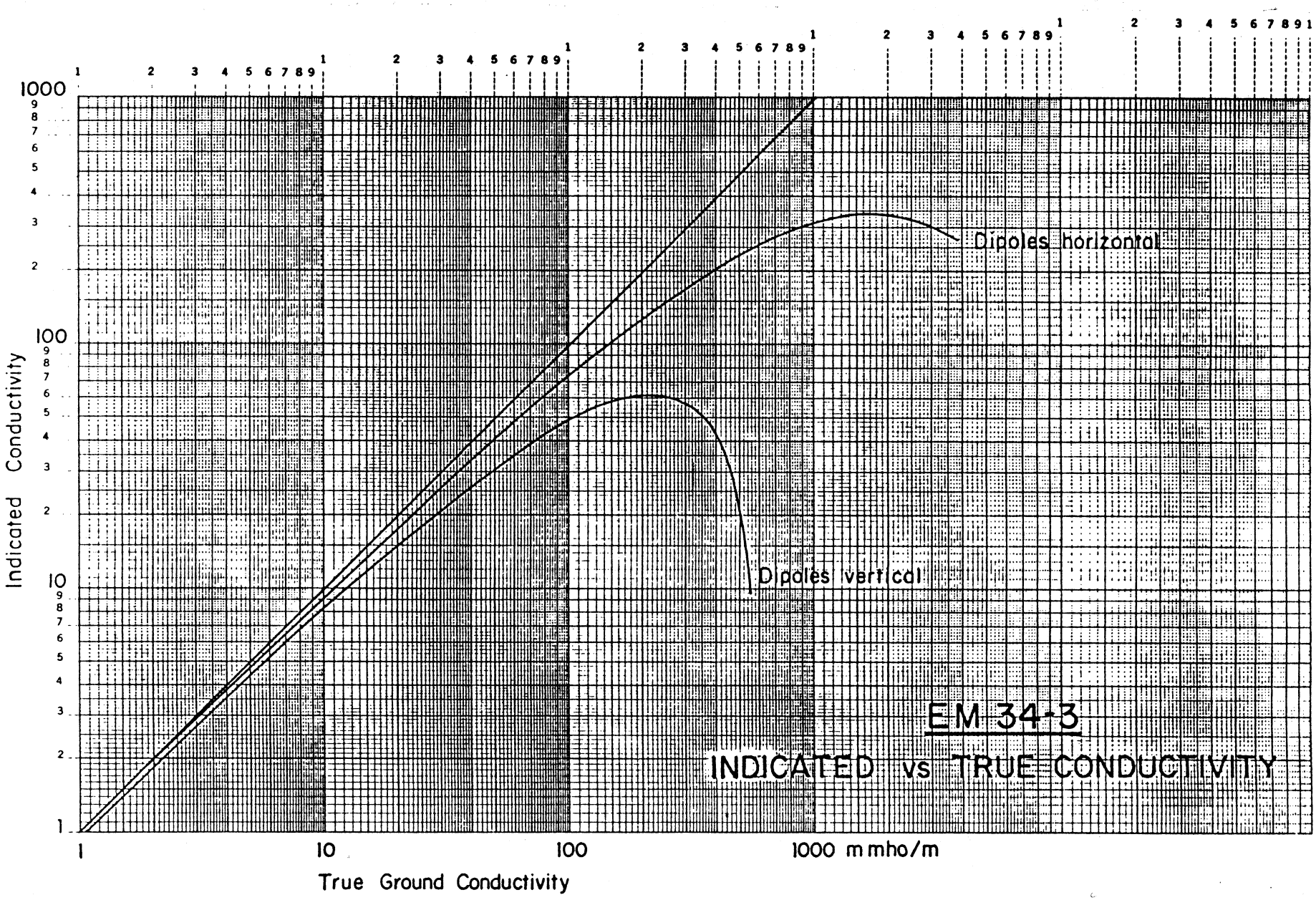
EM 34-3
INDICATED vs TRUE CONDUCTIVITY
Dipoles horizontal
Dipoles vertical
Indicated Conductivity
True Ground Conductivity
1
10
100
1000 mmho/m

FIG. 1

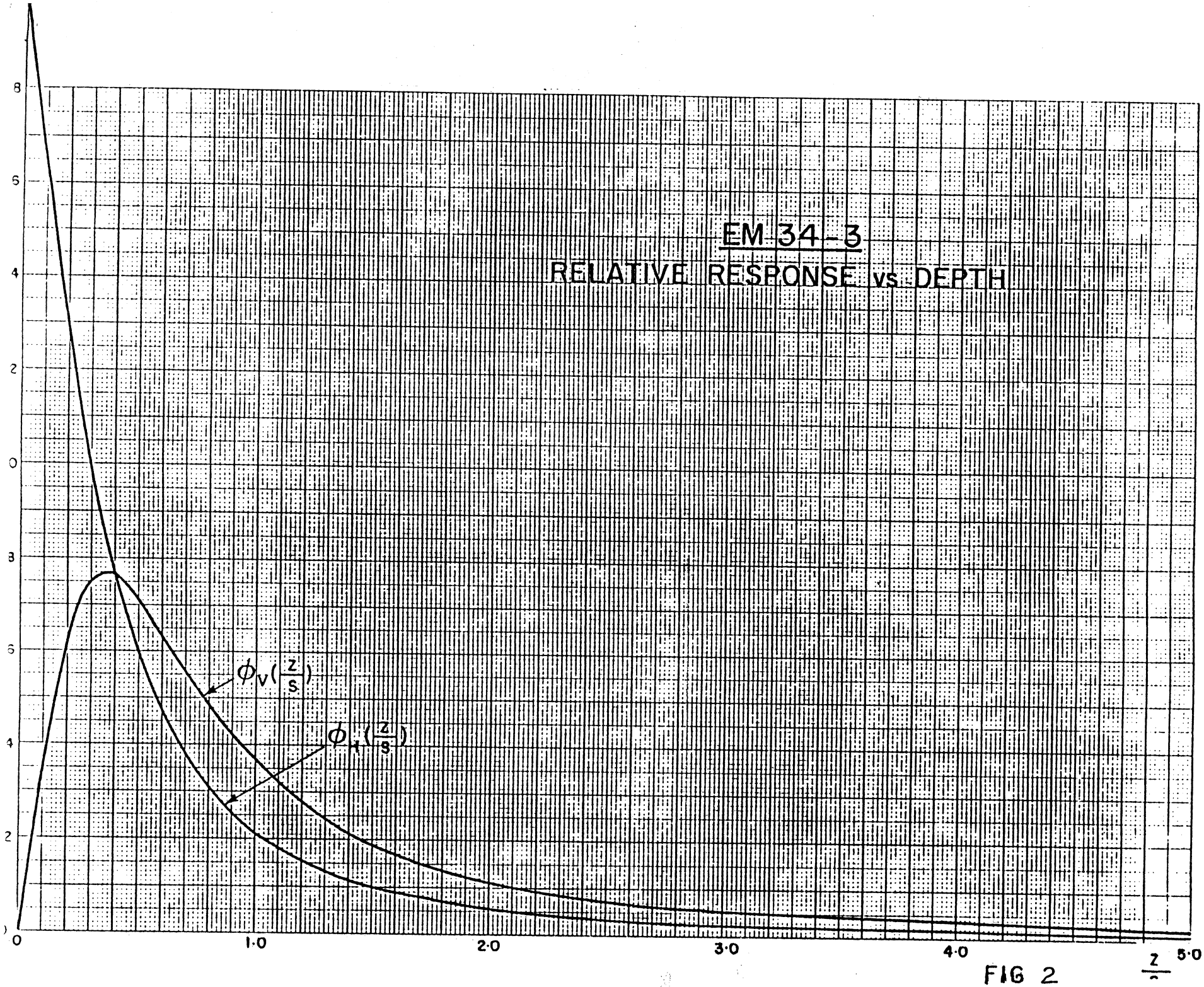
EM 34-3
RELATIVE RESPONSE vs DEPTH
$\phi_V(\frac{z}{s})$
$\phi_H(\frac{z}{s})$
8
6
4
2
0
8
6
4
2
0
1·0
2·0
3·0
4·0
5·0
$\frac{z}{s}$

FIG 2

11.0 EM34-3 & EM34-3XL INSTRUMENT SPECIFICATIONS
(Model with Digital Readout)

Measured Quantity	:	Apparent conductivity of the ground, milliSiemens/meter (mS/m)
Range of Conductivity	:	0-10, 100, 1000, mS/meter
Instrument Noise Level	:	Less than 0.2 mS/meter
Measurement Accuracy	:	±5% at 20 mS/meter
Measurement Precision	:	±2% of full scale deflection
Primary Field Source	:	Self-contained dipole transmitter
Sensor	:	Self-contained dipole receiver
Intercoil spacing	:	10 meters, 20 meters or 40 meters
Operating Frequencies	:	6.4 kHz at 10 meter spacing 1.6 kHz at 20 meter spacing 0.4 kHz at 40 meter spacing
Operating Temperature Range	:	-40°C to +50°C
Power Supply	:	Transmitter: 8 disposable "D" cells Life: 20 hrs continuous duty - "NORMAL" Life: 7 hrs continuous duty - "HIGH" Receiver: 8 disposable "C" cells Life: 20 hrs continuous
Recorder Connector	:	Output connector for interface with digital data logger DL720
Reference Cable	:	Lightweight 2 wire shielded cable
Optional	:	Rechargeable Battery supply with dual transmitter/receiver battery charger 115/220 volts

Weights & Dimensions

Receiver Console	:	3.1 kg	19.5 x 13.5 x 26 cm
Receiver Coil	:	4.0 kg	63 cm
Transmitter Console	:	3.0 kg	15 x 8 x 26 cm
Transmitter Coil (EM34-3)	:	7.2 kg	63 cm
Transmitter Coil (EM34-3XL)	:	8.5 kg	100 cm
Shipping Weight & Dimensions (EM34-3)	:	43.0 kg	27.5 x 75 x 75 cm
Shipping Weight & Dimensions (EM34-3XL)	:	51.0 kg	106 x 106 x 20 cm

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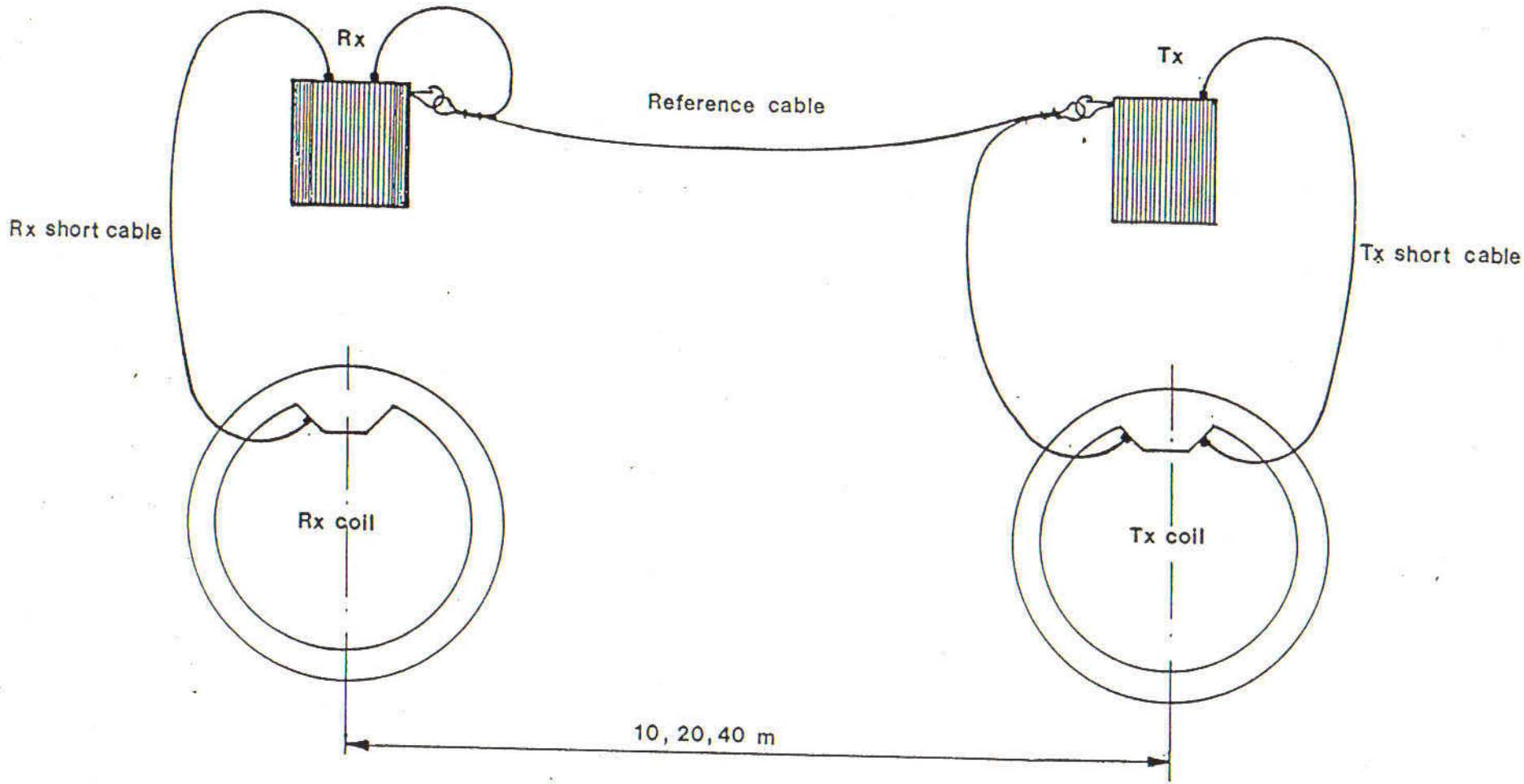
APPENDIX I.

- Instrument Visual Aids & Cable Connections

EM34-3 RECEIVER
GEONICS LIMITED
MISSISSAUGA CANADA
RECORDER
CHARGER
SEPARATION
meters
10
20
40
BATT.+
BATT.-
HD
VD
NULL
NULL
ON
POWER
REFERENCE
COIL
SENSITIVITY RANGE
millisiemens/meter
10
100
1000
NULL
RECORD

EM34-3
TRANSMITTER
CHARGER
ON
POWER
SEPARATION
meters
10
20
40
LEVEL
NORMAL
HIGH
GEONICS LIMITED
MISSISSAUGA CANADA

EM 34-3 CABLE CONNECTION