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Attenuation of drill cables

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Abstract: The frequency characteristics of a drill cable determines both the type of communication that can be used between a drill or logger and the surface, as well as the maximum rate of information that can be transferred. In order to revise the design, the attenuation of the cable was measured. The result was far from the characteristics of a coaxial cable. At medium audio frequencies, the attenuation was quite low. However at both low and high frequencies, the attenuation increased significantly, and the high frequency cut off could be approximated by a 3-order low pass filter with a cut off frequency of 8 kHz. For comparison, the attenuation of a similar size coaxial type cable will be in order of 1 dB/300 m at 150 kHz increasing to 2 dB/300 m at 1 MHz. If a bandwidth higher than 10 kHz is required for a 4 km long oceanographic type electromechanical steel armoured cable, this has to be of coaxial construction with a shield separated from the armour.

The frequency characteristics of a drill cable determines both the type of communication that can be used between a drill or logger and the surface, as well as the maximum rate of information that can be transferred. Traditionally, the Copenhagen Glaciology group has used standard oceanographic 4 conductor cables (Fig. 1) for both the shallow and deep drills. In the deep drills, all 4 conductors are connected in parallel. Both the power and the communication shares the same wires, and a transformer separates the signal and DC power. We have until recently never had any problem with this type of cable. Also, because we originally used commercially type modems at the surface, the frequency range was limited to the audio range used by telephone lines. This forced us to use a technique requiring a modest data rate. Later, we doubled the data rate from 300 to 600 baud full duplex, and are now using a frequency spectrum of 2 to 5 kHz, *i.e.* well within the audio range. This relatively low data rate has allowed all important parameters to be updated twice a second.

In an attempt to update the outdated technique used previously, a carrier type modem is used for the EPICA drill (International Glaciological Society, 2000; Gundestrup *et al.*, 1996) used at Dome C, Antarctica. This type of modem shifts the communication to be centered at a higher frequency, here with a nominal minimum frequency of 50 kHz. This turned out not to be possible due to excessive cable loss, and required a marginal design in order to be usable.

In order to revise the design, the attenuation of the cable was measured. The 4 center conductors were connected in parallel, *i.e.* the cable was in a coaxial configuration. The attenuation was measured from the console, through 4 km of standard 7.2 mm oceanogra-

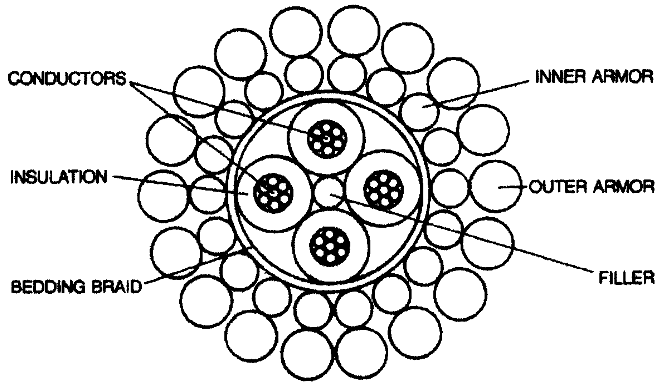

Fig. 1. Typical construction of a multiconductor electromechanical oceanographic cable.

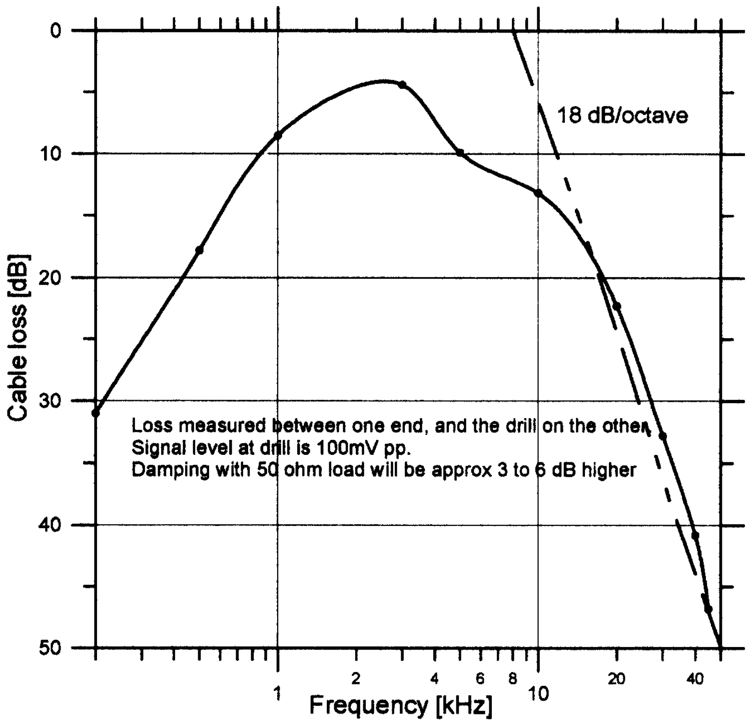

Fig. 2. Loss of 4 km of spooled cable.

phic cable (Camesa 4H28RZ) spooled on a steel winch. The measurement was made with a constant low level signal at the remote (drill site). The signal level was so low, that it could not turn ON the input diode—no DC current was used. Thus effectively, the drill cable could be considered as almost unloaded at the drill. At the console side, the voltage over the cable was measured, and the attenuation recorded.

The result was far from the characteristics of a coaxial cable as shown on Fig. 2. At medium audio frequencies, the attenuation was quite low. However at both low and high frequencies, the attenuation increased significantly, and the high frequency cut off could be approximated by a 3-order low pass filter with a cut off frequency of 8 kHz. Also, changing abruptly the current absorbed by the drill, produced significant voltage spikes at

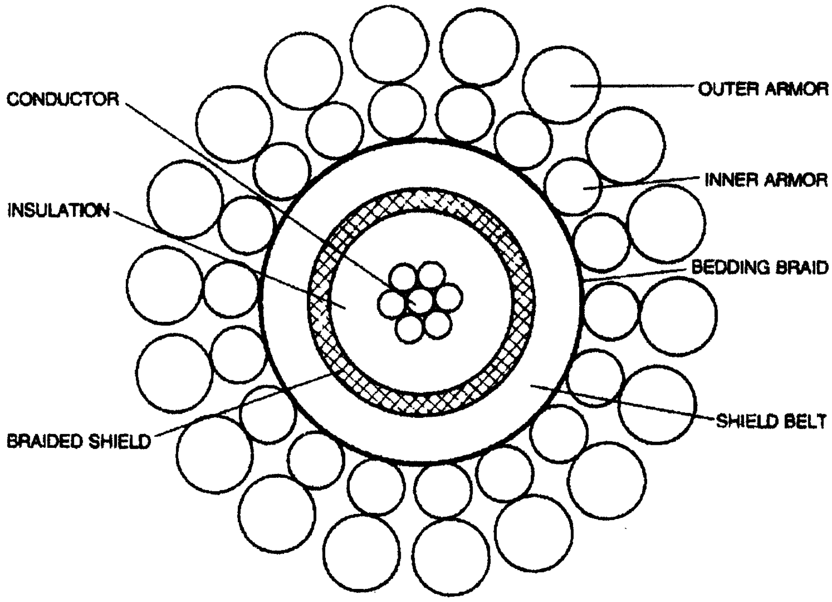

Fig. 3. Coaxial type electromechanical cable. Note the insulated shield.

the drill, showing that the cable acted more like an inductor than a transmission line. For comparison, the attenuation of a similar size coaxial type cable (Fig. 3) will be in order of 1 dB/300 m at 150 kHz increasing to 2 dB/300 m at 1 MHz.

Our interpretation is, that because the cable is uninsulated, the signal current in the cable wound on the drum don't follow the cable, leaving the centre conductors as a coil. If the cable is unspooled, the induction is reduced, and the signal loss should be reduced significantly. Although we have not made any measurements on an unspooled cable, indirect measurements still indicate high losses at higher frequencies, so the explanation of the high frequency cable losses is not complete.

Conclusion: If a bandwidth higher than 10 kHz is required for a 4 km long oceanographic type electromechanical steel armoured cable, this has to be of coaxial construction with a shield separated from the armour.

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