HERZ TOTEM-2A

Multi-Channel VLF Electromagnetic
Continuous Measuring Survey Instrument

Airborne VLF data are mainly used for the interpretation of large scale geological features such as faults and conducting rock units, although under favourable circumstances, smaller conductors such as those due to sulphide mineralization may be revealed. VLF data are regarded as an excellent, cost-effective complement to airborne magnetic data.

The TOTEM-2A receives the magnetic component of fields radiated from VLF transmitters in the 15 to 25 kHz frequency range. These transmitters are located around the world for the purposes of navigation and communication with submarines. The parameters normally measured are the change in total field and the vertical quadrature component and the total field gradient from dual sensors. The sign of the quadrature polarity is also recorded.

A TOTEM-2A system includes a sensor comprising three mutually orthogonal Air-coil or ferrite-cored coils and a pre-amplifier mounted on an assembly, which can be placed inside an aerofoil (either a stinger or towed bird with 4.5 inch (114 mm) Inside diameter). A cable connects the sensor to an electronics console which provides outputs for analog and digital recorders.

The TOTEM-2A employs highly unique digital and linear integrated circuits to implement the functions of crystal-controlled phase-locked loop frequency synthesizers, dual frequency heterodyne conversion and proprietary time domain sampling vector computation techniques.

Simultaneous dual frequency operation ensures that transmitters can be selected to provide good coupling with conductors of any orientation. The gradient mode measurements enhance interline contouring and delineation of multiple conductors.

Because of its simplicity, size and ease of operation, this VLF system is an ideal add-on to existing airborne geophysical exploration systems.

Air-Coil Sensor

Outstanding Features

Automatic Measurement of two VLF Stations:

The TOTEM-2A can be configured to measure two VLF transmitting stations simultaneously, which results in greatly improved data quality for two important reasons. First, the likelihood of finding conductive bodies that strike in different directions is enhanced. Secondly, responses from more than one transmitter can be correlated to verify the results of each measurement, thereby resulting in better confidence in the data and thus better interpretations.

TOTEM-2A VLF Nose Stinger
(Photo courtesy of Tundra Airborne Surveys Ltd.)

Accurate Frequency Selection:

The frequency of the Line and Ortho channels can be selected individually by means of three digital thumbwheel switches, in 100 Hz steps, throughout the full range of 15.0 to 24.3 kHz. Optionally through special modification the range can be extended to cover 10 to 30 kHz; however by doing so, the TOTEM-2A VLF station frequency thumbwheel settings will not read direct, but be indicative with an offset.

Wide Signal Bandwidth:

As VLF stations are located at 100 Hz increments, the acceptance bandwidth around the nominal frequency is sufficient to accommodate modulation plus some offset without causing severe modulation noise.

Detects Geological Strikes in almost any direction:

The TOTEM-2A has the capability to detect conductors with strikes in almost any direction due to its efficiency in operation making it feasible to read two transmitted signals.

Quantities Measured by the TOTEM-2A:

The TOTEM-2A VLF can process simultaneously dual frequency information from each of two spatially separated sensors, thereby permitting gradient measurement at two primary field azimuths.

Primary Fields:

The horizontal magnetic field component Ho of the propagating field from VLF radio transmission stations is utilized by the TOTEM-2A as the source of primary excitation. This component continues to exist beneath the earth's surface as Hd, decreasing at a rate dependent on the ground conductivity.

Secondary Field:

Conductivity variations in the horizontal plane, due to localized mineralization or other geological structure, causes a secondary field to be generated.

The TOTEM-2A avoids the need for independent orientation, and amplitude or phase reference by effectively measuring the change in magnitude and the ellipticity (polarization) of the total field (primary plus secondary).

Because anomalous secondary fields are generally quite small in comparison with the primary field, these measurements equate very closely with measurement of the in-phase horizontal and quadrature vertical secondary fields.

The nominal 100% primary magnitude is determined in an anomaly free zone.

To avoid interference from aircraft or bird roll, pitch and yaw, it is necessary to make field measurements with an orthogonal (xyz) array of three antennae.

The three directional antennae components are designated as LINE, ORTHO and ERECT.

1) ***LINE*** couples maximally with a field in the nominal direction of flight (in-line with flight).

2) ***ORTHO*** couples maximally with a field in the nominal direction at 90º to the direction of flight (orthogonal to flight).

3) ***ERECT*** couples maximally with a nominally vertical field.

The field parameters which are actually computed by the TOTEM-2A are determined relative to the principal axis signal, which may be designated as either Line or Ortho.

The TOTEM-2A can process VLF signals from two primary field azimuths simultaneously, one in each of the two principal axis channels.

Parameters Measured

Total Field:

The change in magnitude of the vector sum of the principal axis field and the in-phase components of the other two orthogonal fields. (100% primary field magnitude is considered to be above the absolute magnitude of the total field established in an anomaly free zone.)

Vertical Quadrature:

Magnitude of that component of the Erect axis field in quadrature with the principal axis field.

Horizontal Quadrature:

Magnitude of that component of field, on the Line or Ortho axis orthogonal to the principal, in quadrature to the principal axis.

Gradient:

As the TOTEM-2A can process VLF signals from two spatially separated sensors simultaneously, it can therefore, perform gradient measurements.

Gradient is defined as the difference in magnitude of the total field at the lower sensor with the total field at the upper sensor. Total field is by definition independent of sensor orientation; hence the magnitude of the gradient anomaly will not be modulated by relative misorientation between upper and lower sensors.

TOTEM-2A SPECIFICATIONS

PRIMARY SOURCE

Magnetic field component radiated from VLF radio transmitters (one or two simultaneously)

PARAMETERS MEASURED

Total field, vertical quadrature, horizontal quadrature and gradient

FREQUENCY RANGE

15 kHz to 25 kHz; front panel selectable for each channel in 100 Hz steps

Extended Range 10 to 30 kHz (Contact RMS Instruments)

SENSITIVITY RANGE

130 mV m to 100 mV m at 20 kHz, 3 dB down 14 kHz and 24 kHz

VLF SIGNAL BANDPASS

-3 dB at ±80 Hz; < 4% variation at ±50 Hz

ADJACENT CHANNEL REJECTION

300 to 800 Hz : 20 to 32 dB;
800 to 1500 Hz : 32 to 40 dB;
> 1500 Hz : 40 dB (for < 2% noise envelope)

OUT OF BAND REJECTION

10 kHz to 2.5 kHz = 5 x 10^{-4} Am to 5 x 10^{-1} Am ; < 2.5 kHz rising at 12 db octave;

30 kHz to 60 kHz = 5 x 10^{-4} Am to 8 x 10^{-3} Am ; > 60 kHz rising at 6 dB octave (for no overload condition)

OUTPUT FILTER

Time constant 1 sec. for 0% to 50% or 10% to 90%, noise bandwidth 0.3 Hz (second order LP)

INTERNAL NOISE

1.3 mV m rms (ambient noise will exceed this)

ELECTRIC FIELD REJECTION

< 0.5% error for 20 m tow cable

SFERICS FILTER

Reduces noise contribution of the impulse interference

CONTROLS

Power switch

Frequency selector switches (Line and Ortho)

Meter switch (total quad)

Sferics filter switch

DISPLAYS

Meters (Line and Ortho)

Sferics light

Overload light

INPUTS

Power:
23 to 32 VDC;
0.5 Amps, fused

Signal:
Sensor upper;
Sensor lower

OUTPUTS

a) Total, quad, gradient, multiplexed (line and ortho);
Span: ± 1.0 V

b) Audio monitor, stereo line and ortho; approx. 3 V p-p

DIMENSIONS AND WEIGHT

Console:
480 mm x 45 mm x 340 mm
19" (1U) rack mount
(19 x 1.75 x 13.4 inch.)
3.8 kg (8.3 lbs.)

Sensor and Preamplifier Assembly:

Air-coil: 110 mm x 490 mm
(4.3 x 19.3 in.),
2.5 kg (5.5 lbs.)

Optional:
Ferrite: 110mm x 570 mm
(4.3 x 22.4 in.),
1.5 kg (3.3 lbs.)

ENVIRONMENTAL

Operating temperature:
Console: 0 - 50ºC
Preamp/Antenna: -10 - 50ºC

Storage temperature:
-40 - 70ºC

Relative Humidity:
0 - 99% non-condensing

Altitude:
0 - 20,000 ft.

Specifications subject to change without notice

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For additional information on these and other products, contact:

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