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Operational/Product Description/Technical Description

Introduction

The purpose of the system is to enable an Underground Horizontal Boring Machine to be used in a controlled manner, monitor its progress and provide orientation information so that steering corrections can be made.

It is intended to be compatible for use with the DrillTrack G2 Receiver (ND2422) and provides a design modification of the DrillTrack G2 DataView.

Product Details

Product Description

The System comprises a cable powered DataSonde transmitter, Surface Control unit and a DataView remote display unit. The sensor data from the DataSonde is modulated on to an AC carrier signal, and output by means of an EM signal propagated into free space and by an AC current flowing in the power supplies. The bore rods and a cable running inside them form the power supply circuit, this circuit is completed by connecting to the Surface Control Box at the surface.

A DrillTrack G2 Receiver (11/ND2422), not forming part of the system for approval purposes, can also be used to pinpoint the spatial position of the DataSonde underground and decode orientation sensor data uses the field shape characteristics of the modulated output EM signal from the DataSonde.

The DataSonde output is an AC modulated carrier signal at 33725 Hz. A solenoid antenna forms the output EM and current signals, the AC current is applied to the power supply circuit by a secondary winding on the antenna using the incoming power supply cable.



Certificate No FM12608

The Surface Control unit is powered from an external 12-24V DC power supply. This unit is connected to the DataView to provide power and serial data communications between units and provides a regulated 22-28V DC supply to the DataSonde. Using the power supply circuit formed by the internal cable and bore rods the modulated AC current, impressed by the DataSonde, is recovered and decoded by electrical circuits and a Microcontroller. The data is error checked and conditioned by software processes and output serially to the DataView.

The DataView unit provides the primary user interfaces, with a custom LCD display, LED array and audio sounder. The unit is powered by the Surface Control unit and displays data from both the Surface Control unit, via the serial digital interface, and a DrillTrack Receiver, via a low power UHF radio link. To manage system configurations where a DrillTrack Receiver or Cable powered DataSonde may not be used, there is bi-directional data flow between the Surface Control unit and DataView and software processes are used to automatically manage each configuration.

As the bore progresses the power supply circuit is extended by butt splicing sections of cable inside each rod. Typically each rod is 3m in length and bores extend to between 30 and 300m depending on the technical requirements of the bore.

Product operation

Each unit is portable and battery powered so that it can be simply fitted and removed from different boring machines as required. The DataView and Surface Control Box are magnetically attached to the machine metalwork and each other. They are connected to each other using a supplied interconnection cable and to a customer-supplied external 12-24 V DC battery.

The DataSonde is fitted into a custom designed head assembly manufactured by the boring machine manufacturer. The DataSonde power supply cable is output from the machine using a manufacturer supplied slip ring assembly and connected to the Surface Control unit using the supplied output lead.

Correct operation of the software within the Surface Control unit is indicated by a green coloured LED on the front panel. Pressing the push button on the front panel applies the 22-28V output voltage to the DataSonde power supply circuit, the circuit impedance and correct operation of the DataSonde are indicated on the front panel by 3 LED's. A green LED (OK) indicates that data is being recovered correctly, either of two red LED's indicate a short or open circuit fault condition, which can be used by the operator to diagnose and rectify the fault.



When the DataSonde has been powered up it transmits the EM location signal for the DrillTrack Receiver, if used, and circulates the AC current in the power supply circuit. When the Surface Control unit has correctly recovered this data it is then transmitted to the DataView where it is decoded and displayed.

The Surface Control unit and DataSonde act together to provide remote voltage sensing of the output voltage at the DataSonde, this compensates for any voltage drop through the cable and rod circuit. Software within the DataSonde monitors the DC voltage and sends this back as part of the data stream, the Surface Control unit software extracts this data and uses it to adjust the applied output voltage in 3 equal steps from 22.6 to 28.6 V.

The DataView unit can be operated on its own, from its own battery pack, or connected to a Surface Control unit. In either operating configuration the unit displays DataSonde and Locate data on a custom LCD, a series of LED's and a sounder as appropriate. An LCD backlight can be turned on to improve low light visibility.

When connected to a Surface Control box, one pair of batteries must be removed and an interconnection cable and connector assembly fitted in replacement of the battery cover, mechanical interlocking prevents the batteries being fitted. The connector assembly has 4x spring loaded ball pin connections which mate to corresponding contacts within the DataView. When assembled these connections enable bi-directional RS232 data transmission between units, the DataView is powered from the Surface Control unit.

Technical Description

DataSonde Wireline Output PCB 09/ND2545/D

The cable input from the power supply circuit is connected through a winding of the EM solenoid antenna (mounted within the Sonde assembly) and to the output PCB. The PCB input passes through a reverse polarity input protection device (TR6) and EMC filter C27.

A DC-DC converter (IC3) boost regulates the incoming voltage, in the range 18 to 22.6V up to 24 V $\pm 5\%$, this provides the regulated supply for the EM output signal. Provision is made for future product development by enabling the output to be set to 6V $\pm 5\%$ if the input voltage falls below 7V input. This feature does not form part of the current system operational functionality.

Further DC-DC regulation of the 24V supply is made to 5V $\pm 5\%$ (IC5) for logic devices and a linear regulator (IC4) provides a 3V3 $\pm 5\%$ supply for the Processor. PCB (09/ND2426/D).



The output signal applied to the EM antenna is formed using a similar process used and described for the Surface Control unit (09/ND2971/D). A PIC microcontroller (IC1) outputs two complementary outputs at 33725 Hz, modulated ON:OFF with the serial data, which drive MOSFET's TR1 and TR2. The resulting output signals from the solenoid antenna are an EM field and AC current in the power supply circuit

DataSonde Wireline Processor PCB 09/ND2546/D

The microprocessor board contains the majority of the digital electronics. The processor (IC8) is responsible for reading the attitude sensors (IC2,3,5) a temperature sensor (IC4) and monitoring the incoming DC supply voltage. The microprocessor operates with a 7.680 MHz crystal.

The resulting sensor data is processed and output in the form of a serial datastream, which is used as the modulation input to the PIC on the Output PCB (09/ND2545/D).

Using the same circuits as described on the Surface Control unit (09/ND2971/D) the processor controls a programmable frequency synthesiser (IC10) to provide a frequency accurate and stable clock and derive the output signal carrier on the output PCB (09/ND2545/D)

Manufacturing calibration constants are stored in an I²C interface EEPROM (IC9) which is read immediately after the system power is applied and written to during manufacturing Calibration processes.

Provision is made for an externally mounted Piezo electric shock sensor to be connected to the PCB (PIN3). This sensor is not currently fitted as part of this design.

The processor RESET is applied by IC12 when the power supply voltage falls below a pre-set minimum or if a Watchdog reset function, provided during normal operation of software, is not set within a pre-set time interval.

To enable half-duplex communication between the DataSonde and Surface Control units, used only during manufacture for test and Calibration processes. A data receiver circuit and AM demodulator, similar to that used in the Surface Control unit (09/ND2971/D) is formed with a secondary winding on the solenoid antenna, an instrumentation amplifier (IC6), an AM demodulation envelope detector (D1 and C56) and a comparator (IC7). The output logic level signal is connected to a serial Rx data pin on the microprocessor. Data communication rate is 4800 BAUD maximum.

