COMMUNICATION IN A SUBSEA WELL CONTROL SYSTEM

FIELD OF THE INVENTION

This invention relates to communication in a subsea well control system, such as a control system for a subsea well hydrocarbon extraction facility.

BACKGROUND OF THE INVENTION

In a communications and power system (CAPS) based subsea control well system (such as a subsea control system for a subsea well hydrocarbon extraction facility), the cost of the copper conductors, within an umbilical between a surface control platform and the subsea well complex, used for data communications becomes significant due to the long offsets.

SUMMARY OF THE INVENTION

According to the invention from one aspect, there is provided a communication arrangement for a subsea well control system, comprising an umbilical between a topside location and a subsea location, an electrical conductor in said umbilical and means for transmitting and receiving data between said locations via said conductor, wherein a return path for said data comprises the sea. Typically, said means for transmitting and receiving data comprises:

first data supply means, at said topside location;

second data supply means, at said subsea location;

first data receiving means, at said topside location, for receiving data from said second data supply means via said umbilical; and

second data receiving means, at said subsea location, for receiving data from said first data supply means via said umbilical.

Such an arrangement could comprise first switching means, at said topside location, and second switching means, at said subsea location, the arrangement being such that,

when said first data supply means transmits data to said second data receiving means, said second switching means connects said conductor to the sea and, when said second data supply means transmits data to said first data receiving means, said first switching means connects said conductor to the sea.

In this case, in one embodiment:

said first data supply means comprises a first direct current source and means for alternately switching said first switching means between a position in which it connects said first source to said conductor and a position in which it connects said conductor to the sea, in dependence on the data to be transmitted to the second receiving means; and

said second data supply means comprises a second direct current source and means for alternately switching said second switching means between a position in which it connects said second source to said conductor and a position in which it connects said conductor to the sea, in dependence on the data to be transmitted to the first receiving means.

In another embodiment, said first data supply means comprises a first data source and said second data supply means comprises a second data source, the arrangement being such that said first switching means connects said first source to said conductor for transmitting data to said second receiving means and said second switching means connects said second source to said conductor for transmitting data to said first receiving means. Each of said first and second sources could comprise a source of digital data or a source of modulated analogue data.

According to this invention from another aspect, there is provided a method of communication in a subsea well control system which comprises an umbilical between a topside location and a subsea location and an electrical conductor in said umbilical, the method comprising using means for transmitting and receiving data to transmit between said locations via said conductor and using the sea as a return path for said data.

BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1 and 2 illustrate a first embodiment of the invention in two conditions;

Figs. 3 and 4 illustrate a second embodiment of the invention in two conditions; and

Figs. 5 and 6 illustrate a third embodiment of the invention in two conditions.

Detailed Description of the Invention

Referring first to Figs. 1 and 2, in a well control system (such as a control system for a subsea well hydrocarbon extraction facility), reference numeral 1 designates a direct current (DC) supply at a topside location for supplying a voltage VCC-TOP and reference numeral 2 designates a DC supply at a subsea location for supplying a voltage VCC-SUB. Reference numeral 3 designates a switch at the topside location and reference numeral 4 designates a switch at the subsea location. There is a long offset between supplies 1 and 2, there being between them an electrical conductor 5 in the form of a single wire in an umbilical 6 for transmitting communications between from the topside to subsea and vice-versa, the conductor 5 not carrying power.

Rtop designates a resistor at the topside location in series with conductor 5, across which resistor is an amplifier 7 for topside reception of data from the subsea location and Rsub designates a resistor at the subsea location in series with conductor 5 across which resistor there is an amplifier 8 for reception of data from the topside location. At the topside location, for transmitting data to the subsea location, a digital signal TX1 can cause switch 3 to operate via an amplifier 9 alternately to connect and disconnect in a predetermined manner the voltage from supply 1 to conductor 5, in which condition switch 4 connects conductor 5 to the sea at a sea connection (see Fig. 1). At the subsea location, for transmitting data to the topside location, a digital signal TX2 can cause switch 4 to operate via an amplifier 10 to alternately connect and disconnect in a predetermined manner the voltage from supply 2 to conductor 5, in which condition switch 3 is connected to the sea at a sea connection (see Fig. 2). At the topside location, the sea connection is at a potential of Vsea-top and at the subsea end the sea connection is at a potential of Vsea-sub.

In Fig. 1, communication of data is from the topside location to the subsea location in dependence on the operation of switch 3 and in Fig. 2, communication of data is from the subsea location to the topside location in dependence on the operation of switch 4, in each case the communication return path is via the sea, the resistance of the sea water being Rsea.

When transmitting data from the topside location to the subsea location (Fig. 1), the received signal being RX1, VCC-TOP must be large enough to compensate for the voltage drop along the conductor 5 of the umbilical 6 (Vumbilical-drop).

e.g. VCC-TOP = Vumbilical-drop + V digital-offset,

where: Vdigital-offset = Min [Abs(Vsea-top – Vsea-sub) + Vdigital]

Vdigital is recommended to be at least 24 volts.

Thus, the subsea transmitted signal is as follows:

- Logic 1: voltage drop across resistor Rsub when switch 3 is connected to supply 1 (approx Vdigital)

- Logic 0: voltage drop across resistor Rsub when switch 3 is connected to the sea (approx 0 volts)

When transmitting data from the subsea location to the topside location (Fig. 2), the received signal being RX2, similar conditions as per the above supply to VCC-SUB.

Referring to Figs. 3 and 4, in which items which correspond with those in Figs. 1 and 2 have the same reference numerals as in Figs. 1 and 2, reference numerals 11 and 12 designate digital data supplies at the topside and subsea locations respectively. For transmitting data from the topside location to the subsea location, switch 3 is connected to supply 1 and switch 4 is connected to the sea (Fig. 3); and for transmitting data from the subsea location to the topside location, switch 4 is connected to supply 2 and switch 3 is connected to the sea (Fig. 4).

As with Figs. 1 and 2, the communication of data from the topside location to the subsea location and vice-versa is via conductor 5 with the return path via the sea. The DC level of the digital signals supplied by supplies 11 and 12 should meet the conditions set out above with reference to Figs. 1 and 2 for VCC-TOP and VCC-SUB.

Figs. 5 and 6 illustrate an alternative to the embodiment of Figs. 3 and 4 in which supplies 11 and 12 are replaced by analogue modulated communication supplies 13 and 14 at the topside and subsea locations respectively, for example supplying analogue signals digitally encoded, such as by differential quadrature phase shift keying (DQSPK).

ADVANTAGES OF USING THE INVENTION

The key advantage of this invention is the substantial reduction in the umbilical costs by the reduction of conductors.

CLAIMS:

1. A communication arrangement for a subsea well control system, comprising an umbilical between a topside location and a subsea location, an electrical conductor in said umbilical and means for transmitting and receiving data between said locations via said conductor, wherein a return path for said data comprises the sea.

2. An arrangement according to claim 1, wherein said means for transmitting and receiving data comprises:

first data supply means, at said topside location;

second data supply means, at said subsea location;

first data receiving means, at said topside location, for receiving data from said second data supply means via said umbilical; and

second data receiving means, at said subsea location, for receiving data from said first data supply means via said umbilical.

3. An arrangement according to claim 1 or claim 2, comprising first switching means, at said topside location, and second switching means, at said subsea location, the arrangement being such that, when said first data supply means transmits data to said second data receiving means, said second switching means connects said conductor to the sea and, when said second data supply means transmits data to said first data receiving means, said first switching means connects said conductor to the sea.

4. An arrangement according to any preceding claim, wherein:

said first data supply means comprises a first direct current source and means for alternately switching said first switching means between a position in which it connects said first source to said conductor and a position in which it connects said conductor to the sea, in dependence on the data to be transmitted to the second receiving means; and

said second data supply means comprises a second direct current source and means for alternately switching said second switching means between a position in which it connects said second source to said conductor and a position in which it connects said conductor to the sea, in dependence on the data to be transmitted to the first receiving means.

5. An arrangement according to any preceding claim, wherein said first data supply means comprises a first data source and said second data supply means comprises a second data source, the arrangement being such that said first switching means connects said first source to said conductor for transmitting data to said second receiving means and said second switching means connects said second source to said conductor for transmitting data to said first receiving means.

6. An arrangement according to any preceding claim, wherein each of said first and second sources comprises a source of digital data.

7. An arrangement according to any preceding claim, wherein each of said first and second sources comprises a source of modulated analogue data.

8. A method of communication in a subsea well control system which comprises an umbilical between a topside location and a subsea location and an electrical conductor in said umbilical, the method comprising using means for transmitting and receiving data to transmit between said locations via said conductor and using the sea as a return path for said data.

9. A method according to claim 8, wherein said means for transmitting and receiving data comprises:

first data supply means, at said topside location;

second data supply means, at said subsea location;

first data receiving means, at said topside location, for receiving data from said second data supply means via said umbilical; and

second data receiving means, at said subsea location, for receiving data from said first data supply means via said umbilical.

10. A method according to claim 8 or claim 9, wherein the system comprises first switching means, at said topside location, and second switching means, at said subsea location, the method being such that, when said first data supply means transmits data to said second data receiving means, said second switching means connects said conductor to the sea and, when said second data supply means transmits data to said first data receiving means, said first switching means connects said conductor to the sea.

11. A method according to any of claims 8 to 10, wherein:

said first data supply means comprises a first direct current source, the method comprising alternately switching said first switching means between a position in which it connects said first source to said conductor and a position in which it connects said conductor to the sea, in dependence on the data to be transmitted to the second receiving means; and

said second data supply means comprises a second direct current source, the method comprising alternately switching said second switching means between a position in which it connects said second source to said conductor and a position in which it connects said conductor to the sea, in dependence on the data to be transmitted to the first receiving means.

12. A method according to any of claims 8 to 11, wherein said first data supply means comprises a first data source and said second data supply means comprises a second data source, the method being such that said first switching means connects said first source to said conductor for transmitting data to said second receiving means and said second switching means connects said second source to said conductor for transmitting data to said first receiving means.

13. A method according to any of claims 8 to 12, wherein each of said first and second sources comprises a source of digital data.

14. A method according to any of claims 8 to 13, wherein each of said first and second sources comprises a source of modulated analogue data.