

PATENT SPECIFICATION

(11)

1 437 032

1 437 032

- (21) Application No. 13039/74 (22) Filed 4 April 1973
(62) Divided out of No. 1437031
(23) Complete Specification filed 18 March 1974
(44) Complete Specification published 26 May 1976
51) INT CL² H04Q 1/38
(52) Index at acceptance
H4K 1A2 1A5Z 1A8 1H13 1HX
(72) Inventor: DAVID WILLIAM HARRISON



(54) A POWER FEED AND BIDIRECTIONAL SIGNALLING ARRANGEMENT

(71) We, THE PLESSEY COMPANY LIMITED, a British Company of 2/60 Vicarage Lane, Ilford, Essex, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

The invention relates to a power feed and bidirectional signalling arrangement having a particularly but not necessarily an exclusive application in a House Exchange telephone system of the kind described in our co-pending patent application number 16016/73 (Serial No. 1437031).

In the House Exchange telephone system described in our co-pending patent application number 16016/73 (Serial No. 1437031) a plurality of extension line units are connected to a single stage switching matrix using a first conductor pair for each extension and to a common control unit using a second conductor pair for each extension, the first conductor pair being used for speech transmission and signalling to a public exchange whilst the second conductor pair is used for supplying power to the extension line unit and for system signalling. A line signalling interface accommodates most of the control features appertaining to the control signalling.

The invention provides a power feed and bidirectional signalling arrangement wherein first and second equipment units are interconnected by means of a single pair of conductors, the arrangement including a constant voltage source for supplying power to the first and second equipment units, the second equipment unit being powered from the first equipment unit on the single conductor pair; voltage modulation means for modulating the voltage supply to the single conductor pair in order to effect signalling from the first to the second equipment unit; first means for detecting the voltage modulation

at the second equipment unit, the first means being capacitively coupled to the single conductor pair and adapted to provide an output signal representative of the said voltage modulation; voltage regulation means for the second equipment unit; current modulation means, the series resistance of which is variable in order to effect signalling from the second to the first equipment unit, the series resistance variations effecting modulation of the current drawn from the constant voltage source; means responsive to the current modulation at the first equipment unit to provide corresponding voltage variations; and third means for detecting the voltage variations at the first equipment unit, the third means being capacitively coupled to the single conductor pair and adapted to provide an output signal representative of the said voltage variations.

The foregoing and other features of the invention will be better understood from the following description with reference to the accompanying drawings in which:

Figure 1 diagrammatically illustrates, in the form of a block diagram, a power feed and bidirectional signalling arrangement according to the invention.

Figure 2 illustrates a practical circuit arrangement for the balanced voltage modulator of Figure 1.

Figure 3 illustrates a practical circuit arrangement for the series voltage regulator of Figure 1.

Figure 4 illustrates a practical circuit arrangement for one of the balanced threshold detectors of Figure 1, and

Figure 5 illustrates a practical circuit arrangement for part of the other one of the balanced threshold detectors of Figure 1.

Referring to Figure 1 of the drawings, the power feed and bidirectional signalling arrangement diagrammatically illustrated therein in the form of a block diagram is especially adapted for use in a House Ex-

50

55

60

65

70

75

80

85

90

change telephone system of the kind described in our co-pending patent application number 16016/73 (Serial Number. 1437031) but could be used in any system wherein two equipment units are interconnected by means of a single pair of conductors and wherein it is required to effect, on the single conductor pair, powering of one of the equipment units from a voltage source located at the other one of the equipment units in combination with bidirectional signalling between the two equipment units.

The block within the dotted line 2 at the left hand side of Figure 1 represents the circuits of one equipment unit, for example, a signalling interface unit of a House Exchange telephone system of the kind outlined in preceding paragraphs, and the block within the dotted line 1 at the right hand side of Figure 1 represents the circuits of another equipment unit, for example an extension instrument of the House Exchange telephone system. The two units 1 and 2 are interconnected by a single pair of conductors which are represented in Figure 1 by resistances RL, the maximum value of RL being 50 ohms in the case of a House Exchange telephone system.

The single conductor pair, i.e. the line RL is fed from a constant voltage source VL, a low impedance source being preferred to a high impedance source as regards the effect of interference. Likewise, the signal modulation and detection circuits are balanced as far as possible so as to provide good longitudinal interference rejection.

At the unit 2, the information data which is to be passed to the unit 1 via the line RL modulates the constant voltage VL using a balanced voltage modulator arrangement 3 which includes a balanced voltage modulator in series with each side of the line RL and a logic level translator. The voltage modulation is detected at the unit 1 by means of a balanced threshold detector 4. The detector 4 is connected to the line RL by means of capacitors C4 and C5 and its output is applied to a load 5 of the unit 1. The load 5 would be constituted by the extension instruments logic circuits when the arrangement forms part of a House Exchange telephone system.

Since the line voltage at the unit 1 varies, due to line signalling and line length variations, the supply voltage for the circuits of the unit 1 is derived from a series voltage regulator 6. The input impedance of the voltage regulator 6 is arranged so that it matches the line RL at the upper signal frequencies. In a House Exchange telephone system the impedance of the voltage regulator 6 would be 120 ohms.

The output from the voltage regulator 6 provides a 'primary' voltage reference for the balanced threshold detector 4 and for a cur-

rent modulator 7 which provides for signalling from the unit 1 to the unit 2. A 'secondary' voltage Vs for the load 5 is derived from a constant current source 8 in order to prevent load variations from reflecting into the line RL and thence into the signal detectors.

Signalling from the unit 1 as just indicated, is by means of the current modulator 7. The series resistance of the current modulator 7 is varied in a binary manner in accordance with the 'data to line' signals that are applied to the modulator. This variation of the modulator's series resistance effects modulation of the current drawn from the constant voltage source VL at the unit 2. The current variations are differentially detected at the unit 2 in terms of the resulting voltage variations across a series resistance RD in each of the lines RL. These voltage variations or pulses are a.c. coupled by the capacitors C1 and C2 into the unit's balanced threshold detector 9 the output of which is a 'data from line' signal.

The combined values of the resistances RD and the output impedance of the line unit's balanced voltage modulator 47 approximate to 120Ω so as to match the line RL.

The current modulation from the unit 1 is arranged so that the resulting voltage pulses on the line RL are of inverse polarity with respect to the voltage pulses from the unit 2 in order to prevent the signals sent by the unit 1 from feeding back into its logic circuits via the balanced threshold detector 4.

The detailed arrangements and functions of the various circuits of Figure 1 will now be outlined in greater detail with reference to Figures 2 to 5 of the drawings.

With reference to Figure 2 of the drawings, a circuit diagram of the balanced voltage modulator 3 of Figure 1 is illustrated therein with typical values for the various circuit components being indicated for the House Exchange telephone system application. Transistors TR1, TR2 and TR3 and their associated circuitry provide the necessary control for line feed transistors TR4 and TR5, the collector/emitter circuits of which are each connected in series with one of the previously mentioned line resistances RD. In the case of a House Exchange telephone system a minimum voltage swing of 2 volts is required at the unit 1 of Figure 1 in order to effect signalling which means that in order to cater for all line lengths, a voltage swing of about 5.5 volts is needed at the unit 2.

When there is no 'data to line' signal applied to the bases of the transistors TR1 and TR2 via the associated resistance/capacitance parallel combination, the transistors TR1, TR2, and TR3 are switched off, and therefore, the voltages at the bases, and hence, the emitters of the transistors TR4 and TR5 are defined by the voltage drop

across the 620Ω resistances R1 and R2 which are respectively connected across the base/collector circuits of the transistors TR4 and TR5 and which are each connected in series with a separate one of the 5.6KΩ resistances R3 and R4 across the electrical supply. The collectors of the transistors TR3 and TR2 are respectively connected to the junctions of the series resistance combinations R1/R3 and R2/R4 and the collector/emitter circuits of these two transistors are respectively connected in series with diodes D1 and D2. The emitter voltages of the transistors TR4 and TR5 are about 30.8 volts and 4.2 volts respectively.

When there is a high 'data to line' input signal at the bases of the transistors TR1 and TR2, the transistors TR1, TR2 and TR3 are caused to conduct and the transistors TR2 and TR3 become saturated. The resistances R1 and R2 are, therefore, under these conditions each shunted by a saturated transistor in series with a diode. This gives rise to a voltage drop of about 0.8 volts which takes the emitter voltages of the transistors TR4 and TR5 to about 33.5 volts and 1.5 volts respectively. This represents the required voltage swing of 5.4 volts.

Figure 3 illustrates the circuit diagram of the series regulator 6, the current modulator 7 and the constant current generator 8 of Figure 1 with typical values for the various circuit components being indicated for the House Exchange telephone system application.

In Figure 3 the circuit of the series voltage regulator 6 is a well known type of circuit wherein the base, and hence the emitter of a transistor TR6 is held at a voltage defined by a reference zener diode Z1. The 120Ω resistance R5 in the collector-base circuit of the transistor TR6 provides the necessary line-matching at the higher signal frequencies.

As previously outlined, the voltage supply for the load is derived from a constant current generator 8. The circuit of Figure 3 containing a transistor TR8 is a conventional constant current generator and it provides sufficient current to satisfy the peak 'steady' current for the load, any transient demand being provided by a capacitor C3 which is connected in shunt with the load. The constant current generator also provides sufficient current to ensure adequate voltage regulation from a reference zener diode Z2.

As previously outlined, signalling from the unit 1 of Figure 1 is effected by means of current modulation. The requirement of the circuits in this respect is that for the House Exchange telephone system application a minimum current change of 9 mA should be effective in the two series resistances RD in the unit 2 of Figures 1 and 2. In order that this change can be guaranteed with all lengths of line, a current change of 24-25 mA is

required at the unit 1. A current modulator constituted by a transistor TR7 and its associated components is operated by the 'data to line' signals which are applied via a 15KΩ resistance to the base of the transistor TR7. When this data signal is low the transistor TR7 is switched off and there is no current in the 430Ω collector resistance R6 of the transistor. When the data signal is high, the transistor TR7 saturates and draws collector current Ic which is given by the following equation:—

$$I_c = \frac{V_p - 0.8}{R_6} = \frac{11.3 - 0.8}{430} = 24.4 \text{ mA}$$

wherein the figure 0.8 is the approximate voltage drop across the saturated transistor TR7 and a diode D3 in the emitter circuit of the transistor TR7.

On a long line, the current modulation results in a minimum current change of 9 mA in the series resistances RD, which, as illustrated in Figure 2, have a minimum value of 56Ω. This gives a minimum differential voltage change of $2 \times 56 \times 9 \times 10^{-3}$ i.e. 10 volt and this differential voltage change is, as is illustrated in Figure 1, capacitively coupled by the capacitors C1 and C2 to the balanced threshold detector 9.

At the unit 2 signals from line are sampled coherently at instants when they are expected to be present. This process offers adequate protection against noise on the line.

At the unit 1 operation is asynchronous and any noise signal exceeding the detector threshold will be treated as a valid signal. For this reason it is necessary to provide as high a noise immunity as possible at the unit 1.

At the unit 2 of Figure 1, the balanced threshold detector 9 can be based on the well known long-tailed pair circuit and a typical arrangement of such a circuit is illustrated in Figure 4 of the drawings.

As illustrated in Figure 4, the long-tailed pair is constituted by transistors TR17 and TR18 and their associated circuitry, the differential voltage change on the line RL being capacitively coupled by the capacitors C1 and C2 of Figure 1 to the bases of the transistors TR17 and TR18. The data output i.e. the 'data from line' signal, of the circuit for application elsewhere in the user system is taken from the collector of a transistor TR16 whose base is resistively connected to the collector to the transistor TR18.

At the unit 1 of Figure 1 the threshold detector 4 is preceded by a linear, balanced amplifier the circuit of which is illustrated in Figure 5 of the drawings.

In Figure 5, a transistor TR9 and its associated circuitry constitutes a constant current source which ensures that two transistors TR10 and TR11 which are connected in a long-tailed pair configuration, operate in a

non-saturating linear mode. The bias conditions on the transistors TR10 and TR11 are arranged to provide adequate swing at the collector of the transistor TR11 when the two inputs, which are capacitively coupled via capacitors C4 and C5 of Figure 1, are unbalanced by the presence of a line signal. If longitudinal noise is present, the base potentials of the transistors TR10 and TR11 are affected by an equal amount and their collector currents do not change. The output from the collector of the transistor TR11 is taken to the load circuit 5 via a simple threshold detector which can be of any known type.

WHAT WE CLAIM IS:—

1. A power feed and bidirectional signalling arrangement wherein first and second equipment units are interconnected by means of a single pair of conductors, the arrangement including a constant voltage source for supplying power to the first and second equipments unit, the second equipment unit being powered from the first equipment unit on the single conductor pair; voltage modulation means for modulating the voltage supply to the single conductor pair in order to effect signalling from the first to the second equipment unit; first means for detecting the voltage modulation at the second equipment unit, the first means being capacitively coupled to the single conductor pair and adapted to provide an output signal representative of the said voltage modulation; voltage regulation means for the second equipment unit; current modulation means the series resistance of which is variable in order to effect signalling from the second to the first equipment unit, the series resistance variations effecting modulation of the current drawn from the constant voltage source; second means responsive to the current modulation at the first equipment unit to provide corresponding voltage variations; and third means for detecting the voltage variations at the first equipment unit, the third means being capacitively coupled to the single conductor pair and adapted to provide an output signal representative of the said voltage variations.

2. A power feed and bidirectional signalling arrangement as claimed in claim 1 wherein the voltage modulation and the detection means are balanced in order to provide longitudinal interference rejection.

3. A power feed and bidirectional signalling arrangement as claimed in claim 1 or claim 2 wherein the voltage regulation means includes a voltage regulator connected in series with one of the pair of conductors and adapted to supply a first reference voltage for the current modulation means and the first means; a constant current generator connected in series with a zener diode across the output of the series voltage regulator and

adapted to supply a second reference voltage for a load circuit of the second equipment unit; and a capacitor which is connected in shunt with the load circuit and adapted to satisfy transient feed current demands.

4. A power feed and bidirectional signalling arrangement as claimed in claim 3 wherein the series voltage regulator includes a first transistor, the emitter-collector circuit of which is connected in series with the said one of the pair of conductors and the base of which is connected to the other conductor of the pair via a zener diode and to the collector via a resistance having a value which effects impedance matching between the single conductor pair and the series voltage regulator.

5. A power feed and bidirectional signalling arrangement as claimed in claim 3 or claim 4 wherein the current modulation means includes a second transistor the base of which is resistively connected to a signal input and the emitter-collector circuit of which is connected to the first reference voltage supply, the emitter being connected to one side of the first reference voltage supply via a diode.

6. A power feed and bidirectional signalling arrangement as claimed in any one of the preceding claims wherein the second means consist of a series resistance for each of the pair of conductors.

7. A power feed and bidirectional signalling arrangement as claimed in any one of the preceding claims wherein the third means include third and fourth transistors connected in a long-tailed pair configuration, the base of each of the transistors being capacitively coupled to a separate one of the pair of conductors; and a fifth transistor the base of which is resistively connected to the collector of one of the third and fourth transistors and the collector of which is connected to an output terminal of the third means.

8. A power feed and bidirectional signalling arrangement as claimed in any one of the preceding claims wherein the first means include a voltage threshold detector connected in series with a linear, balanced amplifier, the inputs of the amplifier being capacitatively coupled to a separate one of the pair of conductors.

9. A power feed and bidirectional signalling arrangement as claimed in any one of the preceding claims wherein the voltage modulation means include a balanced voltage modulator in series with each one of the pair of conductors; and a logic level translator the output of which is connected to each of the balanced voltage modulators and the input of which is connected to a modulating signal input terminal.

10. A power feed and bidirectional signalling arrangement as claimed in any one of



non-saturating linear mode. The bias conditions on the transistors TR10 and TR11 are arranged to provide adequate swing at the collector of the transistor TR11 when the two inputs, which are capacitively coupled via capacitors C4 and C5 of Figure 1, are unbalanced by the presence of a line signal. If longitudinal noise is present, the base potentials of the transistors TR10 and TR11 are affected by an equal amount and their collector currents do not change. The output from the collector of the transistor TR11 is taken to the load circuit 5 via a simple threshold detector which can be of any known type.

WHAT WE CLAIM IS:—

1. A power feed and bidirectional signalling arrangement wherein first and second equipment units are interconnected by means of a single pair of conductors, the arrangement including a constant voltage source for supplying power to the first and second equipments unit, the second equipment unit being powered from the first equipment unit on the single conductor pair; voltage modulation means for modulating the voltage supply to the single conductor pair in order to effect signalling from the first to the second equipment unit; first means for detecting the voltage modulation at the second equipment unit, the first means being capacitively coupled to the single conductor pair and adapted to provide an output signal representative of the said voltage modulation; voltage regulation means for the second equipment unit; current modulation means the series resistance of which is variable in order to effect signalling from the second to the first equipment unit, the series resistance variations effecting modulation of the current drawn from the constant voltage source; second means responsive to the current modulation at the first equipment unit to provide corresponding voltage variations; and third means for detecting the voltage variations at the first equipment unit, the third means being capacitively coupled to the single conductor pair and adapted to provide an output signal representative of the said voltage variations.

2. A power feed and bidirectional signalling arrangement as claimed in claim 1 wherein the voltage modulation and the detection means are balanced in order to provide longitudinal interference rejection.

3. A power feed and bidirectional signalling arrangement as claimed in claim 1 or claim 2 wherein the voltage regulation means includes a voltage regulator connected in series with one of the pair of conductors and adapted to supply a first reference voltage for the current modulation means and the first means; a constant current generator connected in series with a zener diode across the output of the series voltage regulator and

adapted to supply a second reference voltage for a load circuit of the second equipment unit; and a capacitor which is connected in shunt with the load circuit and adapted to satisfy transient feed current demands.

4. A power feed and bidirectional signalling arrangement as claimed in claim 3 wherein the series voltage regulator includes a first transistor, the emitter-collector circuit of which is connected in series with the said one of the pair of conductors and the base of which is connected to the other conductor of the pair via a zener diode and to the collector via a resistance having a value which effects impedance matching between the single conductor pair and the series voltage regulator.

5. A power feed and bidirectional signalling arrangement as claimed in claim 3 or claim 4 wherein the current modulation means includes a second transistor the base of which is resistively connected to a signal input and the emitter-collector circuit of which is connected to the first reference voltage supply, the emitter being connected to one side of the first reference voltage supply via a diode.

6. A power feed and bidirectional signalling arrangement as claimed in any one of the preceding claims wherein the second means consist of a series resistance for each of the pair of conductors.

7. A power feed and bidirectional signalling arrangement as claimed in any one of the preceding claims wherein the third means include third and fourth transistors connected in a long-tailed pair configuration, the base of each of the transistors being capacitively coupled to a separate one of the pair of conductors; and a fifth transistor the base of which is resistively connected to the collector of one of the third and fourth transistors and the collector of which is connected to an output terminal of the third means.

8. A power feed and bidirectional signalling arrangement as claimed in any one of the preceding claims wherein the first means include a voltage threshold detector connected in series with a linear, balanced amplifier, the inputs of the amplifier being capacitively coupled to a separate one of the pair of conductors.

9. A power feed and bidirectional signalling arrangement as claimed in any one of the preceding claims wherein the voltage modulation means include a balanced voltage modulator in series with each one of the pair of conductors; and a logic level translator the output of which is connected to each of the balanced voltage modulators and the input of which is connected to a modulating signal input terminal.

10. A power feed and bidirectional signalling arrangement as claimed in any one of

70

75

80

85

90

95

100

105

110

115

120

125

130



the preceding claims wherein the first equipment unit is a signalling interface unit of a House Exchange telephone system and wherein the second equipment unit is an extension instrument of the House Exchange telephone system.

11. A power feed and bidirectional signal-

ling arrangement substantially as hereinbefore described with reference to the accompanying drawings. .10

R. NICHOLSON,
Chartered Patent Agent,
For the Applicant.