(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
12 March 2015 (12.03.2015)

WIPO | PCT

(10) International Publication Number
WO 2015/033119 A1

(51) International Patent Classification:
H04B 3/54 (2006.01) *H04L 12/10* (2006.01)
H04B 3/56 (2006.01) *H04L 12/40* (2006.01)

(21) International Application Number:
PCT/GB2014/052645

(22) International Filing Date:
1 September 2014 (01.09.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
1315680.7 3 September 2013 (03.09.2013) GB

(71) Applicant: **COOPER TECHNOLOGIES COMPANY** [US/US]; 600 Travis, Suite 5600, Houston, Texas 77002 (US).

(72) Inventors; and
(71) Applicants *(for US only)*: **WILLIAMS, David, Gareth** [GB/GB]; 35 Dammersey Close, Markyate, St. Albans, Hertfordshire AL3 8JS (GB). **PRICE, Les, John** [GB/GB]; 6 Easthill Rd, Houghton Regis, Dunstable, Bedfordshire LU5 5EQ (GB).

(74) Agent: **WP THOMPSON**; 55 Drury Lane, London WC2B 5SQ (GB).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*

[Continued on next page]

(54) Title: NETWORK FIELDBUS POWER SUPPLY

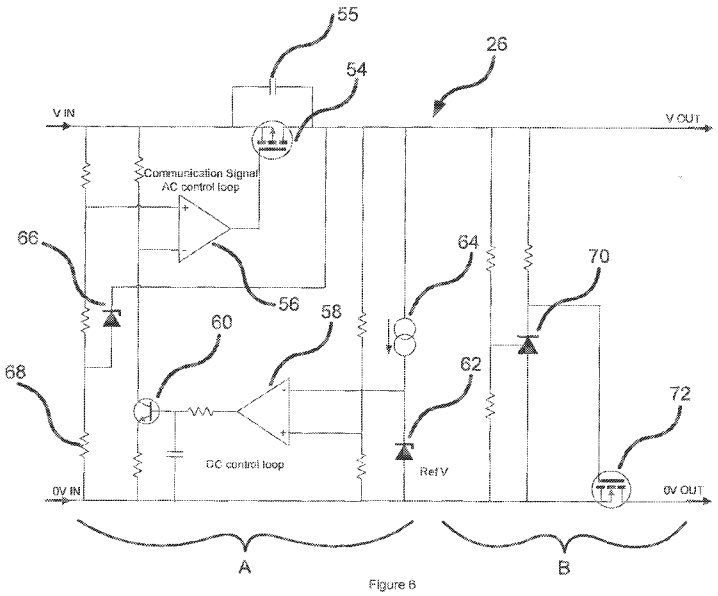


Figure 6

(57) Abstract: The invention provides for a network power-supply voltage adaptor arranged to receive an input voltage (V in) from a network trunk cable and to present an internal voltage derived from the said input voltage (V in), the adaptor being arranged, when at least one of the input voltage (V in) or the said internal voltage is above a reference voltage (Ref V), to regulate the received input voltage (V in) to provide an adaptor output dc power supply voltage (V out) at a substantially constant dc power supply level less than that of the input voltage (V in), and independent of changes in the input voltage level (V in), and the adaptor further comprising at least one communication feed-through loop (55, 56, 66, 68) for the passage of substantially unaltered communications signals through the adaptor.

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— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

Network Power Supply

The present invention relates to a network power supply voltage adaptor and related method and network bus system and, in particular, but not exclusively, to a fieldbus power supply adaptor, and related system and method.

Bus network systems are commonly employed in situations where a variety of signals including power, control and measurement signals are to be delivered to, returned from, a variety of networked terminal devices. In many instances, the certainty with which a signal of particular characteristic, and in particular its voltage level, can be supplied to a network device can prove critical to the effective/safe operation of the device and even the whole network system. This is particularly the case in scenarios where the presence and operation of the various network devices may also have an impact on the signals supplied throughout the network and particularly by way of a common bus system.

In many instances, the bus system has to operate in accordance with specifications and set standards where it can prove disadvantageously limiting and inappropriate to rely on the compliance of such separate network devices in order to achieve overall bus system compliance. The architecture of such known systems can further prove disadvantageous in placing constraints on the location and physical size of the network and, in particular, the network bus system.

The invention seeks to provide for a network power supply adaptor, related method of power supply and related network bus system having advantages over known such adaptors, methods and systems.

According to one aspect of the present invention there is provided a network power supply voltage adaptor arranged to receive an input voltage from a network trunk cable and, when the level of the input voltage, or a proportion thereof, is above a threshold value, to regulate the received input voltage to provide an output dc power supply voltage at substantially constant dc power supply level independent of changes in the input voltage level, or the proportion thereof, above the threshold value.

Advantageously, the voltage can then be regulated in a manner independent of the compliance of one or more networked terminal devices and in a particularly effective, reliable and efficient manner. Thus, if the input voltage to the adaptor exceeds a predefined output voltage limit the adaptor circuit regulates its output to achieve the predefined voltage limit.

As part of a further advantage, the adaptor can include at least one communication feed-through arrangement for the passage of substantially unaltered communications signals through the adaptor.

The feed-through arrangement can include capacitive coupling and/or an active control circuit.

Further, a plurality of feed-through arrangements can be provided for different regions respectively of the frequency spectrum of the communications signals.

As required therefore, the voltage level delivered to the network trunk cable can be at a level sufficient to allow for the use of longer trunk cabling than might otherwise be the case.

In one arrangement the level of the constant output voltage, or a proportion thereof, can equate to the level of the threshold voltage.

Further, the adaptor can be arranged such that substantially no voltage reduction is applied if the input voltage, or the proportion thereof, falls below the threshold value, and the output voltage is then arranged to simply follow the input voltage.

Advantageously, all required functionality can be achieved in the adaptor in a way that allows communications signals to be passed substantially unaltered between input and output or between output and input.

As further features, the adaptor can include over voltage protection circuitry, and/or thermal protection circuitry.

In one particular embodiment the adaptor is arranged such that the voltage reduction is applied by way of a voltage dropper circuitry which can comprise a voltage dropper arranged to provide a linear voltage drop.

A particularly advantageous embodiment includes the use of at least one control loop.

In another embodiment the voltage dropper can comprise a switched mode device.

According to another aspect of the invention there is provided a bus network system including a network power supply voltage adaptor as defined above.

According to a further aspect of the invention, there is provided a method of adapting a power supply voltage from a network trunk cable and including the step of, when the level of the input voltage, or a proportion thereof, is above a threshold value, applying voltage regulation to the received input voltage to provide an output dc power supply voltage at a substantially constant dc power supply level, less than that of the input voltage and independent of changes in the input voltage level above the threshold value.

As noted above in relation to the adaptor, the constant output voltage employed in the method can equate to the level of the threshold voltage.

Also, the method can be arranged such that substantially no voltage reduction is applied if the input voltage, or a proportion thereof, falls below the threshold value and the output voltage then follows the input voltage.

Further, the step of voltage reduction can be applied by way of a voltage dropper circuitry, and such voltage dropper can be arranged to provide a linear voltage drop.

Advantageously, the method includes passing communications signals, substantially unaltered, through the adaptor.

One or more communication feed-through arrangements can also be employed within the method of the invention to achieve the required voltage drop in a manner transparent to any data signalling carried by the power supply.

The method can further include passing signals from different regions in the frequency spectrum of the communications signals through different respective feed-through arrangements. Capacitive coupling and/or active control loops can be employed in this regard.

The method is particularly useful for providing output to an intrinsically safe environment.

As will be appreciated, the present invention can prove particularly advantageous in providing a method of achieving Ex ic compliance, particularly in accordance with the IEC 60079-11 Standard for intrinsic safety and the invention can find ready application in relation to complex bus network systems. The present invention can find particular application in relation to foundation fieldbus H1 or indeed other similar networks.

Further benefits can be derived from the present invention as the following discussions demonstrates, and with non-limiting reference to a foundation fieldbus implementation of the invention.

A typical foundation fieldbus segment consists of a fieldbus power supply unit arranged to supply current to a fieldbus spur wiring hub by way of a fieldbus cable that can be up to 1.9 kilometres in length. However it should be appreciated that the present invention can find ready application in relation to cable/trunk lengths in excess of such values and where such length is dependent on, or determined by, the operational characteristics/requirements of the particular network system.

In one of many possible non-limiting examples of the present invention, it can find application in situations wherein fieldbus spurs are connected to devices in an intrinsically safe hazardous area, and where it is necessary to apply current limitation and this is generally achieved by way of the wiring hub. Here also, the power supply voltage is to be limited and such limitation is usually provided by way of the fieldbus power supply unit. To allow the use of intrinsically safe devices with a Ui of 17.5V, the maximum voltage supplied is limited to 17.5V and this means that the fieldbus power supply would nominally be set to 17V or less. It is generally known that the fieldbus spur wiring hub has a minimum operating voltage in the order of 10V. Accordingly, and

allowing for a 1V tolerance, it can be concluded that the maximum permitted voltage drop along the cable from the fieldbus power supply unit to the wiring hub should be in the order of 6V. With a standard type A fieldbus cable (44 ohms/loop km), this imposes a disadvantageous limitation on trunk cable length and current; such limitations being in the order of a cable length of 358 metres for a supply current of 380mA, and a length in the order of 1km for a supply current of 136mA.

Through use of the present invention trunk cables of far greater length than this can be employed.

The invention is described further hereinafter, by way of an example only, with reference to the accompanying drawings in which:

Fig.1 is a schematic block diagram of a fieldbus arrangement according to an embodiment of the present invention;

Figs. 2 and 3 are schematic block diagrams of examples of a voltage-adjusting element of a power supply adaptor according to an embodiment of the present invention and as employed in the system illustrated with reference to Fig. 1;

Fig. 4 and 5 are schematic block diagrams of examples of a voltage-limiting element of a power supply adaptor according to an embodiment of the present invention and as employed in the system illustrated with reference to Fig. 1; and
Fig. 6 is a circuit diagram showing further details of an example of an adaptor according to an embodiment of the invention.

Turning now to Fig. 1, as illustrated, a fieldbus system 10 arranged for supplying power and signalling from a first zone 12 comprising a non-hazardous environment, to a second zone 14, comprising a hazardous environment and in an intrinsically safe manner.

The elements of the fieldbus system 10 illustrated in the first zone 12 are of a standard design and configuration and in this example comprise a bulk power supply 16 arranged

to receive mains power and to deliver a 24V DC signal to a fieldbus power supply unit 18 arranged to supply intrinsically safe isolation as required.

The fieldbus power supply unit 18 then delivers its output power supply signal by way of a fieldbus trunk 20 to network elements, such as terminal equipment, located in the second, hazardous, zone 14.

Also located in the first zone 12 in a standard manner is a distributed control system 22 also receiving mains supply and which is intended to offer isolation prior to its connection to a host H1 fieldbus card 24, in turn connected to the fieldbus trunk 20.

As is well known therefore, the fieldbus trunk 20 is arranged to supply not only the power required by the terminal equipment operating in the second zone 14, but also the control/measurement etc. signalling to be exchanged between the distributed control system 22, 24 and the terminal equipment such as field devices as discussed further below and as located within the second zone 14.

In the illustrated embodiment of the present invention of Fig. 1, the fieldbus trunk 20 is connected to a power supply adaptor 26 located in the second zone 14 which, in turn, serves to deliver power to a fieldbus spur wiring hub 28 in the form of a megablock wiring hub. In the illustrated example, the wiring hub 28 comprises a multi drop configuration providing a first 30, and a second 32 fieldbus spur connected respectively to two terminal equipment devices such as first and second fieldbus devices 34, 36 which can of course comprises any appropriate field device for receiving and or supplying control/data signalling.

While, for ease of reference, the adaptor 26 is illustrated separate from the wiring hub 28, it will of course be appreciated that the functionality of both elements 26, 28 can be provided in a integrated manner within a single network device.

As discussed further below, the adaptor 26 is arranged to provide both voltage dropping and voltage limitation with regard to the voltage it receives from the fieldbus trunk 20. The "dropped" voltage is then delivered to the wiring hub 28 and onward to the fieldbus devices 34, 36.

As will be appreciated, the functionality of the adaptor of the present invention advantageously provides for a separate control element serving to achieve compliance with appropriate network/safety standards and in a manner which places far less reliance upon the compliance exhibited by other network devices. The adaptor of the illustrated embodiment is provided in series with the trunk input of the wiring hub 28 and advantageously allows for higher currents to be provided with significantly longer trunk cable lengths by allowing use of a higher output voltage from the fieldbus power supply 18 which can be 19V or greater.

As discussed in further detail with reference to Figs. 2 and 3; and Figs 4 and 5, the illustrated embodiments of the present invention provide two main functions. The first is to drop the incoming voltage, for example to a level between 11V and 17V, and the second is to provide over-voltage protection as required by the relevant safety standards. Further, this is achieved in a way that allows communications signals to be passed substantially unaltered between input and output or between output and input. These functions are advantageously implemented with a minimum of trunk current drain. Further, the adaptor 26 can also include thermal protection circuitry arranged to turn the output off in an event of excessive temperature being detected. Such an event would normally be due to operation outside of the specified conditions.

With regard to the voltage dropping aspect of the present invention a voltage reduction circuit is provided to drop, in a linear manner, the incoming voltage from the fieldbus trunk 20 to an appropriate output voltage of, say 15V. The reduction circuit is arranged such that if the voltage drops below the regulated level, then the output voltage will simply follow the input voltage down to a minimum level of, say 10V as is required for operation of the wiring hub 28.

A particular implementation is described further below with initial reference in particular to Figs 2 and 3.

As noted above, and with initial reference to Figs. 1-3, a trunk input of a voltage dropper circuit 38 of an adaptor 26 according to an embodiment of the present invention is

arranged to be connected, via a length of trunk cable 20, to a DC power source 16, 18 that has been also been conditioned to support digital communication.

In operation, if the input voltage to the voltage dropper 38 exceeds a predetermined output voltage limit, the voltage dropper 38 serves to regulate its output by way of a series voltage-adjustment element 40 to achieve the predefined voltage limit.

The output voltage of the voltage dropper circuit 38 is monitored by a control circuit 42 and compared against a voltage reference 44. Any difference noted from this comparison is employed within a negative feed-back loop to adjust the series voltage-adjustment element 40 to achieve the required regulated DC output via element 42B of the control circuit 42.

If the applied input voltage is too low to achieve such regulation, the output voltage of the voltage dropper 38 tracks the input voltage at a level marginally below the trunk input voltage. The control circuit 42 also includes an element 42A arranged to allow digital communication signals to pass from input to output, or from output to input as required, with negligible modification to the wave shape or amplitude.

Fig. 2 illustrates the series voltage adjustment element 40 in the positive voltage path of the voltage dropper 38, whereas Fig. 3 shows an alternative configuration with the same elements 38, 40, 42 and 44 but with the series voltage-adjustment element 40 in the negative voltage path of the voltage dropper circuit 38.

In some applications, it will be necessary to limit the trunk voltage applied to devices connected downstream and in a particular embodiment of the present invention, it is intended that the output of the voltage dropper 38 feeds directly into the input of a voltage limiter circuit.

Turning now to Figs. 4 and 5, there is provided a schematic illustration of such a voltage limiter 46 of an adaptor 26 according to an embodiment of the present invention.

When used in conjunction with the voltage dropper circuit 38, the voltage limit of the voltage limiter circuit 46 is arranged to be set sufficiently above that of the voltage

dropper output to avoid any significant modification to the wave shape or amplitude of the digital communications signals passing through the adaptor 26.

The input voltage of the voltage limiter circuit 46 received from the voltage dropper 38 such as that of Figs. 2 and 3, is monitored by a trunk-voltage comparator 48 and compared against a reference voltage 50. If it is determined that the output voltage equals or exceeds, the predefined limit voltage, the comparator 48 serves to drive a series switch 52 to assume a high-impedance mode by preventing a supply of current being available at the output of the voltage limiter 46 and thus the adaptor 26.

Fig. 4 shows a series switch 52 in the positive voltage path of the voltage limiter circuit 46, and Fig. 5 shows an alternative configuration with the series voltage switch 52 in the negative voltage part of the voltage limiter circuit 46.

It should be appreciated that the voltage reduction circuit can also be implemented by way of non-linear arrangement, such as a switch mode circuit. This would exhibit the advantage of reducing power dissipation and so allowing for a greater voltage drop within the device and thus the use of longer cable lengths.

Advantageously, the output voltage is regulated by means of one or more control loops which ensure that fieldbus communications signals from/to the fieldbus devices remain substantially, i.e. effectively unaffected on their passage in either direction through the adaptor. Such control loops can be provided to ensure that the communication signals on the incoming trunk 20 appear unaltered on the output of the adaptor 26 to the field wiring hub 28, and similarly, that the communication signals on the wiring hub 28 appear via the adaptor 26 on the fieldbus trunk 20 in a transparent manner.

Turning now to Fig. 6, there is provided a circuit diagram of one example of an adaptor 26 according to an embodiment of the present invention.

The adaptor 26 is arranged to receive an input voltage V IN from a trunk cable such as the trunk cable 20 of Fig. 1, and to supply an output voltage V OUT for onward delivery to, for example, the wiring hub 28 of Fig.1.

The adaptor 26 comprises circuit elements such as those discussed in relation to Fig. 2 and Fig. 3; and Fig. 4 and Fig. 5, and including a voltage dropper section A with integrated feature of communication signal pass-through between input and output, or between output and input, sides of the voltage dropper section A, and an overvoltage switch section B.

Referring first to the voltage dropper section A, there is provided series voltage adjustment element 54, in this example provided in the positive voltage path of the voltage dropper 26, and comprising a P-channel FET arranged to pass the incoming voltage, when less than 15V, directly to the output of the adaptor 26 via the overvoltage switch section B, or to limit the output voltage to a nominal 15V when the incoming voltage is above that level. An enhanced frequency response for the voltage dropper section A is provided by a capacitance 55 in parallel with the P-channel FET 54 and serving to facilitate the passage of substantially undistorted communication signals between input and output or between output and input. Accurate signal replication is achieved for higher frequencies of the communication signal by the capacitive coupling provided by the capacitance 55. For lower frequencies of the communication signal, an active control loop can be provided to achieve the required accurate signal passage through the adaptor. It will also be appreciated that the required accurate signal replication could be achieved by active control for the full communication signal bandwidth, or by capacitive coupling for the full communication signal bandwidth.

From Fig. 3, it will also be appreciated that this functionality can be provided on the low power rail and, of course, such functionality could be provided by any appropriate one or more semi-conductor components.

The actual voltage control is achieved by way of a voltage control circuit 56, 58 comprising a dual-operation amplifier arrangement configured such that the output voltage is regulated to a maximum of 15V and communication signalling is copied, substantially unaltered, from the input to output, or from output to input, of the adaptor 26 as required.

Again, such functionality could also be performed by way of discrete semiconductor components. An operational amplifier 56 provides for a communication signal AC

control loop, whereas the operational amplifier 58 in conjunction with the operational amplifier 56, provides for a slower DC control loop. Further, a transistor 60 is provided as a level-shifter within the DC control loop of the operational amplifier 58 and diode component 62 serves to provide for a reference voltage to allow the output voltage to be controlled to a nominal 15V. A low-constant current source 64 is also provided to supply the voltage reference diode 62 such that the reference voltage is unaffected by the communication signalling and the trunk-load current drawn by the adaptor 26 is then suitably stable. A zener diode 66 with resistor 68 provide for a version of the output with a negative offset voltage to ensure operational amplifier 56 has a practical operating point.

Turning now to the overvoltage switch element B, in this illustrated example, this includes a shunt voltage regulator device 70 employed to monitor the output voltage and, in the event of the output voltage exceeding a specified maximum, for example 17.5V, the output voltage is removed. While a shunt-voltage regulatory integrated circuit is employed as an example, the same functionality could of course be provided using discrete semiconductors and/or other integrated circuit devices.

An N-channel FET 72 comprises a control element which serves to disconnect the output in the event of identification of an overvoltage condition but again, this functionality can also be provided in the high side power rail (V IN).

Of course, a variety of alternatives readily exist and one alternative protection method comprises the inclusion of an output voltage clamp using either silicone control rectifier or an alternative semiconductor solution.

It should of course be appreciated that the invention is not restricted to the details of the illustrated embodiment.

That is, the invention can be applied in relation to any appropriate complex bus network system and in particular those seeking readily compliant control of network power supply signals that are also sensitive to the data being carried on the network.

The adaptor can therefore be employed in relation to any appropriate hub or device coupler and in relation to any appropriate configuration of single drop, or otherwise, fieldbus devices. Also, the invention is not restricted in any way to the details implied from the particular power supply and Distributed Control System of the illustrated embodiments.

Claims

1. A network power-supply voltage adaptor arranged to receive an input voltage from a network trunk cable and to present an internal voltage derived from the said input voltage, the adaptor being arranged, when at least one of the input voltage or a proportion thereof, or the said internal voltage, is above a reference voltage, to regulate the received input voltage to provide an adaptor output dc power supply voltage at a substantially constant dc power supply level less than that of the input voltage, and independent of changes in the input voltage level, and the adaptor further comprising at least one communication feed-through arrangement for the passage of substantially unaltered communications signals through the adaptor.

2. An adaptor as claimed in Claim 1, wherein the feed-through arrangement includes capacitive coupling.

3. An adaptor as claimed in Claim 1, wherein the feed-through arrangement includes an active control circuit.

4. An adaptor as claimed in Claim 1, 2 or 3, and including a plurality of feed-through arrangements provided for respective regions of the frequency spectrum of the communications signals.

5. An adaptor as claimed in Claim 4, and including capacitive coupling for frequencies of the communication signals at the higher end of the frequency spectrum.

6. An adaptor as claimed in Claim 4 or 5, and including an active control loop for frequencies of the communications signals at the lower end of the frequency spectrum.

7. An adaptor as claimed in any one or more of the preceding claims, wherein the said internal voltage comprises the adaptor output voltage or a proportion thereof.

8. An adaptor as claimed in any one or more of the preceding claims, wherein the level of the constant output voltage or a proportion thereof is equal to the reference voltage level.

9. An adaptor as claimed in any one or more of the preceding claims, and arranged such that no voltage reduction is applied if voltage compared with the reference voltage falls below the reference voltage, and such that the output voltage then follows the input voltage.

10. An adaptor as claimed in any one or more of the preceding claims, and including overvoltage protection circuitry.

11. An adaptor as claimed in Claim 10, wherein the overvoltage protection circuitry includes a voltage limiter circuit connected at an output of the adaptor.

12. An adaptor as claimed in Claim 10 or 11, wherein the overvoltage protection circuitry includes means for comparing a voltage input thereto with a second reference voltage.

13. An adaptor as claimed in Claim 12, and including switch means provided at the output of the overvoltage protection circuitry and arranged to operate responsive to the result of the said comparison with the said second reference voltage.

14. An adaptor as claimed in any one or more of the preceding claims and including thermal protection circuitry.

15. An adaptor as claimed in any one or more of the preceding claims, and arranged such that the voltage reduction is applied by way of a voltage dropper circuitry.

16. An adaptor as claimed in Claim 15, wherein the voltage dropper is arranged to provide a linear voltage drop.

17. An adaptor as claimed in Claim 15, wherein the voltage dropper comprises a switch mode device.

18. An adaptor as claimed in any one or more of Claims 15 to 17, wherein the said internal voltage comprises an output voltage of the voltage dropper circuit.

19. An adaptor as claimed in any one or more of Claims 15 to 18, wherein the voltage dropper circuitry is arranged to be controlled by negative feedback derived from comparison with the said reference voltage.

20. An adaptor as claimed in any one or more of Claims 15 to 19, wherein the voltage dropper circuit includes a series voltage adjustment element.

21. An adaptor as claimed in any one or more of the preceding claims and arranged to provide an output to an intrinsically safe environment.

22. An adaptor as claimed in any one or more of the preceding claims and arranged to receive a voltage from a network trunk cable comprising a field bus trunk cable.

23. An adaptor as claimed in any one or more of the preceding claims, and arranged to provide an output to a spur wiring hub.

24. An adaptor as claimed in any one or more of the preceding claims and formed integrally with the spur wiring hub.

25. A bus network system including a trunk cable and a network power supply voltage adaptor as claimed in any one or more of the preceding claims.

26. A method of adapting a power supply voltage received from a network trunk cable, including the step of deriving an internal voltage from the said input voltage and when at least one of the input voltage, or a proportion thereof, or the said internal voltage is above a reference voltage, applying voltage regulation to the received input voltage to provide an output dc power supply voltage at a substantially constant dc power supply level, less than that of the input voltage, and independent of changes in the input voltage level, and passing substantially unaltered communications signals through the adaptor.

27. A method as claimed in Claim 26, wherein the said internal voltage comprises the output dc power supply voltage or a proportion thereof.

28. A method as claimed in Claim 26 or 27, and including the step of passing the communications signal through at least one feed-through arrangement.

29. A method as claimed in Claim 28, and including the step of passing higher frequencies of the communications signal, and lower frequencies of the communications signal, through respective first and second feed-through arrangements.

30. A method as claimed in Claim 29, and including passing the said higher frequencies by capacitive coupling.

31. A method as claimed in Claim 29 or 30, and including passing the said lower frequencies through an active control loop.

32. A method as claimed in any one or more of Claims 26 to 31 wherein the level of the constant output voltage or proportion thereof is equal to the reference voltage value.

33. A method as claimed in any one or more of Claims 26 to 32, wherein the output voltage follows the voltage produced by the input voltage if the voltage produced by the input voltage or proportion thereof falls below the reference voltage value.

34. A method as claimed in any one or more of Claims 26 to 33, and including the step of comparing a voltage input to a voltage limiter with a second reference voltage.

35. A method as claimed in Claim 34, including the step of controlling a switch provided in an output of the voltage limiter and responsive to the result of the said comparison with the second reference voltage.

36. A method as claimed in any one or more of Claims 26 to 35, and applying the voltage reduction by way of voltage dropper circuitry.

37. A method as claimed in Claim 36, wherein the voltage produced by the input voltage for comparison with the reference voltage comprises an output of the voltage dropper circuitry.

38. A method as claimed in Claim 36 or 37, and including the step of controlling the voltage dropper circuitry by negative feedback derived from the voltage comparison with the reference voltage.

39. A method as claimed in any one or more of Claims 26 to 38, and providing a linear voltage drop.

40. A method as claimed in any one or more of Claims 26 to 38, and providing a voltage drop by way of a switch mode device.

41. A method as claimed in any one or more of Claims 26 to 40 and including the step of providing an output to an intrinsically safe environment.

42. A method as claimed in any one or more of Claims 26 to 41, and including the step of receiving a voltage from a field bus trunk cable.

43. A method as claimed in any one or more of Claims 26 to 42, and including the step of providing an output to a spur wiring hub.

44. A network power supply voltage adaptor substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawings.

45. A bus network system substantially as hereinafter described with reference to, and as illustrated in, the accompanying drawings.

46. A method of adapting a power supply voltage from a network trunk cable substantially as hereinafter described with reference to the accompanying drawings.

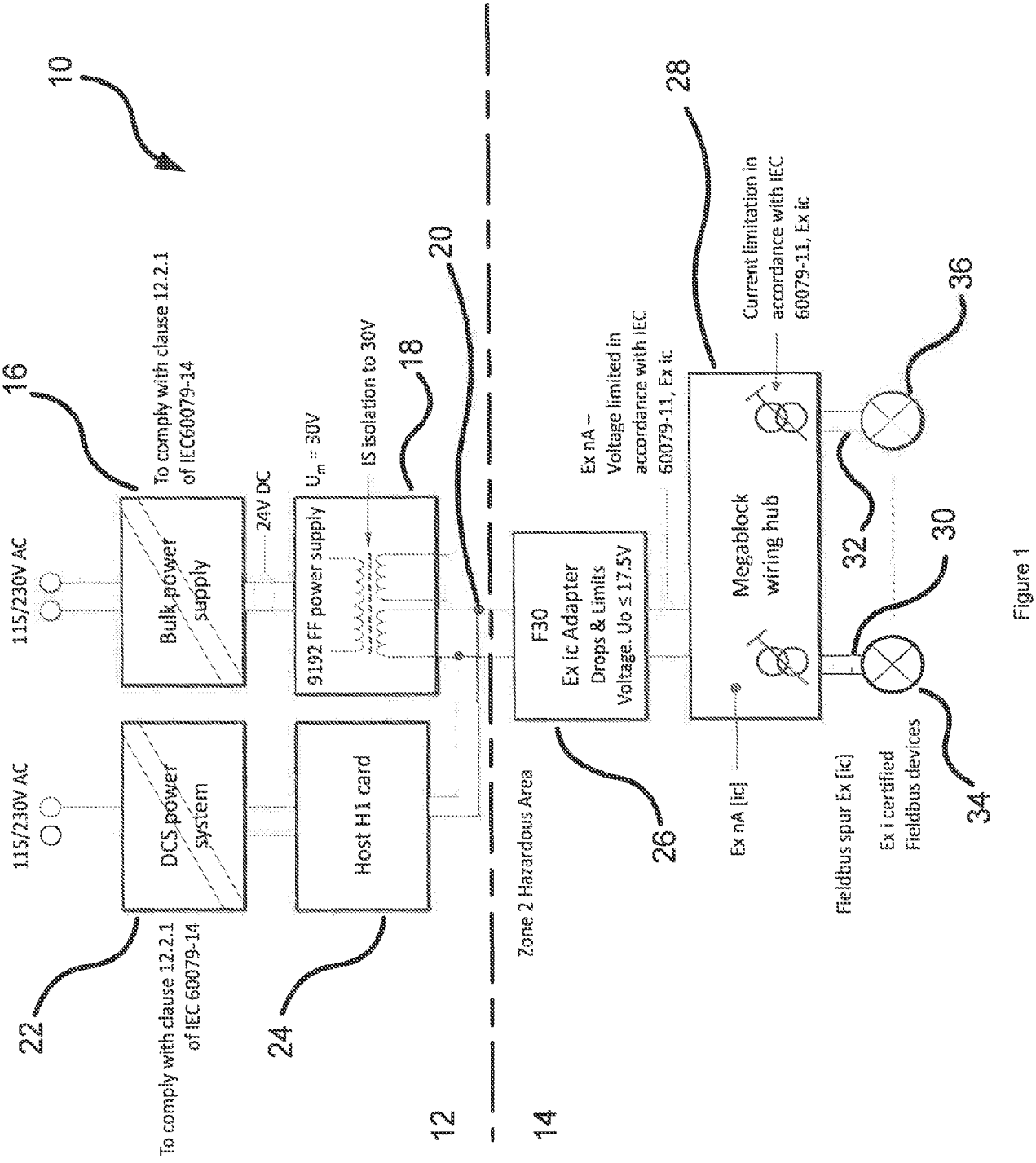

10
16
115/230V AC
Bulk power supply
To comply with clause 12.2.1 of IEC60079-14
24V DC
9192 FF power supply
U_m = 30V
IS isolation to 30V
18
20
115/230V AC
DCS power system
To comply with clause 12.2.1 of IEC 60079-14
22
Host H1 card
24
12
14
Zone 2 Hazardous Area
F30
Ex ic Adapter
Drops & Limits
Voltage. Uo ≤ 17.5V
Ex nA –
Voltage limited in accordance with IEC
60079-11, Ex ic
26
28
Megablock wiring hub
Current limitation in accordance with IEC 60079-11, Ex ic
Ex nA [ic]
Fieldbus spur Ex [ic]
Ex i certified Fieldbus devices
32
30
34
36

Figure 1

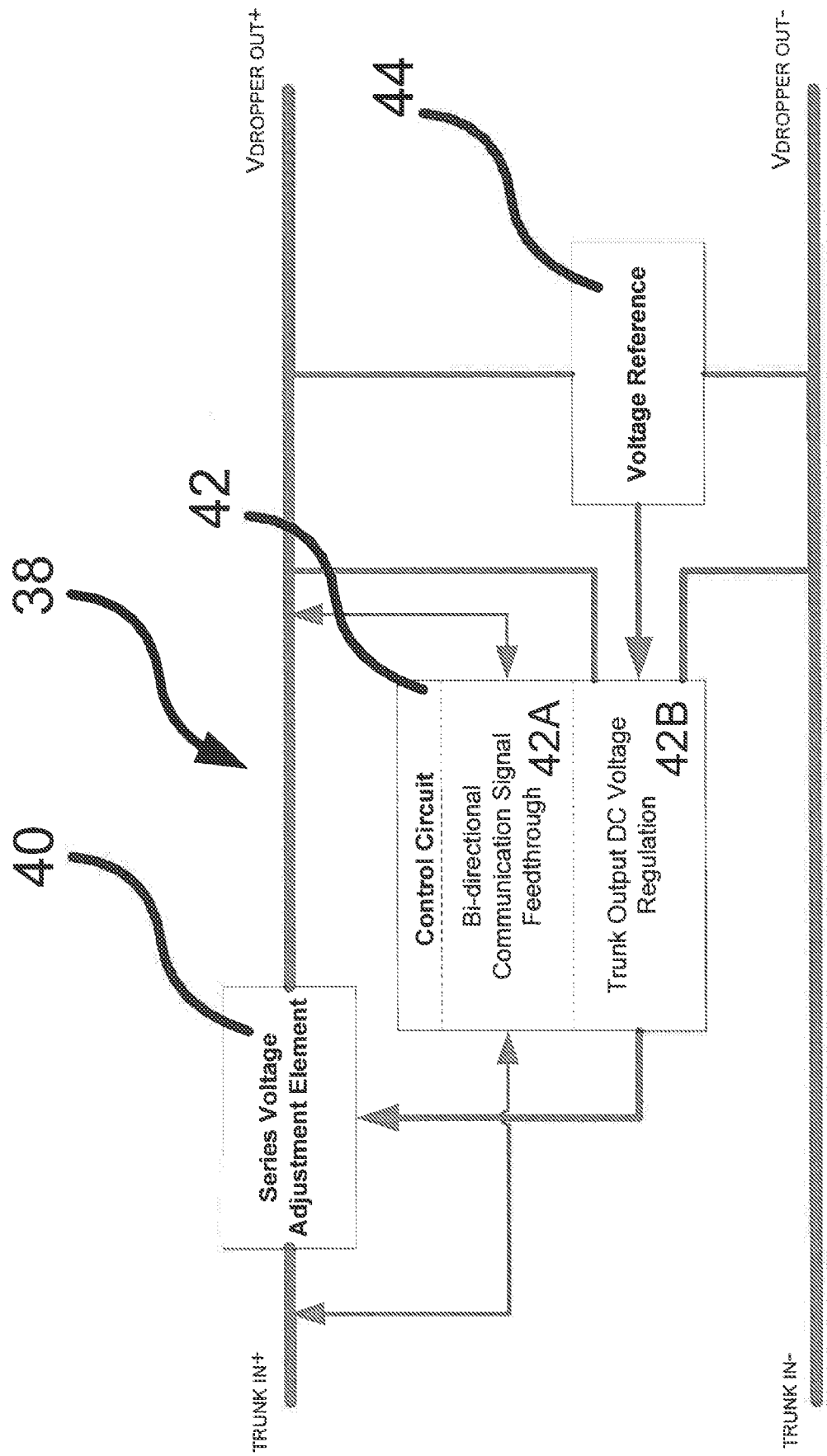

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Voltage Reference
Control Circuit
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42B
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TRUNK IN+
TRUNK IN-

Figure 2

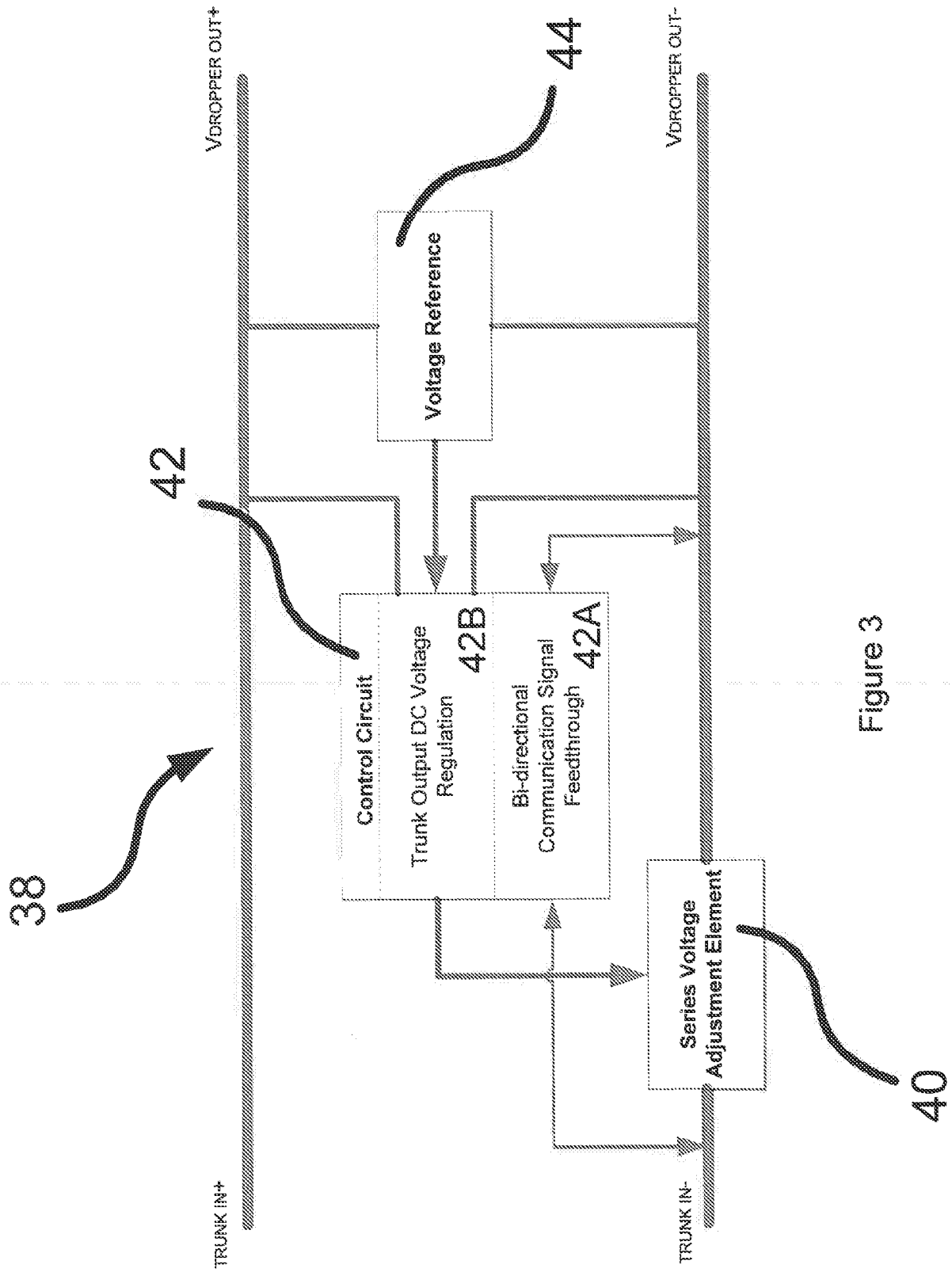

38
42
44
40
VDROPPER OUT+
VDROPPER OUT-
TRUNK IN+
TRUNK IN-
Voltage Reference
Control Circuit
Trunk Output DC Voltage Regulation
42B
Bi-directional Communication Signal Feedthrough
42A
Series Voltage Adjustment Element

Figure 3

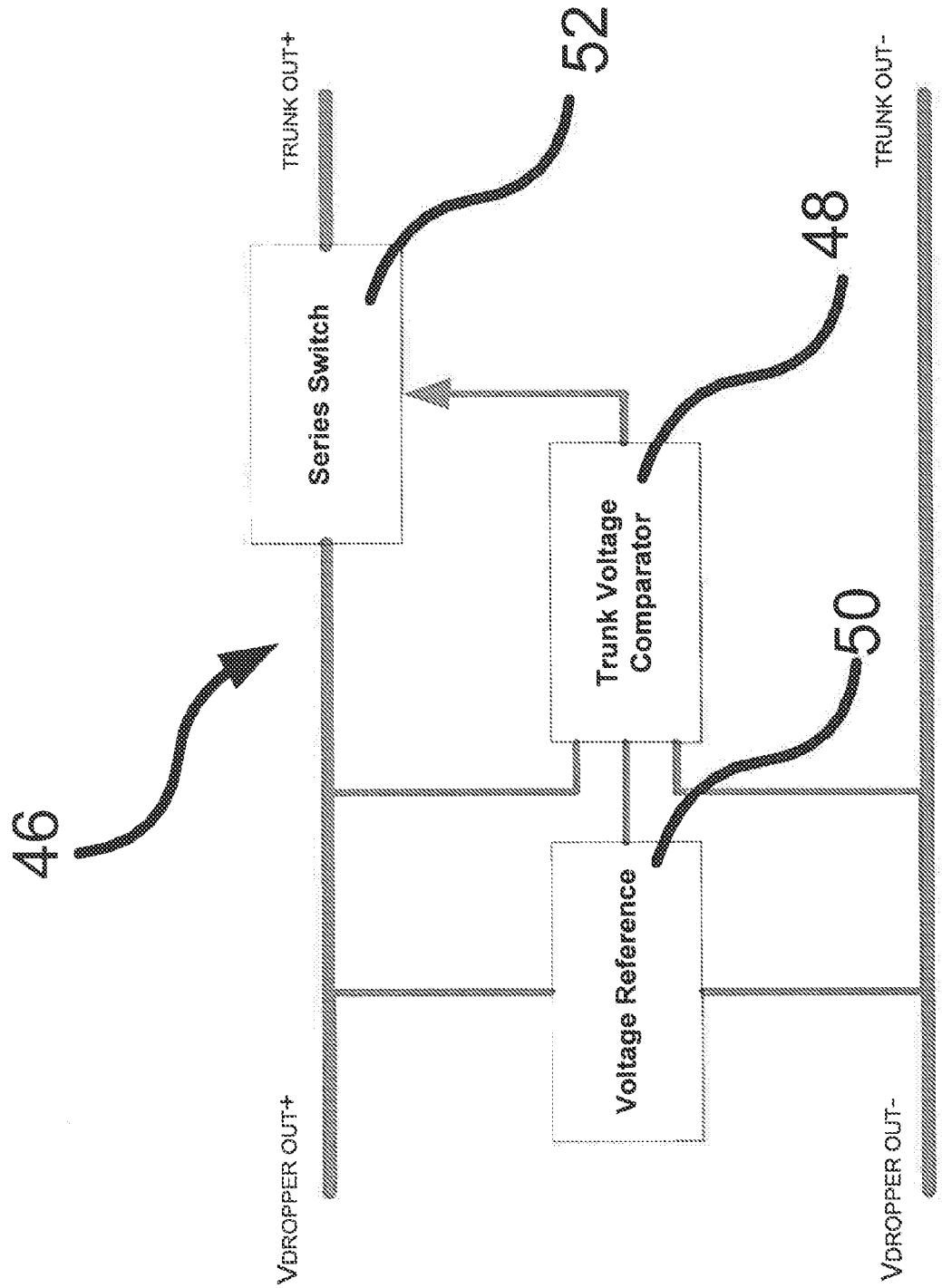

46
52
48
50
TRUNK OUT+
TRUNK OUT-
Series Switch
Trunk Voltage Comparator
Voltage Reference
VDROPPER OUT+
VDROPPER OUT-

Figure 4

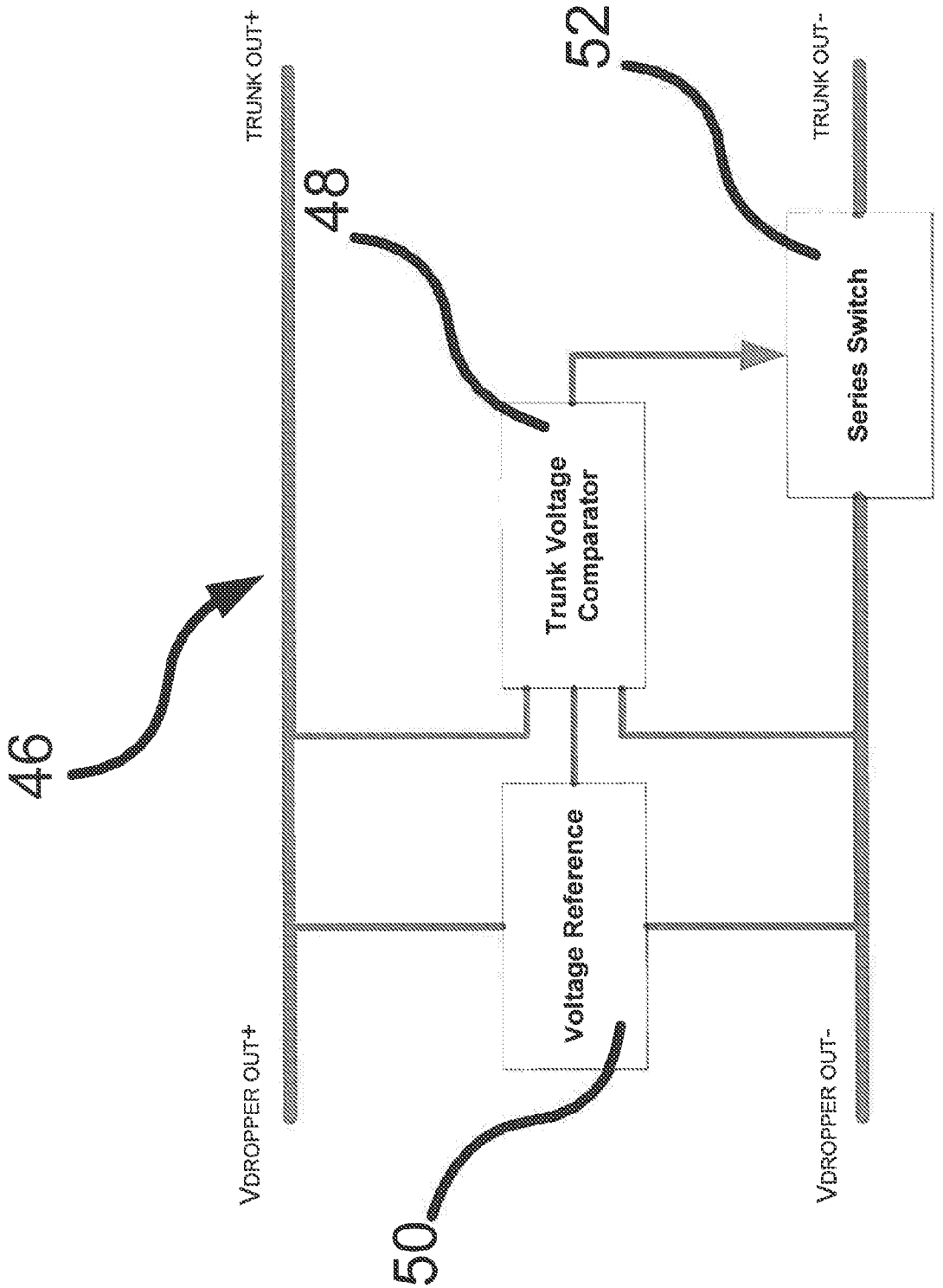

46
TRUNK OUT+
48
52
TRUNK OUT-
Trunk Voltage Comparator
Series Switch
Voltage Reference
50
VDROPPER OUT+
VDROPPER OUT-

Figure 5

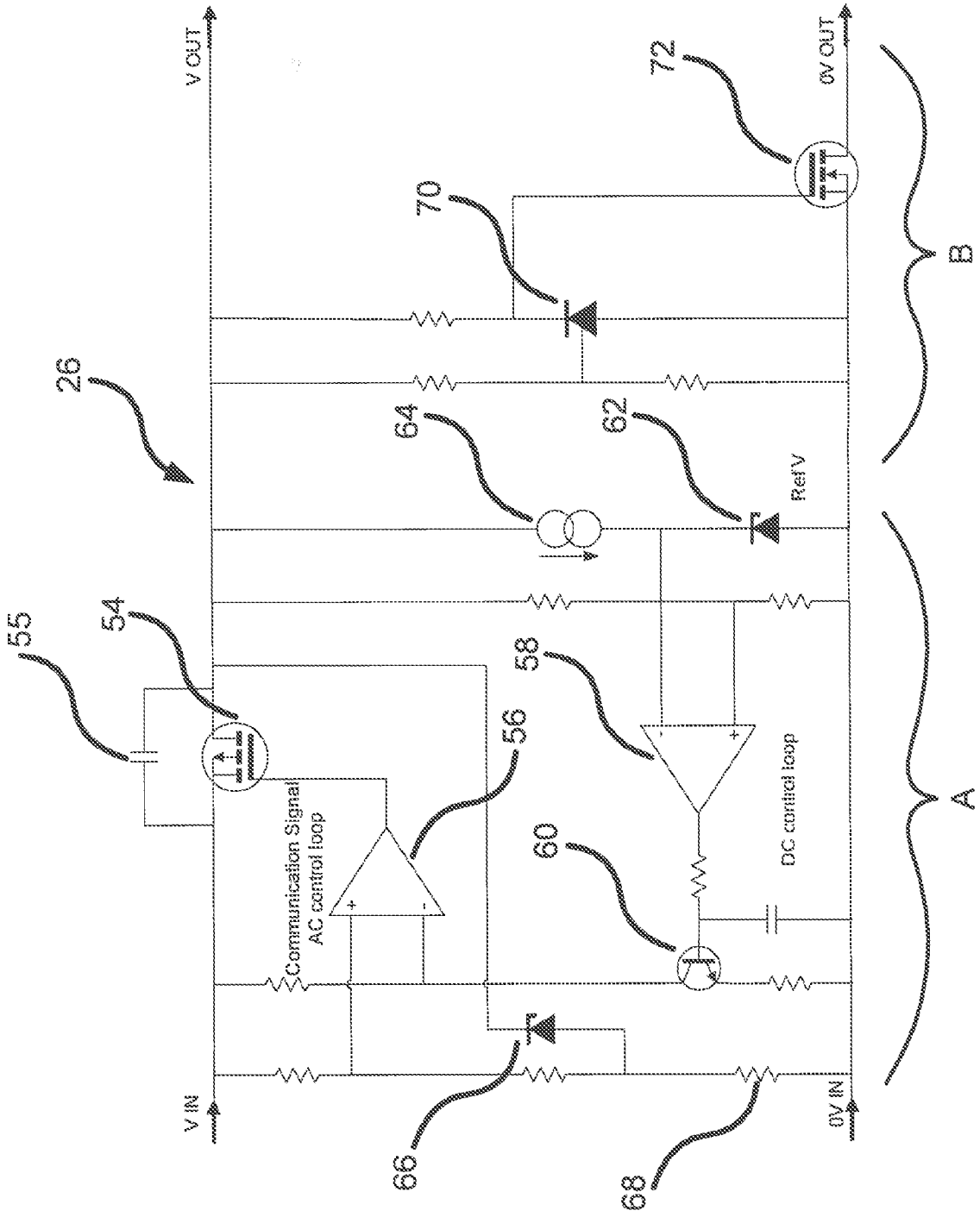

V OUT
0V OUT
72
70
26
64
62
Ref V
B
55
54
58
56
Communication Signal
AC control loop
DC control loop
60
A
V IN
0V IN
66
68

Figure 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2014/052645

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04B3/54 H04B3/56 H04L12/10 H04L12/40
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04B H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2011/085703 A1 (GIERSIEPEN GIRA GMBH [DE]; TAPKO TECHNOLOGIES GMBH [DE]; TOMIC PETAR []) 21 July 2011 (2011-07-21) figures 3,4,5,6 page 1, line 1 - line 3 page 7, line 1 - line 24 page 3, line 17 - line 27	1-46
X	WO 2007/003254 A1 (VIMAR SPA [IT]; GUSI PIERO CAMILLO [IT]) 11 January 2007 (2007-01-11) figure 5 page 6, line 25 - page 8, line 18	1-46
A	EP 0 854 587 A1 (SIEMENS AG [DE]) 22 July 1998 (1998-07-22) figure 1 column 2, line 45 - column 4, line 39	1-46

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"E" earlier application or patent but published on or after the international filing date

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 January 2015	20/01/2015

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Nold, Michael

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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