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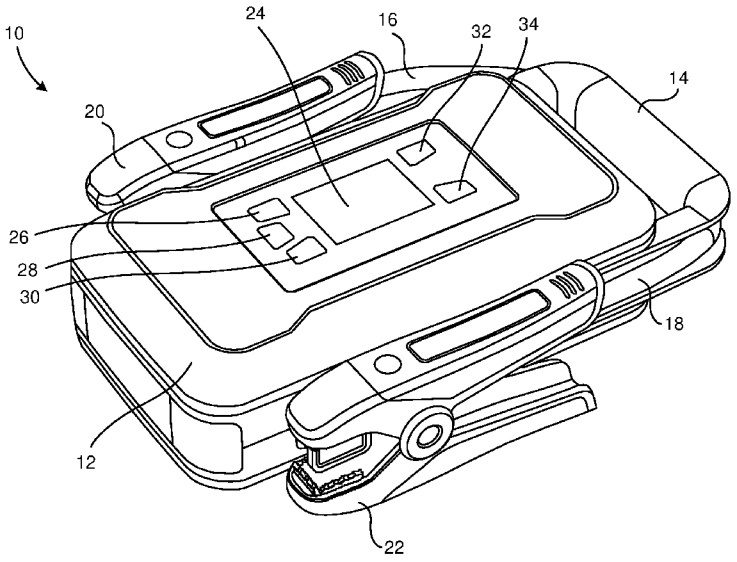

FIGURE 1

(57) Abstract: An apparatus for jump starting vehicle having a battery, the battery having positive and negative battery terminals, including: a rechargeable internal power-supply; battery clamps respectively having positive and negative polarities; one or more contactors connected between internal power-supply and battery clamps; a vehicle battery sensor connected to the battery clamps, and configured to detect both presence and polarity of vehicle battery connected to the battery clamps; and a microcontroller configured to receive an output signal from the vehicle battery sensor, and to provide output signal to selectively close one or more contactors, wherein the vehicle battery sensor is configured to: sense voltage range between the battery clamps including voltages indicative of, an absence of the vehicle battery connected to the battery clamps, and polarity of the vehicle battery connected to the battery clamps; and convert sensed voltage range into corresponding voltage range able to be read by the microcontroller.

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VEHICLE BATTERY JUMP STARTER

Field

The present invention relates generally to apparatus for jump-starting a vehicle having a depleted or faulty (open circuit) starter battery.

Background

The following discussion of the background to the invention is intended to facilitate an understanding of the invention. However, it should be appreciated that the discussion is not an acknowledgement or admission that any of the material referred to was published, known or part of the common general knowledge in Australia or any other country as at the priority date of any one of the claims of this specification.

The automobile industry is replete with devices used for jump starting a vehicle when the battery of the vehicle has insufficient charge to accomplish this task. The simplest means by which to jump start a vehicle with a dead battery is to connect a pair of jump starter cables or jump leads between a fully charged battery of another vehicle to the engine circuit of the vehicle with the dead battery. However, this solution is only possible in situations where other vehicles are in the vicinity.

To address this problem, portable booster devices comprising an internal battery were devised. These portable booster devices can be connected to the vehicle's engine starter via a pair of jump leads and battery terminal clamps to jump start the vehicle.

Problems such existing portable booster devices arise when either the jumper terminals or clamps of the cables are inadvertently brought into contact with each other while the other ends were connected to a charged battery, and when the positive and negative terminals are connected to the opposite polarity terminals in the vehicle to be jumped, thereby causing a short circuit resulting in sparking and potential damage to batteries and/or bodily injury.

Moreover, in existing portable booster devices it is possible for the battery to be charged to a gassing state by faulty vehicle alternator.

It would therefore be desirable to provide an apparatus for jump starting a vehicle having a battery, which will overcome or substantially ameliorate at

least some of the deficiencies of the prior art, or to at least provide an alternative.

Summary

A first aspect of the present invention provides an apparatus for jump starting a vehicle having a battery, the battery having positive and negative battery terminals, including:

a rechargeable internal power supply;

battery clamps respectively having positive and negative polarities;

one or more contactors connected between the internal power supply and the battery clamps;

a vehicle battery sensor connected to the battery clamps, and configured to detect both the presence and polarity of a vehicle battery connected to the battery clamps; and

a microcontroller configured to receive an output signal from the vehicle battery sensor, and to provide an output signal to selectively close the one or more contactors,

wherein the vehicle battery sensor is configured to:

a) sense a voltage range between the battery clamps including voltages indicative of,

an absence of the vehicle battery connected to the battery clamps; and

the polarity of the vehicle battery connected to the battery clamps; and

b) convert the sensed voltage range into a corresponding voltage range able to be read by the microcontroller.

The vehicle battery sensor may be further configured, at step (a), to sense a short circuit between the battery clamps.

The vehicle battery sensor may be configured to sense a short circuit between the battery clamps by:

sensing a voltage range between the battery clamps including voltages indicative of a potential short circuit;

applying a voltage pulse to the battery clamps; and

if the sensed voltage between the clamps is close to zero, activating a short circuit protection circuit to protect against short circuiting.

The vehicle battery sensor may be configured to separately sense voltages indicative of a positive polarity and a negative polarity connection of the vehicle battery connected to the battery clamps.

In one or more embodiments, the microcontroller is further configured to selectively close the one or more contactors to connect the internal power supply to the battery clamps in response to a signal from the vehicle battery sensor indicating to the microcontroller that a vehicle battery is connected to the battery clamps with a proper polarity.

The microcontroller may be further configured to selectively close the one or more contactors automatically.

The vehicle battery sensor may act to convert a first range of clamp voltages including both positive and negative voltages to a second range of voltages able to be read by the microcontroller. In one or more embodiments, the conversion is linear.

In practice, the first range of voltages may be from +40V to -30V, and the second range of voltages is from 0V to +3.0V.

A second aspect of the present invention provides a method for sensing an operative state of an apparatus for jump starting a vehicle having a battery, the battery having positive and negative battery terminals, including a rechargeable internal power supply; battery clamps respectively having positive and negative polarities; one or more contactors connected between the internal power supply and the battery clamps; a vehicle battery sensor connected to the battery clamps, and configured to detect both the presence and polarity of a vehicle battery connected to the battery clamps; and a microcontroller

configured to receive an output signal from the vehicle battery sensor, and to provide an output signal to selectively close the one or more contactors,
the method including the steps of:
at the vehicle battery sensor,

a) sensing a voltage range between the battery clamps including voltages indicative of:
    an absence of the vehicle battery connected to the battery clamps; and
    the polarity of the vehicle battery connected to the battery clamps; and
b) converting the sensed voltage range into a corresponding voltage range able to be read by the microcontroller.

The method may further include, at the vehicle battery sensor, at step (a), sensing a short circuit between the battery clamps.

The method may further include, at the vehicle battery sensor, separately sensing voltages indicative of a positive polarity and a negative polarity connection of the vehicle battery connected to the battery clamps.

A third aspect of the present invention provides a method of operating of an apparatus for jump starting a vehicle having a battery, the battery having positive and negative battery terminals, including a rechargeable internal power supply; battery clamps respectively having positive and negative polarities; one or more contactors connected between the internal power supply and the battery clamps; a vehicle battery sensor connected to the battery clamps, and configured to detect both the presence and polarity of a vehicle battery connected to the battery clamps; and a microcontroller configured to receive an output signal from the vehicle battery sensor, and to provide an output signal to selectively close the one or more contactors,
the method including the steps of:
at the vehicle battery sensor:
    sensing a voltage range between the battery clamps including voltages indicative of;

an absence of the vehicle battery connected to the battery clamps; and

the polarity of the vehicle battery connected to the battery clamps; and

converting the sensed voltage range into a corresponding voltage range,

sensing a short circuit between the battery clamps by,

sensing a voltage range between the battery clamps including voltages indicative of a potential short circuit,

applying a voltage pulse to the battery clamps, and

if the sensed voltage between the clamps is close to zero, activating a short circuit protection circuit to protect against short circuiting.

The method may further include:

at the microcontroller, selectively closing the one or more contactors to connect the internal power supply to the battery clamps in response to a signal from the vehicle battery sensor indicating to the microcontroller that a vehicle battery is connected to the battery clamps with a proper polarity.

The method may further include:

at the microcontroller, selectively closing the one or more contactors automatically.

Brief Description of the Drawings

The invention will now be described in further detail by reference to the accompanying drawings. It is to be understood that the particularity of the drawings does not supersede the generality of the preceding description of the invention.

Figure 1 is a perspective view of one embodiment of an apparatus for jump-starting a vehicle according to the invention;

Figure 2 is a functional block diagram of electronic and electrical components forming part of the apparatus for jump-starting a vehicle shown in Figure 1;

Figure 3 is a circuit diagram of a first embodiment of vehicle battery sensor forming part of the electronic and electrical components shown in Figure

2, the vehicle battery sensor being configured to detect both the presence/absence of a vehicle battery and positive or negative polarity connection between the battery terminal clamps and positive and negative battery terminals of the vehicle battery;

Figures 4 is a state diagram chart showing operation of the electronic and electrical components shown in Figure 2 to detect active the battery jump-starting apparatus and detect the application of clamps to the battery terminals;

Figure 5 is a flow chart depicting operations taken by the vehicle battery sensor of Figure 3 and a Master Control Unit forming part of the electronic and electrical components shown in Figure 2 to detect both the presence/absence of a vehicle battery and positive or negative polarity connection between the battery terminal clamps and positive and negative battery terminals of the vehicle battery;

Figure 6 is a state diagram chart showing operation of the electronic and electrical components shown in Figure 2, when including the first embodiment of vehicle battery sensor shown in Figure 3, to automatically engage the battery jump-starting apparatus, and under what conditions automatic engagement occurs;

Figure 7 shows a circuit diagram of a second embodiment of vehicle battery sensor forming part of the electronic and electrical components shown in Figure 2;

Figure 8 is a state diagram chart showing operation of the electronic and electrical components shown in Figure 2, when including the second embodiment of vehicle battery sensor shown in Figure 7, according to a first mode of operation; and

Figure 9 is a state diagram chart showing operation of the electronic and electrical components shown in Figure 2, when including the second embodiment of vehicle battery sensor shown in Figure 7, according to a second mode of operation.

Detailed Description

The present invention is predicated on the finding of an apparatus for use in jump starting a vehicle, in which the apparatus comprises a rechargeable power supply consisting of a plurality of rechargeable lithium-based cells. Each

of the cells can accept a high charge current, which means that the rechargeable power supply can be fully recharged by an alternator of the vehicle in a matter of mere minutes.

Referring firstly to Figure 1, there is shown generally a perspective view of a portable apparatus 10 for use in jump starting a vehicle (not shown) according to a preferred embodiment of the present invention.

The apparatus 10 includes a housing 12, a handle 14, positive and negative jumper leads 16 and 18, battery terminal clamps 20 and 22, electrically connected respectively to the ends of jumper leads 16 and 18. The housing 12 includes a display panel 24 and user-operable buttons 26 to 34 to facilitate user control of the apparatus 10.

It should be appreciated that Figure 1 merely depicts one possible embodiment of an apparatus for jump-starting a vehicle according to the invention, and that many variations are possible.

For example, the display panel 24 could be replaced or supplemented with audible user alerts, and the user-operable buttons 26 to 34 could be replaced by a single multi-function button, dial or other user operable device. Alternatively, the apparatus could be controlled by a mobile phone app connected via Bluetooth or similar connection, and all control and alert/display functions could take place on the mobile phone.

Similarly, whilst the positive and negative jumper leads 16 and 18 are shown as being fixed in Figure 1, they could easily be removable leads in other embodiments.

Figure 2 is a functional block diagram of electronic and electrical components forming part of the apparatus 10. The apparatus 10 includes a rechargeable power supplies 50 and 52 having positive and negative terminals, cell voltage sensing and balancing circuits 54 and 56, a DC-DC regulator 58, a charging circuit 60, short circuit detection circuit 62, contactors S1 to S4, battery terminal clamps 64 and 66, a master control unit (MCU) 68, keypad and backlight 70 - including buttons 26 to 34 – and the display 24, as well as a vehicle battery sensor 72. The battery terminal clamps 64 and 66 can be connected to positive and negative terminals of a vehicle starter battery 74, which is connected in parallel with an alternator 76.

The MCU 68 receives various inputs and produces data as well as control outputs, as depicted in Figure 2 and described herein. The MCU 68 is programmable, and in one embodiment comprises a 32-bit microcontroller with 128K x 8 bits of flash memory. Microcontrollers are well known, and other configurations will be able to be envisaged.

The rechargeable power supplies 50 and 52 comprises one or more lithium-based rechargeable cells connected in series. The size of cells is largely determined by cranking current required to jump start a vehicle.

In the preferred form, rechargeable power supplies 50 and 52 comprises four lithium-iron phosphate (LiFePO4) cells connected in series.

LiCoO2 cells can provide higher current than LiFePO4 for the same size of battery, however LiFePO4 is safer. If 4 cells are connected in series it matches the 12V vehicle alternator voltage. As a result, it can be recharged by alternator.

LiFePO4 cells also offer longer lifetimes and have a constant discharge voltage that stays close to the nominal output voltage (3.2V) associated with the cell during discharge until the cell is exhausted. This allows lithium-iron phosphate cells to deliver virtually full power until they are discharged.

A variety of lithium-iron phosphate cell are commercially available including but not limited to LiFePO4, LiFeMgPO4 and LiFeYPO4 based cells.

The rechargeable power supplies 50 and 52 are respectively connected to cell voltage sensing and balancing circuits 54 and 56. The cell voltage sensing and balancing circuits sense and balance the cell voltages across the lithium-based rechargeable cells (not shown) forming each rechargeable power supply.

Once the cell voltage for each of the rechargeable cells has been determined, the difference in cell voltage between rechargeable cells is then compared to identify the cell with the minimum voltage (Vmin) and the cell with the maximum voltage (Vmax) The (Vmin) and (Vmax) values are then used to balance the overall cell voltage across the four cells. By virtue of this arrangement, it is possible to selectively discharge a cell if the cell voltage of that cell is greater or less than a predetermined voltage threshold.

A more detailed disclosure the voltage sensing and balancing circuits is provided in International Patent Application No. WO 2018/064713, in the name

of the present Applicant, the entire contents of which is hereby incorporated into the present Application.

The contactors S1 to S4 configured to selectively connect either of the rechargeable power supplies 50 and 52, or both rechargeable power supplies 50 and 52 in series, to the battery terminal clamps 64 and 66. In the example depicted in Figure 2, contactors S1, S2 and S4 are closed by the MCU 68 when +12V are intended to be supplied to the vehicle starter battery 74 / alternator 76, whereas contactors S2 and S3 are closed by the MCU 68 when +24V is intended to be supplied to the vehicle starter battery 74 / alternator 76.

When the MCU 68 detects that the charging voltage is present between the battery terminal clamps 64 and 66, it causes contactor S5 to connect rechargeable power supplies 50 and 52 in parallel. After that, it turns on an internal MOSFET to allow the input current to charge the rechargeable power supplies 50 and 52. The MCU 68 monitors the cell voltage and terminal voltage of rechargeable power supplies 50 and 52. The charging process is terminated, in this exemplary embodiment, if the cell voltage reaches 3.6V and terminal voltage reaches 14.4V.

To check whether or not the battery terminal clamps 64 and 66 are short circuited, the MCU 68 activates a low current voltage source and applies the voltage source or voltage pulse across the clamps. Then, the MCU 68 monitors the clamp voltage. If the clamp voltage is measured being close to zero, the MCU 68 activates the short circuit protection circuit 62 to protect against short circuiting. The diode D2 allows the MCU 68 to be woken up by clamp voltage. The diode D1 allows the MCU 68 to turn on the DC-DC regulator 58 once it “wakes up”.

Figure 3 shows several electronic elements forming a first embodiment of the vehicle battery sensor 72. The vehicle battery sensor 72 includes a differential amplifier 90 including two inputs 92 and 94, an output 96 and reference voltage input 98. The vehicle battery sensor 72 further includes potential dividers 100 and 102 respectively connected between the battery terminal clamps 64 and 66 and the inputs 92 and 94, a voltage reference circuit 104 connected to the reference voltage input 98, and a voltage smoothing circuit 106 connected between the output 96 and an input of the MCU 68 to reduce the output 96 to an acceptable range able to be read by the MCU 68.

The potential dividers 100 and 102 act to scale down clamp voltages at the battery terminal clamps 64 and 66, in this example, by a factor of 10. The voltage reference circuit 104 acts to apply an offset voltage, in this example of +3V, to the voltage at the output 96 of the differential amplifier 90.

The vehicle battery sensor 72 acts to linearly convert a range of clamp voltages including both positive and negative voltages, in the case from +40V to -30V, to a range of voltages able to be read by the microcontroller 68. In this example, the range of voltages is of a single polarity, and is a range of positive voltages from 0V to +3.0V. By reading and analysing the output of the voltage smoothing circuit 106, the MCU 68 is able to obtain the clamping voltage and its polarity.

The MCU 68 uses the clamp voltage to determine whether:

1. An operator needs to be alerted to confirm the voltage selection,
2. A 12V electrical system is connected,
3. A 24V electrical system is connected, or
4. The clamps are reversely connected.

When a 12V or 24V electrical system is detected, the MCU 68 activates the corresponding contactors S1 to S4 automatically to provide 12V or 24V jumpstart voltage.

Accordingly, the vehicle battery sensor 72 acts to sense a voltage range between the battery clamps including voltages indicative of an absence (e.g. 0V) of a vehicle battery between the battery clamps, a positive polarity connection of the vehicle battery (e.g. +12V) between the battery clamps and the positive and negative battery terminals and a negative polarity connection of the vehicle battery (e.g. -12V) between the battery clamps and the positive and negative battery terminals, and then convert the sensed voltage range into corresponding voltage range (e.g. +4.2V, +3V and +1.8V) at the output 96. In practice, the voltage at the output 96 can vary from 0 to 7V. The voltage smoothing circuit 106, which includes a potential divider and filter capacitor, is connected between the output 96 and an input of the MCU 68 to scale the voltage at the output 96 down to a range (0V to +3.0V) able to be read by the MCU 68.

The relationship between clamp voltages and vehicle battery sensor output voltages to the MCU 68 for these three conditions, in relation to the

embodiment of the vehicle battery sensor 72 shown in Figure 3, is set out in Table 1 below.

Condition	Clamp voltage	Output voltage
Battery connected, correct polarity	+12V	+1.6V
No battery connected	0V	+1.29V
Battery connected, reverse polarity	-12V	+0.77V

Table 1

In such an arrangement, short circuit resulting in sparking and potential damage to batteries and/or bodily injury resulting from the positive and negative terminals being connected to the opposite polarity terminals in the vehicle to be jumped are avoided.

Advantageously, in such an arrangement a power switch can be either manually or automatically turned on to connect the internal power supply to the battery clamps in response to a signal from the vehicle battery sensor indicating to the microcontroller that a vehicle battery is connected to the battery clamps with a proper polarity.

Figure 4 depicts a series of possible states of the apparatus 10 during jumper starter wake-up and clamp detection, and conditions which will cause the MCU 68 to change the state of the apparatus 10.

In inactive state 120, the apparatus 10 is off and will remain so if the detected clamp voltage remains between -3V and +3V. The MCU 68 causes the apparatus 10 to manually wake up, or enter an activated state 122, upon activation of one or more of the user operable buttons 26 to 34. Once a user has then connected battery terminal clamps 64 and 66 to the starter battery 74, the apparatus 10 then enters an operable state 124.

The operable state 124 can also be entered automatically from the inactive state 120 if clamp engagement is detected by the MCU 68, which in this case occurs if a clamp voltage greater than +3V and less than -3V is detected by the MCU 68.

Figure 5 shows a series of operations performed by the MCU 68 and the vehicle battery sensor 72 to determine if a vehicle battery is connected to the battery clamps with a proper polarity. At step 130, the vehicle battery sensor 72 senses a range of clamp voltages including both positive and negative voltages, and notably including voltages between the battery clamps indicative of an absence of connection, positive polarity connection and negative polarity connection between the battery clamps and the positive and negative battery terminals.

At step 132, the vehicle battery sensor 72 converts the sensed range of voltages into a range of voltages able to be read by the microcontroller 68.

At step 134, the MCU 68 determines at step 136 if the voltage level at the output of the vehicle battery sensor 72 indicates that the battery 74 is connected, but with reverse polarity. At step 138, the MCU 68 determines at step 140 if the voltage level at the output of the vehicle battery sensor 72 indicates that no battery is connected to the apparatus 10. At step 142, the MCU 68 determines at step 144 if the voltage level at the output of the vehicle battery sensor 72 indicates that the battery 74 is connected, and with correct polarity.

Figure 6 depicts a series of possible states of the apparatus 10 during automatic engagement, and conditions which will cause the MCU 68 to change the state of the apparatus 10. From an idle state 150, the apparatus 10 enters an operable state 152 (corresponding to operable state 124) when the MCU 68 detects a clamp voltage greater than +3V or less than -3V.

In this operable state 152, the MCU 68 disengages the contactors and detects if there is any failure of contactors which leads to permanent connection between rechargeable power supplies (50 and 52) and battery terminal clamps (64 and 66). If failure is detected, the apparatus 10 enters an error state 154.

The MCU 68 also checks the temperature of rechargeable power supplies (50 and 52), ambient temperature and contactors' temperatures. The apparatus 10 enters the error state 154 if the temperatures are outside the pre-defined operational range.

The MCU 68 also checks the voltage of rechargeable power supplies (50 and 52). The apparatus 10 enters the error state 154 if the voltage is below 12.95V.

The MCU 68 further monitors the clamp voltage via the vehicle battery sensor 72.

The apparatus 10 enters the error state 154 if reverse polarity is detected (e.g. the output of vehicle battery sensor 72 is below 1.28V or calibrated value).

The apparatus 10 enters an 12V Contactors Activated state 156 if the clamp voltage is detected by the MCU 68 between 1 and 14.6V. The apparatus 10 alternatively enters 24V Contactors Activated state 158 if the clamp voltage is detected by the MCU 68 between 19 and 30V.

The error state 154 is entered, and an operator alert is correspondingly generated on the display 24 or by other audible or visible means, if the error conditions of low battery voltage level, excessive clamp voltage, internal battery and ambient temperatures, internal battery permanently short-circuited to battery terminal clamps 64 and 66, clamp reverse connection, contactor overtemperature, or short circuit of battery terminal clamps 64 and 66, are detected by the MCU 68.

Over voltage protection is provided by the MCU 68 together with the cell balancing circuits 54 and 56. The MCU 68 monitors the cell and battery pack voltage through the cell balancing circuits 54 and 56. If the battery pack voltage is detected to be greater than 15.6V, a warning signal or other operator alert is displayed on the screen 24.

If the MCU 68 detects a clamp voltage of between 1V and 14.6V, then a state 156 is entered in which selective operation of contactors S1 to S4 is made to connect one or both of the rechargeable power supplies 50 and 52 in parallel, to provide 12V charging of the battery 74. However, if the MCU 68 detects a clamp voltage of between 19V and 30V, then a state 158 is entered in which selective operation of contactors S1 to S4 is made to connect both of the rechargeable power supplies 50 and 52 in series, to provide 24V charging of the battery 74.

Figure 7 shows several electronic elements forming a second embodiment of the vehicle battery sensor, referenced 200 in this figure. The vehicle battery sensor 200 includes a differential amplifier 202 which is identical to the differential amplifier 90 in Figure 3. The differential amplifier 202 includes two inputs 204 and 206, an output 208 and reference voltage terminal 210.

Input circuitry 212 connecting the battery terminal clamps 214 and 216 to the vehicle battery sensor 200 is functionally identical to the potential dividers 100 and 102 shown in Figure 3. However, in this embodiment, output circuitry 218 connected to the output 208 and reference voltage terminal 210 acts as a voltage clamp which limits the output voltage from output terminal 208 to a range able to be read by the MCU 68.

The voltage clamp is formed by offset voltage reference circuit 222, resistor 228 and diodes 230 and 232, and limits the signal from output 208 to 3.3V. The offset voltage reference circuit 222 acts to apply an offset voltage, in this example of +2.5 V, to the voltage at the output 208 of the differential amplifier 202.

The vehicle battery sensor 200 covers clamp voltages from -5V to +30V, and is configured to provide a linear relationship between voltages at output 208 and input 204 from -5 to +2V. The vehicle battery sensor 200 also provides a linear relationship from +1V and +30V between the clamp voltage and an OUT+ terminal between series connected resistors 234 and 236 interconnecting the clamp terminals 214 and 216.

The relationship between clamp voltages and vehicle battery sensor output voltages to the MCU 68 for these three conditions, in relation to the embodiment of the vehicle battery sensor 200 shown in Figure 7, is set out in Table 2 below.

Condition	Clamp voltage	Output voltage
Battery connected, correct polarity	+12V	+2.7V – +3.0V
Battery connected, reverse polarity	-12V	+0.15V – +2.4V
No battery connected (Open circuit)	0V	+2.6V
Clamps are short circuited	0V	+2.5V

Table 2

The vehicle battery sensor 72 shown in Figure 3 covers full range of clamp voltages (-40V to 30V), and the voltage at output 106 and the clamp voltage maintains a linear relationship in this range. However, in order to use an MCU which has high resolution Analog to Digital Converter (ADC) whilst minimising production costs, in the vehicle battery sensor 200 shown in Figure 7 the voltage at the output 208 of the linear amplifier 202 maintains a linear relationship with the clamp voltage only at reduced range from -5 to 2V. The clamp voltage outside this range is measured at OUT+.

Advantages provided by such an arrangement include reduction of ADC required resolution, better visibility at low clamp voltages and providing detection of short circuits before connecting the internal battery to the clamp.

The vehicle battery sensor 200 notably enables the microcontroller 68 to provide primary short-circuit, reverse polarity and clamp connection detection. In this embodiment, the output voltage of the vehicle battery sensor 200 has about 0.1V difference between short-circuit, open clamp connection and reverse polarity conditions, as follows:

- When the battery terminal clamps 64 and 66 are open, due to the leakage current from the vehicle battery sensor 202 resistors 220 and 224 forming part of the input circuitry 212 create a net input voltage and the voltage at output of the vehicle battery sensor 200 equals to around 2.6V (which may need to be calibrated).
- When the battery terminal clamps 64 and 66 are shorted, resistors 224 and 226 forming part of the input circuitry 212 are in parallel. The combined resistance of these two resistors 224 and 226 is selected to be close to that of resistor 220. As a result, the leakage current effect is effectively cancelled out and no net input voltage is created. The voltage at the output of vehicle battery sensor 200 becomes 2.5V (need to be calibrated).
- When the battery terminal clamps 64 and 66 are reversely connected with 0.2V source 222, the voltage at the output of the vehicle battery sensor 200 becomes around 2.4V.

During production, the output voltage of the vehicle battery sensor 200 is may be calibrated under short circuit and open clamp conditions. The calibrated voltages are stored in a memory of the MCU 68.

When the portable apparatus 10 is turned on or battery terminal clamps 64 and 66 are connected to a starter battery 74 – as indicated by a voltage of more than +1.5V or less than -1.5V - the internal MCU 68 firstly wakes up and checks the voltage at the vehicle battery sensor 200 output according to the state diagram shown in Figure 8.

As can been seen in that state diagram, at a Welcome state 300, the MCU 68 checks the vehicle battery sensor 200 output voltage. Prior to wake up, that is where voltage of more than +1.5V or less than -1.5V is not detected between the battery terminal clamps 64 and 66, the MCU 38 remains in an idle state 301.

If the vehicle battery sensor 200 output voltage is greater or equal to 2.7V, the MCU 68 will check the voltage at the secondary clamp voltage sensing point at state 302. According to value of the secondary clamp voltage, the MCU 68 will go to a 12V relay activation state 304, a 24V relay activation state 306 or to a manual override state 308.

If the vehicle battery sensor 200 output voltage is between 0.15V and 2.4V, the MCU 68 will go to reverse connection warning state 310.

If the vehicle battery sensor 200 output voltage is greater than/equal to 2.4V and less than 2.7V, the MCU 68 will apply 12V pulse to the clamps at state 312. If the vehicle battery sensor 200 output voltage increases at least 50mV above the calibrated open circuit voltage, the MCU 68 will go to the manual override state 308. However, if the vehicle battery sensor 200 output voltage increases less than 50mV above open circuit voltage, the MCU 68 will return to Welcome state 300.

If the vehicle battery sensor 200 output is equal to the calibrated short-circuit voltage after 12V pulse is applied, the MCU 68 will go to a short-circuit warning state 314.

At the Welcome state 300, if 12V or 24V button is pressed, the MCU 68 will go to the manual override state 308.

Furthermore, the vehicle battery sensor 200 also provides reverse polarity detection. When the clamps are reversely connected with 0.2V source, the voltage at the vehicle battery sensor 200 output becomes around 2.4V.

When the portable apparatus 10 is turned on or battery terminal clamps 64 and 66 are connected to a starter battery 74 (which has more than 1.5V), at

a Welcome state 400, the internal MCU 68 firstly wakes up and checks the voltage at the vehicle battery sensor 200 output according to the state diagram shown in Figure 9. Prior to wake up, that is where voltage of more than +1.5V or less than -1.5V is not detected between the battery terminal clamps 64 and 66, the MCU 38 remains in an idle state 401.

If the vehicle battery sensor 200 output voltage is greater or equal to 2.7V, the MCU 68 will check the secondary clamp voltage sensing point at state 402. According to the value of the secondary clamp voltage, the MCU 68 will go to a 12V relay activation state, a 24V relay activation state 406 or to a manual override state 408.

If the vehicle battery sensor 200 output voltage is between 0.15V and 2.4V, the MCU 68 will go to a reverse connection warning state 410.

If the vehicle battery sensor 200 output voltage is outside the above voltage ranges, the MCU 68 will stay in Welcome state 400 until a 12V or 24V button is pressed.

On a Welcome screen during the Welcome state 400, if a 12V button is pressed, the MCU 68 will go to a 12V override screen at the override state 408. If 12V button is pressed again in this state, the MCU 68 will go to the 12V relay activation state 404, connect the internal battery to the battery terminal clamps 64 and 66 and monitor the clamp output voltage. If the clamp output voltage is less than 4.5V, the MCU 68 will go to a short-circuit warning state 412.

On Welcome screen during the Welcome state 400, if a 24V button is pressed, the MCU 68 will go to a 24V override screen at the override state 408. If 24V button is pressed again, the MCU 68 will go to 24V relay activation state 406, connect the internal battery to the battery terminal clamps 64 and 66 and monitor the clamp output voltage. If the clamp output voltage is less than 8V, the MCU 68 will go to the short-circuit warning state 412.

While the invention has been described in conjunction with a limited number of embodiments, it will be appreciated by those skilled in the art that many alternative, modifications and variations considering the foregoing description are possible. Accordingly, the present invention is intended to embrace all such alternatives, modifications and variations as may fall within the spirit and scope of the invention as disclosed.

Where the terms "comprise", "comprises", "comprised" or "comprising" are used in this specification (including the claims) they are to be interpreted as specifying the presence of the stated features, integers, steps or components, but not precluding the presence of one or more other features, integers, steps or components, or group thereof.

Claims

1. An apparatus for jump starting a vehicle having a battery, the battery having positive and negative battery terminals, including:
a rechargeable internal power supply;
battery clamps respectively having positive and negative polarities;
one or more contactors connected between the internal power supply and the battery clamps;
a vehicle battery sensor connected to the battery clamps, and configured to detect both the presence and polarity of a vehicle battery connected to the battery clamps; and
a microcontroller configured to receive an output signal from the vehicle battery sensor, and to provide an output signal to selectively close the one or more contactors,
wherein the vehicle battery sensor is configured to:

a) sense a voltage range between the battery clamps including voltages indicative of,
    an absence of the vehicle battery connected to the battery clamps, and
    the polarity of the vehicle battery connected to the battery clamps; and
b) convert the sensed voltage range into a corresponding voltage range able to be read by the microcontroller.

2. An apparatus according to claim 1, wherein the vehicle battery sensor is further configured, at step (a), to sense a short circuit between the battery clamps.

3. An apparatus according to claim 2, wherein the vehicle battery sensor is configured to sense a short circuit between the battery clamps by:
    sensing a voltage range between the battery clamps including voltages indicative of a potential short circuit,
    applying a voltage pulse to the battery clamps, and

if the sensed voltage between the clamps is close to zero, activating a short circuit protection circuit to protect against short circuiting.

4. An apparatus according to any one of the preceding claims, wherein the vehicle battery sensor is configured to separately sense voltages indicative of a positive polarity and a negative polarity connection of the vehicle battery connected to the battery clamps.

5. An apparatus according to any one of the preceding claims, wherein the microcontroller is further configured to selectively close the one or more contactors to connect the internal power supply to the battery clamps in response to a signal from the vehicle battery sensor indicating to the microcontroller that a vehicle battery is connected to the battery clamps with a proper polarity.

6. An apparatus according to claim 5, wherein the microcontroller is further configured to selectively close the one or more contactors automatically.

7. An apparatus according to any one of the preceding claims, wherein the vehicle battery sensor acts to convert a first range of clamp voltages including both positive and negative voltages to a second range of voltages able to be read by the microcontroller.

8. An apparatus according to claim 4, wherein the conversion is linear.

9. An apparatus according to either one of claims 4 or 5, wherein the first range of voltages is from +40V to -30V.

10. An apparatus according to any one of claims 4 to 6, wherein the second range of voltages is from 0V to +3.0V.

11. A method for sensing an operative state of an apparatus for jump starting a vehicle having a battery, the battery having positive and negative battery terminals, including a rechargeable internal power supply; battery clamps

respectively having positive and negative polarities; one or more contactors connected between the internal power supply and the battery clamps; a vehicle battery sensor connected to the battery clamps, and configured to detect both the presence and polarity of a vehicle battery connected to the battery clamps; and a microcontroller configured to receive an output signal from the vehicle battery sensor, and to provide an output signal to selectively close the one or more contactors,

the method including the steps of:

at the vehicle battery sensor,

a) sensing a voltage range between the battery clamps including voltages indicative of,

an absence of the vehicle battery connected to the battery clamps; and

the polarity of the vehicle battery connected to the battery clamps; and

b) converting the sensed voltage range into a corresponding voltage range able to be read by the microcontroller.

12. A method according to claim 11, and further including, at the vehicle battery sensor, at step (a), sensing a short circuit between the battery clamps.

13. A method according to either one of the claims 11 or 12, and further including, at the vehicle battery sensor, separately sensing voltages indicative of a positive polarity and a negative polarity connection of the vehicle battery connected to the battery clamps.

14. A method of operating of an apparatus for jump starting a vehicle having a battery, the battery having positive and negative battery terminals, including a rechargeable internal power supply; battery clamps respectively having positive and negative polarities; one or more contactors connected between the internal power supply and the battery clamps; a vehicle battery sensor connected to the battery clamps, and configured to detect both the presence and polarity of a vehicle battery connected to the battery clamps; and a microcontroller

configured to receive an output signal from the vehicle battery sensor, and to provide an output signal to selectively close the one or more contactors,

the method including the steps of:

at the vehicle battery sensor,

sensing a voltage range between the battery clamps including voltages indicative of,

an absence of the vehicle battery connected to the battery clamps; and

the polarity of the vehicle battery connected to the battery clamps; and

converting the sensed voltage range into a corresponding voltage range,

sensing a short circuit between the battery clamps by,

sensing a voltage range between the battery clamps including voltages indicative of a potential short circuit,

applying a voltage pulse to the battery clamps, and

if the sensed voltage between the clamps is close to zero, activating a short circuit protection circuit to protect against short circuiting.

15. A method according to claim 14, and further including:

at the microcontroller, selectively closing the one or more contactors to connect the internal power supply to the battery clamps in response to a signal from the vehicle battery sensor indicating to the microcontroller that a vehicle battery is connected to the battery clamps with a proper polarity.

16. A method according to claim 15, and further including:

at the microcontroller, selectively closing the one or more contactors automatically.

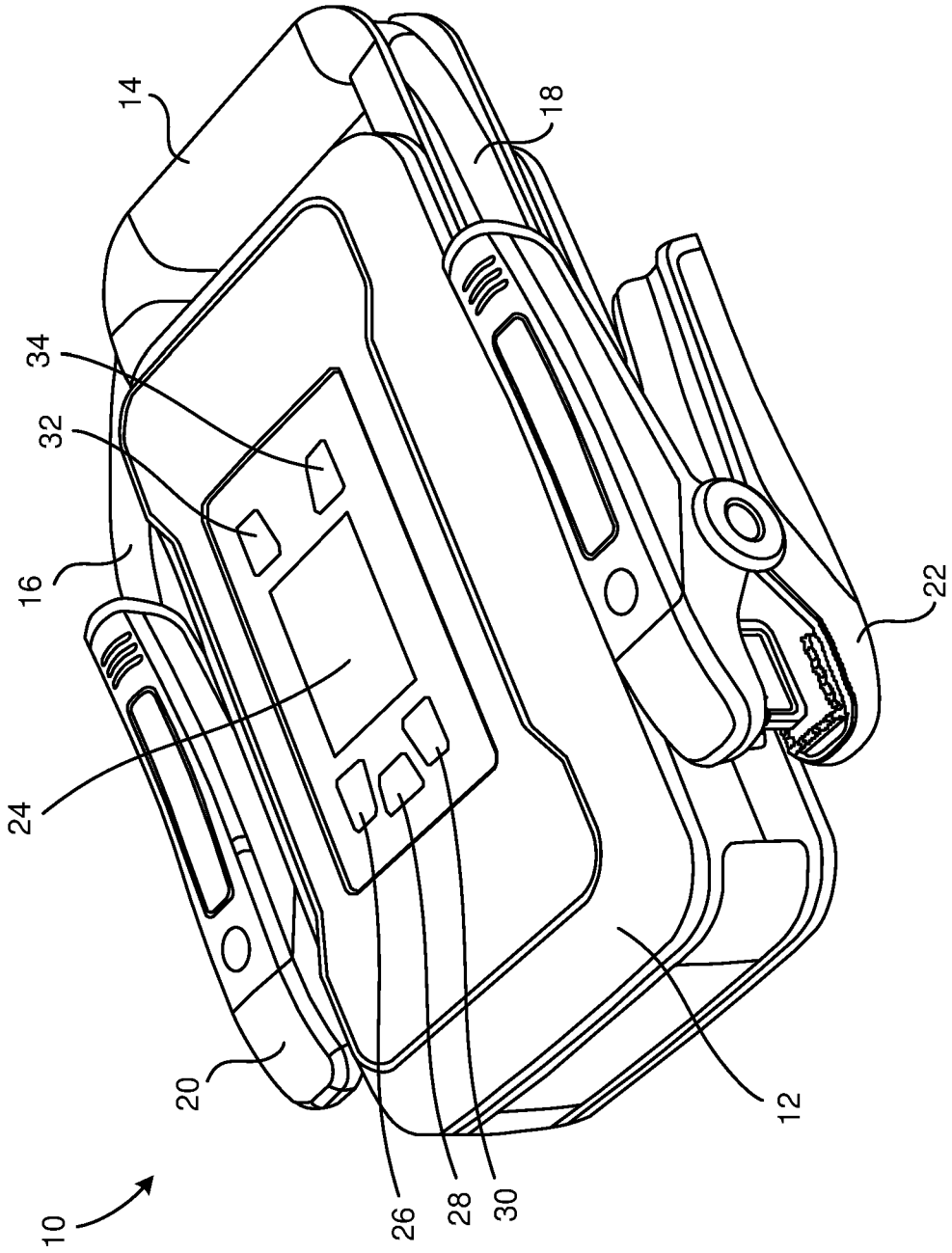

FIGURE 1

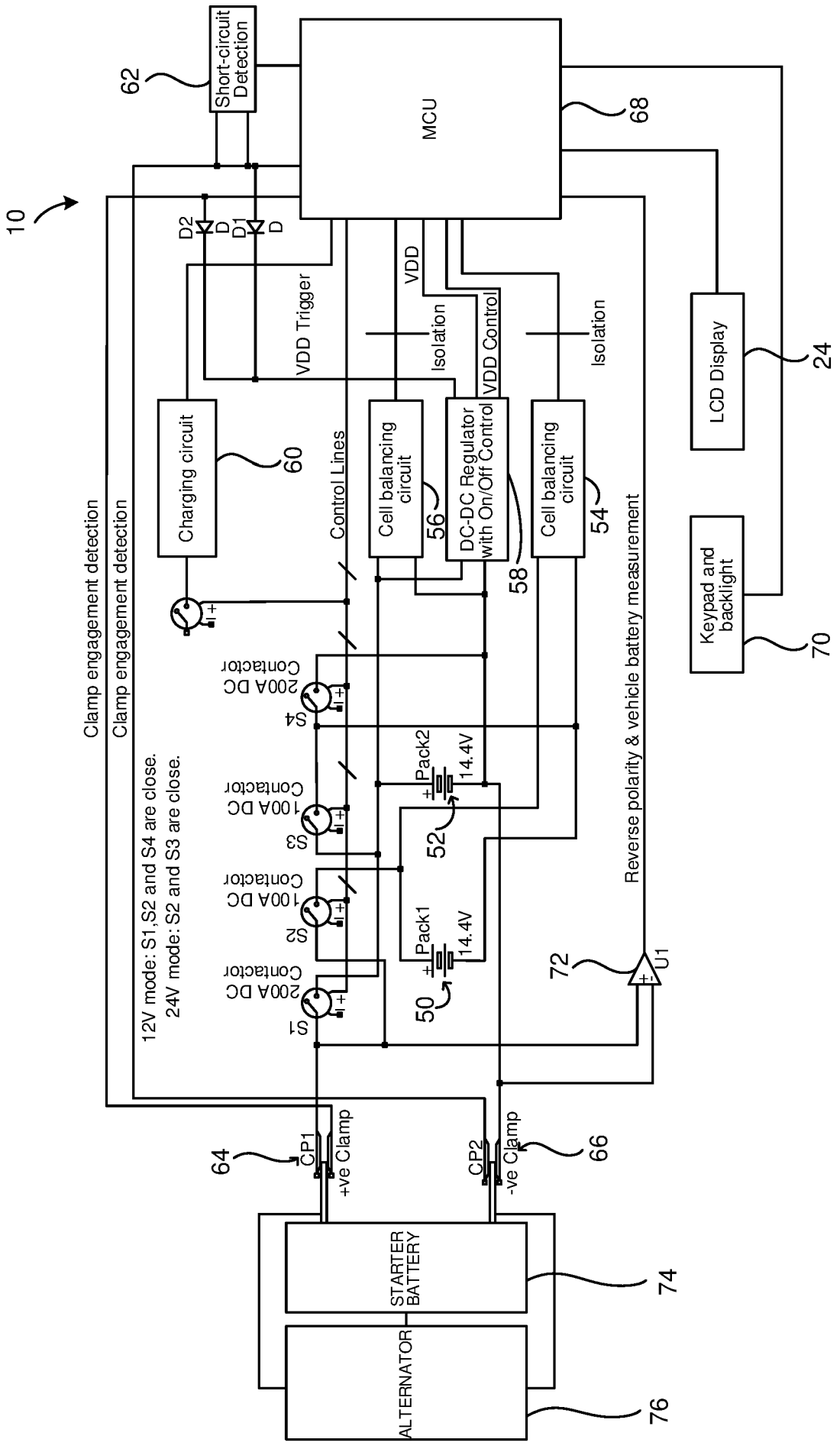
10
62
Short-circuit Detection
MCU
68
D2
D1
VDD Trigger
VDD
Isolation
VDD Control
Isolation
LCD Display
24
Charging circuit
60
Control Lines
Cell balancing circuit
56
DC-DC Regulator with On/Off Control
58
Cell balancing circuit
54
Keypad and backlight
70
Clamp engagement detection
Clamp engagement detection
12V mode: S1,S2 and S4 are close.
24V mode: S2 and S3 are close.
200A DC Contactor
S4
Pack2
14.4V
100A DC Contactor
S3
52
100A DC Contactor
S2
Pack1
14.4V
200A DC Contactor
S1
50
72
U1
Reverse polarity & vehicle battery measurement
64
CP1
+ve Clamp
CP2
-ve Clamp
66
STARTER BATTERY
74
ALTERNATOR
76

FIGURE 2

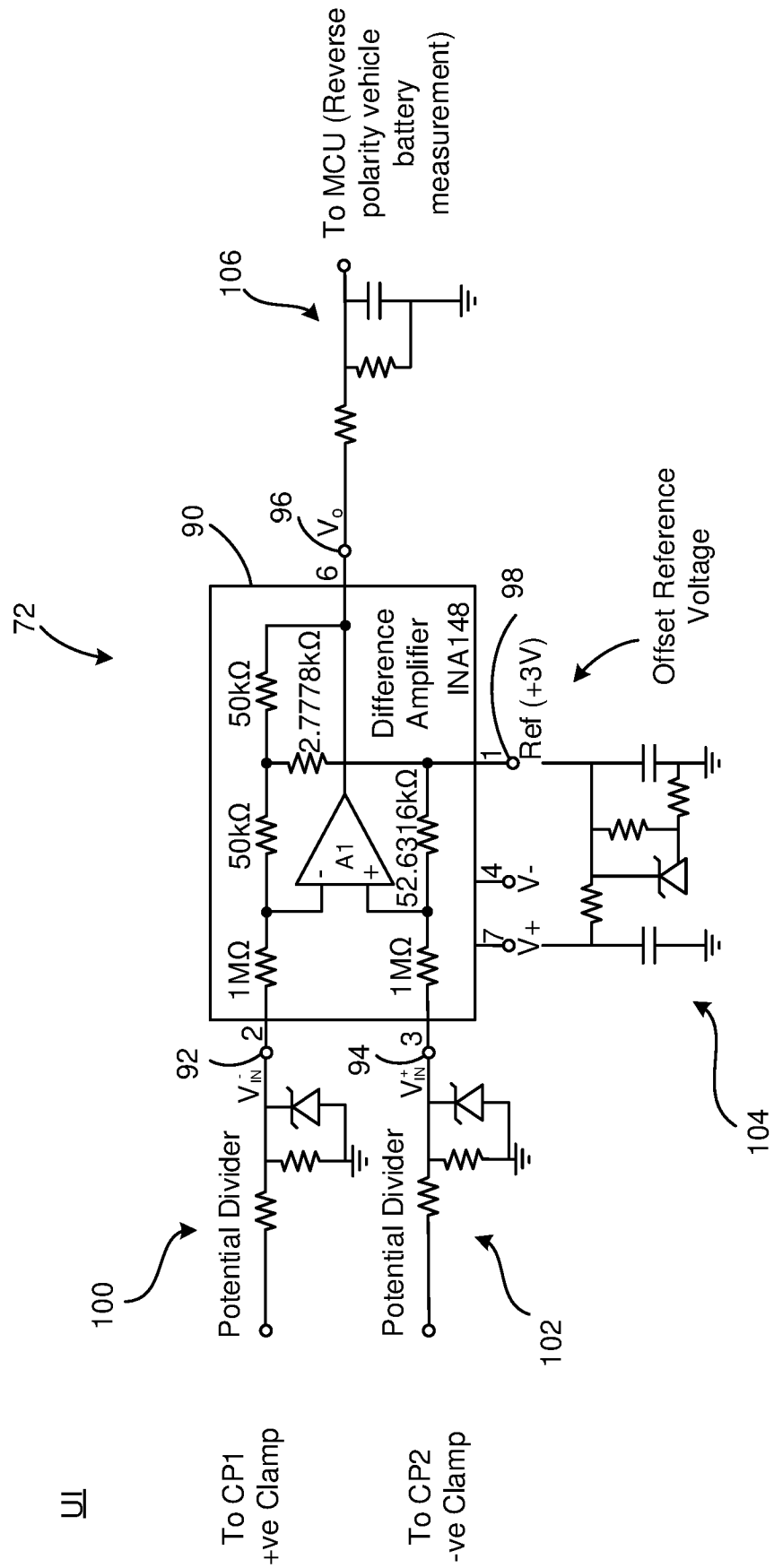
To MCU (Reverse polarity vehicle battery measurement)
106
96
V_o
90
72
6
50kΩ
2.7778kΩ
Difference Amplifier INA148
98
Ref (+3V)
Offset Reference Voltage
50kΩ
52.6316kΩ
A1
1
4
V-
7
V+
1MΩ
1MΩ
2
3
92
94
V_{IN}^-
V_{IN}^+
104
Potential Divider
Potential Divider
100
102
UI
To CP1 +ve Clamp
To CP2 -ve Clamp

FIGURE 3

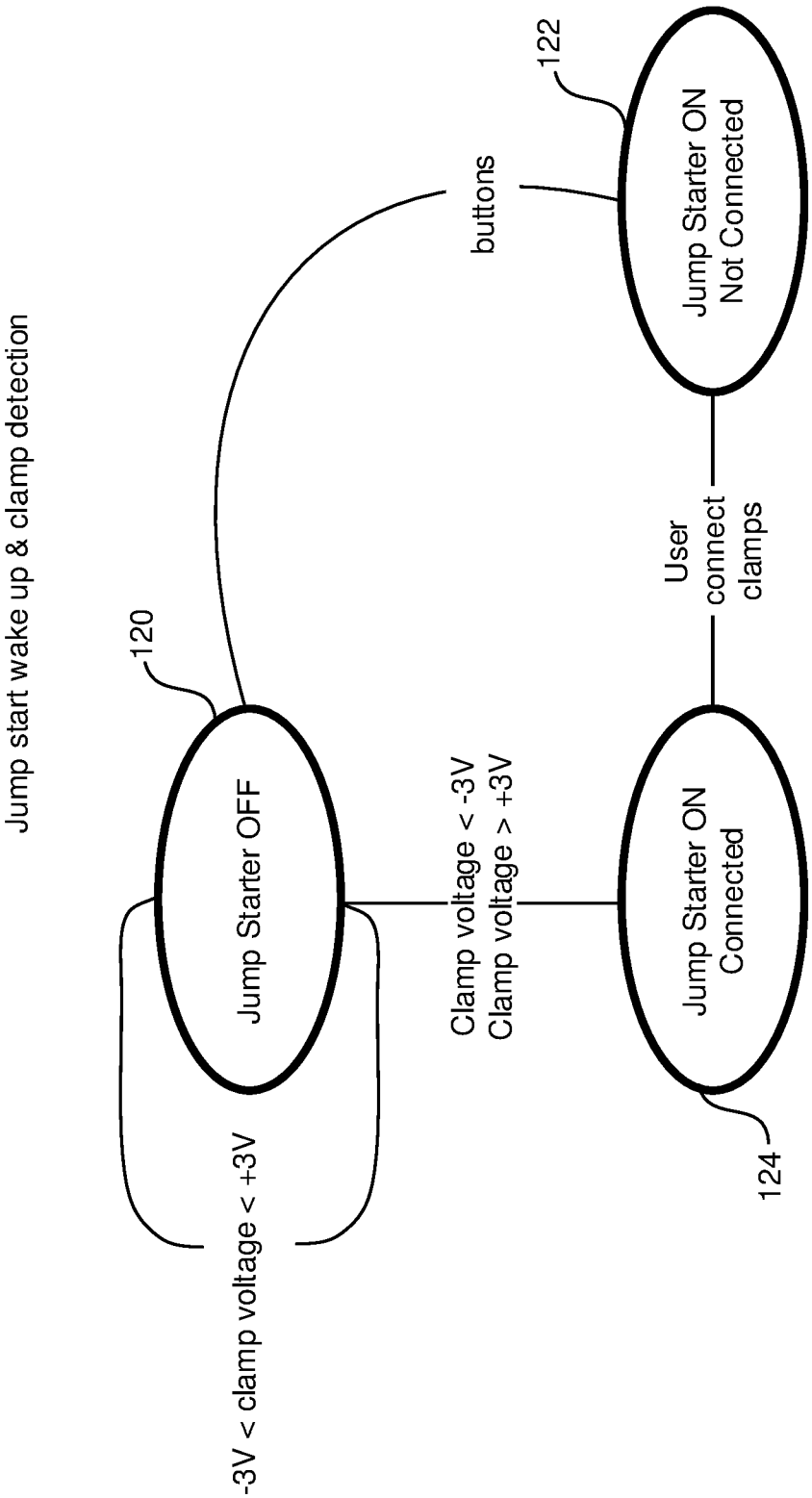
Jump start wake up & clamp detection
120
Jump Starter OFF
-3V < clamp voltage < +3V
Clamp voltage < -3V
Clamp voltage > +3V
Jump Starter ON
Connected
124
User
connect
clamps
Jump Starter ON
Not Connected
122
buttons

FIGURE 4

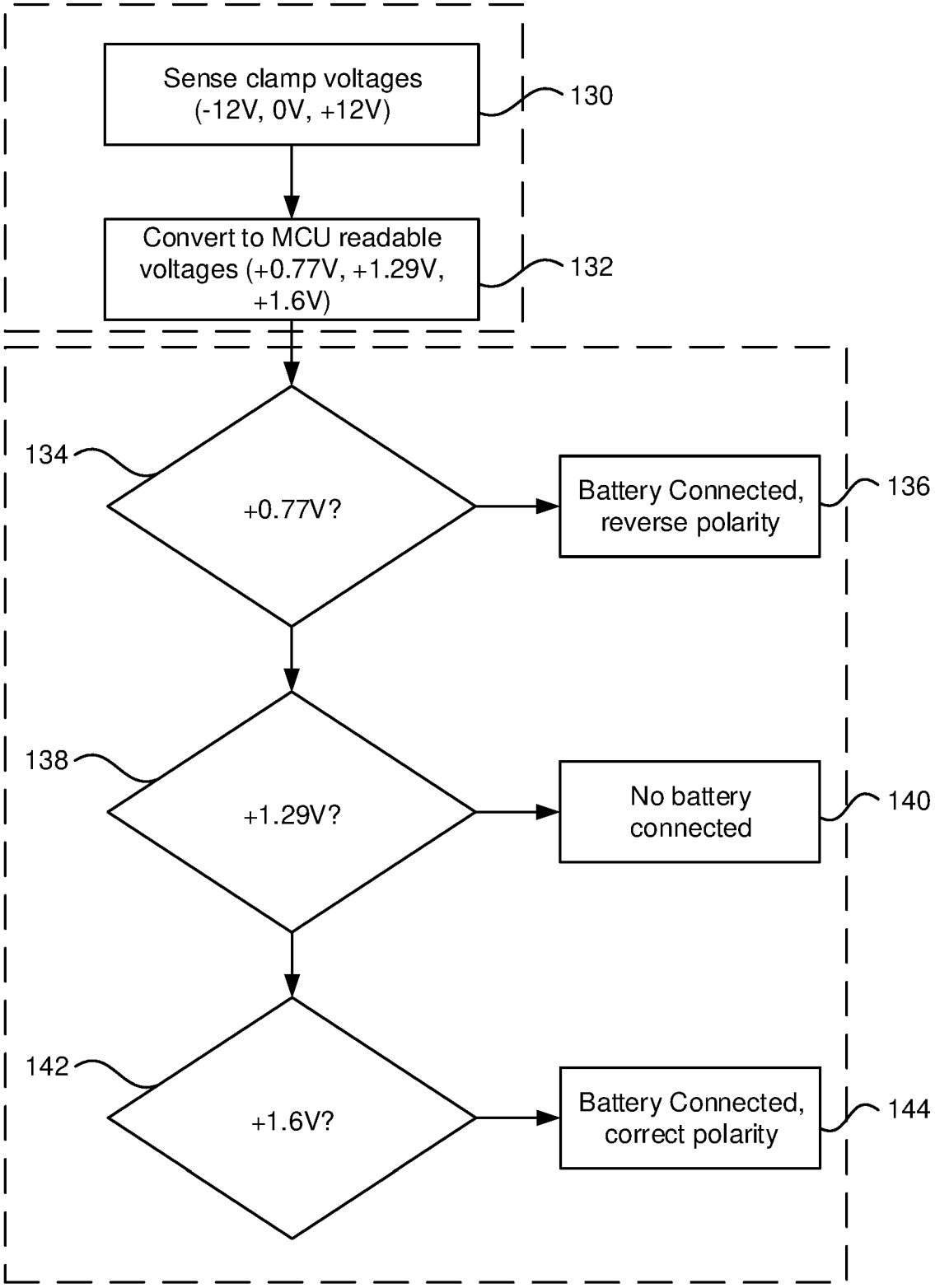
Sense clamp voltages (-12V, 0V, +12V)
130
Convert to MCU readable voltages (+0.77V, +1.29V, +1.6V)
132
134
+0.77V?
Battery Connected, reverse polarity
136
138
+1.29V?
No battery connected
140
142
+1.6V?
Battery Connected, correct polarity
144

FIGURE 5

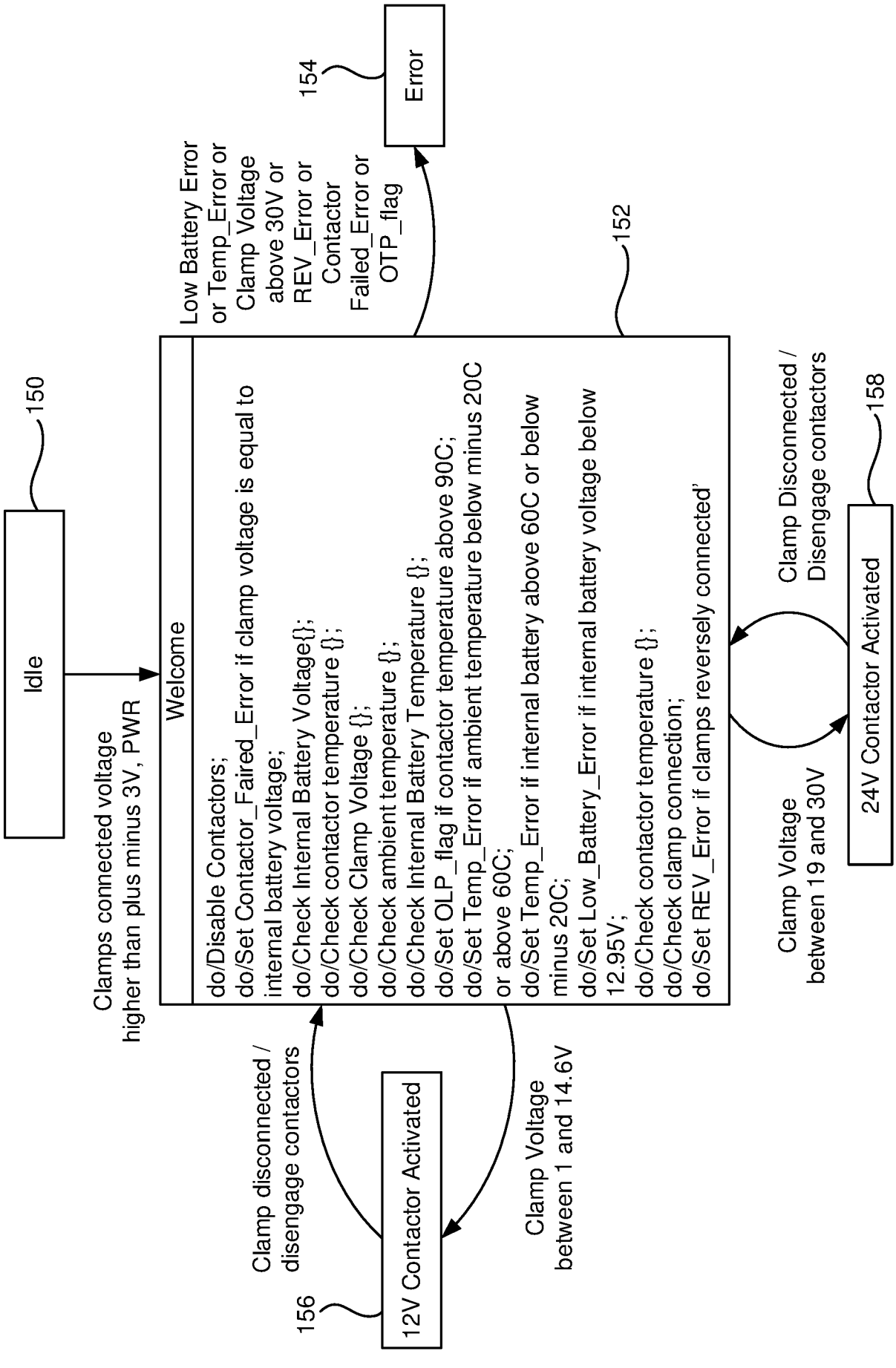
Idle
150
Clamps connected voltage higher than plus minus 3V, PWR
Welcome
do/Disable Contactors;
do/Set Contactor_Faired_Error if clamp voltage is equal to internal battery voltage;
do/Check Internal Battery Voltage{};
do/Check contactor temperature {};
do/Check Clamp Voltage {};
do/Check ambient temperature {};
do/Check Internal Battery Temperature {};
do/Set OLP_flag if contactor temperature above 90C;
do/Set Temp_Error if ambient temperature below minus 20C or above 60C;
do/Set Temp_Error if internal battery above 60C or below minus 20C;
do/Set Low_Battery_Error if internal battery voltage below 12.95V;
do/Check contactor temperature {};
do/Check clamp connection;
do/Set REV_Error if clamps reversely connected'
152
Low Battery Error or Temp_Error or Clamp Voltage above 30V or REV_Error or Contactor Failed_Error or OTP_flag
154
Error
Clamp disconnected / disengage contactors
156
12V Contactor Activated
Clamp Voltage between 1 and 14.6V
Clamp Voltage between 19 and 30V
Clamp Disconnected / Disengage contactors
158
24V Contactor Activated

FIGURE 6

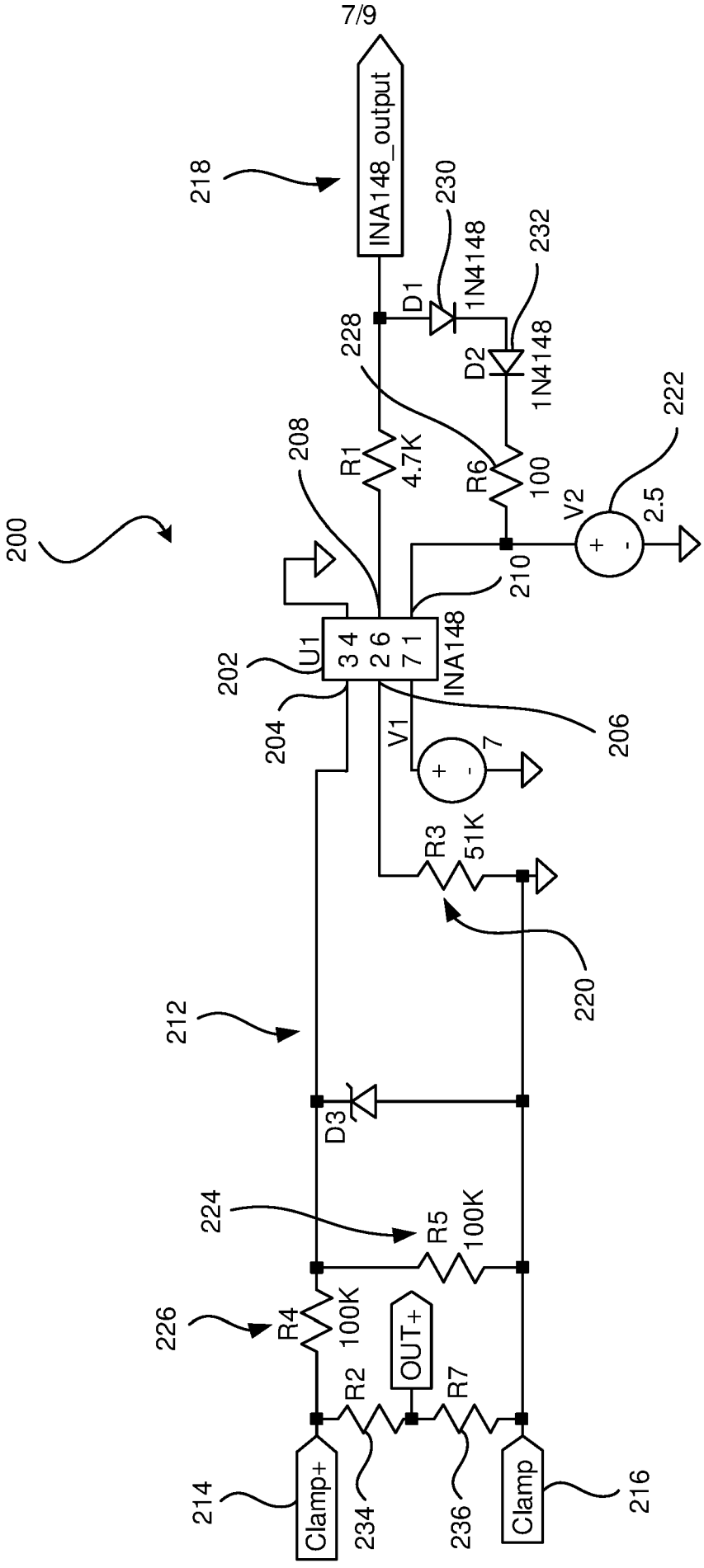
200
202
204
206
208
210
212
214
216
218
220
222
224
226
228
230
232
234
236
U1
INA148
3 4
2 6
7 1
R1
4.7K
R2
R3
51K
R4
100K
R5
100K
R6
100
R7
D1
1N4148
D2
1N4148
D3
V1
7
V2
2.5
INA148_output
OUT+
Clamp+
Clamp

FIGURE 7

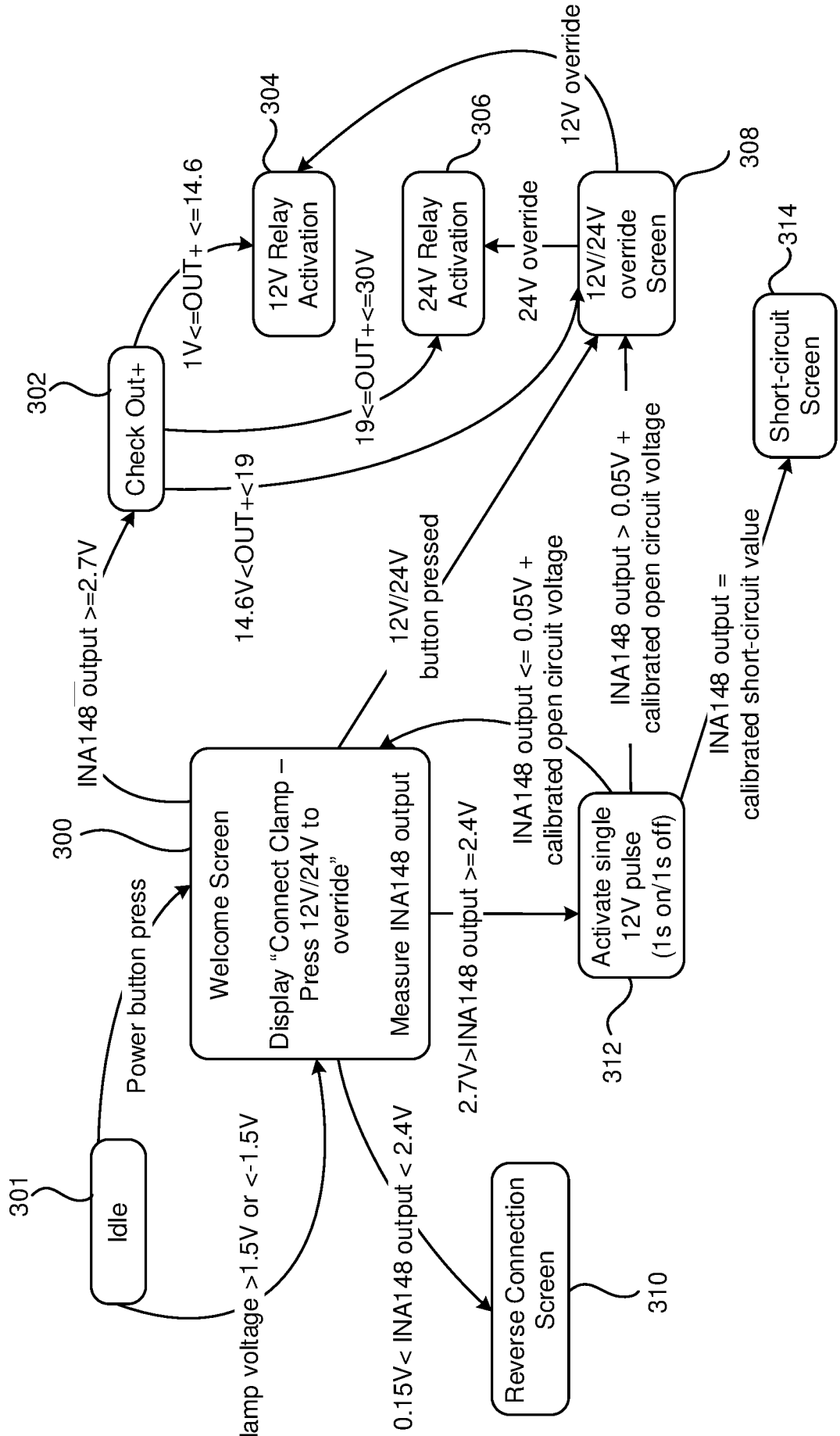

FIGURE 8

Use calibrated open circuit INA148 voltage for clamp detection when the relay and contactor is engaged

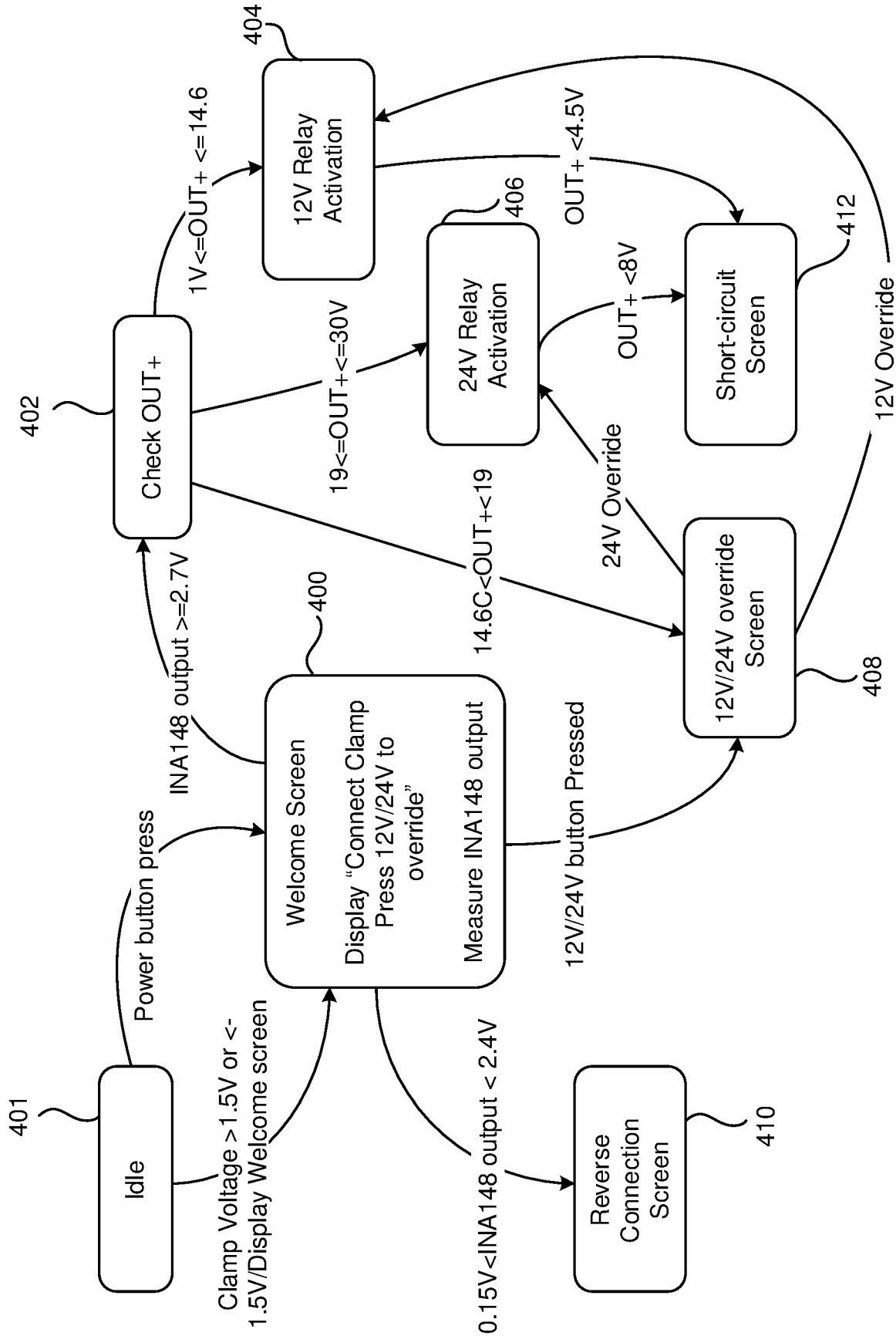
401
Idle
Power button press
Clamp Voltage >1.5V or <-1.5V/Display Welcome screen
400
Welcome Screen
Display "Connect Clamp Press 12V/24V to override"
Measure INA148 output
INA148 output >=2.7V
0.15V<INA148 output < 2.4V
402
Check OUT+
1V<=OUT+ <=14.6
19<=OUT+<=30V
14.6C<OUT+<19
404
12V Relay Activation
406
24V Relay Activation
OUT+ <4.5V
OUT+ <8V
412
Short-circuit Screen
12V Override
24V Override
12V/24V button Pressed
408
12V/24V override Screen
410
Reverse Connection Screen

FIGURE 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2021/050801

A. CLASSIFICATION OF SUBJECT MATTER

H02J 1/10 (2006.01) H02J 7/00 (2006.01) H02J 7/14 (2006.01) H02J 7/34 (2006.01)

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)

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)

Databases: PATENW (EPODOC, WPIAP & TXTE), ESPACENET, GOOGLE, GOOGLE PATENTS & GOOGLE SCHOLAR
IPC/CPC: H02J1/122, H02J7/0034, H01M50/597, H01M2010/4271, H02J7/00308, H02J7/0047
Keywords: vehicle, jump, start, battery, clamps, voltage, sensor, polarity, microcontroller, voltage range, short circuit, detect, internal, power supply, electrode and similar keywords.

Applicant(s)/Inventor(s) name search performed in ESPACENET, DOCDB, DWPI and in IP Australia Internal Databases.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"D" document cited by the applicant in the international application

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

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"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
17 September 2021	17 September 2021

Name and mailing address of the ISA/AU

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Telephone No. +61262256158

INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. **PCT/AU2021/050801**
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	AU 2020201224 A1 (THE NOCO COMPANY) 12 March 2020 See Whole Document and in particular Title, Figs. 2A-2C, 4; paragraphs [0014] - [0015], [0024] - [0033], [0040] and claim 1	1 - 16
X	WO 2017/005158 A1 (SHEN ZHEN JQB INDUSTRIAL CO. LTD. et al.) 12 January 2017 See Whole Document and in particular Abstract, Figs. 1, 2, 3, 6, 10, 11 and paragraphs [0003] - [0004], [0033], [0037], [0042], [0044] - [0045], [0049], [0052], [0056] - [0059], [0062] - [0064], [0070], [0079] - [0080], [0095], [0097], [0099], [0114]	1 - 16
A	US 6344733 B1 (CRASS et al.) 05 February 2002 See Whole Document	1 - 16

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2021/050801**

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Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
AU 2020201224 A1	12 March 2020	AU 2020201224 A1	12 Mar 2020
		AU 2015258229 A1	28 Jan 2016
		AU 2016269555 A1	05 Jan 2017
		AU 2016269555 B2	06 Dec 2018
		AU 2016392707 A1	30 Nov 2017
		AU 2016392707 B2	31 Oct 2019
		AU 2017217661 A1	14 Dec 2017
		AU 2017217661 B2	15 Nov 2018
		AU 2019201081 A1	07 Mar 2019
		AU 2019201081 B2	27 Aug 2020
		AU 2019201559 A1	28 Mar 2019
		AU 2019201559 B2	21 Nov 2019
		AU 2020200268 A1	06 Feb 2020
		AU 2020200268 B2	22 Jul 2021
		AU 2020201222 A1	12 Mar 2020
		AU 2020201223 A1	12 Mar 2020
		AU 2020201223 B2	07 May 2020
		AU 2020277175 A1	24 Dec 2020
		AU 2021202399 A1	20 May 2021
		CA 2916782 A1	07 Jan 2016
		CA 2957431 A1	11 Aug 2017
		CA 3005971 A1	17 Aug 2017
		CA 3107432 A1	11 Aug 2017
		CN 107852004 A	27 Mar 2018
		CN 108884801 A	23 Nov 2018
		DE 102014114997 A1	07 Jan 2016
		EP 3286429 A1	28 Feb 2018
		EP 3308446 A1	18 Apr 2018
		EP 3407405 A1	28 Nov 2018
		EP 3641019 A2	22 Apr 2020
		GB 2527858 A	06 Jan 2016
		GB 2527858 B	24 May 2017
		GB 2557733 A	27 Jun 2018
		GB 2557733 B	30 Dec 2020
		GB 2562950 A	28 Nov 2018
		GB 2562950 B	03 Mar 2021

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2021/050801**

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Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
		GB 2588555 A	28 Apr 2021
		GB 2591175 A	21 Jul 2021
		JP 2018534892 A	22 Nov 2018
		JP 2018536789 A	13 Dec 2018
		JP 2020127354 A	20 Aug 2020
		JP 2021013299 A	04 Feb 2021
		US 9007015 B1	14 Apr 2015
		US 2016001666 A1	07 Jan 2016
		US 9770992 B2	26 Sep 2017
		US 2018215274 A1	02 Aug 2018
		US 10328808 B2	25 Jun 2019
		US 2018111491 A1	26 Apr 2018
		US 10604024 B2	31 Mar 2020
		US 2018269703 A1	20 Sep 2018
		US 2018342891 A1	29 Nov 2018
		US 2018345803 A1	06 Dec 2018
		US 2019308518 A1	10 Oct 2019
		US 2020215926 A1	09 Jul 2020
		US 2020317068 A1	08 Oct 2020
		US 2021031640 A1	04 Feb 2021
		US 2021094428 A1	01 Apr 2021
		WO 2016003471 A1	07 Jan 2016
		WO 2017138963 A1	17 Aug 2017
		WO 2017139524 A1	17 Aug 2017
		WO 2021071949 A1	15 Apr 2021

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2021/050801**

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Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
WO 2017/005158 A1	12 January 2017	WO 2017005158 A1	12 Jan 2017
		US 2019081472 A1	14 Mar 2019
		US 10826286 B2	03 Nov 2020
US 6344733 B1	05 February 2002	US 6344733 B1	05 Feb 2002
		AU 4708301 A	07 Aug 2001
		AU 771405 B2	18 Mar 2004
		CA 2396860 A1	02 Aug 2001
		EP 1258068 A1	20 Nov 2002
		JP 2003521210 A	08 Jul 2003
		WO 0156132 A1	02 Aug 2001

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.