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(54) **DUAL-SLOPE CURRENT BATTERY-FEED CIRCUIT**

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(58) **Field of Search** 379/413, 400, 379/399

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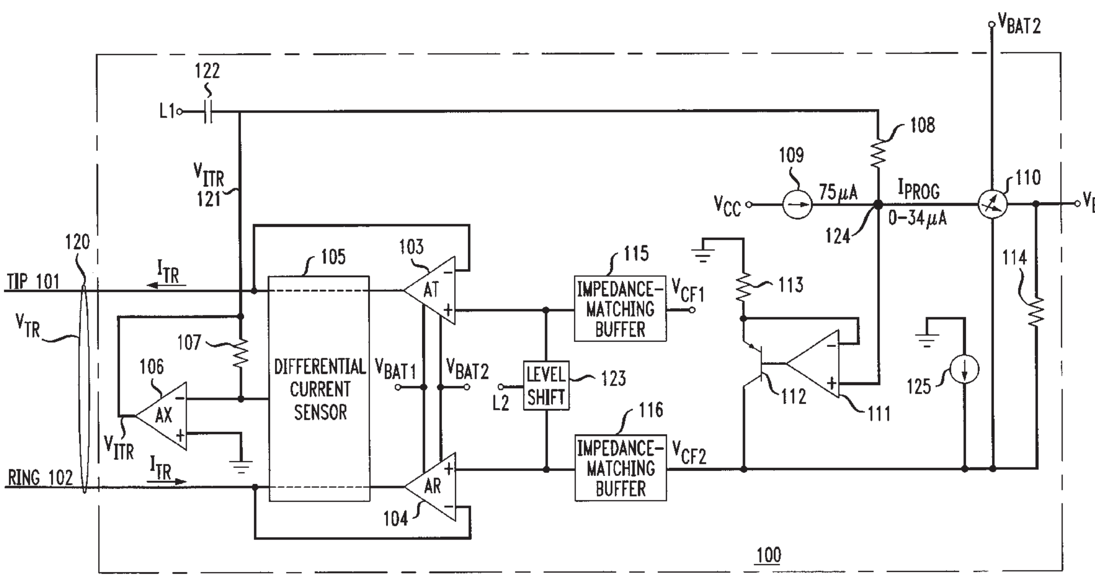
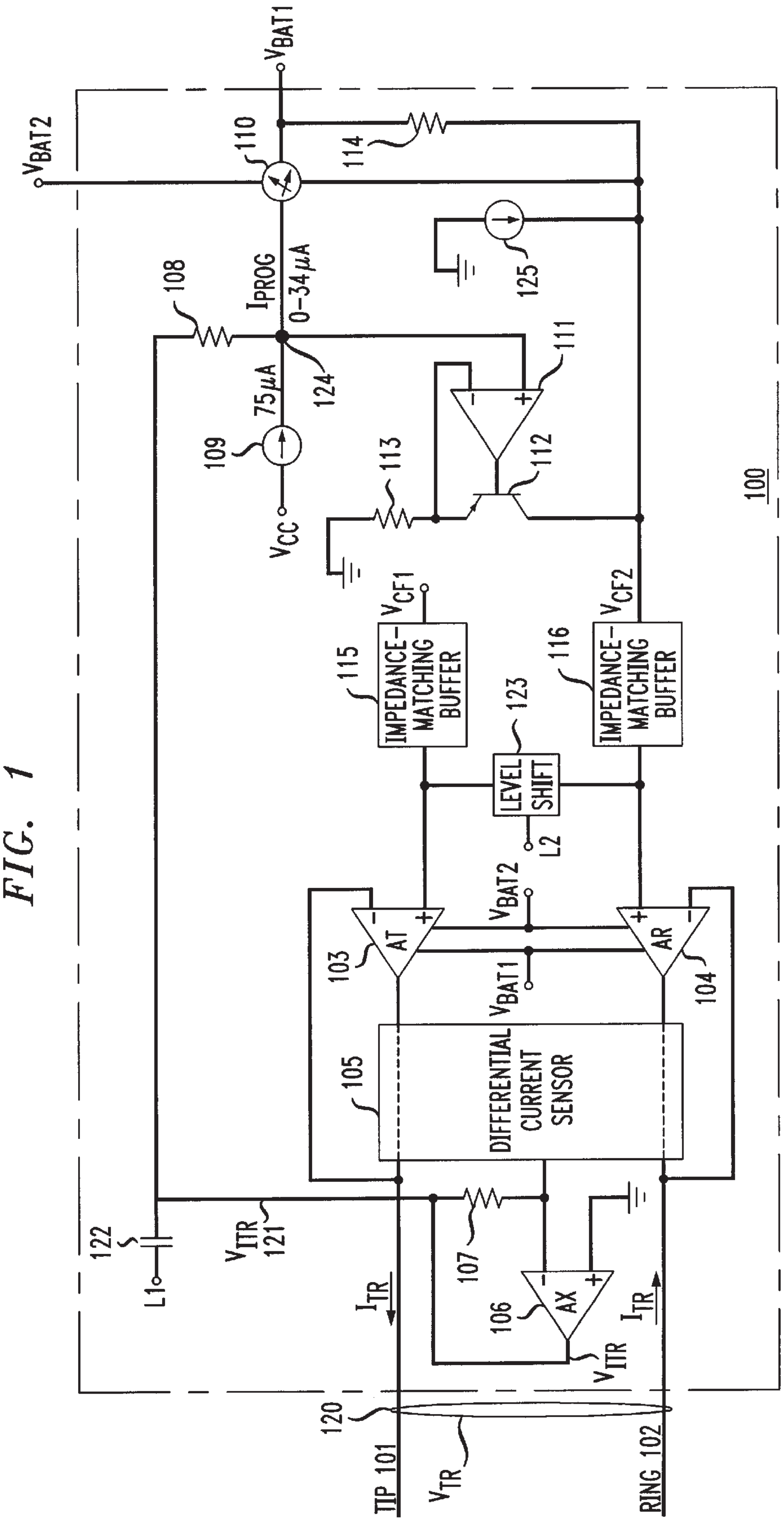
(57) **ABSTRACT**

A dual-supply line-interface circuit **(100)** uses a –48V power supply (V_{BAT1}) to drive long subscriber loops **(120)** and uses a –28V power supply (V_{BAT2}) to drive short subscriber loops. For intermediate-length loops, a dual-slope current-feed profile (FIG. **4**) is employed to limit the line-circuit's power dissipation. The line-interface circuit operates in an apparent constant-current mode, generating about 40 mA of differential line current using the low power supply, up to a threshold line voltage of about 25V, which is equal to the low power supply voltage minus required overhead. For longer loops, the line-interface circuit switches to a second constant-current mode, generating about 22 mA of differential current using the high power supply, which maintains the loop current constant until it drops to the 48V resistive-feed value.

14 Claims, 3 Drawing Sheets





V_{BAT1}
V_{BAT2}
110
114
108
I_{PROG}
0–34 μA
125
111
124
75μA
109
113
112
V_{CC}
V_{CF1}
V_{CF2}
115
IMPEDANCE-MATCHING BUFFER
116
IMPEDANCE-MATCHING BUFFER
123
LEVEL SHIFT
L2
100
V_{BAT2}
AT
AR
103
104
V_{BAT1}
105
DIFFERENTIAL CURRENT SENSOR
122
L1
V_{ITR}
121
107
106
AX
I_{TR}
I_{TR}
V_{ITR}
120
TIP 101
V_{TR}
RING 102

FIG. 1

FIG. 2

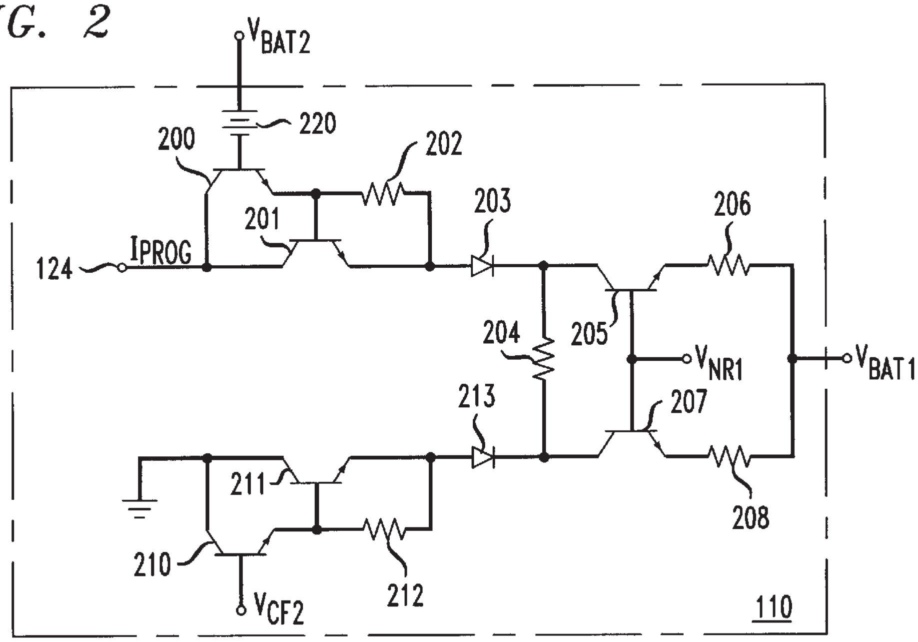


FIG. 3

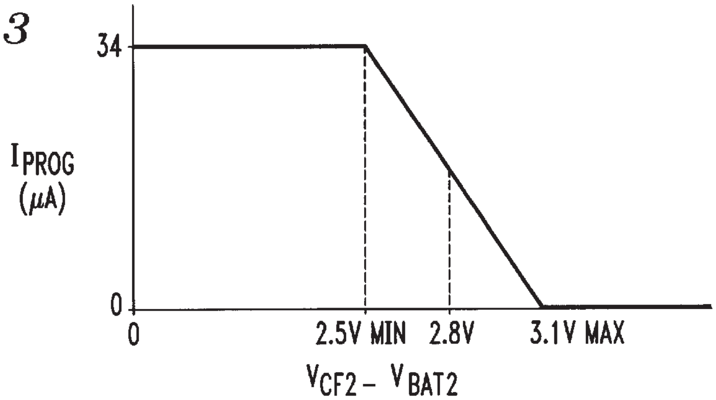


FIG. 4

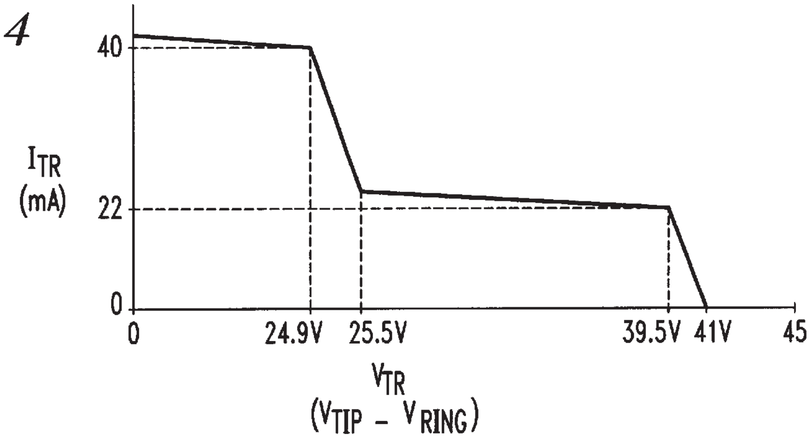
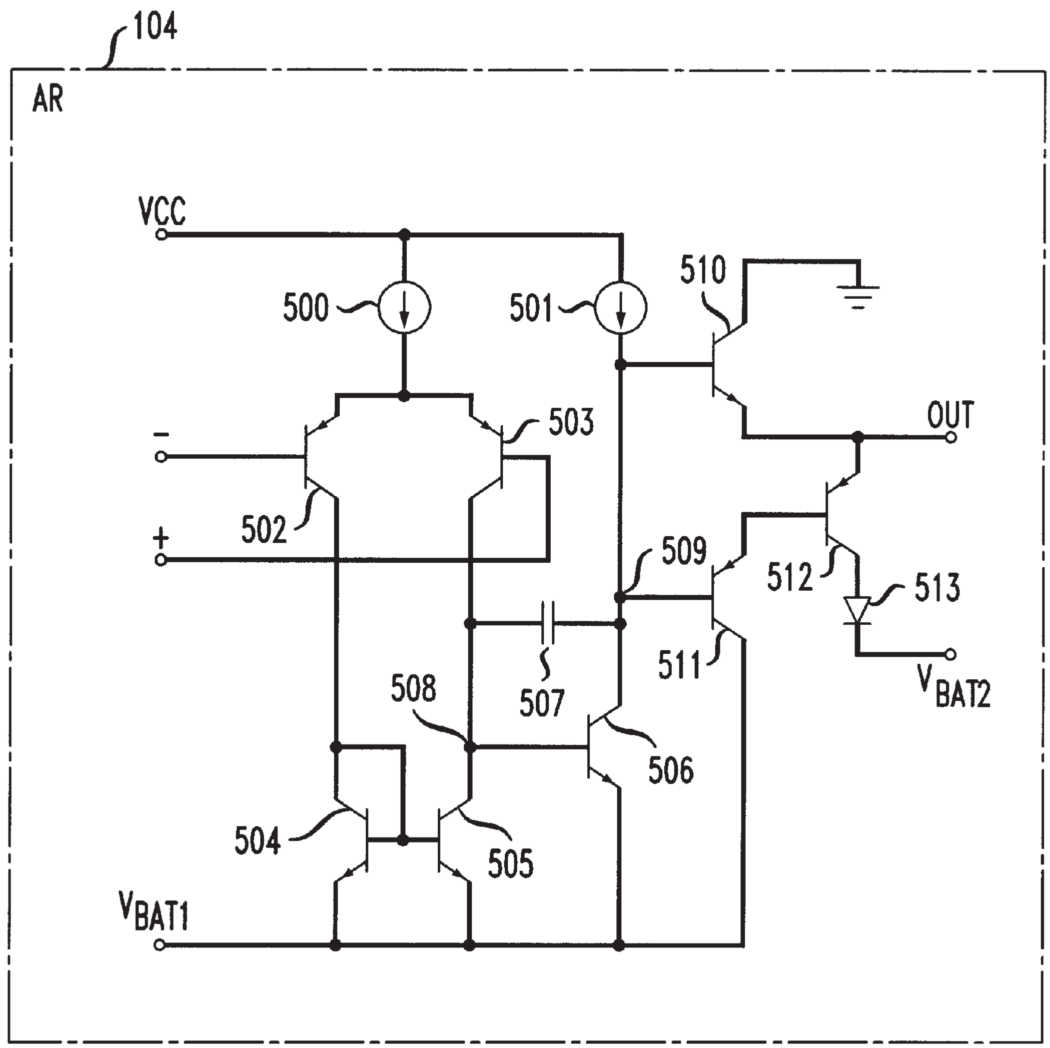


FIG. 5



104
AR
VCC
500
501
510
503
OUT
−
502
+
509
512
513
507
511
V_{BAT2}
508
506
504
505
V_{BAT1}

DUAL-SLOPE CURRENT BATTERY-FEED CIRCUIT

TECHNICAL FIELD

This invention relates generally to analog telephone line interface circuits, and specifically to the battery feed circuits of such line interface circuit.

BACKGROUND OF THE INVENTION

Conventional analog telephone line-interface circuits, also known as analog port circuits, require a 48VDC power supply for operation and for reliable signaling on long subscriber loops (telephone lines). Long loops have a high resistance relative to short loops, and therefore require a relatively high voltage to drive them. The circuit which couples the DC power to the telephone line is known as a battery-feed circuit. Even though battery-feed circuits commonly employ current-limiting and limit loop current to 42mA, 2W of power can be dissipated by the line-interface circuit. This high power dissipation limits the number of line-interface circuits that can be integrated on a single integrated-circuit device (a "chip"), as well as the number of telephone lines that can be served by a single 48V power supply.

To reduce power dissipation, the art has employed dual-supply line-interface circuits. These circuits employ a second power supply having a voltage lower than the high-voltage (48V) power supply, for powering short subscriber loops.

SUMMARY OF THE INVENTION

In order to reduce even further the power dissipated by a dual-supply line-interface circuit, a dual-slope current-limit profile is employed for operation of the line-interface circuit to effect current limiting. The second power supply preferably operates at 28V, which can be generated from the high-voltage (48V) supply via a DC-to-DC converter. This significantly increases the supply current that is made available by the line-interface circuit to short subscriber loops, and thus significantly increases the number of short subscriber loops which the power supply can handle. For example, assuming 90% efficiency of the converter, the supply current and the short-loop-handling capacity of the power supply are increased by 50%. The 48V supply is still used directly to drive long loops. For intermediate-length loops, the dual-slope current-feed profile is employed to limit the line-interface circuit's power dissipation. The line-interface circuit operates in an apparent constant-current mode using the low power supply up to a threshold line voltage which is equal to the low power supply voltage minus required overhead. For longer loops, the line-interface circuit switches to a second constant-current mode which is substantially lower than the constant current for the shorter loops, which maintains the loop current constant until the loop current drops to the 48V resistive-feed value (the minimum value required to drive a telephony device connected to the loop).

Generally according to the invention, a line-interface circuit for connecting to an analog telephone line that comprises a pair of leads (e.g., tip and ring leads) has a battery-feed circuit that monitors line voltage across the pair of leads and substantially maintains line current flowing between the leads at one of two substantially constant values. When the line voltage is exceeded by a first threshold voltage (e.g., ~25V), the battery-feed circuit maintains the

line current at a first substantially-constant value (e.g., 40 mA). When the line voltage exceeds a second threshold voltage (e.g., ~25.5V), the battery-feed circuit maintains the line current at a second substantially-constant value (e.g., 22 mA). If the two thresholds are not one and the same, the battery-feed circuit preferably varies the line current between the first and the second values as the line voltage varies between the first and the second thresholds. Preferably, the line current monitored by the battery-feed circuit is differential current between the two leads. More specifically according to a preferred embodiment of the invention, the battery-feed circuit comprises a driver for driving (powering) the line which uses a first power supply of dual power supplies to drive the line while the line current is at the first current value, and uses a second power supply of the dual power supplies to drive the line while the line current is at the second value. The dual power supplies operate at voltages of significantly different magnitudes—for example, the first power supply operates at −28VDC and the second power supply operates at −48VDC.

Illustratively, the battery-feed circuit includes a current-feedback loop that includes a constant-current supply that generates a constant current for driving the feedback loop to produce a constant current of one of the first and the second current values on the line. The feedback loop further includes a variable-current supply that generates a variable current that combines with the constant current generated by the constant-current supply to drive the feedback loop. The variable current varies with the line voltage to cause the feedback loop to produce the constant current of the one current value on the line when the line voltage is exceeded by the first threshold value, and to cause the feedback loop to produce a constant current of another of the first and second current values on the line when the line voltage exceeds the second threshold value. The variable current further illustratively causes the feedback loop to produce a line current that varies between the first and the second current values as the line voltage varies between the first and the second threshold values, and vice versa.

In one implementation, a line-interface circuit for connecting to an analog phone line comprising a pair of leads has a battery-feed circuit that powers the line from one of a pair of power supplies operating at significantly different voltages. The battery-feed circuit comprises a pair of drivers, each driving a different one of the pair of leads and each sensing voltage on the different one of the pair of leads. One driver uses a first one of the pair of power supplies to drive the line while the differential current on the leads of the line is at a first value, and uses a second one of the pair of power supplies to drive the line while the differential current is at a second value. The two power supplies operate at voltages of significantly different magnitude. The battery-feed circuit also includes a differential-current sensor for sensing the differential current flowing between the pair of leads and generating a first voltage representative of the differential current. The first voltage is used to control a second voltage at a junction. The battery-feed circuit further includes a transconductance amplifier that drives the one of the pair of drivers. It has an input connected to the junction. A variable-current source generates a variable current at the junction as a function of line voltage in order to create a variable said second voltage at the junction. The net effect is that the differential-current sensor, the variable-current generator, the transconductance amplifier, and the one driver form a current-feedback loop that maintains the differential current at a substantially constant first value when the line voltage is below the first threshold value, and maintains the

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