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(54) **CONTROL HEAD WITH ELECTROLUMINESCENT PANEL IN LAND MOBILE RADIO**

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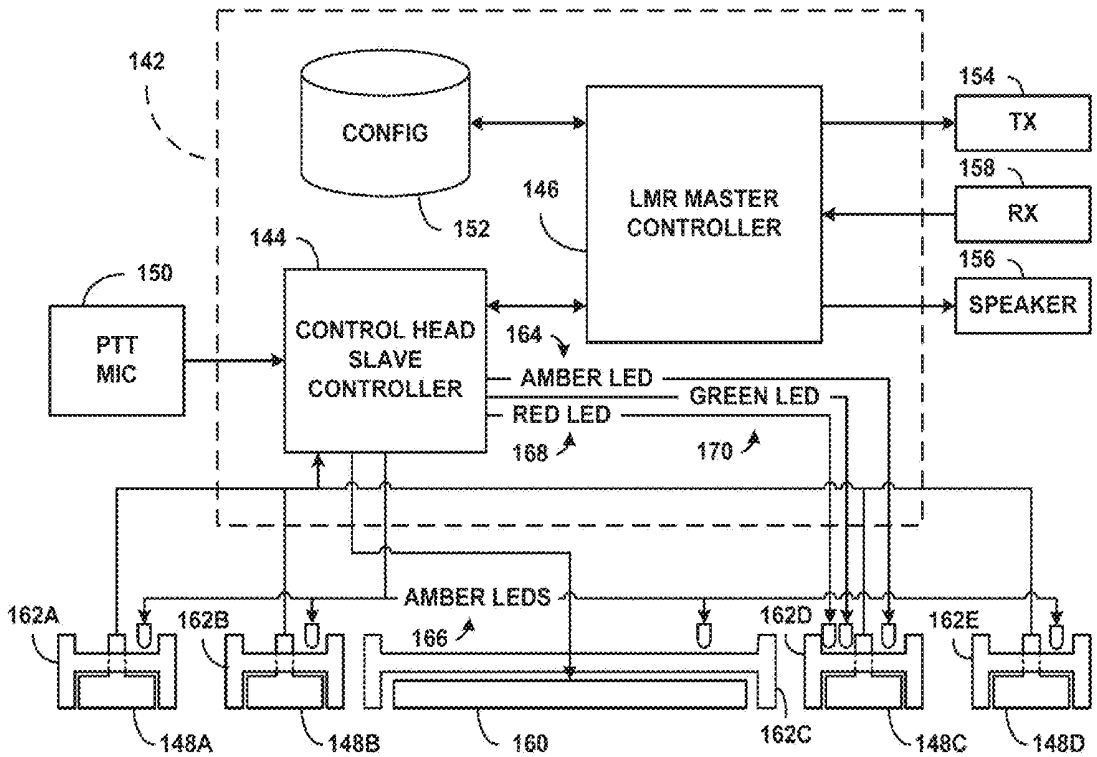
(57) **ABSTRACT**

An exemplary land mobile radio control head and method are provided. In one embodiment, the control head has the capability to utilize halo light of the control head to implement a multi-function indicator that communicates a state of the land mobile radio. In another embodiment, the control head has the capability to provide buffer images constructed from data received from the land mobile radio into a video stream for rendering on an electroluminescent display. In another embodiment, the control head provides the capability for a user to modify a configuration stored on the land mobile radio that defines one of several display modes to be utilized in generating data for use in forming images to be rendered on an electroluminescent display.



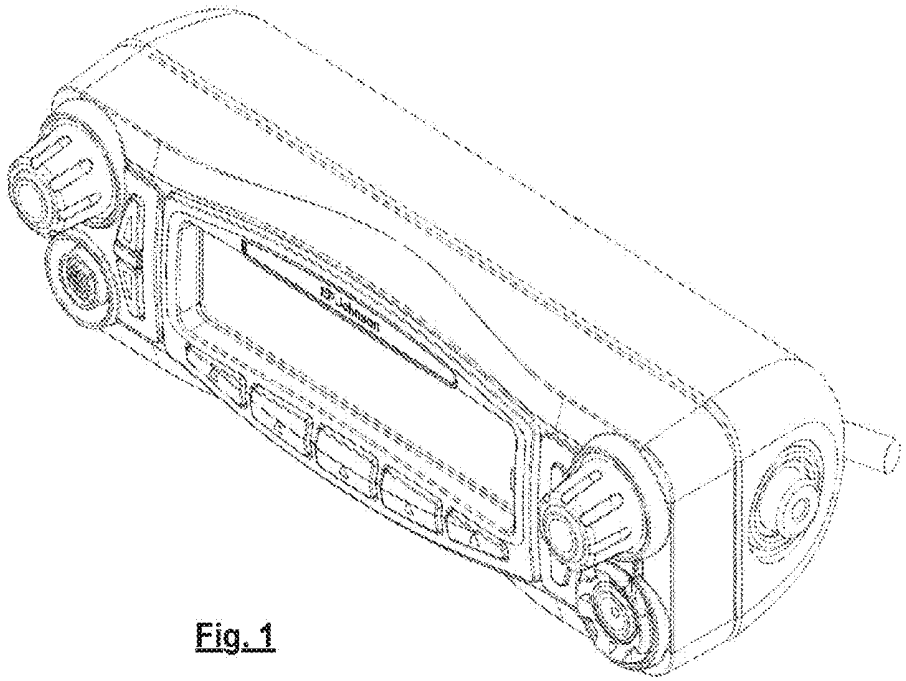


Fig. 1

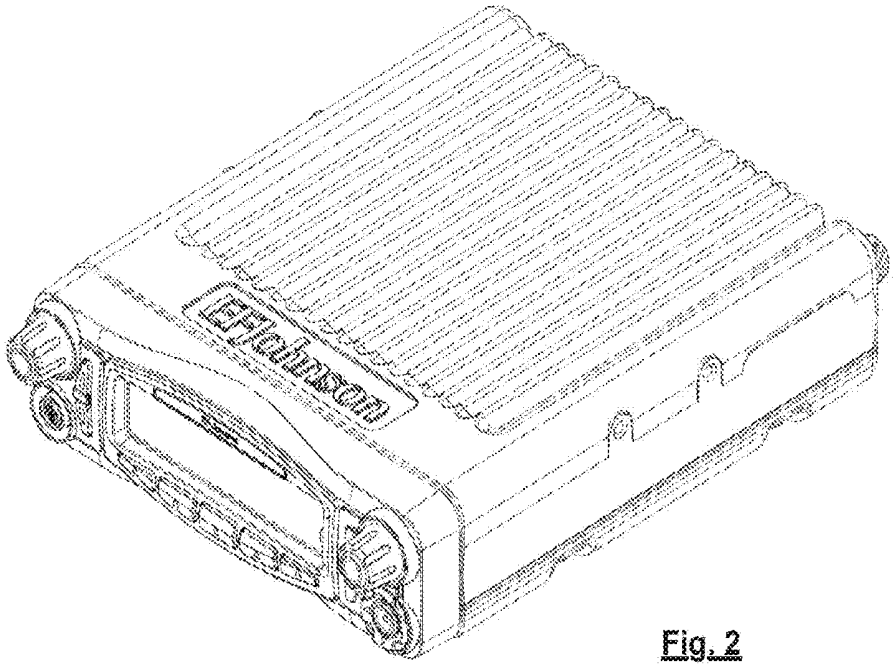


Fig. 2

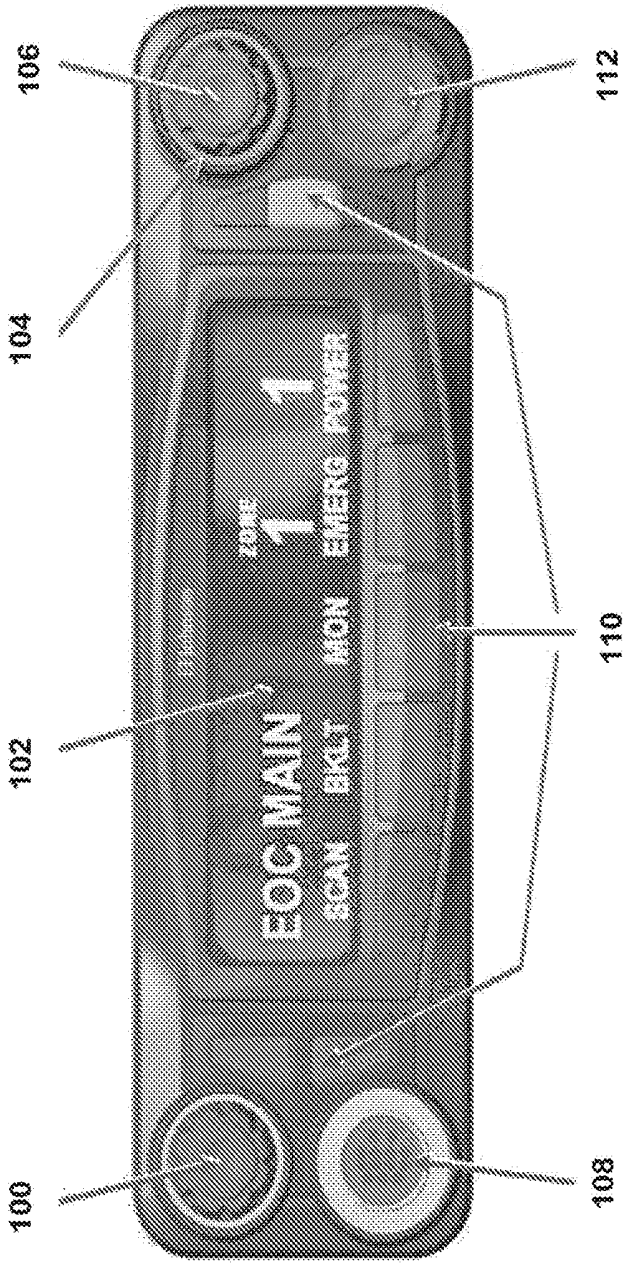

106
112
104
102
110
100
108
EOC MAIN
SCAN
BRGT
MON
EMERG POWER
1
1

Fig. 3

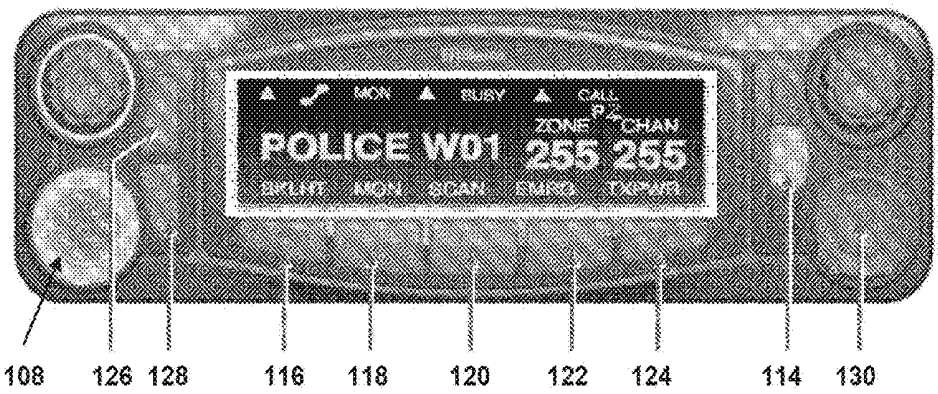

MON
BUSY
CALL
ZONE
CHAN
POLICE W01
255 255
BKLT
MON
SCAN
EMRG
POWR
108
126
128
116
118
120
122
124
114
130

Fig. 4

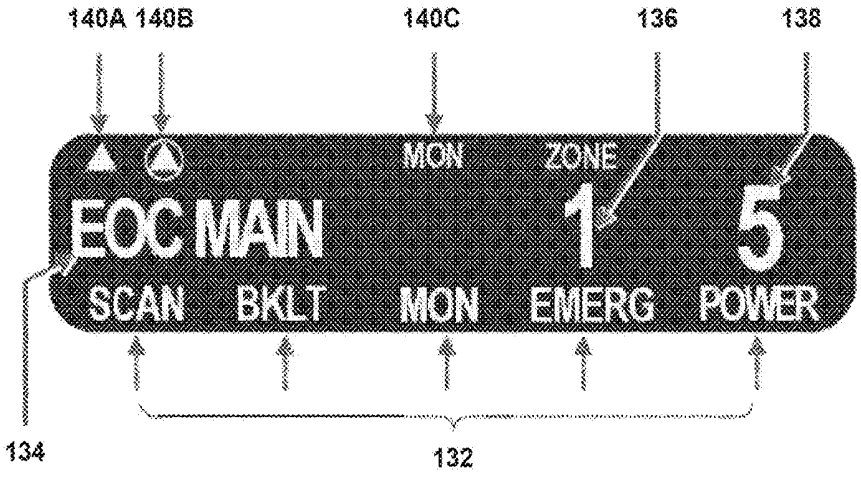

140A
140B
140C
136
138
MON
ZONE
EOC MAIN
1
5
SCAN
BKLT
MON
EMERG
POWER
134
132

Fig. 5

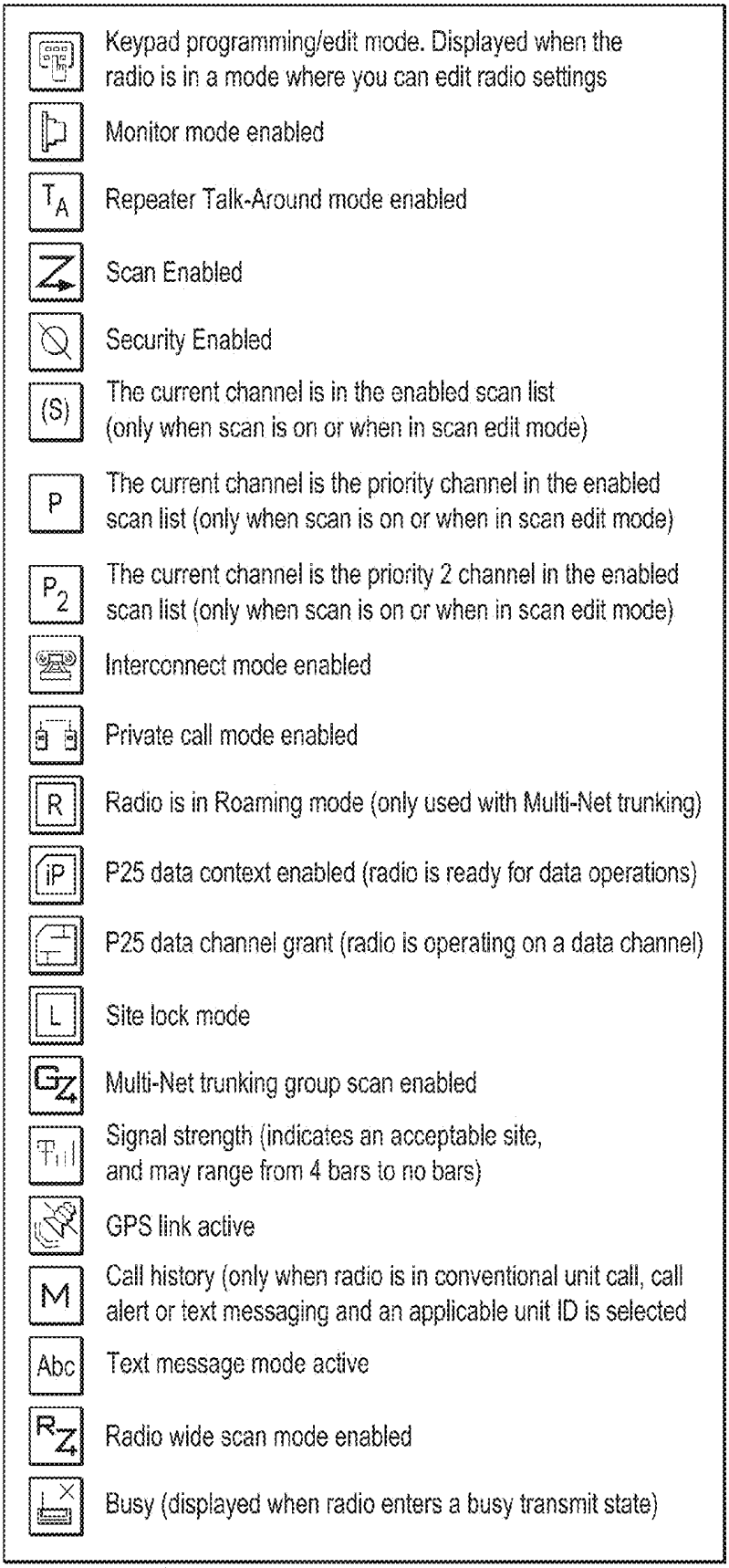

Keypad programming/edit mode. Displayed when the radio is in a mode where you can edit radio settings
Monitor mode enabled
TA
Repeater Talk-Around mode enabled
Scan Enabled
Security Enabled
(S)
The current channel is in the enabled scan list (only when scan is on or when in scan edit mode)
P
The current channel is the priority channel in the enabled scan list (only when scan is on or when in scan edit mode)
P2
The current channel is the priority 2 channel in the enabled scan list (only when scan is on or when in scan edit mode)
Interconnect mode enabled
Private call mode enabled
R
Radio is in Roaming mode (only used with Multi-Net trunking)
iP
P25 data context enabled (radio is ready for data operations)
P25 data channel grant (radio is operating on a data channel)
L
Site lock mode
GZ
Multi-Net trunking group scan enabled
Signal strength (indicates an acceptable site, and may range from 4 bars to no bars)
GPS link active
M
Call history (only when radio is in conventional unit call, call alert or text messaging and an applicable unit ID is selected
Abc
Text message mode active
RZ
Radio wide scan mode enabled
Busy (displayed when radio enters a busy transmit state)

FIG. 6

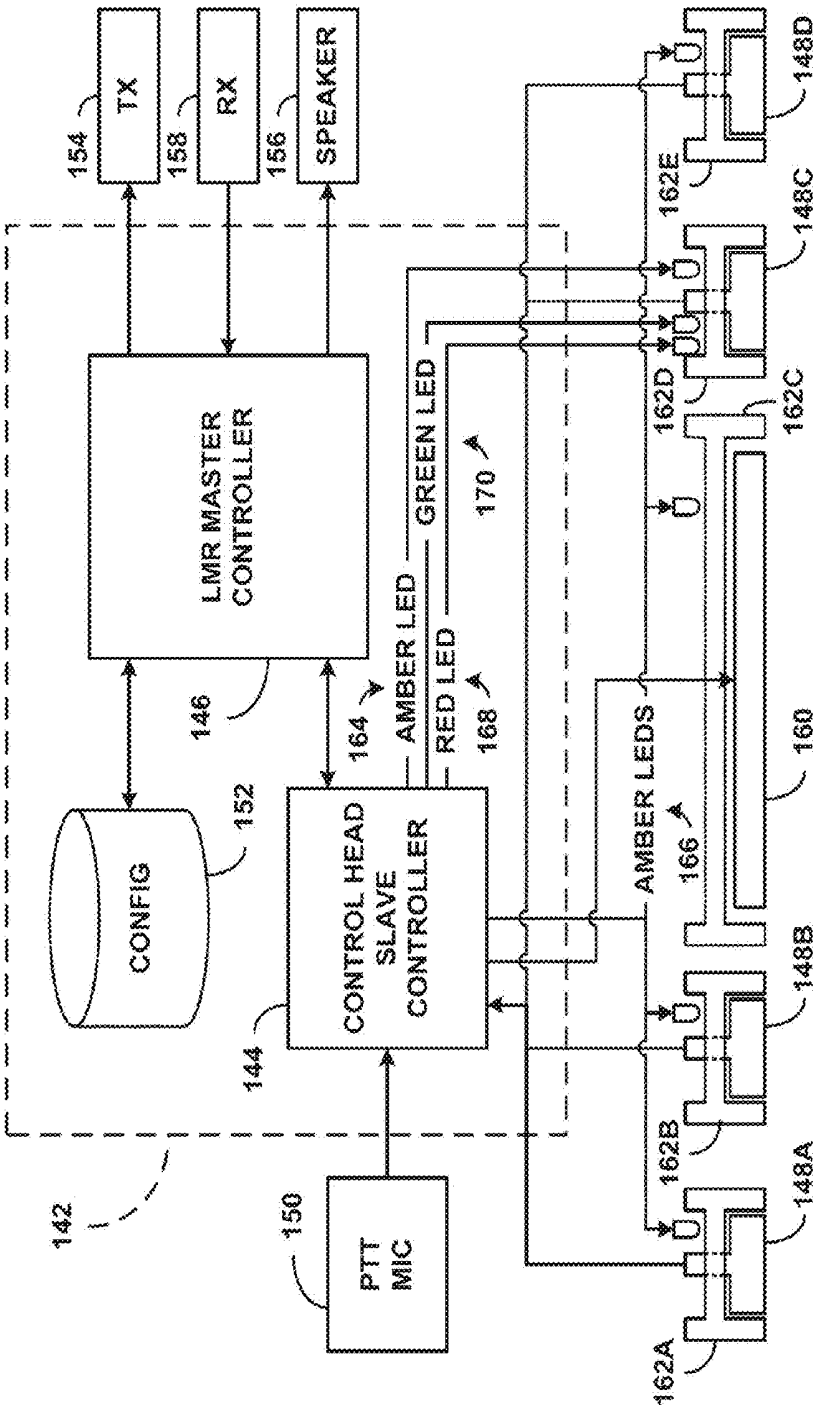

142
144
146
148A
148B
148C
148D
150
152
154
156
158
160
162A
162B
162C
162D
162E
164
166
168
170
AMBER LED
AMBER LEDS
CONFIG
CONTROL HEAD SLAVE CONTROLLER
GREEN LED
LMR MASTER CONTROLLER
PTT MIC
RED LED
RX
SPEAKER
TX

Fig. 7

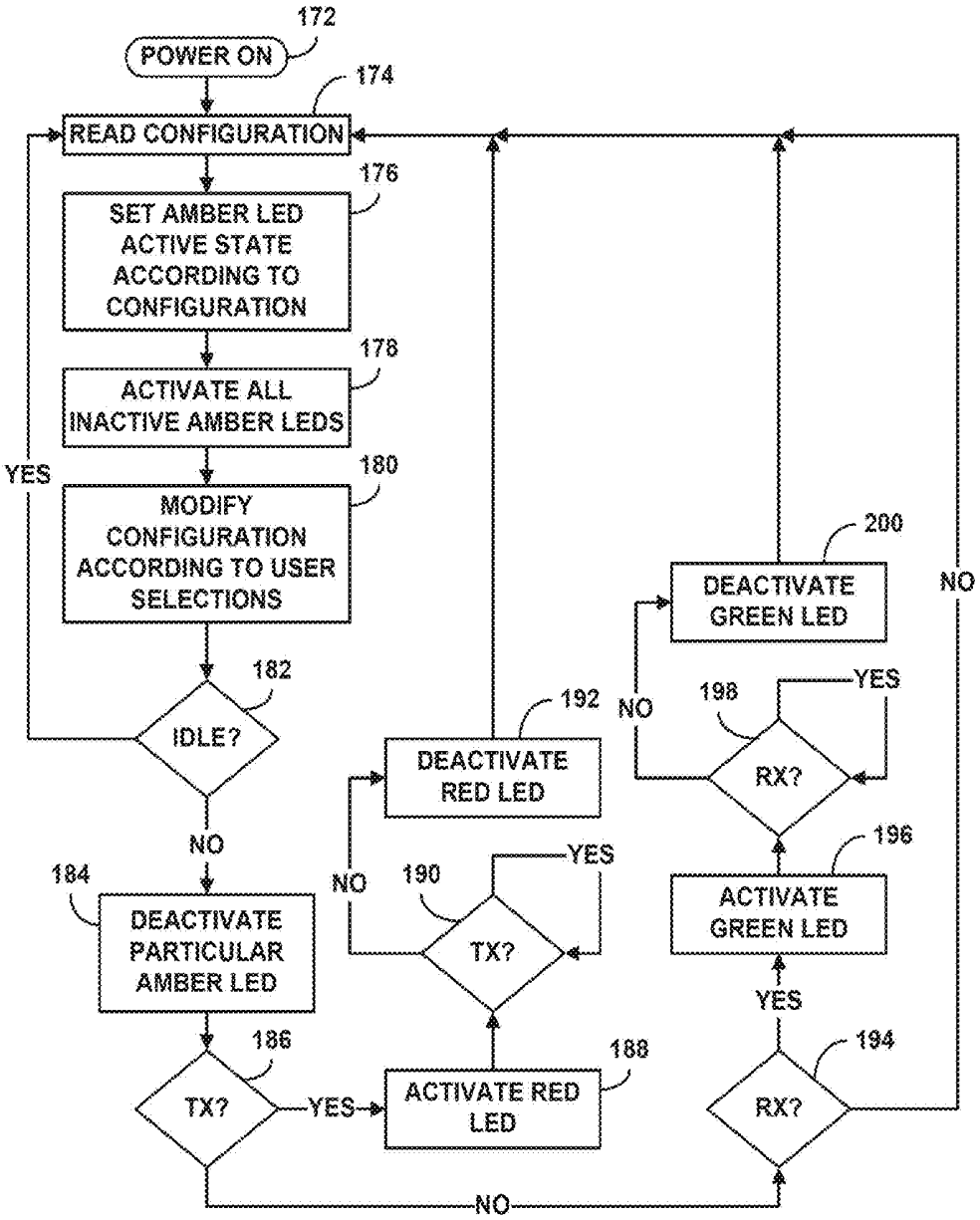

172
POWER ON
174
READ CONFIGURATION
176
SET AMBER LED ACTIVE STATE ACCORDING TO CONFIGURATION
178
ACTIVATE ALL INACTIVE AMBER LEDS
180
MODIFY CONFIGURATION ACCORDING TO USER SELECTIONS
182
IDLE?
YES
NO
184
DEACTIVATE PARTICULAR AMBER LED
186
TX?
YES
NO
188
ACTIVATE RED LED
190
TX?
YES
NO
192
DEACTIVATE RED LED
194
RX?
YES
NO
196
ACTIVATE GREEN LED
198
RX?
YES
NO
200
DEACTIVATE GREEN LED

Fig. 8

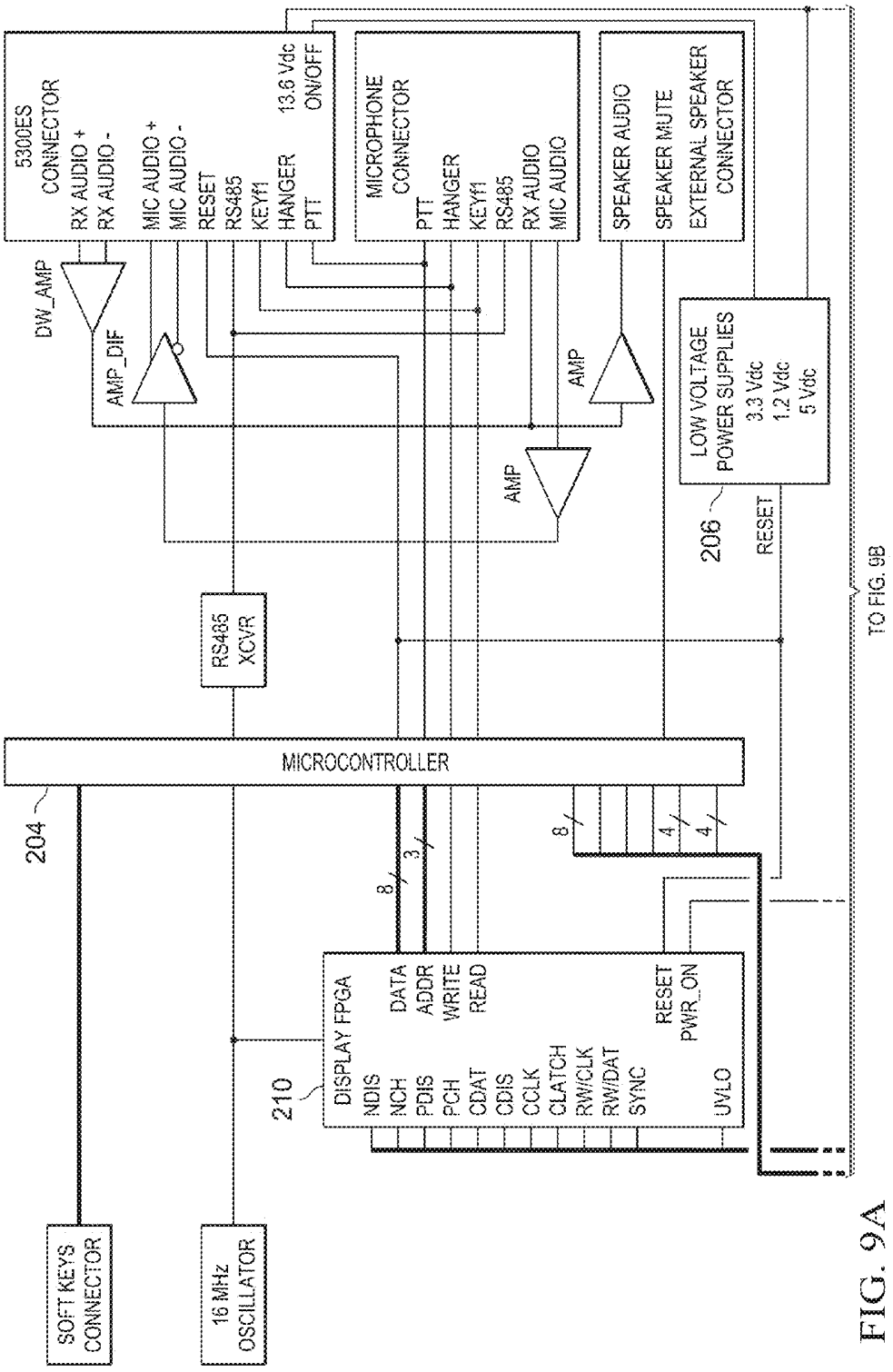

5300ES CONNECTOR
RX AUDIO +
RX AUDIO -
MIC AUDIO +
MIC AUDIO -
RESET
RS485
KEYf1
HANGER
PTT
13.6 Vdc
ON/OFF
MICROPHONE CONNECTOR
PTT
HANGER
KEYf1
RS485
RX AUDIO
MIC AUDIO
SPEAKER AUDIO
SPEAKER MUTE
EXTERNAL SPEAKER CONNECTOR
DW_AMP
AMP_DIF
AMP
AMP
LOW VOLTAGE POWER SUPPLIES
3.3 Vdc
1.2 Vdc
5 Vdc
206
RESET
TO FIG. 9B
RS485 XCVR
MICROCONTROLLER
204
8
3
8
4
4
DISPLAY FPGA
210
NDIS
NCH
PDIS
PCH
CDAT
CDIS
CCLK
CLATCH
RW/CLK
RW/DAT
SYNC
DATA
ADDR
WRITE
READ
RESET
PWR_ON
UVLO
SOFT KEYS CONNECTOR
16 MHz OSCILLATOR

FIG. 9A

FIG. 9B

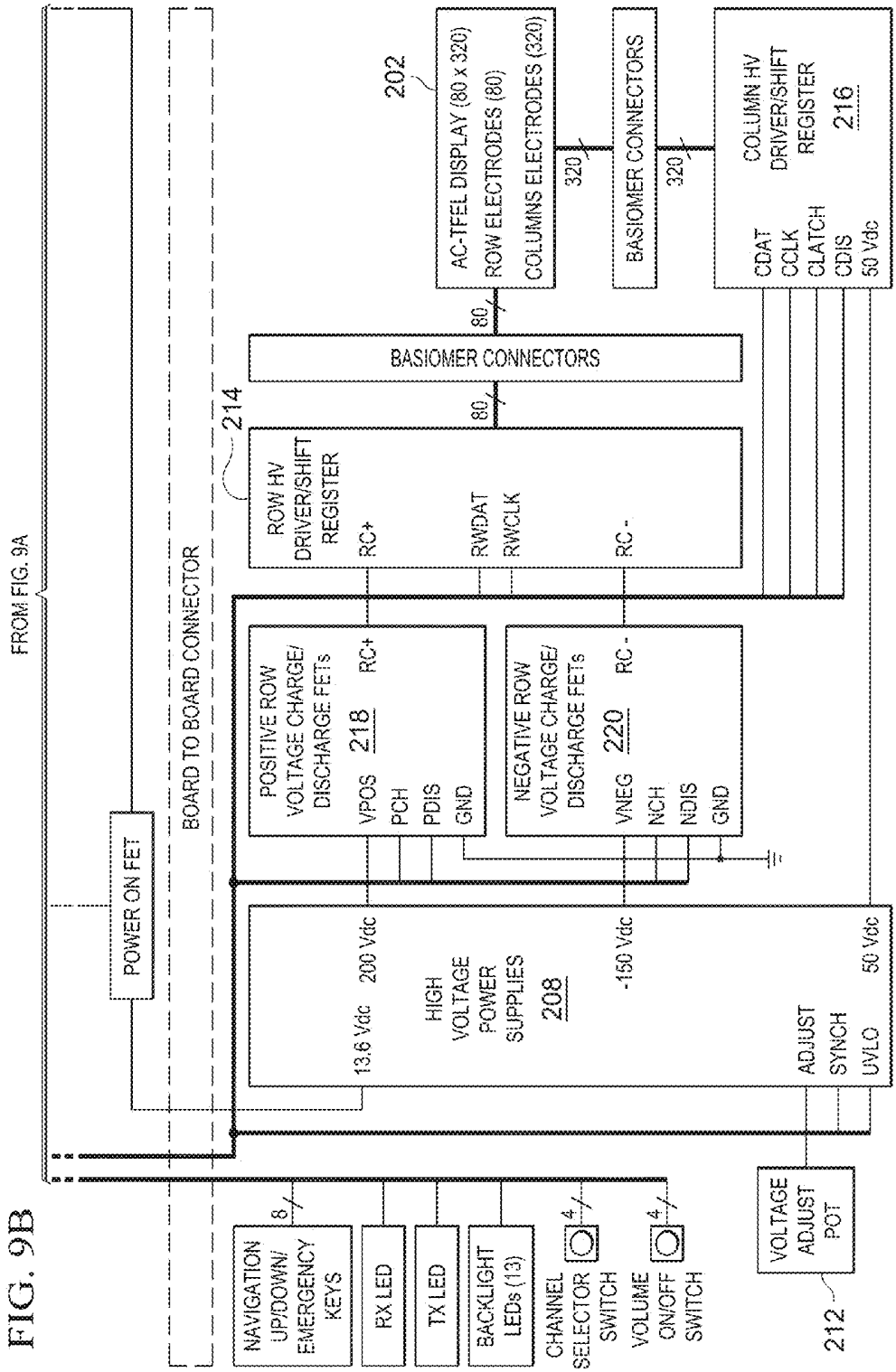

FROM FIG. 9A
POWER ON FET
BOARD TO BOARD CONNECTOR
214
ROW HV DRIVER/SHIFT REGISTER
RC+
RWDAT
RWCLK
RC -
80
BASIOMER CONNECTORS
80
202
AC-TFEL DISPLAY (80 x 320)
ROW ELECTRODES (80)
COLUMNS ELECTRODES (320)
320
BASIOMER CONNECTORS
320
COLUMN HV DRIVER/SHIFT REGISTER
216
CDAT
CCLK
CLATCH
CDIS
50 Vdc
POSITIVE ROW VOLTAGE CHARGE/ DISCHARGE FETs
218
VPOS
PCH
PDIS
GND
RC+
NEGATIVE ROW VOLTAGE CHARGE/ DISCHARGE FETs
220
VNEG
NCH
NDIS
GND
RC -
HIGH VOLTAGE POWER SUPPLIES
208
13.6 Vdc
200 Vdc
-150 Vdc
50 Vdc
ADJUST
SYNCH
UVLO
NAVIGATION UP/DOWN/ EMERGENCY KEYS
8
RX LED
TX LED
BACKLIGHT LEDs (13)
CHANNEL SELECTOR SWITCH
4
VOLUME ON/OFF SWITCH
4
VOLTAGE ADJUST POT
212

FIG. 10

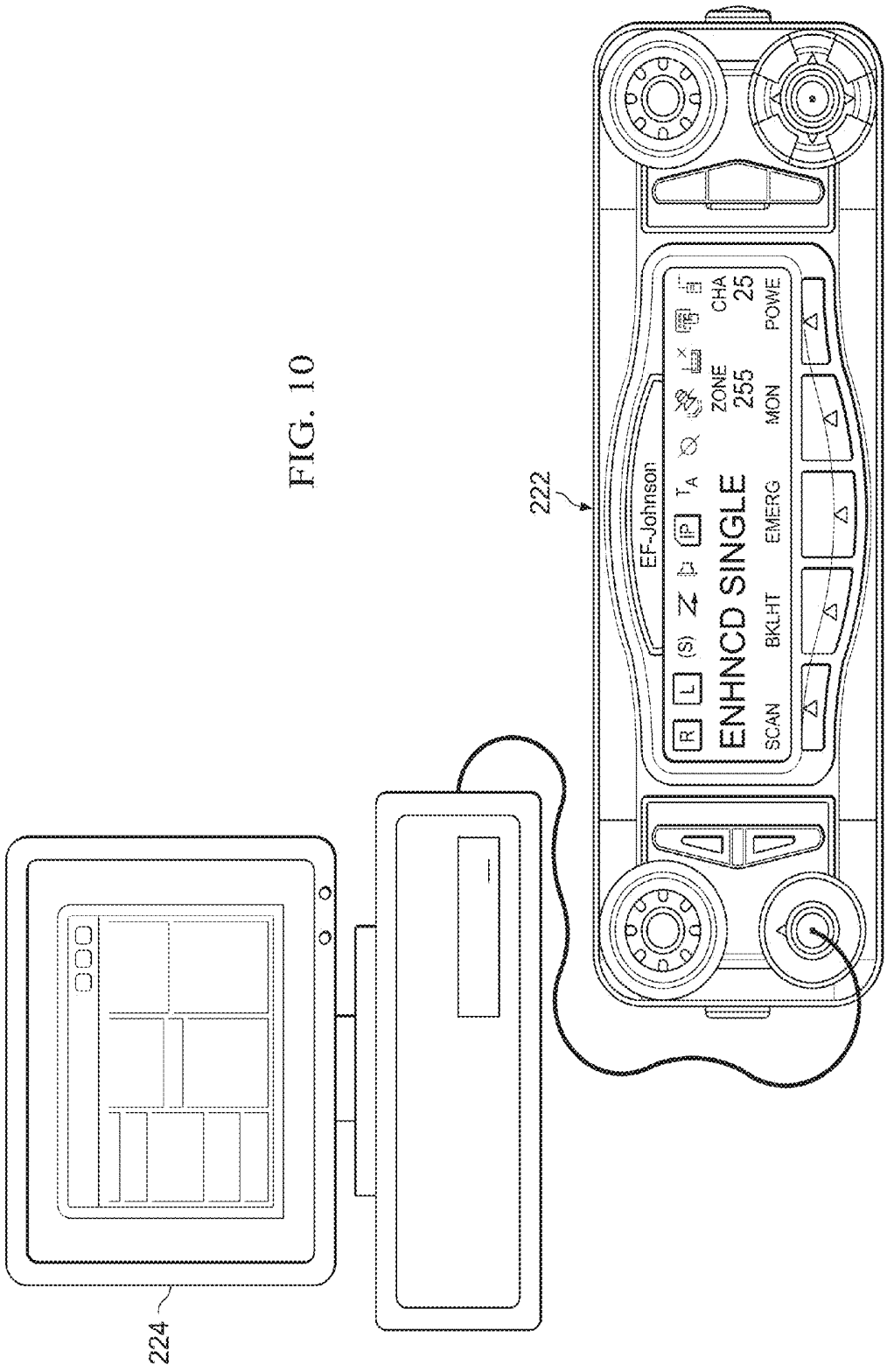
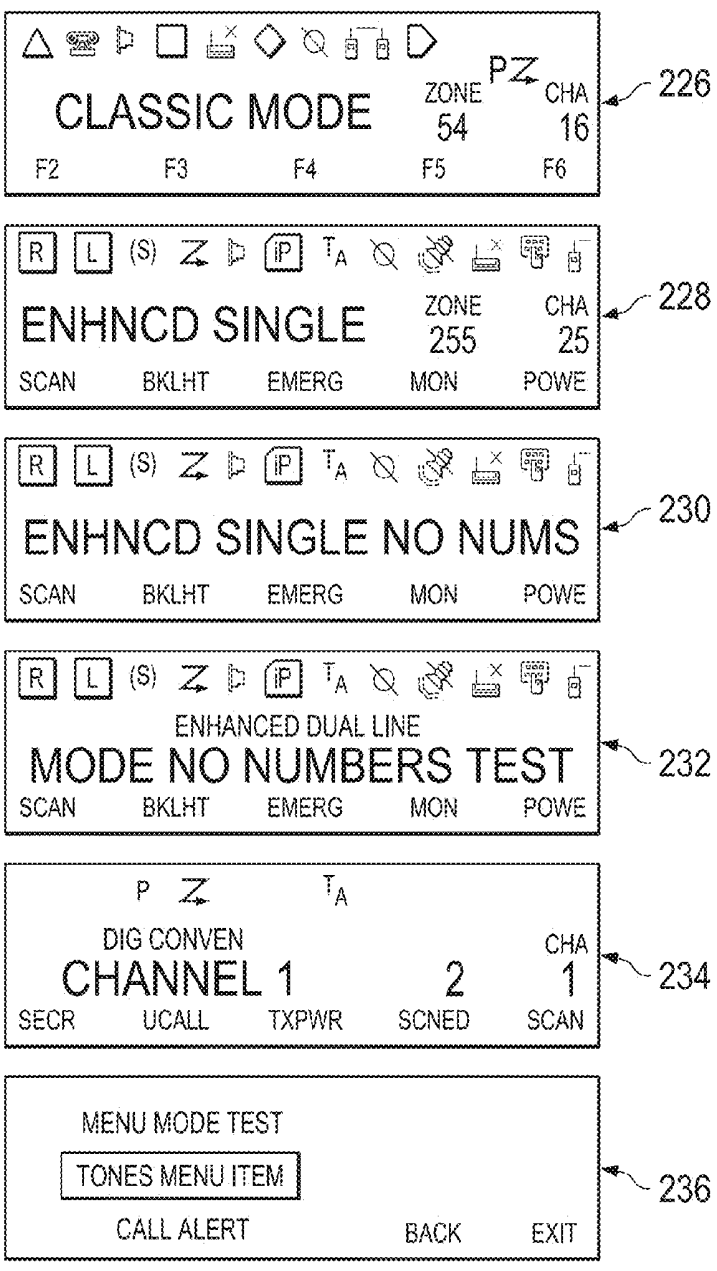

222
224
EF-Johnson
ENHNCD SINGLE
ZONE
255
CHA
25
MON
EMERG
BKLHT
SCAN
POWE

FIG. 11


CLASSIC MODE
ZONE
PZ
CHA
54
16
F2
F3
F4
F5
F6
226
R
L
(S)
ENHNCD SINGLE
ZONE
CHA
255
25
SCAN
BKLHT
EMERG
MON
POWE
228
ENHNCD SINGLE NO NUMS
230
ENHANCED DUAL LINE
MODE NO NUMBERS TEST
232
P
DIG CONVEN
CHANNEL 1
2
1
SECR
UCALL
TXPWR
SCNED
SCAN
234
MENU MODE TEST
TONES MENU ITEM
CALL ALERT
BACK
EXIT
236

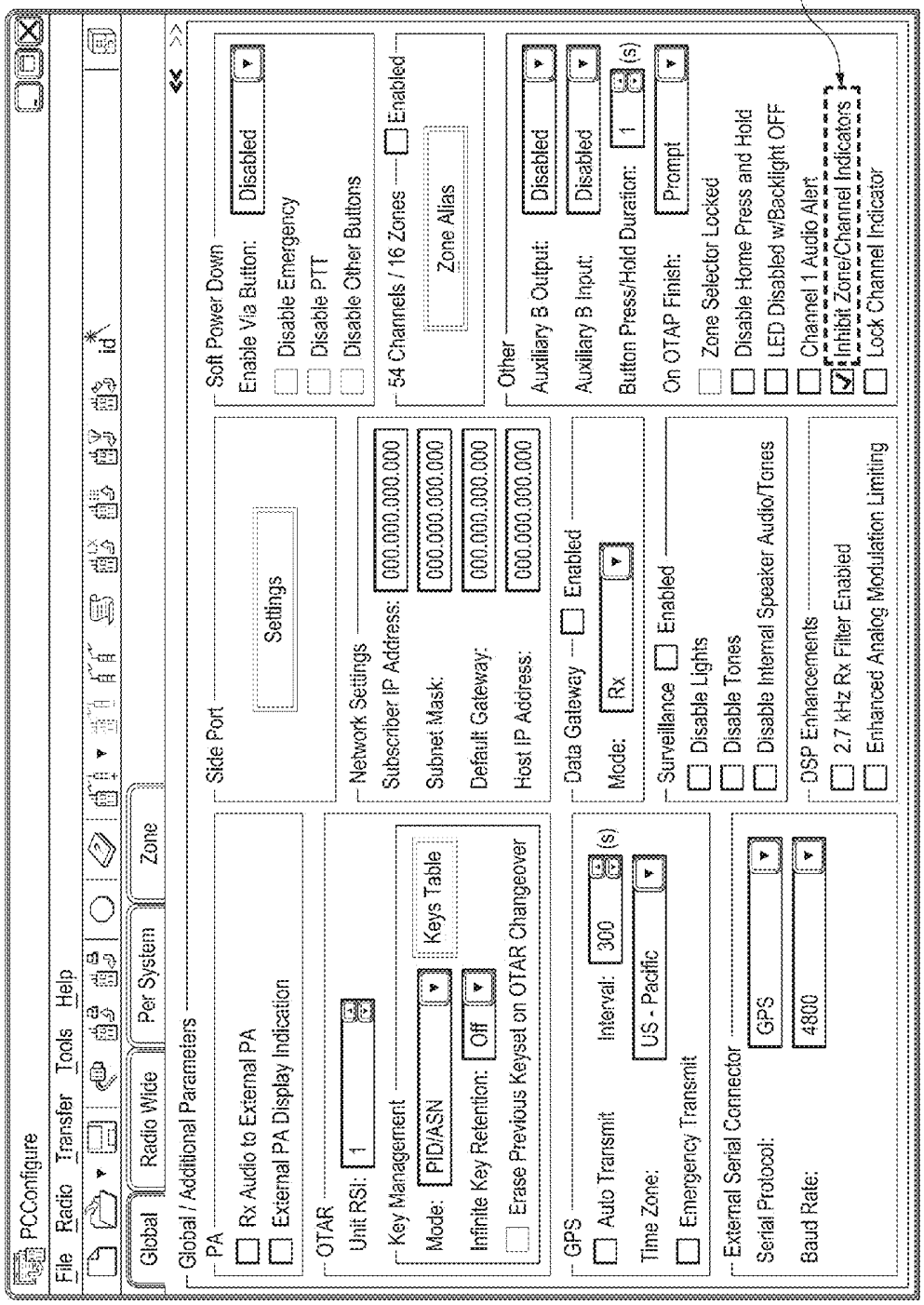

PCConfigure
File Radio Transfer Tools Help
Global
Radio Wide
Per System
Zone
Global / Additional Parameters
PA
Rx Audio to External PA
External PA Display Indication
OTAR
Unit RSI: 1
Key Management
Mode: PID/ASN
Keys Table
Infinite Key Retention: Off
Erase Previous Keyset on OTAR Changeover
GPS
Auto Transmit
Interval: 300 (s)
Time Zone: US - Pacific
Emergency Transmit
External Serial Connector
Serial Protocol: GPS
Baud Rate: 4800
Side Port
Settings
Network Settings
Subscriber IP Address: 000.000.000.000
Subnet Mask: 000.000.000.000
Default Gateway: 000.000.000.000
Host IP Address: 000.000.000.000
Data Gateway
Enabled
Mode: Rx
Surveillance
Enabled
Disable Lights
Disable Tones
Disable Internal Speaker Audio/Tones
DSP Enhancements
2.7 kHz Rx Filter Enabled
Enhanced Analog Modulation Limiting
Soft Power Down
Enable Via Button: Disabled
Disable Emergency
Disable PTT
Disable Other Buttons
54 Channels / 16 Zones
Enabled
Zone Alias
Other
Auxiliary B Output: Disabled
Auxiliary B Input: Disabled
Button Press/Hold Duration: 1 (s)
On OTAP Finish: Prompt
Zone Selector Locked
Disable Home Press and Hold
LED Disabled w/Backlight OFF
Channel 1 Audio Alert
Inhibit Zone/Channel Indicators
Lock Channel Indicator
238

FIG. 12

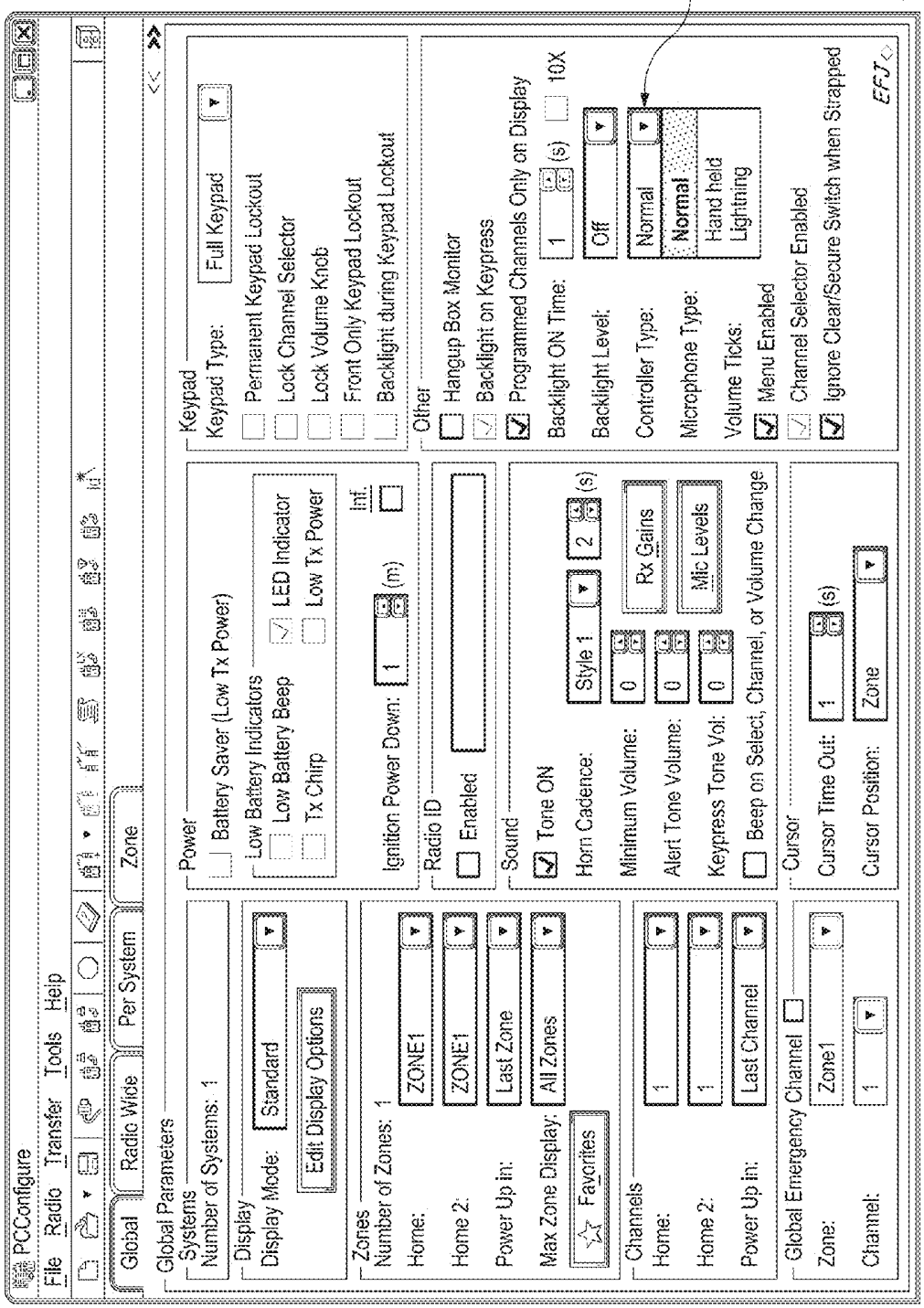

PCConfigure
File Radio Transfer Tools Help
Global
Radio Wide
Per System
Zone
Global Parameters
Systems
Number of Systems: 1
Display
Display Mode: Standard
Edit Display Options
Zones
Number of Zones: 1
Home: ZONE1
Home 2: ZONE1
Power Up in: Last Zone
Max Zone Display: All Zones
Favorites
Channels
Home: 1
Home 2: 1
Power Up in: Last Channel
Global Emergency Channel
Zone: Zone1
Channel: 1
Power
Battery Saver (Low Tx Power)
Low Battery Indicators
Low Battery Beep
Tx Chirp
LED Indicator
Low Tx Power
Ignition Power Down: 1 (m) Inf.
Radio ID
Enabled
Sound
Tone ON
Horn Cadence: Style 1 2 (s)
Minimum Volume: 0 Rx Gains
Alert Tone Volume: 0 Mic Levels
Keypress Tone Vol: 0
Beep on Select, Channel, or Volume Change
Cursor
Cursor Time Out: 1 (s)
Cursor Position: Zone
Keypad
Keypad Type: Full Keypad
Permanent Keypad Lockout
Lock Channel Selector
Lock Volume Knob
Front Only Keypad Lockout
Backlight during Keypad Lockout
Other
Hangup Box Monitor
Backlight on Keypress
Programmed Channels Only on Display
Backlight ON Time: 1 (s) 10X
Backlight Level: Off
Controller Type: Normal
Microphone Type: Normal Hand held Lightning
Volume Ticks:
Menu Enabled
Channel Selector Enabled
Ignore Clear/Secure Switch when Strapped
240
EFJ

FIG. 13

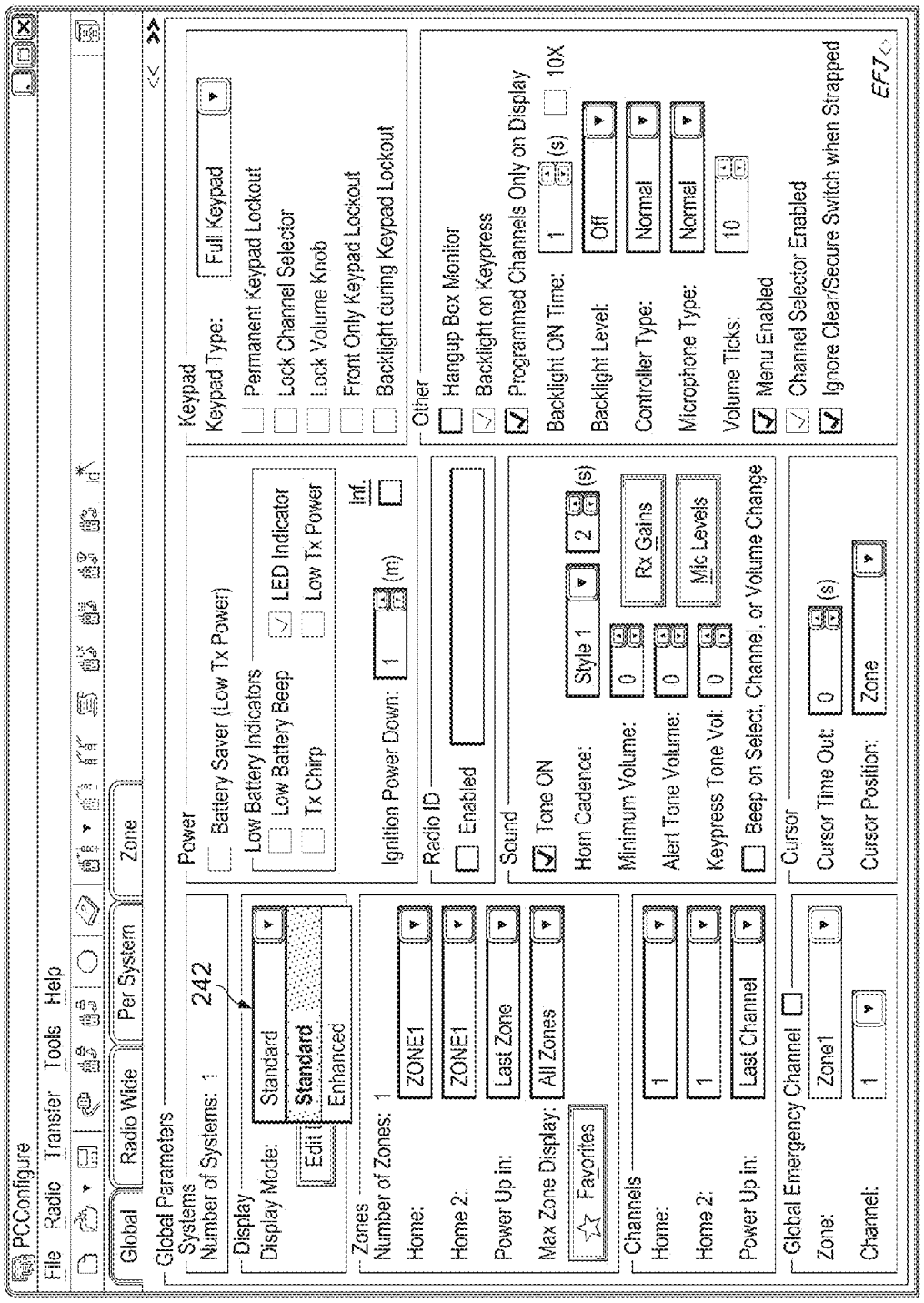

PCConfigure
File Radio Transfer Tools Help
Global
Radio Wide
Per System
Zone
Global Parameters
Systems
Number of Systems: 1
242
Display
Display Mode:
Standard
Edit
Standard
Enhanced
Zones
Number of Zones: 1
Home:
ZONE1
Home 2:
ZONE1
Power Up in:
Last Zone
Max Zone Display:
All Zones
Favorites
Channels
Home:
1
Home 2:
1
Power Up in:
Last Channel
Global Emergency Channel
Zone:
Zone1
Channel:
1
Power
Battery Saver (Low Tx Power)
Low Battery Indicators
Low Battery Beep
Tx Chirp
LED Indicator
Low Tx Power
Ignition Power Down:
1
(m)
Inf.
Radio ID
Enabled
Sound
Tone ON
Horn Cadence:
Style 1
2
(s)
Minimum Volume:
0
Rx Gains
Alert Tone Volume:
0
Mic Levels
Keypress Tone Vol:
0
Beep on Select, Channel, or Volume Change
Cursor
Cursor Time Out:
0
(s)
Cursor Position:
Zone
Keypad
Keypad Type:
Full Keypad
Permanent Keypad Lockout
Lock Channel Selector
Lock Volume Knob
Front Only Keypad Lockout
Backlight during Keypad Lockout
Other
Hangup Box Monitor
Backlight on Keypress
Programmed Channels Only on Display
Backlight ON Time:
1
(s)
10X
Backlight Level:
Off
Controller Type:
Normal
Microphone Type:
Normal
Volume Ticks:
10
Menu Enabled
Channel Selector Enabled
Ignore Clear/Secure Switch when Strapped
EFJ

FIG. 14

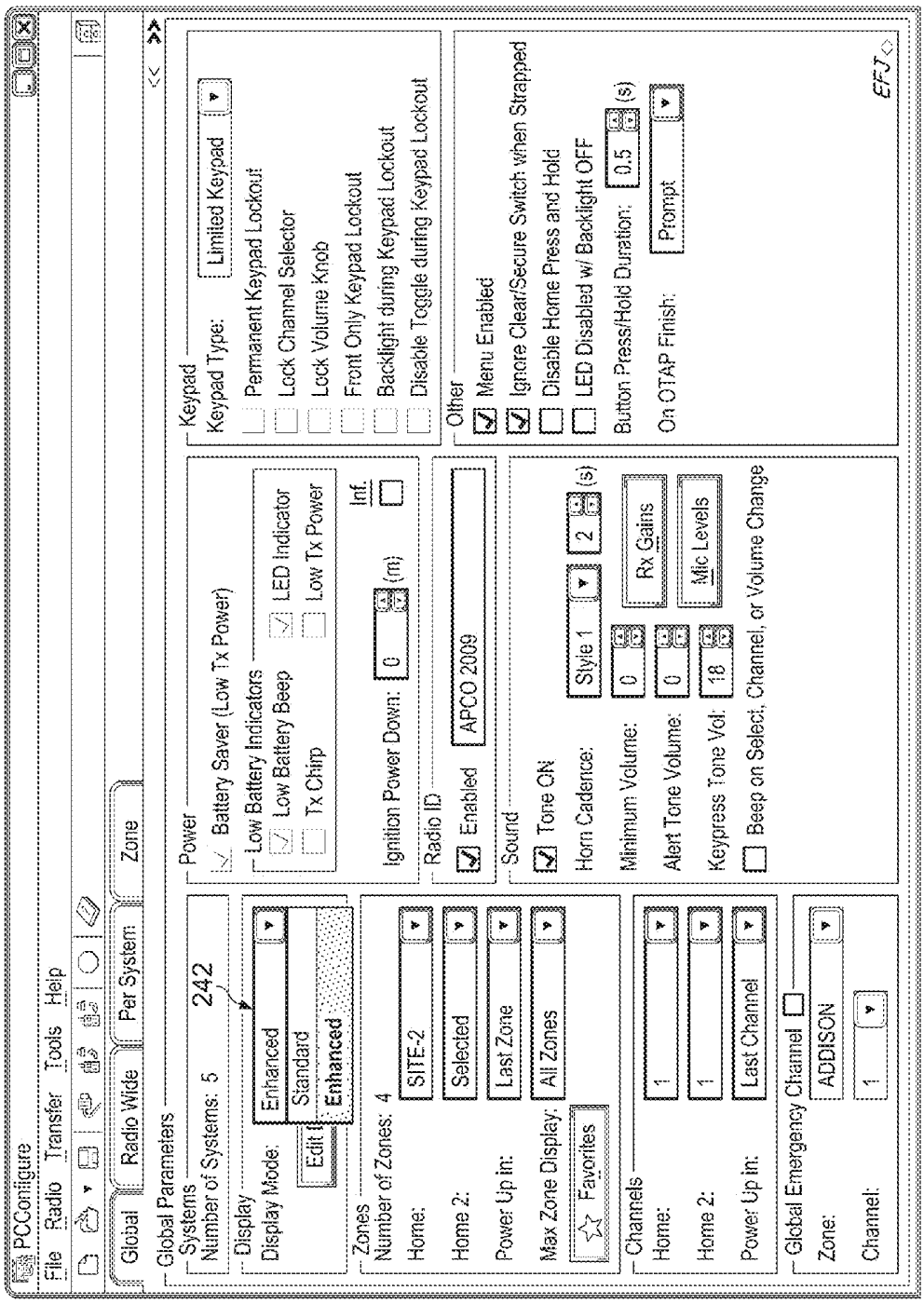

PCConfigure
File Radio Transfer Tools Help
Global
Radio Wide
Per System:
Zone
Global Parameters
Systems
Number of Systems: 5
242
Display
Display Mode:
Enhanced
Standard
Edit
Enhanced
Zones
Number of Zones: 4
Home:
SITE-2
Home 2:
Selected
Power Up in:
Last Zone
Max Zone Display:
All Zones
Favorites
Channels
Home:
1
Home 2:
1
Power Up in:
Last Channel
Global Emergency Channel
Zone:
ADDISON
Channel:
1
Power
Battery Saver (Low Tx Power)
Low Battery Indicators
Low Battery Beep
Tx Chirp
LED Indicator
Low Tx Power
Ignition Power Down:
0
(m)
Inf.
Radio ID
Enabled
APCO 2009
Sound
Tone ON
Horn Cadence:
Style 1
2
(s)
Minimum Volume:
0
Rx Gains
Alert Tone Volume:
0
Mic Levels
Keypress Tone Vol:
18
Beep on Select, Channel, or Volume Change
Keypad
Keypad Type:
Limited Keypad
Permanent Keypad Lockout
Lock Channel Selector
Lock Volume Knob
Front Only Keypad Lockout
Backlight during Keypad Lockout
Disable Toggle during Keypad Lockout
Other
Menu Enabled
Ignore Clear/Secure Switch when Strapped
Disable Home Press and Hold
LED Disabled w/ Backlight OFF
Button Press/Hold Duration:
0.5
(s)
On OTAP Finish:
Prompt
EFJ

FIG. 15

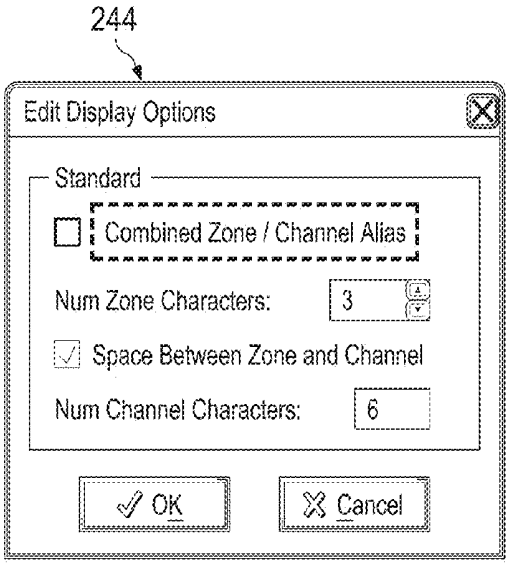

244
Edit Display Options
Standard
Combined Zone / Channel Alias
Num Zone Characters:
3
Space Between Zone and Channel
Num Channel Characters:
6
OK
Cancel

FIG. 16

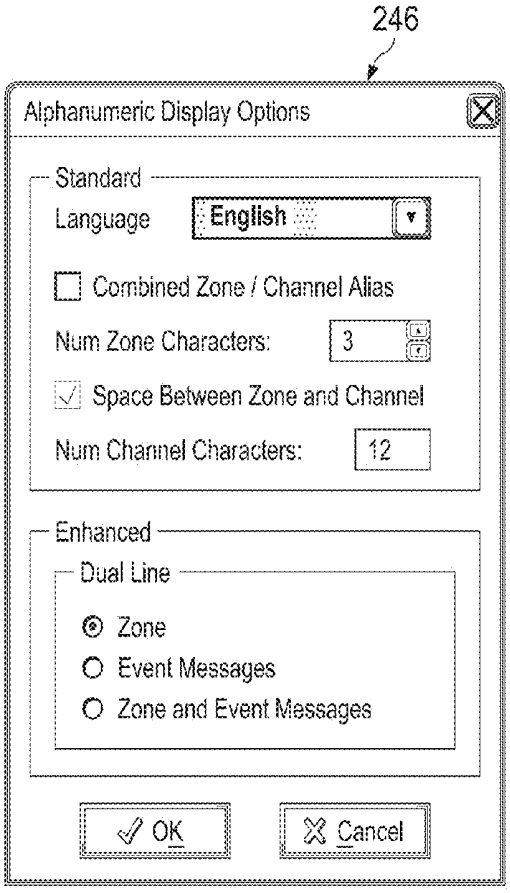

246
Alphanumeric Display Options
Standard
Language
English
Combined Zone / Channel Alias
Num Zone Characters:
3
Space Between Zone and Channel
Num Channel Characters:
12
Enhanced
Dual Line
Zone
Event Messages
Zone and Event Messages
OK
Cancel

FIG. 17

CONTROL HEAD WITH ELECTROLUMINESCENT PANEL IN LAND MOBILE RADIO

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] Pursuant to 35 U.S.C. §120, this application is a continuation of U.S. patent application Ser. No. 12/614,348, entitled "Control Head with Electroluminescent Panel in Land Mobile Radio," filed Nov. 6, 2009, which claims the benefit of U.S. Provisional Patent Application Ser. No. 61/112,086, entitled "Control Head with Electroluminescent Panel in Land Mobile Radio," filed Nov. 6, 2008, all of which are incorporated herein by reference for all purposes.

TECHNICAL FIELD

[0002] The present disclosure relates generally to the field of land mobile radio and more particularly, but not by way of limitation, to a control head having an electroluminescent panel.

BACKGROUND

[0003] Land Mobile Radio (LMR) systems are deployed by organizations requiring instant communication between geographically dispersed and mobile personnel. Typical users of LMR systems include police departments, fire departments, medical personnel, EMS and the military.

SUMMARY

[0004] According to an exemplary aspect of the present disclosure, a control head for land mobile radio comprises an electroluminescent panel. As described below, it comprises several aspects capable of enabling one or more of a multitude of advantages and benefits.

[0005] One technical aspect of the exemplary control head may be the capability to utilize halo light of the control head to implement a multi-function indicator that communicates a state of the land mobile radio.

[0006] Another aspect may be the capability to buffer images constructed from data received from the land mobile radio into a video stream for rendering on an electroluminescent display.

[0007] Another aspect may include the capability for a user to modify a configuration stored on the land mobile radio that defines one of several display modes to be utilized in generating data for use in forming images to be rendered on an electroluminescent display.

[0008] Other technical advantages may be readily apparent to one skilled in the art after review of the following figures and description associated herewith.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] For a more complete understanding of the present disclosure and the advantages thereof, reference is now made to the following brief description, taken in connection with the accompanying drawings and detailed description, wherein like reference numerals represent like parts, in which:

[0010] FIG. **1** is a perspective view of a control head remote from a land mobile radio.

[0011] FIG. **2** is a perspective view of a control head attached to or integrated with a land mobile radio.

[0012] FIG. **3** is a frontal view of an electroluminescent panel of a control head.

[0013] FIG. **4** is another frontal view of the electroluminescent panel of a control head.

[0014] FIG. **5** is a view of a display of a control head.

[0015] FIG. **6** is a list of symbols that may be used on the display to indicate various operating modes and status.

[0016] FIG. **7** is a functional block diagram illustrating a land mobile radio system implementing a control head.

[0017] FIG. **8** is a flow diagram illustrating a method of operation for controlling a multi-function indicator implemented utilizing a halo light of a control head.

[0018] FIGS. **9**A and **9**B illustrate an electronic circuit diagram for a control head.

[0019] FIG. **10** is a perspective view illustrating programming of a configuration of a control head utilizing a computer processor.

[0020] FIG. **11** is a set of views illustrating results of varying configurations of a control head to provide different display modes.

[0021] FIG. **12** is a screenshot illustrating a user interface component whereby a selection is made for the control head configuration whether to inhibit a zone/channel indicator.

[0022] FIG. **13** is a screenshot illustrating a user interface component whereby a selection is made for a control head configuration of a controller head type.

[0023] FIG. **14** is a screenshot illustrating a user interface component whereby a selection is made for a control head configuration of a display mode.

[0024] FIG. **15** is a screenshot illustrating the user interface component of FIG. **14** whereby another selection is made for the control head configuration of a different display mode.

[0025] FIG. **16** is a screenshot illustrating a user interface component whereby a selection is made for a control head configuration of display options for the display mode selected in FIG. **14**.

[0026] FIG. **17** is a screenshot illustrating a user interface component whereby a selection is made for a control head configuration of display options for the display mode selected in FIG. **15**.

DETAILED DESCRIPTION

[0027] It should be understood at the outset that although exemplary implementations of the present disclosure are illustrated below, the present disclosure may be implemented using any number of techniques, whether currently known or in existence. The present invention should in no way be limited to the exemplary implementations, options, drawings, and techniques illustrated below, including the exemplary design and implementation illustrated and described herein. Additionally, the drawings contained herein are not necessarily drawn to scale.

[0028] A component for land mobile radios is a control head that offers superior readability and display options for the radio user. Referring to FIG. **1**, the control head can be fitted to a remote mount in a land mobile radio installation. Alternatively, referring to FIG. **2**, the control head can be fitted or integrated as a dash mount in a land mobile radio installation.

[0029] Turning to FIG. **3**, the front panel of the control head can have multiple features. For example, it can have an on-off/volume switch **100** for turning the power on/off function to the radio. When the power is on, this control can be rotated to adjust the radio speaker volume. Also, an electroluminescent

display **102** can show all primary operating information, such as active channel, zone, channel/zone alias, status symbols, and labels for the function buttons under the display. In the embodiment shown in FIG. **3**, five buttons are provided under the display on the control head. Additionally, a multi-function indicator **104** can be provided in which halo light surrounding a button or switch, such as a select zone/channel switch **106**, is used to indicate radio transmit and receive status. A steady red halo, in one embodiment, may indicate that the radio is transmitting, while a steady green halo may indicate that the radio is receiving, and a steady amber halo may indicate that the radio is idle. Further, the select zone/channel switch **106** may be implemented with two actions: rotation and press. In normal nonmenu mode, pressing the control can select either the zone or the channel. Then, rotation of the control can change either the zone or channel. An indication can be provided on the display whether zone or channel is selected. Yet further, a microphone connection **108** can be provided that allows a compatible microphone to plug into this jack connector. Further still, the control head can have a number, such as eight, one-touch buttons **110**, including two on the left of the display, five under the display, and an orange button on the right of the display. These buttons in certain embodiments may be programmed with different radio functions. Finally, a 4-way navigation pad **112** may be provided for navigating through various radio functions and menus. In other embodiments the navigation pad **112** may be implemented with either more or less than a 4-way pad. Like the buttons **110**, the pad **112** can be programmed with different radio functions.

[0030] Turning now to FIG. **4**, as mentioned above, the control head can have a number, such as nine, of programmable controls **114-130**. A number of land mobile radio functions can be assigned to these buttons using a computer processor that connects to the land mobile radio control head via the microphone connection **108**. Example radio functions that the user can configure include scan, backlight level, monitor, emergency, and transmitter power.

[0031] Referring now to FIG. **5**, an advantageous feature of the control head is a highly readable electroluminescent display. In some embodiments, the display is a monochrome display with 320×80 pixels. This display can support a Classic Single Line display mode familiar to users of previous types of land mobile radio control head displays. In Classic Single Line display mode, the display can have primary fields corresponding to the fields available on earlier model(s) of control heads, but with the addition of the soft menu keys and display of labels **132** of functions assigned to those soft menu keys as described above. More familiar display contents include channel name **134**, zone number **136**, channel number **138**, and symbols **140**A-**140**C to indicate operating mode and status. A list of symbols used on the display to indicate various operating modes and status that may be implemented in certain embodiments is provided in FIG. **6**.

[0032] The electroluminescent display panel provides a clear, bright and readable display, which is advantageous in public safety applications. In some embodiments, the electroluminescent display features high brightness and contrast, resists fading, provides long operating life, has a viewing angle greater than 160°, and provides 200 G shock durability. Furthermore, the electroluminescent display incorporates, in some embodiments, emissive pixel technology, which makes small text more legible. The electroluminescent display may be operated in a reflective mode to provide crisp, clear viewing of the electroluminescent display in bright light, even through polarized lenses. Additionally, the size of alphanumeric characters presented on the electroluminescent display may be adjusted.

[0033] Turning now to FIG. **7**, a land mobile radio system **142** generally has a control head controller **144** that operates as a slave to a land mobile radio master controller **146**. The control head controller **144** detects user actuations of controls **148**A-**148**D and signals the master controller **146**. Controller **144** also reacts to user actuation of a push to talk microphone by signaling transmission and passing the audio data.

[0034] The master controller **146** transmit audio data from microphone **150** via transmitter **154**, and drive speakers **156** to output audio data received via receiver **158**. Also, the master controller **146** constructs user interface data frame contents of electroluminescent display **160** in accordance with a configuration stored in data store **152**. Additionally, the master controller **146** operates the UI in response to the user actuations at least partly in accordance with the configuration. Controller **144** constructs UI data received from master controller **146** into images that are buffered into a video stream for rendering on electroluminescent display **160**.

[0035] Additional components of the control head operated by master controller **146** in accordance with the configuration include indicators, such as lights or LEDs, located behind light pipes **162**A-**162**E. These light pipes provide halo light for controls **148**A-**148**D, and for display **160**. In one embodiment, each of the light pipes **162**A-**162**E has an amber LED that provides the halo light at an intensity level recorded in the configuration, and that can be adjusted by user actuation of one of the controls **148**A-**148**D, or another control. At least one of the light pipes additionally may include red and green LEDs collocated with its amber LED. A signal line **164** to that amber LED can be controlled independently of signal lines **166** to the other amber LEDs. The red and green LEDs may also have independently controllable signal lines **168** and **170**.

[0036] Turning now to FIG. **8**, the controllers operate the LEDs according to a method that accomplishes indication of the LMR transmit/receive status. Beginning at power up **172**, the configuration is read at step **174** to determine an intensity level for the amber LEDs, and an active state is set for the amber LEDs at step **176** according to the configuration. Next, one or all inactive amber LEDs may be activated at step **178**. Thereafter, the user can adjust intensity of the LEDs by actuation of one of the controls of the control head, resulting in modification of the configuration according to the user selections at step **180**. If the radio is determined to be idle at decision step **182**, then processing may return to step **174** and steps **174-182** are traversed continually, resulting in adjustment of the intensity level of the amber LEDs according to the user selections.

[0037] When the radio is transmitting or receiving, this state change will be detected at step **182**, resulting in deactivation at step **184** of the amber LED that is collocated with the red and green LEDs. Then, if the radio is determined to be transmitting at decision step **186**, then the red LED, in one embodiment, is activated at step **188**. Thereafter, as long as the radio is determined to still be transmitting at decision step **190**, the red LED will remain active. Once a determination is made at step **190** that the transmission has ended, then the red LED is deactivated at step **192**, and processing returns to step **174**. Thereafter, the amber LED is reactivated at step **178** and remains active as long as the radio is determined to be idle at step **182**.

[0038] Processing during a receive state similar to that during the transmit state. If the radio is determined to be receiving at decision step **194**, then the green LED, in one embodiment, is activated at step **196**, and it remains activated as long as the radio is determined to be receiving at decision step **198**. Once the receipt is determined to have ended at step **198**, the green LED is deactivated at step **200**, and processing returns to step **174**. Thus, a halo light behind one of the user interface components serves as a multifunction indicator without interfering with the halo function of the other components, and while allowing the intensity of the amber halo light of the components to be adjusted independently of the red and green indicator lights.

[0039] Turning now to FIGS. **9**A and **9**B, the control head display **202**, in one embodiment, can be implemented as an alternating-current thin-film electroluminescent (AC-TFEL) display. In this case, the display glass panel can be covered by two sets of electrodes (80 row electrodes and 320 column electrodes) in the horizontal and vertical directions. The electrodes are separated by thin film insulating layers. The sensor layer can be a phosphor layer that emits light when exposed to a strong electric field. A single light emitting pixel is created at the intersection of each row and column electrode. The brightness of the pixel is determined by the voltage between the two electrodes. In other embodiments, the control head display **202** may be implemented using other known or available display technology.

[0040] The control head controller **204**, in one embodiment, may be Freescale MC9S08QE128 which has internal FLASH and SRAM for program and data storage, general purpose I/O ports, and a UART port for communication with the master controller in the land mobile radio. In some embodiments, the control head controller **204** is configured to operate as a slave to the master controller in the land mobile radio for most I/O. In this case, it reports keypresses, switch changes, and microphone inputs to the master controller via RS485 serial data links. In one embodiment, the control head controller **204** does not act on these data. Similarly, control of LEDs and other output functions can be directed by the master controller. In one embodiment, the control head controller **204** formats the data, from the master controller, into a pixel image that is displayed on the AC-TFEL Display.

[0041] The low voltage power supply **206** can be one or more switching and low drop out linear regulators which provide power to the logic and analog circuits. Contained within this plot is a circuit that generates a reset signal if the battery (13.6 Vdc nominal) supply from the radio, the 3.3 Vdc supply, or 1.2 Vdc supply, for example, is out of tolerance.

[0042] The high voltage (HV) power supply **208** may be a PWM controlled flyback transformer design which provide nominal 220 Vdc, 50 Vdc, and −150 Vdc outputs to power the AC-TFEL Display. Input power to supply may be provided in one implementation from the radio battery supply (13.6 Vdc nominal) through a FET switch controlled by the Display FPGA **210**. The output voltage levels can be adjusted by volume adjustment potentiometer **212** to set the brightness level of the AC-TFEL Display. The power supply switching frequency (150 kHz) is controlled by Display FPGA **210**.

[0043] A display frame in one implementation may be composed of 80 lines of 320 bits (pixels) for a total of 25600 pixels per frame. In operation, a line of pixels (**320**) can be shifted into a Column HV Driver/Shift Register **216** and latched into output registers which control the outputs of the HV output drivers attached to the column electrodes on the AC-TFEL Display. A new line of pixels is shifted into the register **216** after the pixels for the line have been latched into the output registers.

[0044] When the column data is latched, a HV pulls from the Row HV Driver/Shift Register **214** can be applied to the AC-TFEL Display row electrode associated with that line of pixels. The HV pulse on the active row electrode is either 200 Vdc or −150 Vdc. A pixel will begin to emit light when the voltage across its row and column electrode exceeds approximately +/−180 Vdc. For a positive row voltage of pulse of 200 Vdc, a column voltage of 0 Vdc will light the pixel and a column voltage of 50 Vdc will turn it off. For a negative row voltage of pulse of −150 Vdc, a column voltage of 50 Vdc will light the pixel and a column voltage of 0 Vdc will turn it off.

[0045] The Row HV Driver/Shift Register **214** may be loaded at the beginning of each frame, in one embodiment, with a seed bit that enables a single row HV driver output. After a row is pulsed, the seed bit is shifted to the next row to enable its HV driver output. The polarity of the row voltage pulse alternates with each line of pixels. The Positive Row Voltage Charge/Discharge FET **218** and Negative Row Voltage Charge/Discharge FET **220** circuits generate the HV pulses applied to the row electrode through the HV output drivers in the Row HV Driver/Shift Register **214** and discharge the electrode after the pulse has been applied.

[0046] The Display FPGA **210** controls the operation of the circuitry associated with the AC-TFEL Display **202** to display images on the display that are generated by the control head controller **204**. Functionally the Display FPGA **210** contains a display data buffer, a frame timing generator, and display control logic to control operation of the Negative Row Voltage Charge/Discharge FET **220**, Positive Row Voltage Charge/Discharge FET **218**, Row HV Driver/Shift Register **214**, and Column HV Driver/Shift Register **216**.

[0047] The display buffer can be a 3200 byte dual port RAM that is accessed by the control head controller **204** to load pixel data for screen images and by the internal frame generator logic to read the pixel data. The control head controller can load data into the display buffer through an eight bit parallel data port. Two internal eight bit registers form the byte address of the display buffer to which the control head controller writes data. The control head controller **204** can load an address into these registers through the eight bit parallel data port. The combined address register can be auto-incremented each time the control head controller **204** writes to the display buffer.

[0048] The frame timing generator can generate internal frame start, line start, pixel data, and pixel clock signals that are used by the display control logic to control the circuitry surrounding the AC-TFEL Display **202**. The frame refresh rate can be controlled by register that is set by the control head controller **204** via the eight bit parallel data port.

[0049] The display control logic can use the framing, clock, and pixel data from the frame timing generator to generate the actual signals used by the AC-TFEL Display electronics. This signal generation can include timing for HV row charge/discharge pulses, shifting and latch column and row data, and alternating polarity of row charge/discharge pulses. Additionally, the display control logic can provide for an orderly start up/shut down of the AC-TFEL Display **202** after reset or if the High Voltage Power Supply **208** is in an under voltage condition.

[0050] Turning now to FIG. **10**, the display mode of the land mobile radio **222** can be programmed by the end user, in

one implementation, employing a computer processor **224** to define a display configuration of the land mobile radio **222**. To this end, the computer processor **224** can communicate with the land mobile radio **222** by a cable that connects to the microphone port on the control head. The computer processor **224** runs a program that allows the user to define the configuration stored in a processor memory of the radio through a set of menus. By defining this configuration, a number of different display modes can be realized.

[0051] Turning to FIG. **11**, there are a variety of display modes that can be available in some embodiments. For example, a classic mode **226** can be available that provides a display mode like that provided by previous land mobile radios not having electroluminescent displays. There can also be an enhanced single line mode **228** with zone/channel display similar to that of the classic mode, but with soft key function labels and additional or different symbols or indicating operational modes and statuses of the radio.

[0052] Another display mode **230** can be an enhanced single line mode in which display of zone and channel is inhibited, permitting display of additional text. An additional display mode **232** can be an enhanced dual line display mode allowing display of even more text with zone and channel display inhibited.

[0053] Yet another display mode **234** can be a dual line display mode in which zone and channel are displayed. Finally, an enhanced menu **236** can be displayed with user configurable options that are navigable by use of a control on the control head. These modes can be selected by the user selecting options for controller head type, whether to inhibit zone/channel display, a classic versus enhanced display mode, and if in the enhanced mode, whether to exercise the option to display two lines of text, as indicated below in table 1.

TABLE 1

	Control Head Type Normal/Lightning	Inhibit Zone Chan Indicator Checkbox	Display Mode Standard/ Enhanced
Classic with Zone Chan	Normal	Off	Standard
Classic without Zone Chan	Normal	On	Standard
Enhanced Single with Zone/Chan	Lightning	Off	
Enhanced Single without Zone Chan	Lightning	On	
Enhanced Dual with Zone/Chan	Lightning	Off	
Enhanced Dual without Zone/Chan	Lightning	On	

[0054] There are a number of menus that allow the user to configure the display mode of the control head in addition to other functions of the radio. For example, turning to FIG. **12**, one of the menus that allows the user to make a selection for configuring the display mode can contain a checkbox **238** for exercising an option to inhibit the zone/channel indicator. Selecting this checkbox can inhibit the display of the zone/channel indicator even in the classic mode. Also, turning to FIG. **13**, a controller type drop down menu **240** can allow the user to select controller type. Turning to FIGS. **14** and **15**, a display mode drop down menu **242** allows the user to select a standard or enhanced display mode, which can affect options provided for configuring the radio. Some of these options relate to display options. For example, turning to FIGS. **16** and **17**, display options **244** for the standard display mode do not permit selection to display two lines of text. In contrast, the display options **246** in the enhanced mode permit selection to display two lines of text.

[0055] Thus, it is apparent that there has been provided, in accordance with the present disclosure, a control head that satisfies one or more of the advantages that forth above. Although the preferred embodiment has been described in detail, it should be understood that various changes, substitutions, and alterations can be made herein without departing from the scope of the present disclosure, even if all of the advantages and benefits identified above are not present. For example, the various embodiments and examples shown in the drawings and descriptions provided herein illustrate that the present disclosure may be implemented and embodied in numerous different ways that still fall within the scope of the present disclosure, whether expressly shown herein or not. For example, the various elements or components may be combined or integrated in another system or certain features may not be implemented. Also, the techniques, systems, subsystems, and methods described and illustrated in the preferred embodiment discrete or separate may be combined or integrated with other systems, designs, techniques, or methods without departing from the scope of the present disclosure. For example, the control head can be used with a wide variety of types of LMR systems and networks, including those not specifically discussed herein. Other examples of changes, substitutions, and alterations are readily ascertainable by one skilled in the art and could be made without departing from the spirit and scope of the present disclosure.

What is claimed is:

1. A control head for use with a land mobile radio, the control head comprising:

a plurality of user interface input/output components;

one or more first light pipes each having a first LED operable to illuminate a respective one of the one or more first light pipes to provide a light for at least one of said user interface input/output components;

a second light pipe having a plurality of indicator LEDs operable to illuminate the second light pipe to provide an indicator light for at least another one of said user interface input/output components; and

a control system configured to determine a state of the land mobile radio, to control activation of the first LEDs, and to control activation of the indicator LEDs to indicate the state of the land mobile radio via the indicator light, wherein the second light pipe is illuminated different hues for different states of the land mobile radio.

2. The control head of claim **1**, wherein the another one of said user interface input/output components comprises a user actuable button.

3. The control head of claim **1**, wherein at least one of the user interface input/output components comprises an electroluminescent display.

4. The control head of claim **1**, wherein the light provided by the first LED and the illuminated first light pipe is a halo light.

5. The control head of claim **1**, wherein the indicator light is an indicator halo light.

6. The control head of claim **1**, wherein the control system is operable to monitor the state of the land mobile radio and, in response to detecting a change in the state of the land

mobile radio, to control activation of each of the indicator LEDs to indicate the change in the state of the land mobile radio via the indicator light.

7. The control head of claim **1**, wherein the control system is operable to activate a first one of the plurality of indicator LEDs to illuminate the second light pipe and the indicator light a first hue to indicate the land mobile radio is in a first state.

8. The control head of claim **7**, wherein the first state is an idle state.

9. The control head of claim **1**, wherein the control system is operable to activate a second one of the plurality of indicator LEDs to illuminate the second light pipe and the indicator light a second hue to indicate the land mobile radio is in a second state.

10. The control head of claim **9**, wherein the second state is a transmit state.

11. The control head of claim **1**, wherein the control system is operable to activate a third one of the plurality of indicator LEDs to illuminate the second light pipe and the indicator light a third hue to indicate the land mobile radio is in a third state.

12. The control head of claim **11**, wherein the third state is a receive state.

13. The control head of claim **1**, wherein the control system is further operable to generate display data on one of the user interface input/output components in accordance with a user-selected display mode.

14. The control head of claim **13**, wherein the user-selected display mode is selected from various display modes defined by a configuration.

15. The control head of claim **1**, wherein the control system comprises a master controller and a control head slave controller.

16. A method of operation for a control head for use with a land mobile radio, the control head having a plurality of user interface input/output components, one or more first light pipes each having a first LED, a second light pipe having a plurality of indicator LEDs, and a control system, the method comprising:

activating, via the control system, one or more of the first LEDs to illuminate one or more of the first light pipes to provide a light for one or more of the user interface input/output components;

determining, via the control system, a state of the land mobile radio; and

activating, via the control system, one of the plurality of indicator LEDs to illuminate the second light pipe to provide an indicator light for at least another one of the user interface input/output components to indicate the state of the land mobile radio via the indicator light, wherein the second light pipe is illuminated different hues for different states of the land mobile radio.

17. The method of claim **16**, wherein the another one of said user interface input/output components comprises a user actuable button.

18. The method of claim **16**, wherein at least one of said user interface input/output components comprises an electroluminescent display.

19. The method of claim **16**, wherein the light provided by the first LED and the illuminated first light pipe is a halo light.

20. The method of claim **16**, wherein the indicator light is an indicator halo light.

21. The method of claim **16**, further comprising:

monitoring, via the control system, the state of the land mobile radio; and

in response to detecting a change in the state of the land mobile radio, controlling, via the control system, activation of each of the plurality of indicator LEDs to indicate the change in the state of the land mobile radio via the indicator light.

22. The method of claim **16**, wherein indicating the state of the land mobile radio via the indicator light includes activating, via the control system, a first one of the plurality of indicator LEDs to illuminate the second light pipe and the indicator light a first hue when the land mobile radio is in a first state.

23. The method of claim **22**, wherein the first state is an idle state.

24. The method of claim **16**, wherein indicating the state of the land mobile radio via the indicator light includes activating, via the control system, a second one of the plurality of indicator LEDs to illuminate the second light pipe and the indicator light a second hue when the land mobile radio is in a second state.

25. The method of claim **24**, wherein the second state is a transmit state.

26. The method of claim **16**, wherein indicating the state of the land mobile radio via the indicator light includes activating, via the control system, a third one of the plurality of indicator LEDs to illuminate the second light pipe and the indicator light a third hue when the land mobile radio is in a third state.

27. The method of claim **26**, wherein the third state is a receive state.

28. The method of claim **16**, further comprising generating, via the control system, display data on one of the user interface input/output components in accordance with a user-selected display mode.

29. The method of claim **28**, wherein the user-selected display mode is selected from various display modes defined by a configuration.

30. The method of claim **16**, wherein the control system comprises a master controller and a control head slave controller.

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专利名称(译)	在陆地移动无线电中使用电致发光面板的控制头		
公开(公告)号	US20160198540A1	公开(公告)日	2016-07-07
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[标]申请(专利权)人(译)	公司的特洛伊 邓尼根表示威廉伯爵 李维dulie		
申请(专利权)人(译)	FRANDSEN，TROY 邓尼根，WILLIAM EARL REAVILL，DULIE		
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发明人	FRANDSEN, TROY DUNNIGAN, WILLIAM EARL REAVILL, DULIE		
IPC分类号	H05B33/08 H04B1/401 H05B33/12 F21V23/00 F21V23/04		
CPC分类号	H05B33/0845 F21V23/003 F21V23/04 F21Y2101/02 H04B1/401 F21Y2105/006 H05B33/12 F21Y2115/10 F21Y2105/00 F21Y2115/20 G09G3/30 H01H13/83 G06F3/0482 G06F3/04842 G06T1/60 G09G3/3258 G09G2310/08 H05B45/10		
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摘要(译)

提供了示例性陆地移动无线电控制头和方法。在一个实施例中，控制头具有利用控制头的晕光来实现传递陆地移动无线电的状态的多功能指示器的能力。在另一个实施例中，控制头具有将从陆地移动无线电接收的数据构成的缓冲图像提供到视频流中以便在电致发光显示器上呈现的能力。在另一个实施例中，控制头为用户提供修改存储在陆地移动无线电上的配置的能力，该配置定义了若干显示模式中的一种，用于生成数据以用于形成要在电致发光显示器上呈现的图像。