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Pilat et al.

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(54) **UNIVERSAL WIRELESS TRAINABLE TRANSCEIVER UNIT WITH INTEGRATED BIDIRECTIONAL WIRELESS INTERFACE FOR VEHICLES**

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This patent is subject to a terminal disclaimer.

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G08C 17/02 (2006.01)

(52) **U.S. Cl.**
CPC ***H04B 1/202*** (2013.01); ***G08C 17/02*** (2013.01); *G08C 2201/20* (2013.01); *G08C 2201/92* (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,614,891 A 3/1997 Zeinstra et al.
5,619,190 A 4/1997 Duckworth et al.
(Continued)

FOREIGN PATENT DOCUMENTS

EP 0 935 226 B1 8/1999
JP 09-233566 9/1997
JP 2003-319470 11/2003
WO WO-2008/027824 A2 3/2008

OTHER PUBLICATIONS

Office Action dated Nov. 11, 2014, in corresponding Japanese application No. 2012-550141, 4 pages.
(Continued)

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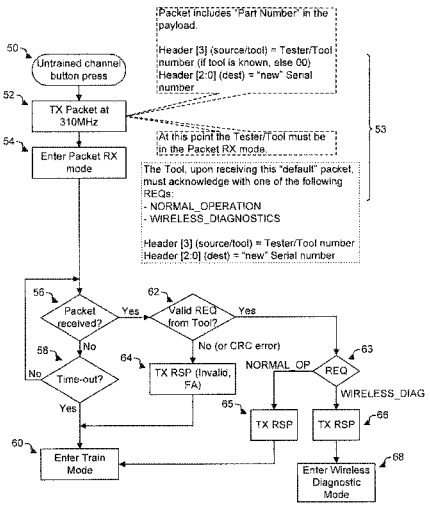
(57) **ABSTRACT**

The invention relates to a universal wireless trainable transceiver unit with integrated bidirectional wireless interface functionality, and a method for same. Using a scan, push button or untrained channel mode, a user may enter into a wireless bidirectional interface mode of a trainable transceiver. The interface mode allows a user to select a sub-set of modes that include diagnostics, flash and vehicle interface. Each mode provides the trainable transceiver to communicate wirelessly in a bidirectional manner with another remote device.

19 Claims, 10 Drawing Sheets



Related U.S. Application Data

continuation of application No. PCT/US2011/022002, filed on Jan. 21, 2011.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,661,804	A	8/1997	Dykema et al.
5,850,188	A	12/1998	Doyle et al.
5,903,226	A	5/1999	Suman et al.
6,225,898	B1	5/2001	Kamiya et al.
6,292,230	B1	9/2001	Shui et al.
7,221,256	B2	5/2007	Skekloff et al.
7,346,374	B2	3/2008	Witkowski et al.
2004/0048622	A1	3/2004	Witkowski et al.
2006/0089118	A1	4/2006	Whitehouse
2009/0059890	A1	3/2009	Cordeiro et al.
2010/0113011	A1	5/2010	Gregg et al.

OTHER PUBLICATIONS

Supplementary Search Report in corresponding European application No. 11 73 7465.2 dated Feb. 16, 2015.

Office Action dated May 13, 2015 in corresponding Chinese Application No. 201180006670.9, 3 pages.

Office Action in corresponding Chinese appliction No. 201180006670.9 dated Sep. 2, 2014.

Office Action in U.S. Appl. No. 13/530,478 dated Jan. 28, 2014.

Written Opinion of the International Searching Authority dated Mar. 22, 2011.

Notice of Allowance dated Sep. 11, 2014, in U.S. Appl. No. 13/530,478.

Notice of Allowance and Issue Fee(s) Due dated Oct. 2, 2015, in U.S. Appl. No. 13/530,478.

Office Action dated Aug. 31, 2016, received in corresponding Korean Application No. 10-2012-7021882 (3 pages) and English translation (2) pages.

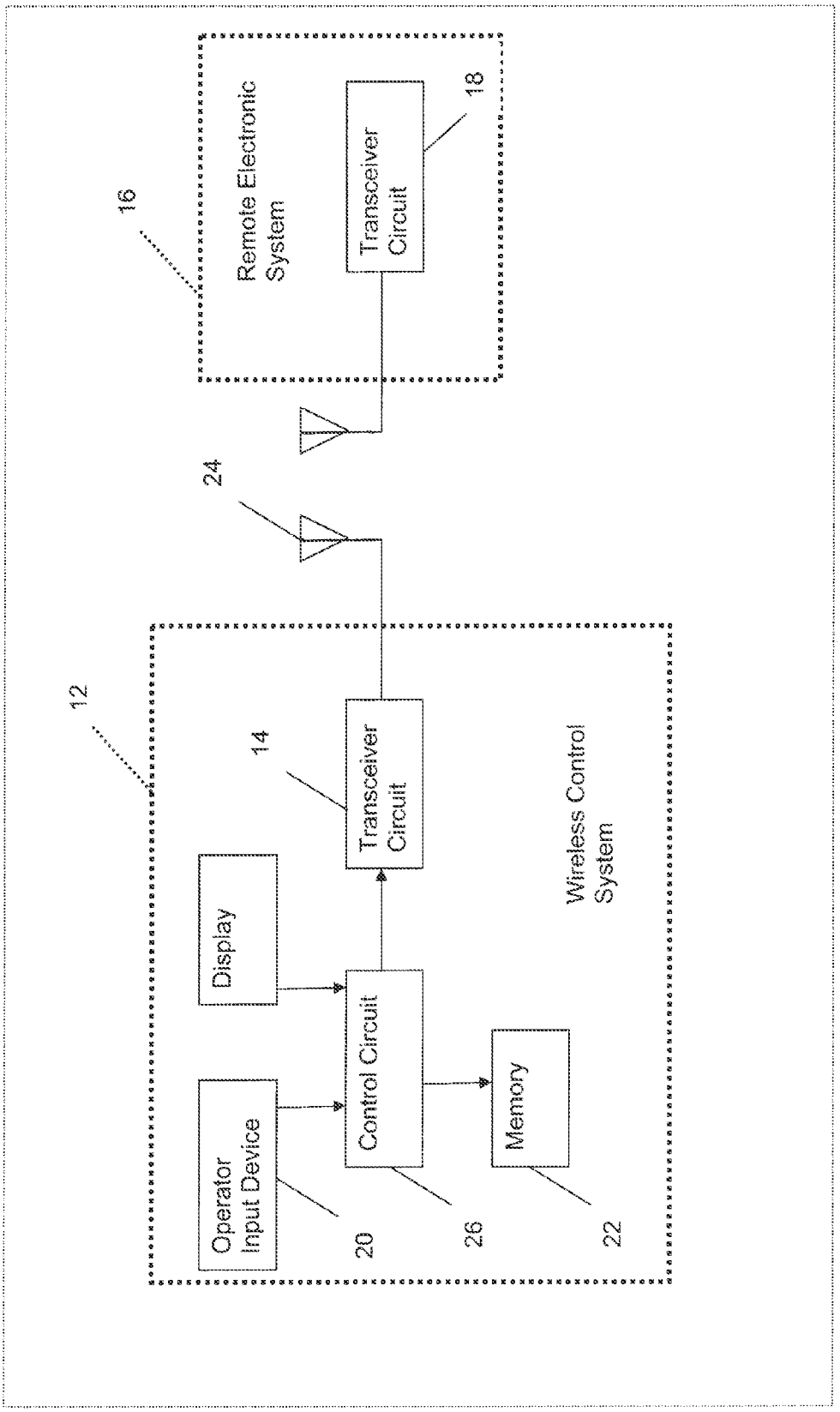

16
Remote Electronic System
Transceiver Circuit
18
24
12
14
Transceiver Circuit
Display
Wireless Control System
Operator Input Device
Control Circuit
Memory
20
26
22

FIG. 1

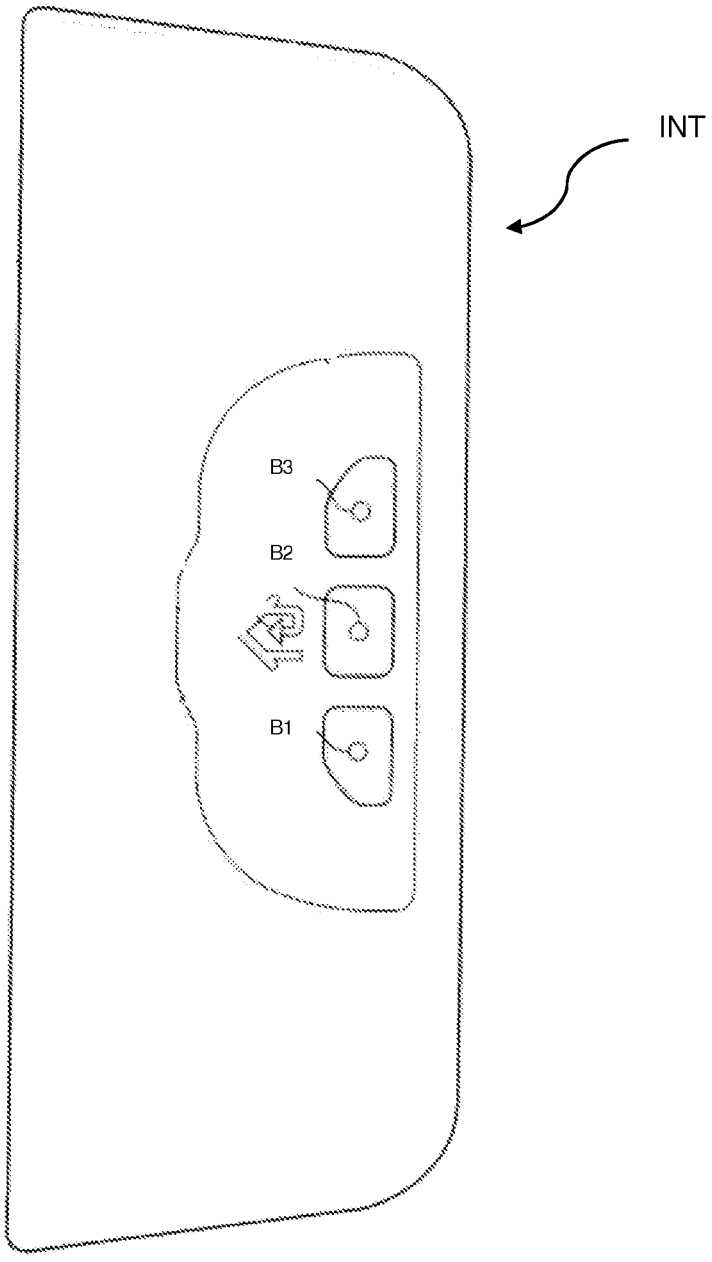


FIG. 2

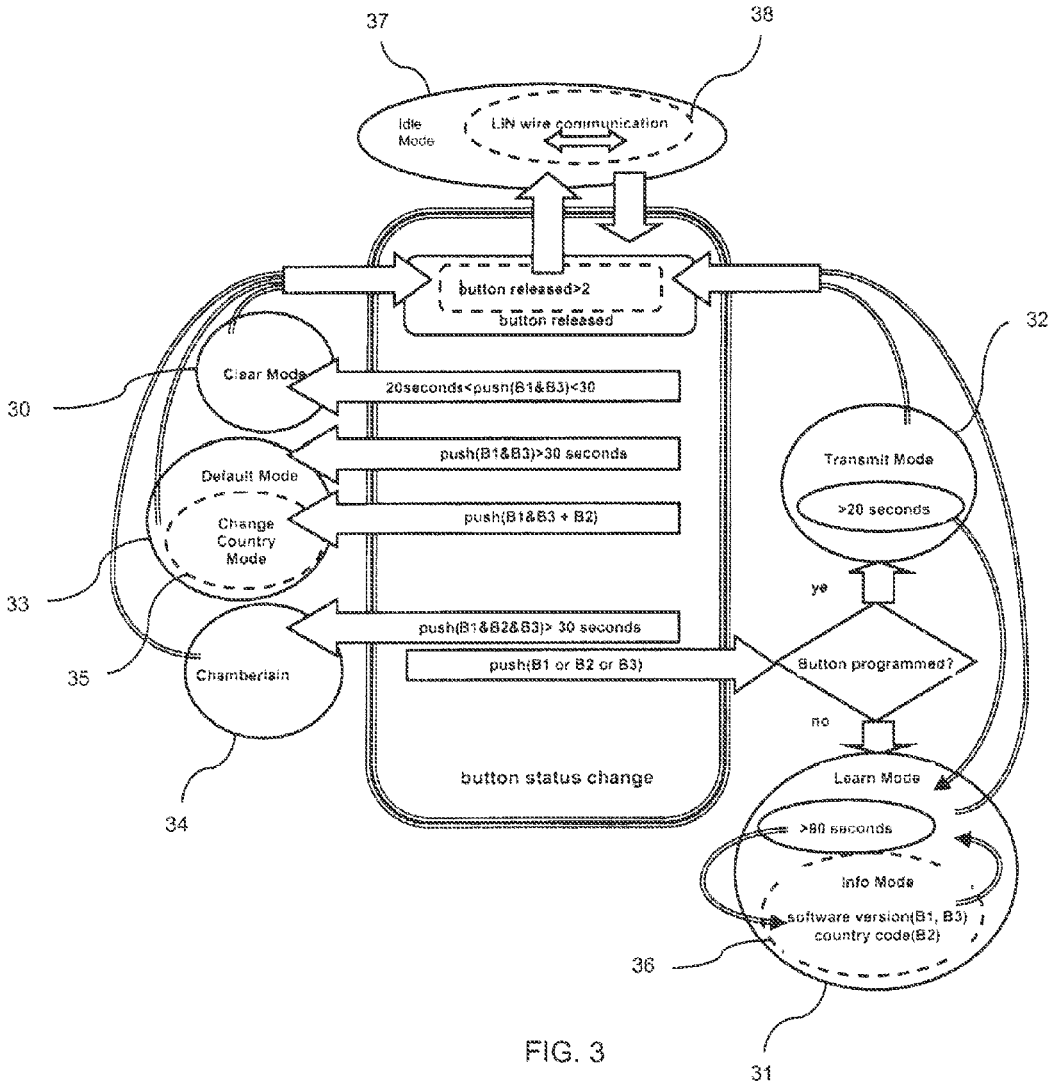

37
38
Idle Mode
LIN wire communication
button released>2
button released
Clear Mode
20seconds<push(B1&B3)<30
push(B1&B3)>30 seconds
Default Mode
Change Country Mode
push(B1&B3 + B2)
push(B1&B2&B3)> 30 seconds
Chamberlain
push(B1 or B2 or B3)
button status change
Transmit Mode
>20 seconds
ye
Button programmed?
no
Learn Mode
>80 seconds
Info Mode
software version(B1, B3)
country code(B2)
30
32
33
35
34
36
31

FIG. 3

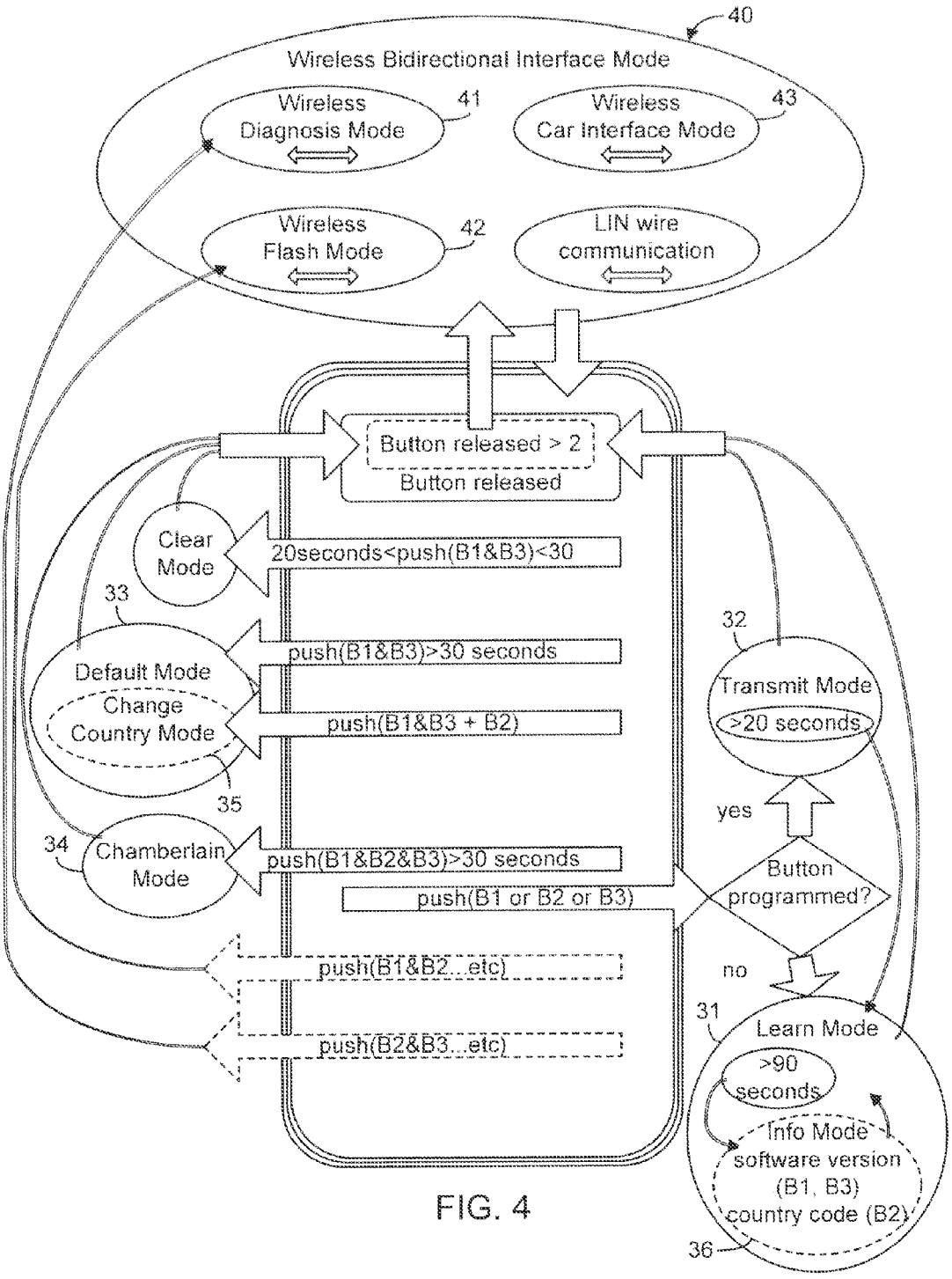

40
Wireless Bidirectional Interface Mode
Wireless Diagnosis Mode
41
Wireless Car Interface Mode
43
Wireless Flash Mode
42
LIN wire communication
Button released > 2
Button released
Clear Mode
20seconds<push(B1&B3)<30
33
Default Mode
Change Country Mode
push(B1&B3)>30 seconds
push(B1&B3 + B2)
35
34
Chamberlain Mode
push(B1&B2&B3)>30 seconds
push(B1 or B2 or B3)
push(B1&B2...etc)
push(B2&B3...etc)
32
Transmit Mode
>20 seconds
yes
Button programmed?
no
31
Learn Mode
>90 seconds
Info Mode
software version
(B1, B3)
country code (B2)
36

FIG. 4

RFCOMM_DataPacket.Command	**RFCOMM_DataPacket.PayloadLength** (bytes)
0x10 – REFLASH_ENC_DATA	62
0x11 – REFLASH_ACK	3
0x12 – REFLASH_STATUS	10
0x80 – DIAG_REQ (request)	1 – 62
0x81 – DIAG_RSP (response)	1 – 62

FIG. 5

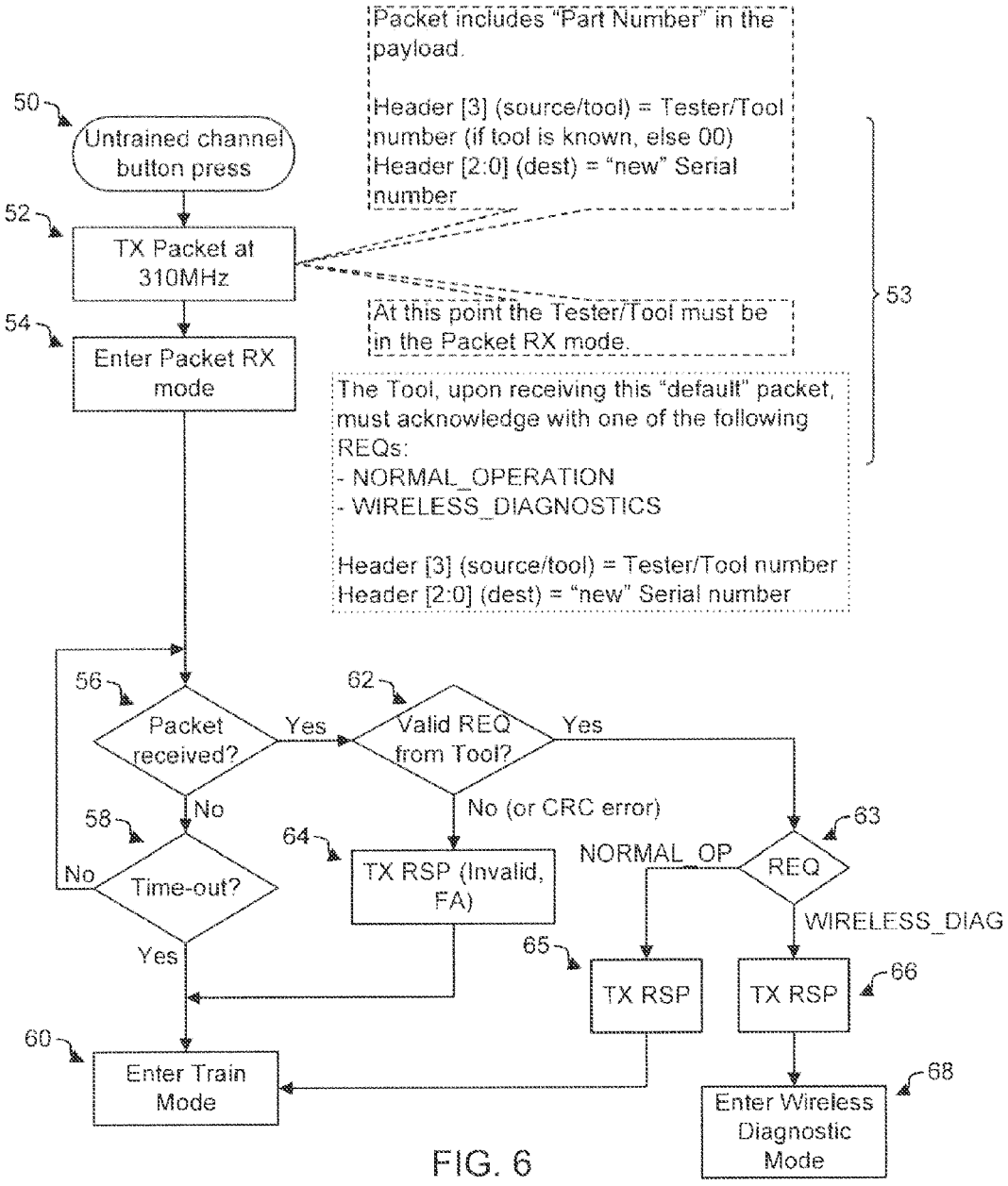

Packet includes "Part Number" in the payload.
Header [3] (source/tool) = Tester/Tool number (if tool is known, else 00)
Header [2:0] (dest) = "new" Serial number
50
Untrained channel button press
52
TX Packet at 310MHz
At this point the Tester/Tool must be in the Packet RX mode.
53
54
Enter Packet RX mode
The Tool, upon receiving this "default" packet, must acknowledge with one of the following REQs:
- NORMAL_OPERATION
- WIRELESS_DIAGNOSTICS
Header [3] (source/tool) = Tester/Tool number
Header [2:0] (dest) = "new" Serial number
56
Packet received?
Yes
62
Valid REQ from Tool?
Yes
No
No (or CRC error)
58
No
Time-out?
64
TX RSP (Invalid, FA)
63
NORMAL_OP
REQ
WIRELESS_DIAG
Yes
65
TX RSP
TX RSP
66
60
Enter Train Mode
68
Enter Wireless Diagnostic Mode

FIG. 6

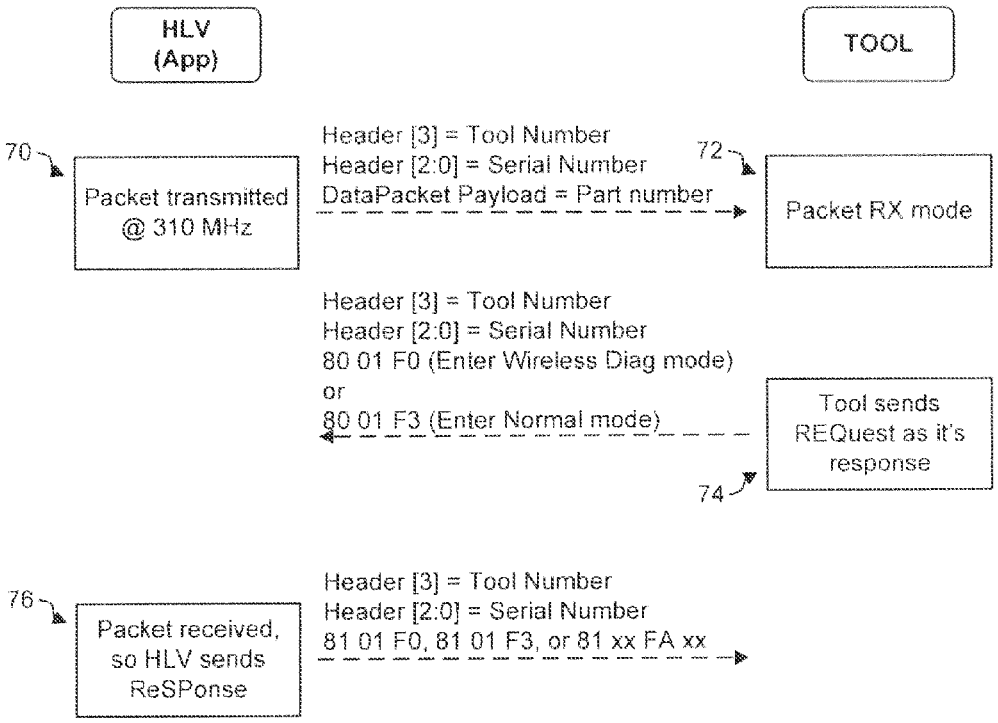

HLV
(App)
TOOL
70
Packet transmitted
@ 310 MHz
Header [3] = Tool Number
Header [2:0] = Serial Number
DataPacket Payload = Part number
72
Packet RX mode
Header [3] = Tool Number
Header [2:0] = Serial Number
80 01 F0 (Enter Wireless Diag mode)
or
80 01 F3 (Enter Normal mode)
Tool sends
REQuest as it's
response
74
76
Packet received,
so HLV sends
ReSPonse
Header [3] = Tool Number
Header [2:0] = Serial Number
81 01 F0, 81 01 F3, or 81 xx FA xx

FIG. 7

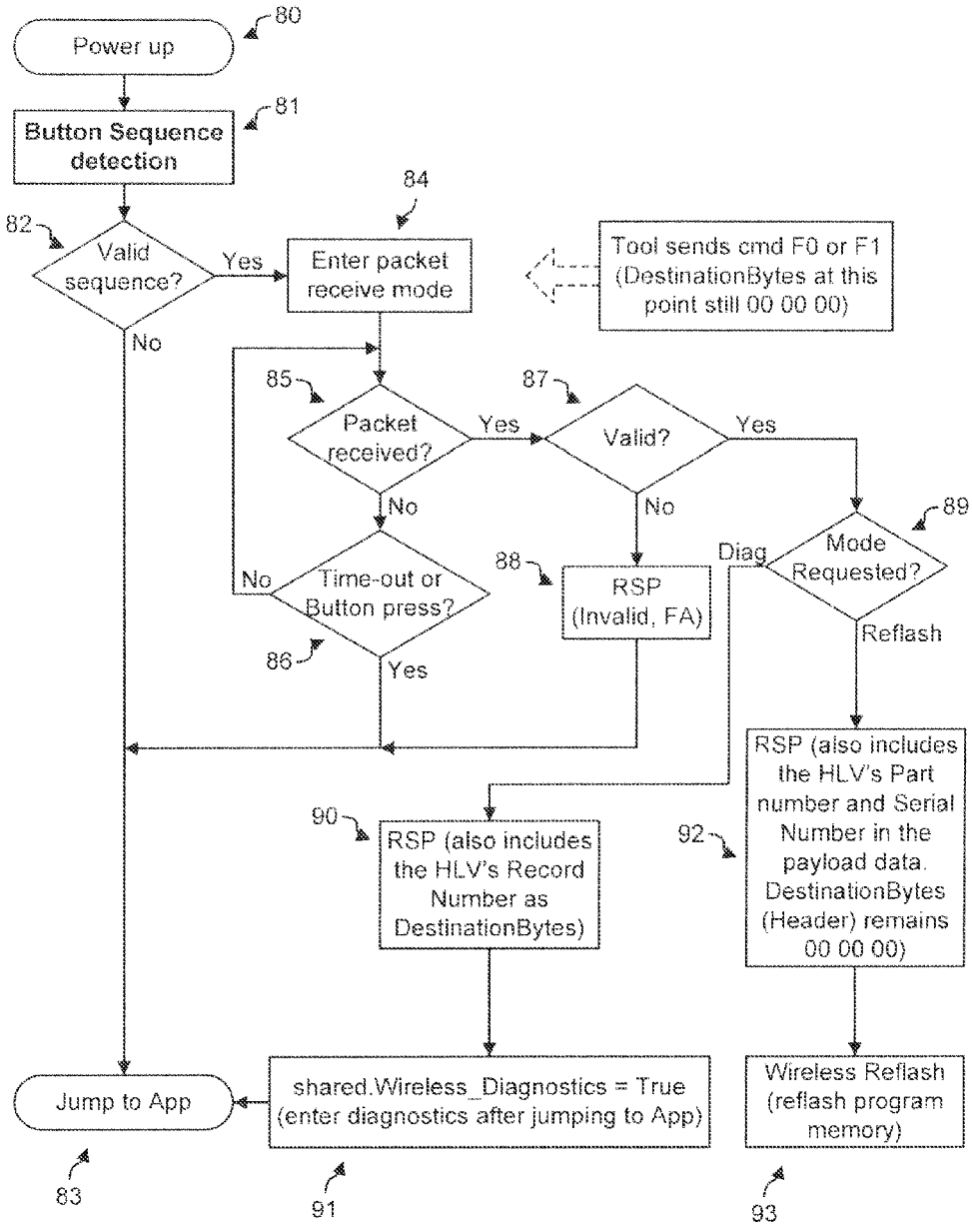

Power up
80
Button Sequence detection
81
82
Valid sequence?
Yes
No
84
Enter packet receive mode
Tool sends cmd F0 or F1 (DestinationBytes at this point still 00 00 00)
85
Packet received?
Yes
No
87
Valid?
Yes
No
89
Mode Requested?
Diag
Reflash
88
RSP (Invalid, FA)
No
Time-out or Button press?
86
Yes
90
RSP (also includes the HLV's Record Number as DestinationBytes)
92
RSP (also includes the HLV's Part number and Serial Number in the payload data. DestinationBytes (Header) remains 00 00 00)
Jump to App
shared.Wireless_Diagnostics = True (enter diagnostics after jumping to App)
Wireless Reflash (reflash program memory)
83
91
93

FIG. 8

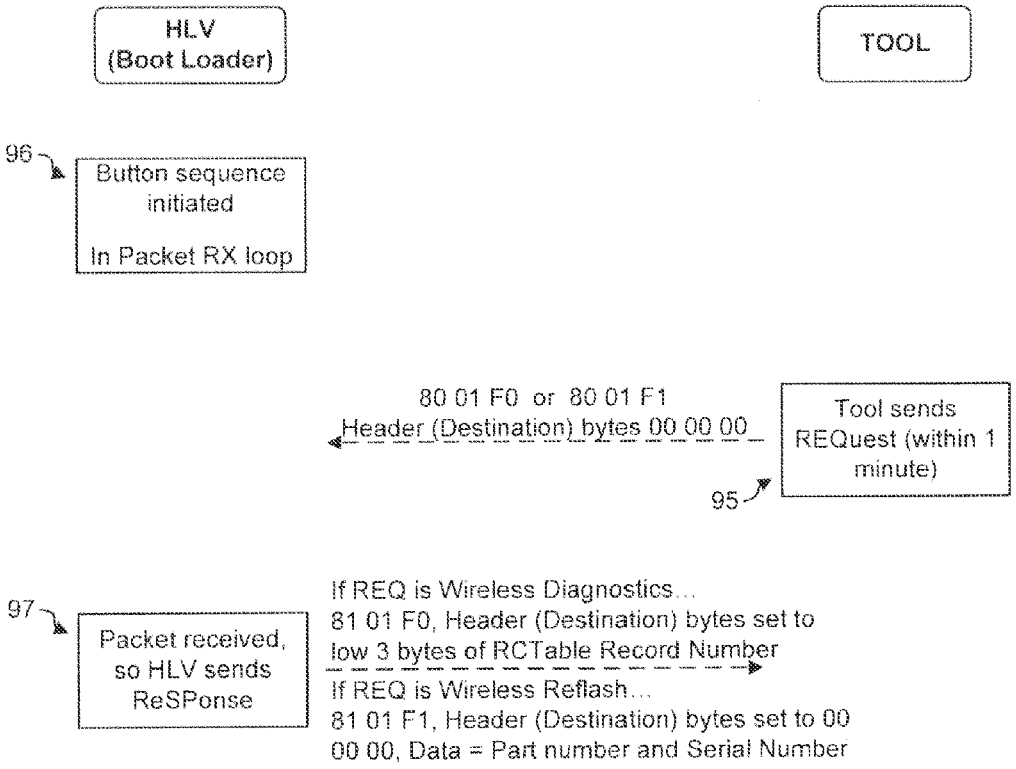

HLV
(Boot Loader)
TOOL
96
Button sequence initiated
In Packet RX loop
80 01 F0 or 80 01 F1
Header (Destination) bytes 00 00 00
Tool sends REQuest (within 1 minute)
95
97
Packet received, so HLV sends ReSPonse
If REQ is Wireless Diagnostics...
81 01 F0, Header (Destination) bytes set to low 3 bytes of RCTable Record Number
If REQ is Wireless Reflash...
81 01 F1, Header (Destination) bytes set to 00 00 00, Data = Part number and Serial Number

FIG. 9

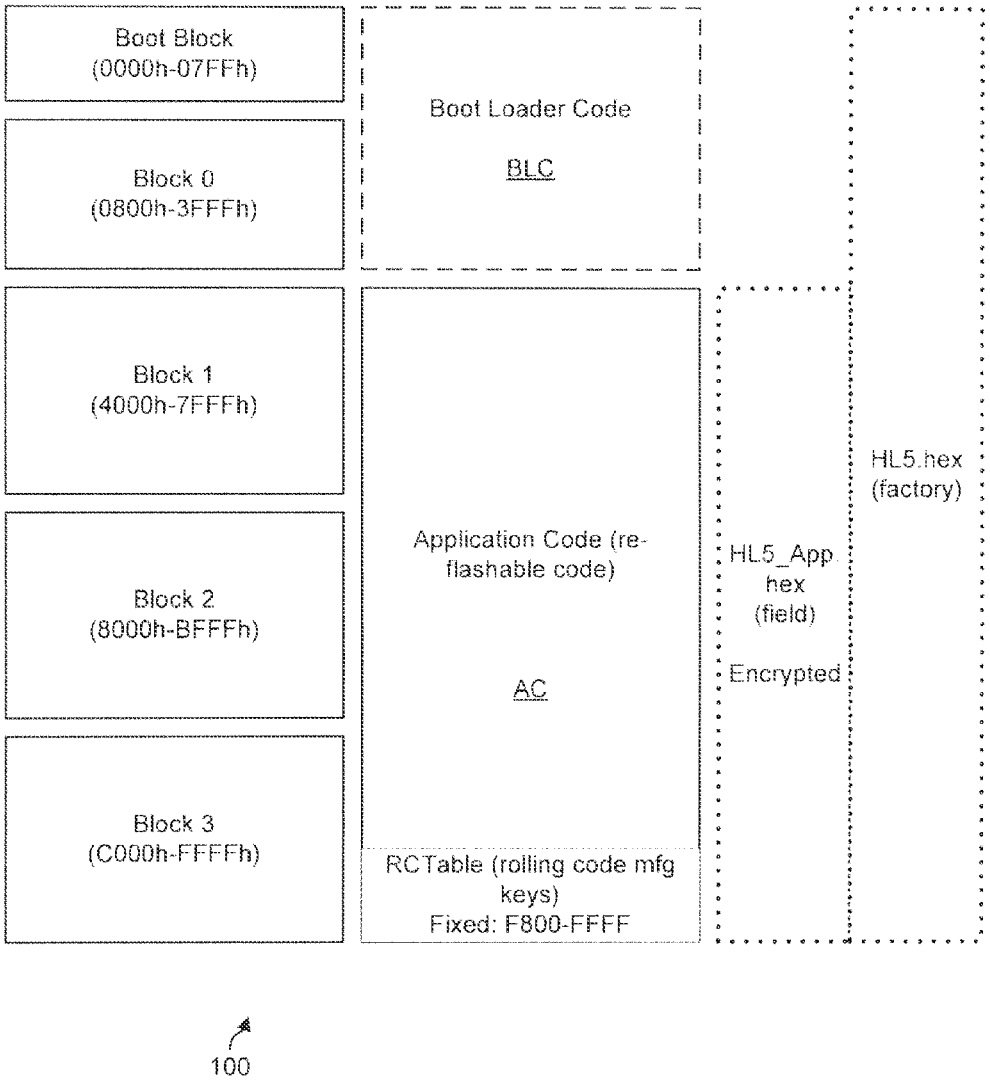

Boot Block
(0000h-07FFh)
Block 0
(0800h-3FFFh)
Block 1
(4000h-7FFFh)
Block 2
(8000h-BFFFh)
Block 3
(C000h-FFFFh)
Boot Loader Code
BLC
Application Code (re-flashable code)
AC
RCTable (rolling code mfg keys)
Fixed: F800-FFFF
HL5_App.hex
(field)
Encrypted
HL5.hex
(factory)
100

FIG. 10

UNIVERSAL WIRELESS TRAINABLE TRANSCEIVER UNIT WITH INTEGRATED BIDIRECTIONAL WIRELESS INTERFACE FOR VEHICLES

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 13/530,478, filed on Jun. 22, 2012, which is a continuation of International Patent Application Serial No. PCT/US2011/022002 filed on Jan. 21, 2011, entitled "Universal Wireless Trainable Transceiver Unit With Integrated Bidirectional Wireless Interface for Vehicles" which claims priority to German Application No. DE 102010005385.6, filed Jan. 21, 2010, the entire disclosures of these applications are hereby incorporated by reference.

TECHNICAL FIELD

The invention relates to a universal wireless trainable transceiver unit with integrated bidirectional wireless interface functionality, and a method for same.

BACKGROUND

Conventional systems for controlling appliances and devices, such as garage door openers, security gates, home alarms, lighting, computers, etc., use individual remote controls to operate a respective appliance and/or device. With this conventional system, it is difficult to control multiple devices or appliances, much less consolidate operation of the appliances and devices into a single, controllable system. For example, garage door opener mechanisms open and close a garage door in response to a radio frequency control signal. The control signal is typically generated and transmitted from a remote control that is sold with the garage opener. The control signal has a preset carrier frequency and control code such that the garage door opener mechanism is responsive only to the remote control issuing the associated control signal. A problem associated with this type of system is that the door opener must receive a specific predetermined control signal in order to be operated. That is, each appliance and device must receive a specific predetermined control signal. Therefore, a user wishing to control multiple appliances and/or devices is required to have multiple remote controls.

With an ever evolving technological society, there is an increasing demand for a communication system that is capable of operating multiple appliances and devices in a consolidated manner. Communication systems currently exist which enable multiple appliances and devices to communicate with a central or single remote device. One such system is Homelink™, owned by Johnson Controls, Inc., in which a trainable transceiver is able to "learn" characteristics of received control signals such that the trainable transceiver may subsequently generate and transmit a signal having the learned characteristics to a remotely controlled device or appliance. FIG. **1** is an example of a wireless control system **12** having a transceiver circuit **14** and a remote electronic system **16** (remote device) which also has a transceiver circuit **18**. One such system is disclosed in U.S. Pat. No. 5,903,226, hereby incorporated by reference. Another such system is disclosed in EP Pat. No. 0 935 226 B1, also hereby incorporated by reference.

In order for the trainable transceivers to operate, each signal is typically associated with a user-actuated switch **20**

or a user selects one of the learned signals on the trainable transceiver by selecting an associated switch **20** (e.g. by pressing a button on the trainable transceiver associated with the device to be operated). For example, a user may select one or multiple of buttons B1, B2, B3 illustrated in FIG. **2**. For the trainable transceiver to learn the signal characteristics of various signals of different length and duration, the amount of memory **22** provided and allocated within the trainable transceiver for each transmission channel must be sufficient to store the characteristics of the largest signal to be learned.

Additionally, in order for the trainable transceiver to work properly in the communication system, it must be compatible to the appliance or device, and in particular, with potentially numerous appliances and devices that the trainable transceiver is likely to communicate with over the course of time. Naturally, it is difficult to predict which appliances and/or devices a user may wish to control such that the trainable transceiver may be programmed for compatibility. Moreover, as new appliances and devices are developed, after the trainable transceiver has been initially programmed, there is no current process to update the trainable transceiver such that the new appliances and devices are compatible for use in the communication system.

SUMMARY OF THE INVENTION

The invention relates to a universal wireless trainable transceiver unit with integrated bidirectional wireless interface functionality, and a method for same.

In one embodiment of the invention, there is a method of wirelessly interfacing with a trainable transceiver located in a vehicle, including entering into one of a plurality of modes; and interfacing with a remote device using one of the plurality of modes in a bidirectional communication.

In one aspect of the invention, the method further includes selecting one of a plurality of inputs on the trainable transceiver; transmitting packets from the trainable transceiver to the remote device; receiving packets from the remote device, the packet including a request command; and transmitting a response command to the remote device based on the requested command.

In another aspect of the invention, the method further includes determining whether the packet received by the trainable transceiver is valid; when the received packet is invalid, and a predetermined period of time has elapsed, entering into train mode; and when the received packet is valid, determining whether the request from the remote device is valid: if the request is invalid, entering into train mode, and if the request is valid, entering into the train mode when the request is for normal operation, and entering into a wireless diagnostic mode when the request is for diagnostic mode.

In still another aspect of the invention, the method further includes selecting a sequence of one of a plurality of inputs on the trainable transceiver; determining whether the sequence is valid; if the sequence is invalid, entering into a normal operation mode; and if the sequence is valid, receiving a request command from the remote device at the trainable transceiver, and transmitting a response command to the remote device from the trainable transceiver based on the request command.

In yet another aspect of the invention, the method further includes determining whether the packet has been received; if the packet has been received and is valid, determining which one of the plurality of modes has been requested by

the request command; if the request command is for diagnostics, sending a response command to the remote device to set a flag to enter into wireless diagnostic mode, and entering into the wireless diagnostic mode; and if the request command is for flash, sending a response command to the remote device and entering into a wireless flash mode.

In another aspect of the invention, the method further includes if the packet has not been received, and a predetermined amount of time has elapsed, entering into normal operation mode; if the packet has been received, determining whether the received packet is valid; and if the received packet is invalid, entering into normal operation mode.

In yet another aspect of the invention, the plurality of modes includes one of a wireless diagnostic mode, a wireless flash mode and a wireless vehicle interface mode.

In still another aspect of the invention, each of the plurality of modes is an executable program product stored in memory of the trainable transceiver and executable by a microcontroller.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exemplary schematic diagram of a trainable receiver in accordance with the prior art.

FIG. **2** is an exemplary interface for a trainable transceiver in accordance with FIG. **1**.

FIG. **3** is an exemplary diagram of a trainable transceiver in accordance with one embodiment in accordance with the invention.

FIG. **4** is an exemplary diagram of a trainable transceiver in accordance with another embodiment in accordance with the invention.

FIG. **5** is an exemplary table including packet commands for transmission and receipt in accordance with the invention.

FIG. **6** is an exemplary flow diagram of entry into various modes in accordance with the invention.

FIG. **7** is an exemplary diagram of communication between a trainable transceiver and a testing apparatus in accordance with the invention.

FIG. **8** is an exemplary flow diagram of entry into various modes of the invention.

FIG. **9** is an exemplary diagram of communication between a trainable transceiver and a testing apparatus in accordance with the invention.

FIG. **10** is an exemplary boot loader code BLC and application code AC memory in the trainable transceiver in accordance with the invention.

DESCRIPTION OF THE INVENTION

The invention relates to a universal wireless trainable transceiver unit with integrated bidirectional wireless interface functionality, and a method for same. Using a scan, push button or untrained channel mode, a user may enter into a wireless bidirectional interface mode of a trainable transceiver. The interface mode allows a user to select a sub-set of modes that include, but are not limited to, diagnostics, flash (e.g. programming and reprogramming) and vehicle interface. Each mode provides the trainable transceiver to communicate wirelessly in a bidirectional manner with another remote device.

The system provides two types of functionality. The first type of functionality is a trainable transceiver that replaces one or more remote controls with a single built-in component through the learning and reproduction of radio frequency codes of remote controls used, for example, to activate garage doors, property gates, security and lighting systems.

Versions of the trainable transceiver of this type base functionality on a button status change and use wired communication, as depicted in FIG. **3**. That is, in order to change modes on the trainable transceiver, a button or combination of buttons or button sequence must be initiated. Once initiated, the status mode changes to one of the following: an Idle Mode **37** (without an active LIN communication **38**), Clear Mode **30**, Learn Mode **31**, Transmit Mode **32**, Default Mode **33**, Chamberlain Mode **34**, Change Country Code Mode **35** and Info Mode **36**. Specifically, in Idle Mode **37**, the trainable transceiver must wait for an active LIN wire communication **38** from the vehicle in order to accomplish diagnostics, re-flash of memory, etc.

The second type of functionality is a trainable transceiver having bidirectional communication (transmit-receive) with a remote device, as described in more detail below. The trainable transceiver of the invention enhances functionality by providing a wireless bidirectional interface mode **40**. The wireless bidirectional interface mode **40** provides new modes of operation, namely wireless diagnostic mode **41**, wireless flash mode **42**, and wireless vehicle interface mode **43**. These three modes are in addition to the Clear Mode **30**, Learn Mode **31**, Transmit Mode **32**, Default Mode **33**, Chamberlain Mode **34**, Change Country Code Mode **35** and Info Mode **36** used in the prior versions of the trainable transceiver.

The trainable transceiver of the instant invention replaces the idle mode **37** with a wireless bidirectional interface mode **40** (transmit-receive mode). The wireless bidirectional interface mode **40** enables the trainable transceiver to communicate wirelessly with a remote device in one of the three modes: 1) automatic scan mode; 2) push button mode; and 3) untrained channel mode.

In one embodiment, the trainable transceiver continuously or automatically scans for devices using a receiver **24** of the built-in wireless transceiver **14**. Each device has a frequency and an ID data code associated therewith. When one of the frequencies is received, the microcontroller **26** in the trainable transceiver checks to determine whether a corresponding ID code exists in memory **22**, and if so, begins a communication with the remote device. The mode of communication (e.g. wireless diagnostic mode **41**, wireless flash mode **42**, wireless vehicle interface mode **43**) depends on the remote device detected. For example, if the remote device is a diagnostic tool, the trainable transceiver will enter into the wireless diagnostic mode **41**. Additionally, the data received from the remote device could be transferred to other electronic devices in the car through an internal network.

The wireless bidirectional interface mode may also be set using a push button mode (button status change). As illustrated, for example, in FIG. **4**, a user may select or push buttons B1, B2 and B3 on the interface INT (FIG. **2**) to enter into a specified mode. For example, pressing buttons B1 and B2 (concurrently or in sequence) on interface INT results in entering the wireless diagnostic mode **41**, whereas pressing buttons B2 and B3 (concurrently or in sequence) on interface INT results in entering the wireless flash mode **42**. In another exemplary, if the Boot Loader Code BLC (FIG. **10**) detects a power up initiated by the following exemplary sequence: 1) all three buttons B1, B2, B3 pressed, 2) all three buttons B1, B2 and B3 are released, 3) the outer buttons B1 and B3 are pressed within a predetermined amount of time, then released, and 4) the middle button B2 is pressed within a predetermined amount of time, the Boot Loader Code BLC

will go into a packet receive mode, and wait for a predetermined amount of time for a command from the remote device indicating what mode to enter (wireless diagnostic mode **41**, wireless flash mode **42** or wireless vehicle interface mode **43**). If a valid command is not received within the predetermined amount of time, the trainable transceiver will remove the power hold and power down. Pressing a button during this time, as well as any time while in one of the modes will also remove the power hold and allow the trainable transceiver to power down. It is appreciated that the number of buttons, sequences and/or time frame is not limited to the illustrated embodiment. Any variation or number of buttons and time frames may be used to enter into a specified mode.

Another method to enter into the wireless bidirectional interface mode **40** is to use the untrained channel default transmission method as best shown in FIG. **6**. When an untrained channel button is pressed at step **50** (e.g. selection of a no-trained button), the trainable transceiver transmits a packet at step **52** for a predetermined period of time. In response to the transmission, the trainable transceiver will enter a packet receive RX mode at step **54** to wait for a request from a remote device to enter a specified mode (e.g. wireless diagnostic mode), as described in more detail below.

Setting or activating the wireless bidirectional interface mode **40** enables a user to select any one of three sub-modes, including 1) a wireless diagnostic mode **41**; 2) a wireless flash mode **42**; and 3) a wireless vehicle interface mode **43**. These three modes **41**, **42**, **43** may be entered by scan, push button or untrained channel selection as described above or as described in the detailed, exemplary embodiments that follow.

Wireless Diagnostic Mode

Wireless diagnostics provides a wireless interface (i.e. there is no need to disassemble the trainable transceiver to connect cables for diagnostics) for performing specific diagnostic functions internal to the trainable transceiver diagnostics found in vehicles. Wireless diagnostic mode **41** is typically for near field communications, such as using the diagnostic tool to diagnose the trainable transceiver. Diagnostic commands support manufacturing and bench testing and information gathering, as shown for example in the table of FIG. **5**. The diagnostic packet commands include, for example, DIAG_REQ (request) and DIAG_RSP (response). It is understood that these commands are exemplary in nature and are not limited to those described in the table of FIG. **5**.

FIG. **6** discloses an exemplary sequence for entering the wireless diagnostic mode **41**. Here, once an untrained channel button (mode) press has been performed at step **50** as described above, the trainable transceiver may enter into either a wireless diagnostic mode **41**, or a train/learn mode. Specifically, once an untrained channel button press has been accomplished at step **50**, a packet is transmitted (TX) for a predetermined amount of time at step **52**. The packet can include, for example, a default code, a part number, etc. in the payload. Additionally, in order for the remote device (for example, Tool) to receive the packet, it must be in packet receipt mode. Upon transmitting packets in step **52**, the trainable transceiver and tool enter into a communication state as depicted in FIG. **7** (described below). Upon receipt of the initial packet from the trainable transceiver at the Tool, the Tool acknowledges receipt of the packet and sends a command back (e.g. a Request REQ) to the trainable receiver at step **53**, and the packet receive mode begins at step **54**.

The communication state is illustrated, for example, in FIG. **7**. Here, a packet is transmitted by the trainable transceiver (represented by HLV (App), which refers to the application code AC of the trainable transceiver memory) at step **70**. Upon receipt by the tool during packet receive mode **72**, a request (REQ) is sent from the Tool in step **74** until a predetermined amount of requests are sent or a response (RSP) is received back from the trainable transceiver at **76**.

As packets are transmitted between the trainable transceiver and the Tool, the following is carried out. With reference to FIG. **6**, at step **56** it is determined whether a packet has been received. If no packet has been received, then at step **58** it is determined whether a time out has occurred. If a time out has occurred, then the trainable transceiver enters into the Train/Learn Mode at step **60**. Otherwise, the procedure loops back to step **56** to monitor whether a packet has been received until such time out occurs. If, on the other hand, a packet has been received from the Tool, the procedure determines whether the received packet is a valid REQ from the Tool at step **62**. If the packet is determined to be invalid, then an invalid RSP is transmitted as determined at step **64** and Train/Learn Mode is entered at step **60**. Alternatively, an error may be present in the REQ sent from the Tool, in which case an invalid transmission response (TX RSP) is also determined at step **64**. Ifthe packet received is determined to be valid REQ from the Tool in step **62**, then it is determined at step **63** whether the REQ is a "NORMAL_OP" (normal operation) or a "WIRELESS_DIAG" (wireless diagnostic) REQ. If it is determined in step **63** that the REQ is a wireless diagnostic request, then a response RSP for entering diagnostic mode is transmitted at step **66**, and the wireless diagnostic mode **41** is entered at **68**. If, on the other hand, the REQ is a normal operation request, then a RSP for entering Train/Learn Mode is transmitted at step **65**, and the Train/Learn Mode is entered at **60**. It is appreciated that the wireless diagnostic mode **41** may also be entered via scan mode or button sequence detection (push button mode), as described below with respect to the wireless flash mode **42**. It is also understood that the REQ is not limited to the described embodiments, and that any command or text may be used as the REQ.

Wireless Flash Mode

The wireless flash mode **42** enables a user to program (flash) or reprogram (reflash) the trainable transceiver. The details of programming/reprogramming the trainable transceiver are not discussed in this application. Rather, the ability to enter into wireless flash mode **42** using the trainable transceiver is addressed as follows and with reference to FIG. **8**. FIG. **8** is an exemplary flow diagram of entry into various modes of the invention. Specifically, the flow diagram illustrates a user entering into the wireless diagnostic mode **41** or the wireless flash mode **42** using a predefined button sequence. It is appreciated that other modes may also be entered into using the button sequence mode, including the wireless vehicle interface mode **43** and wireless diagnostic mode **41**. Upon powering up the trainable transceiver (for example, pressing a button B1, B2, B3) at step **80**, a user enters a sequence of buttons which are detected by the trainable transceiver at step **81**. For example, as depicted in FIG. **4**, the user may pushbuttons B2 and B3 on the interface INT to initiate the button sequence detection in step **81**. If a valid button sequence is not detected at step **82**, then the procedure continues to step **83** ("Jump to App," which refers to the normal operation Application code of the trainable transceiver depicted in FIG. **10**). If, on the other hand, a valid button sequence is detected at step **82**, then the

procedure continues to the enter packet receive mode in step **84**. In this mode, the trainable transceiver and Tool begin communicating as explained below with reference to FIG. **9**.

It is determined in step **85** whether a packet has been received from Tool. If no, then it is determined at step **86** whether a time out (e.g. predetermined time limit has expired) or button selection has occurred. If no time out of button selection has occurred as determined at step **86**, the procedure loops back to step **85** to determine whether a packet has been received. If a time out or button selection has occurred, then the procedure continues to step **83** and returns to the "Jump to App" sequence (e.g. the normal operation application code sequence stored in memory of the trainable transceiver).

As packets are transmitted between the trainable transceiver and the Tool, the following is carried out. If it is determined at step **85** that a packet has been received, then the trainable transceiver determines whether the packet is valid at step **87**. If the packet is determined to be invalid, then at step **88** a RSP is sent to the Tool indicating that the packet is invalid and the procedure continues to step **83** where the trainable transceiver enters into normal operation mode by jumping to the appropriate application residing in the application code AC section of the trainable transceiver memory **100** as best shown in FIG. **10**. If, on the other hand, it is determined that the packet is valid, then at step **89** the trainable transceiver determines which mode has been requested by the Tool in step **76** as shown in FIG. **7**. If the wireless diagnostic mode **41** has been requested, then a flag is sent at step **90** indicating that the wireless diagnostic mode should be entered at step **91**. The wireless diagnostic mode **41** is entered at step **83** by jumping to the application code AC residing in the trainable transceiver memory **100** depicted in FIG. **10**. If the request at step **89** is to enter the wireless flash mode **42**, then the trainable transceiver transmits a RSP at step **92** to enter into the wireless flash mode at step **93**.

Wireless Vehicle Interface Mode

The wireless vehicle interface mode **43** provides the ability to link the trainable transceiver with various equipment located in or external to the vehicle (near field or far field), such as remote keyless systems, tire pressure gauges, mobile devices, other vehicles, garage doors, etc. Traditionally, for each of the aforementioned equipment, the vehicle includes a module that enables communication between the vehicle and the equipment. These modules can be replaced with the trainable transceiver such that the trainable transceiver becomes the communication interface between the vehicle and the equipments (the trainable transceiver replaces the modules). The trainable transceiver can be programmed to enable interfacing with countless devices and applications.

FIG. **9** illustrates an exemplary boot loader code BLC and application code AC memory of the trainable transceiver. At step **95**, the Tool beings sending requests REQ (e.g. request for diagnostic or flash mode) back to the trainable transceiver. Once a button sequence has been initiated, the trainable transceiver begins to receive packets from the Tool at step **96**. In response to the transmitted packets from the Tool, the trainable transceiver sends a response RSP back to the Tool including information relevant to the REQ at step **97**.

Those skilled in the art can now appreciate from the foregoing description that the broad teachings herein can be implemented in a variety of forms. Therefore, while the described features have been described in connection with particular examples thereof, the true scope of the features should not be so limited since other modifications will become apparent to the skilled practitioner upon a study of the drawings and the present specification.

What is claimed is:

1. A method of wireless communication and interfacing between a trainable transceiver located in a vehicle and a remote device, comprising:

establishing bidirectional communication between the trainable transceiver and the remote device, wherein the trainable transceiver waits to receive a request command from the remote device;

transmitting a request command from the remote device to the trainable transceiver, wherein the request command is configured to cause the trainable transceiver to enter into one of the plurality of modes of operation; and

transmitting a response command from the trainable transceiver to the remote device based on the request command,

wherein the trainable transceiver enters into one of a plurality of modes of operation in response to the request command from the remote device received during the bidirectional communication between the trainable transceiver and the remote device, wherein entering into one of the plurality of modes of operation includes determining whether the request command from the remote device is valid and:

upon determining that the request command is invalid, entering into a training mode, and

upon determining that the request command is valid, entering into the training mode when the request command is for normal operation, and entering into a wireless diagnostic mode when the request command is for diagnostic mode.

2. The method of claim **1**, wherein the plurality of modes of operation include one of a wireless diagnostic mode, a wireless flash mode, and a wireless vehicle interface mode,

wherein the wireless diagnostic mode of the trainable transceiver is configured to perform diagnostic functions internal to the trainable transceiver at the direction of the remote device, wherein the remote device is a diagnostic tool;

wherein the wireless flash mode of the trainable transceiver is configured to reprogram the trainable transceiver; and

wherein the wireless vehicle interface mode of the trainable transceiver is configured to link the trainable transceiver with equipment related to the vehicle.

3. The method of claim **1**, wherein establishing bidirectional communication between the trainable transceiver and the remote device comprises:

transmitting first information from the trainable transceiver to the remote device; and

transmitting second information from the remote device to the trainable transceiver, wherein the second information includes the request command.

4. The method of claim **1**, further comprising:

determining, at the trainable transceiver and while waiting to receive the request command, that the request command has not been received within a predetermined amount of time; and

ending the bidirectional communication between the trainable transceiver and the remote device in response to determining that the request command has not been received.

5. The method of claim 4, further comprising:
entering, at the trainable transceiver, a training mode,
wherein the training mode is configured to cause the trainable transceiver to learn information used in reproducing one or more radio frequency codes of remote controls used to control an appliance.

6. The method of claim 1, further comprising:
determining which one of the plurality of modes of operation has been requested by the request command;
in response to determining that the request command is for wireless diagnostic mode, sending the response command to the remote device to set a flag to enter into wireless diagnostic mode, and entering into the wireless diagnostic mode at the trainable transceiver; and
in response to determining that the request command is for wireless flash mode, entering into a wireless flash mode at the trainable transceiver.

7. The method of claim 1, further comprising:
if a packet including the request command transmitted from the remote device to the trainable transceiver has not been received by the trainable transceiver, and a predetermined amount of time has elapsed, entering into normal operation mode;
if the packet transmitted from the remote device to the trainable transceiver has been received by the trainable transceiver, determining whether the received packet transmitted from the remote device to the trainable transceiver is valid; and if the received packet transmitted from the remote device to the trainable transceiver is invalid, entering into normal operation mode.

8. The method of claim 1, further comprising:
receiving one of a plurality of inputs on the trainable transceiver to enter into one of the plurality of modes of operation; and
exiting a current mode of operation and entering a new mode of operation based on the one or a plurality of inputs.

9. A method of wireless communication and interfacing between a trainable transceiver located in a vehicle and a remote device, comprising:
receiving a sequence of a plurality of inputs on the trainable transceiver;
determining whether the sequence is valid;
if the sequence is invalid, entering into a normal operation mode; and
if the sequence is valid:
receiving a request command from the remote device at the trainable transceiver,
transmitting a response command to the remote device from the trainable transceiver based on the request command, and
wherein the trainable transceiver enters into one of a plurality of modes of operation in response to the request command from the remote device received during the bidirectional communication between the trainable transceiver and the remote device, wherein entering into one of the plurality of modes of operation includes determining whether the request command from the remote device is valid and:
upon determining that the request command is invalid, entering into a training mode, and
upon determining that the request command is valid, entering into the training mode when the request command is for normal operation, and entering into a wireless diagnostic mode when the request command is for diagnostic mode.

10. The method of claim 9, wherein the plurality of modes of operation include one of a wireless diagnostic mode, a wireless flash mode, and a wireless vehicle interface mode,
wherein the wireless diagnostic mode of the trainable transceiver is configured to perform diagnostic functions internal to the trainable transceiver at the direction of the remote device, wherein the remote device is a diagnostic tool;
wherein the wireless flash mode of the trainable transceiver is configured to reprogram the trainable transceiver; and
wherein the wireless vehicle interface mode of the trainable transceiver is configured to link the trainable transceiver with equipment related to the vehicle.

11. The method of claim 9, further comprising:
entering into one of a plurality of modes of operation in response to the plurality of inputs received at the trainable transceiver,
wherein the plurality of modes of operation include one of a wireless diagnostic mode, a wireless flash mode, and a wireless vehicle interface mode.

12. A trainable transceiver unit for a vehicle comprising:
a microcontroller;
a memory in communication with said microcontroller; and
a wireless bidirectional interface mode stored in said memory and having executable instructions configured to establish wireless bidirectional communication between said transceiver unit and at least one remote device,
wherein the trainable transceiver is configured to receive a request command from a remote device using wireless bidirectional communication with the remote device, and wherein the trainable transceiver enters one of a plurality of modes of operation in response to the request command received from the remote device during the bidirectional communication between the trainable transceiver and the remote device, wherein entering into one of the plurality of modes of operation includes determining whether the request command from the remote device is valid and:
upon determining that the request command is invalid, entering into a training mode, and
upon determining that the request command is valid, entering into the training mode when the request command is for normal operation, and entering into a wireless diagnostic mode when the request command is for diagnostic mode.

13. The trainable transceiver of claim 12, wherein the plurality of modes of operation includes at least one of a wireless diagnostic mode, a wireless flash mode, or a wireless vehicle interface mode,
wherein the wireless diagnostic mode of the trainable transceiver is configured to perform diagnostic functions internal to the trainable transceiver at the direction of the remote device, wherein the remote device is a diagnostic tool;
wherein the wireless flash mode of the trainable transceiver is configured to reprogram the trainable transceiver; and
wherein the wireless vehicle interface mode of the trainable transceiver is configured to link the trainable transceiver with equipment related to the vehicle.

14. The trainable transceiver of claim 12, wherein the trainable transceiver is configured to transmit first information from the trainable transceiver to the remote device, wherein the trainable transceiver is configured to receive

second information from the remote device, wherein the second information includes the request command, and wherein bidirectional communication between the trainable transceiver and the remote device is established upon the receipt of the second information by the trainable transceiver.

15. A trainable transceiver unit as set forth in claim **12**, further comprising: a wireless transceiver, wherein said wireless bidirectional interface mode includes an automatic scan mode having executable instructions configured to initiate a continuous scan for the at least one remote device using the wireless transceiver.

16. A trainable transceiver unit as set forth in claim **12**, further comprising:

a plurality of user input devices in communication with said microcontroller selectable by a user to initiate said wireless bi-directional interface mode of said transceiver unit.

17. A trainable transceiver unit as set forth in claim **16**, further comprising:

the plurality of modes of operation including a wireless diagnostic mode having executable instructions configured to provide a wireless interface for diagnosing the trainable transceiver;

a predefined wireless diagnostic mode selection sequence stored in said memory; and

wherein the microcontroller is configured to detect a selection sequence of user inputs received at the plurality of user input devices and execute said executable instructions of said wireless diagnosis mode in response to the selection sequence correlating with said predetermined wireless diagnostic mode selection sequence.

18. A trainable transceiver unit as set forth in claim **16**, further comprising:

the plurality of modes of operation including a wireless flash mode having executable instructions configured to enable a user to program and reprogram said trainable transceiver;

a predefined wireless flash mode selection sequence stored in said memory; and wherein the microcontroller is configured to detect a selection sequence of user inputs received at the plurality of user input devices and execute said executable instructions of said wireless flash mode in response to the selection sequence correlating with said predetermined flash mode selection sequence.

19. A trainable transceiver unit as set forth in claim **16**, further comprising:

the plurality of modes of operation including a wireless vehicle interface mode having executable instructions configured to link said trainable transceiver unit with the at least one remote device;

a predetermined wireless vehicle interface mode selection sequence stored in said memory; and

wherein the microcontroller is configured to detect a selection sequence of the user inputs received at the plurality of user input devices and execute said executable instructions of said wireless flash vehicle interface mode in response to the selection sequence correlating with said wireless vehicle interface mode selection.

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