LIONEL L.L.C.
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Functional Description of the Announcement Coach

The Announcement Coach is a wireless model train car that is offered as a separate sale add-on for several different remote controlled train sets. The Announcement Coach plays one of several different phrases stored in the coach when triggered by a command received from the existing train set remote control. The Announcement Coach is compatible with two different versions of model train sets, those using Lionel's proprietary communication protocol and those using standard Bluetooth communications.

The Announcement Coach consists of a series of subsystems used in combination to perform the functions necessary to operate. The central core of the Announcement Coach is a Bluetooth module built around a Texas Instruments CC2541 transceiver chip running the Texas Instruments Bluetooth 4.0 stack and the Lionel Announcement Coach application. The Bluetooth module handles the Bluetooth communication, controls two outputs to drive LEDs, controls the speech processor and controls the proprietary protocol communication. The module connects to the subsystems by either a parallel or serial interfacing techniques. The antenna for the Bluetooth module is a foil pattern on the module PCB.

The Bluetooth module operates in the 2.402 GHz to 2.480 GHz range using 40 individual channels spaced 2 MHz apart. The Bluetooth maximum output power is 1 mW. Information packets are transmitted and received using a GFSK encoding method at a data rate of 1Mbs. One data packet consisting of 20 bytes is transmitted every 100ms.

The Announcement Coach uses a separate 2.4GHz RF transceiver module to handle the proprietary protocol communications. The RF transceiver module is connected to the Bluetooth module using a SPI serial interface. Information packets are passed between the RF transceiver module and the Bluetooth module as necessary. These packets contain both data and status information on the operation of the transceiver. The antenna for the RF transceiver module is a foil pattern on the module PCB.

The RF transceiver module operates in the 2.404 GHz to 2.476 GHz range using 18 individual channels. Information packets are transmitted and received using a GFSK encoding method at a data rate of 250Kbs. One data packet consisting of ten bytes is transmitted every 20ms. Every packet is acknowledged by the receiver. CRC error detection is included to insure data integrity. If an error is detected during transmission it is corrected by using a proprietary protocol that uses retransmission techniques for correction.

Sounds are produced by a dedicated speech processor connected to the Bluetooth module using a I^2C serial interface. The speech processor runs at 2MHz and contains all of the dialog stored in ROM. The output of the processor is a differential analog signal that is filtered and passed to a power audio amplifier to drive a speaker.

When first powered on the Bluetooth module broadcasts in an attempt to detect any available Bluetooth remote controls. At the same time the RF transceiver module scans the proprietary protocol channels in receive mode to detect any remote controls transmitting using Lionel's proprietary protocol. The coach initiates a connection with the first remote control detected. If coach pairs with a Bluetooth remote control the RF transceiver is disabled. Conversely, if the coach detects a remote control using the proprietary protocol remote control the Bluetooth transceiver is disabled.

The Announcement Coach is receives power from the train set track which may be connected to 8-18V AC or DC. It contains a switching voltage regulator used to maintain a stable operating voltage for the circuitry.