

LH Compass/Temperature/Trip/Homelink® Module Description of Operation

The LH module consists of two basic sections. The Compass/Temperature/Trip (CTT) section, and the Homelink® section.

The CTT section provides data to the user via a Vacuum Fluorescent Display (VFD) display. There are switches on board, four of which allow the user to change CTT modes operation, and three others which allow the user to select Homelink® operation. The CTT micro-processor then powers up the Homelink® section, and communicates to the Homelink® microprocessor which channel has been selected.

The Homelink® transmitter is a radio frequency transceiver device whose primary function is to determine both frequency and bit code format of typical garage door remote control devices and identically re-transmit them to the original garage door opener receiver. The on-board microcontroller maintains the operational frequency band as 288Mhz to 418Mhz excluding forbidden bands of 240MHz to 285MHz, 322MHz to 335.4MHz and 399.9MHz to 410 MHz.

The "training" operation is performed by scanning the legal frequencies with a single conversion superheterodyne receiver, looking for valid garage door opener bit code formats.

In addition to being frequency and data format adaptive the Homelink® transmitter is also RF amplitude adaptive. During the training sequence, the duty factor of the incoming bit code format is evaluated by the microcontroller determining the greatest amount of on-time in a 100 mS window. The duty factor is then used to mathematically adjust the output power in a range of 80% (1.9dB) to an upper limit of 30% (10.5dB) duty cycle. A 9 bit attenuator is adjusted by a closed loop power control algorithm in the microcontroller.

After the training sequence the frequency bit code format and attenuator setting is stored in non-volatile memory (NVM) and retrieved on subsequent power ups. The VCO is set on the desired RF carrier frequency stored in NVM. The antenna is fine tuned by sweeping twice around the expected tuning point. The voltage controlled oscillator(VCO) is then modulated with the appropriate bit code information from the NVM.

GENERAL

This system provides the vehicle owner with compass, temperature, trip computer information, and integrated HomeLink[®]. The HomeLink[®] portion of the circuit is separate from the compass section, except that the compass microprocessor controls the power to the HomeLink[®] section, and serially communicates to the HomeLink[®] microprocessor which switch has been pressed. All the following information refers to the HomeLink[®] part of the system.

Operational Description

This system gives the vehicle owner the ability to use a garage door opener (GDO) that is integral to the interior trim of the vehicle. The HomeLink[®] shall be capable of learning and remembering variables required to emulate three different GDO transmitters. In the learn mode of operation, the user selects one of three channels. The HomeLink[®] determines the frequency, data and, where applicable, the Rolling Code manufacturer of the original GDO transmitter (OT). The frequency and data stream or rolling algorithm parameters (created within the OT's Rolling Code guidelines) are then stored in non-volatile memory (NVM) for use in the transmit mode of operation. Once contained in memory, the HomeLink[®] shall activate the given receiver by repeating, at the proper frequency, either a fixed data stream or a hopping data stream created with the OT's Rolling Code algorithm.

HomeLink[®] Transmit Mode of Operation

If a selected channel has been previously trained, the HomeLink[®] shall operate in transmit mode. To operate the HomeLink[®] in the transmit mode, the user shall activate one of three transmit buttons. The Compass microprocessor shall determine which button has been activated and send the information serially to the HomeLink[®] microprocessor, which shall generate appropriate data at the proper frequency.

The VFD indicator shall be ON continually during transmit mode.

The VFD indicator shall rapidly blink ($4\text{Hz} \pm 10\%$) for $2 \pm 10\%$ seconds followed by continuous illumination during Rolling Code PWM transmissions.

The HomeLink[®] will continue in the transmit mode for twenty ($20 \pm 10\%$) seconds before proceeding to the learning mode of operation.

HomeLink[®] Default Mode of Operation

If a selected channel has never been previously trained nor previously erased, the HomeLink[®] shall operate in default mode. To operate the HomeLink[®] in the default mode, the user shall activate one of three transmit buttons. The HomeLink[®] shall determine which button has been activated, and using a pre-determined identification code and frequency (see Appendix B for details) shall transmit such data with the VFD indicator continually on. The HomeLink[®] will continue in the default mode for twenty ($20 \pm 10\%$) seconds before proceeding to the learning mode of operation.

HomeLink[®] Rolling Code Default Mode of Operation

The user places the HomeLink[®] in rolling code default mode by simultaneously holding down buttons one, two, and three for $30 \pm 10\%$ seconds.

If buttons one, two and three are released while the VFD is rapidly blinking (< 10 seconds), all three channels will be cleared of data. When one of these channels is subsequently

activated, the device shall immediately enter the learn mode of operation.

To operate the HomeLink[®] unit in the rolling code default mode, the user shall activate one of the three transmit buttons. The HomeLink[®] unit shall determine which button has been activated and using a pre-determined code-hopping algorithm, bit period and frequency (see Appendix B for details) shall transmit such data with the VFD indicator rapidly blinking ($4\text{Hz} \pm 10\%$) for $2 \pm 10\%$ seconds followed by continuous illumination.

HomeLink[®] Learn Mode of Operation

The HomeLink[®] system can learn up to three (3) separate garage door opener (GDO) systems. To train a GDO transmitter to the HomeLink[®] system, the user shall complete the following steps:

- select one of three channels by selecting 1 of three transmit buttons. If more than one channel is selected at one time, the HomeLink[®] shall give the lowest numbered channel highest priority. For example if channel 2 and 3 are selected, channel 2 shall have the higher priority.
- hold a transmit button for twenty ($20 \pm 10\%$) seconds at which time the learn mode shall be indicated. The HomeLink[®] shall be in learn mode only if the VFD indicator is blinking at a rate of $1\text{Hz} \pm 10\%$. (The HomeLink[®] shall immediately enter learn mode if the selected channel is determined to be clear of data. See 1.2.4)
- hold the present GDO transmitter near the HomeLink[®]. The HomeLink[®] shall train when the OT is held within 1 inch, and shall not train if the OT is held more than 3 feet away from the unit. Once in learn mode, the training process will be complete in ≤ 90 seconds and shall be indicated by rapidly blinking the VFD ($4\text{Hz} \pm 10\%$) 40 times. After completion the VFD indicator shall be off.
- the data containing the frequency of operation and security code information shall be stored in non-volatile memory (NVM).

HomeLink[®] Clear Mode of Operation

The NVM of the HomeLink[®] can be completely erased by simultaneously holding down buttons one and three for $20 \pm 10\%$ seconds. Successful erasure of the memory shall be indicated by rapidly blinking the VFD indicator ($4\text{Hz} \pm 10\%$) 40 times.

- If buttons one and three are released while the VFD indicator is blinking rapidly (< 10 seconds), all three channels shall be cleared of data. When one of these channels is subsequently activated, the device shall immediately enter learn mode of operation.
- If buttons one and three are continually activated for more than 10 seconds after the rapid blinking starts, the VFD indicator shall be off. When one of these channels is subsequently activated, the device shall immediately enter default mode of operation.
- If buttons one, two, and three are continually activated for more than 10 seconds after the rapid blinking starts, the VFD indicator shall be off. When one of these channels is subsequently activated, the device shall immediately enter rolling code default mode of operation.