HP104 PPM In Home/ Out of Home Indicator

1.1 In Home/Out of Home Transmitter

Subscribers to Arbitron's ratings service are not just interested in *which* radio or television station a panelist listens to, but also *where* the station was heard: In their home, or somewhere out of home such as in their car, at work, etc?

To meet this need, the PPM system's Hub (also known as the household collector) contains a low power 433 MHz RF transmitter that acts as a continuous "at-home" beacon. If a panelist is home and within 100 feet of the Hub transmitter, an RF receiver in his personal meter (i.e., his PPM) will detect the transmission. The PPM records successful detections in its listening log every few minutes. The In Home/Out of Home Indicator system is illustrated in Figure 1 below.

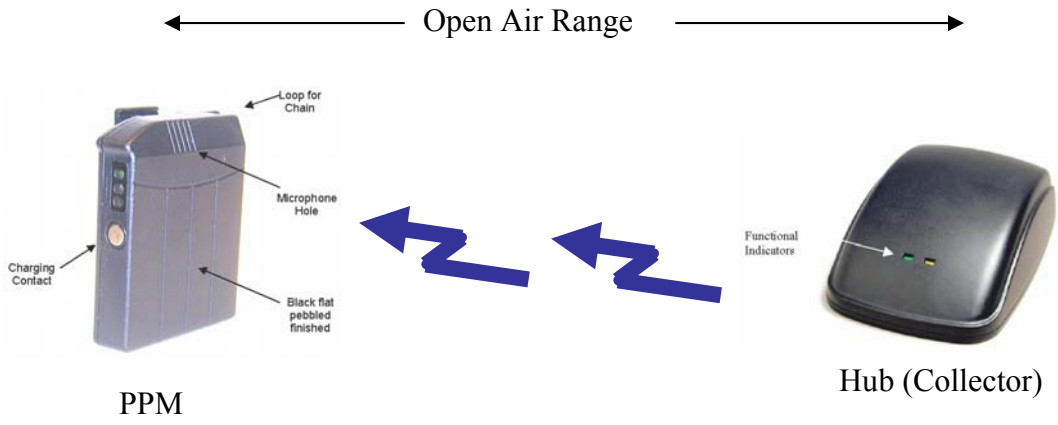

Figure 1. If a panelist is home and within 100 feet of the Hub transmitter, an RF receiver in his PPM will detect the transmission and log a positive "in Home" event.

1.2 In Home/Out of Home Transmitter

The Enhanced Locator Hub contains a Linx TXM-433 which is a low-power (0 dBm) 433.92 MHz RF transmitter mated to a custom antenna (see Figures 2 and 3 below). The TXM-433 is driven by the Echelon Neuron microcontroller.

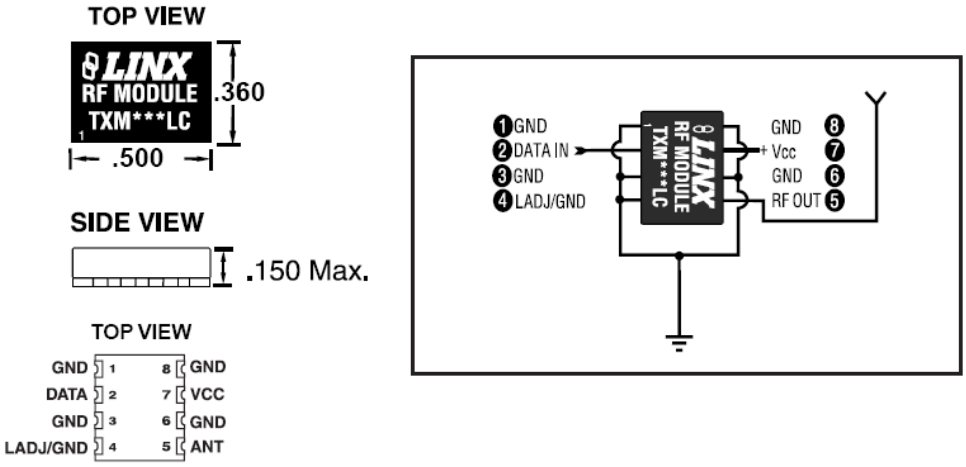

Figure 2. The Linx TXM-433 transmitter IC has a nominal 0 dBm power output.

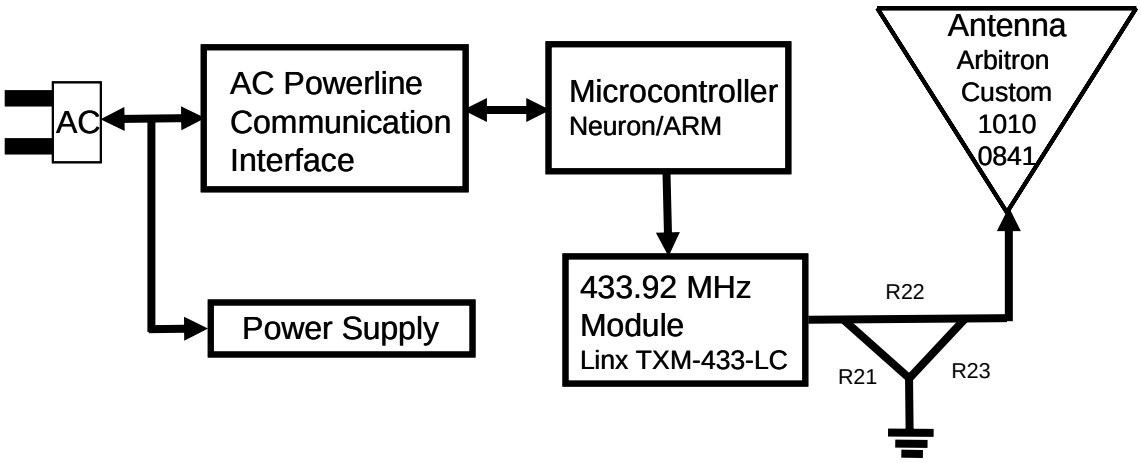

Figure 3. The HP104 Locator Hub contains a 433.92 MHz low power transmitter (Linx TXM-433 mated with a custom antenna) which provides an "at home" signal to panelist meters. A π filter formed by R21, R22, and R23 attenuates the peak output power of the TXM-433 by 6 dB for FCC 15.231 compliance. Emissions testing at an independent lab determined that R21=R22=R23= 82 Ohm (with a 14% duty cycle) permits the maximum transmitted power under FCC rules.

1.3 FCC Transmitter Regulations

As an intentional radiator, the In Home/Out of Home transmitter needs to be compliant with FCC regulations outlined under section 15.231, which contains five subsections: (a), (b), (c), (d), and (e).

Subsection (a) allows for three types of intentional transmitters: manually operated, or automatically triggered but restricted to transmitting less than 2 seconds per hour. Subsection (b) specifies the power limits for subsection (a) devices, while subsections (c) and (d) specify bandwidth and band-limit requirements.

Subsection (e) provides a special exception to subsection (a) with allowable transmission levels of less than *half* those provided under subsection (b). In addition, subsection (e) devices must not transmit for greater than one second and the silent period between transmissions must be at least 30 times the duration of the transmission but in no case less than 10 seconds. Lastly, subsection (e) devices must meet the bandwidth and band-limit requirements of subsection (b), which includes a power-measuring requirement covered under section 15.35. Specifically, the measured field strength must be determined from the average absolute voltage during a 0.1 second interval when the transmitted pulse code is at its maximum.

For reference, the Subsection (e) 433.92 MHz power limit is 4,399 µV/m (72.9 dBµV/m).

1. Transmitter Power
   The Lynx TXM433 module transmits at its maximum 0 dBm power level.
2. Transmitter 100 ms burst duty cycle
   The transmitter emits 2 ms power pulses every 16 ms. Within a worst-case 100 ms window there are 7 power pulses, resulting in 2x7/100 = 14% duty cycle. [Note: 15.35(b) ...*When average radiated emission measurements are specified in the regulations there is also a limit on the radio frequency emissions corresponding to 20 dB above the maximum permitted average limit for the frequency being investigated ....*
   So, since 20*log(0.1) = -20dB, this means that a duty cycle less than 10% is not useful for lowering the FCC power level compliance further.]
3. Total Transmission Time
   The total transmission time is 978 ms. Note this is less than the one second section 15.231(e) maximum.
4. Transmitter Silent Period
   The transmitter will be silent for 30.022 seconds between transmissions. Section 15.231 (e) requires a minimum silent period of 30 x 0.978 = 29.340 seconds or 10.00 seconds, which ever is greater.
5. Transmitter Transmission Period
   The transmitter's 0.978 second "on" time followed by the 30.022 "off" time equates to a 31.000 second period repeating transmission pattern.

The resulting transmitted pattern is illustrated in Figures 4 and 5 below.

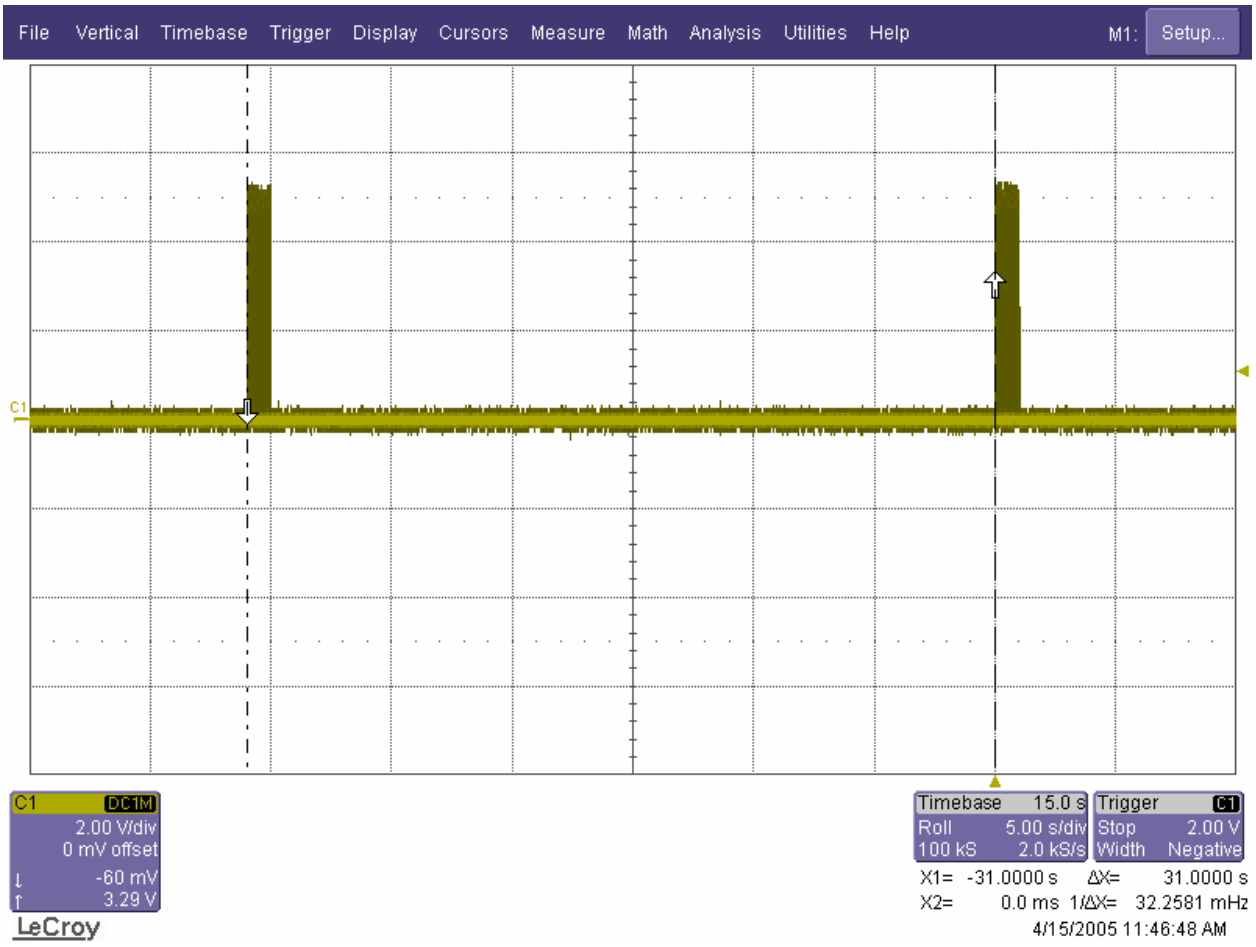

Figure 4. The In Home/Out of Home transmitter emits 2 ms power pulses every 16 ms, for 978 ms, then remains silent for 29.340 seconds, then repeats.

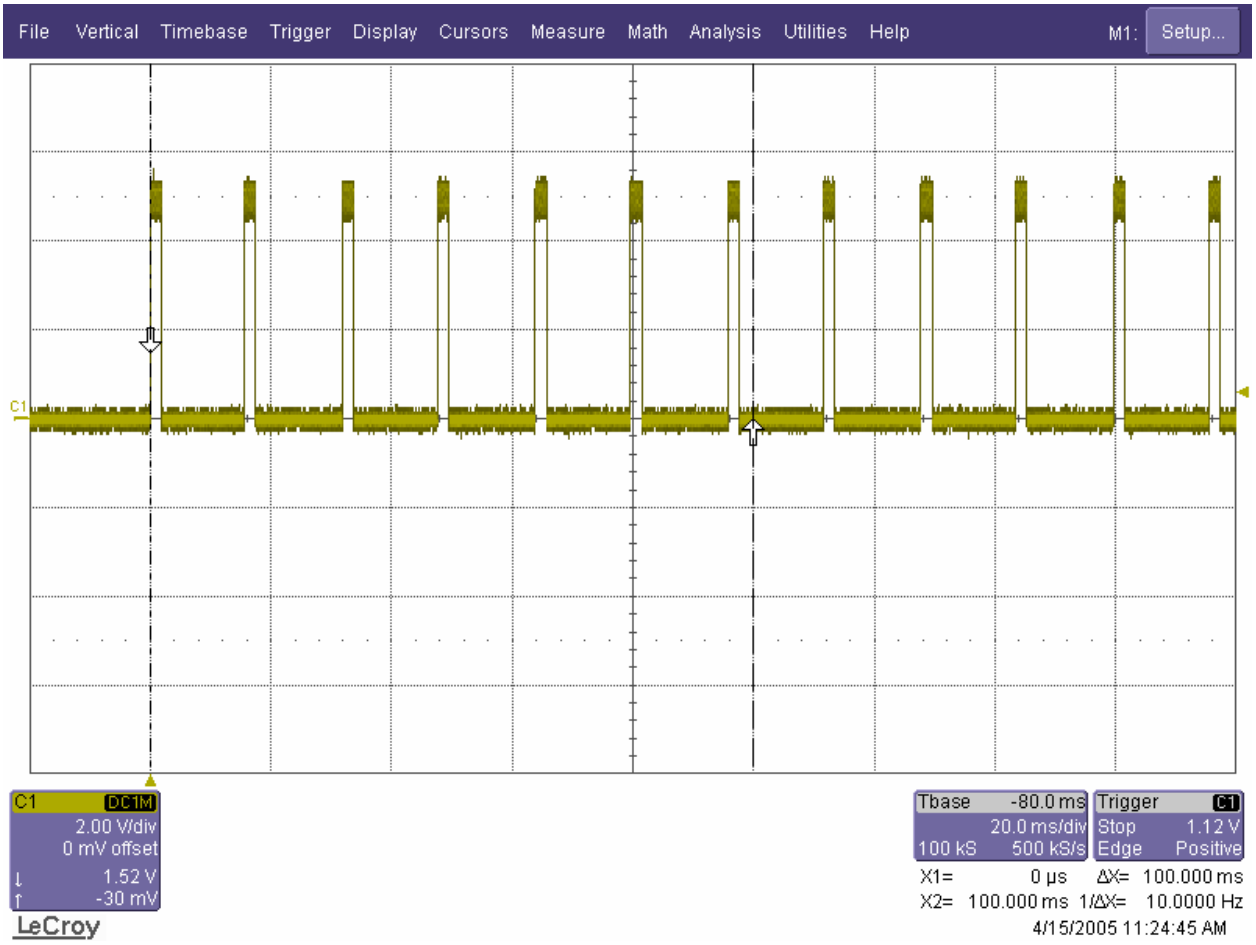

Figure 5. The HP104 Transmitter duty cycle within a worst-case 100 ms window.