RF RECEIVER MODULE – COMPLETE TECHNICAL SPECIFICATION

For BX68R004 / BX68EV004 433.92 MHz OOK Transmitter

1. Purpose of This Document

This document defines the complete and detailed technical requirements for designing, implementing, and manufacturing a receiver module that is fully compatible with the BX68R004-based RF transmitter. It includes RF requirements, electrical characteristics, protocol timing, decoding rules, button coding, and explicit handling of cases where no valid button code is transmitted. This document is intended to be directly shared with a receiver design, firmware, or manufacturing team without any additional explanation.

2. System Overview

The system consists of a handheld RF transmitter operating at 433.92 MHz using On-Off Keying (OOK) modulation and a fixed receiver that converts received RF bursts into digital button commands. Each button press on the transmitter generates a short RF message containing a synchronization pulse and a 4-bit button code. The receiver must decode this message and generate a corresponding command event.

3. RF Receiver Hardware Requirements

3.1 RF Characteristics

Carrier Frequency: 433.92 MHz
Modulation Type: OOK / ASK (envelope detection required)
Receiver Architecture: Superheterodyne receiver is strongly recommended
Sensitivity: ≤ –105 dBm (minimum acceptable –100 dBm)
IF Bandwidth: ≥ 200 kHz
Antenna Input: 50-ohm matched input, external wire or PCB antenna

3.2 Electrical Characteristics

Supply Voltage Range: 3.0 V to 5.5 V
Receiver Data Output: Raw digital data (not decoded)
Logic Levels: CMOS / TTL compatible
Idle Data Output Level: Logic LOW when no RF signal is present
Startup Time: ≤ 5 ms

4. RF Protocol Description

The protocol is a custom, clockless pulse-presence encoding scheme. There is no fixed baud rate. All decoding is based on measuring relative pulse widths and time windows derived from the synchronization pulse.

4.1 RF Frame Structure

Each RF transmission frame has the following structure:

SYNC → Bit3 → Bit2 → Bit1 → Bit0 → FRAME GAP

The entire frame is transmitted twice for reliability.

4.2 Synchronization Pulse (SYNC)

The SYNC pulse is a long RF ON period that marks the beginning of a frame. It allows the receiver to reset its decoder state machine and establish timing reference.

Nominal Duration: 40 time units
Acceptable Detection Range: 30–60 time units
Pulses shorter than this range must not be treated as SYNC.

4.3 Data Bit Encoding

Each data bit is transmitted within a fixed-duration window of approximately 20 time units.

Logic 1: RF ON for ~10 units followed by RF OFF for ~10 units
Logic 0: RF remains OFF for the entire 20-unit window

The receiver must determine the bit value solely based on pulse presence within the window.

4.4 Frame Repetition

Each frame is transmitted exactly two times with an RF OFF gap between repetitions. The receiver may accept the first valid frame or may require two identical frames before accepting the command for improved noise immunity.

5. Timing Parameters and Tolerances

All timing values are relative and must be interpreted with tolerance to account for oscillator variation, temperature drift, and component tolerances.

SYNC pulse: 30–60 units
Bit ON pulse: 6–15 units
Bit window: 15–30 units
Frame gap: ≥ 30 units

Any pulse shorter than approximately 3 units must be treated as noise and ignored.

6. Button Coding and Command Definition

The payload consists of a 4-bit value transmitted MSB first. Each value directly represents the button number pressed on the transmitter.

6.1 Button Code Table

Button 1 → 0001 (decimal 1)
Button 2 → 0010 (decimal 2)
Button 3 → 0011 (decimal 3)
Button 4 → 0100 (decimal 4)
Button 5 → 0101 (decimal 5)
Button 6 → 0110 (decimal 6)
Button 7 → 0111 (decimal 7)
Button 8 → 1000 (decimal 8)
Button 9 → 1001 (decimal 9)
Button 10 → 1010 (decimal 10)
Button 11 → 1011 (decimal 11)
Button 12 → 1100 (decimal 12)
Button 13 → 1101 (decimal 13)
Button 14 → 1110 (decimal 14)

6.2 No Button / Idle Condition (No Button Code)

When no button is pressed on the transmitter, no RF frames are transmitted. There is no valid button code corresponding to an idle state. The receiver must interpret prolonged RF silence as 'no command'.

If an incomplete frame is received (SYNC without 4 valid bit windows, or timing violation), the receiver must discard the frame and must not generate any command output.

7. Receiver Firmware Implementation Requirements

The receiver firmware must be implemented as a deterministic state machine with the following states:
IDLE → SYNC DETECT → BIT CAPTURE → FRAME VALIDATION → COMMAND OUTPUT → LOCKOUT → IDLE

The MCU must provide at least one timer capable of measuring pulse widths with sufficient resolution to distinguish between noise, bit pulses, and synchronization pulses. A lockout period of 50–150 ms after a valid command is recommended to prevent false retriggering.

8. Manufacturing and Production Test Requirements

Each receiver unit must be tested using a known-good transmitter or RF signal generator. Correct decoding must be verified at signal levels of –60 dBm, –90 dBm, and –105 dBm. Under noise-only conditions or invalid RF activity, the receiver must not generate any output command.

9. Conclusion

This document fully defines the RF, electrical, protocol, timing, and button coding requirements for a receiver compatible with the BX68R004 OOK transmitter. Compliance with this specification ensures reliable interoperability and production readiness.