TECHNICAL DESCRIPTION

The MC10 is a wireless remote display used to interface Alpine marine head units. It is comprised of a 2.4GHz transceiver and microcontroller using the Freescale MC13213 SIP controller. The circuitry is powered from the 12Vdc power used in typical marine applications. The MC10 communicates with the Alpine marine head unit using IIC communication port on the MCU section of the MC13213. It sends the information wirelessly to the MC10 display unit for interaction with the user. The user will interface with the MC10 display unit through a 13 function keypad and graphic LCD. A key press will be decoded and wirelessly transmitted to the MC10 head unit interface.

The MC13213 contains an RF transceiver which is an 802.15.4 Standard compliant radio that operates in the 2.4 GHz ISM frequency band. The transceiver includes a low noise amplifier, 0.1mW nominal output power, PA with internal voltage controlled oscillator (VCO),integrated transmit/receive switch, on-board power supply regulation, and full spread-spectrum encoding and decoding. The device supports 250 kbps Offset-Quadrature Phase Shift Keying (O-QPSK) data in 2.0 MHz channels with 5.0 MHz channel spacing per the 802.15.4 Standard. The MC1321x also contains a microcontroller based on the HCS08 Family of Microcontroller Units (MCU),specifically the HCS08 Version A, and can provide up to 60KB of flash memory and 4KB of RAM. The onboard MC13213 2.4 GHz Low Power Transceiver for the IEEE® 802.15.4 Standard plus Microcontroller MCU allows the communications stack and also the application to reside on the same system-in-package (SIP).

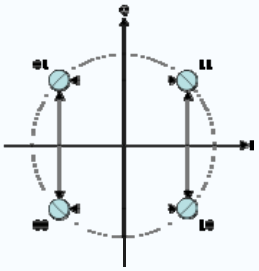
The RF section is a dual port application topology which also uses a printed copper F antenna. Both the RFIN and PAO ports are used and the internal T/R switch is bypassed. Matching is provided for both differential ports by L1, L2, L3, and L4 and C20 and C21. A balun is used for both receive and transmit paths which are provided by the external T/R switch, U6. This implementation gives better performance due to the reduced loss of the external T/R switch and the more optimum match provided to the PAO and RFIN ports. The switch control is connected to the CT_Bias pin which serves as its control signal. The CT_Bias signal can be programmed to be active high or active low (depending on TX versus RX) and will switch appropriately based on the radio operation. No interaction with the MCU on an operation-by-operation basis is required. The microcontroller is used to interface the keypad, LCD and onboard memory using the IIC bus system.

Offset QPSK (OQPSK)

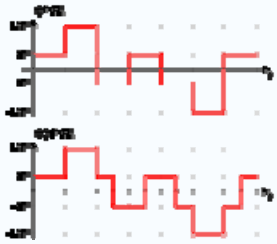
Offset quadrature phase-shift keying (*OQPSK*) is a variant of phase-shift keying modulation using 4 different values of the phase to transmit. Taking four values of the phase at a time to construct a QPSK symbol can allow the phase of the signal to jump by as much as 180° at a time. When the signal is low-pass filtered, these phase-shifts result in large amplitude fluctuations, an undesirable quality in communication systems. By offsetting the timing of the odd and even bits by one bit-period, or half a symbol-period, the in-phase and quadrature components will never change at the same time. In the constellation diagram shown below, it can be seen that this will limit the phase-

shift to no more than 90° at a time. This yields much lower amplitude fluctuations than non-offset QPSK and is sometimes preferred in practice.

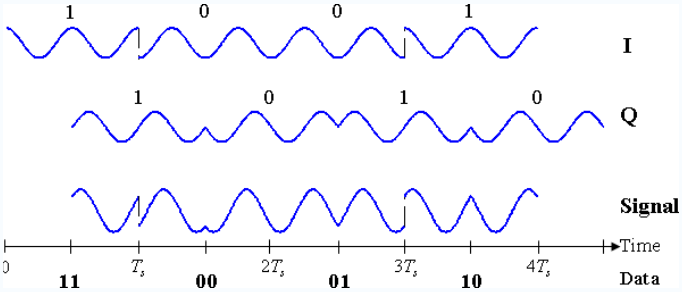
The modulated signal is shown below for a short segment of a random binary data-stream. Note the half symbol-period offset between the two component waves. The sudden phase-shifts occur about twice as often as for QPSK (since the signals no longer change together), but they are less severe. In other words, the magnitude of jumps is smaller in OQPSK when compared to QPSK



Signal doesn't cross zero, because only one bit of the symbol is changed at a time



Difference of the phase between QPSK and OQPSK



Timing diagram for OQPSK.

The binary data stream is shown beneath the time axis. The two signal components with their bit assignments are shown on the top and the total, combined signal at the bottom..