Application of the MM53200 Encoder/Decoder

National Semiconductor
Application Note 290
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INTRODUCTION

The MM53200 is an easy-to-use MOS-LSI encoder-decoder designed for simple and reliable on-off signaling applications, such as garage door openers, electronic key, and alarm systems.

Application of the MM53200 requires only a resistor and capacitor to function as an encoder or decoder. In the encoder mode, a 12-bit pulse width data stream is generated according to the state of the data select inputs. Input pullup resistors require only that a single pole closure to ground be made to change a particular bit.

In the receive mode, the data stream is compared bit by bit to the data inputs of the decoder chip. If no errors are found, a "valid" signal is generated which clears a 64 ms counter and clocks a 3-stage counter. Valid pulses are counted by the 3-stage counter so that when four valid data streams have been received, the decoder output goes low, and remains low as long as one in six data streams are valid. This arrangement guarantees the decoder will not accept a "valid" transmission on noise, yet have enough hysterisis not to "chatter" on noisy signals.

A simple signaling system for two wire applications is shown in *Figure 1*. This system uses base band signaling and has been tested successfully to simulated distances of over 1,000 ft. of No. 22 twisted-pair telephone wire. Output current limits the capability of the part to drive substantially more wire capacitance, however, the addition of a buffer amplifier will substantially increase the distance signaling that may be achieved.

In most applications, the data stream will be used to modulate a carrier frequency that is optimum for the medium over which the command signal must be sent.

These carriers will generally fall in the following catagories:

a. Ultrasonic: 30 kHz–60 kHz

b. Carrier Current: 50 kHz–300 kHz

c. Unlicensed RF Transmission: 49 MHz or 300 MHz

d. Light: Red or Infrared

In the normal mode of operation, with a 100 kHz clock frequency, the MM53200 generates 0.3 ms pulses (or a baud rate of 3 kHz). In order to pass these pulses, the baseband channel bandwidth must be greater than 6 kHz. Since a data word lasts 11.52 ms, with a 11.52 ms "dead" time between words, the low frequency response of the channel must be 20 times less than the pulse duration for less than 10% base line shift, or approximately 2 Hz.

SIGNAL-TO-NOISE PERFORMANCE

In any practical communications system, noise is the limiting factor in communications distance. For a given transmitted power, whether limited by FCC or practical constraints, the received signal can only be amplifed to the point that receiver noise masks the signal and makes decoding impossible.

Figure 2 shows a typical communications link. The input to the receiver consists of both signal and noise. From this point on, the only thing that can be done to improve the signal-to-noise ratio is reducing the bandwidth of the filter. However, this can only be done to the point where there is no loss of signal—in fact, an optimum point exists which is approximately: $B\tau = 0.7$ for a multistage RC filter, where B = bandwidth in Hz; τ = pulse width in seconds.

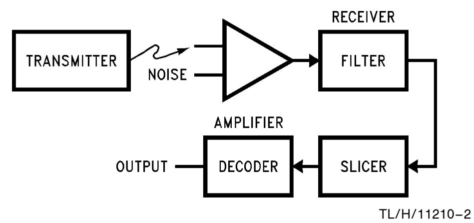

FIGURE 2. Typical Communications Link

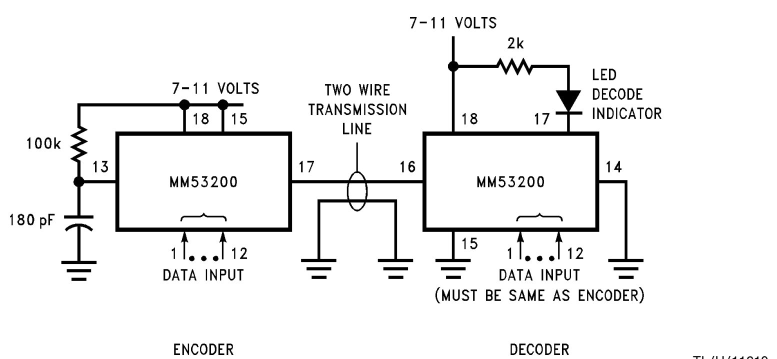

FIGURE 1. Simple Two-Wire Signaling System or Test Circuit

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This factor can be determined experimentally for any digital decoder by using circuitry similar to that of *Figure 3*. Signal amplitude is adjusted for a convenient level at the test point, while the slicing level is set to be halfway between the peak-to-peak signal level. Noise is increased until decoding occurs 50% of the time and the ratio of peak-to-peak signal vs. rms noise as measured at the test point is noted. If this ratio is plotted vs. normalized filter bandwidth, the curve of *Figure 4* results.

Ultrasonic Remote Control

The clock of MM53200 is set to 12.5 kHz, with pulses of 3.2 ms (100k, c = 1500 pF).

The LF357, a fast operational amplifier, is connected as a square wave oscillator, which is triggered by the transistor. It will deliver bursts of the carrier frequency (38 kHz depending on the transducer used). The optimum value is adjusted with the 100 kHz potentiometer, according to the transducer specifications.

The ultrasonic decoder uses a dual BI-FET™ op amp, LF353. The first stage is simply an amplifier with a gain of 41 dB. The signal is then demodulated by the diode, DC level is isolated by the 3.3 μF capacitor, and signal is again amplified by the second half of the LF358. The signal is then formed through a third op amp (one-half LM358) which acts as a comparator and drives the receiving MM53200. The second half of the LM358 is used as a buffer to drive the load.

This circuitry has been tested up to 30 ft. The range could be increased with other special transducers.

UHF REMOTE CONTROL LINK

A UHF transmitter/receiver application for the MM53200 is described. The circuits are suitable for general purpose remote control over distances of 100 ft.–1,000 ft. The circuits shown are suitable for FCC approval under Part 15, Subpart D for the transmitter and Subpart C for the receiver. They operate in the 300 MHz–400 MHz band.

The transmitter is a grounded-base Colpitts-type tuned-collector oscillator, similar to that used for television and FM local oscillators. Output pulses from the MM53200 are applied to the base of the oscillator transistor turning it on and off. Frequency of operation is determined by L1, C2, and stray capacitance. Feedback is between collector and emitter via stray capacitance in Q1.

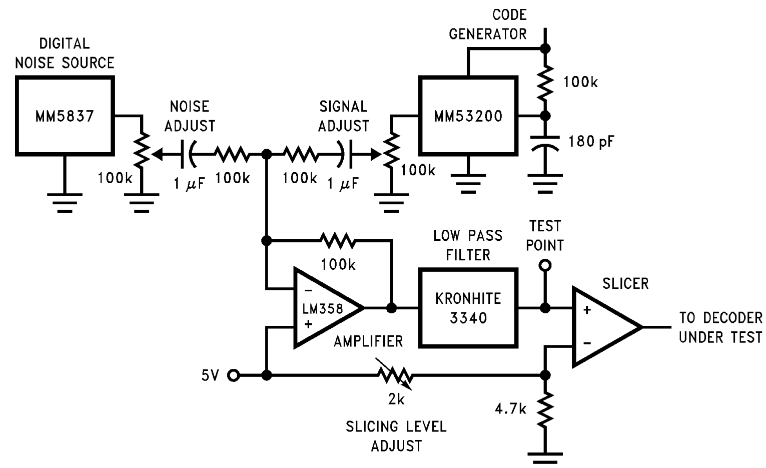

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FIGURE 3. Signal-to-Noise Test Circuit

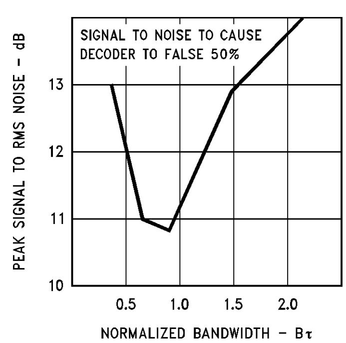

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FIGURE 4. Signal-to-Noise vs. Normalized Bandwidth

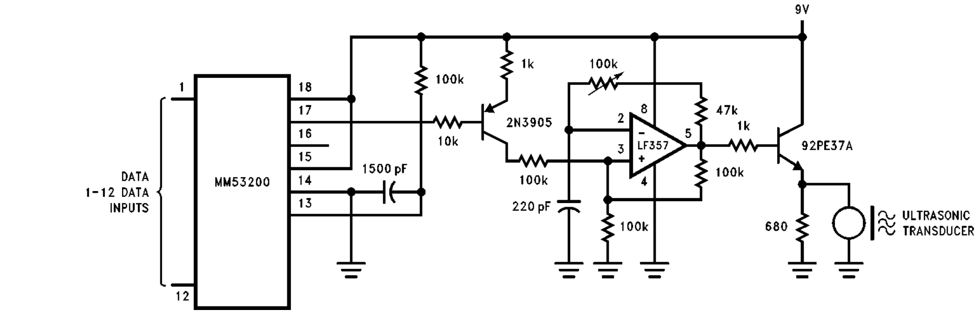

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FIGURE 5. Ultrasonic Transmitter

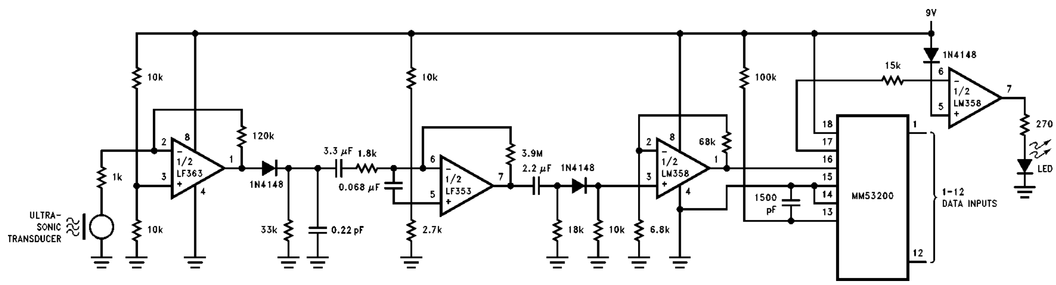

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FIGURE 6. Ultrasonic Receiver

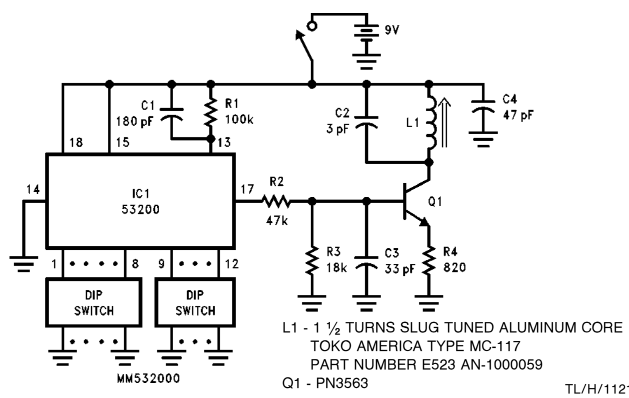

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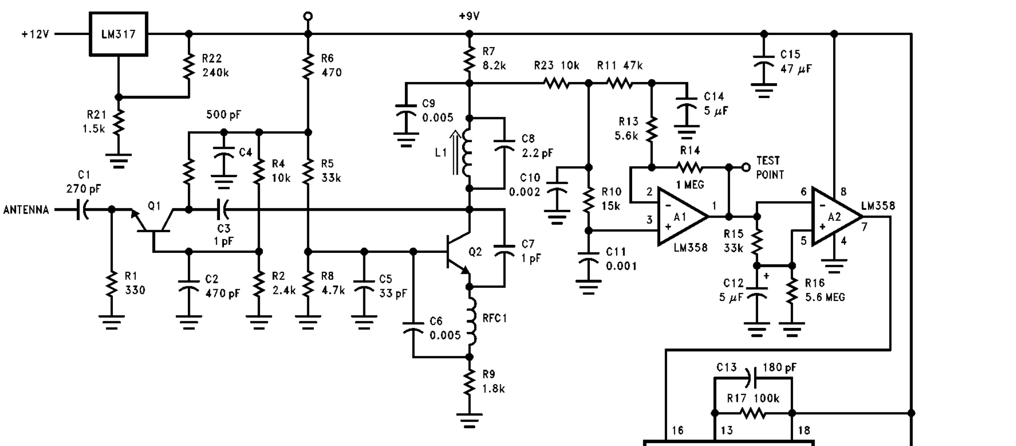
FIGURE 7. Remote Control Transmitter

The receiver is a superregenerative type with a grounded-base RF amplifier (Q1) to increase sensitivity and reduce detector radiation. Q2 functions as the detector which is essentially a UHF oscillator that continues to turn itself on and off at a 200 kHz rate. The detected signal is amplified by a dual operational amplifier, one half of which is used as a linear small signal amplifier while the second is used as a comparator to drive the decoder IC.

With a 4 μV peak RF input signal, approximately 0.5 mV of signal is available from the detector, and 100 $mV_{p\text{-}p}$ is available at the input of A2. At this level, the peak signal to rms noise at the output of A1 is approximately 12 dB and satisfactory decoding should result. Receiver center frequency may be varied by changing C8 with little effect on sensitivity, A2 produces logic level pulses for the MM53200 decoder, whose input data stream agrees with the preset code.

A voltage regulator is required since the detector circuit has no power supply rejection and small variations in supply voltage due to ripple and load variation will cause loss of data.

A properly operating system will have very narrow pulses of 6V peak at a 200 kHz–400 kHz rate across R9. Detector operation may be checked by using Pin 1 of A1 as a test point. Here, with no input signal, there should be approximately 0.2 $V_{P\text{-}P}$ noise. This point may be used to tune receivers and transmitters together for maximum response.



RFC1 9 TURNS 3/16 DIAMETER CLOSE WOUND. 0.35 μH

L1: 1½ TURNS SLUG TUNED ALUMINUM CORE
TOKO AMERICA TYPE MC-117
PART NUMBER E523 AN-10000 59

Q1: MPSH11 NATIONAL SEMICONDUCTOR PROCESS 47

Q2: MPSH10 NATIONAL SEMICONDUCTOR PROCESS 47 (THIS IS A CRITICAL DEVICE; SIMILAR PART NUMBERS FROM DIFFERENT MANUFACTURERS MAY RESULT IN DEGRADED PERFORMANCE).

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FIGURE 8. Remote Control Receiver

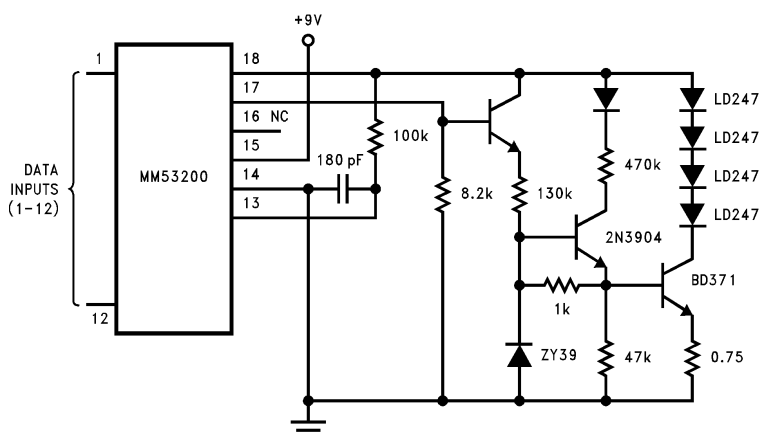

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FIGURE 9. Infrared Transmitter

INFRARED LINK

For infrared transmission, the encoded signal has to be amplified to drive the emitting diode. We are using a 3-transistor amplifier, with a constant current driving capability. The signal is transmitted by four infrared emitting diodes (here LD247). One LED is connected in series, in the collector of one of the transistors to ''show'' transmission.

The receiver uses two infrared sensitive diodes (BPW61). The first diode is actually the receiver, which receives both the signal and the ambient light (noise). The second diode receives only ambient light. A difference amplifier gives the resulting signal with low distortion, which is again amplified and fed into Pin 16 of MM53200. The amplifier is a LM324 quad op amp. Two small signal diodes (1N4148) are used to limit input signal amplitude, which might be used when the receiver is very close to the transmitter.

We show here three receivers connected in parallel after one filter, each of which is programmed on a different code and switches for a different transmitted code.

In a typical application, control has been obtained over 20 ft.

ADDING A LATCH FUNCTION

Figure 11 shows an application where the system latches itself as soon as a message has been received.

In the idle mode, output 17 is high and Q1 is on. The RC oscillator output pin is free running, and MM53200 is waiting for incoming code.

If a valid signal is received on Pin 16, output 17 goes low. Q1 turns off, the RC network stops oscillating, and the MM53200 internal clock stops working. The MM53200 stays in the same position, i.e., output low. In our example, Q2 will stay on and the LED will be on. The system is reset by resetting the clock by connecting the base of Q1 to V+ through a push-button. The oscillator starts again, and MM53200 waits for another call.

This latch function costs the user one npn transistor and one resistor. For example, it could be used to power on another remote-controlled function running from the same output decoder after receiving the correct ''address'' code.

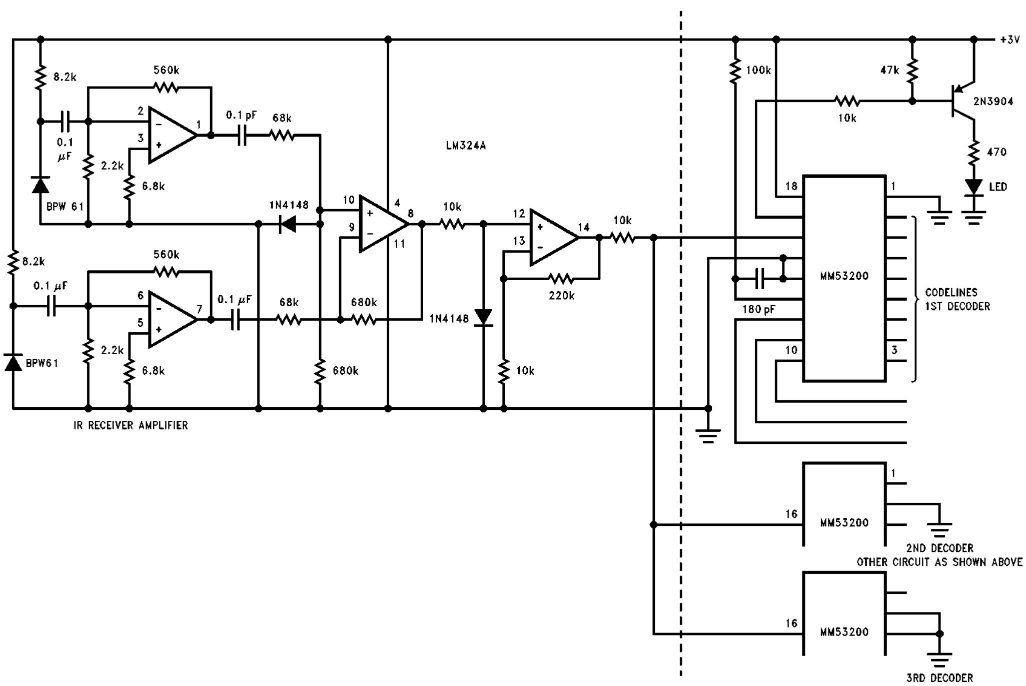

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FIGURE 10. IR Receiver Application

A LATCHED ON-OFF FUNCTION

With the addition of a JK flip-flop, a 2-state sequential application is possible. *Figure 12* shows how either of two outputs may be enabled with a single decoder. One output of the 74C73 flip-flop will force a change in data to the receiver, so, in order to switch back to the original state, the original code must be present.

CONCLUSION

MM53200 is a versatile encoder-decoder that finds its application in numerous cases. The type of transmitting method has to be chosen according to the application and the desired range. For short distances—up to 30 ft.—infrared or ultrasonic or visible light may be chosen for both indoor or outdoor applications. For longer distances, up to 500 ft., radio transmissions of either 49 MHz or 300 MHz may be used.

This is a very inexpensive and easy way to control functions, and the over 4,000 different combinations make it a very safe encoding system.

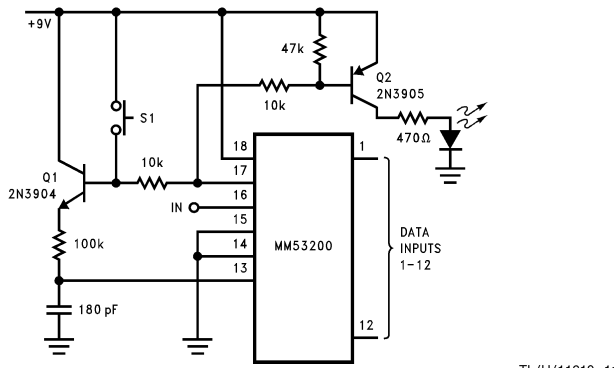

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FIGURE 11. Latch Function

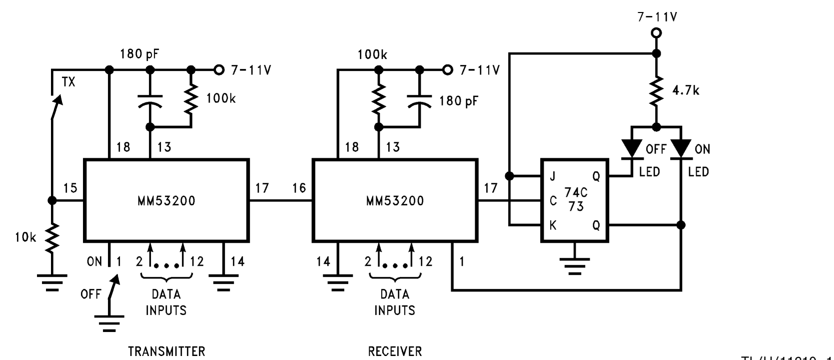

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FIGURE 12. MM53200 Latched ON/OFF Applications

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