Encoding and Decoding with Motorola MC145026/28 Series Chips

The Motorola MC145026 encoder and MC145028 decoder allows you to dial in a code and use that code to remotely address a specifc device. These chips have 9 address pins that accept trinary input (high, low and open) for a total of 19,683 possible codes. The chips transmit words twice during the encoding sequence for added security.

MOTIVATION AND AUDIENCE

The focus of this tutorial is to demonstrate the use of the MC145026/238 to encode an address and decode it remotely for use in operating a device. This tutorial will teach you:

- ***How the MC145026 and MC145028 work.***
- ***How to construct a circuit to demonstrate encoding and decoding.***
- ***How to troubleshoot the MC145026 and MC145028.***

To do this, it is assumed that you already:

- ***Have basic soldering and circuit construction skills.***
- ***Know how to operate an oscilloscope.***

The rest of the tutorial is presented as follows:

PARTS LIST AND SOURCES

To contruct this circuit you will require the following parts:

PART DESCRIPTION	VENDOR	PART	PRICE (2003)	QTY
Motorola Encoder	**Digikey**	MC145026P-ND	$2.19	1
Motorola Decoder	**Digikey**	MC145028P-ND	$3.03	1
49.9 Kohm Resistor	**Digikey**	BC49.9KXCT-ND	$1.95	5
42.2 Kohm Resistor	**Digikey**	BC42.2KXCT-ND	$1.95	5
221 Kohm Resistor	**Digikey**	BC221KXCT-ND	$1.95	5
100 Kohm Resistor	**Digikey**	BC100KXCT-ND	$1.95	5
.0047 uF Capacitor	**Digikey**	P4559-ND	$0.81	10
.022 uF Capacitor	**Digikey**	P4553A-ND	$2.52	10
.1 uF Capacitor	**Digikey**	P4561A-ND	$4.14	10

The resistor and capacitor values chosen were determined from relationships between various timing elements. This will be covered in greater detail later.

To construct the circuit, you will also need:

- ***a soldering iron with a fine point***

- ***materials for soldering (solder, flux, etc.)***
- ***perf board (or solderless bread board)***
- ***small gauge wire***
- ***wire strippers***
- ***multimeter***
- ***DC power supply***

The items listed above can all be purchased from an electronics store such as Radio Shack. Some hardware stores such as Home Depot carry tools like wire strippers and multimeters.

BACKGROUND

The purpose of the encoder/decoder system is to generate a digital signal that rpresents the address set in the encoder. This signal is then sent to the decoder. If the decoder has the same adderss wired into it, it sets the VT (Verify Transmission) pin high. Otherwise, the pin remains low. This ouput could be used to control a relay that would then turn on a device. Several decoders could be connected to a single encoder, thereby allowing you to address several different devices with one encoder by simply dialing into the correct address.

The basic circuit is shown in Figure 1 below:

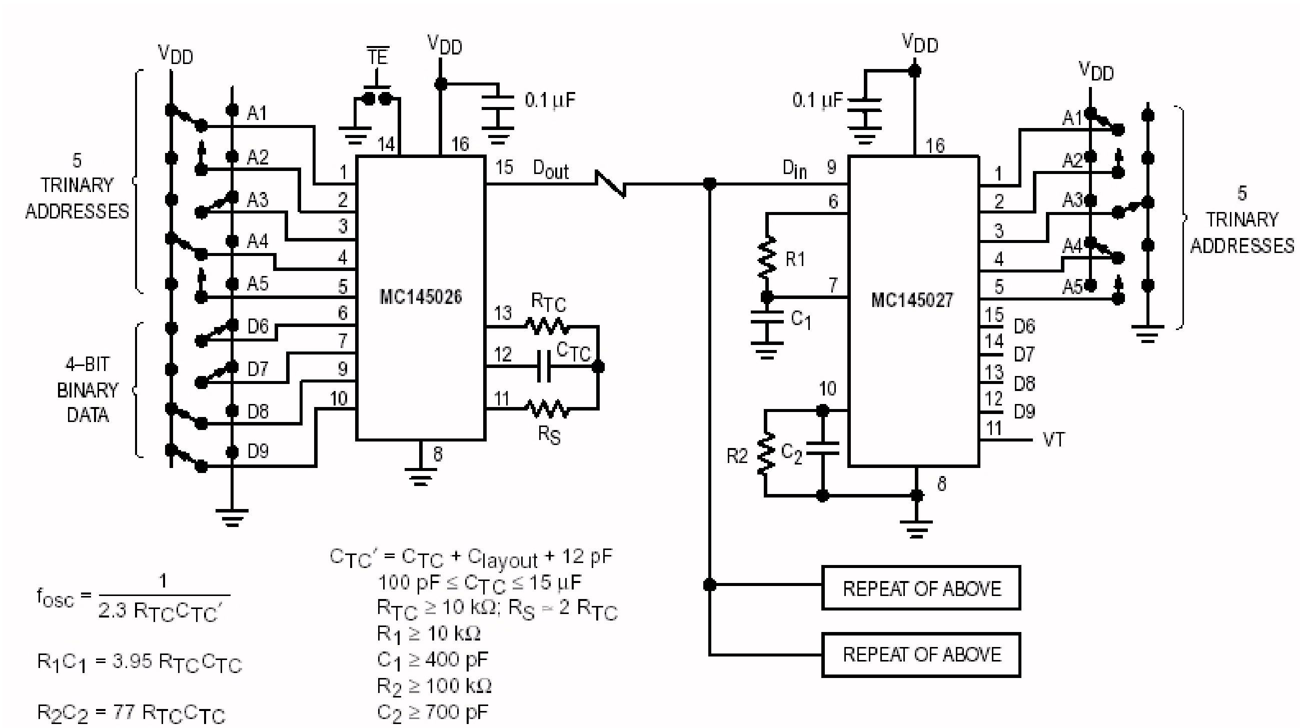


Figure 1

RS, CTC, RTC
(Pins 11, 12, and 13)
These pins are part of the oscillator section of the encoder. The values of these components determine the frequency that data is transmitted from the encoder.

R1, C1
Resistor 1, Capacitor 1 (Pins 6, 7)
These pins accept a resistor and capacitor that are used to determine whether a narrow pulse or wide pulse has been received. The time constant R1 x C1 should be set to 1.72 encoder clock periods:

R1 C1 = 3.95 RTC CTC

R2/C2
Resistor 2/Capacitor 2 (Pin 10)

This pin accepts a resistor and capacitor that are used to detect both the end of a received word and the end of a transmission. The time constant is used to determine whether the Din pin has remained low for four data periods (end of transmission). This time constant R2 x C2 should be 33.5 encoder clock periods:

R2 C2 = 77 RTC CTC

The encoded signal is a combination of ones, zeros and opens. Each of these values is shown in Figure 2. Figure 3 displays a typical data transfer sequence.

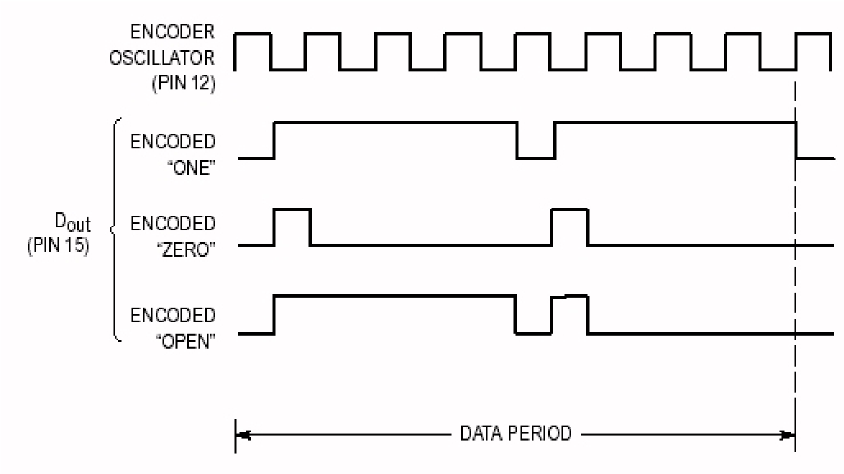


Figure 2

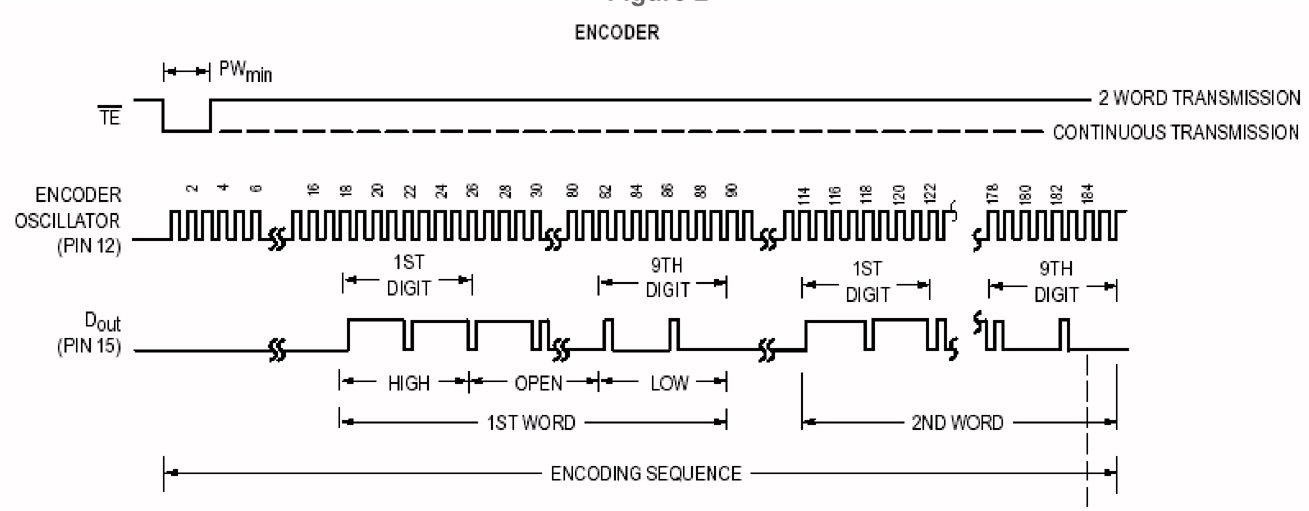


Figure 3

As can be seen, when the TE (Transmit Enable) Pin on the encoder goes high, the encoded signal transmission begins. Each trinary digit is encoded into a pulse. A logic 0 (low) is encoded as two consecutive short pulses, a logic 1 (high) as two consecutive long pulses, and an open (high impedance) as a long pulse followed by a short pulse. An oscilloscope capture of an encoded address can be seen in Figures 4 and 5. This sequence corresponds to pins 1 and 2 being open and the remaining pins being set low.

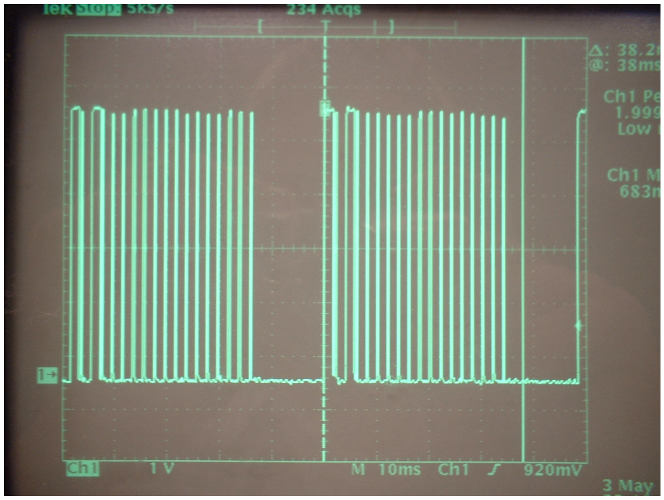


Figure 4

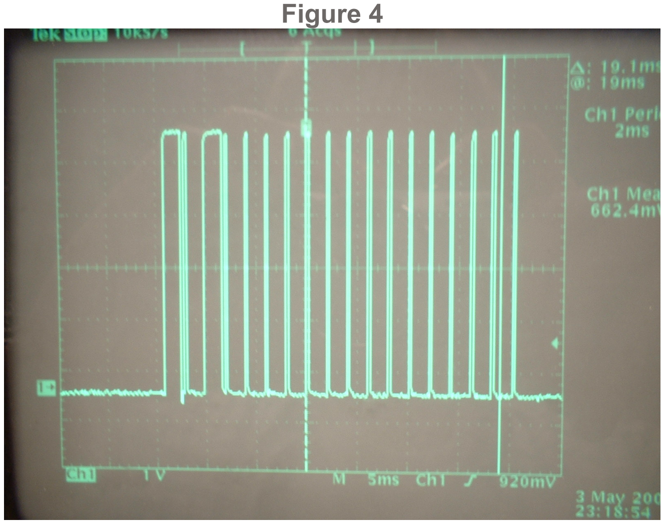
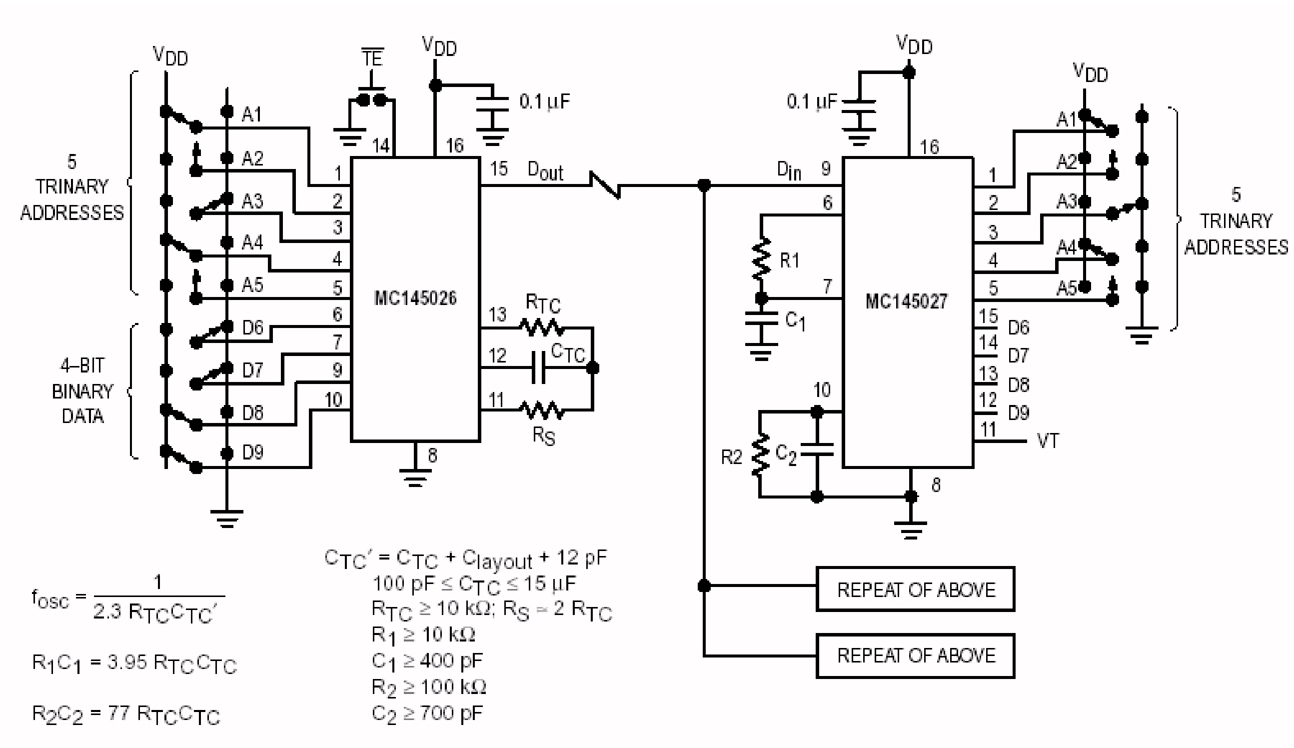


Figure 5

The decoder receives this signal and if it matches the address wired to the decoder, the VT pin is brought high. Two consecutive words matching the address must be received before the VT pin is brought high.

CONSTRUCTION

The circuit diagram with appropriate values is shown below in Figure 6:



LABEL	VALUE	UNITS	LABEL	VALUE	UNITS
RTC	49.9	kOhms	**R1**	42.2	kOhms
CTC	.0047	uF	**C1**	.022	uF
RS	100	kOhms	**R2**	221	kOhms
			C2	.1	uF

Figure 6

When constructing the circuit, assign the devices and address by setting the adress pins (encoder pins 1-10, decoder pins 1-5 and 12-15) to either supply, ground, or open. Be sure that you set the same address for both devices. It would be easier and more insightful if you built in the ability to change addresses by either using a solderless bread board or by incorporating a dip switch. A completed circuit is shown in Figure 7. Note how all address pins are set to low (ground).

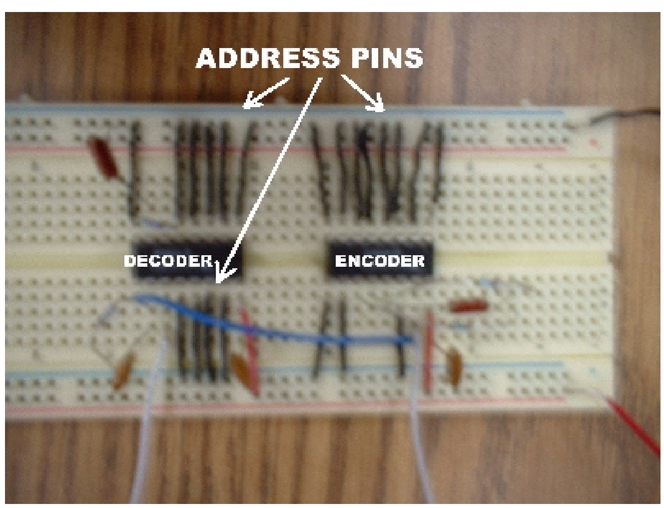


Figure 7

TROUBLESHOOTING

There are two ways you can confirm the timing of the circuit to ensure that the timing of the decoder matches that of the encoder.

To verify the MC145028 timing, check the waveforms on C1 (Pin 7) and R2/C2 (Pin 10) as compared to the incoming data waveform on Din (Pin 9). The R–C decay seen on C1 discharges down to 1/3 VDD before being reset to VDD. This point of reset (labelled “DOS” in Figure 8) is the point in time where the decision is made whether the data seen on Din is a 1 or 0. DOS should not be too close to the Din data edges or intermittent operation may occur.

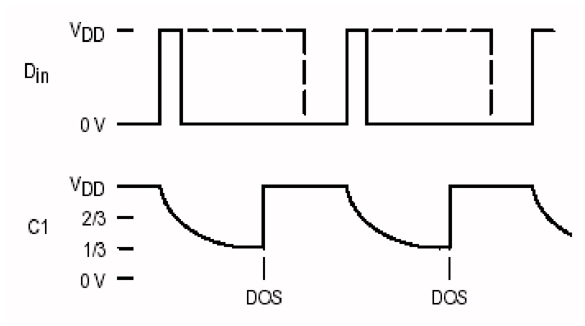


Figure 8

The other timing to be checked on the MC145028 is on R2/C2 (see Figure 9). The R–C decay is continually reset to VDD as data is being transmitted. Only between words and after the end–of–transmission (EOT) does R2/C2 decay significantly from VDD. R2/C2 can be used to identify the internal end–of–word (EOW) timing edge which is generated when R2/C2 decays to 2/3 VDD. The internal EOT timing edge occurs when R2/C2 decays to 1/3 VDD. When the waveform is being observed, the R–C decay should go down between the 2/3 and 1/3 VDD levels, but not too close to either level before data transmission on Din resumes.

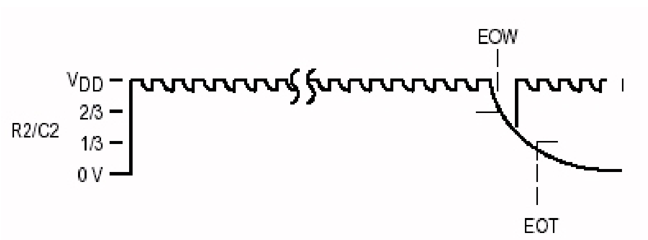


Figure 9

Verification of the timing described above should ensure a good match between the MC145026 transmitter and the MC145028 receiver.

FINAL WORDS

After completing this tutorial you should be familiar with the MC145026 encoder and MC145028 decoder, how to construct a circuit to utilize them and how to troubleshoot the circuit.

If you have questions about this tutorial you can email me at **Keithicus@drexel.edu**.