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APPLICATION NOTE

AN1126

Evaluation Systems for Remote Control Devices on an Infrared Link

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The introduction of many remote control devices and their modest costs now permits the designer a wide choice of inexpensive options in the low-end control area. When this choice is coupled with the ease and economics of infrared communication links, applications for the combination of the two abound. This paper provides information for constructing the basic building blocks for evaluation of both the IR transmitter/receiver and the most popular remote control devices. Schematics and single-sided PC board layouts are presented that should enable the designer to quickly put together a basic control link and evaluate its suitability for his application in terms of data rate, effective distance, error rate, and cost. Sources for speciality parts required are also given.

Motorola offers a wide variety of devices suitable for remote control applications, and these are grouped in three distinct families. The oldest of the three is the MC145026/7/8 series, comprising one encoder sending nine bits of information and two decoders, one considering all transmitted data as an address, the other utilizing less addressing possibilities and using the difference as four bits of data. This series also uses trinary addressing, permitting greatly increased numbers of address codes for a given pin count.

The next series is comprised of one part, the MC145030, which is an encoder and decoder on the same part. Thus, it is suitable for applications requiring bidirectional or half-duplex control. It is capable of nine bits of address, no data.

Derived from the internal architecture of the MC145030 is the MC145033/4/5 series, which comprise a wide variety of choices of address/data combinations, outputs, and a single-chip encoder/decoder. This series can encode up to 17 address bits, or 13 address/4 data. Other features, such as an ability to defeat attempts to break the code, are also included. At present, these devices are available in surface mount packages only.

This paper presents simple board layouts and schematics for encoder/decoder pairs "connected" by IR transmitter/receiver links. For each of the three families of devices, there are two PC layouts and schematics, one encoder/transmitter and one decoder/receiver. These are made sufficiently general that each can be modified and jumpered so as to enable evaluation of any member of that family.

Note that only one IR transmitter and one IR receiver design is used for all of the encoder/decoder options, and so there is only one schematic of each of these two, and it would be mated with the encoder or decoder schematic of choice to form a complete system. The PC layouts all have these sections included, of course.

DESIGN SPECIFICS

The IR transmitter schematic shows two IR LEDs. While most designs will use but one, the other is allowed for on the PC layout for evaluation of other options, such as lower total current, greater range, misalignment for less directionality, etc. The generation of the transmitted frequency (in this case 50 kHz) is not done with minimal components, but allows for flexibility in frequency, and selection of other crystals via some cuts and aditional resistors. A production design would likely utilize a common oscillator for the transmitter and encoder sections or even include the ability to startup on request to minimize power. Open pads are provided to enable jumpering of different frequencies with a combination of divider taps and crystals/resonators.

The IR receiver section uses an MC3373P as an amplifier/data detector. This is a high-gain device working with some very low signal levels. Thus, shielding will likely be required, and ground area is provided for its attachment. The component values are "middle-of-the-road" and will work well as presented; the designer will want to evaluate for himself whether to permit higher gains, different low frequency rolloffs, or other sensitivities. The choice of the LC tank values is of particular interest. The values shown are adequate for many applications, but higher Q's may be needed. This comes at the cost of slower rise and fall times on the data envelope, visible at pin three of the MC3373P, and is the primary factor governing the maximum data bit rate of the design. Lower Q's will yield "squarer" data envelopes (higher possible bit rates), broader tuning, and less selectivity. Tuning is accomplished by placing a transmitting source several feet away, and adjusting the inductor for maximum data envelope at pin three. The output of the MC3373P is squared and inverted by a Schmitt-trigger MC74HC14 device. In many designs, a slower and quieter version of this device may be preferred, such as the MC14093 NAND Schmitt. This device will generate less system noise, critical to good operation of the receiver, and also would operate on higher supply voltages, such as 12 V, where the MC3373 receiver also works well.

The output of the receiver section is presented to a red LED to indicate that data is being received (activity on the MC3373 output). This, of course, does not indicate valid data, but only that something is being detected. It may be an indication of noise or power-line pickup and require design changes or shielding. Valid data is indicated via a green LED driven by the output of the decoder device and annunciates that it has received its correct address (set by the DIP switches).

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The transmitting section is attached to one of the three encoder designs, and three PC layouts are presented; the same is true of the receiver and the three possible decoders. The receiver schematic in Figure 1 is joined with the decoders of Figures 3, 5, and 7 and the transmitter schematic of Figure 2 with those encoders in Figures 4, 6, and 8. Each encoder or decoder layout can be used with more than one version in the same family, and appropriate pads and jumpers are provided on the layout. Other situations certainly are possible, such as changing minor portions of the layout to make the data bits on some systems available to a connector, or remote transmit enables, etc., and these layouts may serve as a starting point.

One caution on the choice of R and C values for the encoders and decoders: the tolerance and dielectric type are important, especially for production-volume designs intended to operate over temperature. Refer carefully to the data sheets of the appropriate device for a discussion of these parameters and permitted tolerances.

CONCLUSION

The designs as presented here are intended for a 5 V supply and a transmitter carrier frequency of 50 kHz. Other frequencies should be investigated for ease of generation, minimum components, increased data rates, and different Qs. With a single transmitting LED driven with about 250 mA, the author achieved effective distances of about 10 meters. This distance could be extended by a few meters if two LEDs were utilized. There are applications that do not require this level of sensitivity, and the receiver should be modified accordingly. On the other hand, greater distances or those requiring less directionality may require adding more LEDs, driving them harder, utilizing multiple receiving diodes, and/or adding Fresnel lensing in front of them. For more information on IR techniques, see Application Note AN1016, and the CMOS Application-Specific Standard IC Data Book, DL130 rev. 1.

SPECIFIC COMPONENT SOURCES

Trinary DIP switch, 8 position	AMP #436172-3
Trinary DIP switch, 9 position	AMP #436172-2
Other DIP switches	AMP series 7100 or similar
PB switch, transmitter enable	Digi-Key # P9950
Inductor, variable, shielded, 4.7 mH, type 7PA	Toko # 126LNS–T1028Z Digi-Key # TK3209
Ceramic resonator, 400 kHz	Panasonic # EFO-A400K04B Digi-Key # P9940
Transmitting IR LED	Motorola MLED81
Receiving IR diode	Motorola MRD821
Shielding Material, 0.005" Tin sheet, solders easily	K & S "Easy Solder Tin Sheet" Most hobby shops

NOTE: Motorola cannot recommend one supplier over another and in no way suggests that this is a complete listing of component suppliers.

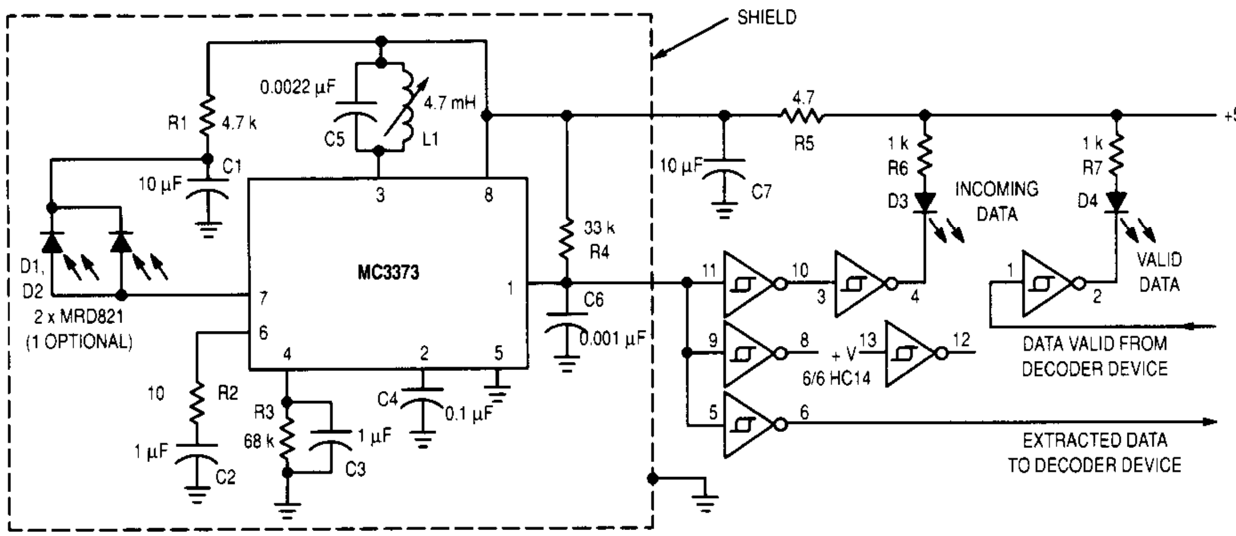

Figure 1. IR Receiver section common to all receiver boards. Values shown are for a 50 kHz carrier frequency and a 5 V supply. Note that the use of two receiving diodes is optional and provided for on the board layout. The shield is required in all but the shortest range applications.

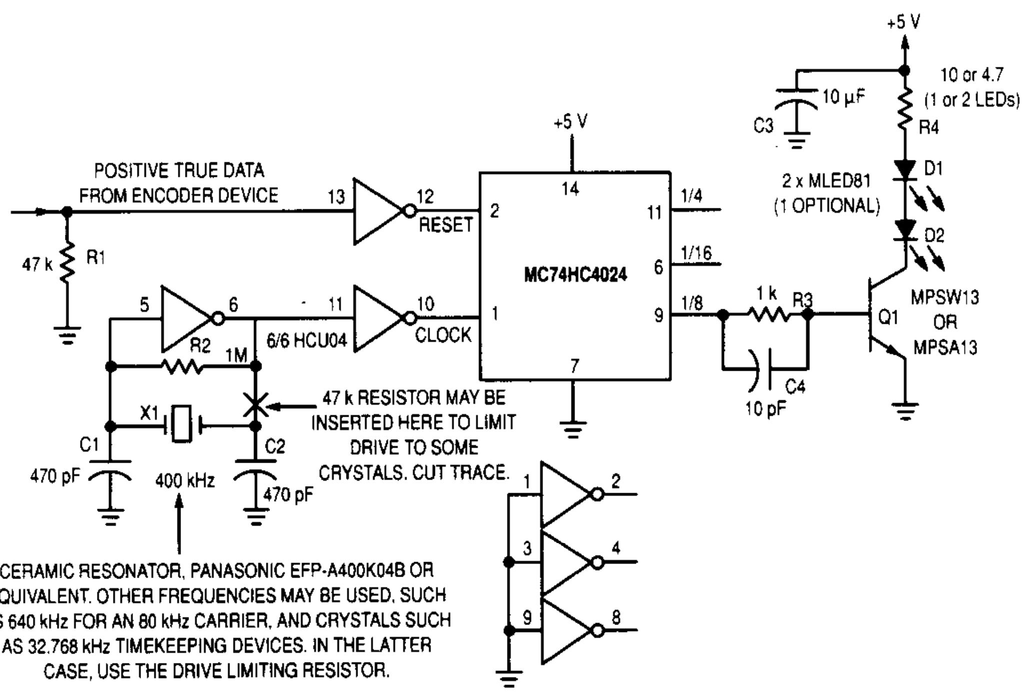

Figure 2. IR transmitter section common to all transmitter boards. Note that the use of two IR LEDs is optional but is provided for on the board layout. Choose R4 for an LED current appropriate to the application. Common values are from 100 to more than 500 mA, with 250 mA being common.

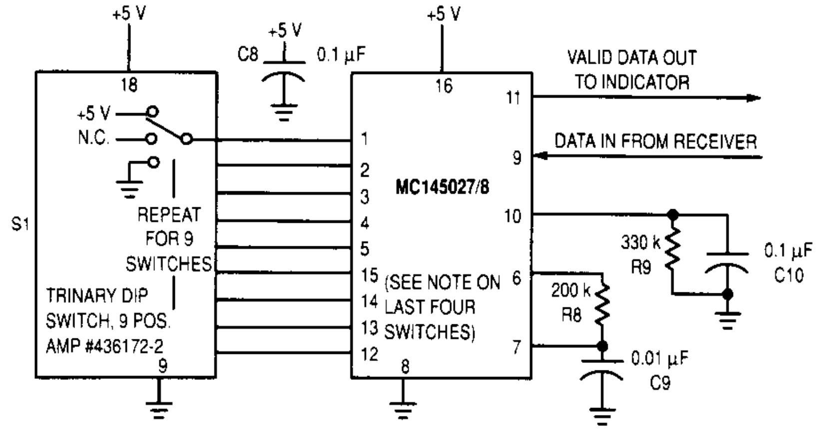

Figure 3. Two decoders, identical except that the MC145027 uses only 5 bits of address, considering the last 4 bits as data. To use this device, leave the last four Dip switch positions open as these pins (12, 13, 14, 15) become outputs.

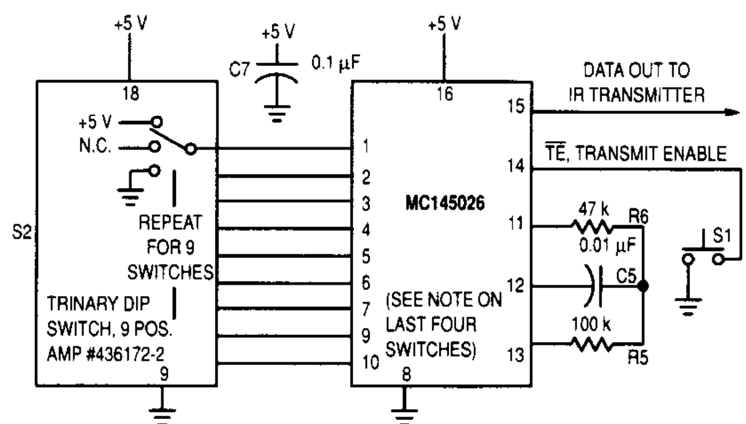

Figure 4. The MC145026 Encoder. Note that when used with the MC145028 decoder in the receiver, all 9 switches are considered addresses, and that with the MC145027 the last four are interpreted as data. In the latter case, a trinary (open) position is decoded as a logical one.

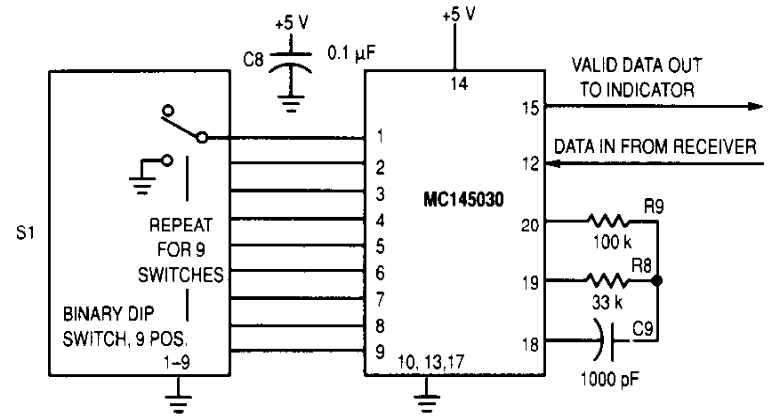

Figure 5. The MC145030 as a decoder. Note that the 9 DIP switches take advantage of the on-chip pullup resistors on the device. Also the decoder out (pin 15) toggles with each successful data reception, unlike the MC145027/8 devices.

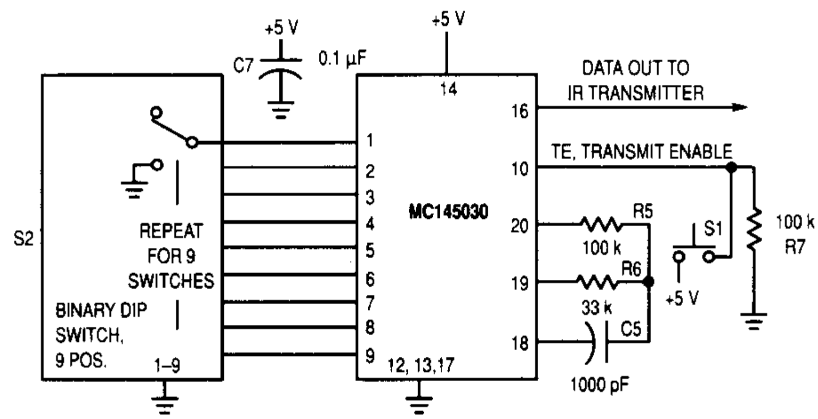

Figure 6. The MC145030 as an encoder. Note that transmit enable occurs on the rising edge of the waveform.

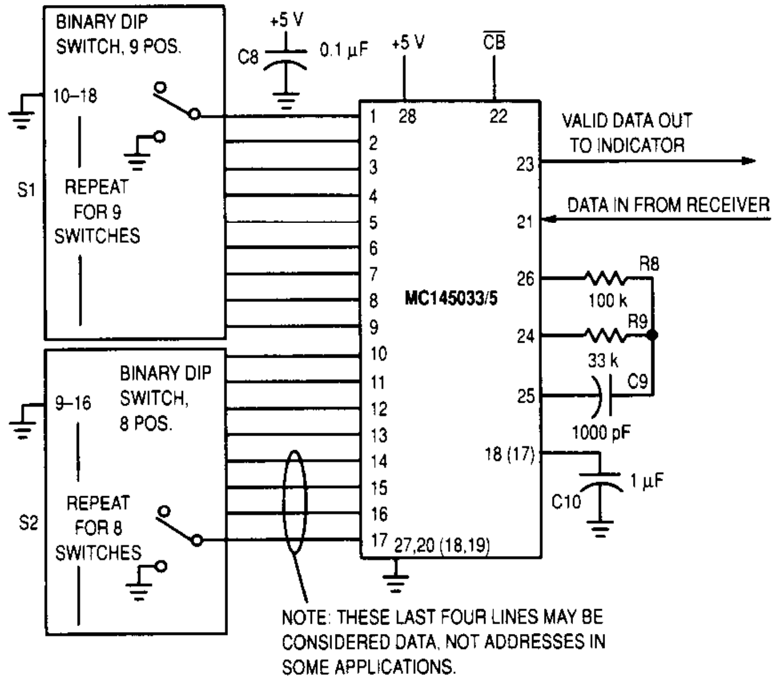

Figure 7. The MC145033/5 as a decoder. Note that there are two DIP switches, one 9 position, one 8. In the event of using the upper addresses as data, leave these pins open (center position). Also the CE pin may be either 18 or 17 depending on the device, and pin 18 is strapped to ground on the MC145033. "Mode," pin 19, is grounded on the MC145035.

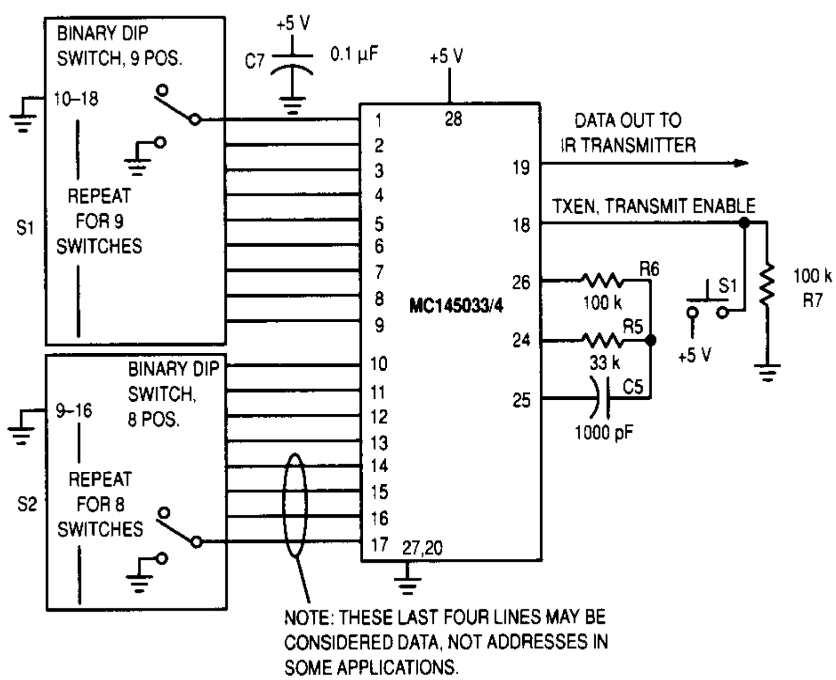

Figure 8. The MC145033/4 as an encoder. Note that transmit enable occurs on the rising edge of the waveform. Pin 20 is grounded on the MC145033.

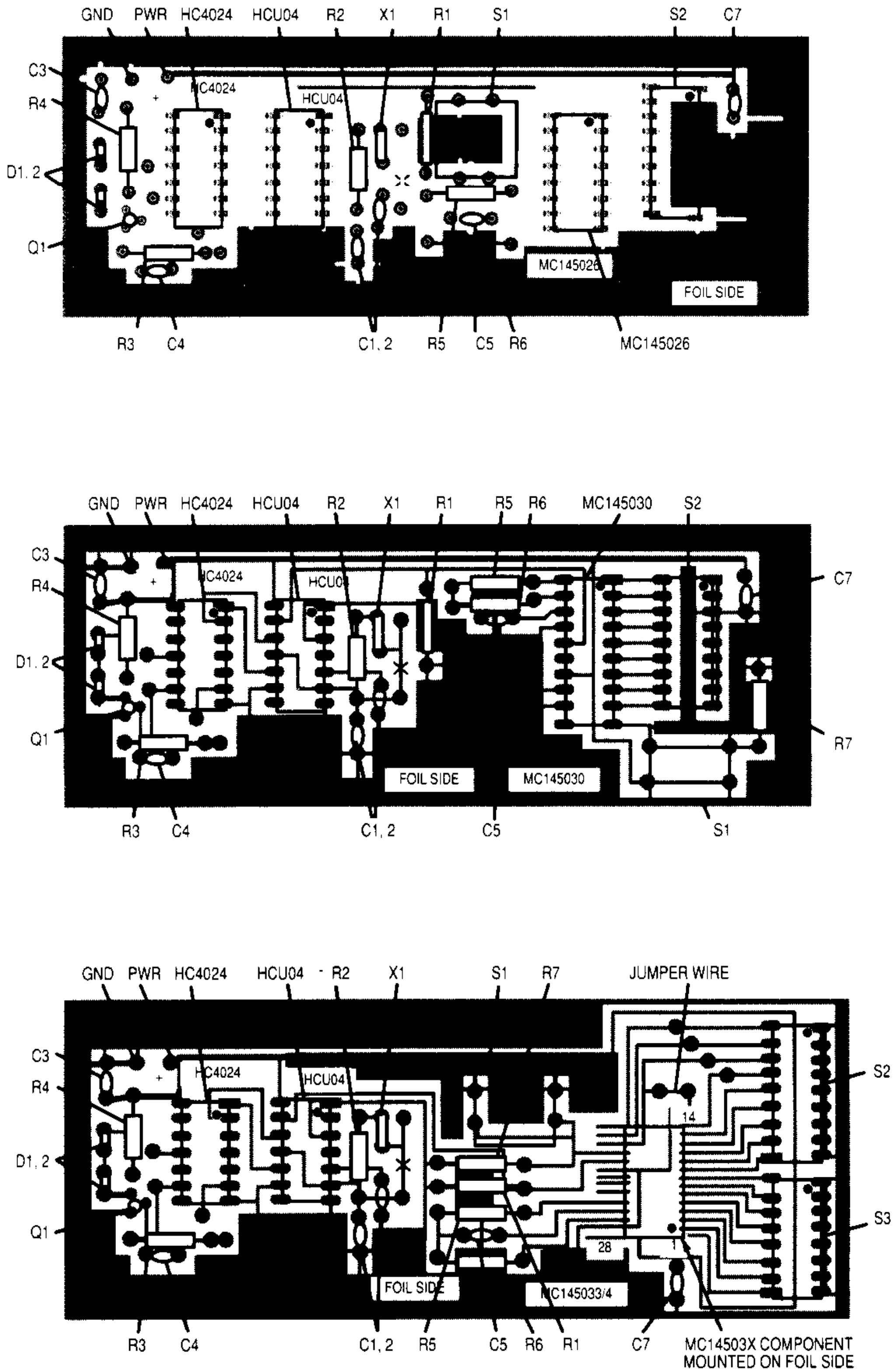

Figure 9. Three component layouts for IR transmitters, top—MC145026; middle—MC145030; bottom—MC145033/4.

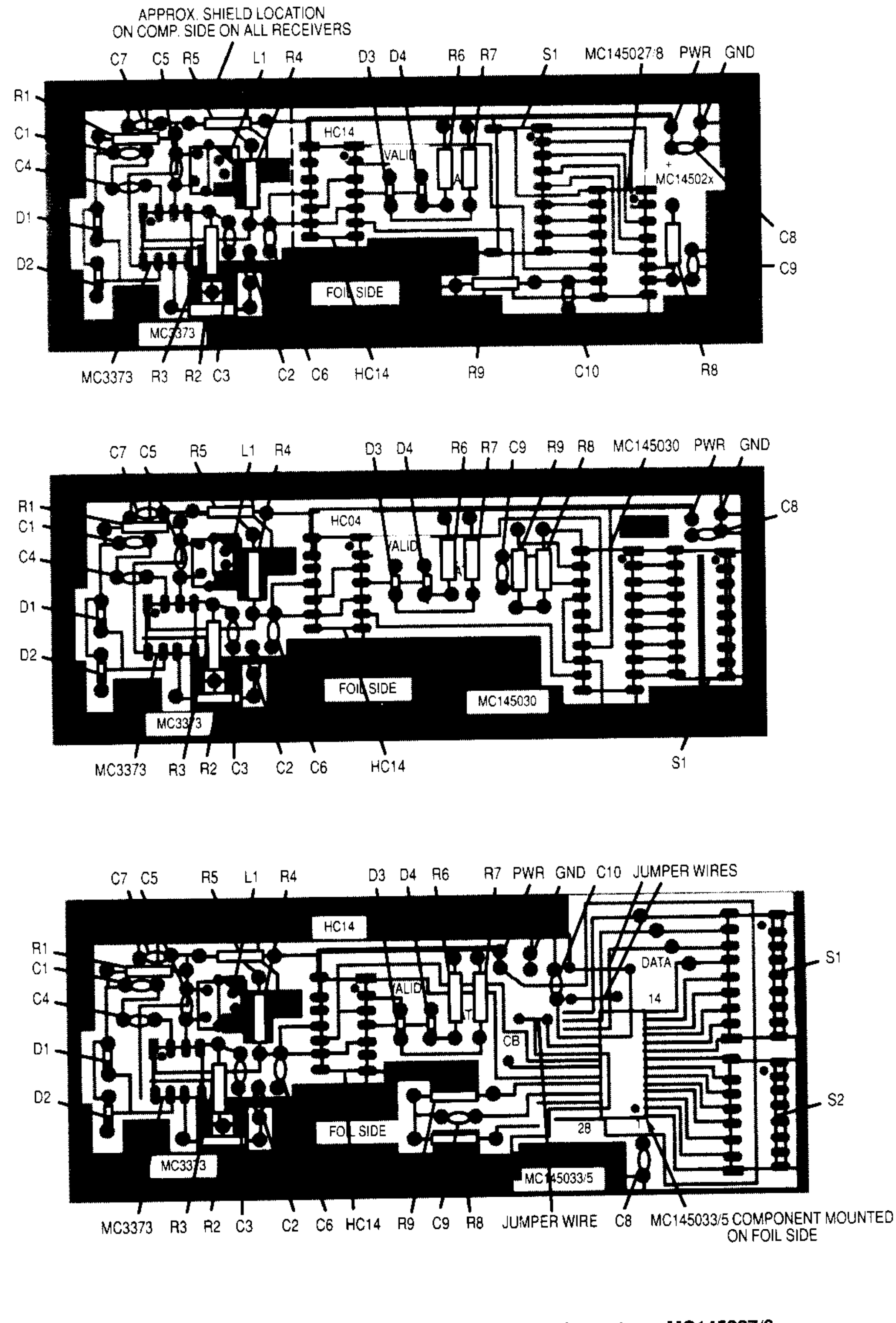

Figure 10. Three component layouts for IR receivers, top—MC145027/8; middle—MC145030; bottom—MC145033/5.

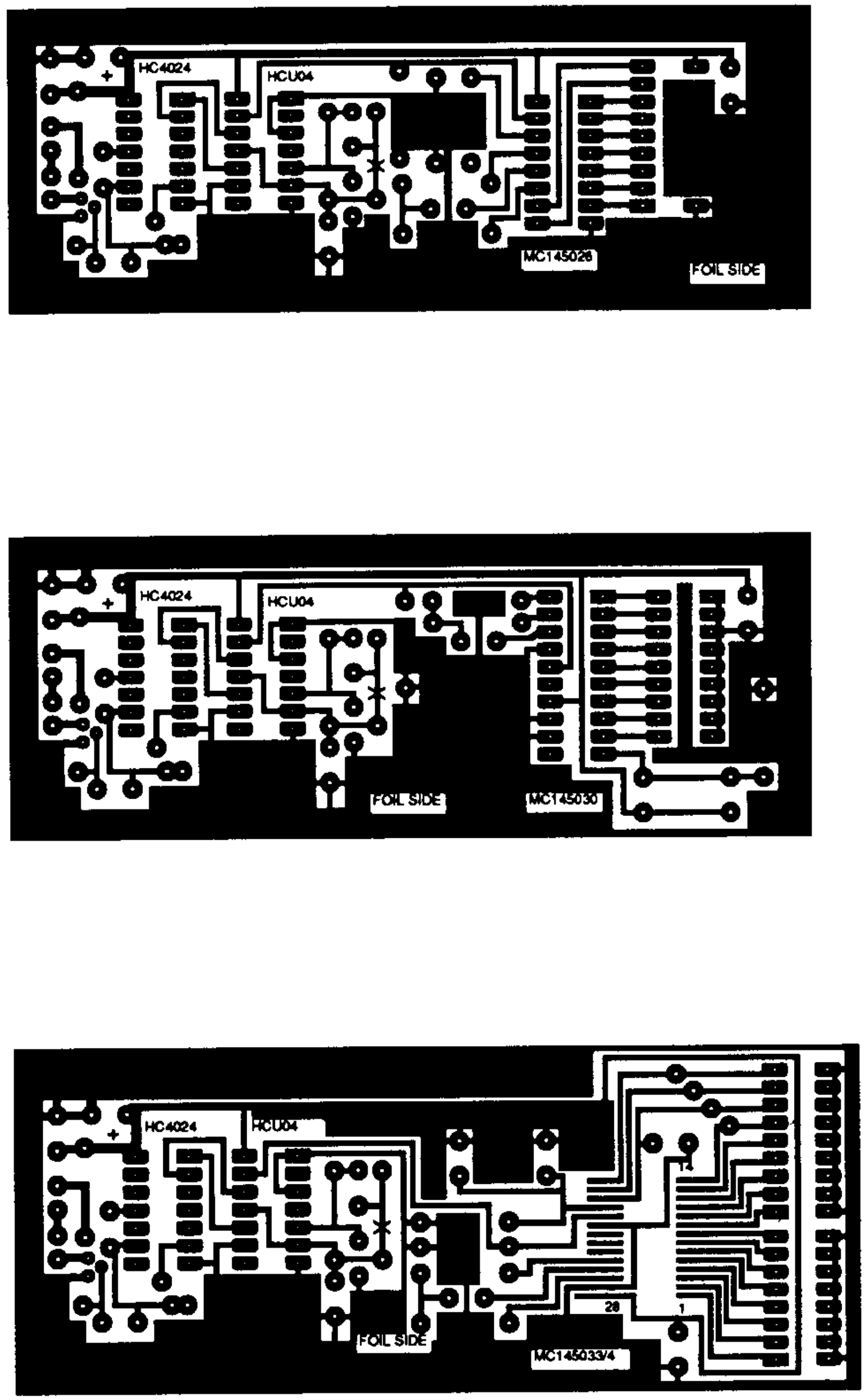

Figure 11. Three PC layouts for IR transmitters, top—MC145026; middle—MC145030; bottom—MC145033/4.

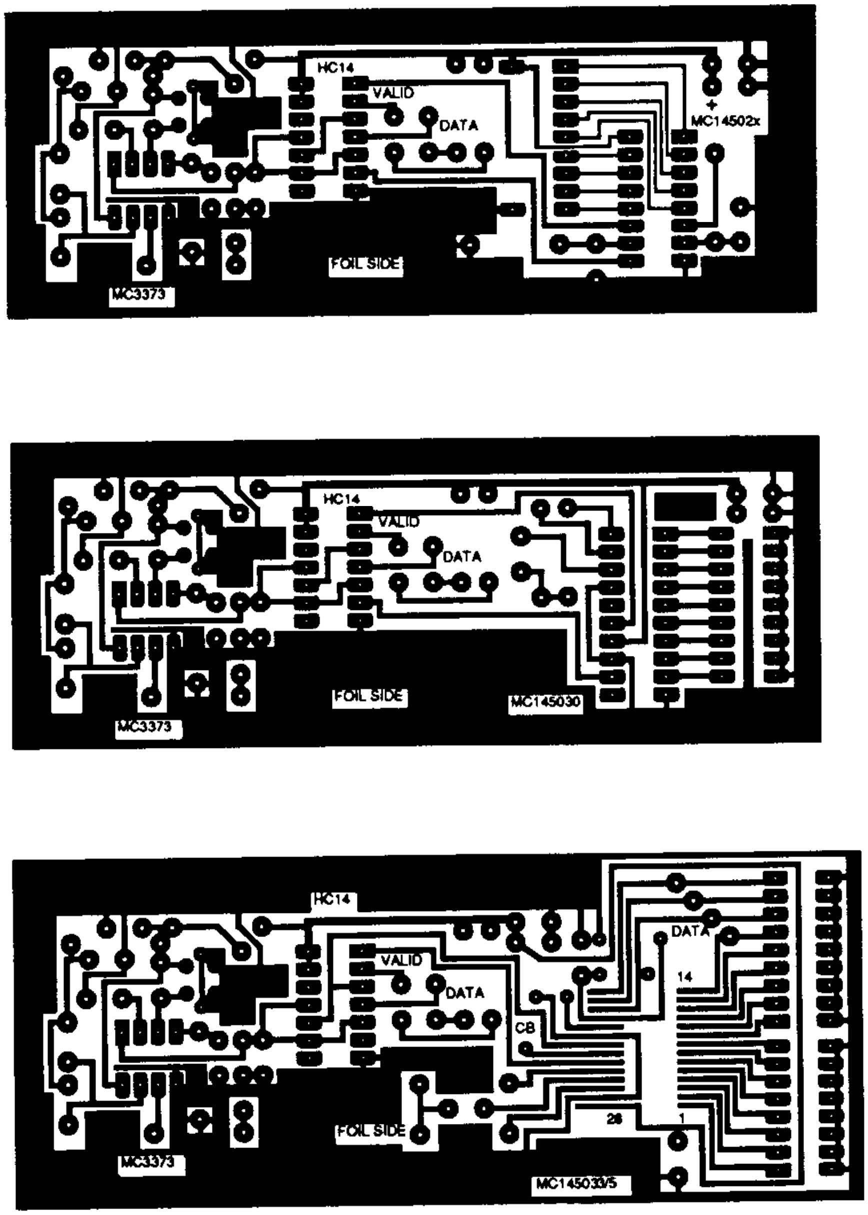

Figure 12. Three PC layouts for IR receivers, top—MC145027/8; middle—MC145030; bottom—MC145033/5.

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