FOUR CHANNEL WIRELESS TRANSMITTER AND RECEIVER MANUAL

KT4A
KR4A

GLOLAB
CORPORATION

Thank you for buying our Wireless KT4A Transmitter and/or KR4A Receiver.

The goal of Glolab is to produce top quality electronic kits, products and components. All of our kits are designed by Glolab engineers and tested in our laboratory. Mechanical devices, prototypes and enclosures are fabricated in our precision machine shop.

We think that Glolab kits are the easiest to assemble of any available. To ease assembly for both experienced and new kit builders, we package each part in individual plastic zip-lock envelopes that are labeled with the value and part number. It is not necessary to read resistor color codes or capacitor number codes while assembling the PC boards. You simply locate the part and insert it into the PC board where the corresponding part number is marked on the board. Each kit includes assembly instructions and a complete description of how it works.

In addition to our kits, we supply some special and hard to find parts for those of you who want to design and build your own projects.

Technical help is available by email from lab@glolab.com.

NOTICE:

The TM1V and RM1V wireless modules used in these kits have not been certified by the Federal Communications Commission. The kits are intended for personal and experimental use. If these kits are used as part of a design that is to be sold as a product then that product must be sent to a testing laboratory and certified by the FCC before it is sold.


Introduction_____

 The Wireless KT4A Transmitter and KR4A Receiver have been designed to offer more data channels than the original KT418S2 and KR418S2 projects that were published in the April 1999 issue of Popular Electronics magazine. These new kits have four data inputs and outputs and they use our GL-104 encoder/decoder with advantages over other manufacturer's devices. Four data bits can be transmitted individually or simultaneously and data outputs can be momentary or cumulatively latched.

In the past, building a simple and reliable RF transmitter and sensitive receiver was not easy. And after building them some difficult adjustments would have to be made to set operating frequency, minimize harmonic radiation and maximize sensitivity. But now, thanks to TM1V transmitter and RM1V receiver modules from Glolab, you simply apply power, add antennas and they are ready to transmit and receive data. These modules are used in the KT4A and KR4A kits. Please refer to the TM1V, RM1V module manual for a complete description and specifications. It can be viewed and downloaded in PDF format at http://www.glolab.com/modules/module1.html

The KT4A and KR4A are designed for remote control applications. The maximum data rate that can be fed into the KT4A transmitter is 20 transitions per second. The block diagram below shows the functions of the encoder and decoder. The encoder receives control inputs and address bits, serializes both, and feeds the serialized bits into the transmitter module which sends the bits as RF data. The receiver module receives the RF data and feeds it into the decoder which deserializes it, compares address bits, and outputs the control data as parallel bits through open collector NPN bipolar transistors.

BOLCK DIAGRAM OF KT4A AND KR4A
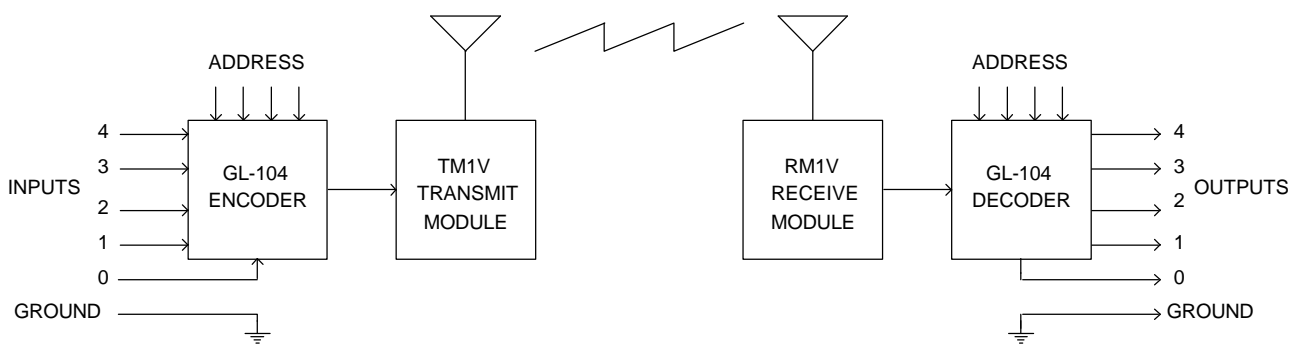
How it works_____

General_____

The following applies to both figure 1 transmitter and figure 2 receiver applications.

Encoder/Decoder

The KT4A and KR4A kits use the GL-104 encoder/decoder which is configured as an encoder for use with a transmit module by connecting pin 7 to Vdd, and as a decoder for use with a receiver module by connecting pin 7 to Vss. When used as an encoder and when no input data is being applied (no buttons are pressed), the GL-104 automatically goes into a low power standby mode where it dissipates only one microampere. When used as a decoder it automatically goes into a low power standby mode when no serial data is being received. Please refer to the GL-104 manual for a complete description and specifications. The manual can be viewed and downloaded in PDF format at http://www.glolab.com/encdec/gl-104.html.

Addressing

Pulldown resistors R1 - R4 are connected from address pins 2, 3, 17 and 18 to pin 1 which is a switched pulldown pin that goes low only when the GL-104 is active. Four address positions of Switch SW4 in the transmitter and SW5 in the receiver are connected to the address pins and to Vdd allowing the selection of up to sixteen different addresses. When a switch is closed its address pin is connected to Vdd and cannot be pulled low to Vss by the pulldown resistor. When a switch is open, its address pin is pulled down to Vss through the pulldown resistor. When the GL-104 is not active (not serializing or deserializing data), pulldown pin 1 goes high to Vdd and no power is dissipated in any address pulldown resistors that may be connected to Vdd through closed switches because both ends of these resistors are now at an UP level. Addresses must be set exactly the same in a transmitter and receiver pair.

Resonator

Ceramic resonator CR4, connected between pins 15 and 16, controls the internal 4 MHz clock frequency and synchronizes serial data transmission. This resonator has internal capacitors that connect from each outer pin to a center pin that is grounded (connected to Vss).

Reset

Voltage detector and reset device VDR (IC3) automatically resets the encoder circuits in case of a brownout where the power supply voltage may drop below the circuit operating level but not low enough to produce an internal power on reset. The VDR protects against loss of memory data or unpredictable operation. Its output connects to GL-104 reset pin 4 in both the transmitter and receiver applications.

Power supply

The transmitter is powered by a 9 volt battery. A Telcom TC55 micropower low dropout voltage regulator IC2 drops and regulates the 9 volts from a battery down to 5 volts. This regulator has a standby current of only 1 microampere. Diode D1 protects against a reverse battery connection that would damage the regulator and other circuits. A .1 mfd bypass capacitor shunts transients to ground.

The receiver is powered by a 12 volt 200 milliampere DC wall transformer. A 470 mfd electrolytic filter capacitor filters the DC before it feeds into 7805 regulator IC2. A 100 mfd capacitor, C2 and .1 mfd capacitor C3 provide low and high frequency bypassing to ground at the output of the regulator. Unregulated 12 volts DC directly from the wall transformer is brought out to a terminal block for powering loads.

Transmitter_____

Figure 1 is a schematic of the transmitter. A GL-104, IC1 is configured as an encoder by connecting pin 7 to Vdd. The encoder data input pins 6, 10, 11, 12 and 13 each have internal 200 microampere pullup current sources. These inputs are connected to terminal block positions 0 - 4. A transmission is initiated by pulling one or more inputs LOW to Vss through switches or other devices. An external voltage source of from ground (Vss) to +5 volts (Vdd) may also be applied to these inputs. An input voltage below 0.8 volts is accepted as a LOW level and a voltage above 2.0 volts is accepted as an HIGH level. An input voltage in the threshold range of 0.8 to 2.0 volts will produce unpredictable results.

The TM1V RF transmitter module receives digital serial data from encoder pin 9 and sends it as radio frequency signals at 418 MHz. The digital modulation applied to the TM1V module input pin 5 produces an OFF or ON carrier so that there is no RF output when a LOW level is applied to its data input pin, and full RF output when a HIGH level is applied. The TM1V module draws only one microampere when a LOW level input is applied and an average of about 1.5 milliamperes when a HIGH level is applied.

Push button or other switches may be connected from ground (Vss) to data inputs 1 - 4 and to remote reset input 0. Data will be transmitted when any one or more of these switches is closed,. A bias terminal that supplies Vdd through 200 ohm resistor R5 is provided on the terminal block for use by external devices or circuits, other than switches, that may be connected to the data inputs.

A transmitter address of 0 to 15 is set in binary format by DIP switch SW4. This address must match the address setting used in the receiver.
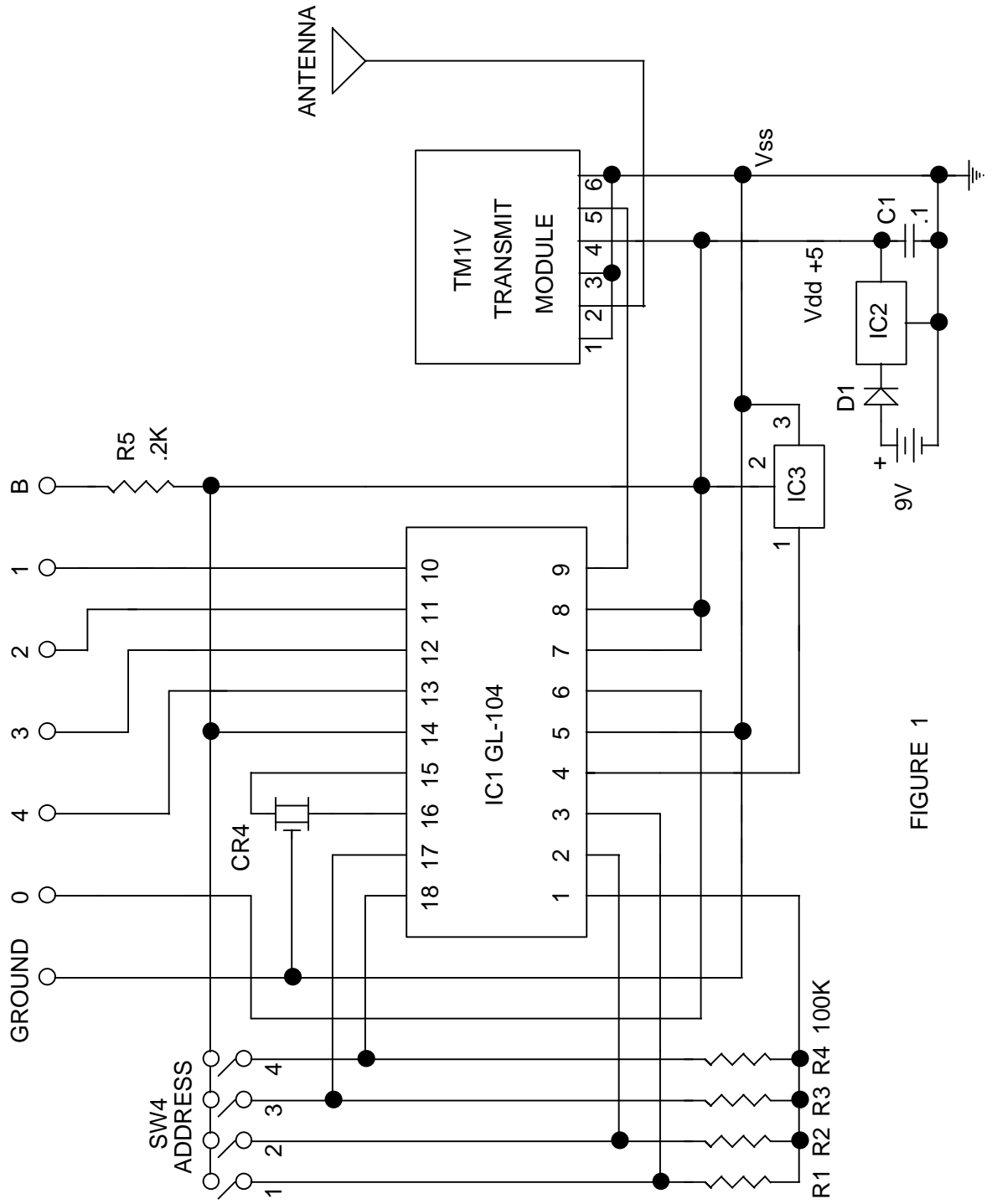
FIGURE 1

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Receiver_____

Figure 2 is a schematic of the receiver.

A GL-104, IC1 is configured as a decoder by connecting pin 7 to Vss. Serial data received by the RM1V module feeds into serial data input pin 13 of the decoder. Positions 1 - 4 of DIP switch SW5 select addresses as described on page 3. These address settings are compared with the address contained in the received data and if they match, the received data is considered valid and is sent to the decoder output pins.

The receiver outputs are five open collector NPN bipolar transistors that can sink 400 milliamperes each. The collectors of these transistors are connected to terminal block positions 0 - 5. Output 0 will be ON whenever any valid data is being received. Outputs 1, 2, 3 and 4 are data bit outputs.

Position 5 of DIP switch SW5 selects either momentary outputs when it is closed or latched outputs when it is open. When momentary operation is selected, each output that is turned ON (Q1 ~ Q4 conducting) by a transmitter will be ON only as long as valid data is being received.

When latched operation is selected, any or all outputs, except valid data output 0, that are turned ON will latch ON until reset by grounding the reset terminal of terminal block position RES or by receiving a bit 0 transmission from a transmitter which will remotely reset the latched outputs. A bit 0 transmission will not reset latched outputs unless it is the only bit being transmitted. Valid data output 0 will be momentary regardless of the SW5 position 5 setting.

Light emitting diodes indicate when any output is ON. A ground terminal is provided on the terminal block for external reset and to connect an external power supply that powers loads driven by Q0 - Q4. A terminal marked +12 provides unregulated 12 volt DC power directly from the wall transformer to power loads such as relays having a total current drain of 150 ma or less. The no load voltage at this terminal may be greater than 12 volts. For heavier loads or other voltages, an external power supply of up to 35 volts may be used to power loads.
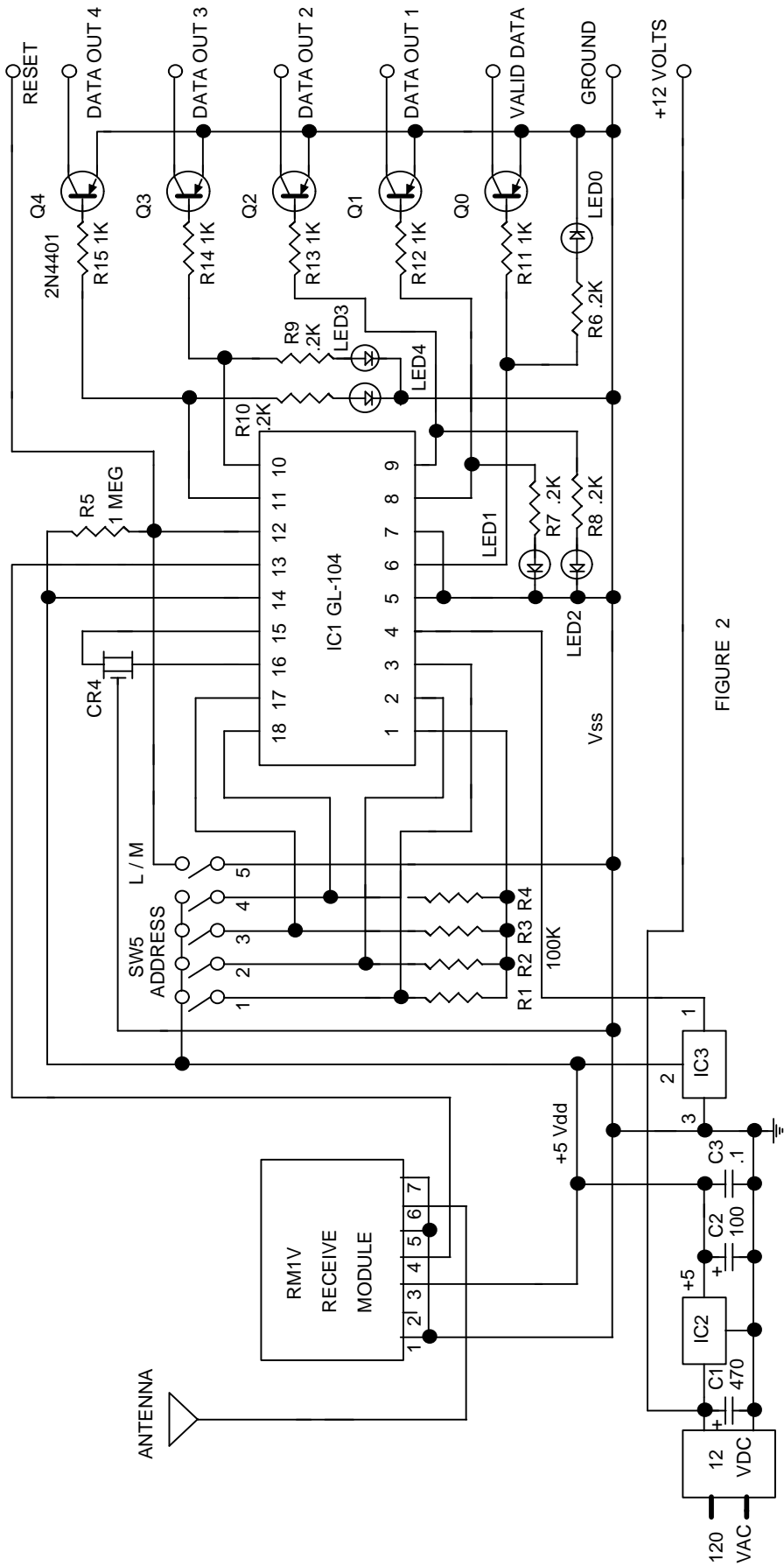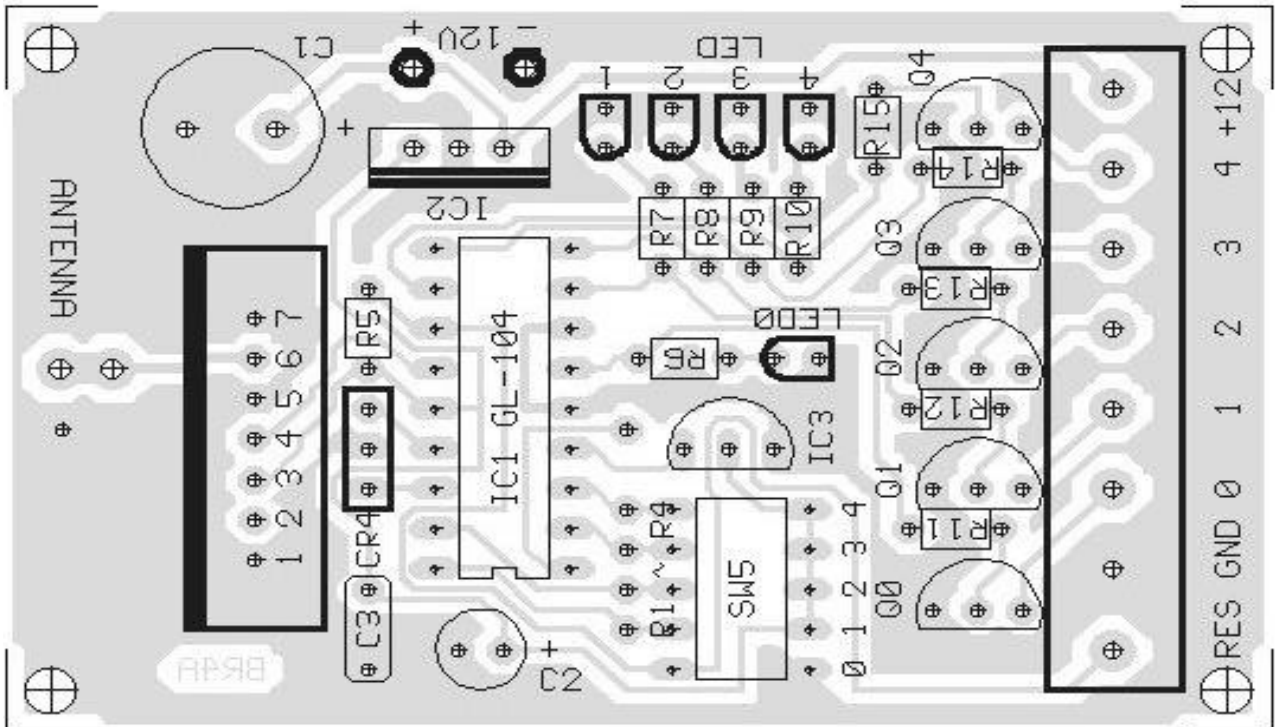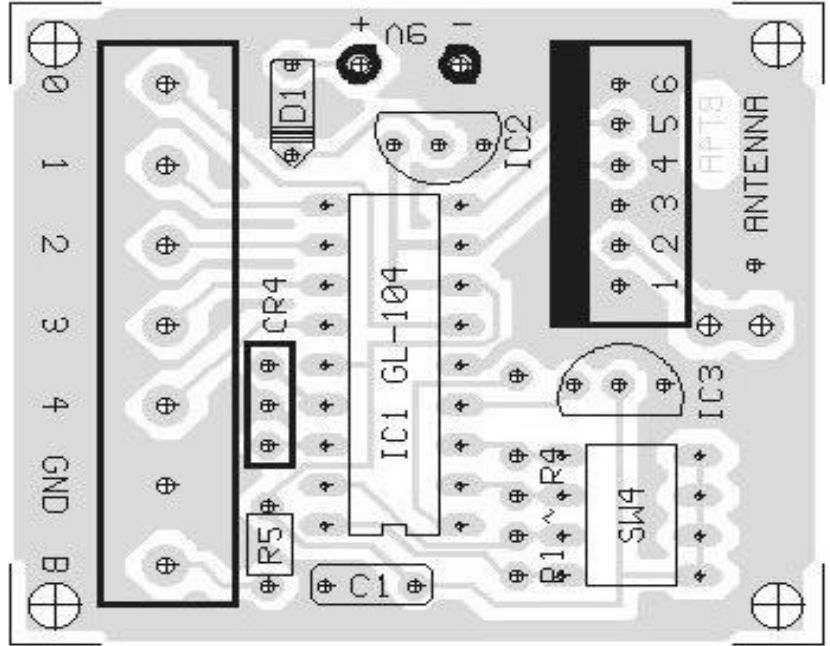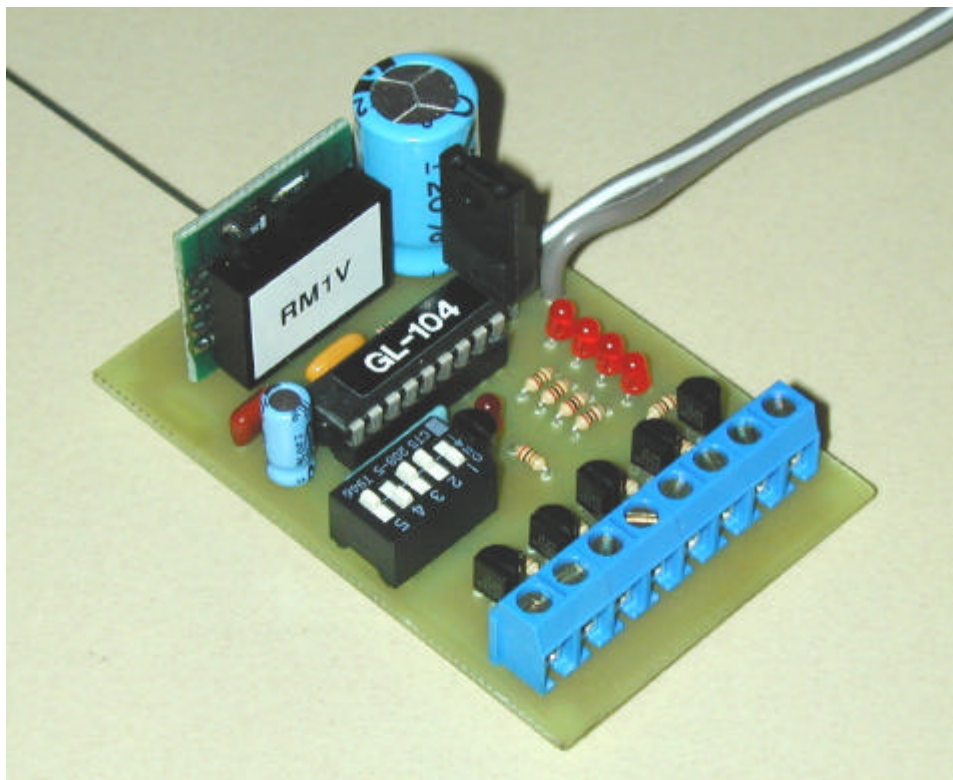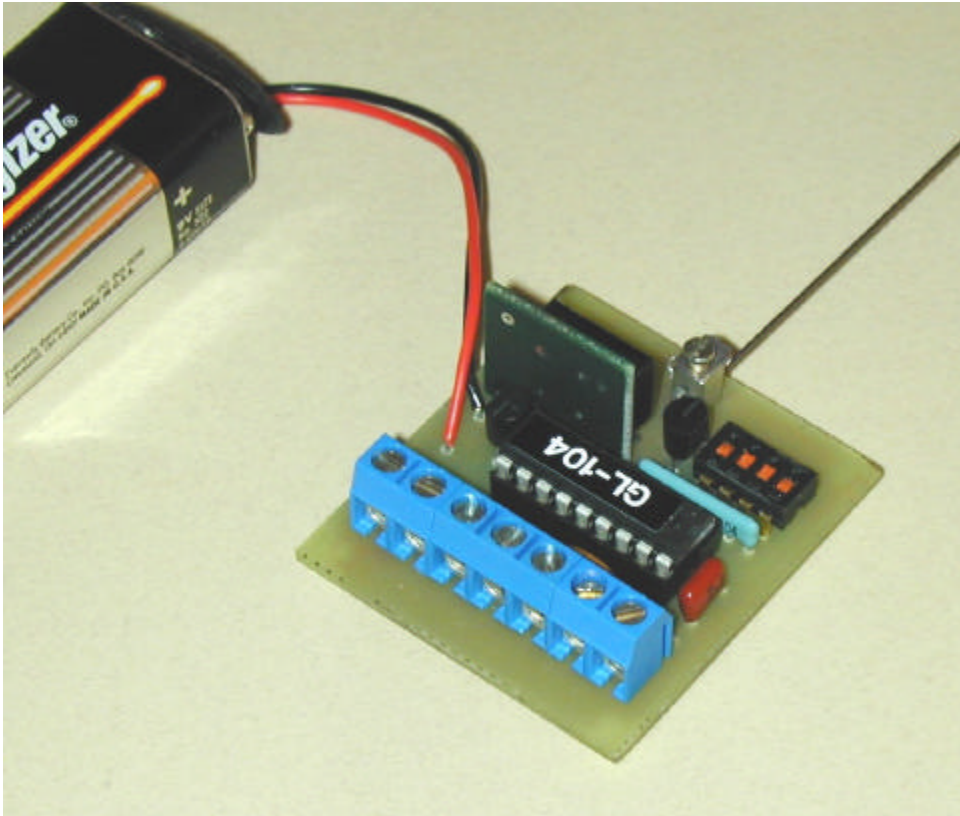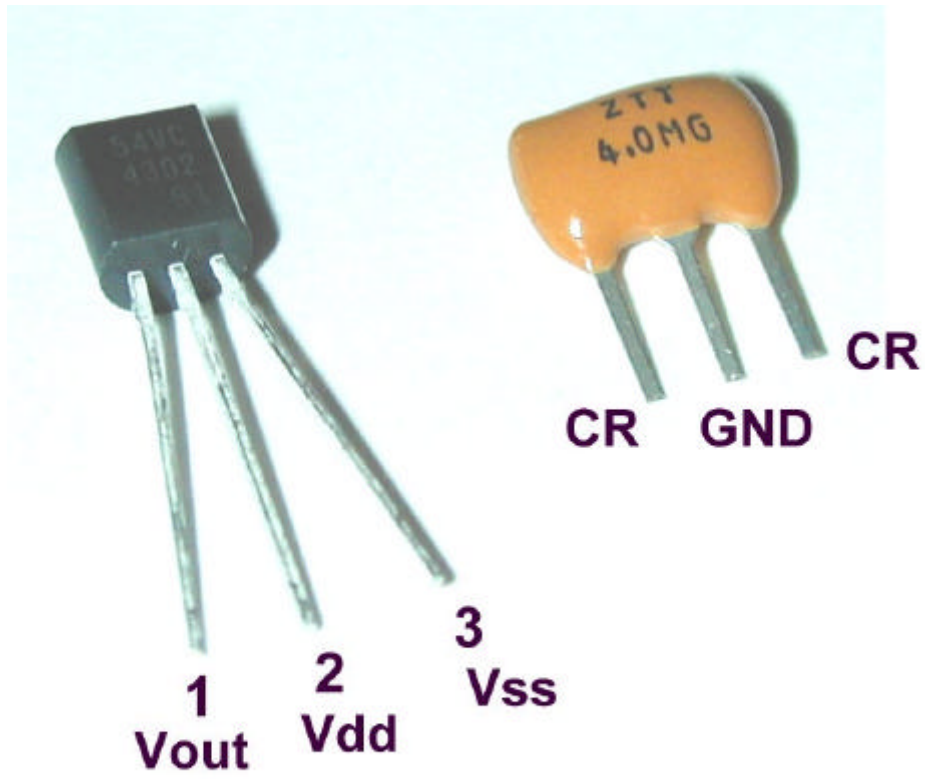
FIGURE 2

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TRANSMITTER BOARD 1.6 X 1.8 INCHES

RECEIVER PC BOARD 1.8 X 2.8 INCHES

VDR and CR4 pin assignments

KT4A Transmitter parts list
R1 ~ R4 - 100K resistor network
R5 - 0.2K 1/8 watt 5%
C1 - .1 mfd 50 volt metalized film
D1 - 1N914 diode
IC2 - 5 volt micropower low dropout regulator
CR4 - 4.0 MHz ceramic resonator w/capacitors
IC3 -VDR 4 volt voltage detector reset
IC1 - GL-104 encoder
TM1V - 418 MHz transmitter module
IC socket - 18 pin
SW4 - 4 position DIP switch
TERM - 7 position terminal block (2-2, 1-3)
AT1 - 1 position antenna terminal
WC418 wire whip antenna
Battery snap - 4" leads
BT4A - PC board

KR4A Receiver parts list
R1 ~ R4 - 100K resistor network
R5 - 1 MEG 1/8 watt 5%
R6 ~ R10 - 0.2K 1/8 watt 5%
R11 ~ R15 - 1K 1/8 watt 5%
C1 - 470 mfd 25 volt electrolytic
C2 - 100 mfd 10 volt electrolyic
C3 - .1 mfd 50 volt metalized film
LED1, LED2, LED3, LED4, LED5 - T1 LED
IC2 - 7805 5 volt regulator
CR4 - 4.0 MHz ceramic resonator w/capacitors
IC3 - VDR 4 volt voltage detector reset
IC1 - GL-104 decoder
Q0 ~ Q4 - 2N4401 NPN transistor
RM1V - 418 MHz receive module
IC socket - 18 pin
SW5 - 5 position DIP switch
TERM - 8 position terminal block (1-2, 2-3)
AT1 - 1 position antenna terminal
WC418 wire whip antenna
Wall transformer - 12 volt DC 200 ma
BR4A - PC board

Asembly instructions _____

1. Bend the leads of diode D1 and of the resistors close to the diode or resistor body, insert into the PC boards and bend the leads against the back side of the board. Cut the excess leads off short enough that they do not touch other connections but long enough to retain the diode or resistor until it is soldered. Be sure to insert diode D1 with its cathode band in the correct direction as shown on the KT4A board. Solder all diode and resistor leads.

2. Insert the resistor networks. Hold the networks in place and solder all pins

3. Insert voltage regulators IC2 and VDR devices IC3 in the direction indicated on the PC boards. Insert these devices so they stand at least 1/8 inch above the board. Solder all pins and cut off the excess leads.

4. Insert transistors Q0 - Q4 in the direction indicated on the KR4A board so they stand at least 1/8 inch above the board. Solder all pins and cut off excess leads.

5. Insert LED0 - LED4 into the KR4A board with their long leads close to the resistors and their short leads connected to ground. The short lead is the negative side of the LED. This short lead is the only visible way to identify the negative side so do not cut the leads until they are inserted into the PC board in the correct direction. Solder all leads and then cut excess leads off.

6. Insert ceramic resonators CR4 in either direction. Hold in place and solder.

7. Insert capacitor C1 on the KT4A board and capacitors C1, C2 and C3 on the KR4A board, bend the leads against the board and cut the excess leads off. Solder all connections. Be sure that C2 and C3 are inserted in the correct diection.

8. Insert the IC1 sockets with their notch as indicated on the PC boards and hold them against the board while soldering a few pins. Solder all remaining pins.

9. Insert the DIP switches with pin 1 away from the board edge. Hold in place and solder all pins.

10. Insert antenna terminals and hold in place by bending pins slightly or with a piece of wood or other heat insulating tool and solder both pins.

11. Slide one 3 position and two 2 position terminal blocks together so they form a 7

position terminal block for the KT4A. Slide two 3 position and one 2 position terminal blocks together so they form an 8 position terminal block for the KR4A. Insert the terminal blocks in the boards so the holes are accessible from the board edge and solder all pins.

12. Insert the battery clip leads in the KT4A board with the red lead in the hole marked + and the black in the hole marked - and solder.

13. Insert the leads of the wall transformer into the KR4A board with the lead that has the white stripe in the hole marked + and solder.

14. Insert the TM1V module with its flat side facing away from the antenna terminal and solder all pins.

15. Insert the RM1V module with its flat side facing the antenna terminal and solder all pins.

16. Insert GL-104 IC1 into their sockets on the KT4A and KR4A boards with pin 1 near the socket notch.

17. Insert wire whip antennas into their terminal blocks and tighten screws. Antennas may be bent in a vertical position if desired.

Applications _____

Transmitter

Figure KT4app1 shows the simplest form of data inputs using toggle or push button switches to connect inputs to ground. Switches may be closed individually or simultaneously to transmit one or more bits.
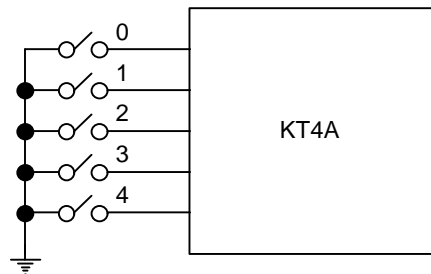
KT4app1

Figure KT4app2 shows an NPN transistor with its collector connected to data input 4. A voltage of from 1 to 5 volts may be applied to the base of the transistor through R1 to turn it on and pull input 4 down. Only 20 microamperes of base current is required to turn the transistor on.
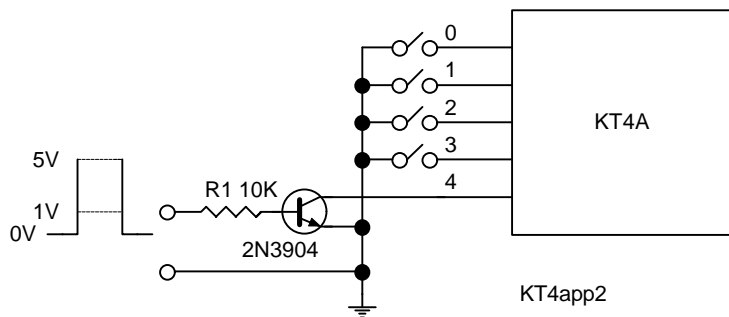
KT4app2

Figure KT4app3 uses a Field Effect transistor for applications that require a very high input impedance. The 2N7000 FET is shown connected to input 4 but may be used with any input. Its gate is driven by 0 to 5 volts.
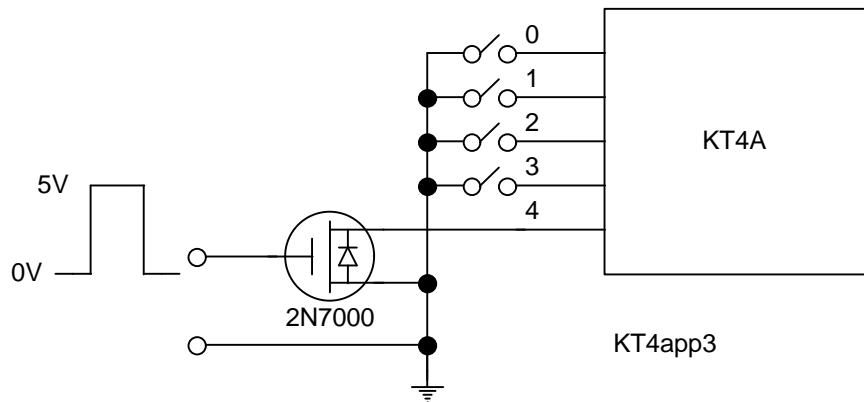

KT4app3

Figure KT4app4 shows how a momentary function can be added to a data input. This is useful when a switch may be closed for a long time but only a momentary transmission is desired such as when a switch is used on a mailbox door and the door is left open. When the switch to data input 4 is open, both ends of C1 are at an UP level. When the switch is closed, a LOW level is applied to input 4 through C1 until C1 charges to an UP level through the input 4 internal current source. When the switch opens, C1 will discharge through R1 and the input 4 internal ESD protection diode. This application makes use of the bias terminal B to supply pullup current to discharge C1 through R1. The switch may be replaced by a transistor or FET as above.
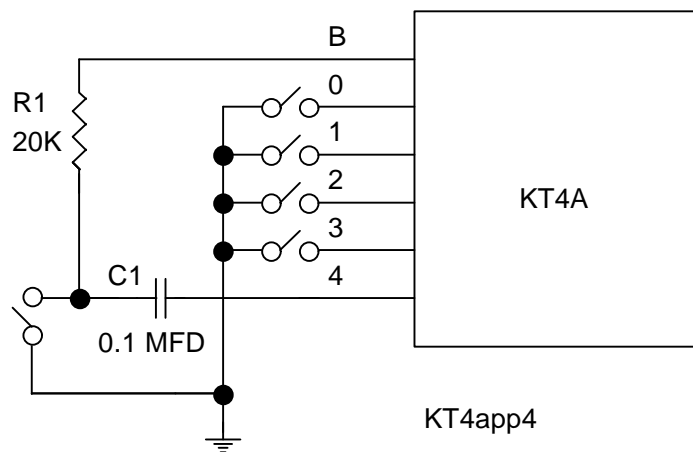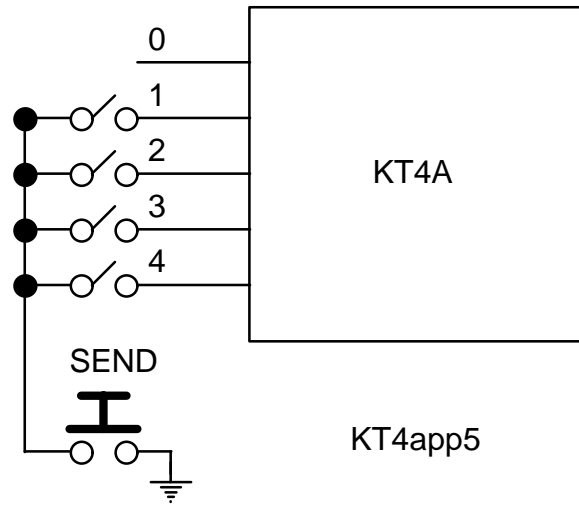

KT4app4

Figure 5 shows four toggle switches used to preset data bits 1 - 4 and a push button switch to initiate a transmission. This scheme can be used to transmit preset bits simultaneously in binary format.


KT4app5

Receiver

Figure KR4app1 shows simple load connections. The loads may be mechanical or solid state relays or other similar devices. 12 volt unregulated power (+V) for the loads is available at the +12 terminal block, however the total current drawn from this terminal should be limited to a maximum of 150 milliamperes to avoid exceeding the wall transformer rating. An external power supply may be used for a total load current of 1 ampere. If inductive loads such as mechanical relays are used, a diode should be placed across each load to prevent back EMF damage to the driver transistors.
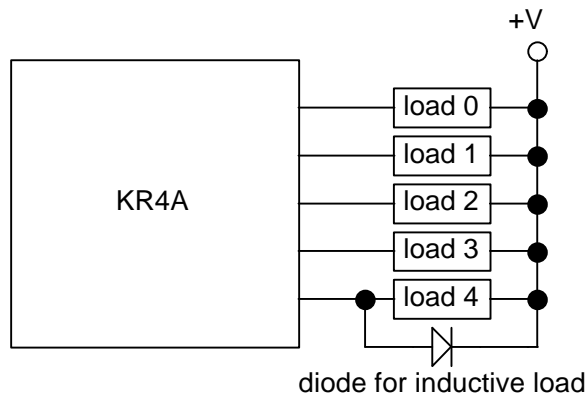
KR4app1

Figure KR4app2 shows how four data bits sent in binary format can be further decoded into 16 outputs using either a CD4514 that has inverted outputs or a CD4515 with non-inverted outputs. When data is decoded this way, only one bit at a time can be ON.
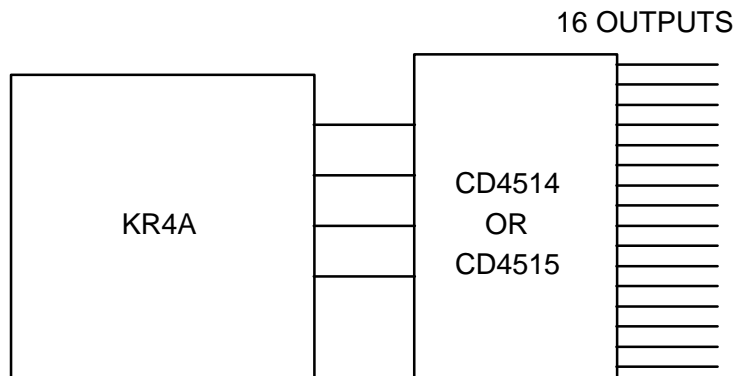
KR4app2

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