



BASIC WIRELESS TRANSMITTER AND RECEIVER KIT MANUAL

**KTS418
KRS418**

**GLOLAB
CORPORATION**

Thank you for buying our Basic Wireless KTS418 Transmitter and KRS418 Receive kits. These kits are designed for wireless remote control applications. They will not transmit or receive audio, video or high-speed serial data.

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.

In addition to our kits, Glolab supplies 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 wireless transmitter and receiver devices 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.

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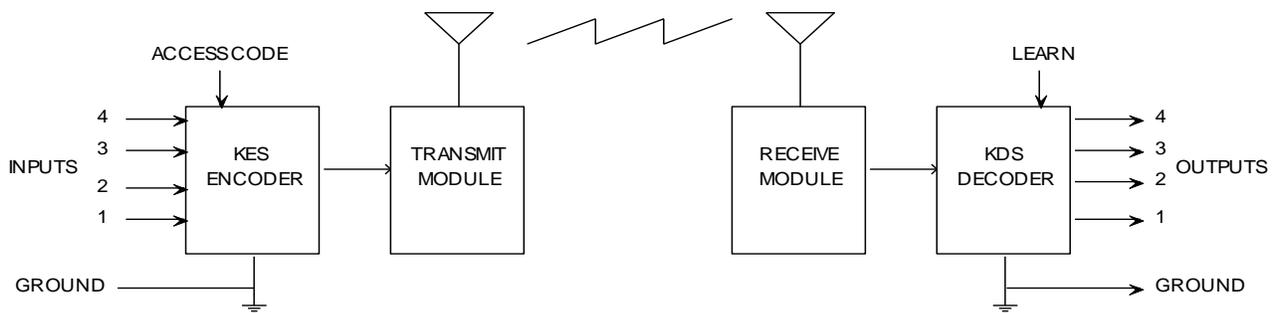
Introduction_____

Please read the soldering and assembly instructions on page 15 before building the kit.

The Wireless KTS418 Transmitter and KRS418 Receiver send and receive remote control data at 418 MHz where unlicensed operation is allowed. The transmitter has four data inputs and the receiver has four momentary outputs. Four data bits can be transmitted individually or simultaneously. The transmitter uses our KES encoder and receiver use our KDS decoder.

The KTS418 and KRS418 are offered as a wireless remote control system in its most simple form. Each of these basic kits is supplied as a PC board with a surface mount RF circuit soldered to the board. Other kit components include an encoder/decoder, voltage regulator, resistors and capacitors. Power, antenna and I/O connections can be made by soldering directly to the PC board pads or optional terminal blocks for power, antenna and I/O connections available from electronic parts distributors can be used. Space is provided on the PC boards for mounting optional parts. A list of these parts and sources for them can be found on page 12 of this manual.

The KTS418 and KRS418 are designed for remote control applications only. They cannot send or receive video, audio or high-speed serial data. The maximum data rate that can be fed into the KTS418 transmitter is 20 transitions per second. The block diagram below shows the functions of the encoder and decoder. The encoder receives control inputs and generates address bits, serializes both, and feeds the serialized bits into the transmitter RF circuit which sends the bits as wireless RF data. The receiver RF circuit receives the RF data and feeds it into the decoder, which de-serializes it, compares address bits, and outputs the control data as parallel bits. Decoder outputs can both source and sink 5 volts at 25 milliamperes each. Outputs are low when no signal is being received and go high to +5 volts when a signal is received.



BLOCK DIAGRAM OF KTS418 AND KRS418

Transmitter description_____

The KTS418 Transmitter operates at 418 MHz using CW modulation. It has a KES encoder with a programmable access code to control which receiver is activated by its transmissions. The encoder is supplied with a default access code of 1. A new random access code can be generated by grounding the A terminal for one second. The random access code will be a number from 1 to 1000. The access code will be stored in non-volatile memory and will not be lost when the KTS418 is powered down.

The transmitter has four data inputs and can send up to four control data bits individually or in any combination including all four bits simultaneously. All data inputs are internally pulled up to 5 volts through 200 microampere current sources. Transmission starts when one or more transmitter data inputs are grounded to circuit board ground. When not grounded, the data inputs should be allowed to float; they should not be directly driven to a high level. If high level drive is required the circuit shown in figure KTSap2 on page 17 can be used. A transmission will continue for as long as a data input is grounded. When no inputs are grounded the KES encoder automatically goes into a low power standby mode where it draws only one microampere. The RF transmitter circuit draws no current when it is not sending data (no input grounded).

If a certified product is required the transmitter output power may be adjusted during product certification by changing the value of a chip resistor labeled RX that feeds power to the transmitter circuit. Changing the value of this resistor may be necessary to bring the transmitter power within FCC limits. The output power will be at its maximum when a low value resistor is used. The KTS418 is supplied with an RX resistance of one ohm.

Power supply

Any voltage of from 6 to 15 volts will power the transmitter. An on-board voltage regulator generates 5.0 volts to power the encoder and RF circuit regardless of the power source voltage. The power source may be AAA, AA or lithium coin cells or a 9 or 12 volt battery. A 9 volt battery is a good choice and will last many months in normal use since the transmitter draws only two microamperes when not transmitting. The transmitter power system is reverse polarity protected. If a wall transformer is used, be sure its output does not exceed 15 volts. A wall transformer usually outputs more than its rated voltage when lightly loaded.

Receiver description_____

The KRS418 receiver operates at 418 MHz and receives CW modulated data. It has a learning decoder that can learn the access code sent by any KTS418 transmitter. The decoder is supplied with a default access code of 1. Learning a new access code is done by grounding the L terminal for one second and then transmitting any data from a KTS418 transmitter. The received access code is stored in a non-volatile memory and will not be lost when power is turned off.

Access codes from up to ten transmitters can be learned and stored in the receiver's memory so that one receiver can receive data from up to ten transmitters, however, only one transmitter should transmit at a time to avoid data collisions (see characteristics of a wireless system, page 6). The purpose of the access codes is to control access by transmitters to receivers.

Access code scanning

When a KRS418 receiver module receives a transmission, it scans its ten memory locations to see if it can find an access code that matches the transmitter's access code. If it finds a match, the receiver sends the received data to its data output terminals. If a match cannot be found, the receiver LED will blink fast eight times to indicate that it has received a transmission but does not recognize the access code. Data received from an unrecognized transmitter will not be transferred to the data output terminals.

Learning access codes

A receiver is placed into learn mode by grounding the L terminal for about one second which causes the receiver LED to double blink four times. When a transmission is received, the transmitter's access code will be stored in memory and the receiver LED will blink slow three times indicating that the receiver has learned the transmitter's code. The receiver is now ready to receive data from the transmitter that it has learned. The receiver can be placed into learn mode again and can store the access code from another transmitter. This can be repeated until the receiver learns ten access codes. Additional access code learning will cause the first stored code to be lost and replaced by the new learned code.

Although access codes cannot be erased, they can be replaced by new codes. For example the KRS418 receiver can be placed into learn mode ten times and the same code transmitted and stored ten times which will have the effect of erasing all other stored access codes.

Data outputs

Receiver outputs are at 0 volts when no data is being received and will go high to +5 volts while data is being received. Each of the four data outputs can both source and sink up to 25 milliamperes. The board-mounted LED will light while any valid data is being received. The RF receiver circuit and KDS decoder draw about 10 milliamperes of current all of the time while waiting for a signal to be received. Current will be higher when loads are connected and data is being received.

Power supply

The receiver is powered by a 7 to 25 volt 200 milliampere power source that can be a battery or preferably a wall transformer. A voltage regulator IC2 drops and regulates the power source down to 5 volts to power the RF circuit and decoder. The receiver is not reverse polarity protected.

Learn input terminal and indicator LED

The learn input and the indicator LED are both multiplexed to decoder pin 2 which alternately switches between being an input 50% of the time and an output 50% of the time. When pin 2 is an input and the learn terminal is open, pin 2 is pulled up by current flowing through R3 and through the LED. When pin 2 is an input and the learn terminal is grounded, pin 2 is pulled down by current flowing through R2. When pin 2 is an output and at a logic high level, no current flows through the LED and it does not light. When pin 2 is an output and at a logic low level, current flows through R3 and through the LED into pin 2 and the LED lights. The LED cannot light while the learn input is being held at ground because the LED anode is grounded and current flows through R3 into ground instead of through the LED. Due to the multiplexing of pin 2 the LED becomes a functional part of the circuit as well as an indicator. The receiver will not work without the LED installed or if it is reversed so it is therefore important to be sure that the LED is installed in the correct direction

Characteristics of a wireless system _____

Access codes are used to give identities to individual transmitters and receivers to allow control over which transmitter produces output from a receiver. Each receiver is capable of learning and storing access codes from up to ten transmitters so that up to ten transmitters can control one receiver even if each transmitter has a different access code. A receiver will not output data from a transmitter until it has learned its access code.

However, since all transmitters and receivers operate on the same frequency of 418 MHz, only one transmitter is allowed to send data at a time. If two or more transmitters send data simultaneously there will be a data collision and all data will be corrupted. The result of multiple simultaneous transmissions is that no valid data will be received by any receiver within range of two or more transmitters that are sending data simultaneously.

High frequency signals can reflect from surrounding objects and can arrive at a receiving antenna at a different time than the signal that comes directly from the transmitter. This time difference results in a phase shift that can partially cancel the direct signal if its phase is opposite that of the direct signal. The result will be reduced reception range. Since the wavelength at 418 MHz is short, moving the transmitter or receiver a few inches might change the phase angle between a direct and reflected signal enough to improve range. This effect is more likely to occur indoors and wherever reflecting objects are present.

Transmitter_____

Figure 1 is a schematic of the KRS418 transmitter. Figure 2 is a layout of the PC board showing power, antenna and input pads. The transmitter board is 1.0 inch wide and 1.8 inch long.

KES encoder IC1 data input pins 2, 3, 6, 7 each have internal 200 microampere pullup current sources. These inputs are connected to PC board pad positions 1 - 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 VSS to VDD can also be applied to these inputs. An input voltage below 0.8 volts is accepted as a logic low level and a voltage above 2.0 volts is accepted as a logic high level. An input voltage in the threshold range of 0.8 to 2.0 volts will produce unpredictable results. If a voltage is applied to any input it must not be more than VDD + 0.3.

The RF transmitter circuit receives digital serial data from IC1 encoder serial output pin 5 and sends it as radio frequency signals at 418 MHz. The digital modulation applied to the transmitter circuit IC2 by the KES encoder produces an OFF or ON carrier so that there is no RF output when a low level is applied to its data pin and full RF output when a high level is applied by the encoder.

Push button or other switches can be connected from VSS (ground) to KTS418 data inputs 1, 2, 3 and 4. Data will be transmitted when any one or more of these switches is closed. The KTS418 draws only 2 microamperes when not transmitting (no inputs pulled low) and about 5.5 milliamperes while transmitting.

The KTS418 is supplied with resistor RX that has a resistance value of one ohm. This produces maximum RF output power during transmission. However, if the module is to be certified for use in a product, the RX resistance value might be adjusted by the certifying agency in order to comply with FCC maximum radiation limits.

ANT	ANTENNA	CONNECT A 6.7 INCH LONG WIRE OR ANTENNA
GND	GROUND	CAN BE USED FOR COAXIAL CABLE SHIELD
+	POSITIVE POWER TERMINAL	CONNECT BATTERY POSITIVE
-	NEGATIVE POWER TERMINAL	CONNECT BATTERY NEGATIVE
A	RANDOM ADDRESS GENERATOR	GROUND TO GENERATE NEW ADDRESS
1	DATA INPUT 1	GROUND TO SEND DATA CHANNEL 1
2	DATA INPUT 2	GROUND TO SEND DATA CHANNEL 2
3	DATA INPUT 3	GROUND TO SEND DATA CHANNEL 3
4	DATA INPUT 4	GROUND TO SEND DATA CHANNEL 4
G	GROUND	GROUND FOR ADDRESS AND DATA INPUTS

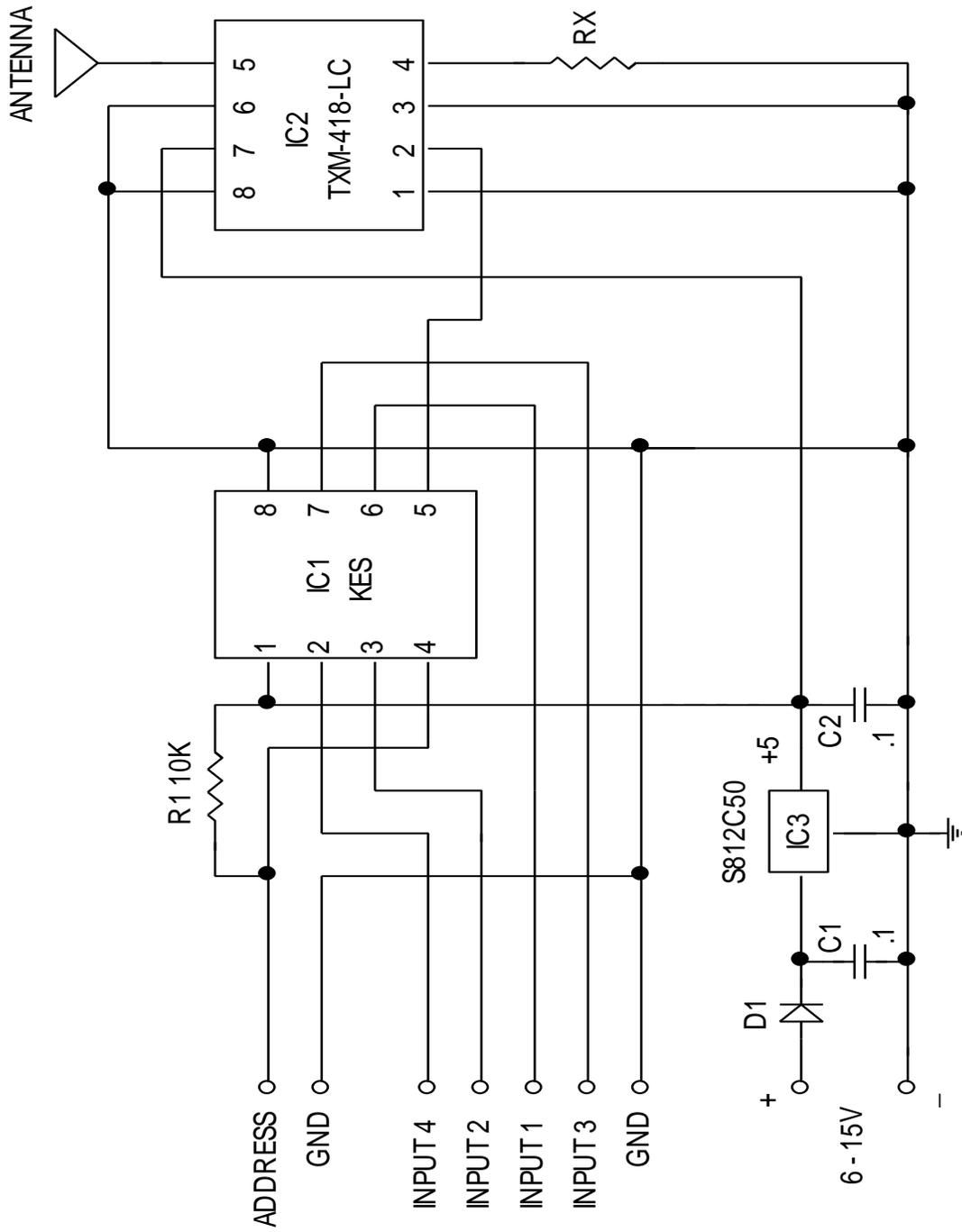
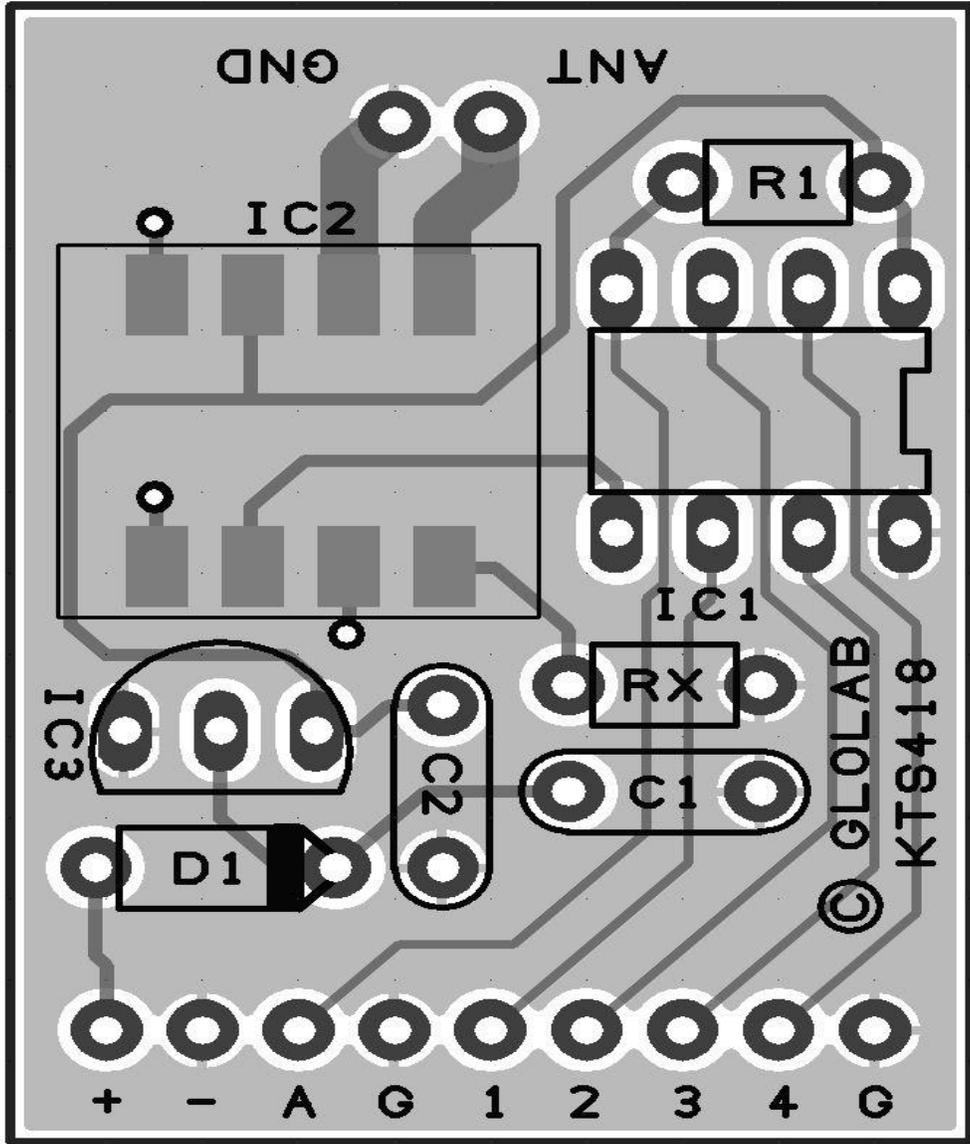


FIGURE 1



KTS418 TRANSMITTER 1.0" X 1.4"

FIGURE 2

Receiver_____

Figure 3 is a schematic of the KRS418 receiver. Figure 4 is a layout of the PC board

Serial data received by the receiver circuit IC1 feeds into serial data input pin 4 of the IC2 decoder. The address stored in the decoder memory is 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 KRS418 receiver outputs are low when no signal is being received and each output will go high to +5 volts when a signal is received by grounding a corresponding transmitter input. The decoder outputs are connected to PC board output pad positions 1, 2, 3 and 4. Outputs can both source and sink 25 milliamperes each. An output can directly power a load that draws up to 25 milliamperes at 5 volts when it is high and can sink up to 25 milliamperes from an external 5 volt source when it is low. The KRS418 draws about 6 milliamperes all of the time while waiting for a signal to be received. Current will increase to about 15 milliamperes when a signal is received and the LED lights and might increase more if a load is driven.

The LED on the receiver module will light whenever any valid data is being received and it also indicates the following conditions:

- Double blinks fast four times to indicate learn mode has been entered.
- Blinks slow three times to indicate that a new address has been learned.
- Blinks eight times to indicate that a signal was received but an address match could not be found in memory.

ANT	ANTENNA	CONNECT A 6.7 INCH LONG WIRE OR ANTENNA
GND	GROUND	CAN BE USED FOR COAXIAL CABLE SHIELD
+	POSITIVE POWER TERMINAL	CONNECT BATTERY OR POWER POSITIVE
-	NEGATIVE POWER TERMINAL	CONNECT BATTERY OR POWER NEGATIVE
L	ADDRESS LEARN	GROUND TO LEARN NEW ADDRESS
1	DATA OUTPUT 1	0 TO 5 VOLT OUTPUT DATA CHANNEL 1
2	DATA OUTPUT 2	0 TO 5 VOLT OUTPUT DATA CHANNEL 2
3	DATA OUTPUT 3	0 TO 5 VOLT OUTPUT DATA CHANNEL 3
4	DATA OUTPUT 4	0 TO 5 VOLT OUTPUT DATA CHANNEL 4
G	GROUND	GROUND FOR LEARN INPUT AND DATA OUTPUTS

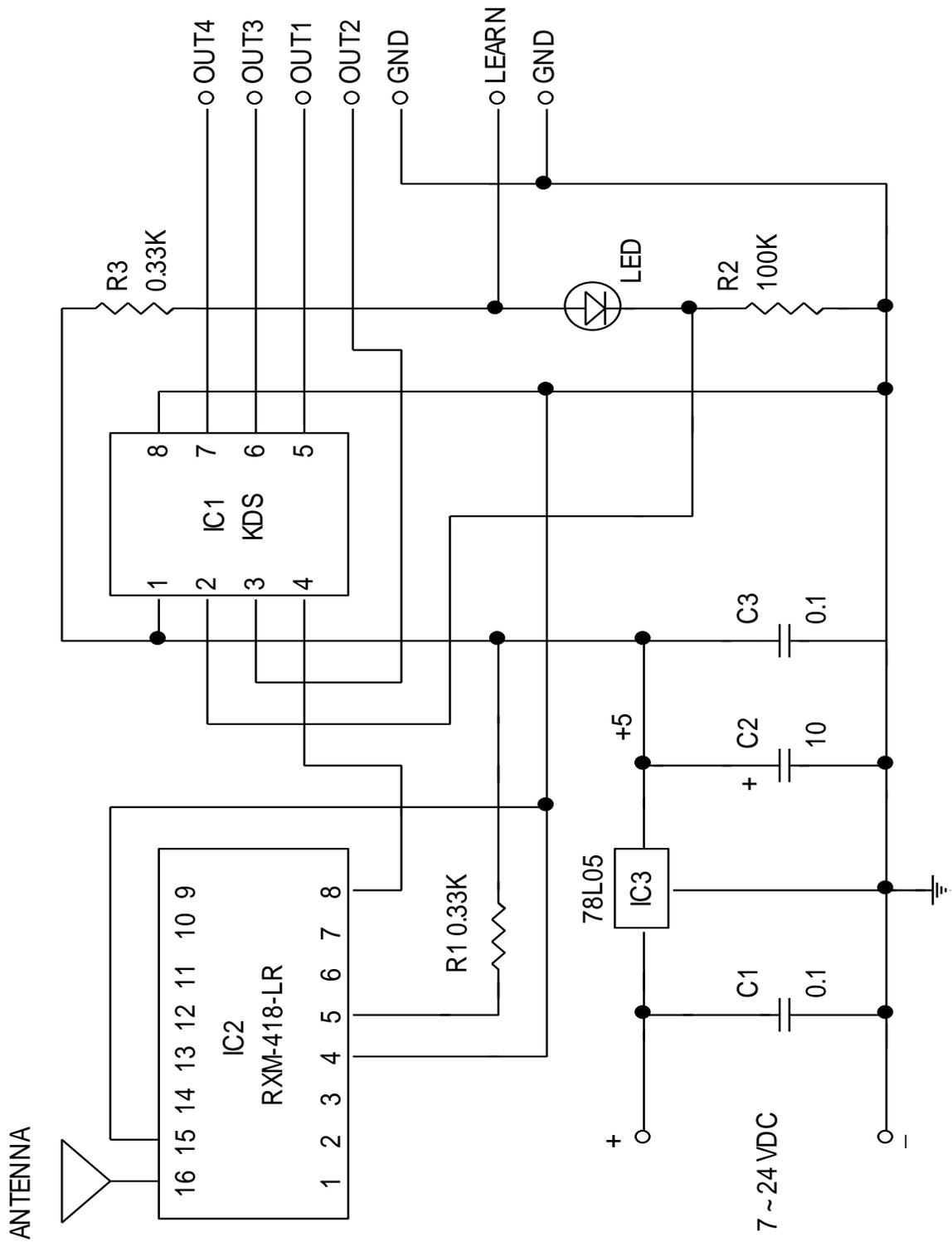
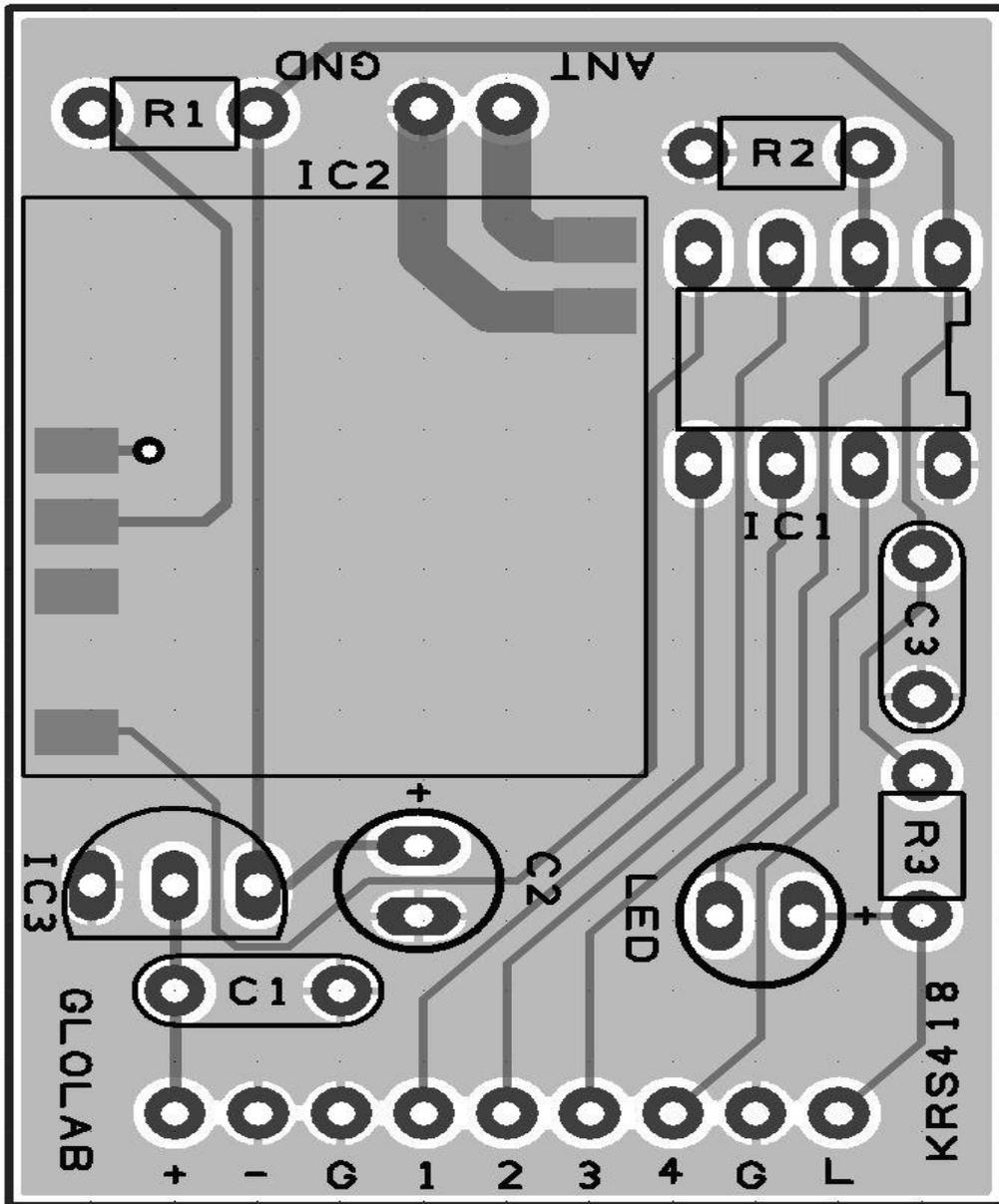


FIGURE 3

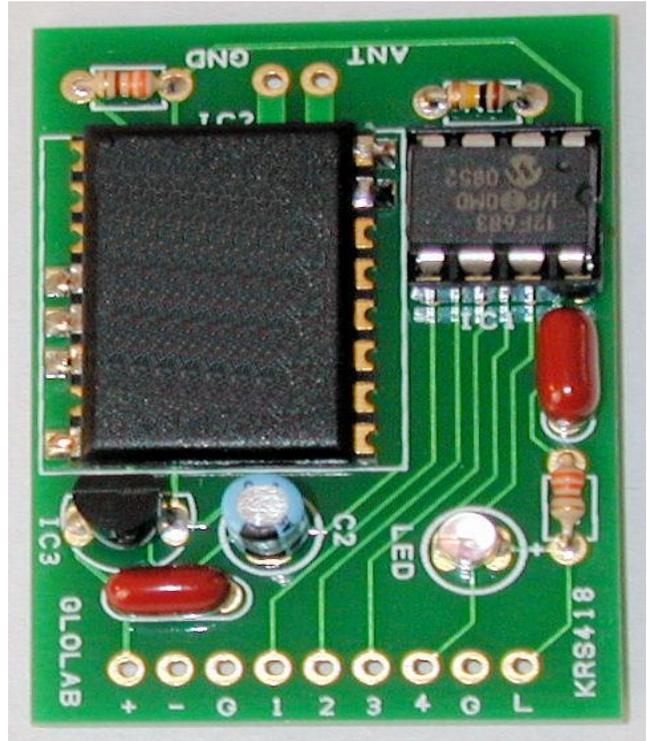


KRS418 RECEIVER 1.2" X 1.7"

FIGURE 4



KTS418



KRS418

These photos show assembled modules. The PC boards are supplied with the RF transmitter and receiver units already soldered in place. All other components are through-hole type.

KTS418 Transmitter parts list	
R1	– 10K 1/8 watt 5% carbon
RX	– 1 ohm 1/8 watt 5% carbon
C1, C2	- 0.1 mfd 50 volt metalized film
D1	- 1N914 diode
IC1	– KES encoder
IC2	- RF transmitter mounted on Double sided PC board
IC3	– VR5L micropower 5 volt regulator
IC socket	- 8 pin

KRS418 Receiver parts list	
R1, R3	– 330 ohm 1/8 watt 5% ca
R2	– 100K 1/8 watt 5% carbon
C1, C3	- 0.1 mfd 50 volt metalized film
C2	- 10 mfd 16 volt electrolytic
LED	– light emitting diode T1
IC1	– KDS decoder
IC2	– RF receiver mounted on Double sided PC board
IC3	– 78L05 5 volt regulator
IC socket	- 8 pin

The following are additional parts that can be used with the KTS418 and KRS418 kits. Space is provided on the PC boards for mounting the terminal blocks listed below. Parts are available from Mouser Electronics and other electronic parts distributors.

#	Accessory parts list	Source	Part number
1	Antenna terminal block – 2 position	Mouser	651-1725656
1	Power and data terminal block – 9 position	Mouser	651-1725724
1	9 volt battery snap	Mouser	121-0426/I
1	9 volt 200 milliamperes wall transformer	Mouser	412-109021

Mouser Electronics, 1-800-346-6873, www.mouser.com

Soldering _____

Use a small soldering iron of about 25 watts or smaller and small diameter rosin core solder. Kester solder with no-clean flux, Mouser part number 533-23-6337-8806 works well. Touch the tip of the iron against both the component lead and the board metal where the lead touches the metal and apply solder between the tip of the iron and the board metal. The solder will melt where it touches the iron and immediately flow onto the component lead and the board metal and it will then help to transfer heat to the joint. You can now apply a little more solder to other areas of the joint if necessary.

Do not apply just heat to one side of the joint and solder to other side as some soldering instructions tell you to do as this will result in overheating of the joint before the solder melts, burning the flux and oxidizing the solder.

Assembly instructions _____

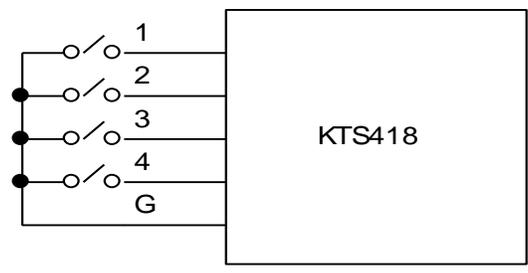
If optional terminal blocks are to be mounted on the PC board, they should be ordered from a distributor and be ready for installation. The use of terminal blocks avoids soldering power, antenna and I/O leads directly to the PC board and makes changes in I/O connections easier. The terminal blocks p/n 651-1725656 that have two terminals, used for the antenna and ground have plastic pins extending from the bottom. These plastic pins should be broken off with pliers so the terminal block will fit flush against the PC board.

- A. Bend the leads of diode D1 close to the diode body, insert into the KTS418 transmitter PC board and bend the leads against the back side of the board. Cut excess leads off short enough that they do not touch other connections but long enough to retain the diode until it is soldered. Insert the diode with its cathode band in the correct direction as shown on the KTS418 PC board.
- B. Insert capacitors C1 and C2 and resistors R1 and RX on the KTS418 transmitter board and capacitors C1 and C3 and resistors R1, R2 and R3 on the KRS418 receiver board in either direction, bend the leads against the board and cut off excess leads. Solder all connections.
- C. Insert electrolytic capacitor C2 on the KRS418 receiver board with its long positive + lead as shown on the KRS418 PC board and solder. Cut off excess leads
- D. Insert light emitting diode in KRS418 receiver board with its long anode + lead as shown on the PC board. Do not bend leads; hold in place and solder one lead. Check alignment and adjust if necessary, then solder the other lead. Cut off excess leads.

- E. Insert KTS418 transmitter and KRS418 receiver voltage regulators IC3 in the direction indicated on the PC boards. Insert IC3 so it stands about 1/8 inch or more above the board. Solder all pins and cut off the excess leads.
- F. Insert and solder IC sockets with notch facing in the direction indicated on the PC boards.
- G. If optional terminal blocks are used, insert and solder them.
- H. Insert the KES encoder IC1 on the KTS418 and KDS decoder IC2 on the KRS418 boards into their sockets and with pin 1 near the socket notch. ICs come from the manufacturer with pins flared out as required by automatic testing equipment. Pins should be straightened before inserting in the socket by using a pin straightener available from electronic parts distributors or by resting the IC on its side on a flat surface and tilting it slightly while pressing down. Handle these ICs as static sensitive devices.
- I. Insert a 6.7 inch long (1/4 wavelength) wire into the antenna pad on the KTS418 and KRS418 and solder. If a terminal block is used, insert the wire and tighten the screw. The antenna wire can be bare or insulated and either solid or stranded wire. A coaxial cable feeding a remote antenna can also be used.
- J. Connect power sources to the PC boards being sure to connect with the correct polarity.

Applications _____

Figure KTSap1 shows the simplest form of data inputs using toggle or push button switches to connect inputs to ground. Switches can be closed individually or simultaneously to transmit one or more bits.



KTSap1

Figure KTSap2 uses a Field Effect transistor for applications that require a very high input impedance or high level drive. The 2N7000 Field Effect Transistor (FET) is shown connected to input 4 but can be used with any input. Its gate is driven by 0 to 5 volts. The circuit transmits when the input is at 5 volts.

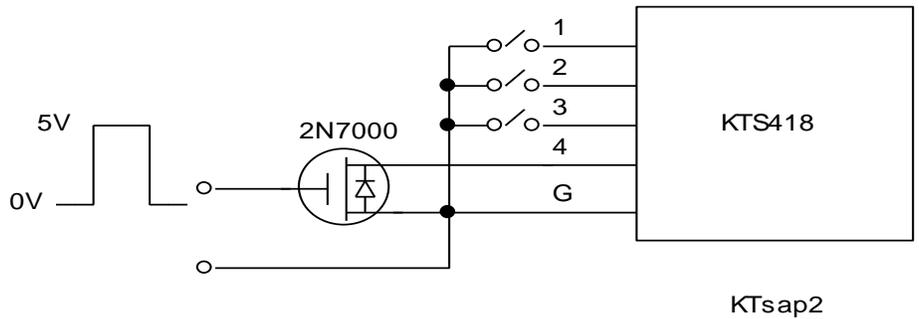
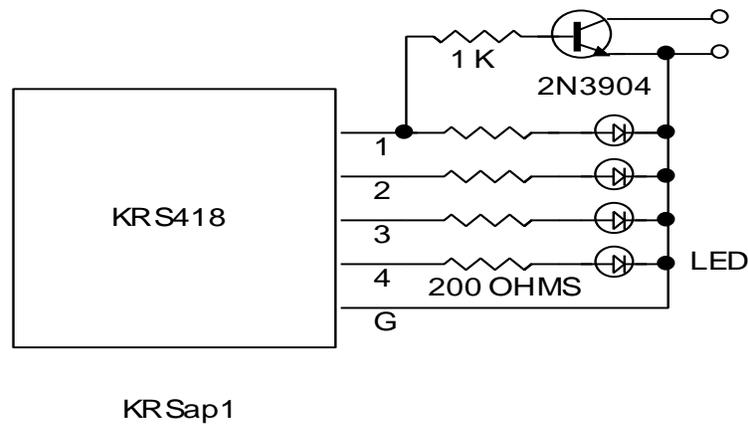
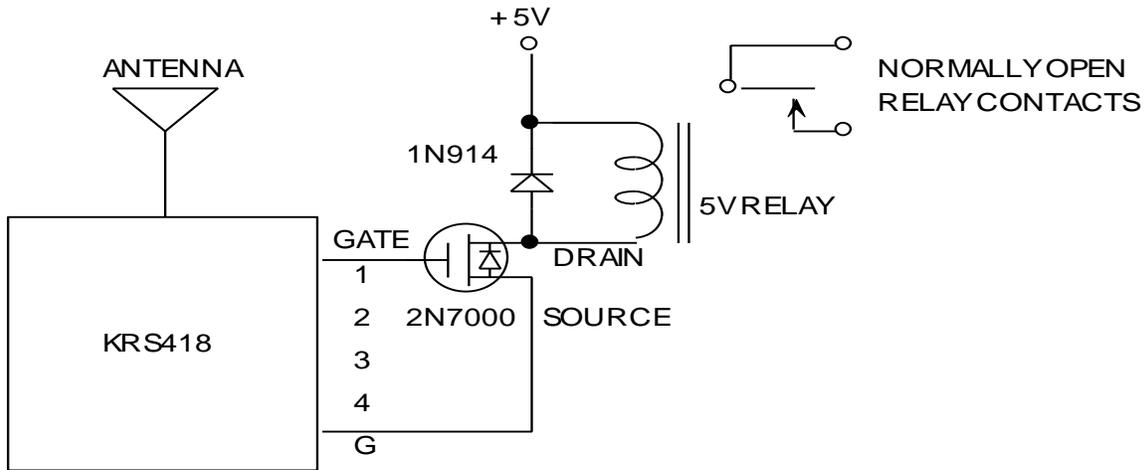


Figure KRSap1 Shows how to connect light emitting diodes to indicate a received signal on four of the data outputs. A 200 ohm resistor in series with each LED limits its current to 15 milliamperes.

Also shown connected to output 1 is a bipolar transistor with a 1K base current limiting resistor. The transistor can drive a high current load powered by an external supply. A diode should be connected across the load if it is inductive such as a relay coil.

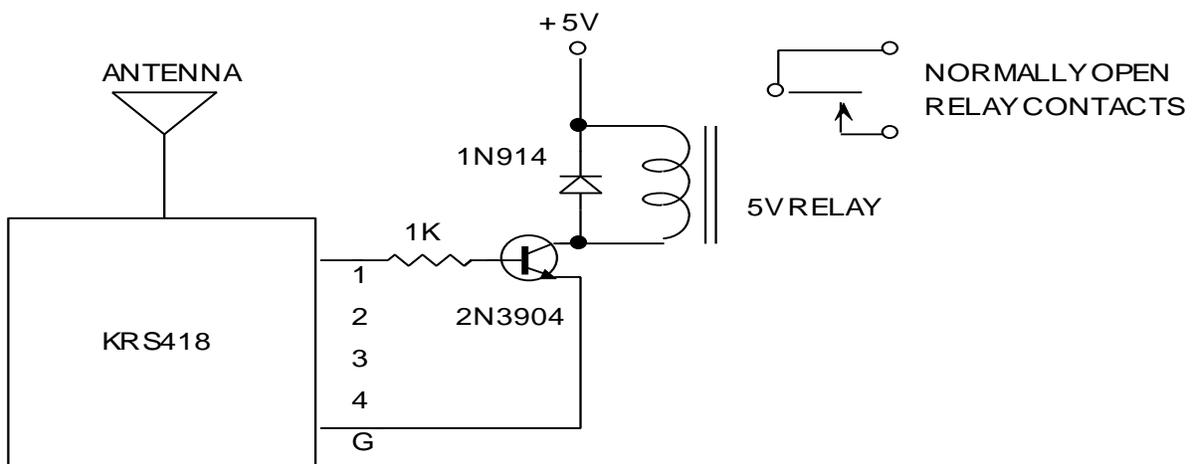


A small low current relay having a coil voltage rating of 5 volts and resistance of 200 ohms or higher and with a protection diode across its coil can be powered directly from an output. Higher current relays can be powered by adding an N channel field effect driver transistor as shown in Figure KRSap2. The gate is shown connected to output 1 but it can be connected to any of the four outputs.



KRSap2

Higher current relays can also be powered by adding an NPN bipolar driver transistor as shown in Figure KRSap3. A current limiting resistor must be placed in series with the transistor base. The diagram shows a 5 volt relay powered by 5 volts but any voltage up to 40 volts can be used with a relay rated for that voltage.



KRSap3



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