VIDEOWIRE

Introduction _____________

The Videowire converts a baseband video signal into a low impedance differential signal that can be sent over ordinary four conductor telephone wire. A send board mounted close to the camera generates the differential signal and a receive board near the monitor converts it back into single wire video that is fed to a monitor. The video signal is sent over two of the four conductors in the telephone wire and power for both the send board and the camera are carried over the other two conductors. The telephone wire connects to the boards with standard RJ11 modular plugs.

The send board can be attached to the back of a camera board with pieces of double sided tape or insulated with some electrical tape and tucked anywhere in the camera enclosure. The receive board can be housed in a small metal enclosure. Figure 1 is a block diagram showing power and signal flow.

Send board

Figure 2 is a schematic diagram of the Videowire circuits. The send board uses a MAX435 dual output wideband transconductance amplifier to convert the NTSC video from the camera into a differential signal. Each output line is terminated in 50 ohms and connects to the red and green center wires of the flat telephone wire. Twelve volt DC power for the amplifier and camera is supplied by the receive board and is carried over the outer yellow and black wires. The MAX435 is designed to operate on - 5 volts, ground and + 5 volts. However, in this application it operates on ground, +5 volts and +10 volts. Circuit components that would normally connect to ground are connected to +5 volts instead. Two 78L05 voltage regulator ICs generate the +5 and +10 volts to power the MAX435, while a 12 volt Zener diode regulates power to the camera.

The 12volt DC power that is regulated by D1 and powers the camera also connects to the inputs of IC2 and IC3. IC3 provides a +5 volt output. The ground terminal of IC2 connects to +5 volts instead of ground, causing its output to be +10 volts. Pulldown resistor R7 sinks the quiescent current of IC2 and the output drive current of IC1 to keep positive current flowing out of IC3 at all times. The video signal from the camera is terminated by R1 and coupled to the amplifier input through C1. R2 provides a +5 reference for the input, R3 sets the amplifier gain at 1 and R4 sets its operating current.

Receive board

Two 78L05 voltage regulators IC5, IC6 and pulldown resistor R16 function the same as IC2, IC3 and R7 described above to supply power for amplifier IC4. The purpose of 10 volt Zener diode D3 is to reduce the voltage applied to IC5 and IC6 to avoid exceeding their input voltage rating and to reduce their power dissipation. The differential video signal from the send board feeds through C6 and C7 into the inputs of IC4, a MAX436 single output wideband transconductance amplifier. R8 terminates the lines and R9, R10 keep the IC4 inputs at a common mode voltage of +5 volts. Potentiometer R12 varies the gain of the amplifier to compensate for line losses. D2 is a variable capacitance diode to provide high frequency compensation. Potentiometer R18 varies the capacitance of D2 by changing its reverse bias. Amplifier operating current is set by R14. The output is terminated in 75 ohms by R15.

Power

The Videowire's current mode power system is the key to its ability to drive operating voltages for the camera and send board over very long, highly resistive wire. Power for the camera and both Videowire boards is supplied by 24 volt AC adapter transformer T1, DIP bridge rectifier BR1 and 2200 mfd filter capacitor C13. Power for the send board and camera goes through LM317 voltage regulator IC7 connected as a constant current source. Its output current can be varied from about 160 ma to 260 ma for use with different types of cameras by adjusting potentiometer R22. The power supply is designed to provide about 26 volts which is more than twice the 12 volts required by the boards and camera. There is a small voltage loss in R20 but most of the additional voltage is used to compensate for the voltage drop in long lines between boards. This means that a voltage drop of 10 to 14 volts, depending on the camera current, can be tolerated in the telephone wire while still maintaining 12 volts at the camera and send board. The LM317, operating as a current regulator, automatically raises its output voltage to compensate for increased wire resistance so that no adjustments are needed when wire length is changed.

The Videowire is designed for use with cameras that draw between 80 and 180 ma. The operating current of the send board is 60 ma. If, for example, a camera that draws 100 ma is used then a total of 160 ma must be supplied, and about 10 to 20 ma extra current to guarantee that 12 volts will always be present at the send board. The surplus current above 160 ma is then shunted by Zener diode D1.

Construction

The send circuit is assembled on a 1.2 X 1.2 inch single sided printed circuit board. The positive side of C2 goes near R6 and the positive side of C3 goes near C2. Solder the camera power and video leads onto the board as shown in figure 3. To allow flexibility of board placement, RJ11 jack J1 has wire leads and is not mounted on the board. Cut the J1 leads about 2 inches long and solder them onto the board with the green wire to IC1 pin 9 and the red wire to IC1 pin 13. The black wire goes to - and the yellow to +. Since video cameras vary in size and shape, an appropriate enclosure must be chosen for the send board and type of camera used. A hole must be cut in the enclosure for the camera lens to fit through and another for J1.

The receive circuit and power supply are assembled on a 2.5 X 3.2 inch double sided printed circuit board. The LM317, IC7 must have a heat sink capable of at least four watts power dissipation. Potentiometers R12 and R18 are mounted and soldered onto the bottom side of the board to allow adjustment through holes in the bottom of an enclosure. Parts placement for the receive board is shown in figure 4.

Testing

Caution! If the send board is powered up without a camera connected, a dummy load must be used in place of the camera. The dummy load can be a 100 ohm 2 watt resistor connected to the camera power terminals on the send board. Failure to do this will result in damage to Zener diode D1 and possible damage to IC1 because D1 will be forced to shunt all of the current that would normally flow through the camera.

Be sure a wire is not plugged into RJ11 jack J2. Plug the AC adapter transformer into an AC outlet and measure the voltages at the outputs of IC5, IC6 and at the positive side of C14. The voltage at C14 should be approximately 33 volts with no load. The negative side of C14 which is ground in the schematic should be used as a voltage reference when making these measurements. Do not connect your negative meter lead to the large copper area of the board as this is connected to + 5 volts. Connect a milliammeter directly from the positive side of C14 to the negative side of C14. Small pieces of wire can be temporarily tack soldered to the board to make connections easier. The current should be adjustable from about 160 ma to 260 ma by turning R22. Do not leave the meter connected too long as excessive heating of IC7 may result due to the total power supply voltage being dissipated within it. If everything tests good install the board in the enclosure. Be sure a camera or dummy load is connected to the send board and R22 is turned fully counterclockwise. Plug one end of a telephone wire with RJ11 plugs attached into J1 on the send board and the other end into J2 on the receive board. The wire should have RJ11 plugs attached as shown in figure 3. Flat telephone wire can be purchased with RJ11 plugs already crimped on both ends. If one of these wires is used, it should be of the “straight through” type so that the positive terminal of the send board connects to the positive terminal of the receive board. Measure the voltage across D1 and if necessary, adjust R22 until you get 12 volts across it. If you measure -.8 volts across D1 this means that one of the RJ11 plugs must be reversed. Cut one of the plugs off, turn the wire over and crimp another plug on. Measure the voltages at the outputs of IC2 and IC3 using the anode side of D1 which is ground in the schematic as a voltage reference. If everything tests good continue with the adjustments.

Adjustments and operation

If a dummy load was used during testing, replace it with the camera that you will be using with the Videowire. To avoid unnecessary power dissipation in D1, R22 should first be set for minimum current, (fully counterclockwise), then adjusted until 12 volts is obtained across D1 and then turned about 1/8 turn more to supply some extra current. This adjustment can be made with a short wire interconnecting the send and receive boards since the current adjustment is independent of wire length as long as the maximum allowable length as shown in table 1 is not exceeded. If a short wire length is used during adjustment, the voltage reading may be made across C14 instead of across D1. Connect a monitor to J3 and you should see the camera output. Adjust R12 for desired contrast and R18 for best sharpness.

Installation

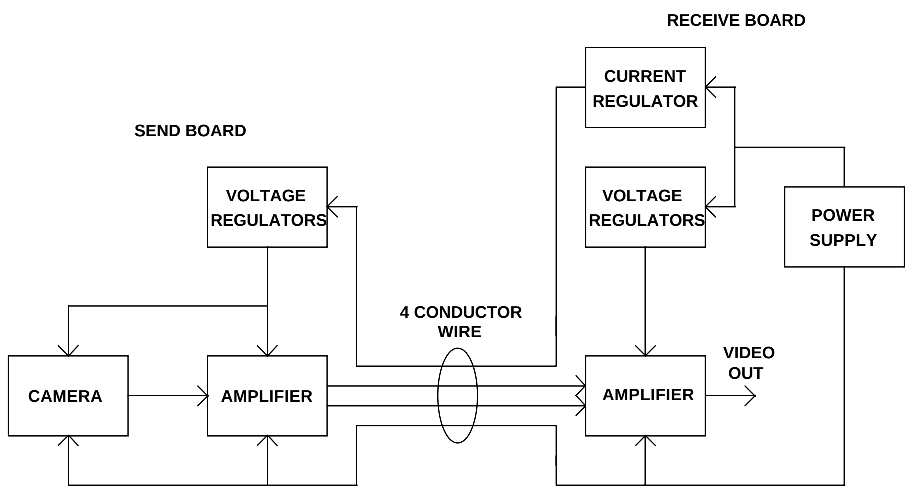
The resistance of a typical four conductor flat 28 gauge telephone wire is about 7 ohms per 100 feet. Since voltage drops appear in both the plus and minus power supply leads, the total series resistance is about 14 ohms per 100 feet. Maximum allowable wire length depends on the total current requirements of the camera and send board. Using a camera that draws 100 ma, for example, a total current of about 180 ma is required and therefore a maximum of approximately 500 feet of 28 gauge flat telephone wire can be used. If a longer wire is needed, the round type of 22 gauge four conductor telephone wire offers much lower resistance. Its resistance per 100 feet is approximately 3.3 ohms total for both the positive and negative power wires. Using this wire and a 100 ma camera, the wire length can be approximately 2000 feet. Some round wire is weatherproof and more suitable for outdoor use, although the flat wire has also been used outdoors. Table 1 shows the approximate maximum wire lengths allowed using flat 28 gauge and round 22 gauge wire for various camera currents. Check the manufacturers specifications to determine the current drawn by your camera or connect it in series with a milliammeter to a 12 volt power supply and terminate the video output with 75 ohms.

CAMERA CURRENT MA	FLAT WIRE MAXIMUM FEET	ROUND WIRE MAXIMUM FEET
80	575	2400
100	500	2100
120	425	1800
140	360	1525
160	310	1300
180	265	1100

Table 1

AMERICAN ELECTROMECHANICAL

Wireless Control



BLOCK DIAGRAM OF VIDEOWIRE FIGURE 1

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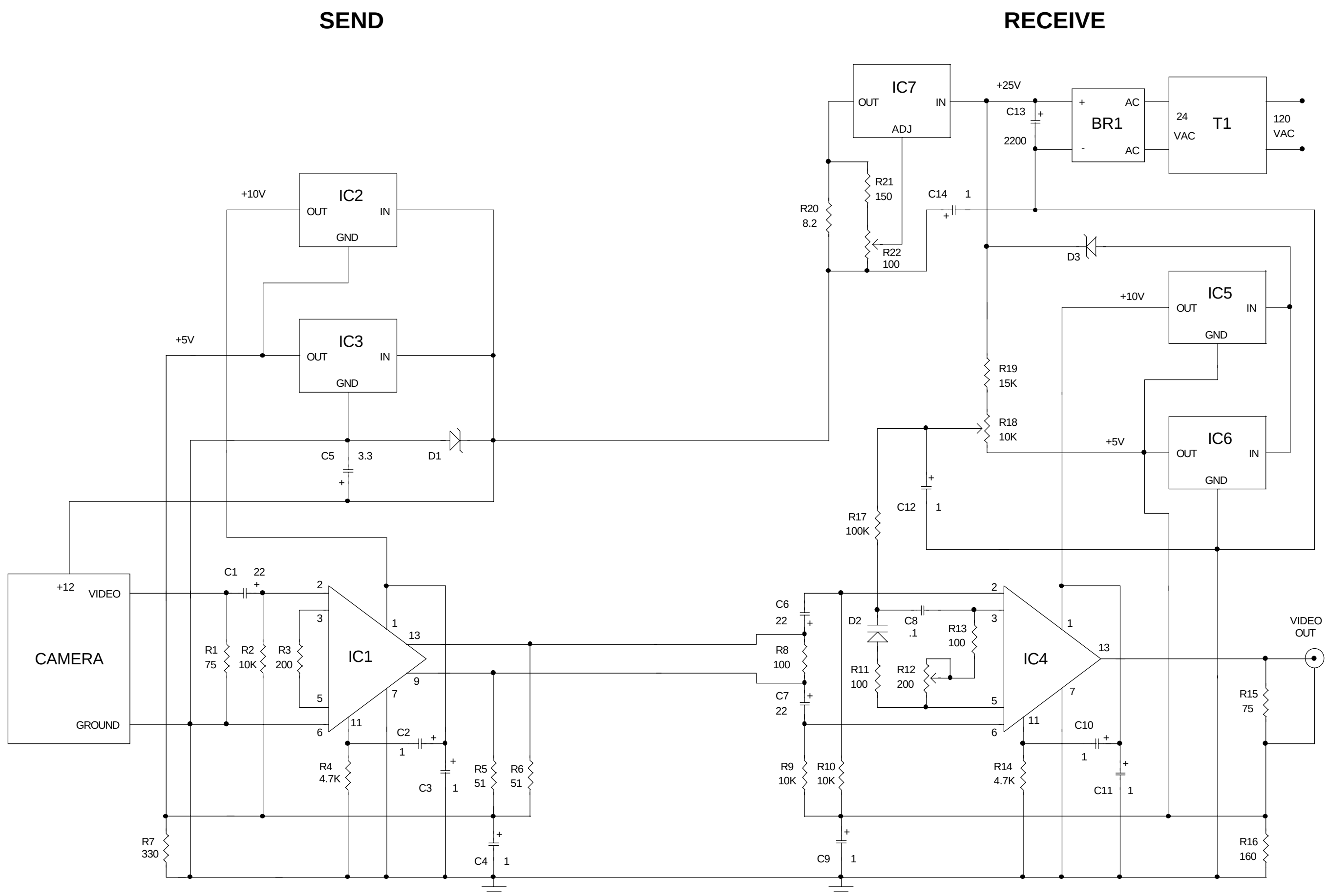
AMERICAN ELECTROMECHANICAL

Videowire



VIDEOWIRE CIRCUIT FIGURE 2

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Videowire Parts List

Description	Source
R1, R15 - 75 ohms 1/8 watt	Digi Key
R2, R9, R10 - 10K 1/8 watt	Digi-Key
R3 - 200 ohms 1/8 watt	Digi-Key
R4, R14 - 4.7K 1/8 watt	Digi-Key
R5, R6 - 51 ohms 1/8 watt	Digi-Key
R7 - 330 ohms 1/8 watt	Digi-Key
R8, R11, R13 - 100 ohms 1/8 watt	Digi-Key
R12 - 200 ohms potentiometer	Digi-Key
R16 - 160 ohms 1/4 watt	Digi-Key
R17 - 100K 1/8 watt	Digi-Key
R18 - 10K potentiometer	Digi-Key
R19 - 15K 1/8 watt	Digi-Key
R20 - 8.2 ohm 1/2 watt	Digi-Key
R21 - 150 ohm 1/8 watt	Digi-Key
R22 - 100 ohm potentiometer	Digi-Key
R dummy - 100 ohm 2 watt	Digi-Key
C1 - 22 mfd 6.3 volt tantalum	Digi-Key
C2, C3, C4, C9, C10, C11, C12 - 1 mfd 16 volt tantalum	Digi-Key
C5 - 3.3 mfd 16 volt tantalum	Digi-Key
C6, C7 - 22 mfd 16 volt tantalum	Digi-Key
C8 - .1 mfd 50 volt metalized film	Digi-Key
C13 - 2200 mfd 50 volt electrolytic	Digi-Key
C14 - 1 mfd 50 volt tantalum	Digi-Key
D1 - 12 volt 1 watt zener diode	
D2 - Motorola MVAM109 tuning diode	DC Electronics
D3 - 10 volt 1 watt zener diode	
BR1 - 1 amp 400 volt DIP bridge rectifier	
IC1 - Maxim MAX435 dual output amplifier	Digi-Key
IC2, IC3, IC5, IC6 - 78L05 voltage regulator	
IC4 - Maxim MAX436 single output amplifier	Digi-Key
IC7 - LM317 adjustable voltage regulator	
J1 - RJ11 6P4C telephone jack with leads	Mouser
J2 - RJ11 6P4C board mount telephone jack	Mouser
J3 - chassis mount angle coaxial F connector	Mouser
four conductor telephone wire with RJ11 plugs	
TO220 5 watt clip on heat sink	Digi-Key
four threaded spacers 6-32 X 1/2 inch long	
eight 6-32 X 1/4 inch screws	
rubber grommet for 1/4 inch hole	
2.2 X 3.3 X 4 inch metal enclosure with vent holes	Jameco
T1 - 24 volt AC 400 ma adapter transformer	Jameco
send and receive circuit boards	American Electromechanical

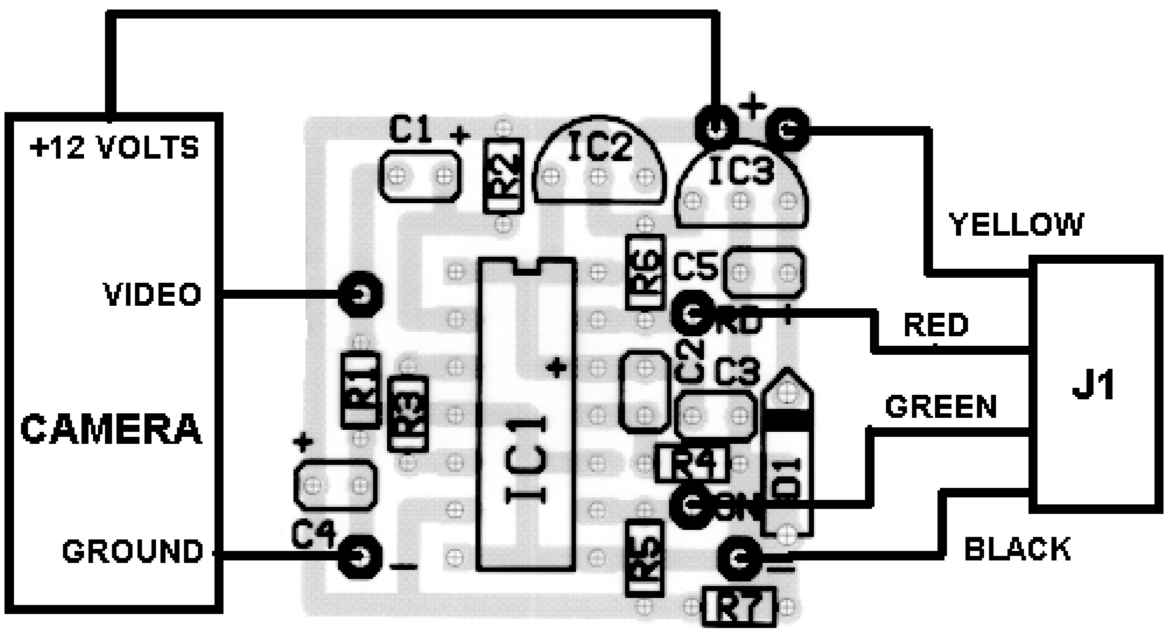


FIGURE 3

Parts placement and connections to send board

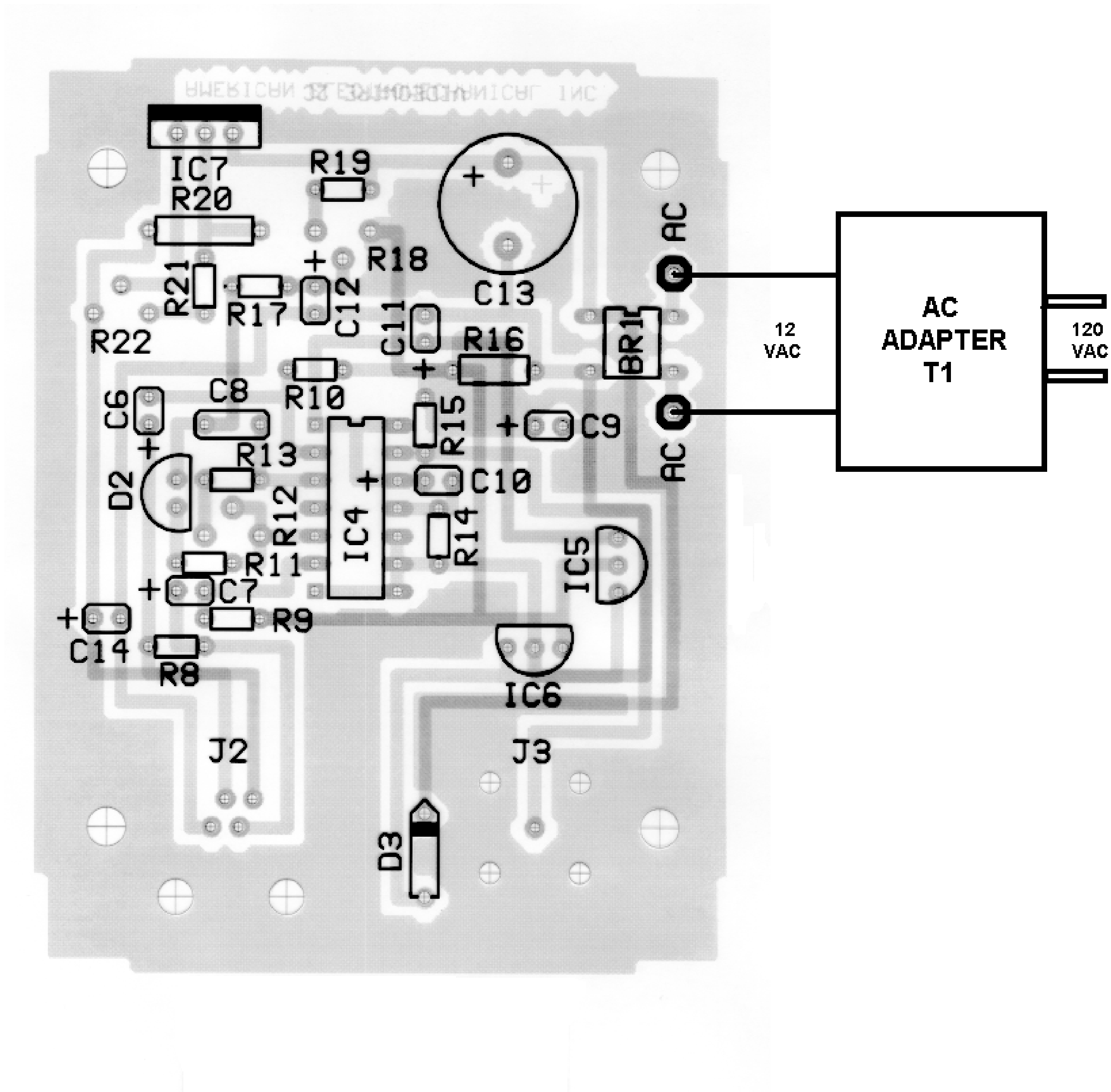
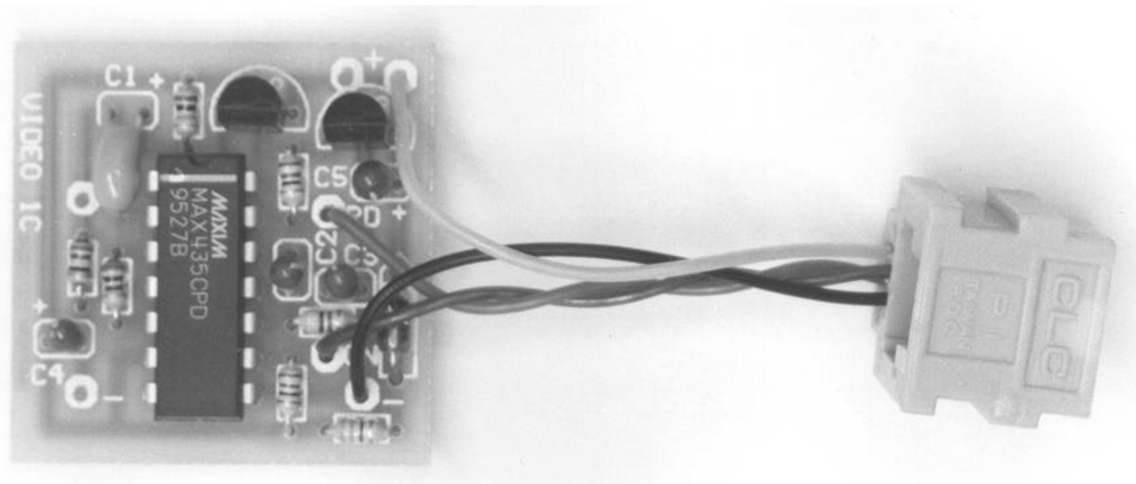
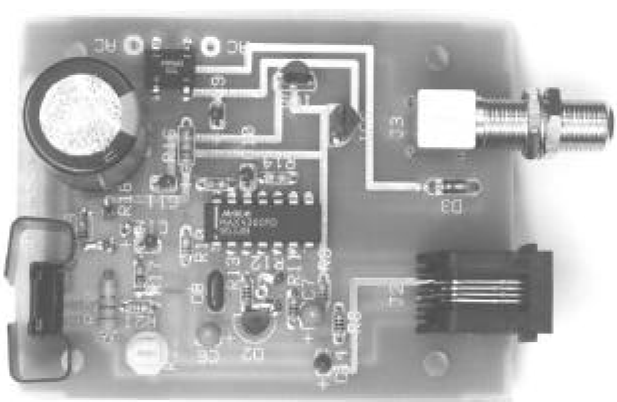


FIGURE 4

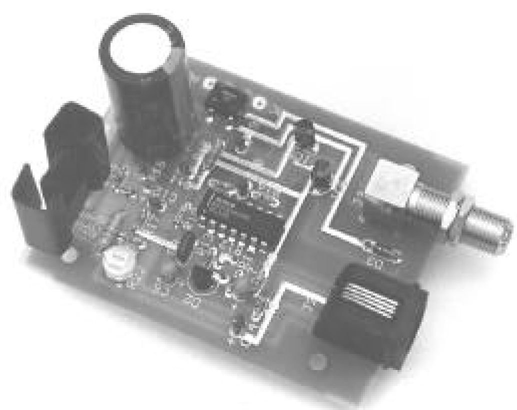
Parts placement and connections to receive board



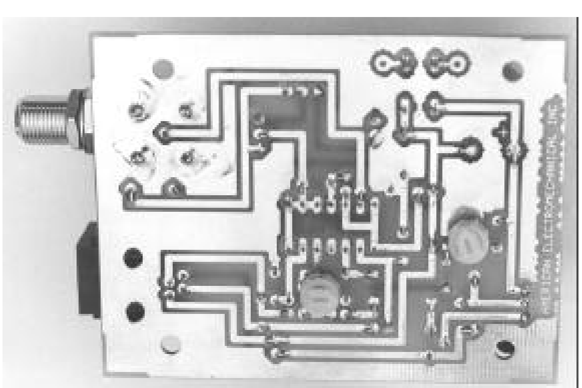
Top view of send board
with RJ11 jack connected



Top view of receive board



Angle view of receive board



Bottom view of receive board showing
location of R12 and R18

Receive board mounted in enclosure

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Videowire assembly instructions

Send board

1. Insert and solder all resistors.

2. Insert and solder all capacitors being careful to insert them with the correct polarity. The long lead is the positive + side of most capacitors but some have both leads of the same length. Polarity is also marked on the capacitors. Polarity is marked on the circuit board and is shown in figure 3. The positive side of C2 goes near R6 and the positive side of C3 goes near C2.

3. Insert and solder D1 with its cathode band as shown on the circuit board and in figure 3.

4. Insert and solder IC2 and IC3 with their flat sides as shown on the circuit board and in figure 3.

5. Insert and solder IC1 with pin 1 toward the notch as shown on the board and in figure 3.

6. Cut the J1 leads to about 2 inches long and strip about 1/4 inch of insulation. Solder them onto the send board with the green wire to IC1 pin 9 and the red wire to IC1 pin 13. The black wire goes to - and the yellow to + as shown in figure 3.

7. Insert and solder the camera leads as shown in figure 3. A 100 ohm 2 watt dummy load resistor may be temporarily used in place of the camera. If the dummy load is used, leave the leads long and solder them in place of the camera +12 volt and ground leads.

8. Set the send board aside while you assemble the receive board. After the Videowire is completed and operating, the camera and send board may be placed in an enclosure of your own design. The enclosure may be plastic or metal with a hole for the lens and another for J1. For a weatherproof enclosure the entire camera, board and connector may be sealed in a clear plastic box with silicone rubber.

Receive board

9. Insert and solder all 1/8 watt resistors.

10. Insert and solder R16.

11. Insert and solder R20.

12. Insert and solder C8.

13. Insert and solder all other capacitors except C13 being careful to insert them with the correct polarity. The long lead is the positive + side of most capacitors but some have both leads of the same length. Polarity is also marked on the capacitors. Polarity is marked on the circuit board and is shown in figure 4.

14. Insert and solder D3 with its cathode band as shown on the circuit board and in figure 4.

15. Insert and solder D2 with its flat side as shown on the circuit board and in figure 4.

16. Insert and solder R22.

17. Insert and solder IC5 and IC6 with their flat sides as shown on the circuit board and in figure 4. Insert these ICs until they are about 1/8 inch from the circuit board.

18. Insert and solder BR1 with pin 1 toward the notch as shown in figure 4.

19. Insert and solder IC4 with pin 1 toward the notch as shown in figure 4.

20. Hold F connector J3 tight against the board and solder its center pin. Rest J3 on a heat resistant surface and solder the four outer pins. A larger soldering iron of about 35 watts or more may be needed to solder these pins.

21. Press J2 into its mounting holes and solder its pins.

22. Insert R12 on the bottom side of the board and solder it in place from the top side.

23. Insert R18 on the bottom side of the board and solder it in place from the top side.

24. Insert and solder IC7 with the tab facing the edge of the circuit board as shown in figure 4.

25. Insert and solder C13 with the correct polarity.

26. Install the clip-on heat sink on IC7.

27. Connect and solder the T1 wires to the receive board as shown in figure 4.

28. Make test measurements and adjustments as described in the text.

The receive board may be installed in an enclosure with appropriate holes cut for the RJ11 jack, “F” connector and R12 and R18 . If an enclosure is used, the board should be mounted using 1/2 inch threaded spacers to allow room for R12 and R18 below.