

Build A Video Switcher

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BUILD A VIDEO SWITCHER

FRANK MONTEGARI

Watch several cameras on one monitor with this simple device

With the cost of security cameras going down, adding a surveillance system for your store, office or home is becoming more practical all the time. However, you might be dismayed at the thought of having to buy a monitor for every camera that's installed. dedicating a single monitor to a single camera also runs the risk of burning the camera's image into the phosphor screen of the CRT.

If you prefer a single monitor instead of the "NASA-Mission Control" look, you could buy a special monitor that has a video switcher built in. That type of monitor can automatically switch between several camera inputs in sequence. With that type of arrangement, you'd have to watch only one screen instead of having to scan a wall of CRTs. Switching between several cameras would also prevent image burn-in on the monitor. Those types of monitors, unfortunately, are also very expensive, offsetting the cost savings of even the cheapest surveillance camera.

Video switchers are also available, but the cost of a switcher and a monitor could be as expensive as a monitor/switcher combination unit. A viable alternative for a video switcher is to build your own. Thanks to some recently introduced ICs, the cost and effort of designing and building such a unit has become both quite affordable and easy.

The video switcher described here can display the output of two, three, or four

cameras on a single monitor. The number of cameras is set by a DIP switch on the circuit board. That feature avoids blank displays if less than four cameras are used by sequencing through only the inputs that are connected to a camera. In the automatic mode, the cameras are switched at a rate that can be varied with a panel mounted control. The switching rate can be set from about once per second to about once every 20 seconds. In the manual mode, one camera output is displayed continuously. A momentary-toggle switch is then used to step through the various cameras.

How it works

The heart of the video switcher is a Maxim MAX454. That integrated circuit contains a four-way video multiplexer and an amplifier that operates as a low-impedance line driver. The resulting video output is high quality with very low phase distortion. The video inputs are selected by applying a binary number to the address inputs. The binary number is also used to light a series of LEDs that indicate which camera input is currently selected. The circuit is powered by a 9-volt AC wall-adaptor transformer, two diodes, and two voltage regulators.

Circuit description

Figure 1 is a schematic diagram of the video switcher. Multiplexer IC1 has four video inputs, two address inputs, one video output, one external amplifier input, and three power terminals. The video cameras

connect to the video inputs through J1-J4. The inputs are terminated with 75 ohm resistors R1-R4. The gain of the internal video amplifier is set by a feedback network connected to pin 13 of IC1. That feedback network consists of R5-R8 and C3. The gain is set to 2 in order to compensate for any loss through the 75 ohm terminator resistor, R9. The resulting net gain is 1 at output J5.

The binary addressing circuit is built around IC2, a CD4017 decade counter. That chip produces one positive output at a time on each of its ten outputs in sequence for every clock pulse. The first four outputs at pins 3,2,4, and 7 are connected to transistors Q1-Q4. Those transistors drive LED1-LED4 through current limiting resistor R15. The outputs from IC2 (pins 2,4, and 7) are also decoded into binary logic by diodes D1-D4. The binary logic is sent to the address input lines of IC1.

The number of cameras connected to the video switcher is set with S1. Each switch in S1 is connected to an output from IC2. If, for example, there are only two cameras connected to the video switcher, S1-a is closed. That connects the third output to IC2's reset line. When IC2 advances to the third count, that output passes through S1-a to the reset, and IC2 resets to zero, activating the first camera. The sequence would be camera 1, camera 2, then back to camera 1. Closing S1-b or S1-c instead of S1-a will let the video switcher cycle through three or four cameras, respectively.

Clock pulses for the counter are generated by IC3, an LMC555 CMOS timer. The pulse rate and pulse width is controlled by C4, R10, R11 and potentiometer R12. By adjusting R12, the output frequency of IC3 can be controlled between 1 Hz and 1/20 Hz. The clock pulses from IC3 are connected to IC2 through S2, a three position toggle switch. Switching S2 to the auto position lets the pulses from IC3 select the next camera at a rate set by R12. When S2 is in its center-off position, no switching takes place, and whatever camera input is selected is passed through to the output. The select position on S2 is a momentary contact. That position raises the clock input of IC2 to 5 volts, which increments the

binary count and selects the next camera. When S2 is released, it springs back to its center-off position. The clock input of IC2 is then held at a low-logic level by R13.

The MAX454 requires ± 5 volts while the other ICs require only +5 volts. Power is supplied by AC adapter T1, rectifier diodes D5 and D6, regulators IC4 and IC5, and filter capacitors C6-C9.

Construction

Because of the high frequency video signals involved, the video switcher should be built on a printed circuit board. The circuit is simple enough to fit onto a single-sided board with only two jumpers needed. A foil pattern is included for etching and drilling your own board. Alternatively, an etched board can be purchased from the source given in the parts list. A feature of that board design is ground traces that run between all of the video signal traces in order to keep induced noise and crosstalk between the signals to a minimum.

Whether you etch a board from the foil pattern or purchase one from the source in the parts list, use the parts-placement diagram in fig. 2 for component placement.

It is easiest to install and solder the resistors and diodes first. Once those components are in place, scrap component leads can be used for the two jumper wires. Next, install S1 and sockets for IC2 and IC3. Do not use a socket for IC1, the MAX454 multiplexer.

When installing J1-J5, hold the connectors tight against the board while soldering the center pin. The assembly can then be placed on a heat-resistant surface and the ground pins soldered. Because of their size and mass, a larger soldering iron might be needed to solder J1-J5. Otherwise the board might be damaged if heat is applied too long.

Once the connectors are soldered in place, Q1-Q4, IC4, IC5, and all the capacitors can be installed. The LEDs should be installed next, leaving their leads long so that they

can be bent to reach through the front panel of the enclosure. Double-check the orientation of the polarized components, so that they are not installed backwards by accident. Once a component is soldered in place, removing it becomes much more difficult.

Solder two 3-inch long wires onto the two terminals of R12 that are clockwise when viewing the potentiometer from the back. Connect those wires to the holes for R12 on the board. Three additional 3-inch long wires are soldered onto the terminals of S2. The center terminal connects to the hole near C5 and R13. The momentary-contact terminal connects to the hole near R14. The remaining terminal connects to the hole near IC3 and R10.

Solder IC1 directly onto the circuit board. That will result in the shortest possible lead length for the video signals. Plug IC2 and IC3 into their sockets, being careful to handle them as static-sensitive CMOS devices. Solder the T1 leads onto the board.

Examine the board for any wiring errors, bad solder joints, and incorrect components. Once the assembly is inspected, it can be tested.

Testing

Plug T1 into an AC outlet and measure the voltages across C8 and C9. The voltage

across C8 should measure +5 volts. Across C9, the voltage should be -5 volts. To select two cameras, set S1-a on; to select three cameras, set S1-b on; and to select all four cameras, set S1-c on. Only one switch at a time should be on. When switch S2 is toggled to its momentary position, the LEDs should sequence to the next indicator each time S2 is toggled. The order of the LEDs should cycle from 1 through 4 and repeat. When S2 is set to automatic, the LEDs should automatically at a rate that should vary as potentiometer R12 is adjusted.

Connect cameras to J1-J4 and a monitor to J5. The video signal on the monitor should switch from camera to camera according to the LEDs.

After testing is completed, drill appropriate holes in a suitable enclosure for J1-J5, LED1-LED4, S2, and R12. Mount the board in the enclosure using the mounting hardware for J1-J5 to hold it in place. Mount R12 and S2 in the front panel and bend the LEDs so they fit through the holes in the panel. The hole for the T1 wire should be drilled at a point where the two halves of the enclosure meet. Tie a knot in the wire for strain relief and place the wire in the enclosure hole with the knot on the inside of the enclosure before closing the case.

That completes the project. If all has gone well, as is likely, your video switcher is now ready for use. Ω

PARTS LIST

SEMICONDUCTORS

IC1 - MAX454 multiplexer, integrated circuit (MAXIM)

IC2 - CD4017 decade counter, integrated circuit

IC3 - LMC555 timer, integrated circuit

IC4 - 78105 voltage regulator, integrated circuit

IC5 - 79105 voltage regulator, integrated circuit

Q1-Q4 - MPSA14, NPN transistor

D1-D4 - 1N914, silicon diode

D5, D6 - 1N4004, silicon diode

LED1-LED4 - Light emitting diode, red

RESISTORS

(all resistors are 1/8 watt, 5% units unless otherwise noted)

R1-R4, R9-R15 - 75 ohm

R5 - 150,000 ohm

R6 - 620 ohm

R7 - 1100 ohm

R8 - 1000 ohm

R10 - 10,000 ohm

R11 - 51,000 ohm

R12 - 1 megohm potentiometer, panel mount

R13, R14 - 100,000 ohm

CAPACITORS

C1,C2,C5 - 0.1 μ F, 50 WVDC, metalized film

C3 - 6.8 pF, ceramic disc

C4 - 10 μ F, 50 WVDC, low leakage electrolytic

C5, C7 - 470 μ F, 25 WVDC, electrolytic

C8, C9 - 100 μ F, 16 WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

S1 - DIP switch, 3 position

S2 - Toggle switch, single pole double throw, one momentary position (Digi-Key CK1028-ND or similar)

J1-J5 - Video connector, chassis mount, "F" type

T1 - 9 volt AC wall adapter transformer
PC board, IC sockets, LED holders, 22 gauge hookup wire, knob, enclosure, hardware, etc.

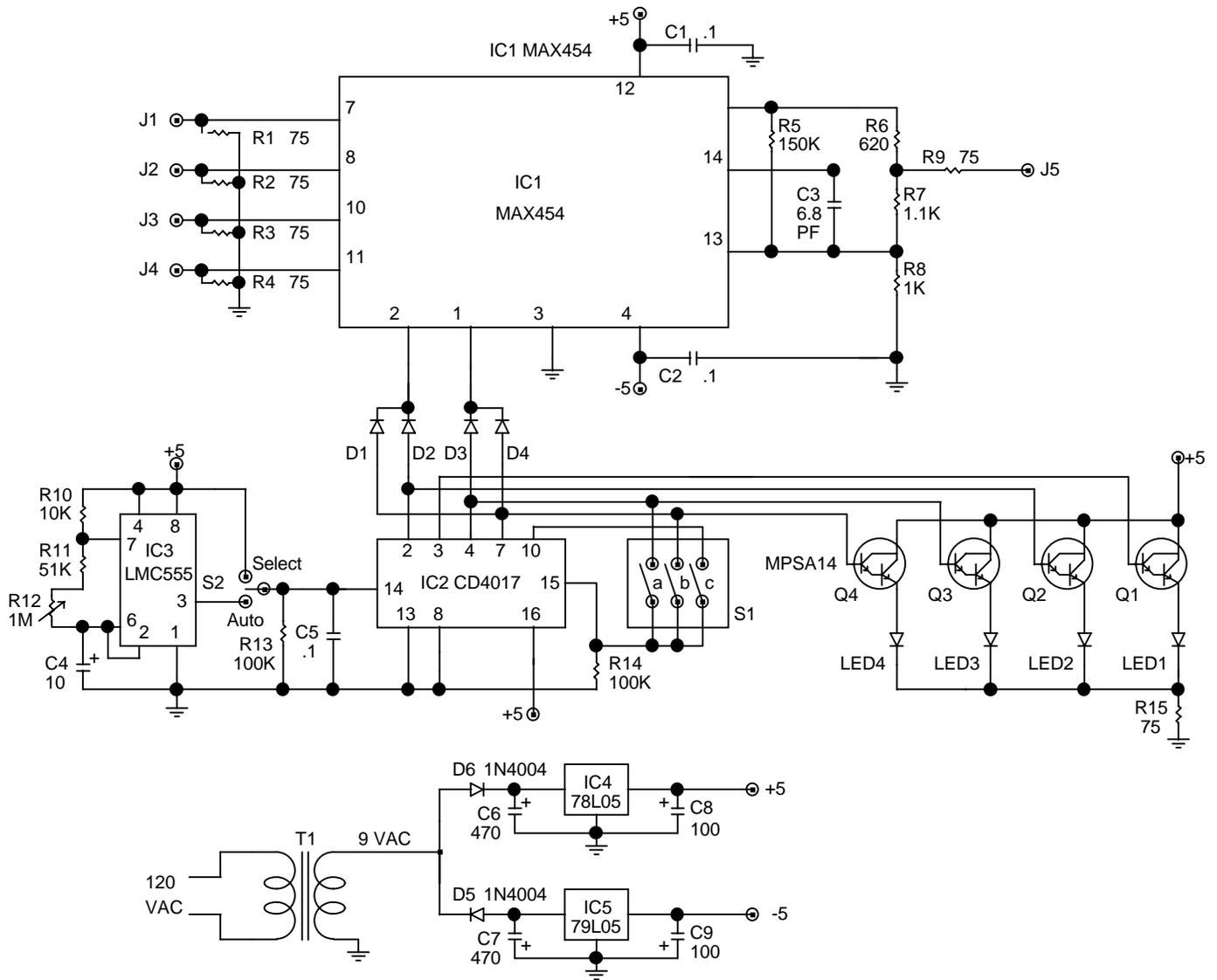


Fig. 1 The video switcher is built around a Maxim MAX454 multiplexer chip. Up to four cameras can be viewed on one monitor in sequence.

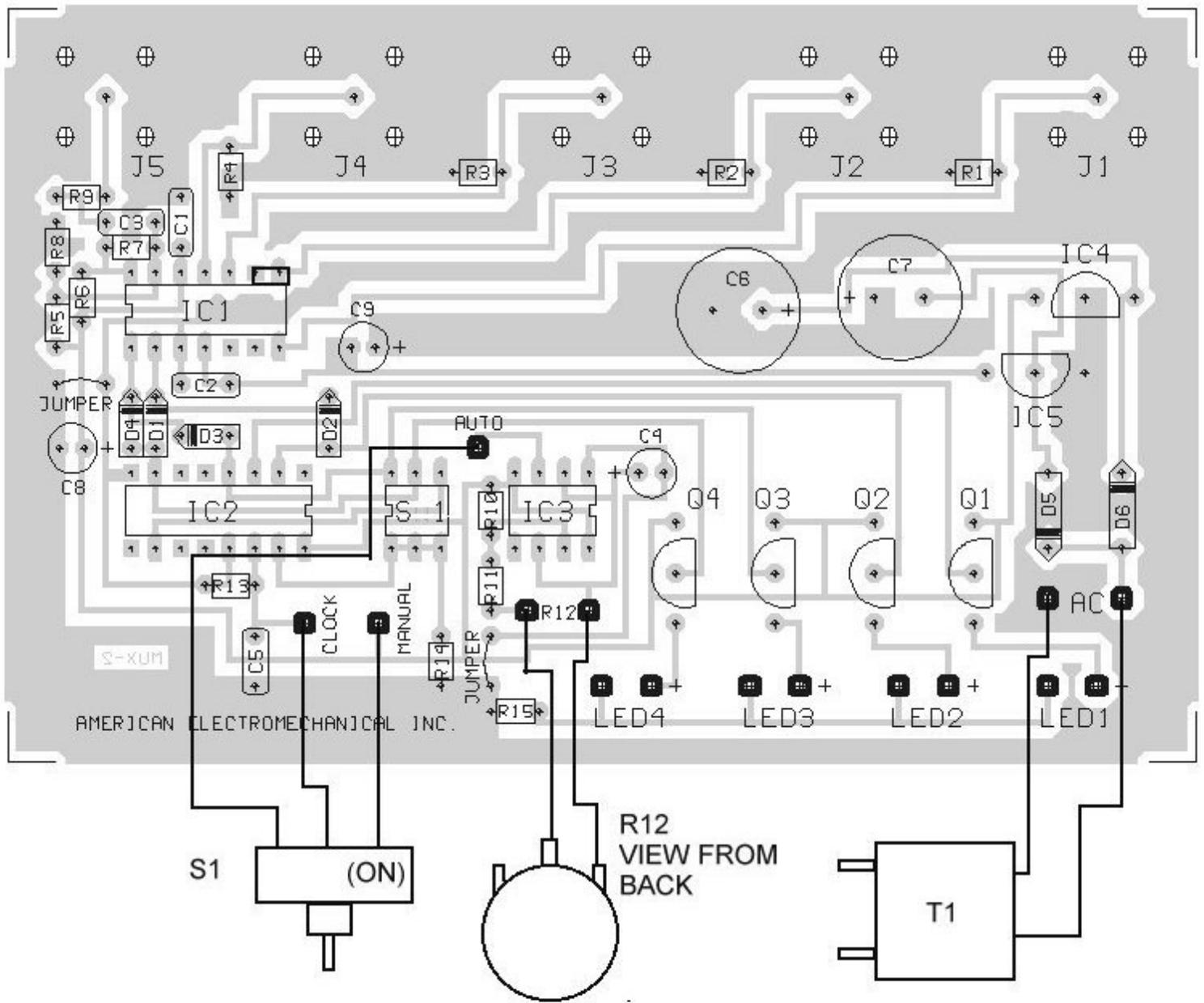
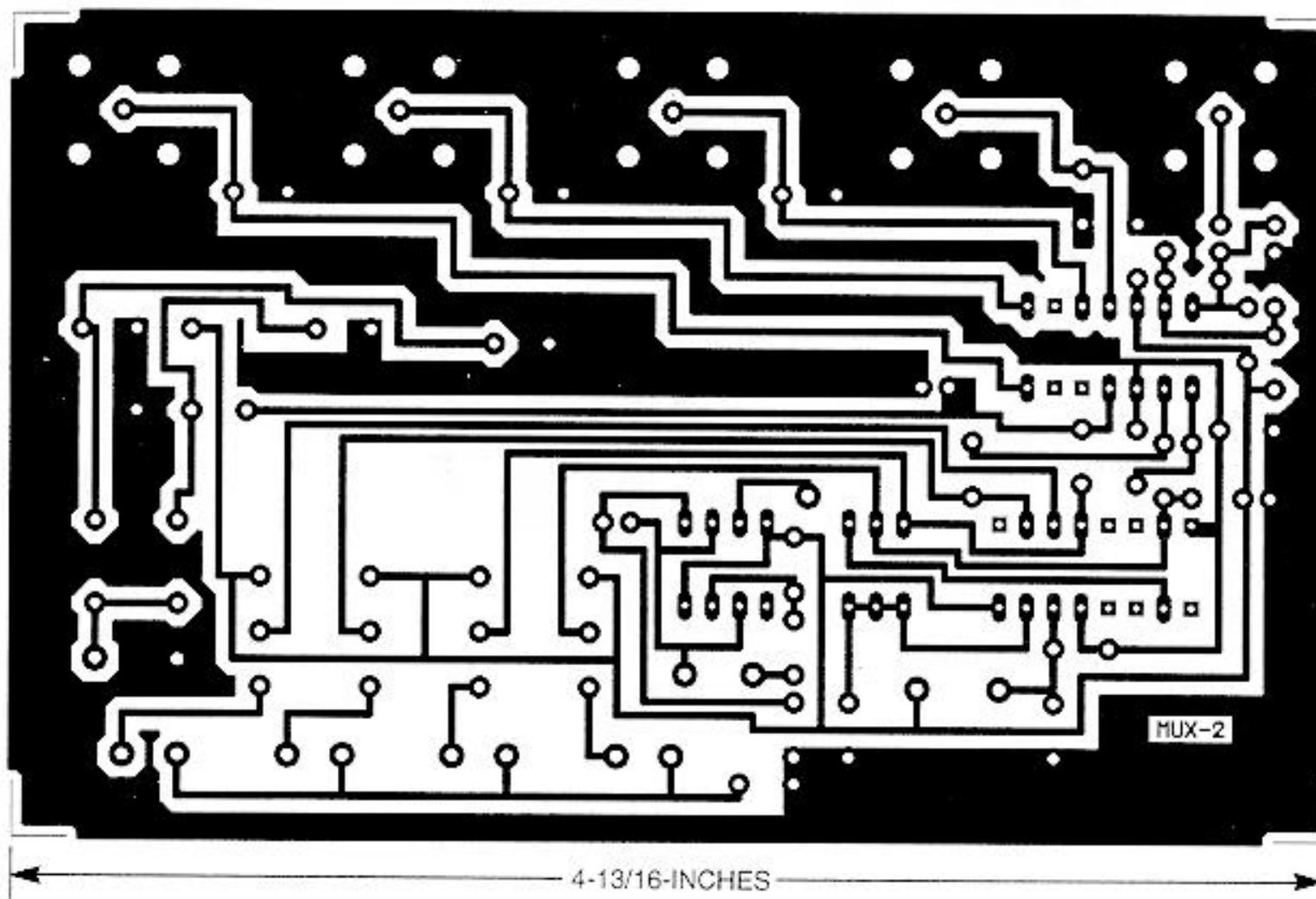


Fig. 2 Use this parts-placement diagram if you're building the video switcher with a board made from the foil pattern provided. Don't forget the two jumper wires, or the circuit won't work.



Here's the foil pattern for the video switcher. The circuit fits easily on a single-sided board. Ground traces around the video lines prevent noise and crosstalk.