Want to know what your RS-232 connectors are doing? Then, buld this test circuit, today!

☐IF YOU'RE INTO ANYTHING MORE THAN JUST PLUGGING together matching computer and communications equipment, one of the handiest gadgets to have around your shop, school or electronics club is an RS-232 Breakout Box. The device quickly lets you interchange the wiring, or determine the status, of just a few or all of the 25 connections used to interface devices with RS-232 I/O (input/output). When you can't seem to connect the gadgets to the gizmos, it's more than likely that the Breakout Box will help you pinpoint what's causing the problem in minutes, rather than hours.

Why do we need to interchange connections when RS-232 is a *standard*? Because it's a standard in name *only*! Considering how often we waste hours before we discover a manufacturer has decided that one, maybe two, connections will be *off-the-standard*, imagine how bad things would be if there were no standard at all.

Before we go any farther, maybe we should clarify the difference between RS-232 and RS-232C, RS-232C being the designation usually associated with peripherals intended for use with personal computers. RS-232 is an EIA standard for interfacing data equipment. Within the RS-232 standard there is RS-232B and RS-232C. In the simplest of terms, RS-232B has a negative ground with the signal lines normally held positive. RS-232C has a positive ground with the signal lines normally held negative. For personal computers only the RS-232C positive ground interface is used. Often, advertisers, authors, and technicians *shorten* RS-232C to RS-232. While technically incorrect, we all know what we are talking about, so that the terms RS-232 and RS-232C are used interchangeably in personal computer chit-chat.

A breakout box that will open all 25 RS-232 connections doesn't come cheap. In actual fact, more often than not only 10 or fewer connections are used, and two of them are ground while another is not generally used. So tops, all we need worry about are seven active circuits, which can be easily handled by an RS-232 Breakout Box built mostly from junk-box parts, such as shown in the photographs and Fig. 1.

In the RS-232 Breakout Box shown in Fig. 1, switch S1 reverses the connection of the RS-232 signal lines, which are 2 and 3. That is needed because RS-232-2 is used when providing a signal to a printer, while RS-232-3 is the signal feed to a modem. If your computer's RS-232 output doesn't

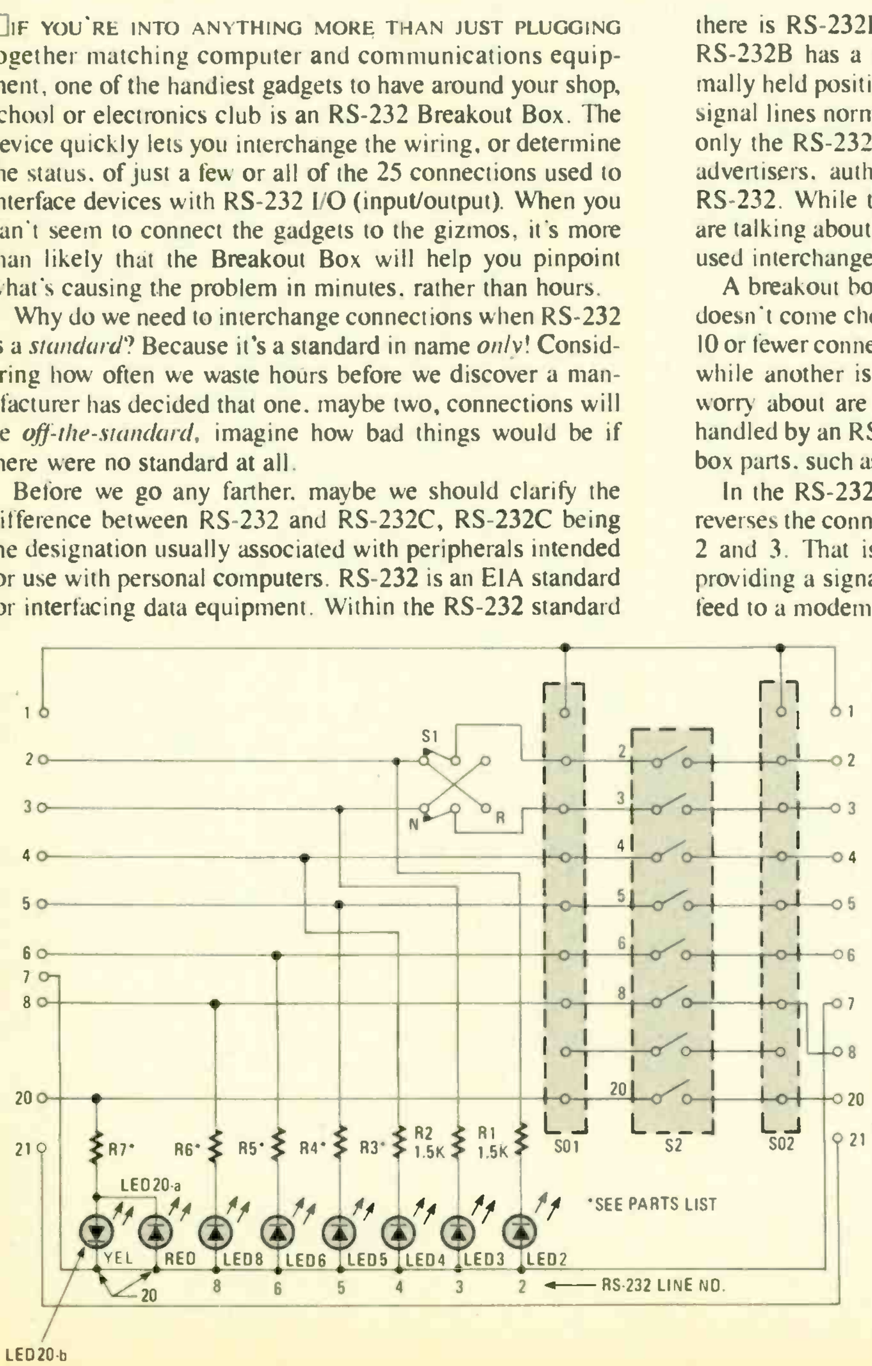


FIG. 1—COMPLETE schematic diagram of the Breakout Box makes its principle of operation easy to understand. You'll need a little RS-232 background provided by the text. The light emitting diodes are numbered to correspond to the signal lines in the cable. Whether they are on, or off, or flickering, will indicate to you the status of the RS-232 signals in the cable.

BREAKOUT BOX

By Herb Friedman

and connect a jumper across SO1 sockets pins 6 and 8 and SO2 sockets pins 6 and 8. If everything works correctly, you just make up a permanent connecting cable that corresponds to the connections of the RS-232 Breakout Box.

Light Tips

Each of the commonly used RS-232 connections has a light-emitting diode (LED) status indicator. LED1 through LED7 are red. LED8 is yellow or green, or anything else easily distinguished from red. Any light-emitting diode that is *on* indicates a normal *high* on the circuit. If the LED is not *on*, the circuit is *low*. If the LED flickers, it's an indication that there is data being transmitted on the circuit. For example, when feeding a modem, the status 3 light-emitting diode (LED3) will flicker when keys are pressed. (Note: in Fig. 1 the practice of numbering LED's consecutively has been discontinued in favor of having the LED's symbol designation coincide with the RS-232 signal line. Thus, line 20 is common to LED20 with a LED panel marking of "20" on the box.) Similarly, LED2 will flicker when the modem passes data to the computer. Actually, when using a full-duplex modem, LED3 will flicker followed almost immediately by a flicker from the LED2 as the modem receives the echo of the keyboard entry from the host computer.

The exception to the on-off rule is for status 20 on the RS-232 line. Here two light-emitting diodes are used—LED20-a (red) and LED20-b (yellow or green). While the most common use of the line 20 handshake is *high* for send, *low* for stop, some computers use a reverse handshake. (Early Heath/Zenith HB computers used the reversed handshake.) If you don't know that the handshake is reversed from what's considered normal you can spend hours searching for trouble that doesn't exist. If the handshake is reversed, the yellow light (LED20-b) will normally be *on* and the red LED will be *off*. Keep in mind that the RS-232 status 20 LED's monitor the handshake on the signal line, not the polarity required by the particular device. If, for example, your printer is sending a positive *standby* handshake (indicated by the red light (LED20-a) and the computer requires a negative handshake, nothing is going to work. The RS-232 Breakout Box will only tell you the status of the connections—not if they are correct for the particular equipment you are using.

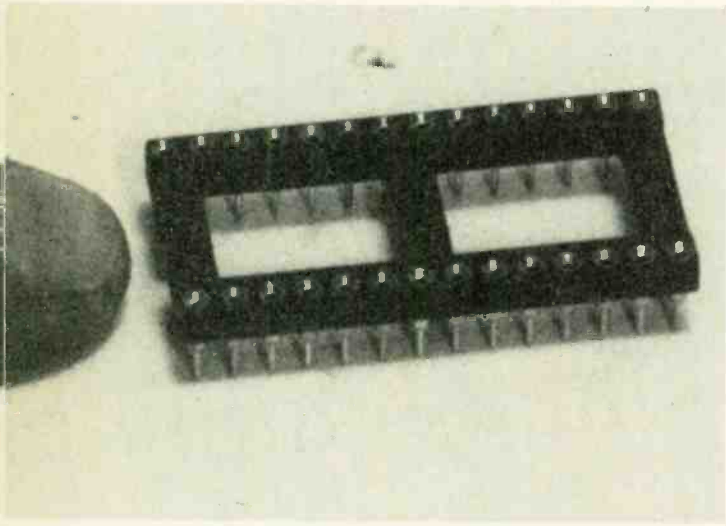
As shown in Fig. 1, three connections pass through the

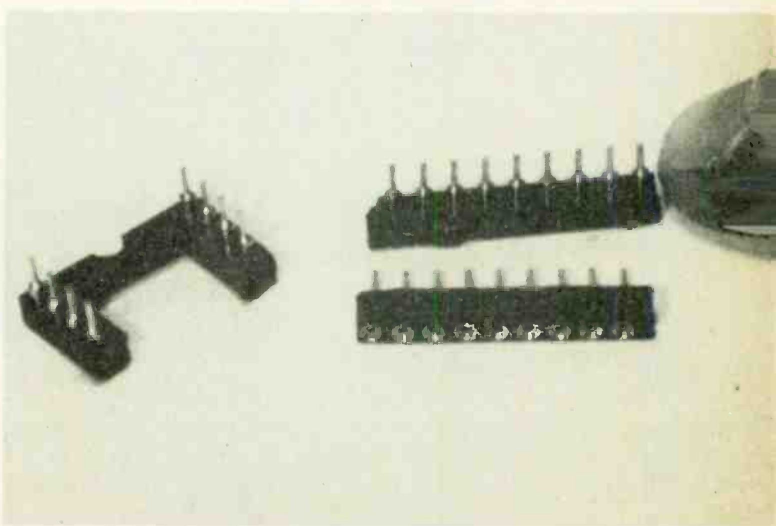
drive the printer and flipping switch S2 to the reverse (*r*) position causes the printer to work, you know you need a *reversing* cable between the computer and the printer. Switch S2 is an 8-section DIP switch that opens and closes the commonly used RS-232 connections. Jumper wires connected from matching sockets SO1 and SO2 can be used to bridge or interchange the connections when individual S2 sections are open.

More Examples

For example, the usual serial printer handshake connection is terminal 20. Some computer serial inputs, however, handshake on terminal 4. If your computer isn't correct, you can open switch S2's sections 4 and 20 and then connect a wire jumper from pin 20, SO1 socket, to pin 4, SO2 socket. (Or vice versa, depending on which side of the device you consider to be the input.) Pin 1 on SO1 and SO2 are *ground*, and aren't generally used unless you need a grounding wire for tests or experiments.

For proper printer operation from the particular printer you're using, the computer must have RS-232 terminals 6 and 8 shorted together independent of a short across printer terminals 6 and 8. No problem: simply open DIP sections 6 and 8,

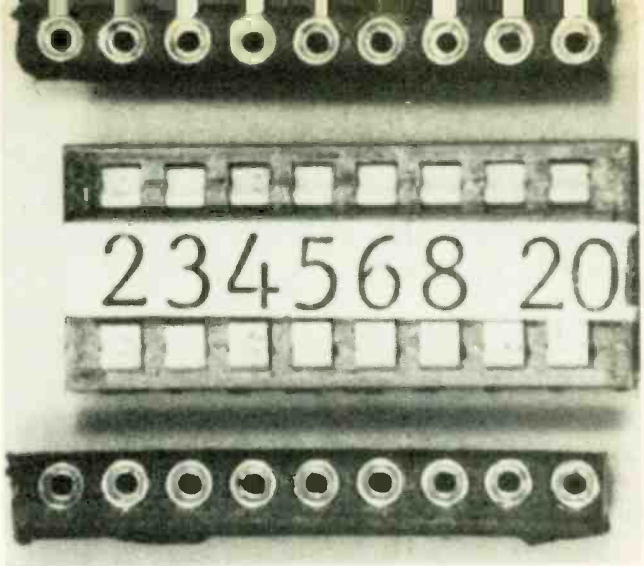




IF YOU CAN'T locate IC-socket strip material, SO1 and SO2 can be cut from a standard IC socket—the open-type (left) with formed individual socket terminals. The socket strips look like this (right) when you cut your own. Each is 9-pins long, though you can change the number of pin-terminals should you modify the RS-232 Breakout Box.

PARTS LIST FOR BREAKOUT BOX

RESISTORS
(All resistors are 1/4-watt, composition types)
R1, R2—1500-ohm
R3-R7—270- to 560-ohm (see text)
LIGHT-EMITTING DIODES
LED2-LED6, LED8, LED20-a—Red light-emitting diode (see text)
LED20-b—Yellow or green light-emitting diode (see text)
ADDITIONAL PARTS AND MATERIALS
S1—DPDT, center-off, miniature, printed-circuit switch (see text)
S2—8-section, on-off, DIP switch
SO1, SO2—9-terminal, IC-socket strip (see text)
2 DB-25 connectors (see text), printed-circuit materials, solder, ribbon-cable (see text), decals, etc.



RENUMBER THE DIP SWITCH of each section to correspond to the signal line it controls. The spacing between the switches corresponds to a 10-pitch typewriter, so you can type the signal line numbers on a strip of adhesive label. The switch section between circuits 8 and 20 isn't used.

RS-232 Breakout Box. They are: RS-232-1, the equipment ground; RS-232-7, the electrical ground, or common; and RS-232-21, which is the ring detector for an auto-answer modem. If you're into *modemry* (a term just created) you might want to add an LED status indicator for connection RS-232-21. Use the same LED and resistor values you use for RS-232 lines 2 and 3.

Construction

The RS-232 Breakout Box shown in the photos is built on a printed-circuit board that serves as the cover for a Radio Shack plastic cabinet approximately 5- × 2⅝- × 1⅝-inches. A full-size template for the printed-circuit board is shown in Fig. 2. Depending on the particular cabinet you get, you might have to round off the board's corners to fit the cabinet. Since some of the printed-circuit foils pass very close to the holes for the mounting screws, you might prevent some later problems if you drill the four mounting holes before you apply the resist patterns.

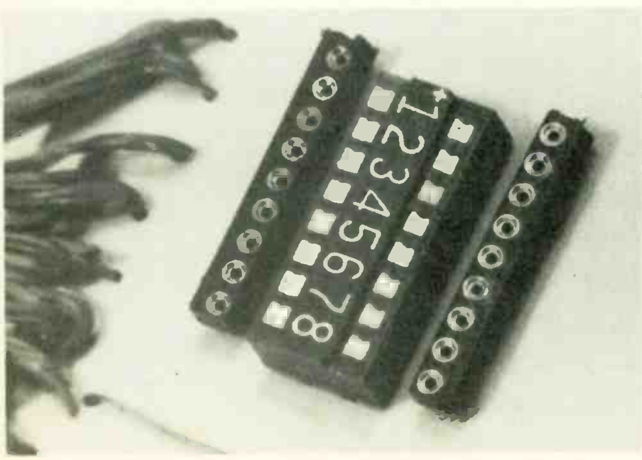
All component holes except those for S1's terminals are made with a No. 60 drill bit; a No. 53 bit is suggested for S1's terminals. Switch S1 is DPDT with a center-off position that allows both the RS-232-2 and -3 signal lines to be opened simultaneously (and easily) for testing. If you have no need for the function, or want to cut costs to rock-bottom, use whatever DPDT switch you have.

The socket strips needed for SO1 and SO2 are available from some mail-order houses, but you probably won't be able to make up the minimum-cost order. You can do the next best thing by cutting them from a 20 or 48 terminal IC socket. That's the way we made the socket strips for the unit shown. You can cut through the socket strips using a hand "mototool" with a saw blade, or abrasive disc, or with a jeweler's saw, or a fine coping saw blade.

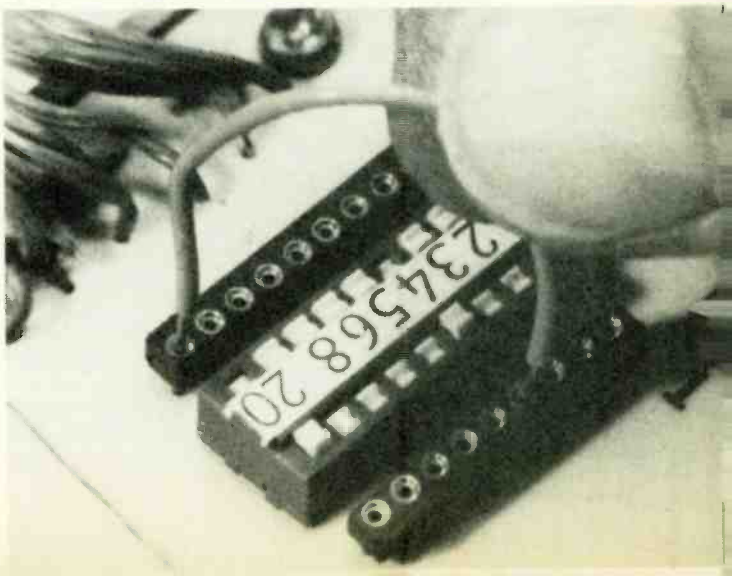
Virtually any LED can be used, though the diffused-lens LED's are usually the easiest to distinguish from a distance. All the red LED's in the RS-232 Breakout Box came from a 20-for-$1 LED kit. All red LED's have their cathodes connected to the RS-232-7 line. The yellow one (LED20-b) is connected with reversed polarity; that is, its anode connects to the RS-232-7 foil line.

To limit the current *stolen* from the circuits by the status LED's resistors R1 and R2 should be 1500 ohms—don't substitute anything smaller. The remaining resistors can be

THE SOCKET strips are installed on the printed-circuit board flanking the 8-section DIP switch. Notice the original DIP switch engraved numbering which should be masked in order to avoid confusion with RS-232 signal lines.



TO INTERCHANGE CIRCUITS, simply open the corresponding DIP switch section(s) and use a No. 22 solid-wire jumper from SO1 to SO2. Here, sections 4 and 20 of the DIP switch are open and a jumper is placed from cable-side 20 to box-side 4.



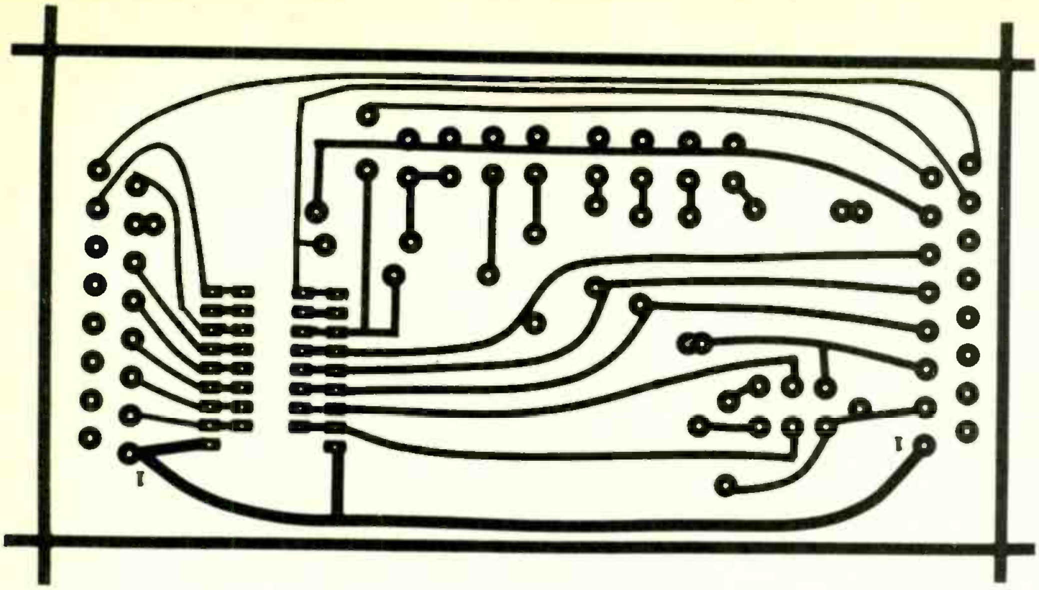


FIG. 2—FOIL PATTERN of the printed-circuit board is shown here same size so the builder could either trace it or photographically copy it onto a light-sensitive foil surface for etching. You may want to use a perfboard with 0.1-inch holes spacing and save yourself a lot of time.

270 to 560 ohms because their circuit voltage is normally ±5-volts DC, in contrast to the common voltage of ±12-volts DC on the RS-232-2 and -3.

Finishing Up

The schematic diagram (Fig. 1) for the RS-232 Breakout Box doesn't show the DB-25 connectors used for input and output connection, because you must select the type that fits your needs. In actual fact, either the A or B connections can be the input or output. The most common arrangement, however, would be a female connector for the A terminals and male connector for the B terminals.

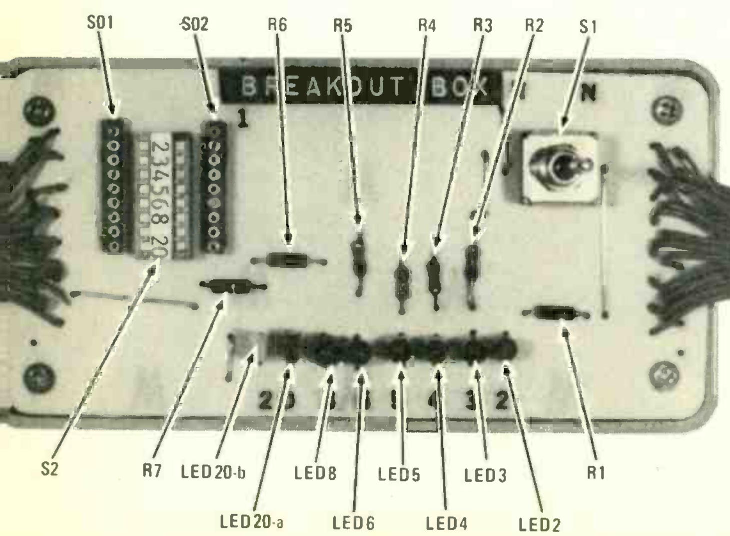
The solder pads on the printed-circuit board will accommodate both solder-type and ribbon DB-25 connectors. Should you use solder connectors, use a round, multi-wire cable and connect to the printed-circuit solder pads for RS-232 terminals 1-8, 20 and 21.

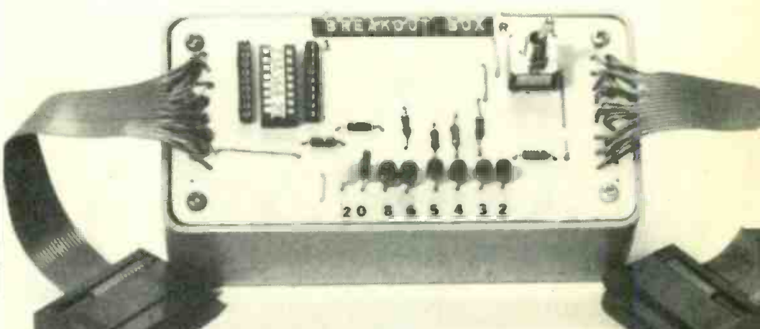
Should you use ribbon cable, extra solder pads are provided on the printed-circuit board just to tie down the ribbon neatly. If you have no need for RS-232-21, use a 15-wire ribbon cable. When you *squish* the connector(s) on the ribbon cable, you will automatically make terminals 1-8 and 14-20. At the free end, carefully separate the wires for a depth of about 2 inches, remove ¼-inch insulation from each wire and insert the wires in the correct holes in the printed circuit board. Take care to remember that ribbon wire alternates; that is, the first wire is No. 1, the second wire is No. 14, the third wire is No. 2, the fourth wire is No. 15, etc. In short, the odd wires are Nos. 1, 2, 3, 4, 5, 6, 7, and 8, while the even wires are Nos. 14, 15, 16, 17, 18, 19, and 20.

If you need the RS-232-21 connection, use a 16-wire ribbon cable; the extra wire is automatically RS-232-21. The printed-circuit board has the necessary foils for the RS-232-21 connection. (The 15-wire ribbon cable is suggested because it is a standard width—16-wire ribbon cable must usually be peeled from 24, 30 or 26 wire ribbon cable.)

When the unit is finished, apply RS-232 circuit numbers to DIP switch S2 selectors. For standard DIP switches, the section spacing exactly matches pica typewriter spacing, 10 characters to the inch; so if you just type the RS-232 line numbers on a small gummed label they will line up precisely with the DIP selectors.

THE BREAKOUT BOX is a special test unit for RS-232 I/O lines that allows the user to open any of the common signal circuits, and interchange the connections through wire patches. LED's indicate the signal condition on these lines.





THE COMPLETED PROJECT is shown here. Switch S1 at the upper right reverses the RS-232-2 and RS-232-3 signal connections. *N* means normal straight-through connection while *R* means that these RS-232 signal lines are reversed.