RS-232 BreakOut Box CE

Model 232BOB1

Document No. 232BOB15299

This product Designed and Manufactured
of domestic and imported parts by

B&B Electronics

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1993 B&B Electronics -- Revised January 2000

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INTRODUCTION

The RS-232D Standard is the set of guidelines specifying how two pieces of computer equipment should be cabled together so that they can communicate in a certain way. The problem with this standard is that it is not a "standard" at all. It isn't a standard in the same sense that American television signals, LP records, and the alternating current that flows from the typical wall socket are. "Recommended Standard Number 232, Revision D", as defined and promulgated by the Electronics Industry Association (EIA), is something that simply is not scrupulously followed by manufacturers of printers, computer terminals, graphic plotters, data acquisition equipment, or any of the other gear that is sold as "RS-232D compatible."

Most standards, like those cited above, are as crisp, clear, and uncompromising as a snapshot. A unit is either compatible with the standard or it is not, and if it’s not, it doesn’t work. Period. Record and appliance manufacturers aren’t fools. As a result, any LP record can be played on any turntable, and everything from a radial saw to a food processor will spring to life when plugged into an electrical outlet anywhere in the country.

Why can’t every dot matrix and letter-quality printer behave the same way when plugged into any personnel computer? It is fair to say that more hours have been wasted over the apparently simple task of getting Computer A to talk to Printer B than over any other problem in personal computing.

What all of this means is that whether you are a dealer, an end user, a corporate information center, or anyone else, if you set out to connect two "RS-232 compatible" devices you are, in fact, embarking upon a veritable magical mystery tour of conflicting interfaces and creative wiring. You must first figure out what each device is doing with the 25 pins or sockets that compose the RS-232 interface. Then you must figure out how to build or specify a cable that fiddles with those pins in a way that successfully mates the two machines.

The B&B Break-Out Box can be a big help in both phases of the operation. If you're experienced at this sort of thing, you might want to skip ahead to the step-by-step instructions presented later in this manual. But if serial communications is new to you, stick around and we'll see if we can't bring some order to the chaos of the RS-232 "Standard" and give you the background information you need to solve almost any machine mating puzzle.

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BITS, BYTES, AND VOLTAGES

The first thing you need to know is that computers communicate in "bits", a term that is short for "binary digits." Just as a bicycle has two wheels, a binary digit has two forms. Both of them are electrical, of course, and can be variously described as ON or OFF, 1 or 0, HI or LOW, SPACE or MARK, and so on. For our purposes, we'll think of bits at the physical level, that is, as two different electrical voltages, each of which exists on a wire or other conductor for a certain number of microseconds.

If electricity is the lifeblood of a personal computer, bits are its red and white corpuscles. They are constantly whizzing around inside a system, even when it isn't doing anything in particular. But unlike corpuscles, bits don't whiz at random. They are, for the computer, a means of communication with its separate parts. When the computer wants one of its disk drives to come on, for example, a pattern of bits is dispatched to carry the message to the circuit board that controls the disk drive, and instantly the drive is turned on. Other bit patterns, fired off to other sections of the system, control other operations.

The next thing that you need to know is that in virtually all micro or personnel computers, eight bits are required to send any message. All of the bits are required to send any message. All of the bits in a given message depart and arrive at the same time. In other words, bits travel in groupings of eight and they travel abreast.

To make it possible for bits to travel in this fashion, the internal components of most computers are typically connected by electrical highways. Think of the highways as wires and imagine them running between any Point A and any Point B within the machine and you'll begin to get the picture. Naturally, all of the highways or "wires" are parallel. And that, if you haven't guessed it already, is why this arrangement is called "parallel communications".

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TALKING TO THE OUTSIDE WORLD

Personal computers and similar devices could communicate with external devices via eight-bit-at-a-time parallel communications. In fact, many of them do. A parallel printer for example, expects to receive information from its attached computer in eight-bit chunks, with each bit in a chunk or byte arriving at the same time. Of course, in order for this to happen, a cable with a minimum of nine wires must be used to connect computer and printer. You need one wire for each of the eight bits and one wire to serve as circuit common ("signal ground," or "common return").

Cables like these have the advantage of letting a computer communicate with an external device almost as quickly as it communicates with its own disk drives or other internal components. While they are normally not cheap, in short runs (1.5 to 3 meters, five to ten feet) or so parallel cables are not exorbitant.

Longer distances, however, are another matter. The cost of running at least nine wires from one device to another can mount up quickly as the distance increases. That’s just for one-way communication. If you want device-to-device conversation to flow in both directions, even more wires will be required in the cable and the cost will rise even faster.

Small wonder then that a host of modern technologies (coaxial cable, multiplexed signals, fiber optic data pipes, etc.) have been developed to get around this problem. However, when the RS-232 Standard was developed (1969) there was really only one inexpensive alternative, the so-called "twisted-pair" of two wires used by the phone system.

We can dispose of the relatively complicated problem of how to end eight-bit units over a two-wire cable very simply: ultimately a microchip was invented to handle the job. The chip is called a UART (UNIVERSAL ASYCHRONOUS RECEIVER/TRANSMITTER). The UARTs supplied by different chip companies have different capabilities. But in essence, they all do the same thing.

Imagine a military drill team in eight-abreast formation with each bit facing north. The UART gives a command and the bits begin marking time. Another command and the rightmost bit remains in the same spot while all of the bits to its left march forward and begin to swing their row around him like a garden gate or a clock’s secondhand moving from nine to noon. When the "secondhand" reaches twelve, the bits stop and execute a left-face so that when they finish, everyone is facing north at twelve o’clock.

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By issuing these commands, the UART has changed the arrangement of the bits from "parallel" into "serial." You can still move this squad from one machine to another, but now each bit will depart and arrive one after the other, in a “series”, instead of eight at once. It will now take eight times longer to transfer a single byte from one machine to the other, but only two wires (one for the bits and one to serve as circuit common) will be needed to bring it off. Because electro-mechanical devices like printers are slow compared to computers, the time difference probably won’t be a factor, and as the external device expects to receive its bits in series, you’ll rarely notice the difference.

To complete the analogy, assume that each bit on the team wears either a green or red helmet. Green means that the bit is a negative voltage (sometimes called "mark" or "LO"). Red means that it is a positive voltage ("space" or "HI"). It is the arrangement of the bits in each eight-bit squad (byte) that is significant to both sender and receiver and this is how they tell them apart.

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PLUG AND RECEPTACLES: The First Incompatability

As we've said, a successful one-way serial connection can be made with only two wires: one for sending data and one to serve as circuit common. As Joe Campbell points out in his book, "The RS-232 Solution", "The circuit common is often erroneously called 'circuit ground.' It has absolutely nothing to do with ground or earth. It is just the absolute voltage reference for all the interface circuitry, the point in the circuit from which all voltages are measured."

Successful two-way connections that allow both devices to send and receive information can be made by adding just one other wire, for a total of three. For a variety of reasons, three wires usually aren't enough. Indeed, the RS-232 Standard provides for a total of 25 wires and specifies which signals should be sent on each.

Originally, the RS-232 Standard said nothing about the physical dimensions of the plugs and receptacles used to connect two machines. Equipment manufacturers were free to make them any way they wanted. Most settled on the DB-25 connector. The latest version of the standard, RS-232D incorporates that connector.

However, it is worth pointing out that the presence of a DB-25 connector does not automatically mean a serial, RS-232 connection. IBM PCs, for example, use one for the parallel connector. Conversely, the absence of the familiar DB-25 does not mean that the connection is not RS-232 serial. For example, some equipment use round DIN plugs.

Plug problems are the first incompatibility you may encounter. While they are not nearly as widespread as other forms of incompatibility, they are the first point you should check. If you find that one RS-232 compatible device sports a non-DB-25 connector, contact your dealer for a cable that will plug into the device and terminate in a DB-25 connector.

Note that DB-25 connectors come in two sexes-male (the one with the pins) and female (the one with receptacle holes). If both devices are male or both are female, B&B Electronics has the tools you need to perform a "sex change operation". These are the B&B Gender Reversers, and they are available as two males or two female connectors. Male/male and female/female cables are also available in 1.8 meter (six ft.) and 3 meter (ten ft.) lengths.

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PIN ASSIGNMENTS: The Second Incompatability

At this point, we know we need a minimum of two pins (or wires) for one-way communication and three pins for a connection in which both devices can send and receive information. Fortunately, almost all manufacturers obey the RS-232 Standard regarding which of the 25 pins should be given these assignments. Pin 7 is almost always the circuit common, while pin 2 is used to transmit data and pin 3 is used to receive it.

If that were all that were necessary, connecting two machines would be a relatively simple matter of making sure that pin 7 was "wired straight through" (both pin 7s connected to each other) and that the sending pin of one device was connected to the receiving pin of the other device. Sometimes a connection like that will work perfectly and you'll have no need of the other available pins. But more often than not, this isn't the case. And a typical computer-to-printer connection makes it easy to see why.

A computer or "terminal" has the ability to send information to a piece of peripheral equipment almost as fast as the speed of electricity. But a printer labors under a significant handicap-each time a byte comes in from the computer it must physically move a printing element and make a mark on a piece of paper. Consequently, printers cannot accept information anywhere near the speed with which computers are capable of sending it.

The computer terminal doesn't know this of course. All it knows is that it has information to send to the printer, and it's going to send it. Left on its own, the computer would send, send, send. In a very short while, the small reception room ("printer buffer") most printers maintain for incoming information, would overflow. Still, the incoming information flow would continue. The printer could easily be choked by this deluge and stop working. Unable to keep up with the flow and turn your letter into so much garbled hen scratching.

The obvious solution is to make it possible for the printer to issue some sort of control signal to the computer terminal saying "Hold up a minute, will you! Just stop sending until I get this last lot of characters printed." Once the characters have been dealt with, the printer must be able to say, "All right, send me some more characters to print."

Likewise, it may be necessary or desirable to have the printer send a signal indicating that it is powered up and ready to go to work (or powered down, "offline," or otherwise not on duty), out of paper, in need of a new ribbon, or something else. Modems, plotters, laboratory instruments, and tape drives, need to exchange additional non-data signals with the computers that control them. The computers themselves may need to exchange such signals with their peripherals.

With nearly 25 pins to play with, an equipment designer has enough capacity to implement such signals til he is content. Many have done exactly that, ignoring what the RS-232 Standard has to say about which signals should be carried on which pins. The people who write software to control the interfaces have been similarly creative.

To equipment designers and software code writers this approach may be perfectly justifiable. The RS-232 Standard, many would point out, was written for one purpose only: to facilitate the connection of Data Terminal Equipment (computers) with Data Communications Equipment (modems). If you're not making that kind of connection, then all bets are off. The standard doesn't apply. Yet the pins, the UART, and the circuitry are there, so why shouldn't we use them? Justifiable or not, the result has led to untold confusion and frustration on the part of anyone who would connect a Brand X computer to a Brand Y printer or other serial device.

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THE DIFFERENCE BETWEEN CONTROL SIGNALS AND DATA SIGNALS

The signals we’ve been talking about are referred to with terms like "flow control," "device control," "control logic," and "handshaking" signals. At this point there is no need to get that specific. Instead, we’ll refer to all such signals as control signals.

Though they employ the same two voltage levels used by the data pins (pins 2 and 3), control signals use voltages for a different purpose and in a different way. For instance, if a printer is ready to receive data, it may signal that fact to the computer by putting a positive voltage on pin 20. Sensing this, the computer will begin to dump data to the printer and it will continue to do so as long as pin 20 carries a positive voltage.

As the printer’s buffer begins to fill, it will realize that it must tell the computer to temporarily stop sending characters. So it will put a negative voltage on pin 20 and keep it there until it is ready to accept more characters. The computer will respond by refusing to send any more characters until pin 20 once again is seen to carry a positive voltage, signaling that the printer is once again ready to accept data.

In other words, control signals, unlike data signals, do not rapidly change from one voltage to another. They thus are more like traffic lights than strobe lights. In computer parlance, positive voltage control signals are said to be "asserted" or "enable." Positive signals cause the LED indicator light on B&B equipment to glow red, while negative signals cause them to grow green.

RS-232D PINS AND PIN ASSIGNMENTS

Take a good look at the following list of pins and pin assignments as specified by the RS-232 Standard. Then read the text that follows.

1. Protective Ground
2. Transmit Data
3. Receive Data
4. Request to Send
5. Clear to Send
6. Data Set Ready
7. Circuit Common
8. Carrier Detect
9. (Reserved for Testing)
10. (Reserved for Testing)
11. Not Assigned
12. Secondary Carrier Detect
13. Secondary Clear to Send
14. Secondary Transmit Data
15. Transmission Signal Timing
16. Secondary Receive Data
17. Receiver Signal Timing
18. Not Assigned
19. Secondary Request to Send
20. Data Terminal Ready
21. Signal Quality Detector
22. Ring Indicator
23. Data Rate Selector
24. Transmission Signal Timing
25. Not Assigned

Of the 25 pins listed above, in most cases, you'll only have to be concerned with seven or eight. Here are the main pins most people will have to deal with, accompanied by their data communications shorthand abbreviations in parentheses:

2. Transmit Data (TD or TxD)
3. Receive Data (RD or RxD)
4. Request to Send (RTS)
5. Clear to Send (CTS)
6. Data Set Ready (DSR)
7. Circuit Common or Signal Ground (SG)
8. Carrier Detect (CD or DCD)
20. Data Terminal Ready (DTR)

Of these, we already know that pin 7, the one carrying the signal that all others use as a reference point, must be wired straight

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through. We also know that each Break-Out Box's receiving pin must be connected to the other Break-Out Box's sending pin.

That leaves the following control signals:

4. Request to Send (RTS)
5. Clear To Send (CTS)
6. Data Set Ready (DSR)
20. Data Terminal Ready (DTR)
8. Carrier Detect (CD or DCD)

Naturally, it's no accident that we've presented the first four signals in pairs. In almost every case, the existence of one implies the existence of its mate on the same interface. To put it another way, if you plug your computer into the B&B Break-Out Box and notice that the LED for pin 4 (Request to Send) lights up, you can bet that pin 5 (Clear to Send) is also "active" as far as your computer is concerned, even though its LED lamp is not on at the moment. Your computer will almost certainly be wired so that it expects to receive a signal on pin 5 before it hands over its data to a peripheral device. The same points apply to the Data Set Ready/Data Terminal Ready pair on pins 6 and 20: If one is active, its mate is active as well. The terms "data set" and "data terminal" reflect the RS-232 Standard.

Carrier Detect, the signal carried on pin 8, is something of a loner. As John E. McNamera says in his book, "Technical Aspects of Data Communication (Digital Equipment Corporation, 1977)," "An additional lead called "Received line signal detect" or "carrier detect" has the following function. . . when asserted it indicates that the receiver section of the modem is receiving tones from the distant modem." (The pin’s signal may also be called "Data Carrier Detect"). This means that your modem and the distant modem will probably be able to lock onto each other and thus facilitate data communications between your computer and the remote systems.

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But since no carrier is involved in computer, printer and similar hook-ups, "carrier detect" has no meaning. Thus equipment designers are free to use the pin for some other purpose. The pin is sometimes used, for example, to disable the receiving section of the UART chip in much the same way that pin 5 (Clear to Send) disables the transmitting section of the same chip.

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THE IMPORTANCE OF SOFTWARE

Whether it is embedded in microchips as "firmware" or loaded into memory from disk, each time the power is turned on or the system is re-set, software controls virtually every aspect of a computer’s operations. It is software that "initializes" (prepares and activates) a computer's serial port, its UART, and RS-232 interface. It is software that determines how fast data will be sent and received. And it is software that often controls whether data will be sent or not.

The software exerts its control by monitoring the status of various pins on the interface and responding accordingly. For example, the software will more than likely keep an eye on pin 6 (Data Set Ready) of its RS-232 interface. If that pin carries a negative voltage, the software will undoubtedly refuse to allow the UART to send any characters to the peripheral. Only when it sees the pin go high (positive voltage) signaling that the "data set" is now ready will it allow transmission to proceed. It is sensible for a program to monitor virtually all of the control signals we’ve been discussing. Where things get complicated is when a program monitors additional pins as well.

For example, you might very well run a word processing program on your computer with the ability to send text to your serial printer. That program might monitor not only the pins cited above, but pin 19 (secondary request to send) as well. It might do this because it expects to receive a signal on that line if your printer runs out of paper. Should that happen, the program would then stop sending text to the printer. The only problem is this: Suppose you’re using a printer that doesn’t send anything at all on pin 19? Suppose that as far as your printer is concerned, pin 19 doesn’t even exist?

If that's the case, your word processing software will probably refuse to print anything at all. A different word processing program, however, might not care about pin 19 and start dumping text in the same printer like mad.

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Similarly, most communications programs will refuse to send data to a modem if there isn't a positive voltage on pin 20 (Carrier Detect). If you’re using an inexpensively built modem, the Break-Out Box may not send anything on pin 20 or it may send incorrect signals. Either way, you won't be able to communicate.

In both cases, the demands of the software are crucial to the success of your interface. And in both cases, the problems can be solved by first identifying the pins involved and then by cross-wiring them to appropriate mates.

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HOW TO SUCCESSFULLY CONNECT TWO RS-232 DEVICES

We're now ready to move into the actual interfacing process. And at this point it seems worthwhile to point out that any time you are trying to solve a computer related problem, it is essential to adopt a patient, methodical approach. A mental attitude characterized as "Zen and the Art of RS-232 Interfacing" might be appropriate as well. To do otherwise is to put your personal sanity on the line with the odds overwhelming in the house's favor. Take the first step first, the second step second. Don't omit any steps. And make careful notes on the results of everything you try.

Your ultimate goal is the creation of a cable or jumper box that will successfully link two "RS-232 compatible" devices so that each functions as it was intended to function, regardless of the design or manufacturer of the device on the other end of the line. To build this cable or jumper box, or to instruct others on how it should be built, you must first discover which RS-232 pins have to be cross-wired, jumpered, disconnected, or otherwise fiddled with to make a successful connection. The B&B Break-Out Box is your primary diagnostic tool in this endeavor. Of course you can obtain all the materials you need to build custom cables or jumper boxes from B&B as well.

GENERAL CONSIDERATIONS

There are a few things to be aware of before beginning the process. The first of these is that the voltages we'll be dealing with will not harm man nor RS-232 interface. According to the standard, a positive voltage must be somewhere in the range of +5 and +15 volts; negative voltages must range from -5 to -15 volts. And as the standard stipulates, all RS-232 interfaces are designed to "withstand an open circuit, a short circuit," and any cross-connection "without sustaining damage to itself or its associated equipment." In other words, as long as the two devices are RS-232 interfaces, you can connect any pin to any other pin at any time without causing your circuit boards to melt. (It goes without saying that you must make sure that both interfaces are indeed RS-232, regardless of what their plugs and receptacles look like.)

Secondly, voltages on RS-232 pins can be freely "borrowed." The interface is designed to let you connect more than one input pin to a single output pin and thus share the output pin's voltage. This means that if your computer software needs to see a signal on a particular pin that your printer or other peripheral does not supply, you can connect that pin to one that the printer does not actively use. This is called "jumpering" or "strapping" one pin to another. It results in "pulling up" the formally inactive pin by supplying it with some form of voltage.

Thirdly, while pin 7 (the circuit common that everything else uses as a reference) should always be connected straight through, you may or may not want to connect pin 1, protective ground, all the way through. This pin is supposed to eventually lead back through the machines to the round prong on their power cords and from there through the building's electrical system til it reaches the earth.

In a private home, this isn't likely to cause a problem. But in an office building with a far-flung electrical system it can result in electrical differences between the two machine bodies that can prevent communication. As Joe Campbell points out in the book mentioned earlier, ". . . under ordinary circumstances, you are more likely to induce problems by connecting the pin 1s . . . If your peripherals behave as if possessed, check your cables for connected pin 1s; you may be able to exorcise the ghosts and spirits by simply snipping the pin 1s. In any case, in the RS-232D Standard, pin 1 is optional."

Finally, as you read your hardware manuals you will undoubtedly come across the terms Data Terminal Equipment (DTE) and Data

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Communications Equipment (DCE). You may not yet know what they are, but you can be certain that the terms were not created by an information theory specialist. There is virtually no way to determine what they signify from the words alone.

Data Terminal Equipment is your computer. Data Communications Equipment is your modem. Not surprisingly, the RS-232 interface on the "terminal" is designed to mate with the interface on the modem. This means that the computer's information-sending pin is connected to the modem's information-receiving pin, for example, and so with all the other mating pins discussed earlier.

In other words, since the plugs or receptacles on the interface are already set up this way, no cross-wiring is necessary. That’s why the terms are still relevant, even if you don't have a modem. They are used to refer to interfaces that are wired like a modem's RS-232 interface or wired like a computer terminal's RS-232 interface.

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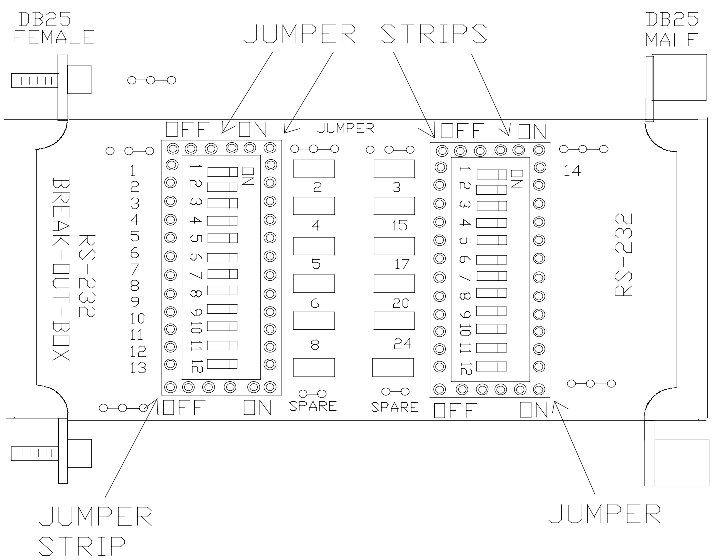
THE B&B BREAK-OUT BOX

Preliminary step one is to familiarize yourself with the B&B Break-Out Box . The Break-Out Box has a male DB-25 connector on one side and a female on the other. Two columns of DIP (Dual In-line Package) switches stand between these two connectors, making it possible to selectively connect the pins on either side. A small screw driver or ball-point pen is the ideal tool to use for this. Note that when the switches are "ON" signals will flow from whatever is plugged into the right side of the Break-Out Box to the left side. Note, too, that the numbers printed on the switches themselves should be ignored. Use only the numbers printed in white on the Break-Out Box to determine which switch governs which pin or receptacle.

Next, you should look at the twelve LED indicator bulbs. The Break-Out Box contains an LED for pins 2, 3, 4, 5, 6, 8, 15, 17, 20, and 24. There are also two indicators labeled "SPARE." These indicators glow GREEN when there is negative voltage on their respective pins and RED when the voltage is positive.



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Note that the numbers on the label are under their respective LEDs. The bottom two LEDs are the SPAREs. To use the SPARE LEDs, connect to the strips (two pin-) that are located right below and next to them. The three pin strips that are located above and below the switches are for patching. The three pins are connected to each other and no where else. The spare LEDs are important because while most serial interfaces limit themselves to the pins cited above, some activate other pins as well. To see if a pin is active as an output, put one end of a jumper wire into one of the spare receptacles and touch each others jumper receptacle in turn. If the spare LED lights up when you touch the receptacle for pin 29, for example, you know that the interface makes some use of that pin.

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AT THE INTERFACE

The following is the general procedure you should follow whenever you want to get two RS-232D devices to live up to their billing as "compatible."

Step 1: Make sure the communications parameters match.

Communications parameters are not covered in this manual, but they should be covered in the manuals that came with your equipment. If they're not, you will find a complete explanation in Alfred Glossbrenner's "Complete Handbook of Personal Computer Communications."

Actually, the important thing is not so much to know what "baud," "parity," "stop bits," and "character length" (also known as word length or the number of data bits) mean as it is to make sure that these settings match exactly on both pieces of equipment. Mismatched communications settings can cause even a properly wired RS-232 connection to fail to pass data.

Step 2: Load the actual software you will be using day to day.

As mentioned earlier, different programs may treat the pins of the RS-232 interface differently. (One program may expect to see a signal on a pin that some other program ignores, etc.) Consequently, it only makes good sense to load the software you will actually be using (communications program, word processing program, or whatever) in your day-to-day work and match the interface to its requirements. In most cases, the interface you set up for one program will probably work for all programs, but it is important to be aware that this may not always be the case.

Step 3: Try the B&B Quick Fix.

One of the most common interfacing problems results when both machines are wired like "terminals" (DTE). The best example would be the RS-232 communications ports on two computers. In almost every case, both will be set up to be plugged into a modem (DCE). That means they will both be sending data on pin 2 and expect to receive data on pin 3. To make them talk to each other, these and other relevant pins must be switched so that each computer thinks that it is talking to a modem (DCE). This situation is so common that companies like B&B Electronics sell null modems and pin 2/3 reversers (also called "crossover cables" or "modem eliminators") that have been pre-wired to make the switch.

As mentioned earlier, B&B sells null modem plugs. But before buying one, even if you feel strongly that a null modem connection is what you need, plug each cable into the Break-Out Box and see if

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the LED for pin 2 (Transmit Data) lights up. If it lights up in both cases then you can be pretty certain that a null modem will do the trick. If it lights in one case but not the other, a null modem will do you no good, so skip ahead to the next step. If pin 3 (Receive Data) lights up in both cases you also need a null modem.

To use the B&B Break-Out Box as a null modem, begin by turning all of the DIP switches on the Break-Out Box off (or "open") except pin 7. Then use the supplied jumper cables to crossover the following pins:

Left Side to Right Side:

2......................3
3......................2
4......................5
5......................4
6......................20
20....................6

Next, plug each machine's cable into one of the DB-25 connectors on the Break-Out Box, and try to send some characters from one machine to another. If you are successful, try transmitting five or more pages of text from one machine to the other. If this does not work, verify once again that all of your communications parameters on both machines match and try again.

If the B&B Quick Fix is going to work, it will work now. If it does not work, remove the Break-Out Box's DIP wires, and ponder the Zen kaon of your choosing. It might also help to roll up your sleeves since it’s time to get ready for some real work.

Step 4: Examine the cable.

It 's a good idea at this point to physically check the wiring of the DB-25 connectors on the cable supplied with your equipment. Since not all connectors contain all 25 pins, look at the connector to see which pins are present. Make a note of that fact since, if they're present, they are probably active.

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Even on DB-25 connectors that contain all 25 pins (or holes) there's a good chance that not all 25 are connected from one end of the cable to the other. To check this, see if you can remove the shell of your DB-25 connector. If you can, you may be able to see exactly which pins or receptacles are connected to the cable. Again, this information is an important clue. (If you find that any of the pins are wired together within the connector, be certain to make a note of it since this kind of information can be invaluable later on.)

If you cannot remove the connector shell, you can still test the cable using a continuity tester (available at your local hardware store). Hold the two ends of the cable side-by-side, then test each pin and its corresponding receptacle hole (or pin) on the other end of the cable. If the continuity tester lights up, you will know that a pin is connected straight through the cable. Again, take notes on which pins are connected.

Though it probably will not be the case, if you discover that the continuity tester does not come on when testing pin 2 and receptacle 2 on your cable, try testing pin 2 and receptacle 3. If the tester comes on, you almost certainly have a null modem cable. Since such a cable may be intended for use with some device other than the one you want to connect at this time, you may need to use a different cable or rewire the one you have.

Step 5: Determine which pins are active on each interface.

Though it may not be necessary, it is not a bad idea at this point to start fresh if you have previously fiddled with the interface in this session. Reboot your computer and reload any necessary software. Verify that any applicable communications parameter settings match.

If you will be using a communications package (terminal software) on your computer, be sure that it is loaded and in terminal mode (ready to communicate). If you are trying to connect a printer, turn it off for a moment to clear any signals that may have been caught in its circuitry, and turn it on again. Then make sure that it is in its "on-line" mode (ready to receive data from the computer). In other words, regardless of the equipment you are using, make certain that it is an active mode such that if a proper RS-232 interface did exist, it would perform its functions as it is supposed to do.

Now use the B&B Break-Out Box to determine which pins are active on each RS-232 interface. Plug one machine's interface into

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the Break-Out Box and look and see which LED lights come on. Write the name of the device ("printer," "terminal," "tape drive," etc.) at the start of a column on a piece of paper. Make a note of each pin that lights and what color appears. A green light means that the pin is carrying a negative voltage, red means positive.

Note that the data pins (2 and 3) will glow green. The RS-232 Standard specifies that, when in their idle state, these pins must hold a negative voltage. (In some older communications manuals, this is called MARKING. SPACE is the term used to refer to the momentary positive voltage that appears on the line when a positive bit is transmitted or received.) If the pin is one of the ones used to carry control signals, a negative voltage means that the control signal is inhibited at this time; red means it is being asserted.

Next insert one end of a jumper into one of the "Spare" jumper sockets and touch each of the jumper holes that do not have their own LED bulb in turn. If any of them cause the "Spare" LED to light, write down the pin number and bulb color in the column. Unplug the first machine and plug in the second. Repeat the above procedure and begin the column of notes for the second machine next to the first.

Step 6: Which pins are natural mates on the interfaces.

You will now have a preliminary indication of the requirements of the two interfaces. Review your notes. Which of the pins in the first column has a natural mate listed in the second column? Remember, pins 2 and 3; pins 4 and 5; pins 6 and 20 are natural mates.

Draw lines between the pin numbers in each column to its natural mate.

Step 7: Which pins remain?

Review your notes again and check off all the pins that are the same on both devices. What pins remain on each list? That is, which pins are unique to the interface on each device?

This, as they say, is where the fun begins. In the best of all possible worlds, there wouldn't be any unique pins. In the second best of all possible worlds, all of the unique pins will be on one side of the interface. One machine may use pin 8 (carrier detect), for example, while the other one does not.

When all of the unique pins are on the same side, your main job is to find some appropriate wiring to satisfy those pins. You can do this in one of two ways: either borrow voltage from the opposite side of the interface (the other machine) or borrow voltage from some pin on the same side of the interface.

For example, as Martin D. Seyer points out in his book "RS-232 Made Easy," in some connections pins 4, 5, 6, 8, and 20 (or some combination of these pins) may interface, with no connection between any of them and the other side. Other connections may involve both same-side jumpering and cross connections. For example, you might jumper pins 5, 6, and 8 together on one interface and then connect pin 5 to pin 20 on the other interface. This has the effect of borrowing voltage from pin 20 on the other side and distributing it to 5, 6, and 8.

The third best of all possible worlds (which isn't very good) is when each side of the interface has unique pins. When this is the case it is often best to begin by trying to treat each side separately. That is, satisfy the unique pins on one side first. Then satisfy the unique pins on the other side. Try to do this first by ignoring the other side's unique pins. But if that does not work, go ahead and add those pins to the equation.

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Step 8: Make a "best guess" about the purpose of each unique pin.

Before plugging both machines into the B&B Break-Out Box at the same time and starting work on the actual interface, stop and think for a moment about those unique signals. What could they signify? If pins 4, 5, 6, or 20 are involved, you can be pretty certain they represent the standard request/clear to send and data set/data terminal ready signals.

But suppose pins 8, 11, 19, or even 25 are involved. More than likely they are designed to enable or disable the flow of data by telling the other machine that some condition has occurred. (If you are dealing with a modem, pin 8 probably really is "data carrier detect."

Try to imagine under what condition the device might want to stop the flow of data. A tape not mounted on a tape drive, a printer that is out of paper, or a device not in its "on-line" mode, are all good possibilities. You may even be able to conveniently test your guesses by plugging the device into the B&B Break-Out Box and artificially creating one of these conditions. For example, suppose you plug your printer into the Break-Out Box and notice that pin 11 causes a spare LED to glow red. Now suppose that you hit a button on the printer that takes it offline. If pin 11 now glows green, you can be certain that you've determined its function.

Take some notes on your ideas and guesses. They may or may not all be accurate, but they can be very helpful later on when you must decide how to enable a particular control pin.

Step 9: Connect both devices to the B&B Break-Out Box and dump data.

Now, making sure that all of the DIP switches are off or "open," plug each device's RS-232 connector into the B&B Break-Out Box. With a small screwdriver or ballpoint pen, close the DIP switch on pin 7. This will connect the two pin 7s.

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Next, check your data pin connections. Is each device sending to the other device's receive data pin? Note that most printers (if they do not have a built-in buffer) have no need to send data back to their computers and consequently their data transmitting pins will probably not be active.

Next, check pins 4 and 5, the Request/Clear To Send pair. In most situations these pins have a physical effect on the UART chip. That is, if they are not satisfied with a positive voltage, the UART is rendered unable to send data. If one machine has a Clear to Send pin (pin 5) and the other does not have a pin 4 to mate with it, you'll have to borrow some voltage from some other pin. Often, the simplest solution is to jumper pins 4 and 5 together on the same side of the interface.

At this point you're ready to conduct your first real test of the interface. Set your computer to begin dumping data out of its RS-232 port. If you are using a communications program, for instance, order it to "download" a long text file. If you are interfacing a printer, enter the proper operating system command to get the system to "copy" or "type" a file to the printer. The idea is to set up a continuous data flow that will cause the peripheral to come to life and at least do something when one or more of the right connections are made on the B&B Break-Out Box.

Step 10: Continuous data flow test.

If you can get some data to flow, as shown by the LED on pin 2 or 3 changing rapidly from green to red, then check your output device.

Pin 6 and 20 work similar to pins 4 and 5 above. If they are used in your interface they may have to be forced high or connected together to get the data to flow. Pin 8, Carrier Detect, may have to be forced high in some cases also, but this is rare unless you are interfacing a modem. If all else fails try forcing it high.

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When you have data flow and your output device is printing or whatever, let it go for a long time and see if it continues to output (print) correctly. This is especially important if you are interfacing to a printer with a buffer. The buffer can accept data faster than the printer can print. When the buffer gets full it must be able to stop the device driving it. Pin 20, Data Terminal Ready is normally used for this control. When pin 20 is high it is OK to send data into the buffer, but, when it goes low (LED Green) the sending device must stop. You can connect pin 20 to whatever pin on your device will stop data flow.

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The Final Goal: A cable that works!

Once you have the B&B Break-Out Box set up with all of the jumper wires and switches where you want them, and everything works, it is time to build a cable. Carefully make a chart that shows every jumper wire connection and turned on switch that is needed. Use the chart to assemble a cable that is your finished product-a cable that works!

If you have an existing cable that you wish to modify you must first determine how it is wired and then you can change it to match your chart. With an existing cable that you do not wish to change you can add another short cable to make the connections correct or you can use a jumper box (available from B&B Electronics) to rewire one end to match your chart.

GOOD LUCK AND GOOD CABLING!

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DECLARATION OF CONFORMITY

DECLARATION OF CONFORMITY	
Manufacturer's Name:	B&B Electronics Manufacturing Company
Manufacturer's Address:	P.O. Box 1040 707 Dayton Road Ottawa, IL 61350 USA
Model Numbers:	232BOB1
Description:	RS-232 BreakOut Box
Type:	Light industrial ITE equipment
Application of Council Directive:	89/336/EEC
Standards:	EN 50082-1 (IEC 801-2, IEC 801-3, IEC 801-4) EN 50081-1 (EN 55022, IEC 1000-4-2) EN 61000 (-4-2, -4-3, -4-4, -4-6, -4-8) ENV 50204
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FEDERAL COMMUNICATIONS COMMISSION
RADIO FREQUENCY INTERFACE STATEMENT

Class A Equipment

This equipment has been tested and found to comply with the limits for Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at personal expense.