You can make

The Right Connections

Hook your Apple II or Mac to peripherals with cable connectors you make yourself.

After I'd finally sold the Macintosh Office System idea at work—to the tune of thousands of dollars—I cringed at the thought of having to cost-justify another purchase order of $40 per Macintosh for connector cables to wire them to our VAX. I mentioned my dilemma to an engineer who, within a matter of minutes, whipped up a connector cable by modifying a generic one he'd picked up at an electronic shop's close-out sale for 50¢.

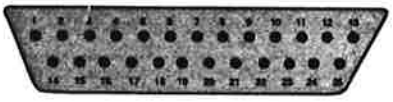
After about a thousand questions, starting with "Why do they charge $40 for these things at computer stores?" I decided I had to learn how to make connector cables myself. Here are the results of that research—simple directions on how to make serial connector cables for the Apple II family, the Macintosh, and some Apple peripherals. I won't go into parallel cables, since they are extremely complex and shouldn't be attempted by novices.

Basically, all you need to do to build a cable is to look at the tables here or those in the SAMS books or *MicroMatch* (see "Selected Bibliography"). Find the connection you want to make, and then solder the connectors to the appropriate length of cable. We'll get to an actual example in a moment, but first, since Apple Computer has built some form of compatibility into all of its products in the form of the ubiquitous standard known as RS-232C, it won't hurt to learn a little more about that standard before you get out your soldering iron.

DIN-5

Mini DIN-8

DB-9



DB-25

Figure 1: Apple uses the connectors shown to the left for its Apple II and Macintosh families of computers. The numbers are for the male pins and are reversed (left to right) for the female sockets.

The RS-232C

Recommended Standard (RS) number 232 of the Electronics Industries Association (EIA) has gone through three revisions: A, B, and the present standard—C, hence RS-232C. Although the entire standard covers a broad scope—everything from the number of pins to the amount of voltage—fortunately, you, as a cable constructor, don't need to know every nuance. All you need to know is *which* pin goes *where*, and you can find that information for most Apple products our accompanying charts.

I have also included a chart listing the EIA-standard RS-232C pin assignments, in case your owners' manual doesn't list your peripheral's pin assignments, but your peripheral may or may not conform. So if you are not connecting to an Apple peripheral, check the owners' manual for pin assignments. This information, along with our charts, should be enough information to let you deduce *what* needs to be soldered *where*.

The Hardware

DB-*n* describes certain connectors, where *n* is the number of pins for male, or sockets for female, in the connector. Apple has several different connectors besides the DB-25, a 25-pin connector that is commonly

D BISHOP

used on interface cards for Apple II, II Plus, and IIe computers for the RS-232C. The modem and printer ports on the back of the Macintosh are both RS-422 (another EIA standard—faster and useful for longer-length cables—which Apple has made quite compatible with RS-232C) DB-9 connectors (see figure 1). The Macintosh Plus also uses the RS-422 but has a new Mini DIN 8 connector. The Apple IIc uses a 5-pin DIN connector with nonstandard DIN labels for both of its serial ports (see figure 1). Most connectors have the numbers of the pins printed near the pin or socket, or you can refer to figure 1 to see the numbers for the male connector. All of Apple's connectors, with their pin assignments, appear in the accompanying charts.

A Typical Scenario

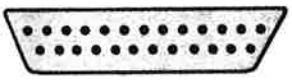
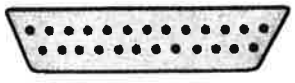
I fear all this is sounding too complex. Let me show you how I recently made a connector cable for connecting a Macintosh to an Apple IIe so I could transfer data with Southeastern Software's MacTransfer. Note, the cable I'm about to describe can also serve as an ImageWriter connector cable. This type of cable is known as a null-modem cable or a modem eliminator. (See "Flip a DIP Switch" in last month's issue for a full explanation of modem eliminators. Basically, a modem eliminator enables two DTEs [terminals or printers] to talk directly rather than through two DCEs [modems] by switching the wires on the number 2 and number 3 pins on one end of the cable).

Normally a cable connecting two computers requires the Super Serial Card's (SSC) jumper block to point toward TERMINAL. I wanted to keep my SSC jumper block pointed toward MODEM, though, whether I was using my modem or my custom cable to connect my two computers. So I needed to construct a modem-eliminator cable for the connection.

All I needed to do was design a cable that connected the female DB-9 on the back of the Macintosh with the female DB-25 on the back of the IIe, coming from a Super Serial Card within the computer, as described above. Obviously, I needed some male connectors.

I remembered an article I'd read in the Berkeley, California, Macintosh Users Group's (BMUG) newsletter, saying you could cut and modify a joystick extension cable (20 feet of

The Apple Cable(

COMPUTER	PERIPHERAL
II, II+, IIe with Super Serial Card  DB-25	ImageWriter
	ImageWriter II
	LaserWriter
	Daisy Wheel Printer
	Scribe Printer
	Modem 300/1200
	Personal Modem
	Color Plotter
	Macintosh
IIc  DIN-5	ImageWriter
	ImageWriter II
	Scribe Printer
	Daisy Wheel Printer
	Modem 300/1200
	Personal Modem
	Color Plotter
III with Super Card III  DB-25	ImageWriter (4)
	ImageWriter II
	Scribe (4)
	Daisy Wheel Printer (4)
	Modem 300/1200
	Personal Modem
	Color Plotter

Note: All cables should have shield-to-shield connections.
Most of the information in this chart was obtained on AppleLink, an on-line service provided by Apple to authorized Apple dealers.

e Connection

PIN CONFIGURATION The first number is for the computer's connector. The second number is for the peripheral's connector.							NOTES	CABLE NUMBER
1–1	13–13	19–19	23–23				(1)	590-0037
1–20	2–8	3–2	4–7	5–3	8–7		(1) on DB-25:jump 8–6	590-0335
1–1	2–2	3–3	7–7				(1) (2)	custom
1–1	13–13	19–19	23–23				(1)	590-0037
Match identical pin numbers							(1)	590-0121
6–2	7–3	3–5	20–6	8–7	1–8	2–9	(3) on DB-25: jump 8–5	590-0212
8–1	20–2	3–3	7–4	2–5	7–8		(3) on DB-25: jump 8–6	590-0331
1–1	13–13	19–19	23–23				(1)	590-0037
1–1	3–7	5–3	7–20	9–2			(3)	590-0169
1–6	2–3	3–7	4–2	5–20				590-0191
1–1	5–2	2–3	3–4	4–5	3–8			590-0333
1–6	2–3	3–7	4–2	5–20				590-0191
1–6	2–3	3–7	4–2	5–20				590-0191
1–6	2–9	3–3	4–5	5–2			on DB-9: jump 3–8	590-0192
1–1	5–2	2–3	3–4	4–5	3–8			590-0333
1–6	2–3	3–7	4–2	5–20				590-0191
1–1	13–13	19–19	23–23					590-0037
8–1	20–2	3–3	7–4	2–5	7–8		on DB-25: jump 8–6	590-0331
1–1	13–13	19–19	23–23					590-0037
1–1	13–13	19–19	23–23					590-0037
6–2	7–3	3–5	20–6	8–7	1–8	2–9	on DB-25: jump 8–5	590-0121
8–1	20–2	3–3	7–4	2–5	7–8		on DB-25: jump 8–6	590-0331
1–1	13–13	19–19	23–23					590-0037

(1) On Super Serial Card (SSC) rotate jumper block toward TERMINAL.
(2) On SSC: SW1—4, 6, 7 on; SW2—1, 4 on. Requires Xon/Xoff handshaking.
(3) On Super Serial Card (SSC) rotate jumper block toward MODEM.
(4) Also needs modem-eliminator cable (see Special Cables).

cord connecting a male and a female DB-9). At press time, these cost $5.37 at K-Mart. These extensions are also available from Radio Shack. I figured just the 20 feet of cable (normally 20¢ to 40¢ per foot) made the $5.37 a bargain. Unfortunately, if you go this route, the connector's molding is closed, so you can't see which wire connects to which pin (the wires' color coding normally shows you). Consequently, you will have to test each wire (with a continuity tester or a battery and a light bulb) to see which wire comes from which pin on the DB-9 connector.

If you want to buy a DB-9 that is not molded closed, most electronics stores, including Radio Shack, carry them. They also have the DB-25s and the DIN-5 for the IIc. Be sure to buy the hoods for these connectors, as they usually come separately and are a *must* for safety's sake.

My engineer acquaintance who bought the cable for 50¢ had a prefabricated DB-25-to-DB-9, male-to-male connector cable. Since the pin assignments were wrong, he used a pin extractor (available at computer-supply stores for around $4), which looks a lot like a miniature nail punch, to punch out the pins and reinsert them in their proper holes. If you use a pin extractor, be sure to buy some extra pins; they break easily. Cut off any pins you don't need for the connection and tape them with electrician's tape where the main insulation is stripped back.

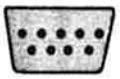
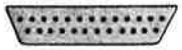
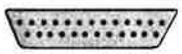
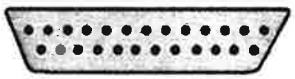
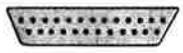
Anyway, I went to K-Mart, bought the joystick extension cable, and then stopped at a Dick Smith's Electronics store (these Australian equivalents of Radio Shacks are sprouting like Eucalyptus trees all over California) and got a male DB-25 with a hood. When I got home, I cut off the female end of the joystick extension cable, along with 18 feet of cable, which left two feet of cable on the male end of the cable—my Apples like to snuggle up close.

Since I don't own a continuity tester, I rigged one up by taping a battery to one of the leads of a battery tester, hooking a wire onto the other end of the battery, and then used the other lead and the wire's end to find out which wire came from which prong on the extension cable. I used this information to make a color chart categorizing each

Continued on page 64

The Apple Cable Connection

Continued

COMPUTER	PERIPHERAL
Mac  DB-9	**ImageWriter** 
	ImageWriter II 
	Modem 300/1200 
	Personal Modem 
	non-Apple modem 
	Apple IIe 
Mac Plus  Mini DIN-8	**ImageWriter** (5) 
	ImageWriter II 
	Modem 300/1200 (6) 
	Personal Modem 
	Hayes Smart modem 
Mac XL  DB-25	**ImageWriter** (4) 
	ImageWriter II 
	Daisy Wheel Printer 
	Modem 300/1200 
	Personal Modem 
Special Cables	**Modem eliminator**
	Mini DIN-8 to DB-9 (7)
	SCSI System cable
	SCSI cable terminator
	SCSI cable extender
	SCSI peripheral interface

Note: All cables should have shield-to-shield connections.

Most of the information in this chart was obtained on AppleLink, an on-line service provided by Apple to authorized Apple dealers.

PIN CONFIGURATION The first number is for the computer's connector. The second number is for the peripheral's connector.							NOTES	CABLE NUMBER
1–1	3–7	5–3	7–20	9–2				590-0169
1–7	2–6	3–9	4–1	5–5	6–8	7–7	8–4	590-0332
3–3	5–9	6–6	7–7	8–8	9–5		on both ends: jump 3–8	590-0197
1–7	2–6	3–9	4–1	5–5	6–8	7–7	8–4	590-0332
1–1	3–7	5–2	7–20	9–3			on DB-9: jump 3–8	custom
See Apple IIe to Macintosh above								custom
2–20	3–3	4–1	5–2	8–7				custom *
1–2	2–1	3–5	4–4	5–3	6–8	7–7	8–6	590-0340
1–6	2–7	3–9	4–3&8	5–5	8–7			custom
1–2	2–1	3–5	4–4	5–3	6–8	7–7	8–6	590-0340
1–20	4–7	3–2	2–5	5–3				custom
1–1	13–13	19–19	23–23					590-0037
8–1	20–2	3–3	7–4	2–5	7–8		on DB-25: jump 8–6	590-0331
1–1	13–13	19–19	23–23					590-0037
6–2	7–3	3–5	20–6	8–7	1–8	2–9	on DB-25: jump 8–5	590-0121
8–1	20–2	3–3	7–4	2–5	7–8		on DB-25: jump 8–6	590-0331
1–1	2–3	3–2	4&5–8	6–20	7–7	8–4&5	20–6	590-0166
1–6	2–7	3–5	4–3	5–9	6–4	8–8	on DB-9: jump 1–3	590-0341
Refer to reference materials supplied with Apple cables								590-0345
Refer to reference materials supplied with Apple cables								590-0348
Refer to reference materials supplied with Apple cables								590-0347
Refer to reference materials supplied with Apple cables								590-0346

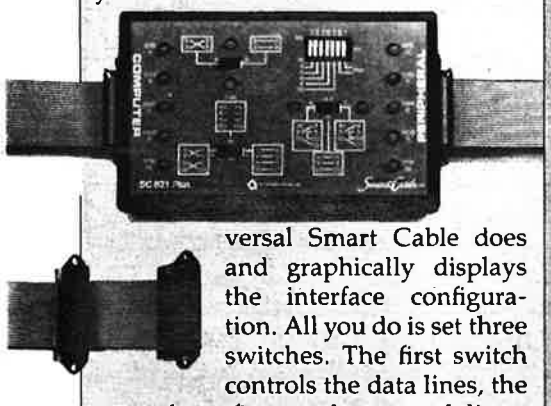
(5) Or use DIN-8 adapter (590-0341) and Macintosh ImageWriter cable (590-0169).
(6) Or use DIN-8 adapter (590-0341) and Macintosh Modem cable (590-0197).
(7) An adapter for converting the DB-9 connector on a Macintosh to a Mini DIN-8 connector for use with the ImageWriter II or Personal Modem.

Smart Cables

Maybe you have borrowed a friend's printer and have forgotten the cable. You don't have a reference manual for it, so you cannot easily construct one. So you pull out your box of tangled cables and, through trial and error, finally find a cable that works. There is an easier way.

IQ Technologies manufactures a complete line of "smart" RS-232 interface cables. The basic Universal Smart Cable automatically looks at both serial interfaces and configures itself to correctly connect the data, control, and handshake lines. That's right, you can use a single cable with your serial printer, a modem, and your friend's printer—or any other RS-232 devices—and you never have to pull out the soldering iron.

If you don't just want to get your peripheral working but also want to construct a custom cable, you'll be interested in IQ Technologies' Smart Cablemaker. It instantly connects your two RS-232 devices like the Universal Smart Cable does and graphically displays the interface configuration. All you do is set three switches. The first switch controls the data lines, the second configures the control lines, and the third sets the correct handshaking protocol.



Universal Smart Cable, Smart Cablemaker, and **Apple IIc Smart Cable**
IQ Technologies, Inc.
11811 NE First Street
Bellevue, WA 98005/(206) 451 0232
Distributed by IAM
P.O. Box 2545
Fair Oaks, CA 95628/(916) 961-8082
List Price: Universal Smart Cable (SC821), $49.95; Smart Cablemaker (SC821Plus), $149.95; Apple IIc Smart Cable (SC809), $39.95
Require: Universal Smart Cable and Smart Cablemaker require any RS-232 device with DB-25 connectors; Apple IIc Smart Cable requires Apple IIc

CIRCLE 375 ON READER SERVICE CARD

Pin Assignments

These tables show the signal names and pin assignments of common Apple serial connectors.

EIA STANDARD

RS-232C

PIN	SIGNAL NAME
1	Protective Ground
2	Transmitted Data (TXD)
3	Received Data (RXD)
4	Request to Send (RTS)
5	Clear to Send (CTS)
6	Data Set Ready (DSR)
7	Signal Ground (GND)
8	Received Line Detector
9	Reserved for Data Testing
10	Reserved for Data Testing
11	Unassigned
12	Secondary Received Line Signal Detector
13	Secondary Clear to Send
14	Secondary Transmitted Data
15	Transmission Signal Element Timing (DCE Source)
16	Secondary Received Data
17	Receiver Signal Element Timing
18	Unassigned
19	Secondary Request to Send (SCTS)
20	Data Terminal Ready (DTR)
21	Signal Quality Detector
22	Ring Indicator
23	Data Signal Rate Selector
24	Transmit Signal Element Timing
25	Unassigned

COMPUTERS

Apple II, II+, IIe Super Serial Card (SSC)

PIN	SIGNAL NAME
1	Frame Ground
2	Transmit Data (TXD)
3	Receive Data (RXD)
4	Request to Send (RTS)
5	Clear to Send (CTS)
6	Data Set Ready (DSR)
7	Signal Ground (GND)
8	Data Carrier Detect (DCD)
19	Secondary Clear to Send (SCTS)
20	Data Terminal Ready (DTR)

Apple IIc Printer and Modem Serial Ports

PIN	SIGNAL NAME
1	Data Terminal Ready (DTR)
2	Transmit Date (TXD)
3	Ground (GND)
4	Receive Data (RXD)
5	Data Set Ready (DSR)

Macintosh Printer and Modem Serial Ports

PIN	RS-422 SIGNAL NAME
1	Frame Ground
2	+5v*
3	Signal Ground (GND)
4	Transmit Data (TXD+)
5	Transmit Data (TXD–)
6	+12v*
7	Handshake
8	Receive Data (RXD+)
9	Receive Data (RXD–)

*Apple provides power in pins 6 and 2 for reference purposes only; the company recommends that you *not* use this voltage to power external devices.

BY CHIP CARMAN

Macintosh Plus Printer and Modem Serial Ports

PIN	RS-422 SIGNAL NAME
1	Handshake, Output (HSKo +12v)
2	Handshake, Input (HSKi)
3	Transmit Data (TXD–)
4	Frame Ground (GND)
5	Receive Data (RXD–)
6	Transmit Data (TXD+)
7	Not connected
8	Receive Data (RXD+)

Macintosh Plus SCSI Port

PIN	SIGNAL NAME
1	Request (REQ–)
2	Message (MSG–)
3	I/O–
4	Reset (RST–)
5	Acknowledge (ACK–)
6	Busy (BSY–)
7	Ground (GND)
8	Data Line 0 (DB0–)
9	Ground (GND)
10	Data Line 3 (DB3–)
11	Data Line 5 (DB5–)
12	Data Line 6 (DB6–)
13	Data Line 7 (DB7–)
14	Ground (GND)
15	Carrier Detect (C/D–)
16	Ground (GND)
17	Attention (ATN–)
18	Ground (GND)
19	Select (SEL–)
20	Parity (DBP–)
21	Data Line (DB1–)
22	Data Line (DB2–)
23	Data Line (DB4–)
24	Ground (GND)
25	Not connected

NOTE:
The minus sign indicates that the signal voltage levels are negative. The SCSI port uses –5v logic levels.

WARNING: Because the SCSI port is a DB-25, it looks like an RS-232 port. *Do not* plug an RS-232 device into the SCSI port. Special precaution is necessary when considering a SCSI device for the SCSI port. Check with the SCSI-device manufacturer to make sure the device is not expecting termination power from the Macintosh Plus.

MODEMS

Modem 300/1200

PIN	SIGNAL NAME
1	Not connected
2	Data Set Ready (DSR)
3	Signal Ground (GND)
4	Not connected
5	Receive Data (RXD)
6	Data Terminal Ready (DTR)
7	Data Carrier Detect (DCD)
8	Frame Ground (GND)
9	Transmit Data (TXD)

Personal Modem

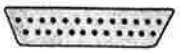
PIN	SIGNAL NAME
1	Data Set Ready (DSR)
2	Data Terminal Ready (DTR)
3	Receive Data (RXD)
4	Signal Ground (GND)
5	Transmit Data (TXD)
6	Signal Ground (GND)
7	Data Carrier Detect (DCD)
8	Not connected

PRINTERS

LaserWriter

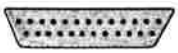
PIN	SIGNAL NAME
1	Ground (GND)
3	Ground (GND)
4	Transmit Data, Plus (TXD+)
5	Transmit Data, Minus (TXD–)
8	Receive Data, Plus (RXD+)
9	Receive Data, Minus (RXD–)

LaserWriter



PIN	SIGNAL NAME
1	Frame Ground (GND)
2	Transmit Data (TXD)
3	Receive Data (RXD)
4	Ready to Send (RTS)
7	Signal Ground (GND)
20	Data Terminal Ready (DTR)

ImageWriter



PIN	SIGNAL NAME
1	Frame Ground
2	Transmit Data (TXD)
3	Receive Data (RXD)
4	Request to Send (RTS)
7	Signal Ground (GND)
14	Fault
20	Data Terminal Ready (DTR)

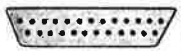
ImageWriter II

PIN	RS-422 SIGNAL NAME
1	Data Terminal Ready (DTR)
2	Data Set Ready (DSR)
3	Transmit Data Minus (TxD–)
4	Signal Ground (GND)
5	Receive Data Minus (RxD–)
6	Transmit Data Plus (TxD+)
7	Not connected
8	Receive Data Plus (RxD+)

Apple Daisy Wheel Printer (DWP)

PIN	SIGNAL NAME
1	Frame Ground
2	Transmit Data (TXD)
3	Receive Data (RXD)
4	Request to Send (RTS)
5	Clear to Send (CTS)
6	Data Set Ready (DSR)
7	Signal Ground (GND)
8	Data Carrier Detect (DCD)
20	Data Terminal Ready (DTR)

Apple Scribe Printer



PIN	SIGNAL NAME
1	Frame Ground
2	Transmit Data (TXD)
3	Receive Data (RXD)
4	Request to Send (RTS)
7	Signal Ground (GND)
20	Data Terminal Ready (DTR)

wire by color and DB-9 pin number. Then I checked the Apple Cable Chart for the Apple IIe-to-Macintosh pin configuration to find where the wires from the DB-25 should be soldered on the DB-9.

You will need a small vice or clamp to hold any of the connectors during soldering, because you will need to have both hands free. Write down the color of the wires next to the pin number on the chart you are following.

Start by cutting off about an inch of the main insulation from the main cable to expose the small wires inside. Strip the wires for soldering, but not too far. The metal shouldn't protrude beyond the end of the sheath it is to fit into (the one on the top of the pin—see figure 2). Heat the sheath, touch the solder to it, and then heat the wire as you press it against the sheath. Heating the component, rather than the solder, draws the solder into the component.

Cut back any wires you aren't going to use to where you have stripped away the outer main coat of insulation—in the above example, that's the wires from pins 2, 4, and 6 on the DB-9. If solder or bare wire touches, or can touch, any other metal components, you must resolder that wire—excess metal or solder is an invitation to a short circuit.

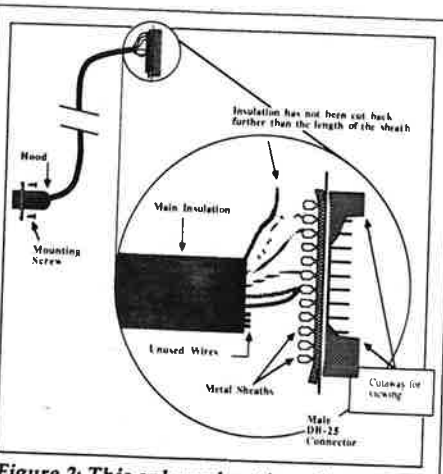


Figure 2: This enlarged section of a DB-25 connector shows proper connections for a null-modem cable as described in the text. Notice how the insulation on the small wires has not been cut back beyond the sheath. Also note how the unused wires have been cut back to where the main insulation was stripped away.

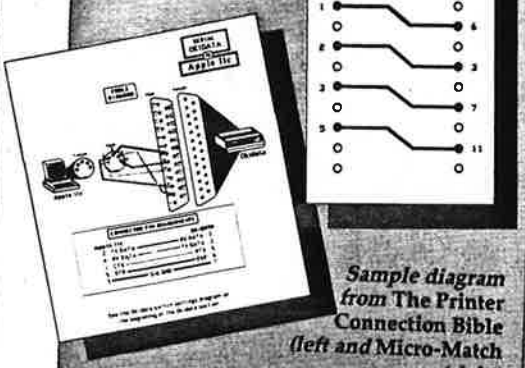
Check Your Work

After I finished soldering, I used my "continuity meter" to check my work, to be sure the correct pins were connected to each other. Then I clipped back the unused wires 2, 4, and 6 from the DB-9 and installed the hood on the DB-25. I checked again for correct connections and hooked the cable up to watch the magic: Apple Writer II files appearing on the Macintosh screen. In the microelectronic world of complex circuits and incredibly tiny devices inside your computer, it's nice to know there are still some things you can do yourself—with your own two hands. ✚

Brian Cutter is a writer who writes users' guides for VAX mainframe-class financial software during the day, Apple articles in the early evening, MAUG missives at night, and Pascal poetry in the wee hours.

Selected Bibliography

Our focus here is providing cable-construction solutions for Apple products, but because many other manufacturers also make peripherals, we are supplying additional sources of information we think are useful.



Sample diagram from The Printer Connection Bible *(left and* Micro-Match *(right)*

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House, Kim G., and Jeff Marble
Howard W. Sams & Co., Inc.
4300 West 62nd Street
Indianapolis, IN 46268

Modem Connections Bible
Curtis, Carolyn, and Daniel L. Majhor
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Cardinal Point, Inc.
P.O. Box 596
Ellettsville, IN 47429

Getting the Most Out of Your Epson Printer
Kater, David A., and Richard L. Kater
McGraw-Hill Book Company
1221 Avenue of the Americas
New York, NY 10020

Minute Manual for the Dot Matrix Printer
Pirisino, Jim
MinuteWare
P.O. Box 2392
Columbia, MD 21045

MicroMatch
Command Computer Corporation
36 Columbia Terrace
Weehawken, NJ 07087

The Apple Interface Manual
Apple Computer, Inc.
20525 Mariani Avenue
Cupertino, CA 95014

Test Your Cable I.Q.

Now that you know how to make the right connections, can you recognize the six types of Apple cable connectors and the products on which you find them? See answers on page 152.