A Xerox 820-1 Compendium

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The August 1985 issue of the *AMRAD Newsletter* presented a Xerox™ 820-1 Compendium, compiled and introduced by Andre Kesteloot, N4ICK. *QEX* is proud to present this same information to its readers, with permission to do so granted by the Amateur Radio Research and Development Corporation. The Compendium will be presented in several installments, beginning this month. Every experimenter familiar with the Xerox 820-1 will find this reference material of extreme value.

A number of articles on the Xerox 820-1 computer have appeared in this newsletter[1] over the past 18 months and in a few other publications during the past several years. The Xerox 820 was chosen by the ARRL ad-hoc digital committee for developing network systems,[2] and AMRAD decided to present complete reference material required to help the experimenter get his or her computer up and running.

History

During the summer of 1980, Digital Computer of Texas marketed a Z80® computer in kit form and named it the Big Board, or BB-1. The hardware was designed by Jim Ferguson of Ferguson Engineering,[3] but by late 1980, Xerox had bought manufacturing rights to the circuitry. The company rearranged the circuits on a multiple-layer board and renamed it the 820-1. (Beware of hidden connections; some of the +5-V and ground lines are now sandwiched inside the fiberglass board!) The circuitry remained identical, but all IC numbers were changed. (See note 4 for a comparative description of the BB-1 vs the 820-1.)

By 1982, Xerox marketed the 820-2. It sported a faster clock speed, double density and offered a possibility of adding a 16-bit co-processor. Although there are similarities between the 820-1 and the 820-2, there are also a number of differences. This Compendium will deal exclusively with the 820-1. For a comparison between the 820-1 and the 820-2, see note 5.

Notes appear on page 8

As obsolete 820-1 boards were removed by Xerox and replaced with the newer 820-2 board, the 820-1 surfaced on the surplus market. By October 1982, these surplus boards were selling for $435 each, and as of July 1985, they could be found for as little as $50 (untested).

Description

The Xerox 820-1 is a single-board computer using the Zilog Z80 CPU, one of the most popular CPUs ever made. The board operates under CP/M® 2.2 and features 64-kbytes of RAM, one parallel (PIO) and two serial (SIO) outputs, an 80 × 24 video display and a single-density disk controller.

Hardware

[During 1985 when the Compendium was first published, the 820-1 board and components were available for the prices listed. Because the parts are a surplus item, prices will fluctuate. Call or write the referenced sources for product availability and a new price listing before sending a check in the specified amount.—Ed.]

To install a workable system, the following items are the minimum requirements:
An 820-1 board—They are available untested "as is" from Xerox Surplus Outlet[6] for $50, plus shipping. Mine arrived with a damaged crystal and a bad video-output chip. Because of the board's configuration, crystals are quite likely to suffer in shipment. New crystals can be obtained from BG Micro for $3 each.[7] (Some boards operate as soon as they are connected; others need attention. Depending on your technical capability, you may opt for an "as is untested" or a tested board.)

The boards can be purchased in tested and operating condition from SW Computers[8] for less than $100. You might also check with Lolir Lectronics Corp[9] and Ferguson Engineering.

Ferguson Engineering also sells the 820-1 board, as is, less the two ROMs and the 1771 disk-controller chip, for $45. Those three chips should be available separately for about $20 total.

Wilcox Enterprises[10] offers many goodies for the board: cables, CP/M, connectors, ROMs and so on. A flyer will be sent on request. BG Micro sells a bare board, the two ROMs, the data and the 32 memory chips for $40, but you will have to assemble it.

A power supply—The 820-1 requires +5 V at 3 Amps, +12 V at 0.25 Amps and −12 V at 0.5 Amps. One or two 5-inch disk drives or even a 12-V video monitor may be attached to your setup. The equipment can easily be powered by a small switching power supply manufactured by California DC (part no. LR1015) and sold by BG Micro for $24.95. It comes ready to run and is equipped with the correct mating plug for the Xerox board! I have used both the California DC and the Harris no. 144813 supplies with equal success. Astec makes a suitable power supply, too (part no. AA11760), but I have not tried it.

A keyboard—The original design requires a parallel ASCII keyboard. These keyboards are available from a variety of sources. The *Computer Shopper*[11] and *Nuts and Volts*[12] often list classified ads of this nature. If you cannot find a parallel keyboard, or if you already own a serial ASCII keyboard, a parallel-to-serial interface[13] can be built easily. This gives you the advantage of being able to use a coiled, 4-wire telephone-like cable between the keyboard, instead of the 11-(minimum) conductor cable required for the parallel ASCII keyboard (8 wires for the eight bits, plus one wire each for +5 V, strobe and ground). If you construct your own parallel-keyboard cable, I recommend connecting several conductors in parallel for the ground return. Very flexible, round, 15-conductor cable can be purchased by the foot from Arlington Electronics.[14] (I am using 5 feet of Alpha Wire (part no. 1181-15) cable between my 820 board and my keyboard without any problem.)

A video monitor—The 820-1 generates positive-going noncomposite video, positive-going horizontal sync and negative-going vertical sync pulses. These signals will directly drive a TTL-video monitor and 12-inch video monitors (available at hamfests for around $20). A cute 5-inch TTL monitor is available from Halted Specialties and from United Products for less than $30. It needs only the above signals and +12 V at 1 A

(I have two of these monitors and they work well. For a review of this monitor, see note 15). If you are interested in using a composite-video monitor, a section describing my composite-video board will follow in an upcoming installment. Finally, if you do not need TTL video and you only want a composite-video output and you don't mind modifying your 820-1 board, follow the modifications performed by David Borden, K8MMO, and outlined in another section of this Compendium.

A 5¼-inch disk drive—BG Micro sells excellent Canon drives (2/3 height) for $45. Other drives, such as the Shugart 455 or the Teac FD55F ½ height drives work just as well, albeit priced in the $100 range. Look in *Computer Shopper* and *Nuts and Volts* for sources. (Details on how to connect these drives follow.)

Cables—You may have to construct the cables that go between the keyboard and the 820-1 board. Another cable will have to connect the board to the disk drives. This cable, Xerox part no. 117P80668 REV A, is available from SW Computers, Epic Sales[16] and Ferguson Engineering. (While it is possible to make your own cable, I don't recommend it.)

Connectors—Nine connections are necessary to make your system work. I will go through each of them.

- Power Connectors (J5): pin 1 = −12-V dc; pin 2 = +12-V dc no. 1; pin 3 = +12-V dc no. 1; pins 4, 5 and 6 = dc ground; pin 7 = +12-V dc no. 2; pins 8 and 9 = +5-V dc.
- Video Output (J7): pins 1 and 2 = no connection; pin 3 = vertical sync; pin 4 = horizontal sync; pin 5 = video; pins 6 through 10 = ground.
- Channel A Serial I/O Connector (J4): pin 1 = protective ground; pin 2 = transmit data (TXD); pin 3 = receive data (RXD); pin 4 = request to send (RTS); pin 5 = clear to send (CTS); pin 6 = data set ready; pin 7 = protective ground; pin 8 = carrier detect (DCD); pin 15 = transmit clock; pin 17 = receive clock; pin 20 = data terminal ready (DTR); pins 9 through 14, and pins 16, 18, 19 and 21 through 25 are unused. (It is possible, by changing the strapping on J9, to allow serial port A to communicate either with a modem, or with a terminal. See the Xerox documentation package.)
- Channel B Serial I/O (J3): pin 1 = ground; pin 2 = received data; pin 3 = transmitted data; pin 4 = clear to send; pin 5 = request to send; pin 6 = data set ready; pin 7 = ground; pin 8 = terminal ready; pin 20 = data-carrier detect; all other pins are unused.
- Keyboard connector (J2 on the 820): pins 1 through 8 are connected, respectively, to bits 0 through 7; pin 9 = strobe; pin 10, 11 and 12 = unused; pin 13 = +5-V dc; pins 14 through 25 = ground.
- Connector on the Keyboard: My original Xerox keyboard is a Micro-Switch, part no. 630107-02 (Xerox part no. 2160095). If you have one of these, here is how to connect it to your Xerox motherboard. Looking into the pins of the connector on your keyboard, the upper row is comprised of odd-numbered pins, with pin 1 being on your right, and pin 29 on your left (nearest the edge of the keyboard). Pin 1 = bit 7; pin 3 = bit 6; pin 5 = bit 5; pin 7 = bit 4; pin 9 = bit 3; pin 11 = bit 2; pin 13 = bit 1; pin 15 = bit 0; pin 27 = strobe; pin 29 = +5-V dc; pins 17, 19, 21, 23 and 25 are not used. The even numbered pins of the bottom row (near the printed-circuit board) are or should be grounded and are to be connected to the 820-1 ground (J2 pins 14 through 25).
- Video Monitor Connector (J6): pin 1 = ground; pin 2 = +12-V dc.
- Parallel I/O Connector (J8): (You can use this port to feed a printer, but remember to ground *all* odd-numbered pins of J8 to ground on the 820-1 board. Xerox forgot to do it! See note 17 for more details). For the even-numbered pins—pin 2 = port A strobe; pin 4 = port A ready; pins 6 through 20 = port A bit 0 through 7, respectively; pin 22 = port B ready; pin 24 = port B strobe; pins 26 through 40 = port B bit 0 through 7, respectively.
- Disk Drive Connector (J1): (Note that the following description matches the 820-1 board. The listing shown in the Xerox Service Manual, p 10-50, is incorrect.) pin 1 = no connection; pin 2 = 8-inch/5-inch select (this pin must be grounded for 5-inch drives); pin 3 = no connection; pin 4 = index sensor; pin 5 = select drive no. 1; pin 6 = select drive no 2; pin 7 = side select; pin 8 = head load; pin 9 = step direction; pin 10 = step command; pin 11 = write data; pin 12 = write gate; pin 13 = track 00 sensed; pin 14 = write protect notch open; pin 15 = read data; pin 16 = low current; pin 17 = drive ready; pin 18 = (this pin can be used to supply +12-V dc to the disk drives, or for any other purpose); pin 19 = +5-V dc; pins 20 through 37 = ground.

Documentation—Although this Compendium lists all the connector pins and other basic information you need to get your board running, you may want to obtain additional information. There is a complete 820-1 documentation package available from Ferguson Engineering for $15. It is very useful, but the drawings are not always legible. Ferguson also offers a set of six schematic diagrams, measuring 18 × 24 inches. It is available for $18. A CP/M Primer (the handbook Xerox packaged with its computers) can be purchased for a cost of $7.50.

MicroCornucopia[18] is a magazine published six times per year. It is devoted to single-board computers such as the Big Board, Xerox, Kaypro and the Slicer.

Accessories—If you want to modify the 820-1 for double density operation, you will want to add one of two double-density daughterboards available. The first, made by SWP Microcomputers of Arlington, TX[19] (not to be confused with SW Computers and Electronics of Albuquerque, NM), plugs into the 1771 floppy disk controller-chip socket. No modification to the board is required, but the double-density format produced by this board is not compatible with most other systems. (I understand that this SWP board was supplied by Xerox as an upgrade; it is much simpler to install). The 32-page instruction manual is well-written and very informative. The second board, marketed by Emerald Microware[20] requires a few trace cuts and other alterations to the 820-1 board, but produces a double-density format that is generally Kaypro-compatible. (Terry Fox, WB4JFI, built and installed the Emerald board on his 820 and is satisfied with it.) That board is sold with an excellent set of instructions. Before deciding which board to purchase, write to both manufacturers for details and for a comparative study of both boards (see note 21). Next month's installment will feature "smoke" tests, the Xerox 820 Big Board and the 820 and Packet Radio.

Notes

[1]*AMRAD Newsletter,* PO Drawer 6148, McLean, VA 22106-6148

[2]T. Fox, WB4JFI, "Protocol," *AMRAD Newsletter,* Nov/Dec 1984.

[3]Ferguson Engineering, PO Box 300085, Arlington, TX 76010; tel 817-640-0207

[4]J. P. Marlin, "Xerox 820 Notes," *MicroCornucopia* No. 8, Oct 1982.

[5]J. P. Marlin, "Xerox 820 Notes," *MicroCornucopia,* No. 9, Dec 1982.

[6]Xerox Surplus Outlet, 1341 W. Mockingbird, MS503, Dallas, TX 75247; tel 214-960-3367.

[7]BG Micro, PO Box 280298, Dallas, TX 75228; tel 214-271-5546.

[8]SW Computers, and Electronics, 3232 San Mateo, NE, Albuquerque, NM 87110; tel 505-821-2521.

[9]Lolir Lectronics, 13933 N Central Expressway, Suite 212, Dallas, TX 75243; tel 214-234-8032.

[10]Wilcox Enterprises, PO Box 395, Nauvoo, IL 62354; tel 217-453-2345.

[11]*Computer Shopper Magazine,* 407 S Washington Ave, Titusville, FL 32781.

[12]*Nuts and Volts Magazine,* PO Box 1111, Placentia, CA 92670.

[13]Philip Plumbo, "Serial Keyboard Interface," *MicroCornucopia* No. 10, Feb 1983.

[14]Arlington Electronics, 3636 Lee Highway, Arlington, VA 22207; tel 703-524-2412.

[15]David McLanahan, "The Kagadenchi Five-Inch Monitor," *Computer Smyth,* Feb 1985, p 46.

[16]Epic Sales, 132 Walnut Plano Center, Garland, TX; tel 800-223-EPIC.

[17]J. W. Mink, "Parallel Printing With the Xerox 820," *MicroCornucopia* No 18, June 1984.

[18]*MicroCornucopia,* PO Box 223, Bend, OR 97709; tel 503-382-8048.

[19]SWP Microcomputer Products, 2500 E Randol Mill Rd, Arlington, TX 76011; tel 817-924-7759.

[20]Emerald Microware, PO Box 6118, Aloha, OR; tel 503-642-1860.

[21]Mitchell Mlinar, "The Xerox Column," *MicroCornucopia* No. 23, April/May 1985.