

The Hilker CX-85 Conversion

Converting an Atari CX-85 Numerical Keypad into a Coleco controller-port keypad — Michael D. Hilker (WA6MAX), as sent to John Busby

DOCUMENT SCOPE

This article documents a user-level hardware modification plan preserved as paper correspondence — eight sheets of hand-drawn plans, a photocopied Atari service schematic with annotations, and a kit of parts bagged for the recipient. The hardware itself (a built conversion unit) is not in the museum collection at the time of writing; this is a plans-and-parts record. All claims below are evidence-tagged **CONFIRMED**, **INFERRED**, or **OPEN**.

1. Provenance and dating

The sender's block on the encoding chart (Figure 8) identifies the author unambiguously: **Michael D. Hilker**, amateur-radio callsign **WA6MAX**, address *34447-14 Yucaipa Blvd, Yucaipa CA 92399*. The cover note (Figure 6) is signed "Mike Hilker." **CONFIRMED**

The cover note on the encoding chart (Figure 8) is addressed "*To John Busby*"; this positions the correspondence as a technical hand-off between two ADAM community members.

CONFIRMED

No date appears on any sheet. The paper is yellowed, the schematic is a plain-paper photocopy, and the handwriting style and ZIP+2 postal format are consistent with late-1980s / early-1990s ADAM community correspondence — the era when surplus Atari CX-85 keypads were cheap and the ADAM user community was actively trading hardware mods via BBS and newsletter channels. A firmer date would come from an FCC ULS lookup of the WA6MAX license grant/renewal history. **OPEN**

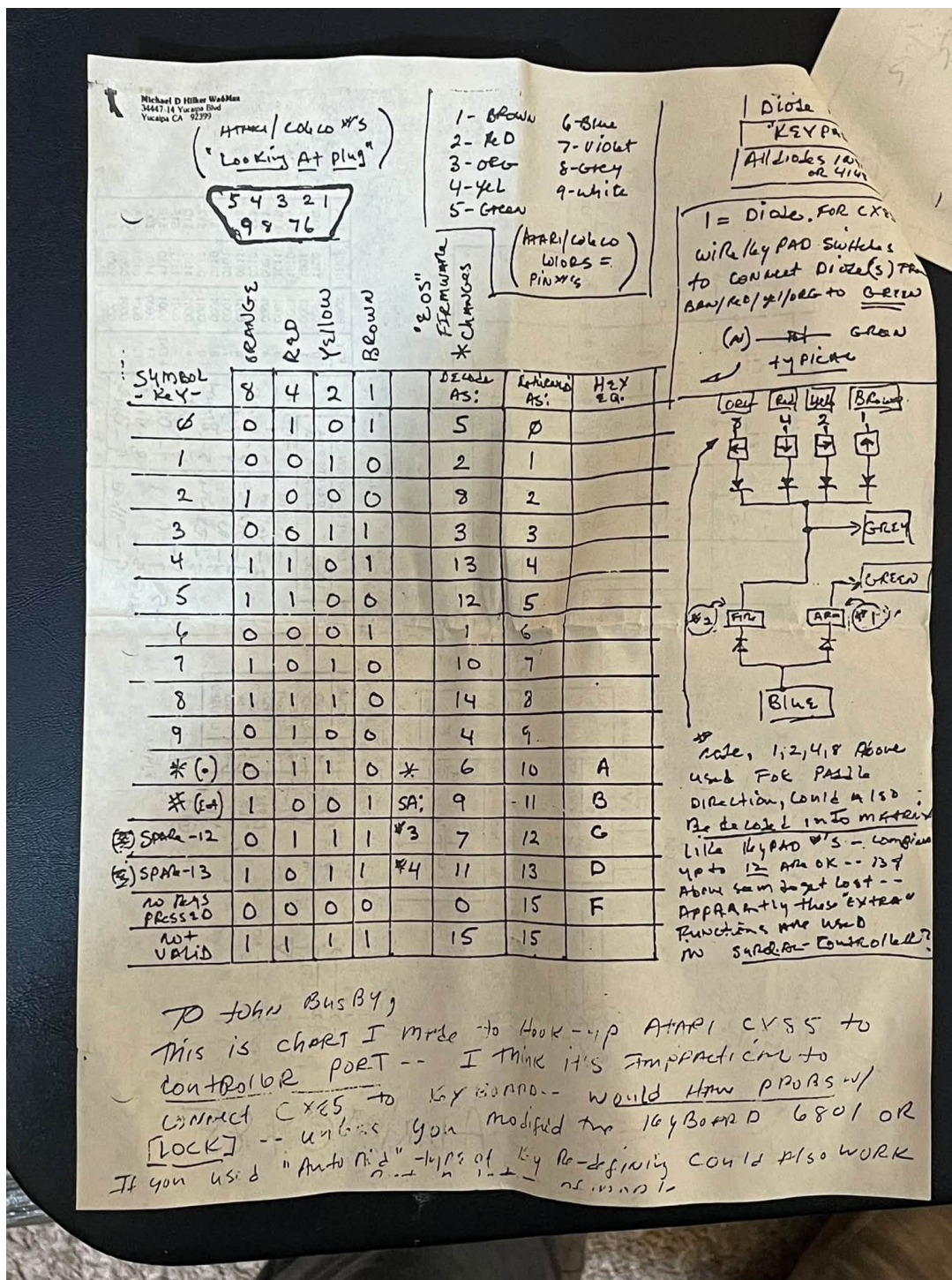


Fig 8. Encoding chart sent to John Busby. Hilker's return-address block, callsign WA6MAX, is visible at upper left; the recipient is named in the cover note at bottom. The main body is the key-to-wire mapping table discussed in §7.

2. Kit contents (as photographed)

The shipment preserved in the archive consists of the following items (Figure 5): **CONFIRMED**

- One complete Atari CX-85 Numerical Keypad — black housing, built-in coiled cable, DE-9 male plug on tail. Donor platform.
- One short silver-grey modular / RJ cable, 4-conductor — role not stated in plans; possibly a signal-cable replacement candidate.
- Two Winchester Electronics card-edge sockets, markings 49-11255-0 WIN. EL. SM and 49-11210-0 WIN. EL. SM — low-profile IDC-to-card-edge adapters.
- Several short lengths of grey ribbon cable with red stripe (IDC-ready).
- The Atari CX-85 service schematic (page 6–7 photocopy) with hand annotations "CONVERT ATARI CX-85 TO ADAM" (Figure 7).
- Five sheets of hand-drawn plans (Figures 1, 3, 4, 6, 8).

Not in the shipment but explicitly called out as required: a salvaged **Coleco controller diode-matrix PCB**. Hilker recommends taking one from a Super Action Controller to save fabrication time (see Figure 6 cover note). **CONFIRMED**



Fig 5. Kit as received. The annotated Atari CX-85 service schematic (top), the keypad itself with its coiled cable and plug, the modular/RJ cable, two Winchester IDC-to-edge sockets, and several lengths of grey ribbon cable.

3. Design intent — what this mod does

The modification converts the Atari CX-85 from an *intelligent keypad* (an Atari-protocol device with its own onboard scan encoder) into a *passive diode-matrix keypad* that plugs into a Coleco ADAM / ColecoVision **controller port**. After the conversion the ex-Atari pad behaves exactly

like the keypad half of a stock Coleco hand controller. **INFERRED** (from the combined evidence of the schematic annotations, encoding chart, and cover note).

Hilker explicitly rules out the alternative design — wiring the keypad into the ADAM's AdamNet keyboard port. From the cover note on Figure 8: **CONFIRMED**

“I think it's impractical to connect CX-85 to Keyboard — would have probs w/ [LOCK] — unless you modified the Keyboard 6801 or if you used 'Auto Fire' type of key re-defining could also work...”

His one-line verdict on the controller-port approach, from the cover note (Figure 6): **CONFIRMED**

“It works so (cool) on controller port — no (lock) probs, etc & easy to do.”

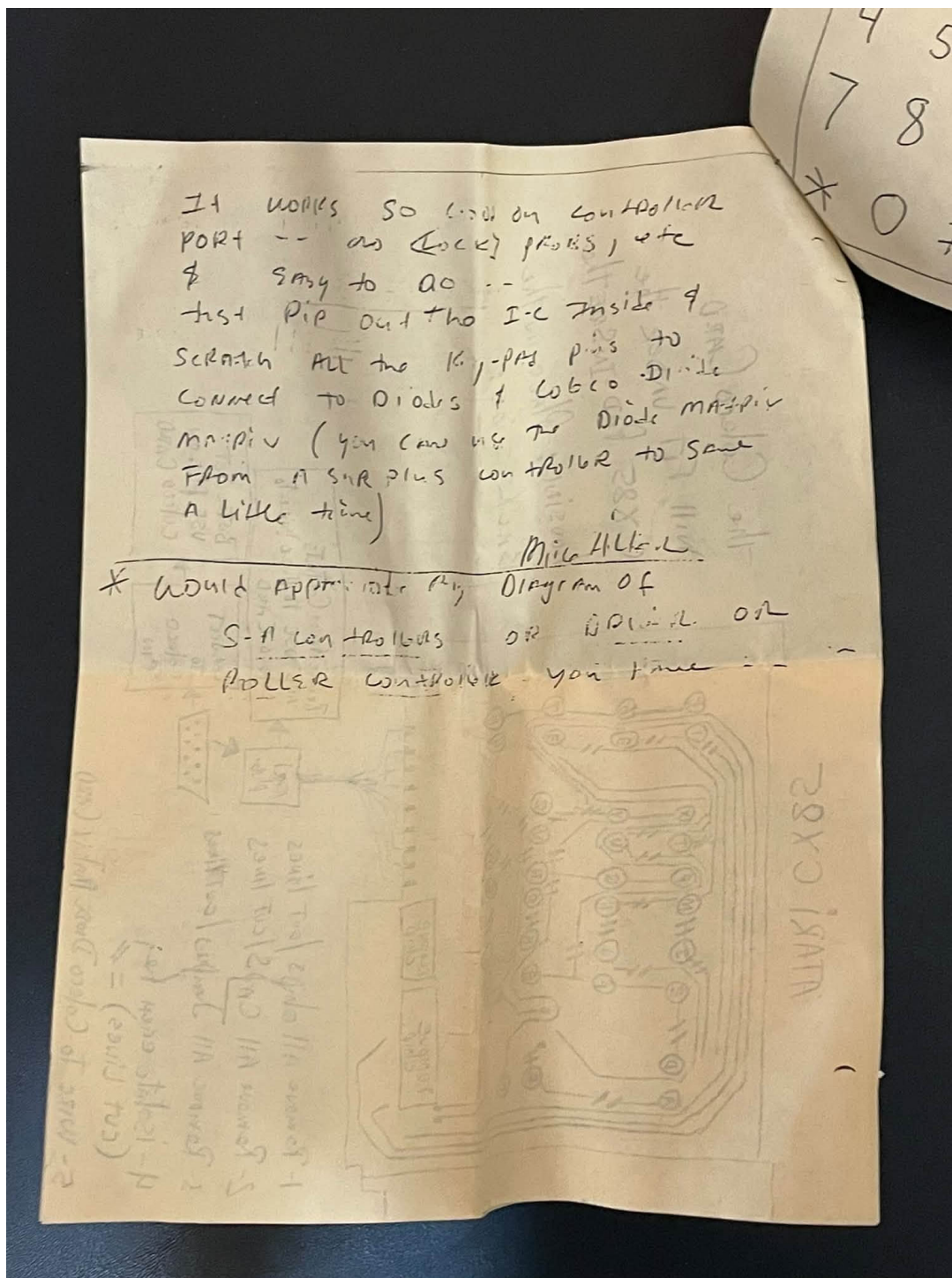


Fig 6. Hilker's cover note. The paragraph confirms the controller-port design intent, cites the Super Action Controller as a convenient donor for the diode matrix, and signs off "Mike Hilker."

4. The Atari CX-85 as a donor platform

From the annotated Atari service schematic (Figure 7), the stock CX-85 has the following architecture: **CONFIRMED**

Element	Specification
Keypad layout	4×4 matrix: numeric keys 1–9 plus +/ENTER · 0 · YES(F4) · ESC(F1); NO(F2) and DEL(F3) as function keys
Keypad encoder IC	Motorola MCM74C923N — 20-DIP CMOS 20-key encoder with internal scan oscillator, 2-key rollover, debounce, latched 5-bit output (Data Available plus 4 data lines)
Output buffer	Motorola MC14049B — 16-DIP CMOS hex inverting buffer; level-shifts and drives the output cable
Timing capacitors	C1 = 0.01 µF (scan clock); C2 and C3 = 1 µF (debounce)
Output connector	DE-9 male, Atari joystick pinout: 1=FWD, 2=BACK, 3=LEFT, 4=RIGHT, 5=B POT, 6=TRIGGER, 7=Vcc +5V, 8=GND, 9=A POT (unused)
Output logic levels	CMOS: V_OL = 0.4V @ 3.2 mA; V_OH = 4.0V @ 0.7 mA
Cable wire colors	1-Green, 2-Yellow, 3-Orange, 4-Red, 5-Brown, 6-White, 7-Grey, 8-Violet, 9-Blue

Natively the CX-85 presents a 4-bit binary key value plus a Data Available strobe on the Atari joystick signal lines, so Atari 8-bit and 2600 software sees it as a numeric keypad. None of that native behavior survives the conversion.

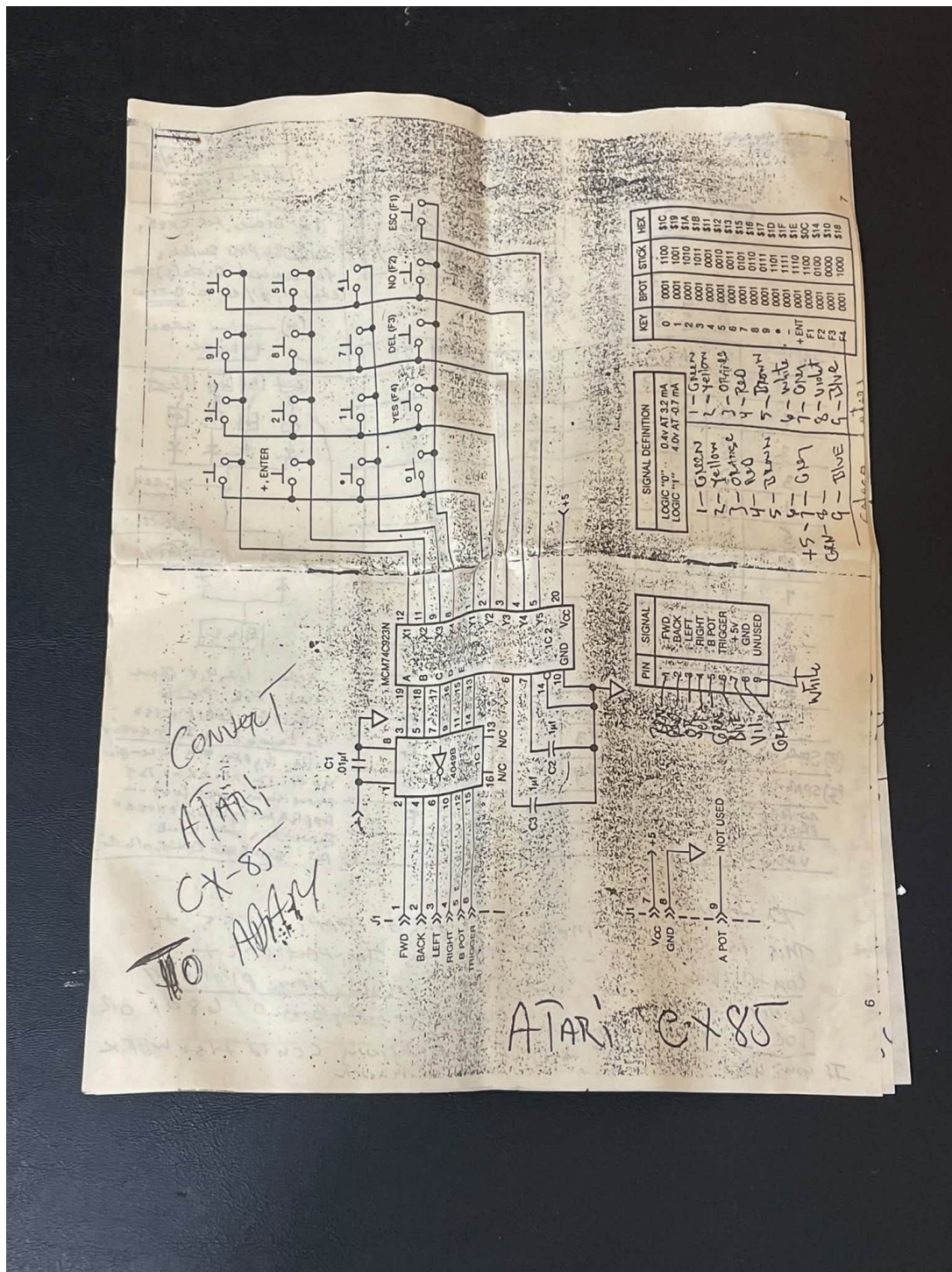


Fig 7. Atari CX-85 service schematic (page 6–7), photocopy with Hilker's added header "CONVERT ATARI CX-85 TO ADAM." The 4×4 switch matrix drives the MCM74C923N encoder; MC14049B buffers its outputs to the DE-9. The right-hand tables give wire colors (D1–D9), CMOS logic levels, and the DE-9 pin assignments.

5. Why the CX-85 chips must come out

The Coleco controller port keypad protocol expects a *passive diode matrix*, not a scanning encoder with latched outputs. The ADAM/ColecoVision polls the keypad by driving one of

several column-select lines through the controller connector and reading back which of 4 return lines are pulled low by diodes in the pressed-key path. If the MCM74C923N encoder were left in place, its CMOS outputs would fight the ADAM's column drives — at best producing garbage reads, at worst damaging the encoder. **INFERRED** (from first principles; Hilker's plan removes the ICs without stating the electrical reason).

Hilker's teardown procedure (annotated on Figure 3): **CONFIRMED**

1. Remove all chips, cut lines
2. Remove all capacitors, cut lines
3. Remove all jumpers, cut lines
4. Isolate each key (cut lines) so every switch is a bare, independent SPST
5. Wire each switch into a Coleco diode matrix card

After step 4 the CX-85 PCB is nothing but 15 isolated momentary switches and bare copper real estate — the perfect substrate for grafting a Coleco diode matrix beneath it. From Figure 6:

“Just rip out the IC inside & scratch all the keypad pins to connect to diodes & Coleco diode matrix (you can use the diode matrix from a Super Controller to save a little time).”

Diode specification is given on a torn note on Figure 3: all diodes are **1N914 or 1N4148**, standard small-signal silicon. **CONFIRMED**

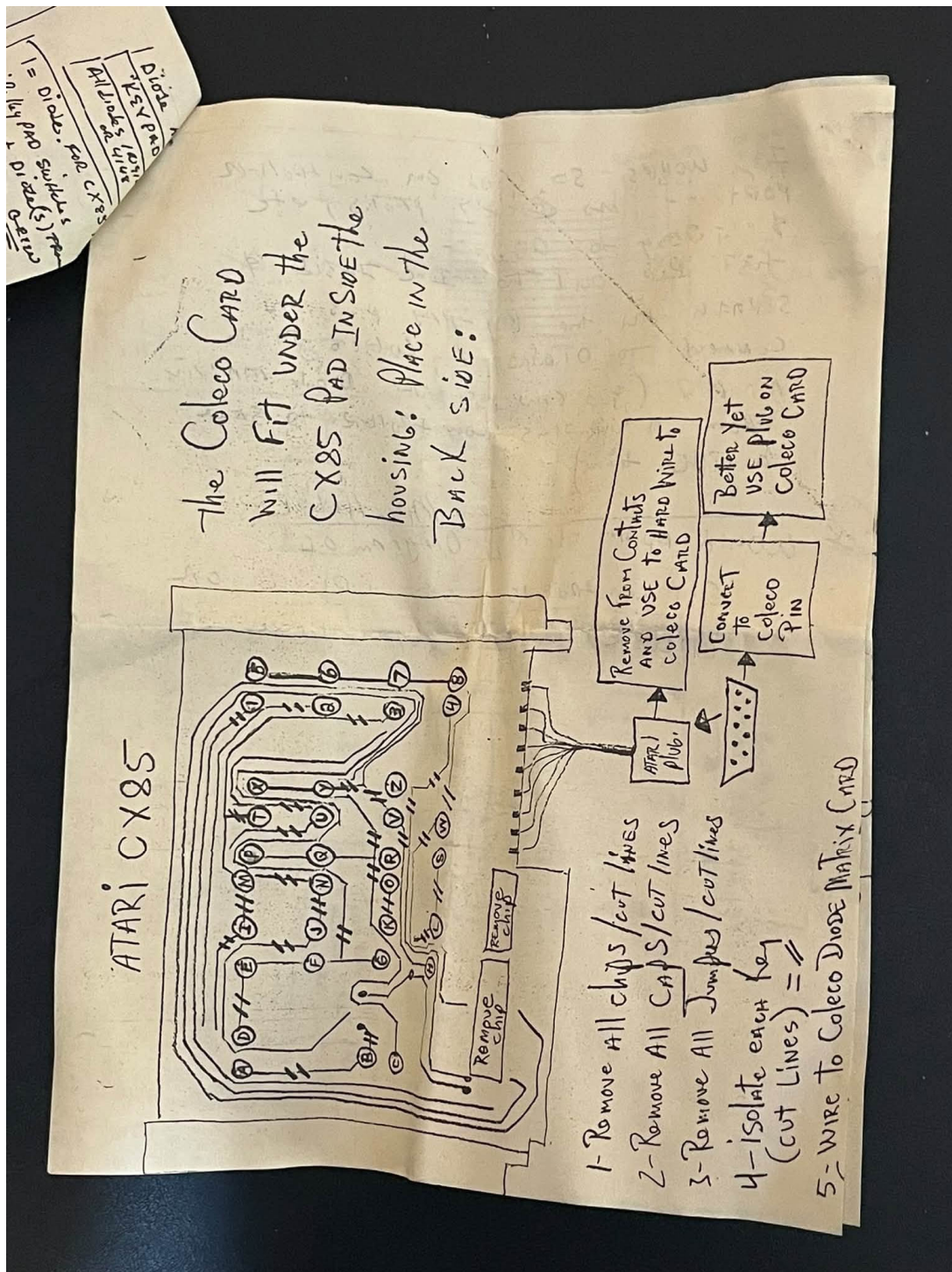


Fig 3. Hilker's PCB-level teardown plan for the Atari CX-85. Each switch position in the keypad matrix is labeled; the five-step procedure at the lower left reduces the board to isolated switches. The call-outs on the right describe two options for the output cable — hard-wire to the Coleco card, or (preferred) fit a Coleco controller plug for drop-in use.

6. Mechanical plan

From the handwritten note at the top of Figure 3: **CONFIRMED**

"The Coleco card will fit under the CX-85 pad inside the housing. Place in the back side."

The salvaged Coleco diode-matrix PCB tucks underneath the CX-85's own switch board, inside the original Atari housing. Nothing on the outside of the finished unit distinguishes it from a stock CX-85 except (optionally) a different output plug on the end of the cable.

Figure 1 adds a dimensional note for an alternative output location: a female connector cutout **3 inches from one edge** of the back of a “keyboard” housing. The sheet is labeled "FEMALE CONNECTOR LOCATION — BACK OF KEYBOARD." **OPEN** — it is unclear whether this refers to the CX-85 housing itself (unlikely, given its small size) or to a separate adapter enclosure Hilker contemplated for the finished unit. The reverse side of the sheet carries a secondary partial sketch that is not fully legible at the current scan resolution.

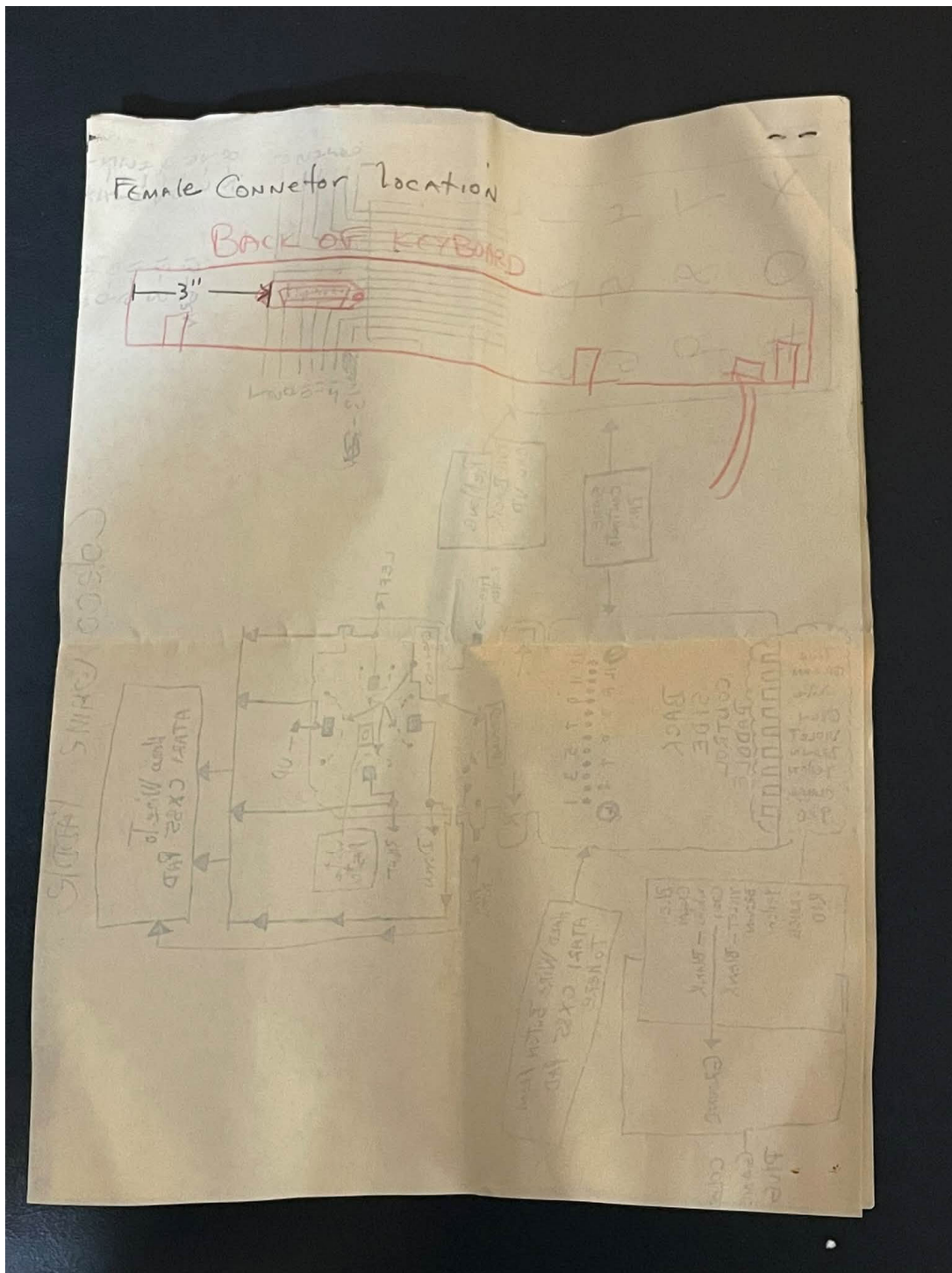


Fig 1. Mechanical note "Female Connector Location, Back of Keyboard," with a 3-inch dimensional callout. The surrounding faint pencil work (partially legible) appears to be an earlier draft of the diode-matrix and controller-interface sketches that appear more clearly on Figures 3 and 4.

7. The encoding chart — CX-85 keys to Coleco raw codes

Figure 8 is the primary technical deliverable from Hilker to Busby. For each key on the (ex-)Atari pad it specifies which of the four Coleco keypad return wires (Orange = 8, Red = 4, Yellow = 2, Brown = 1) must be pulled low when the key is pressed. The chart then shows the

raw 4-bit value SmartWriter / EOS firmware decodes before translation, and the final keypad digit value seen by application code.

The wire color legend printed above the chart matches the standard Coleco controller cable (Hilker's nine colors, pin numbers "looking at plug"): **CONFIRMED** 1-Brown, 2-Red, 3-Org, 4-Yel, 5-Green, 6-Blue, 7-Violet, 8-Grey, 9-White.

Transcribed table (CONFIRMED from Figure 8):

Symbol / Key	Or (8)	Rd (4)	Yl (2)	Br (1)	EOS raw	Deciphered	Hex
0	0	1	0	1	5	0	0
1	0	0	1	0	2	1	1
2	1	0	0	0	8	2	2
3	0	0	1	1	3	3	3
4	1	1	0	1	13	4	4
5	1	1	0	0	12	5	5
6	0	0	0	1	1	6	6
7	1	0	1	0	10	7	7
8	1	1	1	0	14	8	8
9	0	1	0	0	4	9	9
* (period)	0	1	1	0	6	10	A
# (SA:)	1	0	0	1	9	11	B
Spare-12	0	1	1	1	7	12	C
Spare-13	1	0	1	1	11	13	D
No key pressed	0	0	0	0	0	15	F
Invalid (all low)	1	1	1	1	15	15	F

WHY THE RAW CODES ARE SHUFFLED

The "EOS raw" column (5, 2, 8, 3, 13, 12, 1, 10, 14, 4...) is not sequential, and that is deliberate. The Coleco keypad codes were allocated so that no two adjacent digit values share a single-bit encoding, so a single stuck or shorted wire cannot silently fake a different key, and the two edge codes (0000 and 1111) serve as sentinel values for "nothing pressed" and "all wires pulled low / short." EOS and every CV keypad routine translate the raw code through a lookup table to produce the final digit value.

The two "Spare" entries (raw 7 and raw 11, decoded 12 and 13, hex \$C and \$D) are the **Super Action Controller's extra purple and blue action-key codes**. Hilker calls this out explicitly in the note at the lower right of Figure 8: **CONFIRMED**

"Note, 1, 2, 4, 8 above used for paddle direction. Could also be decoded into matrix like keypad #'s. Combined up to 12 are OK — 13 & above seems to get lost — apparently these 'extra' functions are used in Sard-Ac Controller?"

("Sard-Ac" is Hilker's shorthand for the Super Action Controller.) Hilker correctly identifies that the standard CV/ADAM keypad routines ignore codes \$C and \$D, but that software written for the SAC can read them — which means this converter can also serve as a cheap substitute for the Super Action Controller's keypad half, in software that expects those codes.

8. Diode-matrix wiring plan

The small schematic at the upper right of Figure 8 sketches the standard Coleco controller internal structure that Hilker's salvaged donor PCB implements: **CONFIRMED**

- Four "column" return wires — Orange (8), Red (4), Yellow (2), Brown (1) — pulled high internally.
- Each keypad switch, when pressed, routes current through 1–4 small-signal diodes to the common Green return.
- Fire button and Arm button take dedicated diode paths to Blue.
- Grey is the second-row return (used for joystick-direction decode on a full controller).

This is textbook Coleco controller topology; the diode matrix on a stock hand controller PCB implements exactly this pattern with its printed-PCB diodes. Hilker's recommended shortcut — lifting the diode PCB from a Super Action Controller donor — is sound because the SAC's matrix already includes the extra diodes for codes \$C and \$D, saving the builder the trouble of adding them to a stock-controller donor.

9. Coleco controller flex pinout reference

Figure 4 enumerates the 13-pin internal flex connector on the back of a standard Coleco controller, with the pin-numbering flow and the wire-color harness: **CONFIRMED**

Blue, Green, White, Grey, Violet, Brown, Yellow, Orange, Red — the nine distinct wire colors found on a stock Coleco controller internal cable, carrying the matrix returns and the joystick direction lines.

The "pull back and up" and "same contacts / pins" call-outs document how to lift the stock keypad flex off the stock controller, leaving the diode PCB behind for transplantation into the CX-85 shell. The right-hand side of the sketch shows the joystick direction decoding (ground, left, right, up, down, fire button) through the diode matrix — useful for a reader interpreting the salvaged PCB's layout.

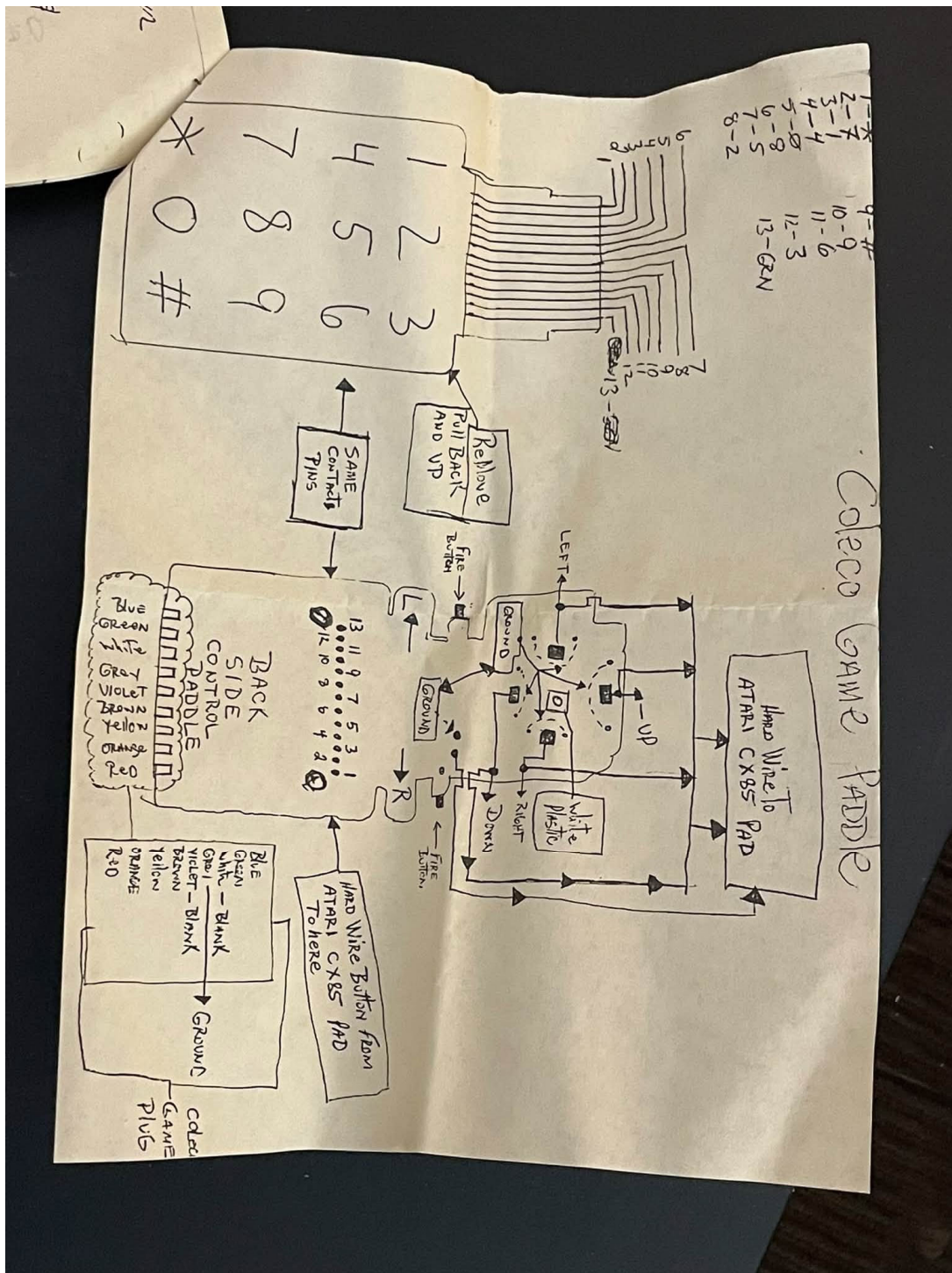


Fig 4. Hilker's reference sketch of a stock Coleco controller's internal flex connector (left table, columns 1–13), its wire-color harness, and the direction-plus-fire decoding of the joystick portion of the diode matrix. Call-outs explain how to lift the keypad flex off a donor controller and transfer its pin pattern.

10. Compatibility notes

The finished converter will work with: **INFERRED** from the design matching the standard Coleco keypad protocol.

- Any ColecoVision cart that reads keypad input (Donkey Kong, Smurfs, Mouse Trap, War Games, etc.)
- SmartWriter — the keypad is read as a controller keypad, not as the ADAM main keyboard
- EOS and CP/M applications that poll JS1 / JS2 keypad bytes
- SmartBASIC JOY(n) keypad functions
- Any ADAM-native title that reads controllers via EOS
- Super Action Controller-aware software, for the two extra codes (\$C, \$D), when the SAC donor's full diode matrix is used

The finished converter will NOT provide:

- Alphabetic keys. The CX-85 is a numeric pad; the Atari function keys (F1–F4, YES, NO, DEL, +/ENTER) at best map to the two "Spare" slots or to the * / # positions. There is no path to the ADAM keyboard matrix without going through the keyboard's AdamNet 6801 — the exact path Hilker explicitly rejected (see §3).
- The CX-85's native rollover and debounce. Once the MCM74C923N is removed, the pad is bare switches with no hardware debounce. The Coleco keypad poll loop in EOS and cart ROMs provides software debounce, so in practice this is not a problem.

11. Open items and next steps

- Higher-resolution flatbed scans of all eight sheets — the photocopied Atari schematic (Figure 7) and the encoding chart (Figure 8) are the primary technical content and merit archival-grade reproduction before further paper aging. **OPEN**
- FCC ULS lookup for callsign WA6MAX — brackets the correspondence by license grant and renewal history, giving a workable date range. **OPEN**
- Community cross-reference — any mention of Hilker or this specific mod in ADAM News Network, AUG, FAQ archives, or BBS captures? If this was published anywhere beyond the direct letter to Busby, that is the citation of record. **OPEN**
- Confirmation of John Busby's identity in the ADAM community (there is more than one well-known Busby in retro computing). **OPEN**
- Confirmation of whether a built example of this conversion exists in any collection (museum or community) — the plans and parts are preserved but the completed unit is not currently in the museum collection. **OPEN**
- Clarification of the Figure 1 "back of keyboard" dimensional note — which housing does it refer to? **OPEN**
- Role of the modular / RJ cable in the shipped kit (Figure 5) — its purpose is not stated in any of the written plans. **OPEN**

12. Figure index

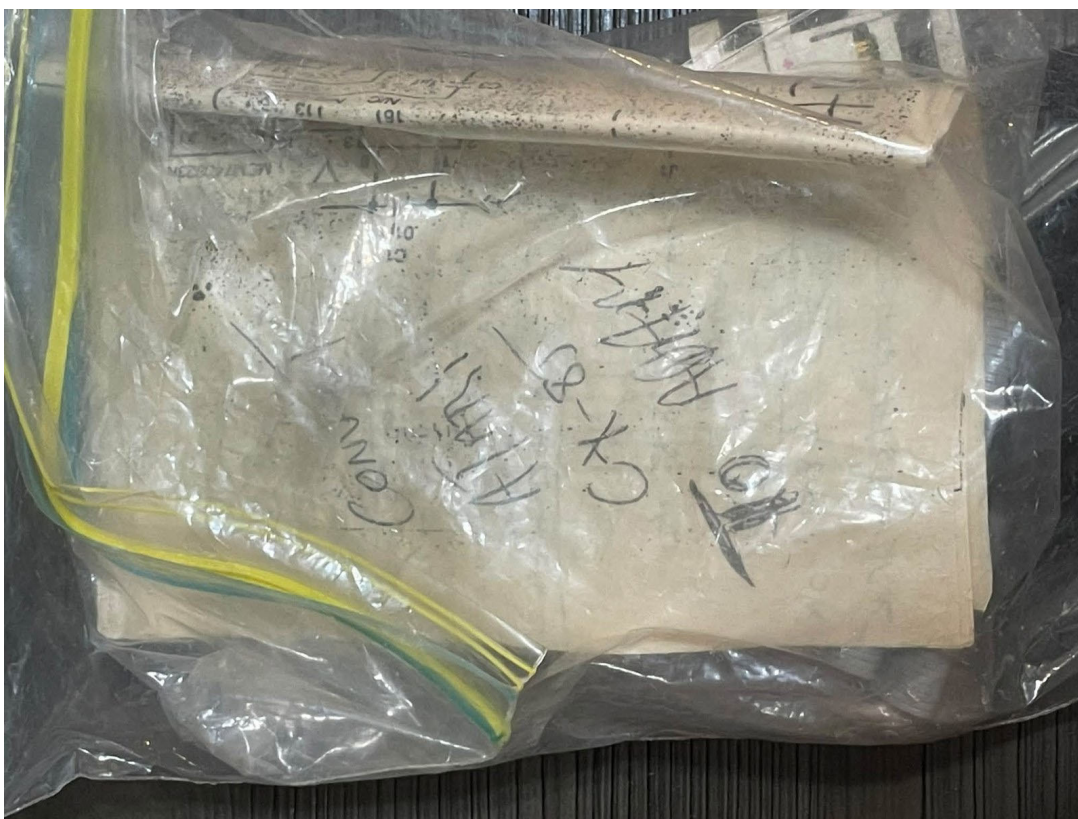


Fig 2. The bag the correspondence and parts were preserved in. Secondary interest only — included for provenance completeness.

All eight source photographs are reproduced inline above at the sections that reference them, except Figure 2 (shipping bag) which has no technical content and appears here as the provenance record. Figure numbering follows the order sheets are discussed in the body text, not the file order of the original image set.

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Prepared by Rich DiRocco. Documents and parts photographed from the museum's correspondence archive.
Source author: Michael D. Hilker (WA6MAX). All claims evidence-tagged per CVA documentation standard.