Cadetwriter

(ASCII Terminal)

User Guide

CHM Computer History Museum

IBM 1620 Jr. Team
Computer History Museum
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Contents

- Arduino IDE, version 1.8.13.
  https://www.arduino.cc/en/Main/Software
- Teensyduino IDE, version 1.53.
  https://www.pjrc.com/teensy/td_download.html

E.4 Accessories

- Optional paper guide:
  https://www.github.com/IBM-1620/Cadetwriter/blob/master/accessories/williamson_paper_guide.zip

E.5 Supplies

- IBM/Lexmark Courier 10 ASCII printwheel, IBM/Lexmark P/N 1353909.
  https://www.aroundtheoffice.com/IBM-Printwheel-Courier-10-1353909/productinfo/PW-IBM-1353909
  https://www.amazon.com/s?k=ibm+1353909
- IBM/Lexmark Artisan 10 printwheel, IBM/Lexmark P/N 1353520.
  https://www.aroundtheoffice.com/IBM-Printwheel-Artisan-10-1353520/productinfo/PW-IBM-1353520
  https://www.ibmtypewriters.com/type.html
- IBM/Lexmark ribbon, IBM/Lexmark P/N 1380999.
  https://www.staples.com/Wheelwriter-Systems-IBM-Superior-Write-Correctable-Film-Ribbon-model-1380999/product_140111
- Fanfold 9.5” x 11” printer paper.
  https://www.staples.com/Staples-Blank-White-Computer-Paper-Ultra-Perforated-20-lb-9-1-2-x-11-1-000-Box/product_177089
  https://www.staples.com/Staples-Computer-Paper-Ultra-Perforated-9-1-2-x-11-Blank-White-20lb-2-500-Box/product_177154

E.6 Sales and Parts

- Batchelor Business Machines
  https://www.ibmtypewriters.com/
- Around the Office
  https://www.aroundtheoffice.com/
- Typewriters.com
  https://www.typewriters.com/
- eTypewriters.com
  https://www.etypewriters.com/

E. References

Here are a useful set of references for Cadetwriter:

E.1 Documentation

- Cadetwriter User Guide, version 1.00, April 2021.
  https://www.github.com/IBM-1620/Cadetwriter/tree/master/docs/user_guide/cadetwriter_user_guide_1.00.pdf
  https://www.github.com/IBM-1620/Cadetwriter/tree/master/docs/user_guide/cadetwriter_user_guide_1.00_booklet.pdf
- Cadetwriter bulletin boards.
  https://cadetwriter.slack.com
- Cadetwriter technical documentation and files.
  https://www.github.com/IBM-1620/cadetwriter
- IBM/Lexmark Wheelwriter 1000 User's Guide, P/N 1419147, Form No. SA40-0825-00, July 1994.
  https://www.github.com/IBM-1620/Cadetwriter/blob/master/docs/wheelwriter/wheelwriter_1000_user_manual.pdf

E.2 Hardware

- Cadetwriter adaptation guide, version 2.0.
  https://github.com/IBM-1620/Cadetwriter/blob/master/docs/adaptation_guide/wheelwriter-adaptation-instructions.pdf
- Cadetwriter Serial Interface Board, version 2.0.
  https://www/github.com/IBM-1620/Cadetwriter/tree/master/hardware

E.3 Firmware

- Cadetwriter firmware source, version 6R0.
  https://www.github.com/IBM-1620/Cadetwriter/blob/master/firmware/serial_interface_board/Serial_Interface_Board.ino
- Cadetwriter firmware HEX binary, version 6R0.
  https://www.github.com/IBM-1620/Cadetwriter/blob/master/firmware/serial_interface_board/Serial_Interface_Board.ino.TEENSY35.hex
- SlowSoftSerial library.
  https://www.github.com/MustBeArt/SlowSoftSerial
- Teensyduino HEX loader, version 1.53.
  https://www.pjrc.com/teensy/loader.html

1. Introduction

This guide describes the operation of Cadetwriter, a Wheelwriter-based computer terminal. It is an extension of the console typewriter created for the Computer History Museum's IBM 1620 Jr. project. Its complete design, assembly instructions, and firmware is available, free-of-charge from: *https://github.com/IBM-1620/Cadetwriter*.

1.1 Description

Cadetwriter is a general-purpose, ASCII computer teleprinter similar to a Teletype, DECwriter, Flexowriter, or IBM 2741 terminal. It can be used as an input/output device connected to any computer - old, new, or replica – with an RS-232 or USB interface. It can also be operated as a stand-alone typewriter by changing a hardware jumper.

Cadetwriter is built by installing a custom serial interface board inside an IBM/Lexmark Wheelwriter 1000 electronic typewriter.[1] Firmware in this board's ARM processor reads the keyboard, controls the printer, and communicates with the computer.

1.2 Features

Cadetwriter has the following features:

- Print speed up to 16 or 20 characters-per-second, depending on Wheelwriter model.
- 10, 12, or 15 pitch interchangeable typewheels, multiple fonts.[2]
- 80 - 198 characters per line depending on printwheel pitch and carriage size.
- Full ASCII character set.
- RS-232 and USB interfaces.
- Full or half duplex.
- Baud rates: 50, 75, 110, 134, 150, 200, 300, 600, 1200, 1800, 2400, 4800, 9600, 19200, 38400, 57600, 76800, 115200, or 230400.
- None, odd, or even parity.
- 7 or 8 data bits.
- 1 or 2 stop bits.

[1] Although Cadetwriter was created using a Wheelwriter 1000, other model Wheelwriters also work with little or no changes to the firmware or serial interface board.

[2] Cadetwriter output is optimized for the Courier 10 ASCII (#1353909) and Artisan 10 (#1353520) printwheels.

D. Support

Cadetwriter was developed by the Computer History Museum's IBM 1620 Jr. project team. It is being made available free-of-charge to computer hobbyists with no implied warranty or formal support. However, the team is interested in helping others be successful with Cadetwriter and will make a best-effort attempt to help.

The primary source of information and help with Cadetwriter is a set of channels at: https://cadetwriter.slack.com. These include:

- Announcements – Updates to the firmware, build instructions, documents, etc. will be announced here.
- Building – Used by those building a Cadetwriter to exchange information.
- Description – Contains general information about Cadetwriter.
- Operating – Information and questions/answers about using Cadetwriter.
- Suggestions – A place to post and discuss suggestions for changes/enhancements to Cadetwriter.

All of the Cadetwriter technical documentation and files are freely available at: https://github.com/IBM-1620/Cadetwriter. This is also the site to file bugs in Cadetwriter firmware or hardware.

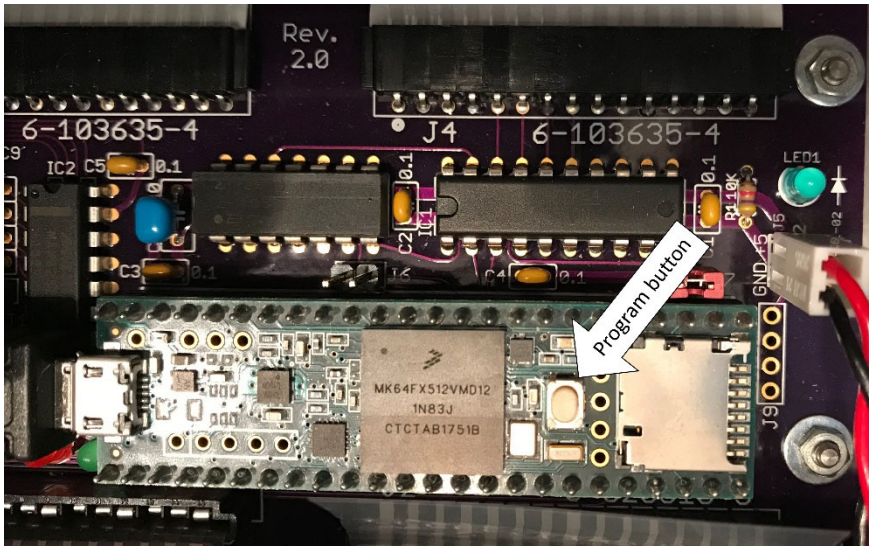
Finally, questions and comments can be emailed to: cadetwriter@ibm1620.org.

C. Updating Firmware

In normal operation, there is no need to update the firmware in *Cadetwriter*. However, it is easy to install new firmware when it is needed to get a new feature or a bug fix.

The steps to update the firmware are:

1. Download the operating-system-specific Teensyduino HEX loader from: https://www.pjrc.com/teensy/loader.html
2. Download the latest firmware HEX binary from: https://github.com/IBM-1620/Cadetwriter/blob/master/firmware/serial_interface_board/Serial_Interface_Board.ino.TEENSY35.hex
3. Connect the *Cadetwriter* to the computer using a USB cable.
4. Turn on the *Cadetwriter*.
5. Run the downloaded Teensyduino HEX loader and select "File -> Open HEX File" supplying the downloaded firmware HEX binary.
6. It may be necessary to press the Program button on the Cadetwriter serial interface board if the load doesn't start on its own.



7. Once the loading completes, turn the *Cadetwriter* off and back on.

It is also possible to modify the source code to add custom feature(s), but describing that is beyond the scope of this User Guide. Note that the *Cadetwriter* Principles of Operation is documented in the source code itself.

- Hardware (RTS/CTS or RTR/CTS) or software (XON/XOFF) flow control.
- Uppercase/lowercase or uppercase only.
- End-of-line: CR, LF, CR/LF, or LF/CR.
- Adjustable left and right margins.
- Settable tab stops.
- All settings are permanently retained.[3]

1.3 Keyboard

The *Cadetwriter* keyboard is as close to a typical ASCII terminal layout as possible with the Wheelwriter typewriter. In addition to printable characters, the keyboard includes keys to set/clear margins and tabs, move the carriage, and enter SetUp mode. The "Code" key functions as the "Ctrl" (control) key. This is *Cadetwriter*'s keyboard using replacement ASCII keycaps:

1.4 Printer

The printer in *Cadetwriter* is a Daisy wheel mechanism which prints fully-formed characters. Many printwheels exist for the Wheelwriter typewriter with different fonts, pitches, and foreign languages. Most of them contain a "typewriter" set of print characters which includes ½, ¼, ¢, ±, °, ², ³, §, and ¶. Missing are the ASCII characters <, >, \, ^, `, {, |, }, and ~.

IBM/Lexmark produced a limited number of special "ASCII" printwheels with all of the ASCII characters, but they are rare and hard to find. These are the preferred ones to use with *Cadetwriter* as they produce the best-looking output and print at maximum speed. Here is *Cadetwriter*'s full character set when using the Courier 10 ASCII printwheel (#1353909):

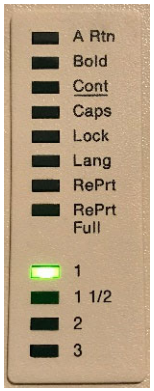
```
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz
0123456789 !"#$%&'()*+,-./:;<=>? @[\]^_`{|}~
```

[3] Wheelwriter settings are stored in volatile memory, preserved by battery backup. All *Cadetwriter* setting are stored in non-volatile EEPROM.

When using a standard, non-ASCII printwheel, *Cadetwriter* synthesizes the missing characters by overprinting available characters, or "period graphic" characters[4], or a combination of the two methods. Composite characters, due to their complexity, take longer to print than the native ones, reducing the effective print speed. Here is the full ASCII character set as printed by *Cadetwriter* using the Artisan 10 printwheel (#1353520):

```
ABCDEFGHIJKLMNOPQRSTUVWXYZ abcdefghijklmnopqrstuvwxyz
0123456789 !"#$%&'()*+,-./:;<=>? @[\]^_`{|}~
```

1.5 Indicator Lights

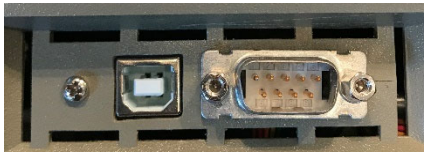


In normal operation, only the single-spacing indicator light will be on. However, after printing several pages of output, the "RePrt Full" will light up, but will not affect the operation of the terminal.

The Shift Lock key on the keyboard will function as expected, but the "Lock" indicator will not light up. This is due to the way *Cadetwriter* interfaces with the Wheelwriter electronics.

Note that when operating as a stand-alone Wheelwriter typewriter, all of the indicator lights will have their standard meaning.

1.6 Serial Ports



Cadetwriter has two serial ports for connecting to a computer – RS-232 and USB. The RS-232 port is a male DE-9 (DTE) connector. The USB port is a male USB-B connector. Which port is used and its communication parameters are specified in the configuration settings [see section 2.2].

[4] Period graphic characters are formed by a combination of micro-space carriage movements (up, down, left, and right) and printing periods.

problem: **Period graphic characters (<, >, \, ^, `, {, |, }, ~) don't print correctly in column 1.**

solution: Most of the period graphic characters need to micro-space to the left of character-center to print a period. Physical column 1 of the Wheelwriter is up against a mechanical stop and the carriage cannot move to the left. Make sure that the **line offset** setting is at least 1.

problem: **Lines are overprinting or double spacing.**

solution: This happens when the *Cadetwriter* **transmit end-of-line** and/or **receive end-of-line** settings don't match what the computer is using. Correct the end-of-line settings.

problem: **The carriage isn't automatically or consistently returned when the right margin is hit.**

solution: This can happen when the **auto return** setting in SetUp mode is "false". It should normally be set to "true". An irregular automatic carriage return can happen when the Wheelwriter's **A Rtn** setting is on. If the "A Rtn" indicator is on, then turn off the setting using SetUp mode's typewriter command #4.

problem: **Printed characters are not spaced evenly or the carriage doesn't return all the way.**

solution: This is a mechanical issue with the Wheelwriter. Lubricating the guide rails will often correct the problem.

problem: **The "RePrt Full" light comes on.**

solution: The Wheelwriter stores all output in an internal print buffer to allow the user to re-print pages (when used as a standalone typewriter). When the buffer is full, the "RePrt Full" light is turned on. *Cadetwriter* doesn't use this feature and has no way to turn it off. It does not affect correct operation and can be safely ignored.

problem: **The "Lock" light does not turn on when the "Lock" key is pressed.**

solution: This is expected - keyed alphabetic characters will be properly treated as uppercase, the light just won't be on. It is a limitation caused by how the *Cadetwriter* serial interface board is connected to the Wheelwriter.

problem: **The carriage moves right and jiggles the printwheel across the entire line.**

solution: This is a normal behavior to set the margins and tab stops. It happens:

- Every time the terminal is turned on and the **batteries installed** setting [section 3] is false. If the batteries are really installed, correct the batteries installed setting.
- One time when the **line length** and/or **line offset** settings [section 3] are changed.
- One time when the terminal is turned on after the hardware emulation jumpers were changed.

problem: **The terminal beeps a lot.**

solution: There are many reasons that the terminal beeps:

- A single beep happens when a Ctrl-G [BEL, 0x07] is received from the computer.
- A single beep happens when the carriage is five spaces from the right margin.
- A double beep happens when the Wheelwriter's spell checker detects a word not in its built-in dictionary. Cadetwriter is designed to operate with the spell checker off. When the **batteries installed** setting isn't correct, the Cadetwriter firmware and the Wheelwriter can get out-of-sync. Correct the **batteries installed** setting. The SetUp mode's typewriter command #1 can be used to turn the spell check feature off.
- A triple beep and all of the line spacing lights are blinking happens when there is a problem with the Wheelwriter's batteries. Turn off the terminal and replace the batteries.
- A triple beep with no blinking lights happens when the Wheelwriter's input buffer is getting full. This can sometimes occur when the computer sends a large volume of output to be printed. This is not an error condition and all characters will print correctly with none lost.
- Six beeps and one or more lights blinking happens when the printwheel and/or ribbon are installed incorrectly. Turn off the terminal and reinstall the printwheel and ribbon.

problem: **Some characters are not printed correctly.**

solution: There are many different size, font, and language printwheels available. Cadetwriter was designed to use the Courier 10 ASCII (#1353909) or Artisan 10 (#1353520) printwheels. Use the correct printwheel.

The DE-9 pin assignments are:

Pin	Signal
1	DCD – Data Carrier Detect †
2	RXD – Received Data
3	TXD – Transmitted Data
4	DTR – Data Terminal Ready †
5	GND – Common Ground
6	DSR – Data Set Ready †
7	RTS – Request To Send / RTR – Ready To Receive
8	CTS – Clear To Send
9	RI – Ring Indicator †

† DTR and DSR are not active and are connected together. DCD and RI are not connected.

2. Setup

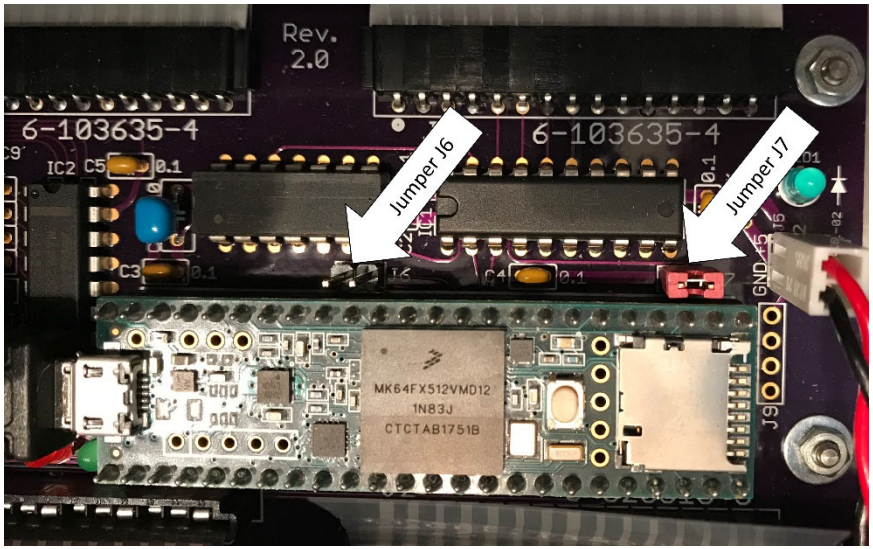
When connecting *Cadetwriter* to a computer for the first time, a little setup is required.

2.1 Selecting the Emulation

Four emulations are available by setting hardware jumpers on the serial interface board:

J6 Jumper	J7 Jumper	Emulation
		IBM 1620 Jr. Console Typewriter
	X	*Cadetwriter* ASCII Terminal
X		<available for future emulation>
X	X	Standalone Wheelwriter Typewriter

Here are the jumpers set to *Cadetwriter* ASCII Terminal emulation:



The emulation jumpers are tested only once when *Cadetwriter* is turned on. They can be changed when the device is off or on, but only take effect the next time it is turned on.

2.2 Configuring *Cadetwriter*

Most of the operations of *Cadetwriter* can be controlled by firmware configuration settings. These values are set interactively via a sequence of queries and controlled responses when in SetUp mode. The settings are

The possible warnings are:

Warning	Comments
Short column scan	A column scan was shorter than normal.
Long column scan	A column scan was longer than normal. This can be caused when too many synthesized characters are printed close together. When this happens, the terminal beeps 3 times and there can be a noticeable pause in printing.
Unexpected column scan	A column was scanned out-of-order.
Serial input incorrect parity	A character was received from the computer with incorrect parity.

B.3 Problems

Listed below are some common problems and suggested solutions. Other typewriter-specific problems and their solution can be found in the Wheelwriter User's Guide.

problem: **The terminal is not connecting with the computer.**

solution: Communication problems have several causes.

- Is the correct port on the computer being used?
- Are the hardware jumpers [section 2.1] set to ASCII Terminal?
- Is the serial port setting [section 3] correct?
- If the RS-232 port is selected, are the **baud rate** and **dps** settings [section 3] correct?
- If the RS-232 port is being used, an incorrect [crossover aka null modem] cable might be the problem. Replace the cable with a straight-thru one or add a null modem adapter.

problem: **Typed characters do not print.**

solution: If characters from the computer print, but keys typed on the keyboard don't, that indicates a mismatch between the computer's **duplex** setting and the terminal's. Either set the computer to full duplex or the terminal to half duplex [section 3].

Print buffer full	The internal print buffer is full. This could happen if the computer is flooding the terminal with data and flow control is either disabled or not working correctly.
Bad print code	An internal, predefined character string contains an invalid print code. This is a coding error in the firmware.
Bad escape sequence	An invalid escape sequence was received and the **escape sequences** setting is "ignore". There is no way to properly handle sequences that do not follow the ISO/IEC 6429 standard, so it is possible that some sequence characters are erroneously printed or non-sequence characters lost.
Bad element type	The type value in a character element is invalid. This is a coding error in the firmware.
Bad print spacing	The spacing value in a character element is invalid. This is a coding error in the firmware.
Bad printwheel position	The printwheel position value in a character element is invalid. This is a coding error in the firmware.
Bad key action	The action value in a key action table is invalid. This is a coding error in the firmware.
Bad serial action	The action value in a serial action table is invalid. This is a coding error in the firmware.

B.2 Warnings

The Cadetwriter firmware contains checks which can detect minor, unexpected conditions. If the **record warnings** setting is true [the default is false], then any warnings that occur will be counted and the blue Warning LED will be turned on. Warnings do not affect the correct functioning of Cadetwriter.

The SetUp mode "errors" command will print a list of any warnings that have occurred with their counts. Optionally, the warning counts can be cleared.

The Wheelwriter motherboard controls the scanning of the keyboard. Most of the time, the [column] scans are in a consistent order and timing, but occasionally, they are not. The Cadetwriter firmware properly handles these abnormalities and no data is lost.

effective for as long as Cadetwriter is turned on and can be optionally stored in EEPROM for persistence.

SetUp mode is entered by pressing the "Code" and "SetUp" keys together, aka Ctrl-SetUp. The "SetUp" key is ignored if not used with the "Code" key. SetUp mode is not available when Cadetwriter is jumpered to be a standalone Wheelwriter typewriter.

While in SetUp mode, no data is sent to the computer and flow control (if enabled in settings) is asserted so that data should not be sent by the computer. If data is received, it will not be processed until SetUp mode is exited and may be lost if communication settings are changed.

SetUp mode starts by printing the following header which reports the emulation selected and the revision number of the firmware.

```
---- Cadetwriter: ASCII Terminal (v6R0) Setup
```

Next, the following command query is typed:

```
Command [settings/errors/character set/typewriter/QUIT]:
```

This illustrates the consistent way that SetUp mode queries commands and non-typewriter settings:

- "Command" or the name of a specific setting (i.e.: **parity**) is printed first.
- Next, all valid responses are shown inside brackets, separated by "/"s.[5]
  - For commands, the default option is printed in all uppercase. All other possible commands are in lowercase.
  - For settings, the current value [default] of the setting is printed in all uppercase. All other possible responses are in lowercase.
- The print mechanism spaces to the right so that the entire query is viewable.
- The user now enters a response to the query. Responses are case-insensitive. Only enough characters to uniquely specify a value need to be typed. In most cases, the first character is sufficient. If an invalid character is typed, nothing prints and the terminal beeps.

[5] The exceptions are the **baud rate**, **line length**, and **line offset** settings which print the supported range of values and the current [default] value within the brackets. For example: "baud rate [50-230400, 1200]".

- Once enough characters are entered to uniquely identify the response, the remaining characters of it are printed and SetUp mode executes the command or updates the setting and moves on to the next one.
- When responding to the **line length** and **line offset** settings, a carriage return terminates the value.
- If only a carriage return is entered, then the default response is used. For commands, this exits SetUp mode. For settings, this retains the current value.
- At the end of all settings, SetUp mode asks if the new settings should be saved in EEPROM.

```
Save settings [yes/NO]?
```

If “yes”, all settings are preserved until changed. If "no", the new settings are in effect only as long as *Cadetwriter* remains turned on.

There are five commands:

settings - Interactively review and optionally change all firmware configuration settings. See section 3 of this guide for details.

errors - Print all errors and warnings that have occurred since the last power on or reset. Optionally, the error and warning counters can be cleared.

character set - Print the full character set.

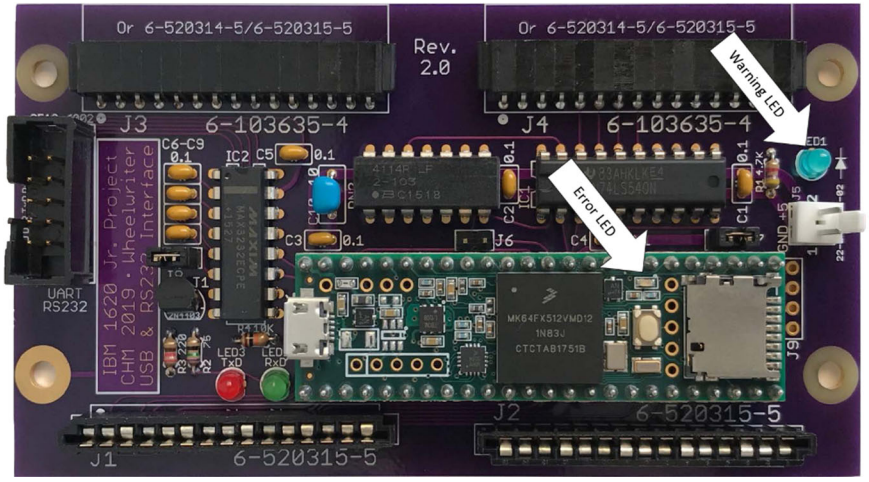
typewriter - Set or clear all relevant typewriter settings. See section 4 of this guide for details.

quit - End SetUp mode.

It is also possible to reset all firmware configuration settings to their “factory” default by pressing the “Shift”, “Code”, and “SetUp” keys together, aka Shift-Ctrl-SetUp. After resetting the settings, the firmware will re-establish all margins & tab stops and a confirmation message will be printed.

B. Troubleshooting

Once *Cadetwriter* is set up and properly configured, it is a reliable computer terminal. However, there can be occasional problems, often caused by incorrect settings.



B.1 Errors

The *Cadetwriter* firmware contains checks which can detect serious errors. If the **record errors** setting is true [the default is true], then any errors that occur will be counted and the orange Error LED will be turned on. All errors can cause the loss of data.

The SetUp mode “errors” command will print a list of any errors that have occurred with their counts. Optionally, the error counts can be cleared.

The possible errors are:

Error	Comments
Command buffer full	The internal command buffer is full. This could happen if the firmware’s main routine failed.
Receive buffer full	The internal receive buffer is full. This could happen if flow control is disabled or not working correctly.
Send buffer full	The internal send buffer is full. This could happen if flow control is disabled or not working correctly.
Transfer buffer full	The internal transfer buffer is full. This could happen if the firmware’s main routine failed.

Cadetwriter recognizes the full set of Escape Sequences defined by ISO/IEC 6429 (ECMA-48, ANSI X3.64).

Escape (1 char)	**Opener** (1 char)	**Parameters** (0 - n chars)	**Intermediates** (0 - n chars)	**Final** (1 char)
<esc> 0x1B	**[** 0x5B	**0123456789:;<=>?** 0x30 - 0x3F	***<space>*****!"#$%&'()*+,-./** 0x20 - 0x2F	**@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~** 0x40 - 0x7E
<esc> 0x1B			***<space>*****!"#$%&'()*+,-./** 0x20 - 0x2F	**0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~** 0x30 - 0x7E
Escape (1 char)	**Opener** (1 char)	**Strings** (0 - n chars)		**Final** (1 char)
<esc> 0x1B	**PX]^_** 0x50, 0x58, 0x5D, 0x5E, 0x5F	***<bs><tab><lf><vt><ff><cr><space>*****!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~** 0x08 - 0x0D, 0x20 - 0x7E		***<esc>*** **** 0x1B & 0x5C ***<bel>*** 0x07

There are special cases with escape sequences:

- NUL (0x00) and DEL (0x7F) are always ignored.
- CAN (0x18) and SUB (0x1A) immediately abort the sequence.
- All control characters (0x01 - 0x1F) except CAN (0x18), SUB (0x1A), and ESC (0x1B) anywhere, except in String bodies, perform their normal action.
- P (0x50), X (0x58),] (0x5D), ^ (0x5E), and _ (0x5F) cannot be used to terminate Function sequences unless they contain at least one Intermediate character.
- Any ESC (0x1B) after the first, except in Strings, immediately aborts the current sequence and starts another one.

When using the RS-232 serial port, the default settings are:

```
record errors [TRUE/false]:
record warnings [true/FALSE]:
batteries installed [TRUE/false]:
serial [usb/RS232]:
duplex [half/FULL]:
baud rate [50-230400, 9600]:
dps [7o1/7e1/8N1/8o1/8e1/8n2/8o2/8e2]:
impression [light/NORMAL/heavy]:
sw flow control [none/XON_XOFF]:
hw flow control [NONE/rts_cts/rtr_cts]:
ASCII printwheel [true/FALSE]:
uppercase only [true/FALSE]:
auto return [TRUE/false]:
transmit end-of-line [CR/crlf/lf/lfcr]:
receive end-of-line [cr/CRLF/lf/lfcr]:
escape sequences [none/IGNORE]:
line length [80-165, 80]:
line offset [1-10, 1]:
```

When using the USB serial port, the default settings are:

```
record errors [TRUE/false]:
record warnings [true/FALSE]:
batteries installed [TRUE/false]:
serial [USB/rs232]:
duplex [half/FULL]:
parity [NONE/odd/even]:
impression [light/NORMAL/heavy]:
sw flow control [none/XON_XOFF]:
ASCII printwheel [true/FALSE]:
uppercase only [true/FALSE]:
auto return [TRUE/false]:
transmit end-of-line [CR/crlf/lf/lfcr]:
receive end-of-line [cr/CRLF/lf/lfcr]:
escape sequences [none/IGNORE]:
line length [80-165, 80]:
line offset [1-10, 1]:
```

3. Configuration Settings

The firmware configuration settings are:

3.1 record errors

values: true, false
default: true
description: If “true”, keeps a count of internal errors and turns on the orange LED if an error occurs. If “false”, errors are not recorded.

3.2 record warnings

values: true, false
default: false
description: If “true”, keeps a count of internal warnings and turns on the blue LED if a warning occurs. If “false”, warnings are not recorded.

3.3 batteries installed

values: true, false
default: false
description: Notifies the firmware whether the Wheelwriter backup batteries are installed or not. If the value of this setting is not correct, there could be subtle terminal operational problems.

3.4 serial

values: usb, rs232
default: usb
description: Controls which serial communication port is used.

3.5 duplex

values: half, full
default: full
description: Controls whether Cadetwriter operates in full or half duplex.

3.6 parity

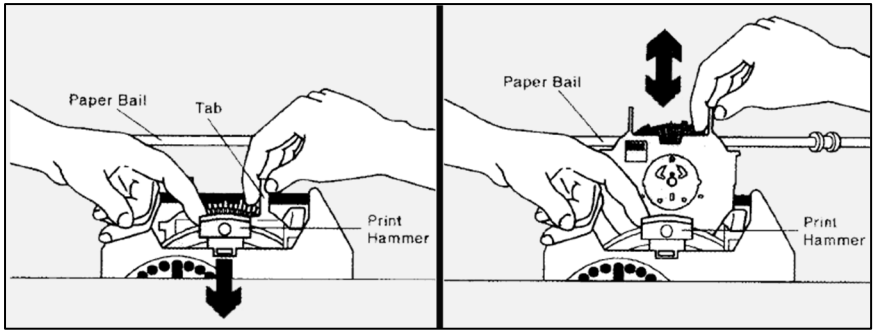
values: none, odd, even
default: none
description: *Only applies when serial = usb.*
Controls the parity of transmitted characters. The parity of incoming characters is checked and generate a warning if incorrect.

A. ASCII Character Set

Dec	Char	Dec	Char	Dec	Char	Dec	Char
0	NUL (null)	32	SPACE	64	@	96	`
1	SOH (start of heading)	33	!	65	A	97	a
2	STX (start of text)	34	"	66	B	98	b
3	ETX (end of text)	35	#	67	C	99	c
4	EOT (end of transmission)	36	$	68	D	100	d
5	ENQ (enquiry)	37	%	69	E	101	e
6	ACK (acknowledge)	38	&	70	F	102	f
7	BEL (bell)	39	'	71	G	103	g
8	BS (backspace)	40	(	72	H	104	h
9	TAB (horizontal tab)	41	)	73	I	105	i
10	LF (NL line feed, new line)	42	*	74	J	106	j
11	VT (vertical tab)	43	+	75	K	107	k
12	FF (NP form feed, new page)	44	,	76	L	108	l
13	CR (carriage return)	45	-	77	M	109	m
14	SO (shift out)	46	.	78	N	110	n
15	SI (shift in)	47	/	79	O	111	o
16	DLE (data link escape)	48	0	80	P	112	p
17	DC1 (device control 1)	49	1	81	Q	113	q
18	DC2 (device control 2)	50	2	82	R	114	r
19	DC3 (device control 3)	51	3	83	S	115	s
20	DC4 (device control 4)	52	4	84	T	116	t
21	NAK (negative acknowledge)	53	5	85	U	117	u
22	SYN (synchronous idle)	54	6	86	V	118	v
23	ETB (end of trans. block)	55	7	87	W	119	w
24	CAN (cancel)	56	8	88	X	120	x
25	EM (end of medium)	57	9	89	Y	121	y
26	SUB (substitute)	58	:	90	Z	122	z
27	ESC (escape)	59	;	91	[	123	{
28	FS (file separator)	60	<	92	\	124	|
29	GS (group separator)	61	=	93	]	125	}
30	RS (record separator)	62	>	94	^	126	~
31	US (unit separator)	63	?	95	_	127	DEL

Cadetwriter supports the full ASCII character set.

5.5 Replacing the Printwheel



The steps to replace the printwheel are:

1. Turn off Cadetwriter.
2. Pull the print hammer all the way forward and hold it.
3. Grasp the printwheel tab and lift the printwheel straight up and out of the slot.
4. Hold the new printwheel so the letters IBM are in the upper left corner.
5. Lower the printwheel into the slot. Make sure that it is fully seated.
6. Release the print hammer.

3.7 baud rate

values: 50, 75, 110, 134, 150, 200, 300, 600, 1200, 1800, 2400, 4800, 9600, 19200, 38400, 57600, 76800, 115200, 230400
default: 9600
description: *Only applies when serial = rs232.*
Controls the baud rate of the RS-232 serial communication port.

3.8 dps

values: 7o1, 7e1, 8n1, 8o1, 8e1, 8n2, 8o2, 8e2
default: 8n1
description: *Only applies when serial = rs232.*
Controls the number of data bits, parity type, and number of stop bits of the RS-232 serial communication port. These are the only combinations supported by the Cadetwriter serial interface hardware.

3.9 impression

values: light, normal, heavy
default: normal
description: Manages the typewriter's impression control.

3.10 sw flow control

values: none, xon_xoff
default: xon_xoff
description: Controls whether software flow control is used with the selected serial communication port.

3.11 hw flow control

values: none, rts_cts, rtr_cts
default: none
description: *Only applies when serial = rs232.*
Controls whether hardware flow control is used with the RS-232 serial communication port. The difference between "rts_cts" and "rtr_cts" is the handling of the DE-9 connector's pin #7. In older RS-232 specifications, pin #7 was RTS [Request To Send] which was used by the DTE to request permission to send data to the DCE. As of the 1991 RS-232-E specification, RTS is assumed to always be asserted and pin #7 is now RTR [Ready To Receive] which the DTE uses to signal that it is able to receive data from the DCE. Pin #8 has always been CTS [Clear To Send] used to signal that the DTE can send data to the DCE. Many vendors incorrectly state their interface uses RTS when in fact it uses RTR. With true RTS, Cadetwriter cannot stop the computer from overwhelming it with data to print using hardware flow control.

3.12 ASCII printwheel

values: true, false
default: false
description: Indicates whether a specialized ASCII printwheel is installed. If "true", native characters are used for all characters. If "false", period graphic characters are used for the symbols missing from the printwheel.

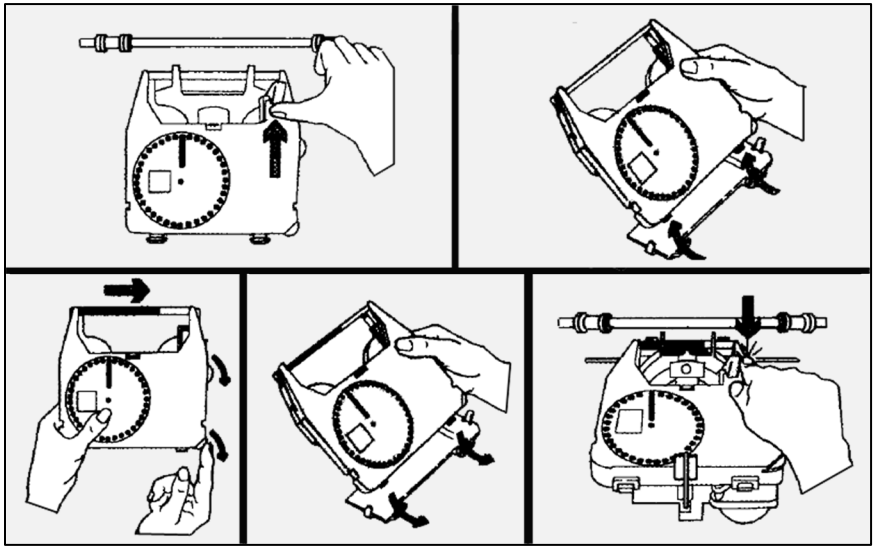
3.13 uppercase only

values: true, false
default: false
description: Controls whether Cadetwriter operates as an uppercase-only device. This is equivalent to a permanent "Caps Lock".

3.14 auto return

values: true, false
default: true
description: Controls what happens when the carriage reaches the right margin. If "true", a local carriage return is done. If "false", characters stop printing and each one triggers a beep until a carriage return is entered or received.

5.4 Replacing the Ribbon



The steps to replace the ribbon are:

1. Turn off Cadetwriter.
2. Push the blue lever to release the ribbon cassette.
3. Lift the ribbon cassette up and out.
4. Advance the ribbon on the new cassette to make it taut.
5. Slide the ribbon cassette into the typewriter.
6. Press down firmly on the ribbon cassette until it locks in place.

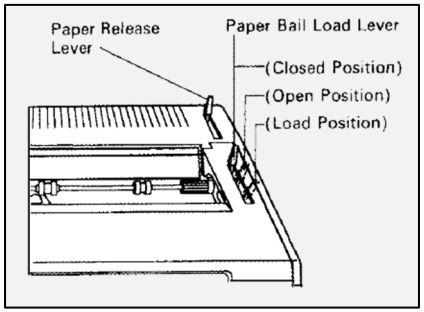
- Two special functions are available but not labelled on the keyboard:

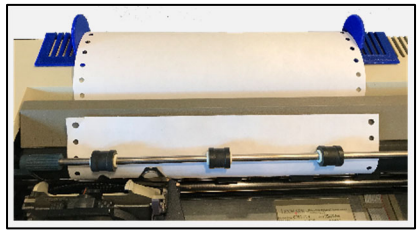
  Ctrl-Esc – This operates as Margin Release. Press Ctrl-Esc to allow moving left beyond the left margin. It only functions when the carriage is at the left margin.

  Shift-Ctrl-SetUp – This resets all configuration settings to their "factory" value.

- Reviewing and/or changing firmware configuration settings is triggered by pressing Ctrl-SetUp.
- The Lock key is Shift Lock. It causes all alphabetic keys to be uppercase until a Shift key is pressed. The Lock indicator will not light.
- ASCII characters that are not on the installed printwheel have to be synthesized. They take longer to print, but printing will catch up with the subsequent characters. No characters will be lost.

5.3 Loading Paper





Shown with optional, add-on paper guides.

The steps to load paper are:

1. Turn on Cadetwriter.
2. Push the Paper Release Lever all the way back.
3. Place the paper in the terminal.
4. Pull the Paper Bail Load Lever to the load position. When the paper begins to feed, release the Paper Bail Load Lever.
5. Push the Paper Bail Load Lever back to the closed position.

3.15 transmit end-of-line

values: cr, crlf, lf, lfcr
default: cr
description: Controls what character(s) are sent when the carriage return key is pressed. Options include all combinations of carriage return [CR, Ctrl-M] and/or line feed [LF, new line, NL, Ctrl-J]. This option does not affect a manually typed Ctrl-M or Ctrl-J which is always sent as that single control character.

3.16 receive end-of-line

values: cr, crlf, lf, lfcr
default: crlf
description: Controls what character(s) trigger a local carriage return when received from the computer. Options include all combinations of carriage return [CR, Ctrl-M] and/or line feed [LF, new line, NL, Ctrl-J]. When a Ctrl-M or Ctrl-J character is received that is not part of a selected end-of-line combination, it performs the expected operation – Ctrl-M returns the carriage without advancing the paper, Ctrl-J advances the paper without returning the carriage.

3.17 escape sequences

values: none, ignore
default: ignore
description: Controls what happens when a recognized ANSI Escape Sequence is received. If none, escape sequences are treated as normal characters to be printed. If ignore, all recognized escape sequences are ignored.

3.18 line length

values: 80 - 165 [198 for wide carriage]
default: 80
description: Specifies the printable line length.

3.19 line offset

values: 1 - 10
default: 1
description: Controls whether all printing is offset to the right by the specified number of columns. This must be at least 1 for period graphic special characters to print correctly in column 1. Some of the period graphic characters must micro-space to the left of character-center to print a period in the proper position.

4. Typewriter Settings

The majority of the Wheelwriter settings don't apply to Cadetwriter. Most of them are off when the typewriter is turned on, but **spell check** and **A Rtn** may be on and can cause operational problems. These settings are toggles and there is no way for the firmware to determine their current state, so the user must manually turn them off. This is done within the SetUp typewriter command by typing the associated index number (#1 for **spell check** and #4 for **A Rtn**), which toggles the setting.

There are three typewriter settings – **line spacing**, **powerwise**, and **bold** – which the user may find useful. Typing their index number will toggle the setting (#5 - **bold**), sequence through the possible settings (#2 - **line spacing**), or allow a value to be input (#3 - **powerwise**).

Finally, there are two options in the typewriter setting's menu for dealing with margins and tab stops. The restore option (#7) resets both margins and all tab stops to their "factory" default – left margin at column 1, right margin at the line length column, and tabs every 8 columns. The change option (#6) allows the user to interactively set the margins and tab stops by following the printed directions.

The typewriter settings available within SetUp mode are:

```
  1. spell check   2. line spacing   3. powerwise   4. a rtn     5. bold
  6. change margins & tabs           7. restore margins & tabs   Q. QUIT

  cmd> spell check: on = beep, off = printwheel jiggle  (must be off)
  cmd> line spacing: see 1, 1 1/2, 2, 3 indicators
  cmd> powerwise: 0 (off) - 90 minutes inactivity, enter value =
  cmd> a rtn: see A Rtn indicator  (must be off)
  cmd> bold: see Bold indicator
  cmd> change margins & tabs using:
       left & right arrows = move carriage position
                       Tab = tab to next tab stop
                 Code-C Rtn = return carriage
                   Code-Esc = release left margin
                      L Mar = set left margin (L)
                      R Mar = set right margin (R)
                      T Set = set tab (+)
                      T Clr = clear tab (-)
                 Code-T Clr = clear all tabs (=)
                      C Rtn = end margin & tab changing
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
L      T       T       T       T       T       T       T       T       T       R

  cmd> restore margins & tabs

         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
L      T       T       T       T       T       T       T       T       T       R
```

5. Operation

5.1 Powering On

When Cadetwriter is powered on, it performs a Power-On Self-Test (POST), restores all internal settings, flashes all indicator lights, resets the printwheel and ribbon, returns the carriage, beeps, moves over **line offset** spaces, and optionally sets all margins and tabs.

The POST reports firmware execution by turning on the orange LED when the startup code begins, turns off the orange LED when the startup code finishes and the main code begins, and blinks the blue LED for the first 5 seconds that keyboard scanning is occurring. After the POST, the orange and blue LEDs revert to indicating when an error or warning has occurred.

The margin / tab setting is done when the **batteries installed** setting is false or the hardware emulation jumpers have changed since the last power on. To set the margins and tabs, the carriage moves across the entire line and the printwheel jiggles as each margin and tab stop is set.

5.2 Using the Terminal

In general, Cadetwriter functions like any computer teleprinter. Here are the unique characteristics:

- Two keys (Esc and | \) are in non-standard locations.
- The key labelled Code is the Ctrl (control) key.
- The arrow keys on the lower-right of the keyboard cause local carriage movement – up, down, left, right. Ctrl-<up arrow> and Ctrl-<down arrow> cause the carriage to roll up and down micro positions. Ctrl-CRtn performs a local carriage return. No data is sent to the computer for any of these local carriage movements.
- The movement keys – up arrow, left arrow, down arrow, right arrow, space, and backspace – are auto-repeating. If they are depressed for more than six seconds, they repeat at a 10 cps rate until released.
- The L Mar, R Mar, T Set, and T Clr keys on the left side of the keyboard are used to set/clear margins and tabs. These function locally and no data is sent to the computer. First, position the carriage to the desired position using the arrow keys, then press the appropriate key to set/clear a margin or a tab. The typewriter will respond with a beep or jiggling the printwheel. Margin and tab locations are preserved in the EEPROM.