



ARL-TN-1083 • SEP 2021



Tektronix Curve Tracer Modification: Mass Storage Conversion to USB Memory Device

by C Wesley Tipton IV

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Tektronix Curve Tracer Modification: Mass Storage Conversion to USB Memory Device

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REPORT DOCUMENTATION PAGE

*Form Approved
OMB No. 0704-0188*

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1. REPORT DATE (DD-MM-YYYY) September 2021		2. REPORT TYPE Technical Note		3. DATES COVERED (From - To) July–August 2021	
4. TITLE AND SUBTITLE Tektronix Curve Tracer Modification: Mass Storage Conversion to USB Memory Device				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) C Wesley Tipton IV				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) DEVCOM Army Research Laboratory ATTN: FCDD-RLS-CP Adelphi, MD 20783-1138				8. PERFORMING ORGANIZATION REPORT NUMBER ARL-TN-1083	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release: distribution unlimited.					
13. SUPPLEMENTARY NOTES ORCID ID: CW Tipton, 0000-0003-3180-5330					
14. ABSTRACT This technical note describes the modifications and procedures needed to replace the floppy disk drive of the Tektronix 371A and 370B curve tracers with a GoTek floppy disk emulator using the FlashFloppy control software. This modification seeks to extend the operational life of these instruments as storage technologies and data processing systems evolve.					
15. SUBJECT TERMS floppy disk emulator, curve tracer, Tektronix 370B, Tektronix 371A, GoTek, FlashFloppy					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 26	19a. NAME OF RESPONSIBLE PERSON C Wesley Tipton IV
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			19b. TELEPHONE NUMBER (Include area code) (301) 394-5209

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1. Introduction and Background

In an effort to extend the operating life of electronic equipment that incorporates removable mass storage, such as oscilloscopes, numerically controlled machine tools, electronic instruments, and embroidery machines, manufacturers have developed floppy drive emulators (FDEs). One of these units, produced by GoTek Systems, allows 3.5-inch floppy diskettes to be replaced with USB-based memory devices. This technical note describes the modifications and procedures used to replace the floppy disk drive in a Tektronix 371A and 370B Curve Tracer (CT) with a GoTek emulator. Figure 1 shows a curve tracer with an FDE installed.



Fig. 1 Tektronix 371A with GoTek floppy drive emulator installed

2. Hardware Modifications

Warning

Dangerous, high-voltage potentials may exist at several locations within the CT. When this instrument is operated with its covers removed, do not touch exposed connections or components. Disconnect power to the instrument and allow stored energy to dissipate before replacing parts.

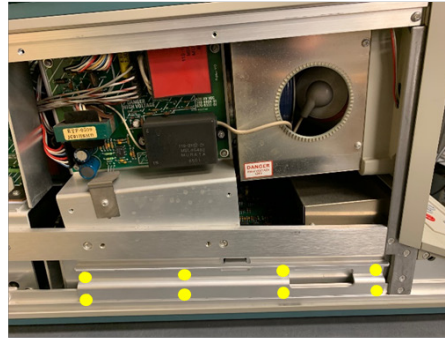
The CT's floppy disk drive is mounted on a chassis subcomponent referred to as the drawer unit. Access to the drawer unit and drive removal is accomplished by the following:

- 1) Remove the right- and left-side cabinet panels by first removing the four plastic corner caps and two panel screws on the rear of the unit.
- 2) Remove the right- and left-side mounting brackets that affix the drawer unit to the main chassis by removing the eight screws (in each bracket) shown in Fig. 2.

a) Right side



b) Left side



Remove screws located at yellow circles.

Fig. 2 Tektronix 371A disassembly of a) right-side and b) left-side drawer unit mounting brackets

- 3) Slide the drawer unit forward (out of) the main chassis as shown in Fig. 3. This requires some force to disengage the electrical connectors located at the rear of the drawer unit.

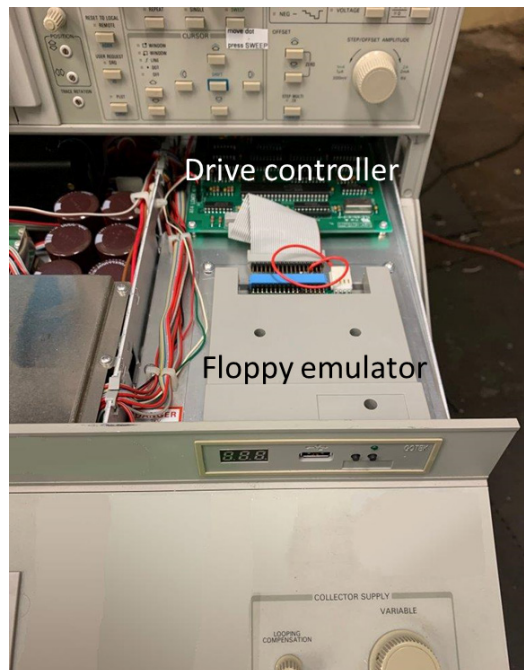


Fig. 3 Tektronix 371A drawer unit in a forward position with the installed floppy drive emulator

- 4) With the disk drive now accessible, remove the four screws holding the drive mounting plate to the drawer unit and disconnect the 34-pin connector from the disk drive.
- 5) Remove the four screws holding the disk drive to the mounting plate and note the orientation of the plate relative to the disk drive so that the FDE may be mounted in the same orientation.

2.1 Power and Control Connections

The CT 371A unit upgraded in this work had a TEAC FD-235GF floppy drive installed. Although this model can support a high-density format (1.2 MB per disk), it is operated in the double-density (720 kB) mode only. Also, this drive is powered through the 34-pin interface cable from the floppy drive controller. This is somewhat unusual in that most drives, as well as the FDE, receive power through a dedicated, 4-conductor, advanced technology extended (ATX) power cable. To use the FDE, a cable adaptor, shown in Fig. 4, was constructed using a Harwin M50-3301742 insulation displacement connector (IDC) and Samtec MTSW-117-06-T-D-000, square-post header. On the original drive, power (+5 V) was delivered on pins 7, 9, and 11 of the ribbon-cable connector. However, these pins are grounded on the FDE. Therefore, the adaptor ensures that these pins are not interconnected, and applied power is from pin 1 of a 4-pin ATX power connector (TE Connectivity, 171822-4). Pins 1, 3, and 5 of the 34-pin ribbon cable are also not connected to the FDE to avoid potential signal conflicts.

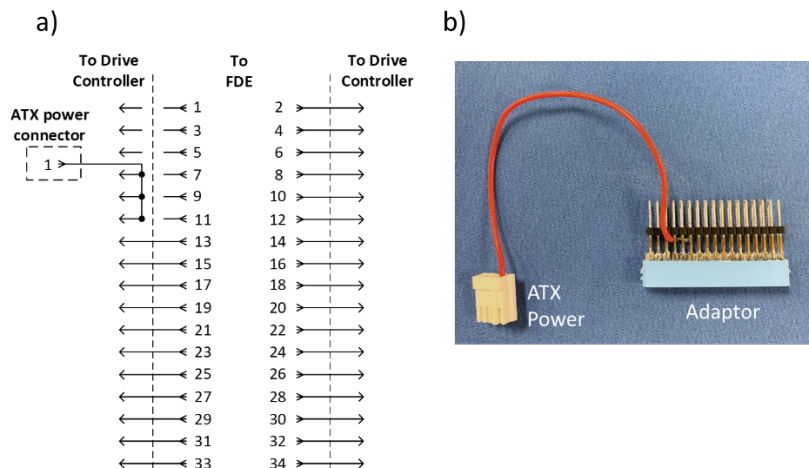


Fig. 4 34-pin adaptor a) schematic and b) implementation

2.2 Emulator Configuration

The FDE has a configuration jumper block located at the rear of the unit and is shown in Fig. 5. Of these jumpers, only S0, which sets the drive select value to Drive 0, should be installed.

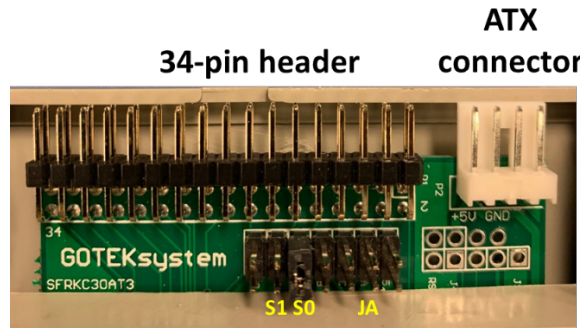


Fig. 5 Floppy drive emulator connector and configuration jumper locations

2.3 Firmware Modifications

The GoTek emulator (model, SFR1M44-U100) is designed to replace high-density (1.44 MB) drives and therefore cannot be used in this application without modification to its firmware. (GoTek does offer a 720-kB emulator; however, it is not as widely available as the 1.44 MB version.) An open-source program, FlashFloppy, developed by Keir Fraser,¹ allows a multitude of operational configurations of the GoTek emulator hardware. The installation of FlashFloppy entails reprogramming the GoTek microcontroller for which several online resources^{2,3} are available detailing this procedure.

After making the cable adaptor and reprogramming, the FDE should be mounted on the floppy drive mounting plate. In turn, these should be reinstalled on the CT's drawer unit and the ribbon cable should be attached as previously shown in Fig. 3.

This concludes the hardware modification and installation. The CT's mounting brackets and side panels may be reassembled.

3. Operation

Before the user is able to store data on a USB-based memory device (hereafter referred to as a memory stick), there are a few additional steps to complete. First, we must define the operating parameters of the FlashFloppy software that allow it to emulate the original drive. Refer to Fraser¹ for an overview of FlashFloppy. These parameters are defined in the FF.CFG and IMG.CFG parameter files that must be created and saved in the root directory (or \FF directory) of the memory

stick. The original CT floppy drive was configured as shown in Table 1. Because pins 2 and 34 were defined as HD Out and Ready Out, respectively, the *interface* parameter (located in FF.CFG) is set to Japanese PC alternate (jppc-hdout). Recall that we previously defined the FDE as Device 0 with the installation of jumper S0. All other parameters in the FF.CFG remain set to their default or recommended values. The contents of the FF.CFG file used for the 371A are given in Appendix A.

Table 1 Tektronix 371A floppy disk drive installed jumpers

Installed jumper	Description
HO2	High-density output signal on pin 2
HA	Density set by diskette type (sensor)
RY34	Ready output signal on pin 34
DS0	Drive select 0 on pin 10
FG	Frame ground

Parameters defined in the IMG.CFG file are primarily focused on the data format specification of the floppy drive. The FlashFloppy software is able to accommodate a wide variety of drive formats and only those commonly used in 3.5-inch disk drives are listed in Table 2. Specifically, the Tektronix 371A utilizes the 720-kB, double-density mode, and the parameter values within the IMG.CFG file given in Appendix B reflect this.

Table 2 Common 3.5-inch floppy disk drive characteristics

Capacity	Tracks	Heads	Sector/track	Bytes/sector	RPM	Kbits/s
720 kB	80	2	9	512	300	250
1.2 MB	80	2	15	512	360	500
1.44 MB	80	2	18	512	300	500
2.88 MB	80	2	36	512	300	1000

3.1 Memory Stick Initialization

Modern USB memory sticks have storage capacities of tens of gigabytes whereas the older, double-density floppy drives used by the CT permits only 720 kB. Therefore, an opportunity exists to put hundreds of virtual floppy diskettes on one memory stick. To accomplish this, FlashFloppy requires one uniquely named floppy image file per virtual diskette to be created on the stick. That is, at least one image file must be created on the memory stick before use. As recent versions of the Microsoft Windows operating system do not include a utility for creating floppy image files, third-party software is required. In this work, the program DiskGenius⁴ was used to create an image file template. Multiple image files may be created by copying and renaming the template file.

The format of the image file name is defined in the IMG.CFG file and, in the present configuration, the default image prefix of “DSKA” was used with an applied tag name of “tek371a”. It follows that the 720-kB image files take the form of

DSKA0000.tek371a.img
DSKA0001.tek371a.img
DSKA0002.tek371a.img
...
DSKA0999.tek371a.img

To initialize the memory stick:

- 1) On a stand-alone computer, format the USB memory stick using the FAT32 file system.
- 2) Save a copy of the FF.CFG and IMG.CFG files to the root directory (or folder named /FF) of the memory stick.
- 3) Using DiskGenius, create a 720-kB floppy disk image file template with the function found under its menu structure: Disk>Create New Virtual Disk File>Create *.IMG Image File. (Uncheck the “Build Bootable DOS System” option box.)
- 4) Copy (up to the maximum of 1000) and rename, in sequential order, as many of the disk image files as required to the memory stick.

3.2 Memory Stick Operation on the Curve Tracer

Operation of the CT with the FDE is nearly identical to the original drive. If the instrument is powered up without a memory stick installed, “F-F” will be shown on the FDE display (Indicating that the FlashFloppy firmware is installed.) After the stick is first inserted, the display will alternately flash “000” and “_00”. The 3-digit number represents the index of the active image file and the 2-digit number shows the number of data files stored in that image. The GoTek buttons are used to select the active image file by scrolling up or down the index values. Before first use, the active image file should be considered an unformatted floppy; therefore, use the CT’s front-panel buttons to initiate the floppy format operation. Data and setting files may now be stored on the memory stick using the standard CT commands/keystrokes.

3.3 Accessing Data on the Memory Stick

After measurement data files are stored within the floppy image file, they are not directly accessible using conventional methods such as File Explorer on a Microsoft Windows-based computer. The image file must be “mounted” as a virtual drive to

gain access to the data files. Because the Microsoft Windows 10 file-mounting function supports only the New Technology File System (NTFS) format, a third-party software product such as OSFMount⁵ must be used.

- 1) Install the memory stick into a stand-alone computer’s USB port.
- 2) From within the OSFMount program, select File>Mount New Virtual Disk and provide the name of the image file. Accept the default values of the remaining pop-up windows.
- 3) Individual data files are now accessible through File Explorer by selecting the virtual drive letter assigned by OSFMount.
- 4) Once data has been transferred, dismount the virtual drive by selecting File>Dismount All and Exit within OSFMount.

4. Tektronix 370B Curve Tracer Modification

A GoTek emulator has also been installed in a Tektronix 370B curve tracer. In this case, the curve tracer had a TEAC model FD-235HF, 1.44-MB disk drive (configured as shown in Table 3), which has a 34-pin connector and ATX power connector. Therefore, no incompatibility with the native control software or connector pin assignments existed and the original drive was directly replaced by the GoTek unit. In this installation, jumpers S1 and JA were installed on the emulator.

Table 3 Tektronix 370B TEAC floppy disk drive installed jumpers

Installed jumper	Description
HO2	High-density output signal on pin 2
HA	Density set by diskette type (sensor)
RY34	Ready output signal on pin 34
DS1	Drive select 1 on pin 12
FG	Frame ground

Here are the steps needed to use the native GoTek emulator:

- 1) Format memory stick using the FAT32 file system on a stand-alone computer.
- 2) Power the CT (memory stick not installed) – the GoTek should display “00.0.”.
- 3) Insert the memory stick and the display should change to “000”.

- 4) Using the control panel, command the CT to format the drive. A folder named *370B* will be created in which all subsequent data files will be saved.
- 5) Data, setting, and bitmap files may now be stored on the memory stick using the standard CT commands/keystrokes. However, to complete each write operation the user must select an index value other than “000” and then return back to index “000” before the next file can be saved. It is unclear why this is the case and installing the other configuration jumpers did not change this behavior.

To use the FlashFloppy software on the 370B, follow the same installation procedure described in Section 2 with the exceptions noted in this Section and the operating procedure of Section 3. Because the Tektronix 370B is designed for a 1.44-MB drive, different FF and IMG configuration files are needed. The parameter changes for the files given in the appendices are shown in Table 4. Note, specifically, that the automatic density detection mode does not work on the 370B.

Table 4 FlashFloppy parameter changes for Tektronix 370B

File	Parameter	Value
FF.CFG	<i>pin02</i>	ndens
	<i>tag name</i>	[tek370b::]
IMG.CFG	<i>secs</i>	18
	<i>rate</i>	500

5. References

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2. GoTek Floppy emulator: new 2021 FlashFloppy and mods procedure. [accessed 2021 July 23]. youtube.com/watch?v=mvjgHGA9Gc8&ab_channel=retrofriends.
3. GoTek Floppy to USB emulator user manual. [accessed 2021 July 23]. [SFR1M44-U100K-SFR1M44-U100K-R-SFR1M44-TU100K-UM.pdf \(goughlui.com\)](https://www.goughlui.com/SFR1M44-U100K-SFR1M44-U100K-R-SFR1M44-TU100K-UM.pdf).
4. DiskGenius. DiskGenius version 5.4.2. EASSOS Technology Co; [accessed 2021 July 28]. www.diskgenius.com
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Appendix A. Tektronix 371A FF.CFG File

This appendix appears in its original form, without editorial change.

```

## FF.CFG: TEK371A FlashFloppy Configuration File

# Place in the root folder or FF/ subfolder of your USB drive.
# NOTE: If FF/ exists, IMG.CFG must reside there, not the root folder.

# Uncommented lines below are the default settings.
# Uncommented options cannot be overridden by settings in other config files.

##
## DRIVE EMULATION

# Floppy-drive interface mode (interface pins 2 and 34)
# jc: Specified by jumper JC (open: shugart, closed: ibmpc)
# shugart: P2=DSKCHG, P34=RDY (Amiga, Atari ST, many others)
# ibmpc: P2=unused, P34=DSKCHG (IBM PC interface)
# ibmpc-hdout: P2=HD_OUT, P34=DSKCHG (not generally needed: prefer 'ibmpc')
# jppc: P2=unused, P34=RDY (Japanese PC standard)
# jppc-hdout: P2=HD_OUT, P34=RDY (Japanese PC alternate: prefer 'jppc')
# akai-s950: Legacy alias of 'jppc-hdout', previously used for Akai S950
# amiga: P2=DSKCHG, P34=DRIVE_ID (not generally needed: prefer 'shugart')
interface = jppc-hdout

# Host platform: Improves image-format detection for generic types such as IMG
# acorn: Acorn ADFS
# akai: Akai (S01, S20, S950), Korg, SC Prophet 3000
# casio: Casio (FZ-1)
# dec: DEC (RX33, RX50)
# ensoniq: Ensoniq (ASR, TS, etc)
# fluke: Fluke 9100
# gem: General Music (S2, S3)
# ibm-3174: IBM 3174 Establishment Controller
# memotech: Memotech
# msx: MSX
# nascom: Nascom
# pc98: NEC PC-98
# pc-dos: PC DOS Format (geometry determined from Bios Parameter Block)
# tandy-coco: Tandy Color Computer (CoCo)
# ti99: TI-99/4A
# uknc: UKNC / DVK Soviet PDP-11
# unspecified: Common default geometries (including IBM PC)
host = unspecified

# Pins 2 & 34 output (drive->host) manual configuration
# auto: Auto-configure from interface= setting
# nc: Unused/No Connection [eg. if pin is an input (host->drive) on your host]
# low: Always 0 volts (0v)
# high: Always 5 volts (5v)
# rdy: Drive ready (Ready = 0v)
# nrdy: Logical complement of above
# dens: Density mode (High Density = 0v)
# ndens: Logical complement of above
# chg: Disk changed (Changed = 0v)
# nchg: Logical complement of above
# Values: auto, nc, low, high, rdy, nrdy, dens, ndens, chg, nchg
pin02 = auto
pin34 = auto

```

```

# Forcibly write-protect images, or respect the FAT read-only attribute?
# Values: yes | no
write-protect = no

# Filter glitches in the SIDE-select signal shorter than N microseconds
# Values: 0 <= N <= 255
side-select-glitch-filter = 0

# Rotational offset of disk after a track change
# instant: No rotation during track change
# realtime: Emulate rotation of disk while track is changing
# Values: instant | realtime
track-change = instant

# Rotational offset of disk after draining a write to Flash
# instant: No rotation
# realtime: Disk rotates in real time during drain
# eot: Disk rotates to (near) end of track
# Values: instant | realtime | eot
write-drain = instant

# Index pulses suppressed when RDATA and WDATA inactive?
# Values: yes | no
index-suppression = yes

# Milliseconds from head-step start to RDATA active.
# Values: 0 <= N <= 255
head-settle-ms = 12

# Milliseconds delay from motor-on to drive ready.
# On a standard unmodified Gotek the motor signal is not connected and a
# non-default value here will have no effect. Most systems and software do
# not care about correct motor behaviour, and default (ignore) works fine.
# Values: ignore | 0 <= N <= 1000
motor-delay = ignore

# What causes the disk-change (chg) signal to reset after disk insertion?
# step: Step command received
# pa14: CHGRST (pin 1 on old Sony drives), connected to PA14 (JTCK/SWCLK)
# delay-N: Automatically after N*0.5sec (0 <= N <= 15)
chgrst = step

##
## STARTUP / INITIALISATION

# Disk image loaded or ejected at startup?
# Values: yes | no
ejected-on-startup = no

# Which image (or folder) is selected at startup?
# last: Last-selected item at power-off (recorded in IMAGE_A.CFG)
# static: Static path specified in INIT_A.CFG
# init: First item in root folder
# Values: last | static | init
image-on-startup = last

```

```

# Time in milliseconds to attempt to probe attached display.
# You may set this to 0 if you have a 2-digit LED display attached.
# Values: 0 <= N <= 65535
display-probe-ms = 0

##
## IMAGE NAVIGATION

# Auto-select the current file after N seconds
# N=0: disable auto-select
# Values: 0 <= N <= 255
autoselect-file-secs = 2

# Auto-select the current folder after N seconds
# N=0: disable auto-select
# Values: 0 <= N <= 255
autoselect-folder-secs = 2

# Sorting of folder entries in native navigation mode.
# always: Always sort folder entries. Large folders may be truncated.
# never: Never sort folder entries, instead presenting them in FAT order.
# small: Only sort folders which are small enough to sort in full.
# Values: always | never | small
folder-sort = always

# Priority of files vs subfolders when sorting folder entries:
# folders: Folders listed before files
# files: Files listed before folders
# none: Files and folders are not differentiated
# Values: folders | files | none
sort-priority = folders

# Navigation mode for selecting images/slots
# native: Navigate through all valid images/dirs
# indexed: Navigate through DSKA0000, DSKA0001, ...
# default: native unless overridden by HxC-compatible mode config
nav-mode = indexed

# When navigating slots or folder, loop at min/max?
# Values: yes | no
nav-loop = yes

# Actions of first two buttons.
#      B1 | B2 | Both
# zero:  Prev | Next | Slot 0
# eject: Prev | Next | Eject/Insert
# htu:   +10 | +1  | +100
# rotary: Up-dir | Select/Eject/Insert | -
# rotary-fast: Prev | Next | Up-dir [Prev/Next are accelerated]
# reverse: Reverse sense of B1 and B2
# Multiple values can be separated by commas, eg twobutton-action=eject,reverse
twobutton-action = zero

# Input sensor type at the rotary-encoder inputs (pins PC10 and PC11):
# [full | half | quarter]:

```

```

# Rotary encoder, identified by fraction of a Gray-code cycle performed
# per detent/click. If default value ('full') requires multiple
# clicks/detents to move position then change to 'half' (if 2 clicks
# per move) or 'quarter' (if 4 clicks).
# [trackball]:
# Blackberry-style trackball (eg. using Hall-effect sensors).
# [buttons]:
# Push-to-ground Prev/Next buttons.
# [reverse]:
# If the input is working in reverse, use this option to swap directions.
# [v2]:
# Use the rotary encoder logic from FlashFloppy v2.x. Use this if the
# v3 logic is too strict and results in no, or missing, movements.
# Multiple values can be separated by commas, eg rotary=quarter,reverse
# Values: none | quarter | half | full | trackball | buttons | reverse | v2
rotary = full

# Prefix for image names in indexed navigation mode. String can be empty ("").
indexed-prefix = "DSKA"

##
## DISPLAY

# Display Type.
# auto: Auto-detect (7-seg LED, LCD, OLED)
# lcd-CCxRR: CCxRR backlit LCD with I2C backpack (16<=CC<=40, 02<=RR<=04)
# oled-128xNN: 128xNN I2C OLED (NN = 32 | 64)
# -rotate: OLED view is rotated 180 degrees
# -narrow[er]: OLED view is restricted to Gotek display cutout
# (-narrow: 18 chars; -narrower: 16 chars)
# -inverse: Inverse/reverse video (black text on white background)
# -ztech: ZHONGJY_TECH 2.23" 128x32 SSD1305 OLED display
# Values: auto | lcd-CCxRR | oled-128xNN[-rotate][-narrow[er]]...
display-type = auto

# OLED Font. Narrow and wide options.
# Narrower 6x13 font permits:
# - More characters per row
# - Use of Gotek display cutout (eg. "display-type=oled-128x32-narrow")
# Values: 6x13 | 8x16
oled-font = 6x13

# OLED contrast/brightness.
# Values: 0 <= N <= 255
oled-contrast = 143

# Text height and arrangement on LCD/OLED
# 'default', or a comma-separated list (one entry per LCD/OLED row, top down).
# Each list item is a digit plus optional height specifier: <content-row>[d]
# content-row: '0-3' = specified content row, '7' = blank
# 0: Current image name
# 1: Status
# 2: Image/Volume info
# 3: Current subfolder name
# height specifier: 'd' = double height (32px, OLED only; ignored for LCD)
# 'default' depends on display, eg.: oled-128x32='0,1' ; oled-128x64='3,0d,1'

```

```

# Values: [0-7][d] | default
display-order = default

# Turn an LCD or OLED display off after N seconds of inactivity
# N=0: always off; N=255: always on
# Values: 0 <= N <= 255
display-off-secs = 60

# Switch on LCD/OLED display when there is drive activity?
# yes: Trigger on track changes and disk writes
# sel: Trigger on drive select
# no: No automatic trigger
# Values: yes | sel | no
display-on-activity = yes

# LCD/OLED long filename scroll rate in milliseconds per update
# Values: 100 <= N <= 65535
display-scroll-rate = 200

# LCD/OLED pause time at start/end of scroll, in milliseconds
# Zero means endless scroll
# Values: 0 <= N <= 65535
display-scroll-pause = 2000

# LCD/OLED long filename scroll rate during navigation (ms per update)
# Values: 0 <= N <= 65535
nav-scroll-rate = 80

# LCD/OLED long filename pause before scroll, during navigation (milliseconds)
# Values: 0 <= N <= 65535
nav-scroll-pause = 300

##
## MISCELLANEOUS

# Speaker volume for head STEP
# Values: 0 <= N <= 20
step-volume = 10

# Report the specified version number to host software
# Values: <quoted-string> ("" means report real version)
# eg. da-report-version = "v3.0.0.0"
da-report-version = ""

# Automatically extend certain types of truncated image file (SSD,DSD,TRD)?
# Values: yes | no
extend-image = yes

```

Appendix B. Tektronix 371A IMG.CFG File

This appendix appears in its original form, without editorial change.

IMG.CFG: Example FlashFloppy Geometry Configuration File for Raw IMG Images

Supports tagged IMG/IMA raw image files with self-identifying geometry.

If you wish to use this feature, your IMG.CFG must be placed in the
root folder or FF/ subfolder of your USB drive.

NOTE: If FF/ exists, IMG.CFG must reside there, not the root folder.

A badly-defined section (eg. undefined mandatory parameters) may result in
error 31 (Bad Image).

#####

TAG in square brackets.

Format: [<tagname>][:<filesize>]

Matching Rules:

1. <tagname> matches images of the form *.<tagname>.{img,ima,dsk}

2. Missing (empty) tagname matches any *.{img,ima,dsk} which is untagged

or does not match any other defined tag.

3. Tagnames and their matches are NOT case sensitive.

4. <filesize>, if specified, must exactly match the image filesize.

5. If an image matches no tag, FlashFloppy uses normal geometry

auto-detection based on the host= setting in FF.CFG.

[dsdd80::737280] matches images with names of the form *.dsdd80.{img,ima,dsk}
and with size exactly 720kB (737280 bytes).

[tek371a::]

DISK-SCOPE PARAMETERS

Apply to the whole disk image. Cannot appear in a @tracks sub-section.

Mandatory: Number of cylinders (1-255).

cyls = 80

Mandatory: Number of heads (1-2).

heads = 2

Image file track layout. Default is "interleaved".

Comma-separated values:

sequential: Sequential cylinder ordering: all side 0, then side 1.

interleaved: Interleaved cylinder ordering: c0s0, c0s1, c1s0, c1s1, ...

reverse-sideN: Side-N cylinders are ordered from high to low (N=0,1).

sides-swapped: Sides 0 and 1 ordering is swapped in the image file.

eg. "sequential,reverse-side1"

file-layout = interleaved

TRACK-SCOPE PARAMETERS

These can vary across tracks. By default they apply to all tracks unless

preceded by a @tracks declaration.

tracks = <track-list>

Specify the tracks that the following track-scope parameters applies to.

Format:

track-list ::= <track-range>[,<track-list>]

track-range ::= <cylinder>[.<head>] | <cylinder>-<cylinder>[.<head>]

cylinder ::= [0-9][0-9]*

head ::= 0|1

```
# If no head is specified in a track-range, then all heads are assumed.
# Examples:
# "0-23.1,45.0" specifies head 1 of cyls 0-23 and head 0 of cyl 45.
# "27-33" specifies all heads of cyls 27-33.

# Number of sectors per track (0-256). Default is 0.
secs = 9

# Bytes per sector (128, 256, 512, 1024, 2048, 4096, 8192).
# Mandatory if @secs is non-zero.
bps = 512

# ID of first sector on each track (0-255). Default is 1.
# Numbers may be expressed in hexadecimal with 0x prefix (eg. 0xab).
# id = 1

# Head number for all sectors on this track (auto|0|1). Default is auto.
# auto = use physical drive head number
# h = auto

# Recording mode (fm | mfm). Default is mfm.
# mode = mfm

# Sector interleave. Default is 1:1 (no interleave).
# interleave = 1

# Sector skew per cylinders. Default is 0 (no skew).
# cskew = 0

# Sector skew per head. Default is 0 (no skew).
# hskew = 0

# Rotational RPM. Default is 300.
rpm = 300

# Post-Data Gap (auto|0-255). Default is auto.
# auto = based on recording mode and sector size.
# gap3 = auto

# Post-Index Gap (auto|0-255). Default is auto.
# auto = based on recording mode and sector size.
# gap4a = auto

# Index Address Mark (yes | no). Default is yes.
# iam = yes

# Data rate in kHz (kbit/s) (eg. MFM DD = 250). Default is 0.
# 0 = based on recording mode and size of track.
rate = 250
```

List of Symbols, Abbreviations, and Acronyms

ATX	advanced technology extended
CT	curve tracer
FDE	floppy drive emulator
IDC	insulation displacement connector
kB	kilobyte
MB	megabyte
NTFS	New Technology File System
RPM	revolutions per minute
USB	Universal Serial Bus

1 DEFENSE TECHNICAL
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DTIC OCA

1 DEVCOM ARL
(PDF) FCDD RLD DCI
TECH LIB

11 DEVCOM ARL
(PDF) FCDD RLS CP
C TIPTON
D URCIUOLI
D PORSCHE
H O'BRIEN
A OGUNNIYI
M HINOJOSA
R THOMAS
B GEIL
FCDD RLS ED
A LELIS
D HABERSAT
R GREEN