

# Persci and Shugart Drives Together on the Cromemco 16FDC

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## Objective

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Cromemco floppy disks and disk images (e.g. .IMD files) are still available various places on the Internet. However, they come in a variety of disk formats: 5.25" disks or 8" disks, single-sided or double-sided versions of both disk sizes, and single-density or double-density for all of these types of disk.

Cromemco originally intended their 4FDC floppy disk controllers to use Persci 277 drives, which are somewhat rare now, and a bit tricky to get working. However, a working Persci drive is a very high-performance floppy drive, with its voice-coil head servo mechanism. The Cromemco 16FDC also supports the Persci 299 drive, which is the 2-sided, double density equivalent of the 277, and is even rarer than the 277. Shugart 8" drives (the SA800 and SA850) are much more common.

The objective of this paper is to allow combinations of Persci and Shugart drives to work together with a Cromemco 16FDC controller. For example, if you own a Persci 277 drive, you might like to keep that as the primary drive on your Cromemco system, but still have the ability to read all of the drive types, so you can read all types of disk images. You would therefore need to have one 2-sided, double-density 5.25" drive, as well as one 2-sided, double-density 8" drive, in addition to your Persci drive (which appears as 2 drives). Your configuration might look like this:

CDOS/Cromix Drive	Disk Drive Type
A	Left half of Persci 277 or 299
B	Right half of Persci 277 or 299
C	2SDD 5.25" drive (e.g. SA450)
D	Shugart SA851 2SDD drive

Drive C is simple - the 5.25" drive is configured as drive C (without a terminating resistor) and is connected to the 16FDC via J2. The 8" drives are a little trickier - this paper describes how to configure 8" drives so that they work together on the Cromemco 16FDC's 50-pin interface.

## Background

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The Cromemco 16FDC floppy disk controller has two connectors for connecting floppy disk drives. J2 is a 34-pin header for 5.25" disks, and J3 is a 50-pin header that is intended for Persci-type 8" disks.

Persci's 50-pin drive pinout differs from the standard Shugart 8" disk drive pinout. However, it is reasonably simple to support (single-sided) Shugart 800 drives by configuring the SA800 drive correctly, as shown on page 6.

But, the 16FDC does not provide the signal "TG43" (Track Greater than 43) on J3. This signal is required by SA850 drives to reduce write current on the inner tracks, especially when writing a double-density disk. This signal is available as an output pin from the 16FDC's WD1793 Floppy Disk Controller IC, but it is not connected to anything. The 16FDC therefore cannot reliably write double-density disks on SA850 drives without modification.

Also, the SA850 uses a few more signals on its 50-pin interface than does the SA800, mostly related to 2-sided disk detection and operation. These additional signals conflict with Persci signals on the same pins.

## Pinout Comparison

Here are is a pinout comparison between the 16FDC, the Persci 277 (single-sided) and 299 (double-sided) drives as configured for the Cromemco 16FDC, and the Shugart SA800 (single-sided) and SA850 (double-sided) drives. The pink cells indicate conflicts.

Pin	16FDC		Persci 277		Persci 299		Shugart 800		Shugart 850	
	Signal	Dir	Signal	Dir	Signal	Dir	Signal	Dir	Signal	Dir
Odd	GND		GND		GND		GND		GND	
2	Side Select	out	N/C		Side Select	in	N/C		Write-Current Switch	in
4	-DS4	out	-DS2 right	in	-DS2 right	in	N/C		N/C	
6	N/C		-Ready 1 (1)	out	-Ready 1 (1)	out	N/C		N/C	
8	N/C		-Index 1 (2)	out	-Index 1 (2)	out	N/C		N/C	
10	-Seek Complete	in	-Seek Complete	out	-Seek Complete	out	N/C		-2 Sided (6)	out
12	-Restore	out	-Restore	in	-Restore	in	-Disk Change (7)	out	-Disk Change (7)	out
14	-Eject	out	-Eject 0	in	- Eject 0	in	N/C		Side Select	in
16	N/C		-Direct Head Load (3)	in	-Direct Head Load (3)	in	-In Use	in	-In Use	in
18	-DS3	out	-DS2 left	in	-DS2 left	in	-Head Load	in	-Head Load	in
20	-Index	in	-Index 0	out	-Index 0	out	-Index	out	-Index	out
22	-Ready	in	-Ready 0	out	-Ready 0	out	-Ready	out	-Ready	out
24	-Motor On	out	-Motor On	in	-Motor On	in	-Sector (8)	out	-Sector (8)	out
26	-DS1	out	-DS1 left	in	-DS1 left	in	-DS1	in	-DS1	in
28	-DS2	out	-DS1 right	in	-DS1 right	in	-DS2	in	-DS2	in
30	N/C		-Write Prot 1 (4)	out	-Write Prot 1 (4)	out	-DS3	in	-DS3	in
32	N/C		- Eject 1 (5)	in	- Eject 1 (5)	in	-DS4	in	-DS4	in
34	DIRC	out	DIRC	in	DIRC	in	DIRC	in	DIRC	in
36	-Step	out	-Step	in	-Step	in	-Step	in	-Step	in
38	-Write Data	out	-Write Data	in	-Write Data	in	-Write Data	in	-Write Data	in
40	-Write Gate	out	-Write Gate	in	-Write Gate	in	-Write Gate	in	-Write Gate	in
42	-Track 00	in	-Track 00	out	-Track 00	out	-Track 00	out	-Track 00	out
44	-Write Prot	in	-Write Prot 0	out	-Write Prot 0	out	-Write Prot	out	-Write Prot	out
46	-Read Data	in	-Read Data	out	-Read Data	out	-Read Data	out	-Read Data	out
48	N/C		-Sep Data	out	-Sep Data	out	-FM Sep Data	out	-FM Sep Data	out
50	N/C		Sep Clock	out	Sep Clock	out	-FM Sep Clock	out	-FM Sep Clock	out

- (1) In the standard Cromemco configuration, Persci drives will drive both Ready 0 and Ready 1 to indicate ready
- (2) In the standard Cromemco configuration, Persci drives will drive both Index 0 and Index 1 to indicate Index
- (3) In the standard Cromemco configuration, the drives load their heads when they are selected, and do not use the Head Load signal.
- (4) In the standard Cromemco configuration, Persci drives will drive both Write Prot 0 and Write Prot 1 to indicate Write Protect
- (5) In the standard Cromemco configuration, Persci drives will ignore Eject 1
- (6) This output can be disabled with the "2S" jumper on the SA850
- (7) This output can be disabled with the "DC" jumper on the SA800 and the SA850
- (8) SA 801/SA851 (hard sectored) option. This output is disabled with the "S" jumper on the SA800 and SA850.

## Sharing the Interface

Sharing the 16FDC's J3 interface with both a Persci drive and a Shugart SA850 drive requires a minor modification to the 16FDC, an adapter cable between the 16FDC and the SA850, and correct configuration of the SA850. The Persci drive stays as Cromemco originally configured it.

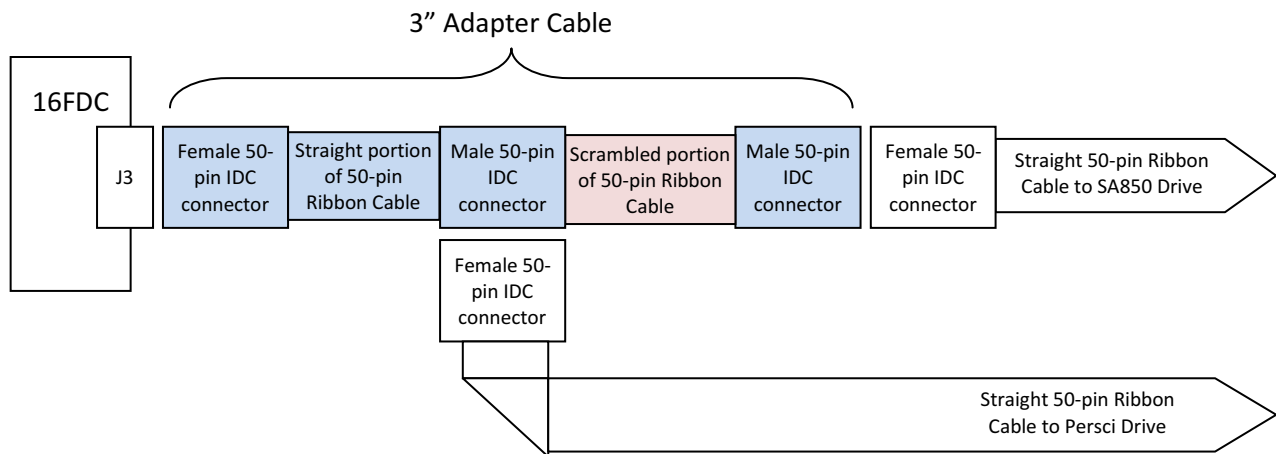
### 16FDC Modification

Add two jumper wires to the (Rev E) 16FDC to bring the TG43 signal to J3 pin 32, using a spare inverting buffer in U11. (Pin 32 is the only pin that is not connected on the 16FDC, and also not connected on Persci drives, when they are configured for Cromemco 16FDC application.)

- (1) Jumper from IC26 pin 9 to IC11 pin 4.
- (2) Jumper from IC11 pin 5 to J3 pin 32

### Adapter Cable

Fabricate a short (3") adapter cable like this:



The Adapter Cable can be fabricated by starting with a ribbon cable that is a couple of inches longer than the final adapter will be. Crimp the left two connectors (for the 16FDC and the Persci drive) in place, about an inch and a half apart. Slit the ribbon cable for a couple of inches between the groups of wires in the table below. Carefully route the groups of wires to the right-hand connector (for the SA850), according to the following table, and clamp the connector shut. Trim off the excess ribbon cable.

16FDC Side	SA850 Side	Signal
1,2	13,14	GND & -Side Select
3,4	31,32	GND & -DS4
5-12	5-12	(Unchanged)
13,14	No Connect	GND & -Eject
15,16	15,16	(Unchanged)
17,18	29,30	GND & -DS2
19-28	19-28	(unchanged)
29,30	No Connect	GND & No Connect
31,32	1,2	GND & -TG43
33-50	33-50	(unchanged)

## SA850 Configuration

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Configure the jumpers on the SA850 as follows:

Jumpers	Setting	Purpose
R-Pack at 5E	Removed (1)	No termination (Termination is in the Persci drive.)
DS1-DS3	Open	Not Drive Select from interface pins 26,28,30
DS4	Jumper	Drive Select from interface pin 32
1B-4B	Open	No Side Select using drive select
RR	Jumper	No radial Ready (jumper disables this option)
RI	Jumper	No radial Index (jumper disables this option)
R	Jumper	-Ready output to interface pin 22
2S	Open	No "-2-sided disk detected" output to interface pin 10
850/851	851 Jumpered	Soft-sectored disks
I	Jumper	-Index output to interface pin 20
S	Open	No -Sector output to interface pin 24
DC	Open	No -Disk Change output to interface pin 12
HL	Jumper	Stepper power from Head Load & Door Closed (note A,B,X)
DS	Open	No stepper power from Drive Select
WP/NP	WP Jumpered	Write inhibited when disk Write Protect notch is present
D	Open	No In-Use input from the interface pin 16
M	Open	No multimedia option
DL	Open	No door latch option
A,B,X	All Jumpered	Head load from Drive Select
C	Open	No -Head Load input from the interface pin 18
Z	Jumper	In-Use from Drive Select
Y	Open	No In-Use from Head Load
S1	Open	No Side Select from Direction Select
S2	Jumper	Normal Side Select from interface pin 14
S3	Open	No Side Select from Drive Select
TS, FS	FS Jumpered	Standard Data Separator Option
IWI/IWG	IWI Jumpered	Head current switching from interface pin 2
RS/RM	RS Jumpered	Standard Ready signal
HLL	Open	No Head Load Latch
IT	Jumper	In-Use terminator (used as pullup)
HI	Open	No Head Load or In-Use to the In-Use Circuit
F (or FM)	Open	No M2FM encoding
AF/NF (or MFM/ M2FM)	AF (or MFM) Jumpered	Active Read Filter for reading FM and MFM

Notes: (1) If this drive does not have the terminator resistor pack, then install a 150-ohm resistor between pins 1 and 14, and another between pins 5 and 10 at the R-pack location, 5E.

## Persci 277 Configuration

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For reference, here are the standard jumper and optional component settings for a Persci 277 drive (Persci assembly number 200131-006) in a Cromemco system. The “Nearest IC” column will help you find the jumpers on a Persci 277, though these locations may be incorrect for some versions of the Persci 277.

Jumpers	Nearest IC	Setting	Component	Nearest IC	Value
U11	U11	2-13,4-11	R88	U10	36K
2,4,8,16,32	U16	None	R94	U10	36K
2,4,8,16,32	U27	None	C40	U10	0.1 uF
A,B,C	U17	A-B	C41	U10	0.1 uF
D,E	U17	None	U16		None
F,G	U17	None			
H,J,Z	U4	J-Z			
K,L	U8	K-L			
M,N,P	U3	N-P			
R,S,T	U3	S-T			
U,V	U9	U-V			
W,X,Y	U10	W-X			
AA,AB,AC	U15	AB-AC			
AD,AE,AF	U15	AD-AE			
AH,AJ,AK	U10	AH-AJ			
AL,AM,AN	U1	AL-AM			
AP,AR	U8	AP-AR			
AS,AT,AY	U3	AS-AT			
AU,AV,AW	U11	AV-AW			
BA,BB,BC	U3	BA-BB			
BD,BE	U7	BD-BE			
BF,BH,BJ	U15	None			
BK,BL,BM	U3	BK-BM			

## Shugart SA800 Configuration

For reference, here are the Shugart SA800 Jumper settings for use on a Cromemco 16FDC, potentially sharing the interface with a Cromemco-configured Persci drive. No wiring changes are required: a Shugart SA800 drive that is configured this way will work with the 4FDC or 16FDC controller, and can share the interface with a Persci 277 or 299 drive. (You need a 16FDC to use a Persci 299 drive.)

If you intend to use the SA800 with an adapter cable as described above, then use DS3 and DS4 jumpers to select drive C and drive D. Without the adapter cable, DS3 and DS4 require jumper wires, as shown below.

Jumpers	Jumper Position	Comment
T1, T3-T6	Jumper for termination	Not Jumpered if the Persci drive is terminated
DS1,DS2	DS1 or DS2 (1)	Drive Select 1 or 2 from interface pins 26 or 28
DS3 & 18	Jumper DS3 to 18 (1)(2)	Drive Select 3 from interface pin 18
DS4 & 4	Jumper DS4 to 4 (1)(3)	Drive Select 4 from interface pin 4
RR	Jumper	Radial Ready when removed
RI	Jumper	Radial Index & Sector when removed
R	Jumper	Ready Output to interface pin 22
800/801	800 Jumpered	Soft-sectored disks
I	Jumper	Index output to interface pin 20
S	Open	No Sector output to interface pin 24
DC	Open	No Disk Change output to interface pin 12
HL/DS	HL Jumpered	Stepper power from Head Load & Door Closed (note A,B,X)
WP/NP	WP Jumpered	Write inhibited when disk Write Protect notch is present
D	Open	No In-Use Input from the interface pin 16
D1, D2, D4, DDS	Open	No user-installed drive decode
A,B,X	All Jumpered	Head load from Drive Select
C	Open	No Head Load input from the interface pin 18
Y/Z	Z Jumpered	In-Use from Drive Select (not from head load)
DFO	Open	No Non Force Output
TS	Open	No true FM data separation

Notes: (1) Install only one Drive Select jumper.

(2) Connect from the DS3 jumper pin that is farthest from J1 to the pin labeled "18"

(3) Connect from the DS4 jumper pin that is farthest from J1 to the pin labeled "4"