Last Updated: April 26, 2018

SCSI device emulator RaSCSI
-Rasperry pi As a SCSI target device emulator for X68000-

Introduction

RaSCSI is a type of emulator that virtually reproduces SCSI devices (hard disk, MO, CD-ROM) that have been converted into past relics. It was developed using SCSI control of XM6 Type G. By introducing it to Raspberry Pi (hereinafter referred to as RPI), RPI behaves like a SCSI device. Use 18 RPI GPIOs + 1 GND instead of SCSI connector. In order to connect RPI to X68000 (SUPER or later SCSI machine), you need to make your own conversion cable. By the way, RaSCSI performs various functions expansion by combining with X68000, but I think that it can be used with other retro PC adopting SCSI such as FM TOWNS when using it as a simple SCSI hard disk.
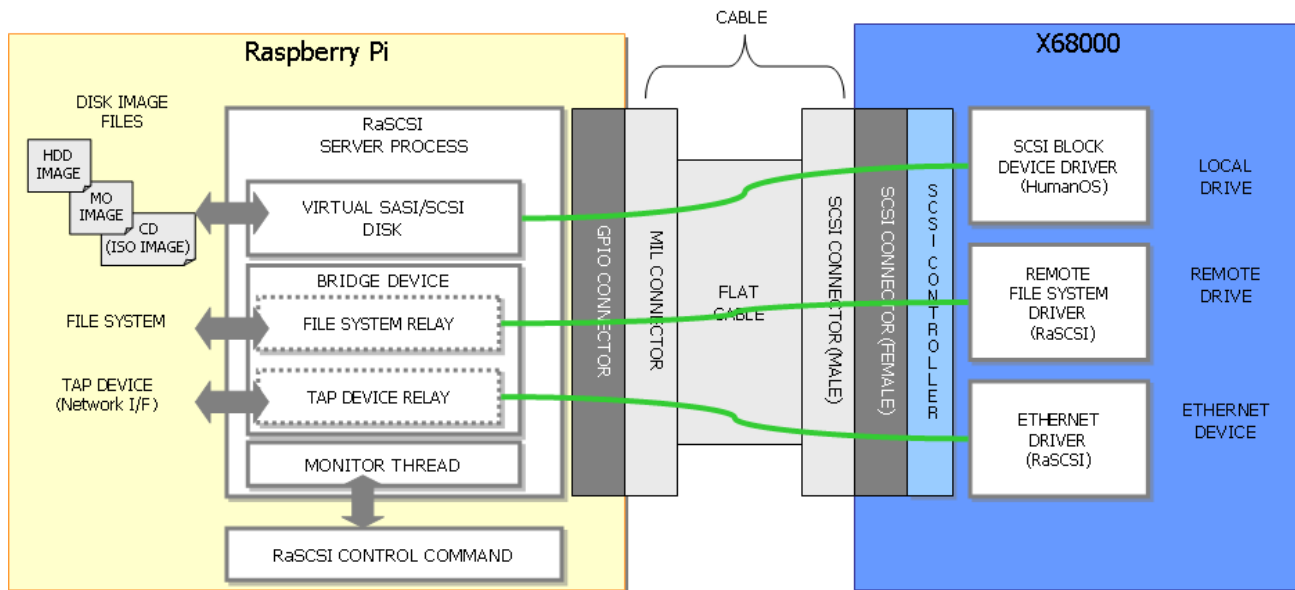
Characteristic

Virtual disk device (HDD, MO, CD)

Emulate SCSI connected hard disk, magneto-optical (MO) disk, CD-ROM. On the RPI side, the disk image file that can be created with XM 6 is recognized as a virtual SCSI disk device, but on the X68000 side a physical device is recognized as being present. I also officially supported SASI from version 1.24.

Ethernet communication

By installing the Ethernet driver provided by RaSCSI on the X68000 side, communication using the TAP device (virtual network I / F) can be performed through the RPI side bridge device. The X68000 side driver can be replaced with the Neptune - X driver.

Remote drive

By installing the remote file system driver provided by RaSCSI on the X68000 side, RPI file system can be recognized as a drive through RPI side bridge device as it is. It provides the same function as Windmill's XM6 Windrv XM on the actual machine.

Initiator mode

You can use the initiator mode to control SCSI devices (host side). This allows applications such as dumping and restoring physically connected SCSI hard disks etc. However, it is necessary to use a conversion board which can be used directly or initiator mode explained later.

Connection method (conversion board edition)

Recently, there are people who mainly produce conversion board for RaSCSI through Twitter neighborhood. Since it is consigned to sell in Akihabara somehow please get it. Please refer to the connection method below (direct connection) if you are directly connected at risk prejudice.

KENCHAN daughter hard (kit) of household appliances is recommended

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Circuit design of conversion board

For amateurs who want to create their own conversion boards, it is amateurs but I will write reference information. At the TTL level, 5 V is divided at 220 Ω and 330 Ω at the TTL level (in the case of passive terminator), so that the state where the voltage slightly less than 3 V is applied to each signal line is in a steady state (signal negatively). When trying to assert the signal (= 0 V) by the initiator side or the target side, the total current of $5000 \div 220 \times 2 = 45$ mA will flow from the terminators at both ends (the data sheet of MB 88352 which is the SCSI controller of X68000 It is Iol 48 mA as a sink current when looking). RPI GPIO can not absorb such large sink current. In order to make an electrically safe connection, it is necessary to make conversion board with general purpose logic IC etc. For general-purpose logic ICs, we use high power type open collector such as 74LS06 or 07 which can withstand 48mA sink current. The authors confirmed that it operates without any problems by performing basic SCSI direction control with 74 HC 541 × 3, 74 HC 126 × 1,74 HC 0 4 × 1 and further combining circuits that drive the bus using 74 LS 07 × 3. In addition, if you use 74LS641-1 which is a derivative version of 74LS641, the circuit can be constructed simply. Unlike normal products, it is not necessary to use 74LS07 because the sink current is 48mA compatible. But availability is not that good.

This is a circuit diagram example of a conversion board that supports target mode (HDD, MO, CD, etc.). There are many conversion boards developed based on this circuit diagram (GAMERnium.com version etc.).
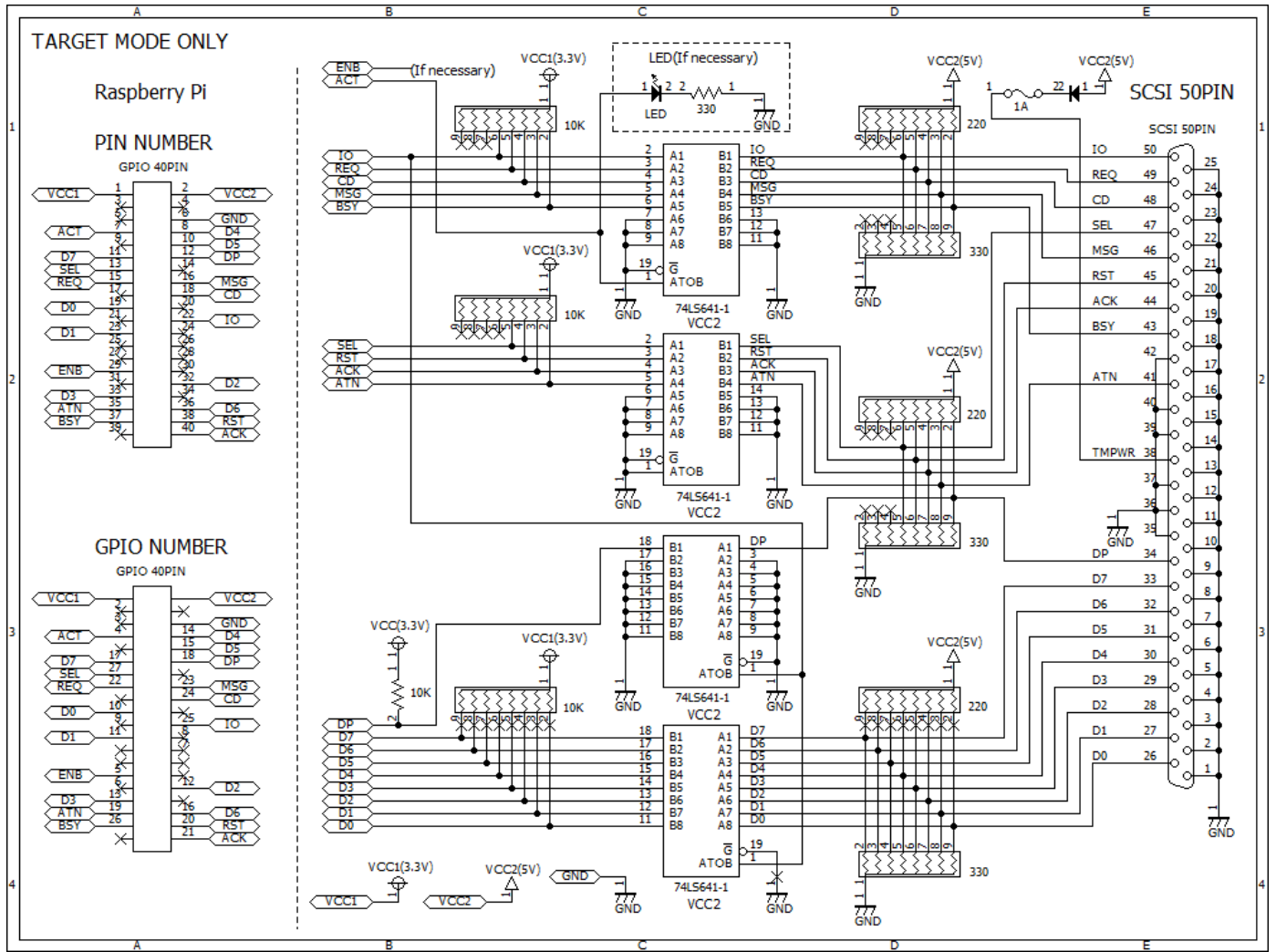
This is a circuit diagram example of a conversion board that supports the initiator mode (host function) in addition to the target mode (HDD, MO, CD etc.). We will use one more GPIO to control the initiator mode. Also, 74LS86 is required to invert the direction control. There is no conversion board currently based on this circuit diagram.
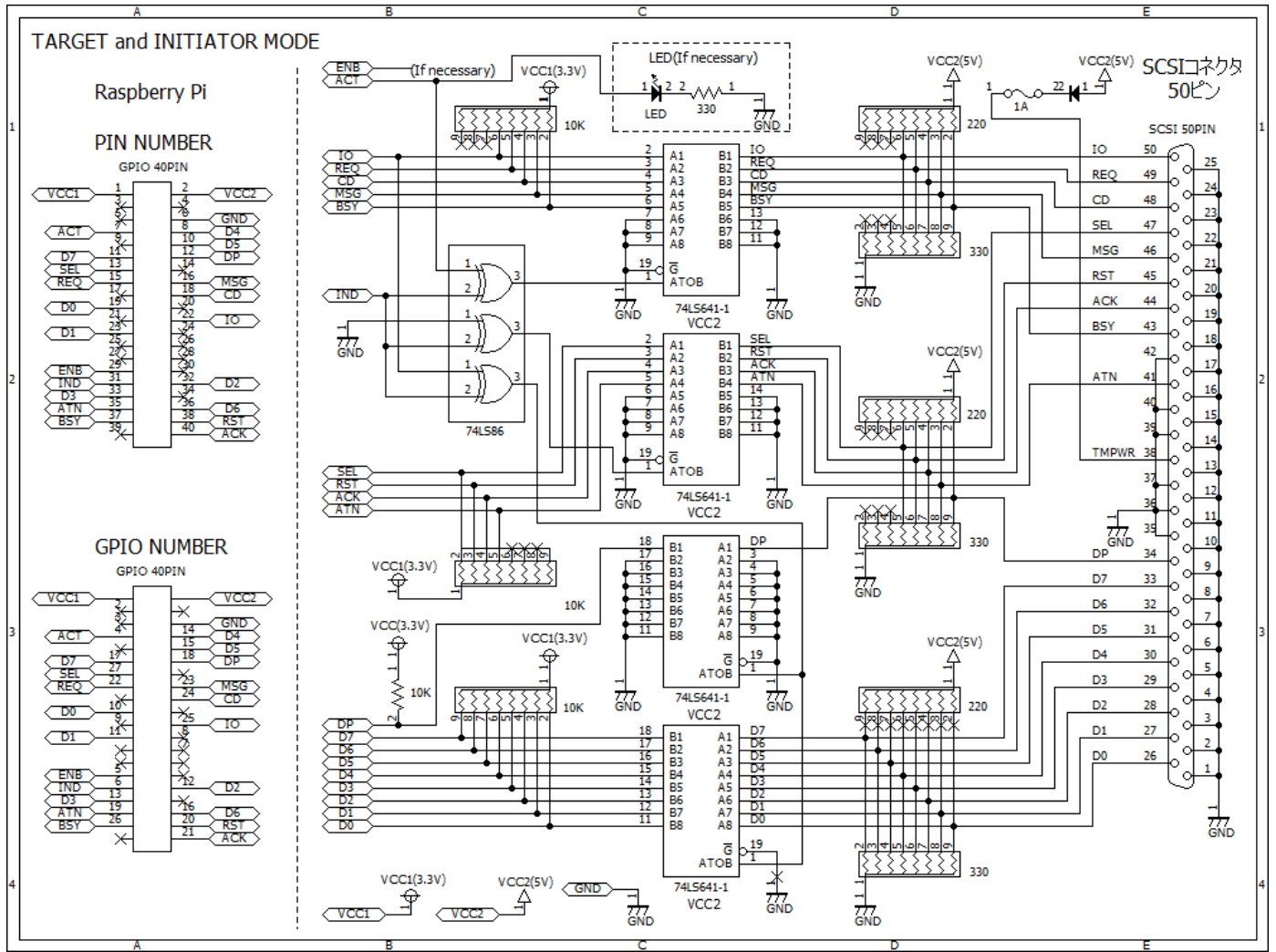
This is a circuit diagram example of a conversion board that supports target modes (HDD, MO, CD etc.), initiator mode (host function), monitor mode (SCSI signal monitoring). We use three GPIOs. The direction control of all 74LS641-1 is controlled from the RaSCSI side. There is no conversion board currently based on this circuit diagram. The Aibomu version using a dedicated driver IC is close to this.
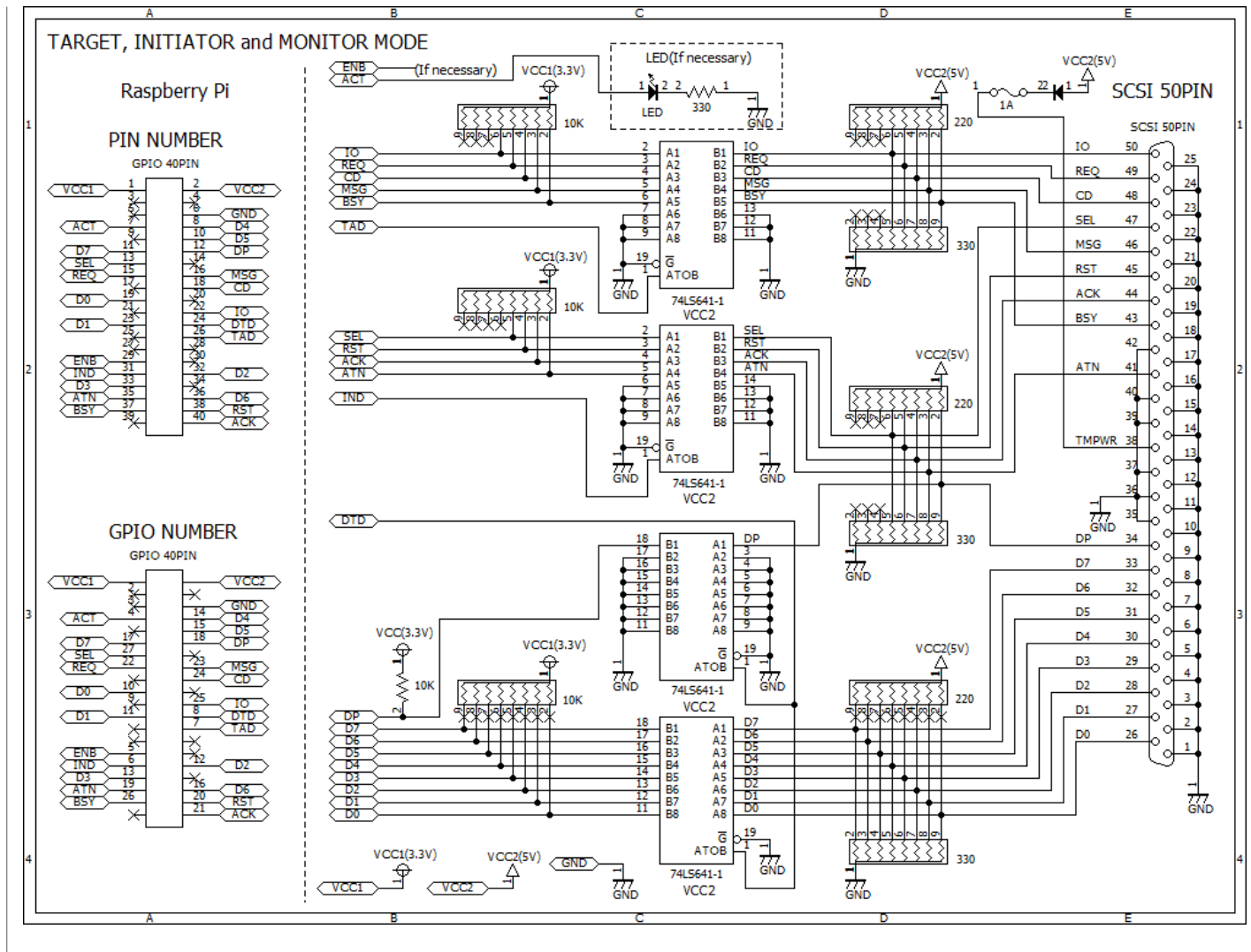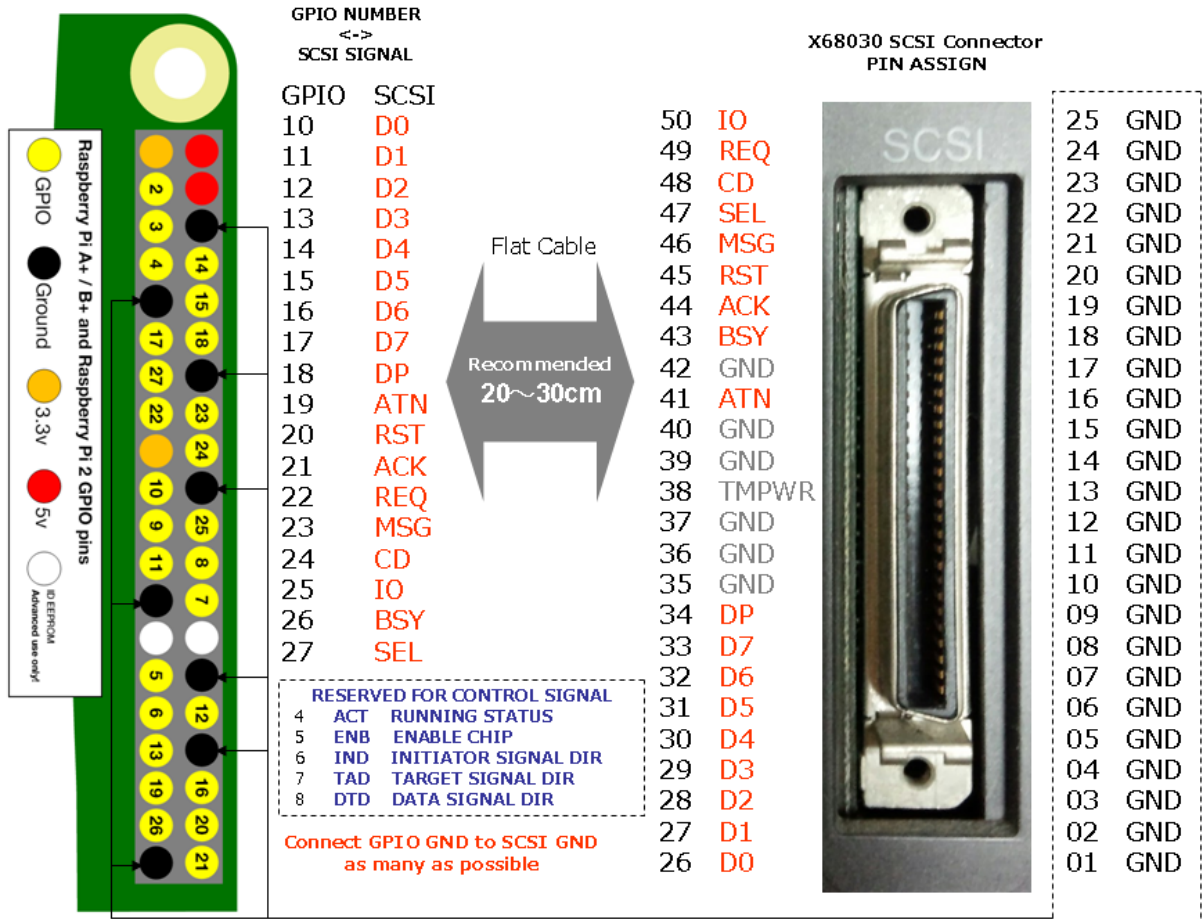
Connection method (direct connection)

warning!

Due to the difference in electrical specifications between GPIO and SCSI, there is risk involved in direct connection. Conversion boards must be used to make an electrically safe connection. People who can not understand this risk should give up. Your X68000 is probably okay but Raspberry Pi has an unexpected load. The unexpected load is the sink current explained at the conversion board. Since there is no terminator in direct connection, a sink current of about 22 mA will be generated but since it exceeds the maximum drive capability of GPIO, it will not be able to drive up to near 0 V with low sink current. Incidentally, RaSCSI is running for several months, but it has not yet become a failure. Even if it breaks down, it is not an expensive item, so please consider it as a consumable item.

Cable connection diagram
Raspberry Pi (GPIO) <=> Connection (conversion) cable <=> (external SCSI connector) X68000

RASCSI PIN ASSIGN

UPDATE 2017/9/2

GPIO NUMBER
<->
SCSI SIGNAL

X68030 SCSI Connector
PIN ASSIGN

GPIO	SCSI
10	D0
11	D1
12	D2
13	D3
14	D4
15	D5
16	D6
17	D7
18	DP
19	ATN
20	RST
21	ACK
22	REQ
23	MSG
24	CD
25	IO
26	BSY
27	SEL

Raspberry Pi A+ / B+ and Raspberry Pi 2 GPIO pins

GPIO
Ground
3.3v
5v
ID EEPROM
Advanced use only!

Flat Cable

Recommended
20~30cm

RESERVED FOR CONTROL SIGNAL
4   ACT   RUNNING STATUS
5   ENB   ENABLE CHIP
6   IND   INITIATOR SIGNAL DIR
7   TAD   TARGET SIGNAL DIR
8   DTD   DATA SIGNAL DIR

**Connect GPIO GND to SCSI GND
as many as possible**

50	IO		25	GND
49	REQ		24	GND
48	CD		23	GND
47	SEL		22	GND
46	MSG		21	GND
45	RST		20	GND
44	ACK		19	GND
43	BSY		18	GND
42	GND		17	GND
41	ATN		16	GND
40	GND		15	GND
39	GND		14	GND
38	TMPWR		13	GND
37	GND		12	GND
36	GND		11	GND
35	GND		10	GND
34	DP		09	GND
33	D7		08	GND
32	D6		07	GND
31	D5		06	GND
30	D4		05	GND
29	D3		04	GND
28	D2		03	GND
27	D1		02	GND
26	D0		01	GND

It seems to be stable when pulling out the GND on the SCSI connector side as much as possible (preferably 8 wires) and connecting it to the RPI side GND.

Cable production example
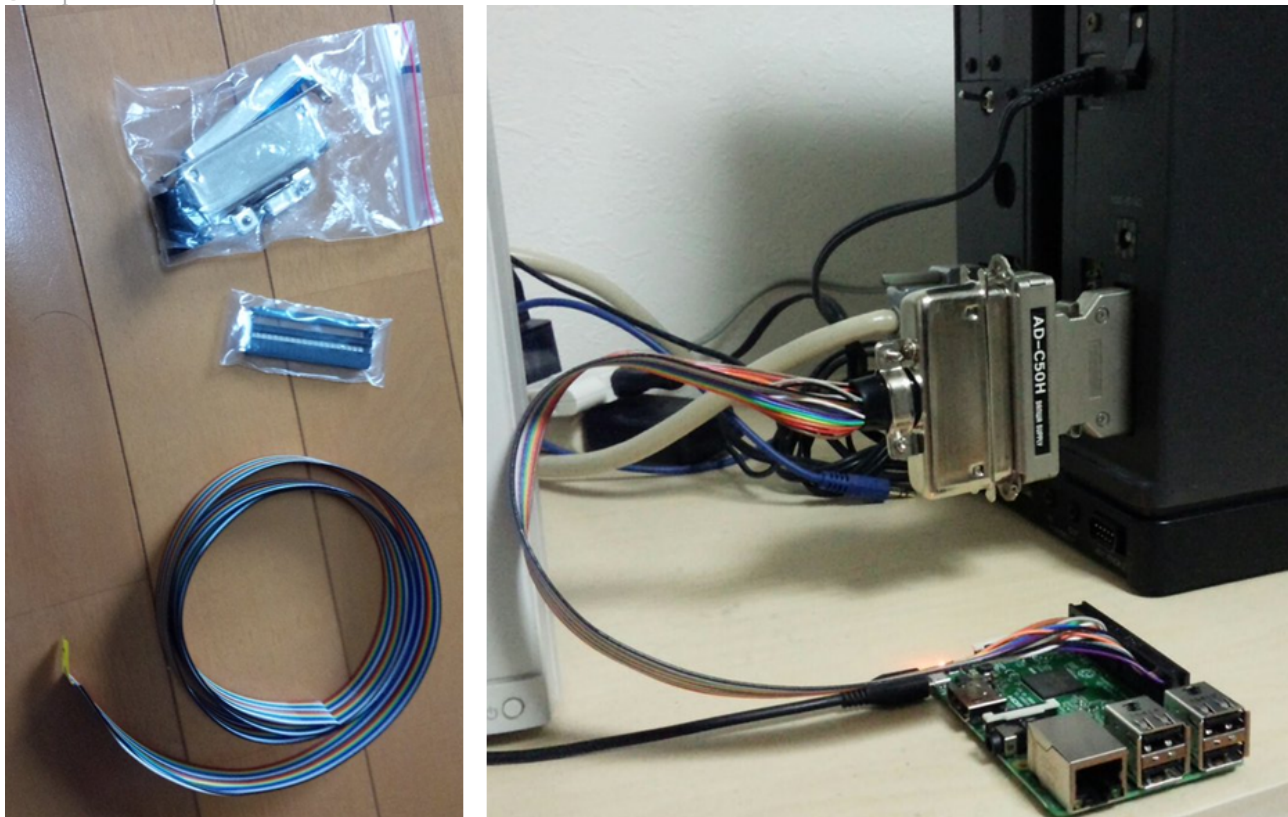
The material used was a 40-pin MIL connector, Centronics 50 pin male, flat cable. It is advisable to keep the flat cable within 30 cm (there is no track

record over this length). For SCSI connectors X68030 and XVI Compact are half size male (ribbon type) and other SCSI machines will be full size male. There is also the use of a conversion adapter like the photo. GPIP pins are not lined up beautifully, but because they are using jumping pins on top of making applications, it is a troubling place as to which to adjust the connection. I soldered the SCSI connector side normally and crimped the wiring one by one on the MIL side.

Example of directly connected substrate
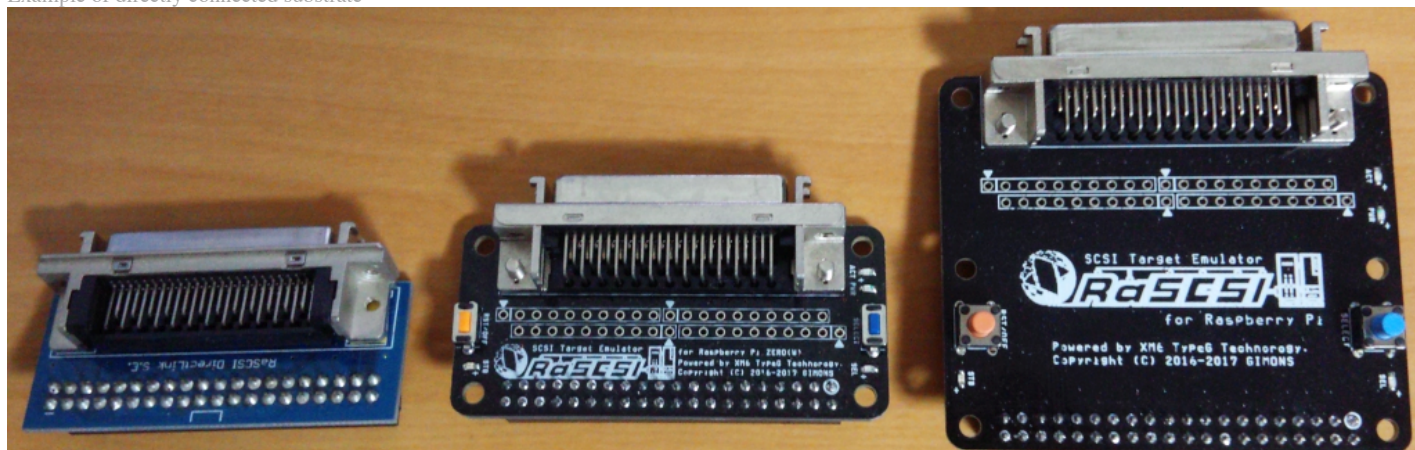
There is also a direct connection board. Basically it is the same as the directly connected cable, but it is electrically stable or it does not seem to be a problem even if using the SCSI cable.

Operating environment (RPI)

It operates in the following operating environment.

Raspberry Pi

Raspberry Pi 3 Model B is recommended.
It is thought that Raspberry Pi 2 Model B and Zero also work. There is also a report that you changed pin assignment independently and operated it with Raspberry Pi 1.

Supported OS

Developed and tested with RASPBIAN STRETCH. It is updated with sudo apt-get update and sudo apt-get upgrade. At the time of writing this document, the kernel version is Linux raspberrypi 4.9.59 - v 7 +. Since RaSCSI controls the SCSI signal using GPIO, it is necessary to use it with low latency as much as possible. Therefore we recommend using it in CUI mode. Please stop unnecessary service as much as possible.

Operating environment (X68000)

It operates in the following operating environment.

X68000

SCSI machine after SUPER is recommended. Even models with SCSI boards added have a track record of operation.
Only SASI hard disk emulation can be used with SASI machines such as the first generation, ACE, EXPERT, PRO, etc. SxSI is not confirmed so much, so it will be appreciated if you can report the operation. Incidentally, since parity is not used, it is not necessary to add a parity circuit.

Supported OS

Since Ethernet function and remote drive function provide only Human's device driver, Human 3.02 is recommended for using all functions.
If it is only SCSI storage, it will not be a problem with NetBSD etc.

Disk image

RaSCSI itself is a derivative of XM6 Type G which is an X68000 emulator. Therefore, it is assumed that creation of a disk image is done from the "Tools" menu of XM6 TypeG. Of course, it is possible to create an empty image file with dd etc. according to the following specifications.

SCSI hard disk

HDS file format (extension HDS / HDN / HDI / NHD / HDA extension)
File size is arbitrary size (in 512 byte units) in the range of 10 MB or more and 4095 MB or less.
When the extension is "HDN", NEC genuine hard disk emulation for PC9800 series PC-9801-55 board is performed. There is a difference in the

information returned by INQUIRY or MODE SENSE. When the extension is "HDI" or "NHD", they use SCSI hard disk images of PC98 emulators Anex 86 and T 98 Next, respectively. As with HDN, some information is converted for NEC (Thansk sava).

When the extension is "HDA", APPLE genuine hard disk emulation for Macintosh is performed. There is a difference in the information returned by INQUIRY and MODE SENSE.

SASI hard disk

HDF file format (extension HDF)
File size is 10441728 bytes, 20748288 bytes, or 41496576 bytes (corresponding to 10 MB drive, 20 MB drive, 40 MB drive respectively).

SCSI magneto-optical (MO) disk

MOS file format (extension MOS)
The file size is one of the following four types.

128 MB type (127398912 bytes)
230 MB type (228518400 bytes)
540 MB type (533248 000 bytes)
640 MB type (635600896 bytes)
128 MB, 230 MB, 540 MB is 512 bytes / sector, 640 MB is 2048 bytes / sector.

SCSI CD-ROM

ISO file format (extension ISO, ISO 9660 solid image)
Mode 1 (2048 bytes / sector) corresponds to both data stored only in file and file recorded in RAW format.

download

RaSCSI (version 1.34)
RaSCSI RPI side program and X68000 driver and documentation. The source code of each program is also included in the archive. Since it is about one year since RASPBIAN STRETCH release, the JESSIE version is abolished.

Download RaSCSI version 1.34 for RASPBIAN STRETCH (1,082,580 bytes)

Download (past)

RaSCSI (version 1.33)

Download RaSCSI version 1.33 for RASPBIAN STRETCH (1,074,944 bytes)
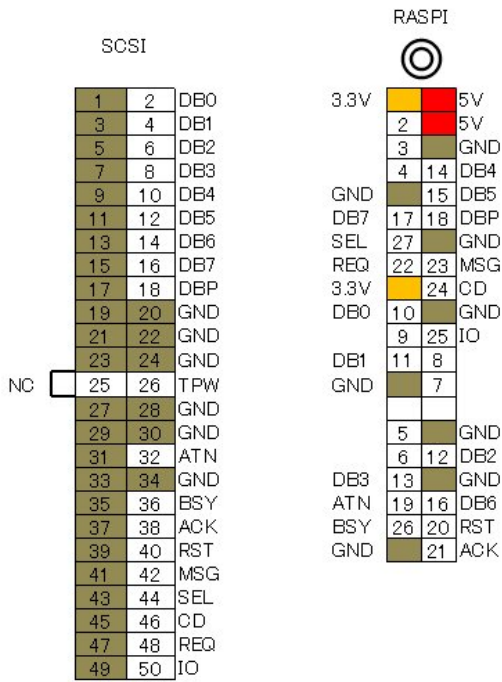Download RaSCSI version 1.33 for RASPBIAN JESSIE (1,075,771 bytes)

RaSCSI (version 1.32)

Download RaSCSI version 1.32 for RASPBIAN STRETCH (1,075,741 bytes)
Download RaSCSI version 1.32 for RASPBIAN JESSIE (1,076,378 bytes)

Reference information

SCSI Flat cable signal line

上から見た図

RASPI

SCSI			RASPI			
1	2	DB0	3.3V			5V
3	4	DB1		2		5V
5	6	DB2		3		GND
7	8	DB3		4	14	DB4
9	10	DB4	GND		15	DB5
11	12	DB5	DB7	17	18	DBP
13	14	DB6	SEL	27		GND
15	16	DB7	REQ	22	23	MSG
17	18	DBP	3.3V		24	CD
19	20	GND	DB0	10		GND
21	22	GND		9	25	IO
23	24	GND	DB1	11	8	
25	26	TPW	GND		7	
27	28	GND				
29	30	GND		5		GND
31	32	ATN		6	12	DB2
33	34	GND	DB3	13		GND
35	36	BSY	ATN	19	16	DB6
37	38	ACK	BSY	26	20	RST
39	40	RST	GND		21	ACK
41	42	MSG				
43	44	SEL				
45	46	CD				
47	48	REQ				
49	50	IO				

NC

It is the information received from the RaSCSI fighter connected by the SCSI flat cable.

screenshot

Full Disk
SCSI ID can be freely assigned from 0 to 7. Normally the PC main body adds an ID with an initiator, so it is actually up to 7 units.

You can also use it as a boot disk boot device.

DSKBENCH
Benchmarks will also beat out numerical values. It is not inferior to physical HDD (SCSI 1 though).

I could use FM TOWNS II
I developed it for X68000, but I used it normally for FM TOWNS as well.

The power of RASDRV which can taste Windrv XM mood even though it is a real machine that uses the file of Raspai as it is.

It also comes with an Ethernet connection
During TELNET from X68000 to RPI. I do not need Neptune-X any more.

History

2018/4/26 Version 1.34 is released (rasdump improvement, 256 bytes / sector is released experimentally with HDN and HDI, merge NetBSD compatible patch)

Published 2018/2/10 Version 1.33 (GAMERnium.com full spec version compatible, timing correction)

Release 2017/12/3 Version 1.32 (strengthen support for PC 98, timing improvement, full spec version binary addition, other bug fixes)

Release 2017/9/5 Version 1.31 (Initiator mode compatible, RASDRV improved)

2017/7/1 Version 1.30 released (PC-9801-55 genuine NEC HD compatible, Apple genuine HD compatible for Macintosh)

Published 2017/6/25 Version 1.26 (Expansion for 55 boards for PC 98, Experiment on MAC)

Published 2017/6/18 Version1.25L10 (urgent response to RASPBIAN's cpuinfo specification change)

Publish 2017/6/18 Version 1.25 (Transfer error processing and RST signal reception processing are modified)

Release 2017/6/17 Version 1.24 (Improve stability by kernel driver)

2017/5/21 Version 1.23 is released (55 board compatible experiment for PC 98, SASI hard disk compatible experiment, @ 132 sync version, tomcat version converted binary addition)

Publish 2017/5/1 Version 1. 22 (Correct processing when receiving ATN signal, add output of ENABLE signal, add SCSI control logic for conversion board * recompile required)

2017/4/10 Version 1.21 is released (deletion of unnecessary code, correspondence of pin assignment, addition of output of ACTIVE signal, correction of bug of host file system)

Circuit design is added to 2017/4/9 "Consideration of electrically safe connection method"

2017/3/23 "Consideration of electrically safe connection method" etc. added

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