MSXPi Interface Version 1.1

Users & Developers Guide

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Introduction

MSXPi is a hardware and software solution to allow MSX computers to use Raspberry Pi devices as generic peripherals. The project implements a MSX compatible interface that can be used with most MSX 1,2,2+ and Turbo R. Due to some specific hardware implementation of some MSX models, the interface may not work on all MSX models. Also, the integrated MSX-DOS only works on 64K machines.

MSXPi software is composed of different components running on MSX and on Raspberry Pi. On the Raspberry Pi side, there is the MSXPi server component which listen for GPIO events, decode serial data using a few pins and transform that data into control commands and parameters. On the MSX side, there are different software components depending on how the user wants to use MSXPi:

- MSX-DOS is stored in the MSXPi ROM. This is the MSX-DOS v1.0 customized with the MSXPi low level drivers to allow boot from MSX standard disk images stored on Raspberry Pi. The ROM also contain the MSXPi BIOS with a set of CALL commands that can be used BASIC.
- MSX-DOS commands - these are “P” .com commands that implement a series of functionalities on MSX-DOS allowing greater experience with MSXPi, such as setting system clock and access to internet resources.
- MSXPIEXT.BIN is the MSXPi BIOS implementaton that can be loaded from BASIC and behave similar to a MSXPi with an installed ROM. The BIOS is installed in the RAM in the the 4000h cartridge area, becoming available for BASIC programs.

Whats is New

This version is a major overhaul of the MSXPi. It was added support to the Z80 /wait signal, allowing a change to the low level drivers to be simpler, more straighforward and easy to support and add software. To support this major change, existing interfaces will need a small simple hardware mod, and to use the new software versions available.

Changes on Version 1.1

- PCB redesigned for software erasable EEPROM AT28C256. With this change the ROM can be re-written directly form the MSX-DOS using the included programmer. Jumpers modified to support the new features.
- Transfer routines changed again, for simplicity and stability. Uodated all clients and MSX-DOS driver.
- Pcopy command improved to detect when copies are done to the disk images, and copy the files directly to the image without the need to send to MSX, which in turn would send it back to the image.

- All “p” commands return a header: Return Code (1byte), Block size (2 bytes), Data (BLKSIZE). This is an optional parameter in the transfer function, which can be disabled for custom developed commands
- Added mapping of network & internet locations configurable by user using pset command: R1: (defaults to msx1 roms in msxarchive.nl), R2: (defaults to msx2 roms in msxarchive.nl), M: (defaults to local ftp server ftp://192.168.1.100). This work with commands pcd and pcopy, for example: pcopy /z R1:frogger.zip
- Added supported to automatically decompress archive files during the transfer with “pcopy /z”
- Added improved recover logic to stop MSXPi from staying in sync error loop.
- Lots of other bug fixes and improvements

Changes on Version 1.0

- PCB redesigned with support for /wait signal, use of by-pass capacitors for greater stability, and external pull-up resistors on all RPi GPIOs used by the interface.
- Requires a Mod to the existing interfaces v0.7: remove the BUSDIR jumper. Wire the CPLD pin 11 to the MSX /wait signal (requires a simple soldering skills).
- CPLD logic redesigned to implement the /wait signal, although at this version it will be set to tristate at all times.
- Server architecture completed re-written to be simple, more modular, easier to extend and maintain.
- All client applications re-engineered to support the new interface architecture.
- MSX-DOS ROM was recompiled to support the new interface architecture.
- Added CRC16 error correction on all download transfers (RPi to MSX)
- Server-side configurable number of transfers retry upon errors

Changes from Version 0.8.2

- A more complete set of CALL commands

  Starting at ROM build 20171230.00077, MSXPi contain a new set of CALL commands in ROM allowing it to be used in BASIC and from within BASIC programs.

  Not all MSXPi commands are be compatible, but some are (such as PRUN, PSET, PDIR) and allow exchange of data with Pi in BASIC.
- The new CALL commands also available as a BASIC extension (msxpiext.bin) for MSXPi that interfaces with older ROMs.
- New server in Python

The msxpi-server has been ported to Python. This improves development time, at the same time allowing same level of transfer rate since the transfer of blocks of data are still using the C function.

- IRC client and WhatsUp client

  Two messaging clients are available, in BASIC, for these messaging platforms. They use the new CALL commands, and are compatible with either the new ROM or the msxpiext.bin extension.

Getting Started

Assembling the Interface

Preparig the SD Card for Raspberry Pi

Using the MSXPi Pre-Installed SD Card

Installing and configuring Raspbian from Scratch

Preparing the MSX

Users Guide

MSXPi can be used as a standalone disk drive, booting from a MSX-DOS 1.03 in a disk image (.dsk) stored in the Raspberry Pi. This works to an extent, although there are several limitations and bugs. It’s not the recommended way to use the MSXPi, although it is a reasonable option if there is not another storage device available to boot the MSX with Nextor or MSX-DOS 2.

The best method to use MSXPi is to use it along with the SD Card interface running Nextor or MSX-DOS2 (such as a Megaflashrom Scc+ SD). In this configuration, the user has the best option for storage and along with all the features the MSXPi provides.

Either way, the P commands are available and can be used in the MSX-DOS 1, 2 and Nextor. The MSXPi BIOS (CALL COMMANDS) can also be used irrespective of how the system was booted, with options to have the BIOS in an EEPROM (AT28C156) or load it from BASIC by running the “msxpiext.bin” extension.

Booting with the MSXPi

When booting the MSXPi with the integrated ROM, it will try to boot into MSX-DOS 1.03 in a floppy disk image stored in the Raspberry Pi. After a successful boot, drive A: and B: will be available for the user. These drives are stored in the Raspberry Pi as .dsk disk images:

/home/pi/msxpi/disks/msxpiboot.dsk (Drive A:)

/home/pi/msxpi/disks/tools.dsk (Drive B:)

Note that booting from the integrated MSX-DOS 1 require the Raspberry Pi to complete its boot sequence and start the msxpi-server.py - for this reason, a MSX cold boot (power on) may take a few minnutes to sucessfully boot into the MSX-DOS.

To bypass the MSX-DOS 1.03 boot and go directly to BASIC, keep ESC pressed during the boot sequence.

To boot from another interface (for example, with Nextor), insert that interface in a lower slot, and the MSXPi in the higher slot, and power on the MSX. To skip the MSXPi waiting time during the boot, keep ESC pressed during the boot sequence.

Using the MSXPi Commands

P commands are the ".com" commands available under the DOS system (MSX-DOS1/2,Nextor). These commands works tin the same way independent of the MSX-DOS version, and are described in details in this section because they are the "core" MSXPi commands.

at28c256

Write a ROM file to the EEPROM. The ROM may be 8KB, 16KB or 32KB.

It's possible to write two ROMs (16KB each) and switch between them by swithing the jumper A14/A15 (the ROMs must be previously merged).

Examples:

at28c256 /i (Display headers of all identified ROMs)

at28c256 /s 2 MSXPIDOS.ROM (write MSXPi BIOS to the EEPROM in slot 2)

msxpiupd

Perform a full upgrade of the MSXPi (client and server - the ROM is not updated).

This command download all P commands from github to the MSX drive - existing versions re overwritten. The server components are also updated, including the two disk images used by the MSX-DOS 1.03.

pdate

Sets the MSX-data and time by readingn these informaton from Raspberry Pi. This command does not accept any parameter.

pcd

Sets the path for the MSXPi commands pdir and pcopy. Is called without parameters, will display the current path.

The path may be a Raspberry Pi filesystem path, a http/ftp/smb url, or one of the three virtual devices below. Any of thesse three devices can be changed via ***pset*** command.

- **m** A user local network resources. The default path for m: is ftp://192.168.1.100
- **r1** A internet location. Default path is the msxarchive.nl roms for MSX1
- **r2** A internet location.Default path is the msxarchive.nl roms for MSX2

Examples:

pcd

pcd /home/pi

pcd m:

pcd r1:

pcd http://www.msxarchive.nl/pub/msx/

pdir

Show contents of current path in the MSXPi when no path is passed as parameter.

Show contents of given path when passed as parameter.

Note that the path can be local to the Raspberry Pi and also a remote / network resource.

Examples:

pdir /home/pi

pdir http://www.msxarchive.nl/pub/msx

pcopy

Copy a file from a Rapsberry Pi path (filesystem or network) to the MSX drive.

The file can be in the Raspberry Pi s card (any folder), in the network (ftp/http/smb) on in one fo the three virtual devices (m, r1 and r2).

pcopy accepts the parameter "*/z*" to desompress a file, lookup its original name inside the compressed archive, and use it to save in the MSX drive.

Examples:

pcopy /home/pi/msxpi/msxpi.ini msxpi.ini

pcopy ftp://192.168.1.100/pver.com

pcopy m:pver.com

pcopy /z r1:frogger.zip (download frogger.zip from msxarchive, unzip, save as frogger.rom)

prun

Run a command in the Raspberry Pi. Note that commands that require inputs are not supported.

Pipe is suported, but must be replaced by "::" in the MSXPi.

Examples:

prun ls -l /etc

prun cat /home/pi/msxpi/msxpi.ini

prun ps -ef :: grep msx

prun wget http://www.msxarchive.nl/pub/msx/games/roms/msx1/frogger.zip

pset

This command is used to manage the MSXPi variables, such as the wifi ssid, wifi password, virtual drives, MSXPi current path, disk images and other user variables.

The variables are saved in a file: /home/pi/msxpi/msxpi.ini and loaded when MSXPi starts.

When used to set the disk images for MSXPi, this command will enforce the loading of the new disk image, making it available immediately.

***Note**: It's recommended to not change variable DriveA, because it defines the disk with MSX-DOS and the P commands for the MSX-DOS 1.03 boot. Changing this variable may lock the user oout of the DOS, requiring manual changes to the msxpi.ini file to recover the boot.*

Examples:

pset

pset WIFISSID My Wifi Name

pset WIFIPWD MyWifiPass

pset DRIVE1 /home/pi/msxpi/disks/diskb.dsk

pwifi

Display the current network interface information, and set the wifi using the Wifi variables

Examples:

pwifi

pwifi set

*Note: "**pwifi set**" will use "**WIFISSIDW**" and "**WIFIPWD**" MSXPi variables to configure the Wifi interface. After "pwifi set" command, a reboot is required for the Raspberry Pi to enable and acquire the new network configuration.*

prestart

Restart the MSXPi Server (msxpi.server.py) in the Raspberry Pi.

preboot

Reboot the Raspberry Pi.

pshut

Shtudown the Raspberry Pi.

Developers Guide

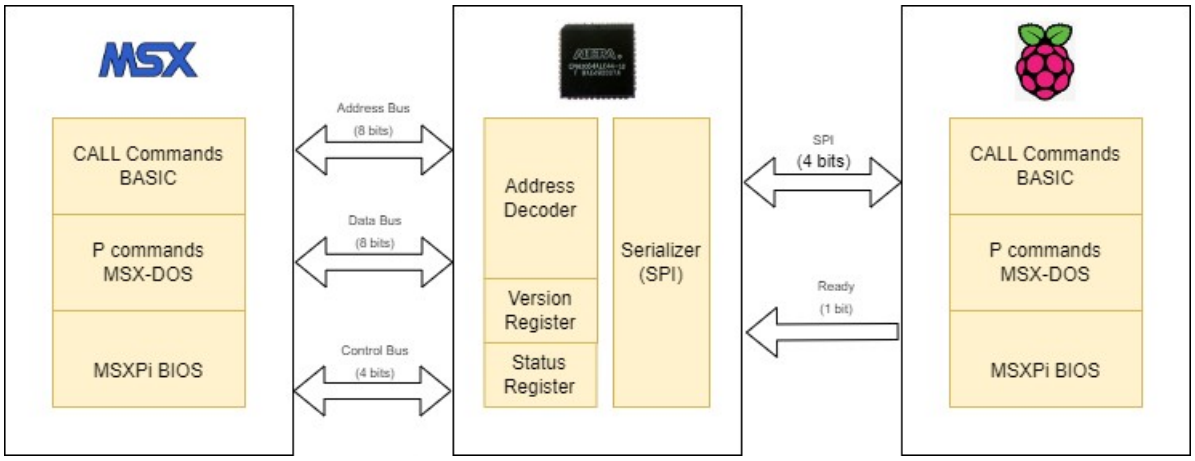
This section is directed to developers that want to create new MSXPi programs, in either BASIC or Assembly in the MSX side. Note that all code on the server side is always Python.

MSXPi Architecture

MSXPi contains three main components:

- MSX client software for both MSX-DOS and BASIC
- MSXPi interface (cartridge to insert in the MSX slot)
- Raspberry Pi server software

These components are connected and interact as shown in this architecture diagram:



The interface is enabled when the MSX write or read the IO ports 0x56, 0x57 and 0x5A. These ports are decoded by the CPLD in the interface, serialize the data in the data bus and transfer to the Raspberry Pi, which convert the data back bytes and process it as defined in the MSXPi protocol (see next section).

MSXPi Protocol

The commended method to develop for MSXPi is to use the BIOS and routines available. These routines implements all the low level aspects fo the interface, making it easy to implement new commands and exchange data with the Raspberry Pi.

All programs must always start with a command being sent to Raspberry Pi. This command has a fixed length of 8 valids characters in the range A-Z or a-z (case is actually irrelevant). The command is always parsed and processed by the msxpi-server.py program, whch will then call a function in with the same same in the program. This function must have been implemented, otherwise the server will return an error.

Data is transfered in blocks of size 8,128,, 256,or 512 bytes, depending pn the stage and function being implememnted. Its posible to use blocks of any size when calling the basic transfer routines directly (SENDDATAT and RECVDATA).

Each block contains also three (3) additional bytes used for header, which must be considered when reserving buffer areas for the commands (these are discussed later in the next sections). This header contains the return code provide by the Raspbery Pi, and the size of useful data in the block (this will be covered in details in the development sections below).

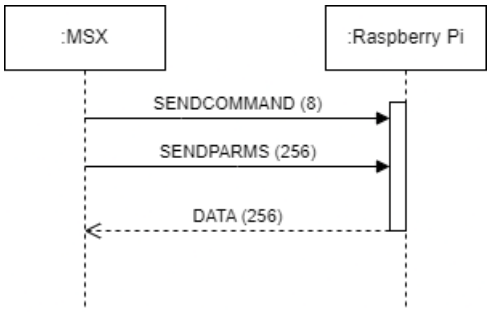
Once the function is called, it's up to the programmer to implement the required behaviour, which may include passing additionnal parameters, sending and receiving data on both directions, etc. The MSXPi BIOS routines have a number of funcions the developer can use to implement their programs, which will be described later.

Most of the MSXPi commands follow this sequence:

1. Send a command (8 bytes)
2. Send the parameters (256 bytes)
3. Receive the response (256 bytes or more)

The command name (8 bytes string) corresponds to a function in the msxpi-server.py running in the Raspberry Pi. These comamnds (such as "pcd") will be executed in the Raspberry Pi, and return the output as a 256 bytes data block – in some cases, the returned data is larger than 256 bytes, in which case the P command must be prepared to detect and process correctly the additional blocks – failing to do this will cause the MSXPi to enter an "out of sync" state and fail.

There are many variations of the high level protocol, but as previously mentioned, they all must start with a command being set to Raspberry Pi. Below it's shown the main possible variations of the structure and sequence of actions in MSXPi commands.

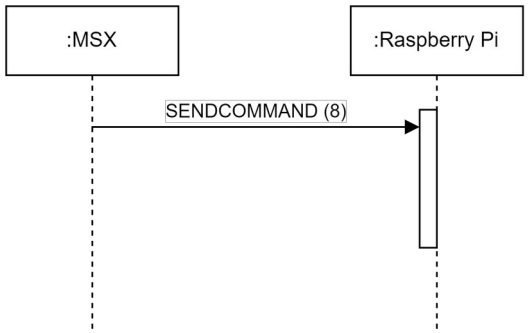


MSXPiProtocol 1

Send a command, followed by the parametes. Expect to to receive at least one block of data back as response. This is the most common structure, because the response will contain useful data to be presented to the user in either sucessful or failure situations:

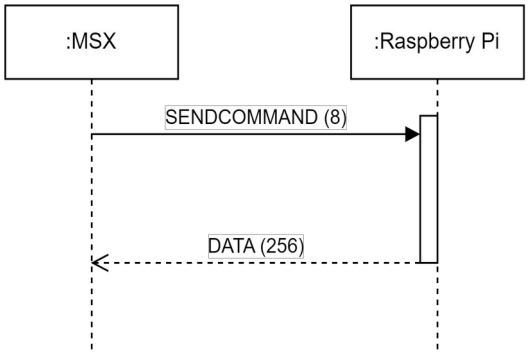
- Output of the command executed in the Raspberry Pi
- Error message when the command failed

This structure is used in most of the P commands, and is also implemented in the CALL MSXPI for BASIC development. The user can easily implement additional functinality for MSXPi using this structure by cloning the TEMPLATE code (in the Clients/src folder) and the “template()” function in the msxpi-server.py.



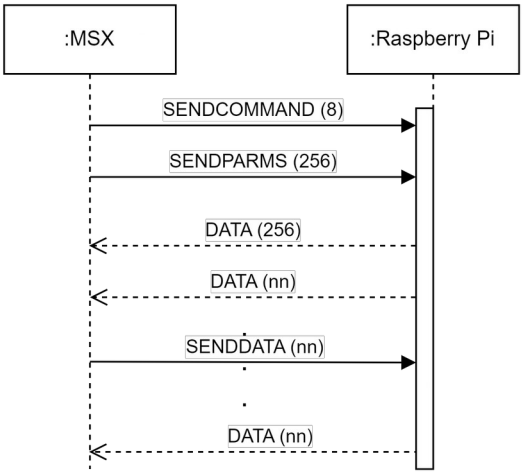
MSXPiProtocol 2

Send a command, and do not expect a response.



MSXPiProtocol 3

Send a command and expect one block of data (256 bytes).



MSXPiProtocol 4

Send a command, send additional parameters, and receive many blocks of data. Optionally, send also additional data during the execution of this command.

This is a more complex implementation, and there are different ways this structure can be implemented, by either locking on not locking the msxpi-server. Study the command PCOPY (locking the server to a single command) and the BASIC program IRC.BAS (not locking the server).

“Locking the server” means that the command takes over the MSXPi until its completelly finished. “Not locking the server” means the operatons are assynchronous, and one program span across several calls to MSXPi, allowing other commands to be used in between calls.

Developing in Basic

Programs can be developed in BASIC to use MSXPi resources by using three BIOS commands:

- CALL MSXPI – Send a command and parameters to Raspberry Pi, and receive back a reply
- CALL MSXPISEND – Send a block of data to Raspberry Pi, which must be already waiting for it.
- CALL MSXPIRECV – Receive a block of data from Raspberry Pi.

All commands need a buffer address, which can be provided by the developer. If a buffer area is not provided, the MSXPI BIOS command will automatically reserve one with 259 bytes at the top of the RAM. Note that leaving the BIOS to reserve the buffer might be dangerous, because if the commands return data larger than the buffer, it will start to overwrite system ram (and the STACK) at the top of the RAM, causing a crash.
The recommended way to allocate a buffer is to do it explicitly in the command, with enough capacity for the data that is expected to be received. For example, if the developer leaves the buffer allocation resposibility for the MSXPi BIOS while using executing CALL MSXPI(“prun ls -lR /”), the computer will crash because the amount of data returned by the command is immensely larger than the buffer, consequently causing a crash.

CALL MSXPI

Syntax:

CALL MSXPI(“<stdout>,<buffer address>,<command>”)

Examples:

call msxpi(“pdir”)

call msxpi(“0,pdir”)

call msxpi(“1,pdir /home/pi/msxpi”)

call msxpi(“2,D000,pdir /etc”)

Executes a command (function) defined in the “msxpi-server.py”, receives the reply data and process it according to the option specified in the “stdout” parameter.

Possible values for stdout parameters

stdout	Description
0	Ignore the date returned by RPi
1	Print tall received data o screen. If the data is 1 block only, full data is also available in the buffer. If it is larger than one block, only last block is available in the buffer
2	Store all received data in the memory starting in the address provided in the command (the buffer). May corrupt the top RAM and stack if data is larger than the available space in the buffer.

Buffer Address: This is a string composed of four hexadecimal digits for a memory area to receive data from RPi – for example, “C000”. It must have at least 259 bytes (BLKSIZE) available from this address.

Command: Any command defined in the “msxpi-server.py” program. Each command is created as a function in the server, as for example “pdir”, “pcd”, “prun” or any other command created by the developer. Parameters are also accepted.

CALL MSXPi uses a buffer of size BLKSIZE (259 bytes) to receive data from RPi. Each block received will contain a header, as shown in this table:

Address	Buf+0	Buf+1	Buf+2	Buf+3 up to Buf+3+Size
Content	Return code	# Data Size (lsb)	# Data Size (msb)	Data (this area size=lsb+256*msb)

A transfer occurs BLKSIZE bytes at a time, and it may have one or more blocks. If the total data to transfer is larger than the BLKSIZE, then more than one block transfer will be required - the CALL MSXPi command takes care of these, making sure all data is available for the user. However, if you implement your own commands in the server to be called by CALL MSXPi, then you must assure that the server contains the correct logic to send the blocks sequentially as described. Refer to one of the MSXPi server commands to understand how it can be done.

lsb and msb bytes contain the data size for the data in this block. This is required because even tough the transfers occur in blocks of fixed size (BLKSIZE), the actual user data might be less that a block – all remaining data in the block is always padded with zeros. It's also needed in cases where the data is larger than one block – the header in each block contain the size of the useful data in that block. The client program must control how much data and blocks is read from RPi based on this header.

The size for the useful data in the block can be calculated in BASIC as follows (assuming it was passed "D000" in the CALL MSXPi command):

```
SIZE=PEEK(&HD001)+256*PEEK(&HD002)
```

Note that this buffer structure is hard-coded in the MSXPi BIOS commands, and need to be respected by the MSXPi Server commands running in the Raspberry Pi.

The return codes in each block can be one of:

RC_TXERROR	Connection error or checksum error after all retries. This code is generated by the MSX client software because the transfer failed. There is not valid data in the buffer.
RC_SUCCESS	Operation successful. This code is returned by the RPi. There is no blocks to be transferred. Buffer contain valid data.
RC_FAILED	Operation failed. This code is returned by RPi. There is no more blocks to be transferred. Buffer may contain a valid error message.
RC_READY	Operation successful. This code is returned by the RPi. There are more blocks to be transferred. Buffer contain valid data.

Other return codes are available for use in development – consult the include.asm file reference.

When the command is called, the following scenarios may develop:

1. Connection error: RPi did not receive the command or it failed the checksum. The return code will be RC_TXERROR (set by the MAX due to lack of communication with RPi)

2. RPi received the command, processed it but it failed: The return code will be set by RPi to RC_FAILED and there will be an error message in the buffer - some server-side programs might set to a different error code, it's up to the developer to define which error code they want to use.

3. RPi received the command, processed and it succeed. The return code is RC_SUCCESS, and there will be data available in the buffer.

4. RPi received the command, processed and it succeed. The return code is RC_READY, meanign there is another blocks of data ready to be transferred. When receivig this return code, the client

software must read anotehr block, otherwise the service will be stuck waiting to send the data, causing an “out of sync” situation.

CALL MSXPISEND

CALL MSXPIRECV

Developing in Assembly