

General notice Assembly and instructions





This guide presents the essential stages of the project and will guide you through the creation and commissioning of the system.**ModulAM**.

This manual is a summary of the various documents published and freely downloadable on the ModulAM 8frequency AM modulator website. Links are provided throughout this document to access detailed instructions.

> System version affected by this notice: Hardware, modulator card: v1.2.1 OPZ Software: from v2.0



Perhaps before we begin, you would like to know a little more about the nature of this project? Its designers and authors? Its organization? Its human-machine interface?

So, a visit to the website is essential as soon as possible: htt ps: / /modu l am. retro t ec hn i c. o rg /

Reading time: about ten minutes, no more, unless you suddenly find yourself caught up in the HMI simulator... or in the discovery of block diagrams and electronics?

This equipment is an achievement Retro-engineering .





I – BEFORE YOU BEGIN...

To successfully complete this project with ease, it is strongly recommended that you follow all the steps in this guide carefully.

This project combines several very different fields: analog electronics, digital electronics, computing, wiring, mechanics.

To avoid pitfalls, the documents were carefully written in the clearest possible language, then reread, amended and validated by specialists as well as by non-specialists in order to limit ambiguities and increase clarity.

But the best of documents is only effective if it is followed with the necessary attention by the reader!

It's time to test this adage by starting the adventure with a preliminary step that is generic to all Retrotechnique projects: familiarizing yourself with the elements relating to the safety of people and materials, the tools and some advice for wiring.

THE<u>vade-mecum</u> of the enlightened amateur.

It's done ?

So head to the next page to discover what the material looks like.



II – THE MATERIAL

-In the base assembly

How the modulator works**ModulAM**is based around three essential hardware subsets:

- A modulator board generating 8 AM carriers distributed over the standardized GO and PO ranges, with amplification devices RF and band filtering. This board must be wired entirely using precise plans and diagrams and a component placement assistance tool, attached to a detailed parts list. This is the "big part" of this project (figure II-01).
- A processor module on the market, the Raspberry Pi Pico H. It is this which generates the carriers in digital format following the SDR principle (figure II-02).
- A second manufactured module, the Orange Pi Zero
 2. It is a nano computer that manages all the functions, manages the flow of radio programs and hosts the HMI software. Its hard drive supporting the software consists of a 32 GB Micro SD memory card (figure II-03).







-Hardware option

This option was developed in order to provide the **ModulAM** a Bluetooth modem (figure II-04), thus enabling the broadcasting of audio sources from podcasts, pay-per-view music services or audio files, from a simple Smartphone or tablet. Specific documentation has been published for the implementation of this option (freely downloadable): Bluetooth option:<u>assembly instructions and instructions</u>.





-N ome nclature of accessories

To make the whole thing functional, a few additional interconnecting and control components are needed.

The nomenclature in the following table summarizes the minimum elements required to constitute a functional copy of the **ModulAM**.

The "supplier" column provides a link to a possible distributor of these supplies: of course, there are others and everyone can contact their preferred supplier.

Item	Designation	Brand	Reference	Q	Link
1	8-frequency modulator turntable	-	ModulAM v1.2.1	1	Chapter III.1
2	Nano computer - 1GB RAM	Orange Pi	Pi Zero 2	1	https://urls.fr/HbkauV
3	Processor(1)	Raspberry	Pico H	1	https://urls.fr/XR7Mhz
4	Power supply unit	Sunshine	5 V – 4 A	1	http://tinyurl.com/3sxcbbeb
5	32GB Micro-SD memory card	Miscellaneous	32 GB	1	https://urls.fr/E8ZVrn
6	Push button switch	ALIEXPRESS	PBS170	1	http://tinyurl.com/25xj6ukx
7	USB-A/USB micro B cable 30 cm	AS-DISCOUNT	95735	1	http://tinyurl.com/2s3bdh9w
8	DUPONT F/F 2 Br 70cm cord	TYNITRONICS	SKU:002051	2	http://tinyurl.com/2ypcfb2d
9	Ferrite ring toroid	FERROXCUBE	TN14/9/5-3E25	1/+	http://tinyurl.com/2hrp4ryv

(1): this component is already integrated into the general level 1 nomenclature of the plate ModulAMv1.2.1

In the case of regular use, it is strongly recommended to integrate the sub-assemblies into a reception box supporting the connectors necessary for connecting external links as well as some control and signaling components guaranteeing more comfortable and, above all, more secure operation.

A complete file was drawn up for this purpose, enabling a rational integration and presentation of the system to be obtained (figures II-05 and II-06).



Figure II-05: front face of the reception box supporting the controls and signals.



Figure II-06: rear face of the receiving box supporting all input and output connections.

The complete file of the production of the reception box is available for free download.



II. 1 - LACARTE 8 FREQUENCY MODULATOR

This map is the essential element of the project. It was designed using standard electronic components with classic references and "through-hole" type. Many European or Asian distributors are likely to offer this type of supply.

The amateur will have to assemble the components as well as the printed circuit (v1.2.1) then install and wire the assembly to obtain a modulator board in working order (figure II-07).



Figure II-07: the modulator board (v1.2.1) once all the components have been installed and soldered.

The esc om components

Here again, assistance documents and tools have been designed to significantly facilitate the stages of component procurement (type, reference, supplier proposal) and wiring, using a very detailed method following the step-by-step principle.

Three levels of <u>nomenclatures are available for free download</u>, depending on the detail desired in the description of the components.

Item	Repère schéma / Cl	Designation	Valeur	Format	Quantité	Infos	Fourniseur possible	Lien direct
1	Circuit imprimé	CI ModulAM	v1.2	Circuit imprimé	1		JLCPCB - 5p	https://jlcpcb.com/
2	D1 à D48	Diode	1N4148	1N4148_P7.62mm_Horizontal	48		Ali Express - 100p	https://urls.fr/fxPPf3
3	R65	Résistance	47 Ω	R_10.16mm_0,25w - 5% ou moins	1			
4	R67, R60, R59, R66	Résistance	<u>68 Ω</u>	R_10.16mm_0,25w - 5% ou moins	4			
5	R17, R18, R19, R20, R21, R22, R23, R24, R25, R26, R31, R32, R37, R42, R47, R48, R62, R71, R75	Résistance	220 Ω	R_10.16mm_0,25w - 5% ou moins	19			
6	R68	Résistance	330 Ω	R_10.16mm_0,25w - 5% ou moins	1			
7	R49, R50, R55, R56, R76	Résistance	1 kΩ	R_10.16mm_0,25w - 5% ou moins	5			
8	R1, R3, R5, R7, R9, R11, R13, R15, R27, R29, R33, R35, R38, R40, R43, R45, R74	Résistance	1,5 KΩ	R_10.16mm_0,25w - 5% ou moins	17			
9	R61	Résistance	2,2 kΩ	R_10.16mm_0,25w - 5% ou moins	1			
10	R2, R4, R6, R8, R10, R12, R14, R16, R28, R30, R34, R36, R39, R41, R44, R46	Résistance	27 kΩ	R_10.16mm_0,25w - 5% ou moins	16		Ali Express - 1% - 100p	https://urls.fr/FuqpAu

Figure II-08: extract from the level 1 nomenclature of the modulator board.

Complete nomenclatures (levels 1 to 3)freely downloadable on this page.



-The printed circuit board

For the manufacture of the printed circuit, we propose the supplier who produced all the prototypes for this project accompanied by a complete manufacturing file in the form of a compressed file (*.zip format) which simply needs to be sent to them to validate the technical aspect of the order.

Manufacturing file (Gerber file) of the printed circuit board:<u>freely downloadable here</u> .

Ordering procedure from supplier JLCPCB: freely downloadable here.

-A d amo - editing assistance software

Once the printed circuit board is received and all the components are assembled, the wiring should not pose any problems, provided that you pay a little attention to the direction in which certain components are installed.

However, we recommend using the "adamo" assembly assistance tool, which has been designed to assist you step by step, following an optimized timeline and providing support using photos and awareness messages when the direction of installation of a component must be strictly respected.

This tool is reassuring for everyone, whatever your experience in wiring, and allows you to save time, take breaks even of several days and find your work where you left it, the backup of your work session being automatically carried out at the place of validation of the last installed component.

Discover and test (even virtually) this tool on<u>the adamo page</u> from the website of the**ModulAM**.

	🗛 Projet : ModulAM - Ex. 3
	Souder le transistor BC547C à l'emplacement Q1 Attention : respecter impérativement le sens de l'implantation 1
	🗹 🕤 🔟 🕋
Modulateur PO-GO V1.21	

Figure II-09: Copy of the screen of the "adamo" editing assistance software.

Once wired and visually checked, the modulator board is ready to be integrated into the system, as it does not require any special adjustment or fine-tuning to benefit from these optimal characteristics.



II. 2 – THE MO OF LEP ROC ESSEUR RA SPBERRYPIPI CO H

This manufactured module can be used as is without the addition of additional components (<u>item 3</u> of the nomenclature).



The H version has two rows of 20 pins already soldered (figure II-10) allowing direct insertion of the processor on the support wired on the modulator card.

At this stage of the project, do not yet install this processor on the modulator board, because a download operation of the carrier generation software must first be carried out.

Figure II-10

II. 3 - THE MO DU LE NA NO ORDI NA TE UR O RANG EPIZE RO 2 (OPZ)

This manufactured module (<u>item 2</u> of the nomenclature) requires that we dwell on it in order to discover its main components.

This Orange Pi Zero2 nano-computer has all the elements of a classic computer, organized around a powerful 64-bit Quadcore Cortex-A53 processor, Allwinner H616, clocked at 1.5 GHz (figures II-11 to II-13).

The module offers standard communication interfaces and connectors as well as numerous additional, programmable input/output ports.

The whole thing is arranged on a printed circuit board with reduced dimensions: 53 mm x 35 mm.



Figure II-11

OPZ manages and processes digital streams of audio programs from selected broadcasting stations, manages audio files at

mp3 format and ensures communication with the Raspberry Pi Pico H processor located on the carrier generator modulator board.

Furthermore, it is this module that supports the HMI software which allows the user to simply configure the various operating and broadcasting parameters of the**ModulAM**, from a simple internet browser.



-Position of the main circuits and connectors on the OPZ module





Figure II-13



III – INSTALLATION OF SOFTWARE

With all the modules now available and ready, the next steps will be to download and install the system application software into the Raspberry processor and the OPZ nano computer.**ModulAM**.

After this operation, the sub-assemblies can be connected to each other, then to the TSF receiver(s) in order to start broadcasting radio programs.

III. 1 – PREREQUISITES

To proceed with the installation of the software, it is necessary to have the following external elements:

- A laptop or desktop computer connected to an internet connection,
- On the internet box, a connection port is available for a wired RJ45 type connection,
- A USB / Micro SD adapter, if the laptop or desktop computer does not have this access port,

This procedure was written based on the commands and screens available on a PC type computer, equipped with an MS Windows 10 operating system.®. We have particularly worked on the "simplicity" aspect of software installation, based on the principle that the user of theModulAMhas no specific knowledge of computer language and/or coding. For the more knowledgeable, a flowchart of the software architecture is published<u>Chapter VII-4</u>, at

For the more knowledgeable, a flowchart of the software architecture is published<u>Chapter VII-4</u>, at <i>the end of this notice.

-The software to install

On the Raspberry PI Pico processor:

- <u>A software for generating the eight AM carriers</u> which must be copied into the Raspberry PI Pico processor: the file for this software is named:ModulAMv2.uf2.

On the PC computer connected to the internet:

- <u>An image file copy management utility software</u> : Available in open access, this software allows you to copy the image of the OPZ software package onto the 32 GB SD memory card. It is only used for this task, but it is recommended to keep it on the PC, for future use, which is always possible. Name of this software:Win32 Disk Imager.

On the Orange pi Zero2 (OPZ) module:

<u>A software "package" that comes in the form of a single image file</u>, which contains the operating system (Linux) and the operating software of the**ModulAM**supporting the human/machine interface (HMI), the management of audio streams from the web, as well as all the "utilities" necessary for the ancillary functions (management of input and output ports, for commands and visualizations, in particular). Name of this image file:ModulAM-2504-OPZ2-V1-1.img. This file is to be copied to the 32 GB SD card, via the PC computer and the utility software.



For the uninitiated, here is some basic information to better understand the context of this software installation procedure on the Raspberry Pi Pico processor module and the Orange Pi Zero 2 nano computer module.

In a simplistic, but explicit way, let's compare the digital materialModulAMwith a PC type computer, operating under a Windows environment and running an office application, such as the Word word processor:

- The Orange Pi Zero 2 module: this is the PC,
- The micro SD memory card: this is the PC's hard drive,
- The OPZ2's Linux operating system: it's Windows,
- The operating software of the ModulAM:it's Word or Excel,
- The Raspberry Pi Pico module and its embedded software, responsible for manufacturing and restoring the 8 carriers: it is a peripheral, like a printer connected to the PC integrating its own software for managing its printing functions.

III. 2 – INSTALLATI ON OF THE SOFTWARE DEGENERATION OF THE 8 PO RTERS

This software must be installed directly on the Raspberry PI Pico processor module.

-H ardware preparation of the R aspberry P i P ico module

Connect the Raspberry Pi Pico processor module to the computer via the USB port of each device, using a USB-A to USB-Micro B cable, following the following procedure:

- Connect the micro USB end of the cord to the RPI module (HAS)
- Press the small push button marked BOOTSEL located on the RPI (B) see figure III-1 below While
- **now this button pressed**, connect the USB plug to the PC computer (**C**) Release the BOOTSEL
- button.



Figure III-1: Connecting the Raspberry module to the computer via a USB link.

After connection, the Raspberry Pi Pico (RPI) processor will be detected by the computer as a USB flash drive or external hard drive under the name: RPI-RP2.

Using your computer's file explorer, ensure that the module is detected by the computer, then locate its location.

You will be able to view the names of the two files already present originally in the RPI: INDEX.HTMAndINFO UF2.TXT. Do not intervene on these files.

-Download 8 carrier generation software With the computer connected

to the internet:

Connect to the software and documents server**ModulAM**, at the following address: https://modulam.retrotechnique.org/the-software-package/

On this page, in chapter I: "Operation: the ModulAM software package"

- Click on the button "**Download**» from the paragraph "8 carrier generation software: ModulAMv2.uf2» (or the most recent version compatible with hardware version v1.2.1)
- Download complete (almost instantaneous) store this fileModulAMv2.uf2, in a directory on the computer, in order to keep a copy.

-Installing the software on the RPI module

- Drag the copied file directly under the root of the RPI "disk" (RPI-RP2). This copy is almost instantaneous, given the small size of the file (< 100 kb)
- It is very likely that after the short time of copying this file, the PC computer will automatically eject the diskRPI-RP2If this is not the case, eject the RPI module following the usual procedure recommended by the computer's operating system.
- Place the Raspberry Pi Pico module on the support located on the main board of the ModulAM, taking into account the assembly direction, as shown in figure III-2.



PlatinumModulAM, placed as shown

Raspberry Pi Pico Module USB connector facing up

Figure III-2: Placement of the Raspberry Pi Pico 2 module on the board ModulAM



Once the fileModulAMv2.uf2copied to the RPI module, when it is restarted, this program file is transferred to another area of the RPI microcontroller's memory. This means that with the PC explorer, we do not see it appear in the directory accessible in USB key format, alongside the two files already present within the RPI. But don't worry, it's well copied!

III. 3 – INSTALLATI ON OF THE LOG HERE COPY OF THE IERI MAG E FI CH

Several solutions are offered through different editors to make "image" copies of files. We have chosen the one namedWin32 Disk Imager.

-**Download software W in 3 2 D isk Imager** Many websites offer this software for free download. The official website: <u>https://win32diskimager.org/</u> On the homepage of the site, click on the download link:Win32DiskImager-1.0.0-install.exe

-Installing the W in 3 2 D isk I mager software

Once downloaded (a few seconds) just click on the filewin32DiskImager-1.0.0-install.exe and follow the few steps to accept the publisher's conditions and the options offered by default.

This installation takes a few seconds and ends with the opening of an information text file.

Check that the software is installed correctly by opening it (by default an iconWin32DiskImageris present on the PC desktop.

Opening the software causes the window in Figure III-3 opposite to be displayed.

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Read On Progression	ly Allocated	Partitions		

The copy software is now functional.

Figure III-3

III. 4 – INSTALLATION OF THE MODULE AM SOFTWARE PACKAGE

-Material preparation

If the computer does not have a port for the micro SD format, use an external USB / Micro SD adapter.

Then place the 32 GB micro SD memory card in the reader (figure III-4).



General instructions – Assembly and instructions



Figure III-4: Connecting the micro SD memory card to the computer.

Using File Explorer, check that the computer has detected the new device consisting of the 32 GB micro SD card.

No need to format beforehand. The Win32 Disk Manager utility performs an automatic format before copying new files.

-Download OPZ software package With the computer

connected to the internet:

- Connect to the software and documents server**ModulAM**, at the following address: <u>https://modulam.retrotechnique.org/the-software-package/</u>

On this page, in chapter I: "Operation: the ModulAM software package"

- Click on the button "**Download**»from the paragraph "Operating Software. Reference: ModulAM-2504-OPZ2-V1-1.img» (or the most recent version)
- The download may take from 2 to 10 minutes, depending on the speed of your internet connection.
- Once the download is complete, store this fileModulAM-2504-OPZ2-V1-1.img, in a directory on the computer, in order to keep a copy.

For specialists who would like to check the integrity of the downloaded software, the checksum following the SHA256 protocol is displayed on the site page**ModulAM**, right next to the "Download" button, of the softwareModulAM-2504-OPZ2-V1-1.img(or newer version).

-Copy the software package image to the micro SD card

Perform the actions in the order indicated below:

- Make sure the 32GB micro SD card is detected by the PC computer
- Open the utility softwareWin32DiskImager installed previously in order to find the home window in figure III-3
- Select, in the "Device" frame (**HAS**) the 32GB micro SD card reader

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👒 Win32 Disk	Imager - 1.0	/		×	_	
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Read Only Al	llocated Partitions					
Progression				46%		
Annuler	Lire Ecrire	Verify Or	ly Fer	mer		
11.236MB/s			02:15/0	4:53		
É		D	Figui	re III-:	5	



- Select (B) the directory then the file ModulAM-2504-OPZ2-V1-1.img previously downloaded
- The file name should then be displayed in the "Image File" window (**C**)
- Confirm the writing of the copy of the image file on the 32 GB micro SD card by pressing the "Write" button (**D**).
- Confirm the warning indicating the risk of media corruption in order to start writing. The progress bar (E)
- allows you to follow the progress of the copy (estimated duration approximately 5 minutes, depending on the speed of your computer and its USB ports).

After the copy timeout, the message in Figure III-6 appears, indicating that the copy is complete.

To complete the procedure, eject the micro SD card using the usual procedure recommended by the computer's operating system

Fichier image			P	ériphérique
odulAM/Modu Hash	📚 Term	iné - 1.0	×	D:\]
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Figure III-6

-Inserting the micro SD card into the OPZ module reader

The 32GB micro SD card now contains the software package needed to operate the**ModulAM**. Simply insert this card into the reader of the Orange Pi Zero 2 (OPZ2) module, as shown in figure III-7 below.



Orange Pi Zero 2 Module

The micro SD card reader is located on the back of the OPZ module. A key prevents insertion in the wrong direction.

To remove the card from the reader, press on it to unlock the reader and thus authorize the card to be removed.

Figure III-7: Inserting the 32 GB micro SD memory card into the OPZ module reader.



IV - MOUNTING AND ASSEMBLY

Before connecting between the circuits, it is advisable to create the devices which, once connected to the modules of the **ModulAM**, will enable its commissioning to be ensured.

IV. 1 - REALIZATION OF AN ELI GN EDEC OR PL AG ERF

This RF coupling test line will allow you to check the operation of the **ModulAM** and could then serve as a model for the creation of a more complete line intended to supply numerous receivers.

-Principle

The two RF outputs (GO, PO), available inJ10AndD11 on the modulator board can be used to feed the receivers with the broadcast programs assigned to the carriers configured via the HMI, respectively within each of these two frequency bands, via a transmission line.

But the most interesting thing is to use the RF GO+PO output available inD15 of the module, the latter authorizing the broadcasting of the GO and PO bands, simultaneously on all receivers and using a single line. In addition, this output benefits from an amplification of the RF signal, guaranteeing excellent listening comfort on all coupled receivers, as long as they are perfectly functional.

The coupling line consists of two wires with any but identical characteristics, twisted to avoid any parasitic radiation, then terminated by a resistive load which stabilizes the output characteristics of the amplifier.

The creation of a test cable to validate the transmission line, but also the operation of the entire system**ModulAM**, is detailed below.



Figure IV-1: Schematic diagram of the test coupling line.



-Necessary components and tools

Gather the following components:

- A following ferrite core<u>item 9</u> of the nomenclature,
- Two lengths of approximately 2 meters of thin-gauge flexible wiring (e.g. KY30-05 / EPDX00 Gauge AWG22, section 0.34 mm²),
- A length of about 50 centimeters of this same wire,
- A 220 Ω resistor (Red / Red / Brown); regardless of the power, from ¼ watt,
- Shrinkable sheath or insulation,
- A flat pliers,
- A pair of wire cutters,
- A soldering iron + solder.

Wire for the coupling line: the diameter and type of wire used are irrelevant. However, it is much simpler to twist relatively thin wires and it is much easier to run the cable of this twisted pair behind the TSF receivers, if it is made from flexible multi-strand wires, which are more malleable than rigid wires.

-Realization of the alignment of the coupling

Follow the different steps in the order stated below, in order to best succeed with this coupling line.

- Prepare two wires of about two meters for the coupling line,
- Insert the ferrite core into one of the two wires and position it approximately in the middle of the wire (about one meter from one end),
- Rotate the torus on the wire, 360 degrees, in order to obtain a tight turn around the ring (figure IV-2),





Figure IV-2: Making a turn in the ferrite core

Figure IV-3: Twisting the coupling line

- Twist the two wires of the coupling line along their entire length (figure IV-3).



i

A simple and effective method for making the twist: join the two wires at one end and secure them in a vice (or tie a knot between the two wires and secure them to a door handle or fixed hook). Stretch the two wires and cut the longest one (the one without the torus) to obtain an equivalence of lengths.

Using a cordless drill, secure these two new ends in the chuck. While pulling gently to keep both wires taut, operate the drill until the twist is comfortable. There's no need to create a very tight braid.

- Strip the two wires at the four ends,
- On one side of the twisted cable, insert a heat shrink sleeve (or an insulating sleeve) over each of the two wires,
- Take the 220 Ω resistor and, using the flat pliers, bend the resistor legs 90 degrees, flush with the resistor body,
- Cut the tails of the resistor to leave only about 1.5 cm,
- On the free side of the twisted cable, insert a heat shrink sleeve (or an insulating sleeve) again on each of the two wires,
- Connect each wire to each end of the resistor, using a splice,
- Solder each splice,
- Place a sleeve over each splice, then heat to shrink them.



- Finish by tinning the other ends of the 2 wires of the coupling line to be connected toD15.



-Making the coupling cord with a TSF receiver

For testing, this procedure assumes that the amateur has a working receiver on the GO and PO bands, with inputs**HAS**antenna and**T**wanders on "banana" type bases.

Follow the different steps in the order listed below.

- Take the wire of length approximately 50 cm,
- Pass the wire inside the ferrite ring of the coupling line,
- Fold it and equalize the two lengths (so, about 25 cm),
- Twist the two parts of this wire along their entire length, tightening well at the torus so that the coil thus formed is not loose,
- Strip the ends of the twist obtained, then mount a banana plug on each of them.
- -



Figure IV-5: Making a turn in the ferrite core



Figure IV-6: line of coupling completed

The coupling cord from the ferrite core of the coupling line to the receiver can have any length (a few centimeters to a few meters) without affecting the quality of the transmitted signal. This remains true for each receiver coupled to each of the cores that equip the coupling line. Some will prefer to run the line close to each receiver, others will want to make a coupling line along a wall and then distribute each receiver by a cord of a length adapted to the position of the receiver.

IV. 2 – IMPLEMENTATION OF THE MODULATOR STOP COMMAND

Everyone will have understood that the eight-carrier generator module is digitally controlled by the second module, which is a nano-computer (Orange Pi Zero2); "nano" in size rather than in functions, power, or speed. Indeed, this module is entirely comparable, in principle, to the "tower" of a desktop computer with basic performance.

It is therefore necessary to reason in "computer" mode, particularly for the Start/Stop operations of the entire system.

So, on a computer, you don't stop it by removing the power plug...! But either by carrying out the correct procedure using the mouse and keyboard, or by pressing a specific button present



on the hardware, the action of which will trigger a whole series of commands to properly close the session of current work, properly close all open files and stop the read/write processes on the various disks. Only once these operations have been carried out is the power cut.



The risk of irreparably damaging certain disks and essential files does exist. Even if the operating system (Linux) used here is relatively well protected to avoid this type of accident,It is strongly recommended not to unplug the power supply until you have properly shut downthe system**ModulAM**.

That's why a button is provided**STOP**, in the form of a momentary action push button switch, which will "organize" the stopping and switching off of the modules following a suitable procedure and without any risk. Once this stop command has been taken into account and carried out, it is then possible to disconnect the power supply unit from the power supply.

To complete this order, follow the different steps in the order listed below.

- Select the push button switch (<u>item 6</u> of the nomenclature),
- Take one of the two DUPONT cords (<u>item 8</u> of the nomenclature) composed of a pair of wires (red and black) terminated at each end by a small two-pin female DUPONT type connector, cut it into two roughly equal parts (2 x 35 cm),
- Strip each end of the two free wires,
- As a precaution, insert a heat-shrink or insulating sleeve on each of the wires,
- Solder each wire to each of the output pins of the push switch,
- Position each sleeve to cover solder joints and pins, then heat to shrink them.



Figure IV-7: Production of the system STOP control cordModulAM, using the push button switch.

IV. 3 – ASS EMB L AG EDES MO DU LESET RA C CO RD EME NT S

Once these steps have been completed, the equipment is ready for connection, before the first control commissioning.

-Necessary materials and tools Gather the

following materials and cables:

- Access to your internet box and verification that there is at least one RJ45 port available for connecting the **ModulAM**,
- A standard network cable a few meters long, equipped with an RJ45 connector at each end. Typically, the box supplier will supply a set of RJ45 cords with the box.
- A functional and standard performance TSF receiver on the GO and PO bands, with input connectors**HAS**antenna and**T**wander.

-Preparation of the printed circuit boards of the two modules

Still with the aim of protecting the modules as best as possible, it is advisable to mount each printed circuit on spacers using the fixing holes provided for this purpose.



This will allow them to be fixed later in a suitable housing and will improve the safety of the components during future handling by preventing the underside of the circuits from touching a metal surface or elements that could cause unwanted electrical contact. Figure IV-8 opposite shows an example of the type of spacer that can be used for this operation. Length: between 5 and 15 mm, diameter of the part to be screwed: 3 mm.



ATTENTION: on the nano-computer circuit, as a precaution, mount insulating washers, because the printed circuit tracks and certain components are dangerously close to the fixing holes.



-Interconnection - modules

This step consists of ensuring the connections between the two plates of the **ModulAM** as well as the connection of the Reset, Stop and output control to the coupling line, as shown in Figure IV-9, below.



Modulator plate.

Nano computer board.



Timeline for making these various connections:

Reset command – DUPONT-F / DUPONT-F 2-pin cord

This connection between the two modules allows the processor to be reset in the event of a malfunction of a stream from the web or a system reset.

Take the second DUPONT 2-pin female / 2-pin female cord (<u>item 8</u> of the nomenclature), then connect it as follows:

Modulator board side v1.2.1, connector identificationD14.
 Insert the female plug of the DUPONT cord, taking care to place the red wire towards the right of the connectorD14, as shown in Figure IV-10, next page.







Figure IV-11: Identification of pins 25 and 26 of the Orange Pi Zero2 module expansion connector and the direction of connection of the DUPONT cord: wireredleft.

Locate the connection pins on the 26-pin expansion connector located on the right of the printed circuit board, which consists of two parallel rows of 13 pins.

The female connector on the second end of the DUPONT cable should be connected to the pins**25** And**26**which are located at the upper end of each of the two rows of pins.

Insert the female plug of the DUPONT cord, taking care to position the wirered oriented **inward** of the multi-pin connector, on the inner row, in pin**26**, as shown in Figure IV-11.





ATTENTION: no keying device and no pin number marking on the OPZ circuit. Vigilance is required!

Stop Control - Push Button Switch / DUPONT-F 2 Pin This involves

connecting the switch prepared above (<u>Chapter IV.2</u>).

The 2-pin female DUPONT connector on the end of the cord wired to the push button switch must be connected to the Orange Pi Zero2 module, as shown in Figure IV-12 below.



Figure IV-12: connecting the system shutdown control switch to the Orange Pi Zero2 module.

The female connector on the end of the DUPONT cable should be connected to the pins**9**And**11**which are located on the right row of the OPZ connector (side outside the module).

It doesn't matter which way the DUPONT connector is facing. By convention, we have placed the wireredoriented **upwards**, on the spit**11**of the multi-pin connector.

Care must be taken when identifying the pins on the multi-pin connector of the Orange Pi Zero2 module, as no numbering is visible on the printed circuit board.

+5 VDC power supply

Connect the power supply (<u>item 4</u> of the nomenclature) directly onto the USB connector of the Orange Pi Zero2 module (represented by a gray link in the diagram in figure IV-9).

USB-A / USB-Micro B cable

Take the 30 cm USB-A / USB-Micro B cord (<u>item 7</u> of the nomenclature) which ensures the connection of the power supply and the transfer of data from the Orange Pi Zero2 nano-computer module to the modulator board via the Raspberry Pi Pico processor.

Connect this cord as shown in Figure IV-9 (this cord is shown in brown).



Attention, if you already have a USB-A / USB-Micro B cable, it is essential to ensure that it has the electrical connections between all the respective pins of the two connectors. In fact, most of these cables supplied with peripheral equipment are intended for charging the latter's batteries and only provide the connection of the power supply voltage, but do not include any data connection wire! Obviously this type of cord is not suitable here...

RJ45 cable

Connect the RJ45 port of the Orange Pi Zero2 module to an RJ45 port on your internet box.

-water modulator coupling alignment connection to the receiver

This step consists of connecting the test coupling line (see creation of this line in<u>Chapter V.1</u>) between the connectorD15of the modulator and the inputs**HAS**antenna and**T**TSF receiver error available for testing.

ConnectorD15: main RF output GO + PO

Connect the twisted wire of the coupling line to the two stripped and tinned ends, prepared previously, on the screw terminal blockD15of the modulator board by screwing the red wire onto the bottom terminal of the terminal block and the black wire onto the top terminal marked with the "Gnd" silkscreen, as shown in figure IV-9 (the coupling line is represented by two twisted red and green wires).



The coupling cord must remain electrically independent of any other external assembly. All RF signals from the 8 radio channels are transmitted to the receivers exclusively by coupling through the ferrite rings, thus with total galvanic isolation. It should be noted that these RF signals are superimposed on a direct voltage of approximately 5 volts. Any electrical contact with another assembly, or with a ground common to the modulator **would be destructive to the RF output stage**of**ModulAM**. If a direct electrical connection is required, use only the auxiliary output GO+PO available on the terminal block.D16from the modulator board.

Connection to the receiver

Connecting the two banana plugs to the inputs**HAS**antenna and**T**receiver error.

There is no point in separating the banana plug markings: the signal carried by the loop coupled via the ferrite core to the coupling line is completely "floating" and symmetrical, without any reference to any potential. The assignment of the two poles is therefore of absolutely no importance.

The main thing is that one of the banana plugs is connected to the socket**HAS** receiver antenna and the other, to the base **T**wandering from this same receiver.

Figure IV-13: example of connection of the coupling loop to the terminalsHAS<i>antenna and T wandering of a TSF receiver from the fifties (Philips BF321A).





V – COMMISSIONING AND BASIC OPERATION

To facilitate this initial commissioning, all operations will be carried out without the aid of an external computer and therefore without the assistance of the Human Machine Interface (HMI) software.

This commissioning will use the "factory" configuration that was programmed into the downloaded software.

At this point, it is assumed that all actions detailed in previous chapters have been correctly performed and checked.

V. 1 – CON FIGU RA TI ON US INE

THE**ModulAM**benefits from a "default" configuration of all eight of its broadcast channels.

This list pre-recorded within the system's SD memory card is named:**ModulAM_Factory**.

This is the list that is taken into account when the device is first switched on and each time it is switched on again, as long as the user does not decide to create one or more new lists, from which he will have selected the one that will become the new current list.

We arbitrarily chose eight broadcast programs while respecting, for the GO band, the names and frequencies of the four disappeared stations, whose coverage concerned almost the entire French territory.

For the PO range, since broadcasting is regional in principle, we have placed four stations distributed evenly across the band.

The table in Figure V-1 below shows the programming adopted in this "factory" file named **ModulAM_Factory**.

CHANNEL	BAND	PROGRAM	FREQUENCY	WAVELENGTH
1	GO	France Inter	162 kHz	1,851 m
2	GO	Europe 1	183 kHz	1,638 m
3	GO	RMC Info Talk Sport	216 kHz	1,388 m
4	GO	RTL	234 kHz	1,281 m
5	PO	Jazz Radio	603 kHz	497 m
6	PO	Classic Radio	891 kHz	336 m
7	PO	FIP News	1278 kHz	235 m
8	РО	France Info	1548 kHz	194 m

*Figure V-1: table of programs making up the list***ModulAM_Factory***.*



V. 2 - MISEENSE RV ICE - ON / OFF

Now that all the steps in the previous chapters have been completed, it is now possible to power on the **ModulAM**. Beforehand:

- Switch on the test TSF receiver to ensure that the eight programs are being received,
- Make sure your internet connection is working by going to any website using your usual computer,
- Locate the two tiny LEDs (one red and one green) on the OPZ nano-computer module (figure V-3 opposite), as they will allow you to monitor the progress of the startup of the entire system.



Figure V-3

-Power on

Once these final markings and checks have been carried out, connect the power supply unit to the **ModulAM** on a 230 VAC socket.

The following events must occur, consecutively:

- The small red LED on the nano-computer module lights up almost instantly,
- After about 8 seconds, this same LED turns off and the green LED turns on,
- For about 30 to 50 seconds, the nano-computer module software, via the SD memory card, initializes itself, then starts the application before communicating with the modulator board and providing it with the frequencies from the broadcast list.

At the same time, information is sent to the box to establish communication, then to ensure the link with the eight websites corresponding to the eight radio programs on the list. **ModulAM_Factory**.

Figure V-4: Exchanges with the box and the internet activate the two LEDs on the RJ45 connector of the Orange Pi Zero2 module by flashing in time with the data flow.

Left: yellow LED Right: green LED



- At this point, you must wait another ten seconds or so, while the buffer memory of the **ModulAM**stores a few seconds of digital audio streams from the eight radio programs, with the aim of avoiding audible sound cuts, in the event that the connection to the internet is interrupted.



Once these delays have been accumulated, which is approximately a little over a minute and a half (be careful, when you wait in front of a device, this time can seem infinitely long...), the time has come to tune the TSF receiver in order to check the good reception of the eight programs at the indicated frequencies and to assess the real listening comfort and the quality of the modulation broadcast.

This time the system **ModulAM** is operational!

-Stop and turn off the power

It is important to follow and memorize the procedure for turning ON and OFF the equipment.



The stop / start of the**ModulAM**requires some attention, because as explained in <u>Chapter V.2</u>, this equipment can be compared to a computer, which is therefore not stopped by directly cutting its mains power! It is strongly recommended that you do not unplug the power supply until you have properly shut down the equipment.

To properly stop the **ModulAM** and turn it off, follow the following procedure:

- Press the previously connected momentary action push button for at least two seconds. This command forces the nanocomputer to end its dialogue with the box, close its current files, properly close the application and position its circuits in functional shutdown mode.
- These actions take about ten seconds to complete. The system's effective shutdown is visible when the green LED on the nanocomputer goes out (Figure V-3).
- Once this LED is off, disconnect the power supply from the 230 VAC network.

The system is now ready to be put back into service by repeating the power-up procedure (<u>previous chapter VI.2.1</u>). However, before performing a new power-up **immediately after**After performing a power off, carefully read the following information note.

As soon as the system is switched off via the push button control, it then consumes very little energy because all essential circuits are switched off. Subsequently unplugging the power supply from the mains will not instantly interrupt the 5 VDC voltage, because of the high-capacity filter capacitors that equip the unit. This means that the voltage will remain present for approximately 1 minute and a half (measured time of 1' 30" for U = 1 V and 2' 45" for U = 0.5 V!), because the load represented by the circuits of the **ModulAM** in standby mode is too low to ensure rapid reduction of this voltage.



It is therefore necessary to wait for the power supply to discharge (minimum 1 minute) before reconnecting the power supply, otherwise the**ModulAM**will not be able to "see" this power off and**will not restart**The system must absolutely detect the disappearance of 5 VDC, then the presence of the 5 VDC power supply again, in order to be able to initialize its start-up procedure. To avoid this phenomenon, we have provided, for those who wish to integrate their system **ModulAM**within a reception box, a switch which cuts not the 230 VAC mains voltage but the 5 VDC power supply (see also the file "<u>Reception box</u> "). For those who wish to keep the kit as is, a tip is detailed in<u>Chapter VII.2</u> to significantly reduce the discharge waiting time.

In summary, the On/Off/On cycle of the **ModulAM** must be done as follows:

- 1 Connect the power supply to the 230 VDC network,
- 2 Wait about one minute to one and a half minutes (initialization) before the radio programs are actually broadcast on the receiver,
- 3 Stop the system by holding down the button switch for a few seconds stop button,
- 4 Disconnect the power supply from the 230 VAC network,
- 5 Wait for the power supply to discharge (at least one minute) before putting it back into

service. 6 – Start again from point 1 for a new start-up.



VI – OPERATION VIA HMI SOFTWARE

The HMI (Human Machine Interface) software allows you to intuitively configure all of the system's functions.**ModulAM**Its use is simple and user-friendly.

Once set up, the**MolulAM**can operate autonomously without the aid of the HMI, therefore without the need for a computer, tablet or smartphone.

However, to benefit from the range of functions available and to allow the editing and configuration of stations such as playlists, it is necessary to have the commands that have been developed within this software interface.

We advise amateurs to discover the organization and functionalities of this software through our online simulator, freely accessible at this address:<u>https://modulam.retrotechnique.org/ihm/</u>. You will be able to carry out all the manipulations as if you had a system**ModulAM**complete, which is probably the best way to get familiar with this tool.

The HMI software behaves like a website that would be embedded in the **ModulAM**.

This means that to access it, simply type its address in the address bar of your favorite browser (Chrome, MS Edge, Firefox, etc.), from a desktop or laptop computer connected to your personal network, via your box, as shown in figure VI-1, below.



Figure VI-1: connection principle of the ModulAM for operation from the HMI software for advanced configuration and editing of stations, frequencies and modulation audio streams, via the personal local network of a classic internet access installation.



Launching the HMI must follow the following procedure:

- THE**ModulAM**is operational following the commissioning instructions detailed above;
- Check using a test receiver that the modulator is actually broadcasting the eight stations of the factory configuration channels;
- On the computer connected to the local network, open an internet browser;
- In the address bar, enter:modulam.local(see info below);
- The HMI home screen (Figure VI-2 below) should appear very quickly.

If the browser does not display the HMI home screen with the namemodulam.local, then search for the IP address of theModulAM. For this, two possible methods:

1 / via the "Prompt" mode on the computer (Type "Command" in the field of the lower Windows ribbon named "Type to search")

In the prompt window, typessh orangepi@modulam(respect the space afterssh) + Enter.

A password will be requested: enterorangepi(attention, no view of the input) + Enter. The system-generated IP address (dynamic mode) is displayed in the information. It is in the format: IP:192.168.1.xx.

Close terminal mode and then enter this IP address in the browser address bar.

2 / via the internet box.

Connect to the box by entering its address or name into your browser. The box's IP address is usually found on its identification sheet or in the user manual, depending on the provider.

Otherwise, do an internet search by entering "How to connect to the XXXXX box" (XXX being the name of the supplier and the generic model of the box; example: Orange LiveBox 6).

There are many tutorials that show the method.

Once connected to the box, navigate the menu to identify the names of the equipment connected to the network via the box.

Generally, one section concerns equipment connected via an RJ45 wired connection and one section concerns equipment connected in Wi-Fi mode.

Select the correct case, then locate the device named "modulam". The modulam's IP address is noted near this name.

Note this address.

Then enter this new address in the browser and the HMI home screen of the ModulAM will <i>appear (provided the equipment is in service...).



VI. 1 – HOME SCREEN

As soon as the connection is established with the **ModulAM**, the following screen appears.



Figure VI-2: Home screen visible when launching the GUI of the ModulAM.

VI. 2 – EXPLO ITATI ON

-List of active stations

To the right of the home screen, three boxes show the summary of the channels currently broadcast on the equipment's RF outputs.

Top frame (gray background): the name of the current mailing list. HereModulAM-Factorycorresponds to the list of stations appearing by default in the factory configuration of the**ModulAM**, when first powered on.

Center frame (green background): indicates the frequency (in kHz) followed by the name of each of the stations programmed on the Long Wave (LW) band – Here 4 stations.

Bottom frame (yellow background): indicates the frequency (in kHz) followed by the name of each of the stations programmed on the Short Wave (SW) band – Here 4 stations.



Each channel is preceded by a marker, in the form of a pictogram indicating the origin of the audio source of the program which feeds the channel currently being broadcast.

Example of a list containing all possible origins offered by the **ModulAM**, in figure VI-3.

World map: program from an audio stream from the web.

Musical note: program from an MP3 file saved in the system (USB key).

Incoming arrow: program from an audio signal connected to the external line input.

Sinus: sine frequency file ("Measurements" list).

Bluetooth: audio file from the Bluetooth modem. (Function and pictogram available subject to the Bluetooth option being installed).

Figure VI-3: Meaning and assignment of pictograms.

-Viewing the broadcast status

The screen allows you to differentiate between three distinct operating states.

State 1: system stopped:

The system is stopped, the STOP button is pressed. The screen, the magic eye, and the texts are completely grayed out. No playlist is displayed on the right side of the screen.

State 2: system in service, broadcast stopped: The screen is colored, but the text is completely grayed out. The list of pending broadcasts is displayed in grayed-out characters on the right side of the screen.

The magic eye is active, but open. No keyboard keys are pressed.

State 3: system in service, broadcasting in progress: The DIFF key is pressed and lit. On the dial, the station names are colored. The magic eye is closed.

On the right of the screen, the list of broadcast stations:

- In green: on the GO strip
- In yellow: on the PO strip.











-Keyboard control: DIFF key

The key**DIF**FUSION allows you to validate or stop the broadcasting of the current channels on all the RF outputs of the equipment.

Provided that the **ModulAM** is in service, so that the magic eye is not grayed out:

• Pressing the key**DIFF** causes the validation of the current broadcast: the screen goes to state 3 (figure VI-6) and the magic eye goes into green-closed mode; but during the thirty seconds necessary for the initialization of the process within the Orange Pi Zero2 nano computer and the loading of the buffers of the audio program streams, the keyboard is blocked and an hourglass appears superimposed on the key**DIFF** (figure VI-7).



Figure VI-7

The hourglass then disappears and the keyboard sees its key**DIFF**pressed and lit. At this moment the programs are actually broadcast on the RF outputs.

• A second press on the key**DIFF**stops the current broadcast. The screen goes to state 2 (figure VI-5): the texts and markers are grayed out, the key**DIFF**is not pressed or lit, so the sending on the airwaves is no longer validated and the magic eye is open. Before reaching this standby state, the hourglass appears for a short moment on the key**DIFF**, until the system closes the current broadcast session. Then the hourglass disappears and no more programs are broadcast on the RF outputs.

-Keyboard control: STOP key

The key**STOP**allows you to stop and turn off the**ModulAM**.

Pressing this button stops the current broadcast and causes the equipment to stop and turn off completely. The screen then changes to state 1 (figure VI-4).

It is then necessary to close the internet browser, because the connection between the computer and the **ModulAM**is now broken, the equipment being turned off. Otherwise, the browser will display a message stating that this site is inaccessible, or unavailable, or any other similar information.

If the wish is to put the equipment back into operation, it is necessary to follow the detailed commissioning procedure from the <u>Chapter V.2</u>.



*After a stop made from the key***STOP***or the push button switch accessible on the***ModulAM***, it is essential to unplug the power supply and wait for it to discharge completely before restarting the modulator, as mentioned in the information in the*<u>Chapter V.2.2</u>*.*

Only once the equipment has been powered back up following the indicated procedure and the programmed channels are being broadcast, it is again possible to reconnect via the internet browser by entering the expressionmodulam.localor the IP address of the **ModulAM** identified (<u>see info</u> from the beginning of Chapter VI):192.168.1.xx(Or<u>http://192.168.1.xx</u>).

VI. 3 - CONFIGURATION

-Keyboard control: C ON F key

Beyond simple visualizations of states and broadcast and stop commands of the**ModulAM**, the amateur can build, edit, delete his own broadcast lists by choosing the nature and name of the programs, the broadcast frequencies and the organization of the channels.

One press of the key**CONF**(Configuration) displays the window in Figure VI-8 with the choice of two types of configuration (creation, edition, deletion):

- * Simultaneous broadcast lists of 1 to 8 stations
- * Sound sources to be assigned to frequencies.

Special case

If the key is pressed**CONF**while the key**DIFF**is pressed and lit, that is, the**ModulAM**is broadcasting a list of stations, the message in Figure VI-9 appears for a few seconds and the system automatically switches to**DIFF**Off (key**DIFF**raised and extinguished). Configurer les listes de diffusion (plan de fréquences 9 kHz) Choisir une liste de diffusion v Configurer les sources (stations) personnelles. Permet d'ajouter des stations à la liste fournie. Choisir une station v Quitter Figure VI-8

B.	Afin que vous puissiez intervenir dans la configuration, la diffusion va s'arrèter. Veuillez patienter.
	Figure VI-9

In fact, during the configuration phases (creation or modification of stations or existing lists), broadcasting is stopped in order to avoid conflicts within the system and the display.

Once the configuration is complete, simply restart the broadcast by pressing the button**DIFF**.

Configuring Mailing Lists

After pressing the buttonChoose a mailing listof the window (figure VI-8), a drop-down list offers the choice of all the lists already saved.

By default, this drop-down menu allows you to validate the listModulAM-Factoryor the action[new list]. In the case of list selectionModulAM-Factory, this one is displayed in a new window. One action on the buttonSelect this listthen switches this list to the main broadcast screen of the

ModuAM.



current action.

If the option[new list]is chosen, a configuration window is proposed authorizing the creation but also the modification or deletion of station lists (example in figure VI-10)

* **Frequency**:selection, via a drop-down list, of the broadcast frequency in GO or PO.

* **Station**:opposite each frequency, selection of the name of the station to be broadcast to choose from more than 300 programs and/ or those created by the user and/or those from other sources (figure VI-11).

* **Dial**:choice of the type of dial to associate with the broadcast list.

Once the list is established, it is enough to eitherto validateeither of give up the



In the case of a selection from an already existing list the additional buttonDeletion from the list allows its permanent deletion from the mailing list.





Station configuration

The amateur may wish to create his own radio stations, if he cannot find what he is looking for in the lists of some 300 stations already offered or if he wishes to create a station from an mp3 file.

In this case, from the window in Figure VI-8, the selection of the actionChoose a stationallows the creation but also the modification or deletion of stations created by the user. The origin of the sound signal is chosen from 2 sources: *** The Web**, by entering an address (URL),

* An MP3 file, saved on the system's MicroSD card.

Information indicates in which list(s) this station (source) is present (example in figure VI-12).

VI. 4 – SELECTI ON OF AN ELISTEDCA NA UX TO DISTRIBUTE

Once any specific stations have been created and the playlist(s) have been developed and saved, the user must now select the playlist (or external or optional source) that he wishes to broadcast on the RF outputs of the **ModulAM**.

Pressing the key**SALT**(Selection) allows you to select the desired list for a future broadcast, using the drop-down menu: List to broadcast.

The selection made (example figure VI-13: listVintage music, including 7 stations out of 8 possible). This window summarizes the attributes: Range; Frequency; Name; Dial type. Pressing the buttonSelect this listtransfers this list to the main broadcast screen.



Choisir une station V

Source MP3 ~

Figure VI-12

SYST

CONF

Web

Nom de la station Ma radio MP3

Emplacement Maison - Salor

Valider Abandonner

STOP

DIFF

SEL

Cette station est présente dans : • ma_radio_perso.lst • test2_dwk.lst

VI. 5 – SYSTEM F ONC TI ON

One press of the key**SYST**(System) provides information and configuration of generic functions (figure VI-14).

* **User language**:French, Spanish, English, Dutch. Ability to save other language files.

* Frequency plan:9 kHz (Europe) or 10 kHz (USA, Canada).

* Choice of dial:to choose from among many models.

*** Type of markers**:None, Needles, Points. Allows you to locate the stations currently broadcasting on the dial.

*** Wave range pellets**:choice of pictogram for identifying the GO and PO frequency bands.

* **Bluetooth option**:validation or not of the function (if the hardware option is installed).

 Plan de fréquence Choix du cadran Type de repères Pastilles gammes de control de cont	s 9 kHz v france - chelle croissante - marron Vguilles v fondes 60 + P0 v M	v
Choix du cadran Type de repères Pastilles gammes c Option bluetooth <u>Site officiel Modul</u> Recherche de mise	Trance - échelle croissante - marron Viguilles v l'ondes • GO • PO v	~
Type de repères Pastilles gammes d Option bluetooth Site officiel Modul Recherche de miss	Viguilles V l'ondes 60 + P0 V	
 Pastilles gammes of Option bluetooth <u>Site officiel Modul</u> <u>Recherche de mise</u> 	ľondes • GO ◆ PO ▼	
Option bluetooth <u>Site officiel Modul</u> <u>Recherche de mise</u>	AM	
Site officiel Modul Recherche de mise	AM	
• Recherche de mise	1.1	
	a jour (3)	
ModulAM 2024-2025	- Vers. V2.0 - 10 Mai 2025 - Free and Figure	re VI-14



* Links to the <u>official website</u> of **ModulAM**, to the server offering updates and to the text (About) of the conditions of the free software license (GNU).

*** Search for update**: allows you to check whether the software in operation is up to date with the latest version. If not, allows a one-click update (see following chapters).

-Check software version

The team that designed and developed the**ModulAM**regularly improves the software to make it simpler, more comprehensive and more reliable to use.

It is advisable, from the first commissioning and thereafter, regularly, to carry out a software version check in order to always benefit from the latest developments of the system.

To do this, simply click on "Search for update» in the functions window of the **SYST**th to ensure that the screen displays the message "Your software is up to date» preceded by a small green checked box (figure VI-15 opposite).

Rechero	he de mise à jour
• Versio	n locale : V2 - 13 Mai 2025
• Derniè	re version publiée : V2 - 13 Mai 2025
Votre	e logiciel est à jour
Recomm Quitte	encer la mise à jour ? r
ModulAM	2024-2025 - Vers. V2 - 13 Mai 2025 - Free as in Freedom
	Figure VI-1.
	5.00

-One-click software update

If, after clicking on "Search for update» the screen in figure VI-16 opposite indicates the availability of a more recent version, it is advisable to activate the update.

Simply validate the update request by pressing the button "Yes", after having carefully read the information and warning indicated in the info bubble below.

	ie a jour votre togiciet avec la derniere
ersion officielle	?
Oui non	

Figure VI-16

-Update: Advanced features

Click on the pictogram located after the link "Search for update", representing a cogwheel doubled with a key offersthe user the possibility of carrying out a retroactive update.

The selection of the desired version is offered through a drop-down list offering all available versions (figure VI-17).

This provision allows the user to possibly revert to a previous version that he considers more appropriate for his use.

Mise à jour : fonctions avancées	
• Version locale : V2 - 13 Mai 2025	
Mises a jour disponibles : 2025_04_15_V1_2	
Mettre à jour avec la version sélectionnée ? Oui non	
Quitter	PI\/3
ModulAM 2024-2025 - Vers. V2 - 13 Mai 2025 - Free as in	Freedom

Figure VI-17





Automatic one-click updating means that the ModulAM connects to the Rétrotechnique server <i>hosting the latest version of the software. It is therefore mandatory to connect the equipment to the internet network.

Furthermore, it is strongly recommended to use a wired network connection (RJ45) rather than a Wi-Fi connection, especially if the latter does not offer optimum coverage, in order to avoid any risk of the update failing.

One-click update of the ModulAM does not destroy current lists. Thus, user-created stations, such as playlists, are retained within the system's memory.



During the entire phase of automatic software download and installation, during the update sequence, operation is deliberately blocked. It is then impossible to manipulate the functions accessible via the HMI keyboard. Moreover, heIt is imperative not to force a shutdown or unplug the mains power until the update is complete..

Once validated, the update takes place automatically in 4 main stages indicated to the user by different displays.

Step 1: Download and copy

THE**ModulAM**connects to the Rétrotechnique server and requests the download of the software in its latest version, in the form of a compressed file.

The information window in Figure VI-18 opposite is displayed throughout the execution of this download and copy phase within the nano-computer of the **ModulAM**.

This step can last between 30 seconds and a few minutes depending on the performance of your internet connection.

Step 2: Decompression

Once downloaded and stored within the**ModulAM**, the system will proceed to decompress the software in order to recover all the files and data from the new version of the software.

This phase is marked by the display of the information window in figure VI-19 opposite. This step is quick (from two to a few seconds).

	Version locale : V1.2 - 15 Avril 2025
	Derniere version publiee : V2 - 13 Mai 2025
	Traitement en cours, veuillez patienter
	Copie du fichier compressé
	AGPL
1	ModulAM 2024-2025 - Vers. V1.2 - 15 Avril 2025 - Free as in Freedom
	Figure
e	therche de mise à jour
V	ersion locale : V1.2 - 15 Avril 2025
C	ernière version publiée : V2 - 13 Mai 2025
1	raitement en cours, veuillez patienter
	Décompression

Figure VI-19



Step 3: Preparing for installation

Once the software is unzipped, some internal operations are performed to calibrate and prepare for the installation of the new version.

Figure VI-20 opposite shows the information window corresponding to this phase of work. This step is quick (from two to a few seconds).

Step 4: Installation

The software is installed automatically, in replacement of the previous version.

During this fourth and final stage, which lasts no more than ten seconds, the information window in figure VI-21 opposite is displayed.

echerche de mise à jour	
Version locale : V1.2 - 15 Avril 2025	
Dernière version publiée : V2 - 13 Mai 2025	
Traitement en cours, veuillez patienter	
Préparation de l'installation	
odulAM 2024-2025 - Vers. V1.2 - 15 Avril 2025 - Free as in F	reedom
Fi	gure
· · .	
echerche de mise à jour	
echerche de mise à jour Version locale : V1.2 - 15 Avril 2025	

Traitement en cours, veuillez patienter Installation

ModulAM 2024-2025 - Vers. V1.2 - 15 Avril 2025 -

```
Figure VI-21
```

Updated

When all operations have been completed, the message in the information window shown in Figure VI-22 opposite is displayed.

Complete the procedure by pressing the "To leave".

If the update fails, a proposal to repeat the operation is offered, or an error message is displayed. Note this and contact the <u>administrators of Rétrotechnique</u> to report the incident.

Version locale : V	.2 - 15 Avril 2025	
Dernière version	ubliée : V2 - 13 M	ai 2025
La mise à jour s'e	st effectuée avec	succès
0.111		

Figure VI-22

Once the update is complete, it is possible to operate the system normally again.**ModulAM**, via the HMI. With exploitation, it is advisable to restart the system (STOP on the keyboard, then action on the A/M switch of the power supply).

An operating software update tracking document is available at<u>this page</u> from the website of the ModulAMThis document lists all the modified, improved and corrected points in the new version, as well as the new features developed, where applicable. In addition, the list of improvements, corrections and/or new features is announced for planned updates.



-Supplements

Further details on dial types, needle type, identification of programs currently being broadcast, are available on the page "<u>Documentation</u> » from our website.

Furthermore, we invite the user to familiarize himself with this operating interface of the**ModulAM**by manipulating the various controls and features on the<u>simulator</u> freely available online.

VI. 6 – F ONC TI ON S ANNEXES

-External audio input

THE**ModulAM**allows the user to create his own broadcast program on one of the 8 broadcast channels, from an analog audio signal to be connected to the modulator card.

The wiring details for this external input are detailed in the attached document called "Reception box for the system**ModulAM**–Part 2", freely downloadable from the section<u>Docking box for the</u> system**ModulAM** of the website.

The user will find the wiring plan and connection instructions from page 6.

Once the external analog audio source is connected, this program will be associated with a new station to be created via the function<u>station configuration</u> .

Then it will be possible to assign this station to a broadcast frequency (in GO or in PO) via the function<u>mailing list configuration</u>.

Optimal adjustment of the audio level can be made via the adjustable potentiometerPOT1wired to the modulator board and accessible on the lower left part of the printed circuit board.

Audio input**EXT**erne materially concerns channel 8 of the turntable of the**ModulAM**.

During the CONFiguration of a list, regardless of the rank (1 to 8) on which the user programs this station [External audio input], it will be automatically directed to channel 8 of the modulator, via the HMI software.

The user will ensure that the inverter is operated correctly.Web/MP3 / AF-Ext. (front of the docking box), on the positionAF-Ext, in order to validate the hardware switching of the external analog audio source.

The station [External audio input] can only be programmed once per list. Otherwise, a message warns the user of a blocking anomaly: "You cannot program more than one external source".



-Bluetooth option

When this hardware option is installed, the user can assign the output of this Bluetooth modem to one of the 8 broadcast channels, on the frequency of his choice.

The methods of production and installation on the "modulator" board of the **ModulAM** of this Bluetooth option are detailed in a separate notice, named:

Bluetooth option:<u>assembly instructions and instructions</u>, freely downloadable from the website of the **ModulAM**.

The modem output of the Bluetooth option is hardware related to channel 7 of the board of the ModulAM.

During theCONFiguration of a list, regardless of the rank (1 to 8) on which the user programs this station [Bluetooth modem], it will be automatically directed to channel 7 of the modulator, via the HMI software.

The station [Bluetooth modem] can only be programmed once per list. Otherwise, a message warns the user of a blocking anomaly: "You cannot program more than one Bluetooth channel".

-D iffusion of digital audio files

The system**ModulAM**also allows the broadcasting of an audio source from files in mp3, ogc or flac formats.

Streaming MP3, OGC, or FLAC files requires first downloading them into the system's memory. Several GB are available for this purpose on the SD memory card in the Orange Pi Zero2 nano computer module's reader.

Below is a simple procedure for placing audio files into the memory of the**ModulAM**:

Download a file transfer utility software, for example:

- For Windows:WinSCP
- For Android, macOS, iOS:<u>termius</u>



This procedure is illustrated using the WinSCP utility software.

- Ensure that the**ModulAM**is in service and connected to the network,
- Open the WinSCP software,
- In the invitation window, connect to the ModulAMwiththe username and password of the Orangepi (figure VI.23 opposite).

Vouveau Site Mon espace de travail orangepi@ModulAM	Session Protocole de fichier	7
	SEIP Nom d'hôto	Numéro do port
	Modulam.local	22
	Nom d'utilisateur	Mot de passe
	orangepi	•••••
	Éditer	Avancé

Figure VI.23

Once WinSCP is connected, the screen offers a file explorer separated into two windows (figure VI.24 below).



- On the left, we can see the computer folders: you must then expand the tree structure (**HAS**) until the audio file(s) you wish to copy are displayed,
- On the right, these are the files of the **ModulAM**via the Orange pi Zero; you have to expand the tree structure (**B**) until you reach the "media" folder (**C**) :home/orangepi/modulam/media.
- Open this "media" folder: many *.mp3 files are already present there. They correspond for the most part to the files of the recorded frequencies and sinusoidal frequency sequences accessible for assistance in aligning the receivers (figure VI-25).
- Using the computer mouse, drag the file(s) from the left window to the right window to copy them into the memory space dedicated to audio files.**ModulAM.**



General instructions – Assembly and instructions

Local Marquer Fichiers Commandes	Onglets Options Distant Aide						
🕀 🤮 💓 Synchroniser 🗾 🧈 🙋	🛚 🚫 🎒 File d'attente 🖌 Réglag	ges de transfert Défaut	• 🙎 •				
📮 orangepi@ModulAM 🗙 📑 Nouv	el onglet 👻						
🔜 Bureau 🔹 🚰 🕶 💌 🔹 🔹	🕨 🔁 🔯 🏠 🚼		📙 media 🔹 🖬 🕈 🝸 🔹 📥 🔹 🔶	12 🔁 🏠 🖓	Rechercher des fichie	ers 🔚	
🕼 Envoyer 🛛 🛛 Éditer 🗝 🗙 🛃 [👌 Propriétés 👻 🎦 Nouveau 🕶 🛛 🕂		📲 Télécharger 🖌 📝 Éditer 🔸 📈 🗋	Propriétés 🕶 🔛	Nouveau 🕶 📑 🗖 💟		
Cilibiant Weltmuck? Creating Mes docu	ments\5_ModulAM\IHM\Fichiers audi	o\	/home/orangepi/modulam/media/				
Nom	Taille Type	Date de modification	Nom	Taille	Date de modification	Droits	Propriétair
	Répertoire parent	19/03/2025 10:52:35	0 100-3000Hz-30s.mp3	306 KB	28/02/2025 15:45:22	rw-rr	orangepi
Bashung_Je_t_ai_manqué.mp3	6 866 KB Fichier MP3	08/12/2008 08:51:54	0 100-3000Hz-60s.mp3	541 KB	28/02/2025 16:16:59	rw-rr	orangepi
Rolling_Stones_Goin_Home.mp3	19472 KB Fichier MP3	29/12/2010 21:13:18	250-3500Hz-30s.mp3	281 KB	28/02/2025 10:07:38	rw-rr	orangepi
			250-3500Hz-60s.mp3	573 KB	28/02/2025 10:30:36	rw-rr	orangepi
			AA-800-0326.mp3	939 KB	28/02/2025 07:21:43	rw-rr	orangepi
			🔶 🧕 Bashung_Je_t_ai_manqué.mp3	6 866 KB	08/12/2008 08:51:54	rw-rr	orangepi
			Burst1.mp3	1 137 KB	28/02/2025 17:15:41	rw-rr	orangepi
			Goin_Home.mp3	19 172 KB	29/12/2010 21:13:18	rw-rr	orangepi
			Rolling_Stones_Goin_Home.mp3	19 172 KB	29/12/2010 21:13:18	rw-rr	orangepi
			RuptureFlux.mp3	2 009 KB	22/01/2025 10:50:37	rw-rr	orangepi
			S300.mp3	235 KB	26/02/2025 16:00:24	rw-rr	orangepi
			S300-0328.mp3	235 KB	28/02/2025 10:33:57	rw-rr	orangepi
Figure VI-25			S0400.mp3	3 517 KB	04/12/2024 15:37:20	rwxr-xr-x	orangepi

- Close the file transfer utility software.
- It's over.

Then simply configure a station with the desired file, following<u>the procedure</u> described in this notice.

Example: from the HMI: CONF key / "Choose a station" button / [New station]

The following window is proposed:



Once all the fields have been completed, press "Validate". This station "My personal radio" is now created and can be inserted into a playlist.



The name of the mp3 files**must not**contain spaces or apostrophes. To maintain clarity, replace spaces with the "underscore" character (underscore of 8 on the keyboard: _).

Although our tests showed that accented letters were taken into account, this should be avoided.

Also, use short names to identify files.





After copying the audio files into the "media" folder, and regardless of the method used for transfer, the mp3 files do not automatically link together like a playlist! The user wishing to stream several tracks in a row must first create a single mp3 file by merging the ones they wish to stream.

This is a simple operation offered by several audio editing software and utilities. Simply type "how to merge MP3 files" into a search engine: many programs, including several free ones, are available.

VI. 7 – WIFI LINK

The Orange Pi Zero2 module has an internal Wi-Fi router connected to a mini antenna already in place on the module.

Validating Wi-Fi mode requires specific settings.

-Preparation

Remove the mini antenna connected to the Orange Pi Zero2 module from any immediate proximity to the components of the OPZ module by placing it next to the circuit or by fixing it with adhesive, along the front face of the host box, for those who have chosen this solution for integrating their**ModulAM**.

Place the**ModulAM**, near the box (WiFi comfort zone), connect it to the box via a wired connection (RJ45), put it into service and ensure that it is working correctly by connecting via the HMI to obtain the home screen according to the<u>Figure VI-2</u>.

-W ifi mode settings

- Open a window in "Terminal" mode on the PC.
- In the prompt window, typessh orangepi@modulam(respect the space afterssh) + Enter.
- A password is required: enterorangepi(note: no input view) + Enter. Various information is displayed regarding the system status and address.
- Next, enter the command:sudo nmtui(respect the space aftersudo) + Enter. Re-
- enter password:orangepi(note: no view of the input) + Enter. This command opens the OPZ network connection configurator.

The window in Figure VI-27 opposite is then
displayed.

[NetworkManager TUI
	Please select an option
	Edit a connection
	Activate a connection Set system hostname
	Quit
	<0K>
<i>Figure VI-27</i>	



Using the keyboard arrow keys (up/down), select the function Activate a connection(figure VI-28 opposite). Then validate using the Enter key on the keyboard. <i>Figure VI-28</i>	Please select an option Edit a connection Activate a connection Set system hostname Quit <ok></ok>
The window in Figure VI-29 opposite then appears.	Wired * Wired connection 1

Using the arrow keys, selectWi-Fi.

Validate using the Enter key on the keyboard.

Wired * Wired connection :	1
Wi-Fi Livebox-A950	
	2

NetworkManager TUI

After validation, the window in figure VI-30 appears and shows that the box has been automatically detected and recognized.



Figure VI-30

Figure VI-29

Using the Tab key on your keyboard, place the cursor on "Deactivate» and activate the connection by pressing Enter on the keyboard.

We then obtain the status "Activate» as shown in Figure VI-32 opposite.

Figure VI-32





Confirm the name of the box using the Enter key on the keyboard. The window shown in Figure VI-33 opposite

appears.

Enter the password (WEP key) for accessing the Wi-Fi network, then confirm with Enter.

Authentication required by wireles	ss network
Passwords or encryption keys are required wireless network 'Livebox-A950'.	to access the
Password	
	<cancel> <ok></ok></cancel>

Figure VI-33

The procedure is complete.

Network cable streaming automatically disconnects. So there will probably be a loss of radio program streams and the alert message "Here is the ModulAM, pay attention to the URL address, etc.»will be broadcast on all channels, which is normal.

To restart properly, exit the connection configurator by returning to the initial menu (using the tab key, validate "back» then Enter) to obtain the window shown in figure VI-34 opposite. Select "Quit» with the arrow keys on the keyboard and confirm with Enter. The terminal window reappears: entersudo reboot(respect the space after sudo) + Enter. This action completely stops the ModulAM and Figure VI-34

automatically restarts it in Wifi mode.

address.

1 14	ELWOI	Kridiid	ager.	IUI
Plea	ase s	elect	t an	optio
Edit	tac	onne	tior	ı
Act:	ivate	a co	onnec	tion
Set	syst	em ho	ostna	me
	-			
Outit	-			
Qui				
Qui				201

Then close the PC terminal mode window.

Once the programs are broadcast again, it is possible to unplug the RJ45 network cable.

Validation of the Wifi mode within the ModulAM is the result of a recent development, therefore with little experience. Some users may encounter difficulties when setting up this connection method, depending on their IT environment and the behavior of the box linked to the internet service provider. The settings changes of the **ModulAM**(switching to Wi-Fi mode, returning to wired mode) can cause the equipment's IP address to change. In this case, the HMI will no longer be able to connect to the system unless the new IP address of the ModulAM in the browser. The authors attempt to list these various behaviors, incidents and the most frequently asked questions which will then be published in the FAQ section of the website, by offering suitable

If you have any questions or difficulties, it is therefore wise to consult this section regularly.

solutions such as, for example, the configuration of the **ModulAM** with a fixed (static) IP



For those who prefer to use external Wi-Fi, a reasonably priced router has been tested and found to be completely satisfactory.<u>See here</u> .

No special settings are required within the**ModulAM**for the implementation of this type of external router. The user will follow the instructions and procedures indicated in the router installation manual.

Other models are of course available on the market.

It is important to remember that the connection between the "box" and theModulAMmust be of excellent quality, given the constant flow of data passing through it. This is why it is widely recommended, wherever possible, to favor a wired connection via an RJ45 cable.

Otherwise, place theModulAMin a Wi-Fi coverage area considered optimal, or choose an external router model with performance adapted to the distance separating the "box" from theModulAM.

VI. 8 – ME SS AG ESD ERROR / ALERT

In order to guide the user during possible incidents in the different operating phases of the**ModulAM**, many error messages have been created and are presented in an audible or visual form when an anomaly is detected.

Some of these messages are explicit and invite the user to restart a procedure or to reset the system, others are more technical and intended particularly for the development team in order to help them diagnose the causes of the incident and therefore resolve more effectively any observed malfunction.

In this configuration, it is advisable to note the contents of this message (or to take a screenshot of the GUI at the time it is displayed) and to send the whole thing to this address:

reports@retrotechnique.org

Please include with this report the terms of use that caused the message to appear.

-My wise men

These messages are broadcast in place of the audio program(s) of the stations in the current broadcast list. They are therefore heard in the connected receiver(s), on the frequencies concerned by the incident.

Message type 1:

"Here the **ModulAM**–Please note, the URL for the station broadcast on this frequency is broken – please change or replace it.»



Cause: One or more audio streams were interrupted during broadcast on the channel(s) broadcasting this message.

A relaunch of the broadcast (press on **DIFF**Off, then on **DIFF**This usually resolves the issue provided that the stream(s) are re-identified on that station's website.

Otherwise, change stations.

Please note that this message is broadcast consecutively in 6 languages (French, English, German, Dutch, Spanish and Italian).

Message type 2:

"Alert: We have noticed a general interruption of all radio program streams; Please check your internet connection, then restart the broadcast mode.**AM Module**".

Cause: Internet connection with the ModulAM. No

audio programs are available anymore.

Either the RJ45 cable is unplugged, or the Wi-Fi connection does not provide sufficient comfort, or an interruption of the internet service is observed (box, faulty ISP, etc.).

After identifying the problem and reestablishing the connection, restart the broadcast by pressing the key**DIFF**Off, then on**DIFF**On, in order to find the programs.

-My visual messages

These messages appeared either within the settings or configuration windows in progress, or via messages embedded on the screen, when the system noted the incident.

Configuration window (CONF) :

Incompatible broadcast frequencies:in the configuration window of a<u>mailing list</u>, the message " <u>Blocking anomaly(ies)</u>» appears when one or more combinations of broadcast frequencies may cause an interference problem in the connected receiver(s).

Above this message, the risk details are clearly stated. Figure VI-32 opposite shows an example of a "prohibited" combination: 531 kHz and 1593 kHz. The third harmonic of the first frequency is equal to the value of the second frequency, which would potentially generate interference of the latter.

	Anomali	e(s)	bloquante(s)	
	Fréqu. 1593 harmo	niqu	e de 531- risque de	brouillage
	veutilez modi	ner	t une de ces freque	nces
Fréqu. 1 :	531 kHz (565 m)	~	FIP	v
Fréqu. 2 :	1593 kHz (188 m)	~	Africa No1	~
Fréqu. 3 :		*		~
Fréqu. 4 :		*		~
Fréqu. 5 :		*		~
Fréqu. 6 :		~		×
Fréqu. 7 :		~		v
Fréqu. 8 :		*		~
 Choix 	du cadran france	e - é	chelle croissante - ble	eu v

The user is prompted to change the value of one of the two frequencies involved.

EXT audio input: This entry can only be programmed once per mailing list. Otherwise, a message indicating a blocking anomaly is displayed: "You cannot program more than one external source» (figure VI-33).

Nom de la liste : Test EXT	(9 kHz)
Anomalie(s) bloquante(s)	
Vous ne pouvez pas programmer plus d'une source	extérieure
Fréqu. 1 : 153 kHz (1959 m) 🗸 [Entrée audio ext.]	~
Fréqu. 2 : 207 kHz (1448 m) ✓ [Entrée audio ext.] Fréqu. 3 : ✓	~

Figure VI-33



Bluetooth modem: The Bluetooth modem output (hardware option) can only be programmed once per broadcast list. Otherwise, a message indicating a blocking anomaly is displayed: "You cannot program more than one bluetooth channel» (figure VI-34).

(7 KH2)		ХT	la liste : Test EX	om de	Non
	lie(s) bloquante(s)	mali	Anom		
urce extérieure	programmer plus d'un	as pi	Vous ne pouvez pa		•
~	 Entrée audio ext.) ~	153 kHz (1959 m)	qu. 1 :	
	d I Catalo audia aut) ~	207 kHz (1448 m)	qu. 2 :	Fréqu
~	Entree audio ext.				Fréqu Fréqu
1	Entree audio ext.				Fréqu Fréqu

One-click update (SYST) :

Updating online with a single mouse click is a sensitive operation, by definition. In the event of an incident during the various stages of this update, if the system is still operational, a message inviting you to repeat the procedure may appear: "No response from the server within the expected timeframe. Please try again or consult the online help.".

Other messages may appear if an item was not installed correctly.

Examples of some "technical" messages that may be displayed:

"Error writing current version file»

"Error: inc/define.php not found»

"Error: Software installation failed to start»

"Error while decompressing»

"Error reading tar file»

"Error writing tar file»

In any case, it is advisable to repeat the update procedure.

If you notice a new failure, note the error message and report it to the address indicated on the previous page.

Note: Not all possible warning or error message labels are listed here. However, the procedure remains the same for the user.



VI I – ANNEXED TECHNICAL INFORMATION

VII. 1 – COU PL AG WITH DIFFERENT STYPEDER RECEIVER S

THE**ModulAM**can be paired with almost any type of receiver. Since it is possible to have an Antenna socket and an Earth socket, it is even simpler...

But even models that do not offer direct connections to an antenna and/or an earth accessible via an external terminal can benefit from coupling, using other means of proximity radiation.

Below we examine the most frequent cases, which the amateur can extrapolate to his own TSF, depending on the technology and accessibility of the equipment.

The community of radio enthusiasts*presents*on the forum<u>retrotechnology</u> will undoubtedly constitute a suitable playground for developing some tips to satisfy all old TSF receivers.

-Standard TSF receivers

We have arbitrarily named "standard" the TSF tube receivers that operate on the mains and have Antenna and Earth sockets.

The presence of an "Earth" socket accessible via a terminal clearly marked on the back box indicates that the chassis of this receiver model is isolated from the mains. Therefore, a priori, there is no risk of electrocution for the user when connecting this socket.

The coupling of this type of receiver has already been detailed in<u>chapter V.3.4</u> of this notice.



Figure VII-1

Figure VII-2

The image in Figure VII-2 opposite shows an example of connecting the coupling loop to the terminals **HAS** antenna and**T**wandering of a TSF receiver from the fifties (Philips BF321A – Figure VII-1).



-All-purpose TSF receivers

So-called "All Current" substations do not have a galvanically isolated transformer. This means that one of the poles of the mains network is directly connected to the chassis!

These economical positions were mass-produced, particularly in the 1950s and 1960s.



Figure VII-3



Figure VII-4

Figures VII-3 and VII-4 show one of the most widespread models of "all-current" receivers: the Philips B1F 71, shown here in version A (123 V / 220 V).

These stations, which are entirely enclosed in a plastic shell, therefore do not offer an earth connection. On the rear panel, you can clearly see that only an "Antenna" terminal is available.

The connection of the coupling line with the **ModulAM** therefore requires removing the rear panel to access the chassis.



SAFETY – DANGER TO PERSONS!

He is**imperative**to disconnect the receiver from the mains before starting to dismantle the rear panel of a receiver of all currents and to avoid any handling under voltage until the cover or the protective rear panel is refitted. Failure to follow these instructions could cause a serious or even fatal accident for the person concerned.



1 / Basic assembly -Real danger

When the chassis is visible, you must identify a place to connect (a screw as in the example of the B1F 71A, figure VII-5) or a solder lug under the chassis.



Figure VII-6

The coupling line is made using a twisted insulated wire, connected at one end to the chassis and at the other end to the receiver's antenna socket, the center of this wire passing through the coupling ferrite core (Figure VII-6).

By passing this line through the rear hood there is therefore no particular risk.

EXCEPTthat if the station is powered on and the "Antenna" plug is unplugged, then This plug is directly connected to the chassis, therefore to the mains. Vigilance is therefore essential for this type of assembly.

Variant 1 – Improved security

Although the assembly described above is entirely satisfactory in terms of RF coupling, it is nonetheless dangerous when handling while the station is live.

We will therefore prefer the variant consisting of inserting as close as possible to the connection on the chassis, a capacitor of approximately 1 nF (1000 pF) suitably insulated (400 V or more) in series with the coupling line. Figure VII-5 shows the connection of such a capacitor after having interrupted the connection (red cross).

On the RF side, the RF attenuation is not significant given the available voltage, but the protection is effective even if it is not total. Indeed 1 nF = 32 k Ω at a frequency of 50 Hz (i.e. 7 mA max). This is far from representing infinite insulation...So, stay vigilantduring handling.

Variant 2 – Total security



The 1950s and 1960s radios, whether common or not, were often equipped with a fixed or rotary control frame. The common Philips B1F 71 had two ferrite frames, which allowed comfortable reception without the need to connect a wire antenna.

The first frame for the PO and GO bands and the second for the BE and OC bands.

The assembly proposed in figure VII-7 is almost ideal.

Locate the ferrite frame of the PO and GO strips: this is the one that accommodates the windings with the greatest number of turns, it is visible to the naked eye.

Then, using a wiring wire (green in figure VII-7 opposite), make 3 or 4 turns at the end of the PO / GO ferrite bar. Glue or melt a drop of wax on the turns for a durable hold, then twist the two wires and pass them through the back face, for easy disposal, once the cover or cardboard of this back face is reassembled.

This time, safety is total, since there is no electrical contact between the receiver and the coupling line.



Figure VII-7

Then connect this line to the one leading to the coupling ferrite core and you're done. RF efficiency is excellent across the entire MW and LW bands.

-Galena TSF receivers

There are many types of crystal receivers. From simple "toys" to sophisticated receivers with multiple settings (antenna, tuning), or even an amplification stage, they all have Antenna and Ground inputs in common.

The connection of the coupling line is therefore carried out following the same diagram as that implemented for the connection of a "standard" station.

Figure VII-8 opposite shows an example of the "Le Radio Cristal" receiver.

The coupling line is connected between the two Antenna and Earth terminals on the upper face.



Figure VII-8



The selectivity of crystal receivers is obviously not on a par with that of more modern receivers. Therefore, it will take a lot of patience and a certain dexterity on the part of the crystal detector operator to "isolate" a station among the eight broadcast by the**ModulAM**.

To avoid mixing up programs in the receiver, it is advisable to build a broadcast configuration with a small number of programs (three or four) or to configure several channels with the same audio program. This will make tuning the receiver much easier.

-Transistor receivers

The term "transistor" receivers is used here to refer to portable, stand-alone receivers that the general public at the time called "Transistor"; all had a ferrite frame to pick up the LW and MW bands.

Some also had an "Antenna" socket for installation on board a car, an input often controlled by an ANT/FRAME switch button.

For the example we have chosen a receiver from the sixties, claiming to be both an indoor station and connectable to a car antenna: the SONOLOR PLEIN-AIR 64 manufactured from 1964 (figure VII-9 opposite).



Figure VII-9

Coupling via antenna input

This is the simplest and allows you not to worry about the internal layout of the receiver.

You still need to have a "car radio antenna" type plug. Simply connect this plug to the end of the twisted wire coupled to the ferrite core and position the ANT/CAD button in the ANTENNA position (figure VII-10 opposite).



When the receiver does not have an external antenna input or the male plug is missing, it is necessary to ensure that the ferrite frame picks up the RF signal broadcast by the**ModulAM**.

To optimize the coupling with this frame, it must be located as precisely as possible: is it placed horizontally? vertically? in the center of the receiver? To find out, remove the rear panel and locate the position of the frame (figure VII-11 opposite). Here, it is horizontal and placed almost in the center of the chassis.



Figure VII-10



Figure VII-11



Two possibilities are available to the amateur:

Direct coupling

This coupling is carried out directly on the frame, by winding two or three turns on the ferrite bar, identical to what has been proposed for the coupling with all current mains stations, (see<u>Figure VII-7</u>). This winding should preferably be placed in the center of the ferrite bar so that both coils (PO and GO) benefit from similar RF levels.

Bring both ends of the wire out through a gap in the rear cover and connect them to the line joining the coupling ferrite core. This solution ensures a high RF level at the input of the receiver's RF stages.

Indirect coupling

This time we don't touch the receiver. Using a fairly thin wire, preferably in a color close to the front of the receiver, so that it goes almost unnoticed, wrap the latter with two or three turns of the wire, thus forming a loop.**parallel** to the coils located on the ferrite bar of the receiving frame (figure VII-12 opposite). Here again, place the loop preferably towards the center of the ferrite bar. Carry out tests first with a single turn, then increase the number, if the reception is not sufficiently clear (presence of hiss). All this remains variable because it is linked to the sensitivity of the receiver and the proximity of the loop to the ferrite bar.

Then twist the wire until it connects to the line coupled to the core assigned to this receiver.



Figure VII-12: For the photograph, a red wire was chosen to clearly demonstrate the principle. A thin, gray wire would avoid making this coupling loop, formed here by two turns, too visible.

-Car radio receivers

This type of receiver does not include a ferrite frame but only a socket intended to be imperatively connected to an antenna. We will therefore proceed exactly as with the "Antenna" input of a classic transistor radio, as indicated in<u>previous chapter</u>.



VII. 2 – HOW TO QUICKLY DISCHARGE THE DC POWER SUPPLY

The stop of the **ModulAM** requires a special procedure allowing the nano computer to close its files "cleanly", followed by cutting off the DC power supply for a complete shutdown. The <u>recommended method</u> (chapter V.2.2), before the equipment is put back into service, requires a significant waiting time (approximately 1 minute and thirty seconds), attributable to the time taken to discharge the power supply unit's capacities.

It is possible to reduce this time to around ten seconds by loading the power supply output with a resistor permanently connected to the 5 VDC distribution circuit.

The additional consumption of approximately 50 mA remains insignificant during the various operating phases (maximum consumption of approximately 800 mA for the entire system) but is sufficient to discharge the block's capacitors relatively quickly when it is disconnected from the mains.

The recommended resistance for this function is 100 Ω (Brown / Black / Black) ½ watt.

The connection of this resistor is made between the pins4(+5 VDC) and6(0 V GND) of the Orange Pi Zero2 module expansion connector, as shown in Figure VII-13 below.



Figure VII-13: Connection of a power supply discharge resistor.

This resistor can be installed using the leftover 2-pin female Dupont cable or using a specialized connector.



VII. 3 – STEC HN I CAL CA RA CT ERISTI C OF MODUL AM

Average level of RF outputs, after coupling to TN14/9/5 - 3E25 type toroid: J15:

RF output GO+PO /	GO Carriers	- 47 dBm (1 mV)
	PO Carriers	- 39 dBm (2.51 mV)
J10: RF output GO		- 53 dBm (0.5 mV)
output PO	Average level	- 48 dBm (0.9 mV)
of the auxiliary RF output	t GO+PO, capacitive coupling:	
J16: AUX RF output GO+P	0	- 30 dBm (2.24 mV)
Linearity of the RF filter o	f the GO output in the 153 kHz to 280 kHz band	+0.5 / -0.5 dB
Linearity of the RF filter o	f the PO output in the 540 kHz to 1700 kHz bandAF	+0.5 / -1 dB
EXT input (J12):		
Input sensitivity (F=800	Hz @ Modulation depth 50%)	- 21.5 dBu (65 mV)
Modulation depth linea	rity (range 10% to 70%)	+0.2 / -0.5 dB
Response curve at -3 dE	3	80 Hz to 3500 Hz
Response curve at -6 dE	3	50 Hz to 5000 Hz
Harmonic distortion (TH	ID) F=800 Hz @ Modulation depth 50%)	0.33%
distortion (THD) F=800 I	Hz @ Modulation depth 70%)	0.63%
according to SINAD pro	cedure (F=800 Hz Modulation depth 50%) Signal to noise ratio	50 dB
according to SINAD pro	cedure (F=800 Hz Modulation depth 70%) Supply	52.3 dB
voltage	Current	5 VDC
consumption:		
During the system start	-up phase In DIFF ON	775 mA
mode (with 8 modulate	d carriers) In DIFF OFF	450 mA
mode (system ON but n	o RF carriers) During the system	360 mA
shutdown phase	Average	625 mA
consumption in DIFF Of	N mode (with 8 modulated carriers)	2.5 W

VII. 4 – REPERTORY OF MEASUREMENT FREQUENCY FI CH IERS

THE**ModulAM**offers a series of sinusoidal frequencies and sinusoidal frequency sequences intended to assist the amateur in troubleshooting and/or alignment of the stages of a TSF receiver.

It is thus possible to establish one or more broadcast lists containing some of these files (the same file can be assigned to several broadcast frequencies) in order to follow an RF signal, to align the frequencies on the dial, to align the RF and MF stages, to control and qualify the AF stages, etc.

The table below lists all 25 available files with the station name as it appears in the station list, the nature of the audio file content and the reference of the file saved in the Orange Pi Zero nano computer.

Station name	Nature of the audio file content	File reference
Sliding 30s	Sliding frequency from 100 Hz to 3000 Hz over a period of 30 seconds, logarithmic progression. Modulation rate: 30% - Without voice announcement.	100-3000Hz-30s.mp3
Sliding 30s_A	IdemSliding 30sbut with voice announcement of the sequence.	100-3000Hz-30s-A.mp3
Sliding 60s	IdemSliding 30sbut over a duration of 60s – Without voice announcement.	100-3000Hz-60s.mp3
Sliding 60s_A	IdemSliding 30sbut over a duration of 60s and with voice announcement.	100-3000Hz-60s-A.mp3
Sequence 16 Fr	Sequence of 16 sinusoidal frequencies from 100 Hz to 3000 Hz, increasing in third-octave increments. Modulation rate: 30%. Duration of each train: 7.5s. Spacing between two trains: 2.5s – Without voice announcement.	SEQ-100-3150.mp3
Sequence 16 Fr_A	IdemSequence 16FR_Abut with voice announcement of each frequency.	SEQ-100-3150-A.mp3
Sine 100 Hz	Sine wave frequency 100 Hz, modulation rate: 30% - Continuous mode.	S100-0328.mp3
Sine 125 Hz	Sine wave frequency 125 Hz, modulation rate: 30% - Continuous mode.	S125-0328.mp3
Sine 160 Hz	Sine wave frequency 160 Hz, modulation rate: 30% - Continuous mode.	S160-0328.mp3
Sine 200 Hz	Sine wave frequency 200 Hz, modulation rate: 30% - Continuous mode.	S200-0328.mp3
Sine 250 Hz	Sine wave frequency 250 Hz, modulation rate: 30% - Continuous mode.	S250-0328.mp3
Sine 300 Hz	Sine wave frequency 300 Hz, modulation rate: 30% - Continuous mode.	S300-0328.mp3
Sine 315 Hz	Sine wave frequency 315 Hz, modulation rate: 30% - Continuous mode.	S315-0328.mp3
Sine 400 Hz	Sine wave frequency 400 Hz, modulation rate: 30% - Continuous mode.	S400-0328.mp3
Sine 500 Hz	Sine wave frequency 500 Hz, modulation rate: 30% - Continuous mode.	S500-0328.mp3
Sine 630 Hz	Sine wave frequency 630 Hz, modulation rate: 30% - Continuous mode.	S630-0328.mp3
Sine 800 Hz	Sine wave frequency 800 Hz, modulation rate: 30% - Continuous mode.	S800-0328.mp3
Sine 1000 Hz	Sine wave frequency 1000 Hz, modulation rate: 30% - Continuous mode.	S1000-0328.mp3
Sine 1250 Hz	Sine wave frequency 1250 Hz, modulation rate: 30% - Continuous mode.	S1250-0328.mp3
Sine 1600 Hz	Sine wave frequency 1600 Hz, modulation rate: 30% - Continuous mode.	S1600-0328.mp3
Sine 2000 Hz	Sine wave frequency 2000 Hz, modulation rate: 30% - Continuous mode.	S2000-0328.mp3
Sine 2500 Hz	Sine wave frequency 2500 Hz, modulation rate: 30% - Continuous mode.	S2500-0328.mp3
Sine 3000 Hz	Sine wave frequency 3000 Hz, modulation rate: 30% - Continuous mode.	S3000-0328.mp3
Sine 3150 Hz	Sine wave frequency 3150 Hz, modulation rate: 30% - Continuous mode.	S3150-0328.mp3
Single carrier	Unmodulated carrier. No AF signal.	PORT-Silence.mp3



VII. 5 – LOG ICIAL ARCHITECTURE

The functional program of the **ModulAM** was developed according to the architecture represented by the diagram in figure VII.4 below.



Figure VII-14: Software architecture and data flow.

The principle:

Two programs, automaton and modulator, are executed in parallel.

The first one, which is executed automatically when the power is turned on, is the PLC program. It is responsible for launching the second one and communicating with the HMI.

This dialog leads it to start, if necessary, the execution of "bash" type scripts to carry out the actions desired by the user.

The automaton program is a bit like a conductor who leads an instrumental ensemble whose first violin would be the modulator program.

The modulator program is responsible for broadcasting audio streams to the Raspberry Pico microcontroller.

To push the analogy, we can consider this microcontroller as its instrument except that here we are talking about eight violins played simultaneously by a single violinist!



VII. 6 - MANAGEMENT OF RO ITS OF SOFTWARE

The functional programs of the **ModulAM**are free software; you can redistribute them or modify them under the terms of the GNU General Public License as published by the Free Software Foundation; either version 3 of the License or any later version. These programs are distributed in the hope that they will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU General Public License for details. The GNU General Public License is available at:http://www.gnu.org/licenses.



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V0.8: provisional version – 01/2025
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V1.0: stabilized version – 02/2025
V1.1: version corrected for an omission – 02/2025 V1.2:
version corrected for minor errors – 02/2025
V1.3: revised version following the new version (from V1-1) of the functional software – 04/2025
V2.0: Revised version following new features integrated into the HMI software (measurements, Bluetooth option, advanced update management) – Published on May 16, 2025.

Notice attached to the equipment**ModulAM**having the following hardware and software versions: Modulation deck hardware version: v1.2.1 or v1.2.2 RPI processor software version: ModulAMv1.uf2 OPZ2 software package version: ModulAM-2503-OPZ2-V1-1.img (or higher).

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End of notice.