# XM-PRO Lite general connection & deployment

The **XM-PRO Lite** is a motherboard which forms part of the **XTREME** family of products, intended to be connecter on top of a high-end FPGA carrier board.
In conjunction with all kind of **XTREME** family of audio/video cables/adapters/DACs, input encoders, kick-harness, SNAC (Serial Native Accessory Converter) adapters, JAMMA & JVS adapters it becomes one of the most complete, flexible and future-proof FPGA arcade-gaming platform existing.

**Key features:**

- It greatly **expands the input-controllers flexibility, as well as the audio/video input and output capabilities of an FPGA carrier board**, mainly used for retro-gaming FPGA core development and for playing. It's typically plugged on top of a **Terasic DE10-Nano** carrier board (sold separately), as well as on other under development **next-gen FPGA GAMING boards**.
The DE10-Nano it's currently very well supported by the **MiSTer FPGA project**, as well as by other platforms such as the **MOnSieurFPGA**, and the **FPGA-Arcade DE10 platform**.

- We mainly **focused on CRT and ARCADE enthusiasts**, as well as on **multi-player gaming (more than 2 players => more fun)**, typically not so well covered by the main scope of any FPGA and general gaming platforms. We are offering the most accurate hardware recreation and gaming experience of retro-computer/consoles/arcade machines, mainly from the 80s and 90s, when the HDTV monitors didn't existed.
We also offer **premium audio & video, inputs & outputs** for different kind of **custom modern arcade cabinet projects**, typically including a modern open-frame LCD monitor, and powering external passive-speakers (even without a JAMMA) with an embedded **high-fidelity 32bit 192kHz audio DAC** and an embedded and **powerful stereo audio power-amplifier**, able to handle some of the most demanding two channel (stereo) passive setups, i.e. a ~500 ft² (50m²) room with TWO passive 3 to 8 ohm full-range speakers, a custom made DIY cabinet setups, NeoGeo MVS (stereo) cabinets, as well as any JAMMA MONO cabinet. Moreover, with our solution is straight forward to upgrade any JAMMA dual-speaker MONO configuration to STEREO, to be able to enjoy many stereo computer, console and arcade platforms at a whole new fidelity and power level. We specially love how the Jotego's CAPCOM Q-Sound based CPS cores stereo-experience sound with this platform!. Our idea is that the user won't ever need any external audio power amplifier or auxiliary hardware to upgrade your cabinet audio capabilities, just simple wiring skills. We can give support for both kinds of setups: an isolated MONO setup (as in the JAMMA connector), and any pair of two powerful speakers (referenced to ground) for instance at a large gaming-room.
We ended up with a power amplifier rated at 11+11W RMS, that is soldered to several different ground planes of the 6-layer PCB of the motherboard, as well as cooled-down with a custom-maid active-cooler solution, for optimal thermal performance. We use an SMD power amplifier an SOLID CAPACITORS at the audio-path (for a lower distortion and much better durability at higher temperatures). The power amplifier requires a dedicated +24V@1.5A capable DC-DC converter (designed to be 5A capable for a much better robustness and thermal efficiency), and we also use different +12V, -12V, +5V and +24V power rails (with several ground and power planes) into our motherboards for the different analog audio buffering (i.e. at the SCART and at the line-input), for powering the FPGA carrier board and for powering the audio power amplifier. We also implemented a **reverse polarity as well as overvoltage input protections** (>10A rated), a **power switch** (5A rated), and **three different power input alternative interfaces**: +12V & +5V from the JAMMA, and two external +12V @ 5A max. inputs with different connectors to give maximum flexibility on customs setups. Remember, not all the XM-PRO arcade (and non-arcade) setups have to be connected to a JAMMA harness. Take a look at the diagram to get an idea of how many other different **PRO** setups are possible.

- It allows for **as flexible as possible DIY living-room (and multi-room) kind of multi-monitor & multi-player projects**, with a mix of a modern HDTV and possibly multiple CRTs (ideal for retro-gaming with minimum video-lag), all monitors connected and maybe used at the same time (i.e. yoko & tate monitors), and different speakers at several rooms too, with independent volume control per room. The deployment possibilities are endless with a **single-motherboard design**, a unique **cable management organization**, a **consolized/computerized modern looking** (with **different open-source** and **very customizable enclosure** options available). The number of embedded audio/video IO ports also avoids the use of typically more-pricy analog video cables/converters, which may deal to some video level inaccuracy when connected to different analog-video output-impedance boards. Not all video DACs are built the same way and with a very controlled output impedance, specially to **match all IRE levels as good as possible**.

- We have implemented one of the **most accurate at 10 to 100 IRE level R2R VIDEO DAC implementation, tailored for the MiSTer cores, adjusted with the Artemio's 240p Suite on the MiSTer_devel SNES core**, to have the **most linear an accurate IRE levels at all the analog video ports**; the **DSBU15-3** (RGBHS or RGBS or YPbPr) video port, the **buffered SCART** (RGBS + buffered audio) port, and the **buffered and amplified video JAMMA** (RGBS) port. The JAMMA video port is shared and wired up to a more complete **external CRT arcade monitor port**, provided with several pluggable terminal blocks, supporting both RGBHV and RGBS arcade monitors, with the same ~3V CMOS video signal levels, and TTL sync levels. This external arcade monitor port, and the direct stereo speaker port allow for easier DIY cabinet project with CRT monitors and powerful full-range stereo speakers.

- All the **XTREME** family of motherboards include a **XNOR SYNC combiner by hardware**, which can be optionally used or overrided by the **FPGA CSYNC combiner**, in case you have a very sensitive CRT monitor, such as some Sony BVM (broadcast grade monitor) series A and G (for instance), which may present SYNC issues in this specific case.

- All our motherboard also include a **SYNC protection for 15kHz monitors by hardware**, with a RED LED alarm indication. They don't output any HSYNC or VSYNC signals at the 3 different analog video output ports (VGA, SCART and JAMMA) when the HSYNC input signal is over ~17kHz. This protection can be disabled with a single hardware toggle switch on board. We really care and know how precious your 15kHz CRT arcade monitors and 15kHz CRT TVs can be!.

- We allow for an **as flexible as possible video-output configurations** such as a mixed RGBHV and RGBS, i.e. **DSUB15 (RGBHV) + SCART (RGBS) + JAMMA (RGBS), and even HDMI or HDMI-to-VGA (24bits RGBHV) at the same time**, when the FPGA is not configured to always output a "composite_sync" video signal (at the analog video output and at the HDMI port when the "direct_video" mode is also activated, though the HDMI port). When the MiSTer "composite_sync" is activated all the outputs would be forced to RGBS, including the DSUB15. Moreover, with the "video_settings" hardware dip-switch available on all the **XTREME** motherboards, we can select between the embedded SYNC combiner of the FPGA generated HSYNC/CSYNC signal at the DSUB15 port, choose a 75ohm or a TTL level HSYNC/CSYNC levels, completely disable (HighZ) the VSYNC line (problematic for some special CRT monitors in RGBS or RsGB mode), and enable a +5V output power pin in the DSUB15. We also give support for a mirrored displays with S-VIDEO or Composite (PAL or NTSC) encoded video outputs, by using a combination of one or two MikeS11 Y/C active or passive boards, or any other combination of RGBHV / RGBS and encoded S-VIDEO/Composite video outputs at the TWO consumer-grade video-level outputs (VGA & SCART) that are better illustrated at the diagram. The multi-CRT / multi-MONITOR possibilities are endless.

- All the **XTREME** boards have other unique specs, such as the possibility to **maintain your original JVS cabinet (collection) hardware (i.e., SEGA NAOMI CPU, Taito Type-X CPU, etc), or even an existing Gaming PC with a VGA output in your collectors cabinet (or DIY cabinet), not forcing the user to replace any original / existing "CPU" in their cabinet hardware when adding the new FPGA platform inside**. The XTREME boards have a **audio line-in** as well as a **VGA RGBHV (or RGBS) input**, with analog muxes, for mixing the audio and video from a multi-HOST setup.
You may switch to the FPGA outputs to enjoy the well supported retro-platforms at the FPGA with an impressive accuracy and the lowest possible input/audio/video lags, and next switch back to your original/existing cabinet hardware to maybe enjoy several more modern/different platforms still not supported at the current FPGA generation platform, maybe with 3D accelerated graphics, native NAOMI or TAITO titles, or several Windows/Linux games when using a gaming PC. Modern videoconsoles audio/video/controllers can also be muxed with all of our **XTREME** motherboards using additional HDMI to VGA+Audio adapters (sold separately). And other multi modern-console setups and an HDMI MUXing are possible too, but we prefer to postpone its presentation maybe for a near future.
For and easy remote control, we provide an special 4SNAC-USB peripheral (shown at the bottom of the diagram) that allows a straight forward remote control the configuration of the different audio/video analog inputs as well as of a USB2.0 host port (switching all the connected USB2.0 peripherals/controllers/hard_drive between the two hosts/platforms), and even multiple JVS connections (between the original JVS hardward and the FPGA platform, as shown in the diagram).
This AV/USB/HDMI/JVS IO configuration is persistent among different power cycles, so it's really convenient to be at your arcade service compartment, for an easy access. A USB3.0 extension cable can also be used to access the remote board from outside a cabinet.
Open-source 3D printable enclosures will be provided later for all these peripheral boards. Metal enclosures could also be offered in the future, depending on the demand.

- The XM-PRO and XM-PRO Lite motherboards provide a **build-in very-low latency 4-players USB2.0 input encoder** (that could be **externally added to the XM (non-PRO) motherboard by adding an external controller interface), with a BLE5.1 remote control/configuration capabilities** (from an smartphone or tablet... which is work in progress at Android app level), and **greatly simplifies the learning curve required to globally configure and update the whole FPGA platform, without the need of any network interface configured!.**
**It's a peer-to-peer wireless connection, between the XTREME and your smartphone, with wireless OTA firmware upgrades supported too.**

- All the **XTREME** family of motherboards include an **enhanced 4-player capable SNAC (4SNAC-IO)** port with the following features and advantages over the existing SNAC official and unofficial implementations:
  - **"ZeroLag" microsecond-level input-lag in SNAC mode**, with a direct connection with the FPGA IOs. It requires an specific core support.
  - **Extended IO capabilities:** with more IOs from the FPGA, the **4SNAC-IO** port can handle up to **4-player SNAC configurations** on Nintendo NES/SNES, Sega(DB9), NeoGeo(DB15), Sega Saturn, etc, as well as other custom made **4-player arcade joysticks configurations... everything using a single built-in USB-C port.**
  - The **4SNAC-IO** port is implemented using a mechanically **super-durable USB-C (full-featured 24pin) connector, very high-speed capable, very high-current capable** (3A), and with **industrial-grade ESD, EFT & Lightning protections**, as well as **current limit & overvoltage protections for the 4SNAC-IO port**, for the BLE5.1 module (4-player input encoder) **and for the FPGA:**
    - **IEC61000-4-2 (ESD) ±25kV (air), ±20kV (contact).**
    - **IEC61000-4-4 (EFT) 40A (5/50ns).**
    - **IEC61000-4-5 (Lightning) 4.5A (8/20µs).**
  - **It has an embedded USB2.0 High-Speed (480Mbps) communications port**, so it can be used with **hybrid 4SNAC/USB external peripherals using a SINGLE power / USB2.0 data / SNAC data cable**, while the existing oficial SNAC implementation is limited to 7x IOs with the FPGA and lacks of a USB2.0 port in the same cable, due to the lack of available pins at the chosen previous MiSTer AnalogIO board USB3.0 port. Another unofficial SNAC implementation with a single extra IO pin with the FPGA, improves the multi-player capabilities to some extra 2-player configurations, but it could never be so flexible, high-speed, high-power capable and 4-player capable as our implementation, and it would always lack of an embedded USB2.0 High-Speed (480Mbps) general purpose communication port on the same connector.
  - **JAMMA-SNAC** (2-players) and **JVS-SNAC** (with typically 2-player but up to 4-players with 2x dual-player cabinets or up to 4x single player JVS cabinets) support!. Both with the **4SNAC and USB2.0 support** at the same time for a **universal core support on any FPGA platform.**

Both JAMMA-SNAC and JVS-SNAC, for the first two players, were implemented to be backward compatible with the existing dual-player DB15 SNAC implementation, supported by some core developers such as Jotego, Atrac17, Darren, and others... We also support other **different JVS RS-485 based USB2.0 (single and dual JVS port) adapters** to provider **build-in JVS universal core support on the MiSTer**. They are just different JVS-controller support alternatives which requires more or less hardware parts and cables, providing different levels of input-lag.
  - The **4SNAC-IO** port provides two unique features: **hot-plug cable detection** as well as an **automatic peripheral identification** capabilities.
  - It has a **BACKWARDS COMPATIBILITY with all the MiSTer-Devel SNAC7(USB3.0 AnalogIO board port) peripherals**, with an extra **USB-C to USB3.0 adapter** (shown at the diagram).
  - The **XTREME** motherboard 4SNAC-IO ports do **not** incorporate weak pull-up resistors **at the motherboard close to the SNAC port**, which could drastically affect the impedance matching of the transmission lines, reduce the maximum port bandwidth (depending on the core and protocol implemented) and limit the possible cable lengths to maybe no more than a few centimeters. With our Signal Integrity (SI) and impedance matching implementation, we can **handle custom higher-speed serial protocols from the FPGA, up to several MHz with a lower signal integrity impact when using longer cables, supporting 3.3V as well as 5V peripherals signal levels transparently**, and again with a high-level of ESD/EFT/Lightning and overvoltage protections. The possible (stronger) pull-ups for longer cable lengths for the MiSter-devel SNAC backward compatibility (when using a "WEAK_PULL_UP_RESISTOR" configuration at the USER_IO port of the FPGA core) can be placed at the external SNAC adapters, converters or peripherals, which is not a big deal, as those passive components are super inexpensive. The 4SNAC-to-USB3.0 adapter already includes such stronger pull-ups.

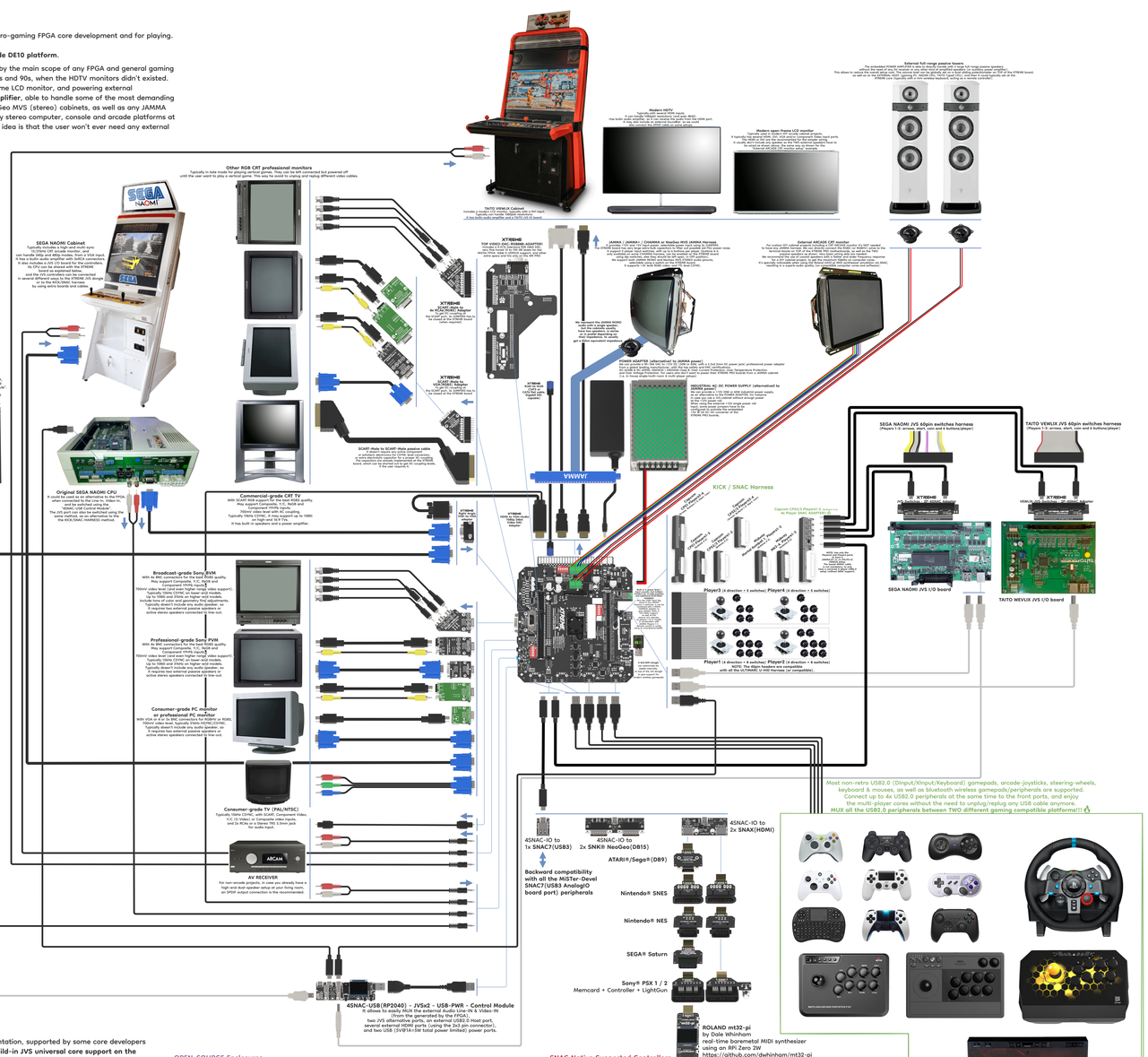
- The XM-PRO and XM-PRO Lite motherboards provide **2x 40pin male header connectors**, for a direct connection with the BLE5.1 (Cortex-M4) USB2.0 very-log input-lag input encoder, for directly wiring up to 4-player arcade joystick configurations, where the Players 1 and 2 pins are wired to the JAMMA port controllers too. These two dual-player ports allow to add several types of **KICK/SNAC-HARNESS** boards on TOP of the **XTREME** motherboards, and we didn't limited the KICK-HARNESS to the typical CPS1 or CPS2/3 for Players 1-2 (and buttons 4-6), we also support way more original collector arcade scenarios:
  - Capcom CPS1 (players 3-4, arrows, start, coin and buttons 1-2): Cadillacs and Dinosaurs, Captain Commando...
  - Capcom CPS2/3 (players 3-4, arrows, start, coin and buttons 1-4): Aliens vs Predator, Dungeons & Dragons...
  - Midway Mortal Kombat 1 (players 1-2, buttons 4-6),
  - Midway MK2-4...(players 1-2, buttons 4-6): Mortal Kombat II and 3, Ultimate Mortal Kombat 3, Mortal Kombat 4, Killer Instinct 1 and 2, War Gods and WrestleMania.
  - **Capcom CPS2/3 (players 1-2, buttons 4-6) -AND- 4-player SNAC ports to support: 1) JAMMA-SNAC, 2) JVS-SNAC, 3) JVS-VERSUS (up to 4x cabinets), and 4) JAMMA-vs-JVS.**

**In all cases up to 4-player USB2.0 and up to 4-player 4SNAC support at the same time for a better core compatibility.**

- The XM-PRO and XM-PRO Lite motherboards provide a **TOP ADD-ON expansion port**. Gives **extra JAMMA-VERSUS support**, the capability to add external video DACs, external embedded host (with I2S audio input), an extended parallel 4SNAC-IO (with even more IOs, extra I2C, SPI and USB2.0), and only for the XM-PRO (not available on the XM-PRO Lite), external volume and external line-out capabilities. Therefore, with both **PRO** boards it's possible to link several JAMMA cabinets in VERSUS mode, several JVS cabinets (up to 4 cabinets) in VERSUS mode, or even a mix of a JAMMA and several JVS cabinets together, with an unprecedented flexibility at the AUDIO and VIDEO inputs & outputs available from a single-board design. **Both the SEGA NAOMI and TAITO VEWLIX JVS cabinets are specially supported.** All these combinations with an **USB2.0 and an extended 4SNAC support at the same time**, to be universally supported on any FPGA core with a sub-millisecond input lag, and with an even better microsecond-level inputlag on certain FPGA cores (when the SNAC mode is supported & activated).

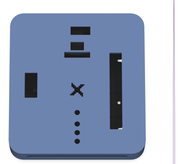
- Finally, when we compare to other software based emulation platforms, the FPGA platform provides the best possible input controller native support, allowing an almost direct GPIO connection from the controller port to the FPGA balls. This manner we can obtain the **lowest possible input-lag, audio-lag and video-lag, for the best possible hardware recreation of retro-machines.** In the case of the software emulation platforms there is a lack of he hardware parallelism only possible when using an FPGA. After ceirtain level of accuracy only an FPGA can do the work correctly, and it can do it in real-time. The FPGA cores are not software implemented, but hardware implementations.

- FPGA platforms such as the MiSTer (DE10-Nano) provides a **high-end UPSCALING up to 1200p in real-time to drastically improves the user experience when connected to modern HDTVs**, computer or modern-arcade monitors by HDMI/DVI, typically starting from a 240p CGA resolutions on retro-arcade and retro-console systems. The FPGA also provides **one of the best VIDEO-FILTERING implementations on the open-source community**, again implemented in real-time at the FPGA and with minor impact on the video-lag: high-quality recreation of vertical and horizontal scanlines, LCD panel effects, different commercial CRT TVs video presets and video masks (Sony PVM, BVM, JVS...). Both the upscaler and video filters provide a unique and very realistic retro experience on modern HTDVs, as an alternative to the CRT monitors support, also provided at it's higher level of accuracy by the **XTREME** family of products. Other future next-gen FPGA platforms will allow to go further, up to 4K and much more...




**OPEN-SOURCE Enclosures**

**FR4 or ACRYLIC plates**
The lateral FR4 or ACRYLIC plates are only compatible with the XM-PRO motherboard. The TOP & BOTTOM plates are compatible with all of them.
Customizable material color & thickness.
The FR4 has a robust & flat surface, perfect for a high-resolution UV1 printing, on TOP or on any lateral plates.
NOTE: Other kind of lateral FR4 / ACRYLIC plates would be possible, by adding slots at the TOP & BOTTOM plates. We provide open-source plate design, so that the user could freely modify and cover other possibilities like this, that we don't specially like due to asthetically reasons.



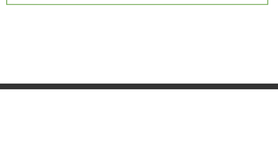
**3D PRINTED enclosure parts**
Customizable material color & finish, glittered color MOF PLA/PETG are perfect for TOP cover. BLACK resin is perfect of interior support parts. BLACK color PLA/PETG is recommended for BOTTOM cover, for an easier insert nuts installations (optional).
Remember to choose the right TOP cover for the XM, XM-PRO Lite or XM-PRO.

**SNAC Native Supported Controllers**

Some examples of retro console controllers natively supported with ZeroLag* by a direct connection with the FPGA.

*NOTE: The **input-lag is as accurate and low as possible**, as originally implemented by Nintendo®, Sega®, Sony®, etc.

On SNK® **NeoGeo(DB15)** controllers the priority is get the **lowest possible input-lag** by sampling several parallel-to-serial converters at high-frequency from the FPGA, without the USB2.0 overhead from the ARM/Linux (side of the FPGA), resulting in a **microsecond-level** added-input lag, perfect for fighting/shooting games.



## CREDITS

**Main core developers and MiSTer contributors**

- **Alexey Melnikov "Sorgelig"**, founder and mainly maintainer of the **MiSTer FPGA project**, a community driven free-software project built on top of the 3rd party & proprietary **Terasic DE10-Nano (Intel CycloneV)** FPGA carrier board:
https://www.patreon.com/FPGAMiSTer, https://github.com/MiSTer-devel/Wiki_MiSTer/wiki, https://www.misterfpga.org
https://www.terasic.com.tw/cgi-bin/page/archive.pl?Language=English&CategoryNo=167&No=1046

- **José Tejada "jotego"**, made and published emulators, contributed to MAME, published FPGA cores for YM2612, YM2203, YM2151 FM synthesizers, contributed to Megadrive core for MiST and MiSTer, sound of NeoGeo core, published the FPGA core for Capcom CPS1, CPS1.5 and CPS2, Ghosts'n Goblins, Block Tiger, 1943 arcade boards among many others: https://www.patreon.com/topapate https://twitter.com/topapate https://github.com/jotego

- **Atrac17, one-half of the Coin-Op Collection development team (with va7deo) which is responsible for the development of over 14 FPGA Arcade Cores. He is also the co-author of MOnSieurFPGA (with DJ Hard Rich), an alternative DE10-Nano & MiSTer FPGA-Compatible platform with many developer and end-user improvements. Created an LS-30 Rotary Joystick encoder board firmware/verilog implementation with DJ Hard Rich and va7deo.**
https://www.patreon.com/atrac17 https://github.com/MOnSieurFPGA/MOnSieurFPGA-SD_Image_Builds

- **va7deo, co-author of the x86 ASM implementation of the Motorola 68000 used in MAME 0.34b5 and onward. Author of the MAME Toaplan driver, 68020 support for Psikyo games in MAME, and countless other drivers/improvements in MAME. He is One-half of the Coin-Op Collection development team (with atrac17), and one of the most prolific authors in both the FPGA and software emulation communities.**

- **pr4m0d, author of the Raizing FPGA Core (MiSTer and Analogue Pocket) and the FPGA implementation of Midway's NARC/Smash TV. His focus on hardware that pushes current FPGA platforms to their limits is extremely impressive, and his contributions expand what is possible in the Open Source FPGA development community.**

- **Robert Peip "FPGAzumSpass"**, released Playstation, GBA, Lynx, Wonderswan, Atari Lynx cores. Currently working on the N64 core. Major 486 cache/speedup and GB features (e.g. savestates, fastforward, splitscreen). NES core features (savestates):
https://www.patreon.com/FPGAzumSpass https://twitter.com/AzumFpg https://github.com/RobertPeip

- **Sergey Dvodnenko "srg320"**, released the SNES, PCE CD, Mega CD, Sega 32X, Saturn cores:
https://www.patreon.com/srg320 https://twitter.com/srg320_ https://github.com/srg320

- **Furrtek** released the NeoGeo core and did multiple chip decaps:
https://www.patreon.com/furrtek https://twitter.com/furrtek https://github.com/furrtek

- **Josh Bassett "nullobject"**, released the Rygar, Gemini Wing, Silkworm and Cave cores such as DoDonPachi: https://www.patreon.com/nullobject https://twitter.com/nullobject https://github.com/nullobject

- **Ace**, released Arkanoid and Konami arcade cores, audio expert: https://ko-fi.com/ace9921
https://twitter.com/ace9921tweets https://github.com/Ace9921

- **MiSTer-X**, released (New)Rally-X, DigDug, The Tower of Druaga(Mappy,Motos,DigDug II), Gaplus, Ninja-Kun, Green Beret (Rush'n Attack), Solomon's Key, Food Fight, Atari Tetris, SEGA System 1, Gyruss and Penguin-Kun Wars cores: https://www.patreon.com/MrX_88 https://twitter.com/mrx_8b
https://github.com/MrX-8B

- **Blackwine**, released many arcade fixes and improvements: https://www.patreon.com/blackwine
https://twitter.com/blk_yn https://github.com/blackwine

- **Jegor van Opdorp "Jopdorp"**, released various arcade cores and analog sound: https://www.patreon.com/jopdorp

- **Javier Fuentes "RndMnkIII"**, released various arcade games: https://t.co/Hzxtx0Fy6N
https://twitter.com/RndMnkIII https://github.com/RndMnkIII

- **Jim Gregory "JimmyStones"**, released various arcade cores and MiSTer tools:
https://ko-fi.com/jimmystones https://twitter.com/mrjimmystones https://github.com/JimmyStones

**Other credits:**

- **MikeS11 Y/C hardware video encoders creator, for a much better core-independent S-VIDEO and Composite PAL/NTSC video encoders: https://github.com/MikeS11/MiSTerFPGA_YC_Encoder**

- **Mr.Fusion** image creation project by Michael Smith https://github.com/michaelshmitty https://github.com/MiSTer-devel/mr-fusion

- **Update_All_MiSTer** and **Downloader** scripts by José Manuel Barroso Galindo "theypsilon" https://www.patreon.com/theypsilon https://twitter.com/theypsilon https://github.com/theypsilon

- **d0pefish**, mt32pi author: https://dope.fish/ https://twitter.com/_d0pefish_

- **Mdfourier/240p Team: Artemio & Pinobatch**, Testing tools used often to improve core accuracy:
https://www.patreon.com/ourbina https://twitter.com/Artemio http://youtube.com/c/ArtemioUrbina

- **Bobby Dilley "bobbydilley" and Javier Rodas "JaviRodasG"** (as collaborator), JVSCore for supporting Naomi based arcade cabinet JVS I/O boards on Linux (and on the DE10-Nano): https://dilley.uk/ https://twitter.com/bobbydilleyuk
https://github.com/bobbydilley https://github.com/javier-rodas

**Special thanks to:**

- The **HFS-Play** family, for being so excellent people, helpful and friendly, and allow me to validate some of the **XTREME** prototypes for several different JAMMA, as well as JVS cabinets (both NAOMI and VIEWLIX) during an #HFSSummer event in France. Also thank you so much for providing us a second SEGA NAOMI board for testing: https://www.hfsplay.fr

- **Mike Johnson**, an FPGA & very-high speed layout hacker, author of several Minimig / Amiga 500 core implementations on different FPGAs targets. He is the founder of the FPGA-Arcade and the author of Replay board, and he is currently working on a next-gen Replay2 FPGA platform: https://www.fpgaarcade.com discussions at https://discord.gg/ztdmh3kd. Thanks for his great help and SI design tips during some of the **XTREME** boards high-speed layout development.

- The **FPGA-Arcade** team: https://discord.gg/ztdmh3kd

- **ulao**, for having one of the most complete, almost universal and auto-detectable input controller solutions for retro-gaming, used in port as a base of a new family of **XTREME modular multi-player peripherals (not presented yet)**, compatible with all existing HDMI Bliss-Box cables, as well as other HDMI-SNAC cables: https://www.Bliss-Box.net

- **Ricardo Saraiva**, for his great support with hardware samples and his help with the MiSTer platform: https://ultimatemister.com

- **Ruben "@CrakerMc"**, for being so supportive and helpful with the MiSter platform: https://www.patreon.com/Craker http://Paypal.me/Craker https://www.twitch.tv/CrakerMc https://twitter.com/CrakerMc https://www.youtube.com/@CrakerMc https://discord.gg/HNejv6dq

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