ZSA: Z80 Standard Architecture

A Proposal for A Z80-based DIY Computer Architecture

By K. Cardoza, G. Sutherland, et. al.

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Abstract

This proposal will outline the physical, electrical, and software requirements for a community-owned, open-source hardware, 3.3V logic level DIY computer architecture, built around Z80 and compatible CPUs. Inspired by, and physically similar to, the Industry Standard Architecture, or ISA, bus, this bus will serve the same purpose for new, Z80-based DIY computer systems: provide an open standard to which any and all participants are welcome.

The inspiration and motivation behind this proposal is, simply put, the current reality facing computer hobbyists: 5V parts are becoming harder to find, while 3.3V parts are plentiful, inexpensive, and far more broad in their natures and selection. Moving from a 5V standard logic to 3.3V opens up a new world of potential, enabling the use not only of more modern surface-mount logic and memory and processor devices, but CPLDs, FPGAs, microcontrollers, and specialized ASICs which all default to 3.3V logic levels.

A 3.3V standard for DIY computer kits and accessories will enable the use of all these components and many more than can be enumerated here, as well as enable the use of modern, high-quality, economical PCB fabrication and population facilities provided to the modern hobbyist by such services as PCBWAY and JLCPCB, among others.

Such a standard will also enable small businesses and craftspeople, such as might be found among the sellers on Tindie, to build original products for a common platform.

Definitions

The terms below are to be interpreted with the following definitions:

1. “The standard” refers to this document.
2. “Backplane” means a PCB with female edge connector slots meant to provide power and signal connections to expansion cards.
3. “Expansion card” means a PCB which is designed to connect to the ZSA bus using the 70-pin edge connector.
4. “Implementation” means a physical product or design meant to be used under this standard.
5. “Conforming implementation” means an implementation which meets all “MUST” and MUST NOT requirements, and is thus entitled to carry the conformance marks and advertise its conformance to the standard.

6. “Coforming backplane” means a backplane which is a conforming implementation.
7. “Conforming expansion card” means an expansion card which is a conforming implementation.
8. “Conforming system” means a collection of one or more conforming impelemntations which collectively implement a usable computer system compliant with this standard.
9. “MUST” means that an implementation is not compliant if it does not meet the listed requirement.
10. “MUST NOT” means that an implemention is not compliant if it does what is listed in the rule.
11. “MAY” means that an implementation’s compliance status is neither confirmed nor denied by the inclusion or absence of the designated attribute(s).
12. “SHOULD” means the same as “MAY” with the addtion that the adherence to the rule is strongly advised.
13. “EITHER” means that a requirment is for a “MAY” or “MUST” rule in one of two ways, separated by an “OR”.
14. “Implementation defined” means that the specific methods and designs of a requirement are left to the designer of the conforming implementation to decide.
15. “Z80 CPU” means a processor, or emulation of a processor[1], which is logically and electrically compatible with the ZSA bus and executes Z80 opcodes.
16. The “rear” edge of an expansion card is the edge which has the Keystone mounting holes.
17. The “front” edge of an expansion card is the edge directly opposite the rear edge.
18. The “top” edge of an expansion card is the edge directly opposite the male 70 pin edge connector.
19. The “bottom” edge of an expansion card is the edge which has the 70 pin male edge connector.

[1] This includes FPGA and microcontroller-based CPU emulations.

1. Bus Signals

1. The bus which is covered by this standard is carried on female edge connectors with a pin pitch of 2.54mm.
2. Through-hole female connectors are recommended for mechanical strength.
3. The bus consists of 50 signals with a 70-pin edge connector[2].
4. All signals are specified to use 3.3V logic levels, and are assumed to be 5V-intolerant.
5. Each signal on the connector is adjacent to a ground pin, either on the same side of the connector or directly opposite.
6. A conforming backplane MUST provide, for each expansion slot, EITHER a two pin 2.54mm pitch pin header OR a SPST switch, which links the /INT2IN and /INT2OUT pins when connected.
7. A conforming expansion card MUST pass signals from /INT2IN to /INT2OUT, even if it does not use those pins itself.
8. A conforming expansion card which makes use of the /INT2OUT signal MUST block signals from /INT2IN at any time when it is asserting the /INT2OUT signal.
9. A conforming expansion card MAY connect unidirectional TVS diodes between all data lines and ground, physically near the card edge connector. If TVS diodes are present:
    1. Such TVS diodes MUST be rated for a minimum of 50MHz during normal operation, AND
    2. Such TVS diodes MUST have a junction capacitance not exceeding 5pF.
10. A conforming backplane, which provides more than eight expansion slots, MUST provide implementaton-defined signal buffering of the address and data lines, with no less than one set of buffers for every eight expansion slots.
11. Unless otherwise specified in this standard the pins of the male edge connector on a conforming expansion card MUST measure 1.524mm wide by 7.62mm tall.
    1. Pin 67 of the bus connector is is defined as a 1.524mm by 5mm pin, aligned to the top of the row of pins; being shorter than the other pins, Pin 67 will only be connected when all other signals on the bus are already connected.
        1. A conforming backplane MUST route each expansion slot's pin 67 signal trace separately.
        2. A conforming backplane MUST implement pin 67 and its supporting logic for all expansion slots it provides.
        3. Provided the present/absent state of pin 67 in every set of eight card slots in a backplane can be read from a single

[2] An example connector part which might be used is the EDAC 395-070-520-201.

documented I/O address (which MAY be user-configurable), the exact logic to implement pin 67 functionality is implementation-defined.

2. A conforming backplane MAY also have implementation-defined logic such that bridging and disconnecting of an empty slot's / INT2IN and /INT2OUT pins is automatic.
    1. Such a conforming backplane is exempt from having to include pin headers or SPST switches to handle the Mode 2 interrupt daisy-chaining.

2. Physical Requirements

1. A conforming backplane MUST place its expansion slots at a centre-to-centre distance from each other of exactly 20.3mm.
2. A given expansion slot in a conforming backplane may be designated “external” or “internal”.
    1. An internal expansion slot is an expansion slot which is intended for use with expansion cards which lack externally-usable ports or connections.
    2. An external expansion slot is any expansion slot which is intended for use with expansion cards having externally-usable ports or connections.
3. A conforming backplane MUST locate all external expansion slots such that the external connectors on expansion cards used in those slots are visible when the backplane is installed in a compatible case.
4. A conforming backplane MUST locate all internal expansions slots such that no expansion card with a “Keystone” bracket installed may be inserted into the slot.
5. A conforming backplane MAY be physically compatible with any existing case mounting standard.
    1. Such a backplane MUST be clearly marked as to which case mounting standard it is compatible, on the side with the conformance mark(s).
6. A conforming expansion card MUST have board dimensions and outline matching those in figure 1.
7. A conforming expansion card design MAY make “cuts” into the top or front-facing edges of the PCB to allow for connecting “IDC” style ribbon cable edge connectors to the board.
    1. Such “cuts” SHOULD remove no more material from the specified board outline than is necessary to securely connect the required connector.
    2. Such additional edge connectors may not cause the width or height of a conforming expansion card to exceed the limits in figure 1.
8. A conforming expansion card MAY place two-row, 2.54mm pitch pin headers positioned parallel to the PCB, mounted to the top- or front-facing edge of the expansion card PCB.
9. A conforming expansion card MUST have 45º bevels on the bottom corners of the edge connector, each forming a right triangle with the perpendicular sides each measuring 1mm in length.
10. A conforming expansion card MAY have the mating edge of the PCB chamfered.
11. A conforming expansion card have a nominal thickness of 1.6mm.
12. A conforming expansion card MUST have all the mounting holes in the locations shown in figure 1.
    1. The “Alternative Mounting Hole” in figure 1 is intended to be used with 18mm M3 nylon standoffs, to mechanically link cards

together when the backplane is not installed into a case which makes use of the Keystone brackets.

    1. In such a case, the Keystone bracket can be removed, and the top mounting rear mounting hole used for a second 18mm M3 nylon standoff.

13. A conforming expansion card MAY place rear-facing ports, such as (but not limited to) D-subminature connectors, in the area between the two Keystone 9202 mounting holes on the rear-facing edge of the PCB.
    1. Those ports, when possible, MUST be positioned such that existing, off-the-shelf, pre-fabricated Keystone-compatible brackets can be affixed to the PCB.
14. A conforming backplane MAY provide one or more slots intended for use with “cartridge” PCBs.
    1. Such a backplane MAY use any of the bus signals in such a “cartridge slot”, in an arrangement that is implementation-defined.
    2. Such a backplane MUST ensure that the electrical requirements for all signals used in a “cartridge slot” are met as if they were used in a regular expansion slot.
    3. Notwithstanding §1.11.1.2 and §2.14.2, a conforming backplane MAY elect not to implement “presence detect” logic (as used in pin 67 of the expansion bus connector) for cartridge slots.

3. Electrical Requirements

1. A conforming backplane MUST safely provide no less than 2500mA of peak current on the 3.3V power rail, with no less than 2000mA safe continious current.
2. A conforming expansion card MUST draw no more than a peak total of 500mA on the +3.3V rail, and no more than 400mA of continuous current.
3. A conforming expansion card MAY make use of a supplemental power source, provided that power source is referenced to the same gound level as the +3.3V rail.
    1. Such supplemental power MUST NOT be connected directly to the +3.3V rail.[3]
    2. A card which makes use of supplemental power source(s) MUST note, in the silkscreen on the card, the voltage, pinout, and current requirements of the supplemental power source.
4. A conforming backplane MAY use any power supply design or connector which safely provides at least the minimum required current on the positive voltage rail.
5. A conforming impelmentation MUST ensure that all PCB traces for the address and data signals have a characteristic impedance of 50Ω ± 10%.
6. A conforming implementation MUST ensure that all PCB traces have an adjacent reference plane to provide a low impedance path for return currents and minimise the risk of signal integrity issues.
    1. A conforming implementation utilising a two-layer PCB SHOULD route all signal traces on one layer and place an unbroken ground plane on the other layer.
    2. A conforming implementation utilising a four-layer PCB SHOULD arrange the layers as follows: Two inner ground layers, in between two outer layers which have signals and +3.3V power.
    3. A conforming implementation utilising a PCB with six or more layers SHOULD ensure that each signal layer references a plane on the same side of the core.
7. A conforming implementation MAY integrate the functionality of a backplane with that of various other devices, such as serial UARTs, memory, or even CPU, into a single unified “motherboard” PCB.
    1. Such an implementation MUST include at least two expansion card slots.
    2. Such an implementation is considered a backplane for the purposes of standard conformance.

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[3] An example of this would be a 4-pin Molex style connector using one of an ATX power supply’s drive plugs to add a +5V and +12V rail for use on the card.

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2. A conforming implementation's schematic diagram(s) MUST be made available under the terms of the CERN Open Hardware License, version 1.2, or, at the designer and/or licensee's preference, any later version.

Appendix A

CERN Open Hardware License, Version 1.2

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Appendix B: Bus Signals

The table below defines the signal names and pin assignments for the bus covered by this standard.

Pin Name	Pin Number	Desciption
+3.3V	2, 69	+3.3 volt power rail
A0..A23	40, 42, 44, 48, 50, 52, 56, 58, 60, 64, 66, 68, 63, 61, 59, 55, 53, 51, 47, 45, 43, 39, 37, 35	24-bit address bus
/MREQ	15	Memory request (active-low)
/IORQ	13	I/O request (active-Llw)
/RD	19	Bus read (active-low)
/WR	21	Bus write (active-low)
/INT	5	Interrupt (active-low)
/NMI	11	Non-maskable interrupt (active-low)
D0..D7	36, 34, 32, 28, 26, 24, 20, 18	8-bit data bus
RXD	12	+3.3V serial recieve
TXD	16	+3.3V serial transmit
CTS	8	+3.3V serial “clear to send” handshake line
RTS	10	+3.3V serial “ready to send” handshake line
/INT2OUT	4	Mode 2 interrupt daisy-chain output (active-low)
/INT2IN	3	Mode 2 interrupt daisy-chain input (active-low)
/CS0../CS3	23, 27, 29, 31	“Chip select” lines (active-low)
/PD	67	Presence detect (active-low)
GND	1, 9, 17, 25, 33, 41, 49, 57, 65, 70, 62, 54, 46, 38, 30, 22, 14, 6	Ground

Table 1: Pin and Signal Descriptions

Appendix C: Expansion Card Specifications

The following figure illustrates the requirements for a compliant expansion card's phsyical dimensions.

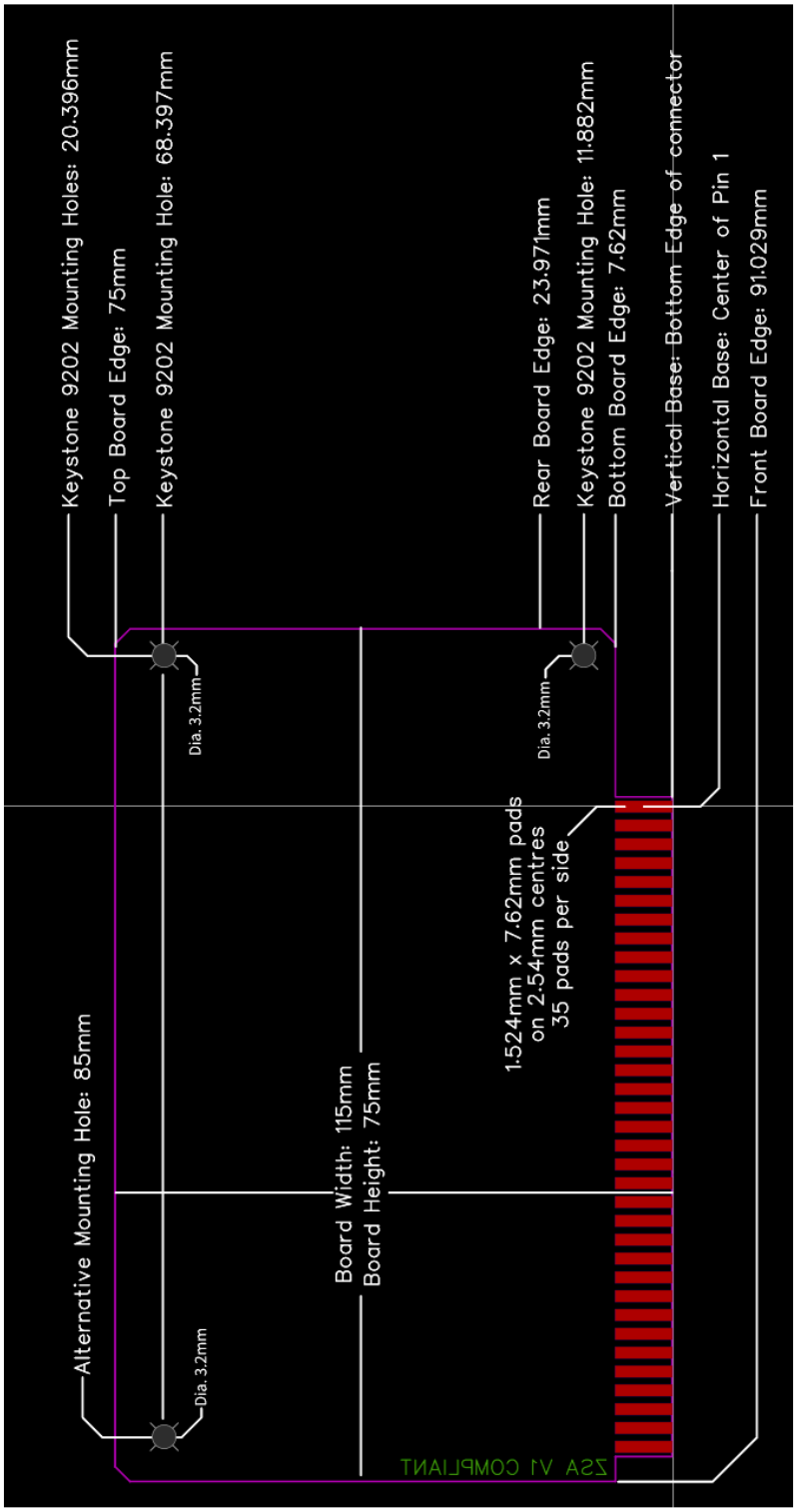

Figure 1: ZSA Expansion Card Specifications