ZSA: Z80 Standard Architecture

A Proposal for A Z80-based DIY Computer Architecture

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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.

Rationale

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:

“The standard” refers to this document.

“Backplane” means a PCB with female edge connector slots meant to provide power and signal connections to expansion cards.

“Expansion card” means a PCB which is designed to connect to the ZSA bus using the 70-pin edge connector.

“Implementation” means a physical product or design meant to be used under this standard.

"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.

"Coforming backplane" means a backplane which is a conforming implementation.

"Conforming expansion card" means an expansion card which is a conforming implementation.

"Conforming system" means a collection of one or more conforming impelemntations which collectively implement a usable computer system compliant with this standard.

"MUST" means that an implementation is not compliant if it does not meet the listed requirement.

"MUST NOT" means that an implemention is not compliant if it does what is listed in the rule.

"MAY" means that an implementation's compliance status is neither confirmed nor denied by the inclusion or absence of the designated attribute(s).

"EITHER" means that a requirment is for a "MAY" or "MUST" rule in one of two ways, separated by an "OR".

"Implementation defined" means that the specific methods and designs of a requirement are left to the designer of the conforming implementation to decide.

"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.

The "rear" edge of an expansion card is the edge which has the Keystone mounting holes.

The "front" edge of an expansion card is the edge directly opposite the rear edge.

The "top" edge of an expansion card is the edge directly opposite the male 70 pin edge connector.

The "bottom" edge of an expansion card is the edge which has the 70 pin male edge connector.

Bus Signals

The bus of this standard is carried on female edge connectors with a pin pitch of 2.54mm. Through-hole female connectors are recommended for mechanical strength. All signals are specified to use 3.3V logic levels, and are assumed to be 5V-intolerant.

The bus consists of 50 signals with a 70-pin edge connector. Each signal on the board is adjacent to a ground pin, either on the same side of the connector or directly opposite.

The pin and signal descriptions are found in table 1 below. The bus is designed with the expectation that conforming systems will use static RAM and flash ROM, rather than more complicated memory systems.

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.

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

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

A conforming expansion card MUST pass signals from /INT2IN to /INT2OUT, even if it does not use those pins itself.

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.

Presence Detect

Pin 67 of the bus connector is special: It is defined as a 1.524mm by 5mm pin, aligned to the top of the row of pins; being shorter than the other pins, /

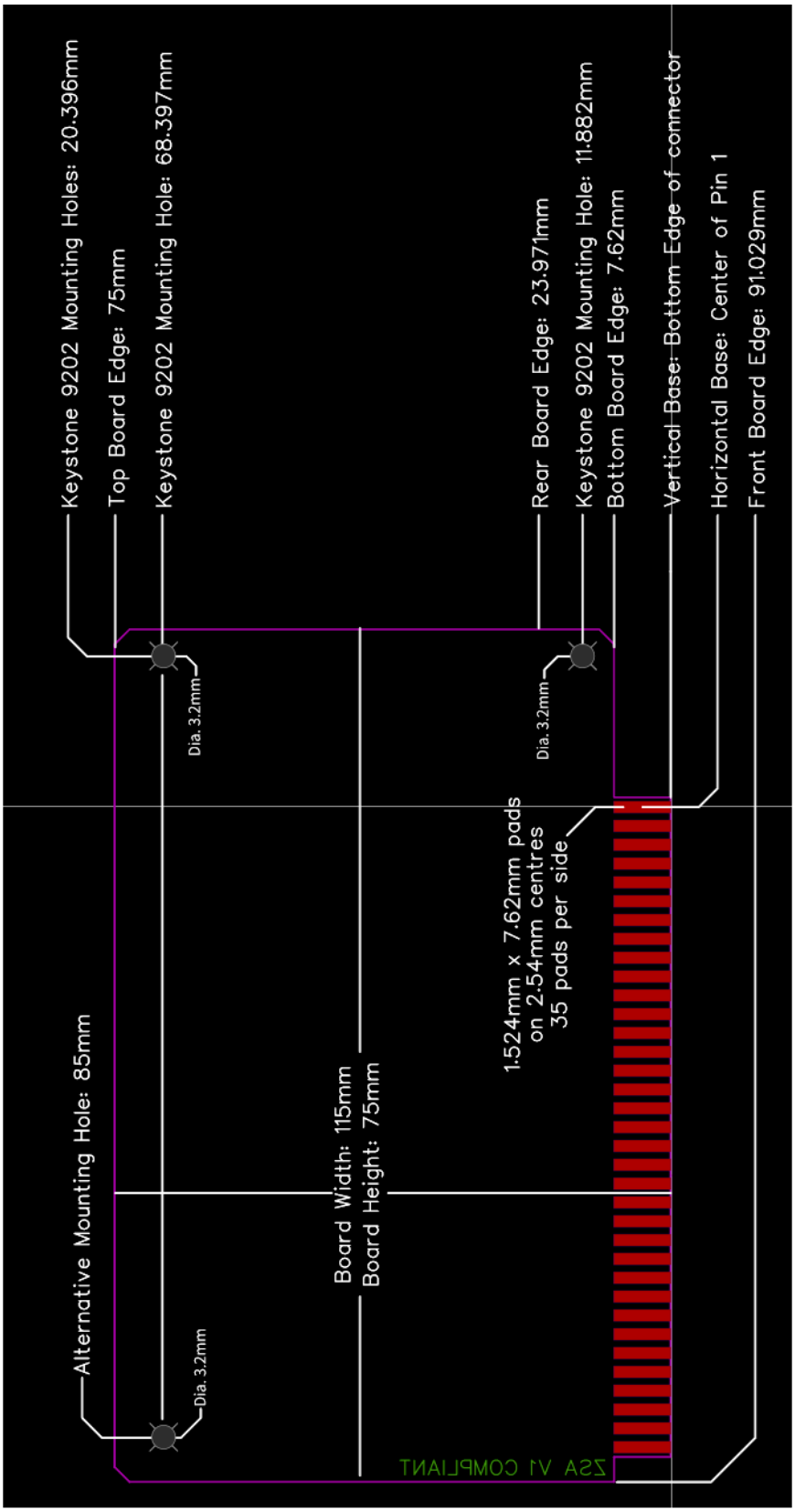

Figure 1: ZSA Expansion Card Specifications

PD will only be connected when all other signals on the bus are already connected.

The purpose of /PD is simple: To enable the backplane to determine which slots have cards in them, and which do not. Each of the backplane's /PD lines (one per slot) is pulled up to +3.3V by a 10KΩ resistor. Each expansion card pulls its /PD pin down to ground through a 4.7kΩ resistor. For each such slot, one of the bits in a latch (connected to an I/O register) is pulled low. This enables the CPU to detect which slots have cards in them.

A conforming backplane MUST implement /PD and its supporting logic for all slots it provides. Provided the state of every set of eight card slots in a backplane can be read from a documented I/O address (which MAY be user-configurable), the exact logic to implement /PD is implementation-defined.

As a secondary effect, a conforming backplane MAY also have implementation-defined logic such that connecting an empty slot's /INT2IN and /INT2OUT pins is automatic. Such a conforming backplane is then exempt from having to include pin headers or SPST switches to handle the Mode 2 interrupt daisy-chaining.

Power

A conforming backplane MUST safely provide no less than 3A of peak current on the 3.3V power rail, with no less than 2500 safe continious current.

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.

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. Such supplemental power MUST NOT be connected directly to the +3.3V rail.[2]

Physical Requirements

A conforming backplane MUST place its expansion slots at a centre-to-centre distance from each other of exactly 20.3mm.

A conforming backplane MAY be physically compatible with any existing case mounting standard. Such a backplane MUST be clearly marked as to which case mounting standard it is compatible, on the side with the conformance mark(s).

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.

A conforming expansion card MUST have board dimensions and outline matching those in figure 1.

A conforming expansion card 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.

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[2] 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.

A conforming expansion card MAY have the mating edge of the PCB chamfered.

A conforming expansion card MUST be a PCB with a nominal thickness of 1.6mm.

A conforming implementation, which is a PCB with exactly four layers, MUST have the ground rail connected to the copper fill on two inner layers, and the +3.3V rail connected to the copper fill on the outer two layers.

A conforming implementation, which is a PCB with more than two layers, MUST connect layers whose copper fill is connected to the same rail (+3.3V or ground) using a grid of vias, spaced no more than 20mm apart. For the purposes of this requirement, all plated through holes connected to the ground and +3.3V rails count as vias.

A conforming expansion card MUST have all the mounting holes in figure 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. 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.

Ports

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. Those ports, when possible, should be positioned such that existing, off-the-shelf pre-fabricated Keystone-compatible brackets can be affixed to the PCB.

Alternative Processors

A conforming implementation MAY provide a CPU compatible with an architecture other than the Z80, as a coprocessor for, or as a replacement for the Z80 CPU.

A conforming implementation, which provides a CPU compatible with an architecture other than the Z80, must meet all other requirements for standards compliance as listed in this document.

A conforming implementation which does not proviode a CPU compatible with the Z80 architecture must be clearly marked, on the same side of the PCB as the compliance marks, as to the CPU architecture provided by the implementation.

A conforming system MUST have one or more Z80 compatible processors, and MAY have zero or more alterntive processors.

A conforming implementation which provides a non-Z80-compatible CPU MUST provide a publicly documented method for mediating access to the bus between the Z80 and alternative CPU(s).

Licensing

The license terms under which a conforming implementation are released are not specified by the standard.

Conforming implementations MUST carry the mark [MARK TEXT TBD] on the side facing pin 2 of the expansion connector in the case of an expansion card, or on the top-facing side in the case of a backplane.

Conforming implementations MAY carry the [LOGO NAME TBD] graphic on either or both sides of the PCB.