Flatbed Design Specification

Revision 0.01

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1. License

2. Scope

This document defines the technical specifications for the Flatbed 48V Rack to 12V IT Payload Adapter ("Flatbed") used in Open Compute Project OpenRack V2.0 ("ORv2") systems.

The intention is to provide a set of high-level requirements for Flatbed Tray Sub-Components that ensures compatibility with the ORv2 rack standard and datacenter environmental constraints (primarily thermal). In addition, the Flatbed partitioning of power and cooling control is intended to present a common interface for monitoring and control loop software development within an OpenBMC framework running on the Flatbed tray IT Gear Payload.

This specification does not attempt to completely define the detailed implementation of Flatbed tray designs or submodules, recognizing that many distinct (but compliant) designs may be required to support the desired diversity of Payloads and deployments.

Overview

The Flatbed 48V Rack to 12V IT Payload Adapter is used to provide a standardized method of supporting both standard-compliant motherboards (such as ATX/microATX or Open Compute Project) and certain proprietary IT payloads within an ORv2-compliant rack with 48V internal power distribution.

A 48V-native power distribution within the rack can provide the opportunity for increased end-to-end power conversion and delivery efficiency, while allowing disaggregation of power conversion and battery backup functions from individual servers. This in turn can lead to higher resource utilization and lower integrated rack cost by better matching available power to load requirements. Rack power train components can also be serviced without affecting individual server operation.

However, the majority of currently available servers and other IT payloads require 12V inputs.

Flatbed ***streamlines*** the use of both pre-existing industry standard servers and new, novel 12V payloads in a 48V rack architecture well suited to large warehouse-scale datacenter deployments. Both HW and SW re-use is enabled by providing a "toolkit" to bridge between IT Gear payload and the datacenter ecosystem using defacto- and industry-standard interfaces (I2C, PCIe, ORv2, etc.).

Flatbed provides a ***migration path*** for datacenters to move to a 48V rack-level power distribution architecture to better accommodate future high-power rack loads, while still supporting proven 12V IT Gear payloads. By forming a "wrapper" around existing payloads, existing or future 48V-to-PoL powertrain payloads can also be integrated in the same rack in a non-homogeneous fashion.

Design Outline

A Flatbed IT Gear "tray" or "sled" is comprised of several sub-components, generally selected from a toolbox of general-purpose adaptors. The ORv2-compliant sheetmetal tray provides an interface to the mechanical features of the ORv2 rack and physical support for the other components. As an example, these components will include the following:

- The IT Gear payload
- A "Tractor" PCBA used as a power adaptor and as an interface to tray-level fans and thermal sensors
- Fans, cooling shrouds, and heatsinks to implement cooling of the payload
- Cabled interconnect between the individual subcomponents

The Flatbed tray can be of any width, depth, and height supported by the ORv2 specification.

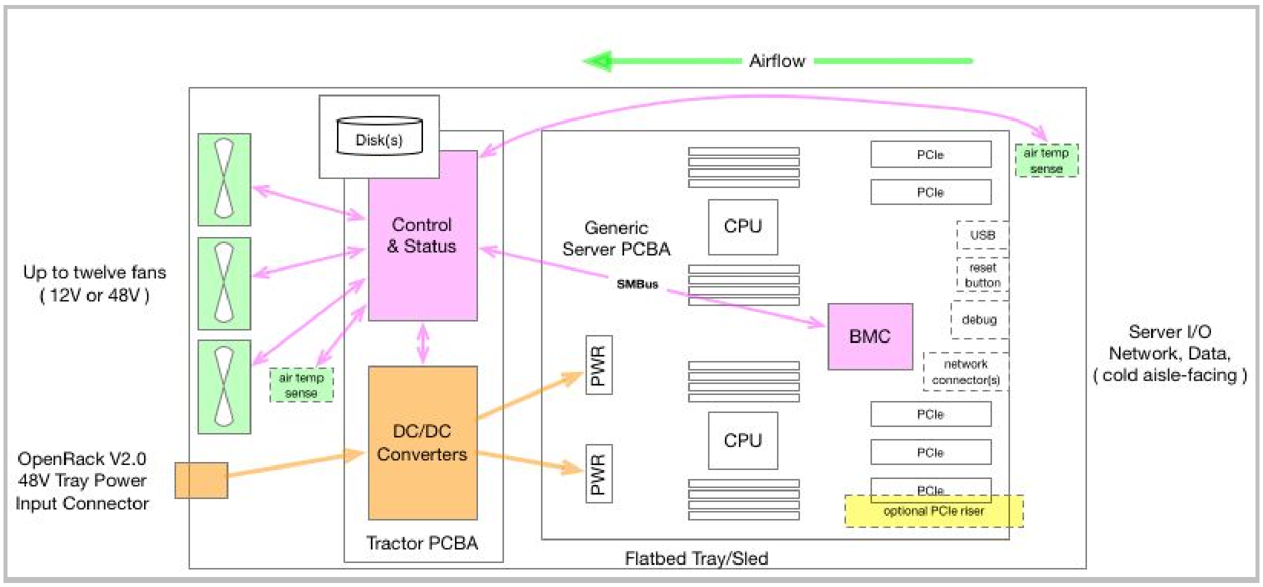


Figure 1: Generic Flatbed Tray

The IT Gear payload is typically a server motherboard populated with CPU(s), memory, NIC(s) and any other communications interface cards. Any I/O for users or cabled connectivity to other gear is located at the front of the tray. Cooling airflow is from the front to back of the tray; component orientations and placements that support this airflow direction are strongly recommended.

The Tractor PCBA provides power conversion from the ORv2 48V tray connector to the IT Gear Payload. Different Tractor PCBAs can be optimized for cost, capability, and tray width/depth. A minimum subset of Tractor PCBA features will include tray-level thermal controls and power status/consumption monitoring.

Cooling shrouds and component heatsink designs are expected to vary by payload and be closely tied to the actual IT Gear payload requirements, as well as the environmental envelope of the targeted datacenter(s). Flatbed tray height may vary between use cases to accommodate cooling solutions with the desired performance and lifetime TCO (Total Cost of Ownership).

Subcomponents in the Flatbed tray are connected by cable assemblies to maximize flexibility and re-use of the adapter PCBA sub-designs.

3. Rack Compatibility

Flatbed is designed to function in an OCP ORv2.0-compliant rack with 48V power distribution. The Flatbed tray and mechanical features shall be compatible with the OCP ORv2 specification (of the applicable revision level).

Flatbed supports a variety of payload IT tray widths and heights. Flatbed can be designed to fit any allowable rack depth; however, many design details are intended to ease implementation in the ORv2 "modular shallow" IT Gear depth of ~660mm (rack depth nominally 762mm [30.0in] from front to back).

Flatbed requires "front to back" airflow across the IT Gear payload and other supporting PCBAs in the tray, compatible with ORv2 racks.

Flatbed trays shall comply to the OCP ORv2 specification for IT Interconnect to the 48V BUSBAR (ORv2.0 sections 5 & 6), including interconnection, power and electrical specifications, and safety & compliance. Optional features and target capabilities outlined in the ORv2.0 spec remain as such in the Flatbed implementation.

Flatbed does not support the ORv2 12V power distribution interface (as of revision level TBD).

4. Flatbed TRAY Thermal Design Requirements

The aggregated components of the Flatbed tray shall support operation of the paired IT Gear payload within the datacenter thermal environment. This may require different thermal designs depending on payload power levels and the selected form factors of the Flatbed tray. The Flatbed specification does not require a specific cooling design, and can support a variety of heatsinking technologies, including both air and water cooling.

For example, a Flatbed server with tray of height 1 Open U (ORU) may require heatpipe or thermosyphon heatsink designs, whereas a lower power server in a tray height of 2 ORU may be adequately cooled by simple passive metal heatsinks and fairings.

4.1 Data Center Environmental Conditions

Individual end users will require operation over different environmental conditions. The following Flatbed tray system-level parameters must be defined by the end user.

- Operating temperature range
- Operating humidity range
- Maximum operating elevation
- Air Temperature rise at a TBD reference pressure drop

4.2 Server Operational Conditions

Thermal compliance reports for each Flatbed & Payload integrated system shall include one or more of the following:

- Industry-standard or custom load test benchmarks used during thermal characterization
- Individual measured component power levels during thermal characterization (CPU power, DIMM power, etc.)

4.3 Thermal Kit Requirements

Thermal kits are strongly encouraged to utilize PCBA mounting features provided for CPU sockets in the CPU vendor reference designs for heatsink attachment.

Thermal kits are required to meet Flatbed flammability and materials safety and compliance requirements. (Sections xxx)

Thermal kits must provide thermal monitoring attachment points adequate to mount I2C-interface temperature sensor for the following:

- Inlet air temperature
- Exit air temperature for any independent “zones” or plenums at the air exit (upstream of any tray fans at the rear edge of tray)
- Any additional air temperature zones which thermal simulation or lab measurement shows to be significantly independent of exit air temperature

Note: Payload and Tractor PCBA critical components shall have die-level or PCBA-level temperature sensors as appropriate to allow the Payload BMC to manage the Flatbed tray-level thermal control loop.

5. Tractor PCBA Physical Specifications

5.1 Tractor Adapter PCBA Block Diagrams

The Tractor PCBA primarily provides power conversion & monitoring, fan control, and temperature sensor interfaces in Flatbed.

Two conceptual block diagram examples of Tractor PCBA designs which can fulfil the specification requirements are shown below:

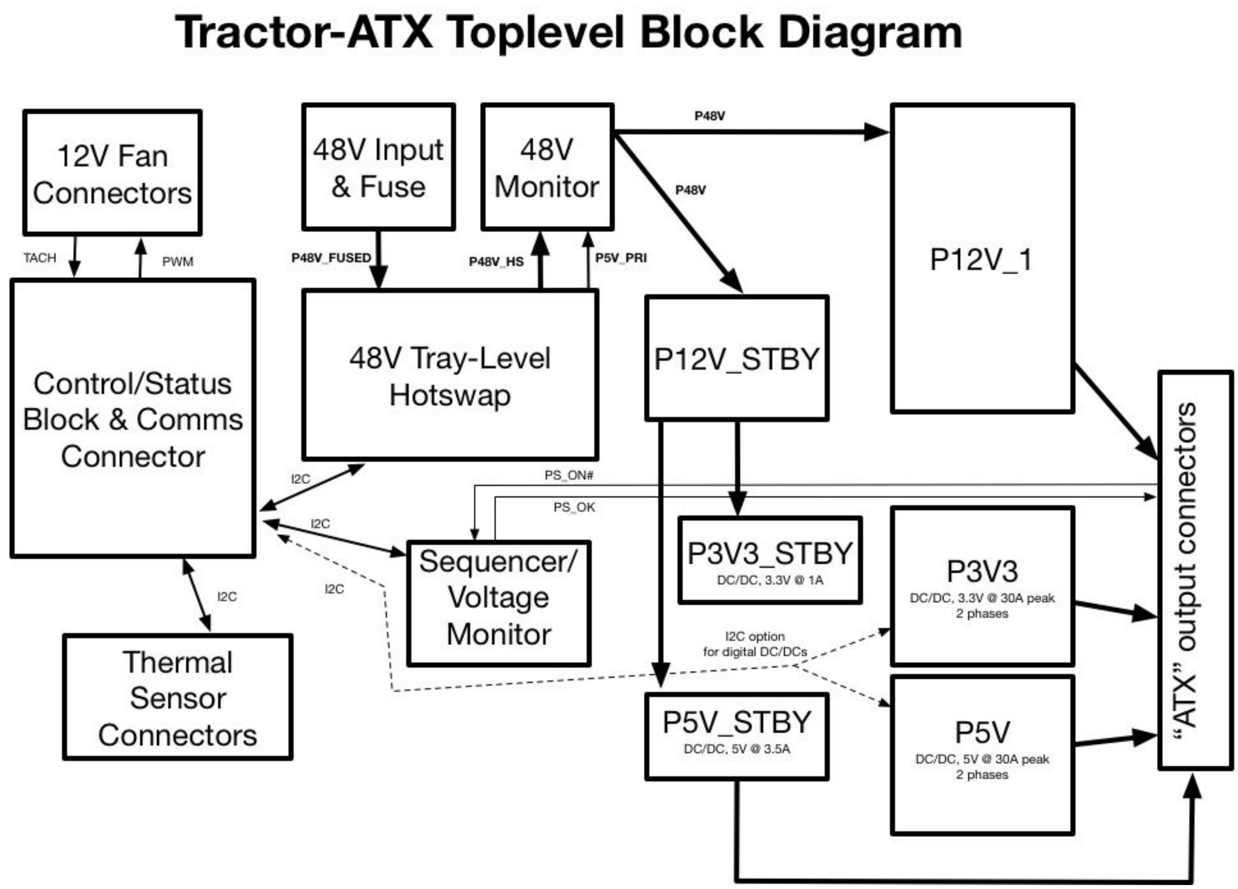


Figure 2: Tractor-ATX Conceptual Block Diagram

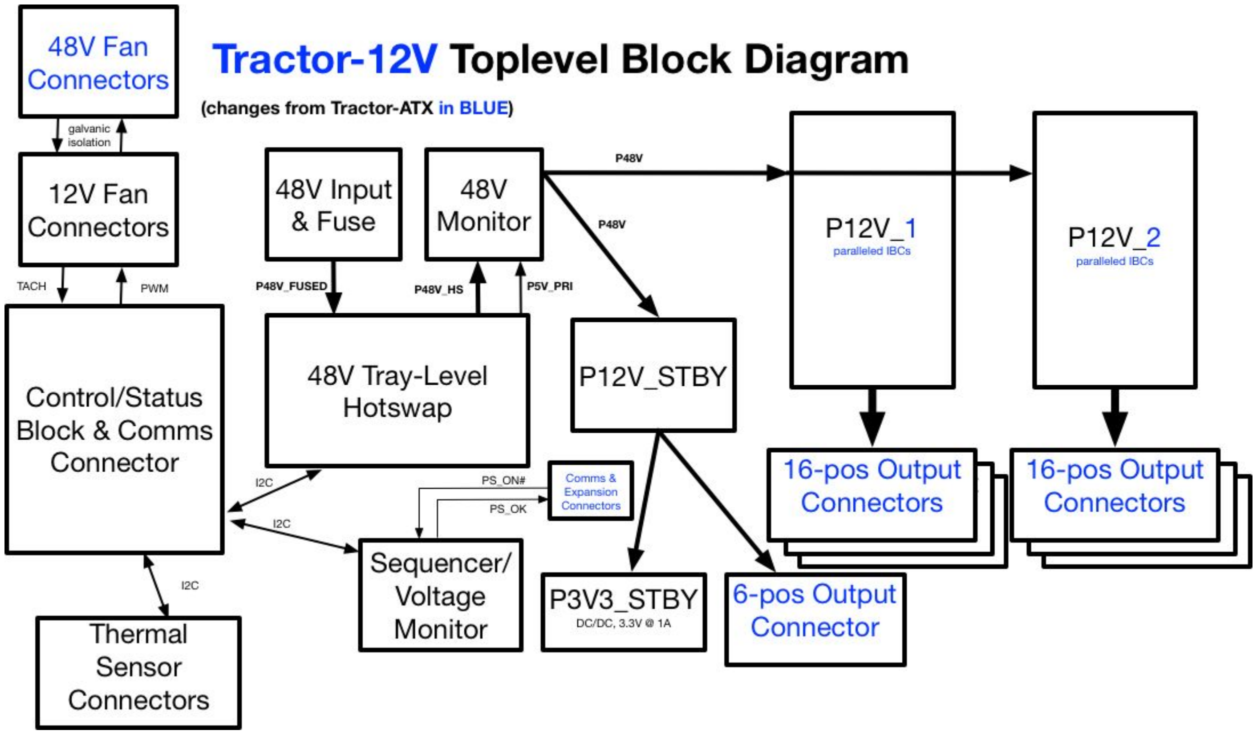


Figure 3: Tractor-12V Conceptual Block Diagram

5.2 Placement and Form Factor

The Flatbed specification does not enforce a single allowed placement or form factor for any sub-component, including the Tractor PCBA. However, the placement of sub-components within the tray must comply with applicable ORv2 specifications for IT payloads, and the tray-level thermal requirements detailed in Section xxx.

5.3 PCB Stack-Up

Flatbed IT Gear Payload PCBAs and other adaptor PCBAs (such as the Tractor PCBA) may use any stackup which supports the high-level requirements, including electrical performance, safety, and compliance.

6. Tractor PCBA Control and Status Sub-System

6.1 Comms I2C Interface

The Payload BMC is intended to utilize the Tractor PCBA as a slave resource for monitoring and controlling the Flatbed tray power and thermal operating point. To present a relatively consistent and uniform hardware abstraction to BMC firmware across multiple payloads and tray designs, the Tractor PCBA has a single control and status interface connection through a cabled I2C link to the Payload BMC. This link is subsequently referred to as the “Comms” interface.

This I2C link is fanned out to the various Tractor PCBA resources through a multiplexing scheme. Either a discrete I2C multiplexer chip or a small uC-based interface may be used to implement the fanout from the Tractor PCBA Comms interface connector to the various I2C resources on the Tractor PCBA (power monitors, fan controllers, etc).

Tractor PCBA interrupt aggregation via a single I2C expander is recommended to decrease interrupt handling latency, if interrupts (SMBus ALERT) are implemented.

The Comms connector shall provide a reset pin, dedicated to any I2C-controlled multiplexers to assist in recovery from potential stuck-bus failures. This reset pin shall be pulled to a non-asserted state on the Tractor PCBA. The Flatbed Payload BMC may control this optional reset via a spare BMC GPIO pin if available.

Some Tractor PCBA designs may have high capacitive loading on the I2C buses. Tractor shall use I2C multiplexers or repeaters if necessary to ensure:

- The combined capacitive loading with the with the expected Comms cable assembly is less than the I2C bus specification of 400pF
- The maximum transaction speed is at least 100KHz

TBD: Do we remove reference to the address translation below in the figure and following text? I vote keep it in as a recommendation.

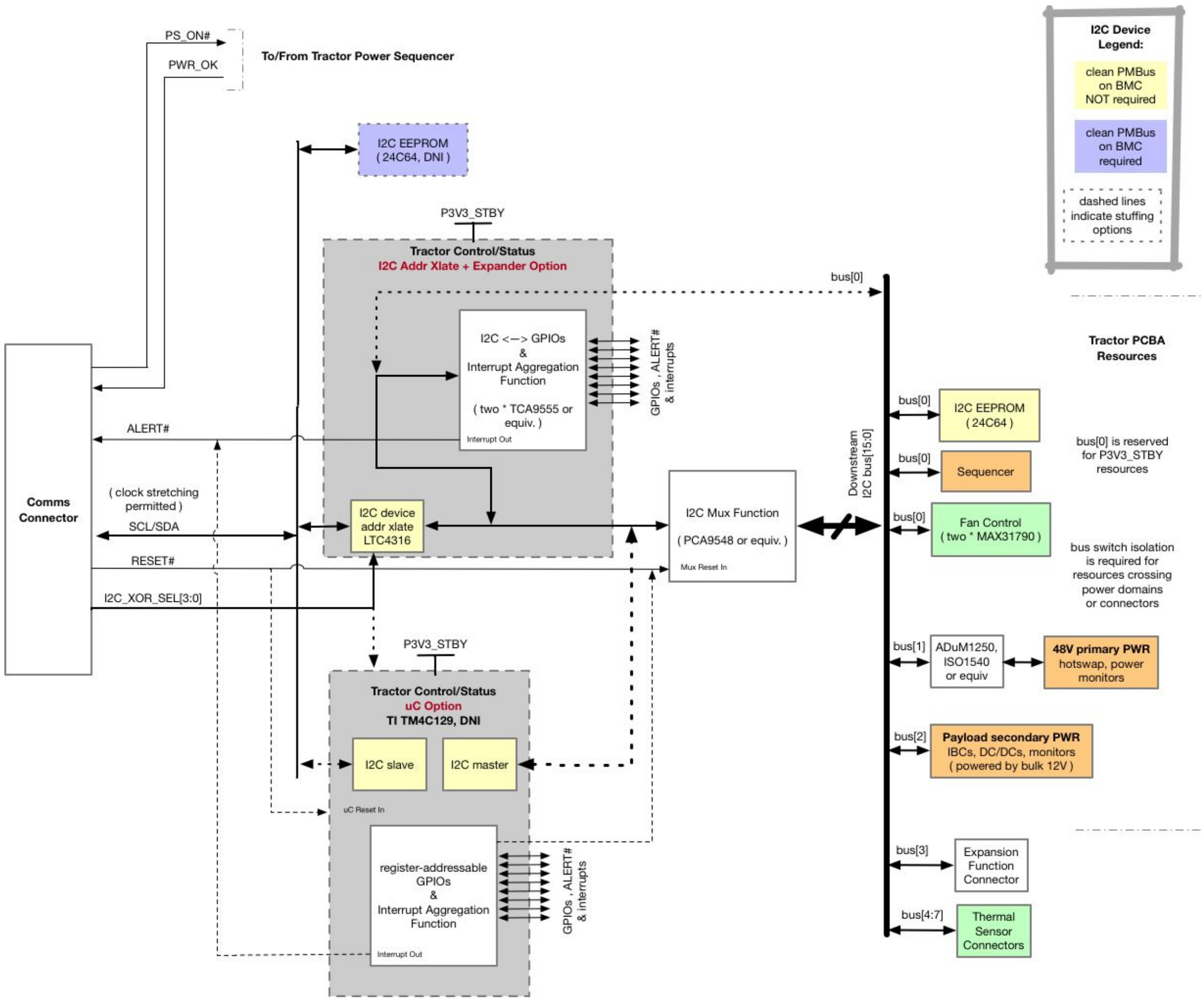


Figure 4: Recommended Tractor PCBA Control and Status Implementation

6.2 I2C Device Address Translation

The Tractor PCBA may experience I2C bus device address conflicts with accessible (ie., connectorized) I2C buses on the Payload BMC. It is recommended to provide an option for I2C device address translation immediately downstream of the Comms connector.

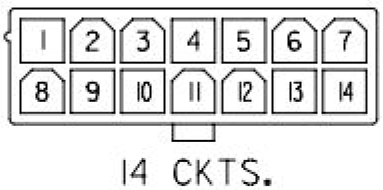
6.3 Comms Connector and Cable

The Comms interface cable is expected to be up to approximately 30" in length.

A shielded 24AWG cable bundle is recommended; this should result in a capacitive loading of approximately 15pF/foot. The I2C signals shall be shielded, with the shield drain connected to the Payload GND. Other signals may be included within the same shield, if they are predominantly static during I2C transactions (PWR_ON#, PS_OK, etc).

The Tractor PCBA will have a 14-pin 3.00mm pitch MicroFit Wire-to-Board Header (Molex 43045-1413, or equivalent) connector.

Pin #	Signal	Notes
1	SDA	To/from payload BMC
2	SCL	To/from payload BMC
3	GND	For harness to payload BMC SMBus header
4	ALERT#	To payload BMC
5	PS_ON#	ATX/EPS12V emulation (weak pullup to P3V3_STBY on Tractor), input
6	PWR_OK	ATX/EPS12V emulation, output
7	GND	For harness to payload power control header (if separate)
8	RESET#	Strong pullup on Tractor to P3V3_STBY. Resets Tractor PCBA I2C muxes and/or Tractor uC. May be driven by a payload BMC GPIO/Spare signal if available.
9	GND	For RESET# and/or SPARE and/or I2C_XOR_SEL signals, in harness to appropriate payload header.
10	SPARE0	
11..14	I2C_XOR_SEL[3:0]	Selectively short to GND in harness, controls Tractor PCBA I2C address XOR translation for a given Flatbed Payload. Use a wire AWG smaller (by #4) than max allowed in connector crimp to allow multiple wires to be crimped to a single GND (pin 9).



6.4 Programmable Devices and Configuration EEPROM

The Tractor PCBA shall include a reprogrammable EEPROM (24C04 or equivalent) to be used for recording system configuration information.

As per the ORv2 Tray firmware management requirements, any Tractor PCBA programmable or field-configurable devices must be reprogrammable via the I2C interface, with the hardware hooks to implement a backup/verify/fallback scheme for firmware upgrades.

6.5 TBD additional details/requirements….

7. TRAY Rear Power I/O and Tractor PCBA Power Path

7.1 Overview of Footprint and Population Options

The Tractor adaptor PCBA must support a wide variety of Payloads. This specification outlines two distinct configurations intended to support most currently available off-the-shelf server motherboards:

- Tractor-ATX
  - Power outputs and functionality emulating ATX/EPS12V “silverbox” power supplies
- Tractor-12V
  - Power outputs for 12V-only servers
  - Two separate 12V bulk power domains with stuffing-selectable capacity (240W to 2KW per domain)
  - One 12V_STANDBY power supply output, capable of up to 4A

7.2 Rear Side Connectors

Flatbed trays must provide a floating rear power entry connector (aka “busbar clip”) to mate with the horizontal IT Tray Shelf 48V busbar. This rear power connector supports live insertion and extraction (hotswap) and shall be compliant to ORv2 specification.

7.3 Intra-Tray Power Interconnect

Board-to-wire connectors and cable harnesses are used to connect Tractor power outputs to the Payload PCBA power inputs. Molex Minifit-series connectors compliant with the ATX and/or EPS12V power supply standards are recommended. The connectors must offer a positive retention latch.

7.4 Tractor Power Requirements

The Tractor PCBA shall support all electrical requirements listed in the ORv2 IT Tray specification. In particular, it must include the following details:

Tractor shall include input fusing and an input hotswap/softstart circuit capable of providing safe live insertion and extraction. It must comply to the operating voltage ranges and provide noise immunity to power bus transients and as detailed in the ORv2 IT Tray specification.

The tray-level input 48V power bus shall include monitoring and telemetry capability via the Tractor Comms interface:

- Voltage accuracy of better than 1.5%
- Current accuracy of better than 2.5%
- Derived power measurements shall have an accuracy of better than 3.5%
- Sample rates of up to at least 10 samples/second shall be supported.

Each Tractor PCBA power output to the payload shall include monitoring and telemetry capability via the Comms interface:

- Voltage accuracy of better than 1.5%
- Current measurement is optional, accuracy of better than 2.5% is recommended
- Sample rates of up to at least 10 samples/second shall be supported.

The Tractor PCBA shall support power cycle commands under software control via three alternative paths:

- The ATX-style PS_ON# signal from the payload BMC to the Tractor sequencer (STANDBY power supplies remain energized)
- A monostable one-shot function driven via I2C access from the payload BMC to the Tractor hotswap (STANDBY power supplies turn off, then on again)

8. Fan Power and Control

The Tractor PCBA shall provide independent fan connectors, independent fused power, independent PWM control, and independent Tachometer status for each IT Flatbed Tray fan. The number of fans per tray will vary depending on application; provisions for as many as twelve independent fans are recommended for maximum width ORv2 tray designs. The fan connectors must offer a retention feature or positive latch.

The Tractor PCBA shall provide a local RPM control loop for the fans. The Payload BMC is expected to issue RPM control commands to Tractor over the Comms I2C interface.

- Fan PWM signal input duty cycle error shall be less than 5% when measured at an operating fan connector at a 22.5KHz nominal PWM frequency.
- Fan Tach signal monitoring accuracy shall be within 5%.

Support for 48V fans is strongly encouraged on high-power IT tray designs. A PWM holdoff path which clamps all fan PWM signals to 0% duty cycle during the Tractor power train on-sequencing period is recommended. Non-volatile storage of default powerup fan PWM settings is optional, but desirable.

The Tractor PCBA shall provide appropriate fusing upstream of the power pin(s) of each fan connector. A typical example for a 12V fan would be a 3A to 5A fast-blow fuse.

9. Thermal Sensors

The Tractor PCBA shall provide connectors for at least four independent I2C interface thermal sensor modules. The connectors must offer a retention feature. Each connector shall provide:

Signal	**Notes**

3.3V STBY	Same supply as used by Tractor PCBA Control/Status block, up to 10mA
SCL	10K pullup to 3.3V_STBY
SDA	10K pullup to 3.3V_STBY
GND	

10. Tractor PCBA Expansion Connector

Tractor will provide a single expansion connector PCB footprint. This footprint will accommodate a variety of connector types (board-to-board, ribbon, wire-to-board) and be a composite footprint. The PCBA footprint will be a standard plated thru-hole 10pin 25-mil square post vertical 100mil pitch double-row header. Example stuffing options include:

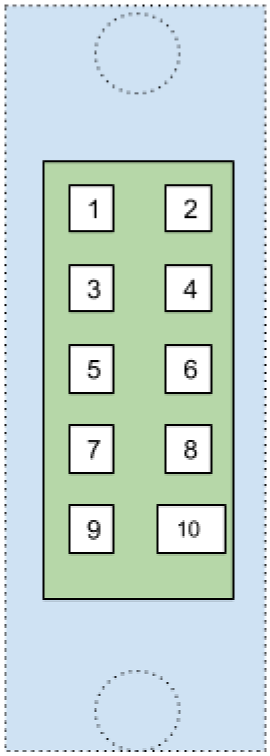
A. Tyco Connectivity 5499910-1 (shrouded + keying, ejector latches)
B. Molex 90130-1210 (shrouded + keying, no latches)
C. Samtec HW-TH series (board-to-board stacker options in various heights)

Clearance areas (no routes, no components) must be provided at the ends of each connector adequate for:

- Locking cable retention latches, approximately 300 mils past the ends of the pinfield
- 6-32 hex machined metal standoffs to a PCBA mezzanine mating with the tractor expansion connector(s)

Overlapping footprints are suggested for this area, as pictured below. ***Please note that the pinout shown has pin 1 in the upper-left corner, similar to the standard ribbon cable pinout (Tyco 5499910-1). The pin 2 of the Molex 90130-1210 connector instance on the schematic must connect to pin 1 of the the Tyco 5499910-1 connector instance.***

Final PCBA Footprint Dimensions TBD, specification will provide a supporting .dxf or equivalent file.



Tyco Pin Number	Molex Pin Number	Signalname	Notes
1	2	P3V3_EXPANSION	Provide a stuffing option to use P3V3 (fused) or P3V3_STBY
2	1	P3V3_EXPANSION	Provide a stuffing option to use P3V3 (fused) or P3V3_STBY
3	4	EXP_SMB_SDA	
4	3	GND	
5	6	GND	
6	5	EXP_SMB_SCL	
7	8	GND	Second function: USB shield/GND
8	7	EXP_GPIO1_RSVD	Reserved for Future Use (RFU)
9	10	EXP_GPIO2_RSVD	RFU, second function: USB-
10	9	EXP_GPIO3_RSVD	RFU, second function: USB+

11. TRAY Regulatory Compliance

Each tray-level integrated Flatbed design must comply with the following environmental and regulatory specifications, reference below in the Flatbed Payload Requirements Section XXX, Standards Compliance. (entire section applies..).

12. TRAY Environmental Requirements

12.1 Vibration & Shock

Each tray-level integrated Flatbed design must pass a TBD level of shock & vibe testing as an unpowered assembly with no damage.

Additionally, and vendor-provided shipping containers shall be tested with the Flatbed design to TBD specifications.

12.2 Regulations

TBD

12.3 Labels and Markings

TBD

13. TRAY Reliability and Quality

In general, reliability, quality, and materials requirements are specific to the individual sub-assemblies comprising a Flatbed IT Gear Tray design, and will be covered in separate sub-assembly detailed specifications.

~~13.1 Specification Compliance~~

~~13.2 Change Orders~~

~~13.3 Failure Analysis~~

~~13.4 Warranty~~

~~13.5 MTBF Requirements~~

~~13.6 Control Change Authorization and Revision Control~~

~~13.7 PCB Tests~~

~~13.8 Secondary Component~~

13.9 Prescribed Materials

In general, materials and design derating requirements are specific to the individual sub-assemblies comprising a Flatbed IT Gear Tray design, and will be covered in separate sub-assembly detailed specifications.

~~13.9.1 Disallowed Components~~

~~13.9.2 Capacitors & Inductors~~

~~13.9.3 Component De-rating~~

14. Flatbed PAYLOAD Specification Requirements

The Flatbed Payload (IT Gear, such as a server motherboard) shall meet certain minimum requirements.

14.1 Power Inputs

- The Payload shall be powered by one of the following two options:
  ATX/EPS12V specification-compliant
  - +12V/+5V/+3.3V/+5V_STBY
  - Up to 950W total
  - Standard sequencing and control/status (PS_ON#, PWR_OK)
- 12V+12V_STBY
  - One or two separate 12V domains (12V_1, 12V_2)
  - Up to 2000W per domain
  - Up to 4A on 12V_STBY
  - Main 12V power drain must be <25A until PWR_OK assertion (asserts within 250mS after 12V initially rises above 10V)

14.2 I2C/SMBus Requirements

Any I2C or SMBus buses accessible on Payload PCBA connectors shall operate at 3.3V levels, including local pullups and any local active pullup devices or I2C bus multiplexers.

These buses include PCIe connector SMBus, as well as other connectors for power supply PMBus communication and miscellaneous expansion boards (such as the Flatbed Tractor PCBA).

14.2.1 Address Space on Expansion Connectors

The I2C address space on all connector-accessible buses must be “clean”, having no devices other than a master and optionally an I2C multiplexer to isolate other devices addressed by the same master. See the illustrations below for examples:

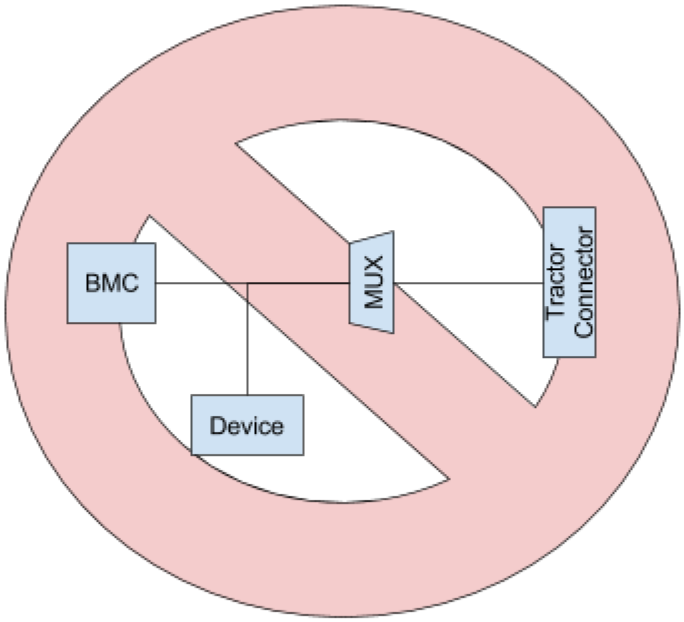


Figure 5: Example of bad I2C configuration with “unclean” address space

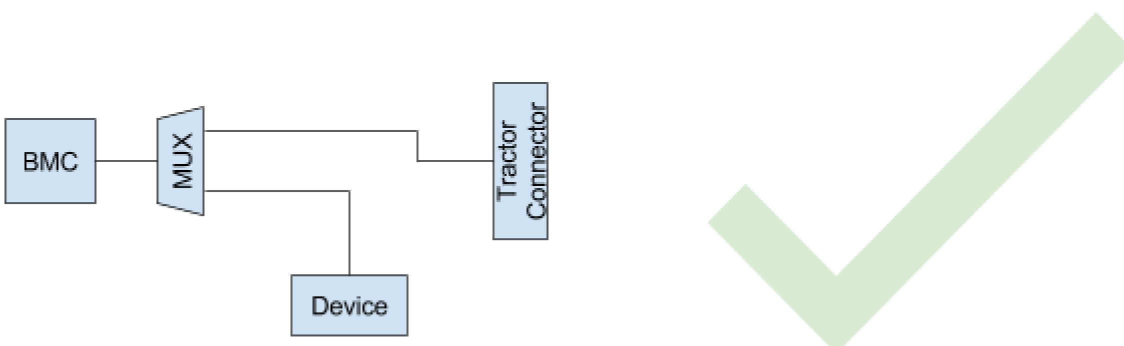


Figure 6: Example of good I2C with “clean” address spaces

This guideline includes each PCIe and expansion slot, which must have a clean I2C address space. This can be accomplished with MUXes or switches as shown above. No addressable devices other than an I2C MUX with one of the addresses listed below may be present on the bus.

14.2.2 I2C Multiplexer Usage

The following 7-bit addresses may be used for MUXes on the motherboard:

- 0x71
- 0x74
- 0x75
- 0x77

Note: I2C addresses shown are all 7-bit. For example, address 0x75 is:

A6	A5	A4	A3	A2	A1	A0	RW
1	1	1	0	1	0	1	X

All I2C MUXes and/or switches must be soft disable-able, or must have a NULL switch port (no outputs enabled) which can be activated when the MUX is not active.

There may be no more than one in-band addressable MUX before each connector.

It is recommended to avoid the use of any discrete I2C MUXes and use separate master controllers on each Payload I2C bus routed to an accessible connector.

14.3 BMC

The Payload BMC must be able to boot Linux.

Note: OpenBMC is intended as the primary software baseline for Flatbed tray-level control. Support of OpenBMC is strongly recommended.

The Payload shall support BMC image updates via one or more of the below methods:

- Update via REST API
- Update via physical replacement of BMC/ROM device.

The BMC shall be capable of updating the Payload BIOS image.

14.3.1 BMC NC-SI

The Payload shall have a 100Base-TX RJ45 connector suitable for NC-SI use by the BMC.

14.3.2 BMC I^2C

The Payload must provide a header with an I2C bus and GND/shield for communication with the Flatbed Tractor PCBA. This I2C bus should have pullups to the same Payload 3.3V power supply used by other BMC I/O.

The BMC I2C master must have I2C specification-compliant drivers (slew rate limited) and receivers (glitch rejecting).

This I2C port must be connected to the BMC, and it must have a “clean” address space as described in the general I2C/SMBus Requirements section.

No addressable devices other than an I2C MUX with one of the allowed addresses listed may be present on the bus when communicating with Tractor. Other downstream devices may be accessed by the same master as long as they are behind different MUX ports.

See section 14.2 for I2C requirements.

14.4 Timebase Accuracy

The Payload should be capable of creating timestamps with short-term accuracy equal to or better than 1.5ppm over the full operating temperature range of the Flatbed tray assembly.

A Payload PCB schematic and layout that provides an appropriate TCXO footprint as an alternative clock oscillator stuffing is recommended.

The following devices must receive a clock of this accuracy level:

- CPU(s)
- For Intel server architectures: PCH

14.5 PCIe Slots

The Payload PCIe slots shall support standard pin usage where possible, including RSVD pin usage.

Re-purposed use of the RSVD pins outside of industry standards or pending standards is generally discouraged (examples may include link/lane splitting, USB). An example of a widely accepted RSVD pin re-mapping is the PROCHOT and PRWBRK# functions.

Additional mechanical requirements on PCIe slots are listed in the Mechanicals section.

14.6 BIOS

The current definition of Flatbed is generally independent of BIOS implementation details.

14.7 Mechanicals

Airflow

- Front to back
- DIMMs, PCIe cards, heatsink fins long edges shall all be oriented in the same direction, along the airflow direction.

Dimensions

- Height agnostic. Minimum height is 1 Open Rack Unit (ORU).
- Max width 495.3mm (19.5”)
- Max depth 404.0mm (15.9”) for shallow ORv2 (762mm Rack depth)
- Suggested max depth 544.0mm (21.4”) for deep ORv2 (1048mm Rack depth)
- Mounting hole max spans, hole sizes TBD
- Backside component maximum height 10mm (394 mils) TBD
- PCBA thickness
  - 62 mils to 120 mils nominal thickness
  - no more than +/-15% maximum deviation from nominal specified thickness

Preferred Layouts

- PCIe Slots
  - PCIe at the “front” edge of PCBA, facing the cold aisle.
  - Pitch of PCIe cards no closer than standard spacing
  - Preferred pitch of leftmost and rightmost PCIe slots is 1.5x standard or more to support taller card heatsinks
- CPU socket attachment points & details on the PCB should follow the CPU vendor reference design(s) closely to ease the re-use of standard heat sink components
- Power input connector(s) preferred location at rear for shortest cable length to Tractor PCBA
- Comms connector for SMBus (to Tractor PCBA) should be located within a 24” manhattan route distance from the “left rear” corner of the Payload PCBA, as defined by the front-to-rear airflow direction constraint.
- User connectors and I/O such as LEDs, pushbuttons (reset, etc.)
  - Preferred on same edge as PCIe (front edge, cold aisle, air intake)
  - Location is at a much lower priority than PCIe (do not move PCIe slots to rear to make room for USB at front edge)
    - If user I/O is not located at “front” edge, connectorization which supports cabled I/O “dongles” is recommended.

14.8 Thermals

The Flatbed Payload must support a thermal management design which enables Flatbed tray operation within the thermal environment detailed in Section XXX.

The Payload shall include local temperature sensing of critical die and/or component temperatures, accessible by the BMC.

14.9 Standards Compliance

Materials

The entire Payload board(s) shall be RoHS-6 compliant.

Basic Compliance Requirements

Safety

The equipment must meet all applicable safety requirements and certifications when operating under maximum normal load conditions. Applicable standards may include the following:

- UL/CSA/IEC/EN 60950-1
- UL/CSA/IEC/EN 62368-1

EMC

The equipment must meet the following requirements when operating under typical load conditions and with all ports fully loaded:

Emissions

6dB margin from the FCC Class A limit is required for all emission test, both radiated emission and conducted emission. When the EUT is DC powered, DC line conducted emission test is required.

Primary EMC Standards apply to emission test include, but not limited to

- FCC Part 15, Subpart B
- EN 55022: 2010 / CISPR 22: 2008 (Modified)
- EN 55032: 2012 / CISPR 32: 2012 (Modified) - Effective 05/03/2017
- EN61000-3-2: 2006/A1 : 2009/A2 : 2009
- EN61000-3-3: 2008

For DC power related testing, when applicable GR 1089 / GR 3160 may be referenced.

Immunity

Primary EMC Standards apply to immunity test include, but not limited to

- EN 55024: 2010 / CISPR 24: 2010 (Modified)
- CISPR 35: 2014 (current publication: CISPR/I/463/FDIS 2013-12)

Each individual basic standard for immunity test has its specific passing requirement as illustrated below. When the EUT is DC powered, immunity test involves disturbance applied to power line apply to the DC input power.

- EN61000-4-2 Electrostatic Discharge Immunity (6kV contact, 8kV air)
- EN61000-4-3 Radiated Immunity [> 10V/m]
- EN61000-4-4 Electrical Fast Transient Immunity (1kV power (AC), 0.5kV signal)
- EN61000-4-5 Surge AC Port (2kV CM, 1kV DM)
- EN61000-4-5 Surge Signal Port (2KV CM, 1KVDM)

- EN61000-4-5 Surge DC Port (0.5kVCM, 0.5KVDM)
- EN61000-4-6 Immunity to Conducted Disturbances [> 10V rms]
- EN61000-4-8 Power Frequency Magnetic Field Immunity (30A/m), when applicable
- EN61000-4-11 Voltage Dips, Short Interruptions, and Voltage Variations

For DC power related testing, when applicable GR 1089 / GR 3160 may be referenced.

Country Specific EMC Requirements

Most countries / region have country specific / regional EMC requirements. In addition to above listed EMC standards, the equipments shall demonstrate compliance to standards which includes, but not limited to

- CNS 13438: 2006
- AS/NZS CISPR22: 2009/A1:2010
- Industry Canada ICES-003
- VCCI V-3/2013-04
- KN 32/ KN 35
- ANATEL Resolution 242 / 323 / 442

General Compliance

Please note that “Products with the CE marking indicate compliance with the 2014/35/EU and 2014/30/EU directives which include the Safety and EMC standards listed.”

Unless otherwise noted, compliance is to the latest version of the standards listed above.

The equipment shall be designed and NRTL-C/CB certified to comply with the most current version of the standards specified above. The preferred safety agencies are CSA, UL, TUV and VDE. Please consult with the client for approval if it is desired to use a safety agency other than the customer’s preferred safety agencies. These requirements may change throughout the life of the product, and upon request by the client, the vendor shall obtain additional certifications for any other standards.

EMC Laboratory shall meet the basic accreditation requirement by A2LA or NvLAP. In addition, to obtain FCC, the EMC laboratory selected shall reside in the country which maintain MOU with FCC. Google retains the right to audit any EMC laboratory selected by vendor. The selection of EMC laboratory shall be approved by Google.

When in-country testing is required, it is important for vendor to ensure confidentiality of the product when sent for in country testing. Proper NDA shall be developed between vendor and the selected test laboratory listed by the respective regulatory agency.

Product Compliance Requirements

The equipment shall be designed and certified to comply with national standards and regulations. Below is the list of specific countries requiring product certification.

- US/Canada (NRTL/C, FCC/IC)
- EU (CE)
- International (CB Scheme)

From time to time the countries shown below (not exclusive) may be added to the list with the understanding that the certifications needed and their priority will be determined on a case by case basis.

- Taiwan (BSMI)
- Japan (VCCI)
- Australia/New Zealand (RCM)
- Brazil (Anatel)
- India (BIS)
- Korea (KC)
- South Africa (NRCS LoA)
- Saudi Arabia (CITC)