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DOCUMENT SUMMARY

This guide provides an overview of the types of chassis that are available and includes representative examples of Hybricon® solutions. It is intended to be used by system engineers, project engineers, architects, design engineers, and engineering managers. As our array of solutions is very broad, please contact us for additional options if the solutions in this guide don’t satisfy your needs. For contact information, please visit our web site: www.atrenne.com or see page 36.

INTRODUCTION

Chances are that at this stage of your system development you have already selected your software environment and defined the key elements of the backplane architecture and requirements for your payload.

As the industry’s leading supplier of rugged COTS embedded computing modules, backplanes, and chassis, Atrenne Computing Solutions is uniquely positioned to help you optimize the selection of COTS and Modified COTS (MCOTS) elements in order to minimize your risk and speed your development schedule.

No matter what your system needs comprise or how you plan to cool it, Atrenne Computing Solutions is ready to assist you with expert guidance and support from end-to-end. Whether you are building a development, demonstration, or deployable application, and whether you need it air-cooled, conduction-cooled, liquid-cooled, or something else, we can be your one-stop shop. If you prefer not to perform the integration yourself, we can even integrate rugged COTS embedded computing modules, backplanes, and chassis into an application-ready subsystem.
CHASSIS TYPES

Chassis come in many shapes and sizes, and meet a wide range of environmental, electronic, and thermal criteria. This guide explores three broad chassis categories:

1. **Development Chassis**: intended for benign and/or lab environments and can be designed for use with air-cooled payload, conduction-cooled payload, or hybrids.
2. **Rugged Air-Cooled Chassis**: intended for moderately ruggedized applications with air-cooled payload.
3. **Rugged Conduction-Cooled Chassis**: intended for highly ruggedized applications with conduction-cooled payload.

DEVELOPMENT-TO-DEPLOYMENT (D2D) SCENARIOS

In defense, aerospace, and first responder applications, System Integrators targeting highly rugged applications often utilize conduction-cooled modules because of their superior performance in harsh environments. Historically, these have often been proprietary application-specific designs, but today’s tighter budgets mean that System Integrators are increasingly turning to COTS suppliers to minimize non-recurring costs and shorten time to market. With many of their customers seeking the same thing, the result is a need for System Integrators to utilize IRAD funding to develop subsystems that are ready to demonstrate. While the deployable product often needs to be highly ruggedized (e.g. ATR form factor), this has not been practical for development and demonstration phases due to the fluidity of the design and the lead time required for an application-specific rugged chassis. Current development strategies include:

**Traditional Air-Cooled Development Approach**

System Integrators often perform early development activities using COTS commercial-grade air-cooled modules and COTS air-cooled development chassis.

**Conduction-Cooled Development Approach**

Rather than performing early development activities using commercial-grade air-cooled modules and air-cooled development chassis, customers can now perform early development activities using COTS conduction-cooled modules and COTS commercial-grade conduction-cooled development chassis.

**Development-to-Deployment (D2D) Approach**

After listening to our customers, we originated the Development-to-Deployment (D2D) approach to reduce risk, schedule, and cost for our customers. This approach enables the D2D ATR product to use the very same platform to support customers through their entire program life cycle.

We have been expanding our family of D2D chassis offerings, with new 9-slot D2D chassis models now available. Please see our website for more information.
THERMAL MANAGEMENT CRITERIA

Thermal management is a key chassis criteria that becomes particularly critical with higher power payloads (e.g. OpenVPX™). Some important thermal criteria need to be defined up-front:

- **How much power is being dissipated by the payload?** Watts per slot? Total watts? Any hot slots?

- **How is the payload cooled?** Your application may be open to one or more payload cooling approaches, including natural convection; forced air; conduction; and LFT. Other things to consider include:
  - If payload cooling is by conduction: What card edge temperature does each module require? What is the thermal resistance of the wedgelock thermal interface to the chassis rail?
  - If payload cooling is by forced air: How much cooling air (CFM) does each module require, and at what pressure drop? Can the payload be exposed to the ambient cooling air or is a heat exchanger required?

- **How is the chassis cooled?** Your application may be open to one or more chassis cooling approaches, including natural convection; forced air provided to chassis; forced air (fan in chassis); conduction (e.g. to baseplate); and forced liquid provided to chassis. Additional criteria to consider include:
  - If chassis cooling is by natural convection or forced air: What is the operating temperature/altitude envelope?
  - If chassis cooling is by forced air provided to chassis: What is the cooling air mass flow rate, cooling air operating temperature range, and maximum cooling air pressure drop allowed?
  - If chassis cooling is by conduction (e.g. to baseplate): Where are the conduction plate surface(s) located? What is the operating temperature range of the conduction plate(s)?
  - If chassis cooling is by forced liquid provided to chassis: What is the liquid coolant type, coolant flow rate, and coolant operating temperature range? What is the maximum coolant pressure drop allowed?

CHASSIS THERMAL MANAGEMENT CATEGORIES

It is important to note that the cooling type for the internal payload could be very different than the cooling type for the chassis itself; this is accomplished with various types of heat exchangers. For the purpose of this guide, Chassis Thermal Management has been broken down into five broad categories based on how the chassis is cooled:

1. Natural Convection-Cooled Chassis
2. Forced Air-Cooled Chassis
3. Baseplate Conduction-Cooled Chassis
4. Forced Liquid-Cooled Chassis
5. Refrigeration-Cooled Chassis
### Natural Convection-Cooled Chassis Types

<table>
<thead>
<tr>
<th>Chassis Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exterior fins and internal conduction-cooled</td>
<td>• Commonly ATR style for highly rugged deployed applications</td>
</tr>
<tr>
<td></td>
<td>• A popular style for rugged deployed applications</td>
</tr>
<tr>
<td></td>
<td>• Have significant cooling limitations with higher power payload and/or high altitude operation</td>
</tr>
<tr>
<td>Exterior fins and internal air-cooled</td>
<td>• May have internal fans and heat exchanger</td>
</tr>
<tr>
<td></td>
<td>• Not popular for rugged deployed applications</td>
</tr>
<tr>
<td>Internal air-cooled</td>
<td>• Ambient natural convection air currents flow directly from ambient across payload</td>
</tr>
<tr>
<td></td>
<td>• Not popular for rugged deployed applications</td>
</tr>
</tbody>
</table>

### Forced Air-Cooled Chassis Types

<table>
<thead>
<tr>
<th>Chassis Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air forced upon/through fins and internal conduction-cooled</td>
<td>• Commonly ATR style for highly rugged deployed applications</td>
</tr>
<tr>
<td></td>
<td>• A popular style for rugged deployed applications</td>
</tr>
<tr>
<td></td>
<td>• Some cooling limitations with higher power payload</td>
</tr>
<tr>
<td>Internal air-cooled payload that is cooled directly by exterior air (ambient air or air supplied to chassis)</td>
<td>• Well suited to high power payload in moderately rugged applications</td>
</tr>
<tr>
<td></td>
<td>• Commonly rackmount style for moderately rugged deployed applications</td>
</tr>
<tr>
<td></td>
<td>• Rackmount and desktop style chassis also commonly used for development</td>
</tr>
<tr>
<td>Indirectly air-cooled via air/air heat exchanger</td>
<td>• Indirectly cooled via air/air heat exchanger separating internal fan and re-circulating air from ambient air</td>
</tr>
<tr>
<td></td>
<td>• Commonly ATR style for moderately rugged deployed applications but can also be rackmount style</td>
</tr>
<tr>
<td></td>
<td>• Some cooling limitations with higher power payload</td>
</tr>
</tbody>
</table>

### Baseplate Conduction-Cooled Chassis Types

<table>
<thead>
<tr>
<th>Chassis Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exterior cold plate attachment surface(s) and internal conduction-cooled payload</td>
<td>• Commonly ATR style for highly rugged deployed applications. Some cooling limitations with higher power payload</td>
</tr>
<tr>
<td>Exterior cold plate attachment surface(s) and internal air-cooled</td>
<td>• May have internal fans and heat exchanger</td>
</tr>
<tr>
<td></td>
<td>• Not popular for rugged deployed applications</td>
</tr>
</tbody>
</table>

### Forced Liquid-Cooled Chassis Types

<table>
<thead>
<tr>
<th>Chassis Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid coolant forced upon/through fins or passages and internal conduction-cooled</td>
<td>• Commonly ATR style for highly rugged deployed applications but could also be rackmount style</td>
</tr>
<tr>
<td>Internal air-cooled payload (indirectly cooled via liquid/air heat exchanger with internal fan and re-circulating air)</td>
<td>• Well suited to high power payload in highly rugged applications</td>
</tr>
<tr>
<td>Internal conduction-cooled</td>
<td>• Commonly ATR style for moderately rugged deployed applications but can also be rackmount style</td>
</tr>
<tr>
<td></td>
<td>• Well suited to high power payload in moderately rugged applications</td>
</tr>
</tbody>
</table>

### Refrigeration-Cooled Chassis Types

<table>
<thead>
<tr>
<th>Chassis Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal air-cooled</td>
<td>• Not commonly used due to increased size, weight, power, and cost</td>
</tr>
<tr>
<td>Internal conduction-cooled</td>
<td>• Suitable for applications with extreme temperature environments, or less rugged payload</td>
</tr>
</tbody>
</table>
This section contains examples of our COTS Development Chassis, available in both air-cooled and conduction-cooled styles. The examples featured are just some of the many COTS Development Chassis we offer – for additional models and styles, contact us using the information on page 36.
HYBRICON STANDARD DESKTOP STYLE DEVELOPMENT CHASSIS FOR 3U & 6U MODULES

Versions are available for both air-cooled and conduction-cooled module styles. Several of these Hybricon chassises are designed to provide the extreme power and cooling defined by the OpenVPX standard. Contact us for Modified COTS application-specific units.

### OpenVPX Open Frame/Development Forced Air-Cooled, 6/8-slot
- **Payload:** 6U, 1"/0.8"
- **Size:** 20.68"x8.58"x14.00" (HxWxD)
- **Cooling:** >19 CFM per slot per ANSI/VITA 65 OpenVPX
- **Power Supply:** Up to 1200W

### OpenVPX Open Frame/Development Forced Air-Cooled, 6/8-slot
- **Payload:** 3U, 1"/0.8"
- **Size:** 15.43"x8.58"x14.00" (HxWxD)
- **Cooling:** >19 CFM per slot per ANSI/VITA 65 OpenVPX
- **Power Supply:** Up to 900W

### OpenVPX Desktop/Development Forced Air-Cooled Portable Tower, 6/8-slot
- **Payload:** 6U, 1"/0.8"
- **Size:** 23.27"x8.38"x14.00" (HxWxD)
- **Cooling:** >19 CFM per slot per ANSI/VITA 65 OpenVPX
- **Power Supply:** Up to 1200W

### OpenVPX Desktop/Development Forced Air-Cooled Portable Tower, 6/8-slot
- **Payload:** 3U, 1"/0.8"
- **Size:** 18.02"x8.38"x14.00" (HxWxD)
- **Cooling:** >19 CFM per slot per ANSI/VITA 65 OpenVPX
- **Power Supply:** Up to 900W

### OpenVPX Desktop/Development Forced Air Conduction-Cooled Portable Tower, 6-slot
- **Payload:** 6U, 1"
- **Size:** 23.27"x8.38"x14.00" (HxWxD)
- **Cooling:** 150W per slot, conduction-cooled per OpenVPX standard
- **Power Supply:** Up to 1200W

### OpenVPX Desktop/Development Forced Air Conduction-Cooled Portable Tower, 6-slot
- **Payload:** 3U, 1"
- **Size:** 18.02"x8.38"x14.00" (HxWxD)
- **Cooling:** 75W per slot, conduction-cooled per OpenVPX standard
- **Power Supply:** Up to 1200W

### Open Frame/Development Forced Air-Cooled, 16/20-slot
- **Payload:** 6U, 1"/0.8"
- **Size:** 20.00"x19.00"x17.25" (HxWxD)
- **Cooling:** 20 CFM per slot
- **Power Supply:** 2000W

### VPX Desktop/Development Forced Air Conduction-Cooled, 6-slot
- **Payload:** 6U, 1"
- **Size:** 10.47"x17.18"x16.00" (HxWxD)
- **Cooling:** 18 CFM per slot
- **Power Supply:** Up to 1900W
- **Separate rackmount ears support both desktop and rackmount applications**

### OF-SMART6
- **Payload:** 6U, 1"/0.8"
- **Size:** 20.68"x8.58"x14.00" (HxWxD)
- **Cooling:** >19 CFM per slot per ANSI/VITA 65 OpenVPX
- **Power Supply:** Up to 1200W

### OF-SMART3
- **Payload:** 3U, 1"/0.8"
- **Size:** 15.43"x8.58"x14.00" (HxWxD)
- **Cooling:** >19 CFM per slot per ANSI/VITA 65 OpenVPX
- **Power Supply:** Up to 900W

### COOL-XC6
- **Payload:** 6U, 1"/0.8"
- **Size:** 23.27"x8.38"x14.00" (HxWxD)
- **Cooling:** >19 CFM per slot per ANSI/VITA 65 OpenVPX
- **Power Supply:** Up to 1200W

### COOL-XC3
- **Payload:** 3U, 1"/0.8"
- **Size:** 18.02"x8.38"x14.00" (HxWxD)
- **Cooling:** >19 CFM per slot per ANSI/VITA 65 OpenVPX
- **Power Supply:** Up to 900W

### COOL-CC6
- **Payload:** 6U, 1"
- **Size:** 23.27"x8.38"x14.00" (HxWxD)
- **Cooling:** 150W per slot, conduction-cooled per OpenVPX standard
- **Power Supply:** Up to 1200W

### COOL-CC3
- **Payload:** 3U, 1"
- **Size:** 18.02"x8.38"x14.00" (HxWxD)
- **Cooling:** 75W per slot, conduction-cooled per OpenVPX standard
- **Power Supply:** Up to 1200W

### OF-XC
- **Payload:** 6U, 1"/0.8"
- **Size:** 20.00"x19.00"x17.25" (HxWxD)
- **Cooling:** 20 CFM per slot
- **Power Supply:** 2000W

### DT-CC
- **Payload:** 6U, 1"
- **Size:** 10.47"x17.18"x16.00" (HxWxD)
- **Cooling:** 18 CFM per slot
- **Power Supply:** Up to 1900W
- **Separate rackmount ears support both desktop and rackmount applications**

### DT-XC
**HYBRICON STANDARD RACK MOUNT STYLE DEVELOPMENT CHASSIS FOR 3U & 6U MODULES**

We also offer a wide range of COTS rugged chassis products, but most applications require some modifications and customizations. For Modified COTS application-specific units or for more information, please get in touch with our Engineered Packaging Product Specialist using the contact information on page 36.

### OpenVPX Desktop/Development Forced Air-Cooled, 16-slot
- Rack Height: 13U
- Payload: 6U, 1”
- Size: 22.69”x16.85”x19.88” (HxWxD)
- Cooling: up to 150W per slot per ANSI/VITA 65 OpenVPX
- Power Supply: 3300W Embedded

![RME13XC](image)

### OpenVPX Development Forced Air Conduction-Cooled, 16-slot
- Rack Height: 13U
- Payload: 6U, 1”
- Size: 22.69”x16.85”x19.53” (HxWxD)
- Cooling: up to 150W per slot per ANSI/VITA 65 OpenVPX
- Power Supply: 3000W Embedded

![RME13CC](image)

### Desktop/Development Forced Air-Cooled, 21-slot
- Rack Height: 10U
- Payload: 6U, 0.8”
- Size: 17.47”x17.38”x21.00” (HxWxD)
- Cooling: 85W per slot, Hot Swap fan tray
- Power Supply: 1000W or 1600W Rear mounted or up to 3x 600W redundant Hot Swap

![RME21](image)

### Rackmount Rugged Front Load Forced Air-Cooled, 16/21-slot
- Rack Height: 10U
- Payload: 6U, 1”/0.8”
- Size: 17.47”x17.25”x23.00” (HxWxD)
- Cooling: 145W per slot cooling for 17.9 CFM per slot
- Power Supply: 1600W Rear mounted, 2400W Rear mounted

![RME1021C/M](image)

### Desktop/Development Forced Air-Cooled Rackmount, 4/6/8-slot
- Rack Height: 2U/3U/4U
- Payload: 6U/3U, 0.8”
- Size: 3.47”/5.22”/6.97”x 17.52”x8.5” (HxWxD)
- Cooling: 45 - 80W per slot, 10W per rear slot, Hot Swap fan tray
- Power Supply: 350W Embedded ATX or redundant 3U cPCI style Hot Swap

![2/3/4U SRME](image)

### OpenVPX Desktop/Development Forced Air-Cooled, 12-slot
- Rack Height: 9U
- Payload: 3U, 1”
- Size: 15.72”x16.85”x19.93” (HxWxD)
- Cooling: 18 CFM per slot per VITA 65
- Power Supply: 2600W Embedded

![RME9XC](image)

### OpenVPX Development Forced Air Conduction-Cooled, 12-slot
- Rack Height: 9U
- Payload: 3U, 1”
- Size: 15.69”x16.85”x19.53” (HxWxD)
- Cooling: up to 150W per slot per ANSI/VITA 65 OpenVPX
- Power Supply: 2600W Embedded

![RME9CC](image)

### Desktop/Development Forced Air-Cooled, 16/21-slot
- Rack Height: 10U
- Payload: 6U, 1”
- Size: 17.47”x17.38”x21.00” (HxWxD)
- Cooling: 100W per slot
- Power Supply: 1600W, 1400W, 1000W Rear mounted

![RME21XC](image)

### Rackmount Rugged Front Load Forced Air-Cooled, 16/21-slot
- Rack Height: 8U
- Payload: 6U, 0.8”
- Size: 13.97”x17.25”x24.38” (HxWxD)
- Cooling: 60W per slot, 10 CFM per slot cooling for 60W
- Power Supply: 1200W Embedded

![RME821C/M](image)

### Desktop/Development Forced Air-Cooled Rackmount, 2-slot
- Rack Height: 1U
- Payload: 6U, 0.8”
- Size: 1.75”x17.12”x12.00” (HxWxD)
- Cooling: 55W per slot, 10W per rear slot
- Power Supply: 150W Embedded ATX

![1U PRME](image)

**sales@atrenne.com**
This section features examples of our Application-Specific Development Solutions. These versatile solutions are typically intended for benign and/or lab environments and can be designed for use with air-cooled payload, conduction-cooled payload, or hybrids. Benefits include the ability to closely emulate the deployed chassis configuration for development and/or demonstration, streamlining the integration of the deployed system.
Hybricon Hybrid 3U/6U Hybrid Cooling OpenVPX Rackmount Development Chassis

- 10U high modified COTS rackmount solution
  - 10.47” x 17.18” x 21” (HxWxD)
- Hybrid forced air/conduction card cage
  - (2) 3U OpenVPX conduction-cooled slots
  - (6) 6U OpenVPX air-cooled slots
- Application-specific hybrid 3U – 6U OpenVPX backplane
  - (2) 3U OpenVPX slots
  - (6) 6U OpenVPX slots
  - Based on rugged ATR backplane
- I/O configured to match rugged ATR

Hybricon Conduction-Cooled 3U OpenVPX Benchtop Test Chassis

- Conduction-cooled 3U OpenVPX test chassis based on ATR
- Bench top assembly with backplane circuit card, front panel circuit card and front panel I/O connections
  - Application-specific OpenVPX backplane from ATR
  - I/O board – early access version based on ATR but with board slots spaced apart for probe access
  - Front panel I/O connections to match ATR
- Conduction machined card guides – cooling provided externally
- DC power entry using power and ground studs located on the backplane – power provided externally

Hybricon UAV Airborne ISR Hybrid 3U/6U OpenVPX Forced Air Conduction-Cooled Test Chassis

- Modified COTS hybrid 3U/6U OpenVPX forced air conduction-cooled test chassis
- Based on COTS development chassis
- Application-specific hybrid 3U/6U OpenVPX backplane
  - (14) slots 6U OpenVPX and (2) slots 3U OpenVPX
  - Pass-through I/O connections and VPX+ cables
  - Power and cooling for 150W per slot (6U)
  - Hybricon rugged Power & Control Module (PCM) supporting Ethernet/SNMP System Monitoring
Hybricon 12U Rackmount VPX Forced Air Conduction-Cooled Environmental Chamber  
Solution for -40 to +70°C Operation

- 12U Rackmount Chassis:  
  - 20.97” x 17.376” x 21” (HxWxD)
- Designed for testing in an environmental chamber  
  - Chassis: -40 to +70°C operating temperature
- Extreme cooling rackmount forced air conduction-cooled
- Application-specific 6U 8-slot VPX REDI 1” pitch backplane
- External 1750W Power Supply Unit with umbilical cable

Hybricon Forced Air Conduction-Cooled 3U VPX Test Platform Demonstration Chassis with Active Backplane

- 7U Rackmount Test Platform  
  - 12.22” x 18.98” x 21.0” (HxWxD)
- Forced air conduction-cooled
- (14) 3U VPX 1.1” and 2” pitch slots per VITA 48.2
- Application-specific 3U VPX backplane:  
  - 6 Gbaud signaling rates
  - FPGAs on the backplane

Hybricon Modified COTS Hybrid 3U/6U OpenVPX VITA 67 Desktop Forced Air Conduction-Cooled Development Chassis

- Based on COTS COOL-CC6 conduction-cooled development chassis
- Hybrid 3U/6U conduction-cooled card cage
- Application-specific 3U/6U OpenVPX backplane  
  - (2) 6U OpenVPX slots
  - (6) 3U OpenVPX slots
- VITA 67.1 and VITA 67.2 RF feed-through on selected slots  
  - VPX+ cabling to VPX RTM connectors

sales@atrenne.com
This section features examples of our Application-Specific Rugged Rackmount Solutions. These solutions are intended for moderately ruggedized applications, typically with air-cooled payload, and are often used for deployment in commercial or derivative aircraft, shipborne, and ground wheeled vehicles. Benefits include low up-front cost and short lead time.
Hybricon Under Sea 2U Rugged Rackmount VME64x Chassis Solution for EW Application

- 2U 19” rackmount chassis:
  - 3.50” x 17.52” x 21” (HxWxD)
- 6U horizontal card cage
- 4-slot VME64X backplane
- 115 VAC input, 291W power supply
- SNMP based system monitoring
- Operating Temperature: +4 to 40°C
- EMI: MIL-STD-461

This chassis is easily adapted for other backplane configurations such as OpenVPX or different power requirements - contact factory.

Hybricon 2U Shipborne Rugged Rackmount OpenVPX Chassis Solution for ISR Application

- 2U Rackmount Chassis:
  - 3.44” x 17.38” x 20.67” (HxWxD)
- 1-slot 6U OpenVPX – application-specific pitch
- Hybricon rugged Power & Control Module (PCM) supporting Ethernet/SNMP System Monitoring
- MIL-STD-1399 1+1 redundant 350W power supply
- 55 CFM per slot N+1 Redundant Extreme Cooling
- Operating Temperature: +4.4 to +29.4°C

Hybricon 2U Shipborne Rugged Rackmount VXS Solution for EW Application

- 2U rackmount chassis for 23” rack: 3.46” x 22.97” x 22.01” (HxWxD)
- Shipborne above deck application with Salt Fog requirements
- 4-slot hybrid VME64x/VXS backplane
- Hybricon rugged Power & Control Module (PCM) supporting Ethernet/SNMP System Monitoring
- 28 VDC input, redundant 525W power supplies
- Cooling: 15 CFM per slot
- FRU’s: Power Supply, Fan, Monitoring Subassemblies field replaceable
- Operating Temperature: 0 to +50°C
- EMI: MIL-STD-461F

This chassis is easily adapted for other backplane configurations such as OpenVPX or different power requirements - contact factory.
Hybricon 6U High Power Rugged Rackmount Top Load VXS Chassis Solution

- Chassis: 6U, 10.47" x 19.0" x 22.503" (HxWxD)
  - Top loading 8 slots, 6U x 160mm card cage area
- Backplane: Application-specific 8-slot VXS backplane
- Power: 28 VDC Input, 1100W power supply
- Cooling: Provides 30 CFM per slot air flow with high pressure drop VXS payload
- Operating Temperature: 0 to +40°C
- Altitude: 0 to 20 kft
- EMI: MIL-STD 461
- Ethernet/SNMP System Monitoring

This chassis is easily adapted for other backplane configurations such as OpenVPX or different power requirements - contact factory

Hybricon 8U High Power Top Load Hybrid 3U-6U OpenVPX VITA 67 RF Chassis Solution

- Chassis: 8U, 13.93" x 19.0" x 20.75" (HxWxD)
  - Top loading, 10 slots
  - Hybrid air/conduction-cooled supporting air-cooled 6U and conduction-cooled 3U payload
- Backplane: Application-specific 10-slot OpenVPX
  - Hybrid 3U/6U
  - VITA 67.1 & VITA 67.2 RF Feedthrough
- Power: 1600W power supply, 220VAC 50/60 Hz input
- Cooling:
  - Provides extreme cooling of 20 CFM per slot air flow with high pressure drop 6U OpenVPX payload
  - Maintains conduction-cooled 3U card edge temperature <70°C at 43°C ambient at 10,000 ft
- Operating Temperature: 0 to +50°C
- Altitude: 0 to 10 kft
- Extensive I/O including RF inputs
- Ethernet/SNMP System Monitoring

This chassis is easily adapted for other backplane configurations such as OpenVPX or different power requirements - contact factory
Hybricon 7U Airborne Lightweight Chassis Solution

- Lightweight Airborne Top load chassis
- 12.22" x 16.45" x 21.97" (HxWxD)
- 6U 160 mm IEEE 1101.10 top load card cage
- Air-cooled cards
- Backplanes:
  - Solution 643-00: 20-slot hybrid VXS/VME64x
  - Solution 644-00: 20-slot VME64x
- MIL-STD-704F 28 VDC input with rear breaker
- Modified COTS 1850W power supply
- Ethernet/SNMP monitor solution with front LCD monitor display
- Extreme cooling with 15 CFM per slot
- Operating Temperature: -20 to +50°C
- Operating Altitude: 10kft

This chassis is easily adapted for other backplane configurations such as OpenVPX or different power requirements - contact factory.

Hybricon 8U Shipborne Rugged Rackmount VXS Solution for EW Application

- (3) Different configurations with different application-specific backplanes and I/O
- Rugged 8U Front Load Extreme Cooling 20-slot Rackmount Chassis
  - 20 CFM per slot cooling
  - Hybricon rugged Power & Control Module (PCM) supporting Ethernet/SNMP System Monitoring
  - Hybrid 20-slot application-specific VME64x/VXS backplanes
  - N+1 Redundant 2050W power supply
  - N+1 Redundant cooling

This chassis is easily adapted for other backplane configurations such as OpenVPX or different power requirements - contact factory.

Hybricon 8U Airborne High Power Rugged Rackmount Top Load VXS Chassis Solution for ISR Application

- 8U Top Load Rackmount
- 20-slot Hybrid VME64x/VXS backplane
- Ethernet/SNMP System Monitoring
- Power: 28 VDC MIL-STD-704F, 1800W power supply
- Cooling: 20 CFM per slot for 125W per slot payload

This chassis is easily adapted for other backplane configurations such as OpenVPX or different power requirements - contact factory.
Hybricon Rackmount Shipborne Solution with RF Blind Mate Through Backplane

- Rackmount chassis: 19.02" x19.0" x 24.00" (HxWxD)
- Air-cooled 6U x 400 mm card cage
- 20-slot application-specific backplane
- 770W power supply
- RF coax contacts feed through the backplane to rear I/O and/or rear RF components to 8 GHz
- Also developed several 6U x 400 mm RF circuit cards with on-board semi-flex coax
- Operating Temperature: +10 to +50°C

Hybricon Rugged Airborne Redundant SIGINT Chassis Solution with Application-Specific SNMP Built-In Test

- 10U Modified COTS rugged rackmount 20-slot forced air cPCI chassis solution
- (2) Redundant 10-slot subsystems in one chassis
- (2) 10-slot cPCI b control system with application-specific features:
  - Ability to RESET (9) cPCI slots via SNMP
  - Monitor (10) cPCI board HEALTHY* pins
- Application-specific redundant power supplies, 990W 115 VAC, 3-phase MIL-STD-704F
- (2) application-specific 10-slot cPCI backplanes
  - Application-specific connectivity to RESET (9) cPCI slots via SNMP
  - Application-specific connectivity to monitor (10) cPCI board HEALTHY* pins
- Operating Temperature: +5 to +35°C
This section features examples of our Application-Specific Rugged ATR Solutions for Air-Cooled Payload. These solutions are intended for moderately ruggedized applications with air-cooled payload and are often used for demonstration activities. Benefits include low up-front cost and short lead time.
Application-Specific Rugged ATR Solutions for Air-Cooled Payload
Hybricon Air-Cooled 3/4-ATR Tall Long 9-slot OpenVPX Development-to-Deployment Chassis

- Air-cooled 3/4-ATR Tall Long supports OpenVPX compatible cabling to rapidly configure backplane and I/O during the development phase
- Ability to secure cabling for the demonstration phase
- Application-specific backplane and I/O board replaces cabling for the deployment phase
- Blank I/O front panel ready for customization
- MIL 28V-input power supplies
- EMI shielding
- 9-slot 3U Gen-3 optimized pass-through OpenVPX backplane with patent pending Gen-3 signal integrity optimizations

This chassis is easily adapted for applications specific requirements including I/O, other backplane configurations or different power requirements - contact factory

Hybricon OpenVPX ATR Heat Exchanger Chassis Solution

- Modified ATR form factor: 12.25” x 14.00” x 17.5”D (HxWxD), not including handles, connectors and fan assembly (+3.74”)
- Unusual liquid/air heat exchanger solution allows use of air-cooled payload in rugged airborne applications
- Liquid-cooled chassis and power supply
- Supports air-cooled chassis payload with re-circulating cooling air utilizing liquid/air heat exchanger and internal MIL-grade fans
- Application-specific 10-slot hybrid 3U/6U OpenVPX backplane:
  - Liquid-cooled using PAO
  - Operating Temperature: -10 to +50°C
  - Altitude: 0 to 20 kft
- 3-phase 115 VAC input MIL-STD-704F 900W power supply
- Elapsed time indicator
Hybricon ATR Airborne Heat Exchanger Chassis Solution

- Modified ATR form factor: 12.25" x 14.00" x 17.5"D (HxWxD), not including handles, connectors and fan assembly (+3.74")
- Unusual liquid/air heat exchanger solution allows use of air-cooled payload in rugged airborne applications
- Liquid-cooled chassis and power supply
- Supports air-cooled chassis payload with re-circulating cooling air utilizing liquid/air heat exchanger and internal MIL-grade fans
- (2) Application-specific VME64x backplanes:
  - 9-slot VME64x backplane
  - 4-slot VME64x backplane
  - Flex circuits for extensive I/O
- Liquid-cooled using PAO
- Operating Temperature: -40 to +56°C
- Altitude: 0 to 50 kft
- 3-phase 115 VAC input MIL-STD-704A 700W power supply
- Elapsed time indicator

Hybricon Airborne Air-Cooled ½-ATR Long Tall Chassis Solution

- ½-ATR Long Tall
- Air-cooled cards
- (4) Slots VME64x
- Cooling for 40W per slot at 30,000 ft
- Power Supply: 230W MIL-STD-704F Single Phase 115 VAC 400 Hz input
- Operating Temperature: -20 to +50°C
- EMI: MIL-STD-461E aircraft environment

This chassis is easily adapted for other backplane configurations such as OpenVPX or different power requirements - contact factory
Hybricon Airborne Air-Cooled ¾-ATR Long Tall Chassis Solution

- ¾-ATR Long Tall
- Air-cooled cards
- (10) Slots 3U cPCI with PCI bridge
- Cooling for 20W per slot at 30,000 ft
- 200W MIL-STD-704F 28 VDC input Power Supply
- Operating Temperature: -20 to 65°C
- EMI: MIL-STD-461E aircraft environment

This chassis is easily adapted for other backplane configurations such as OpenVPX or different power requirements - contact factory

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Hybricon Ground Vehicle Air-Cooled 1-ATR Tall Chassis Solution

- Application-specific 1-ATR tall air-cooled
- 11-slot VME64x backplane
- Application-specific power supply
- Operating Temperature: -10 to +50°C up to 5,000 ft
- Targeted for deployment in ground-based vehicles

This chassis is easily adapted for other backplane configurations such as OpenVPX or different power requirements - contact factory
<table>
<thead>
<tr>
<th>Feature</th>
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</thead>
<tbody>
<tr>
<td>1 ½-ATR short tall</td>
</tr>
<tr>
<td>Air-cooled cards</td>
</tr>
<tr>
<td>(10) Slots VME64x</td>
</tr>
<tr>
<td>Air-air heat exchanger</td>
</tr>
<tr>
<td>Internal re-circulating air path through heat exchanger</td>
</tr>
<tr>
<td>External air path through heat exchanger</td>
</tr>
<tr>
<td>External air path separated from internal air path</td>
</tr>
<tr>
<td>500W DC Power</td>
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</tbody>
</table>

This chassis is easily adapted for other backplane configurations such as OpenVPX or different power requirements - contact factory
This section features examples of our Application-Specific Rugged ATR Solutions for Conduction-Cooled Payload. These solutions are intended for highly ruggedized applications, offering superior performance in harsh environments. With the exception of D2D (development to deployment models), these chassis typically require application-specific backplanes and I/O.
Hybricon High Power Small Form Factor 3U OpenVPX Conduction-Cooled Cold Plate Chassis

- Modified COTS Cold Plate Style Small Form Factor Chassis
- 28 VDC MIL-STD-704F and MIL-STD-1275B power input
- 450W power supply
- Central switch topology 5-slot 3U OpenVPX backplane
- 3U OpenVPX payload – total of (9) Core i7 processors, Core i7 SBCs and XMCs
- Operating Temperature: -40 to +55°C
- Altitude: 28 kft
- Shock: 40 Gs, 11ms
- Vibration: MIL-STD-810 ground vehicle and propeller aircraft methods
- EMI/EMC: MIL-STD-461E

Hybricon UAV Airborne ¾-ATR Forced Air Conduction ATR Solution for Radar Application - Lightning Pin Injection

- ¾-ATR based on D2D chassis
- 7.58” x 7.45” x 14.77” (HxWxD)
- Application-specific 3U 5-slot Hybrid OpenVPX/cPCI backplane
  - (2) slots for expansion
- Application-specific 28 VDC input 216W Power Supply
- I/O protection circuitry for severe RTCA/DO-160 Lightning Pin Injection
- Operating Temperature: -45 to +71°C
- Altitude: 0 to 25 kft
Hybricon Airborne Forced Air Conduction-Cooled 6U OpenVPX ATR Chassis Solution for ISR Application

- Application-specific side-load forced air conduction deployable ATR chassis
- 10.65” x 12” x 16.9” (HxWxL)
- Hybrid 11-slot 3U/6U OpenVPX backplane with mixed pitch
- Power Input: 28 VDC, MIL-STD-704F
- Application-specific 625W power supply
- Hybricon rugged Power & Control Module (PCM) supporting Ethernet/SNMP System Monitoring
- Operating Temperature: -40 to 55°C
- Altitude: 50,000 ft MSL
- Shock: 20 Gs, 11ms
- Vibration: 4.74 Gs RMS
- EMI/EMC: MIL-STD-461E

Hybricon Airborne Liquid-Cooled VXS 1-ATR Solution for EW Application

- Brazed construction
- Liquid-cooled card cage side walls
- Conduction-cooled cards with up to 97W per slot power dissipation
- Application-specific 6-slot VITA 41 VXS backplane with I/O provisions
- Top load modified 1-ATR with Fiber Cover
- 800W MIL-STD-704A Three Phase 400 Hz AC Power Supply
- EMI: MIL-STD-461

This chassis is easily adapted for other backplane configurations such as OpenVPX or different power requirements - contact factory
Hybricon UAV Airborne Hybrid 3U/6U OpenVPX 1+ ATR Chassis Solution for ISR Application

- 1 ½-ATR forced air conduction-cooled
- 10.58” x 15.36” x 19.57” (HxWxD)
- Active circuitry on backplane
- (10) 6U OpenVPX and (2) 3U OpenVPX 1.0” pitch
- 28 VDC input MIL-STD-704E 1569W power supply
- Operating Temperature: -40 to +40°C
- Altitude: 0 to 35 kft

Solution 79-182

Hybricon 1-ATR Long Ultra High Power Liquid Conduction-Cooled OpenVPX ATR Chassis Solution for ISR Application

- 1-ATR long liquid-cooled:
  - 12.56” x 12.59” x 23.23” (HxWxD)
- Application-specific 6U OpenVPX backplane:
  - (13) slots 6U OpenVPX
  - Ultra high speed Gen-3 10 Gbaud signaling
  - (3) slots 6U VITA 62 power supplies
- 28 VDC MIL-STD-704F input
- 2.7 kW power supply

Solution 63-173

Hybricon Airborne 3U OpenVPX ½-ATR Forced Air Conduction ATR Solution for Mission Computer Application

- Modified ½-ATR per specific legacy form factor
- 8.25” x 5.24” x 16.31” (HxWxD)
- Application-specific 3U OpenVPX backplane
  - (10) 3U OpenVPX 1.0” pitch slots
  - (1) 3U MIL-STD-704F ANSI/VITA 62 power supply slot
  - (1) 3U AC/DC input/holdup power supply slot
- Application-specific I/O panel CCA
- Modified COTS MIL-STD-704F three-phase 400 Hz AC-input 233W Power Supply with 50msec holdup
- Operating Temperature: -40 to +49°C
- Altitude: 0 to 40kft

Solution 87-187
Hybricon Airborne Liquid-Cooled OpenVPX 1-ATR Solution for EW Application

- Brazed construction
- Liquid-cooled card cage side walls
- Cooling for conduction-cooled cards with up to 150W per slot power dissipation
- Application-specific 6-slot Hybrid OpenVPX - VXS backplane with I/O provisions
- Top load modified 1-ATR Short
- 750W MIL-STD-704A Three Phase 400 Hz AC Power Supply
- EMI: MIL-STD-461E

This chassis is easily adapted for other backplane configurations or different power requirements - contact factory

Solution 99-193

Hybricon UAV Airborne Rotary Wing High Power Hybrid 3U OpenVPX/cPCI ¾-ATR Forced Air Conduction ATR Solution for Radar Applications

- ¾-ATR based on D2D chassis
- 7.45" x 7.57" x 15.2" (WxHxD)
- Application-specific 3U 9-slot Hybrid OpenVPX/cPCI backplane
- Dual 230W current-sharing application-specific MIL-STD-704E Power Supplies
- Operating Temperature: -40 to +71°C
- Altitude: 0 to 20 kft
- EMI: MIL-STD-461

This chassis is easily adapted for other backplane configurations or different power requirements - contact factory

Solution 58-170
The Problem: The customer needed several types of chassis for an Airborne Application, including:

- OpenVPX forced air lab chassis – Quick Delivery
- OpenVPX Hybrid 3U/6U, Hybrid Cooling demonstration chassis – Quick Delivery
- OpenVPX forced air conduction-cooled deployable ATR chassis

How We Helped: Atrenne Computing Solutions proposed a hybrid 3U/6U OpenVPX backplane to address OpenVPX signal processing and storage requirements and developed several chassis, including:

1. Modified COTS rackmount forced air chassis based on a standard OpenVPX chassis design
   - (2) COTS backplanes
   - Provided capability to bring up payload boards for software development
2. Modified COTS hybrid 3U/6U forced air and conduction demonstration chassis based on the chassis in (1) above except
   - Backplane & I/O to match final configuration
   - Early capability for software development with the final payload configuration and I/O
3. Application-specific forced air conduction deployable ATR chassis based on an existing chassis design
   - Hybrid 3U/6U OpenVPX chassis and backplane
   - Multi-vendor COTS payload
   - Assisted customer to resolve integration issues with 3rd party COTS payload

The Result? Atrenne Computing Solutions delivered test chassis and ATR chassis solutions on an expedited schedule. The test chassis described in #2 above was used to successfully demonstrate functional capability on a test flight for the final system. The final production chassis passed qualification testing with no issues.
The Problem: The customer needed several types of chassis for an Airborne UAV Radar Application, including:

- 3U OpenVPX forced air conduction-cooled test platform leveraging ATR backplane and I/O connections
  Quick Delivery
- 3U OpenVPX forced air conduction-cooled ATR chassis for limited thermal environment
- 3U OpenVPX forced air conduction-cooled ATR chassis for final configuration

How We Helped: Atrenne Computing Solutions developed several chassis, including:

1. Application-specific test platform for lab use
   - Application-specific OpenVPX backplane and I/O to match final ATR
   - Payload slots were spaced out in order to allow for debugging at the board level
2. Application-specific forced air conduction limited thermal environment (LTE) rugged ATR chassis based on an existing chassis design
   - Lab use only with commercial fans
   - Initially powered by a lab supply
   - 3U 5-slot Hybrid (OpenVPX/cPCI) chassis and backplane (2 slots for expansion)
3. Application-specific 3U forced air conduction deployable rugged ATR chassis based on COTS ATR chassis
   - 3U 5-slot Hybrid (OpenVPX/cPCI) chassis and backplane (2 slots for expansion)
   - I/O protection circuitry to meet extreme RTCA/DO-160 Lightning Pin Injection
   - Application-specific 3U Power Supply

The Result? Atrenne Computing Solutions delivered the test chassis and ATR chassis solutions on schedule. The test platform allowed early access for firmware development six months before the final ATR was available. The LTE ATR provided final configuration capability before the MIL-grade fans were available (two months early) allowing for demonstration of capability to the end customer. The final configuration is now in Qualification testing.
The Problem: The customer needed several types of chassis for an Airborne UAV ISR Application, including:

- Hybrid 3U/6U OpenVPX forced air conduction-cooled test chassis with pass-through I/O connections
  VPX+ cables
  - Modified COTS chassis and backplane
  - Quick Delivery
- Hybrid 3U/6U OpenVPX forced air conduction-cooled ATR chassis
  - High Power, High Altitude extended operating temperature
  - Severe Shock and Vibration operating profile
  - Aggressive Weight requirement

How We Helped: Atrenne Computing Solutions developed several chassis to meet the customers’ needs, including:

1. Modified COTS conduction-cooled development chassis
   - Application-specific OpenVPX backplane with application-specific rear transition cabling
   - Modified COTS enclosure to support both 6U and 3U modules
2. Application-specific forced air conduction deployable rugged ATR chassis based on an existing chassis design
   - Hybrid 3U/6U OpenVPX backplane
   - Application-specific 6U Power Supply
   - Application-specific I/O front Panel
   - Optimized Chassis Brazement for Structural integrity and weight.

The Result? Atrenne Computing Solutions delivered the test chassis for firmware and software development. Initially the ATR chassis was used with a lab supply while waiting for the final power supply to be delivered which allowed for final configuration development and debugging.
Atrenne Computing Solutions also offers a wide range of COTS development chassis and COTS rugged chassis products in different styles (see our website), and can provide Modified COTS versions of these chassis if required. To learn more, please see the contact information below and reference the resources available.

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sales@atrenne.com

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