



### Silicom *ThunderFjord* - FPGA SmartNIC FB2CDG1@AGM3x Series

Dual port QSFPDD56, 2x400 GE, PCIe Gen5 x16, Intel® Agilex™ M-series FPGA Based, up to 32GB HBM2e with 2xARC6-16 connector (16x28 Gbps), for Ethernet, PCIe or interconnect

#### Product Description

The Silicom *ThunderFjord B* is a high-performance programmable PCIe Server adapter based on the Altera® Agilex™ M-series AGMx039 FPGA (available with AGMx032 and other options).

The Altera Agilex-M™ is an extremely powerful FPGA which also features up to on-chip 32GB HBM2e memory providing an unprecedented 2 x 2.6 Tbps HBM2e bandwidth. The combination of lightning fast logic and equally fast memory ensures a platform that can deliver. The ThunderFjord can also be offered with FPGA models without HBM2e.

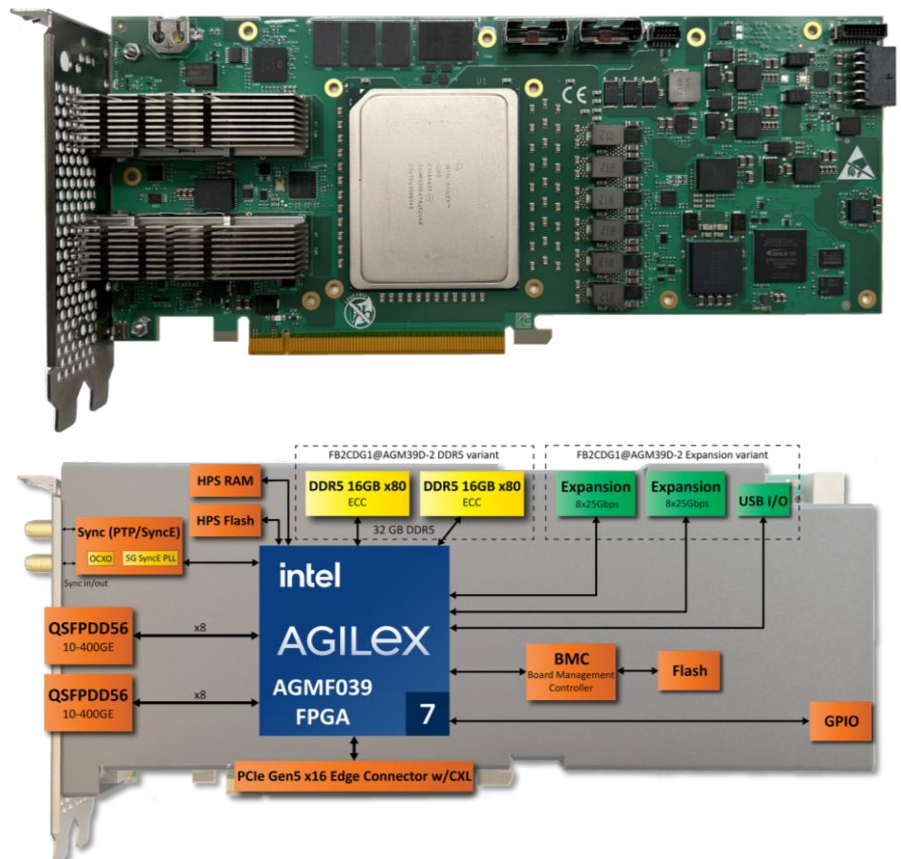
The card is equipped with 2 x QSFPDD56 for supporting 2x 400GE, as well as a wide range of other link speed combinations like 16x10/25GE or even 8x100G with the appropriate breakout modules.

The *ThunderFjord* features 2 x AcceleRate® Slim Cable Assembly (ARC6) connectors with 2x 8x28Gbps from Samtec. The ARC6 connectors add unprecedented flexibility in host bandwidth and network connectivity. Silicom offers an adaptor a additional PCIe Gen4 x16 connector that can be employed for additional host bandwidth. The same connectors can alternatively be used with Firefly™ flyover cables for connecting additional 2x 8xFSFP28 or 2x 2xQSFP28 for higher Ethernet link capacity to the solution in appliances. Silicom offers a 4xQSFP28 bracket for easy utilization of the expansion option. The AR6-16 can alternatively be used for direct connection of two boards, connect multiple cards in series or daisy chain, or connect to other products with suitable interface.

The AGM FPGA series features CXL 1.1 and 2.0 (transceiver speed grade 1), providing heterogeneous processing and computing in performance-intensive workloads like AI, machine learning and analytics. Additionally, the AGM FPGA device includes Quad-core 64 bit Arm Cortex A53 processor.

#### Key Use Cases for ThunderFjord

- **Network Security & Telemetry**
  - Virtual Firewall (vFW)
  - DDoS Mitigation
  - IDS/IPS function
  - IP Security (IPsec)
  - Transport Layer Security (TLS)
  - Packet monitoring and analytics
- **Network Functions**
  - 5G/6G User Plane Function (UPF)
  - 5G Access Gateway Function (AGF)
  - Virtual Broadband Network Gateway (vBNG)
  - Virtual Application Delivery Controller
  - Carrier Grade Network Address Translation
  - Cloud Gateway
  - Application Access Gateway
- **Application acceleration**
  - AI/ML inference offload
  - Data analysis offload
  - Sensor aggregation and analysis
  - Sensor recording



## Key Features of ThunderFjord

- Intel® Agilex™ AGM 032/039 FPGA
- 2 x QSFPDD56 ports
- HBM2e options: 32GB, 16BG, No HBM2e
- 4GB DDR5 ECC RAM (available to HPS)
- 2 x AcceleRate® Slim Cable Assembly (ARC6) expansion connectors each with 8x28Gbps
- PCIe x16 Gen5 w/CXL(option)
- 5G SyncE PLL with Silicom TimeSync Solution (STS)
- USB/JTAG connector and GPIO
- Intel® Max® 10 Board Management Controller
- 1 x PPS/10MHz SMA connector
- Dual slot passive heat sink (single slot option on request)
- On-board power and temperature sensors
- FPGA controlled link and status LEDs

## ThunderFjord expansion use cases

Silicom ThunderFjord provides high capacity and high speed expansion options. The card comes with 2 ARC6-16 connectors each providing 8 x 28 Gbps high speed I/O. Along with an internal flat cable side band signals supporting the High speed I/O expansion options and use cases.

On the PCB, the ARC6-16 connectors are routed to the FPGA on an F-Tile's 16 channels at 32 Gbps (NRZ). Being connected to an F-tile allows for the Highspeed IO to be used with the tiles Hard IPs, such as

- 400 GbE hard IP block (10/25/50/100/200/400 GbE FEC/PCS/MAC)
- PCI Express\* (PCIe\*) hard IP block (Gen4.0 x16)

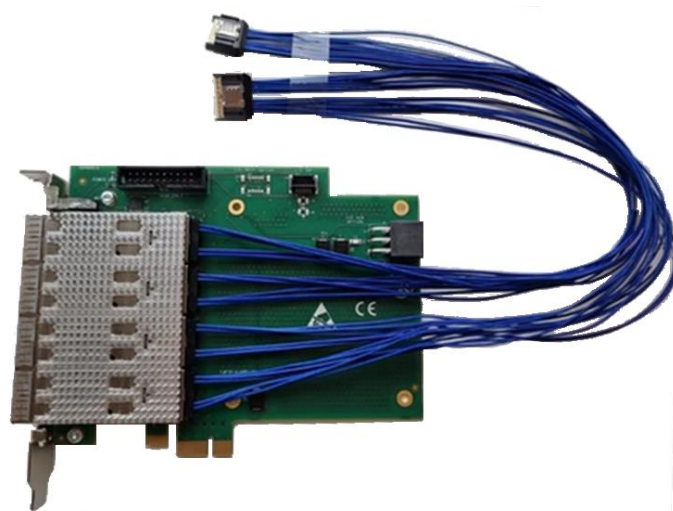


This allows for easy and standardized expansion for the host system internally or externally

Using ARC6-16 connector cables in the onboard ARC6-16 sockets, the high speed I/O can be used for interfacing with card external devices or systems.

The ARC-6 cables can be provided in custom lengths and have the great advantage that the cables are highly flexible yet still securely shielded and very robust. Fitting the expansion options in servers is very easy due to the very flexible cables

Silicom and Samtec have designed and produced cable assemblies with ARC6-16 connectors specifically for operation with Silicom ThunderFjord card, utilizing the Samtec Flyover® cable technology. Silicom offers Samtec flyover cable assemblies for 8x25GE FSFP28 and for 2x100GE QSFP28 for device integration. The 2x100GE QSFP28 is utilized in a PCB/assembly offered by Silicom where 2 of the 2x100GE QSFP28 cable assemblies are mounted on a PCI compliant PCB with bracket and AUX power. This allows for easy expansion with 4 extra QSFP28 ports in spare PCI slot using ThunderFjord's 2xARC6-16 connectors. An actual PCI slot is not required as the card can be powered via AUX power cable, and there no need for the PCI slot for any signaling. The ports are fully controlled by the ThunderFjord FPGA.



With the adaptor offered the ThunderFjord provide QSFP-DDs for 400GE along-side 4xQSFP28s for extra 4x100GE or 16x10/25GE via breakout cables ensuring additional Ethernet bandwidth and high port and speed flexibility.



Additionally, Silicom and Samtec have designed a PCIe Gen4 x16 expansion cable adaptor connecting to the ThunderFjord's 2xARC6-16 in unison. Utilizing all 16x28Gbps channels provided to extend the PCIe Gen4 connectivity of the FPGA's F-tile to connect to host or other device providing a standard PCIe Gen4 x16 socket.

## Technical Specifications

Network Interface	
IEEE standard	IEEE 802.3 400GE, 200GE, 100GE, 25GE, 10GbE
Interfaces	<ul style="list-style-type: none"> <li>Physical interface: 2 x QSFPDD56 slots</li> <li>Multimode SR4/SR8 (850nm), Single Mode LR4/LR8 (1310nm) or DAC (Twinax)</li> <li>Data rate: 2x400, 4x200, 2x200, 1x400, 4x100, 8x100G via CU DAC, 16x25, 16x10 GE</li> <li>Optional ARC-6 expansion: 4xQSFP28 (4x100GE) PCI adaptor (no PCI slot requirement)</li> <li>Optional ARC-6 expansion: Two 2xFlyover-QSFP28 cable assembly (4x100GE max)</li> <li>Optional ARC-6 expansion: Two 8xFlyover-SFP28 cable assembly (16x10/25GE max)</li> </ul>
Host Interface	
PCI bus	<ul style="list-style-type: none"> <li>PCIe 5.0 x16</li> <li>Optional ARC-6 expansion: PCI Gen4 x16 cable assembly</li> </ul>
General Technical Specifications	
FPGA Details	<b>Intel® Agilex™ AGM 032/039 FPGA</b> <ul style="list-style-type: none"> <li>R47A package, with 3 x F and 1 x R tile</li> <li>Fabric speed grade -2, Transceiver Speedgrade -1 for CXL support</li> <li>Quad-core 64-bit Arm Cortex®-A53 (HPS) (option)</li> <li>HBM2e: 32GB, 16GB, No HBM2e options</li> <li>3 x 600GE HIPs (F-tiles), 2 for front ports, 1 usable for expansion connectors</li> </ul>
Configuration	<ul style="list-style-type: none"> <li>Configuration flash can be made to support multiple boot images with automatic fallback to factory default image</li> <li>Upload of FPGA configuration to flash via PCIe – with supporting image and tool</li> </ul>
On-chip Memory	<ul style="list-style-type: none"> <li>HBM2e: 0, 16GB and 32GB options in Agilex™ M-series FPGA</li> </ul>
On-board Memory	<ul style="list-style-type: none"> <li>DDR5, 4GB ECC (available to HPS)</li> </ul>
Expansion Connectors	<ul style="list-style-type: none"> <li>2 x 32pin ARC6-16 connector for 2x 8x28Gbps <ul style="list-style-type: none"> <li>Expand with additional network ports <ul style="list-style-type: none"> <li>via Silicom 4xFQSFP28 adaptors</li> <li>via up to 2x 8x28Gbps Flyover SFP28 cables</li> </ul> </li> <li>Allows an extra x16 PCIe Gen4 via adapter for extra Host PCI BW and resources</li> <li>Interconnect with other products, in P2P or daisy chain configuration</li> </ul> </li> </ul>
On-board Clock	<ul style="list-style-type: none"> <li>PCIe clock: 100 MHz</li> <li>DPLL ZL30793</li> <li>Jitter cleaner</li> <li>8 output reprogrammable clock generator (PLL) with SyncE support</li> <li>Optional expansion via secondary bracket with 4x SMA connector (PPS/10MHz/In/Out)</li> </ul>
Additional Board Support	<ul style="list-style-type: none"> <li>On-board power and temperature sensors (via SMBus/I2C)</li> <li>LEDs for board status and board management</li> </ul>
Physical Dimensions	<ul style="list-style-type: none"> <li>Weight: ~1200 g</li> <li>Full height, 123.4 mm</li> <li>¾ length, 254.0 mm (+bracket)</li> <li>Dual slot</li> </ul>
Environment	<ul style="list-style-type: none"> <li>Storage temperature: -10C to 60C</li> <li>Operating temperature: 0C to 40C</li> <li>Hardware compliance: RoHS, FCC Class A, CE, UL</li> </ul>
Thermal Design	<ul style="list-style-type: none"> <li>Passive dual heat sink</li> <li>Passive single slot heat sink may be provided.</li> </ul> <p>Reduces thermal capacity, limiting processing capacity</p>

<b>Power/TDP</b>	<ul style="list-style-type: none"> <li>Max power (TDP) 225 W, with standard server airflow for cooling</li> <li>Typical power consumption 100W – 150W</li> <li>The combined server-PCIe card solution may be limited in average power consumption by thermal constraints. Maximum supported power is higher than TDP if adequate cooling is provided. Typical use cases are fully dependent on FPGA implementation.</li> <li>High power connector 2x6 with 4 sideband signals for PCI AUX power (PCIe CEM 5.1)</li> <li>65 W max from the PCIe slot, 345 W max from the 12V high power Aux connector *) (including optical modules)</li> </ul>
<b>Port LEDs</b>	<ul style="list-style-type: none"> <li>2 x Link/ ACT for the 2 x QSFPDD56, on bracket</li> <li>1 x multi color status LED, on bracket</li> </ul>
<b>Time Synchronization</b>	<ul style="list-style-type: none"> <li>Silicom TimeSync Solution (STS)</li> <li>IEEE 1588-2019, G8273.2, G8273.4 (T-BC/T-TSC), G8262(SyncE)</li> <li>1 x PPS In/Out, 10Mhz In/Out (optional)</li> <li>DPLL ZL30793</li> <li>OCXO</li> <li>PTP stack: Linux PTP (ptp4l) on HPS or x86</li> <li>Optional expansion via secondary bracket with 4x SMA connector (PPS/10MHz/In/Out)</li> </ul>
<b>Board Management</b>	<ul style="list-style-type: none"> <li>Intel® Max® 10 FPGA Board Management Controller</li> <li>Voltage level monitoring</li> <li>Thermal shut-down protection</li> <li>Over current protection on 12V input</li> <li>I2C and PLDM</li> </ul>
<b>Supported frameworks</b>	<ul style="list-style-type: none"> <li>Silicom Board support package</li> <li>Silicom Accelerated Crypto Adaptor (SACA)</li> <li>Intel Application Stack Accelerator Function (ASAF) framework</li> <li>Silicom PacketMover (Core)</li> <li>DYNANIC Packet processing</li> </ul>

## Ordering Information

Ordering P/N	Notes
<b>FB2CDG1@AGM32E-20XP2</b>	AGM 032, 2x 8x32Gbps connector, No HBM2e, HPS, 4GB DDR5 Expansion connector: supporting 16x28Gbps for Ethernet or PCIe Gen4x16
<b>FB2CDG1@AGM32A-20XP2</b>	AGM 032, 2x 8x32Gbps connector, 16GB HBM2e, HPS, 4GB DDR5 Expansion connector: supporting 16x28Gbps for Ethernet or PCIe Gen4x16
<b>FB2CDG1@AGM32B-20XP2</b>	AGM 032, 2x 8x32Gbps connector, 32GB HBM2e, HPS, 4GB DDR5 Expansion connector: supporting 16x28Gbps for Ethernet or PCIe Gen4x16
<b>FB2CDG1@AGM39F-20XP2</b>	AGM 039, 2x 8x32Gbps connector, No HBM2e, HPS, 4GB DDR5 Expansion connector: supporting 16x28Gbps for Ethernet or PCIe Gen4x16
<b>FB2CDG1@AGM39C-20XP2</b>	AGM 039, 2x 8x32Gbps connector, 16GB HBM2e, HPS, 4GB DDR5 Expansion connector: supporting 16x28Gbps for Ethernet or PCIe Gen4x16
<b>FB2CDG1@AGM39D-20XP2</b>	AGM 039, 2x 8x32Gbps connector, 32GB HBM2e, HPS, 4GB DDR5 Expansion connector: supporting 16x28Gbps for Ethernet or PCIe Gen4x16
<b>FBF4CG@FLYN-ULN</b>	4xQSFP28 expansion PCI adaptor with 2xARC6-16 and sideband connector 250mm
<b>FBF4CG@FLYN-USN</b>	4xQSFP28 expansion PCI adaptor with 2xARC6-16 and sideband connector 400mm
<b>CBL000341</b>	2xARC6-16 to PCIE edge PCIeGen4 x16
<b>FB-SYNC-4S-EXT</b>	Sync extension bracket with 4x SMA connector

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