Waveshare RDK X5 4GB Developer Kit

Waveshare RDK X5 4GB Developer Kit Instruction Manual

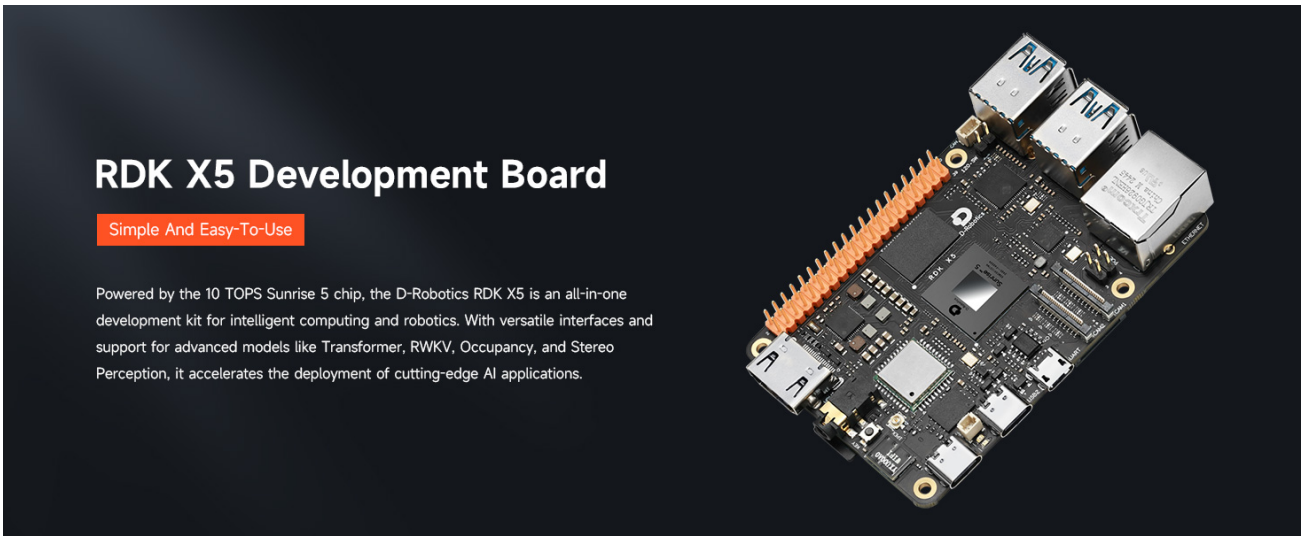
Model: RDK X5 4GB Developer Kit

1. Introduction

This manual provides detailed instructions for the setup, operation, and maintenance of your Waveshare RDK X5 4GB Developer Kit. The RDK X5 is an all-in-one development kit powered by the 10 TOPS Sunrise 5 chip, designed for intelligent computing and robotics applications. It offers versatile interfaces and supports advanced AI models, accelerating the deployment of cutting-edge AI solutions.

2. Package Contents

Verify that all items listed below are included in your package. If any components are missing or damaged, please contact customer support.

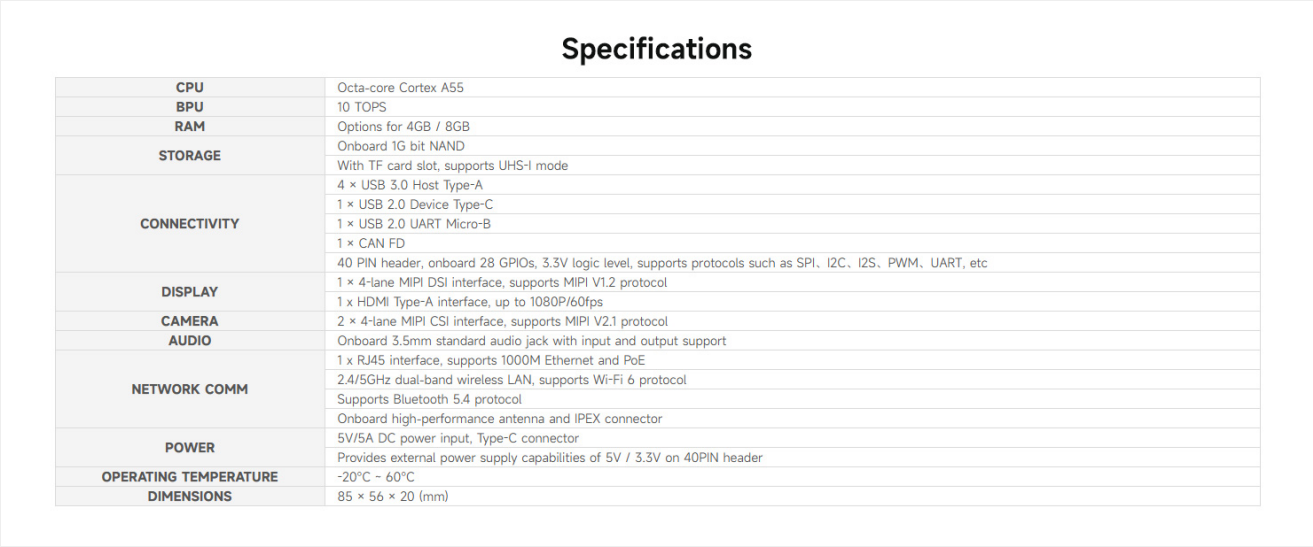


This image displays the complete package contents of the Waveshare RDK X5 4GB Developer Kit. It includes the RDK X5 4GB development board, RDK stereo camera module with FPC cables, a 64GB TF card, a heatsink, a card reader, a Type-A to Type-C cable, and a 27W PD power supply with US/EU/UK plug adapters.

- RDK X5 4GB Development Board
- RDK Stereo Camera Module + FPC cables
- 64GB TF card
- Heatsink
- Card reader
- Type-A to Type-C cable
- 27W PD power supply (with US/EU/UK plug adapters)

3. Product Overview and Specifications

The RDK X5 Development Board is engineered for high-performance intelligent computing. It features an octa-core Cortex A55 CPU and a 10 TOPS BPU, providing robust processing power for demanding tasks. The board supports various interfaces for comprehensive connectivity and versatile display/camera support.



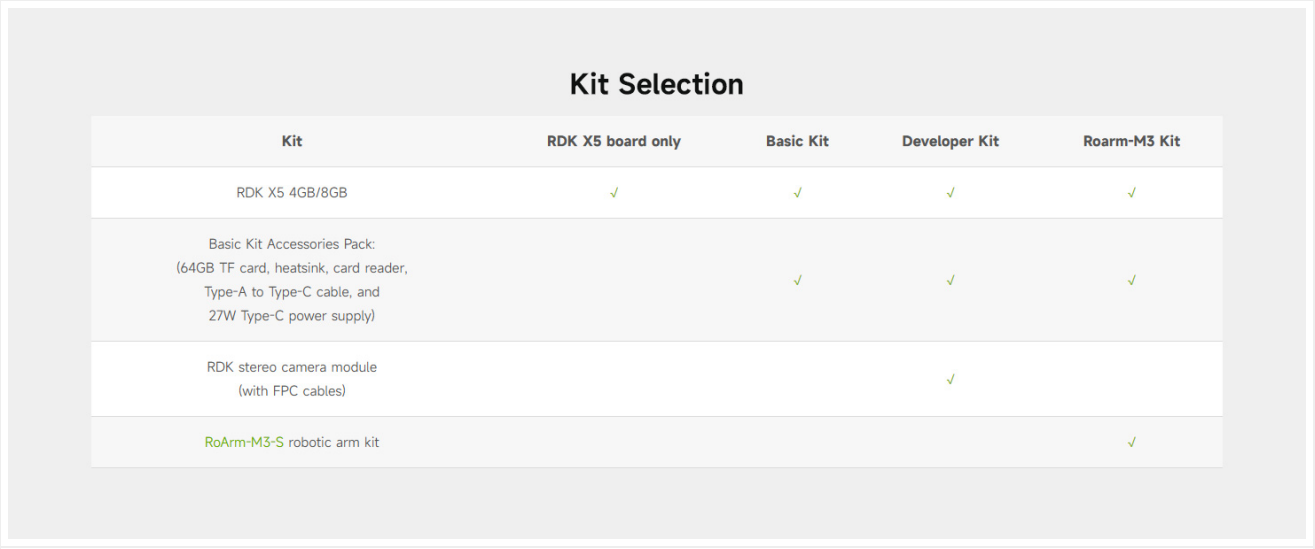
This image provides an overview of the RDK X5 Development Board, highlighting its key features and specifications. The board is powered by the 10 TOPS Sunrise 5 chip, designed for intelligent computing and robotics applications.

Key Features:

- **Processor:** Octa-core Cortex A55 CPU and 10 TOPS BPU.
- **Memory & Storage:** 4GB RAM (expandable to 8GB options), onboard 1G bit NAND storage, TF card slot (UHS-I mode).
- **Connectivity:** 4 × USB 3.0 Host Type-A, 1 × USB 2.0 Type-C, 1 × USB 2.0 UART, 1 × CAN FD, 40-pin header with 28 GPIOs (SPI, I2C, UART support).
- **Display:** 1 × 4-lane MIPI DSI interface, HDMI output up to 1080P/60fps.
- **Camera:** Dual 4-lane MIPI CSI interfaces.
- **Audio:** Onboard 3.5mm standard audio jack.
- **Network:** 1000M Ethernet with PoE, dual-band Wi-Fi 6, Bluetooth 5.4.
- **Power:** 5V/5A DC input (Type-C connector), external 5V/3.3V from 40-pin header.
- **Operating Temperature:** -20°C to 60°C.
- **Dimensions:** 85 × 56 × 20 mm.

4. RDK Platform Architecture

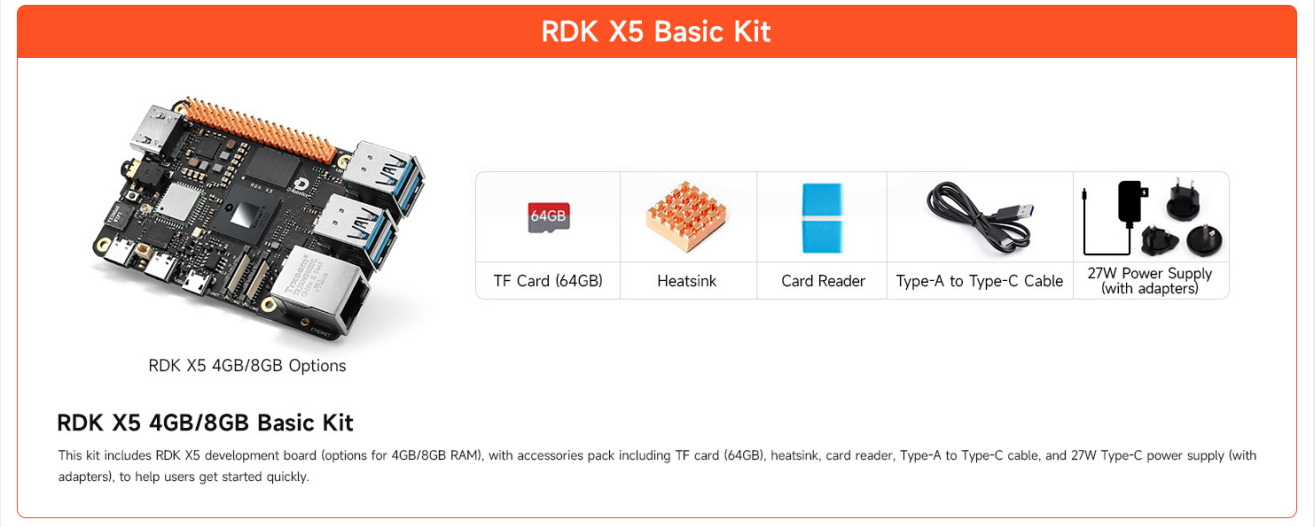
Understanding the board's architecture is crucial for effective development. The RDK X5 features a comprehensive layout of ports and interfaces to support diverse applications.



This image illustrates the RDK Platform Architecture, detailing the various ports and connectors on the development board. Key components include the RJ45 Ethernet Port, USB 3.0 ports, CAN FD High-Speed Interface, 40PIN GPIO, IPEX-1 External Antenna Connector, DSI Interface, TF Card Slot, HDMI Interface, 3.5mm Jack, RTC Battery Header, Type-C Power Supply, 2xCSI Interface, PoE Header, Debug Serial Port, and Multi-function Programming Port.

5. Powerful AI Computing and Algorithms

The RDK X5 is designed to handle advanced AI workloads, offering significant computing power and support for a range of algorithms essential for robotics and intelligent systems.

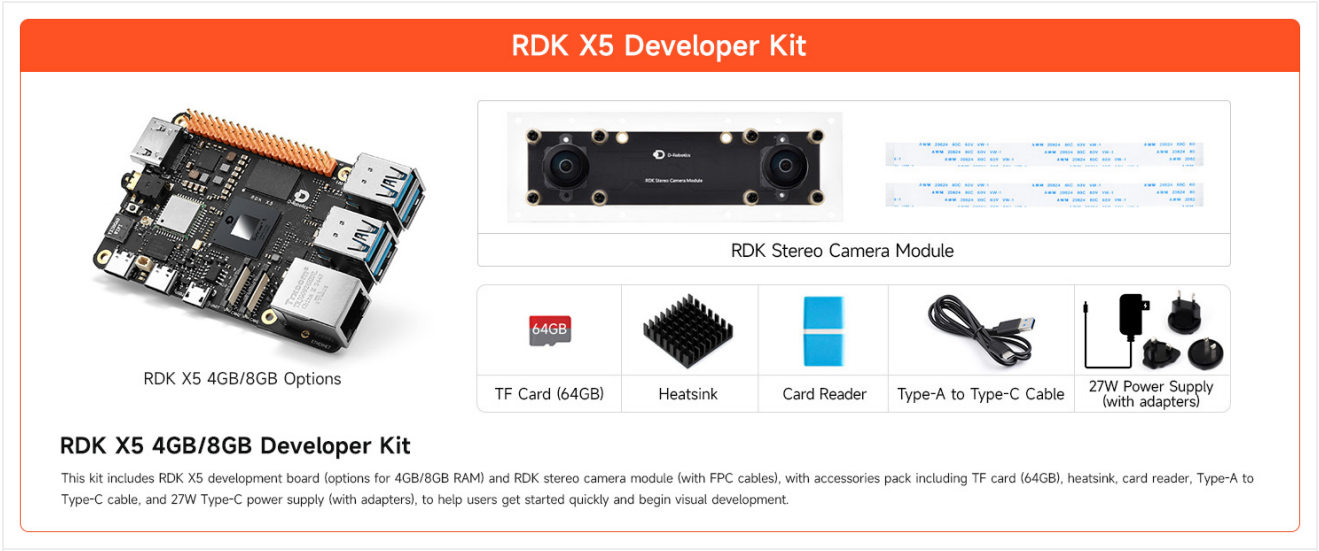


This image highlights the powerful AI computing capabilities and algorithms supported by the RDK X5. It shows a comparison of CPU and BPU performance, emphasizing its high cost-effective intelligent computing platform.

- Supports deployment of large models such as Transformer, RWKV, and CLIP.
- Natively supports Volcano Engine's LLM Gateway for advanced language models.
- Provides dedicated and efficient algorithms including Occupancy, Stereo, Perception, YOLO, and World.
- Performance benchmarks indicate significant execution speed improvements for intelligent algorithms compared to previous generations.

6. Minimalist Robotics Development Experience

The RDK X5 simplifies the robotics development process through its integrated design and versatile Type-C connectivity.

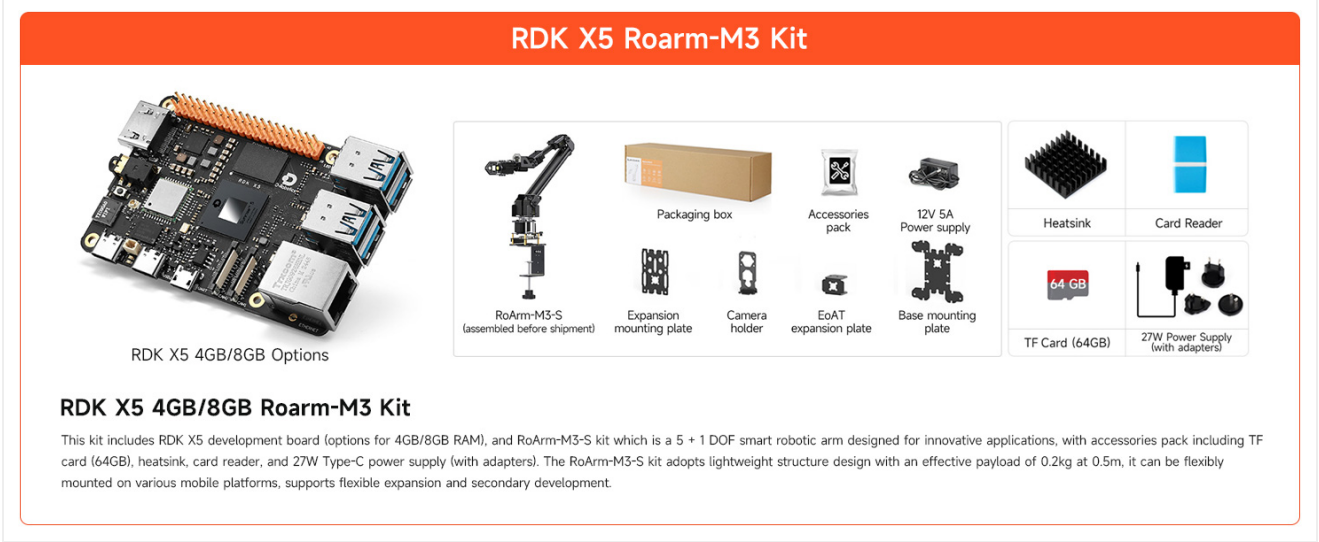


This image illustrates the simplified robotics development experience offered by the RDK X5, emphasizing that a single Type-C cable can manage numerous applications. It shows the RDK X5 connected to a laptop via a Type-C cable.

- A single Type-C cable can manage the entire development process, including system programming, demo execution, application development, desktop display, and hardware monitoring.
- The RDK X5 is a full-stack robotics development platform, integrating RDK OS, RDK Nodehub, RDK Studio, and RDK Cloud.
- Onboard robotics development interfaces include mono/stereo MIPI, USB3.0 × 4, CAN, audio/video, and PWM, reducing the need for external conversion modules.

7. Upgrading Boards

Follow these steps to upgrade the RDK X5 board firmware or operating system:



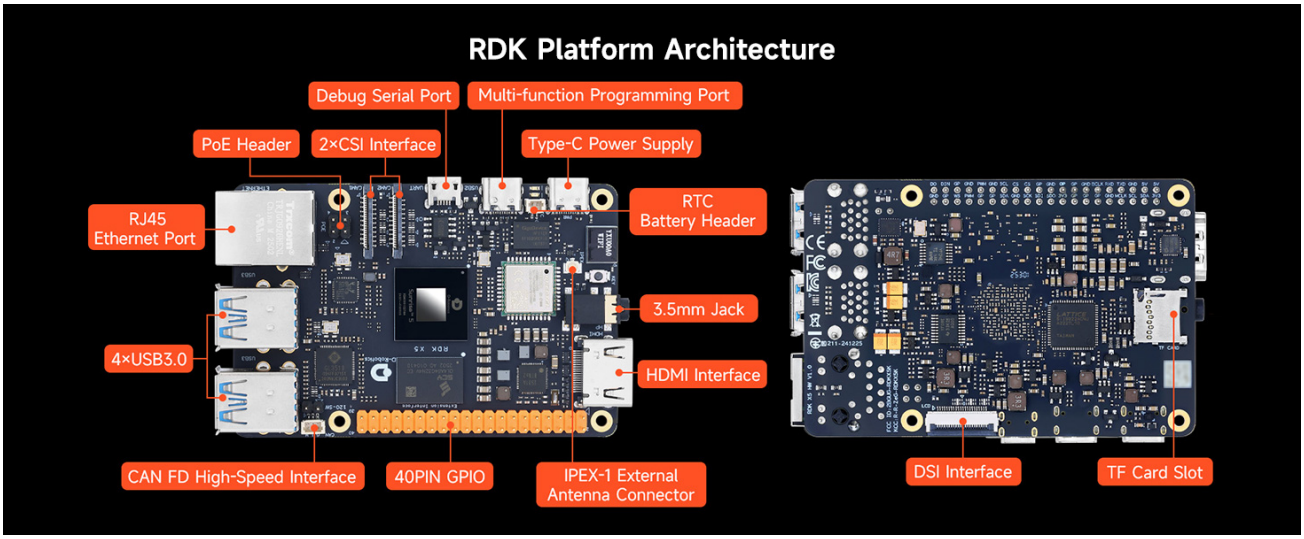
This image provides a step-by-step guide on how to upgrade the RDK X5 board. It shows the process of inserting a TF card, connecting the board to a computer via Type-C, pressing the switch, and connecting the power supply.

1. Locate the card slot on the back of the board and insert the prepared TF card with the upgrade image.
2. Use a Type-C cable to connect the RDK X5 board to your computer.
3. Press and hold the switch on the board, then connect the board to the computer simultaneously.

4. Connect another Type-C cable to the board for power supply. Release the switch after the board powers on for 3-5 seconds.

8. Quick Application Startup

The RDK X5 comes with pre-installed applications for immediate use, streamlining your development workflow.

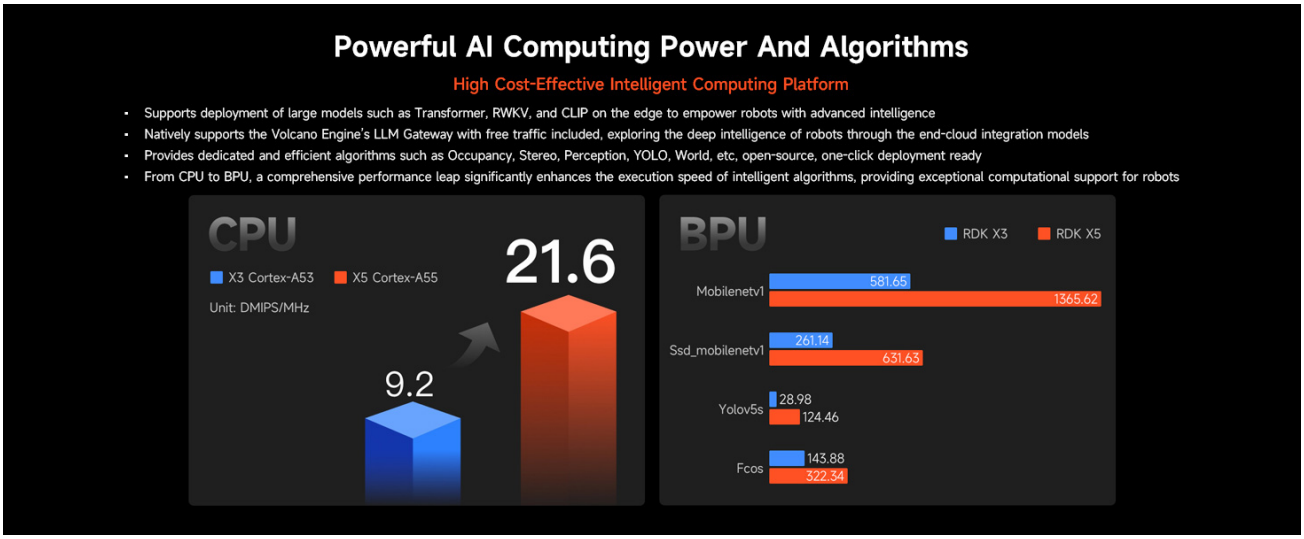


This image displays various built-in applications available for quick startup on the RDK X5, designed to streamline development work.

These applications allow for one-click startup, enabling you to focus on development tasks without extensive setup.

9. Unified Management of Development Boards

The RDK X5 platform offers tools for unified management of your development boards, providing insights into resource utilization and system status.



This image illustrates the unified management capabilities for RDK X5 development boards, showing graphical representations of CPU, BPU, Memory, and Disk usage, and an interface for equipment management.

After integrating the board with the management software, you can quickly retrieve the status of each board, including CPU, BPU, memory, and disk usage.

10. Comprehensive Community Ecosystem Support

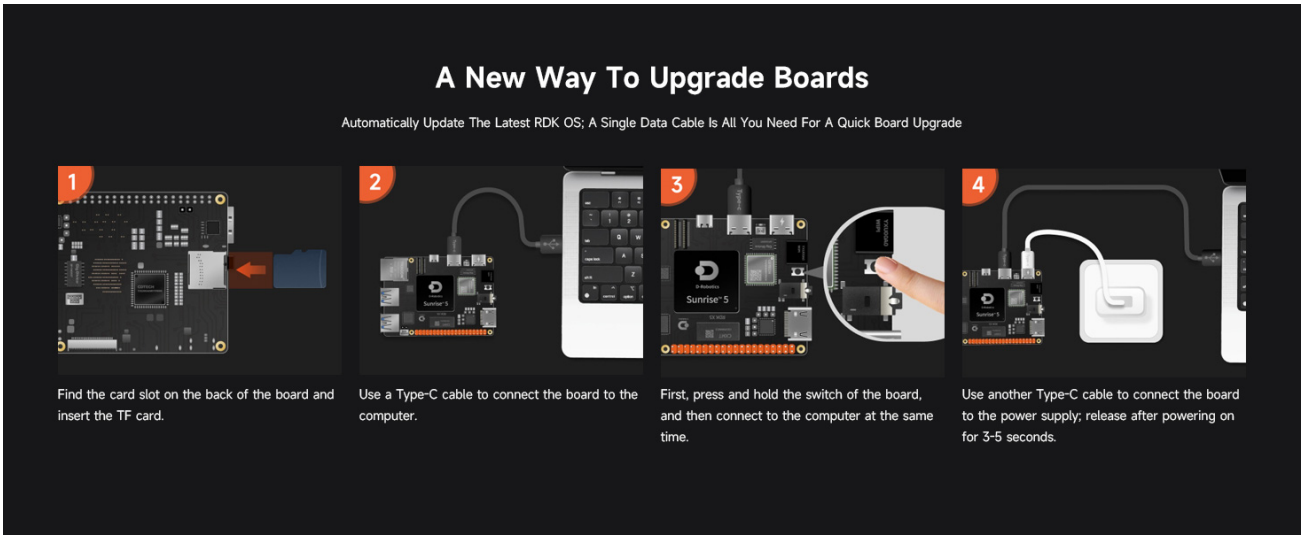
Waveshare provides a robust ecosystem to support your robotics development journey.

This image highlights the comprehensive community ecosystem support available for RDK X5 users, including access to resources, a large developer community, and hands-on practice opportunities.

- Access to hundreds of accessories and robotics kits.
- Join a community of over 100,000 developers for knowledge sharing and support.
- Benefit from rich content and diverse competitions to enhance your technical skills.

11. NodeHub - Intelligent Robot Application Center

NodeHub serves as an intelligent robot application center, designed to empower robotics enthusiasts in developing intelligent robots efficiently.



This image introduces NodeHub, an intelligent robot application center tailored for robotics enthusiasts. It emphasizes rapid deployment, easy expansion, and development and sharing features.

- **Rapid Deployment:** Achieve node deployment with a 100% success rate in just one minute.
- **Easy Expansion:** Combine nodes via configuration for advanced applications without complex programming.
- **Develop and Share:** Access all project source code on GitHub, fostering open sharing and collaboration.

12. Advantageous Algorithm Matrix

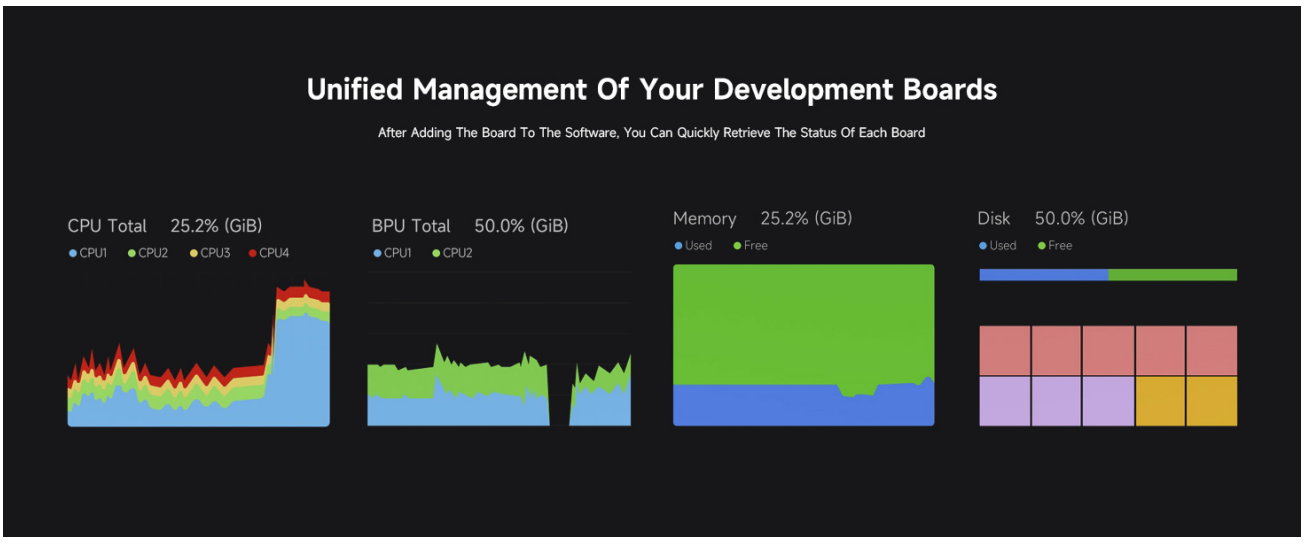
The RDK X5 integrates advanced algorithms to enhance robotic perception and decision-making.

This image showcases the advantageous algorithm matrix of the RDK X5, featuring Keypoint Detection and Matching Based On Deep Learning, Stereo Depth Estimation Algorithm, and Occupancy for precise 3D geometry and semantic information.

- **Keypoint Detection and Matching:** Utilizes deep learning for robust feature detection.
- **Stereo Depth Estimation:** Provides accurate depth perception for environmental understanding.
- **Occupancy:** Offers precise 3D geometry and semantic information for obstacle avoidance and local path planning.

13. Outline Dimensions

The physical dimensions of the RDK X5 development board are provided for integration planning.



This image provides the outline dimensions of the RDK X5 development board, showing its length as 85mm and width as 56mm.

The RDK X5 board measures 85mm in length and 56mm in width.

14. Setup Instructions

Follow these general steps to set up your RDK X5 Developer Kit:

1. **Prepare TF Card:** Insert the provided 64GB TF card into the card reader, then connect it to your computer to

flash the desired operating system or development environment. Refer to the Waveshare Wiki for specific OS images and flashing tools.

2. **Install Heatsink:** Attach the heatsink to the main processor on the RDK X5 board to ensure proper thermal management during operation.
3. **Connect Camera Module:** Carefully connect the RDK Stereo Camera Module to the MIPI CSI interfaces on the RDK X5 board using the FPC cables. Ensure correct orientation and secure connections.
4. **Insert TF Card:** Once the OS is flashed, insert the TF card into the dedicated slot on the RDK X5 board.
5. **Connect Peripherals:** Connect any necessary peripherals such as a display via HDMI or MIPI DSI, a keyboard and mouse via USB 3.0 ports, and network cables to the RJ45 Ethernet port.
6. **Power Connection:** Connect the 27W PD power supply to the Type-C power input on the RDK X5 board. Use the appropriate plug adapter for your region.

15. Operating Instructions

Once the RDK X5 Developer Kit is set up, follow these steps for initial operation:

1. **Power On:** After connecting the power supply, the board should automatically power on and begin booting the operating system from the TF card.
2. **Initial Boot:** Allow sufficient time for the first boot process, as it may involve system configuration.
3. **Access Interface:** Depending on your setup, you can access the RDK X5 via a connected display, SSH over the network, or a serial console via the UART port.
4. **Software Development:** Utilize the pre-installed development tools and environments, or install additional software as required for your specific AI and robotics projects.
5. **Shutdown:** Always perform a proper system shutdown through the operating system interface before disconnecting power to prevent data corruption.

16. Maintenance

Proper maintenance ensures the longevity and optimal performance of your RDK X5 Developer Kit:

- **Keep Clean:** Regularly clean the board and heatsink to prevent dust accumulation, which can hinder cooling efficiency. Use compressed air or a soft brush.
- **Environmental Conditions:** Operate the board within the specified temperature range (-20°C to 60°C) and avoid high humidity environments.
- **Cable Management:** Ensure all cables are securely connected and not under strain. Avoid bending FPC cables sharply.
- **Software Updates:** Keep the operating system and installed software up to date to benefit from performance improvements and security patches.
- **Storage:** When not in use, store the kit in a dry, anti-static environment.

17. Troubleshooting

If you encounter issues with your RDK X5 Developer Kit, consider the following troubleshooting steps:

- **No Power:** Ensure the 27W PD power supply is correctly connected and functioning. Verify the Type-C cable is fully inserted.
- **No Display Output:** Check HDMI or MIPI DSI cable connections. Ensure your display is set to the correct input source. Verify the OS image is properly flashed and booting.

- **Peripheral Not Detected:** Confirm USB devices are properly connected. For network issues, check Ethernet cable or Wi-Fi configuration.
- **System Instability:** Ensure the heatsink is correctly installed and the board is not overheating. Check power supply stability. Re-flash the OS if software corruption is suspected.
- **Camera Module Issues:** Verify FPC cable connections to the MIPI CSI interfaces. Ensure camera drivers are installed and configured in the OS.

For more detailed troubleshooting guides and solutions, refer to the official Waveshare Wiki resources.

18. Support and Resources

Waveshare provides extensive resources to assist you with your RDK X5 Developer Kit:

- **Official Wiki:** Access detailed documentation, tutorials, code examples, and community forums. Visit the Waveshare store page and look for the Wiki link.
- **Community Support:** Engage with a large community of developers for assistance and project ideas.
- **Contact Support:** For specific technical issues not covered in the Wiki, contact Waveshare customer support through their official channels.