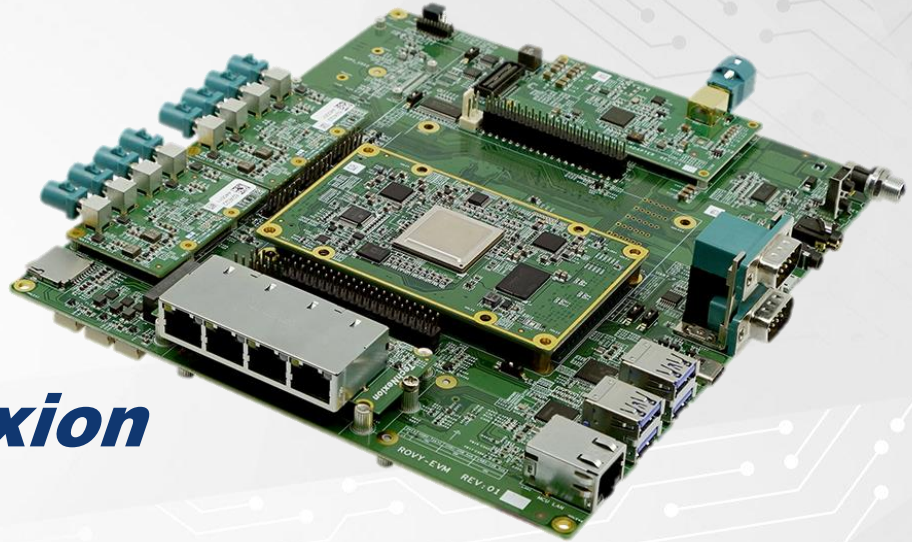
Build cost-effective robots faster with ROVY-4VM based on TDA4VM processor

Feb. 23rd, 2023



TechNexion

Texas Instruments

Our Presenters

Texas Instruments

Brian Berner

Brian is a Marketing Manager working with global partners to deliver system-level solutions using TI's portfolio of Arm®-based processors. The Platform Marketing team is dedicated to creating a thriving ecosystem built around low-cost starter kits, open-source SBC community boards, and a wide range of SOM offerings to help customers go to market faster.

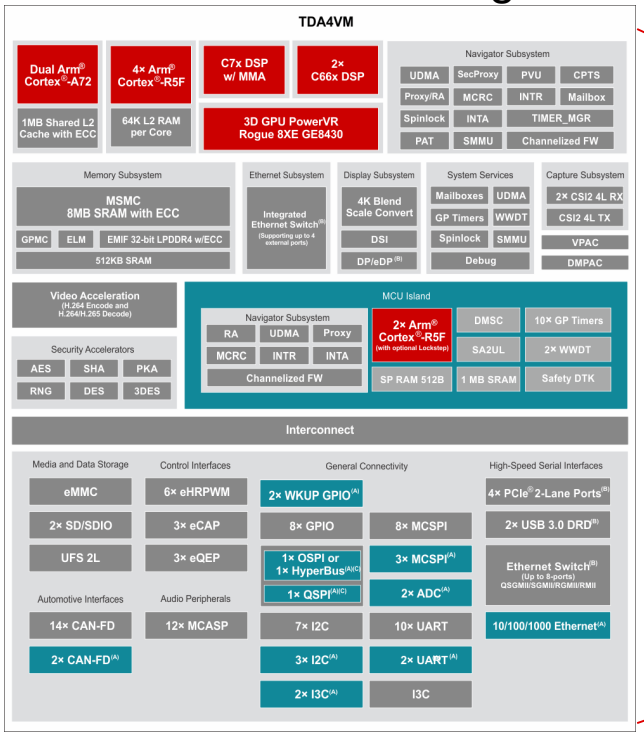
TechNexion

John Weber

As business development engineer for TechNexion, he supports all TechNexion products and customers in the North and South America and he leads the development of the ROVY product line, TechNexion's robotics and industrial-focused embedded compute platform based on TI's Jacinto processor family. Established in 2001, TechNexion Ltd. is a Taiwan-based turnkey embedded solutions company with products ranging from system-on-modules, embedded computers, wireless, and vision solutions.

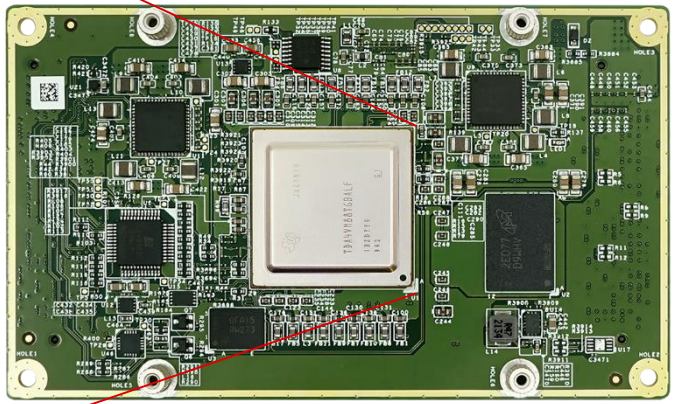
TI Processors | TDA4VM block diagram + SoM

SoC functional block diagram

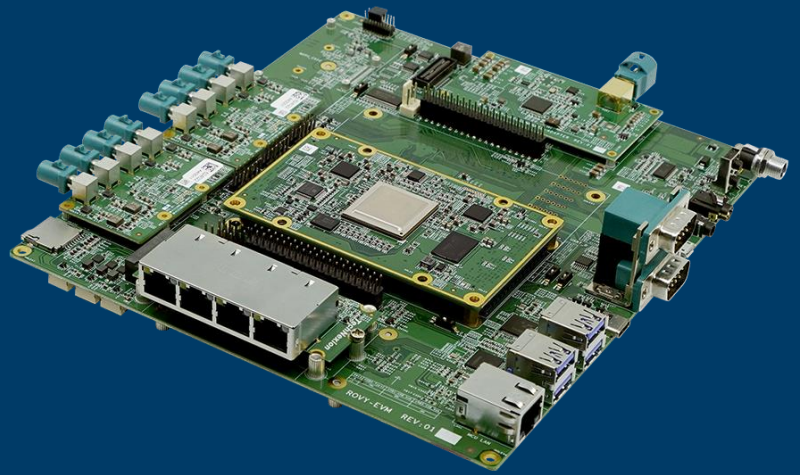


TechNexion System-on-Module

ROVY-4VM populated with TDA4VM



Building cost-effective robots faster with ROVY-4VM



TechNexion
INNOVATORS OF TECHNOLOGY

Who we are

A Turnkey Embedded Solutions Company

- **Founded in 2001**
- **140+ employees**
- **50% employees R&D related tasks**
- **High-end fully automated Manufacturing Facility**
- **ISO-9001 / ISO-14001 / ISO-13485 certified**


SGS
TechNexion Ltd.
ISO 9001:2015


SGS
TechNexion Ltd.
ISO 14001:2015


SGS
Produxion Ltd.
ISO 13485:2016
EN ISO 13485:2016

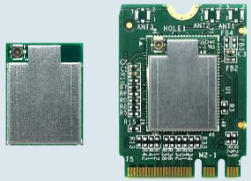
TechNexion Product Ecosystem

2001
Embedded Product Design

2008
System on Modules

2015
Fanless Systems and Panel computers

2018
Wireless

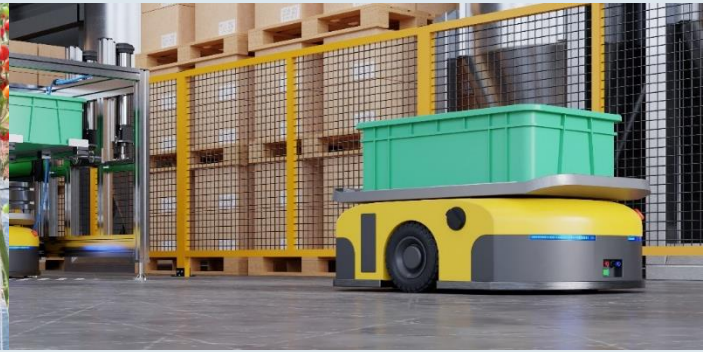


2022
Embedded Vision

2023
Robotic and Sensor solutions

Our motivation

- **Robots are going to change the way we live, work, and play**
  - 4Ds: **D**ull, **D**irty, **D**angerous, or **D**ifficult
- **Robotic systems should be safer, easier to develop, and easier and maintain**



Market Predictions: Warehouse Automation

Warehouse Automation

34.13%
CAGR for AMR through 2030
Source: Next MSC

>1 million
AMR Installed by end of 2024
Source: Interact Analysis

53,000
Factories with AGV/AMR installed by end of 2025
Source: Interact Analysis

Drivers

Labor shortages	Demand for faster, cheaper delivery	Rising labor costs
eCommerce	COVID-19	Need to reduce strenuous labor

Market Predictions: Agricultural Robots

Agricultural Robots

34.4%
CAGR for Agricultural through 2030
Source: Emergen Research

$82B
Market size in 2028
Source: Blueweave Consulting

Drivers

- Decreasing workforce
- Public Subsidies
- Increasing population
- Technological advancements

Robots today

- **Expensive to develop and build**
  - Integrates many off-the-shelf components
  - Elevates component cost
  - Increases integration cost
  - Limits minimum system size

- **RaaS (Robot as a Service) business models**
  - Lowers upfront end customer capital expenditure
  - Prioritizes platform cost optimization

Off-the-shelf Electronics

Industrial PC +
Vision processing +
AI acceleration +
Wireless router +
Ethernet switch +
Safety PLC +
Hubs/Adapters +
Sensors

Average AMR cost

20K USD

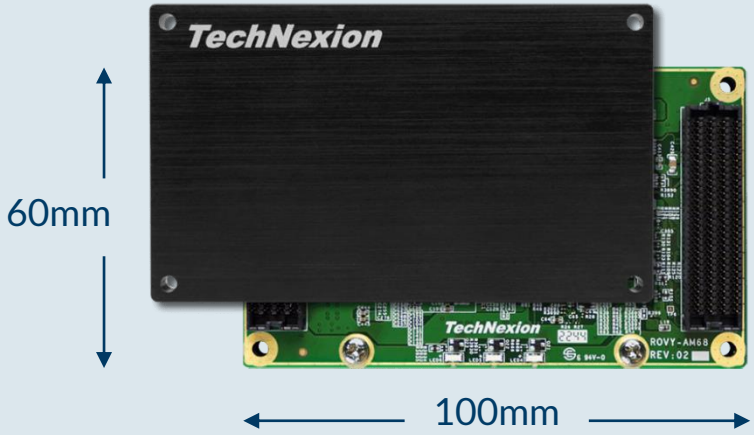
IPC-based AMR System

Wheel
Motor + Encoder
Drive System
Motor + Encoder
Wheel
Batter y
Onboard Power Regulation & Monitoring
Contacto r
Safet y Shut Off
E-Stop
Safety PLC
USD
Safet y Zone Signa l
2D LIDAR
2D LIDAR
ETH
ETH
UART
Primary Controller (IPC)
Vision/AI/ML Accelerators
USB/PCIe
MIPI
2D Camera
MIPI
2D Camera
USB
Depth Camera
USB
Depth Camera
UART
To Payload
USB
US B Hu b
USB
Adaptor
UART
GPS
USB
Adaptor
UART
IMU
USB
Adaptor
SPI
LED Driver
ETH
ETH
ETH
Ethernet Switch
ETH
Industrial WLAN
ETH
Cellular

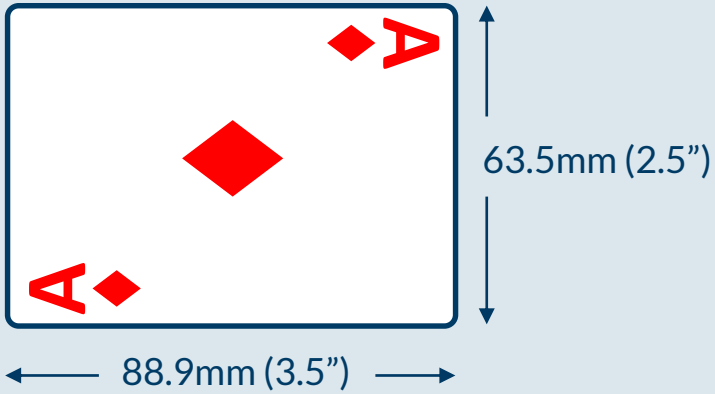
Enabling Compact, Cost-efficient Robots

Compute power of an IPC + video coprocessor + AI/ML accelerator + safety processor + 8-port GbE switch + industry-leading embedded I/O

ROVY-4VM

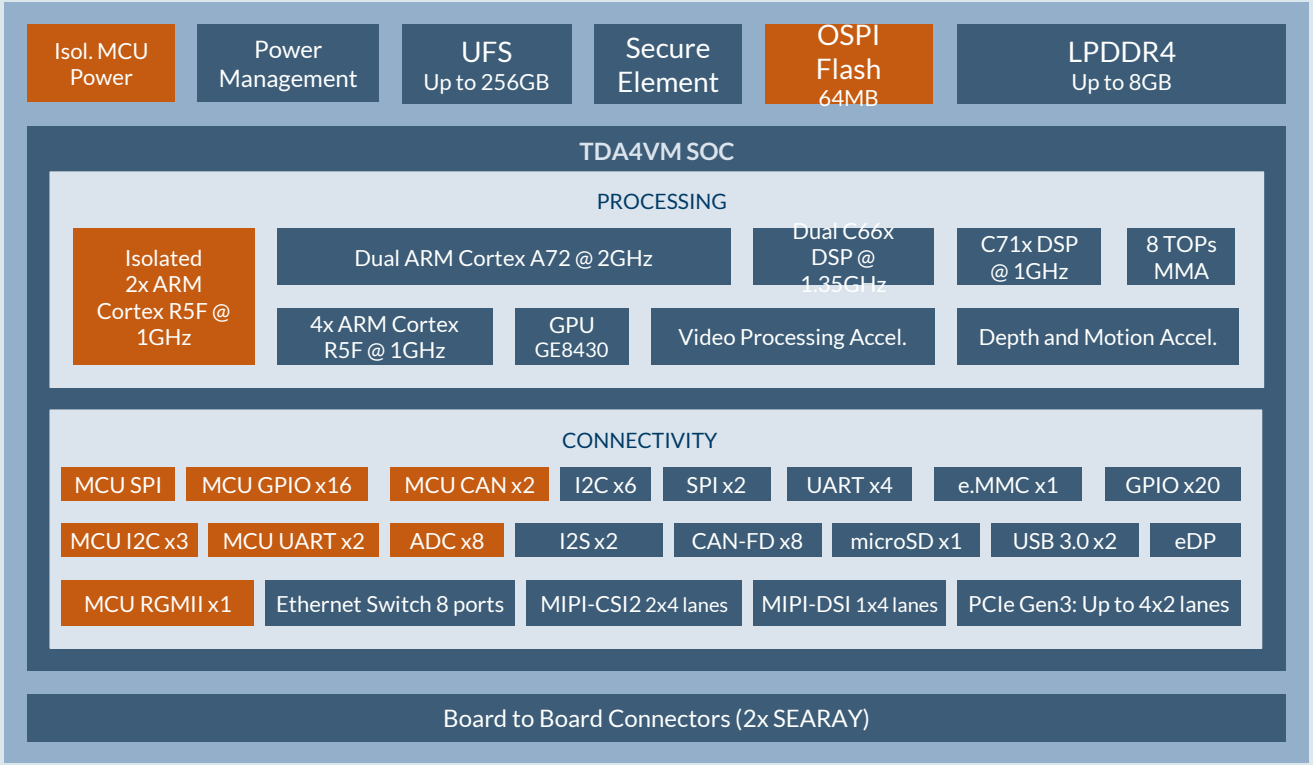


Playing Cards



ROVY-4VM Overview

- **Compute Processing Power**
  - General-purpose compute: 2x ARM Cortex A72 @ 2GHz
  - Realtime processing: 6x ARM Cortex R5F @ 1GHz
  - Video and signal processing: 2x C66x DSPs + 1 C71x DSP up to 112 GFLOPS
  - AI acceleration: Up to 8 TOPs
- **Functional safety certifiable**
  - Isolated lockstep MCUs, ECC on internal SRAM & inline ECC on LPDDR4, ASIL-D power design
- **Accelerated Vision Processing**
  - Video preprocessing up to 600 MP/sec, motion and stereo processing engine
  - Capture up to 8 cameras via MIPI virtual channels
  - Hardware H.264 video decode/encode
- **Industrial Temperature Range:**
  - -40 to +85C
- **Availability: Q2 2023**

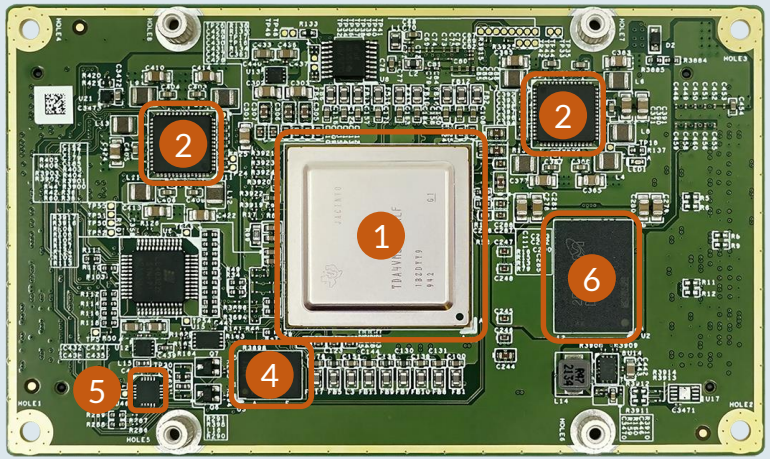


Module Features

1 TDA4VM SOC
2x A72, 6x R5F, 3x DSP, 8 TOPS
Video, ISP, Acceleration, 9 GbE, 4 PCIe.
10 CAN-FD

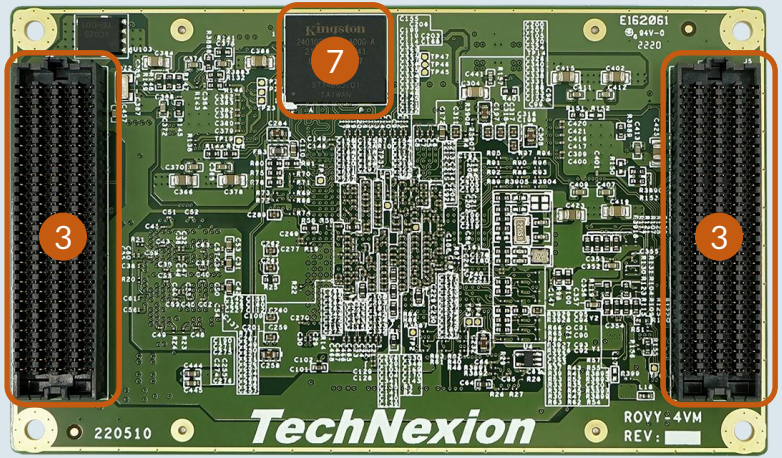
2 Dual PMIC
Supports isolated safety MCU

3 Baseboard Connectors
2x 240-pin SEARAY



60mm

100mm



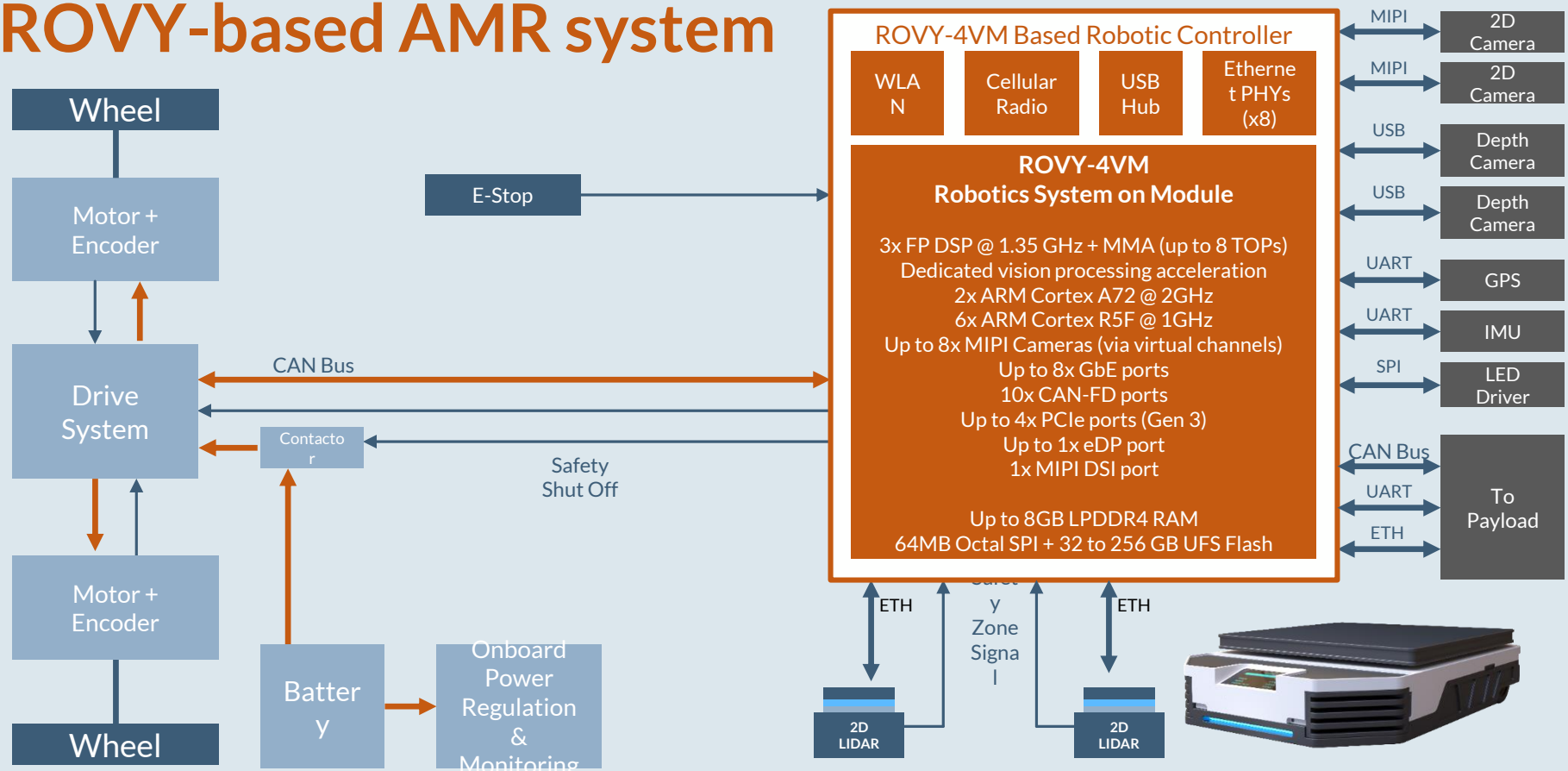
4 Octal SPI Flash
Up to 512MB

5 Secure Element
Auth, key storage, provisioning

6 Up to 8GB LPDDR4
With inline ECC

7 UFS Flash Storage
Up to 256 GB

ROVY-based AMR system



Robotic System Block Diagram

Up to **8x** VisionLink Cameras

ROVY-4VM
Robotics System on Module

Board to Board Connectors

I/O Breakout

VizionLink x1 | x2 | x4 FPDLink III — MIPI-CSI2

VizionLink x1 | x2 | x4 FPDLink III — MIPI-CSI2

VizionPanel or HDMI FPDLink III — MIPI-DSI

USB 3 Hub

GbE PHY

microSD

M.2 WLAN/BT

M.2 WWAN (4G/5G)

M.2 nVME Storage

IMU

Ethernet x8

USB x4

Audio in/Out

User HMI Connector

Payload Connector

Digital I/O

CAN

Power Interconnect

Power Management and Drive Control

Power Out

Digital Control

2D LIDAR

Stereo Depth Camera

User voice interaction

User HMI Panel

Power button, Display, E-Stop

Payload

Arm, Lift, Sensors, etc.

Display User Interface

Vehicle Battery

Battery Connector

Contactors

Drive Motors

Encoders

UAV/Drone System Block Diagram

Up to **8x** VisionLink Cameras

ROVY-4VM
Robotics System on Module

Board to Board Connectors

I/O Breakout

VizionLink x1 | x2 | x4 MIPI-CSI2

VizionLink x1 | x2 | x4 MIPI-CSI2

USB3 Hub

GbE PHY

FMU

IMU

GPS Module

M.2 WWAN (4G/5G)

M.2 nVME Storage

M.2 WLAN/BT

Ethernet x4

USB x4

microSD

GPS Connector

User HMI Connector

Payload Connector

CAN Connectors

Power Interconnect

Power Management and Drive Control

Battery Connector

Power Out

Vehicle Battery

2D LIDAR

Stereo Depth Camera

GPS Antenna

User HMI Panel

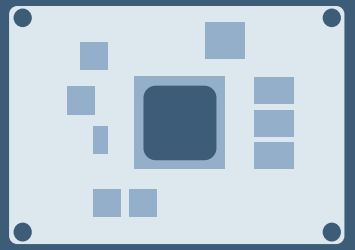
Power button, Display, E-Stop

Payload

Camera, Actuators, LEDs

CAN ESC

ROVY Family Roadmap



ROVY-4VM

- 3x FP DSP up to 8 TOPS
- 2x ARM Cortex A72 @ 2GHz
- 6x ARM Cortex R5F @ 1GHz
- Up to 8GB RAM x32b @ 4266 MT/s
- Up to 9x Gb Ethernet
- Up to 4x PCIe
- 2x MIPI-CSI2, up to 8 VizionLink cameras
- 1x MIPI DSI Display

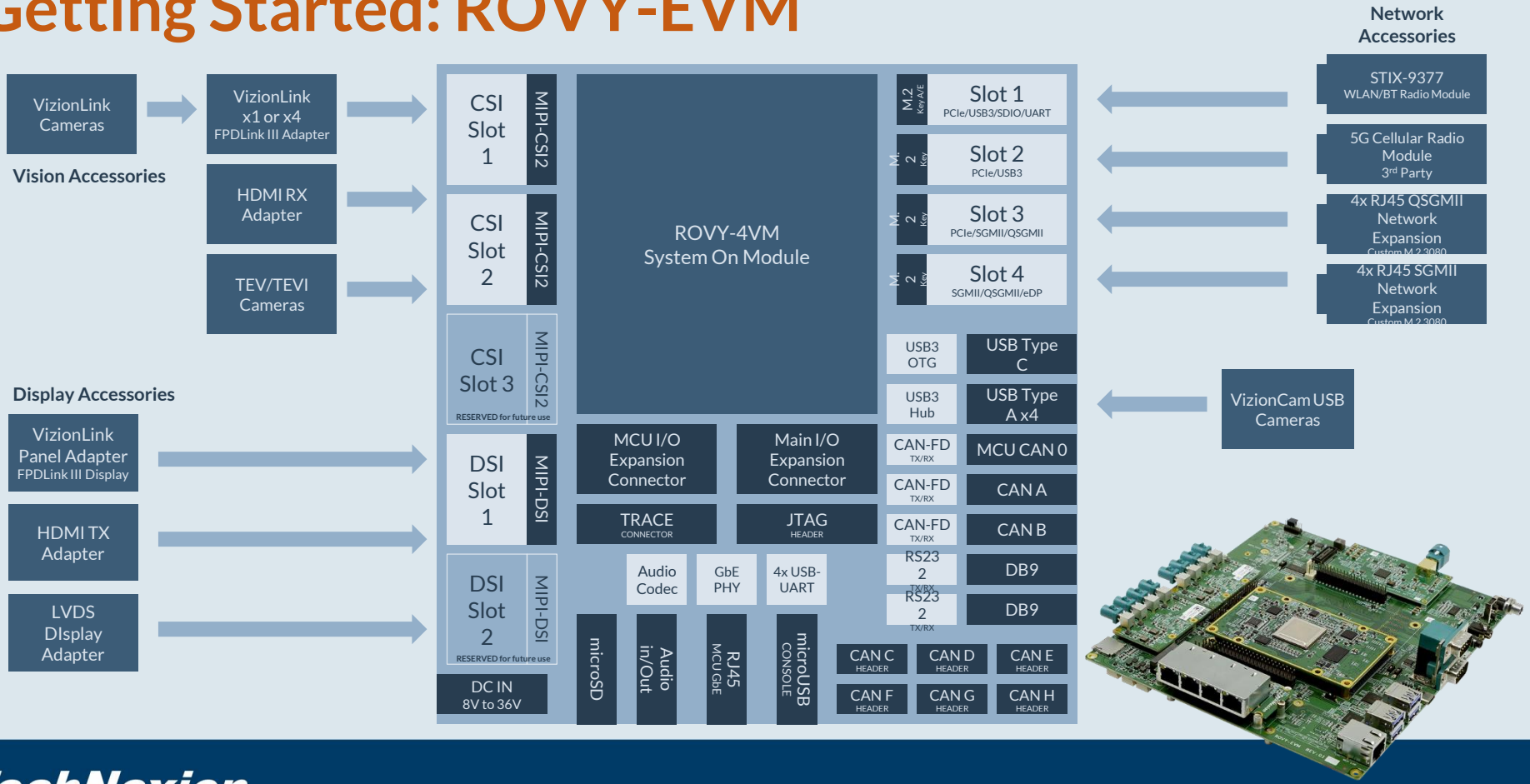
ROVY Next

- **4x DSP compute (up to 32 TOPS)**
- **4x General Purpose Compute**
- 6x ARM Cortex R5F @ 1GHz
- **Up to 32GB RAM x128b** @ 4266 MT/s
- Up to 9x Gb Ethernet
- Up to 4x PCIe **(add x4 lane support)**
- 3x MIPI-CSI2, up to 12 VizionLink cameras
- 2x MIPI DSI displays

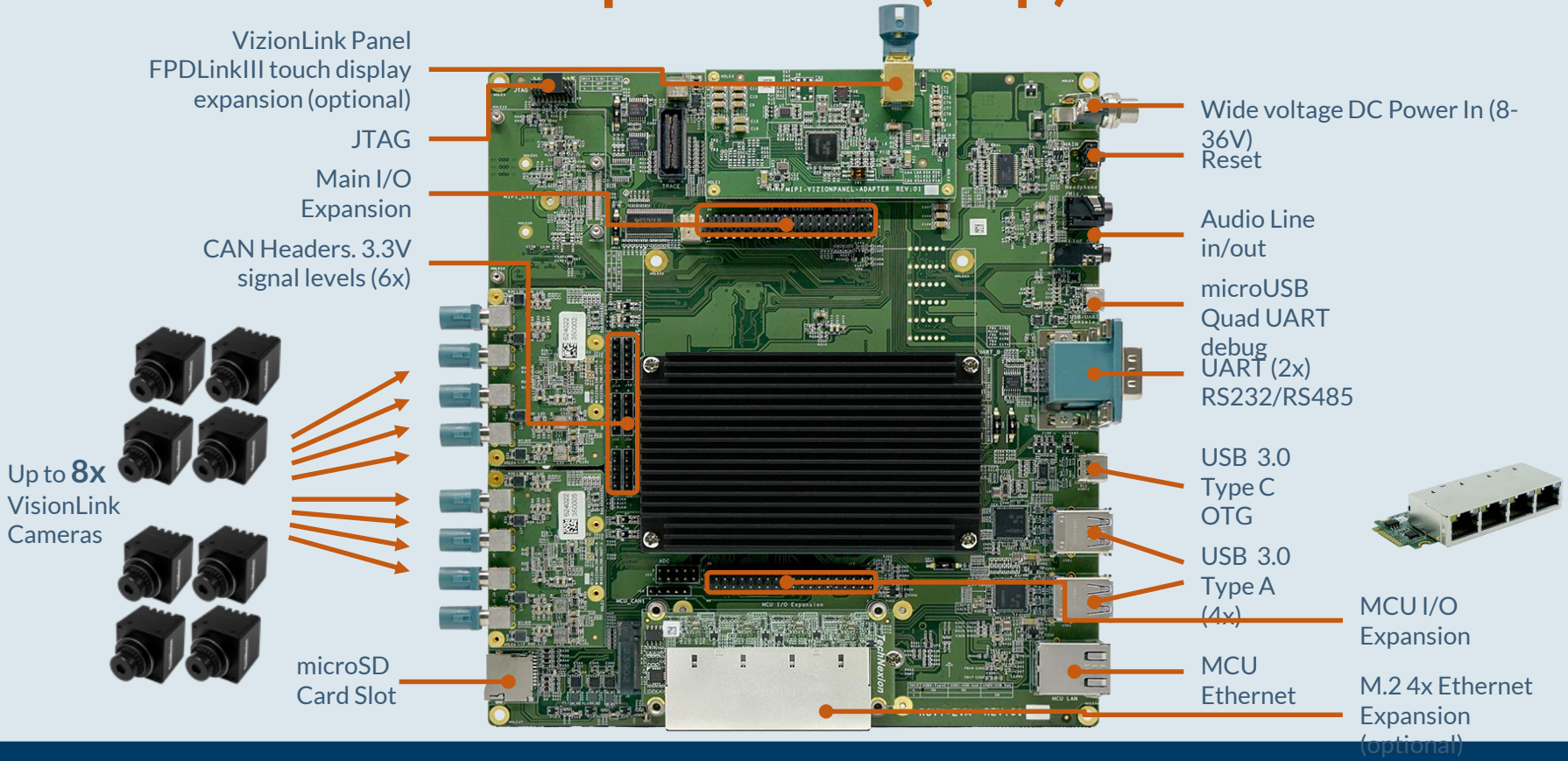
ROVY-4VM Safety Features

- **Designed with TI TDA4VM Jacinto™ 7 SOC**
  - Certifiable with mixed criticality
    - IEC 61508:2010 SIL-3 Systematic integrity
  - In-line ECC on LPDDR4 and on-board SRAMs
  - Additional built-in hardware diagnostics and software diagnostics for fault coverage
- **Isolated Dual-core Cortex R5F MCU subsystem for safety processing**
  - Independently powered, dedicated boot flash (Octal SPI)
  - Lockstep operation able to detect and catch errors in execution
  - Dedicated peripherals (2x CAN, 3x I2C, SPI, RGMII, GPIO, 8x ADC)
  - Monitor all safety-critical systems (power, sensing, actuation)
- **SIL-3 certifiable power management system**
  - All power rails are monitored for over voltage and current
  - Input supply monitored and protected for over voltage

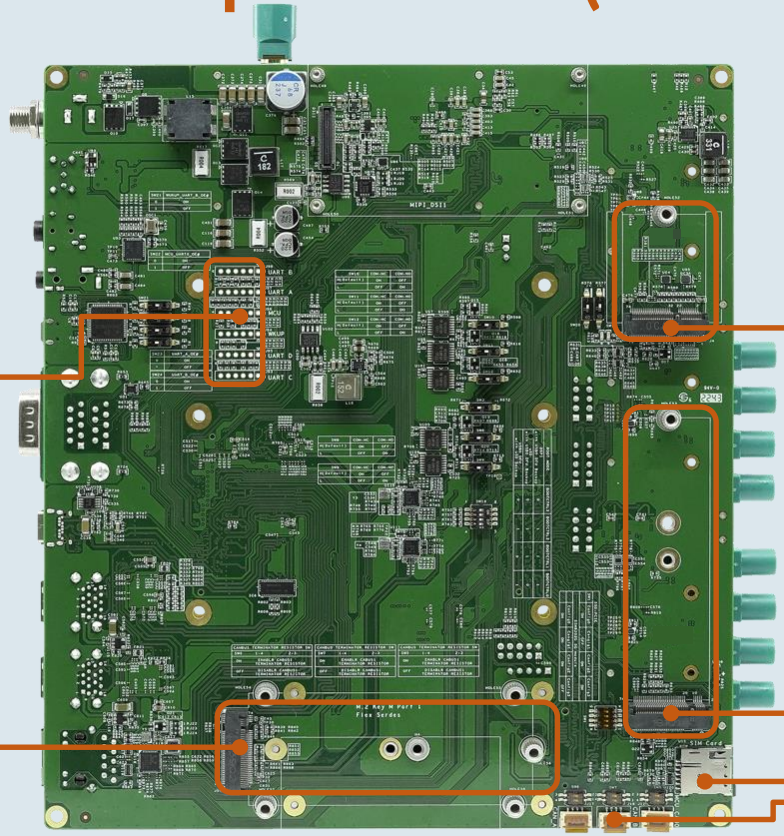
Getting Started: ROVY-EVM



ROVY-EVM Development Kit (Top)



ROVY-EVM Development Kit (Bottom)



UART headers (3.3V signal levels)

M.2 Key E Slot (PCIE_A/USB)

M.2 Key B Slot (PCIE_B/USB)

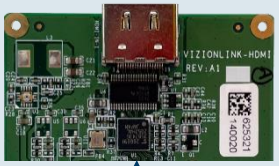
Nano SIM Slot

CAN ports (3x)

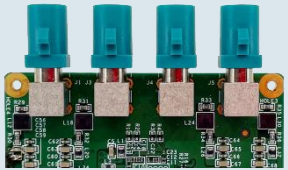
M.2 Key M Slot (NVME or QSGMII/SGMII network expansion

Adding cameras and displays

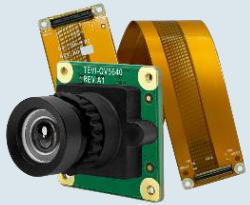
HDMI Capture
(HDMI input)

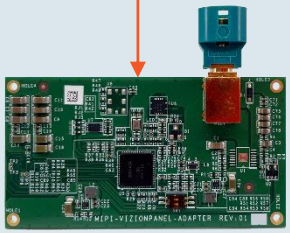


Vizionlink Camera
(FAKRA input)

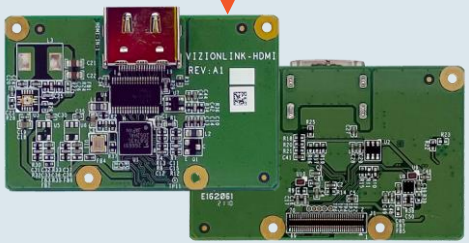


Camera Module
(MIPI-CSI2 input)





Vizionlink Panel
(FAKRA output)



Monitor
(Swap for MIPI-DSI to HDMI)

LCD Touchpanel Kits
(MIPI-DSI/LVDS)

Software Development

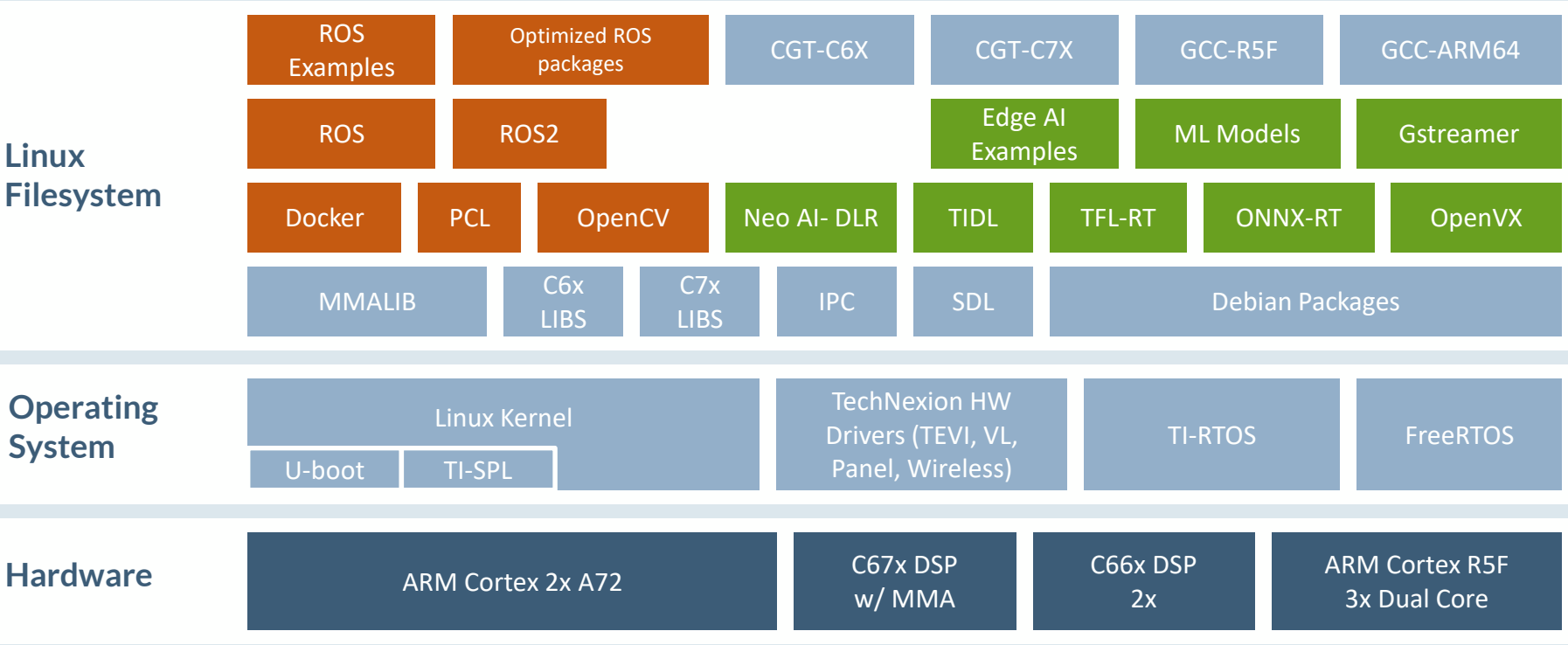
- **Getting Started: TechNexion Software Loader**
  - Easily install runtime images from the cloud
- **Operating System Support**
  - Yocto
    - Build your own distro, highly customizable, most control
    - Includes the most recent SDKs
    - More frequent releases
  - Debian
    - Easier application development out of the box
    - Pre-integrated support for ROS, ROS2, and TI optimized video/AI/ML hardware acceleration libraries
    - Less frequent releases

debian

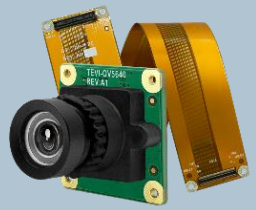
ROS 2

ROVY Software Stack

From PSDK | From Edge AI SDK | From Robotics SDK



Embedded Vision Product Overview



TEV / TEVI Camera Modules
Optional Image Signal Processor (ISP)
OEM Integration
S-Mount(M12) Lens Options
Resolutions from 1MP to 13MP
Global and Rolling Shutter

Vizioncam
C-Mount and S-Mount Lens Options
USB 3.2 Gen 1x1 Type-C Interface
Resolutions from 1MP to 13MP
Global and Rolling shutter

Vizionlink
High-speed Serial Link up to 15m
Single-wire Coax (FAKRA)
Robust, Compact, IP68 Housing
Resolutions from 1MP to 13MP
Global and Rolling shutter

On Semi Image Sensors

Rolling Shutter

Low light

- AR0521 5MP (H)
- AR0522 5MP (H, N)
- AR0821 8.3MP (H)
- AR0822 8MP (H, N)
- AR1335 13MP

Applications

Access Control
Image analysis
Security
Surveillance
Inspection
Microscopy
Drone

(H) **HDR+** : Captures images in high dynamic range modes.
(N) **Near-IR+** : Enhanced NIR response.

Global Shutter

Low Power

- AR0144 1MP
- AR0145 1MP Coming soon
- AR0234 2.3MP
- AR0235 2.3MP Coming soon

Applications

Navigation
High-speed Inspection
Failure Analysis
Machine Vision

VizionLink Panels

Vizionlink Panel Adaptor (FAKRA output)

Vizionlink-COAX4-Cable (up to 15m)

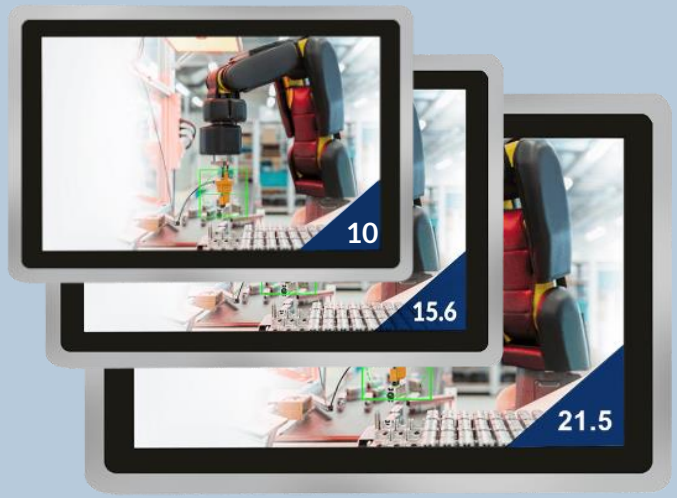
Vizionlink-COAX4-Cable-0300,
Length=**3M** for Vizionlink Display

Vizionlink-COAX4-Cable-0500,
Length=**5M** for Vizionlink Display

Vizionlink-COAX4-Cable-1500,
Length=**15M** for Vizionlink Display

VisionLink Panels

- Rugged FAKRA Connectors
- Multitouch PCAP touchscreens
- 10” , 15.6”, 21.5” sizes



Getting Started

- **Development kit**
  - Available for purchase on www.technexion.com
  - Optional Accessories (Cameras, Displays, Network Adapters)
  - Development software images
  - Source code published on Github (www.github.com/technexion)
- **Documentation**
  - Hardware manual
  - How-to guides and tutorials on developer portal (developer.technexion.com)
- **Contact information:**
  - John Weber: john.weber@technexion.com
  - General Sales: sales@technexion.com

For ROVY updates: