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ADI 高性能产品方案助力人形机器人应用设计

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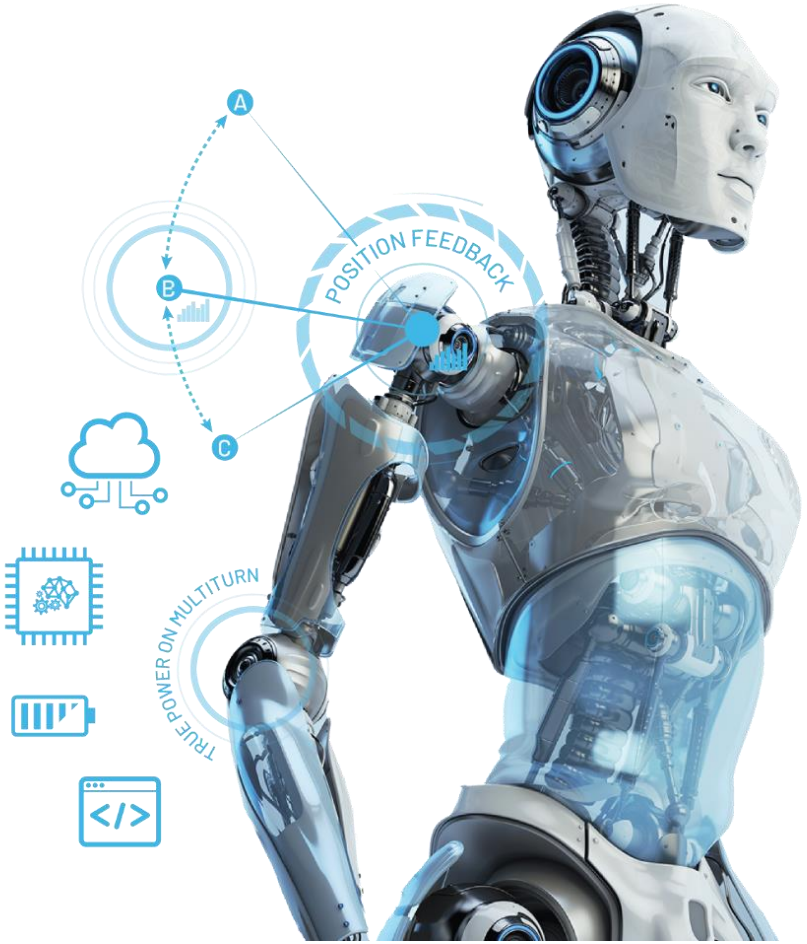
Focus and Overview of Content

- **How is the market**
  - Highest market growth within the Industrial Market space.
- **What is a Humanoid**
  - Clickable technology overview of a humanoid architecture.
- **How are ADI adding value to the Humanoid market**
  - Individual products and highlights on how to bring value to our customers.
- **What is our services**
  - A mix of standard product's, sub-system modules and partner solutions / products.
  - Key technology and new products releasing



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Humanoid Market Brief

Geographical Landscape: Humanoids Adoption

The regions developing humanoid robots are also the primary consumers, as the technology is still in its early stages of adoption. The adoption of humanoid robots across different regions is driven by **Technological advancements *(in space of AI)*, Labour shortages, Healthcare needs and Supportive government policies**.

Asia Pacific

- Holds the largest share, driven by high adoption rates in countries like *Japan, South Korea, and China*.
- Accounted for **53%** of the market in 2022.

North America

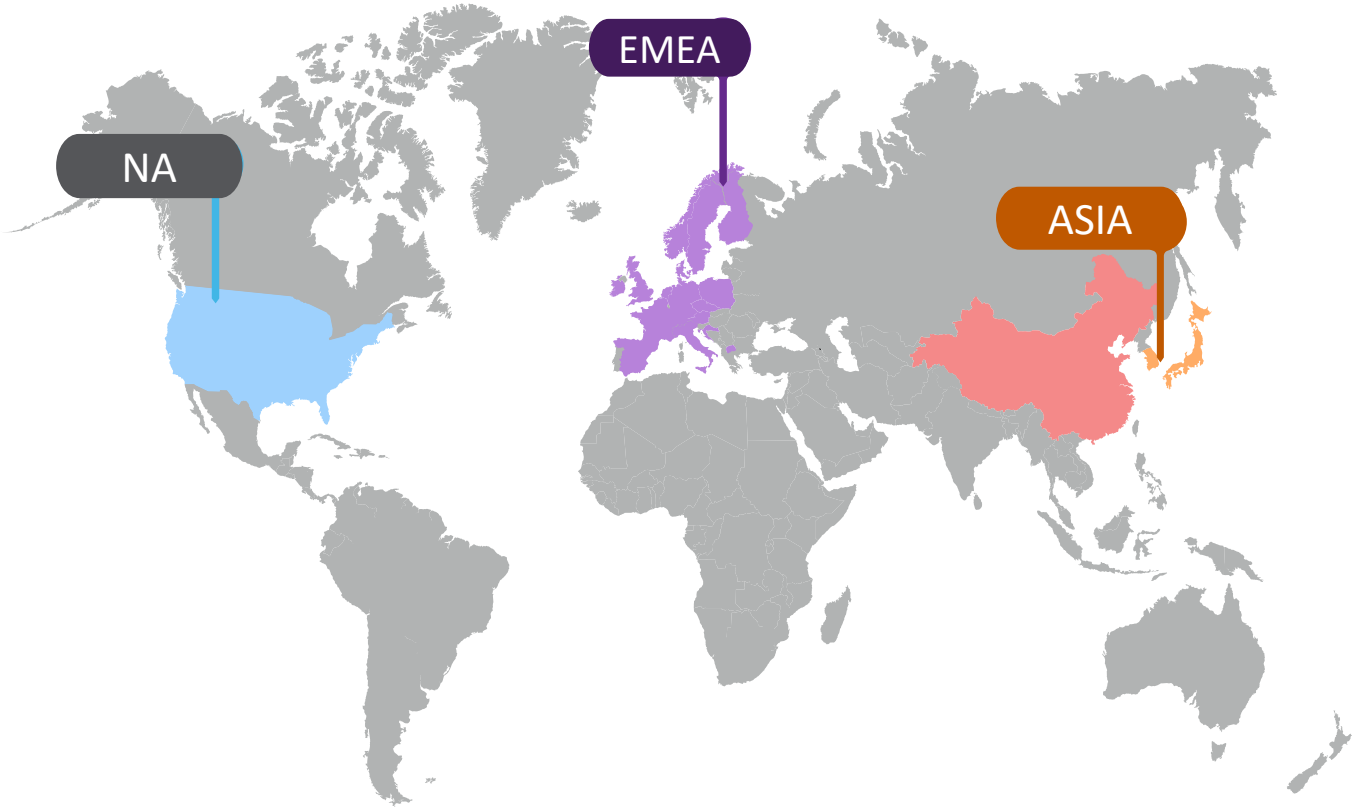
- Expected to see the fastest growth, with a CAGR of **22% driven by Tesla, Boston Dynamics, Apptronik and others** .
- Companies like **Tesla and Nvidia** are investing heavily in this technology, indicating confidence in its potential.

EMEA

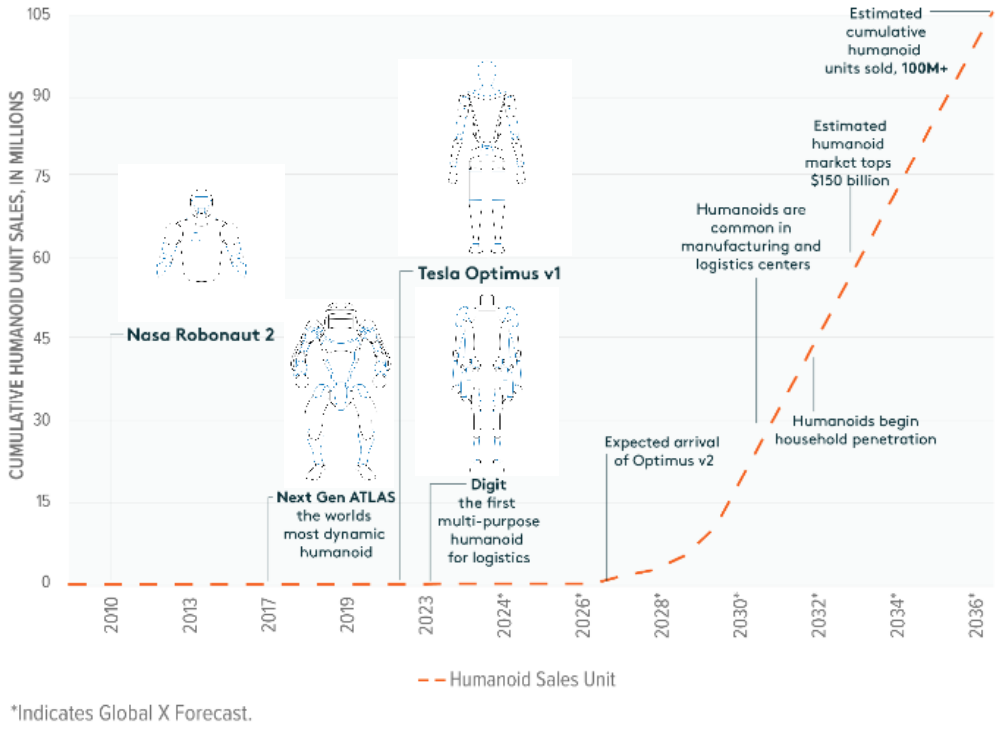
- Europe is a significant contributor within the EMEA region, with countries like Germany, the UK, and France leading the adoption of humanoid robots.
- Advanced industrial automation, government support for technological innovation, and increasing applications in healthcare and service industries.

Global Top Global Players

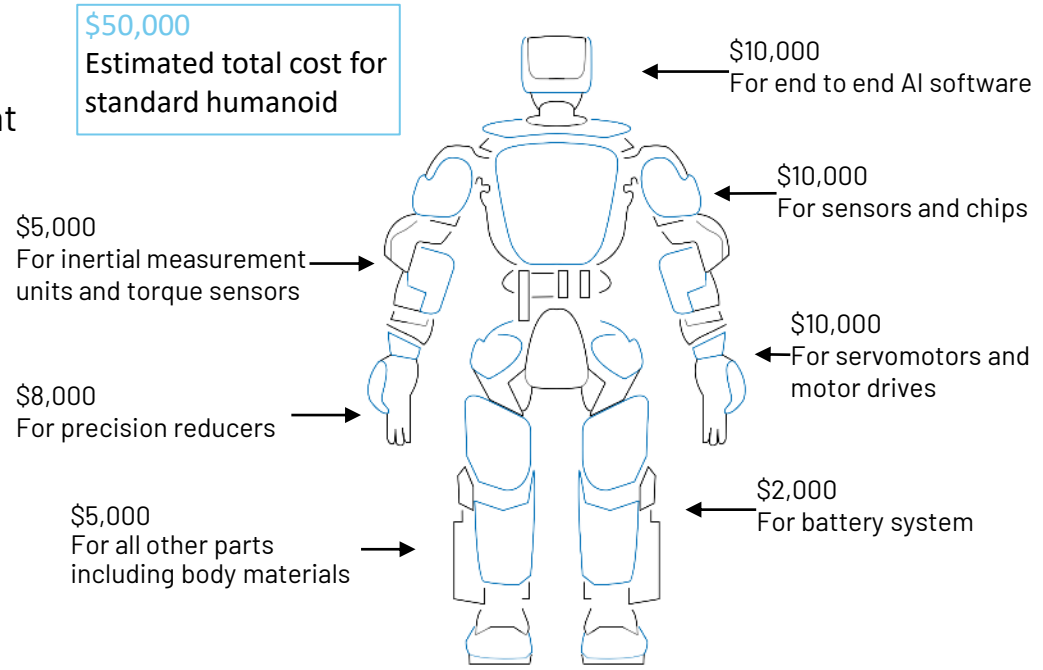
PAL, Agility Robotics, Apptronik, Fourier Intelligence, Boston Dynamics (Robotics company), Tesla, Figure, Sanctuary AI



Decreasing BOM Cost and Humanoid Growth Trend



- Market Potential **~$1.75T by 2035**
- Project Shipment **~15M in 2030**



- Recent technological breakthroughs and **decreasing production costs** make mass production and **adoption of humanoid robots more of a reality than ever**.
- Historical automobile industry trends and the growth of collaborative robots suggest that **humanoids are poised for mainstream adoption, fueled by technological advancements, supply chain challenges, wage inflation, and aging population.**
- **Investors looking for exposure to the humanoid market can find opportunities across the supply chain**, particularly in robotic manufacturers, AI chipmakers, sensor developers, and related component and material suppliers. Cloud infrastructure and data management software providers are also in line to potentially benefit from the increase in data generation.

Eco-system & Supply Chain

Upstream Industry: Components & Parts System Suppliers

Middle-stream Industry

Downstream Industry by application scenario

Actuator

Rotary actuator	Linear actuator	Multi-fingered hand
• Reducer, • Frameless torque motor • Torque sensor	• Trapezoidal screw • Coreless motor • Bearings	• Driver • Servo motor • Step motor

Sensing

Force sensor	• Torque sensor, magnetoelectric sensor, Pressure electrical sensor, torque sensor, etc.
Vision	• Lidar, 2D/3D Depth Camera, etc.
Encoder/ Magnetic Sensor IC	

Control & HMI

Algorithms and systems	Human-computer interaction, hand-eye coordination, vision and Navigation, language interaction, IoT
Processor	GPU, CPU

Power

Batteries, charging devices

Structural & Thermal component

Humanoid Robotic Suppliers' Types

- Robotics Development (IDM)
- Robot body design and Manufacture robots
- Robot System Integration (Software system integration Scene training)

Key Humanoid Robotic Suppliers'

- Overseas/USA
- Boston(Atlas), Tesla(Optimus Gen), Agility Robotics(Digit), etc.
- China
- Robot Research Institute (Nanjing, Shanghai)
- CloudMinds, AGIBOT, Fourier intelligence
- ...etc

Military Science

Industrial

- Automobile industry
- Electronics Assembly
- Coal mining, chemical industry, food processing, etc.

Service

- Home service,
- Restaurant, Shopping mall, etc.
- Public service, Security, Logistics
- Health care..etc

Humanoid Robot Technologies

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Humanoids - ADI's Core and System Offerings

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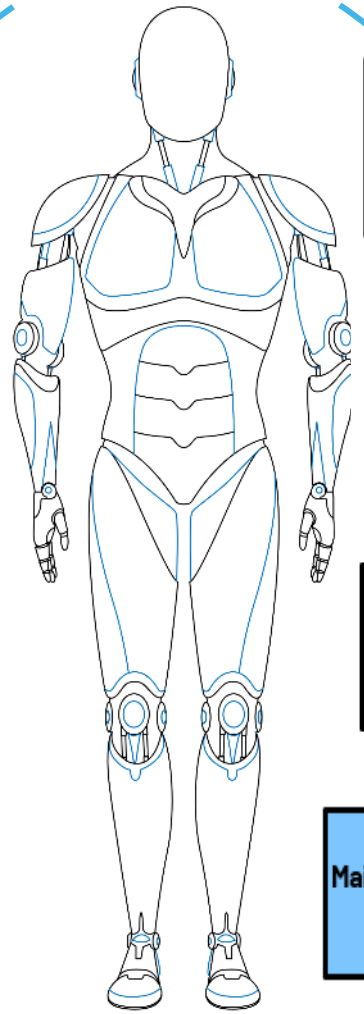
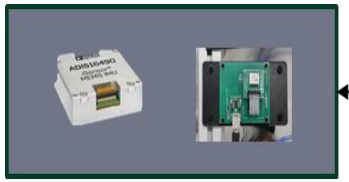


Sense Nodes
IMUs
Gyros

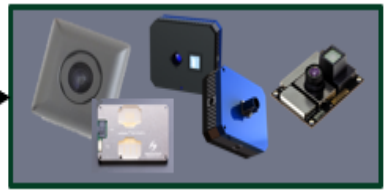
Environment Positioning



Navigation & Localisation - IMU

Depth Camera Navigation and imaging (3DToF) + Radar

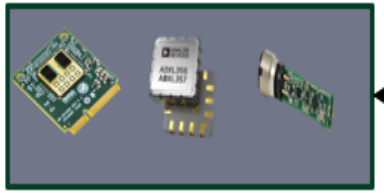
Environment Awareness



2-3 sensing zones
3D Depth imaging
Radar solutions

Physical & Cyber
MEMS vibration
Secur
Power Monitors

Collaboration and Engagement



Safety / Security Proximity, Vibration & Connect

Power Distribution & BMS

Efficiency & Uptime

Charging & Efficient Battery Operation
BMS
Hot Swap
Power Distribution

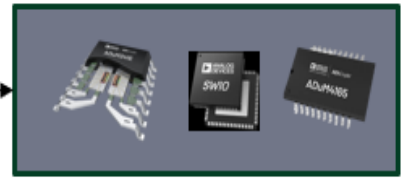
Hands & Fingers
Trinamic
MAX78000
MEMS

Human-like Actuation

End Effector Gripper/Arm Force Sensing, Torque and Control

Software I/O & Isolation

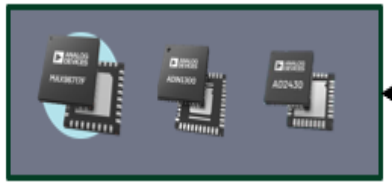
Robustness



To Sensors, Stations, other humanoids
ISO-USB
SWIO

Mix of needs
GMSL
High speed LVDS
Ethernet
USB

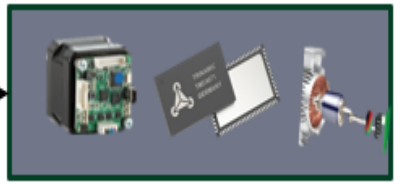
Low Latency Connectivity



Internal Connectivity (Ethernet, GMSL, USB LVDS)

Main Motion Control of all individual Limbs

Real Time Control

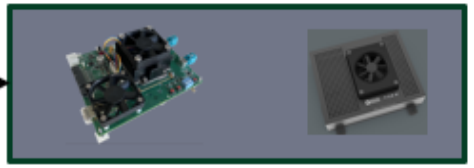


15+ Motors
Multi-turn MAG
Trinamic

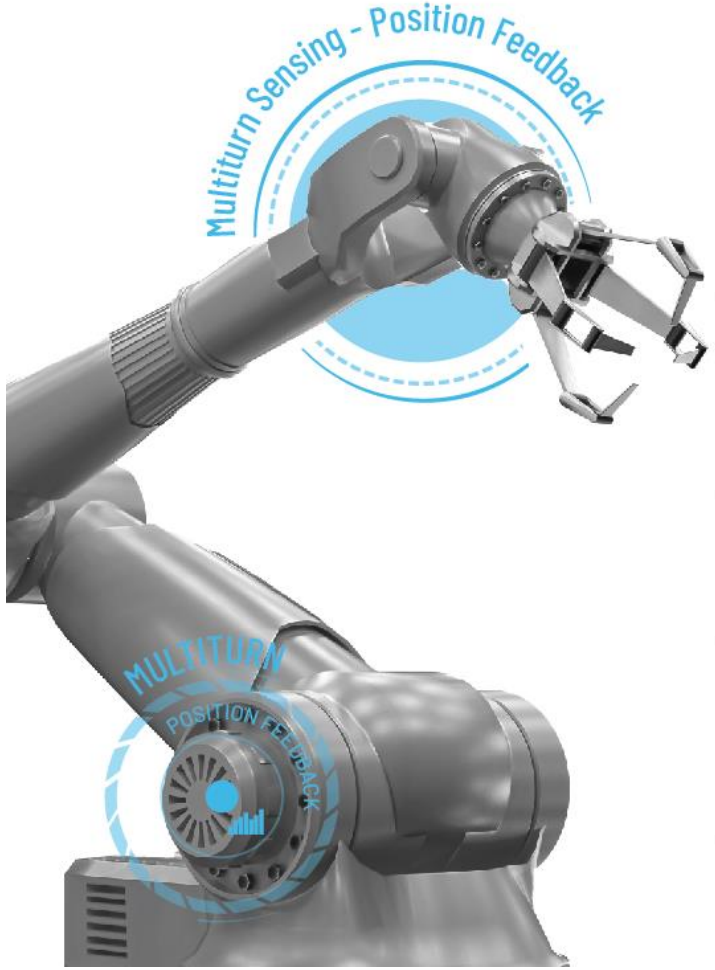
Software & Middleware

Compute and Intelligence

Complete System Coordination



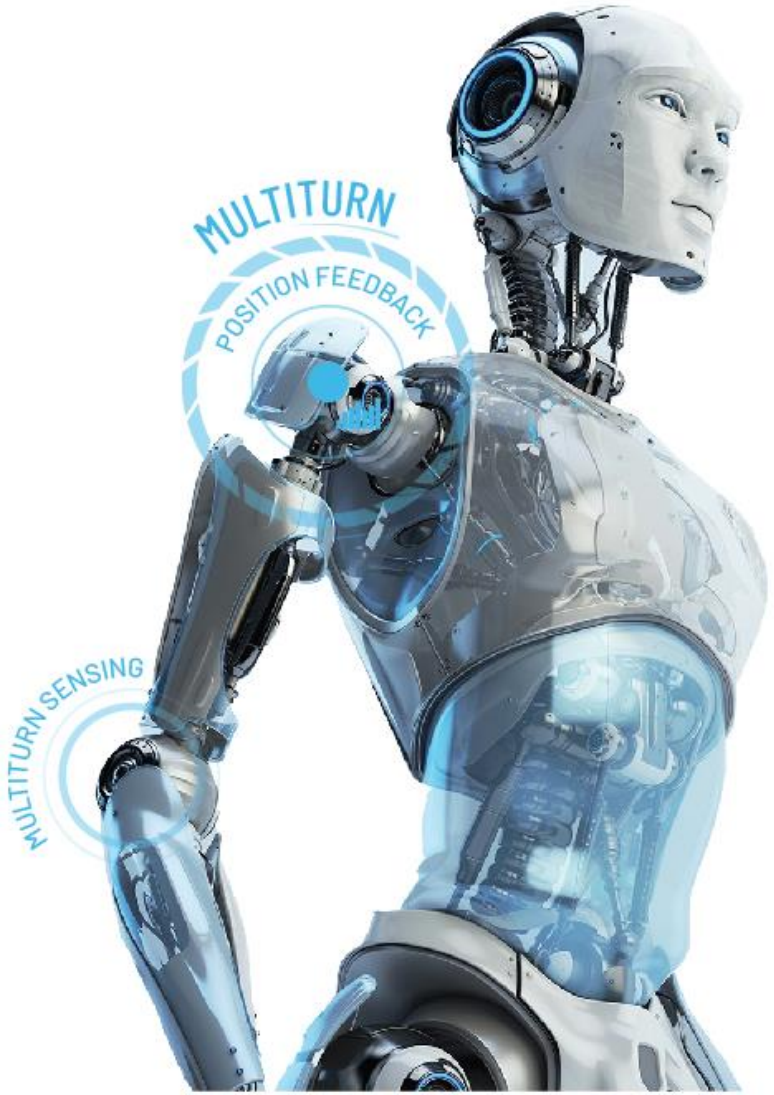
ADI Multiturn Technology Revolutionizing Actuator Control



Real Time Control

Main Motion Control of all individual Lems

- Unique **True-Power-On Multiturn technology** counts Turns without Power or Contact
- Tracks Robotic & Humanoid Joint motion without power
- Eliminates need for re-homing or calibration on power-up or following battery swap
- The **ADMT4000** is the world's first single chip Multiturn position sensor

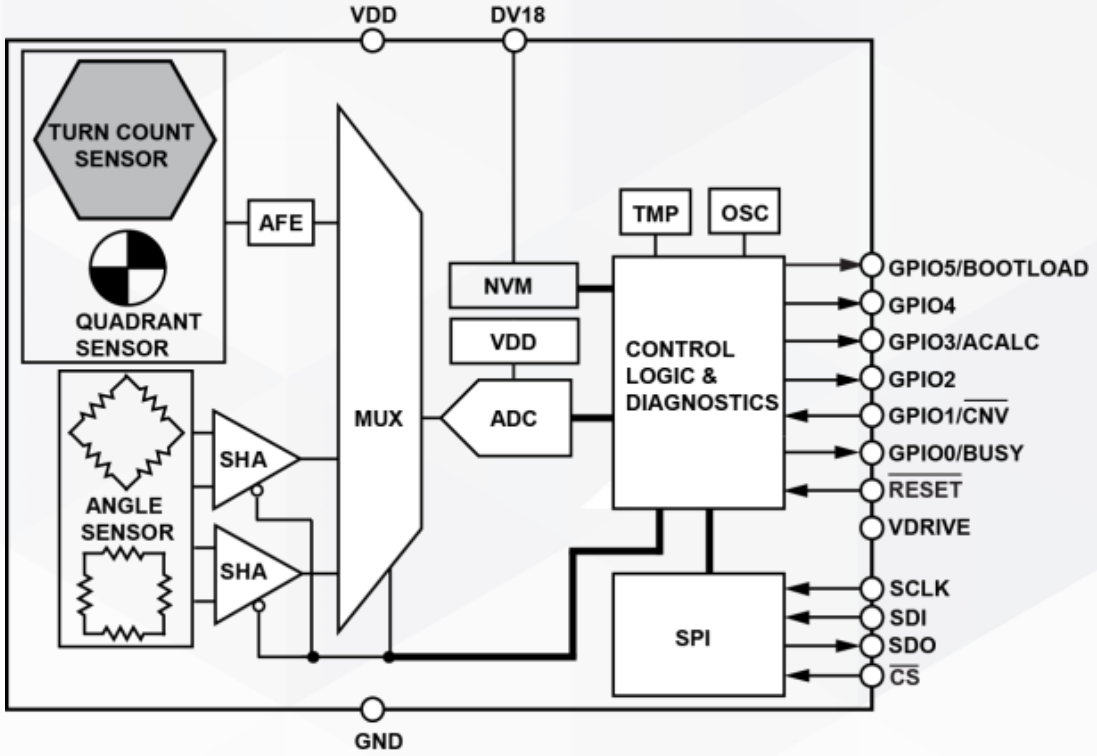


ADMT4000 Product Overview

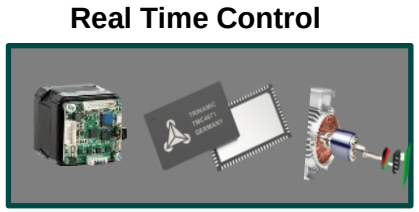
The true power-on 46 turn multiturn position sensor

- 360°angle sensor ±0.25° typical accuracy
- Data rate 2 kSPS turn count, 100 kSPS angle
- 16 mT to 31 mT magnetic operating window
- Internal temperature sensor
- IC supply, 3.3 V
- SPI interface, 1.7 V to 5.5 V
- Ambient temperature range: -40°C to +125°C
- 24-lead TSSOP

Automotive Functional Safety version in development

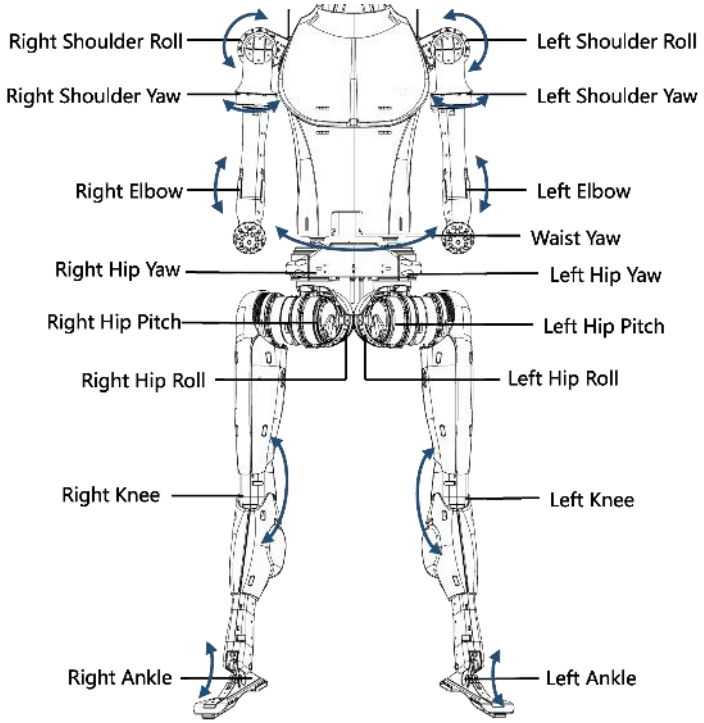


Real-Time Control



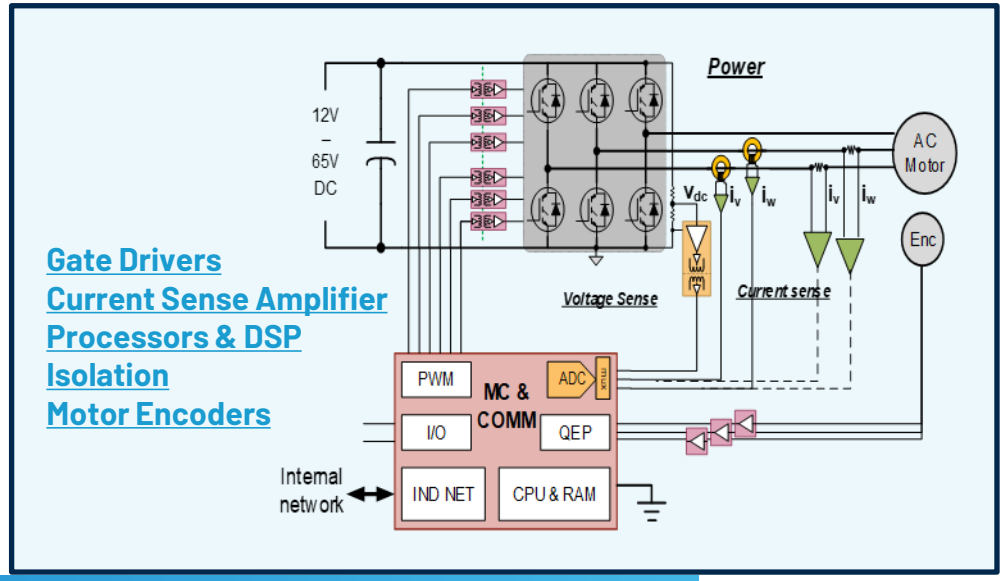
Main Motion Control of all individual Lems

- Joint movement, such as **elbows and wrists**, where **exact positioning** is critical for Encoder and precise Control Loops.
- **Manipulation tasks**, such as finger movements or detailed object handling.
- **>30 PMSM/BLDC motors** are typically used:
  - 4 in each arm (shoulder, elbow, wrist),
  - 6 in the legs (hips, knees, ankles),
  - several in the hands,
  - and a few in the neck and torso .
- These motors typically operating in the range of 12V to 65V and capable of delivering currents from 1A to over 20A, are controlled by motor drives that manage **speed, torque, and position with high precision**.



- **Key Products:**
  - The **TMCM-2611-AGV** is a dual-axis servo drive platform designed for 3-phase BLDC motors, capable of running at up to 14ARMS and +48V. This module is particularly valuable for humanoid robots due to its ability to provide precise and smooth motor control, essential for complex robotic movements.
  - The **TMC6100** **and** **TMC6200** from Trinamic provide significant value to humanoid robots by enhancing motor control capabilities. The TMC6100 is a highly efficient gate driver for BLDC and PMSM motors, ensuring smooth and precise movements essential for complex robotic tasks. The TMC6200 integrates a MOSFET driver for 3-phase motors, offering robust performance and reliable operation under high current loads.
  - **ADMT4000** is ideal for humanoid robots due to its unique capability of still counting turns even while unpowered, removing the need for re-homing procedures and the need of extra sensors. This can be extremely beneficial in power-down events.

Generic Motion Control Loop at Low Voltage



TMC9660 Monolithic FOC Controller with Gate Driver

Features

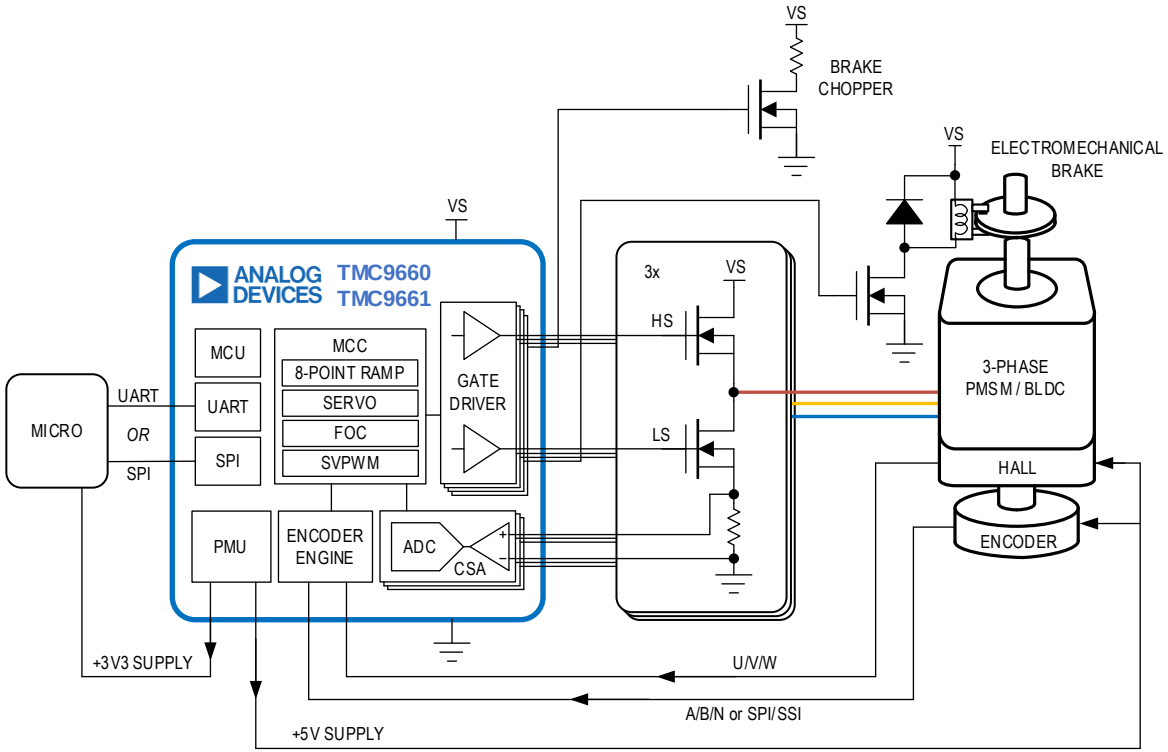
- 4.7V...70V/2A gate driver for Stepper, BLDC, or BDC
- Ultra low offset bottom shunt current measurement
- Motion control core (MCC) in hardware with field oriented current controller (FOC*) and fast PWM engine
- Encoder engine (Hall, A/B/N, abs. SPI/SSI, analog)
- EightPoint ramp controller in hardware
- Buck converter +3V3 and +5V/600mA and LDOs for gate driver, IO and core supply
- SPI or UART communication interfaces
- -40°C to +125°C Operating Temperature Range

Benefits

- Minimize BOM and board space (One-Chip Solution)
- FOC in hardware; no code required
- Maximize battery lifetime using most efficient motor control by ADI TRINAMIC

Applications

- 3D Printing
- Prosumer CNC
- Power tools
- E-Bikes / Scooters
- Robots



Schedule

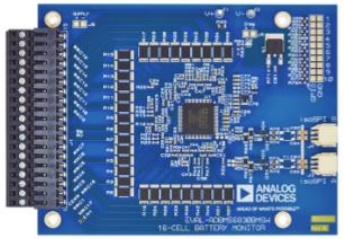
- Target sample date: Available
- Product Intro / Production Start: Now

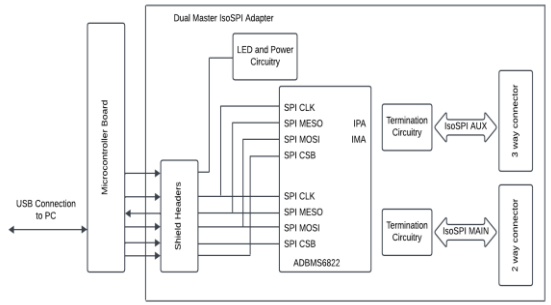
*Field Oriented Control (FOC) also known as vector control is the most efficient way to control a synchronous motor. The general algorithms are public, but the implementation in Software is tedious and there are a lot of pitfalls. TM01 has the FOC implemented in hardware, so the software only needs to set parameters.

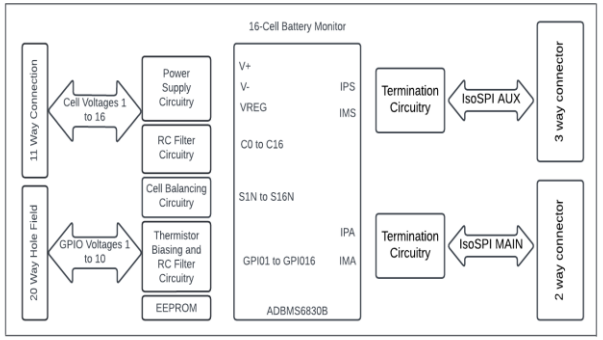
Optimized Power Management

Efficiency & Uptime

Power Distribution & BMS





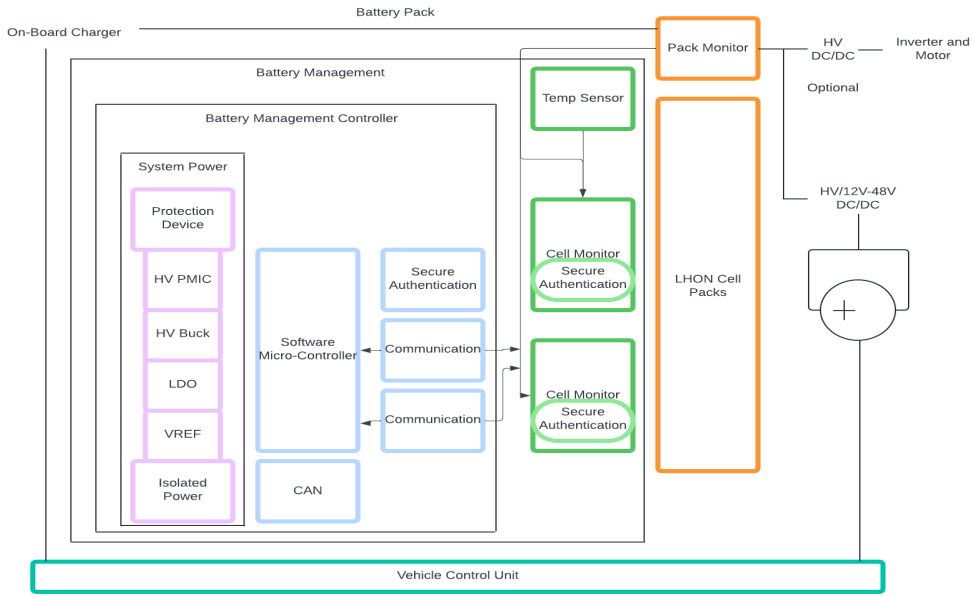


- Power management solutions significantly **enhance the functionality of humanoid robots** by optimizing energy efficiency and prolonging battery life, **ensuring longer operational periods**, **precise control over power distribution, reducing energy waste and heat generation**, which is crucial for maintaining the reliability and performance of the robot. Power management systems support high power density and compact designs, enabling the integration of advanced features without increasing the **size or weight of the robot**.

[BMS – System]
[Current Sense Amplifier]
[Processors]
[Power Control]

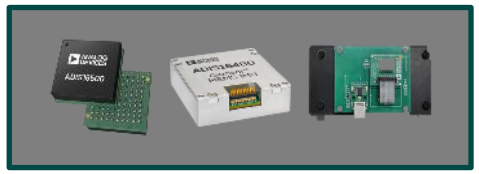
- **Key Products:**
  - The [ADBMS6948] is a multi-cell battery monitor with the industry's first parallel measurement architecture, which measures up to 16 series-connected battery cells with a TME of less than 3 mV over the full temperature range and lifetime. The parallel measurement architecture ensures the lowest external component cost in its category.
  - The [ADBMS6830] is a multicell battery stack monitor that measures up to 16 series connected battery cells with a lifetime total measurement error (TME) of less than 2 mV over the full temperature range. The measurement input range of −2 V to +5.5 V makes the ADBMS6830 suitable for most battery chemistries and allows measurement of voltages across bus bars. ([ADBMS6822] is isoSPI transceiver for intercommunication between battery monitors)
  - Also, Partner systems and platform are available on request ([EWERT Energy])

Generic BMS – Robot System



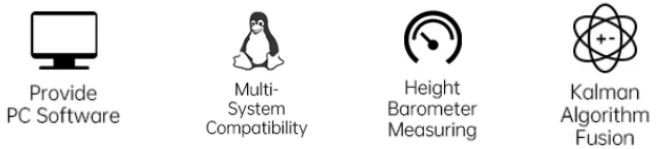
Complex and Reliable Positioning

Environment Positioning

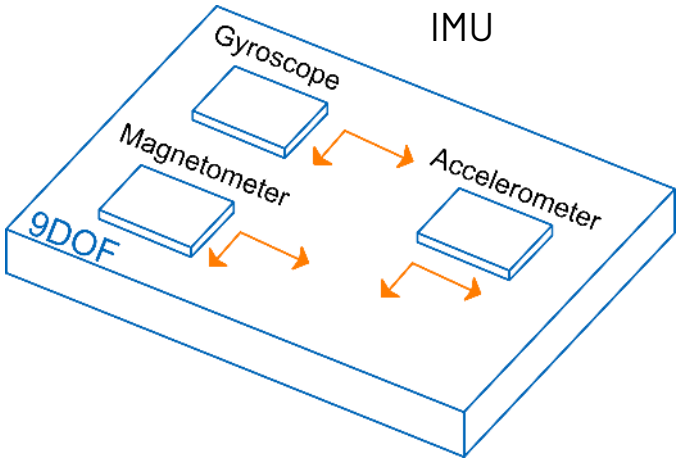


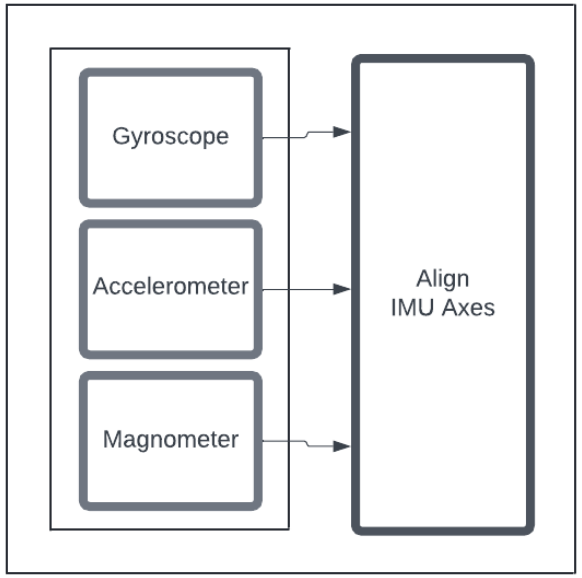
⇦ **Navigation & Localisation - IMU**

- The number of IMUs used in a humanoid robot can vary depending on the complexity and requirements of the design. A humanoid may use multiple **IMUs placed at different joints** and segments to achieve comprehensive motion sensing and control or a single 6 or 9 DoF IMU can effectively manage the complex motions and balance required for humanoid robots, making it a versatile and efficient choice for enhancing the robot's overall performance.
- **6-10 IMUs** distributed across critical joints and body segments.



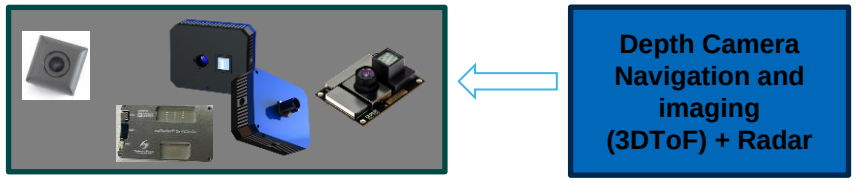
- **We provides a wide range of Inertial Measurement Units (IMUs) that deliver superior performance and reliability across various applications. With comprehensive factory calibration, embedded processing, and a user-friendly interface , combine with sophisticated signal processing to offer high precision, low noise, and exceptional stability over time and temperature.**
- ***Key Products:***
  - ADIS16480- A high-performance IMU with 10DoF, Fully factory-calibrated for bias, sensitivity, alignment, and linear acceleration, it minimizes the need for field calibration. It features a digital SPI interface for easy integration with digital systems. Its rugged design ensures reliable operation in extreme conditions**.**
  - ADIS16500- Is a high performance and reliability, optimized for low noise and high stability, ideal for accurate navigation and stabilization. It supports multiple interfaces, including SPI, with configurable output data rates and filtering options for flexible system integration. Built to endure harsh environments, it offers high shock and vibration tolerance and operates over an extended temperature range, making it suitable for various industrial and aerospace applications.





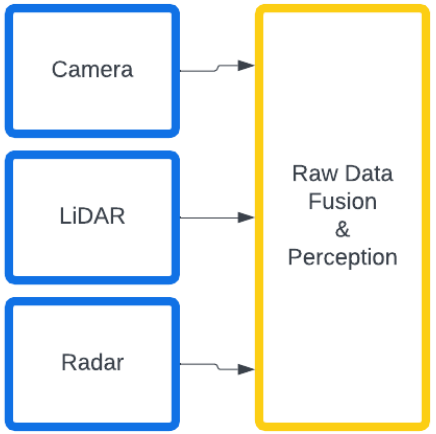
Low Latency Awareness (Behaving like a human)

Environment Awareness



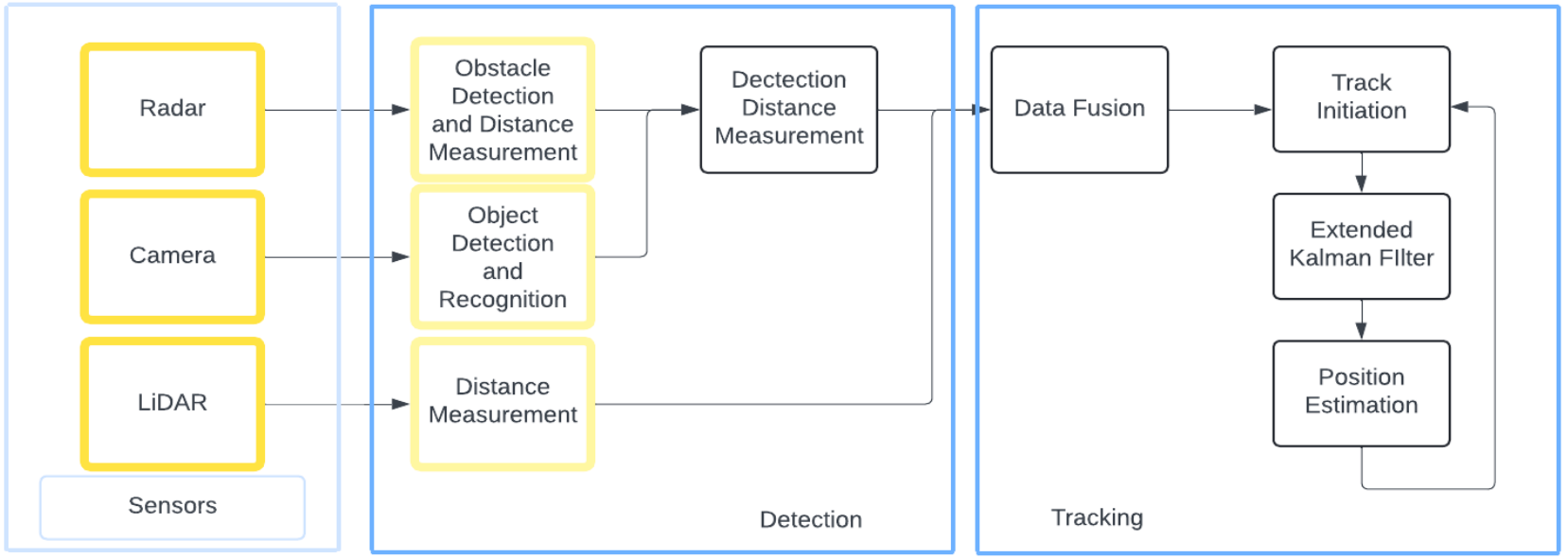
Depth Camera Navigation and imaging (3DToF) + Radar

- Perception Sensors and image-processing technologies enable humanoid robots to recognize objects ,navigate spaces, **provide essential spatial awareness allowing the robot to understand and adapt to its environment**. A Humanoid have – 2+ vision systems, including stereo vision, depth cameras, peripheral cameras & Lidar/Radar.

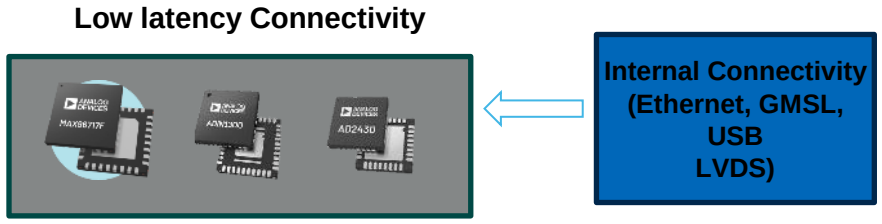


- **The capabilities of humanoid robots can be enhanced by utilizing Time-of-Flight (ToF) and RADAR technologies. ToF sensors provide highly accurate distance measurements and close measurements by calculating the time taken for light pulses to travel to and from objects, facilitating detailed 3D mapping and precise navigation in complex environments. RADAR technology offers long-range detection and is effective in various conditions, such as smoke, fog, and dust, ensuring reliable performance irrespective of lighting conditions**

- ***Key Products:***
  - ADTF3175 significantly boosts the functionality of humanoid robots by offering precise distance measurements and detailed 3D imaging, essential for accurate navigation, manipulation, and interaction in diverse environments.
  - **Radar(Sakura Tech)** enhances the sensory capabilities of humanoid robots. The 76-79 GHz radar offers high-resolution short-range detection, ideal for precise object recognition and close-proximity interactions. Meanwhile, the 24 GHz radar provides broader range detection, suitable for general navigation and obstacle avoidance.
  - Tier IV and other partners (GMSL Camara "Hyperion")



Real-Time Intercommunication

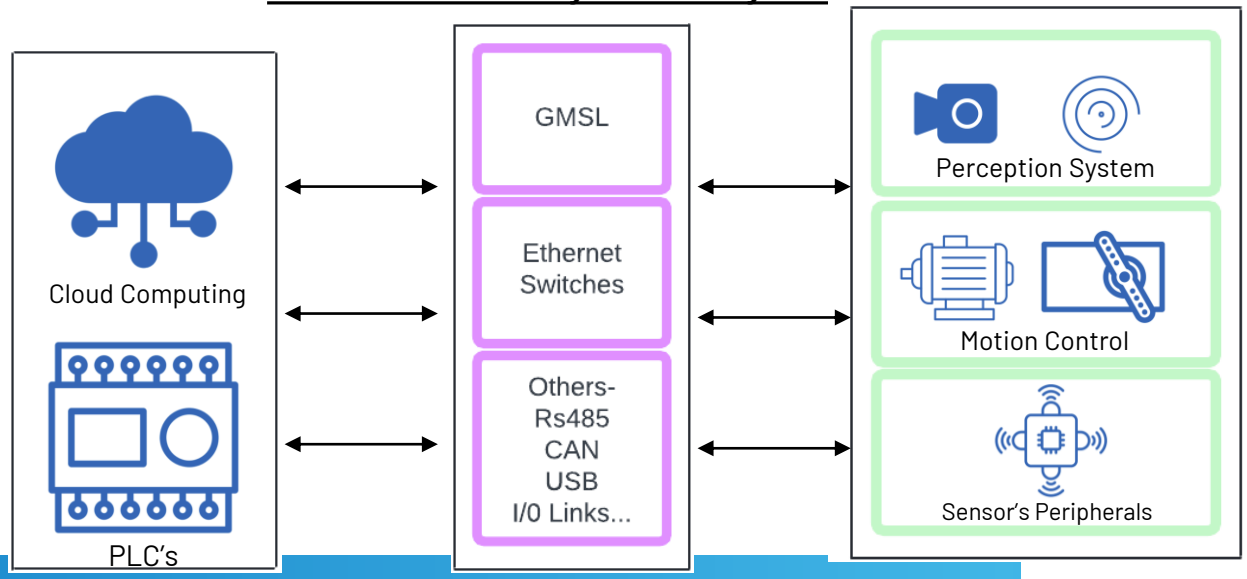


- Connectivity is vital for enabling advanced functionalities, **real-time decision-making, and efficient human-robot interactions**
- Connectivity in humanoid robots is a multifaceted domain that integrates various technologies and protocols to ensure seamless communication within the robot, with other robots, and with external systems.
- **Peripherals in Humanoids Connectivity**:
  - Sensor Interfaces
  - Actuator & Power Interfaces
  - Vision and Imaging Interfaces
  - Audio Interfaces
  - Human Machines Interfaces

- **We enhances humanoid connectivity through advanced communication interfaces, robust sensor integration, and reliable low-latency solutions. Edge and Cloud connectivity support real-time data processing and AI enhancements, while comprehensive development tools simplify implementation.**

- **Key Products:**
  - The ADIN1300 is a low power, single port, Gigabit Ethernet transceiver with low latency and power consumption specifications primarily designed for industrial Ethernet applications.
  - GMSL (MAX96717/MAX96724)-A highly configurable, high speed SERDES (Serializer and Deserializer) interconnect solution that enables the transmission of real-time uncompressed video and sensor data, control data and power over a single wire.
  - AD2430-The Automotive Audio Bus (A2B®) provides a multichannel, I2S/TDM link over distances of up to 15 m between nodes. It embeds bidirectional synchronous pulse-code modulation (PCM) data (for example, digital audio), clock, and synchronization signals onto a single unshielded twisted pair (UTP) differential cable.
  - Industrial Interface offerings (ADI web)

Generic Connectivity – Robot System



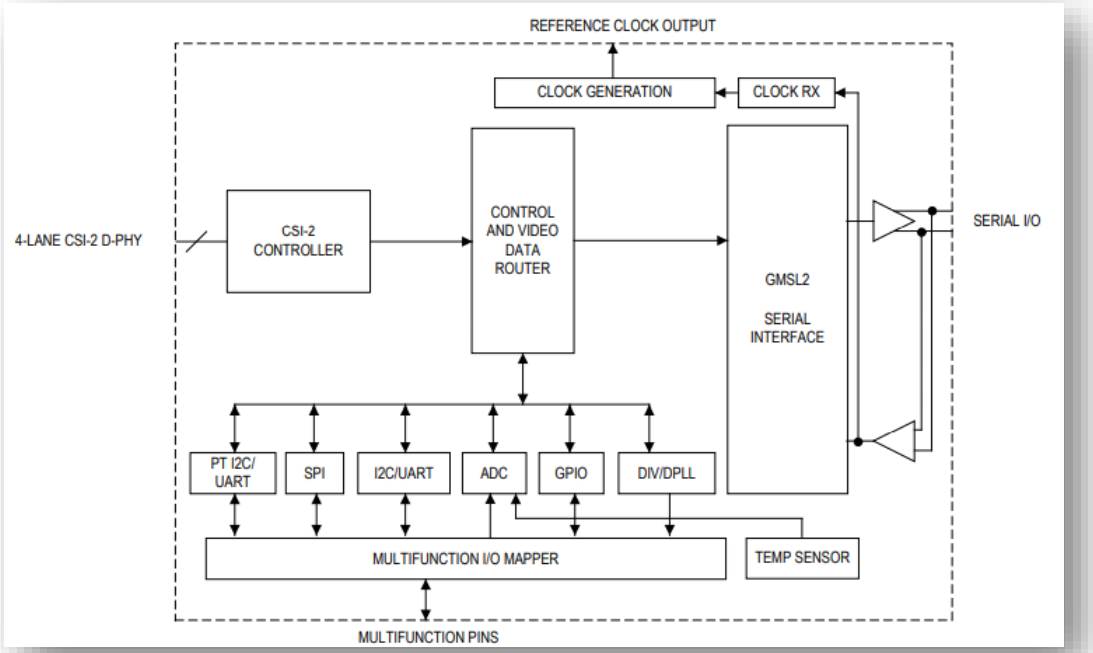
Product Highlight: Single MAX96717 Serializer

Features

- Full duplex over a single wire
  - Pin-compatible variants for 3G and 6G forward link rate
  - 187.5 Mbps reverse link rate with I^2C support
- ASIL B, AEC-Q100 qualified, Grade 2
- 4-lane D-PHY MIPI CSI-2 v1.3 input ports
  - 16 virtual channels
  - Support any CSI-2 data type in tunneling mode
- Small 5 × 5 TQFN package

Key Benefits

- Supports 1 MP to ~8 MP imagers/sensors with no change in infrastructure
- End-to-end data integrity on forward and return channel
- Continuous link margin monitoring and optimization with real-time adaptive equalization
- Reference over reverse (RoR) clocking supports crystal free operation for BOM reduction



Options Available

- MAX96717: 6 Gbps GMSL2
- MAX96717F: 3 Gbps GMSL2
- MAX96717R: 3 Gbps lite version

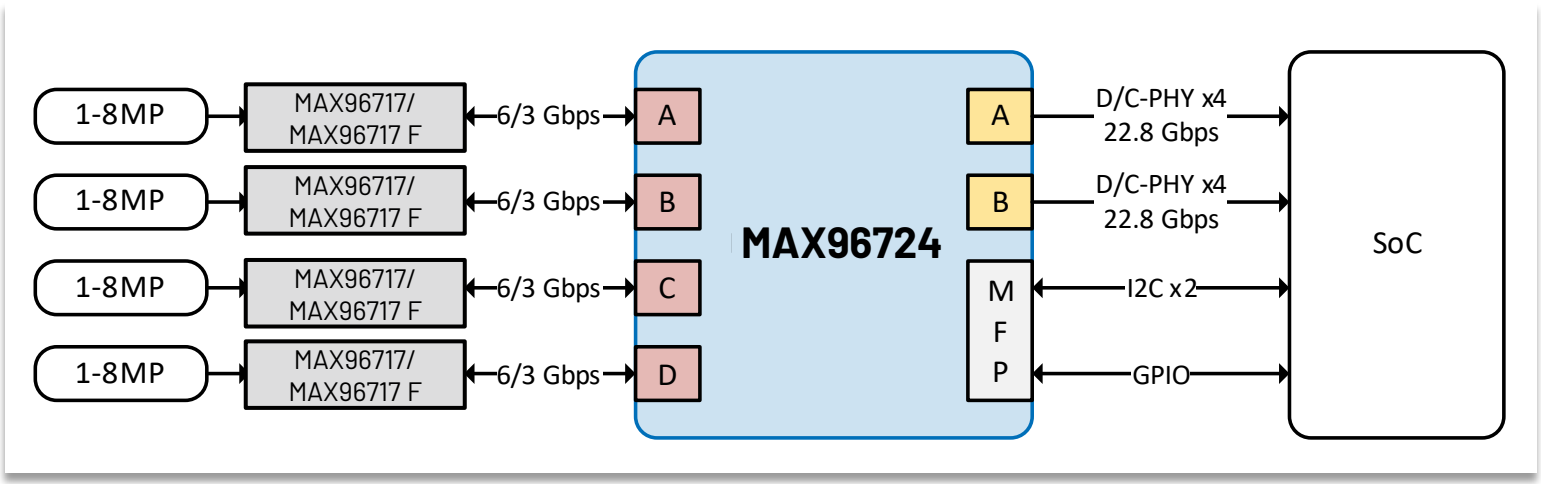
Highlights: Quad MAX96724 Deserializer

Features

- Pin-compatible 6G, 3G, 1.74G GMSL2/GMSL1 data rates
- 187.5 Mbps reverse link rate with I^2C support
- ASIL B, AEC-Q100 qualified, Grade 2
- 2× 4-lane CSI-2 v1.3 ports, D-PHY/C-PHY with config options for 4× 2-lane
- D-PHY to C-PHY translation in tunneling mode
- Small 8 × 8 TQFN package

Key Benefits

- **Scalable:** Supports 1 MP to ~8 MP imagers with no change in infrastructure
- **Security:** End-to-end data integrity on forward and return channel
- **BOM Reduction:** Aggregate and replicate video data from up to four imagers
- **Robust Link:** Full-duplex communication, supports up to –21 dB of insertion loss over –40°C to +105°C



Options Available

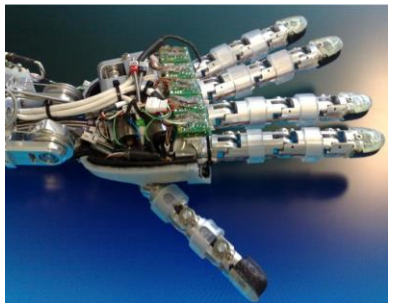
- MAX96724: 6 Gbps GMSL2
- MAX96724F: 3 Gbps GMSL2
- MAX96724R: 3 Gbps lite version

Actuation – End of ARM Tools (EoAT)

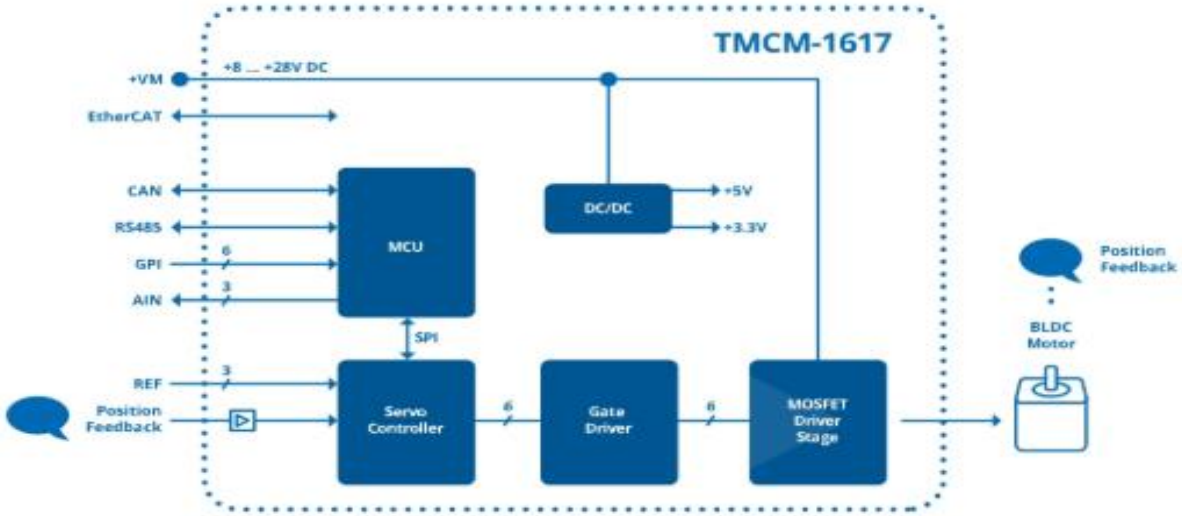
Human like Actuation

End Effector
Gripper/Arm
Force Sensing,
Torque and Control

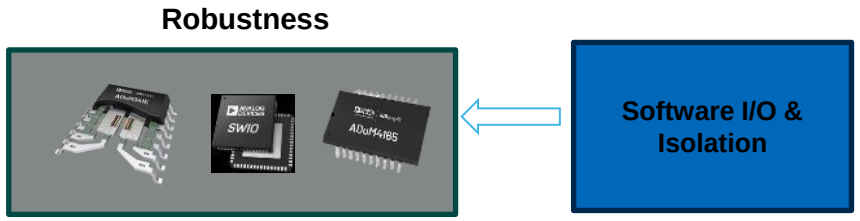
- Grippers are essential for enabling humanoid robots to perform a wide range of tasks that require dexterity and precision. By incorporating advanced sensing, control systems, and materials, grippers enhance the robot's ability to interact with its environment safely and effectively.



- **By enhancing the value of grippers in humanoid robots through advanced sensing, signal processing , force sensing, power management, and communication technologies. These contributions result in more precise, reliable, and efficient grippers, enabling humanoid robots to perform complex tasks with greater dexterity and adaptability.**
- **Key Products:**
  - **TMCM-1617** is a low-weight miniaturized single axis servo driver for 3-phase BLDC motors with up to 18A RMS motor current and +24V supply. With CAN, RS485, and EtherCAT® it offers various communication options.
  - **TMC8100**-The TMC8100 is a dedicated serial protocol converter IC, especially for absolute encoder bus protocols. It can deliver the extracted and adjusted encoder position information via SPI or UART.
  - **TMC5130**- The TMC5130 cDriver™ is an integrated motor driver and motion controller solution for gripper and automated equipment applications
  - **ARMA (Partner Products)**



Robustness



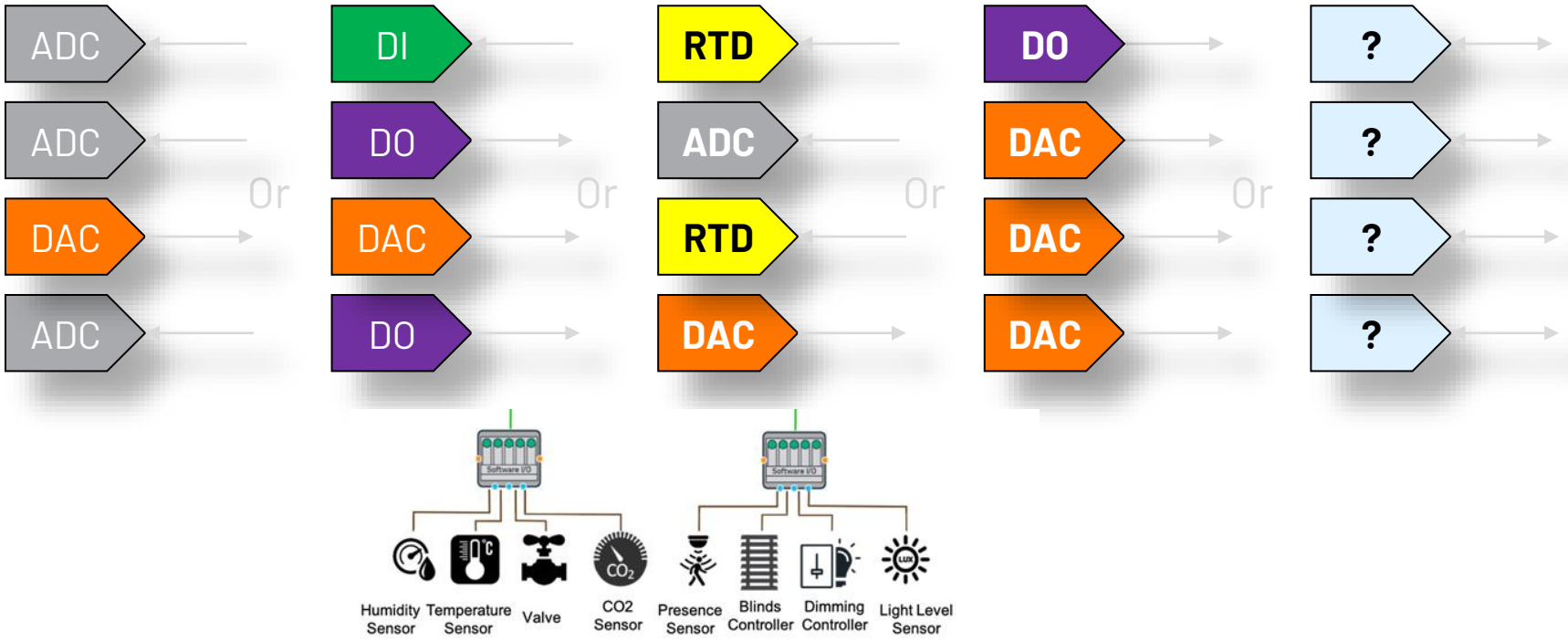
Software I/O and isolation technologies are indispensable for the efficient, reliable, and safe operation of humanoid robots. Software I/O provides the flexibility and control necessary for complex and adaptive behaviours, while isolation protects sensitive electronics from noise, spikes, and other electrical disturbances. Together, these technologies ensure that humanoid robots can perform a wide range of tasks accurately and safely in diverse and challenging environments. Key Products:

- ADuM3165–The ADuM3165/ADuM3166 are USB 2.0 port isolators, utilizing Analog Devices, Inc., iCoupler® technology to dynamically support all USB 2.0 data rates: low (1.5 Mbps), full (12 Mbps), or high (480 Mbps), as required. The devices support host isolation with automatic speed negotiation as well as peripheral isolation.

- ADN4622 + MAX4950A – They ensures safe and reliable data / transmission between different robot subsystems, such as sensors, actuators, and control units, while maintaining noise immunity essential for high-speed communication lines because of common mode transit immunity and isolation groundbreaking

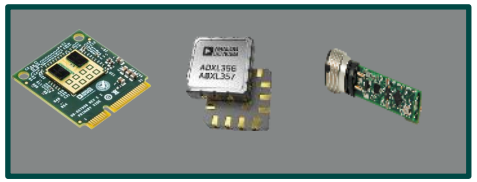
- **Flexibility**: Allows the robot to adapt to various sensors and actuators without changing hardware, enabling diverse functionalities (analog output, analog input, digital output, digital
- input, resistance temperature detector (RTD), and thermocouple
  Compact design, reduced cables: Saves space within the robot's design, which is crucial for maintaining a compact form factor.
- **Eases of integration**: Different subsystems (temperature sensing, inputs, outputs) reducing design complexity and development time.
- **Power Management and robust**: Optimizes power consumption, essential for battery-operated robots to extend operational time while providing robust performance in different environments, crucial for the varied tasks humanoid robots perform.

Application for humanoid: End of arm tool, environment monitoring sensing (gas, C02 etc)



Safe Operation and Wireless Connectivity

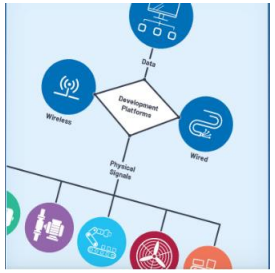
Collaboration and engagement



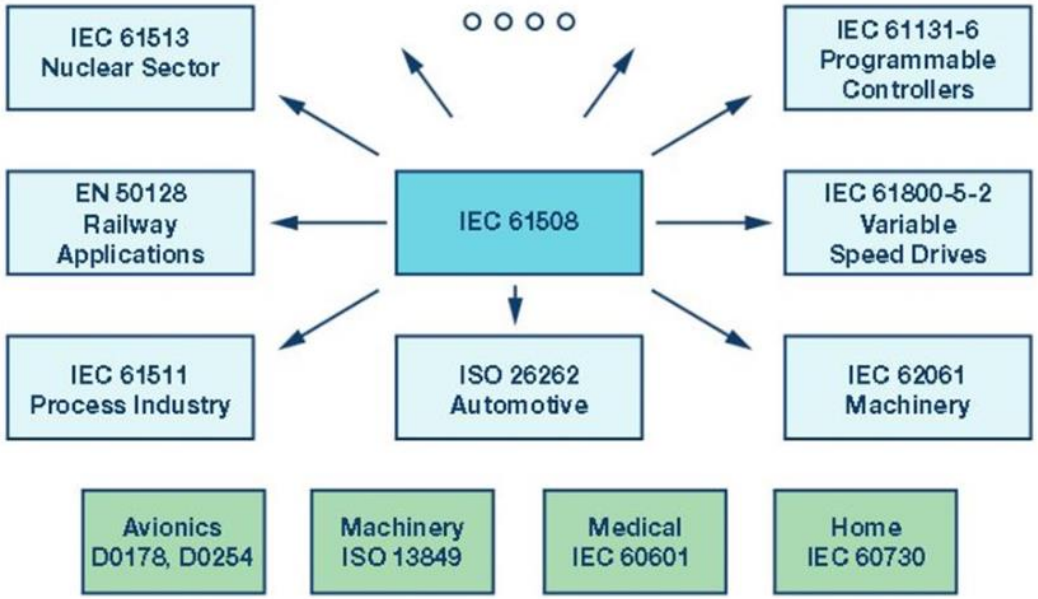
Safety & Security Proximity, Vibration & Connect

Wireless Connectivity

Embedded Security

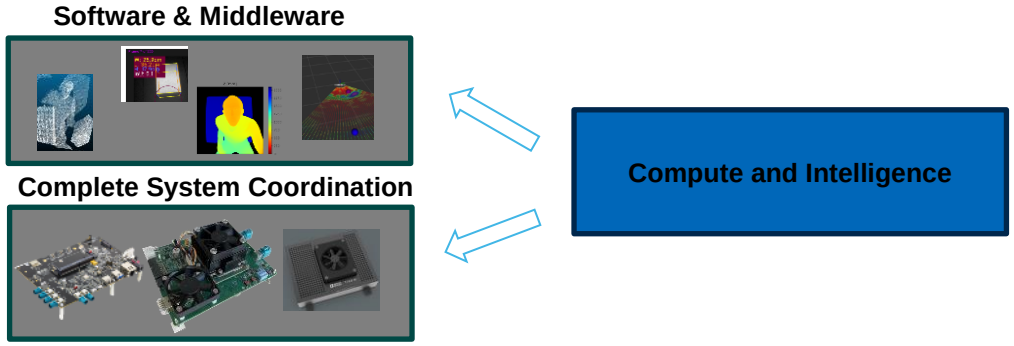


- **The deployment of humanoid robots in various end applications relies heavily on advanced solutions to enhance data throughput and communication speed, ensure secure and reliable operation, and maintain the health of the system.**



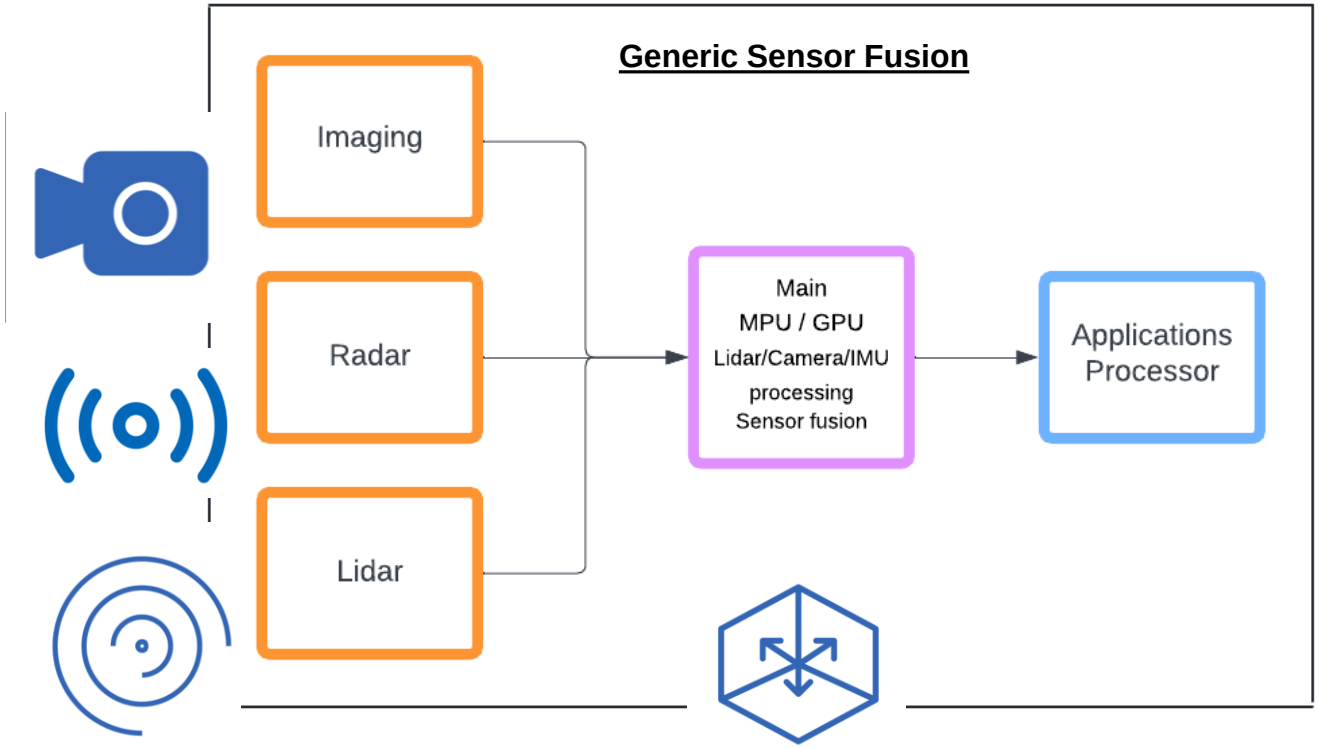
- **Wireless data transfer, Wireless data transfer in End-of-Arm Tooling (EOAT) for humanoid robots enables unrestricted movement and enhanced manoeuvrability by eliminating cables. It simplifies mechanical design and reduces complexity, improving overall efficiency.**
- **Key Products:**
  - **ADMV9611/ADMV9621-** Is a complete millimeter wave (mmWave) wireless connectivity solution in a small printed circuit assembly (PCA) format Together with the ADMV9621, the ADMV9611 provides a complete, full duplexed 60 GHz data link for high-speed data transmission in the unlicensed 60 GHz industrial, scientific, and medical (ISM) band.
- **Security authentication, and Vibration sensing, significantly enhance the capabilities, reliability, and safety of humanoid robots. These technologies enable high-speed communication, secure operation, and proactive maintenance, making humanoid robots more efficient and adaptable to a wide range of applications, from industrial automation to healthcare and beyond. Key Products:**
  - **MAXQ1065 / DS2478** Security coprocessor that provides turnkey cryptographic functions for root-of-trust, mutual authentication, data confidentiality and integrity, secure boot, secure firmware update, and secure communications with generic key exchange and bulk encryption or complete TLS support.
  - **ADXL1005-**The ADXL1005 delivers ultralow noise density over an extended frequency range and is optimized for bearing fault detection and diagnostics. The ADXL1005 delivers ultralow noise density over an extended frequency range and is optimized for bearing fault detection and diagnostics.
- **Functional Safety (Blog / Thoughts)**

Compute and Intelligence



- **We add substantial value through software and middleware solutions that complement their advanced hardware offerings, significantly enhancing system's performance, reliability, and integration across various applications. With solutions that allow for the seamless integration of new components without extensive reconfiguration. For example, sensor fusion algorithms combine data from multiple sensors to provide accurate and reliable information, which is essential for applications such as humanoid robots.**
- **ROS Page**
- **Analog Devices Git Hub**
- **NVIDIA / TIER IV platforms**

- Middleware serves as the essential **bridge between the robot's hardware and high-level application software**, enabling seamless communication and integration of various subsystems. This integration is crucial for managing the complex interactions between sensors, actuators, and control algorithms that govern a humanoid's behaviour.
- Middleware facilitates **the real-time processing and fusion of data from multiple sensors**, such as cameras, LiDAR, and IMUs, providing a comprehensive understanding of the robot's environment. This capability is vital for tasks requiring spatial awareness and navigation in dynamic settings.
- Advanced Software solutions also support the implementation of sophisticated **control algorithms, enhancing the robot's ability** to perform complex manoeuvres and interact safely



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Humanoid Robot Power & Sub-system Products

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Power Solutions for Humanoid Robot

Released

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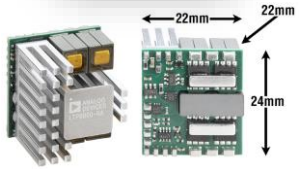
LTC3639
LT7103

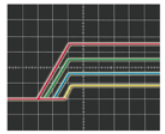
HV Buck

LTP8800



48V to core

ADM1266
MAX42500



Sequencer /supervisor

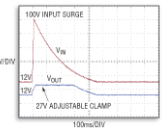
LTM4659
LTM4723

Ultra-thin PoL

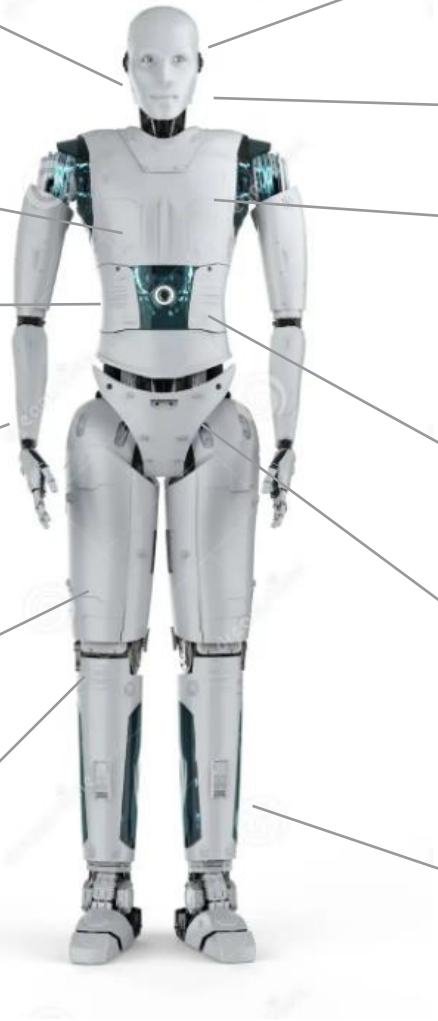
LTM47xx

GaN based

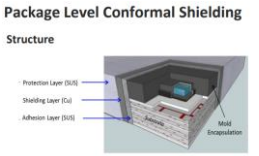
MAX17614
LT4363



Protection



Low EMI



LTM8060F

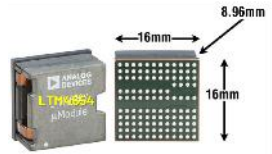
Functional safety

MAX42500

Core power

LTM4660

Bidirectional module

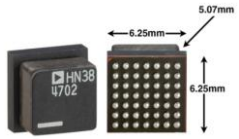


LTM4654

High power controller

LTC7871+LTC7060
LT8708

Point of Load (12V)



LTM4702

Motion: TMCM1690

Integrated Field Oriented Control **Servo Controller** Gate Drive Module

Released

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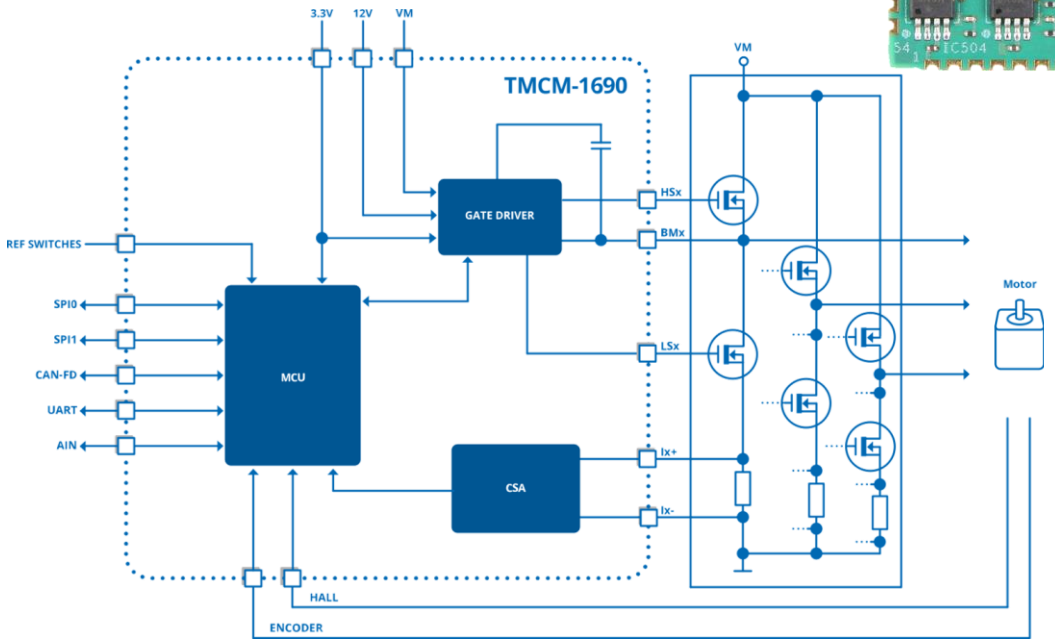
Need of the Robotic Market

- Robots often require precise control for tasks such as manipulation, pick-and-place operations, or inspection. The TMCM-1690 offers microstepping and advanced motion control algorithms, ensuring high levels of accuracy.
- The TMCM-1690's **CoolStep** technology minimizes energy consumption, extending battery life in AGV/AMR and reducing operational costs in industrial settings.

Key Features and Benefits

- Supply Voltage **+10 to +60V DC**
- **FOC Servo Controller** and Gate Driver
- Module for BLDC and DC Motors
  - 0.5A/1.0A/1.5A Gate Drive current
  - Up to 120kHz PWM Frequency
- Onboard Current-sense Amplifiers
- Supports UART (RS232/RS485-ready) and CAN Interface
- Supports Incremental Encoders (ABN),
  - Digital HALL Sensors, Absolute SPI
  - Encoders
- Reference Switch Inputs
- Compact Size (27mm x 22.5mm)



Applications

- **Autonomous Mobile Robots**
- **Manufacturing**

Availability

- **Released**
- **WEB link**
- **ROS Node Link**

Perception: ADTF3175

Depth Sensing Sub-system 1Mpx resolution and 75deg FOV

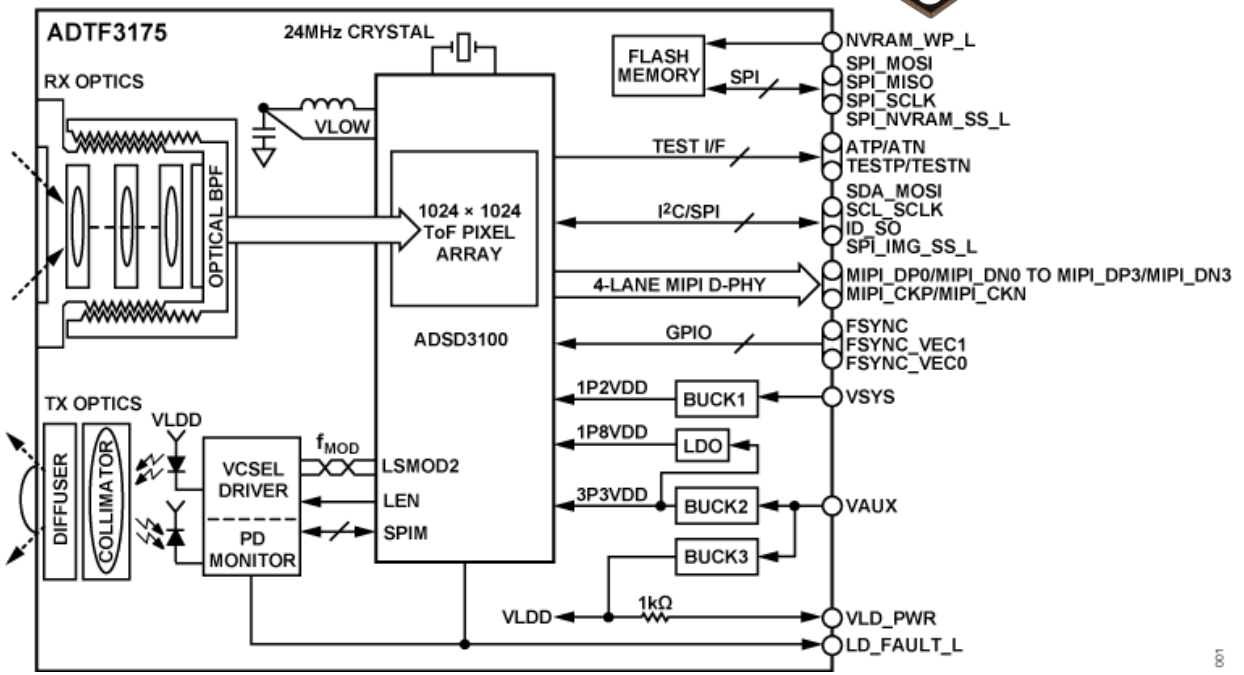
Released

Need of the Robotic Market

- The **ADTF3175** Time-of-Flight (ToF) module distinguishes itself with its high-resolution 1 Megapixel CMOS iToF imager, offering detailed 3D depth sensing. With field of view for comprehensive area coverage. Pre-calibrated for multiple range and resolution modes
- Interfaces with companion ADSD3500 Dept ISP to process raw phase frames from the ToF imager, generating radial depth, active brightness, and confidence frames, enhancing depth data accuracy.

Key Features and Benefits

- **1024 × 1024 ToF** imager with 3.5 µm × 3.5 µm pixels
- **75 × 75 deg Field of view (FOV)**
- Imager lens subassembly with 940nm bandpass filter
- Illumination subassembly with eye safety support
- 4-lane MIPI CSI-2 Tx interface, 1.5 Gbps per lane
- 4-wire SPI and 2-wire I2C serial interfaces
- Power regulators for local imager and illumination rails
- Calibrated modes
  - **1024 × 1024**
  - **512 × 512 resolutions**
- Depth range: **0.4 m to 4 m** (depth noise (1 σ) 15 mm maximum, 19% minimum target reflectance, 3 klux equivalent sunlight)
- Depth accuracy: ±5 mm (across full depth range)



Applications

- **Autonomous Mobile Robots**
- **Industrial Robotics**
- **Humanoids**

Availability

- **Released**
- **Web Link**
- **ROS Node Link**

Communication: ADMV9615/25

60 GHz Millimeter-wave Short Data Link

Released

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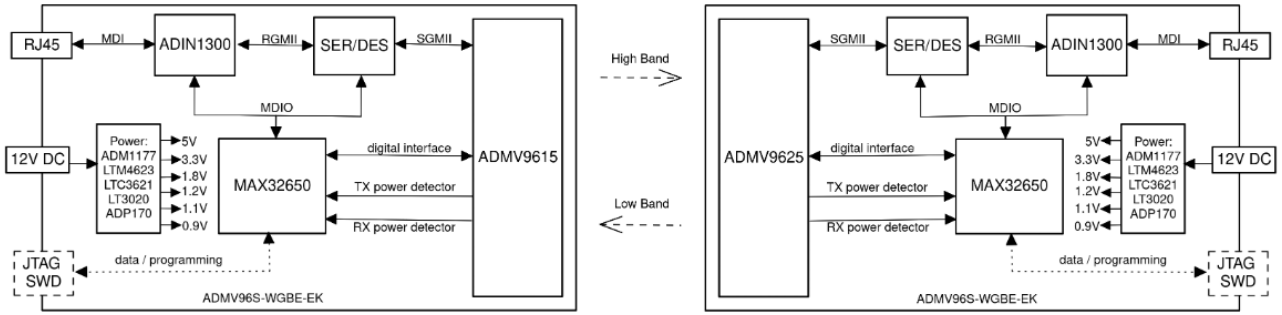
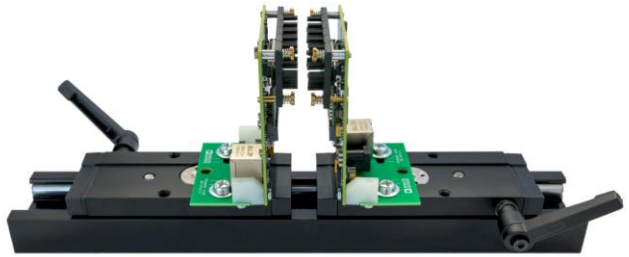
Need of the Robotic Market

- Delivering **high-speed, low-latency mmWave connectivity**, enables seamless real-time communication for autonomous and industrial robots.
- Its integrated omnidirectional antennas provide reliable data transmission, making it ideal for **rotational and mobile robotic applications** where uninterrupted connectivity is critical.





Key Features and Benefits

- Meets V-band worldwide frequency requirements.
- Integrated circularly polarized antenna.
- Integrated high band and low band diplexer for improved multipath distortion.
- Full-duplex operation.
- Simple AM scheme.
- **Data rate: 1 Gbps.**
- Ultra-low latency.
- **Link communication distance: 1 cm to 5 cm typical**
- Size -34.70 mm × 29.89 mm.

Applications

- **Autonomous Mobile Robots**
- **Manufacturing**

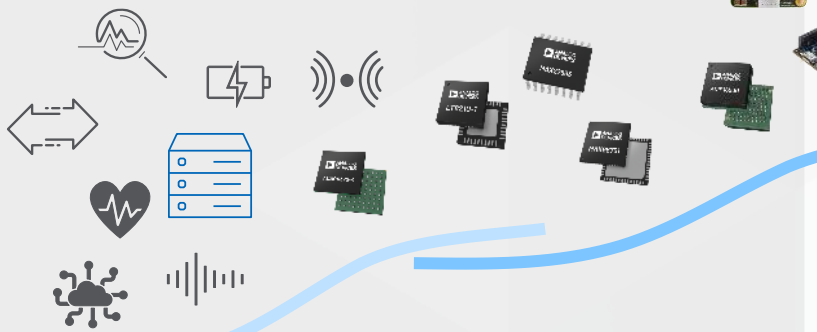
Availability

- **Released**
- **WEB link**

Technologies and Future Enhancements

ROBOTICS OVERVIEW

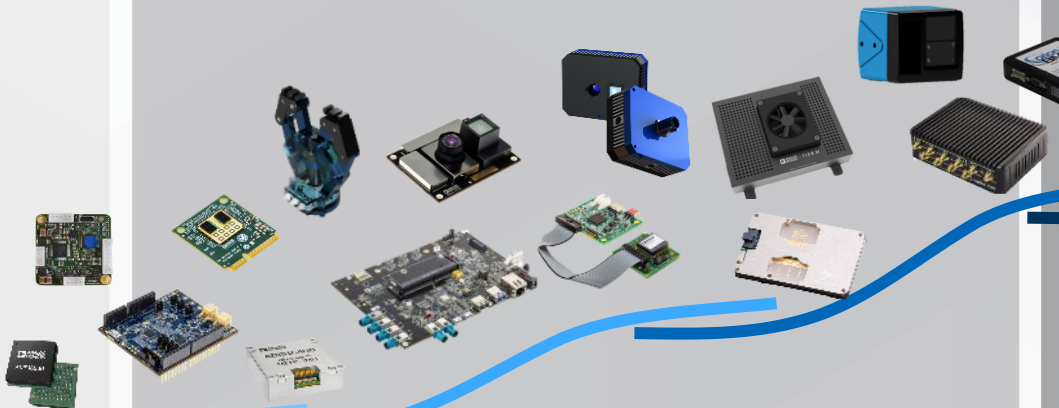
Core Components and Expertise



- Expertise in core technologies - Highest performance and total portfolio coverage

Sub- System Products

Reference Demonstrators



- Core functionality enhanced by demonstrating through rapidly deployable robotics sub-system products.
- Partner-Modules are developed in a lean, robotic form to demonstrate the end functionality of the system.

Autonomous & Personalized Systems

- True autonomy, Real Time Awareness and information capture.
- Artificial Intelligence (AI), Machine-2-Machine & Machine-Human

Yesterday | Today | Tomorrow

Key Take Aways

- **Integrated Solutions**: Our comprehensive solutions address key challenges in humanoid robotics, ensuring enhanced performance and reliability.
- **Cutting-Edge Technology**: We provide advanced technologies that enable humanoid robots to perform complex tasks with high precision and efficiency.
- **Collaborative Partnerships**: By working closely with leading companies, we offer integrated solutions that meet diverse application needs.
- **ADI’s Future Expansions in Humanoid deployment**: Elevate domain expertise and advancement in system integration. Value on more Embedded and Integrated hardware and software solutions.

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