助力‘双碳’，ADI智能工厂方案

于常涛

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Agenda

- ADI工业自动化领域产品和技术方案概述
- 运动控制系统方案介绍
- IO产品介绍
- 工业以太网产品介绍
- 答疑

China Industry Brief

“十四五计划” 经济发展指导思想

“科技创新”

“碳达峰”与“碳中和”

“双循环”

带动的行业

智慧城市

芯片

工业自动化

新能源

工业互联网

智能交通

IAT Focus Areas

Industry 4.0 Delivers on Increased Productivity

See where ADI is accelerating the transition to the secure connected enterprise

Flexibility

The shift to more flexible architectures allows for greater capacity and faster reconfiguration. Using universal analog I/O (input/output) brings integration, robustness, flexibility, and efficiency with significant time and cost savings. All of which create opportunities for virtualization utilizing AI and digital twin technologies.

Efficiency

Even a 1% reduction in energy use can bring tremendous savings to a factory operator. These savings can be realized through the adoption of inherently lower power solutions that are then augmented by condition-based machine monitoring analytics.

Communications

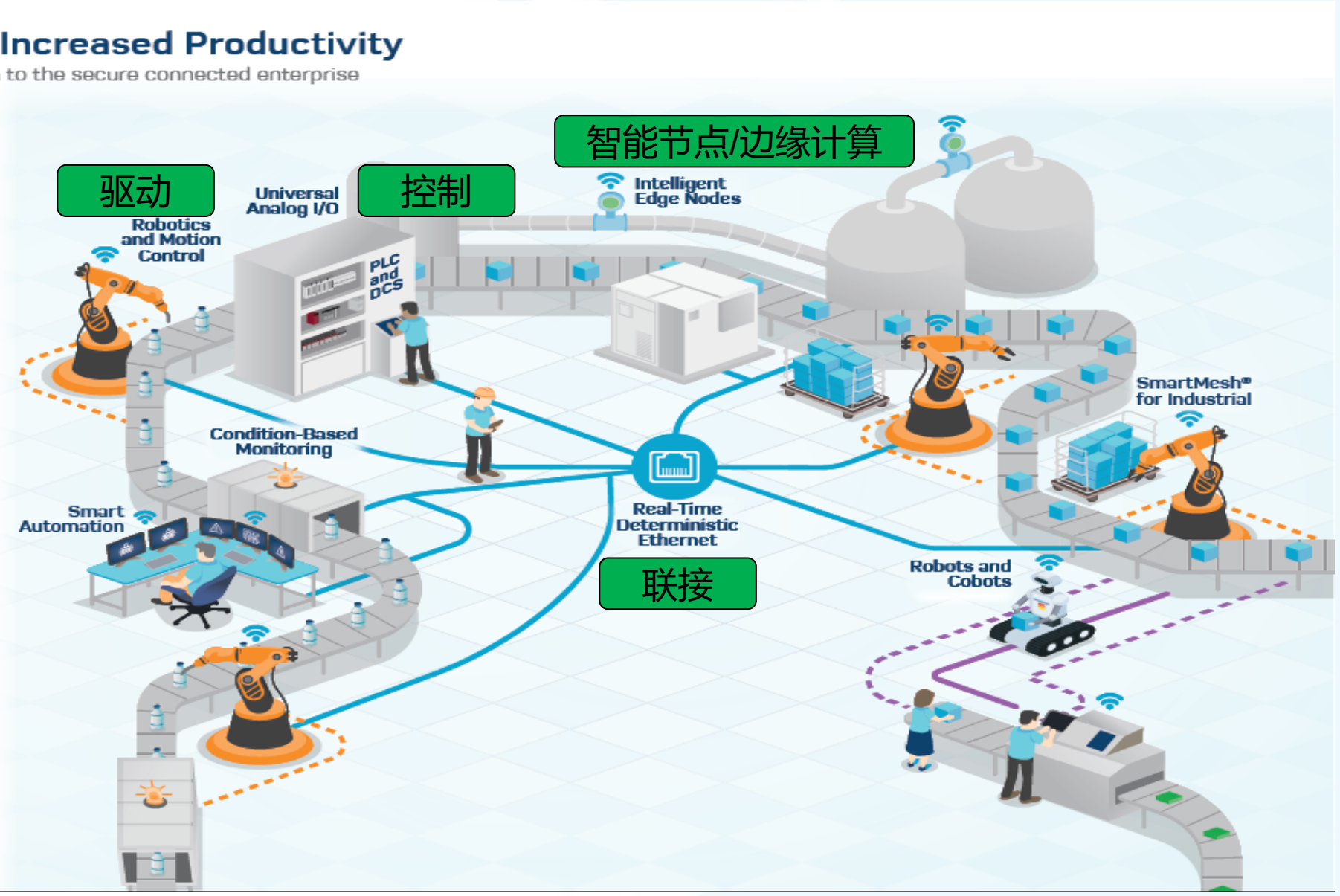
Central to the execution of Industry 4.0 is robust and secure wired and wireless communication that must support legacy standards and provide a clear path to Ethernet to the Edge and time sensitive networks (TSN).

Safety

A system is not smart if it is not safe. Functional safety is ubiquitous in automation systems with strict standardization and certifications requirements.

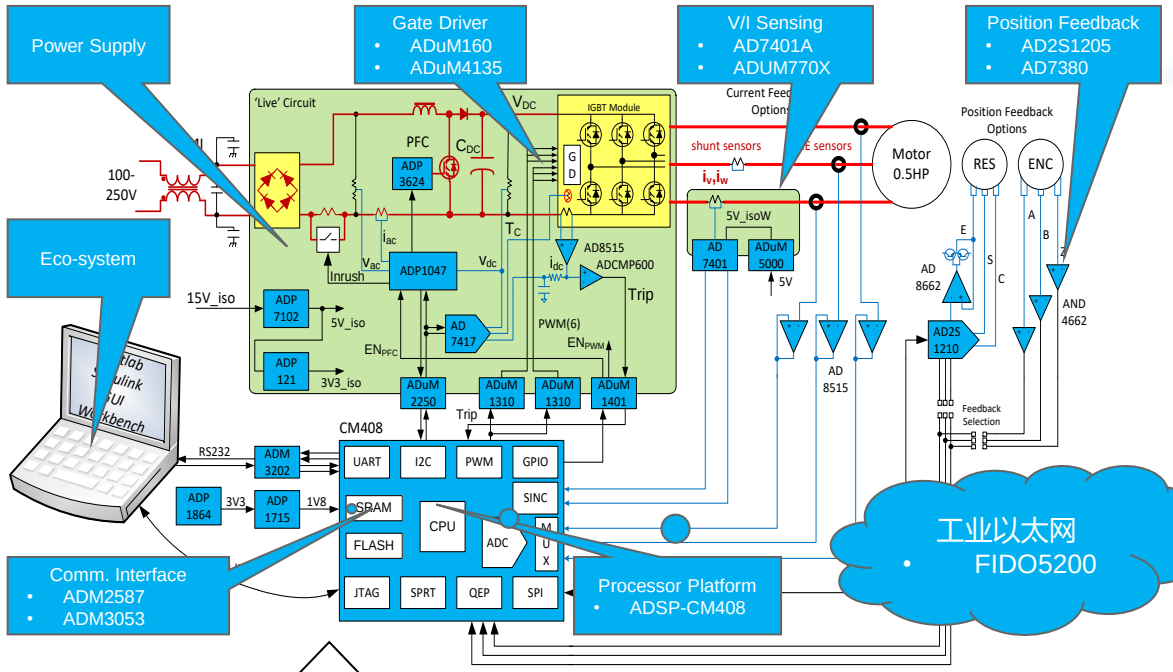
Security

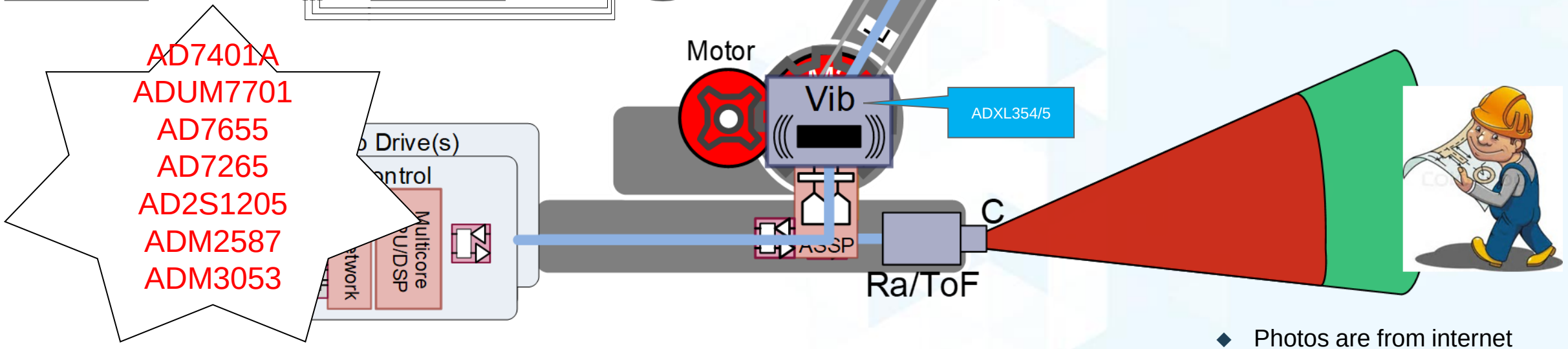
Greater connectivity of smart machines with Industry 4.0 brings with it risks from cyber attacks. Factory operators and solution providers need to develop stronger cybersecurity strategies that are more vigilant and resilient to attack.



PART 1 : MOTION (ROBOTIC / AGV/AMR)

Accelerate Robotic Integration

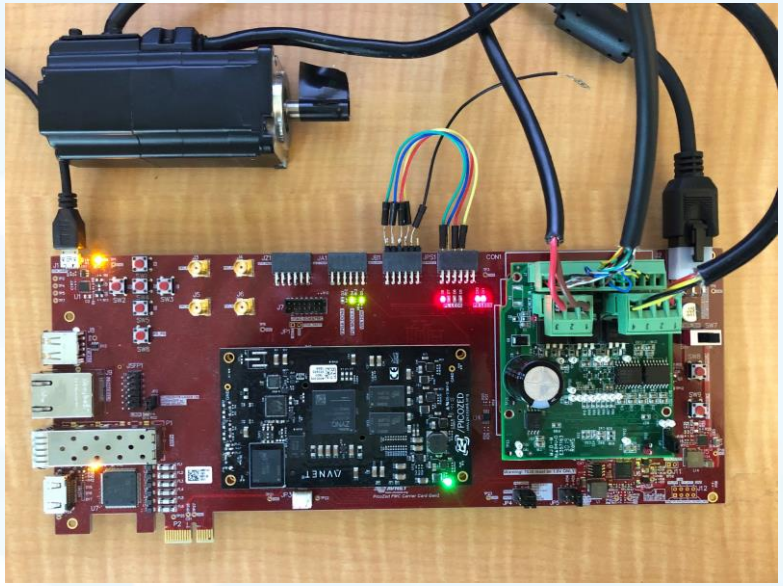




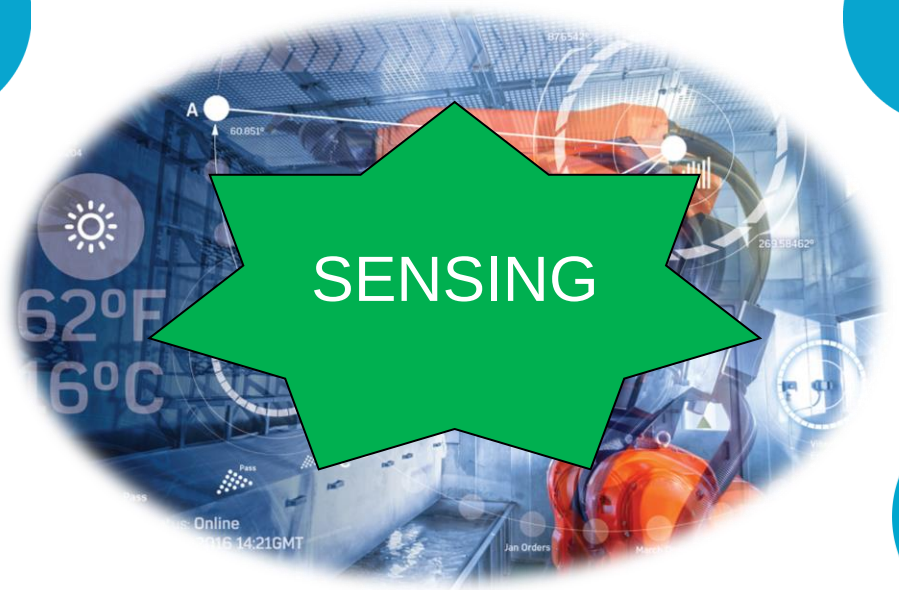
AD7401A
ADUM7701
AD7655
AD7265
AD2S1205
ADM2587
ADM3053

- Photos are from internet

Servo/Drive Platforms



ADI Technologies Advancing Robotics



Servo Drive Signal Chain

Functional Safety

Industrial Ethernet Solutions

Cyber Security

SmartMesh® Wireless Networks

Proximity Detection

Power by Linear

Navigation & Mapping

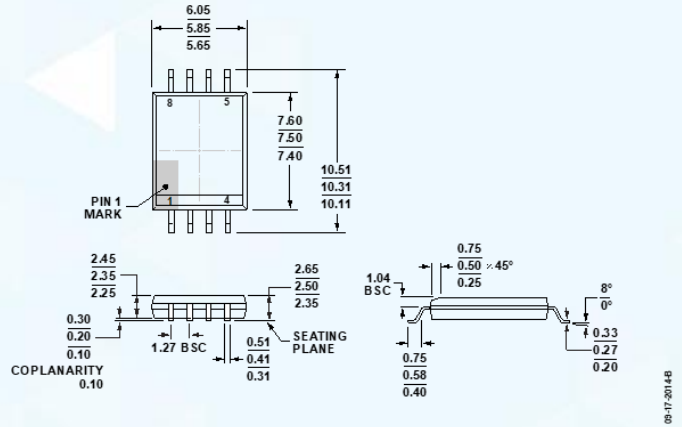
Machine Health Monitoring

Battery Management

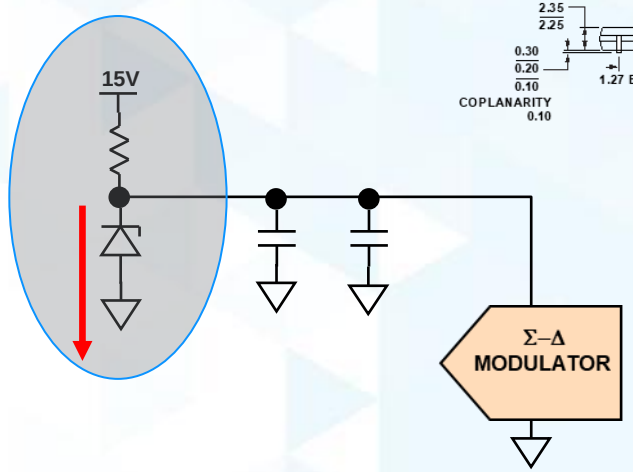
Stabilisation & Orientation

Current/Voltage Sensing
ADuM7703, Integrated LDO

- Space saving package RI-8, 8-lead wide body SOIC



- ADuM7703/04-8 only devices with integrated LDO in 8-lead package

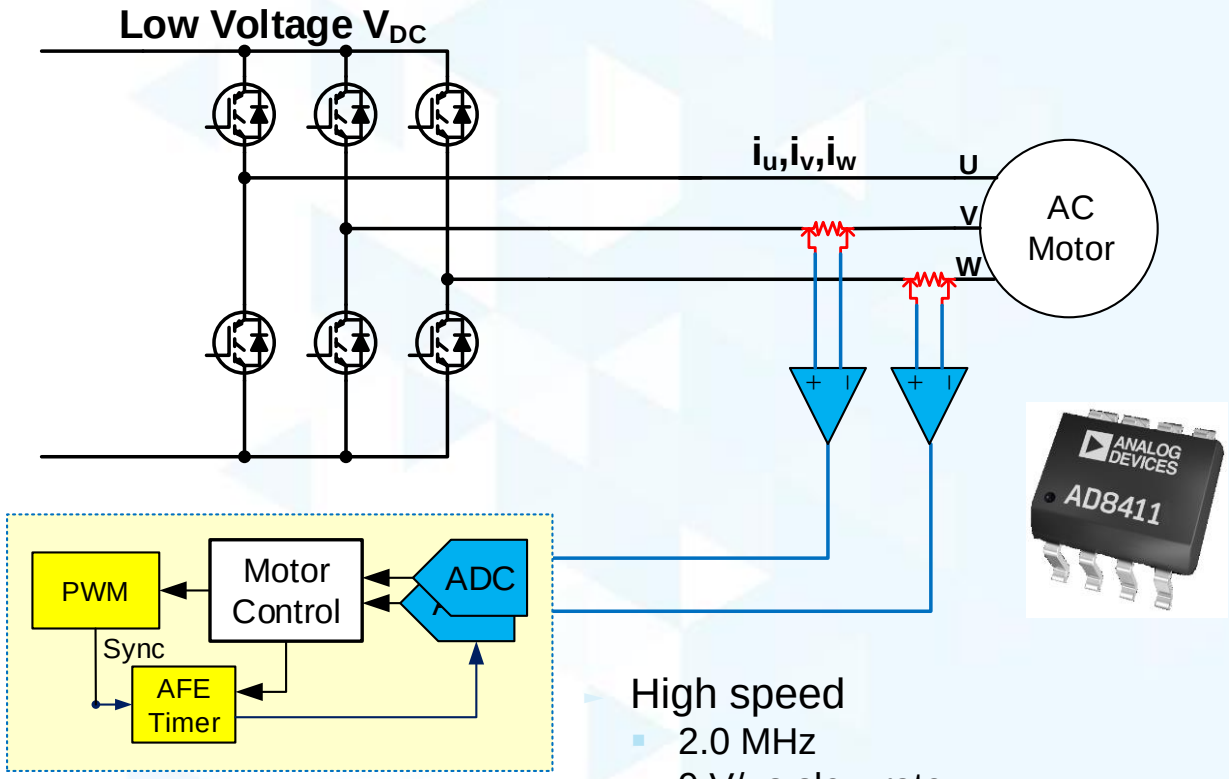


- No external LDO or bootstrapping required
  - Delivering board area savings, fewer components
  - Bootstrap zener diode breakdown voltage varies vs. temperature adding additional offset error
  - Current loss through Zener

- **ADuM770x reduces system size, weight and cost compared to competition**

Current/Voltage Sensing
Low Voltage System

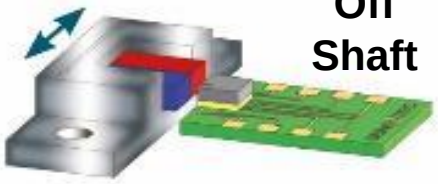
- Low voltage DC bus option in cobots and light payload robots
  - Controller Box space saving
  - Wiring reduction
- Drives integrated into robot arms, joints
- Typically 48V – No isolation requirement
  - Shunt + High common mode amplifiers
- Isolated signal chain may still used in LV systems for noise reduction



- High speed
  - 2.0 MHz
  - 9 V/µs slew rate
- High input common-mode voltage
  - -2V to +70V Continuous Operation
- Small packages for integration in robot joints
  - 8-lead SOIC_N
  - 8-lead MSOP
- Low drift: 1.0 µV/°C max

Positioning -- xMR Measurement

End of Shaft

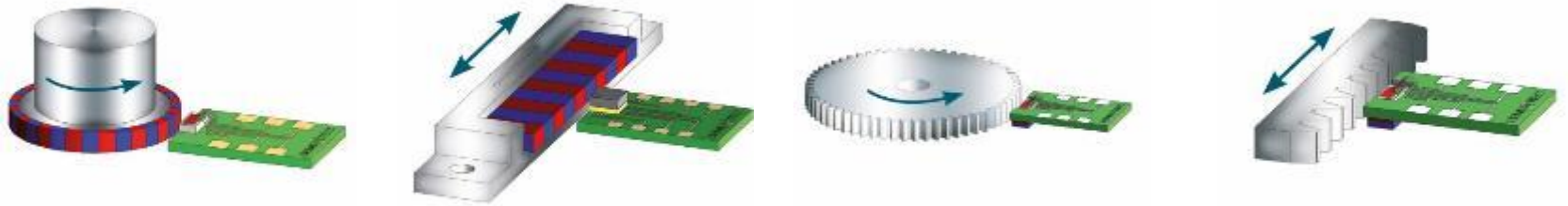


Off Shaft

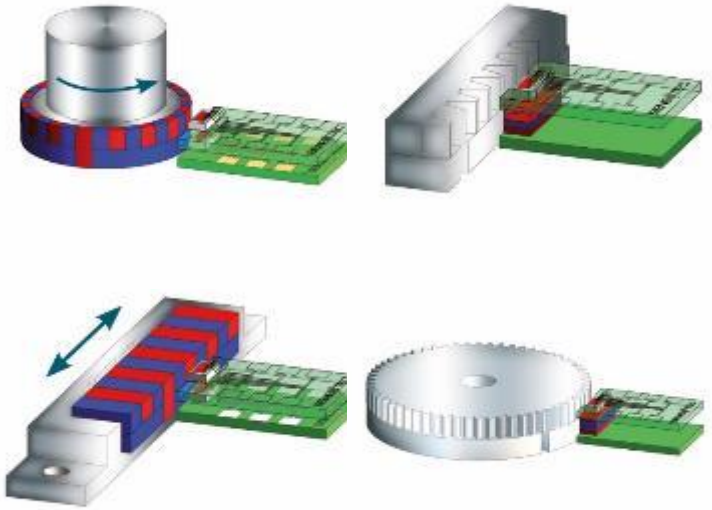
1

Absolute Position

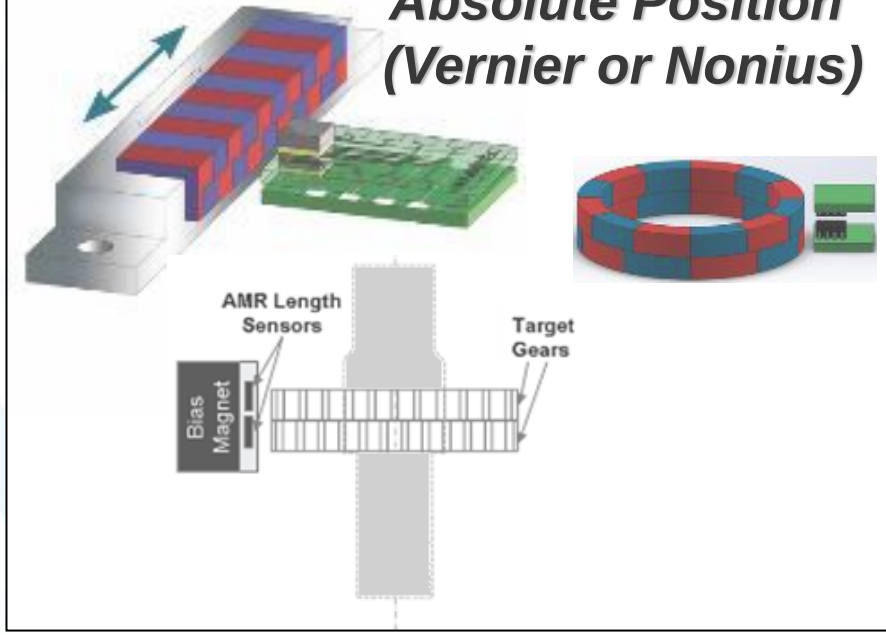
2 ***Incremental***



3 ***Incremental + Index***

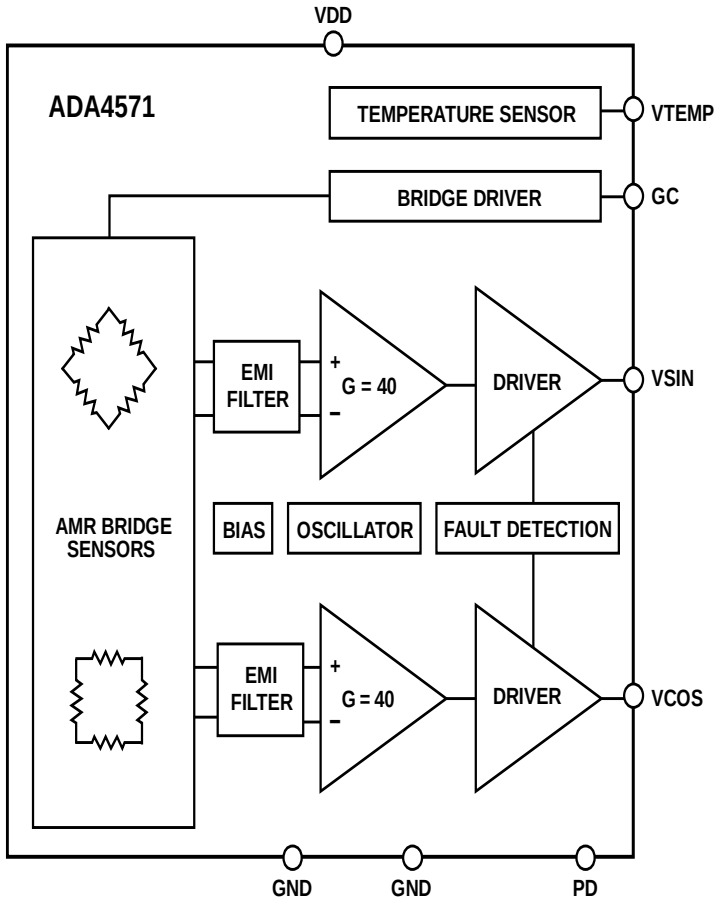


4 ***AMR Length Sensor Absolute Position (Vernier or Nonius)***



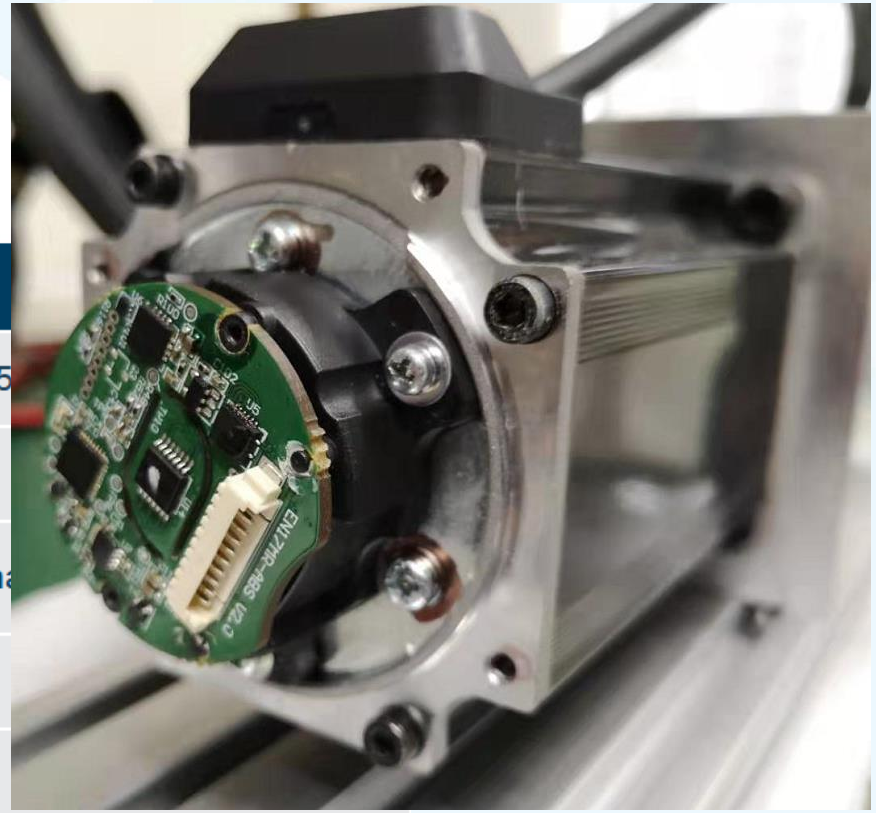
Positioning -- AMR Encoder

The resistance of the formed ferromagnetic thin film metal varies according to the strength of the applied magnetic filed with the specific direction. A sensor utilizing this effect is the AMR sensor.



Key Benefits

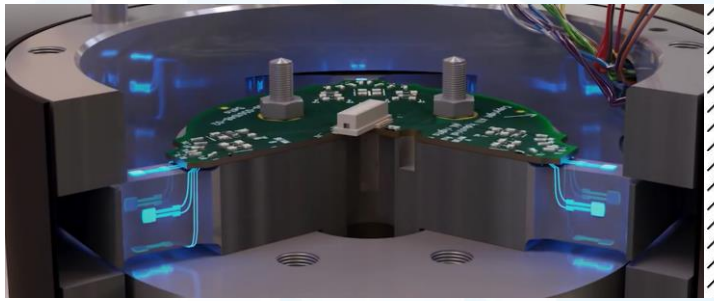
- Production Tested Angular Error 0.1⁰ Typical, 0.5
- Automotive Qualified (AEC-Q100)
- Fastest Integrated analog AMR sensor on the ma
- Low temperature and lifetime drift
- Ratiometric output voltages
- 2.7-5.5V operation
- Maximum Magnetic Field Frequency 50k RPM
- Partnership with xMR industry leader: Sensitec
- Well known in EU by Automotive and Industrial customers
- Best in industry package position tolerances (+/- 50um)

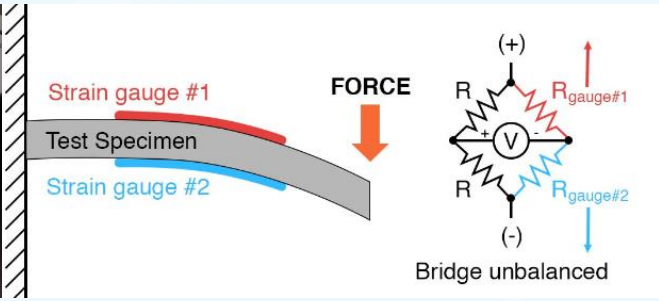


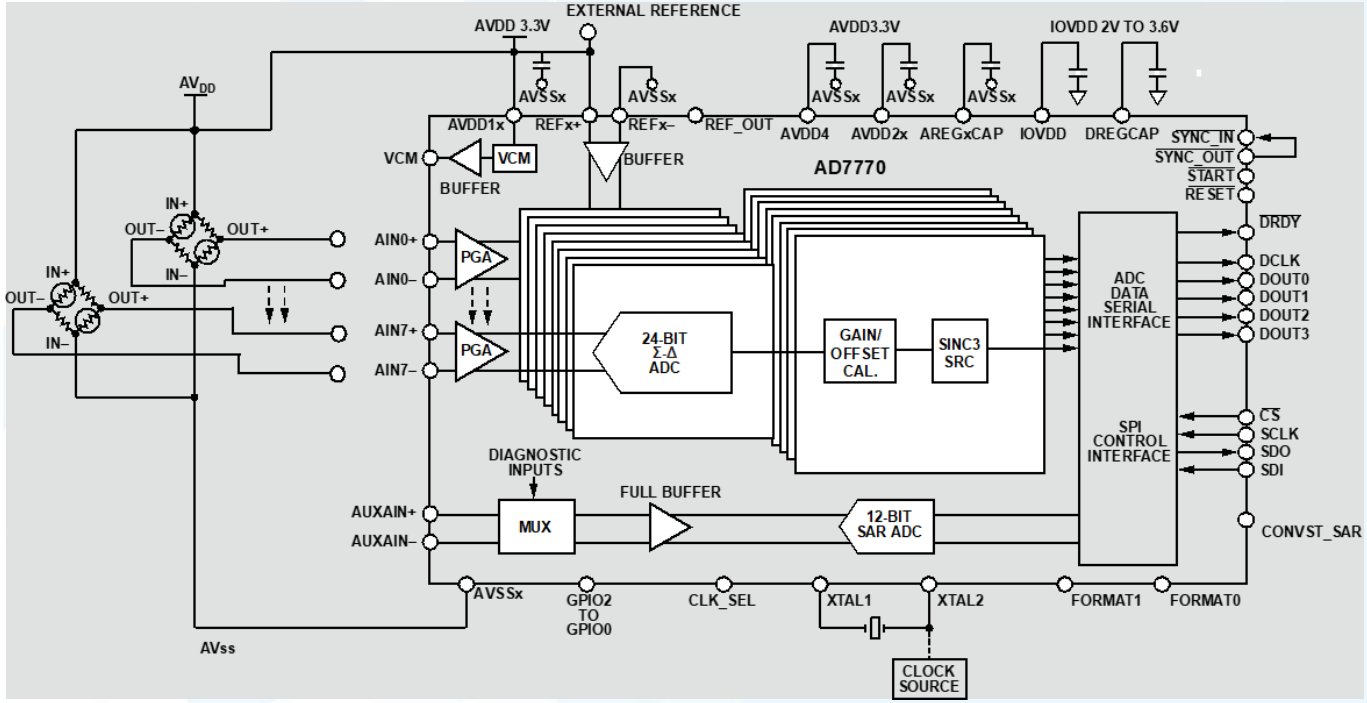
ADA4571
ADA4570
ADA4573

Force Sensing Solutions

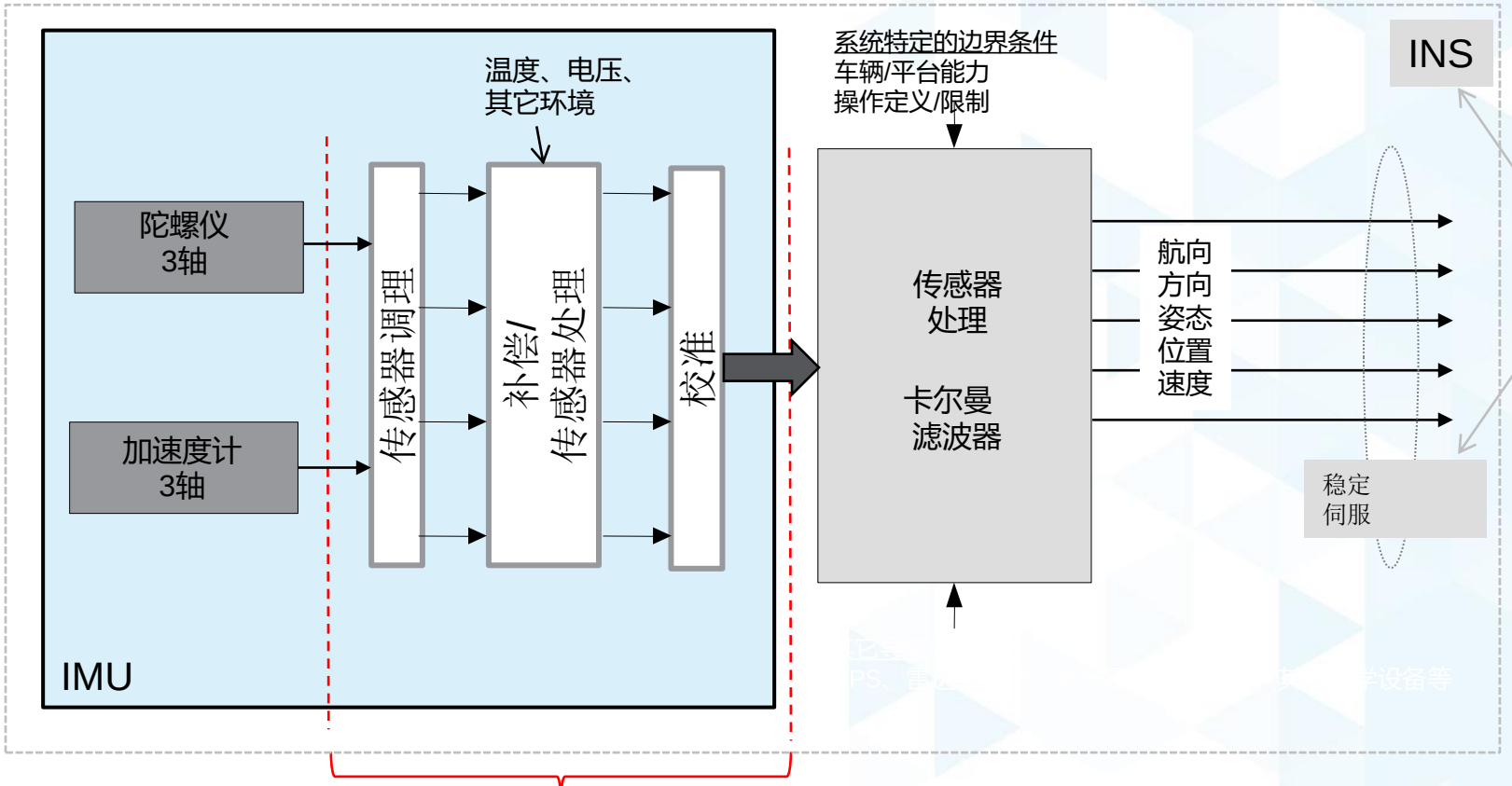
- Typical wrist force and torque sensor
  - 3 stress beams
  - 4 strain gauges per beam
  - Typically 4mV/V to 80mV/V sensors
  - 6x simultaneous sampling half bridge channels
  - Sub 10kHz sampling
- Ideally suited to ∑Δ signal chain
- AD777x
  - 8x sim sampling
  - Integrated PGAs, 1x, 2x, 4x, 8x
  - Configurable filters

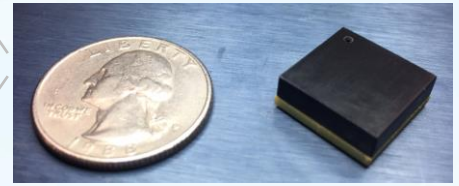






Stability & Navigation --- IMU





ADIS16500/ADIS16505/
ADIS16507 IMU

“传感器”与“导航引擎”的分际，代表：

- 开发周期衡量单位：*人-年*
- 性能改进衡量单位：*数量级*
- 测试设备衡量单位：*10万美元数*
- 单台设备生产测试时间衡量单位：*小时*
- 传感器处理衡量单位：*技术先进程度*

ADIS16505
ADIS16507

Y
Z
X
Low g

XYZ
GYRO

Extended Factory Calibration

Yaw/Roll/Pitch
xyz

Compact Performance
SMT IMU

ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™

✓ Compact Performance

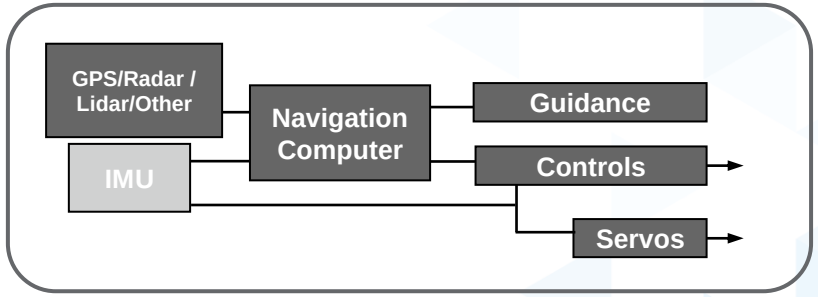
- In-run bias stability of 2.5°/hr and 3.6μ*g* (industry leading)
- Lowest angular random walk (0.15°/√hr) and velocity random walk (0.012 m/sec/√hr)
- Gyro range: 500°/s, Accelerometer: 8g
- Achieved via extended factory calibration

✓ Industry-Leading Compact Footprint

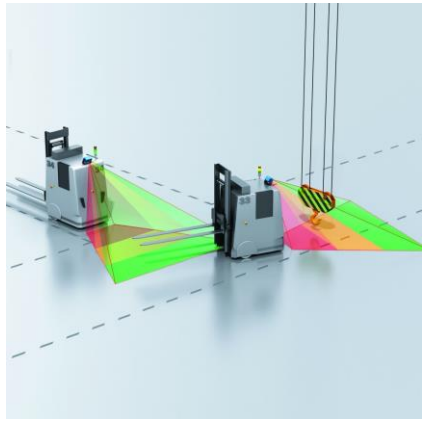
- Much smaller than Fiber Optic Gyros (FOG) used in prototype vehicles today

✓ Robust performance in automotive testing environments

- High level of immunity to vibration (0.01°/s/g) and shock (2,000g) over -40 to 105C temperature range
- ADI's *i*Sensor portfolio is already on the road in Autonomous Driving prototype systems



Environmental Sensing



Obstacle Avoidance

- AGV moves around an obstacle or another AGV
- Robot avoids a companion workpiece

Safety

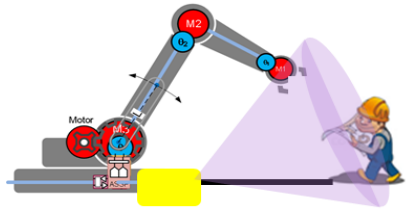
- AGV slows or stops near humans
- Robot slows or stops with human in vicinity

SLAM

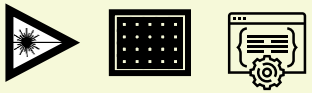
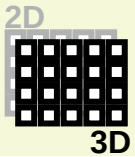
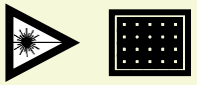
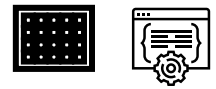
- AGV uses sensors to map dynamic environment

Object ID

- Production system identifies different items by dimensions
- Robot picks randomly sorted objects



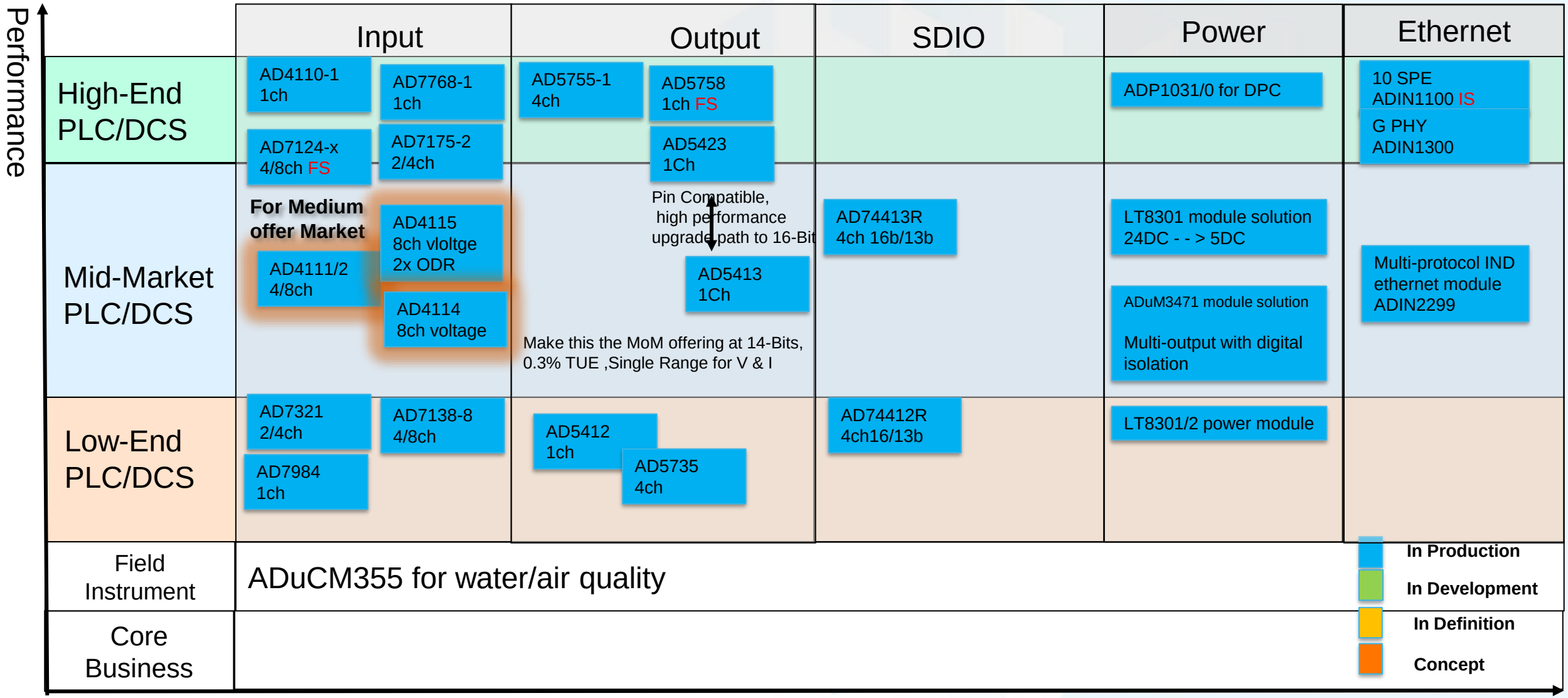
ADI ToF Key Enablers

	ADI next-gen system feature	Application enabler	Component facilitator
	High depth resolution	▪ High **modulation frequency** (320 MHz) ▪ High **raw frame rate** (500 FPS) ▪ Innovative **modulation schemes**	
	High dynamic range	▪ Low **readout noise** (3e-) ▪ High **raw frame rate**	
	Ease of use	▪ Innovative **modulation schemes** (ease of calibration) ▪ Temperature compensation & eye-safety monitoring	
	Outdoor operation	▪ High **sensitivity at 940nm** (27% QE) ▪ Efficient illumination	
	Flexible depth & 2D	▪ Small pixel (3.5 x 3.5 µm^2) ▪ Depth & 2D IR binned and ROI modes up to 1 mega-pixel	
	Multi-system operation	▪ **In-pixel cancellation** of interfering light ▪ Camera synchronization	

= laser driver
= image sensor
= algorithms

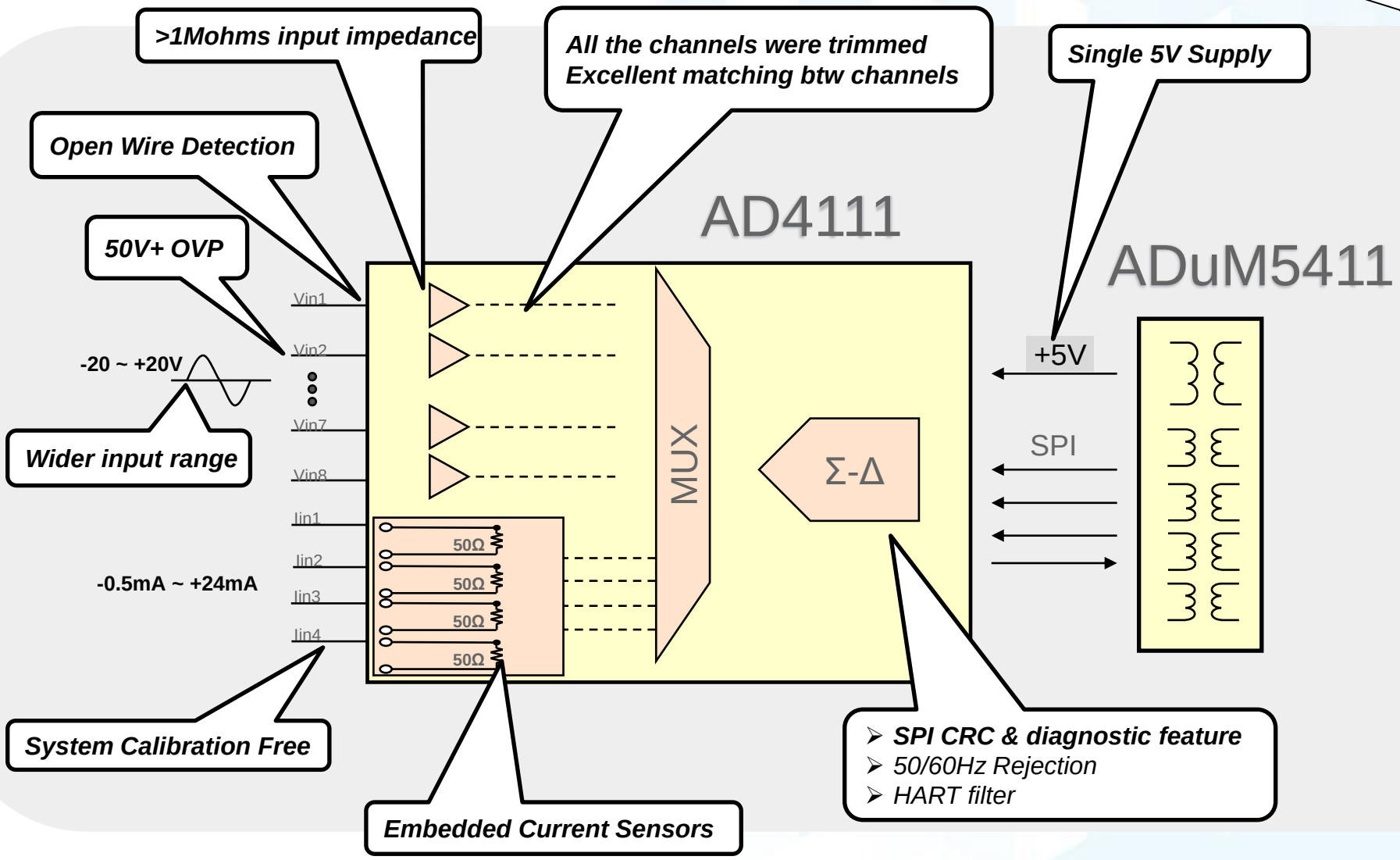
PART 2 : Process Control

Factory Automation



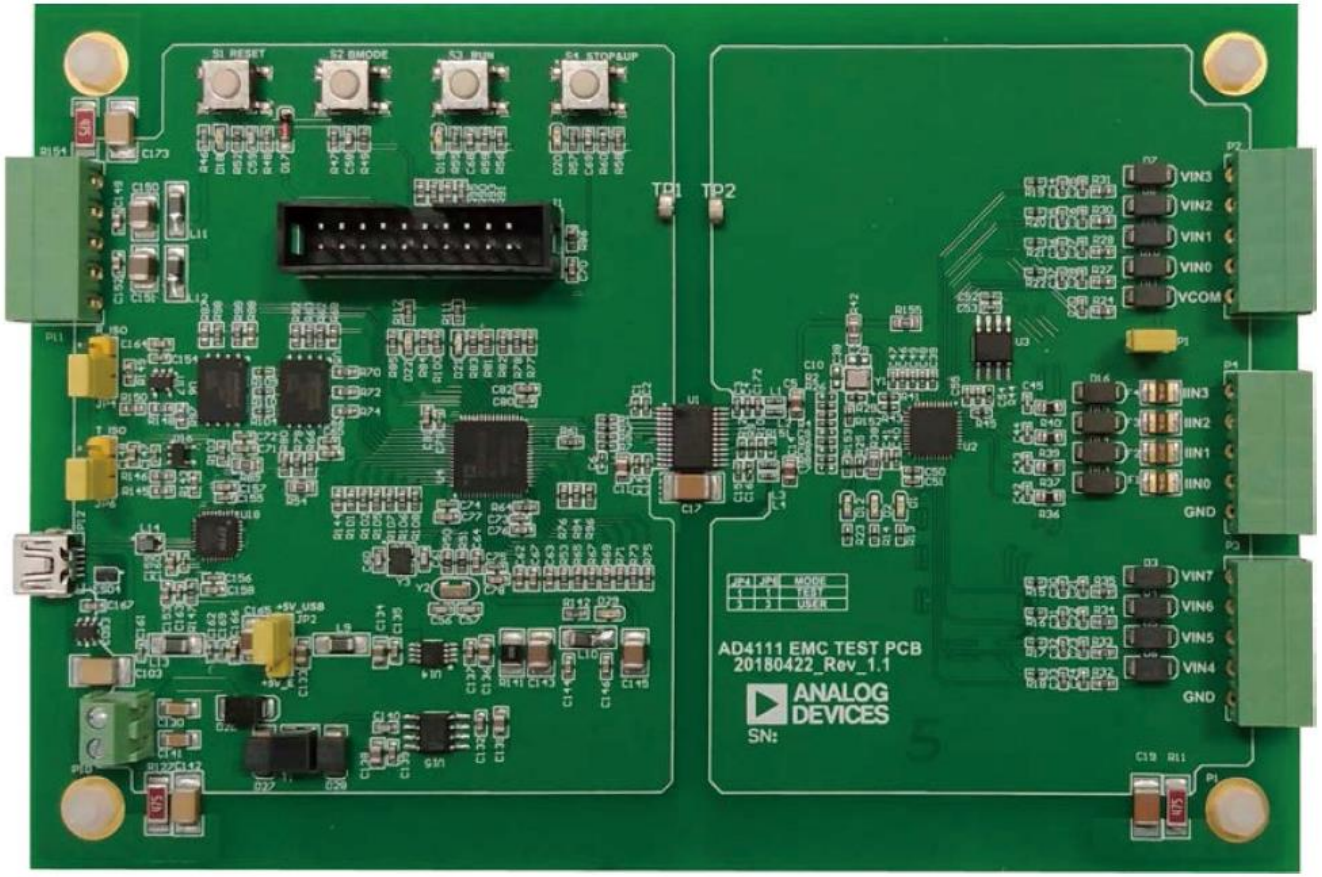
AD4111 Simplify whole Signal Chain

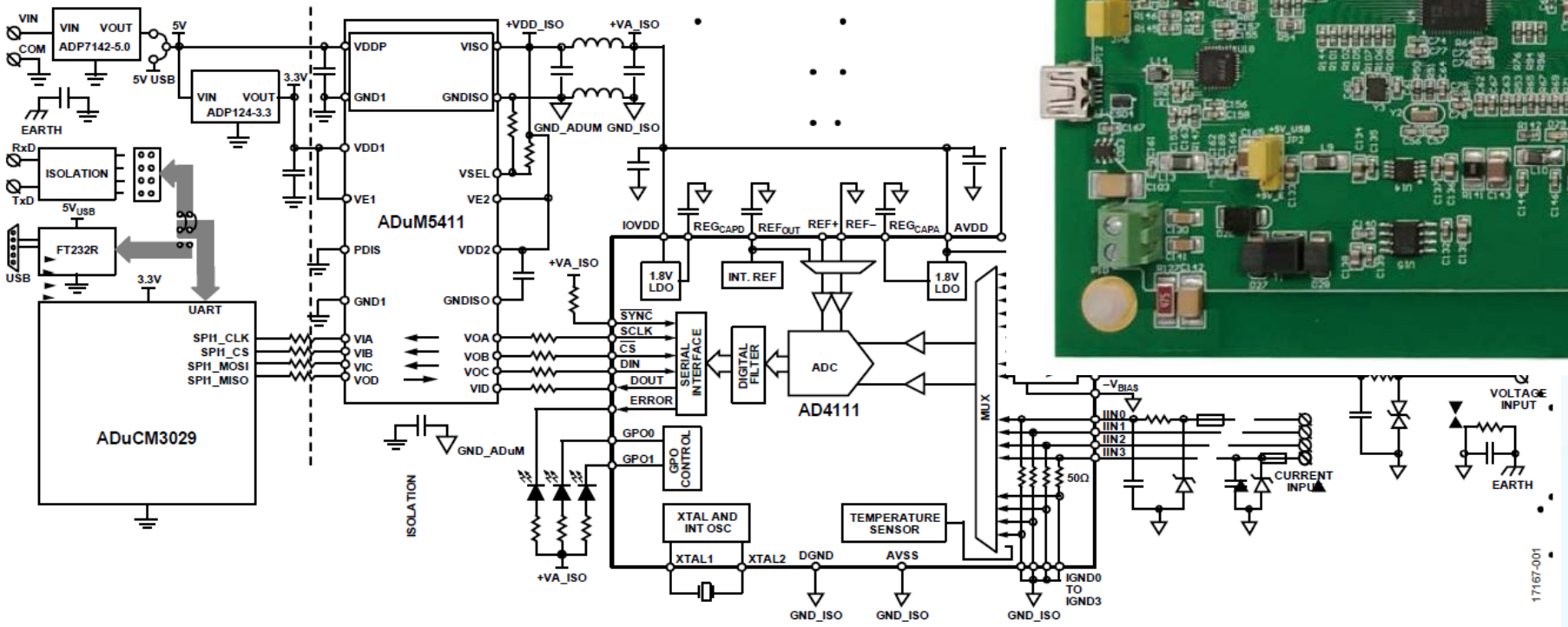
AD4112
AD4114
AD4115
AD4116



AD4111/2 EMC EVAL KIT --- AN1572

- IEC 61000-4-2
- IEC 61000-4-3
- IEC 61000-4-4
- IEC 61000-4-5
- IEC 61000-4-6
- CISPR 11





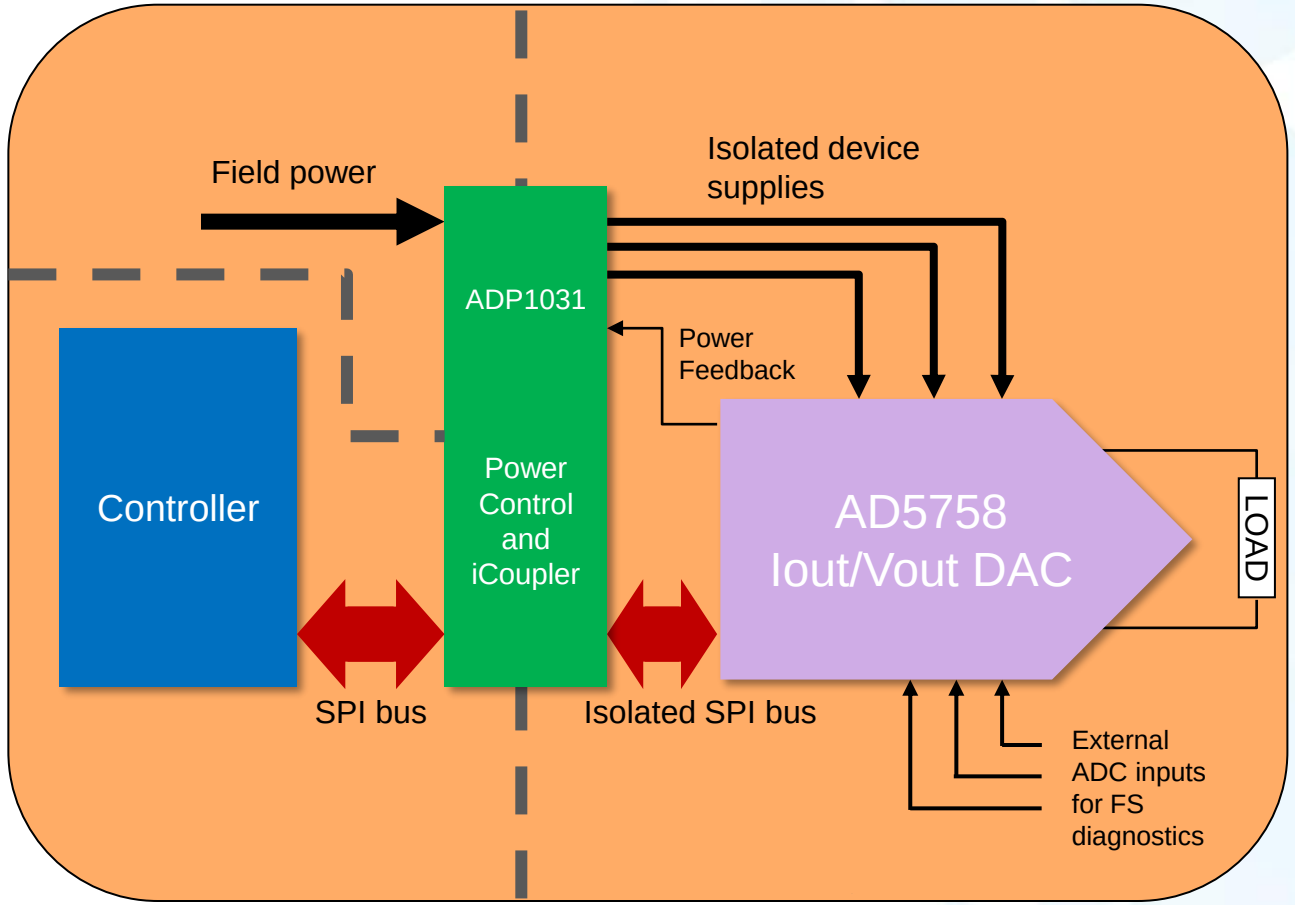
AD5758 + ADP1031 --- DEMO-AD5758-AO8Z

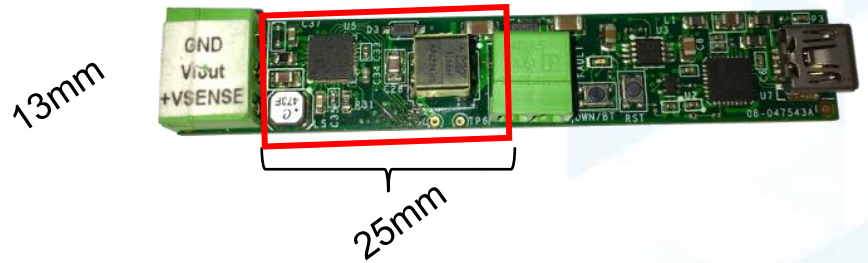
HIGH PERFORMANCE

Single Channel high performance 16-bit DAC
High feature integration
Vout/Iout flexibility
Dedicated power control with built in Isolators

SIL CERTIFIED FUNCTIONAL SAFETY ENGINEERING AS61508 AS61511

SIL certified design for simple customer TUV approval
Inbuilt diagnostics for high fault visibility





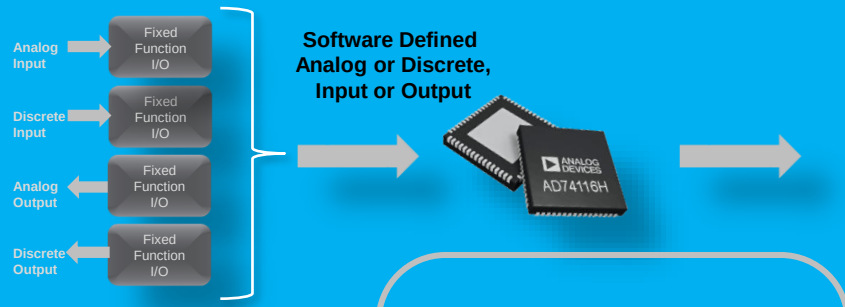
<250mW/ch, 325mm²/ch

AD5758
AD5413

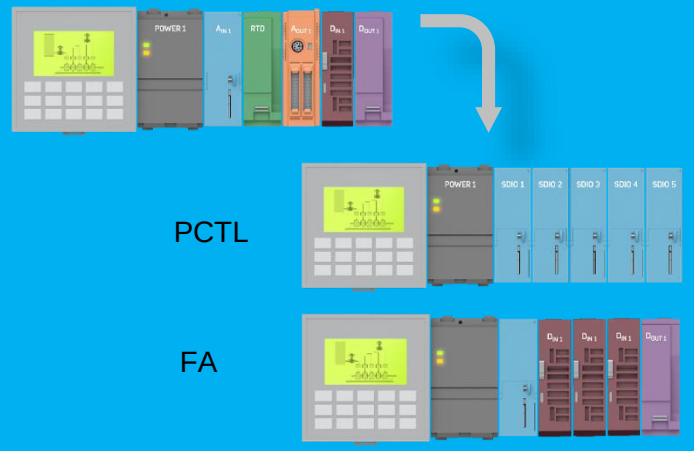
2nd Generation Dynamic Power Control for minimum power consumption and dissipation
enables 8 channel per board
Reduces OPEX over lifetime

High integration, Vout/Iout on single pin
Minimal system footprint and highest efficiency when combined with ADP1031

Software Configured IO



Industrial I/O “On Demand”
= End user flexibility

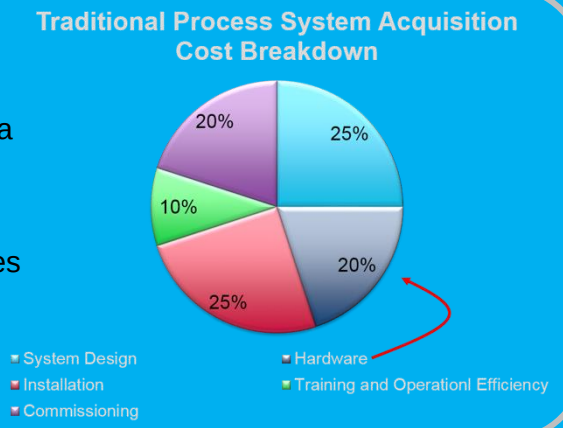


Customer:
Platform design and standardized controller I/O
Reduced R&D, Manufacturing, Logistic, Support cost
User:
Reduced control system design time and cost
Simplified installation (much lower cost)
Immediate in-field configuration
Reduced Logistic and possible line-down costs
Bridge to 10SPE

PCTL:

Hardware only a small % of total cost.

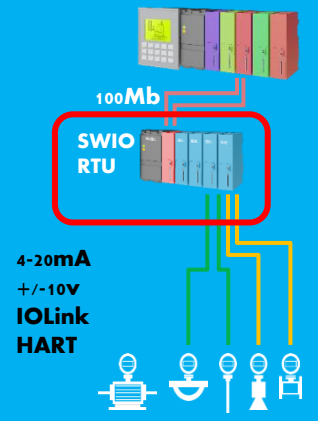
SWIO addresses the larger cost points



PCTL:

New T1L needs for Brownfield

SWIO bridges to Legacy field nodes

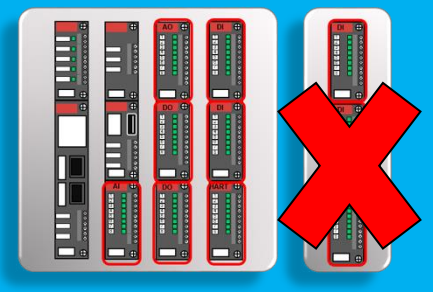


AD74413
AD74412

FA:

Reduces need to redundant I/O or Additional expansion board

Per Channel Granularity



AD74413R – PLC – Additional/Improved Features

Additional Features targeted at Process Automation Customers

- Accuracy, with external Reference
  - IOUT TUE: 0.28%FSR
  - IIN TUE: 0.1% FSR
- Thermocouple measurement
- Diagnostics
  - Low Voltage Analog I/P pin
- HART modem compatability
  - Current Ouput Rate-Of-Change slew option
  - Current I/P functions available with input Imdedance >230Ohm to allow for HART compatabaility
- 10ppm On chip 2.5v reference
- Supports IEC61131-2 Type I/II/III Digital Inputs
- Supply Range: 14V to 28.8V
- Temperature range: -40°C to +105°C

- User configurable modes
  - Voltage input
  - Current input
  - Voltage output
  - Current output
  - Digital input
  - RTD measurement
- Internal 16-bit, Σ-Δ ADC with optional 50 Hz and 60 Hz rejection

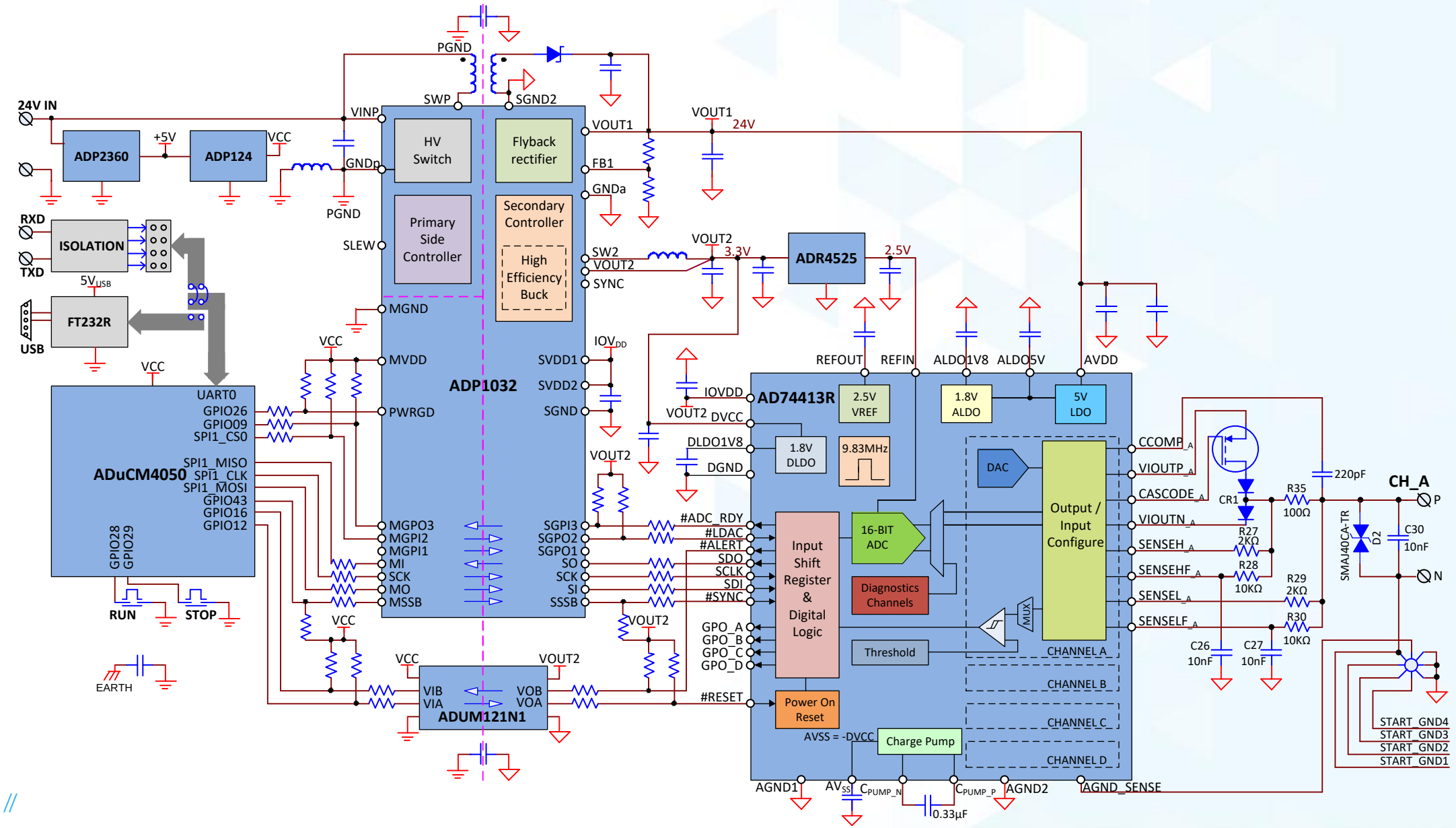
x indicates Channel count

AD74x1x family

Released | Released | Sampling

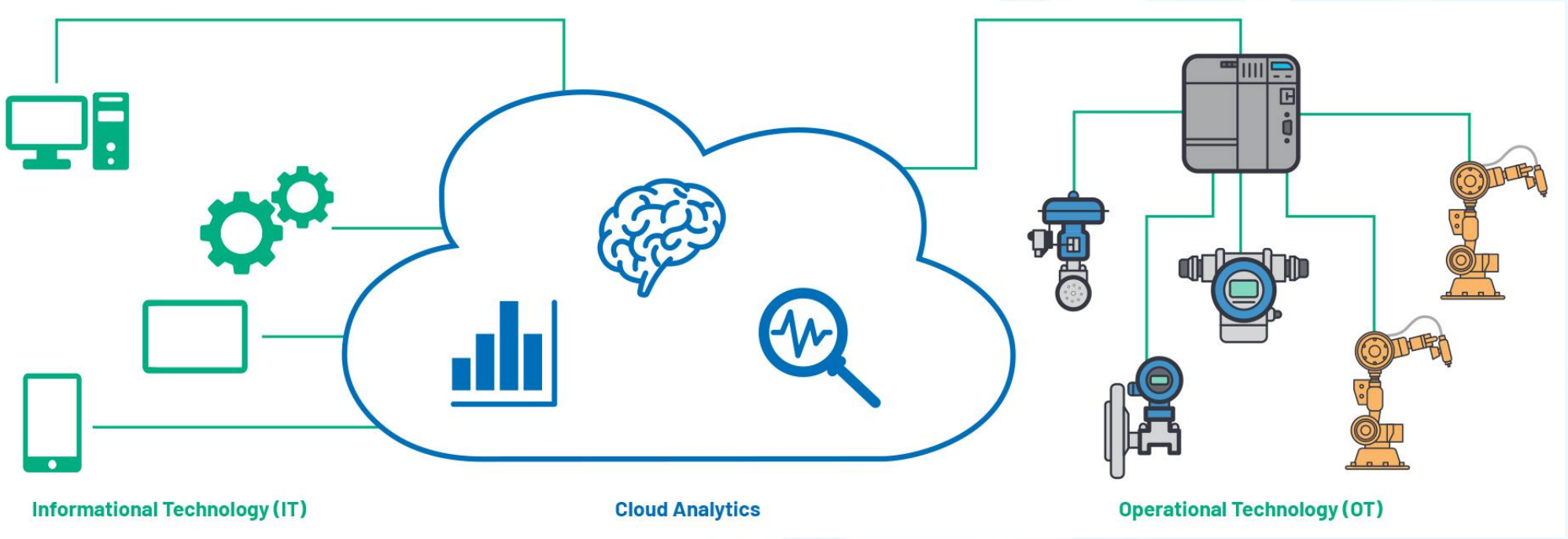
Feature	AD74412R (Building Control)	AD74413R (Low end PLC/DCS & Drives)	AD74115/H Single Channel DCS	AD74415 (Mid/High PLC/DCS) Full Feature
Channel Configuration	Quad	Quad		
Thermal Management	Cascode	Cascode		
Supply	Avdd +10 to +26.4V (Charge pump for -5V AVss)	AVdd +10 to +28.8V (Charge pump for -5V AVss)		
Analog Output: Current	TUE: 0.55% (Int Vref) 0-25mA, 13bit	TUE: **0.28%** + Rsense Error (Ext Vref) 0-25mA, 13bit		
Analog Output: Voltage	TUE 0.4% (Int Vref) 0 to +11v, 13bit	TUE: **0.2%** (Ext Vref) 0 to +11v, 13bit		
Analog Input: Current Loop Powered Ext Powered	TUE: 0.5% (Int Vref) 25mA, 16 Bit Current limited, 16Bit	TUE: **0.1%** (Ext Vref) 25mA, 16 Bit Current limited, 16Bit		
Analog Input: Voltage	TUE: 0.4% (Int Ref) 10V, 16bit	TUE: **0.1%** (Ext Ref) 10V, 16bit		
Digital Input (Loop Powered or Logic with programmable debounce)	Programmable Voltage Thresholds	Programmable Voltage Thresholds **IEC61131-2 Type I/II/III** **Counter**		
Digital Output current	-	-		
Thermocouple capability	No	Yes +/-104mV range		
RTD measurement capability	2 wire RTD	2 wire RTD (3-wire RTD capable with 2 channels)		
On-board-reference	2.5V, 20ppm	2.5V, **15ppm**		
Output Fault Tolerance	+/-40V	+/-40V		
ADC Conversion rates	20SPS, 4.8ksps (full settled, conv on demand), 16Bit	10SPS, 20SPS, 1.2kSPS, 4.8kSPS (full settled, conv on demand), 16Bit		
Tambient / Tjmax	-40 to 85'C / (105'C Tj max)	**-40 to 105'C / (125'C Tj max)**		
Other	-	**HART Impedance & Ramp Modes**		
Package	64 LFCSP (9x9) 0.5pitch	64 LFCSP (9x9) 0.5pitch		

AD74413R+ADP1032 EMC Test Board Diagram



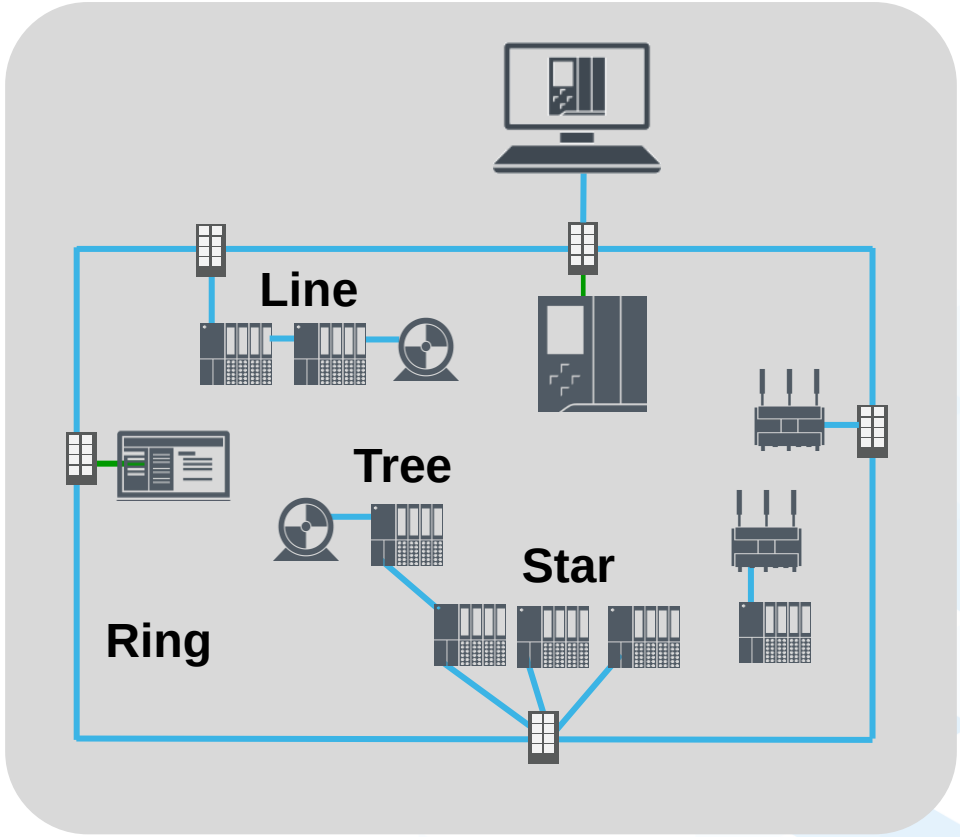
PART 3 : CONNECTION

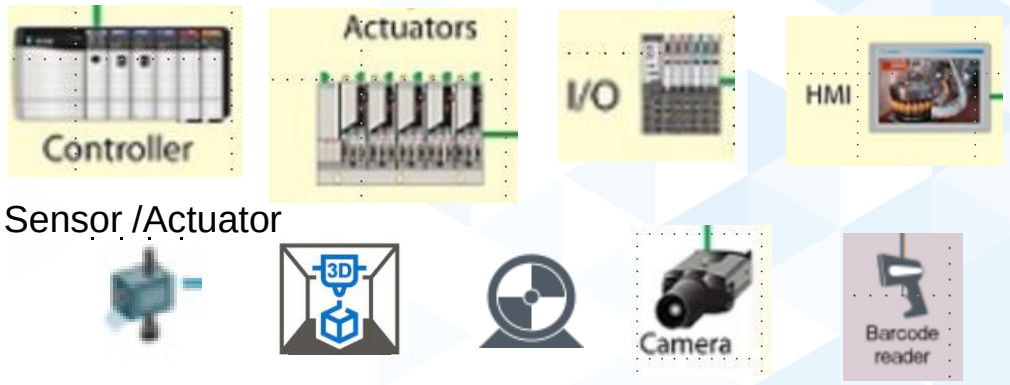
Data to Drive Actionable Insights



Factory Automation

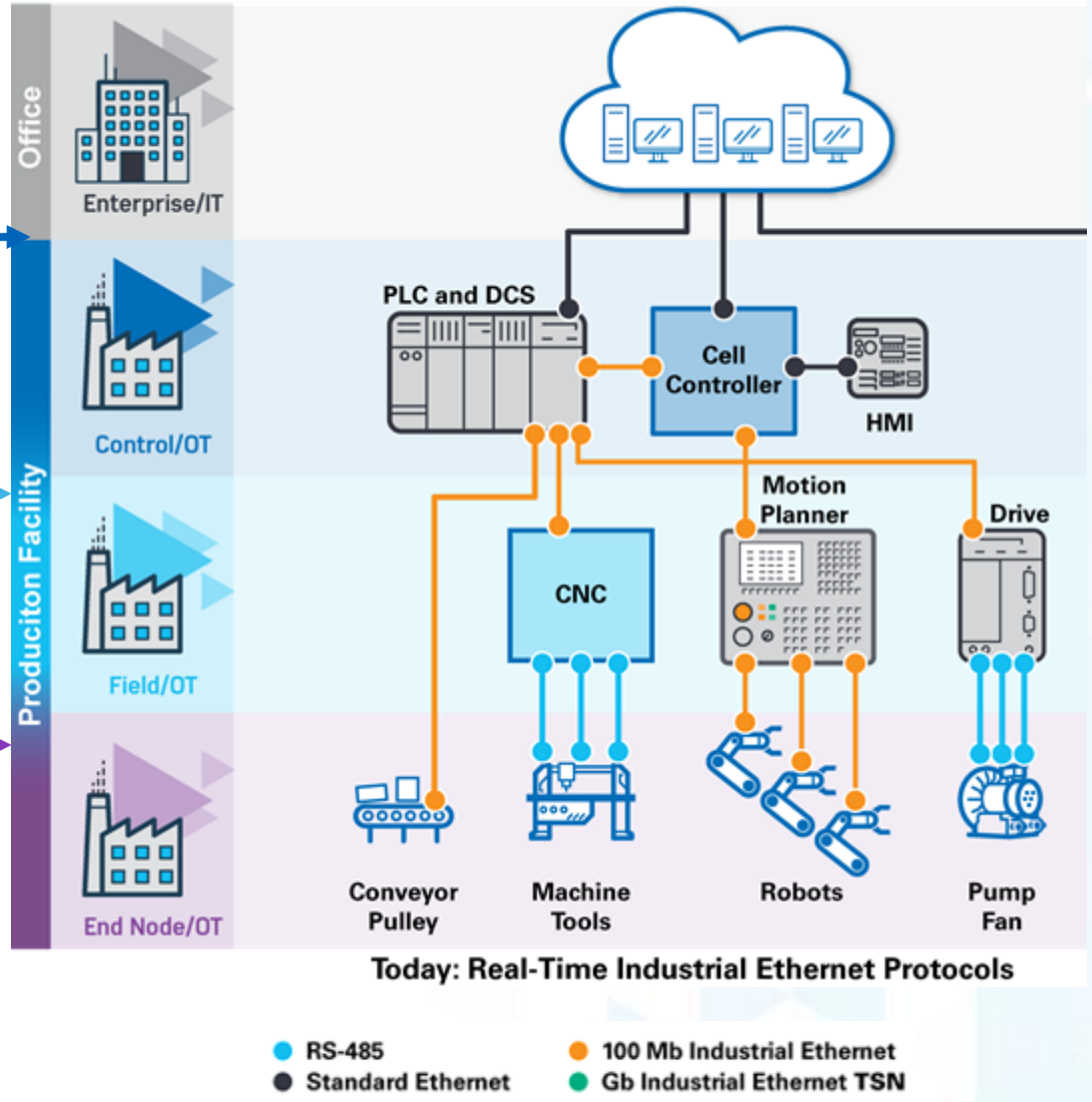
- Majority are line / ring networks
  - Dominated by 3 ports
- The Topology follows the Plant Structure
  - Line structure through integration of switch ports in devices
  - Tree and star topologies for plant orientated configurations
    - Reduced delays
  - Redundant rings with reconfiguration in real time
- **Key Requirements**
  - **Today** – 10/100Mbit
  - **Tomorrow** - Gbit
  - Real Time performance Requirements
- Adding Diagnostics via MQTT Applications running locally.
- End nodes/machines developed by many supplier, but all must connect to one network at control level.

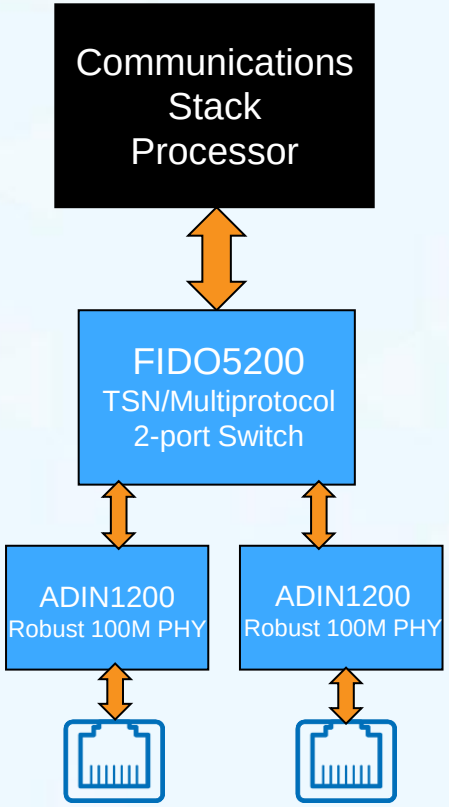




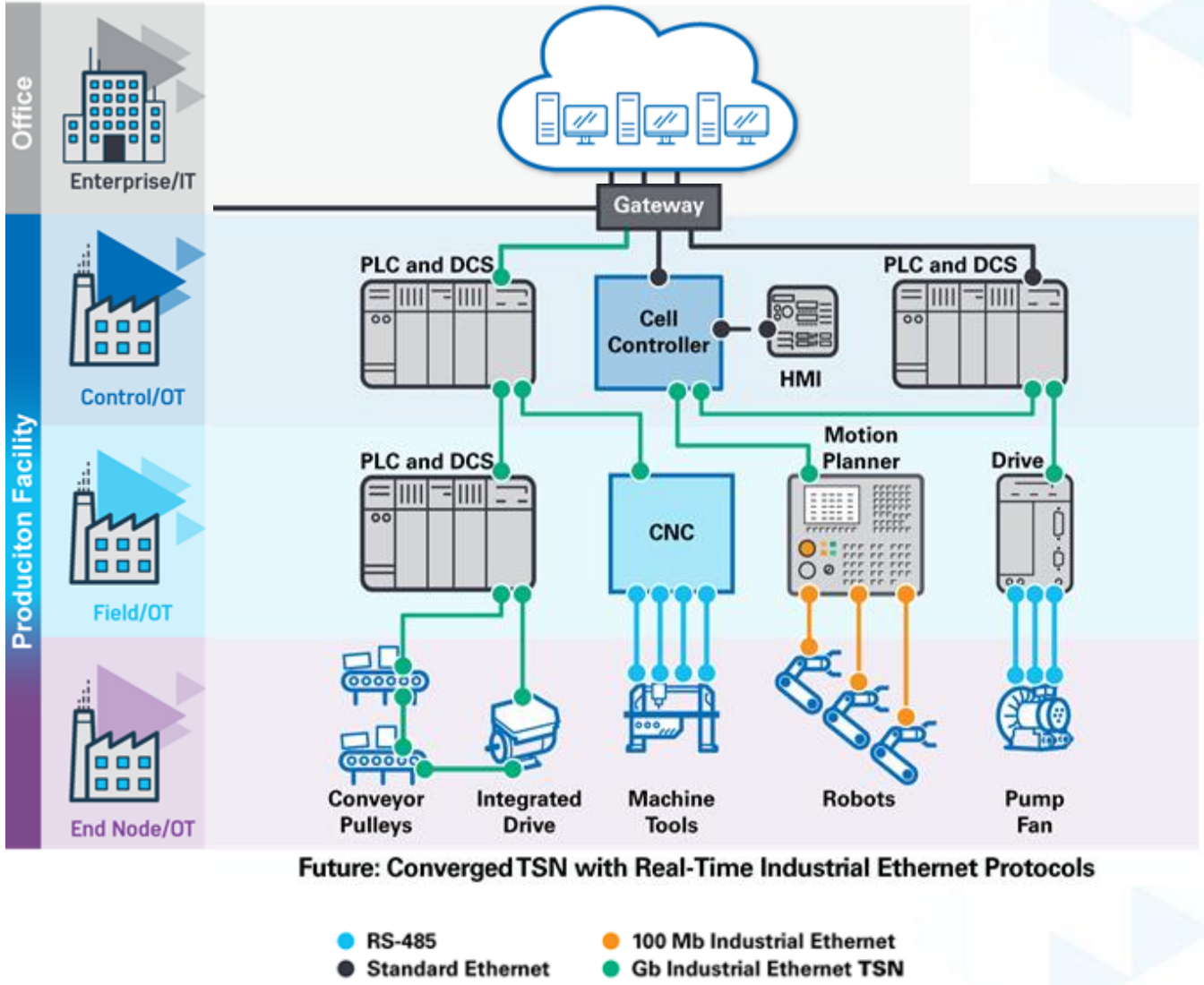
Factory Automation – Operational Hierarchy

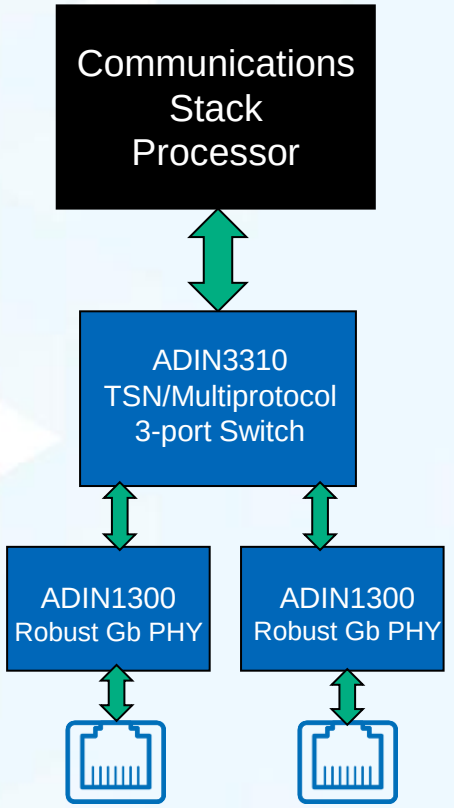
- **Information Level**
  - Top Level of Plant or Automation System.
- **Control Level**
  - Typically Peer-To-Peer Networks between Controllers (PLCs).
- **Cell Sublevel**
  - Cells combined in Application Oriented Groups.
- **Field Level**
  - Typically binary and analog field devices.





Factory Automation – Moving To Gbit & TSN





Transition to Gigabit

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ADI IND Ethernet Full Picture

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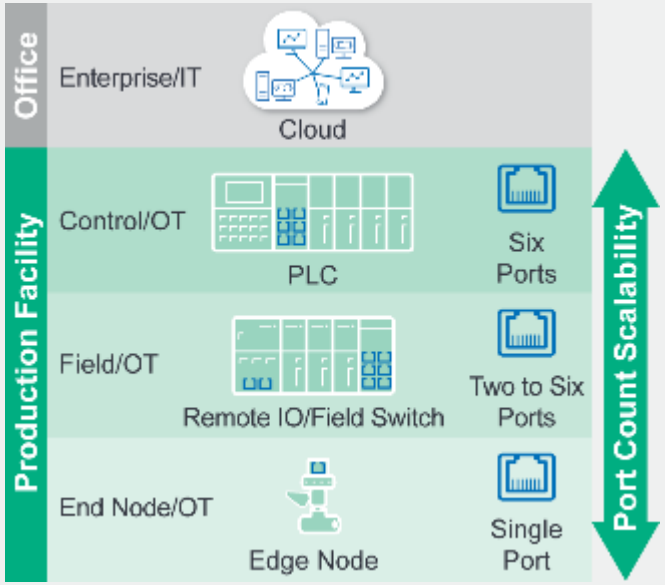
Robust Physical Layer

- 1000BASE-T
- 100BASE-TX
- 10BASE-T
- 10BASE-T1L

Port Count



Bandwidth

- 1G
- 100M
- 10M

Industrial Protocols

TSN
Time Sensitive Networking

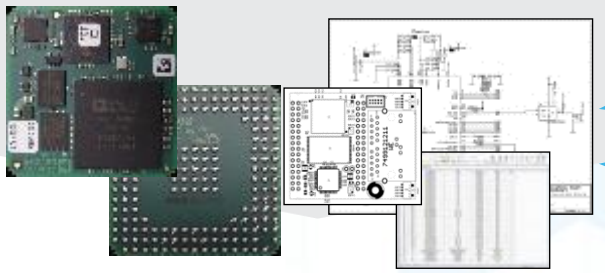
PROFINET
ETHERNET POWERLINK
EtherCAT
EtherNet/IP
Modbus

Cybersecurity

- Hardware Root-of-Trust
- Secure Boot/Update
- Device Authentication
- Secure Communications
- Secure Life-Cycle

TSN Agent (Software)

Security

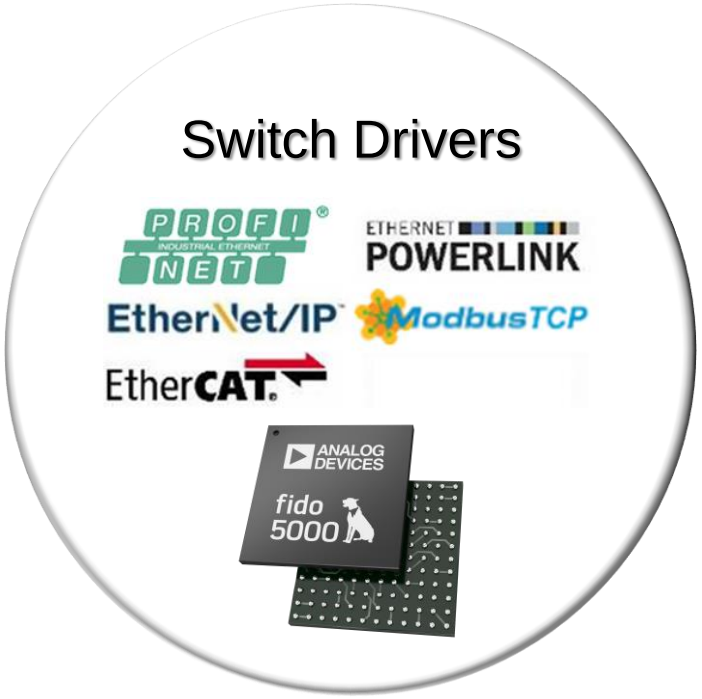


Robust PHYs

TSN Switch

Customer Choice – DIY or Get Quick To Market

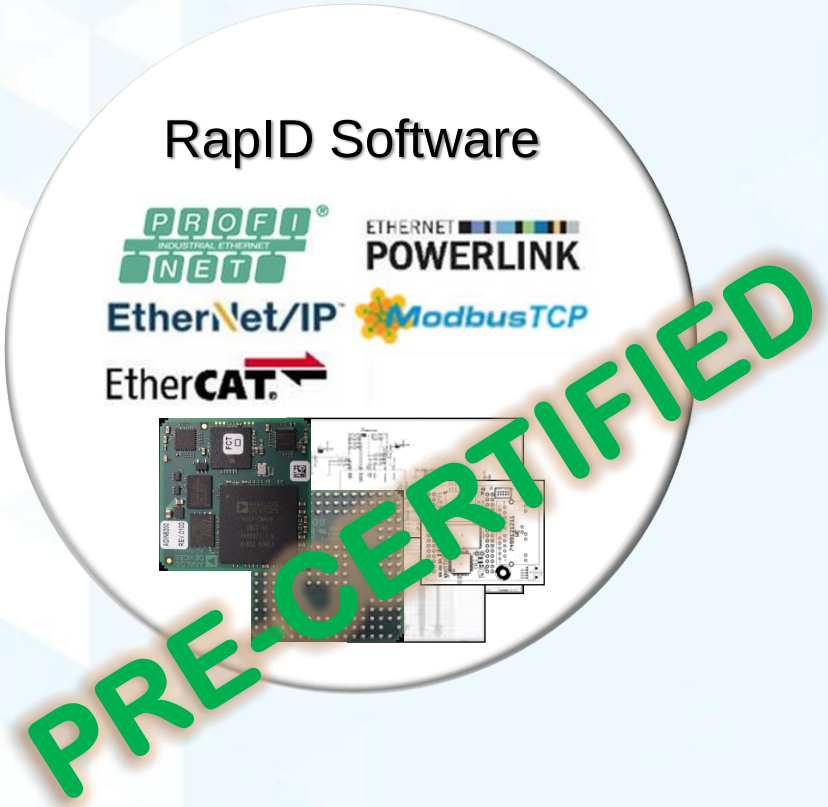
Full Custom Design Based On FIDO + Driver



Custom Solution – we provide chip + driver

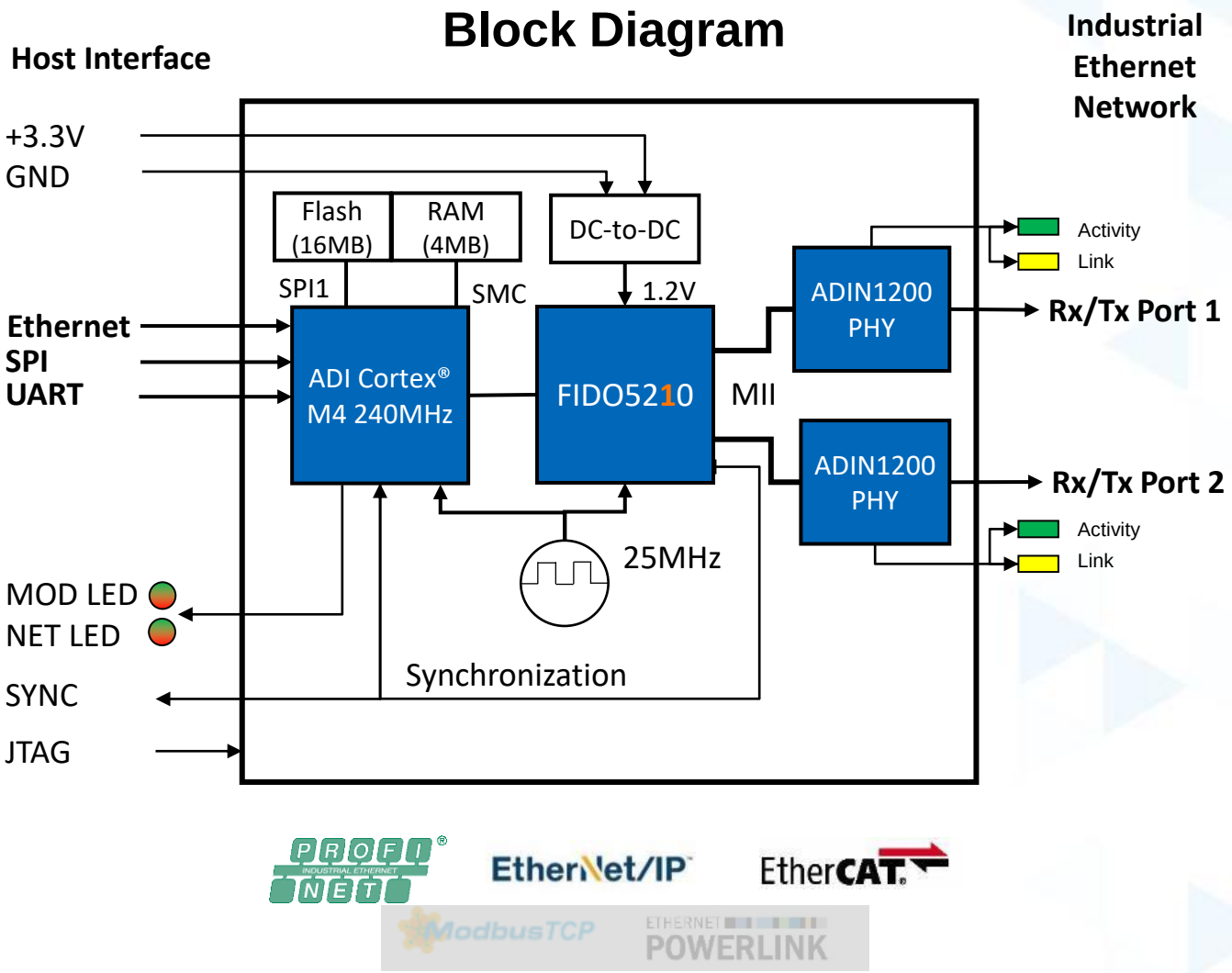
ADIN2299 or

Embedded Reference Design



We provide per-certified, well tested building block

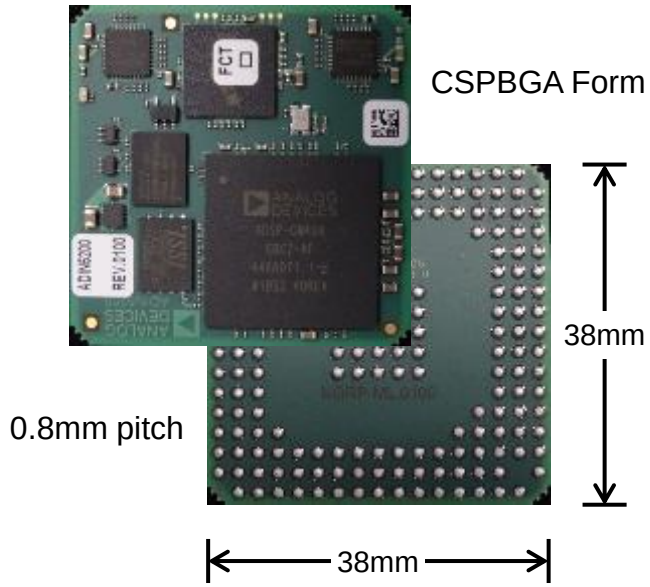
RapID Generation 2 Embedded Reference Design



- "**Design-n-Play**" -
  - Purchase BOM Elements
  - Verified Schematic supplied
  - Layout Recommendations supplied
- Access the **pre-certified network software** from web portal
- Evaluation board available to support trial, customized for each protocol:
  - EtherNet/IP: EV-RPG2-ENZ
  - EtherCAT: EV-RPG2-ECZ
  - Profinet: EV-RPG2-PNZ
  - Powerlink: EV-RPG2-PLZ
  - ModbusTCP: EV-RPG2-MBZ
- Common software interface speeds Host Processor integration

ADIN2299 – Network Interface Module

- **Complete** fully tested **off-the-shelf** solution.
  - Tested and Verified Solution with Datasheet Specifications
- **Software**
  - User downloads desired **network software** (PROFINET, EtherNet/IP, EtherCAT, POWERLINK, ModbusTCP) from Developer Portal and installs via host interface
  - Common software interface and host driver speeds integration
- **Ease of Deployment**
  - Pre-certification speeds Time-to-Market
- **Ease of Upgrade**
  - No changes required to host application code for protocol updates or changes.
  - Seamless transition to Embedded Reference Design in future if needed for cost rationalization
- **Optimized Performance**
  - Small footprint - **647 mm^2**
  - Low Power - **800mW**



PROFINET EtherNet/IP EtherCAT ModbusTCP ETHERNET POWERLINK

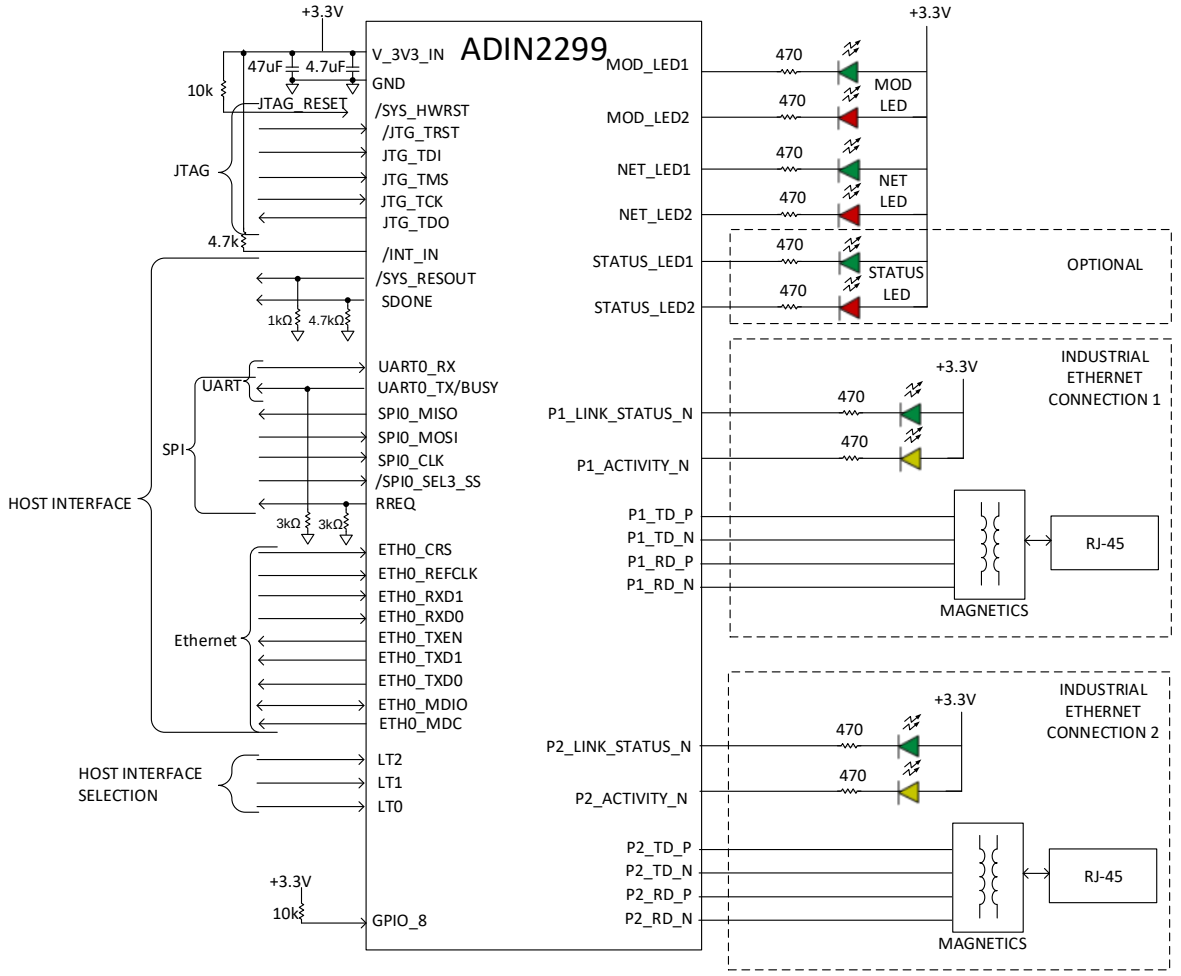
Save Time

Reduce Cost of Development

Reduce Risk

ADIN2299 – Detailed Description

- Configurable Host Interface
  - UART: 115200bps
  - Ethernet at 10/100Mbps
  - SPI slave: 10MHz max clock
- Single 3.3V Power Supply, 800mW
- Cycle Time down to 1ms
- 194 lead Chip Scale BGA form factor
- ROHS 3 compliant
- –40°C to +85°C industrial temperature range
- Host Interface Selection via LT0,1,2
  - Host Interface is defined by base board



Steps from Evaluation to Finished Product

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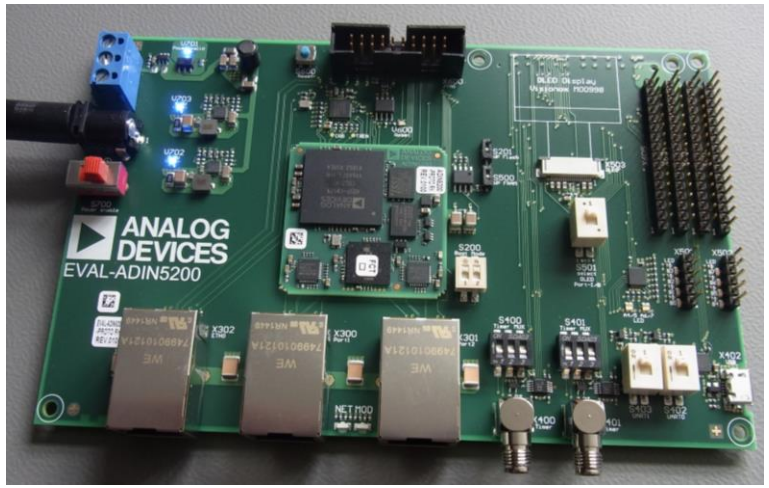
ADIN2299 Evaluation Board



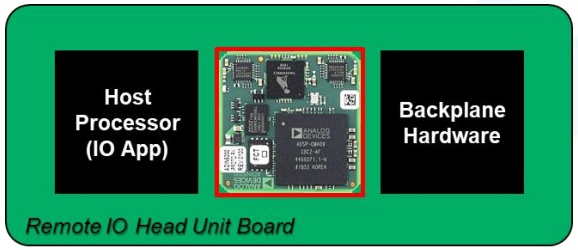
① ② ③ ④

Remote IO Product

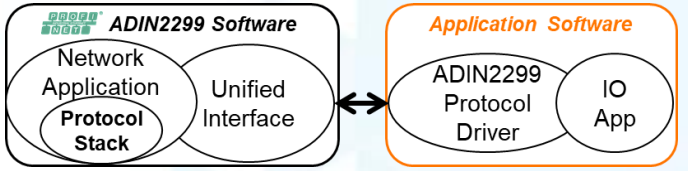
- 4 Steps done once for any protocol
  - Possible to complete in 3-6 months
- Reprogram ADIN2299 to change protocol
  - No need to repeat steps
  - No need to reprogram application software

PROFINET INDUSTRIAL ETHERNET

① Evaluate ADIN2299 with protocol in an Industrial Network



② Integrate ADIN2299 hardware (module or ERD) with application hardware

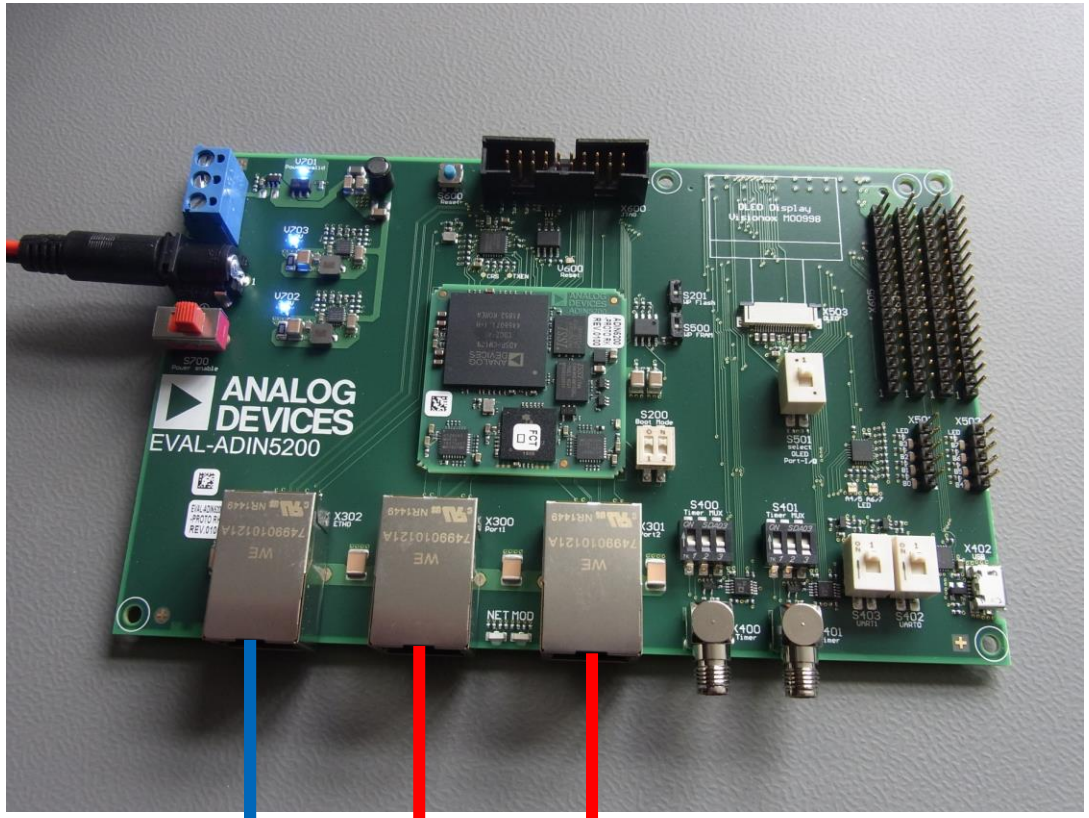


③ Integrate application software with ADIN2299 protocol driver

④ Certify Product

EV-RPG2-xxx – ADIN2299 Evaluation Kit

- Initial evaluation with PC example application
- Transition to evaluation with host processor

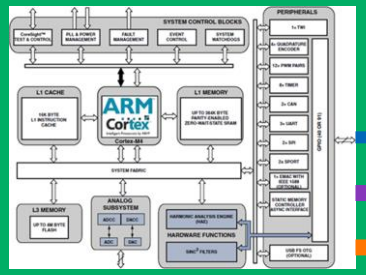


- Change protocols to evaluate network with required PLCs

PC

Field Device Application

Host Application Processor



100M Ethernet

- or -

SPI

- or -

UART

PROFINET INDUSTRIAL ETHERNET

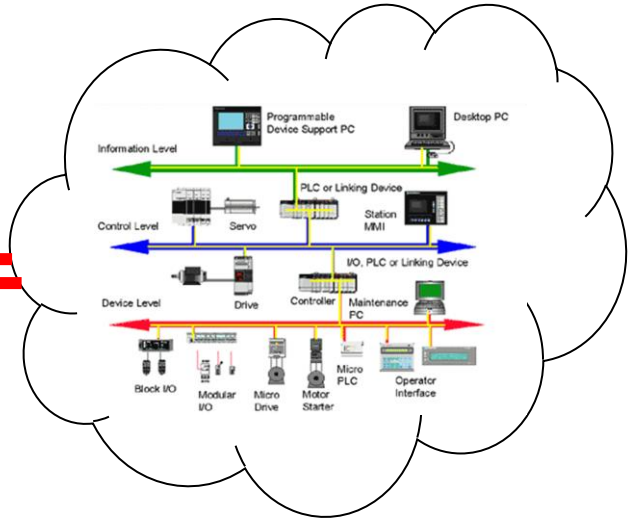
ETHERNET POWERLINK

EtherNet/IP

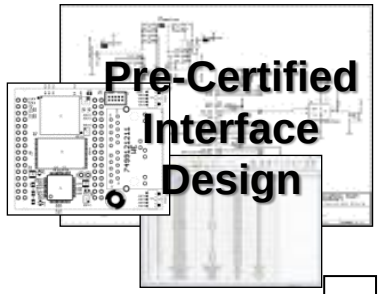
ModbusTCP

EtherCAT

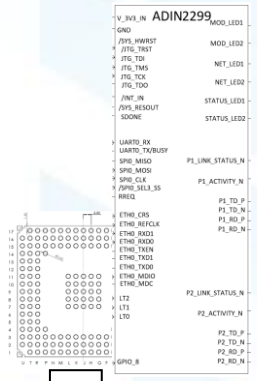
Industrial Ethernet Network

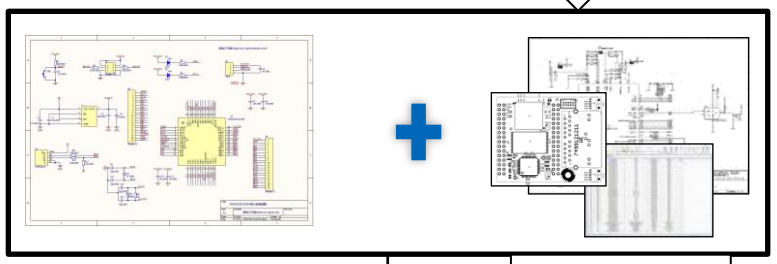


RAPID G2 Hardware Design Support

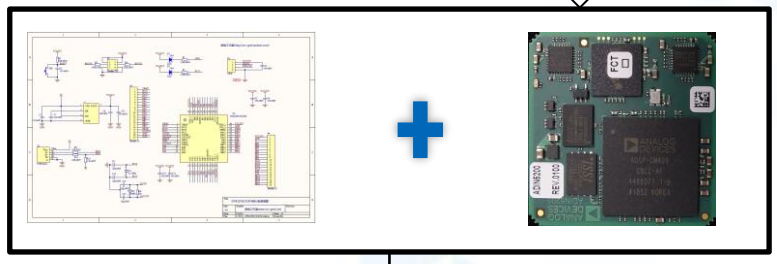


OR





JTAG



Note: A JTAG connector still recommended

File formats available for both, ERD and Module:

cadence

Allegro PCB Design Solution

OrCAD
CADENCE PCB SOLUTIONS

*Can be imported into many tools such as Altium

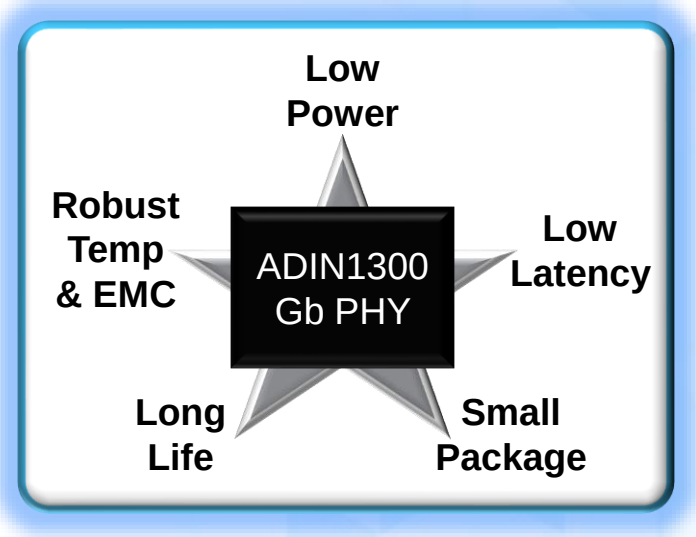
Customer Product

CERTIFIED!

ADIN1200 / ADIN1300 Industrial Ethernet PHYs

- ADIN1300 10/100/1000 Gigabit Ethernet PHY
  - Robust Temperature Range: -40 to 105C
  - Robust EMI / EMC / ESD performance
  - Small Footprint: 6x6mm 40-LFCSP
  - Low Power: 330mW
  - Low Latency: 294ns Tx & Rx (RGMII)
- ADIN1200 10/100 Fast Ethernet PHY
  - Robust Temperature Range: -40 to 105C
  - Robust EMI / EMC / ESD performance
  - Small Footprint: 5x5mm 32-LFCSP
  - Low Power : 139mW
  - Low Latency : 300ns Tx & Rx (MII)

Generic	Package	Temperature Range
ADIN1300 Gb PHY with RGMII	40 Lead LFCSP	-40C to 105C
	40 Lead LFCSP	-40C to 85C
ADIN1200 100M PHY	32 Lead LFCSP	-40C to 105C
	32 Lead LFCSP	-40C to 85C



Industrial 10MBit/s Single Pair Ethernet (10SPE)

- ADI involved in the IEEE standard development
  - IEEE 802.3cg Task Force Group
  - ADI co-presented the ‘Call for Interest’ with universal support (July 2016)
  - ADI played a leading role to complete the development of new ‘10SPE’ standard
  - IEEE 802.3cg Standard Approved.

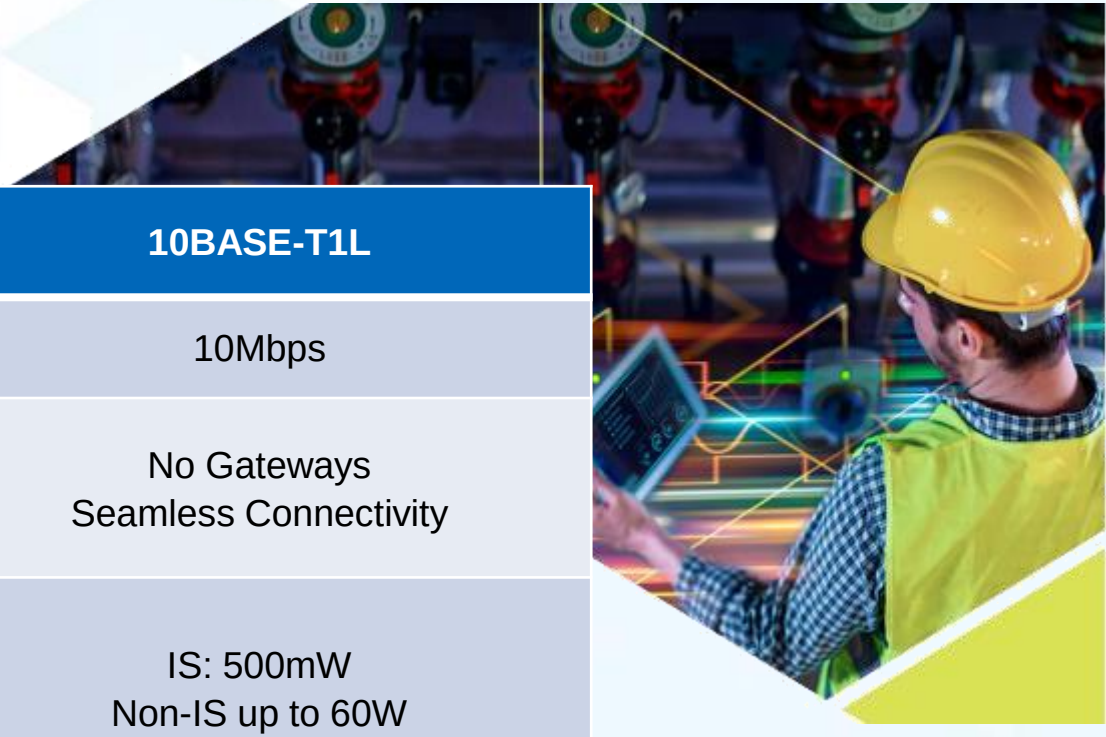
- 10BASE-**T1L**
  - 10MBit/s
  - Power over the cable
  - Single twisted pair (Fieldbus Cable, NOT Standard CAT-x Cable)
  - Full duplex, Point to point
  - Distance up to 1km
  - Suitable for intrinsic safe (explosive safe) applications

- 10BASE-**T1S**
  - 10MBit/s
  - Power over the cable
  - Single twisted pair
  - Various modes - Half Duplex, Full Duplex, Multi-Drop, Point to Point
  - Distance up to 15m, total 25m in Multi-Drop

ADIN1100
ADIN1110
ADIN2111

- Photos are from internet

4-20mA HART vs. Fieldbus vs. 10BASE-T1L



Comparison	4-20mA with HART	Fieldbus	10BASE-T1L
Data Bandwidth	1.2kbps	31.25kbps	10Mbps
Higher Level Ethernet Connectivity	Complex Gateways	Complex Gateways	No Gateways Seamless Connectivity
Power to Instrument	<40mW	Limited Power	IS: 500mW Non-IS up to 60W (Cable Dependent)
Knowledge/ Expertise	Shrinking Knowledge/Expertise	Shrinking Knowledge/Expertise	Ethernet technology is very familiar to all college graduates

- Photos are from internet

IEEE802.3cg / 10BASE-T1L PHY Standard Complete

PHY Key Features	10/100/1000	10BASE-T1L	Benefit
Cabling	2 or 4 pair Ethernet	Single Pair Ethernet	Potential to reuse existing fieldbus cabling
Distance	100m	Up to 1km	Field Device Connectivity
Speed	10Mb, 100Mb, Gb	10Mb	Upgrade from 4-20mA and Fieldbus data rates
Connector	RJ45	Two Pin Connector	Small two pin connector
IS Compatibility	No	Yes	Can be used in Zone 0, Div. 1
Power	PoE	PoDL / Engineered Power	Power and Data on SPE

- Photos are from internet

Comparison of Existing Communication Standard

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Comparison of Existing Communications Standards with 10BASE-T1L

Protocol	Packet Fromats	Cable Length	Bit Rate	Power Supply via Data Cable	Connector	Intrinsic Safe Use Case
PROFIBUS PA	UART/PROFIBUS	1200 m	31.25 kbps, bus, half duplex	No	M12, Terminal Screw	Yes
Modbus RTU and Other RS-485 Profocols	UART/Modbus	1200 m (up to approximately 185 kbps, at 375 kb 300 m, at 500 kb, 200 m)	Typically 19.2 kbps, bus, half duplex	No	DB9, M12	N/A
I/O Link	I/O link	20 m	Max 230.4 kbps, half duplex	No	M12	No
4 mA to 20 mA	Analog interface	>10 km	-/-	Yes, 36 mW	Screw	Yes
HART	Digitally modulated over 4 mA to 20 mA	>1500 m	1200 bps, bus, half duplex	Yes, 36 mW	Screw	Yes
10BASE-T1L	Ethernet IEEE 802.3	1000 m (2.4 V) with up to 10 joints (terminal boxes) >200 m (1.0 V)	10 Mbit, full duplex	Yes, up to 60 W In Ex Zone 0 up to 500 mW	Terminal screw or IDC connector, optional single pair Ethernet connector	Yes

ADIN1100 10BASE-T1L PHY

Industry's Lowest Power 10BASE-T1L PHY

FEATURES

- **10BASE-T1L IEEE® Std 802.3cg™ -2019 compliant**
  - Supports 1.0 V pk-pk & 2.4 V pk-pk transmit levels
- **Low power consumption**
  - 1V pk-pk Dual Supply – **39 mW**
  - 1V pk-pk Single Supply – 45 mW
  - 2.4V pk-pk Multiple Supplies – **75 mW**
    - Specification for all power options in datasheet
- **Cable Reach with *Auto-Negotiation* - 1700m**
- **Small package** 40-lead (6 mm x 6 mm) LFCSP
- **Industrial temperature range** -40ºC to 105ºC

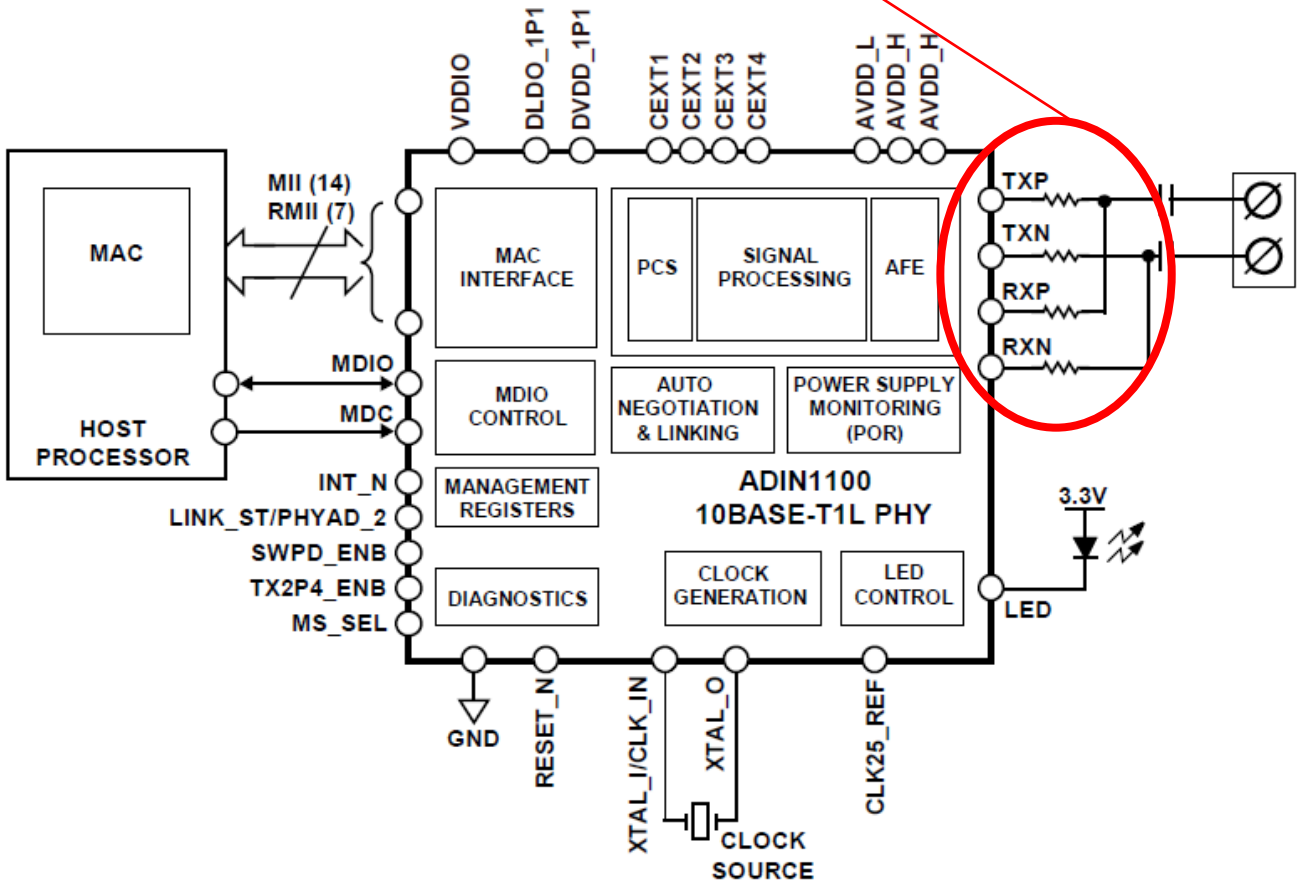
www.analog.com/ADIN1100

ADIN1100: 10BASE-T1L PHY for IS Applications

1.0V amplitude mode required to meet the Zone 0 IS, maximum energy requirements.

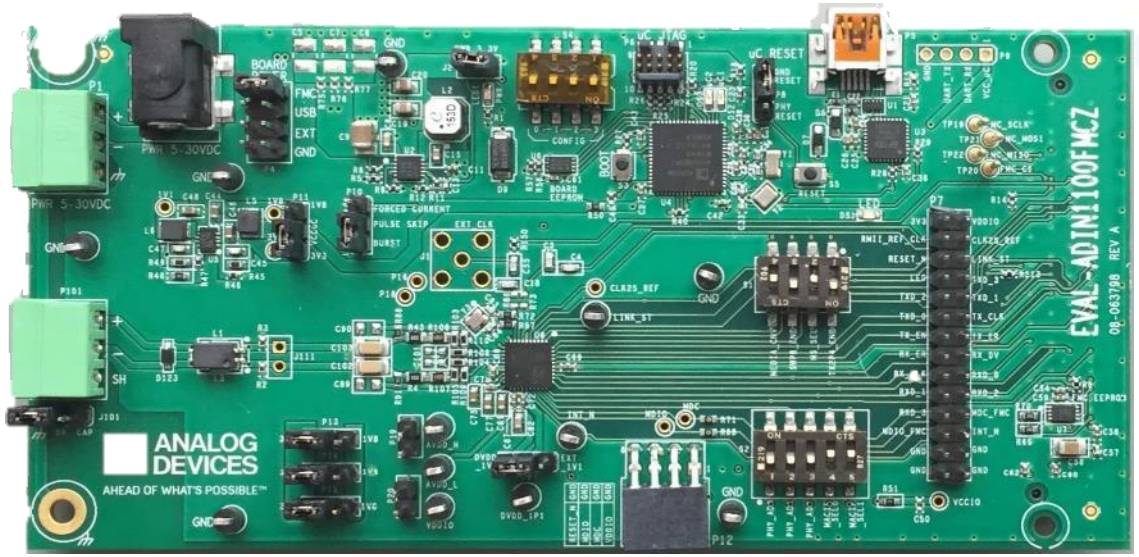
- **10BASE-T1L IEEE® Std 802.3cg-2019™ compliant**
- **Supports 1.0 V & 2.4 V Transmit Levels**
- **Supports Intrinsic Safe Applications**
- **MII & RMII, RGMII MAC Interfaces**
- **Cable Reach of 1.7km with Auto-negotiation**
- **MDIO Interface**
  - **Clause 22 / Clause 45**
  - **Two programmable Link/ Activity LEDs**
- **TX / RX start of packet for IEEE 1588 time stamp support**
- **Diagnostics**
  - Frame Generator and Checker
  - Multiple Loopback Modes
  - IEEE Test Mode Support
  - **Cable Diagnostics**
- **Unmanaged Configuration using Pin Strapping including:**
  - Master/Slave Selection
  - Transmit Amplitude
  - PHY Address
- **Crystal oscillator/25 MHz clock input frequency**
  - (50 MHz for RMII)
- **Single Supply 1.8 V/3.3 V Operation (Mode Dependent)**
- **Low Power Consumption**
  - **Single Supply 1 V pk-pk – 45 mW typ**
  - **Dual Supply 1 V pk-pk – 39mW typ**

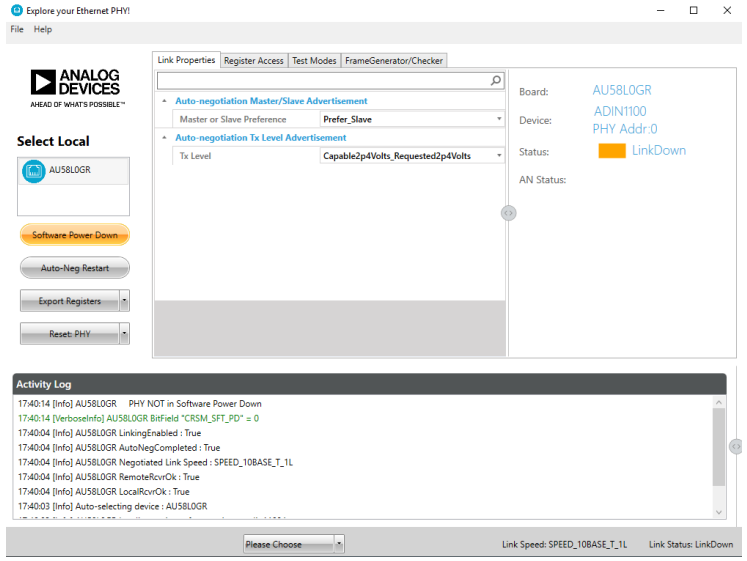
External resistor required to meet Zone 0 IS protection requirements.



Very Low PHY power consumption, required for Zone 0 IS applications

EV-ADIN1100FMCZ-U1 / EV-ADIN1110EBZ-U1



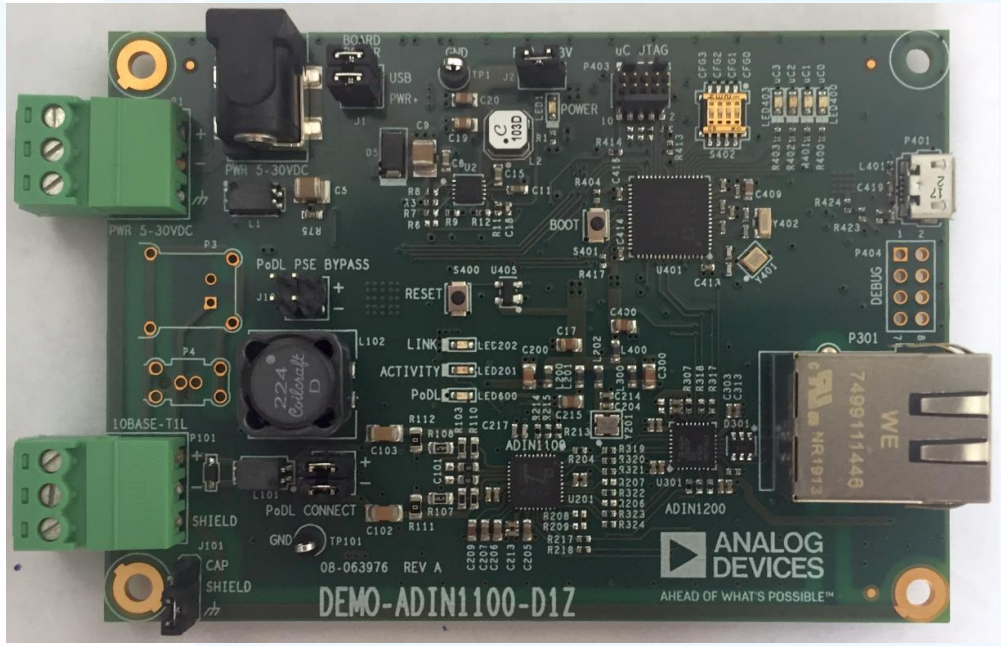


- **Robustness Testing ongoing** – Consult Datasheet for latest information
  - IEC 61000-4-4 electrical fast transient (EFT)
    - (±4 kV)
  - IEC 61000-4-2 ESD
    - (±8 kV contact discharge)
  - IEC 61000-4-2 ESD
    - (±15 kV air discharge)
  - IEC 61000-4-6 conducted immunity
    - (10 V)
  - EN55032 radiated emissions
    - (Class A)

- **Diagnostics Features**
  - Frame Generator and Checker
  - Multiple Loopback Modes
  - IEEE Test Mode Support
  - Cable Diagnostics

DEMO-ADIN1100-D1Z – Media Converter

- Media converter
  - Converting “standard” 10BASE-T Ethernet to the new 10BASE-T1L standard.
  - Can provide power, from an external power supply, to a device connected over the 10BASE-T1L cable.
  - Enables connecting 10BASE-T1L devices to an existing Ethernet network during design, prototyping and evaluation of the 10BASE-T1L technology.
  - Includes the ADIN1200 for 10/100Mbps Standard Ethernet



ADIN1100/ADIN1110 - Power Regulation

ADP5304 - Ultralow 50mA DC-DC

LTC3549 – Low VIN DC-DC

1.8V or 3.3V

DC-DC*

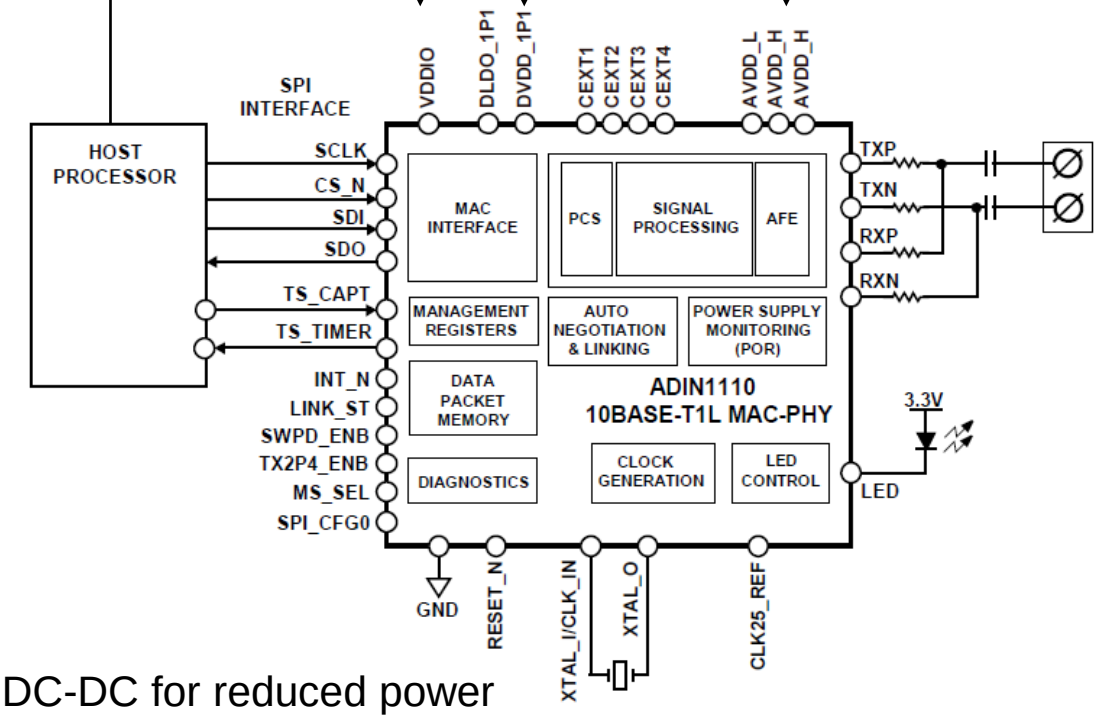
DC-DC

~17V

ADP2360 – 60V 50mA DC-DC

LT8604 – 42V 100mA DC-DC

ADP2441 – 40V 1A DC-DC

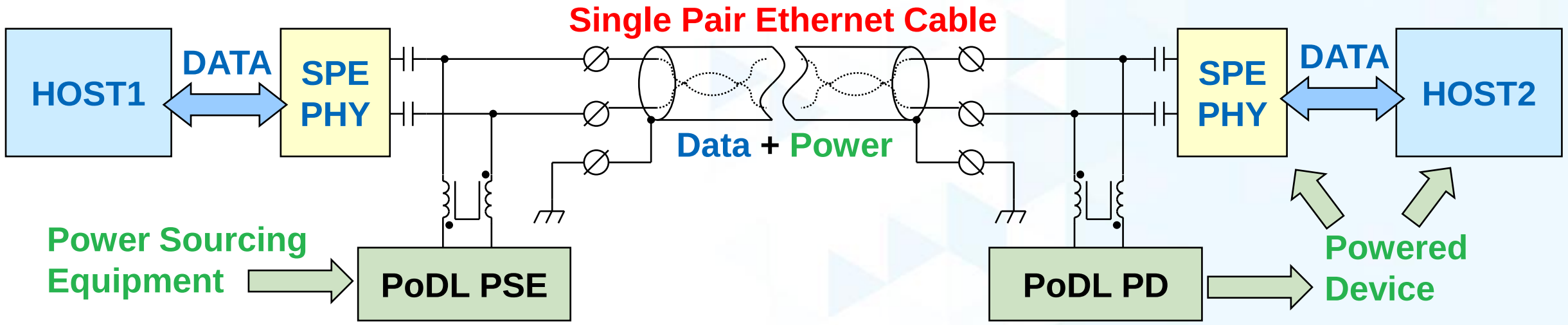


* Optional 1.1V DC-DC for reduced power

Power over Data Line (PoDL)/Single Pair PoE (SPoE) 10BASE-T1L: IEEE Std 802.3cg™-2019

Class	10	11	12	13	14	15
$V_{PSE(max)}$ (V)	30	30	30	58	58	58
$V_{PSE_OC(min)}$ (V)	20	20	20	50	50	50
$V_{PSE(min)}$ (V)	20	20	20	50	50	50
$I_{PI(max)}$ (mA)	92	240	632	231	600	1579
$P_{class(min)}$ (W)	1.85	4.8	12.63	11.54	30	79
$V_{PD(min)}$ (V)	14	14	14	35	35	35
$P_{PD(max)}$ (W)	1.23	3.2	8.4	7.7	20	52

- PoDL - Power over Data Line
  - PoDL is PoE for one-pair Ethernet PHYs
- PoDL is an industry standard: IEEE Std. 802.3bu
- IEEE Std. 802.3cg further specifies PoDL for 10Mbps industrial systems
- Intended for industrial sensors, factory automation, Internet of Things, etc.
  - Safe, fault-tolerant and easy to install
  - Anywhere that both data and power over just two conductors is valuable



Thank You!

For More Information:

analog.com/industry4.0

ADI Wechat