INDUSTRIAL SUMMIT 2024

POWERING YOUR SUSTAINABLE INNOVATION

Economic Reliable Connectivity MCC-ST60

Danny Sheng

ST60

Agenda

1 General Introduction

2 Application Examples

3 Product Family

4 ST60A2 Product Overview

5 ST60A3 Product Overview

6 Partners

7 Ecosystem & Solutions

8 Demo Introduction

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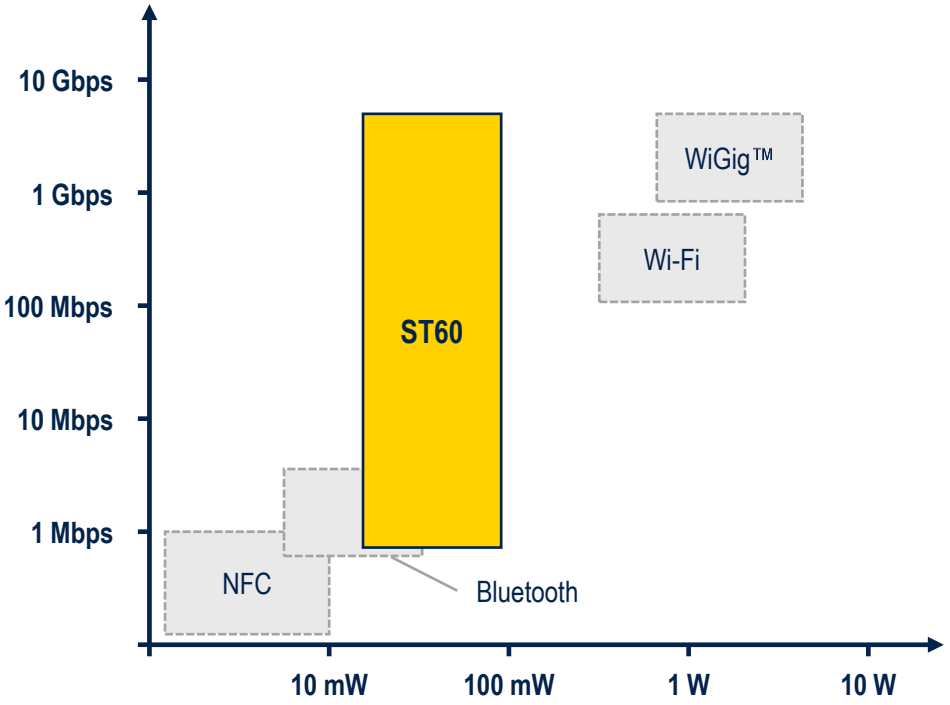
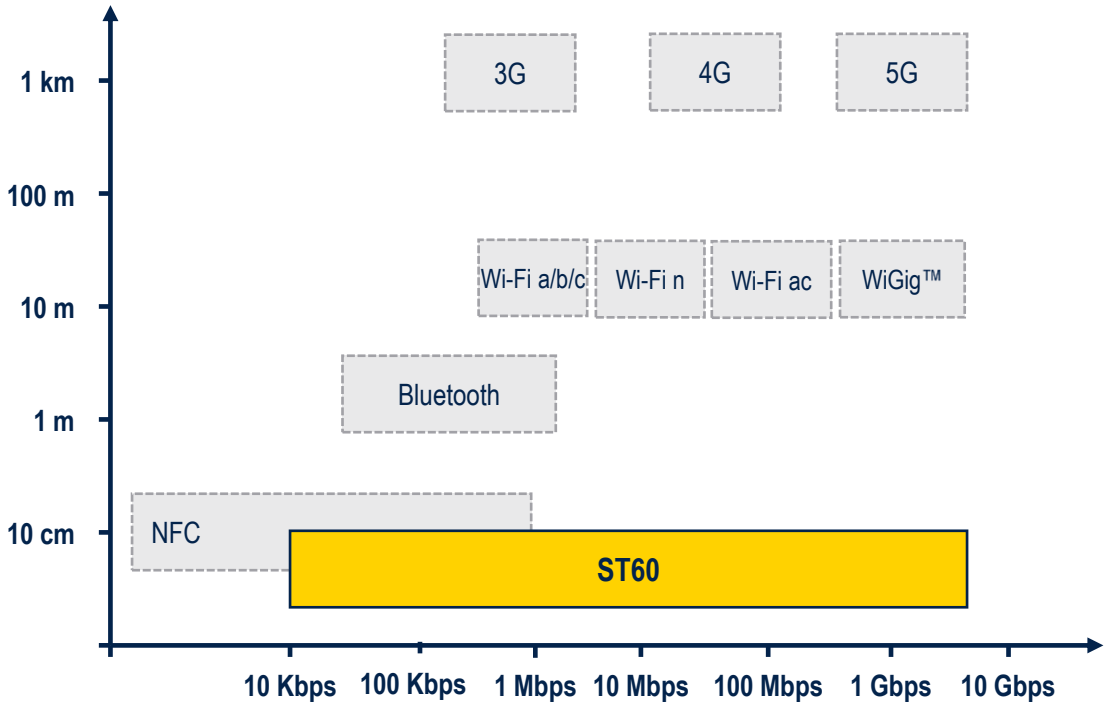
Introducing ST60
60 GHz Contactless Connectivity

Extreme speed performance at very-low power

Industry best power per bit
8.9 pJ / bit for Tx & 6.4 pJ/bit for Rx



Up to 6.25 Gbps speed



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ST60: A New Solution For Contactless Connectivity

High-speed, low-power, short range, point to point 60 GHz RF link

- **Up to 6 Gbps**
- **Small footprint**

- **Ultralow power**
- **-40°C to 105°C**

- Cables and rotating joints replacement
- Connector-free solutions
- Solve product design challenges

- Immune to humidity / dust / vibration
- Rotation support
- Electrical / galvanic isolation
- No wear & tear
- Connector-less devices

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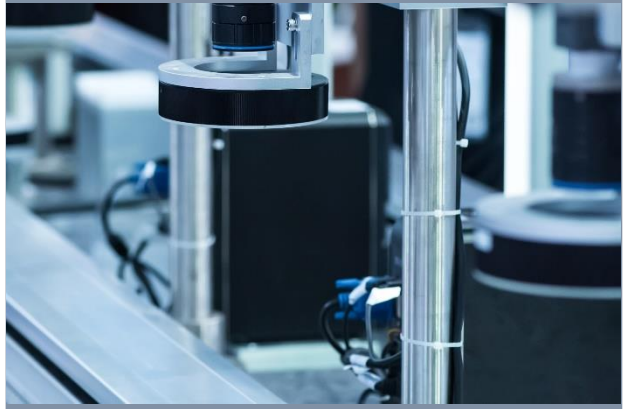
Electronic appliance



Factory automation

Robotics

Accessories & modular devices (camera, etc.)

Low data rate transfer (up to 480 Mbps)
Automation, debug, and firmware transfer. Safe & reliable rotation

High data rate transfer (up to 6 Gbps)
Ethernet, video, camera, robotics. Safe & reliable rotation

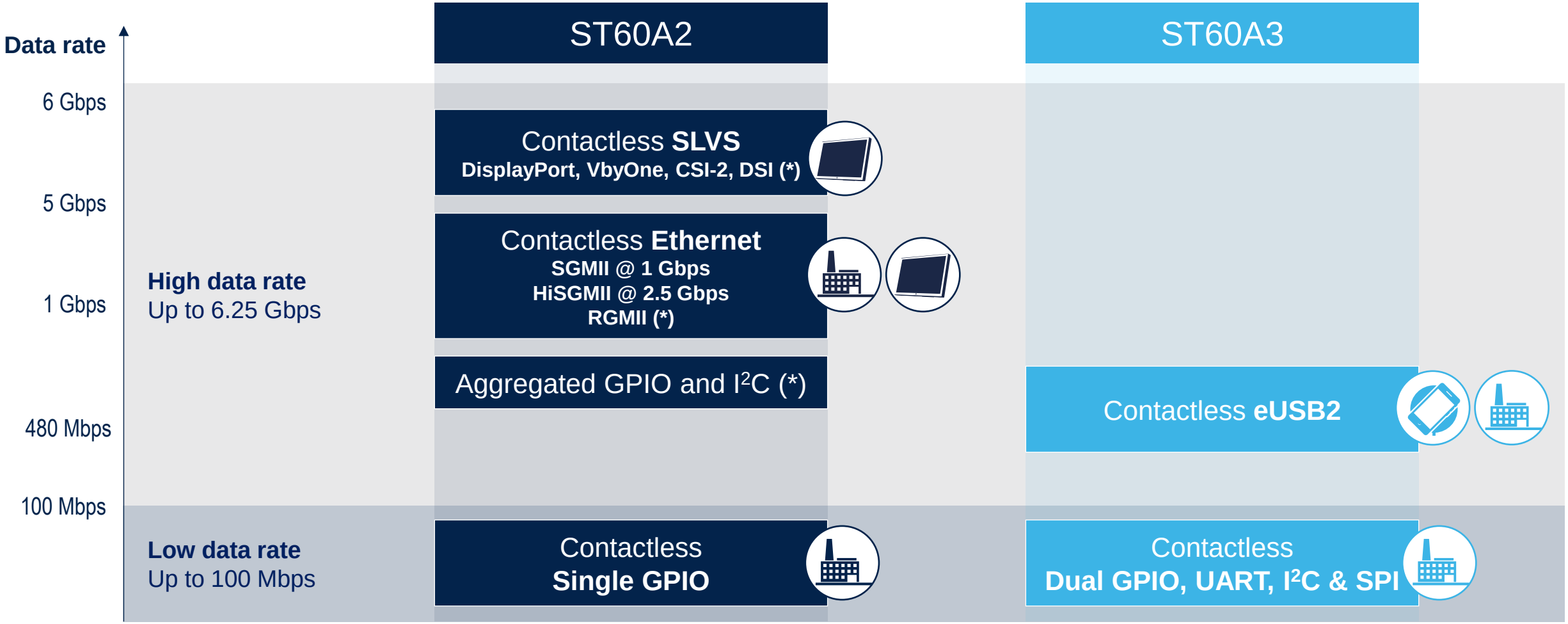
Slipring/lidar applications

Personal electronics
(Docking/firmware transfer)

Industrial safety

Video walls

ST60 Applications Portfolio



(*) leveraging companion chips / serializer

ST60 Features

Features	ST60A2G0	ST60A3H0	ST60A3H1
Antenna	• External antenna • PCB patch antennas or directive SMT horn antennas supporting both end-fire and broadside radiation patterns	• External antenna • Multiple solutions available (vertical, horizontal radiation), up to 36 dB link budget • Compatible with H1 internal antenna	• Antenna in package (AiP) • Broadside radiation, up to 5 cm FSPL • Smallest footprint, ease of integration
Low data rate	• **GPIO**: Single GPIO, up to 100 Mbps	• **GPIO**: up to 6 Mbps, dual CMOS I/O, LP and ULP modes, single and bidirectional tunneling, • **UART**: up to 6 Mbps, dual CMOS I/Os, LP & ULP modes • **I²C**: up to 1 Mbps, standard mode, fast mode and fast mode plus, dual CMOS I/Os	• **GPIO**: up to 6 Mbps, dual CMOS I/O, LP and ULP modes, single and bidirectional tunneling, • **UART**: up to 6 Mbps, dual CMOS I/Os, LP & ULP modes • **I²C**: up to 1 Mbps, standard mode, fast mode and fast mode plus, dual CMOS I/Os
High data rate	**HDR/FDR (SLVS)** • SLVS half duplex @ 6.25 Gbps max • SGMII @ 1.25 Gbps	**eUSB2** • Hybrid repeater • LS, FS & HS modes, up to 480 Mbps • Several eUSB2 configurations supported	**eUSB2** • Hybrid repeater • LS, FS & HS modes, up to 480 Mbps • Several eUSB2 configurations supported
Package	• BGA 2.2 x 2.2 x 0.8 mm • 0.4 mm pitch	• BGA 2.2 x 2.6 x 0.8 mm • 0.4 mm pitch	• BGA 2.9 x 4.1 x 0.8 mm • 0.4 mm pitch • Antenna in package

Power	• VDD 1.8 V / 1.45 V
	• SLVS @ 3.125 Gbps:
	  • Rx: 30 mW
	  • Tx: 55 mW
	• GPIO @ 100 Mbps:
	  • Rx: 17 mW
	  • Tx: 46 mW
		• VDD: 1.8 V / 1.2 V
		• eUSB2 HS Rx/Tx tunneling – 110/130 mW
		• UART Rx/Tx tunneling – 90 mW / 15 mW (ULP)
		• I²C tunneling – 90 mW
		• GPIO tunneling – 90 mW
		• Low power mode – 120 µW
		• Standby mode – 27 µW
			• VDD: 1.8 V
			• eUSB2 HS Rx/Tx tunneling – 110/130 mW
			• UART Rx/Tx tunneling – 90 mW / 15 mW (ULP)
			• I²C tunneling – 90 mW
			• GPIO tunneling – 90 mW
			• Low power mode – 120 µW
			• Standby mode – 23 µW

Temperature range	• Consumer: -20,+85°C • Industrial: -40,+105°C	• Consumer: -20,+85 °C	• Consumer: -20,+85 °C

ST60A2 Product Overview

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ST60A2 Overview & Key Benefits

Compact solution integrating full 60 GHz RF transceiver

BGA 2.2 x 2.2 mm²

- Up to 6.25 Gbps contactless connectivity
- Cost optimized BOM & miniature footprint
  Flexible antenna configurations
- Ultralow power – 55 mW Tx, 30 mW Rx*
- Industrial temperature range [-40 , +105°C]

(*) Typical power consumption in FDR 3.125 Gbps with dual power supply

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ST60A2 Product Overview

Fully integrated 60 GHz V-band transceiver

- Transmit and receive paths
- Power management with single or dual supply
- Configuration through I²C bus or hardware control pins

Point-to-point wireless link

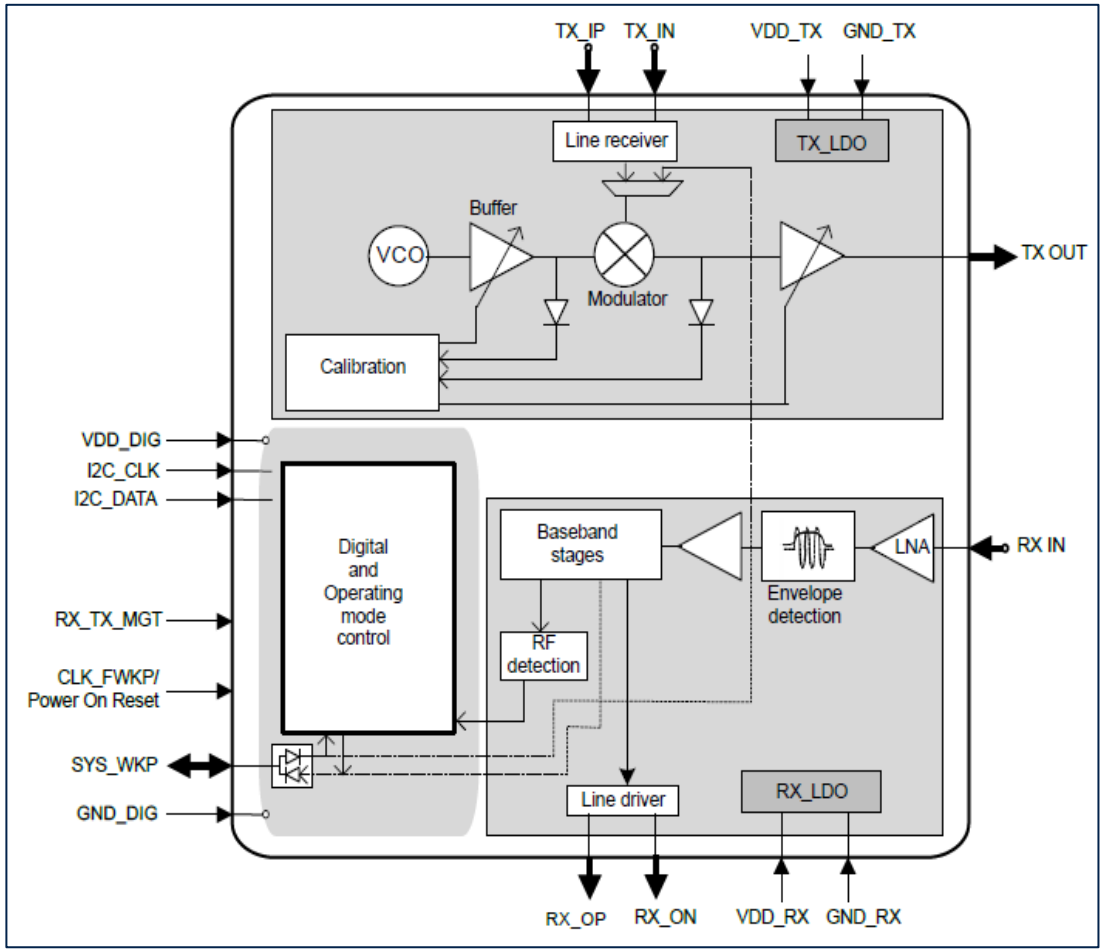
- Single-ended CMOS I/O up to 100 Mbps
- Differential analog SLVS TX/RX port for up to 6.25 Gbps
- Operate in half-duplex mode with ASK modulation
- 28 dB typical total link budget at 5 Gbit/s

Very low power consumption

- 55 mW in Tx, 30 mW in Rx @ 3.125 Gbps (dual supply)
- 7.7 µW in OFF mode

Very small form factor with optimized BOM

- VFBGA 2.2 mm x 2.2 mm x 0.8 mm, 25 balls, 0.4 mm pitch
- No need for external matching network and clock references



ST60A2 Antenna Offer

Horizontal, vertical, and rotating links, an expanding eco-system of antenna offers

Broadside radiation

MAJA

稳联 SKYRF

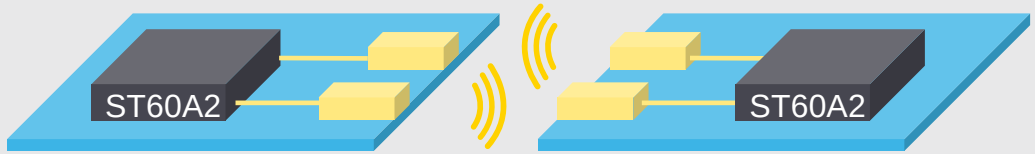
SENSORVIEW

End fire radiation

Radiall

稳联 SKYRF

SENSORVIEW

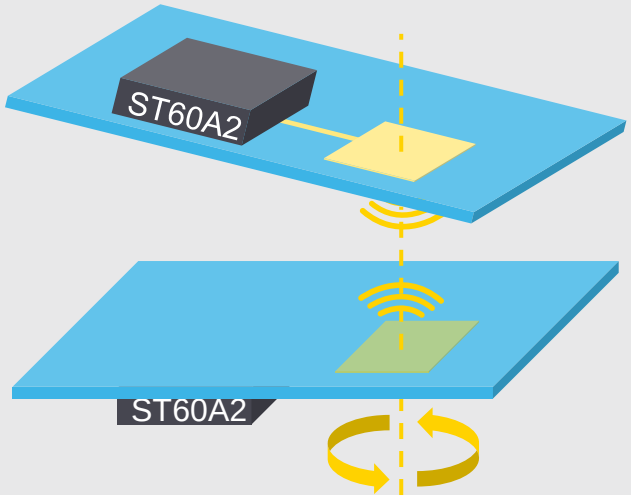


With rotation

Rosenberger

MAJA

稳联 SKYRF



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ST60A2 Operating Modes

Full/high data rate modes (FDR/HDR)

- SLVS differential input-output port (TX/RX)
- Need DC balanced data 8b/10b coded
- FDR mode: from 1 Mbps to 5 Gbps
- HDR mode: from 500 Mbps to 6.25 Gbps
- Typical interfaces:
  - LVDS (need level adaptation)
  - 1 Gbps Ethernet with SGMII PHY
  - 2.5 Gbps Ethernet with Hi-SGMII PHY

Contactless gigabit Ethernet bridge (SLVS/HDR)

Low data rate mode (LDR)

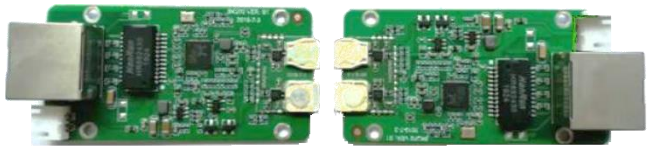
- Single-ended CMOS I/O: from 9.6 kbps to 100 Mbps
- Typical interfaces: UART, GPIO

Contactless fast GPIO (GPIO/LDR)

ST60A2 Contactless Gigabit Ethernet Solution

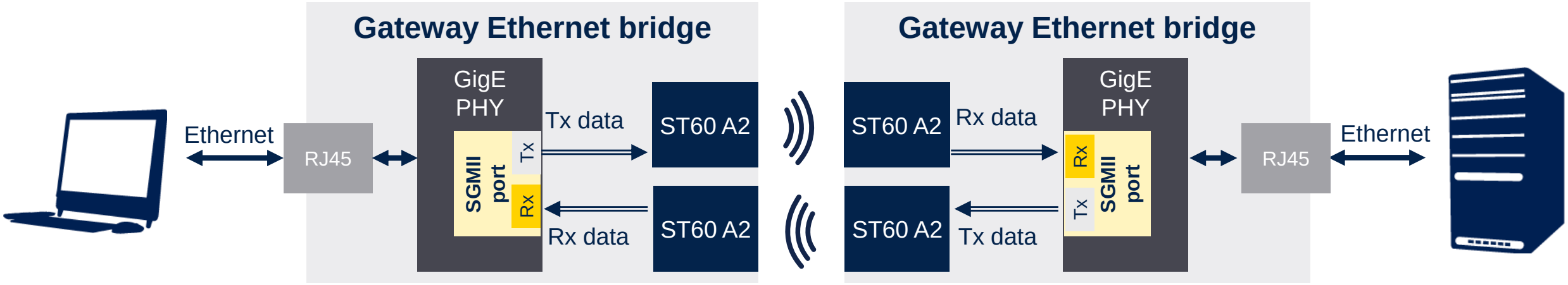
Vertical (antenna on board) & horizontal (horn antenna) transmission

AoB antenna



Horn antenna

- Gigabit Ethernet SGMII full duplex
- Supports 10 or 100 or 1000 Mbps
- Support of EtherCAT when using a low latency PHY

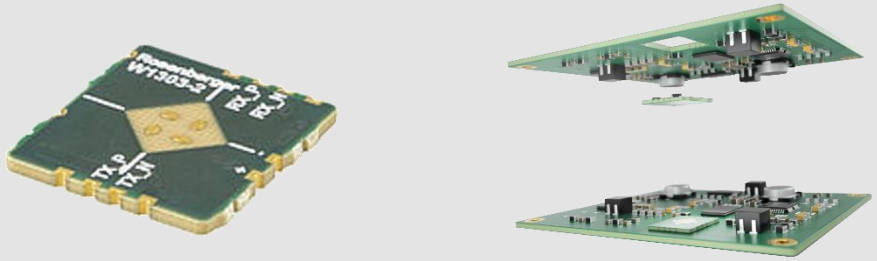


ST60A2 Partners

ST60 partner offer page: [ST60A2G0 - 60 GHz RF transceiver A2 family]

Rosenberger

RoProxCon® - System-on-Module (SoM) full duplex

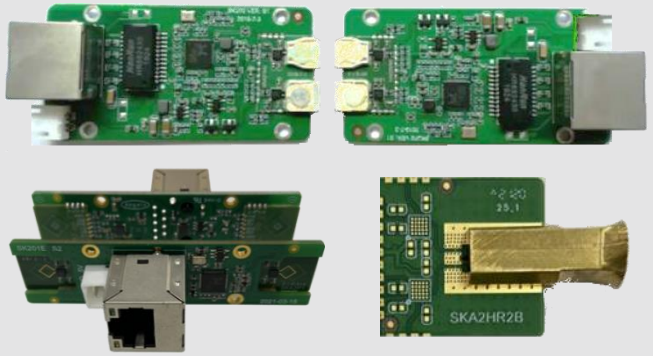


RoProxCon® - Data (Inline / adaptor)

RoProxCon® - Hybrid (power and data)

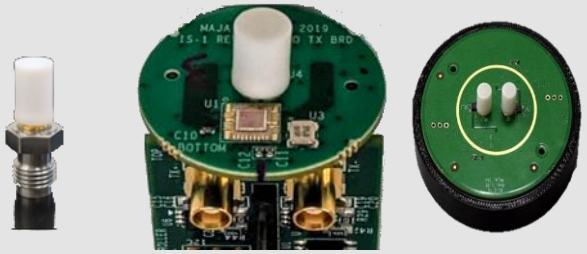
稳联 SKYRF

Contactless Ethernet and RF modules



MAJA

Half and full duplex rotative module design service

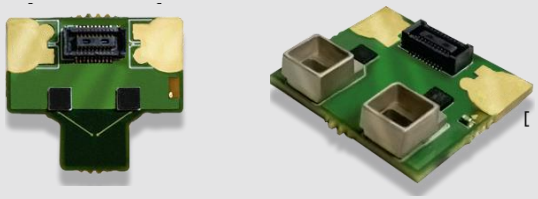


Radiall

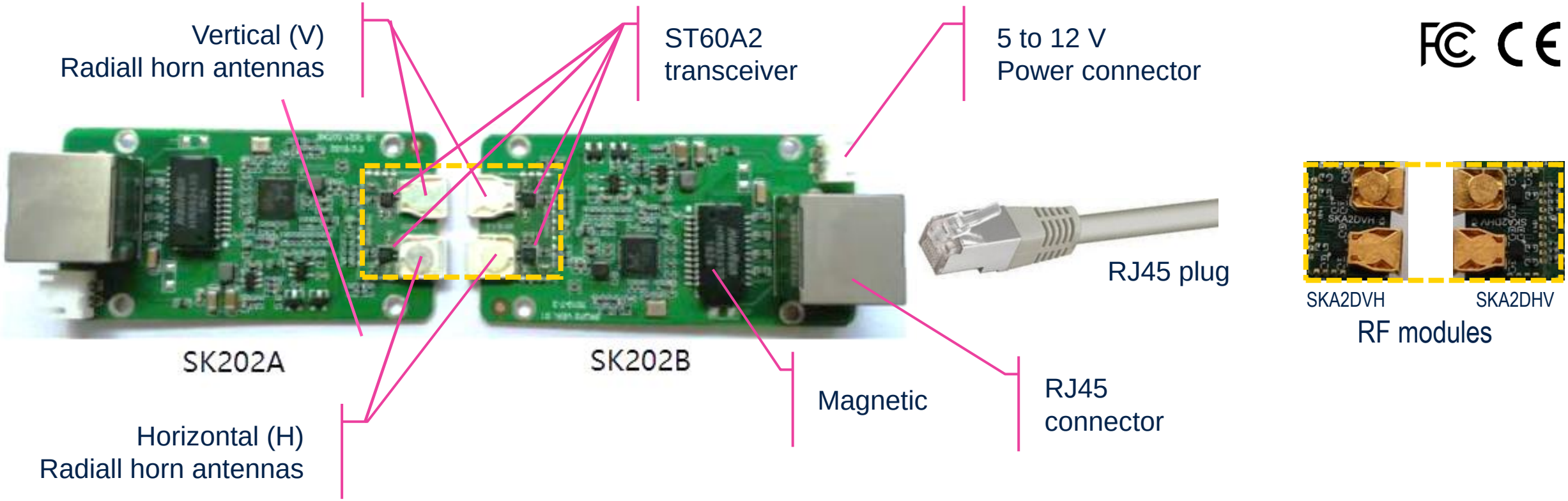
H&V polarized antennas

SENSORVIEW

Antenna on board design service Soldered modules



Gigabit Ethernet Module SK202
Horn Antennas



Product specifications available **here**

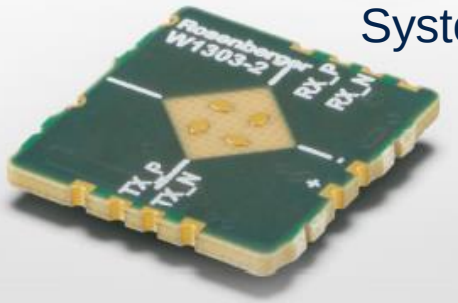
Product available at ARROW: click **here**

Contact: sales@sk-rf.com

RoProxCon Contactless Connectivity

Hybrid
Wireless power

Data
Available with common industrial interfaces



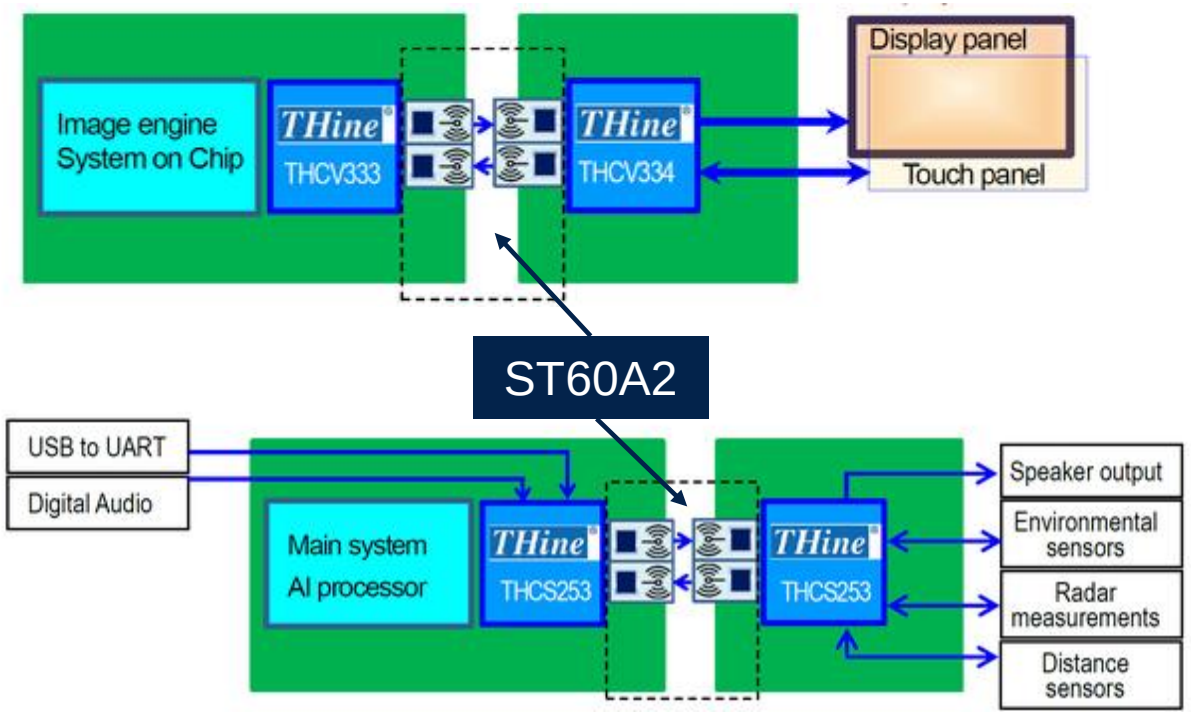
System on module (SoM)

RoProxCon – contactless data and power transmission

THine Electronics & ST60A2 Contactless Connectivity Solutions

Board-to-board connection (flex cable removal) and connector free solutions (dust proof devices, device sync, seamless docking)

Press release from Thine Electronics



VbyOne detachable touch panel display

- Mechanical connectors replacement for large signage modules
- Water-proof, dust-proof, and vibration-resistant devices

Aggregation of 32 GPIO, UART & I²C controls of the environmental and radar sensors

- Seamless device-to-device data transfer w/o cables and connectors
- Docking stations for PCs, game consoles

ST60A3 Product Overview

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ST60A3 Portfolio

ST60A3H1

Contactless eUSB2 | UART | I²C | GPIO

Antenna in package (AiP)

3 x 4 x 0.8 mm package

ST60A3H0

Contactless eUSB2 | UART | I²C | GPIO

External antennas – rotation support

2.2 x 2.6 x 0.8 mm package

ST60A3 Overview

60 GHz V-Band transceiver for contactless connectivity up to 480 Mbps

- Up to 480 Mbps wireless connectivity (eUSB2)
- Small footprint with integrated antenna (ST60A3H1)
  Flexible antenna configurations (ST60A3H0)
- Ultralow power
- Temperature range [-20 , +85°C]

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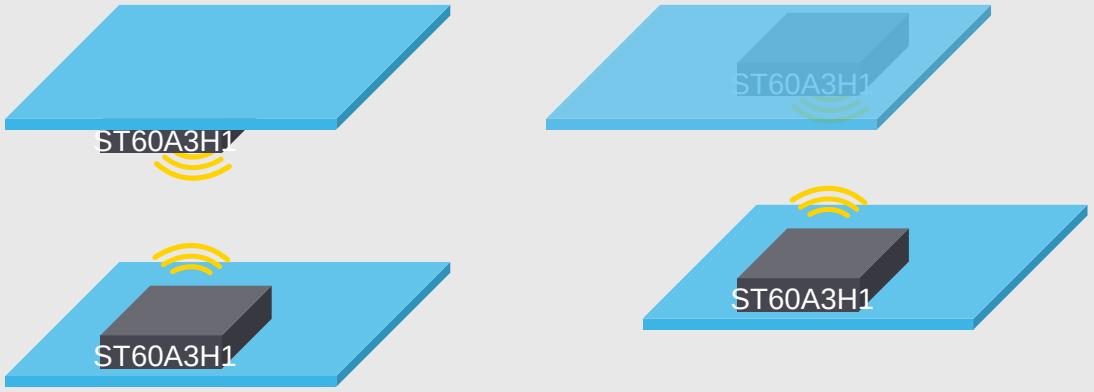
ST60A3H1 Overview

60 GHz V-Band transceiver for short range contactless connectivity up to 480 Mbit/s with linear polarization antenna in package



Rotation supported combining linear & circular polarization antennas

- Full RF transceiver and linear polarization antenna (AiP), operating in half-duplex mode
- 42 dB typical total link budget, up to 5 cm free-space propagation loss
- eUSB2, UART, GPIO, or I²C RF tunneling
- Single 1.8 V supply
- Low power consumption (typical values with single 1.8 V supply):
  - eUSB2 Rx / Tx – 110 / 130 mW
  - UART / GPIO / I²C – 90 mW
  - Standby – 23 µW
- Optimized BOM without external matching network and clock references
- Package: VFBGA 2.9 mm x 4.1 mm x 0.8 mm

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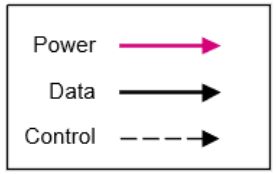
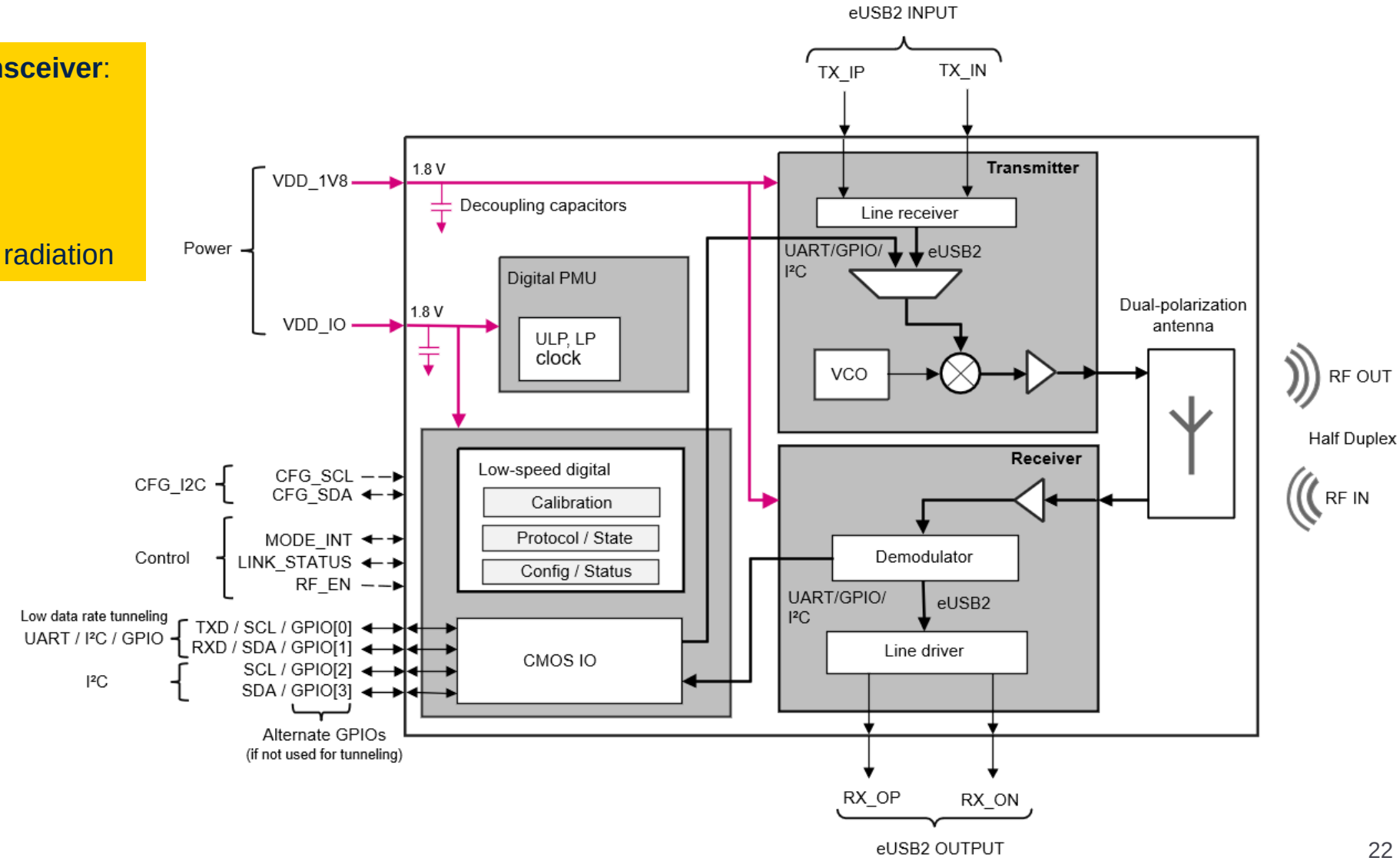
ST60A3H1 Block Diagram

Fully integrated 60 GHz V-Band transceiver:

- Transmit & receive paths
- Digital control
- Power management
- Integrated antenna with broadside radiation

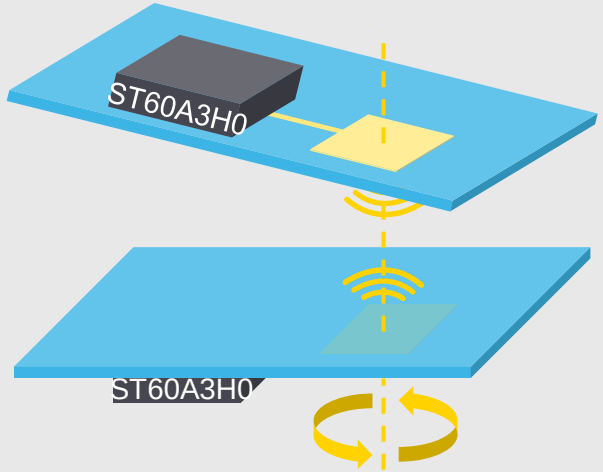




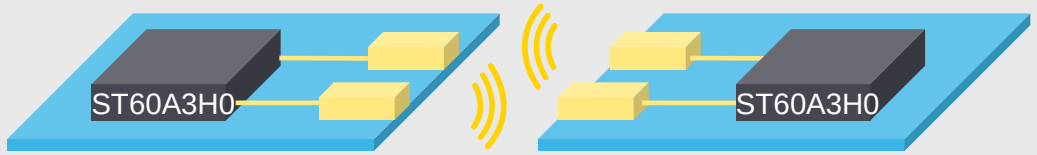
ST60A3H0 Overview

60 GHz V-Band transceiver for short range contactless connectivity up to 480 Mbit/s to be used with external antenna or waveguide

Broadside radiation with patch antenna on board.
Rotation if one of the antennas is with circular polarization



End-fire radiation with SMT horn antennas



- Full RF transceiver operating in half-duplex mode
- 34 dB typical total link budget
- eUSB2, UART, GPIO, or I²C RF tunneling
- Single 1.8 V supply or dual supply 1.8 V (analog/RF) & 1.2 V (digital/GPIO)
- Low power consumption (typical values with single 1.8 V supply):
  - eUSB2 Rx / Tx – 110 / 130 mW
  - UART / GPIO / I²C – 90 mW
  - Standby – 23 µW
- Optimized BOM without external matching network and clock references
- Package: VFBGA 2.2 mm x 2.6 mm x 0.8 mm

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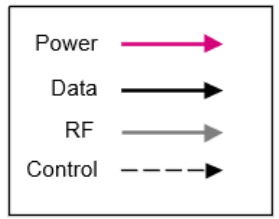
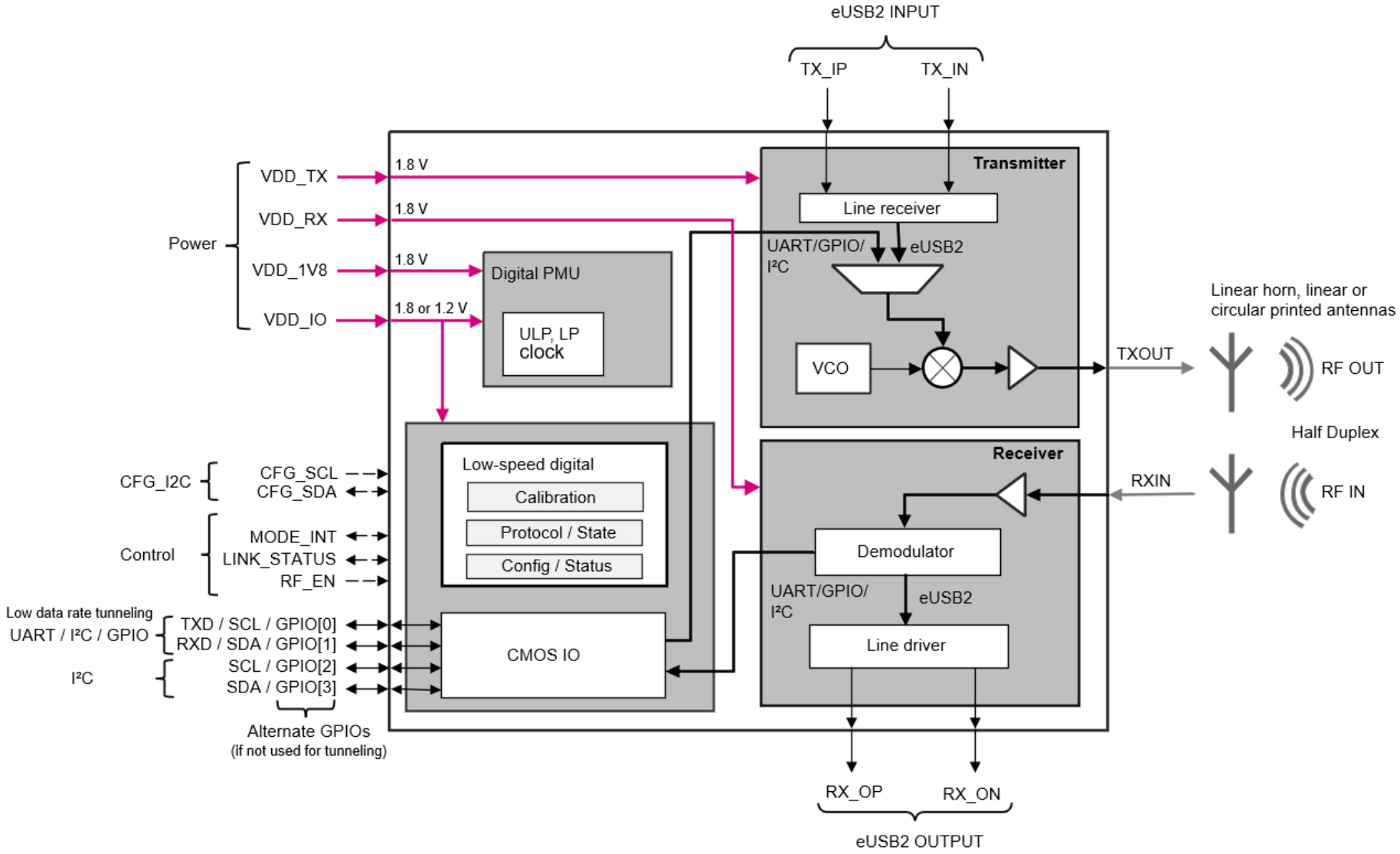
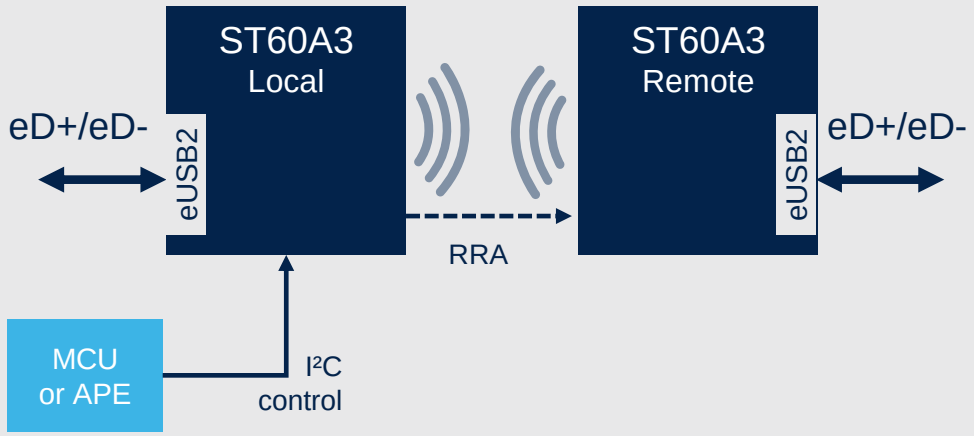
ST60A3H0 Block Diagram





ST60A3 Functional Overview

Wireless eUSB2 bus with data rate up to 480 Mbps



Fully integrated transceiver

- The I²C configuration bus and hardware control pins configure and manage the transitions of the ST60A3.
- No need for an external antenna since integrated in the package.

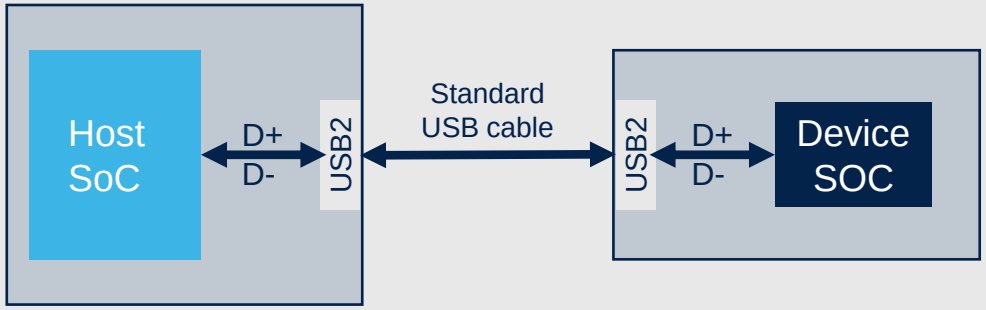
Power efficient behavior

- RF disabled in standby mode. Power consumption of a few µW
- Once RF is enabled, both ST60A3 chips enter a discovery state. Remote power consumption is a few µW.
- When a partner is detected, the RF link is established, and the 2 devices enter in low power mode. Power consumption is in the range of 100 µW.

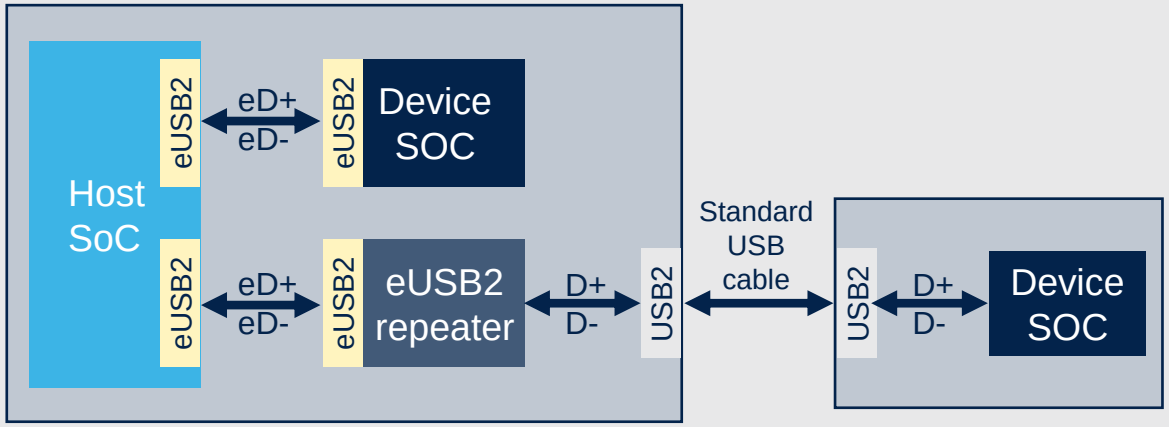
Simple integration within application

- In low power mode, the local ST60A3 is configured by I²C.
- The remote ST60A3 is either configured by I²C, or over-the-air by remote register access (RRA) over the RF link.
- An I²C command to the local device set the pair of ST60A3 in the desired tunneling mode (eUSB2, UART, I²C, or GPIO).

eUSB2 Introduction



Legacy USB2 architecture



New eUSB2 architecture for SoC in the most advanced process nodes

What is eUSB2?

- Embedded USB2 spec. released first in 2018 by USB forum
- eUSB2 offers same speed as legacy USB2 replacing 3.3 V signaling with 1/1.2V.

Why eUSB2 matters?

Maintaining legacy 3.3 V USB2 in advanced SoC is complex and expensive. Still feasible in 7 nm, very complex in 5 nm

eUSB2 can be used for low voltage interchip communications or to provide a fully compliant USB2.0 interface by using a repeater

- Native mode provides on-board chip-chip communications with the benefit of lower I/O voltage and power efficiency while remaining compliant to USB2 at protocol layer
- Repeater mode allows to connect to standard host or device through a separated eUSB2 repeater

ST60 For Contactless Connectivity Wearable Example

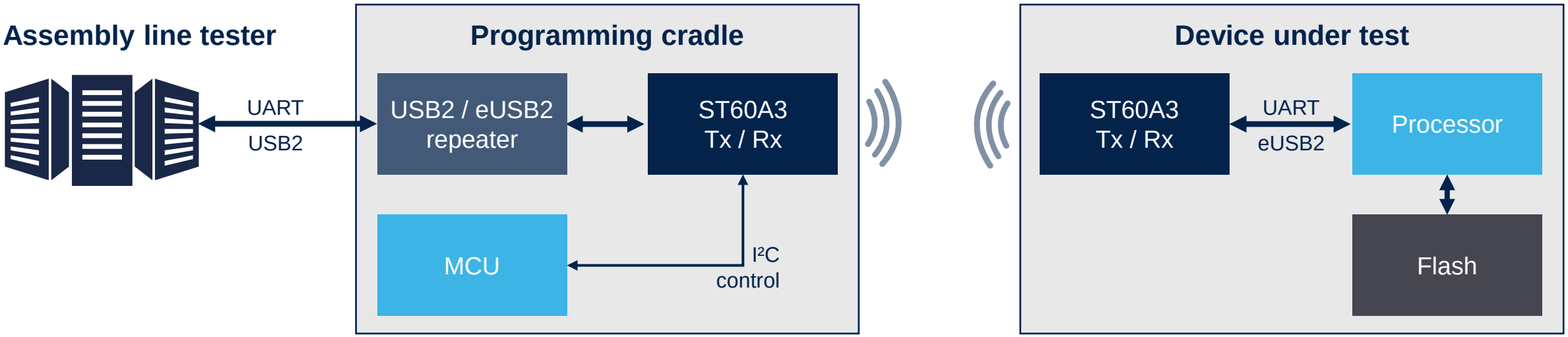
Factory testing & after-sales service

- No pairing needed
- Higher FOTA speed
- Improves reliability vs connector wear & tear
- Simple connection for SW loading & testing before and after housing
- Faster production throughput

Smart docking

- Port less and full water-proof sleeker design
- Instant sync, no pairing required
- Fully compatible with wireless charging
- 480 Mbps eUSB2 data transfer (pictures, data)
- High security

Factory Testing

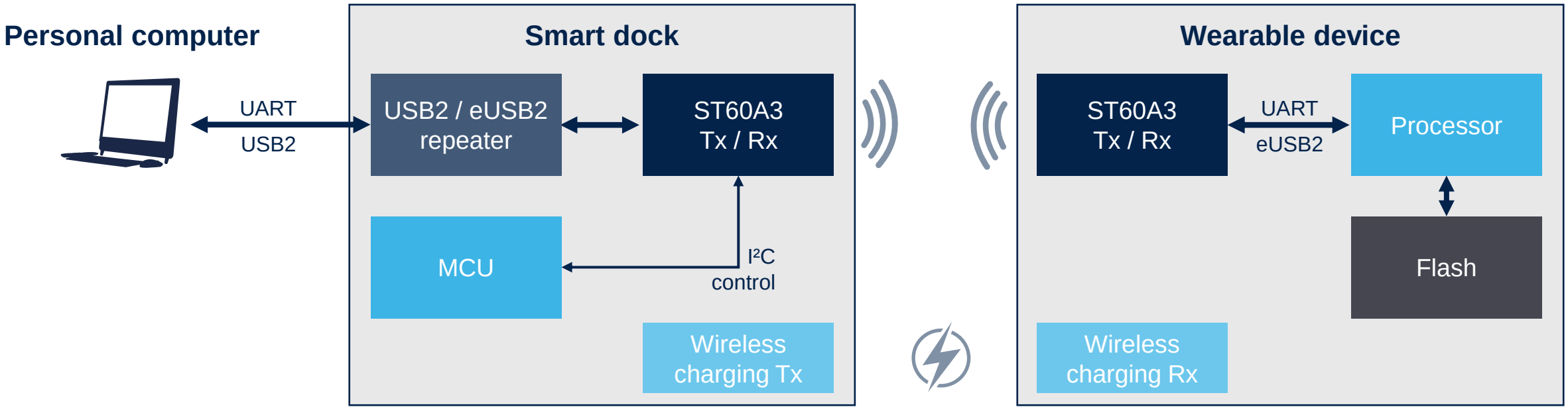


Use ST60A3 USB2 or UART mode for

- Wireless control of the device: self-discovery of mate (DUT), remote register access, remote boot of DUT
- Wireless test software upload over eUSB2 @ 480 Mbps
- Wireless firmware flashing over eUSB2 @ 480 Mbps
- Removal of pogo pins & connectors, making devices totally waterproof

→ Allows testing and firmware upload of assembled devices offering improved efficiency over Bluetooth & Wi-Fi

Smart Docking

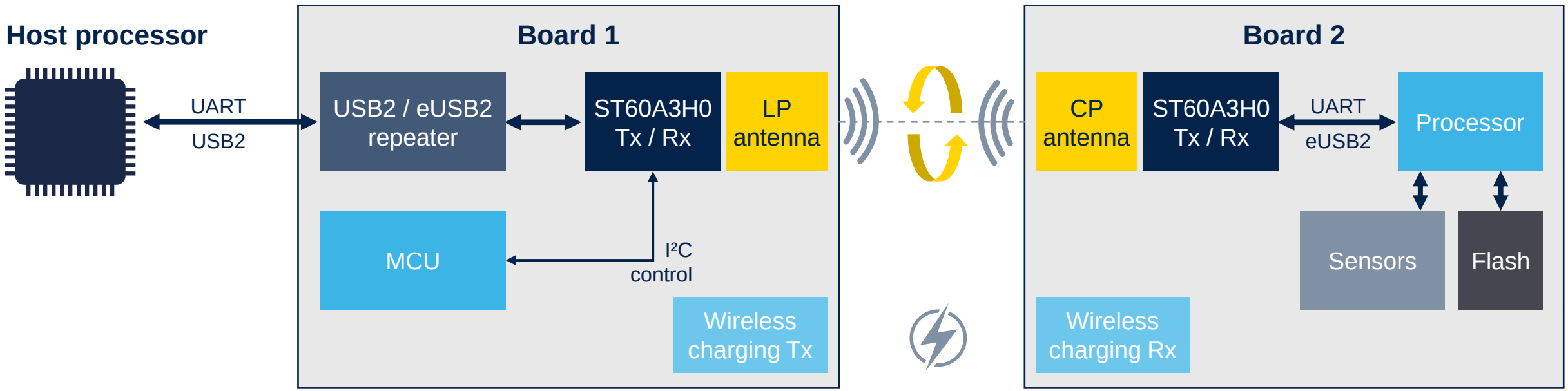


Use ST60A3 USB2 or UART mode for

- Wireless control of the device
- Wireless download of the content of the flash memory (pictures for example)
- Wireless firmware update

→ Allows contactless data sync with PC, without any connectors, at much higher data rate than Wi-Fi & Bluetooth

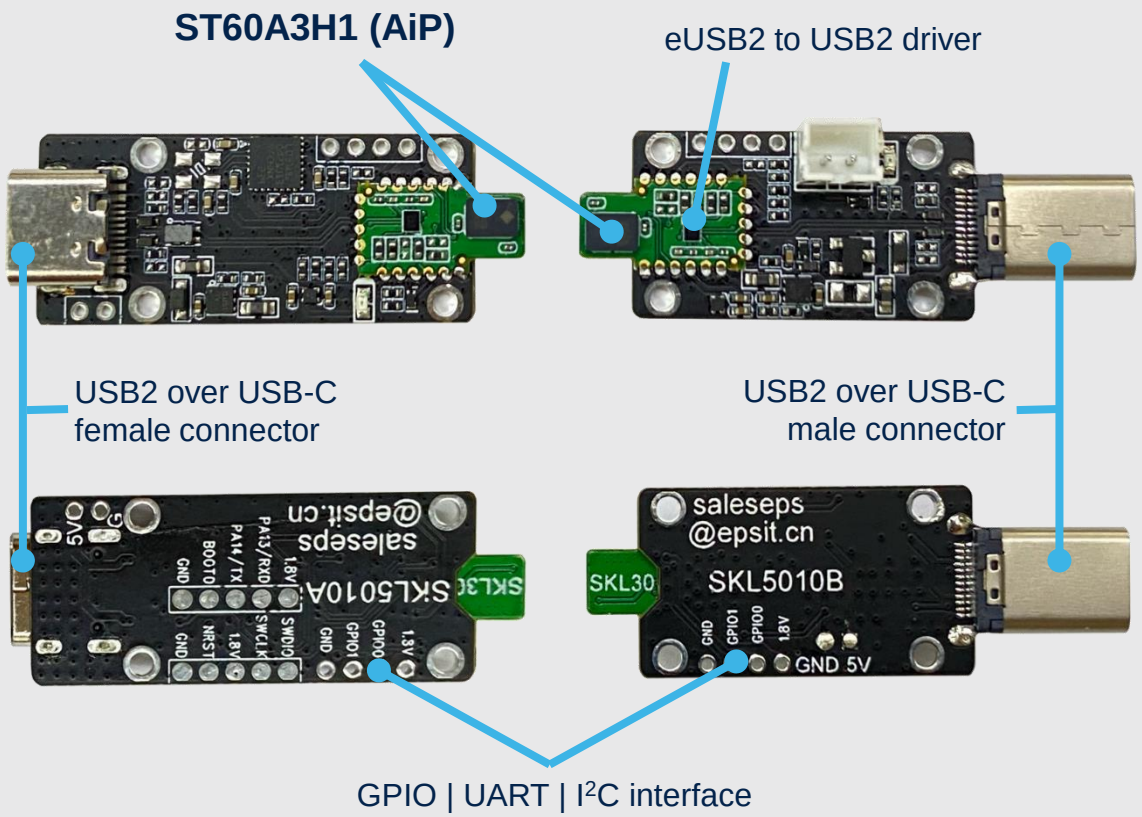
Board-To-Board Connection Over Rotation



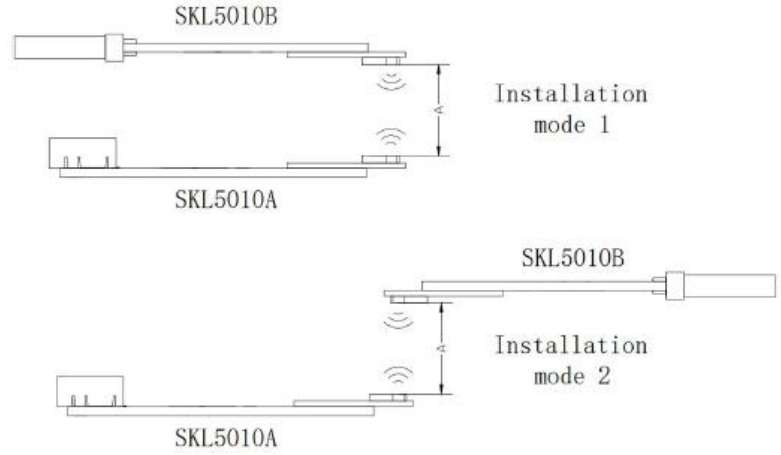
Contactless board to board connection supporting USB2 or UART/LDR mode

- Compatible with wireless charging
- Rotation is supported by combining ST60A3H0 with external linear (LP) and circular (CP) polarization antennas or waveguide solutions
- Replacement of slip rings, rotating joints, or Wi-Fi links offering improved reliability, shorter latency, and lower power consumption

SKL5010 Kit From SK-RF
FCC & ETSI Certified



- 60 GHz V-Band transceiver with ST60A3H1 AiP
- USB2.0 short range contactless connectivity up to 480 Mb/s
- Supports UART / GPIO / I²C data transfer in low-speed mode
- Half duplex, full RF transceiver and integrated antenna
- USB Type-C interface input
- Used in pairs (SKL5010A & B)



Product specifications available **here**

Product available at ARROW: click **here**

Contact: sales@sk-rf.com

ST60 Live Demonstration

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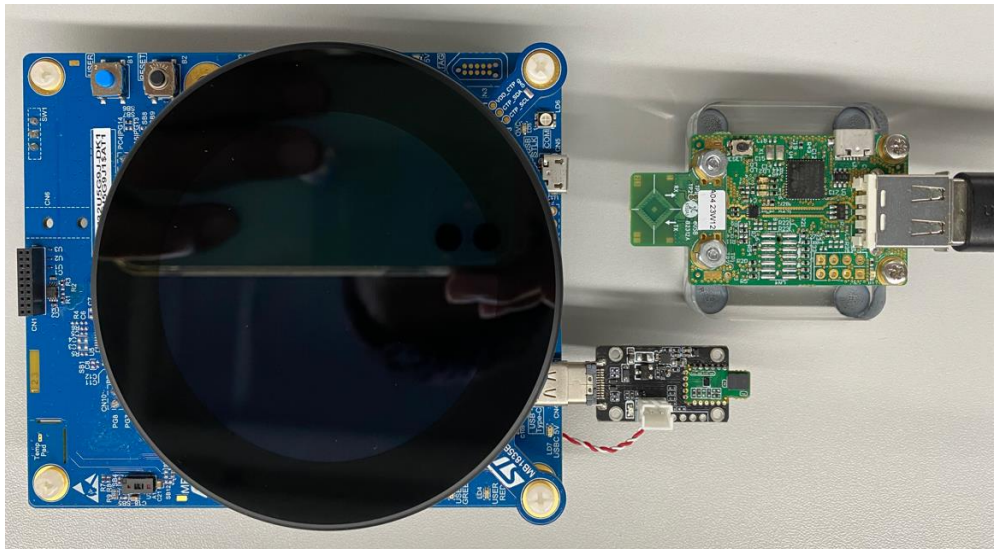
Contactless FOTA For STM32 Smart Watch Platform



eUSB2 480Mbps
Half Duplex

Contactless FOTA for STM32 smart watch platform

- STM32U5 ultra-low-power platform for smart watch application
- Contactless flashing STM32U5 through DFU
- eUSB2 tunneling with data rate up to 480 Mbps
- Remote control of DUT through ST60 RRA

ST60A3 features

- Support 480 Mbps – eUSB2
- Small footprint – BGA 2.9 x 4.1 x 0.8 mm^3 (AiP)
- Low power – 110/130 mW (Rx/Tx) eUSB2
- Support - AiP or external antenna
- Consumer temperature -20°C to 85°C

Dimensions

- 20 x 20 x 10 cm + laptop

ST parts: ST60A3

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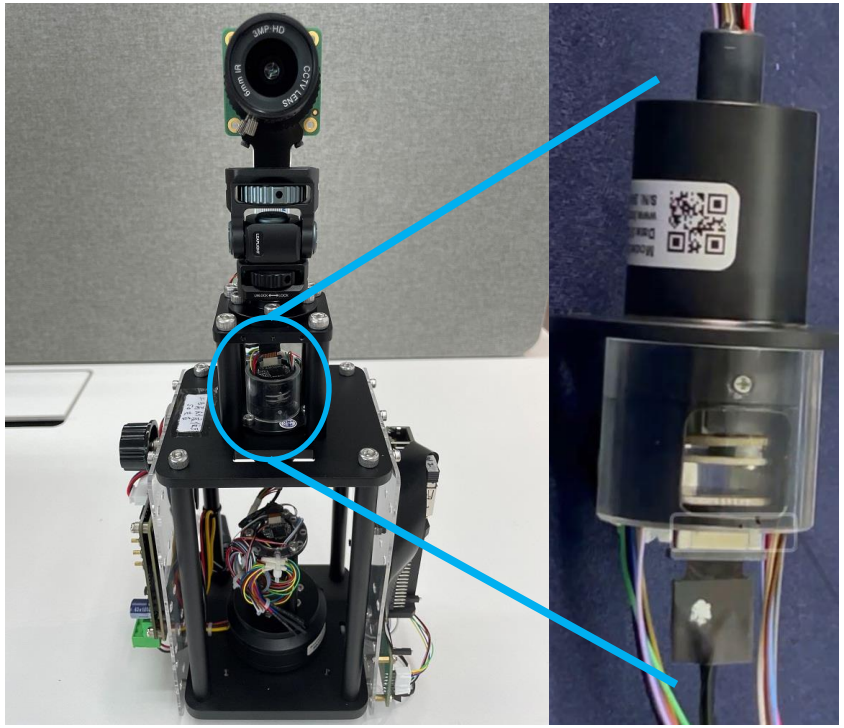
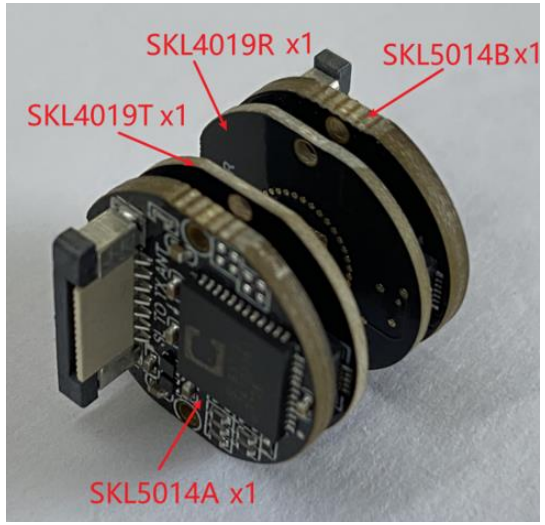
ST60 MIPI Hybrid Slipring



Wireless CSI Hybrid Slipring Camera

- Contactless wireless CSI interface: 4 lanes, 800 Mbps/lane
- 4k@30Hz video resolution supported
- Uncompression and Zero latency video transmission
- 0-250 rpm
- Support high data throughput via ST60
- Support 15 low speed GPIO includes power and ground



ST60A2 features

- High speed - 6.25 Gbps SLVS
- Small footprint – BGA 2.2 x 2.2 x 0.8 mm^3
- Low power – 44/27 mW Tx/Rx @5 Gbps
- Flexible antenna – support circular polarization
- Industrial temperature -40°C to 105°C

Dimensions

- 35 x 35 x 50 cm + display (or TV)

ST parts: ST60A2

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