Imaging Solutions for Embedded and Edge Applications

Image Sensing Overview

Image sensing is a critical element of a variety of modern technologies – automation, robotics, security systems, medical applications, drones, traffic cameras, and driver assistance systems, are just a few examples where image sensing ensures that critical tasks are accomplished without a glitch. Image sensing has seen massive growth in recent years due to its increased application in vision systems for IoT. Embedding the right image sensor technology into IoT end nodes can drive greater accuracy in inspection, depth sensing, object recognition, and tracking.

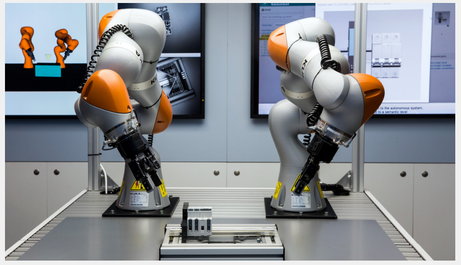
There are many ways the latest image sensing and camera technologies amplify the impact of humans in a variety of industrial and commercial processes.

Beyond the Human Eye: Multispectral, microscopic and high-speed imaging are good examples of vision capabilities that can be incorporated into cameras to identify special aspects of products, personnel, or processes, regardless of the environment.

Exceptional Quality: Special cameras allow for quality levels that no amount of human inspection can afford. Contactless dimension measurement, defect identification, etc. are just a few cases where image sensors augment human processes and ensure that standards for quality are met.

Reach: Cameras can go to places that humans cannot go. This makes cameras particularly valuable in mundane applications like pipe inspection to lifesaving applications in internal medicine. Space exploration and underwater exploration would not be possible without cameras.

Artificial Intelligence: Cameras have become invaluable for artificial intelligence. Facial recognition for security, occupancy detection, damage assessment, gesture detection, etc. are key applications making our world safer and helping users engage with providers in new ways.



Robotics/AI & ML Systems

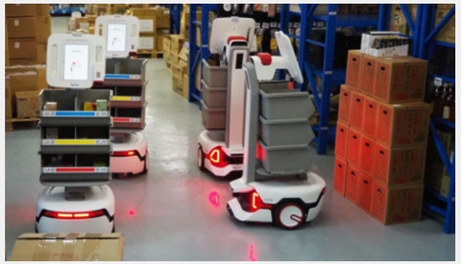
Automotive/Traffic

Security Access Control

Medical/Dental Equipment

Agriculture/Livestock

Drones

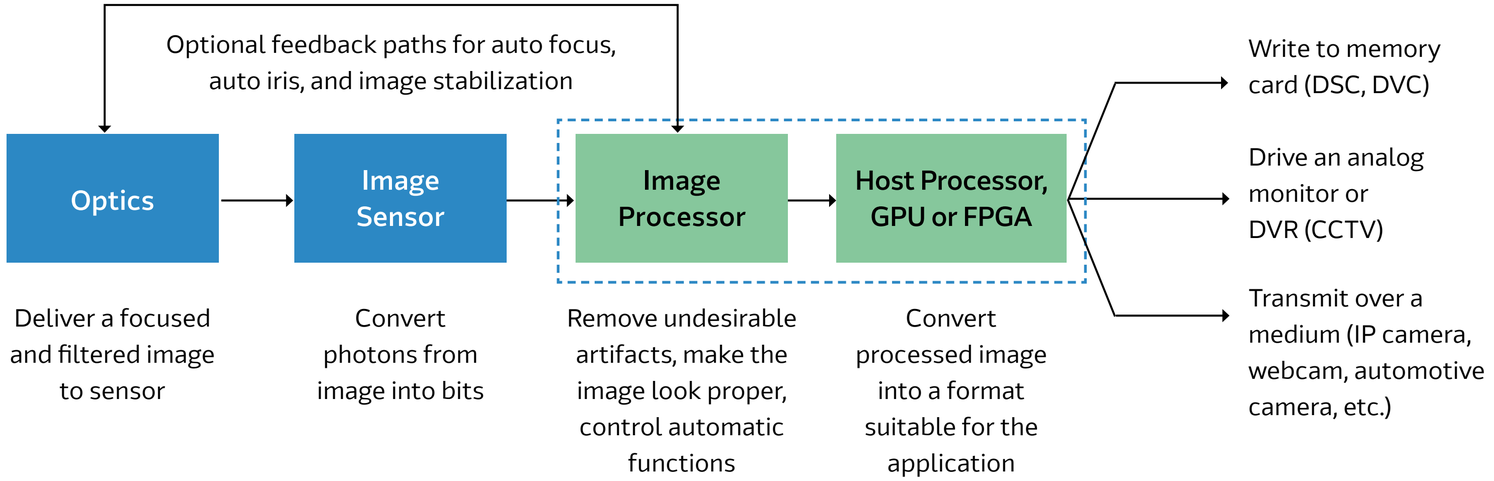


Warehouse Management and Logistics

VR/AR Systems

A Complete Image Sensing System

A typical image sensing system has three main hardware components – an image acquisition block comprising optics and the image sensor, a processing engine to analyze and act on the information, and a communication interface to connect to the external world. All these components play a significant role in the performance of an imaging system. Proper selection and integration of all these components, including cameras, sensors, processors, firmware, drivers, application software, and cables result in optimal system performance.



Selection Criteria

Optics

- Optical filter
- Focal length and zoom
- Len mounting
- Image stabilization
- Color and IR filter
- Field of view (FOV)
- Aperture
- Options for lens grouping

Image Sensors

- Shutter speed
- Pixel size/count (resolution)
- Frames per second (FPS)
- Dynamic range
- Signal to noise (SNR)
- Image format/compression
- Shutter type

Processors/ISPs

- Required compute capacity (Number of ISP/CPU/GPU cores)
- On-chip imaging accelerators
- AI/ML accelerators
- Regulatory/certification
- I/O interface support

Additional Selection Criteria for Image Sensing Systems

Below are system-level considerations that play a critical role in system-level architecture definition and build vs. buy decisions.

- **Product Requirements**
  - Power: Battery-powered or plugged in
  - Performance and image quality
  - Price: High-end or cost critical
  - Product size: Mounted or handheld
- **Selecting the right lens/sensor combination**
  - Distance to objects: variable or fixed, aerial, zoom capability, etc.
  - Indoor or outdoor, light conditions, fixed or mobile application
  - Sensor format: Some formats have more off-the-shelf lenses available
- **Time-to-market objectives**
- **Future-proofing, scalability, ease of upgrading**
- **Ease of integration**

Designing Image Sensing Solutions

Engineers have the choice to assemble various components of the system themselves by procuring individual components or buying modules. Time-to-market, in-house expertise, and the risk of failure drive the choice. Building a system has the advantage of offering the greatest flexibility of customization and can be very cost-effective for high-volume applications. However, building a system can involve high upfront development costs and pose project risks. Also, future-proofing the system and integration with other aspects of the manufacturing process will require additional effort and constant upkeep.

In contrast, modules offer a high level of integration and limit customization. Fully integrated systems that come with smart cameras are small, compact, all-in-one vision systems that incorporate lens, image sensors, system storage, and processors into a single device. These are increasingly popular as they take away the hassle of assembling all the components. Fast time-to-market and low risk are additional benefits accrued by buying a pre-built system.

Chip-Down Design

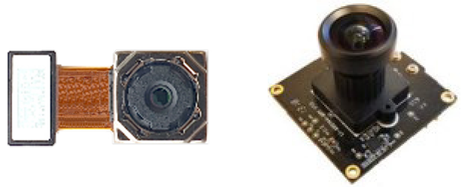
Pros

- Design flexibility and customization to fit application needs
- Cost-efficient for high-volume applications

Cons

- Slow time-to-market, multiple design cycles and increased chances for design failure
- Resource and expertise intensive
- Low ROI for small volume applications

Module-Based Design



Pros

- Fast development and ease of design reuse
- Faster time to market and lowered design risk, especially for small form-factor applications

Cons

- Less design flexibility
- Design must fit module
- The product size may be limited

Finished Product

Pros

- Extremely fast time-to-market
- Zero hardware design required. Focus on software, configuration, and application

Cons

- Limited hardware flexibility for customizations
- Low ROI for high-volume applications

onsemi Image Sensor Portfolio for Chip-Down Designs

onsemi leverages the most advanced CCD and CMOS imaging technologies to provide the broadest, most capable portfolio of image sensors for industrial, automotive, and consumer applications. onsemi's image sensing portfolio ranges from VGA to over 50 MP (megapixel) resolution, and from 4 to over 800 fps (frames per second). The broad portfolio enables flexibility in configuration and combines optimal performance characteristics, such as high speed, high sensitivity, and high image quality to match specific application requirements. It also provides an easy upgrade path for existing customers and allows OEMs to leverage a single camera design to support multiple products to accelerate time-to-market.

Industrial

High speed, scalable portfolio
Quadratic speed increase with ROI

- PYTHON 25K — 25MP 4.5um
- PYTHON 16K — 16MP 4.5um
- PYTHON 5000 — 5MP 4.8um
- PYTHON 2000 — 2MP 4.8um
- PYTHON 1300 — 1.3MP 4.8um
- PYTHON 480 — VGA 4.8um

Machine Vision & Intelligent Traffic Systems

Performance, price, speed
29mm cameras, system solutions

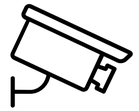
- XGS 32000 — 32MP 3.2um
- XGS 45000 — 45MP 3.2um
- XGS 20000 — 20MP 3.2um, 1:1 aspect ratio
- XGS 30000 — 30MP 3.2um, 1:1 aspect ratio
- XGS 12000 — 12MP 3.2um
- XGS 16000 — 16MP 3.2um, 1:1 aspect ratio
- XGS 8000 — 8MP 3.2um
- XGS 9400 — 9.4MP 3.2um, 1:1 aspect ratio
- XGS 3000 — 3MP 3.2um
- XGS 5000 — 5MP 3.2um
- XGS 2000 — 2MP 3.2um

Edge AI

Small sensors, low power
NIR optimized

- AR0234 — (1920 x 1200) 2.3MP 3.0um
- AR0135 — (1280 x 960) 1.2MP 3.75um GS
- AR0144 — (1280 x 800) 1.0MP 3.0um GS
- AR0522 / AR0521 — (2592 x 1944) 5.0MP 2.2um
- AR0431 / AR0430 — (2317 x 1746) 4.0MP 2.0um

Machine Vision Everywhere



Event detection
Very low power, flexible states

- ARX3A0 — (560 x 560) VGA 2.2um pGS
- LiDAR/SiPM — R Series
- SPAD Arrays — Pandion

Arrow Compact Camera Module (CCM) Offerings for Small Form-Factor Applications

Arrow Electronics is introducing a family of camera modules based on sensor technology from onsemi. The modules provide original equipment manufacturers (OEMs) with a simple and cost-effective path to incorporating a wide range of camera functionalities in their products. All camera modules comply with onsemi IAS standard and have the same connector and pinout, providing compatibility with the popular 96boards development ecosystem. Arrow has partnered with Timesys for Linux drivers.

AP-Vision-ARX3A0-55

onsemi ARX3A0 sensor

- 1/10.3” 560 x 560 Mono +NIR
- 0.3Mp @ 360fps
- Fixed focus 49° FOV
- F# 2.0
- Length: 21.95 mm

Target Applications:

- IoT applications
- Super low power applications
- Machine vision
- Artificial intelligence
- Eye tracking

AP-Vision-AR0430-54

onsemi AR0430 sensor

- 1/3.2” 2316 x 1746 Color
- 4Mp @ 120fps
- Fixed focus 81.5° FOV
- F# 2.4
- Length: 23.5 mm

Target Applications:

- Consumer devices
- Door camera
- Dual camera
- Robotics
- Drone camera

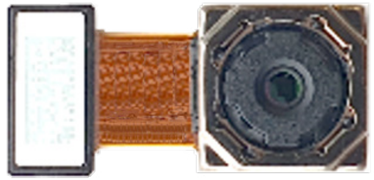
AP-Vision-AR1335-74

onsemi AR1335 sensor

- 1/3.2” 4208 x 3120 Color
- 13Mp @ 30fps
- Autofocus 64° FOV
- F# 2.0
- Length: TBD mm

Target Applications:

- Digital still cameras
- Drone cameras
- AI vision
- Body camera
- Sports camera



Development Resources for Arrow CCM Modules

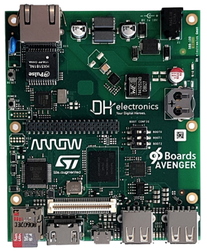
Arrow worked with Shiratech Solutions to create camera mezzanine cards compliant with the 96boards specification. Compatibility with the 96boards open platform enables customers to rapidly start implementation of new imaging designs and to optimize systems once operational. The mezzanine board has the onsemi AP1302 image signal processor (ISP). The ISP offloads core functions like sensor configuration and calibration, image format conversation, basic transformations, and autofocus from the processor.

Arrow CCM module on Shiratech Mezzanine board

Includes an onsemi AP1302 ISP

+

Options for processor platforms. 96boards development platforms can be used for testing and verification



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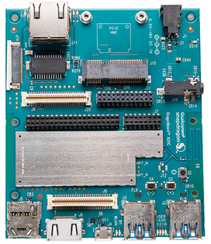
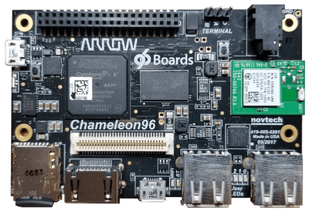


Qualcomm

NXP



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Arrow CCM modules compatible with onsemi Demo3 System and DevWareX

The modules are compatible with onsemi's Demo3 EVK system and DevWareX software which allows for many possibilities for testing, debugging, and analysis.

- Generate initialization files
- Log register changes when setting modes
- Save or load images for analysis
- Watch specific registers
- Manual white balance adjustments

Image Analytics

- Intensity graphs
- Noise measurements
- Image histograms
- Vectorscope graphs

Basler Camera Module Solutions and Development Kits

Basler is a leading international manufacturer of high-quality imaging components for computer vision applications. In addition to classic area scan and line scan cameras, lenses, frame grabbers, light modules, 3D products, and software, the company offers embedded vision solutions, that comprise consulting services, customer specific software development as well as customized products. Basler's products are used in a variety of markets and applications, including factory automation, medical, logistics, retail, and robotics. They are characterized by high reliability, an excellent price/performance ratio, and long-term availability.

Core Offerings

Product category	Product families	onsemi products featured
Modules	Basler dart BCON for MIPI Cameras (5, 8 & 13 MP)	– onsemi AR0821 - daA3840-30mc (S-Mount) - Basler dart – onsemi AR1335 - daA4200-30mci (S-Mount) - Basler dart
Kits	Different development Kits for NVIDIA Jetson Family and NXP i.MX8 Applications Processor series	– onsemi AR1335 - daA4200-30mci-JNANO-NVDK-AIA - Embedded Vision Kits – Onsemi AR1335 - daA4200-30mci-MX8MM-VAR - Embedded Vision Kits
Firmware and application-level software	Complete Driver Packages & Application-specific software	N/A
Services	Complete Solution Design (From Product idea to Life Cycle Management)	N/A

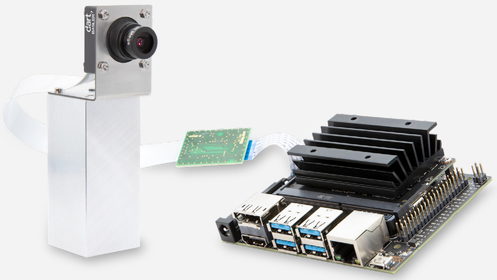
Core Market - Factory Automation

– Automotive Industry, Robotics, Electronics & Semiconductors, Photovoltaics, Food & Beverages, Pharma & Healthcare Products, and Printing & Webbed Materials

Featured Solutions

Embedded Vision Development Kits
All components in one package

Embedded Vision Development Kits include a camera, a processing board and all accessories and therefore are ready-to-use kits to start prototyping your application immediately. The software including camera driver and pylon Software Development Kit (SDK) are pre-installed.



New AI Vision Solution Kit with Cloud Connectivity

The Basler AI Vision Solution Kit with Cloud Connectivity is a Development Kit for integrating a Basler dart camera with a BCON for MIPI interface. It contains a dart BCON for MIPI camera module, an NVIDIA® Jetson Nano™ Developer Board, a lens and a cable. Additionally, it includes all necessary drivers, software as well as cloud support and thus offers a complete plug and play design-in package for rapid prototyping of AI-based IoT applications.

Leopard Imaging Camera Module Solutions and Development Kits

Leopard Imaging is a global leader that provides high definition (HD) embedded cameras and AI-based camera solutions — focusing on core technologies that improve image processing in autonomous vehicles, drones, IoT, robotics, and healthcare devices. As a Preferred NVIDIA Partner and a member of the AWS Partner Network, Leopard Imaging also works closely with Intel, Qualcomm, onsemi, and other companies in producing advanced camera solutions. With high-tech and manufacturing capabilities in the US and Asia, the entire team at Leopard Imaging is dedicated to providing camera technology with excellent quality products and extraordinary services — consistently aligning with certified quality management systems.

Core Offerings

Product families	Product types	onsemi product featured	Firmware support
Driver monitoring systems (DMS) cameras	– Modules – Kits (with USB 3.0)	AR0144IVEC	Gesture and facial expression recognition software solutions
DMS cameras	– Modules – Kits (Qualcomm automotive platform)	AR0234AT	Runs Qualcomm automotive platform
Robotics and drones	– Modules – Kits (USB3.0, GMSL2 with RAW or YUV)	AR0234CS	Runs on USB3.0, GMSL2
OMS cameras	– Modules – Kits (Ambarella CV2 or GMSL2)	AR0239	Runs on Ambarella CV2 and GMSL2
Camera for IoT and drones	– Modules – Kits (NVIDIA Jetson or USB 3.0)	AR0821CS	Runs on Jetson and USB3.0
Stereo camera	– Modules – Kits (NVIDIA Jetson Platform)	AR0234CS	3D Depth engine on NVIDIA Jetson Platform

Markets Served

– Autonomous Driving, ADAS, Drone, Robotics, and IoT

Featured Solutions

LI-AR0144IVEC-GMSL2-055H Camera

The LI-AR0144IVEC-GMSL2-055H is equipped with ON Semiconductor In-Vehicle Experience Camera Module (IVEC) AR0144 1/4-Inch CMOS Camera Module, Maxim GMSL2 Serializer MAX9295A and built-in IR LED. This camera outputs 1280 x 800 YUYV image data.

Features onsemi AR0144 sensor

LI-AR0144IVEC-GMSL2-055H

LI-USB30-AR0234CS-YUV-GMSL2-060H Camera

The LI-AR0234CS-YUV-GMSL2 is equipped with ON Semiconductor CMOS digital image sensor AR0234CS, AP1302 ISP and Maxim GMSL2 serializer MAX9295A/B. This camera outputs 1920 x 1200 YUV data.

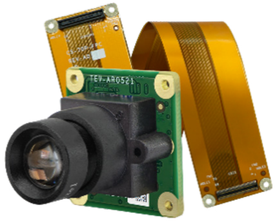
Features onsemi CMOS Image Sensor AR0234CS

LI-USB30-AR0234CS-YUV-GMSL2-060H

TechNexion Camera Module Solutions and Development Kits

TechNexion

TechNexion Embedded Vision Solutions provide embedded system developers access to high-performance, industrial-grade camera solutions to accelerate their time-to-market for embedded vision projects.



TEV/TEVI

Optional Image Signal Processor (ISP)

OEM Integration

12mm Lens Options

Resolutions from 1MP to 8MP

Global and Rolling shutter

VizionCam

Rugged, Compact housing

USB 3.0 Type C Interface

UVC Support

Resolutions from 1MP to 8MP

Global and Rolling shutter

VizionLink

High-speed Serial Link up to 15m

Single-wire Coax (FAKRA)

Robust, Compact, IP68 Housing

Resolutions from 1MP to 8MP

Global and Rolling shutter

TechNexion Solutions Based on onsemi Image Sensors

Rolling Shutter

AR1335 13MP AR0821 8MP AR0521 5MP	**Applications** Access Control Security Surveillance Inspection Microscopy

Global Shutter

AR0234 2.3MP AR0144 1MP	**Applications** Navigation High-speed Inspection Failure Analysis Machine Vision

Web link: Embedded Vision Solutions

Watch video: TechNexion Vision Solutions

Arrow Electronics and onsemi Image Sensing Portfolio

Implementing an imaging system requires a thorough analysis of the requirements, evaluation, and prototyping to ensure that the final solution achieves business objectives. Comprehensive solution providers like Arrow offer solutions for chip-down and module options and can also support with design services

Arrow's image sensing ecosystem simplifies design, reduces risk, and lowers time-to-market for solutions based on onsemi image sensors. Coupled with service offerings for every step of the design and deployment phase, Arrow helps OEMs develop leading applications for industrial, automotive, consumer, and healthcare markets.

Technology	Ecosystem															
	ADLINK	APPLETEC Ltd.	Basler	elnfochips	Intel	Lattice	Leopard Imaging	Microchip	NVIDIA	NXP	OMRON	Onsemi	Qualcomm	STMicro	Thundercomm	Timesys
Image Sensor												√				
Camera Module		√	√				√				√					
ISP/MPU/FPGA			√	√	√	√	√	√	√	√	√	√	√	√	√	
SW Firmware/ Driver, Tuning			√	√	√		√			√	√	√	√		√	√
Smart Camera	√			√	√										√	

onsemi

Arrow

Arrow Engineering Services for Image Sensing Application Design

Module Customization

- Small changes can be made to the existing module for a low NRE
  - Flex length, connector or the pin-out, FOV, etc.
- New module can be designed in as short as four weeks for $1,000-$1,500 NRE
  - Using a different camera sensor depending on sensor
  - Different off the shelf lens

Imaging System Design

- Sensor Selection
- ISP/FPGA selection
- Integration with host processor
- Training on imaging systems
- Image Tuning
  - Sensor characterization for parameters that affect image quality
  - Lens and color shading compensation
  - Auto exposure and auto white balance tuning
  - High-performance image pipe tuning
  - High-quality image pipe tuning
  - Subjective and custom image tuning

Complete System Design

- Hardware development
- Multilayer PCB design
- Lighting and illumination
- SW driver development
- SW OS porting
- SW application development
- Inventory management
- AI app development
- Video analytics
  - Motion detection
  - Situation analysis

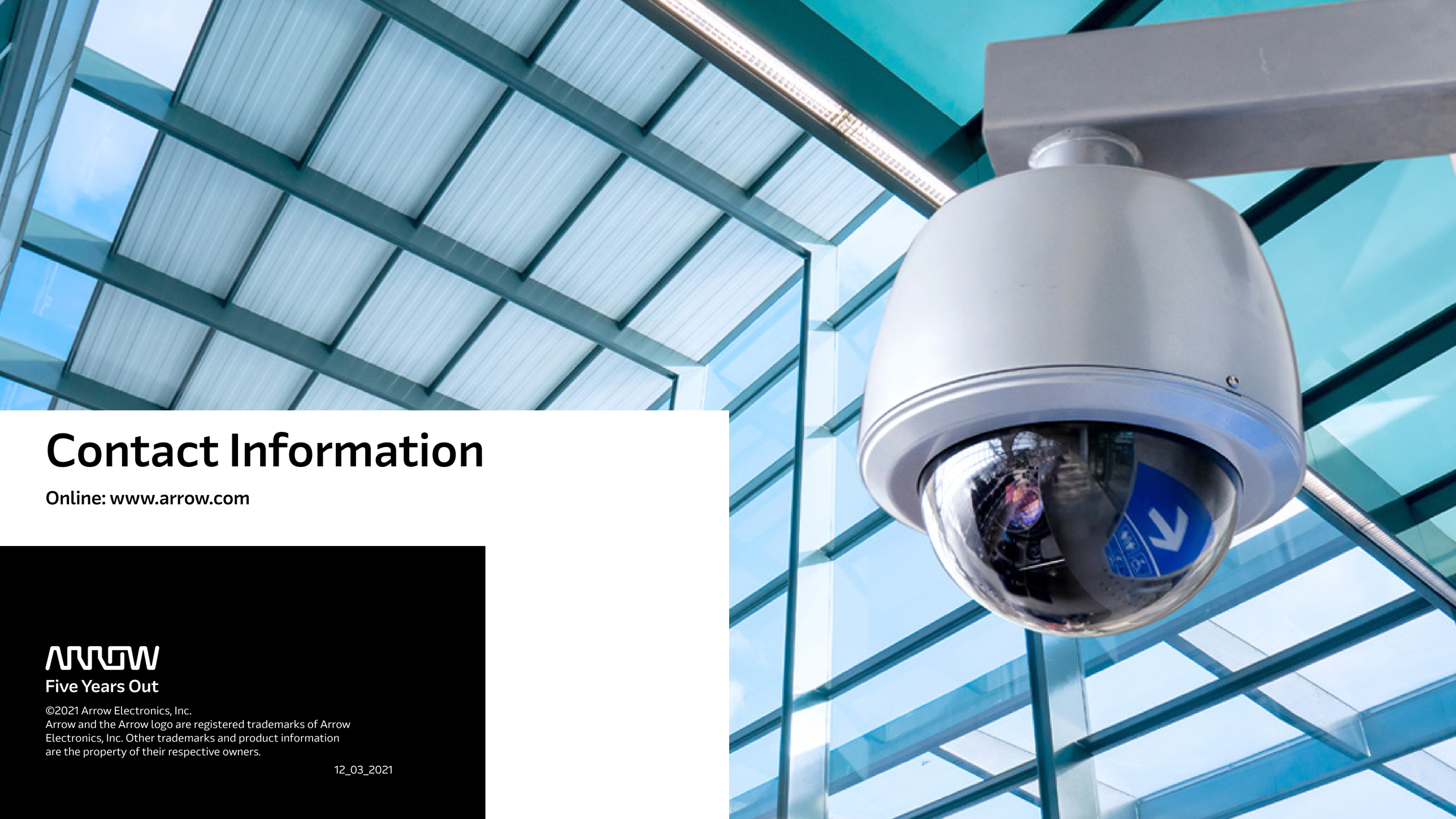
Ordering Information

Arrow CCM Modules

Description	Part number
Compact camera module based on onsemi ARX3A0 sensor	AP-Vision-ARX3A0-55
Compact camera module based on onsemi AR0430 sensor	AP-Vision-AR0430-54
Compact camera module based on onsemi AR1335 sensor	AP-Vision-AR1335-74

Development Boards

Description	Part number
onsemi Demo3 base board	AGB1N0CS-GEVK
Shiratech 96boards mezzanine card based on onsemi AR0430 image sensor	SRT-Vision96-AR0430
Shiratech 96boards mezzanine card based on onsemi ARX3A0 image sensor	SRT-Vision96-ARX3A0
96boards single-board computer powered by the NXP i.MX 8M SoC, incorporating a quad-core 64-bit ARM® Cortex A53	I.IMX8_THOR96
ST Microelectronics Avenger96 board features dual Arm Cortex-A7 cores and an ARM® Cortex-M4 core	STM32MP157AAC
eInfochips Qualcomm® QCS610 Development Kit	EIC-QCS610-210
Novtech Chameleon96™ Kit with dual-core ARM® Cortex-A9 processors	Chameleon96 Kit



Contact Information

Online: www.arrow.com

Five Years Out

12_03_2021