

# 1/1.8-inch 20 MP CMOS Digital Image Sensor

## AR2020

### General Description

The onsemi AR2020 is a stacked 1/1.8-inch back side illuminated (BSI) CMOS active-pixel digital image sensor with a pixel array of 5120H x 3840V (5136H x 3856V including border pixels). The AR2020 has enhanced NIR response.

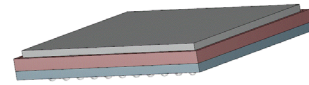
It incorporates sophisticated on-chip camera functions such as Wake on Motion (WOM), context switching and multiple subsampling modes. It is programmable through a simple I<sup>2</sup>C interface and has very low power consumption.

The AR2020 digital image sensor features onsemi's breakthrough low-noise CMOS imaging technology.

The AR2020 sensor can generate full resolution image at up to 60 frames per second (fps) in 10-bit linear mode. AR2020 can achieve 30 fps in line interleaved high dynamic range (LI-HDR) and enhanced Dynamic Range (eDR) modes.

### Features

- 20 MP CMOS Sensor with Advanced 1.4  $\mu\text{m}$  Pixel Stacked BSI Technology
- Enhanced NIR Response at 850 nm and 940 nm Wavelength
- LI-HDR: Supports Line Interleaved T1/T2 Readout to Enable HDR Processing in ISP Chip
- enhanced Dynamic Range (eDR)
- In Sensor Scaler that Supports both Mono and Bayer RGB Version
- Super Low Power Mode (SLP)
- Smart Roi:
  - ◆ Capability to Output Two Roi's Over Different Mipi Virtual Channels
  - ◆ Capability to Have Individual Image Crop Selection
  - ◆ Capability to Select Channel for Scaled Image
- Wake On Motion (WOM)/Motion Detection
- Subsampling Modes: Skipping, Binning, Summing
- Data Interfaces:
  - ◆ MIPI D-PHY – 2x4 Lanes
- Bit-depth Compression Available for MIPI Interface
- I<sup>2</sup>C Fast Mode+ Serial Interface
- Various Trigger Modes for Multi-sensor Synchronization
- Electronic Rolling Shutter (ERS) and Global Reset Release (GRR) Modes Supported
- Context Switching
- 1952 bytes One-time Programmable Memory (OTPM) for Storing Shading Correction Coefficients and Module Information
- Programmable Controls: Gain, Horizontal and Vertical Blanking, Frame Size/Rate, Exposure, Window Size, Cropping and Mirror and Flip
- On-chip Temperature Sensor with  $\pm 5$  °C accuracy
- On-chip Lens Shading Correction for RGB Bayer and Mono



PBGA78 13x10.5  
CASE 117CV

### ORDERING INFORMATION

See detailed ordering and shipping information on page 3 of this data sheet.

## Public Data Sheet

**Interested in what you see?** If you would like more detailed information, please request the full version of our data sheet.

[Request Full Data Sheet](#)

### Applications

- Surveillance Camera
- Video Conferencing
- Machine Vision
- 3D and Stereo Imaging

Table 1. KEY PERFORMANCE PARAMETERS

| Parameter                                                     |                        | Value                                                                                        |
|---------------------------------------------------------------|------------------------|----------------------------------------------------------------------------------------------|
| Optical Format                                                |                        | 1/1.8-inch 20 MP (4:3)                                                                       |
| Active Pixels                                                 |                        | 5120H x 3840V                                                                                |
| Color Filter Array                                            |                        | RGB Bayer, Monochrome                                                                        |
| Pixel Size                                                    |                        | 1.4 $\mu\text{m}$ Back Side Illuminated (BSI)                                                |
| Chief Ray Angle (CRA)                                         |                        | 13°                                                                                          |
| Input Clock Frequency                                         |                        | 6 – 48 MHz                                                                                   |
| Interface                                                     |                        | 2x4-lane MIPI (1x1, 1x2, 1x4, 2x4-lane supported) using D-PHY;<br>Max data rate: 2 Gbps/lane |
| ADC Resolution                                                |                        | 10-bits, on die                                                                              |
| Frame Rate                                                    | Full Size, Linear Mode | 60 fps (MIPIx2), 30 fps (MIPIx1)                                                             |
| Gain Control: Gain Table                                      |                        | Linear Mode: 0 – 50.62 dB total (Analog 0 – 26.38 dB, Digital 0 – 24.24 dB)                  |
| Subsampling                                                   |                        | Subsampling: Skipping (RGB, Mono), Binning (RGB), Summing (Mono)                             |
| Scaler                                                        |                        | Adjustable x- and y-scaling up to 32x, with 0.05% accuracy, for Bayer and Mono variant.      |
| SmartROI                                                      |                        | Support SmartROI feature that can send out two ROIs over different MIPI Virtual Channels.    |
| Temperature Sensor                                            |                        | 10-bit, controlled by two-wire serial I/F, $\pm 5^\circ\text{C}$ accuracy                    |
| Compression                                                   |                        | DPCM: 10–8                                                                                   |
| 3D Support                                                    |                        | Frame rate and exposure synchronization                                                      |
| Supply Voltage                                                | Analog, Pixel          | 2.8 V ( $2.7 < V_{\text{supply}} < 2.9$ V)                                                   |
|                                                               | I/O                    | 1.8 V ( $1.7 \text{ V} < V_{\text{supply}} < 1.9$ V)                                         |
|                                                               | Digital, PLL, MIPIphy  | 1.05 V ( $1.0 \text{ V} < V_{\text{supply}} < 1.1$ V)                                        |
| Power Consumption                                             |                        | 430 mW (Typical) at (RGB) 20 MP and 60 fps                                                   |
| Responsivity                                                  |                        | 17.3 ke-/lux-sec (Clear in Mono)<br>8.7 ke-/lux-sec (Green in RGB)                           |
| SNRMAX                                                        |                        | 39.9 dB                                                                                      |
| Dynamic Range                                                 |                        | 73 dB (eDR 1-exp)<br>100 dB (LI-HDR Mode)                                                    |
| Operating Temperature Range (at junction) – $T_J$             |                        | $-30^\circ\text{C}$ to $+85^\circ\text{C}$                                                   |
| Performance Specified Temperature Range (at junction) – $T_J$ |                        | $0^\circ\text{C}$ to $+60^\circ\text{C}$                                                     |
| Package Options:                                              |                        | MPBGA-78 (13 mm x 10.5 mm)                                                                   |
| $\theta_{JA}$ (Note 1)                                        |                        | $30^\circ\text{C/W}$                                                                         |
| $\theta_{JB}$                                                 |                        | $18^\circ\text{C/W}$                                                                         |

1.  $\theta_{JA}$  is dependent on the customer module design and should not be used for calculating junction temperature.



## AR2020

**Table 2. MODES OF OPERATION 10-BIT**

| Modes                             | Sensor Resolution | Mode Name | FPS (2x4 MIPI) | FPS (1x4 MIPI) |
|-----------------------------------|-------------------|-----------|----------------|----------------|
| 20M Linear                        | 5120x3840         | Native    | 60             | 37             |
| 20M LI-HDR                        | 5120x3840         | Native    | 30             | 18             |
| 20M LI-eDR                        | 5120x3840         | Native    | 30             | 15             |
| 5M Linear                         | 2560x1920         | Bin2      | 120            | 120            |
| 1280x960 Linear                   | 1280x960          | Bin4      | 240            | 240            |
| 20M SLP Linear                    | 5120x3840         | Native    | 1              | 1              |
| Wake On Motion (WOM)              | 640x480           | Skip2Bin4 | 2              | 2              |
| Wake ON Motion (WOM) w/ streaming | 1280x960          | Bin4      | 2              | 2              |

NOTE: Contact your **onsemi** Field Applications Engineer for additional modes.

**Table 3. MODES OF OPERATION 12-BIT**

| Modes   | Sensor Resolution | Mode Name | FPS (2 x 4 MIPI) | FPS (1 x 4 MIPI) |
|---------|-------------------|-----------|------------------|------------------|
| 20M eDR | 5120x3840         | Native    | 30               | 25               |

NOTE: Contact your **onsemi** Field Applications Engineer for additional modes.

**Table 4. ORDERING INFORMATION**

| Part Number             | Product Description                           | Orderable Product Attribute Description |
|-------------------------|-----------------------------------------------|-----------------------------------------|
| AR2020CSSC13SMTA0-DP    | 20 MP 1/1.8" CMOS Image Sensor<br>RGB 13° CRA | mPBGA with Protective Film              |
| AR2020CSSC13SMTA0-DP2   | 20 MP 1/1.8" CMOS Image Sensor<br>RGB 13° CRA | mPBGA with Protective Film, Small MOQ   |
| AR2020CSSC13SMTAH3-GEVB | 20 MP 1/1.8" CMOS Image Sensor<br>RGB 13° CRA | Demo3 Headboard                         |

|                         |                                                |                                       |
|-------------------------|------------------------------------------------|---------------------------------------|
| AR2020CSSM13SMTA0-DP    | 20 MP 1/1.8" CMOS Image Sensor<br>Mono 13° CRA | mPBGA with Protective Film            |
| AR2020CSSM13SMTA0-DP2   | 20 MP 1/1.8" CMOS Image Sensor<br>Mono 13° CRA | mPBGA with Protective Film, Small MOQ |
| AR2020CSSM13SMTAH3-GEVB | 20 MP 1/1.8" CMOS Image Sensor<br>Mono 13° CRA | Demo3 Headboard                       |

NOTE: Refer to AR2020 Die Data Sheet for Die Part Numbers & Ordering Information.

# AR2020

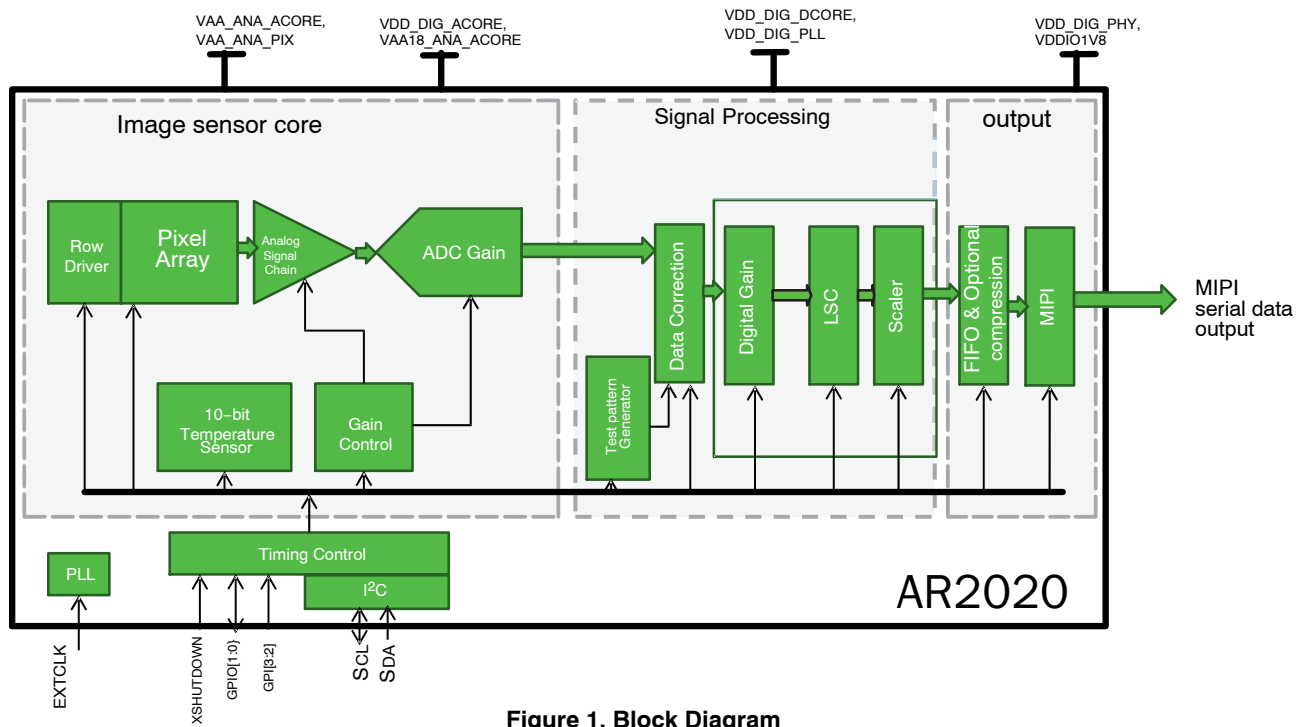
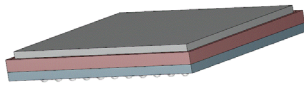
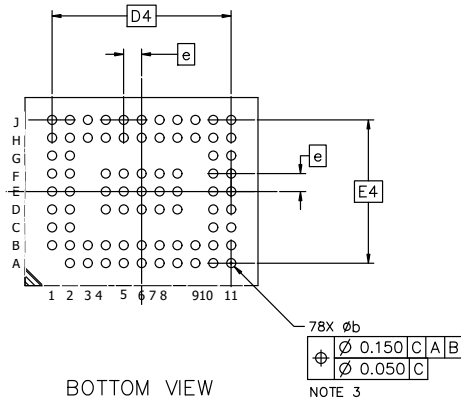
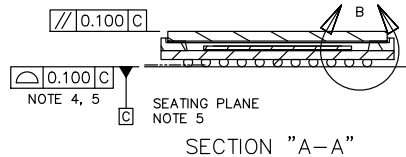
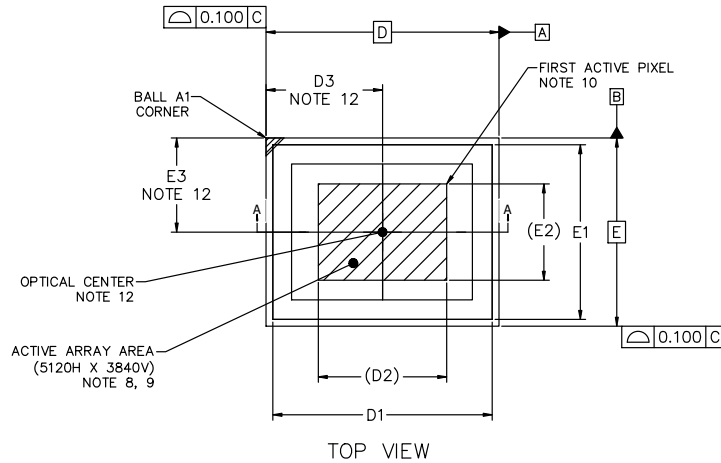


Figure 1. Block Diagram

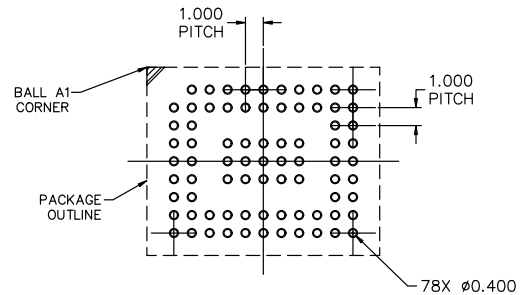
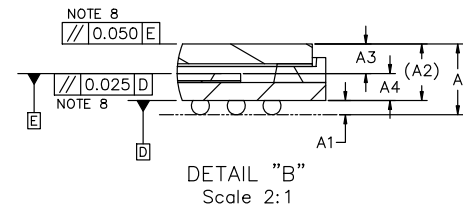


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| MILLIMETERS |            |        |        |
|-------------|------------|--------|--------|
| DIM         | MIN        | NOM    | MAX    |
| A           | ---        | ---    | 2.100  |
| A1          | 0.350      | 0.400  | 0.450  |
| A2          | 1.575 REF  |        |        |
| A3          | 0.725      | 0.825  | 0.925  |
| A4          | 0.650      | 0.750  | 0.850  |
| b           | 0.450      | 0.500  | 0.550  |
| D           | 13.000 BSC |        |        |
| D1          | 12.200     | 12.250 | 12.300 |
| D2          | 7.168 REF  |        |        |
| D3          | 6.400      | 6.500  | 6.600  |
| D4          | 10.000 BSC |        |        |
| E           | 10.500 BSC |        |        |
| E1          | 9.700      | 9.750  | 9.800  |
| E2          | 5.376 REF  |        |        |
| E3          | 5.150      | 5.250  | 5.350  |
| E4          | 8.000 BSC  |        |        |
| e           | 1.000 BSC  |        |        |



NOTES:

- DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2018.
- CONTROLLING DIMENSION: MILLIMETERS [mm].
- SOLDER BALL DIAMETER IS MEASURED AT THE MAXIMUM SOLDER BALL DIAMETER PARALLEL TO DATUM C.
- COPLANARITY APPLIES TO THE SPHERICAL CROWNS OF THE SOLDER BALLS.
- DATUM C, THE SEATING PLANE IS DEFINED BY THE SPHERICAL CROWNS OF THE SOLDER BALLS.
- GLASS: 0.550 THICKNESS; REFRACTIVE INDEX = 1.52.
- AIR GAP BETWEEN GLASS AND PIXEL ARRAY: 0.275 THICKNESS.
- PARALLELISM APPLIES ONLY TO THE ACTIVE ARRAY.
- MAXIMUM ROTATION OF ACTIVE ARRAY RELATIVE TO DATUMS A AND B IS  $\pm 1^\circ$ .
- REFER TO THE DEVICE DATA SHEET FOR TOTAL PIXEL ARRAY DEFINITIONS.
- PACKAGE CENTER (X, Y) = (0.000, 0.000).
- OPTICAL CENTER RELATIVE TO PACKAGE CENTER (X, Y) = (0.000, 0.000).
- PLAIN COVER GLASS WITHOUT AR COATING.

RECOMMENDED MOUNTING FOOTPRINT

\*For additional information on our Pb-Free strategy and soldering details, please download the onsemi Soldering and Mounting Techniques Reference Manual, SOLDERM/D.

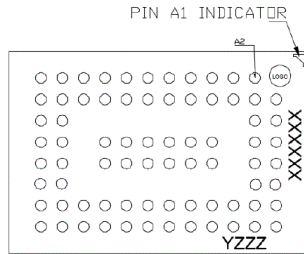
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**GENERIC  
MARKING DIAGRAM\***



XXXX = Specific Device Code  
Y = Year  
ZZZ = Lot Traceability

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

|                         |                                       |                                                                                                                                                                                  |
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