

# 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.

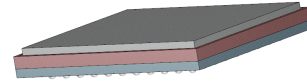
It incorporates sophisticated on-chip camera functions such as Wake on Motion (WOM), context switching and multiple subsampling modes. It is programmable through a simple I<sup>2</sup>C interface and has very low power consumption.

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  $\mu$ 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



PBGA78 13x10.5  
CASE 117CV

### ORDERING INFORMATION

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

## Non-NDA 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

## AR2020

- On-chip Temperature Sensor with  $\pm 5^{\circ}\text{C}$  accuracy
- On-chip Lens Shading Correction for RGB Bayer and Mono

**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 ( $1.7 < V_{\text{supply}} < 1.9$ V)                                                   |
|                                                               | Digital, PLL, MIPIphy  | 1.05 V ( $1.0 < V_{\text{supply}} < 1.1$ 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 °C to +85 °C                                                                             |
| Performance Specified Temperature Range (at junction) – $T_J$ |                        | 0 °C to +60 °C                                                                               |
| Package Options:                                              |                        | MPBGA-78 (13 mm x 10.5 mm)                                                                   |
| $\theta_{JA}$ (Note 1)                                        |                        | 30 °C/W                                                                                      |
| $\theta_{JB}$                                                 |                        | 18 °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

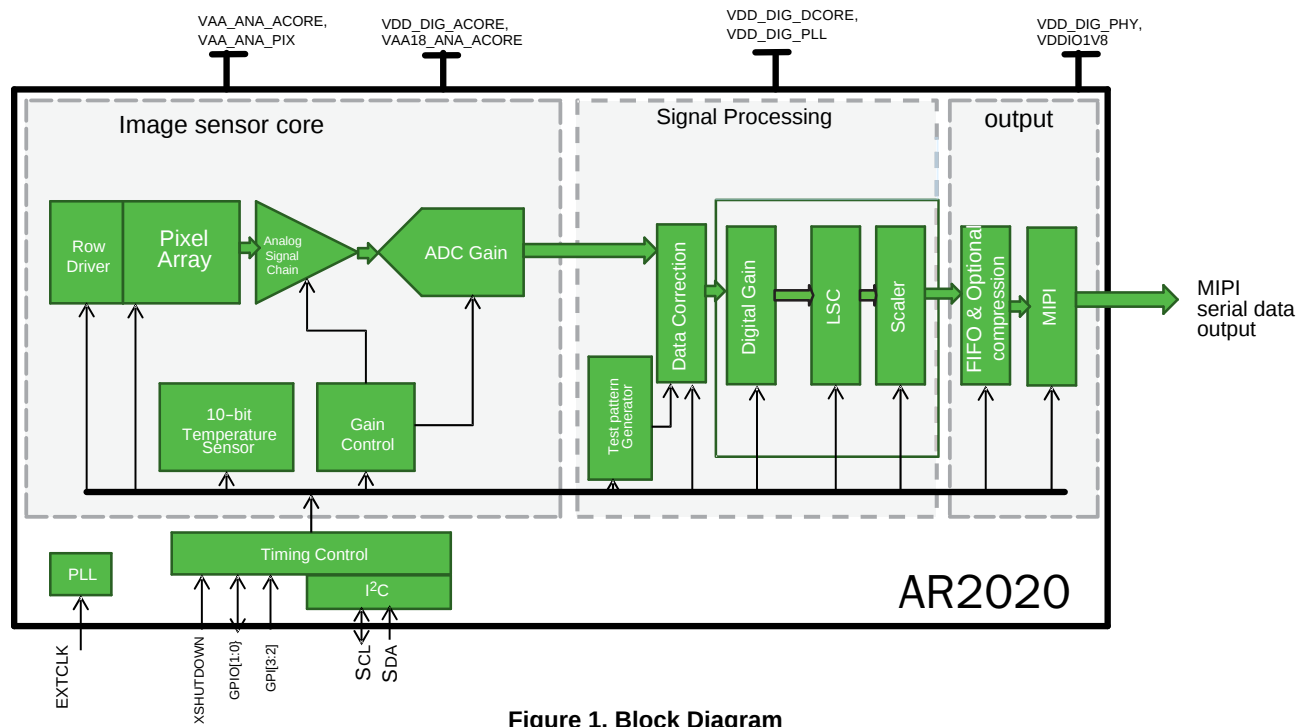
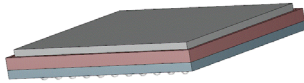
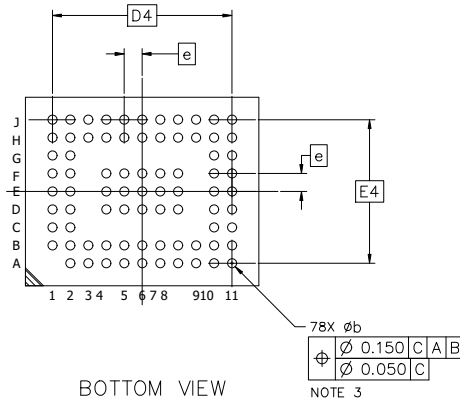
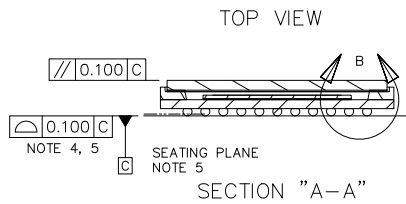
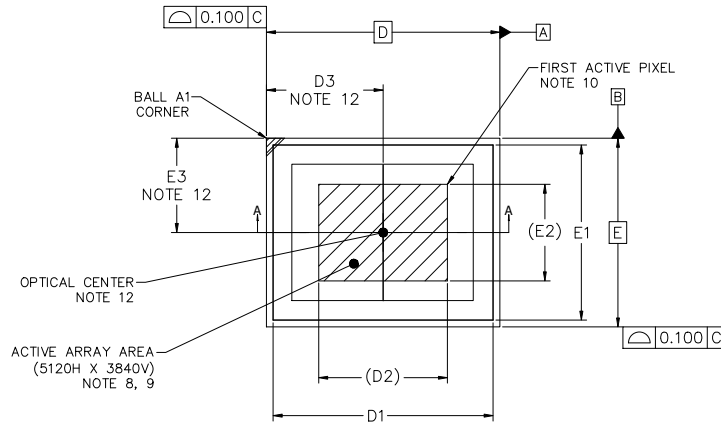


Figure 1. Block Diagram



**PBGA78 13.00x10.50x1.57, 1.00P**  
**CASE 117CV**  
**ISSUE A**

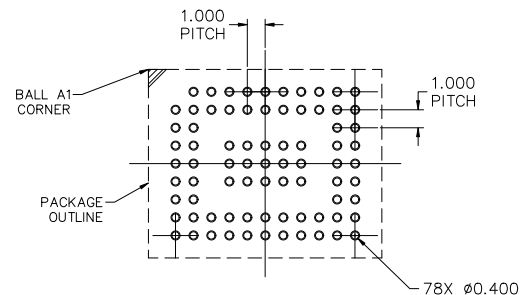
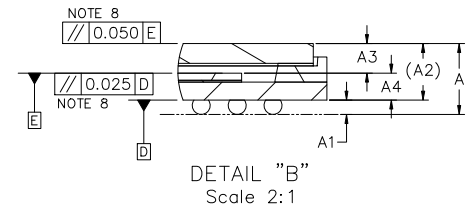
DATE 21 FEB 2025



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2018.
2. CONTROLLING DIMENSION: MILLIMETERS [mm].
3. SOLDER BALL DIAMETER IS MEASURED AT THE MAXIMUM SOLDER BALL DIAMETER PARALLEL TO DATUM C.
4. COPLANARITY APPLIES TO THE SPHERICAL CROWNS OF THE SOLDER BALLS.
5. DATUM C, THE SEATING PLANE IS DEFINED BY THE SPHERICAL CROWNS OF THE SOLDER BALLS.
6. GLASS: 0.550 THICKNESS; REFRACTIVE INDEX = 1.52.
7. AIR GAP BETWEEN GLASS AND PIXEL ARRAY: 0.275 THICKNESS.
8. PARALLELISM APPLIES ONLY TO THE ACTIVE ARRAY.
9. MAXIMUM ROTATION OF ACTIVE ARRAY RELATIVE TO DATUMS A AND B IS  $\pm 1^\circ$ .
10. REFER TO THE DEVICE DATA SHEET FOR TOTAL PIXEL ARRAY DEFINITIONS.
11. PACKAGE CENTER (X, Y) = (0.000, 0.000).
12. OPTICAL CENTER RELATIVE TO PACKAGE CENTER (X, Y) = (0.000, 0.000).

| 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  |        |        |



RECOMMENDED MOUNTING FOOTPRINT

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

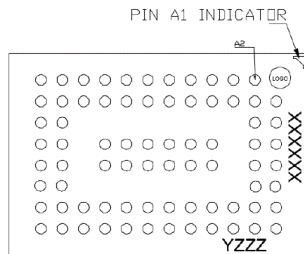
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**PBGA78 13.00x10.50x1.57, 1.00P**  
CASE 117CV  
ISSUE A

DATE 21 FEB 2025

**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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