AS5920M

Datasheet

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AS5920M 4-side buttable system-in-package solution

1 General description

The AS5920M is a 72x24 pixel, four-side buttable module solution for photon counting applied for spectral computed tomography detectors. The 1728-channel proprietary Buttable System-In-Package (BSIP) integrates three AS5920 photon counting ICs as well as passive components.

The BSIP allows on the top side to form electrical connections to the direct conversion CdTe or CZT sensor material, which converts each X-ray photon into charge pulses. The bottom side of the BSIP forms the digital interface to the FPGA, supply connections as well as the thermal heat dissipation to the carrier.

During a CT scan, the AS5920 IC counts the X-ray photon generated charge pulses with an amplitude proportional to the energy deposited by the photon. 576-channel per AS5920 discriminates the incoming photon energy by counting the number of pulses exceeding 5 different energy thresholds. The threshold levels are adjustable by 8-bit DACs with a step size of typ. 0.7 keV/LSB, the number of comparators enabled per channel are selectable for power optimizations. Lowest power dissipation with all 5 comparators enabled is as low as typ. 0.64 mW/pixel in non-paralyzable mode having BLR enabled and typ. 0.58 mW/pixel in paralyzable mode with only static leakage compensation.

A 15-bit counter register accumulates the comparator output events and transmits 14/16-bit LVDS data within an integration time of minimum 104 µs. During its maximum frame rate of 9615 Fps, the AS5920 transfers the output data via a high-speed LVDS interface to the FPGA, the device operates up to an input count rate of 250 Mcps per pixel (2 Gcps/mm²). The AS5920 has both paralyzable and non-paralyzable counting mode implemented that are selectable via SPI. In paralyzable mode, it allows for a maximum output count rate of 15 Mcps/pixel (120 Mcps/mm²) at 25 keV and exceeding 40 Mcps/pixel (>320 Mcps/mm²) in non-paralyzable mode.

The signal chain of the AS5920 with its low-noise charge sensitive amplifier (CSA) and its high-speed shaper allows for lowest electronic noise of 330 electrons resulting in an ASIC-intrinsic energy resolution of the measured photon of 3.5 keV FWHM.

The photon counting IC AS5920 features an on-chip voltage reference and internal temperature sensor and is embedded in the AS5920M. The AS5920M is delivered as 1728-channel, 4-side buttable module integrating three ICs in one 24.52 mm x 8.75 mm Buttable

System-In-Package (BSIP). Pixel sizes of the BSIP are 341 µm x 365 µm and customizable for pixel pitch of 340 µm and above. The performance temperature range of AS5920 and AS5920M is specified from 20°C to 70°C.

1.1 Key specifications & features

The benefits and features of AS5920M, B-Samples, are listed below:

Table 1: Key benefits & features

Benefits	Features
4-Side Buttable System-In-Package (BSIP) 1728-channel in 24.52 mm x 8.75 mm	Unique module assembly concept of BSIP No external components required.
Paralyzable and non-paralyzable counting mode integrated and selectable via SPI	Three ASICs and passive components embedded in BSIP
15-bit counting depth up to an input count rate of 250 Mcps per pixel (2 Gcps/mm²)	BSIP pixel size of 341 µm x 365 µm. Package customizable for pixel pitches of 340 µm and above
Highest output count rate of 15 Mcps/pixel (120 Mcps/mm²) in paralyzable model and typ. 40 Mcps/pixel (320 Mcps/mm²) in non-paralyzable mode	Ease-of-use, no ASIC specific calibrations required
Ultra-low noise down to 330 electrons for an energy resolution of about 3.5 keV FWHM	Applicable for all electron collection type of direct conversion materials
Lowest power dissipation with all 5 comparators down to typ. 0.64 mW/pixel in non-paralyzable mode and 0.58 mW/pixel in paralyzable mode	Adjustable number of thresholds for power optimization
Up to 5 selectable comparators with 8-bit adjustable thresholds for 0.7 keV/LSB	Adjustable integration time, maximum frame rate up to 9615 Fps
Fast shaper pulse width of typ. 15 ns FWHM	Static leakage compensation of 250 nA and dynamic compensation of up to 700 nA in high range mode
Configurable equivalent dead time for non-paralyzable mode	On-chip voltage reference and temperature sensor

1.2 Applications

- Photon-counting CT
- Medical, industrial and security X-ray detectors

Photon counting CT in comparison to conventional energy integrating CTs will allow for significantly reduced radiation dose, higher image resolution and spectral imaging. X-ray

detectors based on photon counting, count the number of incoming photons and measure their energy, thus eliminates the electronic noise and enables energy discrimination.

1.3 Block diagram and module solution

The functional blocks of this device are shown below:

Figure 1: Functional blocks of AS5920M

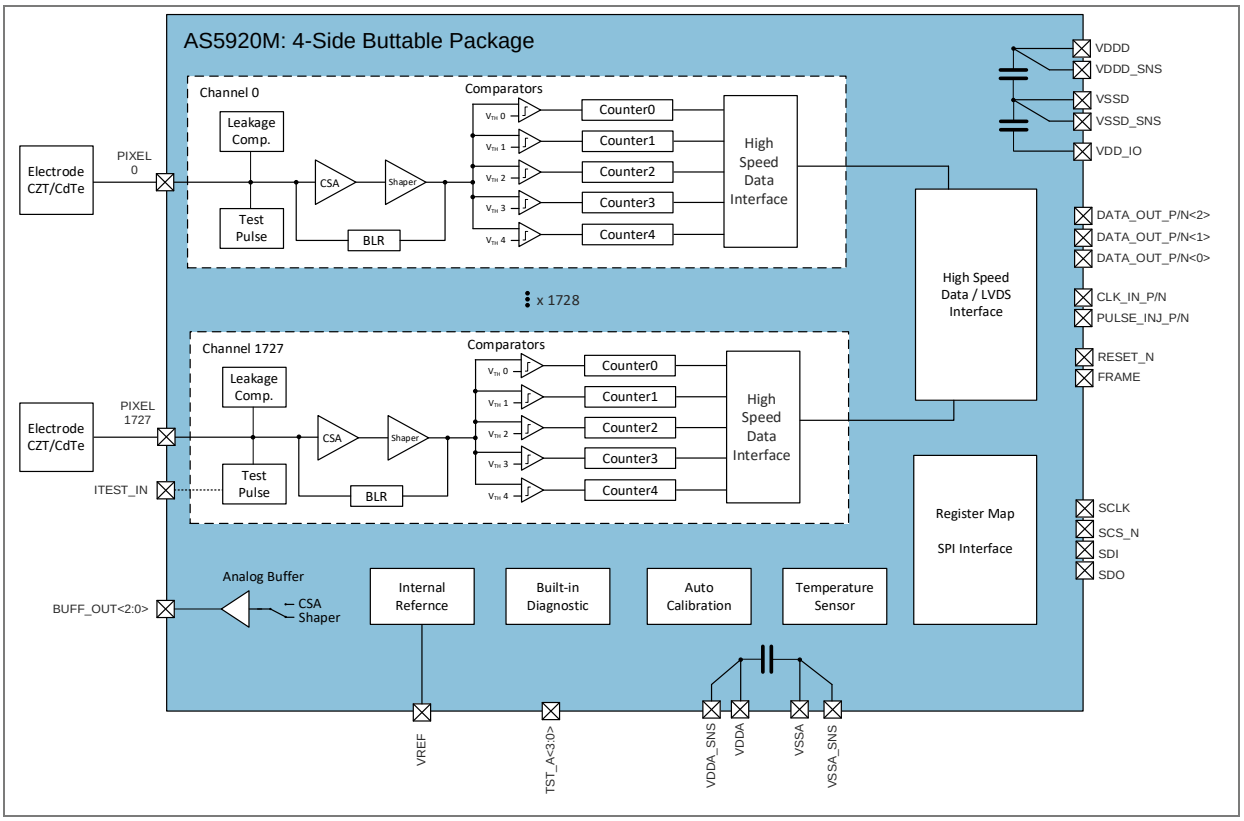


Figure 2: AS5920M – top view of module

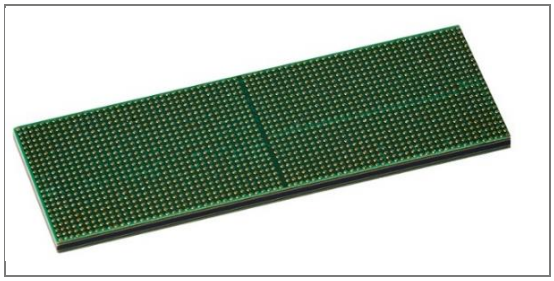
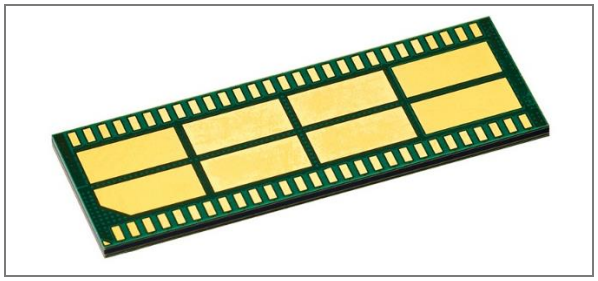


Figure 3: AS5920M – bottom view of module



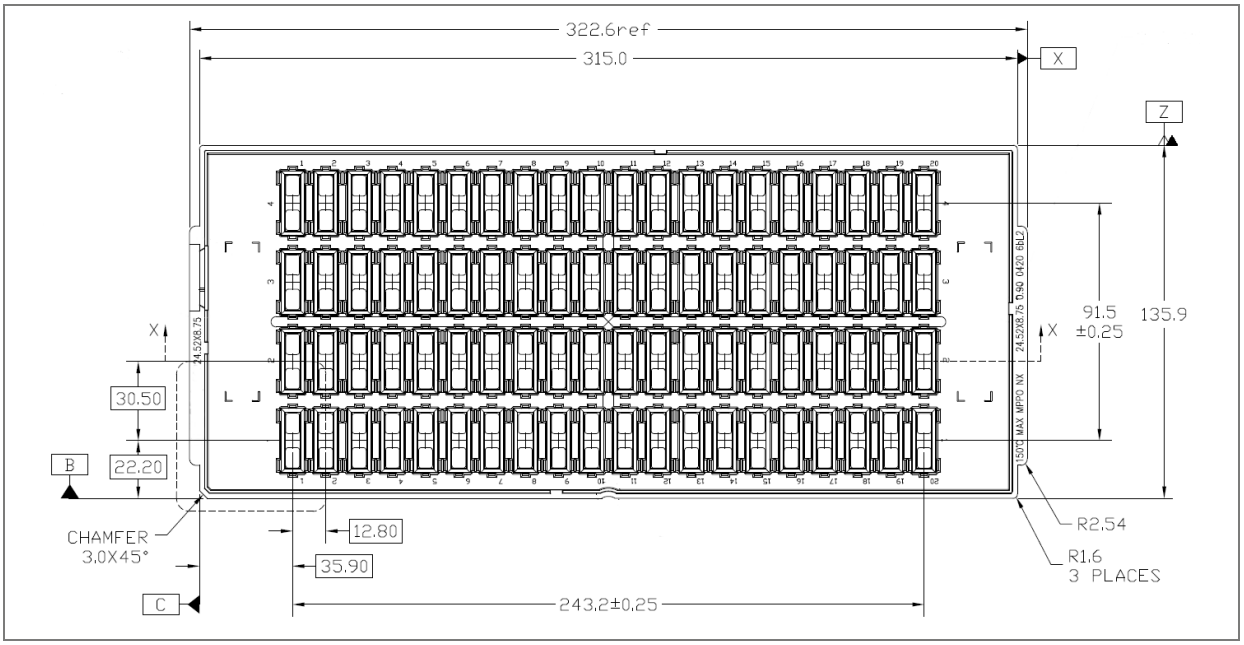
2 Ordering information

Ordering code	Package	Delivery form	Delivery quantity
AS5920M	BSIP 24.52 mm x 8.75 mm	Trays	80 pcs / tray

3 Delivery information

BSIPs are delivered in JEDEC trays where the pixel side is facing upwards, pin 1 indicator is pointing to the chamfered corner of the tray.

Figure 4: Tray dimensions of AS5920M(1)



(1) All dimensions in millimeters. BSIPs are pointing to chamfer direction.

4 Appendix

Table 2: Abbreviations

Term	Description
AS5920	Single die having 576-pixel
AS5920M	M for Module solution, BSIP with 1728-pixel having embedded three die of AS5920
CSA	Charge Sensitive Amplifier
BSIP	Buttable System In Package
WL-CSP	Wafer Level Chip Scale Package
BLR	Baseline Restorer
CZT	Cadmium Zinc Telluride
CdTe	Cadmium Telluride
DIE	AS5920, Single IC, 3 die assembled in AS5920M
ADC	Analog-to-Digital Converter
DAC	Digital-to-Analog Converter
LVDS	Low Voltage Differential Signaling
SPI	Serial Peripheral Interface
IP	Integration Period
OTP	One Time Programmable
RH	Relative Humidity

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This short datasheet is derived from the full datasheet v1-00	

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