CMOS MT9D112 Camera Module

1/4-Inch 3-Megapixel Module Datasheet

Rev 1.0, Mar 2013

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1 Introduction

The MT9T112 has a color image sensor with a Bayer color filter arrangement and a 3.1Mp active-pixel array with electronic rolling shutter (ERS). The sensor core readout is 10-bit, supports skipping and binning, and can be flipped and/or mirrored. The sensor core also supports separate analog and digital gain for all four color channels (R, Gr, Gb, B).

The MT9T112 also has an embedded phase-locked loop oscillator (PLL) that can generate the internal sensor clock from the common clock signals available in typical mobile phone systems. When in use, the PLL adjusts the incoming clock frequency up, allowing the MT9T112 to run at almost any desired resolution and frame rate within the sensor's capabilities. The PLL can be bypassed and powered down to reduce power consumption.

The MT9T112 has numerous power-conserving features including a soft standby mode and a hard standby mode. In standby mode, the sensor can be configured to consume less power than normal operation, with the option of retaining the internal configuration settings. By default, entering standby disables the internal VDD power rail. The MT9T112 can be used with the parallel data output interface, which has a programmable I/O slew rate to minimize EMI and an output FIFO to eliminate output data bursts. JPEG format can be output in both the MIPI and the parallel data output interfaces. The advanced image flow processor (IFP) and flexible programmability of the MT9T112 provide a variety of ways to enhance and optimize the image sensor performance. Builtin optimization algorithms enable the MT9T112 to operate at factory settings as a fully automatic, highly adaptable camera; however, most of its settings are user-programmable. These algorithms include black level conditioning, shading correction, defect correction, noise reduction, color interpolation, color correction, aperture correction, and image formatting such as cropping and scaling.

The MT9T112 also includes a sequencer that coordinates all events triggered by the user. The sequencer manages auto focus, auto white balance, flicker detection, anti-shake, and auto exposure for the different operating modes, which include preview, still capture, video, and snapshot with flash. All modes of operation are individually configurable and are organized as two contexts. A context is defined by sensor image size, frame rate, resolution, and other associated parameters. The user can switch between the two contexts by sending a command through the two-wire serial interface. A two-wire serial register interface bus enables read/write access to control registers, variables, and special function registers within the MT9T112. The hardware registers include sensor core controls, color pipeline controls, and output controls. The general purpose I/Os can be configured to allow the user extended platform functionality or achieve a 10-bit parallel Bayer output.

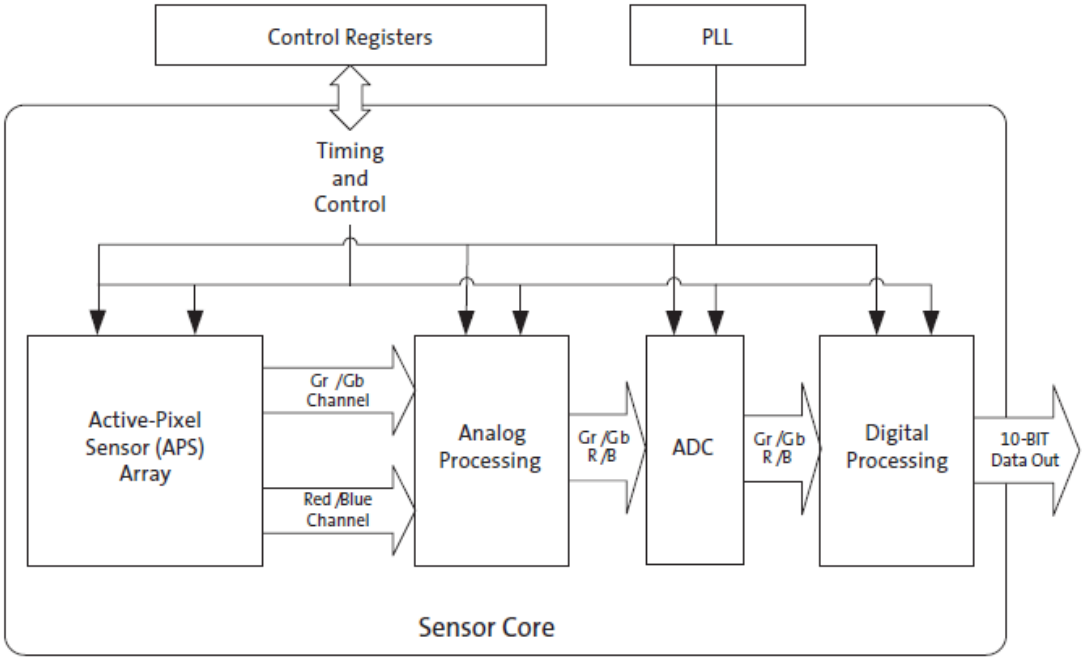
2 Features

- DigitalClarity™ CMOS imaging technology
- Superior low-light performance
- Ultra-low-power, low-cost
- Dual camera bridging support with MT9V013
- Anti-shake support
- One time programmable (OTP) memory for automatic positional gain adjustments
- Parallel data output and serial mobile industry processor interface (MIPI) data output
- Integrated real-time JPEG encoder
- Flexible support for external auto focus, optical zoom, and mechanical shutter
- Internal master clock generated by on-chip phase-locked loop (PLL) oscillator
- Electronic rolling shutter (ERS), progressive scan
- Integrated image flow processor (IFP) for single-die camera module
- Automatic image correction and enhancement
- Selectable output data format: YCbCr, 565RGB, 555RGB, 444RGB, JPEG 4:2:2, processed Bayer, RAW8- and RAW10-bit
- Output FIFO for data rate equalization
- Programmable I/O slew rate
- Xenon and LED flash support with fast exposure adaptation
- Configurable gamma correction based on scene brightness
- Arbitrary image scaling with anti-aliasing
- Two-wire serial interface providing access to registers and microcontroller memory

3 Key Specifications

Parameter		Value
Optical format		1/4-inch (4:3)
Full resolution		2048 x 1536 pixels (QXGA)
Pixel size		1.75µm x 1.75µm
Dynamic range		67.4dB (preliminary)
SNR MAX		38dB (preliminary)
Responsivity		0.44 V/lux-sec (preliminary)
Chief ray angle		24.99° MAX at 80% image height
Color filter array		RGB Bayer pattern
Active pixel array area		3.62mm x 2.72mm
Shutter type		Electronic rolling shutter (ERS)
Input clock frequency		6–54 MHz
Maximum frame rate		15 fps at full resolution (JPEG), 30 fps in preview mode
Maximum pixel data output		48 Mp/s
Maximum pixel clock frequency		96 MHz
Supply voltage	Analog	2.5–3.1V
	Digital	1.7–1.95V
	I/O	1.7–3.1V
	PLL	2.5–3.1V
	MIPI	1.7–1.95V
ADC resolution		10-bit, on-die
Power consumption		377.4mW at 15 fps, full resolution mode
		355mW at 30 fps, preview mode
Current consumption		20µA, standby, at +70°C
Operating temperature (at junction)		–30°C to +70°C

4 Block Diagram

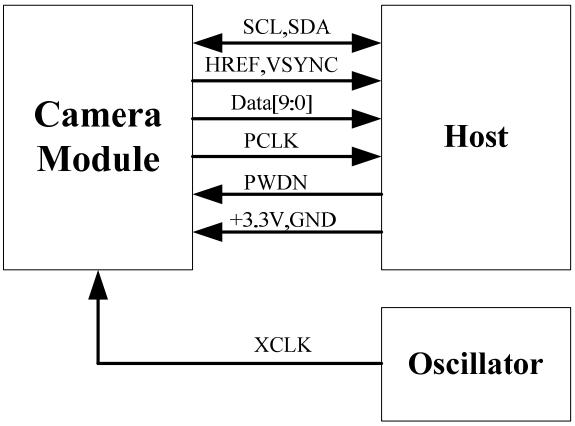


Note: MT9T112 camera module only support DVP interface, it doesn't support MIPI interface.

5 Application

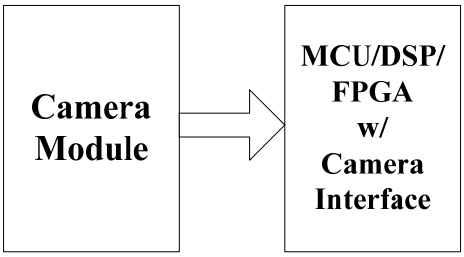
- Cellular phones
- PDAs
- Toys
- Other battery-powered products
- Can be used in Arduino, Maple, ChipKit, STM32, ARM, DSP, FPGA platforms

The following schematic diagram show a basic camera based system. The camera module is powered from a single +3.3V power supply. An external oscillator provide the clock source for camera module XCLK pin. With proper configuration to the camera internal registers via I2C bus, then the camera supply pixel clock (PCLK) and camera data (Data[9:0]) back to the host with synchronize signal like HREF and VSYNC.

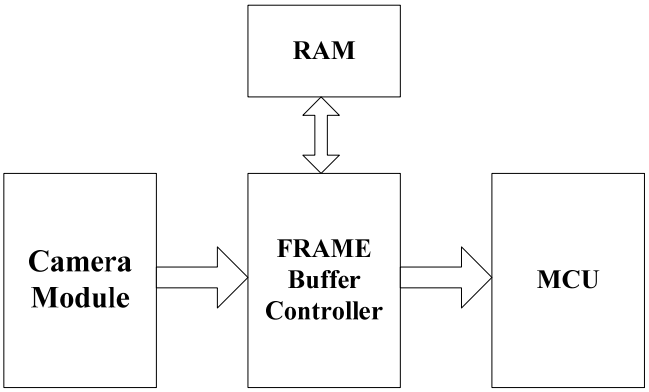


The host may have integrate camera interface like STM32F2 or STM32F4 series MCUs, or

ARM9/11 which has dedicate camera port, and DPS like TI TMS320DM series, as well as FPGAs that user can design special logic for camera application. The typical connection between these system and camera module would show like following diagram.



For the host that doesn't have a dedicate camera interface, additional hardware is needed. User need to buffer a entire frame before read them out with low speed MCUs. For example ArduCAM shield is a additional hardware that can be connected to Arduino UNO/Mega board, user can take a photo or something like that easily. The following diagram show the system without dedicate camera interface.



6 Pin Definition

Pin No.	PIN NAME	TYPE	DESCRIPTION
1	VCC	POWER	3.3v Power supply
2	GND	Ground	Power ground
3	SCL	Input	Two-Wire Serial Interface Clock
4	SDATA	Bi-directional	Two-Wire Serial Interface Data I/O
5	VSYNC	Output	Active High: Frame Valid; indicates active frame
6	HREF	Output	Active High: Line/Data Valid; indicates active pixels
7	PCLK	Output	Pixel Clock output from sensor
8	XCLK	Input	Master Clock into Sensor
9	DOUT9	Output	Pixel Data Output 9 (MSB)
10	DOUT8	Output	Pixel Data Output 8
11	DOUT7	Output	Pixel Data Output 7
12	DOUT6	Output	Pixel Data Output 6
13	DOUT5	Output	Pixel Data Output 5
14	DOUT4	Output	Pixel Data Output 4
15	DOUT3	Output	Pixel Data Output 3
16	DOUT2	Output	Pixel Data Output 2 (LSB)
17	PWDN	Input	Power down
18	RSV	NC	Reserved
19	DOUT1	Output	Pixel Data Output 1(10bit mode)
20	DOUT0	Output	Pixel Data Output 0 (10bit mode)

7 Mechanical Dimension