CMOS MT9D111Camera Module

1/3.2-Inch 2-Megapixel Module Datasheet

Rev 2.0, Nov 2018

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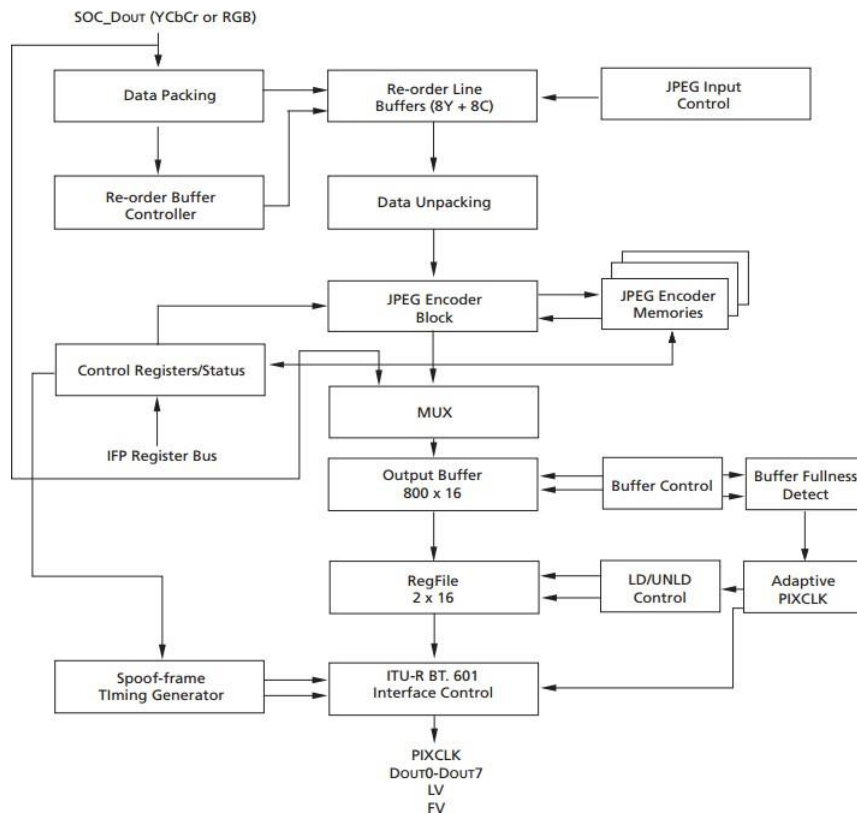**www.ArduCAM.com**

1   Introduction

Micron® Imaging MT9D111 is a 1/3.2 inch 2-megapixel CMOS image sensor with an integrated advanced camera system. The camera system features a microcontroller (MCU) and a sophisticated image flow processor (IFP) with a real-time JPEG encoder. It also includes a programmable general purpose I/O module (GPIO), which can be used to control external autofocus, optical zoom, or mechanical shutter.

The microcontroller manages all components of the camera system and sets key operating parameters for the sensor core to optimize the quality of raw image data entering the IFP. The sensor core consists of an active pixel array of 1668 x 1248 pixels, programmable timing, and control circuitry including a PLL and external flash support, an analog signal chain with automatic offset correction and programmable gain, and two 10-bit A/D converters (ADC). The entire system-on-a-chip (SOC) has ultra-low power requirements and superior low-light performance that is particularly suitable for mobile applications. The excellent low-light performance of MT9D111 is one of the hallmarks of DigitalClarity™— Micron's breakthrough low-noise CMOS imaging technology that achieves CCD image quality (based on signal-to-noise ratio and low-light sensitivity) while maintaining the inherent size, cost, power consumption, and integration advantages of CMOS.

2   Features

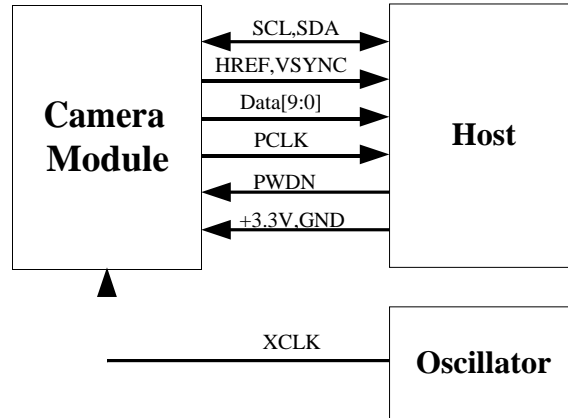| Parameter		Value
Optical format		1/3.2-inch (4:3)
Full resolution		1,600 x 1,200 pixels (UXGA)
Pixel size		2.8μm x 2.8μm
Active pixel array area		4.73mm x 3.52mm
Shutter type		Electronic rolling shutter (ERS) with global reset
Maximum frame rate		15 fps at full resolution, 30 fps in preview mode, (800 x 600)
Maximum data rate/ master clock		80 MB/s 6 MHz to 80 MHz
Supply voltage	Analog	2.5V–3.1V
	Digital	1.7V–1.95V
	I/O	1.7V–3.1V
	PLL	2.5V–3.1V
ADC resolution		10-bit, on-die
Responsivity		1.0/lux-sec (550nm)
Dynamic range		71dB
SNR$_{MAX}$		42.3dB
Power consumption		348mW at 15 fps, full resolution
		223mW at 30 fps, preview mode
Operating temperature		-30°C to +70°C
Package		Bare die, 64-ball iCSP

3 Diagram

4 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 shows a basic camera-based system. The camera module is powered from a single +3.3V power supply. An external oscillator provides the clock source for camera module XCLK pin. With a 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 synchronizing signals like HREF and VSYNC.

```
                   SCL,SDA
              ┌──────────────┐
  ┌─────────┐ │  HREF,VSYNC  │ ┌─────────┐
  │         ├─┤              │ │         │
  │ Camera  │ │   Data[9:0]  │ │  Host   │
  │ Module  │ │     PCLK     │ │         │
  │         │ │     PWDN     │ │         │
  │         ├─┤  +3.3V,GND   ├─┤         │
  └────┬────┘ └──────────────┘ └─────────┘
       ▲
              XCLK            ┌────────────┐
  ───────────────────────────┤ Oscillator │
                             └────────────┘
```
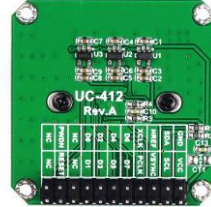
The host may have integrated camera interface like STM32F2 or STM32F4 series MCUs or ARM9/11 which has dedicated camera port, and DPS like TI TMS320DM series, as well as FPGAs that user can design special logic for camera application. The typical connection between these system and camera module would show as the following diagram.

```
  ┌─────────┐       ┌────────────┐
  │         │       │  MCU/DSP/  │
  │ Camera  │ ═════▶ │   FPGA     │
  │ Module  │       │    w/      │
  │         │       │  Camera    │
  │         │       │ Interface  │
  └─────────┘       └────────────┘
              ┌─────────┐
              │   RAM   │
              └─────────┘
                   ▲
                   ▼
  ┌─────────┐ ┌─────────┐ ┌─────────┐
  │ Camera  │ │  FRAME  │ │         │
  │ Module  │▶│ Buffer  │▶│   MCU   │
  │         │ │Controller│ │        │
  └─────────┘ └─────────┘ └─────────┘
```

For the host that doesn't have a dedicated camera interface, additional hardware is needed. The user needs to buffer an entire frame before reading them out with low-speed MCUs. For example, ArduCAM shield is additional hardware that can be connected to Arduino UNO/Mega board, and the user can take a photo or something like that easily. The following diagram shows the system without dedicate camera interface.
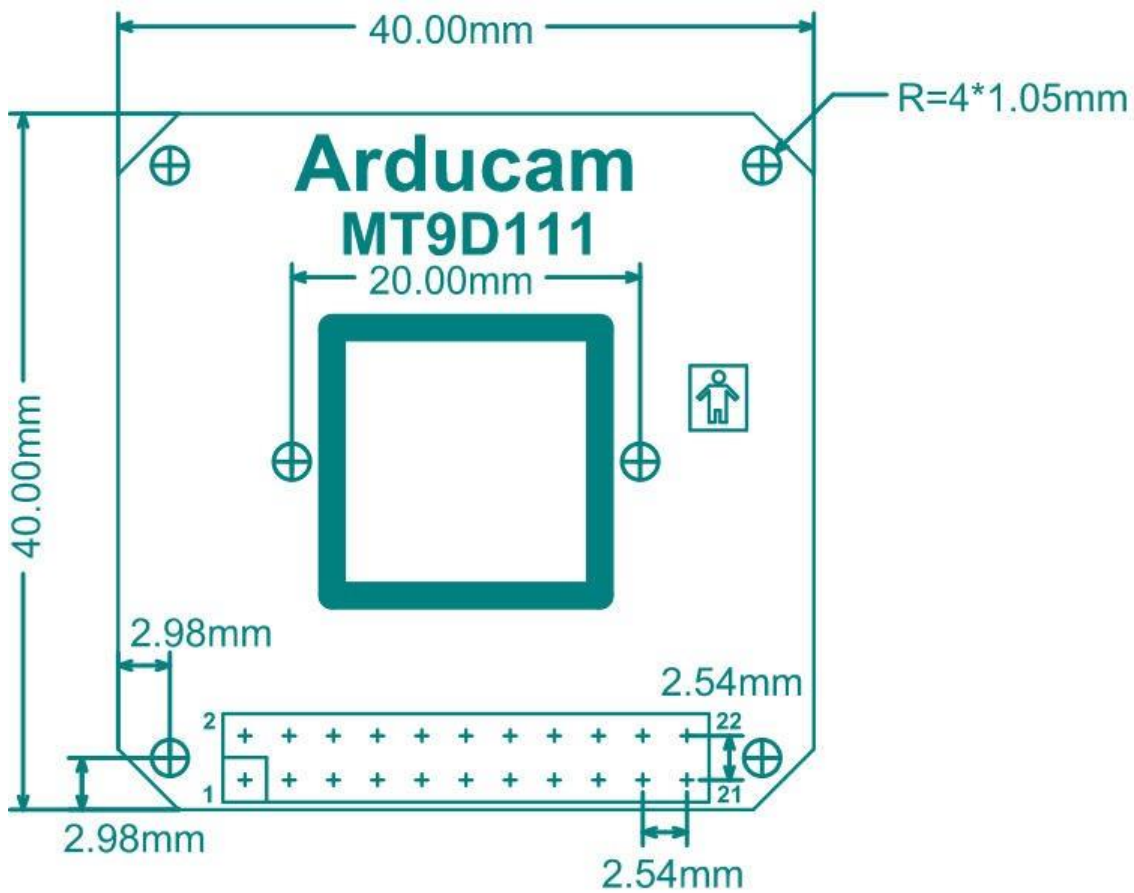
5 Pin Definition

The MT9D111 module uses standard ArduCAM camera pinout. The pin number is listed as bellows.

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	DOUT7	Output	Pixel Data Output 7
10	DOUT6	Output	Pixel Data Output 6
11	DOUT5	Output	Pixel Data Output 5
12	DOUT4	Output	Pixel Data Output 4
13	DOUT3	Output	Pixel Data Output 3
14	DOUT2	Output	Pixel Data Output 2 (LSB)
15	DOUT1	Output	Pixel Data Output 1(10bit mode)
16	DOUT0	Output	Pixel Data Output 1(10bit mode)
17	NC	-	-
18	NC	-	-
19	PWDN	Input	Power down
20	RESET	Input	Reset, active low
21	NC	-	-
22	NC	-	-

6   Mechanical Dimension

2	GND	SDA	HREF	XCLK	D6	D4	D2	D0	NC	PWDN	NC	22
1	VCC	SCL	VSYNC	PCLK	D7	D5	D3	D1	NC	RESET	NC	21