
**PAC207B SINGLE-CHIP CIF CMOS IMAGE SENSOR
WITH USB INTERFACE**

1. GENERAL DESCRIPTION

The PAC207B is a single chip CMOS image sensor embedded with an USB 1.1 interface and image compression function. The PAC207B is suitable for low-cost high performance PC camera applications. It integrates on-chip power regulators to transfer the 5V voltage from USB host power to proper voltage levels to supply the CMOS sensor and analog and digital circuitry. Hence there is no need to have external power regulator on the PCB. All the image processing functions, interpolation, auto exposure, auto white balance, de-flickering and sharpness, are performed by software in PC side. The optical size is 1/7", which can easily be embedded into LCD monitors, notebooks or PDA.

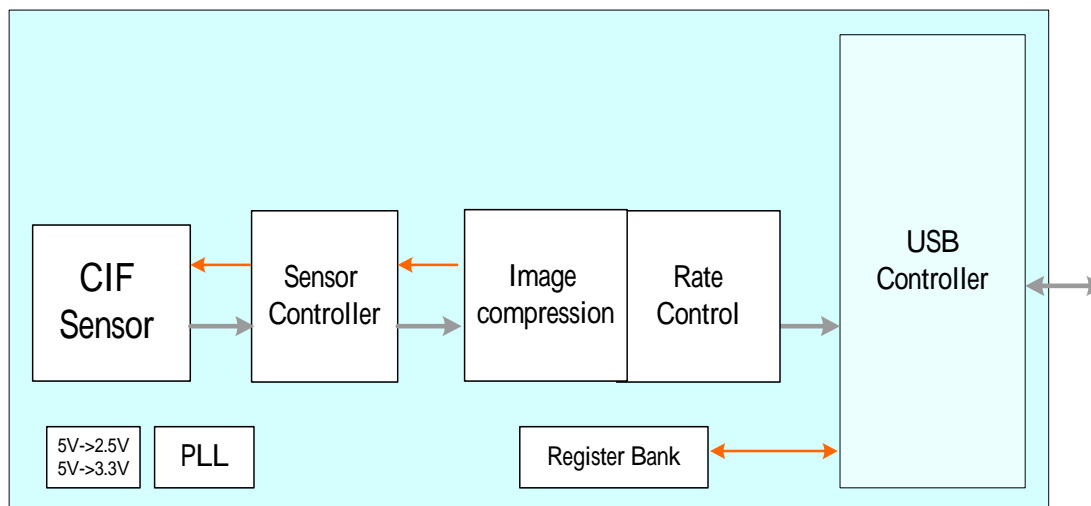
Key Specification of Electrical and Optics

- Power supply: +5V (Default)
- Sensor array: 352 x 288.
- Frame rate: up to 30fps.
- Pixel Size: 5.6um x 5.6um.
- Crystal frequency: 12MHz(Default)
- S/N ratio: 35dB.
- Power consumption: < 25mA.
- PGA gain: 31.6 dB max
- Sensitivity: 190 Level/lux-sec (Green pixel)
- Exposure time: frame time ~ 1/160000
- Optical format: 1/7"
- Color filter: RGB Bayer Pattern
- Scan mode: Progressive
- Package: 32-pin LCC

2. FEATURES

- 12Mhz or 6Mhz crystal in for on-chip PLL, to generate 48Mhz
- Embedded 1/7", 5.6um x 5.6um CIF CMOS image sensor, with 0.25um process technology
- On-chip 10-bit ADC
- Programmable sensor control through USB control pipe.
- Support video data transfer through USB isochronous pipe.
- Snapshot control through USB interrupt pipe.
- Frame Rate:
 - Up to 24fps @CIF format (352x288) with lossy compression, with 8 Mbps USB bandwidth
 - Up to 24fps @QVGA format (320x240) with lossy compression, with 8 Mbps USB bandwidth
 - Up to 30fps @QCIF format (176x144) without compression, with 5.6~6 Mbps USB bandwidth
 - Up to 30fps @QQVGA format (160x120) without compression, with 5.6~6 Mbps USB bandwidth
- Auxiliary image processing:
 - Synchronized color gain setting and gain parameter control.
 - Exposure measurement report (center area & outer area of window).
- Output frame number identify, full frame identify, AE/AG updating identify, compression codebook reassignment identify.
- Supported USB suspend mode
- USB Vendor ID, Product ID, device release number, maximum power consumption and string descriptor can be set by a serial EEPROM (93C46A 16bit) or by metal mask.
- USB 5V power in, on-chip 3.3V regulator for Sensor, on-chip 2.5V regulator for core logic
- 6 IO-trapping pins to set product ID and max power consumption (100mA or 500mA).
- Embed micro-wire controller to support external EEPROM (93C46A 16bit) for customized Vendor ID, Product ID, device release number, max power consumption, product string, manufacturer string, sensor parameters, etc.
- Single power supply from USB cable
- Package: 32 Pin, dimension: 9mm x 9mm
- Power consumption: < 25mA

3. BLOCK DIAGRAM



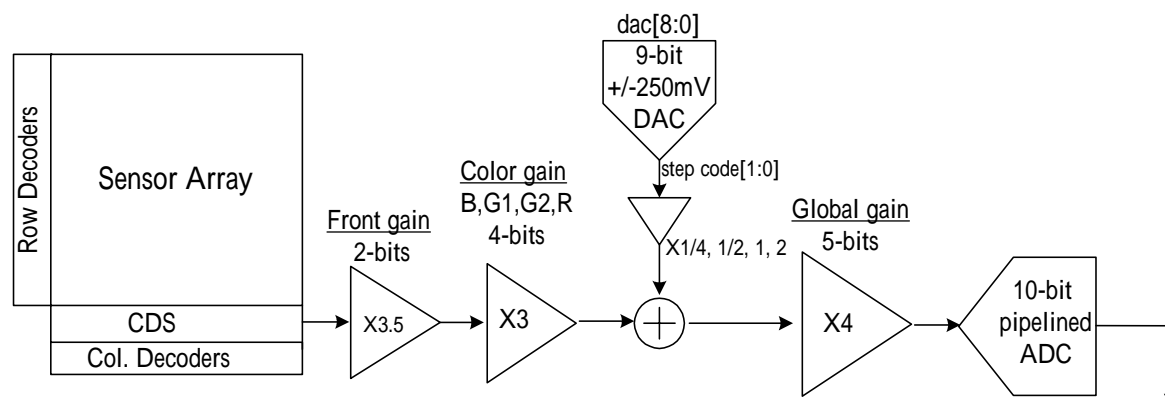
PAC207B is a single-chip USB camera. It includes a CIF sensor based on Pixart PAS106 with enhanced image quality and sensitivity, a 48MHz PLL, internal regulators, proprietary image compression, image processing schemed, control registers, on-chip SRAM for image data buffer and USB controller. All register parameters are set by USB interface. And the compressed image data is transmitted by USB 1.1 isochronous pipe.

4. PIN ASSIGNMENT

Pin No.	Name	Type	Description
1	VSSA	GND	Analog GND
2	VRB	Bypass	Analog voltage reference
3	VCM	Bypass	Analog voltage reference
4	VRT	Bypass	Analog voltage reference
5	Vdday2	PWR	Sensor Readout power
6	Vdday1	PWR	Sensor reset power
7	VSSAY	GND	Sensor GND
8	EPR_DO	I	Data output of EEPROM; (IO Trap pin for PID4)
9	EPR_SK	O	Serial clock for EEPROM; (IO Trap pin for PID3)
10	EPR_DI	O	Data input of EEPROM; (IO Trap pin for PID1)
11	PID0	I	(IO Trap pin for PID0)
12	LED	O	LED driver; (IO Trap pin for max power select, 0/1: 500mA/100mA)
13	Xtal0	I	Bios selection of crystal oscillator circuit
14	EPR_EnH	I	Enable signal of EEPROM
15	IOTrap_EnL	I	I/O trap enable signal (0: enable, 1: disable)
16	EPR_CS	O	Chip select of EEPROM; (IO Trap pin for PID2)
17	VSSA	GND	Analog ground
18	VDDM	PWR	Main power, (5V when on-chip regulator enable)
19	VDD2P5	Bypass	Power for core logic, 2.5V
20	KEY#	I	Snapshot control signal (Active Low)
21	Test_EnH	I	Test mode enable, "1" to enable
22	RST#	I	RST_ when P-cam power-up
23	VSSQ	GND	Ground for I/O and PHY
24	DN	Bi-	DN for USB1.1 PHY
25	VDDQ	PWR	Power for I/O and PHY
26	DP	Bi-	DP for USB1.1 PHY
27	XIN	CLK	Crystal IN
28	XOUT	CLK	Crystal OUT
29	VDDP	PWR	Analog power for PLL, bypass when internal regulator enable.
30	VDDD	PWR	Logic power for mixed-mode circuit, bypass when internal regulator
31	VDDA	PWR	Analog power for AD/DA/PGA, bypass when internal regulator enable
32	VDDM	PWR	Main power, (5V when on-chip regulator enable)

5. FUNCTIONAL DESCRIPTION

5.1 ANALOG DATA PATH



PAC207B embedded a high quality CMOS image sensor with Pixart advanced sensor structure. With correlated-double-sampling (CDS) circuit, it cancelled the column-wise fixed pattern noise (FPN) and pixel mismatch at sensing node for each pixel. Hence PAC207B can deliver a clean image quality.

With a progressive scanning timing, the analog pixel signal is transferred into “Front-Gain” stage. Then transferred the pre-amplifier analog signal into programmable gain amplifier (PGA). Then ADC will convert the analog signal into a 10 bit digital code.

The gain stage can be set by digital register setting, please refer to the following equation to get the mapping gain.

$$\begin{aligned}
 \text{Front Gain} &= 2^{+(n/2)}, & n &= 0, 1, 2, 3 \\
 \text{Color Gain} &= 1^{+(m/8)}, & m &= 0, 1, 2, \dots, 15 \\
 \text{Global Gain} &= 1^{+(q/10)}, & q &= 0, 1, 2, \dots, 31
 \end{aligned}$$

5.2 IMAGE COMPRESSION

PAC207B utilize the PixArt proprietary compression algorithm to maintain the balance between image quality and frame rate. PAC207B also supported a unique frame sync & frame header identity, which indicates the frame start information and the frame properties, then followed a compressed data line by line.

Operation Modes

1. Excellent Quality
2. High quality
3. Normal quality
4. High compression
5. Bandwidth release

Decision priority of compression mode selection

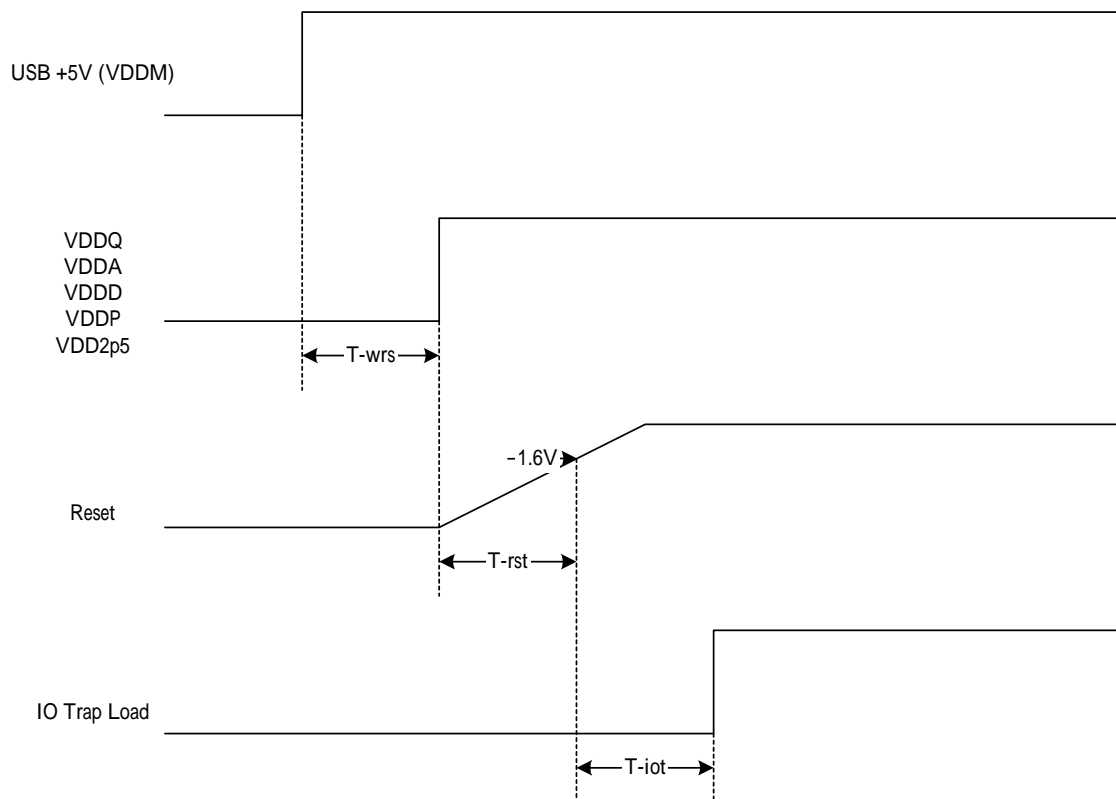
The PAC207B utilized a multiple mode image compression algorithm with an advanced rate control scheme to get the best image quality under different USB bandwidth or image complexity. By setting the register of address 66~74, the PAC207 can adjust the data rate of compressed image data while maintain a good image quality. When CMOS sensor running at a slow frame rate as low-luminance condition, the compression can easily switch to raw data mode, which has minimum compression errors.

5.3 USB VIDEO ISO_IN ALTERNATE SETTING

Alternate setting	0	1	2	3	4	5	6	7	8
Max packet size (Bytes) of ISO-IN pipe	0	128	256	384	512	640	768	896	1023

When the device is plugged, the driver will allocate bandwidth by USB host controller status. The “Alternate setting” and “Max Packet size of ISO-IN pipe” will be set as much as possible depend on the available bandwidth. The alternate-setting table is shown all bandwidth option above.

5.3 Power on sequence



	Min	Typical	Max
T-wrs : Wait Regulator Stable Time		3ms	
T-rst : Reset Time	10ms	30ms	50ms
T-iot : IO Trap Setup Time	666.67ns		

6. DC and AC CHARACTERISTICS

Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Unit
VDDM	DC supply voltage	-0.5	5.5	V
Vin	DC input voltage	0.5	3.8	V
Vout	DC output voltage	-0.5	3.8	V
Tstg	Storage temperature	0	70	

DC Electrical Characteristics (VDD=3.3V±5%, Ta=0°C~40°C)

Symbol	Parameter	Min.	Typ.	Max.	Unit
Type :PWR					
VDDM	Main power from USB cable	4.5	5.0	5.5	V
IDD	Operating Current	20	25	30	mA
Type :IN & I/O Reset and SYSCLK					
VIH	Input voltage HIGH	2.0		VDDQ	V
VIL	Input voltage LOW	0		0.8	V
Cin	Input capacitor			10	pF
Ilkg	Input leakage current			1.0	uA
Type : OUT & I/O for PXD0:9, PXCLK, H/VSYN & SDA, load 10pf, 1.2k , 3.3volts					
VOH	Output voltage HIGH	Vddq-0.2			V
VOL	Output voltage LOW			0.2	V

AC Operating Condition

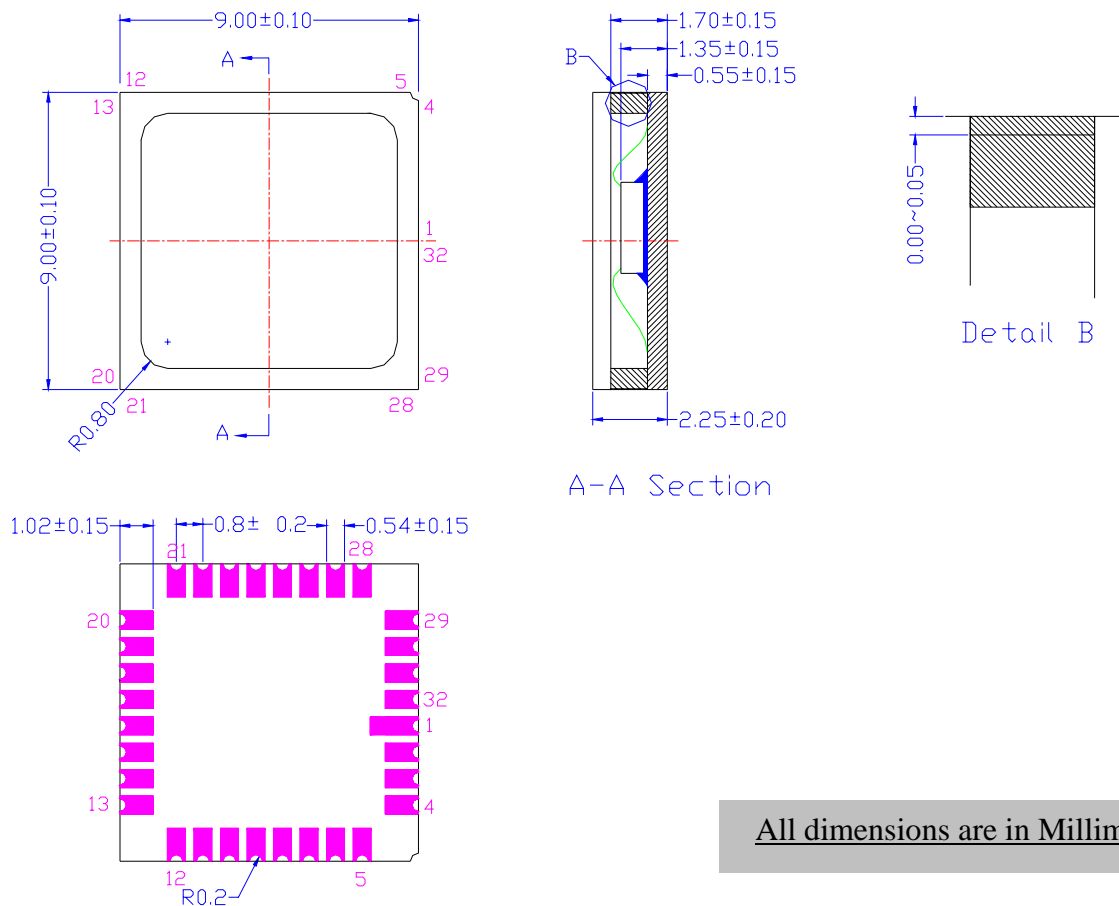
Symbol	Parameter	Min.	Typ.	Max.	Unit
Fsysclk	Master clock frequency	6	12	24	MHz
Fpxclk	Pixel clock rate		3	4	MHz

Sensor Characteristics (Light source: 3200K halogen lamp; 8bit resolutions)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Photo response non-uniformity	PRNU		1.87		%	
Saturation output voltage	Vsat.		235		Level	
Dark output voltage	Vdark		2.15		Level/sec	
Dark signal non-uniformity	DSNU		0.56		Level	
Sensitivity (Red channel)	R		240		Level/Lux-sec	
Sensitivity (Green channel)	G		190		Level/Lux-sec	
Sensitivity (Blue channel)	B		150		Level/Lux-sec	

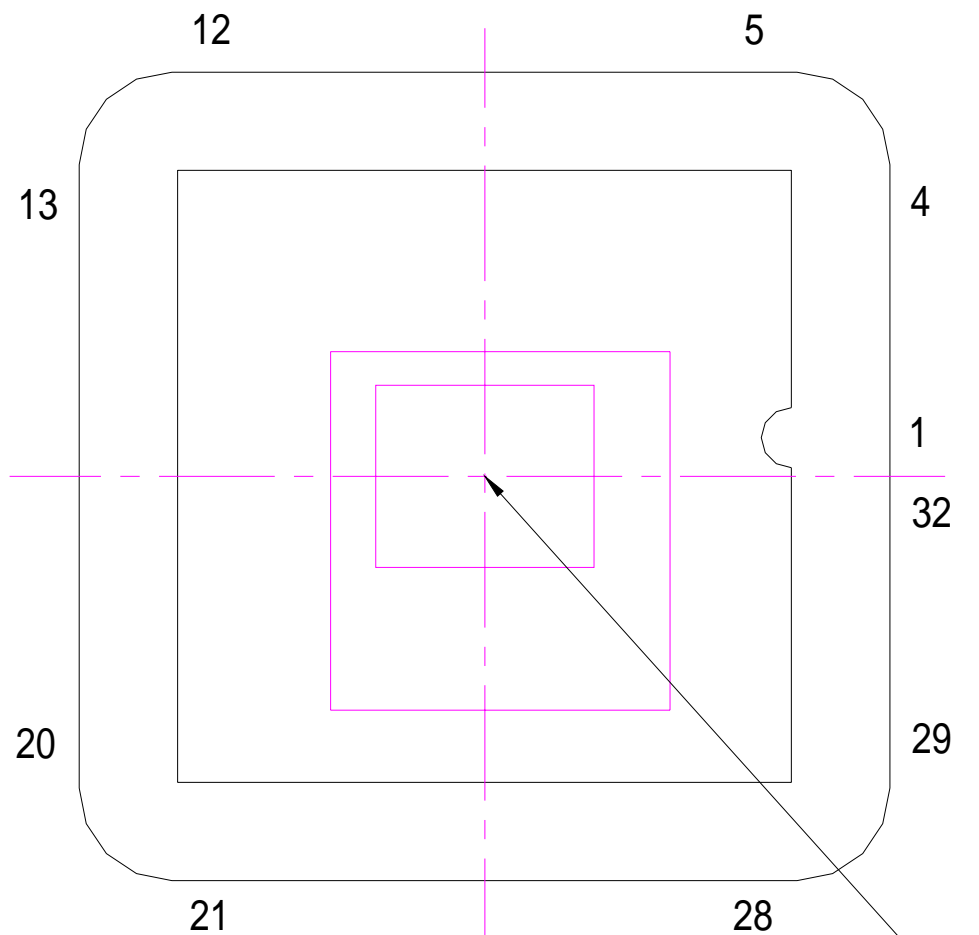
7. Package information

7.1. Package Outline Dimension



All dimensions are in Millimeters.

7.2. Optical Center Information

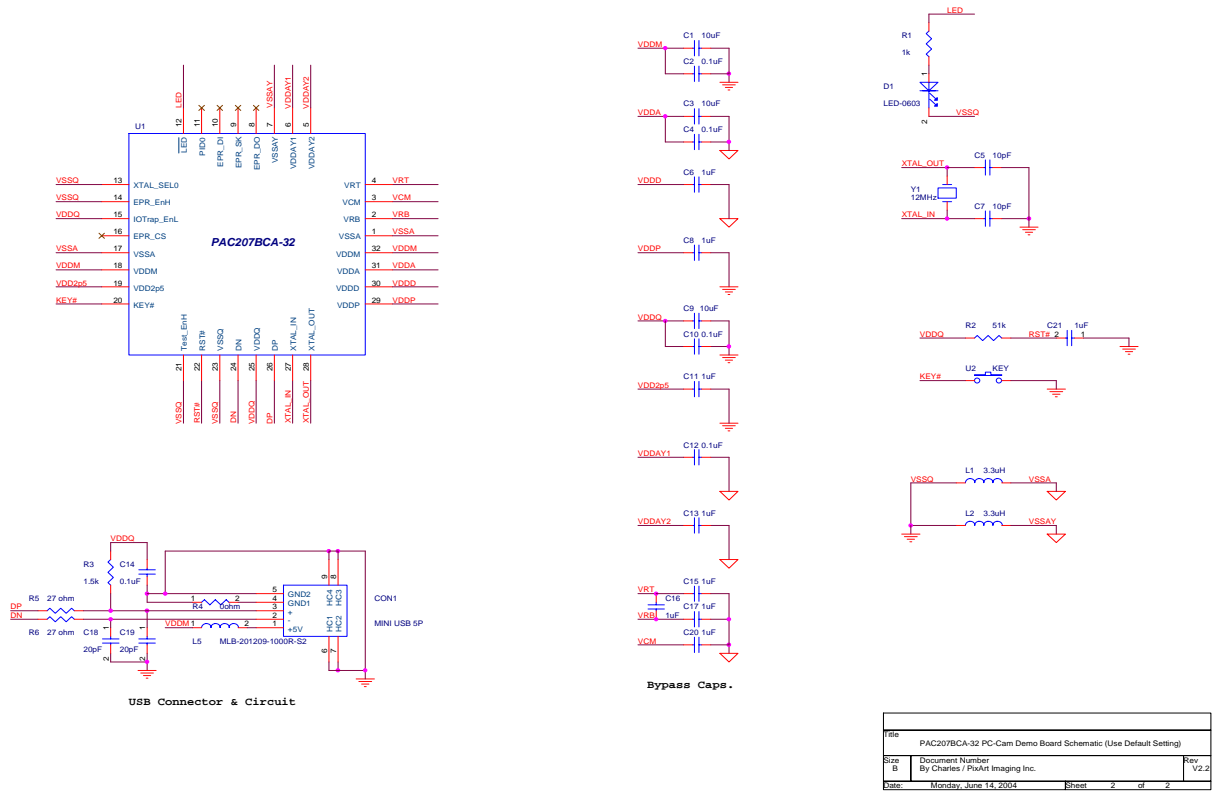


Sensor Array Center = Package Center

-- TOP VIEW --

Note: Sensor Array Center = Package Center

8. Reference Application Circuit



title	PAC207BCA-32 PC-Cam Demo Board Schematic (Use Default Setting)	
Size	Document Number	Rev
B	By Charles / PixArt Imaging Inc.	V2.2
date	Monday, June 15, 2004	Sheet 2 of 2