

UIC5003CH WEB Camera Controller

General Description

This document is the source of technical information about image processing chip for the WEB camera with USB1.1 interface (USB PC Camera) and WEB camera based on this chip.

The UIC5003CH transforms raw Bayer pixel data from CMOS sensors into either still images or video stream and communicates it over a USB bus. Controller includes pixel processor for getting high quality image and fully configured Wavelet coder for compress data stream.

System overview

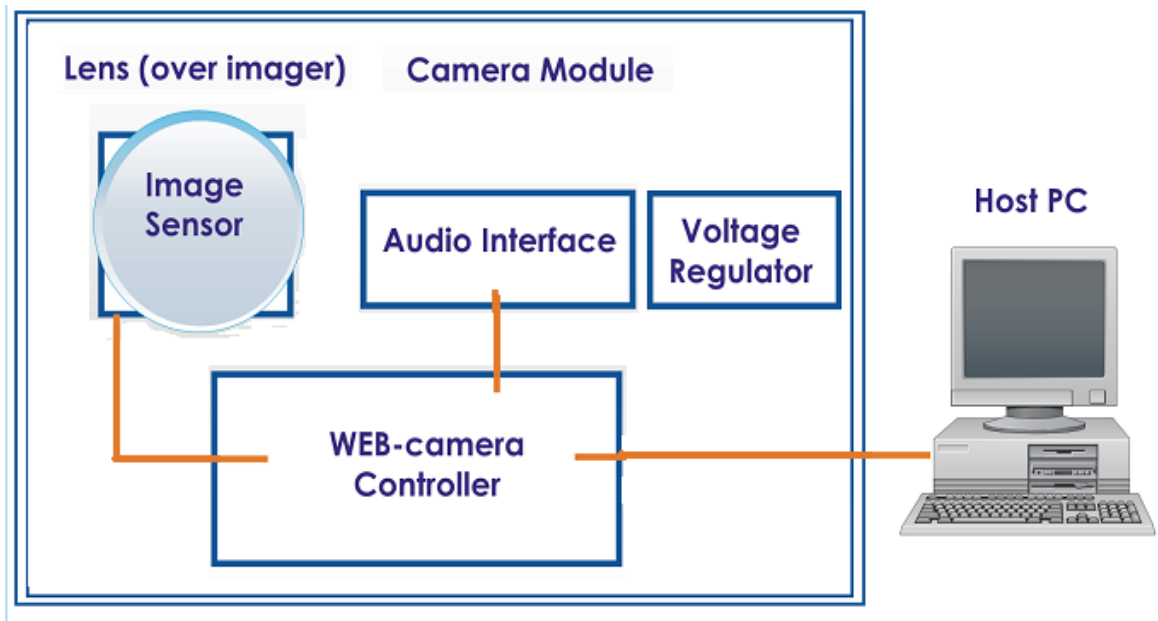
UIC5003CH provides a complete image processing system and includes:

- Image sensor data end control interface
- Pixel processor
- Wavelet video coder
- USB 1.1 interface
- Audio interface
- Crystal oscillator
- Voltage regulator
- Test circuits
- General purpose I/O port

Key specification

Output host interface	USB 1.1, Bulk, Isochronous, up to 1.2 Mbytes/second
Maximum frame rates	640×480 @ 30 fps (VGA)
Image size	From 4×4 to 1024×1024
Video mode	Still images or video stream
Image modes	Full color, Raw Bayer Pixel output data
Image Sensor	HDCS-2020, ADCS2021 (Agilent)
Sensor interface	10-bit data input, 2 wire synchronous control, 24/48 MHz clock
Video synchronization	Start-of-frame, end-of-line, and_of_frame
Auto-expose	Adjust sensor gain and exposure time
White balance	Equalize average pixel luminance
Compression	2D Wavelet 5,3
Quantization	Auto Q adjust function or manually scale the quantization table
Huffman coder	Programmable correction Huffman code tables
Audio interface	Output data rate is 64 kb/s
Voltage regulator	Input 3.3 V, output 2.5 V
Crystal oscillator	48 MHz and program control frequency for controller and sensor
Crystal frequency	48 MHz
Voltage requirement	3.3 V
Process	Standard CMOS Logic Process 0.25um (<i>1st Silicon</i>)
Package	LQFP 44, H18.64-1B, H14.42-1B

Structure of WEB- camera



Structure of Controller

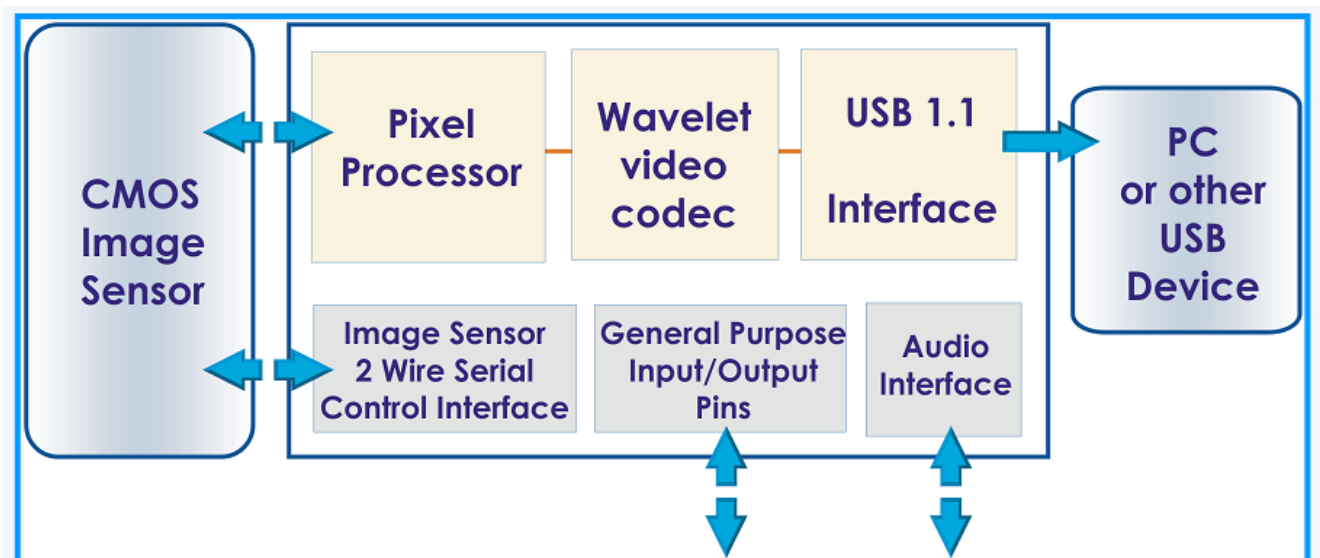


Image sensor control interface

The controller uses a two wire serial controller interface for configuring CMOS image sensor. PS software can transmit through USB interface and controller inside RAM data to image sensor.

USB interface

USB interface transmits processed image frames and provide read/write access to the chip's registers and RAMs.

Software

The software for web camera includes:

1. Kernel streaming driver, with decompression functions and ability to change camera settings.
2. Program for viewing camera, getting photos and recording videos.

Image pre-processing stage (pixel processor stage)

Stage destination

The image pre-processing stage takes raw data from the CMOS image sensor and outputs image frames ready for Wavelet compression.

Introduction

The image pre-processing stage provides a complete image-processing pipeline for the CMOS image sensor. It transforms raw Bayer pattern data from the CMOS image sensor into high quality color image in predefined color coordinate system. The stage includes complete auto-exposure with white balance constraints to assure optimal image quality in most lighting situations.

System overview

The image pre-processing stage consists of consequent image processing block set. All blocks are listed below in order of appearance for image signal.

- Auto exposure unit with white balance constraints.
- Image statistics unit.
- Image sensor control unit.
- Serial interface unit.

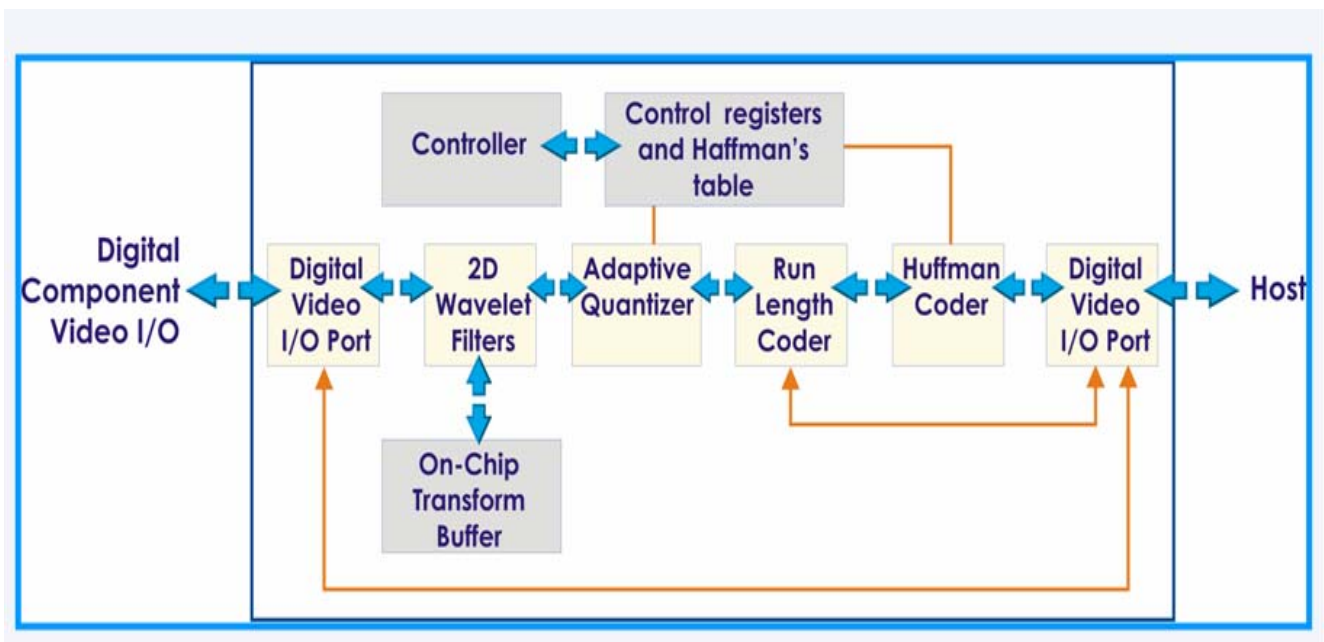
Detailed system blocks description

Auto exposure unit	Adjusts sensors gain to meet target pixel luminance and equalize average pixel luminance among color bands
Image statistics unit	Collect image statistics such as pixel sums
Image sensor control unit	Configuration and control of image sensor
Serial interface unit	Control of image sensor

Wavelet video coder

Wavelet video codec consist of: wavelet filters, quantizer, run length coder, huffman coder, controller, digital video and host ports, etc.

Wavelet filters makes a filtration of the data. Unit of adaptive quantization is used to increase number of zeros. Run length coder makes compression of sequences of zero to reduce volume of the data. Huffman Codec is coding of the sequence compressed on zero of the data. Wavelet controller performs management of work of the calculator on coding of the data. Unit of the control registers and Huffman's table are used too. The management is made through the registers of the given unit.

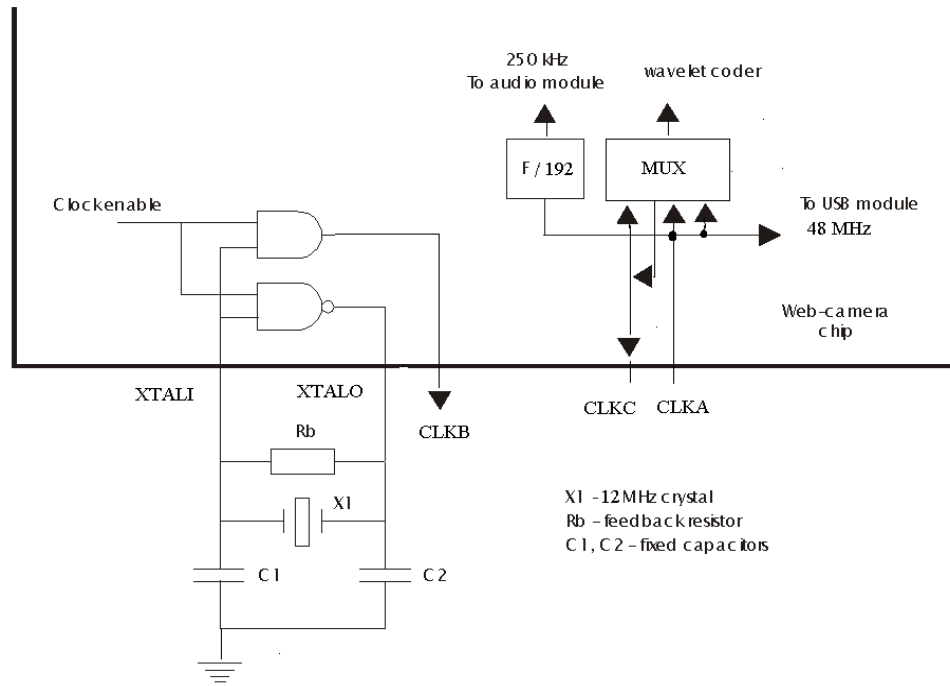


The unit of the USB-interface

The unit of the USB-interface realizes the USB-protocol of an exchange of the data between the camera and computer. The flow given from the camera in the computer carries the compressed video information, the return flow contains the information on changes which are brought in by the user in real time in mode of operations of system, as that: change of the sanction, parameters image sensor, Huffman table etc. The transfer is carried out in isochronous mode for maintenance of the maximal throughput of the trunk; for reception of working parameters the mode bulk is used.

Oscillator

The oscillator module provides the reference clocks for all inner modules of the chip. The oscillator circuit can be used with an external crystal or generator to provide accurate clock source. In its typical configuration, the oscillator is connected in a Pierce oscillator configuration, as shown in the next figure.



Wavelet coder frequency and Maximum frame rates

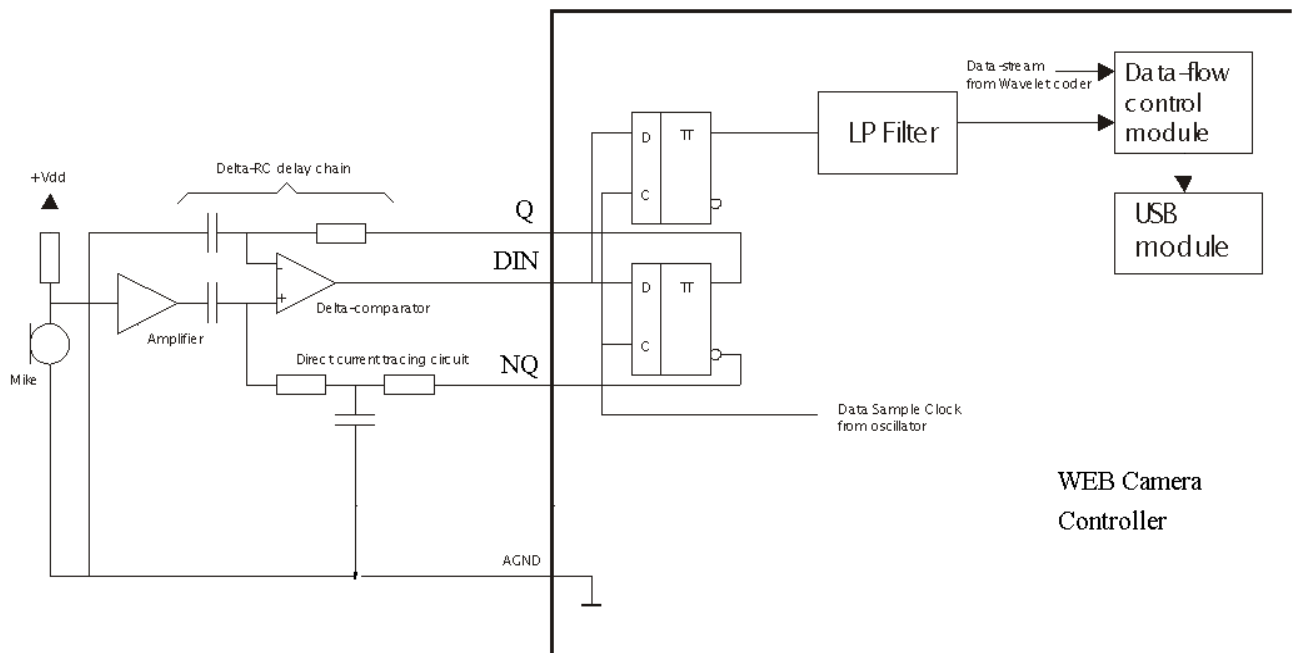
12 MHz 320x240@ 30fps
 48 MHz 640x480@ 30fps
 72 MHz 800x600@ 30fps
 80 MHz 1024x1024@ 15fps
 120 MHz 1024x1024@ 22fps

Image sensor interface

The image sensor interface provides communication between image sensor and embedded preliminary image processing module. The interface includes: 10 data lines (D0-D9) from sensor, output signal for sensor reset (RESOUT), output clock signal for sensor (CLKC) frame synchronization lines and row synchronization line. By default these pins are intended to control Agilent HDCS-2020, ADCS-2021 video sensor or similar one.

Audio interface

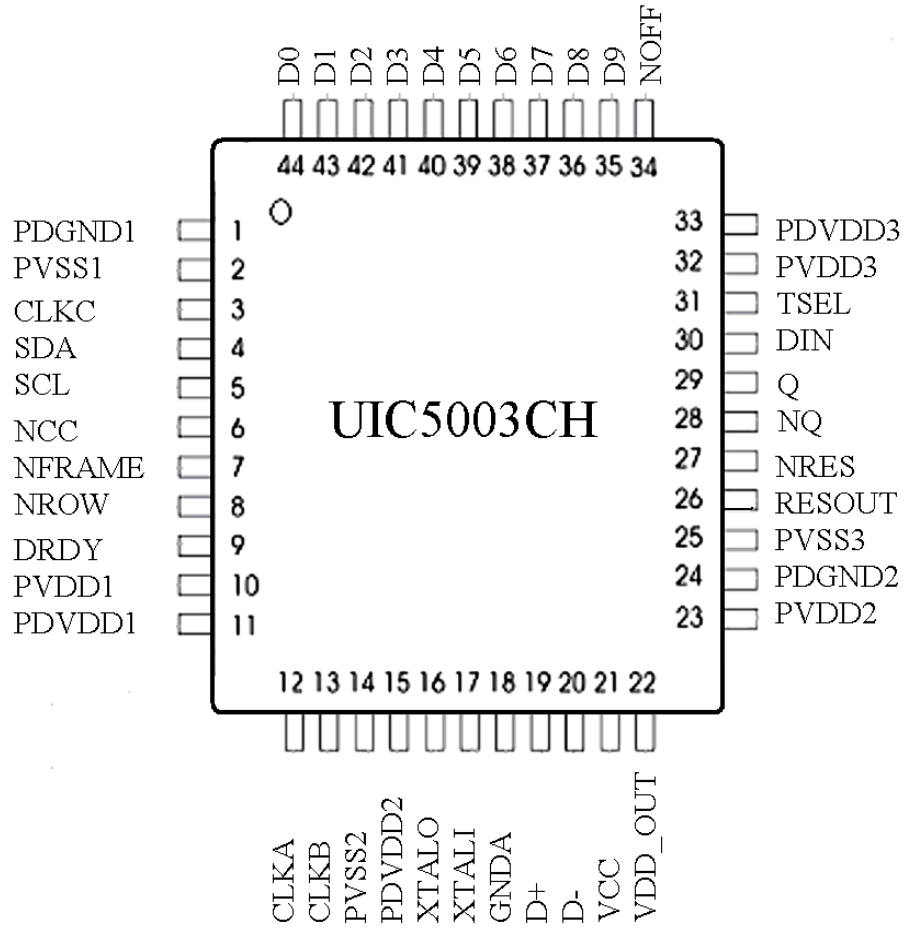
The audio interface works with simple external analog circuit to provide delta analog-to-digital conversion, as shown in the next figure. Input data bits stream is coming into a digital low-pass filter. Output data rate is 64 kb/s. Output audio data is added to a video-data stream in a data flow control module and finally transferred via USB interface.



General-purpose I/O ports and USB lines

These lines provide USB interface and input/output pins for external indication and control buttons. USB interface can be complemented as 2-line interface (D+, D-). In this case input analog receivers/transceivers are incorporated in the chip (NOFF=1). Analog circuits can also be situated outside the chip (NOFF=0). In this case USB interface uses 7 lines for external receivers/transceivers control (special package type).

The UIC5003CH Package Diagram



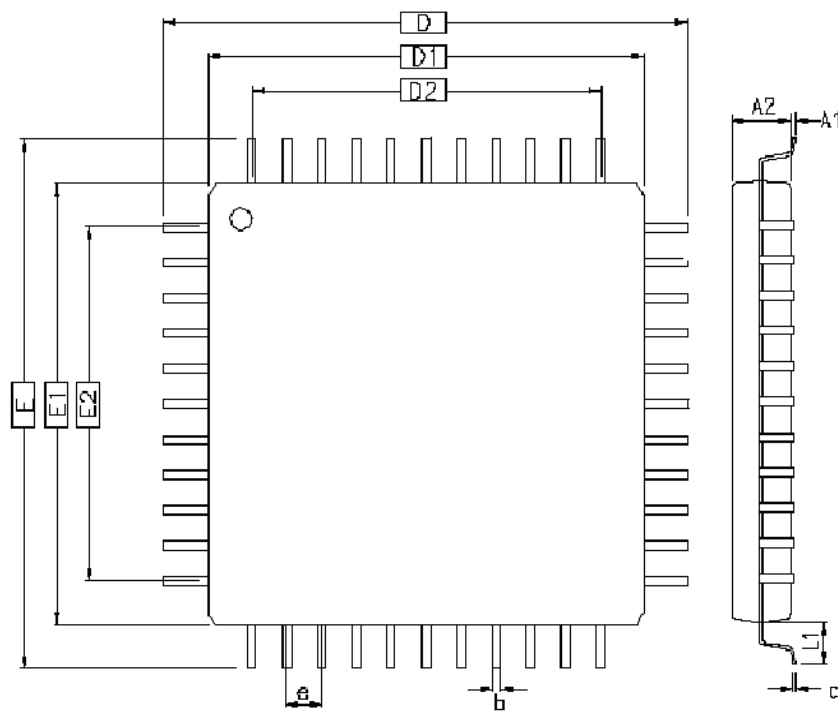
The UIC5003CH Pin Description

Pin Number	Name	Pin Type	Function/Description	
1	PDGND1	Power	Digital ground	
2	PVSS1	Power	Digital ground	
3	CLKC	I/O	Image Sensor clock	
4	SDA	I/O	Serial interface data	
5	SCL	Output	Serial interface clock	
6	NCC	Input	Sensor capture complete Strobe	
7	NFRAME	Input	Vertical synchronization	
8	NROW	Input	Horizontal synchronization	
9	DRDY	Input	Sensor Data Strobe	
10	PVDD1	Power	Digital Core VDD (2.5V)	
11	PDVDD1	Power	Digital I/O VDD (3.3V)	
12	CLKA	Input	External clock 48 MHz	
13	CLKB	Output	Generator output clock	
14	PVSS2	Power	Digital ground	
15	PDVDD2	Power	Digital I/O VDD (3.3V)	
16	XTALO	Output	Crystal clock output	NC
17	XTALI	Input	Crystal clock input	NC
18	GNDA	Power	Analog ground	
19	D+	Analog	USB interface line D+	
20	D-	Analog	USB interface line D-	
21	VCC	Power	Analog Supply for analog circuits (3.3V)	
22	VDD_OUT	Analog	Output Analog Supply (2.5V)	
23	PVDD2	Power	Digital Core VDD (2.5V)	
24	PDGND2	Power	Digital ground	
25	PVSS3	Power	Digital ground	
26	RESOUT	Output	Power reset output. Active Low.	
27	NRES	Input	Reset input. Active Low.	
28	NQ	Output	Audio interface output	
29	Q	Output	Audio interface output	
30	DIN	Input	Audio interface input	
31	TSEL	Input	Test line (No connection)	NC
32	PVDD3	Power	Digital Core VDD (2.5V)	
33	PDVDD3	Power	Digital I/O VDD (3.3V)	
34	NOFF	Input	USB mode line (No connection)	NC
35	D9	Input	Video port input bit[9] (MSB)	
36	D8	Input	Video port input bit[8]	
37	D7	Input	Video port input bit[7]	
38	D6	Input	Video port input bit[6]	
39	D5	Input	Video port input bit[5]	
40	D4	Input	Video port input bit[4]	
41	D3	Input	Video port input bit[3]	
42	D2	Input	Video port input bit[2]	
43	D1	Input	Video port input bit[1]	
44	D0	Input	Video port input bit[0] (LSB)	

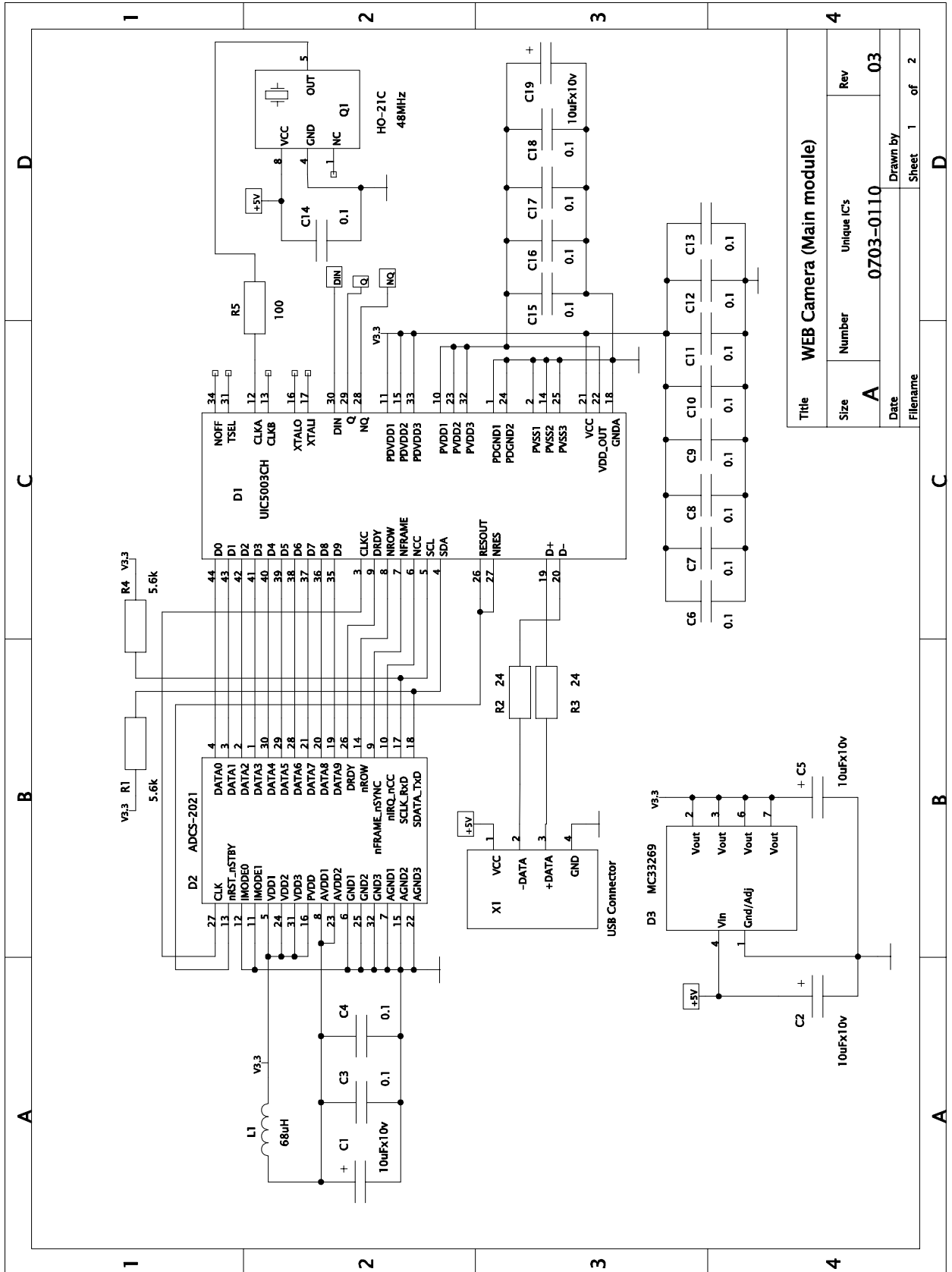
Packaging

- Package: LQFP 44
- General Package Specs

Body Size						Lead Count	Stand - off	Body Thickness	Lead Length	Lead Width	Lead Frame Thickness	Lead Pitch
D	E	D1	E1	D2	E2							
12	12	10	10	8	8	44	0.1	1.4	1.0	0.30	0.127	0.80



Applying the UIC5003CH



Title				WEB Camera (Main module)			
Size	A	Number	0703-0110	Unique IC's		Rev	03
Date						Drawn by	
Filename						Sheet	1 of 2

