



REALTEK

RTS5842

(Part Number: RTS5842-VA-GR)

USB2.0 PC CAMERA CONTROLLER WITH IMAGE SIGNAL PROCESSING AND MJPEG ENCODER

DATASHEET

**Rev. 0.80
16 Oct 2014**



REALTEK

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USING THIS DOCUMENT

This document is intended for the hardware and software engineer’s general information on the Realtek RTS5842 PC camera IC.

Though every effort has been made to ensure that this document is current and accurate, more information may have become available subsequent to the production of this guide. In that event, please contact your Realtek representative for additional information that may help in the development process.

REVISION HISTORY

Revision	Release Date	Summary
0.10	2013/02/20	Initial release
0.20	2013/04/26	Corrected ISP version and typo
0.30	2013/06/06	Corrected ISP version and ordering information status
0.40	2013/07/31	Change pin-out and package type to QFN46 Add new generation HDR description
0.50	2014/01/28	Update SVA/SVIO pin descriptions
0.60	2014/03/21	Update supported Serial Flash list and the spec. of VBUS power
0.70	2014/04/14	Update part number to RTS5842-VA-GR
0.80	2014/10/17	Modify supported USB2.0 data flow type

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1. General Description

The RTS5842 is a USB 2.0 compliant camera controller designed for Ultrabook, laptop and desktop PCs. The built-in extreme low-power transceiver provides the superior compatibility with USB host and the best quality for image applications. It is fully compliant with USB Video Class, properly works with native driver provided in Windows XP, Windows Vista, Windows 7 and Windows 8 operation system.

RTS5842 integrates USB 2.0 transceiver that is optimized for high performance data transfer rate, high speed MCU (Micro Processor Unit), DC-to-DC regulators, sensor controller, image signal processing engine, MJPEG compression into a single chip. It can support most available CMOS sensors from VGA (640x480) to UXGA (2048x1536) resolution.

The RTS5842 is designed to have MIPI CSI-2 two lane data or parallel interface to achieve the CMOS image sensors, it reserves the good compatible flexibilities to support more image sensors provided from various sensor vendors.

The 5th generation ISP (Image Signal Processing) engine supports most of UVC defined image adjustments (detail descriptions are listed in following section). In addition, this engine also has practical functions like as Lens Shading Correction, dead pixel cancellation, G1G2 filter, Color Correction Matrix, histogram statistic Auto White Balance, scaling function and so on. These functions are very useful to compensate intrinsic inaccuracy in lens and image sensor to get better image quality. The inside scaling filter can scale down higher resolution to lower one for reducing size purpose.

More than the plenty processing functions, RTS5842 integrates 4 regulators to save BOM cost and PCB area. One 5V-to-3.3V regulator converts USB bus power to 3.3V power for device I/O, one 3.3V-to-1.2~3.1V adjustable regulator converts 3.3V power for sensor's analog parts, two 3.3V-to-1.2V regulator converters 3.3V power to be 1.2~3.1V core power for RTS5842 and sensor.

One of the most significant in RTS5842 is enhanced power management. Its power consumption is 20% less compared with other controllers. With multiple regulators, image signal processing engine and motion JPEG encoder are integrated, RTS5842 consumes less power from USB bus no matter in normal operation, standby and suspend mode.

2. Features

2.1. General System Features

- USB2.0/1.1 PC Camera Controller with Image Signal Processing engine and MJPEG encoder
- USB Video Class compliant, works with native driver in Microsoft Windows XP 32-bit/64-bit, VISTA 32-bit/64-bit, Windows 7 and Windows 8 system
- On chip high performance and low power MCU
- SPI (Serial Peripheral Interface, Mode 0~Mode 3) connect to external serial flash for switching code and configuring customized parameters
- On chip firmware default supports major sensors without external serial flash
- Upgradeable firmware and customized parameters through USB interface
- Software controlled connection to USB bus for re-enumeration
- Motion JPEG hardware encoder integrated
- Built in 5.0V to 3.3V regulator output for I/O power
- Built in 3.3V to 1.2V~3.1V regulator for internal core power
- Built in 3.3V to 1.2V~3.1V adjustable regulator output for image sensor analog circuitry & IO power
- Adjustable and dynamic frame rate control on USB transaction
- Automatic frame rate adjustment when exposure in low light environment
- Selective suspend to minimize power consumption
- Supports 3 GPIO (General Purpose Input/Output) pins with programmable driving strength
- LED indicator on video streaming through GPIO
- Support property page write back at serial flash cache mode
- 46-pin QFN 'Green' package
- Memory BIST (Built-In Self Test) integrated

2.2. USB Controller

- Compliant with USB Specification 2.0/1.1 Full-Speed and High-Speed transfer mode

- Compliant with USB Video Class Specification Rev1.0 required for Windows XP, Vista , Windows 7 and Windows 8
- Support Suspend and Remote Wake-Up mode
- Built in Self-Loop-Back BIST for testing purpose

2.3. Sensor Controller

- Support MIPI CSI-2 two data lane up to 1GHz and parallel data format from sensor
- Support raw and YUV (4:2:2) input format from sensor
- Support standard 2-wire serial interface for sensor control
- Wide range (2MHz to 96MHz, default 24MHz) and programmable system clock output for sensor

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2.4. Micro Controller Unit

- Variable clock speed (15MHz/20MHz/24MHz) for performance and power saving
- Firmware is upgradeable, and quickly on-fly configuring E²PROM and serial flash through USB interface
- Software controlled connection to USB bus for re-enumeration
- Watch-Dog control for MCU reset and interrupt
- Configurable VID (Vendor ID), PID (Product ID) and serial number string from external serial flash
- Loadable 8K bytes of firmware from external serial flash to replace part of embedded firmware
- Support customized parameters for UVC (USB Video Class) defined and Realtek proprietary functions from external serial flash

2.5. Image Signal Processing (ISP) Engine

- The 5th generation ISP support up to 3 Mega pixels (2048x1536) sensors
- Programmable global Gamma correction (UVC defined)
- Sharpness enhancement and smooth processing (UVC defined)
- Auto Exposure and Manual Exposure adjustment (UVC defined)
- Automatic White Balance (AWB) adjustment (UVC defined)
- Manual White Balance control according to color temperature setting (UVC defined)
- High friendly brightness adjust, RGB domain (UVC defined)
- Dynamic contrast adjust, RGB domain (UVC defined)
- High friendly saturation adjust, RGB domain (UVC defined)
- Hue processing (UVC defined)
- Backlight compensation (UVC defined)
- Power line flicker compensation (UVC defined)
- New generation High Dynamic Range (HDR) Video

- Auto banding function
- Individual Len Shading Correction for R/G/B channel
- Negative, Mono and Gray Processing
- G1G2 compensation filter
- Programmable gamma table, R/G/B individual curve and Y gamma block.
- Black Level Compensation for individual R/G/B channel
- Static dead pixels cancellation, up to 80 pixels information stored in serial flash
- Dynamic dead pixel detection and cancellation
- Edge detection and enhancement
- Input pattern interpolation and noise reduction
- Global and individual gain control for R/G/B channel
- Configurable Color Correction Matrix for R/G/B channel
- AWB (auto white balance) control with both White Point and Gray World algorithm
- AE (auto Exposure) adjustment with Y channel of histogram statistic
- Zoom In and Zoom Out image from sensor, and output with various resolution
- Sharpness block : detecting all direction
- YUV offset and gain after Y domain edge enhancement

2.6. Motion JPEG Encoder Engine

- 60MHz operation clock rate, maximum up to 96MHz
- Support compression resolution up to FHD (1920x1080)
- Compliant with USB Video Class MJPEG payload
- Programmable compression ratio depends on transport bandwidth and image quality option

2.7. Video/Still Image Output Formats

- Support up to FHD resolution for still image capture
- Use UVC still image capture method 2
- Support USB Video Class uncompressed YUV (4:2:2) and USB Video Class MJPEG video and still image format output. The maximum output frame rate of these two video formats in different USB operation modes are listed in following tables.
- Support YUV420 video format
- Support RGB Bayer pattern bypass output mode

2.8. Software Features

- USB Video Class compliant, properly works with native driver in Microsoft Windows XP 32-bit/64-bit , VISTA 32-bit/64-bit , Windows 7 32-bit/64-bit and Windows 8 32-bit/64-bit system
- Provides certified logo driver for Microsoft Windows XP , VISTA , Windows 7 and Windows 8 operation systems
- Linux UVC driver, open source at <http://linux-uvc.berlios.de/>
- Intuitive Control Panel (Realtek Camera Manager) to enhance user experience
 - Enabling face tracking function for single and multiple users
 - Digital Zoom-In and Zoom-Out processing
 - Video and voice streaming recording
 - Still image capture
 - Interface for R/G/B gamma curve adjustment
 - Provide various preset image styles for video streaming and still captured image
- Selective suspend function to save power in Standby mode

2.9. Microphone Interface

- Stereo Digital microphone is supported
- Supports industry standard digital microphone interface to output digital voice to onboard HD (High Definition) Audio Codec
- Provides reference voltage output to bias analog microphone directly without requiring external regulator
- Clock rate for sample data 8KHz /16KHz /44.1KHz /48KHz

2.10. System Applications

- Laptop PCs
- Netbook PCs
- All-In-One PCs
- Ultra mobile devices

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3. Pin Assignments

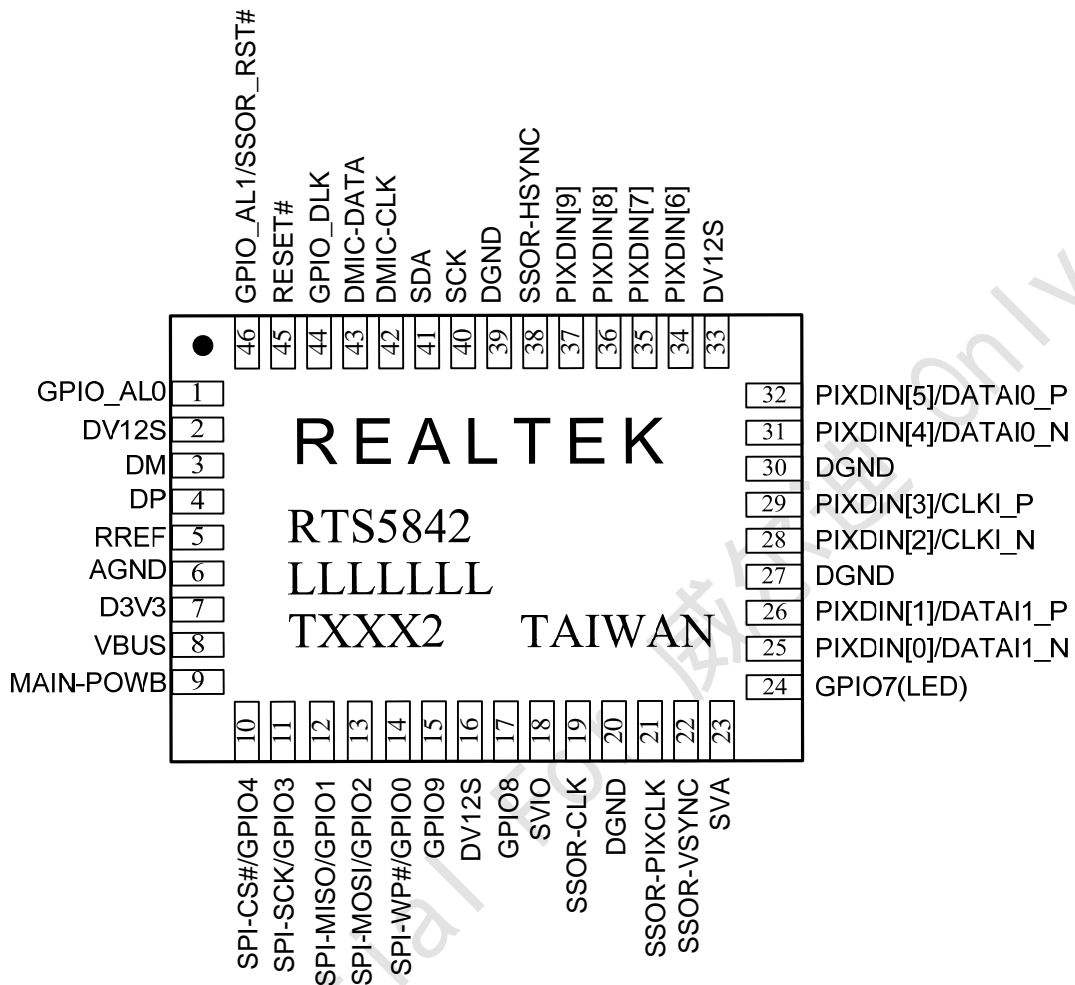


Figure 1. QFN-46 Pin Assignments

3.1. Package and Version Identification

Green package is indicated by a ‘G’ in the location marked ‘T’. The silicon and FW ROM version number is shown in the location marked ‘V’.

4. Pin Descriptions

Table 1. I/O Type Description

I/O Type	Description
I	Input
O	Output
IH	Input with internal pull-up 200K
IL	Input with internal pull-down 200K
IO	Input / Output
IOH	Input/Output with internal pull-up 200K
IOL	Input/Output with internal pull-down 200K
IOSH	Input/Output with Schmitt trigger
IO-U	USB related IO
CLK	Clock related IO
PWR-O	Power output pin
PWR-I	Power input pin
GND	Ground related pin

4.1. USB Transceiver Interface

Table 2. USB Transceiver Pins

Name	Type	Pin No.	Description
DP	IO-U	4	USB D+ signal
DM	IO-U	3	USB D- signal
RREF	-	5	External Reference. Requires 1% precision 6.25K resistor to ground
			Total: 3 Pins

4.2. System Interface

Table 3. System Interface Pins

Name	Type	Pin No.	Description
RESET#	IOSH	45	System reset.
MAIN_POWB	I	9	5V-to-3.3V power control, low enable. Follow digital level input threshold voltage
			Total: 2 Pins

4.3. GPIO, SPI Serial Flash Interface

Table 4. GPIO/E2PROM/Serial Flash Interface

Name	Type	Pin No.	Description
GPIO0/ SPI-WP#	IOH	14	General purpose input and output/ SPI serial flash write protected
GPIO1/ SPI-MISO	IOH	12	General purpose input and output/ Serial data in from external flash
GPIO2/ SPI-MOSI	IOH	13	General purpose input and output/ Serial data out to external flash
GPIO3/ SPI-SCK	IOH	11	General purpose input and output/ Clock signal to external flash
GPIO4/ SPI-CS#	IOH	10	General purpose input and output/ Chip select to external flash
GPIO8	IOH	17	General purpose input and output.
GPIO9	IOH	15	General purpose input and output.
GPIO7 (LED)	IOH	24	General purpose input and output, default used as LED indicator
GPIO_AL1/ SSOR-RST#	IOH	46	General purpose input and output, work even on USB suspend mode / Sensor reset control, drives LOW to reset image sensor
GPIO_AL0	IOH	1	General purpose input and output, work even on USB suspend mode
GPIO_DLK	IOH	44	General purpose input and output, default used as de-link function
			Total: 11 Pins

4.4. CMOS Image Sensor Interface

Table 5. CMOS Image Sensor Interface

Name	Type	Pin No.	Description
PIXDIN[9]	IL	37	Pixel Data Bus bit-9
PIXDIN[8]	IL	36	Pixel Data Bus bit-8
PIXDIN[7]	IL	35	Pixel Data Bus bit-7
PIXDIN[6]	IL	34	Pixel Data Bus bit-6
PIXDIN[5]/ DATAI0_P	IL	32	Pixel Data Bus bit-5/ MIPI data input 0 positive signal
PIXDIN[4]/ DATAI0_N	IL	31	Pixel Data Bus bit-4/ MIPI data input 0 negative signal
PIXDIN[3]/ CLKI_P	IL	29	Pixel Data Bus bit-3/ MIPI clock input positive signal
PIXDIN[2]/ CLKI_N	IL	28	Pixel Data Bus bit-2/ MIPI clock input negative signal
PIXDIN[1]/ DATAI1_P	IL	26	Pixel Data Bus bit-1/ MIPI data input 1 positive signal
PIXDIN[0]/ DATAI1_N	IL	25	Pixel Data Bus bit-0/ MIPI data input 1 negative signal
SSOR-VSYNC	IL	22	Vertical sync signal from image sensor

SSOR-HSYNC	IL	38	Horizontal sync signal from image sensor
SSOR-PIXCLK	IL	21	Pixel clock from image sensor
SCK	O	40	I ² C Bus Clock
SDA	IOL	41	I ² C Bus Data Pin
SSOR-CLK	O	19	System master clock to image sensor
			Total: 16 Pins

4.5. Microphone Interface

Table 6. Microphone Interface

Name	Type	Pin No.	Description
DMIC-DATA	IO	43	Digital microphone data output to on board HD Codec (0~3.3V level signal)/ Digital microphone data input from D-Mic on module
DMIC-CLK	IO	42	1.5MHz~3.0MHz clock input from on board HD Codec (0~3.3V level signal)/ 1.5MHz~3.0MHz clock output to D-Mic on module
			Total: 2 Pins

4.6. Power/Ground

Table 7. Power and Ground pins

Name	Type	Pin No.	Description
SVA	PWR-O	23	Regulator output for sensor analog power (100mA output capability)
DV12S	PWR-O	2, 16, 33	Regulated 1.2V output for RTS5823-VB core power, 0.1uF capacitor to digital ground. (150mA output capability)
D3V3 ^(*1)	PWR-O	7	3.3V power output from integrated VBUS-to-3.3V regulator for RTS5823-VB and sensor I/O (300mA output capability)
VBUS ^(*2)	PWR-I	8	USB bus 5.0V power input for integrated multiple regulators. This power pin can accept 3.3V of USB power input for 3.3V system
SVIO	PWR-O	18	Regulator output for sensor IO power (150mA output capability)
DGND	GND	20, 27, 30, 39	Digital ground
AGND	GND	6	Analog ground
			Total: 12Pins

Note1: SVA, SVIO, DV12S and D3V3 voltages are from integrated regulators, the source is regulated voltage from VBUS-to-3.3V regulator. The total and maximum output current is limited to be 300mA

Note2: The integrated VBUS-to-3.3V regulator is enabled if 5.0V bus power is provided at VBUS pin. This regulator will be disabled automatically if VBUS power is 3.3V, and D3V3 output current capability is limited by USB bus.

5. Functional Descriptions

5.1. Block Diagram

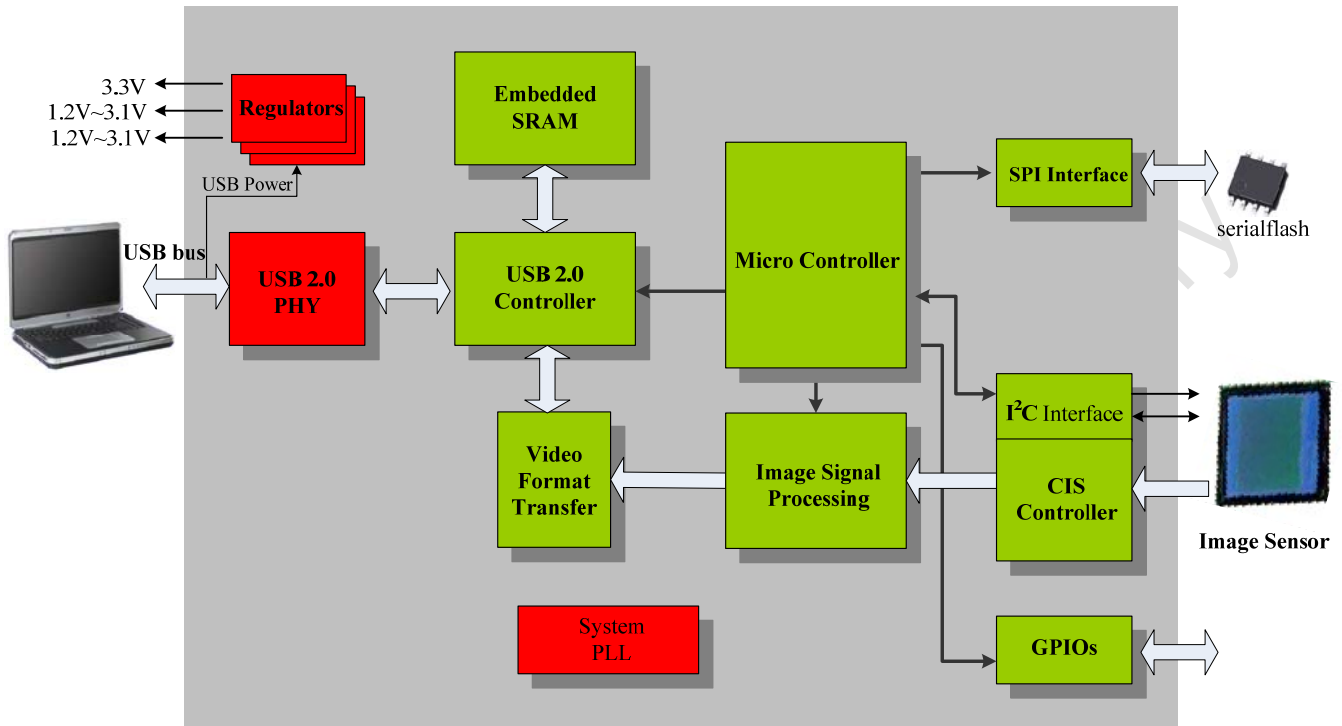


Figure 2. RTS5842 Block Diagram

5.2. CMOS Image Sensor Supporting

RTS5842 is designed to support up to RAW data and YUV 4:2:2 input in MIPI or parallel data format from image sensors. With a flexible CIS (CMOS Image Sensor) controller design, RTS5842 supports various CMOS image sensors, firmware is upgradeable from external serial flash. Realtek will update this datasheet once a new image sensor is ready in RTS5842. Following table shows sensors default supported by RTS5842 can achieve good image quality without serial flash for configuring.

5.3. Serial Peripheral Interface Flash

RTS5842 default supports various types of serial flash to store configurable parameters of sensor and vendor information. Following table lists serial flash have been verified by Realtek, any component compatible with model number listed in this table should be confirmed by Realtek to guarantee compatibility.

Table 8. Supported Serial Flash

Type	Vendor	Model No.	Size (Bytes)
SPI Serial Flash	Eon	EN25F10	128k
	GigaDevice	GD25Q10	128k
	MXIC	M25L1021E	128k
	PCT	PCT25VF010	128k
	Chingis (Pflash)	PM25LV010	128k
	Winbond	W25X10CL	128k

5.4. Microphone Interface

Digital microphone is getting popular and adapted on laptop PCs designed for Windows Vista system. It has good immunity against noise from radio frequency device and hard drive, will not be interfered on the cable from camera module on front panel to onboard HD Audio Codec. Then the shielded cable is not required. In addition, Realtek HD Audio Codec driver can also provide Realtek proprietary Acoustic Echo Cancellation, Noise Suppression and Beam Forming technologies for voice input to improve user experience.

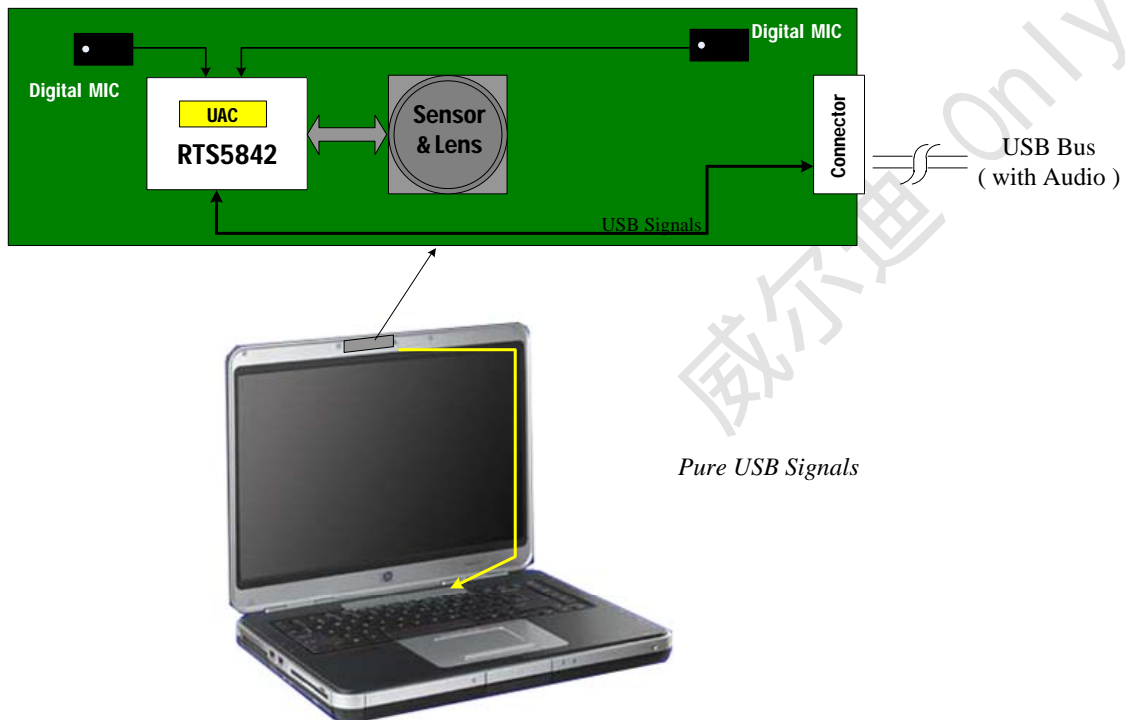


Figure 6. Digital Microphone Input with UAC

5.5. Integrated Multiple Regulators

Although most of controllers had integrate regulators to save BOM cost, an external regulator with dual output voltage is still required to power various CMOS image sensors need different supply voltages. To save external regulator cost further, the RTS5842 integrates multiple regulators for itself and external devices. A 5V-to-3.3V regulator is built in to power 3.3V I/O, two 3.3V-to-1.8V regulators are individually used to provide core power for RTS5842 and image sensor, and a 3.3V-to-2.8V regulator with adjustable voltage from 1.2V to 3.1V is good to power various image sensors need different analog power voltages.

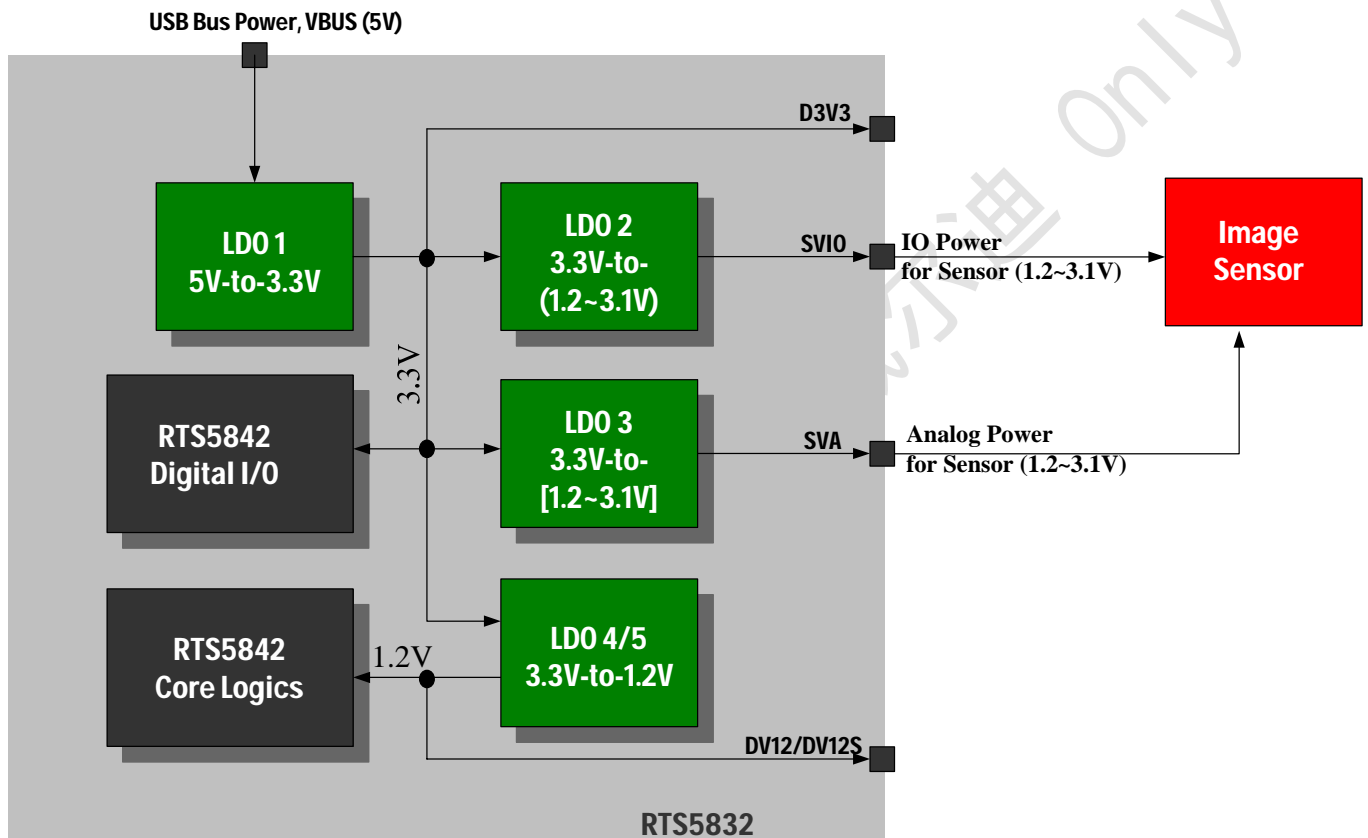


Figure 3. RTS5842 Integrates Multiple Regulators to Save Regulator Cost

6. Electrical Characteristics

6.1. DC Characteristics

6.1.1. Absolute Maximum Ratings

Table 9. Absolute Maximum Ratings

Parameter	Symbol	Minimum	Typical	Maximum	Units
Power Supply Input					
Bus Power from USB	VBUS***	3.0	5.0	5.5	V
Regulator Power Output*					
For sensor analog part	SVA	1.2	2.8	3.1	V
For RTS5842 core	DV12	1.0	1.2	1.35	V
For RTS5842 and sensor I/O	D3V3	3.0	3.3	3.3	V
For sensor IO part	SVIO	1.2	1.8	3.1	V
Ambient Operating Temperature	Ta	0	-	+70	°C
Storage Temperature	Ts	-	-	+125	°C
ESD (Electrostatic Discharge, Human Body Mode)					
Susceptibility Voltage					
All Pins				> 5000V	

*: These powers are generated by integrated regulators, the typical output voltages may be various depend on the USB bus power (VBUS).

** : The standard testing condition of RTS5842 before shipping is VBUS = 5.0V unless specified. Customers designing with a different VBUS should contact Realtek technical support representatives for special testing support.

***: For LDO output voltage, VBus must keep at least 0.35V gap to let LDO generates stable voltage.(i.e., SVA=2.8V, VBus must be higher than 3.15V to protect voltage-drop).

6.1.2. Threshold Voltage

VBUS=5.0V±5%, T_{ambient}=25°C.

Table 10. Threshold Voltage

Parameter	Symbol	Minimum	Typical	Maximum	Units
Input Voltage Range, VBUS	V _{in}	3.0	5.0	5.5	V
Digital Low Level Input Voltage	V _{IL}	-0.5	-	0.8	V
Digital High Level Input Voltage	V _{IH}	2	-	-	V
Digital High Level Output Voltage	V _{OH}	3.0	3.3	3.6	V
Digital Low Level Output Voltage	V _{OL}	-0.5	-	0.4	V
Input Pin Capacitance	C _{in}	-	-	10	pF
Supply Current Consumed from VBUS	I _{DD}	-	100	300	mA
Suspend Current Consumed from VBUS	I _{SUS}	320	-	470	uA
Internal Pull Up Resistance	-	-	200k	-	Ω
Internal Pull Down Resistance	-	-	200k	-	Ω

6.1.3. Integrated Low Dropout Regulator Electrical Characteristics

VBUS=3.3V~5.0V±5%, T_{ambient}=25°C.

Table 11. Integrated LDO Output voltage and current

Parameter	Description	Symbol	Minimum	Typical	Maximum	Units
LDO SVIO (3.3V to 1.2~3.1V)	IO power for sensor	SVIO	1.2	1.8	3.1	V
	Fan-out current capacity	I _{SVIO}	-	-	150	mA
LDO SVA (3.3V to 1.2~3.1V)	Analog power for sensor	SVA	1.2	2.8	3.1	V
	Fan-out current capacity	I _{SVA}	-	-	100	mA

*: SVIO/SVA output voltage could be programmable by FW

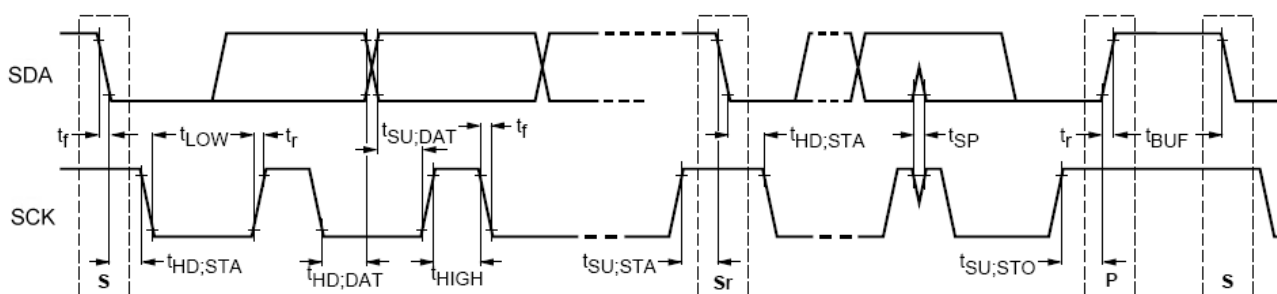
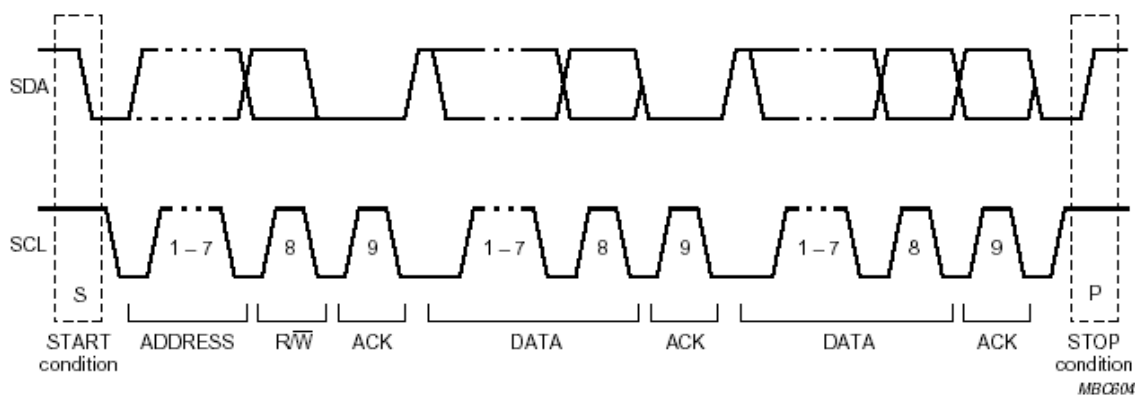
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6.2. AC Characteristics

6.2.1. Standard Serial Control Interface

Table 12. Characteristics of the SCK and SDA on the I²C Bus

Parameter	Symbol	Standard Mode		Fast Mode		Units
		Minimum	Maximum	Minimum	Maximum	
Clock Frequency	f_{SCK}	0	100	0	400	kHz
Hold Time START Condition	$t_{HD:STA}$	4.0	-	0.6	-	us
LOW Period of the SCK Clock	t_{LOW}	4.7	-	1.3	-	us
HIGH Period of the SCK Clock	t_{HIGH}	4.0	-	0.6	-	us
Setup Time for START Condition	$t_{SU:STA}$	4.7	-	0.6	-	us
Data Hold Time (master)	$t_{HD:DAT}$	5.0	-	-	-	us
Data Hold Time (device)		0	3.45	0	0.9	
Data Setup Time	$t_{SU:DAT}$	250	-	100	-	ns
Setup Time for STOP Condition	$t_{SU:STO}$	4.0	-	0.6	-	us
Bus Free Time between STOP and START	t_{BUF}	4.7	-	1.3	-	us


Figure 4. Definition of timing for I²C Bus

6.2.2. Serial Peripheral Interface

VDD=3.3V±5%, T_{ambient}=25°C

Table 13. Characteristics of Serial Peripheral Interface

Parameter	Symbol	Minimum	Typical	Maximum	Units
Clock Frequency	f _{SCK}	1kHz	5	30	MHz
Clock HIGH Time	t _{CH}	7	-	-	ns
Clock LOW Time	t _{CL}	7	-	-	ns
CS# Active Setup Time	t _{SLCH}	5	-	-	ns
CS# Not Active Hold Time	t _{CHSL}	5	-	-	ns
Setup Time of Data to Flash	t _{DVCH}	2	-	-	ns
Hold Time of Data to Flash	t _{CHDX}	5	-	-	ns
CS# Active Hold Time	t _{CHSH}	5	-	-	ns
CS# Not Active Setup Time	t _{SHCH}	5	-	-	ns
CS# Deselect Time	t _{SHSL}	100	-	-	ns
Disable Time of Data from Flash	t _{SHQZ}	-	-	6	ns
Hold Time of Data from Flash	t _{CLQX}	0	-	-	ns
Clock Low to Data Input Valid	t _{CLQV}	-	-	8	ns

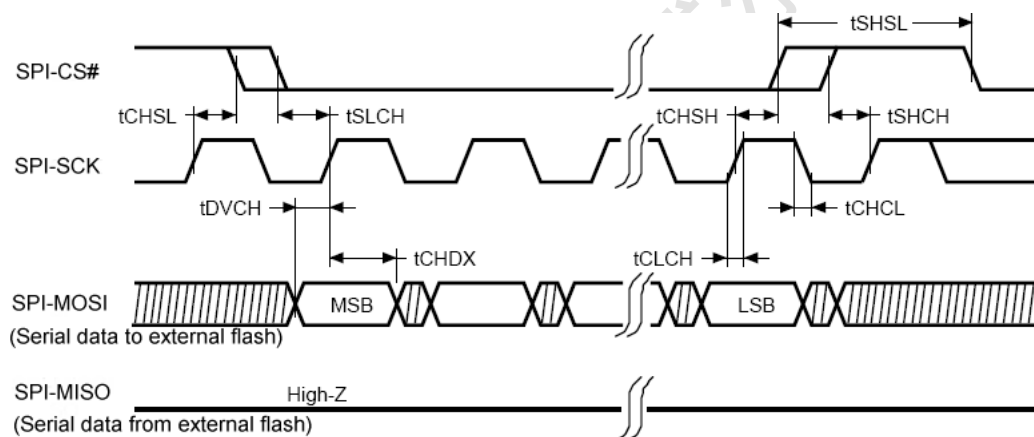


Figure 5. Data Output Timing to external serial flash

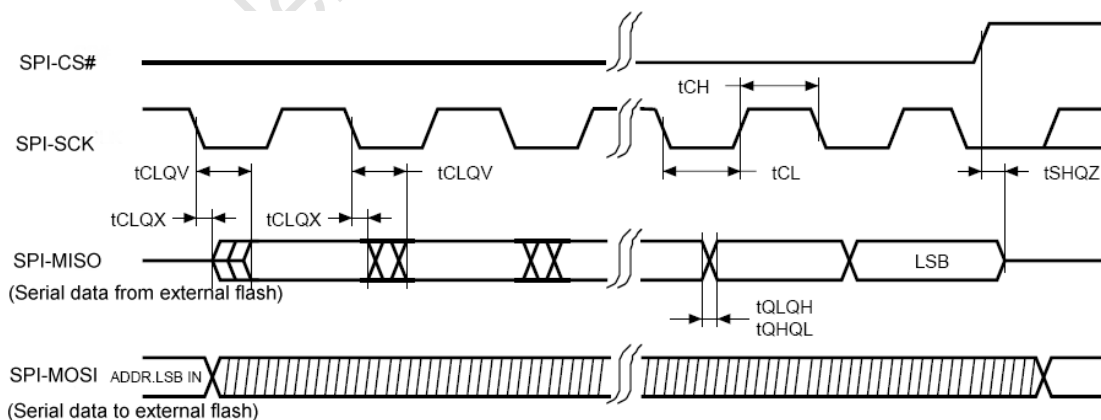


Figure 6. Data Input Timing from external serial flash

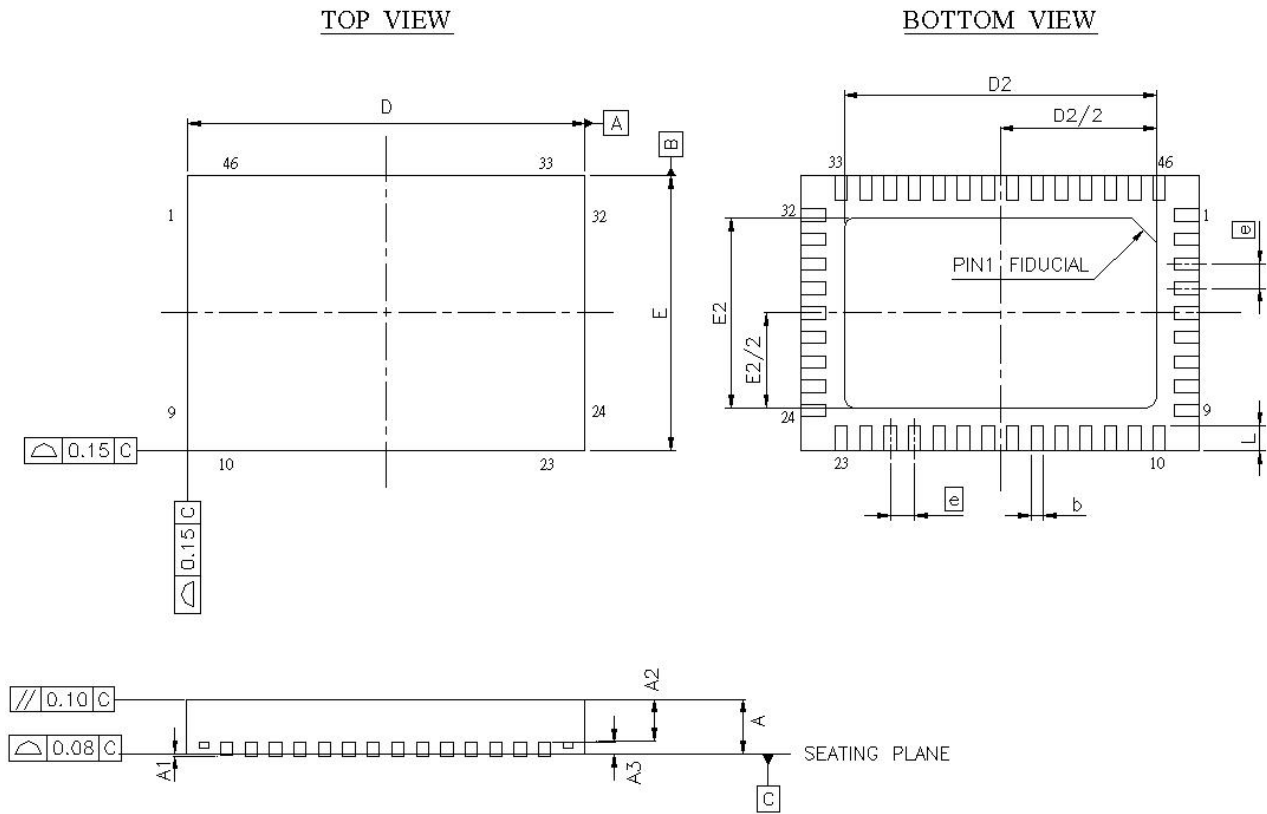
7. Application Circuits

To guarantee the best compatibility and image quality in hardware design with specific image sensor, please contact Realtek to get the up to date application circuits. Any modification is recommended to be double checked by Realtek. Realtek may update the latest application circuits without modifying this datasheet.

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8. Package Mechanical Dimensions

8.1. QFN-46 Dimension



Symbol	Dimension in mm			Dimension in inch		
	Min	Nom	Max	Min	Nom	Max
A	0.75	0.85	1.00	0.030	0.034	0.039
A ₁	0.00	0.035	0.05	0.000	0.001	0.002
A ₂	0.55	0.65	0.80	0.022	0.026	0.032
A ₃	0.20 REF			0.008 REF		
b	0.15	0.20	0.25	0.006	0.008	0.010
D	6.50BSC			0.256BSC		
D2	4.85	5.1	5.35	0.191	0.201	0.211
E	4.5BSC			0.177BSC		
E2	2.50	2.80	3.10	0.098	0.110	0.122
e	0.40BSC			0.016BSC		
L	0.30	0.40	0.50	0.012	0.016	0.020

Notes :

1. CONTROLLING DIMENSION : MILLIMETER(mm).
2. REFERENCE DOCUMENTL : JEDEC MO-220.

9. Ordering Information

Table 14. Ordering Information

Part Number	Package	Status
RTS5842-VA-GR	46-pin QFN 'Green' Package	MP

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