RTD2556T-CG

MULTI-FUNCTION DISPLAY CONTROLLER

DATASHEET

(CONFIDENTIAL: Development Partners Only)

Rev. 0.01
26 February 2016
Track ID: JATR-8275-15

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USING THIS DOCUMENT

This document is intended for the software engineer's reference and provides detailed programming information.

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.

REVISION HISTORY

Revision	Release Date	Summary
0.01	2016/02/26	First release.

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1. General Description

The Realtek RTD2556T-CG monitor controller combines an analog RGB input interface, HDMI 1.4 compliant digital input interfaces with HDCP1.4, DP1.2 digital input interfaces with HDCP1.4 and DVI digital input interfaces with HDCP1.4. The embedded MCU is based on an industrial standard 8051 core with external serial flash.

The RTD2556T-CG is suitable for multiple market segments and display applications, such as monitor, All in One PC, and embedded applications.

2. Features

General

- RTD2556T-CG supports input format up to 1920x1200 @ 60Hz.
- Support LVDS panel interfaces
- Zoom scaling up and down
- Embedded one MCU with SPI flash controller.
- It contains 4 ADCs in key pad application
- Require only one crystal to generate all timing.
- Programmable internal low-voltage-reset (LVR)
- High resolution 6 channels PWM output, and wide range selectable PWM frequency.

Crystal

- Support 14.318MHz crystal type

Analog RGB Input Interface

- 1 Analog input supported
- Integrated 8-bit triple-channel 210MHz ADC/PLL
- Embedded programmable Schmitt trigger of HSYNC
- Support Sync-On-Green (SOG) and various kinds of composite sync modes
- On-chip high-performance hybrid PLLs
- High resolution true 64 phase ADC PLL
- YPbPr support up to HDTV 1080p resolution

High Speed Combo Receiver

- RTD2556T-CG supports 2 ports of high speed receivers including one port of DisplayPort1.2 and HDMI1.4 Combo receiver receiver and other port of HDMI1.4 and DVI Combo receiver.
- In DisplayPort mode, the latest DisplayPort 1.2 is supported
- In DisplayPort mode, two link layer speed HBR (2.7GHz), RBR (1.62GHz) are supported
- In DisplayPort mode, 6-bit, 8-bit, 10-bit, and 12-bit color depth transport is supported
- In DisplayPort mode, High-Bandwidth Digital Content Protection (HDCP 1.4) is supported
- In DisplayPort mode, audio is allowed to transmit to I2S/SPDIF output
- In HDMI mode, HDMI1.4 is supported
- In HDMI mode, data enable only mode is supported
- In HDMI mode, 6-bit, 8-bit, 10-bit, and 12-bit color depth transport is supported
- In HDMI mode, High-Bandwidth Digital Content Protection (HDCP 1.4) is supported
- In HDMI mode, HDMI audio is allowed to transmit to I2S/SPDIF output
- In DVI mode, Digital Content Protection (HDCP 1.4) is supported

Embedded MCU

- Industrial standard 8051 core with external serial flash
- Low speed ADC for various application
- I2C Master or Slave hardware supported

Auto Detection /Auto Calibration

- Input format detection
- Compatibility with standard VESA mode and support user-defined mode
- Smart engine for Phase/Image position/Color calibration

Audio

- Output: IIS , SPDIF
- Embedded Audio DAC
- Embedded headphone amp

Scaling

- Fully programmable zoom ratios
- Independent horizontal/vertical scaling
- Advanced zoom algorithm provides high image quality
- Sharpness/Smooth filter enhancement
- Support non-linear scaling from 4:3 to 16:9 or 16:9 to 4:3

Color Processor

- True 10 bits color processing engine
- xvYCC supported
- sRGB compliance
- Advanced dithering logic for 18-bit panel color depth enhancement
- Dynamic overshoot-smear canceling engine
- Brightness and contrast control
- Programmable 10-bit gamma support
- Peaking/Coring function for video sharpness

VividColorTM

- Independent color management (ICM)
- Dynamic contrast control (DCC)
- Precise color mapping (PCM)
- Image Adaptive Power Saving (IAPS)
- Support ADC Noise Reduction
- Support UltraVivid III function to enhance image quality with minimal artificial effect on productivity applications

Output Interface

- Support 8-bit / 10-bit output through either LVDS
- Support 2-port LVDS with the speed of each port up to 93MHz
- Fully programmable display timing generator
- Flexible data pair swapping for easier system design.
- Fixed Last Line output for perfect panel capability

Embedded OSD

- Embedded 30K SRAM dynamically stores OSD command and fonts
- Support multi-color RAM font, 1, 2 and 4-bit per pixel
- 64 color palette
- Maximum 26 window with alpha-blending /
- gradient / gradient target color / gradient reversed color/ dynamic fade-in/fade-out, bordering/ shadow
- Rotate 90,180,270 degree
- Independent row shadowing/bordering
- Programmable blinking effects for each character
- OSD-made internal pattern generator for factory mode
- Support 12x18 ~ 4x18 proportional font
- Hardware decompression for OSD font
- Support OSD scrolling
- Support 2 independent font based OSD

Frame Buffer Support

- LiveShow™ Function, High-performance RTC (response time compensation).
- Frame Rate Control Function
- Video rotate 180 degree

Power Supply

- 3.3V / 2.5V / 1.1V power supply

3. System Applications

- Display System on Motherboard, Monitor
- Display System for All in One PCs and embedded applications

4. Block Diagram

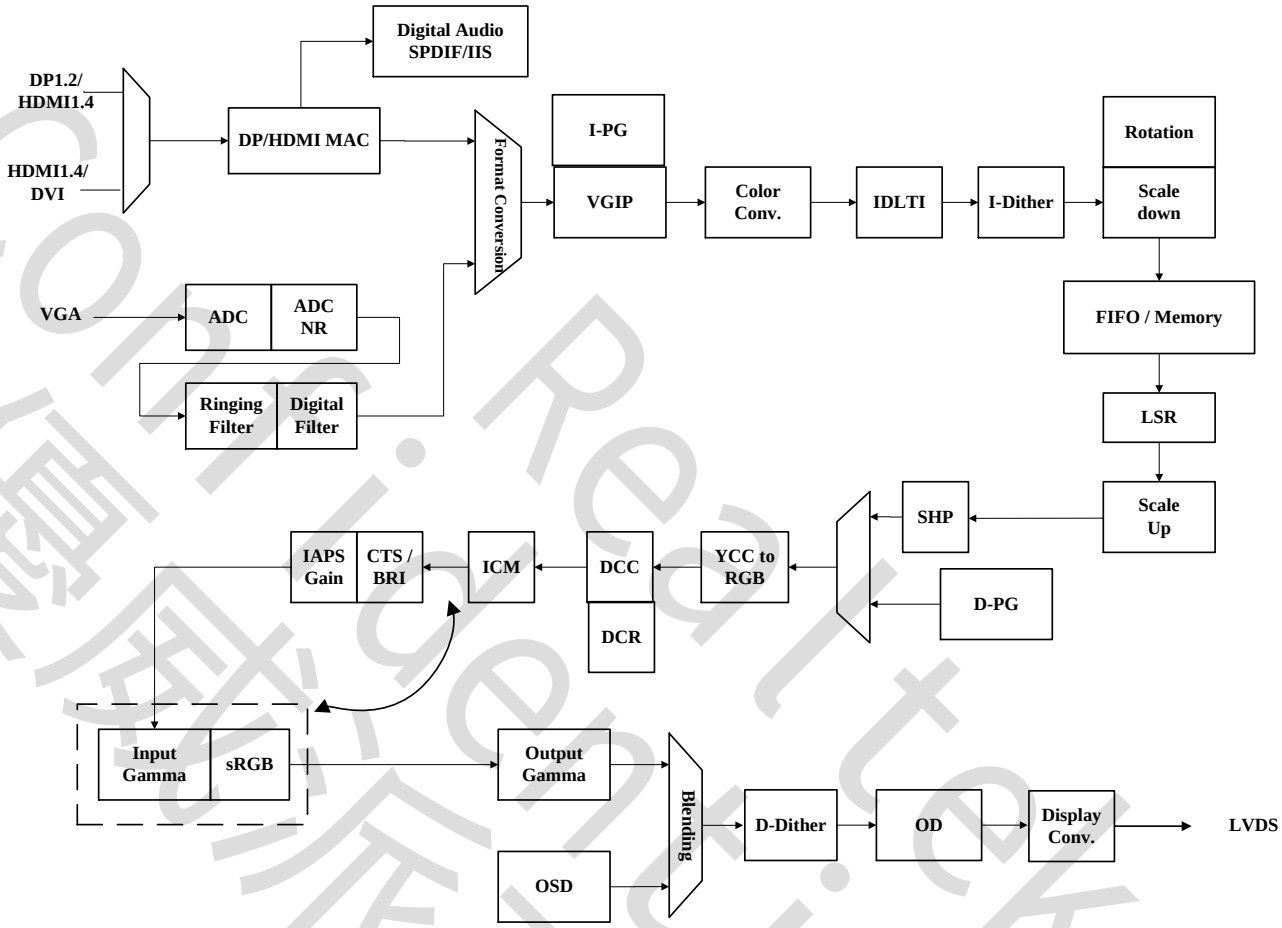

Figure 1. Block Diagram

5. Pin Assignments

LQFP156

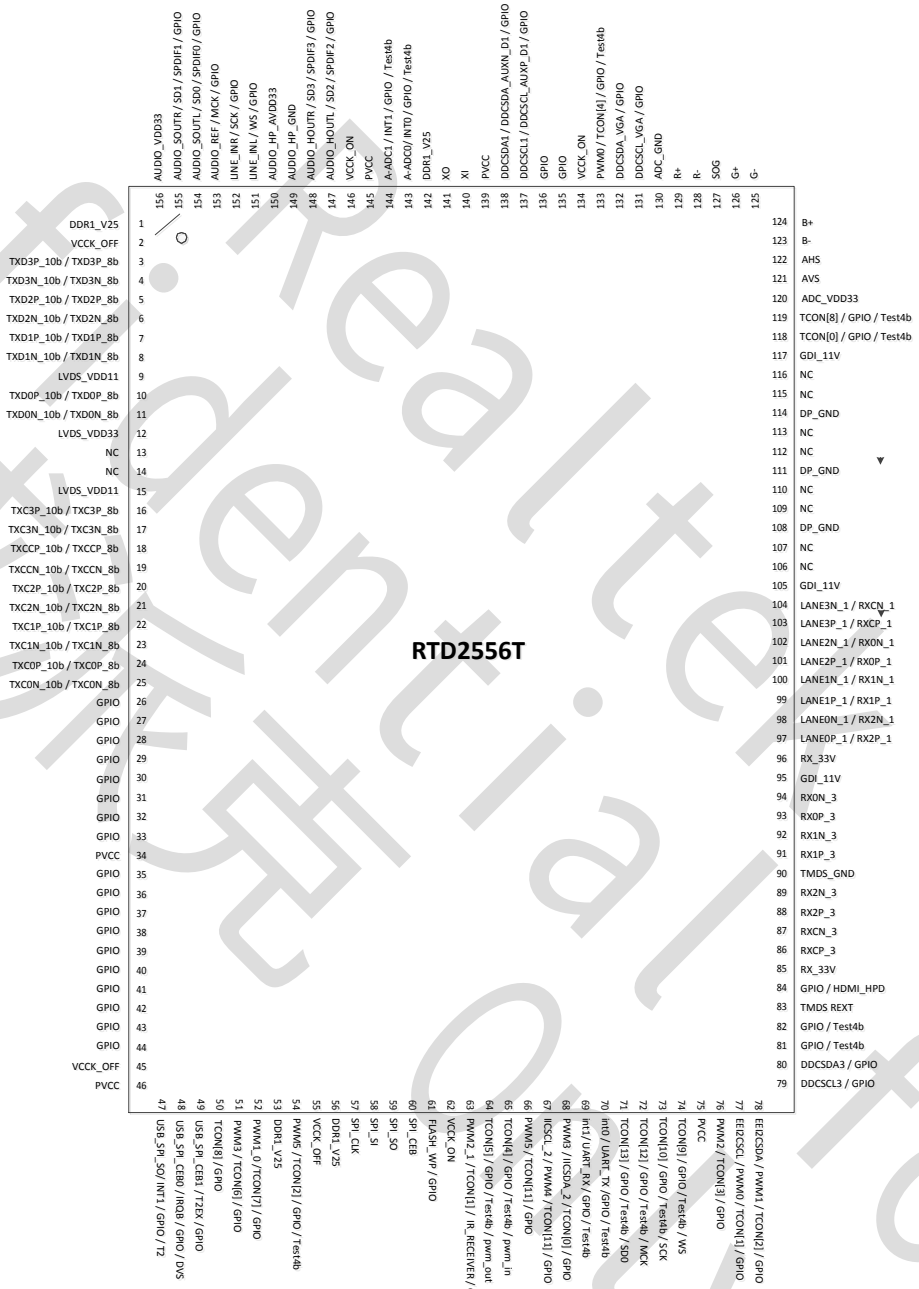

Figure 2. Pin Diagram of LQFP156

6. Pin Assignments Table

Table 1. Signals Pin Assignment of LQFP156

(I/O Legend: A = Analog, I = Input, O = Output, P = Power, G = Ground)

Pin Name	I/O	Pin #	Description	Note
DDR1_V25	AP	1	DDR1 2.5V Power	(2.5V)
VCCK_OFF	DP	2	Core Power	(1.1V)
TXD3P_10b / TXD3P_8b	NC	3	LVDS	3.3V Tolerance
TXD3N_10b / TXD3N_8b	NC	4	LVDS	3.3V Tolerance
TXD2P_10b / TXD2P_8b	NC	5	LVDS	3.3V Tolerance
TXD2N_10b / TXD2N_8b	NC	6	LVDS	3.3V Tolerance
TXD1P_10b / TXD1P_8b	AO	7	LVDS	3.3V Tolerance
TXD1N_10b / TXD1N_8b	AO	8	LVDS	3.3V Tolerance
LVDS_VDD11	AP	9	LVDS 1.1V Power	(1.1V)
TXD0P_10b / TXD0P_8b	AO	10	LVDS	3.3V Tolerance
TXD0N_10b / TXD0N_8b	AO	11	LVDS	3.3V Tolerance
LVDS_VDD33	AP	12	LVDS 3.3V Power	(3.3V)
NC	NC	13	NC Pin	
NC	NC	14	NC Pin	
LVDS_VDD11	AP	15	LVDS 1.1V Power	(1.1V)
TXC3P_10b / TXC3P_8b	AO	16	LVDS	3.3V Tolerance
TXC3N_10b / TXC3N_8b	AO	17	LVDS	3.3V Tolerance
TXCCP_10b / TXCCP_8b	NC	18	LVDS	3.3V Tolerance
TXCCN_10b / TXCCN_8b	NC	19	LVDS	3.3V Tolerance
TXC2P_10b / TXC2P_8b	NC	20	LVDS	3.3V Tolerance
TXC2N_10b / TXC2N_8b	NC	21	LVDS	3.3V Tolerance

TXC1P_10b / TXC1P_8b	NC	22	LVDS	3.3V Tolerance
TXC1N_10b / TXC1N_8b	NC	23	LVDS	3.3V Tolerance
TXC0P_10b / TXC0P_8b	NC	24	LVDS	3.3V Tolerance
TXC0N_10b / TXC0N_8b	NC	25	LVDS	3.3V Tolerance
GPIO	AI O	26	MCU GPIO	3.3V Tolerance
GPIO	AI O	27	MCU GPIO	3.3V Tolerance
GPIO	AI O	28	MCU GPIO	3.3V Tolerance
GPIO	AI O	29	MCU GPIO	3.3V Tolerance
GPIO	AI O	30	MCU GPIO	3.3V Tolerance
GPIO	AI O	31	MCU GPIO	3.3V Tolerance
GPIO	AI O	32	MCU GPIO	3.3V Tolerance
GPIO	AI O	33	MCU GPIO	3.3V Tolerance
PVCC	DP	34	Pad Power	(3.3V)
GPIO	AI O	35	MCU GPIO	3.3V Tolerance
GPIO	AI O	36	MCU GPIO	3.3V Tolerance
GPIO	AI O	37	MCU GPIO	3.3V Tolerance
GPIO	AI O	38	MCU GPIO	3.3V Tolerance
GPIO	AI O	39	MCU GPIO	3.3V Tolerance
GPIO	AI O	40	MCU GPIO	3.3V Tolerance
GPIO	AI O	41	MCU GPIO	3.3V Tolerance
GPIO	AI O	42	MCU GPIO	3.3V Tolerance
GPIO	AI O	43	MCU GPIO	3.3V Tolerance
GPIO	AI	44	MCU GPIO	3.3V

	O			Tolerance
VCCK_OFF	DP	45	Core Power	(1.1V)
PVCC	DP	46	Pad Power	(3.3V)
USB_SPI_SO/ INT1 / GPIO / T2	IO	47	SPI Serial Data Output / MCU EXINT / MCU GPIO / Timer	5V Tolerance when power off
USB_SPI_CEB0 / IRQB / GPIO / DVS	IO	48	SPI Chip Enable / IRQB / MCU GPIO / DVS	5V Tolerance when power off
USB_SPI_CEB1 / T2EX / GPIO	IO	49	SPI Chip Enable / T2EX / MCU GPIO	5V Tolerance when power off
eTCON[8] / GPIO	IO	50	TCON / MCU GPIO	5V Tolerance when power off
PWM3 / TCON[6] / GPIO	IO	51	PWM / TCON / MCU GPIO	5V Tolerance when power off
PWM1_0 / TCON[7] / GPIO	IO	52	PWM / TCON / MCU GPIO	5V Tolerance when power off
DDR1_V25	AP	53	DDR1 2.5V Power	(2.5V)
PWM5 / TCON[2] / GPIO / Test4b	IO	54	PWM / TCON / MCU GPIO / Test4b	5V Tolerance when power off
VCCK_OFF	DP	55	Core Power	(1.1V)
DDR1_V25	AP	56	DDR1 2.5V Power	(2.5V)
SPI_CLK	IO	57	SPI flash serial clock	3.3V Tolerance
SPI_SI	IO	58	SPI flash serial Data Input	3.3V Tolerance
SPI_SO	IO	59	SPI flash serial Data Output	3.3V Tolerance
SPI_CEB	IO	60	SPI flash Chip Enable	3.3V Tolerance
FLASH_WP / GPIO	IO	61	FLASH Write Protect / MCU GPIO	3.3V Tolerance
VCCK_ON	DP	62	Core Power	(1.1V)
PWM2_1 / TCON[1] / IR_RECEIVER / GPIO	IO	63	PWM / TCON / IR Receiver / MCU GPIO	5V Tolerance when power off
TCON[5] / pwm_out / GPIO / Test4b	IO	64	TCON / PWM_OUT / MCU GPIO / Test4b	5V Tolerance when power off

TCON[4] / pwm_in / GPIO / Test4b	IO	65	TCON / PWM_IN / MCU GPIO / Test4b	5V Tolerance when power off
PWM5 / TCON[11] / GPIO	IO	66	PWM / TCON / MCU GPIO	5V Tolerance when power off
IICSCL_2 / PWM4 / TCON[11] / GPIO	IO	67	IIC BUS / PWM / TCON / MCU GPIO	5V Tolerance when power off
PWM3 / IICSDA_2 / TCON[0] / GPIO	IO	68	PWM / IIC BUS / TCON / MCU GPIO	5V Tolerance when power off
int1/ UART_RX / GPIO / Test4b	IO	69	MCU EXINT / UART RX / MCU GPIO / Test4b	5V Tolerance when power off
int0 / UART_TX /GPIO / Test4b	IO	70	MCU EXINT / UART TX / MCU GPIO / Test4b	5V Tolerance when power off
TCON[13] / GPIO / Test4b / SD0	IO	71	TCON / MCU GPIO / Test4b / I2S	5V Tolerance when power off
TCON[12] / GPIO / Test4b / MCK	IO	72	TCON / MCU GPIO / Test4b / I2S	5V Tolerance when power off
TCON[10] / GPIO / Test4b / SCK	IO	73	TCON / MCU GPIO / Test4b / I2S	5V Tolerance when power off
TCON[9] / GPIO / Test4b / WS	IO	74	TCON / MCU GPIO / Test4b / I2S	5V Tolerance when power off
PVCC	DP	75	Pad Power	(3.3V)
PWM2 / TCON[3] / GPIO	IO	76	PWM / TCON / MCU GPIO	3.3V Tolerance
EEI2CSCL / PWM0 / TCON[1] / GPIO	IO	77	EEPROM IIC BUS / PWM / TCON / MCU GPIO	3.3V Tolerance
EEI2CSDA / PWM1 / TCON[2] / GPIO	IO	78	EEPROM IIC BUS / PWM / TCON / MCU GPIO	3.3V Tolerance
DDCSCL3 / GPIO	IO	79	DDC Channel (Open drain I/O) / MCU GPIO	5V Tolerance when power off
DDCSDA3 / GPIO	IO	80	DDC Channel (Open drain I/O) / MCU GPIO	5V Tolerance when power off

GPIO / Test4b	IO	81	MCU GPIO / Test4b	5V Tolerance when power off
GPIO / Test4b	IO	82	MCU_GPIO / Test4b	5V Tolerance when power off
TMDS REXT	AI	83	Impedance Match Resistor	12K ohm Reference to GND
GPIO / HDMI_HPD	AI O	84	MCU_GPIO / HDMI Hot-plug	5V Tolerance when power off
RX_33V	AP	85	GDI 3.3V Power	(3.3V)
RXCP_3	AI	86	TMDS Differential Signal Input	
RXCN_3	AI	87	TMDS Differential Signal Input	
RX2P_3	AI	88	TMDS Differential Signal Input	
RX2N_3	AI	89	TMDS Differential Signal Input	
TMDS_GND	AG	90	TMDS Ground	
RX1P_3	AI	91	TMDS Differential Signal Input	
RX1N_3	AI	92	TMDS Differential Signal Input	
RX0P_3	AI	93	TMDS Differential Signal Input	
RX0N_3	AI	94	TMDS Differential Signal Input	
GDI_11V	AP	95	GDI 1.1V Power	(1.1V)
RX_33V	AP	96	GDI 3.3V Power	(3.3V)
LANE0P_1 / RX2P_1	AI	97	DP Differential Signal Input / TMDS Differential Signal Input	
LANE0N_1/ RX2N_1	AI	98	DP Differential Signal Input / TMDS Differential Signal Input	
LANE1P_1 / RX1P_1	AI	99	DP Differential Signal Input / TMDS Differential Signal Input	
LANE1N_1/ RX1N_1	AI	100	DP Differential Signal Input / TMDS Differential Signal Input	
LANE2P_1 / RX0P_1	AI	101	DP Differential Signal Input / TMDS Differential Signal Input	
LANE2N_1/ RX0N_1	AI	102	DP Differential Signal Input / TMDS Differential Signal Input	
LANE3P_1 / RXCP_1	AI	103	DP Differential Signal Input / TMDS Differential Signal Input	
LANE3N_1/ RXCN_1	AI	104	DP Differential Signal Input / TMDS Differential Signal Input	
GDI_11V	AP	105	GDI 1.1V Power	(1.1V)
NC	NC	106	NC Pin	
NC	NC	107	NC Pin	
DP_GND	AG	108	DP Ground	

NC	NC	109	NC Pin	
NC	NC	110	NC Pin	
DP_GND	AG	111	DP Ground	
NC	NC	112	NC Pin	
NC	NC	113	NC Pin	
DP_GND	AG	114	DP Ground	
NC	NC	115	NC Pin	
NC	NC	116	NC Pin	
GDI_11V	AP	117	GDI 1.1V Power	(1.1V)
TCON[0] / GPIO / Test4b	IO	118	TCON / MCU_GPIO / Test4b	5V Tolerance when power off
TCON[8] / GPIO / Test4b	IO	119	TCON / MCU_GPIO / Test4b	5V Tolerance when power off
ADC_VDD33	AP	120	ADC 3.3V Power	(3.3V)
AVS	AI	121	ADC Vertical Sync Input	5V Tolerance when power off
AHS	AI	122	ADC Horizontal Sync Input	5V Tolerance when power off
B-	AI	123	Negatice Blue analog input (Pb-)	3.3V Tolerance
B+	AI	124	Positive Blue analog input (Pb+)	3.3V Tolerance
G-	AI	125	Negatice Green analog input (Y-)	3.3V Tolerance
G+	AI	126	Positive Green analog input (Y+)	3.3V Tolerance
SOG	AI	127	Sync-On-Green	3.3V Tolerance
R-	AI	128	Negative RED analog input (Pr-)	3.3V Tolerance
R+	AI	129	Positive RED analog input (Pr+)	3.3V Tolerance
ADC_GND	AG	130	ADC Ground	
DDCSCL_VGA / GPIO	IO	131	DDC VGA (Open drain I/O) / MCU GPIO	5V Tolerance when power off
DDCSDA_VGA / GPIO	IO	132	DDC VGA (Open drain I/O) / MCU GPIO	5V Tolerance when power off
PWM0 / TCON[4] / GPIO / Test4b	IO	133	PWM / TCON / MCU_GPIO / Test4b	5V Tolerance when power

				off
VCCK_ON	DP	134	Core Power	(1.1V)
GPIO	IO	135	MCU GPIO	5V Tolerance when power off
GPIO	IO	136	MCU GPIO	5V Tolerance when power off
DDCSCL1 / DDCSCL_AUXP_ D1 / GPIO	IO	137	DDC Channel (Open drain I/O) / DPRX AUX-CH / MCU GPIO	5V Tolerance when power off
DDCSDA1 / DDCSDA_AUXN_ D1 / GPIO	IO	138	DDC Channel (Open drain I/O) / DPRX AUX-CH / MCU GPIO	5V Tolerance when power off
PVCC	DP	139	Pad Power	(3.3V)
XI	AI	140	Crystal Input	3.3V Tolerance
XO	AO	141	Crystal Output	3.3V Tolerance
DDR1_V25	AP	142	DDR1 2.5V Power	(2.5V)
A-ADC0/ INT0 / GPIO / Test4b	AI O	143	5bits MCU ADC Input / MCU EXINT / MCU GPIO / Test4b	3.3 V tolerance when using ADC Input; 5V Tolerance power on when using GPIO
A-ADC1 / INT1 / GPIO / Test4b	AI O	144	5bits MCU ADC Input / MCU EXINT / MCU GPIO / Test4b	3.3 V tolerance when using ADC Input; 5V Tolerance power on when using GPIO
PVCC	DP	145	Pad Power	(3.3V)
VCCK_ON	DP	146	Core Power	(1.1V)
AUDIO_HOUTL / SD2 / SPDIF2 / GPIO	AI O	147	AUDIO_HOUTL / I2S / SPDIF / MCU GPIO	3.3V Tolerance
AUDIO_HOUTR / SD3 / SPDIF3 / GPIO	AI O	148	AUDIO_HOUTL / I2S / SPDIF / MCU GPIO	3.3V Tolerance
AUDIO_HP_GND	AG	149	AUDIO HP Ground	

AUDIO_HP_AVDD33	AP	150	AUDIO HP 3.3V Power	(3.3V)
LINE_INL / WS / GPIO	AIO	151	LINE_INL / I2S / MCU GPIO	3.3V Tolerance
LINE_INR / SCK / GPIO	AIO	152	LINE_INR / I2S / MCU GPIO	3.3V Tolerance
AUDIO_REF / MCK / GPIO	AIO	153	AUDIO_REF / I2S / MCU GPIO	3.3V Tolerance
AUDIO_SOUTL / SD0 / SPDIF0 / GPIO	AIO	154	AUDIO_SOUTL / I2S / SPDIF / MCU GPIO	3.3V Tolerance
AUDIO_SOUTR / SD1 / SPDIF1 / GPIO	AIO	155	AUDIO_SOUTR / I2S / SPDIF / MCU GPIO	3.3V Tolerance
AUDIO_VDD33	AP	156	Audio DAC 3.3V Power	(3.3V)

7. Electrical Specifications

Electrical Specifications

LQFP156 DC Characteristics (RTD2556T-CG Series)

7.1. Recommended Operating Conditions

Table 2. Recommended Operating Conditions of LQFP156

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
Voltage on Input (5V tolerance)	V_{IN}	-1		5.3	V
Supply Voltage	PVCC	3.14	3.30	3.47	V
Core Power On Voltage	VCCK_ON	1.05	1.1	1.15	V
Core Power Off Voltage	VCCK_OFF	1.05	1.1	1.15	V
Electrostatic Discharge	V_{ESD}			±2.5	kV
Latch-Up	I_{LA}			±100	mA
Ambient Operating Temperature	T_A	0		70	ºC
Storage Temperature (plastic)	T_{STG}	-55		110	ºC
Thermal Resistance (Junction to Air)	θ_{JA}		25.2		ºC/W
Thermal Resistance (Junction to Case)	θ_{JC}		10.1		ºC/W
Junction Acceptable Temperature	T_j			125	ºC

7.2. Absolute Maximum Ratings

Table 3. Absolute Maximum Ratings of LQFP156

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
Supply Voltage	PVCC			3.6	V
Storage Temperature (plastic)	T_{STG}			150	ºC
Junction Acceptable Temperature	T_j			125	ºC

Note : Operation under the absolute maximum ratings does not imply well-functioning. Long-term stress to the absolute maximum ratings would probably affect the device reliability or further cause permanent damage.

7.3. Reset Period

Table 4. Reset Period of LQFP156

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
Reset Pulse Period	Trst-en[1]	1120			ns
Power-on-Reset Period	Tpor-rst[2]	145	146.5	148	ms

1. 16 * Xtal_cycle(1/14.3Mhz)
2. 65536*16*2*Xtal_cycle(1/14.3Mhz)

8. Mechanical Specifications

Thermal Enhanced Low Profile Plastic Quad Flat Package 156 Leads

14x20mm^2 Outline

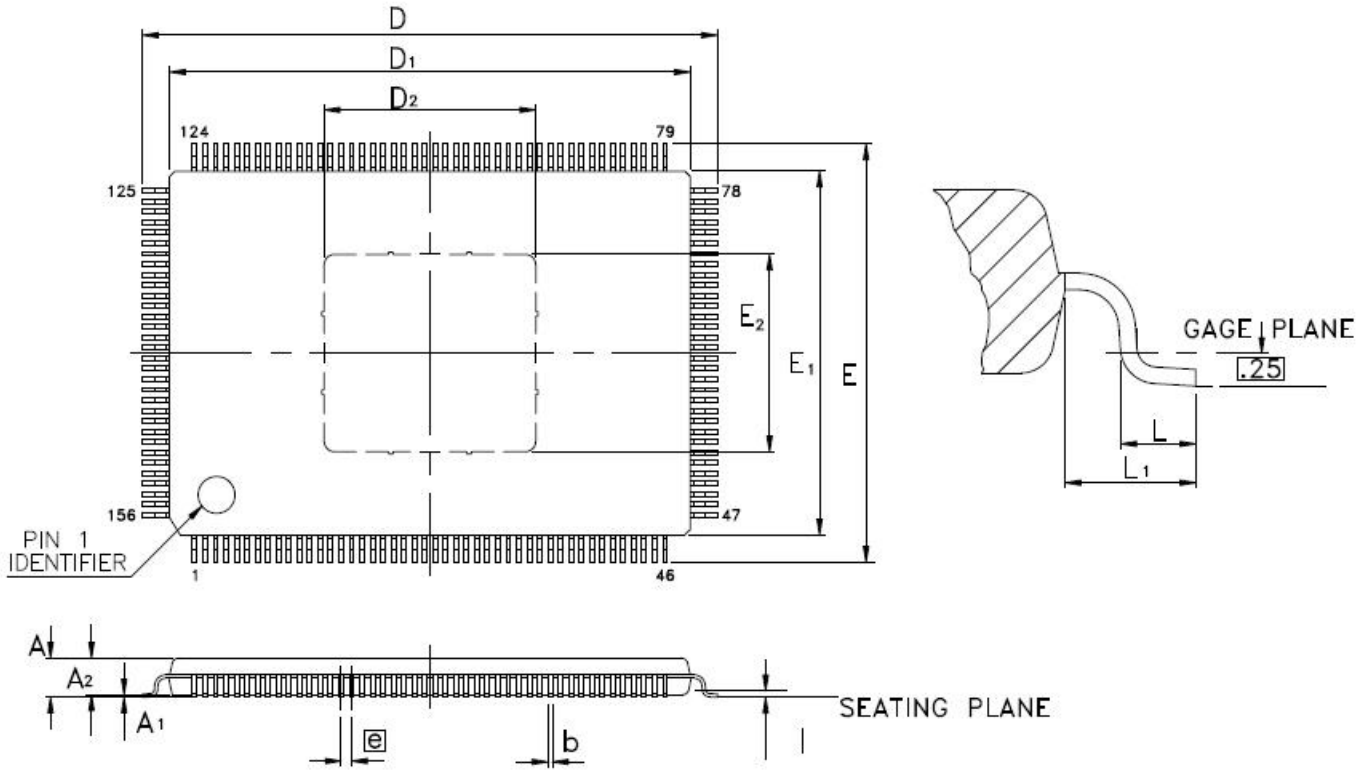

Figure 3. Mechanical Specification of LQFP156 Leads

Table 5. Mechanical Specification of LQFP156 Leads

Symbol	Dimension in mm			Dimension in inch		
	Min	Nom	Max	Min	Nom	Max
A	—	—	1.60	—	—	0.063
A_1	0.05	—	0.15	0.002	—	0.006
A_2	1.35	1.40	1.45	0.053	0.055	0.057
b	0.13	0.18	0.23	0.005	0.007	0.009
D	21.90	22.00	22.10	0.862	0.866	0.870
E	15.90	16.00	16.10	0.626	0.630	0.634
D_1	19.90	20.00	20.10	0.783	0.787	0.791
E_1	13.90	14.00	14.10	0.547	0.551	0.555
D_2	7.85	8.10	8.35	0.309	0.319	0.329
E_2	7.30	7.55	7.80	0.287	0.297	0.307
e	0.40 BSC			0.016 BSC		
L	0.45	0.60	0.75	0.018	0.024	0.030
L1	1.00 REF			0.039 REF		

Notes：

1. CONTROLLING DIMENSION：MILLIMETER(mm).

9. Ordering Information

Table 6. Ordering Information

Part No.	Max. Resolution	Input : VGA	Input : DP1.2/ HDMI1.4	Input : HDMI1.4/ DVI	Output : LVDS	PKG
RTD2556T-CG	1920x1200 @60Hz	●	1 Ports	1 Ports	●	LQFP156

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