

Rockchip RK1820/ RK1828 Datasheet

**Revision 1.4
Dec 2025**

Revision History

Date	Revision	Description
2025-12-04	1.4	Update package dimension pictures in 2.3 Correct minimum supply voltage for DRAM VPPEX in Table 3-2
2025-11-25	1.3	Confirm ambient operating temperature in Table 3-2
2025-11-20	1.2	Change overview description, highlighting its AI feature and applications in LLM and VLM Update description of PCIe 2.1 interface
2025-09-22	1.1	Add features and package information of RK1828
2025-07-28	1.0	Initial release

Table of Content

Table of Content	3
Figure Index	4
Table Index.....	5
Warranty Disclaimer.....	6
Chapter 1 Introduction	7
1.1 Overview	7
1.2 Features	7
1.3 Block Diagram	12
Chapter 2 Package Information.....	13
2.1 Order Information	13
2.2 Top Marking	13
2.3 Package Dimension	14
2.4 MSL Information	15
2.5 Lead Finish/Ball material Information	15
2.6 Pin Number List	15
Chapter 3 Electrical Specification	25
3.1 Absolute Ratings	25
3.2 Recommended Operating Condition	25
3.3 DC Characteristics.....	26
3.4 Electrical Characteristics for General IO	26
3.5 Electrical Characteristics for PLL	26
3.6 Electrical Characteristics for USB2.0 Interface	27
3.7 Electrical Characteristics for SARADC	27
3.8 Electrical Characteristics for TSADC.....	27
3.9 Electrical Characteristics for Multi-PHY.....	28
Chapter 4 Thermal Management.....	29
4.1 Overview	29
4.2 Package Thermal Characteristics	29

Figure Index

Fig. 1-1 Block Diagram	12
Fig. 2-1 RK1820 Package Definition	13
Fig. 2-2 RK1828 Package Definition	13
Fig. 2-3 RK1820/ RK1828 Package Top View and Side View	14
Fig. 2-4 RK1820/ RK1828 Package Bottom View	14
Fig. 2-5 RK1820/ RK1828 PKG Detail A.....	15
Fig. 2-6 RK1820/ RK1828 Package Dimension.....	15

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Table Index

Table 2-1 RK1820/ RK1828 Pin Number Order Information	15
Table 3-1 Absolute Ratings	25
Table 3-2 Recommended Operating Condition	25
Table 3-3 DC Characteristics.....	26
Table 3-4 Electrical Characteristics for Digital General IO	26
Table 3-5 Electrical Characteristics for FRAC PLL.....	26
Table 3-6 Electrical Characteristics for USB2.0 Interface	27
Table 3-7 Electrical Characteristics for SARADC	27
Table 3-8 Electrical Characteristics for TSADC	27
Table 3-9 Electrical Characteristics for PCIe PHY.....	28
Table 4-1 Thermal Resistance Characteristics.....	29

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Chapter 1 Introduction

1.1 Overview

RK1820 and RK1828 is a high-performance AI co-processor SoC for machine learning application, especially for Large Language Model (LLM) and Vision Language Model (VLM) related application.

It is based on three 64-bit independent RISC-V cores with FPU. There is a 32KB I-cache, 32KB D-cache and 128KB L2 cache for each core.

The build-in NPU Support INT4/INT8/INT16/FP8/FP16/BF16 hybrid operation and computing power is up to 20TOPs. In addition, with its strong compatibility, network models based on a series of frameworks such as TensorFlow/MXNet/PyTorch/Caffe can be easily converted.

RK1820 and RK1828 have extreme high bandwidth build-in DRAM.

To communicate with the host processor, RK1820 and RK1828 integrate two PCIe 2.0/ USB 3.0 combo PHYs.

1.2 Features

1.2.1 Application Processor

- Three RISC-V cores abbreviated as SRV, VRV0 and VRV1
- SRV is implemented with RV64GCB ISA and VR0/VRV1 is implemented with RV64GCBV ISA
- All cores are integrated FPU with RISC-V H/F/D precision
- Each core has 32KB L1 I-Cache, 32KB L1 D-Cache and 128KB L2 cache
- VRV0 and VRV1 is integrated with 128-bit vector unit

1.2.2 Memory Organization

- Internal on-chip memory
 - Bootrom
 - ◆ Support system boot from the following device:
 - SPI interface
 - eMMC interface
 - SD/MMC interface
 - ◆ Support system code download by the following interface:
 - USB2.0 interface
 - UART interface
 - PCIe interface
 - 512KB system SRAM
 - Build-in Dynamic Memory Interface
 - ◆ Capacity is 2.5GB (RK1820)/ 5GB (RK1828)
- External off-chip memory
 - Combo SDMMC Interface, work at only one of the following modes
 - ◆ eMMC
 - Fully compliant with JEDEC eMMC 4.51 specification
 - Support HS200, but not support CMD Queue
 - Support three data bus width mode: 1bit, 4bits and 8bits
 - ◆ SD/MMC Interface
 - Compatible with SD3.0, MMC ver4.51
 - Support 1bit, 4bits data bus width
 - ◆ SDIO Interface
 - Compatible with SDIO3.0 protocol
 - 4-bit data bus widths

- Flexible Serial Flash Interface (FSPI)
 - ◆ Support transfer data from/to serial flash device
 - ◆ Support 1bit, 2bits or 4bits data bus width
 - ◆ Support 2 chips select

1.2.3 System Component

- CRU (clock & reset unit)
 - Support total 4 PLLs to generate all clocks
 - One oscillator with 24MHz clock input
 - Support clock gating control for individual components
 - Support global soft-reset control for whole chip, also individual soft-reset for each component
- PMU (power management unit)
 - Multiple configurable work modes to save power by different frequency or automatic clock gating control
 - Support 3 separate voltage domains
VDD_TOP, VDD_LOGIC, VDD_PMU
- Timer
 - Support 6 timers with 64bits counter and interrupt-based operation
 - Support two operation modes: free-running and user-defined count for each timer
 - Support timer work state checkable
- Watchdog
 - 32-bit watchdog counter
 - Counter counts down from a preset value to 0 to indicate the occurrence of a timeout
 - WDT can perform two types of operations when timeout occurs:
 - ◆ Generate a system reset
 - ◆ First generate an interrupt and if this is not cleared by the service routine by the time a second timeout occurs then generate a system reset
 - Three Watchdogs
- Interrupt Controller
 - Support 160 interrupt sources input from different components inside SoC for SRV and 64 interrupt sources input for VRV
 - Support 1 software-triggered interrupt in m-mode and s-mode each
 - Input interrupt level is fixed, high-level sensitive
 - Support different interrupt priority for each interrupt source, and they are always software-programmable
- DMAC
 - Support 2 physical channels
 - Support 22 groups of peripheral request interfaces
 - Support 24 logic channels, each logic channel support the following feature
 - ◆ Support the data transfer of memory-to-memory, memory-to-peripherals, peripherals-to-memory
 - ◆ Support Linked list DMA function to complete scatter-gather transfer
 - ◆ Support three kinds of multi-block transfer: contiguous address, auto reload, link list
- Secure System
 - Support one cipher engine
 - ◆ Support Symmetrical algorithms
 - AES-128, AES-192, AES-256, SM4
 - ECB/CBC/OFB/CFB/CTR/CTS/XTS/CCM/GCM/CBC-MAC/CMAC mode for AES

- and SM4
 - ◆ Hash algorithm
 - SHA-1, SHA-256/224, MD5, SM3 with hardware padding
 - HMAC of SHA-1, SHA-256, MD5, SM3 with hardware padding
 - ◆ Asymmetrical algorithms
 - RSA (up to 4096 bits), ECC (up to 256 bits), SM2
 - ◆ Key-ladder (KL)
 - Support obtaining the root key from OTP or RKRNG and deriving it
 - Support writes out root key or derived key to some specific modules
 - Number of stages can be configured
- Mailbox
 - Twelve mailboxes in SoC used to service different RISC-V communication

1.2.4 JPEG CODEC

- JPEG encoder
 - Supports Baseline (DCT sequential)
 - Supports JPEG file interchange format (JFIF) 1.02
 - Supports image size is from 16x16 to 65520x65520
 - Supports YUV400/YUV420/YUV422/YUV444
- JPEG Decoder
 - Support Baseline (DCT sequential)
 - Support JPEG file interchange format (JFIF) 1.02
 - Support image size is from 48x48 to 65520x65520
 - Support YUV400/YUV420/YUV422/YUV440/YUV411/YUV444/RG888/RGB565

1.2.5 Neural Process Unit

- Rockchip NPU engine:
 - Up to 20 TOPS for INT8
 - Support INT4/INT8/INT16/FP8/FP16/BF16 operation
 - Support deep learning frameworks: TensorFlow, Caffe, Tflite, Pytorch, Onnx NN, Android NN, etc.

1.2.6 2D Graphics Engine

- 2D Graphics Engine (RGA)
- Data format
 - SRC0 Input data format:
 - ◆ ARGB8888/RGBA8888/RGBA4444/RGBA5551
 - ◆ RGB888P/RGB565
 - ◆ YUV422-P/YUV422-SP-8bit/10bit (clip to 8bit after input)
 - ◆ YUV420-P/YUV420-SP-8bit/10bit (clip to 8bit after input)
 - ◆ YUV444I/YUV444SP-8bit
 - ◆ YVYU422-8bit
 - ◆ YUV400-8bit
 - ◆ TILE4X4 YUV420/422/444-8bit
 - ◆ TILE4X4 YUV420/422/444-10bit (clip to 8bit after input)
 - ◆ BPP1/2/4/8
 - SRC1 Input data format:
 - ◆ ARGB8888/RGBA8888/RGBA4444/RGBA5551/A8
 - ◆ RGB888P/RGB565
 - Output data format (all YUV format is 8bit):
 - ◆ ARGB8888/RGBA8888/ARGB4444/RGBA4444/ARGB5551/RGBA5551
 - ◆ RGB888/RGB565
 - ◆ YUV420/YUV422 P/SP
 - ◆ YUV400/Y4
 - ◆ YUV444SP/444I
 - Pixel Format conversion, BT.601/BT.709

- Dither operation
- Max resolution : 8192x8192 source, 4096x4096 destination
- Scaling
 - Down-scaling: Average/Bilinear filter
 - Up-scaling: Bi-cubic filter(source>1992 would use Bi-linear)
 - Arbitrary non-integer scaling ratio, from 1/16 to 16
- Rotation
 - 0, 90, 180, 270-degree rotation
 - x-mirror, y-mirror operation
 - Mirroring and rotation co-operation
- BitBLT
 - Block transfer
 - Color palette/Color fill, support with alpha
 - Transparency mode (color keying/stencil test, specified value/value range)
 - Two source BitBLT
 - A+B=B only BitBLT, A support rotate & scale when B fixed
 - A+B=C second source (B) has same attribute with (C) plus rotation function
- Alpha Blending
 - Comprehensive per-pixel alpha (color/alpha channel separately)
 - Fading
 - Support SRC1(R2Y) +SRC0(YUV) -> DST(YUV)
 - Support DST Full CSC convert for YUV2YUV
- OSD Automatic Inversion
 - Support OSD sources in ARGB8888/ARGB1555/ARGB444/ARGB2BPP format
 - Support SRC0 and OSD overlay

1.2.7 Serial Audio Interface (SAI)

- Support 1 SAI interfaces
 - Support 4 TX lanes and 4 RX lanes
 - Support audio protocol: I2S, PCM, TDM
 - Support up to 128 slots available with configurable size
 - Support slot length 8 to 32 bits configurable
 - Support slot valid data length 8 to 32 bits configurable

1.2.8 Connectivity

- MAC 10/100/1000M Ethernet
 - Support one Ethernet controllers
 - Support 10/100/1000-Mbps data transfer rates with the RGMII interfaces
 - Support both full-duplex and half-duplex operation
 - Support for TCP Segmentation Offload (TSO) and UDP Segmentation Offload (USO) network acceleration
 - Support Ethernet packet timestamping as described in IEEE 1588-2002 and IEEE 1588-2008
- USB 2.0 DRD (Dual-Role Device)
 - Support one USB2.0 DRD (Dual-Role Device)
 - Compatible with USB 2.0 specification
 - Support high-speed(480Mbps), full-speed(12Mbps) and low-speed(1.5Mbps) mode
 - Support Enhanced Host Controller Interface Specification (EHCI), Revision 1.0
 - Support Open Host Controller Interface Specification (OHCI), Revision 1.0a
- Multi-PHY Interface
 - Support two multi-PHY with two PCIe2.1 controller and one USB3.0 controller (multiplex to one of the PHY)
 - Support one of the following interfaces for each multi-PHY
 - ◆ USB3.0 Host

- ◆ PCIe2.1
- USB 3.0 Dual-Role Device (DRD) Controller
 - ◆ Static USB3.0 Device
 - ◆ Static USB3.0 xHCI host
 - ◆ USB3.0/USB2.0 OTG A device and B device basing on ID
- PCIe2.1 interface
 - ◆ Compatible with PCI Express Base Specification Revision 2.1
 - ◆ Support one lane
 - ◆ Support dual mode
 - ◆ Support 5.0GT/s serial data transmission rate per lane per direction
- SPI interface
 - Support 2 SPI Controllers
 - Support two chip-select output
 - Support serial-master and serial-slave mode, software-configurable
- I2C Master controller
 - Support 5 I2C ports in Master mode
 - Support 7bits and 10bits address mode
 - Software programmable clock frequency
 - Data on the I2C-bus can be transferred at rates of up to 100k bits/s in the Standard-mode, up to 400K bits/s in the Fast-mode and up to 1M bit/s in high-speed mode
- SMBus slave interface
 - Support 1 independent SMBus
 - Supports slave mode of SMBus bus
 - Support SMBus protocol: write byte/read byte/read word/read 32 protocol/write 32 protocol/block write/block read
 - Support PEC
 - Support Alert
 - Support directed get UDID command
 - Clock stretching and wait state generation
- UART interface
 - Support 3 UART ports
 - Embedded two 64-byte FIFO for TX and RX operation respectively
 - Support 5bit, 6bit, 7bit, 8bit serial data transmit or receive
 - Standard asynchronous communication bits such as start, stop and parity
 - Support different input clock for UART operation to get up to 4Mbps baud rate
 - Support auto flow control mode for UART2
 - Support RS485 function for UART2
- PWM
 - Support 1 PWM interface, total 8 channels
 - Support input capture mode
 - Support continuous mode and one-shot output mode
 - Support two-stage frequency division of working clock
 - Support power key capture mode
 - Support clock frequency meter
 - Support clock counter

1.2.9 Others

- Multiple groups of GPIO
 - All of GPIOs can be used to generate interrupt
 - Support level trigger and edge trigger interrupt
 - Support configurable polarity of level trigger interrupt
 - Support configurable rising edge, falling edge and both edge trigger interrupt

- Support configurable pull direction (a weak pull-up and a weak pull-down)
- Support configurable drive strength
- Temperature Sensor (TS-ADC)
 - Support User-Defined Mode and Automatic Mode
 - In User-Defined Mode, start_of_conversion can be controlled completely by software, and also can be generated by hardware.
 - In Automatic Mode, the temperature of alarm (high/low temperature) interrupt can be configurable
 - In Automatic Mode, the temperature of system reset can be configurable
 - Support 3 channel TS-ADC
 - -40~125°C temperature range and +/-3.5°C temperature accuracy
 - Resolution: 0.01°C
- Successive approximation ADC (SARADC)
 - Support 1 SARADC, each support 2 single-ended input channels
 - 13-bit resolution
 - Up to 2MS/s sampling rate
 - Support single mode and series conversion mode
- OTP
 - Support 8K bits size, 6.5K bits for secure application
 - Support Program/Read/Idle mode
- Package Type
 - **RK1820**: FCBGA 746L (body size:19mm x 19mm; ball size: 0.35mm; ball pitch: 0.65mm)
 - **RK1828**: FCBGA 746L (body size:19mm x 19mm; ball size: 0.35mm; ball pitch: 0.65mm)

1.3 Block Diagram

The following figure shows the basic block diagram.

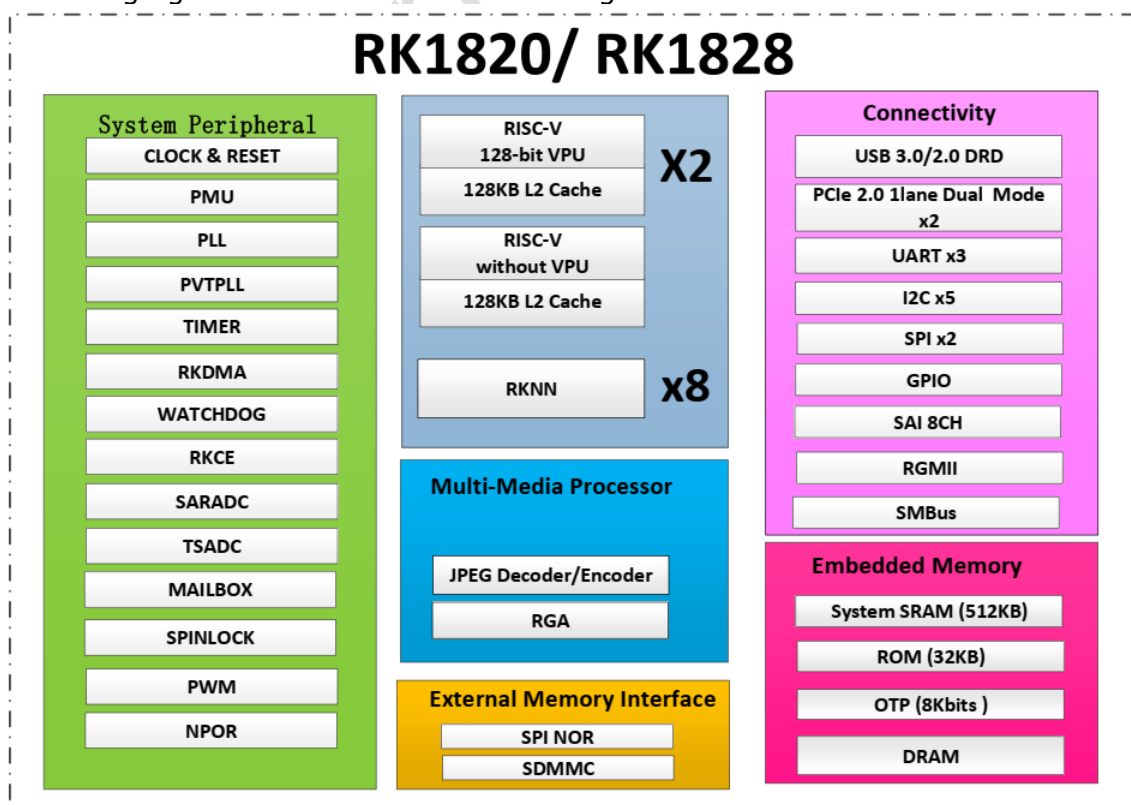


Fig. 1-1 Block Diagram

Chapter 2 Package Information

2.1 Order Information

Orderable Device	RoHS status	Package	Package Q'ty	Device Feature
RK1820	RoHS	FCBGA 746L	420pcs	AI Co-processor
RK1828	RoHS	FCBGA 746L	420pcs	AI Co-processor

2.2 Top Marking

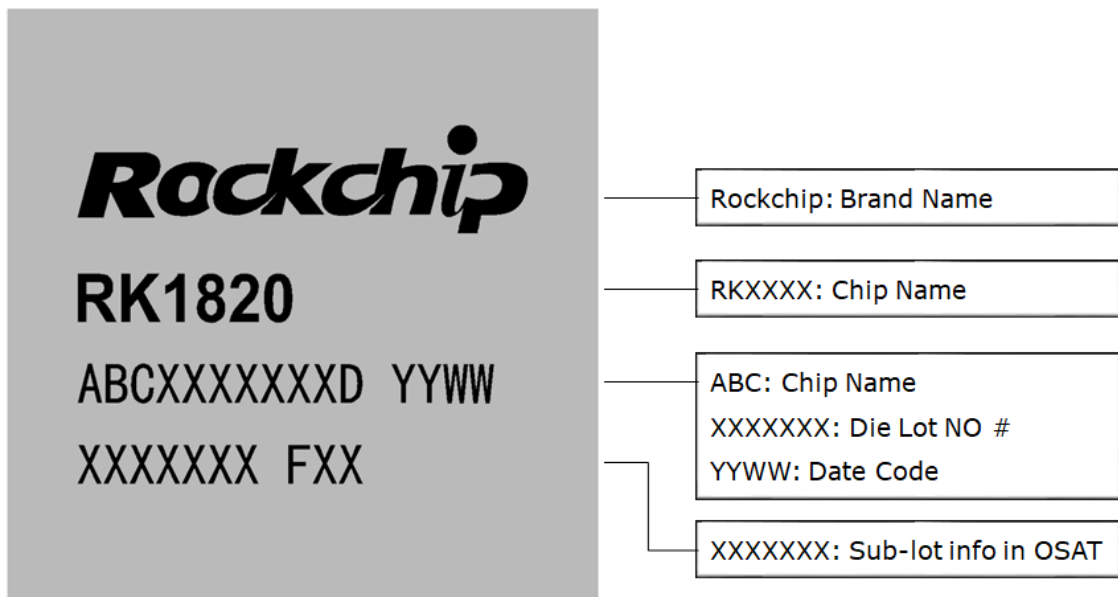


Fig. 2-1 RK1820 Package Definition

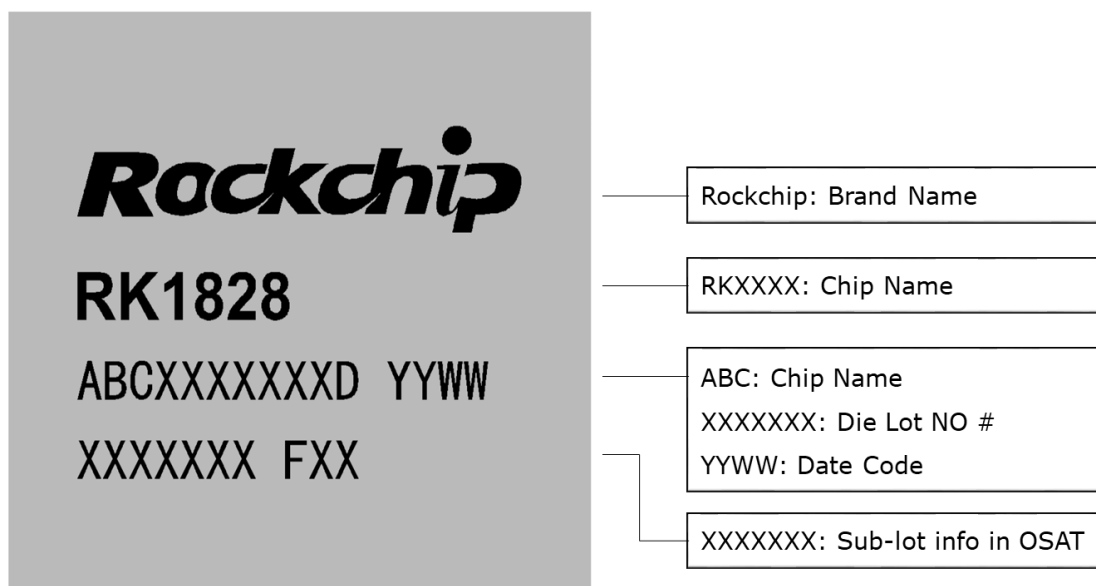


Fig. 2-2 RK1828 Package Definition

2.3 Package Dimension

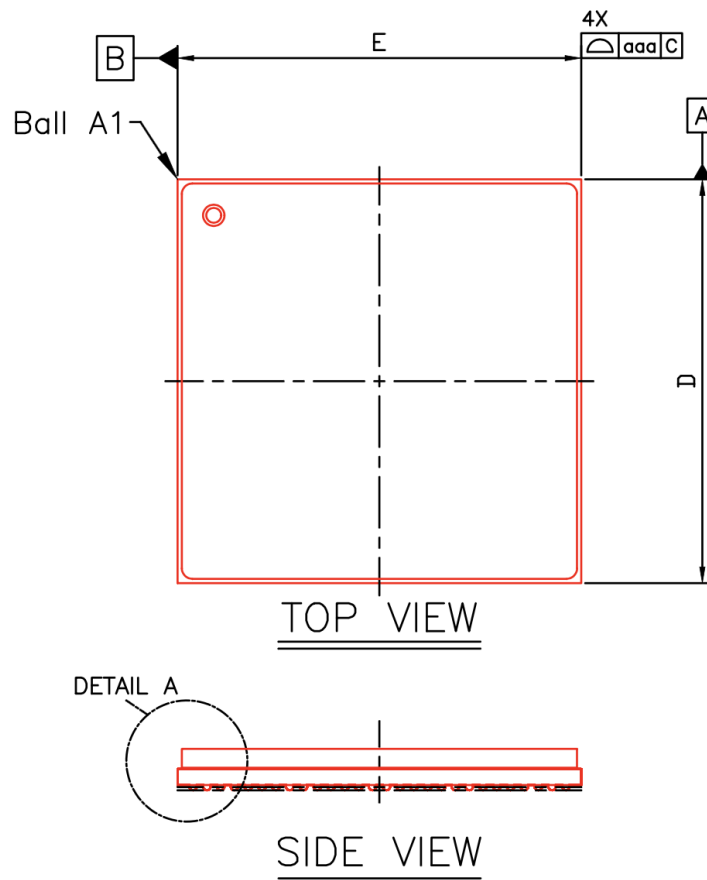


Fig. 2-3 RK1820/ RK1828 Package Top View and Side View

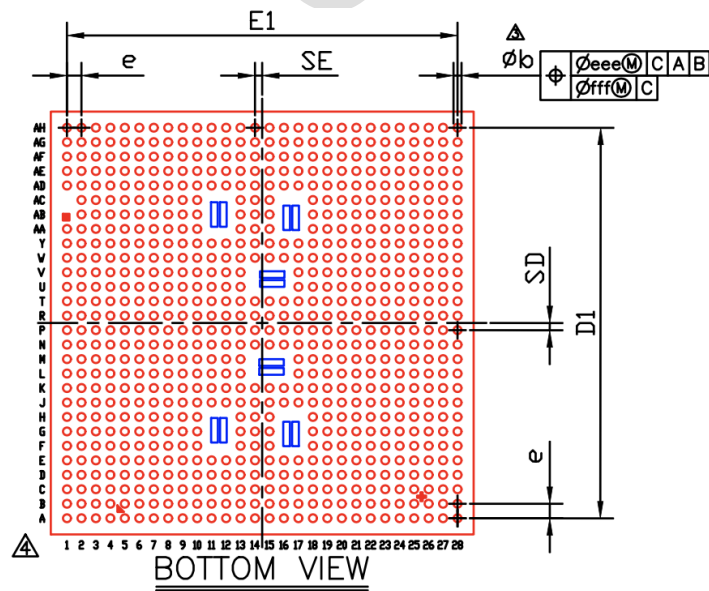


Fig. 2-4 RK1820/ RK1828 Package Bottom View

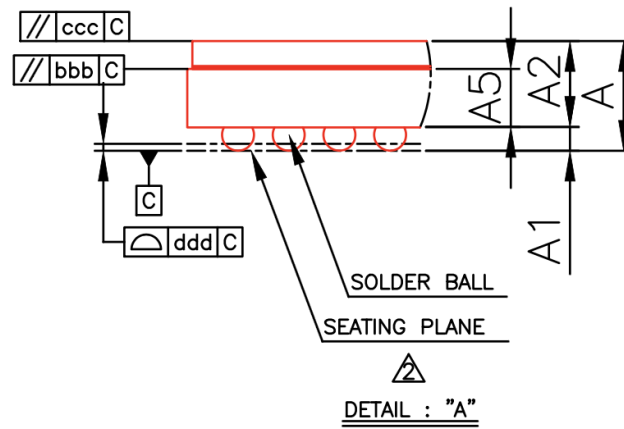


Fig. 2-5 RK1820/ RK1828 PKG Detail A

Symbol	Dimension in mm			Dimension in inch		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.858	1.969	2.083	0.073	0.078	0.082
A1	0.200	0.260	0.320	0.008	0.010	0.013
A2	1.600	1.699	1.801	0.063	0.067	0.071
A5	0.654	0.754	0.854	0.026	0.030	0.034
E	18.850	19.000	19.150	0.742	0.748	0.754
D	18.850	19.000	19.150	0.742	0.748	0.754
E1	---	17.550	---	---	0.691	---
D1	---	17.550	---	---	0.691	---
e	---	0.650	---	---	0.026	---
b	0.310	0.360	0.410	0.012	0.014	0.016
aaa		0.150			0.006	
bbb		0.100			0.004	
ccc		0.350			0.014	
ddd		0.100			0.004	
eee		0.200			0.008	
fff		0.080			0.003	
MD/ME	28/28					
SE		0.325			0.013	
SD		0.325			0.013	

NOTE :

1. CONTROLLING DIMENSION : MILLIMETER.
2. PRIMARY DATUM C AND SEATING PLANE ARE DEFINED BY THE SPHERICAL CROWNS OF THE SOLDER BALLS.
3. DIMENSION b IS MEASURED AT THE MAXIMUM SOLDER BALL DIAMETER, PARALLEL TO PRIMARY DATUM C.
4. THE PATTERN OF PIN 1 FIDUCIAL IS FOR REFERENCE ONLY.
5. BALL PLACEMENT USE 0.350 mm SOLDER BALL.
BGA PAD SOLDER MASK OPENING = 0.300 mm.

Fig. 2-6 RK1820/ RK1828 Package Dimension

2.4 MSL Information

Moisture sensitivity Level: MSL3

2.5 Lead Finish/Ball Material Information

Lead Finish/Ball material: SnAgCu

2.6 Pin Number List

Table 2-1 RK1820/ RK1828 Pin Number Order Information

Pin Name	Pin#	Pin Name	Pin#
VSS_0	A1	VSS_177	P28
I2C2_SDA_M0/UART1_RTSN_M0/PCIE0_PERSTN_M0/SAI_SCLK_M0/GPIO0_B6_d	A2	ETH_TXD3/I2C0_SDA_M1/SPI1_MISO_M2/GPIO1_B1_d	R1

Pin Name	Pin#	Pin Name	Pin#
JTAG_TMS_M0/UART1_RX_M0/SAI_SDI3_M0/SAI_SDO0_M0/GPIO0_C1_d	A3	ETH_TXD2/I2C0_SCL_M1/SPI1_MOSI_M2/GPIO1_B0_d	R2
JTAG_TMS_M1/UART0_RX/GPIO0_C3_u	A4	ETH_MDC/PCIE0_PERSTN_M2/GPIO1_C2_d	R3
VSS_1	A5	ETH_MDIO/PCIE0_CLKREQN_M2/GPIO1_C3_d	R4
VDD_LOGIC_0	A6	VSS_178	R5
VSS_2	A7	VSS_179	R6
VDD_LOGIC_1	A8	VSS_180	R7
VSS_3	A9	VSS_181	R8
DRAM_VEQ_1V4_0	A10	VDD_TOP_9	R9
VSS_4	A11	VSS_182	R10
DRAM_VEQ_1V4_1	A12	VSS_183	R11
VSS_5	A13	VSS_184	R12
DRAM_VPPEX_2V5_0	A14	VSS_185	R13
DRAM_VDD_1V2_0	A15	VSS_186	R14
VSS_6	A16	VSS_187	R15
DRAM_VCC_1V1_0	A17	VSS_188	R16
VSS_7	A18	VSS_189	R17
DRAM_VCC_1V1_1	A19	VSS_190	R18
VSS_8	A20	VSS_191	R19
VSS_SENSE_N	A21	VSS_192	R20
VDD_LOGIC_2	A22	VSS_193	R21
VSS_9	A23	VSS_194	R22
VDD_LOGIC_3	A24	VSS_195	R23
VSS_10	A25	VSS_196	R24
VDD_LOGIC_4	A26	VSS_197	R25
VSS_11	A27	VSS_198	R26
VSS_12	A28	VSS_199	R27
I2C3_SDA_M0/PWM_CH7_M0/SPI1_MOSI_M0/SMBUS_SDA_M0/SAI_SDI1_M0/SAI_SDO2_M0/GPIO0_B4_d	B1	VSS_200	R28
I2C2_SCL_M0/UART1_CTSN_M0/PCIE0_WAKEN_M0/SMBUS_ALERT_M0/SAI_SDI0_M0/SAI_SDO3_M0/GPIO0_B5_d	B2	ETH_CLK_25M_OUT/I2C2_SCL_M1/SAI_SDO2_M2/UART2_CTSN_M0/SPI1_CS1N_M1/GPIO1_C4_d	T1
JTAG_TCK_M0/UART1_TX_M0/SAI_MCLK_M0/GPIO0_C0_d	B3	ETH_MCLK/I2C2_SDA_M1/SAI_SDO1_M2/UART2_RTSN_M0/PWM_CH0_M2/SPI1_MOSI_M1/GPIO1_C5_d	T2
JTAG_TCK_M1/UART0_TX/GPIO0_C2_u	B4	ETH_PTP_REFCLK/SAI_MCLK_M2/PWM_CH1_M2/SPI1_MISO_M1/GPIO1_C6_d	T3
VSS_13	B5	VSS_201	T4
VDD_LOGIC_5	B6	VSS_202	T5
VSS_14	B7	VSS_203	T6
VDD_LOGIC_6	B8	VSS_204	T7
VSS_15	B9	VSS_205	T8
DRAM_VEQ_1V4_2	B10	VDD_TOP_10	T9
VSS_16	B11	VSS_206	T10
DRAM_VEQ_1V4_3	B12	VDD_LOGIC_87	T11
VSS_17	B13	VDD_LOGIC_88	T12
DRAM_VPPEX_2V5_1	B14	VDD_LOGIC_89	T13
DRAM_VDD_1V2_1	B15	VSS_207	T14
VSS_18	B16	VSS_208	T15

Pin Name	Pin#	Pin Name	Pin#
DRAM_VCC_1V1_2	B17	VSS_209	T16
VSS_19	B18	VDD_LOGIC_90	T17
DRAM_VCC_1V1_3	B19	VDD_LOGIC_91	T18
VSS_20	B20	VDD_LOGIC_92	T19
VDD_LOGIC_SENSE_P	B21	VDD_LOGIC_93	T20
VSS_21	B22	VDD_LOGIC_94	T21
VDD_LOGIC_7	B23	VDD_LOGIC_95	T22
VSS_22	B24	VDD_LOGIC_96	T23
VDD_LOGIC_8	B25	VDD_LOGIC_97	T24
VSS_23	B26	VDD_LOGIC_98	T25
VDD_LOGIC_9	B27	VDD_LOGIC_99	T26
VSS_24	B28	VDD_LOGIC_100	T27
PWM_CH4_M0/SPI1_CS0N_M0/GPIO0_B1_d	C1	VDD_LOGIC_101	T28
PWM_CH5_M0/SPI1_MISO_M0/GPIO0_B2_d	C2	ETH_PPSCCLK/PCIE1_WAKEN_M0/SAI_SCLK_M2/PWM_CH2_M2/SPI1_CS0N_M1/GPIO1_C7_d	U1
I2C3_SCL_M0/PWM_CH6_M0/SPI1_CLK_M0/SMBUS_SCL_M0/SAI_SDI2_M0/SAI_SDO1_M0/GPIO0_B3_d	C3	ETH_PPSTRIG/PCIE1_PERSTN_M0/SAI_LRCK_M2/PWM_CH3_M2/SPI1_CLK_M1/GPIO1_D0_d	U2
PCIE0_CLKREQN_M0/SAI_LRCK_M0/GPIO0_B7_d	C4	PCIE1_CLKREQN_M0/SAI_SDI0_M2/UART1_RTSN_M1/PWM_CH4_M2/SPI0_CLK_M1/GPIO1_D1_d	U3
VSS_25	C5	SARADC_IN2/SMBUS_SCL_M1/I2C3_SCL_M1/SAI_SDO3_M2/UART1_TX_M1/PWM_CH6_M1/SPI0_MOSI_M1/GPIO1_D2_d	U4
VDD_LOGIC_10	C6	VSS_210	U5
VSS_26	C7	OSC_AVDD1V8	U6
VDD_LOGIC_11	C8	PLL_AVDD1V8	U7
VSS_27	C9	SARADC_AVDD1V8	U8
DRAM_VEQ_1V4_4	C10	VSS_211	U9
VSS_28	C11	VSS_212	U10
DRAM_VEQ_1V4_5	C12	VSS_213	U11
VSS_29	C13	VSS_214	U12
DRAM_VPPEX_2V5_2	C14	VSS_215	U13
DRAM_VDD_1V2_2	C15	VSS_216	U17
VSS_30	C16	VSS_217	U18
DRAM_VCC_1V1_4	C17	VSS_218	U19
VSS_31	C18	VSS_219	U20
DRAM_VCC_1V1_5	C19	VSS_220	U21
VSS_32	C20	VSS_221	U22
VSS_33	C21	VSS_222	U23
VDD_LOGIC_12	C22	VSS_223	U24
VSS_34	C23	VSS_224	U25
VDD_LOGIC_13	C24	VSS_225	U26
VSS_35	C25	VSS_226	U27
VDD_LOGIC_14	C26	VSS_227	U28
VSS_36	C27	SARADC_IN3/SMBUS_SDA_M1/I2C3_SDA_M1/UART1_RX_M1/PWM_CH7_M1/SPI0_MISO_M1/GPIO1_D3_d	V1
VDD_LOGIC_15	C28	SARADC_IN4/SMBUS_ALERT_M1/SAI_SDO0_M2/UART1_CTSN_M1/SPI0_CS0N_M1/GPIO1_D4_d	V2

Pin Name	Pin#	Pin Name	Pin#
I2C0_SCL_M0/SPI0_CS0N_M0/GPIO0_A5_d	D1	SARADC_IN5/PCIE0_CLKREQN_M1/SAI_SDI1_M2/PWM_CH5_M2/SPI0_CS1N_M1/GPIO1_D5_d	V3
I2C0_SDA_M0/SPI0_MISO_M0/GPIO0_A6_d	D2	SARADC_IN6/PCIE0_PERSTN_M1/I2C4_SCL_M0/SAI_SDI2_M2/UART2_TX_M0/PWM_CH6_M2/ETH_TESTRXCLK_OUT/GPIO1_D6_d	V4
I2C1_SCL_M0/PWM_CH2_M0/SPI0_CLK_M0/GPIO0_A7_d	D3	VSS_228	V5
I2C1_SDA_M0/PWM_CH3_M0/SPI0_MOSI_M0/GPIO0_B0_d	D4	VDD_PMU_0V9	V6
VSS_37	D5	PLL_AVDD0V9	V7
VDD_LOGIC_16	D6	PLL_AVSS	V8
VSS_38	D7	VSS_229	V9
VDD_LOGIC_17	D8	VDD_LOGIC_102	V10
VSS_39	D9	VDD_LOGIC_103	V11
DRAM_VEQ_1V4_6	D10	VDD_LOGIC_104	V12
VSS_40	D11	VSS_230	V13
DRAM_VEQ_1V4_7	D12	VSS_231	V17
VSS_41	D13	VDD_LOGIC_105	V18
DRAM_VPPEX_2V5_3	D14	VDD_LOGIC_106	V19
DRAM_VDD_1V2_3	D15	VDD_LOGIC_107	V20
VSS_42	D16	VDD_LOGIC_108	V21
DRAM_VCC_1V1_6	D17	VDD_LOGIC_109	V22
DRAM_VCC_1V1_7	D18	VDD_LOGIC_110	V23
VSS_43	D19	VDD_LOGIC_111	V24
VSS_44	D20	VDD_LOGIC_112	V25
VDD_LOGIC_18	D21	VDD_LOGIC_113	V26
VSS_45	D22	VDD_LOGIC_114	V27
VDD_LOGIC_19	D23	VDD_LOGIC_115	V28
VSS_46	D24	SARADC_IN0_BOOT	W1
VDD_LOGIC_20	D25	SARADC_IN1	W2
VSS_47	D26	VSS_232	W3
VDD_LOGIC_21	D27	SARADC_IN7/PCIE0_WAKEN_M1/I2C4_SDA_M0/SAI_SDI3_M2/UART2_RX_M0/PWM_CH7_M2/ETH_TESTRXD_OUT/GPIO1_D7_d	W4
VSS_48	D28	AVSS_0	W5
PWR_CTRL0/TEST_CLK_OUT1/GPIO0_A2_z	E1	AVSS_1	W6
PWR_CTRL1/PWM_CH0_M0/SPI1_CS1N_M0/PCIE1_BUTTONRSTN/GPIO0_A3_d	E2	Combo_PHY_AVDD1V8	W7
PWR_CTRL2/PWM_CH1_M0/SPI0_CS1N_M0/PCIE0_BUTTONRSTN/GPIO0_A4_d	E3	Combo_PHY_AVDD0V9_0	W8
REF_CLK_OUT/TEST_CLK_OUT0/GPIO0_A0_d	E4	VSS_233	W9
VSS_49	E5	VSS_234	W10
VSS_50	E6	VSS_235	W11
VDD_LOGIC_22	E7	VSS_236	W12
VDD_LOGIC_23	E8	VSS_237	W13
VSS_51	E9	VDD_TOP_11	W14
DRAM_VEQ_1V4_8	E10	VDD_TOP_12	W15
DRAM_VEQ_1V4_9	E11	VSS_238	W16
VSS_52	E12	VSS_239	W17
VSS_53	E13	VSS_240	W18

Pin Name	Pin#	Pin Name	Pin#
DRAM_VPPEX_2V5_4	E14	VSS_241	W19
DRAM_VDD_1V2_4	E15	VSS_242	W20
VSS_54	E16	VSS_243	W21
DRAM_VCC_1V1_8	E17	VSS_244	W22
DRAM_VCC_1V1_9	E18	VSS_245	W23
VSS_55	E19	VSS_246	W24
VDD_LOGIC_24	E20	VSS_247	W25
VDD_LOGIC_25	E21	VSS_248	W26
VDD_LOGIC_26	E22	VSS_249	W27
VDD_LOGIC_27	E23	VSS_250	W28
VDD_LOGIC_28	E24	VSS_251	Y1
VDD_LOGIC_29	E25	VSS_252	Y2
VDD_LOGIC_30	E26	VSS_253	Y3
VDD_LOGIC_31	E27	AVSS_2	Y4
VDD_LOGIC_32	E28	AVSS_3	Y5
NPOR_DET	F1	AVSS_4	Y6
TSADC_CTRL/GPIO0_A1_z	F2	USB_AVDD0V9	Y7
VSS_56	F3	Combo_PHY_AVDD0V9_1	Y8
FSPI_D3/UART2_RX_M1/GPIO0_C7_u	F4	VSS_254	Y9
VSS_57	F5	DRAM_VCC_1V1_16	Y10
VSS_58	F6	DRAM_VCC_1V1_17	Y11
VDD_LOGIC_33	F7	DRAM_VCC_1V1_18	Y12
VDD_LOGIC_34	F8	VSS_255	Y13
VSS_59	F9	VDD_TOP_13	Y14
DRAM_VEQ_1V4_10	F10	VSS_256	Y15
VSS_60	F13	DRAM_VEQ_1V4_16	Y16
VDD_LOGIC_35	F14	DRAM_VEQ_1V4_17	Y17
VDD_LOGIC_36	F15	DRAM_VEQ_1V4_18	Y18
DRAM_VCC_1V1_10	F18	VSS_257	Y19
VSS_61	F19	VDD_LOGIC_116	Y20
VDD_LOGIC_37	F20	VDD_LOGIC_117	Y21
VSS_62	F21	VDD_LOGIC_118	Y22
VSS_63	F22	VDD_LOGIC_119	Y23
VSS_64	F23	VDD_LOGIC_120	Y24
VSS_65	F24	VDD_LOGIC_121	Y25
VSS_66	F25	VDD_LOGIC_122	Y26
VSS_67	F26	VDD_LOGIC_123	Y27
VSS_68	F27	VDD_LOGIC_124	Y28
VSS_69	F28	OSC_XIN	AA1
FSPI_D1/UART2_RTSN_M1/GPIO0_C5_u	G1	OSC_XOUT	AA2
FSPI_D2/UART2_TX_M1/GPIO0_C6_u	G2	AVSS_5	AA3
FSPI_CLK_OUT/GPIO0_D1_d	G3	PCIE1_REFCLKP	AA4
FSPI_CSN1_u	G4	AVSS_6	AA5
VSS_70	G5	USB_AVDD3V3	AA6
VSS_71	G6	AVSS_7	AA7
VSS_72	G7	AVSS_8	AA8
VDD_LOGIC_38	G8	VSS_258	AA9
VSS_73	G9	DRAM_VCC_1V1_19	AA10
DRAM_VEQ_1V4_11	G10	VSS_259	AA13

Pin Name	Pin#	Pin Name	Pin#
VSS_74	G13	VDD_TOP_14	AA14
VSS_75	G14	VSS_260	AA15
VSS_76	G15	DRAM_VEQ_1V4_19	AA18
DRAM_VCC_1V1_11	G18	VSS_261	AA19
VSS_77	G19	VDD_LOGIC_125	AA20
VDD_LOGIC_39	G20	VSS_262	AA21
VDD_LOGIC_40	G21	VSS_263	AA22
VDD_LOGIC_41	G22	VSS_264	AA23
VDD_LOGIC_42	G23	VSS_265	AA24
VDD_LOGIC_43	G24	VSS_266	AA25
VDD_LOGIC_44	G25	VSS_267	AA26
VDD_LOGIC_45	G26	VSS_268	AA27
VDD_LOGIC_46	G27	VSS_269	AA28
VDD_LOGIC_47	G28	AVSS_9	AB2
VSS_78	H1	AVSS_10	AB3
FSPI_CSNO/GPIO0_D0_u	H2	PCIE1_REFCLKN	AB4
VSS_79	H3	AVSS_11	AB5
FSPI_D0/UART2_CTSN_M1/GPIO0_C4_u	H4	OTP_AVDD1V8	AB6
SDMMC_DETNI2C3_SDA_M2/SAI_MCLK_M1/PCI E1_CLKREQN_M1/SDMMC_TESTCLK_OUT/GPIO1 _A5_u	H5	USB_AVDD1V8	AB7
VSS_80	H6	VSS_270	AB8
VSS_81	H7	VSS_271	AB9
VSS_82	H8	DRAM_VCC_1V1_20	AB10
VSS_83	H9	VSS_272	AB13
DRAM_VEQ_1V4_12	H10	VSS_273	AB14
VSS_84	H13	VSS_274	AB15
VDD_TOP_0	H14	DRAM_VEQ_1V4_20	AB18
VSS_85	H15	VSS_275	AB19
DRAM_VCC_1V1_12	H18	VDD_LOGIC_126	AB20
VSS_86	H19	VDD_LOGIC_127	AB21
VDD_LOGIC_48	H20	VDD_LOGIC_128	AB22
VSS_87	H21	VDD_LOGIC_129	AB23
VSS_88	H22	VDD_LOGIC_130	AB24
VSS_89	H23	VDD_LOGIC_131	AB25
VSS_90	H24	VDD_LOGIC_132	AB26
VSS_91	H25	VDD_LOGIC_133	AB27
VSS_92	H26	VDD_LOGIC_134	AB28
VSS_93	H27	DRAM_VCC_1V1_21	AC10
VSS_94	H28	VSS_278	AC13
SDMMC_D3/SAI_SDI3_M1/UART1_RX_M2/GPIO0 _D5_u	J1	VDD_LOGIC_136	AC14
SDMMC_D5/I2C4_SDA_M2/SAI_LRCK_M1/UART2 _RX_M2/SMBUS_SDA_M2/GPIO0_D7_u	J2	VDD_LOGIC_137	AC15
SDMMC_CLK_OUT/SAI_SDO1_M1/FSPI_TESTCLK _OUT/GPIO1_A3_d	J3	DRAM_VEQ_1V4_21	AC18
VSS_95	J4	VSS_279	AC19
VSS_96	J5	PCIE1_TXN/USB0_DRD_SSTXN_M1	AC2
VSS_97	J6	VDD_LOGIC_138	AC20
VSS_98	J7	VSS_280	AC21
VSS_99	J8	VSS_281	AC22

Pin Name	Pin#	Pin Name	Pin#
VSS_100	J9	VSS_282	AC23
DRAM_VEQ_1V4_13	J10	VSS_283	AC24
DRAM_VEQ_1V4_14	J11	VSS_284	AC25
DRAM_VEQ_1V4_15	J12	VSS_285	AC26
VSS_101	J13	VSS_286	AC27
VDD_TOP_1	J14	VSS_287	AC28
VSS_102	J15	PCIE1_TXP/USB0_DRD_SSTXP_M1	AC3
DRAM_VCC_1V1_13	J16	AVSS_12	AC4
DRAM_VCC_1V1_14	J17	PCIE0_REFCLKP	AC5
DRAM_VCC_1V1_15	J18	AVSS_13	AC6
VSS_103	J19	VSS_276	AC7
VDD_LOGIC_49	J20	VDD_LOGIC_135	AC8
VDD_LOGIC_50	J21	VSS_277	AC9
VDD_LOGIC_51	J22	PCIE1_RXN/USB0_DRD_SSRXN_M1	AD1
VDD_LOGIC_52	J23	DRAM_VCC_1V1_22	AD10
VDD_LOGIC_53	J24	DRAM_VCC_1V1_23	AD11
VDD_LOGIC_54	J25	VSS_290	AD12
VDD_LOGIC_55	J26	VSS_291	AD13
VDD_LOGIC_56	J27	DRAM_VDD_1V2_5	AD14
VDD_LOGIC_57	J28	DRAM_VPPEX_2V5_5	AD15
SDMMC_D0/SAI_SDO2_M1/UART1_CTSN_M2/GPIO0_D2_u	K1	VSS_292	AD16
SDMMC_D4/I2C4_SCL_M2/SAI_SCLK_M1/UART2_TX_M2/SMBUS_SCL_M2/GPIO0_D6_u	K2	DRAM_VEQ_1V4_22	AD17
VSS_104	K3	DRAM_VEQ_1V4_23	AD18
SDMMC_CMD/FSPI_TESTDATA_OUT/GPIO1_A2_u	K4	VSS_293	AD19
VSS_105	K5	PCIE1_RXP/USB0_DRD_SSRXP_M1	AD2
VSS_106	K6	VDD_LOGIC_141	AD20
VCCIO0_VCC3V3	K7	VDD_LOGIC_142	AD21
VSS_107	K8	VDD_LOGIC_143	AD22
VSS_108	K9	VDD_LOGIC_144	AD23
VSS_109	K10	VDD_LOGIC_145	AD24
VSS_110	K11	VDD_LOGIC_146	AD25
VSS_111	K12	VDD_LOGIC_147	AD26
VSS_112	K13	VDD_LOGIC_148	AD27
VDD_TOP_2	K14	VDD_LOGIC_149	AD28
VDD_TOP_3	K15	AVSS_14	AD3
VSS_113	K16	PCIE0_REFCLKN	AD4
VSS_114	K17	AVSS_15	AD5
VSS_115	K18	VSS_288	AD6
VSS_116	K19	VDD_LOGIC_139	AD7
VSS_117	K20	VDD_LOGIC_140	AD8
VSS_118	K21	VSS_289	AD9
VSS_119	K22	PCIE0_TXP/USB0_DRD_SSTXP_M0	AE1
VSS_120	K23	DRAM_VCC_1V1_24	AE10
VSS_121	K24	VSS_297	AE11
VSS_122	K25	DRAM_VCC_1V1_25	AE12
VSS_123	K26	VSS_298	AE13
VSS_124	K27	DRAM_VDD_1V2_6	AE14

Pin Name	Pin#	Pin Name	Pin#
VSS_125	K28	DRAM_VPPEX_2V5_6	AE15
SDMMC_D2/SAI_SDI2_M1/UART1_TX_M2/GPIO0_D4_u	L1	VSS_299	AE16
SDMMC_D1/SAI_SDO3_M1/UART1_RTSN_M2/GPIO0_D3_u	L2	DRAM_VEQ_1V4_24	AE17
SDMMC_RSTN/I2C3_SCL_M2/SAI_SDI1_M1/PCIE1_PERSTN_M1/SDMMC_TESTDATA_OUT/GPIO1_A4_u	L3	DRAM_VEQ_1V4_25	AE18
ETH_RXCLK/I2C4_SDA_M1/GPIO1_C1_d	L4	VSS_300	AE19
VSS_126	L5	PCIE0_TXN/USB0_DRD_SSTXN_M0	AE2
VSS_127	L6	VSS_301	AE20
VCCIO1	L7	VDD_LOGIC_152	AE21
TVSS	L8	VSS_302	AE22
VSS_128	L9	VDD_LOGIC_153	AE23
VDD_LOGIC_58	L10	VSS_303	AE24
VDD_LOGIC_59	L11	VDD_LOGIC_154	AE25
VDD_LOGIC_60	L12	VSS_304	AE26
VSS_129	L13	VDD_LOGIC_155	AE27
VSS_130	L17	VSS_305	AE28
VDD_LOGIC_61	L18	AVSS_16	AE3
VDD_LOGIC_62	L19	USB0_DRD_ID	AE4
VDD_LOGIC_63	L20	VSS_294	AE5
VDD_LOGIC_64	L21	VDD_LOGIC_150	AE6
VDD_LOGIC_65	L22	VSS_295	AE7
VDD_LOGIC_66	L23	VDD_LOGIC_151	AE8
VDD_LOGIC_67	L24	VSS_296	AE9
VDD_LOGIC_68	L25	AVSS_17	AF1
VDD_LOGIC_69	L26	PCIE0_RXP/USB0_DRD_SSRXP_M0	AF2
VDD_LOGIC_70	L27	AVSS_18	AF3
VDD_LOGIC_71	L28	USB0_DRD_VBUSDET	AF4
SDMMC_D6/I2C2_SCL_M2/SAI_SDI0_M1/UART2_CTSN_M2/SMBUS_ALERT_M2/GPIO1_A0_u	M1	VSS_306	AF5
SDMMC_D7/I2C2_SDA_M2/SAI_SDO0_M1/UART2_RTSN_M2/PCIE1_WAKEN_M1/GPIO1_A1_u	M2	VDD_LOGIC_PDN_0	AF6
ETH_RXD1/PWM_CH4_M1/SPIO_CS1N_M2/GPIO1_B5_d	M3	VSS_307	AF7
ETH_RXCTL/PCIE0_WAKEN_M2/PWM_CH5_M1/GPIO1_C0_d	M4	VDD_LOGIC_156	AF8
VSS_131	M5	VSS_308	AF9
VSS_132	M6	DRAM_VCC_1V1_26	AF10
VSS_133	M7	VSS_309	AF11
VSS_134	M8	DRAM_VCC_1V1_27	AF12
VSS_135	M9	VSS_310	AF13
VSS_136	M10	DRAM_VDD_1V2_7	AF14
VSS_137	M11	DRAM_VPPEX_2V5_7	AF15
VSS_138	M12	VSS_311	AF16
VSS_139	M13	DRAM_VEQ_1V4_26	AF17
VSS_140	M17	VSS_312	AF18
VSS_141	M18	DRAM_VEQ_1V4_27	AF19
VSS_142	M19	VSS_313	AF20
VSS_143	M20	VSS_314	AF21
VSS_144	M21	VDD_LOGIC_157	AF22

Pin Name	Pin#	Pin Name	Pin#
VSS_145	M22	VSS_315	AF23
VSS_146	M23	VDD_LOGIC_158	AF24
VSS_147	M24	VSS_316	AF25
VSS_148	M25	VDD_LOGIC_159	AF26
VSS_149	M26	VSS_317	AF27
VSS_150	M27	VDD_LOGIC_160	AF28
VSS_151	M28	PCIE0_RXN/USB0_DRD_SSRXN_M0	AG1
ETH_TXCTL/PCIE1_CLKREQN_M2/PWM_CH2_M1/SPI0_CLK_M2/GPIO1_B2_d	N1	USB0_DRD_DP	AG2
ETH_TXCLK/I2C1_SCL_M1/SPI1_CLK_M2/GPIO1_B3_d	N2	USB1_DRD_DP	AG3
VSS_152	N3	AVSS_19	AG4
ETH_RXD0/PWM_CH3_M1/SPI0_CS0N_M2/GPIO1_B4_d	N4	VSS_318	AG5
VSS_153	N5	VDD_LOGIC_161	AG6
VSS_154	N6	VSS_319	AG7
VCCIO2	N7	VDD_LOGIC_162	AG8
VCCIO2	N7	VSS_320	AG9
VSS_155	N8	DRAM_VCC_1V1_28	AG10
VDD_TOP_4	N9	VSS_321	AG11
VSS_156	N10	DRAM_VCC_1V1_29	AG12
VDD_LOGIC_72	N11	VSS_322	AG13
VDD_LOGIC_73	N12	DRAM_VDD_1V2_8	AG14
VDD_LOGIC_74	N13	DRAM_VPPEX_2V5_8	AG15
VSS_157	N14	VSS_323	AG16
VSS_158	N15	DRAM_VEQ_1V4_28	AG17
VSS_159	N16	VSS_324	AG18
VDD_LOGIC_75	N17	DRAM_VEQ_1V4_29	AG19
VDD_LOGIC_76	N18	VSS_325	AG20
VDD_LOGIC_77	N19	VDD_LOGIC_163	AG21
VDD_LOGIC_78	N20	VSS_326	AG22
VDD_LOGIC_79	N21	VDD_LOGIC_164	AG23
VDD_LOGIC_80	N22	VSS_327	AG24
VDD_LOGIC_81	N23	VDD_LOGIC_165	AG25
VDD_LOGIC_82	N24	VSS_328	AG26
VDD_LOGIC_83	N25	VDD_LOGIC_166	AG27
VDD_LOGIC_84	N26	VSS_329	AG28
VDD_LOGIC_85	N27	AVSS_20	AH1
VDD_LOGIC_86	N28	USB0_DRD_DM	AH2
ETH_TXD1/PCIE1_PERSTN_M2/PWM_CH1_M1/SPI0_MISO_M2/GPIO1_A7_d	P1	USB1_DRD_DM	AH3
ETH_TXD0/PCIE1_WAKEN_M2/PWM_CH0_M1/SPI0_MOSI_M2/GPIO1_A6_d	P2	AVSS_21	AH4
ETH_RXD2/I2C1_SDA_M1/SPI1_CS0N_M2/GPIO1_B6_d	P3	VSS_330	AH5
VSS_160	P4	VDD_LOGIC_167	AH6
ETH_RXD3/I2C4_SCL_M1/SPI1_CS1N_M2/GPIO1_B7_d	P5	VSS_331	AH7
VSS_161	P6	VDD_LOGIC_PDN_1	AH8
VCCIO3	P7	VSS_332	AH9
VSS_162	P8	DRAM_VCC_1V1_30	AH10
VDD_TOP_5	P9	VSS_333	AH11

Pin Name	Pin#	Pin Name	Pin#
VSS_163	P10	DRAM_VCC_1V1_31	AH12
VSS_164	P11	VSS_334	AH13
VSS_165	P12	DRAM_VDD_1V2_9	AH14
VSS_166	P13	DRAM_VPPEX_2V5_9	AH15
DRAM_VMONI	P14	VSS_335	AH16
VDD_TOP_6	P15	DRAM_VEQ_1V4_30	AH17
VDD_TOP_7	P16	VSS_336	AH18
VSS_167	P17	DRAM_VEQ_1V4_31	AH19
VSS_168	P18	VSS_337	AH20
VDD_TOP_8	P19	VSS_338	AH21
VSS_169	P20	VDD_LOGIC_168	AH22
VSS_170	P21	VSS_339	AH23
VSS_171	P22	VDD_LOGIC_169	AH24
VSS_172	P23	VSS_340	AH25
VSS_173	P24	VDD_LOGIC_170	AH26
VSS_174	P25	VSS_341	AH27
VSS_175	P26	VSS_342	AH28
VSS_176	P27		

Chapter 3 Electrical Specification

3.1 Absolute Ratings

The below table provides the absolute ratings.

Absolute maximum or minimum ratings specify the values beyond which the device may be damaged permanently. Long-term exposure to absolute maximum ratings conditions may affect device reliability.

Table 3-1 Absolute Ratings

Parameters	Related Power Group	Min	Max	Unit
Supply voltage for DRAM VEQ	DRAM_VEQ_1V4	-0.3	1.75	V
Supply voltage for DRAM VCC	DRAM_VCC_1V1	-0.3	1.54	V
Supply voltage for DRAM VPPEX	DRAM_VPPEX_2V5	-0.3	3.0	V
Supply voltage for DRAM VDD	DRAM_VDD_1V2	-0.3	1.54	V
0.9V supply voltage	VDD_TOP VDD_PMU_0V9 VDD_LOGIC PLL_AVDD_0V9 USB_AVDD_0V9 Combo_PHY_AVDD0V9_0 Combo_PHY_AVDD0V9_1	-0.3	1.1	V
1.8V supply voltage	SARADC_AVDD1V8 USB_AVDD1V8 Combo_PHY_AVDD1V8 PLL_AVDD1V8 OTP_AVDD1V8 OSC_AVDD1V8	-0.3	2.0	V
3.3V supply voltage	USB_AVDD3V3	-0.3	3.8	V
3.3V supply voltage for VCCIO	VCCIO0_VCC3V3	-0.3	3.8	V
1.8V supply voltage for VCCIO	VCCIO1	-0.3	2.5	V
1.8V/3.3V supply voltage for VCCIO	VCCIO2 VCCIO3	-0.3	3.8	V
Storage Temperature	Tstg	-40	125	°C
Max Conjunction Temperature	Tj	NA	125	°C

3.2 Recommended Operating Condition

Following table describes the recommended operating condition.

Table 3-2 Recommended Operating Condition

Parameters	Related Power Group	Min	Typ	Max	Unit
Supply voltage for DRAM VEQ	DRAM_VEQ_1V4	1.365	1.4	1.435	V
Supply voltage for DRAM VCC	DRAM_VCC_1V1	1.073	1.1	1.128	V
Supply voltage for DRAM VPPEX	DRAM_VPPEX_2V5	2.438	2.5	2.563	V
Supply voltage for DRAM VDD	DRAM_VDD_1V2	1.17	1.2	1.23	V
0.9V supply voltage	VDD_TOP	TBD	0.9	TBD	V
0.9V supply voltage	VDD_LOGIC	TBD	0.9	TBD	V
0.9V supply voltage	VDD_PMU_0V9	TBD	0.9	TBD	V
0.9V supply voltage	PLL_AVDD_0V9 USB_AVDD_0V9 Combo_PHY_AVDD0V9_0 Combo_PHY_AVDD0V9_1	0.81	0.9	0.99	V
1.8V supply voltage	SARADC_AVDD1V8 USB_AVDD1V8 Combo_PHY_AVDD1V8 PLL_AVDD1V8 OTP_AVDD1V8 OSC_AVDD1V8	1.62	1.8	1.98	V
3.3V supply voltage	USB_AVDD3V3	2.97	3.3	3.63	V
3.3V supply voltage for VCCIO	VCCIO0_VCC3V3	2.97	3.3	3.63	
1.8V supply voltage for VCCIO	VCCIO1	1.62	1.8	1.98	
1.8V/3.3V supply voltage for VCCIO	VCCIO2 VCCIO3	1.62 2.97	1.8 3.3	1.98 3.63	V

Parameters	Related Power Group	Min	Typ	Max	Unit
Ambient Operating Temperature	Ta	0	25	85	°C

3.3 DC Characteristics

Table 3-3 DC Characteristics

Parameters	Symbol	Min	Typ	Max	Unit	
Digital GPIO @3.3V	Input Low Voltage	Vil	-0.3	NA	0.8	V
	Input High Voltage	Vih	2.0	NA	VCCIO+0.3	V
	Output Low Voltage	Vol	-0.3	NA	0.4	V
	Output High Voltage	Voh	2.4	NA	VCCIO+0.3	V
	Pullup Resistor	Rpu	16	NA	43	Kohm
	Pulldown Resistor	Rpd	16	NA	43	Kohm
Digital GPIO @1.8V	Input Low Voltage	Vil	-0.3	NA	0.35*VCCIO	V
	Input High Voltage	Vih	0.65*VCCIO	NA	VCCIO+0.3	V
	Output Low Voltage	Vol	-0.3	NA	0.4	V
	Output High Voltage	Voh	1.4	NA	VCCIO+0.3	V
	Pullup Resistor	Rpu	16	NA	43	Kohm
	Pulldown Resistor	Rpd	16	NA	43	Kohm

3.4 Electrical Characteristics for General IO

Table 3-4 Electrical Characteristics for Digital General IO

Parameters	Symbol	Test condition	Min	Typ	Max	Unit	
Digital GPIO @3.3V	Input leakage current	Ii	Vin = 3.3V or 0V	NA	NA	10	uA
	Tri-state output leakage current	Ioz	Vout = 3.3V or 0V	NA	NA	10	uA
	High level input current	Iih	Vin = 3.3V, pulldown disabled	NA	NA	10	uA
			Vin = 3.3V, pulldown enabled	NA	NA	10	uA
	Low level input current	Iil	Vin = 0V, pullup disabled	NA	NA	10	uA
			Vin = 0V, pullup enabled	NA	NA	10	uA
Digital GPIO @1.8V	Input leakage current	Ii	Vin = 1.8V or 0V	NA	NA	10	uA
	Tri-state output leakage current	Ioz	Vout = 1.8V or 0V	NA	NA	10	uA
	High level input current	Iih	Vin = 1.8V, pulldown disabled	NA	NA	10	uA
			Vin = 1.8V, pulldown enabled	NA	NA	10	uA
	Low level input current	Iil	Vin = 0V, pullup disabled	NA	NA	10	uA
			Vin = 0V, pullup enabled	NA	NA	10	uA

Note: VCCIO and DVDD are both IO power Supply

3.5 Electrical Characteristics for PLL

Table 3-5 Electrical Characteristics for FRAC PLL

Parameters	Symbol	Test condition	Min	Typ	Max	Unit	
Frac PLL	Input clock frequency (Frac)	F _{in}	Fin = FREF @1.8V/0.99V	1	NA	1200	MHz
	VCO operating range	F _{vco}	Fvco = Fref * FBDIV @3.3V/0.99V	950	NA	3800	MHz
	Output clock frequency	F _{out}	Fout = Fvco/POSTDIV @3.3V/0.99V	19	NA	3800	MHz

Parameters	Symbol	Test condition	Min	Typ	Max	Unit
Lock time	T_{lt}	@ 3.3V/0.99V, FREF=24M,REFDIV=1	NA	250	500	Input clock cycles

Notes:

- ① REFDIV is the input divider value;
- ② FB DIV is the feedback divider value;
- ③ POSTDIV is the output divider value

3.6 Electrical Characteristics for USB2.0 Interface

Table 3-6 Electrical Characteristics for USB2.0 Interface

Parameters	Symbol	Test condition	Min	Typ	Max	Unit
Transmitter						
Output resistance	ROUT	Classic mode (Vout = 0 or 3.3V)	40.5	45	49.5	ohms
		HS mode (Vout = 0 to 800mV)	40.5	45	49.5	ohms
Output Capacitance	COUT	seen from D+ or D-			3	pF
Output Common Mode Voltage	VM	Classic (LS/FS) mode	1.45	1.65	1.85	V
		HS mode	0.175	0.2	0.225	V
Differential output signal high	VOH	Classic (LS/FS); Io=0mA	2.97	3.3	3.63	V
		Classic (LS/FS); Io=6mA	2.2	2.7	NA	V
		HS mode; Io=0mA	360	400	440	mV
Differential output signal low	VOL	Classic (LS/FS); Io=0mA	-0.33	0	0.33	V
		Classic (LS/FS); Io=6mA	NA	0.3	0.8	V
		HS mode; Io=0mA	-40	0	40	mV
Receiver						
Receiver sensitivity	RSENS	Classic mode	NA	+ -250	NA	mV
		HS mode	NA	+ -25	NA	mV
Receiver common mode	RCM	Classic mode	0.8	1.65	2.5	V
		HS mode (differential and squelch comparator)	0.1	0.2	0.3	V
		HS mode (disconnect comparator)	0.5	0.6	0.7	V
Input capacitance (seen at D+ or D-)			NA	NA	3	pF
Squelch threshold			100	NA	150	mV
Disconnect threshold			570	600	664	mV

3.7 Electrical Characteristics for SARADC

Table 3-7 Electrical Characteristics for SARADC

Parameters	Symbol	Test condition	Min	Typ	Max	Unit
Resolution	ENOB	$f_s=1MS/s$ fclk=24MHz	NA	11.2	13	bit
Analog Input Channel			NA	NA	8	
Analog Input Range	VIN		0	NA	1.8	V
Analog Input maximum voltage					3.3	V
Differential Non-Linearity	DNL		NA	±1	±3	LSB
Integral Non-Linearity	INL		NA	±2	±6	LSB
Conversion Rate	f_s		NA	1	NA	MS/s
Signal to Noise and Distortion Ratio	SINAD	$f_s=1MS/s$ $f_{OUT}=1.17KHz$	NA	69.2	NA	dB
Total Harmonic Distortion	THD		NA	77.3	NA	dB

3.8 Electrical Characteristics for TSADC

Table 3-8 Electrical Characteristics for TSADC

Parameters	Symbol	Test condition	Min	Typ	Max	Unit
Accuracy from -40°C to 125°C	T_{JACC}		NA	NA	±3.5	°C

Parameters	Symbol	Test condition	Min	Typ	Max	Unit
Sensing Temperature Range	T _{RANGE}		-40	NA	125	°C
Resolution	T _{LSB}		NA	0.01	NA	°C

3.9 Electrical Characteristics for Multi-PHY

Table 3-9 Electrical Characteristics for PCIe PHY

Parameters	Symbol	Condition	Min	Typ	Max	Unit
Transmitter						
Differential p-pTx voltage swing	V _{TX-DIFF-PP}		0.8	NA	1.2	V
Low power differential p-p Tx voltage swing	V _{TX-DIFF-PP-LOW}		0.4	NA	1.2	V
Tx de-emphasis level ratio	R _{TX-DIFF-DC}		80	NA	120	ohm
Single Ended Output Resistance Matching	R _{TX-DC-OFFSET}		NA	NA	5	%
The amount of voltage change allowed during Receiver Detection	V _{TX-RCV-DETECT}		NA	NA	600	mV
Output rising time for 20% to 80%	T _r		25	NA	NA	ps
Output falling time for 20% to 80%	T _f		25	NA	NA	ps
AC Coupling Capacitor(USB3.0/PCIE)	C _{TX}		75	NA	200	nF
Receiver						
Unit Interval	UI		399.88	NA	400.12	ps
Input Voltage Swing	V _{rxdpp-c}		250	NA	1200	mV
Input differential impedance	R _{rxd-c}		80	NA	120	ohm
Single Ended input Resistance Matching	T _{rxd-c-ms}		NA	NA	5	%

Chapter 4 Thermal Management

4.1 Overview

For reliability and operability concerns, the absolute maximum junction temperature has to be below 125°C.

4.2 Package Thermal Characteristics

Table 4-1 provides the thermal resistance characteristics for the package used on the SoC. The resulting simulation data for reference only, please prevail in kind test.

Table 4-1 Thermal Resistance Characteristics

Parameter	Symbol	Value	Unit	Note
Junction-to-ambient thermal resistance	θ_{JA}	11.72	(°C/W)	(1)
Junction-to-board thermal resistance	θ_{JB}	4.38	(°C/W)	(2)
Junction-to-case thermal resistance	θ_{JC}	0.06	(°C/W)	(3)
Thermal characterization parameter	ψ_{JT}	0.19	(°C/W)	(4)

Note (1): The package-board system is placed in the natural convection (JEDEC JESD51-2 standard), and the 2S2P test-board is designed in accordance with JESD 51-7/JESD 51-9. The actual system design and environment may be different.

(The PCB is 4 layers, 114.5 mm*101.5 mm)

Note (2): θ_{JB} is measured in the special environment (JEDEC JESD51-8 standard), and the printed circuit board used to mount the devices is specified in JESD51-7.

Note (3): The thermal resistance θ_{JC} is provided in compliance with the JEDEC JESD51-14.

Note (4): ψ_{JT} - The thermal characterization parameter to report the difference between junction temperature and the temperature at the top center of the outside surface of the component package, ψ_{JT} is measured in the test environment of θ_{JA} (JEDEC JESD51-2 standard).