

3. Specifications

3.1 Absolute Maximum Ratings

Caution: Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such conditions can adversely impact product reliability and result in failures not covered by warranty.

Parameter	Minimum	Maximum	Unit
CC1, CC2, RD1, RD2, CSIN, CSIP, VBUS, SNK_DISCHG	-0.3	+60	V
CSIP-CSIN	-0.5	+0.5	V
VSNK_SRC	-0.3	+60	V
VSNK_GATE	-0.3	+66.5	V
	VSNK_SRC - 0.3	VSNK_SRC + 6.5	V
VSRC_SRC	-0.3	+6.5	V
VSRC_BOOT	-0.3	+13	V
	VSRC_SRC - 0.3	VSRC_SRC + 6.5	V
VSRC_GATE	-0.3	+13.3	V
	VSRC_SRC - 0.3	VSRC_BOOT + 0.3	V
GPIO1, GPIO2, GPIO3, GPIO4	-0.3	+6.5	V
OCP#, PROCHOT#, ALERT#	-0.3	+6.5	V
PROG	-0.3	+6.5	V
VSYS33, VDD33	-0.3	+6.5	V
VDD25	-0.3	+3	V
VCONN_POWER	-0.3	+6.5	V
SDA, SCL	-0.3	+6.5	V
GPIO1, GPIO2, GPIO3, GPIO4, SDA, SCL, OCP#, PROCHOT#, ALERT#	-	4	mA
Maximum Junction Temperature	-40	+125	°C
Maximum Storage Temperature Range	-65	+150	°C
Human Body Model (Tested per JS-001-2023)	-1.5	1.5	kV
Charged Device Model (Tested per JS-002-2022)	-0.75	0.75	kV
Latch-Up (Tested per JESD78E; Class 2, Level A)	-	100	mA

3.2 Recommended Operating Conditions

Parameter	Minimum	Maximum	Unit
VSYS33, VDD33	-0.3	+3.6	V
VCONN_POWER	-0.3	+5.5	V
CSIN, CSIP, VBUS, SNK_DISCHG	-0.3	+55	V
VSNK_SRC	-0.3	+55	V
VSNK_GATE	-0.3	+60.5	V
	VSNK_SRC - 0.3	VSNK_SRC + 5.5	V
VSRC_SRC	-0.3	+5.5	V
VSRC_BOOT	-0.3	+11	V
	VSRC_SRC - 0.3	VSRC_SRC + 5.5	V
VSRC_GATE	-0.3	+11.3	V
	VSRC_SRC - 0.3	VSRC_BOOT + 0.3	V
CC1, CC2, RD1, RD2	-0.3	+5.5	V
SDA, SCL, ALERT#, OCP#, PROCHOT#	-0.3	+5.5	V
GPIO1, GPIO2, GPIO3, GPIO4	-0.3	+3.6	V
Ambient Temperature			
Part number: RAA489400ARGNP#HA0 RAA489400ARGNP#MA0	-10	+100	°C
Part number: RAA489400A3GNP#HA0 RAA489400A3GNP#MA0	-40	+105	°C
Junction Temperature	-10	+125	°C

3.3 Thermal Specifications

Parameter	Package	Symbol	Conditions	Typical Value	Unit
Thermal Resistance	32 Ld FCQFN Package	$\theta_{JA}^{[1]}$	Junction to ambient	40	°C/W
		$\theta_{JC}^{[2]}$	Junction to case	6	°C/W

- θ_{JA} is measured on JEDEC std. PCB with Direct Attach features including two 100 μ m dia. vias under pin #4, and two 100 μ m dia. vias under pin #24. See [TB379](#).
- For θ_{JC} , the case temperature is measured on the package bottom surface at pins #4 and #24.

3.4 Electrical Specifications

Recommended operating conditions unless otherwise noted. VSYS33 = 3.3V, VCONN_POWER = 5.0V, and T_A = -40°C to +105°C, unless otherwise specified.

Parameter	Symbol	Test Conditions	Min ^[1]	Typ	Max ^[1]	Unit
UVLO/ACOK						
VBUS OK Rising	VBUS_OK_r	-	3.6	3.81	3.95	V

Parameter	Symbol	Test Conditions	Min ^[1]	Typ	Max ^[1]	Unit
VBUS OK Hysteresis	VBUS_OK_h	-	-	300	-	mV
VSYS33 OK Rising	VSYS33OK_r	-	2.8	2.9	3	V
VSYS33 OK Falling	VSYS33OK_f	-	2.6	2.68	2.8	V
VDD25 2P4 POR Rising	VDD2p5_2P4_r	SMBus	-	2.3	-	V
VDD25 2P4 POR Hysteresis	VDD2p5_2P4_h	-	-	125	-	mV
VDD33 OK Rising	VDD2p9OK_r	-	2.65	2.857	3.06	V
VDD33 OK Hysteresis	VDD2p9OK_h	-	-	100	-	mV
Linear Regulator						
VDD25 Output Voltage	VDD2P5	3.0V < VDD33 < 3.6V, no load	2.45	2.55	2.7	V
VDD25 Dropout Voltage	VDD2P5_dp	10mA, VDD33 = 2.5V	44	66	88	mV
VDD25 Overvoltage Rising	VDD2P5_OV_r	-	-	3.3	-	V
VDD25 Overvoltage Hysteresis		-	-	200	-	mV
VDD33 Output Voltage	VDD3P3	3.8V < VBUS < 51V, no load	3.1	3.3	3.5	V
VDD33 Dropout Voltage	VDD3P3_dp	30mA, VBUS > 3.8V	-	25	-	mV
VDD33 Overcurrent Threshold	VDD3P3_OC	-	25	40	55	mA
Input Current Sense Amplifier, Rs = 10mΩ						
CSIP/CSIN Input Voltage Range	VCSIP/N	-	4	-	55	V
Fast Role Swap						
VBUS Top Window Comparator Falling Threshold	vFrsVbus	Setting 1 (5.2V)	4.9	5.1	5.3	V
		Setting 2 (5.5V)	5.25	5.4	5.55	V
		Setting 3 (5.8V)	5.5	5.7	5.9	V
VBUS Top Window Comparator Hysteresis	-	-	-	0.36	-	V
Protection						
Over-Temperature Threshold	tVconn_ot	-	-	155	-	°C
VBUS Overvoltage Rising Threshold (SPR)	vSprMax	-	23	23.41	24	V
VBUS Overvoltage Hysteresis (SPR)	vVbusOvHysSpr	-	-	260	-	mV
VBUS Overvoltage Rising Threshold (EPR)	vEprMax	-	52.6	54.0	56.2	V
VBUS Overvoltage Hysteresis (EPR)	vVbusOvHysEpr	-	-	550	-	mV
SRC VBUS Undervoltage Falling Threshold	vVbusUv	-	3.45	3.76	4.25	V
SRC VBUS Undervoltage Hysteresis	-	-	-	360	-	mV
SRC 5V VBUS Overvoltage Rising Threshold	vVbusOv	-	5.8	6.3	6.6	mV
SRC 5V VBUS Overvoltage Hysteresis	-	-	-	600	-	mV
SRC VBUS Reverse Voltage Rising Threshold	vVbusRv	V _{VBUS} - V _{CSIN}	20	-	100	mV
SRC VBUS Reverse Voltage Hysteresis	-	-	-	2	-	mV

Parameter	Symbol	Test Conditions	Min ^[1]	Typ	Max ^[1]	Unit
VBUS Overcurrent Rising Threshold	iVbusOc	Setting 1 (1.5A)	1.65	-	1.88	A
		Setting 2 (3A)	3.3	-	3.6	A
		Setting 3 (4A)	4.4	-	4.8	A
		Setting 4 (5A)	5.5	-	6.0	A
VBUS Overcurrent Hysteresis	iVbusOcHys	-	-	400	-	mA
VCONN Overvoltage Rising Threshold	vVconnOv	-	5.8	6.26	6.6	V
VCONN Overvoltage Hysteresis	vVconnOvHys	-	-	500	-	mV
VCONN Undervoltage Falling Threshold	vVconnUv	-	3.45	3.79	4.25	V
VCONN Undervoltage Hysteresis	vVconnUvHys	-	170	210	320	mV
VCONN Reverse Voltage Rising Threshold	vVconnRv	V _{CC1/CC2} - VCONN	250	325	500	mV
VCONN Reverse Voltage Hysteresis	vVconnRvHys	-	-	100	-	mV
VCONN Overcurrent Rising Threshold	iVconnOc	Setting 1 (400mA)	400	-	600	mA
		Setting 2 (600mA)	600	-	800	mA
		Setting 3 (800mA)	800	-	1050	mA
VCONN OC Blanking Time ^[2]	tVconnOcBlnk	-	-	5	-	ms
Oscillator						
24MHz Oscillator Frequency, Digital Core Only	-	-	-	24	-	MHz
3MHz Oscillator Frequency	-	-	-	3	-	MHz
Digital Debounce Time Accuracy ^[2]	-	-	-15	-	15	%
30kHz Oscillator Frequency	-	-	-	30	-	kHz
Charge Pump Gate Drivers						
VBUS Source Gate Vgs	-	VSRC_GATE - VSRC_SRC	4.2	4.4	4.6	V
VBUS Sink Gate Vgs	-	VSINK_GATE - VSINK_SRC	4.5	5.1	5.5	V
Charge Pump Startup Time	tCpStart ^[2]	-	-	-	50	ms
VBUS						
VBUS ADC Accuracy	VBUS > 2.8V	VBUS Voltage	-2	-	+2	%
	2.0V ≤ VBUS ≤ 2.8V	VBUS Voltage	-50	-	+50	mV
	VBUS < 2.0V	VBUS Voltage	-75	-	+75	mV
	VBUS > 600mA	VBUS Current	-5	-	+5	%
	VBUS = 500mA	VBUS Current	-	498	-	mA
	VBUS = 200mA	VBUS Current	-	197	-	mA
	VBUS = 100mA	VBUS Current	-	104	-	mA
SNK VBUS Disconnect Detect DAC Accuracy	-	11-bit DAC, LSB = 25mV, VBUS Voltage > 0.5V	-5	-	+5	%

Parameter	Symbol	Test Conditions	Min ^[1]	Typ	Max ^[1]	Unit
VCONN Mux						
VCONN Switch Rdson	-	-	-	500	-	mΩ
VCONN Switch Turn on Time ^[2]	-	Time from enable to fully on, with 10μF cap	-	-	1.5	ms
VCONN Discharge Stop Voltage	vVconnDischarge	-	-	-	0.8	V
VCONN Discharge Time ^[2]	tVconnZero	-	-	-	100	ms
CCx Discharge						
VCONN Mux Discharge Rdson	Rdch	-	-	100	-	Ω
Cable Settings						
Rd Clamp	-	-	0.8	1.1	1.3	V
Rd Resistor	-	-	4.59	5.1	5.61	kΩ
IP Current	-	Default USB Power	64	80	96	μA
	-	1.5A at 5V	166	180	194	μA
	-	3A at 5V	304	330	356	μA
TX						
Bit Rate	fBitRate	-	270	300	330	Kps
Fall Time	tFall	10% and 90% amplitude points, minimum is under an unload condition	300	-	-	ns
Rise Time	tRise	10% and 90% amplitude points, minimum is under an unload condition	300	-	-	ns
Voltage Swing	vSwing	Applies to both no load condition and under the load condition specified in USB-PD Spec	1.05	-	1.2	V
Output Impedance	zDrive	Source output impedance at the Nyquist frequency of [USB 2.0] low speed (750kHz) while the source is driving the CC line.	33	-	75	Ω
SMBus/I²C, GPIO						
SDA/SCL, GPIO1/2/3/4 Input Low Voltage	VIL	-	-	-	0.5	V
SDA/SCL, GPIO1/2/3/4 Input High Voltage	VIH	-	1.2	-	-	V
SDA/SCL, GPIO1/2/3/4 Input Bias Current	-	-	-	-	1	μA
SDA Output Sink Current	IOL_SDA	VSDA = 0.4V, on	11	-	-	mA
SMBus/I ² C Frequency	fSMB	-	10	-	1000	kHz
ALERT#, OCP#, PROCHOT#, GPIO1/2/3/4 Input Leakage Current	-	-	-	-	1	μA
ALERT#, OCP#, PROCHOT#, GPIO1/2/3/4 Output Sink Current	IOL GPIO	Voltage = 0.4V	4	-	-	mA
GPIO1/2/3/4 Output Source Current	IOH_GPIO	-	4	-	-	mA

Parameter	Symbol	Test Conditions	Min ^[1]	Typ	Max ^[1]	Unit
ALERT#, OCP#, PROCHOT#, GPIO1/2/3/4 Output Low Voltage	VOL	-	-	-	0.4	V
GPIO1/2/3/4 Output High Voltage	VOH	-	2.4	-	-	V

- Parameters with MIN and/or MAX limits are 100% tested at +25°C, unless otherwise specified. Temperature limits established by characterization and are not production tested.
- Limits established by characterization are not production tested.

3.5 SMBus Timing Specification

Parameter	Symbol	Test Conditions	Min ^[1]	Typ	Max ^[1]	Unit
Bus Free Time ^[2]	t_{BUF}	-	0.5	-	-	μs
Start Condition Hold Time from SCL ^[2]	$t_{HD:STA}$	-	0.26	-	-	μs
Start Condition Set-Up Time from SCL ^[2]	$t_{SU:STA}$	-	0.26	-	-	μs
Stop Condition Set-Up Time from SCL ^[2]	$t_{SU:STO}$	-	0.26	-	-	μs
SDA Hold Time from SCL ^[2]	$t_{HD:DAT}$	-	0	-	-	ns
SDA Set-Up Time from SCL ^[2]	$t_{SU:DAT}$	-	50	-	-	ns
SCL Low Period ^[2]	t_{LOW}	-	0.5	-	-	μs
SCL High Period ^[2]	t_{HIGH}	-	0.26	-	50	μs

- Parameters with MIN and/or MAX limits are 100% tested at +25°C, unless otherwise specified. Temperature limits established by characterization and are not production tested.
- Limits established by characterization are not production tested.