

## Programmable USB Type-C Controller

### General Description

The RT1730 is a USB Type-C controller that complies with the latest USB Type-C. The RT1730 integrates a complete Type-C Transceiver including the Rp and Rd resistors. It does the USB Type-C detection including attach and orientation.

### Ordering Information

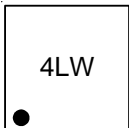
RT1730 □  
 Package Type  
 WSC : WL-CSP-9B 1.38x1.34 (BSC)

Note :

Richtek products are :

- ▶ RoHS compliant and compatible with the current requirements of IPC/JEDEC J-STD-020.
- ▶ Suitable for use in SnPb or Pb-free soldering processes.

### Marking Information



4L : Product Code  
 W : Date Code

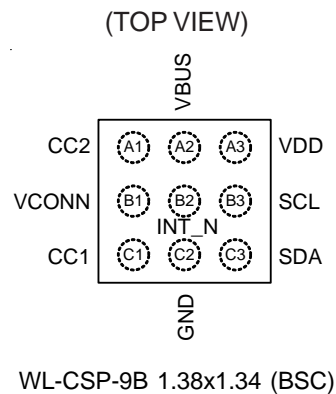
### Features

- Attach/Detach Detection as Host, Device or DRP
- Dead Battery Support
- Ultra-low Power Mode for Attach Detection
- Simple I<sup>2</sup>C Interface with AP or EC
- e-fuse IP
- 9-Ball WL-CSP Package

### Applications

- Smartphones
- Tablets
- Laptops

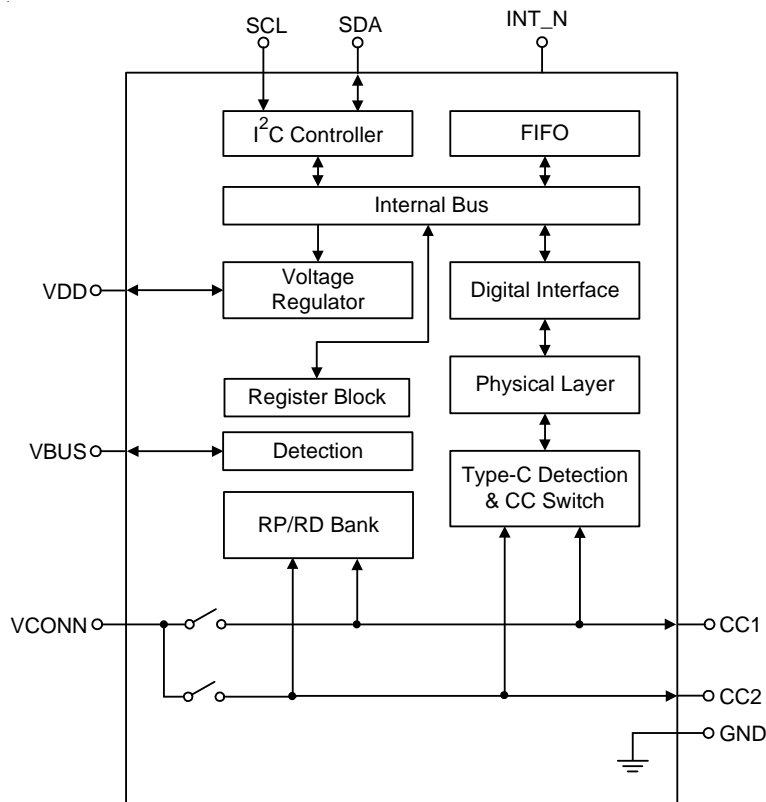
### Pin Configuration



Functional Pin Description

| Pin No. | Pin Name | Pin Function   |
|---------|----------|--|
| A1      | CC2      | Type-C connector Configuration Channel (CC) pins. Initially used to determine when an attach has occurred and what the orientation detected. |
| A2      | VBUS     | VBUS input pin for attach and detach detection when operating as an UFP port (Device).   |
| A3      | VDD      | Input supply voltage.  |
| B1      | VCONN    | Regulated input pin to be switched to correct CC pin as VCONN to power Type-C full-featured cables and other accessories.                    |
| B2      | INT_N    | Active low and open drain type interrupt output used to prompt the processor to read the registers.  |
| B3      | SCL      | I <sup>2</sup> C serial data signal to be connected to the I <sup>2</sup> C master.  |
| C1      | CC1      | Type-C connector Configuration Channel (CC) pins. Initially used to determine when an attach has occurred and what the orientation detected. |
| C2      | GND      | Ground.  |
| C3      | SDA      | I <sup>2</sup> C serial data signal to be connected to the I <sup>2</sup> C master.  |

Functional Block Diagram



**Absolute Maximum Ratings** (Note 1)

- VDD/VCONN ----- -0.3V to 6V
- CC1/CC2 (Testing condition : VDD ≥ 3V) ----- -0.3V to 24V
- CC1/CC2 (Testing condition : VDD < 3V) ----- -0.3V to 6V
- VBUS ----- -0.3V to 28V
- SDA/SCL/INT\_N ----- -0.3V to 6V
- Power Dissipation, P<sub>D</sub> @ T<sub>A</sub> = 25°C  
 WL-CSP-9B 1.38x1.34 (BSC) ----- 1.22W
- Package Thermal Resistance (Note 2)  
 WL-CSP-9B 1.38x1.34 (BSC), θ<sub>JA</sub> ----- 81.5°C/W
- Lead Temperature (Soldering, 10 sec.) ----- 260°C
- Junction Temperature ----- 150°C
- Storage Temperature Range ----- -65°C to 150°C
- ESD Susceptibility (Note 3)  
 HBM (Human Body Model) ----- 2kV

**Recommended Operating Conditions** (Note 4)

- Supply Input Voltage ----- 2.7V to 5.5V
- VCONN Input Voltage ----- 3.3V to 5.5V
- VCON Supply Current ----- 200mA to 600mA
- VCON Supply Voltage ----- 3V to 5.5V
- Junction Temperature Range ----- -40°C to 125°C
- Ambient Temperature Range ----- -40°C to 85°C

**Electrical Characteristics**

(V<sub>DD</sub> = 3.3V, T<sub>A</sub> = 25°C, unless otherwise specified.)

| Parameter                                 | Symbol             | Test Conditions                               | Min | Typ                          | Max | Unit |
|---|--------------------|---|-----|------------------------------|-----|------|
| <b>Power Consumption</b>                  |                    |   |     |                              |     |      |
| Operation Current                         | I <sub>SB</sub>    | Cable attached<br>(Full function on)          | --  | 2.8                          | --  | mA   |
| Ultra-Low Power Mode                      | I <sub>UL</sub>    | VCONN5V supply on, DRP<br>toggle              | --  | I <sub>VDD</sub> =<br>20     | 30  | μA   |
|   |                    | VCONN5V supply off, DRP<br>toggle             | --  | I <sub>VCONN5V</sub><br>= 25 | --  |      |
| <b>Type-C Port Control</b>                |                    |   |     |                              |     |      |
| Ron for VCONN Switch                      | R <sub>ON</sub>    | VCONN input = 3.3V, R <sub>ON</sub> =<br>1.3Ω | --  | 1                            | --  | Ω    |
| OCP Range                                 | I <sub>OCP</sub>   |   | 200 | --                           | 600 | mA   |
| Time for VCONN Switch to<br>Turn-On State | t <sub>SOFT</sub>  |   | --  | 1.2                          | --  | ms   |
| DFP 80μA CC Current                       | DFP <sub>80μ</sub> |   | 64  | 80                           | 96  | μA   |

| Parameter   | Symbol                             | Test Conditions   | Min  | Typ | Max  | Unit       |
|---|------------------------------------|---|------|-----|------|------------|
| DFP 180 $\mu$ A CC Current  | DFP <sub>180<math>\mu</math></sub> |   | 166  | 180 | 194  | $\mu$ A    |
| DFP 330 $\mu$ A CC Current  | DFP <sub>330<math>\mu</math></sub> |   | 304  | 330 | 356  | $\mu$ A    |
| UFP Rd  | Rd                                 |   | 4.59 | 5.1 | 5.61 | k $\Omega$ |
| UFP pull-down Voltage in Dead Battery Under DFP <sub>80<math>\mu</math></sub> and DFP <sub>180<math>\mu</math>A</sub> | V <sub>DBL</sub>                   |   | --   | --  | 1.6  | V          |
| UFP Pull-Down Voltage in Dead Battery Under DFP <sub>330<math>\mu</math>A</sub>                                       | V <sub>DBH</sub>                   |   | --   | --  | 2.6  | V          |
| VBUS Detection Valid Voltage  |                                    |   | --   | 4   | --   | V          |
| VBUS Measure Range  |                                    |   | 5    | --  | 20   | V          |
| VBUS Measurement Step when VBUS Range Under 4 to 10V  |                                    |   | --   | 0.5 | --   | V          |
| VBUS Measurement Step when VBUS Range Under 10 to 20V   |                                    |   | --   | 1   | --   | V          |
| <b>I<sup>2</sup>C Electrical Characteristics</b>  |                                    |   |      |     |      |            |
| I <sup>2</sup> C Bus Supply Voltage   | I <sup>2</sup> C_V <sub>DD</sub>   |   | 1.5  | --  | 3.6  | V          |
| Low-Level Input Voltage   | V <sub>IL</sub>                    |   | --   | --  | 0.4  | V          |
| High-Level Input Voltage  | V <sub>IH</sub>                    |   | 1.3  | --  | --   | V          |
| Low-Level Output Voltage  | V <sub>OL</sub>                    | Open-drain  | --   | --  | 0.4  | V          |
| Input Current Each IO Pin   | I <sub>I</sub>                     | 0.1V <sub>DD</sub> < V <sub>I</sub> < 0.9V <sub>DDMAX</sub> | -10  | --  | 10   | $\mu$ A    |
| SCL Clock Frequency   | f <sub>SCL</sub>                   |   | 0    | --  | 3400 | kHz        |
| Pulse width of spikes that must be suppressed by the input filter   | t <sub>SP</sub>                    |   | --   | --  | 50   | ns         |
| Data Hold Time  | t <sub>HD:DAT</sub>                |   | 30   | --  | --   | ns         |
| Data Set-Up Time  | t <sub>SU:DAT</sub>                |   | 70   | --  | --   | ns         |

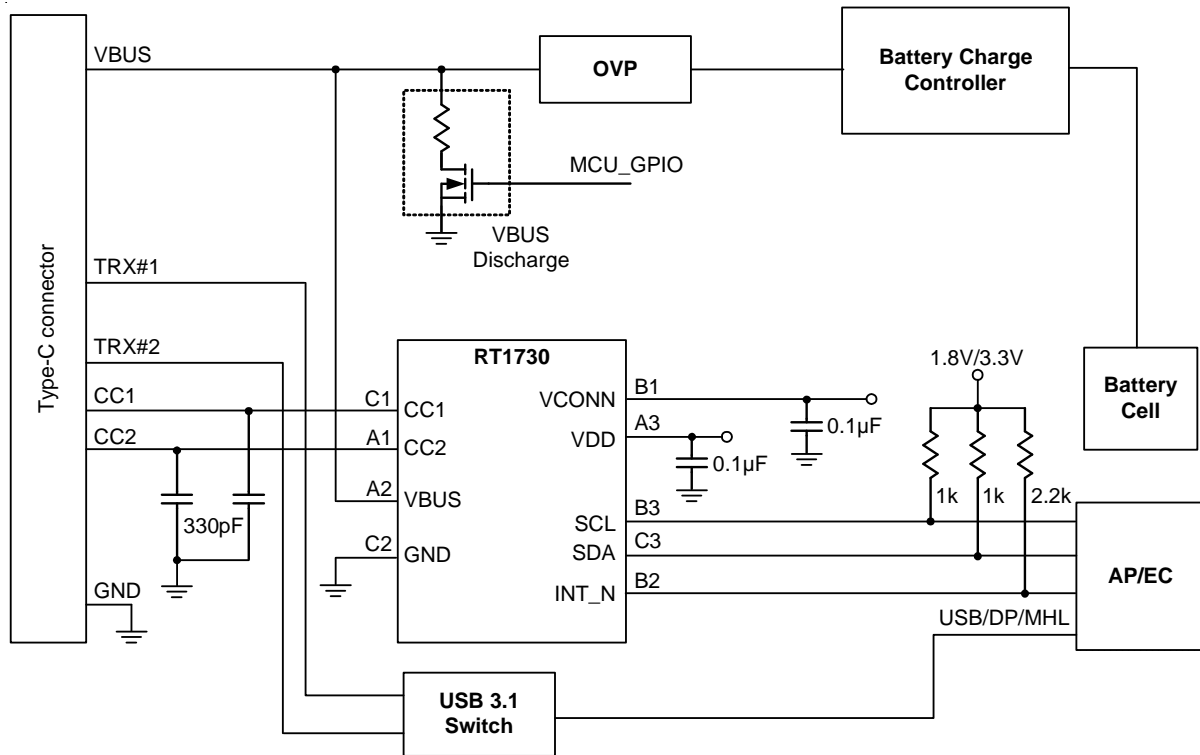
**Note 1.** Stresses beyond those listed "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

**Note 2.**  $\theta_{JA}$  is measured under natural convection (still air) at  $T_A = 25^\circ\text{C}$  with the component mounted on a high effective-thermal-conductivity four-layer test board on a JEDEC 51-7 thermal measurement standard.

**Note 3.** Devices are ESD sensitive. Handling precaution is recommended.

**Note 4.** The device is not guaranteed to function outside its operating conditions.

**Typical Application Circuit**

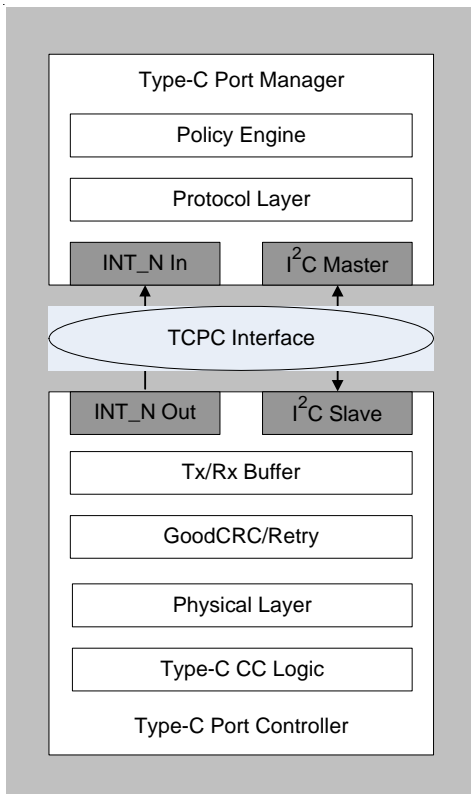


Application Information

Abbreviations :

| Term  | Description                      |
|-------|----------------------------------|
| TCPC  | Type-C Port Controller           |
| TCPCI | Type-C Port Controller Interface |
| TCPM  | Type-C Port Manager              |

Type-C Port Controller (TCPC) Interface :



The Controller Interface uses the I<sup>2</sup>C Protocol :

- The TCPM is the only master on this I<sup>2</sup>C bus
- The TCPC is a slave device on this I<sup>2</sup>C bus
- Each Type-C port has its own unique I<sup>2</sup>C slave address. The TCPC shall have equal numbers of unique I<sup>2</sup>C slave addresses and supported Type-C ports
- The TCPC supports Fast-mode bus speed
- The TCPC has an open drain output, active low INT\_N Pin. This pin is used to indicate change of state, where INT\_N pin is asserted when any Alert Bits are set
- The TCPCI supports an I/O nominal voltage range of 1.8V and 3.3V
- The TCPC can auto-increment the I<sup>2</sup>C internal register address of the last byte transferred during a read independent of an ACK/NACK from the master
- The default I<sup>2</sup>C address shows below.

|     |   |   |   |   |   |   |     |
|-----|---|---|---|---|---|---|-----|
| 1   | 0 | 0 | 1 | 1 | 1 | 0 | R/W |
| MSB |   |   |   |   |   |   | LSB |

**Register Map :**

| Addr | Length | RegName           | Bit | BitName             | Default | Type | Description   |
|------|--------|-------------------|-----|---------------------|---------|------|---|
| 0x00 | 1      | VENDOR_ID         | 7:0 | VID[7:0]            | 0xCF    | R    | A unique 16-bit unsigned integer. Assigned by the USB-IF to the Vendor.                       |
| 0x01 | 1      |                   | 7:0 | VID[15:8]           | 0x29    | R    |   |
| 0x02 | 1      | PRODUCT_ID        | 7:0 | PID[7:0]            | 0x11    | R    | A unique 16-bit unsigned integer. Assigned uniquely by the Vendor to identify the TCPC.       |
| 0x03 | 1      |                   | 7:0 | PID[15:8]           | 0x17    | R    |   |
| 0x04 | 1      | DEVICE_ID         | 7:0 | DID[7:0]            | 0x73    | R    | A unique 16-bit unsigned integer. Assigned by the Vendor to identify the version of the TCPC. |
| 0x05 | 1      |                   | 7:0 | DID[15:8]           | 0x21    | R    |   |
| 0x06 | 1      | USBTYPEC_REV      | 7:0 | USBTYPEC_REV        | 0x11    | R    | Version number assigned by USB-IF (Currently at Revision 1.1 – 0001 0001)                     |
| 0x07 | 1      |                   | 7:0 | Reserved            | 0       | R    |   |
| 0x08 | 1      | USBPD_REV_VER     | 7:0 | USBPD_VER           | 0x11    | R    | 0001 0000 – Version 1.0<br>0001 0001 – Version 1.1<br>Etc.                                    |
| 0x09 | 1      |                   | 7:0 | USBPD_REV           | 0x20    | R    | 0010 0000 – Revision 2.0  |
| 0x0A | 1      | PD_INTERFACE_REV  | 7:0 | PDIF_VER            | 0x10    | R    | 0001 0000 – Version 1.0<br>0001 0001 – Version 1.1<br>Etc.                                    |
| 0x0B | 1      |                   | 7:0 | PDIF_REV            | 0x10    | R    | 0001 0000 – Revision 1.0  |
| 0x10 | 1      | ALERT             | 1   | POWER_STATUS        | 0       | RW   | 0b : Cleared,<br>1b : Port status changed   |
|      |        |                   | 0   | CC_STATUS           | 0       | RW   | 0b : Cleared,<br>1b : CC status changed   |
| 0x11 | 1      | ALERT             | 1   | FAULT               | 0       | RW   | 0b : No Fault.<br>1b : A Fault has occurred. Read the FAULT_STATUS register.                  |
| 0x12 | 1      | ALERT_MASK        | 1   | M_POWER_STATUS      | 1       | RW   | 0b : Interrupt masked,<br>1b : Interrupt unmasked   |
|      |        |                   | 0   | M_CC_STATUS         | 1       | RW   | 0b : Interrupt masked,<br>1b : Interrupt unmasked   |
| 0x13 | 1      | ALERT_MASK        | 1   | M_FAULT             | 1       | RW   | 0b : Interrupt masked,<br>1b : Interrupt unmasked   |
| 0x14 | 1      | POWER_STATUS_MASK | 6   | M_TCPC_INITIAL      | 1       | RW   | 0b : Interrupt masked,<br>1b : Interrupt unmasked   |
|      |        |                   | 3   | M_VBUS_PRESENT_DETC | 1       | RW   | 0b : Interrupt masked,<br>1b : Interrupt unmasked   |
|      |        |                   | 2   | M_VBUS_PRESENT      | 1       | RW   | 0b : Interrupt masked,<br>1b : Interrupt unmasked   |
|      |        |                   | 1   | M_VCONN_PRESENT     | 1       | RW   | 0b : Interrupt masked,<br>1b : Interrupt unmasked   |
| 0x15 | 1      | FAULT_STATUS_MASK | 7   | M_VCON_OV           | 0       | RW   | 0b : Interrupt masked,<br>1b : Interrupt unmasked   |
|      |        |                   | 1   | M_VCON_OC           | 1       | RW   | 0b : Interrupt masked,<br>1b : Interrupt unmasked   |

| Addr | Length | RegName           | Bit | BitName     | Default | Type | Description  |
|------|--------|-------------------|-----|-------------|---------|------|--|
| 0x19 | 1      | TCPC_CONTR<br>OL  | 0   | PLUG_ORIENT | 0       | RW   | 0b : When Vconn is enabled, apply it to the CC2 pin. Monitor the CC1 pin for BMC communications if PD messaging is enabled.<br>1b : When Vconn is enabled, apply it to the CC1 pin. Monitor the CC2 pin for BMC communications if PD messaging is enabled.<br>Required |
| 0x1A | 1      | ROLE_CONTR<br>OL  | 7   | Reserved    | 0       | R    |  |
|      |        |                   | 6   | DRP         | 0       | RW   | 0b : No DRP. Bits B3..0 determine Rp/Rd/Ra settings<br>1b : DRP  |
|      |        |                   | 5:4 | RP_VALUE    | 0       | RW   | 00b : Rp default<br>01b : Rp 1.5A<br>10b : Rp 3.0A<br>11b : Reserved   |
|      |        |                   | 3:2 | CC2         | 10      | RW   | 00b : Reserved<br>01b : Rp (Use Rp definition in B5..4)<br>10b : Rd<br>11b : Open (dDisconnect or don't care)<br>Set to 11b if enabling DRP in B7..6   |
|      |        |                   | 1:0 | CC1         | 10      | RW   | 00b : Reserved<br>01b : Rp (Use Rp definition in B5..4)<br>10b : Rd<br>11b : Open (dDisconnect or don't care)<br>Set to 11b if enabling DRP in B7..6   |
| 0x1B | 1      | FAULT_CONTR<br>OL | 7   | DIS_VCON_OV | 0       | RW   | 0b : Fault detection circuit enabled<br>1b : Fault detection circuit disabled  |
|      |        |                   | 0   | DIS_VCON_OC | 0       | RW   | 0b : Fault detection circuit enabled<br>1b : Fault detection circuit disabled  |



| Addr | Length | RegName       | Bit | BitName         | Default | Type | Description  |
|------|--------|---------------|-----|-----------------|---------|------|--|
| 0x1C | 1      | POWER_CONTROL | 1   | VCONN_POWER_SPT | 0       | RW   | 0b : TCPC delivers at least 1W on VCONN<br>1b : TCPC delivers at least the power indicated in DEVICE_CAPABILITIES.VCONNPowerSupported  |
|      |        |               | 0   | EN_VCONN        | 0       | RW   | 0b : Disable VCONN Source (default)<br>1b : Enable VCONN Source to CC Required   |
| 0x1D | 1      | CC_STATUS     | 7:6 | Reserved        | 0       | R    |  |
|      |        |               | 5   | DRP_STATUS      | 0       | R    | 0b : the TCPC has stopped toggling or (ROLE_CONTROL.DRP = 00)<br>1b : the TCPC is toggling   |
|      |        |               | 4   | DRP_RESULT      | 0       | R    | 0b : the TCPC is presenting Rp<br>1b : the TCPC is presenting Rd   |
|      |        |               | 3:2 | CC2_STATUS      | 0       | R    | <p>If (ROLE_CONTROL.CC2 = Rp) or (DrpResult = 0)<br/>00b : SRC.Open (Open, Rp)<br/>01b : SRC.Ra (below maximum vRa)<br/>10b : SRC.Rd (within the vRd range)<br/>11b : reserved</p> <p>If (ROLE_CONTROL.CC2 = Rd) or (DrpResult = 1)<br/>00b : SNK.Open (Below maximum vRa)<br/>01b : SNK.Default (Above minimum vRd-Connect)<br/>10b : SNK.Power1.5 (Above minimum vRd-Connect) Detects Rp 1.5A<br/>11b : SNK.Power3.0 (Above minimum vRd-Connect) Detects Rp 3.0A</p> <p>If ROLE_CONTROL.CC2 = Ra, this field is set to 00b<br/>If ROLE_CONTROL.CC2 = Open, this field is set to 00b</p> <p>This field always returns 00b if (DrpStatus = 1) or (POWER_CONTROL.EnableVconn = 1 and POWER_CONTROL.PlugOrientation = 0).<br/>Otherwise, the returned value depends upon ROLE_CONTROL.CC2.</p> |

| Addr | Length | RegName      | Bit | BitName           | Default | Type | Description  |
|------|--------|--------------|-----|-------------------|---------|------|--|
| 0x1D | 1      | CC_STATUS    | 1:0 | CC1_STATUS        | 0       | R    | <p>If (ROLE_CONTROL.CC1 = Rp) or (DrpResult = 0)<br/>                     00b : SRC.Open (Open, Rp)<br/>                     01b : SRC.Ra (below maximum vRa)<br/>                     10b : SRC.Rd (within the vRd range)<br/>                     11b : reserved</p> <p>If (ROLE_CONTROL.CC1 = Rd) or DrpResult = 1)<br/>                     00b : SNK.Open (Below maximum vRa)<br/>                     01b : SNK.Default (Above minimum vRd-Connect)<br/>                     10b : SNK.Power1.5 (Above minimum vRd-Connect) Detects Rp-1.5A<br/>                     11b : SNK.Power3.0 (Above minimum vRd-Connect) Detects Rp-3.0A</p> <p>If ROLE_CONTROL.CC1 = Ra, this field is set to 00b<br/>                     If ROLE_CONTROL.CC1 = Open, this field is set to 00b</p> <p>This field always returns 00b if (DrpStatus = 1) or (POWER_CONTROL.EnableVconn = 1 and POWER_CONTROL.PlugOrientation = 0). Otherwise, the returned value depends upon ROLE_CONTROL.CC1.</p> |
| 0x1E | 1      | POWER_STATUS | 6   | TCPC_INITIAL      | 0       | R    | <p>0b : The TCPC has completed initialization and all registers are valid<br/>                     1b : The TCPC is still performing internal initialization and the only registers that are guaranteed to return the correct values are 00h..0Fh</p>  |
|      |        |              | 3   | VBUS_PRESENT_DETC | 1       | R    | <p>0b : VBUS Present Detection Disabled<br/>                     1b : VBUS Present Detection Enabled (default)</p>   |
|      |        |              | 2   | VBUS_PRESENT      | 0       | R    | <p>0b : VBUS Disconnected<br/>                     1b : VBUS Connected</p>   |
|      |        |              | 1   | VCONN_PRESENT     | 0       | R    | <p>0b : VCONN is not present<br/>                     1b : This bit is asserted when VCONN present CC1 or CC2. Threshold is fixed at 2.4V</p>  |

| Addr | Length | RegName                    | Bit | BitName         | Default | Type | Description   |
|------|--------|----------------------------|-----|-----------------|---------|------|---|
| 0x1F | 1      | FAULT_STATU<br>S           | 7   | VCON_OV         | 0       | RW   | 0b : Not in an over-voltage protection state<br>1b : Over-voltage fault latched.  |
|      |        |                            | 1   | VCON_OC         | 0       | RW   | 0b : No Fault detected<br>1b : Over-current VCONN fault latched   |
| 0x24 | 1      | DEVICE_CAPA<br>BILITIES_1L | 7:5 | ROLES_SUPPORT   | 110     | R    | 000b : Type-C Port Manager can configure the Port as Source only or Sink only (not DRP)<br>001b : Source only<br>010b : Sink only<br>011b : Sink with accessory support (optional)<br>100b : DRP only<br>101b : Adapter or Cable (Ra) only<br>110b : Source, Sink, DRP, Adapter/Cable all supported<br>111b : Not valid |
|      |        |                            | 4   | ALL_SOP_SUPPORT | 1       | R    | 0b : All SOP* except SOP'_DBG/SOP''_DBG<br>1b : All SOP* messages are supported   |
|      |        |                            | 3   | SOURCE_VCONN    | 1       | R    | 0b : TCPC is not capable of switching VCONN<br>1b : TCPC is capable of switching VCONN  |
|      |        |                            | 2   | CPB_SINK_VBUS   | 0       | R    | 0b : TCPC is not capable controlling the sink path to the system load<br>1b : TCPC is capable of controlling the sink path to the system load   |
|      |        |                            | 1   | SOURCE_HV_VBUS  | 0       | R    | 0b : TCPC is not capable of controlling the source high voltage path to VBUS<br>1b : TCPC is capable of controlling the source high voltage path to VBUS  |
|      |        |                            | 0   | SOURCE_VBUS     | 0       | R    | 0b : TCPC is not capable of controlling the source path to VBUS<br>1b : TCPC is capable of controlling the source path to VBUS  |

| Addr | Length | RegName                | Bit | BitName            | Default | Type | Description   |
|------|--------|------------------------|-----|--------------------|---------|------|---|
| 0x25 | 1      | DEVICE_CAPABILITIES_1H | 7   | Reserved           | 0       | R    |   |
|      |        |                        | 6   | CPB_VBUS_OC        | 0       | R    | 0b : VBUS OCP is not reported by the TCPC<br>1b : VBUS OCP is reported by the TCPC  |
|      |        |                        | 5   | CPB_VBUS_OV        | 0       | R    | 0b : VBUS OVP is not reported by the TCPC<br>1b : VBUS OVP is reported by the TCPC  |
|      |        |                        | 4   | CPB_BLEED_DISC     | 0       | R    | 0b : No Bleed Discharge implemented in TCPC<br>1b : Bleed Discharge is implemented in the TCPC  |
|      |        |                        | 3   | CPB_FORCE_DISC     | 0       | R    | 0b : No Force Discharge implemented in TCPC<br>1b : Force Discharge is implemented in the TCPC  |
|      |        |                        | 2   | VBUS_MEASURE_ALARM | 0       | R    | 0b : No VBUS voltage measurement nor VBUS Alarms<br>1b : VBUS voltage measurement and VBUS Alarms   |
|      |        |                        | 1:0 | SOURCE_RP_SUPPORT  | 10      | R    | 00b : Rp default only<br>01b : Rp 1.5A and default<br>10b : Rp 3.0A, 1.5A, and default<br>11b : Reserved<br>Rp values which may be configured by the TCPM via the ROLE_CONTROL register |

| Addr | Length | RegName                | Bit | BitName             | Default | Type | Description   |
|------|--------|------------------------|-----|---------------------|---------|------|---|
| 0x26 | 1      | DEVICE_CAPABILITIES_2L | 7   | SINK_DISCONNECT_DET | 0       | R    | 0b : VBUS_SINK_DISCONNECT_THRESHOLD not implemented (default : Use POWER_STATUS.VbusPresent = 0b to indicate a Sink disconnect)<br>1b : VBUS_SINK_DISCONNECT_THRESHOLD implemented  |
|      |        |                        | 6   | STOP_DISC_THD       | 0       | R    | 0b : VBUS_STOP_DISCHARGE_THRESHOLD not implemented (default)<br>1b : VBUS_STOP_DISCHARGE_THRESHOLD implemented  |
|      |        |                        | 5:4 | VBUS_VOL_ALARM_LSB  | 11      | R    | 00 : TCPC has 25mV LSB for its voltage alarm and uses all 10 bits in VBUS_VOLTAGE_ALARM_HI_CFG and VBUS_VOLTAGE_ALARM_LO_CFG.<br>01 : TCPC has 50mV LSB for its voltage alarm and uses only 9 bits. VBUS_VOLTAGE_ALARM_HI_CFG[0] and VBUS_VOLTAGE_ALARM_LO_CFG[0] are ignored by TCPC.<br>10 : TCPC has 100mV LSB for its voltage alarm and uses only 8 bits. VBUS_VOLTAGE_ALARM_HI_CFG[1:0] and VBUS_VOLTAGE_ALARM_LO_CFG[1:0] are ignored by TCPC.<br>11 : reserved |
|      |        |                        | 3:1 | VCONN_POWER         | 010     | R    | 000b : 1.0W      100b : 4W<br>001b : 1.5W      101b : 5W<br>010b : 2.0W      110b : 6W<br>011b : 3W        111b : External  |
|      |        |                        | 0   | VCONN_OCF           | 1       | R    | 0b : TCPC is not capable of detecting a Vconn fault<br>1b : TCPC is capable of detecting a Vconn fault  |

| Addr | Length | RegName                      | Bit | BitName               | Default | Type | Description                                      |
|------|--------|------------------------------|-----|-----------------------|---------|------|--|
| 0x27 | 1      | DEVICE_CAPABILITIES_2H       | 7:0 | Reserved              | 0       | R    |  |
| 0x28 | 1      | STANDARD_INPUT_CAPABILITIES  | 7:3 | Reserved              | 0       | R    |  |
|      |        |                              | 2   | VBUS_EXT_OVF          | 0       | R    | 0b : Not present in TCPC<br>1b : Present in TCPC |
|      |        |                              | 1   | VBUS_EXT_OCF          | 0       | R    | 0b : Not present in TCPC<br>1b : Present in TCPC |
|      |        |                              | 0   | FORCE_OFF_VBUS_IN     | 0       | R    | 0b : Not present in TCPC<br>1b : Present in TCPC |
| 0x29 | 1      | STANDARD_OUTPUT_CAPABILITIES | 7   | Reserved              | 0       | R    |  |
|      |        |                              | 6   | CPB_DBG_ACC_IND       | 0       | R    | 0b : Not present in TCPC<br>1b : Present in TCPC |
|      |        |                              | 5   | CPB_VBUS_PRESENT_MNT  | 0       | R    | 0b : Not present in TCPC<br>1b : Present in TCPC |
|      |        |                              | 4   | CPB_AUDIO_ADT_ACC_IND | 0       | R    | 0b : Not present in TCPC<br>1b : Present in TCPC |
|      |        |                              | 3   | CPB_ACTIVE_CABLE_IND  | 0       | R    | 0b : Not present in TCPC<br>1b : Present in TCPC |
|      |        |                              | 2   | CPB_MUX_CFG_CTRL      | 0       | R    | 0b : Not present in TCPC<br>1b : Present in TCPC |
|      |        |                              | 1   | CPB_CONNECT_PRESENT   | 0       | R    | 0b : Not present in TCPC<br>1b : Present in TCPC |
|      |        |                              | 0   | CPB_CONNECT_ORIENT    | 0       | R    | 0b : Not present in TCPC<br>1b : Present in TCPC |

**Thermal Considerations**

The junction temperature should never exceed the absolute maximum junction temperature  $T_{J(MAX)}$ , listed under Absolute Maximum Ratings, to avoid permanent damage to the device. The maximum allowable power dissipation depends on the thermal resistance of the IC package, the PCB layout, the rate of surrounding airflow, and the difference between the junction and ambient temperatures. The maximum power dissipation can be calculated using the following formula :

$$P_{D(MAX)} = (T_{J(MAX)} - T_A) / \theta_{JA}$$

where  $T_{J(MAX)}$  is the maximum junction temperature,  $T_A$  is the ambient temperature, and  $\theta_{JA}$  is the junction-to-ambient thermal resistance.

For continuous operation, the maximum operating junction temperature indicated under Recommended Operating Conditions is 125°C. The junction-to-ambient thermal resistance,  $\theta_{JA}$ , is highly package dependent. For a WL-CSP-9B 1.38x1.34 (BSC) package, the thermal resistance,  $\theta_{JA}$ , is 81.5°C/W on a standard JEDEC 51-7 high effective-thermal-conductivity four-layer test board. The maximum power dissipation at  $T_A = 25^\circ\text{C}$  can be calculated as below :

$$P_{D(MAX)} = (125^\circ\text{C} - 25^\circ\text{C}) / (81.5^\circ\text{C/W}) = 1.22\text{W for a WL-CSP-9B 1.38x1.34 (BSC) package.}$$

The maximum power dissipation depends on the operating ambient temperature for the fixed  $T_{J(MAX)}$  and the thermal resistance,  $\theta_{JA}$ . The derating curves in Figure 1 allows the designer to see the effect of rising ambient temperature on the maximum power dissipation.

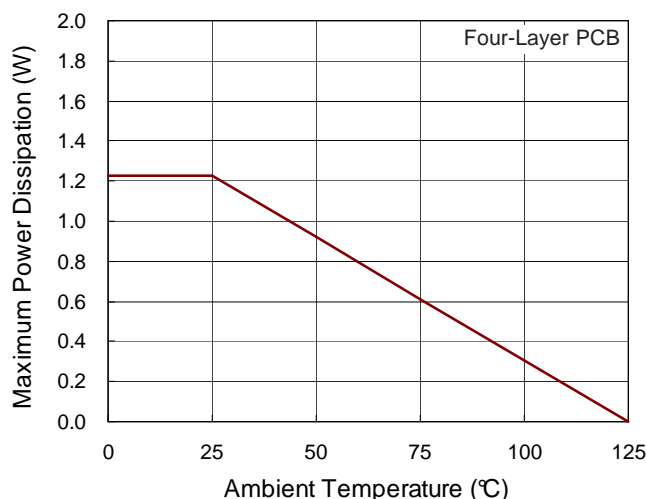
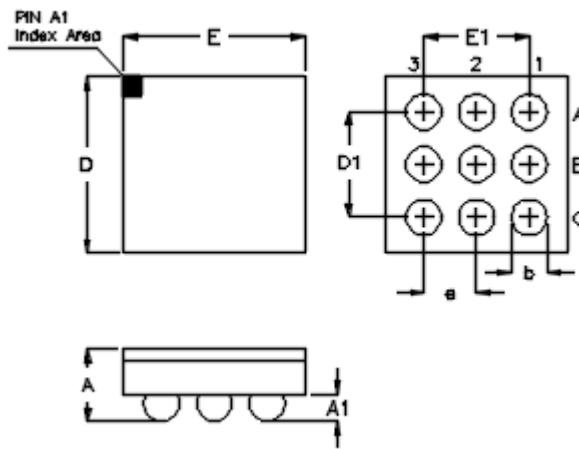


Figure 1. Derating Curve of Maximum Power Dissipation

Outline Dimension

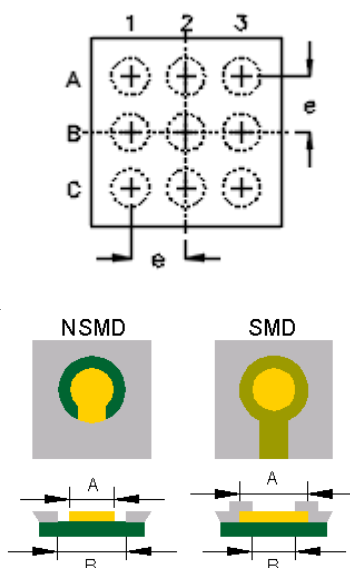


| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | Min                       | Max   | Min                  | Max   |
| A      | 0.500                     | 0.600 | 0.020                | 0.024 |
| A1     | 0.170                     | 0.230 | 0.007                | 0.009 |
| b      | 0.240                     | 0.300 | 0.009                | 0.012 |
| D      | 1.300                     | 1.380 | 0.051                | 0.054 |
| D1     | 0.800                     |       | 0.031                |       |
| E      | 1.340                     | 1.420 | 0.053                | 0.056 |
| E1     | 0.800                     |       | 0.031                |       |
| e      | 0.400                     |       | 0.016                |       |

9B WL-CSP 1.38x1.34 Package (BSC)



**Footprint Information**



| Package                | Number of Pin | Type | Footprint Dimension (mm) |       |       | Tolerance |
|------------------------|---------------|------|--------------------------|-------|-------|-----------|
|                        |               |      | e                        | A     | B     |           |
| WL-CSP1.38*1.34-9(BSC) | 9             | NSMD | 0.400                    | 0.240 | 0.340 | ±0.025    |
|                        |               | SMD  |                          | 0.270 | 0.240 |           |

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