

FXLA2204

Dual-Mode, Dual-SIM-Card Level Translator

Features

- Easy-to-Use “Single Pin” SIM Card Swap Control
- Channel Swap Time: 130 ns (Typical)
- Simultaneous Dual-Mode, Dual-SIM Communication
- Host Ports: 1.65 V to 3.6 V Voltage Translation
- Card Ports: 1.65 V to 3.6 V Voltage Translation
- Leverages the Presence of Existing PMIC LDOs
- ISO7816 Compliant
- Power Switch R_{ON} : 0.5 Ω (Typical)
- Supports Class B 3 V SIM / UIM Cards
- Supports Class C: 1.8 V SIM / UIM Cards
- Non-Preferential Host V_{CC} Power-Up Sequencing
- Activation / Deactivation Timing Compliant per ISO7816-03
- Requires External Pull-Up Resistors for Bi-Directional I/O Pins
- Outputs Switch to 3-State if Host V_{CC} at GND
- Power-Off Protection
- Packaged in 24-Terminal UMLP (2.5 mm x 3.4 mm)

Applications

- Dual-Mode Dual-SIM Applications
- GSM, CDMA, WCDMA, TDSCDMA CDMA2000, 3G Cellular Phones
- Mobile TV: OMA BCAST

Description

The FXLA2204 allows two hosts to simultaneously communicate with two Subscriber Identity Modules (SIMs) or two User Identity Modules (UIMs). Dual Mode refers to the mobile phones that are compatible with more than one form of data transmission or network (such as GSM, CDMA, WCDMA, TDSCDMA, or CDMA2000), resulting in a dual-baseband processor configuration. In a Dual-Mode application, the FXLA2204 host ports interface directly with the baseband processors (*see Figure 10*).

The bi-directional I/O open-drain channel features auto-direction, which requires external pull-up resistors. RST and CLK provide uni-directional translation from host to card only.

Either host can swap SIM slots with the assertion of a single control pin: CH_Swap. The typical channel swap time is 130ns.

The FXLA2204 does not contain internal Low Dropout Regulator (LDOs). Instead, the FXLA2204 architecture incorporates two low- R_{ON} internal power switches for routing existing Power Management Integrated Circuit (PMIC) LDOs to individual SIM slots. This reduces overall system power, leverages existing LDO system resources, and aligns with the philosophy that centralizing LDOs in the PMIC facilitates power management. Since the FXLA2204 does not block the LDO function to the SIM card, existing activation / deactivation timing transparency is maintained between Hosts, PMICs, and SIM cards.

The device allows voltage translation from as high as 3.6 V to as low as 1.65 V. Each port tracks its own port power supply.

Ordering Information

| Part Number | Operating Temperature Range | Package | Packing Method |
|-------------|-----------------------------|---|----------------|
| FXLA2204UMX | -40 to 85°C | 24-Terminal, 2.5 mm x 3.4 mm Ultrathin Molded Leadless Package (UMLP), 0.4 mm Pitch | Tape and Reel |

Block Diagrams

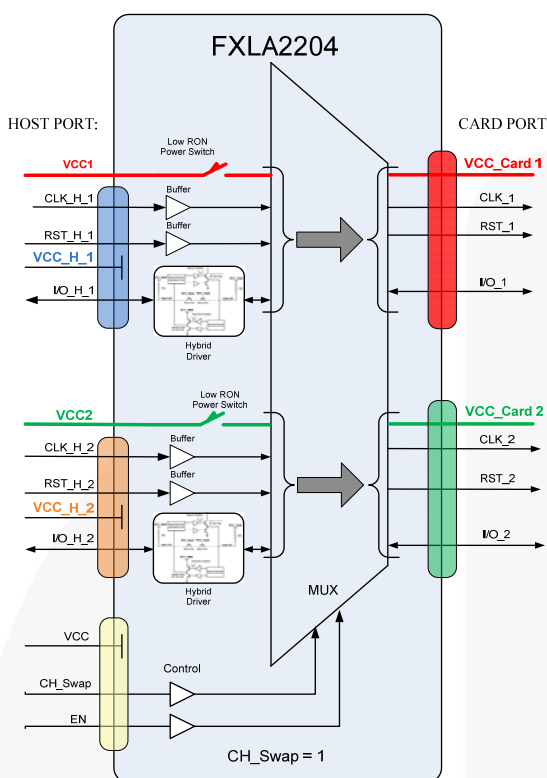


Figure 1. Block Diagram, CH_Swap=1

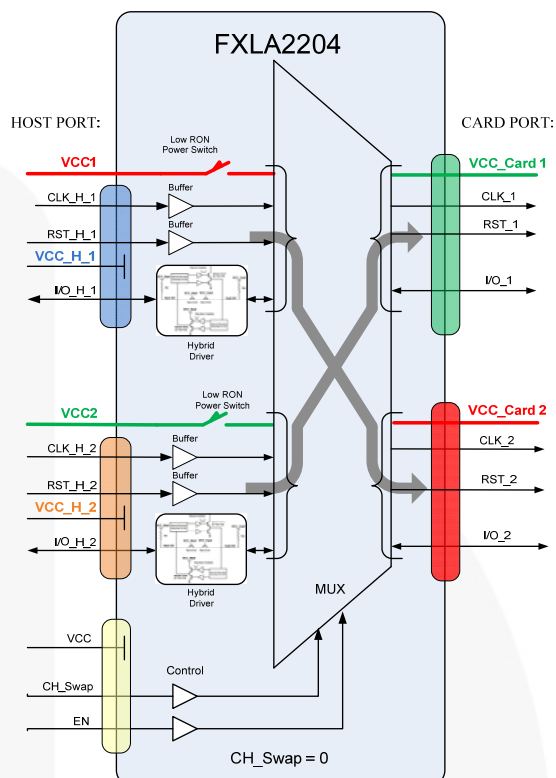


Figure 2. Block Diagram, CH_Swap=0

Notes:

1. V_{CC} must always be greater than or equal to (\geq) V_{CC1} and V_{CC2} .
2. Hybrid driver explained in detail in Figure 13 - I/O Pin Functional Diagram.
3. See Table 2 for CH_Swap truth table.

Pin Configuration

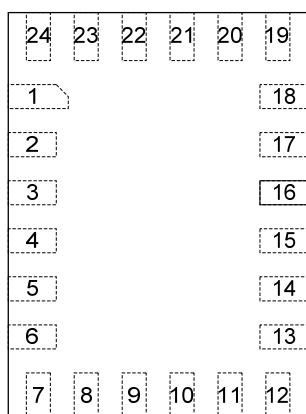


Figure 3. Top Through View

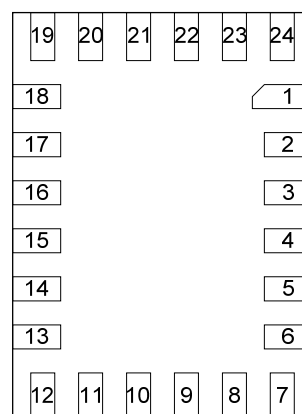


Figure 4. Bottom View

Pin Definitions

| Pin # | Name | Signal | Description |
|-------|-----------------|--------|--|
| 1 | NC | NC | No Connection |
| 2 | VCC1 | I | Power Supply 1 Input: Coming from PMIC 1 LDO |
| 3 | VCC_Card1 | O | Power Output for Card Slot 1 |
| 4 | GND | GND | Ground |
| 5 | VCC_Card2 | O | Power Output for Card Slot 2 |
| 6 | VCC2 | I | Power Supply 2 Input: Coming from PMIC 2 LDO |
| 7 | RST_2 | O | Reset Output to Card Slot 2 |
| 8 | I/O_2 | I/O | Data I/O for Card Slot 2; Open Drain (External Pull-Up Resistors Required) |
| 9 | CLK_2 | O | Clock Output to Card Slot 2 |
| 10 | CLK_H_2 | I | Clock Input of Host Interface 2 |
| 11 | RST_H_2 | I | Reset Input of Host Interface 2 |
| 12 | I/O_H_2 | I | Data I/O of Host Interface 2; Open Drain (External Pull-Up Resistors Required) |
| 13 | VCC_H_2 | Supply | Power Supply of Host Interface 2 |
| 14 | GND | GND | Ground |
| 15 | V _{CC} | Supply | Power Supply of Control Pins: EN and CH_Swap |
| 16 | EN | I | GPIO Enable. LOW disables both SIM card slots. HIGH enables both SIM card slots. Connect to V _{CC} if not used. Default level after power up is LOW. |
| 17 | Ch_Swap | I | Channel Swap. "1" = host 1 to card slot 1, host 2 to card slot 2. "0" = host 1 to card slot 2, host 2 to card slot 1. Connected to V _{CC} if not used. Default level after power up is LOW. |
| 18 | VCC_H_1 | Supply | Power Supply of Host Interface 1 |
| 19 | I/O_H_1 | I/O | Data I/O of Host Interface 1; Open Drain (External Pull-Up Resistors Required) |
| 20 | RST_H_1 | I | Reset Input of Host Interface 1 |
| 21 | CLK_H_1 | I | Clock Input of Host Interface 1 |
| 22 | CLK_1 | O | Clock Output to Card Slot 1 |
| 23 | I/O_1 | I/O | Data I/O for Card Slot 1; Open Drain (External Pull-Up Resistors Required) |
| 24 | RST_1 | O | Reset Output to Card Slot 1 |

Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

| Symbol | Parameter | | Conditions | Min. | Max. | Unit |
|----------------------------------|---|--|--|------|-----------------------|------|
| V _{CC} | Supply Voltage | | V _{CC} | -0.5 | 5.0 | V |
| | | | V _{CC_H_n} , V _{CCn} | -0.5 | 4.6 | V |
| V _{IN} | DC Input Voltage | | Host Ports and Card Ports | -0.5 | 4.6 | V |
| | | | Control Input (EN and CH_Swap) | -0.5 | 5.0 | |
| V _O | Output Voltage ⁽⁴⁾ | | Output 3-State | -0.5 | 4.6 | V |
| | | | Output Active (Host Port) | -0.5 | V _{CC} + 0.5 | |
| | | | Output Active (Card Port) | -0.5 | V _{CC} + 0.5 | |
| I _{IK} | DC Input Diode Current | | V _I < 0 V | | -50 | mA |
| I _{OK} | DC Output Diode Current | | V _O < 0 V | | -50 | mA |
| | | | V _O > V _{CC} | | +50 | |
| I _{OH} /I _{OL} | DC Output Source / Sink Current ⁽⁴⁾ | | | -50 | +50 | mA |
| I _{CC} | DC V _{CC} or Ground Current (per Supply Pin) | | | | ±100 | mA |
| T _{STG} | Storage Temperature Range | | | -65 | +150 | °C |
| P _{DISS} | Power Dissipation at 5 MHz | | | | 0.57 | W |
| ESD | Electrostatic Discharge Capability | Human Body Model, JESD22-A114 ⁽⁵⁾ | Card Side Pins 3-5, 7-9, 14, 22-24 | | 10 | kV |
| | | | All Other Pins | | 4 | |
| | | Charged Device Model, JESD22-C101 | Card Side Pins 3-5, 7-9, 14, 22-24 | | 2 | |
| | | | All Other Pins | | 2 | |

Notes:

4. I_O absolute maximum ratings must be observed.
5. Human Body Model (HBM): R=1500Ω, C=100pF.

Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to Absolute Maximum Ratings.

| Symbol | Parameter | | Conditions | Min. | Max. | Unit |
|------------------|--|--|--|------|---------------------------|------|
| V _{CC} | Power Supply ⁽⁶⁾ | | V _{CC} | 1.65 | 4.35 | V |
| | | | V _{CC_H_n} , V _{CCn} | 1.65 | 3.60 | V |
| V _{IN} | Input Voltage ⁽⁷⁾ | | Host Port | 0 | 3.6 | V |
| | | | Card Port | 0 | 3.6 | V |
| V _{OUT} | Output Voltage ⁽⁷⁾ | | Host Port | 0 | 3.6 | V |
| | | | Card Port | 0 | 3.6 | V |
| | | | Host Port I/O Pin | 0 | V _{CC_H_n} + 0.3 | V |
| | | | Card Port I/O Pin | 0 | V _{CCn} + 0.3 | V |
| T _A | Operating Temperature, Free Air | | | -40 | +85 | °C |
| dt/dV | Input Edge Rate | | RST and CLK | | 10 | ns/V |
| Θ _{JA} | Junction-to-Ambient Thermal Resistance | | | | 52.1 | C/W |

Notes:

6. V_{CC} must always be equal to, or greater than, V_{CC1} and V_{CC2}.
7. All unused inputs and input/outputs must be held at their respective V_{CC} or GND.

DC Electrical Characteristics

$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$; pins I/O_1, I/O_2, I/O_H_1, I/O_H_2 (open drain)⁽⁸⁾.

| Symbol | Parameter | Conditions | $V_{CC_H_n}$ (V) | V_{CCn} (V) | Min. | Max. | Unit |
|----------------|--|--|--------------------|---------------|---------------------------|-----------------------|---------------|
| V_{IH_host} | High-Level Input Voltage | Data Inputs of Host Interface | 1.65 – 3.60 | 1.65 - 3.60 | $0.7 \times V_{CC_H_n}$ | | V |
| V_{IH_card} | | Data Inputs of Card Interface | 1.65 – 3.60 | 1.65 - 3.60 | $0.7 \times V_{CCn}$ | | V |
| V_{IL_host} | Low-Level Input Voltage | Data Inputs of Host Interface | 1.65 – 3.60 | 1.65 - 3.60 | | 0.4 | V |
| V_{IL_card} | | Data Input of Card Interface | 1.65 – 3.60 | 1.65 - 3.60 | | $0.15 \times V_{CCn}$ | V |
| V_{OH_host} | High-Level Output Voltage ⁽⁸⁾ | $I_{OH} = -20 \mu\text{A}$ | 1.65 – 3.60 | 1.65 - 3.60 | $0.7 \times V_{CC_H_n}$ | | V |
| V_{OH_card} | | $I_{OH} = -20 \mu\text{A}$ | 1.65 – 3.60 | 1.65 - 3.60 | $0.7 \times V_{CCn}$ | | V |
| V_{OL_host} | Low-Level Output Voltage | $I_{OL} = 1 \text{ mA}$, $V_{IL} = 0 \text{ V}$ | 1.65 – 3.60 | 1.65 - 3.60 | | 0.05 | V |
| V_{OL_card} | | $I_{OL} = 1 \text{ mA}$, $V_{IL} = 0 \text{ V}$ | 1.65 – 3.60 | 1.65 - 3.60 | | 0.05 | V |
| V_{OL_host} | Low-Level Output Voltage | $I_{OL} = 1 \text{ mA}$, $V_{IL} = 0.100 \text{ V}$ | 1.65 – 3.60 | 1.65 - 3.60 | | 0.15 | V |
| V_{OL_card} | | $I_{OL} = 1 \text{ mA}$, $V_{IL} = 0.100 \text{ V}$ | 1.65 – 3.60 | 1.65 - 3.60 | | 0.15 | V |
| V_{OL_host} | Low-Level Output Voltage | $I_{OL} = 1 \text{ mA}$, $V_{IL} = 0.250 \text{ V}$ | 1.65 – 3.60 | 1.65 - 3.60 | | 0.3 | V |
| V_{OL_card} | | $I_{OL} = 1 \text{ mA}$, $V_{IL} = 0.250 \text{ V}$ | 1.65 – 3.60 | 1.65 - 3.60 | | 0.3 | V |
| I_{OFF} | Power-Off Leakage Current | $V_O = 0 \text{ V}$ to 3.6 V Host and Card Sides | 3.60 | 0 | | ± 1.0 | μA |
| I_{OZ} | 3-State Output Leakage | $V_O = 0 \text{ V}$ or 3.6 V , $EN = \text{GND}$, Host and Card Sides | 3.60 | 3.60 | | ± 1.0 | μA |
| I_{OZ} | 3-State Output Leakage | $V_O = 0 \text{ V}$ or 3.6 V , $EN = 1$, Host and Card Sides | 0 | 3.60 | | ± 1.0 | μA |

Notes:

8. Specifications based on external R_{PU} value of 10 k Ω on I/Os.

DC Electrical Characteristics

$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$; pins EN, CH_Swap.

| Symbol | Parameter | Conditions | V_{CC} (V) | Min. | Max. | Unit |
|-----------|------------------------------|-------------------------------------|--------------|------|---------|---------------|
| V_{IL} | Low-Level Input Voltage | | 3.60 | | 0.65 | V |
| | | | 1.80 | | 0.45 | V |
| V_{IH} | High-Level Input Voltage | | 3.60 | 1.2 | | V |
| | | | 1.80 | 0.9 | | V |
| I_L | Input Leakage Current | $V_I = V_{CC}$ or GND, I/O Floating | 1.65 – 3.60 | | ± 1 | μA |
| I_{CCT} | Increase in I_{CC} per Pin | $V_{IN} = 1.8 \text{ V}$ | 3.60 | | 12 | μA |
| | | $V_{IN} = 0.9 \text{ V}$ | 1.80 | | 10 | μA |

DC Electrical Characteristics

$T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$; pins RST_1, RST_2, RST_H_1, RST_H_2, CLK_1, CLK_2, CLK_H_1, CLK_H_2.

| Symbol | Parameter | Conditions | $V_{CC_H_n}$ (V) | V_{CCn} (V) | Min. | Typ. | Max. | Unit |
|-------------|-----------------------------------|--|--------------------|---------------|----------------------------|------|----------------------------|------------------|
| V_{IL} | Low-Level Input Voltage | | 1.65 – 3.60 | 1.65 – 3.60 | | | $0.35 \times V_{CC_H_n}$ | V |
| V_{IH} | High-Level Input Voltage | | 1.65 – 3.60 | 1.65 – 3.60 | $0.65 \times V_{CC_H_n}$ | | | V |
| V_{OL} | Low-Level Output Voltage | $I_{OL} = 20 \mu\text{A}$ | 1.65 – 3.60 | 1.65 – 3.60 | | | $0.12 \times V_{CCn}$ | V |
| V_{OH} | High-Level Output Voltage | $I_{OH} = -20 \mu\text{A}$ | 1.65 – 3.60 | 1.65 – 3.60 | $0.80 \times V_{CCn}$ | | | V |
| I_I | Input Leakage Current | $V_I = V_{CC}$ or GND | 1.65 – 3.60 | 3.60 | | | ± 1 | μA |
| I_{OFF} | Power-Off Leakage Current | $V_O = 0 \text{ V}$ to 3.6 V | 3.60 | 0 | | | ± 1 | μA |
| I_{OZ} | 3-State Output Leakage | $V_O = 0 \text{ V}$ or 3.6 V , EN=GND | 3.60 | 3.60 | | | ± 1 | μA |
| | | $V_O = 0 \text{ V}$ or 3.6 V , EN=1 | 0 | 3.60 | | | ± 1 | |
| I_{CC} | Quiescent Supply Current | $V_I = V_{CC}$ or GND; $I_O = 0$, EN= V_{CC} , I/O Floating | 1.65 – 3.60 | 1.65 – 3.60 | | | 3 | μA |
| I_{CCZ} | Power-Down Supply Current | $V_I = V_{CC}$ or GND; $I_O = 0$, EN=GND | 1.65 – 3.60 | 1.65 – 3.60 | | | 3 | μA |
| R_{ONPS} | Power Switch On Resistance, EN=1 | $I_{ON} = 50 \text{ mA}$, V_{CCn} to V_{CC_Cardn} | 1.65 – 3.60 | 1.65 – 3.60 | | 0.5 | 0.8 | Ω |
| R_{OFFPS} | Power Switch OFF Resistance, EN=0 | CH_Swap=0 and 1, $V_{CC1/2} = 3.3 \text{ V}$ | 1.65 – 3.60 | 1.80 – 3.60 | | 50 | | $\text{M}\Omega$ |

AC Characteristics

Card Port (RST, CLK)

Unless otherwise specified, output load: $C_L=30$ pF, $R_L \geq 1$ M Ω ; $T_A=-40^\circ\text{C}$ to $+85^\circ\text{C}$; $V_{CCn}=1.65$ V to 3.60 V.

| Symbol | Parameter | Typ. | Max. | Unit |
|--------|---|------|------|------|
| t_r | Output Rise Time Card Port ^(9,11) | 1 | 5 | ns |
| t_f | Output Fall Time Card Port ^(10,11) | 1 | 5 | ns |

Notes:

9. See Figure 7.
 10. See Figure 8.
 11. t_r , t_f guaranteed by characterization; not production tested.

Host and Card Port (I/O Only)

Unless otherwise specified, output load: $C_L=30$ pF, $R_L \geq 1$ M Ω , and open-drain outputs; $T_A=-40^\circ\text{C}$ to $+85^\circ\text{C}$; $V_{CCn}=1.65$ V to 3.60 V; and $V_{CC_H_n}=1.65$ V to 3.60 V.

| Symbol | Conditions | Parameter | Typ. | Max. | Unit |
|-----------------|--|--|------|------|------|
| $t_r^{(12,14)}$ | Open Drain Inputs with 500 μA $I_{\text{SINK}}^{(14)}$ | Output Rise Time Card Port (10% - 90%) | 200 | 500 | ns |
| $t_f^{(13,14)}$ | | Output Fall Time Card Port (90% - 10%) | 2.5 | 4.0 | ns |
| $t_r^{(12,14)}$ | | Output Rise Time Host Port (10% - 90%) | 200 | 500 | ns |
| $t_f^{(13,14)}$ | | Output Fall Time Host Port (90% - 10%) | 2 | 3 | ns |

Notes:

12. See Figure 7.
 13. See Figure 8.
 14. t_r , t_f guaranteed by characterization; not production tested. Specifications based on external R_{PU} value of 10 k Ω on I/Os.

$V_{CC_H_n}=1.65\text{V to }3.60\text{V}^{(15)}$

Unless otherwise specified, $T_A=-40^\circ\text{C}$ to $+85^\circ\text{C}$ and $V_{CCn}=1.65$ V to 3.60 V.

| Symbol | CH_Swap | Direction | Path | Typ. | Max. | Unit |
|-------------------|---------|-------------------------|----------------------------------|------|------|------|
| t_{swap} | HL, LH | Host \rightarrow Card | RST, CLK, I/O and Power Switches | 130 | 400 | ns |

Notes:

15. The power switch swap time assumes no decoupling capacitors on the V_{CC_Card} pins.
 16. t_{swap} is the time required for the CH_Swap pin to swap host to SIM slot connections.
 17. The I/O pin swap time assumes a push / pull driver; otherwise, the rise time (RC time constant) of an open-drain driver masks the actual I/O pin switch time.

Maximum Frequency⁽¹⁸⁾

Unless otherwise specified, CLK (Host to Card), $T_A=-40^\circ\text{C}$ to $+85^\circ\text{C}$, and card port $V_{CCn}=1.65$ V to 3.60 V.

| Host Port: $V_{CC_H_n}$ | CH_Swap | Minimum | Unit |
|---------------------------|---------|---------|------|
| 1.6 V to 3.6 V | 1 | 30 | MHz |
| | 0 | 30 | |

Note:

18. Maximum frequency is guaranteed but not tested.

Power Dissipation Capacitance

$T_A=+25^\circ\text{C}$.

| Symbol | Parameter | Conditions | Typical | Unit |
|----------|-------------------------------|---|---------|------|
| C_{pd} | Power Dissipation Capacitance | $V_{CC_H_n} = V_{CCn} = V_{CC} = 3.3$ V, $V_I = 0$ V or V_{CC} , CH_Swap=1, CLK1 and CLK2 Switching at 5 MHz | 23 | pF |

Test Diagrams

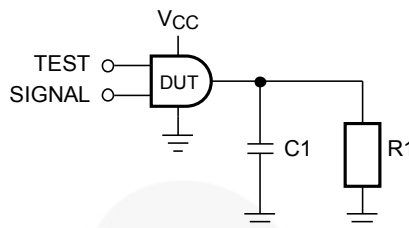


Figure 5. Test Circuit

Table 1. AC Test Conditions

| V_{CCO} | C1 | R1 |
|--------------------|-------|--------------|
| 1.8 V \pm 0.15 V | 30 pF | 1 M Ω |
| 2.5 V \pm 0.2 V | 30 pF | 1 M Ω |
| 3.3V \pm 0.3 V | 30 pF | 1 M Ω |

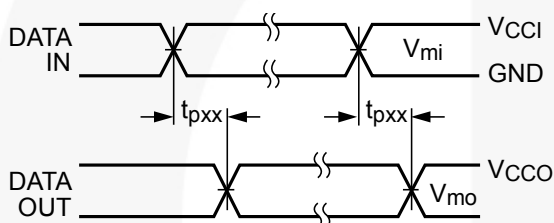


Figure 6. Input Edge Rates for RST and CLK

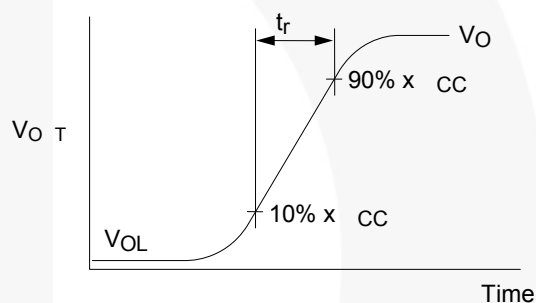


Figure 7. Active Output Rise Time

Notes:

19. Input $t_R=t_F=2.0$ ns, 10% to 90% at $V_I=2.5$ V.
 20. Input $t_R=t_F=2.5$ ns, 10% to 90% at $V_I=2.5$ V.

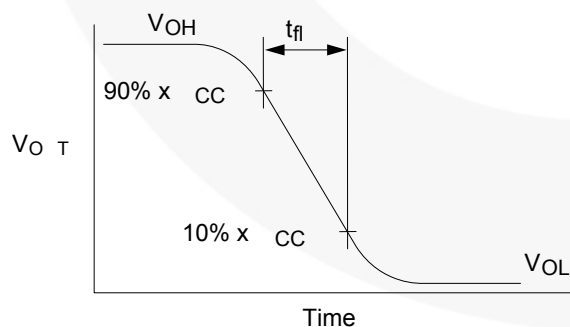


Figure 8. Active Output Fall Time

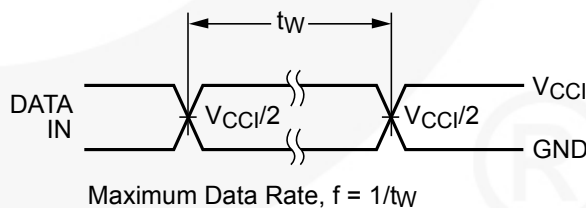


Figure 9. Maximum Data Rate

Application Information

Figure 10 illustrates the FXLA2204 used in a Dual-Mode / dual-SIM application. The FXLA2204 does not contain internal LDOs; instead, the architecture incorporates two

low- R_{ON} internal power switches for routing existing PMIC LDOs to individual SIM slot VCC pins.

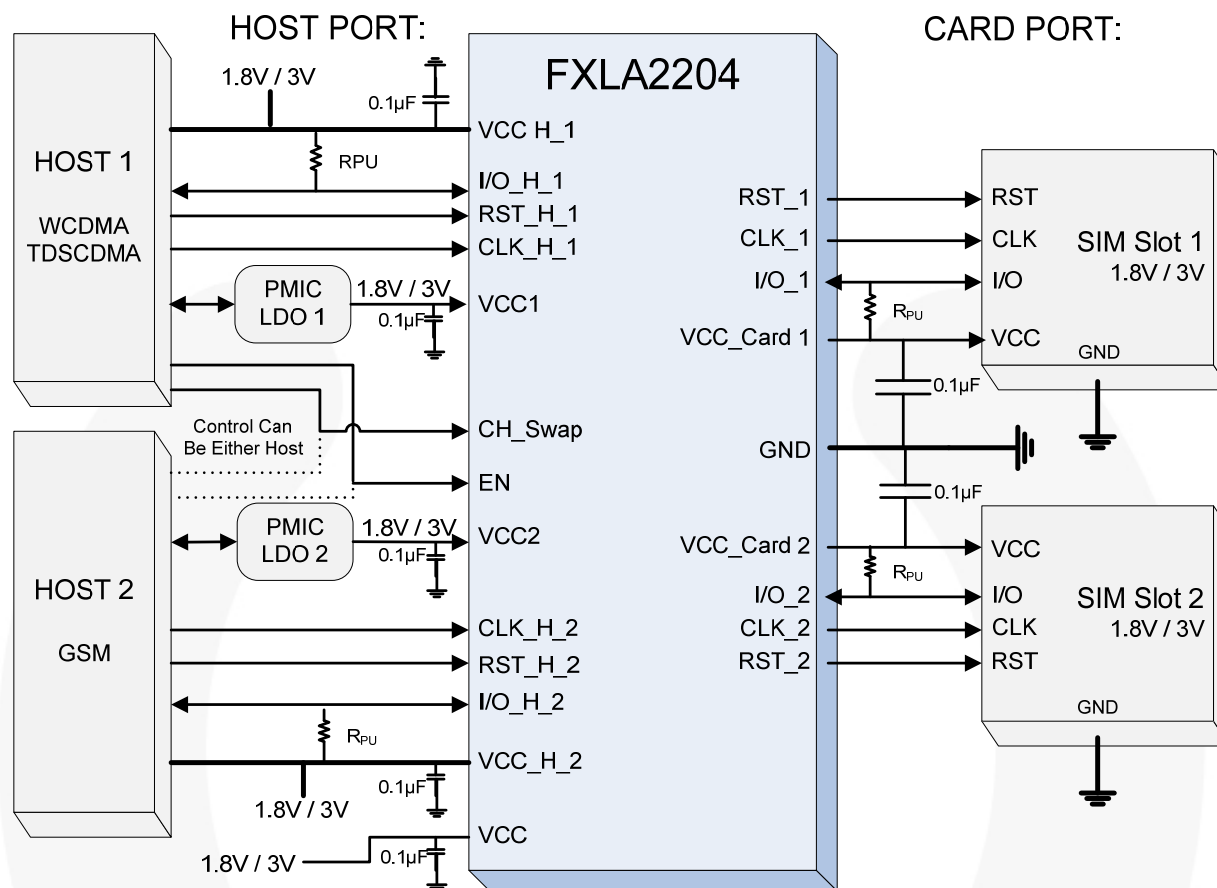


Figure 10. Typical Dual-Mode Application

CH_Swap Truth Table

CH_Swap controls simultaneous communication between Host 1 or Host 2, and either SIM card according to Table 2. Either host can swap SIM slots

(130 ns typical) with the assertion of the CH_Swap pin. This solution is faster and less complicated than SPI or I²C communication protocols.

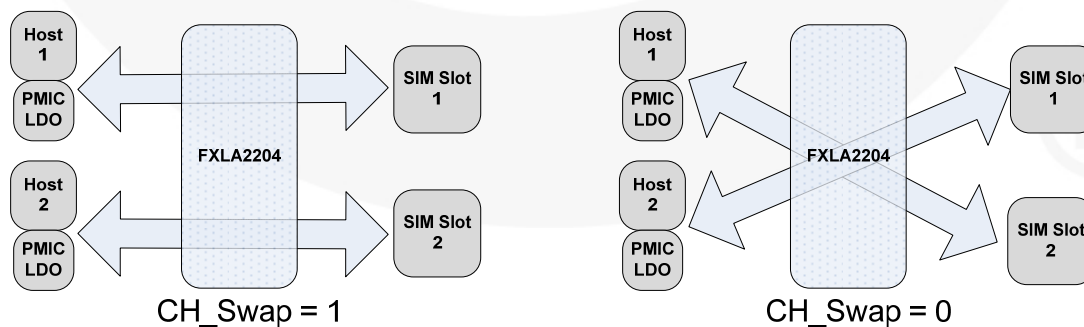


Figure 11. CH_Swap

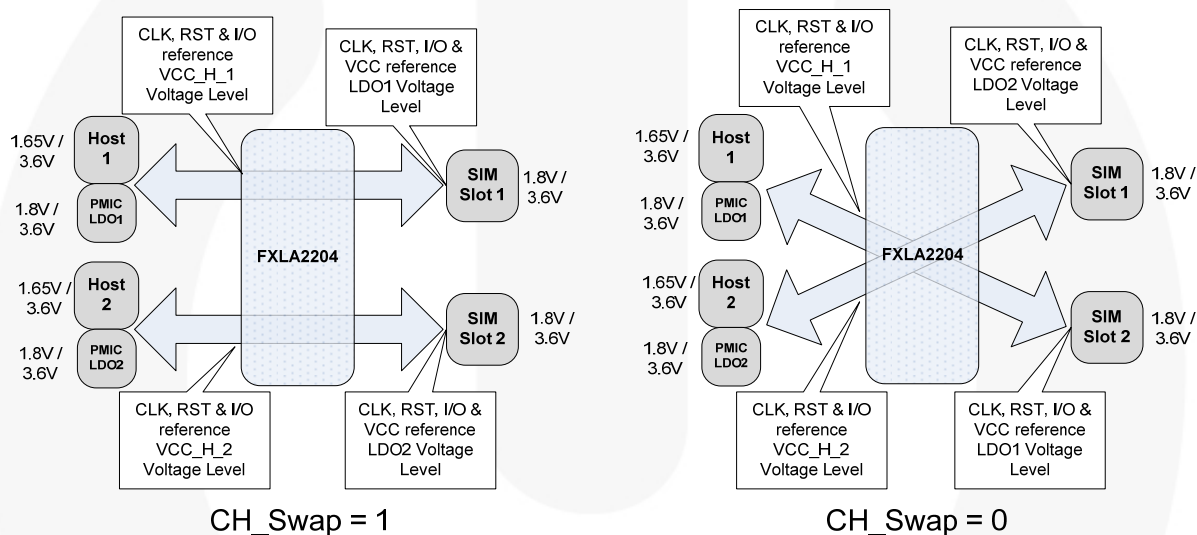
Table 2. Dual-Mode, Dual-SIM Truth Table

| Enable | CH_SWAP | Configuration |
|--------|---------|---------------------|
| 1 | 1 | Host 1 → SIM Slot 1 |
| 1 | 1 | Host 2 → SIM Slot 2 |
| 1 | 0 | Host 1 → SIM Slot 2 |
| 1 | 0 | Host 2 → SIM Slot 1 |

Voltage Translation Description

The FXLA2204 provides full voltage translation, or level shifting, from 1.65 V – 3.6 V between Host 1 or Host 2 and either SIM card (according to Table 3). The host sides reference $V_{CC_H_1}$ and $V_{CC_H_2}$, respectively, while each SIM slot references the external PMIC LDO voltage level determined by the CH_Swap pin. This

architecture offers a flexible solution for problematic V_{CC} domain disagreements. For example, if Host 1 operates at 1.65 V and Host 2 operates at 2.5 V, while slot 1 is populated with a 3.0 V SIM card and slot 2 is populated with a 1.8V SIM card, the FXLA2204 provides seamless voltage translation across all four V_{CC} domains.

**Figure 12. Voltage Translation****Table 3. Translation Truth Table⁽²¹⁾**

| Enable | CH_Swap | SIM Slot 1 Voltage Levels | SIM Slot 2 Voltage Levels |
|--------|---------|---------------------------|---------------------------|
| 1 | 1 | PMIC LDO1 / V_{CC1} | PMIC LDO2 / V_{CC2} |
| 1 | 0 | PMIC LDO2 / V_{CC2} | PMIC LDO1 / V_{CC1} |

Note:

21. V_{CC} must always be greater than or equal to (\geq) V_{CC1} and V_{CC2} .

I/O Pin Function

The ISO7816-3 specification, which governs the SIM card physical layer requirements, identifies the I/O pin as a bi-directional open-drain pin. To provide auto-direction for the I/O pin, the FXLA2204 architecture (see Figure 13) implements two series NpassGates and two dynamic drivers. This hybrid architecture is highly beneficial in a SIM card interface.

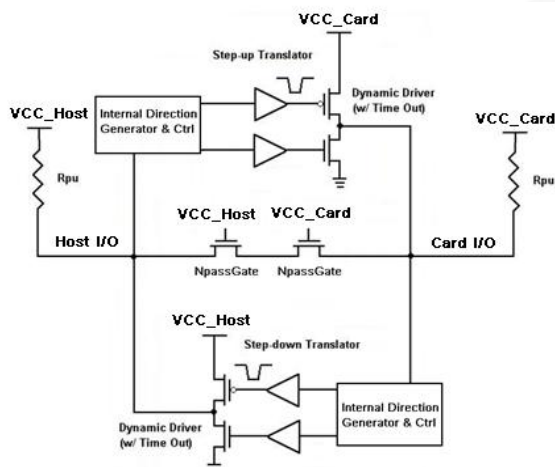


Figure 13. I/O Pin Functional Diagram

Note:

22. R_{PU} would be external.

The hybrid bi-directional I/O channel contains two series NpassGates and two dynamic drivers. This architecture allows auto-direction functionality without a direction pin from either the host or the SIM card and accomplishes an automatic change in direction without the presence of an edge.

Due to open-drain technology, hosts and SIM cards do not use push-pull drivers on the I/O pin. Logic LOWs are pulled down (I_{sink}), while logic HIGHs are “let go” (3-state). During a logic LOW on the I/O pin, both series NpassGates are turned on and act like a very low resistive short between the host and the SIM card. When the host or card lets go of a previously held LOW on the I/O pin, the rise time is largely determined by the RC time constant, where R is the external pull-up resistor and C is the I/O signal trace capacitance. The value of RPU is to be chosen to not exceed 1 mA maximum I_{OL} per ISO7816-3 compliance testing. The FXLA2204 acts as a very low resistive short between the host and SIM card (during a LOW) until either of the port's $V_{CC/2}$ thresholds are reached. After the RC time constant has reached the $V_{CC/2}$ threshold of either port, the port's edge detector triggers both dynamic drivers to drive their respective ports in the LOW-to-HIGH (LH) direction, accelerating the rising edge. The resulting rise time resembles the CH2 waveform (blue) of Figure 14. Effectively, two distinct slew rates appear in the rise time. The first slew rate (slower) is the RC time constant of the I/O signal trace. The second slew rate (faster) is the dynamic driver accelerating edge.

If both the host and card ports of the I/O pin are HIGH, a high-impedance path exists between the host and card ports because both of the series NpassGates are turned

off. If a host or SIM card pulls the I/O pin LOW, that device's driver pulls down (I_{sink}) the I/O pin until the HIGH-to-LOW (HL) edge reaches the host or card port's $V_{CC/2}$ threshold. When either the host or card port threshold is reached, the port's edge detectors trigger both dynamic drivers to drive their ports in the HIGH-to-LOW (HL) direction, accelerating the falling edge.

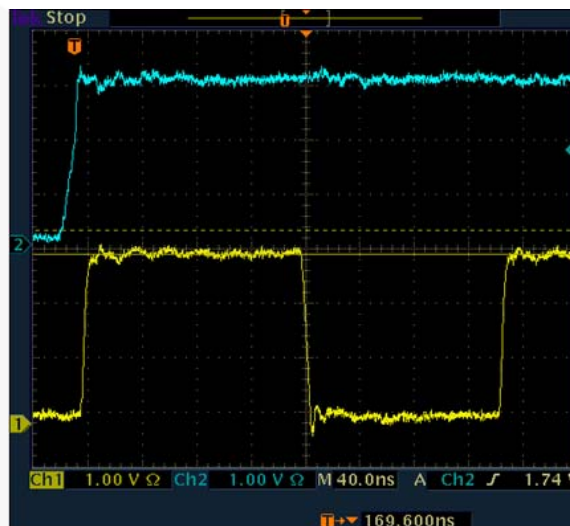


Figure 14. Scope Shot of I/O and Clock Signals
CH1: CLK Pin (Yellow), CH2: I/O Pin (Blue)
Driven by the FXLA2204

Activation / Deactivation

To ensure the SIM card electrical circuits do not activate before the contacts of the SIM card are mechanically connected, ISO7816-3 2006 mandates the activation sequence of events described in Figure 15. The FXLA2204 provides full transparency to the activation timing between host and SIM card.

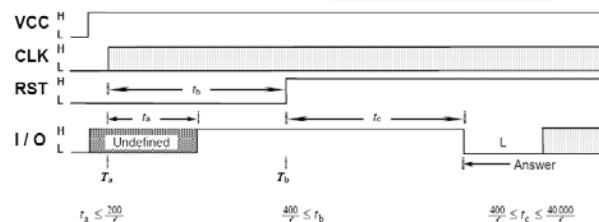


Figure 15. Activation Timing (ISO 7816-3 2006)

To ensure the SIM card electrical circuits properly deactivate before the contacts of the SIM card are mechanically connected, ISO7816-3 2006 mandates the sequence of events described in Figure 16. The FXLA2204 provides full transparency to the deactivation timing between host and SIM card.

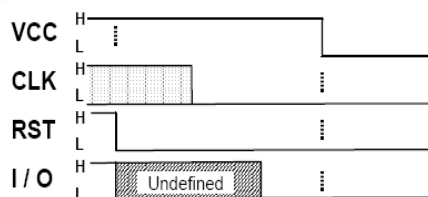


Figure 16. Deactivation (ISO 7816-3 2006)

Power-Up / Power-Down Sequence

Table 4. Power Supply Pins

| Pin | Name | Function |
|-----|---------|-----------------------|
| 1 | VCC | EN and CH_Swap Supply |
| 2 | VCC_H_1 | Host 1 Supply |
| 3 | VCC_H_2 | Host 2 Supply |
| 4 | VCC1 | Power Switch 1 Input |
| 5 | VCC2 | Power Switch 2 Input |

The V_{CC} host power sequencing is non preferential; however, V_{CC} must be higher or equal to V_{CC1} and V_{CC2} . The EN pin must be LOW while V_{CC1} and V_{CC2} ramp up to valid supply voltages or ramp down to 0 V.

A pull-up resistor tying enable (EN) to ground (GND) should be used to ensure that BUS contention, excessive currents, or oscillations do not occur during power up or power down. The size of the pull-up resistor is based upon the current sinking capability of the device driving the EN pin.

Recommended power-up sequence (see Figure 17):

1. Apply power to V_{CC} .
2. Assert EN LOW (FXLA2204 disabled).
3. Apply power to V_{CC1} , V_{CC2} , $V_{CC_H_1}$, and $V_{CC_H_2}$.
4. Assert EN HIGH (FXLA2204 enabled).
5. Begin activation timing (see Figure 15).

Recommended power-down sequence (see Figure 18):

1. Complete deactivation timing (see Figure 16).
2. Assert EN LOW (FXLA2204 disabled).
3. Ramp down power to V_{CC1} , V_{CC2} , $V_{CC_H_1}$, and $V_{CC_H_2}$.
4. Once V_{CC1} and V_{CC2} are OFF, ramp down V_{CC} .

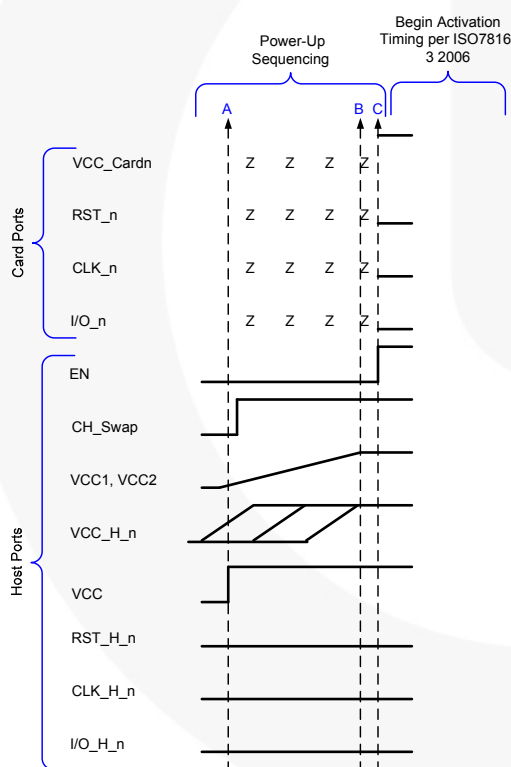


Figure 17. Power-Up Sequencing

Notes:

23. A= V_{CC} becomes a valid voltage, EN=LOW.
24. B= V_{CC1} , V_{CC2} , and $V_{CC_H_n}$ become valid voltages, EN=LOW.
25. C=FXLA2204 enabled (EN goes HIGH), ready for activation (ISO7816-3).

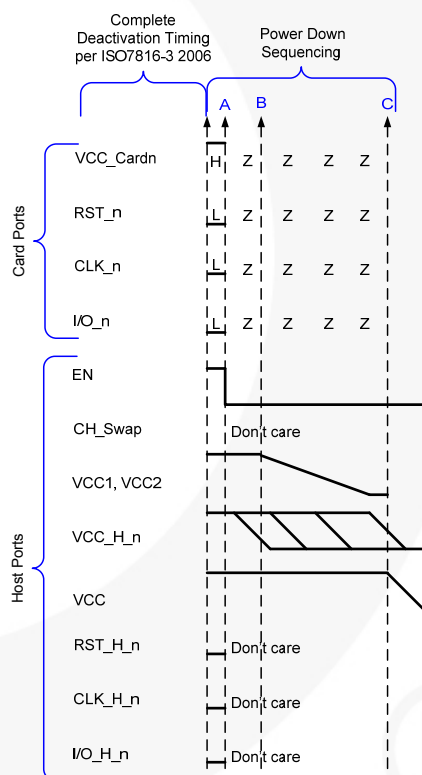


Figure 18. Power-Down Sequencing

Notes:

26. A=Disable FXLA2204, bring EN LOW.
27. B=Ramp down V_{CC1} , V_{CC2} , and $V_{CC_H_n}$.
28. C=Ramp down V_{CC} once V_{CC1} and V_{CC2} are off.

Operation Description

Table 5. Power Supply Pins

| Pin | Name | Function |
|-----|---------|-----------------------|
| 6 | VCC | EN and CH_Swap Supply |
| 7 | VCC_H_1 | Host 1 Supply |
| 8 | VCC_H_2 | Host 2 Supply |
| 9 | VCC1 | Power Switch 1 Input |
| 10 | VCC2 | Power Switch 2 Input |

The control pins EN and CH_Swap reference V_{CC} . V_{CC} can range from 1.65 V to 3.6 V and is independent from the other four power pins; however, V_{CC} must always be higher or equal to V_{CC1} and V_{CC2} .

$V_{CC_HOST_1}$ and $V_{CC_HOST_2}$ can independently range from 1.65 V to 3.6 V and are the power supply pins for their respective host-side interfaces; including RST, I/O, and CLK.

V_{CC1} and V_{CC2} can independently range from 1.65 V to 3.6 V and are the inputs to the internal power switches. V_{CC1} and V_{CC2} should be connected to external PMIC LDOs. Depending on the logic state of the CH_Swap and EN control pins, the external LDOs are routed through the two power switches to either VCC_Card1 or VCC_Card2 (see Table 6). Meanwhile, CH_Swap also routes the host (1 or 2) signal pins; RST, I/O, and CLK to the SIM slot side (1 or 2). See section “SIM Slot Signals: Active vs. 3-State” for details. The voltage reference of each SIM slot is determined by the LDO voltage assigned to that SIM slot.

RST and CLK are uni-directional pins always going in the SIM slot direction. I/O is a bi-directional, open-drain pin. External pull-up resistors are required.

The ISO7816 standard identifies an algorithm that allows a host device to auto-detect the operating voltage of a SIM card. The algorithm is called “class selection” and FXLA2204 is 100% transparent to class selection.

If VCC1 and VCC_H_1 share the same voltage potential; these two pins can be tied together. Likewise, if VCC2 and VCC_H_2 share the same voltage potential, these two pins can be tied together. Under these conditions, and once CH_Swap has been

established, the host can power up or down the SIM card along with the FXLA2204 host side solely by the LDO voltage. This feature is a convenient method for conserving power. V_{CC} must always remain equal to or greater than V_{CC1} and V_{CC2} .

The FXLA2204 I/O pins must be driven by open-drain drivers on the host sides and the card sides.

SIM Slot Power Switch Truth Table

If EN=1 and CH_Swap=1; then the V_{CC} of SIM Slot 1 (VCC_Card_1) tracks the VCC1 voltage (external LDO), while the V_{CC} of SIM Slot 2 (VCC_Card_2) tracks the VCC2 voltage (external LDO).

If EN=1 and CH_Swap=0; then the V_{CC} of SIM Slot 1 (VCC_Card_1) tracks the VCC2 voltage (external LDO), while the V_{CC} of SIM Slot 2 (VCC_Card_2) tracks the VCC1 voltage (external LDO). See Table 7.

Note:

29. V_{CC} must be $\geq V_{CC1}$ and V_{CC2} .

SIM Slot Signal Truth Table

If EN=1 and CH_Swap=1, the host 1 input signal pins (CLK_H_1, RST_H_1, and I/O_H_1) are translated to the SIM slot 1 output signal pins (CLK_1, RST_1, and I/O_1). The VCC1 voltage (external LDO) sets the voltage levels of CLK_1, RST_1, and I/O_1. Host 2 input signal pins (CLK_H_2, RST_H_2, and I/O_H_2) are translated to the SIM slot 2 output signal pins (CLK_2, RST_2, and I/O_2). The VCC2 (external LDO) voltage sets the voltage levels of CLK_2, RST_2, and I/O_2.

If EN=1 and CH_Swap=0, the Host 1 input signal pins (CLK_H_1, RST_H_1 and I/O_H_1) is translated to the SIM slot 2 output signal pins (CLK_2, RST_2, and I/O_2). The VCC1 voltage (external LDO) sets the voltage levels of CLK_2, RST_2, and I/O_2. Host 2 input signal pins (CLK_H_2, RST_H_2, and I/O_H_2) are translated to the SIM Slot 1 output signal pins (CLK_1, RST_1, and I/O_1). The VCC2 (external LDO) voltage sets the voltage levels of CLK_1, RST_1, and I/O_1.

Table 6. Power Switch Truth Table

| VCC1 | VCC2 | EN | CH_Swap | VCC_Card 1 | VCC_Card 2 |
|-------------|-------------|----|---------|------------|------------|
| 0 V – 3.6 V | 0 V – 3.6 V | 1 | 1 | VCC1 | VCC2 |
| 0 V – 3.6 V | 0 V – 3.6 V | 1 | 0 | VCC2 | VCC1 |

Table 7. Signal Truth Table

| EN | CH_Swap | SIM SLOT 1 | SIM Slot 2 |
|----|---------|-------------------------------|-------------------------------|
| 1 | 1 | CLK_H_1, RST_H_1, and I/O_H_1 | CLK_H_2, RST_H_2, and I/O_H_2 |
| 1 | 0 | CLK_H_2, RST_H_2, and I/O_H_2 | CLK_H_1, RST_H_1, and I/O_H_1 |

SIM Slot Signals: Active vs. 3-State

The individual SIM slot signals (CLK, RST, and I/O) are active only if the appropriate VCCn and VCC_H_n supplies are active (1.65 V – 3.6 V).

For example, if EN=1 and CH_Swap is 1, SIM slot 1 signals (CLK_1, RST_1, and I/O_1) are active only if VCC1 and VCC_H_1 are both active (1.65 V – 3.6 V). VCC1 sets the voltage levels of CLK_1, RST_1, and I/O_1. If either VCC1 or VCC_H_1 is below 1.65 V, SIM slot 1 signals (CLK_1, RST_1, and I/O_1) are high impedance. Likewise, SIM slot 2 signals (CLK_2, RST_2, and I/O_2) are active only if both VCC2 and VCC_H_2 are active (1.65 V – 3.6 V). VCC2 sets the voltage levels of CLK_2, RST_2, and I/O_2.

If EN=1 and CH_Swap is 0, SIM slot 1 (CLK_1, RST_1, and I/O_1) signals are active only if VCC2 and VCC_H_2 are active (1.65 V – 3.6 V). VCC2 sets the voltage levels of CLK_1, RST_1, and I/O_1. Likewise, SIM slot 2 signals (CLK_2, RST_2, and I/O_2) are active only if both VCC1 and VCC_H_1 are active (1.65 V – 3.6 V). VCC1 sets the voltage levels of CLK_2, RST_2, and I/O_2.

For a complete listing of all power switch and signal combinations, see 0.

Table 8. Complete Power Switch and Signal Truth Table

| Condition | Inputs | | | | | | | Outputs | | | |
|-----------|--------|----|---------|---------|---------|------|------|---------------------------|---------------------------|-----------|-----------|
| | VCC | EN | CH_SWAP | VCC_H_1 | VCC_H_2 | VCC1 | VCC2 | CLK_1, RST_1, I/O_1 | CLK_2, RST_2, I/O_2 | VCC_Card1 | VCC_Card2 |
| 1 | OFF | X | X | X | X | OFF | OFF | Z | Z | OFF | OFF |
| 2 | ON | L | X | X | X | X | X | Z | Z | Z | Z |
| 3 | ON | H | 1 | OFF | OFF | OFF | OFF | Z | Z | OFF | OFF |
| 4 | ON | H | 1 | OFF | OFF | ON | OFF | Z | Z | ON | OFF |
| 5 | ON | H | 1 | OFF | OFF | OFF | ON | Z | Z | OFF | ON |
| 6 | ON | H | 1 | OFF | OFF | ON | ON | Z | Z | ON | ON |
| 7 | ON | H | 1 | OFF | ON | OFF | OFF | Z | Z | OFF | OFF |
| 8 | ON | H | 1 | OFF | ON | ON | OFF | Z | Z | ON | OFF |
| 9 | ON | H | 1 | OFF | ON | OFF | ON | Z | A | OFF | ON |
| 10 | ON | H | 1 | OFF | ON | ON | ON | Z | A | ON | ON |
| 11 | ON | H | 1 | ON | OFF | OFF | OFF | Z | Z | OFF | OFF |
| 12 | ON | H | 1 | ON | OFF | ON | OFF | A | Z | ON | OFF |
| 13 | ON | H | 1 | ON | OFF | OFF | ON | Z | Z | OFF | ON |
| 14 | ON | H | 1 | ON | OFF | ON | ON | A | Z | ON | ON |
| 15 | ON | H | 1 | ON | ON | OFF | OFF | Z | Z | OFF | OFF |
| 16 | ON | H | 1 | ON | ON | ON | OFF | A | Z | ON | OFF |
| 17 | ON | H | 1 | ON | ON | OFF | ON | Z | A | OFF | ON |
| 18 | ON | H | 1 | ON | ON | ON | ON | A | A | ON | ON |
| 19 | ON | H | 0 | OFF | OFF | OFF | OFF | Z | Z | OFF | OFF |
| 20 | ON | H | 0 | OFF | OFF | ON | OFF | Z | Z | OFF | ON |
| 21 | ON | H | 0 | OFF | OFF | OFF | ON | Z | Z | ON | OFF |
| 22 | ON | H | 0 | OFF | OFF | ON | ON | Z | Z | ON | ON |
| 23 | ON | H | 0 | OFF | ON | OFF | OFF | Z | Z | OFF | OFF |
| 24 | ON | H | 0 | OFF | ON | ON | OFF | Z | Z | OFF | ON |
| 25 | ON | H | 0 | OFF | ON | OFF | ON | A | Z | ON | OFF |
| 26 | ON | H | 0 | OFF | ON | ON | ON | A | Z | ON | ON |
| 27 | ON | H | 0 | ON | OFF | OFF | OFF | Z | Z | OFF | OFF |
| 28 | ON | H | 0 | ON | OFF | ON | OFF | Z | A | OFF | ON |
| 29 | ON | H | 0 | ON | OFF | OFF | ON | Z | Z | ON | OFF |
| 30 | ON | H | 0 | ON | OFF | ON | ON | Z | A | ON | ON |
| 31 | ON | H | 0 | ON | ON | OFF | OFF | Z | Z | OFF | OFF |
| 32 | ON | H | 0 | ON | ON | ON | OFF | Z | A | OFF | ON |
| 33 | ON | H | 0 | ON | ON | OFF | ON | A | Z | ON | OFF |
| 34 | ON | H | 0 | ON | ON | ON | ON | A | A | ON | ON |

Notes:

30. ON = 1.65 V – 3.6 V.

31. OFF = Powered down or 0 V.

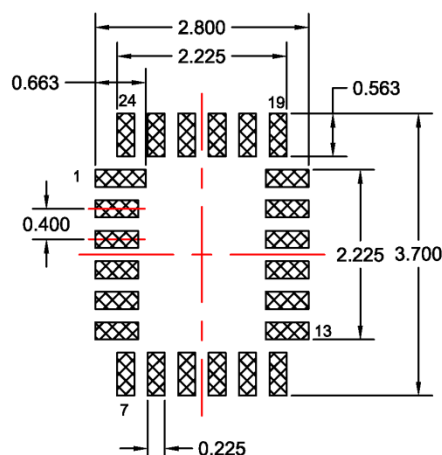
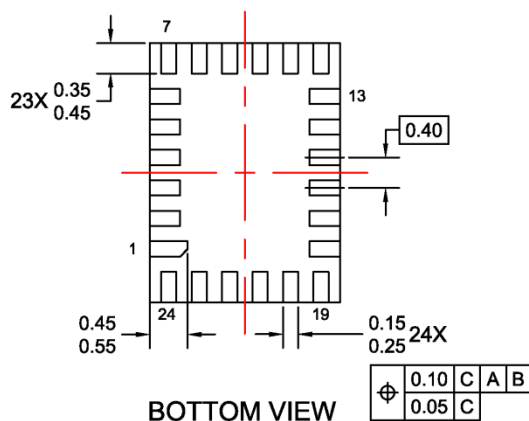
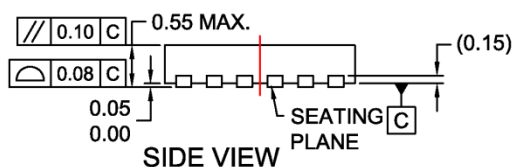
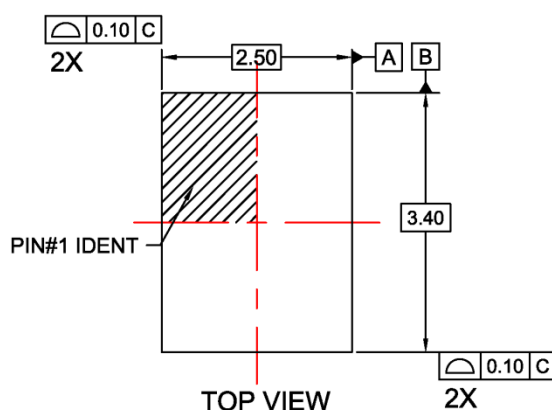
32. X = Don't Care.

33. Z = High impedance.

34. VCC ≥ VCC1 and VCC2.

35. A = Active.

Physical Dimensions



RECOMMENDED LAND PATTERN

NOTES:

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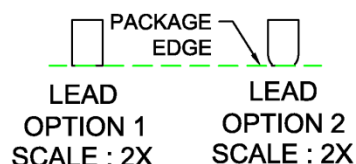


Figure 19. 24-Terminal 2.5mm x 3.4mm Ultrathin Molded Leadless Package (UMLP)

Product-Specific Dimensions

| Description | Nominal Values (mm) | Description | Nominal Values (mm) |
|----------------|---------------------|-----------------|---------------------|
| Overall Height | 0.50 | Lead Length | 0.40 |
| PKG Standoff | 0.012 | Lead Pitch | 0.40 |
| Lead Thickness | 0.15 | Body Length (X) | 2.50 |
| Lead Width | 0.20 | Body Width (Y) | 3.40 |

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