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# 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  $\Omega$  (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

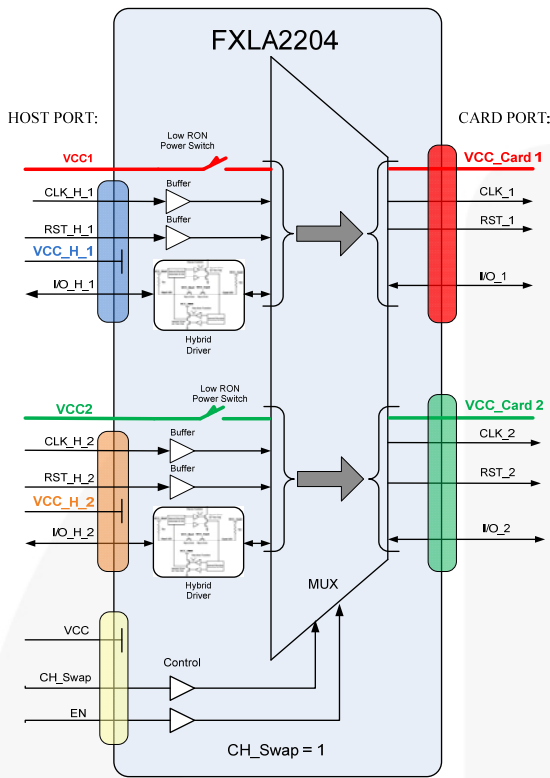


Figure 1. Block Diagram, CH\_Swap=1

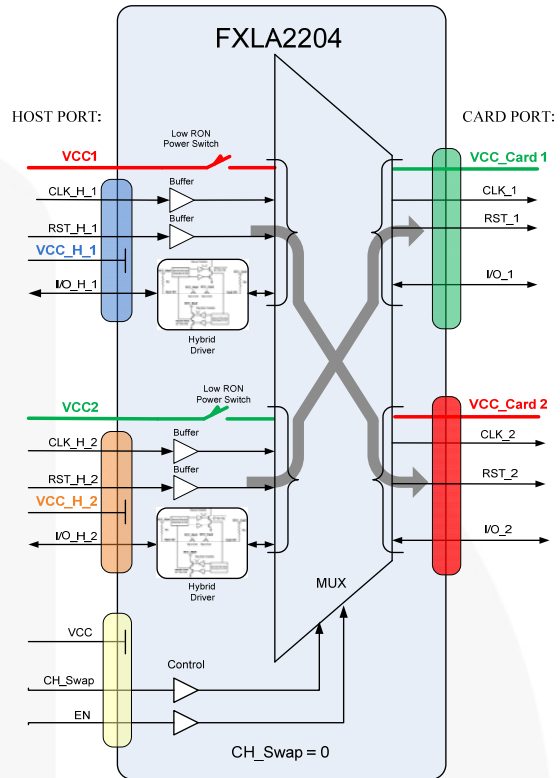


Figure 2. Block Diagram, CH\_Swap=0

### 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

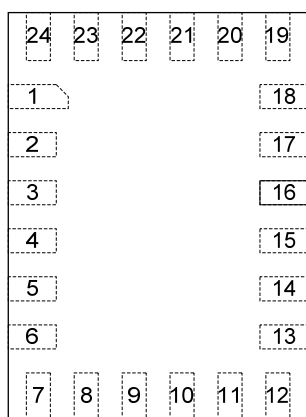


Figure 3. Top Through View

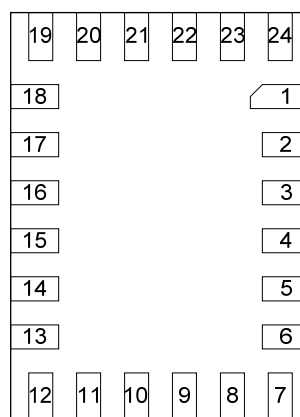


Figure 4. Bottom View

## 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 <sub>CC</sub>	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 <sub>CC</sub> 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 <sub>CC</sub> 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 <sub>CC</sub>	Supply Voltage		V <sub>CC</sub>	-0.5	5.0	V
			V <sub>CC_H_n</sub> , V <sub>CCn</sub>	-0.5	4.6	V
V <sub>IN</sub>	DC Input Voltage		Host Ports and Card Ports	-0.5	4.6	V
			Control Input (EN and CH_Swap)	-0.5	5.0	
V <sub>O</sub>	Output Voltage <sup>(4)</sup>		Output 3-State	-0.5	4.6	V
			Output Active (Host Port)	-0.5	V <sub>CC</sub> + 0.5	
			Output Active (Card Port)	-0.5	V <sub>CC</sub> + 0.5	
I <sub>IK</sub>	DC Input Diode Current		V <sub>I</sub> < 0 V		-50	mA
I <sub>OK</sub>	DC Output Diode Current		V <sub>O</sub> < 0 V		-50	mA
			V <sub>O</sub> > V <sub>CC</sub>		+50	
I <sub>OH</sub> /I <sub>OL</sub>	DC Output Source / Sink Current <sup>(4)</sup>			-50	+50	mA
I <sub>CC</sub>	DC V <sub>CC</sub> or Ground Current (per Supply Pin)				±100	mA
T <sub>STG</sub>	Storage Temperature Range			-65	+150	°C
P <sub>DISS</sub>	Power Dissipation at 5 MHz				0.57	W
ESD	Electrostatic Discharge Capability	Human Body Model, JESD22-A114 <sup>(5)</sup>	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:

- I<sub>O</sub> absolute maximum ratings must be observed.
- 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 <sub>CC</sub>	Power Supply <sup>(6)</sup>		V <sub>CC</sub>	1.65	4.35	V
			V <sub>CC_H_n</sub> , V <sub>CCn</sub>	1.65	3.60	V
V <sub>IN</sub>	Input Voltage <sup>(7)</sup>		Host Port	0	3.6	V
			Card Port	0	3.6	V
V <sub>OUT</sub>	Output Voltage <sup>(7)</sup>		Host Port	0	3.6	V
			Card Port	0	3.6	V
			Host Port I/O Pin	0	V <sub>CC_H_n</sub> + 0.3	V
			Card Port I/O Pin	0	V <sub>CCn</sub> + 0.3	V
T <sub>A</sub>	Operating Temperature, Free Air			-40	+85	°C
dt/dV	Input Edge Rate		RST and CLK		10	ns/V
θ <sub>JA</sub>	Junction-to-Ambient Thermal Resistance				52.1	C/W

### Notes:

- V<sub>CC</sub> must always be equal to, or greater than, V<sub>CC1</sub> and V<sub>CC2</sub>.
- All unused inputs and input/outputs must be held at their respective V<sub>CC</sub> 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)<sup>(8)</sup>.

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 <sup>(8)</sup>	$I_{OH} = -20 \mu\text{A}$	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 $3.6 \text{ V}$ Host and Card Sides	3.60	0		$\pm 1.0$	$\mu\text{A}$
$I_{OZ}$	3-State Output Leakage	$V_O = 0 \text{ V}$ or $3.6 \text{ V}$ , EN=GND, Host and Card Sides	3.60	3.60		$\pm 1.0$	$\mu\text{A}$
$I_{OZ}$	3-State Output Leakage	$V_O = 0 \text{ V}$ or $3.6 \text{ V}$ , EN=1, Host and Card Sides	0	3.60		$\pm 1.0$	$\mu\text{A}$

### Notes:

8. Specifications based on external  $R_{PU}$  value of  $10 \text{ k}\Omega$  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		$\pm 1$	$\mu\text{A}$
$I_{CCT}$	Increase in $I_{CC}$ per Pin	$V_{IN} = 1.8 \text{ V}$	3.60		12	$\mu\text{A}$
		$V_{IN} = 0.9 \text{ V}$	1.80		10	$\mu\text{A}$

## DC Electrical Characteristics

T<sub>A</sub>=-40°C to +85°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 <sub>CC_H_n</sub> (V)	V <sub>CCn</sub> (V)	Min.	Typ.	Max.	Unit
V <sub>IL</sub>	Low-Level Input Voltage		1.65 – 3.60	1.65 – 3.60			0.35 x V <sub>CC_H_n</sub>	V
V <sub>IH</sub>	High-Level Input Voltage		1.65 – 3.60	1.65 – 3.60	0.65 x V <sub>CC_H_n</sub>			V
V <sub>OL</sub>	Low-Level Output Voltage	I <sub>OL</sub> =20 μA	1.65 – 3.60	1.65 – 3.60			0.12 x V <sub>CCn</sub>	V
V <sub>OH</sub>	High-Level Output Voltage	I <sub>OH</sub> =-20 μA	1.65 – 3.60	1.65 – 3.60	0.80 x V <sub>CCn</sub>			V
I <sub>I</sub>	Input Leakage Current	V <sub>I</sub> =V <sub>CC</sub> or GND	1.65 – 3.60	3.60			±1	μA
I <sub>OFF</sub>	Power-Off Leakage Current	V <sub>O</sub> =0 V to 3.6 V	3.60	0			±1	μA
I <sub>OZ</sub>	3-State Output Leakage	V <sub>O</sub> =0 V or 3.6 V, EN=GND	3.60	3.60			±1	μA
		V <sub>O</sub> =0 V or 3.6 V, EN=1	0	3.60			±1	
I <sub>CC</sub>	Quiescent Supply Current	V <sub>I</sub> =V <sub>CC</sub> or GND; I <sub>O</sub> =0, EN=V <sub>CC</sub> , I/O Floating	1.65 – 3.60	1.65 – 3.60			3	μA
I <sub>CCZ</sub>	Power-Down Supply Current	V <sub>I</sub> =V <sub>CC</sub> or GND; I <sub>O</sub> =0, EN=GND	1.65 – 3.60	1.65 – 3.60			3	μA
R <sub>ONPS</sub>	Power Switch On Resistance, EN=1	I <sub>ON</sub> =50 mA, V <sub>CCn</sub> to V <sub>CC_Cardn</sub>	1.65 – 3.60	1.65 – 3.60		0.5	0.8	Ω
R <sub>OFFS</sub>	Power Switch OFF Resistance, EN=0	CH_Swap=0 and 1, V <sub>CC1/2</sub> =3.3 V	1.65 – 3.60	1.80 – 3.60		50		MΩ

## AC Characteristics

### Card Port (RST, CLK)

Unless otherwise specified, output load:  $C_L=30$  pF,  $R_L \geq 1$  M $\Omega$ ;  $T_A=-40^\circ\text{C}$  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 <sup>(9,11)</sup>	1	5	ns
$t_f$	Output Fall Time Card Port <sup>(10,11)</sup>	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 $\Omega$ , 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 $\mu\text{A}$ $I_{\text{SINK}}^{(14)}$	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  $R_{\text{PU}}$  value of 10 k $\Omega$  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
$t_{\text{swap}}$	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.  $t_{\text{swap}}$  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<sup>(18)</sup>

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
$C_{\text{pd}}$	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

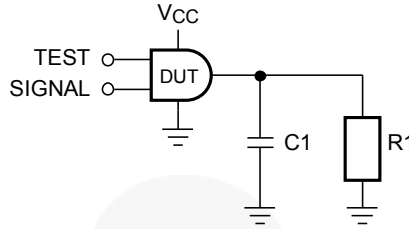


Figure 5. Test Circuit

Table 1. AC Test Conditions

V <sub>CC0</sub>	C1	R1
1.8 V ±0.15 V	30 pF	1 MΩ
2.5 V ±0.2 V	30 pF	1 MΩ
3.3V ±0.3 V	30 pF	1 MΩ

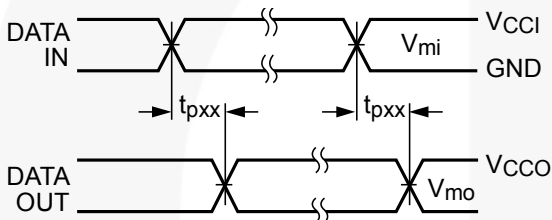


Figure 6. Input Edge Rates for RST and CLK

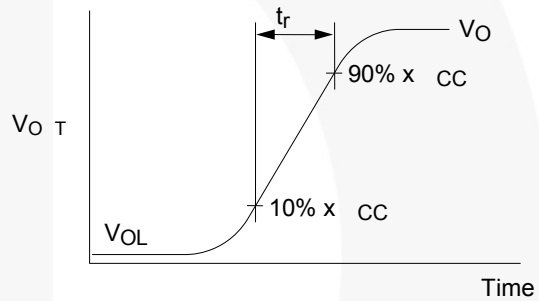


Figure 7. Active Output Rise Time

**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.

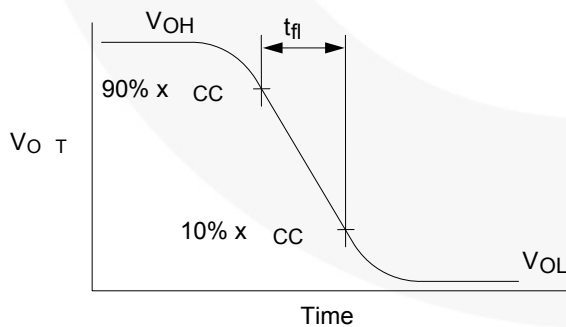


Figure 8. Active Output Fall Time

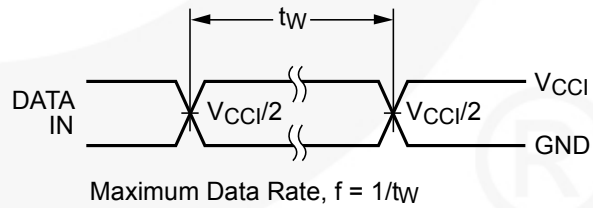


Figure 9. Maximum Data Rate

## 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.

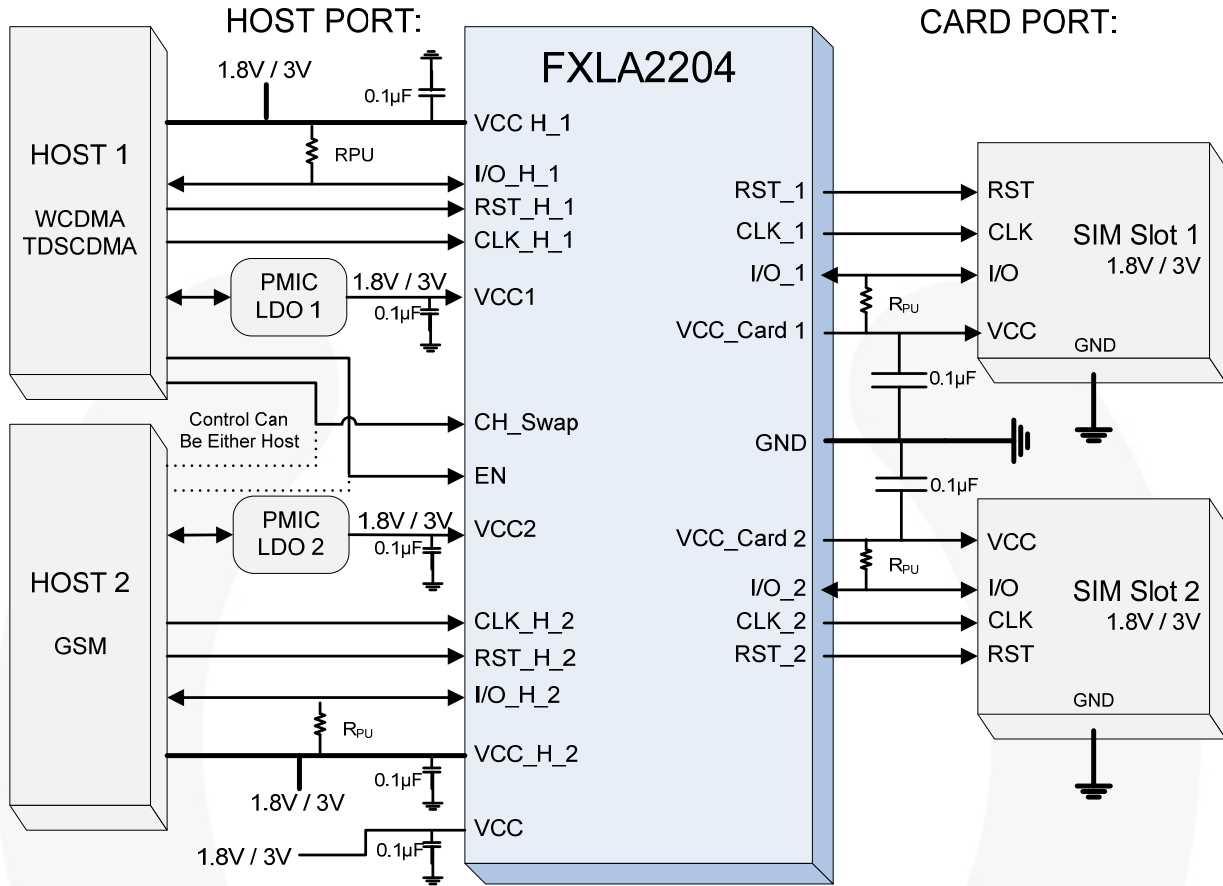


Figure 10. Typical Dual-Mode Application

## 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 I<sup>2</sup>C communication protocols.

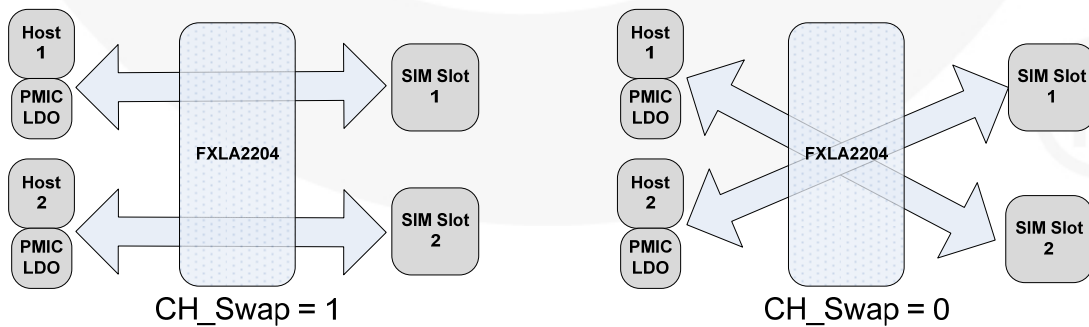


Figure 11. CH\_Swap

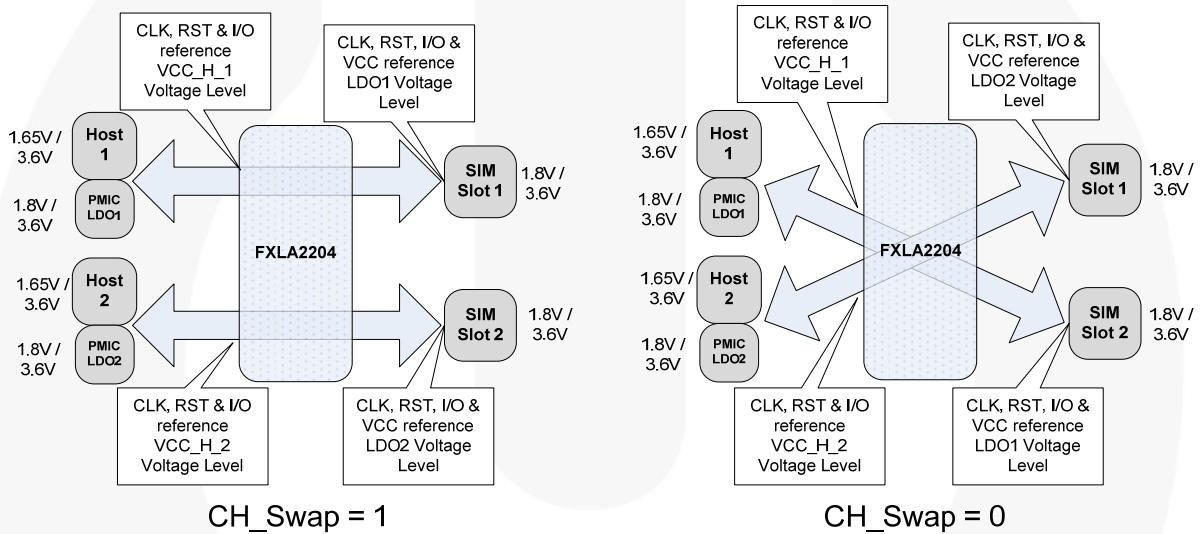
**Table 2. Dual-Mode, Dual-SIM Truth Table**

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<sup>(21)</sup>**

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.

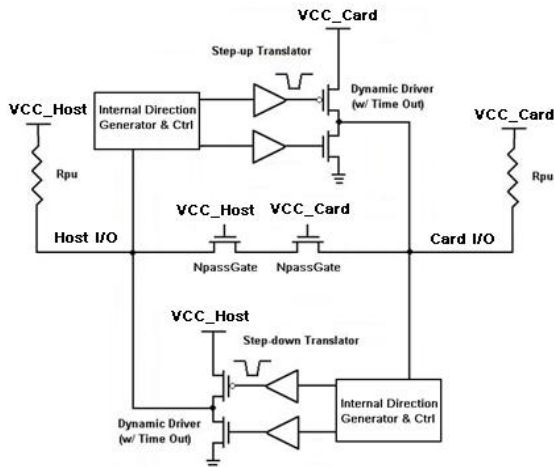


Figure 13. I/O Pin Functional Diagram

### 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  $R_{PU}$  is to be chosen to not exceed 1 mA maximum  $I_{OL}$  per IOS7816-3 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.

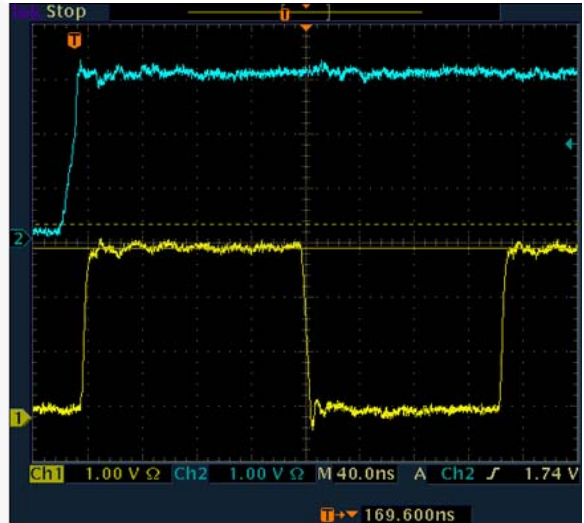


Figure 14. Scope Shot of I/O and Clock Signals  
CH1: CLK Pin (Yellow), CH2: I/O Pin (Blue)  
Driven by the FXLA2204

## 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.

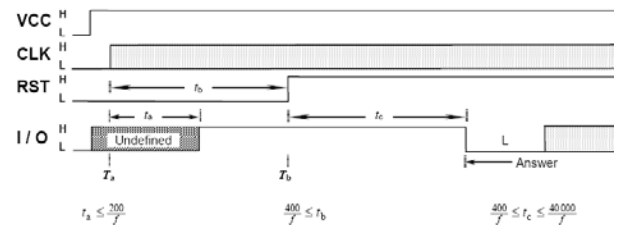


Figure 15. Activation Timing (ISO 7816-3 2006)

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.

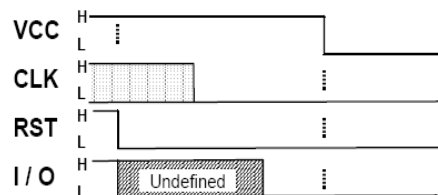


Figure 16. Deactivation (ISO 7816-3 2006)

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

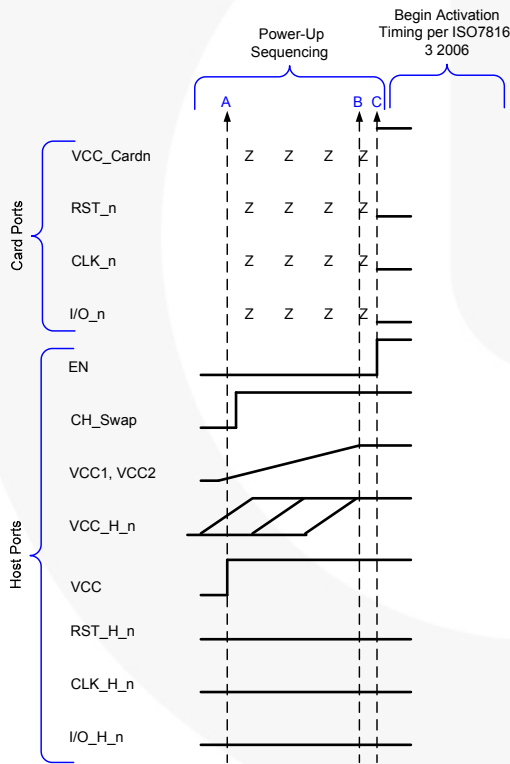
A pull-up resistor tying enable (EN) to ground (GND) should be used to ensure that BUS contention, excessive currents, or oscillations do not occur during power up or power down. The size of the pull-up resistor is based upon the current sinking capability of the device driving the EN pin.

Recommended power-up sequence (see Figure 17):

1. Apply power to V<sub>CC</sub>.
2. Assert EN LOW (FXLA2204 disabled).
3. Apply power to V<sub>CC1</sub>, V<sub>CC2</sub>, V<sub>CC\_H\_1</sub>, and V<sub>CC\_H\_2</sub>.
4. Assert EN HIGH (FXLA2204 enabled).
5. Begin activation timing (see Figure 15).

Recommended power-down sequence (see Figure 18):

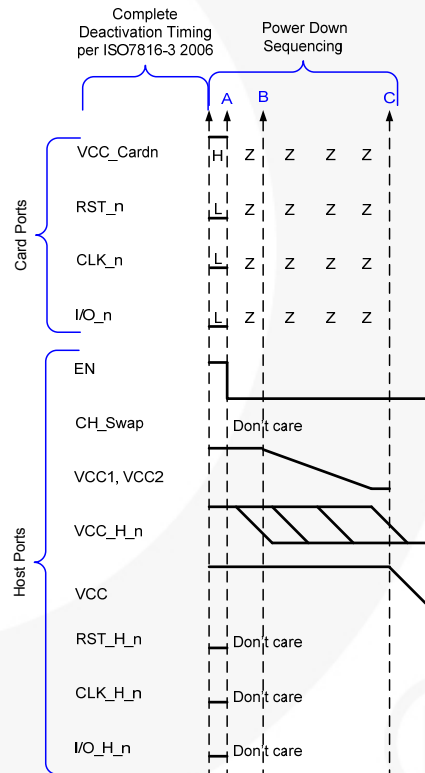
1. Complete deactivation timing (see Figure 16).
2. Assert EN LOW (FXLA2204 disabled).
3. Ramp down power to V<sub>CC1</sub>, V<sub>CC2</sub>, V<sub>CC\_H\_1</sub>, and V<sub>CC\_H\_2</sub>.
4. Once V<sub>CC1</sub> and V<sub>CC2</sub> are OFF, ramp down V<sub>CC</sub>.



**Figure 17. Power-Up Sequencing**

**Notes:**

23. A=V<sub>CC</sub> becomes a valid voltage, EN=LOW.
24. B=V<sub>CC1</sub>, V<sub>CC2</sub>, and V<sub>CC\_H\_n</sub> 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<sub>CC1</sub>, V<sub>CC2</sub>, and V<sub>CC\_H\_n</sub>.
28. C=Ramp down V<sub>CC</sub> once V<sub>CC1</sub> and V<sub>CC2</sub> 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<sub>CC</sub>. V<sub>CC</sub> can range from 1.65 V to 3.6 V and is independent from the other four power pins; however, V<sub>CC</sub> must always be higher or equal to V<sub>CC1</sub> and V<sub>CC2</sub>.

V<sub>CC\_HOST\_1</sub> and V<sub>CC\_HOST\_2</sub> 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<sub>CC1</sub> and V<sub>CC2</sub> can independently range from 1.65 V to 3.6 V and are the inputs to the internal power switches. V<sub>CC1</sub> and V<sub>CC2</sub> 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<sub>CC</sub> must always remain equal to or greater than V<sub>CC1</sub> and V<sub>CC2</sub>.

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<sub>CC</sub> of SIM Slot 1 (VCC\_Card\_1) tracks the VCC1 voltage (external LDO), while the V<sub>CC</sub> of SIM Slot 2 (VCC\_Card\_2) tracks the VCC2 voltage (external LDO).

If EN=1 and CH\_Swap=0; then the V<sub>CC</sub> of SIM Slot 1 (VCC\_Card\_1) tracks the VCC2 voltage (external LDO), while the V<sub>CC</sub> of SIM Slot 2 (VCC\_Card\_2) tracks the VCC1 voltage (external LDO). See Table 7.

#### Note:

29. V<sub>CC</sub> must be ≥ V<sub>CC1</sub> and V<sub>CC2</sub>.

### 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.

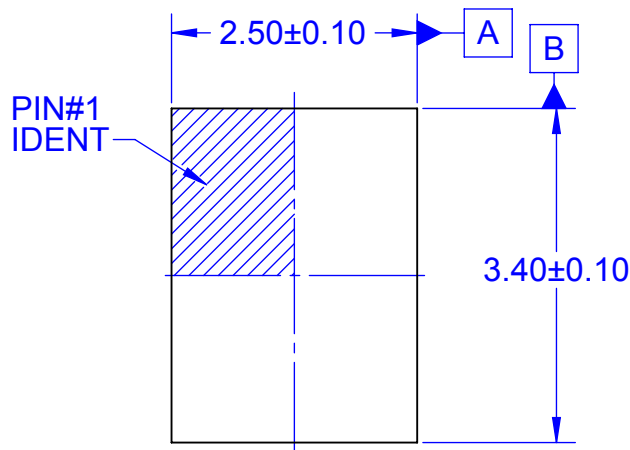
31. OFF = Powered down or 0 V.

32. X = Don't Care.

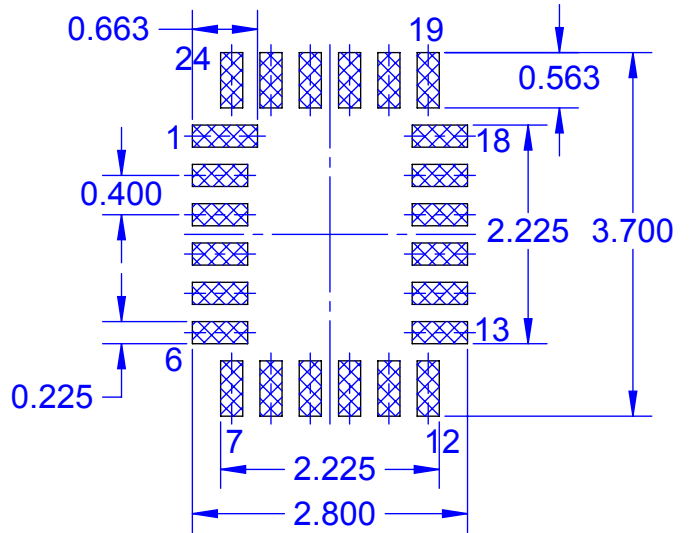
33. Z = High impedance.

34.  $V_{CC} \geq V_{CC1}$  and  $V_{CC2}$ .

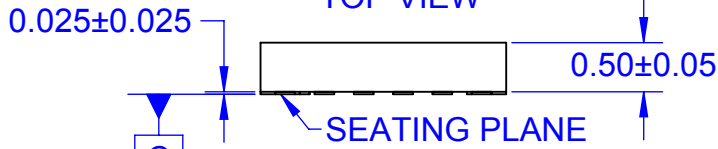
35. A = Active.



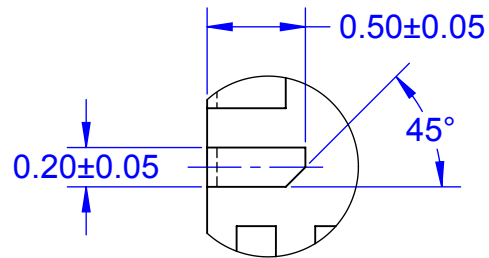
TOP VIEW



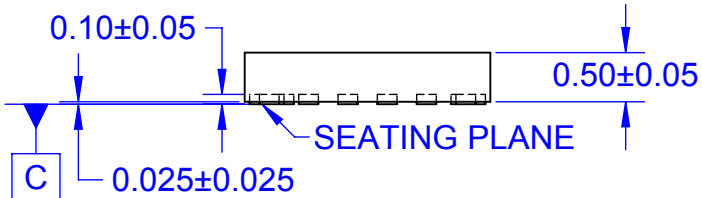
LAND PATTERN RECOMMENDATION



SIDE VIEW - OPTION A



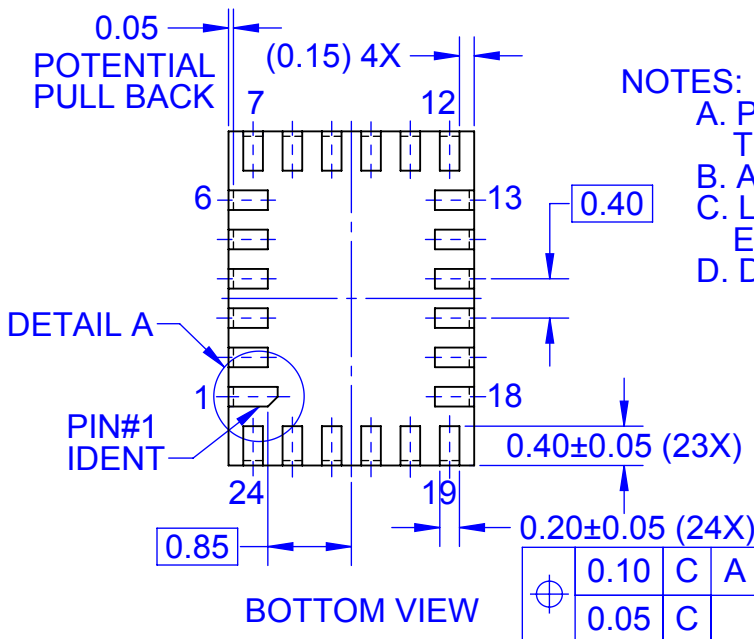
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SCALE 2:1



SIDE VIEW - OPTION B

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