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January 2016

FSA3000 — Two-Port, High-Speed, MHL™ Switch

Features

- Low On Capacitance: 2.7 pF/4.1 pF MHL/USB (Typical)
- Low Power Consumption: 30 µA Maximum
- MHL Data Rate: 4.92 Gbps (f_{3dB} = 2.46 GHz)
- Packaged in 10-Lead MicroPak™
- Over-Voltage Tolerance (OVT) on all USB and MHL Ports; Up to 5.25 V without External Components

Applications

- Cell Phones and Digital Cameras

Description

The FSA3000 is a bi-directional, low-power, two-port, high-speed, USB2.0 and video data switch that supports the Mobile High-Definition Link (MHL) Specification Rev. 2.0. Configured as a double-pole, double-throw (DPDT) switch for data, FSA3000 is optimized for USB2.0 and MHL data sources.

The FSA3000 contains circuitry on the switch I/O pins that allows the device to withstand an over-voltage condition in applications where the V_{CC} supply is powered off (V_{CC}=0). The FSA3000 minimizes current consumption even when the voltage applied to the control pins is lower than the supply voltage (V_{CC}). This feature is especially valuable in mobile applications, such as cell phones; allowing direct interface with the general-purpose I/Os of the baseband processor. Other applications include switching and connector sharing in portable cell phones, digital cameras, and notebook computers.

Ordering Information

Part Number	Top Mark	Operating Temperature Range	Package
FSA3000L10X	LK	-40 to +85°C	10-Lead, MicroPak™ 1.6 x 2.1 mm JEDEC MO255B
FSA3000L10X_F131	LK		10-Lead, MicroPak™ 1.6 x 2.1 mm JEDEC MO255B, Package Rotated 90° in Tape and Reel

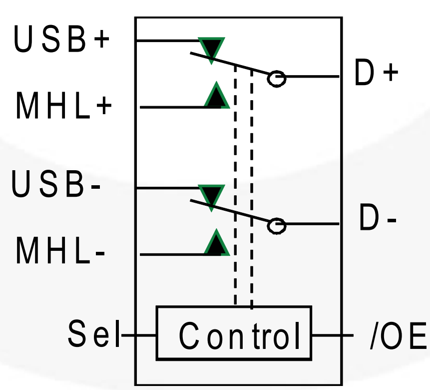


Figure 1. Analog Symbol

All trademarks are the property of their respective owners.

Data Switch Select Truth Table

SEL[(1)]	/OE[(1)]	Function
X	HIGH	USB and MHL paths both high impedance
LOW	LOW	D+/D- connected to USB+/USB-
HIGH	LOW	D+/D- connected to MHL+/MHL-

Note:
1. Control inputs should never be left floating or unconnected.

Pin Configurations

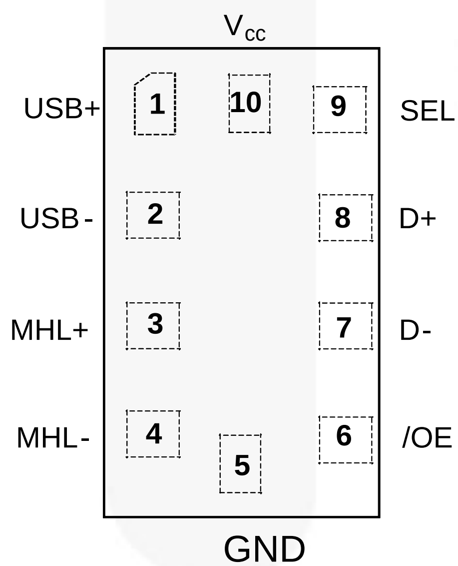


Figure 2. Pin Assignments (Top-Through View)

Pin Definitions

Pin#	Name	Description
1	USB+	USB Differential Data (Positive)
2	USB-	USB Differential Data (Negative)
3	MHL+	MHL Differential Data (Positive)
4	MHL-	MHL Differential Data (Negative)
5	GND	Ground
6	/OE	Output Enable (Active LOW)
7	D-	Data Switch Output (Negative)
8	D+	Data Switch Output (Positive)
9	SEL	Data Switch Select
10	V_{CC}	Supply

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		Min.	Max.	Unit
V_{CC}	Supply Voltage		-0.5	5.5	V
V_{CNTRL}	DC Input Voltage (SEL, /OE)(2)		-0.5	V_{CC}	V
V_{SW}	DC Switch I/O Voltage(2,3)		-0.50	5.25	V
I_{IK}	DC Input Diode Current		-50		mA
I_{OUT}	DC Output Current			100	mA
T_{STG}	Storage Temperature		-65	+150	°C
MSL	Moisture Sensitivity Level (JEDEC J-STD-020A)			1	
ESD	Human Body Model, JEDEC: JESD22-A114	All Pins		3.5	kV
	IEC 61000-4-2, Level 4, for D+/D- and V_{CC} Pins(4)	Contact		8	
	IEC 61000-4-2, Level 4, for D+/D- and V_{CC} Pins(4)	Air		15	
	Charged Device Model, JESD22-C101			2	

Notes:
2. The input and output negative ratings may be exceeded if the input and output diode current ratings are observed.
3. V_{SW} refers to analog data switch paths (USB and MHL).
4. Testing performed in a system environment using TVS diodes.

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	Min.	Max.	Unit
V_{CC}	Supply Voltage	2.7	4.3	V
$t_{RAMP(VCC)}$	Power Supply Slew Rate	100	1000	µs/V
V_{CNTRL}	Control Input Voltage (SEL, /OE)(5)	0	4.3	V
Θ_{JA}	Thermal Resistance		313	C°/W
$V_{SW(USB)}$	Switch I/O Voltage (USB Switch Path)	-0.5	3.6	V
$V_{SW(MHL)}$	Switch I/O Voltage (MHL Switch Path)	1.65	3.45	V
T_A	Operating Temperature	-40	+85	°C

Note:
5. The control inputs must be held HIGH or LOW; they must not float.

DC Electrical Characteristics

All typical value are at T_A=25°C unless otherwise specified.

Symbol	Parameter	Condition	V_{CC} (V)	T_A= -40ºC to +85ºC			Unit
				Min.	Typ.	Max.	
V_{IK}	Clamp Diode Voltage	I_{IN}=-18 mA	2.7			-1.2	V
V_{IH}	Control Input Voltage High	SEL, /OE	2.7 to 4.3	1.25			V
V_{IL}	Control Input Voltage Low	SEL, /OE	2.7 to 4.3			0.6	V
I_{IN}	Control Input Leakage	V_{SW}=0 to 3.6 V, V_{CNTRL}=0 to V_{CC}	4.3	-500		500	nA
$I_{OZ(MHL)}$	Off-State Leakage for Open MHLn Data Paths	V_{SW}=1.65 ≤ MHL ≤ 3.45 V	4.3	-500		500	nA
$I_{OZ(USB)}$	Off-State Leakage for Open USBn Data Paths	V_{SW}=0 ≤ USB ≤ 3.6 V	4.3	-500		500	nA
$I_{CL(MHL)}$	On-State Leakage for Closed MHLn Data Paths(6)	V_{SW}=1.65 ≤ MHL ≤ 3.45 V	4.3	-500		500	nA
$I_{CL(USB)}$	On-State Leakage for Closed USBn Data Paths(6)	V_{SW}=0 ≤ USB ≤ 3.6 V	4.3	-500		500	nA
I_{OFF}	Power-Off Leakage Current (All I/O Ports)	V_{SW}=0 V or 3.6 V, Figure 4	0	-500		500	nA
$R_{ON(USB)}$	HS Switch On Resistance (USB to Dn Path)	V_{SW}=0.4 V, I_{ON}=-8 mA, Figure 3	2.7		3.5	4.8	Ω
$R_{ON(MHL)}$	HS Switch On Resistance (MHL to Dn Path)	V_{SW}=V_{CC}-1050 mV, I_{ON}=-8 mA, Figure 3	2.7		4.7	6.0	Ω
$\Delta R_{ON(MHL)}$	Difference in R_{ON} Between MHL Positive-Negative	V_{SW}=V_{CC}-1050 mV, I_{ON}=-8 mA, Figure 3,	2.7		0.03		Ω
$\Delta R_{ON(USB)}$	Difference in R_{ON} Between USB Positive-Negative	V_{SW}=0.4V, I_{ON}=-8mA, Figure 3	2.7		0.18		Ω
$R_{ONF(MHL)}$	Flatness for R_{ON} MHL Path	V_{SW}=1.65 to 3.45 V, I_{ON}=-8 mA, Figure 3	2.7		0.9		Ω
I_{CC}	Quiescent Supply Current	$V_{/OE}$=0, V_{SEL}=0 or V_{CC}, I_{OUT}=0	4.3			30	µA
I_{CCZ}	Quiescent Supply Current (High Impedance)	V_{SEL}=X, $V_{/OE}$=V_{CC}, I_{OUT}=0	4.3			1	µA
I_{CCT}	Increase in Quiescent Supply Current	V_{SEL}=X, $V_{/OE}$ =1.65 V	4.3		5	10	µA

Note:

6. For this test, the data switch is closed with the respective switch pin floating.

AC Electrical Characteristics

All typical value are for V_{CC}=3.3 V and T_A=25°C unless otherwise specified.

Symbol	Parameter	Condition	V_{CC} (V)	T_A= -40ºC to +85ºC			Unit
				Min.	Typ.	Max.	
t_{ON}	MHL Turn-On Time, SEL to Output	R_L=50 Ω, C_L=5 pF, $V_{SW(USB)}$=0.8 V, $V_{SW(MHL)}$=3.3 V, Figure 5, Figure 6	2.7 to 3.6 V		350	600	ns
t_{OFF}	MHL Turn-Off Time, SEL to Output	R_L=50 Ω, C_L=5 pF, $V_{SW(USB)}$=0.8 V, $V_{SW(MHL)}$=3.3 V, Figure 5, Figure 6	2.7 to 3.6 V		125	300	ns
$t_{ZHM,ZLM}$	MHL Enable Time, /OE to Output	R_L=50 Ω, C_L=5 pF, $V_{SW(MHL)}$=3.3 V, Figure 5, Figure 6	2.7 to 3.6 V		60	150	µs
$t_{ZHU,ZLU}$	USB Enable Time, /OE to Output	R_L=50 Ω, C_L=5 pF, $V_{SW(USB)}$=0.8 V, Figure 5, Figure 6	2.7 to 3.6 V		100	300	ns
$t_{LZM,HZM}$	MHL Disable Time, /OE to Output	R_L=50 Ω, C_L=5 pF, $V_{SW(MHL)}$=3.3 V, Figure 5, Figure 6	2.7 to 3.6 V		35	100	ns
$t_{LZU,HZU}$	USB Disable Time, /OE to Output	R_L=50 Ω, C_L=5 pF, $V_{SW(USB)}$=0.8 V, Figure 5, Figure 6	2.7 to 3.6 V		35	100	ns
t_{PD}	Propagation Delay(7)	C_L=5 pF, R_L=50 Ω, Figure 5, Figure 7	2.7 to 3.6 V		0.25		ns
t_{BBM}	Break-Before-Make(7)	R_L=50 Ω, C_L=5 pF, V_{ID}=V_{MHL}=3.3 V, V_{USB}= 0.8 V, Figure 9	2.7 to 3.6 V	2		13	ns
$O_{IRR(MHL)}$	Off Isolation(7)	V_S=1 V_{pk-pk}, R_L=50 Ω, f=240 MHz, Figure 11	2.7 to 3.6 V		-55		dB
$O_{IRR(USB)}$		V_S=400 mV_{pk-pk}, R_L=50 Ω, f=240 MHz, Figure 11	2.7 to 3.6 V		-45		dB
$Xtalk_{MHL}$	Non-Adjacent Channel(7) Crosstalk	V_S=1 V_{pk-pk}, R=50 Ω, f=240 MHz, Figure 12	2.7 to 3.6 V		-47		dB
$Xtalk_{USB}$		V_S=400 mV_{pk-pk}, R_L=50 Ω, f=240 MHz, Figure 12	2.7 to 3.6 V		-45		dB
BW (Insertion Loss)	Differential -3db Bandwidth(7)	V_{IN}=1 V_{pk-pk}, MHL Path, R_L=50 Ω, C_L=0 Pf, Figure 10, Figure 15	2.7 to 3.6 V		2.46		GHz
		V_{IN}=400 mV_{pk-pk}, USB Path, R_L=50 Ω, C_L=0 pF, Figure 10, Figure 16			1.22		

Note:

7. Guaranteed by characterization.

USB High-Speed AC Electrical Characteristics

Typical values are for V_{CC}=3.3 V and T_A=25°C unless otherwise specified.

Symbol	Parameter	Condition	V_{CC} (V)	Typ.	Unit
$t_{SK(P)}$	Skew of Opposite Transitions of the Same Output[8]	C_L=5 pF, R_L=50 Ω, Figure 8	3.0 to 3.6	6	ps
t_J	Total Jitter[8]	R_L=50 Ω, C_L=5 pf, t_R=t_F=500 ps (10-90%) at 480 Mbps, PN7	3.0 to 3.6	15	ps

Note:
8. Guaranteed by characterization.

MHL AC Electrical Characteristics

Typical values are for V_{CC}=3.3 V and T_A=25°C unless otherwise specified.

Symbol	Parameter	Condition	V_{CC} (V)	Typ.	Unit
$t_{SK(P)}$	Skew of Opposite Transitions of the Same Output[9]	R_{PU}=50 Ω to V_{CC}, C_L=0 pF	3.0 to 3.6 V	6	ps
t_J	Total Jitter[9]	f=2.25 Gbps, PN7, R_{PU}=50 Ω to V_{CC}, C_L=0 pF	3.0 to 3.6 V	15	ps

Note:
9. Guaranteed by characterization.

Capacitance

Typical values are for V_{CC}=3.3 V and T_A=25°C unless otherwise specified.

Symbol	Parameter	Condition	Typ.	Max.	Unit
C_{IN}	Control Pin Input Capacitance[10]	V_{CC}=0 V, f=1 MHz	2.1		pF
$C_{ON(USB)}$	USB Path On Capacitance[10]	V_{CC}=3.3 V, f=240 MHz, Figure 14	4.1	5.0	pF
$C_{OFF(USB)}$	USB Path Off Capacitance[10]	V_{CC}=3.3 V, f=240 MHz, Figure 13	2.8	3.2	pF
$C_{ON(MHL)}$	MHL Path On Capacitance[10]	V_{CC}=3.3 V, f=240 MHz, Figure 14	2.7	3.0	pF
$C_{OFF(MHL)}$	MHL Path Off Capacitance[10]	V_{CC}=3.3 V, f=240 MHz, Figure 13	1.1	1.5	pF

Note:
10. Guaranteed by characterization, not production tested.

Test Diagrams

Note:

11. HSD refers to the high-speed data on USB or MHL paths.

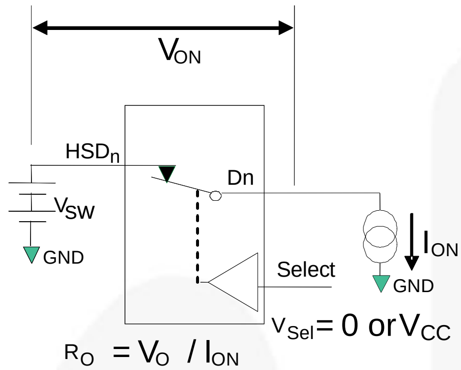


Figure 3. On Resistance

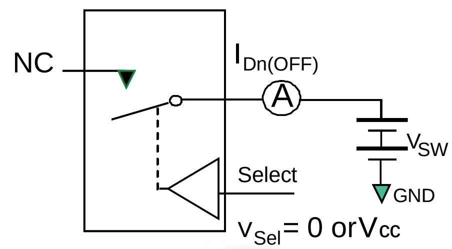


Figure 4. Off Leakage

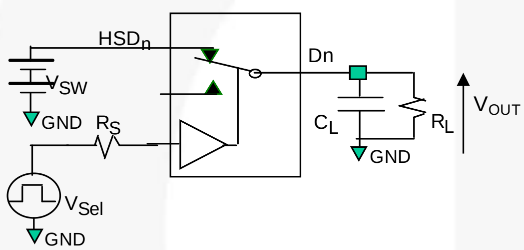


Figure 5. AC Test Circuit Load

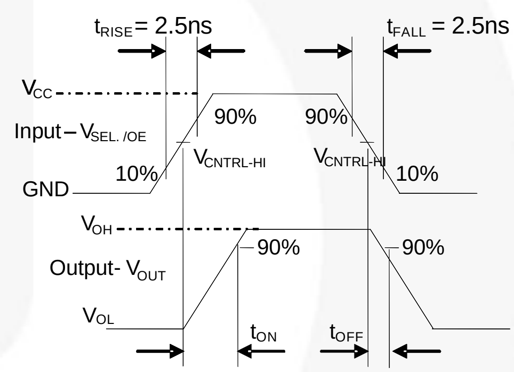


Figure 6. Turn-On / Turn-Off Waveforms

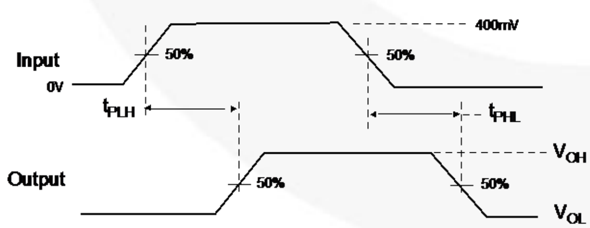


Figure 7. Propagation Delay ($t_R t_F$ – 500 ps)

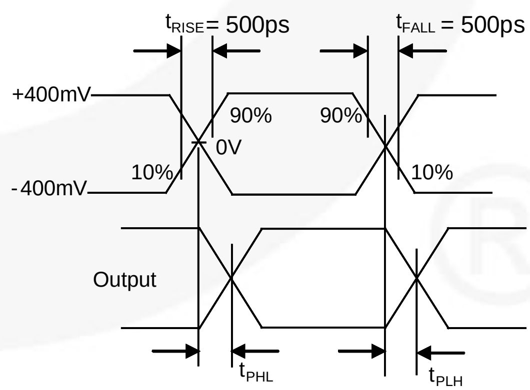
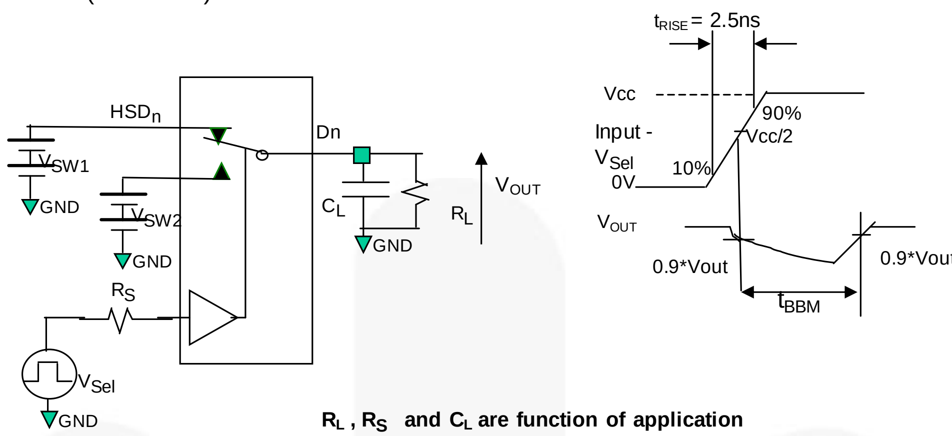


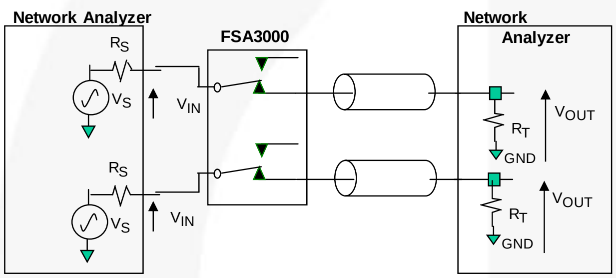
Figure 8. Intra-Pair Skew Test $t_{SK(P)}$

Test Diagrams (Continued)



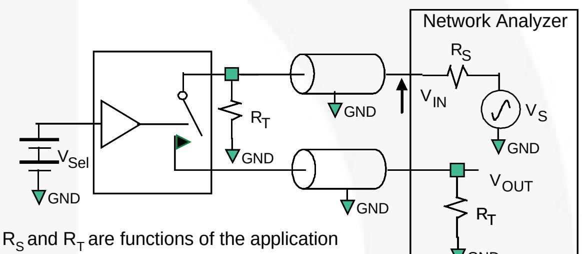
R_L, R_S and C_L are function of application environment (see AC Tables for specific values)
C_L includes test fixture and stray capacitance

Figure 9. Break-Before-Make Interval Timing



V_S, R_S and R_T are function of application environment (see AC/DC Tables for values)

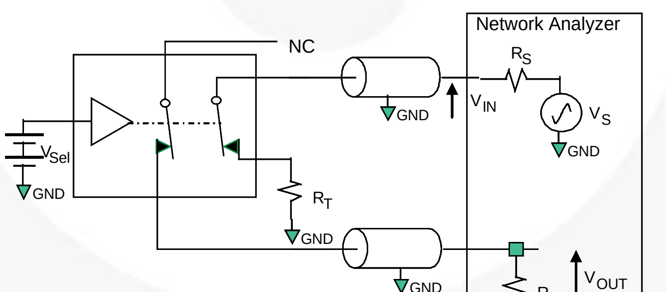
Figure 10. Insertion Loss



R_S and R_T are functions of the application environment (see AC Tables for specific values).

Off isolation = 20 Log (V_{OUT} / V_{IN})

Figure 11. Channel Off Isolation



R_S and R_T are functions of the application environment (see AC Tables for specific values).

Crosstalk = 20 Log (V_{OUT} / V_{IN})

Figure 12. Non-Adjacent Channel-to-Channel Crosstalk

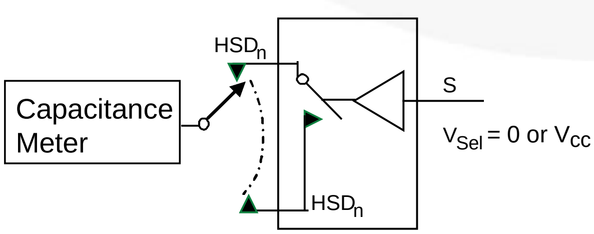


Figure 13. Channel Off Capacitance

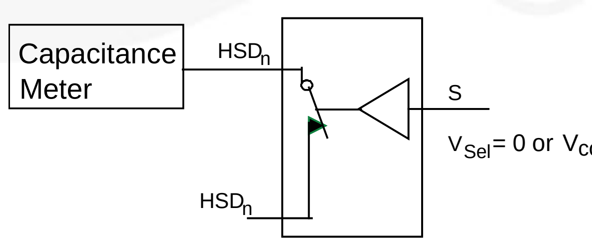


Figure 14. Channel On Capacitance

Insertion Loss

One of the key factors for the FSA3000 in mobile digital video applications is the small amount of insertion loss in the received signal as it passes through the switch. This results in minimal degradation of the received eye. One of the ways to measure the quality of the high data rate channels is using balanced ports and 4-port differential S-parameter analysis, particularly SDD21.

Bandwidth is measured using the S-parameter SDD21 methodology. Figure 15 shows the bandwidth (GHz) for the MHL path and Figure 16 shows the bandwidth curve for the USB path.

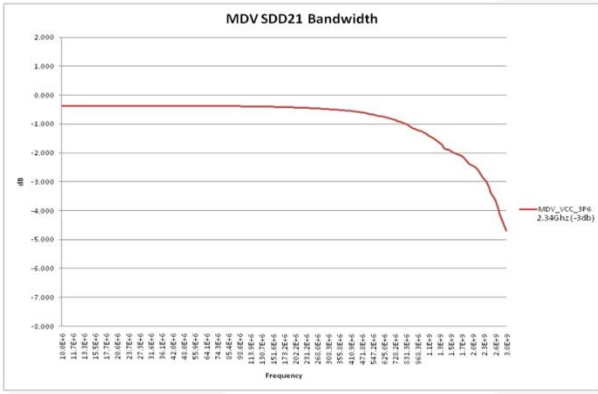


Figure 15. MHL (MDV) Path SDD21 Insertion Loss Curve

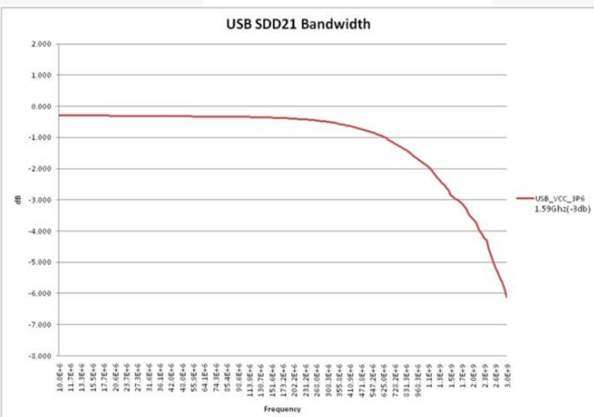


Figure 16. USB Path SDD21 Insertion Loss Curve

Typical Application

Figure 17 shows a typical mobile application using the FSA3000 for MHL switching. The FSA3157 is used for OTG dual-role device implementations where the CBUS of MHL and the ID pin for USB needs to be switched. The 3M resistor for MHL_SEL is optional to ensure that on power up the USB switch path is selected as default.

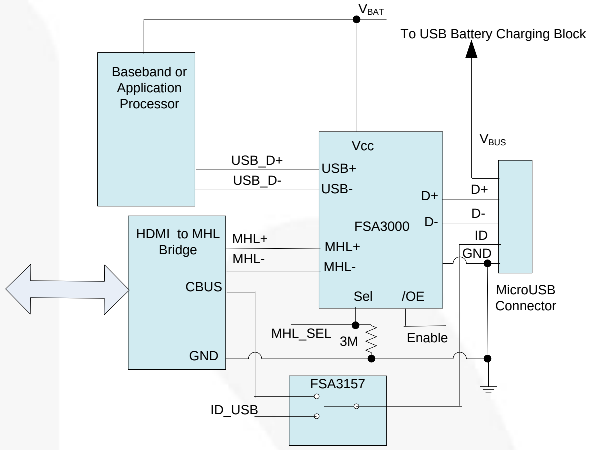


Figure 17. Typical Mobile MHL Application

Packing Specifications

MicroPak 1.6x2.1 F131, Packing Drawing

FAIRCHILD SEMICONDUCTOR®

Packing Description:

MicroPak 1.6x2.1 F131 products are classified under Moisture Sensitive Level 1.

The carrier tape is made from dissipative polystyrene or polycarbonate resin. The cover tape is a multilayer film primarily composed of polyester film, adhesive layer, heat activated sealant, and anti-static sprayed agent. These reeled parts in standard option are shipped with 5000 units per 178 mm diameter reel. Up to three reels are packed in each intermediate box. The reels is made of polystyrene plastic (anti-static coated or intrinsic).

These full reels are individually barcode labeled and placed inside a pizza box made of recyclable corrugated brown paper with a Fairchild logo printing. Up to 3 reels could be packed in the pizza box. And these pizza boxes are placed inside a barcode labeled shipping box which comes in different sizes depending on the number of parts shipped.

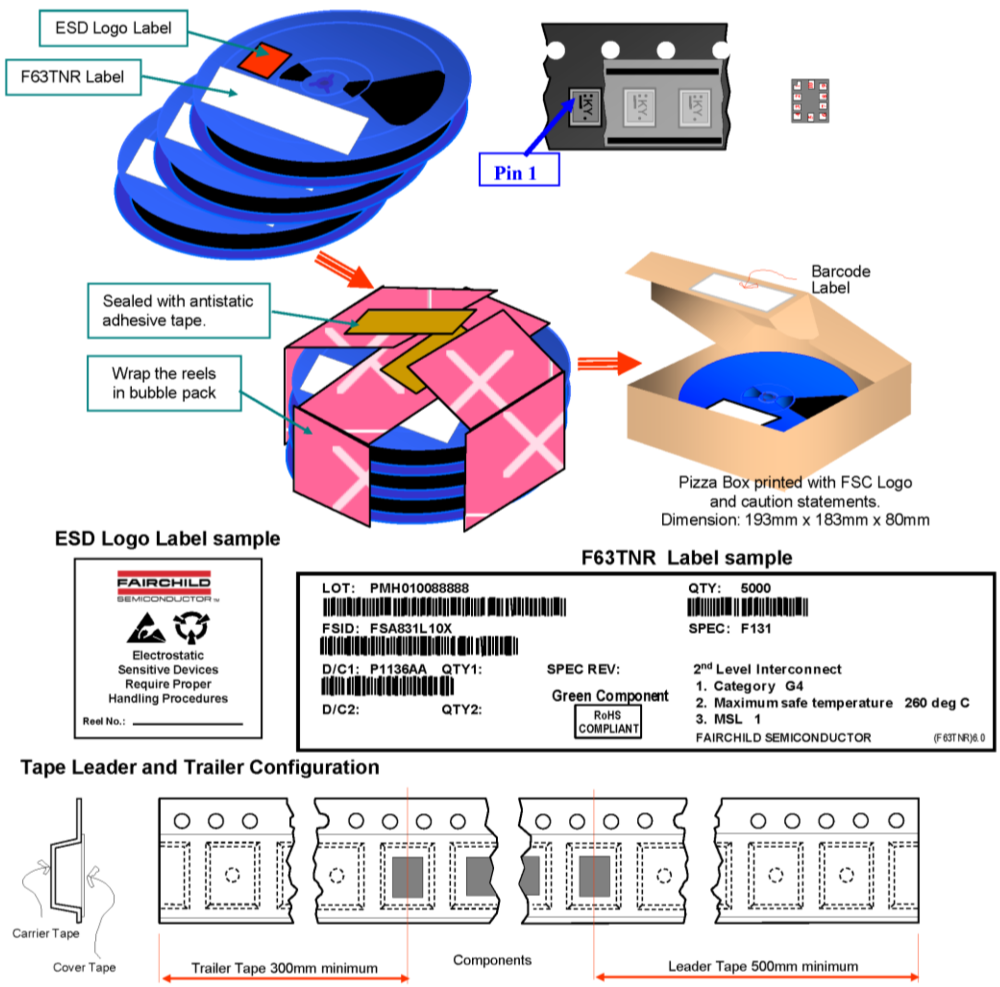
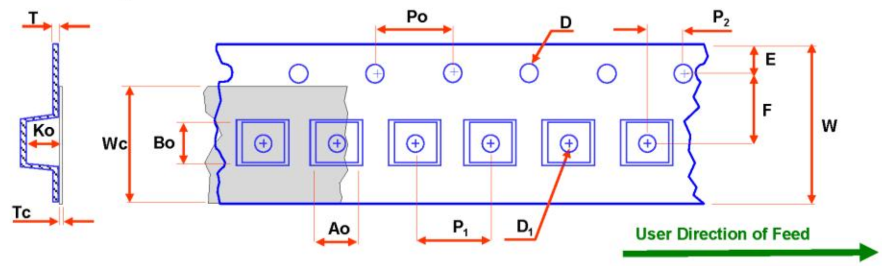


Figure 18. MicroPak™ 1.6 x 2.1 mm, Packing Drawing, Page 1

Packing Specifications (Continued)

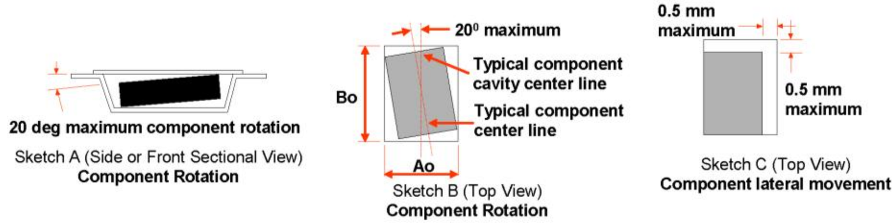
Embossed Tape Dimension



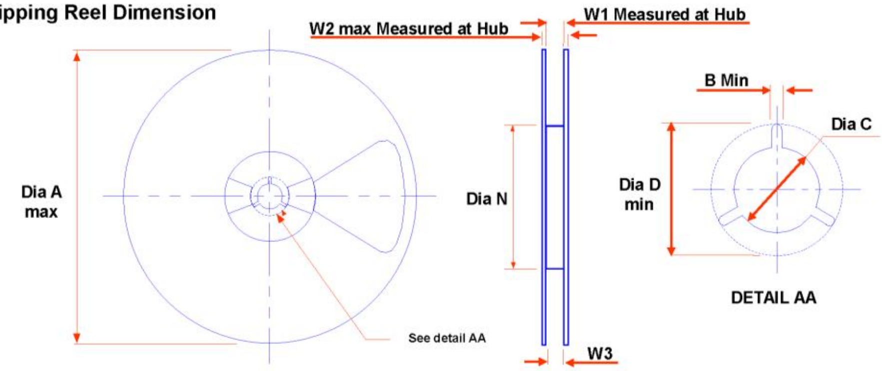
Dimensions are in millimeters

Package	Ao +/-0.05	Bo +/-0.05	D +/-0.10	D_1 min.	E +/-0.1	F +/-0.1	Ko +/-0.05	P_1 TYP	Po TYP	P_2 +/-0/05	T TYP	Tc +/-0.005	W +/-0.3	Wc TYP
MAC10A	1.83	2.34	1.5	0.5	1.75	3.5	0.65	4	4	2.0	0.254	0.06	8	5.3

Notes: Ao, Bo, and Ko dimensions are determined with respect to the EIA /Jedec RS-481 rotational and lateral movement requirements (see sketches A, B, and C).



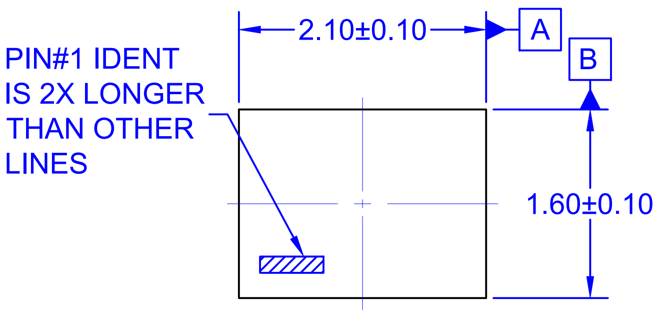
Shipping Reel Dimension



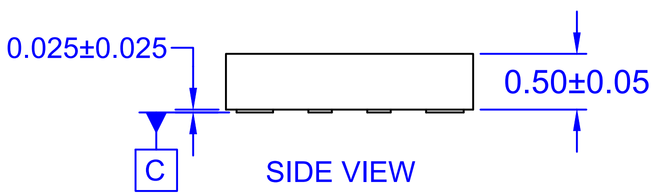
Dimensions are in millimeters

Tape Width	Dia A max	Dim B min	Dia C +.5/-.2	Dia D min	Dim N min	Dim W1 +2/-0	Dim W2 max	Dim W3 (LSL - USL)
8	178	1.5	13	20.2	55	8.4	14.4	7.9~10.4

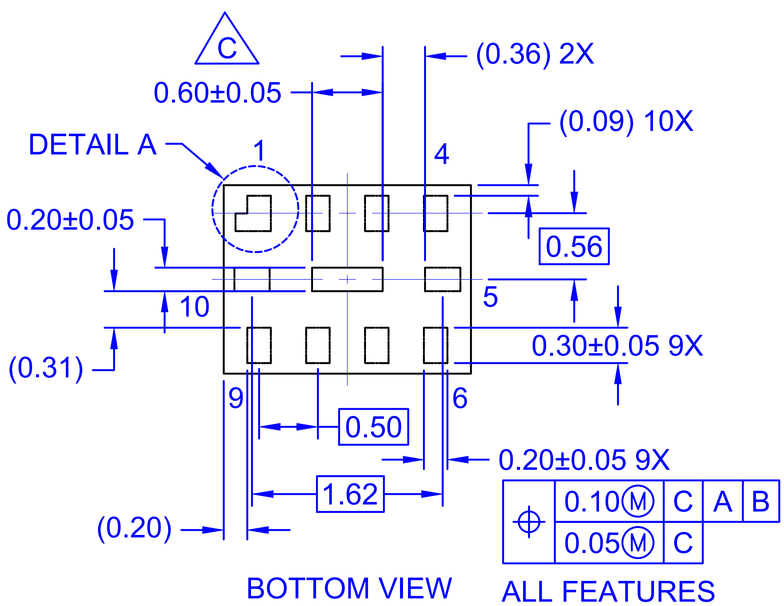
Figure 19. MicroPak™ 1.6 x 2.1 mm, Packing Drawing, Page 2



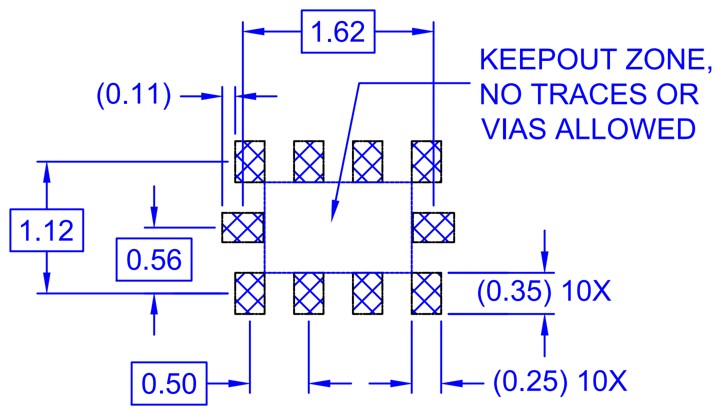
TOP VIEW



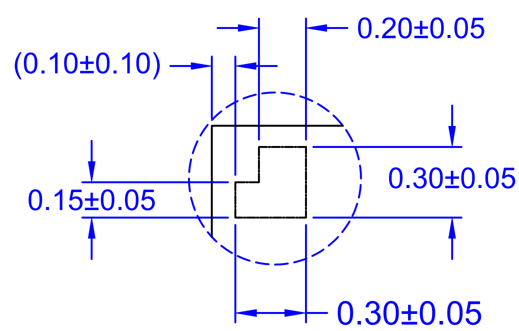
SIDE VIEW



BOTTOM VIEW



RECOMMENDED LAND PATTERN



DETAIL A
SCALE 2:1

NOTES:

A. PACKAGE CONFORMS TO JEDEC REGISTRATION MO-255, VARIATION UABD.

B. DIMENSIONS ARE IN MILLIMETERS.

C. PRESENCE OF CENTER PAD IS PACKAGE SUPPLIER DEPENDENT. IF PRESENT IT IS NOT INTENDED TO BE SOLDERED AND HAS A BLACK OXIDE FINISH.

D. DRAWING FILENAME: MKT-MAC10ArevG.

E. DIMENSIONS WITHIN ( ) ARE UNCONTROLLED.

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