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September 2014

FPF2495
IntelliMAX™ 28 V, Over-Voltage, Over-Current Protection Load Switch with Adjustable Current-Limit Control

Features

- V_{IN}: 2.5 V~5.5 V
- 28 V Absolute Ratings at V_{OUT}
- Current Capability: 2 A
- Adjustable Current Limit: 0.05 A ~ 2 A (Typ.)
  - 0.1 A~2 A with 10% Accuracy
  - < 0.1A with 15% Accuracy
- R_{ON}: Maximum 100 mΩ at 5 V_{IN} and 1 A I_{OUT}
- Output OVP: Min.=5.6 V, Typ.=5.8 V, Max.=6 V
- No Output Discharge During Off State
- Open-Drain OCP on FLAGB
- Thermal Shutdown
- Under-Voltage Lockout (UVLO)
- True Reverse-Current Blocking (TRCB)
- Logic CMOS IO Meets JESD76 Standard for GPIO Interface and Related Power Supply Requirements
- ESD Protected:
  - Human Body Model: >2 kV
  - Charged Device Model: >2.5 kV
  - IEC 61000-4-2 Air Discharge: >15 kV
  - IEC 61000-4-2 Contact Discharge: >8 kV

Applications

- Smart Phones, Tablet PCs
- Storage, DSLR, and Portable Devices

Description

The FPF2495 advanced load-management switch targets applications requiring a highly integrated solution. It disconnects loads powered from the DC power rail (<6 V) with stringent off-state current targets and high load capacitances (<100 µF). The FPF2495 consists of a slew-rate controlled low-impedance MOSFET switch (100 mΩ maximum) and integrated analog features. The slew-rate controlled turn-on characteristic prevents inrush current and the resulting excessive voltage droop on power rails. FPF2495 has over-voltage protection and over-temperature protection.

The FPF2495 has a True Reverse-Current Blocking (TRCB) function that obstructs unwanted reverse current from V_{OUT} to V_{IN} during ON and OFF states. The exceptionally low off-state current drain (<2 µA maximum) facilitates compliance with standby power requirements. The input voltage range operates from 2.5 V to 5.5 V_{DC} to support a wide range of applications in consumer, optical, medical, storage, portable, and industrial-device power management. Switch control is managed by a logic input (active HIGH) capable of interfacing directly with low-voltage control signal / General-Purpose Input / Output (GPIO) without an external pull-down resistor.

The device is packaged in advanced, fully “green” compliant, 1.21 mm x 1.21 mm, Wafer-Level Chip-Scale Package (WLCSP).

Ordering Information

Part Number	Operating Temperature Range	Package	Packing Method	Top Mark
FPF2495UCX	-40 to 85°C	1.21 mm x 1.21 mm, Wafer-Level Chip-Scale Package (WLCSP)	Tape & Reel	TH

Application Diagram

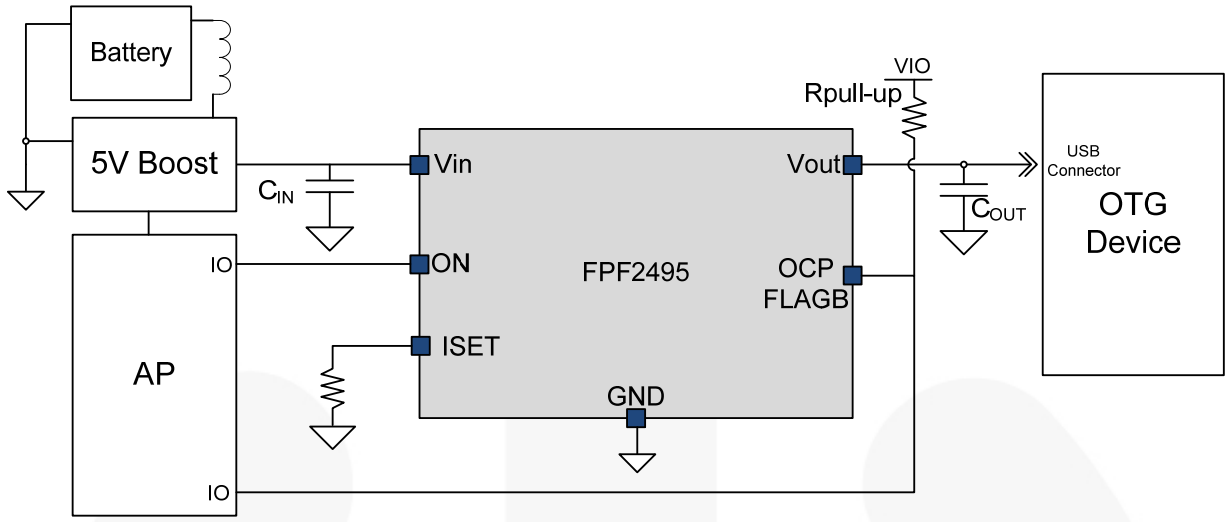


Figure 1. Typical Application

Note:

1. C_{IN} and C_{OUT} capacitors recommended for improvement of device stability.

Functional Block Diagram

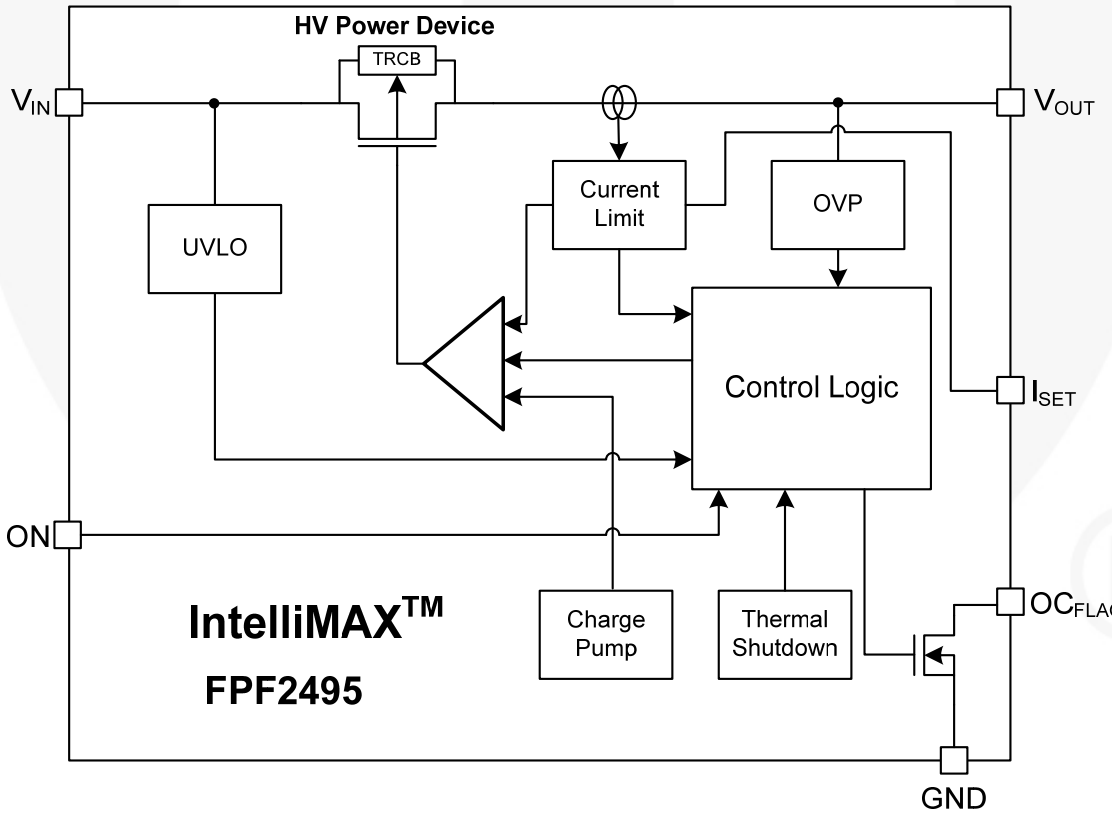


Figure 2. Functional Block Diagram

Pin Configurations

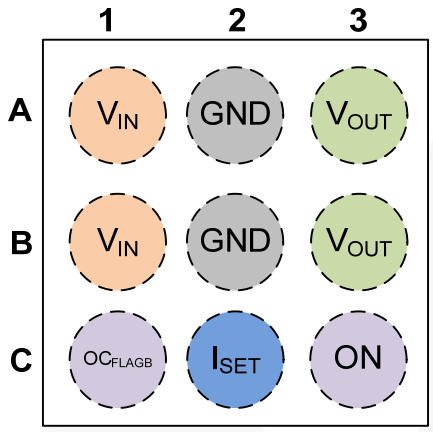


Figure 3. Pin Assignments (Top View)

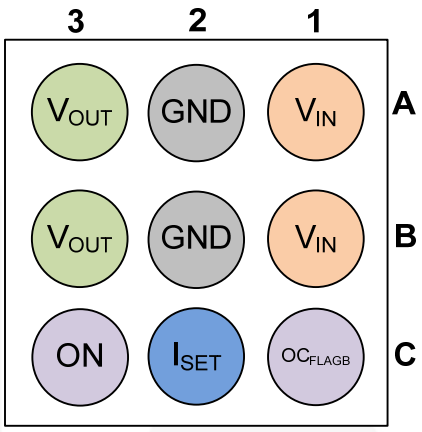


Figure 4. Pin Assignments (Bottom View)

Pin Description

Pin #	Name	Description		
A3, B3	V_{OUT}	**Switch Output**		
A1, B1	V_{IN}	**Supply Input**: Input to the power switch		
A2	GND	**Ground** (true device ground)		
B2				
C3	ON	**ON/OFF Control Input**: Active HIGH - GPIO compatible	**Logic HIGH**	Switch Enable
			Logic LOW	Switch Disable
C1	OC_{FLAGB}	**Fault Output**: Active LOW, open-drain output that indicates an input over current. External pull-up resistor to V_{CC} is required.		
C2	I_{SET}	**Current Limit Set Input**: A resistor from ISET to ground sets the current limit for the switch.		

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	Parameters		Min.	Max.	Unit
V_{PIN}	V_{OUT} to GND, V_{OUT} to V_{IN}		-0.3	28.0	V
	ON, V_{IN}, FLAGB, I_{SET} to GND		-0.3	6.0	
I_{SW}	Maximum Continuous Switch Current[4]			2.2	A
t_{PD}	Total Power Dissipation at T_A=25°C			1.0	W
T_J	Operating Junction Temperature		-40	+150	°C
T_{STG}	Storage Junction Temperature		-65	+150	°C
Θ_{JA}	Thermal Resistance, Junction-to-Ambient (1-inch Square Pad of 2 oz. Copper)			95[2]	°C/W
				110[3]	
ESD	Electrostatic Discharge Capability	Human Body Model, JESD22-A114	2.0		kV
		Charged Device Model, JESD22-C101	2.5		
	IEC61000-4-2 System Level	Air Discharge (V_{IN}, V_{ON}, V_{OUT} to GND)	15.0		
		Contact Discharge (V_{IN}, V_{ON}, V_{OUT} to GND)	8.0		

Notes:

2. Measured using 2S2P JEDEC std. PCB.
3. Measured using 2S2P JEDEC PCB cold plate method.
4. Maximum Junction Temperature = 85°C.

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	Parameters	Min.	Max.	Unit
V_{IN}	Supply Voltage	2.5	5.5	V
T_A	Ambient Operating Temperature	-40	85	°C

Electrical Characteristics

Unless otherwise noted; V_{IN}=2.5 to 5.5 V, T_A=-40 to +85°C; typical values are at V_{IN}=5 V and T_A=25°C.

Symbol	Parameters	Condition	Min.	Typ.	Max.	Unit
Basic Operation						
V_{IN}	Input Voltage		2.5		5.5	V
$I_{Q(OFF)}$	Off Supply Current	V_{ON}=GND, V_{OUT}=Open		1	2	µA
$I_{SD(OFF)}$	Shutdown Current	V_{IN}=5.5 V, V_{OUT}=0 V, V_{ON}=GND		0.1	4.0	µA
I_Q	Quiescent Current	I_{OUT}=0 mA		65	100	µA
R_{ON}	On Resistance	V_{IN}=5.0 V, I_{OUT}=1 A		70	100	mΩ
		V_{IN}=3.7 V, I_{OUT}=1 A		75	105	
R_{ON}	On Resistance[6]	V_{IN}=5.0 V, I_{OUT}=1.5 A		70		mΩ
V_{IH}	ON Input Logic HIGH Voltage	V_{IN}=2.5 V to 5.5 V	1.15			V
V_{IL}	ON Input Logic LOW Voltage	V_{IN}=2.5 V to 5.5 V			0.65	V
V_{IL_FLAG}	FLAGB Output Logic LOW Voltage	V_{IN}=5 V, I_{SINK}=10 mA		0.1	0.2	V
		V_{IN}=2.5 V, I_{SINK}=10 mA		0.15	0.30	
I_{FLAGB_LK}	FLAGB Output HIGH Leakage Current	V_{IN}=5 V, Switch On			1	µA
I_{ON}	On Input Leakage	V_{ON}=0 V to V_{IN}			1.0	µA
R_{ON_PD}	Pull-Down Resistance at ON Pin	V_{IN}=2.5~5.5 V, V_{ON}=HIGH, T_A=-40 to 85°C		14		MΩ
Over-Voltage Protection						
V_{OV_TRIP}	Output OVP Lockout	V_{OUT} Rising Threshold	5.50	5.80	6.00	V
		V_{OUT} Falling Threshold		5.50		
OUT_{HYS}	Output OVP Hysteresis	V_{OUT} Falling Threshold		0.3		V
t_{OVP}	OVP Response Time[6]	I_{OUT}=0.5 A, C_L=1 µF, T_A=25°C, V_{OUT} from 5.5 V to 6.0 V	1		4[6]	µs
Over-Current Protection						
I_{LIM}	Current Limit	V_{IN}=5 V, R_{SET}=20000 Ω, V_{OUT}=1.68 to 5 V with 15% Accuracy[5]	42	50	58	mA
		V_{IN}=5 V, R_{SET}=2100 Ω, V_{OUT}=1.68 to 5 V with 10% Accuracy[5]	450	500	550	
		V_{IN}=5 V, R_{SET}=1070 Ω, V_{OUT}=1.68 to 5 V with 10% Accuracy[5]	900	1000	1100	
V_{UVLO}	Under-Voltage Lockout	V_{IN} Increasing		2.4		V
		V_{IN} Decreasing		2.2		
V_{UVLO_HYS}	UVLO Hysteresis			200		mV
V_{T_RCB}	RCB Protection Trip Point	V_{OUT} - V_{IN}		50		mV
V_{R_RCB}	RCB Protection Release Trip Point	V_{IN} - V_{OUT}		50		mV

Continued on the following page…

Electrical Characteristics (Continued)

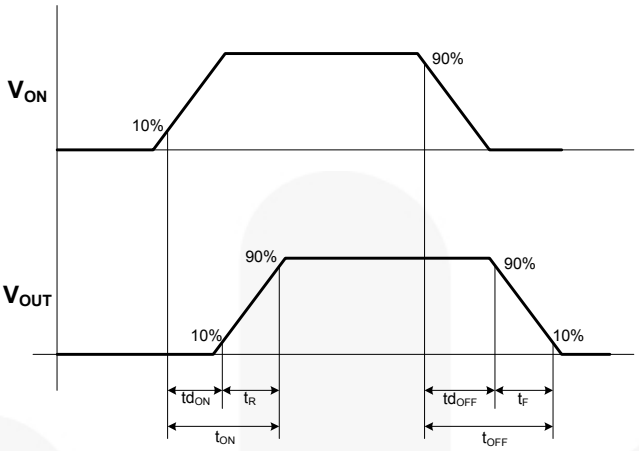
Unless otherwise noted; V_{IN}=2.5 to 5.5 V, T_A=-40 to +85°C; typical values are at V_{IN}=5 V and T_A=25°C.

Symbol	Parameters	Conditions	Min.	Typ.	Max.	Unit
V_{RCB_HYS}	RCB Hysteresis			100		mV
t_{RCB}	Default RCB Response Time	V_{IN}=5 V, V_{ON}=High/Low		2		µs
I_{RCB}	RCB Current	V_{ON}=0 V, V_{OUT}=5.5 V,		7		µA
t_{HOCP}	Hard Over-Current Response Time	Moderate Over-Current Condition, $I_{OUT} \geq I_{LIM}$, V_{OUT}=0 V		6		µs
t_{OCP}	Over-Current Response Time	Moderate Over-Current Condition, $I_{OUT} \geq I_{LIM}$ $V_{OUT} \leq V_{IN}$		7		µs
t_{OC_FLAG}	Over-Current Flag Response Time	When Over-Current Occurs to Flag Pulling LOW		8		ms
TSD	Thermal Shutdown	Shutdown Threshold		150		°C
		Return from Shutdown		130		
		Hysteresis		20		
Dynamic Characteristics						
t_{DON}	Turn-On Delay(6,7)	V_{IN}=5 V, R_L=100 Ω, C_L=1 µF, T_A=25°C, R_{SET}=2040 Ω		0.67		ms
t_R	V_{OUT} Rise Time(6,7)			0.69		ms
t_{ON}	Turn-On Time(6,8)			1.36		ms
t_{DOFF}	Turn-Off Delay(7,6)			0.01		ms
t_F	V_{OUT} Fall Time(7,6)			0.22		ms
t_{OFF}	Turn-Off Time(9,6)			0.23		ms
t_{DON}	Turn-On Delay(7,10)	V_{IN}=5 V, R_L=3.8 Ω, C_L=10 µF, T_A=-40 to 85°C, R_{SET}=634 Ω		0.65	0.78	ms
t_R	V_{OUT} Rise Time(7,10)			0.65	0.82	ms
t_{ON}	Turn-On Time(8,10)			1.3	1.6	ms
t_{DOFF}	Turn-Off Delay(7,10)			4	10	µs
t_F	V_{OUT} Fall Time(7,10)			76	120	µs
t_{OFF}	Turn-Off Time(9,10)			80	130	µs

Notes:

5. Characterization based on 1% tolerance resistor.
6. This parameter is guaranteed by design and characterization; not production tested.
7. $t_{DON}/t_{DOFF}/t_R/t_F$ are defined in Figure 5 below.
8. $t_{ON}=t_R + t_{DON}$.
9. $t_{OFF}=t_F + t_{DOFF}$.
10. This parameter is guaranteed by design.

Timing Diagram



where:

t_{DON} = Delay On Time
t_R = V_{OUT} Rise Time
t_{ON} = Turn-On Time
t_{DOFF} = Delay Off Time
t_F = V_{OUT} Fall Time
t_{OFF} = Turn Off Time

Figure 5. Timing Diagram

Operation and Application Description

Input Capacitor

To limit the voltage drop on the input supply caused by transient inrush current when the switch turns on into discharge load capacitor; a capacitor must be placed in between the V_{IN} and GND pins. A high-value capacitor on C_{IN} can be used to reduce the voltage drop in high-current applications.

Output Capacitor

An output capacitor should be placed between the V_{OUT} and GND pins. This capacitor prevents parasitic board inductance from forcing V_{OUT} below GND when the switch is on. This capacitor also prevents reverse inrush current from creating a voltage spike that could damage the device in the case of a V_{OUT} short.

Fault Reporting

Upon the detection of an over-current, OC_FLAGB signal the fault by activating LOW.

Current Limiting

The current limit ensures that the current through the switch does not exceed the maximum set value, while not limiting the minimum value. The current at which the part's limit is adjustable through the selection of the external resistor connected to the ISET pin. Information for selecting the resistor is found in the section below. The device acts as a constant-current source when the load draws more than the maximum value set by the device until thermal shutdown occurs. The device recovers if the die temperature drops below the threshold temperature.

Under-Voltage Lockout (UVLO)

The under-voltage lockout turns the switch off if the input voltage drops below the lockout threshold. With the ON pin active, the input voltage rising above the UVLO threshold releases the lockout and enables the switch.

True Reverse-Current Blocking

The true reverse-current blocking feature protects the input source against current flow from output to input regardless of whether the load switch is on or off.

Thermal Shutdown

The thermal shutdown protects the die from internally or externally generated excessive temperature. During an over-temperature condition, the switch is turned off. The switch automatically turns on again if the temperature of the die drops below the threshold temperature.

Setting Current Limit

The current limit is set with an external resistor connected between the I_{SET} and GND pins. The resistor is selected using Table 1. Resistor tolerance of 1% or less is recommended.

Table 1. Current Limit Settings by R_{SET}[11]

$R_{SET}\Omega$	Min. Current Limit (mA)	Typ. Current Limit (mA)	Max. Current Limit (mA)
528	1800	2000	2200
604	1570	1750	1920
680	1350	1500	1650
866	1125	1250	1375
1070	900	1000	1100
1200	810	900	990
1330	720	800	880
1500	630	700	770
1740	540	600	660
2100	450	500	550
2320	405	450	495
2550	360	400	440
2940	315	350	385
3400	370	300	330
4020	225	250	275
4990	180	200	220
6490	135	150	165
9530	90	100	110
20000	42	50	58

Note:

11. Table values based on 1% tolerance resistor.
12. For 50 mA setting, tolerance is ±15% with 1%.

Board Layout

For best performance, all traces should be as short as possible. To be most effective, the input and output capacitors should be placed close to the device to minimize the effect that parasitic trace inductance may have on normal and short-circuit operation. Using wide traces for VIN, VOUT, GND helps minimize parasitic electrical effects along with minimizing the case-to-ambient thermal impedance.

Typical Performance Characteristics

T_A=25°C.

Figure 6. t_{ON} Response

Figure 7. OVP Response (Increase V_{OUT} to OVP Trip Point)

Figure 8. OC_FLAGB Response Time (Toggle R_{LOAD} from High to Low Resistance)

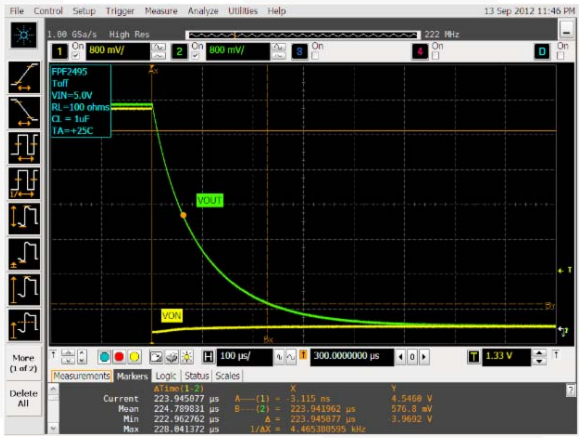


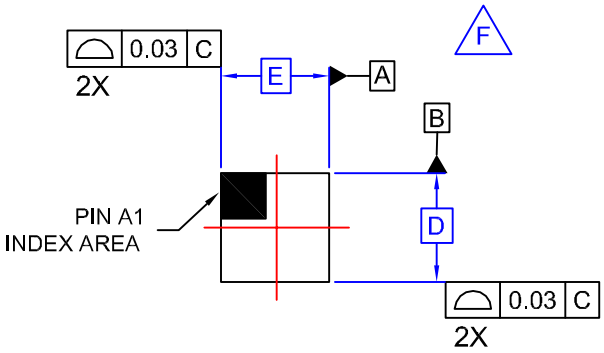
Figure 9. t_{OFF} Response

Figure 10. t_{OCP} Response Time

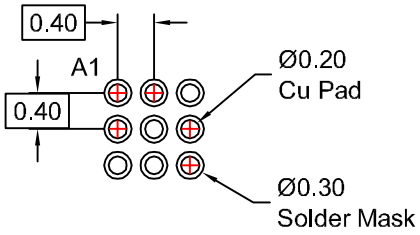
Product-Specific Dimensions

D	E	X	Y
1210 µm ±30 µm	1210 µm ±30 µm	205 µm	205 µm

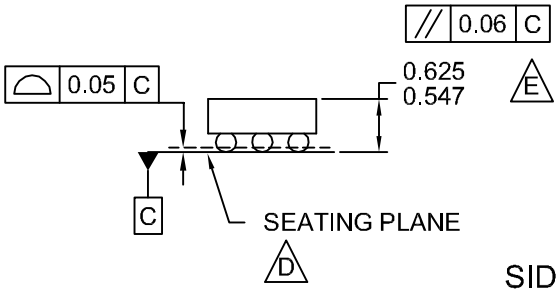
REVISIONS			
REV	DESCRIPTION	DATE	BY/SITE
1	INITIAL DRAWING RELEASE.	2-15-2008	L. ENGLAND/FSME
2	Updated land pattern to individual solder mask openings. Removed solder alloy note. Other misc updates for standardization.	4-9-2010	L. ENGLAND/FSME

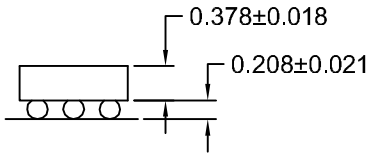


TOP VIEW

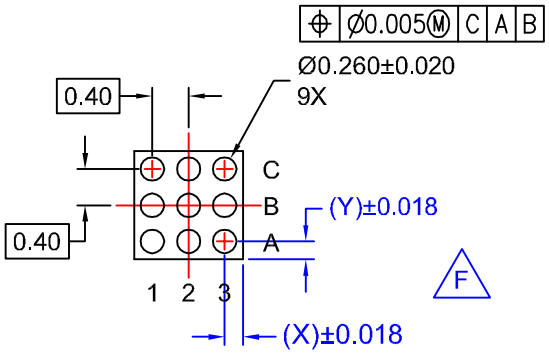


LAND PATTERN RECOMMENDATION
(NSMD PAD TYPE)





SIDE VIEWS



BOTTOM VIEW

NOTES:

A. NO JEDEC REGISTRATION APPLIES.

B. DIMENSIONS ARE IN MILLIMETERS.

C. DIMENSIONS AND TOLERANCE PER ASMEY14.5M, 1994.

D. DATUM C IS DEFINED BY THE SPHERICAL CROWNS OF THE BALLS.

E. PACKAGE NOMINAL HEIGHT IS 586 MICRONS ±39 MICRONS (547-625 MICRONS).

F. FOR DIMENSIONS D, E, X, AND Y SEE PRODUCT DATASHEET.

G. DRAWING FILNAME: MKT-UC009ABrev2

APPROVALS	DATE
DRAWN L. England	4-9-10
DFTG. CHK. H. Allen	4-9-10
ENGR. CHK.	

FAIRCHILD SEMICONDUCTOR™

9 BALL WLCSP, 3X3 ARRAY
0.4MM PITCH, 250UM BALL

PROJECTION
INCH
[MM]

SCALE	SIZE	DRAWING NUMBER	REV
N/A	N/A	MKT-UC009AB	2

DO NOT SCALE DRAWING | SHEET 1 of 1

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