

## ISL6186

## USB Port Power Supply Controller

FN7698

Rev 2.00

November 3, 2011

The ISL6186 USB power controller family provides overcurrent (OC) fault protection for one or more USB ports.

This product family consists of eight individual functional product variants and three package options and is operation rated for a nominal +2.5V to +5V range and specified over the full commercial and industrial temperature ranges.

Each ISL6186 type incorporates a 45mΩ P-channel MOSFET power switch for power control and features internal current monitoring, accurate current limiting, and current limited delay to turn-off for system supply protection along with control and communication I/O.

The ISL6186 family offers product variants with specified continuous output current levels of 1.5A, 3A or 3.6A, enable active high or low inputs, and latch off or automatic retry after overcurrent turn-off, making these devices well suited for many low-power applications.

This family of ICs is offered in an industry standard SOIC package as well as in the 70% smaller 3x3 DFN package, which provides the same performance and an additional Power-Good output feature in the smallest possible (10 Ld DFN) package.

## Features

- 2.5V to 5V Operating Range
- 45mΩ Integrated Power P-channel MOSFET Switches
- Continuous Current Options for 1.5A, 3A and 3.6A
- Thermally Insensitive 12ms of Current Limiting Prior to Turn-Off
- Output Discharges with Reverse Current Blocking When Disabled
- Latch-off or Auto Restart and Enable Polarity Options
- 1µA Off-State Supply Current
- Industry Standard Pin-for-Pin SOIC and Smaller DFN Packages Available

## Applications

- USB Port Power Management Including USB 3.0
- Low Power Electronic Circuit Limiting and Breaker

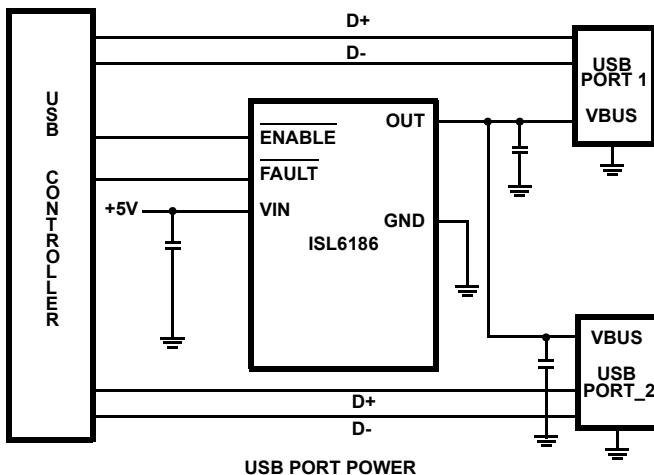
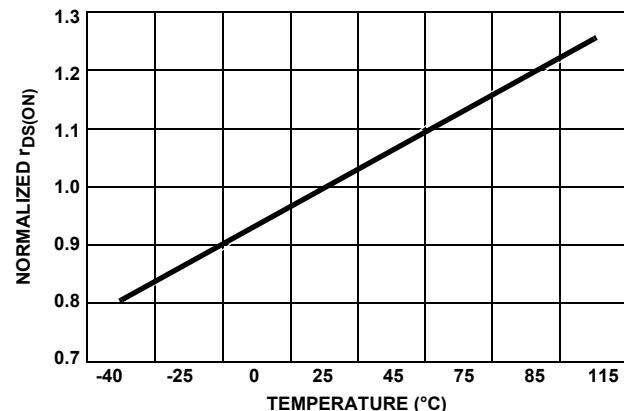
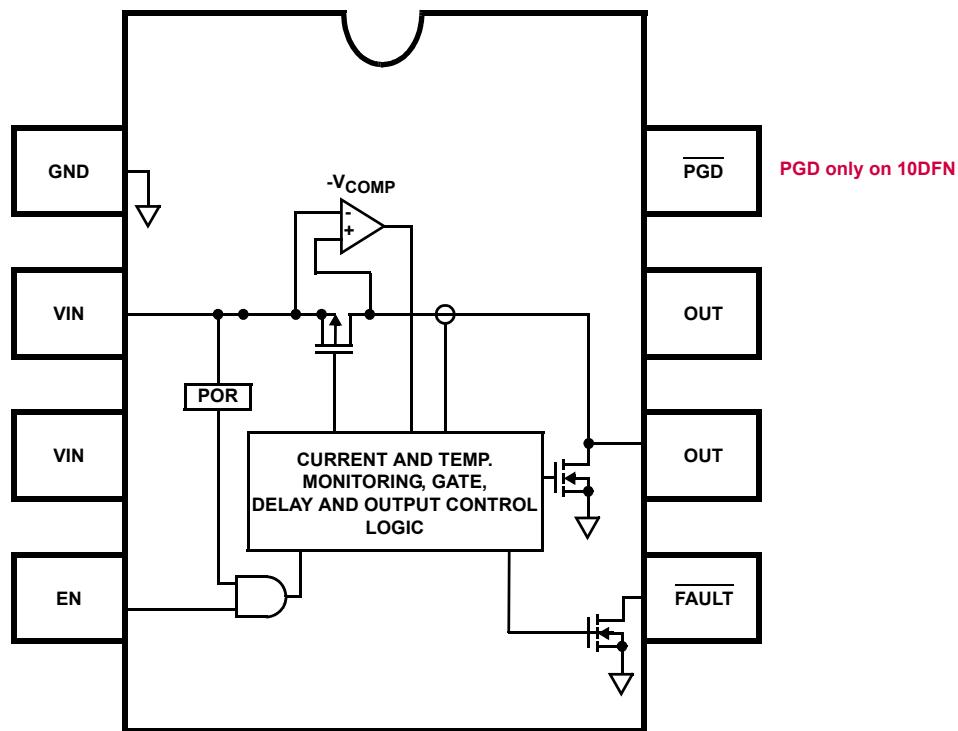


FIGURE 1. TYPICAL APPLICATION

FIGURE 2. NORMALIZED  $r_{DS(ON)}$  TEMPERATURE CHARACTERISTIC CURVE

## Simplified Block Diagram



## Pin Configurations



## Pin Descriptions

PIN NUMBER		SYMBOL	DESCRIPTION
8 Ld SOIC/DFN	10 Ld DFN		
1	1	GND	IC ground reference
2, 3	2, 3, 4	VIN	Chip bias, Controlled Voltage Input, Undervoltage Lock Out (UVLO). $V_{IN}$ provides chip bias voltage. At $V_{IN} < 1.7V$ , chip functionality is disabled, FLT is active and floating and OUT is held low. Range 0V to 5.5V
4	5	EN/EN	Enable/Disable inputs, Active high (EN) and active low ( $\bar{EN}$ ) options enable the power switch. These inputs have internal $1M\Omega$ pull-off resistors. Range 0V to $V_{IN}$

## Pin Descriptions (Continued)

PIN NUMBER		SYMBOL	DESCRIPTION
8 Ld SOIC/DFN	10 Ld DFN		
5	6	FLT	Overcurrent Fault Indicator. Overcurrent fault indicator. $\overline{\text{FLT}}$ floats and is disabled until $V_{IN} > V_{UVLO}$ . This output is pulled low after the current limit time-out period has expired. Fault is not signaled due to over-temperature shut down. Range OV to $V_{IN}$
6, 7, 8	7, 8, 9	OUT	Controlled Supply Output. Upon an OC condition, $I_{OUT}$ is current limited. Current limit response time is within 200 $\mu$ s. This output will remain in current limit for a nominal 12ms before being turned off either for the latch or auto retry versions. Range OV to $V_{IN}$
-	10	PGD	Open drain Power-Good output that pulls low 40ms after $V_{OUT} = 90\%$ of $V_{IN}$ and rises after $V_{OUT} < 85\%$ of $V_{IN}$ . Range OV to $V_{IN}$
PD (DFN only)	PD	EPAD	Thermal Dissipation Exposed PAD Range: Connect to GND.

## Ordering Information

PART NUMBER (Notes 1, 2, 3)	PART MARKING	EN/EN INPUT	$V_{IN} = 5V$ MAXIMUM CONTINUOUS $I_{OUT}$ (A)	LATCH/ AUTO RETRY	POWER-GOOD OUTPUT	TEMP. RANGE (°C)	PACKAGE (Pb-free)	PKG. DWG. #
ISL61861ACBZ	61861A CBZ	EN	1.5	LATCH	NO	0 to +70	8 Ld SOIC	M8.15
ISL61861BCBZ	61861B CBZ	EN	1.5	RETRY	NO	0 to +70	8 Ld SOIC	M8.15
ISL61861CCBZ	61861C CBZ	EN	3	LATCH	NO	0 to +70	8 Ld SOIC	M8.15
ISL61861DCBZ	61861D CBZ	EN	3	RETRY	NO	0 to +70	8 Ld SOIC	M8.15
ISL61861ECBZ	61861E CBZ	EN	1.5	LATCH	NO	0 to +70	8 Ld SOIC	M8.15
ISL61861FCBZ	61861F CBZ	EN	1.5	RETRY	NO	0 to +70	8 Ld SOIC	M8.15
ISL61861GCBZ	61861G CBZ	EN	3	LATCH	NO	0 to +70	8 Ld SOIC	M8.15
ISL61861HCBZ	61861H CBZ	EN	3	RETRY	NO	0 to +70	8 Ld SOIC	M8.15
ISL61862ACRZ	62AC	EN	1.5	LATCH	NO	0 to +70	8 Ld DFN	L8.3x3J
ISL61862BCRZ	62BC	EN	1.5	RETRY	NO	0 to +70	8 Ld DFN	L8.3x3J
ISL61862CCRZ	62CC	EN	3	LATCH	NO	0 to +70	8 Ld DFN	L8.3x3J
ISL61862DCRZ	62DC	EN	3	RETRY	NO	0 to +70	8 Ld DFN	L8.3x3J
ISL61862ECRZ	62EC	EN	1.5	LATCH	NO	0 to +70	8 Ld DFN	L8.3x3J
ISL61862FCRZ	62FC	EN	1.5	RETRY	NO	0 to +70	8 Ld DFN	L8.3x3J
ISL61862GCRZ	62GC	EN	3	LATCH	NO	0 to +70	8 Ld DFN	L8.3x3J
ISL61862HCRZ	62HC	EN	3	RETRY	NO	0 to +70	8 Ld DFN	L8.3x3J
ISL61863ACRZ	63AC	EN	1.5	LATCH	YES	0 to +70	10 Ld DFN	L10.3x3
ISL61863BCRZ	63BC	EN	1.5	RETRY	YES	0 to +70	10 Ld DFN	L10.3x3
ISL61863CCRZ	63CC	EN	3	LATCH	YES	0 to +70	10 Ld DFN	L10.3x3
ISL61863DCRZ	63DC	EN	3	RETRY	YES	0 to +70	10 Ld DFN	L10.3x3
ISL61863ECRZ	63EC	EN	1.5	LATCH	YES	0 to +70	10 Ld DFN	L10.3x3
ISL61863FCRZ	63FC	EN	1.5	RETRY	YES	0 to +70	10 Ld DFN	L10.3x3
ISL61863GCRZ	63GC	EN	3	LATCH	YES	0 to +70	10 Ld DFN	L10.3x3
ISL61863HCRZ	63HC	EN	3	RETRY	YES	0 to +70	10 Ld DFN	L10.3x3
ISL61863ICRZ	63IC	EN	3.6	LATCH	YES	0 to +70	10 Ld DFN	L10.3x3

## Ordering Information (Continued)

PART NUMBER (Notes 1, 2, 3)	PART MARKING	EN/EN INPUT	V <sub>IN</sub> = 5V MAXIMUM CONTINUOUS I <sub>OUT</sub> (A)	LATCH/ AUTO RETRY	POWER-GOOD OUTPUT	TEMP. RANGE (°C)	PACKAGE (Pb-free)	PKG. DWG. #
ISL61863JCRZ	63JC	EN	3.6	RETRY	YES	0 to +70	10 Ld DFN	L10.3x3
ISL61863KCRZ	63KC	EN	3.6	LATCH	YES	0 to +70	10 Ld DFN	L10.3x3
ISL61863LCRZ	63LC	EN	3.6	RETRY	YES	0 to +70	10 Ld DFN	L10.3x3
ISL61861AIBZ	61861A IBZ	EN	1.5	LATCH	NO	-40 to +85	8 Ld SOIC	M8.15
ISL61861BIBZ	61861B IBZ	EN	1.5	RETRY	NO	-40 to +85	8 Ld SOIC	M8.15
ISL61861CIBZ	61861C IBZ	EN	3	LATCH	NO	-40 to +85	8 Ld SOIC	M8.15
ISL61861DIBZ	61861D IBZ	EN	3	RETRY	NO	-40 to +85	8 Ld SOIC	M8.15
ISL61861EIBZ	61861E IBZ	EN	1.5	LATCH	NO	-40 to +85	8 Ld SOIC	M8.15
ISL61861FIBZ	61861F IBZ	EN	1.5	RETRY	NO	-40 to +85	8 Ld SOIC	M8.15
ISL61861GIBZ	61861G IBZ	EN	3	LATCH	NO	-40 to +85	8 Ld SOIC	M8.15
ISL61861HIBZ	61861H IBZ	EN	3	RETRY	NO	-40 to +85	8 Ld SOIC	M8.15
ISL61862AIRZ	62AI	EN	1.5	LATCH	NO	-40 to +85	8 Ld DFN	L8.3x3J
ISL61862BIRZ	62BI	EN	1.5	RETRY	NO	-40 to +85	8 Ld DFN	L8.3x3J
ISL61862CIRZ	62CI	EN	3	LATCH	NO	-40 to +85	8 Ld DFN	L8.3x3J
ISL61862DIRZ	62DI	EN	3	RETRY	NO	-40 to +85	8 Ld DFN	L8.3x3J
ISL61862EIRZ	62EI	EN	1.5	LATCH	NO	-40 to +85	8 Ld DFN	L8.3x3J
ISL61862FIRZ	62FI	EN	1.5	RETRY	NO	-40 to +85	8 Ld DFN	L8.3x3J
ISL61862GIRZ	62GI	EN	3	LATCH	NO	-40 to +85	8 Ld DFN	L8.3x3J
ISL61862HIRZ	62HI	EN	3	RETRY	NO	-40 to +85	8 Ld DFN	L8.3x3J
ISL61863AIRZ	63AI	EN	1.5	LATCH	YES	-40 to +85	10 Ld DFN	L10.3x3
ISL61863BIRZ	63BI	EN	1.5	RETRY	YES	-40 to +85	10 Ld DFN	L10.3x3
ISL61863CIRZ	63CI	EN	3	LATCH	YES	-40 to +85	10 Ld DFN	L10.3x3
ISL61863DIRZ	63DI	EN	3	RETRY	YES	-40 to +85	10 Ld DFN	L10.3x3
ISL61863EIRZ	63EI	EN	1.5	LATCH	YES	-40 to +85	10 Ld DFN	L10.3x3
ISL61863FIRZ	63FI	EN	1.5	RETRY	YES	-40 to +85	10 Ld DFN	L10.3x3
ISL61863GIRZ	63GI	EN	3	LATCH	YES	-40 to +85	10 Ld DFN	L10.3x3
ISL61863HIRZ	63HI	EN	3	RETRY	YES	-40 to +85	10 Ld DFN	L10.3x3
ISL61863IIRZ	63II	EN	3.6	LATCH	YES	-40 to +85	10 Ld DFN	L10.3x3
ISL61863JIRZ	63JI	EN	3.6	RETRY	YES	-40 to +85	10 Ld DFN	L10.3x3
ISL61863KIRZ	63KI	EN	3.6	LATCH	YES	-40 to +85	10 Ld DFN	L10.3x3
ISL61863LIRZ	63LI	EN	3.6	RETRY	YES	-40 to +85	10 Ld DFN	L10.3x3
ISL61861EVAL1Z (ISL61861C)		EN	3	LATCH	NO	-	8 Ld SOIC	EVAL BOARD
ISL61862EVAL1Z (ISL61862F)		EN	1.5	RETRY	NO	-	8 Ld DFN	EVAL BOARD
ISL61863EVAL1Z (ISL61863L)		EN	3.6	RETRY	YES	-	10 Ld DFN	EVAL BOARD

## NOTES:

1. Add “-T\*” suffix for tape and reel. Please refer to [TB347](#) for details on reel specifications.
2. These Intersil Pb-free plastic packaged products employ special Pb-free material sets, molding compounds/die attach materials, and 100% matte tin plate plus anneal (e3 termination finish, which is RoHS compliant and compatible with both SnPb and Pb-free soldering operations). Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020.
3. For Moisture Sensitivity Level (MSL), please see device information page for [ISL6186](#). For more information on MSL please see Tech Brief [TB363](#).

## Absolute Maximum Ratings

Supply Voltage (VIN to GND, Note 7) .....	6.5V
EN, FAULT.....	VIN
OUT.....	GND - 0.3V to VIN 0.3V
Output Current .....	Short Circuit Protected; Limited to 5A
ESD Rating	
Human Body Model (Per MIL-STD-883 Method 3015.7).....	3kV
Machine Model (Per MIL-STD-883 Method 3015.7) .....	300V
Latch Up (Tested per JESD-78B; Class 2, Level A) .....	100mA

## Thermal Information

Thermal Resistance (Typical)	$\theta_{JA}$ (°C/W)	$\theta_{JC}$ (°C/W)
8 Lead SOIC Package (Note 4).....	120	N/A
8 Lead 3x3 DFN Package (Notes 5, 6) .....	48	6
10 Lead 3x3 DFN Package (Notes 5, 6) .....	48	6
Maximum Junction Temperature .....	+150°C	
Maximum Storage Temperature Range .....	-65°C to +150°C	
Pb-Free Reflow Profile.....	see link below <a href="http://www.intersil.com/pbfree/Pb-FreeReflow.asp">http://www.intersil.com/pbfree/Pb-FreeReflow.asp</a>	

## Operating Conditions

Commercial Temperature Range .....	0°C to +70°C
Industrial Temperature Range .....	-40°C to +85°C
Supply Voltage Range (Typical).....	2.5V to 5.5V

CAUTION: Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such conditions may adversely impact product reliability and result in failures not covered by warranty.

### NOTES:

4.  $\theta_{JA}$  is measured with the component mounted on a high effective thermal conductivity test board in free air. See Tech Brief [TB379](#) for details.
5.  $\theta_{JA}$  is measured in free air with the component mounted on a high effective thermal conductivity test board with "direct attach" features. See Tech Brief [TB379](#).
6. For  $\theta_{JC}$ , the "case temp" location is the center of the exposed metal pad on the package underside.
7. All voltages are relative to GND, unless otherwise specified.

## Electrical Specifications

$V_{IN} = 5V$ ,  $T_A = T_J$ , Unless Otherwise Specified. **Boldface** limits apply over the operating temperature range, 0°C to +75°C or -40°C to +85°C.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN (Note 8)	TYP	MAX (Note 8)	UNITS
<b>POWER SWITCH</b>						
$r_{DS(ON)}_{50}$	ON-Resistance at 5.0V (Pulse Tested)	$V_{IN} = 5V$ , $I_{OUT} = 0.5A$ , $T_A = T_J = +25^\circ C$	-	45	48	$m\Omega$
		$T_A = T_J = +85^\circ C$	-	50	<b>54</b>	$m\Omega$
$r_{DS(ON)}_{33}$	ON-Resistance at 3.3V (Pulse Tested)	$V_{IN} = 3.3V$ , $I_{OUT} = 0.5A$ , $T_A = T_J = +25^\circ C$	-	54	57	$m\Omega$
		$T_A = T_J = +85^\circ C$	-	61	<b>64</b>	$m\Omega$
$r_{DS(ON)}_{25}$	On Resistance at 2.5V (Pulse Tested)	$V_{IN} = 2.5V$ , $I_{OUT} = 0.5A$ , $T_A = T_J = +25^\circ C$	-	65	69	$m\Omega$
		$T_A = T_J = +85^\circ C$	-	74	<b>79</b>	$m\Omega$
$V_{OUT\_DIS}$	Disabled Output Voltage	$V_{IN} = 5V$ , Switch Disabled, 50 $\mu A$ Load	-	22	<b>45</b>	$mV$
$R_{OUT\_PD}$	Output Pull-Down Resistor	$V_{IN} = 5V$ , Switch Disabled	<b>3.4</b>	5	<b>6</b>	$k\Omega$
$t_R$	$V_{OUT}$ Rise Time	$R_L = 10\Omega$ , $C_L = 10\mu F$ , 10% to 90%	-	10	-	$\mu s$
$t_F$	Slow $V_{OUT}$ Turn-off Fall Time	$R_L = 10\Omega$ , $C_L = 10\mu F$ , 90% to 10%	-	200	-	$\mu s$
<b>CURRENT CONTROL</b>						
$I_{OUT\_CONT\_5}$	Maximum Continuous Current, $V_{IN} = 5V$ Guaranteed by the Minimum $I_{trip}$ Current Specification	ISL6186xA, B, E, F	-	-	<b>1.5</b>	A
		ISL6186xC, D, G, H	-	-	<b>3.0</b>	A
		ISL6186xI, J, K, L (10 Ld DFN)	-	-	<b>3.6</b>	A
$I_{OUT\_CONT\_3}$	Maximum Continuous Current, $V_{IN} = 3.3V$ Guaranteed by the Minimum $I_{trip}$ Current Specification	ISL6186xA, B, E, F	-	-	<b>1.5</b>	A
		ISL6186xC, D, G, H	-	-	<b>2.5</b>	A
		ISL61861I, J, K, L (10 Ld DFN)	-	-	<b>2.7</b>	A
$I_{OUT\_CONT\_2}$	Maximum Continuous Current, $V_{IN} = 2.5V$	ISL6186xA, B, E, F	-	1.2	-	A
		ISL61861C, D, G, H (SOIC)	-	1.8	-	A
		ISL61862, ISL61863 C, D, G, H (DFN)	-	2	-	A
		ISL61863I, J, K, L (10 Ld DFN)	-	2	-	A

**Electrical Specifications**  $V_{IN} = 5V$ ,  $T_A = T_J$ , Unless Otherwise Specified. **Boldface** limits apply over the operating temperature range,  $0^\circ C$  to  $+75^\circ C$  or  $-40^\circ C$  to  $+85^\circ C$ . (Continued)

SYMBOL	PARAMETER	TEST CONDITIONS	MIN (Note 8)	TYP	MAX (Note 8)	UNITS
$I_{TRIP\_5}$	Trip Current, $V_{IN} = 5V$	ISL6186xA, B, E, F	<b>1.7</b>	2.5	<b>3.3</b>	A
$I_{TRIP\_5}$		ISL6186xC, D, G, H	<b>3.0</b>	3.9	<b>4.5</b>	A
$I_{TRIP\_5}$		ISL61863I, J, K, L (10 Ld DFN)	<b>3.7</b>	3.9	<b>5.0</b>	A
$I_{TRIP\_3}$	Trip Current, $V_{IN} = 3.3V$	ISL6186xA, B, E, F	<b>1.7</b>	2.1	<b>2.7</b>	A
$I_{TRIP\_3}$		ISL6186xC, D, G, H	<b>2.8</b>	3.5	<b>4.0</b>	A
$I_{TRIP\_3}$		ISL61863I, J, K, L (10 Ld DFN)	<b>3.5</b>	3.9	<b>4.3</b>	A
$I_{TRIP\_2}$	Trip Current, $V_{IN} = 2.5V$	ISL6186xA, B, E, F	-	1.8	-	A
$I_{TRIP\_2}$		ISL6186xC, D, G, H	-	3.2	-	A
$I_{TRIP\_2}$		ISL61863I, J, K, L (10 Ld DFN)	-	3.4	-	A
$I_{LIM\_5}$	Current Limit, $V_{IN} = 5V$	ISL6186xA, B, E, F, $V_{IN} - V_{OUT} = 1V$	<b>1.37</b>	1.6	<b>1.81</b>	A
$I_{LIM\_5}$		ISL6186xC, D, G, H, $V_{IN} - V_{OUT} = 1V$	<b>2.82</b>	3.1	<b>3.42</b>	A
$I_{LIM\_5}$		ISL61863I, J, K, L, (10 Ld DFN), $V_{IN} - V_{OUT} = 1V$	<b>3.24</b>	3.6	<b>4.00</b>	A
$I_{LIM\_3}$	Current Limit, $V_{IN} = 3.3V$	ISL6186xA, B, E, F, $V_{IN} - V_{OUT} = 1V$	<b>1.35</b>	1.5	<b>1.77</b>	A
$I_{LIM\_3}$		ISL6186xC, D, G, H, $V_{IN} - V_{OUT} = 1V$	<b>2.72</b>	3.0	<b>3.35</b>	A
$I_{LIM\_3}$		ISL61863I, J, K, L (10 Ld DFN), $V_{IN} - V_{OUT} = 1V$	<b>3.22</b>	3.5	<b>3.95</b>	A
$I_{LIM\_2}$	Current Limit, $V_{IN} = 2.5V$	ISL6186xA, B, E, F, $V_{IN} - V_{OUT} = 1V$	<b>1.30</b>	1.5	<b>1.70</b>	A
$I_{LIM\_2}$		ISL6186xC, D, G, H, $V_{IN} - V_{OUT} = 1V$	<b>2.55</b>	2.9	<b>3.14</b>	A
$I_{LIM\_2}$		ISL61863I, J, K, L (10 Ld DFN), $V_{IN} - V_{OUT} = 1V$	<b>3.07</b>	3.3	<b>3.75</b>	A
$I_{sc\_5}$	Short Circuit Current, $V_{IN} = 5V$	ISL6186xA, B, E, F, $V_{OUT} = 0V$	<b>1.45</b>	2.0	<b>2.35</b>	A
$I_{sc\_5}$		ISL6186xC, D, G, H, $V_{OUT} = 0V$	<b>2.60</b>	3.4	<b>4.50</b>	A
$I_{sc\_5}$		ISL61863I, J, K, L (10 Ld DFN), $V_{OUT} = 0V$	<b>2.48</b>	3.5	<b>5.00</b>	A
$I_{sc\_3}$	Short Circuit Current, $V_{IN} = 3.3V$	ISL6186XA, B, E, F, $V_{OUT} = 0V$	<b>0.95</b>	1.2	<b>1.50</b>	A
$I_{sc\_3}$		ISL6186XC, D, G, H, $V_{OUT} = 0V$	<b>1.95</b>	2.2	<b>2.70</b>	A
$I_{sc\_3}$		ISL61863I, J, K, L (10 Ld DFN), $V_{OUT} = 0V$	<b>2.00</b>	2.5	<b>3.00</b>	A
$I_{sc\_2}$	Short Circuit Current, $V_{IN} = 2.5V$	ISL6186xA, B, E, F, $V_{OUT} = 0V$	-	1.1	-	A
$I_{sc\_2}$		ISL6186xC, D, G, H, $V_{OUT} = 0V$	-	2.1	-	A
$I_{sc\_2}$		ISL61863I, J, K, L, (10 Ld DFN), $V_{OUT} = 0V$	-	2.4	-	A
$t_{sett,lim}$	OC to Limit Settling Time	$V_{IN}/R_L = 2I_{LIM}$ , $C_L = 10\mu F$ to within 10% of $I_{LIM}$	-	200	-	$\mu s$
$t_{sett,lim\_sev}$	Severe OC to Limit Settling Time	$V_{IN}/R_L = 4I_{LIM}$ , $C_L = 10\mu F$ to within 10% of $I_{LIM}$	-	30	-	$\mu s$
$t_{CL}$	Current Limit Duration	$I_{OUT} = I_{LIM}$	<b>9.2</b>	12	<b>15</b>	ms
$t_{RTY}$	Automatic Retry Period		<b>0.80</b>	1	<b>1.35</b>	s

**I/O PARAMETERS**

$V_{fault\_lo}$	Fault Output Voltage	Fault $I_{OUT} = 10mA$	-	-	<b>0.45</b>	V
$I_{fault}$	Fault Leakage		-	5	-	$\mu A$
$V_{enr\_5}$	ENABLE/ENABLE Rising Threshold	$V_{IN} = 5V$	<b>1.5</b>	1.8	<b>2</b>	V
$Hys\_Venr\_5$	EN/EN Threshold Hysteresis	$V_{IN} = 5V$	<b>65</b>	140	<b>175</b>	mV
$V_{enr\_3}$	ENABLE/ENABLE Rising Threshold	$V_{IN} = 3.3V$	<b>1.0</b>	1.3	<b>1.6</b>	V
$Hys\_Venr\_3$	EN/EN Threshold Hysteresis	$V_{IN} = 3.3V$	<b>30</b>	80	<b>120</b>	mV
$V_{enr\_2}$	ENABLE/ENABLE Rising Threshold	$V_{IN} = 2.5V$	<b>0.95</b>	1.1	<b>1.3</b>	V
$Hys\_Venr\_2$	EN/EN Threshold Hysteresis	$V_{IN} = 2.5V$	<b>10</b>	70	<b>110</b>	mV

**Electrical Specifications**  $V_{IN} = 5V$ ,  $T_A = T_J$ , Unless Otherwise Specified. **Boldface** limits apply over the operating temperature range,  $0^\circ C$  to  $+75^\circ C$  or  $-40^\circ C$  to  $+85^\circ C$ . (Continued)

SYMBOL	PARAMETER	TEST CONDITIONS	MIN (Note 8)	TYP	MAX (Note 8)	UNITS
Ren_h	ENABLE Pull-Down Resistor	Enable asserted high options	<b>0.6</b>	1	<b>1.55</b>	MΩ
Ren_l	ENABLE Pull-Up Resistor	Enable asserted low options	<b>0.6</b>	1	<b>1.55</b>	MΩ
$t_{ON}$	Enable to Output Turn-on Time	$R_L = 10\Omega$ , $C_L = 10\mu F$ , Enable 50% to Output 90%	-	0.1	-	ms
$t_{OFF}$	Enable to Output Turn-off Time	$R_L = 10\Omega$ , $C_L = 10\mu F$ , Enable 50% to Output 10%	-	0.25	-	ms
$t_{pdPG}$	Enable to Power Good Output Rising Time	Disable to Power-Good De-assert	-	30	-	ns
PG Vth	Power Good Threshold	PGD pulls low when $V_{OUT}/V_{IN}$	<b>88</b>	91	<b>95</b>	%
PGN Vth	Power Not Good Threshold	PGD release high when $V_{OUT}/V_{IN}$	<b>78</b>	86	<b>93</b>	%
$t_{Vthr2PG}$	PG Vth to $\overline{PG}$ Falling	$\overline{PG}$ delay after PG Vth	-	1.5	-	μs
$t_{Vhf2PG}$	PGN Vth to $\overline{PG}$ Rising	$\overline{PG}$ delay after PGN Vth	-	45	-	μs
<b>BIAS PARAMETERS</b>						
$I_{VDD}$	Enabled $V_{IN}$ Current	Switches Closed, OUTPUT = OPEN	-	57	<b>75</b>	μA
$I_{VDD}$	Disabled $V_{IN}$ Current	Switches Open, OUTPUT = OPEN	-	3.5	<b>5.5</b>	μA
$V_{UVLO}$	Rising POR Threshold	$V_{IN}$ Rising to functional operation	-	2.1	<b>2.3</b>	V
$I_{VR}$	Reverse Blocking Leakage Current	$V_{IN} = 0V$ , $V_{OUT} = 5V$	-	0.3	<b>2.0</b>	μA
Temp_dis	Over-Temperature Disable		-	150	-	°C
Temp_hys	Over-Temperature Hysteresis		-	20	-	°C

## NOTE:

8. Compliance to datasheet limits is assured by one or more methods: production test, characterization and/or design.

## Introduction

The ISL6186 is a single channel overcurrent (OC) fault protection IC for the +2.5V to +5V environment. Each ISL6186 has a  $45m\Omega$  P-channel MOSFET power switch for power control. An enabling input and fault reporting output compatible with 2.5V to 5V logic allows for external control and reporting. This device features an integrated power switch with current monitoring, accurate current limiting, reverse bias protection, and current limited timed delay to turn-off for system reliability. See Figures 11 through 27 for typical operational waveforms including both undercurrent and overcurrent situations.

The ISL6186 offers current sense and limiting with  $V_{IN} = 5V$  to guarantee continuous current levels of 1.5A, 3A and 3.6A, making these devices well suited for a myriad of USB and other low-power (18W max) port power management applications and configurations.

The ISL6186 also provides thermally insensitive timed OC turn-off and fault notification, isolating and protecting the voltage bus in the event of a peripheral OC or short circuit independent of the ambient thermal condition.

The ISL6186 undervoltage lockout feature prevents turn-on of the output unless the correct ENABLE state and  $V_{IN} > V_{UVLO}$  are present. During initial turn-on, the ISL6186 prevents false fault reporting by blanking the fault signal.

During operation, once an OC condition is detected, the output is current limited for  $t_{CL}$  to allow transient OC conditions to pass. If still in current limit after the current limit period has elapsed, the output is then turned off and the fault is reported by pulling the  $\overline{FAULT}$  output low. On the latch-off options, after turn-off, both the output and the  $\overline{FAULT}$  signal are latched low until reset by the enable signal being de-asserted or a POR occurring. At this time, the  $\overline{FAULT}$  signal will clear and the switch is ready to be turned back on. On the auto restart options, the ISL6186 will attempt to periodically turn on the output as long as the enable is asserted.

When disabled, the ISL6186 has a low quiescent supply current and output to input reverse current flow blocking capability.

The ISL6186 family is provided with enable polarity options and an industry standard 8 Ld SOIC pinout along with two versions in the 70% smaller 3x3 DFN. The 8 Ld DFN package offers the same performance as the 8 Ld SOIC whereas the 10 Ld DFN offers higher current capability in the smallest possible package due to its lower package electrical and thermal resistance. Additionally, the 10 Ld DFN has a Power-Good output  $\overline{PGD}$  that pulls low 40ms after  $V_{OUT} > 90\%$  of  $V_{IN}$  and rises after  $V_{OUT} < 85\%$  of  $V_{IN}$ .

## Functional Description

### Power On Reset (POR)

The ISL6186 POR feature inhibits device functionality when  $V_{IN} < V_{UVLO}$ .

### Reverse Polarity Protection

In any event in which the power switch is disabled or powered down, and  $V_{OUT} > V_{IN}$ , there will be no output to input current flow, nor will the output voltage appear on the input.

### Soft-Start

Upon enable, the voltage on the VOUT pin will ramp up according to the equation:  $I_{LIM}/C_{OUT} (V/s)$ . Resistive or active load will slow the VOUT ramp-up toward the top of its curve.

### Fault Blanking On Start-Up

During initial turn-on, the ISL6186 prevents nuisance faults being reported to the system controller by blanking the fault signal until the internal FET is fully enhanced.

### Current Trip and Limiting Levels

The ISL6186 provides integrated current sensing in the MOSFET, which allows for rapid control of OC events. Once an OC condition is detected, the ISL6186 goes into its current limiting (CL) control mode. The ISL6186 is variant specified to allow a continuous current ( $I_{CONT}$ ) operation of 1.5A, 3A or 3.6A. As the current increases past its continuous current rating, it will reach a level that causes the device to enter its current limit mode; that is, the current trip level. The current trip level is in all cases adequately above the  $I_{CONT}$  rating so as not to cause unintended false faults. The current limit is specified at  $V_{OUT} = V_{IN} - 1V$  to test a known representative condition and is featured at a nominal value slightly higher than the continuous current rating. The speed of this current limiting control is inversely related to the magnitude of the OC fault. Thus, a hard overcurrent is more quickly pulled to its limiting value than a marginal OC condition.

### Over-Temperature Shutdown

Although the ISL6186 has an over-temperature shutdown and lockout feature because of the 12ms timed shutdown, the thermal shutdown is likely only to be invoked in extremely high ambient temperatures. FAULT does not respond to OT events.

The over-temperature protection invokes and disables the switch turn-on operation. Once the die temperature is  $\sim +140^{\circ}\text{C}$ , it will turn off an already on switch at  $\sim +150^{\circ}\text{C}$  and releases the part to operation once the die temperature falls to  $\sim +120^{\circ}\text{C}$ .

### Turn-off Time Delay

During operation, once an OC condition is detected, the output is current limited for  $\sim 12\text{ms}$  to allow transient OC conditions to pass. If still in current limit and after the current limit period has elapsed, the output is then turned off, and the fault is reported by pulling the FAULT output low. The internal 12ms timer starts upon current limiting and is independent of ambient or IC thermal conditions, thus providing more consistent operation over the entire temperature range.

### Latch-off Restart/Auto-Restart Start

After turn-off, with the latch-off options, both the output and the FAULT signal are latched low until reset by the enable signal being de-asserted, at which time the FAULT signal will clear and the IC is ready for enable to assert. On the auto-restart options, the ISL6186 will attempt to periodically turn on the output at approximately 1s intervals as long as the enable is asserted. If the OC condition remains indefinitely, so will the fault indication and the restart attempts, until such time as the thermal protection feature is invoked, thus increasing the restart period.

### Power-Good Output

This feature is an active low, open-drain, power-good indicator that asserts after  $V_{OUT}/V_{IN} > 90\%$  and de-asserts when  $V_{OUT}/V_{IN} < 85\%$ . It immediately de-asserts upon the IC being disabled.

### Active Output Pull-down

Another ISL6186 feature is the  $10\text{k}\Omega$  active pull-down on the outputs to  $<60\text{mV}$  above GND when the device is disabled, thus ensuring discharge of the load.

## Typical Performance Curves

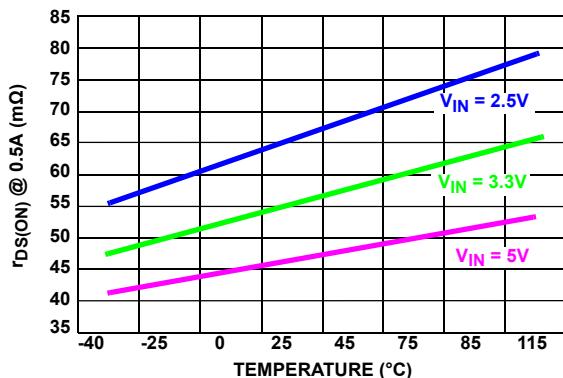


FIGURE 3. SWITCH ON-RESISTANCE AT 0.5A

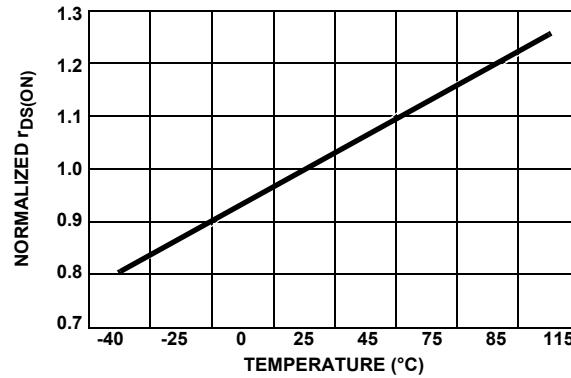


FIGURE 4. NORMALIZED SWITCH RESISTANCE

## Typical Performance Curves (Continued)

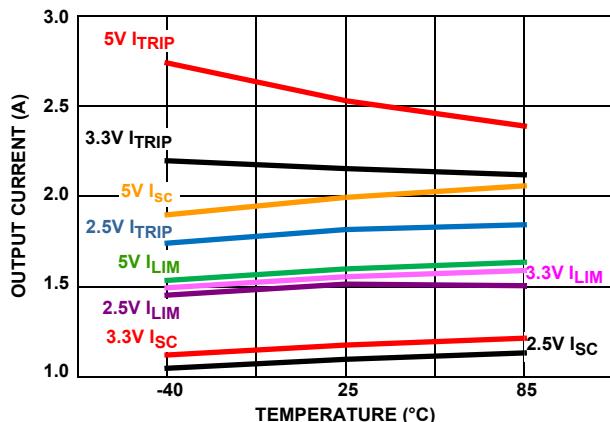


FIGURE 5. 1.5A CONTINUOUS CURRENT CHARACTERISTICS

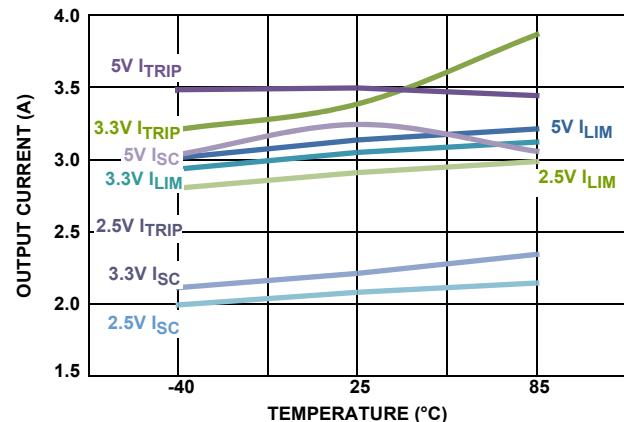


FIGURE 6. 3A CONTINUOUS CURRENT CHARACTERISTICS

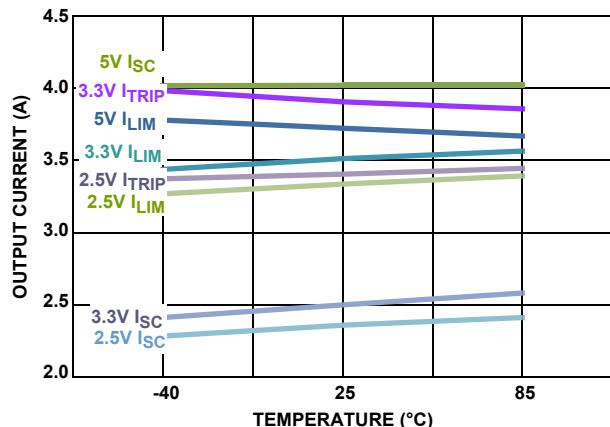
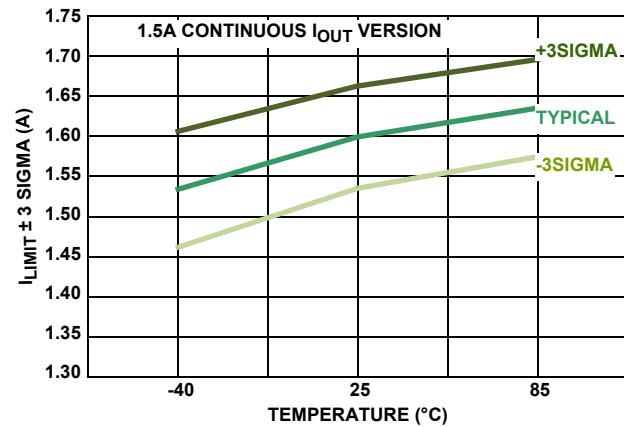
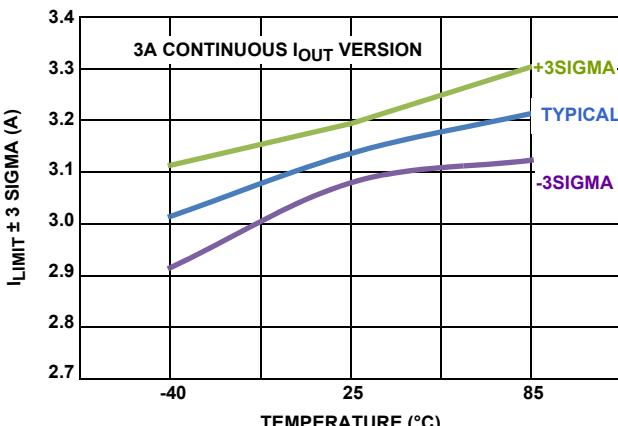
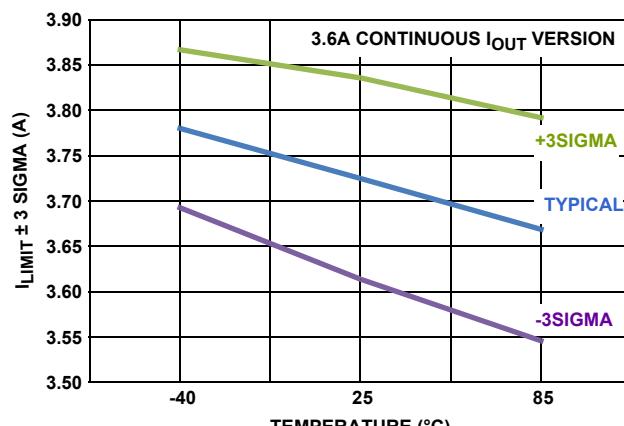


FIGURE 7. 3.6A CONTINUOUS CURRENT CHARACTERISTICS

FIGURE 8. LIMITING CURRENT  $\pm 3$  SIGMA,  $V_{IN} = 5V$ .FIGURE 9. LIMITING CURRENT  $\pm 3$  SIGMA,  $V_{IN} = 5V$ FIGURE 10. LIMITING CURRENT  $\pm 3$  SIGMA,  $V_{IN} = 5V$

## Typical Performance Curves (Continued)

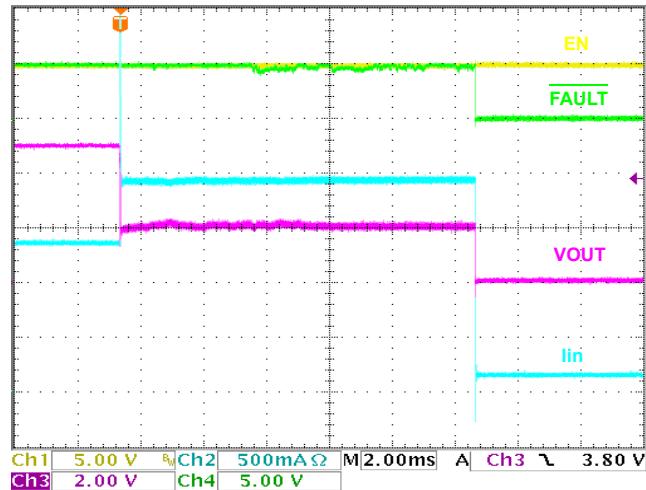
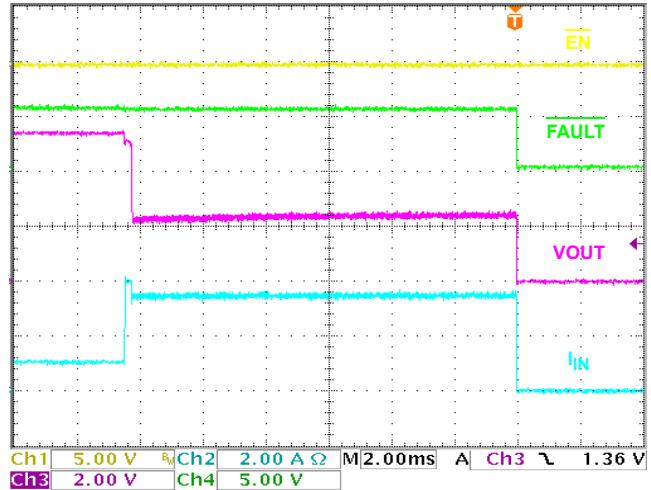
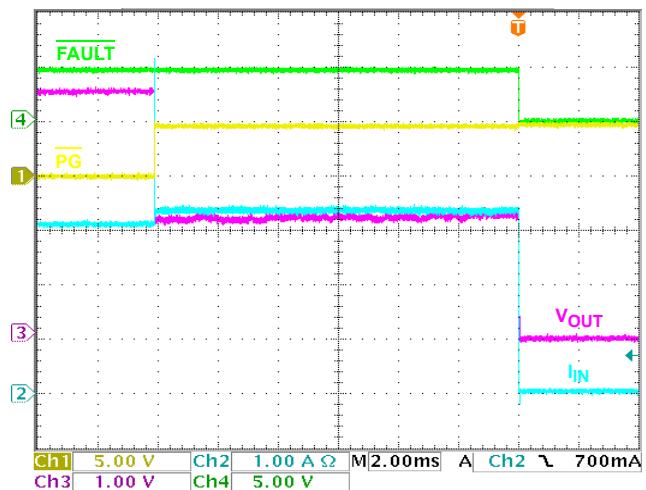
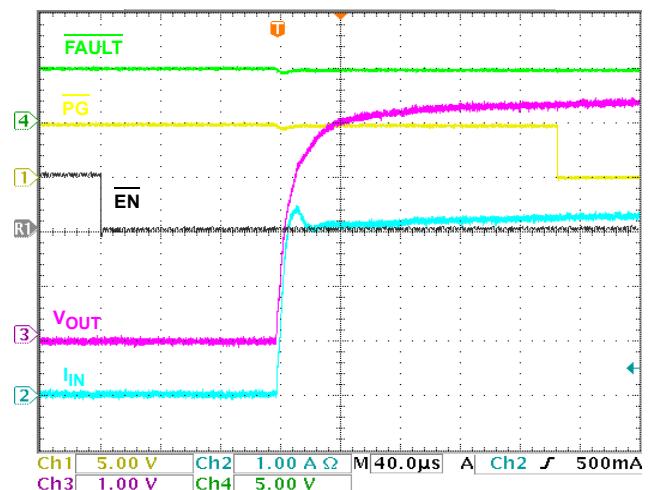
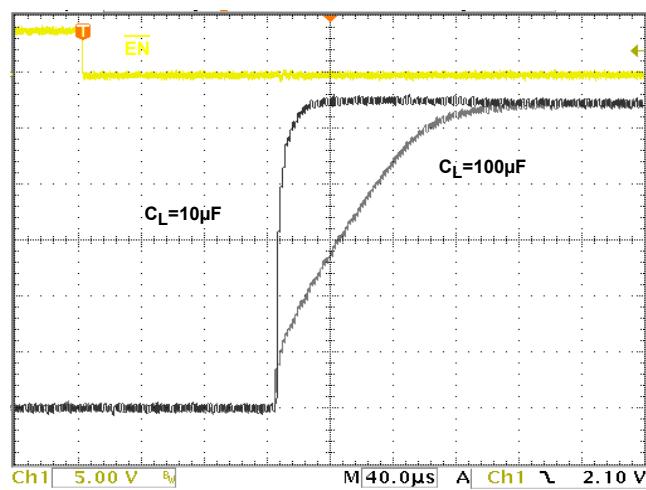
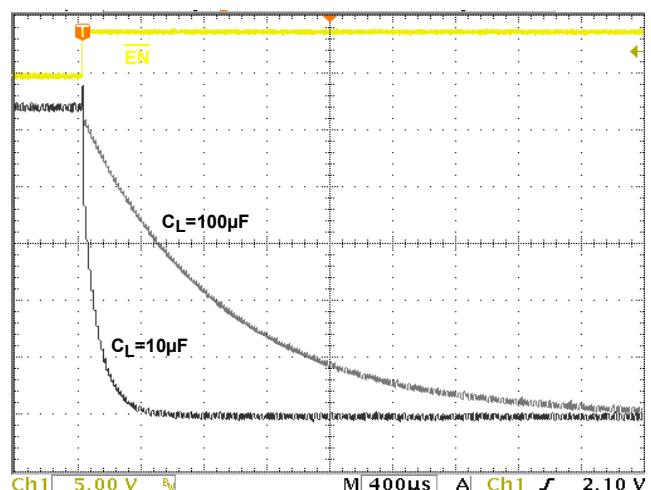
FIGURE 11. 1.5A VARIANT  $I_{LIM}$  WAVEFORMFIGURE 12. 3A VARIANT  $I_{LIM}$  WAVEFORMFIGURE 13. 3.6A VARIANT  $I_{LIM}$  WAVEFORM w PG

FIGURE 14. LISL6186 TURN-ON w PG

FIGURE 15.  $V_{OUT}$  TURN-ON/RISE TIME vs  $C_{LOAD}$ .  $V_{IN} = 5.5V$ ,  $R_L = 10\Omega$ FIGURE 16.  $V_{OUT}$  TURN-OFF/FALL TIME vs  $C_{LOAD}$ .  $V_{IN} = 5.5V$ ,  $R_L = 10\Omega$

## Typical Performance Curves (Continued)

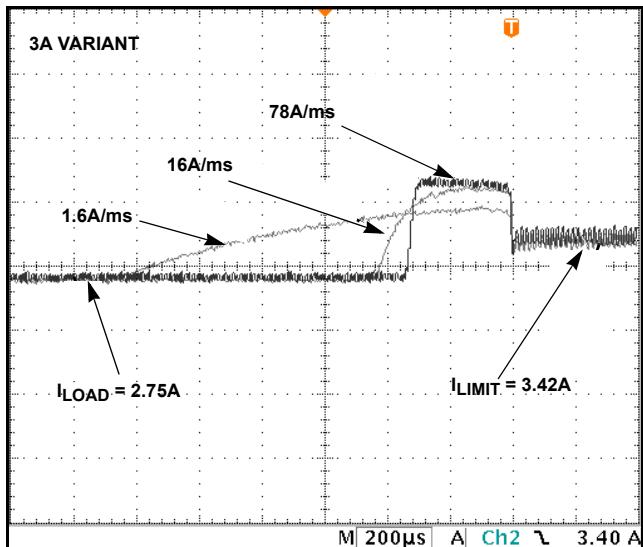
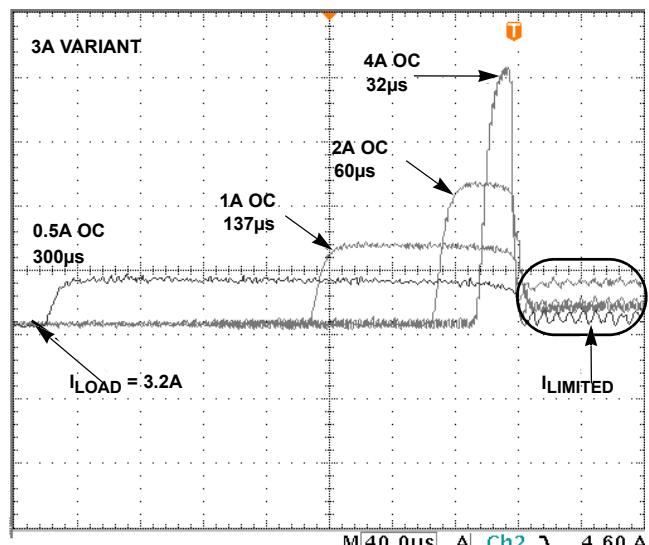
FIGURE 17. OC RAMP RATE  $I_{LIMIT}$  WAVEFORMS

FIGURE 18. PEAK CURRENT SETTLING TIMES

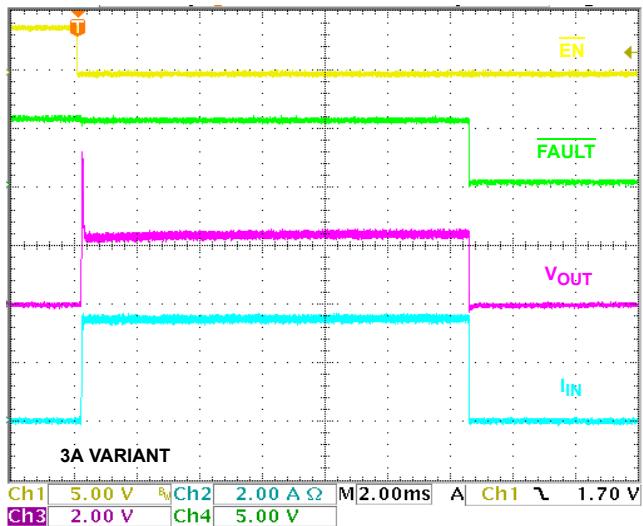


FIGURE 19. TURN-ON INTO AN OVERCURRENT

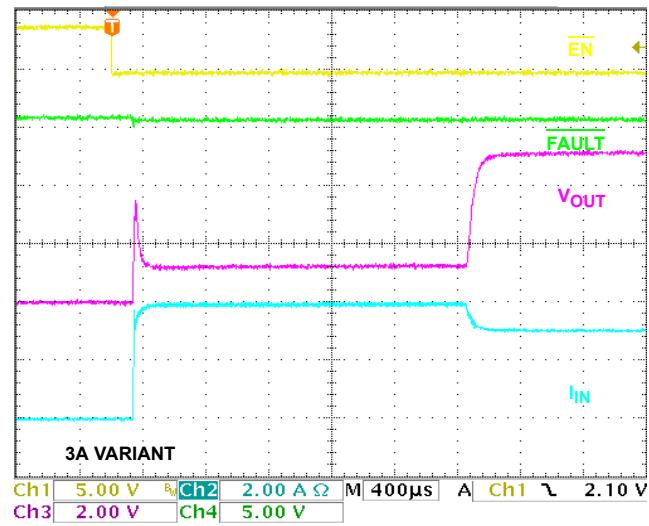


FIGURE 20. TURN-ON INTO MOMENTARY OC

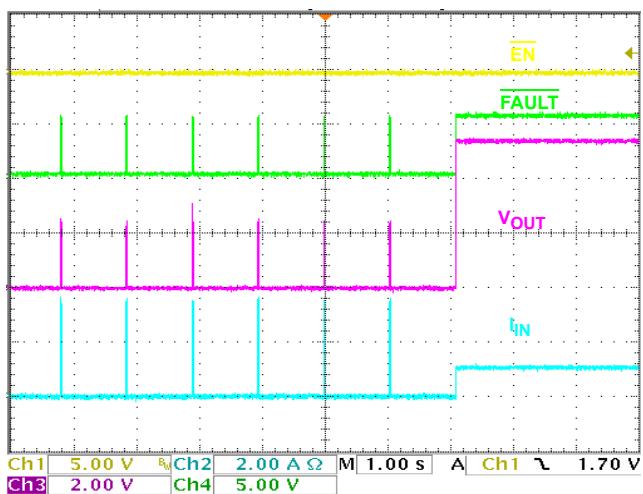


FIGURE 21. OVERCURRENT RETRY FUNCTION

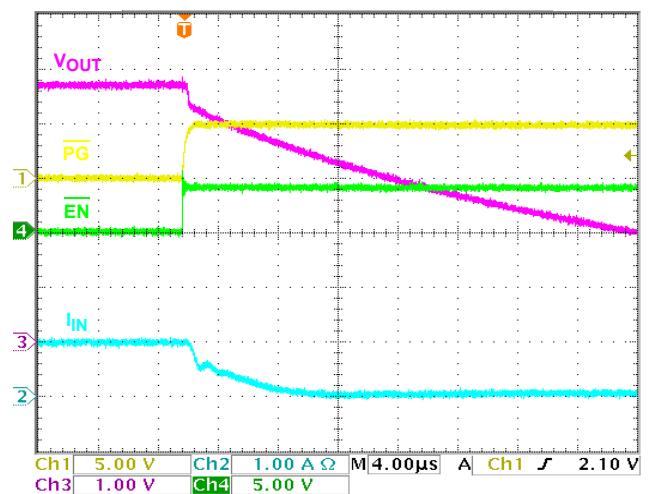
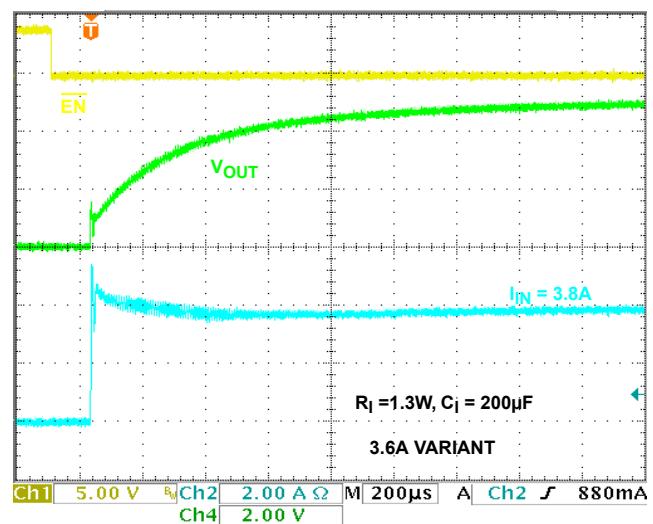
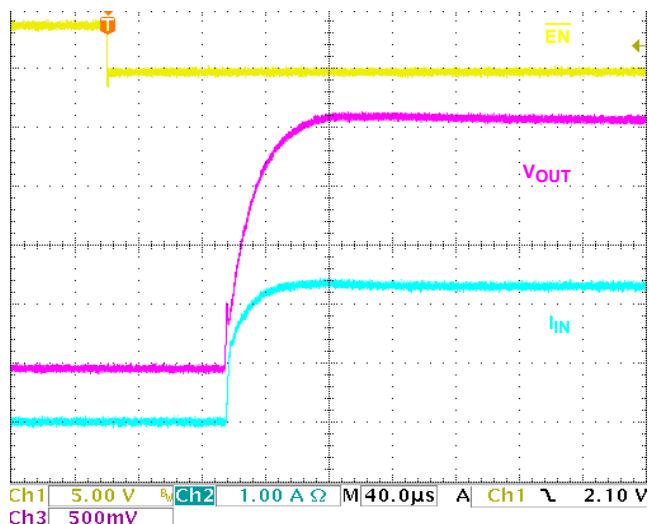
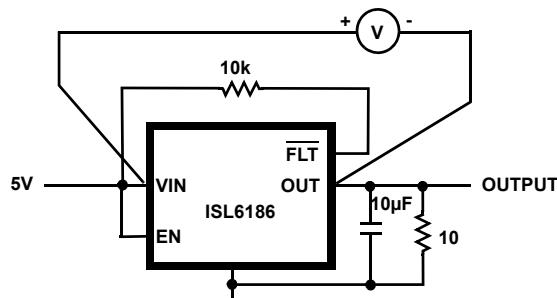


FIGURE 22. TURN-OFF w/ PG

## Typical Performance Curves (Continued)



## Test Circuits



$$r_{DS(ON)} = V/(V_{OUT}/10\Omega)$$

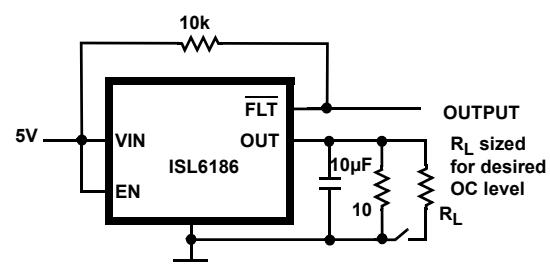
FIGURE 25A.  $r_{DS(ON)}$ 

FIGURE 25B. CURRENT LIMITING

FIGURE 25. DC TEST CIRCUIT

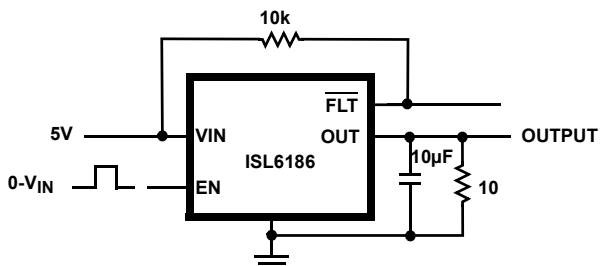


FIGURE 26A. TRANSIENT TEST CIRCUIT

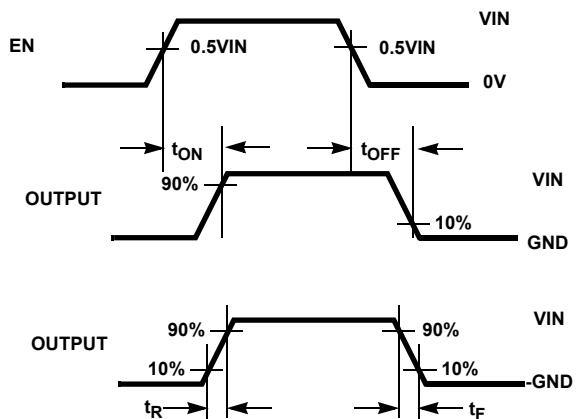


FIGURE 27. TRANSIENT WAVEFORM MEASUREMENT POINTS

## ISL61863EVAL1Z Schematic and Photo

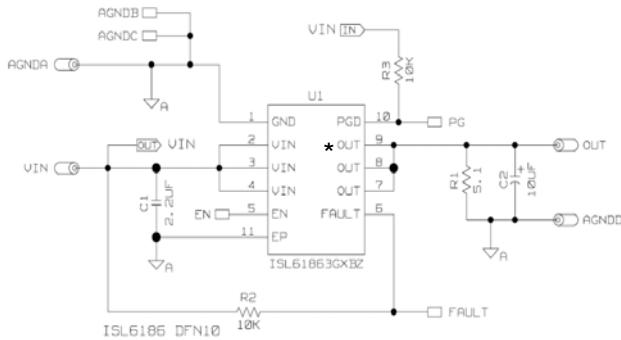


FIGURE 28A. ISL61863EVAL1Z SCHEMATIC

FIGURE 28. ISL61863EVAL1Z SCHEMATIC and ISL61863EVAL1Z PHOTOGRAPH

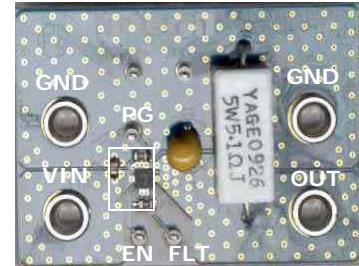


FIGURE 28B. ISL61863EVAL1Z BOARD PHOTO

## Application Information

### Using the ISL6186XEVAL1Z Platform General and Biasing Information

There are three evaluation platforms for the ISL6186 family. There is one for each package style, each with a different continuous output current level and representing a mix of enable polarity and output retry or latch options. The standard available evaluation board options are listed at the end of the Ordering Information table, which starts on page 3. Figure 28A illustrates the schematic for the 10 Ld DFN ISL61863EVAL1Z. Other than the unique PGOOD output on the ISL61863 types, all the schematics and functions are the same across all three package types. Consult the individual package pinouts on page 2 for those differences.

The evaluation platform is biased and monitored through a few labeled test points. See Table 1 for test point assignments and descriptions.

TABLE 1. ISL61863EVAL1Z TEST POINT ASSIGNMENTS

TP NAME	DESCRIPTION
GND	Eval Board and IC Gnd
VIN	Eval Board, IC Bias and Power Input
EN	Enable Switch
OUT	Switch Power Output
PG	Power-Good Output
FLT	Fault Output

Upon proper bias of the evaluation platform and correct enabling of the IC, the ISL6186 will have a nominal  $V_{IN}/5.1\Omega$  load current that is below the continuous current rating passing through each enabled switch. See Figures 14 to 16 for typical ISL6186 turn-on and turn-off waveforms.

External current loading in excess of the trip current level for the particular part being evaluated will result in the ISL6186 entering current limiting mode. Figure 11 illustrates current limiting mode

for the ISL6186 product variants with 1.5A of continuous load current rating. The scope shot shows current limiting for  $\sim 12\text{ms}$  before it is turned off and the fault signal is asserted.

## Application Considerations

See Table 2 for a listing of the ISL6186XEVAL1Z board components.

### Decoupling $V_{IN}$

Application considerations for the ISL6186 family are widely accepted best industry practices. Good decoupling practices on the  $V_{IN}$  pin must be followed by placement close to the IC, with at least  $2.2\mu\text{F}$  being recommended. For the 3.0 and 3.6A versions, at least  $33\mu\text{F}$  is recommended to prevent spiking and glitching on  $V_{IN}$  during an OC event. Use good PCB layout practices to reduce input and output inductance to the ISL6186.

### Loading $V_{OUT}$

When designing with the 3A and 3.6A versions in an implementation in which the output may be unloaded (open) while the ISL6186 is turned on, a minimum of  $4.7\mu\text{F}$  of capacitive loading is recommended to prevent high  $dv/dt$  from unnecessarily activating the surge/ESD circuitry.

### Continuous Current Ratings

The ISL6186 provides several continuous current rated devices specified at  $V_{IN} = 5\text{V}$ : these are the 1.5A, 3A and 3.6A options, which are capable over the entire temperature extreme. At  $V_{IN} = 3.3\text{V}$ , current capability is degraded, and the ISL6186 is specified at 1.5A and 3A. At  $V_{IN} = 2.5\text{V}$ , there are no specifications, but a typical value is provided in the specification table as guidance for  $+25^\circ\text{C}$  operation. This degraded capability is due to the higher  $r_{DS(ON)}$  of the FET switch at the lower bias voltage.

Enhanced thermal characteristics and an increased number of bond wires allows the 10 Ld DFN to have a higher current capability than either the 8 Ld SOIC or 8 Ld DFN.

TABLE 2. ISL6186XEVAL1Z BOARD COMPONENT LISTING

COMPONENT DESIGNATOR	COMPONENT FUNCTION	COMPONENT DESCRIPTION
U1	ISL6186	Intersil, ISL6186
R1	Output Load Resistor	5.1Ω, 5%, 3W
R2	FLT Output Pull-up Resistor	10kΩ, 0805
R3 * only on ISL61863EVAL1Z	PGD Output Pull-up Resistor	10kΩ, 0805
C1	Decoupling Capacitor	2.2μF on ISL61862EVAL1Z 33μF on ISL61861EVAL1Z and ISL61863EVAL1Z
C2	Load Capacitor	10μF 16V Electrolytic, Radial Lead

## Revision History

The revision history provided is for informational purposes only and is believed to be accurate, but not warranted. Please go to web to make sure you have the latest Rev.

DATE	REVISION	CHANGE
10/17/11	FN7698.2	Changed throughout document ISL61861AEVAL1Z, ISL61862HEVAL1Z, ISL61863LEVAL1Z To: ISL61861EVAL1Z, ISL61862EVAL1Z, ISL61863EVAL1Z
9/1/11	FN7698.1	Initial release to web.

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\*For a complete listing of Applications, Related Documentation and Related Parts, please see the respective device information page on [intersil.com](http://intersil.com): [ISL6186](http://intersil.com/ISL6186)

To report errors or suggestions for this datasheet, please go to [www.intersil.com/askourstaff](http://www.intersil.com/askourstaff)

FITs are available from our website at <http://rel.intersil.com/reports/search.php>

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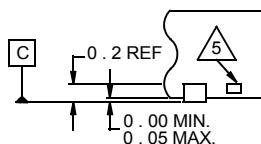
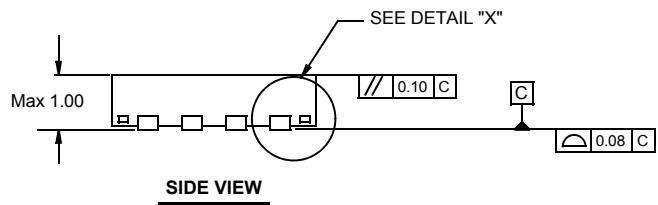
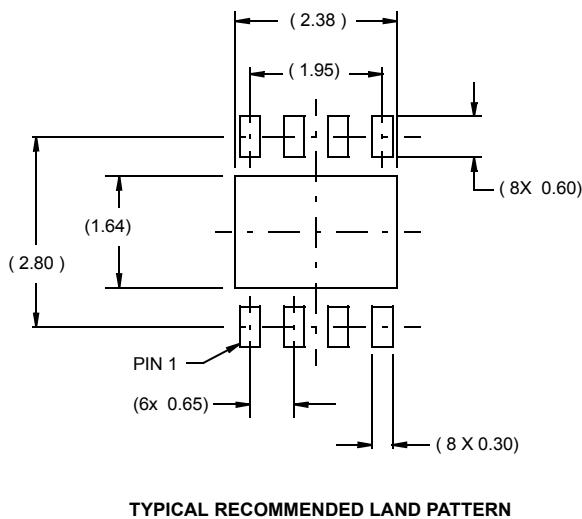
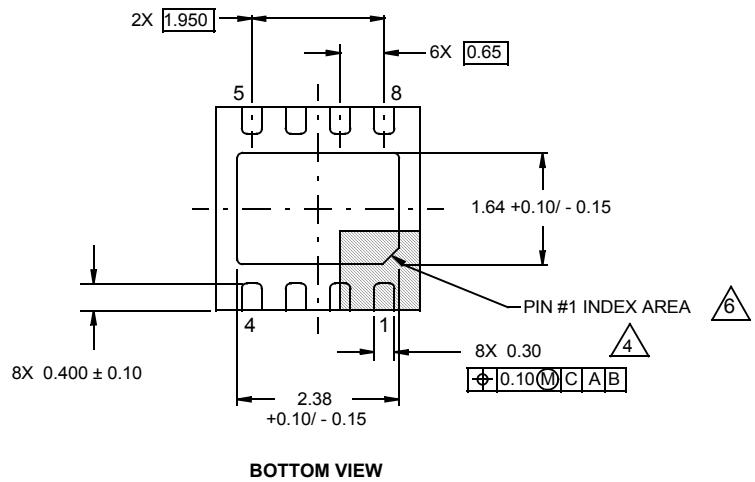
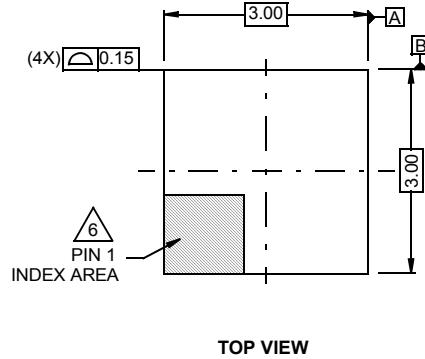
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# Package Outline Drawing

## L8.3x3J

8 LEAD DUAL FLAT NO-LEAD PLASTIC PACKAGE

Rev 0 9/09



## NOTES:

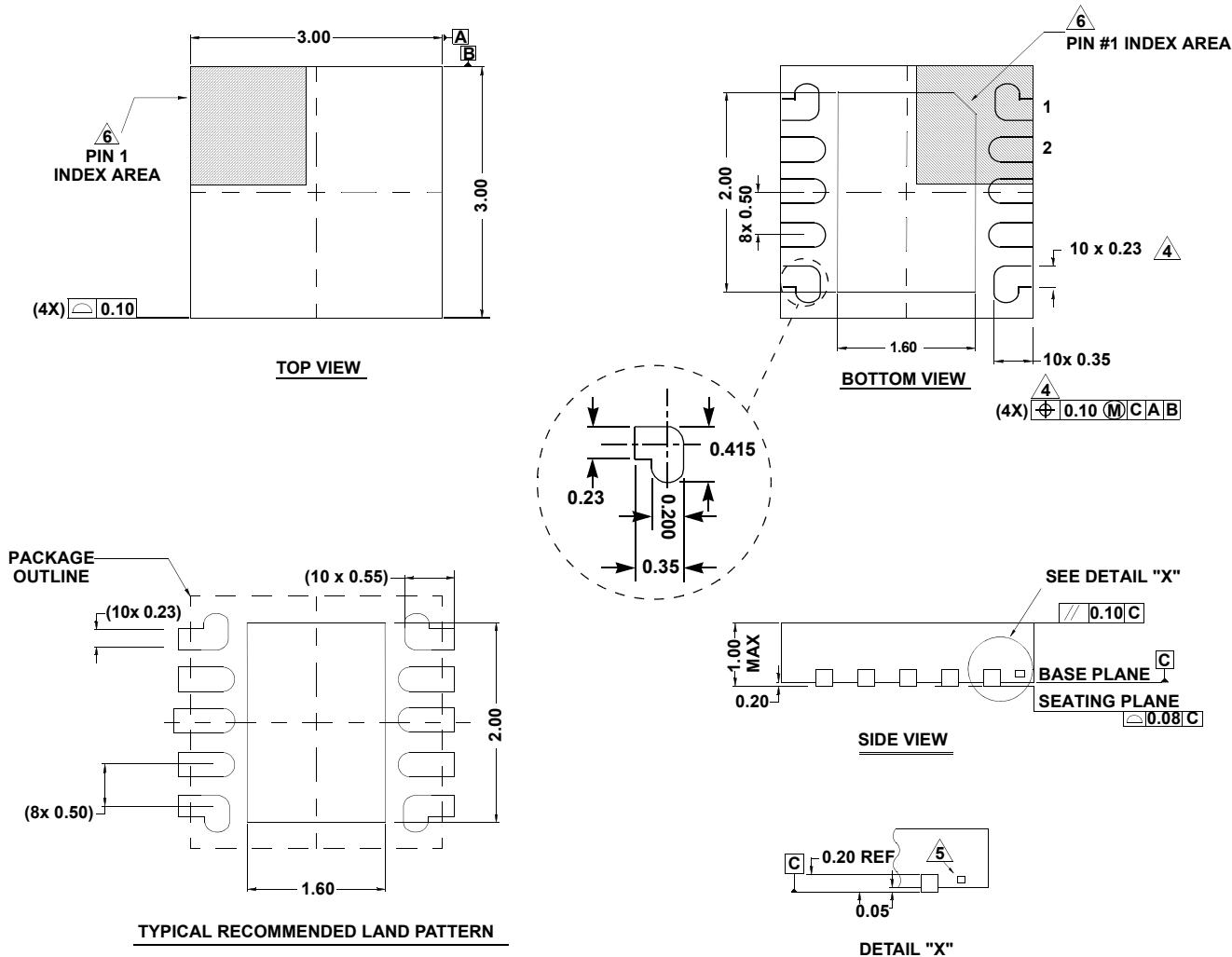
- Dimensions are in millimeters.  
Dimensions in ( ) for Reference Only.
- Dimensioning and tolerancing conform to AMSE Y14.5m-1994.
- Unless otherwise specified, tolerance : Decimal  $\pm 0.05$
- Dimension applies to the metallized terminal and is measured between 0.15mm and 0.30mm from the terminal tip.
- Tiebar shown (if present) is a non-functional feature.
- The configuration of the pin #1 identifier is optional, but must be located within the zone indicated. The pin #1 identifier may be either a mold or mark feature.

# Package Outline Drawing

## L10.3x3

10 LEAD DUAL FLAT PACKAGE (DFN)

Rev 6, 09/09



### NOTES:

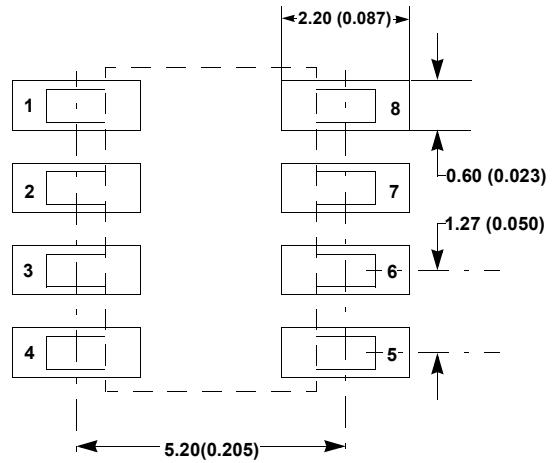
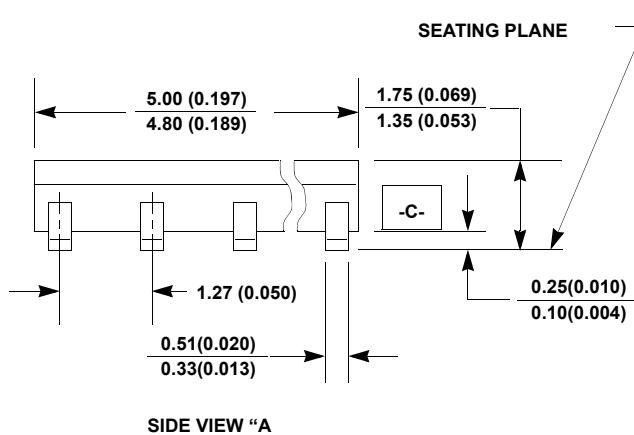
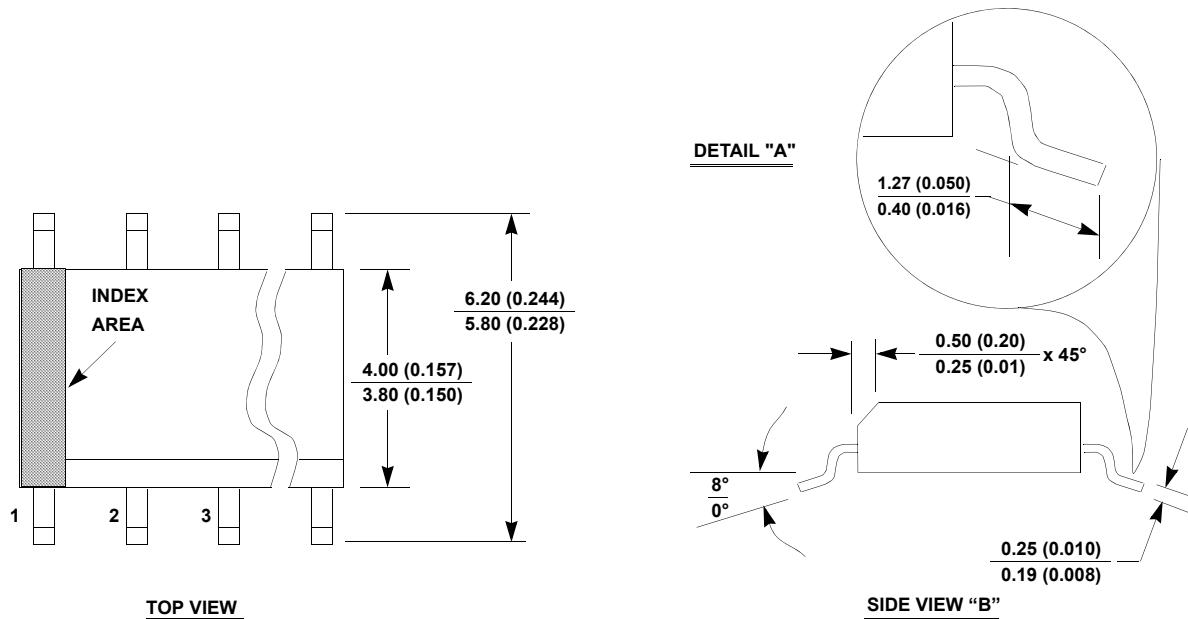
1. Dimensions are in millimeters.  
Dimensions in ( ) for Reference Only.
2. Dimensioning and tolerancing conform to AMSE Y14.5m-1994.
3. Unless otherwise specified, tolerance : Decimal  $\pm 0.05$
4. Lead width applies to the metallized terminal and is measured between 0.18mm and 0.30mm from the terminal tip.
5. Tiebar shown (if present) is a non-functional feature.
6. The configuration of the pin #1 identifier is optional, but must be located within the zone indicated. The pin #1 identifier may be either a mold or mark feature.

# Package Outline Drawing

M8.15

8 LEAD NARROW BODY SMALL OUTLINE PLASTIC PACKAGE

Rev 3, 3/11



## NOTES:

1. Dimensioning and tolerancing per ANSI Y14.5M-1982.
2. Package length does not include mold flash, protrusions or gate burrs. Mold flash, protrusion and gate burrs shall not exceed 0.15mm (0.006 inch) per side.
3. Package width does not include interlead flash or protrusions. Interlead flash and protrusions shall not exceed 0.25mm (0.010 inch) per side.
4. The chamfer on the body is optional. If it is not present, a visual index feature must be located within the crosshatched area.
5. Terminal numbers are shown for reference only.
6. The lead width as measured 0.36mm (0.014 inch) or greater above the seating plane, shall not exceed a maximum value of 0.61mm (0.024 inch).
7. Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact.
8. This outline conforms to JEDEC publication MS-012-AA ISSUE C.