DPS1133

24V/3A 1-CH POWER SWITCH WITH FAST ROLE SWAP

Description

The DPS1133 is part of a family of power switches optimized for the USB Power Delivery and other hot-swap applications. Through the analog interface, exception status is reported and several functions can be programmed: current limit, overvoltage protection, and output voltage ramping up. The fast role swap function, which complies with the requirements defined in the USB Power Delivery Specification Release 3.0, V1.0a is implemented.

This device is designed to operate between 4.5V and 24V. It offers fast short-circuit response time to ensure system robustness. The integrated port-discharge function allows the voltage levels at the input and output ports to be discharged to meet the requirements of the USB Power Delivery Specification. Comprehensive fault detection and recovery mechanisms are provisioned to enable applications which are subjected to heavy capacitive loads and the risk of short circuit. These mechanisms include: reverse voltage and current blocking, input overvoltage protection, output overcurrent, short-circuit protection, and overtemperature shut-down. In addition, the rise time of output voltage can be adjusted to minimize in-rush current and to ensure system stability. Before any exception condition is notified via the low-active FAULTB signal, deglitch of 7ms is applied to prevent false triggering.

The DPS1133 is housed in the low-profile and space-saving V-QFN4040-17 package which is manufactured with environmental-friendly material.

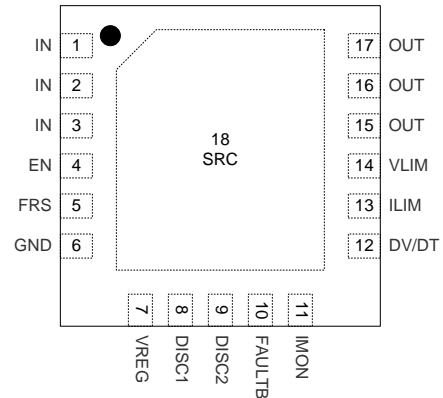## Pin Assignments

(Top View)

V-QFN4040-17

Features

- Wide Operating Voltage Range: 4.5V to 24V
- 1-Channel Power Switch with Integrated Adjustable Current & Voltage Limits
- Ability to Discharge the Input and Output Ports either Individually or Simultaneously via Two External Control Pins
- Fast Short-Circuit Response Time at 2µs
- Comprehensive Built-in Fault Detection and Recovery Mechanisms like Input Undervoltage Lock-Out, Reverse Voltage & Current Blocking, Thermal Shutdown, Overcurrent and Short-Circuit Protection
- $R_{DS(ON)}$ of Embedded MOSFET at 30mΩ
- Adjustable DV/DT Control at Start-Up
- Fault Reporting (FAULTB) with Blanking Time at 7ms Typical
- Fast Role Swap Supported
- UL Recognized, File No. E322375
- IEC60950-1 CB Scheme Certified
- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: NiPdAu Finish, Solderable per MIL-STD-202, Method 208 (e4)
- Weight: 0.0375 grams (Approximate)
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please contact us or your local Diodes representative. https://www.diodes.com/quality/product-definitions/**
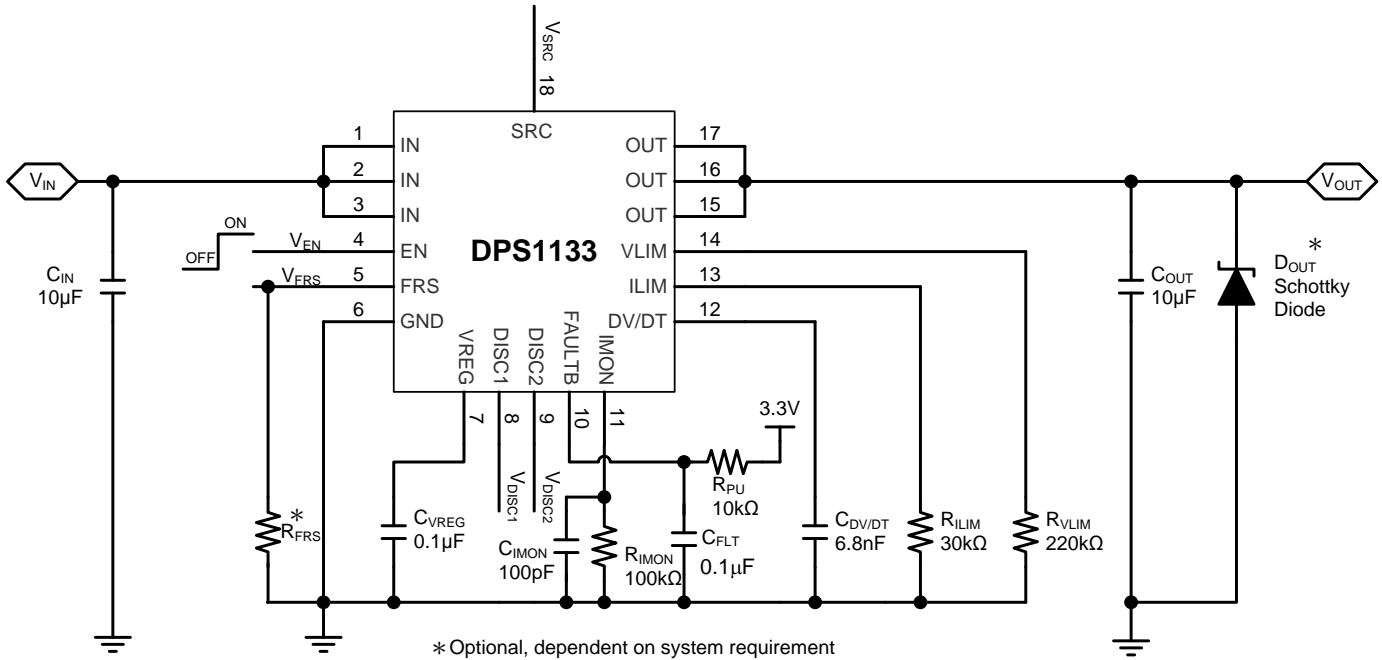
Applications

- Notebook, Desktop, and AIO PCs, Servers, and Tablets
- Docking Stations, Universal and Multimedia Hubs
- FPTVs, PC Monitors
- Set-Top Boxes, Residential Gateways, Storage Devices
- Power Protection in Industrial and Automotive Applications

Notes: 1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

DPS1133
Document number: DS39393 Rev.11 - 2

1 of 16
www.diodes.com

December 2019
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Typical Application Circuit

∗ Optional, dependent on system requirement

Pin Descriptions

Pin Number	Pin Name	Type	Function
1, 2, 3	IN	P	Power Supply and Input port.
4	EN	I	Enable Input. Active high. '0' = Device OFF; '1' = Device ON. This pin must not be left floating.
5	FRS	I	Fast Role Swap Control. This pin enables the Fast Role Swap sequence defined in the USB Power Delivery Specification Release 3.0, V1.0a.
6	GND	GND	Device Ground.
7	VREG	I/O	Voltage Regulator. A 0.1µF is recommended between this pin and GND.
8	DISC1	I	IN Port Discharge Control. '1' = port voltage to be discharged; '0' = disabled.
9	DISC2	I	OUT Port Discharge Control. '1' = port voltage to be discharged; '0' = disabled.
10	FAULTB	O	Fault Status Indicator. An external pull-up resistor is required. This active-low pin is tied to GND when not used.
11	IMON	O	Current Monitor. A 100pF capacitor and a resistor connected in parallel between this pin and GND creates a positive average voltage proportional to the current flowing through the device. This pin can be left floating if current monitoring is not needed.
12	DV/DT	I/O	Ramp-up Control. A capacitor between this pin and GND sets the ramp-up rate.
13	ILIM	I/O	Current Limit Setting. A resistor between this pin and GND sets the overcurrent limit of the OUT port.
14	VLIM	I/O	Voltage Limit Setting. A resistor between this pin and GND sets the over-voltage limit of the IN port.
15, 16, 17	OUT	O	Output Port.
18 (Exposed Pad)	SRC	I/O	Common Source. The exposed pad of the V-QFN4040-17 package must not be connected to any signal.

DPS1133
Document number: DS39393 Rev.11 - 2

2 of 16
www.diodes.com

December 2019
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Functional Block Diagram
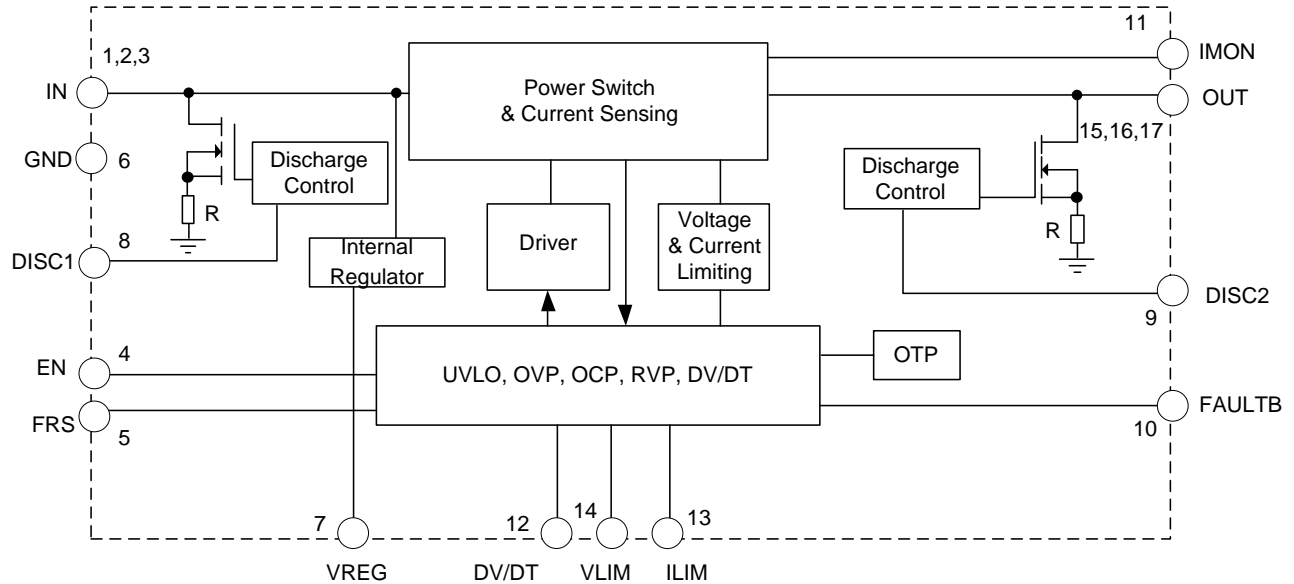
Absolute Maximum Ratings (@ T_A = +25°C, unless otherwise specified) (Note 4)

Symbol	Parameter	Rating	Unit
V_{IN}, V_{OUT}	Voltage Range of Power IN and OUT Pins	-0.3 to 30	V
V_{EN}	Voltage Range of EN Pin	-0.3 to 30	V
$V_{I/O}$	Voltage Range of Other Pins (FRS, VREG, DISC1, DISC2, FAULTB, IMON, DV/DT, ILIM, VLIM)	-0.3 to 6	V
I_{OUT}	Load Current Range	5	A
T_J	Operating Junction Temperature	-40 to +125	°C
$I_{OUTPULSE}$	Load Current Range (R_{ILIM} = 6.8kΩ, 1s Pulse, Duty Cycle = 1%)	14	A
T_L	Lead Temperature	+260	°C
T_{ST}	Storage Temperature	-65 to +150	°C
ESD	Human Body Model (HBM), JESD22-A114	2	kV
	Charge Device Model (CDM)	1	

Thermal Characteristics (@ T_A = +25°C, unless otherwise specified) (Note 5)

Symbol	Parameter	Rating	Unit
P_D	Power Dissipation	1.7	W
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	58.5	°C/W
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case	12.3	°C/W

Notes: 4. These are stress ratings only. Operation outside the absolute maximum ratings can cause device failure. Operation at the absolute maximum rating for extended periods can reduce device reliability.
5. Device mounted on FR-4 substrate PC board, 2oz copper, with 1" × 1" copper pad layout.

DPS1133
Document number: DS39393 Rev.11 - 2

3 of 16
www.diodes.com

December 2019
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Recommended Operating Conditions (@ T_A = +25°C, unless otherwise specified.)

Symbol	Parameter	Min	Max	Unit
V_{IN}	Input Supply Voltage	4.5	24	V
V_{OUT}	Output Voltage	0	24	V
I_{OUT}	Output Load Current	0	3.5	A
C_{IN}	Input Capacitance	10	—	µF
C_{OUT}	Output Capacitance	1	100	µF
V_{EN}	Input Voltage on EN Pin	0	28	V
V_{FRS}, V_{DISC1}, V_{DISC2}	Input Voltage on FRS, DISC1, DISC2 Pins	0	5.5	V
R_{VLIM}	VLIM Resistance	51	270	kΩ
R_{ILIM}	ILIM Resistance	27	200	kΩ

Electrical Characteristics (@ T_A = +25°C, V_{IN} = 4.5V to 24V, C_{IN} = C_{OUT} = 10µF, V_{EN} = 3.3V, V_{FRS} = 0V, $C_{DV/DT}$ = 1nF, R_{VLIM} = 240kΩ, R_{ILIM} = 27kΩ, unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Bias Supply						
V_{REG}	Regulated Voltage	V_{IN} = 5V	—	4.9	—	V
		V_{IN} = 12V	—	5.1	—	
		V_{IN} = 24V	—	5.2	—	
V_{UVLO}	V_{IN} Undervoltage Lock-Out Threshold	V_{IN} Rising	3.2	3.6	4.0	V
V_{UVHY}	V_{IN} Undervoltage Lock-Out Threshold Hysteresis	V_{IN} Falling	—	250	—	mV
I_{SHDN}	Shut-Down Current (Disabled)	V_{IN} = 5V, V_{EN} = 0V	—	—	5	µA
		V_{IN} = 12V, V_{EN} = 0V	—	—	15	
		V_{IN} = 24V, V_{EN} = 0V	—	—	25	
I_Q	Quiescent Current (Enabled)	V_{IN} = 5V, No Load	—	1.5	1.9	mA
		V_{IN} = 12V, No Load	—	1.7	2.1	
		V_{IN} = 24V, No Load	—	2.2	2.6	
MOSFET						
$R_{DS(ON)}$	Switch ON Resistance	V_{IN} = 5V	—	29	36	mΩ
		V_{IN} = 12V	—	29	36	
		V_{IN} = 24V	—	30	36	
I_{LKGSRC}	OUT Leakage Current in OFF State, Sourcing	V_{EN} = 0V, V_{OUT} = 0V	—	—	1	µA
I_{LKGSNK}	OUT Leakage Current in OFF State, Sinking	V_{IN} = 3.3V, V_{EN} = 0V, V_{OUT} = 5V	—	—	15	µA
		V_{IN} = 3.3V, V_{EN} = 0V, V_{OUT} = 12V	—	—	25	
		V_{IN} = 3.3V, V_{EN} = 0V, V_{OUT} = 24V	—	—	40	
Enable Control						
V_{ENL}	EN Threshold Voltage Low	V_{EN} Falling	—	—	0.4	V
V_{ENH}	EN Threshold Voltage High	V_{EN} Rising	1.4	—	—	
I_{EN}	EN Input Leakage Current	V_{IN} = 5V, V_{EN} = 5V	—	—	5	µA
Output Ramping Control						
$I_{DV/DT}$	DV/DT Sourcing Current	$V_{DV/DT}$ = 0V	—	1	—	µA
$G_{DV/DT}$	DV/DT to OUT Gain	ΔV_{OUT} / $\Delta V_{DV/DT}$, Guaranteed by Design	—	12	—	V/V

DPS1133
Document number: DS39393 Rev.11 - 2

4 of 16
www.diodes.com

December 2019
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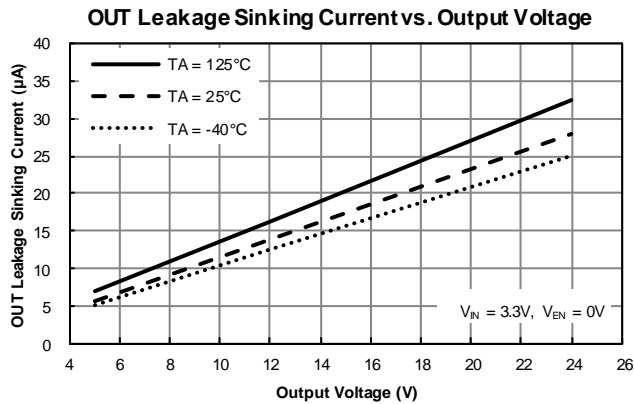## Electrical Characteristics (continued) (@ T_A = +25°C, V_{IN} = 4.5V to 24V, C_{IN} = C_{OUT} = 10µF, V_{EN} = 3.3V, V_{FRS} = 0V, $C_{DV/DT}$ = 1nF, R_{VLIM} = 240kΩ, R_{ILIM} = 27kΩ, unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Output Timing						
t_{DON}	Output Turn-ON Delay Time	V_{IN} = 5V, C_{OUT} = 1µF, V_{EN} = 0V to 3.3V	—	0.2	—	ms
		V_{IN} = 12V, C_{OUT} = 1µF, V_{EN} = 0V to 3.3V	—	0.2	—	
		V_{IN} = 24V, C_{OUT} = 1µF, V_{EN} = 0V to 3.3V	—	0.2	—	
t_R	Output Turn-ON Rise Time	V_{IN} = 5V, C_{OUT} = 1µF, V_{EN} = 0V to 3.3V	—	0.3	—	ms
		V_{IN} = 12V, C_{OUT} = 1µF, V_{EN} = 0V to 3.3V	—	0.8	—	
		V_{IN} = 24V, C_{OUT} = 1µF, V_{EN} = 0V to 3.3V	—	1.6	—	
t_{DOFF}	Output Turn-OFF Delay Time	V_{IN} = 5V, C_{OUT} = 1µF, V_{EN} = 3.3V to 0V	—	1	—	µs
		V_{IN} = 12V, C_{OUT} = 1µF, V_{EN} = 3.3V to 0V	—	2	—	
		V_{IN} = 24V, C_{OUT} = 1µF, V_{EN} = 3.3V to 0V	—	4	—	
t_F	Output Turn-OFF Fall Time	V_{IN} = 5V, C_{OUT} = 1µF, V_{EN} = 3.3V to 0V	—	10	—	µs
		V_{IN} = 12V, C_{OUT} = 1µF, V_{EN} = 3.3V to 0V	—	25	—	
		V_{IN} = 24V, C_{OUT} = 1µF, V_{EN} = 3.3V to 0V	—	50	—	
Fast Role Swap (FRS) Control and Timing						
V_{FRSL}	FRS Threshold Voltage Low	V_{FRS} Falling	—	—	0.4	V
V_{FRSH}	FRS Threshold Voltage High	V_{FRS} Rising	1.4	—	—	
I_{FRS}	FRS Input Leakage Current	V_{IN} = 5V, V_{FRS} = 5V	—	—	7	µA
t_{FRS_ON}	FRS ON Time	V_{IN} = 5V, A Single Positive Pulse Width on FRS and V_{FRSH} = 3.3V, Guaranteed by Design	600	—	—	µs
t_{DON_FRS}	Output Turn-ON Delay Time with FRS	V_{IN} = 5V, C_{OUT} = 1µF, V_{FRS} = 3.3V to 0V, 50% Falling Edge of V_{FRS} to 90% Rising Edge of V_{OUT}, Guaranteed by Design	—	—	60	µs
Discharge Control on IN and OUT Ports						
R_{DISC1} / R_{DISC2}	IN / OUT Discharge Resistance	V_{DISC1} = 5V, V_{DISC2} = 5V	—	105	—	Ω
		V_{DISC1} = 3.3V, V_{DISC2} = 3.3V	—	115	—	Ω
V_{DISC1L} / V_{DISC2L}	DISC1 / DISC2 Threshold Voltage Low	V_{DISC1} /V_{DISC2} Falling	—	—	0.4	V
V_{DISC1H} / V_{DISC2H}	DISC1 / DISC2 Threshold Voltage High	V_{DISC1} /V_{DISC2} Rising	1.4	—	—	V
Overcurrent Protection						
V_{ILIM}	ILIM Bias Voltage	R_{ILIM} = 50kΩ	—	1	—	V
I_{LIM}	Current Limit, 1A	R_{ILIM} = 100kΩ	0.9	1.05	1.20	A
	Current Limit, 2A	R_{ILIM} = 50kΩ	1.8	2	2.2	
	Current Limit, 3A	R_{ILIM} = 33.3kΩ	2.76	3	3.24	
$I_{FASTRIP}$	Fast-Trip Threshold	Guaranteed by Design	—	1.125 × I_{LIM} + 1.8	—	A
Current Monitoring Output						
V_{IMON}	Current Monitoring Output Voltage	—	—	—	4.5	V
G_{IMON}	IMON to OUT Current Gain	I_{IMON} / I_{OUT}	—	10	—	µA/A
Overvoltage Protection						
I_{VLIM}	VLIM Sourcing Current	V_{IN} = 5V, R_{VLIM} = 54.9kΩ	—	10	—	µA
V_{OVPRTH}	Input Overvoltage Threshold, Rising	R_{VLIM} = 54.9kΩ, V_{IN} Rising	—	6	—	V
		R_{VLIM} = 240kΩ, V_{IN} Rising	—	24.5	—	
V_{OVPFTH}	Input Overvoltage Threshold, Falling	R_{VLIM} = 54.9kΩ, V_{IN} Falling	—	5.5	—	
		R_{VLIM} = 240kΩ, V_{IN} Falling	—	24	—	

DPS1133
Document number: DS39393 Rev.11 - 2

5 of 16
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December 2019
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Electrical Characteristics (continued) (@ T_A = +25°C, V_{IN} = 4.5V to 24V, C_{IN} = C_{OUT} = 10μF, V_{EN} = 3.3V, V_{FRS} = 0V, $C_{DV/DT}$ = 1nF, R_{VLIM} = 240kΩ, R_{ILIM} = 27kΩ, unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Reverse-voltage Protection						
V_{RVPFTH}	V_{IN} - V_{OUT} Threshold Entering into Reverse Protection	V_{IN} - V_{OUT} Falling	—	-30	—	mV
V_{RVPRTH}	V_{IN} - V_{OUT} Threshold Exiting from Reverse Protection	V_{IN} - V_{OUT} Rising	—	0	—	
t_{RVPTD}	Reverse Protection Response Time	—	—	2	—	μs
Fault Flag (FAULTB): Active-Low						
R_{FAULTB}	FAULTB Pull-Down Resistor	V_{IN} = 7V, R_{VLIM} = 54.9kΩ, I_{FAULTB} = 10mA Sinking	—	25	—	Ω
$I_{LKGFAULTB}$	FAULTB Leakage Current	V_{IN} = 5V, R_{VLIM} = 54.9kΩ, V_{FAULTB} = 5V	—	—	1	μA
$t_{BLANKFAULTB}$	FAULTB Blanking Time	V_{IN} = 5V, R_{VLIM} = 54.9kΩ, V_{FAULTB} = 5V	—	7	—	ms
Thermal Shut-Down						
T_{SHDN}	Thermal Shut-down Threshold	—	—	+165	—	°C
T_{HYS}	Thermal Shut-down Hysteresis	—	—	+20	—	

DPS1133
Document number: DS39393 Rev.11 - 2

6 of 16
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December 2019
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Performance Characteristics (@ T_A = +25°C, C_{IN} = C_{OUT} = 10µF, V_{EN} = 3.3V, V_{FRS} = 0V, $C_{DV/DT}$ = 1nF, R_{ILIM} = 27kΩ, unless otherwise specified.)

Shutdown Current vs. Input Voltage

TA = 125°C
TA = 25°C
TA = -40°C

V_{EN} = 0V

Quiescent Current vs. Input Voltage

TA = 125°C
TA = 25°C
TA = -40°C

V_{EN} = 3.3V, I_{OUT} = 0A

OUT Leakage Sinking Current vs. Output Voltage

TA = 125°C
TA = 25°C
TA = -40°C

V_{IN} = 3.3V, V_{EN} = 0V

EN Threshold Voltage vs. Ambient Temperature

V_{ENH}

V_{ENL}

IN Discharge Resistance vs. Ambient Temperature

V_{EN} = 0V, V_{IN} = 1V

V_{DISC1} = 5V

V_{DISC1} = 3.3V

OUT Discharge Resistance vs. Ambient Temperature

V_{EN} = 0V, V_{OUT} = 1V

V_{DISC2} = 5V

V_{DISC2} = 3.3V

DPS1133
Document number: DS39393 Rev.11 - 2

7 of 16
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December 2019
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Performance Characteristics (continued) (@ T_A = +25°C, C_{IN} = C_{OUT} = 10µF, V_{EN} = 3.3V, V_{FRS} = 0V, $C_{DV/DT}$ = 1nF, R_{ILIM} = 27kΩ, unless otherwise specified.)

ON Resistance vs. Input Voltage

I_{OUT} = 1A

TA = 125°C
TA = 25°C
TA = -40°C
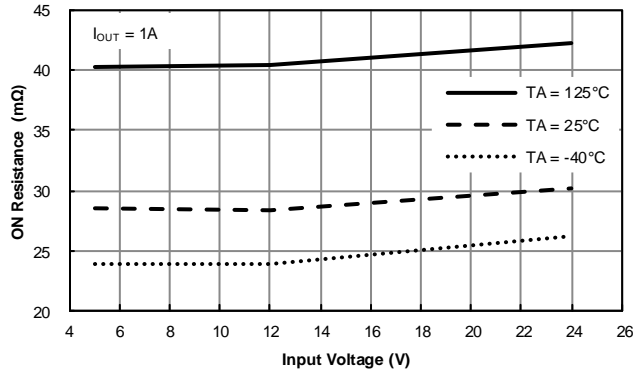
IMON Voltage vs. Load Current

VIN = 5V
VIN = 12V
VIN = 20V

R_{IMON} = 100kΩ
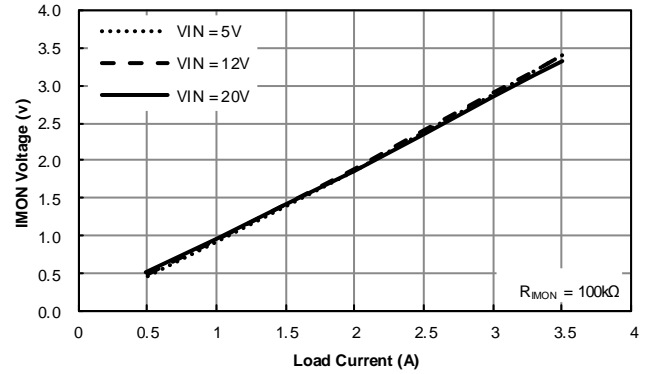
EN Turn ON with a 1.6Ω Load at 5V
V_{IN} = 5V, R_{LOAD} = 1.6Ω

V_{EN} 2V/div

V_{OUT} 2V/div

I_{IN} 2A/div

500µs/div
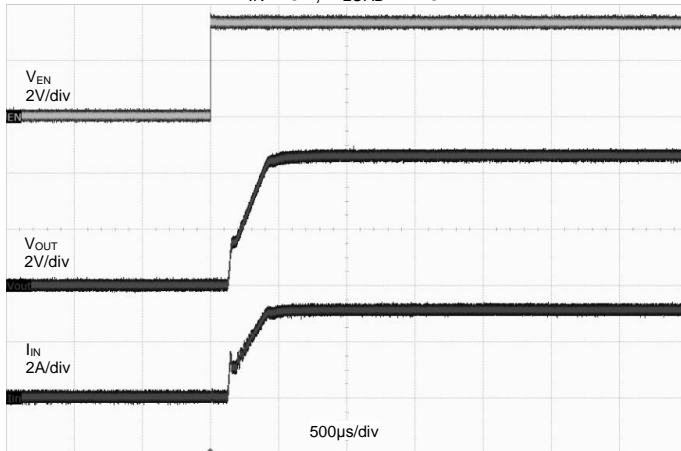
EN Turn OFF with a 1.6Ω Load at 5V
V_{IN} = 5V, R_{LOAD} = 1.6Ω

V_{EN} 2V/div

V_{OUT} 2V/div

I_{IN} 2A/div

500µs/div
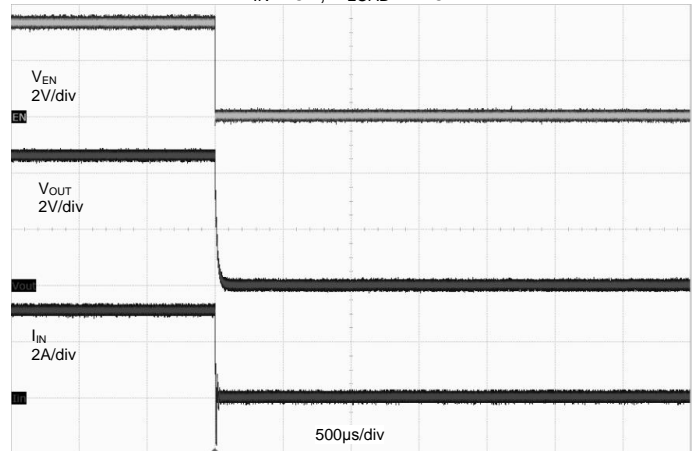
EN Turn ON with a 7Ω Load at 20V
V_{IN} = 20V, R_{LOAD} = 6.7Ω

V_{EN} 2V/div

V_{OUT} 10V/div

I_{IN} 2A/div

500µs/div
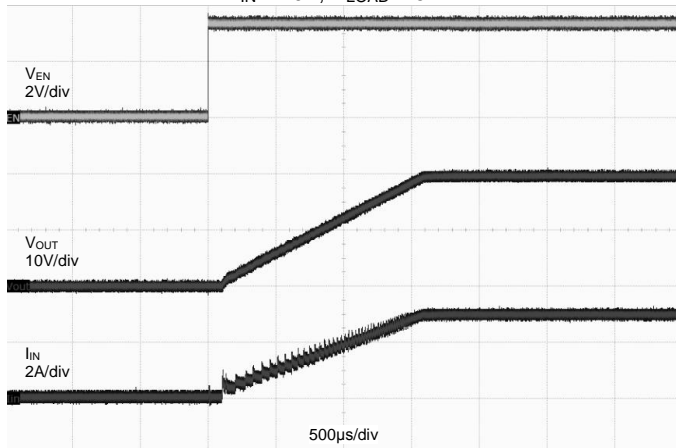
EN Turn OFF with a 7Ω Load at 20V
V_{IN} = 20V, R_{LOAD} = 6.7Ω
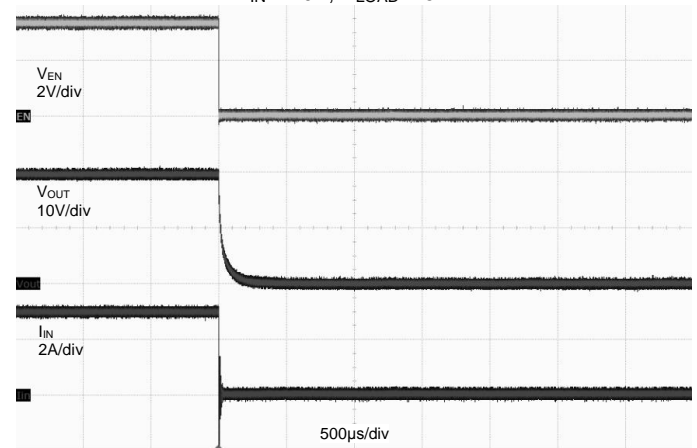
V_{EN} 2V/div

V_{OUT} 10V/div

I_{IN} 2A/div

500µs/div

DPS1133
Document number: DS39393 Rev.11 - 2

8 of 16
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December 2019
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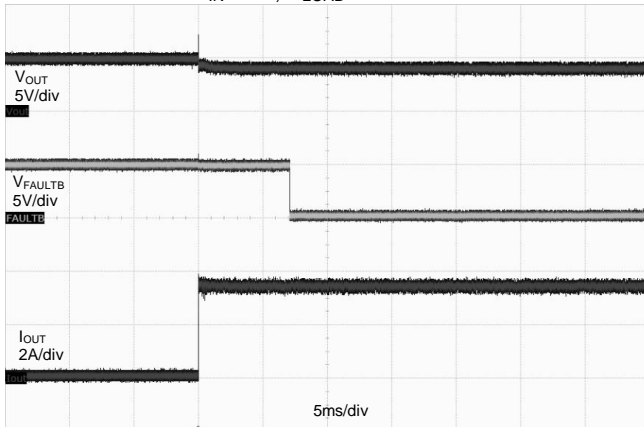
OUT Always Short to Ground at 5V
V_{IN} = 5V, OUT Port Short to Ground
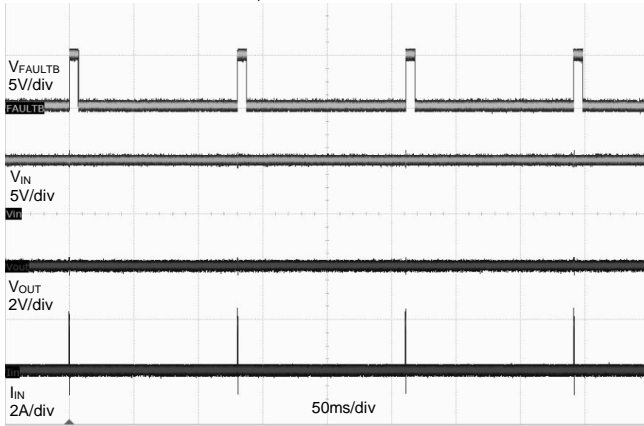
OUT Always Short to Ground at 20V
V_{IN} = 20V, OUT Port Short to Ground
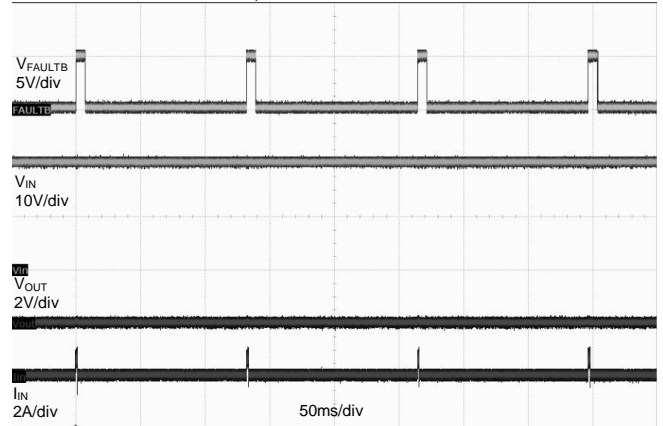
Overcurrent Protection at 5V
V_{IN} = 5V, R_{LOAD} = 100Ω to 1.2Ω

Overcurrent Recovery at 5V
V_{IN} = 5V, R_{LOAD} = 1.2Ω to 100Ω
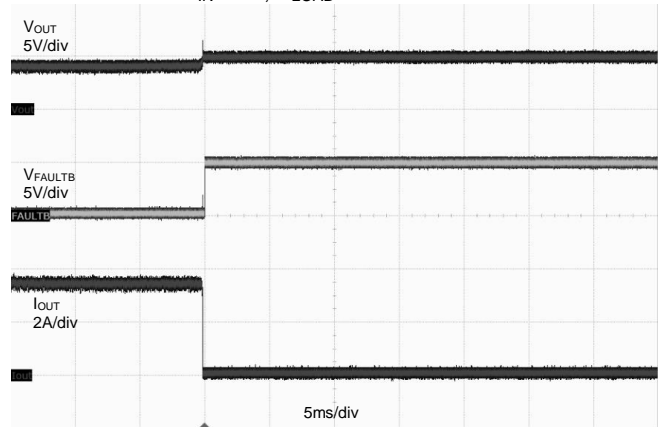
Input Overvoltage Protection and Recovery
V_{IN} = 5V to 7V then back to 5V, R_{VLIM} = 56kΩ, R_{LOAD} = 1kΩ
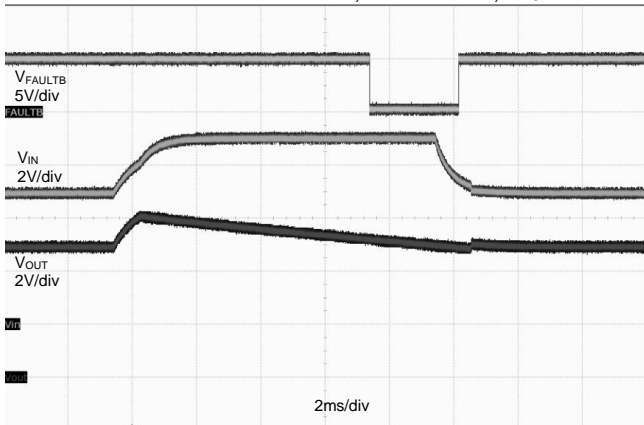
Reverse-Voltage Response
V_{IN} = 5V, Supply 24V to OUT Port

DPS1133
Document number: DS39393 Rev.11 - 2

9 of 16
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December 2019
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Application Information

General Description

The DPS1133 is a 1-channel power switch designed to meet the input and output voltage/current requirement that are common with many hot-pluggable serial interfaces found in the computing and consumer electronics equipment. For example, DPS1133 is compatible with the USB Power Delivery Specification Release 3.0, V1.0a, and many popular USB Type-C™ applications.
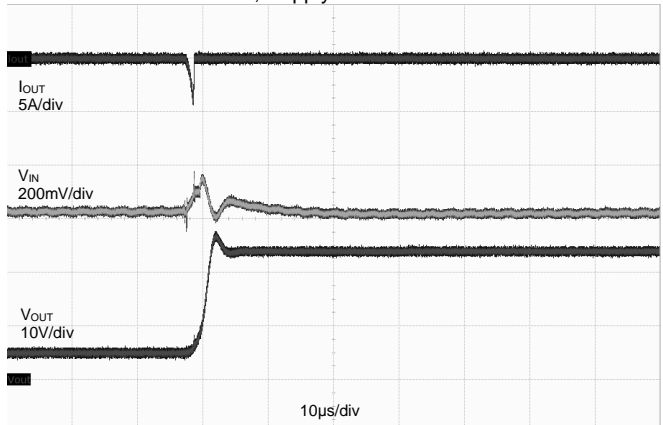
Start-up Time

An external capacitor connected from the DV/DT pin to GND defines the slew rate of the output voltage at power-on:

$$dV_{OUT} / dt = (I_{DV/DT} / C_{DV/DT}) \times G_{DV/DT}$$

Where:

- dV_{OUT} / dt is the desired output slew rate in V/ms

- $I_{DV/DT}$ is in µA and it is 1µA typical

- $C_{DV/DT}$ is the ramp-up control setting capacitor in nF

- $G_{DV/DT}$ is the gain of DV/DT to OUT and $G_{DV/DT} = 12$

The total ramp time $t_{DV/DT}$ of V_{OUT} increasing from 0 to V_{IN} can be calculated using:

$$t_{DV/DT} = 8.3 \times 10^{-2} \times V_{IN} \times C_{DV/DT}$$

Where:

- $t_{DV/DT}$ is the total ramp time in ms

- The unit of V_{IN} is volt and $C_{DV/DT}$ is nF.

Choosing a proper value for the capacitor $C_{DV/DT}$ ensures that the device is turned ON with the preset ramp-up imposed over the output voltage. The in-rush current at power up is limited by the regulated output voltage ramp or the limited current setting.

C_{OUT} (µF)	R_{ILIM} (kΩ)	I_{LIM_MIN} (A)	I_{LOAD_MAX} (A)	C_{DV/DT_MIN} (nF)	Start-Up Time (ms)		
					V_{IN} = 5V	V_{IN} = 12V	V_{IN} = 20V
10	30	3.10	3	0.51	0.21	0.51	0.85
10	43	2.09	2	0.51	0.21	0.51	0.85
10	82	1.04	1	0.51	0.21	0.51	0.85
100	30	3.10	3	3.6	1.50	3.60	6.00
100	43	2.09	2	3.6	1.50	3.60	6.00
100	82	1.04	1	3.6	1.50	3.60	6.00

Input Overvoltage Protection (OVP)

The voltage at the IN port is monitored continuously. Whenever voltage at the IN port is found to be larger than the V_{OVPRTH} value, the built-in overvoltage protection (OVP) fault-handling mechanism is triggered. The internal power MOSFET will be turned OFF to protect the downstream equipment connected. The V_{OVPRTH} value is determined by:

$$V_{OVPRTH} = 0.1 \times R_{VLIM} + 0.5$$

Where

- The unit of V_{OVPRTH} is volt

- R_{VLIM} is kΩ and $51k\Omega \le R_{VLIM} \le 270k\Omega$

Reverse-Voltage Protection (RVP)

The voltage difference, [$V_{IN} - V_{OUT}$], between the IN and OUT ports is monitored continuously. Once the voltage difference drops below the V_{RVPFTH} level, the device immediately turns OFF the internal power MOSFET to prevent the current flowing from the opposite direction. When the reverse-voltage condition is no longer valid, i.e. [$V_{IN} - V_{OUT}$] becomes greater than the V_{RVPRTH} level, the internal power MOSFET is turned ON.

DPS1133
Document number: DS39393 Rev.11 - 2

10 of 16
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Application Information (continued)

Over Temperature Protection (OTP)

During overload conditions, the output voltage would drop with the limited current I_{LIM}. It will result in the increasing junction temperature T_J with the increased power consumption on device. When T_J reaches to the thermal shutdown threshold T_{SHDN}, the internal power MOSFET would be turned OFF. The internal MOSFET would be turned ON again once the condition [$T_J < (T_{SHDN} - T_{HYS})$] occurs.

Overcurrent Protection (OCP)

The output current is being monitored continuously. Whenever the output current I_{OUT} is found to be larger than the I_{LIM} value over 2µs, the embedded overcurrent protection (OCP) fault-handling mechanism is triggered. This results in the output current being clamped at the I_{LIM} value at hundreds of microseconds later, and voltage dropping at OUT port. The I_{LIM} value is set by R_{ILIM},

$$I_{LIM} = 100 / R_{ILIM}$$

Where:

- The unit of I_{LIM} is ampere

- R_{ILIM} is kΩ and 27kΩ ≤ R_{ILIM} ≤ 200kΩ

R_{ILIM} (kΩ)	I_{LIM} (A)		
	Min	**Typ**	**Max**
200	0.50	0.55	0.7
100	0.90	1.05	1.20
66.7	1.35	1.50	1.65
50	1.80	2.00	2.20
40	2.25	2.50	2.75
33.3	2.76	3.00	3.24
28.6	3.22	3.50	3.78

Short-Circuit Protection (SCP)

There are two behaviors to protect device under short-circuit conditions. One is fast trip current detection. When the output current exceeds the fast-trip threshold $I_{FASTRIP}$, the device will switch OFF the internal MOSFET,

$$I_{FASTRIP} = 1.125 \times I_{LIM} + 1.8$$

Where:

- The unit of $I_{FASTRIP}$ and I_{LIM} is ampere

Another is low output voltage detection. During heavy overload or short circuit conditions, the output current is limited to I_{LIM} and the output voltage would drop quickly. When the output voltage drop is exceeded the capability of MOSFET, the power switch will be turned OFF. The device is operating in auto-retry mode and the cycle time is around 128ms.

Adjustable Current Monitoring Output (IMON)

A 100pF capacitor and a resistor R_{IMON} connected in parallel between the IMON pin and GND will generate an average current monitor output voltage V_{IMON}, which is proportional to the load current flowing through the device,

$$V_{IMON} = 10^{-3} \times G_{IMON} \times R_{IMON} \times I_{OUT}$$

Where:

- G_{IMON} is the ratio of the IMON to the load current in µA/A and $G_{IMON} = 10$

- The unit of V_{IMON} is volt, R_{IMON} is kΩ and I_{OUT} is ampere

The resistor R_{IMON} should be chosen to ensure that the voltage at the IMON pin is less than 4.5V under the maximum load current I_{ILIM}. For example, if R_{IMON} is selected as 100kΩ, there will be a 1V output on IMON pin at 1A load, and V_{IMON} = 3V at 3A load. Connecting this IMON pin to an ADC could help to monitor the current information of a system.

DPS1133
Document number: DS39393 Rev.11 - 2

11 of 16
www.diodes.com

December 2019
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Application Information (continued)

Fault Response

An external pull-up resistor is required. The device generates a warning flag whenever one of the following fault conditions becomes valid: input overvoltage, reverse-voltage, overtemperature, short-circuit, overcurrent, and ILIM pin short to ground. After a de-glitch time-out of 7ms, the low-active FAULTB signal is asserted. The FAULTB signal remains at 'low' and the internal power MOSFET remains OFF until the device exits from the exception status.

Support of Fast Role Swap (FRS)

The DPS1133 is designed to support the Fast Role Swap (FRS) operation. This allows the system to change its role from being a power consumer to being a power provider within the time limit defined in the USB Power Delivery Specification Release 3.0 V1.0a. Irrespective of the voltage level at the EN pin, the relevant FRS control circuit inside the device is enabled at the rising edge of any positive pulse appearing at the FRS pin. When the pulse width (t_{FRS_ON}) is found to be larger than 600µs, the internal power MOSFET is turned ON within 60µs from the falling edge of the pulse in the absence of the reverse-voltage condition. At the end of the 60µs, the voltage level at the OUT port is of 90% of the voltage level at the IN port. Thereafter, while a subsequent rising edge at the EN pin must always be ignored, the occurrence of a falling edge disables the device. After the device shuts down, it will not resume proper operation until a rising edge appears at either the EN pin or the FRS pin.
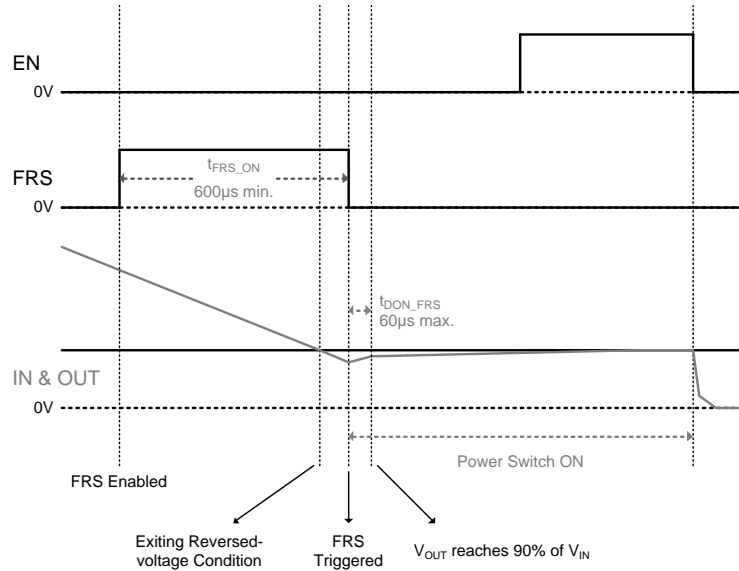

Figure 1. FRS Control Sequence for Fast Role Swap, Power Switch ON at Falling Edge of FRS Signal after Exiting RVP Condition
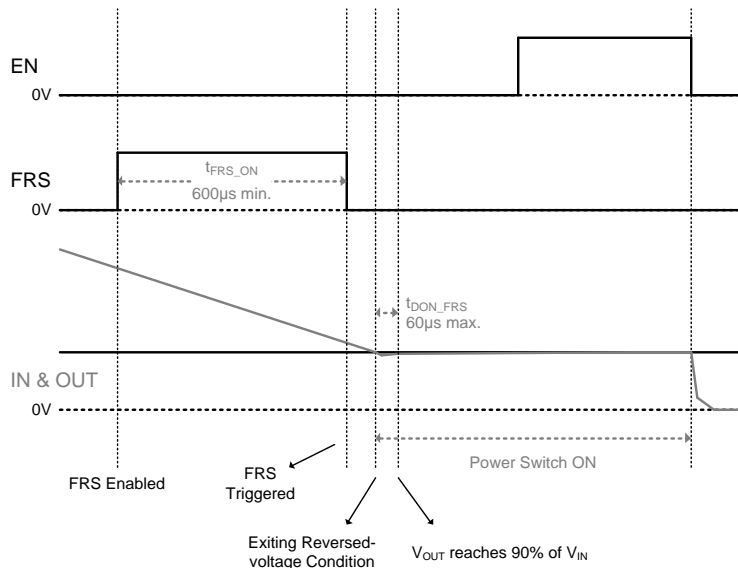

Figure 2. FRS Control Sequence for Fast Role Swap, Power Switch ON when Exiting RVP Condition after FRS is Triggered (Falling Edge)

DPS1133
Document number: DS39393 Rev.11 - 2
12 of 16
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December 2019
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Application Information (continued)

Discharge Function

To facilitate the various applications envisioned by the system designers, the input or output port can be discharged via two external controls: DISC1, DISC2. The internal discharge resistor at each port is approximately 100Ω. The discharge paths are OFF by default with an internal 1MΩ pull-down resistor between DISC1 (or DISC2) and GND. The settings are shown in the table below.

DISC1	DISC2	Description
0	0	Discharge function disabled
0	1	OUT port is being discharged until the pin DISC2 is pulled 'low'
1	0	IN port is being discharged until the pin DISC1 is pulled 'low'
1	1	Both IN and OUT ports are discharged simultaneously

Schottky Diode for Protection of Current Surge

When a cable is hot plugged in/out of the USB-C connector behind which the OUT port of the DPS1133 is connected, a large ground current could be seen at the OUT port of the DPS1133. When the far end of a connected cable is short to ground for whatever reason, the OUT port of the DPS1133 could also see a large ground current. With the Schottky diode, SBR3U40P1, populated as close as possible to the USB-C connector, no ground current can go through the DPS1133 to cause false operation.

PCB Layout Consideration

1. Place the input/output capacitors C_{IN} and C_{OUT} as close as possible to the IN and OUT pins.
2. The power traces, including the power ground, the V_{IN} trace and the V_{OUT} trace should be kept direct, short and wide.
3. Place the resistors and capacitors (R_{VLIM}, R_{ILIM}, R_{IMON}, C_{IMON}, $C_{DV/DT}$ and C_{VREG}) near the device pins.
4. Connect the signal ground to the GND pin, and keep a single connection from GND pin to the power ground behind the input or output capacitors.
5. For better power dissipation, via holes are recommended to connect the exposed pad's landing area to a large copper polygon on the other side of the printed circuit board. The copper polygons and exposed pad of SRC (common source nodes of internal power MOSFET) must not be connected to any of the signal and power grounds on the printed circuit board.
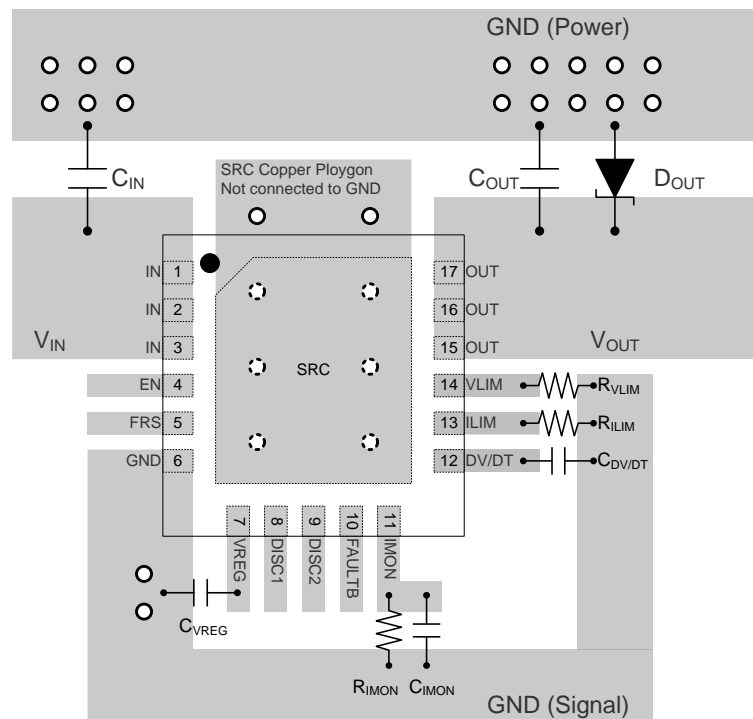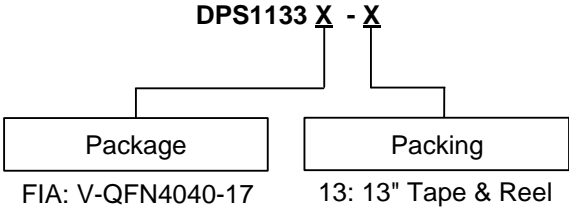

Figure 3. Suggested PCB Layout

DPS1133
Document number: DS39393 Rev.11 - 2

13 of 16
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December 2019
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Ordering Information (Note 6)

DPS1133 X - X

Package	Packing
FIA: V-QFN4040-17	13: 13" Tape & Reel

Part Number	Marking ID	Reel Size (inches)	Tape Width (mm)	13" Tape and Reel	
				Quantity	Part Number Suffix
DPS1133FIA-13	DPS1133	13	12	4000/Tape & Reel	-13

Note:　6. For packaging details, see https://www.diodes.com/design/support/packaging/diodes-packaging/.

Marking Information

Pin 1 →
Logo →
Marking ID →
Date Code →

```
● DII
DPS1133
YY WW
```

YY: Year
WW: Week 01~52; 52
represents 52 and 53 week

DPS1133
Document number: DS39393 Rev.11 - 2

14 of 16
www.diodes.com

December 2019
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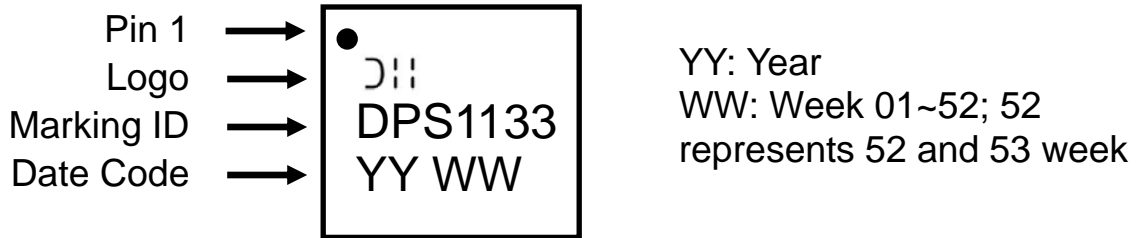
Package Outline Dimensions

Please see http://www.diodes.com/package-outlines.html for the latest version.
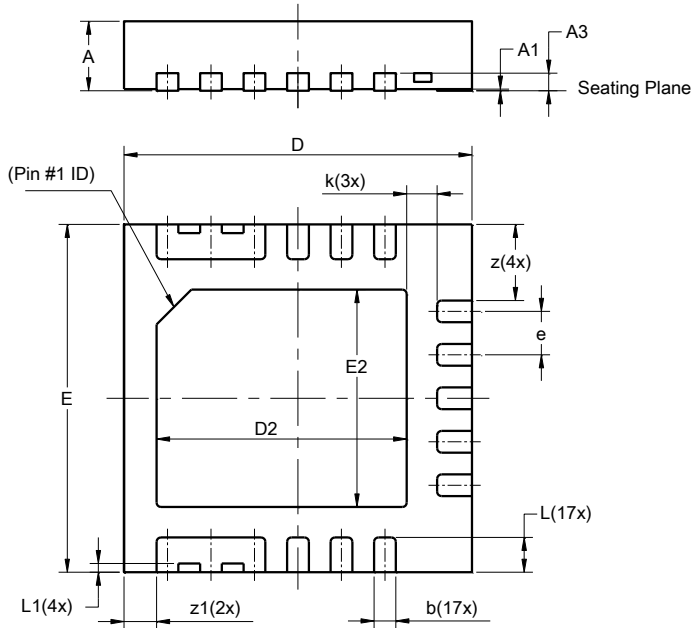
V-QFN4040-17

V-QFN4040-17			
Dim	**Min**	**Max**	**Typ**
A	0.75	0.85	0.80
A1	0.00	0.05	0.02
A3	—	—	0.203
b	0.20	0.30	0.25
D	3.95	4.05	4.00
D2	2.775	2.975	2.875
E	3.95	4.05	4.00
E2	2.40	2.60	2.50
e	0.50 BSC		
k	—	—	0.35
L	0.35	0.45	0.40
L1	—	—	0.10
z	—	—	0.875
z1	—	—	0.375
All Dimensions in mm			

Suggested Pad Layout

Please see http://www.diodes.com/package-outlines.html for the latest version.

V-QFN4040-17
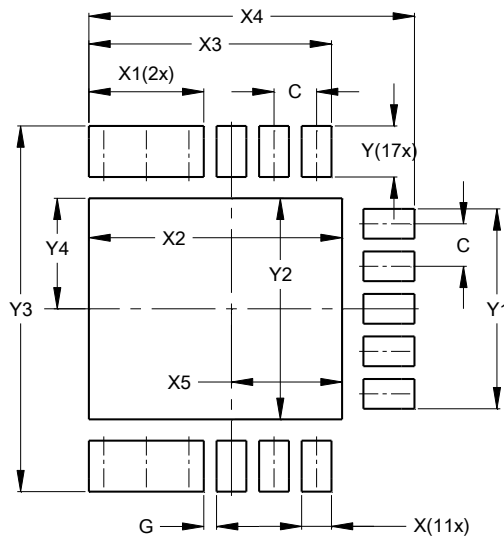
Dimensions	Value (in mm)
C	0.500
G	0.150
X	0.350
X1	1.350
X2	2.975
X3	2.850
X4	3.825
X5	1.300
Y	0.600
Y1	2.350
Y2	2.600
Y3	4.300
Y4	1.300

DPS1133
Document number: DS39393 Rev.11 - 2

15 of 16
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December 2019
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DPS1133
Document number: DS39393 Rev.11 - 2

16 of 16
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