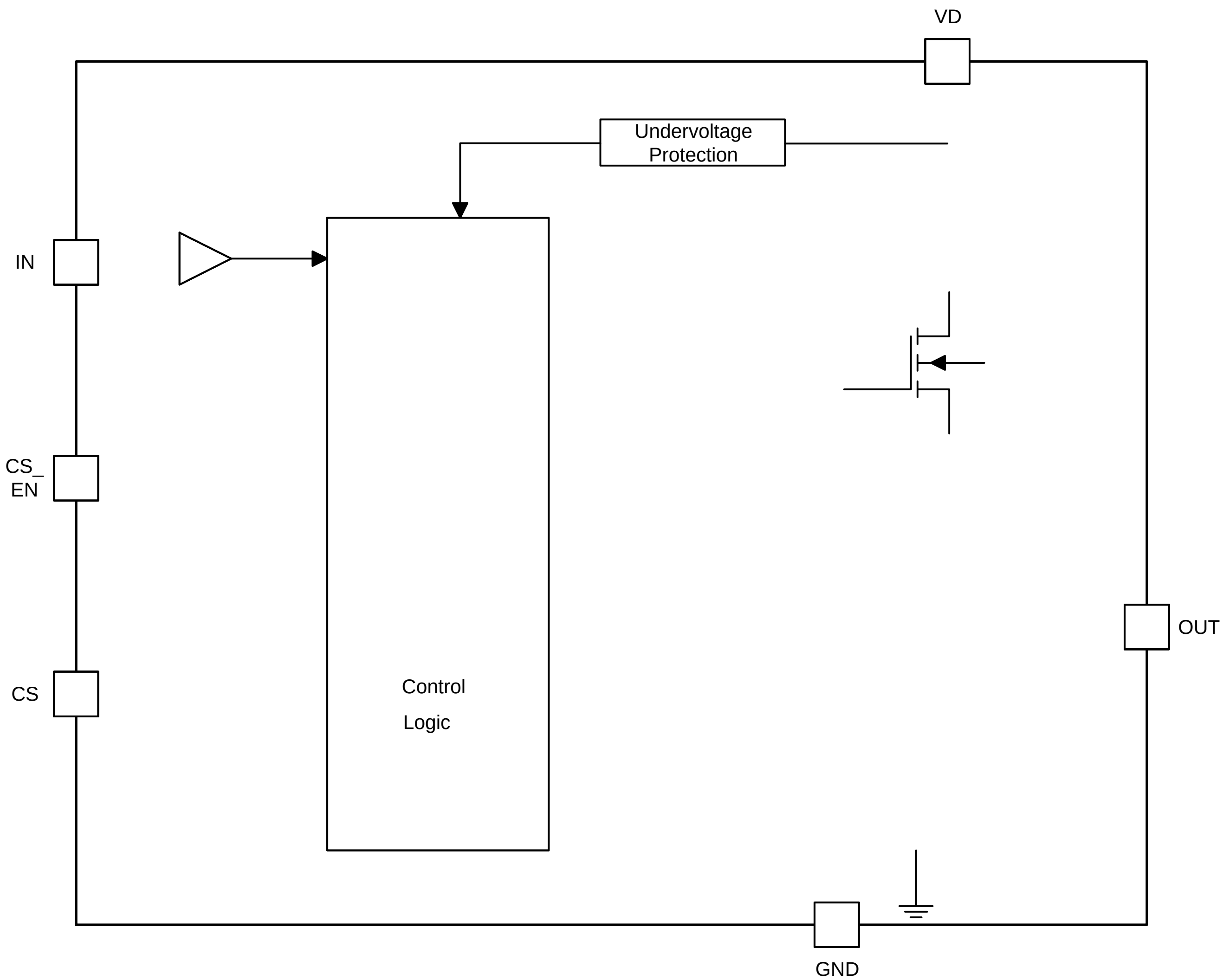
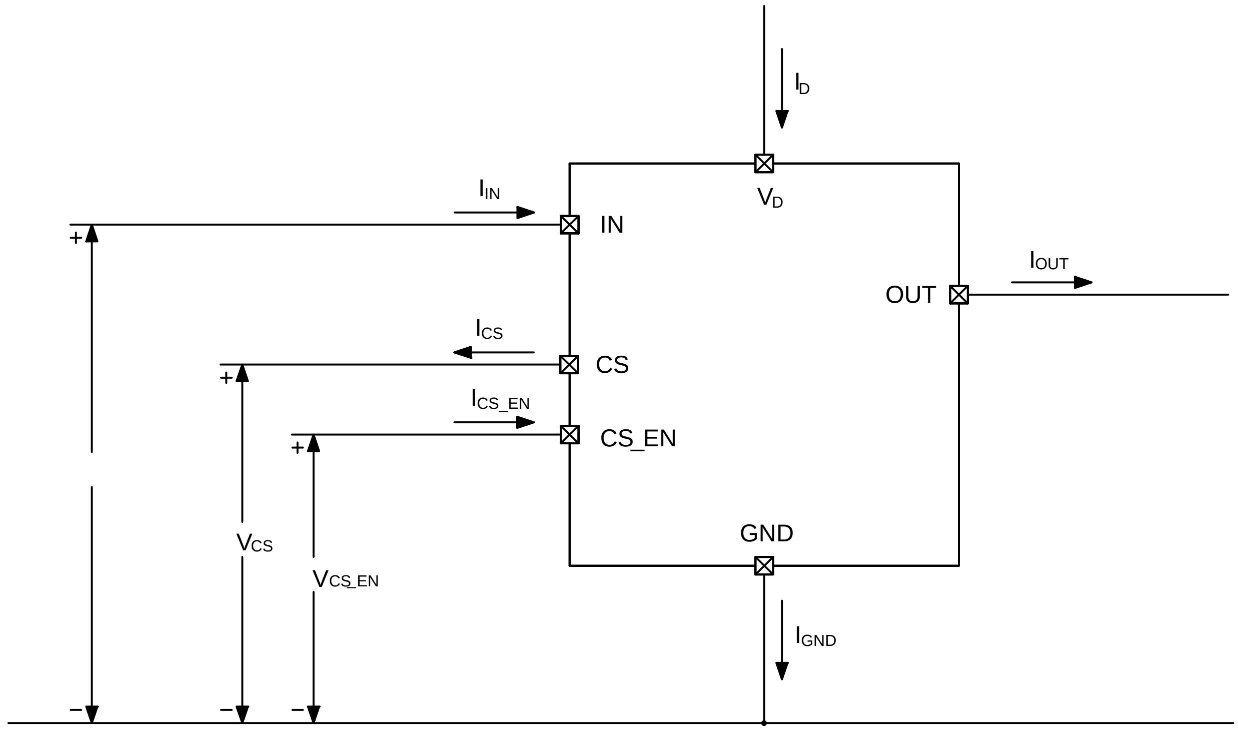

VD
Undervoltage Protection
IN
CS_ EN
CS
Control Logic
OUT
GND



ID
VD
IIN
IN
IOUT
OUT
ICS
CS
ICS_EN
CS_EN
GND
VCS
VCS_EN
IGND
+
+
+
−
−
−

(7 V ≤ V_D ≤ 28 V; −40°C ≤ T_J ≤ 150°C unless otherwise specified)

Operating Supply Voltage	V_D		4	–	28	V
Undervoltage Shutdown	V_{UV}		–	3.5	4	V
Undervoltage Shutdown Hysteresis	V_{UV_hyst}		–	0.4	–	V
On Resistance	R_{ON}	I_{OUT} = 1 A, T_J = 25°C	–	140	–	mΩ
		I_{OUT} = 1 A, T_J = 150°C	–	–	295	
		I_{OUT} = 1 A, V_D = 4.5 V, T_J = 25°C	–	–	210	
Supply Current (Note 7)	I_D	OFF−state: V_D = 13 V, V_{IN} = V_{OUT} = 0 V, Tj = 25°C	–	0.2	0.5	μA
		OFF−state: V_D = 13 V, V_{IN} = V_{OUT} = 0 V, Tj = 85°C (Note 8)	–	0.2	0.5	μA
		OFF−state: V_D = 13 V, V_{IN} = V_{OUT} = 0 V, Tj = 125°C	–	–	3	μA
		ON−state: V_D = 13 V, V_{IN} = 5 V, I_{OUT} = 0 A	–	1.9	3.5	mA
On State Ground Current	$I_{GND(ON)}$	V_D = 13 V, V_{CS_EN} = 5 V V_{IN} = 5 V, I_{OUT} = 1 A	–	–	6	mA
Output Leakage Current	I_L					

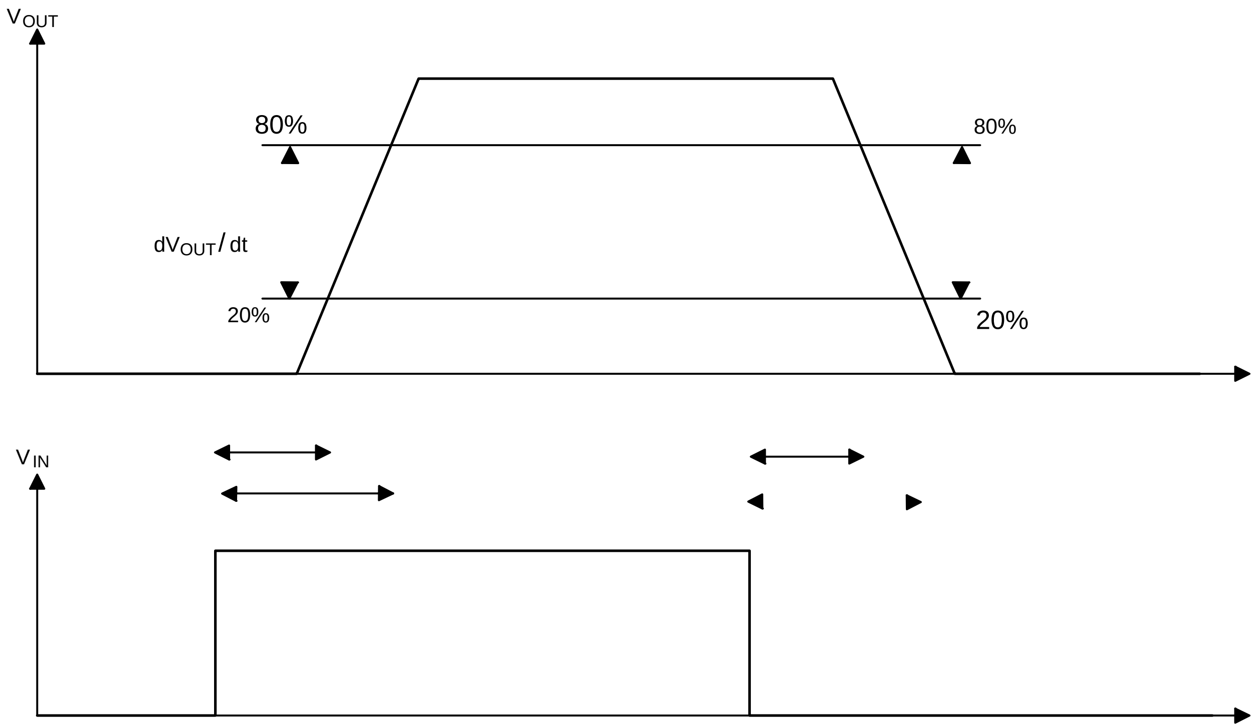
(V_D = 13 V, −40°C ≤ T_J ≤ 150°C)

Turn−On Delay Time	t_{d_on}	V_{IN} high to 20% V_{OUT}, R_L = 13 Ω, T_J = 25°C	5	70	120	μs

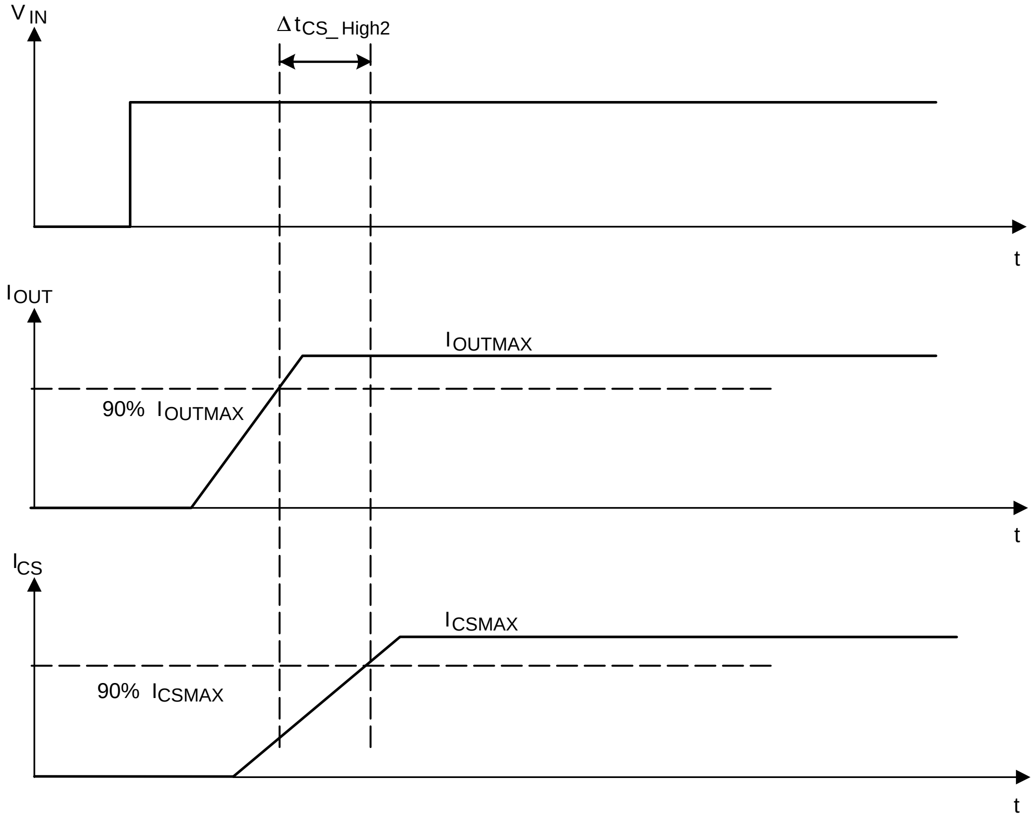
(7 V ≤ V_D

Normal Operation	L H	L H	0 $I_{CS} = I_{OUT}/K_{NOMINAL}$
Overtemperature	L H	L L	0 V_{CS_fault}
Undervoltage	L H	L L	0 0
Overload	H H	H (no active current mgmt) Cycling (active current mgmt)	$I_{CS} = I_{OUT}/K_{NOMINAL}$ V_{CS_fault}
Short circuit to Ground	L H	L L	0 V_{CS_fault}
OFF State Open Load	L	H	V_{CS_fault}

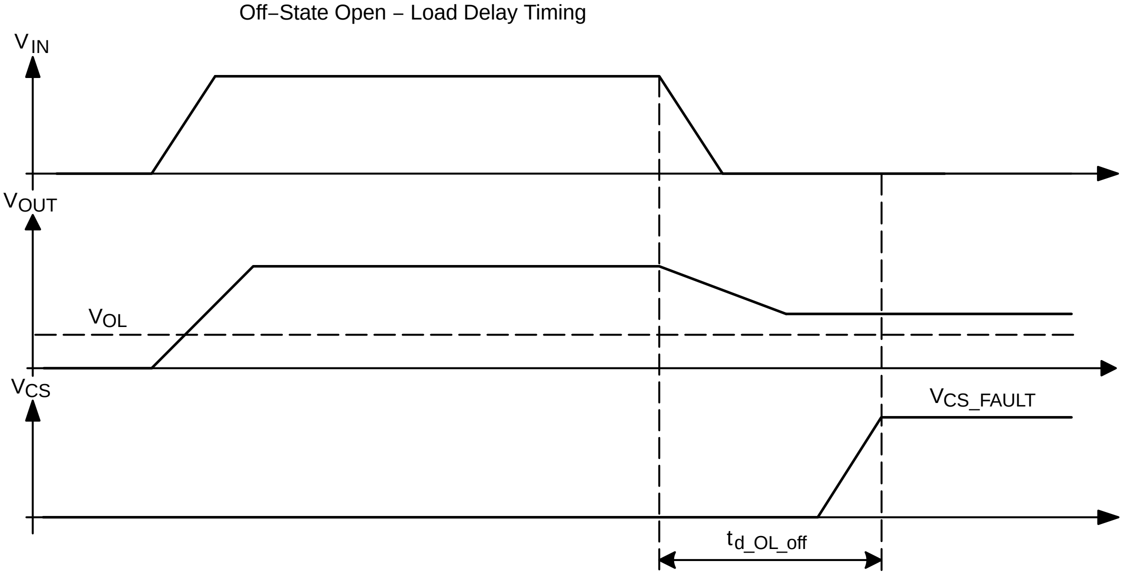
14. If V_{CS_EN} is low, the Current Sense output is at a high impedance, its potential depends on leakage currents and external circuitry.

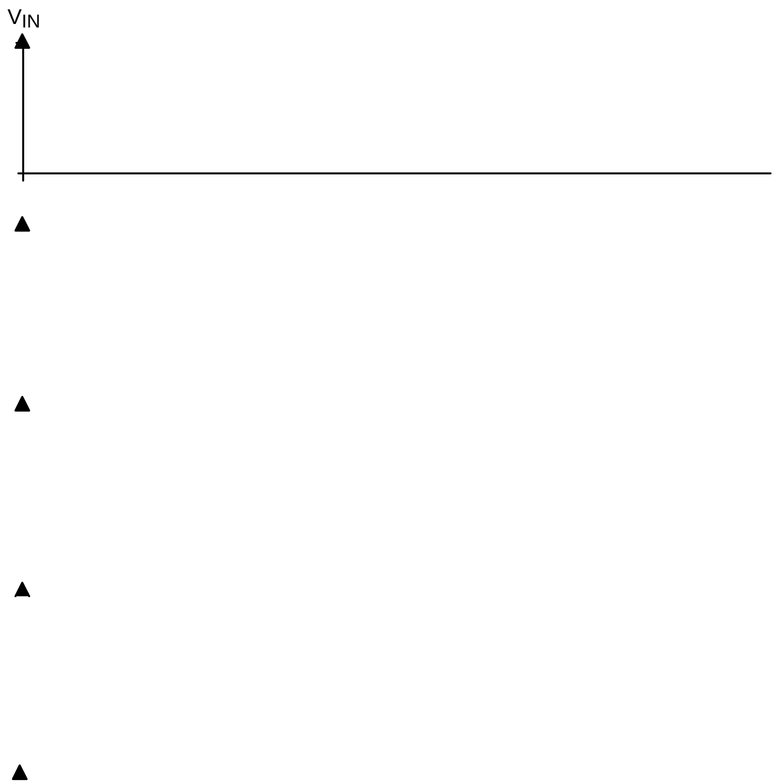


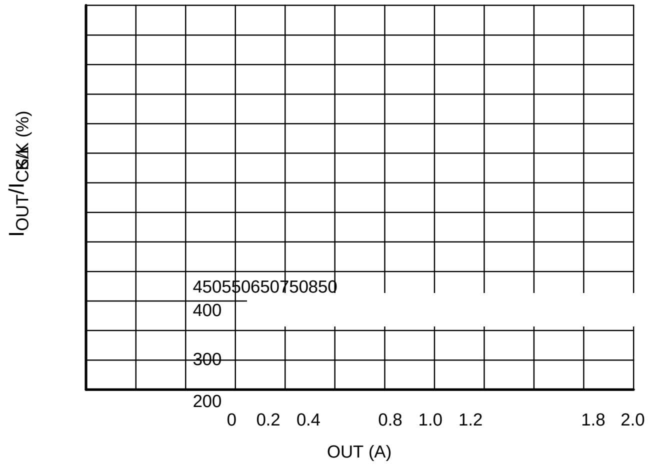
VOUT
80%
80%
dVOUT/dt
20%
20%
VIN



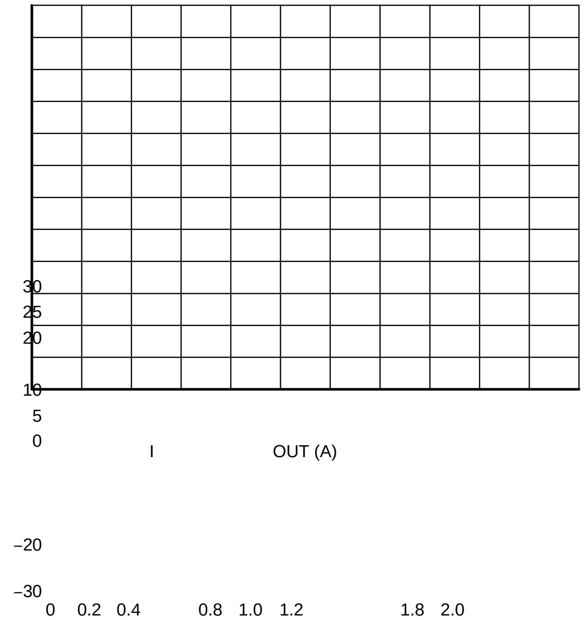
Off−State Open − Load Delay Timing



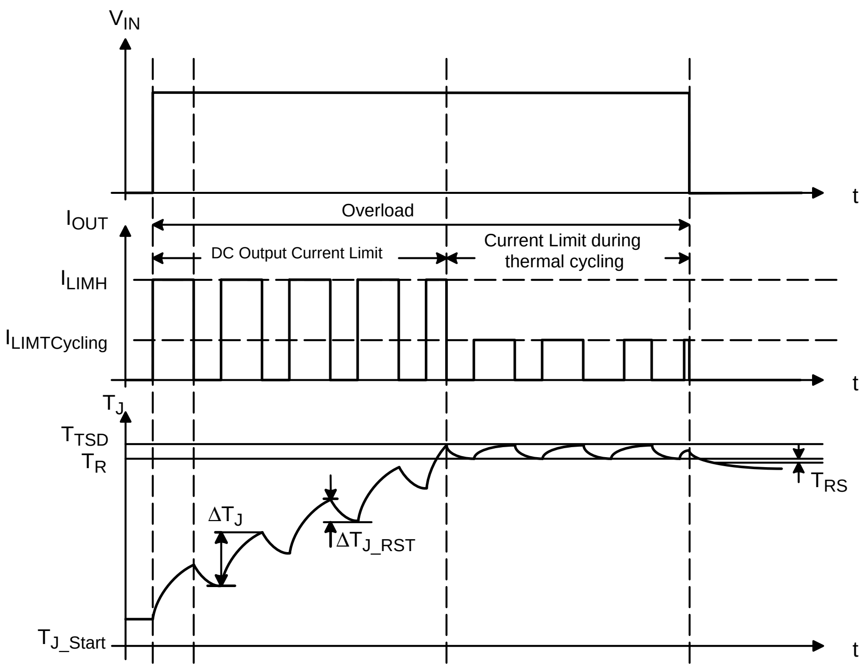

VIN

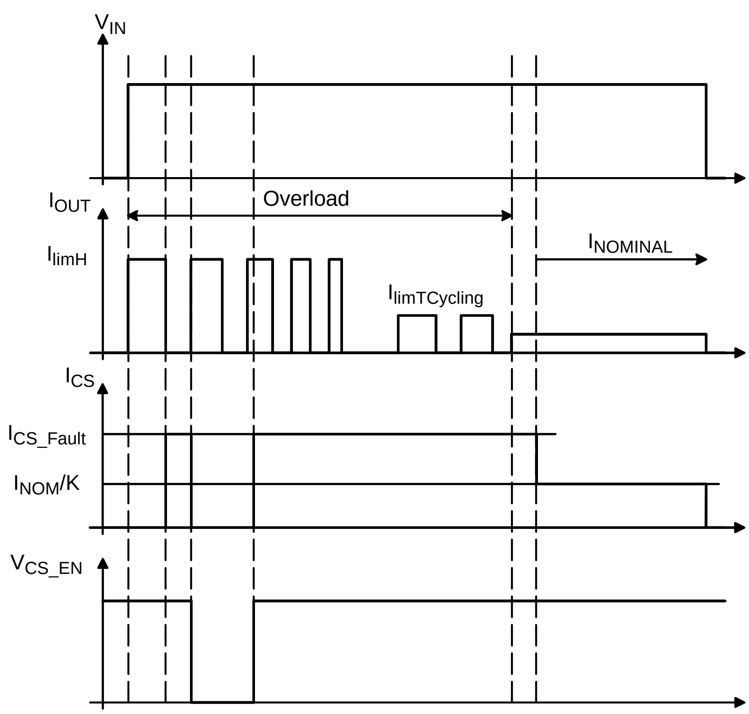


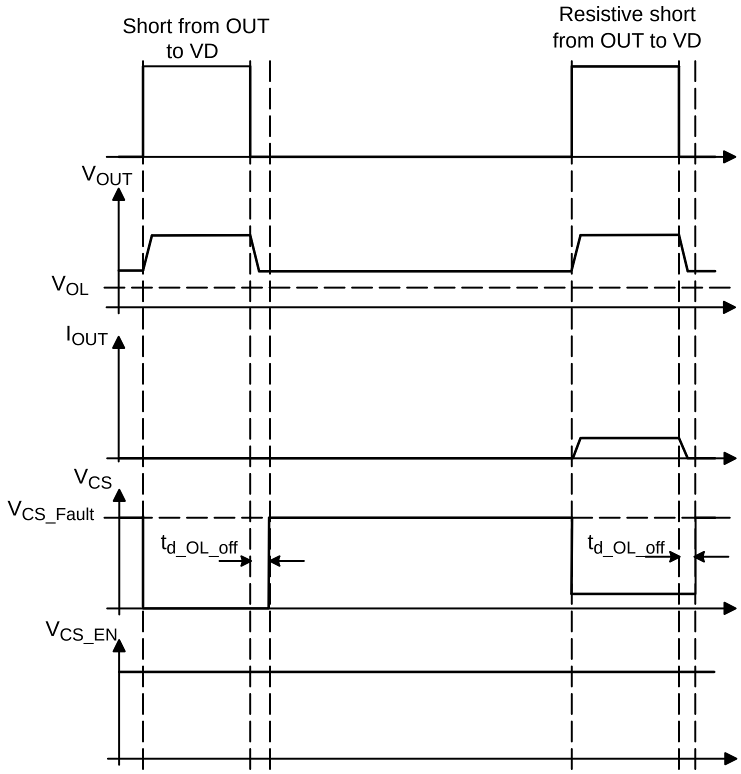
IOUT/ICS/K (%)
450550650750850
400
300
200
0 0.2 0.4 0.8 1.0 1.2 1.8 2.0
OUT (A)



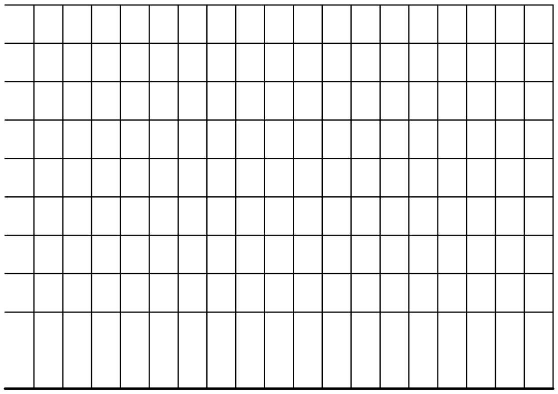
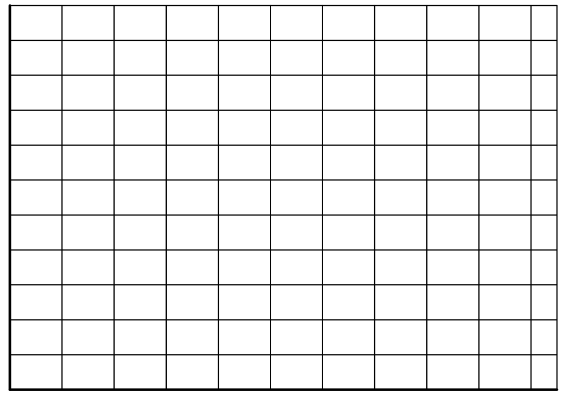
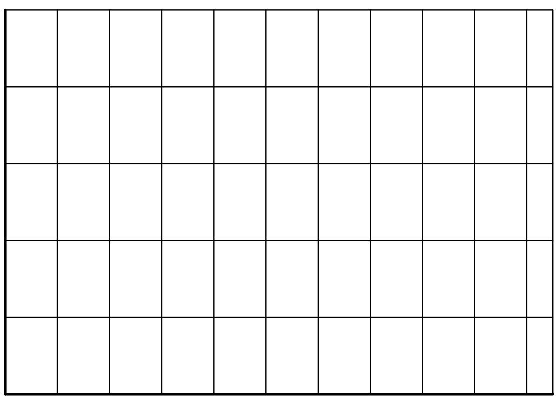
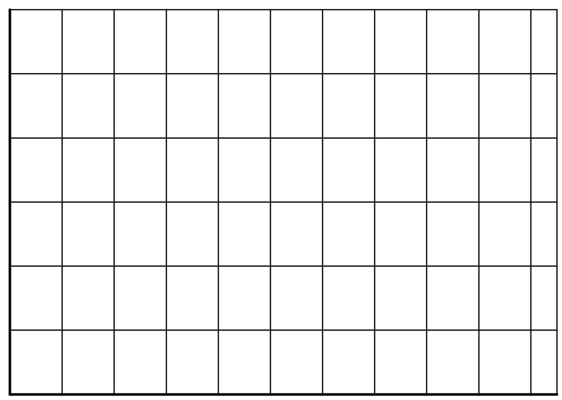
30
25
20
10
5
0
–20
–30
0 0.2 0.4 0.8 1.0 1.2 1.8 2.0
I OUT (A)

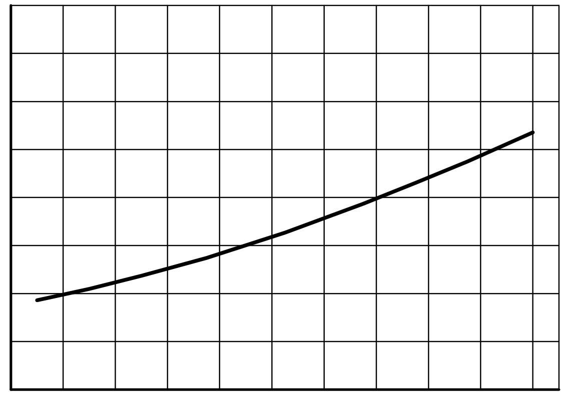

VIN
t
IOUT
Overload
DC Output Current Limit
Current Limit during thermal cycling
ILIMH
ILIMTCycling
t
TJ
TTSD
TR
TRS
ΔTJ
ΔTJ_RST
TJ_Start
t

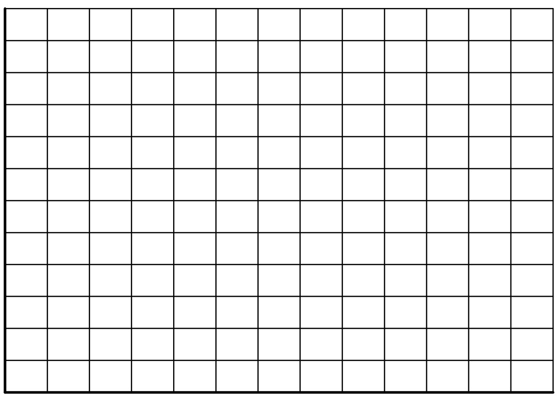

VIN
IOUT
Overload
IlimH
INOMINAL
IlimTCycling
ICS
ICS_Fault
INOM/K
VCS_EN

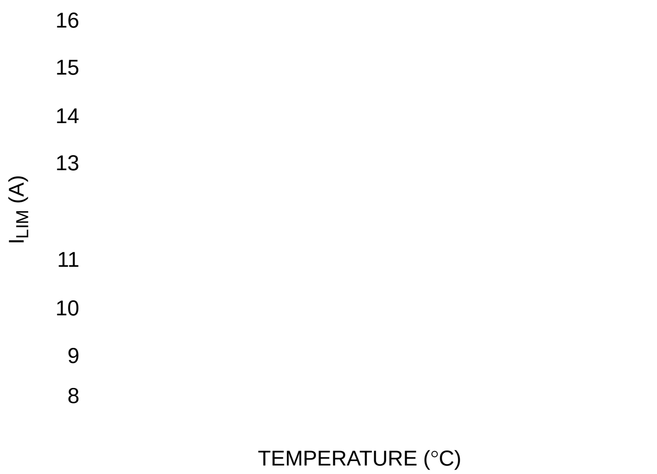


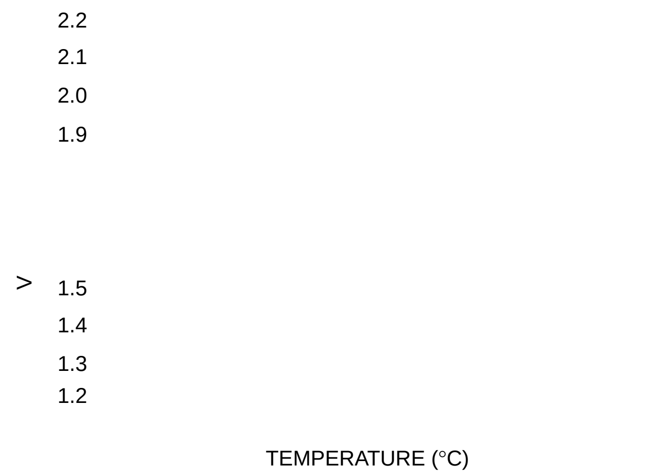
Short from OUT to VD
Resistive short from OUT to VD
VOUT
VOL
IOUT
VCS
VCS_Fault
td_OL_off
td_OL_off
VCS_EN

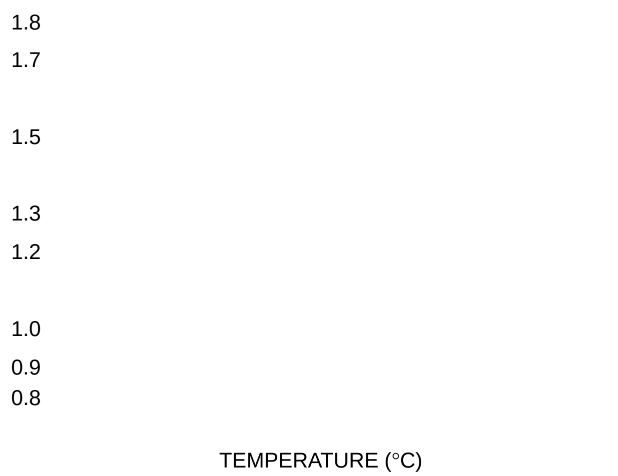





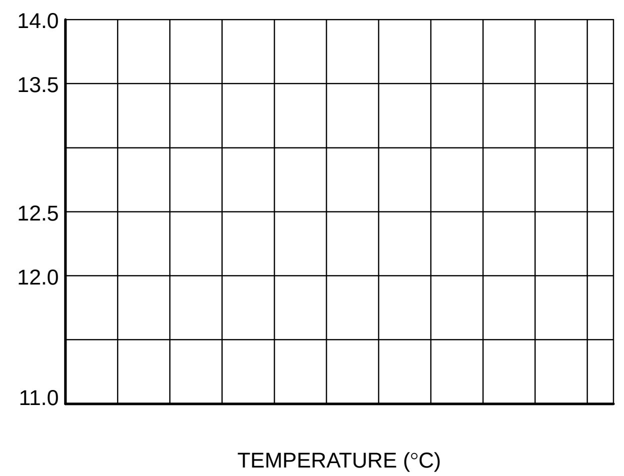





16
15
14
13
ILIM (A)
11
10
9
8
TEMPERATURE (°C)


2.2
2.1
2.0
1.9
V
1.5
1.4
1.3
1.2
TEMPERATURE (°C)

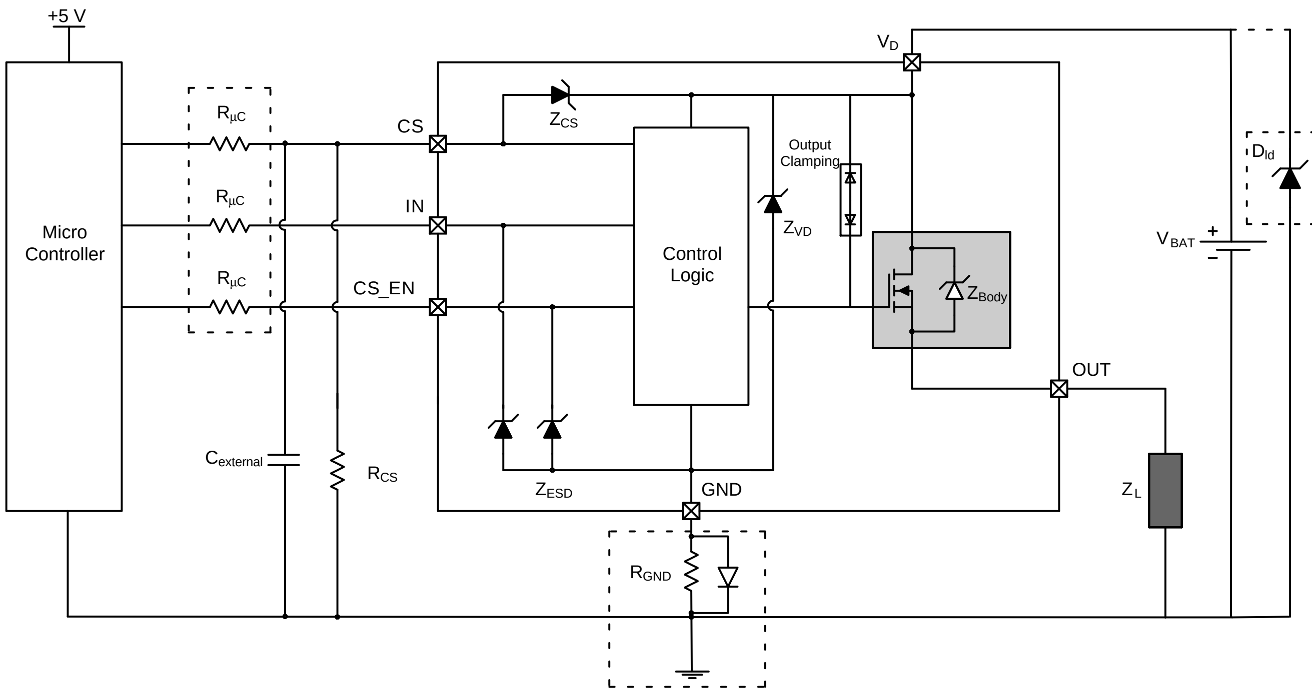

1.8
1.7
1.5
1.3
1.2
1.0
0.9
0.8
TEMPERATURE (°C)


14.0
13.5
12.5
12.0
11.0
TEMPERATURE (°C)

–					
1	–112	–150	2 ms, 10 Ω	500 pulses	0.5 s
2a	55	112	0.05 ms, 2 Ω	500 pulses	0.5 s
3a	–165	–220	0.1 µs, 50 Ω	1 h	100 ms
3b	112	150	0.1 µs, 50 Ω	1 h	100 ms

–					
1		A			
2a	C	E			
3a		A			
3b		A			

A	All functions of a device perform as designed during and after exposure to disturbance.
B	All functions of a device perform as designed during exposure. However, one or more of them can go beyond specified tolerance. All functions return automatically to within normal limits after exposure is removed. Memory functions shall remain class A.
C	One or more functions of a device do not perform as designed during exposure but return automatically to normal operation after exposure is removed.
D	One or more functions of a device do not perform as designed during exposure and do not return to normal operation until exposure is removed and the device is reset by simple “operator/use” action.
E	One or more functions of a device do not perform as designed during and after exposure and cannot be returned to proper operation without replacing the device.



+5 V
Micro Controller
RµC
RµC
RµC
CS
IN
CS_EN
ZCS
Control Logic
Output Clamping
ZVD
ZBody
VD
OUT
Dld
VBAT
+
−
Cexternal
RCS
ZESD
GND
RGND
ZL

When device or ECU ground connection is lost and load is still connected to ground, the device will turn the output OFF. In loss of ground state, the output stage is held OFF independent of the state of the input. Input resistors are recommended between the device and microcontroller.

Solution 1: Resistor in the GND line only (no parallel Diode)

The following calculations are true for any type of load.

In the case for no diode in parallel with R_{GND}, the calculations below explain how to size the resistor.

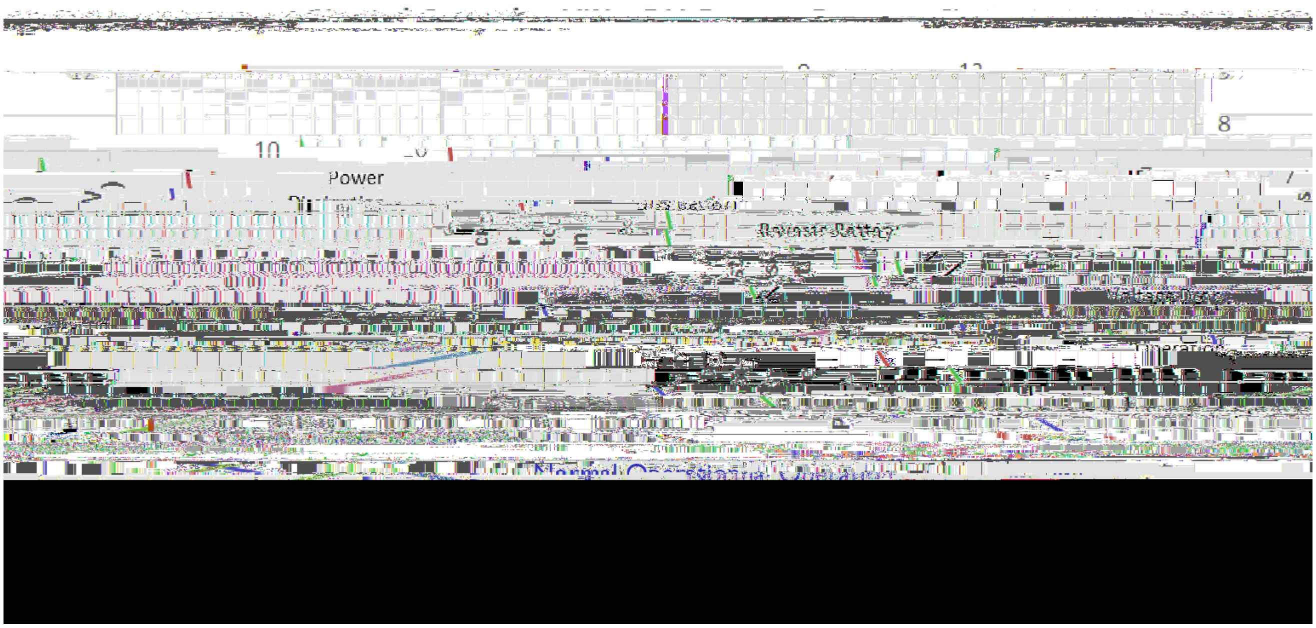
Consider the following parameters:

$-I_{GND}$ Maximum = 200 mA for up to V_D = 32 V.

Where $-I_{GND}$ is the DC reverse current through the GND pin and $-V_D$ is the DC reverse battery voltage.

$$-I_{GND} = \frac{-V_D}{R_{GND}} \qquad \text{(eq. 1)}$$

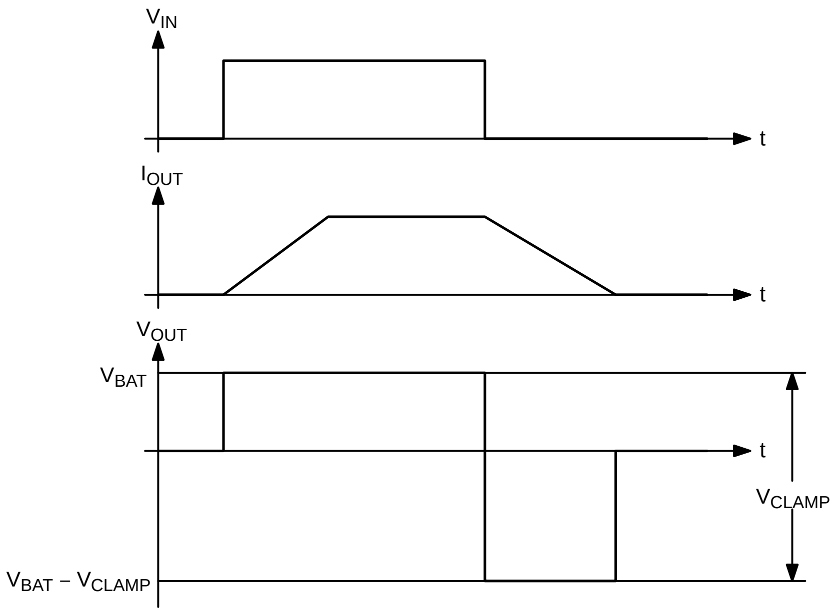
Since this resistor can be used amongst multiple High Side devices, please take note the sum of the maximum active GND currents ($I_{GND(On)max}$) for each device when sizing the resistor. Please note that if the microprocessor GND is not shared by the device GND, then R_{GND} produces a shift of ($I_{GND(On)max} \times R_{GND}$) in the input thresholds and CS output values. If the calculated power dissipation leads to too large of a resistor size or several devices have to share the same resistor, please look at the second solution for Reverse Battery Protection. Refer to Figure 35 for selecting the proper R_{GND}.



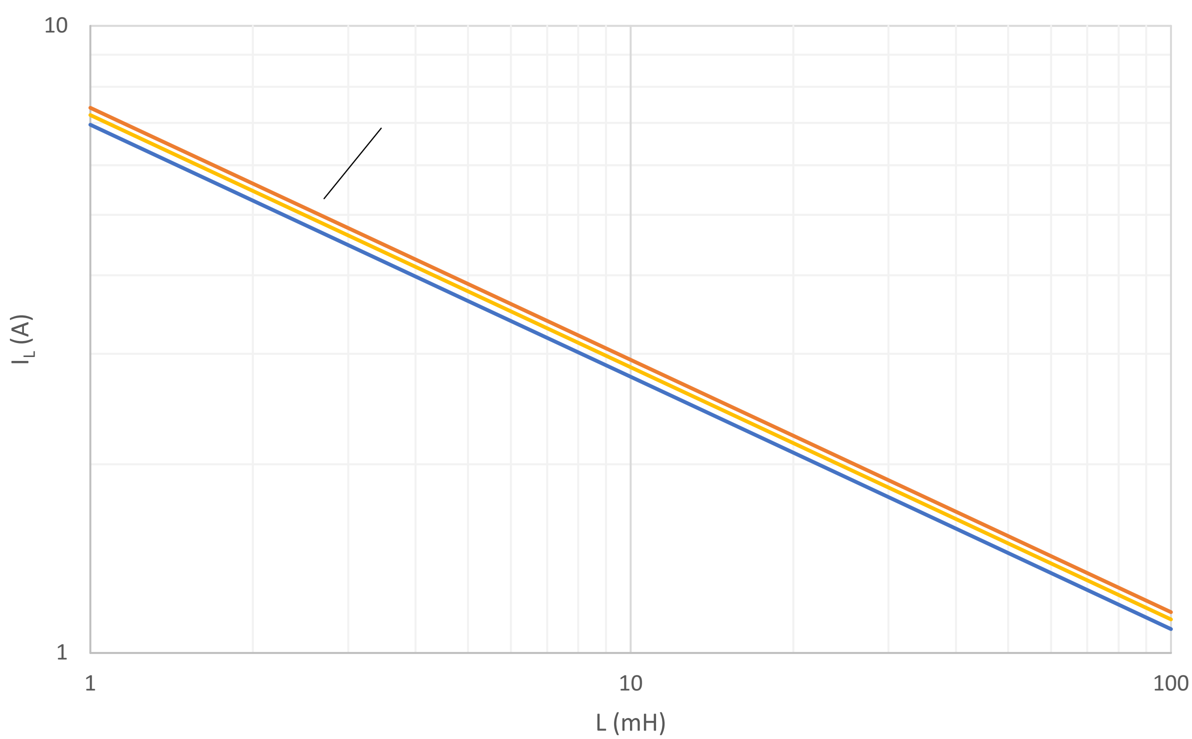
Solution 2: Diode (D_{GND}) in parallel with RGND in the ground line.

A resistor value of R_{GND} = 1 kOhm should be selected and placed in parallel to D_{GND} if the device drives an inductive load. The diode (D_{GND}) provides a ~600 700 mV shift in the input threshold and current sense values if the micro controller ground is not common to the device ground. This shift will not vary even in the case of multiple high side devices using the same resistor/diode network.

The output voltage V_{OUT} drops below GND potential when switching off inductive loads. This is because the inductance develops a negative voltage across the load in response to a decaying current. The integrated clamp of the device clamps the negative output voltage to a certain level relative to the supply voltage V_{BAT}. During output clamping with inductive load switch off, the energy stored in the inductance is rapidly dissipated in the device resulting in high power dissipation. This is a stressful condition for the device and the maximum energy allowed for a given load inductance should not be exceeded in any application.

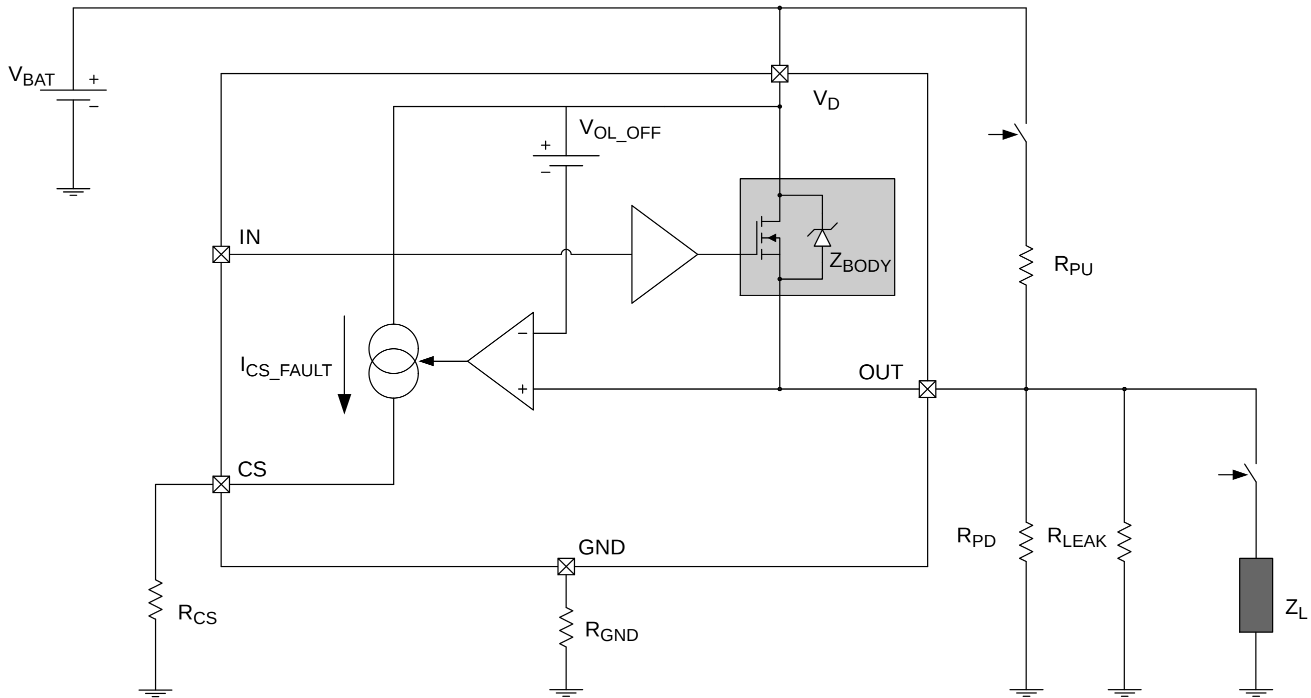


1 100 ((1)1 0 1 11



Ω

Open load diagnosis in OFF state can be performed by activating an external resistive pull up path (R_{PU}) to V_{BAT}. To calculate the pull up resistance, external leakage currents (designed pull down resistance, humidity induced leakage etc) as well as the open load threshold voltage V_{OL} have to be taken into account.



When operating in PWM mode, the current sense functionality can be used, but the timcm 8e timcm timcm.964 w.90

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ISSUE AK

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