onse

BLOCK DIAGRAM & PIN CONFIGURATION

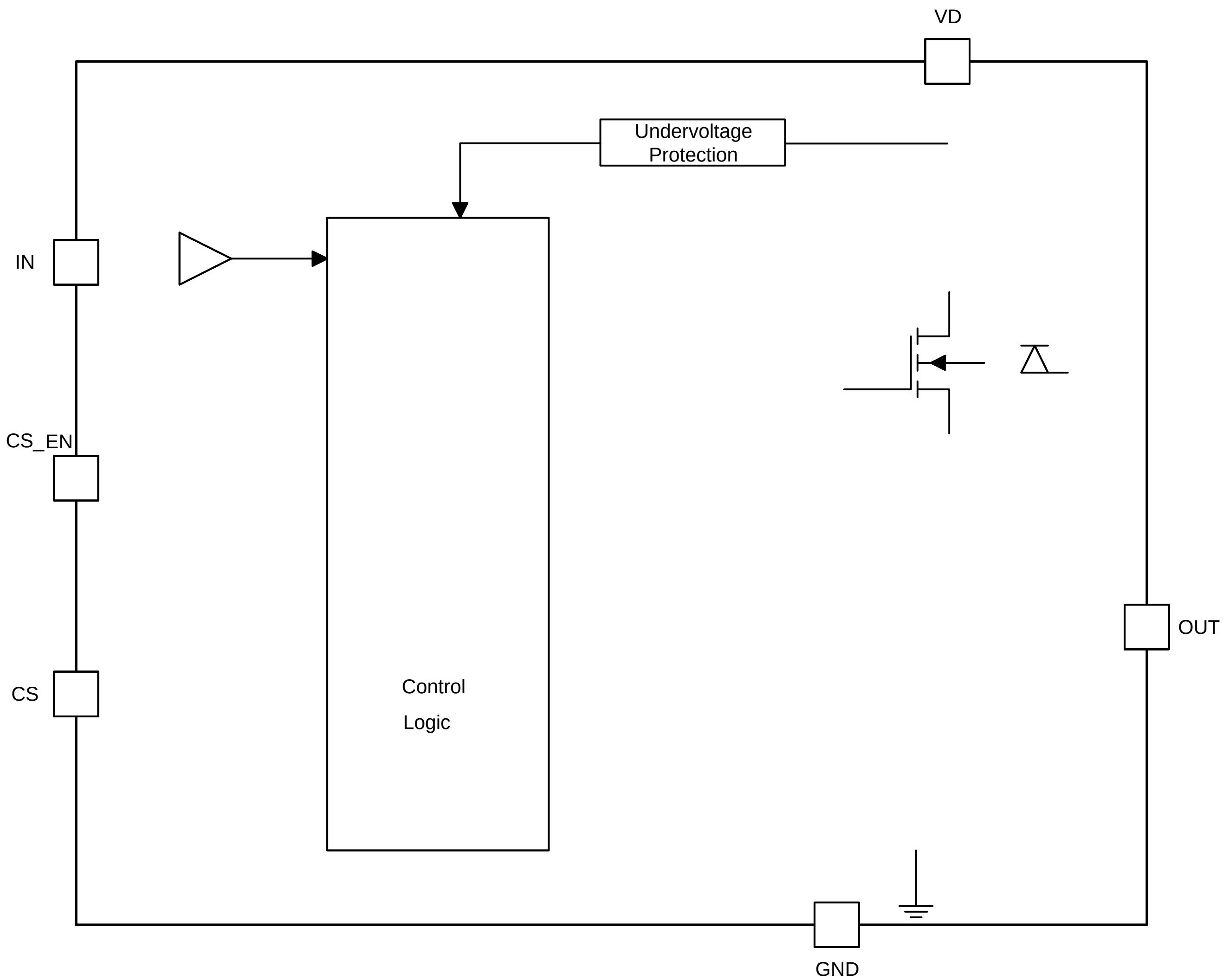


Figure 1. Block Diagram

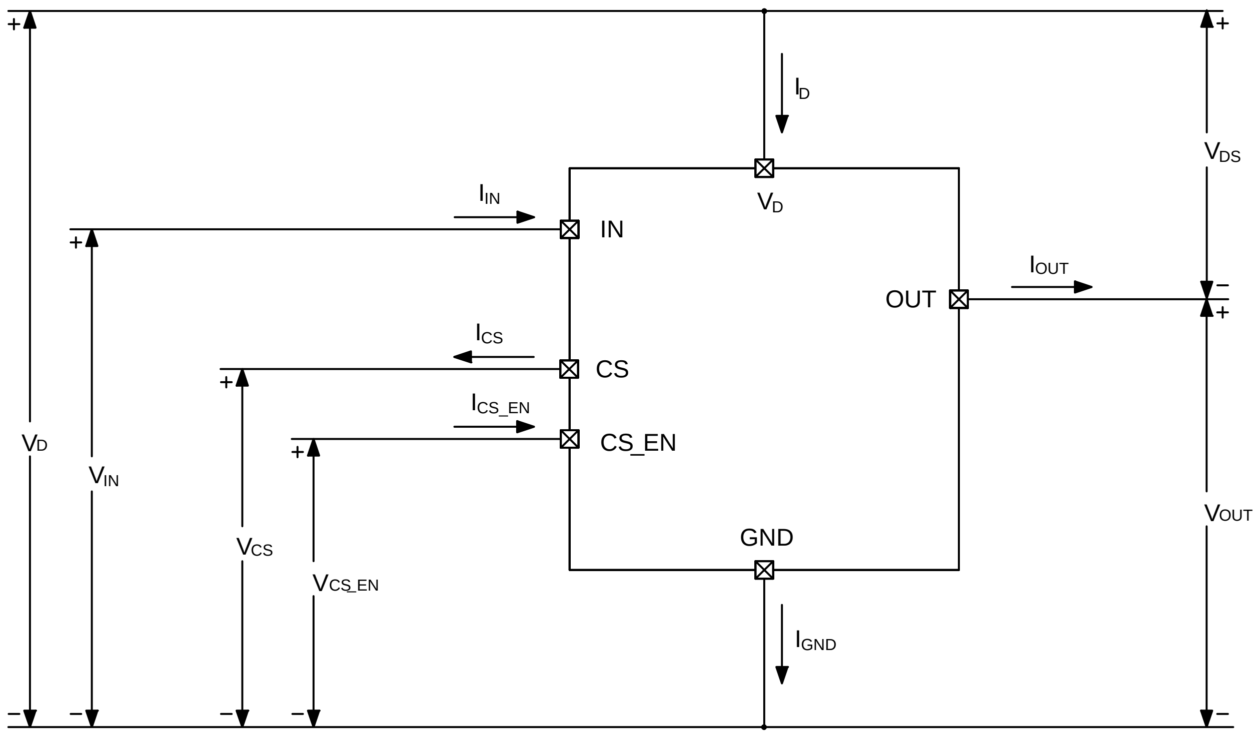
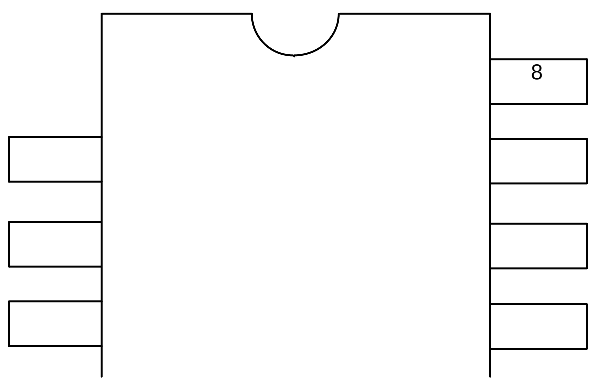


Figure 2. Voltage and Current Conventions

Table 2. Connection suggestions for unused and or unconnected pins

Connection	Input	Output	Current Sense	Current Sense Enable
Floating	X	X	Not Allowed	X
To Ground	Through 10 kΩ resistor	Not Allowed	Through 1 kΩ Resistor	Through 10 kΩ resistor



ELECTRICAL SPECIFICATIONS

Table 3. MAXIMUM RATINGS

Rating	Symbol	Value		Unit
DC Supply Voltage	V_D	−0.3	41	V
Max Transient Supply Voltage (Note 1) Load Dump − SuppressesUC [illegible]				

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

Table 5. POWER

Rating	Symbol	Conditions	Value			Unit
			Min	Typ	Max	
Operating Supply Voltage	V_D		4	−	28	V
[redacted]	V_{UV}		−	3.5	4	V
Undervoltage Shutdown Hysteresis	V					

Table 7. SWITCHING CHARACTERISTICS (Note 9) (V_D = 13 V, −40°C ≤ T_J ≤ 150°C)

Rating	Symbol	Conditions	Value			Unit
			Min	Typ	Max	
Turn−On Delay Time	t_{d_on}	V_{IN} high to 20% V_{OUT}, R_L = 6.5 Ω, T_J = 25°C	5	70	120	μs
Turn−Off Delay Time	t_{d_off}	V_{IN} low to 80% V_{OUT}, R_L = 6.5 Ω, T_J = 25°C	5	40	100	μs
Slew Rate On	dV_{out}/dt_{on}	20% to 80% V_{OUT}, R_L = 6.5 Ω, T_J = 25°C	0.1	0.27	0.7	V / μs
Slew Rate Off	dV_{out}/dt_{off}	80% to 20% V_{OUT}, R_L = 6.5 Ω, T_J = 25°C	0.1	0.35		

[redacted] $V \le V_D \le 18$ V, −40°C $\le T_J \le$ 150°C)

[redacted]	Conditions	Value			Unit
		Min	Typ	Max	
[redacted]	[redacted] 0.010 A, V_{CS} = 0.5 V, V_{CS_EN} = 5 V	350	–	930	
[redacted]	[redacted] 0.025 A, V_{CS} = 0.5 V, V_{CS_EN} = 5 V	350	600	880	
[redacted]	[redacted] 0.025 A, V_{CS} = 0.5 V, V_{CS_EN} = 5 V	−25	–	15	%
[redacted]	[redacted] = 0.07 A, V_{CS} = 4 V, V_{CS_EN} = 5 V	350	570	800	
[redacted]	[redacted] = 0.07 A, V_{CS} = 4V, V_{CS_EN} = 5 V	−20	–	10	%
[redacted]	[redacted] = 0.15 A, V_{CS} = 4V, V_{CS_EN} = 5 V	350	570	755	
[redacted]	[redacted] = 0.15 A, V_{CS} = 4V, V_{CS_EN} = 5 V	−15	–	10	%
[redacted]	[redacted] = 0.7 A, V_{CS} = 4 V, V_{CS_EN} = 5 V	450	570	650	
[redacted]	[redacted] = 0.7 A, V_{CS} = 4V, V_{CS_EN} = 5 V	−10	–	10	%
[redacted]	[redacted] = 2 A, V_{CS} = 4 V, V_{CS_EN} = 5 V	515	570	600	
[redacted]	[redacted] = 2 A, V_{CS} = 4V, V_{CS_EN} = 5 V	−5	–	5	%
[redacted]	I_{OUT} = 0 A, V_{CS} = 0 V V_{CS_EN} = 5 V, V_{IN} = 0 V	–	–	1	µA
[redacted]	I_{OUT} = 0 A, V_{CS} = 0 V V_{CS_EN} = 5 V, V_{IN} = 5 V	–	–	2	
[redacted]	I_{OUT} = 2 A, V_{CS} = 0 V V_{CS_EN} = 0 V, V_{IN} = 5 V,	–	–	0.5	
[redacted]	[redacted] = 7 V, V_{IN} = 5 V, R_{CS} = 10 kΩ, I_{OUT} = 2 A, V_{CS_EN} = 5 V	5	–	7	V
[redacted]	[redacted] = 13 V, V_{IN} = 0 V, R_{CS} = 1 k, V_{OUT} = 4 V, V_{CS_EN} = 5 V	–	10	–	V
[redacted]	[redacted] = 13 V, V_{CS}= 5 V, V_{IN} = 0 V, V_{OUT} = 4 V, V_{CS_EN} = 5 V	7	20	30	mA
[redacted]	V_D = 7 V, V_{CS}= 4 V, V_{IN} = 5 V, T_J = 150°C, V_{CS_EN} = 5 V			=	

Table 12. TRUTH TABLE

Conditions	Input	Output	CS (V_{CS_EN} = 5 V) (Note 14)
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.

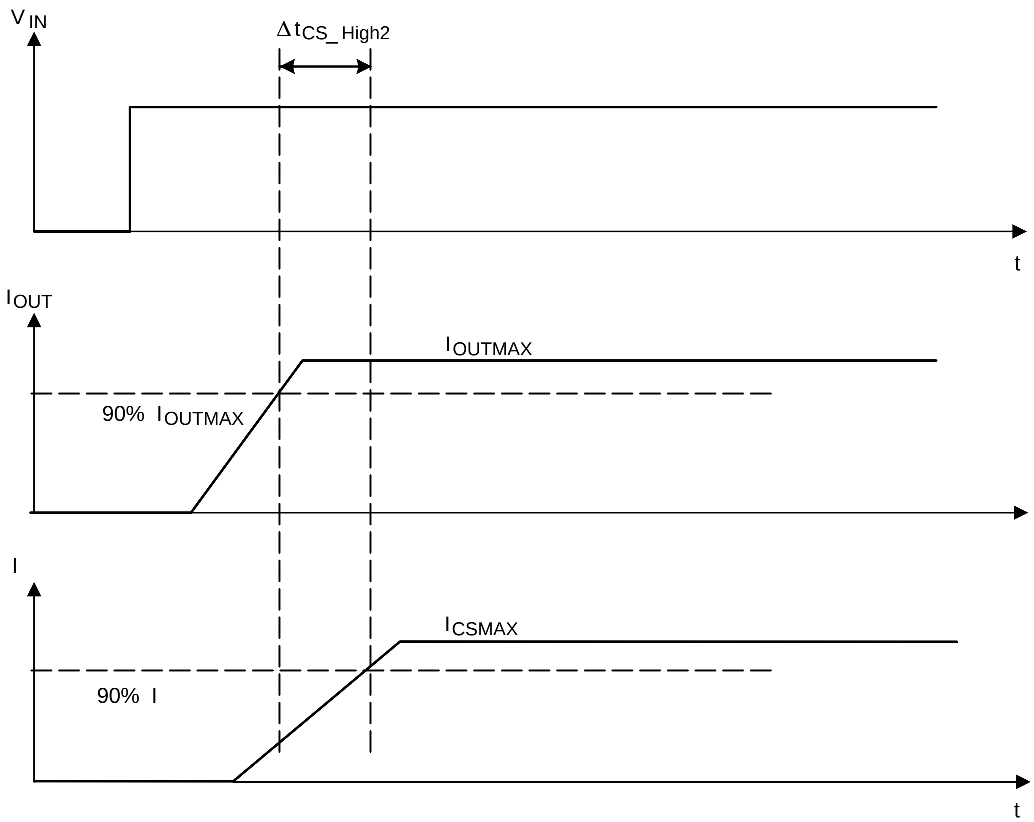


Figure 6. Delay Response from Rising Edge of I_{OUT} and Rising Edge of CS (for CS_EN = 5 V)

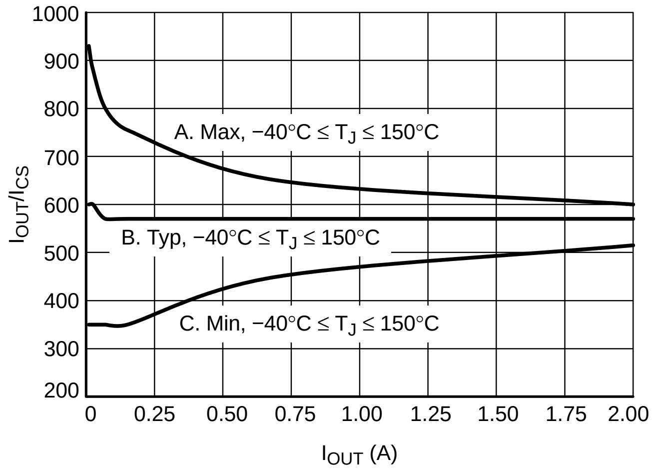


Figure 10. I_{OUT}/I_{CS} vs. I_{OUT}

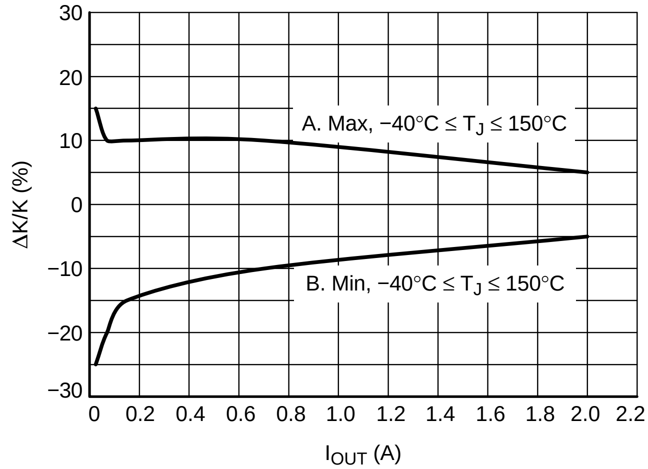


Figure 11. Current Sense Ratio Drift vs. Load Current

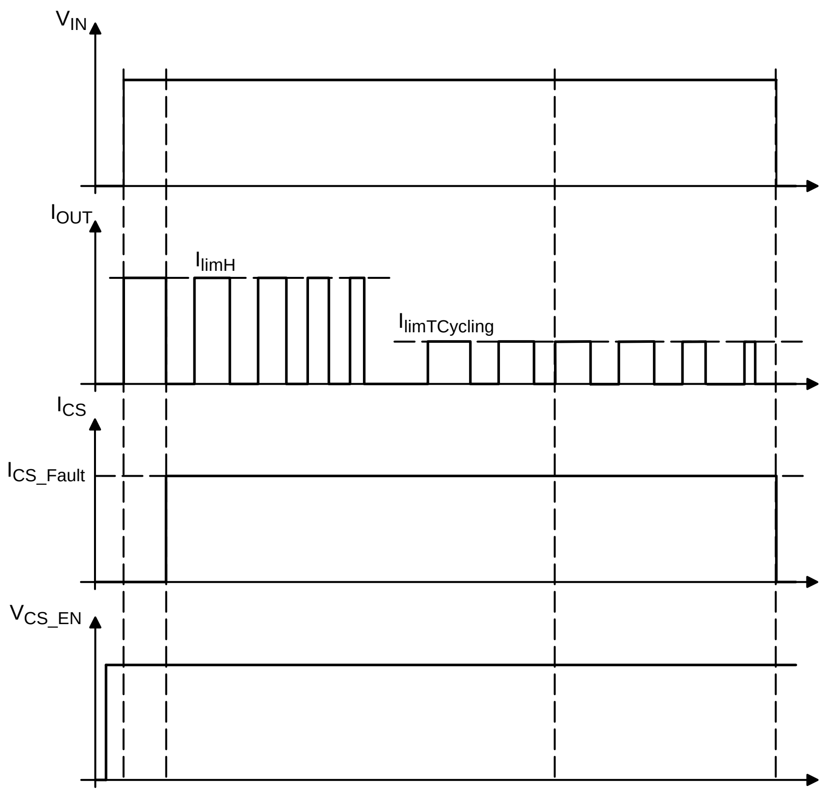


Figure 12. Short to GND or Overload

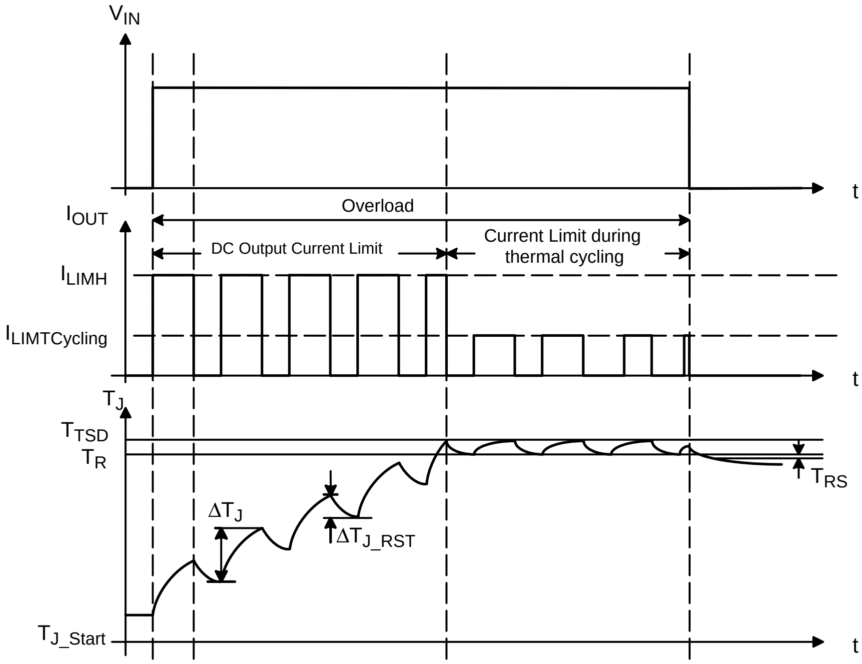


Figure 13. How T_J progresses During Short to GND or Overload

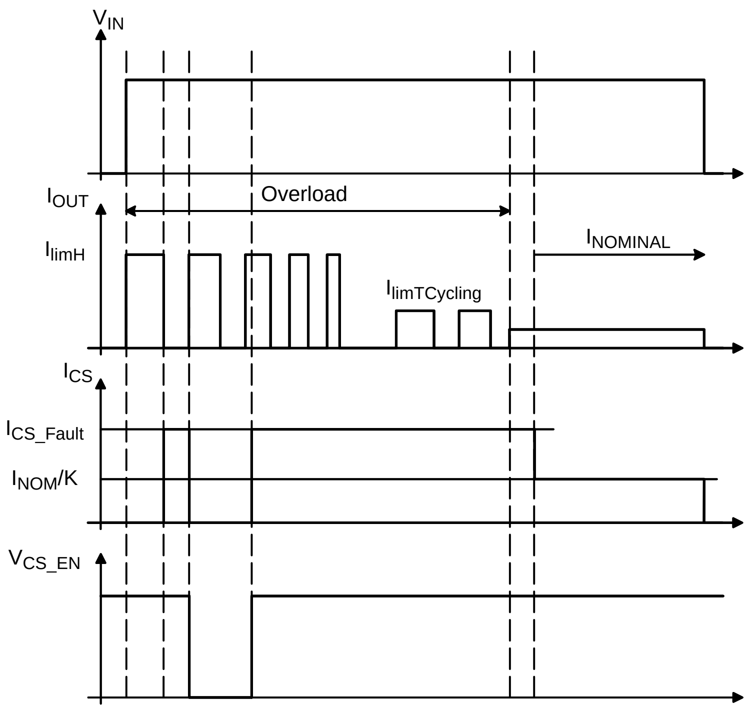


Figure 14. Discontinuous Overload or Short to GND

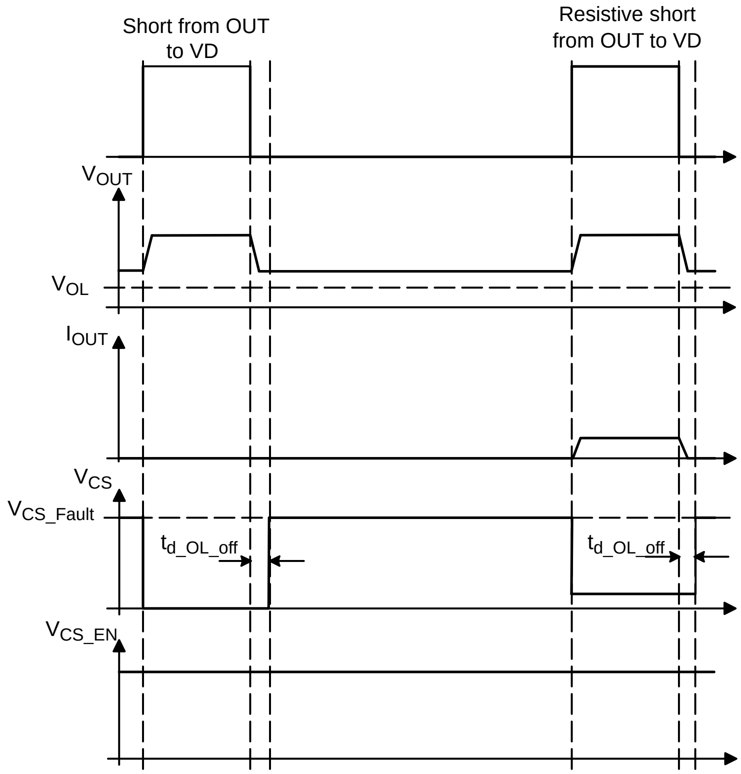


Figure 15. Short Circuit from OUT to V_D

TYPICAL CHARACTERISTICS

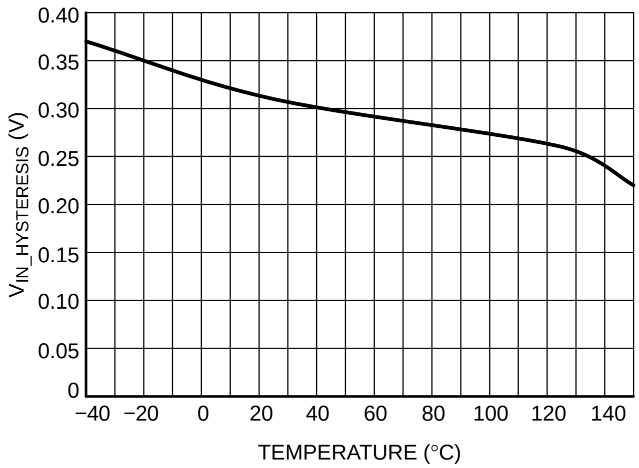


Figure 22. Hysteresis Input Voltage vs. Temperature

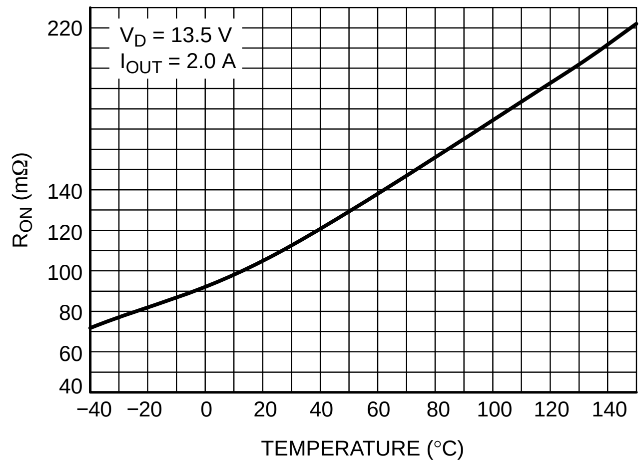


Figure 23. R_{ON} vs. Temperature

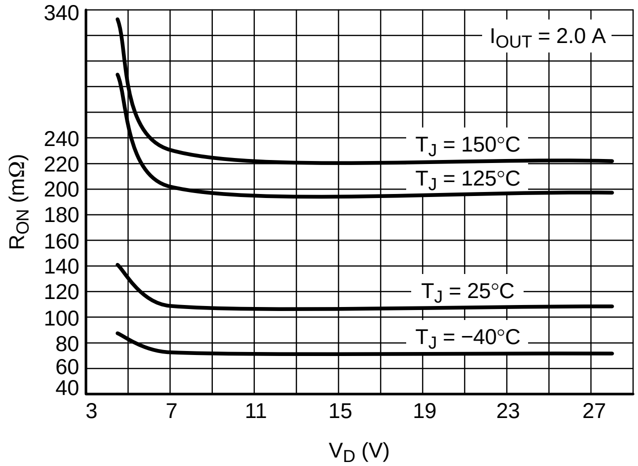


Figure 24. R_{ON} vs. V_D Voltage

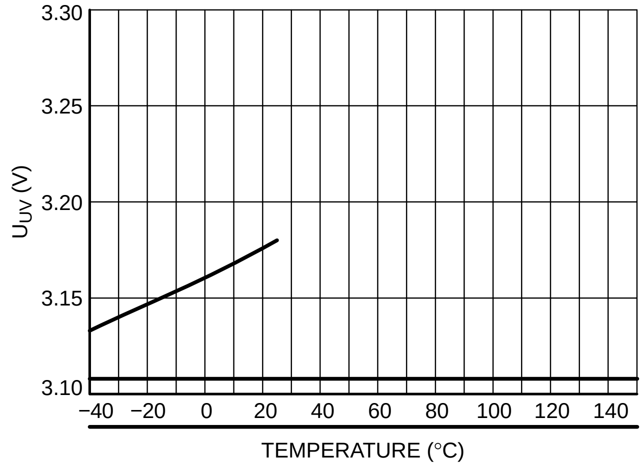


Figure 25. Undervoltage Shutdown vs. Temperature

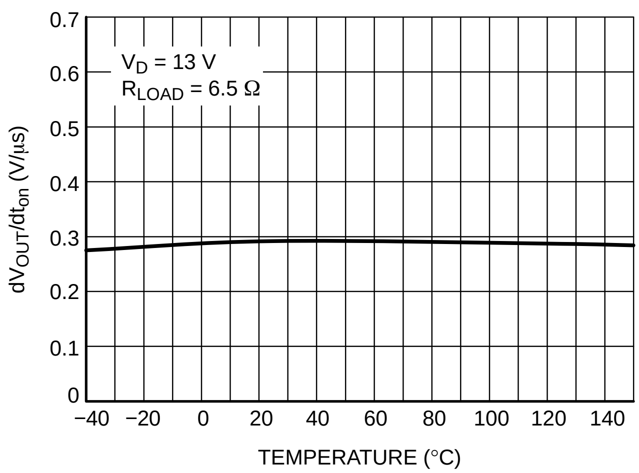


Figure 26. Slew Rate ON vs. Temperature

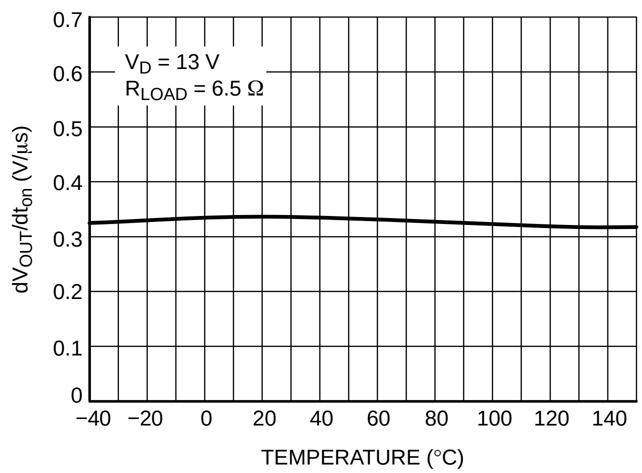


Figure 27. Slew Rate OFF vs. Temperature

TYPICAL CHARACTERISTICS

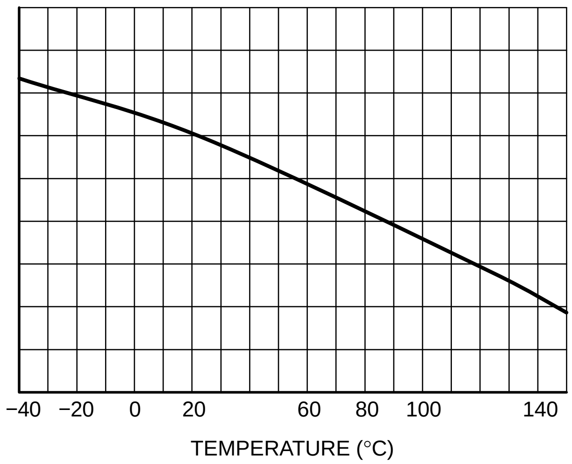


Figure 28. Current Limit vs. Temperature

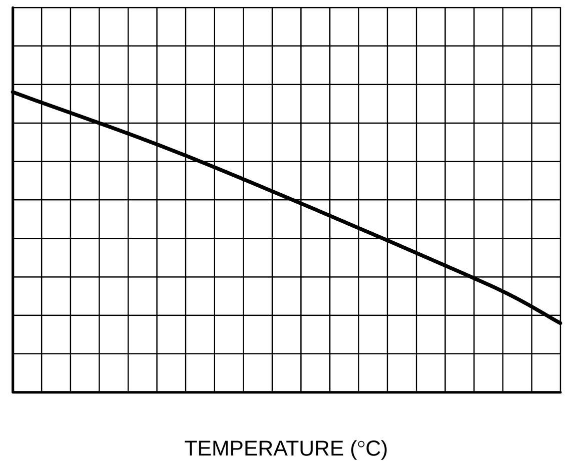
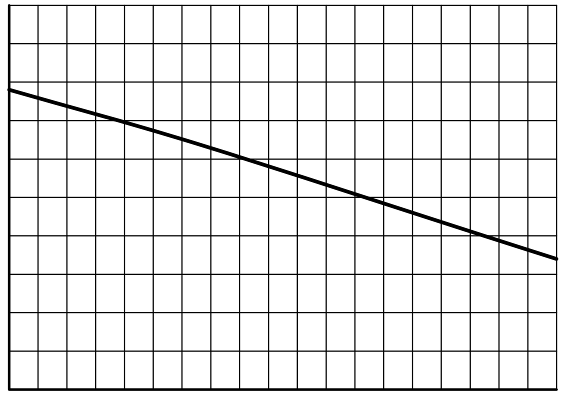
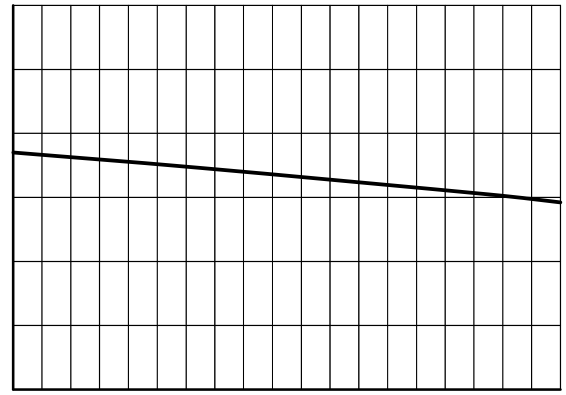


Figure 29. CS_EN Threshold High vs. Temperature





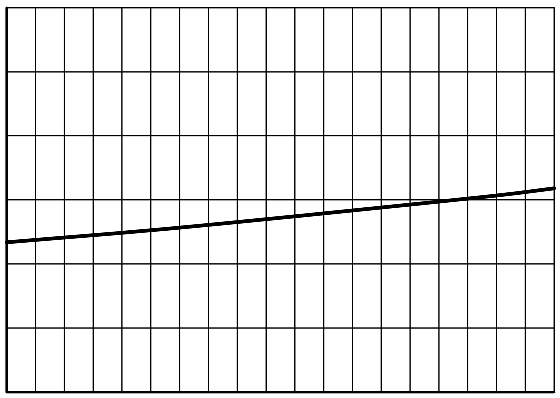


Table 13. ISO 7637−2: 2011(E) PULSE TEST RESULTS

ISO 7637−2:2011(E) Test Pulse

APPLICATION INFORMATION

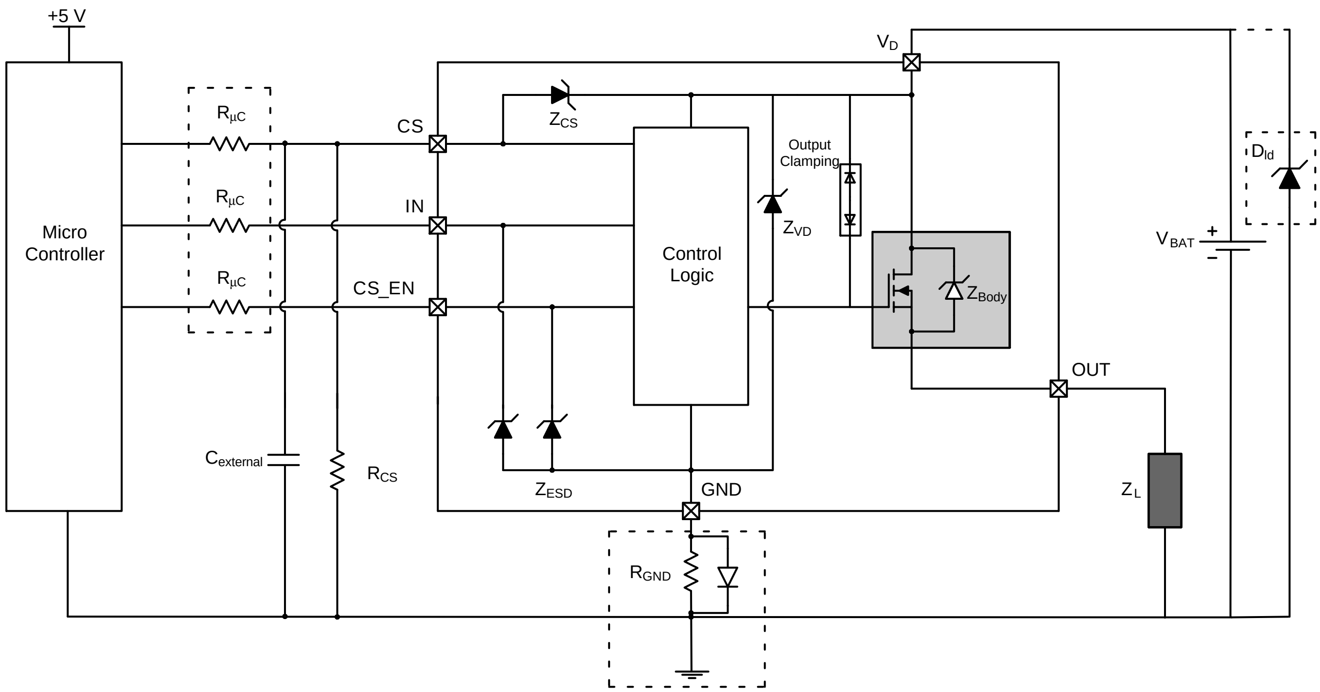


Figure 33. Application Schematic

Loss of Ground Protection

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.

Undervoltage Protection

The device has two under−voltage threshold levels, V_{D_MIN} and V_{UV}. Switching function (ON/OFF) requires supply voltage to be at least V_{D_MIN}. The device features a lower supply threshold V_{UV}, above which the output can remain in ON state. While all protection functions are guaranteed when the switch is ON, diagnostic functions are operational only within nominal supply voltage range V_D.

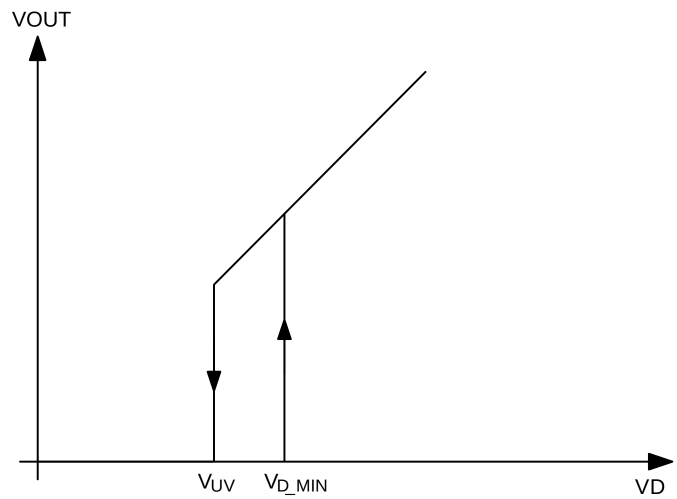


Figure 34. Undervoltage Behavior

Overvoltage Protection

The NCV84120 has two Zener diodes Z_{VD} and Z_{CS}, which provide integrated overvoltage protection. Z_{VD} protects the logic block by clamping the voltage between supply pin V_D and ground pin GND to V_{ZVD}. Z_{CS} limits voltage at current sense pin CS to $V_D – V_{ZCS}$. The output power MOSFET's output clamping diodes provide protection by clamping the voltage across the MOSFET (between V_D pin and OUT pin) to V_{CLAMP}. During overvoltage protection, current flowing through Z_{VD}, Z_{CS} and the output clamp must be limited. Load impedance Z_L limits the current in the body diode Z_{Body}. In order to limit the current in Z_{VD} a resistor, R_{GND} (150 Ω), is required in the GND path. External resistors R_{CS} and R_{SENSE} limit the current flowing through Z_{CS} and out of the CS pin into the micro−controller I/O pin. With RGND, the GND pin voltage is elevated to $V_D – V_{ZVD}$ when the supply voltage V_D rises above V_{ZVD}. ESD diodes Z_{ESD} pull up the voltage at logic pins IN, CS_EN close to the GND pin voltage $V_D – V_{ZVD}$. External resistors R_{IN}, and R_{CS_EN} are required to limit the current flowing out of the logic pins into the micro−controller I/O pins. During overvoltage exposure, the device transitions into a self−protection state, with automatic recovery after the supply voltage comes back to the normal operating range. The specified parameters as well as short circuit robustness and energy capability cannot be guaranteed during overvoltage exposure.

Reverse Battery Protection

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

Overload Protection

Current limitation as well as overtemperature shutdown mechanisms are integrated into NCV84120 to provide protection from overload conditions such as bulb inrush or short to ground.

Current Limitation

In case of overload, NCV84120 limits the current in the output power MOSFET to a safe value. Due to high power dissipation during current limitation, the device's junction temperature increases rapidly. In order to protect the device, the output driver is shut down by one of the two overtemperature protection mechanisms. The output current limit is dependent on the device temperature, and will fold back once the die reaches thermal shutdown. If the input remains active during the shutdown, the output power MOSFET will automatically be re−activated after a minimum OFF time or when the junction temperature returns to a safe level.

Output Clamping with Inductive Load Switch Off

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.

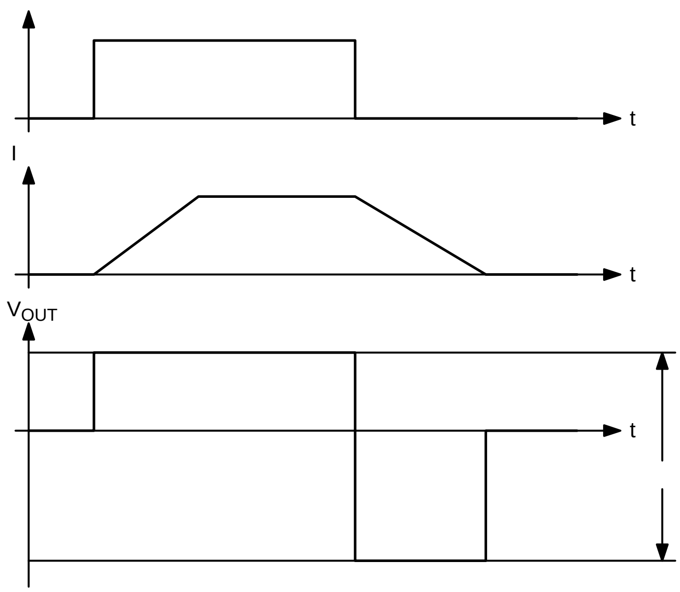


Figure 36. Inductive Load Switching

Inverse Current:

When the output voltage V_{OUT} rises above the supply voltage V_D, the output power MOSFET's integral body diode will be forward biased causing a current flow from the OUT pin to the V_D pin. The device does not provide any protection function such as current limitation or overtemperature shutdown.

Underload Detection in ON State

An underload condition in ON state is indicated by reducing the sense output current to a very minimal current. In order to detect an underload condition, NCV84090 performs a real−time monitoring of the load current. In case the output current falls below a specified threshold level (I_{OL}), the current sense output current is reduced to a very low value (I_{OL}). This mechanism helps to overcome a high absolute tolerance of the current sense signal at very low load current and to implement an accurate underload detection threshold.

Open Load Detection in OFF State

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.

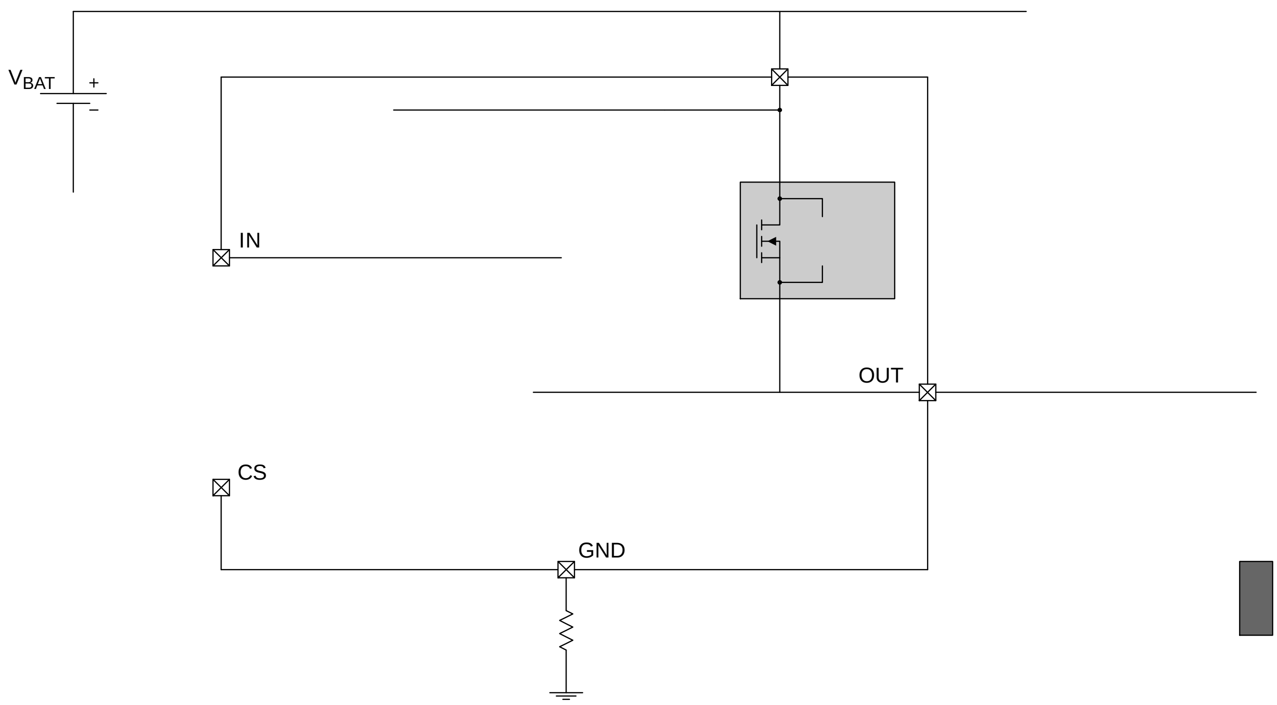


Figure 38. Off State Open Load Detection Circuit

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