The NCV7694 is a device which can drive a string of infra−red LEDs using an external mosfet. The IR LEDs are used to illuminate the surroundings of the image sensor. Since these LEDs can damage the end users' eyes, the power feed to the LEDs needs to be turned off during a fault condition.

The NCV7694 driver features prevents the IR LEDs from being on too long due to an inappropriate exposure time or being turned on too frequently using external resistors. The value of the R_{ETL} resistor defines the maximum T_{ON} time of the emitted light intensity and the value of the R_{FRL} resistor defines the maximum frequency of the FLASH signal from the image sensor.

A LED driver with hardware interlocks helps protect the users' eyes in cases where the control signal has failed or a fault in the LED power path has occurred.

LED brightness level is easily programmed using an external resistor in series with the mosfet transistor.
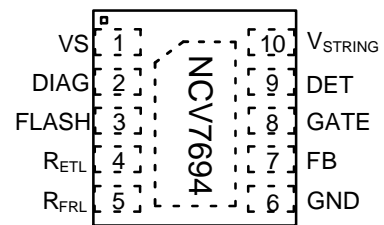
The device can also detect Open Load, Short Circuit to GND and VS. Faults are reported to the DIAG pin, which can directly disable the DC/DC converter to prevent possible damage.

The device is available in 10 pin DFN package.

Features

- Constant Current Output for LED String Drive
- FLASH Input Pin
- Open LED Diagnostic Detection
- Short LED to GND and VS Detection
- Safety Feature Prevent Being ON too long
- Safety Feature Prevent Being ON too frequently
- External Resistor Defining max ON time
- External Resistor Defining min OFF time
- Protection against Short to Ground and Open of the External Resistors
- Detection and Protection Against Under−Voltage and over Temperature
- AEC−Q100 Qualified and PPAP Capable
- ASIL−A safety design, ISO26262 compliant
- 10 Pin Packaging
- Wettable Flank Package for Enhanced Optical Inspection
- These are Pb−Free Devices

Applications

- In−Cabin Monitoring Sensor
- Infrared Illumination for Automotive Cameras
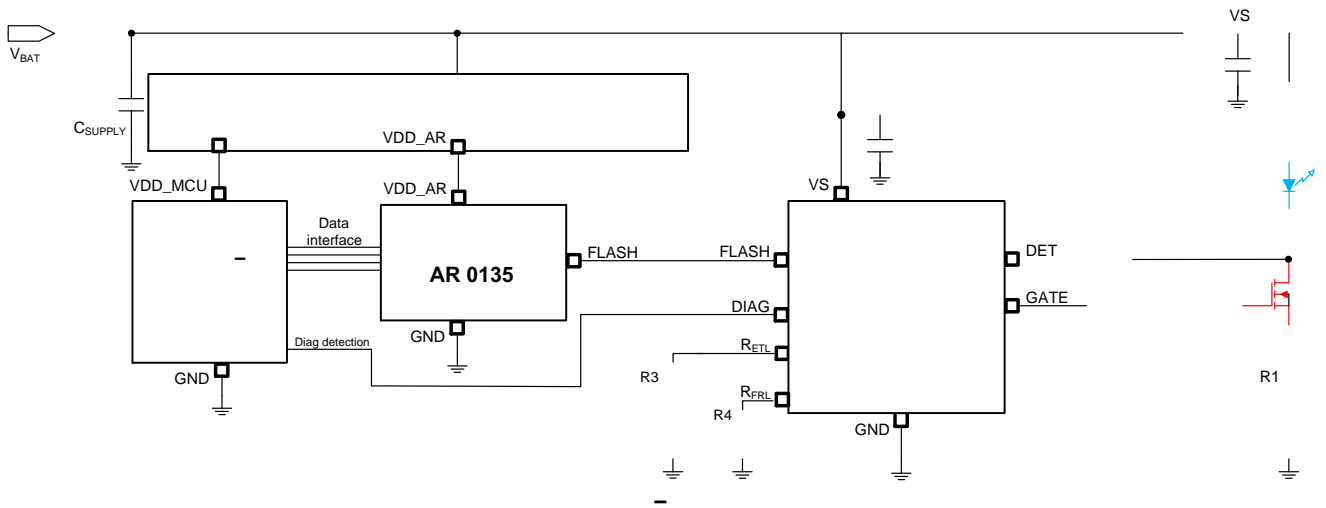- Machine Vision Systems
- Surveillance Systems

DFNW10, 3x3, 0.5P
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MARKING DIAGRAM
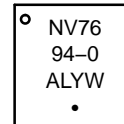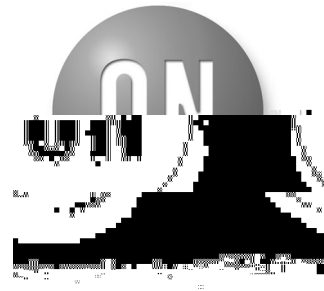
NV76
94−0
ALYW
•

NV7694−0	= Specific Device Code
A	= Assembly Location
L	= Wafer Lot
Y	= Year
W	= Work Week
•	= Pb−Free Package

PIN CONNECTIONS

VS [1] [10] V_{STRING}
DIAG [2] [9] DET
FLASH [3] [8] GATE
R_{ETL} [4] [7] FB
R_{FRL} [5] [6] GND

NCV7694

Top View

ORDERING INFORMATION

Device	Package	Shipping†
NCV7694MW0R2G	DFN10 (Pb−Free)	2500 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

Figure 1. Application Diagram – Powered Directly from Battery

Timing Characteristics

Figure 4. Simplified Internal Timing Characteristic of the Internal ETL, FRL Counter

PIN FUNCTION DESCRIPTION
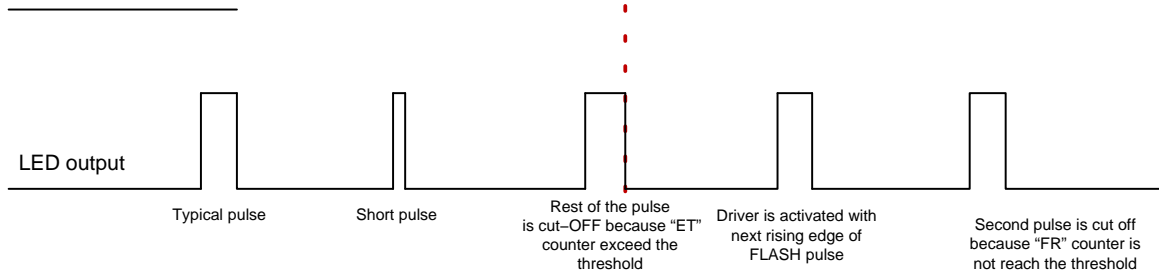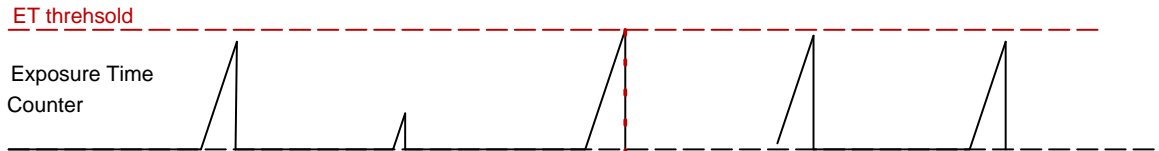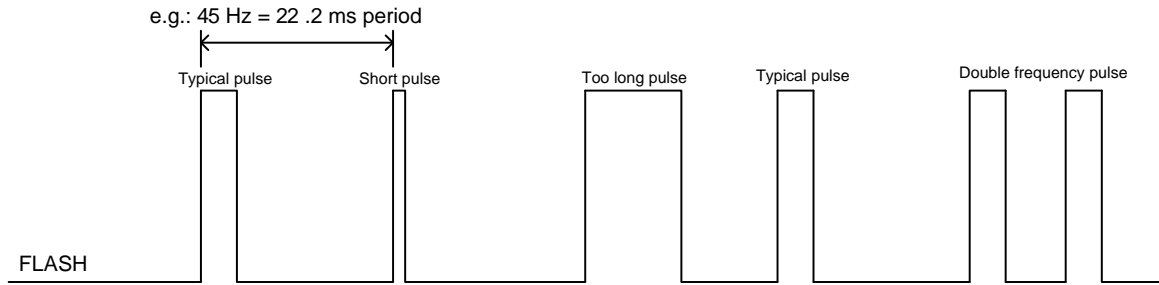
10–pin DFN10 Package		
Pin #	Label	Description
1	VS	Supply voltage of the device
2		

NCV7694

ELECTRICAL CHARACTERISTICS

$(7\ \text{V} < \text{VS} < 28\ \text{V}, R_{ETL} = 4.99\ \text{k}\Omega, R_{FRL} = 1.96\ \text{k}\Omega, 4\ \text{V} < V_{STRING} < 28\ \text{V}$, Transistor = NVTFS5C478NL, LED = SFH 4725AS, $R1 = 100\ \text{m}\Omega, -40°\text{C} \leq T_J \leq 125°\text{C}$, unless otherwise specified)

Characteristic	Symbol	Conditions	Min.	Typ.	Max.	Unit
GENERAL						
Supply Voltage	VS_OP	Parametric operation	7	–	28	V
Supply Under–Voltage Lockout	VSUV	VS rising	4.0	4.5	5.0	V
Supply Under–Voltage hysteresis	VSUVhys		150	300	550	mV
Supply Current in normal condition	I_VS	VS = 14 V, FLASH = High, I_{FRL}, I_{ETL} subtracted	–	4.0	6.0	mA
		VS = 14V, FLASH = Low, I_{FRL}, I_{ETL} subtracted	–	3.8	6.0	mA
Supply Current in Fault condition	I_VSerr	VS = 14 V, FLASH = High, Open Load condition, I_{FRL}, I_{ETL} subtracted	–	4.0	6.0	mA
Thermal Shutdown (TSD)			130	150	170	°C
Thermal Hysteresis			–	15	–	°C
FB DRIVER						
FB Regulation reference	V_{FBref}	Under Voltage Lockout < VS	270	300	330	mV
Gate ON voltage	V_{GATE}	FB = 220 mV, DET = 1.0 V	4.5	–	–	V
Propagation Delay FLASH rising – FB ON	t_{ON}	50% criterion	–	8	15	µs
Propagation Delay FLASH falling – FB OFF	t_{OFF}	50% criterion	–	6.6	15	µs
FLASH propagation Delay Delta	t_{pd_delta}	|(Falling time) – (Rising Time)| 50% criterion	–	1.4	4	µs
Output pull–down resistance	R_{GATE}		5	30	100	kΩ
FLASH INPUT PIN						
Input High Threshold	V_{inH}		1.3	1.2	–	V
Input Low Threshold	V_{inL}		–	1.15	1.1	V
Input pull–down resistance	R_{FLASH}					

ELECTRICAL CHARACTERISTICS

$(7\ V < VS < 28\ V$, $R_{ETL} = 4.99\ k\Omega$, $R_{FRL} = 1.96\ k\Omega$, $4\ V < V_{STRING} < 28\ V$, Transistor = NVTFS5C478NL, LED = SFH 4725AS,
$R1 = 100\ m\Omega$, $-40°C \leq T_J \leq 125°C$, unless otherwise specified)

Characteristic	Symbol	Conditions	Min.	Typ.	Max.	Unit
PROGRAMMING						
FRL resistor operation range	R_{FRL}	external resistor value operation range for $R_{FRL} = 1\ k\Omega \Rightarrow f_{FRL} = 100\ Hz$ (10 ms) for $R_{FRL} = 10\ k\Omega \Rightarrow f_{FRL} = 10\ Hz$ (100 ms)	0.8	–	15	kΩ
Maximum FLASH Frequency (typ)	f_{max}	Derived from R_{FRL} and $K_{FRL(typ)}$; valid for $R_{FRL} = 800\ \Omega$	–	–	125	Hz
FRL multiplication	K_{FRL}	$K_{FRL} = \dfrac{R_{FRL}}{t_{FRL}}$ $t_{FRL} = \dfrac{R_{FRL}}{K_{FRL}} = \dfrac{1.96}{0.1} = 19.6\ ms$ $f_{FRL} = \dfrac{1}{t_{FRL}} = \dfrac{1}{0.0196} = (51\ Hz)$	–	0.1	–	
K_{FRL} tolerance	tol_{FRL}	Tolerance of Frame Rate Limit		±13.0		%
Overcurrent protection R_{FRL}	I_{FRL_lim}	Short to ground Resistor detection for $R_{FRL} < 750\ \Omega$	1.3	–	–	mA
Open Load protection R_{FRL}	I_{FRL_open}	Open Load detection Resistor detection for $R_{FRL} > 17.5\ k\Omega$	–	–	57.5	µA
OPEN LOAD / SHORT TO GND						
Open Load Detection Threshold (FB pin) Open Load Blanking Time	V_{OLth}	FLASH = High	130	150	170	mV

DETAILED OPERATING DESCRIPTION

Under Voltage Lockout

Under voltage Lockout feature is used to protect against an abnormal status during startup. When the initial soft start voltage is greater than 4.5 V (typ) the device starts to be active. Below this threshold the GATE output pin is pulled low to ground to prevent opening external N−MOS transistor and DIAG pin is pulled low to report.

Thermal Shutdown

The thermal shutdown circuit checks the internal junction temperature of the device. When the internal temperature rises above the Thermal shutdown threshold, then after a short filter time the driver is switched off and fault on the DIAG pin is reported.

Exceeding the Flash Pulse

If the duration of the FLASH pulse exceeds the pre−defined timing or the FLASH pulse repetition is too frequent, the GATE of the transistor is switched off. The limitation of the FLASH pulses is also reported on the DIAG pin. The first FLASH pulse after power−on−reset should be delayed longer than FRL period, otherwise the FLASH pulse will be limited and DIAG pin will report a fault until FRL counter expires.

OPEN LOAD BEHAVIOR

Figure 6. Timing of the Open Load Behavior

Short to Ground

In case of short to ground, huge amount of current is passing through the LEDs. To protect the LEDs and Human eyes, the safety mechanism can be implemented. The DIAG output diagnostic pin can be connected directly to the Enable of the DC/DC converter. In case of fault, the DC/DC converter is automatically disabled after blanking times.
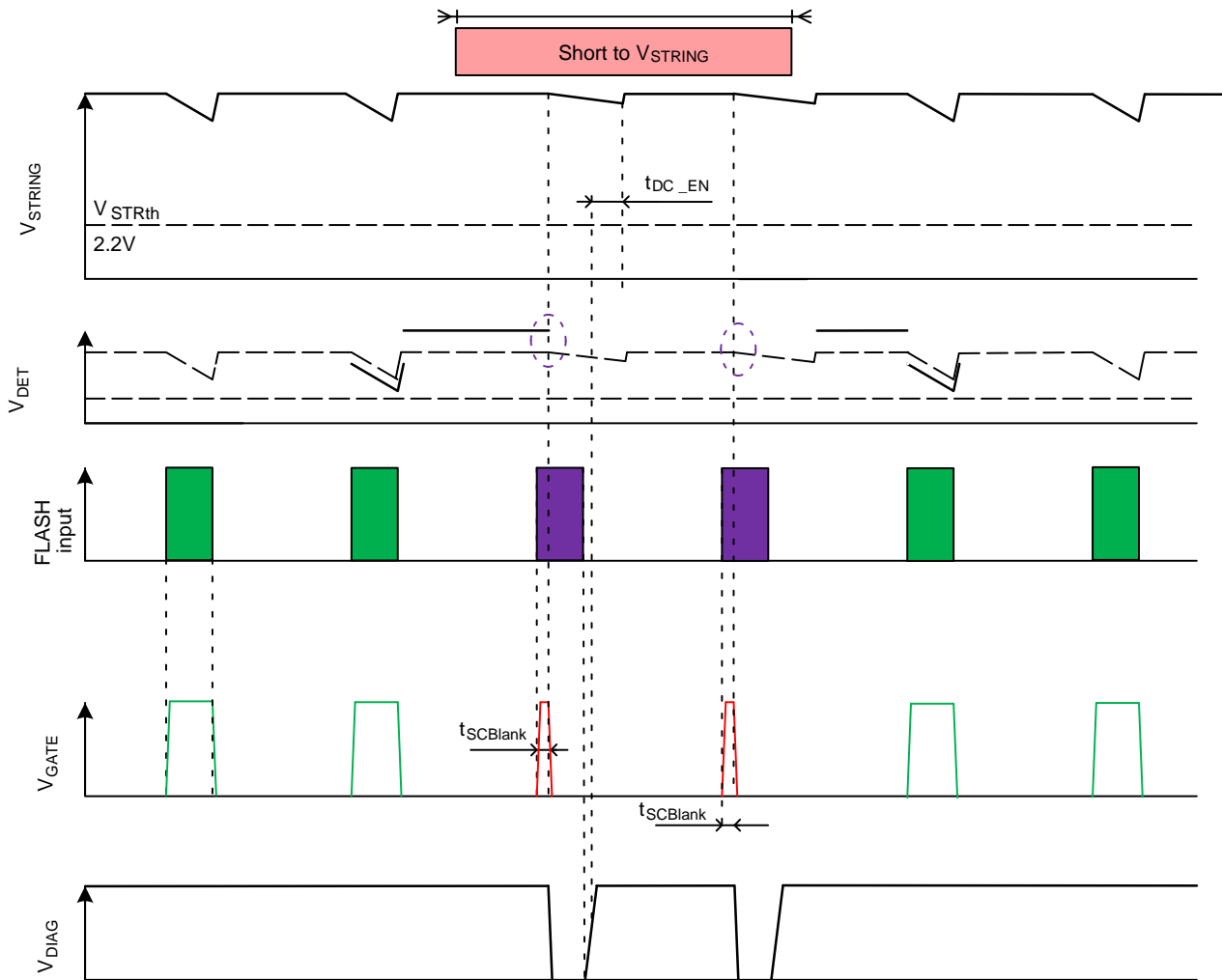

Figure 7. Short to Ground Detection Circuit

BEHAVIOR OF THE SHORT TO GND
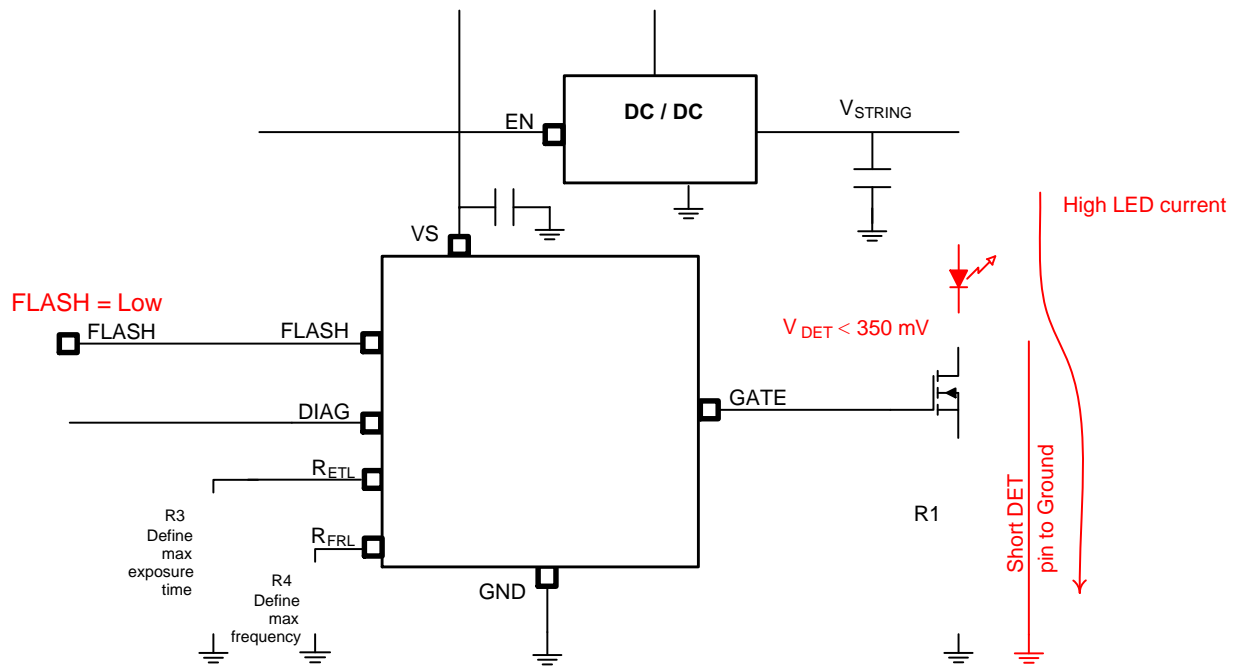
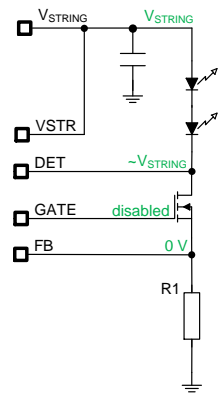### Conditions: VS powered, DC /DC used, EN connected to the DIAG pin
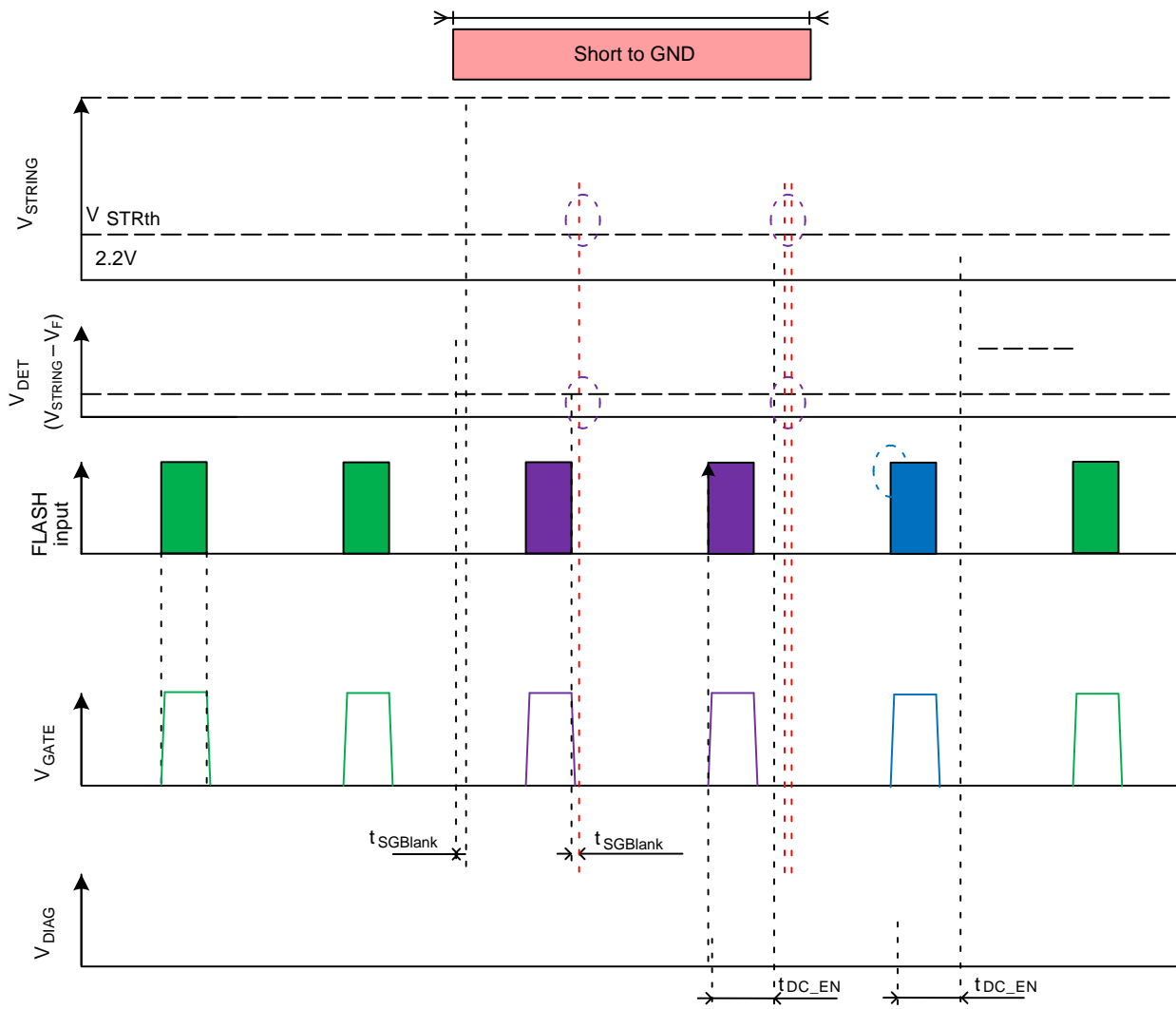
t_{DC_EN} = 1.5 ms activation delay of the DC/DC

FLASH is propagated to the output

Fault is present and detected LEDs are OFF

V_{STRING} is not sufficient, Open

Figure 8. Timing of the Short to GND Behavior

NCV7694

Figure 9. Short to VSTRING Detection Circuit

When Short Cathode of the LEDs to V_{STRING} voltage is introduced during the FLASH = High and $V_{STRING} > V_{STRth}$, the 10 μs blanking time eliminate the false faults. When the blanking time expires, the NCV7694 immediately switch OFF the GATE output to protect the external transistor against high power dissipation. The DIAG pin will report a fault which will lead to switching OFF the DC/DC V_{STRING} voltage if the DIAG pin is connected to the Enable of the DC/DC converter. The fault is latched during the FLASH signal is high or until ETL counter expires. The device will be recovered only with next falling edge on the FLASH or when the ETL counter is expired.

The diagnostic is not active when $V_{STRING} < V_{STRth}$ or also during FLASH = Low.

Behavior of the Short to V$_{STRING}$:

Conditions: VS powered, DC /DC used, EN connected to the DIAG pin

Figure 10. Timing of the Short to VSTRING Behavior

Overview of the Faults

Figure 11. Overview of the Faults

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CASE 507AG
ISSUE B

SCALE 2:1

DATE 14 APR 2020

DETAIL A

D2

E2

1 5

10 6

⊕	0.10	C	A	B
	0.05	C	NOTE 3	

BOTTOM VIEW
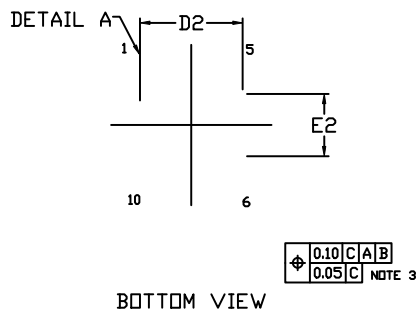
**GENERIC
MARKING DIAGRAM***

1
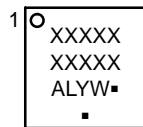
XXXXX
XXXXX
ALYW▪
▪

XXXXX = Specific Device Code
A   = Assembly Location
L   = Wafer Lot
Y   = Year
W   = Work Week
▪   = Pb–Free Package
(Note: Microdot may be in either location)

*This information is generic. Please refer to
device data sheet for actual part marking.
Pb–Free indicator, "G" or microdot " ▪",
may or may not be present. Some products
may not follow the Generic Marking.