MX26631S

40V, 4A, 30mΩ Hot-Swap eFuse Solution

GENERAL DESCRIPTION

MX26631S is a 40V industrial eFuse solution. The device provides robust protection for all systems and applications powered from 4.5V to 40V. For hot-pluggable boards, the device provides hot-swap power management with in-rush current control. Load, source, and device protections are provided with many programmable features including overcurrent and undervoltage. The precision overcurrent limit helps to minimize over design of the input power supply, while the fast response short circuit protection immediately isolates the faulty load from the input supply when a short circuit is detected. The internal robust protection control blocks of the MX26631S along with its 40V rating, helps to simplify the system designs for the industrial surge compliance ensuring complete protection of the load and the device.

APPLICATIONS

Industrial Applications

Servers

Networking

Electronics breakers

FEATURES

♦UL_IEC_62368 certified

UL Certification Number：E537785

♦4.5V to 40V operating input range

♦Internal 60V, 30mΩ Ron hot-swap N-Channel FET

♦Integrated current sensing with sense output

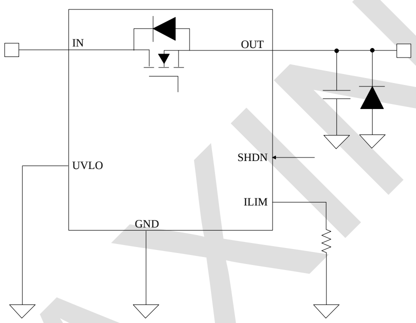
♦Adjustable current limit from 0.6A to 4A

♦Adjustable UVLO

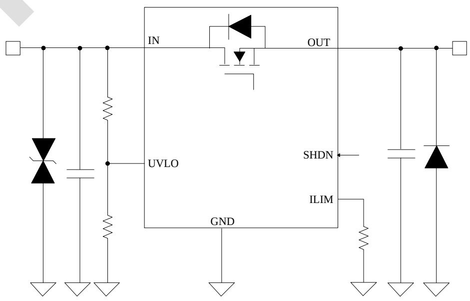
♦ Overcurrent fault response with auto-retry

♦Models with 1.5x pulsed overcurrent support

TYPICAL APPLICATION



Minimum system application



Typical application

General information

Ordering information

Part Number	Description
MX26631S	SOP8，Halogen-free，RoHS

Package dissipation rating

Package	$R_{\theta JA}$（°C/W）
SOP8	170

Absolute maximum ratings

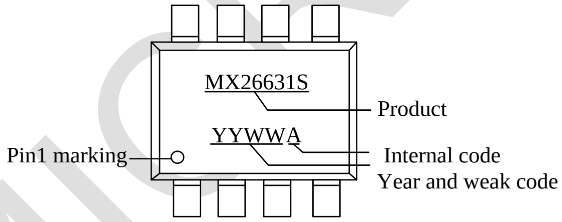
Parameter	Value
IN, OUT, UVLO	-0.3~60V
IN(10ms transient)	-0.3~65V
$\overline{SHDN}$, I_{LIM}	-0.3~5.5V
Junction temperature T_J	-40 to 150°C
Ambient temperature T_A	-40 to 85°C
Storage temperature T_{STG}	-55 to 150°C
ESD(HBM)	±2.0kV
Leading temperature (soldering, 10secs)	260°C

Note: stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.

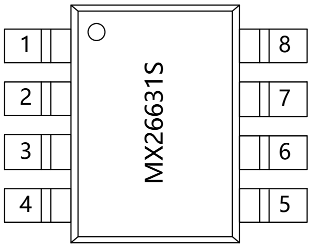
Recommended operating condition

Symbol	Parameter	Range
IN	Input Voltage	4.5~40V
OUT, UVLO		0-40V
$\overline{SHDN}$		0~5V
ILIM	Resistance	8~100kΩ

Marking Information

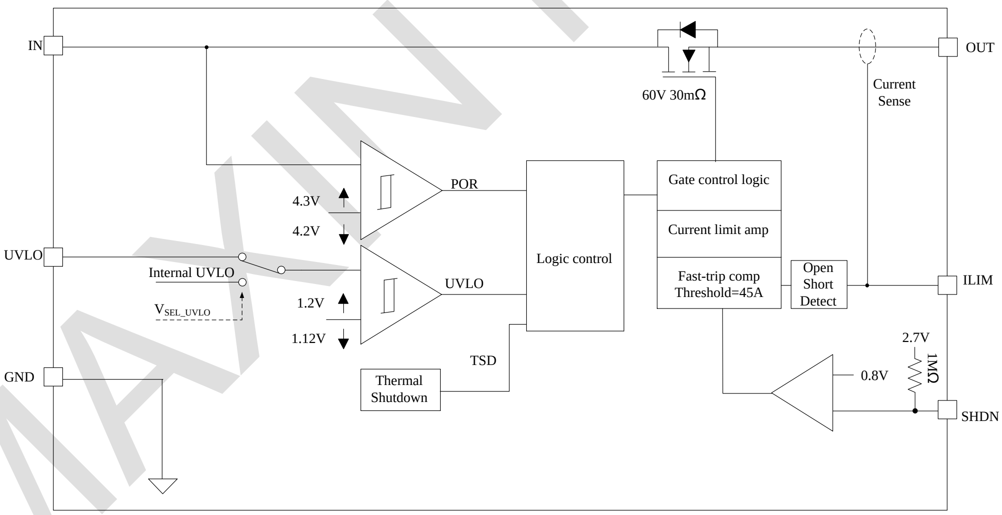


Terminal assignments



PIN NO.	PIN name	Description
1/2	**IN**	Power input. Connect to the Drain of the internal FET.
3	**GND**	System ground pin.
4	**UVLO**	Input for setting the programmable UVLO threshold. Connect UVLO pin to GND to select the internal default threshold.
5	**$\overline{SHDN}$**	Pulling $\overline{SHDN}$ pin low makes the device to enter shutdown mode. Cycling $\overline{SHDN}$ pin voltage resets the device that fast latched off due to a fault condition.
6	**ILIM**	A resistor from this pin to GND sets overload and short circuit current limit.
7/8	**OUT**	Power output of the device.

Block Diagram



Electrical characteristics

4.5V ≤ V_{IN} ≤ 40V, $V_{\overline{SHDN}}$ = 2V, R_{ILIM} = 10kΩ, UVLO = 0V, C_{OUT} = 1μF. (Unless otherwise noted))

Symbol	Parameter	Test condition	Min	Typ.	Max	Unit
IN supply voltage						
V_{IN}	Operating input voltage		4.5		40	V
IQ_{ON}	Supply current	$\overline{SHDN}$ = 3V enable	0.5	1.0	1.5	mA
IQ_{OFF}	Supply current	$\overline{SHDN}$ = 0V disable	5	25	50	μA
Under Voltage Lockout Input						
UVLO	Internal undervoltage trip level	IN rising UVLO=GND	14.8	15.4	16.0	V
		IN falling UVLO=GND	14.0	14.6	14.8	V
V_{SEL_UVLO}	Internal UVLO select threshold		180	210	240	mV
V_{UVLOR}	UVLO threshold voltage, rising		1.18	1.21	1.28	V
V_{UVLOF}	UVLO threshold voltage, falling		1.10	1.17	1.25	V
I_{UVLO}	UVLO input leakage current	0V ≤ V_{UVLO} ≤ 40V	-1	0	1	μA
Current Limit Programming ILIM						
I_{OL}	Overload current limit	R_{ILIM} = 75kΩ, V_{IN} - V_{OUT} = 1V	0.58	0.6	0.72	A
		R_{ILIM} = 24kΩ, V_{IN} - V_{OUT} = 1V	1.6	1.80	2.20	A
		R_{ILIM} = 8.2kΩ, V_{IN} - V_{OUT} = 1V	4.25	4.45	4.70	A
$I_{FASTTRIP}$	Fast-trip comparator threshold	6.2kΩ≤R_{LIM}≤75kΩ	1.5*I_{OL}			A
I_{SCP}	Short circuit protect current		45			A
PASS FET OUTPUT (OUT)						
R_{ON}	IN to OUT total ON resistance	0.6A ≤ I_{OUT} ≤ 5A	20	30	50	mΩ
I_{lkgOUT}	OUT leakage during input supply brownout	VIN = 0V, V_{OUT} = 24V, V_{IN} = Floating, $V_{\overline{SHDN}}$ = 3V, Sinking	3	3.5	7	mA
LOW IQ SHUTDOWN ($\overline{SHDN}$) INPUT						
$V_{\overline{SHDN}}$	Open circuit voltage	$I_{\overline{SHDN}}$ = 0.1μA	2.48	2.7	3.3	V
V_{SHDNF}	$\overline{SHDN}$ threshold voltage for low IQ shutdown, falling		0.8			V
V_{SHDNR}	$\overline{SHDN}$ threshold rising				2	V
$I_{\overline{SHDN}}$	Leakage current	$V_{\overline{SHDN}}$ = 0V	-10	-2.7	0	μA
THERMAL PROTECTION						
$T_{TSDrelease}$	Thermal shutdown release			130		℃
T_{TSD}	Thermal shutdown TSD threshold, rising			140		℃
$T_{TSDhyst}$	TSD hysteresis			11		℃

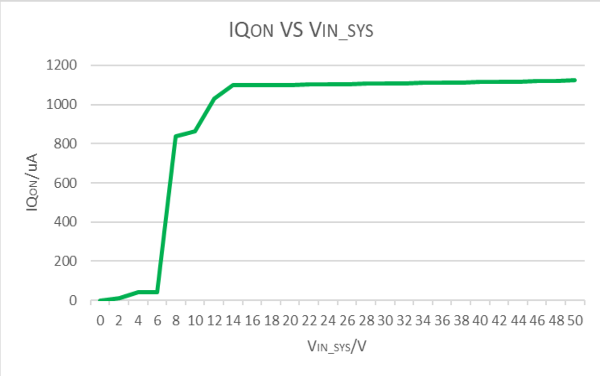
Timing Requirements

4.5V ≤ V_{IN} ≤ 40V, $V_{\overline{SHDN}}$ = 3V, R_{ILIM} = 10kΩ, UVLO = 0V, C_{OUT} = 1 μF. (Unless otherwise noted))

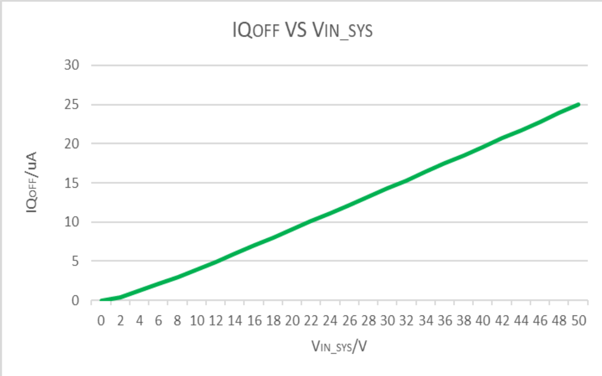
Symbol	Parameter	Test condition	Min	Typ.	Max	Unit
UVLO INPUT (UVLO)						
$UVLO_{ton(dly)}$	UVLO switch turn-on delay	UVLO ↑ (100mV above V_{UVLOR}) to 10% V_{OUT})		730		μs
$UVLO_{toff(dly)}$	UVLO switch turnoff delay	UVLO ↓ (20mV below V_{UVLOF}) to 90% V_{OUT})		520	600	μs
SHUTDOWN CONTROL INPUT ($\overline{SHDN}$)						
$t_{SD(dly)}$	SHUTDOWN entry delay	$\overline{SHDN}$ ↓ (below V_{SHUTF}) to 90% V_{OUT}	0.8	1	1.5	μs
CURRENT LIMIT						
$t_{FASTTRIP(dly)}$	Hot-short response time	I_{OUT} > I_{SCP}		1		μs
	Soft short response	$I_{FASTTRIP}$ < I_{OUT} < I_{SCP}	2.2	3.2	4.5	μs
$t_{CBRetry(dly)}$	Retry delay in Pulse over current limiting		550	670	800	ms
THERMAL PROTECTION						
t_{TSD_retry}	Retry delay in TSD		500	660	800	ms

Typical Characteristics

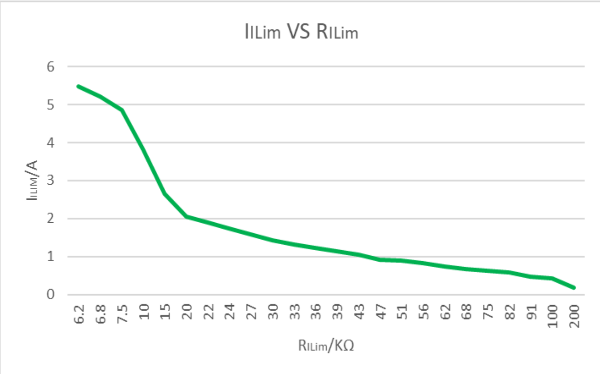
V_{IN} = 24V, $V_{\overline{SHDN}}$ = 3V, R_{ILIM} = 10kΩ, UVLO = 0V, C_{OUT} = 1μF. (Unless stated otherwise)



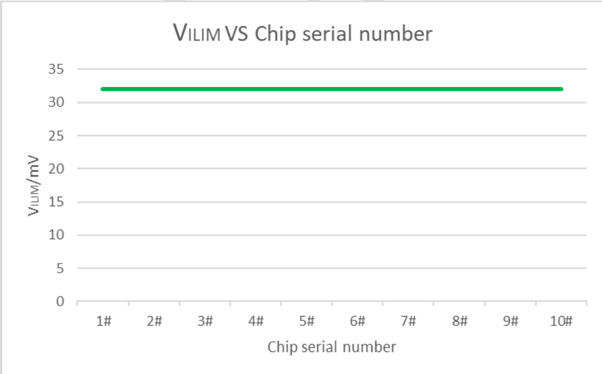
Supply Current vs Supply Voltage During Normal Operation



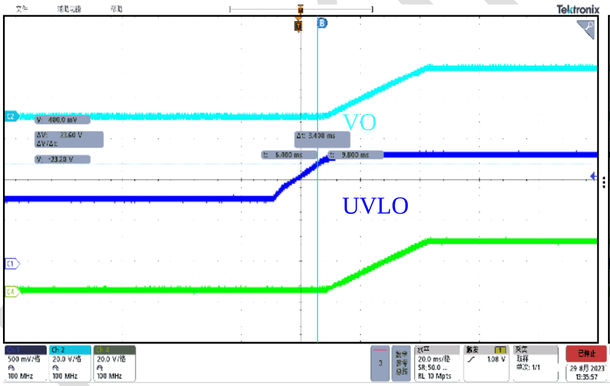
Supply Current vs Supply Voltage in Shutdown



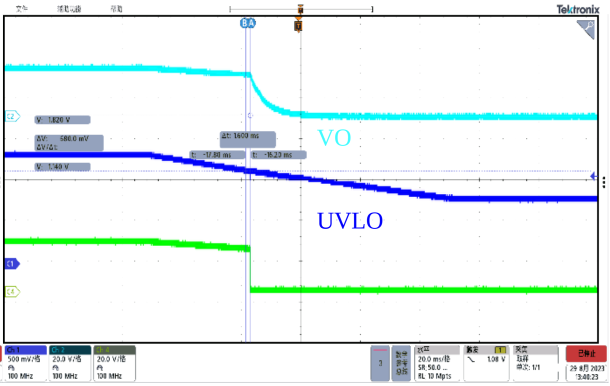
I_{ILIM} VS R_{ILIM} with VIN = 24V



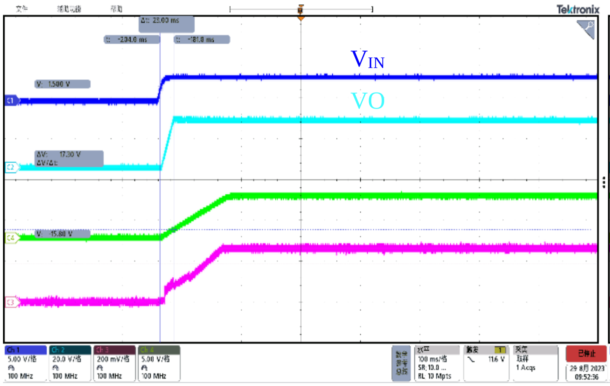
V_{ILIM} consistency between different chips



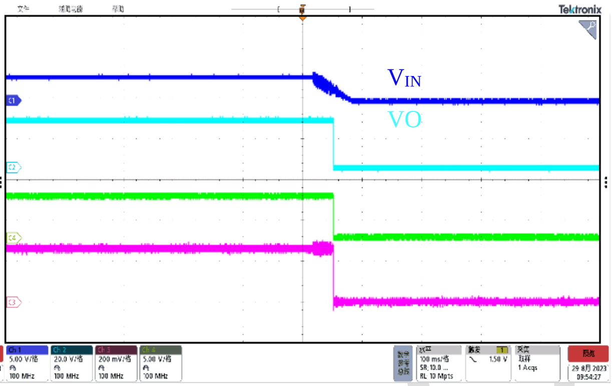
UVLO Performance during $_{VIN}$ from 14V to 24V



UVLO Performance during $_{VIN}$ from 24V to 14V



Turn on control with SHDN



Turn off control with SHDN

Operation description

The MX26631S is an 40V industrial eFuse. The device provides robust protection for all systems and applications powered from 4.5V to 40V. For hot-pluggable boards, the devices provide hot-swap power management with in-rush current control. Load, source, and device protections are provided with many programmable features including overcurrent and undervoltage. The precision overcurrent limit (±10% at 5A) helps to minimize over design of the input power supply, while the fast response short circuit protection immediately isolates the faulty load from the input supply when a short circuit is detected. The internal robust protection control blocks of the MX26631S along with its 40V rating, helps to simplify the system designs for the industrial surge compliance ensuring complete protection of the load and the device. The 40V maximum DC operating and 60V absolute maximum voltage rating enables system protection from 40V DC input supply faults and from industrial SELV power supplies.

The devices provide precise monitoring of voltage bus for brown-out conditions and asserts fault signal for the downstream system. Its overall threshold accuracy of 2% ensures tight supervision of bus, eliminating the need for a separate supply voltage supervisor chip.

Additional features of the MX26631S include:

• Over temperature protection to safely shutdown in the event of an overcurrent event

• De-glitched fault reporting for supply brown-out faults

• Enable and disable control from an MCU using $\overline{\text{SHDN}}$ pin.

Undervoltage Lockout (UVLO)

The MX26631S features an accurate ±5% adjustable undervoltage lockout functionality. When the voltage at UVLO pin falls below V_{UVLOF} during input undervoltage fault, the internal FET quickly turns off. The UVLO comparator has a hysteresis of 78mV (typical). To set the input UVLO threshold, connect a resistor divider network from IN supply to UVLO terminal to GND as shown in the Typical application schematic. The MX26631S also features a factory set 15V input supply undervoltage lockout $VIN_{\_UVLO}$ threshold with 1V hysteresis. This feature can be enabled by connecting the UVLO terminal directly to the GND terminal. If the Undervoltage Lock-Out function is not needed, the UVLO terminal must be connected to the IN terminal. UVLO terminal must not be left floating. The values required for setting the undervoltage are calculated by the following equation:

$$V_{UV} = \frac{R_1 + R_2}{R_2} \cdot V_{UVLOR}$$

Where V_{UVLOR} = 1.21V, voltage rising threshold.

Since R_1 and R_2 will leak the current from input supply VIN, these resistors should be selected based on the acceptable leakage current from input power supply IN. The current drawn by R_1 and R_2 from the power supply $\{I_{R12} = IN / (R_1 + R_2)\}$.

However, leakage currents due to external active components connected to the resistor string can add error to these calculations. So, the resistor string current, I_{R12} must be chosen to be 20x greater than the leakage current expected.

Overload and Short Circuit Protection

The device monitors the load current by sensing the voltage across the internal sense resistor. The FET current is monitored during start-up and normal operation.

Overload Protection

Set the current limit using the following formula:

$$I_{OL} = \frac{42}{R_{ILMT}} \times 10^3 (A) \quad \text{When } 25k \leqslant R_{ILMT} \leqslant 75k;$$

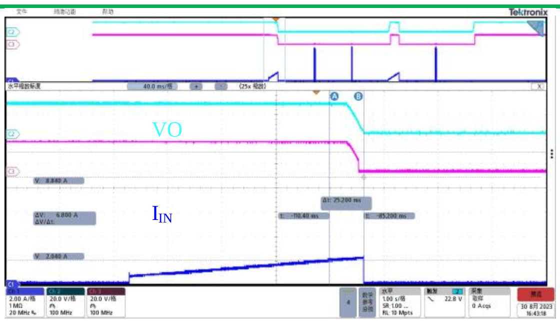
$$I_{OL} = \frac{40}{R_{ILMT}} \times 10^3 (A) \quad \text{When } 10k < R_{ILMT} < 25k;$$

$$I_{OL} = \frac{37}{R_{ILMT}} \times 10^3 (A) \quad \text{When } 5.1k \leqslant R_{ILMT} \leqslant 10k.$$

Where I_{OL} is the over current protection point and R_{ILMT} is the resistor of ILMT pin and the unit is Ω.

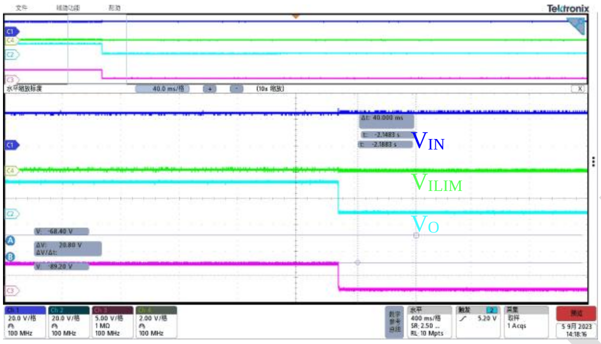
Active Current Limiting with I_{OL} Pulse Current Support

MX26631S after the start-up, if the load current reaches to I_{OL}, the device will pass through the over current demanded by the load not more than I_{OL}. Power dissipation across the device during this operation will be $(V_{IN} – V_{OUT}) \times I_{OL}$ and this could heat up the device and eventually enter thermal shutdown. If load current reaches to $1.5 \times I_{OL}$, the internal FET is shut down immediately.



Overload Performance with MX26631S during Load Step from 0A to 3A

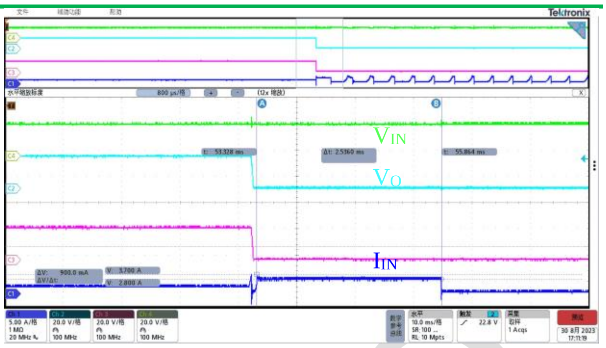
If the voltage of the MODE is less than 1.2V, ILIM pin has short-circuit protection. The MX26631S features open fault detection. When ILIM enters open or short circuit protection, the internal FET is turned OFF and it remains OFF till the ILIM pin fault is removed.



V_{IN} = 24V, R_{ILIM} = 6.2kΩ to GND

Short Circuit Protection

During a transient output short circuit event, the current through the device increases rapidly. As the current-limit amplifier cannot respond quickly to this event due to its limited bandwidth, the device incorporates a fast-trip comparator. The fast-trip comparator architecture is designed for fast turn OFF $t_{FASTTRIP(dly)}$ = 1µs (typical) with I_{SCP} = 45A of the internal FET during an output short circuit event. The fast-trip threshold is internally set to $I_{FASTTRIP}$. The fast trip circuit holds the internal FET off for only a few microseconds, after which the device turns back on slowly, allowing the current-limit loop to regulate the output current to I_{OL}. Then the device functions is similar to the overload condition. The following figure illustrates output hot-short performance of the device.



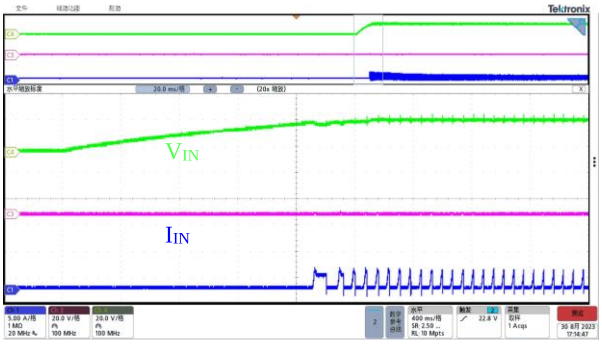
VIN = 24V R_{ILIM} = 20KΩ

Output Hot-Short Response

The fast-trip comparator architecture has a supply line noise immunity resulting in a robust performance in noisy environments. This is achieved by controlling the turn OFF time of the internal FET based on the overcurrent level, $I_{FASTTRIP}$ through the device. Higher the overcurrent, faster the turn OFF time, $t_{FASTTRIP(dly)}$. At overload current level in the range of $I_{FASTTRIP}$ < I_{OUT} < I_{SCP} the fast-trip comparator response is 3.2µs (typical).

Start-Up With Short-Circuit on Output

When the device is started with short-circuit on the output, the current begins to limit at I_{OL}. Due to high power dissipation of V_{IN} x I_{OL} within the device the junction temperature increases. The following figure illustrates the behavior of the device in this condition.



V_{IN} = 24V R_{ILIM} = 20kΩ

Start-Up With Short on Output

Thermal Shutdown

The device has a built-in overtemperature shutdown circuitry designed to protect the internal FET, if the junction temperature exceeds T_{TSD}, 130°C (typical). After the thermal shutdown event, the device commences an auto-retry cycle of 660ms (typical), t_{TSD_retry} after T_J < [T_{TSD} – 11°C].

Low Current Shutdown Control ($\overline{SHDN}$)

The internal, external FET and hence the load current can be switched off by pulling the $\overline{SHDN}$ pin below 0.8V threshold with a micro-controller GPIO pin or can be controlled remotely with an opto-isolator device. The device quiescent current reduces to 10µA (typical) in shutdown state. To assert $\overline{SHDN}$ low, the pull down must have sinking capability of at least 10µA. To enable the device, $\overline{SHDN}$ must be pulled up to at least 2V. Once the device is enabled, the internal FET turns on with dVdT mode.

Layout considerations

• For all the applications, a 0.1µF or higher value ceramic decoupling capacitor is recommended between IN terminal and GND.

• The optimum placement of decoupling capacitor is closest to the IN and GND terminals of the device. Care must be taken to minimize the loop area formed by the bypass-capacitor connection, the IN terminal, and the GND terminal of MX26631S.

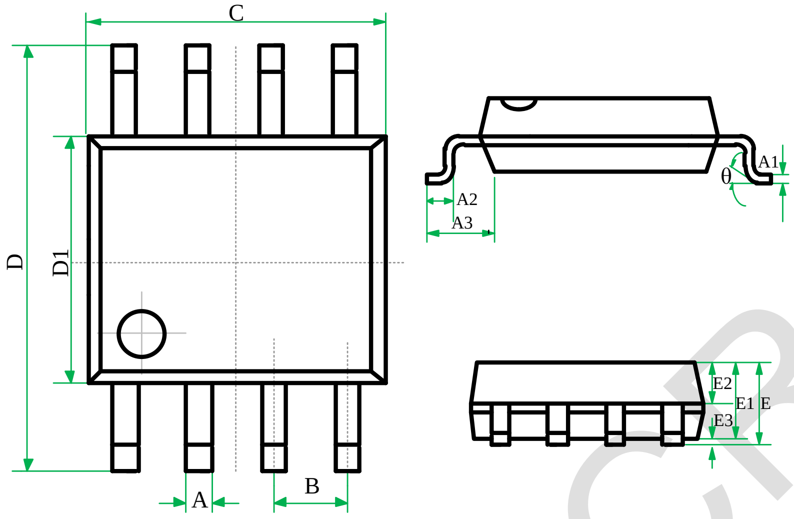
• High current carrying power path connections must be as short as possible and must be sized to carry at least twice the full-load current.

• Locate MX26631S support components R_{ILIM} and UVLO resistors close to their connection pin. Connect the other end of the component to the GND with shortest trace length.

• The trace routing for the R_{ILIM} component to the device must be as short as possible to reduce parasitic effects on the current limit and current monitoring accuracy. These traces must not have any coupling to switching signals on the board.

• Protection devices such as TVS, snubbers, capacitors, or diodes must be placed physically close to the device they are intended to protect and routed with short traces to reduce inductance. For example, a protection Schottky diode is recommended to address negative transients due to switching of inductive loads, and it must be physically close to the OUT and GND pins.

Package information



SYMBOL	MILLIMETERS			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.39	-	0.48	0.0154	-	0.0189
A1	0.21	-	0.28	0.008	-	0.011
A2	0.50	-	0.80	0.020	-	0.031
A3	1.05BSC			0.041BSC		
B	1.27BSC			0.050BSC		
C	4.70	4.90	5.10	0.185	0.193	0.201
D	5.80	6.00	6.20	0.228	0.236	0.244
D1	3.70	3.90	4.10	0.146	0.154	0.161
E	-	-	1.75	-	-	0.069
E1	1.30	1.40	1.50	0.051	0.055	0.059
E2	0.60	0.65	0.70	0.024	0.026	0.028
E3	0.10	-	0.225	0.004	-	0.009
θ	0	-	8°	0	-	8°

SOP8 for MX26631S

Restrictions on Product Use

◆ MAXIN micro is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing MAXIN products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such MAXIN products could cause loss of human life, bodily injury or damage to property.

◆ In developing your designs, please ensure that MAXIN products are used within specified operating ranges as set forth in the most recent MAXIN products specifications.

◆ The information contained herein is subject to change without notice.

Version update record:

V11 The original version