

250mA, 36V, Ultra-Low IQ, Low Dropout LDO

1 Features

- Wide Input Voltage Range: up to 36V
- Output Current: 250mA
- Standard Fixed Output Voltage Options
 - 1.8V, 2.5V, 3.0V, 3.3V, 3.6V and 5.0V
- More Output Voltage Options Available on Request
- Low IQ: 2.6μA Typically
- Low Dropout Voltage
- Short Current Protection: 200mA
- Excellent Load and Line Transient Response
- Line Regulation: 0.01%/V Typically
- Normal Version Available Packages
 - SOT23-3, SOT23-5 and SOT89-3
- Shutdown Version Available Packages
 - SOT23-3, and Tiny DFN1x1-4

2 Applications

- Portable Electric Devices
- Audio/Video Equipment
- Robots
- Smoke Detectors
- Battery Powered Equipment
- Smart Phones and Tables

3 Description

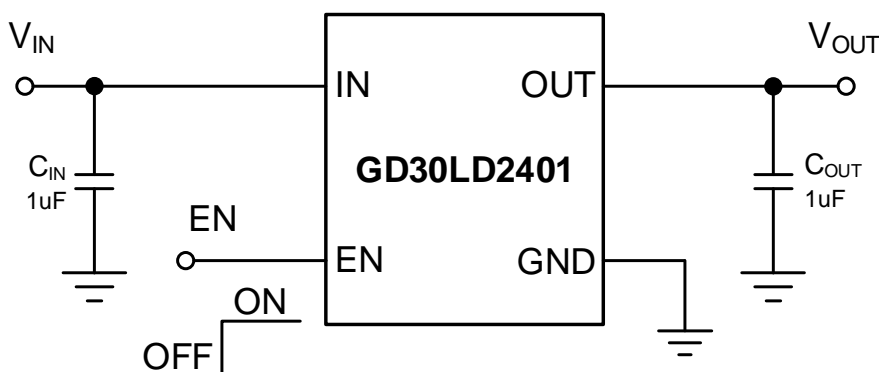
The GD30LD2401 is a high voltage, low power consumption and high performance LDO. The family uses an advanced CMOS process and a P-MOSFET pass device to achieve fast start-up, with high output voltage accuracy. The GD30LD2401 is stable with a 1.0-μF to 10μF ceramic output capacitor, and uses a precision voltage reference and feedback loop to achieve a worst-case accuracy of 2% over all load, line, process, and temperature variations.

Device Information¹

PART NUMBER	PACKAGE	BODY SIZE(NOM)
GD30LD2401	SOT23-3	2.92mm x 1.60mm
	SOT23-5	2.92mm x 1.65mm
	SOT89-3	4.50mm x 2.45mm
	DFN1x1-4	1.00mm x 1.00mm

1. For all available packages, see the [Package Information](#) and [Ordering Information](#) at the end of data sheet.

Simplified Application Schematic¹



1. Shutdown version with enable mode

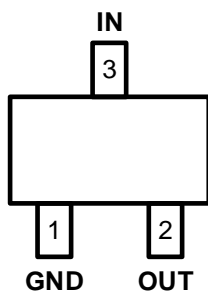
Table of Contents

1	Features	1
2	Applications	1
3	Description.....	1
	Table of Contents	2
4	Device Overview.....	3
4.1	Pinout and Pin Assignment	3
4.2	Pin Description	4
5	Parameter Information	5
5.1	Absolute Maximum Ratings.....	5
5.2	Recommended Operation Conditions	5
5.3	Electrical Sensitivity	5
5.4	Thermal Resistance	5
5.5	Electrical Characteristics	6
5.6	Typical Characteristics	7
6	Functional Description	8
6.1	Block Diagram.....	8
6.2	Operation	8
6.3	Device Mode Description	9
7	Application Information	10
7.1	Typical Application Circuit	10
7.2	Detailed Design Description	10
7.3	Power Dissipation	11
7.4	Typical Application Curves	12
8	Layout Guidelines and Example.....	13
9	Package Information	14
9.1	Outline Dimensions	14
9.2	Recommended Land Pattern	22
10	Ordering Information	26
11	Revision History	27

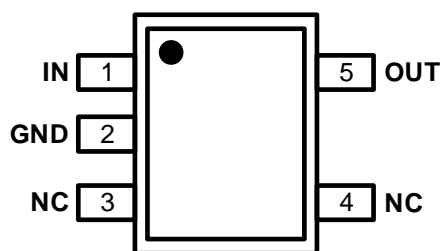
4 Device Overview

4.1 Pinout and Pin Assignment

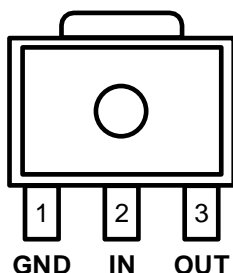
GD30LD2401BSTR-I
SOT23-3
(Top View)



GD30LD2401NSTR-S
SOT23-5
(Top View)



GD30LD2401BWTR-I
SOT89-3
(Top View)



GD30LD2401BWTR-S
SOT89-3R
(Top View)

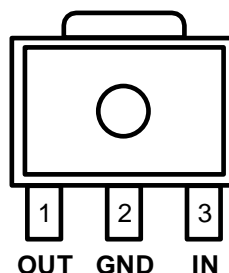
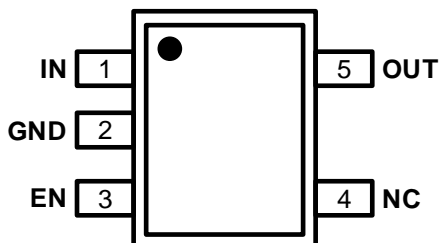


Figure 1. Normal Version Without Enable

GD30LD2401NSTR-I
SOT23-5
(Top View)



GD30LD2401JETR-I
DFN1x1-4
(Top View)

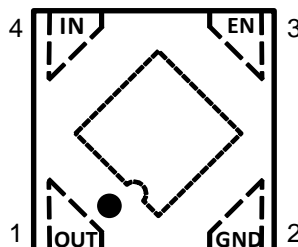


Figure 2. Shutdown Version With Enable

4.2 Pin Description

NAME	PIN NUMBER						PIN TYPE ¹	FUNCTION
	SOT23-3	SOT23-5	SOT23-5	SOT89-3	SOT89-3R	DFN1x1-4		
GND	1	2	2	1	2	2	G	Ground pin.
IN	3	1	1	2	3	4	P	Power supply input pin.
OUT	2	5	5	3	1	1	P	Output pin.
EN			3			3	I	Enable control pin. Active high.
NC		3,4	4					No connection.

1. I = Input, P = Power, G = Ground.

5 Parameter Information

5.1 Absolute Maximum Ratings

Exceeding the operating temperature range(unless otherwise noted)¹

SYMBOL	PARAMETER	MIN	MAX	UNIT
V _{IN}	IN	-0.3	45	V
V _{EN}	EN	-0.3	V _{IN}	V
V _{OUT}	OUT	-0.3	6	V
T _J	Operating junction temperature	-40	150	°C
T _{stg}	Storage temperature	-65	150	°C

1. The maximum ratings are the limits to which the device can be subjected without permanently damaging the device. Note that the device is not guaranteed to operate properly at the maximum ratings. Exposure to the absolute maximum rating conditions for extended periods may affect device reliability.

5.2 Recommended Operation Conditions

SYMBOL ¹	PARAMETER	MIN	TYP	MAX	UNIT
V _{IN}	Input supply voltage range	2.5		36	V
V _{OUT}	Output voltage range	1.8		5	V
T _J	Operating junction temperature	-40		125	°C

1. The device is not guaranteed to function outside of its operating conditions.

5.3 Electrical Sensitivity

SYMBOL	CONDITIONS	VALUE	UNIT
V _{ESD(HBM)}	Human-body model (HBM), ANSI/ESDA/JEDEC JS-001-2017 ¹	±2000	V
V _{ESD(CDM)}	Charge-device model (CDM), ANSI/ESDA/JEDEC JS-002-2022 ²	±500	V

1. JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
2. JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

5.4 Thermal Resistance

SYMBOL ¹	CONDITIONS	PACKAGE	VALUE	UNIT
Θ _{JA}	Natural convection, 2S2P PCB	SOT23-3	360	°C/W
		SOT23-5	250	°C/W
		SOT89-3	135	°C/W
		DFN1x1-4	250	°C/W

1. Thermal characteristics are based on simulation, and meet JEDEC document JESD51-7.

5.5 Electrical Characteristics

$V_{IN} = V_{OUT} + 2V$, $I_{OUT} = 10mA$, $C_{IN} = C_{OUT} = 1.0\mu F$, $T_A = 25^\circ C$, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
V_{IN}	Operating input voltage		2.5		36	V
V_{OUT}	Output voltage accuracy	$T_J = -40^\circ C$ to $125^\circ C$	-2		+2	%
I_{OUT}	Maximum output current	$V_{IN} = V_{OUT} + 2V$	250			mA
I_Q	Quiescent current	$I_{OUT} = 0mA$		2.5	4	μA
I_{SHDN}	Shutdown current	$V_{EN} = 0V$		0.1	1	μA
V_{DO}	Dropout voltage	$V_{OUT} = 3.0V$, $I_{OUT} = 100mA$		330		mV
		$V_{OUT} = 3.0V$, $I_{OUT} = 200mA$		690		mV
$R_{regLINE}$	Line regulation	$2.5V \leq V_{IN} \leq 36V$, $I_{OUT} = 10mA$		0.01	0.04	%/V
$R_{regLOAD}$	Load regulation	$1mA \leq I_{OUT} \leq 300mA$, $V_{IN} = V_{OUT} + 2V$			40	mV
V_{EN_RISE}	Rising enable threshold	EN input voltage high	1.2			V
V_{EN_FALL}	Falling enable threshold	EN input voltage low			0.4	V
I_{EN}	EN pin current	$V_{EN} = 0$ to $36V$		1		μA
PSRR	Power supply rejection ration	$V_{IN} = V_{OUT} + 1V$, $I_{OUT} = 20mA$, $f = 1KHz$		60		dB
V_n	Output noise voltage	$V_{IN} = V_{OUT} + 2V$, $I_{OUT} = 1mA$, $f = 10Hz$ to $100KHz$		100		μV_{rms}
T_{TSD}	Thermal shutdown temperature ¹			155		$^\circ C$
T_{HYS}	Thermal shutdown hysteresis ¹			20		$^\circ C$

1. Guaranteed by design and engineering sample characterization.

5.6 Typical Characteristics

$C_{IN} = C_{OUT} = 1.0\mu F$, $T_A = 25^\circ C$, unless otherwise noted.

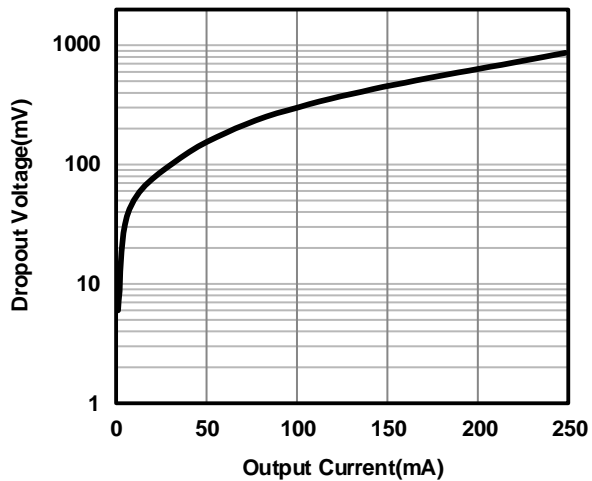


Figure 3. Dropout Voltage vs. Output Current

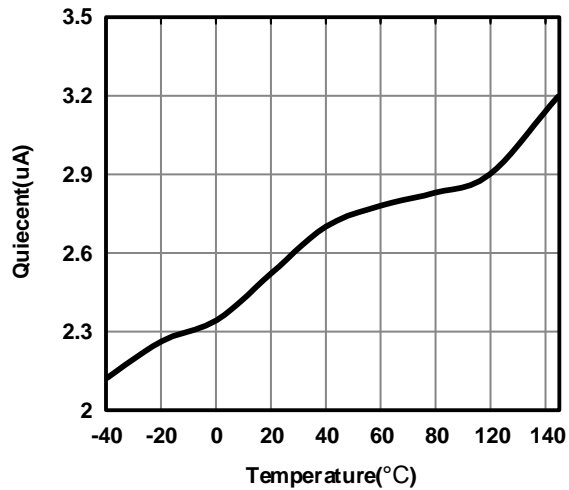


Figure 4. Quiescent Current vs. Temperature

6 Functional Description

6.1 Block Diagram

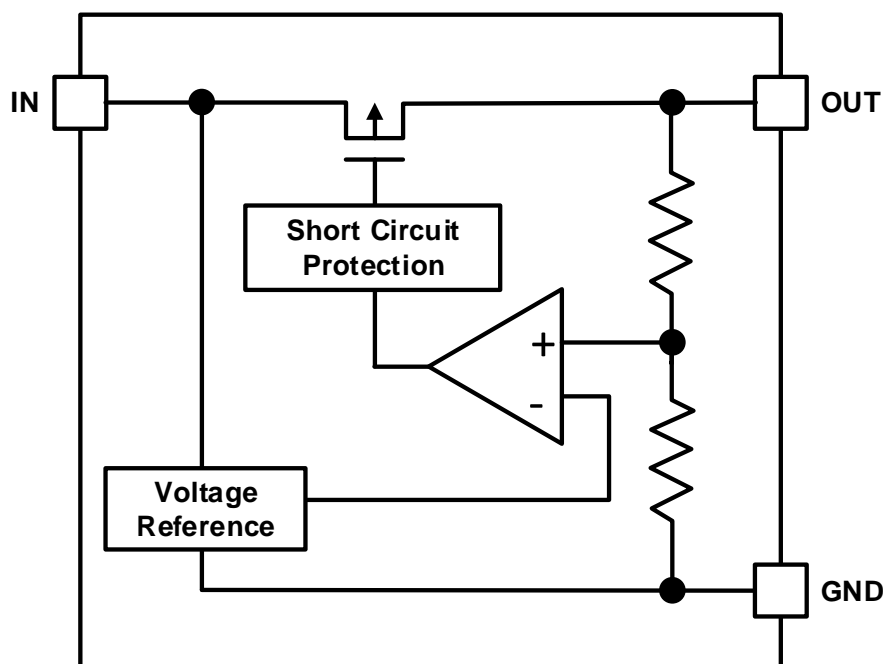


Figure 5. GD30LD2401 Functional Block Diagram

6.2 Operation

The external input and output capacitors of GD30LD2401 series must be properly selected for stability and performance. Use a 1 μ F or larger input capacitor and place it close to the device IN and GND pins. The GD30LD2401 series is designed specifically to work with low ESR ceramic output capacitor in space-saving and performance consideration. Place the output capacitor close to the device OUT and GND pins. Increasing capacitance and decreasing ESR can improve the circuit's PSRR and line transient response.

6.2.1 Dropout Voltage

The GD30LD2401 series use a PMOS pass transistor to achieve low dropout. When ($V_{IN} - V_{OUT}$) is less than the dropout voltage (V_{DO}), the PMOS pass device is in the linear region of operation and the input-to-output resistance is the $R_{DS(ON)}$ of the PMOS pass element. V_{DO} scales approximately with the output current because the PMOS device behaves as a resistor in dropout condition.

6.2.2 Short Circuit Protection

When output current at the OUT pin is higher than current limit threshold or the OUT pin is short-circuit to GND, the short-circuit protection will be triggered and clamp the output current to approximately 200 mA to prevent over-current and to protect the regulator from damage due to overheating.

6.2.3 Thermal Shutdown

The over temperature protection function of GD30LD2401 series will turn off the P-MOSFET when the junction temperature exceeds 155°C (typical). Once the junction temperature cools down by approximately 20°C, the regulator will automatically resume operation.

6.3 Device Mode Description

6.3.1 Device Enable

The GD30LD2401 series has an EN pin to turn on or turn off the regulator, When the EN pin is in logic high, the regulator will be turned on. When the EN pin is in logic low, the shutdown current is almost 0.1μA typical. Furthermore, the EN pin prohibit floating and may be directly tied to IN to keep the part on.

7 Application Information

The GD30LD2401 is high voltage, low power consumption and low dropout LDO. Its output voltage is fixed, providing two versions with or without enable.

7.1 Typical Application Circuit

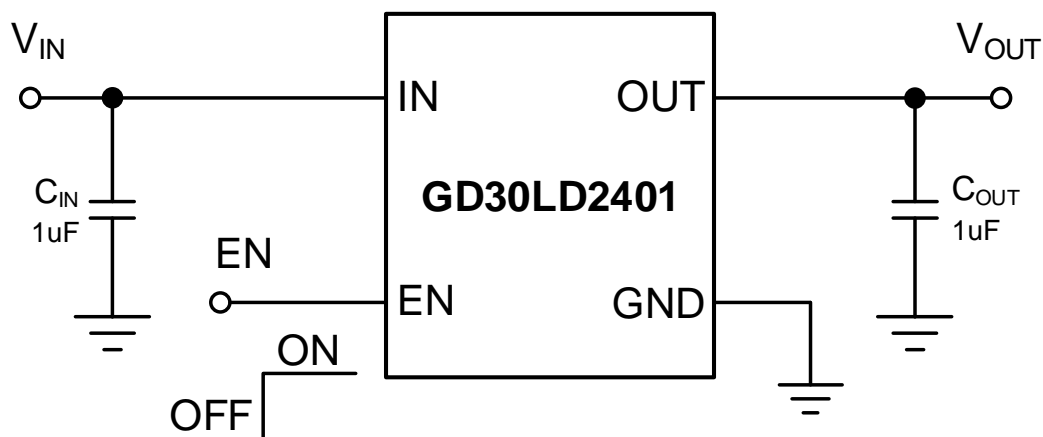


Figure 6. With Enable Mode Reference Design

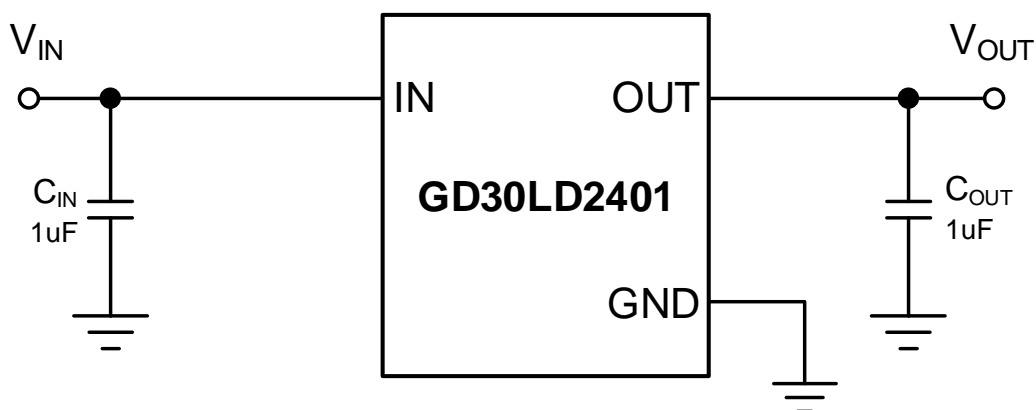


Figure 7. Without Enable Mode Reference Design

7.2 Detailed Design Description

7.2.1 Input Capacitor Selection

A 1 μ F to 10 μ F ceramic capacitor is recommended to connect between IN and GND pins to decouple input power supply glitch and noise. The amount of the capacitance may be increased without limit. This input capacitor must be located as close as possible to the device to assure input stability and less noise. For PCB layout, a wide copper trace is required for both IN and GND.

7.2.2 Output Capacitor Selection

An output capacitor is required for the stability of the LDO. The recommended output capacitance is from 1 μ F to

10 μ F, Equivalent Series Resistance (ESR) is from 5m Ω to 100m Ω , and temperature characteristics are X7R or X5R. Higher capacitance values help to improve load/line transient response. The output capacitance may be increased to keep low undershoot/overshoot. Place output capacitor as close as possible to OUT and GND pins.

7.3 Power Dissipation

Circuit reliability demands that proper consideration is given to device power dissipation, location of the circuit on the printed circuit board (PCB), and correct sizing of the thermal plane. The PCB area around the regulator must be as free as possible of other heat-generating devices that cause added thermal stresses.

Power dissipation in the regulator depends on the input-to-output voltage difference and load conditions.

$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT} + V_{IN} \times I_{GND} \quad (1)$$

$V_{IN} \times V_{OUT}$ represents the static power consumption of the LDO, the value is relatively small and can be ignored. An important note is that power dissipation can be minimized, and thus greater efficiency achieved, by proper selection of the system voltage rails. Proper selection allows the minimum input-to-output voltage differential to be obtained. The low dropout of the device allows for maximum efficiency across a wide range of output voltages.

The main heat conduction path for the device is through the thermal pad on the package. As such, the thermal pad must be soldered to a copper pad area under the device. This pad area contains an array of plated vias that conduct heat to any inner plane areas or to a bottom-side copper plane.

The maximum power dissipation determines the maximum allowable junction temperature (T_J) for the device. Power dissipation and junction temperature are most often related by the junction-to-ambient thermal resistance (θ_{JA}) of the combined PCB, device package, and the temperature of the ambient air (T_A). The maximum power dissipation can be calculated as below:

$$T_J = T_A + \theta_{JA} \times P_D \quad (2)$$

$$I_{OUT} = \frac{T_J - T_A}{\theta_{JA} \times (V_{IN} - V_{OUT})} \quad (3)$$

7.4 Typical Application Curves

$C_{IN} = C_{OUT} = 1\mu F$, $T_A = 25^\circ C$, unless otherwise noted.

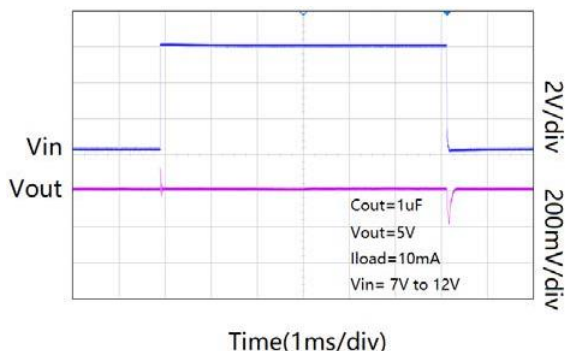


Figure 8. Line Transient Response ($C_{OUT} = 1\mu F$)

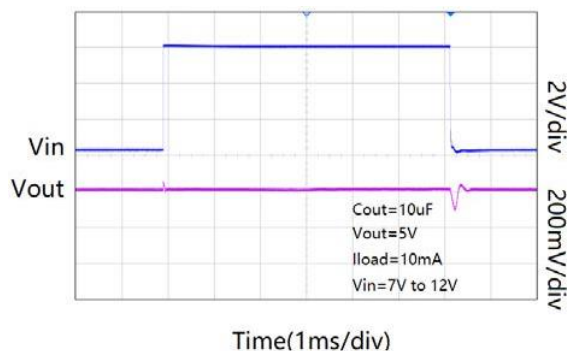


Figure 9. Line Transient Response ($C_{OUT} = 10\mu F$)

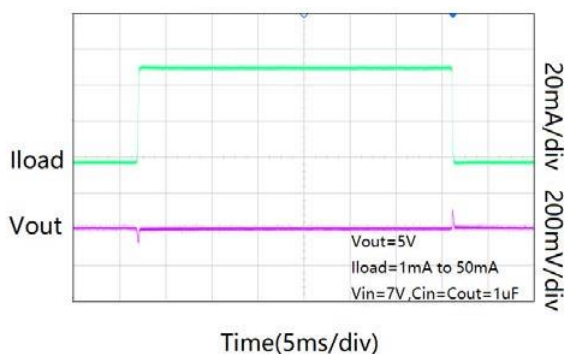


Figure 10. Load Transient Response ($C_{OUT} = 1\mu F$)

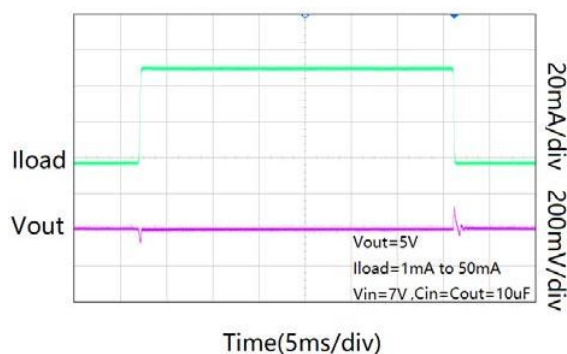


Figure 11. Load Transient Response ($C_{OUT} = 10\mu F$)

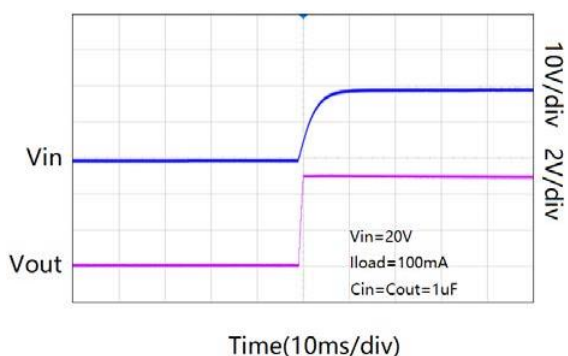


Figure 12. Start Up($C_{OUT} = 1\mu F$)

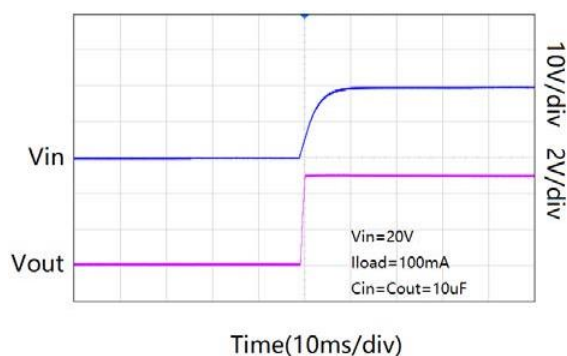


Figure 13. Start Up ($C_{OUT} = 10\mu F$)

8 Layout Guidelines and Example

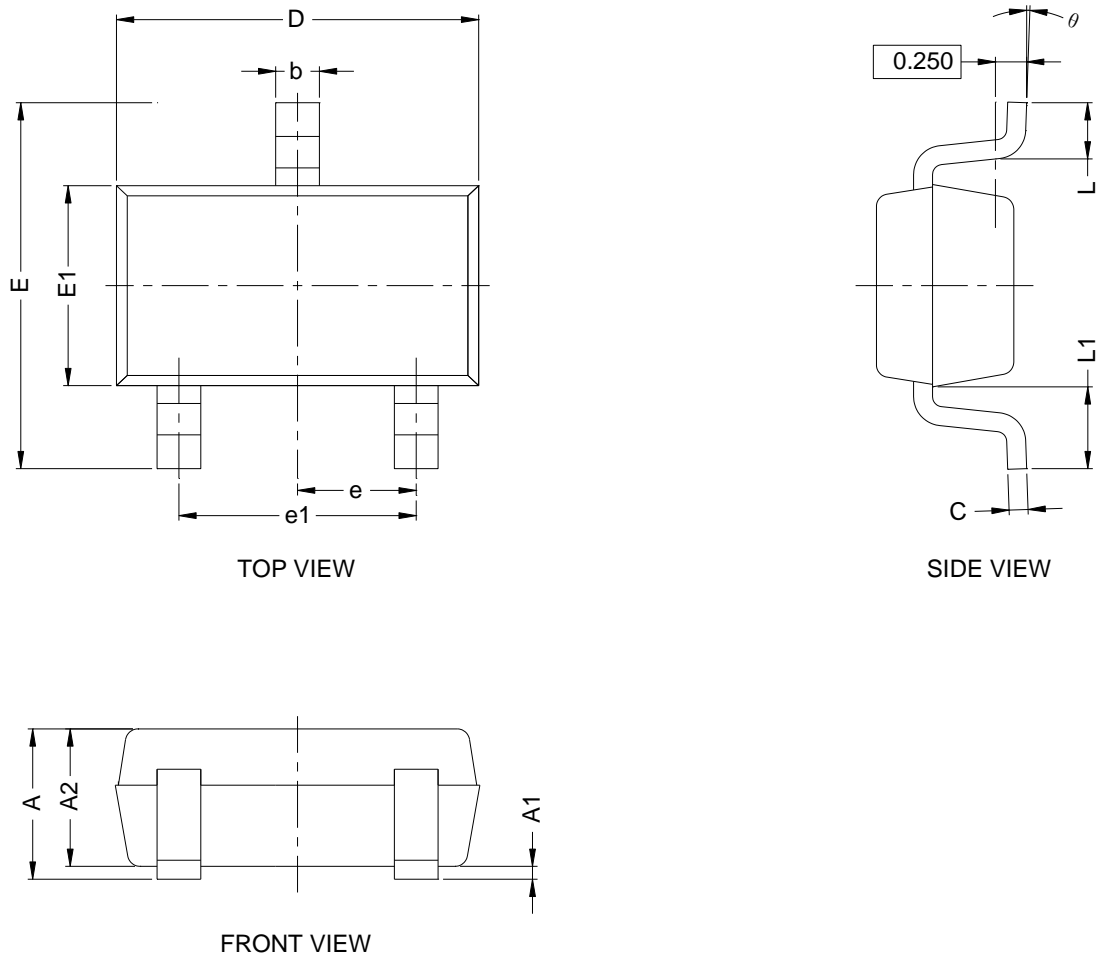
By placing input and output capacitors on the same side of the PCB as the LDO, and placing them as close as is practical to the package can achieve the best performance. The ground connections for input and output capacitors must be back to the GD30LD2401 ground pin using as wide and as short of a copper trace as is practical.

Connections using long trace lengths, narrow trace widths, and/or connections through via must be avoided. These add parasitic inductances and resistance that results in worse performance especially during transient conditions.

9 Package Information

9.1 Outline Dimensions

SOT23-3 Package Outline



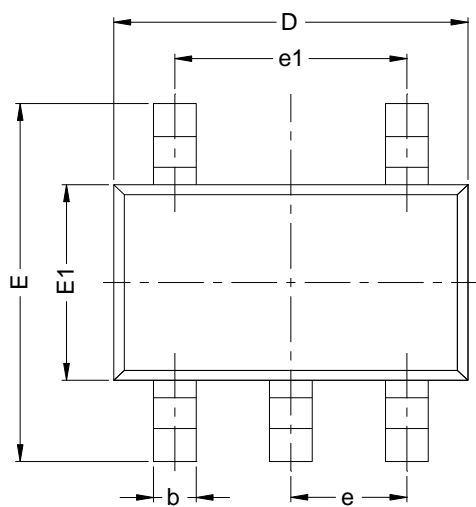
NOTES:

1. All dimensions are in millimeters.
2. Package dimensions does not include mold flash, protrusions, or gate burrs.
3. Refer to the [Table 1 SOT23-3 dimensions\(mm\)](#).

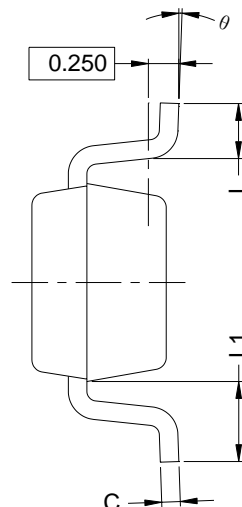
Table 1. SOT23-3 dimensions(mm)

SYMBOL	MIN	NOM	MAX
A			1.25
A1	0.00		0.10
A2	1.05	1.10	1.15
b	0.30		0.40
c	0.10		0.20
D	2.82	2.92	3.02
E	2.60	2.90	3.00
E1	1.50	1.60	1.70
e	0.95 BSC		
e1	1.90 BSC		
L	0.30		0.60
L1	0.49	0.64	0.79
θ	0°		8°

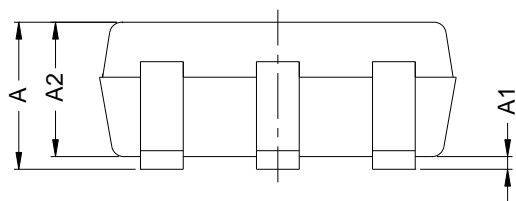
SOT23-5 Package Outline



TOP VIEW



SIDE VIEW



FRONT VIEW

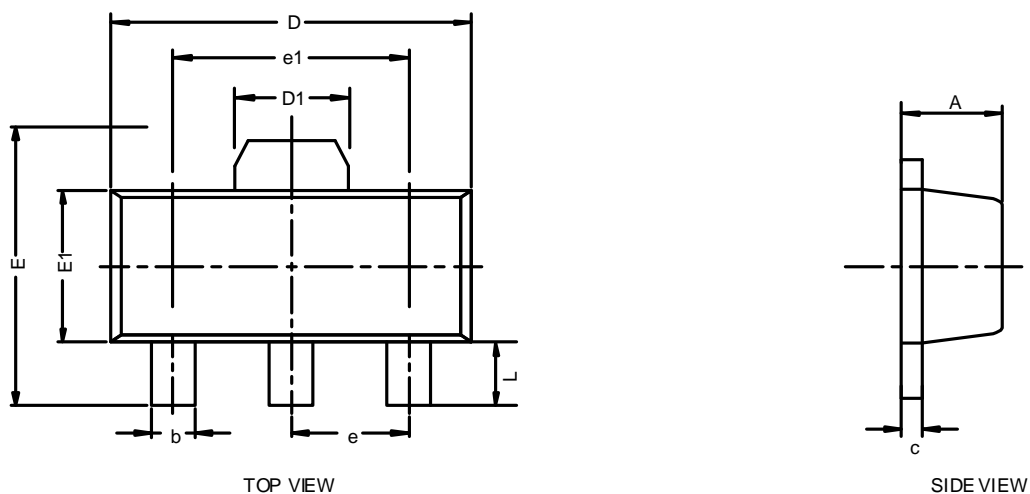
NOTES: (continued)

1. Refer to the [Table 2 SOT23-5 dimensions\(mm\)](#).

Table 2. SOT23-5 dimensions(mm)

SYMBOL	MIN	NOM	MAX
A			1.25
A1	0.00		0.10
A2	1.05	1.10	1.15
b	0.35		0.50
c	0.08		0.20
D	2.82	2.92	3.02
E	2.60	2.90	3.00
E1	1.60		1.70
e	0.95 BSC		
e1	1.90 BSC		
L	0.30		0.60
L1	0.49	0.64	0.79
θ	0°		8°

SOT89-3 Package Outline



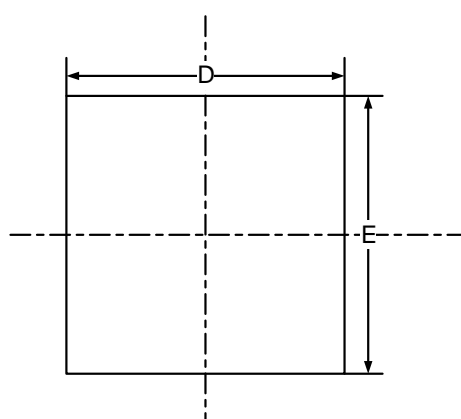
NOTES: (continued)

1. Refer to the [Table 3 SOT89-3 dimensions\(mm\)](#).

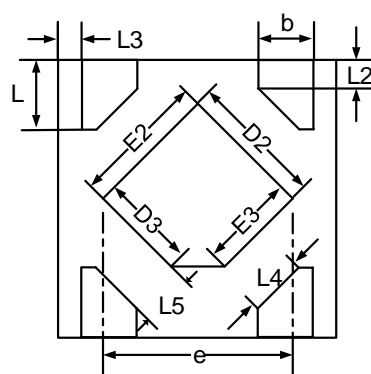
Table 3. SOT89-3 dimensions(mm)

SYMBOL	MIN	NOM	MAX
A	1.40		1.60
b	0.32		0.52
c	0.35		0.44
D	4.40		4.60
D1	1.55REF		
E	3.94		4.25
E1	2.30		2.60
e	1.50BSC		
e1	3.00BSC		
L	0.90		1.20

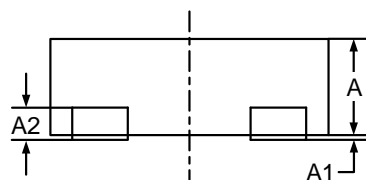
DFN1x1-4 Package Outline



TOP VIEW



BOTTOM VIEW



FRONT VIEW

NOTES: (continued)

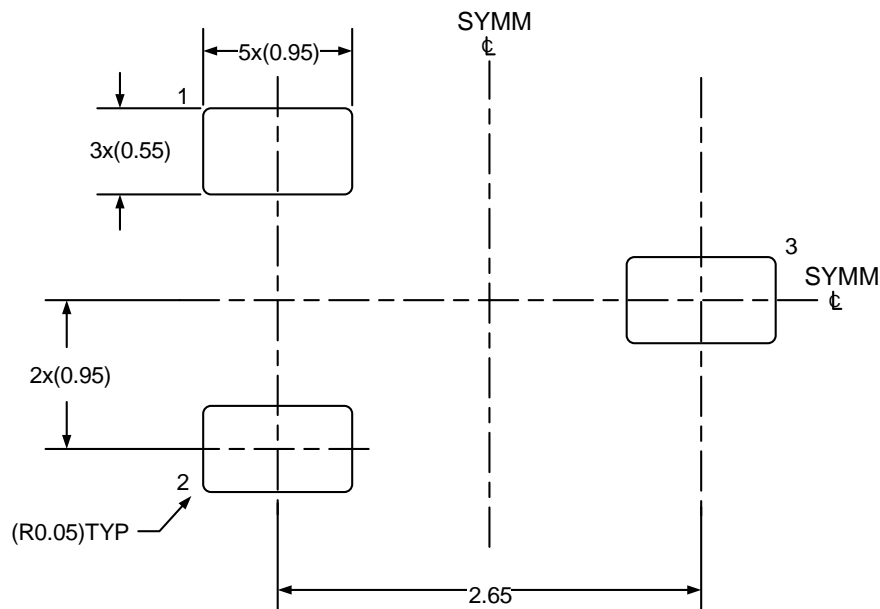
1. Refer to the [Table 4 DFN1x1-4 dimensions\(mm\)](#).

Table 4. DFN1x1-4 dimensions(mm)

SYMBOL	MIN	NOM	MAX
A	0.45	0.50	0.55
A1	0.00	0.025	0.05
A2	0.125REF		
b	0.15	0.20	0.25
D	0.95	1.00	1.05
D2	0.38	0.48	0.58
D3	0.230	0.330	0.430
E	0.95	1.00	1.05
E2	0.38	0.48	0.58
E3	0.230	0.330	0.430
L	0.15	0.25	0.35
L2	0.103REF		
L3	0.075REF		
L4	0.208REF		
L5	0.19	0.195	0.35

9.2 Recommended Land Pattern

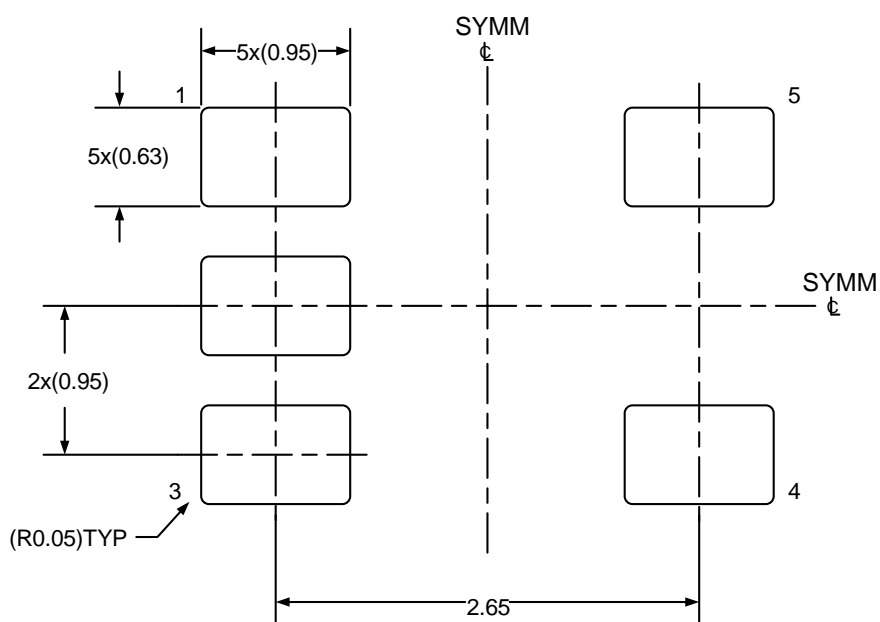
SOT23-3 Land Pattern Example



NOTES:

1. Refer to the IPC-7351 can also help you complete the designs.
2. Exposed metal shown.
3. Drawing is 20X scale.

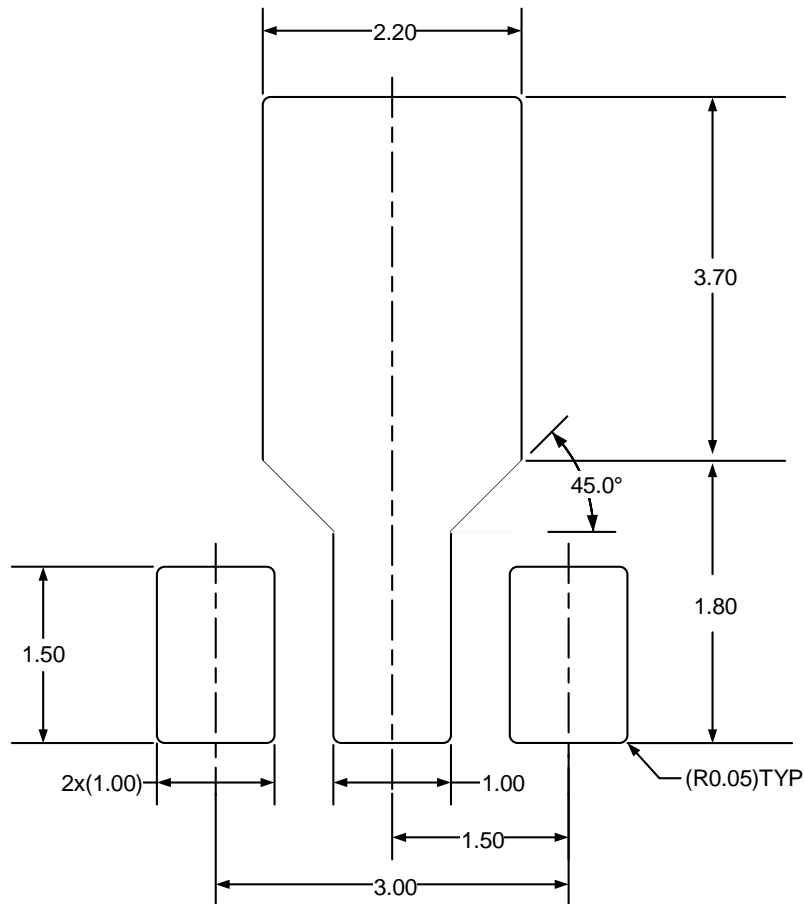
SOT23-5 Land Pattern Example



NOTES: (continued)

1. Refer to the IPC-7351 can also help you complete the designs.
2. Exposed metal shown.
3. Drawing is 20X scale.

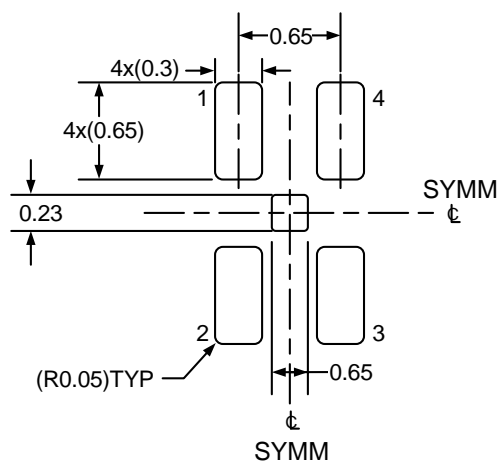
SOT89-3 Land Pattern Example



NOTES: (continued)

1. Refer to the IPC-7351 can also help you complete the designs.
2. Exposed metal shown.
3. Drawing is 15X scale.

DFN1x1-4 Land Pattern Example



NOTES: (continued)

1. Refer to the IPC-7351 can also help you complete the designs.
2. Exposed metal shown.
3. Drawing is 20X scale.

10 Ordering Information

Ordering Code	Package Type	ECO Plan	Packing Type	MOQ	OP Temp(°C)
GD30LD2401BSTR-I18	SOT23-3	Green	Tape & Reel	3000	-40°C to +125°C
GD30LD2401BSTR-I25	SOT23-3	Green	Tape & Reel	3000	-40°C to +125°C
GD30LD2401BSTR-I30	SOT23-3	Green	Tape & Reel	3000	-40°C to +125°C
GD30LD2401BSTR-I33	SOT23-3	Green	Tape & Reel	3000	-40°C to +125°C
GD30LD2401BSTR-I36	SOT23-3	Green	Tape & Reel	3000	-40°C to +125°C
GD30LD2401BSTR-I50	SOT23-3	Green	Tape & Reel	3000	-40°C to +125°C
GD30LD2401NSTR-I18	SOT23-5	Green	Tape & Reel	3000	-40°C to +125°C
GD30LD2401NSTR-I25	SOT23-5	Green	Tape & Reel	3000	-40°C to +125°C
GD30LD2401NSTR-I30	SOT23-5	Green	Tape & Reel	3000	-40°C to +125°C
GD30LD2401NSTR-I33	SOT23-5	Green	Tape & Reel	3000	-40°C to +125°C
GD30LD2401NSTR-I36	SOT23-5	Green	Tape & Reel	3000	-40°C to +125°C
GD30LD2401NSTR-I50	SOT23-5	Green	Tape & Reel	3000	-40°C to +125°C
GD30LD2401NSTR-S18	SOT23-5	Green	Tape & Reel	3000	-40°C to +125°C
GD30LD2401NSTR-S25	SOT23-5	Green	Tape & Reel	3000	-40°C to +125°C
GD30LD2401NSTR-S30	SOT23-5	Green	Tape & Reel	3000	-40°C to +125°C
GD30LD2401NSTR-S33	SOT23-5	Green	Tape & Reel	3000	-40°C to +125°C
GD30LD2401NSTR-S36	SOT23-5	Green	Tape & Reel	3000	-40°C to +125°C
GD30LD2401NSTR-S50	SOT23-5	Green	Tape & Reel	3000	-40°C to +125°C
GD30LD2401BWTR-I18	SOT89-3	Green	Tape & Reel	1000	-40°C to +125°C
GD30LD2401BWTR-I25	SOT89-3	Green	Tape & Reel	1000	-40°C to +125°C
GD30LD2401BWTR-I30	SOT89-3	Green	Tape & Reel	1000	-40°C to +125°C
GD30LD2401BWTR-I33	SOT89-3	Green	Tape & Reel	1000	-40°C to +125°C
GD30LD2401BWTR-I36	SOT89-3	Green	Tape & Reel	1000	-40°C to +125°C
GD30LD2401BWTR-I50	SOT89-3	Green	Tape & Reel	1000	-40°C to +125°C
GD30LD2401BWTR-S18	SOT89-3	Green	Tape & Reel	1000	-40°C to +125°C
GD30LD2401BWTR-S25	SOT89-3	Green	Tape & Reel	1000	-40°C to +125°C
GD30LD2401BWTR-S30	SOT89-3	Green	Tape & Reel	1000	-40°C to +125°C
GD30LD2401BWTR-S33	SOT89-3	Green	Tape & Reel	1000	-40°C to +125°C
GD30LD2401BWTR-S36	SOT89-3	Green	Tape & Reel	1000	-40°C to +125°C
GD30LD2401BWTR-S50	SOT89-3	Green	Tape & Reel	1000	-40°C to +125°C
GD30LD2401JETR-I18	DFN1x1-4	Green	Tape & Reel	10000	-40°C to +125°C
GD30LD2401JETR-I25	DFN1x1-4	Green	Tape & Reel	10000	-40°C to +125°C
GD30LD2401JETR-I30	DFN1x1-4	Green	Tape & Reel	10000	-40°C to +125°C
GD30LD2401JETR-I33	DFN1x1-4	Green	Tape & Reel	10000	-40°C to +125°C
GD30LD2401JETR-I36	DFN1x1-4	Green	Tape & Reel	10000	-40°C to +125°C
GD30LD2401JETR-I50	DFN1x1-4	Green	Tape & Reel	10000	-40°C to +125°C

11 Revision History

REVISION NUMBER	DESCRIPTION	DATE
1.0	Initial release and device details	2023

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