适用于 1ns 脉宽应用的 LMG1020 5V 7A/5A 低侧 GaN 和 MOSFET 驱动器

1 特性

- 用于 GaN 和硅质 FET 的低侧、超快栅极驱动器
- 1ns 最小输入脉冲宽度
- 工作频率高达 60MHz
- 传播延迟：典型值 2.5ns，最大值 4.5ns
- 典型上升和下降时间 400ps
- 7A 峰值拉电流和 5A 峰值灌电流
- 5V 电源电压
- UVLO 和过热保护
- 0.8mm × 1.2mm WCSP 封装

2 应用

- 激光雷达
- 飞行时间激光驱动器
- 面部识别
- E 类无线充电器
- VHF 谐振电源转换器
- 基于 GaN 的同步整流器
- 扩增实境

3 说明

LMG1020 器件是一款单通道低侧驱动器，专为在高速应用 （包括 LiDAR、飞行时间、面部识别和任何涉及低侧驱动器的功率转换器）中驱动 GaN FET 和逻辑电平 MOSFET 而设计。LMG1020 设计简约，可实现 2.5 纳秒的极快传播延迟和 1 纳秒的最小脉冲宽度。通过分别在栅极与 OUTH 和 OUTL 之间连接外部电阻器，可针对上拉和下拉沿来独立调节驱动强度。

该驱动器 提供 过载或故障情况下的欠压锁定 (UVLO) 和过热保护 (OTP)。

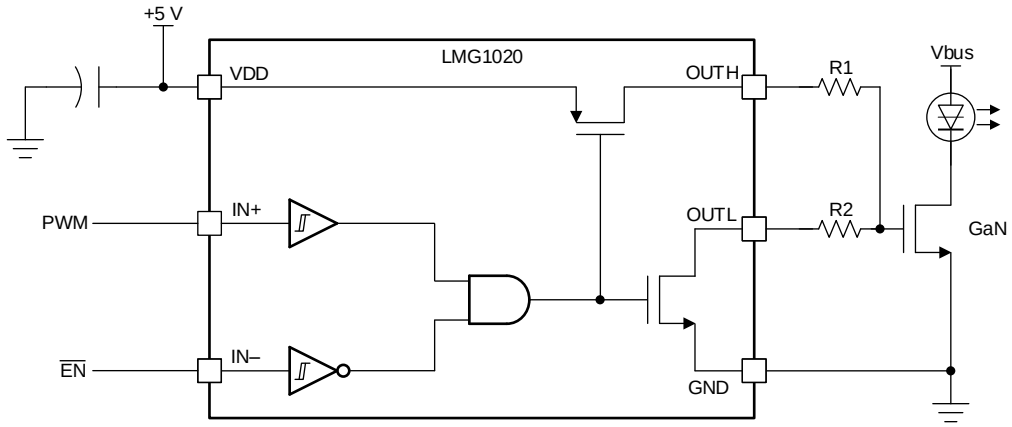
LMG1020 的 0.8mm × 1.2mm WCSP 封装可最大限度地降低栅极回路电感并最大限度地提高高频功率密度要求。

器件信息(1)

器件型号	封装	封装尺寸（标称值）
LMG1020	WCSP (6)	0.80mm × 1.20mm

(1) 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。

简化的激光雷达 (LiDAR) 驱动器级图



本文档旨在为方便起见，提供有关 TI 产品中文版本的信息，以确认产品的概要。 有关适用的官方英文版本的最新信息，请访问 www.ti.com，其内容始终优先。 TI 不保证翻译的准确性和有效性。 在实际设计之前，请务必参考最新版本的英文版本。

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4 修订历史记录

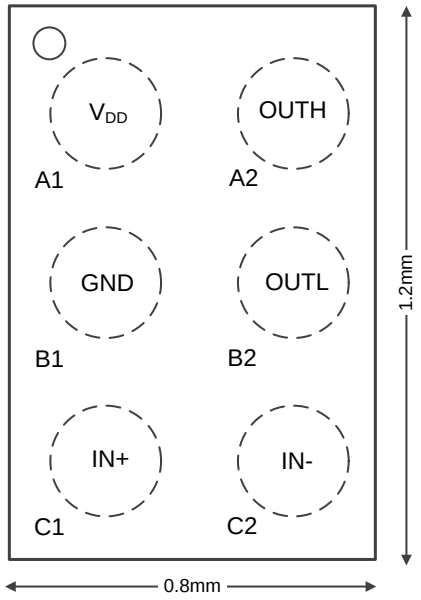
Changes from Original (June 2018) to Revision B **Page**

- 已更改 将图 1 输入结构中的“与非门”更改为“与门” 1

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5 Pin Configuration and Functions

YFF Package
6-Ball WCSP
Top View



Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
GND	B1	—	Ground
IN+	C1	I	Positive logic-level input
IN–	C2	I	Negative logic-level input
OUTL	B2	O	Pulldown gate drive output. Connect through an optional resistor to the target transistor's gate
OUTH	A2	O	Pullup gate drive output. Connect through a resistor to the target transistor's gate
VDD	A1	I	Input voltage supply. Decouple through a small size, low inductance capacitor to GND

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6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)

		MIN	MAX	UNIT
V_{DD}	Supply voltage		5.75	V
V_{IN}	IN+, IN- pin voltage	-0.3	V_{DD} + 0.3	V
V_{OUT}	OUTH, OUTL pin voltage	-0.3	5.75	V
T_{STG}	Storage Temperature	-55	150	°C
T_J	Operating Temperature	-40	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Rating* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Condition*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins(1)	±2000	V
		Charged device model (CDM), per JEDEC specification JESD22-C101, all pins(2)	±500	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 500-V HBM is possible with the necessary precautions.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 250-V CDM is possible with the necessary precautions.

6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

		MIN	NOM	MAX	UNIT
V_{DD}	Supply voltage	4.75	5	5.4	V
V_{INx}	IN+ or IN- input voltage	0		V_{DD}	V
T_J	Operating Temperature	-40		125	°C

6.4 Thermal Information

THERMAL METRIC(1)		SN1020 YFF (WCSP) 6 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	133.6	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	1.7	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	38.1	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	0.5	°C/W
Y_{JB}	Junction-to-board characterization parameter	38.3	°C/W

(1) For more information about traditional and new thermal metrics, see the Semiconductor and IC Package Thermal Metrics application report.

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6.5 Electrical Characteristics

over operating free-air temperature range (VDD=5V unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
DC Characteristics						
$I_{VDD, Q}$	VDD Quiescent Current	IN_+ = IN_- = 0 V			75	µA
$I_{VDD, op}$	VDD Operating Current(1)	fsw = 30 MHz, 2 Ω, 0.1 pF load		40		mA
		fsw = 30 MHz, 2 Ω, 100 pF load		51		mA
$V_{DD, UVLO}$	Under-voltage Lockout	V_{DD} rising	4.06	4.19	4.33	V
$\Delta V_{DD, UVLO}$	UVLO Hysteresis			85		mV
T_{OTP}	Over temperature shutdown, rising edge threshold			170		°C
ΔT_{OTP}	Over temperature hysteresis			18		°C
Input DC Characteristics						
V_{IH}	IN+, IN- high threshold		1.7		2.6	V
V_{IL}	IN+, IN- low threshold		1.1		1.8	V
V_{HYST}	IN+, IN- hysteresis		0.5		1	V
R_{IN+}	Positive input pull-down resistance	To GND	100	150	250	kΩ
R_{IN-}	Negative input pull-up resistance	to V_{DD}	100	150	250	kΩ
C_{IN}	Input pin capacitance(1)	To GND		1.3		pF
Output DC Characteristics						
V_{OL}	OUTL voltage	I_{OUTL} = 100 mA, IN+= IN- = 0 V			36	mV
V_{DD}-V_{OH}	OUTH voltage	I_{OUTH} = 100 mA, IN+= 5 V, IN- = 0 V			50	mV
I_{OH}	Peak source current(1)	V_{OUTH} = 0 V, IN+= 5 V, IN- = 0 V		7		A
I_{OL}	Peak sink current(1)	V_{OUTL} = 5 V, IN+= IN- = 0 V		5		A

(1) Insured by design

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6.6 Switching Characteristics

over operating free-air temperature range (VDD=5V unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{start}	Startup Time, V_{DD} rising above UVLO	IN- = GND, IN+ = V_{DD} , V_{DD} rising to 4.2V to OUTH rising		40	70	µs
$t_{shut-off}$	ULVO falling	IN- = GND, IN+ = VDD , VDD falling below 4.1V to OUTH falling	1	1.9	3.1	µs
$t_{pd,\ r}$	Propagation delay, turn on	IN- = 0 V, IN+ to OUTH, 100 pF load	1.5	2.5	4.1	ns
$t_{pd,\ f}$	Propagation delay, turn off	IN- = 0 V, IN+ to OUTL, 100 pF load	1.8	2.6	4.3	ns
Δt_{pd}	Pulse positive distrortion ($t_{pd,\ f}$ - $t_{pd,\ r}$)			230	603	ps
t_{rise}	Output rise time	0Ω series 100 pF load(1)		375		ps
t_{fall}	Output fall time	0Ω series 100 pF load(1)		350		ps
t_{min}	Minimum input pulse width	0Ω series 100 pF load(1)		1		ns

(1) rise and fall calulated as a 20% to 80%

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6.7 Typical Characteristics

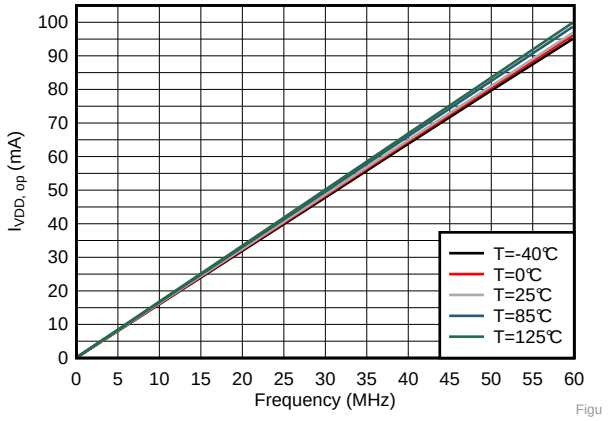


图 1. $I_{VDD, op}$ vs Frequency With 2 Ω Series 100 pF Load

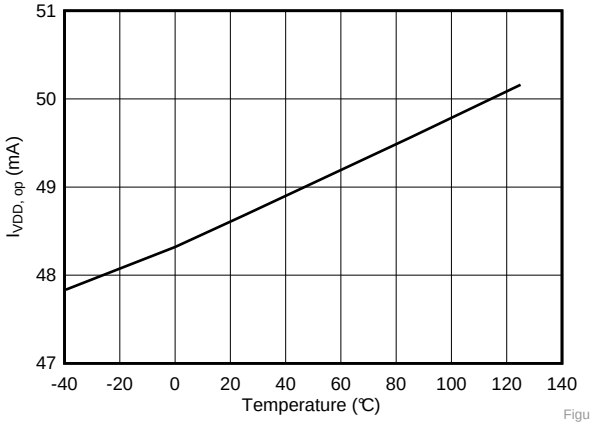


图 2. $I_{VDD, op}$ vs Temperature At 30MHz With 2 Ω series 100 pF Load

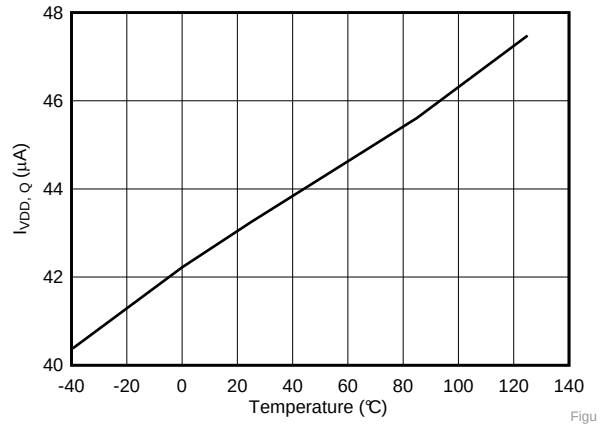


图 3. Quiescent Current vs Temperature

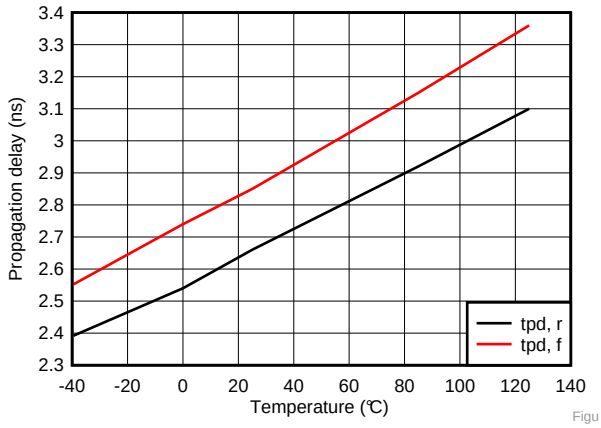


图 4. Propagation Delay vs Temperature

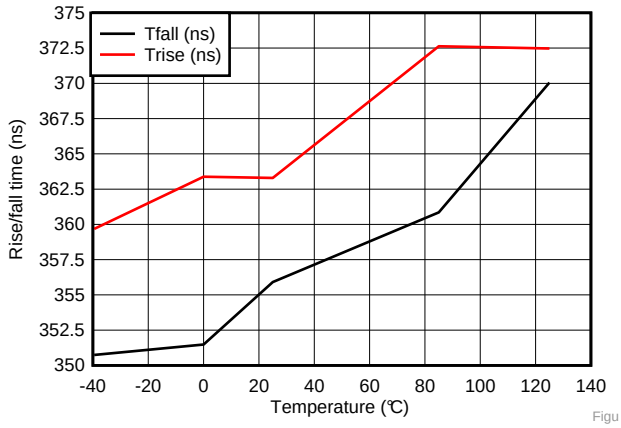


图 5. Rise And Fall Time vs Temperature With 0 Ω Series 100 pF Load

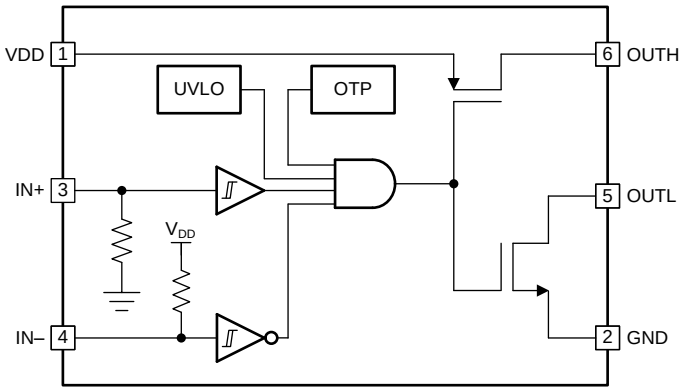
7 Detailed Description

7.1 Overview

LMG1020 is a high-performance low-side 5-V gate driver for GaN and logic-level silicon power transistors. While the LMG1020 is designed for high-speed applications, such as wireless power transmission and LiDAR applications, it is a high-performance solution for any other low-side driving applications.

The LMG1020 is optimized to provide the lowest propagation delay through the driver to the power transistor. LMG1020 is in a small 0.8×1.2mm WCSP ball-grid array package in order to minimize its parasitic inductance. This low inductance design helps achieve high current, low ringing performance in very high frequency operation when driving power FETs.

7.2 Functional Block Diagram



7.3 Feature Description

7.3.1 Input Stage

The input stage features two Schmitt-triggers at the pins IN+ and IN– to reduce sensitivity to noise on the inputs. IN+ signal and the inverted IN– signal are both sent to an AND gate. IN+ is connected with a pull-down resistor while IN– is connected with a pull-up resistor to prevent unintended turnon. The output signal will follow the difference between IN+ and IN–. Both IN+ and IN– are single ended inputs, and these two pins cannot be used as a differential input pair.

7.3.2 Output Stage

LMG1020 provides 7-A source, 5-A sink (asymmetrical drive) peak-drive current capability, and features a split output configuration. The OUTH and OUTL outputs of the LMG1020 allow the user to use independent resistors connecting to the gate. The two resistors allow the user to independently adjust the turnon and turnoff drive strengths to control slew rate and EMI, and to control ringing on the gate signal. For GaN FETs, controlling ringing is important to reduce stress on the GaN FET and driver. The output stage OUTL is also pulled down in undervoltage condition, which prevents the unintended charge accumulation of device C_{iss}.

7.3.3 V_{DD} and undervoltage lockout

LMG1020 features nominal 5V and maximum 5.25V of supply voltage, and its absolute maximum supply voltage is 5.75 V. In the design, it is recommended to limit the variability of the power supply to be within 5% (0.25V), and the overshoot voltage during switching transient not to exceed the absolute maximum voltage. Refer to Section VDD and Overshoot for more the detailed design guide.

LMG1020 also features internal undervoltage lockout (UVLO) to protect the driver and circuit in case of fault conditions. The UVLO point is setup between 4.1V and 4.2V with a hysteresis of 85mV. This UVLO level is specifically designed to guarantee that GaN power devices can be switched at a low $R_{DS(ON)}$ region. During UVLO condition, the OUTL is pulled down to ground.

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Feature Description (接下页)

7.3.4 Overtemperature Protection (OTP)

LMG1020 features overtemperature protection (OTP) function by having a rising edge trigger point at around 170°C. With a hysteresis of 20°C, the device can restart to operate when junction temperature is below 150°C.

7.4 Device Functional Modes

表 1. Truth Table

IN–	IN+	OUTH	OUTL
L	L	OPEN	L
L	H	H	OPEN
H	L	OPEN	L
H	H	OPEN	L

8 Application and Implementation

注

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

8.1 Application Information

To operate GaN transistors at very high switching frequencies and to reduce associated switching losses, a powerful gate driver is employed between the PWM output of controller and the gates of the GaN transistor. Also, gate drivers are indispensable when the outputs of the PWM controller do not meet the voltage or current levels needed to directly drive the gates of the switching devices. With the advent of digital power, this situation is often encountered because the PWM signal from the digital controller is often a 3.3 V logic signal, which cannot effectively turn on a power switch. A level-shift circuit is needed to boost the 3.3 V signal to the gate-drive voltage (such as 5 V) in order to fully turn on the power device and minimize conduction losses.

Gate drivers effectively provide the buffer-drive functions. Gate drivers also address other needs such as minimizing the effect of high-frequency switching noise (by placing the high-current driver IC physically close to the power switch), reducing power dissipation and thermal stress in controllers by moving gate charge power losses from the controller into the driver.

The LMG1020 is a 60-MHz low-side gate driver for enhancement mode GaN FETs and Si FETs in a single-ended configuration. The split-gate outputs with strong source and sink capability provides flexibility to adjust the turnon and turnoff strength independently. As a low side driver, LMG1020 can be used in a variety of applications, including different power converters, LiDAR, time-of-flight laser drivers, class-E wireless chargers, synchronous rectifiers, and augmented reality. LMG1020 can also be used as a high frequency low current laser diode driver, or as a signal buffer with very fast rise/fall time.

8.2 Typical Application

The LMG1020 is designed to be used with a single low-side, ground-referenced GaN or logic-level Si FET, as shown in 图 6. Independent gate drive resistors, R1 and R2, are used to independently control the turnon and turnoff drive strengths, respectively. For fast and strong turnoff, R2 can be shorted and OUTL directly connected to the transistor's gate. For symmetric drive strengths, it is acceptable to short OUTH and OUTL and use a single gate-drive resistor.

TI recommends using at least a 2 Ω resistor at each OUTH and OUTL to avoid voltage overstress due to inductive ringing. Ringing overshoot must not exceed the maximum absolute supply voltage.

For applications requiring smaller resistance values, contact TI E2E for guidance.

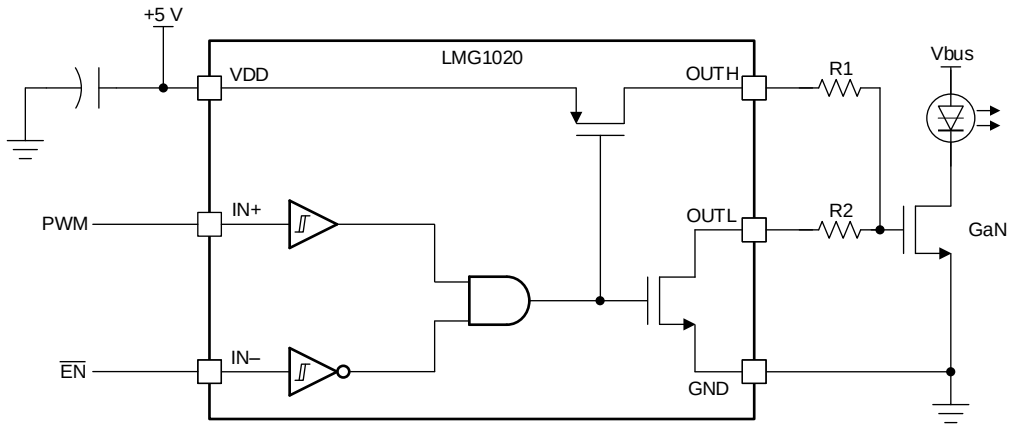


图 6. Typical Implementation of a Circuit

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Typical Application (接下页)

8.2.1 Design Requirements

When designing a multi-MHz (or nano-second pulse) application that incorporates the LMG1020 gate driver and GaN power FETs, some design considerations must be evaluated first to make the most appropriate selection. Among these considerations are layout optimization, circuit voltages, passive components, operating frequency, and controller selection.

8.2.2 Detailed Design Procedure

8.2.2.1 Handling Ground Bounce

For the best switching performance and gate loop with lowest parasitics, it is recommended to connect the ground return pin of LMG1020 as close as possible to the source of the low-side FET in a low inductance manner. However, doing so can cause the ground of LMG1020 to bounce relative to the system or controller ground and lead to erroneous switching logic on the input so as mis-turn on/off on the output.

First of all, LMG1020 has input hysteresis built into the input buffers to help counteract this effect. The maximum di/dt allowed to prevent the input voltage transient from exceeding the input hysteresis is given by 公式 1

$$\frac{di_S}{dt} = \frac{V_{HYST}}{L_{RS}} \quad (1)$$

where

- L_{RS} is the inductance between FET source and ground,
- V_{HYST} is the hysteresis of the input pin,
- and $di_s/\Delta t$ is the maximum allowed current slew rate.

For an assumed parasitic inductance of 0.5 nH and a minimum hysteresis of 0.5 V, the maximum slew rate is 1 A/ns. Many applications would exhibit higher current slew rates, up to the 10 A/ns range, which would make this approach impractical. The stability of this approach can be improved by using the IN– input for the PWM signal and locally tying IN+ to VDD. By using the inverting input, the transient voltage applied to the input pin reinforces the PWM signal in a positive feedback loop. While this approach would reduce the probability of false pulses or oscillation, the transient spikes due to high di/dt may overly stress the inputs to the LMG1020. A current-limiting, 100 Ω resistor can be placed right before the IN– input to limit excessive current spikes in the device.

Secondly, for moderate ground-bounce cases, a simple R-C filter can be built with a simple resistor in series with the inputs. By utilizing the input capacitance of LMG1020, the resistor could be close to its input pin. The addition of a small capacitor on the input as supplement can also be helpful. A small time constant of the R-C filter can can enough to filter out high frequency noises. This solution is acceptable for moderate cases in applications where extra delay is acceptable and the pulse width is not extremely short such as 1ns range.

For more extreme cases, or where no delay is tolerable while pulse width is extremely short, using a common-mode choke provides the best results.

One example application where ground-bounce is particularly challenging is when using a current sense resistor. In configuration A LMG1020 ground is connected to the source of GaN FET, while the controller ground is connected to the other side of the current sense resistor as shown in 图 7. Due to the fast switching and very fast current slew rates, the high ground potential bounce induced by inductance of the sense resistor can disrupt the operation of the circuit or even damage the part. To prevent this, a common-mode choke can be used for IN+ and IN–, respectively. Resistors can also added to the signal output line before LMG1020 depending on the input signal pulse width to provide additional RC filtering. 图 9 presents the schematic using approach A with the preferred filtering method. Approach B as 图 8 places the current sense resistor within the gate drive loop path. In this case, the LMG1020 GND pin is connected to the signal ground, and with good ground plane connection, the ground bounce issue can be less severe than approach A. However, the inductance of the current sense resistor adds common-source inductance to the gate drive loop. The voltage generated across this parasitic inductance will subtract from the gate-drive voltage of the FET, slowing down the turnon and turnoff di/dt of the FET, or even cause mis-turn on and off. Additional gate resistance will have to be added to ensure the loop is stable and ring-free. The slower rise may negate the advantage of the fast switching of the GaN FET and may cause additional losses in the circuit. Therefore, this approach is not recommended.

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Typical Application (接下页)

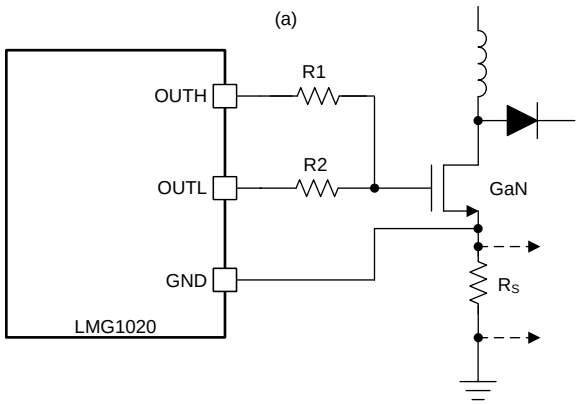


图 7. Source Resistor Current Sense A Configuration

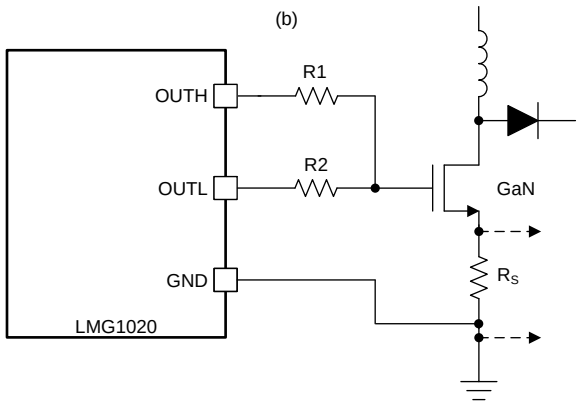


图 8. Source Resistor Current Sense B Configuration

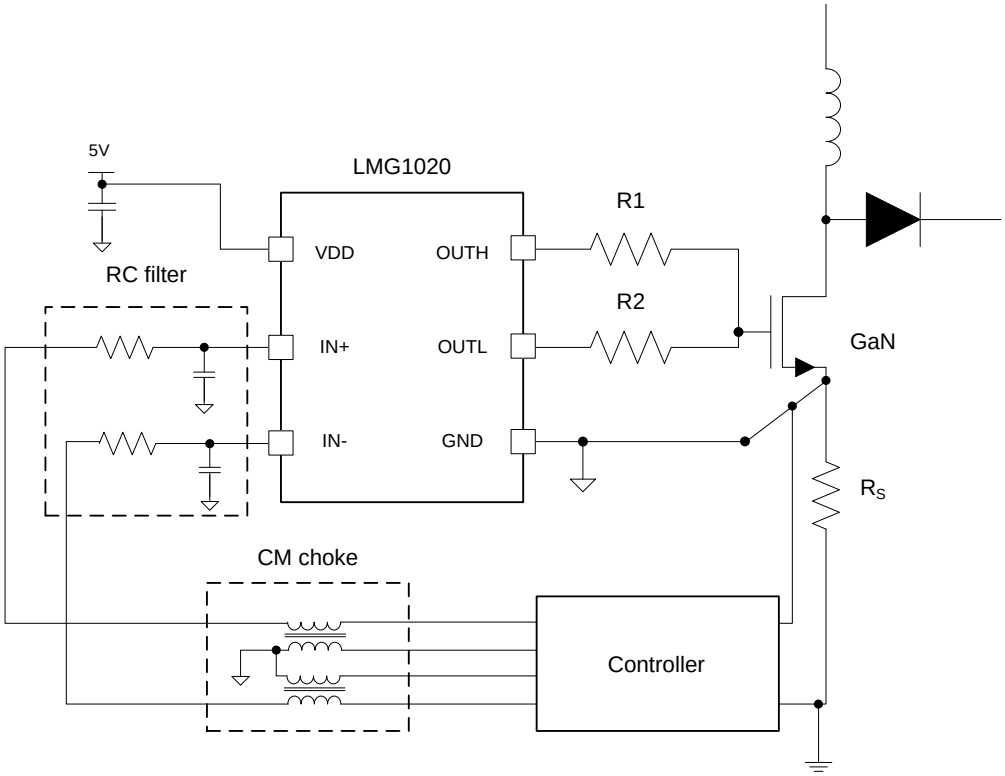


图 9. Filtering For Ground Bounce Noise Handling When Using LMG1020

8.2.2.2 Creating Nanosecond Pulse With LMG1020

LMG1020 can be used to drive pulses of nano seconds duration on to a capacitive load. LMG1020 can be driven with a equivalently short pulse on one input pin. However, this takes a sufficiently strong digital driver and careful consideration of the routing parasitics from digital output to input of LMG1020. Two inputs and included AND gate in LMG1020 provide an alternate method to create a short pulse at the LMG1020 output. Starting with both IN+ and IN– at low, taking IN+ high will cause the output to go high. Now if IN– is taken high as well, output will be pulled low. So a digital signal and its delayed version can be applied to IN+ and IN– respectively to create a

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Typical Application (接下页)

pulse at the output with width corresponding to the delay between the signals, as shown in 图 10. The delay can be digitally controlled in the nanosecond range. This method alleviates the requirements for driving the input of LMG1020. If a separate delayed version of the digital signal is not available, a RC delay followed by a buffer can be used to derive the second signal. Optionally, if LMG1020 must be driven with a single short duration pulse, that pulse can itself be generated using another LMG1020 by the above method to meet drive requirements.

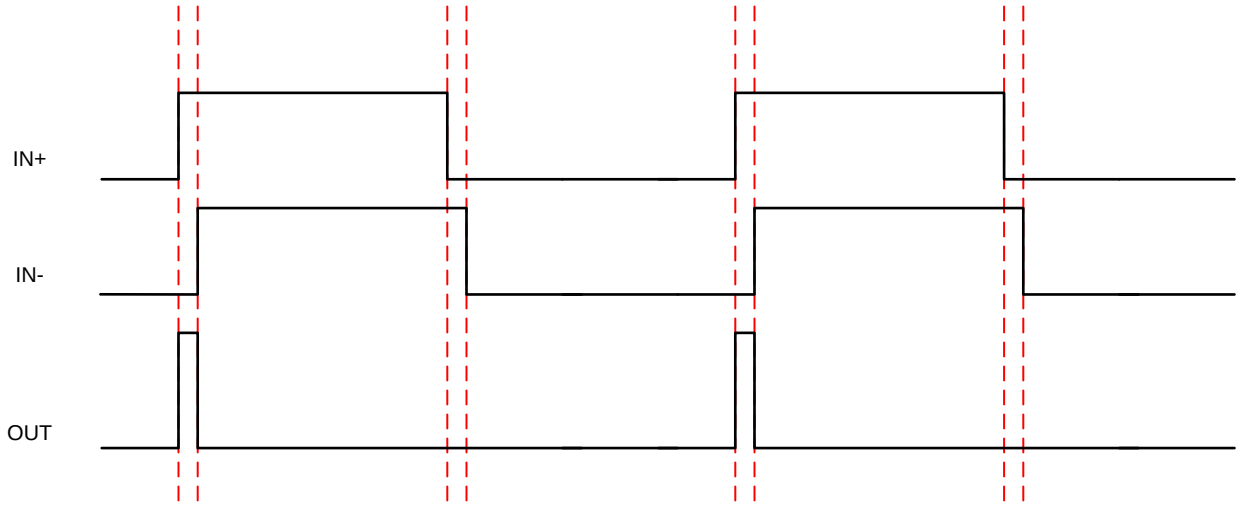


图 10. Timing Diagram To Create Short Pulses

8.2.3 VDD and Overshoot

Fast switching with high current is prone to ringing with parasitic inductances, including those on PCB traces. Overshoot associated with such ringing transients need to be evaluated and controlled as a part of the PCB design process to limit device stress. The parameters affecting stress are how high the overshoot is above the absolute maximum specification and the ratio of overshoot duration to the switching time period. Recommended design practice is to limit the overshoots to the absolute maximum pin voltages. This is accomplished with carful PCB layout to minimize parasitic inductances, choice of components with low ESL and addition of series resistance to limit rise times. For large overshoots, limiting the variability of the power supply may be required. For example, 0.5V of overshoot will be permissible with a maximum recommended supply of 5.25 V (5% variability); however, for larger overshoots, a supply with lower variability will be preferred.

8.2.4 Operating at Higher Frequency

With fast rise/fall time, and capability of achieving 1 ns pulse width, depending on the capacitive load condition, the operating frequency of LMG1020 can be increased in a burst manner. In conditions which requires very high frequency pulsing, a pulse train with certain period of pause between each burst can be adopted to avoid overheat of the device. This will help maintain the RMS output current similar as lower frequency operation but boost the transient frequency to very high. In addition, higher decoupling capacitance will be needed to supply high frequency charging of the capacitive load.

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Typical Application (接下页)

8.2.5 Application Curves

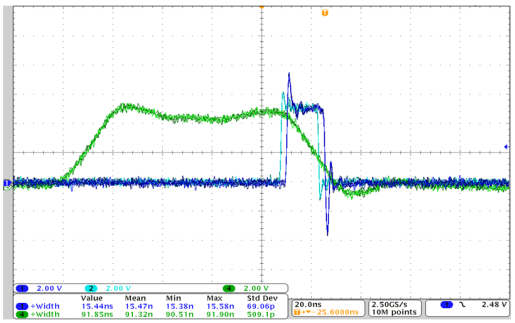


图 11. 90 ns Pulse from Function Generator Yielding 15 ns Pulse On The Input (Cyan) And Gate (Blue) After Pulse Shortening

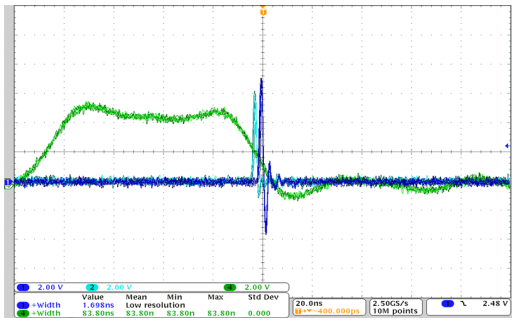


图 12. 90 ns Pulse from Function Generator Yielding 1.5 ns Pulse On The Input (Cyan) And Gate (Blue) After Pulse Shortening

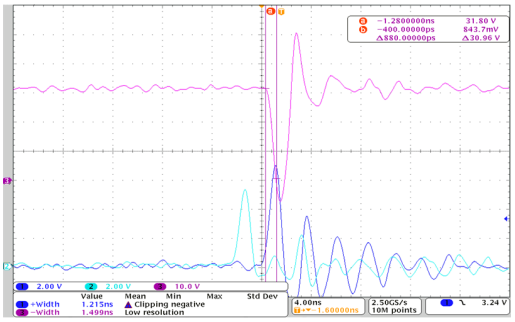


图 13. 1.2 ns Gate Pulse Yielding 1.5 ns 30V Into 1 Ω Pulse (500MHz Scope)



图 14. V_{DS} for 1.5 ns Pulse With 40V of Bus Voltage

图 11 and 图 12 are the waveforms showing the pulse short pulse generation and input/output pulses. The 90ns long pulse (in green color) and its delayed signal are sent through an AND gate, which outputs a short pulse signal as the input of LMG1020. The output signal (in blue color) follows the input (in cyan color) with certain propagation delay. An output pulse short as 1.5 ns can be obtained as 图 12.

图 13 is taken with a 500MHz oscilloscope and shows typical operation waveforms, including the input logic gating signal (cyan), gate signal (blue), and drain to source signal (pink) of the switching GaN FET. On the drain waveform of the FET, it is possible to see a 20V overshoot. This is due to the inductance in the power loop. Vg seems to be oscillating, but this is caused by pickup noise, which is inevitable even when using a spring ground connection.

图 14 shows the waveform of drain to source voltage of a FET driven by LMG1020 with 1.5ns pulse width and 300ps fall time, which drives maximum 60A current at 40V bus voltage.

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9 Power Supply Recommendations

A low-ESR/ESL ceramic capacitor must be connected close to the IC, between V_{DD} and GND pins to support the high peak current being drawn from V_{DD} during turnon of the FETs. It is most desirable to place the V_{DD} decoupling capacitor on the same side of the PC board as the driver. The inductance of via holes can impose excessive ringing on the IC pins.

TI recommends the use of a three-terminal capacitor connecting in shunt-through manner to achieve the lowest ESL and best transient performance. This capacitor can be placed as close as possible to the IC, while another capacitor in larger capacitance can be placed closely to the three-terminal cap to supply enough charge but with slightly lower bandwidth. As a general practice, the combination of a 0.1 µF of 0402 or feed-through capacitor (closest to LMG1020) and a 1 µF 0603 capacitor is recommended.

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10 Layout

10.1 Layout Guidelines

The layout of the LMG1020 is critical to its performance and functionality. The LMG1020 is available in a WCSP ball-grid array package, which enables low-inductance connection to a BGA-type GaN FET. 图 15 shows the recommended layout of the LMG1020 with a ball-grid array GaN FET. 图 16 presents a layout of LMG1020 with a 0.1 µF feed-through capacitor and a larger 1uF capacitor.

A four-layer or higher layer count board is required to reduce the parasitic inductances of the layout to achieve suitable performance. To minimize inductance and board space, resistors and capacitors in the 0201 package are used here. The gate drive power loss must be calculated to ensure an 0201 resistor will be able to handle the power level.

10.1.1 Gate Drive Loop Inductance and Ground Connection

A compact, low-inductance gate-drive loop is essential to achieving fast switching frequencies with the LMG1020. The LMG1020 should be placed as close to the GaN FET as possible, with gate drive resistors R1 and R2 immediately connecting OUTH and OUTL to the FET gate. Large traces must be used to minimize resistance and parasitic inductance.

To minimize gate drive loop inductance, the source return should be on layer 2 of the PCB, immediately under the component (top) layer. Vias immediately adjacent to both the FET source and the LMG1020 GND pin connect to this plane with minimal impedance. Finally, take care to connect the GND plane to the source power plane only at the FET to minimize common-source inductance and to reduce coupling to the ground plane.

10.1.2 Bypass Capacitor

The VDD power terminal of the LMG1020 must by bypassed to ground immediately adjacent to the IC. Because of the fast gate drive of the IC, the placement and value of the bypass capacitor is critical. The bypass capacitor must be place on the top layer, as close as possible to the IC, and connected to both VDD and GND using large power planes. This bypass capacitor has to be at least a 0.1 µF, up to 1 µF, with temperature coefficient X7R or better. Recommended body types are Low Inductance Chip Capacitor (LICC), Inter-Digitated Capacitor (IDC), Feed-through, and LGA. Finally, an additional 1 µF capacitor (not shown in 图 15) must be placed as close to the IC as practical.

10.2 Layout Example

图 15 presents a typical layout of LMG1020 with a 0402 decoupling capacitor C1, which is placed as close as possible to LMG1020. The ground return at GaN FET Kelvin source immediately flows through a via to the closest inner layer, and overlaps with the top layer traces.

图 16 presents a layout of LMG1020 with a 0.1 µF feed-through capacitor (C1) and a larger 1uF capacitor (C3) for decoupling. In this design, the feed-through capacitor C1 is placed in a shunt-through manner for lower noise decoupling, and C3 is placed next to C1. 0201 resistors are used at the output of LMG1020, which brings lower parasitic inductance than 0402 package.

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Layout Example (接下页)

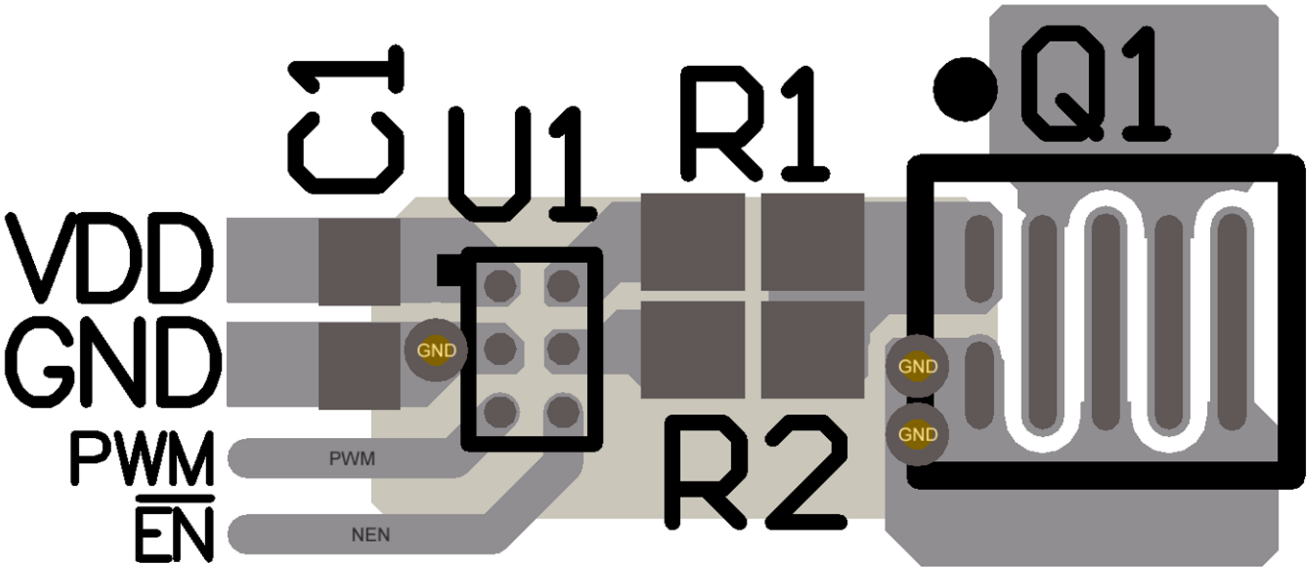


图 15. Typical LMG1020 Layout With Ball-Grid GaN FET And 0402 Decoupling Capacitor

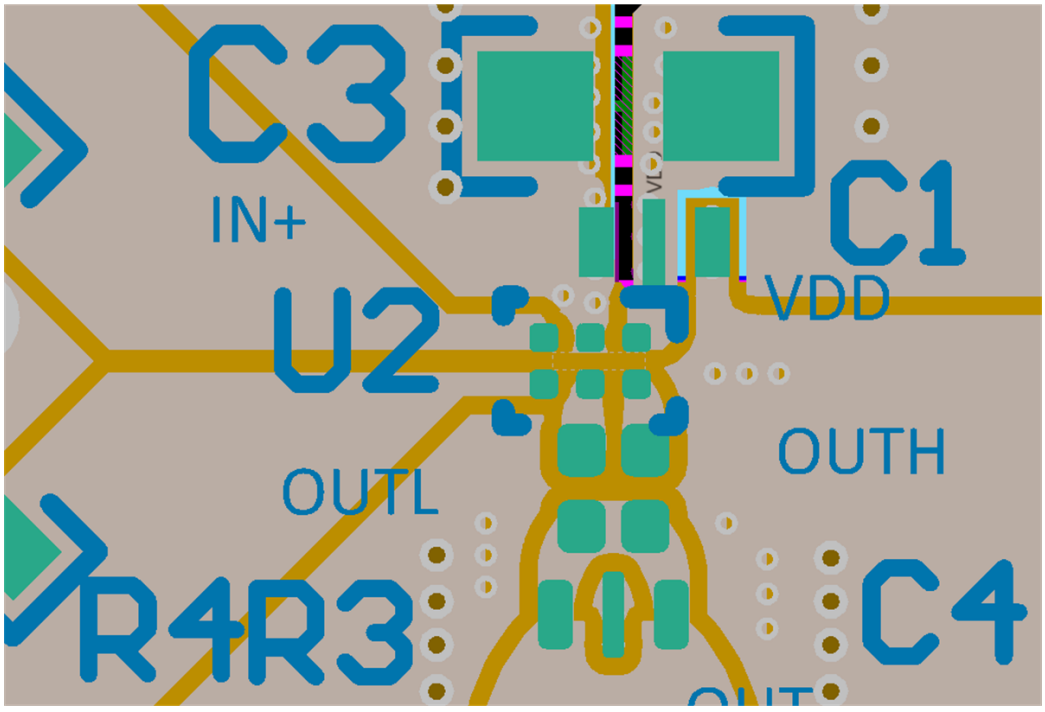


图 16. Typical Layout Of LMG1020 And A Feed-Through Decoupling Capacitor With A Capacitor Load

11 器件和文档支持

11.1 文档支持

11.1.1 相关文档

请参阅如下相关文档：

- *使用 LMG1020-EVM 纳秒 LiDAR EVM* (SNOU150)
- *《LMG1020 PSpice 瞬态模型》*(SNOM618)
- *《LMG1020 TINA-TI 参考设计》*(SNOM619)
- *《LMG1020 TINA-TI 瞬态 Spice 模型》*(SNOM620)
- *《LMG1020EVM Altium 设计文件》*(SNOR025)

11.2 接收文档更新通知

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ESD 的损坏小至导致微小的性能降级，大至整个器件故障。 精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

11.6 术语表

SLYZ022 — *TI 术语表*。

这份术语表列出并解释术语、缩写和定义。

12 机械、封装和可订购信息

以下页面包含机械、封装和可订购信息。这些信息是指定器件的最新可用数据。数据如有变更，恕不另行通知，且不会对此文档进行修订。如需获取此数据表的浏览器版本，请查阅左侧的导航栏。

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PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LMG1020YFFR	ACTIVE	DSBGA	YFF	6	3000	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 125	AT	Samples
LMG1020YFFT	ACTIVE	DSBGA	YFF	6	250	Green (RoHS & no Sb/Br)	SNAGCU	Level-1-260C-UNLIM	-40 to 125	AT	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
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Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

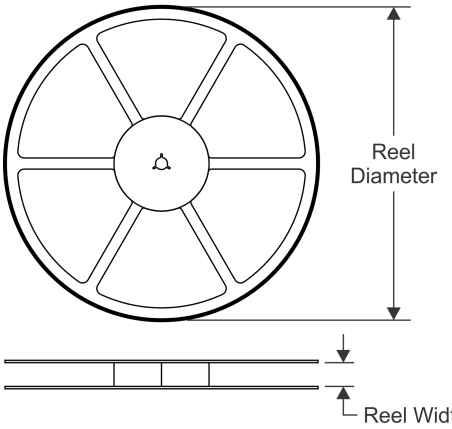
(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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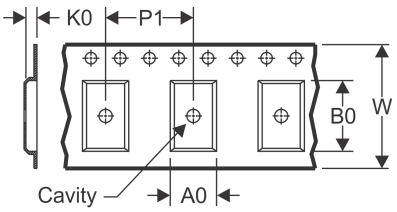
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TAPE AND REEL INFORMATION

REEL DIMENSIONS

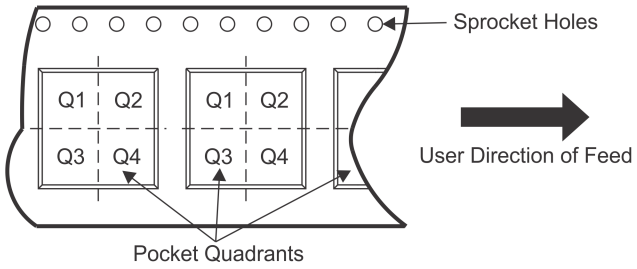


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

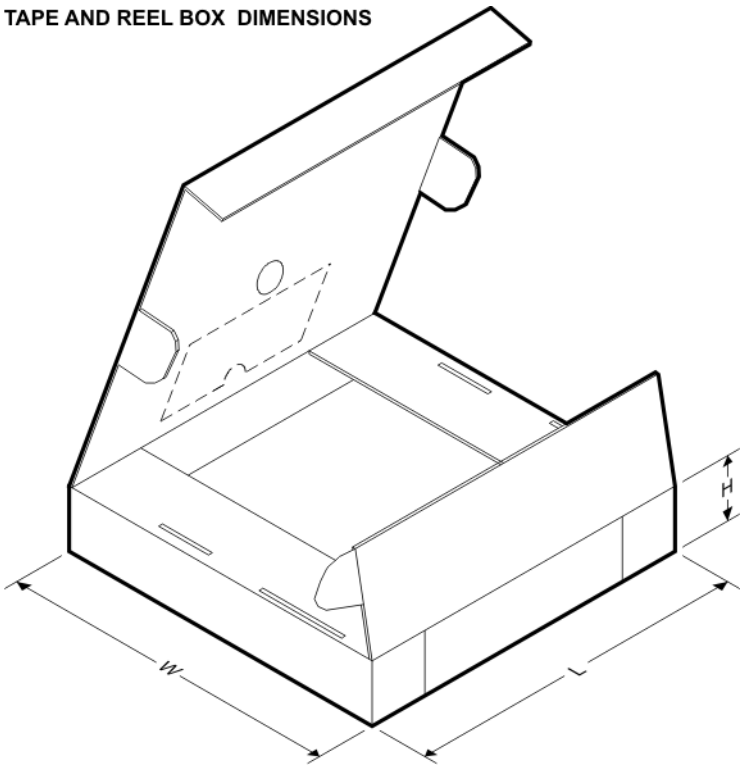
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LMG1020YFFR	DSBGA	YFF	6	3000	180.0	8.4	0.96	1.36	0.69	4.0	8.0	Q1
LMG1020YFFT	DSBGA	YFF	6	250	180.0	8.4	0.96	1.36	0.69	4.0	8.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

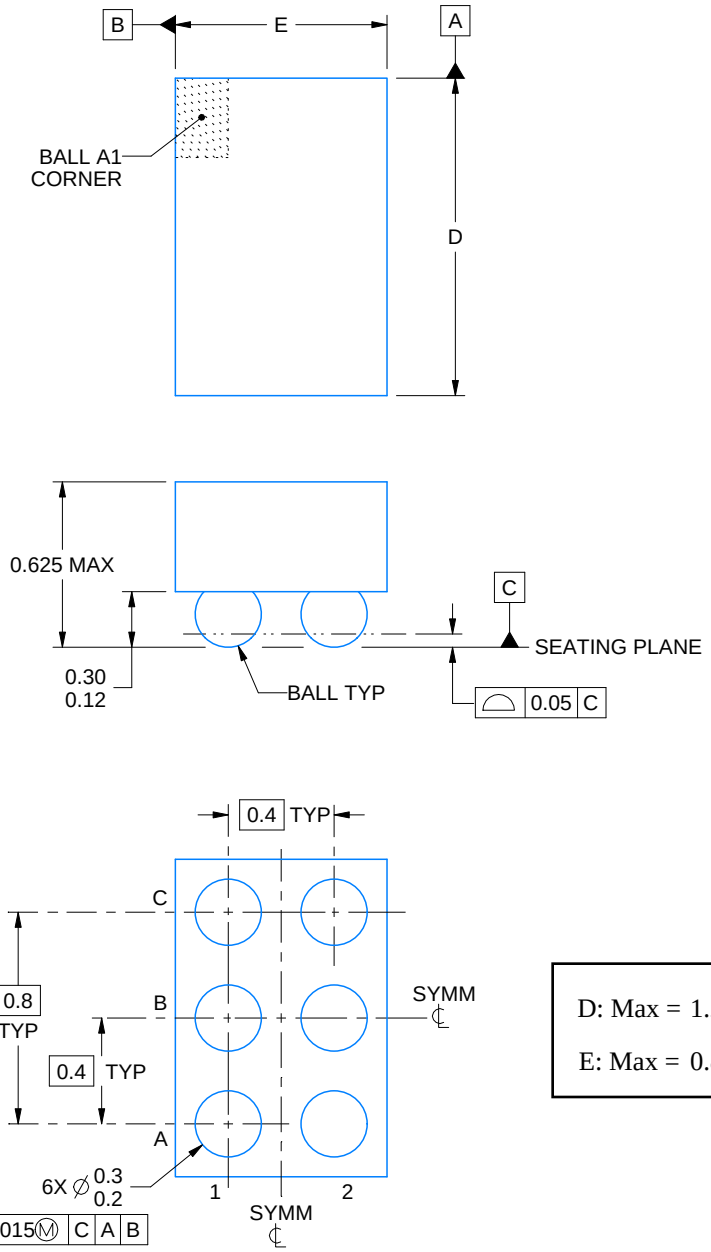
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LMG1020YFFR	DSBGA	YFF	6	3000	182.0	182.0	20.0
LMG1020YFFT	DSBGA	YFF	6	250	182.0	182.0	20.0

PACKAGE OUTLINE

YFF0006

DSBGA - 0.625 mm max height

DIE SIZE BALL GRID ARRAY



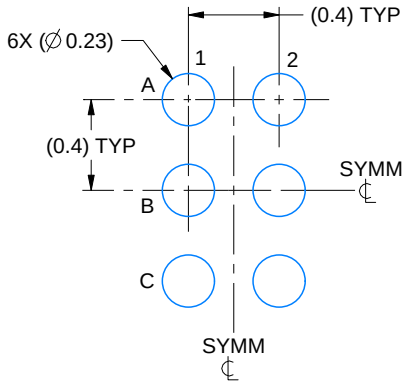
D: Max = 1.285 mm, Min =1.225 mm

E: Max = 0.885 mm, Min =0.825 mm

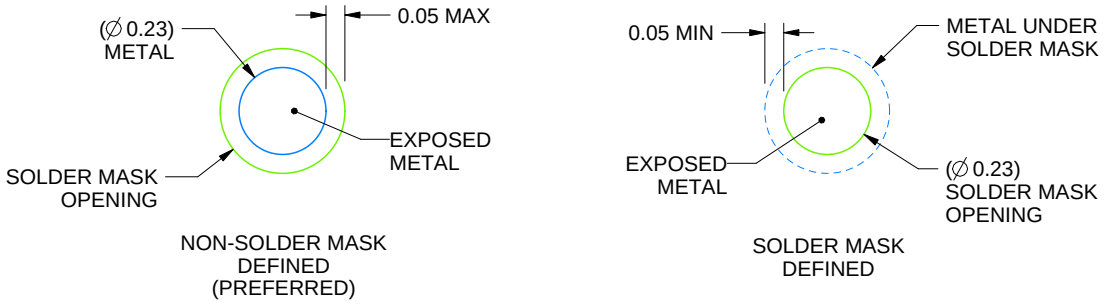
4223785/A 06/2017

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:30X

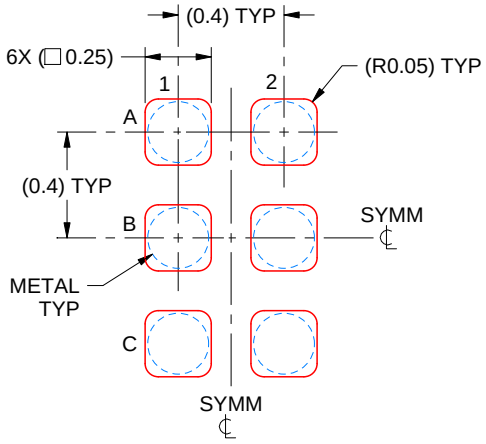


SOLDER MASK DETAILS
NOT TO SCALE

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NOTES: (continued)

3. Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. For more information, see Texas Instruments literature number SNVA009 (www.ti.com/lit/snva009).



SOLDER PASTE EXAMPLE
BASED ON 0.1 mm THICK STENCIL
SCALE:35X

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NOTES: (continued)

4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release.

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