

# NGTB15N60R2FG

## 应用于 Inverter, Fan Motor



ON Semiconductor®

www.onsemi.cn

### RC-IGBT 应用资料

#### 1, 概要

RC-IGBT 为 Reverse Conducting Insulated Gate Bipolar Transistor 的简称, 是与 FWD 搭载于同一芯片的 IGBT。

如同 Inverter 电路, 当同时需要 IGBT 与 FWD 时, 由于它们集成于同一芯片, 所以不但减小了封装面积, 还保持了两者的热平衡。

#### 应用资料

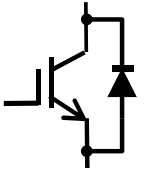

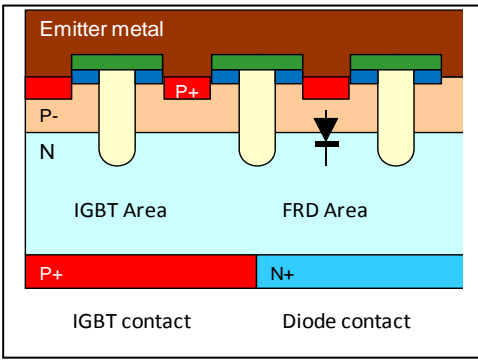
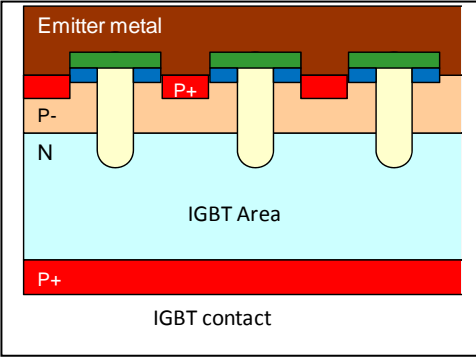
#### 2, RC-IGBT与IGBT的截面构造比较(一般说明)

表.1总结了两者在构造上及动作上的相似点与不同点, 同时进行了截面构造的比较。

RC-IGBT: 通过在背面的一部分生成N+(高浓度N层)来形成二极管。因此Collector(C)侧为Cathode, Emitter(E)侧为Anode, 从电路角度上

可以使之作为 IGBT 的 Free Wheel Diode (FWD)来工作。当然, 作为二极管其为高速设计,  $t_{rr} < 95\text{ns}$ , 确保高速性能。此次的 RC-IGBT 还采用了我司的 FS2 构造, 该工艺被称为 RC2-IGBT。

表.1 RC2-IGBT 与 IGBT 的构造比较

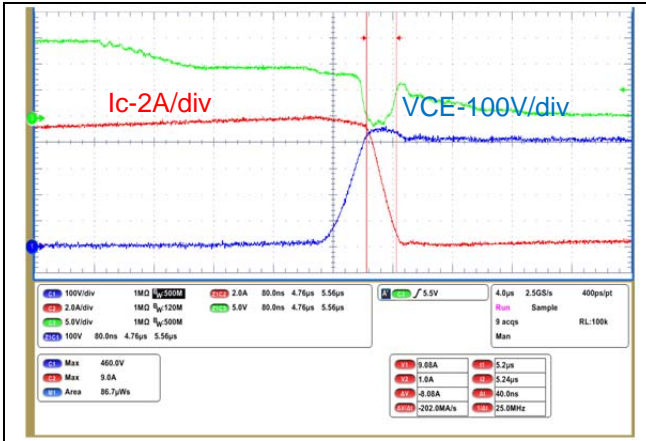
	RC-IGBT	IGBT
芯片构造	FRD 领域的形成:将背面的 P+层的一部分置换成 N+层。	背面都为 P+层。 FRD 为独立的芯片。
电路记号		
芯片截面图 (以一般的构造说明)		

# NGTB15N60R2DT4G 应用资料

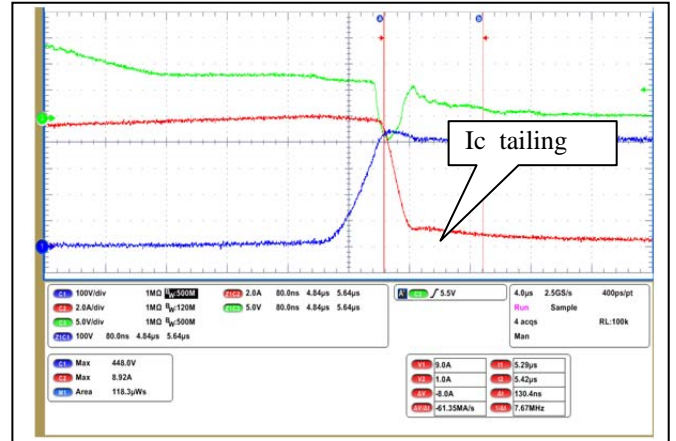
## 3, 关于 RC2-IGBT 的高速 SW 性能

FS2 构造本来为 ON Semi 面向高速开关用途(例如 Full-Switching PFC 用途的 IGBT)所开发的工艺。通过将该构造 用于这次开发的 RC2-IGBT,与以往 (NPT 构造)IGBT 相比,实现了 tf 的大幅高速化。

WP.1 & 2 是以15A规格为例的工作波形的比较。WP.1为RC2-IGBT的15A规格品的工作时的tf波形。与WP.2的15A规格NPT品相比,无 tf Tailing, 实现了高速化。



WP.1 FS2-IGBT Ic=10A tf=40nS



WP.2 NPT-IGBT Ic=10A tf=120nS

## 4, 关于 RC2-IGBT 的产品系列

RC2-IGBT将IGBT与FRD集成于一个芯片,实现了小型化, ON Semi充分利用该特点,推出了以DPak 品为中心的产品系列。

Ic额定电流: 由于实现了小型封装, 由NGTB03N60R2DT4G的Ic=4.5A 实现了 NGTB10N60R2DT4G的Ic=10A。此外, TO-220F封装的NGTB15N60R2FG为系列中电流规格最大的产品。

表.2 RC2-IGBT 产品系列

Type No.	Package	Absolute maximum ratings				Electrical characteristics /Ta=25°C	FRD Electrical Characteristics /	
		VCES	IC	IC	ICP	VCE(sat) typ	VF typ	trr typ
			@Tc=25°C	@Tc=100°C	@Tc=25°C			
NGTB03N60R2DT4G	DPAK	600	9	4.5	12	1.7(3A)	1.5	65*1
NGTB05N60R2DT4G	DPAK		16	8	20	1.65(5A)	1.5	75*1
NGTB10N60R2DT4G	DPAK		20	10	40	1.7(10A)	1.5	90*1
NGTB15N60R2FG	TO-220F-3FS		24	14	60	1.85(15A)	1.7	95*1

\*1 IF=Ic(Tc=100C). VR=300V, di/dt=300A/us

5, RC-IGBT的应用图

下面为Application Map (Fig.1).

TO-220F封装的NGTB15N60R2FG可使用于广范围的输出功率, 因此可用于各种Sets.

此外, DPak的NGTB03N60R2DT4G, 05N60R2与10N60R2为小型封装, 最适用于电冰箱及工作频率较高(15kHz)的Fan Motors.

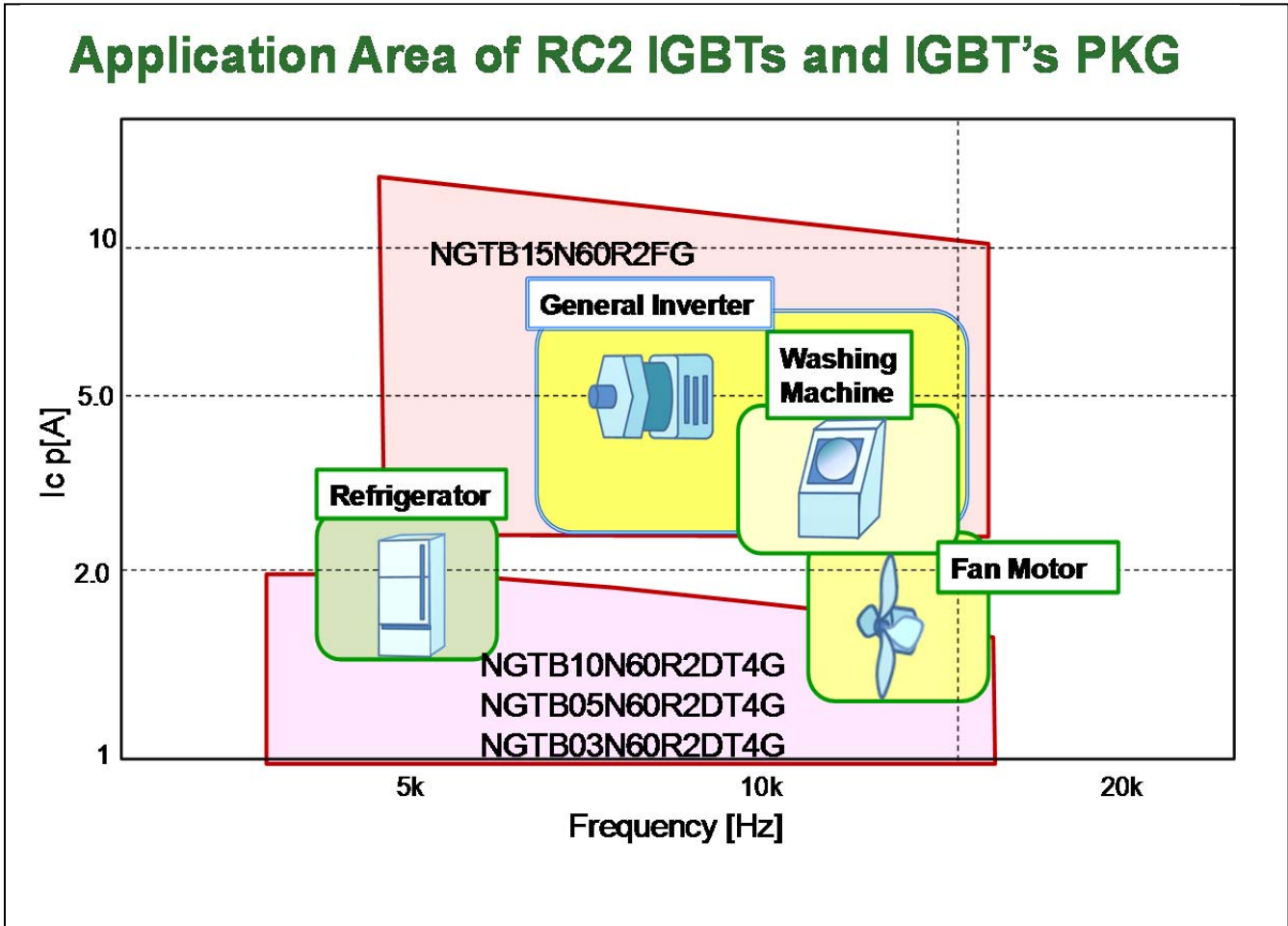


Fig.1 RC-IGBT 的应用领域

6, 应用于BLDC Motor

6-1) 与FRD内置MOSFET的Diode比较

在小输出Inverter Fan应用中, 输出器件经常与FRD(Fast Recovery Diode)内置MOSFET相竞争。FRD内置的MOSFET的Diode在构造上由于使用在MOSFET生成的寄生Diode, 故要求该寄生Diode的trr的高速化。但是MOSFET的场合, 如果高速化, 则RDS(on)会增大, 所以现状是高速化受到限制。

RC-IGBT的场合, 由于IGBT部分 传导度变调, 影响小, 可以实现 trr的高速化。例如, 表.3: 与FRD内置的MOSFET(BFL4007)相比, 虽然规格上Diode的trr相同, 但实际工作时发生trr的差, 工作特性也发生差异。请参照6-2。

# NGTB15N60R2DT4G 应用资料

表.3 IGBT 主要规格 与 MOSFET 的比较

	NGTB15N60R2FG	BFL4007
V <sub>CE(S)</sub> (V <sub>DSS</sub> ) [V]	600	500
I <sub>C</sub> (I <sub>D</sub> ) [A]	15	14
V <sub>CE(sat)</sub> [V]	1.4 (I <sub>C</sub> =15A)	—
R <sub>DS(on)</sub> [Ω]	—	0.52 (I <sub>D</sub> =7.0A)
t <sub>rr</sub> [nS]	95 (I <sub>F</sub> =15A)	95 (I <sub>F</sub> =14A)

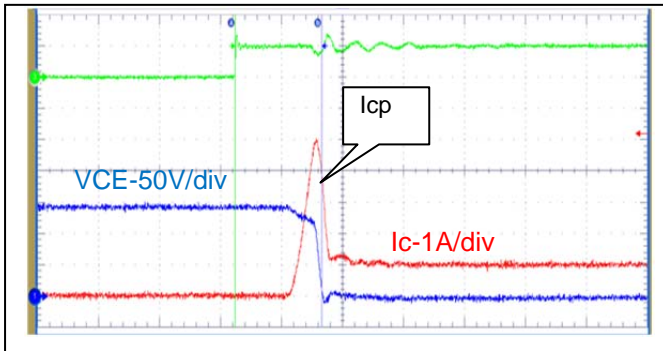
(120°PWM驱动, fc=15kHz)

通过比较工作波形(High-side), 可以观察到: MOSFET在 电流启动处的I<sub>cp</sub>值 较大。这是受Low-side侧的FRD的trr的影响所致。NGTB15N60R2与 BFL4007相比, Datasheet上的trr值虽然相同, 但实际工作ID值是: 由于MOSFET的trr大, ID<sub>p</sub>也变大。(WP.1与WP.2的比较)

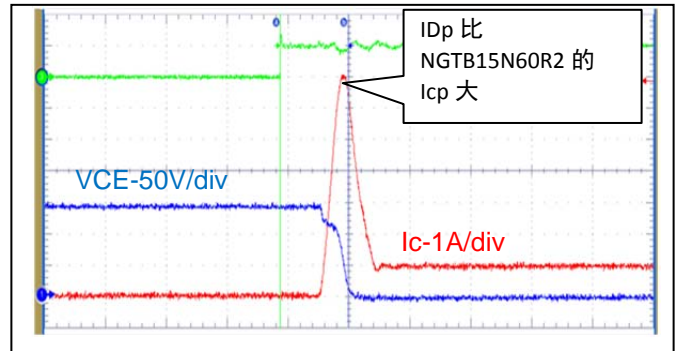
对于MOSFET, 对电流噪音, 有注意的必要性。

## 6-2) 与FRD内置MOSFET的举动比较

Fig.2的电路构成, 对RC-IGBT和MOSFET两者, 在不安装放热板的状态下, 相对低输出 驱动3相BLDC Motor, 比较两者的工作。



WP.1 NGTB15N60R2FG Pout=80W



WP.2 BFL4007 Pout=80W

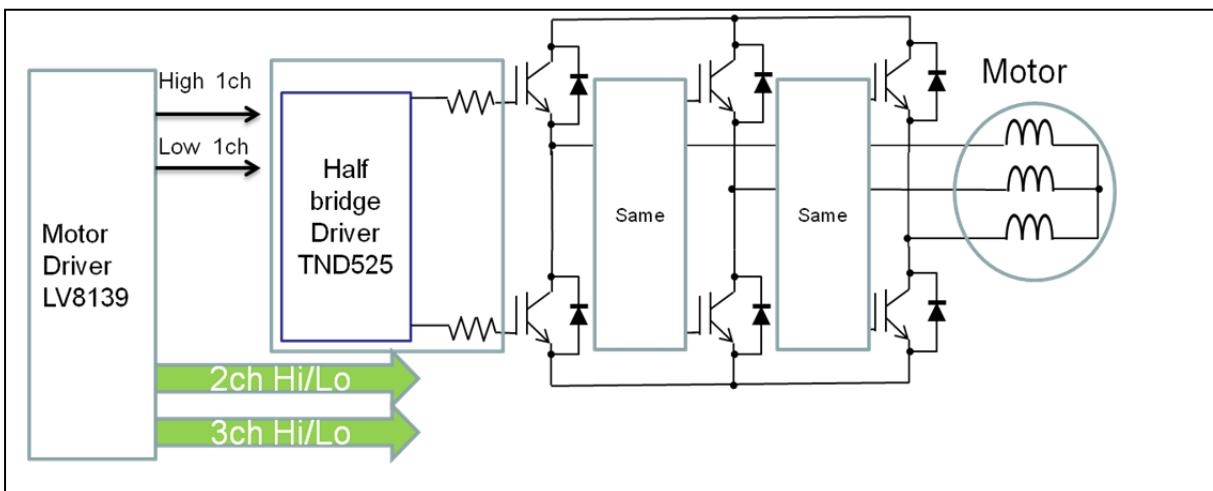


Fig.2 工作电路框图

## NGTB15N60R2DT4G 应用资料

ON Semiconductor and the ON logo are registered trademarks of Semiconductor Components Industries, LLC (SCILLC) or its subsidiaries in the United States and/or other countries. SCILLC owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of SCILLC's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). SCILLC reserves the right to make changes without further notice to any products herein. SCILLC makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does SCILLC assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. "Typical" parameters which may be provided in SCILLC data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. SCILLC does not convey any license under its patent rights nor the rights of others. SCILLC products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the SCILLC product could create a situation where personal injury or death may occur. Should Buyer purchase or use SCILLC products for any such unintended or unauthorized application, Buyer shall indemnify and hold SCILLC and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that SCILLC was negligent regarding the design or manufacture of the part. SCILLC is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.