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# R2J20651NP

## Integrated Driver – MOS FET (DrMOS)

REJ03G1743-0400

Rev.4.00

Mar 12, 2010

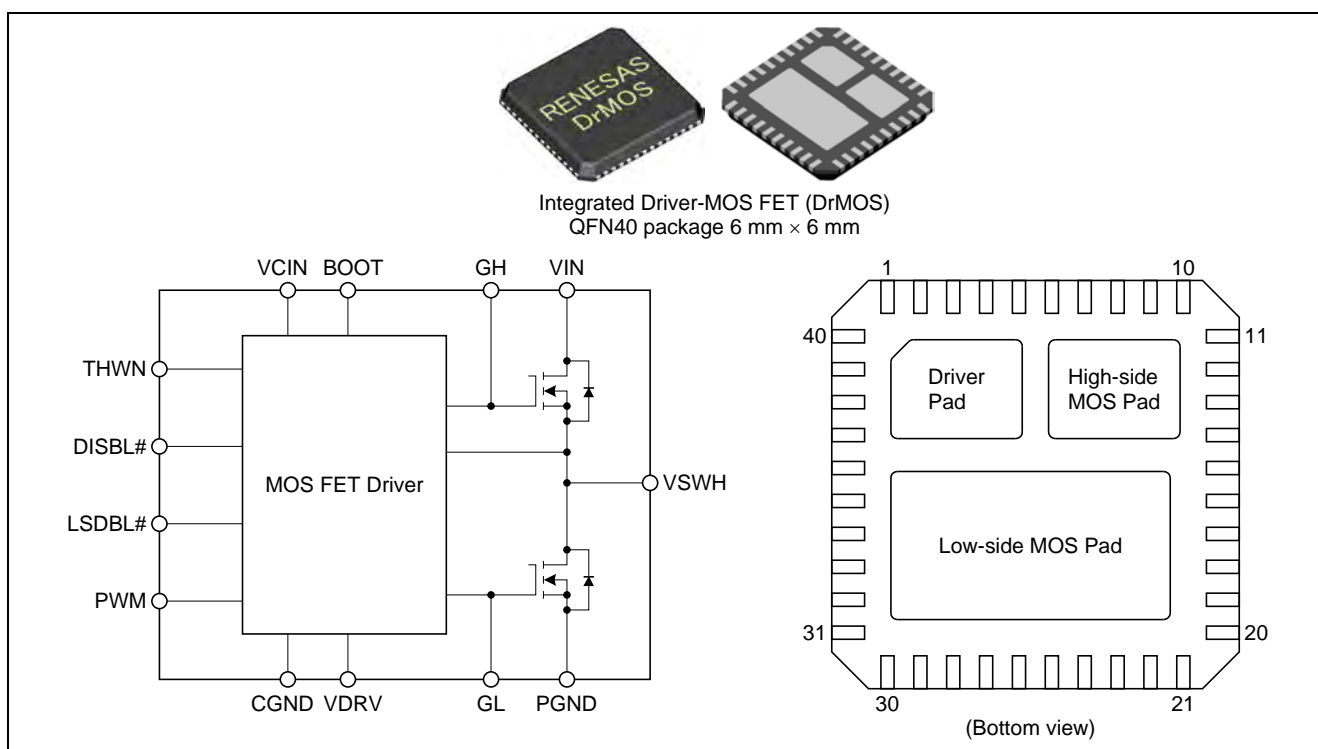
### Description

The R2J20651NP multi-chip module incorporates a high-side MOS FET, low-side MOS FET, and MOS-FET driver in a single QFN package. The on and off timing of the power MOS FET is optimized by the built-in driver, making this device suitable for large-current buck converters. The chip also incorporates a high-side bootstrap Schottky barrier diode (SBD), eliminating the need for an external SBD for this purpose.

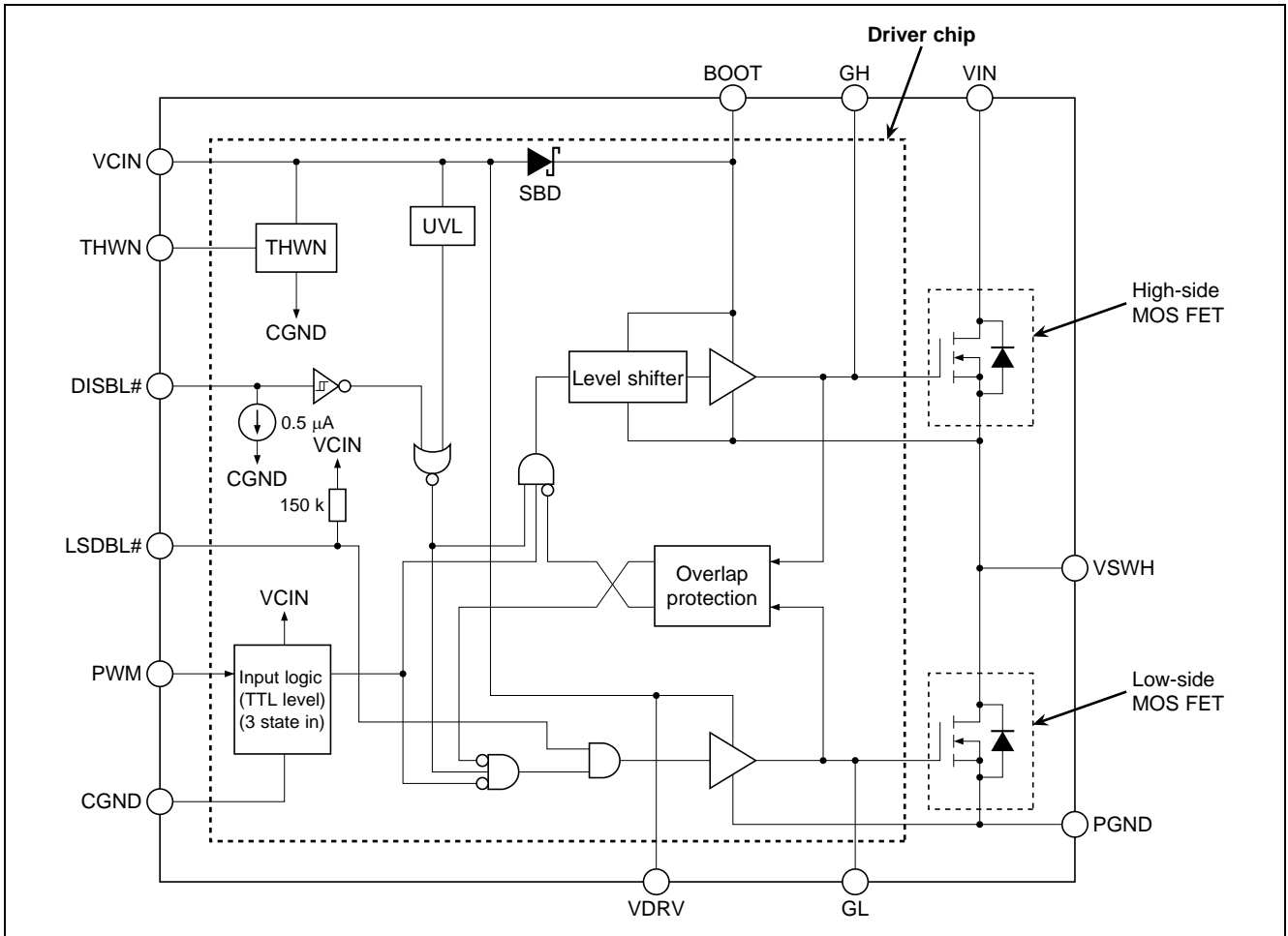
### Features

- Compliant with Intel 6 × 6 DrMOS specification
- Built-in power MOS FET suitable for applications with 5 V/12 V input
- Built-in driver circuit which matches the power MOS FET
- Built-in tri-state input function which can support a number of PWM controllers
- Capable of both 3.3 V and 5 V PWM signal
- VIN operating-voltage range: 16 V max
- High-frequency operation (above 1 MHz) possible
- Large average output current (Max. 35 A)
- Achieve low power dissipation
- Controllable driver: Remote on/off
- Low-side MOS FET disabled function for DCM operation
- Built-in thermal warning
- Built-in Schottky diode for bootstrapping
- Small package: QFN40 (6 mm × 6 mm × 0.95 mm)
- Terminal Pb-free/Halogen-free

### Outline



### Block Diagram



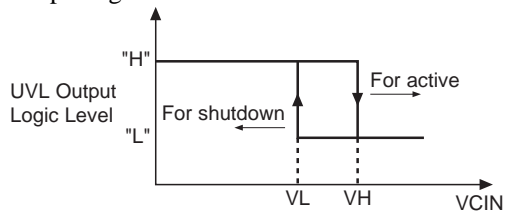
Notes: 1. Truth table for the DISBL# pin.

DISBL# Input	Driver Chip Status
"L"	Shutdown (GL, GH = "L")
"Open"	Shutdown (GL, GH = "L")
"H"	Enable (GL, GH = "Active")

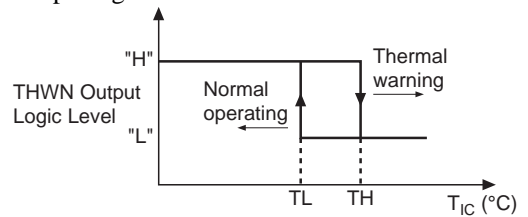
2. Truth table for the LSDBL# pin.

LSDBL# Input	GL Status
"L"	"L"
"Open"	"Active"
"H"	"Active"

3. Output signal from the UVL block



4. Output signal from the THWN block



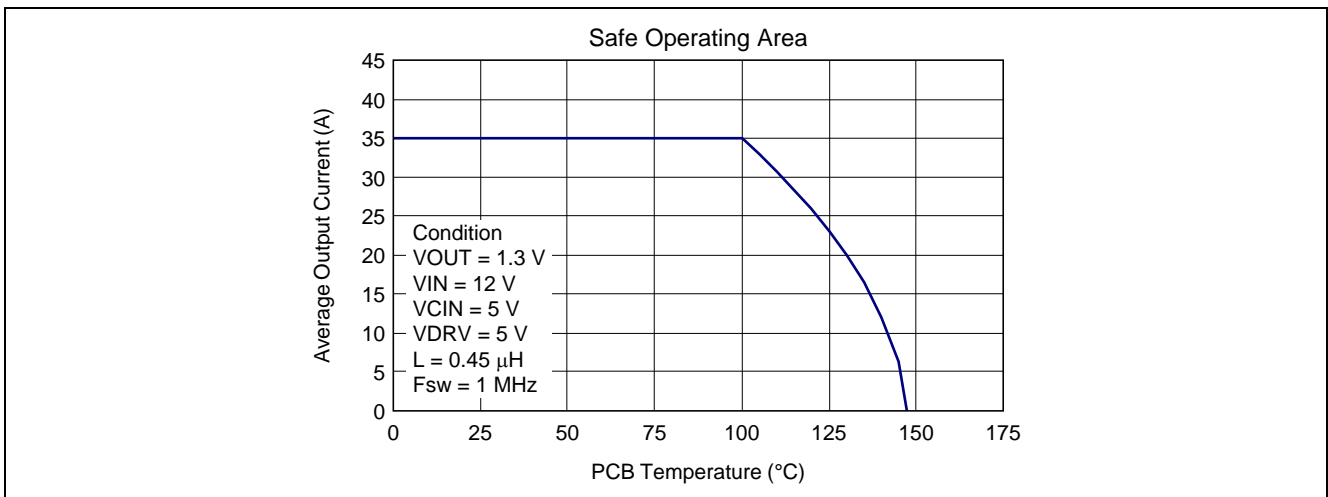


## Absolute Maximum Ratings

(Ta = 25°C)

Item	Symbol	Rating	Units	Note
Power dissipation	Pt(25)	25	W	1
	Pt(110)	8		
Average output current	Iout	35	A	
Input voltage	VIN (DC)	-0.3 to +16	V	2
	VIN (AC)	20		2, 3
Supply voltage & Drive voltage	VCIN & VDRV	-0.3 to +6	V	2
Switch node voltage	VSWH (DC)	16	V	2
	VSWH (AC)	25		2, 3
BOOT voltage	VBOOT (DC)	22	V	2
	VBOOT (AC)	25		2, 3
I/O voltage	Vpwm, Vdisble, Vlsdbl, Vthwn	-0.3 to VCIN + 0.3	V	2, 4
Operating junction temperature	Tj-opr	-40 to +150	°C	
Storage temperature	Tstg	-55 to +150	°C	

- Notes: 1. Pt(25) represents a PCB temperature of 25°C, and Pt(110) represents 110°C.  
 2. Rated voltages are relative to voltages on the CGND and PGND pins.  
 3. The specification values indicated "AC" are limited within 100 ns.  
 4. VCIN + 0.3 V < 6 V



## Recommended Operating Condition

Item	Symbol	Rating	Units	Note
Input voltage	VIN	4.5 to 14	V	
Supply voltage & Drive voltage	VCIN & VDRV	4.5 to 5.5	V	

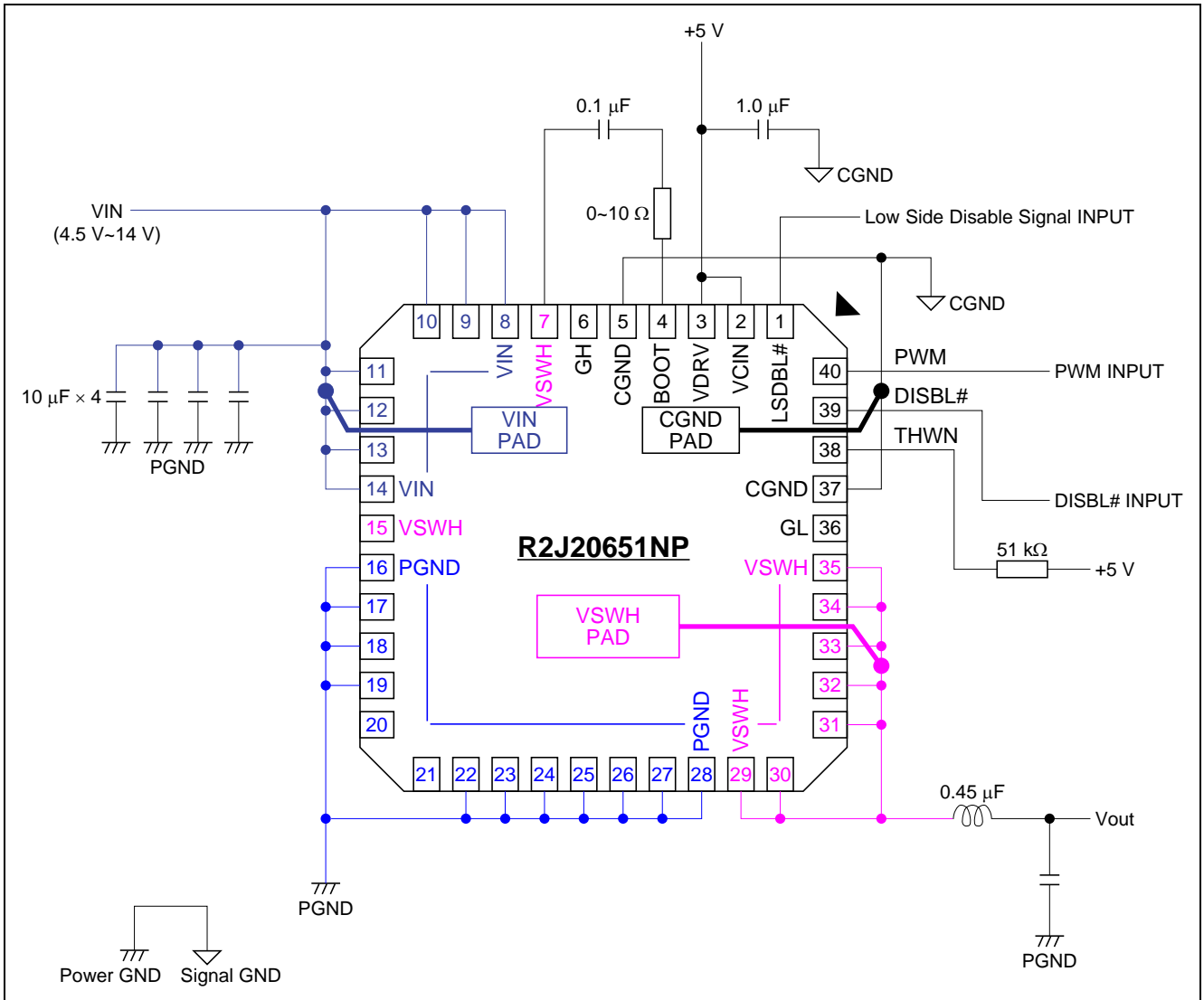
## Electrical Characteristics

(Ta = 25°C, VCIN = 5 V, VDRV = 5 V, VSWH = 0 V, unless otherwise specified)

Item	Symbol	Min	Typ	Max	Units	Test Conditions	
Supply	VCIN start threshold	V <sub>H</sub>	3.1	3.5	3.9	V	
	VCIN shutdown threshold	V <sub>L</sub>	2.7	3.0	3.3	V	
	UVLO hysteresis	dUVL	—	0.5	—	V	V <sub>H</sub> - V <sub>L</sub>
	VCIN operating current	I <sub>CIN</sub>	—	29	—	mA	f <sub>PWM</sub> = 1 MHz, Ton_pwm = 120 ns
	VCIN disable current	I <sub>CIN-DISBL</sub>	—	—	50	μA	DISBL# = 0 V, PWM = 0 V, LSDBL# = Open
PWM input	PWM rising threshold	V <sub>H-PWM</sub>	1.7	2.1	2.5	V	
	PWM falling threshold	V <sub>L-PWM</sub>	0.9	1.2	1.5	V	
	PWM input resistance	R <sub>IN-PWM</sub>	42	70	98	kΩ	PWM = 1 V
	Tri-state shutdown window	V <sub>IN-SD</sub>	V <sub>L-PWM</sub>	—	V <sub>H-PWM</sub>	V	
	Shutdown hold-off time	t <sub>HOLD-OFF</sub> *1	—	240	—	ns	
DISBL# input	Disable threshold	V <sub>DISBL</sub>	0.9	1.2	1.5	V	
	Enable threshold	V <sub>ENBL</sub>	1.9	2.4	2.9	V	
	Input current	I <sub>DISBL</sub>	—	0.5	2.0	μA	DISBL# = 1 V
LSDBL# input	Low-side activation threshold	V <sub>LSDBLH</sub>	1.9	2.4	2.9	V	
	Low-side disable threshold	V <sub>LSDBLL</sub>	0.9	1.2	1.5	V	
	Input current	I <sub>LSDBL</sub>	-54	-27	-13.5	μA	LSDBL# = 1 V
Thermal warning	Warning temperature	T <sub>THWN</sub> *1	110	130	—	°C	Driver IC temperature
	Temperature hysteresis	T <sub>HYS</sub> *1	—	15	—	°C	
	THWN on resistance	R <sub>THWN</sub> *1	1.0	2.5	4.0	kΩ	THWN = 1 V
	THWN leakage current	I <sub>LEAK</sub>	—	0.001	1.0	μA	THWN = 5 V

Note: 1. Reference values for design. Not 100% tested in production.

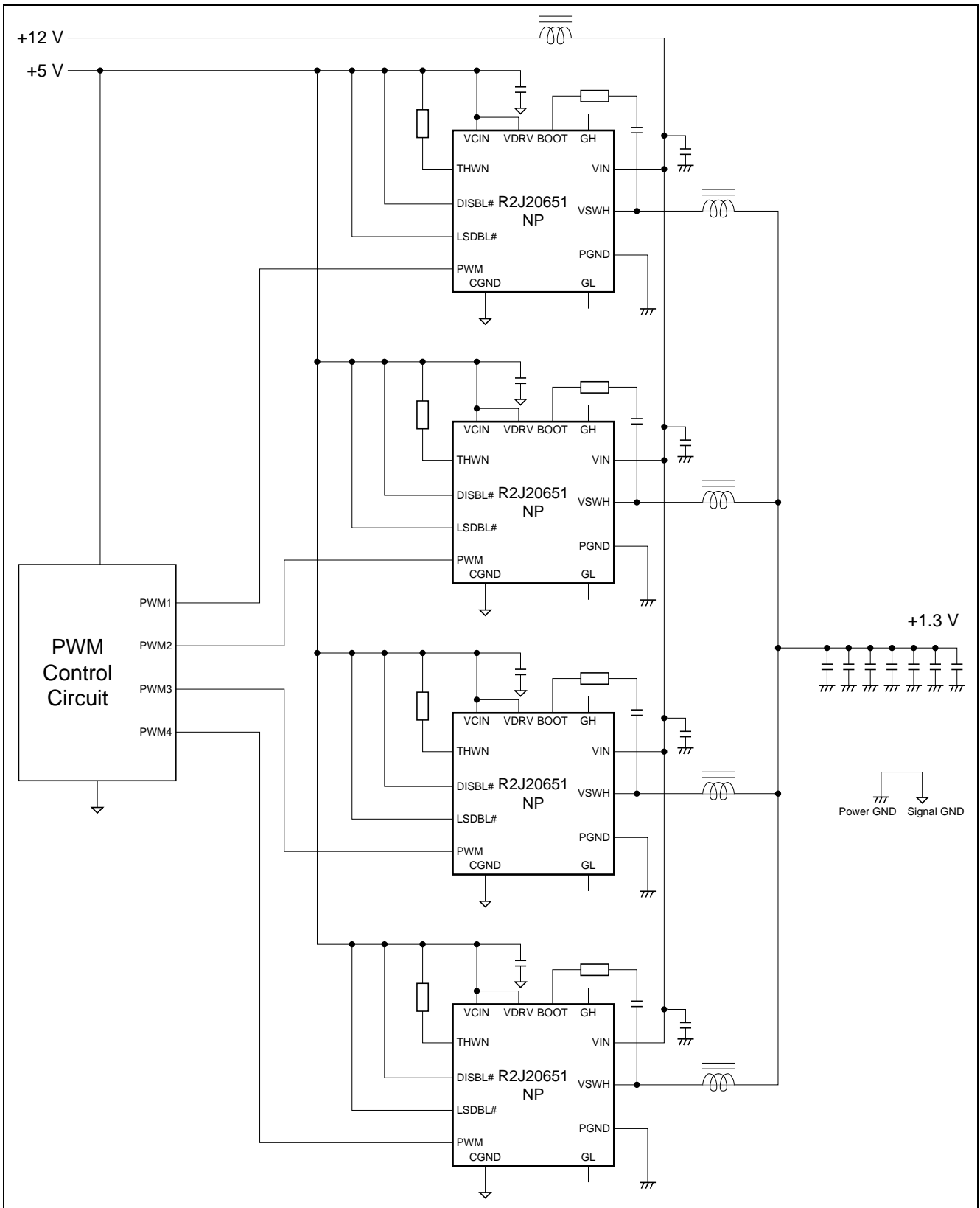
Pin Connection



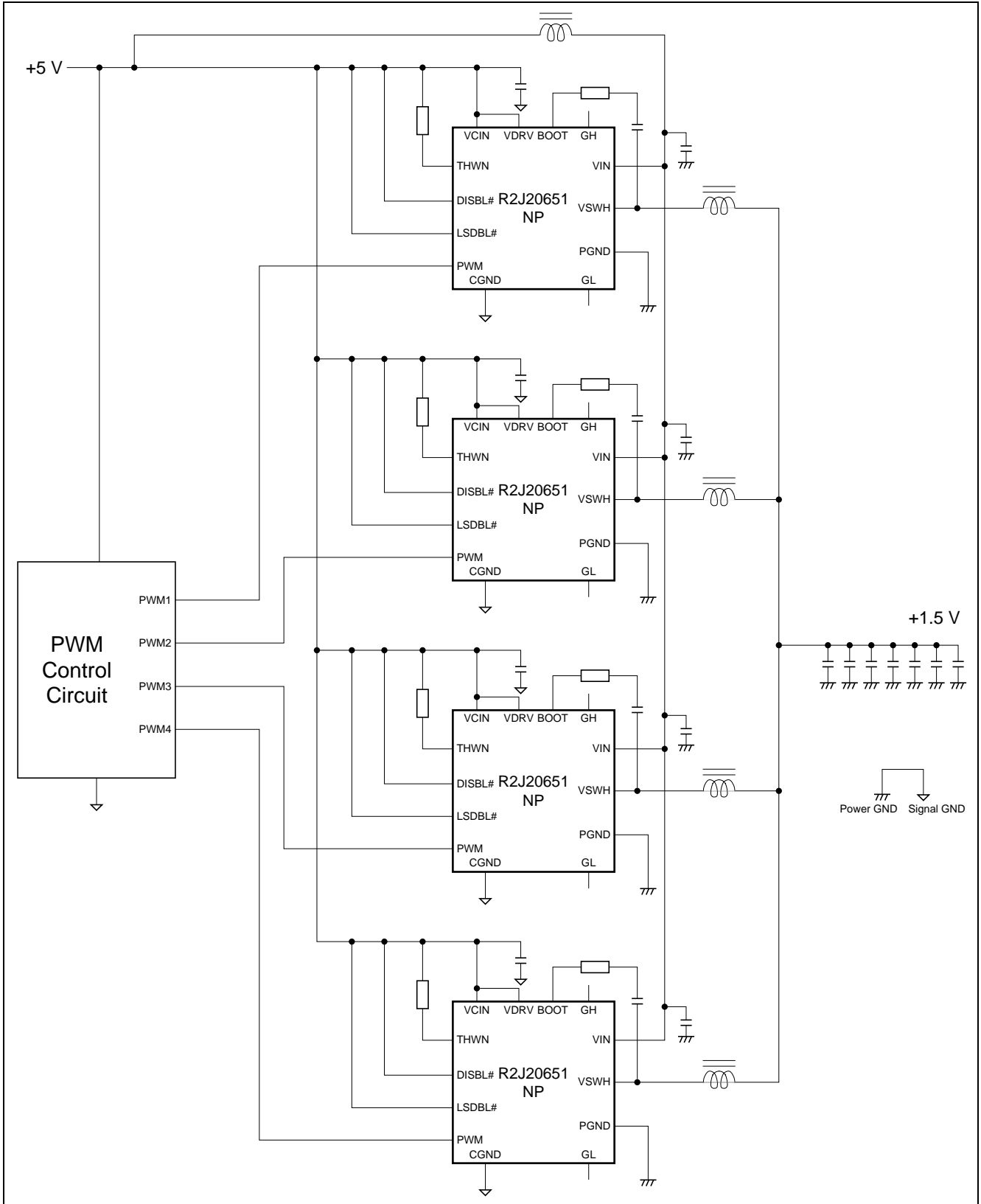


# Typical Application

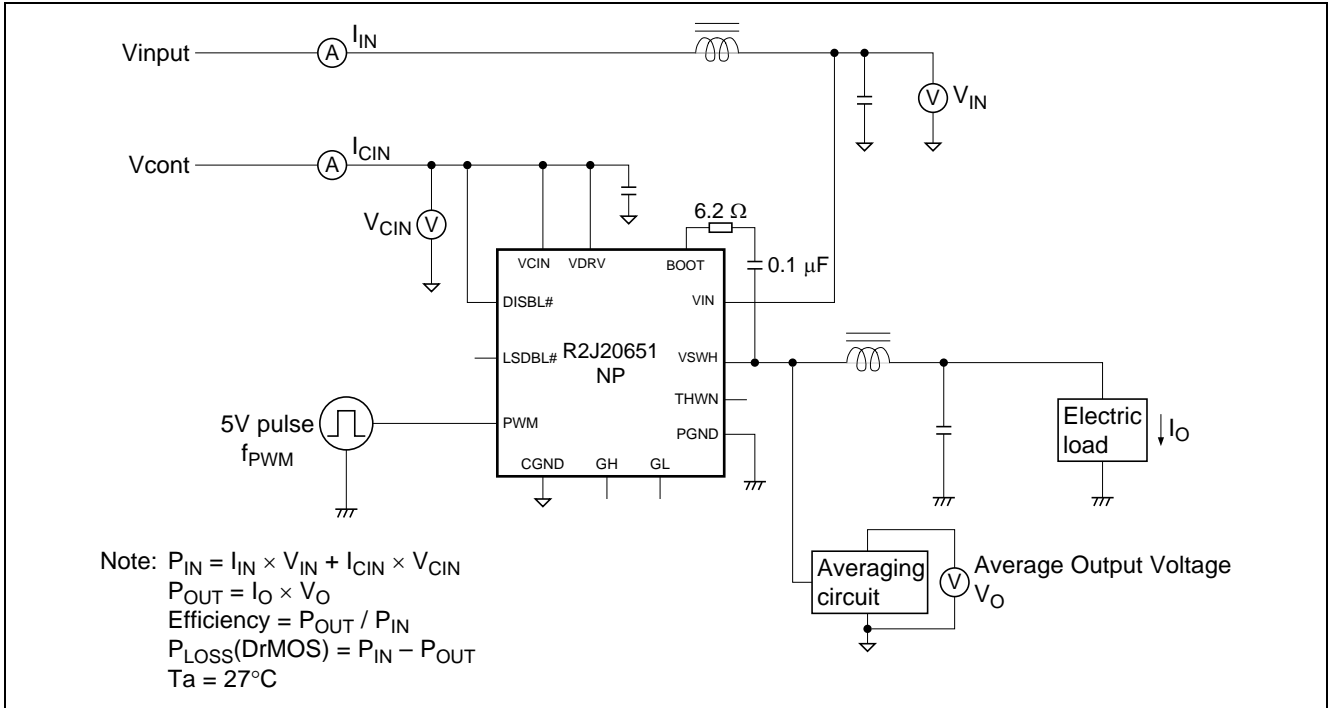
## (1) 12 V Input Power



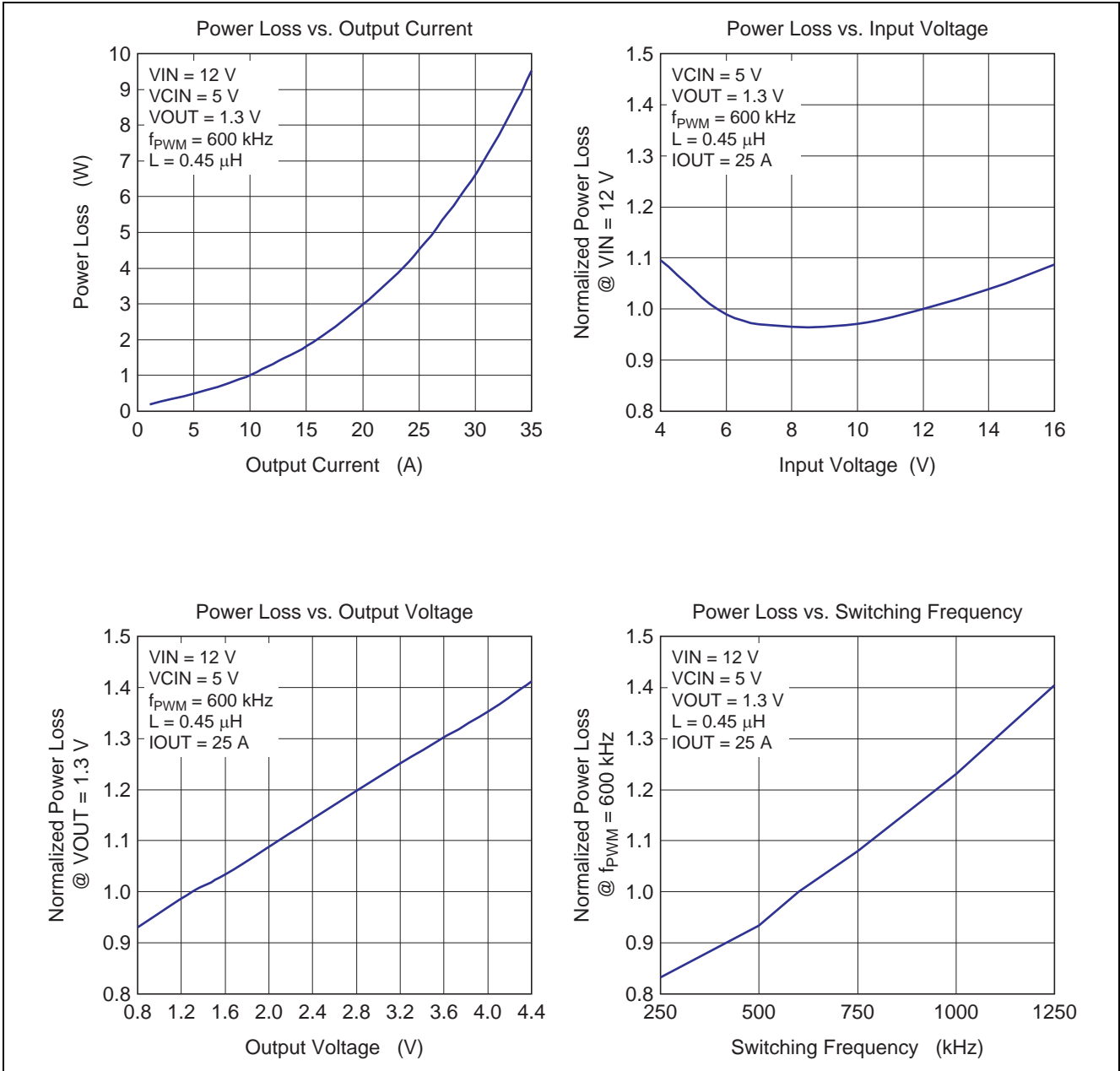
(2) 5 V Input Power



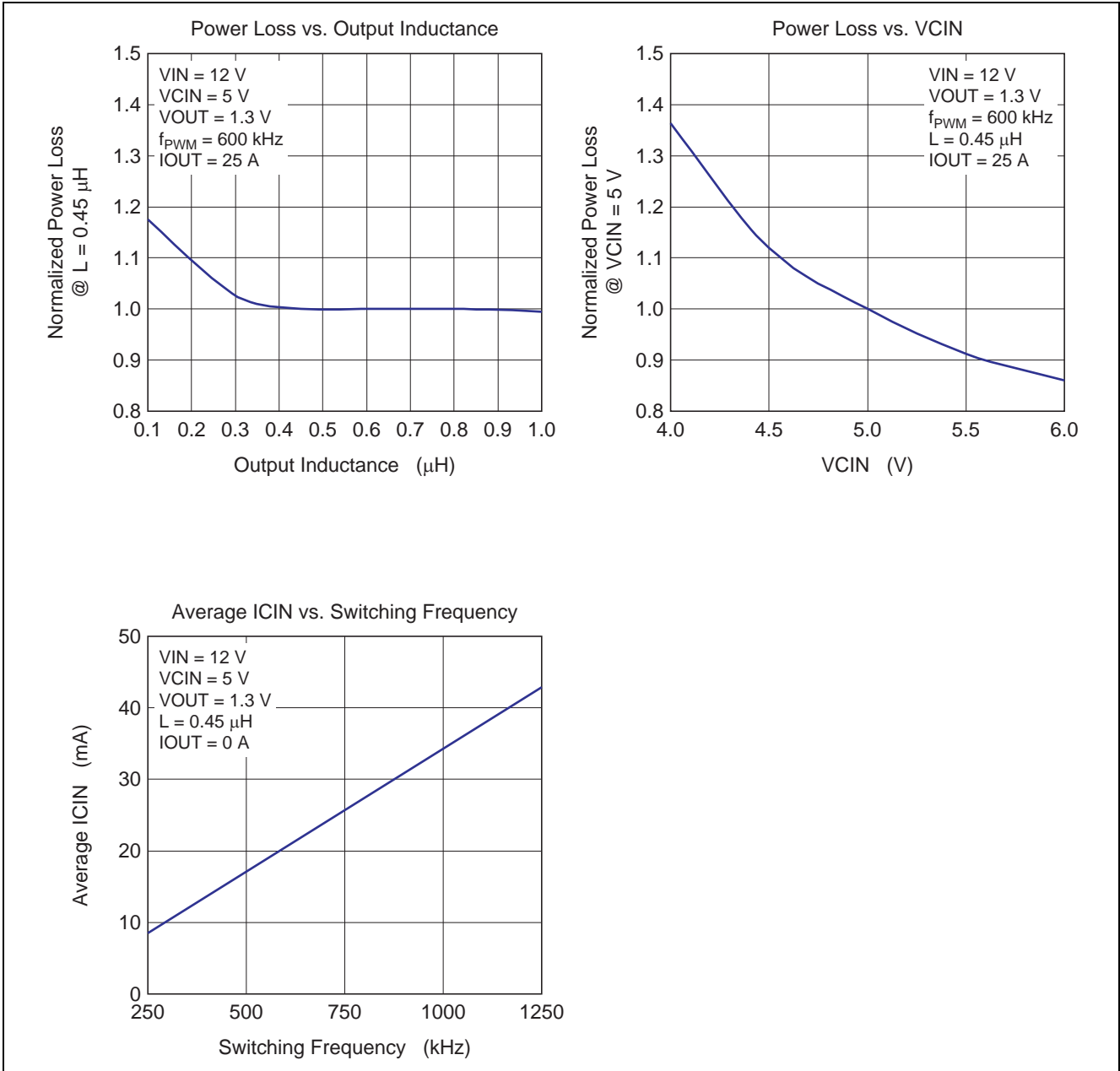
Test Circuit



Typical Data



Typical Data (cont.)



## Description of Operation

The DrMOS multi-chip module incorporates a high-side MOS FET, low-side MOS FET, and MOS-FET driver in a single QFN package. Since the parasitic inductance between each chip is extremely small, the module is highly suitable for use in buck converters to be operated at high frequencies. The control timing between the high-side MOS FET, low-side MOS FET, and driver is optimized so that high efficiency can be obtained at low output-voltage.

### VCIN & DISBL#

The VCIN pin is connected to the UVL (under-voltage lockout) module, so that the driver is disabled as long as VCIN is 3.5 V or less. On cancellation of UVL, the driver remains enabled until the UVL input is driven to 3.0 V or less. The signal on pin DISBL# also enables or disables the circuit.

Voltages from  $-0.3$  V to VCIN can be applied to the DISBL# pin, so on/off control by a logic IC or the use of a resistor, etc., to pull the DISBL# line up to VCIN are both possible.

VCIN	DISBL#	Driver State
L	*	Disable (GL, GH = L)
H	L	Disable (GL, GH = L)
H	H	Active
H	Open	Disable (GL, GH = L)

### PWM & LSDBL#

The PWM pin is the signal input pin for the driver chip. The input-voltage range is  $-0.3$  V to  $(VCIN + 0.3$  V). When the PWM input is high, the gate of the high-side MOS FET (GH) is high and the gate of the low-side MOS FET (GL) is low.

PWM	GH	GL
L	L	H
H	H	L

The LSDBL# pin is the low-side gate disable pin for "Discontinuous Conduction Mode (DCM)" when LSDBL# is low.

Figure 1 shows the typical high-side and low-side gate switching and inductor current ( $I_L$ ) during Continuous Conduction Mode (CCM) and low-side gate disabled when asserting low-side disable signal.

This pin is internally pulled up to VCIN with 150 k $\Omega$  resistor.

When low-side disable function is not used, keep this pin open or pulled up to VCIN.

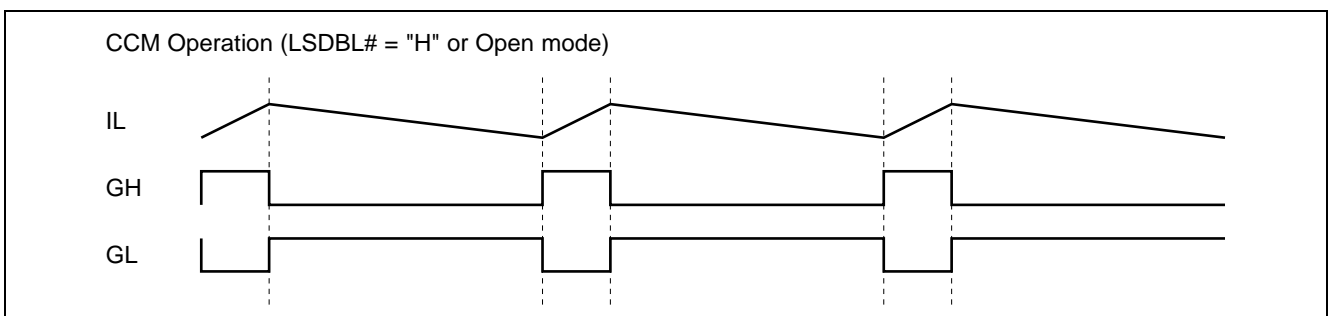
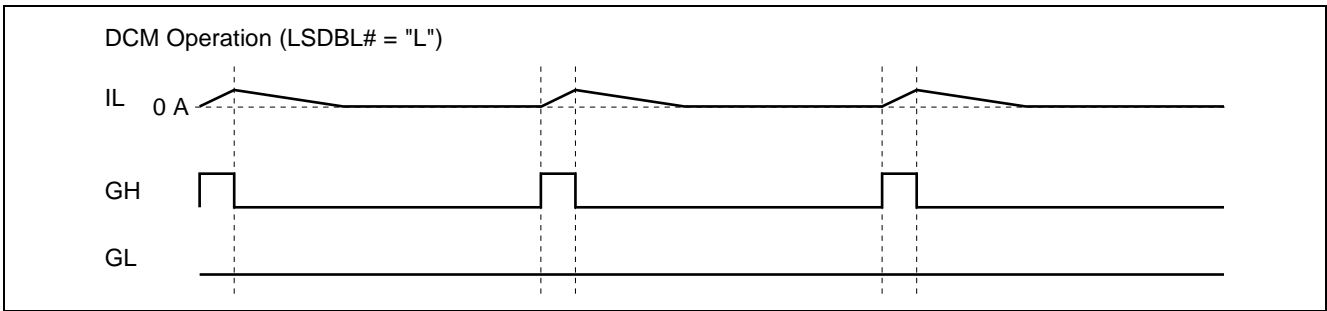
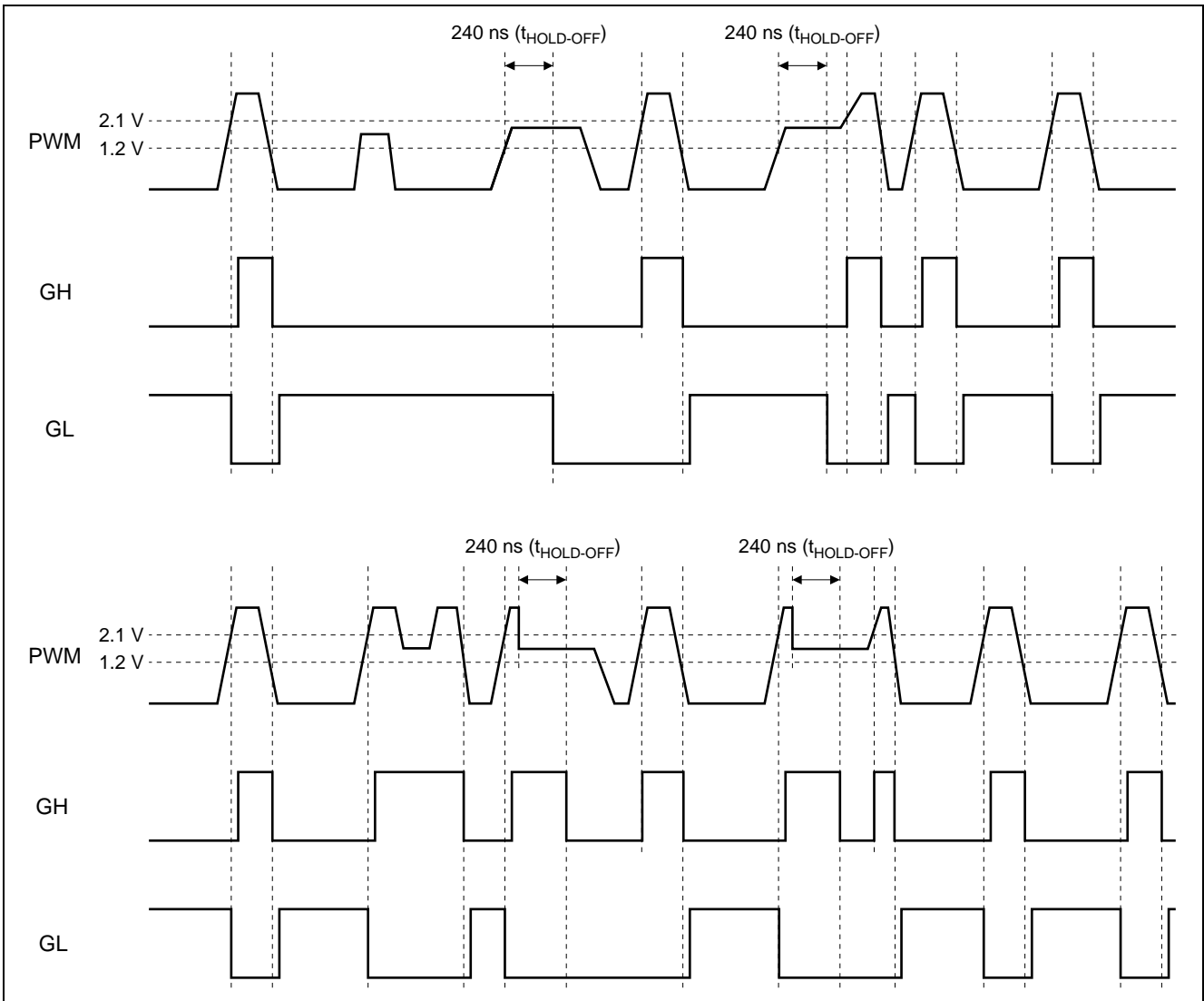


Figure 1.1 Typical Signals During CCM



**Figure 1.2 Typical Signals During Low-Side Disable Operation**

The PWM input is TTL level and has hysteresis. When the signal route from the control IC is high impedance, the tri-state function turns off the high- and low-side MOS FETs. This function operates when the PWM input signal stays in the input hysteresis window for 240 ns (typ.). After the tri-state mode has been entered and GH and GL have become low, a PWM input voltage of 2.1 V or more is required to make the circuit return to normal operation.



**Figure 2**

## THWN

This thermal warning feature is the indication of the high temperature status.

THWN is an open drain logic output signal and need to connect a pull-up resistor (ex. 51 k $\Omega$ ) to THWN for systems with the thermal warning implementation.

When the chip temperature of the internal driver IC becomes over 130°C, thermal warning function operates.

This signal is only indication for the system controller and does not disable DrMOS operation.

When thermal warning function is not used, keep this pin open.

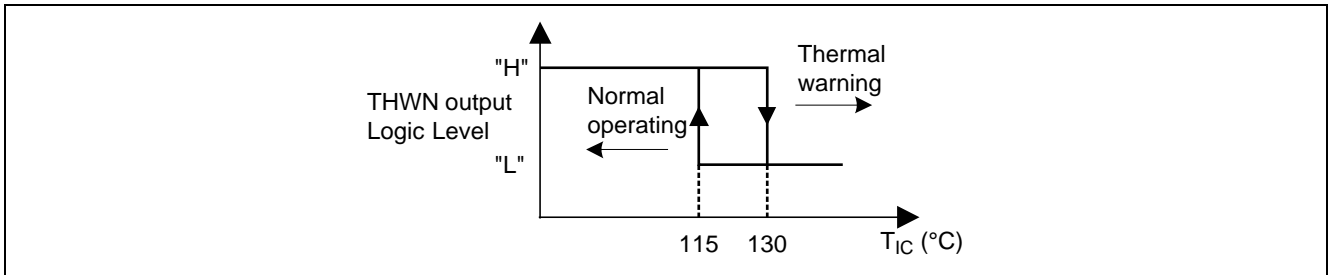


Figure 3

## MOS FETs

The MOS FETs incorporated in R2J20651NP are highly suitable for synchronous-rectification buck conversion. For the high-side MOS FET, the drain is connected to the VIN pin and the source is connected to the VSWH pin. For the low-side MOS FET, the drain is connected to the VSWH pin and the source is connected to the PGND pin.



## PCB Layout Example

Figure 4 shows an example of the PCB layout for the R2J20651NP. Placing several ceramic capacitors (e.g. 10  $\mu\text{F}$ ) between VIN and PGND can be expected to decrease switching noise and improve efficiency.

In that case, it is necessary to connect each GND pattern with low impedance by using other PCB layers.

Moreover, by taking the wide VSWH pattern, the effect of letting the heat from the low side MOS FET can be expected.

When R2J20651NP is mounted on a small substrate like POL module, the temperature rising of the device could be eased if the thermal via-hole is added under the pad of VIN and VSWH.

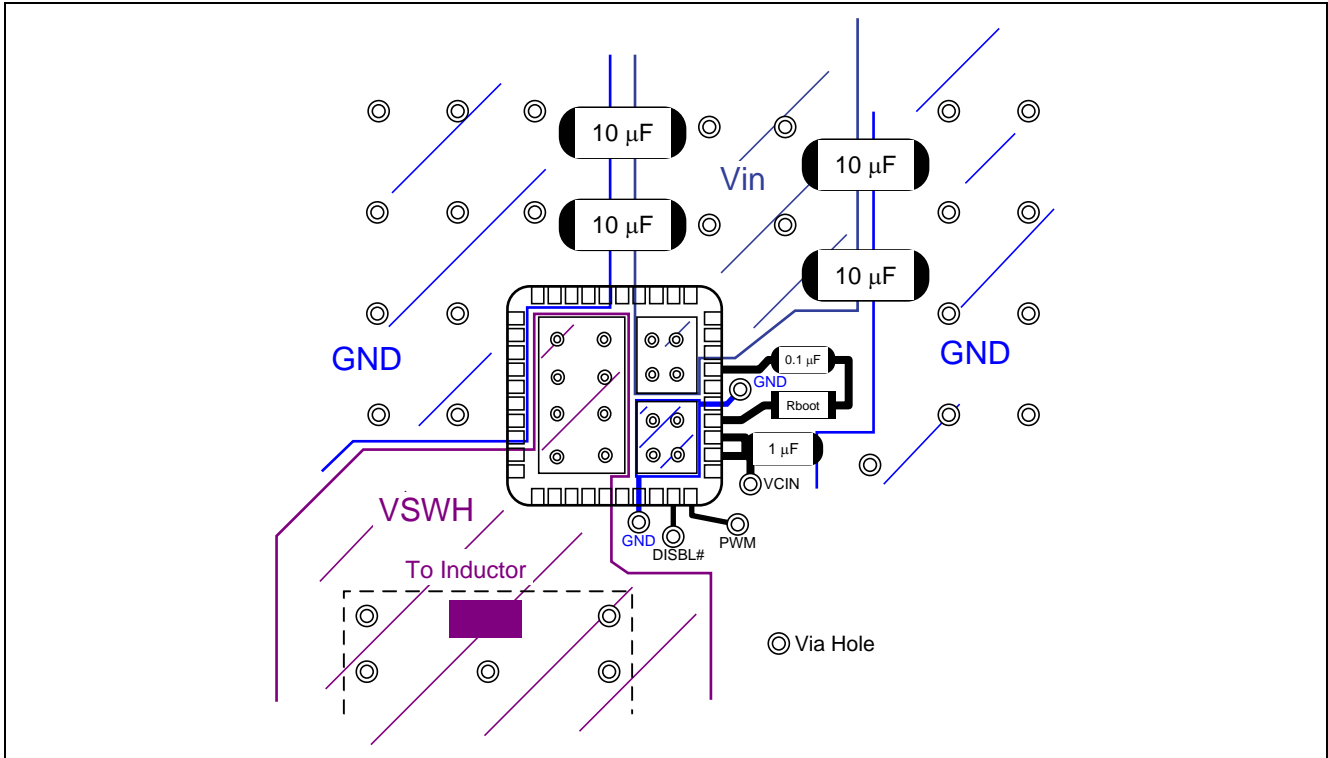


Figure 4 R2J20651NP PCB Layout Example (Top View)





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