

TOSHIBA Multi-Chip Module

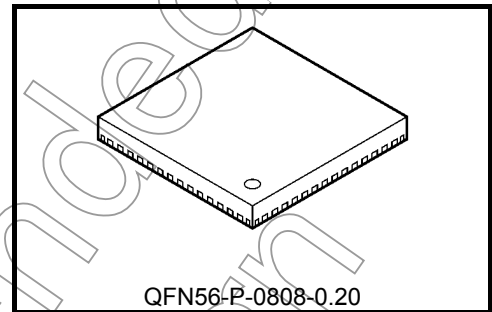
# TB7005FL

## Synchronous Buck Converter Module for High-Current and Low-Voltage Applications

The TB7005FL is a synchronous buck converter (step-down chopper) module. A DC-DC converter can be formed by combining the TB7005FL with a PWM control IC, inductors, and input and output capacitors. Power supply for control circuitry is 5 V input.

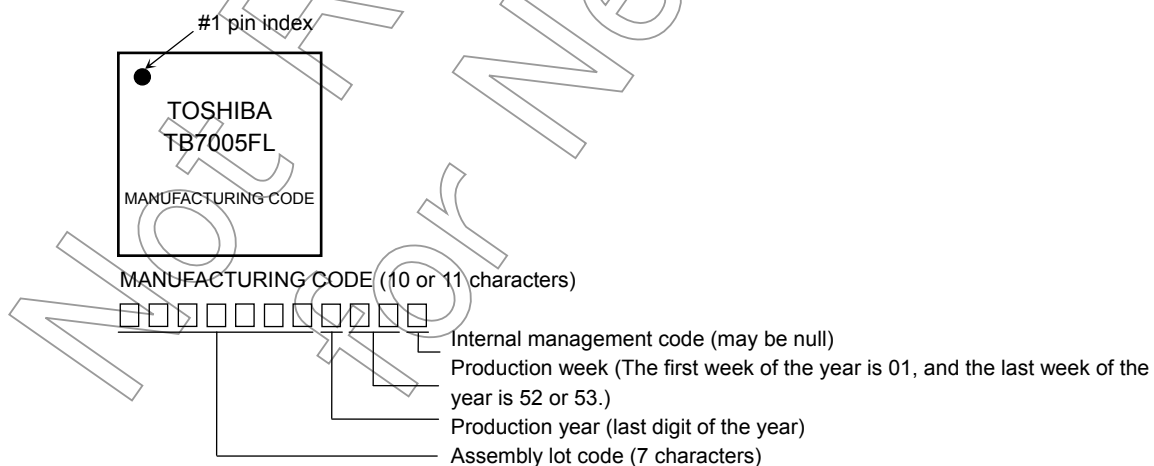
### Features

- Operating frequency: up to 1 MHz
- VCIN undervoltage lockout (UVLO)  
In UVLO mode, the GH and GL outputs are set Low.
- Low-side MOSFET gate drive voltage: 4.5 to 5.5 V  
The low-side MOSFET gate drive voltage is supplied externally via VGIN.
- Low-side MOSFET shut down function: external control signal can set low-side MOSFET off.  
During light load, keeping low-side MOSFET off makes efficiency high.
- DISBL#: H = Enables the internal circuitry.  
L = Disables the internal circuitry and turns off both the high-side and low-side MOSFETs (GH = Low, GL = Low).
- The PWM input signal accepts TTL signal. 3.3-V logic signal is acceptable.  
H: GH = H, GL = L  
L: GH = L, GL = H
- Incorporates boot switch.  
Charge switch for the bootstrap capacitor (The boot switch behaves like a Schottky barrier diode.)



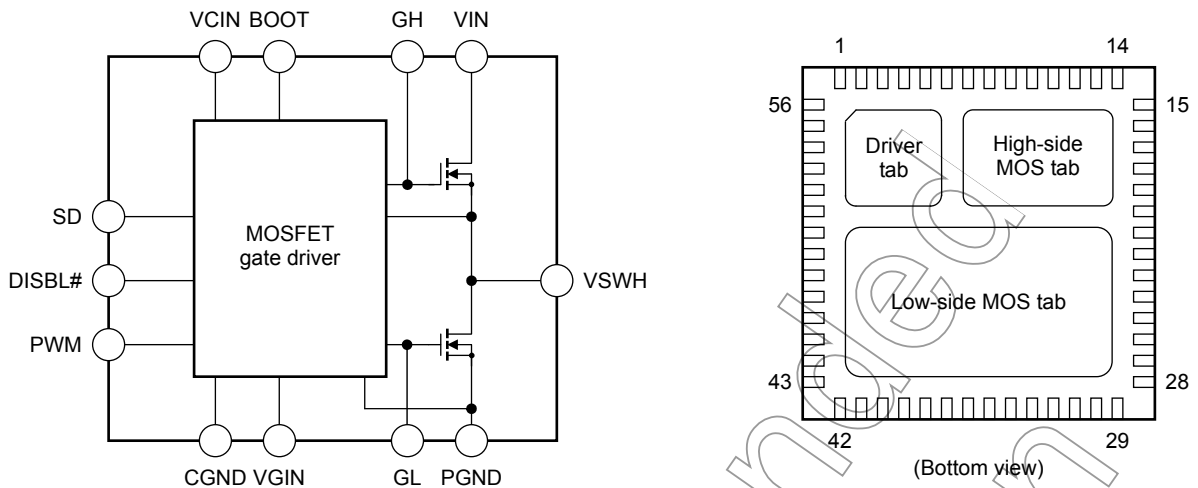
Weight: 0.19 g (typ.)

### Marking

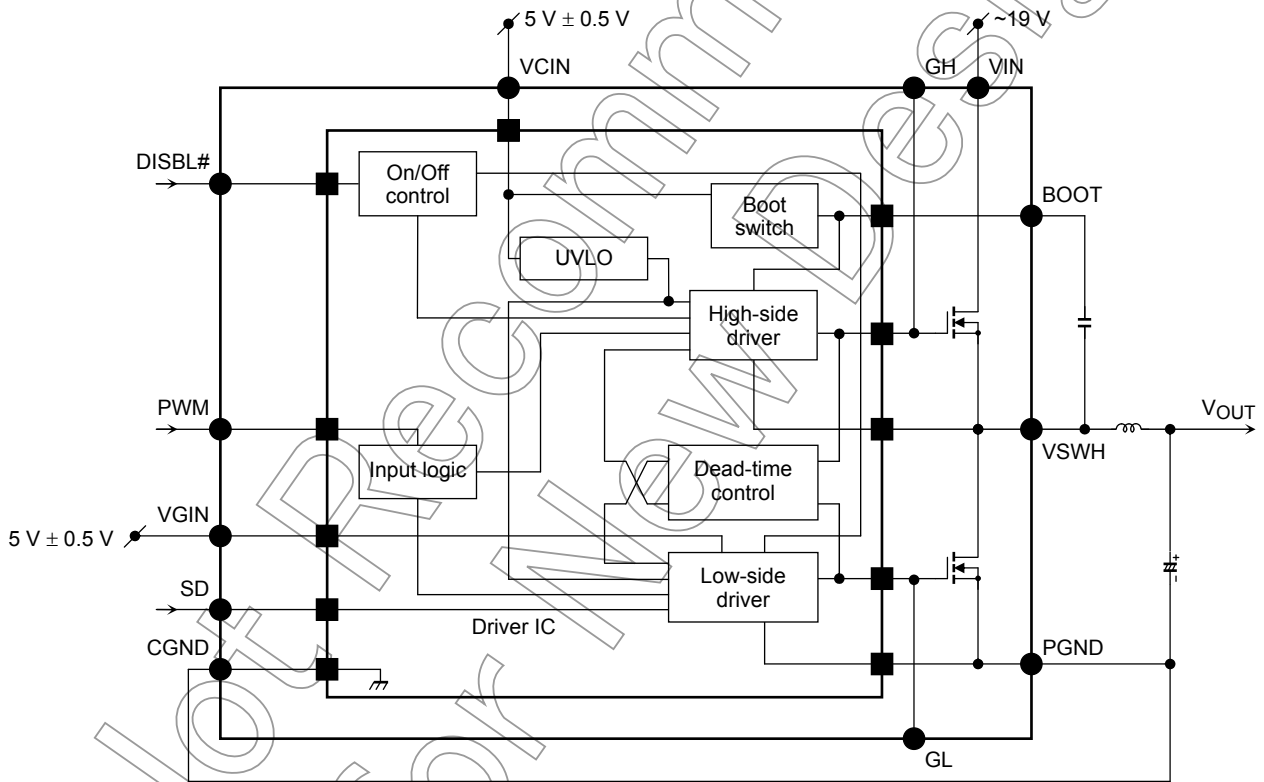


Care should be taken for static electricity when handling this product since it has a MOS structure.

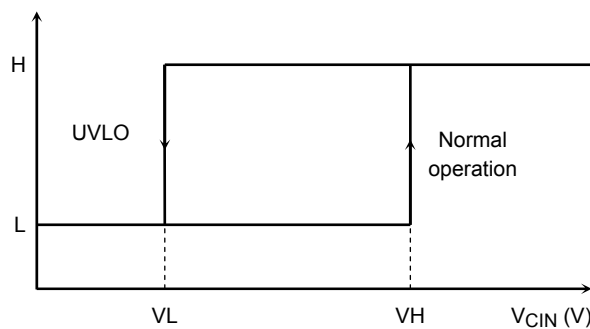
**Simplified Block Diagram**



**Detailed Block Diagram**



**Undervoltage Lockout Circuit Output Signal**





## Absolute Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit	
VIN to PGND voltage	V <sub>IN</sub>	30	V	
VCIN to CGND voltage	V <sub>CIN</sub>	-0.3 to 6	V	
VSWH to PGND voltage	V <sub>SWH</sub>	-2 to 30	V	
VGIN to CGND voltage	V <sub>GIN</sub>	-0.3 to 6	V	
BOOT to VSWH voltage	V <sub>BOOT-VSWH</sub>	-0.3 to VCIN + 0.3	V	
BOOT to CGND voltage	V <sub>BOOT</sub>	-0.3 to 30	V	
PWM to CGND voltage	V <sub>PWM</sub>	-0.3 to VCIN + 0.3	V	
DISBL# to CGND voltage	V <sub>DISBL#</sub>	-0.3 to VCIN + 0.3	V	
SD to CGND voltage	V <sub>SD</sub>	-0.3 to VCIN + 0.3	V	
Output RMS current	I <sub>OUT</sub>	35	A	
Operating duty cycle	D	70	%	
Power dissipation	T <sub>pcb</sub> = 25°C	P <sub>D</sub> (25)	25	W
	T <sub>pcb</sub> = 110°C	P <sub>D</sub> (110)	8	W
Channel temperature	T <sub>ch</sub>	-40 to 150	°C	
Storage temperature	T <sub>stg</sub>	-55 to 150	°C	

Note1: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Not Recommended for New Design

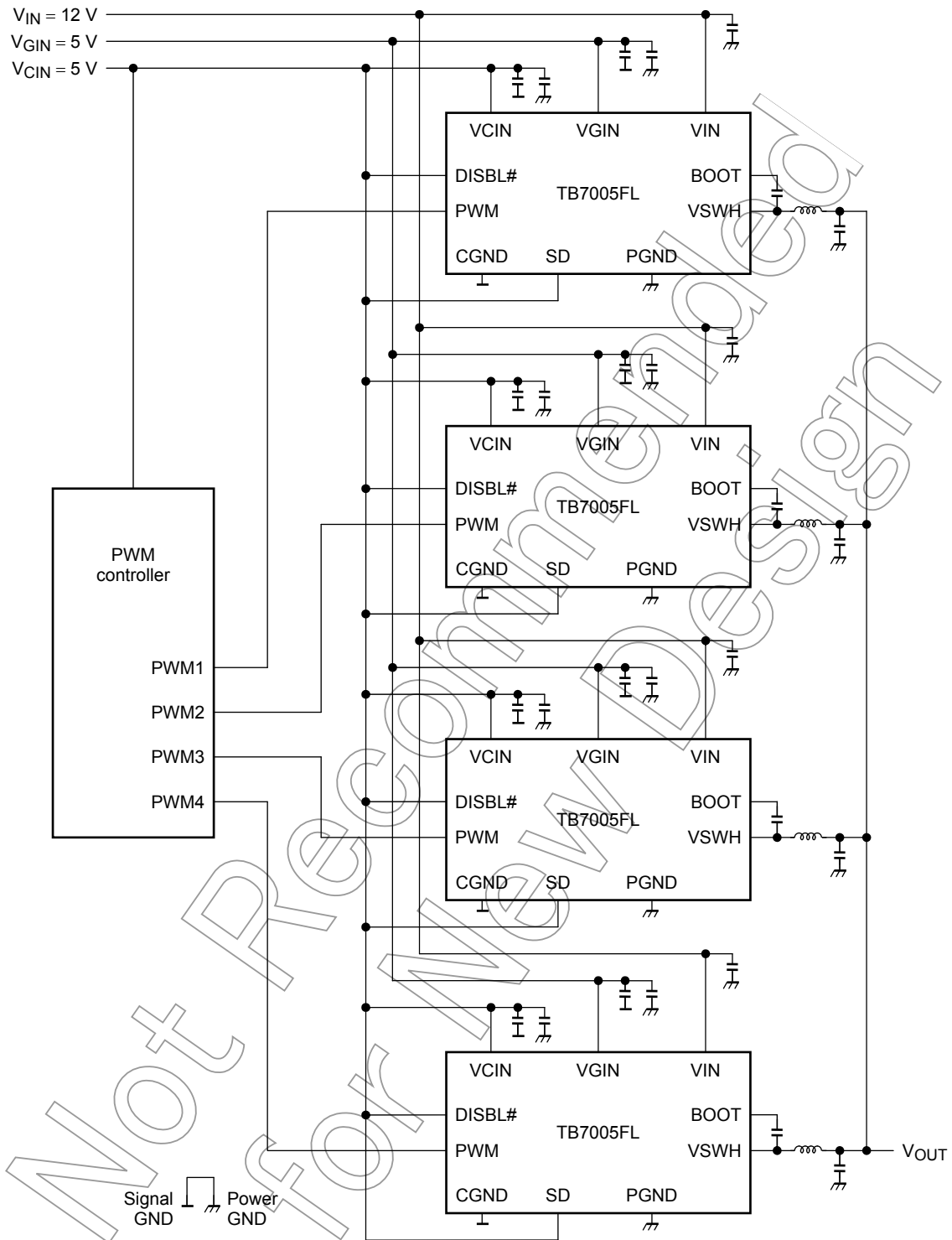
## Electrical Characteristics

( $V_{CIN} = 5\text{ V}$ ,  $V_{GIN} = 5\text{ V}$ ,  $V_{DISBL\#} = 5\text{ V}$ ,  $T_a = 25^\circ\text{C}$ , unless otherwise specified)

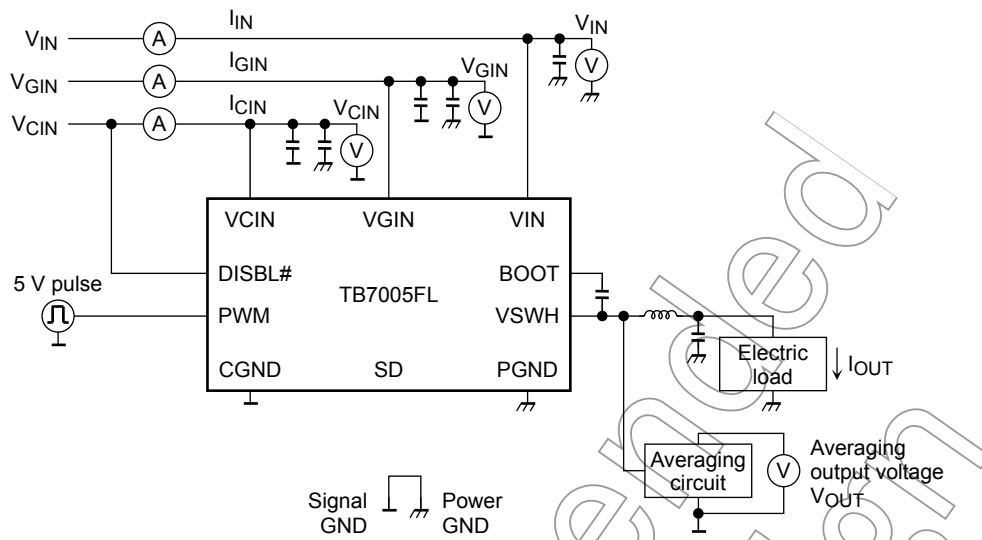
Characteristics	Symbol	Pin	Test Condition	Min	Typ.	Max	Unit
Power supply							
Operating input voltage	$V_{CIN(OPR)}$	VCIN	—	4.5	5	5.5	V
Quiescent current	$I_{CIN(OFF)}$	VCIN	$V_{DISBL\#} = 0$ , $V_{PWM} = 0$ $V_{SD} = 0$	—	—	140	$\mu\text{A}$
Operating $V_{GIN}$ current	$I_{GIN(OPR)}$	VGIN	$f_C = 1\text{ MHz}$ , duty = 10%	—	—	62	mA
Undervoltage lockout threshold	$V_{UVLO}$	VCIN	—	2.6	2.8	3.1	V
Undervoltage lockout hysteresis	$V_{hys-UVLO}$	VCIN	—	—	0.7	—	V
PWM signal input							
PWM input rising threshold	$V_H(PWM)$	PWM	—	2.0	—	—	V
PWM input falling threshold	$V_L(PWM)$	PWM	—	—	—	0.8	V
PWM input current (H)	$I_H(PWM)$	PWM	$V_{PWM} = 5\text{ V}$	—	—	170	$\mu\text{A}$
PWM input current (L)	$I_L(PWM)$	PWM	$V_{PWM} = 0$	—	0	—	$\mu\text{A}$
DISBL# signal input							
DISBL# input rising threshold	$V_H(DISBL\#)$	DISBL#	—	2.0	—	—	V
DISBL# input falling threshold	$V_L(DISBL\#)$	DISBL#	—	—	—	0.8	V
DISBL# input current (H)	$I_H(DISBL\#)$	DISBL#	$V_{DISBL\#} = 5\text{ V}$	—	—	170	$\mu\text{A}$
DISBL# input current (L)	$I_L(DISBL\#)$	DISBL#	$V_{DISBL\#} = 0$	—	0	—	$\mu\text{A}$
SD signal input							
SD input rising threshold	$V_H(SD)$	SD	—	2.0	—	—	V
SD input falling threshold	$V_L(SD)$	SD	—	—	—	0.8	V
SD input current (H)	$I_H(SD)$	SD	$V_{SD} = 5\text{ V}$	—	0	—	$\mu\text{A}$
SD input current (L)	$I_L(SD)$	SD	$V_{SD} = 0$	-170	—	—	$\mu\text{A}$

Not Recommended for New Design

## Typical Application



**Test Circuit**



$$P_{IN} = I_{IN} \times V_{IN} + I_{CIN} \times V_{CIN} + I_{GIN} \times V_{GIN}$$

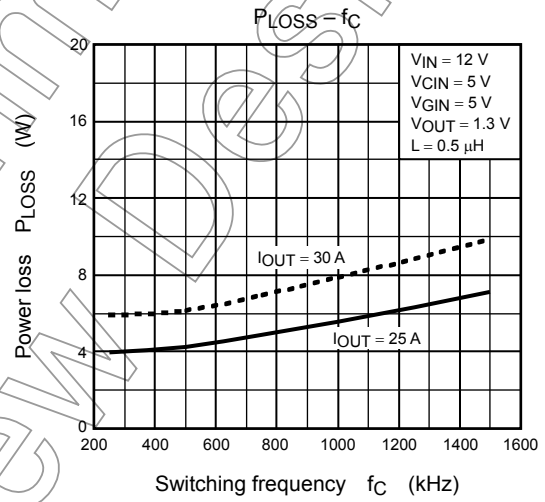
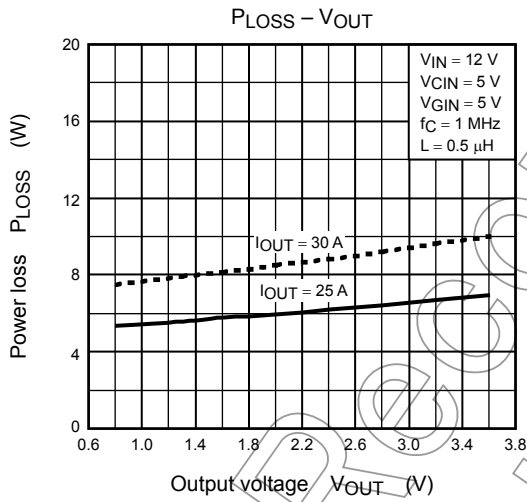
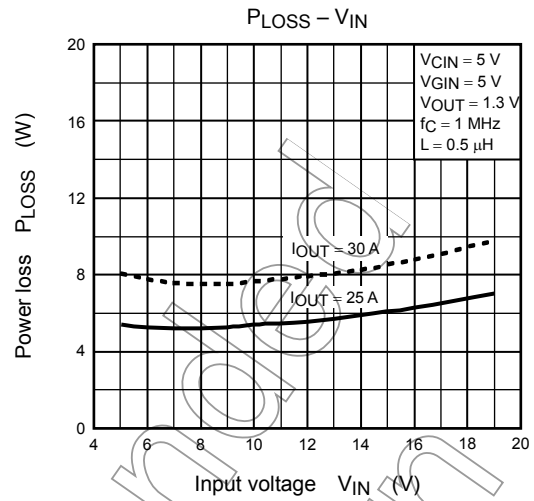
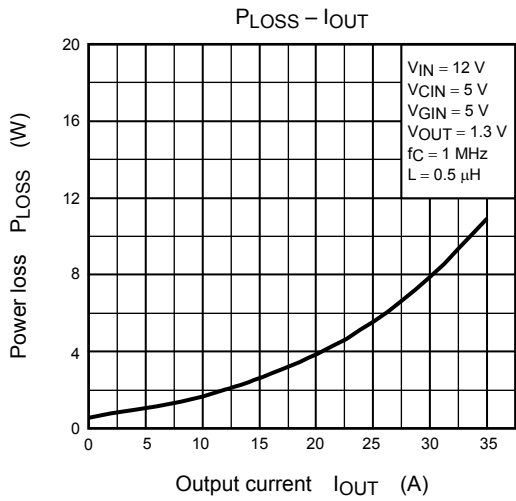
$$P_{OUT} = I_{OUT} \times V_{OUT}$$

$$\text{Efficiency} = P_{OUT} / P_{IN}$$

$$P_{LOSS} = P_{IN} - P_{OUT}$$

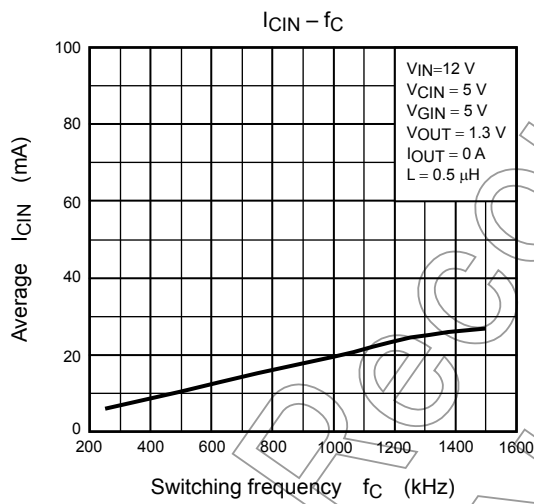
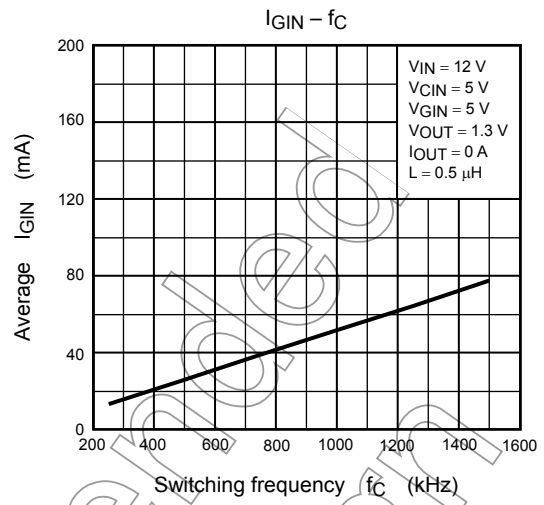
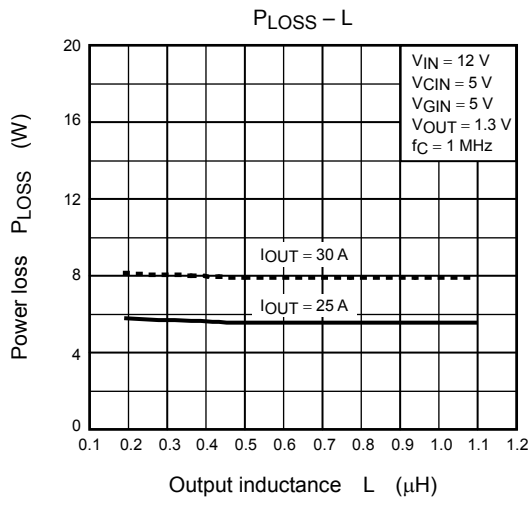
Not Recommended for New Design

**Performance Characteristics**

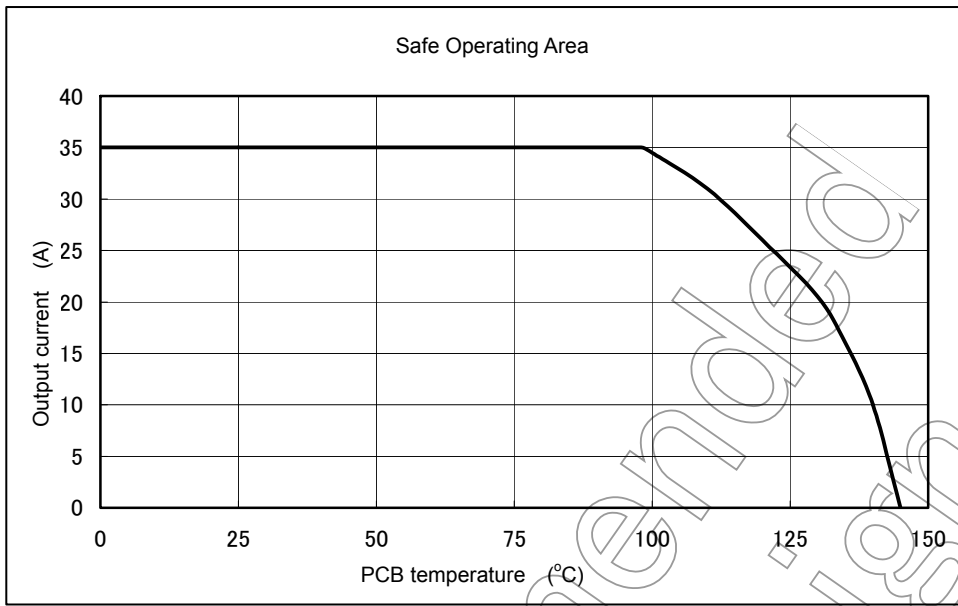


Not for New





Not for New Design



$V_{IN} = 12\text{ V}$ ,  $V_{CIN} = 5\text{ V}$ ,  $V_{GIN} = 5\text{ V}$ ,  $V_{OUT} = 1.3\text{ V}$ ,  $f_C = 1\text{ MHz}$ ,  $L = 0.6\text{ }\mu\text{H}$

Note: This safe operating area was obtained using the following evaluation board. The safe operating area varies with board conditions.

Board conditions

Material: FR-4

Number of layers: 4

Copper thickness: 35  $\mu\text{m}$

Board size: 75 mm  $\times$  55 mm

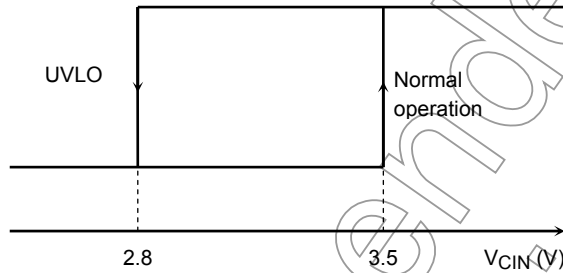
Board thickness: 2.4 mm

Not Recommended for New Design

**Operational Description**

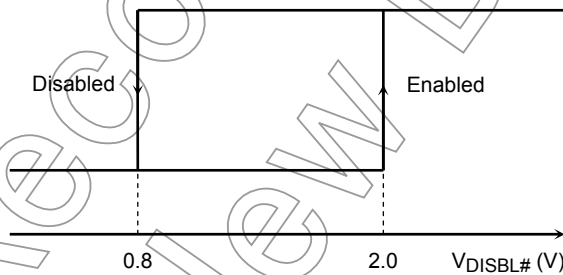
**Power Supplies**

- VGIN: Power supply for low-side MOSFET gate drive  
The low-side gate drive voltage can be selected, independent of VCIN.  
Supply voltage: 4.5 to 5.5 V
- VCIN: Power supply for the internal control circuitry  
Incorporates undervoltage lockout (UVLO.)  
UVLO threshold voltage: 2.8 V (typ.)  
UVLO hysteresis voltage: 0.7 V (typ.)  
In UVLO mode, the TB7005FL turns off both the high-side and low-side MOSFETs.



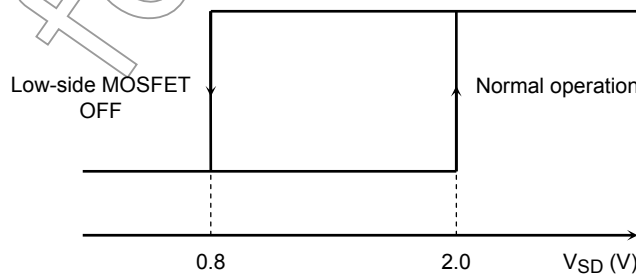
**DISBL#**

- The DISBL# input enables and disables the MOSFET drivers.
- H: Normal operation
- L: Turns off both the high-side and low-side MOSFETs.
- Rising threshold voltage: 2.0 V (min)
- Falling threshold voltage: 0.8 V (max)



**SD**

- The SD input can makes the low-side MOSFET off.
- H: Normal operation
- L: Keeps the low-side MOSFET off regardless of PWM signal.
- Rising threshold voltage: 2.0 V (min)
- Falling threshold voltage: 0.8 V (max)



**PWM**

Control input for the internal power MOSFET drivers

H: Turns on the high-side MOSFET and turns off the low-side MOSFET.

L: Turns off the high-side MOSFET and turns on the low-side MOSFET.

Rising threshold voltage: 2.0 V (min)

Falling threshold voltage: 0.8 V (max)

Inputs				Outputs	
VCIN	DISBL#	SD	PWM	High-Side MOSFET	Low-Side MOSFET
L	—	—	—	OFF	OFF
H	L	—	—	OFF	OFF
H	Open	—	—	OFF	OFF
H	H	L	L	OFF	OFF
H	H	L	H	ON	OFF
H	H	H	L	OFF	ON
H	H	H	H	ON	OFF

**BOOT**

BOOT is an input pin from which the bootstrap capacitor is charged.

The bootstrap capacitor should be connected between this pin and VSWH.

While the PWM signal is Low (i.e., the high-side MOSFET is off), the bootstrap capacitor is charged from the VCIN. Be sure to use a sufficiently large capacitor.

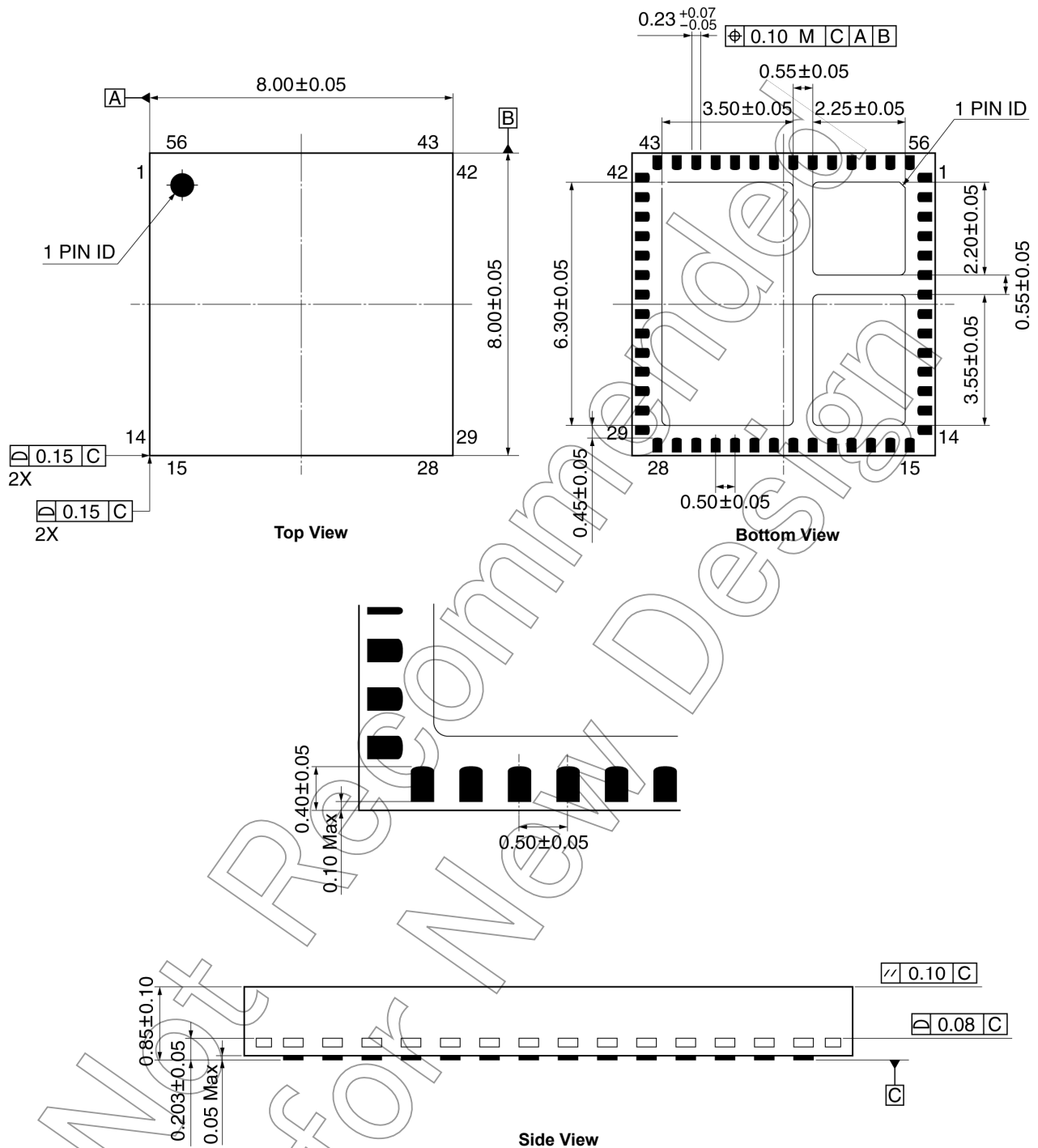
Typical capacitance: > 0.2  $\mu$ F ( $V_{IN} = 12$  V,  $V_{OUT} = 1.3$  V,  $f_C = 1$  MHz)

Not Recommended for New Design

## Package Dimensions

QFN56-P-0808-0.20

Unit: mm



Weight: 0.19 g (typ.)



## RESTRICTIONS ON PRODUCT USE

- Toshiba Corporation, and its subsidiaries and affiliates (collectively "TOSHIBA"), reserve the right to make changes to the information in this document, and related hardware, software and systems (collectively "Product") without notice.
- This document and any information herein may not be reproduced without prior written permission from TOSHIBA. Even with TOSHIBA's written permission, reproduction is permissible only if reproduction is without alteration/omission.
- Though TOSHIBA works continually to improve Product's quality and reliability, Product can malfunction or fail. Customers are responsible for complying with safety standards and for providing adequate designs and safeguards for their hardware, software and systems which minimize risk and avoid situations in which a malfunction or failure of Product could cause loss of human life, bodily injury or damage to property, including data loss or corruption. Before customers use the Product, create designs including the Product, or incorporate the Product into their own applications, customers must also refer to and comply with (a) the latest versions of all relevant TOSHIBA information, including without limitation, this document, the specifications, the data sheets and application notes for Product and the precautions and conditions set forth in the "TOSHIBA Semiconductor Reliability Handbook" and (b) the instructions for the application with which the Product will be used with or for. Customers are solely responsible for all aspects of their own product design or applications, including but not limited to (a) determining the appropriateness of the use of this Product in such design or applications; (b) evaluating and determining the applicability of any information contained in this document, or in charts, diagrams, programs, algorithms, sample application circuits, or any other referenced documents; and (c) validating all operating parameters for such designs and applications. **TOSHIBA ASSUMES NO LIABILITY FOR CUSTOMERS' PRODUCT DESIGN OR APPLICATIONS.**
- Product is intended for use in general electronics applications (e.g., computers, personal equipment, office equipment, measuring equipment, industrial robots and home electronics appliances) or for specific applications as expressly stated in this document. Product is neither intended nor warranted for use in equipment or systems that require extraordinarily high levels of quality and/or reliability and/or a malfunction or failure of which may cause loss of human life, bodily injury, serious property damage or serious public impact ("Unintended Use"). Unintended Use includes, without limitation, equipment used in nuclear facilities, equipment used in the aerospace industry, medical equipment, equipment used for automobiles, trains, ships and other transportation, traffic signaling equipment, equipment used to control combustions or explosions, safety devices, elevators and escalators, devices related to electric power, and equipment used in finance-related fields. Do not use Product for Unintended Use unless specifically permitted in this document.
- Do not disassemble, analyze, reverse-engineer, alter, modify, translate or copy Product, whether in whole or in part.
- Product shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable laws or regulations.
- The information contained herein is presented only as guidance for Product use. No responsibility is assumed by TOSHIBA for any infringement of patents or any other intellectual property rights of third parties that may result from the use of Product. No license to any intellectual property right is granted by this document, whether express or implied, by estoppel or otherwise.
- **ABSENT A WRITTEN SIGNED AGREEMENT, EXCEPT AS PROVIDED IN THE RELEVANT TERMS AND CONDITIONS OF SALE FOR PRODUCT, AND TO THE MAXIMUM EXTENT ALLOWABLE BY LAW, TOSHIBA (1) ASSUMES NO LIABILITY WHATSOEVER, INCLUDING WITHOUT LIMITATION, INDIRECT, CONSEQUENTIAL, SPECIAL, OR INCIDENTAL DAMAGES OR LOSS, INCLUDING WITHOUT LIMITATION, LOSS OF PROFITS, LOSS OF OPPORTUNITIES, BUSINESS INTERRUPTION AND LOSS OF DATA, AND (2) DISCLAIMS ANY AND ALL EXPRESS OR IMPLIED WARRANTIES AND CONDITIONS RELATED TO SALE, USE OF PRODUCT, OR INFORMATION, INCLUDING WARRANTIES OR CONDITIONS OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, ACCURACY OF INFORMATION, OR NONINFRINGEMENT.**
- Do not use or otherwise make available Product or related software or technology for any military purposes, including without limitation, for the design, development, use, stockpiling or manufacturing of nuclear, chemical, or biological weapons or missile technology products (mass destruction weapons). Product and related software and technology may be controlled under the Japanese Foreign Exchange and Foreign Trade Law and the U.S. Export Administration Regulations. Export and re-export of Product or related software or technology are strictly prohibited except in compliance with all applicable export laws and regulations.
- Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product. Please use Product in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. TOSHIBA assumes no liability for damages or losses occurring as a result of noncompliance with applicable laws and regulations.

Not for