



# TF2366M/TF2388M

## 3-Phase Half-Bridge Gate Driver

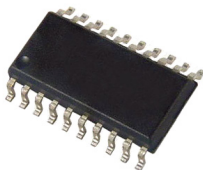
### Features

- Three floating high-side drivers in bootstrap operation to 500V/600V
- 420mA source / 750mA sink output current capability
- Logic input 3.3V capability
- Internal deadtime of 315ns to protect MOSFETs
- Matched prop delay time maximum of 50ns
- Outputs in phase with inputs
- Schmitt triggered logic inputs
- Cross conduction prevention logic
- Undervoltage lockout for all channels
- Extended temperature range: -40°C to +125°C
- Space saving SOIC-20 package

### Applications

- 3-Phase Motor Inverter Driver
- White Goods - Air Conditioner, Washing Machine, Refrigerator
- Industrial Motor Inverter - Power Tools, Robotics
- General Purpose 3-Phase Inverter

SOIC-20



### Description

The TF2366M/TF2388M is a three-phase gate driver IC designed for high voltage three-phase applications, driving N-channel MOSFETs and IGBTs in a half-bridge configuration. TF Semiconductor's high voltage process enables the TF2388M high sides to switch to 600V in a bootstrap operation, and the TF2366M can switch to 500V.

The TF2366M/TF2388M logic inputs are compatible with standard TTL and CMOS levels (down to 3.3V) to interface easily with controlling devices and are enabled low to better function in high noise environments. The driver outputs feature high pulse current buffers designed for minimum driver cross conduction.

The TF2366M/TF2388M offers numerous protection functions. A shoot-through protection logic prevents both outputs being high with both inputs high (fault state), an undervoltage lockout for  $V_{CC}$  shuts down all drivers through an internal fault control, and a UVLO for  $V_{BS}$  shuts down the respective high side output. The TF2366M/TF2388M is offered in SOIC 20 package and operates over an extended -40 °C to +125 °C temperature range.

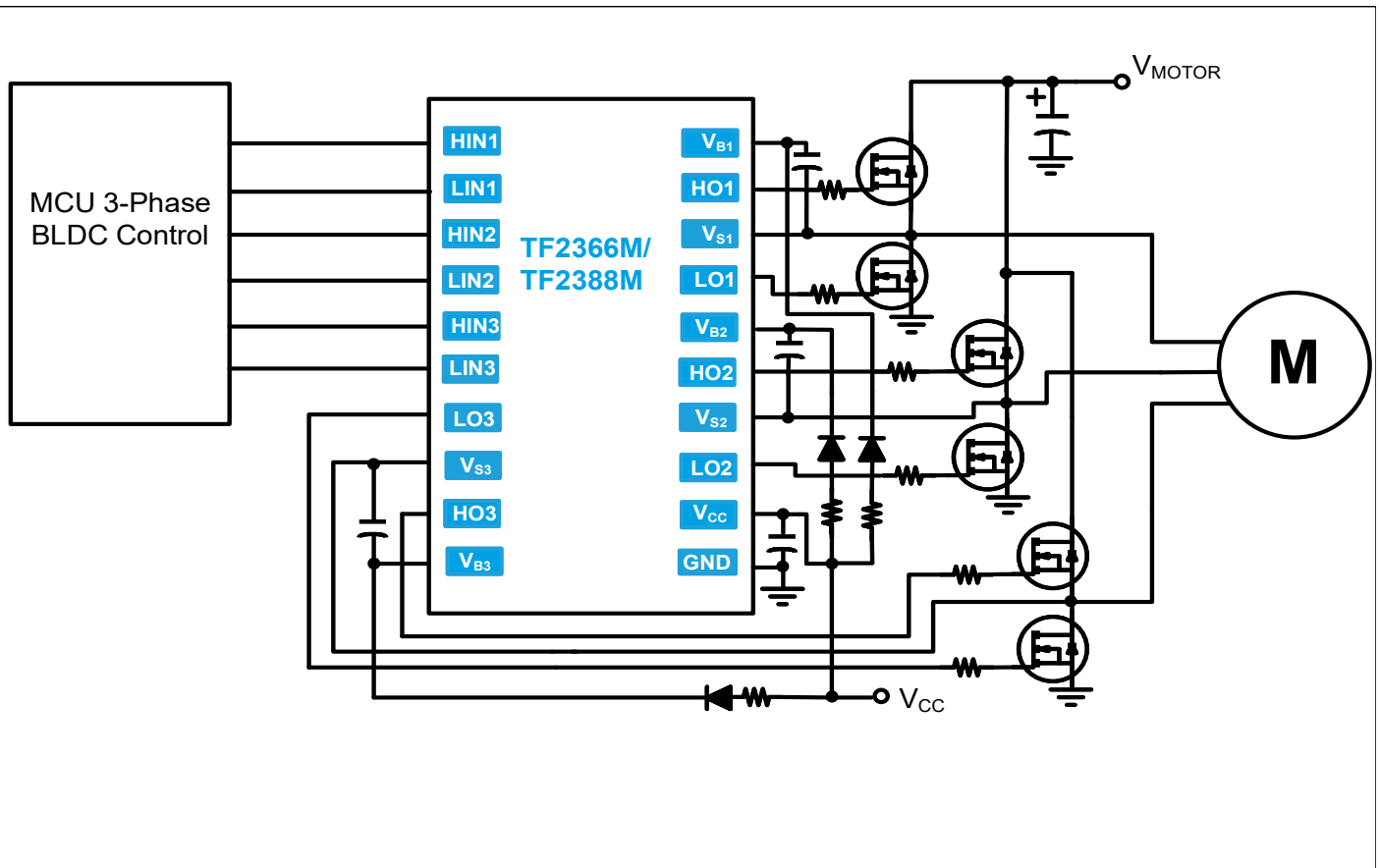
### Ordering Information

Year Year Week Week

PART NUMBER	PACKAGE	PACK / Qty	MARK
TF2366M-TGU	SOIC-20	Tube / 35	YYWW TF2366M
TF2366M-TGH	SOIC-20	T&R / 1500	Lot ID
TF2388M-TGU	SOIC-20	Tube / 35	YYWW TF2388M
TF2388M-TGH	SOIC-20	T&R / 1500	Lot ID

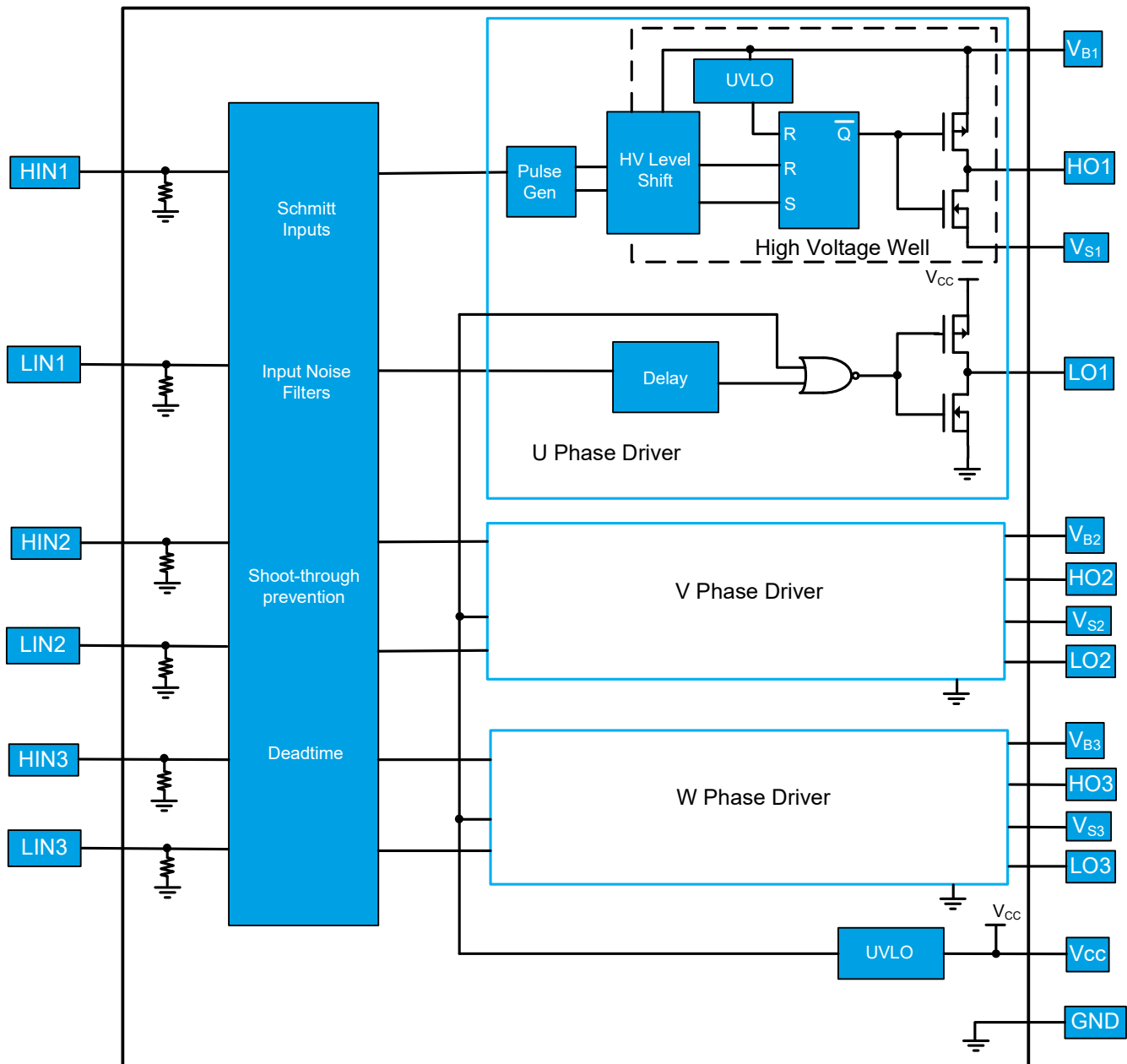


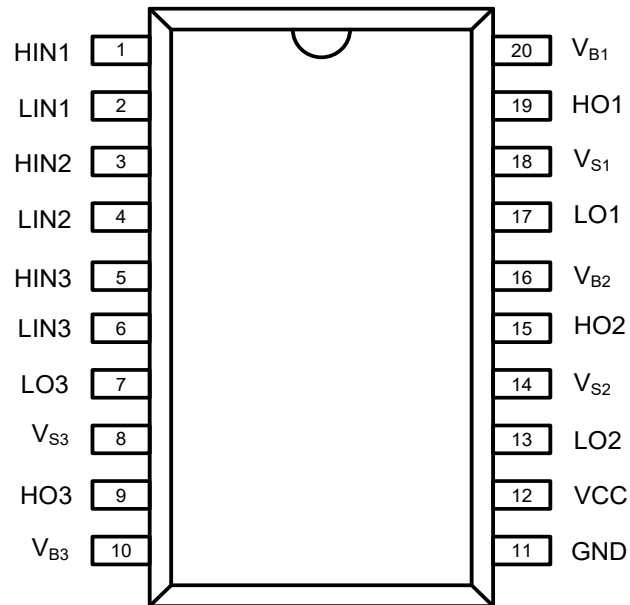
## Typical Application





Functional Block Diagram





Top View: SOIC-20

## Pin Descriptions

PIN NAME	PIN NUMBER	PIN DESCRIPTION
HIN1, HIN2, HIN3	1, 3, 5	Logic input for high-side gate driver output, in phase with HO.
LIN1, LIN2, LIN3	2, 4, 6	Logic input for low-side gate driver output, in phase with LO.
LO3, LO2, LO1	7, 13, 17	Low-side gate driver output
$V_{S3}, V_{S2}, V_{S1}$	8, 14, 18	High-side floating supply return
HO3, HO2, HO1	9, 15, 19	High-side gate driver output
$V_{B3}, V_{B2}, V_{B1}$	10, 16, 20	High-side floating supply
GND	11	Low-side driver and logic return
VCC	12	Low-side and logic fixed supply



## Absolute Maximum Ratings (NOTE1)

$V_B$  - High-side floating supply voltage (TF2366M)..-0.3V to +524V  
 $V_B$  - High-side floating supply voltage (TF2388M)..-0.3V to +624V  
 $V_S$  - High-side floating supply offset voltage... $V_B$ -24V to  $V_B$ +0.3V  
 $V_{HO}$  - High-side floating output voltage..... $V_S$ -0.3V to  $V_B$ +0.3V  
 $V_{LO}$  - Low-side output voltage.....-0.3V to  $V_{CC}$ +0.3V  
 $dV_S/dt$  - Offset supply voltage transient.....50V/ns  
 $V_{CC}$  - Low-side fixed supply voltage.....-0.3V to +24V  
 $V_{IN}$  - Logic input voltage (HIN and LIN).....-0.3V to 5.5V

**NOTE1** Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

$P_D$  - Package power dissipation at  $T_A=25^\circ\text{C}$   
 SOIC-20.....1.88W  
 SOIC-20 Thermal Resistance (**NOTE2**)  
 $\theta_{JA}$ .....66.6 $^\circ\text{C/W}$   
 $T_J$  - Junction operating temperature.....+150  $^\circ\text{C}$   
 $T_L$  - Lead Temperature (soldering, 10 seconds).....+300  $^\circ\text{C}$   
 $T_{stg}$  - Storage temperature .....-55 to 150  $^\circ\text{C}$

**NOTE2** When mounted on a standard JEDEC 2-layer FR-4 board.

## Recommended Operating Conditions

Symbol	Parameter	MIN	MAX	Unit
$V_B$	High side floating supply absolute voltage	$V_S + 10$	$V_S + 20$	V
$V_S$	High side floating supply offset voltage	TF2366M	500	V
		TF2388M	600	
$V_{HO}$	High side floating output voltage	$V_S$	$V_B$	V
$V_{CC}$	Low side fixed supply voltage	10	20	V
$V_{LO}$	Low side output voltage	COM	$V_{CC}$	V
$V_{IN}$	Logic input voltage (HIN and LIN)	0	5	V
$T_A$	Ambient temperature	-40	125	$^\circ\text{C}$

**NOTE3** Logic operational for  $V_S$  of -5V to +500V for TF2366M and +600V for TF2388M.



## DC Electrical Characteristics (NOTE4)

$V_{BIAS} (V_{CC}, V_{BS}) = 15V, T_A = 25^\circ C$ , unless otherwise specified.

Symbol	Parameter	Conditions	MIN	TYP	MAX	Unit
$V_{IH}$	Logic "0" input voltage	<b>NOTES</b>	2.4			V
$V_{IL}$	Logic "1" input voltage				0.8	
$V_{OH}$	High level output voltage, $V_{BIAS} - V_O$	$I_O = 2mA$		0.2	0.5	
$V_{OL}$	Low level output voltage, $V_O$	$I_O = 2mA$		0.07	0.2	
$I_{LK}$	Offset supply leakage current	$V_B=V_S=500V$ (TF2366M) $V_B=V_S=600V$ (TF2388M)			10	$\mu A$
$I_{BSQ}$	Quiescent $V_{BS}$ supply current	$V_{IN} = 0V$ or $5V$		50	80	
$I_{BSO}$	Operating $V_{BS}$ supply current	$f_s = 20kHz$		400		
$I_{CCQ}$	Quiescent $V_{CC}$ supply current	$V_{IN} = 0V$ or $5V$		230	330	
$I_{CCO}$	Operating $V_{CC}$ supply current	$f_s = 20kHz$		500		
$I_{IN+}$	Logic "1" input bias current	$V_{IN} = 5V$		25	80	
$I_{IN-}$	Logic "0" input bias current	$V_{IN} = 0V$			2	
$R_{IN}$	Input pull-down resistance			200		$k\Omega$
$V_{BSUV+}$ $V_{CCUV+}$	$V_{BS}$ and $V_{CC}$ supply under-voltage positive going threshold		7.1	8.5	9.9	V
$V_{BSUV-}$ $V_{CCUV-}$	$V_{BS}$ and $V_{CC}$ supply under-voltage negative going threshold		6.7	8.1	9.5	
$I_{O+}$	Output high short circuit pulsed current	$V_O = 0V, PW \leq 10 \mu s$	270	420		mA
$I_{O-}$	Output low short circuit pulsed current	$V_O = 15V, PW \leq 10 \mu s$	600	750		

**NOTE4** The  $V_{IN}$ ,  $V_{TH}$ , and  $I_{IN}$  parameters are referenced to  $V_{SS}$  and are applicable to all six channels (HIN1,2,3 and LIN1,2,3). The  $V_O$  and  $I_O$  parameters are applicable to the outputs (HO1,2,3 and LO1,2,3 and are referenced to COM.

**NOTES** For optimal operation, it is recommended that the input pulse (to HINx and LINx) should have an amplitude of 2.4V minimum with a pulse width of 600ns minimum.



## AC Electrical Characteristics

$V_{BIAS} (V_{CC}, V_{BS}) = 15V$ ,  $C_L = 1000pF$ , and  $T_A = 25^\circ C$ , unless otherwise specified.

Symbol	Parameter	Conditions	MIN	TYP	MAX	Unit
$t_{on}$	Turn-on propagation delay	$V_s = 0V$	70	120	170	ns
$t_{off}$	Turn-off propagation delay	$V_s = 0V$	70	120	170	
$t_r$	Turn-on rise time	$V_s = 0V$		45	75	
$t_f$	Turn-off fall time			25	40	
$t_{DM}$	Delay matching				50	ns
$t_{DT}$	Deadtime		200	315	430	ns
$t_{DTM}$	Deadtime matching				50	ns

## Timing Waveforms

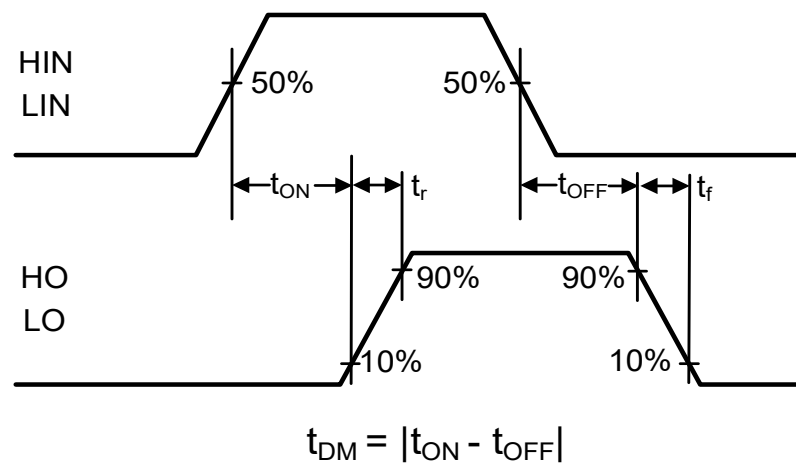


Figure 1. Switching Time Waveform Definitions

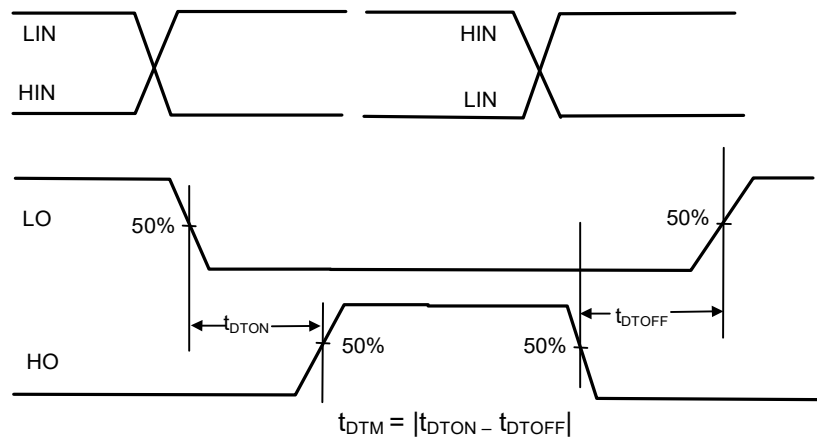
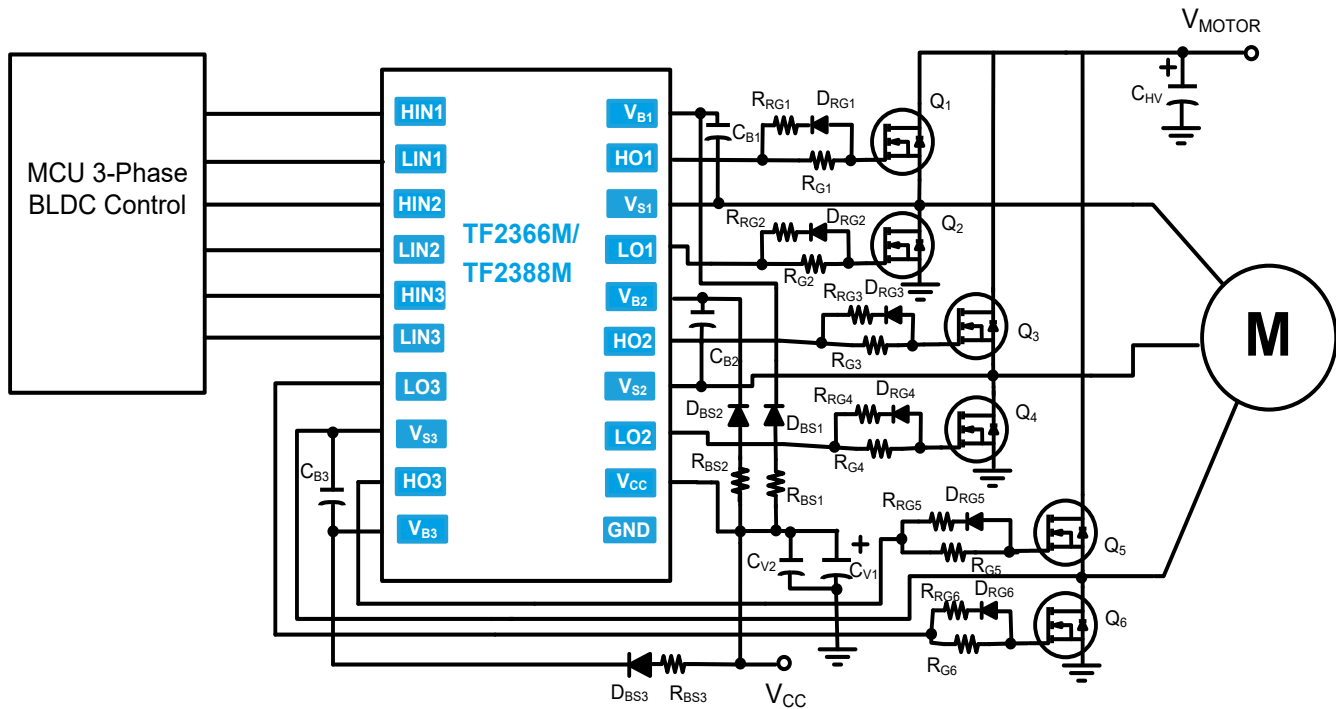


Figure 2. Deadtime Waveform Definitions



## Application Information

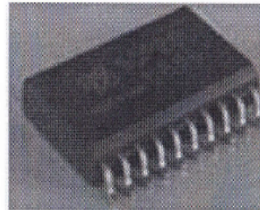
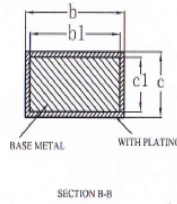
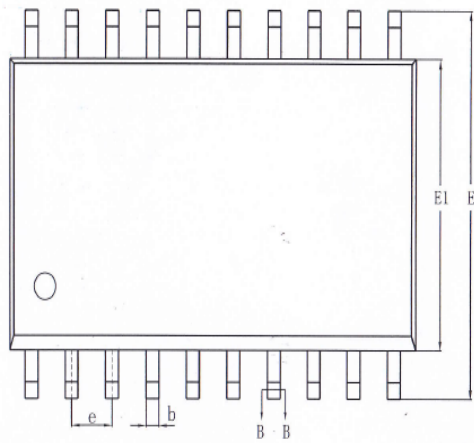
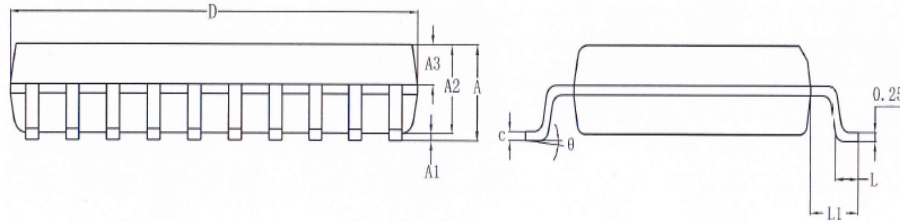


- RRG1 - RRG6 values are typically between  $0\Omega$  and  $10\Omega$ , exact value decided by MOSFET junction capacitance and drive current of gate driver;  $10\Omega$  is used in this example.
- RG1 - RG6 values are typically between  $20\Omega$  and  $100\Omega$ , exact value decided by MOSFET junction capacitance and drive current of gate driver;  $50\Omega$  is used in this example.
- RBS1 - RBS3 values are typically between  $3\Omega$  and  $20\Omega$ , exact value depending on bootstrap capacitor value and amount of current limiting required for bootstrap capacitor charging;  $10\Omega$  is used in this example. Also DBS1 - DBS3 should be an ultra fast diode of 1A rating minimum and voltage rating greater than system operating voltage.
- It is recommended that the input pulse (to HINx and LINx) should have a minimum amplitude of 2.4V and a minimum pulse width of 600ns.





**Package Dimensions (SOIC-20)**



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	2.65
A1	0.10	—	0.30
A2	2.25	2.30	2.35
A3	0.97	1.02	1.07
b	0.35	—	0.43
b1	0.34	0.37	0.40
c	0.25	—	0.29
c1	0.24	0.25	0.26
D	12.70	12.80	12.90
E	10.10	10.30	10.50
E1	7.40	7.50	7.60
e	1.27BSC		
L	0.70	—	1.00
L1	1.40REF		
θ	0	—	8°



## Revision History

Rev.	Change	Owner	Date
1.0	First release, final datasheet	Keith Spaulding	6/22/2022

## Important Notice

TF Semiconductor Solutions (TFSS) PRODUCTS ARE NEITHER DESIGNED NOR INTENDED FOR USE IN MILITARY AND/OR AEROSPACE, AUTOMOTIVE OR MEDICAL DEVICES OR SYSTEMS UNLESS THE SPECIFIC TFSS PRODUCTS ARE SPECIFICALLY DESIGNATED BY TFSS FOR SUCH USE. BUYERS ACKNOWLEDGE AND AGREE THAT ANY SUCH USE OF TFSS PRODUCTS WHICH TFSS HAS NOT DESIGNATED FOR USE IN MILITARY AND/OR AEROSPACE, AUTOMOTIVE OR MEDICAL DEVICES OR SYSTEMS IS SOLELY AT THE BUYER'S RISK.

TFSS assumes no liability for application assistance or customer product design. Customers are responsible for their products and applications using TFSS products.

Resale of TFSS products or services with statements different from or beyond the parameters stated by TFSS for that product or service voids all express and any implied warranties for the associated TFSS product or service. TFSS is not responsible or liable for any such statements.

©2022 TFSS. All Rights Reserved. Information and data in this document are owned by TFSS wholly and may not be edited, reproduced, or redistributed in any way without the express written consent from TFSS.

For additional information please contact [support@tfsemi.com](mailto:support@tfsemi.com) or visit [www.tfsemi.com](http://www.tfsemi.com).