

## Features:

- Drives two N-channel MOSFETs or IGBTs in a half bridge configuration
- Floating high-side driver in bootstrap operation to 600V
- 290mA source/600mA sink output current capability
- Outputs tolerant to negative transients
- Internal logic and deadtime (100ns) to protect MOSFETs
- Logic input (HIN and LIN) 3.3V capability
- Schmitt triggered logic inputs with internal pull down
- Undervoltage lockout for high and low side drivers
- Extended temperature range:-40°C to +124°C

## Description

The TF2304M is a high voltage, high speed gate driver capable of driving N-channel MOSFETs and IGBTs in a half-bridge configuration. TF Semi's high voltage process enables the TF2304M's high side to switch to 600V in a bootstrap operation.

The TF2304M logic inputs are compatible with standard TTL and CMOS levels (down to 3.3V) to interface easily with controlling devices. The driver outputs feature high pulse current buffers designed for minimum driver cross conduction. An internal deadtime of 100ns protects high-voltage MOSFETs from shoot-through.

The TF2304M is offered in 8-pin PDIP and SOIC narrow package and operates over an extended -40°C to +125°C temperature range.

## Applications

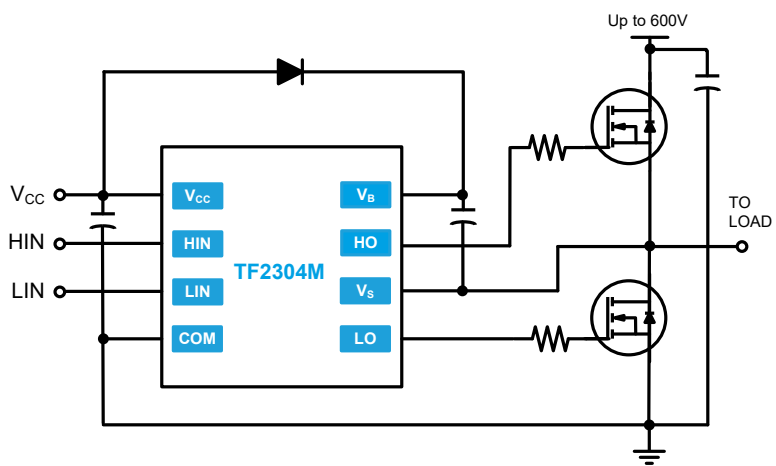
- Motor Controls
- AC-DC Inverters
- DC-DC Converters
- Class D Power Amplifiers



## Ordering Information

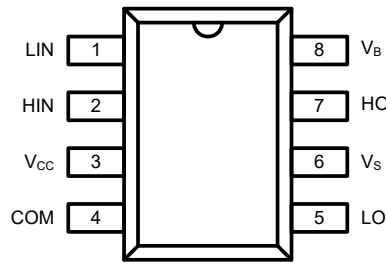
PART NUMBER	PACKAGE	PACKING / Qty	MARK
			Year Year Week Week
TF2304M-3AS	PDIP-8	Tube / 50	YYWW TF2304M Lot ID
TF2304M-TAU	SOIC-8(N)	Tube / 100	YYWW TF2304M Lot ID
TF2304M-TAH	SOIC-8(N)	Tape & Reel / 2500	

## Typical Application





**Pin Diagrams**



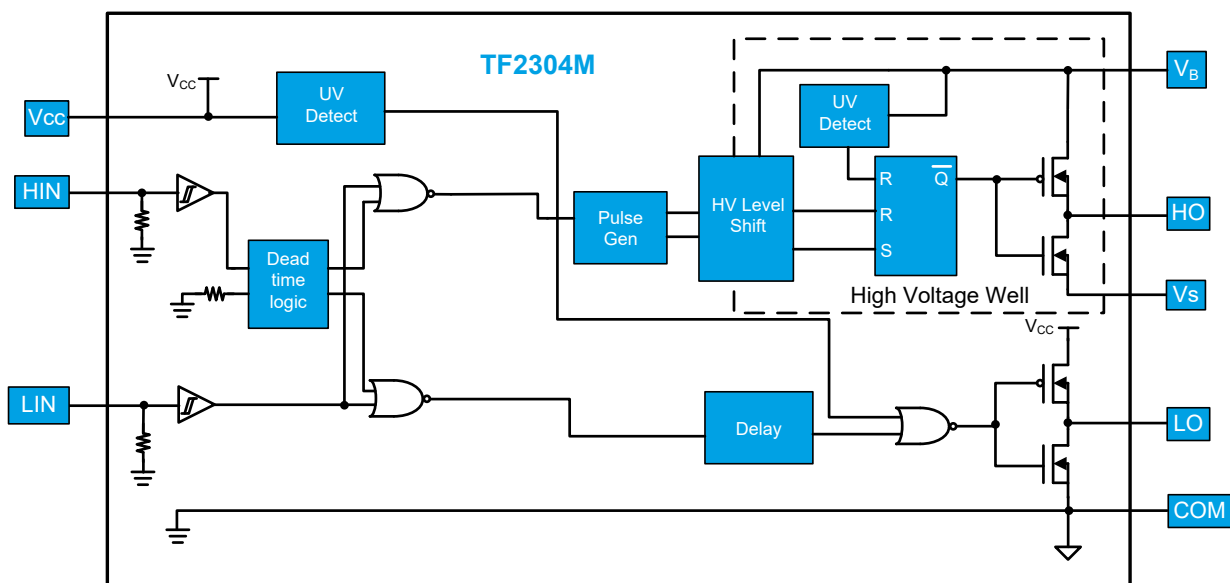
**Top View: SOIC-8, PDIP-8**

**TF2304M**

**Pin Descriptions**

PIN NAME	PIN DESCRIPTION
HIN	Logic input for high-side gate driver output, in phase with HO
LIN	Logic input for low side gate driver output, in phase with LO
COM	Low-side and logic return
LO	Low-side gate drive output
V <sub>cc</sub>	Low-side and logic fixed supply
V <sub>s</sub>	High-side floating supply return
HO	High-side gate drive output
V <sub>b</sub>	High-side floating supply

**Functional Block Diagram**





## Absolute Maximum Ratings (NOTE1)

$V_B$  - High side floating supply voltage.....-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  
 $dV_S/dt$  - Offset supply voltage transient.....50 V/ns

$V_{CC}$  - Low side and logic fixed supply voltage.....-0.3V to +24V  
 $V_{LO}$  - Low side output voltage.....-0.3V to  $V_{CC}$ +0.3V  
 $V_{IN}$  - Logic input voltage (HIN and LIN)..... $V_{SS}$ - 0.3V to  $V_{CC}$ +0.3V

$P_D$  - Package power dissipation at  $T_A \leq 25^\circ\text{C}$

SOIC-8.....1.25W  
 PDIP-8.....1.6W

**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.

PDIP-8 Thermal Resistance (NOTE2)

$\theta_{JC}$ .....15  $^\circ\text{C}/\text{W}$   
 $\theta_{JA}$ .....45  $^\circ\text{C}/\text{W}$

SOIC-8(N) Thermal Resistance (NOTE2)

$\theta_{JC}$ .....25  $^\circ\text{C}/\text{W}$   
 $\theta_{JA}$ .....55  $^\circ\text{C}/\text{W}$

$T_J$  - Junction operating temperature .....+150  $^\circ\text{C}$

$T_L$  - Lead temperature (soldering, 10s) ..... +300  $^\circ\text{C}$

$T_{stg}$  - Storage temperature range .....-55  $^\circ\text{C}$  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	(NOTE 3)	600	V
$V_{HO}$	High side floating output voltage	$V_S$	$V_B$	V
$V_{CC}$	Low side and logic fixed supply voltage	10	20	V
$V_{LO}$	Low side output voltage	0	$V_{CC}$	V
$V_{IN}$	Logic input voltage	0	5	V
$T_A$	Ambient temperature	-40	125	$^\circ\text{C}$

**NOTE3** Logic operational for  $V_S$  of -5 V to +600 V.



## DC Electrical Characteristics (NOTE4)

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

Symbol	Parameter	Conditions	MIN	TYP	MAX	Unit
$V_{IH}$	Logic "1" input voltage	$V_{CC} = 10V$ to $20V$	2.3			V
$V_{IL}$	Logic "0" input voltage	<b>NOTE 5</b>			0.7	
$V_{OH}$	High level output voltage, $V_{BIAS} - V_O$	$I_O = 2mA$		0.05	0.2	
$V_{OL}$	Low level output voltage, $V_O$	$I_O = 2mA$		0.02	0.1	
$I_{LK}$	Offset supply leakage current	$V_B = V_S = 600V$			50	$\mu A$
$I_{BSQ}$	Quiescent $V_{BS}$ supply current	$V_{IN} = 0V$ or $5V$	20	60	150	
$I_{CCQ}$	Quiescent $V_{CC}$ supply current	$V_{IN} = 0V$ or $5V$	50	260	400	$\mu A$
$I_{IN+}$	Logic "1" input bias current	$V_{IN} = 5V$		5	40	$\mu A$
$I_{IN-}$	Logic "0" input bias current	$V_{IN} = 0V$		1.0	5.0	
$V_{BSUV+}$	$V_{BS}$ supply under-voltage positive going threshold		7.7	8.7	9.7	V
$V_{BSUV-}$	$V_{BS}$ supply under-voltage negative going threshold		7.0	8.0	9.0	
$V_{CCUV+}$	$V_{CC}$ supply under-voltage positive going threshold		7.7	8.7	9.7	
$V_{CCUV-}$	$V_{CC}$ supply under-voltage negative going threshold		7.0	8.0	9.0	
$I_{O+}$	Output high short circuit pulsed current	$V_O = 0V$ , $PW \leq 10 \mu s$	60	290		mA
$I_{O-}$	Output low short circuit pulsed current	$V_O = 15V$ , $PW \leq 10 \mu s$	130	600		

**NOTE4** The  $V_{IN}$ ,  $V_{th}$ ,  $I_{IN}$  parameters are referenced to COM and are applicable to the two logic input pins: HIN and LIN. The  $V_O$  and  $I_O$  parameters are referenced to COM and are applicable to the respective output pins: HO and LO.

**NOTE5** For optimal operation, it is recommended that the input pulse (to HIN and LIN) should have an amplitude of 2.3V minimum with a pulse width of 200ns minimum.

## AC Electrical Characteristics

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

Symbol	Parameter	Conditions	MIN	TYP	MAX	Unit
$t_{ON}$	Turn-on propagation delay	$V_S = 0V$		95	210	ns
$t_{OFF}$	Turn-off propagation delay	$V_S = 0V$ or $600V$		100	210	
$t_{DMON}$	Delay matching HS & LS turn on/off				50	
$t_r$	Turn-on rise time			70	120	
$t_f$	Turn-off fall time			35	60	
$t_{DT}$	Deadtime: $t_{DT LO-HO}$ & $t_{DT HO-LO}$		80	100	190	

# Timing Waveforms

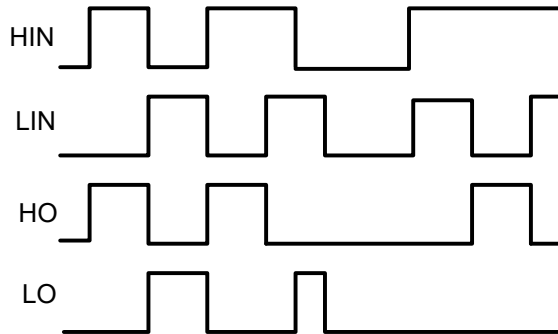


Figure 1. Input / Output Timing Diagram

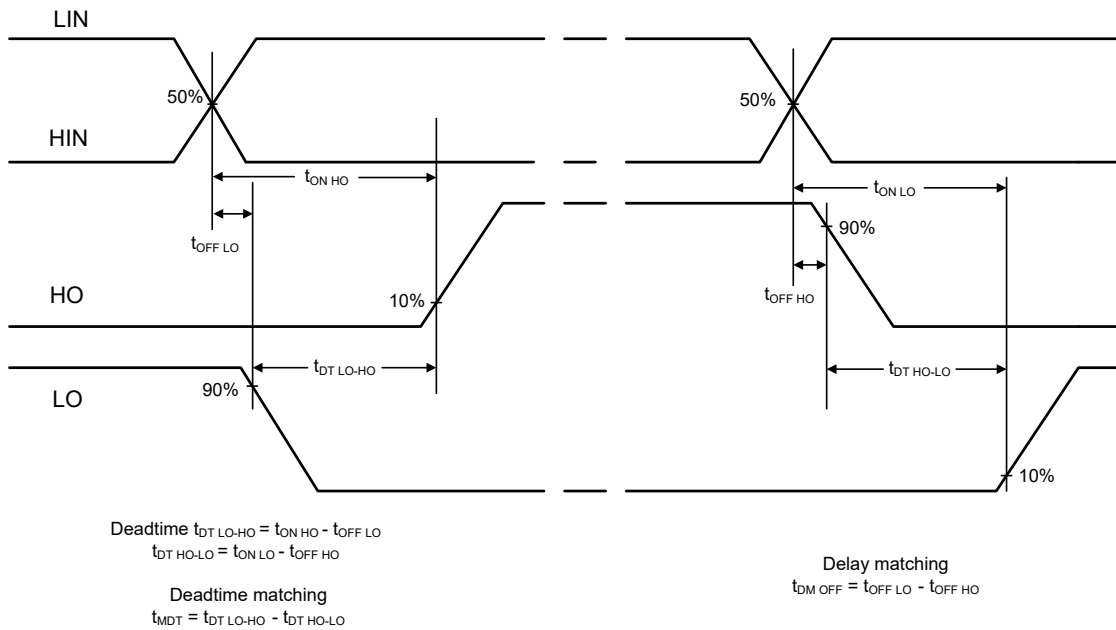
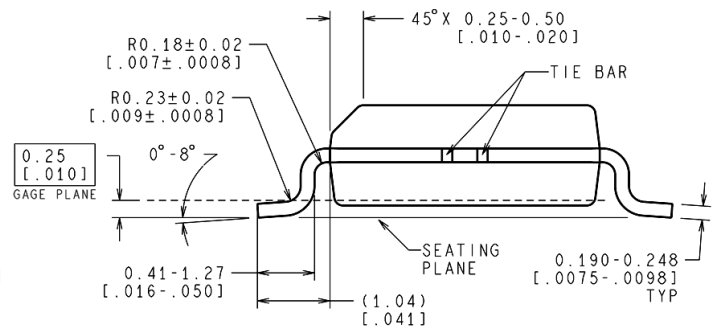
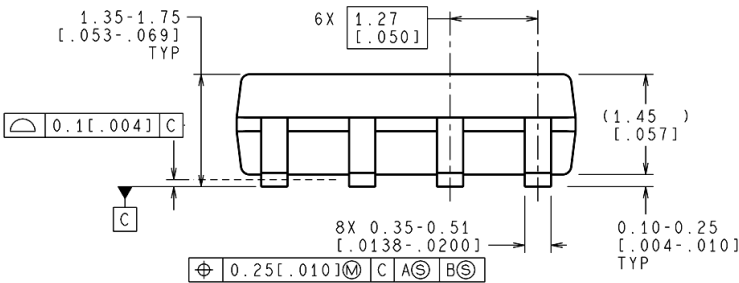
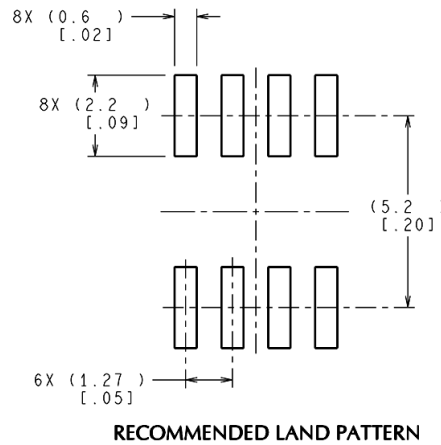
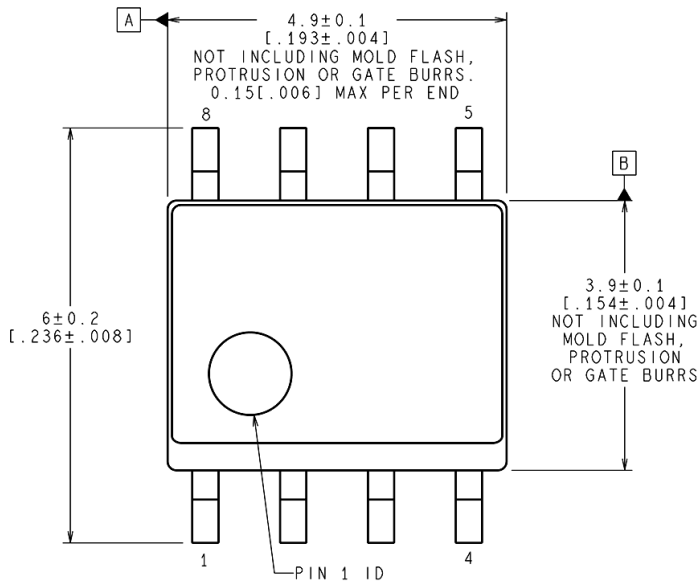


Figure 2. Switching Time Waveform Definition



# Package Dimensions (SOIC-8N)

Please contact support@tfsemi.com for package availability.



NOTES: UNLESS OTHERWISE SPECIFIED

1. REFERENCE JEDEC REGISTRATION MS-012, VARIATION AA.

**CONTROLLING DIMENSION IS MILLIMETER**  
**VALUES IN [ ] ARE INCHES**  
 DIMENSIONS IN ( ) FOR REFERENCE ONLY





## Revision History

Rev.	Change	Owner	Date
1.0	First release, AI datasheet	Keith Spaulding	3/3/2017
1.1	Add Note 5	Keith Spaulding	5/28/2019

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