



# MPQ6527

## 40V, 0.8A, 10-Channel Half-Bridge Motor Driver with Serial Input Control, AEC-Q100 Qualified

### DESCRIPTION

The MPQ6527 is a ten-channel half-bridge DMOS output driver with integrated power MOSFETs. The device has a 5.5V to 40V input voltage range, with a maximum 0.8A of output current capability.

The device's ten half-bridges can be controlled separately from a standard serial data interface, and each channel has various diagnostic functions. The MPQ6527 has very low quiescent current in standby mode.

Full protection includes short-circuit protection (SCP), under-voltage protection (UVP), and thermal shutdown.

The MPQ6527 requires a minimal number of readily available, standard external components, and is available in a TSSOP-28 EP package.

### FEATURES

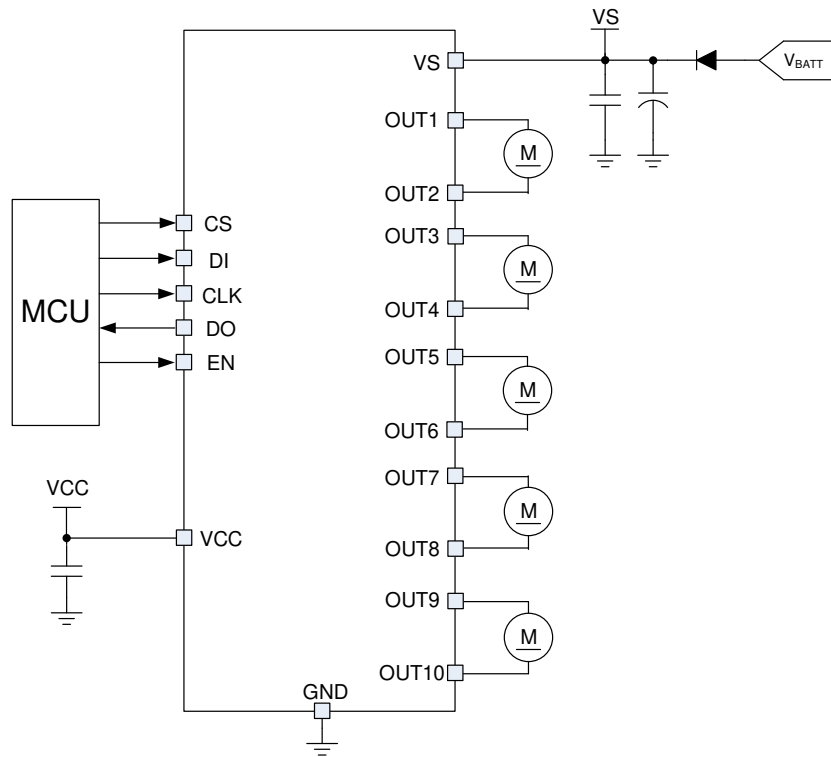
- Wide 5.5V to 40V Operating Input Range
- High-Side and Low-Side Drivers Connected in Half-Bridge Configurations
- Up to 0.8A Output Current
- $R_{DS(ON)}$  (HS-FET and LS-FET), Typically 1.3 $\Omega$
- Very Low Quiescent Current in Standby Mode vs. Total Temperature Range
- Output Short-Circuit Protection (SCP)
- Over-Temperature Protection (OTP) and Pre-Warning
- Under-Voltage (UV) and Over-Voltage Lockout (OVLO)
- Serial Data Interface
- Various Diagnostic Functions: Shorted Output, Open Load, and Over-Temperature, Over-Voltage, and Under-Voltage Conditions
- Serial Interface Clock Frequency Up to 5MHz
- Compliance with 3.3V and 5V Systems
- Available in a TSSOP-28 EP Package
- Available in AEC-Q100 Grade 1

### APPLICATIONS

- Drive Various Loads in Automotive and Industrial Applications
- DC Motors

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## TYPICAL APPLICATION



### ORDERING INFORMATION

Part Number*	Package	Top Marking	MSL Rating
MPQ6527GF-AEC1	TSSOP-28 EP	See Below	2A

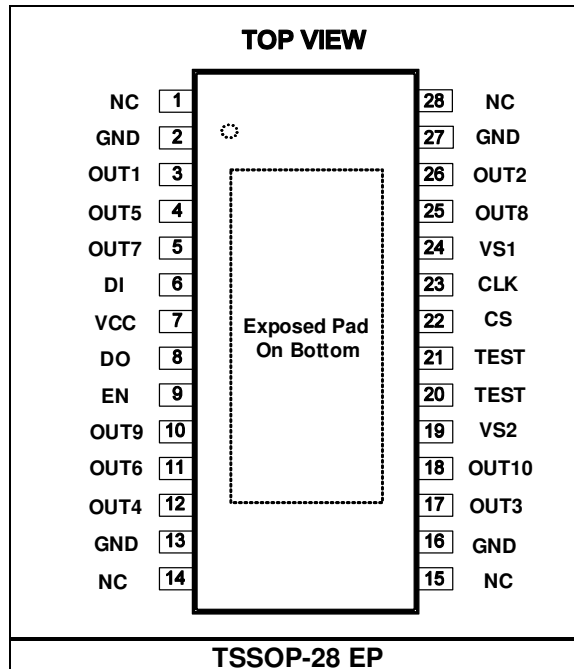
\* For Tape & Reel, add suffix -Z (e.g. MPQ6527GF-AEC1-Z).

### TOP MARKING

MPSYYWW  
 MP6527  
 LLLLLLLLLL

MPS: MPS prefix  
 YY: Year code  
 WW: Week code  
 MP6527: Part number  
 LLLLLLLLLL: Lot number

### PACKAGE REFERENCE



## PIN FUNCTIONS

Pin #	Name	Description
1, 14, 15, 28	NC	No connection.
2, 13, 16, 27	GND	Ground.
3	OUT1	Channel 1 half-bridge output.
4	OUT5	Channel 5 half -bridge output.
5	OUT7	Channel 7 half -bridge output.
6	DI	Serial data input.
7	VCC	Logic supply voltage.
8	DO	Serial data output.
9	EN	Enable pin. When EN is low, the drive is in standby mode; when EN is high, the device operates normally.
10	OUT9	Channel 9 half-bridge output.
11	OUT6	Channel 6 half-bridge output.
12	OUT4	Channel 4 half-bridge output.
17	OUT3	Channel 1 half-bridge output.
18	OUT10	Channel 10 half-bridge output.
19	VS2	Power supply for drivers 3, 4, 6, 9, and 10. This pin must be connected to VS1 externally.
20, 21	TEST	Testing pin. The TEST pin must be connected to ground.
22	CS	Chip selection input. The CS pin is active low.
23	CLK	Serial clock input.
24	VS1	Power supply for drivers 1, 2, 5, 7, and 8, internal LDO, and charge pump. This pin must be connected to VS2 externally.
25	OUT8	Channel 8 half-bridge output.
26	OUT2	Channel 2 half-bridge output.

**ABSOLUTE MAXIMUM RATINGS** <sup>(1)</sup>

Supply voltage ( $V_{VS}$ )	45V
$V_{OUTX}$	-0.3V to $V_{IN} + 0.3V$
Logic supply voltage ( $V_{VCC}$ )	-0.3V to +6V
Logic input voltage	-0.3 to $V_{VCC} + 0.3V$
Logic output voltage	-0.3 to $V_{VCC} + 0.3V$
All other pins	-0.3V to +6.5V
Continuous power dissipation ( $T_A = 25^\circ C$ ) <sup>(2)</sup>	
TSSOP-28EP	3.9W
Junction temperature	150°C
Lead temperature	260°C
Storage temperature	-65°C to +150°C

**ESD Ratings** <sup>(3)</sup>

Human body model (OUTx and VSx pins)	4kV
Human body model (all other pins)	2kV
Machine mode (MM)	200V
Charged device model (CDM)	750V

**Recommended Operating Conditions** <sup>(4)</sup>

Supply voltage ( $V_{VS}$ )	5.5V to 40V
Logic supply voltage ( $V_{VCC}$ )	3.15V to 5.25V
Operating junction temp ( $T_J$ )	-40°C to +150°C

<b>Thermal Resistance</b> <sup>(5)</sup>	$\theta_{JA}$	$\theta_{JC}$
TSSOP-28 EP	32	6

**Notes:**

- 1) Exceeding these ratings may damage the device.
- 2) The maximum allowable power dissipation is a function of the maximum junction temperature,  $T_J$  (MAX), the junction-to-ambient thermal resistance,  $\theta_{JA}$ , and the ambient temperature,  $T_A$ . The maximum allowable continuous power dissipation at any ambient temperature is calculated by  $P_D$  (MAX) =  $(T_J$  (MAX) -  $T_A$ ) /  $\theta_{JA}$ . Exceeding the maximum allowable power dissipation can cause excessive die temperature, and the regulator may go into thermal shutdown. Internal thermal shutdown circuitry protects the device from permanent damage.
- 3) Devices are ESD-sensitive. It is recommended to handle them with caution.
- 4) The device is not guaranteed to function outside of its operating conditions.
- 5) Measured on JESD51-7, 4-layer PCB.

## ELECTRICAL CHARACTERISTICS

$5.5V \leq V_{VS} \leq 40V$ ,  $3.15V \leq V_{VCC} \leq 5.25V$ ,  $EN = V_{VCC}$ ,  $T_J = -40^\circ\text{C}$  to  $+125^\circ\text{C}$ , unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ	Max	Units
Operating supply current (VS)	$I_{VSO}$	$V_{VS} < 28V$ , $EN = V_{CC}$ , no load		5.5	6.5	mA
Operating supply current (VCC)	$I_{VCCO}$	$3.15V < V_{VCC} < 5.25V$ , $EN = \text{high}$ , $DI = \text{CLK} = \text{low}$ , $CS = \text{high}$ , no load		100	150	$\mu\text{A}$
Quiescent current (VS)	$I_{VSOQ}$	$V_{VS} = 13.2V$ , $V_{VCC} = 0V$ or $5V$ , $EN = \text{low}$		1	5	$\mu\text{A}$
Quiescent current (VCC)	$I_{VCCQ}$	$3.15V < V_{VCC} < 5.25V$ , $EN = \text{low}$ , $DI = \text{CLK} = \text{low}$ , $CS = \text{high}$		1	5	$\mu\text{A}$
Discharge current (VS)	$I_{VS}$	$V_{VS} = 40V$ , $EN = \text{low}$			3	mA
Power-on reset threshold	$V_{VCC}$	VCC increasing	2.3	2.7	3.0	V
Power-on reset delay		After switching on $V_{VCC}$	30	100	160	$\mu\text{s}$
VS under-voltage lockout threshold	$V_{VS}$	VS decreasing	3.5		4.5	V
VS under-voltage lockout threshold hysteresis	$V_{UVOFF}$		0.1	0.3	0.5	V
VS under-voltage lockout delay time			7		21	ms
VS over-voltage lockout threshold	$V_{OVOFF}$	OVLO = 1, VS increasing	33	36	39	V
VS over-voltage lockout threshold hysteresis			1	2.5	4	V
<b>Output Specification</b>						
HS and LS switch on resistance	$R_{DS(ON)}$	$T_J = -40^\circ\text{C}$ to $+125^\circ\text{C}$		1.3	2.2	$\Omega$
		$T_J = 150^\circ\text{C}$			2.8	$\Omega$
Over-current limit	$I_{OCP}$		1	1.3	2.5	A
Over-current shutdown delay time	$t_{dOC}$	$V_{VS} = 13.2V$	10	25	50	$\mu\text{s}$
Open-load detection current	$I_{OLD}$	$V_{VS} = 13.2V$ , LS switch on	1	16	45	mA
Open-load delay time	$t_{dOLD}$		200	350	600	$\mu\text{s}$
Output enable time		$V_{VS} = 13.2V$ , $R_{LOAD} = 50\Omega$		50	65	$\mu\text{s}$
Output disable time				50	65	
Delay time		HBCNFx high to OUTx high, $V_{VS} = 13.2V$ , $R_{LOAD} = 50\Omega$		75	105	
		HBCNFx low to OUTx low, $V_{VS} = 13.2V$ , $R_{LOAD} = 50\Omega$		65	95	
Output rise time		$V_{VS} = 13.2V$ , 10% to 90% $V_{OUT}$ , $R_{LOAD} = 50\Omega$	13	27	42	$\mu\text{s}$
Output fall time			11	20	27	

**ELECTRICAL CHARACTERISTICS (continued)**
 $5.5V \leq V_{VS} \leq 40V$ ,  $3.15V \leq V_{VCC} \leq 5.25V$ ,  $T_J = -40^\circ\text{C}$  to  $+125^\circ\text{C}$ , unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ	Max	Units
Dead time		$V_{VS} = 13V$ , $R_{LOAD} = 50\Omega$	1.5			$\mu\text{s}$
<b>EN Input</b>						
EN low-level threshold					0.6	V
EN high-level threshold			2.0			V
EN threshold hysteresis				0.4		V
Pull-down resistor		$V_{EN} = V_{VCC}$		125		k $\Omega$
<b>Serial Interface: Logic Inputs DI, CLK, CS</b>						
Input low-level threshold					0.6	V
Input high-level threshold			2.0			V
Input threshold hysteresis				150		mV
Pull-down resistor for DI, CLK pin		$V_{DI}$ , $V_{CLK} = V_{VCC}$		125		k $\Omega$
Pull-up current for CS pin		$V_{CS} = 0V$		125		k $\Omega$
Input capacitance <sup>(6)</sup>	$C_{IN}$				15	pF
<b>Serial Interface: Logic Output DO</b>						
Output low level					0.4	V
Output high level			$V_{VCC} - 0.6$			V
Leakage current (tri-state)		$0V < V_{DO} < V_{VCC}$ , $V_{CS} = V_{VCC}$	-5		+5	$\mu\text{A}$
<b>Thermal Shutdown and Pre-Warning <sup>(6)</sup></b>						
Thermal pre-warning threshold	$T_{JW}$		120	140	170	$^\circ\text{C}$
Thermal pre-warning hysteresis				20		$^\circ\text{C}$
Thermal shutdown threshold	$T_{JSD}$		150	175	200	$^\circ\text{C}$
Thermal shutdown hysteresis				20		$^\circ\text{C}$
Ratio for thermal shutdown and thermal pre-warning			1.05	1.2		

## SERIAL INTERFACE TIMING CHARACTERISTICS <sup>(6)</sup>

5.5V < V<sub>VS</sub> < 40V, 3.15V ≤ V<sub>VCC</sub> ≤ 5.25V, T<sub>J</sub> = -40°C to +125°C, unless otherwise noted.

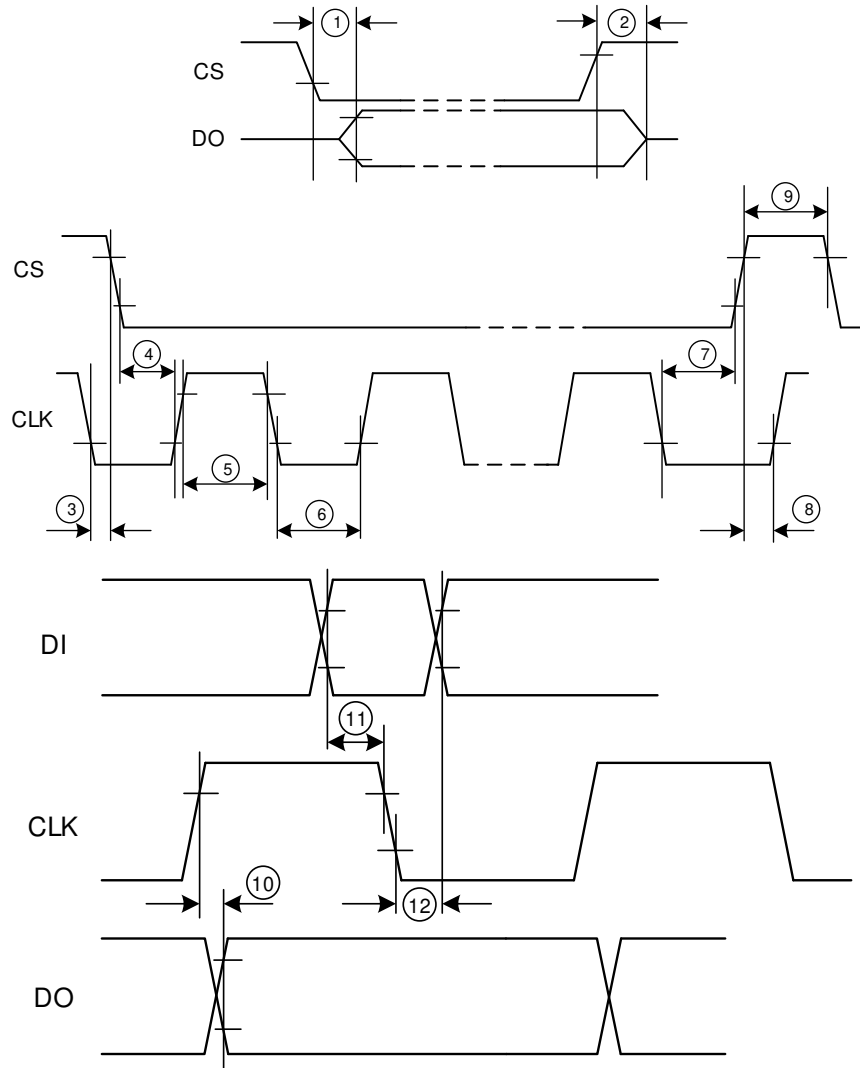
Parameters	Symbol	Condition	Min	Typ	Max	Units
CLK frequency	f <sub>CLK</sub>				5	MHz
CLK period time	t <sub>PCLK</sub>	V <sub>CC</sub> = 5V	200			ns
		V <sub>CC</sub> = 3.3V	500			
CLK high time	t <sub>5</sub>		85			ns
CLK low time	t <sub>6</sub>		85			ns
CLK set-up time (high to low)	t <sub>7</sub>		85			ns
CLK set-up time (low to high)	t <sub>3</sub>		85			ns
DI set-up time	t <sub>11</sub>		50			ns
DI hold time	t <sub>12</sub>		50			ns
CS set-up time (low to high)	t <sub>8</sub>		100			ns
CS set-up time (high to low)	t <sub>4</sub>		100			ns
CS high time	t <sub>9</sub>		5			μs
DO enabled after CS falling edge	t <sub>1</sub>	C <sub>DO</sub> = 40pF			200	ns
DO disabled after CS rising edge	t <sub>2</sub>	C <sub>DO</sub> = 40pF			200	ns
DO fall/rise time		C <sub>DO</sub> = 40pF		10	25	ns
DO valid time	t <sub>10</sub>	C <sub>DO</sub> = 40pF		20	50	ns
EN low valid time		V <sub>CC</sub> = 5V, EN high to low, 50% to OUTx turning off 50%		50		μs
EN high to SPI valid					100	μs
Time between two consecutive SRR commands			100			μs

**Note:**

6) Not subject to production testing. Specified by design.



## SERIAL INTERFACE TIMING DIAGRAM



Inputs DI, CLK, CS: High Level =  $0.7 \times V_{CC}$ , Low Level =  $0.3 \times V_{CC}$   
 Output DO: High Level =  $0.8 \times V_{CC}$ , Low Level =  $0.2 \times V_{CC}$

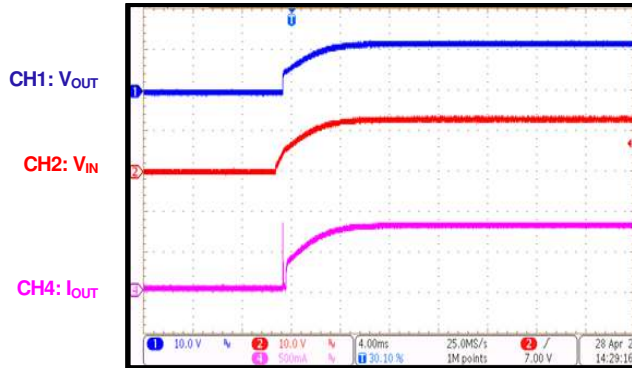
**Figure 1: Serial Interface Timing Diagram**

## TYPICAL PERFORMANCE CHARACTERISTICS

$V_{VS} = 13V$ ,  $V_{VCC} = 3.3V$ ,  $T_A = 25^\circ C$ , unless otherwise noted.

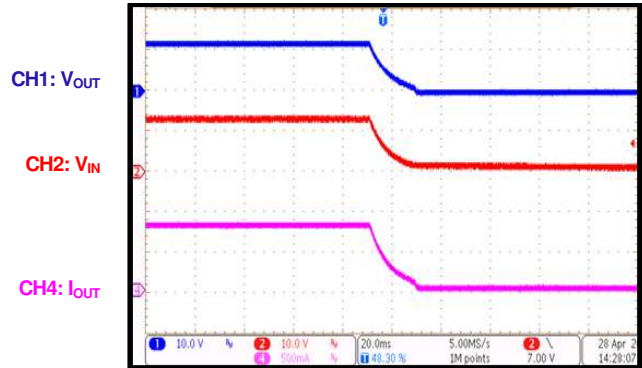
### VIN Start-Up

HS on,  $I_{OUT} = 800mA$



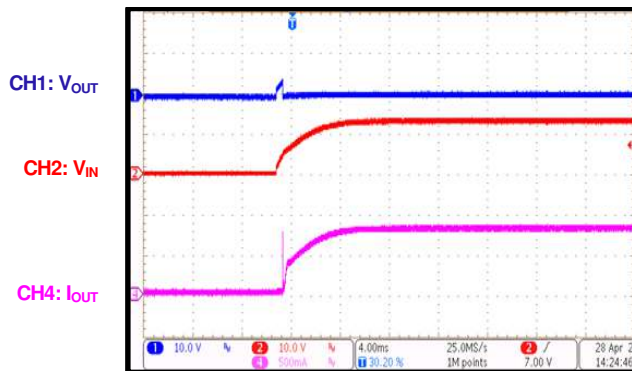
### VIN Shutdown

HS on,  $I_{OUT} = 800mA$



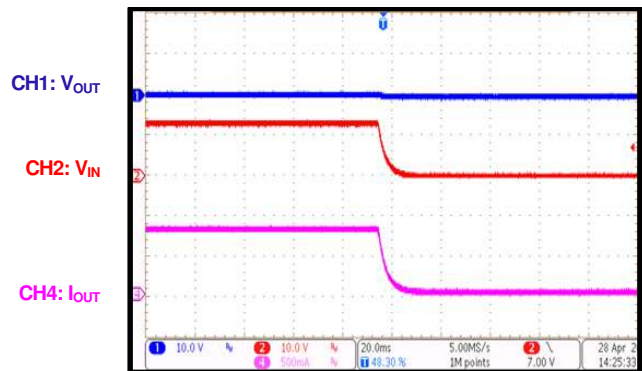
### VIN Start-Up

LS on,  $I_{OUT} = 800mA$



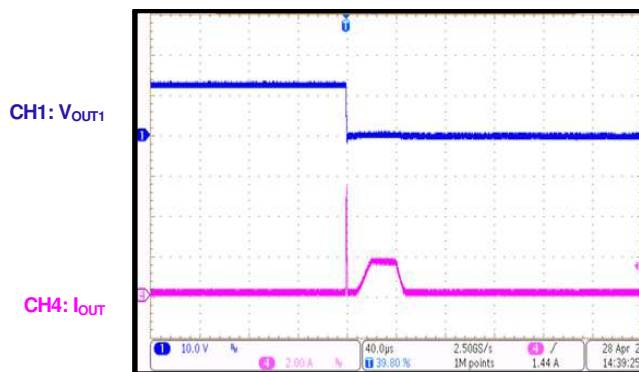
### VIN Shutdown

LS on,  $I_{OUT} = 800mA$



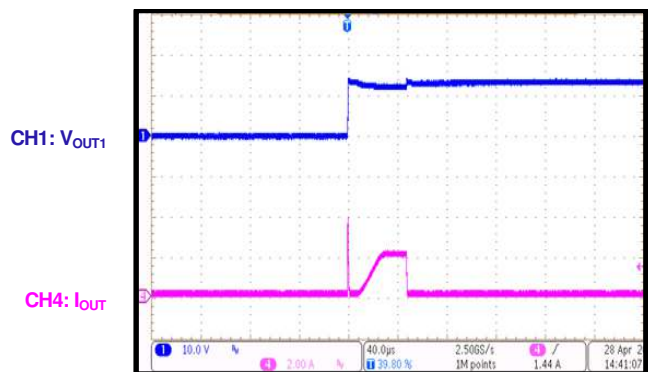
### OCP

OUT shorted to GND



### OCP

OUT shorted to VIN

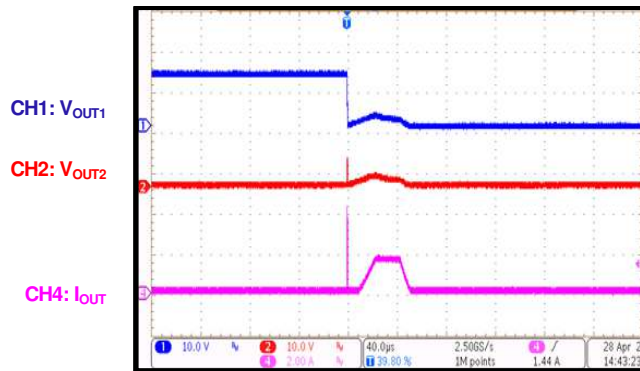


## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

$V_{VS} = 13V$ ,  $V_{VCC} = 3.3V$ ,  $T_A = 25^\circ C$ , unless otherwise noted.

### OCP

OUT shorted to OUT



## FUNCTIONAL BLOCK DIAGRAM

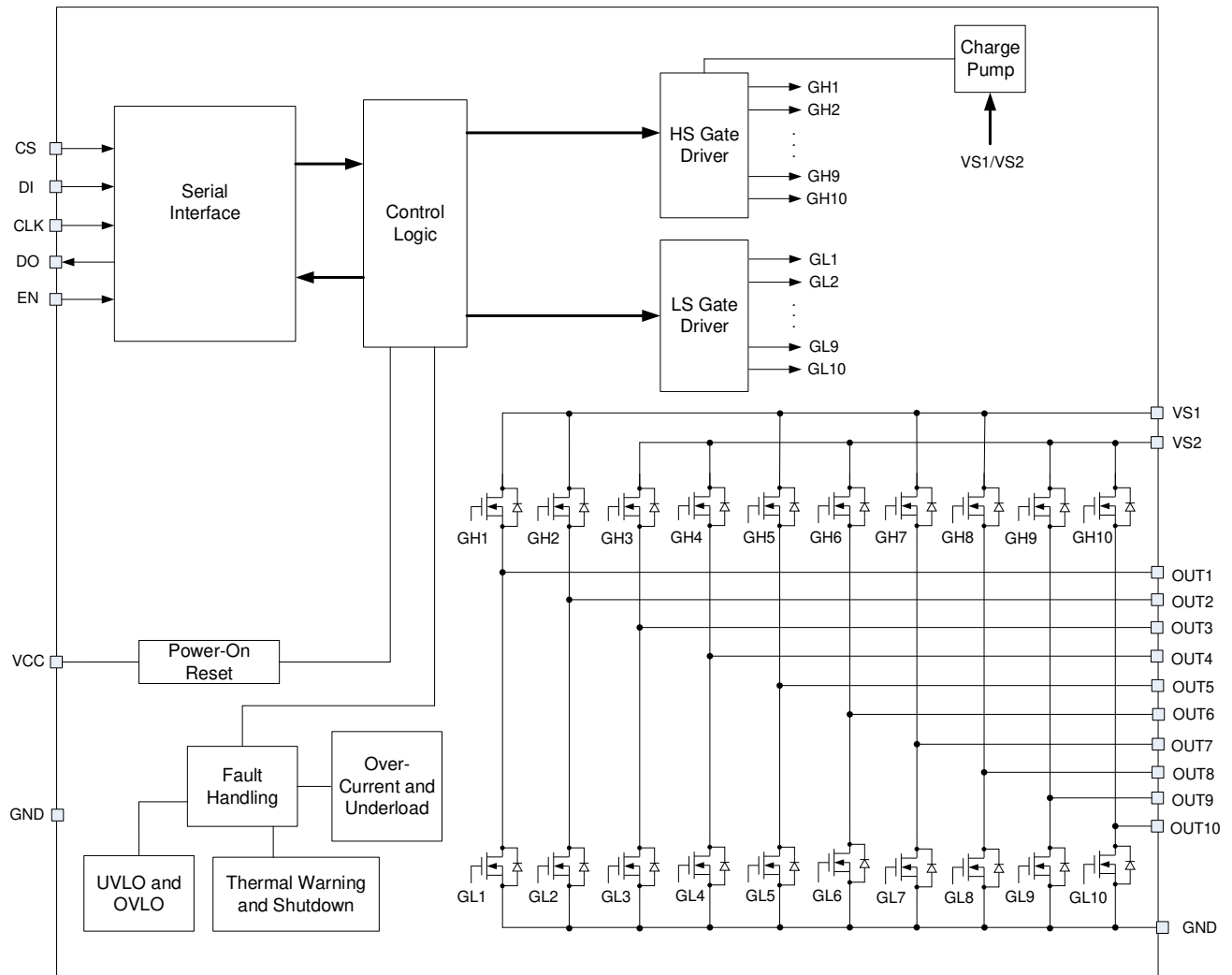


Figure 2: Functional Block Diagram

## OPERATION

The MPQ6527 is a ten-channel half-bridge DMOS output driver with integrated power MOSFETs. The device’s ten half-bridges can be controlled separately from a standard serial data interface, and each has various diagnostic functions.

### Serial Interface

Data transfer starts with the falling edge of the CS signal. Execution of new input data is enabled on the rising edge of the CS signal. Data must appear at DI and be synchronized to CLK; it is then accepted on the falling edge of the CLK signal. For DI, the MSB (SRR, bit[15]) has to be transferred first. The last 16 bits clocked into DI are transferred to the device’s data register if there is no frame error. Otherwise, all DI data is ignored and the previous input data is preserved.

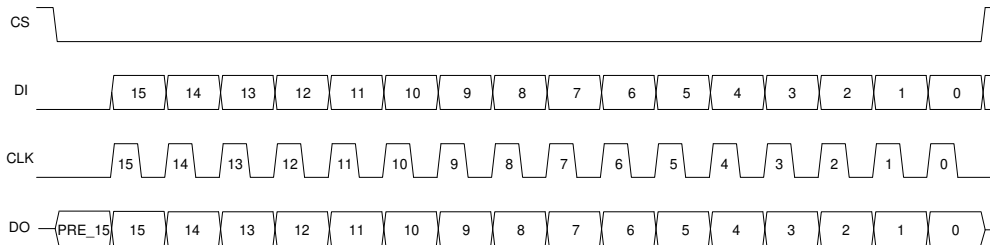
The output data at DO is enabled on the falling

edge of the CS signal. In addition to the 16-bit status data, a pseudo-bit (PRE\_15) can also be retrieved from the DO output. The latched thermal shutdown (TSD) status bit (also PRE\_15) is available on DO until the first rising CLK edge after CS goes low. Output data changes its state with the rising edge of CLK, and remains stable until the next CLK rising edge appears. When CS is high, the DO pin is in a tri-state condition.

The following conditions must be met for a valid TSD read to be captured:

1. CLK and DI are low before the CS cycle.
2. CS transitions from high to low.
3. CS set-up time is complete.

Figure 3 shows the SPI communication. Table 1, Table 2, Table 3, and Table 4 define the input control registers and the output diagnosis registers.



**Figure 3: Data Transfer**

**Table 1: Input Control Registers for Channels 1–6**

Channels 1–6 (Input Bit[14] = 0)		
Bit	Input Register	Function
15	SRR	This bit resets the status register. If SRR is set to 1, the error bits in the corresponding status register in the output data register are set to low.
14	CH_SEL	This bit selects the channel group. 1: Half-bridge, bits[10:7] 0: Half-bridge, bits[6:1]
13	OLSD_EN	This bit enables open-load detection shutdown (OLD_SD) for HB1 to HB6. This feature allows the affected output stage to be switched off if an open-load or underload condition has been detected. 1: Enabled 0: Disabled
12	HBEN6	This bit enables half-bridge 6. 1: Half-bridge 6 is active 0: Half-bridge is in Hi-Z

11	HBEN5	This bit enables half-bridge 5. 1: Half-bridge 5 is active 0: Half-bridge 5 is in Hi-Z
10	HBEN4	This bit enables half-bridge 4. 1: Half-bridge 4 is active 0: Half-ridge 4 is in Hi-Z
9	HBEN3	This bit enables half-bridge 3. 1: Half-bridge 3 is active 0: Half-bridge 3 is in Hi-Z
8	HBEN2	This bit enables half-bridge 2. 1: Half-bridge 2 is active 0: Half-bridge 2 is in Hi-Z
7	HBEN1	This bit enables half-bridge 1. 1: Half-bridge is active 0: Half-bridge is in Hi-Z
6	HBCNF6	This bit configures half-bridge 6. 1: High-side MOSFET (HS-FET) on and low-side MOSFET (LS-FET) off 0: HS-FET off and LS on
5	HBCNF5	This bit configures half-bridge 5. 1: HS-FET on and LS-FET off 0: HS-FET off and LS-FET on
4	HBCNF4	This bit configures half-bridge 4. 1: HS-FET on and LS-FET off 0: HS-FET off and LS-FET on
3	HBCNF3	This bit configures half-bridge 3. 1: HS-FET on and LS-FET off 0: HS-FET off and LS-FET on
2	HBCNF2	This bit configures half-bridge 2. 1: HS-FET on and LS-FET off 0: HS-FET off and LS-FET on
1	HBCNF1	This bit configures half-bridge 1. 1: HS-FET on and LS-FET off 0: HS-FET off and LS-FET on
0	OVLO	This bit enables VSx over-voltage lockout (OVLO). 1: Enabled 0: Disabled

**Table 2: Input Control Registers for Channels 7–10**

Channels 7–10 (Input Bit[14] = 1)		
Bit	Input Register	Function
15	SRR	This bit resets the status register. If SRR is set to 1, the error bits in the corresponding status register in the output data register are set to low.

14	CH_SEL	This bit selects the channel group. 1: Half-bridge, bits[10:7] 0: Half-bridge, bits[6:1]
13	OLSD_EN	This bit enables open-load detection shutdown (OLD_SD) for HB7 to HB10. This feature allows the affected output stage to be switched off if an open-load or underload condition has been detected. 1: Enabled 0: Disabled
12	RESERVED	Reserved.
11	RESERVED	Reserved.
10	HBEN10	This bit enables half-bridge 10. 1: Half-bridge 10 is active 0: Half-bridge 10 is in Hi-Z
9	HBEN9	This bit enables half-bridge 9. 1: Half-bridge 9 is active 0: Half-bridge 9 is in Hi-Z
8	HBEN8	This bit enables half-bridge 8. 1: Half-bridge 8 is active 0: Half-bridge 8 is in Hi-Z
7	HBEN7	This bit enables half-bridge 7. 1: Half-bridge 7 is active 0: Half-bridge 7 is in Hi-Z
6	RESERVED	Reserved.
5	RESERVED	Reserved.
4	HBCNF10	This bit configures half-bridge 10. 1: High-side MOSFET (HS-FET) on and low-side MOSFET (LS-FET) off 0: HS-FET off and LS-FET on
3	HBCNF9	This bit configures half-bridge 9. 1: HS-FET on and LS-FET off 0: HS-FET off and LS-FET on
2	HBCNF8	This bit configures half-bridge 8. 1: HS-FET on and LS-FET off 0: HS-FET off and LS-FET on
1	HBCNF7	This bit configures half-bridge 7. 1: HS-FET on and LS-FET off 0: HS-FET off and LS-FET on
0	OVLO	This bit enables VSx over-voltage lockout (OVLO). 1: Enabled 0: Disabled

**Note:**

7) All input bits are set to 0 after V<sub>CC</sub> power-on reset (POR).

**Table 3: Output Diagnosis Registers for Channels 1–6**

Channels 1–6 (Input Bit[14] = 0)		
Bit	Input Register	Function
PRE_15	TSD	If thermal shutdown occurs, this bit is latched and the corresponding output is switched off. This bit can only be reset via SRR or a power-on reset. 1: Thermal shutdown has occurred 0: Thermal shutdown has not occurred
15	OC (HB [6:1])	If over-current shutdown occurs, this bit is latched. An over-current error is set if any of the HB1 to HB6 bits experiences an overload or short-circuit condition. Then the relevant bit is latched and the corresponding output is switched off. This bit can only be reset via SRR or a power-on reset. 1: An over-current (OC) fault has occurred 0: No OC fault has occurred
14	PSF	If there is a power supply failure (VS1 and/or VS2 experiences an over-voltage or under-voltage condition), this bit is set and all outputs are switched off. Bit[14] is automatically reset if VSx returns to its normal operating range. 1: A power supply fault has occurred 0: No power supply fault has occurred
13	OLD (HB [6:1])	If an open-load error occurs, this bit is set. If any of the HB1 to HB6 bits experiences an open-load or underload condition, this bit is latched and the corresponding output is switched off if this bit is high. Bit[13] can only be reset via SRR or a power-on reset. 1: A load error has occurred 0: No load error has occurred
12	SHBEN6	Half-bridge 6 output status. 1: Half-bridge 6 is active 0: Half-bridge 6 is in Hi-Z
11	SHBEN5	Half-bridge 5 output status. 1: Half-bridge 5 is active 0: Half-bridge 5 is in Hi-Z
10	SHBEN4	Half-bridge 4 output status. 1: Half-bridge 4 is active 0: Half-bridge 4 is in Hi-Z
9	SHBEN3	Half-bridge 3 output status. 1: Half-bridge 3 is active 0: Half-bridge 3 is in Hi-Z
8	SHBEN2	Half-bridge 2 output status. 1: Half-bridge 2 is active 0: Half-bridge 2 is in Hi-Z
7	SHBEN1	Half-bridge 1 output status. 1: Half-bridge 1 is active 0: Half-bridge 1 is in Hi-Z



6	HBCNF6	Half-bridge 6 configuration status. 1: High-side MOSFET (HS-FET) on and low-side MOSFET (LS-FET) off 0: HS-FET off and LS-FET on
5	HBCNF5	Half-bridge 5 configuration status. 1: HS-FET on and LS-FET off 0: HS-FET off and LS-FET on
4	HBCNF4	Half-bridge 4 configuration status. 1: HS-FET on and LS-FET off 0: HS-FET off and LS-FET on
3	HBCNF3	Half-bridge 3 configuration status. 1: HS-FET on and LS-FET off 0: HS-FET off and LS-FET on
2	HBCNF2	Half-bridge 2 configuration status. 1: HS-FET on and LS-FET off 0: HS-FET off and LS-FET on
1	HBCNF1	Half-bridge 1 configuration status. 1: HS-FET on and LS-FET off 0: HS-FET off and LS-FET on
0	TW	This bit indicates if there is a thermal warning, and is set high if the junction temperature reaches $T_{JW}$ . The output remains on until one or more sensors reach $T_{SD}$ . This bit automatically resets if the junction temperature drops below the thermal warning recovery point.  1: A thermal warning fault has occurred 0: A thermal warning fault has not occurred

**Table 4: Output Diagnosis Registers for Channels 7–10**

Channels 7–10 (Input Bit[14] = 1)		
Bit	Input Register	Function
PRE_15	TSD	If thermal shutdown is detected, the bit is latched and the corresponding output is switched off. This bit can only be reset via SRR or a power-on reset.  1: Thermal shutdown has occurred 0: Thermal shutdown has not occurred
15	OC (HB [10:7])	This bit latches if over-current shutdown occurs. An over-current error is set if any one of HB7 to HB10 has an overload or short-circuit condition. Then the bit is latched and the corresponding output is switched off. This bit can only be reset via SRR or a power-on reset.  1: An over-current (OC) fault has occurred 0: No OC fault has occurred
14	PSF	This bit is set if there is a power supply failure (VS1 and/or VS2 experiences an over-voltage or under-voltage condition). All outputs are switched off. Bit[14] is automatically reset if VSx returns to its normal operating range.  1: A power supply fault has occurred 0: No power supply fault has occurred

13	OLD (HB [10:7])	If an open-load error occurs, this bit is set. If and of the HB1 to HB6 bits experiences an open-load or underload condition, this bit is latched and the corresponding output is switched off if this bit is high. Bit[13] can only be reset via SRR or a power-on reset.  1: A load error has occurred 0: No load error has occurred
12	RESERVED	Reserved.
11	RESERVED	Reserved.
10	SHBEN10	Half-bridge 10 output status.  1 = Half-bridge 10 is active 0 = Half-bridge 10 is in Hi-Z
9	SHBEN9	Half-bridge 9 output status.  1 = Half-bridge 9 is active 0 = Half-bridge 9 is in Hi-Z
8	SHBEN8	Half-bridge 8 output status.  1 = Half-bridge is active 0 = Half-bridge is in Hi-Z
7	SHBEN7	Half-bridge 7 output status.  1 = Half-bridge 7 is active 0 = Half-bridge 7 is in Hi-Z
6	RESERVED	Reserved.
5	RESERVED	Reserved.
4	HBCNF10	Half-bridge 10 configuration status.  1: High-side MOSFET (HS-FET) on and low-side MOSGET (LS-FET) off 0: HS-FET off and LS-FET on
3	HBCNF9	Half-bridge 9 configuration status.  1: HS-FET on and LS-FET off 0: HS-FET off and LS-FET on
2	HBCNF8	Half-bridge 8 configuration status.  1: HS-FET on and LS-FET off 0: HS-FET off and LS-FET on
1	HBCNF7	Half-bridge 7 configuration status.  1: HS-FET on and LS-FET off 0: HS-FET off and LS-FET on
0	TW	This bit indicates if there is a thermal warning, and is set high if the junction temperature reaches $T_{JW}$ . The output remains on until one or more sensors reach $T_{SD}$ . This bit automatically resets if the junction temperature drops below the thermal warning recovery point.  1: A thermal warning fault has occurred 0: A thermal warning fault has not occurred

### Enable Control

The MPQ6527 enters low-power mode (also called sleep mode) when the EN pin is pulled low. The EN input has an internal pull-down resistor. In sleep mode, all output stages turn off and the SPI register banks are reset. The output stages can be activated again by switching the EN pin high.

### Status Register Reset (SRR)

The Status Register Reset (SRR) command bit is executed after the next SPI transmission. Sending SRR = 1 clears the status memory and reactivates faulted outputs for the channels selected by CH\_SEL.

If a fault is still present when SRR is sent, the protection is re-enabled and the device can shut down. The device can also be reset by toggling the EN pin or by VCC power-on reset.

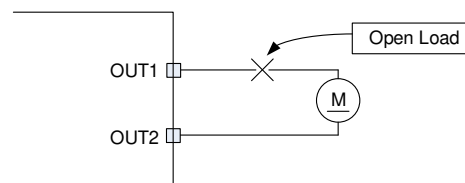
### Open-Load Detection

Open-load detection is turned on by the low-side MOSFETs (LS-FETs) on the bridge outputs. If the current through the low-side transistor is below the reference current ( $I_{OLD}$ ) for longer than the open-load detection delay time ( $t_{DOLD}$ ), the corresponding open-load diagnosis bit is set. If an underload condition occurs in another channel after the global timer has started, the delay for any subsequent underload conditions

is the remainder of the timer. The timer runs continuously if there is a persistent underload condition.

If the OLSD\_EN bit is set and an open load is detected on the LS-FET, the respective output is disabled and the open-load error bit is latched. Otherwise, the output remains on and the open-load error bit is set. If the OLSD\_EN bit is set, the error remains latched and the output remains off until an SRR or power-on reset is performed. The channel group select (CH\_SEL) input bit determines which channels are affected by SRR. SRR also determines which half-bridges are latched off via the OLSD\_EN command bit. This provides the ability to independently diagnose and isolate error flags to their corresponding failed output.

For example, a motor can be connected between outputs OUT1 and OUT2 with a broken wire (see Figure 4).



**Figure 4: H-Bridge Open Load Example**

Table 5 lists the resulting diagnostic information.

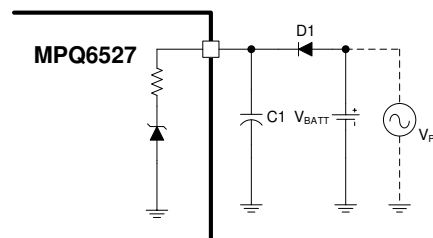
**Table 5: Open-Load Diagnosis Examples**

Control				Diagnostic Information	
				Motor Connected	Motor Disconnected
LS1	HS1	LS2	HS2	OLD (Output Bit[13])	
0	0	0	0	0	0
1	0	0	1	0	1
0	1	1	0	0	1
0	1	0	1	0	0
1	0	1	0	1	1

In motor applications, it is useful to actively brake the motor by turning on both the high-side (HS) and low-side (LS) drivers in two half-bridge channels. If the configuration is two LS drivers (LS brake), an underload may be triggered as the motor current decays normally, so use the HS brake to avoid an underload condition.

### Discharge Circuit

Figure 5 shows a typical application that uses an inverse-polarity protection diode (D1).



**Figure 5: Discharge Circuit Functional Principle**

However, this method can be dangerous. The IC consumes an extremely low current ( $I_{VS}$ ) while in inhibit mode (maximum 20 $\mu$ A). Any peaks on the supply voltage gradually charge the blocking capacitor. D1 prevents the capacitor from discharging via the power supply. due to the extremely small quiescent current, discharging via the IC is negligible. This means that during long periods in inhibit mode, the IC's voltage supply could increase until it exceeds the 40V

voltage limit and damages the IC. The MPQ6527 provides a discharger circuit to prevent this. If  $V_{VS}$  exceeds a threshold value of about 37V, the blocking capacitor is discharged via an integrated resistor until  $V_{VS}$  drops below the threshold.

### Diagnostics and Protections Overview

Table 6 lists the diagnostic classes and functions associated with the MPQ6527.

**Table 6: Diagnostic Classes and Functions**

Fault	Qualifier	State and Recovery	
		OUTx	Output Register
<b>Thermal Shutdown</b>	N/A	Hi-Z, need SRR to reset	TSD = 1, requires SRR to reset
<b>Over-Current Shutdown</b>	N/A		OC = 1, requires SRR to reset
<b>Open-Load Detection</b>	OLSD_EN = 1		Unaffected
	OLSD_EN = 0		
<b>Ove-Voltage Lockout</b>	OVLO = 1	Hi-Z, unlatched <sup>(8)</sup>	PSF = 1, unlatched <sup>(9)</sup>
	OVLO = 0	Unaffected	
<b>Under-Voltage Lockout</b>	N/A	Hi-Z, unlatched <sup>(8)</sup>	
<b>Thermal Warning</b>	N/A	Unaffected	TW = 1, unlatched <sup>(9)</sup>

**Notes:**

- 8) OUTx returns to its previous state or a new state once the fault is removed.
- 9) The corresponding output register returns to its no-fault state once the fault is removed.

### Over-Current Protection (OCP)

The MPQ6527 has internal overload and short-circuit protection. The currents in both the high-side MOSFETs (HS-FETs) and LS-FETs are measured. If any current exceeds the current limit, an internal timer starts. If the over-current shutdown delay time ( $t_{OC}$ ) is reached, the short-circuit detection bit (OC) is set, and the shorted output is disabled. The OC bit is reset by writing the SSR bit in the register to 1, and then the disabled outputs are enabled. The channel group selection input bit (CH\_SEL) determines which channels are affected by SRR.

### Thermal Shutdown and Pre-Warning

Thermal monitoring is integrated into the MPQ6527. Each half-bridge monitors the driver pair's thermal sensor. If the junction temperature exceeds the thermal pre-warning threshold, the temperature pre-warning bit (TW) in the output register is set. If the temperature returns below the thermal pre-warning threshold, the TW bit is reset.

If the junction temperature exceeds the thermal shutdown threshold, the channel's HS and LS drivers latch off, the TW bit remains set, and the TSD (PRE\_15) bit is set. If the junction temperature falls below the thermal shutdown threshold, the TSD bit is cleared and all affected channels in the group resume immediately. This can also be accomplished by setting the SRR bit in the input register to 1. The channel group selection input bit (CH\_SEL) determines which channels are affected by SRR.

The thermal pre-warning and shutdown thresholds have a hysteresis.

### VS Under-Voltage Lockout (UVLO)

If the voltage on the VS pin falls below the under-voltage lockout (UVLO) threshold, an internal timer starts.

If the UVLO delay time is reached, the power supply fail bit (PSF) in the output register is set, and all outputs are disabled. Once  $V_S$  exceeds the UVLO threshold and the PSF bit is cleared, then normal operation resumes immediately.

### **VCC Under-Voltage Conditions**

The SPI interface cannot operate if VCC is below its under-voltage threshold. In this case, all outputs turn off, and the command input and status output registers are cleared.

Once the VCC voltage exceeds the under-voltage threshold, SRR is released and the under-voltage status is reset.

### **VS Over-Voltage Lockout (OVLO)**

If the supply voltage ( $V_{VS}$ ) exceeds the switch-off voltage ( $V_{OV\text{OFF}}$ ), all outputs are switched off if the over-voltage lockout input bit is set ( $OVLO = 1$ ), and the PSF error bit is set. The error is not latched. This means that if  $V_{VS}$  falls below the switch on threshold voltage, the power stages restart and the error flags are reset.

## APPLICATION INFORMATION

### PCB Layout Guidelines

PCB layout is critical for stable operation. For the best results, follow the guidelines below:

1. Place a bulk capacitor on the VIN pin to absorb the energy flowing from the motor or power supply. The capacitor should be sized according to the application requirements.
2. Place the supply bypass capacitor as close as possible to the IC. It is recommended to use a supply-rated X5R or X7R capacitor.
3. Place as much copper as possible on the long pads.
4. Place thermal vias inside the pad area to move heat to the copper layers.
5. Place vias just outside the pad area if vias cannot be placed in the pad area.

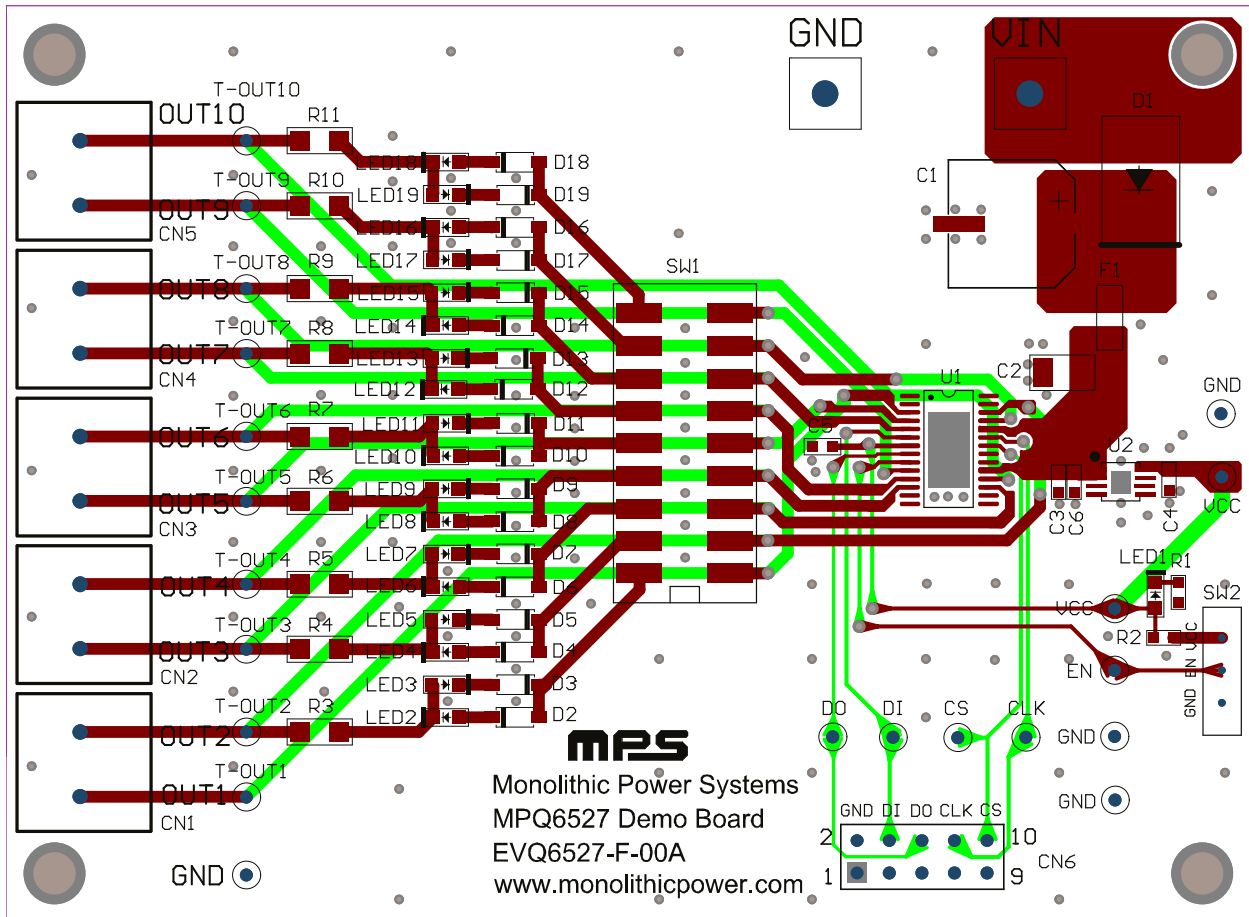
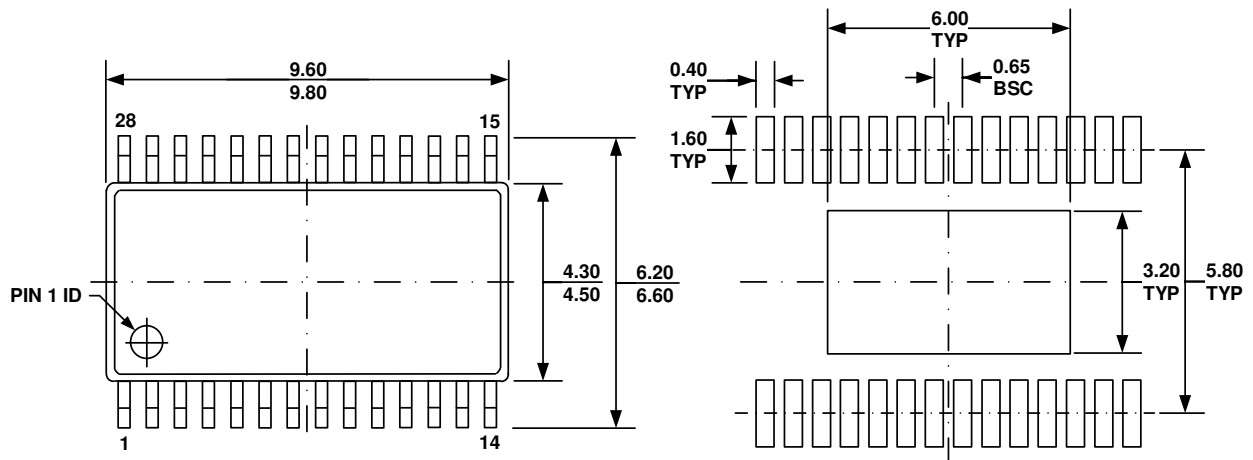


Figure 6: Recommended PCB Layout

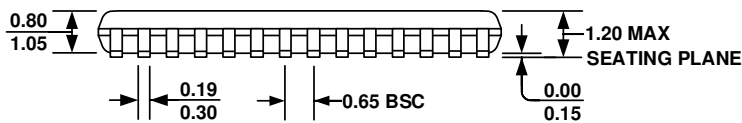
# PACKAGE INFORMATION

## TSSOP-28EP

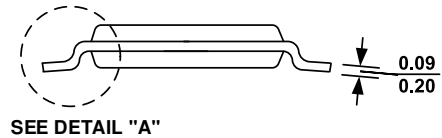


**TOP VIEW**

**RECOMMENDED LAND PATTERN**

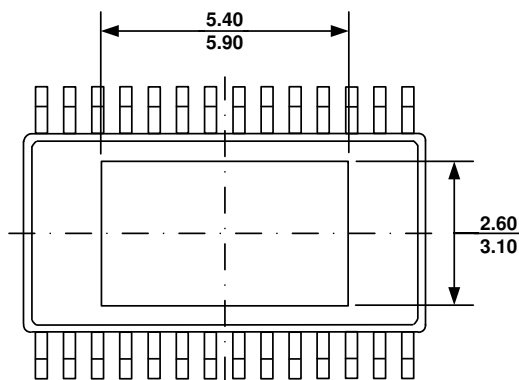


**FRONT VIEW**

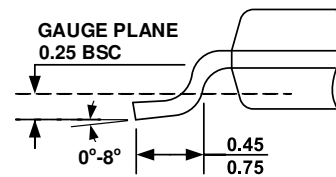


SEE DETAIL "A"

**SIDE VIEW**



**BOTTOM VIEW**

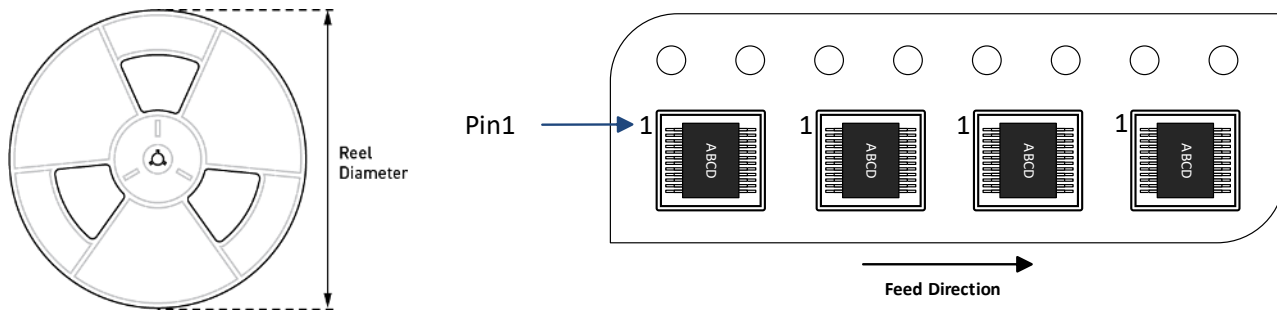


**DETAIL "A"**

**NOTE:**

- 1) ALL DIMENSIONS ARE IN MILLIMETERS.
- 2) PACKAGE LENGTH DOES NOT INCLUDE MOLD FLASH, PROTRUSION, OR GATE BURR.
- 3) PACKAGE WIDTH DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION.
- 4) LEAD COPLANARITY (BOTTOM OF LEADS AFTER FORMING) SHALL BE 0.10 MILLIMETERS MAX.
- 5) DRAWING CONFORMS TO JEDEC MO-153, VARIATION AET.
- 6) DRAWING IS NOT TO SCALE.

### CARRIER INFORMATION



Part Number	Package Description	Quantity/ Reel	Quantity/ Tube	Reel Diameter	Carrier Tape Width	Carrier Tape Pitch
MPQ6527GF-AEC1-Z	TSSOP-28EP	2500	50	13in	16mm	8mm



## REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	9/23/2021	Initial Release	-

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