

Advance Information

# Integrated Stepper Motor Driver with Embedded MCU and LIN Serial Communication

The 908E626 is an integrated single-package solution that includes a high-performance HC08 microcontroller with a SMARTMOS™ analog control IC. The HC08 includes flash memory, a timer, enhanced serial communications interface (ESCI), an analog-to-digital converter (ADC), serial peripheral interface (SPI) (only internal), and an internal clock generator (ICG) module. The analog control die provides fully protected H-Bridge outputs, voltage regulator, autonomous watchdog, and local interconnect network (LIN) physical layer.

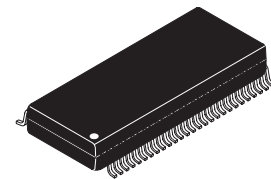
The single-package solution, together with LIN, provides optimal application performance adjustments and space-saving PCB design. It is well suited for the control of automotive stepper applications like climate control and light-levelling.

Features

- High-Performance M68HC08EY16 Core
- 16 K Bytes of On-Chip Flash Memory
- 512 Bytes of RAM
- Internal Clock Generation Module
- Two 16-Bit, 2-Channel Timers
- 10-Bit Analog-to-Digital Converter
- Four Low R<sub>DS(ON)</sub> Half-Bridge Outputs
- 13 Microcontroller I/Os

908E626

STEPPER MOTOR DRIVER WITH EMBEDDED MCU AND LIN



DWB SUFFIX  
CASE 1400-01  
54-TERMINAL SOICWB-EP

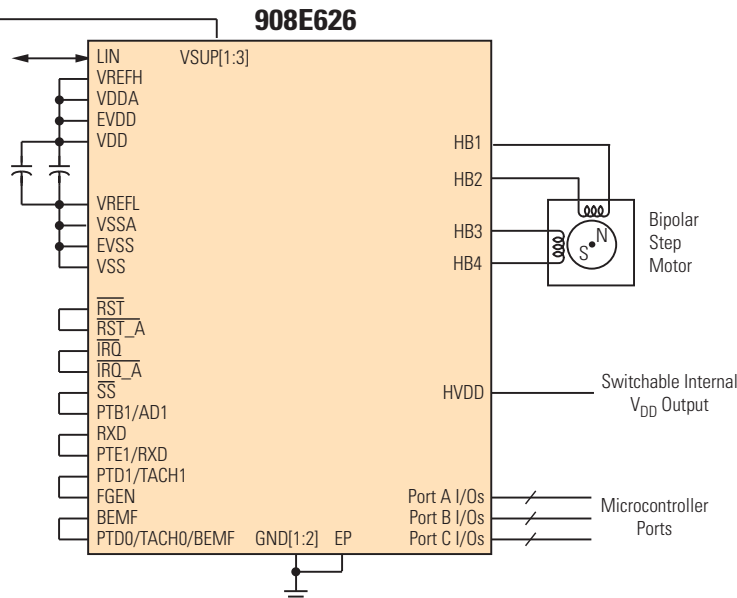
ORDERING INFORMATION

Device	Temperature Range (T <sub>A</sub> )	Package
MM908E626AVDWB/R2	-40°C to 115°C	54 SOIC WB-EP

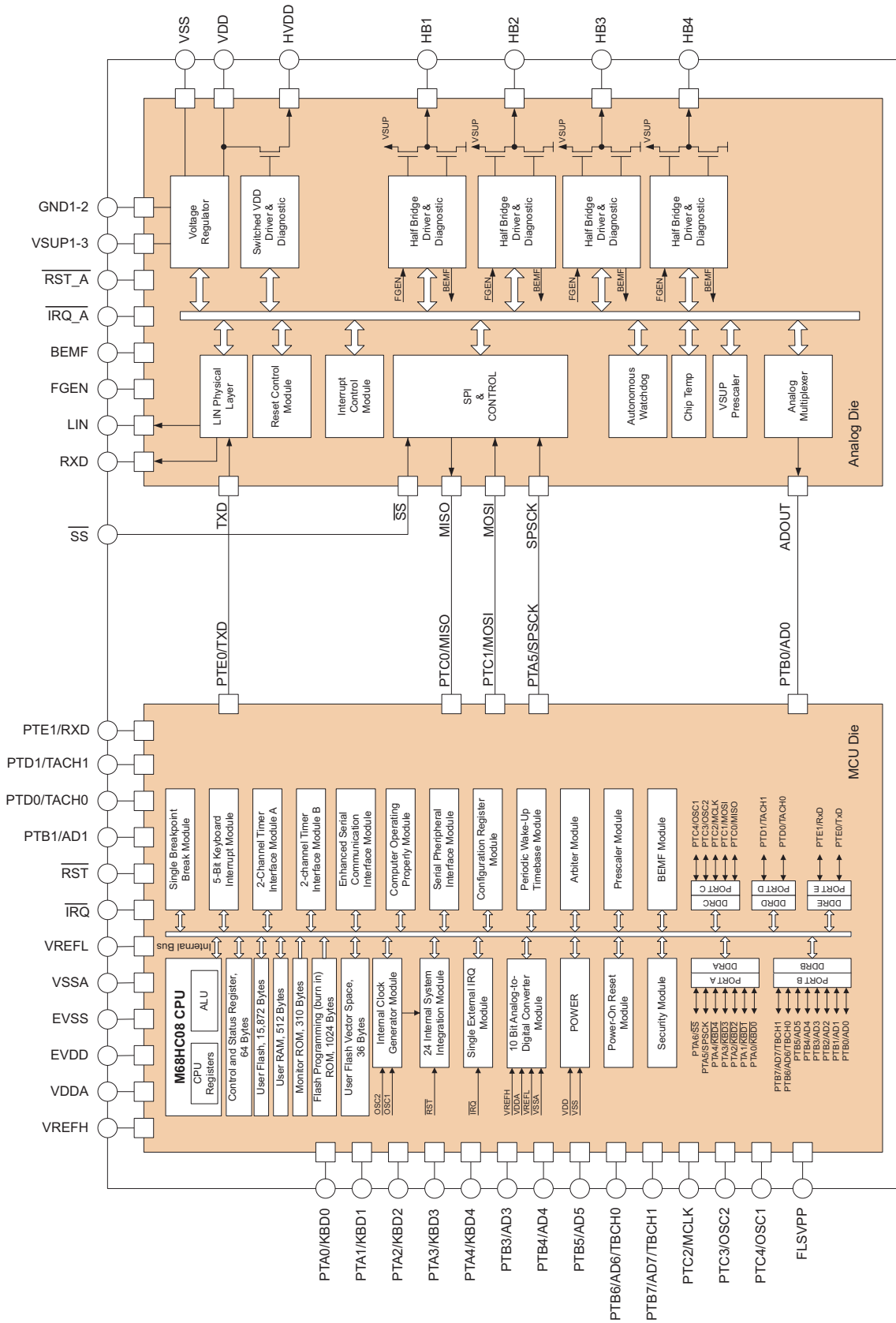
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908E626 Simplified Application Diagram

**Note** Applications with multiple stepper motors in one system (e.g., climate control) typically have a central reverse battery protection.



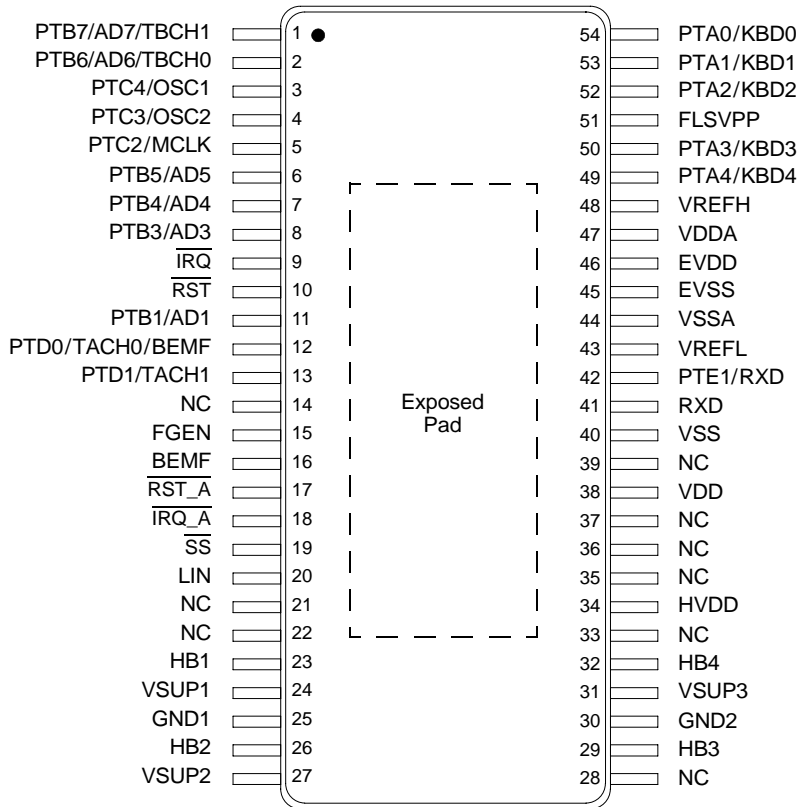
This document contains certain information on a new product. Specifications and information herein are subject to change without notice.



**Figure 1. 908E626 Simplified Internal Block Diagram**

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Transparent Top  
View of Package



## TERMINAL DEFINITIONS

A functional description of each terminal can be found in the System/Application Information section beginning on [page 14](#).

Die	Terminal	Terminal Name	Formal Name	Definition
MCU	1 2 6 7 8 11	PTB7/AD7/TBCH1 PTB6/AD6/TBCH0 PTB5/AD5 PTB4/AD4 PTB3/AD3 PTB1/AD1	Port B I/Os	These terminals are special-function, bidirectional I/O port terminals that are shared with other functional modules in the MCU.
MCU	3 4 5	PTC4/OSC1 PTC3/OSC2 PTC2/MCLK	Port C I/Os	These terminals are special-function, bidirectional I/O port terminals that are shared with other functional modules in the MCU.
MCU	9	IRQ	External Interrupt Input	This terminal is an asynchronous external interrupt input terminal.
MCU	10	RST	External Reset	This terminal is bidirectional, allowing a reset of the entire system. It is driven low when any internal reset source is asserted.
MCU	12 13	PTD0/TACH0/BEMF PTD1/TACH1	Port D I/Os	These terminals are special-function, bidirectional I/O port terminals that are shared with other functional modules in the MCU.
-	14, 21, 22, 28, 33, 35, 36, 37, 39	NC	No Connect	Not connected.
MCU	42	PTE1/RXD	Port E I/O	This terminal is a special-function, bidirectional I/O port terminal that can be shared with other functional modules in the MCU.
MCU	43 48	VREFL VREFH	ADC References	These terminals are the reference voltage terminals for the analog-to-digital converter (ADC).

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## TERMINAL DEFINITIONS (continued)

A functional description of each terminal can be found in the System/Application Information section beginning on [page 14](#).

Die	Terminal	Terminal Name	Formal Name	Definition
MCU	44 47	VSSA VDDA	ADC Supply Terminals	These terminals are the power supply terminals for the analog-to-digital converter.
MCU	45 46	EVSS EVDD	MCU Power Supply Terminals	These terminals are the ground and power supply terminals, respectively. The MCU operates from a single power supply.
MCU	49 50 52 53 54	PTA4/KBD4 PTA3/KBD3 PTA2/KBD2 PTA1/KBD1 PTA0/KBD0	Port A I/Os	These terminals are special-function, bidirectional I/O port terminals that are shared with other functional modules in the MCU.
MCU	51	FLSVPP	Test Terminal	For test purposes only. Do not connect in the application.
Analog	15	FGEN	Current Limitation Frequency Input	This is the input terminal for the half-bridge current limitation PWM frequency.
Analog	16	BEMF	Back Electromagnetic Force Output	This terminal gives the user information about back electromagnetic force (BEMF).
Analog	17	$\overline{\text{RST\_A}}$	Internal Reset	This terminal is the bidirectional reset terminal of the analog die.
Analog	18	$\overline{\text{IRQ\_A}}$	Internal Interrupt Output	This terminal is the interrupt output terminal of the analog die indicating errors or wake-up events.
Analog	19	$\overline{\text{SS}}$	Slave Select	This terminal is the SPI slave select terminal for the analog chip.
Analog	20	LIN	LIN Bus	This terminal represents the single-wire bus transmitter and receiver.
Analog	23 26 29 32	HB1 HB2 HB3 HB4	Half-Bridge Outputs	This device includes power MOSFETs configured as four half-bridge driver outputs. These outputs may be configured for step motor drivers, DC motor drivers, or as high-side and low-side switches.
Analog	24 27 31	VSUP1 VSUP2 VSUP3	Power Supply Terminals	These terminals are device power supply terminals.
Analog	25 30	GND1 GND2	Power Ground Terminals	These terminals are device power ground connections.
Analog	34	HVDD	Switchable $V_{DD}$ Output	This terminal is a switchable $V_{DD}$ output for driving resistive loads requiring a regulated 5.0 V supply; e.g., 3-terminal Hall-effect sensors.
Analog	38	VDD	Voltage Regulator Output	The +5.0 V voltage regulator output terminal is intended to supply the embedded microcontroller.
Analog	40	VSS	Voltage Regulator Ground	Ground terminal for the connection of all non-power ground connections (microcontroller and sensors).
Analog	41	RXD	LIN Transceiver Output	This terminal is the output of LIN transceiver.
–	EP	Exposed Pad	Exposed Pad	The exposed pad terminal on the bottom side of the package conducts heat from the chip to the PCB board.

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## MAXIMUM RATINGS

All voltages are with respect to ground unless otherwise noted. Exceeding limits on any terminal may cause permanent damage to the device.

Rating	Symbol	Value	Unit
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## ELECTRICAL RATINGS

Supply Voltage			V
Analog Chip Supply Voltage under Normal Operation (Steady-State)	$V_{SUP(SS)}$	-0.3 to 28	
Analog Chip Supply Voltage under Transient Conditions (Note 1)	$V_{SUP(PK)}$	-0.3 to 40	
Microcontroller Chip Supply Voltage	$V_{DD}$	-0.3 to 6.0	
Input Terminal Voltage			V
Analog Chip	$V_{IN(ANALOG)}$	-0.3 to 5.5	
Microcontroller Chip	$V_{IN(MCU)}$	$V_{SS}-0.3$ to $V_{DD}+0.3$	
Maximum Microcontroller Current per Terminal			mA
All Terminals Except VDD, VSS, PTA0:PTA6, PTC0:PTC1	$I_{PIN(1)}$	±15	
Terminals PTA0:PTA6, PTC0:PTC1	$I_{PIN(2)}$	±25	
Maximum Microcontroller $V_{SS}$ Output Current	$I_{MVSS}$	100	mA
Maximum Microcontroller $V_{DD}$ Input Current	$I_{MVDD}$	100	mA
LIN Supply Voltage			V
Normal Operation (Steady-State)	$V_{BUS(SS)}$	-18 to 28	
Transient Conditions (Note 1)	$V_{BUS(DYNAMIC)}$	40	
ESD Voltage			V
Human Body Model (Note 2)	$V_{ESD1}$	±3000	
Machine Model (Note 3)	$V_{ESD2}$	±150	
Charge Device Model (Note 4)	$V_{ESD3}$	±500	

## THERMAL RATINGS

Storage Temperature	$T_{STG}$	-40 to 150	°C
Operating Case Temperature (Note 5)	$T_C$	-40 to 115	°C
Operating Junction Temperature			°C
Analog	$T_{J(ANALOG)}$	-40 to 150	
MCU (Note 6)	$T_{J(MCU)}$	-40 to 135	
Peak Package Reflow Temperature During Solder Mounting (Note 7)	$T_{SOLDER}$	245	°C
Thermal Resistance (Junction to Ambient)			°C/W
All Outputs ON (Note 8), (Note 10)	$R_{\theta JA1}$	24	
Single Output ON (Note 9), (Note 10)	$R_{\theta JA2}$	27	

### Notes

1. Transient capability for pulses with a time of  $t < 0.5$  sec.
2. ESD1 testing is performed in accordance with the Human Body Model ( $C_{ZAP} = 100$  pF,  $R_{ZAP} = 1500 \Omega$ ).
3. ESD2 testing is performed in accordance with the Machine Model ( $C_{ZAP} = 200$  pF,  $R_{ZAP} = 0 \Omega$ ).
4. ESD3 testing is performed in accordance with Charge Device Model, robotic ( $C_{ZAP} = 4.0$  pF).
5. The limiting factor is junction temperature, taking into account the power dissipation, thermal resistance, and heat sinking.
6. In the 125°C to 135°C temperature range, the FLASH is guaranteed as read only.
7. Terminal soldering temperature is for 10 seconds maximum duration. Not designed for immersion soldering. Exceeding these limits may cause malfunction or permanent damage to the device.
8. All outputs ON and dissipating equal power.
9. One output ON and dissipating power.
10. Per JEDEC JESD51-2 at natural convection, still air condition; and 2s2p thermal test board per JEDEC JESD51-7 and JESD51-5 (thermal vias connected to top ground plane).

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## STATIC ELECTRICAL CHARACTERISTICS

All characteristics are for the analog chip only. Refer to the 68HC908EY16 datasheet for characteristics of the microcontroller chip. Characteristics noted under conditions  $9.0\text{ V} \leq V_{\text{SUP}} \leq 16\text{ V}$ ,  $-40^\circ\text{C} \leq T_J \leq 135^\circ\text{C}$  unless otherwise noted. Typical values noted reflect the approximate parameter mean at  $T_A = 25^\circ\text{C}$  under nominal conditions unless otherwise noted.

Characteristic	Symbol	Min	Typ	Max	Unit
<b>SUPPLY VOLTAGE</b>					
Nominal Operating Voltage	$V_{\text{SUP}}$	8.0	–	18	V
<b>SUPPLY CURRENT</b>					
NORMAL Mode $V_{\text{SUP}} = 12\text{ V}$ , Power Die ON (PSON=1), MCU Operating Using Internal Oscillator at 32 MHz (8.0 MHz Bus Frequency), SPI, ESCI, ADC Enabled	$I_{\text{RUN}}$	–	20	–	mA
<b>DIGITAL INTERFACE RATINGS (ANALOG DIE)</b>					
Output Terminals $\overline{\text{RST\_A}}$ , $\overline{\text{IRQ\_A}}$ Low-State Output Voltage ( $I_{\text{OUT}} = -1.5\text{ mA}$ ) High-State Output Voltage ( $I_{\text{OUT}} = 1.0\text{ }\mu\text{A}$ )	$V_{\text{OL}}$ $V_{\text{OH}}$	– 3.85	– –	0.4 –	V
Output Terminals BEMF, RXD Low-State Output Voltage ( $I_{\text{OUT}} = -1.5\text{ mA}$ ) High-State Output Voltage ( $I_{\text{OUT}} = 1.5\text{ mA}$ )	$V_{\text{OL}}$ $V_{\text{OH}}$	– 3.85	– –	0.4 –	V
Output Terminal RXD–Capacitance (Note 11)	$C_{\text{IN}}$	–	4.0	–	pF
Input Terminals $\overline{\text{RST\_A}}$ , FGEN, $\overline{\text{SS}}$ Input Logic Low Voltage Input Logic High Voltage	$V_{\text{IL}}$ $V_{\text{IH}}$	– 3.5	– –	1.5 –	V
Input Terminals $\overline{\text{RST\_A}}$ , FGEN, $\overline{\text{SS}}$ –Capacitance (Note 11)	$C_{\text{IN}}$	–	4.0	–	pF
Terminals $\overline{\text{RST\_A}}$ , $\overline{\text{IRQ\_A}}$ –Pullup Resistor	$R_{\text{PULLUP1}}$	–	10	–	k $\Omega$
Terminal $\overline{\text{SS}}$ –Pullup Resistor	$R_{\text{PULLUP2}}$	–	60	–	k $\Omega$
Terminals FGEN, MOSI, SPCK–Pulldown Resistor	$R_{\text{PULLDOWN}}$	–	60	–	k $\Omega$
Terminal TXD–Pullup Current Source	$I_{\text{PULLUP}}$	–	35	–	$\mu\text{A}$

### Notes

11. This parameter is guaranteed by process monitoring but is not production tested.

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## STATIC ELECTRICAL CHARACTERISTICS (continued)

All characteristics are for the analog chip only. Refer to the 68HC908EY16 datasheet for characteristics of the microcontroller chip. Characteristics noted under conditions  $9.0\text{ V} \leq V_{\text{SUP}} \leq 16\text{ V}$ ,  $-40^\circ\text{C} \leq T_{\text{J}} \leq 135^\circ\text{C}$  unless otherwise noted. Typical values noted reflect the approximate parameter mean at  $T_{\text{A}} = 25^\circ\text{C}$  under nominal conditions unless otherwise noted.

Characteristic	Symbol	Min	Typ	Max	Unit
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### SYSTEM RESETS AND INTERRUPTS

High-Voltage Reset					V
Threshold	$V_{\text{HVRON}}$	27	30	33	
Hysteresis	$V_{\text{HVRH}}$	–	1.5	–	
Low-Voltage Reset					V
Threshold	$V_{\text{LVRON}}$	3.6	4.0	4.7	
Hysteresis	$V_{\text{LVRH}}$	–	100	–	mV
High-Voltage Interrupt					V
Threshold	$V_{\text{HVION}}$	17.5	21	23	
Hysteresis	$V_{\text{HVIH}}$	–	1.0	–	
Low-Voltage Interrupt					V
Threshold	$V_{\text{LVION}}$	6.5	–	8.0	
Hysteresis	$V_{\text{LVIH}}$	–	0.4	–	
High-Temperature Reset (Note 12)					$^\circ\text{C}$
Threshold	$T_{\text{RON}}$	–	170	–	
Hysteresis	$T_{\text{RH}}$	5.0	–	–	
High-Temperature Interrupt (Note 13)					$^\circ\text{C}$
Threshold	$T_{\text{ION}}$	–	160	–	
Hysteresis	$T_{\text{IH}}$	5.0	–	–	

### VOLTAGE REGULATOR

Normal Mode Output Voltage $I_{\text{OUT}} = 60\text{ mA}$ , $6.0\text{ V} < V_{\text{SUP}} < 18\text{ V}$	$V_{\text{DDRUN}}$	4.75	5.0	5.25	V
Load Regulation $I_{\text{OUT}} = 80\text{ mA}$ , $V_{\text{SUP}} = 9.0\text{ V}$	$V_{\text{LR}}$	–	–	100	mV

#### Notes

- This parameter is guaranteed by process monitoring but is not production tested.
- High-Temperature Interrupt (HTI) threshold is linked to High-Temperature Reset (HTR) threshold ( $\text{HTR} = \text{HTI} + 10^\circ\text{C}$ ).

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## STATIC ELECTRICAL CHARACTERISTICS (continued)

All characteristics are for the analog chip only. Refer to the 68HC908EY16 datasheet for characteristics of the microcontroller chip. Characteristics noted under conditions  $9.0\text{ V} \leq V_{\text{SUP}} \leq 16\text{ V}$ ,  $-40^\circ\text{C} \leq T_J \leq 135^\circ\text{C}$  unless otherwise noted. Typical values noted reflect the approximate parameter mean at  $T_A = 25^\circ\text{C}$  under nominal conditions unless otherwise noted.

Characteristic	Symbol	Min	Typ	Max	Unit
<b>LIN PHYSICAL LAYER</b>					
Output Low Level TXD LOW, 500 $\Omega$ Pullup to $V_{\text{SUP}}$	$V_{\text{LIN-LOW}}$	–	–	1.4	V
Output High Level TXD HIGH, $I_{\text{OUT}} = 1.0\ \mu\text{A}$	$V_{\text{LIN-HIGH}}$	$V_{\text{SUP}} - 1.0$	–	–	V
Pullup Resistor to $V_{\text{SUP}}$	$R_{\text{SLAVE}}$	20	30	60	k $\Omega$
Leakage Current to GND Recessive State ( $-0.5\text{ V} < V_{\text{LIN}} < V_{\text{SUP}}$ )	$I_{\text{BUS\_PAS\_rec}}$	0	–	20	$\mu\text{A}$
Leakage Current to GND ( $V_{\text{SUP}}$ Disconnected) Including Internal Pullup Resistor, $V_{\text{LIN}}$ @ -18 V Including Internal Pullup Resistor, $V_{\text{LIN}}$ @ +18 V	$I_{\text{BUS\_NO\_GND}}$	–	-600	–	$\mu\text{A}$
	$I_{\text{BUS}}$	–	25	–	$\mu\text{A}$
LIN Receiver					V
Recessive	$V_{\text{IH}}$	$0.6 V_{\text{LIN}}$	–	$V_{\text{SUP}}$	
Dominant	$V_{\text{IL}}$	0	–	$0.4 V_{\text{LIN}}$	
Threshold	$V_{\text{ITH}}$	–	$V_{\text{SUP}}/2$	–	
Input Hysteresis	$V_{\text{IHY}}$	$0.01 V_{\text{SUP}}$	–	$0.1 V_{\text{SUP}}$	



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## STATIC ELECTRICAL CHARACTERISTICS (continued)

All characteristics are for the analog chip only. Refer to the 68HC908EY16 datasheet for characteristics of the microcontroller chip. Characteristics noted under conditions  $9.0\text{ V} \leq V_{\text{SUP}} \leq 16\text{ V}$ ,  $-40^\circ\text{C} \leq T_J \leq 135^\circ\text{C}$  unless otherwise noted. Typical values noted reflect the approximate parameter mean at  $T_A = 25^\circ\text{C}$  under nominal conditions unless otherwise noted.

Characteristic	Symbol	Min	Typ	Max	Unit
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### HALF-BRIDGE OUTPUTS (H1:H4)

Switch ON Resistance @ $T_J = 25^\circ\text{C}$ with $I_{\text{LOAD}} = 1.0\text{ A}$					m $\Omega$
High Side	$R_{\text{DS(ON)HB_HS}}$	–	425	500	
Low Side	$R_{\text{DS(ON)HB_LS}}$	–	400	500	
High-Side Overcurrent Shutdown	$I_{\text{HBHSOC}}$	3.0	–	7.5	A
Low-Side Overcurrent Shutdown	$I_{\text{HBLSOC}}$	3.0	–	7.5	A
Low-Side Current Limitation @ $T_J = 25^\circ\text{C}$					mA
Current Limit 1 (CLS2 = 0, CLS1 = 1, CLS0 = 1)	$I_{\text{CL1}}$	–	55	–	
Current Limit 2 (CLS2 = 1, CLS1 = 0, CLS0 = 0)	$I_{\text{CL2}}$	210	260	315	
Current Limit 3 (CLS2 = 1, CLS1 = 0, CLS0 = 1)	$I_{\text{CL3}}$	300	370	440	
Current Limit 4 (CLS2 = 1, CLS1 = 1, CLS0 = 0)	$I_{\text{CL4}}$	450	550	650	
Current Limit 5 (CLS2 = 1, CLS1 = 1, CLS0 = 1)	$I_{\text{CL5}}$	600	740	880	
Half-Bridge Output HIGH Threshold for BEMF Detection	$V_{\text{BEMFH}}$	–	-30	0	V
Half-Bridge Output LOW Threshold for BEMF Detection	$V_{\text{BEMFL}}$	–	-60	-5.0	mV
Hysteresis for BEMF Detection	$V_{\text{BEMFHY}}$	–	30	–	mV
Low-Side Current-to-Voltage Ratio ( $V_{\text{ADOUT}} [\text{V}]/I_{\text{HB}} [\text{A}]$ )					V/A
CSA = 1	$\text{RATIO}_H$	7.0	12.0	14.0	
CSA = 0	$\text{RATIO}_L$	1.0	2.0	3.0	

### SWITCHABLE $V_{\text{DD}}$ OUTPUT (HVDD)

Overcurrent Shutdown Threshold	$I_{\text{HVDDOCT}}$	24	30	40	mA
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### $V_{\text{SUP}}$ DOWN-SCALER

Voltage Ratio ( $\text{RATIO}_{V_{\text{SUP}}} = V_{\text{SUP}}/V_{\text{ADOUT}}$ )	$\text{RATIO}_{V_{\text{SUP}}}$	4.8	5.1	5.35	–
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### INTERNAL DIE TEMPERATURE SENSOR

Voltage/Temperature Slope	$S_{T\text{to}V}$	–	19	–	mV/ $^\circ\text{C}$
Output Voltage @ $25^\circ\text{C}$	$V_{T25}$	1.7	2.1	2.5	V

## DYNAMIC ELECTRICAL CHARACTERISTICS

All characteristics are for the analog chip only. Please refer to the 68HC908EY16 datasheet for characteristics of the microcontroller chip. Characteristics noted under conditions  $9.0\text{ V} \leq V_{\text{SUP}} \leq 16\text{ V}$ ,  $-40^\circ\text{C} \leq T_{\text{J}} \leq 135^\circ\text{C}$  unless otherwise noted. Typical values noted reflect the approximate parameter mean at  $T_{\text{A}} = 25^\circ\text{C}$  under nominal conditions unless otherwise noted.

Characteristic	Symbol	Min	Typ	Max	Unit
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### LIN PHYSICAL LAYER

Propagation Delay (Note 14), (Note 15)					$\mu\text{s}$
TXD LOW to LIN LOW	$t_{\text{TXD-LIN-low}}$	–	–	6.0	
TXD HIGH to LIN HIGH	$t_{\text{TXD-LIN-high}}$	–	–	6.0	
LIN LOW to RXD LOW	$t_{\text{LIN-RXD-low}}$	–	4.0	8.0	
LIN HIGH to RXD HIGH	$t_{\text{LIN-RXD-high}}$	–	4.0	8.0	
TXD Symmetry	$t_{\text{TXD-SYM}}$	-2.0	–	2.0	
RXD Symmetry	$t_{\text{RXD-SYM}}$	-2.0	–	2.0	
Output Falling Edge Slew Rate (Note 14), (Note 16) 80% to 20%	$\text{SR}_{\text{F}}$	-1.0	-2.0	-3.0	$\text{V}/\mu\text{s}$
Output Rising Edge Slew Rate (Note 14), (Note 16) 20% to 80%, $R_{\text{BUS}} > 1.0\text{ k}\Omega$ , $C_{\text{BUS}} < 10\text{ nF}$	$\text{SR}_{\text{R}}$	1.0	2.0	3.0	$\text{V}/\mu\text{s}$
LIN Rise/Fall Slew Rate Symmetry (Note 14), (Note 16)	$\text{SR}_{\text{S}}$	-2.0	–	2.0	$\mu\text{s}$

### AUTONOMOUS WATCHDOG (AWD)

AWD Oscillator Period	$t_{\text{OSC}}$	–	40	–	$\mu\text{s}$
AWD Period Low = 512 $t_{\text{OSC}}$	$t_{\text{AWDPH}}$	16	22	28	ms
AWD Period High = 256 $t_{\text{OSC}}$	$t_{\text{AWDPL}}$	8.0	11	14	ms

#### Notes

14. All LIN characteristics are for initial LIN slew rate selection (20 kbaud) (SRS0:SRS1= 00).
15. See [Figure 2](#), page 12.
16. See [Figure 3](#), page 12.

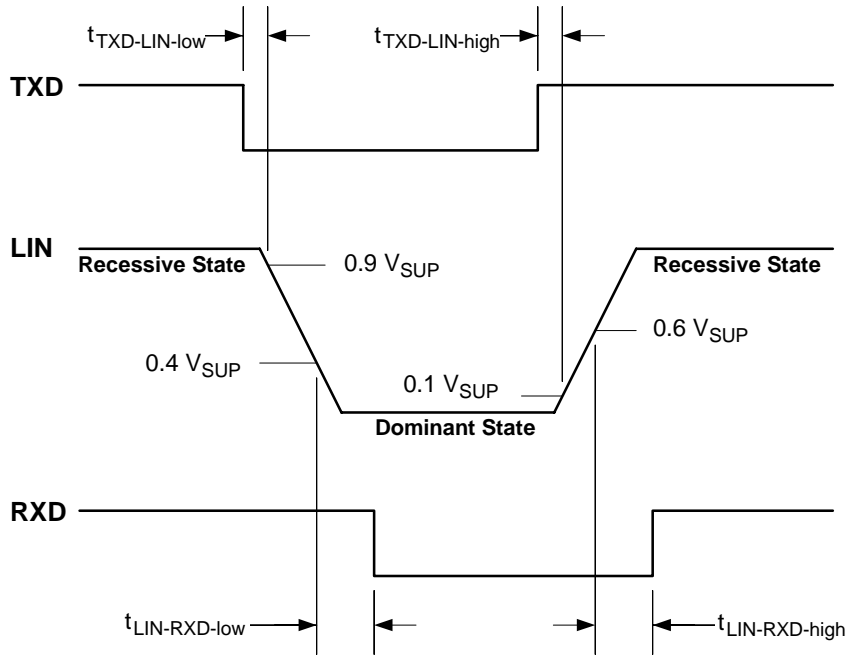
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## MICROCONTROLLER

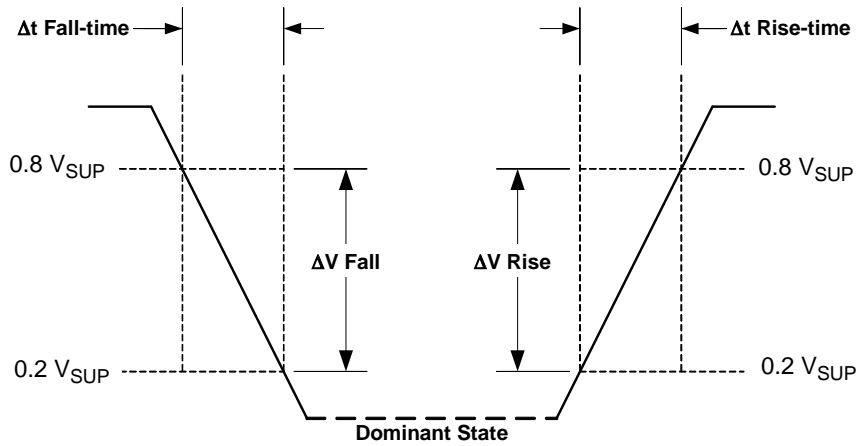
For a detailed microcontroller description, refer to the MC68HC908EY16 datasheet.

Module	Description
Core	High-Performance HC08 Core with a Maximum Internal Bus Frequency of 8.0 MHz
Timer	Two 16-Bit Timers with Two Channels (TIM A and TIM B)
Flash	16 K Bytes
RAM	512 Bytes
ADC	10-Bit Analog-to-Digital Converter
SPI	SPI Module
ESCI	Standard Serial Communication Interface (SCI) Module Bit-Time Measurement Arbitration Prescaler with Fine Baud-Rate Adjustment
ICG	Internal Clock Generation Module
BEMF Counter	Special Counter for <i>SMARTMOS</i> BEMF Output

**Timing Diagrams**



**Figure 2. LIN Timing Description**



$$SR_F = \frac{\Delta V_{Fall}}{\Delta t_{Fall-time}}$$

$$SR_R = \frac{\Delta V_{Rise}}{\Delta t_{Rise-time}}$$

**Figure 3. LIN Slew Rate Description**

Functional Diagrams

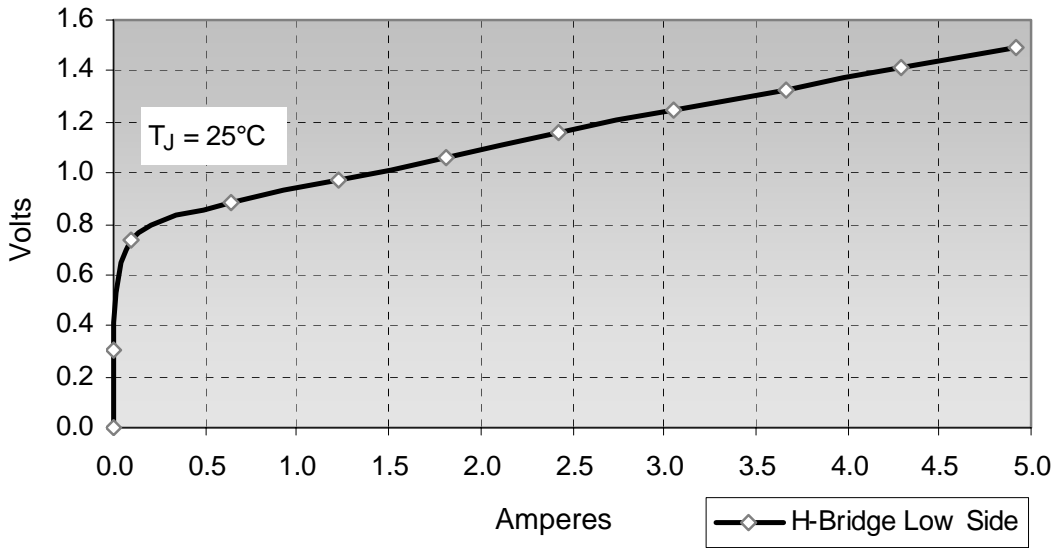


Figure 4. Free Wheel Diode Forward Voltage

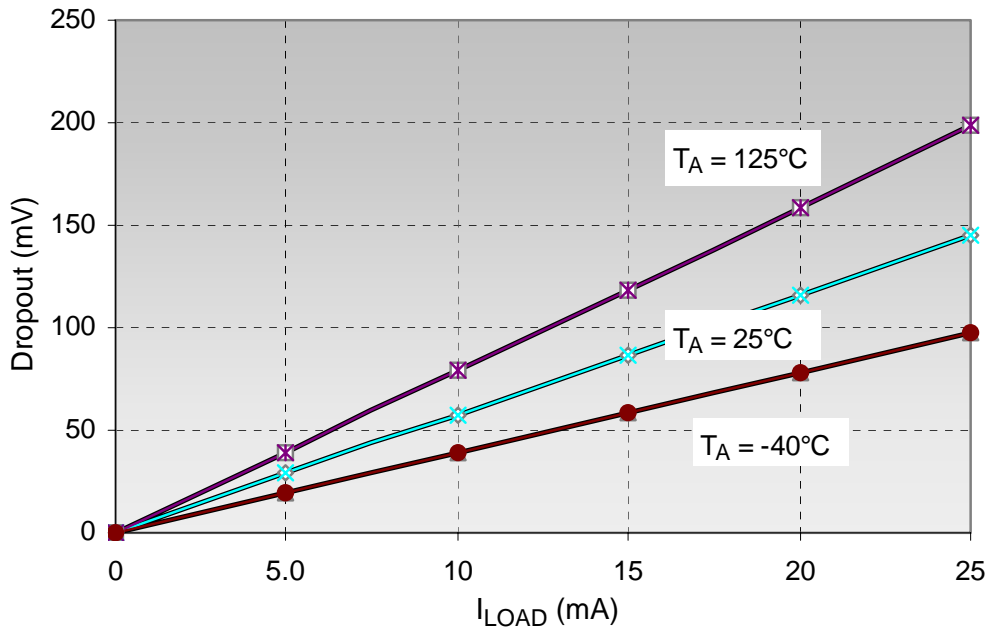


Figure 5. Dropout Voltage on HVDD

## SYSTEM/APPLICATION INFORMATION

### INTRODUCTION

The 908E626 device was designed and developed as a highly integrated and cost-effective solution for automotive and industrial applications. For automotive body electronics, the 908E626 is well suited to perform stepper motor control, e.g. for climate or light-levelling control via a 3-wire LIN bus.

This device combines an standard HC08 MCU core (68HC908EY16) with flash memory together with a *SMARTMOS* IC chip. The *SMARTMOS* IC chip combines power and control in one chip. Power switches are provided on

the *SMARTMOS* IC configured as four half-bridge outputs. Other ports are also provided including a selectable HVDD terminal. An internal voltage regulator is provided on the *SMARTMOS* IC chip, which provides power to the MCU chip.

Also included in this device is a LIN physical layer, which communicates using a single wire. This enables the device to be compatible with 3-wire bus systems, where one wire is used for communication, one for battery, and the third for ground.

### FUNCTIONAL TERMINAL DESCRIPTION

See [Figure 1, 908E626 Simplified Internal Block Diagram](#), page 2, for a graphic representation of the various terminals referred to in the following paragraphs. Also, see the terminal diagram on [page 3](#) for a depiction of the terminal locations on the package.

#### Port A I/O Terminals

These terminals are special-function, bidirectional I/O port terminals that are shared with other functional modules in the MCU. PTA0:PTA4 are shared with the keyboard interrupt terminals, KBD0:KBD4.

The PTA5/SPSCK terminal is not accessible in this device and is internally connected to the SPI clock terminal of the analog die. The PTA6/ $\overline{SS}$  terminal is likewise not accessible.

For details refer to the 68HC908EY16 datasheet.

#### Port B I/O Terminals

These terminals are special-function, bidirectional I/O port terminals that are shared with other functional modules in the MCU. All terminals are shared with the ADC module. The PTB6:PTB7 terminals are also shared with the Timer B module.

PTB0/AD0 is internally connected to the ADOUT terminal of the analog die, allowing diagnostic measurements to be calculated; e.g., current recopy,  $V_{SUP}$ , etc. The PTB2/AD2 terminal is not accessible in this device.

For details refer to the 68HC908EY16 datasheet.

#### Port C I/O Terminals

These terminals are special-function, bidirectional I/O port terminals that are shared with other functional modules in the MCU. For example, PTC2:PTC4 are shared with the ICG module.

PTC0/MISO and PTC1/MOSI are not accessible in this device and are internally connected to the MISO and MOSI SPI terminals of the analog die.

For details refer to the 68HC908EY16 datasheet.

#### Port D I/O Terminals

PTD1/TACH1 and PTD0/TACH0/BEMF are special-function, bidirectional I/O port terminals that can also be programmed to be timer terminals.

In step motor applications the PTD0 terminal should be connected to the BEMF output of the analog die in order to evaluate the BEMF signal with a special BEMF module of the MCU.

PTD1 terminal is recommended for use as an output terminal for generating the FGEN signal (PWM signal) if required by the application.

#### Port E I/O Terminal

PTE1/RXD and PTE0/TXD are special-function, bidirectional I/O port terminals that can also be programmed to be enhanced serial communication.

PTE0/TXD is internally connected to the TXD terminal of the analog die. The connection for the receiver must be done externally.

#### External Interrupt Terminal ( $\overline{IRQ}$ )

The  $\overline{IRQ}$  terminal is an asynchronous external interrupt terminal. This terminal contains an internal pullup resistor that is always activated, even when the  $\overline{IRQ}$  terminal is pulled LOW.

For details refer to the 68HC908EY16 datasheet.

#### External Reset Terminal ( $\overline{RST}$ )

A logic [0] on the  $\overline{RST}$  terminal forces the MCU to a known startup state.  $\overline{RST}$  is bidirectional, allowing a reset of the entire system. It is driven LOW when any internal reset source is asserted.

This terminal contains an internal pullup resistor that is always activated, even when the reset terminal is pulled LOW.

For details refer to the 68HC908EY16 datasheet.

## Current Limitation Frequency Input Terminal (FGEN)

Input terminal for the half-bridge current limitation PWM frequency. This input is not a real PWM input terminal; it should just supply the period of the PWM. The duty cycle will be generated automatically.

**Important** The recommended FGEN frequency should be in the range of 0.1 kHz to 20 kHz.

## Back Electromagnetic Force Output Terminal (BEMF)

This terminal gives the user information about back electromagnetic force (BEMF). This feature allows stall detection and coil failures in step motor applications. In order to evaluate this signal the terminal must be directly connected to terminal PTD0/TACH0/BEMF.

## Reset Terminal ( $\overline{\text{RST\_A}}$ )

$\overline{\text{RST\_A}}$  is the bidirectional reset terminal of the analog die. It is an open drain with pullup resistor and must be connected to the  $\overline{\text{RST}}$  terminal of the MCU.

## Interrupt Terminal ( $\overline{\text{IRQ\_A}}$ )

$\overline{\text{IRQ\_A}}$  is the interrupt output terminal of the analog die indicating errors or wake-up events. It is an open drain with pullup resistor and must be connected to the  $\overline{\text{IRQ}}$  terminal of the MCU.

## Slave Select Terminal ( $\overline{\text{SS}}$ )

This terminal is the SPI Slave Select terminal for the analog chip. All other SPI connections are done internally.  $\overline{\text{SS}}$  must be connected to PTB1 or any other logic I/O of the microcontroller.

## LIN Bus Terminal (LIN)

The LIN terminal represents the single-wire bus transmitter and receiver. It is suited for automotive bus systems and is based on the LIN bus specification.

## Half-Bridge Output Terminals (HB1:HB4)

The 908E626 device includes power MOSFETs configured as four half-bridge driver outputs. The HB1:HB4 outputs may be configured for step motor drivers, DC motor drivers, or as high-side and low-side switches.

The HB1:HB4 outputs are short-circuit and overtemperature protected, and they feature current recopy, current limitation, and BEMF generation. Current limitation and recopy are done on the low-side MOSFETs.

## Power Supply Terminals (VSUP1:VSUP3)

VSUP1:VSUP3 are device power supply terminals. The nominal input voltage is designed for operation from 12 V systems. Owing to the low ON-resistance and current requirements of the half-bridge driver outputs, multiple VSUP terminals are provided.

All VSUP terminals must be connected to get full chip functionality.

## Power Ground Terminals (GND1 and GND2)

GND1 and GND2 are device power ground connections. Owing to the low ON-resistance and current requirements of the half-bridge driver outputs multiple terminals are provided.

GND1 and GND2 terminals must be connected to get full chip functionality.

## Switchable $V_{DD}$ Output Terminal (HVDD)

The HVDD terminal is a switchable  $V_{DD}$  output for driving resistive loads requiring a regulated 5.0 V supply; The output is short-circuit protected.

## +5.0 V Voltage Regulator Output Terminal (VDD)

The VDD terminal is needed to place an external capacitor to stabilize the regulated output voltage. The VDD terminal is intended to supply the embedded microcontroller.

**Important** The VDD terminal should not be used to supply other loads; use the HVDD terminal for this purpose. The VDD, EVDD, VDDA, and VREFH terminals must be connected together.

## Voltage Regulator Ground Terminal (VSS)

The VSS terminal is the ground terminal for the connection of all non-power ground connections (microcontroller and sensors).

**Important** VSS, EVSS, VSSA, and VREFL terminals must be connected together.

## LIN Transceiver Output Terminal (RXD)

This terminal is the output of LIN transceiver. The terminal must be connected to the microcontroller's Enhanced Serial Communications Interface (ESCI) module (RXD terminal).

## ADC Reference Terminals (VREFL and VREFH)

VREFL and VREFH are the reference voltage terminals for the ADC. It is recommended that a high-quality ceramic decoupling capacitor be placed between these terminals.

**Important** VREFH is the high reference supply for the ADC and should be tied to the same potential as VDDA via separate traces. VREFL is the low reference supply for the ADC and should be tied to the same potential as VSS via separate traces.

For details refer to the 68HC908EY16 datasheet.

## ADC Supply Terminals (VDDA and VSSA)

VDDA and VSSA are the power supply terminals for the analog-to-digital converter (ADC). It is recommended that a high-quality ceramic decoupling capacitor be placed between these terminals.

**Important** VDDA is the supply for the ADC and should be tied to the same potential as EVDD via separate traces. VSSA is the ground terminal for the ADC and should be tied to the same potential as EVSS via separate traces.

For details refer to the 68HC908EY16 datasheet.

## MCU Power Supply Terminals (EVDD and EVSS)

EVDD and EVSS are the power supply and ground terminals. The MCU operates from a single power supply.

Fast signal transitions on MCU terminals place high, short-duration current demands on the power supply. To prevent noise problems, take special care to provide power supply bypassing at the MCU.

For details refer to the 68HC908EY16 datasheet.

## Test Terminal (FLSVPP)

For test purposes only. Do not connect in the application.

## Exposed Pad Terminal

The exposed pad terminal on the bottom side of the package conducts heat from the chip to the PCB board. For thermal performance the pad must be soldered to the PCB board. It is recommended that the pad be connected to the ground potential.

## ANALOG DIE DESCRIPTION

### Interrupts

The 908E626 has five different interrupt sources as described in the following paragraphs. The interrupts can be disabled or enabled via the SPI. After reset all interrupts are automatically disabled.

#### Low-Voltage Interrupt

The Low-Voltage Interrupt (LVI) is related to the external supply voltage,  $V_{SUP}$ . If this voltage falls below the LVI threshold, it will set the LVI flag. If the low-voltage interrupt is enabled, an interrupt will be initiated.

With LVI the H-Bridges (high-side MOSFET only) are switched off. All other modules are not influenced by this interrupt.

#### High-Voltage Interrupt

The High-Voltage Interrupt (HVI) is related to the external supply voltage,  $V_{SUP}$ . If this voltage rises above the HVI threshold, it will set the HVI flag. If the High-Voltage Interrupt is enabled, an interrupt will be initiated.

With HVI the H-Bridges (high-side MOSFET only) are switched off. All other modules are not influenced by this interrupt.

#### High-Temperature Interrupt

The High-Temperature Interrupt (HTI) is generated by the on-chip temperature sensors. If the chip temperature is above the HTI threshold, the HTI flag will be set. If the High-Temperature Interrupt is enabled, an interrupt will be initiated.

#### LIN Interrupt

If the LINIE bit is set, a falling edge on the LIN terminal will generate an interrupt.

### Overcurrent Interrupt

If an overcurrent condition on a half-bridge or the HVDD output is detected and the OCIE bit is set and an interrupt generated.

### Interrupt Flag Register (IFR)

Register Name and Address: IFR - \$05

	Bit7	6	5	4	3	2	1	Bit0
Read	0	0	LINF	HTF	LVF	HVF	OCF	0
Write								
Reset	0	0	0	0	0	0	0	0

#### LINF—LIN Flag Bit

This read/write flag is set on the falling edge at the LIN data line. Clear LINF by writing a logic [1] to LINF. Reset clears the LINF bit. Writing a logic [0] to LINF has no effect.

- 1 = Falling edge on LIN data line has occurred.
- 0 = Falling edge on LIN data line has not occurred since last clear.

#### HTF—High-Temperature Flag Bit

This read/write flag is set on a high-temperature condition. Clear HTF by writing a logic [1] to HTF. If a high-temperature condition is still present while writing a logic [1] to HTF, the writing has no effect. Therefore, a high-temperature interrupt cannot be lost due to inadvertent clearing of HTF. Reset clears the HTF bit. Writing a logic [0] to HTF has no effect.

- 1 = High-temperature condition has occurred.
- 0 = High-temperature condition has not occurred.



## LVF—Low-Voltage Flag Bit

This read/write flag is set on a low-voltage condition. Clear LVF by writing a logic [1] to LVF. If a low-voltage condition is still present while writing a logic [1] to LVF, the writing has no effect. Therefore, a low-voltage interrupt cannot be lost due to inadvertent clearing of LVF. Reset clears the LVF bit. Writing a logic [0] to LVF has no effect.

- 1 = Low-voltage condition has occurred.
- 0 = Low-voltage condition has not occurred.

## HVF—High-Voltage Flag Bit

This read/write flag is set on a high-voltage condition. Clear HVF by writing a logic [1] to HVF. If high-voltage condition is still present while writing a logic [1] to HVF, the writing has no effect. Therefore, a high-voltage interrupt cannot be lost due to inadvertent clearing of HVF. Reset clears the HVF bit. Writing a logic [0] to HVF has no effect.

- 1 = High-voltage condition has occurred.
- 0 = High-voltage condition has not occurred.

## OCF—Overcurrent Flag Bit

This read-only flag is set on an overcurrent condition. Reset clears the OCF bit. To clear this flag, write a logic [1] to the appropriate overcurrent flag in the SYSSTAT Register. See [Figure 6](#), which shows the two signals triggering the OCF.

- 1 = High-current condition has occurred.
- 0 = High-current condition has not occurred.

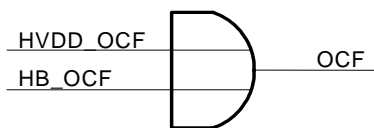


Figure 6. Principal Implementation for OCF

## Interrupt Mask Register (IMR)

Register Name and Address: IMR - \$04

	Bit7	6	5	4	3	2	1	Bit0
Read	0	0	LINIE	HTIE	LVIE	HVIE	OCIE	0
Write	0	0						
Reset	0	0	0	0	0	0	0	0

### LINIE—LIN Line Interrupt Enable Bit

This read/write bit enables CPU interrupts by the LIN flag, LINF. Reset clears the LINIE bit.

- 1 = Interrupt requests from LINF flag enabled.
- 0 = Interrupt requests from LINF flag disabled.

### HTIE—High-Temperature Interrupt Enable Bit

This read/write bit enables CPU interrupts by the high-temperature flag, HTF. Reset clears the HTIE bit.

- 1 = Interrupt requests from HTF flag enabled.
- 0 = Interrupt requests from HTF flag disabled.

### LVIE—Low-Voltage Interrupt Enable Bit

This read/write bit enables CPU interrupts by the low-voltage flag, LVF. Reset clears the LVIE bit.

- 1 = Interrupt requests from LVF flag enabled.
- 0 = Interrupt requests from LVF flag disabled.

### HVIE—High-Voltage Interrupt Enable Bit

This read/write bit enables CPU interrupts by the high-voltage flag, HVF. Reset clears the HVIE bit.

- 1 = Interrupt requests from HVF flag enabled.
- 0 = Interrupt requests from HVF flag disabled.

### OCIE—Overcurrent Interrupt Enable Bit

This read/write bit enables CPU interrupts by the overcurrent flag, OCF. Reset clears the OCIE bit.

- 1 = Interrupt requests from OCF flag enabled.
- 0 = Interrupt requests from OCF flag disabled.

## Reset

The 908E626 chip has four internal reset sources and one external reset source, as explained in the paragraphs below. [Figure 7](#) depicts the internal reset sources.

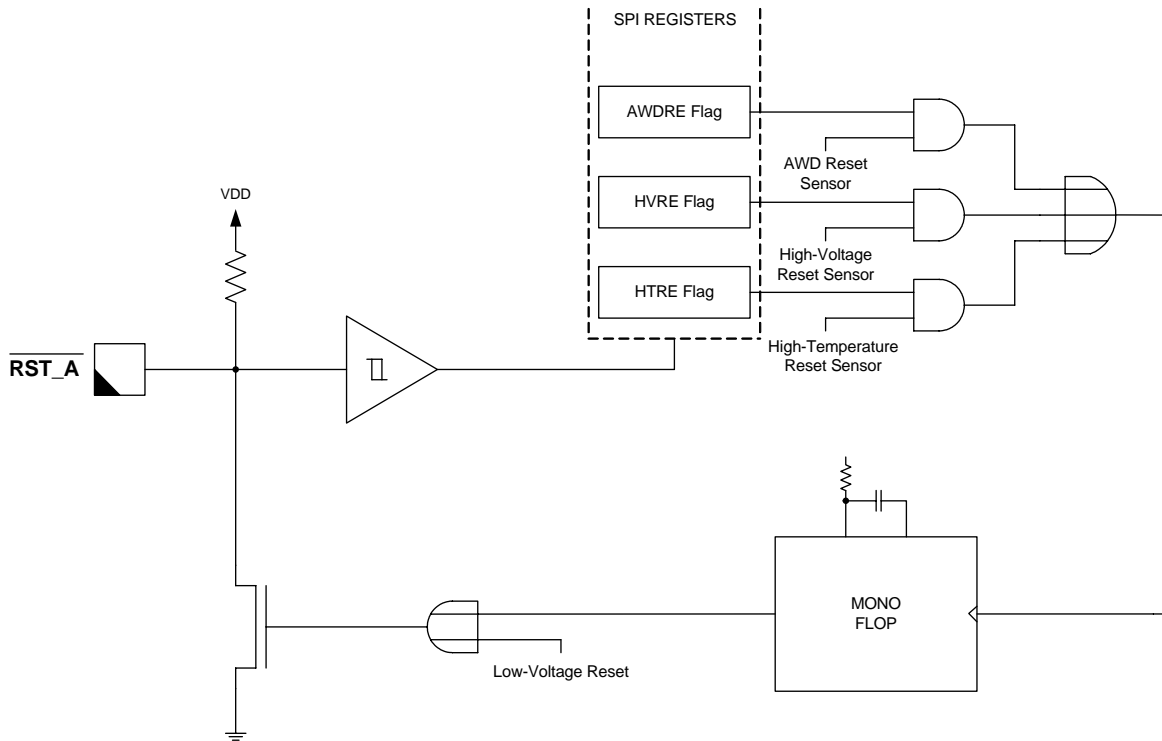


Figure 7. Internal Reset Routing

### Reset Internal Sources

#### Autonomous Watchdog

AWD modules generates a reset because of a timeout (watchdog function).

#### High-Temperature Reset

To prevent damage to the device, a reset will be initiated if the temperature rises above a certain value. The reset is maskable with bit HTRE in the Reset Mask Register. After a reset the high-temperature reset is disabled.

#### Low-Voltage Reset

The LVR is related to the internal  $V_{DD}$ . In case the voltage falls below a certain threshold, it will pull down the  $\overline{RST\_A}$  terminal.

#### High-Voltage Reset

The HVR is related to the external  $V_{SUP}$  voltage. In case the voltage is above a certain threshold, it will pull down the  $\overline{RST\_A}$  terminal. The reset is maskable with bit HVRE in the Reset Mask Register. After a reset the high-voltage reset is disabled.

### Reset External Source

#### External Reset Terminal

The microcontroller has the capability of resetting the SMARTMOS device by pulling down the  $\overline{RST}$  terminal.

#### Reset Mask Register (RMR)

Register Name and Address: RMR - \$06

	Bit7	6	5	4	3	2	1	Bit0
Read	TTEST	0	0	0	0	0	HVRE	HTRE
Write								
Reset	0	0	0	0	0	0	0	0

#### TTEST—High-Temperature Reset Test

This read/write bit is for test purposes only. It decreases the overtemperature shutdown limit for final test. Reset clears the HTRE bit.

- 1 = Low-temperature threshold enabled.
- 0 = Low-temperature threshold disabled.

## HVRE—High-Voltage Reset Enable Bit

This read/write bit enables resets on high-voltage conditions. Reset clears the HVRE bit.

- 1 = High-voltage reset enabled.
- 0 = High-voltage reset disabled.

## HTRE—High-Temperature Reset Enable Bit

This read/write bit enables resets on high-temperature conditions. Reset clears the HTRE bit.

- 1 = High-temperature reset enabled.
- 0 = High-temperature reset disabled.

## SERIAL PERIPHERAL INTERFACE

The serial peripheral interface (SPI) creates the communication link between the microcontroller and the 908E626.

The interface consists of four terminals (see [Figure 8](#)):

- $\overline{SS}$ —Slave Select
- MOSI—Master-Out Slave-In
- MISO—Master-In Slave-Out
- SPCK—Serial Clock (maximum frequency 4.0 MHz)

A complete data transfer via the SPI consists of 2 bytes. The master sends address and data, slave system status, and data of the selected address.

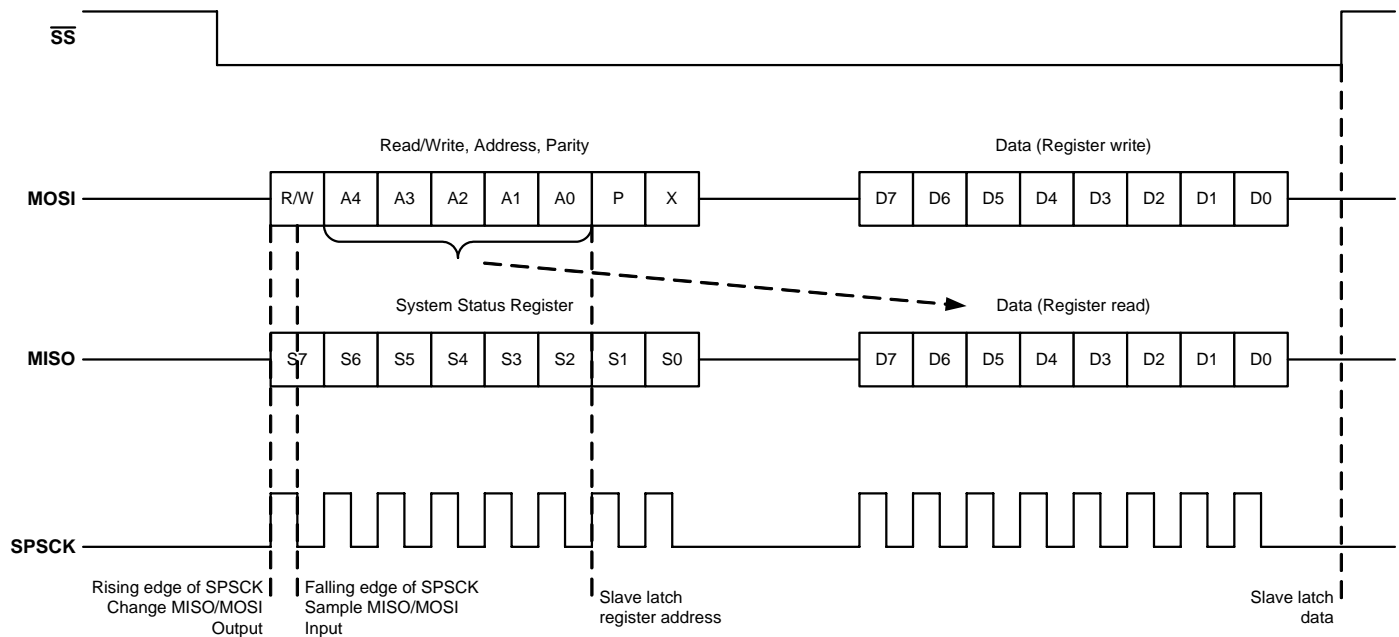


Figure 8. SPI Protocol

During the inactive phase of  $\overline{SS}$ , the new data transfer is prepared. The falling edge on the  $\overline{SS}$  line indicates the start of a new data transfer and puts MISO in the low-impedance mode. The first valid data are moved to MISO with the rising edge of SPCK.

The MISO output changes data on a rising edge of SPCK. The MOSI input is sampled on a falling edge of SPCK. The

data transfer is only valid if exactly 16 sample clock edges are present in the active phase of  $\overline{SS}$ .

After a write operation, the transmitted data is latched into the register by the rising edge of  $\overline{SS}$ . Register read data is internally latched into the SPI at the time when the parity bit is transferred.  $\overline{SS}$  HIGH forces MISO to high impedance.

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## Master Address Byte

### A4:A0

Contains the address of the desired register.

### R/W

Contains information about a read or a write operation.

- If  $R/\overline{W} = 1$ , the second byte of master contains no valid information, slave just transmits back register data.
- If  $R/\overline{W} = 0$ , the master sends data to be written in the second byte, slave sends concurrently contents of selected register prior to write operation, write data is latched in the SMARTMOS register on rising edge of  $\overline{SS}$ .

### Parity P

The parity bit is equal to "0" if the number of 1 bits is an even number contained within R/W, A4:A0. If the number of 1 bits is odd, P equals "1". For example, if  $R/\overline{W} = 1$ , A4:A0 = 00001, then P equals "0."

The parity bit is only evaluated during a write operation.

## Bit X

Not used.

## Master Data Byte

Contains data to be written or no valid data during a read operation.

## Slave Status Byte

Contains the contents of the System Status Register (\$0c) independent of whether it is a write or read operation or which register was selected.

## Slave Data Byte

Contains the contents of selected register. During a write operation it includes the register content prior to a write operation.

## SPI Register Overview

[Table 1](#) summarizes the SPI Register addresses and the bit names of each register.

**Table 1. List of Registers**

Addr	Register Name	R/W	Bit							
			7	6	5	4	3	2	1	0
\$01	H-Bridge Output (HBOUT)	R	HB4_H	HB4_L	HB3_H	HB3_L	HB2_H	HB2_L	HB1_H	HB1_L
		W								
\$02	H-Bridge Control (HBCTL)	R	OFC_EN	CSA	0	0	0	CLS2	CLS1	CLS0
		W								
\$03	System Control (SYSCTL)	R	PSON	SRS1	SRS0	0	0	0	0	0
		W								
\$04	Interrupt Mask (IMR)	R	0	0	LINIE	HTIE	LVIE	HVIE	OCIE	0
		W								
\$05	Interrupt Flag (IFR)	R	0	0	LINF	HTF	LVF	HVF	OCF	0
		W								
\$06	Reset Mask (RMR)	R	TTEST	0	0	0	0	0	HVRE	HTRE
		W								
\$07	Analog Multiplexer Configuration (ADMUX)	R	0	0	0	0	SS3	SS2	SS1	SS0
		W								
\$08	Reserved	R	0	0	0	0	0	0	0	0
		W								
\$09	Reserved	R	0	0	0	0	0	0	0	0
		W								
\$0a	AWD Control (AWDCTL)	R	0	0	0	AWDRE	0	0	AWDF	AWDR
		W								
\$0b	Power Output (POUT)	R	0	0	0	0	0	0	HVDDON	0
		W								
\$0c	System Status (SYSSTAT)	R	0	LINCL	HVDD_OCF	0	LVF	HVF	HB_OCF	HTF
		W								

## Analog Die I/Os

### LIN Physical Layer

The LIN bus terminal provides a physical layer for single-wire communication in automotive applications. The LIN physical layer is designed to meet the LIN physical layer specification.

The LIN driver is a low-side MOSFET with internal current limitation and thermal shutdown. An internal pullup resistor with a serial diode structure is integrated, so no external pullup components are required for the application in a slave node. The fall time from dominant to recessive and the rise time from recessive to dominant is controlled. The symmetry between both slew rate controls is guaranteed.

The LIN terminal offers high susceptibility immunity level from external disturbance, guaranteeing communication during external disturbance.

The LIN transmitter circuitry is enabled by setting the PSON bit in the System Control Register (SYSCTL). If the transmitter works in the current limitation region, the LINCL bit in the System Status Register (SYSSTAT) is set. Due to excessive power dissipation in the transmitter, software is advised to monitor this bit and turn the transmitter off immediately.

### TXD Terminal

The TXD terminal is the MCU interface to control the state of the LIN transmitter (see [Figure 1](#), page 2). When TXD is LOW, LIN output is low (dominant state). When TXD is HIGH, the LIN output MOSFET is turned off. The TXD terminal has an internal pullup current source in order to set the LIN bus in recessive state in the event, for instance, the microcontroller could not control it during system power-up or power-down.

### RXD Terminal

The RXD transceiver terminal is the MCU interface, which reports the state of the LIN bus voltage. LIN HIGH (recessive state) is reported by a high level on RXD, LIN LOW (dominant state) by a low level on RXD.

### Analog Multiplexer/ADOUT Terminal

The ADOUT terminal is the analog output interface to the ADC of the MCU (see [Figure 1](#), page 2). An analog multiplexer is used to read six internal diagnostic analog voltages.

### Current Recopy

The analog multiplexer is connected to the four low-side current sense circuits of the half-bridges. These sense circuits offer a voltage proportional to the current through the low-side MOSFET. High or low resolution is selectable: 5.0 V/2.5 A or 5.0 V/500 mA, respectively. (Refer to [Half-Bridge Current Recopy on page 25](#).)

### Temperature Sensor

The 908E626 includes an on-chip temperature sensor. This sensor offers a voltage that is proportional to the actual chip junction temperature.

### V<sub>SUP</sub> Prescaler

The V<sub>SUP</sub> prescaler permits the reading or measurement of the external supply voltage. The output of this voltage is V<sub>SUP</sub>/RATIO<sub>V<sub>SUP</sub></sub>.

The different internal diagnostic analog voltages can be selected with the ADMUX Register.

### Analog Multiplexer Configuration Register (ADMUX)

**Register Name and Address: ADMUX - \$07**

	Bit7	6	5	4	3	2	1	Bit0
Read	0	0	0	0	SS3	SS2	SS1	SS0
Write								
Reset	0	0	0	0	0	0	0	0

### SS3, SS2, SS1, and SS0—A/D Input Select Bits

These read/write bits select the input to the ADC in the microcontroller according to [Table 2](#), page 22. Reset clears SS3, SS2, SS1, and SS0 bits.

**Table 2. Analog Multiplexer Configuration Register**

SS3	SS2	SS1	SS0	Channel
0	0	0	0	Current Recopy HB1
0	0	0	1	Current Recopy HB2
0	0	1	0	Current Recopy HB3
0	0	1	1	Current Recopy HB4
0	1	0	0	V <sub>SUP</sub> Prescaler
0	1	0	1	Temperature Sensor
0	1	1	0	Not Used
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	
1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	

## HVDDON—HVDD On Bit

This read/write bit enables HVDD output. Reset clears the HVDDON bit.

- 1 = HVDD enabled.
- 0 = HVDD disabled.

## Half-Bridges

Outputs HB1:HB4 provide four low-resistive half-bridge output stages. The half-bridges can be used in H-Bridge, high-side, or low-side configurations.

Reset clears all bits in the H-Bridge Output Register (HBOUT) owing to the fact that all half-bridge outputs are switched off.

HB1:HB4 output features:

- Short circuit (overcurrent) protection on high-side and low-side MOSFETs.
- Current recopy feature (low side MOSFET).
- Overtemperature protection.
- Overvoltage and undervoltage protection.
- Current limitation feature (low side MOSFET).

## Power Output Register (POUT)

Register Name and Address: P<sub>OUT</sub> - \$0b

	Bit7	6	5	4	3	2	1	Bit0
Read	0	0	0	0	0	0	HVDDON	0
Write			(Note 17)	(Note 17)	(Note 17)	(Note 17)		(Note 17)
Reset	0	0	0	0	0	0	0	0

### Notes

17. This bit must always be set to 0.

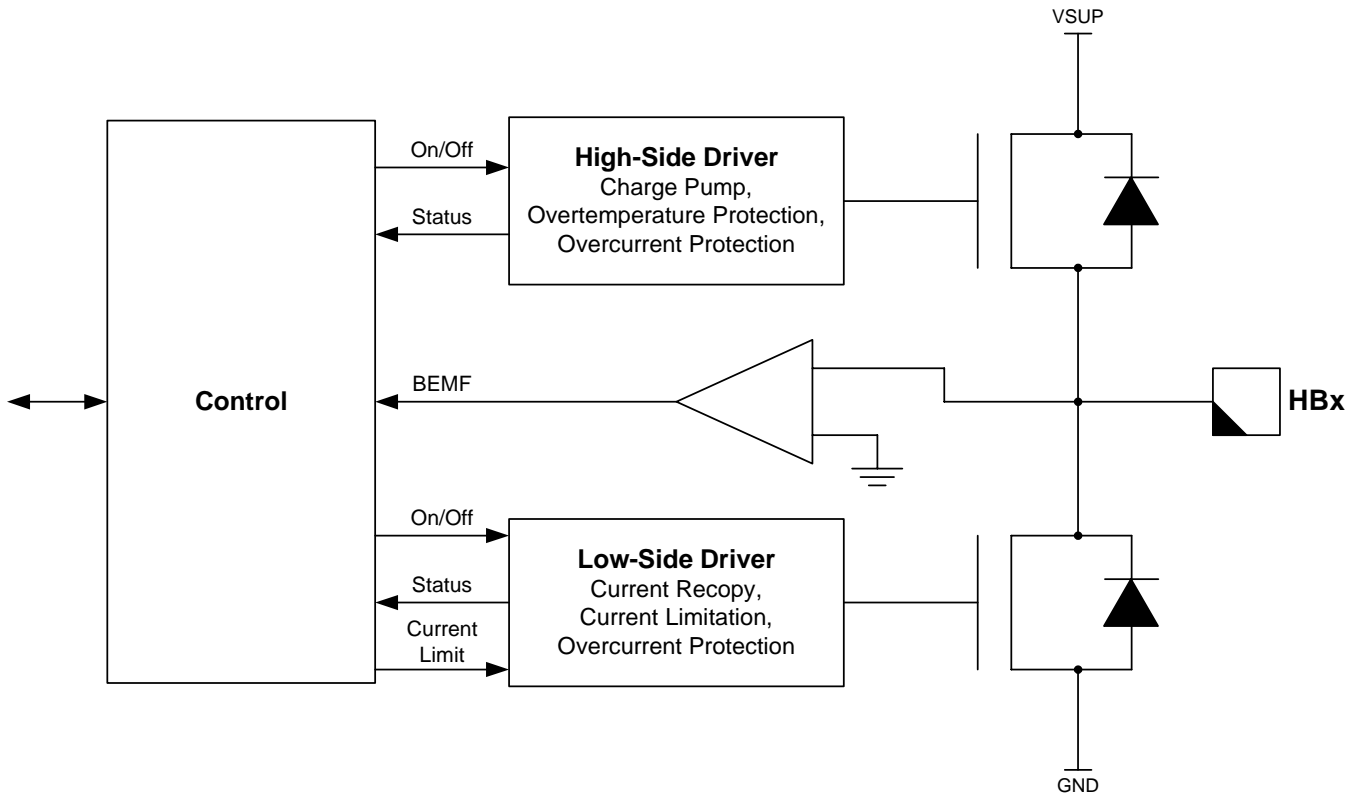


Figure 9. Half-Bridge Push-Pull Output Driver

**Half-Bridge Control**

Each output MOSFET can be controlled individually. The general enable of the circuitry is done by setting PSON in the System Control Register (SYSCTL). HBx\_L and HBx\_H form one half-bridge. It is not possible to switch on both MOSFETs in one half-bridge at the same time. If both bits are set, the high-side MOSFET has a higher priority.

To avoid both MOSFETs (high side and low side) of one half-bridge being on at the same time, a break-before-make circuit exists. Switching the high-side MOSFET on is inhibited as long as the potential between gate and V<sub>SS</sub> is not below a certain threshold. Switching the low-side MOSFET on is blocked as long as the potential between gate and source of the high-side MOSFET did not fall below a certain threshold.

**Half-Bridge Output Register (HBOUT)**

Register Name and Address: HBOUT - \$01

	Bit7	6	5	4	3	2	1	Bit0
Read	HB4_H	HB4_L	HB3_H	HB3_L	HB2_H	HB2_L	HB1_H	HB1_L
Write								
Reset	0	0	0	0	0	0	0	0

**HBx\_L—Low-Side On/Off Bits**

These read/write bits turn on the low-side MOSFETs. Reset clears the HBx\_L bits.

- 1 = Low-side MOSFET turned on for half-bridge output x.
- 0 = Low-side MOSFET turned off for half-bridge output x.

**HBx\_H—High-Side On/Off Bits**

These read/write bits turn on the high-side MOSFETs. Reset clears the HBx\_H bits.

- 1 = High-side MOSFET turned on for half-bridge output x.
- 0 = High-side MOSFET turned on for half-bridge output x.

## Half-Bridge Current Limitation

Each low-side MOSFET offers a current limit or constant current feature. This feature is realized by a pulse width modulation on the low-side MOSFET. The pulse width modulation on the outputs is controlled by the FGEN input and the load characteristics. The FGEN input provides the PWM frequency, whereas the duty cycle is controlled by the load characteristics.

The recommended frequency range for the FGEN and the PWM is 0.1 kHz to 20 kHz.

### Functionality

Each low-side MOSFET switches off if a current above the selected current limit was detected. The 908E626 offers five different current limits (refer to [Table 3](#), page 27, for current limit values). The low-side MOSFET switches on again if a rising edge on the FGEN input was detected ([Figure 10](#)).

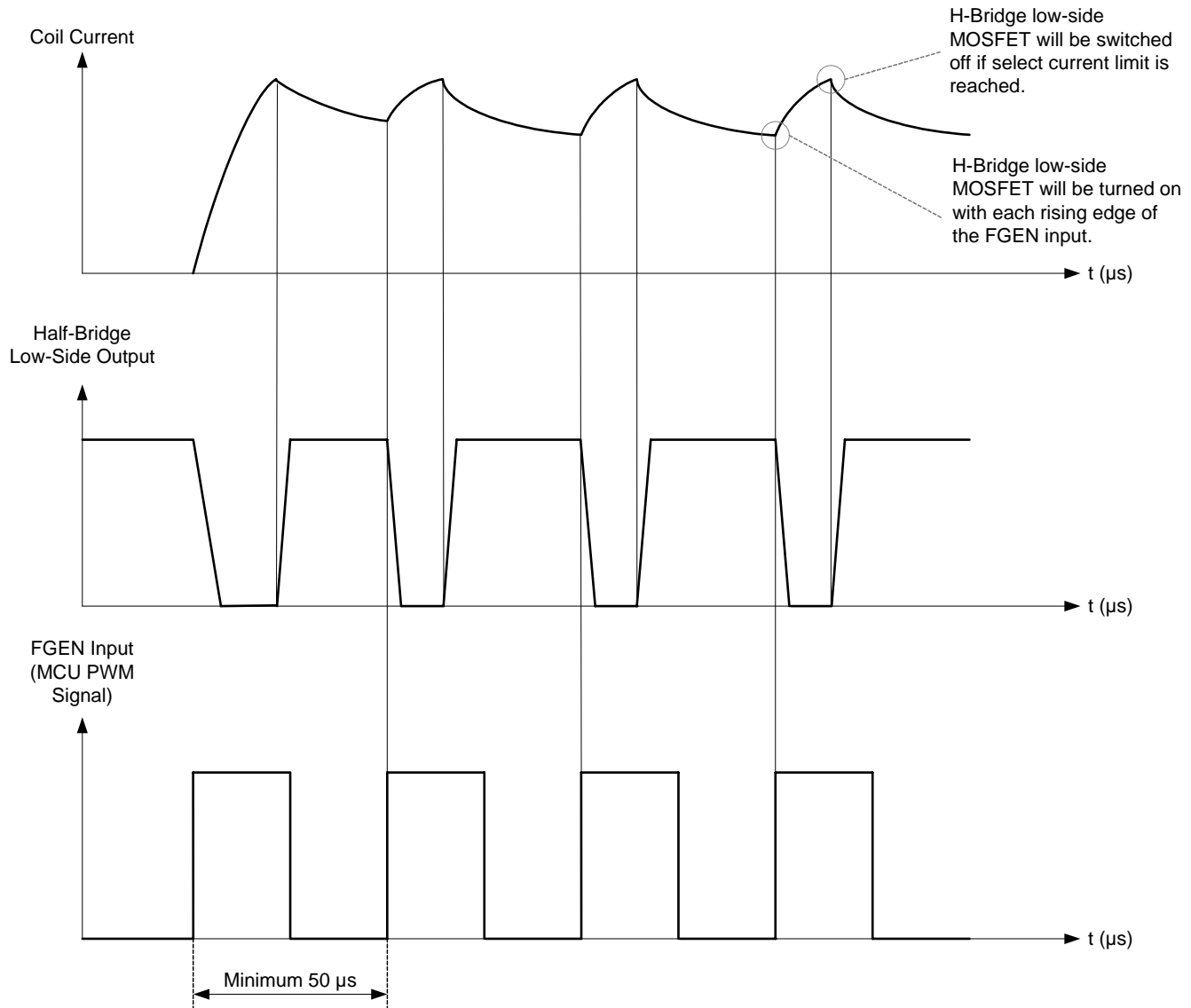


Figure 10. Half-Bridge Current Limitation



## Offset Chopping

If bit OFC\_EN in the H-Bridge Control Register (HBCTL) is set, HB1 and HB2 will continue to switch on the low-side MOSFETs with the rising edge of the FGEN signal and HB3 and

HB4 will switch on the low-side MOSFETs with the falling edge on the FGEN input. In step motor applications, this feature allows the reduction of EMI due to a reduction of the di/dt ([Figure](#)).

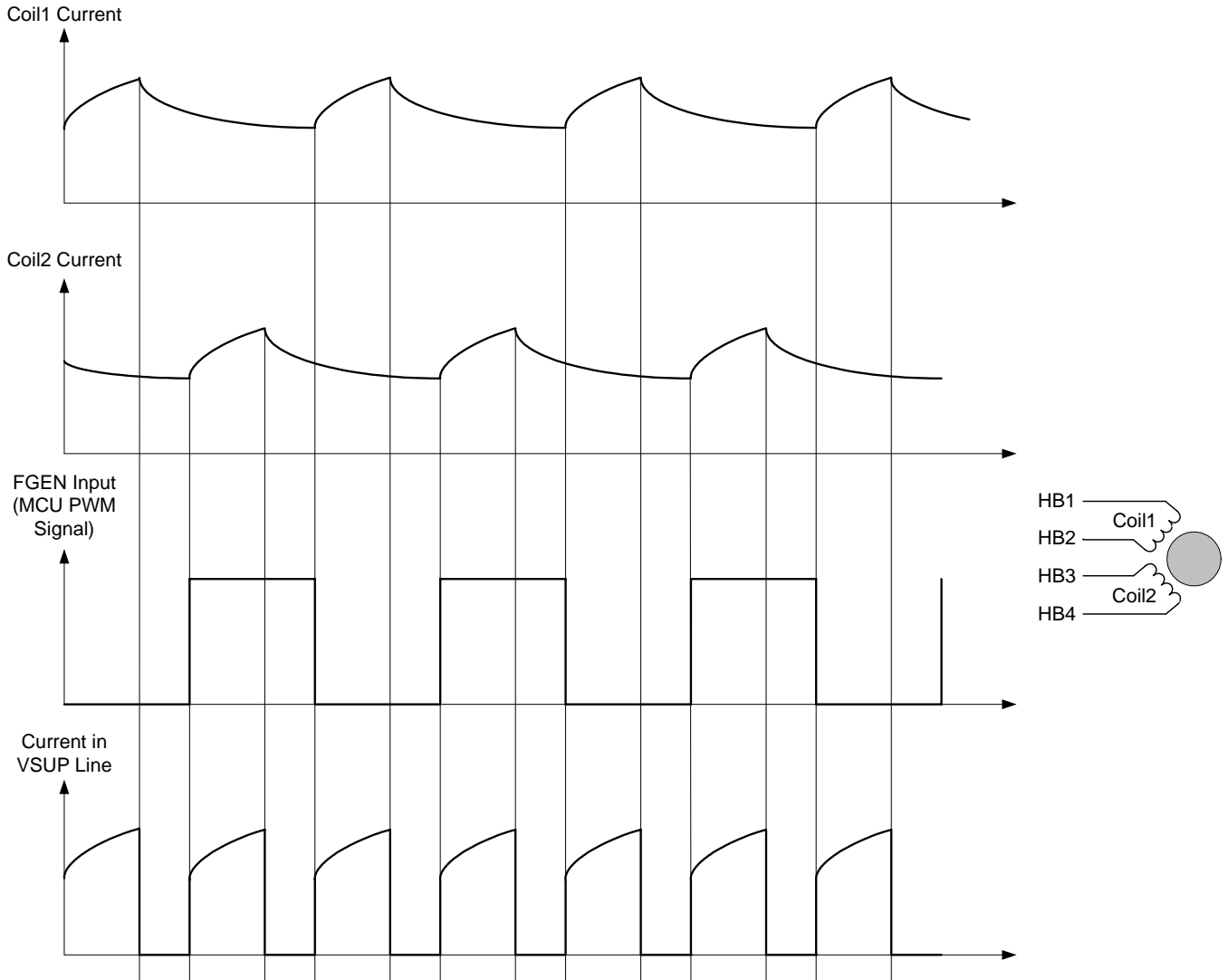


Figure 11. Offset Chopping for Step Motor Control

## Half-Bridge Current Recopy

Each low-side MOSFET has an additional sense output to allow a current recopy feature. This sense source is internally connected to a shunt resistor. The drop voltage is amplified and switched to the analog multiplexer.

The factor for the current sense amplification can be selected via bit CSA in the System Control Register.

- CSA = 1: Low resolution selected (500 mA measurement range).
- CSA = 0: High resolution selected (2.5 A measurement range).

## Half-Bridge BEMF Generation

The BEMF output is set to "1" if a recirculation current is detected in any half-bridge. This recirculation current flows via the two freewheeling diodes of the power MOSFETs. The BEMF circuitry detects that and generates a HIGH on the BEMF output as long as a recirculation current is detected. This signal provides a flexible and reliable detection of stall in step motor applications. For this the BEMF circuitry takes advantage of the instability of the electrical and mechanical behavior of a step motor when blocked. In addition the signal can be used for open load detection (absence of this signal) (see [Figure 12](#), page 26).

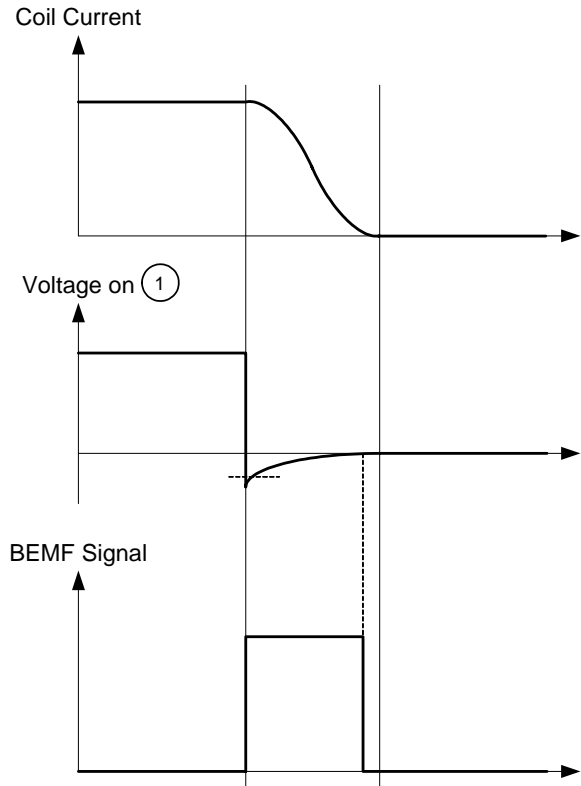
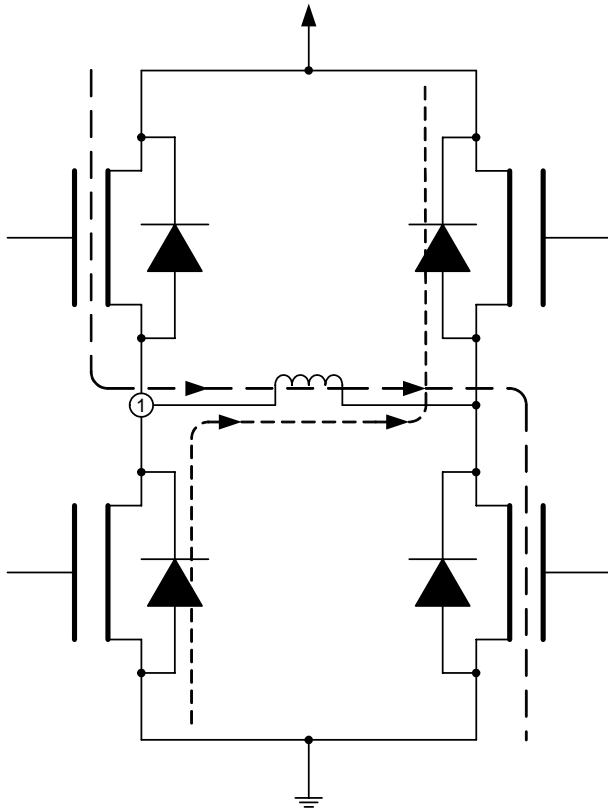


Figure 12. BEMF Signal Generation

### Half-Bridge Overtemperature Protection

The half-bridge outputs provide an overtemperature pre-warning with the HTF in the Interrupt Flag Register (IFR). In order to protect the outputs against overtemperature, the High-Temperature Reset must be enabled. If this value is reached, the part generates a reset and disables all power outputs.

### Half-Bridge Overcurrent Protection

The half-bridges are protected against short to GND, short to VSUP, and load shorts.

In the event an overcurrent on the high side is detected, the high-side MOSFETs on all HB high-side MOSFETs are switched off automatically. In the event an overcurrent on the low side is detected, all HB low-side MOSFETs are switched off automatically. In both cases, the overcurrent status flag HB\_OCF in the System Status Register (SYSSTAT) is set.

The overcurrent status flag is cleared (and the outputs re-enabled) by writing a logic [1] to the HB\_OCF flag in the System Status Register or by reset.

### Half-Bridge Overvoltage/Undervoltage

The half-bridge outputs are protected against undervoltage and overvoltage conditions. This protection is done by the low- and high-voltage interrupt circuitry. If one of these flags (LVF, HVF) is set, the outputs are automatically disabled.

The overvoltage/undervoltage status flags are cleared (and the outputs re-enabled) by writing a logic [1] to the LVF/HVF flags in the Interrupt Flag Register or by reset. Clearing this flag is useless as long as a high- or low-voltage condition is present.

### Half-Bridge Control Register (HBCTL)

Register Name and Address: HBCTL - \$02

	Bit7	6	5	4	3	2	1	Bit0
Read	OFC_EN	CSA	0	0	0	CLS2	CLS1	CLS0
Write								
Reset	0	0	0	0	0	0	0	0

#### OFC\_EN—H-Bridge Offset Chopping Enable Bit

This read/write bit enables offset chopping. Reset clears the OFC\_EN bit.

- 1 = Offset chopping enabled.
- 0 = Offset chopping disabled.

#### CSA—H-Bridges Current Sense Amplification Select Bit

This read/write bit selects the current sense amplification of the H-Bridges. Reset clears the CSA bit.

- 1 = Current sense amplification set for measuring 0.5 A.
- 0 = Current sense amplification set for measuring 2.5 A.

## CLS2:CLS0—H-Bridge Current Limitation Selection Bits

These read/write bits select the current limitation value according to [Table 3](#). Reset clears the CLS2:CLS0 bits.

**Table 3. H-Bridge Current Limitation Value Selection Bits**

CLS2	CLS1	CLS0	Current Limit
0	0	0	No Limit
0	0	1	
0	1	0	
0	1	1	55 mA (typ)
1	0	0	260 mA (typ)
1	0	1	370 mA (typ)
1	1	0	550 mA (typ)
1	1	1	740 mA (typ)

## Switchable VDD Outputs

The HVDD terminal is a switchable VDD output terminal. It can be used for driving external circuitry that requires a  $V_{DD}$  voltage. The output is enabled with bit PSON in the System Control Register and can be switched on/off with bit HVDDON in the Power Output Register. Low- or high-voltage conditions (LVI/HVI) have no influence on this circuitry.

## HVDD Overtemperature Protection

Overtemperature protection is enabled if the high-temperature reset is enabled.

## HVDD Overcurrent Protection

The HVDD output is protected against overcurrent. In the event the overcurrent limit is or was reached, the output automatically switches off and the HVDD overcurrent flag in the System Status Register is set.

## System Control Register (SYSCTL)

**Register Name and Address: SYSCTL - \$03**

	Bit7	6	5	4	3	2	1	Bit0
Read				0	0	0	0	0
Write	PSON	SRS1	SRS0					0 (Note 17)
Reset	0	0	0	0	0	0	0	0

### Notes

18. This bit must always be set to 0.

## PSON—Power Stages On Bit

This read/write bit enables the power stages (half-bridges, LIN transmitter and HVDD output). Reset clears the PSON bit.

- 1 = Power stages enabled.
- 0 = Power stages disabled.

## SRS0:SRS1—LIN Slew Rate Selection Bits

These read/write bits enable the user to select the appropriate LIN slew rate for different baud rate configurations as shown in [Table 4](#).

The high speed slew rates are used, for example, for programming via the LIN and are not intended for use in the application.

**Table 4. LIN Slew Rate Selection Bits**

SRS1	SRS0	LIN Slew Rate
0	0	Initial Slew Rate (20 kBaud)
0	1	Slow Slew Rate (10 kBaud)
1	0	High Speed II (8x)
1	1	High Speed I (4x)

## System Status Register (SYSSTAT)

**Register Name and Address: SYSSTAT - \$0c**

	Bit7	6	5	4	3	2	1	Bit0
Read		LINCL	HVDD_OCF	0	LVF	HVF	HB_OCF	HTF
Write	0			0				
Reset	0	0	0	0	0	0	0	0

## LINCL — LIN Current Limitation Bit

This read-only bit is set if the LIN transmitter operates in current limitation region. Due to excessive power dissipation in the transmitter, software is advised to turn the transmitter off immediately.

- 1 = Transmitter operating in current limitation region.
- 0 = Transmitter not operating in current limitation region.

## HVDD\_OCF—HVDD Output Overcurrent Flag Bit

This read/write flag is set on an overcurrent condition at the HVDD terminal. Clear HVDD\_OCF and enable the output by writing a logic [1] to the HVDD\_OCF Flag. Reset clears the HVDD\_OCF bit. Writing a logic [0] to HVDD\_OCF has no effect.

- 1 = Overcurrent condition on HVDD has occurred.
- 0 = No overcurrent condition on HVDD has occurred.

## LVF—Low-Voltage Bit

This read only bit is a copy of the LVF bit in the Interrupt Flag Register.

- 1 = Low-voltage condition has occurred.
- 0 = No low-voltage condition has occurred.

## HVF—High-Voltage Sensor Bit

This read-only bit is a copy of the HVF bit in the Interrupt Flag Register.

- 1 = High-voltage condition has occurred.
- 0 = No high-voltage condition has occurred.

## HB\_OCF—H-Bridge Overcurrent Flag Bit

This read/write flag is set on an overcurrent condition at the H-Bridges. Clear HB\_OCF and enable the H-Bridge driver by writing a logic [1] to HB\_OCF. Reset clears the HB\_OCF bit. Writing a logic [0] to HB\_OCF has no effect.

- 1 = Overcurrent condition on H-Bridges has occurred.
- 0 = No overcurrent condition on H-Bridges has occurred.

## HTF—Overtemperature Status Bit

This read-only bit is a copy of the HTF bit in the Interrupt Flag Register.

- 1 = Overtemperature condition has occurred.
- 0 = No overtemperature condition has occurred.

## Autonomous Watchdog (AWD)

The Autonomous Watchdog module allows to protect the CPU against code runaways.

The AWD is enabled if AWDRE in the AWDCTL Register is set. If this bit is cleared, the AWD oscillator is disabled and the watchdog switched off.

### Watchdog

The watchdog function is only available in RUN mode. On setting the AWDRE bit, watchdog functionality in RUN mode is activated. Once this function is enabled, it is not possible to disable it via software.

If the timer reaches end value and AWDRE is set, a system reset is initiated. Operations of the watchdog function cease in STOP mode. Normal operation will be continued when the system is back to RUN mode.

To prevent a watchdog reset, the watchdog timeout counter must be reset before it reaches the end value. This is done by a write to the AWDRST bit in the AWDCTL Register.

## Autonomous Watchdog Control Register (AWDCTL)

Register Name and Address: AWDCTL - \$0a

	Bit7	6	5	4	3	2	1	Bit0
Read	0	0	0	AWDRE	0 (Note 17)	0 (Note 17)	0	AWDR
Write			AWDRST					
Reset	0	0	0	0	0	0	0	0

### Notes

19. This bit must always be set to 0.

## AWDRST—Autonomous Watchdog Reset Bit

This write-only bit resets the Autonomous Watchdog timeout period. AWDRST always reads 0. Reset clears AWDRST bit.

- 1 = Reset AWD and restart timeout period.
- 0 = No effect.

## AWDRE—Autonomous Watchdog Reset Enable Bit

This read/write bit enables resets on AWD timeouts. A reset on the RST\_A is asserted when the Autonomous Watchdog has reached the timeout and the Autonomous Watchdog is enabled. AWDRE is one-time settable (write once) after each reset. Reset clears the AWDRE bit.

- 1 = Autonomous watchdog enabled.
- 0 = Autonomous watchdog disabled.

## AWDR—Autonomous Watchdog Rate Bit

This read/write bit selects the clock rate of the Autonomous Watchdog. Reset clears the AWDR bit.

- 1 = Fast rate selected (10 ms).
- 0 = Slow rate selected (20 ms).

## Voltage Regulator

The 908E626 chip contains a low-power, low-drop voltage regulator to provide internal power and external power for the MCU. The V<sub>DD</sub> regulator accepts a unregulated input supply and provides a regulated V<sub>DD</sub> supply to all digital sections of the device. The output of the regulator is also connected to the VDD terminal to provide the 5.0 V to the microcontroller.

## FACTORY TRIMMING AND CALIBRATION

To enhance the ease-of-use of the 908E626, various parameters (e.g. ICG trim value) are stored in the flash memory of the device. The following flash memory locations are reserved for this purpose and might have a value different from the “empty” (0xFF) state:

- 0xFD80:0xFDDF Trim and Calibration Values
- 0xFFFE:0xFFFF Reset Vector

In the event the application uses these parameters, one has to take care not to erase or override these values. If these parameters are not used, these flash locations can be erased and otherwise used.

## PACKAGE THERMAL PERFORMANCE

[Figure 13](#) shows a thermal response curve for a package mounted onto a thermally enhanced PCB.

**Note** The PCB board is a multi-layer board with two inner copper planes (2s2p). The board conforms to JEDEC EIA/JESD 51-5 and JESD51-7. Substrate thickness is 1.60 mm. Top and bottom copper trace layers are 0.7 mm thick, with two inner copper planes of 0.35 mm thickness. Thermal vias have 0.35 mm thick plating.

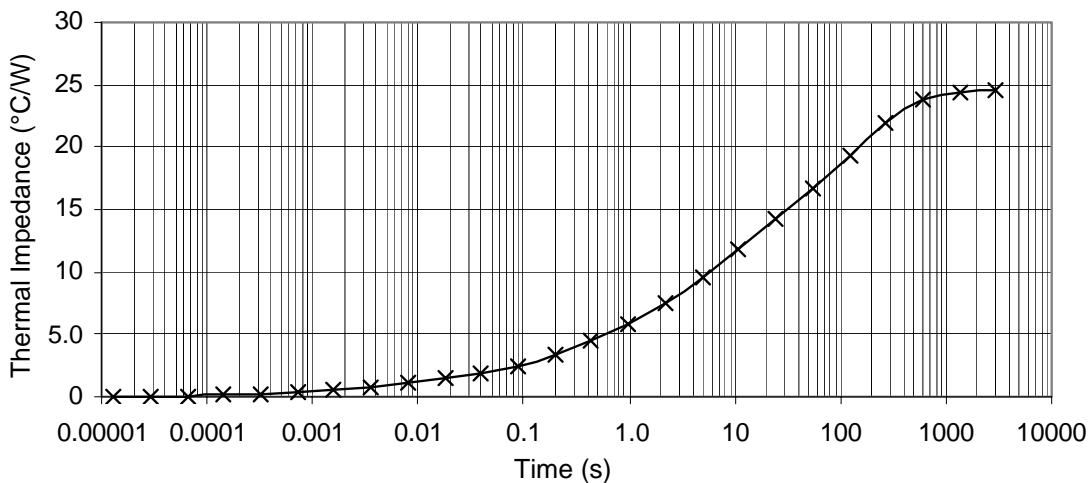
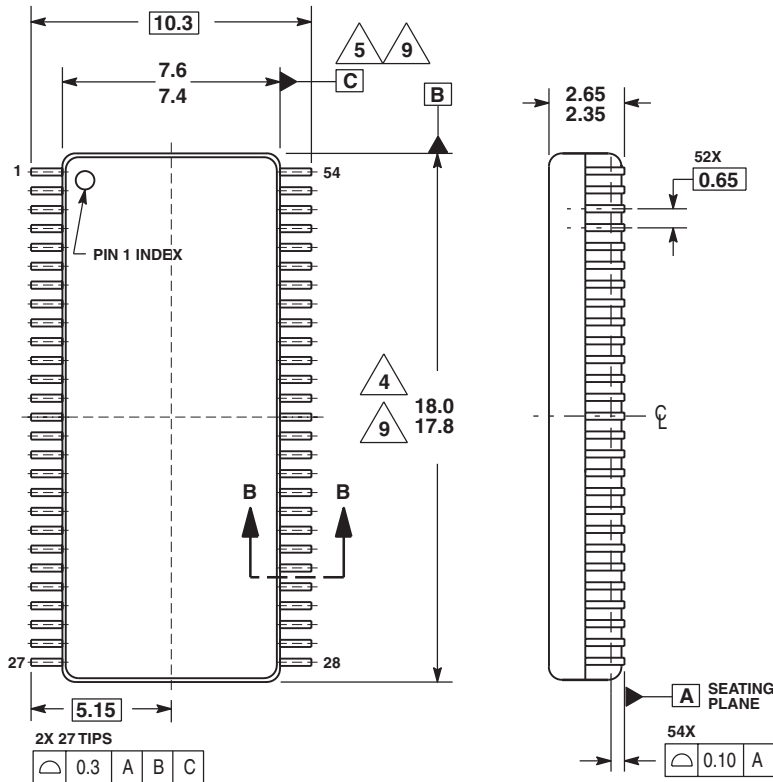


Figure 13. Thermal Response of H-Bridge Driver with Package Soldered to a JEDEC PCB Board

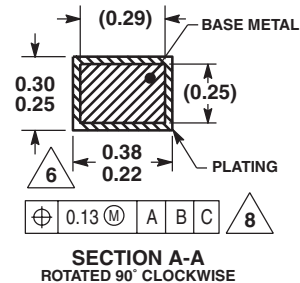
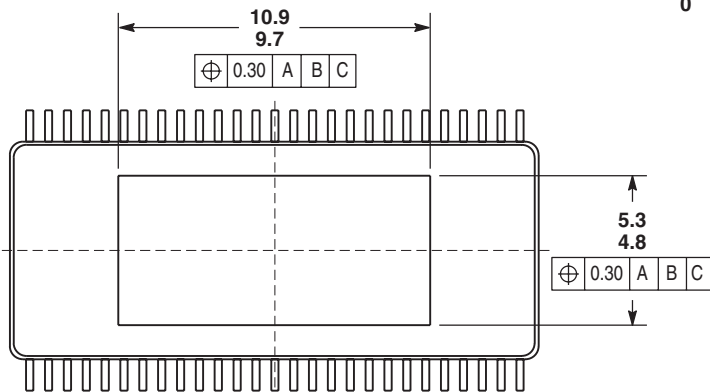
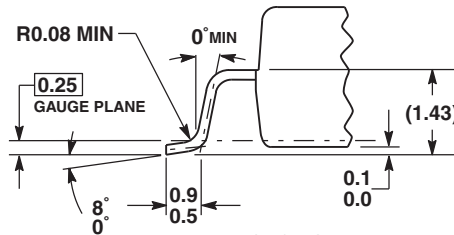
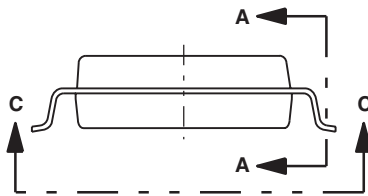
## PACKAGE DIMENSIONS

**DWB SUFFIX**  
**54-TERMINAL SOIC WIDE BODY EXPOSED PAD**  
**PLASTIC PACKAGE**  
**CASE 1400-01**  
**ISSUE B**



**NOTES:**

1. DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
3. DATUMS B AND C TO BE DETERMINED AT THE PLANE WHERE THE BOTTOM OF THE LEADS EXIT THE PLASTIC BODY.
4. THIS DIMENSION DOES NOT INCLUDE MOLD FLASH, PROTRUSION OR GATE BURRS. MOLD FLASH, PROTRUSION OR GATE BURRS SHALL NOT EXCEED 0.15 MM PER SIDE. THIS DIMENSION IS DETERMINED AT THE PLANE WHERE THE BOTTOM OF THE LEADS EXIT THE PLASTIC BODY.
5. THIS DIMENSION DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS. INTERLEAD FLASH AND PROTRUSIONS SHALL NOT EXCEED 0.25 MM PER SIDE. THIS DIMENSION IS DETERMINED AT THE PLANE WHERE THE BOTTOM OF THE LEADS EXIT THE PLASTIC BODY.
6. THIS DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL NOT CAUSE THE LEAD WIDTH TO EXCEED 0.46 MM. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSION AND ADJACENT LEAD SHALL NOT BE LESS THAN 0.07 MM.
7. EXACT SHAPE OF EACH CORNER IS OPTIONAL.
8. THESE DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN 0.1 MM AND 0.3 MM FROM THE LEAD TIP.
9. THE PACKAGE TOP MAY BE SMALLER THAN THE PACKAGE BOTTOM. THIS DIMENSION IS DETERMINED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY EXCLUSIVE OF MOLD FLASH, TIE BAR BURRS, GATE BURRS AND INTER-LEAD FLASH, BUT INCLUDING ANY MISMATCH BETWEEN THE TOP AND BOTTOM OF THE PLASTIC BODY.



NOTES

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