62EM1-Programmable 62mm Electrical Series

Optimized for Silicon Carbide (SiC) MOSFET Modules

Overview

The AgileSwitch 62EM1-62mm Electrical driver provides monitoring and fault reporting information to enable better control and analysis of an SiC MOSFET-based power systems. The 62EM1 provides up to 20 Amps of peak current at an operating frequency up to 125 kHz. The driver includes isolated HI and LO Side DC/DC converters and provides 7 fault conditions that are reported as a combination of the 3 fault lines via the 20 pin control header. All AgileSwitch drivers use automotive temperature grade components and allow for modifying settings of gate resistors.

Software Programmable Features

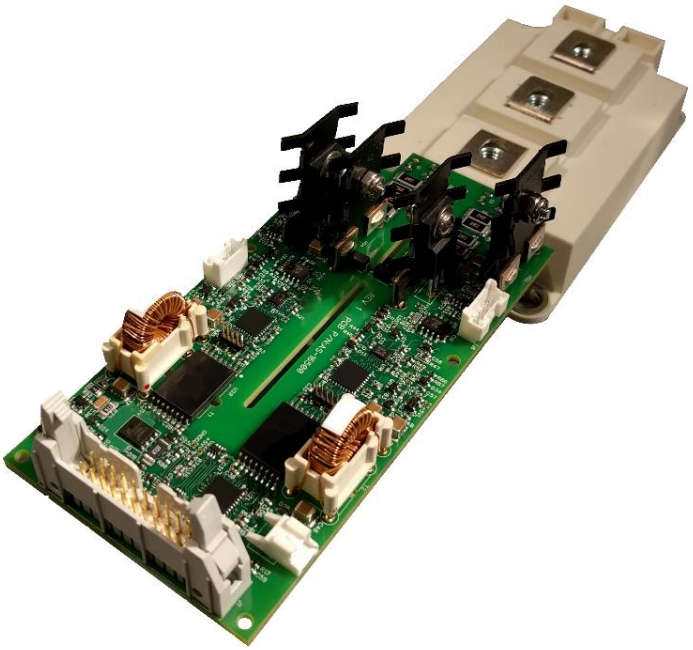
- Augmented Turn-Off™ (ATOff) (Patented)
- Power supply under-voltage lockout (UVLO)
- Power supply over-voltage lockout (OVLO)
- Desaturation detection settings
- Dead time
- Fault lockout settings
- Automatic Reset settings

Key Switch Driver Features

- UL Complaint - 1200V & 1700V SiC
- Temperature Monitoring, PWM
- Isolated High Voltage Monitoring, PWM
- 2 X 10W output power
- RoHs compliant
- Configurable Gate Output Voltages
- Single-ended/Differential Logic (5V, 15V)
- 7 Unique Fault Conditions

Applications

- Solar/PV inverters
- Wind Turbines
- UPS
- HEV/EV
- Motor Drives
- High Speed Trains/Traction
- Induction Welding, Cutting and Heating
- Frequency Conversion



System Overview

The basic topology of the driver is shown in Figure 1.

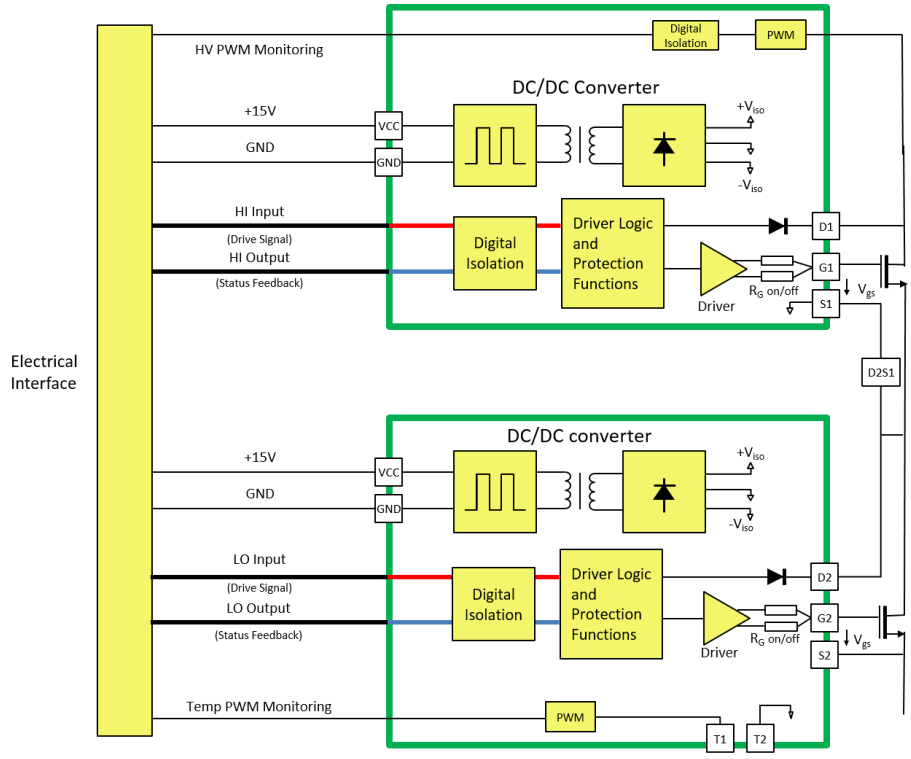


Figure 1: Basic schematic of the 62EM1-62mm Electrical Gate Driver

Absolute Maximum Ratings

Interaction of maximum ratings is dependent on operating conditions

Parameter	Description	Min	Max	Unit
Supply Voltage	VCC to GND	0	18	V
Peak Gate Current	Note 1	-20	20	A
Input Logic Levels	To GND	-0.5	16	V
Output Power per Gate			10.0	W
Switching Frequency	Note 2		125	kHz
Isolation Voltage	Primary to Secondary VAC RMS 1 min		4500	V
Working Voltage	Primary to Secondary, Secondary to Secondary		1200/1700	V
Creepage Distance	Primary to Secondary Side	12		mm
dV/dt*	Rate of change input to output	100		kV/µs
Operating Temperature	Ambient Operating Temperature	-40	+105	°C
Storage Temperature		-40	+90	°C

Electrical Characteristics

Conditions: V_{SUP} = +15.0 V, V_{IN_LOGIC} = 15V or 5V

Power Supply	Description	Min	Typ	Max	Unit
Supply Voltage	VCC to GND	14	15	16	V
Supply Current	Without Load		110		mA
Average Supply Current	Note 3			625	mA
UVLO Level-HI and LO*	Primary Side low voltage detect fault level	13.5	14		V
UVLO Level-HI and LO*	Secondary Side low voltage detect fault level, Note 3	20			V
OVLO Level-HI and LO*	Primary Side high voltage detect fault level		16	16.5	V
V_{SOFT}*	2-Level Turn Off, Note 3		4.75		V
$V_{soft}D1$*	DSAT 1st Level Turn Off Voltage, Note 3		13		V
$V_{soft}D2$*	DSAT 2nd Level Turn Off Voltage, Note 3		7		V

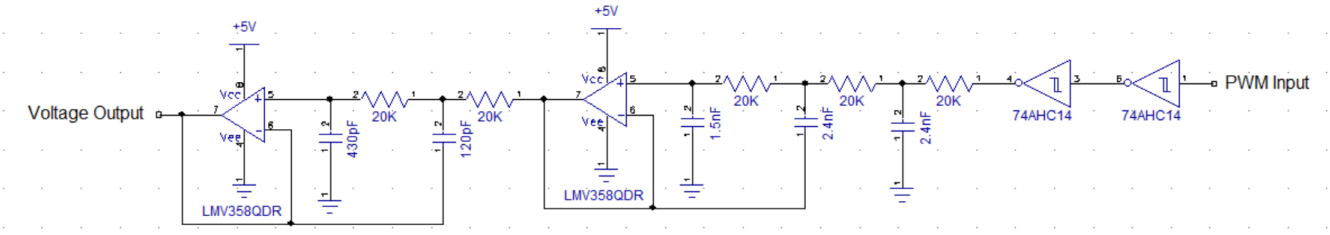
Logic Signal	Description	Min	Typ	Max	Unit
Input Impedance	5V - HI and LO side input level		1		kΩ
	15V - HI and LO side input level		3		kΩ
V_{IN} Low	Turn off threshold			1	V
V_{IN} High	Turn on threshold	2.5			V
Gate Output Voltage Low	Note 3	-6		-4	V
Gate Output Voltage High	Note 3	+17		+21	V
Fault Output Voltage	Fault lines are open collector	0.5			V
Fault Output Current	Note 4			10	mA
Switching Frequency	Note 2			125	kHz
HV & Temp Monitoring	High Voltage (HV) & Temp Monitoring Output	0		5	V
HV & Temp Monitoring	PWM Frequency		31.5		kHz
HV & Temp Monitoring	Output Impedance		510 1%		Ω

MOSFET Short Protection	Description	Min	Typ	Max	Unit
Desat Monitor Voltage*	Between Drain and Sink of MOSFET, Note 3		9.0		V
T_{DSAT}*	Activation after MOSFET Turn on		3.0		µs
Response Time after Fault				200	ns

Note 1: Input signal should not be activated until 40 ms after power is applied to allow on board DC-DC converter to stabilize.
Note 2: Actual maximum switching speed is a function of gate capacitance.
Note 3: SiC MOSFET dependant
Note 4: Fault lines are open collector and require a pull-up resistor, 2KΩ recommended
* Software configurable parameter

Temperature and High Voltage PWM Monitoring: The AgileSwitch 62EM1 Driver provides two 31.5 kHz, 5.0V PWM output signals that monitor the thermistor temperature (non-isolated) and the DC Link Voltage(isolated) (High Side drain to Low Side source) of the SiC MOSFET power module. The PWM signals have an output impedance of 510Ω. When combined with an external low pass filter, these signals represent a real time, isolated voltage for both High Voltage and Thermistor Temperature. A Sallen-Key active low pass filter can be used with these outputs as shown below with a 2 kHz cut-off frequency. The cut-off frequency can be optimized for your application. For simplicity, a simple RC low pass filter with 100 Hz cut-off frequency can also

Figure 2: Example of external 2 kHz low pass filter



be used.

Interconnects

Controller/Power to Driver Connectors

Connector	Type	Manufacturer Part Number
Mating Ribbon Cable	20 Pins	FCI 71600-120LF
Driver Board	20 Pins	FCI 71918-220LF

Master to Slave Driver Connectors (Optional – Please specify if required, otherwise not populated)

Connector	Type	Manufacturer Part Number
Driver Board	5 Pin	JST B05B-PASK-1
Cable Assembly	5 Pin	JST PAP-05V-S
Driver Board	4 Pin	JST B04B-PASK-1
Cable Assembly	4 Pin	JST PAP-04V-S

Pinout – Controller/Power to Driver Connection

Pin No	Signal	Pin No	Signal
1	VCC – +15V Supply Voltage	2	GND
3	VCC – +15V Supply Voltage	4	GND
5	VCC – +15V Supply Voltage	6	GND
7	VCC – +15V Supply Voltage	8	GND
9	HI-F – HI-Fault	10	GND
11	HI-D (+) HI Drive In (+)	12	HI-D (-) HI Drive In (-) or GND
13	LO-F - LO Fault	14	GND
15	LO-D (+) LO Drive In (+)	16	LO-D (-) LO Drive In (-) or GND
17	AL-F – All Faults (Low when HI-F or LO-F)	18	HV-P – Isolated High Voltage Monitoring
19	F-RS – Fault Reset (Auto Reset Optional)	20	TE-P – Temperature Monitoring

Recommended Interface Circuitry

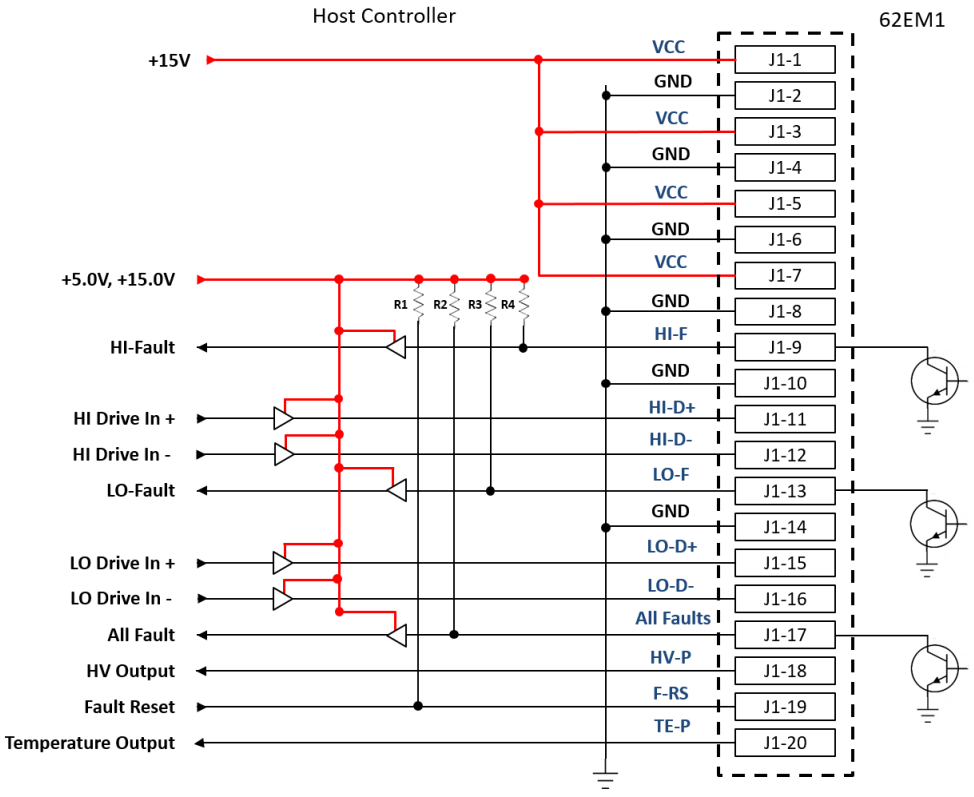


Figure 3: 20 pin pinout diagram for 62EM1-62mm Electrical Gate Driver

Buffer Schematic – Single Ended Inputs

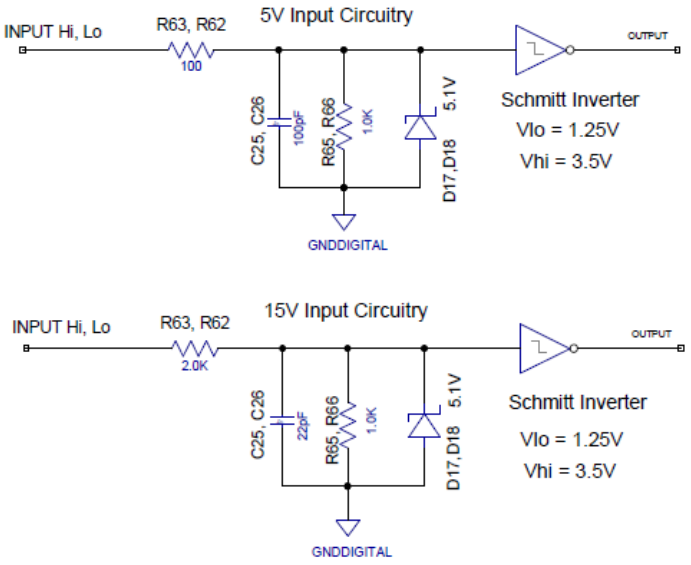


Figure 4: Input buffer schematics for 5V and 15V logic

Buffer Schematic – Differential Inputs

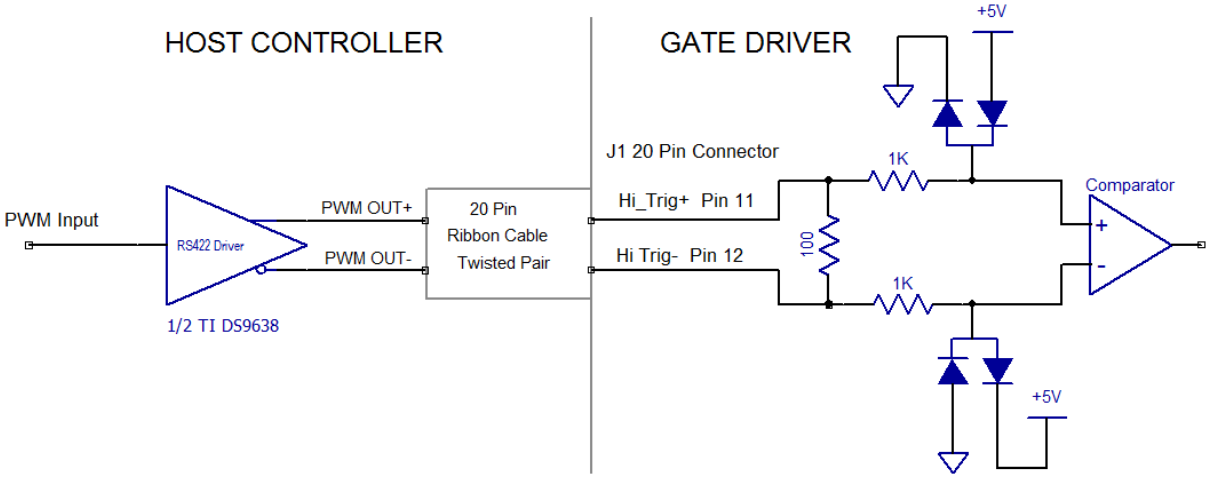


Figure 5: Input buffer schematic - differential inputs

Timing Diagrams

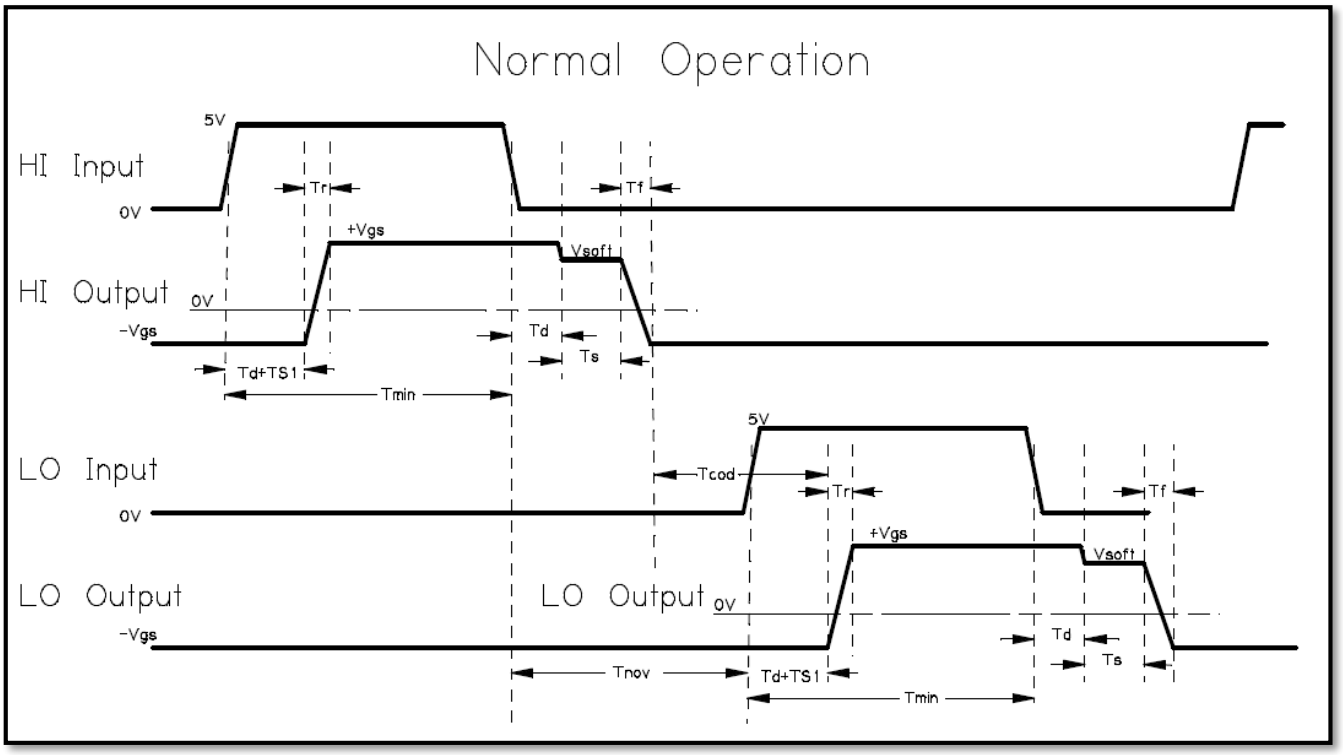


Figure 6: Signal input and output timing diagram.

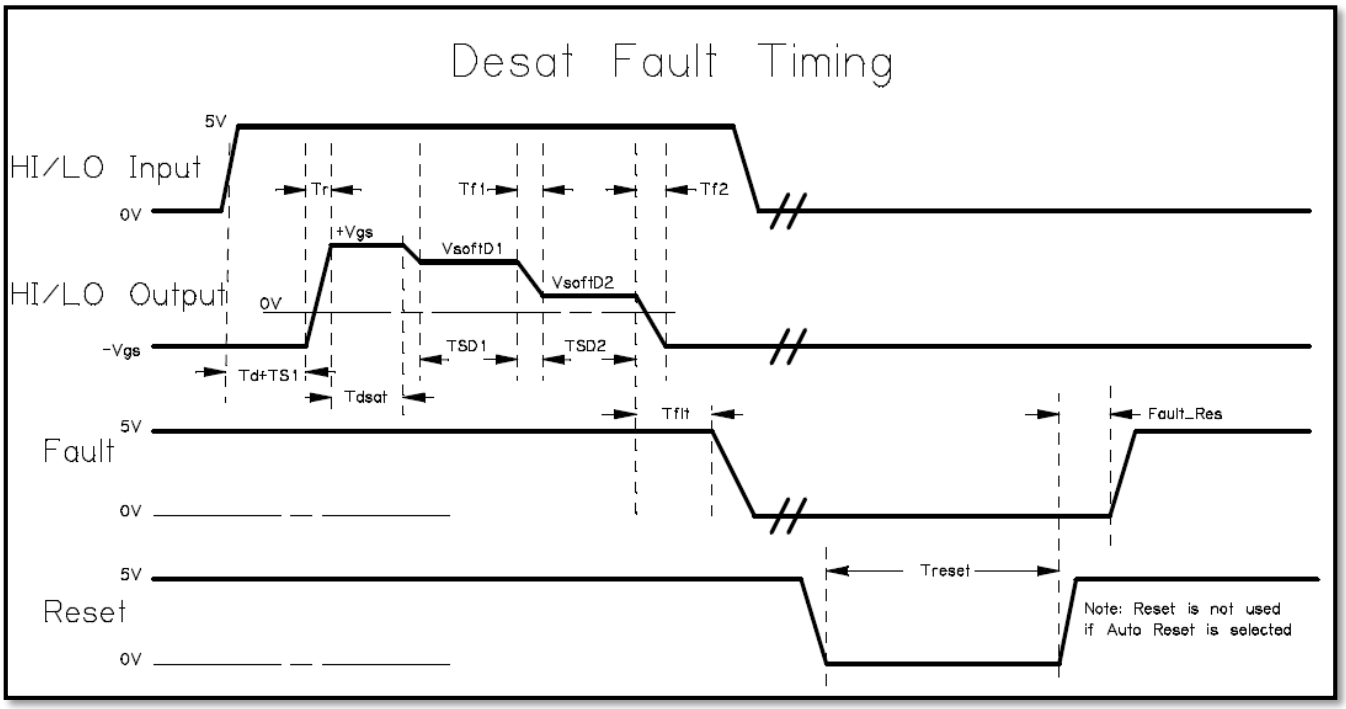


Figure 7: Signal desaturation and fault timing diagram.

Timing Diagram Values

Conditions: V_{SUP} = +15.0 V, Temp = 0 ºC to 85 ºC

Description	Symbol	Min	Typ	Max	Unit	Notes
Minimum Pulse Width	T_{MIN}	1000			ns	
Delay Time	T_D			250	ns	
Rise Time	T_R		80		ns	Measured from 10% to 90% points on edge Measurement Point 1
Fall Time	T_F		90		ns	Measured from 10% to 90% points on edge Measurement Point 2
2-Level Turn-Off Time	T_{S1}		TBD		ns	Software configurable
Desaturation Time	T_{DSAT}	2800	3000	3200	ns	Software configurable
Vsoft D1*	1st DSAT V		13		V	Multi-Level Turn-Off – First DSAT Step
Vsoft D2*	2nd DSAT V		7		V	Multi-Level Turn-Off – Second DSAT Step
First DSAT Time	TSD1		2000		ns	First DSAT 2-level turn-off time
Second DSAT Time	TSD2		4000		ns	Second DSAT 2-level turn-off time
First DSAT Fall Time	Tf1		50		ns	
Second DSAT Fall time	Tf2		50		ns	
Fault Time Delay	T_{FLT}		150	200	ns	
Fault Reset	Fault_Res		1000		ns	
Dead Time - Input	T_{NOV}		1000		ns	Recommended Minimum Time between Inputs
Dead Time – Driver	T_{cod}	1000			ns	Minimum Time between drive signals allowed by driver, software configurable
Reset Timing	T_{reset}	1000			ns	Minimum Reset Time
Automatic Reset (Optional)			5		ms	Standard setting of 5 ms

*Note 3

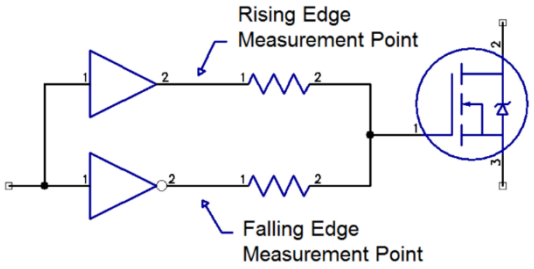


Figure 8: Measurement points for rise and fall time.

Temperature Monitor

The following Chart describes the Temperature Monitor Output Voltage vs. Thermistor Temperature. The linear equation is:

$$T[C°] = TBD$$

*Contact AgileSwitch for detail for Temperature Output Voltage Output. The Thermistor Pin1 is pulled up to +5V with a 1.33KΩ resistor

DC Link Voltage Monitor

The DC Link (HI Side drain to LO Side source) Monitor Output Voltage is 1% accurate from 25V to 975V. The linear equation for the Voltage Monitor PWM Output with a 2 KHz 4 pole filter is:

$$V_{DC}[V] = 200\ X\ Vmonitor$$

Generic Sample Factory Settings

1. TBD

Fault and Monitoring Conditions

AgileSwitch drivers are designed to provide safe, secure and efficient operation of the SiC MOSFET power module, as well as to provide unparalleled information on the condition of the overall system.

Generic samples are set at the factory to perform certain actions (e.g. turn off the HI side or LO side of the SiC MOSFET) and to report that a fault occurred based on performance parameters that occur outside of default ranges. Certain parameters are software configurable. Please contact AgileSwitch for details.

Fault Condition/Action	Generic Sample Default Trigger Values	Action on IGBT if Active (Default Setting)	HI Fault	LO Fault	All Faults
NO FAULTS			HIGH	HIGH	HIGH
UVLO – HI	See Electrical Characteristics	Turn Off HI & LO Side	LOW	HIGH	HIGH
UVLO – LO	See Electrical Characteristics	Turn Off HI &LO Side	HIGH	LOW	HIGH
OVLO	See Electrical Characteristics	Turn Off HI & LO Side	HIGH	HIGH	LOW
Desat – HI	See Electrical Characteristics	Turn Off HI & LO Side	LOW	HIGH	LOW
Desat – LO	See Electrical Characteristics	Turn Off HI & LO Side	HIGH	LOW	LOW
Temperature Fault	125 °C Thermistor Monitor	No Action	LOW	LOW	HIGH
DC Link Voltage Fault	DC Link Voltage above or below setting	Turn Off HI & LO Side	LOW	LOW	LOW

Note: All of the above fault threshold values are software programmable

Important Precautions

Caution: Handling devices with high voltages involves risk to life. It is imperative to comply with all respective precautions and safety regulations.

When installing the ribbon cable, please make sure that power is turned off. Multi-signal values are sent along this ribbon cable, thus hot swapping may cause damage to the IC components on the board.

AgileSwitch assumes that the gate drive board has been mounted on the SiC MOSFET prior to start-up testing. It is recommended that the user checks that the SiC MOSFET power modules are operating inside the Specified Operating Area (SOA) as specified by the module manufacturer including short circuit testing under very low load conditions.

Recommended Start-Up Testing

1. Connect the driver through the 20 pin control header to your drive electronics and supply the driver with +15V.
2. Send the fault reset pin, pin 19, a low signal. Return pin 19 to a high condition. (If Auto Reset is selected, you may ignore this step.)
3. Check the gate voltage:
   a) For the off-state, the nominal gate voltage should be -6V to -4V. (Note 3)
   b) For the on state, it is +17 to +21V. (Note 3)
   c) Check that the supply current of the driver is within spec with inactive trigger signals and then at the desired switching frequency.
4. The system is now ready for application testing under load conditions.
5. Check thermal conditions to verify that the system is operating within specified temperature range.
6. Do NOT apply High Voltage to the SiC Module without first applying power to the GDB.

Mechanical Dimensions

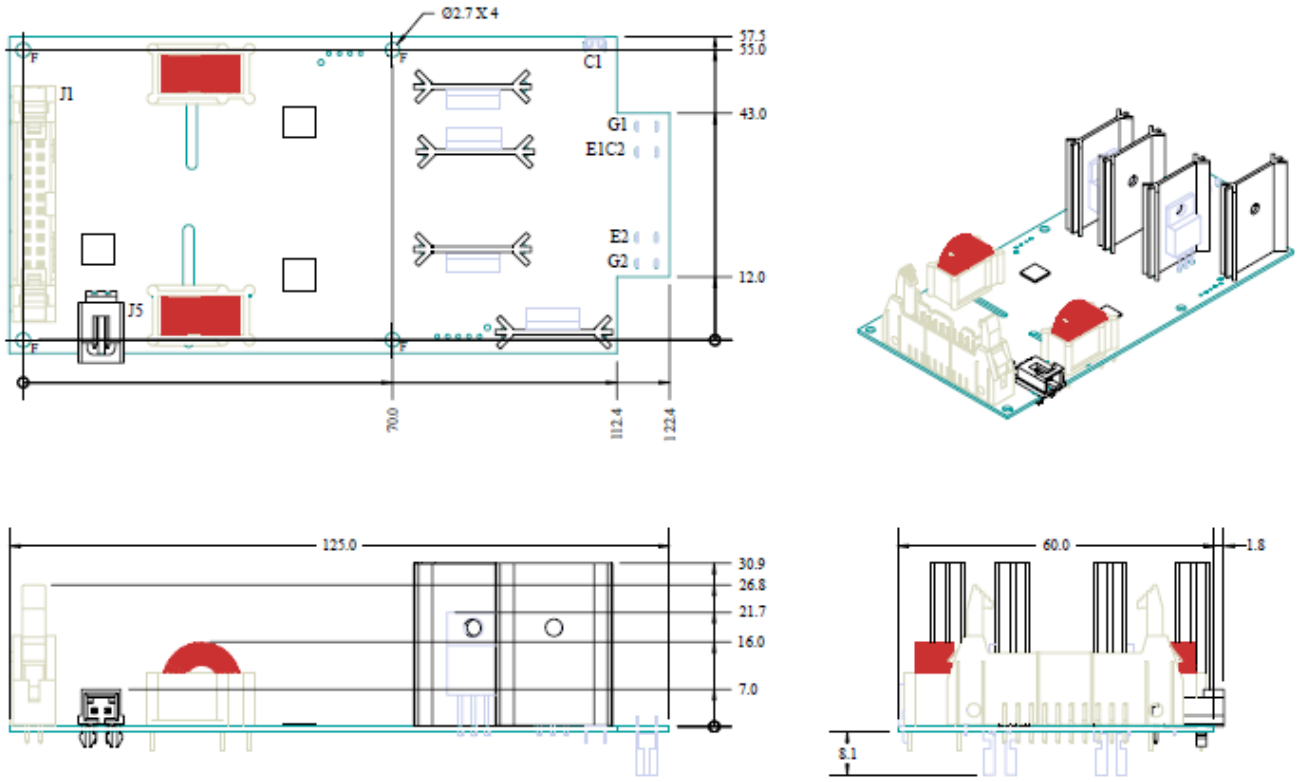


Figure 9: Dimensions of the 62EM1-62mm Electrical Gate Driver (+/- 0.1mm)

Dimensions are in mm.

Download the full drawing and model for additional details. Not all components are shown.
62EM1 Drawing
62EM1 .STEP Model

Revisions

Prepared By	Approved By	Version	Date	Description
N. Satheesh A. Fender	A. Charpentier	01	10/14/2016	Preliminary Release
N. Satheesh		02	10/24/2016	Added Patent Number

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Patent Notices

Offering	Issued U.S. Patent Numbers
AgileStack™ Power Stack	8,984,197
Gate Drivers for WBG Power Semiconductors	9,490,798
Additional Patents Pending	

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