

# HPFM-HPM™ Fiber Series

## Overview

The AgileSwitch HPFM-HPM Fiber driver provides monitoring and fault reporting information to enable better control and analysis of an IGBT-based power system. The HPFM provides up to 30 Amps of peak current at an operating frequency up to 15 kHz. The driver includes an isolated DC/DC converter and provides a single fault that is reported via the dual channel fiber I/O. All AgileSwitch drivers use automotive temperature grade components and allow for modifying settings of gate resistors and active clamping.

## Key Switch Driver Features

- 2-level turn-off time and voltage level
- Soft Shut Down (SSD) time and voltage level
- Desaturation time and voltage level
- Master-Slave capability for parallel operation
- Gate drive voltage +15V/-10V
- Peak gate current +/-30A
- Suitable for IGBTs up to 3300V
- Power supply under-voltage lockout (UVLO)
- 1 X 7W output power

## 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.

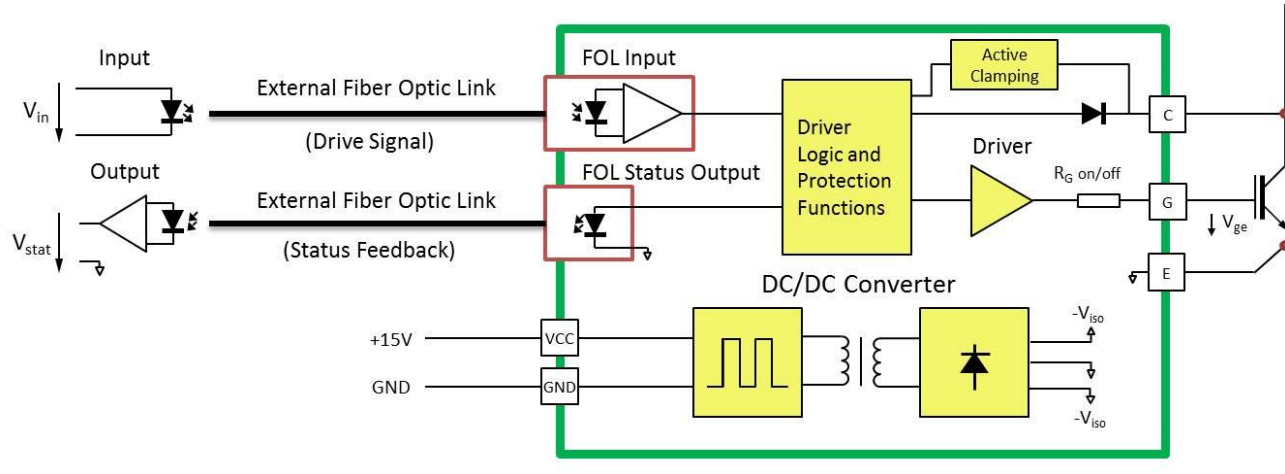


Figure 1: Basic schematic of the HPFM-HPM IGBT driver

## 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	-30	+30	A
Output Power per Gate			7.0	W
Switching Frequency	Note 2	0	15	kHz
Isolation Voltage	Primary to Secondary VAC RMS 1 min		6000	V
Working Voltage	Primary to Secondary, Secondary to Secondary		3800	V
Creepage Distance	Primary to Secondary Side	25		mm
$dV/dt$	Rate of change input to output		50	kV/ $\mu$ s
Operating Temperature		-40	+85	$^{\circ}$ C
Storage Temperature		-40	+90	$^{\circ}$ C

## Electrical Characteristics

Conditions:  $V_{SUP} = +15.0\text{ V}$

Power Supply	Description	Min	Typ	Max	Unit
Supply Voltage	VCC to GND	14.5	15	16	V
Supply Current	Without Load – Note 3		90	110	mA
Average Supply Current	Note 3		170		mA
UVLO Level	Secondary Side low voltage detect fault level	12	12.8	13.5	V
UVLO Shut down	Gate Drive Lock Out	8.8	9.0	9.3	V
Soft Shut Off Voltage( $V_{SOFT}$ )		8.2	8.6	9.0	V

Logic Signal	Description	Min	Typ	Max	Unit
Gate Output Voltage Low		-9	-10	-12	V
Gate Output Voltage High		+14	+15	+16	V
Switching Frequency	Note 2		3	15	kHz

IGBT Short Protection	Description	Min	Typ	Max	Unit
Desat Monitor Voltage	Between Collector and Emitter of IGBT		9		V
$T_{DSAT}^*$	Activation after IGBT Turn on		6.1		$\mu\text{s}$
Response time after Fault			450	500	ns

**Note 1:** Input signal should not be activated until 20 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:** Supply Current with load of  $1.0\ \Omega$  and  $180\text{ nF } C_{INPUT} + 6,000\text{ nC}$  dynamic gate charge at an operating frequency of 5 kHz.

## Interconnects

### Controller/Power to Driver Connectors - Standard

Connector	Type	Manufacturer Part Number
Mating Ribbon Cable	4 Pin	TE Connectivity 104257-3
Driver Board	4 Pin	TE Connectivity 5-103635-3

### Controller/Power to Driver Connectors (Optional - Please specify if required. Replaces Standard)

Connector	Type	Manufacturer Part Number
Mating Ribbon Cable	4 Pin	ERNI 224398
Driver Board	4 Pin	ERNI 214012
Cable Assemblies	Cable	ERNI 839016 (100 mm, terminated at both ends) Contact ERNI for custom cable length

### PINOUT

Pin No	Signal
1	GND
2	VCC – +15V Supply Voltage
3	VCC – +15V Supply Voltage
4	GND

### Recommended Interface Circuitry Power to Driver Connectors

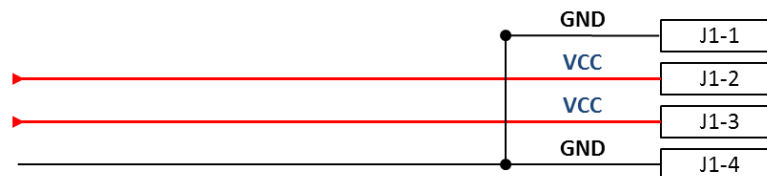


Figure 2: HPFM Power Connector 4-Pin

### ERNI Cable and Connector Ordering Information

#### North America, Canada and Mexico

ERNI Electronics, Inc.  
 2201 Westwood Ave  
 Richmond, VA 23230  
 USA  
 Tel. +1 804 228-4100  
[info@erni.us](mailto:info@erni.us)

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 Tel. +49 7166 50-0  
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 Singapore 569625  
 Tel. +65 6555 5885  
[info@erni-asia.com](mailto:info@erni-asia.com)

## Interconnects

### Controller to Driver Connectors

Connector	Type	Manufacturer Part Number
Fiber Cable	Fiber	Avago HFBR-4516Z
Driver Board Output	Fiber	Avago HFBR-1522ETZ
Driver Board Input	Fiber	Avago HFBR-2522ETZ

### Master to Slave Connectors (Optional - Please specify if required, otherwise not populated)

Connector	Type	Manufacturer Part Number
Ribbon Cable	5 Pin	TE Connectivity 5-103635-4
Driver Board	5 Pin	TE Connectivity 104257-4

## Timing Diagrams

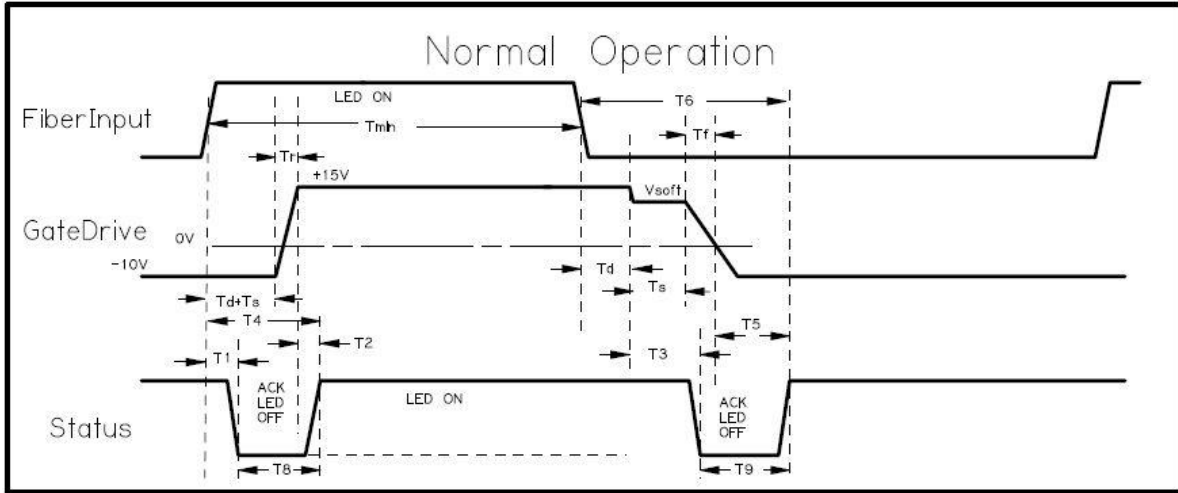


Figure 3: Signal input and output timing diagram

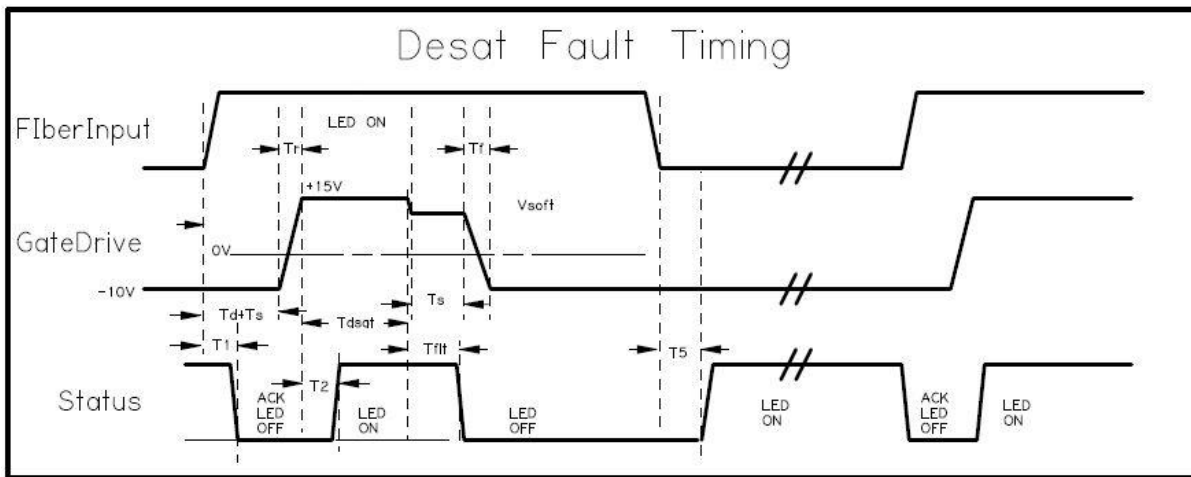


Figure 4: Signal fault timing diagram for Desat.

Note: Application of the Fiber Input to low (LED Off) will clear the Fault signal. If a Desat condition reoccurs the Status/Fault signal will go low again.

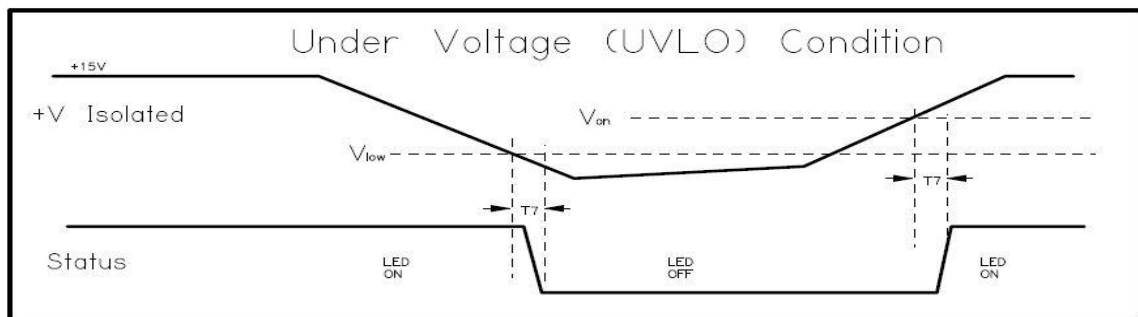


Figure 5: Signal fault timing diagram for UVLO.

Note: Status/Fault Signal will remain low until +V isolated is above specified voltage range of the UVLO Fault. Gate Drive Signal will continue to occur until +V isolated falls below specified voltage range of UVLO Shut Down.

## Timing Diagram Values

Conditions:  $V_{CC} = +15.0\text{ V}$ ,  $\text{Temp} = -40\text{ }^{\circ}\text{C}$  to  $85\text{ }^{\circ}\text{C}$ ,  $R_{g(\text{on})} = 1.5\ \Omega$ ,  $R_{g(\text{off})} = 3.0\ \Omega$

Description	Symbol	Min	Typ	Max	Units	Notes
Minimum Pulse Width	$T_{\text{MIN}}$	3000			ns	
Delay Time	$T_{\text{D}}$	420	450	480	ns	
Soft Turn Off Time	$T_{\text{S}}$	400	450	500	ns	
Rise Time (no load)	$T_{\text{R}}$		50	60	ns	Measured from 0V to 10V at $R_{g\text{ON}}$
Rise Time (with load)	$T_{\text{R}}$		600	650	ns	Measured from 0V to 10V at $R_{g\text{ON}}$ . Timing will vary based on IGBT selection
Fall Time (no load)	$T_{\text{F}}$		30	60	ns	Measured from $V_{\text{soft}}$ to 0V at $R_{g\text{OFF}}$
Fall Time (with load)	$T_{\text{F}}$		350	400	ns	Measured from $V_{\text{soft}}$ to 0V at $R_{g\text{OFF}}$ . Timing will vary based on IGBT selection
Fiber Input (LED On) to Status Ack (LED Off) Delay	$T_1$		700	800	ns	Measured directly from Fiber Input receiver midpoint to Status Ack (LED Off)
Gate Drive On to Status Ack (LED On) Delay	$T_2$	700	750	800	ns	Measured from Gate Drive ( $V_{\text{th}}$ ) to Status Ack (LED On)
Soft Turn Off to Status Ack (LED Off) Delay	$T_3$		150	200	ns	Measured from beginning of $V_{\text{soft}}$ to Status Ack (LED Off).
Fiber Input (LED On) to Status Ack (LED On) Delay	$T_4$	2250	2500	2750	ns	Measured directly from Fiber Input receiver (LED On) midpoint to Status Ack (LED On)
Gate Drive Off to Status Ack (LED On) Delay	$T_5$	400	500	600	ns	Measured from Gate Drive at 0V to top of Status Ack (LED On)
Fiber Input (LED Off) to Status Ack (LED On) Delay	$T_6$	2600	2700	2800	ns	Measured directly from Fiber Input receiver midpoint to Status Ack (LED On).
Under Voltage Output Delay Time	$T_7$		1000	1500	ns	
Status Acknowledge Signal Width (Gate Drive On)	$T_8$	1650	1850	2050	ns	Measured at midpoints. Actual width of the Acknowledge Signal (LED OFF) is a function of the actual gate capacitance of the HPM IGBT (gate drive rise and fall times).
Status Acknowledge Signal Width (Gate Drive Off)	$T_9$	1900	2100	2300	ns	Measured at midpoints. Actual width of the Acknowledge Signal (LED OFF) is a function of the actual gate capacitance of the HPM IGBT (gate drive rise and fall times).
Desaturation Time	$T_{\text{DSAT}}$	5700	6100	6300	ns	Variable dependent on resistor value
Desaturation Fault Status Delay Time	$T_{\text{FLT}}$		250	300	ns	

## Generic Sample Factory Settings

1. The default equivalent gate resistance for the driver is 1.5  $\Omega$  ( $R_{GON}$ ), 1.5  $\Omega$  ( $R_{GOFF}$ ). This is a safe value for all supported IGBT modules. For optimum performance, the equivalent gate resistance may be changed from 3.0  $\Omega$  up to 10.0  $\Omega$ .
2. Desaturation ( $T_{DSAT}$ ) monitoring is set for 6.1  $\mu s$ . This can be adjusted from 1 through 10  $\mu s$ . The voltage level can be configured to any whole number value between 7V to 13V. The default setting is 9V. If the voltage across the IGBT is greater than the set voltage level, a desaturation fault is detected and the IGBT is turned off and a fault signal is output. Please contact AgileSwitch for requested desaturation monitor time and voltage.

## Generic Sample Factory Settings – Fault and Monitoring Conditions

AgileSwitch drivers are designed to provide safe, secure and efficient operation of the IGBT 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 and to report that a fault occurred based on IGBT performance parameters that occur outside of default ranges.

Fault Condition/Action	Generic Sample Default Trigger Values	Action on IGBT (if Active)	Lockout	Fiber Output for Fault
UVLO Fault	See Electrical Characteristics	None	No	Light Off
UVLO Shut down	See Electrical Characteristics	Turn Off	Yes	Light Off
Desat	See Electrical Characteristics	Turn Off	No	Light Off
Active Clamping	950V (1200V IGBT) 1350V (1700V IGBT) 2500V (3300V IGBT)	Active Clamping Occurs	No	

## Fault/Status Reporting Information

When a UVLO or desaturation fault occurs, the fiber output status feedback is light off. The host controller will attempt to trigger the device when a fault occurs. If the fault clears, it was a DSAT, if it does not clear, it is a UVLO. The driver will perform normal triggering once the UVLO fault clears or is cleared. The UVLO fault does not need a trigger to clear.

### Fiber Connectors-Logic

Fiber Direction	Light On	Light Off
Input (Drive Signal)	On Command	Off Command
Output (Status Feedback)	No Fault	Fault



## 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 4 pin power/controller to driver connector, please make sure that power is turned off. Hot swapping is not recommended.**

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

## Recommended Start-Up Testing

1. Connect dual channel fiber I/O lines to the driver.
2. Connect the driver through the 4 pin power header to your drive electronics and supply the driver with +15V.
3. Check the gate voltage:
  - a. For the off-state, the nominal gate voltage should be -9V to -12V.
  - b. For the on state, it is +14V to +16V.
  - c. Check that the supply current of the driver is within spec with inactive trigger signals and then at the desired switching frequency.
3. The system is now ready for application testing under load conditions.
4. Check the Thermal Conditions to verify that the system is operating within the specified temperature range.

## Mechanical Dimensions

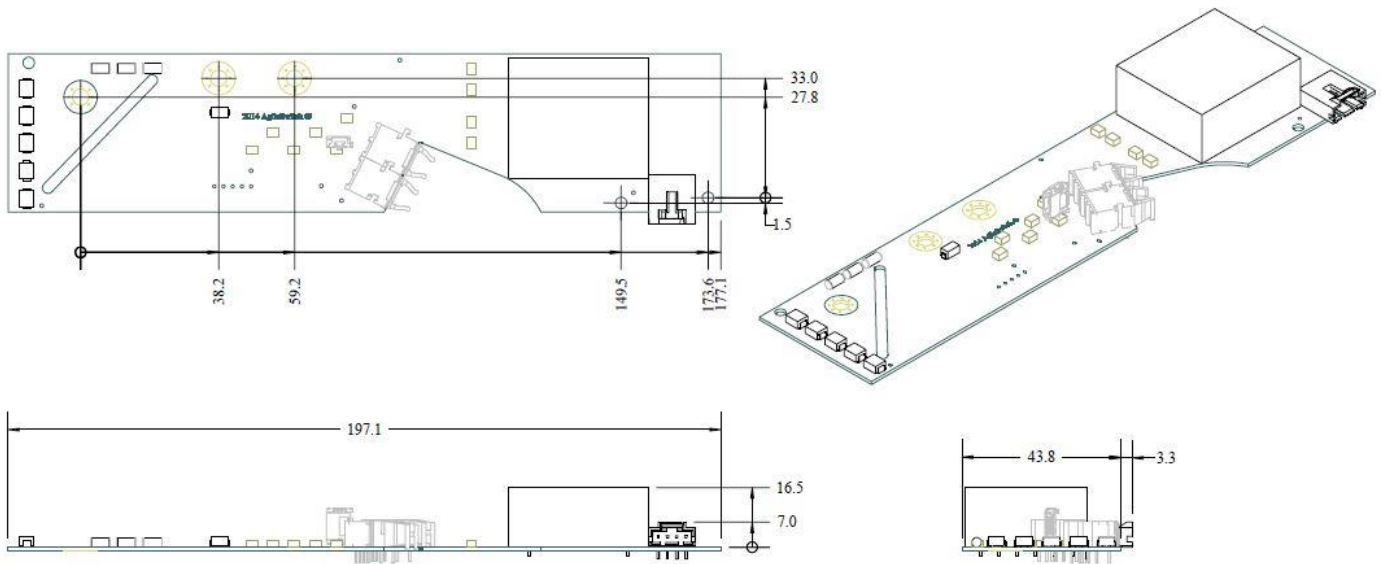


Figure 6: Dimensions of the HPFM-HPM Fiber Series IGBT driver (+/- 0.1mm)

Dimensions are in mm.

Download the full drawing and model on [AgileSwitch.com](http://AgileSwitch.com).

## Part Numbers & Configuration Details

Hardware Settings	Symbol	Part Number
Rgon (Turn-on Gate Resistance)	R <sub>GON</sub>	1.5 Ω
Rgoff (Turn-off Gate Resistance)	R <sub>GOFF</sub>	1.5 Ω
Active Clamping Level	-	1350V
Trigger Acknowledge	-	Enabled
DSAT Monitor Timing	T <sub>DSAT</sub>	6.1 μs
Soft Turn Off Time	T <sub>S</sub>	450 ns

For modification requests, please contact Microchip.

## Revisions

Prepared By	Approved By	Version	Date	Description
A. Fender	A. Charpentier	18	5/13/2015	PCB Rev 3
N. Satheesh	A. Charpentier	19	8/17/2016	Changed product image, peak current ratings
A. Fender	A. Fender	20	10/10/2016	Corrected mechanical dimensions
A. Fender		21	6/17/2020	Added Configuration Table, updated Legal

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Specifications are subject to change without notice.

## Patent Notices

Offering	Issued U.S. Patent Numbers
AgileStack™ Power stack control systems	8,984,197
Gate drive control system for SiC and IGBT power devices	9,490,798
Additional Patents Pending	

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