

# FAD1101A Evaluation Board User's Manual

## EVBUM2954/D

### Introduction

The FAD1101A evaluation board provides a compact and ready-to-use platform for demonstrating and testing the FAD1101A ignition gate driver. It integrates the driver IC together with an ignition IGBT and all required application components, enabling rapid evaluation of ignition-coil charging, current-limit behavior, dwell-time control, and the device's built-in diagnostic and protection functions.

The platform allows users to observe the FAD1101A's programmable maximum dwell-time supervision, implemented via an external capacitor on the Maxdwell pin. When this limit is exceeded, the device executes an immediate Hard-Shutdown (HSD), turning off the IGBT without entering a controlled soft-decay mode. This protects the ignition system against prolonged on-time and prevents overstress of the switching stage.

To ensure safe operation during ignition-level transient events, the PCB incorporates enhanced high-voltage isolation spacing based on automotive and IPC-2221A guidance. The evaluation board provides convenient access to key test nodes, enabling efficient measurement and analysis of the FAD1101A under realistic ignition operating conditions.

### Evaluation Board Features

- 12 V Battery-Level Supply Input
- Two Supply Connectors for Flexible Powering during Evaluation
- Input Connector for the Ignition Trigger (IGT) Signal
- Configurable Current-Limit and Current-Sense Network using the Vsense Input
- Supports Programmable Dwell-time Supervision and Hard-Shutdown (HSD) when Maxdwell is Exceeded
- LED Indicator showing Supply/Bias Voltage Status
- Oscilloscope Test Points on Key Signals (IN, OUTPUT, Vsense, Maxdwell, VBAT)
- Additional High-Voltage Isolation Spacing Implemented according to IPC-2221A for Safe Handling of Ignition-level Transients
- Header for Stacking Multiple Boards or Integrating into a Larger Evaluation Setup

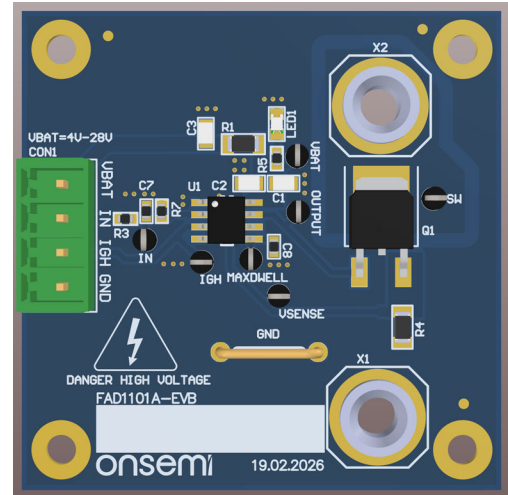
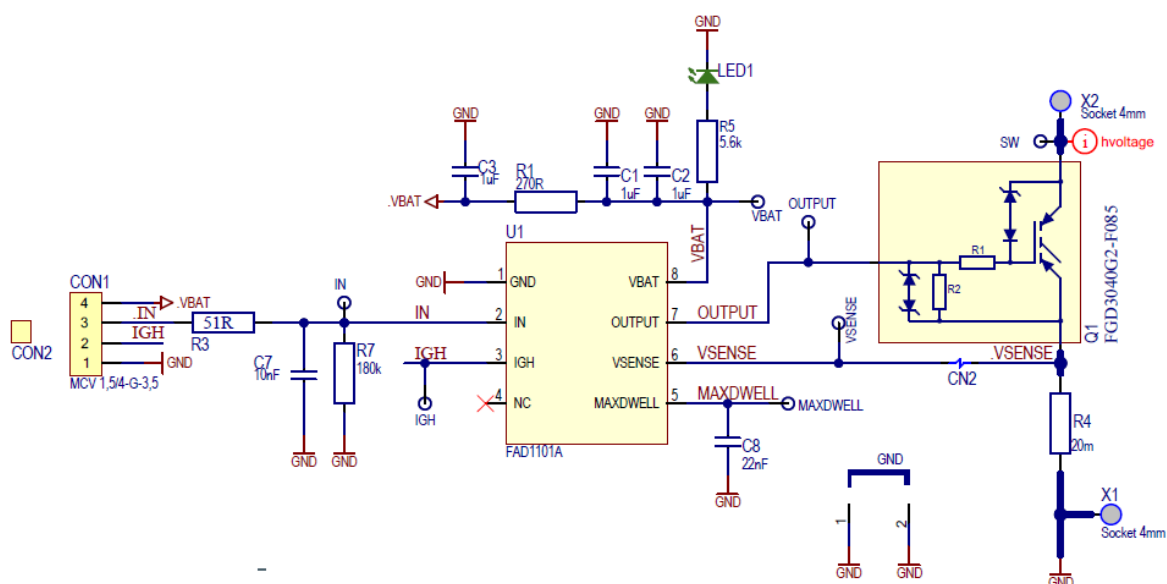


Figure 1. FAD1101A-EVB Board Picture

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**Figure 2. FAD1101A Evaluation Board Schematic**

## MAXIMUM RATINGS

Rating	External Pin	Min	Max	Unit
VBAT (CON1)	.VBAT	4,5	28	V
IN (CON1)	.IN	-2	18	V
Collector Voltage	X2	-400	400	V
Input Current	X2	0	Internally limited	A
IGH (CON1)	IGH	6	28	V
VMAXDWELL	VCSSD	-0.3	3.6	V
VOOUTPUT	VOOUTPUT	-0.3	6.5	V
VSENSE	VSENSE	0	400	mV
FAD1110 Junction Temperature		-50	+150	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

## RECOMMENDED OPERATING RANGES

Rating	External Pin	Min	Max	Unit
VBAT (CON1)	.VBAT	6	16	V
IN (CON1)	.IN (CON1)	0	5	V
Power Supply Voltage 2	VBATPOWER X2	0	60	V
Input Current	VBATPOWER X2	0	Pulse operation only	A
IGH (CON1)	IGH	6	16	V
VMAXDWELL	VCSSD	-0.3	3.6	V
VOOUTPUT	VOOUTPUT	-0.3	6.5	V
VSENSE	VSENSE	0	215	mV
FAD1110 Junction Temperature		-40	+125	°C

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

## FUNCTIONAL DESCRIPTION

The FAD1101A evaluation board provides a compact and complete platform for demonstrating the operation of the FAD1101A ignition gate driver. The board integrates the FAD1101A device together with an external ignition IGBT and the essential application circuitry required to evaluate ignition coil charging, collector current limiting via the VSENSE pin, programmable maximum dwell time, and the device's diagnostic and protection features.

The evaluation platform allows users to observe the maximum dwell control and Hard Shut-Down behavior of the FAD1101A, in which the IGBT is rapidly turned off when the programmed dwell time is exceeded or when an over-voltage condition is detected. This mechanism protects the ignition coil and the IGBT from excessive energy dissipation and fault conditions while ensuring predictable and safe operation.

The board also enables evaluation of the collector current flag (IGF) output, which provides real-time feedback of the IGBT collector current to an external controller, allowing verification of current threshold detection and diagnostic signaling. To support reliable operation under automotive ignition transient conditions, the PCB incorporates enhanced high-voltage isolation spacing in accordance with IPC-2221A design guidelines.

Overall, the FAD1101A evaluation board enables efficient characterization of the device under realistic automotive ignition conditions while providing safe access to critical test points and measurement signals for functional validation and system-level development.

### Supply Strategy

The power supply architecture is divided into three main paths:

- **VBAT supply (CON1)**

This path provides the primary supply voltage to the FAD1101A device. The VBAT pin powers the internal control circuitry and the gate driver output stage. The evaluation board incorporates protection circuitry that allows it to withstand accidental reverse polarity connection during laboratory handling or prototype testing. Proper local decoupling is implemented to ensure stable operation during switching activity and automotive supply transients.

- **IGH control input (CON1)**

The IGH signal on connector CON1 is biased from a 12 V source through a 10 k $\Omega$  series resistor. This arrangement provides a controlled logic-high drive while limiting the input current into the FAD1101A input circuitry during evaluation and laboratory testing.

- **X2 connector – Ignition coil / high-voltage node**

This path is connected directly to the primary winding of the ignition coil, or to an equivalent inductive load via the external ignition IGBT. During coil turn-off events, this node can experience overvoltage transients of up to approximately 500 V due to the release of stored

inductive energy. The PCB layout therefore incorporates extended creepage and clearance distances to safely tolerate these ignition-level voltage spikes.

- **X1 connector – Ground (GND)**

This path provides the direct connection to system ground (GND) and serves as the common reference point for the power supply and the ignition driver. It is routed with low impedance to ensure stable switching behavior and minimized conducted and radiated EMC emissions.

## GETTING STARTED

The CON1 connector serves as the primary power and signal interface for the FAD1101A-F085 ignition driver. The VBAT pin must be connected either to an external DC power supply, typically 12 V, or directly to the high-potential side of the ignition coil primary winding, depending on the selected system configuration. This arrangement allows the driver to control the coil using a low-side switching topology. The GND pin provides a common reference for both the power supply and the external control signal source. To ensure correct operation, accurate current sensing, and reduced electromagnetic interference, a short and low-impedance ground connection is required.

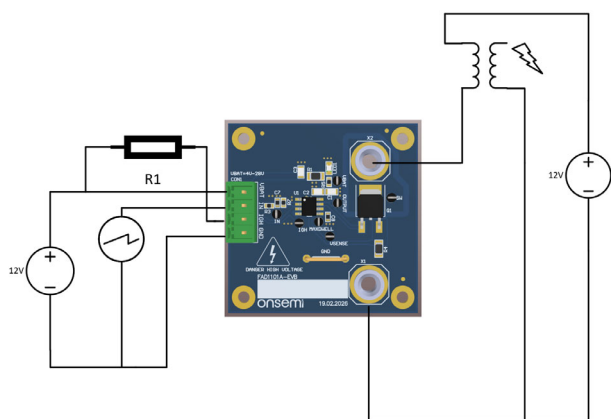
Ignition control is performed through the IN pin, which is the only control input of the device. An external pulse source such as an ECU, microcontroller, or laboratory function generator is connected to this pin. When a logic HIGH level is applied to the IN pin, the output of the driver is enabled, the power IGBT is turned on, and current begins to build up in the primary winding of the ignition coil. The duration of the active HIGH level, commonly referred to as the dwell time, directly determines the amount of energy stored in the coil and therefore the energy of the resulting ignition spark. Typical control pulse widths range from approximately 1 ms to 20 ms, with the maximum on-time limited by the internal Maxwell timer, which provides protection against excessive coil and switch stress. The IN pin also incorporates an internal spike filter with a typical suppression time of about 13  $\mu$ s to prevent unintended switching caused by short noise pulses.

The IGF pin, labeled IGH on the schematic, is a diagnostic output only and does not participate in ignition control. This pin is an open-drain output used to indicate the collector current level of the ignition IGBT. An external pull-up resistor to a logic supply, typically 5 V, is required for proper operation. In the shown circuit, **R1 with a value of 10 k $\Omega$**  serves as the pull-up resistor for the IGF output and enables monitoring of the ignition coil current state by an external control or measurement system. The IGF output signals when predefined current thresholds are reached, but it has no influence on turning the ignition on or off and must not be used as a control input.

The power output of the driver is routed to connector X2 and is intended for low-side switching of the lower end of the ignition coil primary winding. When the IN input is active,

the IGBT is turned on and the primary current rises, with the current magnitude controlled by the internal current-limiting function using the VSENSE pin. When the input signal is removed or when the Maxdwell protection is triggered, the IGBT is rapidly turned off, causing a fast interruption of the primary current. This interruption generates a high-voltage ignition pulse on the secondary winding of the transformer.

The FAD1101A-F085 is designed to operate with a wide range of ignition coils and other inductive loads. Typical supported primary inductance values range from approximately **500  $\mu$ H to 3 mH**, provided that all electrical, thermal, and current limits specified in the datasheet are respected to ensure reliable and safe operation.



**Figure 3. Application Schema for Ignition System**

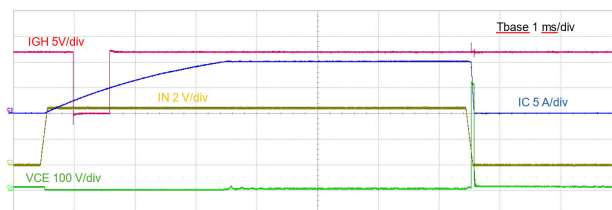
**Current Limit**

The FAD1100 ignition driver incorporates an internal current-limiting mechanism that is activated when the voltage at the **VSENSE** pin exceeds the internally defined reference threshold. The load current is monitored through the R4 sense resistor, across which a voltage proportional to the primary-side current is generated and fed into the VSENSE input. The resulting current limit value is therefore defined by the sense resistor value and the internal reference levels specified in the device datasheet.

As shown in the figure, once the sensed current reaches the configured limit threshold, the driver transitions into a controlled regulation mode by gradually reducing the voltage level at the **OUTPUT** pin. This reduction of gate drive voltage prevents any further increase in the primary current and stabilizes the operating point. In this mode, the device effectively limits the current while maintaining continuous operation, thereby ensuring safe excitation of the ignition transformer and protecting the switching stage from electrical and thermal overstress.

In addition to current limiting, the driver provides the **IGH (IGF)** output, which functions as a diagnostic

current-status signal for the **ECU**. This open-drain output indicates whether predefined current thresholds have been reached and can be interpreted by the ECU as a *current-valid* or *power-good-type* signal during coil charging. The IGH signal thus enables real-time monitoring of the ignition coil current profile without influencing the ignition control itself. The associated current thresholds for IGH assertion and de-assertion are internally referenced and defined in the datasheet.



**Figure 4. Current and IGH Indication of Current Flowing**

**Maximum Dwell Time (Maxdwell) and Controlled Soft Shutdown**

During Maximum Dwell Time (Maxdwell) operation, the ignition driver does not switch the inductive load abruptly when the maximum allowed on-time is exceeded. Instead, the device performs a controlled (soft) shutdown, in which the current is reduced in a regulated manner rather than being instantly interrupted.

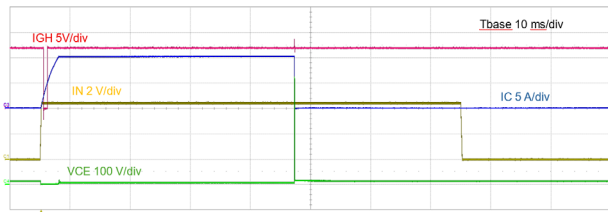
In this mode, the IGBT is not driven directly into the blocking state. Instead, it is actively controlled so that its collector-emitter operating point moves into the controlled resistive region of the output characteristic. As a result, the collector-emitter voltage increases while the current is gradually reduced. A portion of the energy stored in the ignition coil is therefore dissipated as heat inside the IGBT within its safe operating area.

This controlled shutdown behavior ensures that:

- the turn-off current slope ( $di/dt$ ) is limited,
- excessive voltage overshoot across the ignition coil is avoided,
- and the generation of an unintended or parasitic spark is prevented.

As illustrated in the Figure 5, the Maxdwell function is typically characterized by a nearly linear decay of the coil current accompanied by a controlled rise of the collector-emitter voltage (VCE) across the IGBT, with power dissipation occurring internally during the shutdown process. This approach protects both the ignition transformer and the switching stage from electrical and thermal overstress while ensuring predictable and safe turn-off behavior.

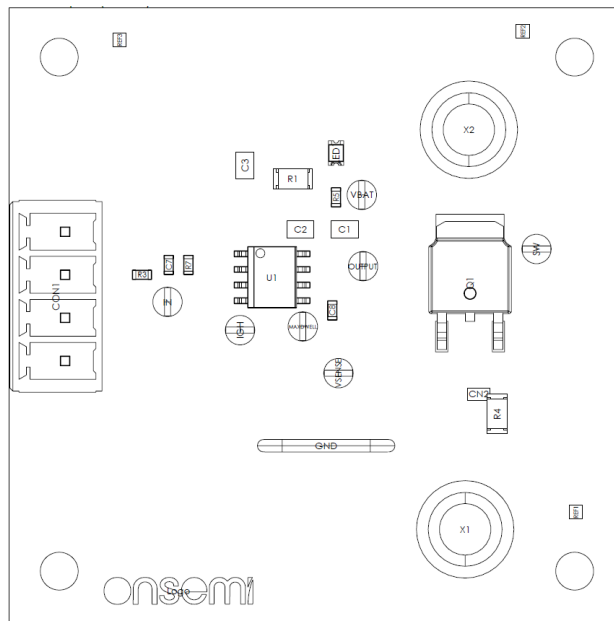
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**Figure 5. Maxdwell Protection with Controlled (Soft) Shutdown of an Inductive Load**

## PCB DRAWINGS

### Assembly Drawings



**Figure 6. FAD1101AEVB PCB Top Assembly Drawing**

Composite Drawings

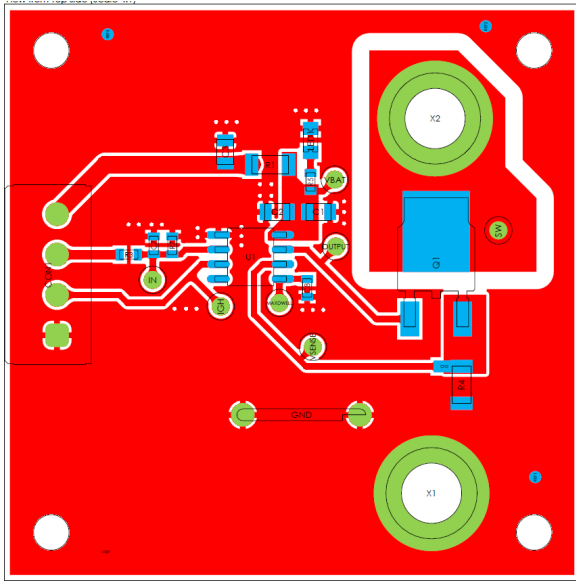


Figure 7. FAD1101AEVB PCB Top Composite Drawing

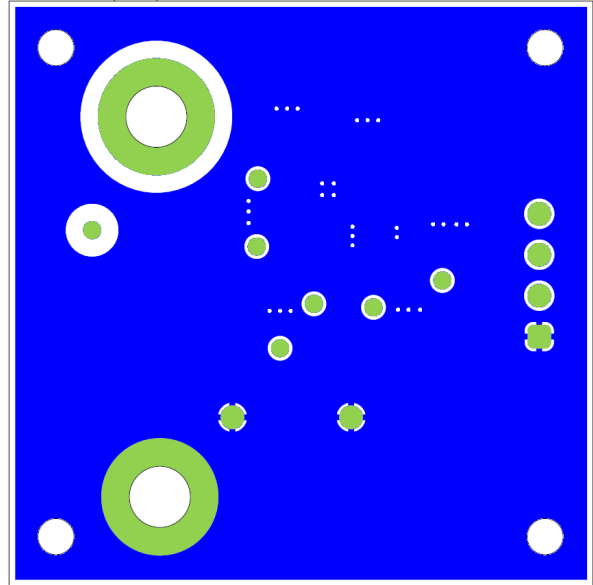


Figure 8. FAD1101AEVB PCB Bottom Composite Drawing (bottom view)

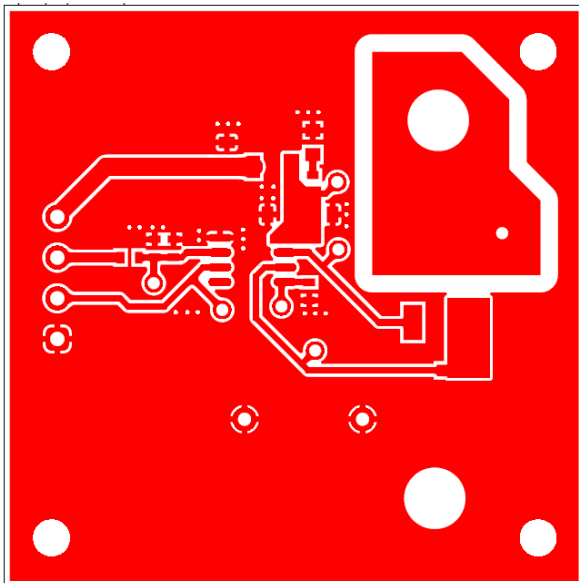


Figure 9. FAD1101AEVB PCB Internal Plane 1 Drawing

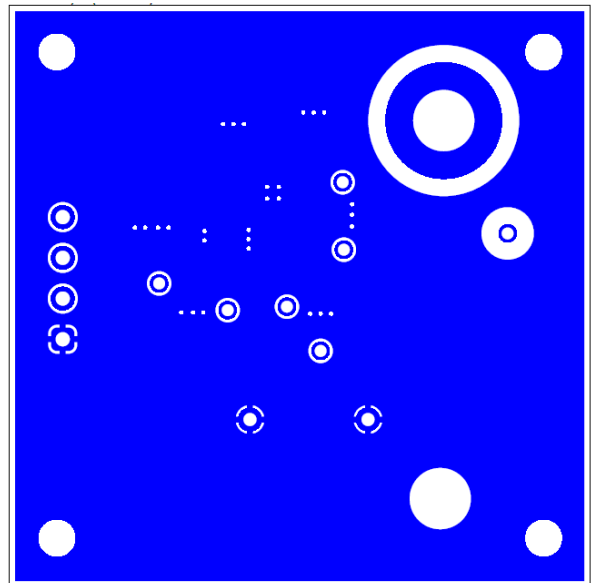


Figure 10. FAD1101AEVB PCB Internal Plane 2 Drawing

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## REVISION HISTORY

Revision	Description of Changes	Date
0	Initial document release.	5/11/2026

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