Quickstart Manual for EVAL KIT HPD G1 SiC

About this document

Scope and purpose

This application note describes how to operate the evaluation kit "*EVAL KIT HPD G1 SiC*".

Intended audience

Experienced engineers evaluating HybridPACK™ Drive CoolSiC™ power modules.

Evaluation Kit

This Evaluation Kit is to be used during the design-in process for evaluating and measuring characteristic curves, and for checking datasheet specifications in designing inverter applications with the HybridPACK™ Drive CoolSiC™ power module and gate driver EiceDRIVER™.

An evaluation kit is not intended to be an optimal design for every specific requirement. But it gives a good starting point and useful design hints for serial development. Furthermore, practical experience from the power module switching characteristic as well as the gate driver features can be obtained in the lab at a minimum effort by using such evaluation tools.

Note: *PCB and auxiliary circuits are NOT optimized for a final customer design.*

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Safety precautions

Note: Please note the following warnings regarding the hazards associated with development systems.

Table 1 Safety precautions

	**Warning:** *The DC link potential of this board is up to 500 VDC. When measuring voltage waveforms by oscilloscope, high voltage differential probes must be used. Failure to do so may result in personal injury or death.*
	**Warning**: *The evaluation or reference board contains DC bus capacitors which take time to discharge after removal of the main supply. Before working on the drive system, wait five minutes for capacitors to discharge to safe voltage levels. Failure to do so may result in personal injury or death. Darkened display LEDs are not an indication that capacitors have discharged to safe voltage levels.*
	**Warning:** *The evaluation or reference board is connected to the grid input during testing. Hence, high-voltage differential probes must be used when measuring voltage waveforms by oscilloscope. Failure to do so may result in personal injury or death. Darkened display LEDs are not an indication that capacitors have discharged to safe voltage levels.*
	**Warning:** *Remove or disconnect power from the drive before you disconnect or reconnect wires, or perform maintenance work. Wait five minutes after removing power to discharge the bus capacitors. Do not attempt to service the drive until the bus capacitors have discharged to zero. Failure to do so may result in personal injury or death.*
	**Caution:** *The heat sink and device surfaces of the evaluation or reference board may become hot during testing. Hence, necessary precautions are required while handling the board. Failure to comply may cause injury.*
	**Caution:** *Only personnel familiar with the drive, power electronics and associated machinery should plan, install, commission and subsequently service the system. Failure to comply may result in personal injury and/or equipment damage.*
	**Caution:** *The evaluation or reference board contains parts and assemblies sensitive to electrostatic discharge (ESD). Electrostatic control precautions are required when installing, testing, servicing or repairing the assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with electrostatic control procedures, refer to the applicable ESD protection handbooks and guidelines.*
	**Caution:** *A drive that is incorrectly applied or installed can lead to component damage or reduction in product lifetime. Wiring or application errors such as undersizing the motor, supplying an incorrect or inadequate AC supply, or excessive ambient temperatures may result in system malfunction.*
	**Caution:** *The evaluation or reference board is shipped with packing materials that need to be removed prior to installation. Failure to remove all packing materials that are unnecessary for system installation may result in overheating or abnormal operating conditions.*

Table of Contents

1 How to order HybridKit Drive

The evaluation kit *EVAL KIT HPD G1 SiC* can be ordered via Infineon sales partners:

- SAP ordering number for **EVAL KIT HPD G1 SiC**: **SP005594933.**
- The evaluation kit is also available at the webshop: http://www.ehitex.com

The shipping content of the **EVAL KIT HPD G1 SiC** include the:

- ✓ HybridPACK™ Drive power module **FS03MR12A6MA1B** (SP001720764)
- ✓ Reference aluminium cooler + recommended sealing ring
- ✓ Gate driver board **HPD GD BOARD G1 SIC** (SP005592047)
- ✓ DC-Link capacitor

The typical appearance of the evaluation kit is shown in Figure 1.

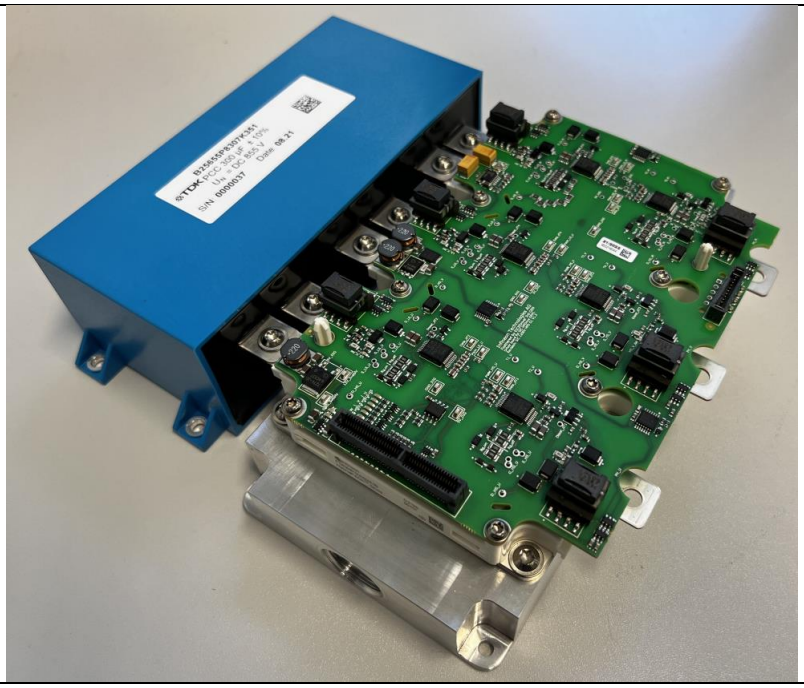

Figure 1 Typical appearance of the evaluation kit EVAL KIT HPD G1 SiC SP005594933.

2 Feature and Limitations Overview

The evaluation kit *EVAL KIT HPD G1 SiC* is a partial inverter system including B6 bridge power module, gate driver board, DC-link capacitor and cooler. The evaluation kit supports the customers in their first steps in designing applications with the HybridPACK™ Drive CoolSiC™.

2.1 Block Diagram

Figure 2 shows the block diagram with simplified signal and power flow connections as well as the implemented key components.

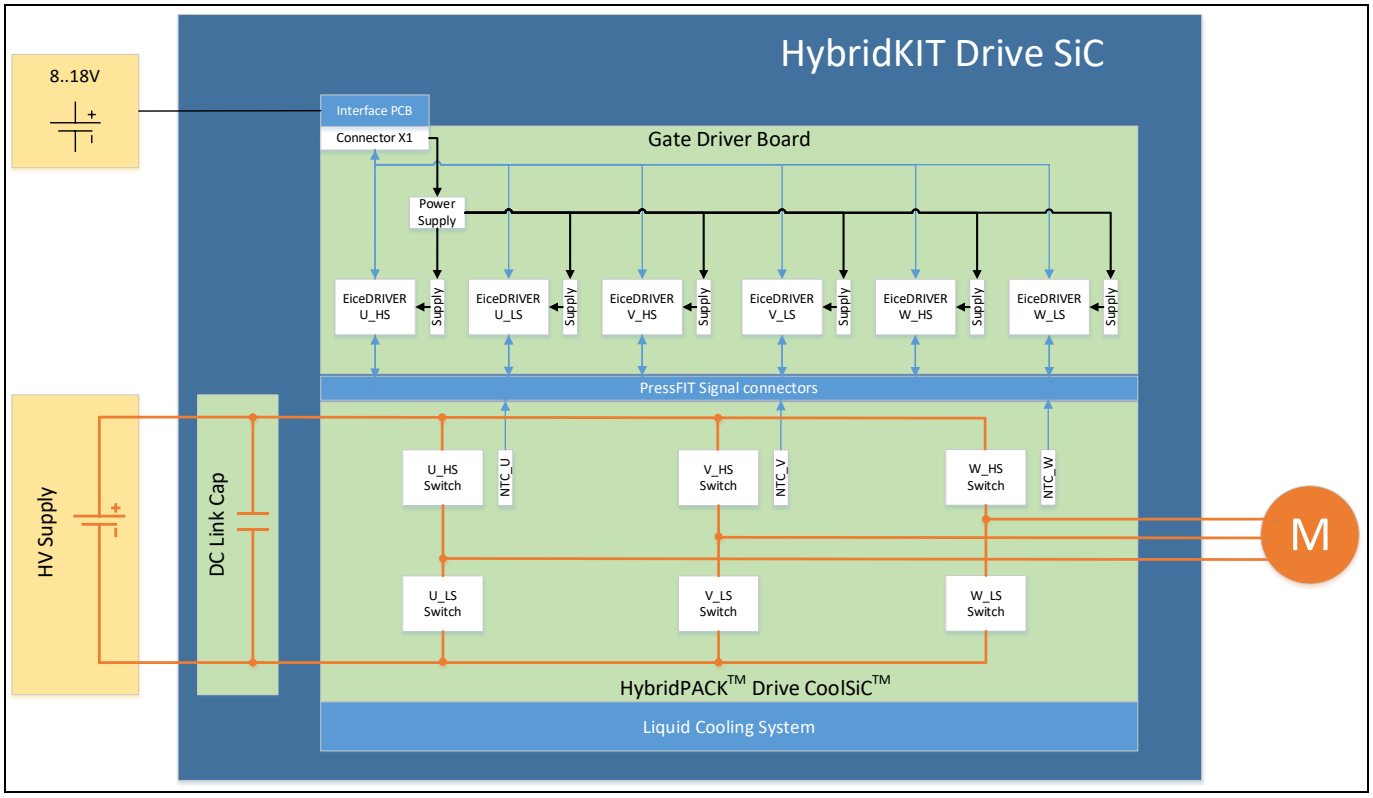

Figure 2 Simplified Block Diagram

2.2 Recommended Operating Conditions

The following recommended operating conditions describe the targeted lab testing environment.
The evaluation kit is not designed for a fixed specification and it cannot be regarded as a protected system, as it would require strict shutdown routines and would limit the main evaluation purpose. Therefore, please respect the specifications of individual parts and especially the thermal limits.

Please see also section 2.4 to understand the limitations.

Table 2 Operating Conditions

Type	Symb	Min	Max	Conditions
Gate Driver Board Supply	V_{supply}	8V	18V	
Working Voltage (DC-Link Voltage)	V_{DC}	0V	500V	Gate driver board's creepage and clearance distances comply with norm IEC-60664-1 for 500V.
Transient Phase Current	I_{ph}	-800A	+800A	limited by T_{vj,op_max}
HybridPACK™ Drive CoolSiC™ module Junction Temperature	$T_{vj,op}$	-40°C	150°C	
PCB Temperature	T_{PCB}		150°C	
Ambient Temperature	T_{amb}		75°C	Limited by T_{PCB}. A higher T_{amb} is achievable at active cooling like a fan
Switching frequency	f_{sw}		20 kHz	Limited by T_{PCB}. A higher f_{sw} is achievable at low ambient temperature or active cooling like a fan

2.3 Key Features

The key features can be summarized:

- Inverter evaluation kit for xEV main inverter applications (up to 200 kW).
- Automotive power module HybridPACK™ Drive CoolSiC™ FS03MR12A6MA1B.
- Automotive gate driver solution based on EiceDRIVER™ 1EDI3033AS.
- SiC MOSFET desaturation (short circuit) detection.
- NTC temperature measurement featured by ADC of EiceDRIVER™.
- DC-Link voltage measurement featured by ADC of EiceDRIVER™.
- Gate driver board's creepage and clearance distances comply with norm IEC-60664-1 for 500V working voltage.

2.4 Limitations of the Evaluation Kit

The evaluation kit should not be regarded as a protected system. It was designed for evaluation under lab conditions with minimum automatic shutdown routines. The design was intended to be usable also under extreme conditions where protection mechanisms would limit the evaluation possibilities. The evaluation kit is not protected against:

- Over- & under- voltages on the signal connectors.
- Overvoltages of the HV working voltage
  (>500V should be avoided)
- Overtemperature of the PCB and Module.
  The power module NTC temperature info is read as a digital signal, but no shutdown limit is set.
- Testing at higher switching frequencies than 20 kHz may require active cooling of the gate driver board at high ambient temperature.
- **Please read and understand the manual and the safety precautions.**

Please note that the list are giving examples and should not be seen as exhaustive.

2.5 Key Components List

Some key components can be found in Table 3. The evaluation kit uses more active and passive components which are not listed here.

Table 3 Key components list.

Part Number	Manufacturer	Description / Implementation
FS03MR12A6MA1B	Infineon	Automotive **HybridPACK™ Drive** CoolSiC™ power module with 1200V SiC MOSFET
1EDI3033AS	Infineon	Automotive Isolated Gate Driver EiceDRIVER™
TLE8386-2EL	Infineon	Automotive SMPS controller used in 500kHz SEPIC converter
B25655P8307K351	TDK	Automotive PCC DC-Link Capacitor 855V, 300µF
P301085-A2 (B78308-A2387-A003)	TDK	Automotive Transformer 1:1.07 with 10mm creepage distance

3 Quickstart Guide

This chapter explains briefly the recommended lab equipment and how to connect the evaluation kit. Please ensure an appropriate current/power/voltage limit of the source. It can happen at any time that the inverter changes the output conditions and/or stops immediately.

3.1 Recommended equipment for evaluation

To perform evaluation tests with the EVAL KIT HPD G1 SiC, following equipment is minimum recommended.

- Logic Supply: 8-18V, 2A.
- Pulse generator: 0V…5V
- Power Source: minimum 30V/2A.
  up to 500V/600A depending on evaluation tests.
- Load: passive 3-phase inductive load or alternative
  3-phase asynchronous (induction) machine.
- Scope: 4 channel scope.
- Cooling system: Optional for light load tests.
  For high power tests use cooling with 10L/min and <2bar absolute pressure operation.

3.2 Connect the Evaluation Kit to power supply and load

The right connection of power supplies and load is shown in Figure 3a. The high voltage DC source has to be connected to the capacitor. Depending on the required currents for the evaluation tests it can be required to mount a busbar over all DC-, DC+ connections. Some busbar examples for high power load tests are shown in Figure 3b and c. For low loads and high power short-term operation it is typically enough to connect the high voltage DC source only at the center DC-Link connections with the cable shoes included in the standard shipping content of the evaluation kit.

Refer to [2] Infineon Application Note AN-HPDKIT-SiC-G1-GATEDRIVE, “User Manual for HPD GD BOARD G1 SiC” for logic supply connection on gate driver board.

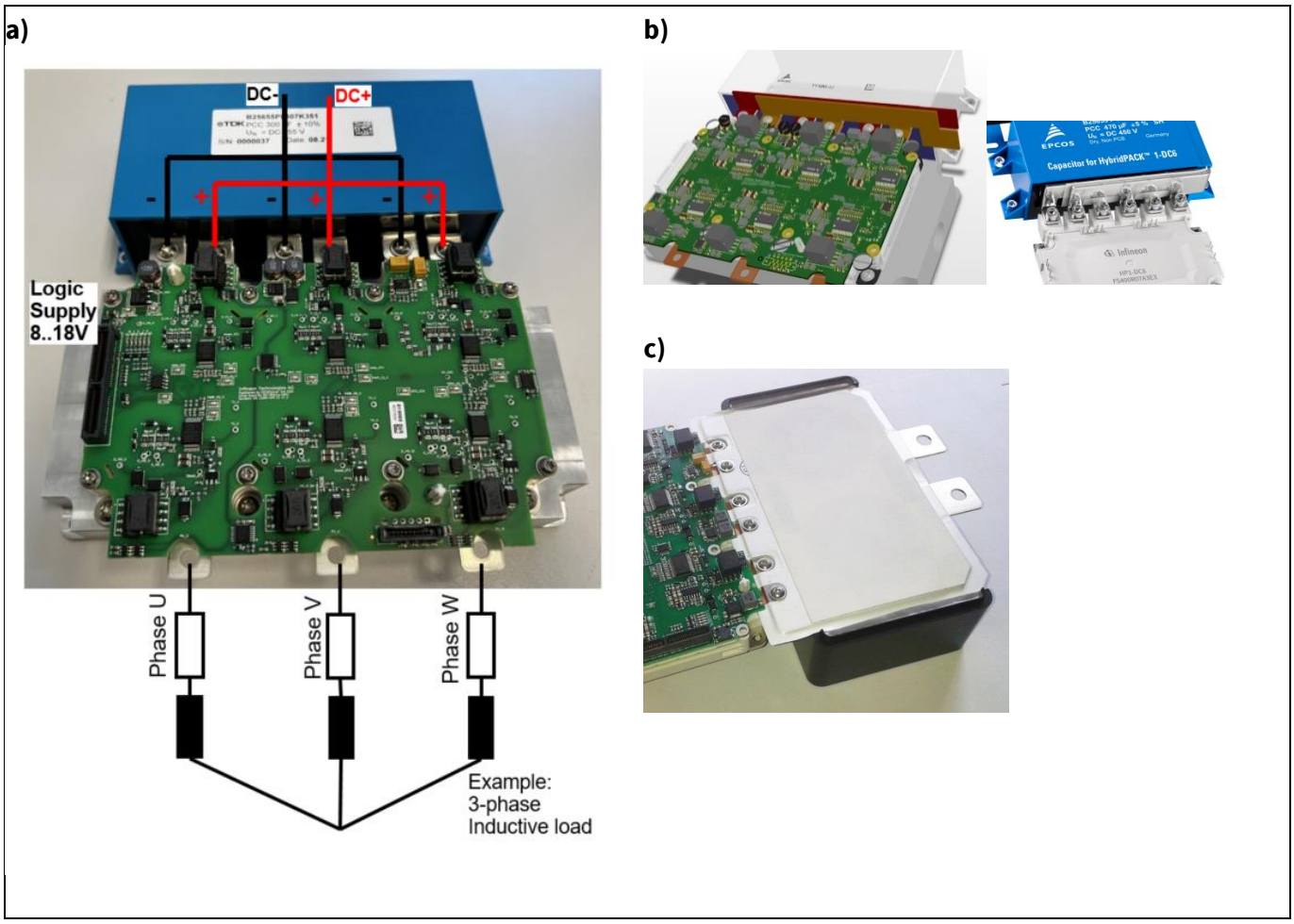

Figure 3 Typical appearance of the evaluation kit and required supplies and load connections (a). For long-term high power load tests a busbar with appropriate current carrying capability may be required at the DC terminals. Concepts with additional external busbars are shown in (b), this example shows solutions from TDK/Epcos [3]. Concepts with busbars integrated in the capacitor is shown in (c), this example shows a solution from SB Electronics [4].

3.3 Connect the Evaluation Kit to a cooling system

The cooler can be connected via the ½ inch G series British standard pipe interface as shown in Figure 4. Please use as cooling fluid 50% water / 50% ethylene glycol and ensure that the cooling fluid corrosion protection is compatible with aluminium cooler and Ni plated baseplate (like typical released automotive cooling mixtures). Do not use pure water cooling fluids as it might damage the power module and reference cooler.

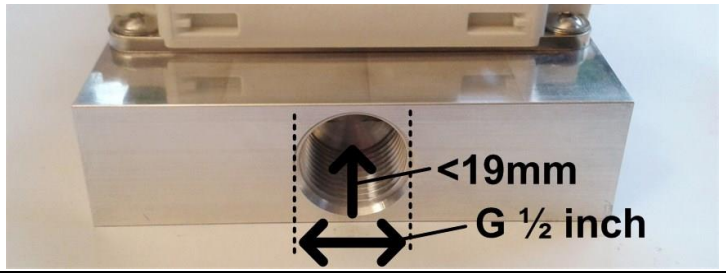

Figure 4 Typical appearance of the evaluation kit and the cooling system interface.

4 Advanced Features

4.1 Double Pulse Testing

For a deeper investigation of the corresponding switching characteristics, it is sometimes useful to perform double pulse tests rather than inverter tests. Such tests can be easily performed by using the following sequence:

1. Connect supplies, load and pulse generator properly
2. Turn on the logic supply (8..18V)
3. Activate and enable gate driver EiceDRIVER™
4. Turn on the high voltage supply and perform double pulse tests

Refer to [2] Infineon Application Note AN-HPDKIT-SiC-G1-GATEDRIVE, “User Manual for HPD GD BOARD G1 SiC” for gate driver board configuration detail, such as logic supply connection, enabling gate driver EiceDRIVER™, etc.

The pulse generator can be connected to test pads on the gate driver board as shown in Figure 5.

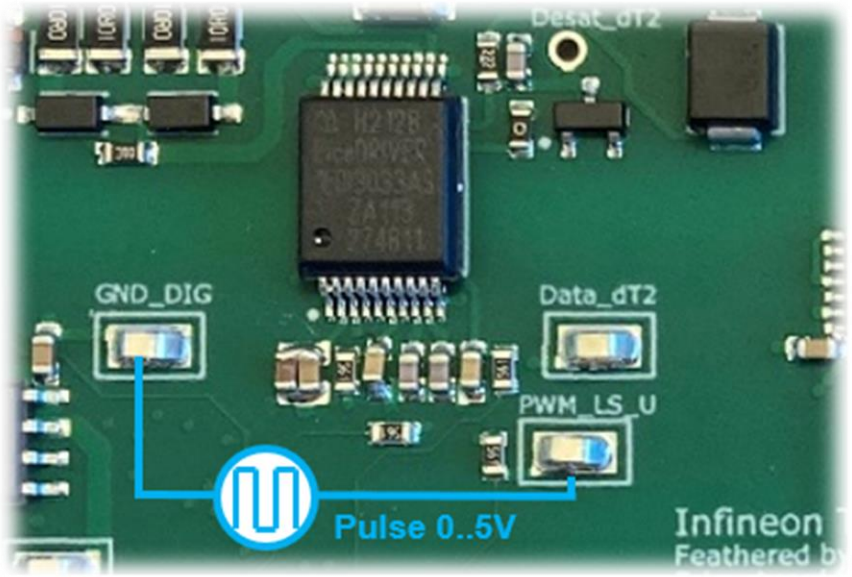

Figure 5 Example how test pads on the gate driver board can be utilized for double pulse test.

5 References and Revision History

The referenced application notes can be found at http://www.infineon.com

[1] Infineon Application Note AN-HPD-ASSEMBLY, “Assembly Instructions for the HybridPACK Drive”

[2] Infineon Application Note AN-HPDKIT-SiC-G1-GATEDRIVE, “User Manual for HPD GD BOARD G1 SiC”

[3] TDK/Epcos Capacitor “B25655P5507K***”

[4] SBE Electronics Capacitor “700D50794-204” OR “700D50795-186”

Revision History

Date	Version	Changed By	Change Description
2022-May	1.0	Dehuai Jiang (IFAG ATV HP HMD TM)	Initial Version

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AN-HPDKIT-SiC-G1-QUICKSTART

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