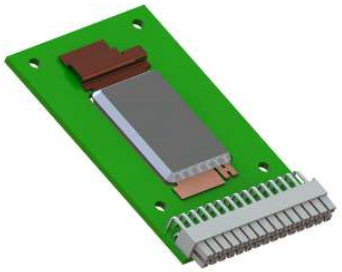
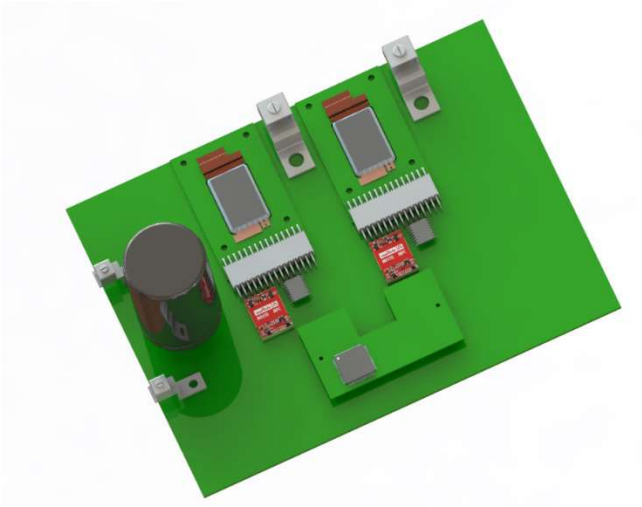
DFPAK Double Pulse Testing (DPT) DFPKIT



Summary

1.Description

The DFPAK DPT Kit (“DFPKIT”) is a compact benchtop platform designed to evaluate the DFPAK High-Power module series. It enables industry-standard testing and characterization, including Power Cycling and Double Pulse Testing (DPT).



The DFPKIT integrates all required power terminals, interconnection fixtures, gate driving circuitry, and control electronics. The Device Under Test (DUT) configuration and operating conditions can be programmed via a PC-compatible user interface, allowing flexible test sequencing and automated evaluation routines.

The system supports comprehensive characterization of DUT electrical and thermal performance, including:

Static Parameters:

- RDS(on) across various drain-source currents and junction temperatures
- Thermal dissipation and thermal resistance (Pd, Rth)
- Power cycling endurance

Dynamic Parameters:

- **Turn-ON Characteristics:**
  td(on), tr, t-on, E-on, dv/dt, di/dt, turn-on switching losses
- **Turn-OFF Characteristics:**
  td(off), tf, t-off, E-off, dv/dt, di/dt, turn-off switching losses

The DPTKIT offers a large envelope of testing: 500A DC continuous (1000A pulse) – 700VDC continuous (1000V pulse < 1ms)

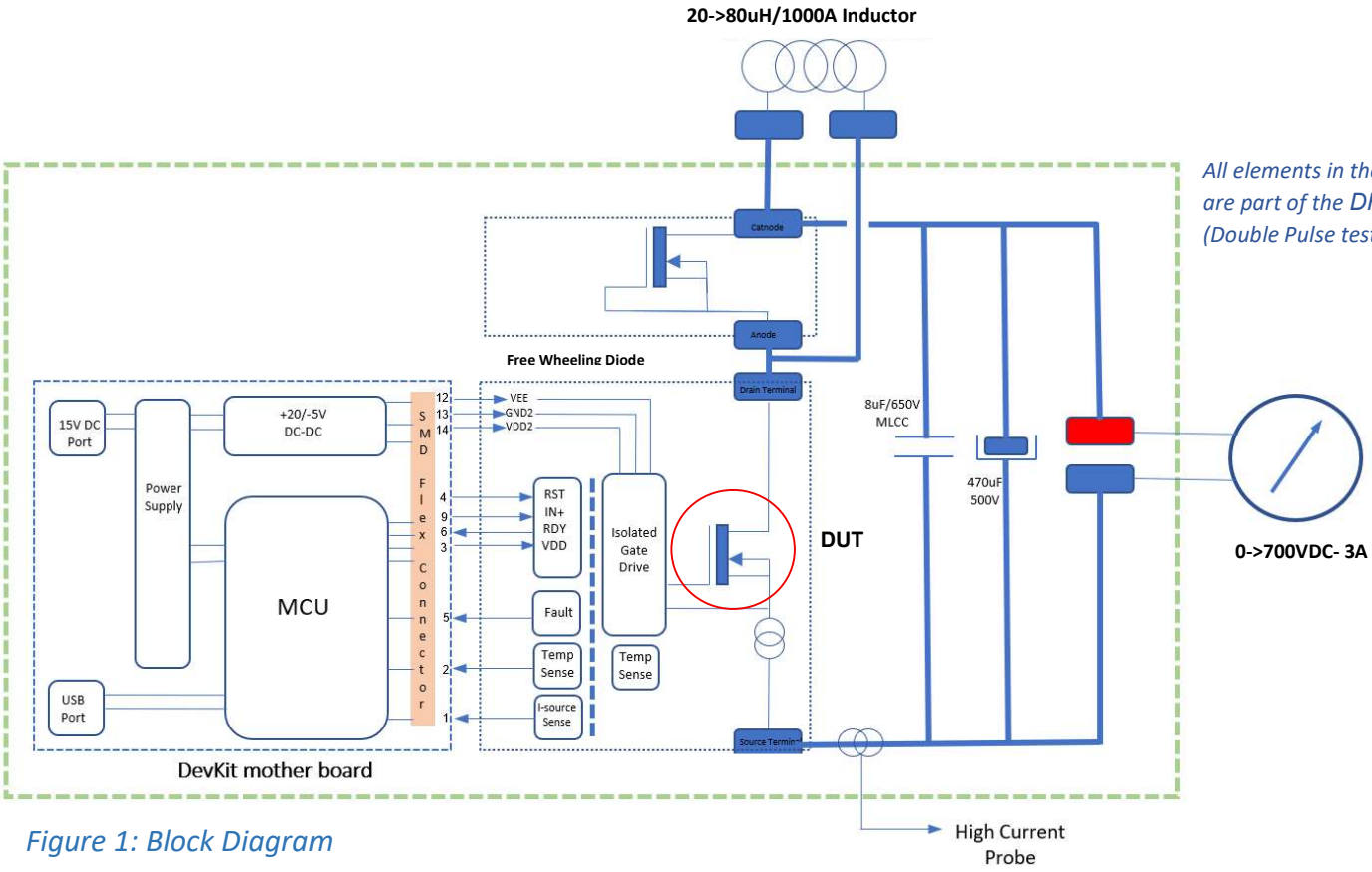


Figure 1: Block Diagram

2. DFPKIT contents

- Bench top platform
- DFPAK500N120G1A/I in socket mounted (2)
- DFPAK500N120G1A/I in socket mounted spare (1)
- Acrylic protection guard (1)
- 12V block adapter (1)
- USB type A cable (1)

3. Warning, disclaimer and precautions

3.1 General Warning

The DFPAK DFPKIT operates at voltages up to 700 V and currents up to 1000 A. These operating conditions involve extremely high electrical energy and present serious hazards including:

- Electric shock
- Arc flash
- Fire
- Explosion
- Severe thermal burns
- Projectile hazards due to component failure

3.2 Qualified Personnel Only

Operation of the DFPKIT is restricted to trained and qualified personnel with demonstrated experience in:

- High-voltage power electronics
- High-current systems
- Laboratory safety procedures
- Emergency response protocols

Unauthorized personnel must not access or operate the equipment.

3.3 Stored Energy Hazard

The DFPKIT contains **large energy storage capacitors**. Hazardous voltages may remain present long after external power sources have been disconnected.

Before servicing or handling:

- Verify complete discharge using properly rated measurement equipment.
- Follow documented discharge procedures.
- Never assume the system is safe based solely on power removal.

Residual stored energy may be lethal.

3.4 Protective Enclosure Requirement

The DFPKIT must **never** be operated without the acrylic protection guard securely installed.

No voltage shall be applied unless:

- The protective guard is properly in place.
- All mechanical fasteners are secured.
- All interconnects are verified.

Bypassing protective shielding is strictly prohibited.

3.5 Personal Protective Equipment (PPE)

All personnel present during testing must use appropriate PPE, including but not limited to:

- Electrically rated gloves
- Safety glasses or face shield
- Flame-resistant lab coat or arc-rated clothing
- Insulated tools when applicable

PPE requirements must follow applicable industrial electrical safety standards.

3.6 Thermal and Fire Hazard

High-current operation can produce rapid and significant temperature rise in:

- Terminals
- Busbars
- Cables
- Connectors

Improper cable gauge selection or insufficient tightening may result in:

- Overheating
- Insulation failure
- Fire
- Equipment damage

Only use cable gauges and hardware specified in this manual. All connections must be torque-verified.

An appropriate electrical fire extinguisher must be readily accessible during operation.

3.7 Mechanical Hazards

The DFPKIT contains mechanical components with sharp edges and precision features.

When assembling or disassembling:

- Use specified tools only.
- Follow documented procedures.
- Wear appropriate hand protection when required.

Improper handling may result in injury or equipment damage.

3.8 Equipment Grounding and Compliance

All equipment must be installed and operated in accordance with:

- Applicable electrical codes
- Laboratory safety standards

Improper grounding may result in shock, equipment damage, or measurement errors.

3.9 Failure Mode Risks

Power electronics systems under high stress may experience catastrophic failure. Failure events may include:

- Device rupture
- Arc events
- Explosion of semiconductor packages
- High-velocity ejection of fragments

Operators must maintain safe distance and use shielding.

3.10 Disclaimer of Warranty and Liability

DF POWER (“DFP”) makes no warranty, express or implied, statutory or otherwise, including but not limited to any implied warranties of merchantability or fitness for a particular purpose, regarding the information or equipment described herein.

DFP shall not be liable to any recipient or third party for any damages, including but not limited to:

- Personal injury
- Property damage
- Loss of profits
- Loss of use
- Business interruption
- Indirect, incidental, special, or consequential damages arising out of or related to the furnishing, performance, or use of the DFPKIT, DFPAK, or any supplied hardware or software.

Use of the DFPKIT constitutes acceptance of these terms.

4. Required test equipment

In addition to the DFPKIT, external power and measurement equipment are required depending on the test methodology. Recommended equipment and detailed specifications are provided in Section 11.

4.1 Double Pulse Testing (DPT)

The following equipment is required to perform Double Pulse Testing:

- DFPAK DFPKIT
- Power Inductor
  - 20 to 80 µH
  - Minimum 1000A DC current capability
  - Low parasitic resistance and inductance (Refer to Application Note)
- DC Variable Power Supply
  - 0 to 700 V output
  - Minimum 3 A capability
  - Current-limited and protected operation required
- Digital Oscilloscope
  - Minimum 4 channels
  - ≥200 MHz bandwidth recommended
  - ≥1 GS/s sampling rate recommended
- High-Current Probe
  - Hall-effect or Rogowski type
  - 1000 A peak capability
  - Sufficient bandwidth for fast switching transitions

- Differential Voltage Probe
  - High CMRR (>80 dB recommended)
  - Appropriate voltage rating for 650 V operation
- Control PC
  - Windows 10 or latest
  - USB port for DFPKIT communication

5. Unpacking and installation

5.1 Unpacking

5.2 Installation

After unpacking, install the DFPKIT on a properly equipped electronic laboratory bench.

The system must be placed:

- On a flat, stable, and clean surface
- With sufficient clearance on all sides
- Over an ESD-safe, fire-retardant mat
- With the mat properly connected to protective earth (ground)

⚠ Ensure all power sources are OFF and disconnected before making any electrical connections.

As delivered, the DFPKIT is preconfigured for Double Pulse Testing (DPT).

1) Software Installation

- Download the DFPKIT control software from the official source.
- Run the installer.
- Follow the on-screen installation instructions.
- Verify successful installation before connecting hardware.

2) High-Voltage DC Supply Connection

- Ensure the DC high-voltage power supply is turned OFF.
- Connect the DC supply to the dedicated DFPKIT input terminals.
- Use minimum 18 AWG (or larger) wire.
- Cable insulation rating must be ≥ 1000 V.
- Verify correct polarity before proceeding.
- Confirm secure mechanical fastening of all terminals.

⚠ Improper polarity or loose connections may result in equipment damage or hazardous conditions.

3) Power Inductor Connection

- Connect the power inductor to the designated DFPKIT terminals.
- Use **1/0 AWG cable** (or as specified for the expected current level).
- Cable insulation rating must be **≥ 1000 V**.
- All terminals must be firmly tightened using appropriate torque.

Due to high-current operation and resulting electromechanical forces:

- Connections must be mechanically secure.
- Recheck torque after initial installation.
- Periodic inspection is recommended during testing.

⚠ Loose connections may cause overheating, arcing, or fire.

4) Current Probe Installation

- Install the Rogowski (or Hall-effect) current probe in the source cavity as shown in Figure 3.
- Ensure proper orientation according to probe polarity markings.
- Verify probe is securely positioned and not in contact with high-temperature surfaces.
- Route probe cable away from high-voltage conductors to minimize noise pickup.

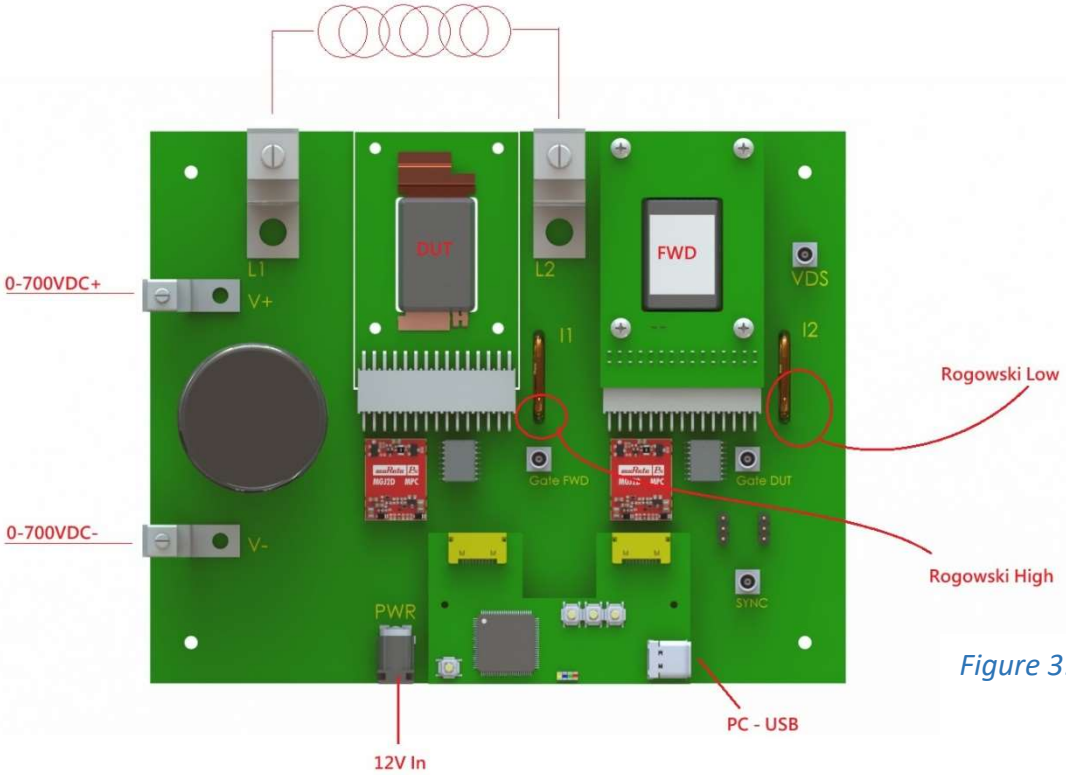


Figure 3: Connections

4) Oscilloscope Installation

- Connect the oscilloscope channel 1 to the DFPKIT mother board pin SYNC and GND
- Set the oscilloscope trigger function to Normal Mode channel 1 “rising” at 2V trigger threshold.
- Connect the differential probe to the test pins device VDS plug. This should be channel 2 of the oscilloscope.
- Connect the “Rogowski” current probe to the channel 3 of the oscilloscope.
- Plug the 12V adaptor to the DFPKIT mother board
- Install the guard and channel all the probe cables and wires through the back opening
- Open the DFPKIT application on the PC. Plug the DFPKIT wall adaptor.
- Select “double pulse test”

- Pulses from SIG1 should be observed on the oscilloscope screen.
- Confirm clearance and that the guard is in place.

6. Performing Double Pulse Test

After completing installation, Double Pulse Testing (DPT) may be performed as follows.

⚠ Ensure the acrylic protection guard is installed and secured before applying voltage.

6.1 Initial Power-Up

- Verify all connections (HV supply, inductor, probes, PC interface).
- Turn ON the DC high-voltage power supply.
- Set the output voltage to 10 V.
- Enable the power supply output.

6.2 Signal Verification

- Verify that gate pulses are visible on Oscilloscope Channel 2.
- Verify that a linear current ramp is visible on Channel 3 during *t-on*.
  - The ramp slope should be consistent with:

$$di/dt = \frac{V_{DC}}{L}$$

  - Non-linear behavior may indicate wiring issues or inductor saturation.

6.3 Increasing Test Voltage

- Gradually increase the DC supply voltage to reach the desired current pulse target.

⚠ Always observe switching waveforms during voltage increase.

6.4 Operating Limits

- Do not exceed the servicing voltage of the DFPKIT line capacitor:
  - Maximum DC Bus Voltage: 700 V
- Monitor Drain-Source voltage overshoot during turn-off:
  - Ensure peak V_{DS}does not exceed 1200 V (DFPAK Breakdown voltage)
  - Overshoot depends on:
    - Inductor quality
    - Parasitic inductance
    - Wiring layout
    - Gate drive settings

⚠ Excessive overshoot may result in device failure.

6.5 Audible Inductor Behavior

- A characteristic magnetic “click” may be audible from the inductor during pulse events. This is typically due to magnetostriction and mechanical forces within the magnetic core.
- Abnormal loud noise may indicate core saturation or mechanical instability.

6.6 Measurement Execution

Perform the desired switching measurements:

- td(on), tr, Eon
- td(off), tf, Eoff
- dv/dt, di/dt
- Switching losses

Ensure oscilloscope bandwidth and probe compensation are properly configured.

6.7 Power-Down Procedure

- Turn OFF the DC power supply output.
- Reset the supply voltage to approximately 10 V.

6.8 Capacitor Discharge Procedure

- Allow the system to run for approximately 30 seconds to purge (discharge) the DC link capacitor through the internal discharge path.

If automatic purge is not functioning:

- Monitor Oscilloscope Channel 2 (set trigger to *Auto Mode*).
- Wait until the measured DC bus voltage drops below 30 V.

⚠ Do not proceed until voltage is verified below 30 V.

6.9 Safe Access

Once DC bus voltage is confirmed below 30 V, it is safe to remove the DFPKIT protection guard.

6.10 Pulse re-configuration

- Refer to the DFPKIT UI section to create different pulse patterns and durations.
- Pulse width
- Pulse spacing
- Current target
- Test repetition
- Custom pulse patterns