Application Note

DRV81545 IEC, CISPR, and Thermal Test Report

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ABSTRACT

The DRV81545 is a four-channel integrated low-side switch (4.5V to 55V) designed for industrial and automotive applications. Each channel features a low-side N-channel FET ($R_{DS(ON)}$ = 235mΩ) with an internal freewheeling diode connected to a configurable VCLAMP pin for inductive load protection.

This report documents system-level compliance testing against IEC 61000-4-5 surge, IEC 61000-4-4 EFT, and CISPR-32 emissions standards. Thermal benchmarking demonstrates the DRV81x4x family operates at lower temperatures than pin-to-pin competitors (IPS4260L, MAX14919A) while delivering 27% higher current capability (DRV81545) across automotive temperature ranges. Energy management validation confirmed the DRV81545 and DRV81646 safely drive four simultaneous channels into 1200mH + 40Ω inductive loads at 24V and 48V respectively, across all three integrated demagnetization modes, without external protection components.

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1 Introduction

The DRV81545 is a four-channel, low-side smart switch designed for demanding industrial and automotive applications requiring robust load switching across wide voltage ranges. Integrating per-channel current limiting, flexible inductive load clamping, and strong EMC immunity, the device simplifies system design while reducing external component count. The features and applications below highlight the DRV81545's versatility across motor drives, factory automation, building control, and beyond.

1.1 Features

- *Robust Surge Immunity (IEC 61000-4-5)*: Withstands up to 2.5kV in the driver ON state with an external TVS, and up to 2.0kV without external clamping components.
- *High EFT Robustness (IEC 61000-4-4)*: Withstands up to 2.6kV on the VM supply line during active driver ON states and up to 2.2kV during the OFF state.
- *CISPR-32 Compliant*: Zero conducted or radiated emissions limit violations observed across all evaluated test configurations.
- *Exceptional Thermal Performance*: Delivers up to 27% (DRV81545) and 42% (DRV81646) higher single-channel current capability alongside cooler operating temperatures compared to the IPS4260L and MAX14919A under identical loads.
- *Component-Free Inductive Driving*: Simultaneously drives four channels into 1200mH + 40Ω inductive loads at 24V across all internal demagnetization modes (slow, fast, fastest) without external protection, supporting up to 48V applications in designated decay modes.

1.2 Applications

- AC drive control module and Servo drive control module for industrial motor drives and actuators
- *Factory Automation & Control Systems*: Drives Programmable Logic Controllers (PLCs) digital output modules, robotic compute boards, end-of-arm tooling actuators, and high-density industrial bus configurations.
- *Inductive Loads (Coils and Solenoids)*: Direct switching of industrial solenoid valves (such as pneumatic manifolds), magnetic fluid couplers, and proportional linear actuators.
- *Relay and Contactor Control Lines:* Safely manages electromechanical coil activation for 12V, 24V, and 36V "ice-cube" control-panel relays and industrial contactors.
- *Capacitive and Resistive Signatures*: Drives multicolor tower lights, machine status displays, and high-inrush visual alert indicators using integrated per-channel current limiting.
- *Building Automation and HVAC Control*: Operates environmental mixing boxes, variable air volume (VAV) controllers, motorized damper actuators, and automatic commercial doors or gates.
- *Auxiliary DC Motor and Pump Modules*: Manages low-side ground paths for small cooling fans, ventilation extraction subsystems, and auxiliary thermal management fluid pumps.

2 Detailed Description

2.1 DRV81545 Surge (IEC 61000-4-5) with External TVS Diode

IEC 61000-4-5 is the international standard for surge immunity. IEC 61000-4-5 characterizes the high-energy transient that can couple into a system from nearby lightning strikes or large inductive switching events on the same power network. The standard defines a 1.2µs / 50µs combination wave (open-circuit voltage / short-circuit current) and specifies five positive and five negative pulses applied to the port under test. For a low-side switch driver, passing this test at the system level demonstrates that the device, together with its external protection circuit, can withstand surge events representative of industrial 24V and 48V supply environments.

2.1.1 Test Details

- Waveform: 1.2µs / 50µs combination wave per IEC 61000-4-5 (most common in industrial systems).
- Effective generator output impedance: 2Ω.
- Five positive and five negative pulses per level, with at least 12s between pulses.
- Coupling: 1kV / 42Ω, all OUTx pins, with the device powered OFF and ON.
- External clamp: SMBJ33A TVS connected to the VCLAMP pin.

2.1.2 Test Setup

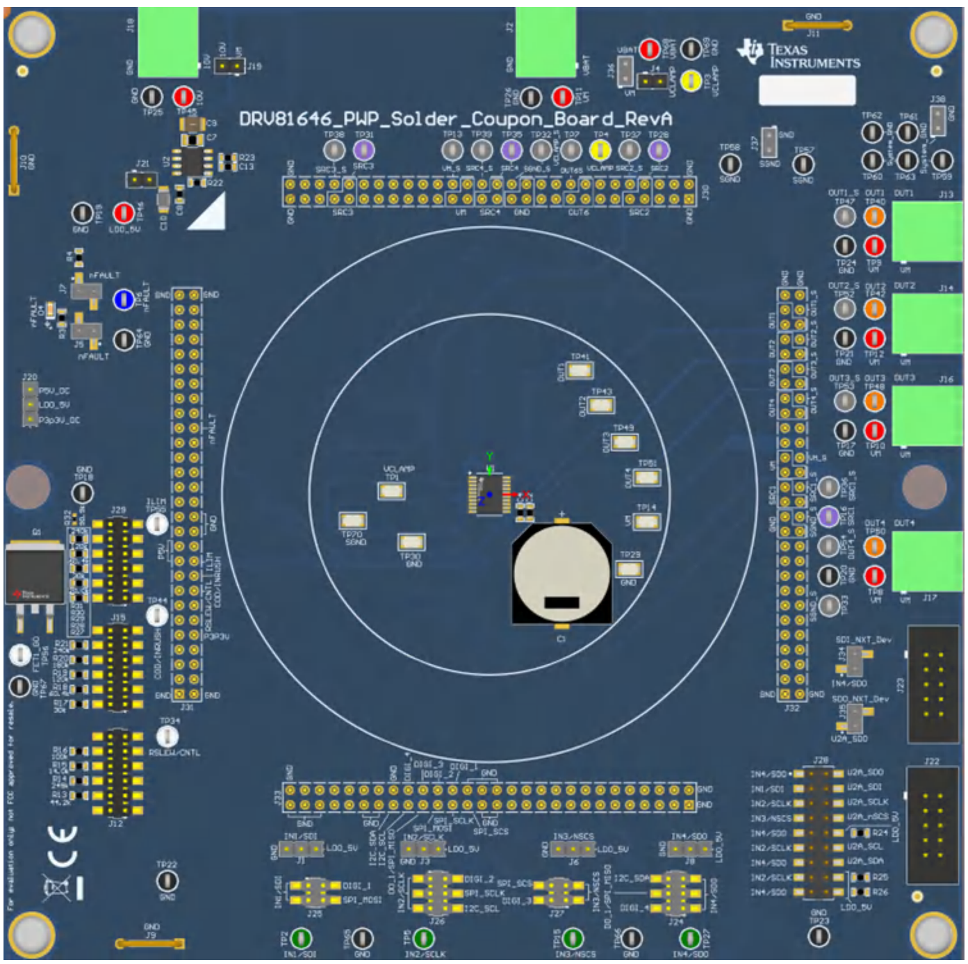

Figure 2-1. DRV81545PWP Test Board Schematic

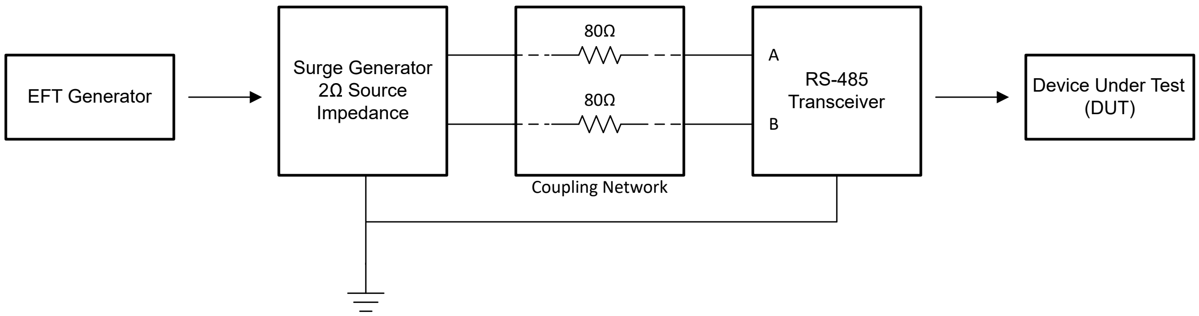

Figure 2-2. Surge Test Setup Block Diagram

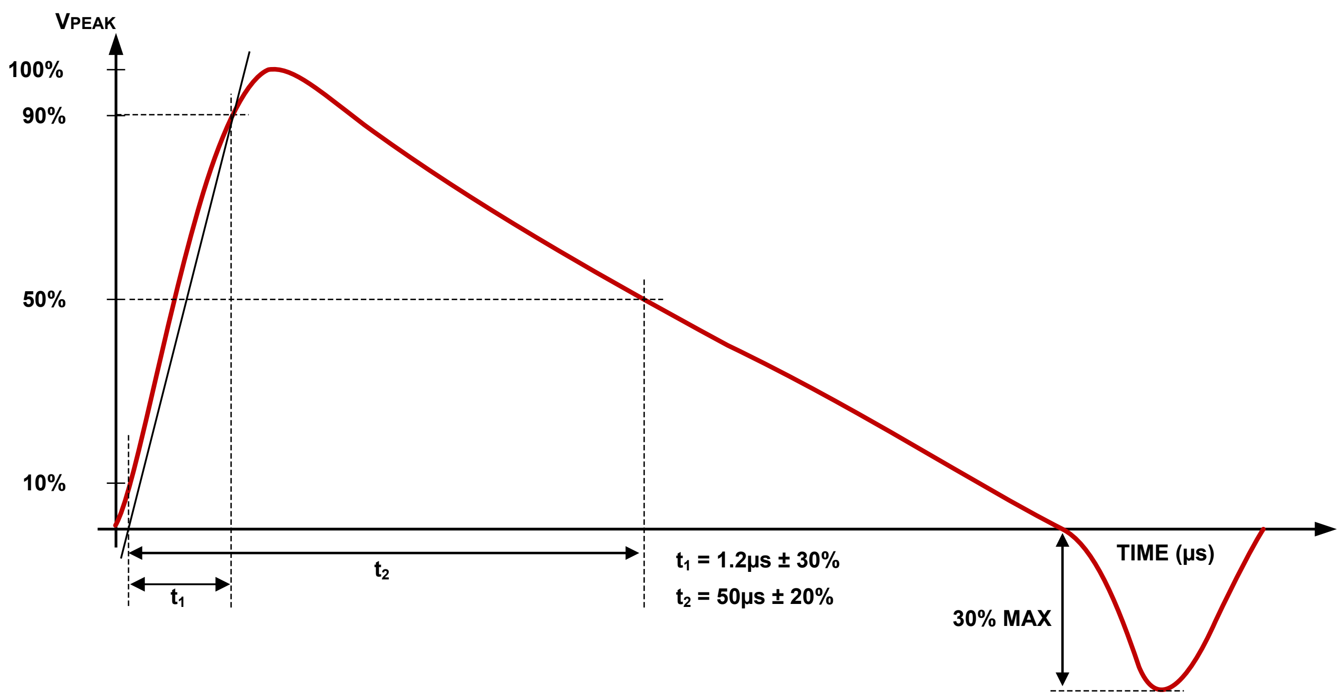

Figure 2-3. 1.2µs / 50µs Combination-wave Surge Waveform

Table 2-1. Surge Test Equipment

Class	Environment	Voltage level
0	Well protected environment, often in a special room	25V
1	Partially protected environment	500V
2	Electrical environment where the cables are well separated, even at short runs	1kV
3	Electrical environment where power and signal cables run in parallel	2kV
4	Electrical environment where the interconnections include outdoor cables along with the power cable, and cables are used for both electronics and electric circuits	4kV
5	Electrical environment for electronic equipment connected to telecommunication cables and overhead power lines in a non-densely populated area	Test level 4

2.1.3 Results and Observations

Figure 2-4. Captured Surge Waveform at 1000V

Figure 2-5. Captured Surge Waveform at 1200V

Driver OFF state - VM = 12V, VM bulk capacitor = 10μF, INx = 0V, no load on OUTx.

Table 2-2. Surge Results, Driver OFF State, With External TVS

Device	Voltage (kV)	No. of Strikes	OUT1	OUT2	OUT3	OUT4
DRV81545	0.75	5	Pass	Pass	Pass	Pass
	1.0	5	Pass	Pass	Pass	Pass
	1.2	5	Pass	Pass	Pass	Pass
	1.6	5	Pass	Pass	Pass	Pass
	1.8	5	Pass	Pass	Fail	Pass

Table 2-3. Surge Results, Driver ON State, With External TVS

Device	Voltage (kV)	No. of Strikes	OUT1	OUT2	OUT3	OUT4
DRV81545	1.8	5	Pass	Pass	Pass	Pass
	2.0	5	Pass	Pass	Pass	Pass
	2.2	5	Pass	Pass	Pass	Pass
	2.5	5	Pass	Pass	Pass	Pass
	2.6	5	Pass	Pass	Fail	Pass

Driver ON state - VM = 12V, VM bulk capacitor = 10μF, INx = 5V, 48Ω load on each OUTx.

2.1.4 Observations

- No damage observed up to 1.6kV in the OFF state and 2.5kV in the ON state
- Three devices were tested and post-test parametric screen showed no parameter shift

2.2 DRV81545 EFT (IEC 61000-4-4) on VM line

IEC 61000-4-4 is the standard for electrical fast transient (EFT) immunity. EFT characterizes the high-frequency burst noise produced by arcing during contactor or relay switching on nearby equipment. Each burst consists of fast (5/50ns rise/fall) pulses repeating at 100kHz; burst trains repeat every 300ms. Passing EFT at the system level demonstrates that the device maintains correct operation under conducted disturbances representative of industrial control panel environments.

2.2.1 Test Details

Burst peak voltage: up to 2.8kV; pulse repetition rate inside burst: 100kHz.

Burst duration: 15ms; burst period: 300ms; one burst frame for 10s with a 10s rest between burst frames; six burst frames total.

Coupling: VM line only.

Device powered with VM = 24V and a 48Ω load on each OUTx.

INx driven with a 20kHz, 3.3V PWM signal in the ON state.

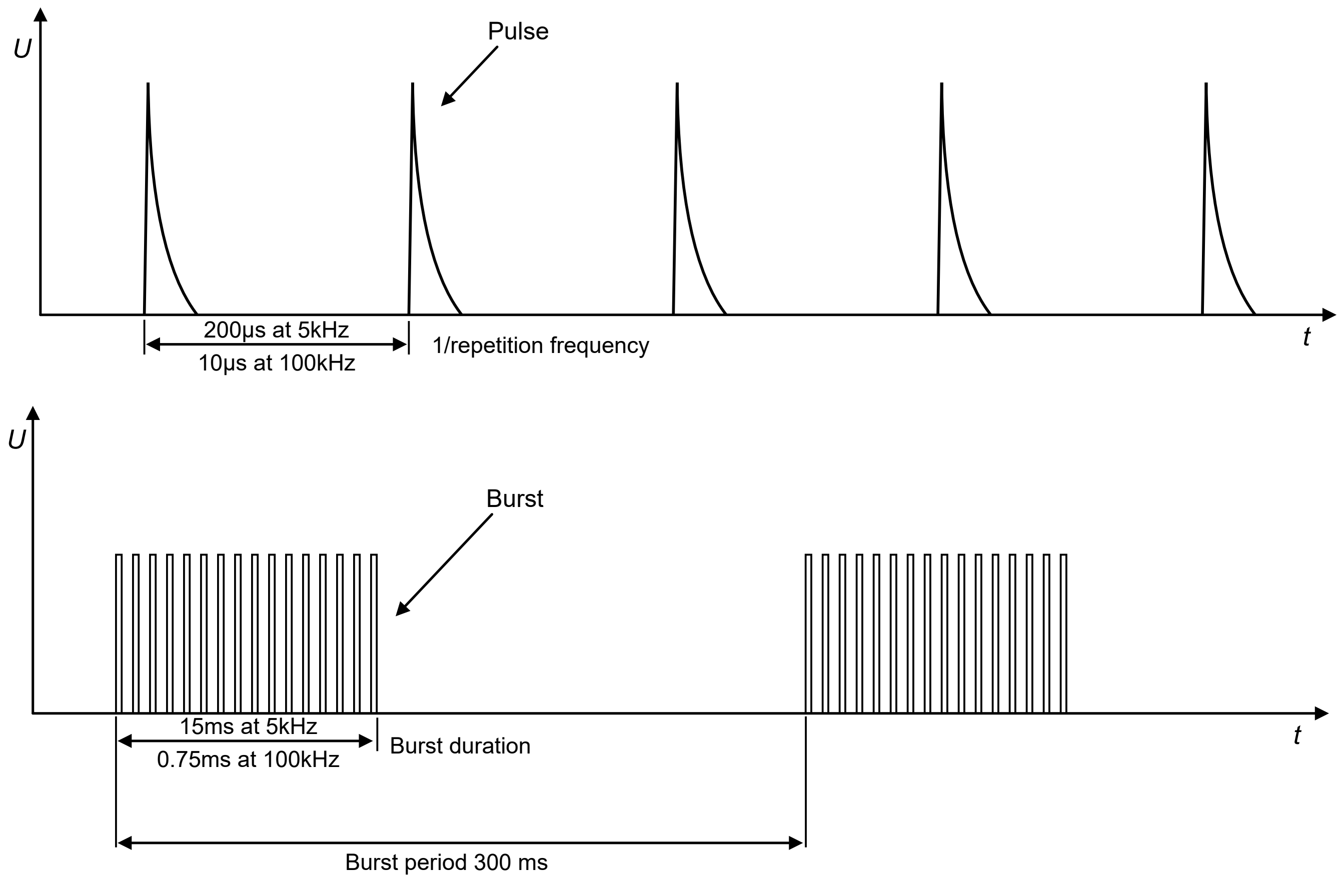

Figure 2-6. EFT 5/50ns Pulse – Definition per IEC 61000-4-4

2.2.2 Test Setup

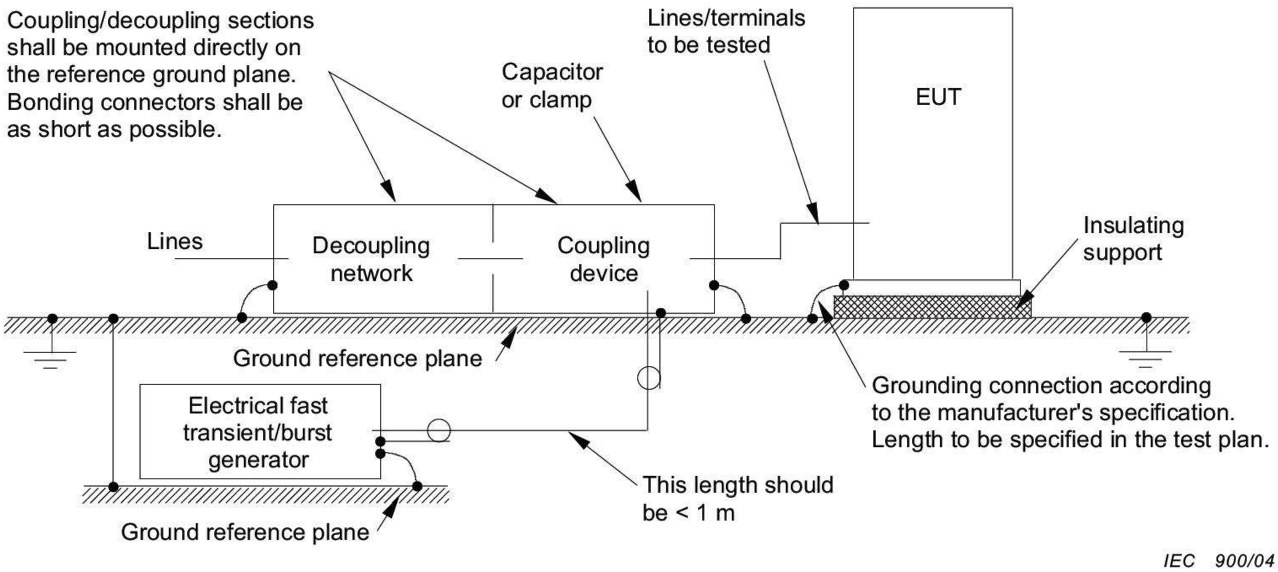

Figure 2-7. Visual Representation of EFT Pulses for Testing

2.2.3 Results and Observations

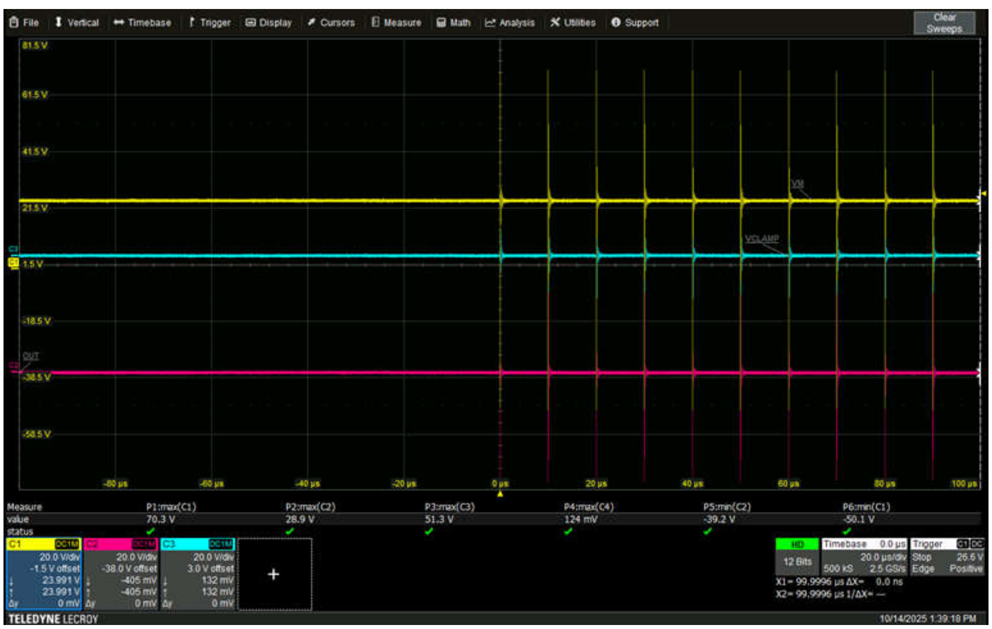

Figure 2-8. Captured Surge Waveform With Driver in OFF State at 1500

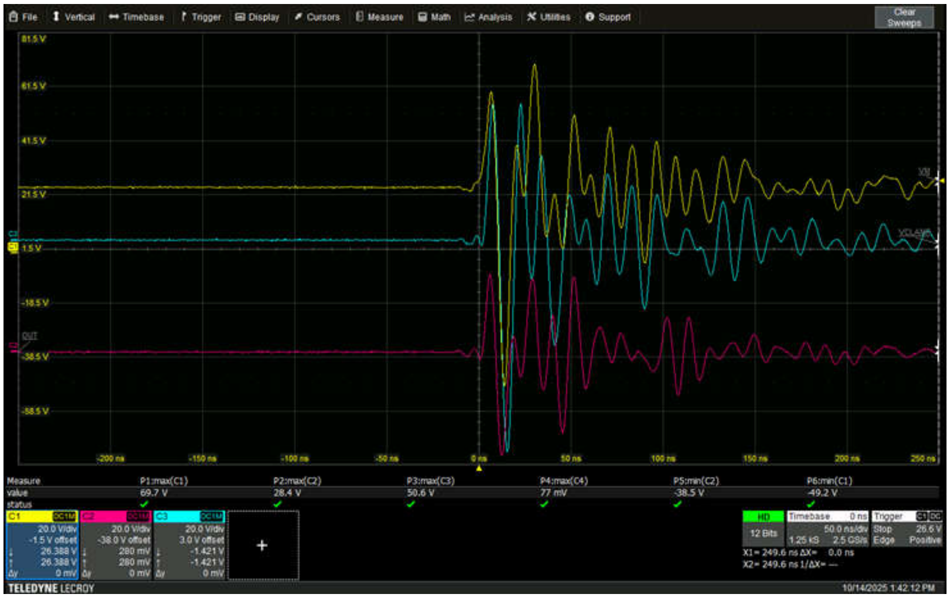

Figure 2-9. Captured Surge Waveform With Driver in OFF State 1500V Zoomed In

Figure 2-10. Captured Surge Waveform With Driver in ON State at 1500V

Figure 2-11. Captured Surge Waveform With Driver In OFF State 1500V Zoomed In

Table 2-4. EFT on VM Line, Driver OFF State

Driver OFF State						
	Voltage (KV)	**No. of strikes**	**OUT1**	**OUT2**	**OUT3**	**OUT4**
DRV81545	1.6	5	Pass	Pass	Pass	Pass
	1.8	5	Pass	Pass	Pass	Pass
	2	5	Pass	Pass	Pass	Pass
	2.2	5	Pass	Pass	Pass	Pass
	2.4	5	Fail	Fail	Fail	Fail

Table 2-5. EFT on VM Line, Driver ON State

Driver ON State						
	Voltage (KV)	**No of strikes**	**OUT1**	**OUT2**	**OUT3**	**OUT4**
DRV81545	1.6	5	Pass	Pass	Pass	Pass
	1.8	5	Pass	Pass	Pass	Pass
	2	5	Pass	Pass	Pass	Pass
	2.2	5	Pass	Pass	Pass	Pass
	2.4	5	Pass	Pass	Pass	Pass
	2.6	5	Pass	Pass	Pass	Pass
	2.8	5	Fail	Fail	Fail	Fail

2.2.4 Observations

Driver OFF state: no damage observed at or below 2.2kV; failure first observed at 2.4kV.

Driver ON state: no damage observed at or below 2.6kV; failure first observed at 2.8kV. The higher withstand level in the driver ON state is consistent with the active switching load reducing the net energy transferred into the supply rail during each EFT burst.

2.3 DRV81545 EFT (IEC 61000-4-4) on OUT line

This section repeats the IEC 61000-4-4 EFT sequence with the burst coupled onto the OUTx motor outputs rather than the VM supply line. This configuration characterizes immunity when the disturbance is conducted through the load wiring, which can run in proximity to other switched cabling in the installation.

2.3.1 Test Details

Burst peak voltage: up to 2.8kV; pulse repetition rate inside burst: 100kHz.

Burst duration: 15ms; burst period: 300ms; one burst frame for 10s; 10s rest between burst frames; six burst frames total.

Coupling: OUTx motor outputs.

Device powered with VM = 24V and a 48Ω load on each OUTx.

INx driven with a 20kHz, 3.3V PWM signal.

2.3.2 Test Setup

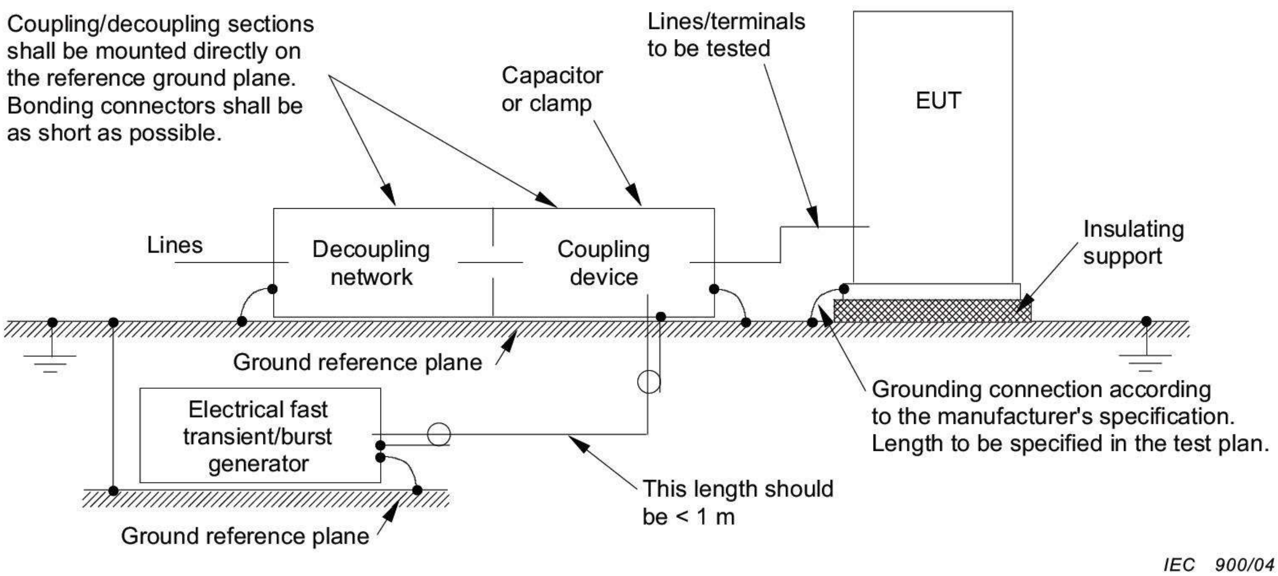

Figure 2-12. EFT Test Setup, OUT Line Coupling

2.3.3 Results and Observations

Figure 2-13. EFT at 2.5kV on OUT Line

Figure 2-14. EFT at 2.5kV on OUT Line – Zoomed View

Table 2-6. EFT OUTx Line, Driver ON State

Driver ON State						
	Voltage (KV)	No of strikes	OUT1	OUT2	OUT3	OUT4
DRV81545	1.6	5	Pass	Pass	Pass	Pass
	1.8	5	Pass	Pass	Pass	Pass
	2	5	Pass	Pass	Pass	Pass
	2.2	5	Pass	Pass	Pass	Pass
	2.4	5	Pass	Pass	Pass	Pass
	2.6	5	Pass	Pass	Pass	Pass
	2.8	5	Fail	Fail	Fail	Fail

2.3.4 Observations

No damage was observed at or below 2.6kV; failure was first observed at 2.8kV.

2.4 DRV81545 CISPR-32 Conducted Emissions

CISPR-32 defines conducted emissions limits for multimedia and information-technology equipment and is widely referenced for industrial product compliance. The conducted emissions measurement quantifies the noise voltage coupled back onto the DC power line through a Line Impedance Stabilization Network (LISN) across 150kHz to 30MHz (extended here to 108MHz). Compliance with these limits indicates that the device does not introduce interference onto a shared power network at levels exceeding the applicable limits.

2.4.1 Test Details

Power the device at 12V in STANDBY state.

Load: OUTx = 48Ω.

Sweep frequency 150kHz to 108MHz with 1kHz step size.

Tests performed on the DRV81545 EVM hardware.

Active runs use 20kHz PWM on INx.

2.4.2 Test Setup

Receiver: Rohde & Schwarz ESW-44 EMI test receiver, version 2.10SP2, calibrated 03 April 2024.

The DUT is powered through a CISPR-32-compliant LISN and conducted noise on the supply line is captured by the receiver.

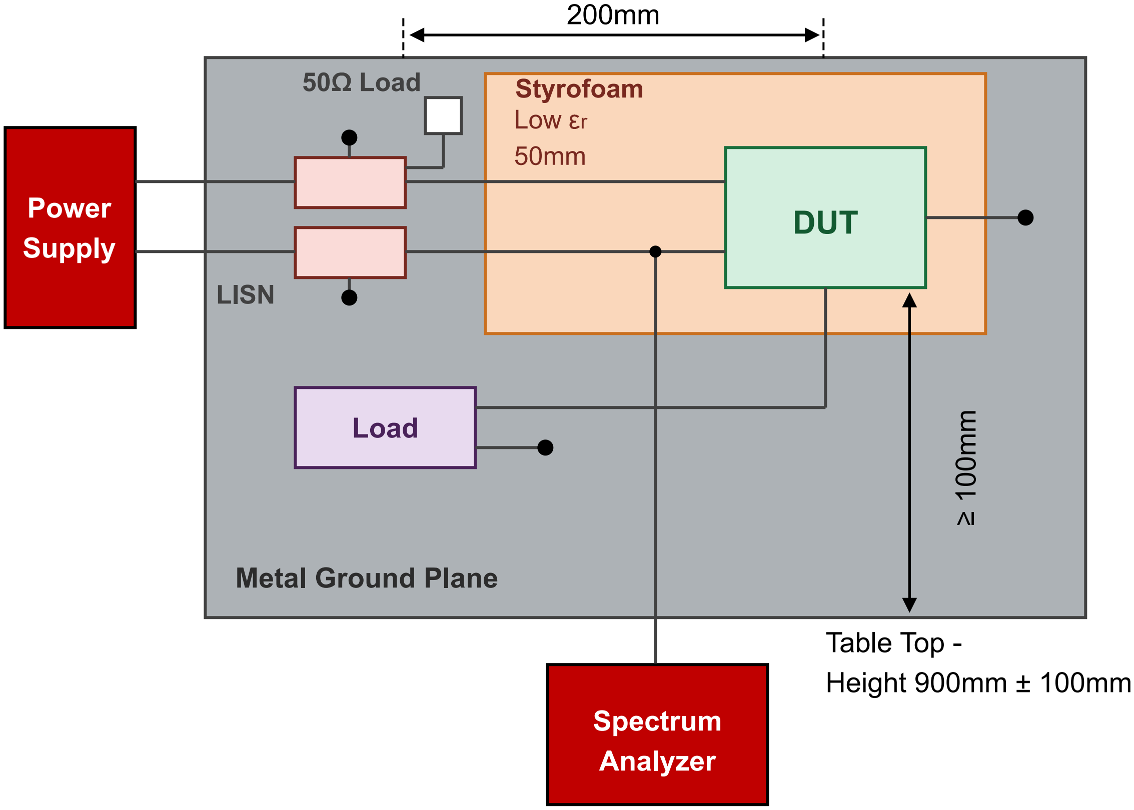

Figure 2-15. CISPR-32 Conducted Emissions Setup

2.4.3 Results and Observations

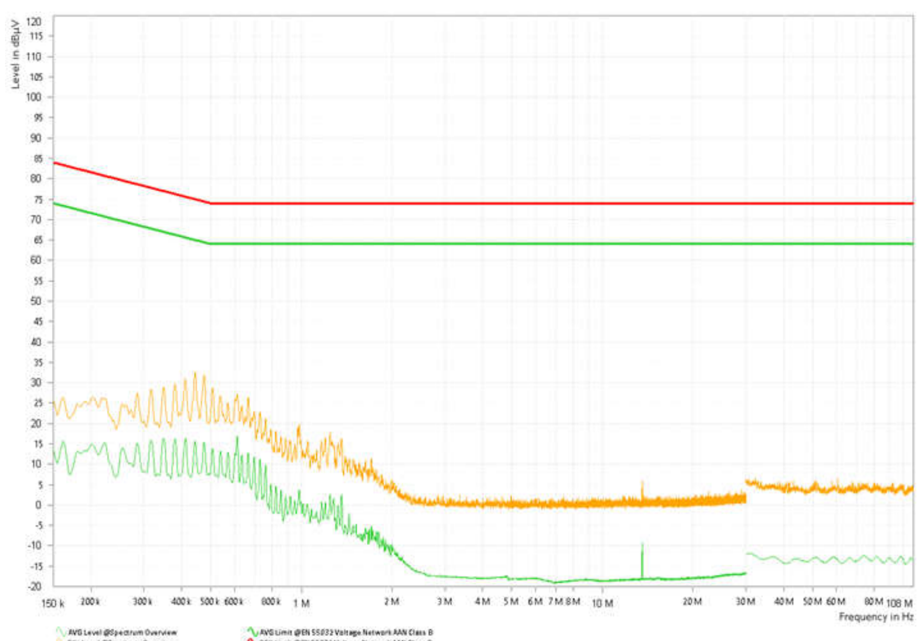

Figure 2-16. Conducted Emissions – Ambient (No DUT Switching)

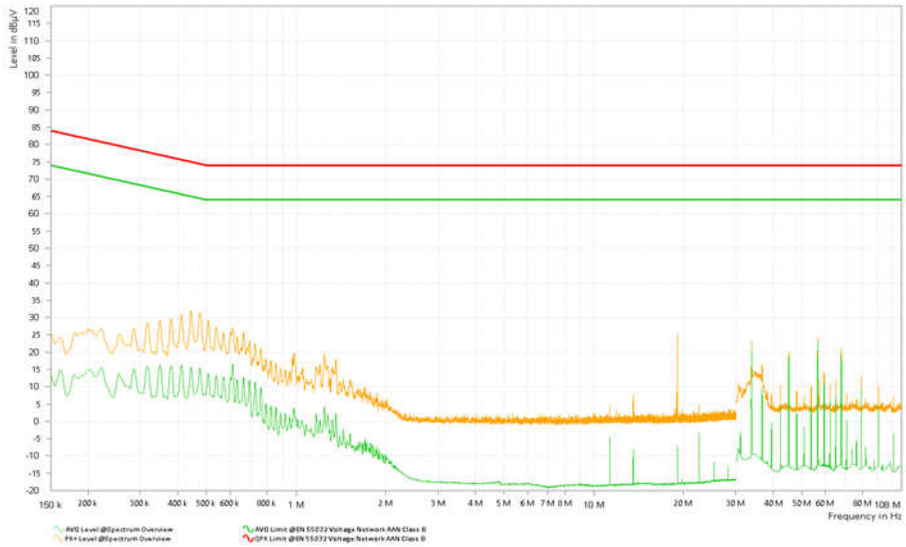

Figure 2-17. Conducted emissions – Standby, VM = 12V, INx = 5V, No Load

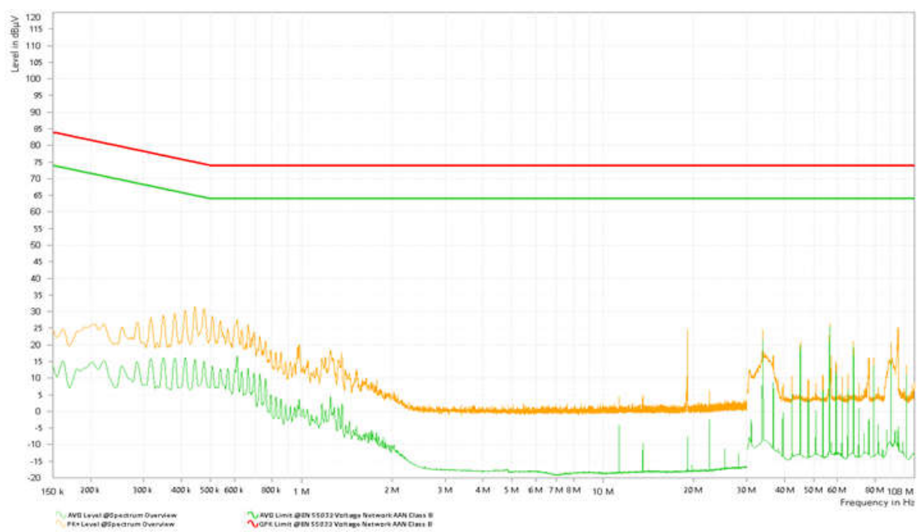

Figure 2-18. Conducted Emissions – Active, VM = 12V, INx = 5V, 48Ω Load

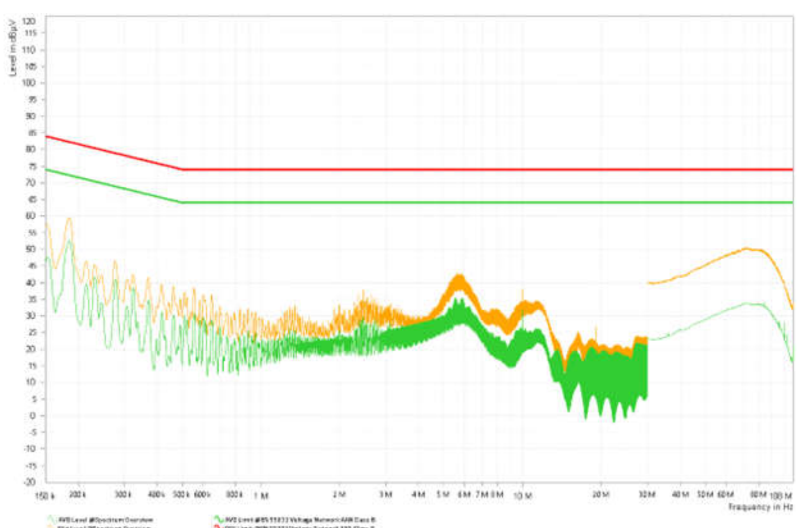

Figure 2-19. Conducted Emissions – Active With PWM, VM = 12V, INx = 3.3V At 20kHz, 48Ω Load

2.4.4 Observations

No CISPR-32 conducted emissions limit violations were observed under any operating condition tested.

2.5 DRV81545 CISPR-32 Radiated Emissions

The radiated emissions portion of CISPR-32 measures the electromagnetic field radiated by the device under test, assessed using calibrated antennas at a defined distance inside a shielded EMC chamber across 30MHz to 1GHz. Compliance with the radiated emissions limits confirms that the device does not produce electromagnetic interference at levels that can affect co-located equipment.

2.5.1 Test Details

Power the device at 12V in STANDBY state.

Load: OUTx = 48Ω.

Sweep frequency 150kHz to 1GHz across the three frequency ranges listed in Table 2-7.

Tests performed on the DRV81545.

2.5.2 Test Setup

Receiver: Rohde & Schwarz ESW-44 EMI test receiver, version 2.10SP2, calibrated 03 April 2024.

The DUT is powered through a CISPR-32-compliant LISN and conducted noise on the supply line is captured by the receiver.

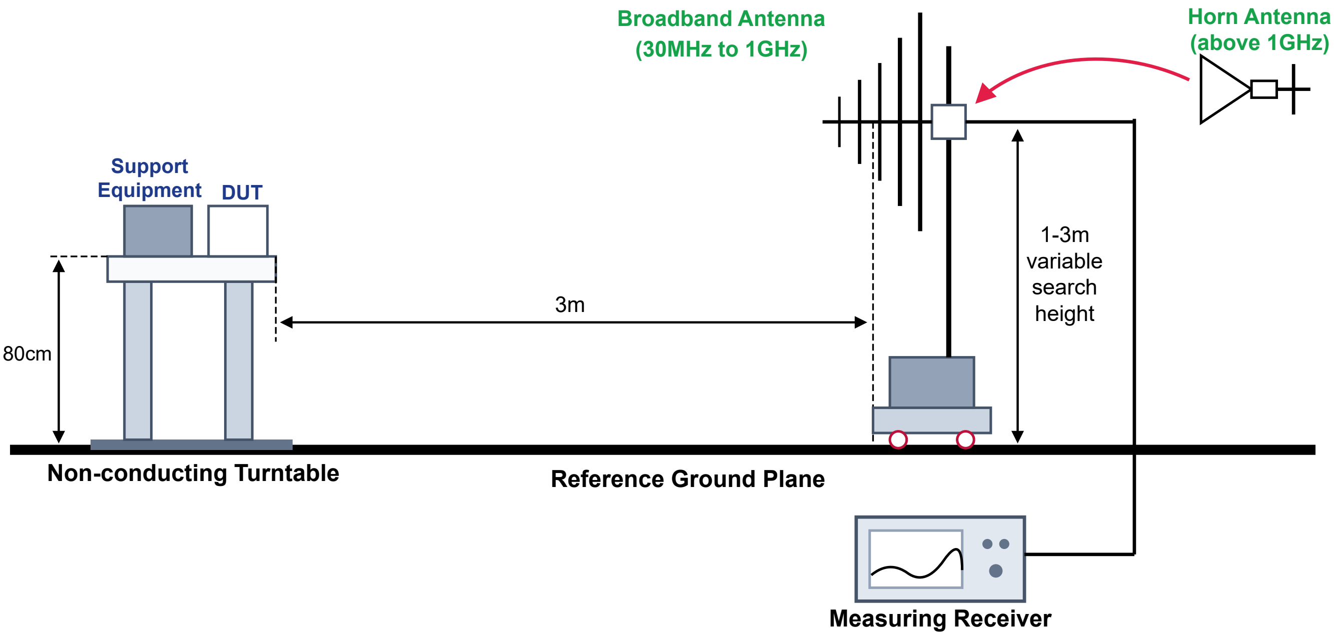

Figure 2-20. CISPR-32 Radiated Emissions Setup

Table 2-7. Radiated Emissions Hardware Setup per Frequency Range

Frequency Range	Receiver	Antenna
Range 1: 30MHz – 100MHz	EMI Test Receiver	AB900 Biconical Antenna RX1
Range 2: 100MHz – 300MHz	EMI Test Receiver	AB900 Biconical Antenna RX2
Range 3: 300MHz – 1GHz	EMI Test Receiver	ALC-100 Log-Periodic Antenna

2.5.3 Results and Observations

Figure 2-21. Radiated Emissions – Ambient (No DUT Switching)

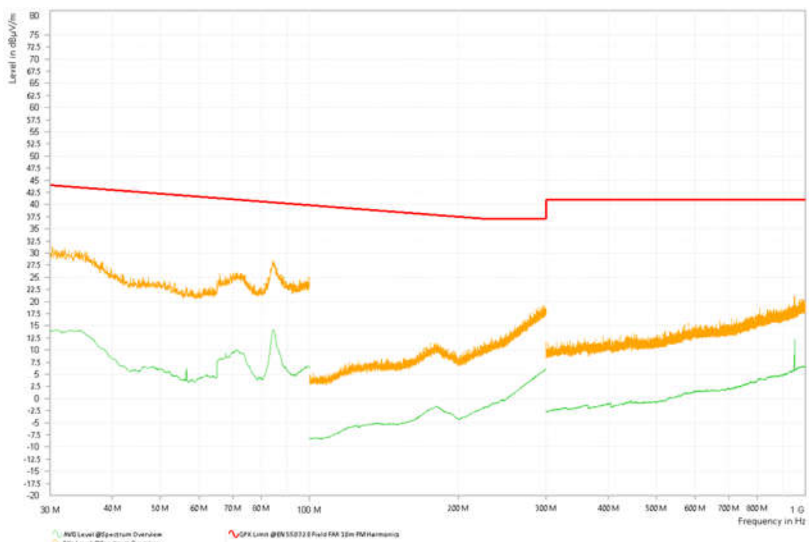

Figure 2-22. Radiated Emissions – Standby, VM = 12V, INx = 5V, No Load

Figure 2-23. Radiated Emissions – Active, VM = 12V, INx = 5V, 48Ω Load

Figure 2-24. Radiated Emissions – Active With PWM, VM = 12V, INx = 3.3V At 20kHz, 48Ω Load

2.5.4 Observations

No CISPR-32 radiated emissions limit violations were observed under any operating condition tested.

2.6 Thermal Comparison against Pin-to-Pin and Similar Competition

DRV81545 PWP package is pin-to-pin compatible with TI's DRV81646 PWP package, as well as some competitor devices.

2.6.1 Test Details

Compared DRV81545 to IPS4260L on the DRV81545EVM.

Compared DRV81646 on the DRV81646EVM to MAX14919A on the MAX14919 Evaluation Kit.

VM = 24V, ILIM = GND, COD = GND, under 65℃ ambient temperature, and room temperature.

2.6.2 Test Setup

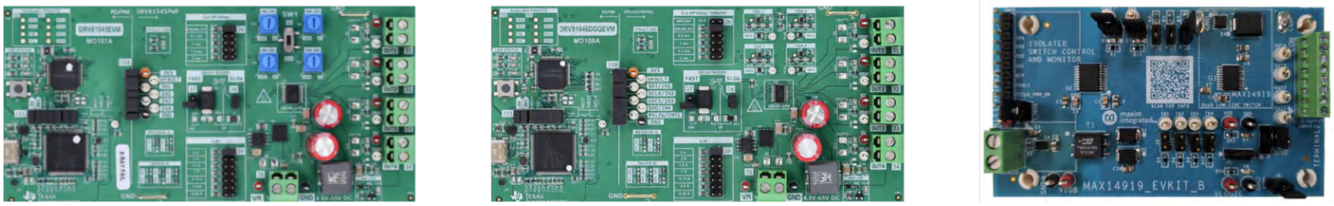

Figure 2-25. DRV81545EVM (Left), DRV81646EVM (Middle), and MAX14919 Evaluation Kit (Right)

2.6.3 Results and Observations

At 0.5A per channel (2A total) and 65℃ ambient, the DRV81x4x family demonstrates lower operating temperature than IPS4260L and MAX14919. DRV81545 reduces temperature by approximately 2.5%, while DRV81646 achieves approximately 6% lower temperature.

DRV81646 supports approximately 30% higher output current (3.3A versus 2.5A) while maintaining approximately 7% lower temperature than IPS4260L.

Across the evaluated operating conditions, the DRV81x4x family consistently demonstrates higher thermal performance compared to IPS4260L and MAX14919A as shown in Table 2-8 and Figure 2-26.

Table 2-8. Thermal Results DRV81545 and DRV81646 vs P2P competition

Device	0.5A per channel (2A total) at 65°C	One channel ON at 25°C (Max rated output current)
DRV81545	69.1°C	82.4°C at 3.3A
DRV81646	66.6°C	69.7°C at 3.3A
DRV81646DGQ	67.4°C	71.1°C at 3.3A
IPS4260L	70.9°C	75.3°C at 2.5A
MAX14919A	70.5°C	92.7°C at 0.8A

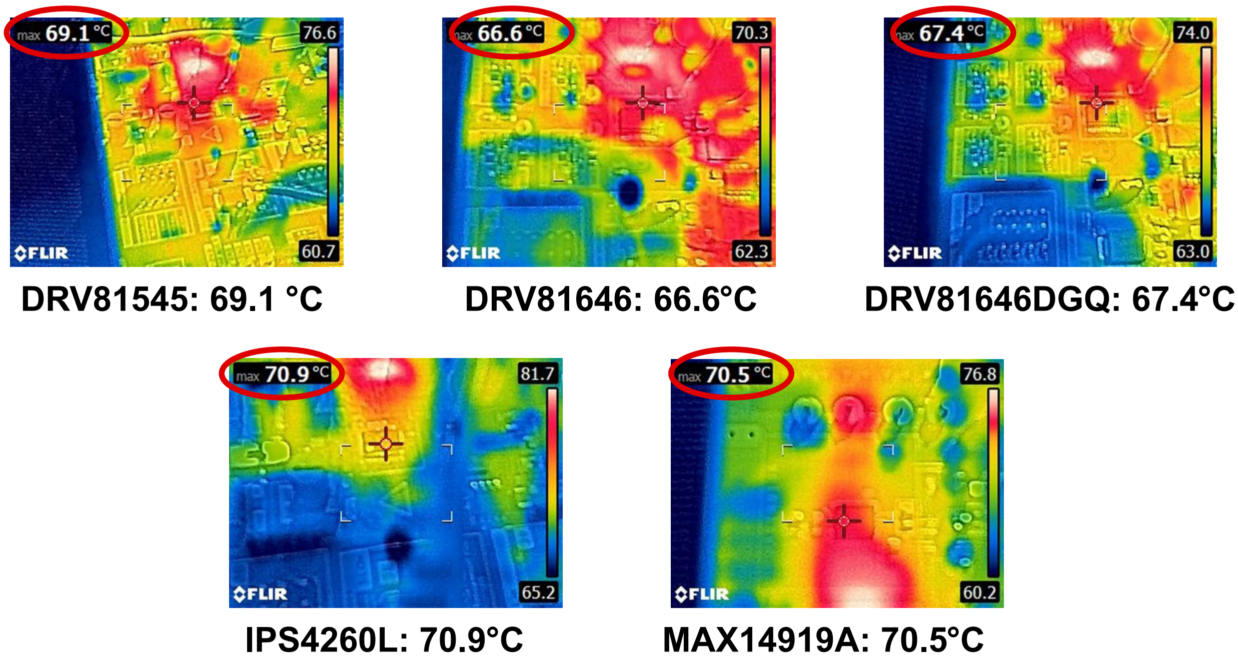

Figure 2-26. Thermal Captures of Each Device With 0.5A per Channel at 65℃

Compared to the IPS4260L, the DRV81x4x family supports up to 42% higher current on a single active channel. When all four channels are active, current capacity increases by up to 11% for the DRV81545 and up to 50% for the DRV81646.

Table 2-9. FET DC Current Capability per OUTx

Device	1 Channel ON				4 Channel ON (Per Channel)			
	25 °C	55°C	85°C	125°C	25 °C	55°C	85°C	125°C
DRV81545	3.3A	3.0A	2.6A	2.0A	2.0A	1.8A	1.6A	1.2A
DRV81646	3.7A	3.4A	3.2A	2.5A	2.7A	2.4A	2.0A	1.5A
DRV81646DGQ	3.4A	3.1A	2.9A	2.4A	2.5A	2.2A	1.7A	1.3A
IPS4260L	2.6A	2.45A	2.35A	1.95A	1.8A	1.75A	1.5A	1.3A

The DRV81545 and DRV81646 family delivers consistently higher thermal performance compared to both the IPS4260L and MAX14919A across all evaluated operating conditions, running cooler under equivalent loads, with the DRV81646 offering a particularly notable temperature advantage even when driving significantly higher currents.

Beyond thermal efficiency, the DRV81x4x family substantially outperforms the competition in current capability across the full automotive temperature range, supporting meaningfully higher output current on both single and multichannel configurations — giving system designers greater headroom and flexibility in demanding industrial and automotive applications.

2.7 Large Inductive Load Test – 1200mH per OUTx

Industrial and factory automation systems — including PLCs and digital output modules — routinely drive highly inductive loads, such as solenoid valves, relay coils, and actuators, where the stored energy in the inductor generates potentially damaging voltage flyback transients at turn-off. To validate real-world robustness under these conditions, the DRV81545 and DRV81646 were tested driving all four channels simultaneously into a representative inductive load (1.2H + 40Ω) at 24V, PWM-switched at 1Hz with a 50% duty cycle — conditions directly reflecting a customer use case. All three integrated demagnetization decay modes (slow, fast, and fastest) were exercised, as the best decay strategy depends on system-level constraints such as external clamp topology and switching speed requirements.

Both devices passed across all applicable decay modes, and the DRV81646 was further validated at 48V, demonstrating practicality for higher-voltage industrial bus environments. This test confirms that the DRV81x4x family can reliably manage inductive energy recirculation across the full range of decay configurations, giving PLC and industrial digital output module designers confidence in safe, flexible, multi-channel operation without the need for additional external protection components.

2.7.1 Test Details

Load of 1200mH + 40Ω inductor on each OUTx pin

VM = 24V to 48V as indicated in the table

PWM at 1Hz, 50% duty cycle

2.7.2 Results and Observations

DRV81545 and DRV81646 can each drive four channels ON, 1.2H + 40Ω load on each output under all decay modes with the given operating condition.

DRV81646 functionality has been tested for 48V, four channels ON, 1.2H + 40Ω load on each output.

<table>
<tr><th>Device</th><th>VM</th><th>Load/OUT</th><th>CH: ON</th><th>Decay</th><th>Status</th></tr>
<tr><td rowspan="3">DRV81545</td><td rowspan="6">24V</td><td rowspan="8">1.2H + 40Ω</td><td rowspan="8">All</td><td>Slow</td><td>Pass</td></tr>
<tr><td>Fast</td><td>Pass</td></tr>
<tr><td>Fastest</td><td>Pass</td></tr>
<tr><td rowspan="6">DRV81646</td><td>Slow</td><td>Pass</td></tr>
<tr><td>Fast</td><td>Pass</td></tr>
<tr><td>Fastest</td><td>Pass</td></tr>
<tr><td>48</td><td>Slow</td><td>Pass</td></tr>
<tr><td>40V due to EVM TVS diode maximum spec</td><td>Fast</td><td>Pass</td></tr>
<tr><td colspan="3">Test omitted; expected output clamp voltage exceeds the 60V device absolute maximum rating due to EVM TVS diode selection</td><td>Fastest</td><td>N/A</td></tr>
</table>

3 Summary

The DRV81545 demonstrates strong practicality for industrial and automotive switching applications, combining wide voltage operation, robust EMC compliance, and exceptional thermal performance in a compact, integrated design. System-level testing confirmed full compliance with IEC 61000-4-5 surge, IEC 61000-4-4 EFT, and CISPR-32 emissions standards, while thermal benchmarking validated a meaningful performance advantage over competing devices. With the ability to drive high-inductance loads across all demagnetization modes without external protection components, the DRV81545 reduces design complexity and bill-of-materials cost — making the DRV81545 a compelling choice for engineers targeting reliable, high-density load switching in space-constrained and cost-constrained environments.

4 References

1. Texas Instruments, https://www.ti.com/product/DRV81545.
2. Texas Instruments, https://www.ti.com/tool/DRV81545EVM.
3. Texas Instruments, https://www.ti.com/product/DRV81646.
4. Texas Instruments, https://www.ti.com/tool/DRV81646EVM.
5. Texas Instruments, https://www.ti.com/tool/DRV81646DGQEVM.