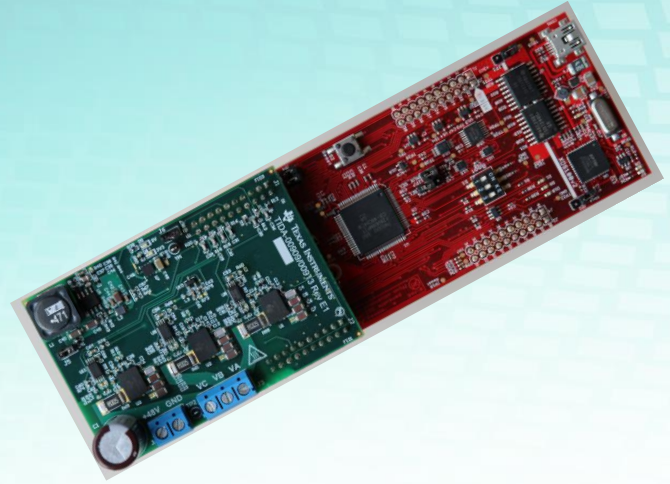


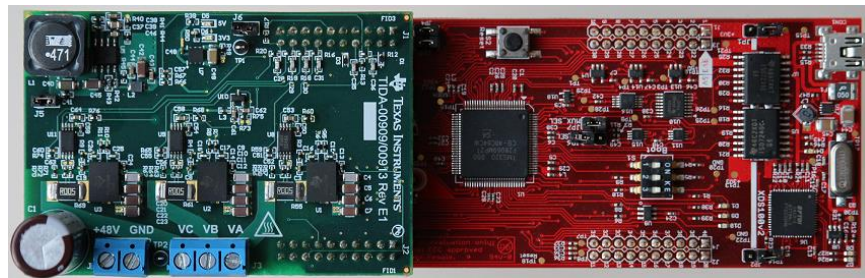
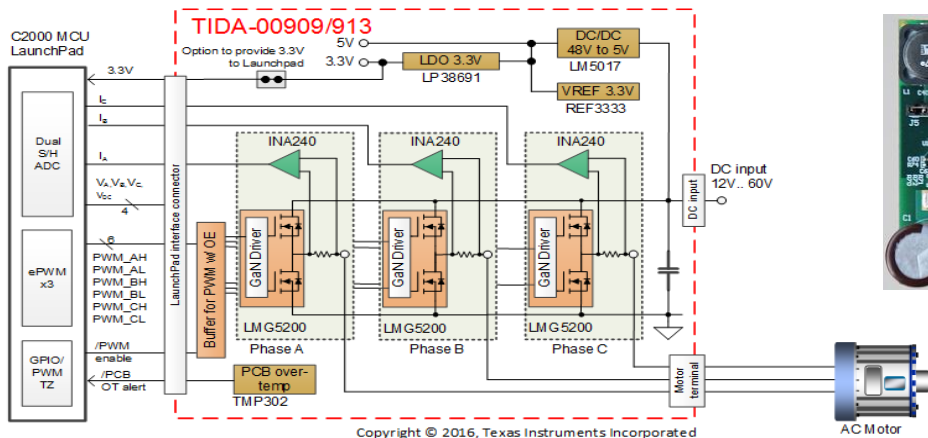
# Reference designs

## High frequency 3-phase GaN inverter



**TI** Designs

# 48V/10A High frequency PWM 3-phase GaN inverter reference design



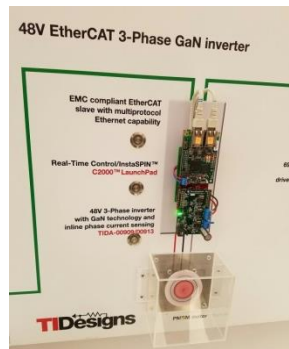
TI Design + C2000 LaunchPad

## Design features

- Inverter w/ three 80V/10A half-bridge GaN power modules LMG5200
- In-line phase current sense amplifiers INA240 with PWM rejection
- Interfaced with C2000 MCU LaunchPad
- Up to 100-kHz PWM inverter with wide input voltage range 12-60V<sub>DC</sub>

## Design benefits

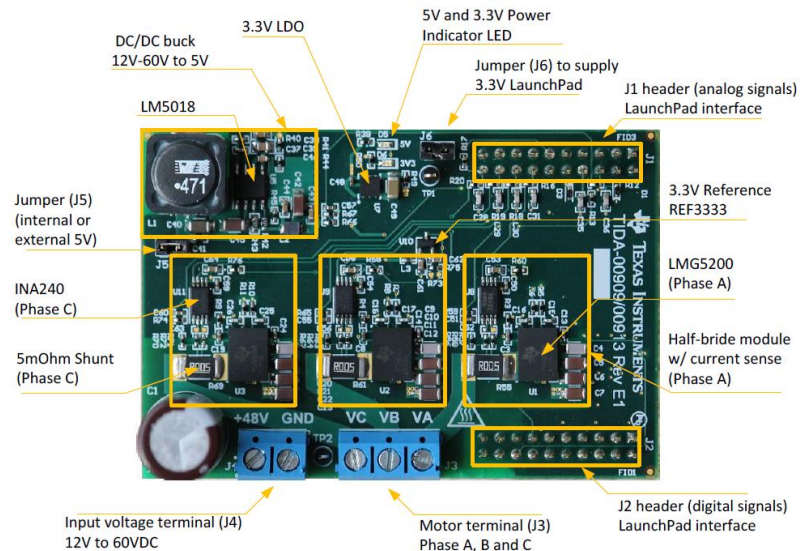
- Very low switching losses, efficiency up to 98.5% at 100-kHz PWM
- Precision current sensing with 0.1% accuracy from -25C to 85C
- Tested up to 100kHz PWM to drive low inductance/high-speed motors



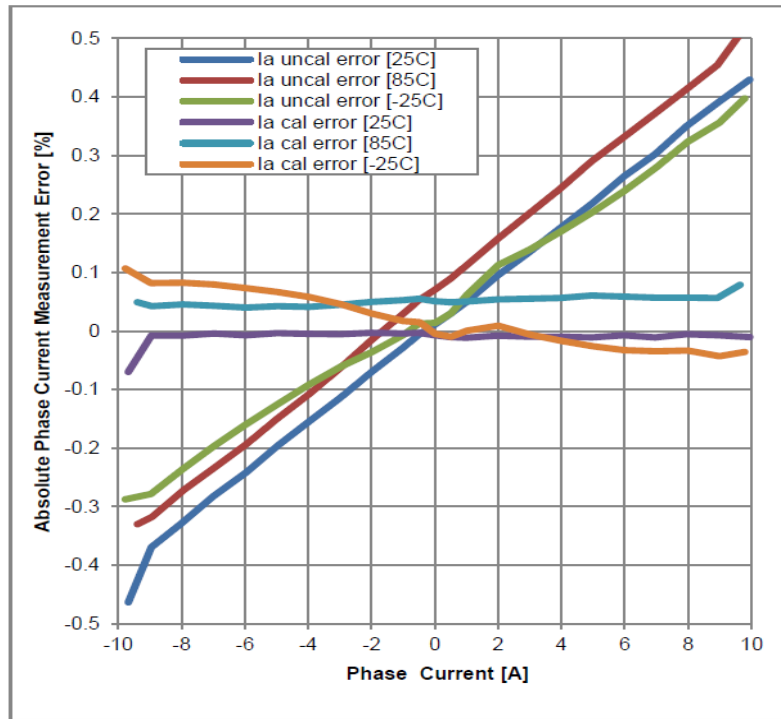
Electronica Demo

# Reference design key specifications

Parameter	Typical value	Comment
DC input	48V (12-60V)	80V abs max
Maximum 3-phase output current	7Arms (10A peak) per phase	
Power FET	GaN technology	LMG5200 GaN power stage
PWM frequency	40kHz – 100kHz	
Maximum efficiency	98.5%	at 100kHz PWM and 400W input power
Phase current accuracy (-25°C to 85°C)	±0.5% (uncalibrated) ±0.1% (calibrated)	Over nominal range ±10A One-time offset and gain calibration at 25°C
PCB over-temp alert	>85°C	Configurable from 70°C to 85°C
Interface to host processor	TI BoosterPack compatible	C2000 MCU LaunchPad LAUNCHXL-F28069M



# Reference design results (phase current accuracy)



- System error over the entire  $-25^{\circ}\text{C}$  to  $85^{\circ}\text{C}$
- Phase current error (uncalibrated)  $\pm 0.5\%$
- Phase current error (calibrated)  $\pm 0.1\%$ 
  - One-time calibration at  $25^{\circ}\text{C}$

Figure 31: Absolute calibrated and uncalibrated error in % of the phase current  $I_A$ , at  $25^{\circ}\text{C}$ ,  $0^{\circ}\text{C}$  and  $85^{\circ}\text{C}$

# Reference design results (PWM rejection)

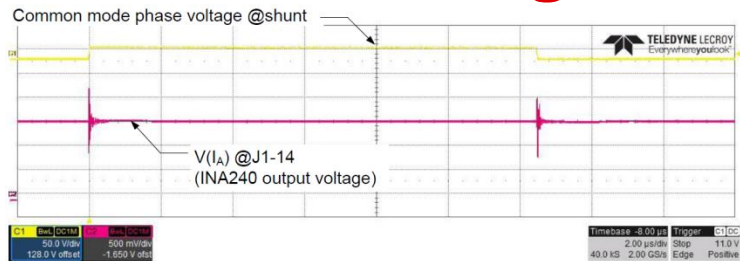


Figure 36: Phase current IA output voltage at J1-18 at 40-kHz PWM, 0A and 24VDC bus voltage

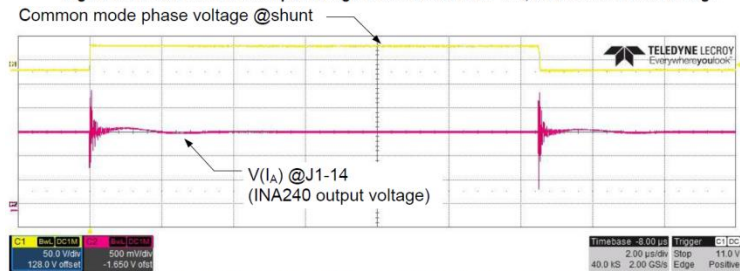


Figure 37: Phase current IA output voltage at J1-18 at 40-kHz PWM, 0A and 48VDC bus voltage

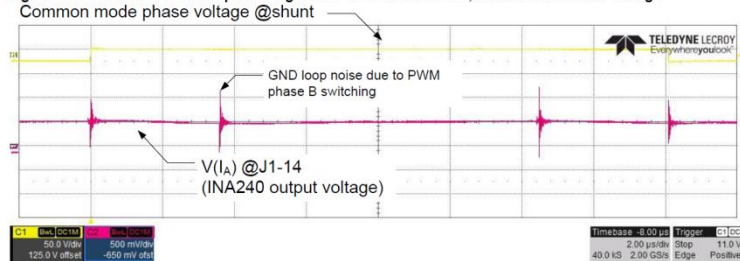


Figure 38: Phase current IA output voltage at J1-18 at 40-kHz PWM, 10A and 24VDC bus voltage

- Extremely high common-mode transients due to the LMG5200 GaN power stage at 48V/ns
- Settling time  $\sim 2\mu\text{s}$   $\rightarrow$  recommended blanking time of  $\geq 2.5\mu\text{s}$

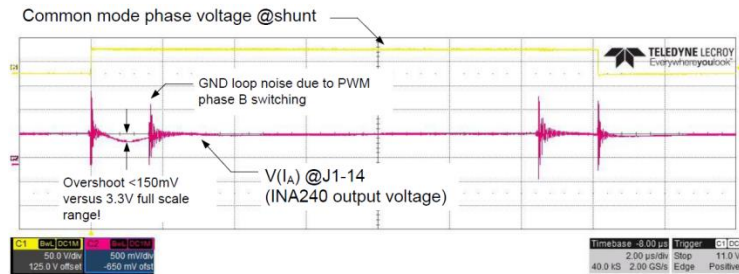


Figure 39: Phase current IA output voltage at J1-18 at 40-kHz PWM, 10A and 48VDC bus voltage

# Reference design results (phase current sensing)

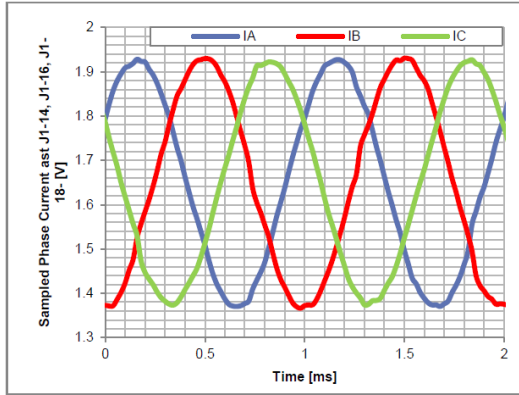


Figure 48: Phase current  $I_A$ ,  $I_B$ ,  $I_C$  output voltage sampled with C2000 MCU center aligned at 100-kHz PWM

These waveforms are what the C2000 12-bit ADC sees!

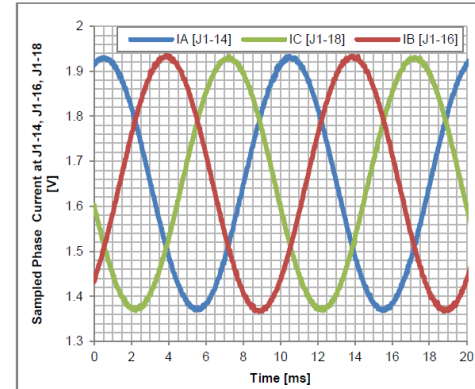


Figure 53: Phase current  $I_A$ ,  $I_B$ ,  $I_C$  output voltage sampled with C2000 MCU center aligned at 40-kHz PWM

- Hi-speed, low inductance BLDC motor typically used in drones
- 100kHz PWM switching frequency
- 2Vrms amplitude
- Low voltage servo motor
- 40kHz PWM switching frequency
- 2Vrms amplitude

**Thank you for joining!**