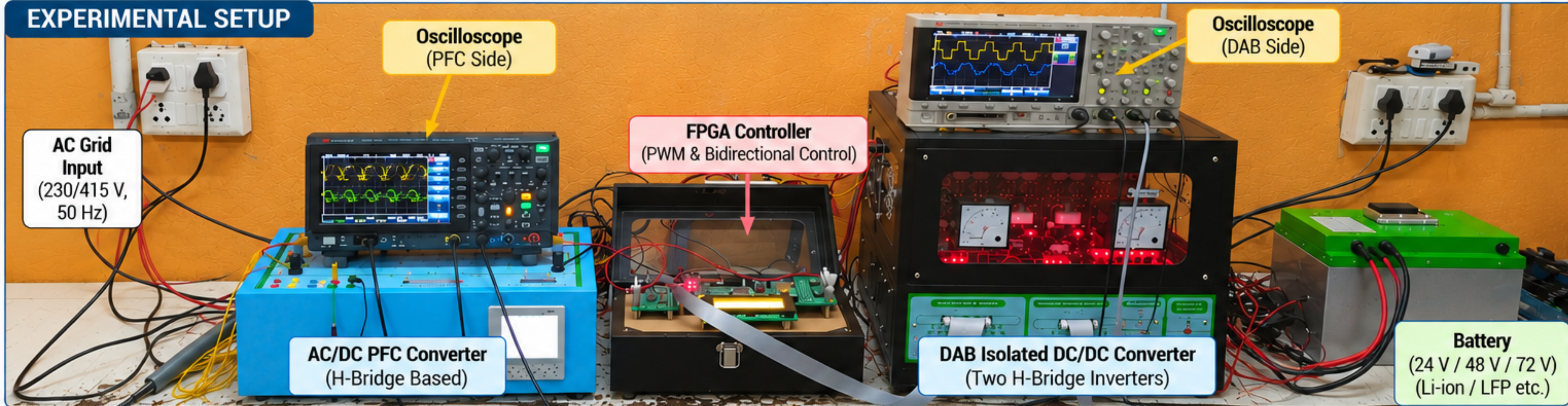


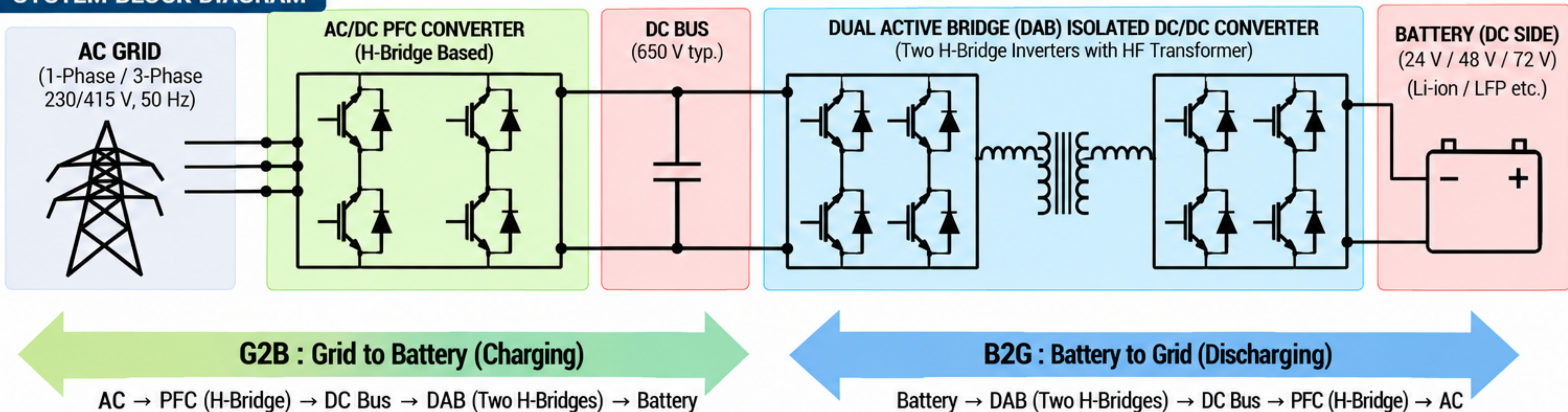
DAB BASED BIDIRECTIONAL CHARGER WITH H-BRIDGE PFC

G2B (Grid to Battery) & B2G (Battery to Grid)

EXPERIMENTAL SETUP



SYSTEM BLOCK DIAGRAM



DAB BASED BIDIRECTIONAL CHARGER WITH H-BRIDGE PFC

G2B (Grid to Battery) & B2G (Battery to Grid)

1. SYSTEM OVERVIEW

This system is a bidirectional AC–DC–DC–AC charger based on H-bridge PFC converter and Dual Active Bridge (DAB) isolated DC/DC converter. It can operate in two directions:

- **G2B (Grid to Battery)** : AC grid → PFC (H-Bridge) → DC Bus → DAB (Two H-Bridges) → Battery (Charging)
- **B2G (Battery to Grid)** : Battery → DAB (Two H-Bridges) → DC Bus → PFC (H-Bridge) → AC grid (Discharging)

The system supports battery voltage range 24 V / 48 V / 72 V (Li-ion / LFP etc.) and provides isolated bidirectional power flow with high efficiency and power factor correction.

4. DUAL ACTIVE BRIDGE (DAB) DC/DC CONVERTER

The DAB stage consists of two full H-bridge inverters connected through a high frequency transformer for galvanic isolation.

- Two active H-bridge inverters
- High frequency transformer (isolation)
- Bidirectional DC/DC power transfer
- Supports battery voltage range: 24 V / 48 V / 72 V
- Soft switching operation (reduces switching loss)
- High power density and high efficiency
- Designed for Li-ion / LFP battery charging and discharging applications

7. KEY FUNCTIONS

- Bidirectional AC–DC–DC–AC operation (G2B & B2G)
- Active power factor correction (PFC)
- Isolated DC/DC conversion using DAB
- Support for multiple battery voltage levels (24 / 48 / 72 V)
- Unity power factor operation
- Low input current harmonics
- High efficiency and high power density
- Soft switching operation
- Real-time monitoring and protection
- Suitable for EV charging, renewable energy integration, energy storage and grid support applications

2. AC/DC PFC CONVERTER (H-BRIDGE BASED)

The AC/DC stage uses a full H-bridge based bidirectional PFC converter.

- 1-Phase / 3-Phase input support (230/415 V, 50 Hz)
- Active power factor correction (PFC)
- Unity power factor operation
- Low input current harmonics (THD)
- Bidirectional power flow (AC to DC and DC to AC)
- Supports both G2B and B2G modes
- High efficiency and wide input voltage range
- Generates regulated high voltage DC bus (~650 V typ.)

5. BATTERY INTERFACE

The system supports different battery voltage levels and chemistries.

- Battery voltage range: 24 V / 48 V / 72 V
- Compatible with Li-ion / LFP batteries
- Bidirectional charging and discharging
- Over-voltage, under-voltage, over-current protection
- Battery current and voltage monitoring
- Designed for energy storage and grid support applications

8. SPECIFICATIONS (TYPICAL)

AC Input	1-Phase / 3-Phase, 230/415 V, 50 Hz
DC Bus Voltage	~650 V (typ.)
Battery Voltage Range	24 V / 48 V / 72 V (Li-ion / LFP etc.)
Power Flow Direction	Bidirectional (G2B & B2G)
Isolation	High frequency transformer (DAB)
Control Platform	FPGA based PWM and control
Protection	OCP, OVP, UVP, OTP, etc.
Communication	UART / CAN / Ethernet (as required)
Applications	EV charging, Renewable energy, Energy storage, Grid support

3. DC BUS

The DC bus is the intermediate high-voltage link between PFC and DAB converters.

- Nominal DC bus voltage: ~650 V (typ.)
- High voltage DC link capacitor bank
- Provides energy buffering and decoupling
- Maintains stable DC bus voltage in both G2B and B2G operations
- DC bus voltage regulation handled by PFC control

6. FPGA CONTROLLER

A high performance FPGA based controller is used for PWM generation, bidirectional power flow control and protection.

- PWM generation for PFC and DAB
- Bidirectional control logic (G2B & B2G)
- Synchronization and protection functions
- Real-time current and voltage measurement interface
- Flexible control algorithm implementation (e.g., phase shift control for DAB)
- Communication interface (UART / CAN / Ethernet as required)
- Fault detection and handling

9. APPLICATIONS

- Bidirectional EV charger (Grid to Vehicle / Vehicle to Grid)
- Energy storage systems (ESS)
- Renewable energy integration (Solar / Wind with storage)
- Grid support (V2G, peak shaving, load leveling)
- Industrial and commercial battery charging systems
- Research and development for power electronics laboratories

10. BENEFITS

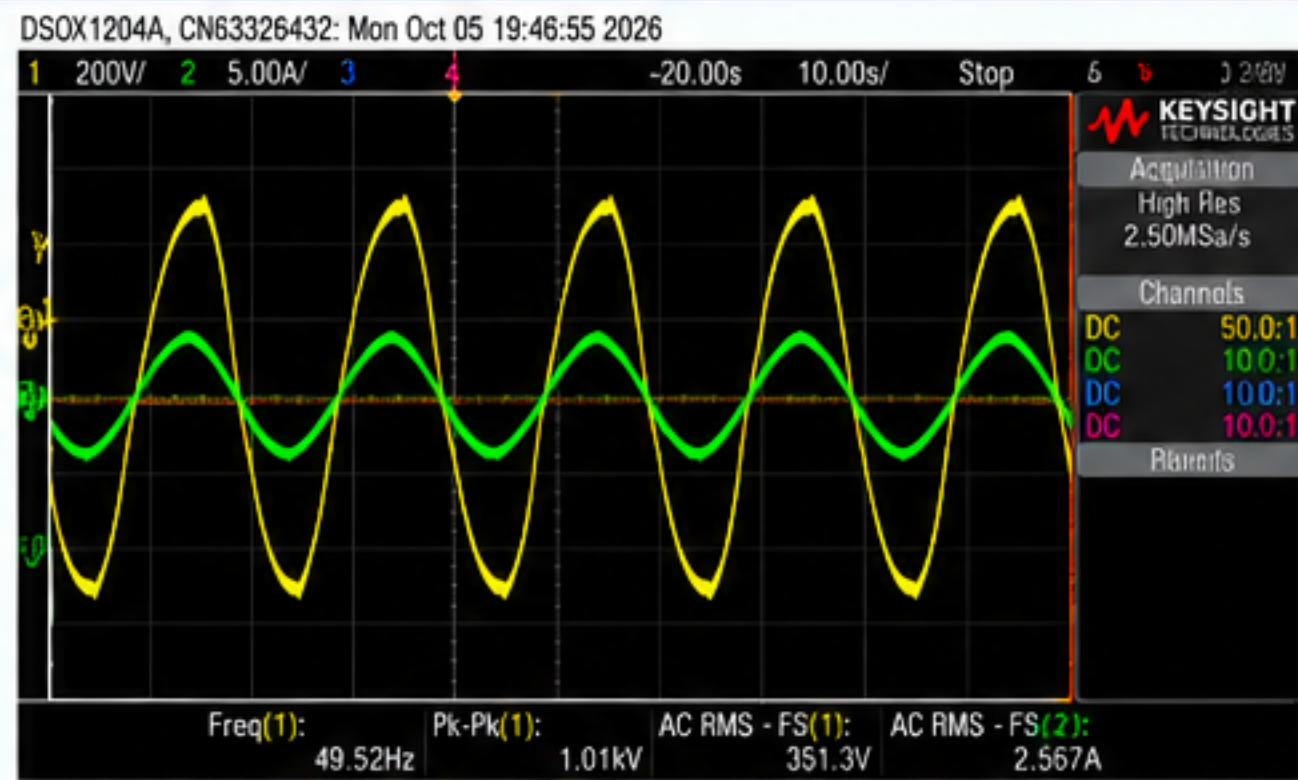
- Isolated bidirectional power flow
- High efficiency and power density
- Supports multiple battery voltage levels (24 / 48 / 72 V)
- Unity power factor and low input harmonics
- Flexible and programmable control using FPGA
- Suitable for a wide range of applications

DAB BASED BIDIRECTIONAL CHARGER WITH H-BRIDGE PFC

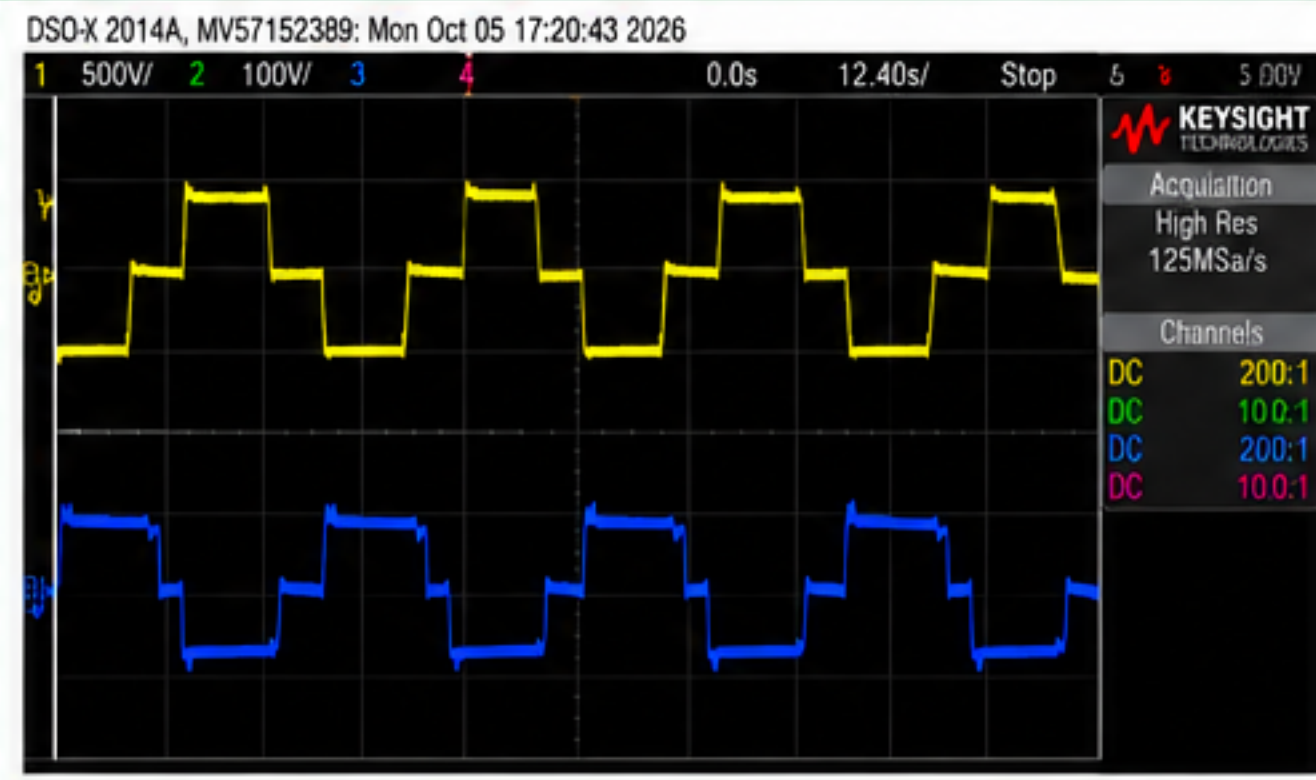
G2B (Grid to Battery) & B2G (Battery to Grid)

PAGE 3
WAVEFORMS AND RESULTS

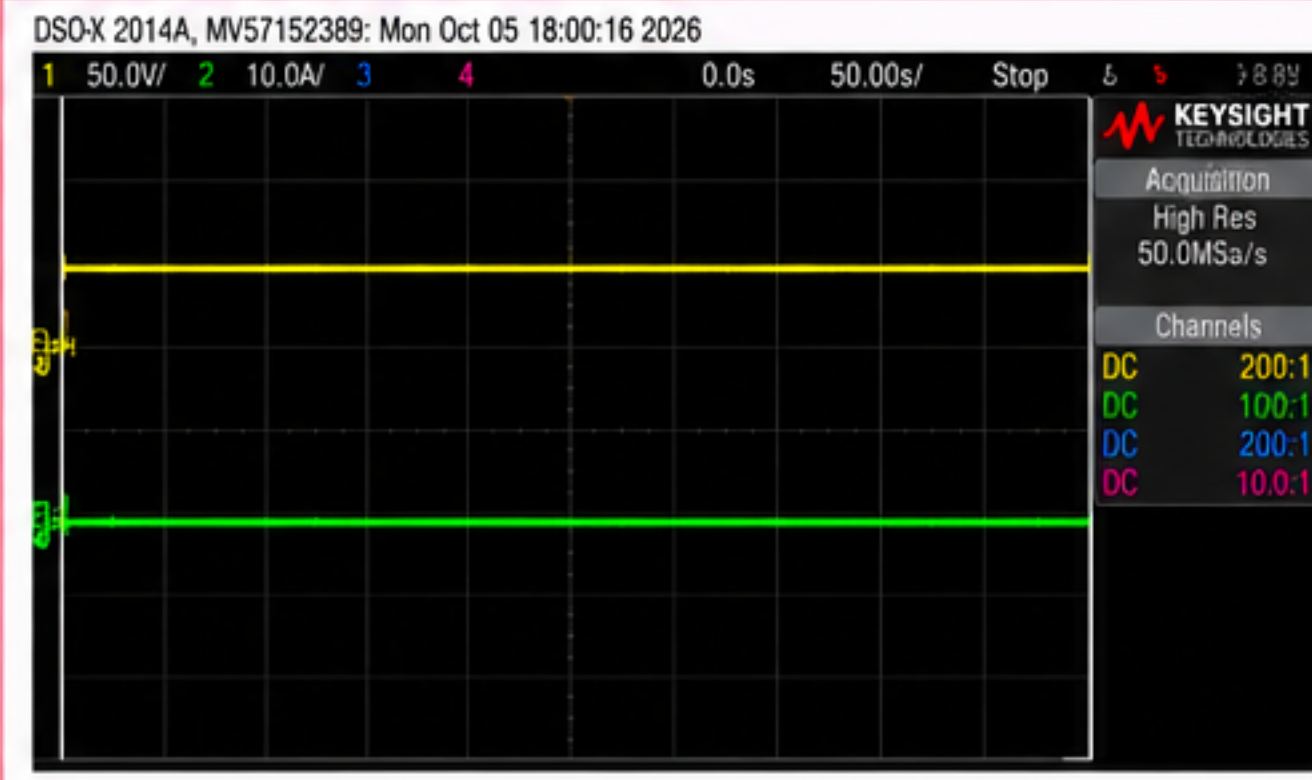
1. GRID VOLTAGE AND GRID CURRENT (G2B - CHARGING)



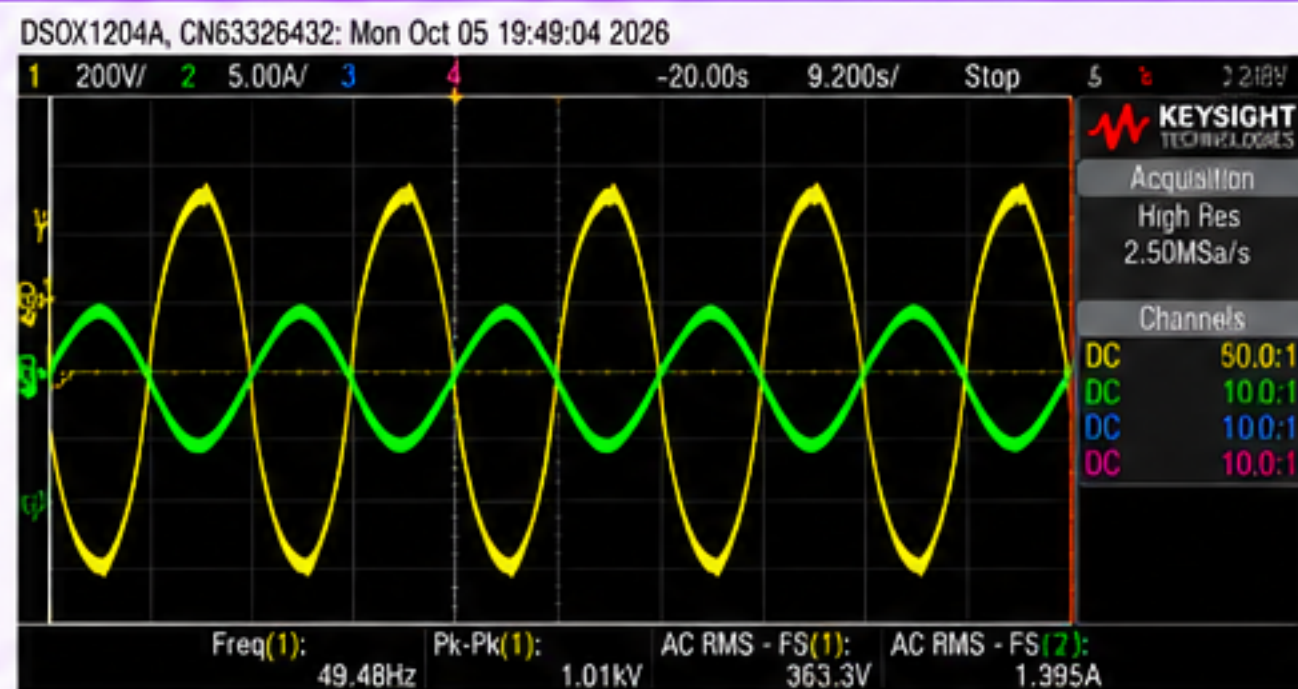
2. DAB PRIMARY AND SECONDARY VOLTAGE (G2B - CHARGING)



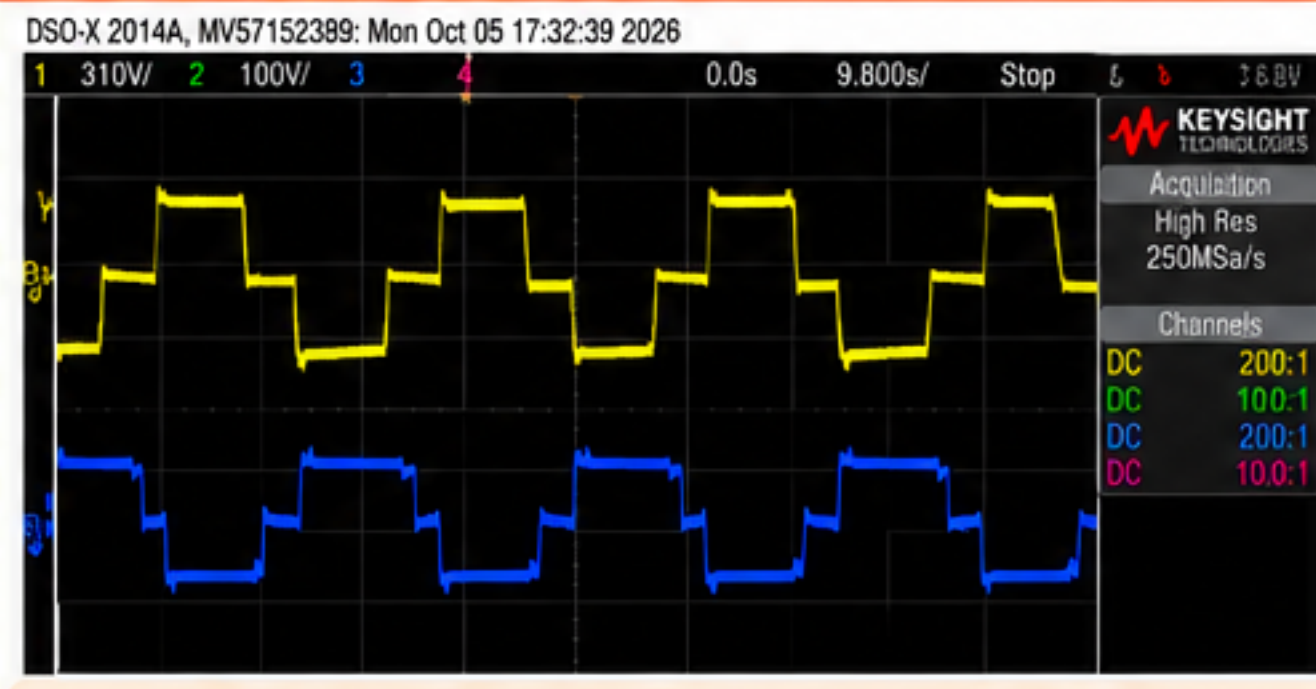
3. BATTERY VOLTAGE AND CURRENT (G2B - CHARGING)



4. GRID VOLTAGE AND GRID CURRENT (B2G - DISCHARGING)



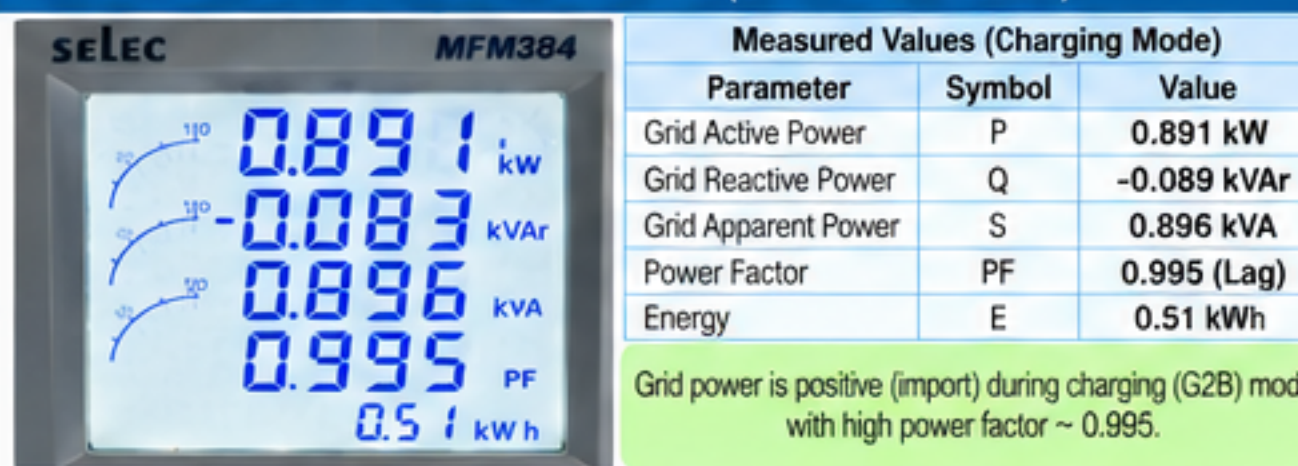
5. DAB PRIMARY AND SECONDARY VOLTAGE (B2G - DISCHARGING)



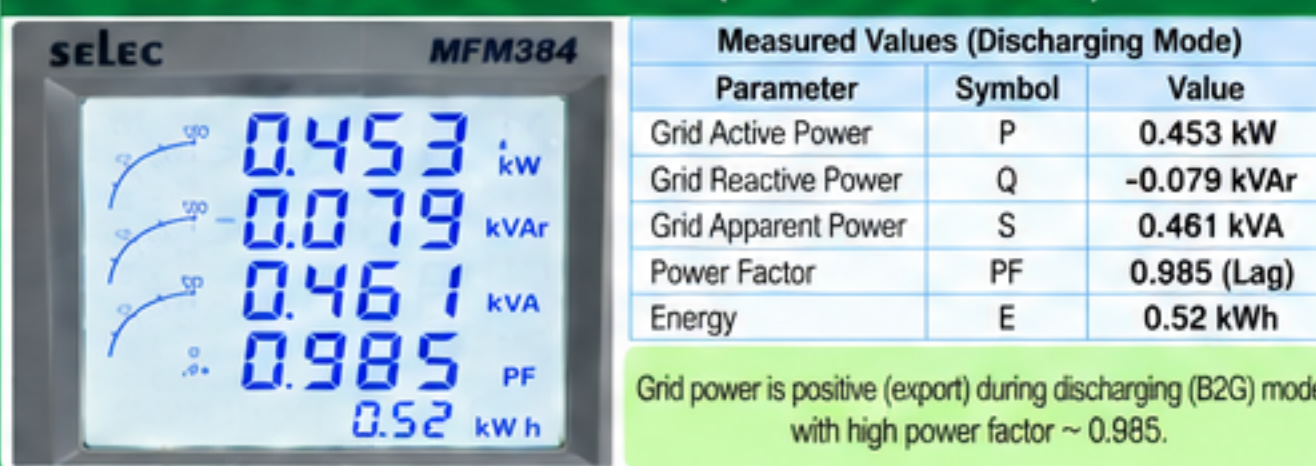
6. BATTERY VOLTAGE AND CURRENT (B2G - DISCHARGING)



7. GRID POWER AND POWER FACTOR (G2B - CHARGING)



8. GRID POWER AND POWER FACTOR (B2G - DISCHARGING)



9. KEY OBSERVATIONS

- In charging (G2B) mode, grid voltage and current are in **phase** with high PF.
- In discharging (B2G) mode, grid current is **180° out of phase** with grid voltage.
- DAB primary and secondary voltages are square waveforms with ~ 30° phase shift.
 - Charging (G2B): Primary leads secondary by ~ 30°.
 - Discharging (B2G): Primary lags secondary by ~ 30°.
- Battery voltage is regulated around 50 – 68.8 V in both modes.
- Battery current is negative in charging (G2B) and positive in discharging (B2G) mode with smooth DC (low ripple) current.
- Waveforms and measured values confirm proper operation of bidirectional charger with H-bridge PFC and DAB.