

Application Note:

TDPV1000E0C1 Single-Phase Inverter Evaluation Board

1. Introduction

The TDPV1000E0C1 inverter kit from Transphorm provides an easy way to evaluate the performance advantages of GaN power transistors in various inverter applications, such as solar and UPS. The kit provides the main features of a single-phase inverter in a proven, functional configuration, operating at or above 100kHz. At the core of the inverter are four GaN transistors configured as a full bridge. These are tightly coupled to gate-drive circuits on a board which also includes flexible microcontroller options and convenient communication connection to a PC. The switch-mode power signals are filtered to provide a pure sinusoidal output.

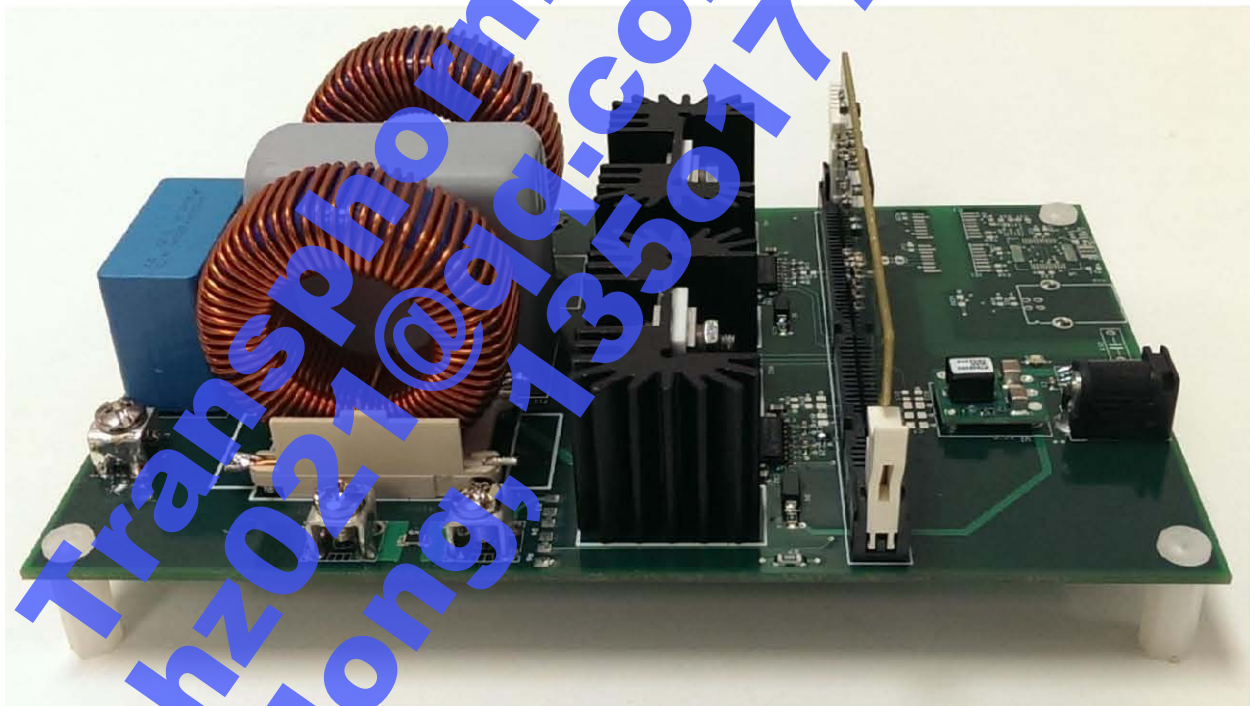


Fig. 1. Single-Phase Inverter Evaluation Board

The TDPV1000E0I inverter is a simple full-bridge inverter. Two GaN half bridges are driven with pulse-width modulated command signals to create the sinusoidally varying output. The output filter largely removes the switching frequency, leaving the 50/60 Hz fundamental sinusoid. The high-frequency (100kHz+) PWM signals are generated by the TI microcontroller and connected directly to high-speed, high-voltage gate drivers. A connection for external communication to the microcontroller is provided by an isolated USB interface. Except for the high-voltage supply for the power stage, all required voltages for the control circuitry are derived from one 12V input.

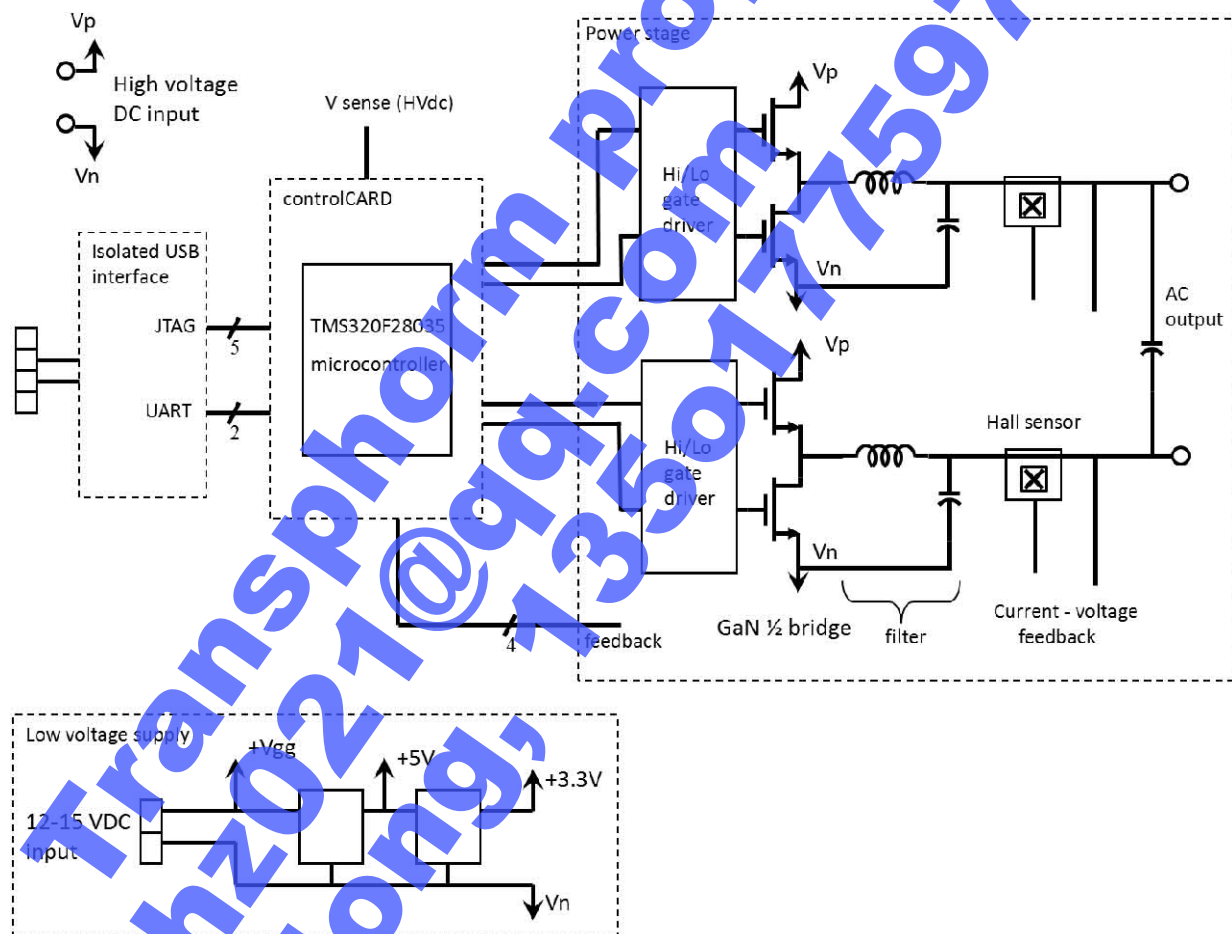


Fig.2. Circuit block diagram

The inverter takes advantage of diode-free operation*, in which the freewheeling current is carried by the GaN HEMTs themselves, without the need of additional freewheeling diodes.

*US patent 7,965,126 B2

has a $\pm 20\text{A}$ range (100mV/A). These parts are pin compatible with $\pm 5\text{A}$ and $\pm 30\text{A}$ versions of the ACS712, should higher or lower ranges be desired. Note that resistor dividers scale the 5V outputs for the 3V range of the A/D. Also note that the scaling resistors are not installed in the PCB as delivered.

Communication

Communication between the microcontroller and a computer is accomplished with a standard USB cable. The isolated USB interface enables simultaneous operation of two physical ports to the microcontroller: a JTAG port for debug and loading of firmware, and a UART for communication with a host application.

Control Card

The microcontroller resides on a removable card, which inserts in a DIM100 socket on the inverter PCB. The socket can accept many of the C2000™ series controlCARDS from Texas Instruments. The TMDSCNCD28035 Piccolo controlCARD supplied with the kit provides capability to experiment with a wide variety of modulation and control algorithms. It comes loaded with firmware to allow immediate (out-of-the-box) operation. Should the user wish to use an alternate microcontroller family, an appropriate control card can be designed to insert into the DIM100 socket.

Heat Sink

The two TO-220 GaN transistors of each half bridge are mounted to a common heat sink. The heat sink is adequate for 1000W operation without forced air flow. Even higher efficiency at high power may be achieved by minimizing the temperature rise. This may be accomplished with forced airflow. Alternately the heat sinks could be replaced with larger or more effective ones.

Connections

Power for the AC output is derived from the HV DC input. This will typically be a DC power supply with output voltage up to 400Vdc . A $22\mu\text{F}$, 450V , low ESR, film capacitor is provided as a bypass capacitor for the HV supply, along with several lower valued ceramic capacitors in

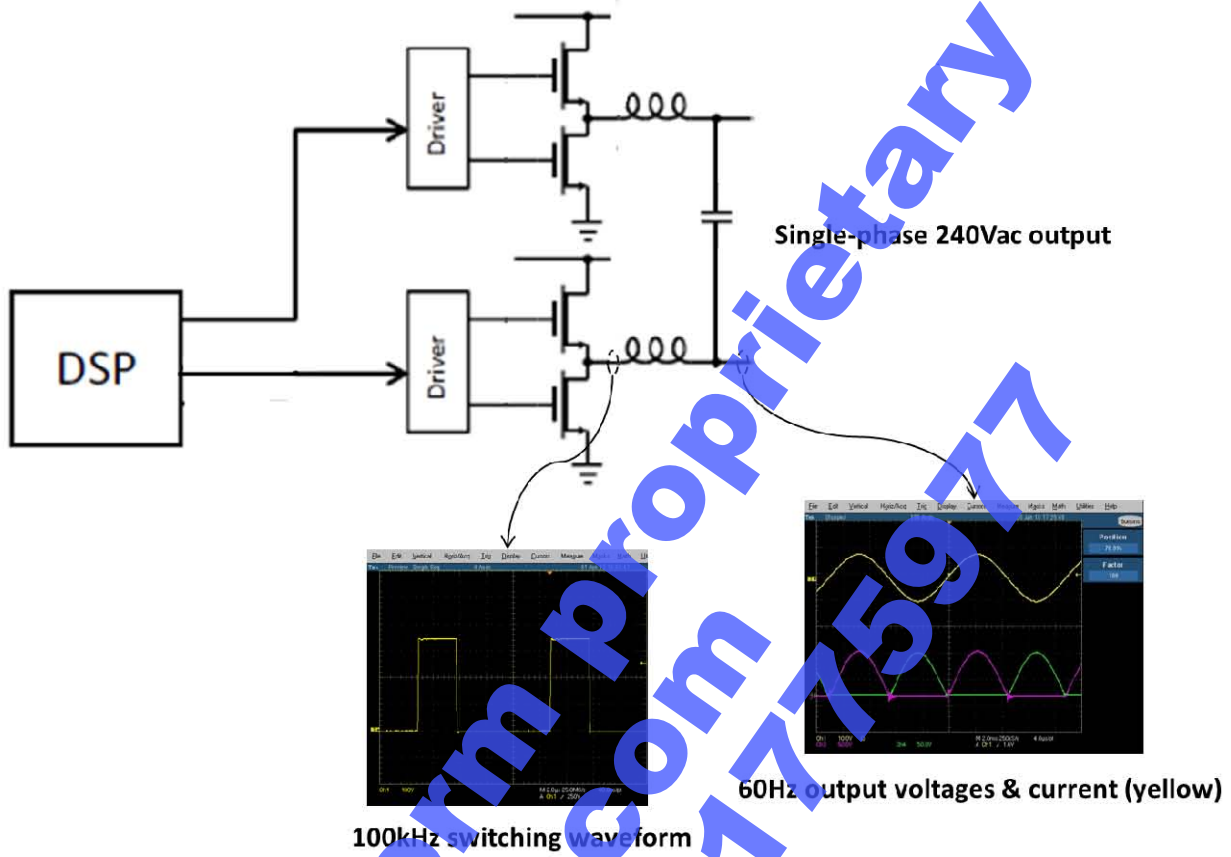


Figure 6. Typical Waveforms

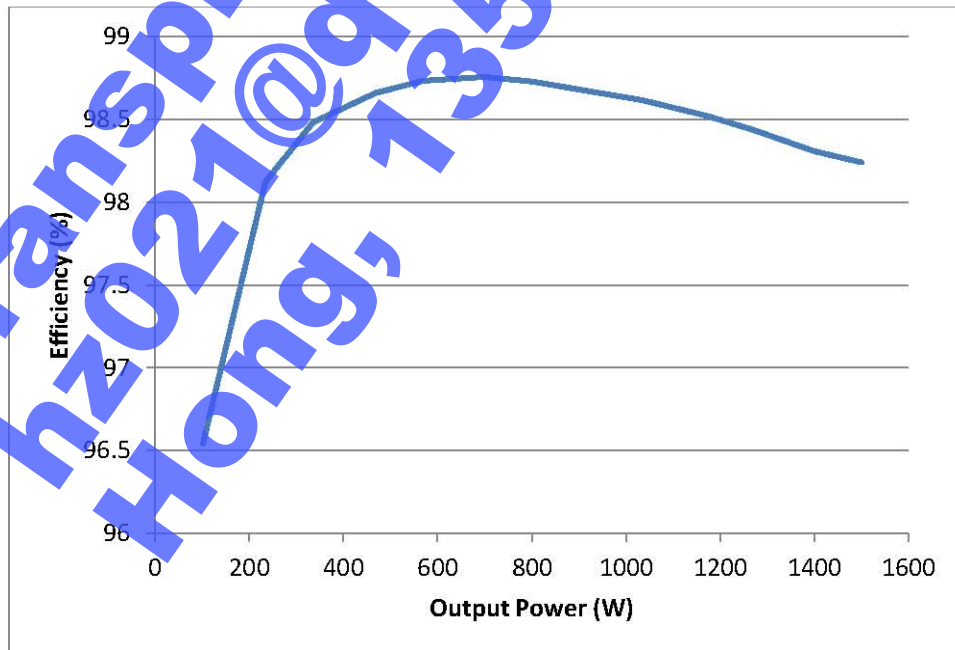


Figure 7. Typical Efficiency 240Vac output