REPLACING TRADITIONAL OPTO-DRIVERS WITH THE Si826X DRIVER FAMILY

1. Introduction

Optocoupler-based gate drivers ("opto-drivers") have been around for decades and favored over other gate drive solutions because they provide safety isolation and level shifting in a single package. Typical opto-driver applications include motor and motion control, switch-mode power delivery, and test and medical systems.

Opto-drivers are, however, not without their problems; they exhibit weaknesses in critical areas making them less-than-optimal for some applications and forcing designers to compromise circuit performance and/or add external components. Until recently, replacing a legacy opto-driver with a modern CMOS isolated gate driver required significant design and PCB changes that increased costs and design risks. The Si826x family changes this dynamic by offering pin- and package-compatible opto-driver replacements that retrofit opto-driver sockets without PCB modification and provide significant gains in performance and reliability. This application note examines these twenty-first century opto-driver upgrades.

2. Si826x Operation

The input-side diode emulator mimics the behavior of an opto-driver LED to ensure compatibility with existing opto-driver input circuits. The diode emulator enables the high-frequency transmitter when input current I_F is at or above its threshold value, sending a high-frequency carrier across the isolation barrier to the receiver. This high-selectivity receiver forces the output driver high when sufficient in-band energy is detected. Input current below the I_F threshold disables the transmitter, causing the receiver to force the output driver low.
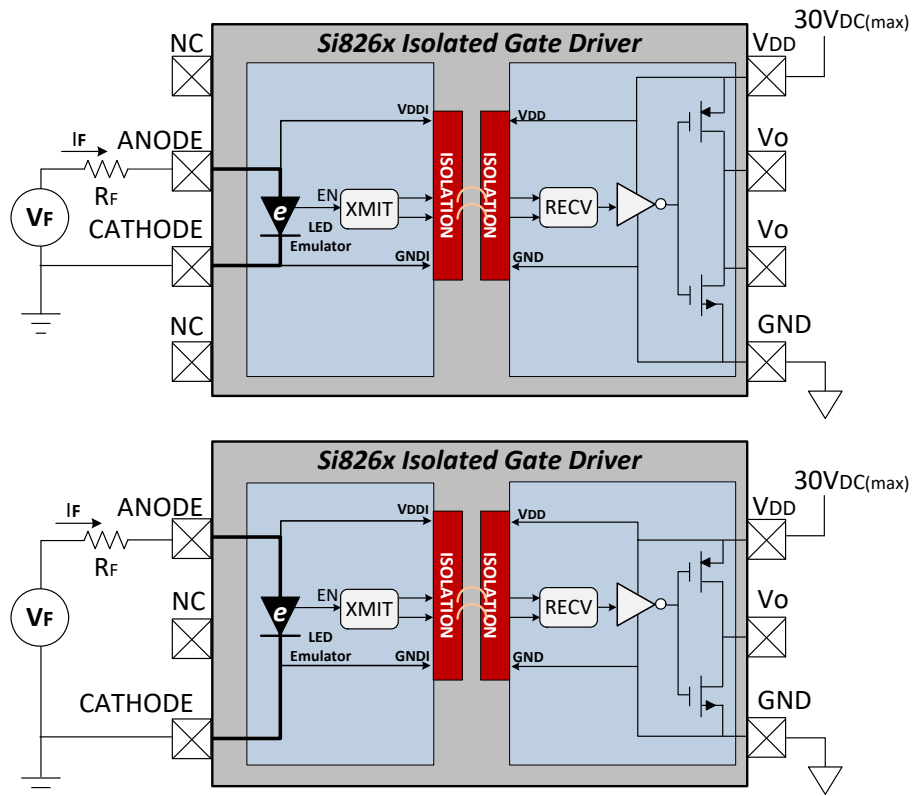

Figure 1. Si826x 4 and 6-Pin Block Diagrams

This architecture provides numerous advantages over opto-drivers:

- **Pin and Package Drop-In Opto-Coupler Upgrade**
  Faster propagation time and better parametric stability over voltage and temperature compared to opto-drivers.

- **Standard CMOS Process Technology**
  CMOS is a well-understood process technology with 40+ years of development and offers 5.5 times lower FIT rate (failures-in-time) than legacy opto-drivers as well as an expanded operating temperature range of –40 to +125 °C (compared to –40 to +85 °C for opto-drivers). The Si826x isolation barrier lifetime is 10 times higher than that of opto-drivers. Part-to-part matching is 14 times tighter than the Gallium Arsenide (GaAs) process technologies used by opto-drivers.

- **Precise Current Thresholds with Hysteresis**
  The Si826x output is either low or high, with none of the ambiguous output states found in opto-drivers, and excellent threshold stability over voltage and temperature.

- **Improved Performance**
  Faster and more precise timing, lower-power operation, higher reliability, reduced internal parasitic coupling for better CMTI, and greater parametric stability over temperature than opto-drivers.

- **Silicon Dioxide Based Capacitive Isolation Barrier**
  Silicon dioxide is an ultra-stable material enabling an unparalleled lifetime of over 60 years, compared to less than 15 years for the mold compound and polyimide tape used in opto-drivers.

- **Superior Surge Tolerance**
  Withstands 10 kV surge per IEC 60065.

- **Wide Product Range**
  The Si826x digital isolators are available in SOIC-8, DIP8, LGA8, and SDIP6 packages. (For more information, see the Si826x isolated driver data sheet.)

3. Applications

3.1. Replacing an Existing Opto-Driver with the Si826x

- Use the Si826x data sheet or online guide to select the correct pin- and package-compatible Si826x version for the end application.
- Desolder and discard the existing opto-driver from the board.
- Solder the selected Si826x device into the site previously occupied by the opto-driver.
- If necessary, adjust the value of R_F to achieve a maximum anode current of 6 mA.
- Connect power and verify proper system operation.

Note that the Si826x is compatible with typical opto-driver circuits commonly used to improve opto-driver CMTI performance (typical components include shorting switches and reverse diode clamps). Components of this type can be left in place or removed at the user's option.

4. Evaluation Board

The Si826x package and pin-compatibility make upgrading existing opto-driver circuits quick and easy. Simply look-up the closest replacement to the incumbent opto-driver and replace it with the Si826x. The EVB shown in Figure 2 exercises the Si826xA or B isolated gate driver and competing opto-driver simultaneously. An external digital input signal is buffered by an onboard driver and fed into the inputs of both devices while the output signals are observed on an oscilloscope. Figure 3 shows the outputs of both devices at 25 °C, while Figure 4 shows the outputs at 85 °C. Note the faster propagation delay rise times provided by the Si826x.
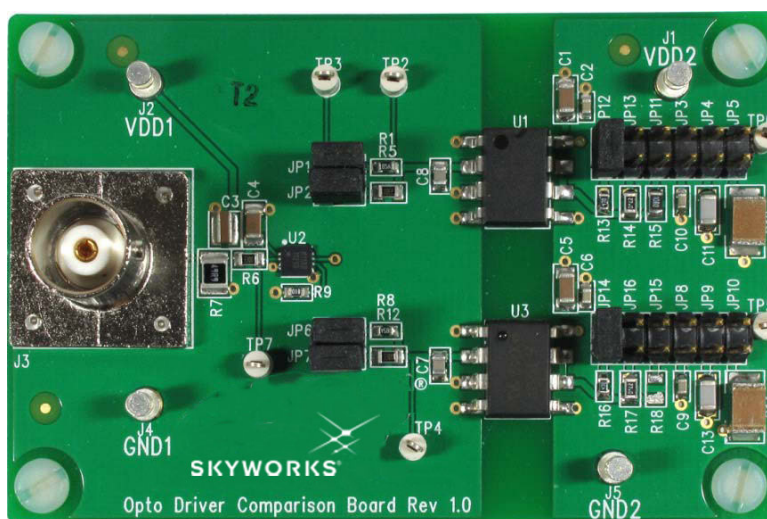
Figure 2. Si826x Isolated Gate Driver vs. Opto-Driver Comparison Board

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Figure 4 uses the same setup as Figure 2 but, operating at an elevated temperature of 85 °C. The Channel 1 waveform is the Si826x output, and the Channel 2 waveform is the HCPL-4506 output. As operating temperature increases, the HCPL 4506 output falling edge is substantially slower, and the propagation delay worsens compared to Figure 3. Note that the Si826x output performance is essentially the same, as shown in Figure 3.
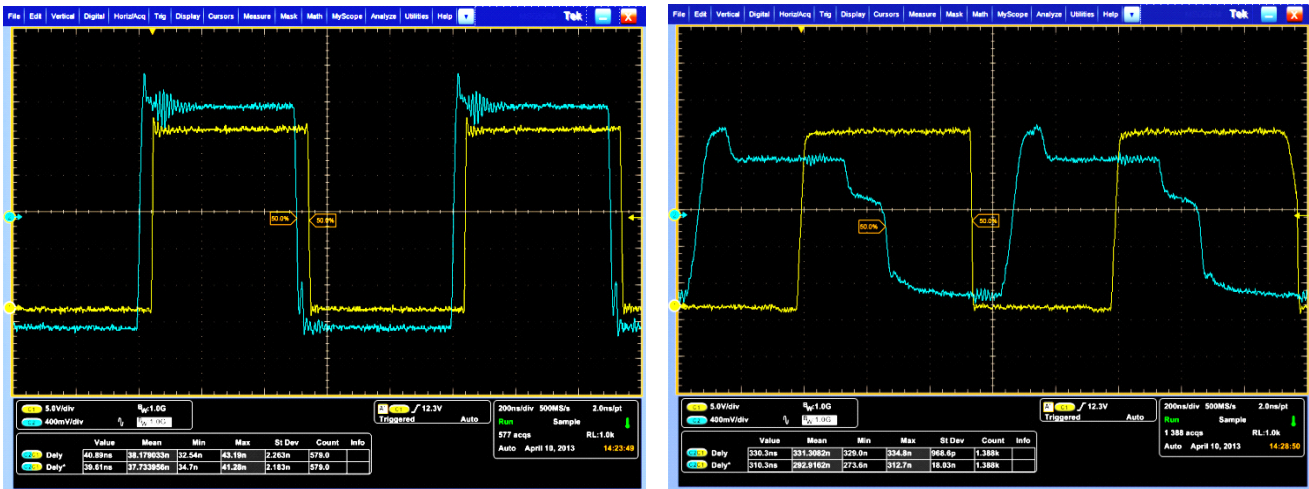
Figure 3. Propagation Delays at 25 °C
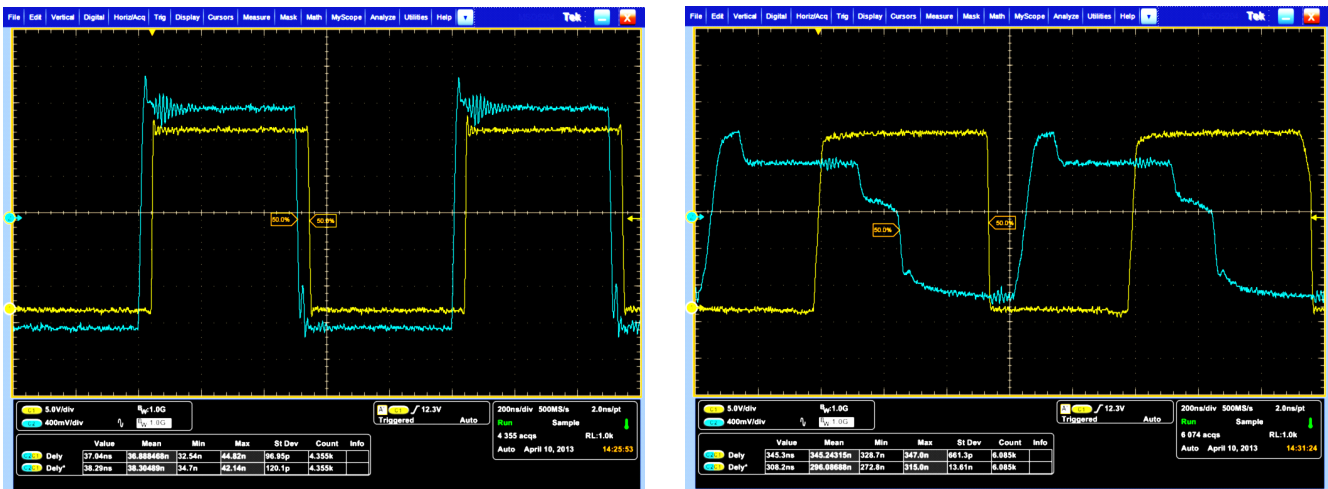
Figure 4. Propagation Delays at 85 °C

5. Summary

The Si826x isolated gate driver upgrade is the first and only enhanced opto-driver replacement technology. This device family offers higher performance and greater reliability and ease-of-use than legacy opto-drivers. The Si826x easily retrofits into existing opto-driver sites and requires no PCB changes. These devices are ideal for retrofit or new designs.

DOCUMENT CHANGE LIST

Revision 0.1 to Revision 0.2

■ Extensive rewrite of document.

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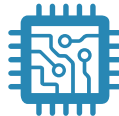
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