

デザイン・ガイド: TIDA-020029

車載リア・ライト用デジタル・インターフェイス LED 駆動モジュールの リファレンス・デザイン



概要

このリファレンス・デザインは、インタラクティブ・テールライト・クラスタなどの車載リア・ライト・アプリケーションに適した、コスト効果の高いソリューションであり、将来的に自動車の安全性向上ならびに自動車設計のパーソナル化を促すものとなります。このリファレンス・デザインには、2つのリニア LED ドライバが搭載されています。コントローラ・エリア・ネットワーク (CAN) 物理層 (またはオプションでローカル相互接続ネットワーク (LIN)) を使用することで、LED ドライバの UART ベース FlexWire インターフェイスにより、EMI 性能を落とさず、簡単に長距離のオフボード通信を実現できます。

リソース

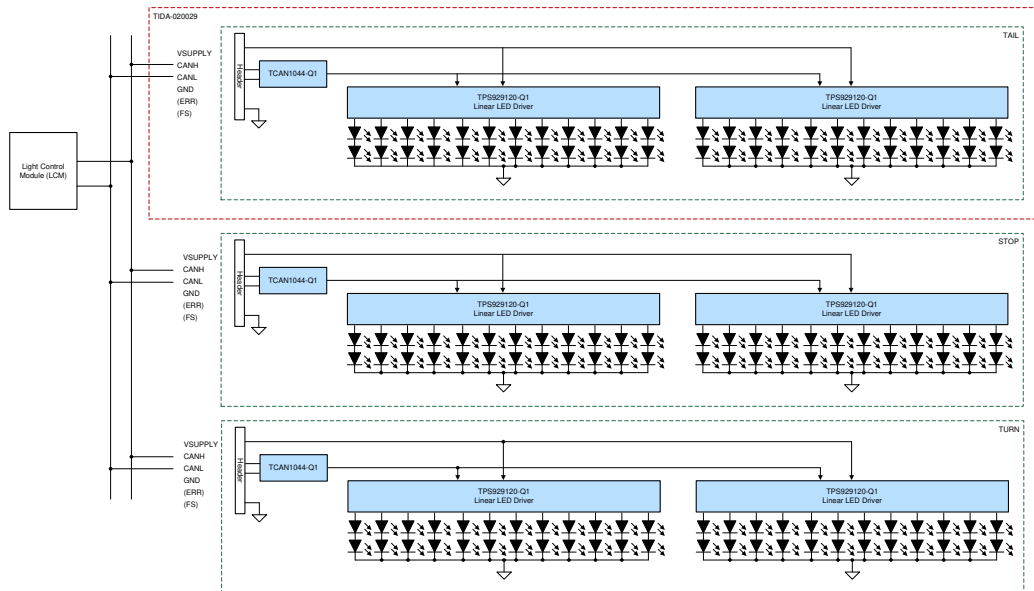
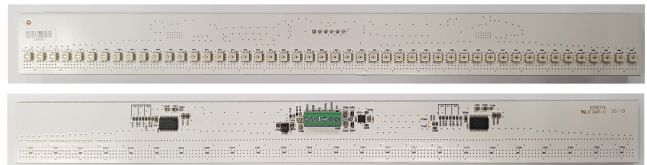
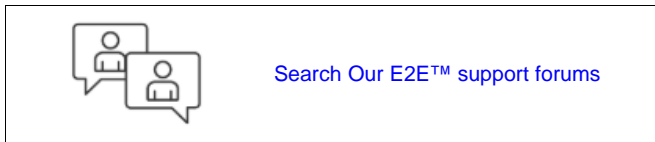
- TIDA-020029 デザイン・フォルダ
- TPS929120-Q1 プロダクト・フォルダ
- TCAN1042-Q1 プロダクト・フォルダ
- TLIN1029-Q1 プロダクト・フォルダ

特長

- 多数のピクセル
 - 48 個の LED (チャンネルあたり 2 個) を駆動
- 各 LED チャンネルで完全な機能セットを使用可能
 - 診断および保護機能
 - パルス幅変調 (PWM) 調光
 - 高精度の電流設定
- UART ベース FlexWire インターフェイス
 - 各 FlexWire バスが最大 17 個のデバイスをサポート

アプリケーション

- リア・ライト: デジタル・インターフェイス LED 駆動モジュール
- 車内照明: 周囲光モジュール





使用許可、知的財産、その他免責事項は、最終ページにあるIMPORTANT NOTICE (重要な注意事項)をご参照くださいますようお願いいたします。

1 System Description

This reference design incorporates two linear LED drivers. By using a controller area network (CAN) physical layer (or a local interconnect network (LIN) optionally), the UART-based FlexWire interface of the LED drivers make it possible to avoid using a local microcontroller and still easily accomplish long-distance, off-board communication. The topology in this reference design offers a cost-effective solution for automotive rear-light applications such as interactive tail-light clusters.

1.1 Key System Specifications

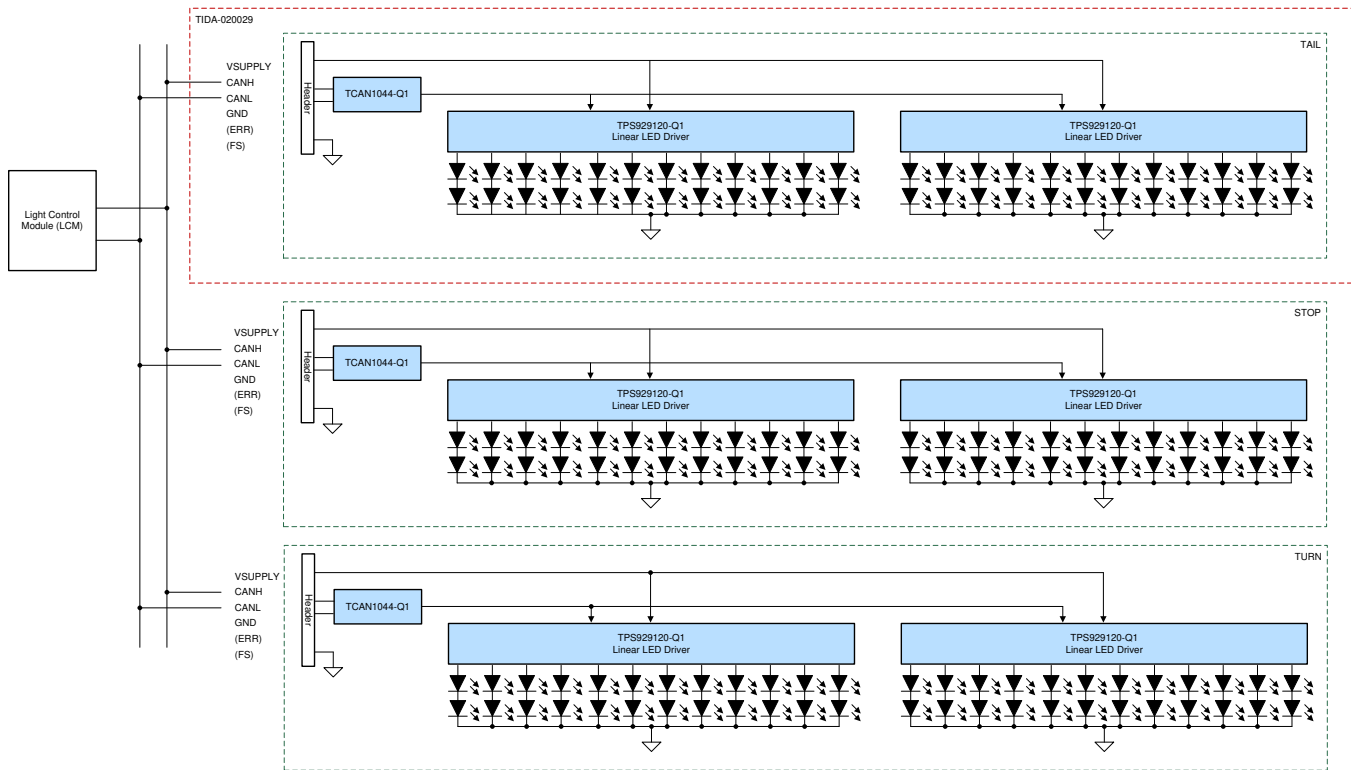
表 1. Key System Specifications

PARAMETER	SPECIFICATIONS
DC input voltage range	4.5 V - 40 V
LDO output voltage	5 V
LED current	6 mA - 50 mA
Operating ambient temperature	-40°C to 85°C
PCB form factor	26.75 mm x 133.75 mm (2 layers)

2 System Overview

2.1 Block Diagram

図 1. TIDA-020029 Block Diagram



2.2 Design Considerations

To simplify this reference design and to increase flexibility for use in a variety of applications, the board consists of two linear LED drivers that are connected to the same communication bus and use LIN or CAN transceiver for off-board communication. This board format has a simple connector interface, which allows this reference design to be evaluated with any selected MCU-Control board with a transceiver on it.

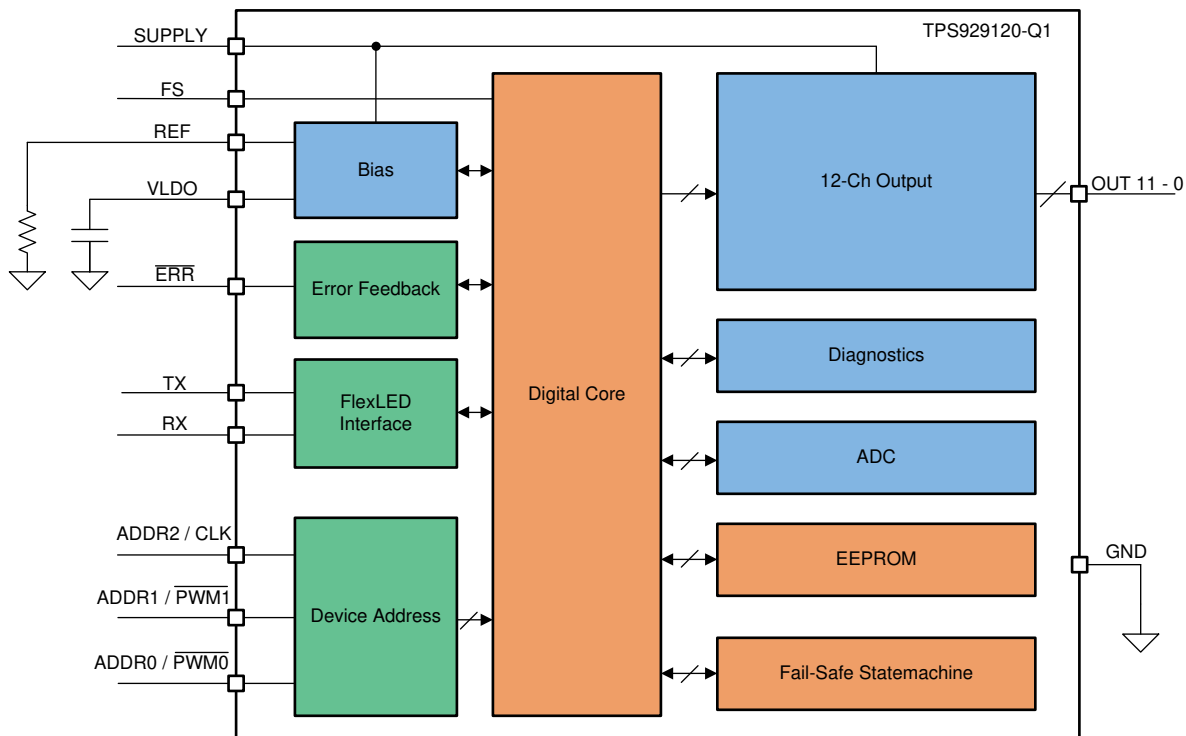
For ease of testing, the reference design board includes 48 LEDs with two on each output channel. Each channel can be controlled individually.

2.3 Highlighted Products

2.3.1 TPS929120-Q1 Linear LED Driver

The TPS929120-Q1 is a 12-channel, 40-V high-side LED driver that controls the 8-bit output current and 12-bit PWM duty cycles. The device meets multiple regulation requirements with LED open-circuit, short-to-ground, and single LED short-circuit diagnostics. A configurable watchdog also automatically sets failsafe states when the MCU connection is lost, and, with programmable EEPROM, TPS929120-Q1 can flexibly be set for different application scenarios.

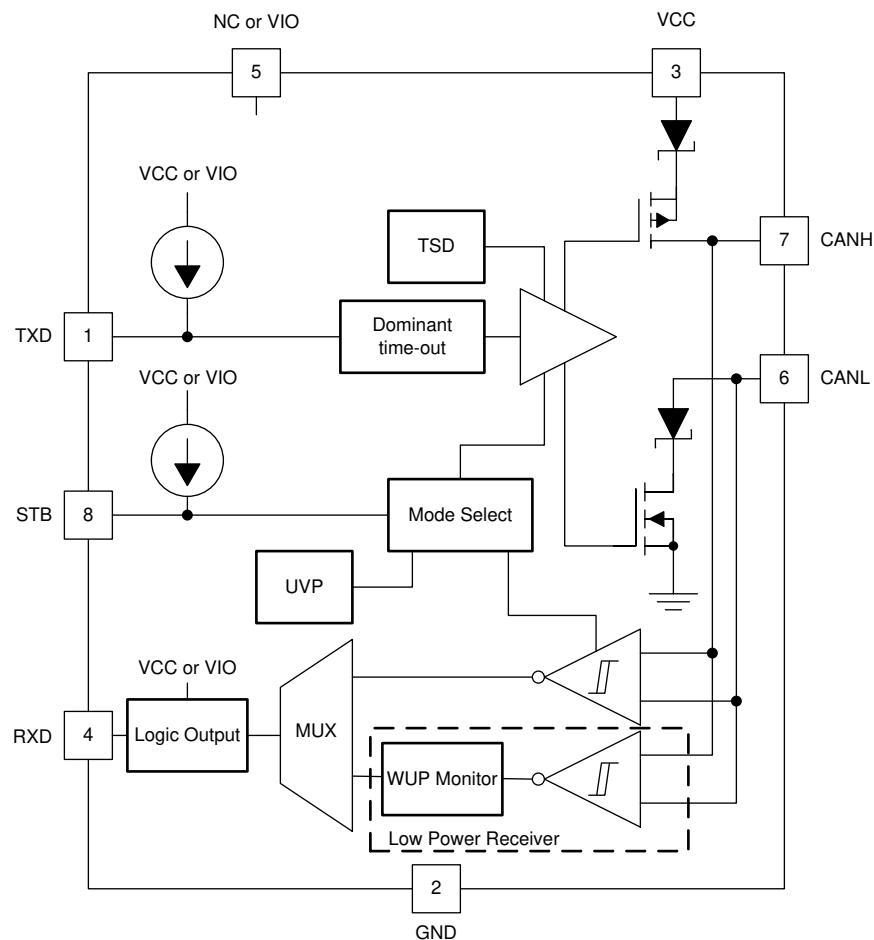
図 2. TPS929120-Q1 Block Diagram



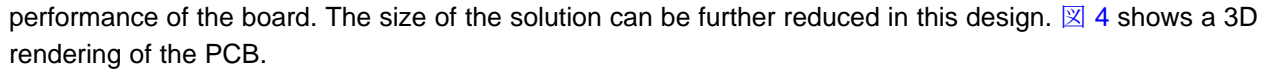
2.3.2 TCAN104x-Q1 CAN Transceiver

This CAN transceiver family meets the ISO11898-2 high-speed CAN (Controller Area Network) physical layer standard. All devices are designed for use in CAN FD networks up to 2 Mbps (megabits per second). Devices with part numbers that include the *G* suffix are designed for data rates up to 5 Mbps, and versions with the *V* suffix have a secondary power supply input for I/O level shifting the input pin thresholds and RXD output level. This family has a low power standby mode with a remote wake request feature. Additionally, all devices include many protection features to enhance device and network robustness.

図 3. TCAN104x-Q1 Block Diagram

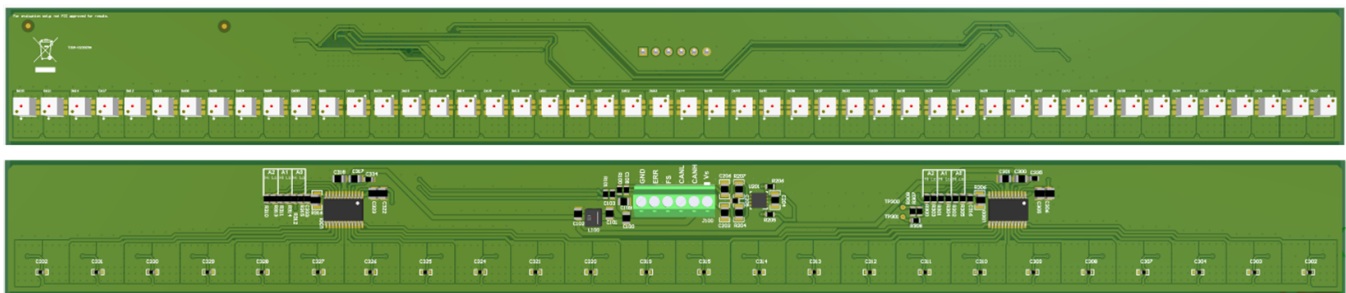


2.4 System Design Theory

This reference design uses a two-layer printed circuit board (PCB) where the LEDs are placed on the top layer and all of the other components are placed on the bottom layer. The PCB integrates 48 LEDs with two LEDs on each channel that can be controlled individually. The PCB is not intended to fit any particular form factor and has dimensions of 26.75 mm x 133.75 mm. The primary objective of the design with regards to the PCB is to make a solution that is compact while still providing a way to test the performance of the board. The size of the solution can be further reduced in this design.  4 shows a 3D rendering of the PCB.

Because each FlexWire bus can support 16 devices, it is possible to use them on one communication bus in up to 8 reference designs.

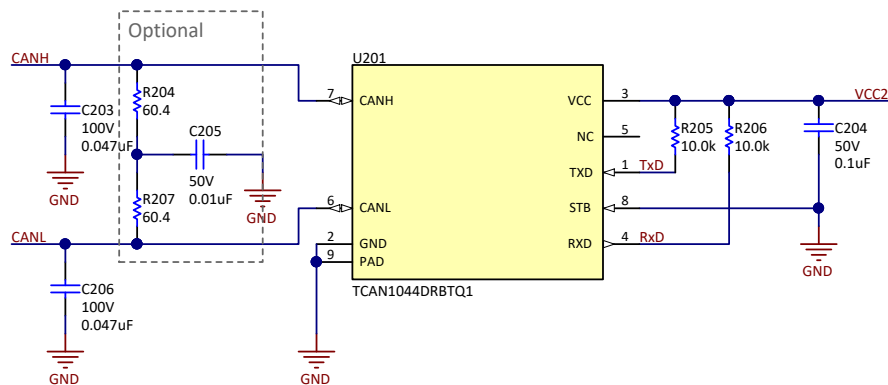
 4. 3D Render of TIDA-020029



2.4.1 TCAN1044-Q1 Automotive High Speed CAN Transceiver

The TCAN1044x-Q1 devices are high-speed controller area network (CAN) transceivers that meet the physical layer requirements of the ISO 11898- 2:2016 high speed CAN specification providing an interface between the CAN bus and a CAN protocol controller.

 5. TCAN1044-Q1 CAN Transceiver Schematic



In this reference design, a CAN transceiver is supplied by 5 V on the VCC pin from the internal LDO of the TPS929120-Q1 device. The pull-up resistor R205 and R206 are required for the UART interface between the TCAN1044-Q1 and TPS929120-Q1. For the CAN transceiver in this design, the standard input filter is used.

2.4.2 TPS929120-Q1 Linear LED Driver

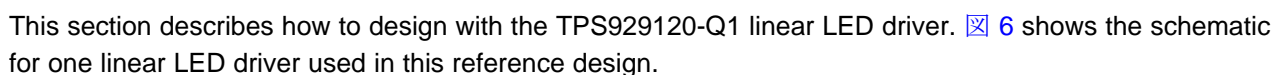
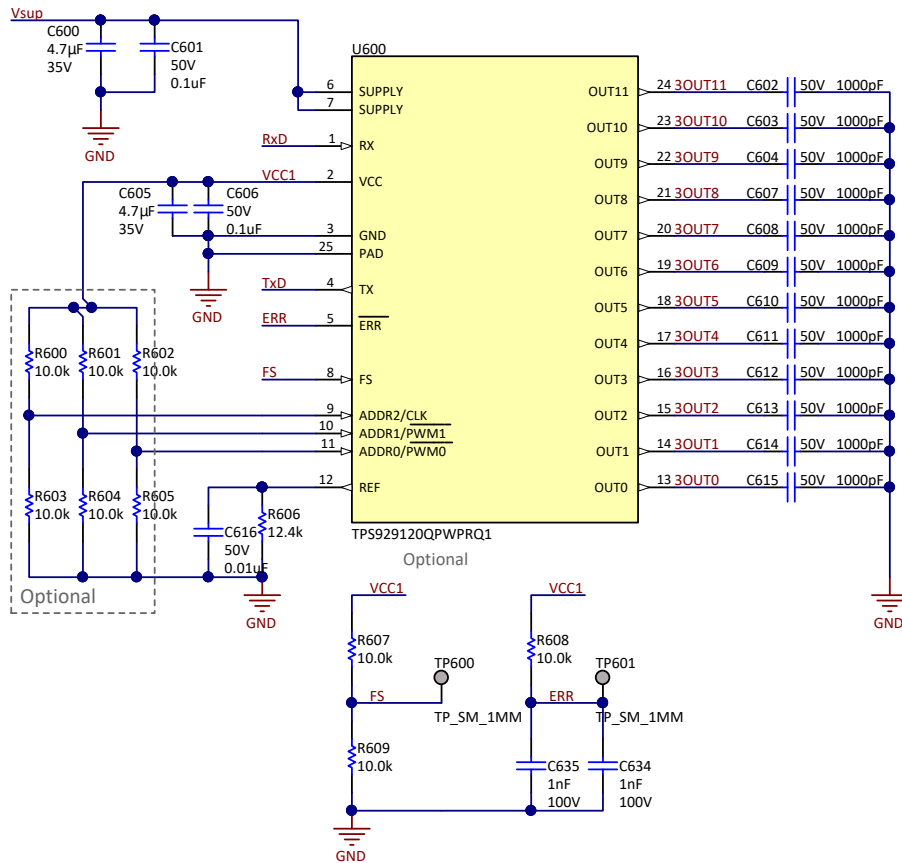
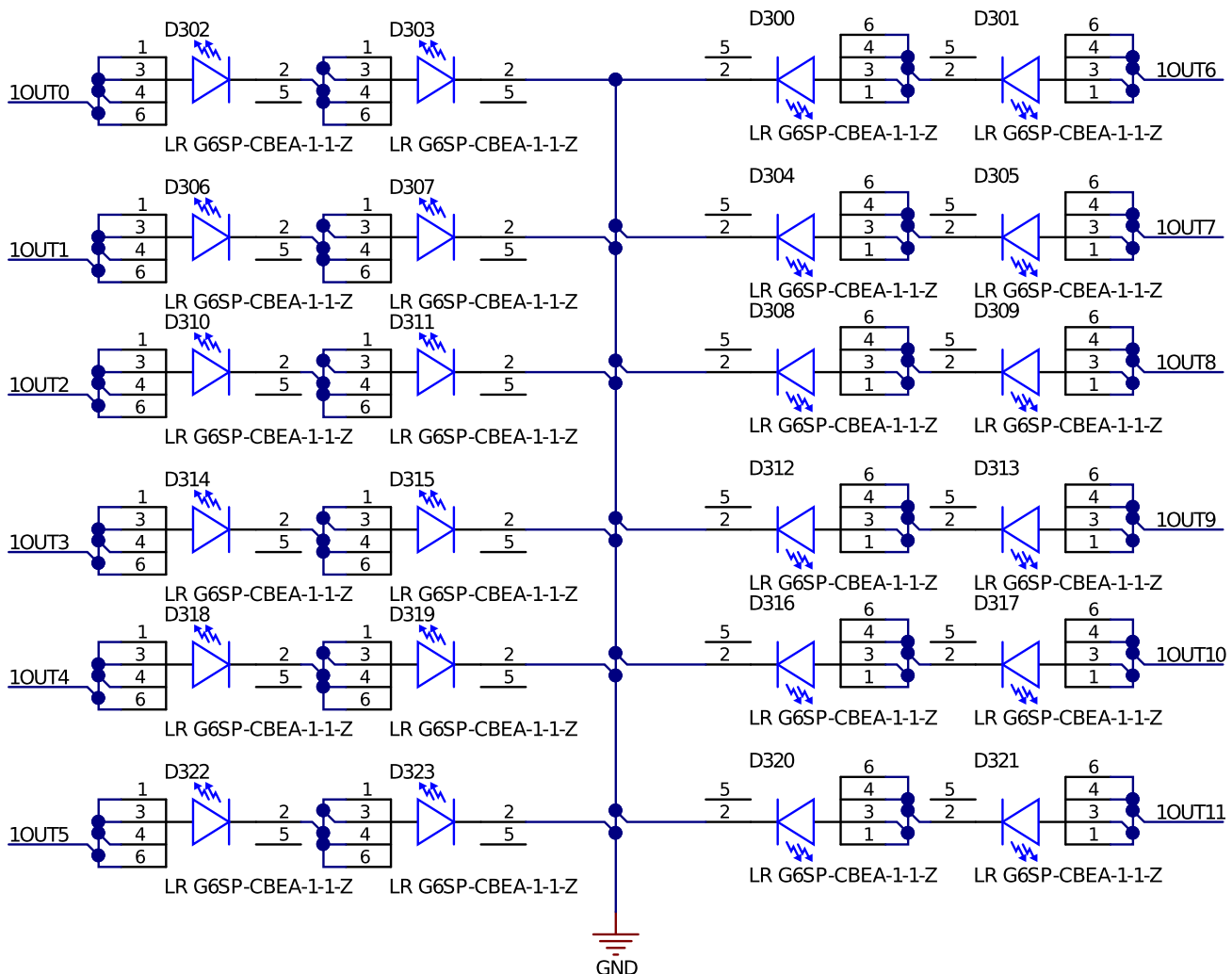
This section describes how to design with the TPS929120-Q1 linear LED driver.  6 shows the schematic for one linear LED driver used in this reference design.

図 6. TPS929120-Q1 Linear LED Driver Schematic



Each channel of the TPS929120-Q1 is capable of sinking a maximum of 75 mA. In this reference design, two LEDs (OSRAM LR G6SP) are in series connected to each channel shown in 図 7, meaning that both LEDs apply the same current and the same dimming level (PWM value). The DC current can be programmed using an external resistor R616 connected between the REF pin and GND. In this design, the maximum LED current is set to 50 mA.

図 7. Schematic of 24 LEDs


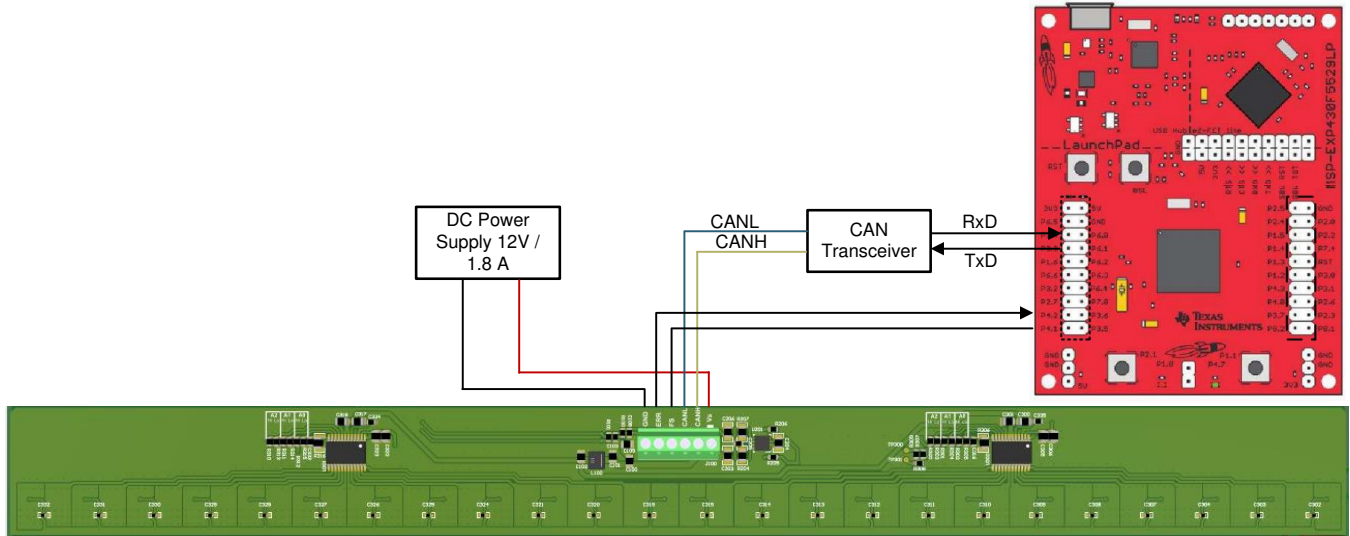
Every TPS929120-Q1 has a unique address used for the communication on the FlexWire bus. Each FlexWire bus supports a maximum of 16 slave devices. The TPS929120-Q1 has 3 pinouts, including ADDR2, ADDR1, and ADDR0, for device address configuration. There are additional 4-bit EEPROM registers to program the slave address of the TPS929120-Q1. The EEPROM register EEP_INTADDR sets the device slave address by either address pins setup or internal EEPROM register code. On this reference design board, external pull-up and pull-down resistors are available that are already connected to the ADDR_x pins (R610, R611, R612, R613, R614, R615) to set the unique address for each individual device on the communication bus. Either a pull-up or a pull-down resistor should be removed from each address pin.

3 Hardware, Software, Testing Requirements, and Test Results

3.1 Required Hardware and Software

This reference design must be connected to a 12-V power supply and to a communication bus. [Figure 8](#) shows the default test setup of this reference design. In this test setup, an MSP430 LaunchPad™ is used as a master device, which is also connected to the same communication bus through a TCAN1044-Q1 device.

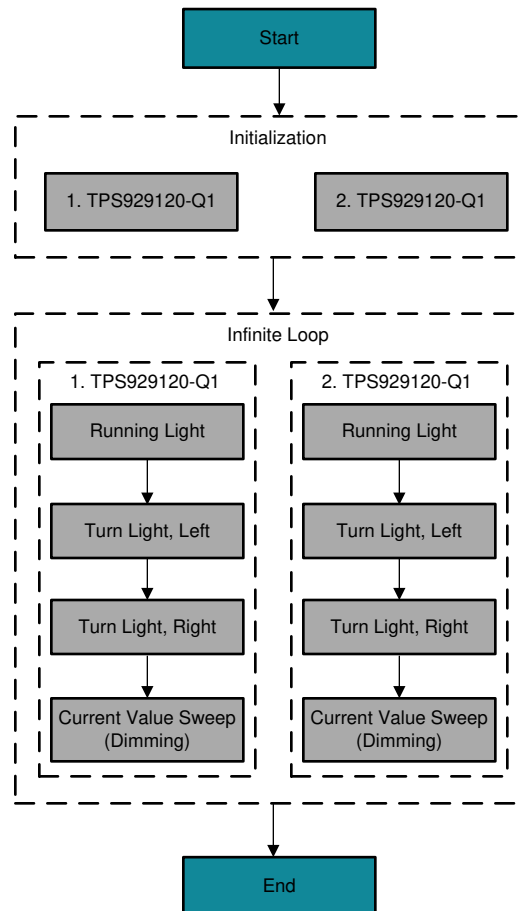
Figure 8. Hardware Test Setup



3.1.1 Software

Special testing software was created for this design that controls the LED drivers through the UART (FlexWire). The software is structured in such a way that the MCU first initializes both TPS929120-Q1 and then sets the values for the set of registers so that all 48 LEDs (24 channels, 2 LED-Drivers) can represent various patterns, such as sequential turn light, dimming light, and running light, where the output channels are switched on one after the other. The flow chart in [Figure 9](#) shows the simplified structure of the software.

Figure 9. Software Flow Chart



3.2 Testing and Results

3.2.1 Thermal Performance

Figure 10 and Figure 11 show the thermal behavior of the TPS929120-Q1, when all channels are outputting maximum current that is set by an external resistor at TPS929120-Q1.

Figure 10. TPS929120-Q1

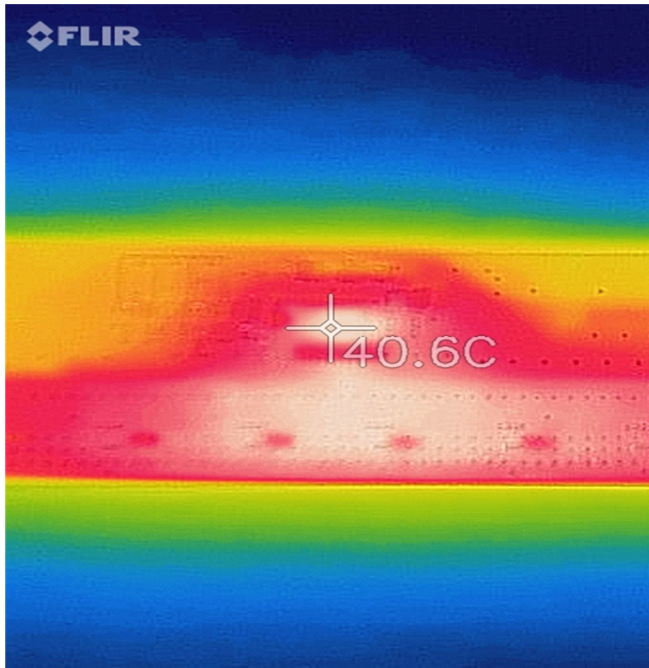
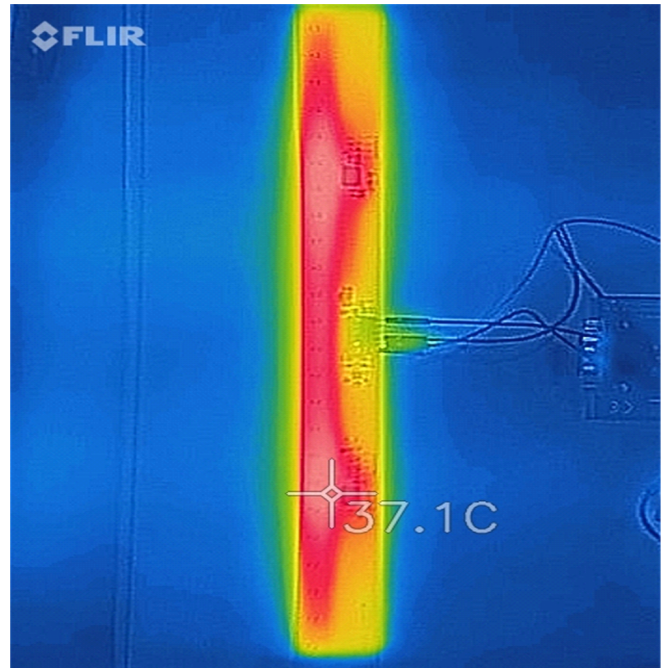


Figure 11. TIDA-020029 With Two TPS929120-Q1



4 Design Files

4.1 Schematics

To download the schematics, see the design files at [TIDA-020029](#).

4.2 Bill of Materials

To download the bill of materials (BOM), see the design files at [TIDA-020029](#).

4.3 PCB Layout Recommendations

4.3.1 Layout Prints

To download the layer plots, see the design files at [TIDA-020029](#).

4.4 Altium Project

To download the Altium Designer® project files, see the design files at [TIDA-020029](#).

4.5 Gerber Files

To download the Gerber files, see the design files at [TIDA-020029](#).

4.6 Assembly Drawings

To download the assembly drawings, see the design files at [TIDA-020029](#).

5 Software Files

To download the software files, see the design files at [TIDA-020029](#).

6 Related Documentation

1. [TPS929120-Q1 12-Channel Automotive 40-V High-Side LED Driver Data Sheet](#)
2. [TCAN1042-Q1 Automotive Fault Protected CAN Transceiver With CAN FD Data Sheet](#)

6.1 商標

E2E, LaunchPad are trademarks of Texas Instruments.

Altium Designer is a registered trademark of Altium LLC or its affiliated companies.

6.2 Third-Party Products Disclaimer

TI'S PUBLICATION OF INFORMATION REGARDING THIRD-PARTY PRODUCTS OR SERVICES DOES NOT CONSTITUTE AN ENDORSEMENT REGARDING THE SUITABILITY OF SUCH PRODUCTS OR SERVICES OR A WARRANTY, REPRESENTATION OR ENDORSEMENT OF SUCH PRODUCTS OR SERVICES, EITHER ALONE OR IN COMBINATION WITH ANY TI PRODUCT OR SERVICE.

重要なお知らせと免責事項

TI は、技術データと信頼性データ(データシートを含みます)、設計リソース(リファレンス・デザインを含みます)、アプリケーションや設計に関する各種アドバイス、Web ツール、安全性情報、その他のリソースを、欠陥が存在する可能性のある「現状のまま」提供しており、商品性および特定目的に対する適合性の黙示保証、第三者の知的財産権の非侵害保証を含むいかなる保証も、明示的または黙示的にかかわらず拒否します。

これらのリソースは、TI 製品を使用する設計の経験を積んだ開発者への提供を意図したものです。(1) お客様のアプリケーションに適した TI 製品の選定、(2) お客様のアプリケーションの設計、検証、試験、(3) お客様のアプリケーションに該当する各種規格や、その他のあらゆる安全性、セキュリティ、規制、または他の要件への確実な適合に関する責任を、お客様のみが単独で負うものとし、

上記の各種リソースは、予告なく変更される可能性があります。これらのリソースは、リソースで説明されている TI 製品を使用するアプリケーションの開発の目的でのみ、TI はその使用をお客様に許諾します。これらのリソースに関して、他の目的で複製することや掲載することは禁止されています。TI や第三者の知的財産権のライセンスが付与されている訳ではありません。お客様は、これらのリソースを自身で使用した結果発生するあらゆる申し立て、損害、費用、損失、責任について、TI およびその代理人を完全に補償するものとし、TI は一切の責任を拒否します。

TI の製品は、[TI の販売条件](#)、または [ti.com](https://www.ti.com) やかかる TI 製品の関連資料などのいずれかを通じて提供する適用可能な条項の下で提供されています。TI がこれらのリソースを提供することは、適用される TI の保証または他の保証の放棄の拡大や変更を意味するものではありません。

お客様がいかなる追加条項または代替条項を提案した場合でも、TI はそれらに異議を唱え、拒否します。

郵送先住所 : Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

Copyright © 2022, Texas Instruments Incorporated