TI Designs: TIDA-00156

Automotive LED Dome Light with Capacitive Touch and Haptics Feedback

System Description

This reference design is a capacitive touch / haptic feedback automotive interior lighting solution optimized for automotive Dome light / Map light applications. The solution features a haptic driver with extensive integrated library (100+ effects) for ERM actuators, constant current LED driver with integrated PWM input permitting LED brightness regulation, low power MCU optimized for capacitive touch, and LIN interface communication.

Featured Applications

- Automotive Dome Light
- Automotive Map Light

Design Resources

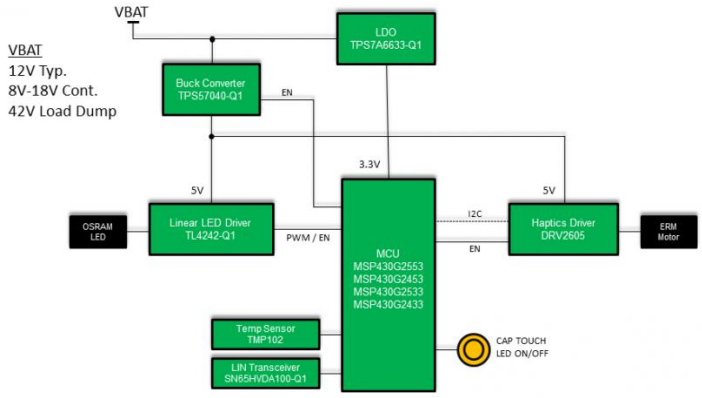
- Block Diagram and Schematic
- Test Data
- Design and Software Files
- Bill of Materials
- Wiki Page

Design Features

- Wide input voltage range: 12V Typical, 8-18V Continuous, 42V Load Dump
- Low system quiescent current consumption (<100uA) handled by the on-board MSP430 putting key components in the system to sleep
- 400 kHz buck converter switching frequency utilized in order to stay out of the AM band
- Design capable of supplying constant LED current and controlled LED current using a PWM signal
- Easily accessible integrated library of waveforms via I2C communication for a variety of haptic feedback effects
- Ability to implement cap touch detection without external components other than the on-board MSP430

Design Photo

Block Diagram



Jump start system design and speed time to market

Comprehensive designs include schematics or block diagrams, BOMs, design files and test reports by experts with deep system and product knowledge. Designs span TI's portfolio of analog, embedded processor and connectivity products and supports a board range of applications including industrial, automotive, medical, consumer, and more. To explore the designs, go to http://www.ti.com/tidesigns

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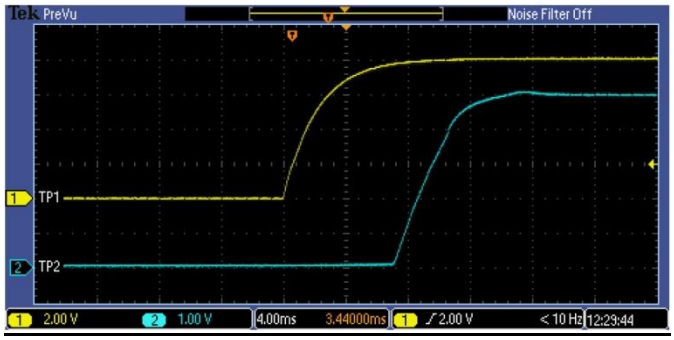
Associated Part Numbers

Part Number	Part Description	EVM Link
TL4242-Q1	Adjustable LED Driver	EVM
DRV2605	Haptic Driver for ERM/LRA w/ Smart Loop Architecture	EVM
MSP430G2553	Ultra-Low Power Mixed Signal 16-Bit MCU	N/A
TPS57040-Q1	3.5V-42V Input, 0.5A Step Down Converter w/ Eco-Mode	N/A
TPS7A6633-Q1	150mA, High Voltage, Ultra Low Iq LDO	N/A
SN65HVDA100-Q1	LIN Physical Interface	N/A
TMP102	Digital Temp Sensor with SMBus/Two-Wire Serial Interface	EVM

Design Considerations and Test Data:

- Components connected to automotive battery power rail were selected to withstand 42V load dump condition
- An LDO with off-battery capability allows the MCU to put the system in a low power state and minimize the quiescent current consumption from the automotive battery
- Buck converter was selected based on its wide VIN range, 500mA output current capability, and 1.5µA typical quiescent current in shutdown mode
    - 5V output voltage was chosen to accommodate a wide range of haptic motors and reduce the power dissipated in the LED driver
    - Switching frequency of 400kHz selected as it is in between long wave and medium wave AM frequency bands
    - Smaller SON package chosen
- LED driver was selected due to the ability to set a maximum constant LED current level and control the LED current using a PWM signal from the MCU
    - Smaller SON package chosen
- Haptics driver was selected due to its integrated library of waveforms easily accessible using the I2C interface
- An MSP430 on the roadmap for automotive qualification was chosen with the ability to implement cap touch recognition without external components
    - Two timers for independent cap touch polling and PWM control of the LED current
    - Cap touch polling rate is software configurable to be able to put the MCU in a low power state and reduce its average current consumption
- Temperature sensor designed into the system to be able to monitor LED temperature during operation
- LIN transceiver enables communication between multiple dome light modules



These waveforms illustrate the startup sequence of the 5V Buck Converter Output after an 8V Power Supply was connected to TP1.

Quick Start Guide

Jump start system design and speed time to market

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1. **What's Needed:**
   - 12VDC 500mA Power Supply
   - Dome Light Enclosure

2. **Configuration:**
   - Follow assembly instructions provided on the Hardware sheet of the Altium Designer files for each project
   - Install jumper on J3 if utilizing LIN bus
   - Install 2-pin male header (motor connections) from Cap Touch Board into J2 using correct polarity if not already done according to assembly instructions

3. **Operation:**
   - To power system, connect the power supply specified in the "What's Needed" section to J1
   - Use J6 and the eZ430-RF2500 USB debugging interface to program the MCU with the software provided
   - Touch the TI Bug on the Cap Touch Board to turn on and off the Dome Light LED. Touch and hold to initiate LED dimming
   - The software provided showcases basic LED dimming and haptic effects to get started
   - Press S1 to reset the MCU if necessary
   - To power down system, disconnect power supply from J1

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