Reference Design Guide

Window Lift

Design overview

This Infineon Reference Design Guide describes the ECU for a window lift, using the H-Bridge MOSFET driver IC TLE9855QX of the MOTIX™ ICs family as DC motor controller, in combination with the Hall-effect sensor TLE4966G.

Four MOSFETs in S308 package are used to drive the DC motor, replacing the relay used in the standard window lift implementation.

The design is capable to drive loads up to 200W at a battery voltage of 12 V.

This application note contains the description of the design, the schematics and the test reports of the measurements.

The EMC performance is tested according to the CISPR25 standard.

Highlighted Components

- TLE9855QX
- IPZ40N04S5-3R1
- TLE4966G

Applications

- Window Lift
- 200W DC Motor for 12 V applications

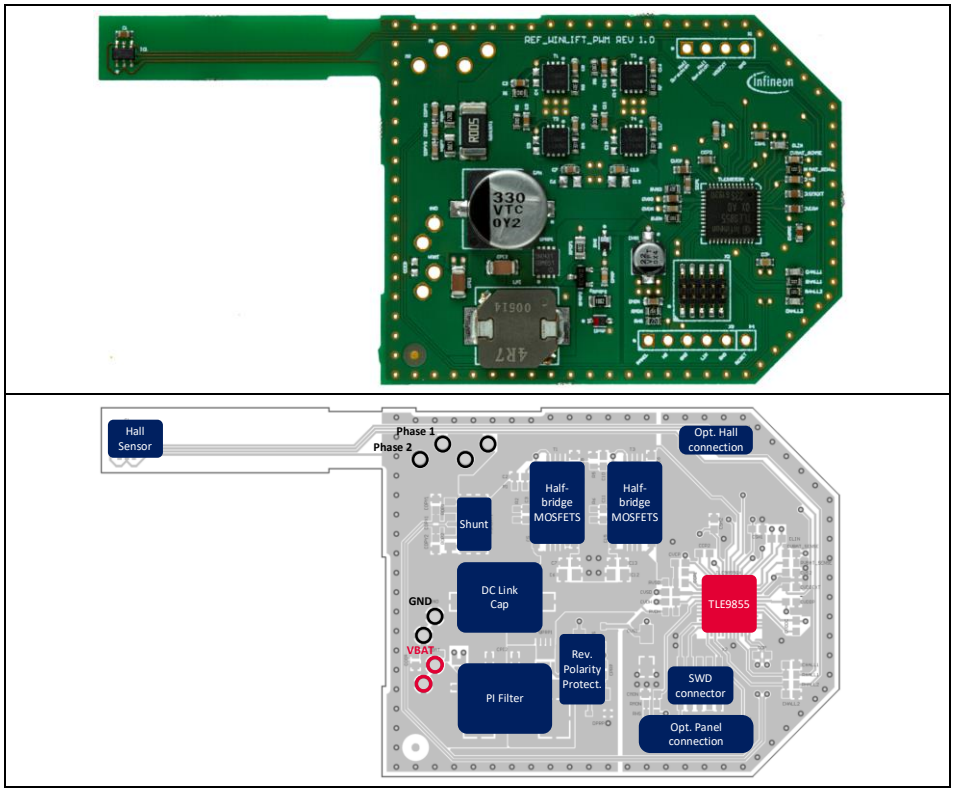
Highlighted Design Aspects

EMC optimized

Cost optimized

Space optimized

Reference design board and Block Diagram



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1 System description

This application note describes the ECU for a window lift working with a DC motor. This solution can be used for similar applications with equal or smaller power consumption. The ECU includes the MOTIX™ TLE9855QX, member of the Embedded Power IC family. The TLE9855QX combines an Arm® Cortex®-M0 microcontroller with application specific modules like an integrated H-Bridge MOSFET driver, power supply and LIN transceiver. In combination with the OptiMOS™-5 S308 MOSFETs, the ECU is optimized in terms of PCB size for this power class. The focus of the reference design is to use standard PCB materials and processes.

1.1 Design specifications

Parameter	Symbol	Values			Unit	Comment
		Min.	Typ.	Max.		
System Parameters						
Input voltage	V_{IN}	-0.3	12	40	V	P_1.1.1 (TLE9855QX)
Functional input voltage	V_{IN}	7	12	18	V	According to window lift requirements
Peak input current	I_{IN}	-	-	15	A	Peak current (<10 s)
Nominal input current	I_{IN}	-	10	15	A	Specified for design
LIN interface	V_{LIN}	-28	12	40	V	P_1.1.7 (TLE9855QX)
Thermal						
Operating temperature	T_A	-40	25	125	°C	Specified for design

Electromagnetic Compatibility		
Conducted emissions	Class 5	CISPR25, 150 kHz -108 MHz

Mechanical Specification	
PCB dimensions	60 mm x 48 mm (W x H): main PCB 37 mm x 9 mm (W x H): PCB side for sensor connection

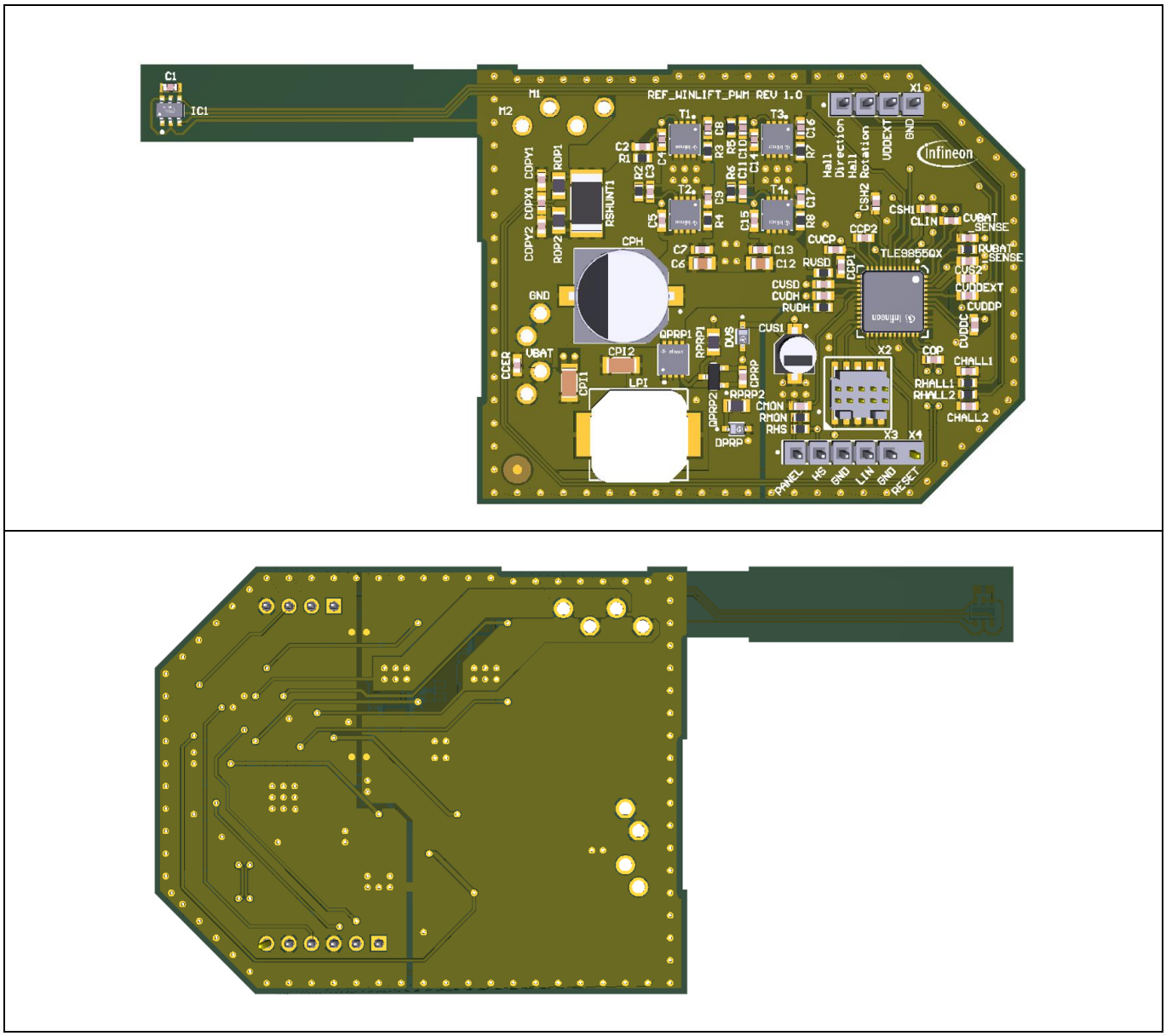

Figure 1 View of the ECU reference design, from top and bottom side

1.2 Highlighted products

1.2.1 OptiMOS™-5 40 V S3O8 (PG-TSDSON-8-33) MOSFET

The S308 package offers high current capability of 40 A with a footprint of 3.3x3.3 mm^2. In combination with Infineon leading OptiMOS™-5 40 V power MOS technology, the S308 gives ~90% volume reduction compared to the traditional DPAK package. This enables layout miniaturization for H-Bridge applications, with Infineon well-known quality level for robust automotive packages. For more information about the product, please visit the Infineon web-page linked below.

- IPZ40N04S5-3R1

Table 1 Automotive TSDSON-8 MOSFET with 40 V OptiMOS™-5

Package	Silicon Technology	Product	Max $R_{DS(on)}$ [mΩ]	ID [A]	QG [nC]
S308 (TSDSON-8)	OptiMOS™-5	IPZ40N04S5-8R4	8,4	40	10,3
		IPZ40N04S5L-7R4	7,4	40	13
		IPZ40N04S5-5R4	5,4	40	17
		IPZ40N04S5L-4R8	4,8	40	22
		IPZ40N04S5-3R1	3,1	40	31
		IPZ40N04S5L-2R8	2,8	40	39

1.2.2 H-Bridge driver IC with integrated arm® Cortex®-M0

The MOTIX™ TLE985x H-Bridge MOSFET driver IC product family is a compact and cost effective SoC for 12 V motor control. It targets automotive applications such as window lift, sunroof, gate lift and pumps.

It integrates a 32-bit Arm® Cortex®-M0 core together with market proven peripherals. It comprises two full duplex serial interfaces (UART) with LIN support, two on-chip temperature and battery voltage measurement units.

The bridge driver of the MOTIX™ TLE985x implements an adaptive control algorithm, which is able to compensate the MOSFET parameters spread in the system. The algorithm is automatically adjusting the gate current settings based on timing measurements. The advantages of this technique are reduction of EMC (slow slew rates) and power dissipation (short dead times). For more information about the product, please visit the Infineon web-page linked below.

- TLE985x

Table 2 Product Family of H- Bridge Driver IC with Integrated Arm® Cortex®-M0

Grade	Product	Flash [kB]	RAM [kB]	Frequency [MHz]	Operational Amplifier	T_{jmax} [°C]
Grade-1	TLE9852QX	48	4	40	NO	150
	TLE9853QX	48	4	40	YES	150
	TLE9854QX	64	4	40	YES	150
	TLE9855QX	96	4	40	YES	150
Grade-0	TLE9854QXW	64	4	40	YES	175

1.2.3 XENSIV™ - TLE4966G double Hall-effect sensor

The TLE4966G is an integrated circuit double Hall-effect sensor, designed specifically for highly accurate applications in the automotive sector. Precise magnetic switching points and high temperature stability are

achieved by active compensation circuits and chopper techniques on chip. They provide a speed signal at Q2 for every magnetic pole pair and a direction information at Q1, available before the speed signal. For more information about the product, please visit the Infineon web-page below.

- TLE4966G

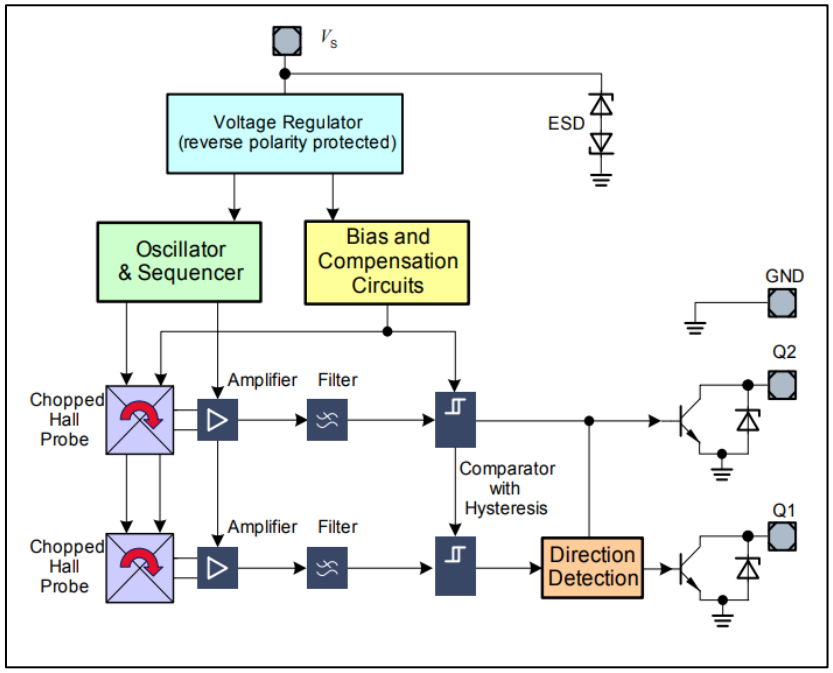

Figure 2 TLE4966G Block Diagram

2 Toolchain installation

In order to get the board ready and running, the software shown in Table 3 shall be installed.

The µVision software is a development tool provided by Arm® Keil®. With code length limitation, the shareware version of the µVision is still able to edit, compile and debug. The Infineon Config Wizard is a tool for configuring peripherals of the Embedded Power IC. The tool can be selected from the pull-down menu of the µVision and helps the user changing parameters from the user interface, generating the software code accordingly. Infineon provides standard motor drive software codes for the Embedded Power IC. They can be downloaded from the Pack Installer within the µVision.

Table 3 Software Toolchain Installation Guide

Steps	Company	Description
STEP1 Download and Install **Keil® µVision5**	Arm® Keil®	• Arm® Keil® µVision is an integrated development environment which consists of code editor, compiler and debugger. • To learn how to use arm® Keil® µVision 5, check out our video "**Get your motor spinning**".
STEP2 Download Config Wizard	Infineon Technologies	• Infineon provides the Config Wizard free of charge, which is designed for configuration of chip modules. Config Wizard supports easy configuring of Embedded Power IC peripherals. • Config Wizard can be installed via the Infineon Developer Center. If you don´t have the Infineon Developer Center yet, please go to **Infineon Development Center** and enjoy the release management for updates.
STEP3 Download and Install **Segger J-Link Driver**	SEGGER	• SEGGER J-Link is a widely used driver for "on-board" or "stand-alone" debugger.
STEP4 Download the SDK via µVision5 Pack Installer	Infineon Technologies	• The Embedded Power Software Development Kit (SDK) is a low level driver library, which can be downloaded within Keil® µVision via the "Pack Installer"

For the toolchain installation and free motor drive software, check the following link:
www.infineon.com/embedded-power
For more information about the tool chain installation steps, watch the Infineon video at the following link.
Toolchain Installation for Embedded Power ICs / TLE98xx

2.1.1 Configuration

To start the configuration, the user shall open a motor drive code project in µVision5, go to “Tools” and then to “Config Wizard”. From there, the user can set-up the parameters of the peripherals of TLE985x. Since the Embedded Power IC has a current-source gate driving scheme, the switching speed is not controlled by gate resistors, but by the “Gate Charge/Discharge” parameters in the BDRV tap. For more details about the configuration, please visit the Infineon website of Embedded Power ICs.

7 Abbreviations and definitions

Table 4 Abbreviations

Abbreviation	Definition
BDRV	Bridge Driver
DC	Direct Current
DUT	Device under test
ECU	Electronic Control Unit
EMC	Electromagnetic Compatibility
ESR	Equivalent Series Resistance
IC	Integrated Circuit
LIN	Local Interconnect Network
PCB	Printed Circuit Board
PWM	Pulse Width Modulation
RBP	Reverse Battery Protection
SoC	System on Chip

8 Reference documents

This document should be read in conjunction with the following documents:

[1] TLE9855QX datasheet, Infineon Technologies AG,

https://www.infineon.com/dgdl/Infineon-TLE9855QX-DS-DataSheet-v01_00-EN.pdf?fileId=5546d462689a790c0169104901f03e18

[2] IPZ40N04S5-3R1 product webpage, Infineon Technologies AG,

https://www.infineon.com/cms/de/product/power/mosfet/automotive-mosfet/ipz40n04s5-3r1/

[3] TLE4966G product webpage, Infineon Technologies AG,

https://www.infineon.com/cms/en/product/sensor/magnetic-sensors/magnetic-position-sensors/magnetic-switches/tle4966g/?redirId=190241

[4] TLE987x/6x HW Design Guideline, Infineon Technologies AG,

https://www.infineon.com/dgdl/Infineon-Z8F80032532_HW_Design_Guideline-ApplicationNotes-v01_00-EN.pdf?fileId=5546d46275b79adb0175bde698f26102

[5] Reverse polarity protection for Embedded Power ICs, Infineon Technologies AG,

https://www.infineon.com/dgdl/Infineon-Reverse_Polarity_Protection-AN-v01_00-EN.pdf?fileId=5546d46267c74c9a01684be08bf45dfb

[6] Benefits of the TLE985x Bridge Driver, Infineon Technologies AG,

https://www.infineon.com/dgdl/Infineon-Benefits-of-the-TLE985x-Bridge-Driver-ApplicationNotes-v01_00-EN.pdf?fileId=5546d4626fc1ce0b01700ba331e21b6d

[7] Rise and fall time regulation with current source MOSFET gate drivers, Infineon Technologies AG,

https://www.infineon.com/dgdl/Infineon-Z8F69449874-Rise-fall-time-regulation-with-current-source-MOSFET-gate-drivers-ApplicationNotes-v01_00-EN.pdf?fileId=5546d46272e49d2a0172eaac3c9b72fb

[8] Analytical calculation of the RMS current stress on the DC-link capacitor of voltage-PWM converter systems, 2006-07, IEE Proc.-Electr. Power Appl., Vol. 153, No.4.

[9] IPC-2152, 2003-05, Institute for Interconnecting and Packaging Electronic Circuits

[10] IEC 60664-1, 2007-04, International Electrotechnical Commission

Revision history

Major changes since the last revision

Date	Version	Description
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