

# BLDC Shield with TLE9879QXA40 for Arduino

## About this document



### Scope and purpose

This application note describes the BLDC Shield for Arduino equipped with the TLE9879QXA40, a single chip 3-Phase motor driver that integrates the industry standard ARM® Cortex® M3 core.

This document provides detailed information on the board's content, layout and use. It should be used along with the [TLE9879QXA40 datasheet](#), which contains full technical details on the device specification and operation.

An Arduino baseboard is mandatory for operation.

### Intended audience

This document is intended for anyone working with the BLDC Shield for Arduino equipped with the TLE9879QXA40.

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## 1 Acronyms

### 1 Acronyms

The following acronyms and terms are used within this document.

**Table 1** Acronyms

Acronyms	Names
ADC	Analog Digital Converter
BLDC	Brushless Direct Current
DC	Direct Current
EMC	ElectroMagnetic Compatibility
GND	Ground
IDE	Integrated Development Environment
I/O	Input/Output
LIN	Local Interconnect Network
n.u.	not used
NFET	Negative Channel Field Effect Transistor
PWM	Pulse Width Modulation
SPI	Serial Peripheral Interface
UART	Universal Asynchronous Receiver Transmitter
VDDEXT	External Voltage Supply Output

2 Introduction

2 Introduction

2.1 TLE9879 BLDC Shield for Arduino Overview

The BLDC Motor Control Shield with TLE9879QXA40 for Arduino Uno makes it easy to control and drive a BLDC motor. It features an Infineon TLE9879QXA40, a single chip 3-Phase motor driver with integrated MOSFETs. The shield can be controlled by a microcontroller via an SPI interface - here the Arduino Uno R3 is used as master. Both the shield and the Arduino board are connected via the pin headers. Up to four shields can be stacked via the pin headers, to control up to four BLDC motors. Dedicated pins are used to select the relevant shield (see [Chapter 3.5](#) on page 12).

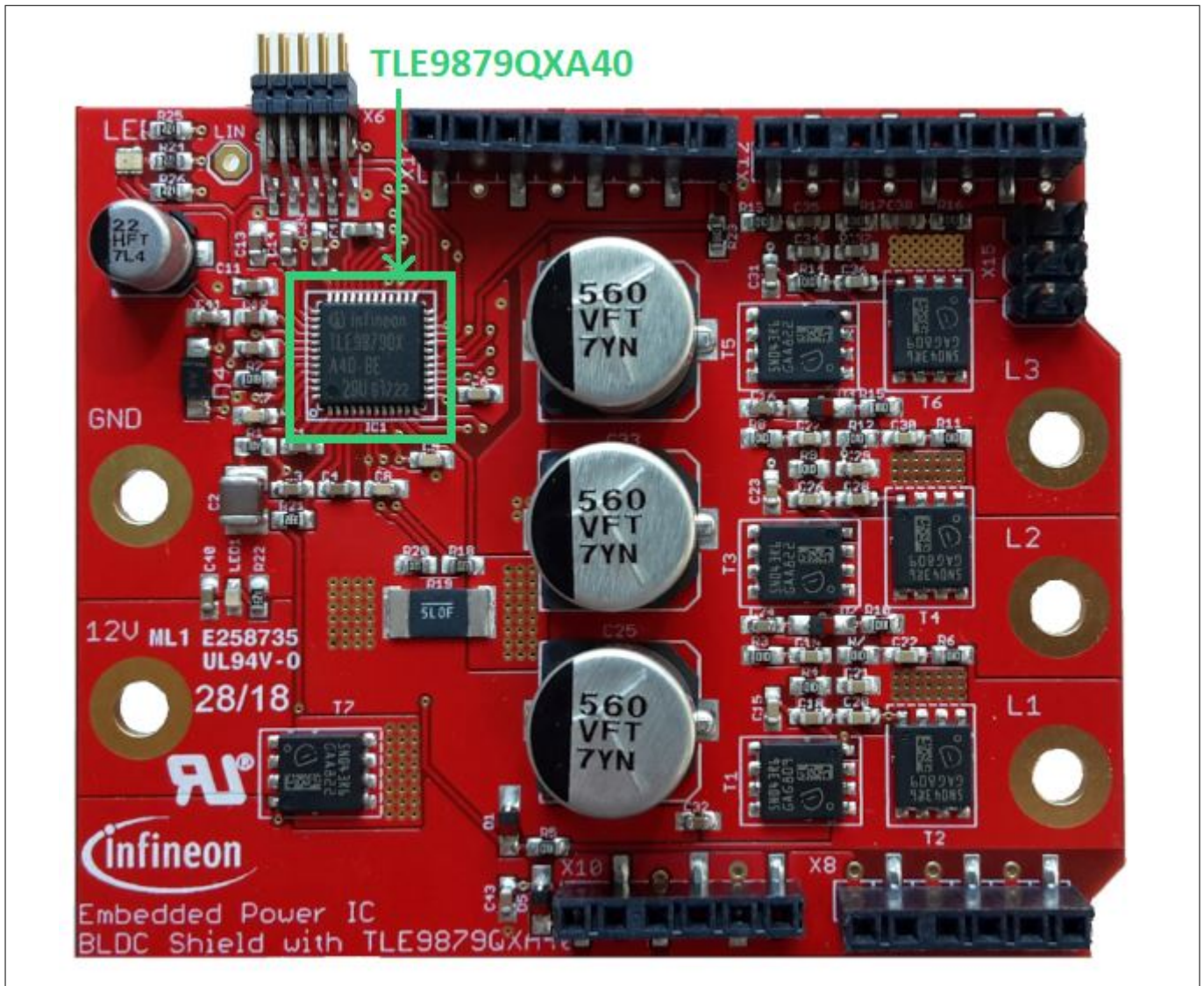


Figure 1 TLE9879 BLDC Shield for Arduino Overview

## 2 Introduction

### 2.2 Key Features

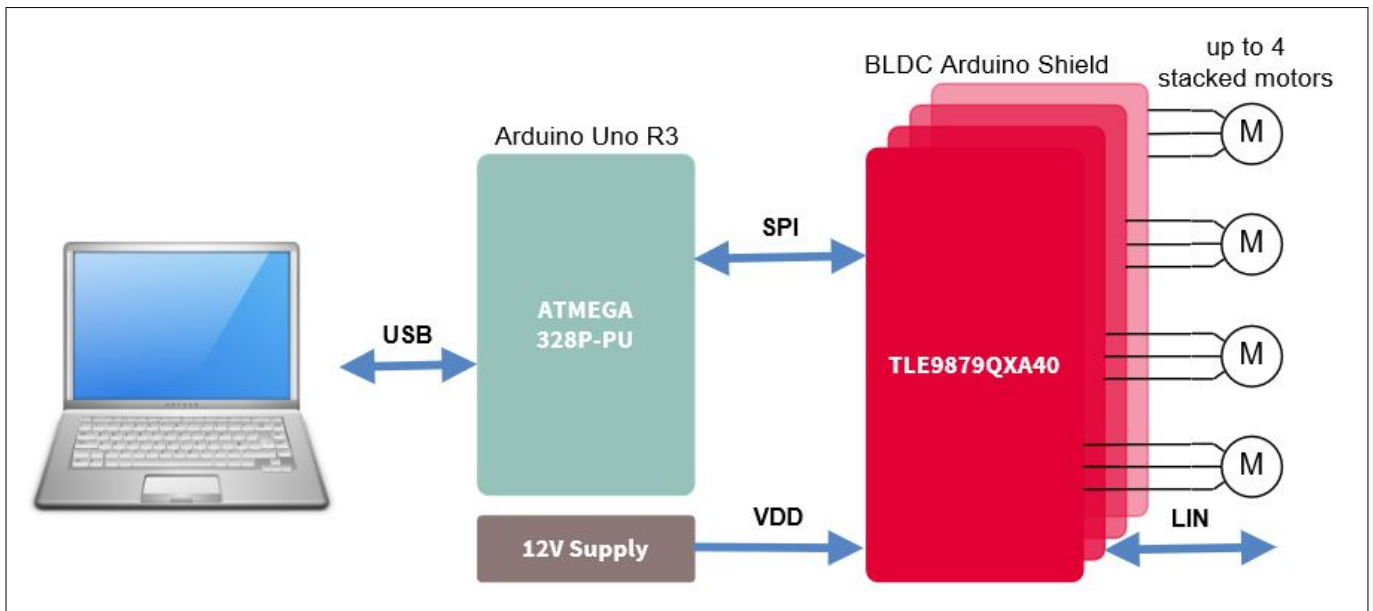
The TLE9879 BLDC Shield for Arduino has the following features:

- An Arduino Uno R3 connected to the shield can control a single chip 3-Phase motor driver via the SPI interface
- BLDC motor control
  - 5.5 V - 28 V normal operating input voltage
  - 28 V - 40 V extended operating input voltage
- Possibility to stack up to four shields
- SPI interface for high configurability and detailed diagnosis
- Protections:
  - overtemperature
  - overcurrent
  - undervoltage
  - overvoltage
- Motor speed control

### 2.3 Application and Block Diagrams

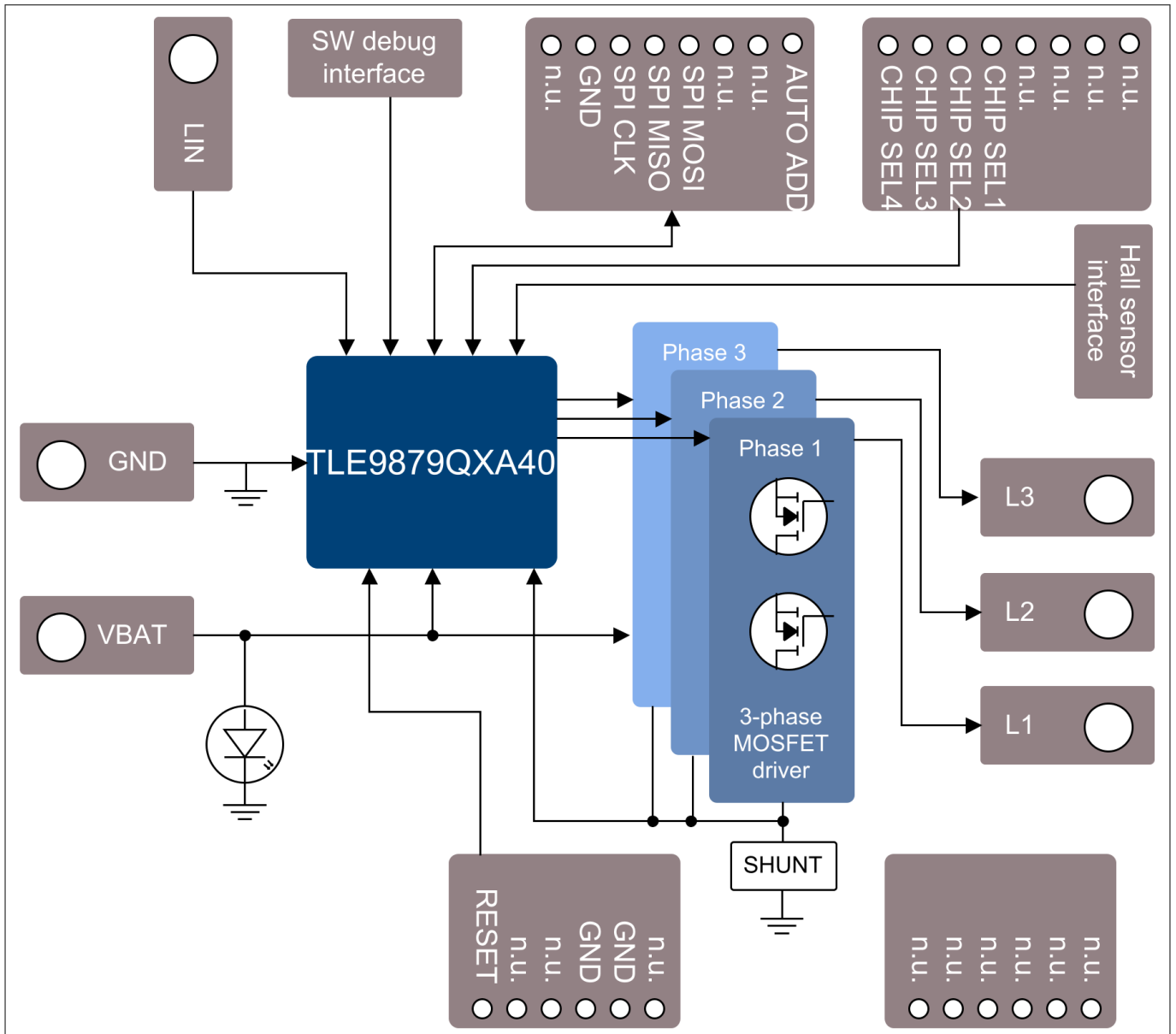
The BLDC Shield is meant to be controlled with an Arduino Uno or Arduino compatible baseboard. The Application Diagram ([Figure 2](#) on page 5) shows the simplified connection scheme.

The Auto-Addressing functionality will configure a dedicated Chip Select, regarding the board position in the stack. An external 12V supply voltage has to be attached to the BLDC shields to provide the right amount of current for the motor control.



**Figure 2** Simplified Application Diagram for TLE9879 BLDC Shield for Arduino

2 Introduction



**Figure 3** Block Diagram for TLE9879 BLDC Shield for Arduino

Refer to [Chapter 4](#) on page 14 or the corresponding datasheet for more information.



3 TLE9879 BLDC Shield for Arduino Description

3 TLE9879 BLDC Shield for Arduino Description

3.1 Overview

The TLE9879 BLDC Shield for Arduino provide the following features (see [Figure 4](#) on page 7):

- A single chip 3-Phase motor driver, TLE9879QXA40
- Solder holes to connect a BLDC motor - marked red
- Several communication interfaces:
  - Pin headers to connect the shield to the Arduino board - X8, X10, X12, X14, marked yellow. See the pin assignment [Chapter 3.5](#) on page 12.
  - LIN via a test point - marked green. It is not populated yet and has to be soldered in the designated solder hole.
  - Debug pin headers - X6, marked blue. It can be used by connecting a Segger J-Link debugger.
  - Hall connector - X15, marked purple. It can be used by connecting a Hall sensor for motor control purpose.
- A RGB LED - marked orange - in the upper left corner, which indicates that the shield is working properly.

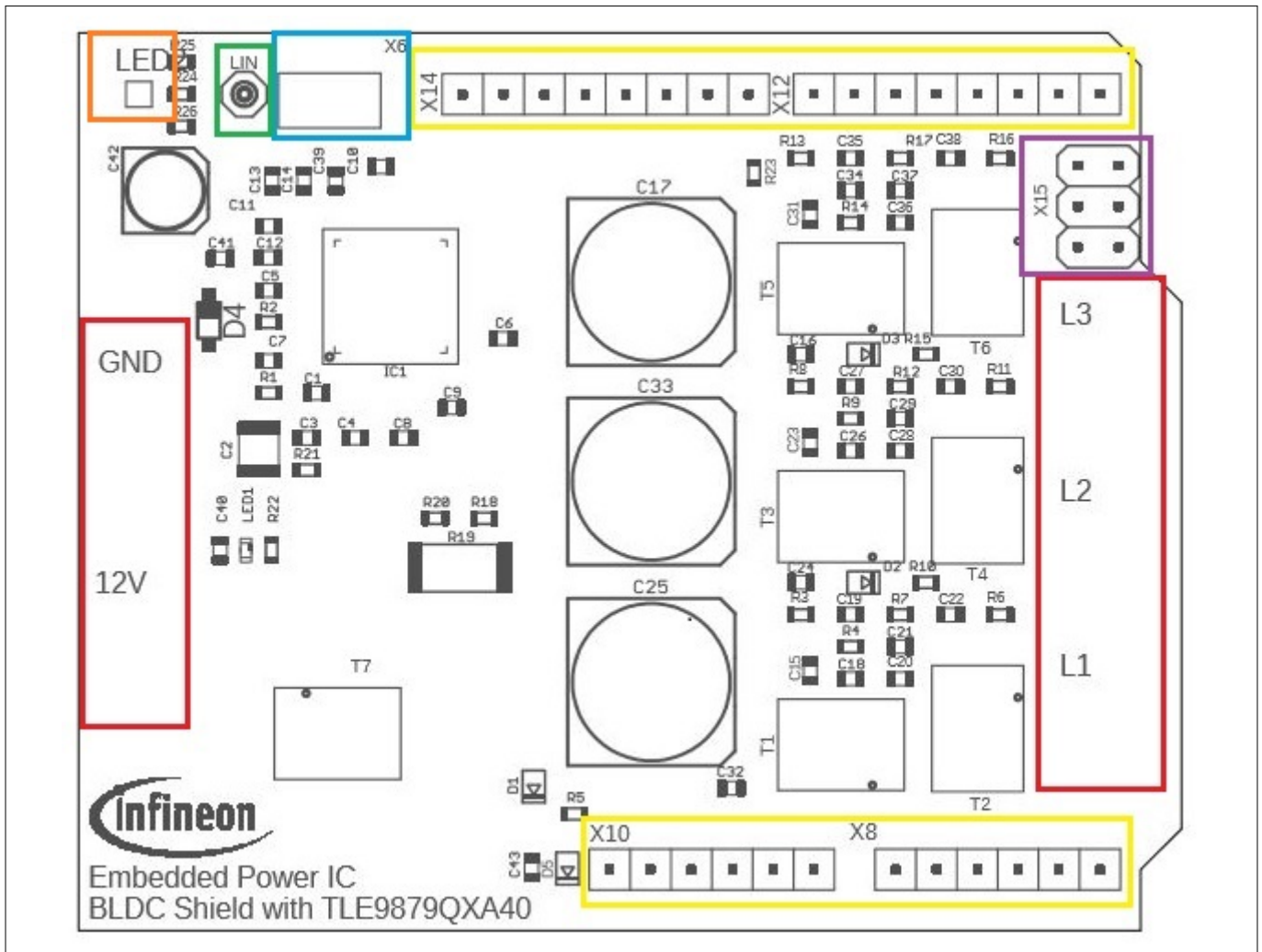


Figure 4 TLE9879 BLDC Shield for Arduino Placements

3 TLE9879 BLDC Shield for Arduino Description

3.2 Schematics

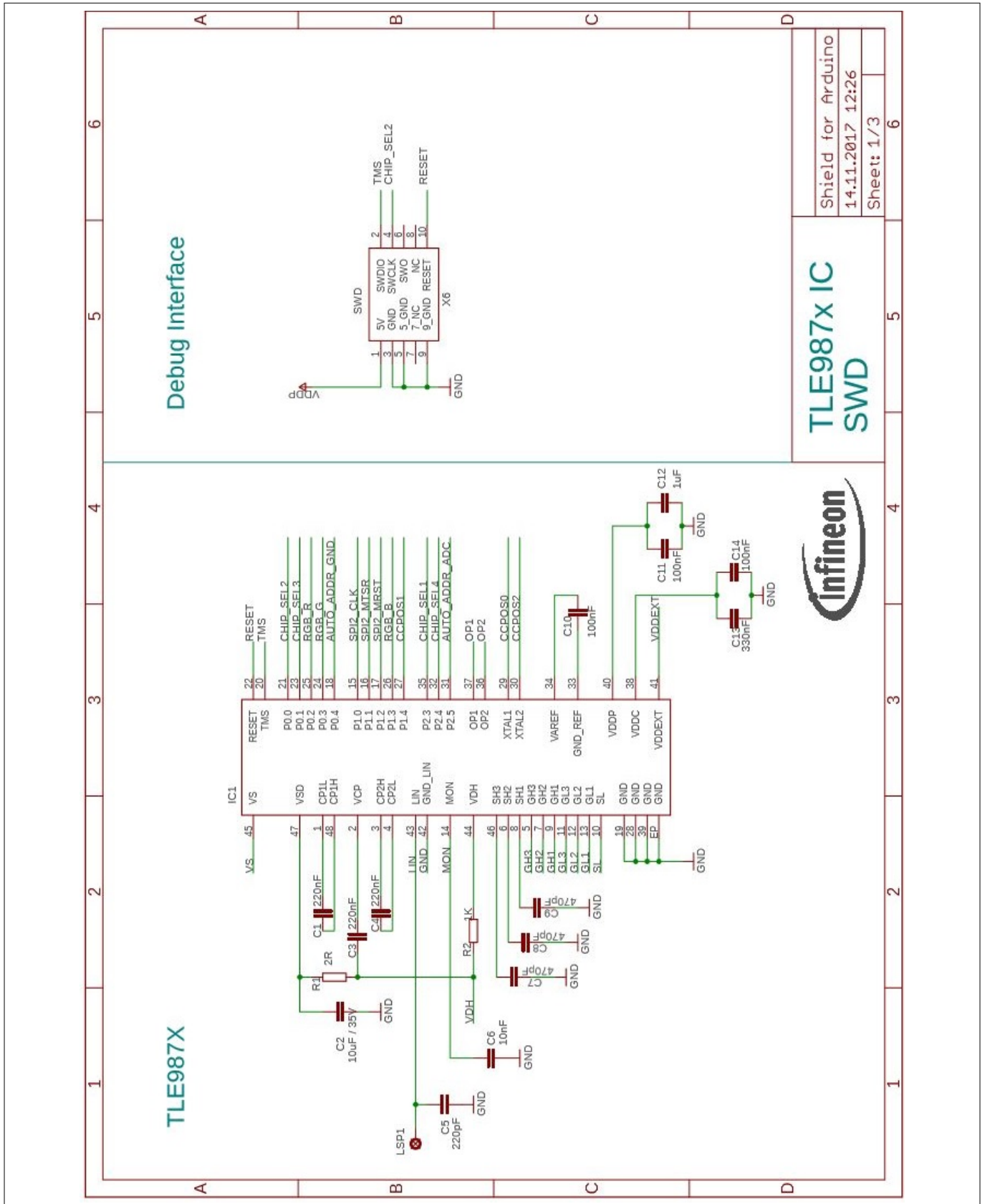


Figure 5 Schematics TLE9879 BLDC Shield for Arduino



3 TLE9879 BLDC Shield for Arduino Description

3.3 Layout

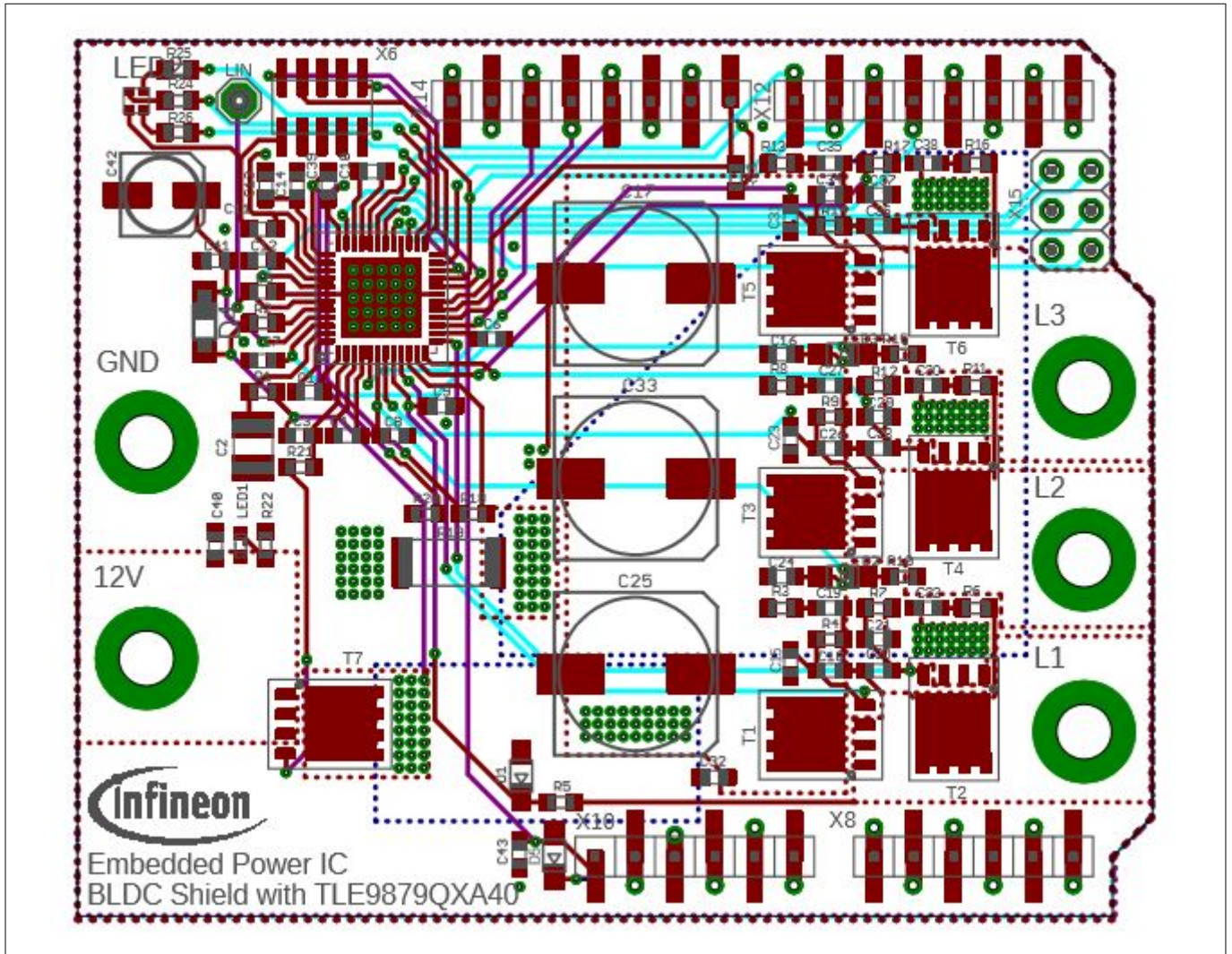


Figure 6 Top Layout

3.4 Bill of Material

Table 2 Bill of Material TLE9879 BLDC Shield for Arduino

Part	Value	Device	Package	Description
C1, C3, C4	220nF / 50V	C-EUC0603	C0603	CAPACITOR, European symbol
C2	10uF / 35V	C-EUC1210	C1210	CAPACITOR, European symbol
C5	220pF / 50V	C-EUC0603	C0603	CAPACITOR, European symbol
C6	10nF / 50V	C-EUC0603	C0603	CAPACITOR, European symbol

**3 TLE9879 BLDC Shield for Arduino Description**
**Table 2 Bill of Material TLE9879 BLDC Shield for Arduino (continued)**

Part	Value	Device	Package	Description
C7, C8, C9	470pF / 50V	C-EUC0603	C0603	CAPACITOR, European symbol
C10, C11, C14, C16, C24, C32, C40, C41	100nF / 50V	C-EUC0603	C0603	CAPACITOR, European symbol
C12	1uF / 50V	C-EUC0603	C0603	CAPACITOR, European symbol
C13	300nF / 50V	C-EUC0603	C0603	CAPACITOR, European symbol
C15, C18, C19, C20, C21, C22, C23, C26, C27, C28, C29, C30, C31, C34, C35, C36, C37, C38	4.7nF / 50V	C-EUC0603	C0603	CAPACITOR, European symbol
C17, C25, C33	560uF / 35V	CPOL-EU153CLV-1014	153CLV-1014	POLARIZED CAPACITOR, European symbol
C39, C43	1nF / 50V	C-EUC0603	C0603	CAPACITOR, European symbol
C42	22uF / 50V	CP-153CLV-0505	153CLV-0505	POLARIZED CAPACITOR, European symbol
D1, D2, D3, D5	BAS3010B03WE63 27HTSA1	DIODE-SOD323-W	SOD323-W	DIODE
D4	SM4004	DIODE-DO-214AC	DO-214AC	DIODE
IC1	TLE9879QXA40	TLE9879QXA40	VQFN48-15_7X7	Infineon SoC
LED1	red	LEDSML0603	SML0603	LED
LED2	GM5WA94310A	GM5WA94310A	GM5WA94310A	Chip LED RGB
LSP1	MCS10B	MCS10B	MCS10B	SOLDER PAD
R1	2R / 1%	R-EU_R0603	R0603	RESISTOR, European symbol
R2, R23	1K / 1%	R-EU_R0603	R0603	RESISTOR, European symbol
R3, R4, R6, R7, R8, R9, R11, R12, R13, R14, R16, R17	100K / 1%	R-EU_R0603	R0603	RESISTOR, European symbol
R5, R10, R15	10R / 1%	R-EU_R0603	R0603	RESISTOR, European symbol
R18, R20	12R / 1%	R-EU_R0603	R0603	RESISTOR, European symbol
R19	5mR / 3W / 0.5%	R-EU_R6332	R6332	RESISTOR, European symbol
R21	3K3 / 1%	R-EU_R0603	R0603	RESISTOR, European symbol
R22	12K / 1%	R-EU_R0603	R0603	RESISTOR, European symbol
R24, R26	220 / 1%	R-EU_R0603	R0603	RESISTOR, European symbol
R25	270 / 1%	R-EU_R0603	R0603	RESISTOR, European symbol

## 3 TLE9879 BLDC Shield for Arduino Description

**Table 2 Bill of Material TLE9879 BLDC Shield for Arduino (continued)**

Part	Value	Device	Package	Description
T1, T2, T3, T4, T5, T6, T7	IPC90N04S5-3R6	IPC90N04S5-3R6	PG-TDSON-8	
X1, X2, X3, X4, X5	SCREW HOLE	SCREW HOLE	SCREW HOLE	SCREW HOLE
X6	FTSH-105-01-L-DH	SWD	SWD	SWD
X7, X9	TSM-106-03-L-SV	PINHD-1X6_2.54-SMD	SAMTEC	PINHD
X8, X10	SSM-106-L-SV	PINHD-1X6_2.54-SMD	SAMTEC	PINHD
X11, X13	TSM-108-03-L-SV	PINHD-1X8_2.54-SMD	SAMTEC	PINHD
X12, X14	SSM-108-L-SV	PINHD-1X8_2.54-SMD	SAMTEC	PINHD
X15	PINHD-2X3_2.54	PINHD-2X3_2.54	2X03	PINHD

3 TLE9879 BLDC Shield for Arduino Description

3.5 Pin Assignment and Functions

Figure 7 on page 12 shows the pin-out/connectors of the TLE9879 BLDC Shield for Arduino.

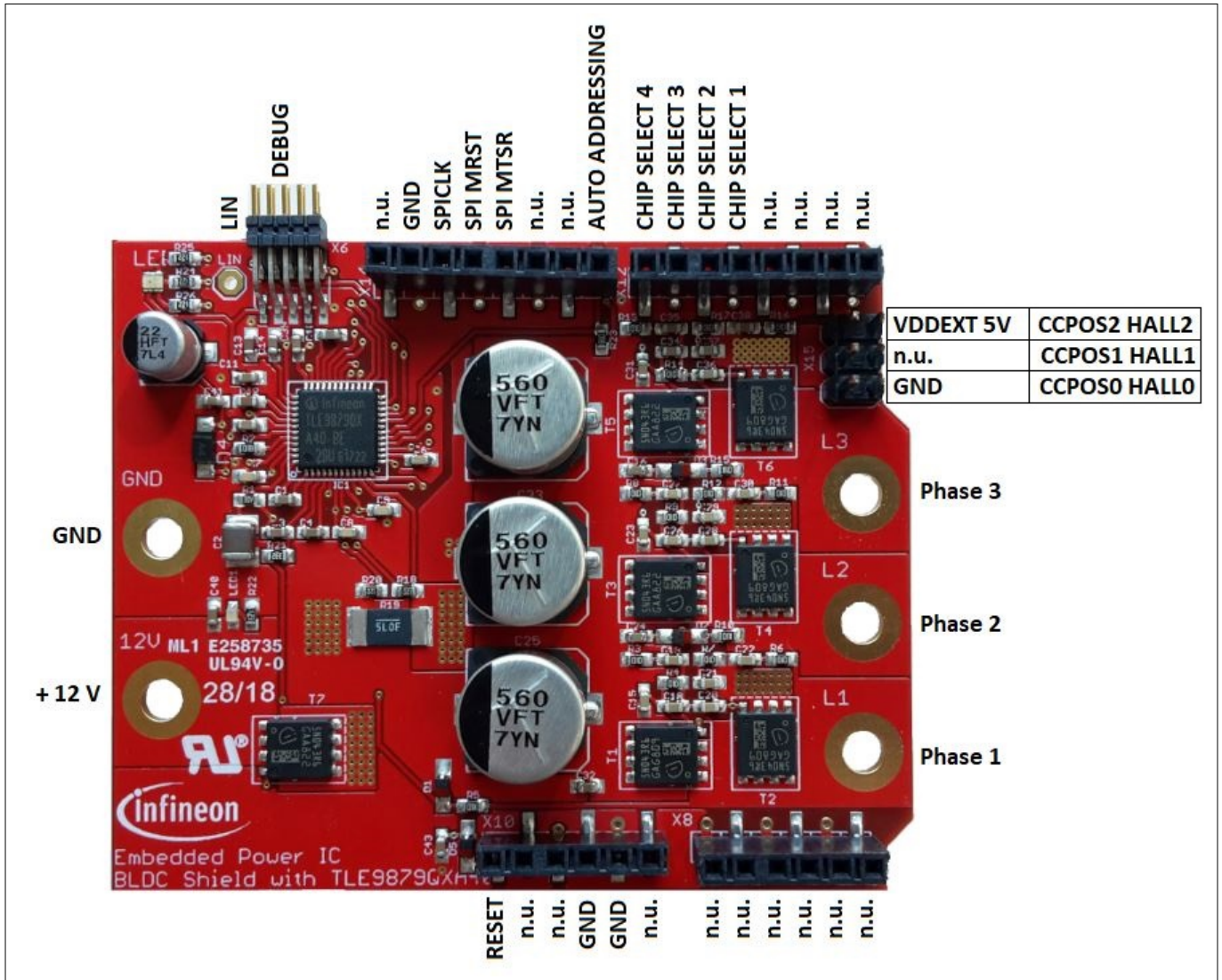


Figure 7 Pin Assignment TLE9879 BLDC Shield for Arduino

Table 3 Pin Assignment

Pin	Function
GND	Ground
SPICLK	Serial Clock
SPI MRST	SPI Master Receive Slave Transmit (similar to MISO)
SPI MTSR	SPI Master Transmit Slave Receive (similar to MOSI)
Auto Addressing	When starting after a reset, gets which shield (out of the four possible) is active
CHIP SELECT 1,2,3,4	Enables to select the shield to control
RESET	Resets the shield
VDDEXT 5V	Supply Voltage for the Hall sensor

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## 3 TLE9879 BLDC Shield for Arduino Description

**Table 3** Pin Assignment (continued)

Pin	Function
CCPOS 0,1,2 HALL 0,1,2	Inputs for the Hall sensors
Phase 1,2,3	Inputs for the motor phases



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## 4 TLE9879QXA40 Overview

### 4 TLE9879QXA40 Overview

The TLE9879QXA40 is a single chip 3-Phase motor driver that integrates the industry standard ARM® Cortex® M3 core, enabling the implementation of advanced motor control algorithms such as field-oriented control.

It includes six fully integrated NFET drivers optimized to drive a 3-Phase motor via six external power NFETs, a charge pump enabling low voltage operation and programmable current along with current slope control for optimized EMC behavior. Its peripheral set includes a current sensor, a successive approximation ADC synchronized with the capture and compare unit for PWM control and 16-bit timers. A LIN transceiver is also integrated to enable communication to the device along with a number of general purpose I/Os. It includes an on-chip linear voltage regulator to supply external loads.

It is a highly integrated automotive qualified device enabling cost and space efficient solutions for mechatronic BLDC motor drive applications such as pumps and fans.

#### 4.1 Key Features

- Six current programmable Drivers with charge pump for N-Channel MOSFET
- Integrated LIN transceiver compatible with LIN 2.2 and SAEJ2602
- Two Full duplex serial interface (UART) with LIN support
- Two Synchronous serial channel (SSC)
- On-chip OSC and PLL for clock generation
- One high voltage monitoring input with wake up functionality
- High speed Operational amplifier for motor current sensing via shunt
- Measurement unit:
  - 8-bit ADC module with 10 multiplexed inputs
  - 10-bit ADC module with 8 multiplexed inputs, 5 external Analog inputs
  - On-chip temperature and battery voltage measurement unit
- Independent Programmable window watchdog
- 5V/1.5V Internal supplies
- External Supply (VDDEXT): 5V+/-2% @ 20mA
- Power saving modes:
  - MCU slow-down Mode
  - Sleep Mode
  - Stop Mode
  - Cyclic wake-up Sleep Mode

4 TLE9879QXA40 Overview

4.2 Block Diagram

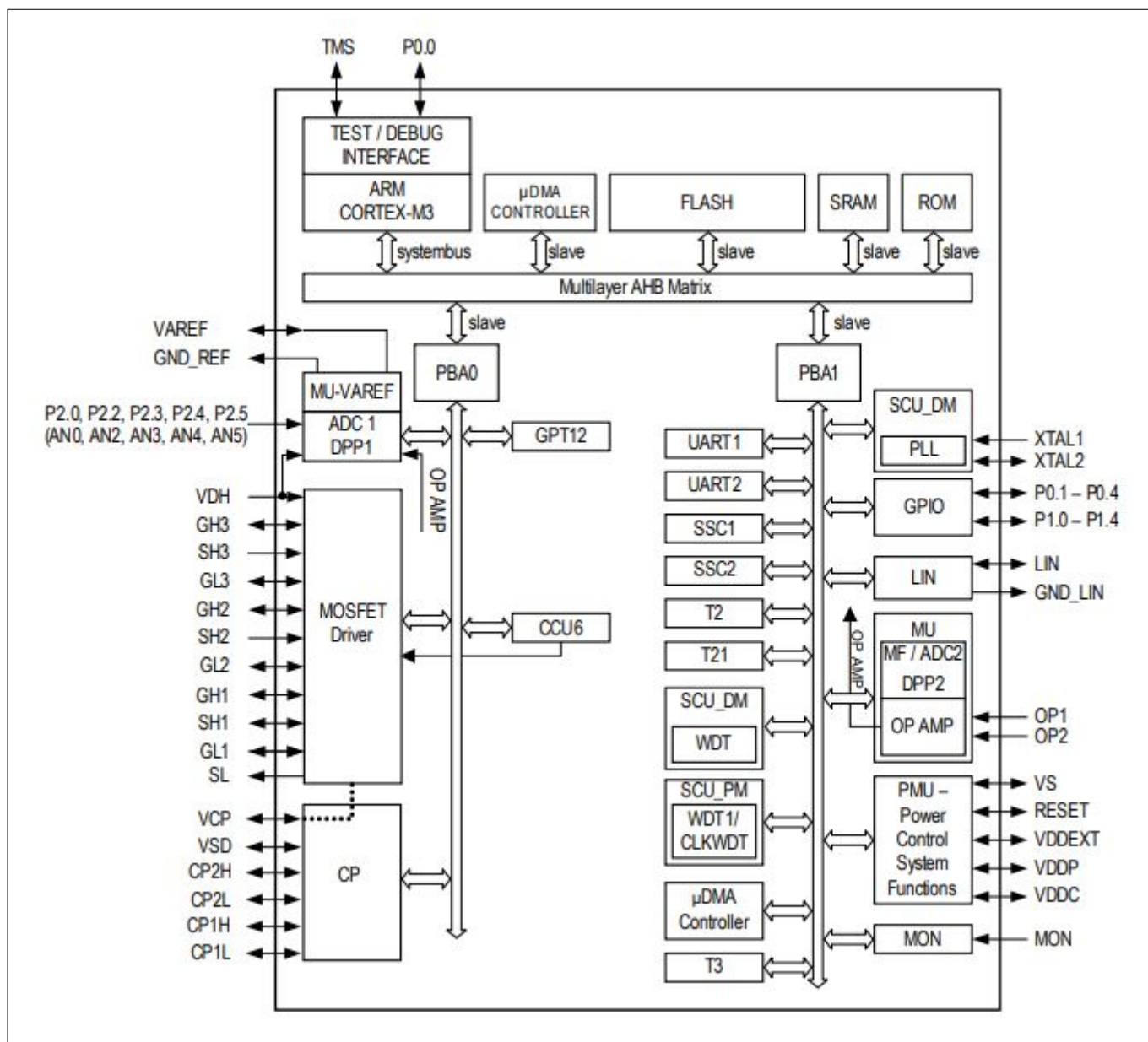


Figure 8 Block Diagram TLE9879QXA40

4 TLE9879QXA40 Overview

4.3 Pin Assignment

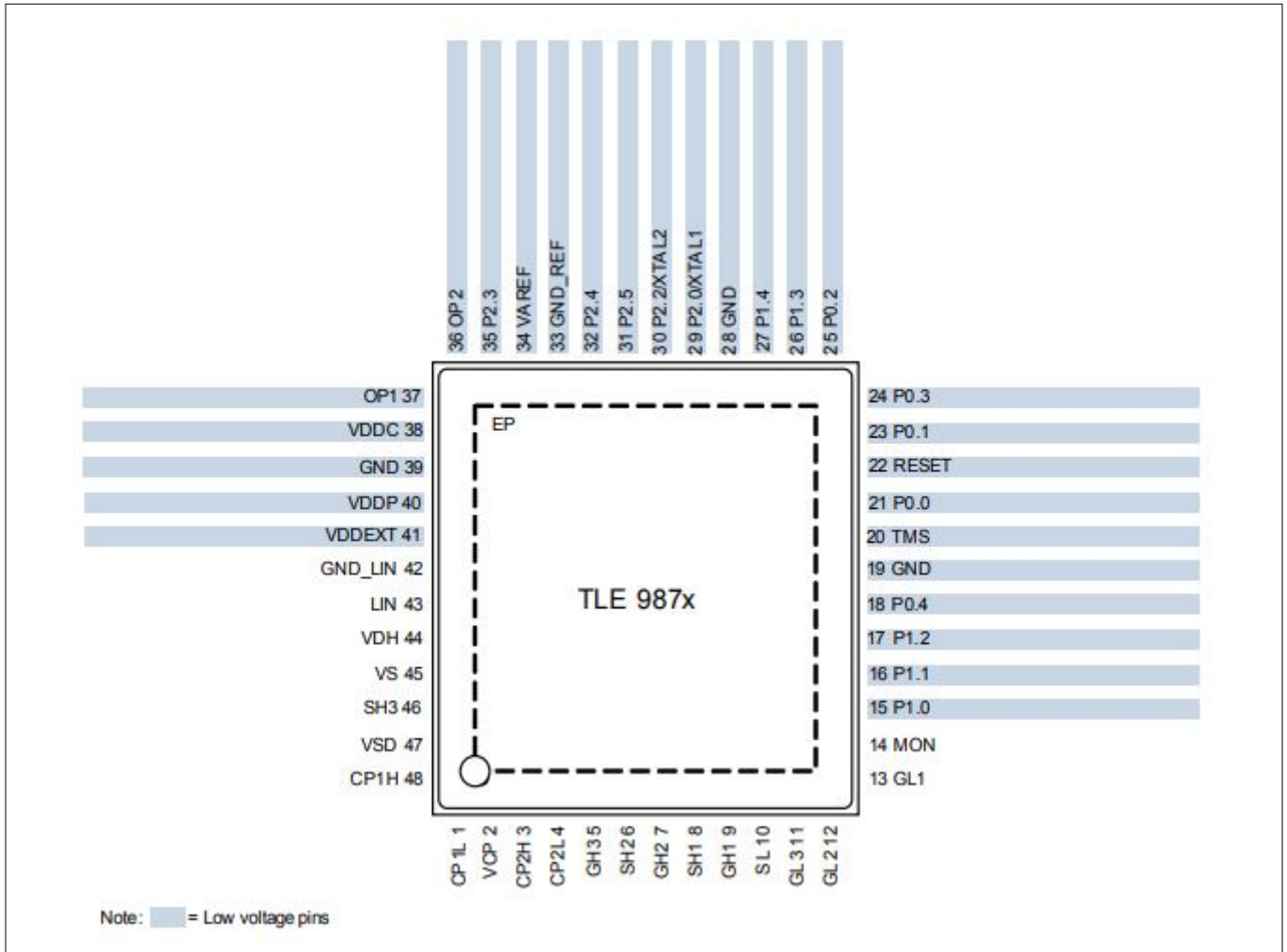


Figure 9 Device Pinout TLE9879QXA40

4.4 Pin Definitions and Functions

Table 4 Pin Definitions and Functions

Pins	Symbols	Functions
1	CP1L	Charge Pump Capacity 1 Low, connect external C
2	VCP	Charge Pump Capacity
3	CP2H	Charge Pump Capacity 2 High, connect external C
4	CP2L	Charge Pump Capacity 2 Low, connect external C
5	GH3	Gate High Side FET 3
6	SH2	Source High Side FET 2
7	GH2	Gate High Side FET 2
8	SH1	Source High Side FET 1
9	GH1	Gate High Side FET 1

4 TLE9879QXA40 Overview

**Table 4 Pin Definitions and Functions (continued)**

Pins	Symbols	Functions
10	SL	Source Low Side FET
11	GL3	Gate Low Side FET 3
12	GL2	Gate Low Side FET 2
13	GL1	Gate Low Side FET 1
14	MON	High Voltage Monitor Input
15	P1.0	GPIO
16	P1.1	GPIO
17	P1.2	GPIO
18	P0.4	GPIO
19	GND	GND Digital
20	TMS	Test Mode Select Input
21	P0.0	Serial Wire Debug Clock
22	RESET	Reset Input, not available during Sleep Mode
23	P0.1	GPIO
24	P0.3	GPIO
25	P0.2	GPIO
26	P1.3	GPIO
27	P1.4	GPIO
28	GND	GND Digital
29	P2.0/XTAL1	ADC Analog Input 0
30	P2.2/XTAL2	ADC Analog Input 2
31	P2.5	ADC Analog Input 5
32	P2.4	ADC Analog Input 4
33	GND_REF	GND for VAREF
34	VAREF	5V ADC1 Reference Voltage
35	P2.3	ADC Analog Input 3
36	OP2	Positive Operational Amplifier Input
37	OP1	Negative Operational Amplifier Input
38	VDDC	Core Supply
39	GND	GND Analog
40	VDDP	I/O Port Supply
41	VDDEXT	External Voltage Supply Output
42	GND_LIN	GND for LIN
43	LIN	LIN Bus Interface I/O

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## 4 TLE9879QXA40 Overview

**Table 4** Pin Definitions and Functions (continued)

Pins	Symbols	Functions
44	VDH	Voltage Drain High Side MOSFET Driver
45	VS	Battery Supply Input
46	SH3	Source High Side FET 3
47	VSD	Battery Supply Input for Charge Pump
48	CP1H	Charge Pump Capacity 1 High, connect external C
-	EP	Exposed Pad, connect to GND



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