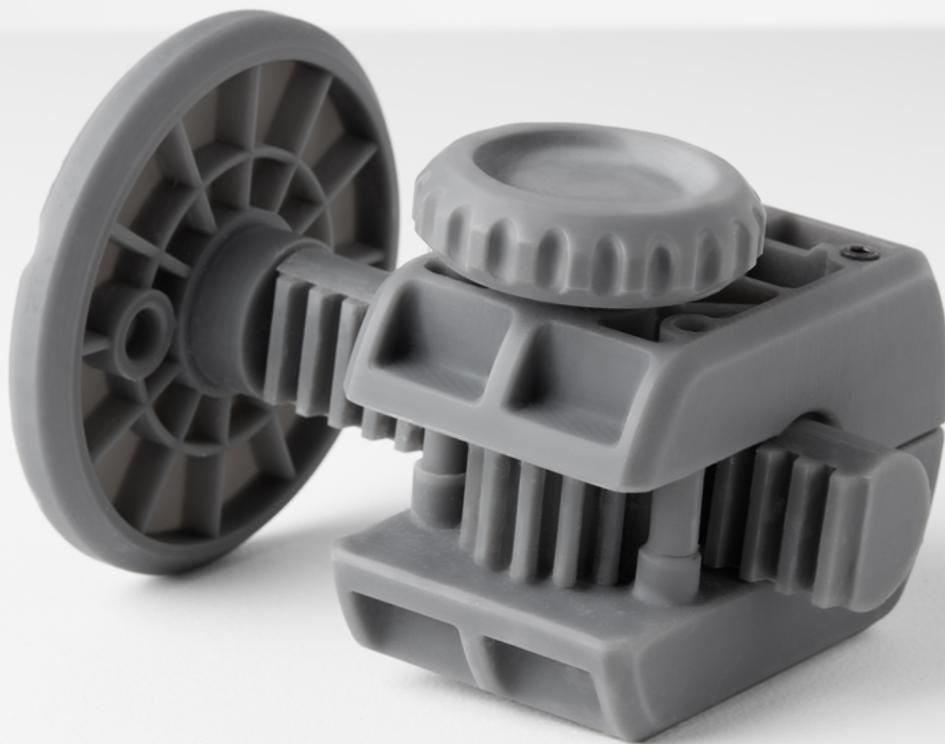


Grey Pro

Photopolymer Resin for Form 2

Grey Pro Resin's high precision, moderate elongation, and resistance to deformation over time make it a versatile material suitable for a wide range of engineering applications.

Supports print resolutions: 100 and 50 microns. **Requires Resin Tank LT.**



FLPRGR01

formlabs 

Prepared 01 . 22 . 2018
Rev 01 01 . 22 . 2018

To the best of our knowledge the information contained herein is accurate. However, Formlabs, Inc. makes no warranty, expressed or implied, regarding the accuracy of these results to be obtained from the use thereof.

Material Properties Data

	METRIC ¹		IMPERIAL ¹		METHOD
	Green ²	Post-Cured ³	Green ²	Post-Cured ³	
Tensile Properties					
Ultimate Tensile Strength	35 MPa	61 MPa	5076 psi	8876 psi	ASTM D 638-14
Tensile Modulus	1.4 GPa	2.6 GPa	203 ksi	377 ksi	ASTM D 638-14
Elongation	32.5 %	13 %	32.5 %	13 %	ASTM D 638-14
Flexural Properties					
Flexural Stress at 5% Strain	39 MPa	86 MPa	5598 psi	12400 psi	ASTM D 790-15
Flexural Modulus	0.94 GPa	2.2 GPa	136 ksi	319 ksi	ASTM D 790-15
Impact Properties					
Notched IZOD	not tested	18.7 J/m	not tested	0.351 ft-lbf/in	ASTM D256-10
Temperature Properties					
Head Deflection Temp. @ 1.8 MPa	not tested	62.4 C	not tested	144.3 °F	ASTM D 648-16
Heat Deflection Temp. @ 0.45 MPa	not tested	77.5 C	not tested	171.5 °F	ASTM D 648-16
Thermal Expansion (-30 to 30° C)	not tested	78.5 um/m/C	not tested	43.4 µin/in/°F	ASTM E 831-13

¹Material properties can vary with part geometry, print orientation, print settings, and temperature.

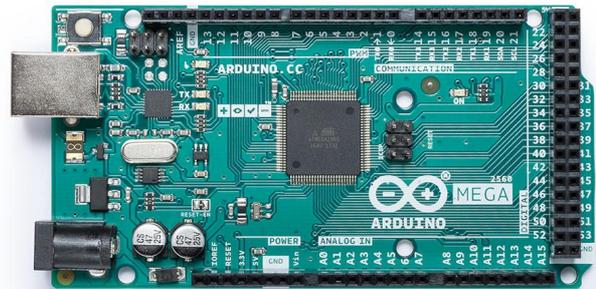
²Data was obtained from green parts, printed using Form 2, 100 µm, Grey Pro settings, without additional treatments.

³Data was obtained from parts printed using Form 2, 100 µm, Grey Pro settings and post-cured with a Formcure for 120 minutes at 80 C.

Solvent Compatibility

Percent weight gain over 24 hours for a printed and post-cured 1 x 1 x 1 cm cube immersed in respective solvent:

Mechanical Properties	24 hr weight gain (%)	Mechanical Properties	24 hr weight gain (%)
Acetic Acid, 5 %	0.75	Hydrogen Peroxide (3 %)	0.75
Acetone	10.77	Isooctane	0.02
Isopropyl Alcohol	1.56	Mineral Oil, light	0.35
Bleach, ~5 % NaOCl	0.65	Mineral Oil, heavy	0.27
Butyl Acetate	0.84	Salt Water (3.5 % NaCl)	0.64
Diesel	0.08	Sodium hydroxide (0.025 %, pH = 10)	0.72
Diethyl glycol monomethyl ether	2.38	Water	0.83
Hydraulic Oil	0.16	Xylene	0.42
Skydrol 5	0.54	Strong Acid (HCl Conc)	8.21



Description

Arduino® Mega 2560 is an exemplary development board dedicated for building extensive applications as compared to other maker boards by Arduino. The board accommodates the ATmega2560 microcontroller, which operates at a frequency of 16 MHz. The board contains 54 digital input/output pins, 16 analog inputs, 4 UARTs (hardware serial ports), a USB connection, a power jack, an ICSP header, and a reset button.

Target Areas

3D Printing, Robotics, Maker



Features

- **ATmega2560 Processor**
 - Up to 16 MIPS Throughput at 16MHz
 - 256k bytes (of which 8k is used for the bootloader)
 - 4k bytes EEPROM
 - 8k bytes Internal SRAM
 - 32 × 8 General Purpose Working Registers
 - Real Time Counter with Separate Oscillator
 - Four 8-bit PWM Channels
 - Four Programmable Serial USART
 - Controller/Peripheral SPI Serial Interface

- **ATmega16U2**
 - Up to 16 MIPS Throughput at 16 MHz
 - 16k bytes ISP Flash Memory
 - 512 bytes EEPROM
 - 512 bytes SRAM
 - USART with SPI master only mode and hardware flow control (RTS/CTS)
 - Master/Slave SPI Serial Interface

- **Sleep Modes**
 - Idle
 - ADC Noise Reduction
 - Power-save
 - Power-down
 - Standby
 - Extended Standby

- **Power**
 - USB Connection
 - External AC/DC Adapter

- **I/O**
 - 54 Digital
 - 16 Analog
 - 15 PWM Output



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1 The Board

Arduino® Mega 2560 is a successor board of Arduino Mega, it is dedicated to applications and projects that require large number of input output pins and the use cases which need high processing power. The Arduino® Mega 2560 comes with a much larger set of IOs when we compare it with traditional Uno board considering the form factor of both the boards.

1.1 Application Examples

- **Robotics:** Featuring the high processing capacity, the Arduino Mega 2560 can handle the extensive robotic applications. It is compatible with the motor controller shield that enables it to control multiple motors at an instance, thus making it perfect of robotic applications. The large number of I/O pins can accommodate many robotic sensors as well.
- **3D Printing:** Algorithms play a significant role in implementation of 3D printers. Arduino Mega 2560 has the power to process these complex algorithms required for 3D printing. Additionally, the slight changes to the code is easily possible with the Arduino IDE and thus 3D printing programs can be customized according to user requirements.
- **Wi-Fi:** Integrating wireless functionality enhances the utility of the applications. Arduino Mega 2560 is compatible with WiFi shields hence allowing the wireless features for the applications in 3D printing and Robotics.

1.2 Accessories

1.3 Related Products

- Arduino® Uno Rev 3
- Arduino® Nano
- Arduino® DUE without headers

2 Ratings

2.1 Recommended Operating Conditions

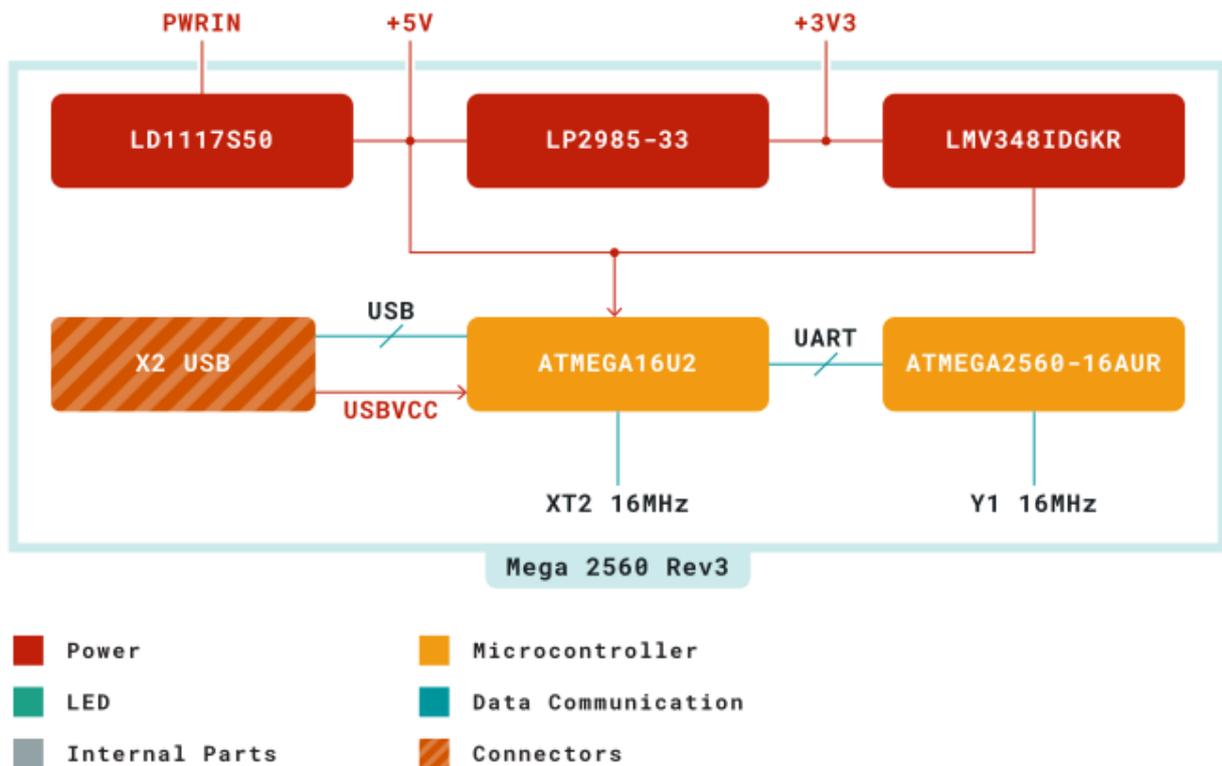
Symbol	Description	Min	Max
	Conservative thermal limits for the whole board:	-40 °C	85 °C

2.2 Power Consumption

Symbol	Description	Min	Typ	Max	Unit
PWRIN	Input supply from power jack		TBC		mW
USB VCC	Input supply from USB		TBC		mW
VIN	Input from VIN pad		TBC		mW

3 Functional Overview

3.1 Block Diagram

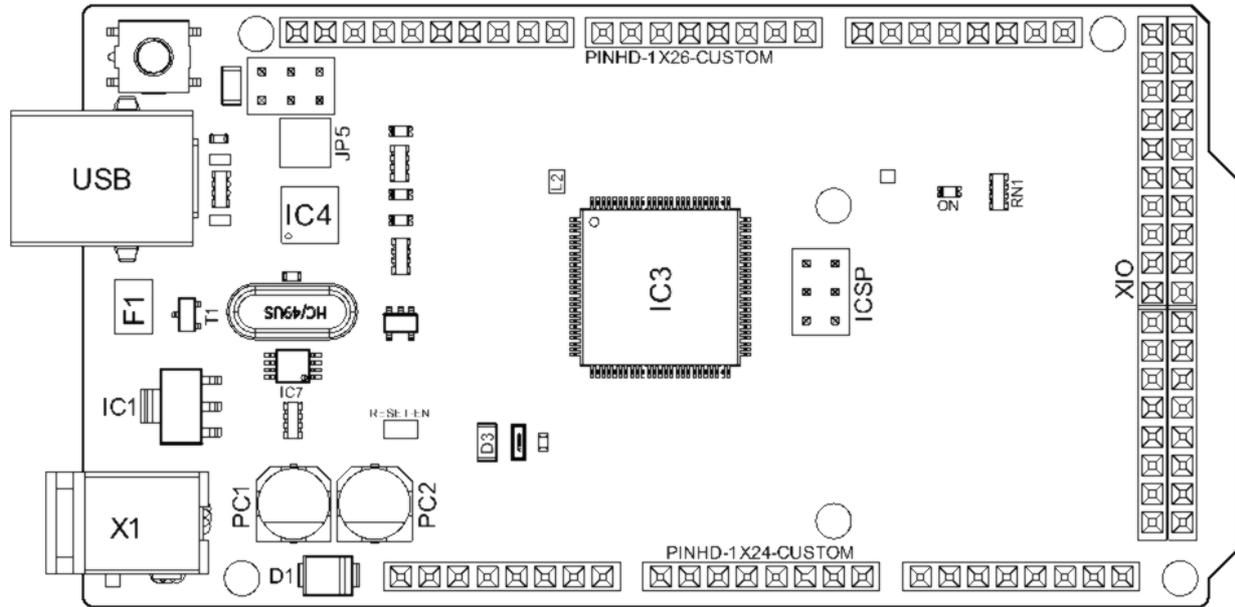


Arduino MEGA Block Diagram



3.2 Board Topology

Front View



Arduino MEGA Top View

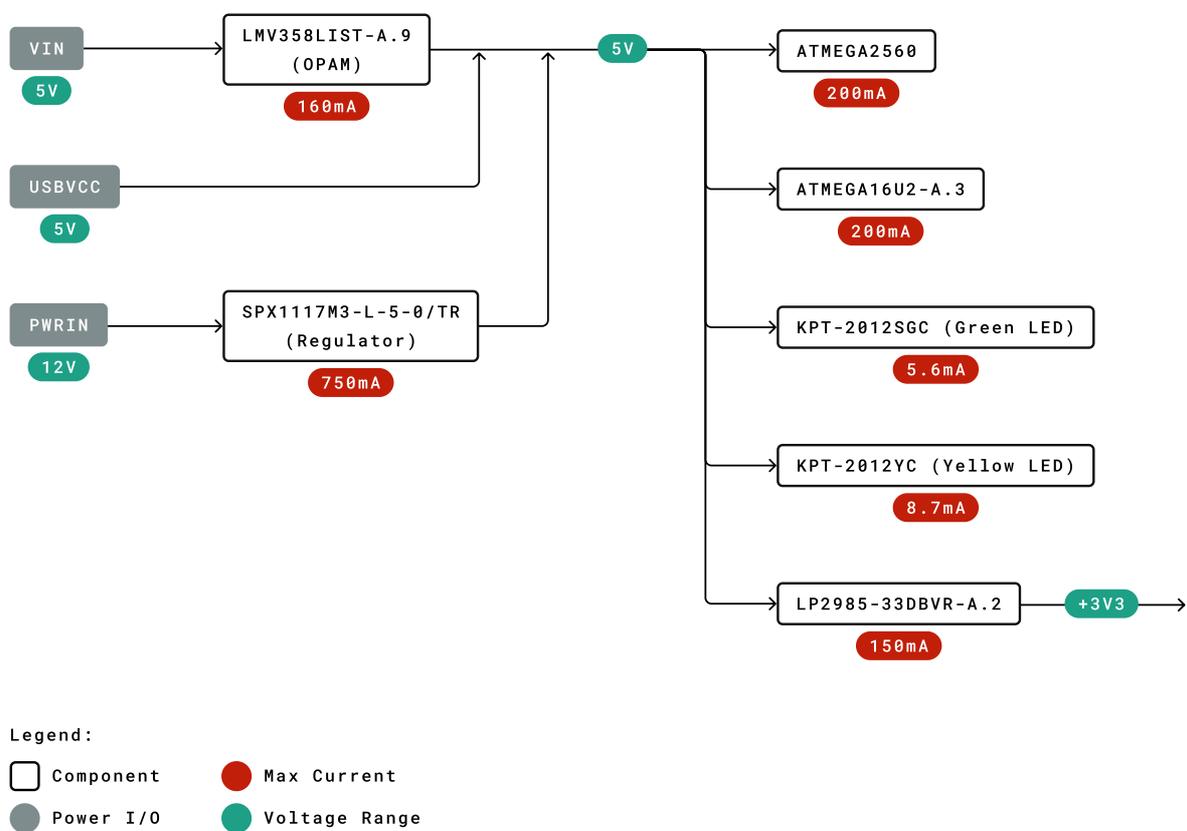
Ref.	Description	Ref.	Description
USB	USB B Connector	F1	Chip Capacitor
IC1	5V Linear Regulator	X1	Power Jack Connector
JP5	Plated Holes	IC4	ATmega16U2 chip
PC1	Electrolytic Aluminum Capacitor	PC2	Electrolytic Aluminum Capacitor
D1	General Purpose Rectifier	D3	General Purpose Diode
L2	Fixed Inductor	IC3	ATmega2560 chip
ICSP	Connector Header	ON	Green LED
RN1	Resistor Array	XIO	Connector



3.3 Processor

Primary processor of Arduino Mega 2560 Rev3 board is ATmega2560 chip which operates at a frequency of 16 MHz. It accommodates a large number of input and output lines which gives the provision of interfacing many external devices. At the same time the operations and processing is not slowed due to its significantly larger RAM than the other processors. The board also features a USB serial processor ATmega16U2 which acts an interface between the USB input signals and the main processor. This increases the flexibility of interfacing and connecting peripherals to the Arduino Mega 2560 Rev 3 board.

3.4 Power Tree



Power Tree



4 Board Operation

4.1 Getting Started - IDE

If you want to program your Arduino® MEGA 2560 while offline you need to install the Arduino® Desktop IDE **[1]**. To connect the Arduino® MEGA 2560 to your computer, you'll need a Type-B USB cable. This also provides power to the board, as indicated by the LED.

4.2 Getting Started - Arduino Web Editor

All Arduino® boards, including this one, work out-of-the-box on the Arduino® Web Editor **[2]**, by just installing a simple plugin.

The Arduino® Web Editor is hosted online, therefore it will always be up-to-date with the latest features and support for all boards. Follow **[3]** to start coding on the browser and upload your sketches onto your board.

4.3 Sample Sketches

Sample sketches for the Arduino® MEGA 2560 can be found either in the "Examples" menu in the Arduino® IDE

4.4 Online Resources

Now that you have gone through the basics of what you can do with the board you can explore the endless possibilities it provides by checking exciting projects on ProjectHub **[5]**, the Arduino® Library Reference **[6]** and the online store **[7]** where you will be able to complement your board with sensors, actuators and more.

4.5 Board Recovery

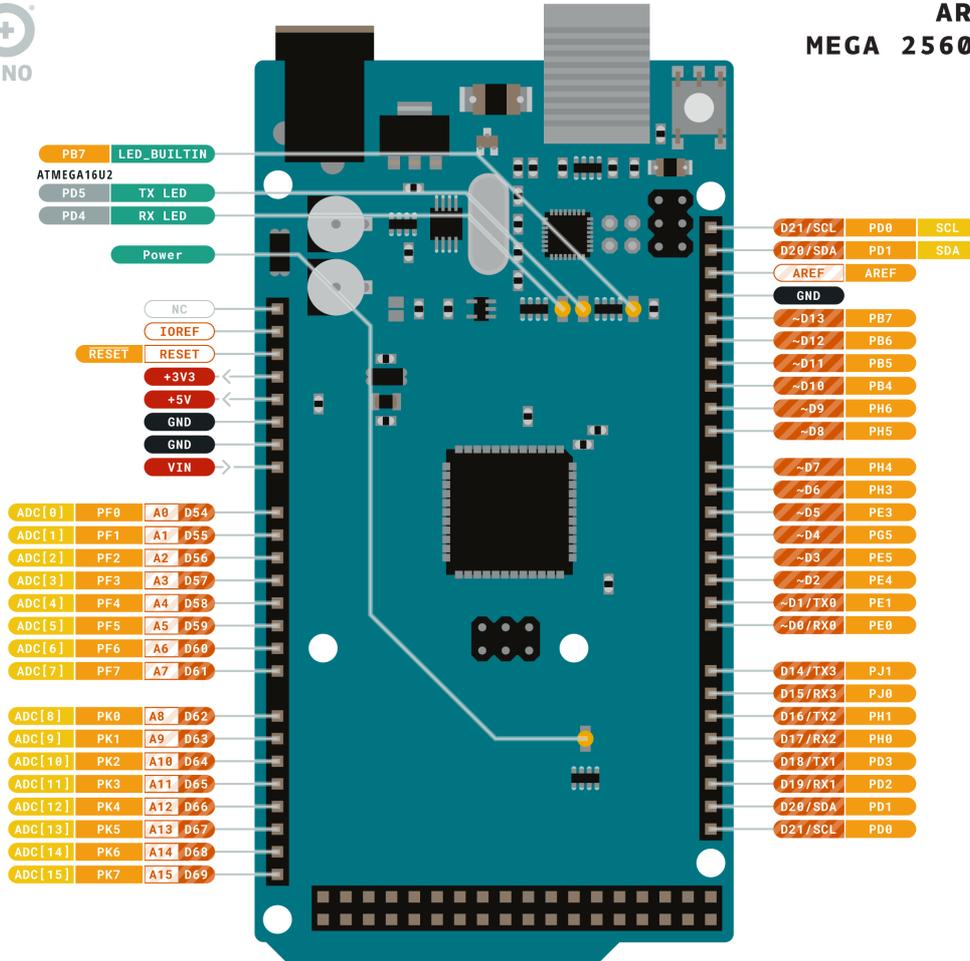
All Arduino boards have a built-in bootloader which allows flashing the board via USB. In case a sketch locks up the processor and the board is not reachable anymore via USB it is possible to enter bootloader mode by double-tapping the reset button right after power up.



5 Connector Pinouts



**ARDUINO
MEGA 2560 REV3**



Ground	Internal Pin	Digital Pin	Microcontroller's Port
Power	SWD Pin	Analog Pin	
LED	Other Pin	Default	

ARDUINO.CC

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Arduino Mega Pinout



5.1 Analog

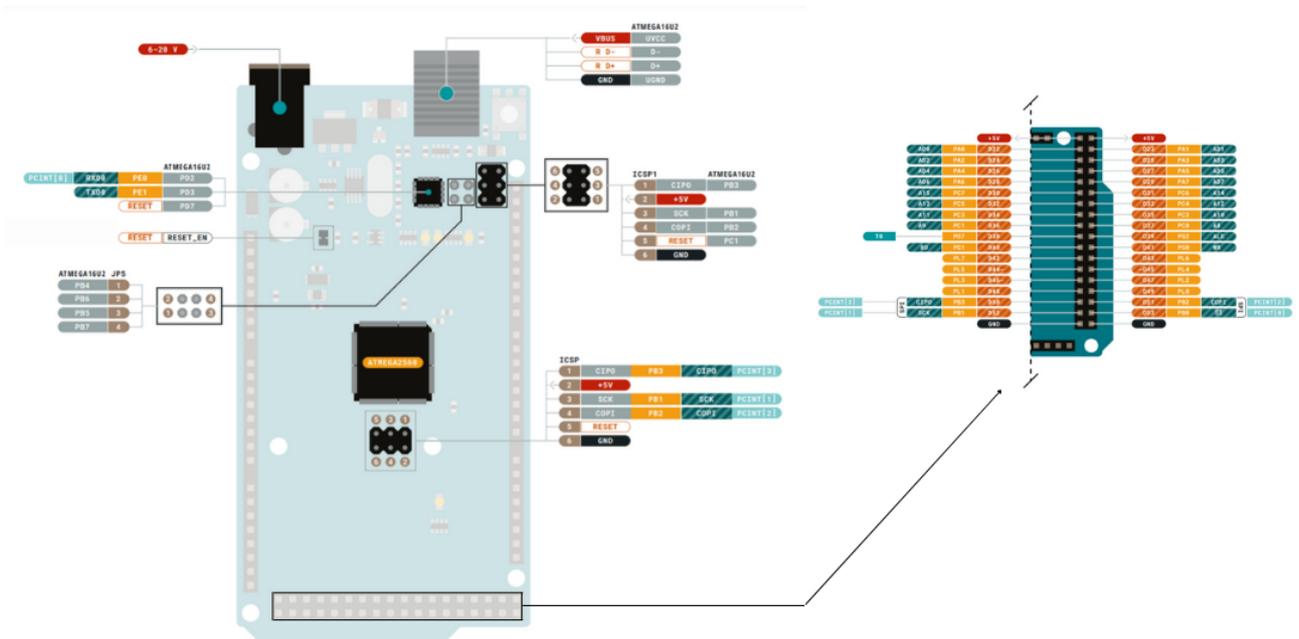
Pin	Function	Type	Description
1	NC	NC	Not Connected
2	IOREF	IOREF	Reference for digital logic V - connected to 5V
3	Reset	Reset	Reset
4	+3V3	Power	+3V3 Power Rail
5	+5V	Power	+5V Power Rail
6	GND	Power	Ground
7	GND	Power	Ground
8	VIN	Power	Voltage Input
9	A0	Analog	Analog input 0 /GPIO
10	A1	Analog	Analog input 1 /GPIO
11	A2	Analog	Analog input 2 /GPIO
12	A3	Analog	Analog input 3 /GPIO
13	A4	Analog	Analog input 4 /GPIO
14	A5	Analog	Analog input 5 /GPIO
15	A6	Analog	Analog input 6 /GPIO
16	A7	Analog	Analog input 7 /GPIO
17	A8	Analog	Analog input 8 /GPIO
18	A9	Analog	Analog input 9 /GPIO
19	A10	Analog	Analog input 10 /GPIO
20	A11	Analog	Analog input 11 /GPIO
21	A12	Analog	Analog input 12 /GPIO
22	A13	Analog	Analog input 13 /GPIO
23	A14	Analog	Analog input 14 /GPIO
24	A15	Analog	Analog input 15 /GPIO

5.2 Digital

Pin	Function	Type	Description
1	D21/SCL	Digital Input/I2C	Digital input 21/I2C Dataline
2	D20/SDA	Digital Input/I2C	Digital input 20/I2C Dataline
3	AREF	Digital	Analog Reference Voltage
4	GND	Power	Ground
5	D13	Digital/GPIO	Digital input 13/GPIO
6	D12	Digital/GPIO	Digital input 12/GPIO
7	D11	Digital/GPIO	Digital input 11/GPIO
8	D10	Digital/GPIO	Digital input 10/GPIO
9	D9	Digital/GPIO	Digital input 9/GPIO
10	D8	Digital/GPIO	Digital input 8/GPIO
11	D7	Digital/GPIO	Digital input 7/GPIO
12	D6	Digital/GPIO	Digital input 6/GPIO
13	D5	Digital/GPIO	Digital input 5/GPIO
14	D4	Digital/GPIO	Digital input 4/GPIO



Pin	Function	Type	Description
15	D3	Digital/GPIO	Digital input 3 /GPIO
16	D2	Digital/GPIO	Digital input 2 /GPIO
17	D1/TX0	Digital/GPIO	Digital input 1 /GPIO
18	D0/Tx1	Digital/GPIO	Digital input 0 /GPIO
19	D14	Digital/GPIO	Digital input 14 /GPIO
20	D15	Digital/GPIO	Digital input 15 /GPIO
21	D16	Digital/GPIO	Digital input 16 /GPIO
22	D17	Digital/GPIO	Digital input 17 /GPIO
23	D18	Digital/GPIO	Digital input 18 /GPIO
24	D19	Digital/GPIO	Digital input 19 /GPIO
25	D20	Digital/GPIO	Digital input 20 /GPIO
26	D21	Digital/GPIO	Digital input 21 /GPIO



Arduino Mega Pinout



5.3 ATMEGA16U2 JP5

Pin	Function	Type	Description
1	PB4	Internal	Serial Wire Debug
2	PB6	Internal	Serial Wire Debug
3	PB5	Internal	Serial Wire Debug
4	PB7	Internal	Serial Wire Debug

5.4 ATMEGA16U2 ICSP1

Pin	Function	Type	Description
1	CIPO	Internal	Controller In Peripheral Out
2	+5V	Internal	Power Supply of 5V
3	SCK	Internal	Serial Clock
4	COPI	Internal	Controller Out Peripheral In
5	RESET	Internal	Reset
6	GND	Internal	Ground

5.5 Digital Pins D22 - D53 LHS

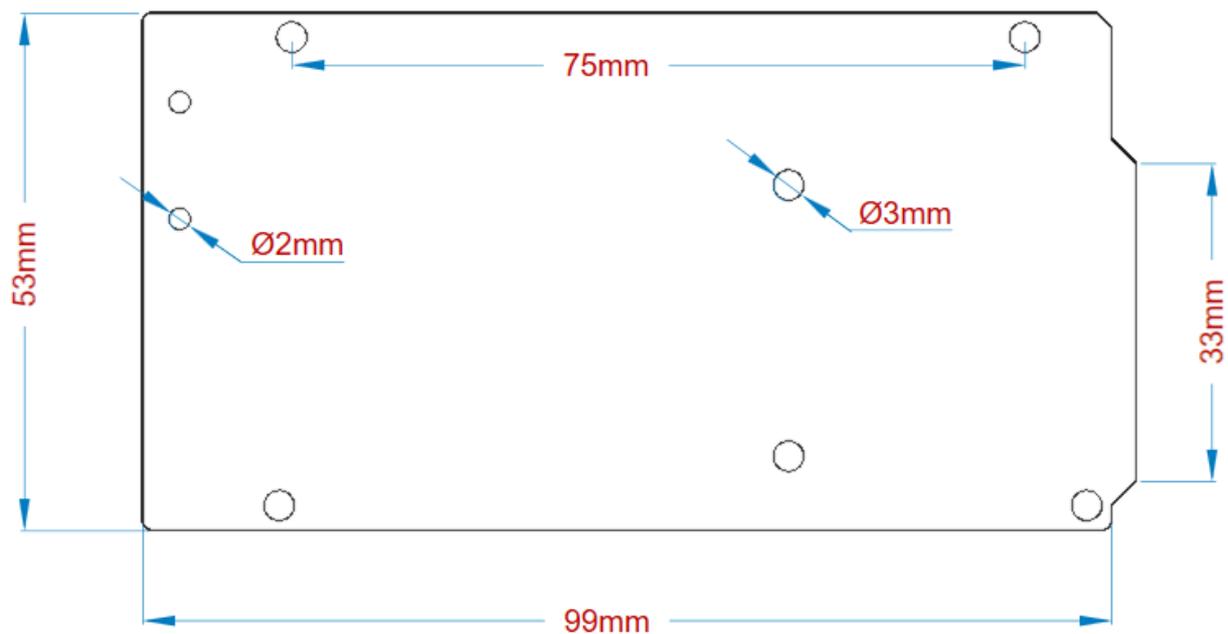
Pin	Function	Type	Description
1	+5V	Power	Power Supply of 5V
2	D22	Digital	Digital input 22/GPIO
3	D24	Digital	Digital input 24/GPIO
4	D26	Digital	Digital input 26/GPIO
5	D28	Digital	Digital input 28/GPIO
6	D30	Digital	Digital input 30/GPIO
7	D32	Digital	Digital input 32/GPIO
8	D34	Digital	Digital input 34/GPIO
9	D36	Digital	Digital input 36/GPIO
10	D38	Digital	Digital input 38/GPIO
11	D40	Digital	Digital input 40/GPIO
12	D42	Digital	Digital input 42/GPIO
13	D44	Digital	Digital input 44/GPIO
14	D46	Digital	Digital input 46/GPIO
15	D48	Digital	Digital input 48/GPIO
16	D50	Digital	Digital input 50/GPIO
17	D52	Digital	Digital input 52/GPIO
18	GND	Power	Ground

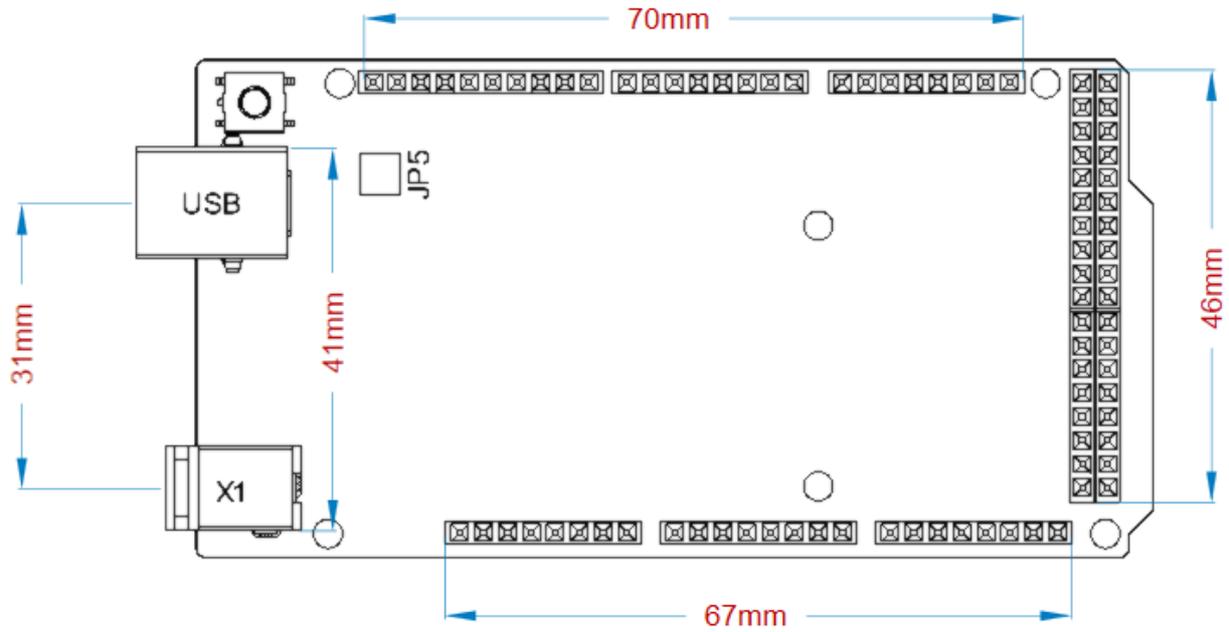
5.6 Digital Pins D22 - D53 RHS

Pin	Function	Type	Description
1	+5V	Power	Power Supply of 5V
2	D23	Digital	Digital input 23/GPIO
3	D25	Digital	Digital input 25/GPIO
4	D27	Digital	Digital input 27/GPIO
5	D29	Digital	Digital input 29/GPIO
6	D31	Digital	Digital input 31/GPIO
7	D33	Digital	Digital input 33/GPIO
8	D35	Digital	Digital input 35/GPIO
9	D37	Digital	Digital input 37/GPIO
10	D39	Digital	Digital input 39/GPIO
11	D41	Digital	Digital input 41/GPIO
12	D43	Digital	Digital input 43/GPIO
13	D45	Digital	Digital input 45/GPIO
14	D47	Digital	Digital input 47/GPIO
15	D49	Digital	Digital input 49/GPIO
16	D51	Digital	Digital input 51/GPIO
17	D53	Digital	Digital input 53/GPIO
18	GND	Power	Ground

6 Mechanical Information

6.1 Board Outline



*Arduino Mega Outline***6.2 Board Mount Holes***Arduino Mega Mount Holes*

Certifications

7 Declaration of Conformity CE DoC (EU)

We declare under our sole responsibility that the products above are in conformity with the essential requirements of the following EU Directives and therefore qualify for free movement within markets comprising the European Union (EU) and European Economic Area (EEA).



8 Declaration of Conformity to EU RoHS & REACH 211 01/19/2021

Arduino boards are in compliance with RoHS 2 Directive 2011/65/EU of the European Parliament and RoHS 3 Directive 2015/863/EU of the Council of 4 June 2015 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

Substance	Maximum Limit (ppm)
Lead (Pb)	1000
Cadmium (Cd)	100
Mercury (Hg)	1000
Hexavalent Chromium (Cr6+)	1000
Poly Brominated Biphenyls (PBB)	1000
Poly Brominated Diphenyl ethers (PBDE)	1000
Bis(2-Ethylhexyl} phthalate (DEHP)	1000
Benzyl butyl phthalate (BBP)	1000
Dibutyl phthalate (DBP)	1000
Diisobutyl phthalate (DIBP)	1000

Exemptions : No exemptions are claimed.

Arduino Boards are fully compliant with the related requirements of European Union Regulation (EC) 1907 /2006 concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH). We declare none of the SVHCs (<https://echa.europa.eu/web/guest/candidate-list-table>), the Candidate List of Substances of Very High Concern for authorization currently released by ECHA, is present in all products (and also package) in quantities totaling in a concentration equal or above 0.1%. To the best of our knowledge, we also declare that our products do not contain any of the substances listed on the "Authorization List" (Annex XIV of the REACH regulations) and Substances of Very High Concern (SVHC) in any significant amounts as specified by the Annex XVII of Candidate list published by ECHA (European Chemical Agency) 1907 /2006/EC.



9 Conflict Minerals Declaration

As a global supplier of electronic and electrical components, Arduino is aware of our obligations with regards to laws and regulations regarding Conflict Minerals, specifically the Dodd-Frank Wall Street Reform and Consumer Protection Act, Section 1502. Arduino does not directly source or process conflict minerals such as Tin, Tantalum, Tungsten, or Gold. Conflict minerals are contained in our products in the form of solder, or as a component in metal alloys. As part of our reasonable due diligence Arduino has contacted component suppliers within our supply chain to verify their continued compliance with the regulations. Based on the information received thus far we declare that our products contain Conflict Minerals sourced from conflict-free areas.

10 FCC Caution

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference
- (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC RF Radiation Exposure Statement:

1. This Transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.
2. This equipment complies with RF radiation exposure limits set forth for an uncontrolled environment.
3. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

English: User manuals for licence-exempt radio apparatus shall contain the following or equivalent notice in a conspicuous location in the user manual or alternatively on the device or both. This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions:

- (1) this device may not cause interference
- (2) this device must accept any interference, including interference that may cause undesired operation of the device.

French: Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

- (1) l'appareil n' doit pas produire de brouillage
- (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

IC SAR Warning:

English This equipment should be installed and operated with minimum distance 20 cm between the radiator and your body.



French: Lors de l'installation et de l'exploitation de ce dispositif, la distance entre le radiateur et le corps est d'au moins 20 cm.

Important: The operating temperature of the EUT can't exceed 85°C and shouldn't be lower than -40°C.

Hereby, Arduino S.r.l. declares that this product is in compliance with essential requirements and other relevant provisions of Directive 201453/EU. This product is allowed to be used in all EU member states.

11 Company Information

Company name	Arduino S.r.l.
Company Address	Arduino SRL, Via Andrea Appiani 25, 20900 Monza MB, Italy

12 Reference Documentation

Ref	Link
Arduino IDE (Desktop)	https://www.arduino.cc/en/Main/Software
Arduino IDE (Cloud)	https://create.arduino.cc/editor
Cloud IDE Getting Started	https://create.arduino.cc/projecthub/Arduino_Genuino/getting-started-with-arduino-web-editor-4b3e4a
Arduino Pro Website	https://www.arduino.cc/pro
Project Hub	https://create.arduino.cc/projecthub?by=part&part_id=11332&sort=trending
Library Reference	https://www.arduino.cc/reference/en/libraries/
Online Store	https://store.arduino.cc/

13 Revision History

Date	Revision	Changes
29/09/2020	1	First Release

DRV8825 Stepper Motor Controller IC

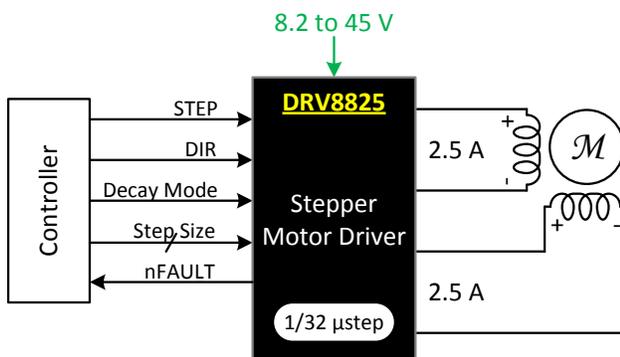
1 Features

- PWM Microstepping Stepper Motor Driver
 - Built-In Microstepping Indexer
 - Up to 1/32 Microstepping
- Multiple Decay Modes
 - Mixed Decay
 - Slow Decay
 - Fast Decay
- 8.2-V to 45-V Operating Supply Voltage Range
- 2.5-A Maximum Drive Current at 24 V and $T_A = 25^\circ\text{C}$
- Simple STEP/DIR Interface
- Low Current Sleep Mode
- Built-In 3.3-V Reference Output
- Small Package and Footprint
- Protection Features
 - Overcurrent Protection (OCP)
 - Thermal Shutdown (TSD)
 - VM Undervoltage Lockout (UVLO)
 - Fault Condition Indication Pin (nFAULT)

2 Applications

- Automatic Teller Machines
- Money Handling Machines
- Video Security Cameras
- Printers
- Scanners
- Office Automation Machines
- Gaming Machines
- Factory Automation
- Robotics

4 Simplified Schematic



3 Description

The DRV8825 provides an integrated motor driver solution for printers, scanners, and other automated equipment applications. The device has two H-bridge drivers and a microstepping indexer, and is intended to drive a bipolar stepper motor. The output driver block consists of N-channel power MOSFET's configured as full H-bridges to drive the motor windings. The DRV8825 is capable of driving up to 2.5 A of current from each output (with proper heat sinking, at 24 V and 25°C).

A simple STEP/DIR interface allows easy interfacing to controller circuits. Mode pins allow for configuration of the motor in full-step up to 1/32-step modes. Decay mode is configurable so that slow decay, fast decay, or mixed decay can be used. A low-power sleep mode is provided which shuts down internal circuitry to achieve very low quiescent current draw. This sleep mode can be set using a dedicated nSLEEP pin.

Internal shutdown functions are provided for overcurrent, short circuit, under voltage lockout and over temperature. Fault conditions are indicated via the nFAULT pin.

Device Information⁽¹⁾

PART NUMBER	PACKAGE	BODY SIZE (NOM)
DRV8825	HTSSOP (28)	9.70 mm x 6.40 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

Microstepping Current Waveform

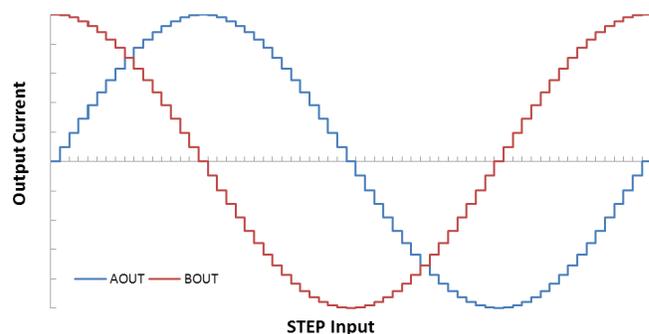


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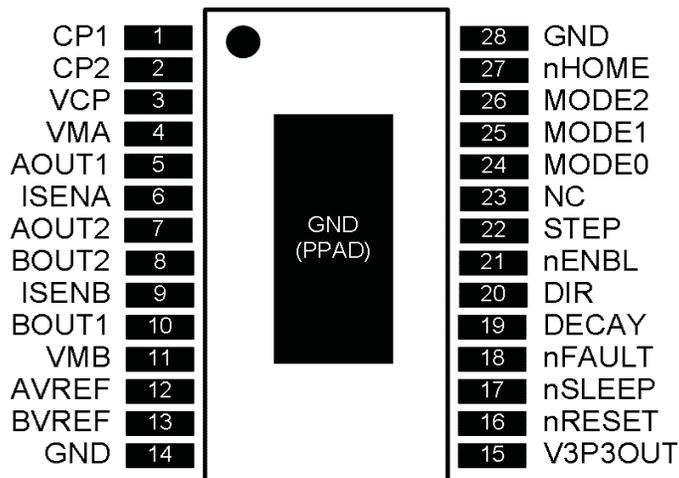
5 Revision History

Changes from Revision E (August 2013) to Revision F

Page

• Added new sections and reordered data sheet to fit new TI flow	1
• Updated pin descriptions	3
• Added power supply ramp rate and updated ISENSE pin voltage in <i>Absolute Maximum Ratings</i>	4
• Updated V_{IL} voltage minimum and typical in <i>Electrical Characteristics</i>	6
• Updated I_{IN} and t_{DEG} in <i>Electrical Characteristics</i>	6

6 Pin Configuration and Functions


Pin Functions

PIN		I/O ⁽¹⁾	DESCRIPTION	EXTERNAL COMPONENTS OR CONNECTIONS
NAME	NO.			
POWER AND GROUND				
CP1	1	I/O	Charge pump flying capacitor	Connect a 0.01- μ F 50-V capacitor between CP1 and CP2.
CP2	2	I/O	Charge pump flying capacitor	
GND	14, 28	—	Device ground	
VCP	3	I/O	High-side gate drive voltage	Connect a 0.1- μ F 16-V ceramic capacitor and a 1-M Ω resistor to VM.
VMA	4	—	Bridge A power supply	Connect to motor supply (8.2 to 45 V). Both pins must be connected to the same supply, bypassed with a 0.1- μ F capacitor to GND, and connected to appropriate bulk capacitance.
VMB	11	—	Bridge B power supply	
V3P3OUT	15	O	3.3-V regulator output	Bypass to GND with a 0.47- μ F 6.3-V ceramic capacitor. Can be used to supply VREF.
CONTROL				
AVREF	12	I	Bridge A current set reference input	Reference voltage for winding current set. Normally AVREF and BVREF are connected to the same voltage. Can be connected to V3P3OUT.
BVREF	13	I	Bridge B current set reference input	
DECAY	19	I	Decay mode	Low = slow decay, open = mixed decay, high = fast decay. Internal pulldown and pullup.
DIR	20	I	Direction input	Level sets the direction of stepping. Internal pulldown.
MODE0	24	I	Microstep mode 0	MODE0 through MODE2 set the step mode - full, 1/2, 1/4, 1/8/1/16, or 1/32 step. Internal pulldown.
MODE1	25	I	Microstep mode 1	
MODE2	26	I	Microstep mode 2	
NC	23	—	No connect	Leave this pin unconnected.
nENBL	21	I	Enable input	Logic high to disable device outputs and indexer operation, logic low to enable. Internal pulldown.
nRESET	16	I	Reset input	Active-low reset input initializes the indexer logic and disables the H-bridge outputs. Internal pulldown.
nSLEEP	17	I	Sleep mode input	Logic high to enable device, logic low to enter low-power sleep mode. Internal pulldown.
STEP	22	I	Step input	Rising edge causes the indexer to move one step. Internal pulldown.
STATUS				
nFAULT	18	OD	Fault	Logic low when in fault condition (overtemp, overcurrent)

(1) Directions: I = input, O = output, OD = open-drain output, IO = input/output

Pin Functions (continued)

PIN		I/O ⁽¹⁾	DESCRIPTION	EXTERNAL COMPONENTS OR CONNECTIONS
NAME	NO.			
nHOME	27	OD	Home position	Logic low when at home state of step table
OUTPUT				
AOUT1	5	O	Bridge A output 1	Connect to bipolar stepper motor winding A. Positive current is AOUT1 → AOUT2
AOUT2	7	O	Bridge A output 2	
BOUT1	10	O	Bridge B output 1	Connect to bipolar stepper motor winding B. Positive current is BOUT1 → BOUT2
BOUT2	8	O	Bridge B output 2	
ISENA	6	I/O	Bridge A ground / Isense	Connect to current sense resistor for bridge A.
ISENB	9	I/O	Bridge B ground / Isense	Connect to current sense resistor for bridge B.

7 Specifications

7.1 Absolute Maximum Ratings⁽¹⁾⁽²⁾

		MIN	MAX	UNIT
V _(VMx)	Power supply voltage	-0.3	47	V
	Power supply ramp rate		1	V/μs
	Digital pin voltage	-0.5	7	V
V _(xVREF)	Input voltage	-0.3	4	V
	ISENSE _x pin voltage ⁽³⁾	-0.8	0.8	V
	Peak motor drive output current, t < 1 μs		Internally limited	A
	Continuous motor drive output current ⁽⁴⁾	0	2.5	A
	Continuous total power dissipation	See Thermal Information		
T _J	Operating junction temperature range	-40	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values are with respect to network ground terminal.
- (3) Transients of ±1 V for less than 25 ns are acceptable
- (4) Power dissipation and thermal limits must be observed.

7.2 Handling Ratings

		MIN	MAX	UNIT	
T _{stg}	Storage temperature range	-60	150	°C	
V _(ESD)	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins ⁽¹⁾	-2000	2000	V
		Charged device model (CDM), per JEDEC specification JESD22-C101, all pins ⁽²⁾	-500	500	

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

7.3 Recommended Operating Conditions

		MIN	NOM	MAX	UNIT
V _(VMx)	Motor power supply voltage range ⁽¹⁾	8.2		45	V
V _(VREF)	VREF input voltage ⁽²⁾	1		3.5	V
I _{V3P3}	V3P3OUT load current	0		1	mA

- (1) All V_M pins must be connected to the same supply voltage.
- (2) Operational at VREF between 0 to 1 V, but accuracy is degraded.

7.4 Thermal Information

THERMAL METRIC ⁽¹⁾		DRV8825	UNIT
		PWP	
		28 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance ⁽²⁾	31.6	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance ⁽³⁾	15.9	
$R_{\theta JB}$	Junction-to-board thermal resistance ⁽⁴⁾	5.6	
ψ_{JT}	Junction-to-top characterization parameter ⁽⁵⁾	0.2	
ψ_{JB}	Junction-to-board characterization parameter ⁽⁶⁾	5.5	
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance ⁽⁷⁾	1.4	

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](#).

(2) The junction-to-ambient thermal resistance under natural convection is obtained in a simulation on a JEDEC-standard, high-K board, as specified in JESD51-7, in an environment described in JESD51-2a.

(3) The junction-to-case (top) thermal resistance is obtained by simulating a cold plate test on the package top. No specific JEDEC-standard test exists, but a close description can be found in the ANSI SEMI standard G30-88.

(4) The junction-to-board thermal resistance is obtained by simulating in an environment with a ring cold plate fixture to control the PCB temperature, as described in JESD51-8.

(5) The junction-to-top characterization parameter, ψ_{JT} , estimates the junction temperature of a device in a real system and is extracted from the simulation data for obtaining θ_{JA} , using a procedure described in JESD51-2a (sections 6 and 7).

(6) The junction-to-board characterization parameter, ψ_{JB} , estimates the junction temperature of a device in a real system and is extracted from the simulation data for obtaining θ_{JA} , using a procedure described in JESD51-2a (sections 6 and 7).

(7) The junction-to-case (bottom) thermal resistance is obtained by simulating a cold plate test on the exposed (power) pad. No specific JEDEC standard test exists, but a close description can be found in the ANSI SEMI standard G30-88.

7.5 Electrical Characteristics

 over operating free-air temperature range of -40°C to 85°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
POWER SUPPLIES						
I_{VM}	VM operating supply current	$V_{(VMx)} = 24\text{ V}$		5	8	mA
I_{VMQ}	VM sleep mode supply current	$V_{(VMx)} = 24\text{ V}$		10	20	μA
V3P3OUT REGULATOR						
V_{3P3}	V3P3OUT voltage	$\text{IOUT} = 0\text{ to }1\text{ mA}$	3.2	3.3	3.4	V
LOGIC-LEVEL INPUTS						
V_{IL}	Input low voltage		0		0.7	V
V_{IH}	Input high voltage		2.2		5.25	V
V_{HYS}	Input hysteresis		0.3	0.45	0.6	V
I_{IL}	Input low current	$V_{IN} = 0$	-20		20	μA
I_{IH}	Input high current	$V_{IN} = 3.3\text{ V}$			100	μA
R_{PD}	Internal pulldown resistance			100		k Ω
nHOME, nFAULT OUTPUTS (OPEN-DRAIN OUTPUTS)						
V_{OL}	Output low voltage	$I_O = 5\text{ mA}$			0.5	V
I_{OH}	Output high leakage current	$V_O = 3.3\text{ V}$			1	μA
DECAY INPUT						
V_{IL}	Input low threshold voltage	For slow decay mode			0.8	V
V_{IH}	Input high threshold voltage	For fast decay mode	2			V
I_{IN}	Input current		-40		40	μA
R_{PU}	Internal pullup resistance (to 3.3 V)			130		k Ω
R_{PD}	Internal pulldown resistance			80		k Ω
H-BRIDGE FETS						
$R_{DS(ON)}$	HS FET on resistance	$V_{(VMx)} = 24\text{ V}, I_O = 1\text{ A}, T_J = 25^{\circ}\text{C}$		0.2		Ω
		$V_{(VMx)} = 24\text{ V}, I_O = 1\text{ A}, T_J = 85^{\circ}\text{C}$		0.25	0.32	
	LS FET on resistance	$V_{(VMx)} = 24\text{ V}, I_O = 1\text{ A}, T_J = 25^{\circ}\text{C}$		0.2		
		$V_{(VMx)} = 24\text{ V}, I_O = 1\text{ A}, T_J = 85^{\circ}\text{C}$		0.25	0.32	
I_{OFF}	Off-state leakage current		-20		20	μA
MOTOR DRIVER						
f_{PWM}	Internal current control PWM frequency			30		kHz
t_{BLANK}	Current sense blanking time			4		μs
t_R	Rise time		30		200	ns
t_F	Fall time		30		200	ns
PROTECTION CIRCUITS						
V_{UVLO}	VM undervoltage lockout voltage	$V_{(VMx)}$ rising		7.8	8.2	V
I_{OCP}	Overcurrent protection trip level		3			A
t_{DEG}	Overcurrent deglitch time			3		μs
t_{TSD}	Thermal shutdown temperature	Die temperature	150	160	180	$^{\circ}\text{C}$
CURRENT CONTROL						
I_{REF}	xVREF input current	$V_{(xVREF)} = 3.3\text{ V}$	-3		3	μA
V_{TRIP}	xISENSE trip voltage	$V_{(xVREF)} = 3.3\text{ V}, 100\%$ current setting	635	660	685	mV
ΔI_{TRIP}	Current trip accuracy (relative to programmed value)	$V_{(xVREF)} = 3.3\text{ V}, 5\%$ current setting	-25%		25%	
		$V_{(xVREF)} = 3.3\text{ V}, 10\%$ to 34% current setting	-15%		15%	
		$V_{(xVREF)} = 3.3\text{ V}, 38\%$ to 67% current setting	-10%		10%	
		$V_{(xVREF)} = 3.3\text{ V}, 71\%$ to 100% current setting	-5%		5%	
A_{ISENSE}	Current sense amplifier gain	Reference only		5		V/V

7.6 Timing Requirements

			MIN	MAX	UNIT
1	f_{STEP}	Step frequency		250	kHz
2	$t_{WH(STEP)}$	Pulse duration, STEP high	1.9		μ s
3	$t_{WL(STEP)}$	Pulse duration, STEP low	1.9		μ s
4	$t_{SU(STEP)}$	Setup time, command before STEP rising	650		ns
5	$t_{H(STEP)}$	Hold time, command after STEP rising	650		ns
6	t_{ENBL}	Enable time, nENBL active to STEP	650		ns
7	t_{WAKE}	Wakeup time, nSLEEP inactive high to STEP input accepted		1.7	ms

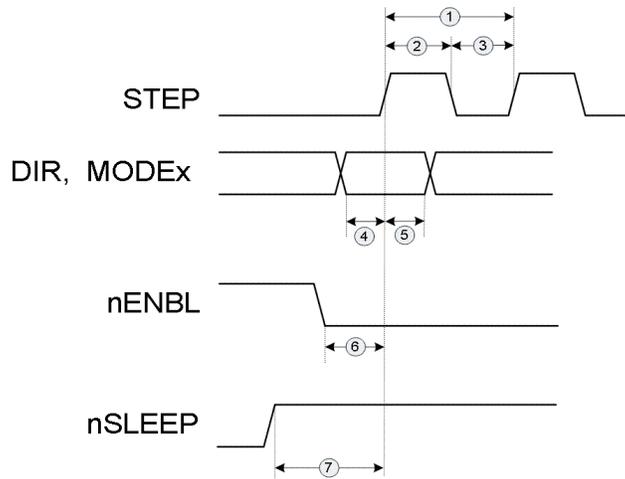


Figure 1. Timing Diagram

7.7 Typical Characteristics

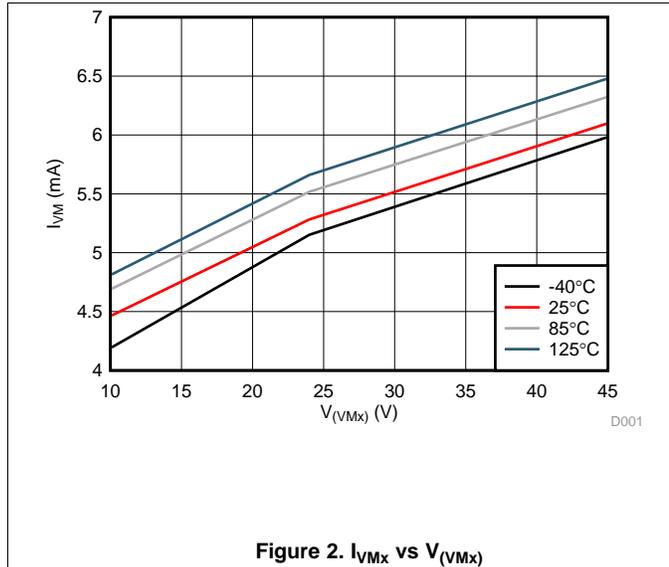


Figure 2. I_{VMx} vs V_{VMx}

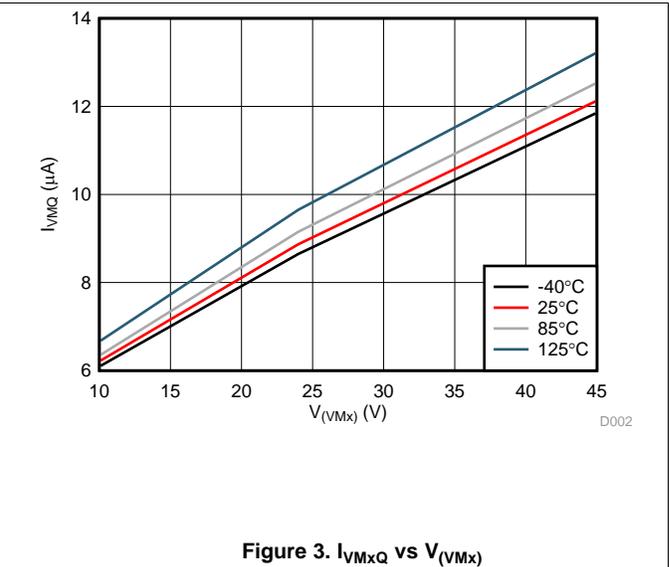


Figure 3. I_{VMxQ} vs V_{VMx}

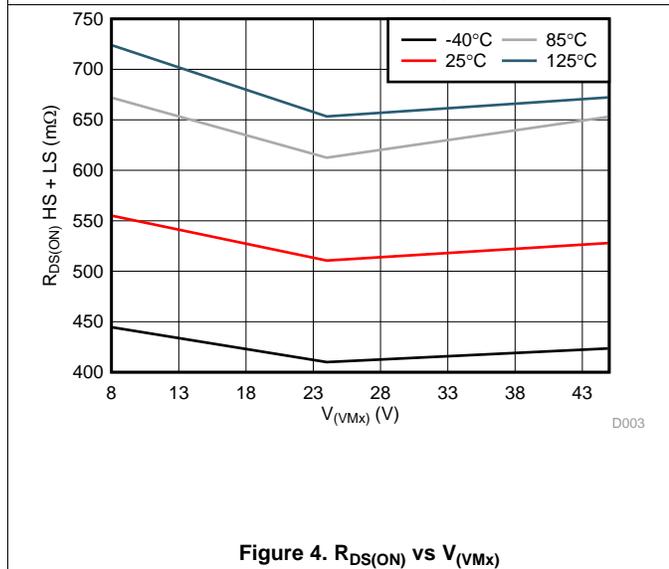


Figure 4. $R_{DS(ON)}$ vs V_{VMx}

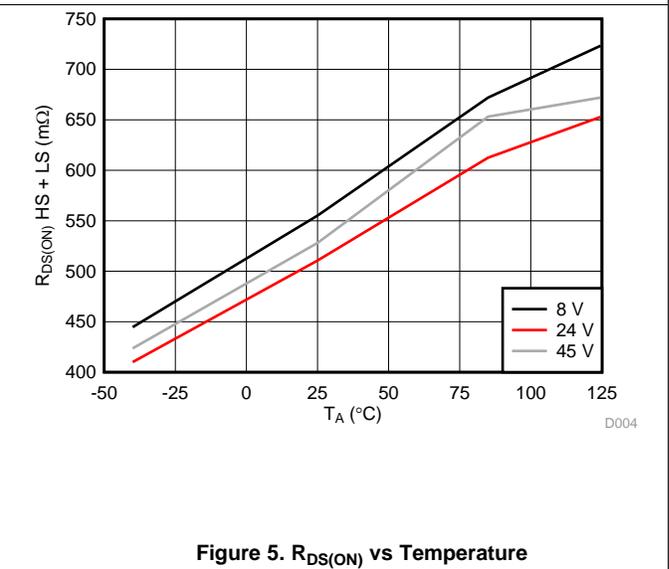


Figure 5. $R_{DS(ON)}$ vs Temperature

8 Detailed Description

8.1 Overview

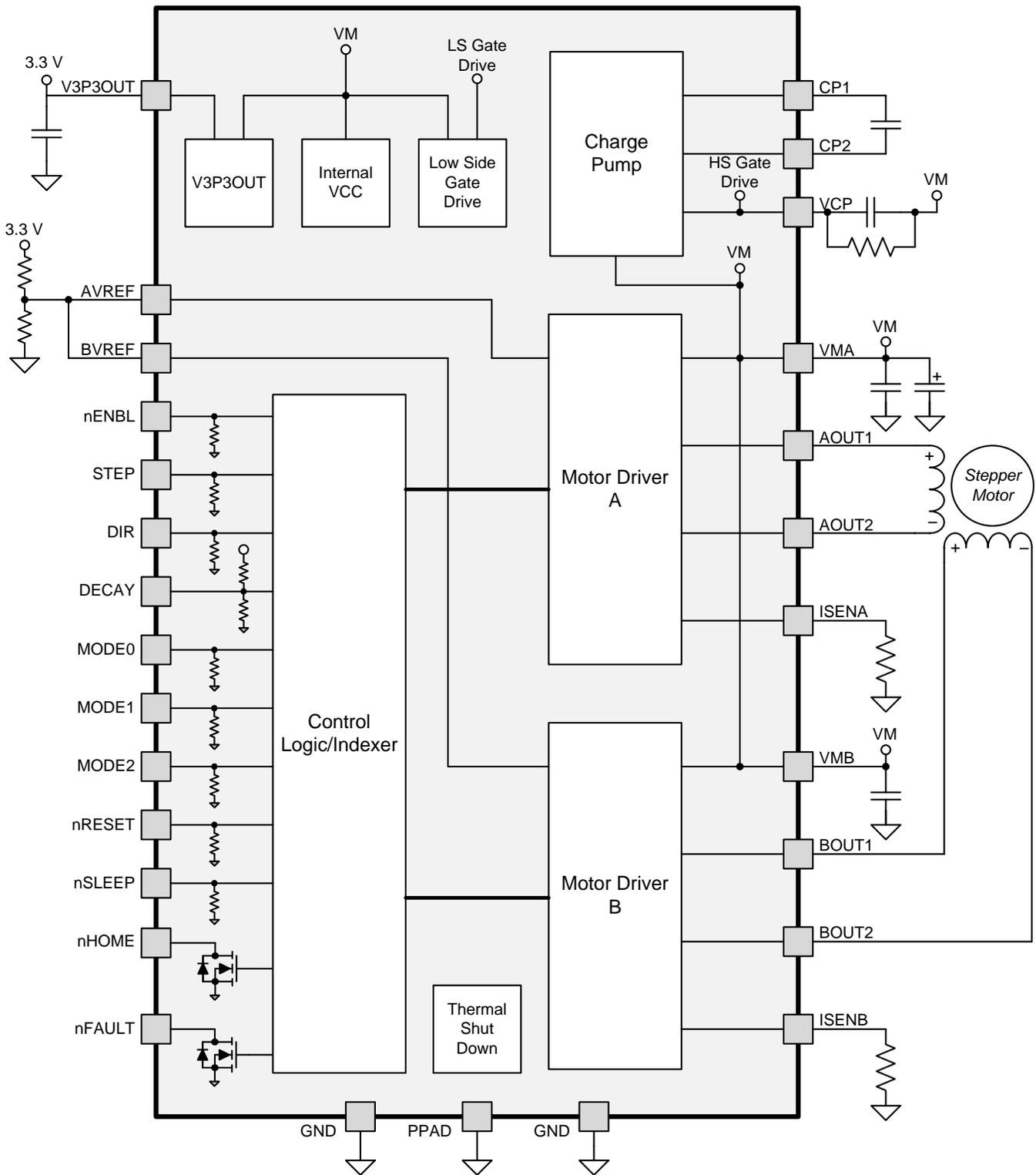
The DRV8825 is an integrated motor driver solution for bipolar stepper motors. The device integrates two NMOS H-bridges, current sense, regulation circuitry, and a microstepping indexer. The DRV8825 can be powered with a supply voltage between 8.2 and 45 V and is capable of providing an output current up to 2.5 A full-scale.

A simple STEP/DIR interface allows for easy interfacing to the controller circuit. The internal indexer is able to execute high-accuracy microstepping without requiring the processor to control the current level.

The current regulation is highly configurable, with three decay modes of operation. Depending on the application requirements, the user can select fast, slow, and mixed decay.

A low-power sleep mode is included which allows the system to save power when not driving the motor.

8.2 Functional Block Diagram



8.3 Feature Description

8.3.1 PWM Motor Drivers

The DRV8825 contains two H-bridge motor drivers with current-control PWM circuitry. Figure 6 shows a block diagram of the motor control circuitry.

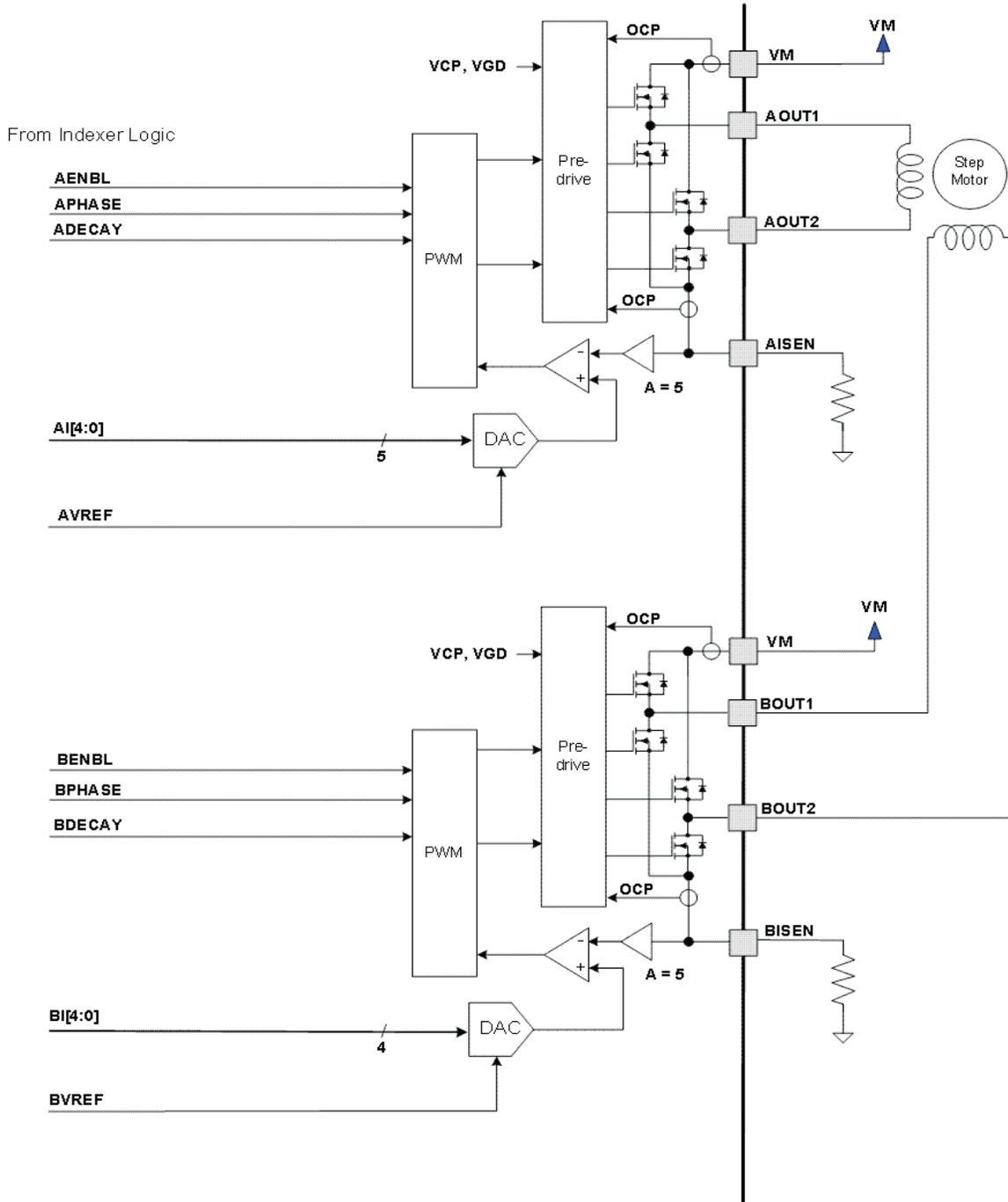


Figure 6. Motor Control Circuitry

Note that there are multiple VM motor power supply pins. All VM pins must be connected together to the motor supply voltage.

Feature Description (continued)

8.3.2 Current Regulation

The current through the motor windings is regulated by a fixed-frequency PWM current regulation, or current chopping. When an H-bridge is enabled, current rises through the winding at a rate dependent on the DC voltage and inductance of the winding. Once the current hits the current chopping threshold, the bridge disables the current until the beginning of the next PWM cycle.

In stepping motors, current regulation is used to vary the current in the two windings in a semi-sinusoidal fashion to provide smooth motion.

The PWM chopping current is set by a comparator which compares the voltage across a current sense resistor connected to the xISEN pins, multiplied by a factor of 5, with a reference voltage. The reference voltage is input from the xVREF pins.

The full-scale (100%) chopping current is calculated in [Equation 1](#).

$$I_{\text{CHOP}} = \frac{V_{(\text{xREF})}}{5 \times R_{\text{ISENSE}}} \quad (1)$$

Example:

If a 0.25-Ω sense resistor is used and the VREFx pin is 2.5 V, the full-scale (100%) chopping current will be $2.5 \text{ V} / (5 \times 0.25 \text{ } \Omega) = 2 \text{ A}$.

The reference voltage is scaled by an internal DAC that allows fractional stepping of a bipolar stepper motor, as described in the microstepping indexer section below.

8.3.3 Decay Mode

During PWM current chopping, the H-bridge is enabled to drive current through the motor winding until the PWM current chopping threshold is reached. This is shown in [Figure 7](#) as case 1. The current flow direction shown indicates positive current flow.

Once the chopping current threshold is reached, the H-bridge can operate in two different states, fast decay or slow decay.

In fast decay mode, once the PWM chopping current level has been reached, the H-bridge reverses state to allow winding current to flow in a reverse direction. As the winding current approaches 0, the bridge is disabled to prevent any reverse current flow. Fast decay mode is shown in [Figure 7](#) as case 2.

In slow decay mode, winding current is recirculated by enabling both of the low-side FETs in the bridge. This is shown in [Figure 7](#) as case 3.

Feature Description (continued)

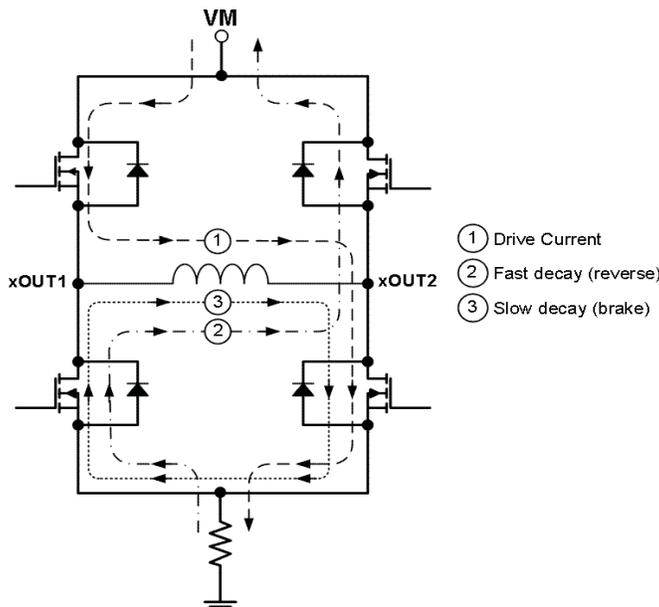


Figure 7. Decay Mode

The DRV8825 supports fast decay, slow decay and a mixed decay mode. Slow, fast, or mixed decay mode is selected by the state of the DECAY pin; logic low selects slow decay, open selects mixed decay operation, and logic high sets fast decay mode. The DECAY pin has both an internal pullup resistor of approximately 130 kΩ and an internal pulldown resistor of approximately 80 kΩ. This sets the mixed decay mode if the pin is left open or undriven.

Mixed decay mode begins as fast decay, but at a fixed period of time (75% of the PWM cycle) switches to slow decay mode for the remainder of the fixed PWM period. This occurs only if the current through the winding is decreasing (per the indexer step table); if the current is increasing, then slow decay is used.

8.3.4 Blanking Time

After the current is enabled in an H-bridge, the voltage on the xISEN pin is ignored for a fixed period of time before enabling the current sense circuitry. This blanking time is fixed at 3.75 μs. Note that the blanking time also sets the minimum on time of the PWM.

8.3.5 Microstepping Indexer

Built-in indexer logic in the DRV8825 allows a number of different stepping configurations. The MODE0 through MODE2 pins are used to configure the stepping format as shown in Table 1.

Table 1. Stepping Format

MODE2	MODE1	MODE0	STEP MODE
0	0	0	Full step (2-phase excitation) with 71% current
0	0	1	1/2 step (1-2 phase excitation)
0	1	0	1/4 step (W1-2 phase excitation)
0	1	1	8 microsteps/step
1	0	0	16 microsteps/step
1	0	1	32 microsteps/step
1	1	0	32 microsteps/step
1	1	1	32 microsteps/step

Table 2 shows the relative current and step directions for different settings of MODEx. At each rising edge of the STEP input, the indexer travels to the next state in the table. The direction is shown with the DIR pin high; if the DIR pin is low the sequence is reversed. Positive current is defined as xOUT1 = positive with respect to xOUT2.

Note that if the step mode is changed while stepping, the indexer will advance to the next valid state for the new MODEx setting at the rising edge of STEP.

The home state is 45°. This state is entered at power-up or application of nRESET. This is shown in **Table 2** by the shaded cells. The logic inputs DIR, STEP, nRESET, and MODEx have internal pulldown resistors of 100 kΩ.

Table 2. Relative Current and Step Directions

1/32 STEP	1/16 STEP	1/8 STEP	1/4 STEP	1/2 STEP	FULL STEP 70%	WINDING CURRENT A	WINDING CURRENT B	ELECTRICAL ANGLE
1	1	1	1	1		100%	0%	0
2						100%	5%	3
3	2					100%	10%	6
4						99%	15%	8
5	3	2				98%	20%	11
6						97%	24%	14
7	4					96%	29%	17
8						94%	34%	20
9	5	3	2			92%	38%	23
10						90%	43%	25
11	6					88%	47%	28
12						86%	51%	31
13	7	4				83%	56%	34
14						80%	60%	37
15	8					77%	63%	39
16						74%	67%	42
17	9	5	3	2	1	71%	71%	45
18						67%	74%	48
19	10					63%	77%	51
20						60%	80%	53
21	11	6				56%	83%	56
22						51%	86%	59
23	12					47%	88%	62
24						43%	90%	65
25	13	7	4			38%	92%	68
26						34%	94%	70
27	14					29%	96%	73
28						24%	97%	76
29	15	8				20%	98%	79
30						15%	99%	82
31	16					10%	100%	84
32						5%	100%	87
33	17	9	5	3		0%	100%	90
34						-5%	100%	93
35	18					-10%	100%	96
36						-15%	99%	98
37	19	10				-20%	98%	101
38						-24%	97%	104
39	20					-29%	96%	107

Table 2. Relative Current and Step Directions (continued)

1/32 STEP	1/16 STEP	1/8 STEP	1/4 STEP	1/2 STEP	FULL STEP 70%	WINDING CURRENT A	WINDING CURRENT B	ELECTRICAL ANGLE
40						-34%	94%	110
41	21	11	6			-38%	92%	113
42						-43%	90%	115
43	22					-47%	88%	118
44						-51%	86%	121
45	23	12				-56%	83%	124
46						-60%	80%	127
47	24					-63%	77%	129
48						-67%	74%	132
49	25	13	7	4	2	-71%	71%	135
50						-74%	67%	138
51	26					-77%	63%	141
52						-80%	60%	143
53	27	14				-83%	56%	146
54						-86%	51%	149
55	28					-88%	47%	152
56						-90%	43%	155
57	29	15	8			-92%	38%	158
58						-94%	34%	160
59	30					-96%	29%	163
60						-97%	24%	166
61	31	16				-98%	20%	169
62						-99%	15%	172
63	32					-100%	10%	174
64						-100%	5%	177
65	33	17	9	5		-100%	0%	180
66						-100%	-5%	183
67	34					-100%	-10%	186
68						-99%	-15%	188
69	35	18				-98%	-20%	191
70						-97%	-24%	194
71	36					-96%	-29%	197
72						-94%	-34%	200
73	37	19	10			-92%	-38%	203
74						-90%	-43%	205
75	38					-88%	-47%	208
76						-86%	-51%	211
77	39	20				-83%	-56%	214
78						-80%	-60%	217
79	40					-77%	-63%	219
80						-74%	-67%	222
81	41	21	11	6	3	-71%	-71%	225
82						-67%	-74%	228
83	42					-63%	-77%	231
84						-60%	-80%	233
85	43	22				-56%	-83%	236
86						-51%	-86%	239

Table 2. Relative Current and Step Directions (continued)

1/32 STEP	1/16 STEP	1/8 STEP	1/4 STEP	1/2 STEP	FULL STEP 70%	WINDING CURRENT A	WINDING CURRENT B	ELECTRICAL ANGLE
87	44					-47%	-88%	242
88						-43%	-90%	245
89	45	23	12			-38%	-92%	248
90						-34%	-94%	250
91	46					-29%	-96%	253
92						-24%	-97%	256
93	47	24				-20%	-98%	259
94						-15%	-99%	262
95	48					-10%	-100%	264
96						-5%	-100%	267
97	49	25	13	7		0%	-100%	270
98						5%	-100%	273
99	50					10%	-100%	276
100						15%	-99%	278
101	51	26				20%	-98%	281
102						24%	-97%	284
103	52					29%	-96%	287
104						34%	-94%	290
105	53	27	14			38%	-92%	293
106						43%	-90%	295
107	54					47%	-88%	298
108						51%	-86%	301
109	55	28				56%	-83%	304
110						60%	-80%	307
111	56					63%	-77%	309
112						67%	-74%	312
113	57	29	15	8	4	71%	-71%	315
114						74%	-67%	318
115	58					77%	-63%	321
116						80%	-60%	323
117	59	30				83%	-56%	326
118						86%	-51%	329
119	60					88%	-47%	332
120						90%	-43%	335
121	61	31	16			92%	-38%	338
122						94%	-34%	340
123	62					96%	-29%	343
124						97%	-24%	346
125	63	32				98%	-20%	349
126						99%	-15%	352
127	64					100%	-10%	354
128						100%	-5%	357

8.3.6 nRESET, nENBL, and nSLEEP Operation

The nRESET pin, when driven active low, resets internal logic, and resets the step table to the home position. It also disables the H-bridge drivers. The STEP input is ignored while nRESET is active.

The nENBL pin is used to control the output drivers and enable/disable operation of the indexer. When nENBL is low, the output H-bridges are enabled, and rising edges on the STEP pin are recognized. When nENBL is high, the H-bridges are disabled, the outputs are in a high-impedance state, and the STEP input is ignored.

Driving nSLEEP low will put the device into a low power sleep state. In this state, the H-bridges are disabled, the gate drive charge pump is stopped, the V3P3OUT regulator is disabled, and all internal clocks are stopped. In this state all inputs are ignored until nSLEEP returns inactive high. When returning from sleep mode, some time (approximately 1 ms) needs to pass before applying a STEP input, to allow the internal circuitry to stabilize. Note that nRESET and nENBL have internal pulldown resistors of approximately 100 k Ω . The nSLEEP pin has an internal pulldown resistor of 1 M Ω . nSLEEP and nRESET signals need to be driven to logic high for device operation.

8.3.7 Protection Circuits

The DRV8825 is fully protected against undervoltage, overcurrent, and overtemperature events.

8.3.7.1 Overcurrent Protection (OCP)

An analog current limit circuit on each FET limits the current through the FET by removing the gate drive. If this analog current limit persists for longer than the OCP time, all FETs in the H-bridge will be disabled and the nFAULT pin will be driven low. The device remains disabled until either nRESET pin is applied, or VM is removed and reapplied.

Overcurrent conditions on both high-side and low-side devices; that is, a short to ground, supply, or across the motor winding all result in an overcurrent shutdown. Note that overcurrent protection does not use the current sense circuitry used for PWM current control, and is independent of the I_{SENSE} resistor value or xVREF voltage.

8.3.7.2 Thermal Shutdown (TSD)

If the die temperature exceeds safe limits, all FETs in the H-bridge will be disabled and the nFAULT pin will be driven low. After the die temperature has fallen to a safe level, operation automatically resumes.

8.3.7.3 Undervoltage Lockout (UVLO)

If at any time the voltage on the VM pins falls below the UVLO threshold voltage, all circuitry in the device will be disabled and internal logic will be reset. Operation will resume when V_(VMx) rises above the UVLO threshold.

8.4 Device Functional Modes

8.4.1 STEP/DIR Interface

The STEP/DIR interface provides a simple method for advancing through the indexer table. For each rising edge on the STEP pin, the indexer travels to the next state in the table. The direction it moves in the table is determined by the input to the DIR pin. The signals applied to the STEP and DIR pins should not violate the timing diagram specified in [Figure 1](#).

8.4.2 Microstepping

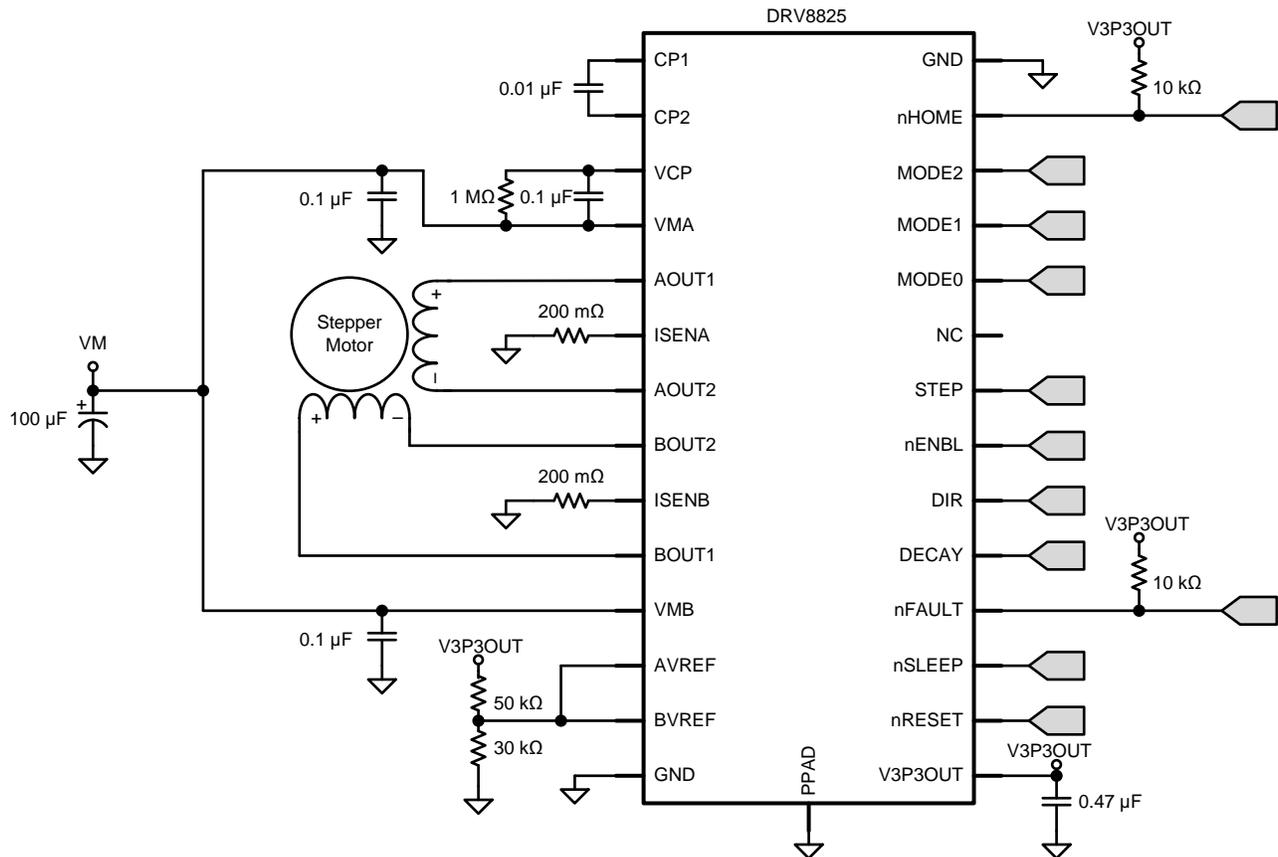
The microstepping indexer allows for a variety of stepping configurations. The state of the indexer is determined by the configuration of the three MODE pins (refer to [Table 1](#) for configuration options). The DRV8825 supports full step up to 1/32 microstepping.

9 Application and Implementation

9.1 Application Information

The DRV8825 is used in bipolar stepper control. The microstepping motor driver provides additional precision and a smooth rotation from the stepper motor. The following design is a common application of the DRV8825.

9.2 Typical Application



9.2.1 Design Requirements

Design Parameter	Reference	Example Value
Supply Voltage	VM	24 V
Motor Winding Resistance	RL	3.9 Ω
Motor Winding Inductance	IL	2.9 mH
Motor Full Step Angle	θ_{step}	1.8°/step
Target Microstepping Level	nm	8 µsteps per step
Target Motor Speed	v	120 rpm
Target Full-Scale Current	IFS	1.25 A

9.2.2 Detailed Design Procedure

9.2.2.1 Stepper Motor Speed

The first step in configuring the DRV8825 requires the desired motor speed and microstepping level. If the target application requires a constant speed, then a square wave with frequency f_{step} must be applied to the STEP pin.

If the target motor startup speed is too high, the motor will not spin. Make sure that the motor can support the target speed or implement an acceleration profile to bring the motor up to speed.

For a desired motor speed (v), microstepping level (n_m), and motor full step angle (θ_{step}),

$$f_{\text{step}} \left(\frac{\mu\text{steps}}{\text{second}} \right) = \frac{v \left(\frac{\text{rotations}}{\text{minute}} \right) \times 360 \left(\frac{\text{degrees}}{\text{rotation}} \right) \times n_m \left(\frac{\mu\text{steps}}{\text{step}} \right)}{60 \left(\frac{\text{seconds}}{\text{minute}} \right) \times \theta_{\text{step}} \left(\frac{\text{degrees}}{\text{step}} \right)} \quad (2)$$

$$f_{\text{step}} \left(\frac{\mu\text{steps}}{\text{second}} \right) = \frac{120 \left(\frac{\text{rotations}}{\text{minute}} \right) \times 360 \left(\frac{\text{degrees}}{\text{rotation}} \right) \times 8 \left(\frac{\mu\text{steps}}{\text{step}} \right)}{60 \left(\frac{\text{seconds}}{\text{minute}} \right) \times 1.8 \left(\frac{\text{degrees}}{\text{step}} \right)} \quad (3)$$

θ_{step} can be found in the stepper motor data sheet or written on the motor itself.

For the DRV8825, the microstepping level is set by the MODE pins and can be any of the settings in [Table 1](#). Higher microstepping will mean a smoother motor motion and less audible noise, but will increase switching losses and require a higher f_{step} to achieve the same motor speed.

9.2.2.2 Current Regulation

In a stepper motor, the set full-scale current (I_{FS}) is the maximum current driven through either winding. This quantity depends on the $x\text{VREF}$ analog voltage and the sense resistor value (R_{SENSE}). During stepping, I_{FS} defines the current chopping threshold (I_{TRIP}) for the maximum current step. The gain of DRV8825 is set for 5 V/V.

$$I_{\text{FS}} \text{ (A)} = \frac{x\text{VREF (V)}}{A_v \times R_{\text{SENSE}} \text{ (}\Omega\text{)}} = \frac{x\text{VREF (V)}}{5 \times R_{\text{SENSE}} \text{ (}\Omega\text{)}} \quad (4)$$

To achieve $I_{\text{FS}} = 1.25 \text{ A}$ with R_{SENSE} of $0.2 \text{ }\Omega$, $x\text{VREF}$ should be 1.25 V .

9.2.2.3 Decay Modes

The DRV8825 supports three different decay modes: slow decay, fast decay, and mixed decay. The current through the motor windings is regulated using a fixed-frequency PWM scheme. This means that after any drive phase, when a motor winding current has hit the current chopping threshold (I_{TRIP}), the DRV8825 will place the winding in one of the three decay modes until the PWM cycle has expired. Afterward, a new drive phase starts.

The blanking time, t_{BLANK} , defines the minimum drive time for the current chopping. I_{TRIP} is ignored during t_{BLANK} , so the winding current may overshoot the trip level.

9.2.3 Application Curves

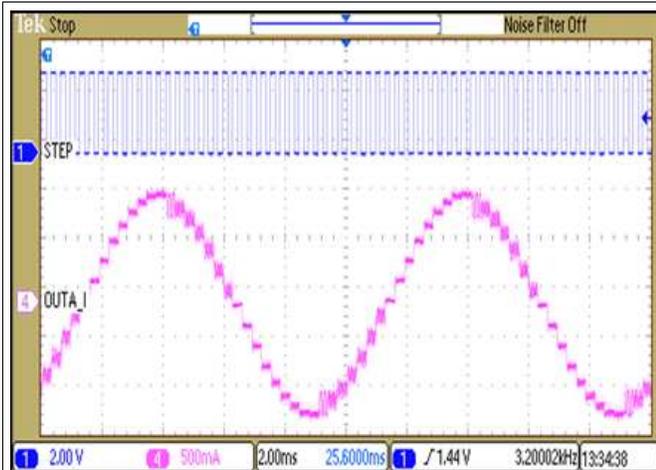


Figure 8. Microstepping Current (Phase A) vs STEP Input, Mixed Decay



Figure 9. Microstepping Current (Phase A) vs STEP Input, Slow Decay on Increasing Steps

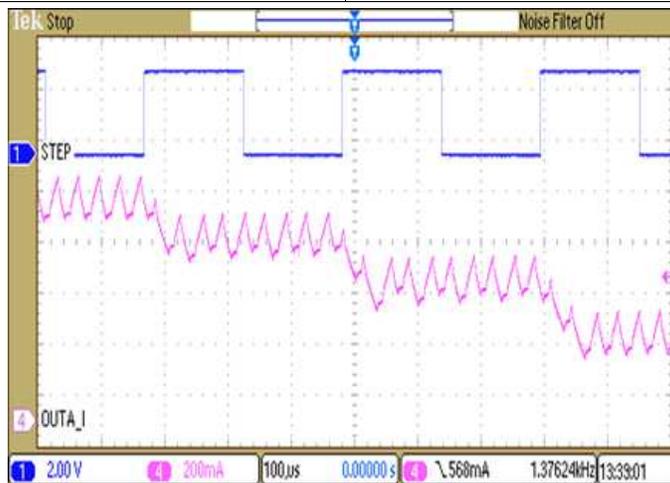


Figure 10. Microstepping Current (Phase A) vs STEP Input, Mixed Decay on Decreasing Steps

10 Power Supply Recommendations

The DRV8825 is designed to operate from an input voltage supply (VMx) range between 8.2 and 45 V. Two 0.1- μ F ceramic capacitors rated for VMx must be placed as close as possible to the VMA and VMB pins respectively (one on each pin). In addition to the local decoupling caps, additional bulk capacitance is required and must be sized accordingly to the application requirements.

10.1 Bulk Capacitance

Bulk capacitance sizing is an important factor in motor drive system design. It is dependent on a variety of factors including:

- Type of power supply
- Acceptable supply voltage ripple
- Parasitic inductance in the power supply wiring
- Type of motor (brushed DC, brushless DC, stepper)
- Motor startup current
- Motor braking method

The inductance between the power supply and motor drive system will limit the rate current can change from the power supply. If the local bulk capacitance is too small, the system will respond to excessive current demands or dumps from the motor with a change in voltage. You should size the bulk capacitance to meet acceptable voltage ripple levels.

The data sheet generally provides a recommended value but system level testing is required to determine the appropriate sized bulk capacitor.

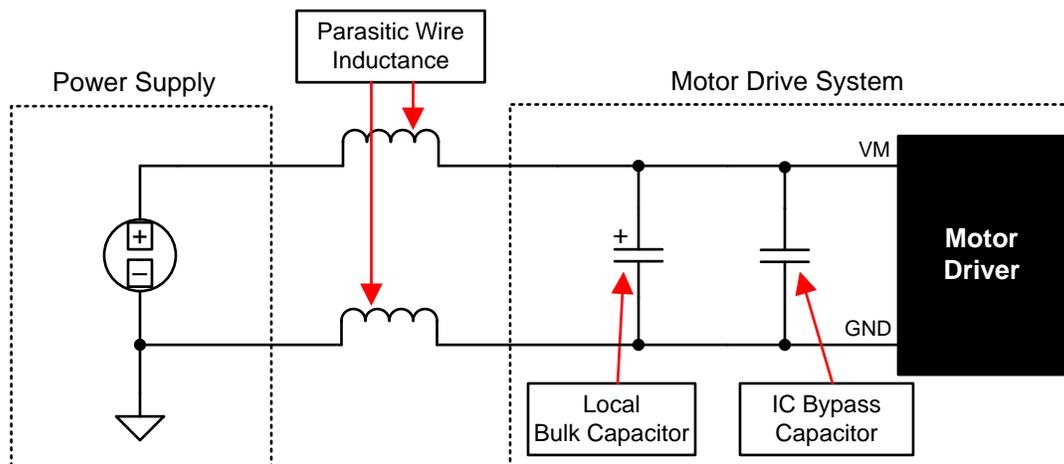


Figure 11. Setup of Motor Drive System With External Power Supply

10.2 Power Supply and Logic Sequencing

There is no specific sequence for powering-up the DRV8825. It is okay for digital input signals to be present before VMx is applied. After VMx is applied to the DRV8825, it begins operation based on the status of the control pins.

11 Layout

11.1 Layout Guidelines

The VMA and VMB pins should be bypassed to GND using low-ESR ceramic bypass capacitors with a recommended value of 0.1- μ F rated for VMx. This capacitor should be placed as close to the VMA and VMB pins as possible with a thick trace or ground plane connection to the device GND pin.

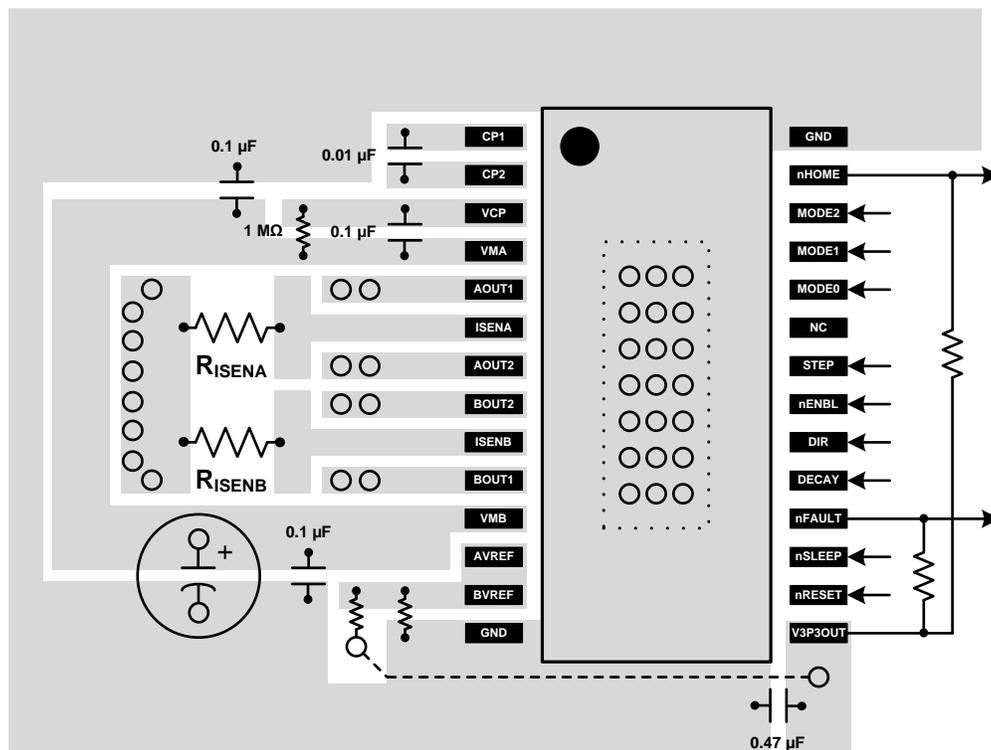
The VMA and VMB pins must be bypassed to ground using an appropriate bulk capacitor. This component may be an electrolytic and should be located close to the DRV8825.

A low-ESR ceramic capacitor must be placed in between the CPL and CPH pins. TI recommends a value of 0.01- μ F rated for VMx. Place this component as close to the pins as possible.

A low-ESR ceramic capacitor must be placed in between the VMA and VCP pins. TI recommends a value of 0.1- μ F rated for 16 V. Place this component as close to the pins as possible. Also, place a 1-M Ω resistor between VCP and VMA.

Bypass V3P3 to ground with a ceramic capacitor rated 6.3 V. Place this bypass capacitor as close to the pin as possible

11.2 Layout Example



11.3 Thermal Protection

The DRV8825 has thermal shutdown (TSD) as described above. If the die temperature exceeds approximately 150°C, the device will be disabled until the temperature drops to a safe level.

Any tendency of the device to enter TSD is an indication of either excessive power dissipation, insufficient heatsinking, or too high an ambient temperature.

11.3.1 Power Dissipation

Power dissipation in the DRV8825 is dominated by the power dissipated in the output FET resistance, or $R_{DS(ON)}$. Average power dissipation when running a stepper motor can be roughly estimated by [Equation 5](#).

Thermal Protection (continued)

$$P_{TOT} = 4 \times R_{DS(ON)} \times (I_{OUT(RMS)})^2 \quad (5)$$

where P_{TOT} is the total power dissipation, $R_{DS(ON)}$ is the resistance of each FET, and $I_{OUT(RMS)}$ is the RMS output current being applied to each winding. $I_{OUT(RMS)}$ is equal to the approximately 0.7x the full-scale output current setting. The factor of 4 comes from the fact that there are two motor windings, and at any instant two FETs are conducting winding current for each winding (one high-side and one low-side).

The maximum amount of power that can be dissipated in the device is dependent on ambient temperature and heatsinking.

Note that $R_{DS(ON)}$ increases with temperature, so as the device heats, the power dissipation increases. This must be taken into consideration when sizing the heatsink.

11.3.2 Heatsinking

The PowerPAD™ package uses an exposed pad to remove heat from the device. For proper operation, this pad must be thermally connected to copper on the PCB to dissipate heat. On a multi-layer PCB with a ground plane, this can be accomplished by adding a number of vias to connect the thermal pad to the ground plane. On PCBs without internal planes, copper area can be added on either side of the PCB to dissipate heat. If the copper area is on the opposite side of the PCB from the device, thermal vias are used to transfer the heat between top and bottom layers.

For details about how to design the PCB, refer to TI application report [SLMA002](#), "PowerPAD™ Thermally Enhanced Package" and TI application brief [SLMA004](#), *PowerPAD™ Made Easy*, available at www.ti.com.

In general, the more copper area that can be provided, the more power can be dissipated. It can be seen that the heatsink effectiveness increases rapidly to about 20 cm², then levels off somewhat for larger areas.

12 Device and Documentation Support

12.1 Trademarks

PowerPAD is a trademark of Texas Instruments.

12.2 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

12.3 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
DRV8825PWP	ACTIVE	HTSSOP	PWP	28	50	RoHS & Green	NIPDAU	Level-3-260C-168 HR	-40 to 85	DRV8825	Samples
DRV8825PWPR	ACTIVE	HTSSOP	PWP	28	2000	RoHS & Green	NIPDAU	Level-3-260C-168 HR	-40 to 85	DRV8825	Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

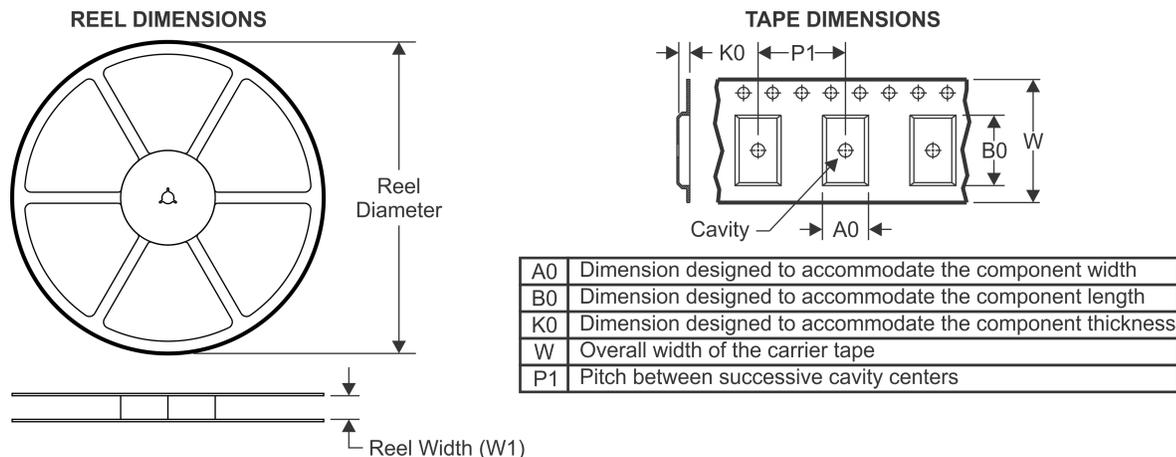
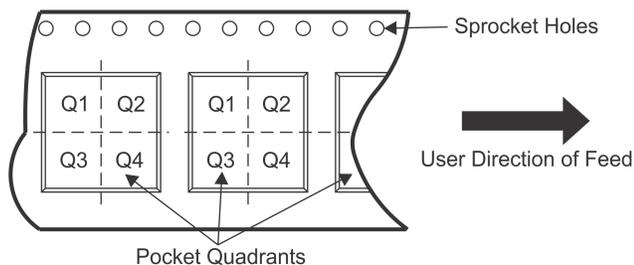
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

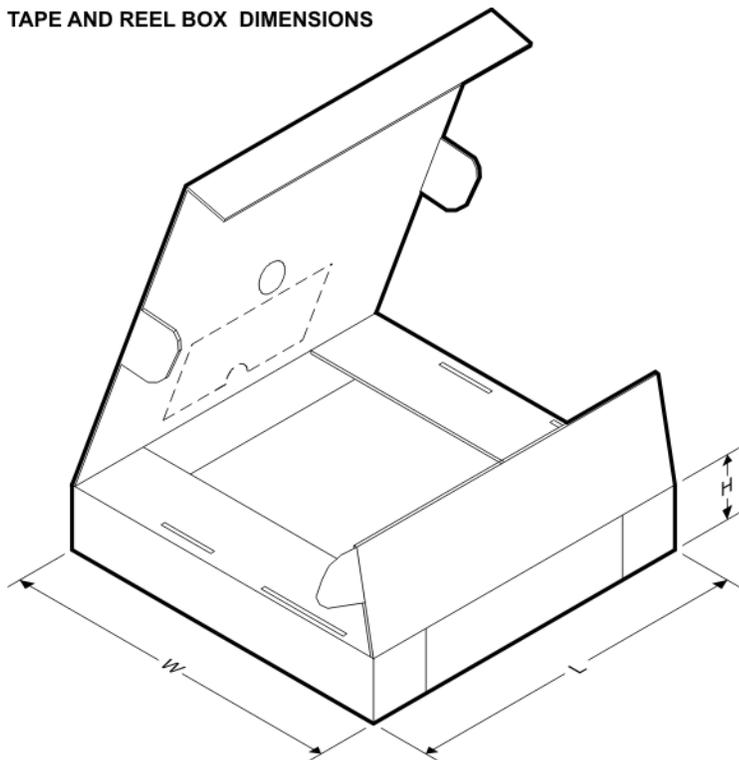
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TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


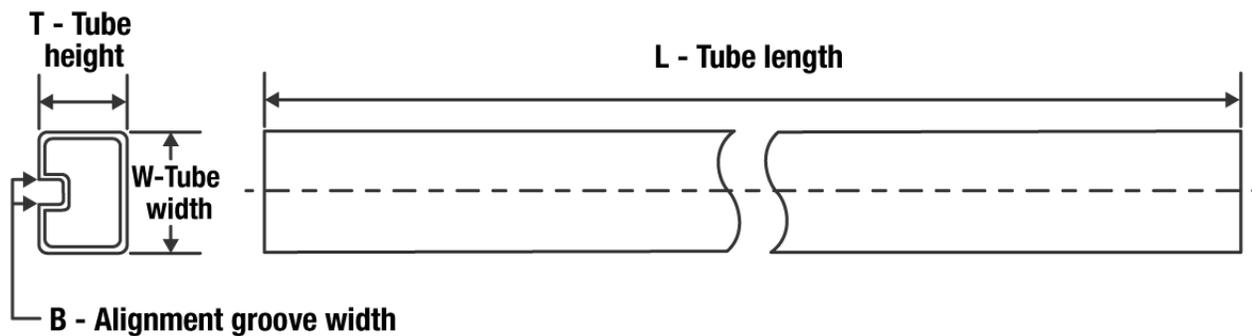
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
DRV8825PWPR	HTSSOP	PWP	28	2000	330.0	16.4	6.9	10.2	1.8	12.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
DRV8825PWPR	HTSSOP	PWP	28	2000	350.0	350.0	43.0

TUBE


*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
DRV8825PWP	PWP	HTSSOP	28	50	530	10.2	3600	3.5

GENERIC PACKAGE VIEW

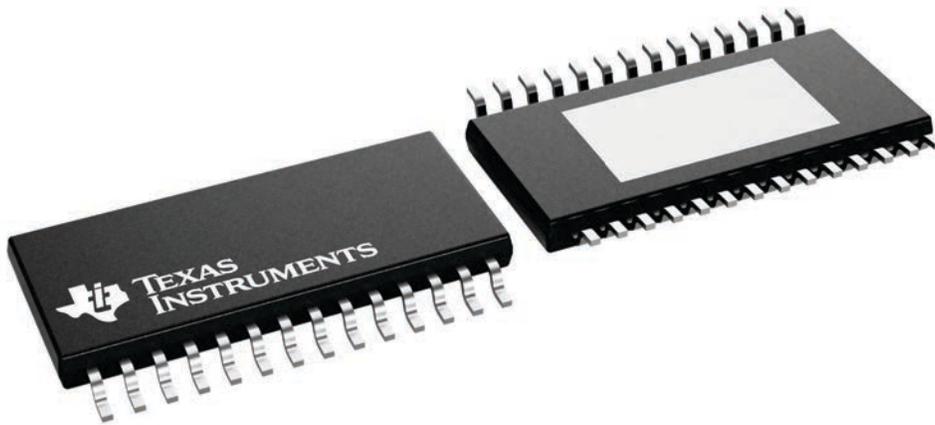
PWP 28

PowerPAD™ TSSOP - 1.2 mm max height

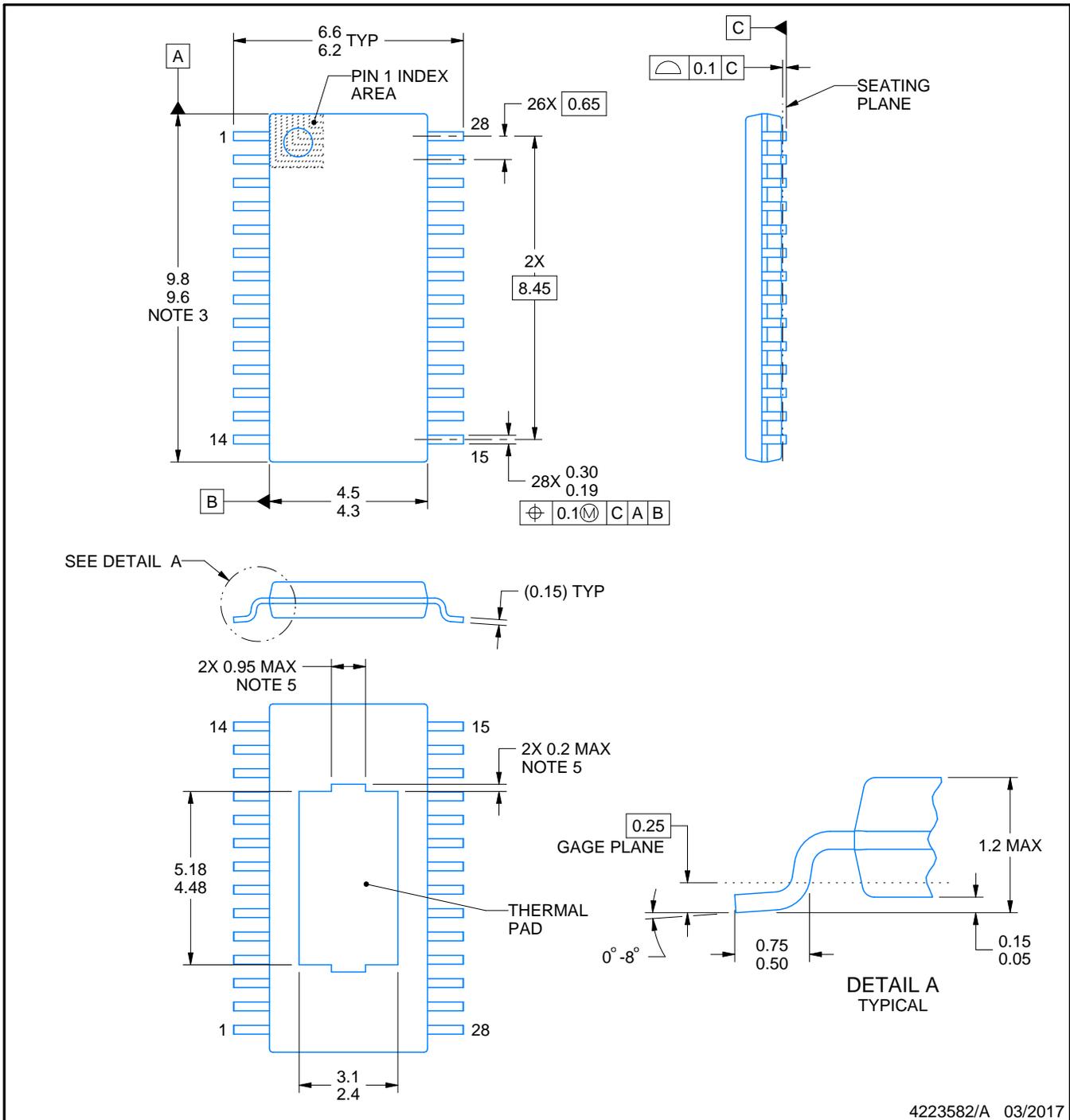
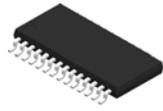
4.4 x 9.7, 0.65 mm pitch

SMALL OUTLINE PACKAGE

This image is a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.



4224765/B



4223582/A 03/2017

NOTES:

PowerPAD is a trademark of Texas Instruments.

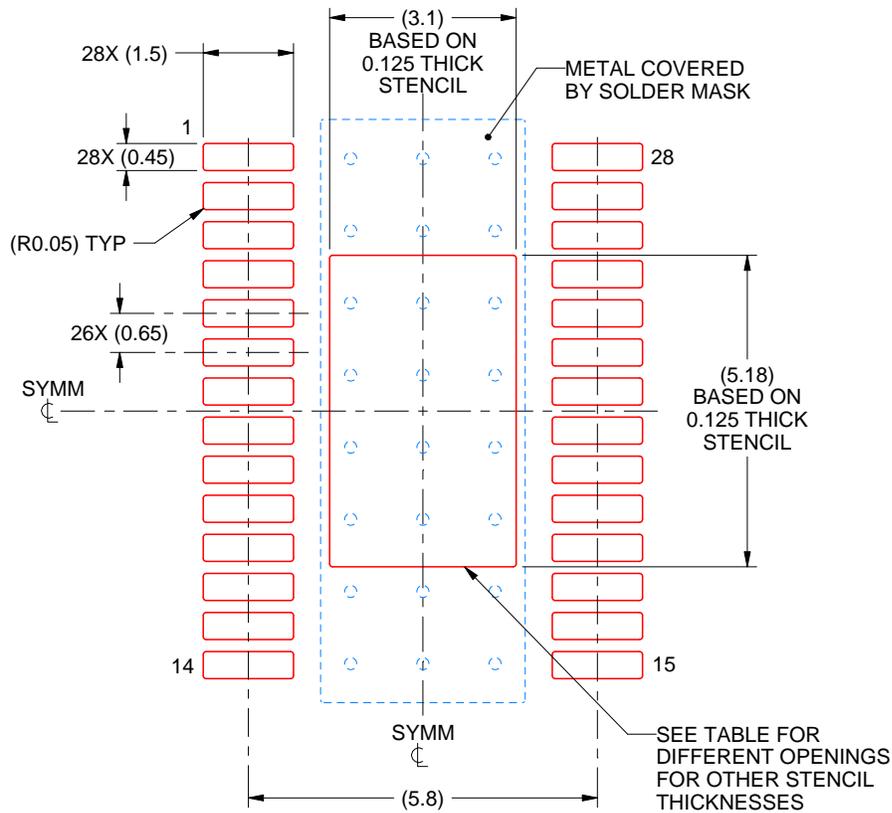
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MO-153.
5. Features may differ or may not be present.

EXAMPLE STENCIL DESIGN

PWP0028C

PowerPAD™ TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
 BASED ON 0.125 mm THICK STENCIL
 SCALE: 8X

STENCIL THICKNESS	SOLDER STENCIL OPENING
0.1	3.47 X 5.79
0.125	3.10 X 5.18 (SHOWN)
0.15	2.83 X 4.73
0.175	2.62 X 4.38

4223582/A 03/2017

NOTES: (continued)

11. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
12. Board assembly site may have different recommendations for stencil design.

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1.8° 42mm Hybrid Stepper Motor-NEMA17



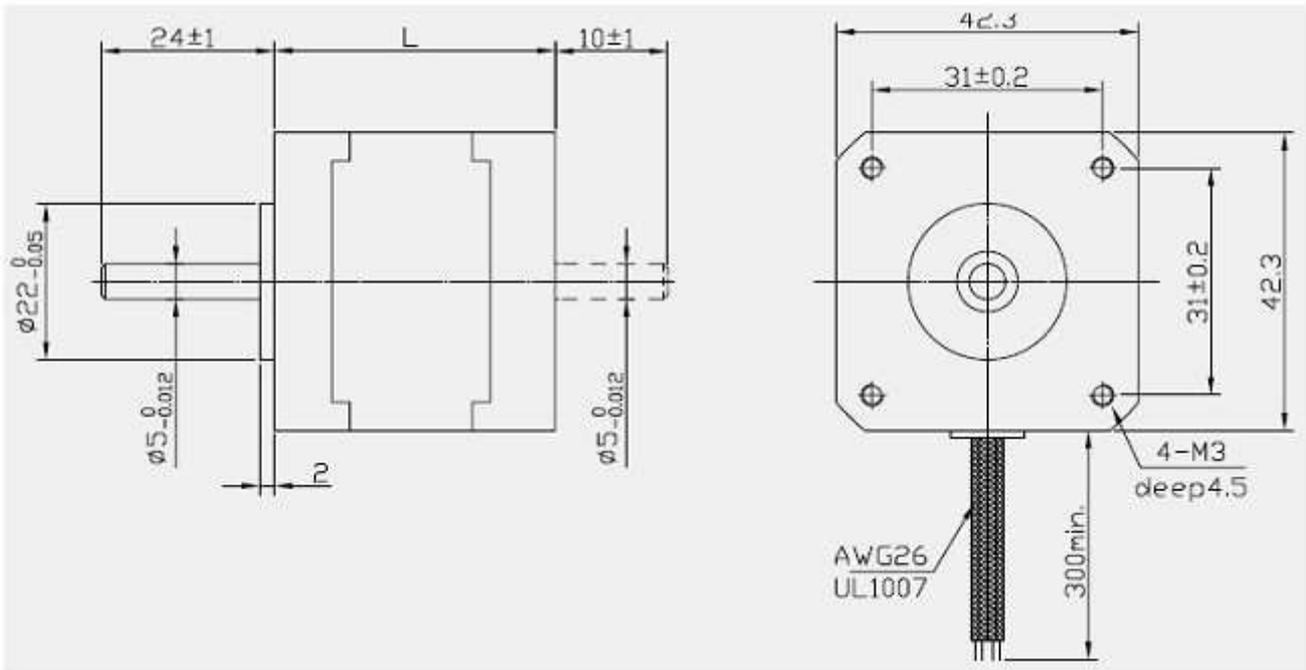
General Specification:

Item	Specifications
Step Angle	1.8°
Temperature Rise	80°C max
Ambient Temperature	-20°C ~+50°C
Insulation Resistance	100 MΩ Min. ,500VDC
Dielectric Strength	500VAC for 1minute
Shaft Radial Play	0.02Max. (450g-load)
Shaft Axial Play	0.08Max. (450g-load)
Max. radial force	28N (20mm from the flange)
Max. axial force	10N

Electrical Specifications:

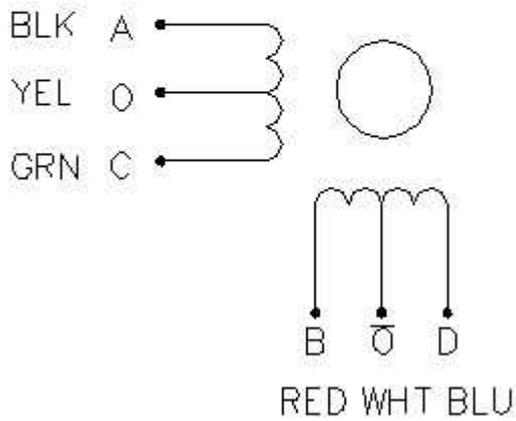
Model No.	Step Angle	Motor Length (L)mm	Current /Phase A	Resistance /Phase Ω	Inductance /Phase mH	Holding Torque kg.cm	# of Leads No.	Detent Torque g.cm	Rotor Inertia g.cm	Mass
	(°)									Kg
42HS34-0956	1.8	34	0.95	4.2	2.5	1.6	6	120	34	0.22
42HS34-0406	1.8	34	0.4	24	15	1.6	6	120	34	0.22
42HS34-0316	1.8	34	0.31	38.5	21	1.6	6	120	34	0.22
42HS34-1334	1.8	34	1.33	2.1	2.5	2.6	4	120	34	0.22
42HS34-0404	1.8	34	0.4	30	35	2.6	4	120	34	0.22
42HS40-0404	1.8	34	0.4	30	60	4.0	4	150	54	0.28
42HS40-1206	1.8	40	1.2	3.3	3.2	2.8	6	150	54	0.28
42HS40-0806	1.8	40	0.8	7.5	6.7	2.6	6	150	54	0.28
42HS40-1704	1.8	40	1.7	1.65	3.2	4.0	4	150	54	0.28
42HS40-0406	1.8	40	0.4	30	30	2.6	6	150	54	0.28
42HS40-1684	1.8	40	1.68	1.65	3.2	4.0	4	150	54	0.28
42HS48-1206	1.8	48	1.2	3.3	2.8	3.17	6	260	68	0.35
42HS48-0806	1.8	48	0.8	7.5	6.3	3.17	6	260	68	0.35
42HS48-0406	1.8	48	0.4	30	25	3.17	6	260	68	0.35
42HS48-1684	1.8	48	1.68	1.65	2.8	4.4	4	260	68	0.35
42HS60-1206	1.8	60	1.2	6	7	6.5	6	280	102	0.5

Dimensions:(Unit=mm)

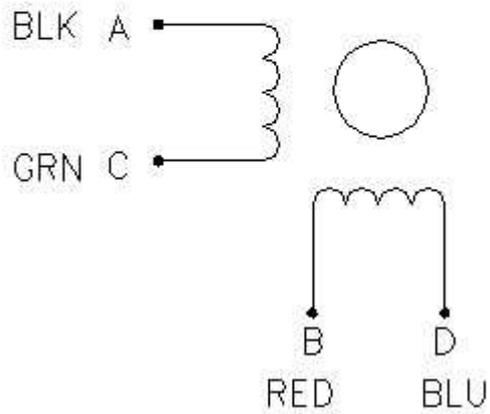


Wiring Diagram:(接线图)

6 LEADS



4 LEADS



Miuzei 6V 20kg RC Digital Servo

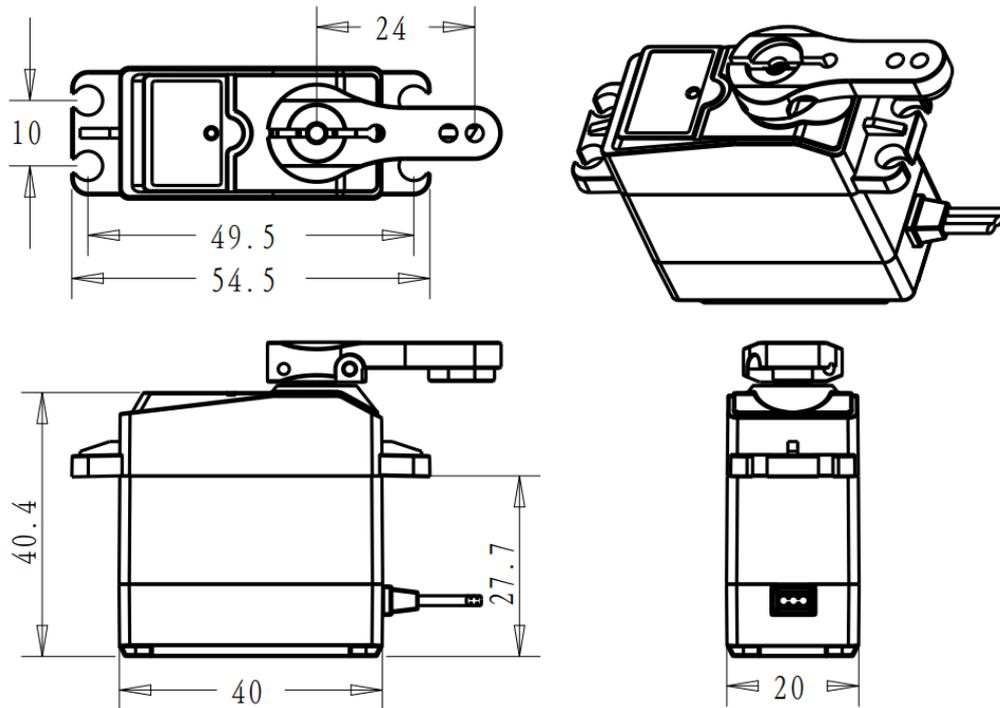
(Product datasheet)

page 1/2

(Product Mode No.): DS3218

(Product Description): 6V 20kg RC Digital Servo

(Drawing)



1. Apply Environmental Condition

No.	Item	Specification
1-1	Storage Temperature Range	-30°C ~ 80°C
1-2	Operating Temperature Range	-15°C ~ 70°C
1-3	Operating Voltage Range	4.8-6.8V

2. Mechanical Specification

No.	Item	Specification
2-1	Size	40*20*40.5mm
2-2	Weight	60g
2-3	Gear ratio	275
2-4	Bearing	Double bearing
2-5	Connector wire	300 ± 5mm
2-6	Motor	3-pole
2-7	Waterproof performance	IP66

Mizuzei 6V 20kg RC Digital Servo

(Product datasheet)

page 2/2

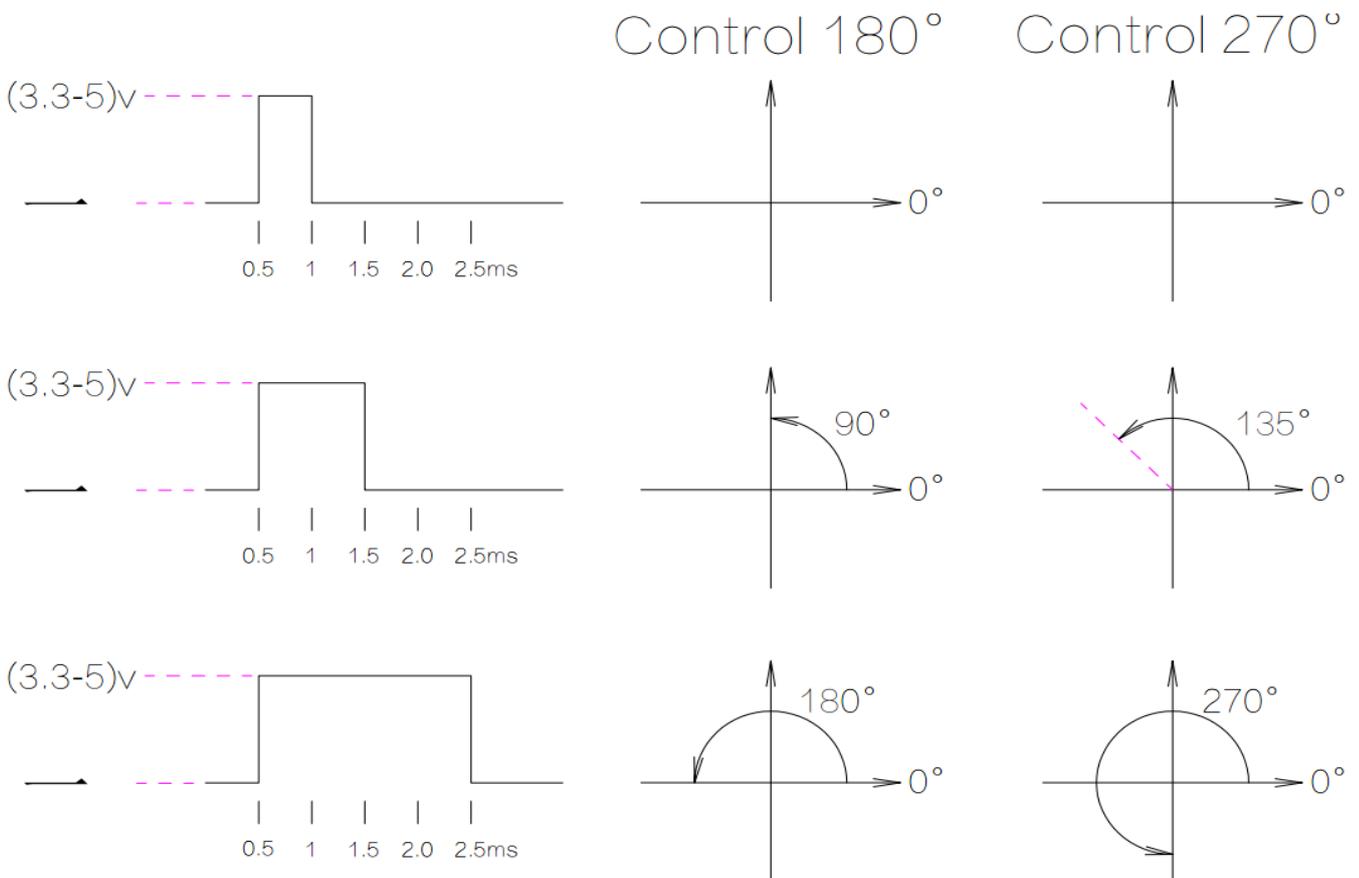
3. Electrical Specification

No.	Operating Voltage	5V	6.8V
3-1	Idle current(at stopped)	4mA	5mA
3-2	Operating speed (at no load)	0.16 sec/60°	0.14sec/60°
3-3	Stall torque (at locked)	18 kg-cm	21.5 kg-cm
3-4	Stall current (at locked)	1.8A	2.2A

4. Control Specification

No.	Item	Specification
4-1	Control System	PWM(Pulse width modification)
4-2	Pulse width range	500~2500 μsec
4-3	Neutral position	1500 μsec
4-4	Running degree	180° or 270° (when 500~2500 μ sec)
4-5	Dead band width	3 μsec
4-6	Operating frequency	50-330Hz
4-7	Rotating direction	Counterclockwise (when 500~2500 μsec)

5. PWM About PWM Control



HC-05

-Bluetooth to Serial Port Module

Overview



HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup.

Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Bluecore 04-External single chip Bluetooth system with CMOS technology and with AFH(Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx27mm. Hope it will simplify your overall design/development cycle.

Specifications

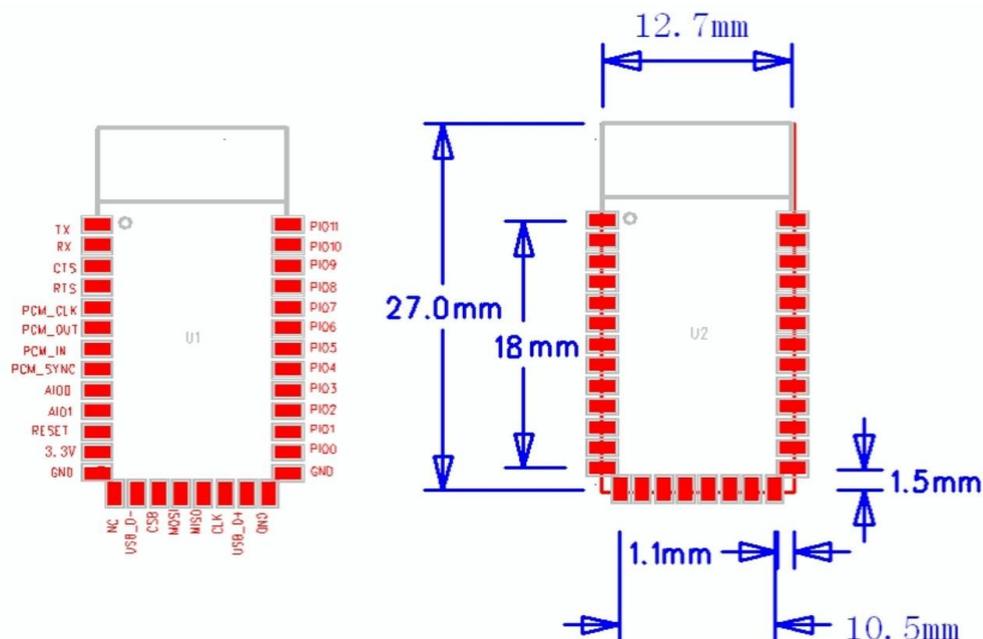
Hardware features

- Typical -80dBm sensitivity
- Up to +4dBm RF transmit power
- Low Power 1.8V Operation ,1.8 to 3.6V I/O
- PIO control
- UART interface with programmable baud rate
- With integrated antenna
- With edge connector

Software features

- Default Baud rate: 38400, Data bits:8, Stop bit:1,Parity:No parity, Data control: has. Supported baud rate: 9600,19200,38400,57600,115200,230400,460800.
- Given a rising pulse in PIO0, device will be disconnected.
- Status instruction port PIO1: low-disconnected, high-connected;
- PIO10 and PIO11 can be connected to red and blue led separately. When master and slave are paired, red and blue led blinks 1time/2s in interval, while disconnected only blue led blinks 2times/s.
- Auto-connect to the last device on power as default.
- Permit pairing device to connect as default.
- Auto-pairing PINCODE:"0000" as default
- Auto-reconnect in 30 min when disconnected as a result of beyond the range of connection.

Hardware



PIN Name	PIN #	Pad type	Description	Note
GND	13 21 22	VSS	Ground pot	
3.3 VCC	12	3.3V	Integrated 3.3V (+) supply with On-chip linear regulator output within 3.15-3.3V	
AIO0	9	Bi-Directional	Programmable input/output line	
AIO1	10	Bi-Directional	Programmable input/output line	
PIO0	23	Bi-Directional RX EN	Programmable input/output line, control output for LNA(if fitted)	
PIO1	24	Bi-Directional TX EN	Programmable input/output line, control output for PA(if fitted)	

PIO2	25	Bi-Directional	Programmable input/output line	
PIO3	26	Bi-Directional	Programmable input/output line	
PIO4	27	Bi-Directional	Programmable input/output line	
PIO5	28	Bi-Directional	Programmable input/output line	
PIO6	29	Bi-Directional	Programmable input/output line	
PIO7	30	Bi-Directional	Programmable input/output line	
PIO8	31	Bi-Directional	Programmable input/output line	
PIO9	32	Bi-Directional	Programmable input/output line	
PIO10	33	Bi-Directional	Programmable input/output line	
PIO11	34	Bi-Directional	Programmable input/output line	

RESETB	11	CMOS input with weak internal pull-up	Reset if low.input debounced so must be low for >5MS to cause a reset	
UART_RTS	4	CMOS output, tri-stable with weak internal pull-up	UART request to send, active low	
UART_CTS	3	CMOS input with weak internal pull-down	UART clear to send, active low	
UART_RX	2	CMOS input with weak internal pull-down	UART Data input	
UART_TX	1	CMOS output, Tri-stable with weak internal pull-up	UART Data output	
SPI_MOSI	17	CMOS input with weak internal pull-down	Serial peripheral interface data input	

SPI_CSB	16	CMOS input with weak internal pull-up	Chip select for serial peripheral interface, active low	
SPI_CLK	19	CMOS input with weak internal pull-down	Serial peripheral interface clock	
SPI_MISO	18	CMOS input with weak internal pull-down	Serial peripheral interface data Output	
USB_-	15	Bi-Directional		

USB_+	20	Bi-Directional		
NC	14			
PCM_CLK	5	Bi-Directional	Synchronous PCM data clock	
PCM_OUT	6	CMOS output	Synchronous PCM data output	
PCM_IN	7	CMOS Input	Synchronous PCM data input	
PCM_SYNC	8	Bi-Directional	Synchronous PCM data strobe	

AT command Default:

How to set the mode to server (master):

1. Connect PIO11 to high level.
2. Power on, module into command state.
3. Using baud rate 38400, sent the "AT+ROLE=1\r\n" to module, with "OK\r\n" means setting successes.
4. Connect the PIO11 to low level, repower the module, the module work as server (master).

AT commands: (all end with \r\n)

1. Test command:

Command	Respond	Parameter
AT	OK	-

2. Reset

Command	Respond	Parameter
AT+RESET	OK	-

3. Get firmware version

Command	Respond	Parameter
AT+VERSION?	+VERSION:<Param> OK	Param : firmware version

Example:

```
AT+VERSION?\r\n
+VERSION:2.0-20100601
OK
```

4. Restore default

Command	Respond	Parameter
AT+ORGL	OK	-

Default state:

Slave mode, pin code :1234, device name: H-C-2010-06-01 ,Baud 38400bits/s.

5. Get module address

Command	Respond	Parameter
AT+ADDR?	+ADDR:<Param> OK	Param: address of Bluetooth module

Bluetooth address: NAP: UAP : LAP

Example:

AT+ADDR?\r\n

+ADDR:1234:56:abcdef

OK

6. Set/Check module name:

Command	Respond	Parameter
AT+NAME=<Param>	OK	Param: Bluetooth module name (Default :HC-05)
AT+NAME?	+NAME:<Param> OK (/FAIL)	

Example:

AT+NAME=HC-05\r\n set the module name to "HC-05"

OK

AT+NAME=ITeadStudio\r\n

OK

AT+NAME?\r\n

+NAME: ITeadStudio

OK

7. Get the Bluetooth device name:

Command	Respond	Parameter
AT+RNAME?<Param1>	1. +NAME:<Param2> OK 2. FAIL	Param1,Param 2 : the address of Bluetooth device

Example: (Device address 00:02:72:od:22:24, name: ITead)

AT+RNAME? 0002, 72, od2224\r\n

+RNAME:ITead

OK

8. Set/Check module mode:

Command	Respond	Parameter
AT+ROLE=<Param>	OK	Param:
AT+ROLE?	+ROLE:<Param>	0- Slave

	OK	1-Master 2-Slave-Loop
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9. Set/Check device class

Command	Respond	Parameter
AT+CLASS=<Param>	OK	Param: Device Class
AT+ CLASS?	1. +CLASS:<Param> OK 2. FAIL	

10. Set/Check GIAC (General Inquire Access Code)

Command	Respond	Parameter
AT+IAC=<Param>	1.OK 2. FAIL	Param: GIAC (Default : 9e8b33)
AT+IAC	+IAC:<Param> OK	

Example:

```
AT+IAC=9e8b3f\r\n
```

```
OK
```

```
AT+IAC?\r\n
```

```
+IAC: 9e8b3f
```

```
OK
```

11. Set/Check -- Query access patterns

Command	Respond	Parameter
AT+INQM=<Param>,<Param2>,<Param3>	1.OK 2. FAIL	Param: 0— inquiry_mode_standard 1— inquiry_mode_rssi Param2: Maximum number of Bluetooth devices to respond to Param3: Timeout (1-48 : 1.28s to 61.44s)
AT+ INQM?	+INQM : <Param>,<Param2>,<Param3> OK	

Example:

```
AT+INQM=1,9,48\r\n
```

```
OK
```

```
AT+INQM\r\n
```

```
+INQM:1, 9, 48
```

```
OK
```

12. Set/Check PIN code:

Command	Respond	Parameter
AT+PSWD=<Param>	OK	Param: PIN code (Default 1234)
AT+ PSWD?	+ PSWD : <Param> OK	

13. Set/Check serial parameter:

Command	Respond	Parameter
AT+UART=<Param>,<Param2>,<Param3>	OK	Param1: Baud Param2: Stop bit Param3: Parity
AT+ UART?	+UART=<Param>,<Param2>,<Param3> OK	

Example:

```
AT+UART=115200, 1,2,\r\n
OK
AT+UART?
+UART:115200,1,2
OK
```

14. Set/Check connect mode:

Command	Respond	Parameter
AT+CMODE=<Param>	OK	Param: 0 - connect fixed address 1 - connect any address 2 - slave-Loop
AT+ CMODE?	+ CMODE:<Param> OK	

15. Set/Check fixed address:

Command	Respond	Parameter
AT+BIND=<Param>	OK	Param: Fixed address (Default 00:00:00:00:00:00)
AT+ BIND?	+ BIND:<Param> OK	

Example:

```
AT+BIND=1234, 56, abcdef\r\n
OK
AT+BIND?\r\n
+BIND:1234:56:abcdef
OK
```

16. Set/Check LED I/O

Command	Respond	Parameter
AT+POLAR=<Param1,<Param2>	OK	Param1:
AT+ POLAR?	+ POLAR=<Param1>,<Param2> OK	0- PIO8 low drive LED 1- PIO8 high drive LED

		Param2: 0- PIO9 low drive LED 1- PIO9 high drive LED
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17. Set PIO output

Command	Respond	Parameter
AT+PIO=<Param1>,<Param2>	OK	Param1: PIO number Param2: PIO level 0- low 1- high

Example:

1. PIO10 output high level

```
AT+PIO=10, 1\r\n
```

```
OK
```

18. Set/Check – scan parameter

Command	Respond	Parameter
AT+IPSCAN=<Param1>,<Param2>,<Param3>,<Param4>	OK	Param1: Query time interval
AT+IPSCAN?	+IPSCAN:<Param1>,<Param2>,<Param3>,<Param4> OK	Param2: Query duration Param3: Paging interval Param4: Call duration

Example:

```
AT+IPSCAN =1234,500,1200,250\r\n
```

```
OK
```

```
AT+IPSCAN?
```

```
+IPSCAN:1234,500,1200,250
```

19. Set/Check – SHIFF parameter

Command	Respond	Parameter
AT+SNIFF=<Param1>,<Param2>,<Param3>,<Param4>	OK	Param1: Max time Param2: Min time
AT+ SNIFF?	+SNIFF:<Param1>,<Param2>,<Param3>,<Param4> OK	Param3: Retry time Param4: Time out

20. Set/Check security mode

Command	Respond	Parameter
AT+SENM=<Param1>,<Param2>	1. OK 2. FAIL	Param1: 0—sec_mode0+off
AT+ SENM?	+ SENM:<Param1>,<Param2>	1—sec_mode1+non_se

	OK	cure 2—sec_mode2_service 3—sec_mode3_link 4—sec_mode_unknow n Param2: 0—hci_enc_mode_off 1—hci_enc_mode_pt_t o_pt 2—hci_enc_mode_pt_t o_pt_and_bcast
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21. Delete Authenticated Device

Command	Respond	Parameter
AT+PMSAD=<Param>	OK	Param: Authenticated Device Address

Example:

AT+PMSAD =1234,56,abcdef\r\n

OK

22. Delete All Authenticated Device

Command	Respond	Parameter
AT+ RMAAD	OK	-

23. Search Authenticated Device

Command	Respond	Parameter
AT+FSAD=<Param>	1. OK 2. FAIL	Param: Device address

24. Get Authenticated Device Count

Command	Respond	Parameter
AT+ADCN?	+ADCN: <Param> OK	Param: Device Count

25. Most Recently Used Authenticated Device

Command	Respond	Parameter
AT+MRAD?	+ MRAD: <Param> OK	Param: Recently Authenticated Device Address

26. Get the module working state

Command	Respond	Parameter
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AT+ STATE?	+ STATE: <Param> OK	Param: "INITIALIZED" "READY" "PAIRABLE" "PAIRED" "INQUIRING" "CONNECTING" "CONNECTED" "DISCONNECTED" "NUKNOW"
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27. Initialize the SPP profile lib

Command	Respond	Parameter
AT+INIT	1. OK 2. FAIL	-

28. Inquiry Bluetooth Device

Command	Respond	Parameter
AT+INQ	+INQ: <Param1> , <Param2> , <Param3> OK	Param1: Address Param2: Device Class Param3 : RSSI Signal strength

Example:

```
AT+INIT\r\n
OK
AT+IAC=9e8b33\r\n
OK
AT+CLASS=0\r\n
AT+INQM=1,9,48\r\n
At+INQ\r\n
+INQ:2:72:D2224,3E0104,FFBC
+INQ:1234:56:0,1F1F,FFC1
+INQ:1234:56:0,1F1F,FFC0
+INQ:1234:56:0,1F1F,FFC1
+INQ:2:72:D2224,3F0104,FFAD
+INQ:1234:56:0,1F1F,FFBE
+INQ:1234:56:0,1F1F,FFC2
+INQ:1234:56:0,1F1F,FFBE
+INQ:2:72:D2224,3F0104,FFBC
OK
```

28. Cancel Inquiring Bluetooth Device

Command	Respond	Parameter
AT+ INQC	OK	-

29. Equipment Matching

Command	Respond	Parameter
AT+PAIR=<Param1>,<Param2>	1. OK 2. FAIL	Param1: Device Address Param2: Time out

30. Connect Device

Command	Respond	Parameter
AT+LINK=<Param>	1. OK 2. FAIL	Param: Device Address

Example:

AT+FSAD=1234,56,abcdef\r\n

OK

AT+LINK=1234,56,abcdef\r\n

OK

31. Disconnect

Command	Respond	Parameter
AT+DISC	1. +DISC:SUCCESS OK 2. +DISC:LINK_LOSS OK 3. +DISC:NO_SLC OK 4. +DISC:TIMEOUT OK 5. +DISC:ERROR OK	Param: Device Address

32. Energy-saving mode

Command	Respond	Parameter
AT+ENSNIFF=<Param>	OK	Param: Device Address

33. Exerts Energy-saving mode

Command	Respond	Parameter
AT+ EXSNIFF =<Param>	OK	Param: Device Address

Revision History

Rev.	Description	Release date
v1.0	Initial version	7/18/2010