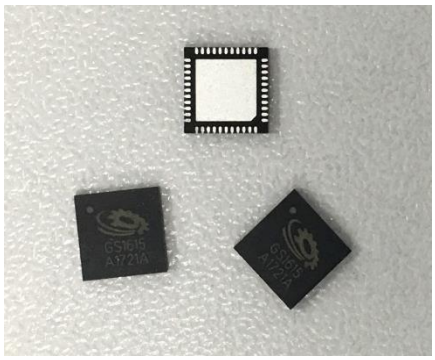
GS1615 BLDC MOTOR DRIVER IC

PRODUCT DATASHEET

GENERAL DESCRIPTION



The GS1615 is a monolithic motor driver IC specifically designed for Brushless DC motors. A single-phase sensored or three-phase sensorless motor driver with integrated full-bridge power MOSFETs. The device can provide continuous drive current up to 1.2 amps RMS, offering >29w output power in 3 phase 6 wire mode. A 3 wire star connected 3 phase motor applies the motor working voltage across 2 windings in series, the voltage across each winding will be half of the working voltage. When compared Gain's Patented 6 wire 3 phase motor driven by full bridges, the voltage applied to each winding will be double that of a 3 wire 3 phase motor. It therefore implies, that for the same motor working voltage, the GS1615 will drive the motor more efficiently and at a higher speed.

The device is specifically designed to enable motor efficiency, resulting in significant power savings in all motors, thus offering the potential to reduce motor cost, reduce noise and lower external component count. GS1615 uses advanced sensored or sensorless control scheme to provide continuous Pure Sinusoidal Drive™, which significantly reduces the pure tone acoustics that typically occur as a result of commutation. The combination of continuous Pure Sinusoidal Drive™ and Gain's patented "6-wire" mode offers industry leading efficiency.

The device also offers protection against over current and over voltage situations with integrated protection circuits, along with an A/D converter, which are used together to ensure smooth rotational operation. The GS1615 therefore enables motor manufacturers to offer higher quality motors reduced in size, at the lower cost point into cost-sensitive application, resulting in a new generation of quieter, smaller and more power efficient end products and appliance.

APPLICATIONS

- Cooker Hoods
- Cooking Ranges
- Air Conditioning
- Extraction Fans
- Ovens (Microwave, Other)
- Residential & Living Fans
- Residential Ductless Aircon Indoor System

FEATURES

- Triple Full Bridge
    - Built-in 30V MOSFETs with Low $R_{DS(ON)}$ (150mΩ)
    - Load Current Indication
    - Short Circuit Protection (5A)
- Wide Operating Voltage Range: 4.5V to 24V recommended, 30V maximum rating
- Built-in LDO (5.3V and 3.3V)
- Package: QFN44L (5mmX5mm)

TYPICAL APPLICATION CIRCUIT

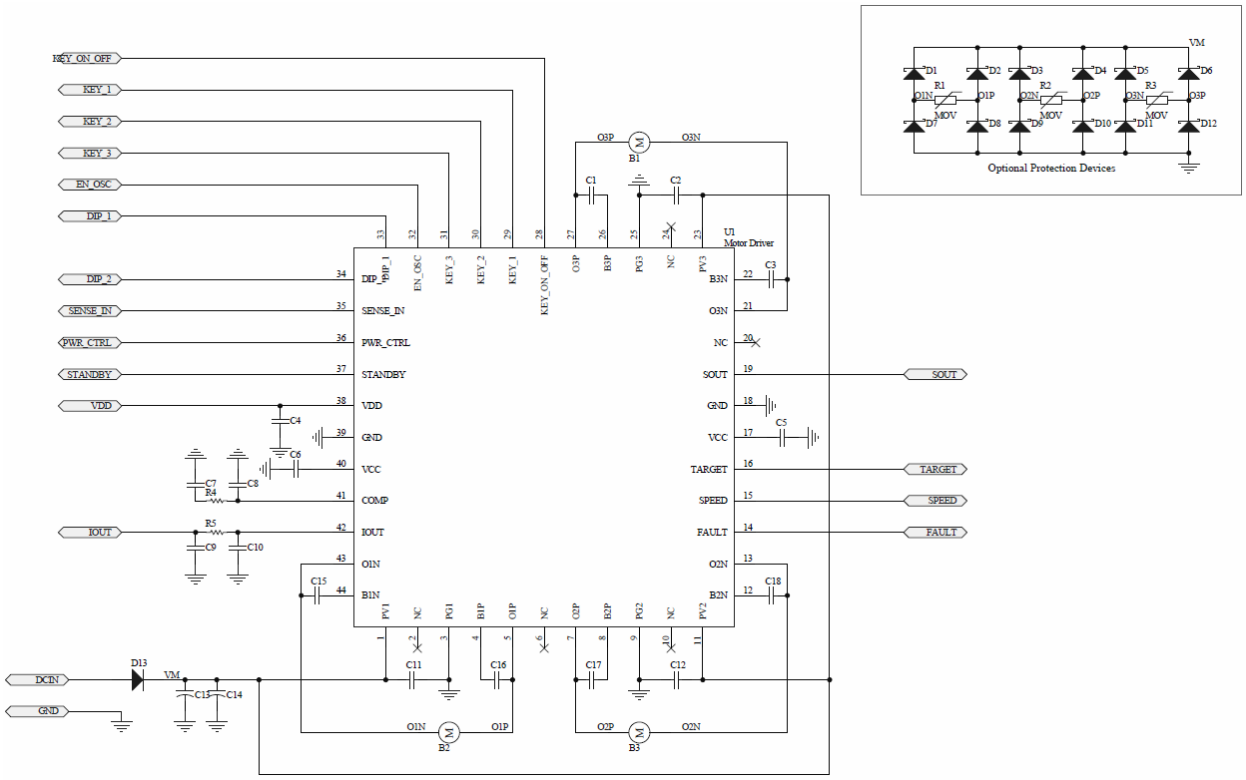


Figure 1: Typical application circuit of the GS1615.

PIN CONFIGURATION

Pin	Name	Type	Description
1	PV1	PWR	Input power of channel 1
2	NC	Z	No connection
3	PG1	PWR	Power ground of channel 1
4	B1P	O	Driver power for positive output of channel 1

Pin	Name	Type	Description
5	O1P	O	Positive output of channel 1
6	NC	Z	No connection
7	O2P	O	Positive output of channel 2
8	B2P	O	Driver power for positive output of channel 2
9	PG2	PWR	Power ground of channel 2
10	NC	Z	No connection
11	PV2	PWR	Input power of channel 2
12	B2N	O	Power ground of channel 2
13	O2N	O	Negative output of channel 2
14	FAULT	O	This pin will go high when the driver is in a protection mode (usually when the motor is blocked)
15	SPEED	O	This pin reflects the speed of the motor
16	TARGET	O	When the motor achieves target speed, this pin will go high
17	VCC	PWR	Output of VCC regulator
18	GND	PWR	Ground connection
19	SOUT	O	Serial data output from the GS1615
20	NC	Z	No connection
21	O3N	O	Negative output of channel 3
22	B3N	O	Driver power for negative output of channel 3
23	PV3	PWR	Input power of channel 3
24	NC	Z	No connection
25	PG3	PWR	Power ground of channel 3
26	B3P	O	Driver power for positive output of channel 3
27	O3P	O	Positive output of channel 3
28	KEY_ON_OFF	I	Power ON/OFF key in single chip mode
29	KEY_1/PWM	I	Speed level 1 in single chip mode
30	KEY_2/SCLK	I	Speed level 2 in single chip mode
31	KEY_3/LATCH	I	Speed level 3 in single chip mode
32	EN_OSC/SDATA	I	Oscillator motor enable in single chip mode
33	DIP_1	I	Mode select 1
34	DIP_2	I	Mode select 2, together with DIP_1 defines the operation mode of the GS1615, 3 single chip modes and 2 MCU control modes
35	SENSE_IN	I	Power monitoring pin

Pin	Name	Type	Description
36	PWR_CTRL	I	Mode 0 of the GS1615 is mainly for USB portable fans, '0' as this pin will enable the GS1615 to drive the motor with extra power
37	STANDBY	I	'1' as this pin will turn the GS1615 into standby mode with all internal MOSFETs being turned OFF
38	VDD	PWR	Output of VDD regulator
39	GND	PWR	Ground connection
40	VCC	PWR	Output of VCC regulator
41	COMP	AIO	Compensation network of PLL
42	IOUT	AIO	Output of total bridge current
43	O1N	O	Negative output of channel 1
44	B1N	O	Driver power for negative output of channel 1

FUNCTIONAL DESCRIPTION

Power Tree

The input power to the system is VM (PV1, PV2 and PV3). Whenever VM is available, the GS1615 will generate another two voltages VCC and VDD for subsequent circuits. VCC is generated for the control circuit of the motor drivers. VDD is generated for the digital circuits.

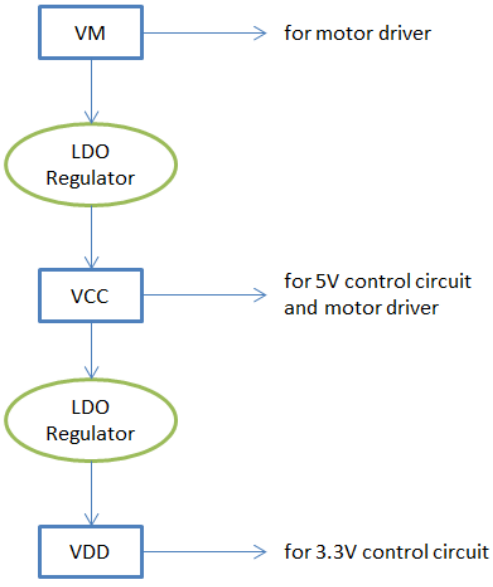


Figure 2: Power tree of the GS1615.

VCC Regulator

The input of the VCC regulator is VM (PV1, PV2 and PV3). It will start operation whenever there is an input voltage. The output voltage of VCC regulator is 5.3V and the maximum loading is 100mA.

VDD Regulator

The input of the VDD regulator is VCC. It will start operation whenever there is an input voltage. The output voltage of the VDD regulator is 3.3V and the maximum loading is 50mA.

Full Bridge

There are three full bridges in the GS1615. The turn-on resistance of each is 120mΩ. Total path resistance is 240 mΩ. All the MOSFETs are controlled by the digital control block after initialization. Short-circuit detection and load current indication are implemented.

Load Current Indicator (IOUT)

The load current of each channel is measured and summed up to the IOUT. The current ratio of the indicator is 20000.

$$I_{OUT} = \frac{I_{CH1} + I_{CH2} + I_{CH3}}{20000}$$

Short-circuit Protection

The short-circuit threshold is set to 5A. All the MOSFETs of the channel will be turned in this event and error is reported to digital control block.

Thermal Protection

The thermal shutdown point is set at 140°C. All MOSFETs of the bridges will be turned off in this case. Error will be reported to digital control block.

Digital Control Block

When both DIP_1 and DIP_2 are high, the GS1615 will go into a MCU control mode in which users are freely able to program the GS1615 as single phase BLDC control driver or 3 phase 6 wire BLDC control driver.

There are 4 pins used for the communication between the MCU and GS1615, these are;

1) SCK – clock pin
2) SDATA – serial data from MCU to GS1615, data is clocked into the GS1615 at SCK rising edge
3) LATCH – data latch pin, this pin goes low to start the data transfer and returns to high when communication is done

4) TARGET – this pin is used only in 3 phase 6 wire mode. This pin will go high to indicate that the desired speed is achieved. With proper use of this pin, the acceleration speed profile of each motor can be tailor-made.

Commands from MCU to GS1615 are group into 37bit, 21bit, 6bit and 5bit. First 5 bits of the 37bit define the 32 bit register (MSB comes first), similarly the first 5 bits of the 21bit command define the 16 bit register. The first 2 bits of the 6 bit command give 4 different ways to access GS1615 internal state and these commands are used only in development state. The 5 bit command gives 32 possible direct commands.

The details of each command will be described as follows;

1) 37bit_command(1,32bit_value) – programmable 32 bit target speed. Under 3 phase 6 wire mode, the output from all 3 channels are pure sinusoidal PWM with 120 electrical degrees apart.
2) 37bit_command(2,32bit_value) – programmable acceleration slope. The frequency of the output will accelerate or decelerate with this slope value
3) 37bit_command(3,32bit_value) – programmable startup angle. This value defines the starting angle of the sine wave with reference to the channel 1.
4) 37bit_command(4,32bit_value) – programmable kick start angle. This value defines the angle of kick start of the motor.
5) 21bit_command(0,16bit_value) – programmable speed delay. This speed will slow down the acceleration/deceleration of the motor
6) 21bit_command(1,16bit_value) – programmable power output scalar. 0xffff for full power
7) 21bit_command(3,16bit_value) – programmable switching frequency. 1371 for 16KHz switching frequency.
8) 21bit_command(4,16bit_value) – programmable constant speed delay time.
9) 21bit_command(5,16bit_vlaue) – programmable braking power. This value should be less than the switching frequency
10) 21bit_command(6,16bit_value) – programmable starting power. This value defines the output power when the motor starts to spin.
11) 21bit_command(7,16bit_value) – programmable target power. When the motor achieves the target speed, this value defines the steady state power.
12) 21bit_command(8,16bit_value) – programmable power change delay. This value slows down the change of starting power to target power.
13) 21bit_command(9,16bit_value) – programmable start looping frequency
14) 21bit_command(10,16bit_value) – programmable ending looping frequency

15) 21bit_command(11,16bit_value) – programmable delta scalar
16) 21bit_command(12,16bit_value) – programmable target delay
17) 21bit_command(13,16bit_value) – programmable speed of single phase motor
18) 21bit_command(14,16bit_value) – programmable PWM width of the oscillator motor
19) 21bit_command(15,16bit_value) – programmable oscillating period of oscillator motor
20) 21bit_command(16,16bit_value) – programmable kick start duration of 3 phase motor
21) 21bit_command(17,16bit_value) – programmable kick start power
22) 23bit_command(23,16bit_value) – programable 3 phase power level
23) 21bit_command(24,16bit_value) – programmable various power factor
24) 5bit_command(1) – 3 phase motor Manual_stage to 1
25) 5bit_command(2) – set motor direction to CW
26) 5bit_command(3) – set motor direction to CCW
27) 5bit_command(4) – clear inifinite_PWM_flag to '0'
28) 5bit_command(5) – set inifinite_PWM_flag to '1'
29) 5bit_command(6) – clear Inifinite_loop_flag to '0'
30) 5bit_command(7) – set Inifinite_loop_flag to '1'
31) 5bit_command(8) – set 3 phase braking mode to '1'
32) 5bit_command(9) – set 3 phase braking mode to '4'
33) 5bit_command(10) – clear DDX_mode to '0'
34) 5bit_command(11) – set DDX_mode to '1'
35) 5bit_command(12) – clear single phase sensor image to '0'
36) 5bit_command(13) – set single phase sensor image to '1'
37) 5bit_command(14) – disable oscillator motor
38) 5bit_command(15) – enable oscillator motor
39) 5bit_command(16) – select single phase motor triple power mode
40) 5bit_command(17) – select single phase motor single channel power mode
41) 5bit_command(20) – set Rotation_2_stage to '1'
42) 5bit_command(21) – clear single phase motor registers

ELECTRICAL CHARACTERISTICS (T_A=25°C and V_{IN}=12V)

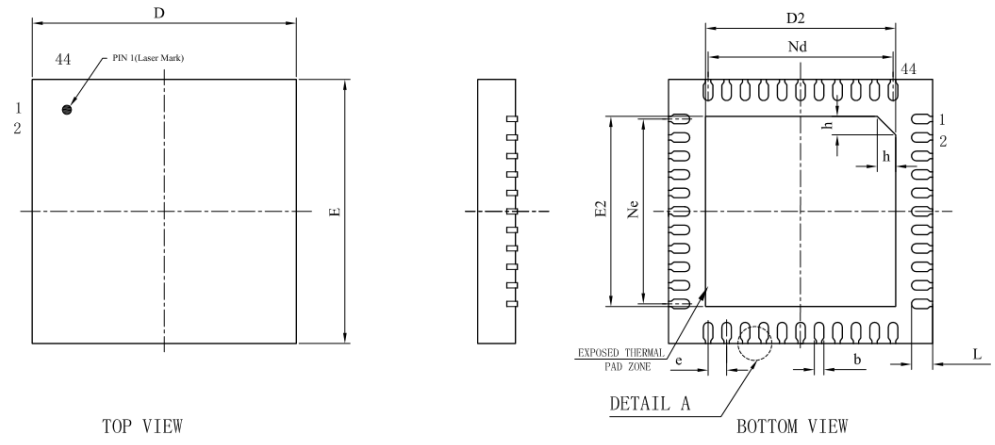
Parameter	Symbol	Conditions	Limit			Unit
			MIN	TYP	MAX	
Overall						
Supply Voltage	V_{PV}	PV1, PV2, PV3	0		30	V
Supply Current	I_{STBY}	Standby Mode		0.5		mA
	I_{OP}	Quiescent Mode		8		mA
VCC Regulator	V_{CC}		5.10	5.30	5.50	V
VCC Current Limit	I_{CCLMT}			100		mA
VDD Regulator	V_{DD}		3.20	3.30	3.40	V
VDD Current Limit	I_{CCLMT}			50		mA
PV Undervoltage Limit	V_{VCCUV}		3.8	4.0	4.2	V
VCC Undervoltage Limit	V_{VCCUV}		2.55	2.70	2.85	V
VDD Undervoltage Limit	V_{VDDUV}		2.35	2.50	2.65	V
Thermal Shutdown	T_{SD}			140		°C
Full Bridge						
MOSFET Resistance	R_{DSON}			150		mΩ
Short-circuit Threshold	I_{SC}			5.0		A
Maximum Duty Ratio	D_{MAX}	f_{PWM}=16kHz		95		%
Minimum Non-zero Duty Ratio	D_{MIN}	f_{PWM}=16kHz		2		%
Current Mirror Ratio	M_{IOUT}			20K		I/I

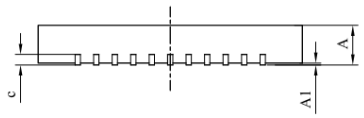
ABSOLUTE MAXIMUM RATINGS

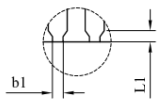
Parameter	Limit
PV1, PV2 and PV3 pins	-0.3V to 30V
O1P, O1N, O2P, O2N, O3P and O3N pins	-0.3V to 30V
B1P, B1N, B2P, B2N, B3P and B3N pins	-0.3V to 30V
VCC and VDD Voltages	-0.3V to 6V
All other pins	-0.3V to V_{DD}+0.3V
Operating Temperature	-40°C to 85°C
Junction Temperature	-40°C to 125°C
Storage Temperature	-65°C to 150°C
Maximum Power Dissipation	0.4W
Soldering Temperature	300°C

PACKAGE INFORMATION

Package Type: QFN44L (5mmx5mm)





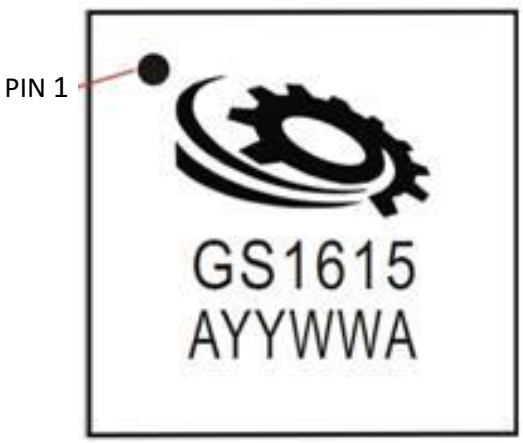


DETAIL A

2:1

SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	—	0.02	0.05
b	0.13	0.18	0.23
b1	0.05	0.10	0.15
c	0.18	0.20	0.25
D	4.90	5.00	5.10
D2	3.50	3.60	3.70
e	0.35BSC		
Nd	3.50BSC		
E	4.90	5.00	5.10
E2	3.50	3.60	3.70
Ne	3.50BSC		
L	0.35	0.40	0.45
L1	0.10REF		
h	0.30	0.35	0.40
L/F载体尺寸 (mil)	150X150		

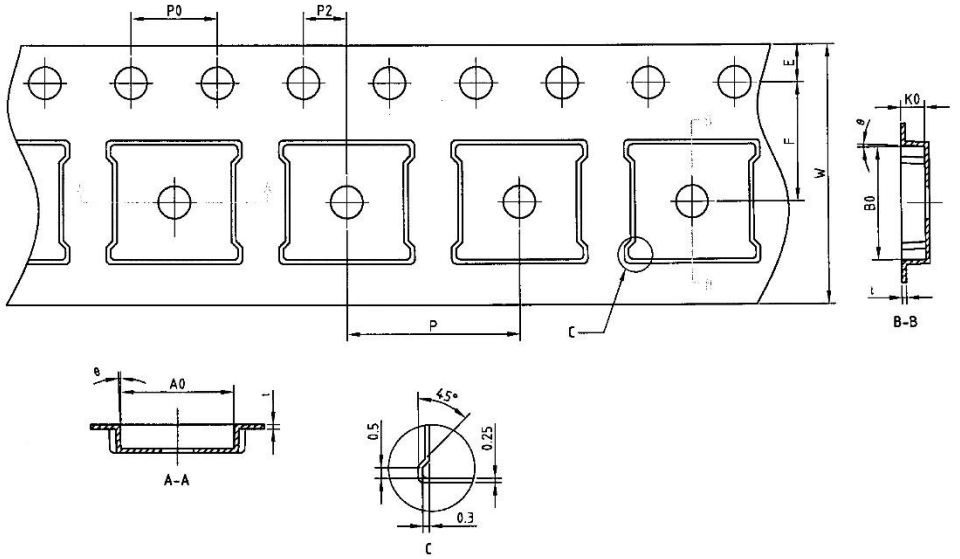
Package Marking Diagram:



- Product Code: “GS1615 ”
- Factory Code: “T”
- Assembly Date Code: “YYWW”, where “YY” is the year code and “WW” is the week code”
- Chip Version Code: “A”

Delivery Form Factor:

The GS1615 is delivered in standard Tape & Reel form factor as per technical specification below.



Technical requirement:
1. Accumulative error of each 10 transmission holes is +-0.2mm
2. Side bend of length is <=1mm/100mm
3. A0/B0 is the measured value which is 0.3mm upon the bottom of pocket
4. K0 is the measured value from the inner bottom of pocket to the surface of carrier tape
5. The surface resistivity of pocket is from 10^5 to 10^10 ohm per pocket
6. Roughness: Ra<0.8um
7. Color: black(CMYK color No. C0 M0 Y35 K100)
8. Concave die manufacturing process

Universal dimension

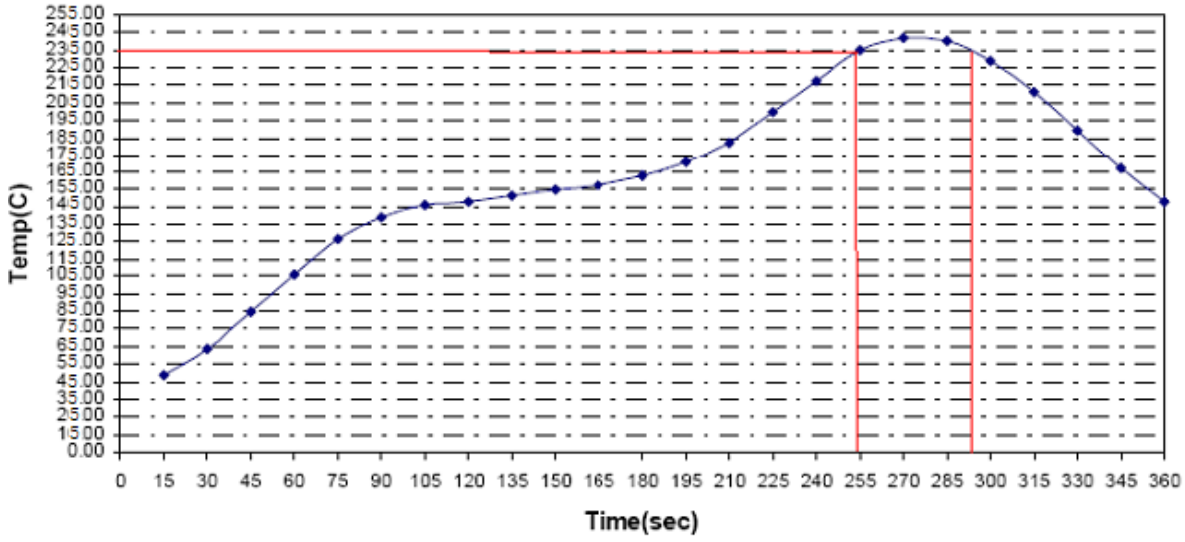
	dimension(mm)
E	1.75±0.10
F	5.50±0.10
P2	2.00±0.10
D	1.55±0.05
D1	$1.55^{+0.25}_{0}$
P0	4.00±0.10
10P0	40.00±0.20

Pocket dimension

	dimension(mm)
W	12.00±0.30
P	8.00±0.10
A0	5.30±0.10
B0	5.30±0.10
L0	1.10±0.10
t	0.30±0.05
θ	3° TYP

Recommended Surface Mount Reflow Temperature Profile:

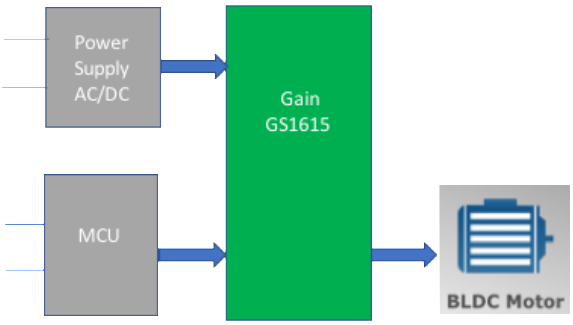
Convection Reflow Profile #3: Required Peal Temperature=240 (±5) deg. C, Ramp Rate=1 deg. C / sec

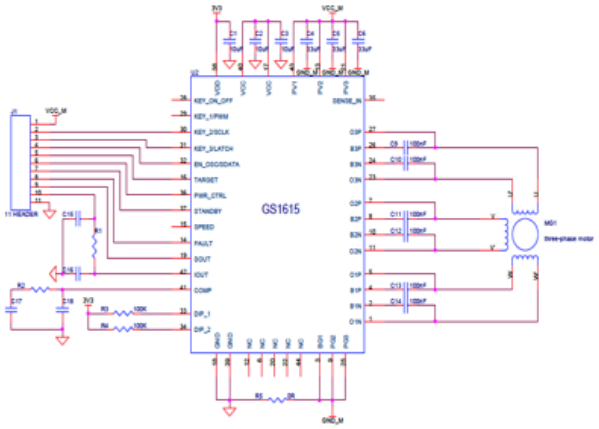


High Level Application Diagrams

Patented 3 Phase 6 Wire

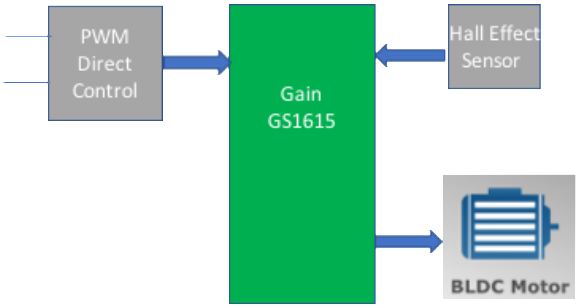
Mode 3b of 5

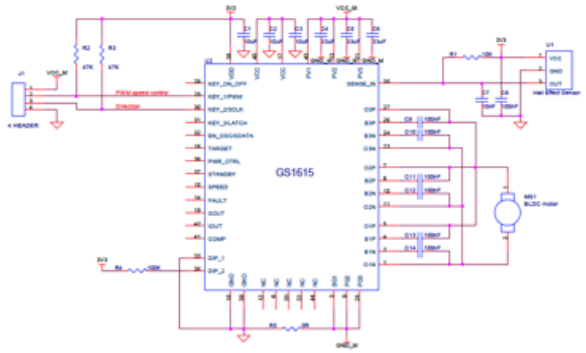




Single Phase Single Chip with Direct PWM Control

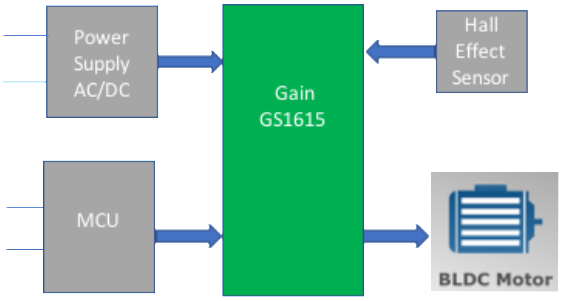
Mode 2 of 5

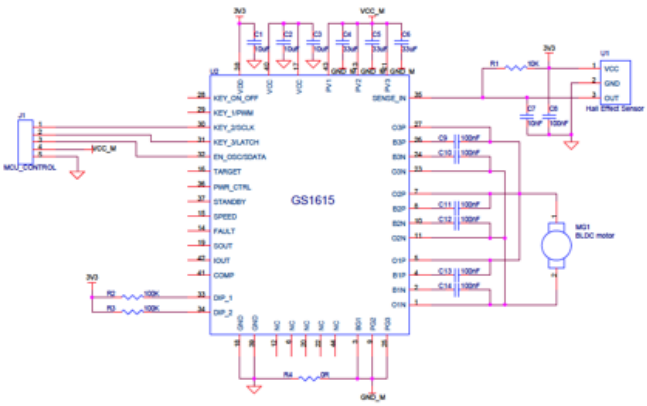




Single phase control mode offers maximum 29W output

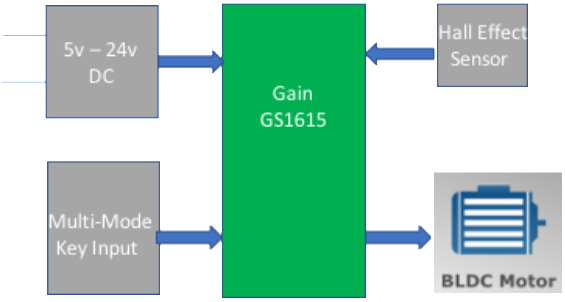
Mode 3a of 5

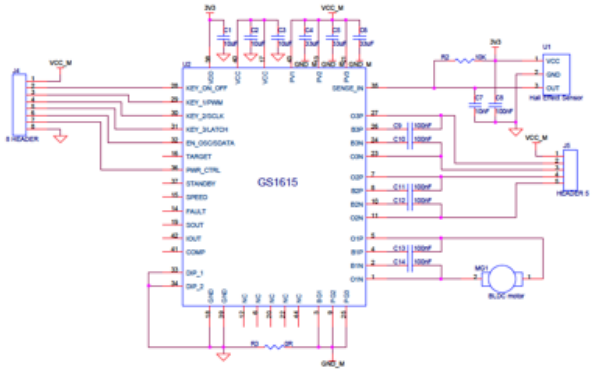




USB applications for a 5V single phase BLDC motor

Mode 0 of 5





Single chip mode with embedded keypad control

Mode 1 of 5