DESCRIPTION

The PT2434 is a three-phase, sensor-less, brushless DC motor control chip. System operating voltage depends on the VM (motor voltage), from 12V to 400Vdc. On-chip LDO can provide 5V voltage for logic and analog circuits operation. The three-phase sensor-less control is based on trapezoid wave, and additional soft-switching scheme is designed for reducing electrical audible noise in motor phase commutation. To combine with an external high voltage gate driver and six n-channel MOSFETs, PT2434 can operate high voltage motor up to 400V. On the 12V to 36V operation, it is easy to setup with simple level-shift circuit and combined with external PN MOSFETs. The PT2434 offers external parameters setting for optimum adjustment with different motors or applications. The package of PT2434 is SSOP28.

FEATURES

- Sensor-less control for 3-phase BLDC
- Current limit function
- Over temperature protection from external NTC
- Motor lock protection
- Reverse function.
- PWM or DC input for speed control

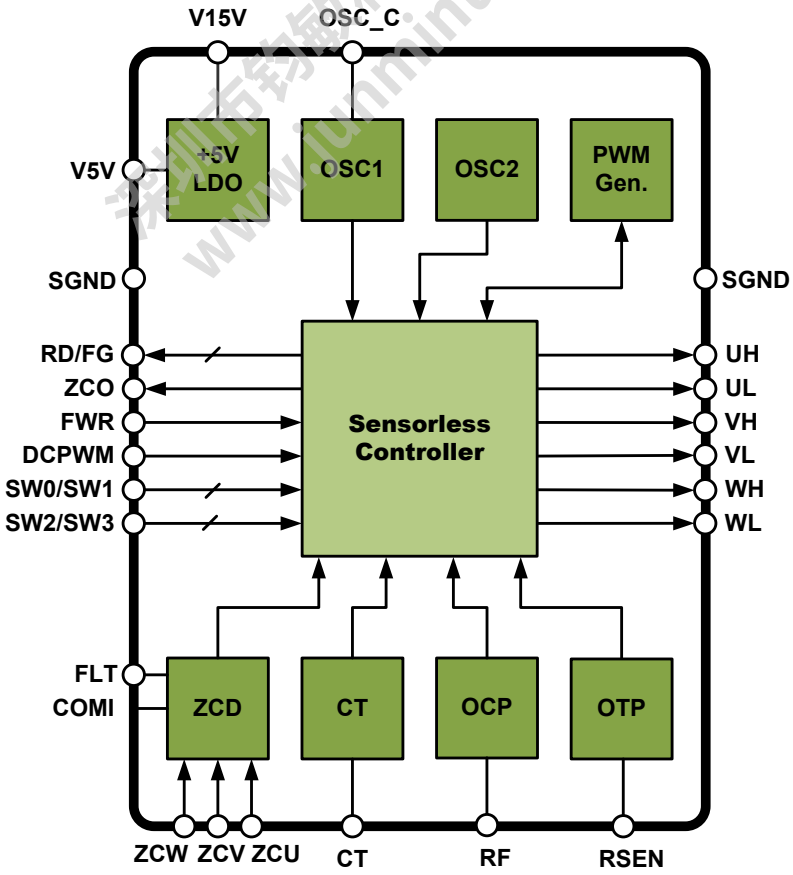
APPLICATIONS

- Three-phase BLDC motor
- Three-phase BLDC fan, blower
- Three-phase BLDC ceiling fan

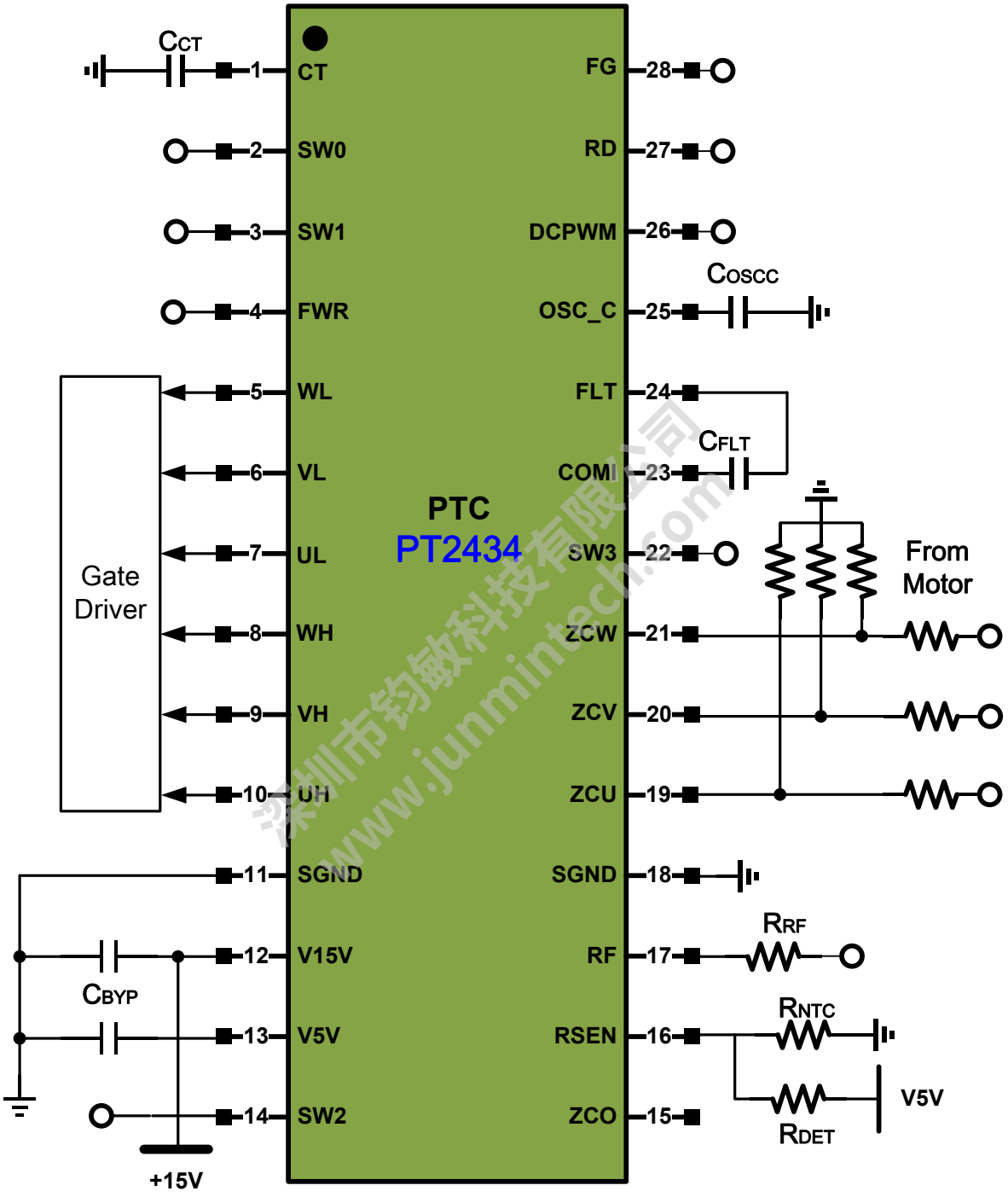
FG OUTPUT FOR ROTATION SPEED

- RD output for look detection

BLOCK DIAGRAM



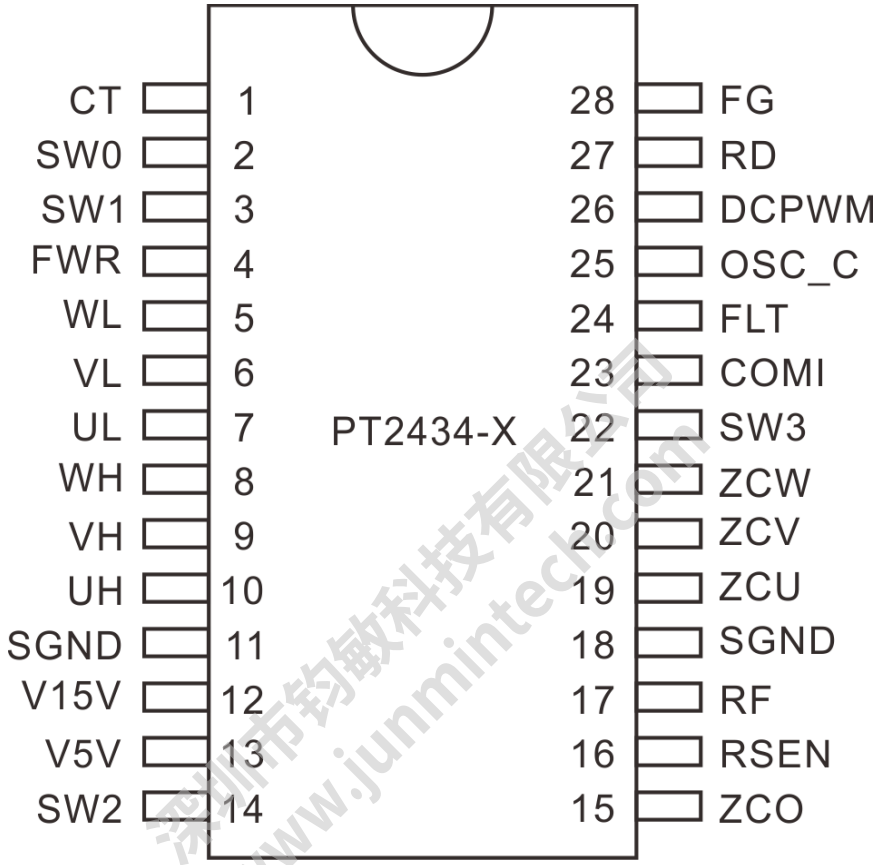
APPLICATION CIRCUIT



ORDER INFORMATION

Valid Part Number	Package Type	Top Code
PT2434-X	28-Pin, SSOP	PT2434-X

PIN CONFIGURATION



PIN DESCRIPTION

Pin Name	I/O/P	Description	Pin No.
CT	O	Connect to external capacitor for setting lock and release time	1
SW0	I	Dead-time parameter setting. Refer to ELECTRIC CHARACTERISTIC, floating for HIGH	2
SW1	I		3
FWR	I	Forward and reverse rotation setting. LOW for CCW, and HIGH (or floating) for CW	4
WL	O	W phase low side signal output	5
VL	O	V phase low side signal output	6
UL	O	U phase low side signal output	7
WH	O	W phase high side signal output	8
VH	O	V phase high side signal output	9
UH	O	U phase high side signal output	10
SGND	P	Signal ground	11
V15V	P	+15V supply input	12
V5V	O	+5V LDO output	13
SW2	I	PWM type setting. LOW for soft-switching, and HIGH (or floating) for normal trapezoid-wave.	14
ZCO	O	ZC comparator output for signal monitoring	15
RSEN	O	Connect to external resistors for over temperature sensing	16
RF	I	Current limit voltage sensing	17
SGND	P	Signal ground	18
ZCU	I	U phase zero crossing input	19
ZCV	I	V phase zero crossing input	20
ZCW	I	W phase zero crossing input	21
SW3	I	Startup alignment strength setting. LOW for normal alignment, and HIGH (or floating) for light alignment	22
COMI	O	Motor virtual neutral voltage	23
FLT	I	Zero crossing filter	24
OSC_C	I	Connect to external capacitor for startup step setting	25
DCPWM	I	DC or PWM input for speed control	26
RD	O	Motor lock indicator, OPEN DRAIN structure, HIGH for abnormal event.	27
FG	O	Motor rotation speed indicator, OPEN DRAIN structure. Refer to FUNCTION DESCRIPTION	28

FUNCTION DESCRIPTION

POWER SUPPLY

Due to PT2434 consumes very low current (<5mA) and is embedded a 15V to 5V LDO for logic and analog circuit operation, so it can use a 15V supply directly from a ordinary HV(<400V) motor system. On the 12V to 36V motor application, PT2434 can use a voltage supply through a simple resistor-voltage-divider, or an external 12V regulator, without adding an external 5V regulator.

To avoid instability on external power, PT2434 will detect the LDO voltage internally. When the LDO voltage reach 3.5V, a power good signal will pass to logic circuits and the logic circuits will start to operate within 10ms.

In motor system, the chip is easily influenced by induced noise, and the bypass capacitors are suggested to be placed to IC power pins.

PWM OR DC INPUT FOR SPEED CONTROL

The PT2434 offers an external DC or PWM control input to change the motor speed. When using PWM input, the high voltage potential needs to be greater than 3.3V and the low potential to be less than 0.6V. The PWM frequency is recommended between 15KHz to 25KHz, and the PWM voltage low level is smaller than 0.3V, high level is higher than 3.5V. When using a DC input, the DC control ranges should be between 0.6V to 3.3V.

PT2434 has no speed control loop and it is suggested to get speed information from FG signal.

SENSORLESS CONTROL

The PT2434 control scheme is based on sensor-less (no Hall sensor) trapezoidal wave. The benefit of sensor-less is to save Hall sensor which causing inconvenience, such as cost, processing effects and temperature deviations issues.

Sensorless control is mainly through measurement of the induced BEMF (back electro-motive force) of motor wires under motor rotation state. When the motor is controlled, UVW coil endpoints voltage (phase voltage) is mixed with control signal and BEMF. It is hardly to find out BEMF from phase voltage. So we need to float motor for a while (an angle) when motor is commutating to obtain BEMF signal. In general, the floating electrical angle is 60 degrees in a pure square wave control, or named as 120 degrees commutation control. And 30 degrees floating angle for trapezoidal wave control is knew as 150 degrees commutation control.

The PT2434 senses UVW phase voltages by dividing resistors to lower the phase voltages to around 5V. It will let analog circuit has ability to handle the singles, among the selectors, filters and comparators to generate ZC (zero crossing) signal for commutation. For motors with different operation voltage, speed and mechanical factors, UVW phase divider resistance and filter need to be adjusted. When the system noise is too large or motor's BEMF signal is too weak, it will impact the control system to collect ZC signal accurately, which may cause control failure.

The PT2434 use 150 degrees commutation and soft-switching control function is helpful to reduce audible electro-current noise.

START UP

The most difficulty of sensor-less control is the startup procedure, because the rotor position is unknown and the BEMF signal is weak, or is even impossible to detect. The startup method of PT2434 is alignment and progressively increasing voltage (or increase the PWM duty) in order to achieve motor excitation and rotation. This behavior of alignment may cause the rotor forward or reverse one time randomly at startup stage. More unclear of ZC signal will cause starting failure. If the motor can not startup at a certain time (CT rise time), the startup procedure is failed and going to locked protection mode.

To consider with different motors or loads, it needs to use different pace to excite motor at startup for getting a proper and smooth behavior. The PT2434 offered "OSC_C" capacitance adjustment for different starting pace. In general OSC_C capacitance value range from 100pF to 3.9nF. The lighter or faster motor use smaller capacitance value, and vice versa.

CURRENT LIMIT

The PT2434 current limit function is implemented by sensing the phase-to-phase current with an external resistor to get a RF voltage. When the detected RF voltage is higher than 0.5V, the PWM signal to motor will be turned off. After the RF voltage is lower than 0.5V, the PWM signal is resumed.

LOCK PROTECTION

PT2434 need detect the periodical ZC signal to operate properly. If it did not detect the expected ZC signal, PT2434 will put itself to lock protection mode. In lock protection mode, PT2434 will wait for a period of time (fall time of CT), then try to re-startup motor again. After 20 times trying, if the motor can not start successfully, PT2434 would go into the dead lock mode. PT2434 no longer re-startup itself at this mode, and we can only cycle the power supply(power-off then power-on) to escape PT2434 from dead lock mode.

The lock protection time is determined by the capacitance on CT pin. CT will charge the external capacitor when motor is starting. If the CT voltage had charged to 3V, but motor still does not start successfully, the control program goes to lock protection mode, and CT capacitor start to discharge. If motor start successfully, CT will charge the capacitor to 5V and keep there. We can change the CT capacitance value or shunt resistance with it to get different lock and release time for motors.

In lock mode or over temperature protection(OTP) mode, RD pin will stay HIGH.
RD pin is open drain structure, and it needs an external pull high resistor to function.

OVER TEMPERATURE PROTECTION

PT2434 use the external negative temperature coefficient resistor (NTC) as the sources of over temperature protection detector. In pin RSEN, a normal resistor will connect to 5V and a NTC resistor will connect to ground. The NTC resistor may be placed near a heat source, such as a MOSFET. If the temperature rises, the NTC resistance will decrease and RSEN voltage level will be reduced. When RSEN voltage is less than 0.8V, PT2434 will enter over temperature protection(OTP) mode to put pin RD high and system in shutdown mode. After the system is cooling, RSEN voltage rise to higher than 1.2V and the system will start again.

In shutdown mode, UH/UL/VH/VL/WH/WL will output as LOW.

FG OUTPUT FOR SPEED INFORMATION

PT2434 has FG output for motor speed indication. When the rotor is running an electric cycle, the FG output one-pair High and Low signal. So when calculating the rotation speed, it is needed to take into account the pole numbers of the rotor. For example, if rotor is 8 poles (four pairs of NS), the motor run a lap will have 4 FG output. Motor speed is usually present in RPM (Revolutions Per Minute), so the rotation speed of the motor is calculated as:

RPM = FG x 120 / POLE, FG is frequency in Hz, “POLE” is pole number of rotor

FG pin is open drain structure, and it needs an external pull high resistor to function.

FORWARD AND REVERSE SETTING

PT2434 can be set as forward or reverse rotation through FR pin. If FR is switched, the motor will stop automatically and rotate with opposite direction. It is also suggested to control the motor speed with monitoring FG signal to optimize the reverse behavior, such as slow down profile or reverse waiting time.

ABSOLUTE MAXIMUM RATINGS

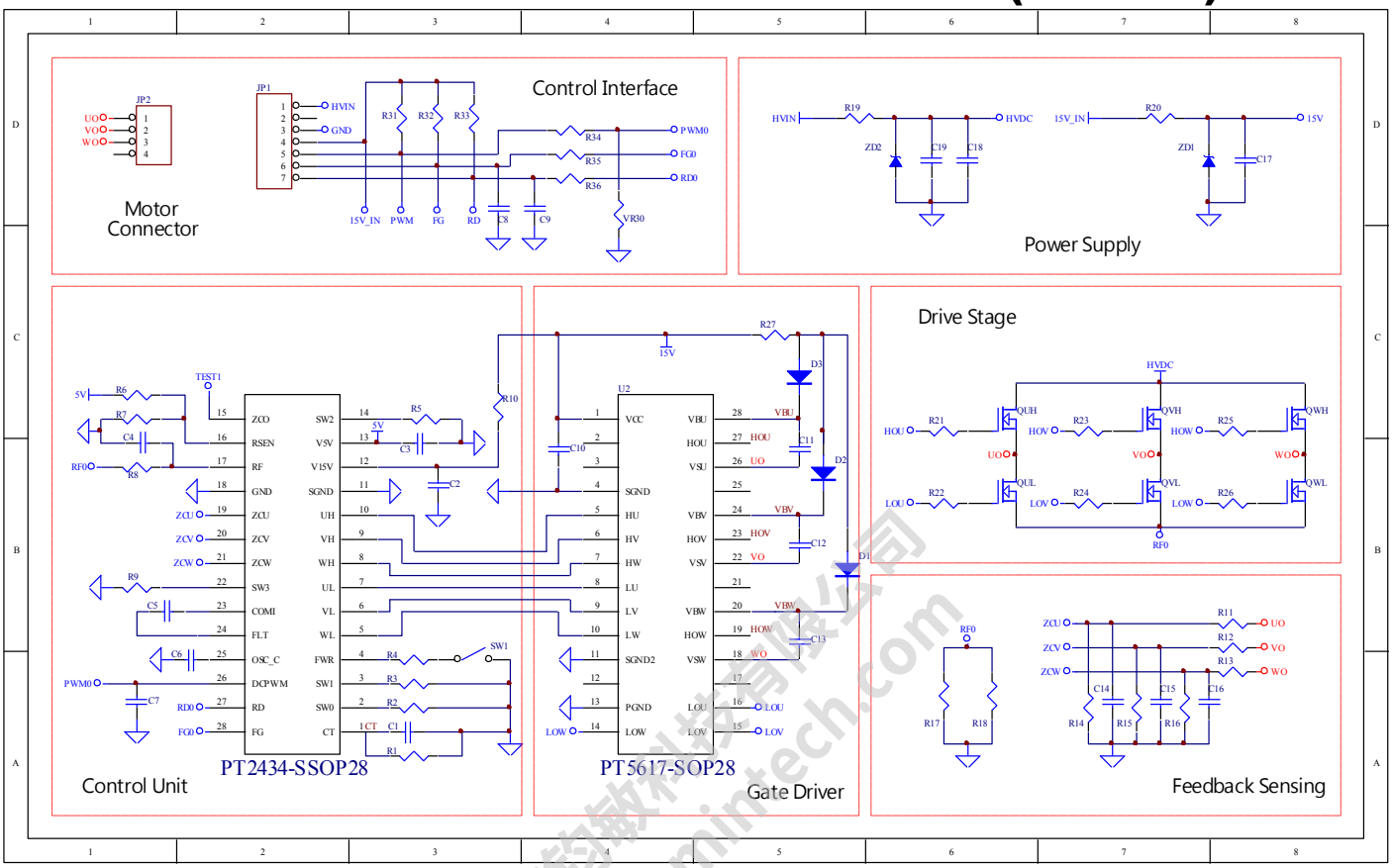
Parameter	Symbol	Min.	Max.	Unit
Supply Voltage Rage	V_{DD}	10	18	V
I/O Voltage	–	-0.3	5	V
Operating Temperature Range	T_A	-40	+85	°C
Storage Temperature Range	T_{STG}	-40	+150	°C

ELECTRICAL CHARACTERISTICS

Nominal conditions: V_{DD} = 15.0V, SGND=V_{SS}, T_A = +27°C.

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
General Characteristics						
Supply voltage	V_{DD}		11	15	18	V
Current consumption	I_{DD}	V_{DD}=15V	2.6	2.9	3.2	mA
Regulator output voltage	V_{REG}		4.5	5	5.5	V
Regulator output current	I_{REG}			20		mA
Parameters Setting						
Over temperature protection trigger voltage	V_{OTP}	RSEN pin		0.8		V
Over temperature protection release voltage	V_{REL}	RSEN pin		1.2		V
Over current protection voltage	V_{OCP}	RF pin		0.5		V
Charge current of lock protection	I_{LOCK}	CT pin		3.4		µA
Discharge current of lock release	I_{UNLOCK}	CT pin		1.7		µA
Lock Threshold	V_{LOCK}	CT pin		3		V
Startup oscillator	F_{OSC_1K}	OSC_C = 1nF		1		KHz
Startup oscillator range	F_{OSC_C}	OSC_C pin	0.1	-	10	KHz
ZC filter Capacitor	C_{FLT}	COMI, FLT pin	1	-	330	nF
Dead time	T_{dead}	SW0 = open SW1=open		2.8		µsec
		SW0 = low SW1=open		2.0		µsec
		SW0 = open SW1=low		1.2		µsec
		SW0 = low SW1=low		0.4		µsec
Operation Characteristics						
PWM switching frequency	Fsw			20		KHz
I/O Interface						
Logic output high level	V_{OH}	UVWL, UVWH	4.0	4.5	5.5	V
Logic output low level	V_{OL}	UVWL, UVWH		0	0.3	V
BEMF sensing input	V_{ZC}	ZCU, ZCV, ZCW			5.5	V
SW0, SW1, SW2, SW3, FWR pin pull high current	I_{SOURCE}	SW0, SW1, SW2, SW3, FWR		6		µA
FG, RD open drain sink voltage	V_{SINK}	I = 1mA		10		mV
DC/PWM internal pull high resistance	R_{DC}	DC pin, connect to V_{REG}		150		KΩ
DC for speed control input level	V_{DC}	DC input (DC pin)	0.6		3.3	V
PWM input high level	V_{PWMH}	PWM input (DC pin)	3.5			V
PWM input low level	V_{PWML}	PWM input (DC pin)			0.3	V
PWM input clock	F_{PWM_IN}	PWM input (DC pin)	15		25	KHz

APPLICATION EXAMPLE – HV MOTOR (< 400V)

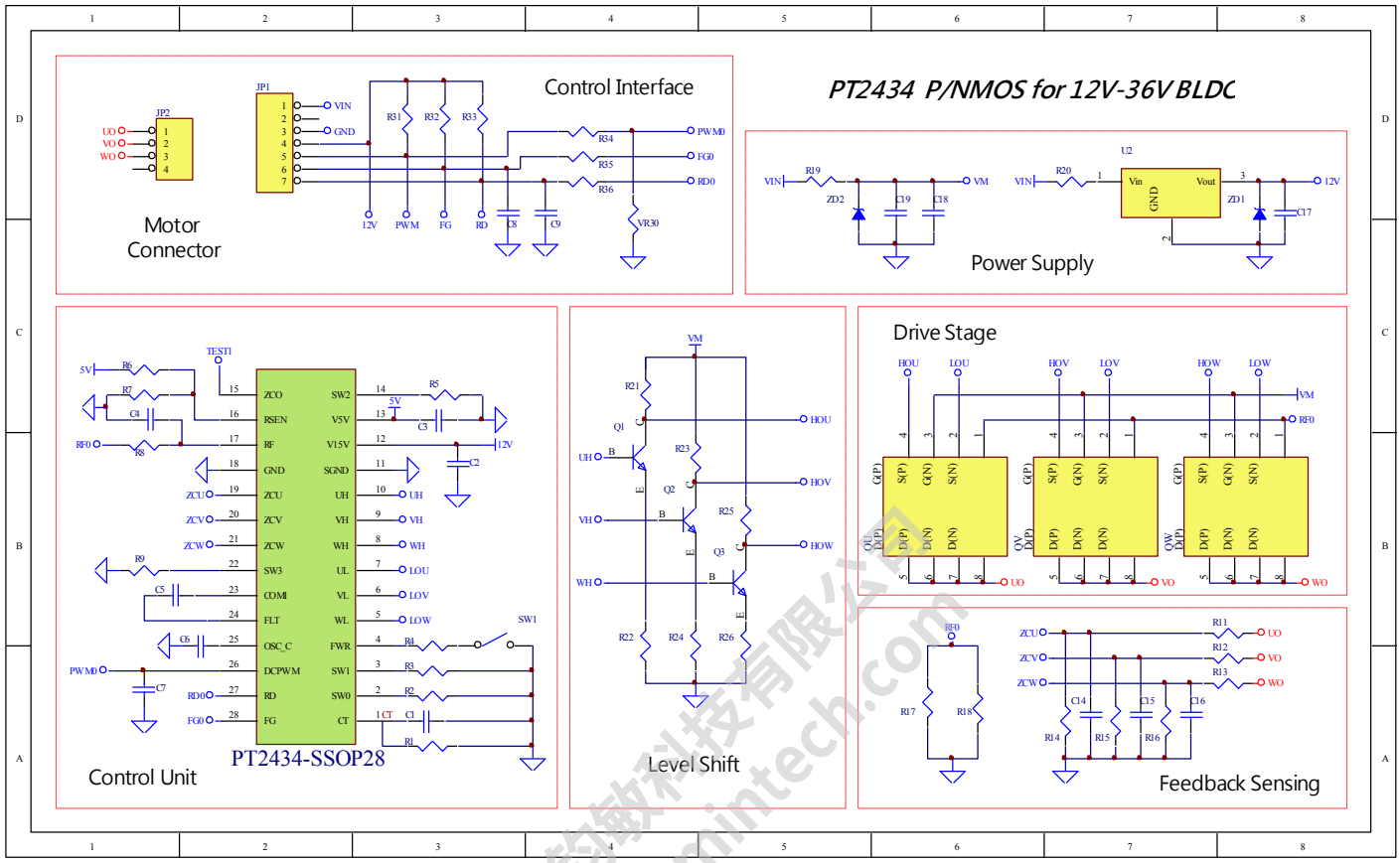


Designator	Part Type	Note
U1	PT2434-SSOP28	
U2	PT5617-SOP28	
R1	1M 5% 0603	R1=NC
R2, R3, R4, R5, R6	100K 5% 0603	R2=R3=NC
R7	NTC resistor 0603	R7=NC
R8	47K 5% 0603	
R9	100K 5% 0603	
R10	100R 5% 0603	
R11, R12, R13	560K 5% 0603	
R14, R15, R16	10K 5% 0603	
R17, R18,	3.3R 5% 1206	
R19	3.3R 5% 1206	
R20	10R 5% 0805	
R21, R23, R25	100R 5% 0603	
R22, R24, R26	100R 5% 0603	
R27	100R 5% 0603	
R31	100K 5% 0603	
R32, R33	100K 5% 0603	
R34, R35, R36	22K 5% 0603	

Designator	Part Type	Note
QUH, QVH, QWH	4N60 - TO252	600V NMOS
QUL, QVL, QWL	4N60 - TO252	600V NMOS
ZD1	Zener Diode 18V 1W	ZD1=NC
ZD2	TVS 400V 400W	
C1	2.2uF 10V 0603	
C2	100nF 25V 0805	
C3	1uF 10V 0603	
C4	330pF 10V 0603	
C5	33nF 10V 0603	
C6	1nF 10V 0603	
C7, C8, C9	100nF 10V 0603	
C10	1uF 25V 1206	
C11, C12, C13	1uF 25V 1206	
C14, C15, C16	1nF 10V 0603	NC
C17	4.7uF 50V 1210	
C18, C19	47nF 500V 1206	
JP1	7 pins connector	
JP2	4 pins connector	To Motor
SW1	SW SPST	CW/CCW
VR30	VR200K SIP3	Speed Control

Note: A part of components value is related to motor styles, operating voltage or applications, need to make appropriate adjustments.

APPLICATION EXAMPLE – 12V/24V/36V MOTOR



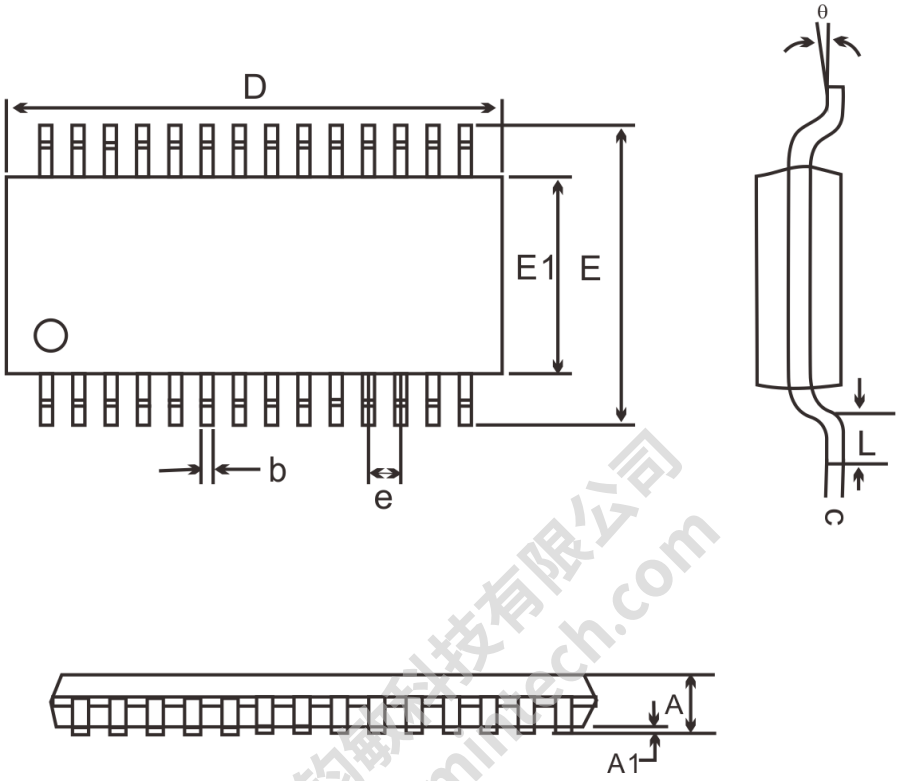
Designator	Part Type	Note
U1	PT2434-SSOP28	
U2	PT5617-SOP28	
R1	1M 5% 0603	R1=NC
R2, R3, R4, R5, R6	100K 5% 0603	R2=R3=NC
R7	NTC resistor 0603	R7=NC
R8	47K 5% 0603	
R9	100K 5% 0603	
R10	100R 5% 0603	
R11, R12, R13	560K 5% 0603	
R14, R15, R16	10K 5% 0603	
R17, R18, R19	0.5R 5% 1206	
R19	0.5R 5% 1206	
R20	10R 5% 0805	
R21, R23, R25	1K 5% 0603	
R22, R24, R26	1K 5% 0603	
R27	100R 5% 0603	
R31	100K 5% 0603	
R32, R33	100K 5% 0603	
R34, R35, R36	22K 5% 0603	

Designator	Part Type	Note
Q1, Q2, Q3	NPN-3904	
QU, QV, QW	SOP8_PN	60V MOS
ZD1	Zener Diode 18V 1W	ZD1=NC
ZD2	TVS 40V 400W	
C1	2.2uF 10V 0603	
C2	100nF 25V 0805	
C3	1uF 10V 0603	
C4	330pF 10V 0603	
C5	33nF 10V 0603	
C6	1nF 10V 0603	
C7, C8, C9	100nF 10V 0603	
C10	1uF 25V 1206	
C14, C15, C16	1nF 10V 0603	NC
C17	4.7uF 25V 1210	
C18, C19	4.7uF 50V 1210	C19=NC
JP1	7 pins connector	
JP2	4 pins connector	To Motor
SW1	SW SPST	CW/CCW
VR30	VR200K SIP3	Speed Control

Note: A part of components value is related to motor styles, operating voltage or applications, need to make appropriate adjustments.

PACKAGE INFORMATION

28 Pins, SSOP 150MIL



Symbol	Min.	Nom.	Max.
A	1.35	-	1.75
A1	0.10	-	0.25
b	0.20	-	0.30
c	0.10	-	0.25
D	9.80	9.90	10.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	0.635 BSC.		
L	0.40	-	1.27
θ	0°	-	8°

Notes:
1. Refer to JEDEC MO-137AF
2. Unit: mm

IMPORTANT NOTICE

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