Integrated Circuits

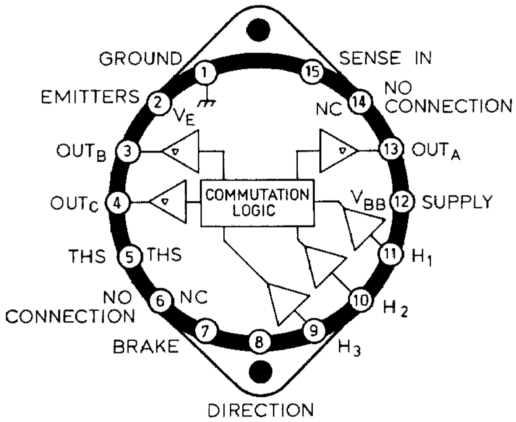
UDS2936V

MIL-STD-883 COMPLIANT

IECQ MFG. APPROVAL   DESC LINE CERTIFICATION

3-PHASE BRUSHLESS DC MOTOR CONTROLLER/DRIVER

UDS2936V



Dwg. PM-001

The UDS2936V combines logic and power to provide commutation and drive for a three-phase brushless dc motor. Each of the three push-pull outputs are rated at 45 V and ±2 A (±2.3 A peak), and have internal inductive-load transient suppression diodes. The driver also includes PWM current control and thermal shutdown protection. Reverse-bias burn-in and 100% high-reliability screening to MIL-STD-883, Class B are standard.

The UDS2936V is compatible with single-ended digital or linear Hall effect sensors and is programmed for 60° electrical separation (other separation sequences, such as 120°, are available). Current control is accomplished by sensing current through an external resistor and pulse-width modulating the source drivers. Voltage thresholds and hysteresis can be externally set by the user. If desired, internal threshold and hysteresis defaults (300 mV, 7.5%) can be used. Internal protection circuitry prevents crossover current when braking or changing direction. The UDS2936V differs from its commercial version (UDN2936W); the output emitters are separated from the current sensor input, thus allowing increased versatility in control techniques.

The UDS2936V is supplied in a 15-pin, flange-mount TO-3/TO-204 style hermetic package for improved power dissipation capabilities. An external heatsink is required for high-current applications. The flange is at ground potential and normally needs no isolation.

ABSOLUTE MAXIMUM RATINGS

Motor Supply Voltage, V_{BB} .... **45 V**
Output Current, I_{OUT} (300 ms) ...... **±2.3 A**
(Continuous) .... **±2.0 A**
Input Voltage Range,
V_{IN} .... **−0.3 V to +15 V***
Threshold Voltage, V_{THS} .... **15 V**
Package Power Dissipation,
P_D .... **See Graph**
Operating Temperature Range,
T_A .... **−55°C to +125°C**
Junction Temperature
T_J .... **+150°C†**
Storage Temperature Range,
T_S .... **−65°C to +150°C**

*V_{IN} must not exceed V_{BB}.

†Fault conditions which produce excessive junction temperature will activate device thermal shutdown circuitry. These conditions can be tolerated, but should be avoided.

Output current rating may be restricted to a value determined by system concerns and factors. These include: system duty cycle and timing, ambient temperature, and use of any heatsinking and/or forced cooling. For reliable operation the specified maximum junction temperature should not be exceeded.

FEATURES

- 10 V to 45 V Operation
- ±2 A Output Current
- Internal Clamp Diodes
- Internal PWM Current Control
- 60° Commutation Decoding Logic
- Internal Thermal Shutdown Circuitry
- Compatible with Digital, Open-Collector Hall Effect Sensors
- Braking and Direction Control
- Hermetically Sealed Package
- High-Reliability Screening

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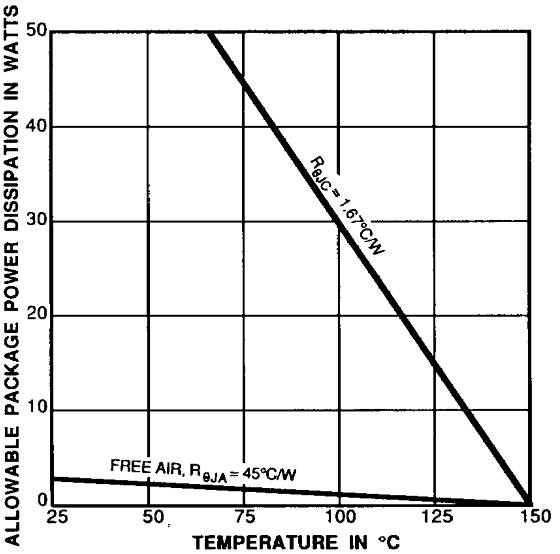

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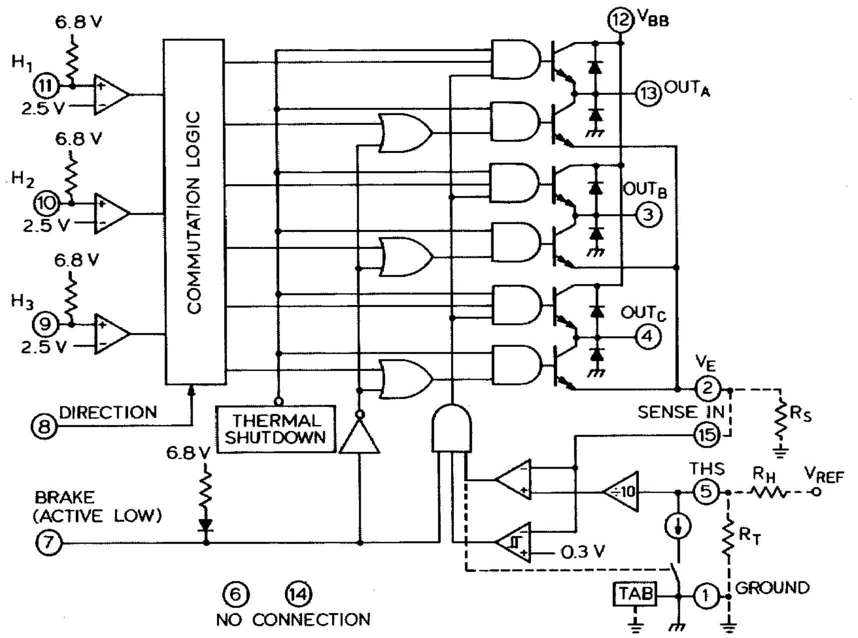
FUNCTIONAL BLOCK DIAGRAM



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COMMUTATION TRUTH TABLE

Hall Sensor Inputs					Outputs		
H_1	H_2	H_3	DIRECTION	BRAKE	OUT_A	OUT_B	OUT_C
High	High	High	Low	High	Z	Low	High
High	High	Low	Low	High	High	Low	Z
High	Low	Low	Low	High	High	Z	Low
Low	Low	Low	Low	High	Z	High	Low
Low	Low	High	Low	High	Low	High	Z
Low	High	High	Low	High	Low	Z	High
High	High	High	High	High	Z	High	Low
High	High	Low	High	High	Low	High	Z
High	Low	Low	High	High	Low	Z	High
Low	Low	Low	High	High	Z	Low	High
Low	Low	High	High	High	High	Low	Z
Low	High	High	High	High	High	Z	Low
X	X	X	X	Low	Low	Low	Low

X = Irrelevant
Z = High Impedance

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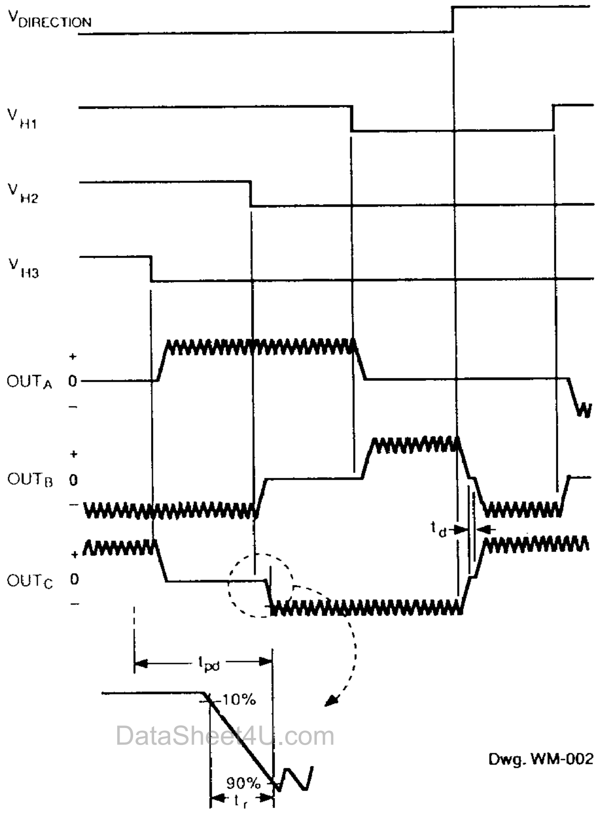
ELECTRICAL CHARACTERISTICS at T_A = -55°C to +125°C, V_{BB} = 45 V (unless otherwise noted)

Characteristic	Symbol	Test Conditions	Limits Min.	Typ.	Max.	Units
Supply Voltage Range	V_{BB}	Operating	10	–	45	V
Supply Current	I_{BB}	V_{BRAKE} = 2.0 V, Outputs Open	–	52	60	mA
		V_{BRAKE} = 0.8 V	–	54	60	mA
Output Drivers						
Output Leakage Current	I_{CEX}	V_{OUT} = V_{BB}, Output State = Z	–	<1.0	10	μA
		V_{OUT} = 0 V, Output State = Z	–	<−1.0	−10	μA
Output Saturation Voltage (T_A = −55° to +25°C)	$V_{CE(SAT)}$	Source Driver, I_{OUT} = −1.0 A	–	1.7	2.1	V
		Sink Driver, I_{OUT} = +1.0 A	–	1.1	1.4	V
		Source Driver, I_{OUT} = −2.0 A	–	1.9	2.3	V
		Sink Driver, I_{OUT} = +2.0 A	–	1.4	1.7	V
Output Saturation Voltage (T_A = +125°C)	$V_{CE(SAT)}$	Source Driver, I_{OUT} = −1.0 A	–	–	1.9	V
		Sink Driver, I_{OUT} = +1.0 A	–	–	1.2	V
		Source Driver, I_{OUT} = −2.0 A	–	–	2.1	V
		Sink Driver, I_{OUT} = +2.0 A	–	–	1.5	V
Output Sustaining Voltage	$V_{CE(sus)}$	I_{OUT} = ±2.0 A, L = 3.0 mH, T_A = +25°C	45	–	–	V
Output Switching Time (Resistive Load)	t_r	Source Driver, 0 to −2.0 A, 10% to 90%	–	1.25	–	μs
		Sink Driver, 0 to +2.0 A, 10% to 90%	–	1.9	–	μs
	t_f	Source Driver, −2.0 A to 0, 90% to 10%	–	1.7	–	μs
		Sink Driver, +2.0 A to 0, 90% to 10%	–	0.9	–	μs
Clamp Diode Leakage Current	I_R	V_R = 45 V	–	<1.0	10	μA
Clamp Diode Forward Voltage	V_F	I_F = 2.0 A, T_A = −55°C to +25°C	–	1.8	2.3	V
		I_F = 2.0 A, T_A = +125°C	–	–	2.5	V
Control Logic						
Logic Input Voltage	$V_{IN(1)}$	V_{DIR} or V_{BRAKE}	2.0	–	–	V
	$V_{IN(0)}$	V_{DIR} or V_{BRAKE}	–	–	0.8	V
Sensor Input Threshold	V_{IN}	H_1, H_2, or H_3	–	2.5	–	V
Input Current	$I_{IN(1)}$	V_{DIR} = 2.0 V	–	150	400	μA
		V_{BRAKE} = 2.0 V	–	<1.0	5.0	μA
		V_H = 5.0 V	–	−190	−220	μA
	$I_{IN(0)}$	V_{DIR} = 0.8 V	–	35	100	μA
		V_{BRAKE} = 0.8 V	–	−5.0	−20	μA
		V_H = 0.8 V	–	−640	−1000	μA
	I_{THS}	V_{THS} ≥ 3.0 V	–	−8.0	−15	μA
		V_{THS} <3.0 V, V_{SENSE} < V_{THS}/10.5	–	−15	−30	μA
		V_{THS} <3.0 V, V_{SENSE} < V_{THS}/9.5	190	250	310	μA
Current Limit Threshold		V_{THS}/V_{SENSE} at trip point, V_{THS}<3.0 V	9.5	10	10.5	–
Default Sense Trip Voltage	V_{SENSE}	V_{THS}≥3.0 V	270	300	330	mV
Default Hysteresis		V_{THS}≥3.0 V	–	7.5	–	%
Propagation Delay Time	t_{pd}	I_{OUT} = ±2.0 A, 50% V_H to 90% I_{OUT}	–	2.0	8.0	μs
Deadtime	t_d	BRAKE or DIRECTION	–	2.0	–	μs
Thermal Shutdown Temp.	T_J		–	165	–	°C
Thermal Shutdown Hysteresis	ΔT_J		–	25	–	°C

Typical Data is for design information only and is at T_A = +25°C.



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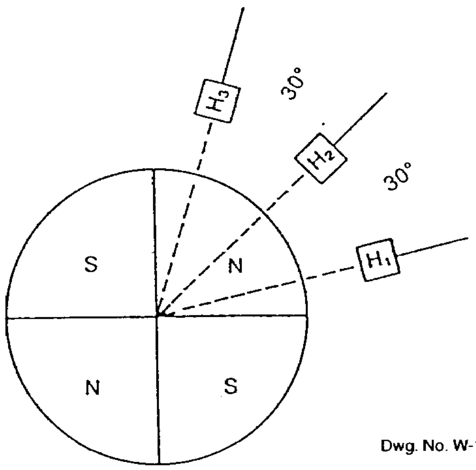
TYPICAL HALL EFFECT SENSOR LOCATIONS



Dwg. No. W-193

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APPLICATIONS INFORMATION

The UDS2936V power driver provides commutation logic and power outputs to drive a three-phase brushless dc motor.

It is designed to interface with single-ended linear or digital Hall effect devices (HEDs). Internal pull-up resistors on the inputs allow for direct use with open-collector digital HEDs. The H_N inputs have 2.5 V thresholds.

The commutation logic provides decoding for HEDs with 60° electrical separation (120° separation is also available). At any one step in the sequencing, one half-bridge driver is sourcing, one driver is sinking, and one driver is in a high-impedance state (see truth table). Changing the logic level of the DIRECTION input inverts the output states, thus reversing the direction of the load current and the motor. A logic low on the BRAKE input turns ON all three sink drivers and turns OFF all source drivers, dynamically braking the motor. An internally generated deadtime (t_d) of approximately 2 μs prevents potentially destructive crossover currents that can occur when changing direction or braking. Circuit design consideration and care should preclude exceeding the specified peak current rating during braking or directional change, especially in applications involving high inertial loads and/or higher motor supply voltage operation.

Motor current is internally controlled by pulse-width modulating the source drivers with a preset hysteresis format. Load current through an external sense resistor (R_S) is constantly monitored. When the current reaches the set trip point (determined by an external reference voltage or internal default), the source driver is disabled. The actual load current will peak slightly higher because of the internal logic and switching delays. Current recirculates through the ground clamp diode, motor winding, and sink driver. An internal constant-current sink reduces the trip current (hysteresis). When the decaying current reaches this lower threshold, the source driver is enabled again and the cycle repeats.

Thresholds and hysteresis can be set with external resistors or internal defaults can be used. With $V_{THS} < 3.0$ V, the trip point is internally set at 300 mV with 7.5% hysteresis. Load trip current is then determined by the equation:

$$I_{TRIP} = 0.3/R_S$$

With $V_{THS} < 3.0$ V, the threshold, hysteresis percentage, and load trip current are set with external resistors according to the equations:

$$\text{Threshold Voltage } (V_{THS}) = \frac{V_{REF} \cdot R_T}{R_H + R_T}$$

$$\text{Hysteresis Percentage} = \frac{R_H}{50 \cdot V_{REF}}$$

$$\text{Load Trip Current } (I_{TRIP}) = \frac{V_{THS}}{10\ R_S}$$

Percentage hysteresis is a fixed value independent of load current. The PWM frequency is a function of circuit parameters including load inductance, load resistance, supply voltage, hysteresis, and switching speed of the drivers.

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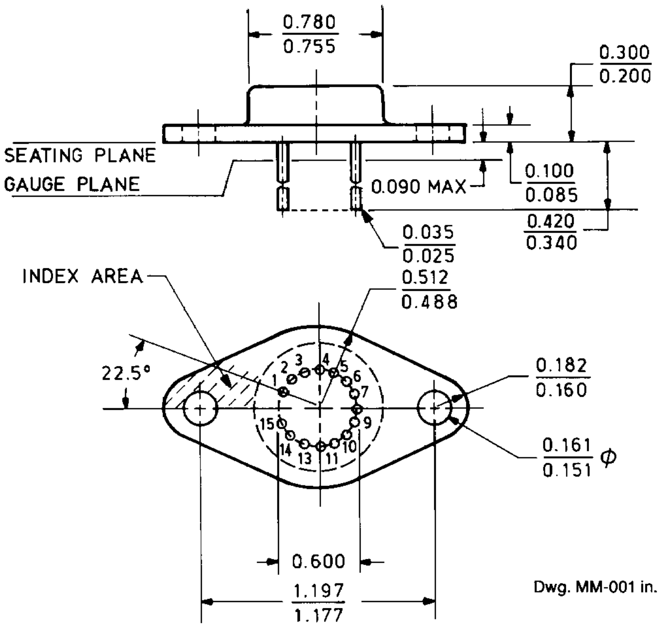
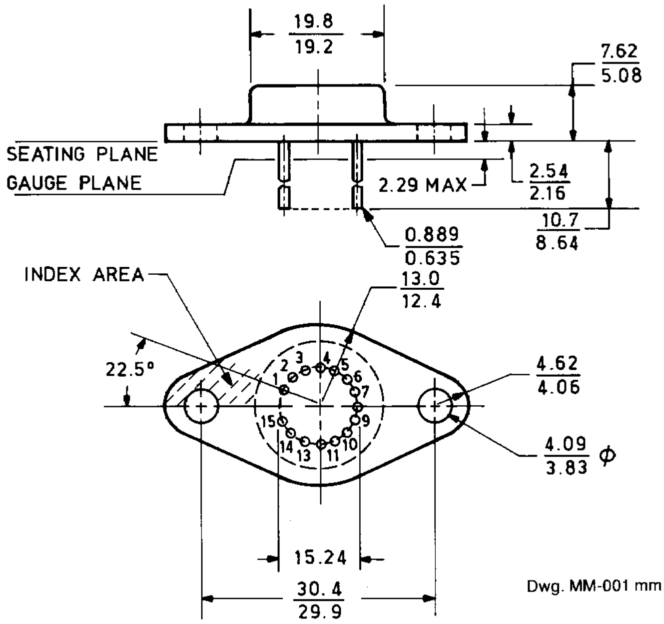
DIMENSIONS IN INCHES



DIMENSIONS IN MILLIMETERS (Based on 1" = 25.4 mm)



These devices are marked to indicate compliance to the latest issue of MIL-STD-883. For example: UDS2936V-883.

NOTES:
1. Lead spacing tolerance is non-cumulative.
2. Exact body and lead configuration at vendor's option within limits shown.
3. Leads missing from their designated positions shall also be counted when numbering leads.

MOUNTING OF FLANGE-MOUNT POWER DEVICES

Flange-mount packages are efficient thermal dissipators when properly utilized. In application, the following precautions should be taken:

1. Strain relief must be provided if there is any possibility of stress to the leads.
2. Thermal grease (Dow Corning 340 or equivalent) should always be used. Thermal compounds are better heat conductors than air but not a good substitute for flat mating surfaces.
3. The mounting surface should be flat to within 0.002 inch/inch (0.05 mm/mm).
4. "Brute force" mounting to poorly finished heat sinks can cause stresses which may damage the internal silicon chip.
5. Mounting holes should be clean of burrs and ridges.
6. Use appropriate hardware including lock washers or torque washers.

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