

**INTERIM DATA SHEET**

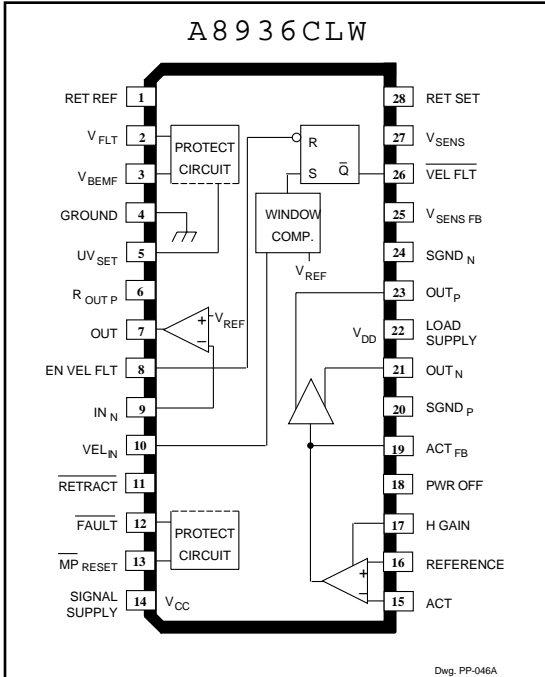
(Subject to change without notice)

March 16, 1993

# 8936

Data Sheet  
26300.6

## VOICE COIL MOTOR DRIVER



Dwg. PP-046A

**ABSOLUTE MAXIMUM RATINGS**

Supply Voltages, $V_{CC}$ and $V_{DD}$ .....	<b>6.0 V</b>
Output Current, $I_{OUT}$ (peak) .....	<b><math>\pm 600</math> mA</b>
(continuous) .....	<b><math>\pm 500</math> mA</b>
Analog Input Voltage Range,	
$V_{IN}$ .....	<b>-0.3 V to <math>V_{CC}</math></b>
Logic Input Voltage Range,	
$V_{IN}$ .....	<b>-0.3 V to +6.0 V</b>
Package Power Dissipation,	
$P_D$ .....	<b>See Graph</b>
Operating Temperature Range,	
$T_A$ .....	<b>0°C to +70°C</b>
Junction Temperature, $T_J$ .....	<b>+150°C†</b>
Storage Temperature Range,	
$T_S$ .....	<b>-55°C to +150°C</b>

† Fault conditions that 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.

Providing control and drive of the voice coil motor used for head positioning in 5 V disk drive applications, the A8936C— is a full-bridge driver which can be configured so that its output current is a direct function of an externally applied control voltage or current. This linear current control function is supplemented by additional circuitry to protect the heads and the data disk during system failure or normal system shutdown. An under- or over-velocity sense disables the system in a controlled sequence if a fault condition occurs.

The two  $\pm 500$  mA MOS driver outputs provide very low saturation voltage and minimal power dissipation. Additional headroom is achieved by the sense-FET structure eliminating the need for an external current-sense resistor. Thermal protection and under-voltage lockout disables the system in a controlled sequence if a fault condition occurs.

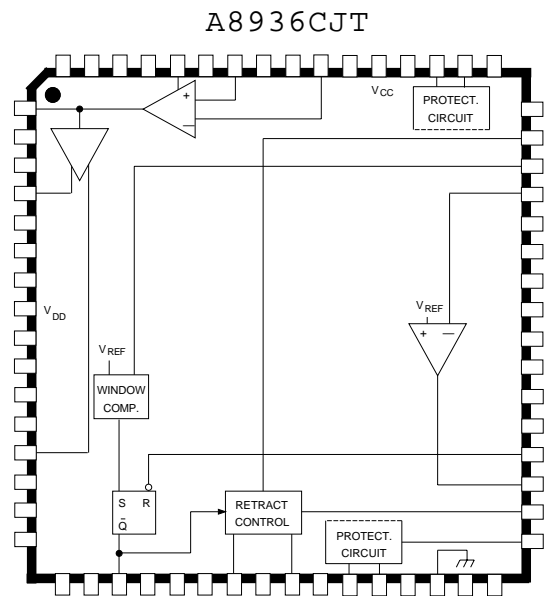
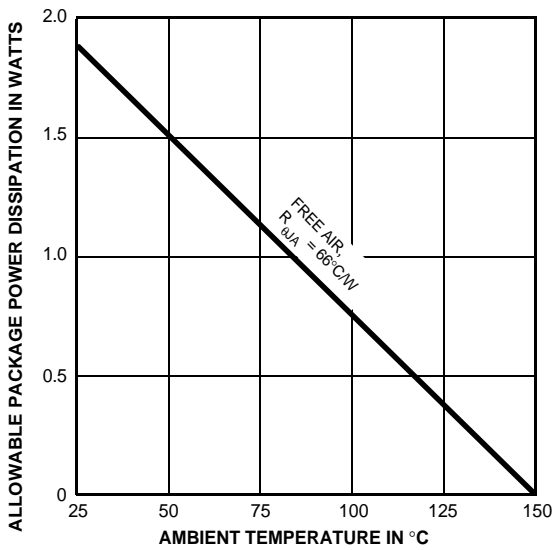
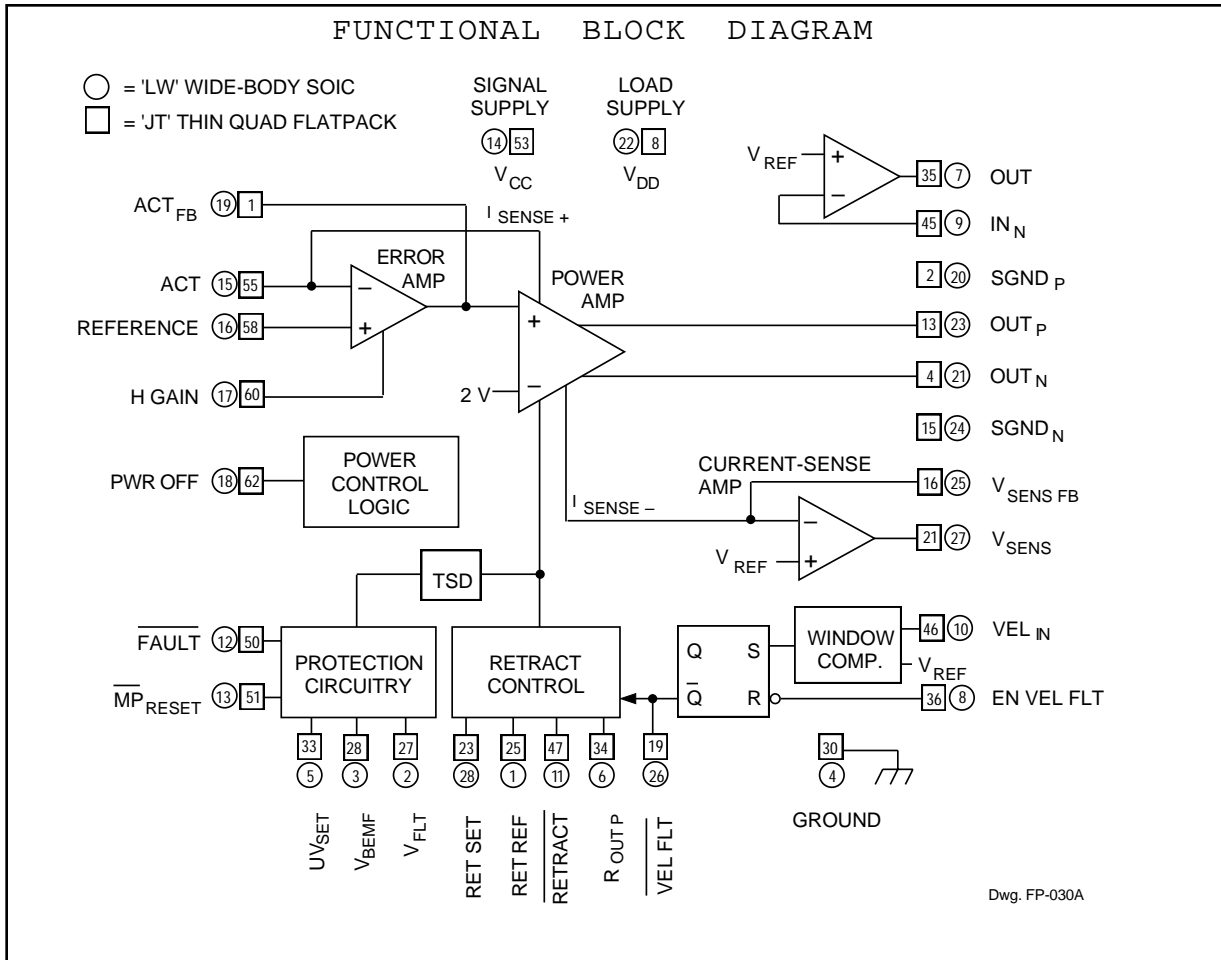
**FEATURES**

- Over-Velocity Fault Function
- Lossless Current Sensing
- Zero Deadband
- High Transconductance Bandwidth
- User-Adjustable Transconductance Gain
- Digital Transconductance Gain Switch (4:1 Ratio)
- 5 Volt Monitor with Selectable UV Trip Point
- Retract Circuitry Functional to 0 Volts
- Chip Enable/Sleep Mode Function
- 1 V at 500 mA Output Saturation Voltage
- Internal Thermal Shutdown Circuitry

Always order by complete part number:

Part Number	Package
<b>A8936CJT</b>	<b>64-Lead Thin Quad Flatpack</b>
<b>A8936CLW</b>	<b>28-Lead SOIC</b>

# 8936 VOICE COIL MOTOR DRIVER



ELECTRICAL CHARACTERISTICS at  $T_A = +25^\circ\text{C}$ ,  $V_{CC} = V_{DD} = 5.0\text{ V}$ ,  $V_{REF} = V_{IN} = 2.0\text{ V}$ , Load =  $150\ \mu\text{H}/3.5\ \Omega$  (unless otherwise noted).

Characteristic	Symbol	Test Conditions	Limits			
			Min.	Typ.	Max.	Units
<b>Error Amplifier</b>						
Input Offset Voltage	$V_{IO}$	$I_{LOAD} = 0\text{ mA}$	—	—	50	mV
Current Gain	$A_{iH}$	H GAIN $\geq 3.5\text{ V}$	7200	8000	8800	—
	$A_{iL}$	H GAIN $\leq 0.7\text{ V}$	1800	2000	2200	—
Current Gain Linearity	$E_{L(adj)}$	$I_{OUT} = 5\text{ mA to }500\text{ mA}, A_i = A_{iL}$	—	—	$\pm 10$	%
		$I_{OUT} = 5\text{ mA to }500\text{ mA}, A_i = A_{iH}$	—	—	$\pm 10$	%
Reference Voltage Range	$V_{REF}$		1.5	—	2.5	V
<b>Current-Sense Amplifier</b>						
Voltage Gain	$A_{VD}$	$R_s = R_{gm}$	—	1.0	—	—
Input Offset Voltage	$V_{IO}$	$I_{LOAD} = 0\text{ mA}, A_i = A_{iL}$	—	—	$\pm 25$	mV
<b>Output Drivers</b>						
Output Saturation Voltage (Source + Sink)	$V_{DS(SAT)}$	$I_{LOAD} = 100\text{ mA}$	—	0.25	—	V
		$I_{LOAD} = 500\text{ mA}$	—	1.5	—	V
Retract Output Saturation Voltage	$V_{DS(SAT)}$	$I_{OUT} \leq 150\text{ mA}$	—	—	1.0	V
Output Current	$I_O$	Pulse Test, $\pm 600\text{ mA}$ Limited	—	—	$\pm 500$	mA
Full Power Bandwidth	BW	-3 dB	1.0	—	—	kHz
<b>Window Comparator</b>						
Lower Trip Point	$VEL_{IN}$		1.12	1.25	1.38	V
Upper Trip Point	$VEL_{IN}$		2.47	2.75	3.03	V
<b>Uncommitted Op Amp</b>						
Voltage Gain	$A_{VS}$		—	91	—	dB
Unity Gain Bandwidth	BW		—	1.0	—	MHz
Max. Load Capacitance	$C_{LOAD}$		40	—	—	pF
Slew Rate	SR		—	4.2	—	V/ $\mu\text{s}$
Output Voltage	$V_O$	$V_{IO} = 100\text{ mV}$	2.5	—	3.5	V
Max. Output Current	$I_O$		—	$\pm 250$	—	$\mu\text{A}$
Input Offset Voltage	$V_{IO}$		—	—	$\pm 10$	mV

Continued next page ...

Negative current is defined as coming out of (sourcing) the specified device terminal.  
Typical Data is for design information only.

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Load =  $150\ \mu\text{H}/3.5\ \Omega$  (unless otherwise noted).

Characteristic	Symbol	Test Conditions	Limits			Units
			Min.	Typ.	Max.	
<b>Miscellaneous</b>						
Under-Voltage Lockout Voltage	$V_{CC}$	$V_{CC} = V_{DD}$	3.9	4.2	4.35	V
Fault Logic Output	$V_{FAULT}$	$V_{RETRACT} \geq 3.5\text{ V}$	—	—	500	mV
		$V_{RETRACT} \leq 0.7\text{ V}$	4.5	—	—	V
	$I_{FAULT}$	$V_{FLT} = 2.25\text{ V}$	20	—	—	$\mu\text{A}$
Power-On Reset	$V_{MPRESET}$	$V_{RETRACT} \geq 3.5\text{ V}$	4.5	—	—	V
		$V_{RETRACT} \leq 0.7\text{ V}$ , $I_{MPRESET} = 1.5\text{ mA}$	—	—	800	mV
Total Supply Current	$I_{CC} + I_{DD}$	Outputs Balanced, No Load	—	—	10	mA
		Sleep Mode, PWR OFF = $V_{CC}$	—	—	2.0	mA
Logic Input Voltage	$V_{IN(0)}$		—	—	0.7	V
	$V_{IN(1)}$		3.5	—	—	V
Thermal Shutdown Temperature	$T_J$		—	165	—	$^\circ\text{C}$
Thermal Shutdown Hysteresis	$\Delta T_J$		—	20	—	$^\circ\text{C}$

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Typical Data is for design information only.



## TERMINAL FUNCTIONS

"JT" Term.	"LW" Term.	Term. Name	Function
25	1	RET REF	The reference supply for setting the voltage across the load during retract.
27	2	V <sub>FLT</sub>	Reservoir (energy storage) capacitor used to operate fault circuitry.
28	3	V <sub>BEMF</sub>	Back-EMF voltage from spindle motor used to retract heads during loss of power.
30	4	GROUND	Circuit reference.
33	5	UV <sub>SET</sub>	Under-voltage trip point reference input. Set internally to 4.3 V but may be over-ridden by external resistor divider. (Equation 4).
34	6	R <sub>OUT P</sub>	Source driver used for retract; externally connected to OUT <sub>P</sub> .
35	7	OUT	Output of uncommitted operational amplifier.
36	8	EN VEL FLT	Logic input for over-velocity fault latch.
45	9	IN <sub>N</sub>	Inverting input to uncommitted operational amplifier.
46	10	VEL <sub>IN</sub>	Analog voltage input corresponding to motor speed.
47	11	RETRACT	An active-low logic input that initiates the retract sequence.
50	12	FAULT	A logic low at this MOS output indicates a thermal shutdown, under-voltage fault, or retract command.
51	13	MP <sub>RESET</sub>	(Power-On Reset) A logic low at this open-collector output may be used to reset the system on under-voltage fault or power ON.
53	14	SIGNAL SUPPLY	V <sub>CC</sub> ; low-current supply voltage in the range of 4.5 V to 5.5 V.
55	15	ACT	Input which controls the current in the load. Transconductance gain is set with an external resistor in series with this input (Equation 1).
58	16	REFERENCE	V <sub>REF</sub> ; reference input for all amplifiers; ac ground.
60	17	H GAIN	Logic input to switch the error amplifier transconductance gain: LOW = 2100, HIGH = 8400.
62	18	PWR OFF	An active-high logic input that puts the device in a "sleep mode". All fault circuitry remains active.
1	19	ACT <sub>FB</sub>	Input connection for feedback network which sets the error amplifier gain and bandwidth.
2	20	SGND <sub>P</sub>	Power ground for the OUT <sub>P</sub> sink driver.
4	21	OUT <sub>N</sub>	Power output. Sinks current when V <sub>ACT</sub> < V <sub>REF</sub> .
8	22	LOAD SUPPLY	V <sub>DD</sub> ; high-current supply voltage for the voice-coil motor.
13	23	OUT <sub>P</sub>	Power output. Sinks current when V <sub>ACT</sub> > V <sub>REF</sub> .
15	24	SGND <sub>N</sub>	Power ground for the OUT <sub>N</sub> sink driver.
16	25	V <sub>SENS FB</sub>	Input connection for feedback network which sets the current-sense amplifier gain and bandwidth. Also called gm SET.
19	26	VEL FLT	An active-low logic output indicating an over-velocity fault.
21	27	V <sub>SENS</sub>	Voltage output representing load current (Equation 2). Also called MONITOR.
23	28	RET SET	An external resistor divider to set the retract voltage across the load. Used in conjunction with V <sub>RET-REF</sub> (Equation 3).

DEVICE DESCRIPTION

**Current Amplifier.** The A8936CJT and A8936CLW voice coil motor drivers feature a wide transconductance bandwidth and no measurable crossover distortion. The transconductance gain is user selectable:

$$g_m = \frac{A_i}{R_{gm}} \quad (\text{Equation 1})$$

where  $A_i$  is either 2000 (H GAIN = Low) or 8000 (H GAIN = High)

The error amplifier's bandwidth and load compensation zero are set utilizing external resistor and capacitor feedback components around the amplifier.

The actuator main loop compensation can be set by applying a square wave and adjusting  $R_z$  and  $C_z$  for optimum response.

**Current and Voltage Sensing.** The load current is sensed internally. Two auxiliary amplifiers are also included to allow various control functions to be implemented. The first of these amplifiers provides a voltage output that is proportional to the load current:

$$V_{SENS} = \frac{R_s I_{LOAD}}{A_{IL}} \quad (\text{Equation 2})$$

The second auxiliary amplifier may be used in conjunction with the first to provide a closed-loop velocity control system for the actuator arm during a controlled retract for head parking.

**Under- & Over-Velocity Fault.** For a constant load, motor current ( $I_{LOAD}$ ) and therefore  $V_{SENS}$  are proportional to motor velocity.  $V_{SENS}$  is amplified by the uncommitted amplifier and compared against the internal 2 V reference and used to indicate a velocity fault if the voltage is greater than a nominal  $\pm 0.75$  V from the 2 V reference. EN VEL FLT may be tied to the FAULT terminal to reset the velocity fault after a tripout.

**Retract and Brake.** A retract-brake sequence is initiated on receiving a fault indication from the internal thermal shutdown (TSD), under-voltage lockout (UVLO), the under- or over-velocity fault, or an externally applied logic High at the RETRACT input.

If the velocity control scheme is implemented, the head can be retracted under the full control of INPUT in conjunction with  $OUT_{SW}$  back-EMF voltage if no fault condition exists. If a fault condition were to occur however, the retract velocity would be controlled by applying a constant user-defined voltage across the load:

$$V_{RET-SET} = \frac{2 R_8}{1000 + R_7 + R_8} \quad (\text{Equation 3})$$

where  $R_7 + R_8 \gg 1000 \Omega$ .

When the sequence is operated, the output voltage is forced to approximately  $V_{RET-SET}$  to retract the heads, and then a fault command ("brake") is sent to the spindle-motor driver. The user determines the total time for the retract sequence, before the spindle brake is enabled, by the choice of an external resistor and capacitor at the FAULT output.

Power for the retract function is provided by the rectified back EMF of the spindle motor by way of the  $V_{BEMF}$  terminal. The A8936CJT/CLW will perform the retract function under low supply conditions (nominally down to 2 V). Operation down to almost 0 V requires an energy-storage capacitor at the  $V_{FLT}$  terminal.

**Protective Features.** The A8936CJT/CLW has a number of protective features incorporated into the design. Under-voltage lockout provides system protection in the event of reduced primary supply voltages. The under-voltage trip point is internally set at approximately 4.3 V. It can be user-defined with an external resistor voltage divider:

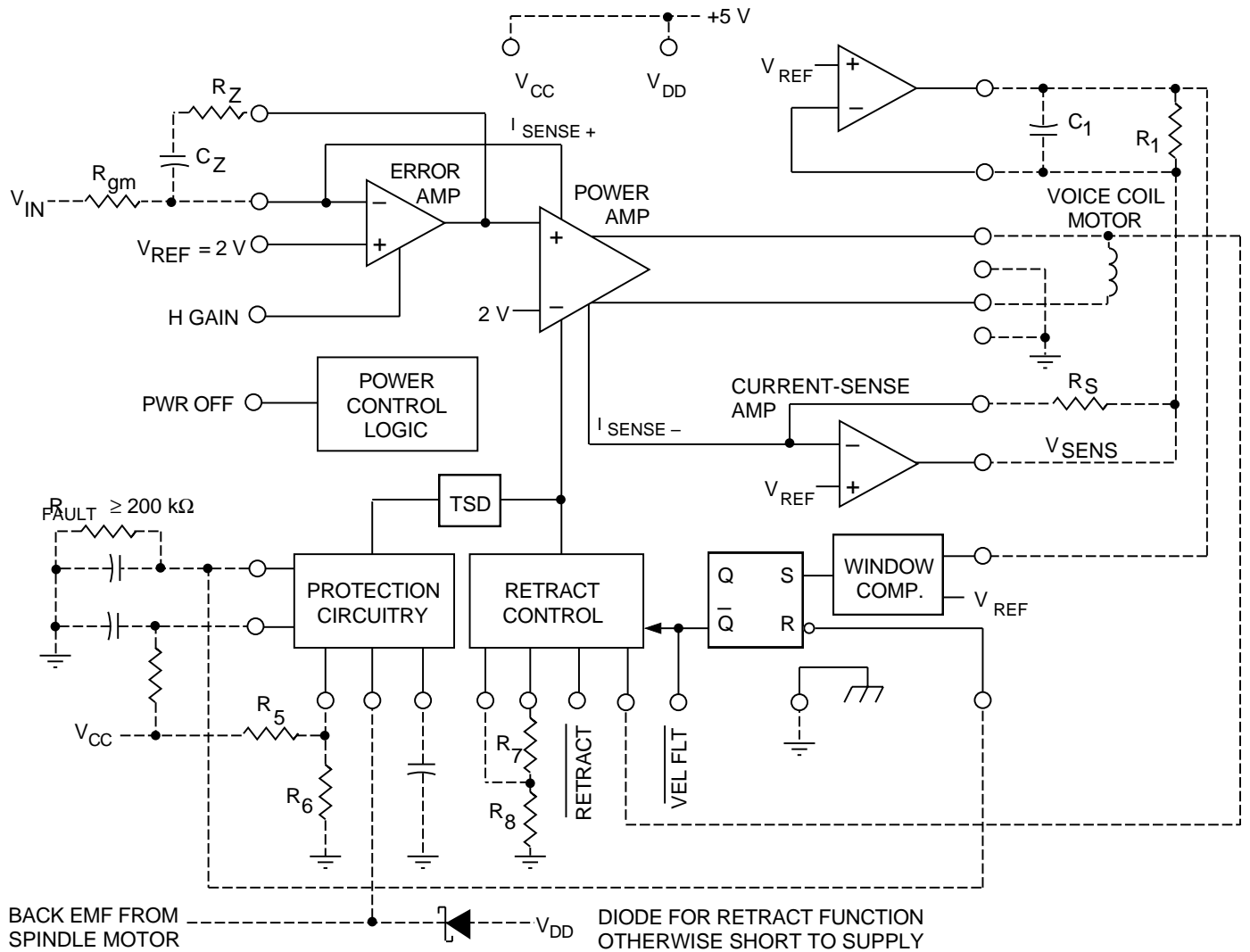
$$UV_{TRIP} = \frac{2 (R_5 + R_6)}{R_6} \quad (\text{Equation 4})$$

where  $R_5 + R_6 \ll 200 \text{ k}\Omega$ .

Thermal shutdown circuitry is included to protect the device from excessive junction temperature. It is only intended to protect the chip from catastrophic failures due to excessive junction temperature.

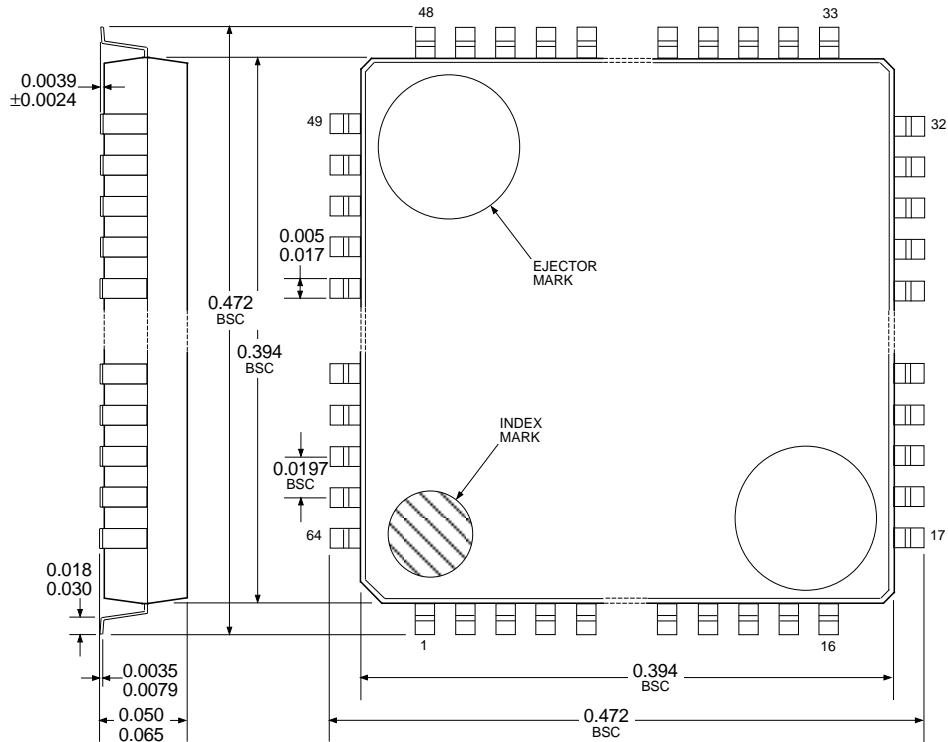
# 8936 VOICE COIL MOTOR DRIVER

## TEST CIRCUIT AND TYPICAL APPLICATION



8936  
VOICE COIL MOTOR DRIVER

A8936CJT  
Dimensions in Inches  
(Based on 1 mm = 0.03937")



Dwg. MA-004 in

- NOTES:
1. This device is similar to JEDEC registration MO-136BJ except for certain tolerances. Contact factory for detailed information.
  2. Lead spacing tolerance is non-cumulative.
  3. Exact body and lead configuration at vendor's option within limits shown.
  4. The top package body size may be smaller than the bottom package body size by as much as 0.006". Body dimensions include mold mismatch but do not include mold protrusion.

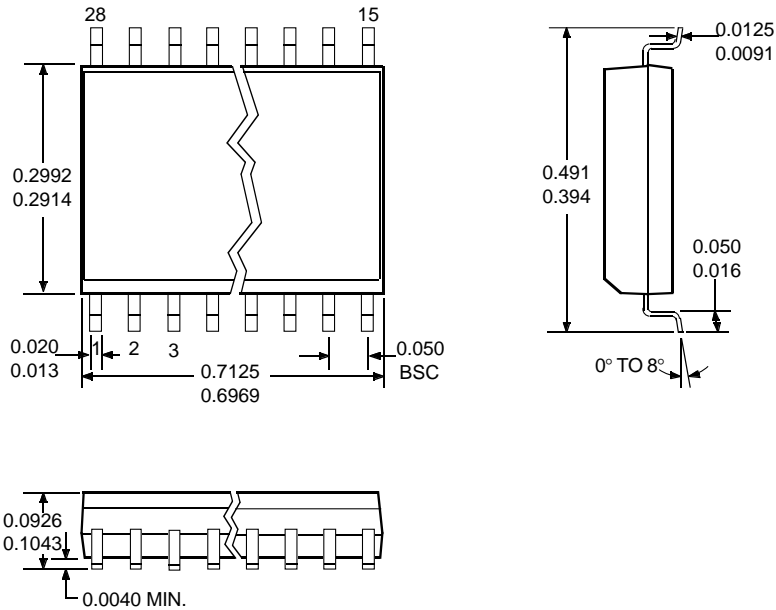




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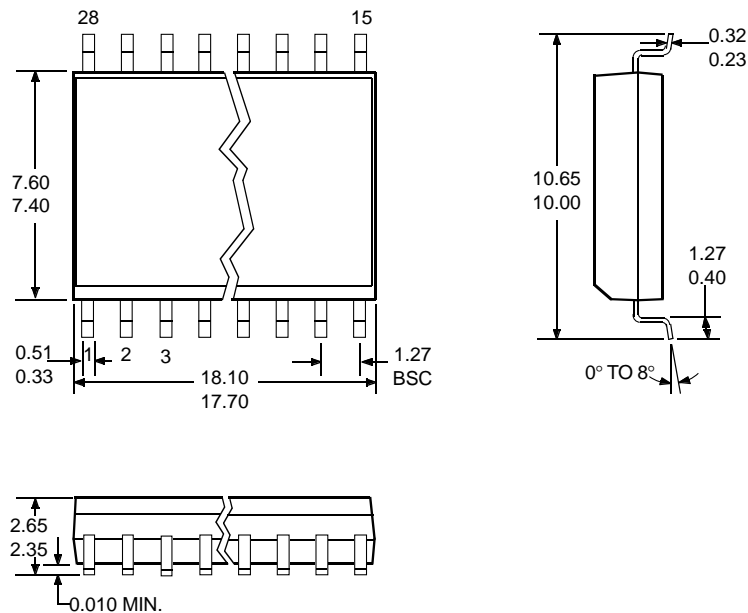
## A8936CLW

DIMENSIONS IN INCHES  
(Based on 1 mm = 0.03937")



Dwg. MA-008-28 in

DIMENSIONS IN MILLIMETERS



Dwg. MA-008-28 mm

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- NOTES: 1. Lead spacing tolerance is non-cumulative.  
2. Exact body and lead configuration at vendor's option within limits shown.



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