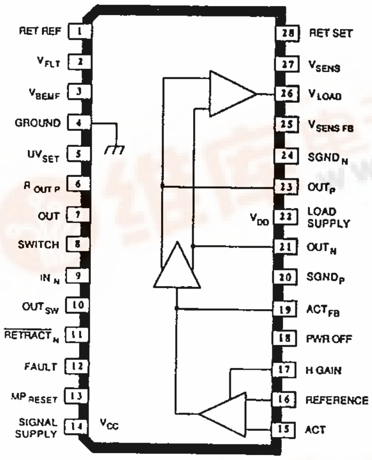
8932

T-52-13-25

VOICE COIL MOTOR DRIVER



Dwg. PP-042

ABSOLUTE MAXIMUM RATINGS

Supply Voltages, V_{CC} and V_{DD} .... 6.0 V

Output Current, I_{OUT} (peak) .... ±600 mA

(continuous) .... ±400 mA

Analog Input Voltage Range,

V_{IN} .... -0.3 V to V_{CC}

Logic Input Voltage Range,

V_{IN} .... -0.3 V to +6.0 V

Package Power Dissipation,

P_D .... See Graph

Operating Temperature Range,

T_A .... 0°C to +70°C

Junction Temperature, T_J .... +150°C†

Storage Temperature Range,

T_S .... -55°C to +150°C

† 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 A8932CLW 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.

The two ±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. Internal circuitry can be configured to provide closed-loop velocity control of the actuator by utilizing the generated back-EMF of the voice coil motor. Thermal protection and under-voltage lockout disables the system in a controlled sequence if a fault condition occurs.

The A8932CLW is supplied in a 28-lead SOIC for surface-mount applications.

FEATURES

- Internal Back-EMF Velocity Loop Option
- 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: **A8932CLW** .

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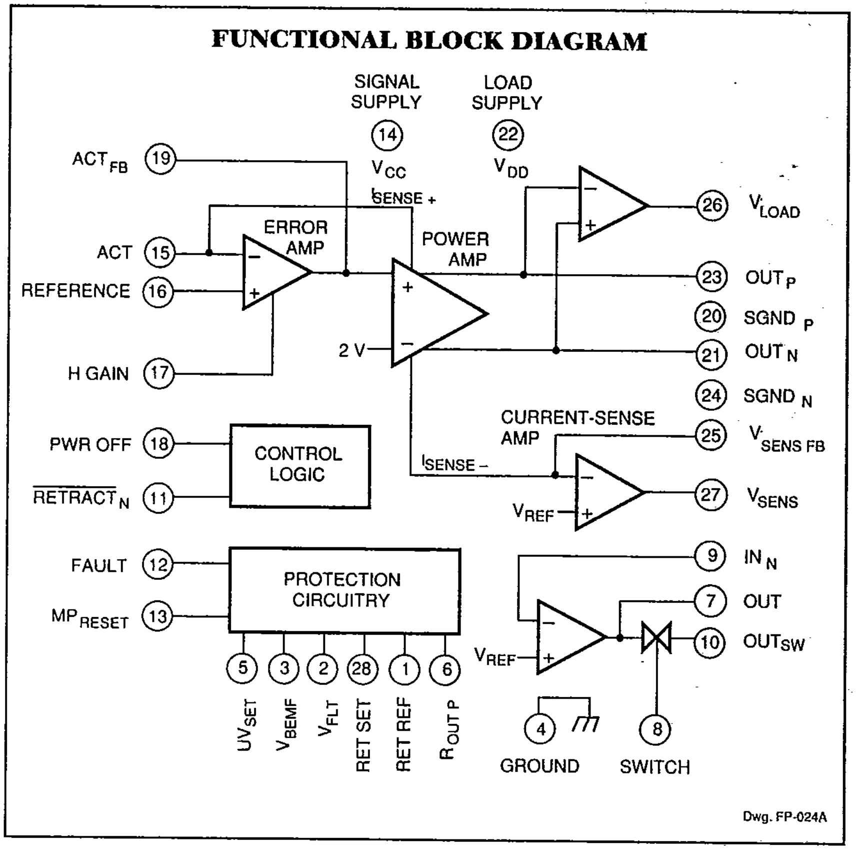

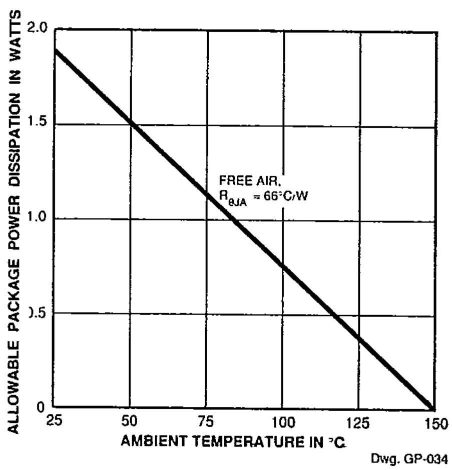

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ELECTRICAL CHARACTERISTICS at T_A = +25°C, V_{CC} = V_{DD} = 4.5 V to 5.5 V, V_{REF} = 2.0 V (unless otherwise noted).

Characteristic	Symbol	Test Conditions	Limits Min.	Typ.	Max.	Units
Input Bias Current	I_{IB}		—	500	—	nA
Input Offset Voltage	V_{IO}		—	5.0	—	mV
Input Resistance	R_{IN}		—	100	—	Ω
Current Gain	A_i	H GAIN ≥ $V_{CC}/2$	—	6240	—	—
		H GAIN ≤ $V_{CC}/2$	—	1560	—	—
Reference Voltage Range	V_{REF}		0.5	—	3.0	V
Power Supply Rejection Ratio	k_{SVR}		—	60	—	dB
Output Saturation Voltage (Source + Sink)	$V_{DS(SAT)}$	I_{LOAD} = 100 mA	—	0.2	—	V
		I_{LOAD} = 500 mA	—	1.0	—	V
Retract Output Voltage	$V_{DS(SAT)}$	I_{OUT} ≤ 150 mA	—	0.5	—	V
Output Current	I_{OM}	Pulse Test, ±600 mA Limited	—	—	±500	mA
Gain Bandwidth	BW	-3 dB	—	100	—	kHz
Miscellaneous						
Under-Voltage Lockout Voltage	V_{CC}		4.24	4.30	4.38	V
Supply Current	I_{CC}	Outputs Balanced, No Load	—	—	10	mA
Logic Input Voltage	$V_{IN(0)}$		—	—	0.7	V
	$V_{IN(1)}$		3.5	—	—	V
Thermal Shutdown Temperature	T_J		—	165	—	°C
Thermal Shutdown Hysteresis	ΔT_J		—	20	—	°C

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

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TERMINAL FUNCTIONS

Term.	Terminal Name	Function
1	RET REF	The reference supply for setting the voltage across the load during retract.
2	V_{FLT}	Reservoir (energy storage) capacitor used to operate fault circuitry.
3	V_{BEMF}	Back-EMF voltage from spindle motor used to retract heads during loss of power.
4	GROUND	Circuit reference.
5	UV_{SET}	Under-voltage trip point reference input. Set internally to 4.3 V but may be overridden by external resistor divider. (Equation 6).
6	$R_{OUT\ P}$	Source driver used for retract; externally connected to OUT_P.
7	OUT	Output of uncommitted operational amplifier.
8	SWITCH	Logic input for transmission gate; a high level connects OUT to OUT_{SW}.
9	IN_N	Inverting input to uncommitted operational amplifier.
10	OUT_{SW}	Transmission-gated output of uncommitted operational amplifier.
11	$RETRACT_N$	An active-low logic input that initiates the retract sequence.
12	FAULT	A logic low at this MOS output indicates a thermal shutdown, under-voltage fault, or retract command.
13	MP_{RESET}	(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.
14	SIGNAL SUPPLY	V_{CC}; low-current supply voltage in the range of 4.5 V to 5.5 V.
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).
16	REFERENCE	V_{REF}; reference input for all amplifiers; ac ground.
17	H GAIN	Logic input to switch the error amplifier transconductance gain: LOW = 1560, HIGH = 6240.
18	PWR OFF	An active-high logic input that puts the device in a "sleep mode". All fault circuitry remains active.
19	ACT_{FB}	Input connection for feedback network which sets the error amplifier gain and bandwidth (Equations 2 and 3).
20	$SGND_P$	Power ground for the OUT_P sink driver.
21	OUT_N	Power output. Sinks current when $V_{ACT} < V_{REF}$.
22	LOAD SUPPLY	V_{DD}; high-current supply voltage for the voice-coil motor.
23	OUT_P	Power output. Sinks current when $V_{ACT} > V_{REF}$.
24	$SGND_N$	Power ground for the OUT_N sink driver.
25	$V_{SENS\ FB}$	Input connection for feedback network which sets the current-sense amplifier gain and bandwidth.
26	V_{LOAD}	An output voltage proportional to the load voltage. Used in conjunction with closed-loop velocity control.
27	V_{SENS}	Voltage output representing load current (Equation 4).
28	RET SET	An external resistor divider to set the retract voltage across the load. Used in conjunction with $V_{RET\text{-}REF}$ (Equation 5).

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DEVICE DESCRIPTION

Current Amplifier. The A8932CLW voice coil motor driver features a wide transconductance bandwidth and no measurable crossover distortion. The transconductance gain is user selectable:

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

where A_i is either 1560 (H GAIN = Low) or 6240 (H GAIN = High)

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

$$R_Z = \frac{L_{LOAD}}{C_Z \times R_{LOAD}} \qquad \text{(Equation 2)}$$

$$C_Z = \frac{5.4}{A_i}\left(\frac{1}{2\pi \times f_{BW} \times R_{LOAD}}\right) \qquad \text{(Equation 3)}$$

with R_Z as above, and H GAIN = Low, the bandwidth is less than 100 kHz. With H GAIN = High, the bandwidth is reduced to less than 25 kHz.

Current and Voltage Sensing. The load current is sensed internally. Three 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:

$$V_{SENSE} = \frac{R_S I_{LOAD}}{A_i} \qquad \text{(Equation 4)}$$

The second and third auxiliary amplifiers 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. This is achieved by determining the back-EMF voltage generated by the voice coil and feeding back this information to the main actuator control input. The back-EMF feedback voltage can be switched in as required by means of the SWITCH logic input.

The back EMF-voltage represents the velocity of the actuator. By subtracting the $I_{LOAD}R_{LOAD}$ voltage component from the voltage across the load, the back-EMF term can be isolated and fed back to close a velocity control loop.

The amplifier output voltage V_{LOAD} is proportional to the voltage across the load ($0.4(V_{OUTN} - V_{OUTP})$). R_S is selected so that V_{SENSE} represents I_{LOAD} while R_3 is dependent on R_{LOAD} as shown in the following equations:

$$V_{LOAD} = -0.4\ ((I_{LOAD}/R_{LOAD}) + V_{BEMF})$$

$$V_{SENSE} = R_S\ I_{LOAD}\ A_i$$

where A_i = 1560 (H GAIN = logic Low)

$$OUT_{SW} = -V_{BEMF}\ R_1/R_2$$

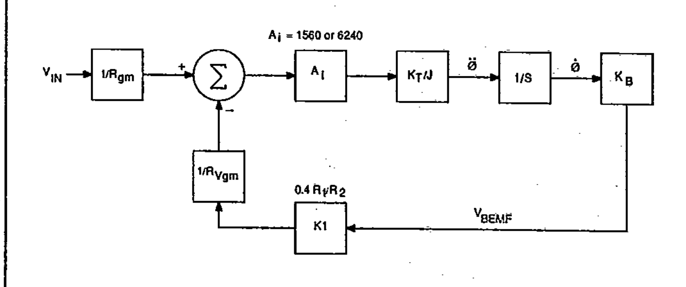
$$R3 = \frac{R_2\ R_S}{0.4\ A_i\ R_{LOAD}}$$

$$\frac{V_{BEMF}}{V_{IN}} = \frac{R_{gm}\ R_2}{R_{VGM}\ R_1}$$

$$BW = \frac{R_1\ K_B\ K_T\ A_i}{2\pi\ R_{VGM}\ R_2\ J}$$

where J is the moment of inertia, K_B is the back-emf motor constant, and K_T is the torque constant.

$$\text{Velocity loop compensation} = L_{LOAD}/R_{LOAD} = R_1\ C_1 = R_3\ C_2$$



Dwg. OP-003

Retract and Brake. A retract-brake sequence is initiated on receiving a fault indication from the internal thermal shutdown (TSD), or under-voltage lockout (UVLO), 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:

$$V_{RET\text{-}REF} = \frac{0.58\,(R_7 + R_8)}{R_8} \qquad \text{(Equation 5)}$$

where $R_8 \geq 130\ k\Omega$.

When the sequence is operated, the output voltage is forced to approximately $V_{PARK\text{-}REF}$ 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.

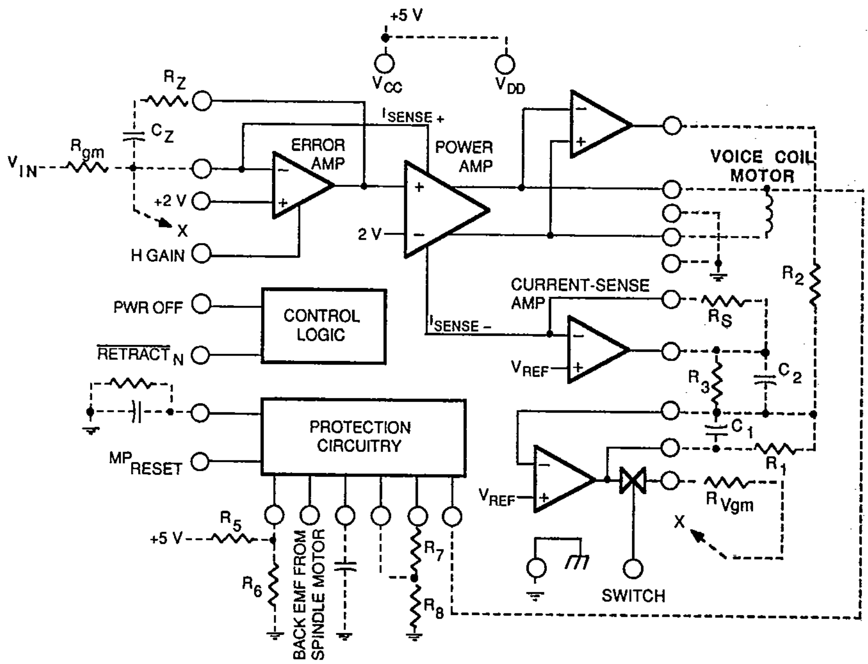
Power for the retract function is provided by the rectified back EMF of the spindle motor by way of the V_{BEMF} terminal. The A8932CLW will perform the retract function under low supply conditions (nominally down to 2 V). Operation down to almost 0 V requires an energy-storage capacitor at the V_{FLT} terminal.

Protective Features. The A8932CLW 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:

$$UV_{TRIP} = \frac{1.5\,(R_5 + R_6)}{R_6} \qquad \text{(Equation 6)}$$

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.

TEST CIRCUIT AND TYPICAL APPLICATION



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