Hybrid Integrated Circuits

HYBRID INTEGRATED CIRCUITS

Texas Instruments is pleased to present the following technical data for your use in evaluating and specifying hybrid integrated circuits. These data sheets describe standard hybrid integrated circuits that are now available. Additional standard circuits are planned for early release.

In addition to these standard components, Texas Instruments offers a total capability for design, fabrication and testing of custom circuits to meet your special needs.

Texas Instruments has been engaged in the development and application of hybrid integrated circuit techniques, both thick-film and thin-film, for more than ten years. These techniques include various methods for thin-film metal deposition, thick-film printing and screening, photo-etching, component and chip attachment, film resistor and capacitor fabrication, special packaging and beam-lead component attachment.

A wide range of materials are available for thin film circuit applications. These include gold, aluminum, nichrome, tantalum, tantalum nitride and cermets. Substrate materials include ceramic, glass and silicon.

Reliability is given major consideration at Texas Instruments and each hybrid circuit is subjected to pre-cap visual inspection, stabilization bake, temperature cycle, centrifuge, fine and gross leak and functional electrical tests. Additional testing is performed if required by customer specifications.

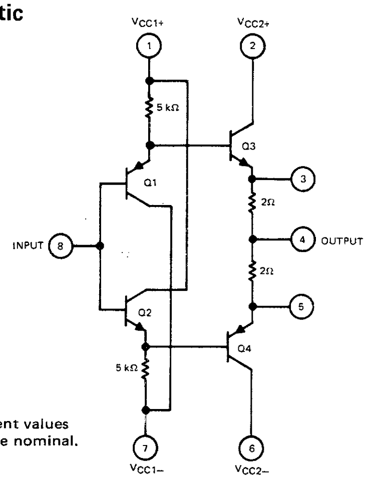
Electrical testing is performed using a computer-controlled, automatic test system capable of testing up to 40 active pins. Functional, dynamic and d-c tests can be performed with data logged by teletype or on magnetic tape. The test head provides space for special interface circuitry necessary to test a specific hybrid and permits testing at various temperature extremes.

A competent engineering staff, with both prototype and production fabrication facilities available, will assist you in satisfying your hybrid integrated circuit needs.

JANUARY 1971

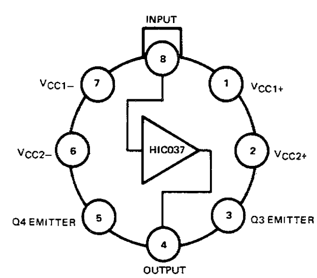
- High Input Impedance—200 kΩ
- Low Output Impedance—6 Ω
- High Power Efficiency
- High Output Voltage Swing
- Operation from ±5 V to ±20 V Supply
- Low Harmonic Distortion
- D-C to 30 MHz Bandwidth

schematic



Component values shown are nominal.

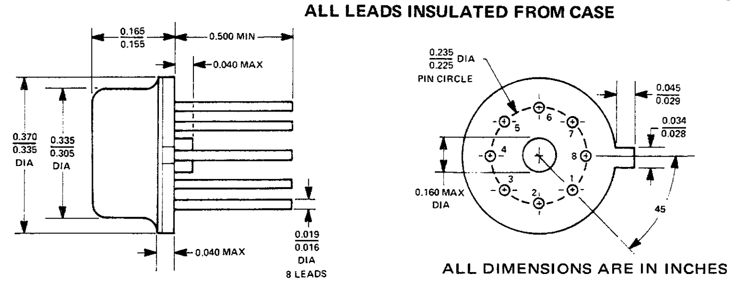
pin assignments



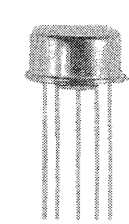
BOTTOM VIEW

mechanical data

ALL LEADS INSULATED FROM CASE



ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED



absolute maximum ratings at 25°C free-air temperature (unless otherwise noted)

Supply voltages V_{CC1+} and V_{CC2+} (See Note 1)	22 V
Supply voltages V_{CC1-} and V_{CC2-} (See Note 1)	−22 V
Input voltage (See Note 1)	$\leqslant V_{CC1}$
Steady-state output current	±100 mA
Pulsed output current (50 ms on, 1 sec off)	±400 mA
Continuous power dissipation at (or below) 25°C free-air temperature (See Note 2)	600 mW
Operating free-air temperature range	−55°C to 125°C
Storage temperature range	−65°C to 150°C

NOTES: 1. All voltage values are with respect to the common zero-reference level of the supply voltages (ground).
2. Derate linearly to 125°C free-air temperature at the rate of 6 mW/°C.

PRELIMINARY DATA SHEET:
Supplementary data will be published at a later date.

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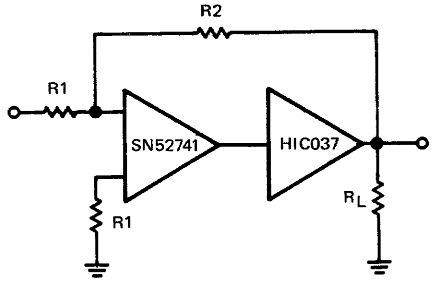
electrical characteristics (see note 3)

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
A_V	Large-signal voltage amplification	R_S = 10 kΩ, V_I = 3 V pp, T_A = −55°C to 125°C	R_L = 1 kΩ, f = 1 kHz,	0.95	0.97		
z_i	Input impedance	R_S = 200 kΩ, f = 1 kHz,	V_i = 1 V rms, R_L = 1 kΩ	180	200		kΩ
z_o	Output impedance	V_i = 1 V rms, R_L = 50 Ω,	f = 1 kHz, R_S = 10 kΩ		6	10	Ω
V_{OPP}	Maximum output voltage swing	R_L = 1 kΩ,	f = 1 kHz	±10	±11		V
V_{IO}	Input offset voltage	R_S = 10 kΩ, T_A = −55°C to 125°C	R_L = 1 kΩ,		±40	±100	mV
I_{IO}	Input offset current	R_S = 10 kΩ, T_A = −55°C to 125°C	R_L = 1 kΩ,		±6	±10	μA
THD	Total harmonic distortion	V_i = 5 V rms,	f = 1 kHz		0.1		%
BW	Bandwidth (3 dB)	V_i = 1 V rms, f = 1 MHz	R_L = 50 Ω,	30	50		MHz
I_{CC+}	Positive supply current	R_S = 10 kΩ,	R_L = 1 kΩ		6	10	mA
I_{CC-}	Negative supply current	R_S = 10 kΩ,	R_L = 1 kΩ		−6	−10	mA

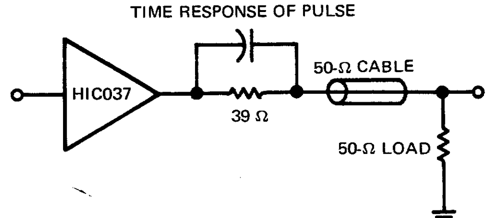
NOTE 3: Specification applies for T_A = 25°C with +12 V on Pins 1 and 2; −12 V on Pins 6 and 7, unless otherwise specified.
†All typical values are at T_A = 25°C.

TYPICAL APPLICATION DATA



SUPPLY = ±5 V to ±15 V

HIGH-CURRENT OPERATIONAL AMPLIFIER



LINE DRIVER

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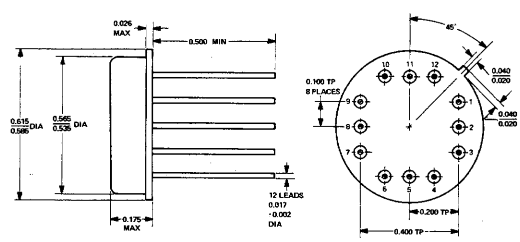
- Output current to 1 ampere without external pass transistor
- No external compensation required
- Output voltage adjustable from 2 to 37.5 volts
- Optional output with internal current limiting
- Series or shunt operation

description

The HIC106 is a hybrid voltage regulator featuring internal compensation, an optional output with internal current limiting, and regulated output currents up to 1 ampere. The HIC106 regulator requires only one external component during normal operation.

Applications include logic card regulators, sub-system and system regulators, instrument power supplies and other power supplies for linear and digital circuits.

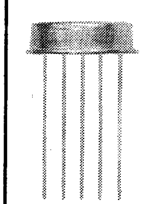
mechanical data



ALL LEADS INSULATED FROM CASE

All dimensions are in inches unless otherwise noted.

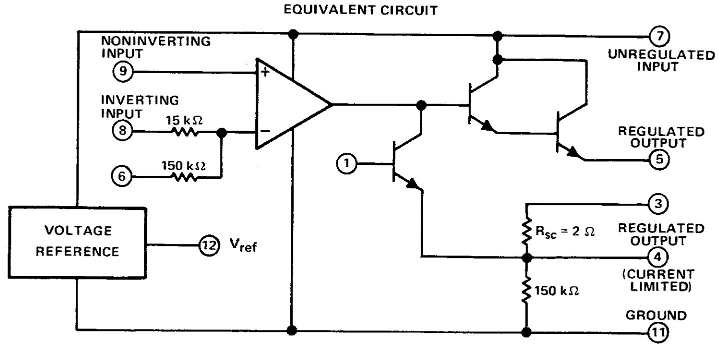
Leads are within 0.007 inch radius of true position (TP) at gauge plane (seating base) with maximum material condition.



pin connections (see equivalent circuit)

Pin 1 = Base of Limit Transistor
Pin 2 = NC
Pin 3 = Limit Resistor
Pin 4 = Output (Current Limited)
Pin 5 = Output
Pin 6 = Feedback Resistor
Pin 7 = Unregulated Input
Pin 8 = Inverting Input
Pin 9 = Noninverting Input
Pin 10 = NC
Pin 11 = Ground
Pin 12 = V_{ref}

EQUIVALENT CIRCUIT



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PRELIMINARY DATA SHEET:
Supplementary data will be published at a later date.

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absolute maximum ratings

Input Voltage (See Note 1) . . . . 40 V
Input-Output Voltage Differential . . . . 40 V
Maximum Output Current . . . . 1 A
Internal Power Dissipation at (or below) 25°C Free-Air Temperature (See Note 2) . . . . . . 2.7 W
Internal Power Dissipation at (or below) 25°C Case Temperature (See Note 3) . . . . . . 5.0 W
Operating Temperature Range . . . . −55°C to 125°C
Storage Temperature Range . . . . −65°C to 150°C

NOTES: 1. All voltages, unless otherwise noted, are with respect to device ground terminal.
2. Derate linearly above 25°C free-air temperature at the rate of 15.4 mW/°C.
3. Derate linearly above 25°C case temperature at the rate of 28.5 mW/°C.

electrical characteristics, see note 4

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input Voltage Range			9.5		40	V
Output Voltage Range			2		37.5	V
Input-Output Voltage Differential			2.5		40	V
Load Regulation	$\frac{\Delta V_O}{V_O \text{ at } I_O = 1\text{ mA}} \times 100\%$	I_O = 1 mA to 300 mA, V_I = 40 V, V_O = 35 V			0.2	%
Line Regulation	$\frac{\Delta V_O}{\Delta V_I} \times 100\%$	V_I = 40 V to 20 V, V_O = 15 V			0.15	%
Ripple Rejection		C_{ref} = 0†, f = 120 Hz		74		dB
		C_{ref} = 5 μF†, f = 120 Hz		86		dB
Temperature Coefficient	$\pm\left[\frac{V_O \text{ at } 125°C - V_O \text{ at } -55°C}{V_O \text{ at } 25°C}\right]\frac{100\%}{180°C}$	T_A = −55°C to 125°C, V_O = 25 V, I_O = 1 mA			±0.02	%/°C
Standby Current Drain		I_O = 0		4.3	6	mA
Short-Circuit Current Limit, I_{OS}		V_I = 9.5 V, V_O = 0		350		mA
Reference Voltage, V_{ref}			6.3	6.8	7.3	V

†C_{ref} is connected between pin 12 and ground.

NOTE 4: Unless otherwise specified, T_A = 25°C, V_I = 30 V, V_O = 15 V, I_O = 15 mA. V_I is the unregulated input voltage, V_O is the regulated output voltage, and I_O is the output current.

TYPICAL CHARACTERISTICS

MAXIMUM LOAD CURRENT
AS A FUNCTION OF INPUT-OUTPUT
VOLTAGE DIFFERENTIAL

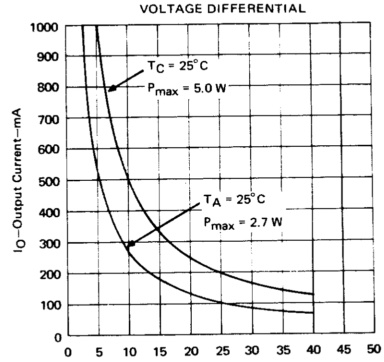

FIGURE 1

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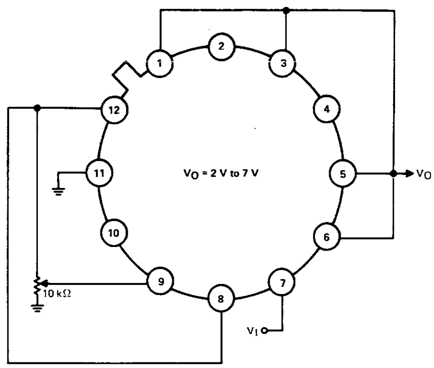
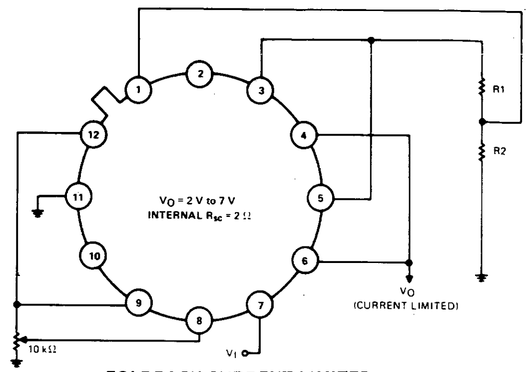
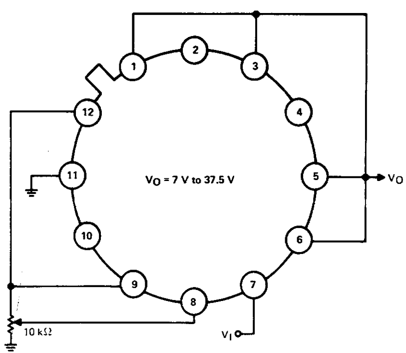
TYPICAL APPLICATION DATA



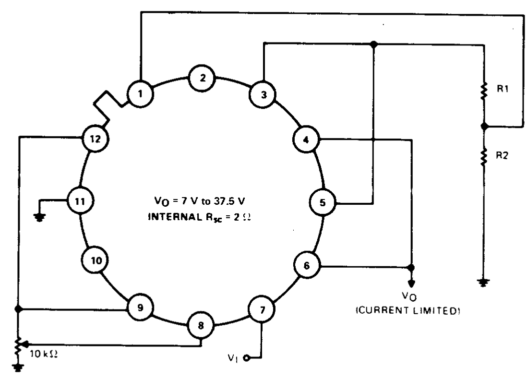
LOW-VOLTAGE REGULATOR
FIGURE 2



FOLDBACK CURRENT-LIMITED
LOW-VOLTAGE REGULATOR
FIGURE 3



HIGH-VOLTAGE REGULATOR
FIGURE 4



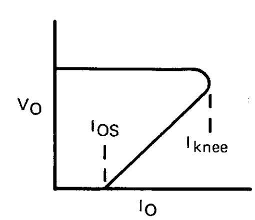
FOLDBACK CURRENT-LIMITED
HIGH-VOLTAGE REGULATOR
FIGURE 5

FOLDBACK CURRENT LIMITING

$$I_{OS} = \frac{(V_{1,4})\,(R1 + R2)}{R_{sc}\,(R2)}$$

$$I_{knee} = \frac{V_O\,R1}{R_{sc}\,R2} + I_{OS}$$

$V_{1,4}$ (voltage between pins 1 and 4) is typically 0.6 V



BOTTOM VIEWS SHOWN

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TYPE HIC107
NEGATIVE VOLTAGE REGULATOR

JANUARY 1971

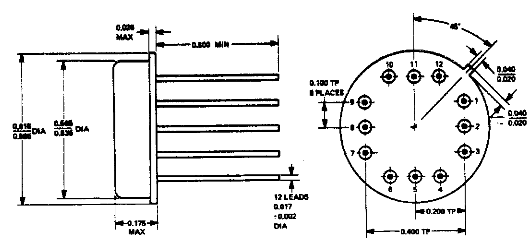
- Output current to 1 ampere without external pass transistor
- No external compensation required
- Output voltage adjustable from −2 to −37 volts
- Optional output with internal current limiting
- Series or shunt operation

description

The HIC107 is a hybrid voltage regulator featuring internal compensation, an optional output with internal current limiting, and regulated output currents up to 1 ampere. The HIC107 regulator requires only one external component during normal operation.

Applications include logic card regulators, sub-system and system regulators, instrument power supplies and other power supplies for linear and digital circuits.

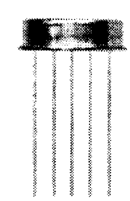
mechanical data



ALL LEADS INSULATED FROM CASE

All dimensions are in inches unless otherwise noted.

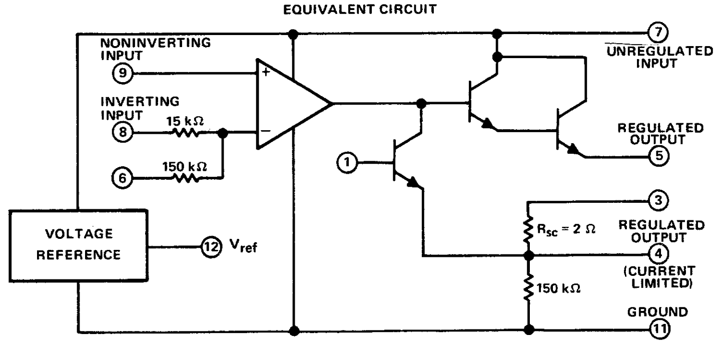
Leads are within 0.007 inch radius of true position (TP) at gauge plane (seating base) with maximum material condition.



pin connections (see equivalent circuit)

Pin 1 = Base of Limit Transistor
Pin 2 = NC
Pin 3 = Limit Resistor
Pin 4 = Output (Current Limited)
Pin 5 = Output
Pin 6 = Feedback Resistor
Pin 7 = Unregulated Input
Pin 8 = Inverting Input
Pin 9 = Noninverting Input
Pin 10 = NC
Pin 11 = Ground
Pin 12 = V_{ref}

EQUIVALENT CIRCUIT



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absolute maximum ratings

Input Voltage (See Note 1)	−40 V
Input-Output Voltage Differential	−40 V
Maximum Output Current	−1 A
Internal Power Dissipation at (or below) 25°C Free-Air Temperature (See Note 2)	2.7 W
Internal Power Dissipation at (or below) 25°C Case Temperature (See Note 3)	5.0 W
Operating Temperature Range	−55°C to 125°C
Storage Temperature Range	−65°C to 150°C

NOTES: 1. All voltages, unless otherwise noted, are with respect to device ground terminal.
2. Derate linearly above 25°C free-air temperature at the rate of 15.4 mW/°C.
3. Derate linearly above 25°C case temperature at the rate of 28.5 mW/°C.

electrical characteristics, see note 4

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input Voltage Range		−9.5		−40	V
Output Voltage Range		−2		−37	V
Input-Output Voltage Differential		−3		−40	V
Load Regulation $\frac{\Delta V_O}{V_O \text{ at } I_O = 1 \text{ mA}} \times 100\%$	I_O = 1 mA to 300 mA, $-V_I$ = −40 V, V_O = −35 V			0.2	%
Line Regulation $\frac{\Delta V_O}{\Delta V_I} \times 100\%$	$-V_I$ = −40 V to −20 V, V_O = −15 V			0.15	%
Ripple Rejection	C_{ref} = 0†, f = 120 Hz		74		dB
	C_{ref} = 5 μF†, f = 120 Hz		86		dB
Temperature Coefficient $\pm\left[\frac{V_O \text{ at } 125°C - V_O \text{ at } -55°C}{V_O \text{ at } 25°C}\right]\frac{100\%}{180°C}$	T_A = −55°C to 125°C, V_O = −25 V, I_O = −1 mA			±0.02	%/°C
Standby Current Drain	I_O = 0		−4.3	−6	mA
Short-Circuit Current Limit, I_{OS}	$-V_I$ = −9.5 V, V_O = 0		−350		mA
Reference Voltage, V_{ref}		−6.3	−6.8	−7.3	V

†C_{ref} is connected between pin 12 and ground.

NOTE 4: Unless otherwise specified, T_A = 25°C, V_I = −30 V, V_O = −15 V, I_O = −15 mA. V_I is the unregulated input voltage, V_O is the regulated output voltage, and I_O is the output current.

TYPICAL CHARACTERISTICS

MAXIMUM LOAD CURRENT
AS A FUNCTION OF INPUT-OUTPUT
VOLTAGE DIFFERENTIAL

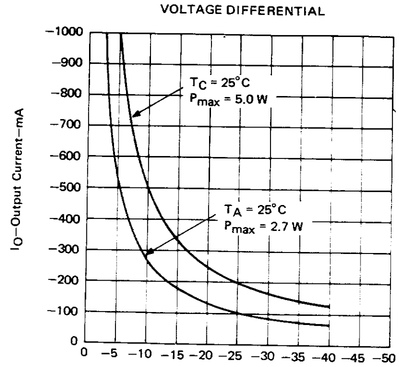
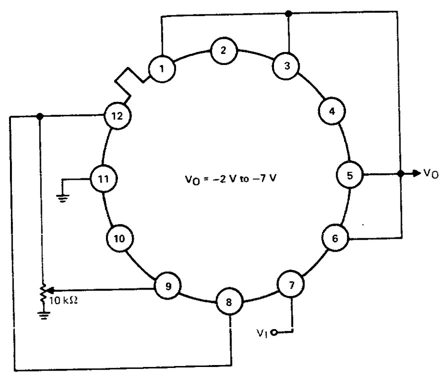
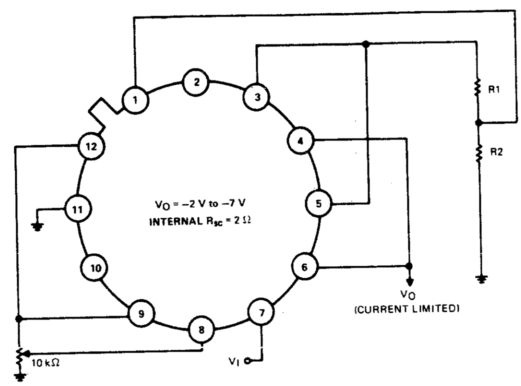


FIGURE 1

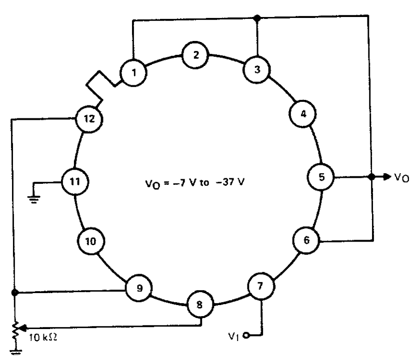
TYPICAL APPLICATION DATA



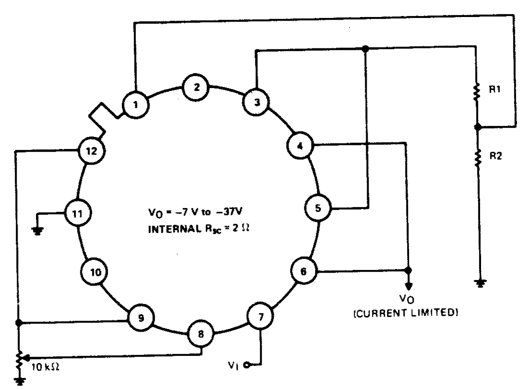
LOW-VOLTAGE REGULATOR
FIGURE 2



FOLDBACK CURRENT-LIMITED
LOW-VOLTAGE REGULATOR
FIGURE 3



HIGH-VOLTAGE REGULATOR
FIGURE 4



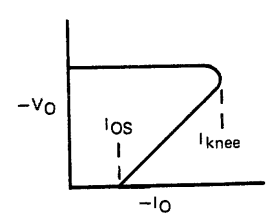
FOLDBACK CURRENT-LIMITED
HIGH-VOLTAGE REGULATOR
FIGURE 5

FOLDBACK CURRENT LIMITING

$$I_{OS} = \frac{(V_{1,4})\,(R1 + R2)}{R_{sc}\,(R2)}$$

$$I_{knee} = \frac{V_O\,R1}{R_{sc}\,R2} + I_{OS}$$

$V_{1,4}$ (voltage between pins 1 and 4) is typically −0.6 V



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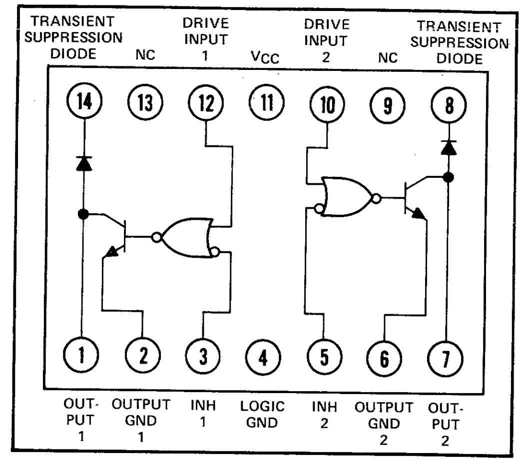
CIRCUIT TYPE TIH101
DUAL POWER LOGIC MODULE

CIRCUIT TYPE TIH101
BULLETIN NO. DL-S 7111431, JANUARY 1971

terminal assignments (top view)



NC—No internal connection

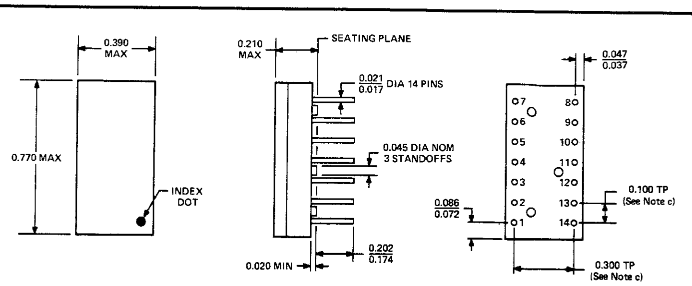
- Low Power Dissipation
- Two Power Logic Functions per Package
- Inputs Compatible with Most TTL and DTL Families
- Pin Spacing Same as Standard 14-Pin Dual-In-Line Package

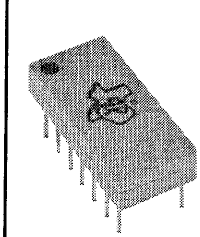
description

The TIH101 is a hybrid circuit designed for applications where the drive requirements exceed the capabilities of standard logic gates. The device contains two electrically independent circuits, each having both drive and inhibit inputs for greater design flexibility. The inputs are compatible with most TTL and DTL families. Each output is capable of sinking up to 6.5 amperes at a 5% duty cycle and pulse widths up to 1.25 milliseconds. A transient suppression diode is included for driving inductive loads. These devices are commonly used as hammer drivers in high-speed printers.

mechanical data

The circuit is mounted on a ceramic substrate enclosed in a glass and ceramic dual-in-line package. The package is intended for mounting-hole rows on 0.300-inch centers.





NOTES: a. All dimensions are in inches.
b. Terminal identification is provided by the index dot on the top of the package.
c. Leads are within 0.005 radius of true position (TP) at maximum material condition.

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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, V_{CC} (see Note 1)	7 V
Input voltage (see Note 1)	5.5 V
Applied output voltage (see Note 1)	60 V
Continuous output current: one output operating	0.75 A
both outputs operating	0.5 A
Peak output current ($t_w \leq$ 1.25 ms, duty cycle = 5%): one output operating	6.5 A
both outputs operating	6.5 A
Voltage between logic ground and output ground	±1 V
Operating free-air temperature range	0°C to 70°C
Storage temperature range	−55°C to 150°C

NOTE 1: Supply (V_{CC}) and input voltages are with respect to the logic ground terminal; output voltage is with respect to the output ground terminal for that particular circuit.

electrical characteristics over operating free-air temperature range, V_{CC} = 4.75 V to 5.25 V

PARAMETER		TEST CONDITIONS	MIN	TYP†	MAX	UNIT
V_{IH}	High-level input voltage		2			V
V_{IL}	Low-level input voltage				0.8	V
$V_{O(on)}$	On-state output voltage	$I_{O(on)}$ = 6 A, See Notes 2 and 3			1.6	V
$I_{O(off)}$	Off-state output current	$V_{O(off)}$ = 60 V			10	μA
I_I	Input current at maximum input voltage	V_I = 5.5 V			1	mA
I_{IH}	High-level input current	V_I = 2.4 V			40	μA
I_{IL}	Low-level input current	V_I = 0.4 V			−1.6	mA
$I_{CC(off)}$	Off-state supply current	See Note 4		8	15	mA
$I_{CC(on)}$	On-state supply current (one circuit on)	See Note 5		110	175	mA

†All typical values are at V_{CC} = 5 V, T_A = 25°C.

electrical characteristics of transient suppression diode over operating free-air temperature range

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_R	Static reverse current	V_R = 60 V			100	μA
V_F	Static forward voltage	I_F = 6 A, See Notes 2 and 3			2	V

NOTES: 2. This parameter must be measured using pulse techniques. t_w = 300 μs, duty cycle ≤ 2%.
3. This parameter is measured with voltage-sensing contacts separate from the current-carrying contacts.
4. $I_{CC(off)}$ is measured with the drive inputs at 4.5 V and the inhibit inputs grounded.
5. $I_{CC(on)}$ is measured by applying 4.5 V to the inhibit input of one circuit and the drive input of the other circuit with the remaining inputs grounded, then likewise for the other circuit.

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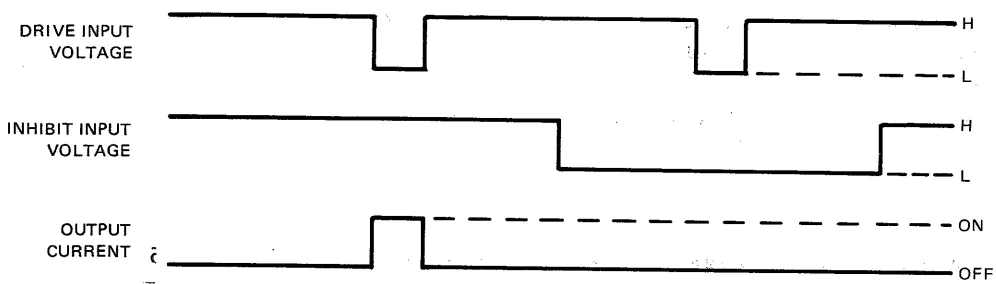
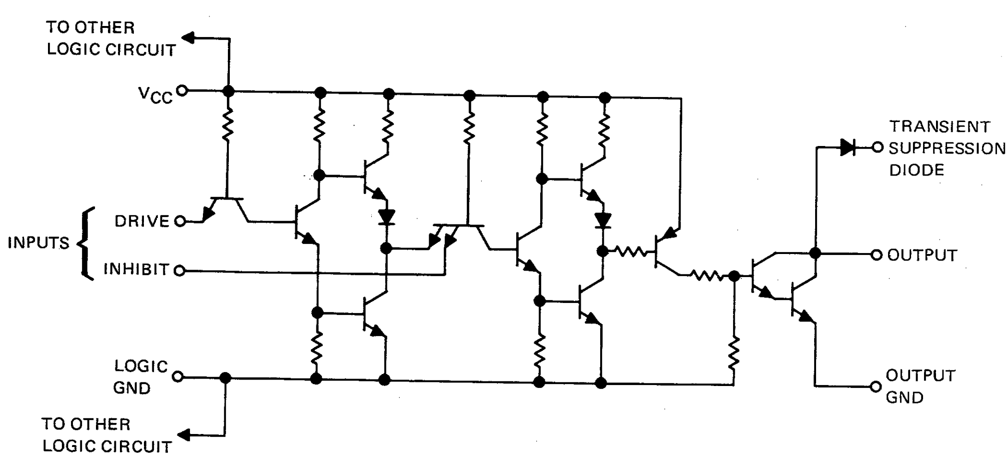
input voltage and output current relationships



schematic (each circuit)



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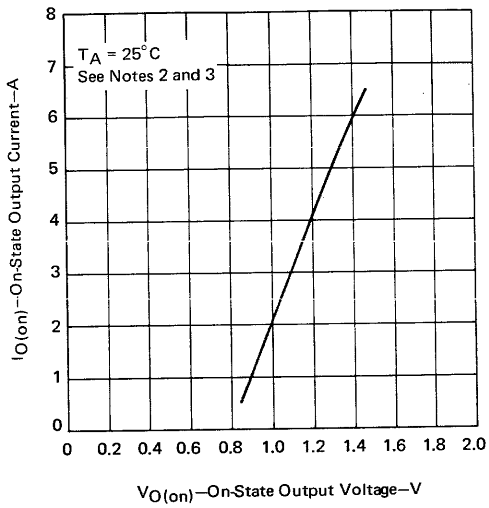
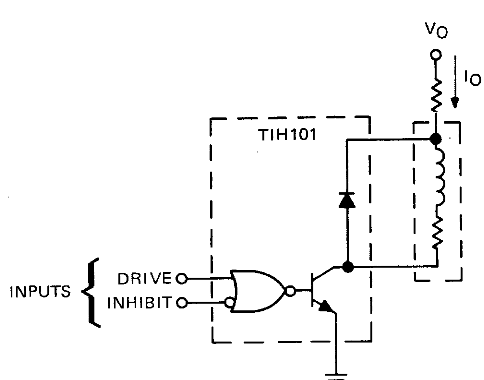
TYPICAL CHARACTERISTICS

ON-STATE OUTPUT CURRENT
vs
ON-STATE OUTPUT VOLTAGE



NOTES: 2. This parameter must be measured using pulse techniques. t_w = 300 μs, duty cycle ≤ 2%.
3. This parameter is measured with voltage-sensing contacts separate from the current-carrying contacts.

TYPICAL APPLICATION DATA



SOLENOID DRIVER

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