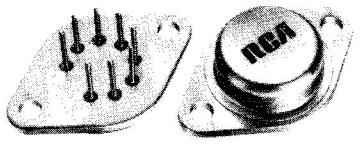
RCA Solid State Europe

Power-Hybrid-Circuits

HC4005 HC4005A
HC4012 HC4012A
HC4015 HC4015A

File No. 571



8-Pin "TO-3" H-1776

5-, 12-, & 15-Volt, High-Current Series Voltage Regulators

Power Hybrid Modules Employing Integrated-Circuit Voltage Regulator and Hometaxial-Base Pass Transistor

Features

- **4-A current rating**
- **Internal emitter-ballast resistors for external booster transistors for increased regulated-current capability (to 12 A)**
- **Remote sensing capability**
- **40-Volt line-voltage capability**
- **Internal foldback-protection circuit**
- **Terminal connection for external adjustment of foldback characteristic**
- **Crowbar trigger circuit**
- **Total regulation: ±1% – HC4005A, HC4012A, HC4015A**
  ±3% – HC4005, HC4012, HC4015
- **Rugged hometaxial-base pass transistor**
- **Dissipation: 62.5 watts (pass transistor)**
- **Terminal connection to permit connection of regulator as a Darlington driver for external transistor(s) to increase current-handling capability (to 100 A)**
- **8-pin "TO-3" hermetic package**

RCA HC4005, HC4005A, HC4012, HC4012A, HC4015, and HC4015A* are complete solid-state hybrid series voltage regulators in compact hermetic packages. They have output-voltage ratings of 5, 12, and 15 volts, respectively. The HC4005, HC4012, and HC4015 provide voltage regulation within ±3%; the "A" versions provide regulation of ±1%.

The HC4000 series of hybrid circuits is intended for voltage-regulator applications with load currents up to 4.0 amperes. With two external booster transistors, these circuits can regulate voltage for load currents up to 12 amperes (see Fig. 9). For load currents greater than 12 amperes, additional current-handling capability can be provided by employing the regulator as a Darlington driver (see Figs. 10 and 11).

*Formerly RCA Dev. Nos. TA7955, TA7957, and TA8397, respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

UNREGULATED INPUT VOLTAGE	40	V
REGULATED CURRENT (PASS TRANSISTOR, Q_4)	4.8	A
POWER DISSIPATION (PASS TRANSISTOR, Q_4):		
At case temperature of 25°C	62.5	W
At case temperature above 25°C, see Fig. 3.		
POWER DISSIPATION (DRIVER TRANSISTOR, Q_2):		
(Due to external drive current)		
At case temperature of 25°C	7	W
At case temperature above 25°C, see Fig. 4.		
EXTERNAL DRIVE CURRENT (FROM TERMINAL 8)	550	mA
TEMPERATURE RANGE:		
Storage	–45 to 125	°C
Operating (Junction)	–45 to 150	°C
PIN TEMPERATURE (DURING SOLDERING):		
At distance ≥ 1/16 in. (1.59 mm) from case for 10 s max.	220	°C
(T_C = 150°C Max.)		

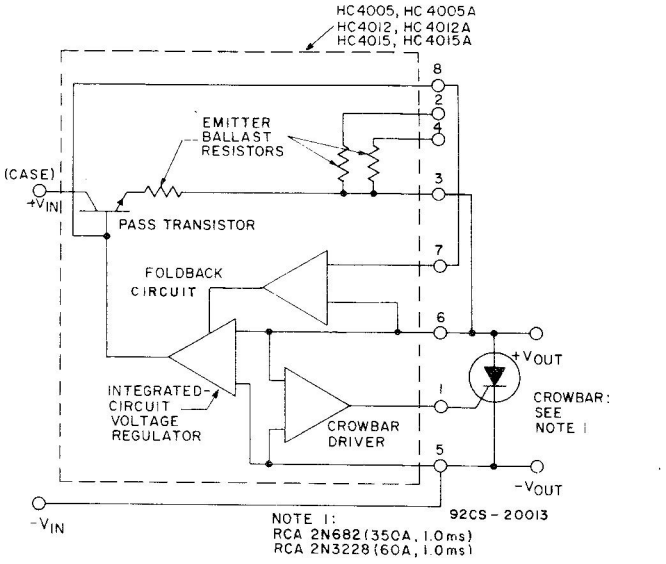
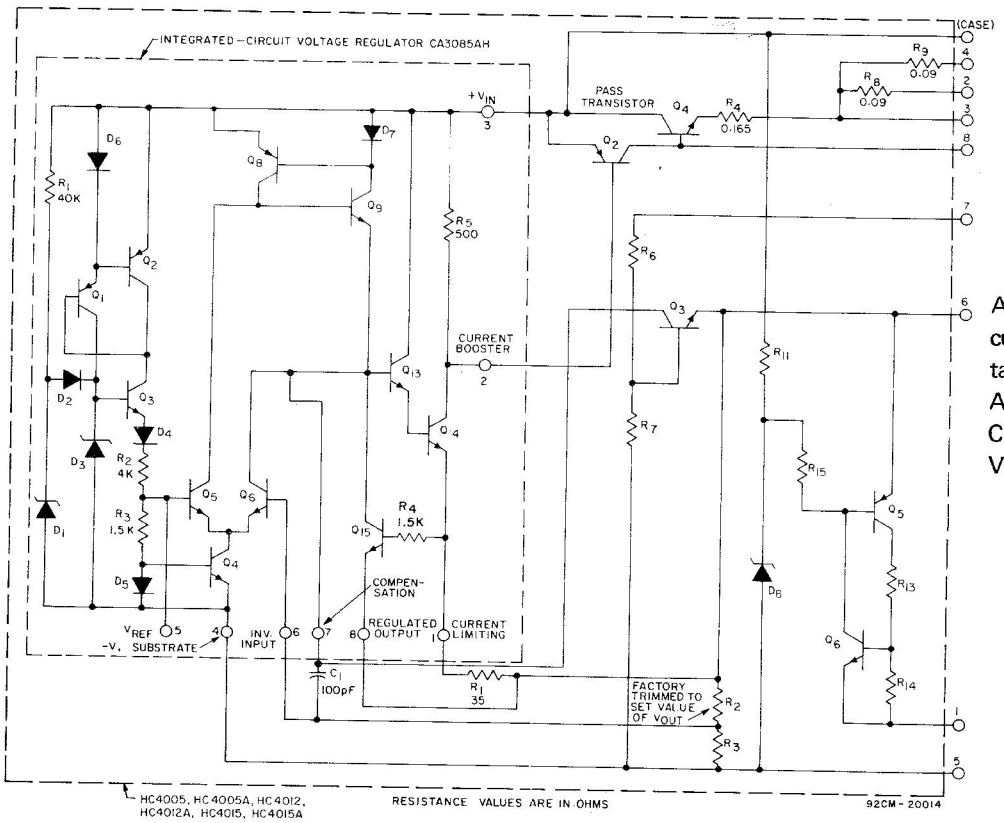


Fig. 1—Type HC4005, HC4005A, HC4012, HC4012A, HC4015, or HC4015A connected as a 4-A series regulator.

ELECTRICAL CHARACTERISTICS, *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTIC	SYMBOL	TEST CONDITIONS		LIMITS MIN.	LIMITS TYPE.	LIMITS MAX.	UNITS
INPUT VOLTAGE RANGE	V_{IN}			7.5	–	40	V
INPUT-OUTPUT VOLTAGE DIFFERENTIAL (See Fig. 6)	$V_{IN}-V_{OUT}$	I_{LOAD} = 4A		4.0	–	–	V
FOLDBACK CURRENT (See Fig. 5)	$I_{F.B.}$			4.1	–	4.8	A
SHORT-CIRCUIT FOLDBACK CURRENT (See Fig. 5)	$I_{S.C.}$			–	–	2.0	A
OUTPUT VOLTAGE	V_{OUT}	$V_{IN} = V_{NOM}$ = 11.5V, HC4005, HC4005A		–	5	–	V
		$V_{IN} = V_{NOM}$ = 18.2V, HC4012, HC4012A		–	12	–	
		$V_{IN} = V_{NOM}$ = 21.7V, HC4015, HC4015A		–	15	–	
LOAD REGULATION		I_{LOAD} = 0.1 to 4A, $V_{IN} = V_{NOM}$	HC4005, HC4012, HC4015	–	–	± 0.6	%V_{OUT}
			HC4005A, HC4012A, HC4015A	–	–	± 0.3	
LINE REGULATION		I_{LOAD} = 1A, V_{IN} = ±15% V_{NOM}	HC4005, HC4012, HC4015	–	–	± 0.6	%V_{OUT}
			HC4005A, HC4012A, HC4015A	–	–	± 0.3	
TOTAL REGULATION INCLUDING LINE AND LOAD REGULATION ACCURACY, OUTPUT-VOLTAGE STABILITY AND CASE-TEMPERATURE VARIATION FROM –45°C TO +100°C		I_{LOAD} = 0.1 to 4A	HC4005, HC4012, HC4015	–	–	± 3.0	%V_{OUT}
			HC4005A, HC4012A, HC4015A	–	–	± 1.0	
EQUIVALENT NOISE OUTPUT VOLTAGE	V_{NOISE}			–	–	0.5	mV p-p
RIPPLE REJECTION RATIO	$\frac{V_{IN(AC)}}{V_{OUT(AC)}}$	I_{LOAD} = 500 mA, $V_{IN(AC)}$ = 1.0 V(p-p), f = 120 Hz		175	–	–	
TEMPERATURE COEFFICIENT OF OUTPUT VOLTAGE	ΔV_o	T_C = –45°C to + 100°C, I_{LOAD} = 100 mA		–	0.0035	–	%/°C
TEMPERATURE COEFFICIENT OF FOLDBACK CURRENT	$\Delta I_{F.B.}$	T_C = –45°C to + 125°C		–	–4.3	–	mA/°C
CROWBAR TRIP VOLTAGE (See Fig. 8)	V_{CB}	T_C = –45°C to +125°C	V_{OUT} = 5.0V	5.75	–	7.25	V
			V_{OUT} = 12.0V	13.9	–	17.3	
			V_{OUT} = 15.0V	16.6	–	20.6	
CROWBAR CURRENT (ON) (See Fig. 8)	I_{CB}	Max. "On-Time" = 1.0s		100	–	350	mA
LOAD TRANSIENT RECOVERY TIME (See Fig. 12)	t_R	1-A STEP		–	10	–	μs
OUTPUT-VOLTAGE STABILITY		P_D = 10W, $R_{\theta CA}$ = 2.0° C/W		–	–	± 0.1	%V_{OUT}
FOLDBACK RESPONSE TIME				–	–	50	μs



TYPE	V_{OUT}	R_6	R_7	R_3	R_{11}	R_{15}	R_{13}	R_{14}	D_8
HC4005-A	5.0	780	4.2K	2.2K	1.4K	1K	1K	4K	5.6V
HC4012-A	12.0	1.3K	17K	1150	2.0K	1K	2.7K	1.6K	15.0V
HC4015-A	15.0	1.1K	17K	1150	2.0K	1K	3.7K	1.6K	17.0V

A complete description of these circuits and their operation is contained in RCA Application Note AN-6026, "General Application Considerations for Hybrid Series Voltage Regulators".

Fig. 2—Schematic diagram of HC4000-type series voltage-regulator hybrid circuits.

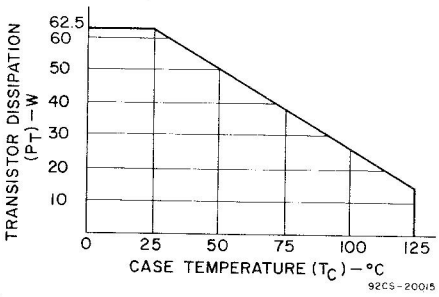


Fig. 3—Allowable power dissipation in pass transistor Q_4.

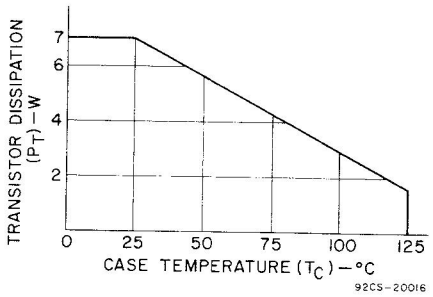


Fig. 4—Allowable power dissipation in driver transistor Q_2 (due to external drive current).

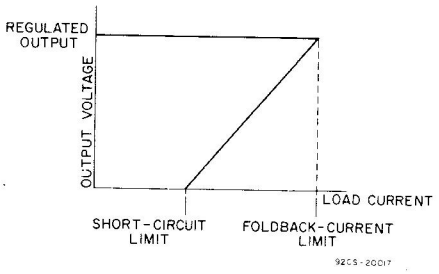


Fig. 5—Typical foldback characteristic for all types.

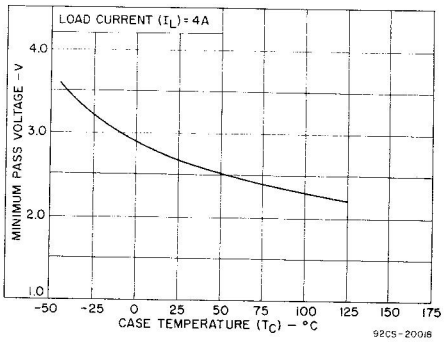


Fig. 6—Typical input-output voltage differential vs. case temperature.

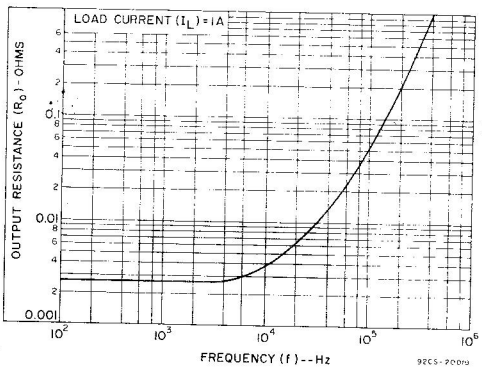


Fig. 7—Output resistance vs. frequency.

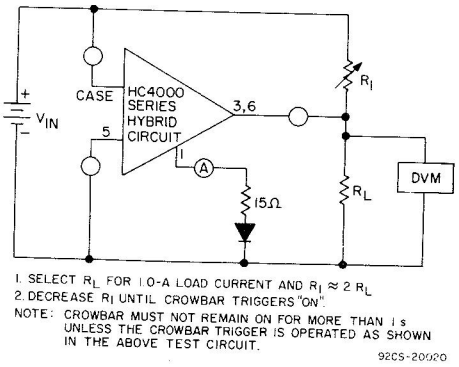


Fig. 8—Crowbar test circuit.

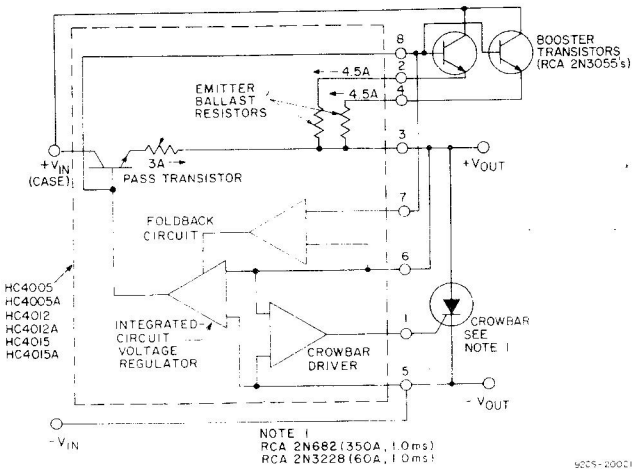


Fig. 9—HC4000-series module connected as a 12-A series regulator.

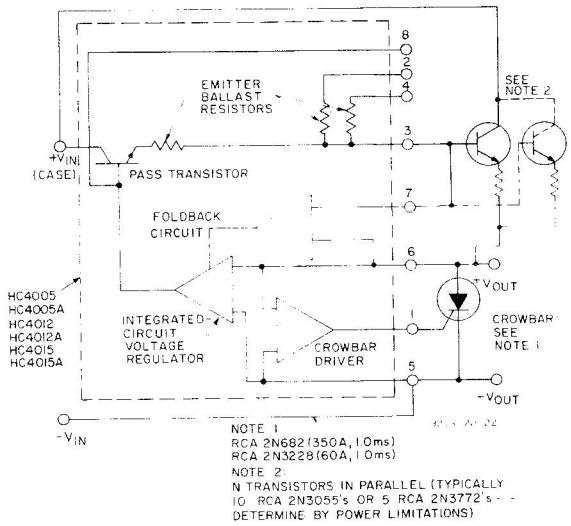


Fig. 10—HC4000-series module connected as a 40-A series regulator.

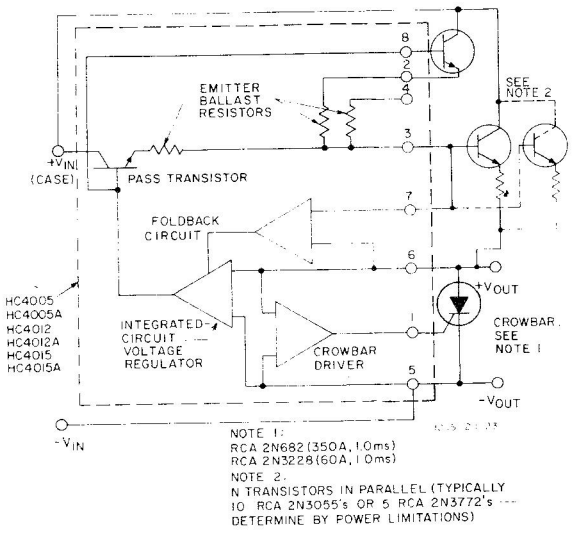


Fig. 11—HC4000-series module connected as a 100-A series regulator.

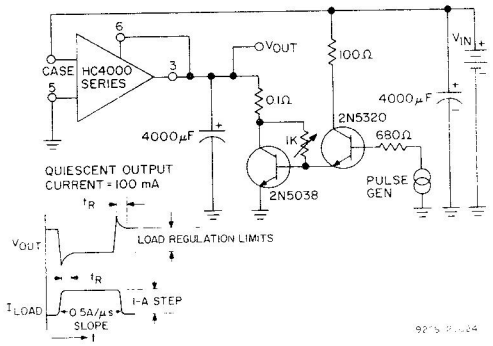


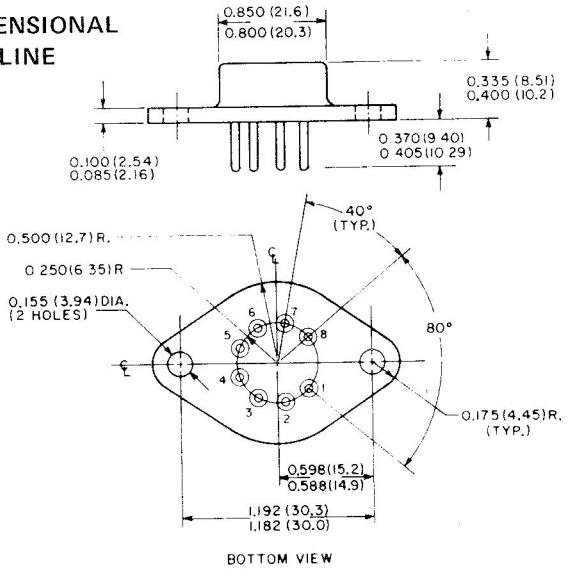
Fig. 12—Recovery-time test circuit with associated waveforms.

HANDLING CONSIDERATIONS

1. The leads of the 8-lead package should not be bent more than 15° from their centerline, nor with a radius of curvature less than 10 diameters at any point.
2. Leads should not be sheared closer than 0.150-inch from the seating plane.
3. Leads should be sheared after attachment whenever possible. When leads must be sheared before mounting, they should be passed through a hardened die of thickness determined by (2) above. This die should constrain each lead from lateral and axial deflection during shearing.

When incorporating RCA Solid State Devices in equipment, it is recommended that the designer refer to "Operating Considerations for RCA Solid State Devices", Form No. 1CE-402,

DIMENSIONAL OUTLINE



DIMENSIONS IN INCHES AND MILLIMETERS.
MILLIMETER VALUES IN PARENTHESES.

92CS-17623R1

TERMINAL CONNECTIONS

See Fig. 1.

Socket:
RCA-DF-263A

3.72/2326-5.72