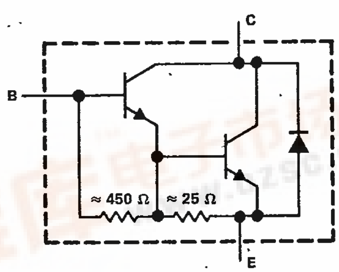
TIP663, TIP664, TIP665
N-P-N DARLINGTON-CONNECTED SILICON POWER TRANSISTORS

REVISED OCTOBER 1984

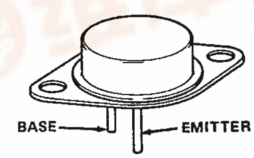
T-33-29

- 150 W at 100°C Case Temperature
- 20 A Continuous Collector Current
- Min h_{FE}...250 at 5 V, 10 A
- Forward-Bias SOA...30 V, 5 A
- Reverse-Bias SOA...300 V to 400 V, 10 A
- High-Voltage, High Forward and Clamped Reverse Energy
- Designed for Ignition Systems, Motor Controls, and Solenoid Driver Applications

device schematic



TO-3 PACKAGE



THE COLLECTOR IS IN ELECTRICAL CONTACT WITH THE CASE

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	TIP663	TIP664	TIP665
Collector-base voltage	400 V	450 V	500 V
Collector-emitter voltage (I_B = 0)	300 V	350 V	400 V
Emitter-base voltage		8 V	
Continuous collector current		20 A	
Peak collector current (see Note 1)		30 A	
Continuous base current		5 A	
Safe operating area at (or below) 25°C case temperature		See Figures 9 and 10	
Continuous device dissipation at (or below) 100°C case temperature (see Note 2)		150 W	
Continuous device dissipation at (or below) 25°C free-air temperature (see Note 3)		5.5 W	
Operating collector junction and storage temperature range		– 65°C to 200°C	
Lead temperature 3,2 mm (0.125 inch) from case for 10 seconds		300°C	

NOTES: 1. This value applies for $t_w \leq 5$ ms, duty cycle $\leq$ 10%.
2. Derate linearly to 200°C case temperature at the rate of 1.5 W/°C or refer to Dissipation Derating Curve, Figure 9.
3. Derate linearly to 200°C free-air temperature at the rate of 31.4 mW/°C or refer to Dissipation Derating Curve, Figure 10.

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electrical characteristics at 25°C case temperature

PARAMETER	TEST CONDITIONS		TIP663 MIN	TIP663 TYP	TIP663 MAX	TIP664 MIN	TIP664 TYP	TIP664 MAX	TIP665 MIN	TIP665 TYP	TIP665 MAX	UNIT
$V_{(BR)CBO}$	$I_C = 1\,mA$, See Note 4	$I_E = 0$,	400			450			500			V
$V_{(BR)CEO}$	$I_C = 10\,mA$, See Note 4	$I_B = 0$,	300			350			400			V
$V_{CEX(sus)}$	$I_C = 20\,A$,	See Figure 1	300			350			400			V
I_{CEO}	$V_{CE} = 250\,V$,	$I_B = 0$			250							μA
	$V_{CE} = 300\,V$,	$I_B = 0$						250				
	$V_{CE} = 350\,V$,	$I_B = 0$									250	
I_{CES}	$V_{CE} = 350\,V$,	$V_{BE} = 0$			250							μA
	$V_{CE} = 400\,V$,	$V_{BE} = 0$						250				
	$V_{CE} = 450\,V$,	$V_{BE} = 0$									250	
I_{EBO}	$V_{EB} = 8\,V$,	$I_C = 0$			50			50			50	mA
h_{FE}	$V_{CE} = 5\,V$, See Notes 4 and 5	$I_C = 5\,A$,	500		10000	500		10000	500		10000	
	$V_{CE} = 5\,V$, See Notes 4 and 5	$I_C = 10\,A$,	250			250			250			
	$V_{CE} = 5\,V$, See Notes 4 and 5	$I_C = 20\,A$,	25			25			25			
$V_{BE(sat)}$	$I_B = 1\,A$, See Notes 4 and 5	$I_C = 10\,A$,			2.1			2.1			2.1	V
	$I_B = 1\,A$, See Notes 4 and 5	$I_C = 20\,A$,			2.5			2.5			2.5	
$V_{CE(sat)}$	$I_B = 400\,mA$, See Notes 4 and 5	$I_C = 10\,A$,			1.3			1.3			1.3	V
	$I_B = 1\,A$, See Notes 4 and 5	$I_C = 20\,A$,			3			3			3	
V_F	$I_F = 20\,A$,	See Notes 4 and 5			3.5			3.5			3.5	V
h_{fe}	$V_{CE} = 5\,V$, $f = 1\,kHz$	$I_C = 1\,A$,	1000			1000			1000			
$\lvert h_{fe} \rvert$	$V_{CE} = 5\,V$, $f = 5\,MHz$	$I_C = 1\,A$,	2			2			2			
C_{obo}	$V_{CB} = 10\,V$, $f = 1\,MHz$	$I_E = 0$,			250			250			250	pF

NOTES: 4. These parameters must be measured using pulse techniques, $t_w = 300\,\mu s$, duty cycle $\leq 2\%$.
5. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts located within 3,2 mm (0.125 inch) from the device body.

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$				0.67	°C/W
$R_{\theta JA}$				31.8	
$R_{\theta CHS}$	See Note 6	0.4			

NOTE 6: This parameter is measured using 0,08 mm (0.003 inch) mica insulator with Dow-Corning 11 compound on both sides of the insulator, a 0.138-32 (formerly 6-32) mounting screw with bushing, and a mounting torque of 0.9 newton-meter (8 inch-pounds).

resistive-load switching characteristic at 25°C case temperature

PARAMETER	TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_d	$I_C = 10\,A$, $I_{B1} = 400\,mA$, $I_{B2} = -440\,mA$, $V_{BE(off)} = -7.1\,V$, $R_L = 25\,\Omega$, See Figure 2		0.05		μs
t_r			0.22		
t_s			6.5		
t_f			1.3		

† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

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TIP Devices

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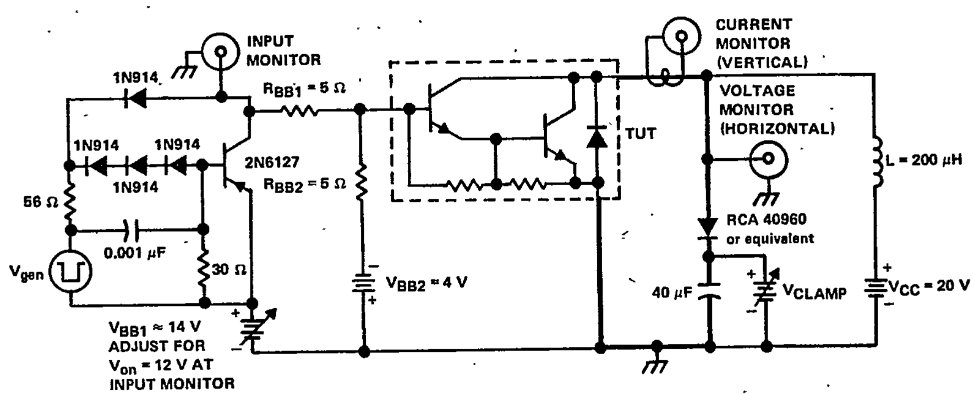
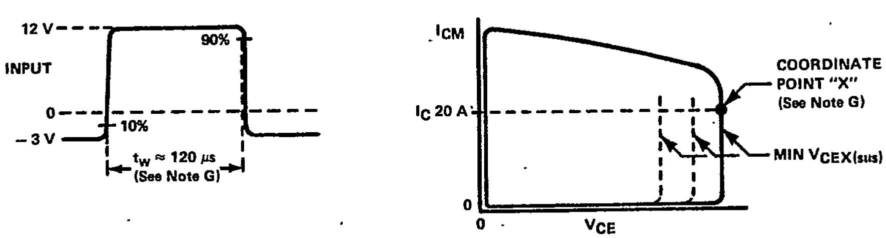
functional tests at 25°C case temperature

TEST	CONDITIONS	LEVEL
Power ($V_{CE} \bullet I_C$)	V_{CE} = 30 V, I_C = 5 A, t_{test} = 1 s	150 W
Reverse Pulse Energy $\left(\frac{I_C{}^2L}{2}\right)$	I_{CM} = 25 A, L = 100 μH, f = 10 Hz, t_{test} = 0.5 s, See Figure 3	31.2 mJ
Forward Pulse Energy $\left(\frac{I_C{}^2L}{2}\right)$	I_{CM} = 8 A, L = 10 mH, V_{clamp} = 320 V, f = 75 Hz, t_{test} = 0.5 s, See Figure 4	320 mJ

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



INPUT WAVEFORM AND X-Y DISPLAY

NOTES: A. V_{gen} is a −20-V pulse into a 50 Ω termination.
B. The V_{gen} waveform is supplied by a generator with the following characteristics: $t_r \leq 15$ ns, $t_f \leq 15$ ns, Z_{out} = 50 Ω, t_w = 120 μs, duty cycle ≤ 2%.
C. Waveforms are monitored on an x-y oscilloscope with the following characteristics: $t_r \leq 15$ ns, $R_{in} \geq 10$ MΩ, $C_{in} \leq 11.5$ pF.
D. Resistors must be noninductive types.
E. The d-c power supplies may require additional bypassing in order to minimize ringing.
F. Heavy lines denote copper bus 12,7 mm by 3,2 mm (0.5 inch by 0.125 inch) fabricated to have minimum inductance.
G. Adjust input pulse duration until collector current is 20 A at point "X". I_{CM} must not exceed 30 A.

FIGURE 1. COLLECTOR-EMITTER SUSTAINING VOLTAGE TEST

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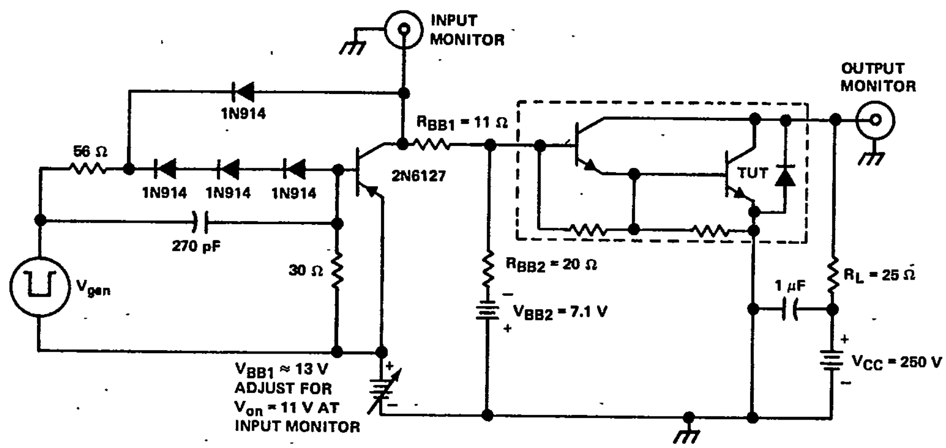
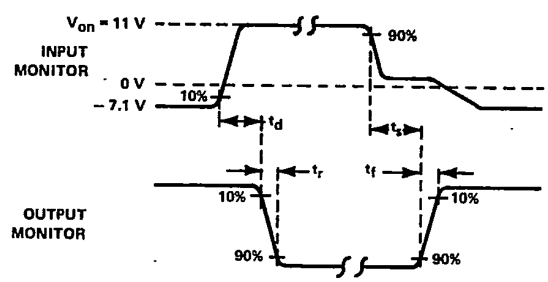
PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTES: A. V_{gen} is a − 30-V pulse into a 50 Ω termination.
B. The V_{gen} waveform is supplied by a generator with the following characteristics: $t_r \leq 15$ ns, $t_f \leq 15$ ns, $Z_{out} = 50\,\Omega$, $t_w = 20\,\mu s$, duty cycle ≤ 2%.
C. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 15$ ns, $R_{in} \geq 10$ MΩ, $C_{in} \leq 11.5$ pF.
D. Resistors must be noninductive types.
E. The d-c power supplies may require additional bypassing in order to minimize ringing.

FIGURE 2. RESISTIVE-LOAD SWITCHING

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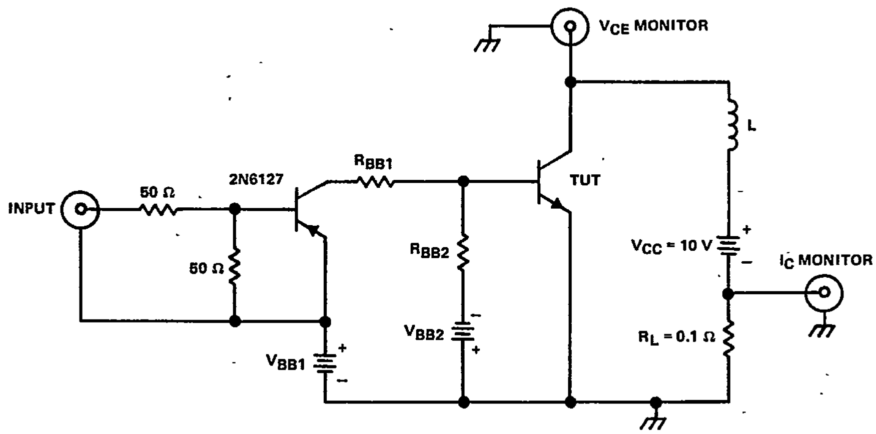
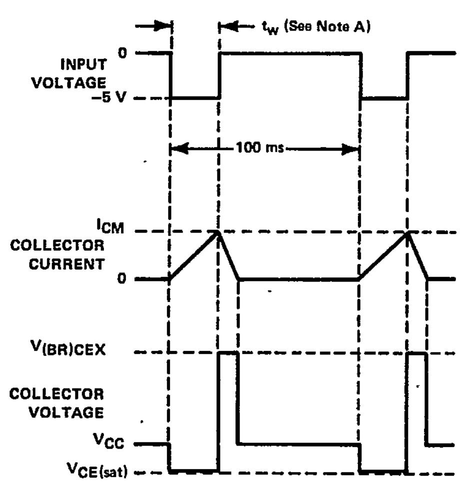
FUNCTIONAL TEST INFORMATION



TEST CIRCUIT



VOLTAGE AND CURRENT WAVEFORMS

NOTES: A. Input pulse duration is increased until the peak collector current reaches the specified value of I_{CM}.
B. Circuit shown is for testing n-p-n transistors. For p-n-p transistors, all voltage supplies and waveforms are reversed and the driver transistor is type 2N6128.

FIGURE 3. REVERSE PULSE ENERGY TEST

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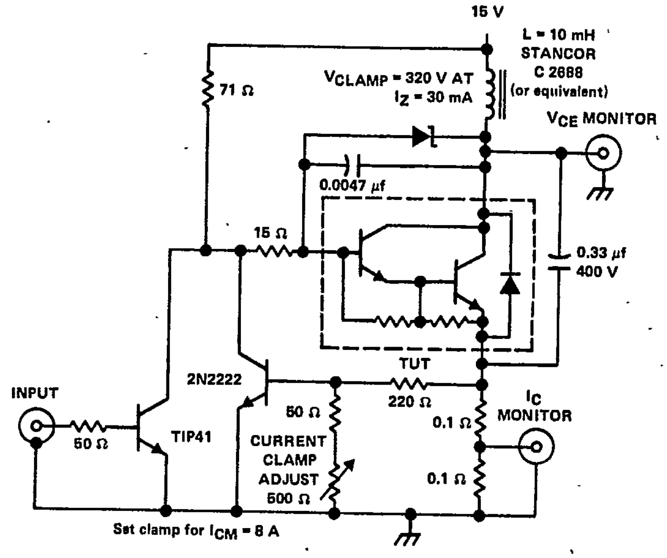
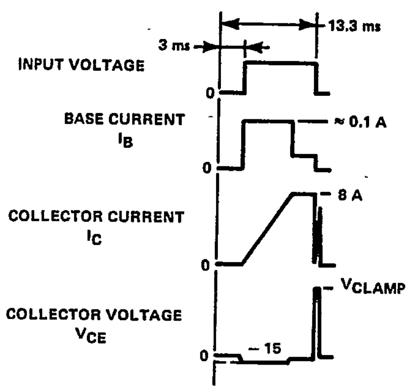
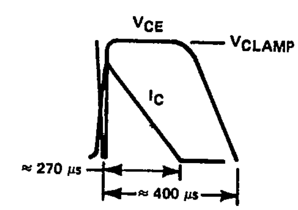
FUNCTIONAL TEST INFORMATION



TEST CIRCUIT



WAVEFORMS



COLLECTOR VOLTAGE AND COLLECTOR CURRENT WAVEFORM DETAIL

NOTES: A. Base and collector currents are measured using current probes such as Tektronix types P6019, P6020, P6021, P6042 or the equivalent.
B. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 20$ ns, $R_{in} \geq 10$ MΩ, $C_{in} \leq 11.5$ pF.

FIGURE 4. FORWARD PULSE ENERGY TEST

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TYPICAL CHARACTERISTICS

TIP665
COLLECTOR CUTOFF CURRENT
vs
CASE TEMPERATURE

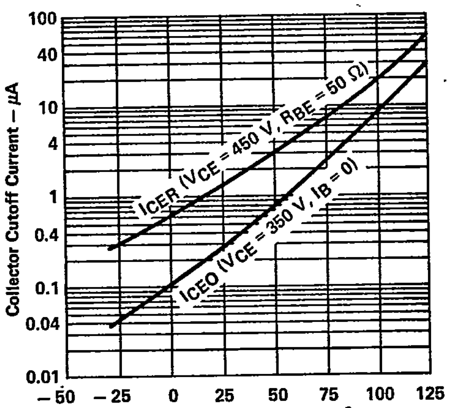

FIGURE 5

STATIC FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

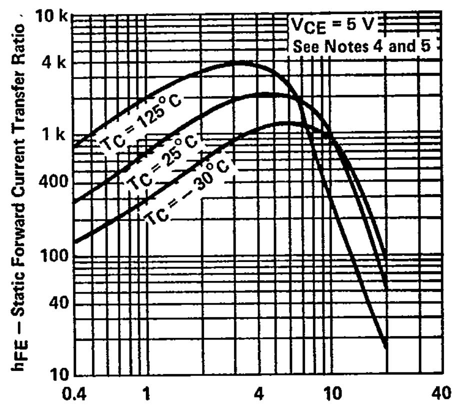

FIGURE 6

BASE-EMITTER VOLTAGE
vs
COLLECTOR CURRENT

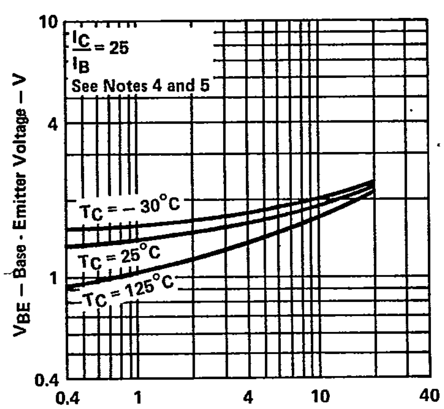

FIGURE 7

COLLECTOR-EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT

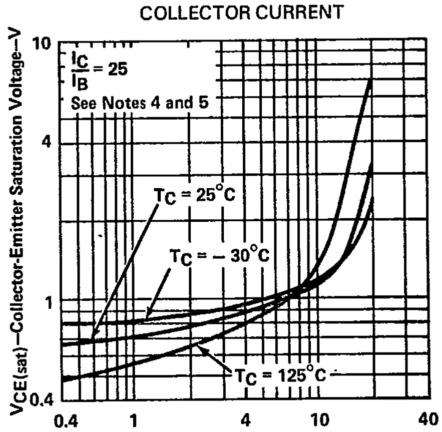

FIGURE 8

NOTES: 4. These parameters must be measured using pulse techniques, t_W = 300 μs, duty cycle ≤ 2%.
5. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts located within 3,2 mm (0.125 inch) from the device body.

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MAXIMUM SAFE OPERATING AREA

FORWARD-BIAS SAFE OPERATING AREA

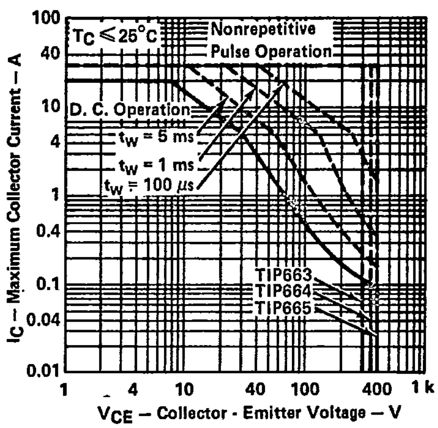

FIGURE 9

REVERSE-BIAS SAFE OPERATING AREA

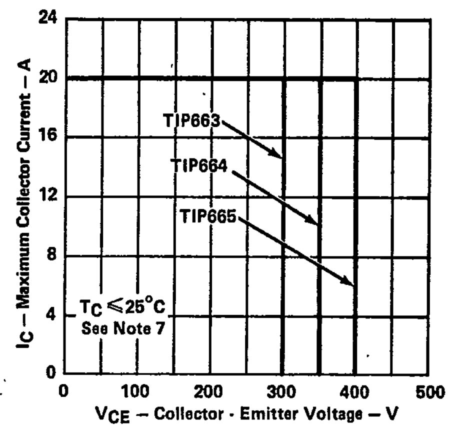

FIGURE 10

NOTE 7: This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load as in Figure 1.

THERMAL INFORMATION

CASE TEMPERATURE
DISSIPATION DERATING CURVE

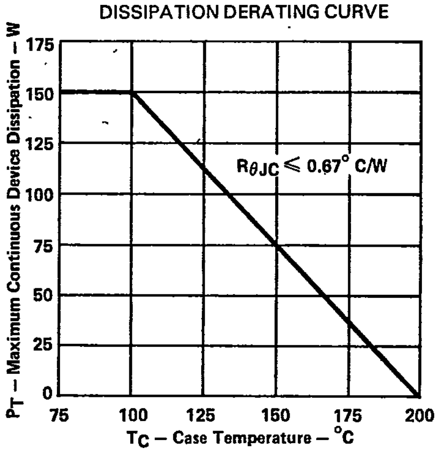

FIGURE 11

FREE-AIR TEMPERATURE
DISSIPATION DERATING CURVE

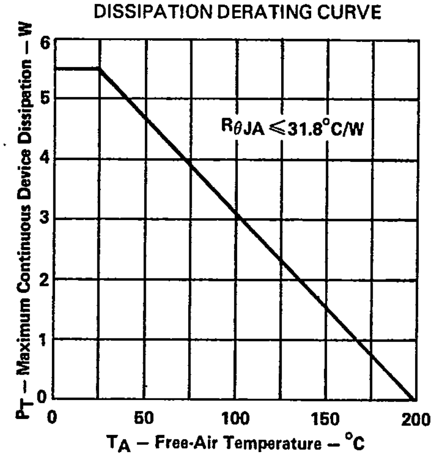

FIGURE 12

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