THAT Corporation

Low-Noise Matched Transistor Array ICs

THAT 300 Series

FEATURES

- 4 Matched NPN Transistors
  - 300 typical h_{fe} of 100
  - 300A minimum h_{fe} of 150
  - 300B minimum h_{fe} of 300
- 4 Matched PNP Transistors
  - 320 typical h_{fe} of 75
- 2 Matched PNP and 2 Matched NPN Transistors
  - 340 PNP typical h_{fe} of 75
  - 340 NPN typical h_{fe} of 100
- Low Voltage Noise
  - 0.75 nV/√Hz (PNP)
  - 0.8 nV/√Hz (NPN)
- High Speed
  - f_T = 350 MHz (NPN)
  - f_T = 325 MHz (PNP)
- 500 μV matching between devices
- Dielectrically Isolated for low crosstalk and high DC isolation
- 36V V_{CEO}

APPLICATIONS

- Low Noise Front Ends
- Microphone Preamplifiers
- Log/Antilog Amplifiers
- Current Sources
- Current Mirrors
- Multipliers

Description

The THAT 300, 320 and 340 are large geometry, 4-transistor, monolithic NPN and/or PNP arrays. They exhibit both high speed and low noise, with excellent parameter matching between transistors of the same gender. Typical base-spreading resistance is 25 Ω for the PNP devices (30 Ω for the low-gain NPNs), so their resulting voltage noise is under 1 nV/√Hz. This makes the 300 series ideally suited for low-noise amplifier input stages, log amplifiers, and many other applications. The four-NPN transistor array is available in versions selected for h_{fe} with minimums of 150 (300A) or 300 (300B).

Fabricated in a dielectrically isolated, complementary bipolar process, each transistor is electrically insulated from the others by a layer of insulating oxide (not the reverse-biased PN junctions used in conventional arrays). As a result, they exhibit inter-device crosstalk and DC isolation similar to that of discrete transistors. The resulting low collector-to-substrate capacitance produces a typical NPN f_T of 350 MHz (325 MHz for the PNPs). Substrate biasing is not required for normal operation, though the substrate should be ac-grounded to optimize speed and minimize crosstalk.

An eight-transistor bare-die array with similar performance characteristics (the THAT 380G) is also available from THAT Corporation. Please contact us directly or through your local distributor for more information. Military-grade temperature range packages are available from TT Semiconductor (see www.ttsemiconductor.com for more information).

Part Number	Configuration	Package
300P14-U	4-Matched NPN Transistors, Beta = 60 min.	DIP14
300S14-U		SO14
300AS14-U	4-Matched NPN Transistors, Beta = 150 min.	SO14
300BS14-U	4-Matched NPN Transistors, Beta = 300 min.	SO14
320P14-U	4-Matched PNP Transistors	DIP14
320S14-U		SO14
340P14-U	2-Matched NPN Transistors and 2-Matched PNP Transistors	DIP14
340S14-U		SO14

Table 1. Ordering Information

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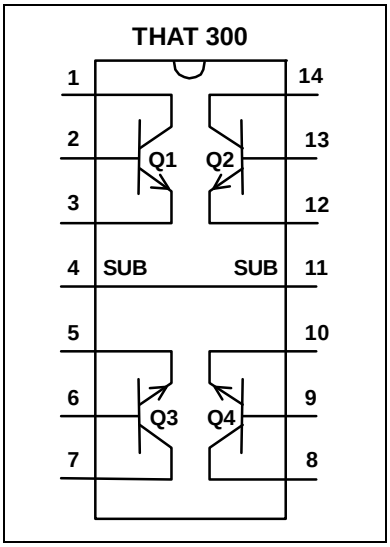

Figure 1. 300 Pinout

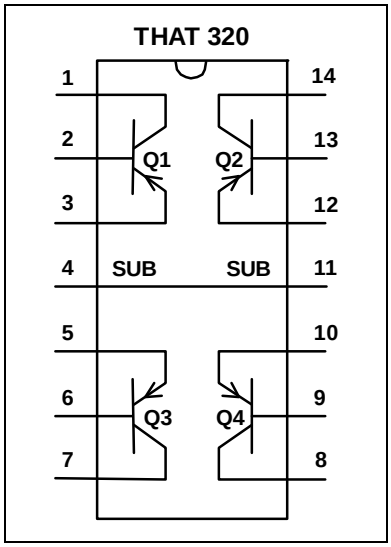

Figure 2. 320 Pinout

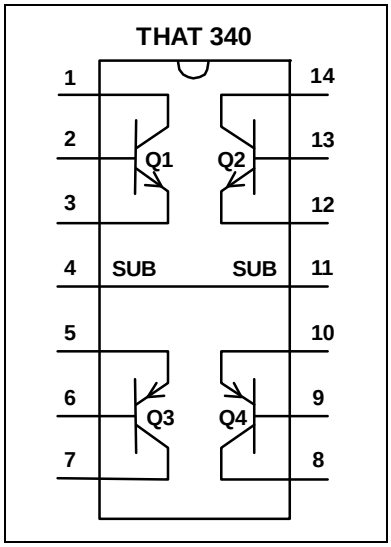

Figure 3. 340 Pinout

SPECIFICATIONS[1]

Absolute Maximum Ratings[2,3]

NPN Collector-Emitter Voltage (BV_{CEO})	36 V	Collector Current	30 mA
NPN Collector-Base Voltage (BV_{CBO})	36V	Emitter Current	30 mA
PNP Collector-Emitter Voltage (BV_{CEO})	–36 V	Operating Temperature Range (T_{OP})	-40 to +85 °C
PNP Collector-Base Voltage (BV_{CBO})	–36 V	Maximum Junction Temperature (T_{JMAX})	+125 °C
Collector-Substrate Voltage (BV_{CS})	± 100 V	Storage Temperature (T_{ST})	-45 to +125 °C

NPN Electrical Characteristics[2]

Parameter	Symbol	Conditions	300 / 340(Q1,Q2)			300A			300B			Units
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
NPN Current gain	h_{fe}	V_{CB} = 10 V, I_C = 1 mA I_C = 10 µA	60 —	100 100	— —	150 —	— —	— —	300 —	— —	— —	
NPN Current Gain Matching	Δh_{fe}	V_{CB} = 10V, I_C = 1mA	—	4	—	—	4	—	—	4	—	%
NPN Noise Voltage Density	e_N	V_{CB} = 10V, I_C = 1 mA, 1kHz	—	0.8	—	—	0.9	—	—	1	—	nV√Hz
NPN Gain-Bandwidth Product	f_T	I_C = 1 mA, V_{CB} = 10V	—	350	—	—	350	—	—	350	—	MHz
NPN ΔV_{BE} 300: $\lvert V_{BE1}-V_{BE2}\rvert$; $\lvert V_{BE3}-V_{BE4}\rvert$ 340: $\lvert V_{BE1}-V_{BE2}\rvert$	V_{OS}	I_C = 1 mA I_C = 10 mA	— —	0.5 0.5	3 —	— —	0.5 0.5	3 —	— —	0.5 0.5	3 —	mV mV
NPN ΔI_B 300: $\lvert I_{B1}-I_{B2}\rvert$; $\lvert I_{B3}-I_{B4}\rvert$ 340: $\lvert I_{B1}-I_{B2}\rvert$	I_{OS}	I_C = 1 mA I_C = 10 µA	— —	500 5	1500 —	— —	200 2	600 —	— —	100 1	300 —	nA nA
NPN Collector-Base Leakage Current	I_{CBO}	V_{CB} = 25 V	—	25	—	—	25	—	—	25	—	pA
NPN Bulk Resistance	r_{BE}	V_{CB} = 0V, 10 µA < I_C < 10mA	—	2	—	—	2	—	—	2	—	Ω
NPN Base Spreading Resistance	r_{bb}	V_{CB} = 10 V, I_C = 1 mA	—	32	—	—	32	—	—	32	—	Ω
NPN Collector Saturation Voltage	$V_{CE(SAT)}$	I_C = 1 mA, I_B = 100µA	—	0.05	—	—	0.05	—	—	0.05	—	V

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SPECIFICATIONS[1] (Cont'd)

NPN Electrical Characteristics[2] (cont'd)

Parameter	Symbol	Conditions	300 / 340(Q1,Q2)			300A			300B			Units
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
NPN Output Capacitance	C_{OB}	V_{CB} = 10V, I_E = 0mA, 100kHz	—	3	—	—	3	—	—	3	—	pF
NPN Breakdown Voltage	BV_{CEO}	I_C = 10 µAdc, I_B = 0	36	40	—	36	40	—	36	40	—	V
Input Capacitance	C_{EBO}	I_C = 0 mA, V_{EB} = 0 V	—	5	—	—	5	—	—	5	—	pF

PNP Electrical Characteristics[2]

Parameter	Symbol	Conditions	Min	Typ	Max	Units
PNP Current Gain	h_{fe}	V_{CB} = -10 V				
		I_C = -1 mA	50	75	—	
		I_C = -10 µA	—	75	—	
PNP Current Gain Matching	Δh_{fe}	V_{CB} = -10 V, I_C = -1 mA	—	5	—	%
PNP Noise Voltage Density	e_N	V_{CB} = -10 V, I_C = -1 mA, 1 kHz	—	0.75	—	nV√Hz
PNP Gain-Bandwidth Product	f_T	I_C = -1 mA, V_{CB} = -10 V	—	325	—	MHz
PNP ΔV_{BE}	V_{OS}	I_C = -1 mA	—	0.5	3	mV
320: $\lvert V_{BE1}-V_{BE2}\rvert$; $\lvert V_{BE3}-V_{BE4}\rvert$		I_C = -10 µA	—	0.5	—	mV
340: $\lvert V_{BE1}-V_{BE2}\rvert$						
PNP ΔI_B	I_{OS}	I_C = -1 mA	—	700	1800	nA
320: $\lvert I_{B1}-I_{B2}\rvert$; $\lvert I_{B3}-I_{B4}\rvert$		I_C = -10 µA	—	7	—	nA
340: $\lvert I_{B1}-I_{B2}\rvert$						
PNP Collector-Base Leakage Current	I_{CBO}	V_{CB} = -25 V	—	–25	—	pA
PNP Bulk Resistance	r_{BE}	V_{CB} = 0 V, -10µA > I_C> -10 mA	—	2	—	Ω
PNP Base Spreading Resistance	r_{bb}	V_{CB} = -10 V, I_C = -1 mA	—	25	—	Ω
PNP Collector Saturation Voltage	$V_{CE(SAT)}$	I_C = -1 mA, I_B = -100 µA	—	–0.05	—	V
PNP Output Capacitance	C_{OB}	V_{CB} = -10 V, I_E = 0 mA, 100 kHz	—	3	—	pF
PNP Breakdown Voltage	BV_{CEO}	I_C = -10 µAdc, I_B = 0	-36	-40	—	V
Input Capacitance	C_{EBO}	I_C = 0 mA, V_{EB} = 0 V	—	6	—	pF

1. All specifications are subject to change without notice.
2. Unless otherwise noted, T_A = 25ºC.
3. Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only; the functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

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Packaging and Soldering Information

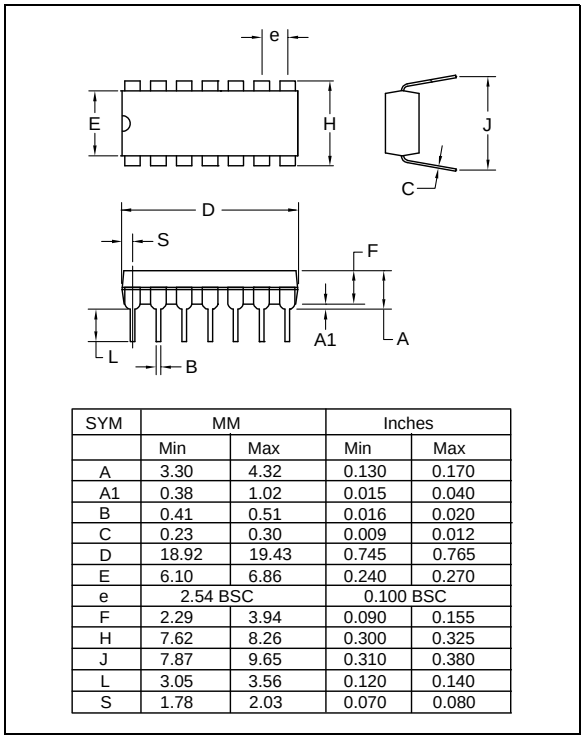
The THAT 300, 320 and 340 are available in 14-pin PDIP and 14-pin surface mount (SOIC) packages. Package dimensions are shown below.

The 300-series packages are entirely lead-free. The lead-frames are copper, plated with successive layers of nickel, palladium, and gold. This approach makes it possible to solder these devices using lead-free and lead-bearing solders.

Neither the lead-frames nor the plastic mold compounds used in the 300-series contains any hazardous substances as specified in the European Union's Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment 2002/95/EG of January 27, 2003. The surface-mount package is suitable for use in a 100% tin solder process.

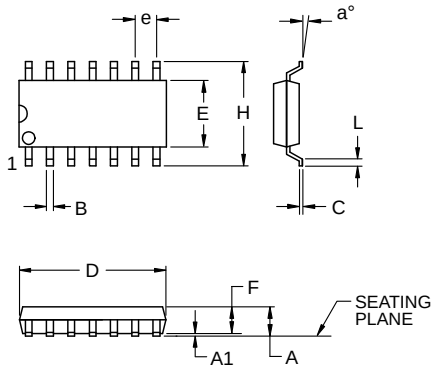
Package Characteristics

Parameter	Symbol	Conditions	Typ	Units
Through-hole package		See Fig. 4 for dimensions	14 Pin PDIP	
Thermal Resistance	θ_{JA}	DIP package soldered to board	100	ºC/W
Environmental Regulation Compliance		Complies with January 27, 2003 RoHS requirements		
Surface mount package		See Fig. 5 for dimensions	14 Pin SOP	
Thermal Resistance	θ_{JA}	SO package soldered to board	100	ºC/W
Soldering Reflow Profile			JEDEC JESD22-A113-D (250 ºC)	
Moisture Sensitivity Level	MSL	Above-referenced JEDEC soldering profile	1	
Environmental Regulation Compliance			Complies with RoHS requirements	



SYM	MM		Inches	
	Min	Max	Min	Max
A	3.30	4.32	0.130	0.170
A1	0.38	1.02	0.015	0.040
B	0.41	0.51	0.016	0.020
C	0.23	0.30	0.009	0.012
D	18.92	19.43	0.745	0.765
E	6.10	6.86	0.240	0.270
e	2.54 BSC		0.100 BSC	
F	2.29	3.94	0.090	0.155
H	7.62	8.26	0.300	0.325
J	7.87	9.65	0.310	0.380
L	3.05	3.56	0.120	0.140
S	1.78	2.03	0.070	0.080

Figure 4. Dual-In-Line Package Outline



	MM		Inches	
SYM	Min	Max	Min	Max
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
B	0.36	0.48	0.014	0.019
C	0.18	0.25	0.007	0.010
D	8.53	8.79	0.336	0.346
E	3.81	4.01	0.150	0.158
e	1.27 BSC		0.050 BSC	
F	1.09	1.65	0.043	0.065
H	5.84	6.20	0.230	0.244
L	0.41	0.89	0.016	0.035
a°	0°	8°	0°	8°

Figure 5. Surface-Mount Package Outline

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THAT Corporation ICs are not designed for use in life support equipment where a malfunction of our ICs might reasonably result in injury or death. Customers who use or sell our ICs for such life suport application do so at their own risk, and shall hold THAT Corporation harmless from any and all claims, damages, suits, or expenses resulting from such use or sale.

CAUTION: THIS IS AN ESD (ELECTROSTATIC DISCHARGE) SENSITIVE DEVICE

Electrostatic charges in the range of several kV can accumulate on the human body as well as test and assembly equipment. This device can be damaged by the currents generated by electrostatic discharge from bodies and equipment. Moreover, the transistors in this device are unprotected in order to maximize performance and flexibility. Accordingly, they are more sensitive to ESD damage than many other ICs which include protection devices at their inputs. Note that all of the pins are susceptible.

Use ESD-preventative measures when storing and handling this device. Unused devices should be stored in conductive packaging. Packaging should be discharged to the destination socket before the devices are removed from their packages. ESD damage can occur to these devices even after they are installed in a board-level assembly. Circuits should include specific and appropriate ESD protection.

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Revision History

Revision	ECO	Date	Changes	Page
00	—	April 2004	Release	
01	2393	April 2010	Changed Max. Operating Temperature from 70 °C to 85 °C.	2
02	2460	Sept. 2010	-Added high h_{fe} versions Models 300A and 300B with accompanying specifications and information. -Revised Features, Applications, and Description sections -Revised Maximum Rating section -Added NPN Breakdown Voltage spec. -Added PNP Breakdown Voltage spec. -Added Packaging Characteristics Table. -Revised disclaimer text	— 1 2 3 3 4 5
03	2760	Mar. 2013	-Corrected surface mount package drawing. -Filled in 300A/B NPN Base Spreading Resistance spec. -Corrected error in PNP Breakdown Voltage conditions.	4 2 3
04	2834	Nov. 2013	-Corrected through-hole package drawing.	4

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