SERIES 24 AND 28
STANDARD AND LOW POWER PROGRAMMABLE READ-ONLY MEMORIES

SEPTEMBER 1979—REVISED AUGUST 1984

- **Expanded Family of Standard and Low Power PROMs**
- **Titanium-Tungsten (Ti-W) Fuse Links for Reliable Low-Voltage Full-Family-Compatible Programming**
- **Full Decoding and Fast Chip Select Simplify System Design**
- **P-N-P Inputs for Reduced Loading On System Buffers/Drivers**
- **Each PROM Supplied With a High Logic Level Stored at Each Bit Location**
- **Applications Include:**
  Microprogramming/Firmware Loaders
  Code Converters/Character Generators
  Translators/Emulators
  Address Mapping/Look-Up Tables

description

The 24 and 28 Series of monolithic TTL programmable read-only memories (PROMs) feature an expanded selection of standard and low-power PROMs. This expanded PROM family provides the system designer with considerable flexibility in upgrading existing designs or optimizing new designs. Featuring proven titanium-tungsten (Ti-W) fuse links with low-current MOS-compatible p-n-p inputs, all family members utilize a common programming technique designed to program each link with a 20-microsecond pulse.

The 4096-bit and 8192-bit PROMs are offered in a wide variety of packages ranging from 18-pin 300 mil-wide thru 24 pin 600 mil-wide. The 16,384-bit PROMs provide twice the bit density of the 8192-bit PROMs and are provided in a 24 pin 600 mil-wide package.

All PROMs are supplied with a logic-high output level stored at each bit location. The programming procedure will produce open-circuits in the Ti-W metal links, which reverses the stored logic level at the selected location. The procedure is irreversible; once altered, the output for that bit location is permanently programmed. Outputs that have never been altered may later be programmed to supply the opposite output level. Operation of the unit within the recommended operating conditions will not alter the memory content.

Active level(s) at the chip-select input(s) (S or $\overline{S}$) enables all of the outputs. An inactive level at any chip-select input causes all outputs to be in the three-state, or off condition.

standard PROMs

The standard PROM members of Series 24 and 28 offer high performance for applications which require the uncompromised speed of Schottky technology. The fast chip-select access times allow additional decoding delays to occur without degrading speed performance.

TYPE NUMBER	PACKAGE† AND TEMPERATURE RANGE DESIGNATORS	OUTPUT CONFIGURATION‡	BIT SIZE (ORGANIZATION)	TYPICAL PERFORMANCE		
				ACCESS TIMES		POWER DISSIPATION
				ADDRESS	SELECT	
TBP24S10	MJ, J, N	▽	1024 Bits (256W × 4B)	35 ns	20 ns	375 mW
TBP24SA10	MJ, J, N	◇				
TBP28S42	MJ, J, N	▽	4096 Bits (512W × 8B)	35 ns	20 ns	500 mW
TBP28SA42	MJ, J, N	◇				
TBP28S46	MJW, JW, NW	▽				
TBP28SA46	MJW, JW, NW	◇				
TBP24S41	MJ, J, N	▽	4096 Bits (1024 × 4B)	40 ns	20 ns	475 mW
TBP24SA41	MJ, J, N	◇				
TBP24S81	MJ, J, N	▽	8192 Bits (2048 × 4B)	45 ns	20 ns	625 mW
TBP24SA81	MJ, J, N	◇				
TBP28S86A	MJW, JW, NW	▽	8192 Bits (1024 × 8B)	45 ns	20 ns	625 mW
TBP28SA86A	MJW, JW, NW	◇				
TBP28S2708A	NW	▽				
TBP28S166	NW	▽	16,384 Bits (2048W × 8B)	35 ns	15 ns	650 mW

†MJ and MJW designates full-temperature-range circuits (formerly 54 Family), J, JW, N, and NW designates commercial-temperature-range circuits (formerly 74 Family).
‡ ▽ = three state, ◇ = open collector.

low power PROMs

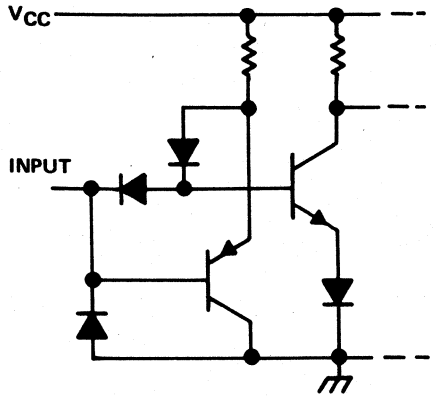
To upgrade systems utilizing MOS EPROMs or MOS PROMs, or when designing new systems which do not require maximum speed, the low-power PROM family offers the output drive and speed performance of bipolar technology, plus reduced power dissipation.

TYPE NUMBER	PACKAGE† AND TEMPERATURE RANGE DESIGNATORS	OUTPUT CONFIGURATION‡	BIT SIZE (ORGANIZATION)	TYPICAL PERFORMANCE		
				ACCESS TIMES		POWER DISSIPATION
				ADDRESS	SELECT	
TBP28L22	MJ, J,N	▽	2048 Bits (256W × 8B)	45 ns	20 ns	375 mW
TBP28LA22	MJ, J, N	◇				
TBP28L42	MJ, J, N	▽	4096 Bits (512W × 8B)	60 ns	30 ns	250 mW
TBP28L46	MJW, JW, NW	▽				
TBP28L86A	MJW, JW, NW	▽	8192 Bits (1024W × 8B)	80 ns	35 ns	350 mW
TBP28L166	NW	▽	16,384 Bits (2084W × 8B)	65 ns	30 ns	350 mW

†MJ and MJW designates full-temperature-range circuits (formerly 54 Family), J, JW, N, and NW designates commercial-temperature-range circuits (formerly 74 Family).
‡ ▽ = three state, ◇ = open collector.

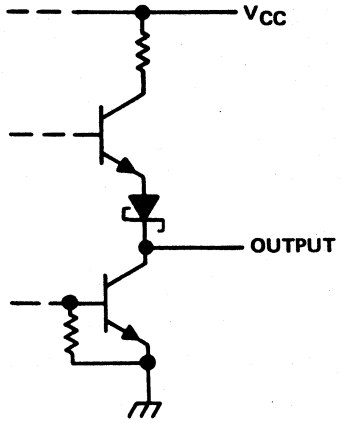
schematics of inputs and outputs

EQUIVALENT OF EACH INPUT



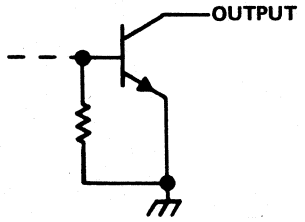
Programming circuit not shown

EQUIVALENT OF 3-STATE OUTPUTS



Programming circuits not shown

EQUIVALENT OF OPEN-COLLECTOR OUTPUTS



Programming circuit not shown

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

Supply voltage (see Note 1) . . . . . 7 V
Input voltage . . . . . 5.5 V
Chip-select peak input voltage (S, S1, S2) (see Note 2) . . . . . 11 V
Off-state output voltage . . . . . 5.5 V
Off-state peak output voltage (see Note 2) . . . . . 16.25 V
Operating free-air temperature range: Full-temperature-range circuits (M suffix) . . −55°C to 125°C
Commercial-temperature-range circuits . . . . . 0°C to 70°C
Storage temperature range . . . . . −65°C to 150°C

NOTES: 1. Voltage values are with respect to network ground terminal.
2. These ratings apply only under the conditions described in the programming procedure.

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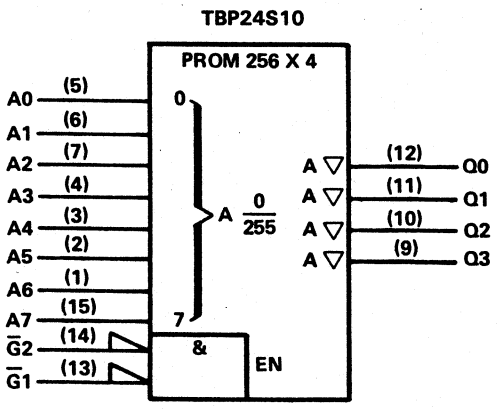
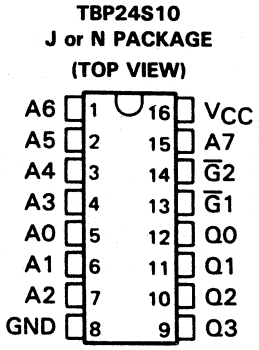
logic symbol



pin assignment



recommended operating conditions

PARAMETER		MJ			J OR N			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
I_{OH}	High-level output current			−2			−6.5	mA
I_{OL}	Low-level output current			16			16	mA
T_A	Operating free-air temperature range	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†		MJ			J OR N			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN,	I_I = −18 mA			−1.2			−1.2	V
V_{OH}	V_{CC} = MIN,	I_{OH} = MAX	2.4	3.1		2.4	3.1		V
V_{OL}	V_{CC} = MIN,	I_{OL} = 16 mA			0.5			0.5	V
I_{OZH}	V_{CC} = MAX,	V_O = 2.4 V			50			50	μA
I_{OZL}	V_{CC} = MAX,	V_O = 0.5 V			−50			−50	μA
I_I	V_{CC} = MAX,	V_I = 5.5 V			1			1	mA
I_{IH}	V_{CC} = MAX,	V_I = 2.7 V			25			25	μA
I_{IL}	V_{CC} = MAX,	V_I = 0.5 V			−0.25			−0.25	mA
I_{OS}§	V_{CC} = MAX		−30		−100	−30		−100	mA
I_{CC}	V_{CC} = MAX			75	100		75	100	mA

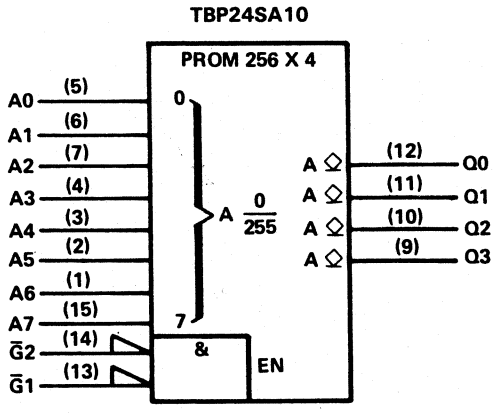
switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MJ			J OR N			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
$t_{a(A)}$	Access time from address	C_L = 30 pF		35	75		35	55	ns
$t_{a(S)}$	Access time from chip select (enable time)	See Note 3		20	40		20	35	ns
t_{dis}	Disable time	C_L = 5 pF See Note 3		15	40		15	35	ns

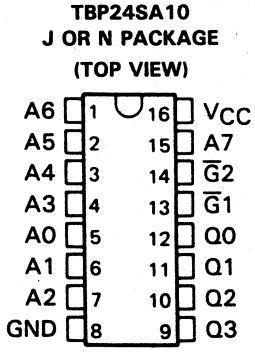
†For conditions shown as MIN or MAX, use appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time, and duration of the short circuit should not exceed one second.
NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

TBP24SA10
1024 BITS (256 WORDS BY 4 BITS)
STANDARD PROGRAMMABLE READ-ONLY MEMORIES WITH OPEN-COLLECTOR OUTPUTS

logic symbol



pin assignment



recommended operating conditions

PARAMETER		MJ			J OR N			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
V_{OH}	High-level output voltage			5.5			5.5	V
I_{OL}	Low-level output current			16			16	mA
T_A	Operating free-air temperature range	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†		MJ			J OR N			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN,	I_I = −18 mA			−1.2			−1.2	V
I_{OH}	V_{CC} = MIN,	V_{OH} = 2.4 V			0.05			0.05	mA
		V_{OH} = 5.5 V			0.1			0.1	
V_{OL}	V_{CC} = MIN,	I_{OL} = 16 mA			0.5			0.45	V
I_I	V_{CC} = MAX,	V_I = 5.5 V			1			1	mA
I_{IH}	V_{CC} = MAX,	V_I = 2.7 V			25			25	μA
I_{IL}	V_{CC} = MAX,	V_I = 0.5 V			−0.25			−0.25	mA
I_{CC}	V_{CC} = MAX			75	100		75	100	mA

switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MJ			J OR N			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
$t_{a(A)}$	Access time from address	C_L = 30 pF		35	75		35	65	ns
$t_{a(S)}$	Access time from chip select (enable time)	R_{L1} = 300 Ω		20	40		20	35	ns
t_{PLH}	Propagation delay time low-to-high-level output from chip select	R_{L2} = 600 Ω See Note 3		15	40		20	35	ns

†For conditions shown as MIN or MAX, use appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

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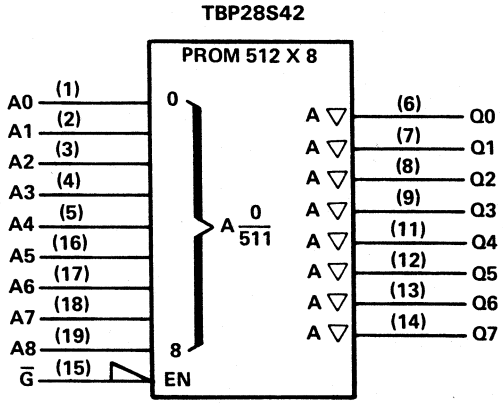
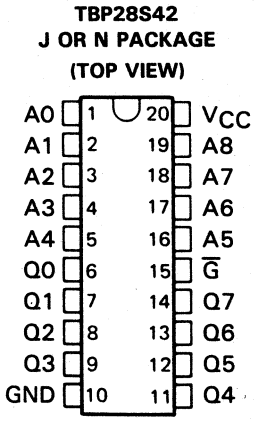
logic symbol



pin assignment



recommended operating conditions

PARAMETER		MJ			J OR N			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
I_{OH}	High-level output current			−2			−6.5	mA
I_{OL}	Low-level output current			16			16	mA
T_A	Operating free-air temperature range	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†		MJ			J OR N			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN,	I_I = −18 mA			−1.2			−1.2	V
V_{OH}	V_{CC} = MIN,	I_{OH} = MAX	2.4	3.1		2.4	3.1		V
V_{OL}	V_{CC} = MIN,	I_{OL} = 16 mA			0.5			0.5	V
I_{OZH}	V_{CC} = MAX,	V_O = 2.4 V			50			50	μA
I_{OZL}	V_{CC} = MAX,	V_O = 0.5 V			−50			−50	μA
I_I	V_{CC} = MAX,	V_I = 5.5 V			1			1	mA
I_{IH}	V_{CC} = MAX,	V_I = 2.7 V			25			25	μA
I_{IL}	V_{CC} = MAX,	V_I = 0.5 V			−0.25			−0.25	mA
I_{OS}§	V_{CC} = MAX		−30		−100	−30		−100	mA
I_{CC}	V_{CC} = MAX			100	135		100	135	mA

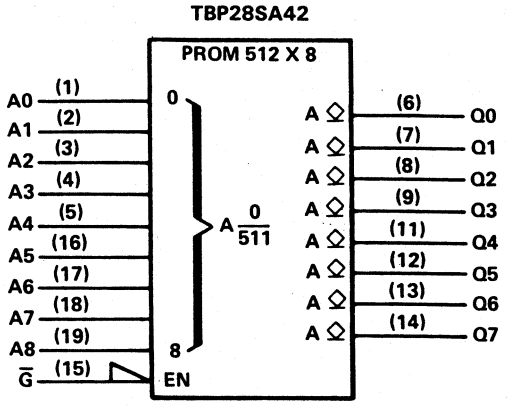
switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MJ			J OR N			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
$t_{a(A)}$	Access time from address	C_L = 30 pF		35	70		35	60	ns
$t_{a(S)}$	Access time from chip select (enable time)	See Note 3		20	45		20	45	ns
t_{dis}	Disable time	C_L = 5 pF See Note 3		15	45		15	40	ns

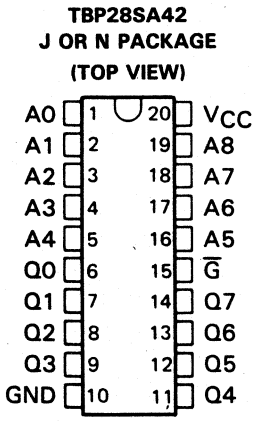
†For conditions shown as MIN or MAX, use appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time, and duration of the short circuit should not exceed one second.
NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

TBP28SA42
4096 BITS (512 WORDS BY 8 BITS)
STANDARD PROGRAMMABLE READ-ONLY MEMORIES WITH OPEN-COLLECTOR OUTPUTS

logic symbol



pin assignment



recommended operating conditions

PARAMETER		MJ			J OR N			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
V_{OH}	High-level output voltage			5.5			5.5	V
I_{OL}	Low-level output current			16			16	mA
T_A	Operating free-air temperature range	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†		MJ			J OR N			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN,	I_I = −18 mA			−1.2			−1.2	V
I_{OH}	V_{CC} = MIN,	V_{OH} = 2.4 V			0.05			0.05	mA
		V_{OH} = 5.5 V			0.1			0.1	
V_{OL}	V_{CC} = MIN,	I_{OL} = 16 mA			0.5			0.5	V
I_I	V_{CC} = MAX,	V_I = 5.5 V			1			1	mA
I_{IH}	V_{CC} = MAX,	V_I = 2.7 V			25			25	μA
I_{IL}	V_{CC} = MAX,	V_I = 0.5 V			−0.25			−0.25	mA
I_{CC}	V_{CC} = MAX			105	135		105	135	mA

switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MJ			J OR N			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
$t_{a(A)}$	Access time from address	C_L = 30 pF, R_{L1} = 300 Ω, R_{L2} = 600 Ω, See Note 3		35	75		35	65	ns
$t_{a(S)}$	Access time from chip select (enable time)			20	45		20	35	ns
t_{PLH}	Propagation delay time low-to-high-level output from chip select			15	45		15	35	ns

†For conditions shown as MIN or MAX, use appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

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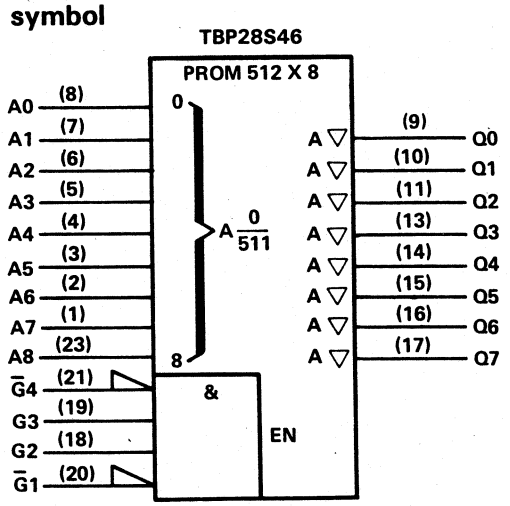
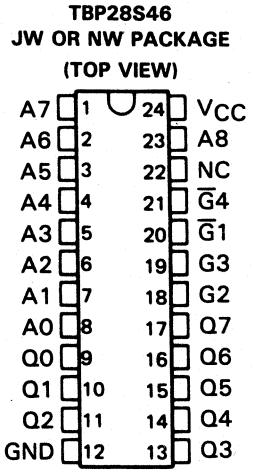
logic symbol



pin assignment



recommended operating conditions

PARAMETER		MJW			JW OR NW			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
I_{OH}	High-level output current			−2			−6.5	mA
I_{OL}	Low-level output current			16			16	mA
T_A	Operating free-air temperature range	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†		MJW			JW OR NW			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN,	I_I = −18 mA			−1.2			−1.2	V
V_{OH}	V_{CC} = MIN,	I_{OH} = MAX	2.4	3.1		2.4	3.1		V
V_{OL}	V_{CC} = MIN,	I_{OL} = 16 mA			0.5			0.5	V
I_{OZH}	V_{CC} = MAX,	V_O = 2.4 V			50			50	μA
I_{OZL}	V_{CC} = MAX,	V_O = 0.5 V			−50			−50	μA
I_I	V_{CC} = MAX,	V_I = 5.5 V			1			1	mA
I_{IH}	V_{CC} = MAX,	V_I = 2.7 V			25			25	μA
I_{IL}	V_{CC} = MAX,	V_I = 0.5 V			−0.25			−0.25	mA
I_{OS}§	V_{CC} = MAX		−15		−100	−20		−100	mA
I_{CC}	V_{CC} = MAX			100	135		100	135	mA

switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

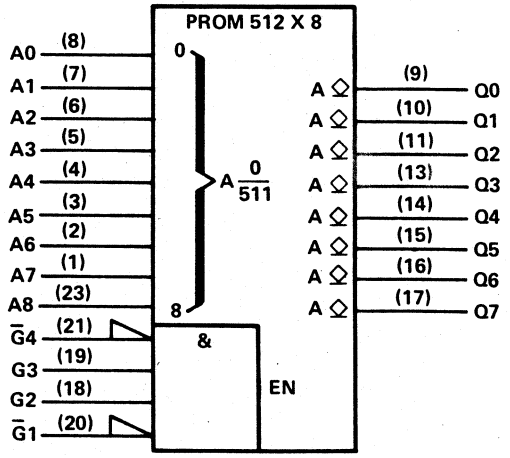
PARAMETER		TEST CONDITIONS	MJW			JW OR NW			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
$t_{a(A)}$	Access time from address	C_L = 30 pF, See Note 3		35	70		35	60	ns
$t_{a(S)}$	Access time from chip select (enable time)			20	45		20	35	ns
t_{dis}	Disable time	C_L = 5 pF, See Note 3		15	40		15	35	ns

†For conditions shown as MIN or MAX, use appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time, and duration of the short circuit should not exceed one second.
NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

TBP28SA46
4096 BITS (512 WORDS BY 8 BITS)
STANDARD PROGRAMMABLE READ-ONLY MEMORIES WITH OPEN-COLLECTOR OUTPUTS

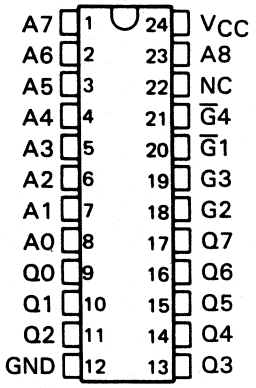
logic symbol

TBP28SA46



pin assignment

TBP28SA46
JW OR NW PACKAGE
(TOP VIEW)



recommended operating conditions

PARAMETER		MJW			JW OR NW			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
V_{OH}	High-level output voltage			5.5			5.5	V
I_{OL}	Low-level output current			16			16	mA
T_A	Operating free-air temperature range	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†		MJW			JW OR NW			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN,	I_I = −18 mA			−1.2			−1.2	V
I_{OH}	V_{CC} = MIN,	V_{OH} = 2.4 V			0.05			0.05	mA
		V_{OH} = 5.5 V			0.1			0.1	
V_{OL}	V_{CC} = MIN,	I_{OL} = 16 mA			0.5			0.5	V
I_I	V_{CC} = MAX,	V_I = 5.5 V			1			1	mA
I_{IH}	V_{CC} = MAX,	V_I = 2.7 V			25			25	μA
I_{IL}	V_{CC} = MAX,	V_I = 0.5 V			−0.25			−0.25	mA
I_{CC}	V_{CC} = MAX			100	135		100	135	mA

switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MJW			JW OR NW			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
$t_{a(A)}$	Access time from address	C_L = 30 pF, R_{L1} = 300 Ω, R_{L2} = 600 Ω, See Note 3		35	75		35	65	ns
$t_{a(S)}$	Access time from chip select (enable time)			20	45		20	35	ns
t_{PLH}	Propagation delay time low-to-high-level output from chip select			15	40		15	35	ns

†For conditions shown as MIN or MAX, use appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

TEXAS INSTRUMENTS
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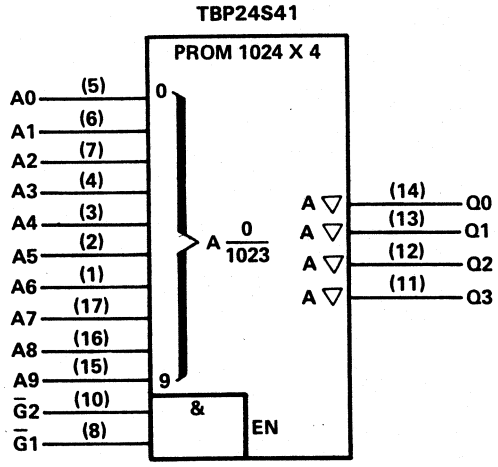
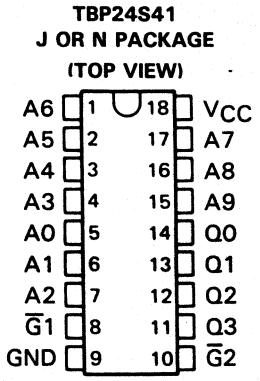
logic symbol



pin assignment



recommended operating conditions

PARAMETER		MJ			J OR N			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
I_{OH}	High-level output current			−2			−3.2	mA
I_{OL}	Low-level output current			16			16	mA
T_A	Operating free-air temperature range	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†		MJ			J OR N			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN,	I_I = −18 mA			−1.2			−1.2	V
V_{OH}	V_{CC} = MIN,	I_{OH} = MAX	2.4	3.1		2.4	3.1		V
V_{OL}	V_{CC} = MIN,	I_{OL} = 16 mA			0.5			0.5	V
I_{OZH}	V_{CC} = MAX,	V_O = 2.4 V			50			50	μA
I_{OZL}	V_{CC} = MAX,	V_O = 0.5 V			−50			−50	μA
I_I	V_{CC} = MAX,	V_I = 5.5 V			1			1	mA
I_{IH}	V_{CC} = MAX,	V_I = 2.7 V			25			25	μA
I_{IL}	V_{CC} = MAX,	V_I = 0.5 V			−0.25			−0.25	mA
I_{OS}§	V_{CC} = MAX		−15		−100	−20		−100	mA
I_{CC}	V_{CC} = MAX			95	140		95	140	mA

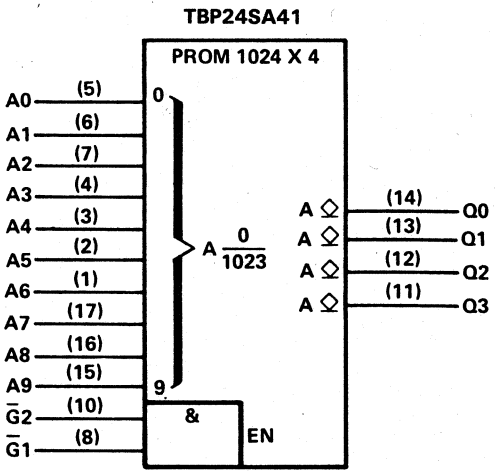
switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MJ			J OR N			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
$t_{a(A)}$	Access time from address	C_L = 30 pF, See Note 3		40	75		40	60	ns
$t_{a(S)}$	Access time from chip select (enable time)			20	40		20	30	ns
t_{dis}	Disable time	C_L = 5 pF, See Note 3		20	40		20	30	ns

†For conditions shown as MIN or MAX, use appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time, and duration of the short circuit should not exceed one second.
NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

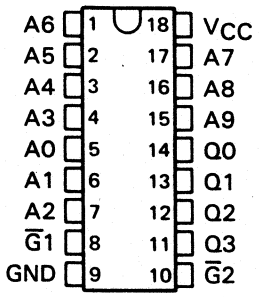
TBP24SA41
4096 BITS (1024 WORDS BY 4 BITS)
STANDARD PROGRAMMABLE READ-ONLY MEMORIES WITH OPEN-COLLECTOR OUTPUTS

logic symbol



pin assignment

TBP24SA41
J OR N PACKAGE
(TOP VIEW)



recommended operating conditions

PARAMETER		MJ			J OR N			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
V_{OH}	High-level output voltage			5.5			5.5	V
I_{OL}	Low-level output current			16			16	mA
T_A	Operating free-air temperature range	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†		MJ			J OR N			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN,	I_I = −18 mA			−1.2			−1.2	V
I_{OH}	V_{CC} = MIN,	V_{OH} = 2.4 V			0.05			0.05	mA
		V_{OH} = 5.5 V			0.1			0.1	
V_{OL}	V_{CC} = MIN,	I_{OL} = 16 mA			0.5			0.5	V
I_I	V_{CC} = MAX,	V_I = 5.5 V			1			1	mA
I_{IH}	V_{CC} = MAX,	V_I = 2.7 V			25			25	μA
I_{IL}	V_{CC} = MAX,	V_I = 0.5 V			−0.25			−0.25	mA
I_{CC}	V_{CC} = MAX			95	140		95	140	mA

switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MJ			J OR N			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
$t_{a(A)}$	Access time from address	C_L = 30 pF		40	75		40	60	ns
$t_{a(S)}$	Access time from chip select (enable time)	R_{L1} = 300 Ω		20	40		20	30	ns
t_{PLH}	Propagation delay time low-to-high-level output from chip select	R_{L2} = 600 Ω See Note 3		20	40		20	30	ns

†For conditions shown as MIN or MAX, use appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

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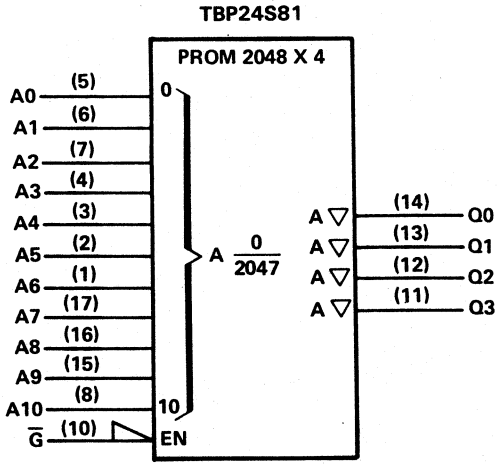
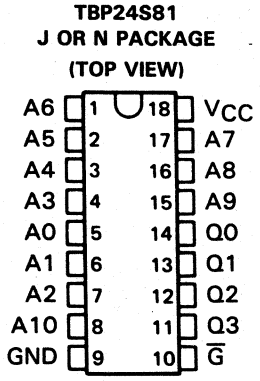
logic symbol



pin assignment



recommended operating conditions

PARAMETER		MJ			J OR N			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
I_{OH}	High-level output current			−2			−3.2	mA
I_{OL}	Low-level output current			16			16	mA
T_A	Operating free-air temperature range	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†		MJ			J OR N			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN,	I_I = −18 mA			−1.2			−1.2	V
V_{OH}	V_{CC} = MIN,	I_{OH} = MAX	2.4	3.1		2.4	3.1		V
V_{OL}	V_{CC} = MIN,	I_{OL} = 16 mA			0.5			0.5	V
I_{OZH}	V_{CC} = MAX,	V_O = 2.4 V			50			50	μA
I_{OZL}	V_{CC} = MAX,	V_O = 0.5 V			−50			−50	μA
I_I	V_{CC} = MAX,	V_I = 5.5 V			1			1	mA
I_{IH}	V_{CC} = MAX,	V_I = 2.7 V			25			25	μA
I_{IL}	V_{CC} = MAX,	V_I = 0.5 V			−0.25			−0.25	mA
I_{OS}§	V_{CC} = MAX		−15		−100	−20		−100	mA
I_{CC}	V_{CC} = MAX			125	175		125	175	mA

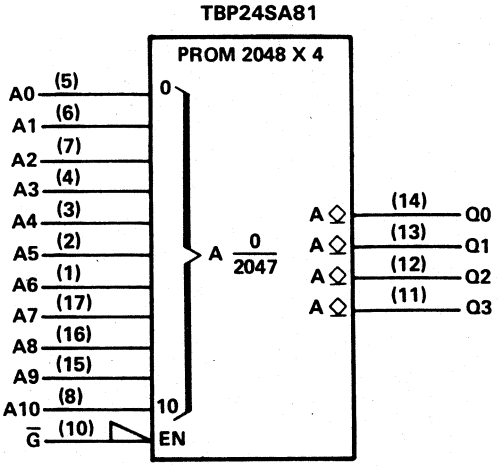
switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MJ			J OR N			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
$t_{a(A)}$	Access time from address	C_L = 30 pF		45	85		45	70	ns
$t_{a(S)}$	Access time from chip select (enable time)	See Note 3		20	50		20	40	ns
t_{dis}	Disable time	C_L = 5 pF See Note 3		20	50		20	40	ns

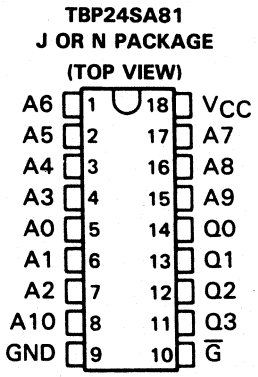
†For conditions shown as MIN or MAX, use appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time, and duration of the short circuit should not exceed one second.
NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

TBP24SA81
8192 BITS (2048 WORDS BY 4 BITS)
STANDARD PROGRAMMABLE READ-ONLY MEMORIES WITH OPEN-COLLECTOR OUTPUTS

logic symbol



pin assignment



recommended operating conditions

PARAMETER		MJ			J OR N			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
V_{OH}	High-level output voltage			5.5			5.5	V
I_{OL}	Low-level output current			16			16	mA
T_A	Operating free-air temperature range	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†		MJ			J OR N			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN,	I_I = −18 mA			−1.2			−1.2	V
I_{OH}	V_{CC} = MIN,	V_{OH} = 2.4 V			0.05			0.05	VmA
		V_{OH} = 5.5 V			0.1			0.1	
V_{OL}	V_{CC} = MIN,	I_{OL} = 16 mA			0.5			0.5	V
I_I	V_{CC} = MAX,	V_I = 5.5 V			1			1	mA
I_{IH}	V_{CC} = MAX,	V_I = 2.7 V			25			25	μA
I_{IL}	V_{CC} = MAX,	V_I = 0.5 V			−0.25			−0.25	mA
I_{CC}	V_{CC} = MAX			125	175		125	175	mA

switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MJ			J OR N			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
$t_{a(A)}$	Access time from address	C_L = 30 pF		45	95		45	70	ns
$t_{a(S)}$	Access time from chip select (enable time)	R_{L1} = 300 Ω		20	50		20	40	ns
t_{PLH}	Propagation delay time low-to-high-level output from chip select	R_{L2} = 600 Ω See Note 3		20	50		20	40	ns

†For conditions shown as MIN or MAX, use appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

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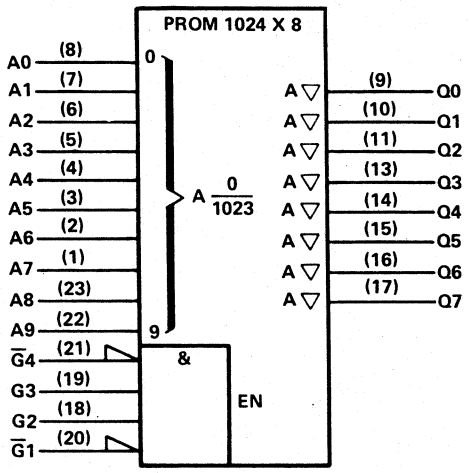
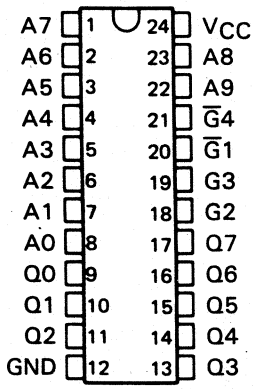
logic symbol

TBP28S86A



pin assignment

TBP28S86A
JW OR NW PACKAGE
(TOP VIEW)



recommended operating conditions

PARAMETER		MJW			JW OR NW			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
I_{OH}	High-level output current			−2			−3.2	mA
I_{OL}	Low-level output current			12			12	mA
T_A	Operating free-air temperature range	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†		MJW			JW OR NW			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN,	I_I = −18 mA			−1.2			−1.2	V
V_{OH}	V_{CC} = MIN,	I_{OH} = MAX	2.4	3.1		2.4	3.1		V
V_{OL}	V_{CC} = MIN,	I_{OL} = 12 mA			0.5			0.5	V
I_{OZH}	V_{CC} = MAX,	V_O = 2.4 V			50			50	μA
I_{OZL}	V_{CC} = MAX,	V_O = 0.5 V			−50			−50	μA
I_I	V_{CC} = MAX,	V_I = 5.5 V			1			1	mA
I_{IH}	V_{CC} = MAX,	V_I = 2.7 V			25			25	μA
I_{IL}	V_{CC} = MAX,	V_I = 0.5 V			−0.25			−0.25	mA
I_{OS}§	V_{CC} = MAX		−15		−100	−20		−100	mA
I_{CC}	V_{CC} = MAX			110	170		110	165	mA

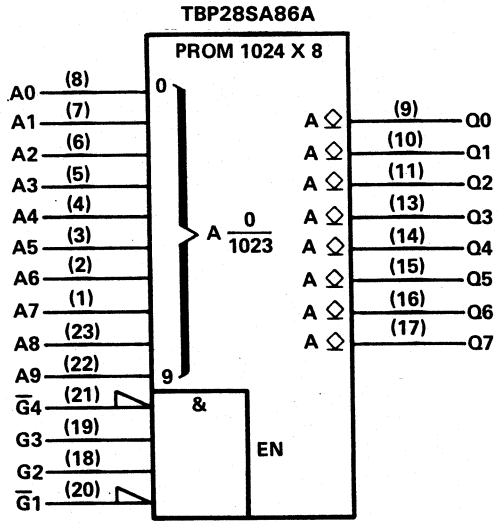
switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MJW			JW OR NW			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
t_{aA}	Access time from address	C_L = 30 pF		35	80		35	65	ns
$t_{a(S)}$	Access time from chip select (enable time)	See Note 3		20	50		20	40	ns
t_{dis}	Disable time	C_L = 5 pF See Note 3		15	40		15	35	ns

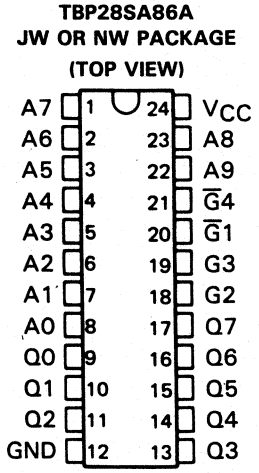
†For conditions shown as MIN or MAX, use appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time, and duration of the short circuit should not exceed one second.
NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

TBP28SA86A
8192 BITS (1024 WORDS BY 8 BITS)
STANDARD PROGRAMMABLE READ-ONLY MEMORIES WITH OPEN-COLLECTOR OUTPUTS

logic symbol



pin assignment



recommended operating conditions

PARAMETER		MJW			JW OR NW			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
V_{OH}	High-level output voltage			5.5			5.5	V
I_{OL}	Low-level output current			12			12	mA
T_A	Operating free-air temperature range	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†		MJW			JW OR NW			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN,	I_I = −18 mA			−1.2			−1.2	V
I_{OH}	V_{CC} = MIN,	V_{OH} = 2.4 V			0.05			0.05	mA
		V_{OH} = 5.5 V			0.1			0.1	
V_{OL}	V_{CC} = MIN,	I_{OL} = 12 mA			0.5			0.5	V
I_I	V_{CC} = MAX,	V_I = 5.5 V			1			1	mA
I_{IH}	V_{CC} = MAX,	V_I = 2.7 V			25			25	μA
I_{IL}	V_{CC} = MAX,	V_I = 0.5 V			−0.25			−0.25	mA
I_{CC}	V_{CC} = MAX			125	175		125	175	mA

switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MJW			JW OR NW			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
$t_{a(A)}$	Access time from address	C_L = 30 pF, R_{L1} = 300 Ω, R_{L2} = 600 Ω, See Note 3		35	80		35	70	ns
$t_{a(S)}$	Access time from chip select (enable time)			20	50		20	40	ns
t_{PLH}	Propagation delay time low-to-high-level output from chip select			15	40		15	35	ns

†For conditions shown as MIN or MAX, use appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

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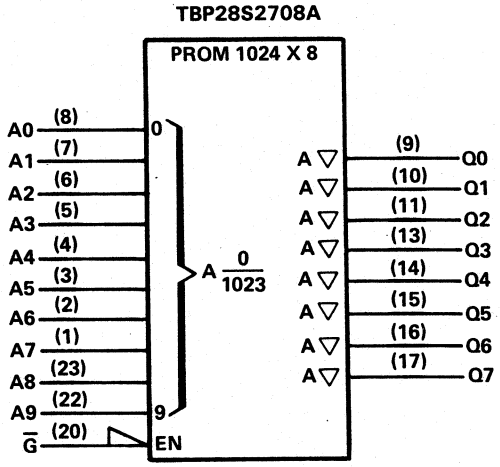
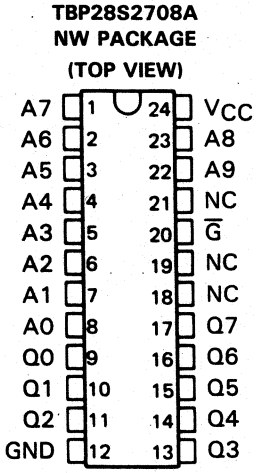
logic symbol



pin assignment



recommended operating conditions

PARAMETER		NW			UNIT
		MIN	NOM	MAX	
V_{CC}	Supply voltage	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			V
V_{IL}	Low-level input voltage			0.8	V
I_{OH}	High-level output current			−3.2	mA
I_{OL}	Low-level output current			12	mA
T_A	Operating free-air temperature range	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS		NW			UNIT
			MIN	TYP†	MAX	
V_{IK}	V_{CC} = 4.75,	I_I = −18 mA			−1.2	V
V_{OH}	V_{CC} = 4.75,	I_{OH} = −3.2 mA	2.4	3.1		V
V_{OL}	V_{CC} = 4.75,	I_{OL} = 12 mA			0.5	V
I_{OZH}	V_{CC} = 5.25,	V_O = 2.4 V			50	μA
I_{OZL}	V_{CC} = 5.25,	V_O = 0.5 V			−50	μA
I_I	V_{CC} = 5.25,	V_I = 5.5 V			1	mA
I_{IH}	V_{CC} = 5.25,	V_I = 2.7 V			25	μA
I_{IL}	V_{CC} = 5.25,	V_I = 0.5 V			−0.25	mA
I_{OS}‡	V_{CC} = 5.25		−20		−100	mA
I_{CC}	V_{CC} = 5.25			110	165	mA

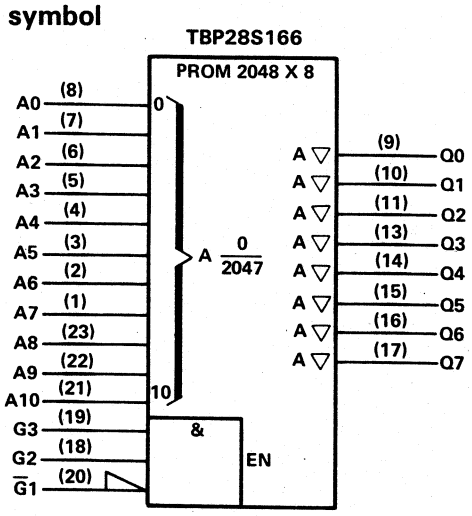
switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER		TEST CONDITIONS	NW			UNIT
			MIN	TYP†	MAX	
$t_{a(A)}$	Access time from address	C_L = 30 pF		45	70	ns
$t_{a(S)}$	Access time from chip select (enable time)	See Note 3		20	40	ns
t_{dis}	Disable time	C_L = 5 pF, See Note 3		20	40	ns

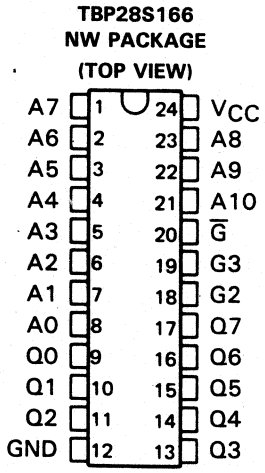
†All typical values are at V_{CC} = 5 V, T_A = 25°C.
‡Not more than one output should be shorted at a time, and duration of the short circuit should not exceed one second.
NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

TBP28S166
16,384 BITS (2084 WORDS BY 8 BITS)
STANDARD PROGRAMMABLE READ-ONLY MEMORIES WITH 3-STATE OUTPUTS

logic symbol



pin assignment



recommended operating conditions

PARAMETER		NW			UNIT
		MIN	NOM	MAX	
V_{CC}	Supply voltage	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			V
V_{IL}	Low-level input voltage			0.8	V
I_{OH}	High-level output current			−3.2	mA
I_{OL}	Low-level output current			16	mA
T_A	Operating free-air temperature range	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS		NW			UNIT
			MIN	TYP†	MAX	
V_{IK}	V_{CC} = 4.75,	I_I = −18 mA			−1.2	V
V_{OH}	V_{CC} = 4.75,	I_{OH} = −3.2 mA	2.4	3.1		V
V_{OL}	V_{CC} = 4.75,	I_{OL} = 16 mA			0.5	V
I_{OZH}	V_{CC} = 5.25,	V_O = 2.4 V			50	μA
I_{OZL}	V_{CC} = 5.25,	V_O = 0.5 V			−50	μA
I_I	V_{CC} = 5.25,	V_I = 5.5 V			1	mA
I_{IH}	V_{CC} = 5.25,	V_I = 2.7 V			25	μA
I_{IL}	V_{CC} = 5.25,	V_I = 0.5 V			−0.25	mA
I_{OS}‡	V_{CC} = 5.25		−20		−100	mA
I_{CC}	V_{CC} = 5.25			130	175	mA

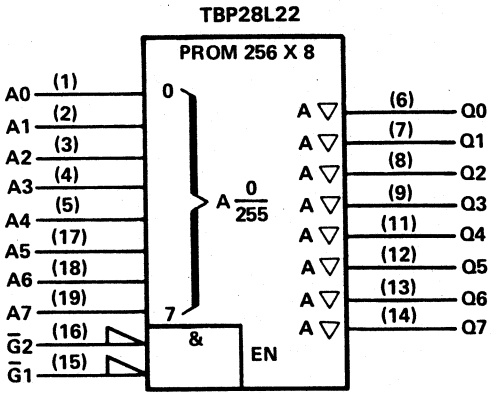
switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER		TEST CONDITIONS	NW			UNIT
			MIN	TYP†	MAX	
$t_{a(A)}$	Access time from address	C_L = 30 pF		35	75	ns
$t_{a(S)}$	Access time from chip select (enable time)	See Note 3		15	40	ns
t_{dis}	Disable time	C_L = 5 pF, See Note 3		15	40	ns

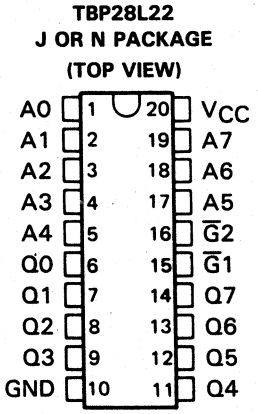
†All typical values are at V_{CC} = 5 V, T_A = 25°C.
‡Not more than one output should be shorted at a time, and duration of the short circuit should not exceed one second.
NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

TEXAS INSTRUMENTS
POST OFFICE BOX 225012 • DALLAS, TEXAS 75265

logic symbol



pin assignment



recommended operating conditions

PARAMETER		MJ			J OR N			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
I_{OH}	High-level output current			−2			−6.5	mA
I_{OL}	Low-level output current			16			16	mA
T_A	Operating free-air temperature range	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†		MJ			J OR N			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN,	I_I = −18 mA			−1.2			−1.2	V
V_{OH}	V_{CC} = MIN,	I_{OH} = MAX	2.4	3.1		2.4	3.1		V
V_{OL}	V_{CC} = MIN,	I_{OL} = 16 mA			0.5			0.5	V
I_{OZH}	V_{CC} = MAX,	V_O = 2.4 V			50			50	μA
I_{OZL}	V_{CC} = MAX,	V_O = 0.5 V			−50			−50	μA
I_I	V_{CC} = MAX,	V_I = 5.5 V			1			1	mA
I_{IH}	V_{CC} = MAX,	V_I = 2.7 V			25			25	μA
I_{IL}	V_{CC} = MAX,	V_I = 0.5 V			−0.25			−0.25	mA
I_{OS}§	V_{CC} = MAX		−25		−100	−30		−100	mA
I_{CC}	V_{CC} = MAX			75	100		75	100	mA

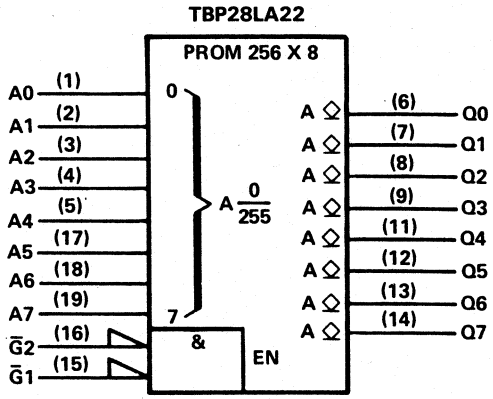
switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MJ			J OR N			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
$t_{a(A)}$	Access time from address	C_L = 30 pF		45	75		45	70	ns
$t_{a(S)}$	Access time from chip select (enable time)	See Note 3		20	40		20	35	ns
t_{dis}	Disable time	C_L = 5 pF See Note 3		15	35		15	30	ns

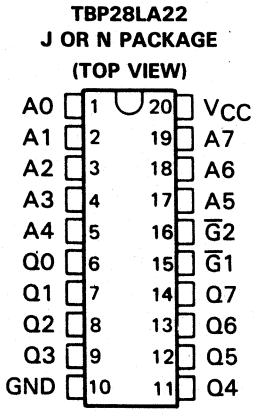
†For conditions shown as MIN or MAX, use appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time, and duration of the short circuit should not exceed one second.
NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

TBP28LA22
2048 BITS (256 WORDS BY 8 BITS)
LOW-POWER PROGRAMMABLE READ-ONLY MEMORIES WITH OPEN-COLLECTOR OUTPUTS

logic symbol



pin assignment



recommended operating conditions

PARAMETER		MJ			J OR N			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
V_{OH}	High-level output voltage			5.5			5.5	V
I_{OL}	Low-level output current			16			16	mA
T_A	Operating free-air temperature range	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†		MJ			J OR N			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN,	I_I = −18 mA			−1.2			−1.2	V
I_{OH}	V_{CC} = MIN,	V_{OH} = 2.4 V			0.05			0.05	mA
		V_{OH} = 5.5 V			0.1			0.1	
V_{OL}	V_{CC} = MIN,	I_{OL} = 16 mA			0.5			0.5	V
I_I	V_{CC} = MAX,	V_I = 5.5 V			1			1	mA
I_{IH}	V_{CC} = MAX,	V_I = 2.7 V			25			25	μA
I_{IL}	V_{CC} = MAX,	V_I = 0.5 V			−0.25			−0.25	mA
I_{CC}	V_{CC} = MAX			75	100		75	100	mA

switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MJ			J OR N			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
t_{aA}	Access time from address	C_L = 30 pF, R_{L1} = 300 Ω, R_{L2} = 600 Ω, See Note 3		40	80		45	75	ns
$t_{a(S)}$	Access time from chip select (enable time)			20	40		20	35	ns
t_{PLH}	Propagation delay time low-to-high-level output from chip select			15	35		15	30	ns

†For conditions shown as MIN or MAX, use appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

TEXAS INSTRUMENTS
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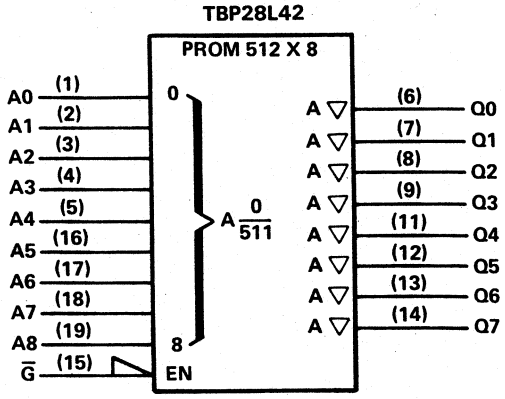
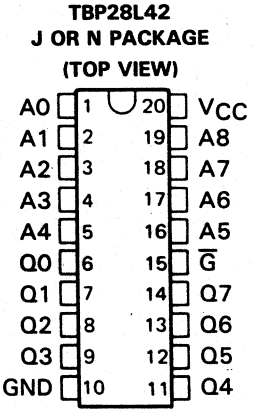
logic symbol



pin assignment



recommended operating conditions

PARAMETER		MJ			J OR N			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
I_{OH}	High-level output current			−1			−1.6	mA
I_{OL}	Low-level output current			8			8	mA
T_A	Operating free-air temperature range	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†		MJ			J OR N			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN,	I_I = −18 mA			−1.2			−1.2	V
V_{OH}	V_{CC} = MIN,	I_{OH} = MAX	2.4	3.1		2.4	3.1		V
V_{OL}	V_{CC} = MIN,	I_{OL} = 8 mA			0.5			0.5	V
I_{OZH}	V_{CC} = MAX,	V_O = 2.4 V			50			50	μA
I_{OZL}	V_{CC} = MAX,	V_O = 0.5 V			−50			−50	μA
I_I	V_{CC} = MAX,	V_I = 5.5 V			1			1	mA
I_{IH}	V_{CC} = MAX,	V_I = 2.7 V			25			25	μA
I_{IL}	V_{CC} = MAX,	V_I = 0.5 V			−0.25			−0.25	mA
I_{OS}§	V_{CC} = MAX		−10		−100	−10		−100	mA
I_{CC}	V_{CC} = MAX			50	85		50	85	mA

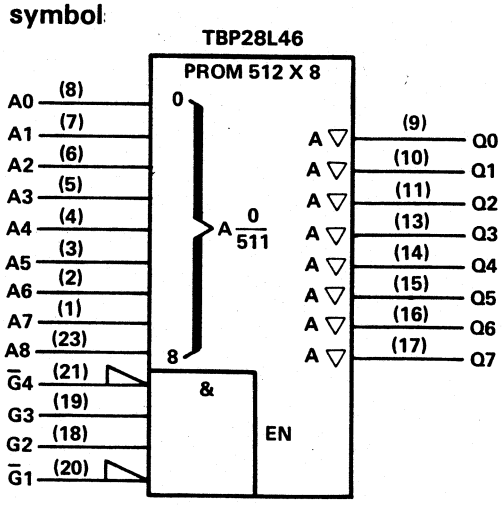
switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MJ			J OR N			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
$t_{a(A)}$	Access time from address	C_L = 30 pF		55	110		55	95	ns
$t_{a(S)}$	Access time from chip select (enable time)	See Note 3		25	60		25	60	ns
t_{dis}	Disable time	C_L = 5 pF See Note 3		25	50		25	40	ns

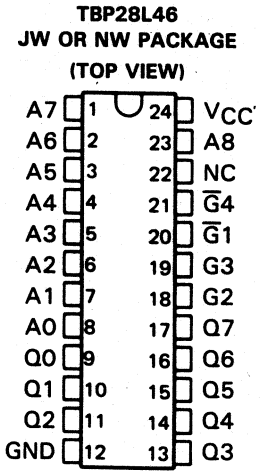
†For conditions shown as MIN or MAX, use appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time, and duration of the short circuit should not exceed one second.
NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

TBP28L46
4096 BITS (512 WORDS BY 8 BITS)
LOW-POWER PROGRAMMABLE READ-ONLY MEMORIES WITH 3-STATE OUTPUTS

logic symbol



pin assignment



recommended operating conditions

PARAMETER		MJW			JW OR NW			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
I_{OH}	High-level output current			−1			−1.6	mA
I_{OL}	Low-level output current			8			8	mA
T_A	Operating free-air temperature range	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†		MJW			JW OR NW			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN,	I_I = −18 mA			−1.2			−1.2	V
V_{OH}	V_{CC} = MIN,	I_{OH} = MAX	2.4	3.1		2.4	3.1		V
V_{OL}	V_{CC} = MIN,	I_{OL} = 8 mA			0.5			0.5	V
I_{OZH}	V_{CC} = MAX,	V_O = 2.4 V			50			50	μA
I_{OZL}	V_{CC} = MAX,	V_O = 0.5 V			−50			−50	μA
I_I	V_{CC} = MAX,	V_I = 5.5 V			1			1	mA
I_{IH}	V_{CC} = MAX,	V_I = 2.7 V			25			25	μA
I_{IL}	V_{CC} = MAX,	V_I = 0.5 V			−0.25			−0.25	mA
I_{OS}§	V_{CC} = MAX		−10		−100	−10		−100	mA
I_{CC}	V_{CC} = MAX			50	85		50	85	mA

switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MJW			JW OR NW			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
$t_{a(A)}$	Access time from address	C_L = 30 pF		55	110		55	95	ns
$t_{a(S)}$	Access time from chip select (enable time)	See Note 3		25	60		25	60	ns
t_{dis}	Disable time	C_L = 5 pF See Note 3		25	50		25	40	ns

†For conditions shown as MIN or MAX, use appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time, and duration of the short circuit should not exceed one second.
NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

TEXAS INSTRUMENTS
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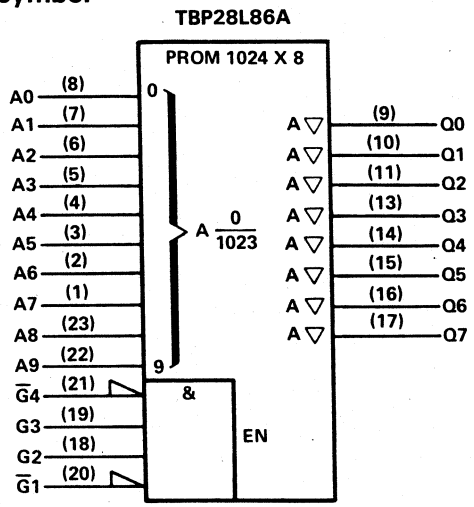
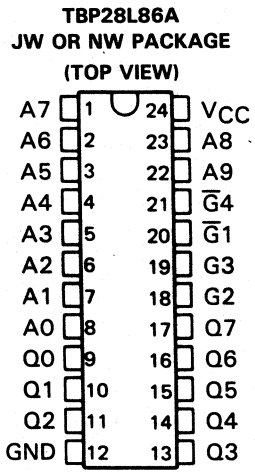
logic symbol



pin assignment



recommended operating conditions

PARAMETER		MJW			JW OR NW			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			2			V
V_{IL}	Low-level input voltage			0.8			0.8	V
I_{OH}	High-level output current			−1			−1.6	mA
I_{OL}	Low-level output current			8			8	mA
T_A	Operating free-air temperature range	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS†		MJW			JW OR NW			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IK}	V_{CC} = MIN,	I_I = −18 mA			−1.2			−1.2	V
V_{OH}	V_{CC} = MIN,	I_{OH} = MAX	2.4	3.1		2.4	3.1		V
V_{OL}	V_{CC} = MIN,	I_{OL} = 8 mA			0.5			0.5	V
I_{OZH}	V_{CC} = MAX,	V_O = 2.4 V			50			50	μA
I_{OZL}	V_{CC} = MAX,	V_O = 0.5 V			−50			−50	μA
I_I	V_{CC} = MAX,	V_I = 5.5 V			1			1	mA
I_{IH}	V_{CC} = MAX,	V_I = 2.7 V			25			25	μA
I_{IL}	V_{CC} = MAX,	V_I = 0.5 V			−0.25			−0.25	mA
I_{OS}§	V_{CC} = MAX		−10		−100	−10		−100	mA
I_{CC}	V_{CC} = MAX			55	95		55	80	mA

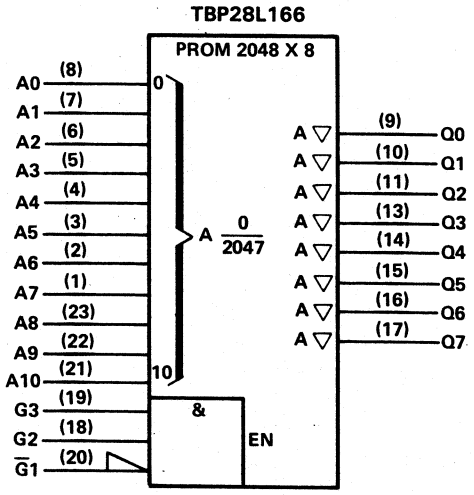
switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MJW			JW OR NW			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
$t_{a(A)}$	Access time from address	C_L = 30 pF		65	200		65	110	ns
$t_{a(S)}$	Access time from chip select (enable time)	See Note 3		40	125		40	80	ns
t_{dis}	Disable time	C_L = 5 pF See Note 3		25	100		25	60	ns

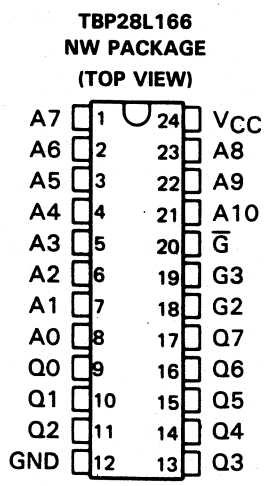
†For conditions shown as MIN or MAX, use appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A = 25°C.
§Not more than one output should be shorted at a time, and duration of the short circuit should not exceed one second.
NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

TBP28L166
16,384 BITS (2084 WORDS BY 8 BITS)
LOW-POWER PROGRAMMABLE READ-ONLY MEMORIES WITH 3-STATE OUTPUTS

logic symbol



pin assignment



recommended operating conditions

PARAMETER		NW			UNIT
		MIN	NOM	MAX	
V_{CC}	Supply voltage	4.75	5	5.25	V
V_{IH}	High-level input voltage	2			V
V_{IL}	Low-level input voltage			0.8	V
I_{OH}	High-level output current			−1.6	mA
I_{OL}	Low-level output current			8	mA
T_A	Operating free-air temperature range	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS		NW			UNIT
			MIN	TYP†	MAX	
V_{IK}	V_{CC} = 4.75,	I_I = −18 mA			−1.2	V
V_{OH}	V_{CC} = 4.75,	I_{OH} = −1.6 mA	2.4	3.1		V
V_{OL}	V_{CC} = 4.75,	I_{OL} = 8 mA			0.5	V
I_{OZH}	V_{CC} = 5.25,	V_O = 2.4 V			50	μA
I_{OZL}	V_{CC} = 5.25,	V_O = 0.5 V			−50	μA
I_I	V_{CC} = 5.25,	V_I = 5.5 V			1	mA
I_{IH}	V_{CC} = 5.25,	V_I = 2.7 V			25	μA
I_{IL}	V_{CC} = 5.25,	V_I = 0.5 V			−0.25	mA
I_{OS}‡	V_{CC} = 5.25		−10		−100	mA
I_{CC}	V_{CC} = 5.25			75	110	mA

switching characteristics over recommended ranges of T_A and V_{CC} (unless otherwise noted)

PARAMETER		TEST CONDITIONS	NW			UNIT
			MIN	TYP†	MAX	
$t_{a(A)}$	Access time from address	C_L = 30 pF		80	125	ns
$t_{a(S)}$	Access time from chip select (enable time)	See Note 3		40	65	ns
t_{dis}	Disable time	C_L = 5 pF, See Note 3		30	65	ns

†All typical values are at V_{CC} = 5 V, T_A = 25°C.
‡Not more than one output should be shorted at a time, and duration of the short circuit should not exceed one second.
NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

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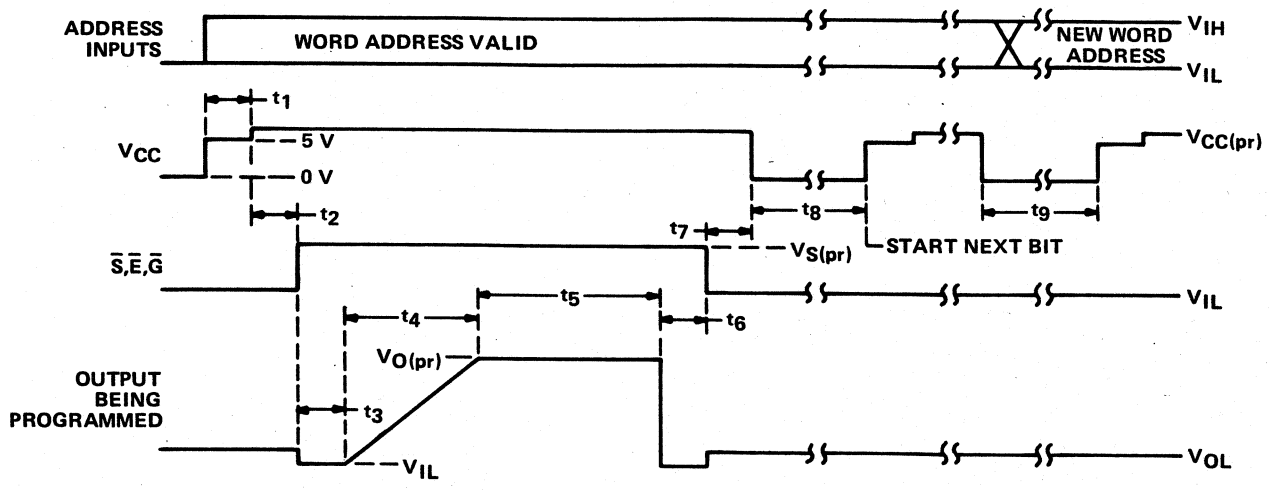
recommended operating conditions for programming (see Figure 1)

		MIN	NOM	MAX	UNIT
Steady-state supply voltage	V_{CC}	4.75	5	5.25	V
Input voltage	V_{IH}	3	4	5	V
	V_{IL}	0	0	0.5	
Voltage at all outputs except the one to be programmed		0	0	0.5	V
Supply voltage level to program a bit	$V_{CC(pr)}$	5.75	6	6.25	V
Select or enable level to program a bit	$V_{S(pr)}$	9.75	10	11	V
Output level during interval t_5	$V_{O(pr)}$	15.75	16	16.25	V
Supply voltage during verification (see step 14)	Low	4.4	4.5	4.6	V
	High	5.4	5.5	5.6	
Time from V_{CC} to settle and to verify need to program	t_1	0	5	10	μs
Time from V_{CC} = 6 V until chip select (enable) is at 10 V	t_2	5	5	10	μs
Time from chip select (enable) high to start of program ramp	t_3	0.1	5	10	μs
Ramp time, output program pulse	t_4	10	15	20	μs
Duration of output program pulse	t_5	15	20	20	μs
Time from end of program pulse to chip select (enable) low	t_6	5	5	10	μs
Time from chip select (enable) V_{CC} = 0 V	t_7	0.1	5	5	μs
Time for cooling between bits	t_8	30	50	100	μs
Time for cooling between words	t_9	30	50		μs
Free-air temperature	T_A	20	25	30	°C

step-by-step programming instruction (see Figure 1)

1. Address the word to be programmed, apply 5 volts to V_{CC} and active levels to all chip select (S and $\overline{S}$) or chip enable (E and $\overline{E}$) inputs.
2. Verify the status of a bit location by checking the output level.
3. Decreass V_{CC} to 0 volts.
4. For bit locations that do not require programming, skip steps 5 through 11.
5. Increase V_{CC} to $V_{CC(pr)}$ with a minimum current capability of 250 milliamperes.
6. Apply $V_{S(pr)}$ to all the $\overline{S}$, $\overline{E}$ or $\overline{G}$ inputs. $I_I \leq 25$ milliamperes. Active-high enables may be left high.
7. Connect all outputs, except the one to be programmed, to V_{IL}. Only one bit is to be programmed at a time.
8. Apply the output programming pulse for 20 microseconds. Minimum current capability of the programming supply should be 250 milliamperes.
9. After terminating the output pulse, disconnect all outputs from V_{IL} conditions.
10. Reduce the voltage at $\overline{S}$, $\overline{E}$, or $\overline{G}$ inputs to V_{II}.
11. Decrease V_{CC} to 0 volts.
12. Return to step 4 until all outputs in the word have been programmed.
13. Repeat steps 2 through 11 for each word in memory.
14. Verify programming of every word after all words have been programmed using V_{CC} values of 4.5 and 5.5 volts.



NOTE 4: Rise and fall times should be ≤ 1 μs.

FIGURE 1. TIMING DIAGRAM AND VOLTAGE WAVEFORMS FOR PROGRAMMING SEQUENCE

TEXAS INSTRUMENTS
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PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
JBP28L42MJ	ACTIVE	CDIP	J	20	1	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	JBP28L42MJ	Samples
JBP28S42MJ	ACTIVE	CDIP	J	20	1	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	JBP28S42MJ	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

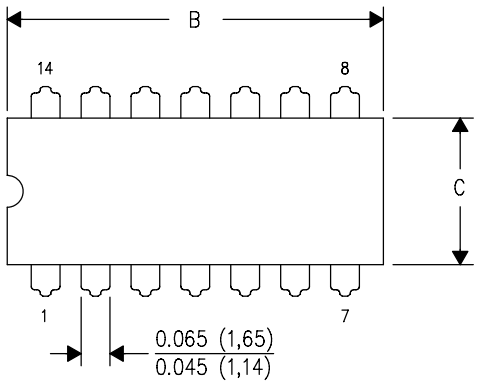
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

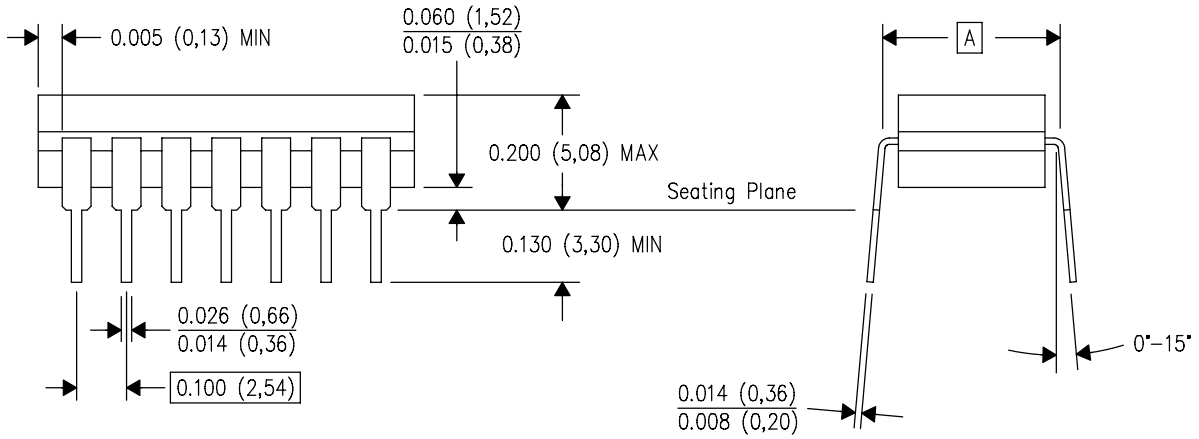
J (R–GDIP–T**)

14 LEADS SHOWN

CERAMIC DUAL IN–LINE PACKAGE



DIM \ PINS **	14	16	18	20
A	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC
B MAX	0.785 (19,94)	.840 (21,34)	0.960 (24,38)	1.060 (26,92)
B MIN	—	—	—	—
C MAX	0.300 (7,62)	0.300 (7,62)	0.310 (7,87)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.220 (5,59)	0.245 (6,22)



4040083/F 03/03

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package is hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
E. Falls within MIL STD 1835 GDIP1–T14, GDIP1–T16, GDIP1–T18 and GDIP1–T20.

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