



LM193, LM293, LM393

Low power dual voltage comparators

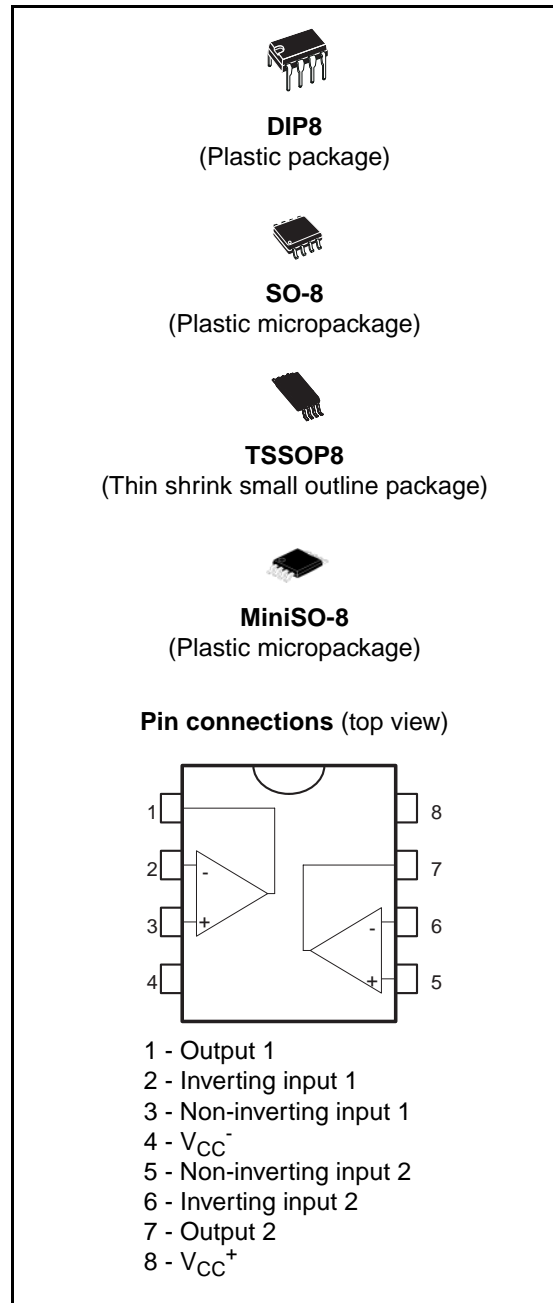
Features

- Wide single-supply voltage range or dual supplies: +2 V to +36 V or ± 1 V to ± 18 V
- Very low supply current (0.4 mA) independent of supply voltage (1 mW/comparator at +5 V)
- Low input bias current: 25 nA typ.
- Low input offset current: ± 5 nA typ.
- Low input offset voltage: ± 1 mV typ.
- Input common-mode voltage range includes ground
- Low output saturation voltage: 250 mV typ. ($I_{\text{sink}} = 4$ mA)
- Differential input voltage range equal to the supply voltage
- TTL, DTL, ECL, MOS, CMOS compatible outputs

Description

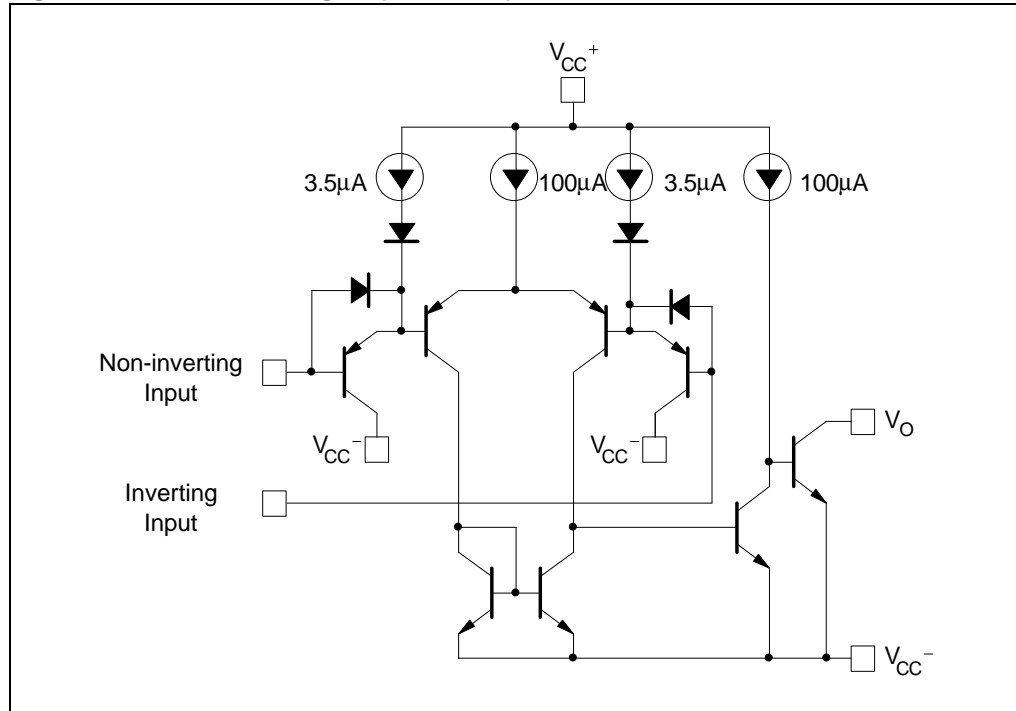
These devices consist of two independent low voltage comparators designed specifically to operate from a single supply over a wide range of voltages. Operation from split power supplies is also possible.

These comparators also have a unique characteristic in that the input common-mode voltage range includes ground even though operated from a single power supply voltage.



1 Schematic diagram

Figure 1. Schematic diagram (1/2 LM193)



2 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	± 18 or 36	V
V_{id}	Differential input voltage	± 36	V
V_{in}	Input voltage	-0.3 to +36	V
	Output short-circuit to ground ⁽¹⁾	Infinite	
R_{thja}	Thermal resistance junction to ambient ⁽²⁾		°C/W
	SO-8	125	
	TSSOP8	120	
	DIP8	85	
R_{thjc}	Thermal resistance junction to case ⁽²⁾		°C/W
	SO-8	40	
	TSSOP8	37	
	DIP8	41	
T_j	Maximum junction temperature	150	°C
T_{stg}	Storage temperature range	-65 to +150	°C
ESD	HBM: human body model ⁽³⁾	800	V
	MM: machine model ⁽⁴⁾	200	
	CDM: charged device model ⁽⁵⁾	1500	

- Short-circuits from the output to V_{CC}^+ can cause excessive heating and potential destruction. The maximum output current is approximately 20 mA independent of the magnitude of V_{CC}^+ .
- Short-circuits can cause excessive heating and destructive dissipation. Values are typical.
- Human body model: A 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 k Ω resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
- Machine model: A 200 pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω). This is done for all couples of connected pin combinations while the other pins are floating.
- Charged device model: all pins and the package are charged together to the specified voltage and then discharged directly to the ground through only one pin. This is done for all pins.

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	2 to 36	V
V_{icm}	Common mode input voltage range ($V_{CC}^+ = 30V$) ⁽¹⁾ $T_{amb} = +25^\circ C$ $T_{min} \leq T_{amb} \leq T_{max}$	0 to $V_{CC}^+ - 1.5$ 0 to $V_{CC}^+ - 2$	V
T_{oper}	Operating free-air temperature range LM193, LM193A LM293, LM293A LM393, LM393A	-55 to +125 -40 to +105 0 to +70	°C

- The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3 V. The high end of the common-mode voltage range is $V_{CC}^+ - 1.5$ V, but either or both inputs can go to +30 V without damage.

3 Electrical characteristics

Table 3. $V_{CC}^+ = +5V$, $V_{CC}^- = 0V$, $T_{amb} = +25^\circ C$ (unless otherwise specified)

Symbol	Parameter	LM193A - LM293A LM393A			LM193- LM293 LM393			Unit
		Min.	Typ.	Max.	Min	Typ.	Max.	
V_{io}	Input offset voltage ⁽¹⁾ $T_{min} \leq T_{amb} \leq T_{max}$		1	2 4		1	5 9	mV
I_{io}	Input offset current $T_{min} \leq T_{amb} \leq T_{max}$		3	25 100		5	50 150	nA
I_{ib}	Input bias current (I^+ or I^-) ⁽²⁾ $T_{min} \leq T_{amb} \leq T_{max}$		25	100 300		25	250 400	nA
A_{vd}	Large signal voltage gain $V_{CC} = 15V$, $R_L = 15k\Omega$, $V_o = 1V$ to $11V$	50	200		50	200		V/mV
I_{CC}	Supply current (all comparators) $V_{CC} = +5V$, no load $V_{CC} = +30V$, no load		0.4 1	1 2.5		0.4 1	1 2.5	mA
V_{id}	Differential input voltage ⁽³⁾			V_{CC}^+			V_{CC}^+	
V_{OL}	Low level output voltage $V_{id} = -1V$, $I_{sink} = 4mA$ $T_{min} \leq T_{amb} \leq T_{max}$		250	400 700		250	400 700	mV
I_{OH}	High level output current $V_{CC} = V_o = 30V$, $V_{id} = 1V$ $T_{min} \leq T_{amb} \leq T_{max}$		0.1	1		0.1	1	nA μA
I_{sink}	Output sink current $V_{id} = 1V$, $V_o = 1.5V$	6	16		6	16		mA
t_{re}	Response time ⁽⁴⁾ $R_L = 5.1k\Omega$ connected to V_{CC}^+		1.3			1.3		μs
t_{rel}	Large signal response time $R_L = 5.1k\Omega$ connected to V_{CC}^+ , $e_1 = TTL$, $V_{(ref)} = +1.4V$		300			300		ns

1. At output switch point, $V_o \approx 1.4V$, $R_s = 0$ with V_{CC}^+ from 5V to 30V, and over the full common-mode range (0V to $V_{CC}^+ - 1.5V$).
2. The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output, so no loading charge exists on the reference of input lines.
3. The response time specified is for a 100 mV input step with 5 mV overdrive. For larger overdrive signals 300 ns can be obtained.
4. Positive excursions of input voltage may exceed the power supply level. As long as the other voltage remains within the common-mode range, the comparator will provide a proper output state. The low input voltage state must not be less than -0.3 V (or 0.3 V below the negative power supply, if used).

Figure 2. Supply current vs. supply voltage

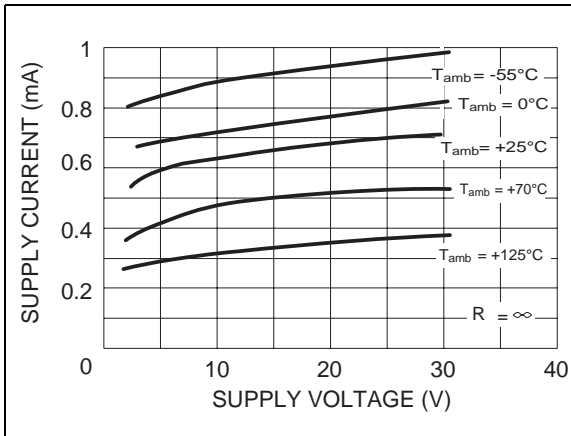


Figure 3. Input current vs. supply voltage

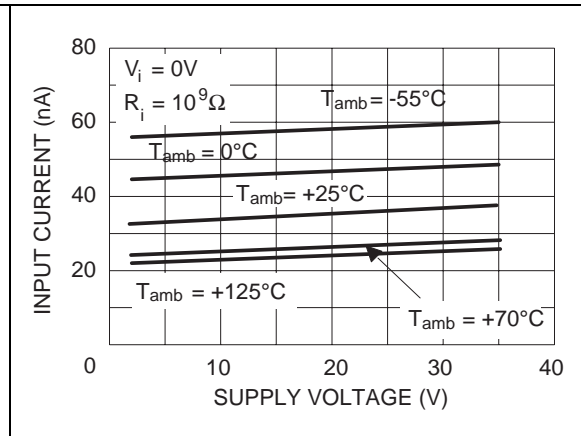


Figure 4. Output saturation voltage vs. frequency

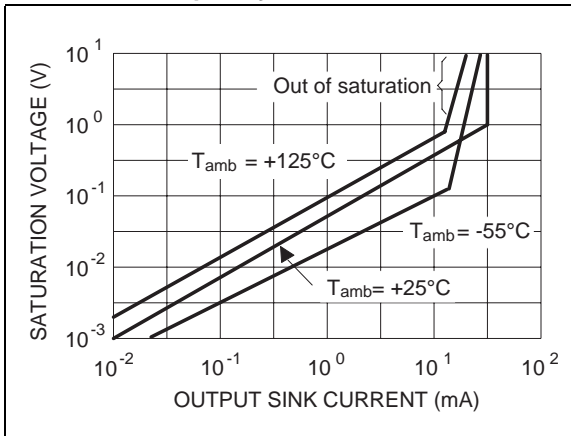


Figure 5. Response time for various input overdrives - negative transition

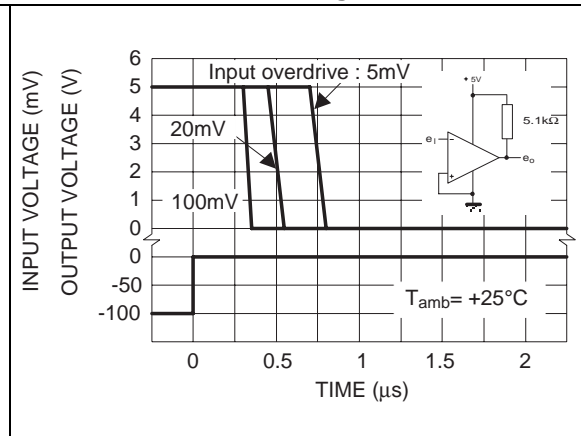
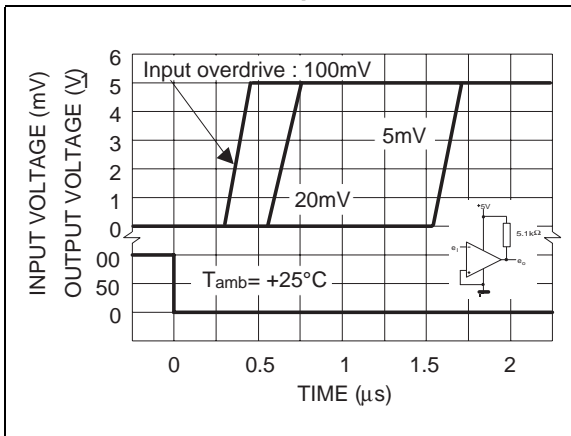


Figure 6. Response time for various input overdrives - positive transition



4 Typical applications

Figure 7. Basic comparator

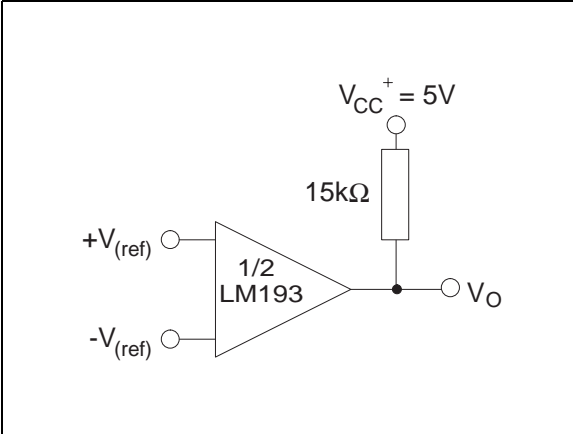


Figure 8. Driving TTL

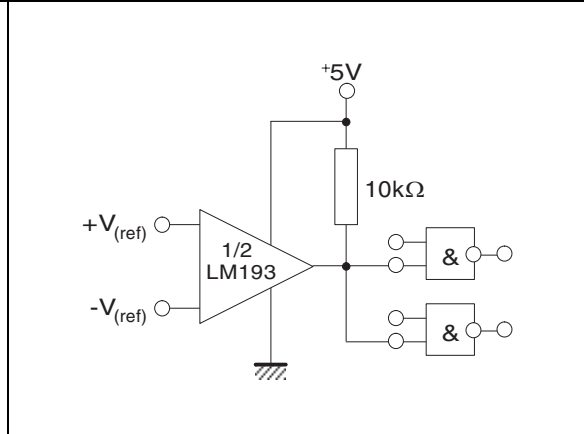


Figure 9. Low frequency op-amp

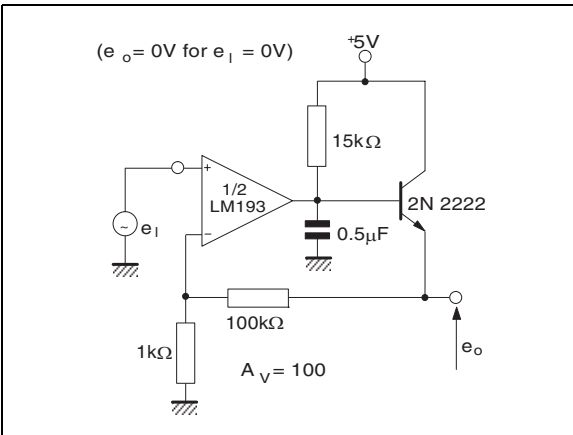


Figure 10. Driving CMOS

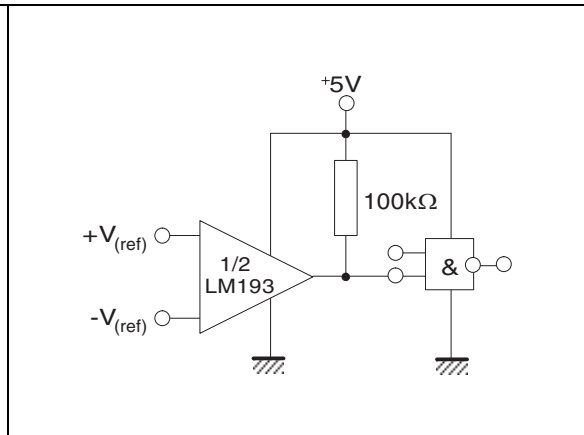


Figure 11. Low frequency op-amp

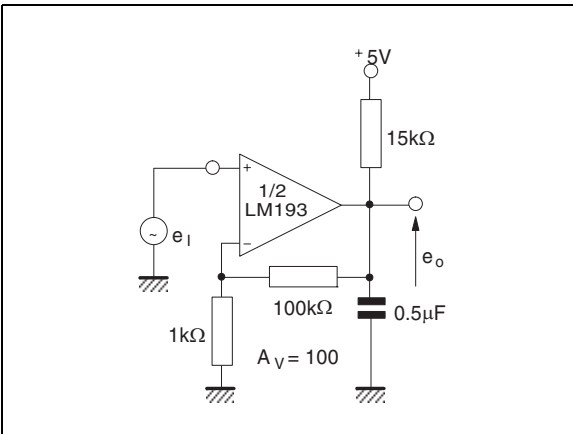


Figure 12. Transducer amplifier

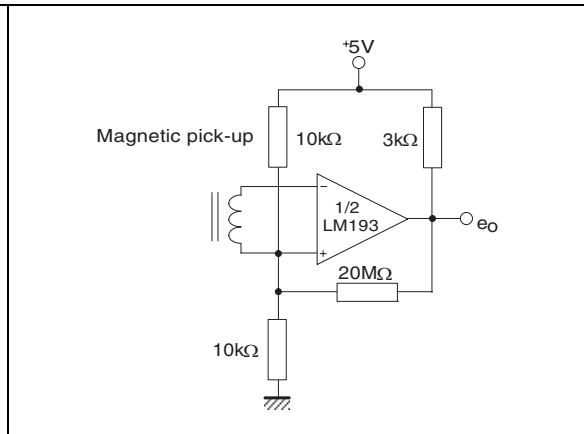


Figure 13. Low frequency op-amp with offset adjust

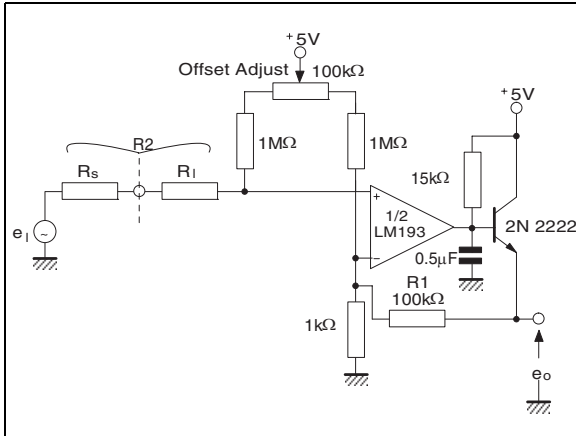


Figure 14. Zero crossing detector (single power supply)

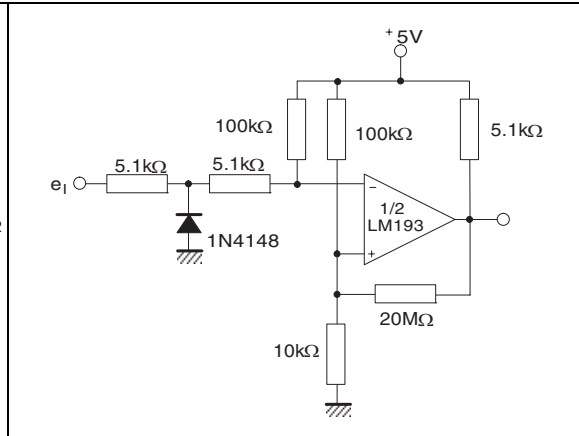


Figure 15. Limit comparator

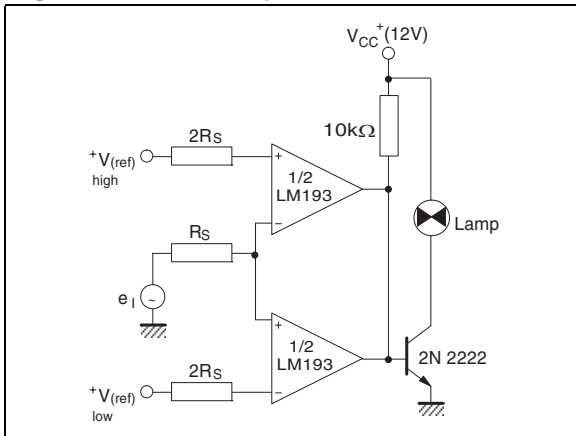


Figure 16. Crystal controlled oscillator

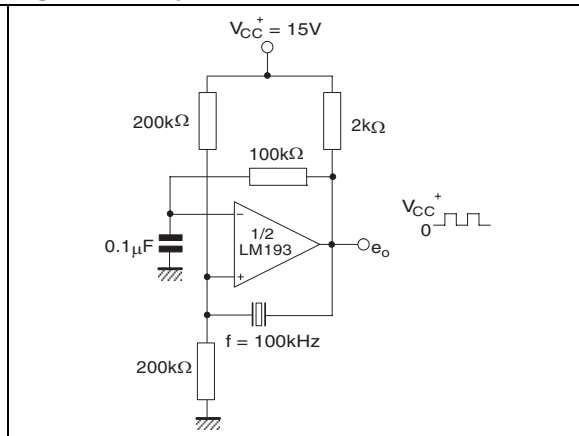


Figure 17. Split-supply applications - zero crossing detector

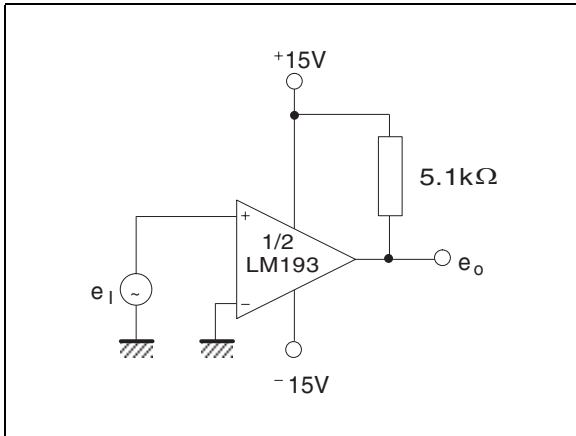


Figure 18. Comparator with a negative reference

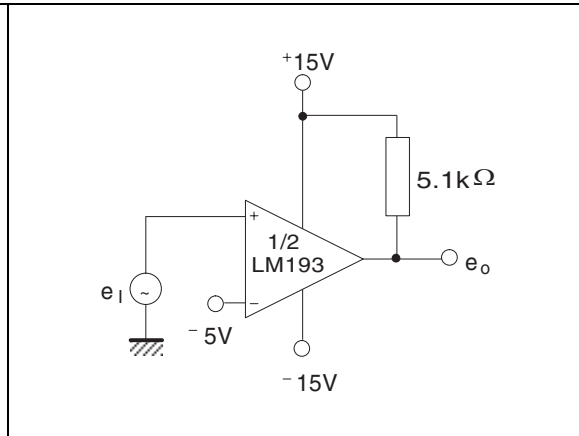
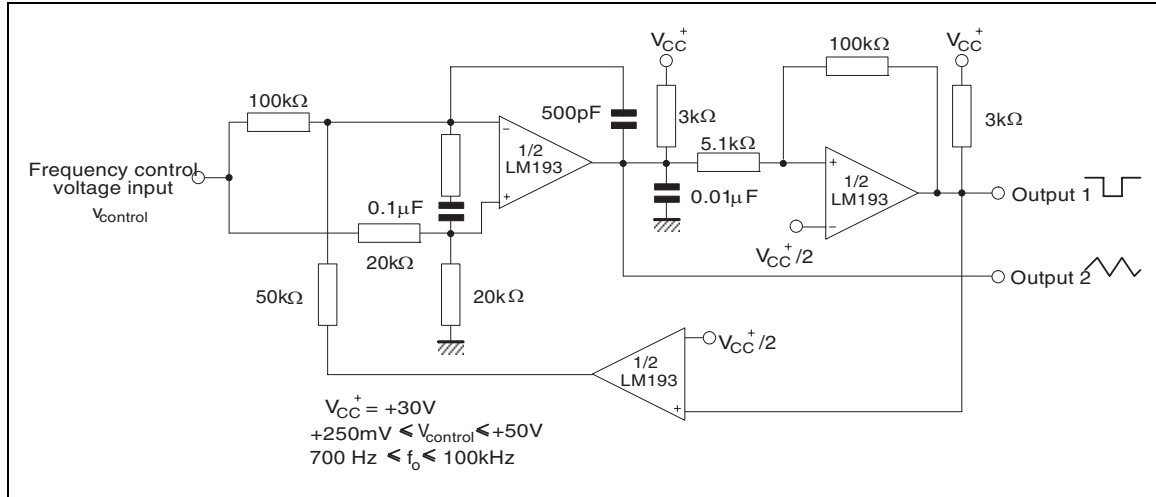


Figure 19. Two-decade high-frequency VCO



5 Package information

In order to meet environmental requirements, ST offers these devices in ECOPACK[®] packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com.

5.1 DIP8 package information

Figure 20. DIP8 package mechanical drawing

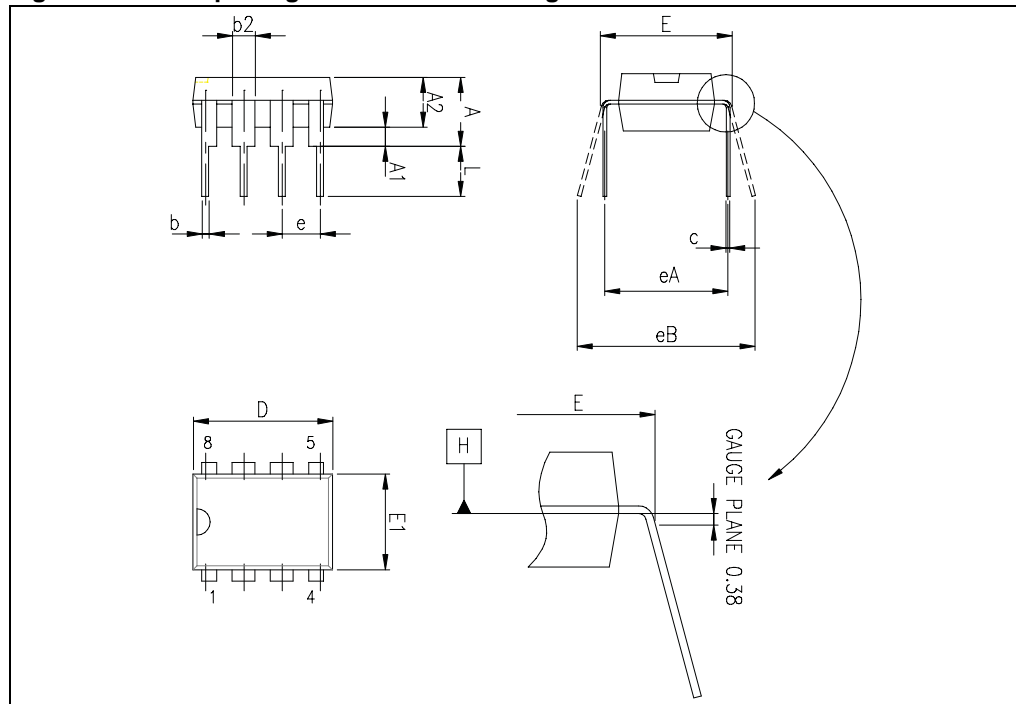


Table 4. DIP8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			5.33			0.210
A1	0.38			0.015		
A2	2.92	3.30	4.95	0.115	0.130	0.195
b	0.36	0.46	0.56	0.014	0.018	0.022
b2	1.14	1.52	1.78	0.045	0.060	0.070
c	0.20	0.25	0.36	0.008	0.010	0.014
D	9.02	9.27	10.16	0.355	0.365	0.400
E	7.62	7.87	8.26	0.300	0.310	0.325
E1	6.10	6.35	7.11	0.240	0.250	0.280
e		2.54			0.100	
eA		7.62			0.300	
eB			10.92			0.430
L	2.92	3.30	3.81	0.115	0.130	0.150

5.2 SO-8 package information

Figure 21. SO-8 package mechanical drawing

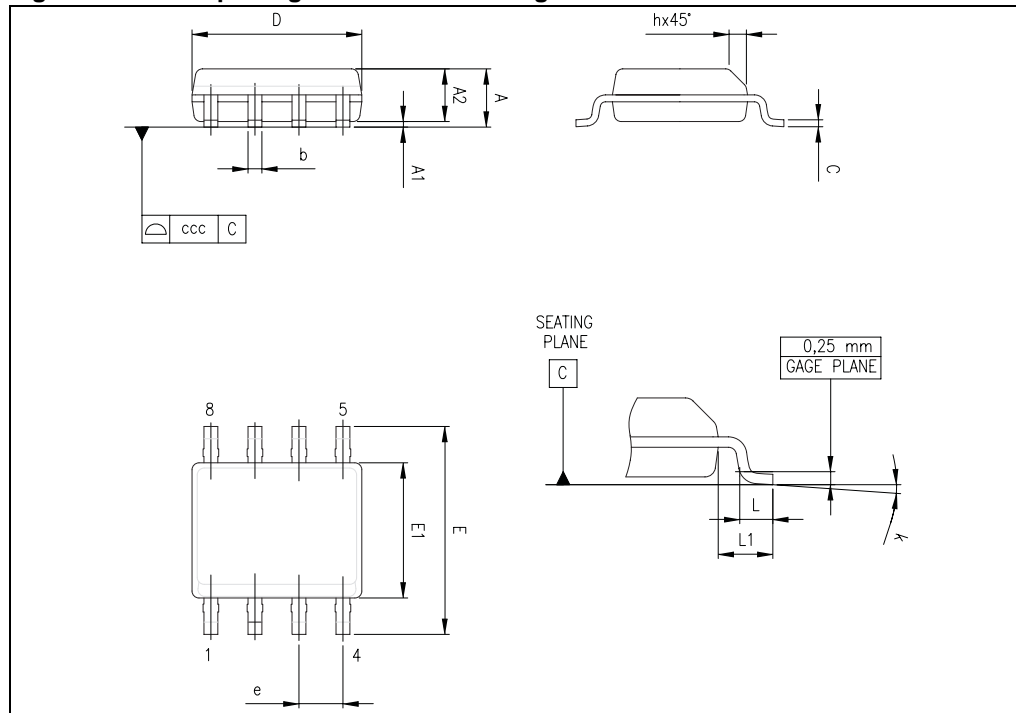


Table 5. SO-8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
A1	0.10		0.25	0.004		0.010
A2	1.25			0.049		
b	0.28		0.48	0.011		0.019
c	0.17		0.23	0.007		0.010
D	4.80	4.90	5.00	0.189	0.193	0.197
E	5.80	6.00	6.20	0.228	0.236	0.244
E1	3.80	3.90	4.00	0.150	0.154	0.157
e		1.27			0.050	
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
k	1°		8°	1°		8°
ccc			0.10			0.004

5.3 TSSOP8 package information

Figure 22. TSSOP8 package mechanical drawing

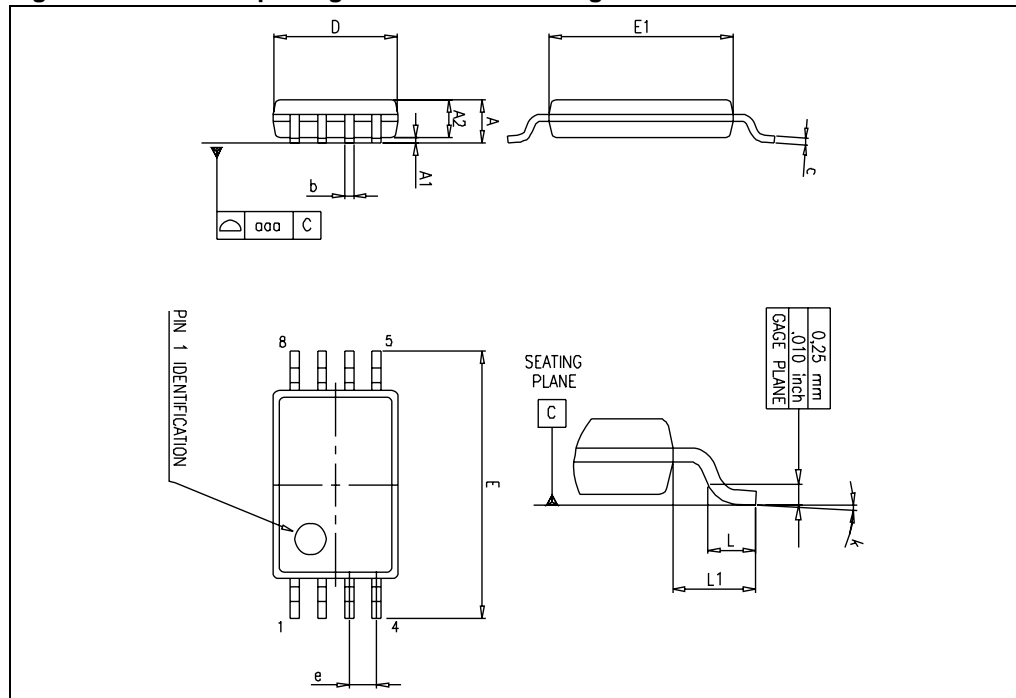


Table 6. TSSOP8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.2			0.047
A1	0.05		0.15	0.002		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.008
D	2.90	3.00	3.10	0.114	0.118	0.122
E	6.20	6.40	6.60	0.244	0.252	0.260
E1	4.30	4.40	4.50	0.169	0.173	0.177
e		0.65			0.0256	
k	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030
L1		1			0.039	
aaa		0.1			0.004	

5.4 MiniSO-8 package information

Figure 23. MiniSO-8 package mechanical drawing

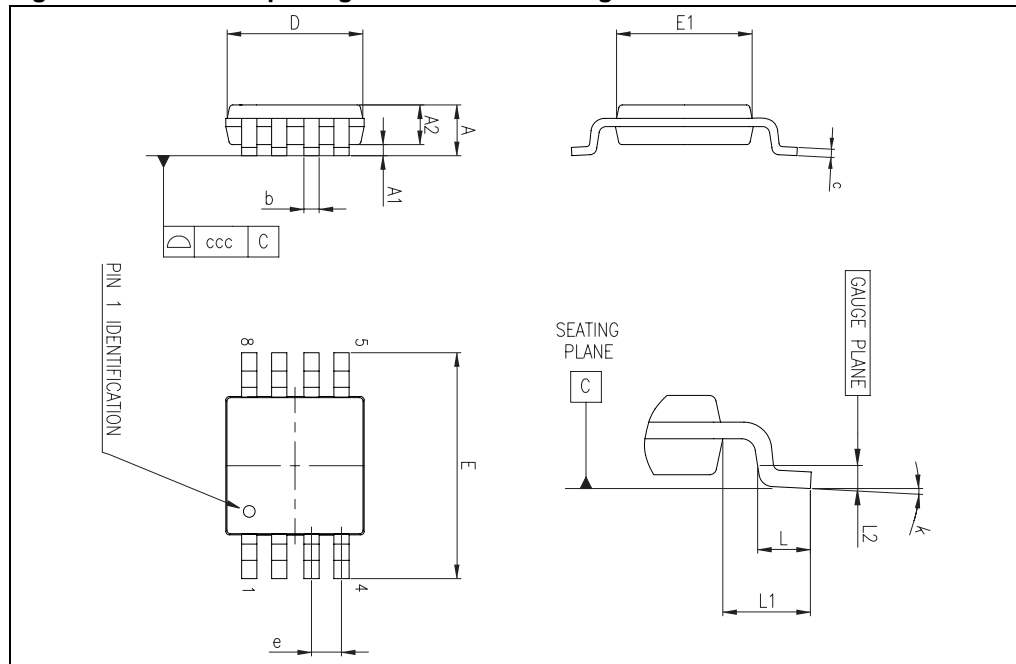


Table 7. MiniSO-8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.1			0.043
A1	0		0.15	0		0.006
A2	0.75	0.85	0.95	0.030	0.033	0.037
b	0.22		0.40	0.009		0.016
c	0.08		0.23	0.003		0.009
D	2.80	3.00	3.20	0.11	0.118	0.126
E	4.65	4.90	5.15	0.183	0.193	0.203
E1	2.80	3.00	3.10	0.11	0.118	0.122
e		0.65			0.026	
L	0.40	0.60	0.80	0.016	0.024	0.031
L1		0.95			0.037	
L2		0.25			0.010	
k	0°		8°	0°		8°
ccc			0.10			0.004

6 Ordering information

Table 8. Order codes

Order code	Temperature range	Package	Packing	Marking	
LM193AD LM193ADT	-55°C, +125°C	SO-8	Tube or Tape & reel	193A	
LM193D LM193DT				193	
LM193AYD ⁽¹⁾ LM193AYDT		SO-8 (Automotive grade)	Tube or Tape & reel	193AY	
LM193YD ⁽¹⁾ LM193YDT				193Y	
LM193AN		DIP8	Tube	LM193AN	
LM193N				LM193N	
LM293AD LM293ADT		-40°C, +105°C	SO-8	Tube or Tape & reel	293A
LM293D LM293DT	293				
LM293AYD ⁽¹⁾ LM293AYDT ⁽¹⁾	SO-8 (Automotive grade)		Tube or Tape & reel	293AY	
LM293YD ⁽¹⁾ LM293YDT ⁽¹⁾				293Y	
LM293AN	DIP8		Tube	LM293AN	
LM293N				LM293N	
LM293PT	TSSOP8		Tape & reel	293	
LM293ST	MiniSO-8		Tape & reel	K512	
LM393AD LM393ADT	0°C, +70°C		SO-8	Tube or Tape & reel	393A
LM393D LM393DT					393
LM393AYD ⁽¹⁾ LM393AYDT ⁽¹⁾		SO-8 (Automotive grade)	Tube or Tape & reel	393AY	
LM393YD ⁽¹⁾ LM393YDT ⁽¹⁾				393Y	
LM393AN		DIP8	Tube	LM393AN	
LM393N				LM393N	
LM393PT		TSSOP8	Tape & reel	393	
LM393ST		MiniSO-8	Tape & reel	M393	

1. Qualified and characterized according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent.

7 Revision history

Table 9. Document revision history

Date	Revision	Changes
02-Jul-2002	1	First release.
02-Jan-2005	2	Class A of the product included in the datasheet.
02-May-2005	3	PPAP references inserted in the datasheet, see Table 6: Ordering information on page 13 .
02-Jul-2005	4	Modification on PPAP references - Errors on part numbers, see Table 6: Ordering information on page 13 .
22-Nov-2005	5	Modification on Table 3 on page 4 . LM293,A must be -40/+105°C instead of -40/+125°C.
16-Feb-2006	6	Unit error for V_{ol} parameter see Table 3 on page 4 .
23-Aug-2007	7	Corrected error in DIP8 package information related to lead thickness, see Figure 20 on page 9 . Added values for R_{thja} and R_{thjc} and ESD parameters in Table 1: Absolute maximum ratings .
08-Nov-2007	8	Updated MiniSO-8 package information. Reformatted package information. Added automotive grade order codes.
19-Feb-2008	9	Corrected error in SO-8 package mechanical data: E dimension in drawing was marked with an F in table.

Please Read Carefully:

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2008 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com

