

## REF19x Series\*

### FEATURES

**Initial Accuracy:**  $\pm 2$  mV max  
**Temperature Coefficient:** 5 ppm/ $^{\circ}$ C max  
**Low Supply Current:** 45  $\mu$ A max  
**Low Dropout Voltage**  
**Load Regulation:** 4 ppm/mA  
**Line Regulation:** 4 ppm/V  
**High Output Current:** 30 mA  
**Short Circuit Protection**  
**Shutdown Mode**

### APPLICATIONS

**Portable Instrumentation**  
**A-to-D and D-to-A Converters**  
**Smart Sensors**  
**Solar Powered Applications**  
**Loop Current Powered Instruments**

### GENERAL DESCRIPTION

REF19x series precision bandgap voltage references utilize a patented temperature drift curvature correction circuit and laser trimming of highly stable thin-film resistors to achieve a very low temperature coefficient and a high initial accuracy.

The REF19x series are micropower, Low Dropout Voltage (LDV) devices providing a stable output voltage from supplies as low as 100 mV above the output voltage and consuming less than 45  $\mu$ A of supply current. In shutdown mode, which is enabled by applying a low TTL or CMOS level to the shutdown pin, the output is turned off and supply current is further reduced to less than 15  $\mu$ A.

The REF19x series references are specified over the extended industrial temperature range ( $-40^{\circ}$ C to  $+85^{\circ}$ C) and High Operating Temperature (HOT) range ( $-40^{\circ}$ C to  $+125^{\circ}$ C) for applications such as automotive.

All grades are available in 8-pin SOIC and PDIP. Products are also available in die form. TSSOP 8-pin available Q4, 1994.

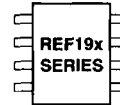
\*Protected by U.S. Patent No. 5291222.

This is a preliminary data sheet. To obtain the most recent version or complete data sheet, call our fax retrieval system at 1-800-446-6212.

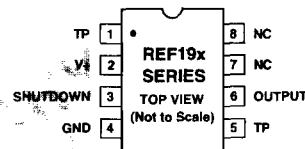
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### PIN CONFIGURATIONS

8-Lead Narrow-Body SO (S Suffix)



8-Lead Epoxy DIP (P Suffix)



NC = NO CONNECT  
 TP PINS ARE FACTORY TEST POINTS -  
 NO USER CONNECTION

Table I.

Part Number	Nominal Output Voltage (V)
REF190*	Adjustable 2 V to 6 V
REF191*	2.048
REF192	2.50
REF193	3.00
REF194	4.50
REF195	5.00
REF196	3.30
REF198	4.096

\*Contact factory for specifications and availability.

# REF19x Series

## REF192—SPECIFICATIONS

### ELECTRICAL CHARACTERISTICS (@ $V_S = +2.6\text{ V}$ , $T_A = +25^\circ\text{C}$ unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Units
INITIAL ACCURACY						
“E” Grade	$V_O$	$I_{OUT} = 1\text{ mA}$	2.498	2.500	2.502	V
“F” Grade			2.495		2.505	V
“G” Grade			2.490		2.510	V
LINE REGULATION						
“E” Grade	$\Delta V_O/\Delta V_{IN}$	$2.6\text{ V} \leq V_S \leq 15\text{ V}$ , $I_{OUT} = 1\text{ mA}$		2	4	ppm/V
“F & G” Grades				4	8	ppm/V
“E” Grade	$\Delta V_O/\Delta I_{LOAD}$	$V_S = 3.8\text{ V}$ , $0 \leq I_{OUT} \leq 30\text{ mA}$		2	4	ppm/mA
“F & G” Grades				4	8	ppm/mA
DROPOUT VOLTAGE	$V_S - V_O$	$V_S = 3.0\text{ V}$ , $I_{LOAD} = 10\text{ mA}$ $V_S = 3.8\text{ V}$ , $I_{LOAD} = 30\text{ mA}$			0.50 1.30	V
LONG-TERM STABILITY	$\Delta V_O$	1000 Hours (@ $+150^\circ\text{C}$ )		2		mV
NOISE VOLTAGE	$e_N$	0.1 Hz to 10 Hz		50		$\mu\text{V p-p}$

### ELECTRICAL CHARACTERISTICS (@ $V_S = +2.65\text{ V}$ , $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$ unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Units
TEMPERATURE COEFFICIENT						
“E” Grade	$\text{TCV}_O/^\circ\text{C}$	$I_{OUT} = 1\text{ mA}$		2	5	ppm/ $^\circ\text{C}$
“F” Grade				5	10	ppm/ $^\circ\text{C}$
“G” Grade						25
LINE REGULATION						
“E” Grade	$\Delta V_O/\Delta V_{IN}$	$2.65\text{ V} \leq V_S \leq 15\text{ V}$ , $I_{OUT} = 1\text{ mA}$		5	10	ppm/V
“F & G” Grades				10	20	ppm/V
“E” Grade	$\Delta V_O/\Delta I_{LOAD}$	$V_S = 3.8\text{ V}$ , $0 \leq I_{OUT} \leq 25\text{ mA}$		5	10	ppm/mA
“F & G” Grades				10	20	ppm/mA
DROPOUT VOLTAGE	$V_S - V_O$	$V_S = 3.0\text{ V}$ , $I_{LOAD} = 10\text{ mA}$ $V_S = 3.8\text{ V}$ , $I_{LOAD} = 30\text{ mA}$			0.50 1.30	V

### ELECTRICAL CHARACTERISTICS (@ $V_S = +2.7\text{ V}$ , $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$ unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Units	
TEMPERATURE COEFFICIENT							
“E” Grade	$\text{TCV}_O/^\circ\text{C}$	$I_{OUT} = 1\text{ mA}$		2	7	ppm/ $^\circ\text{C}$	
“F” Grade				5	15	ppm/ $^\circ\text{C}$	
“G” Grade						25	ppm/ $^\circ\text{C}$
LINE REGULATION							
“E” Grade	$\Delta V_O/\Delta V_{IN}$	$2.7\text{ V} \leq V_S \leq 15\text{ V}$ , $I_{OUT} = 1\text{ mA}$		10	20	ppm/V	
“F & G” Grades				20	30	ppm/V	
“E” Grade	$\Delta V_O/\Delta I_{LOAD}$	$V_S = 3.8\text{ V}$ , $0 \leq I_{OUT} \leq 20\text{ mA}$		10	20	ppm/mA	
“F & G” Grades				20	30	ppm/mA	
DROPOUT VOLTAGE	$V_S - V_O$	$V_S = 3.10\text{ V}$ , $I_{LOAD} = 10\text{ mA}$ $V_S = 3.95\text{ V}$ , $I_{LOAD} = 30\text{ mA}$			0.60 1.45	V	
SHUTDOWN PIN							
Logic High Input Voltage	$V_{IH}$	$V_S = 3.3\text{ V}$	2.4			V	
Logic High Input Current	$I_{IH}$					-5	$\mu\text{A}$
Logic Low Input Voltage	$V_{IL}$					0.8	V
Logic Low Input Current	$I_{IL}$					-5	$\mu\text{A}$
SUPPLY CURRENT		$V_S = 3.3\text{ V}$			45	$\mu\text{A}$	
Sleep Mode					15	$\mu\text{A}$	

Specifications subject to change without notice.

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## REF193—SPECIFICATIONS

ELECTRICAL CHARACTERISTICS (@  $V_S = +3.10\text{ V}$ ,  $T_A = +25^\circ\text{C}$  unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Units
INITIAL ACCURACY “G” Grade	$V_O$	$I_{OUT} = 1\text{ mA}$	2.990	3.0	3.010	V
LINE REGULATION “G” Grade	$\Delta V_O/\Delta V_{IN}$ $\Delta V_O/\Delta I_{LOAD}$	$3.05\text{ V} \leq V_S \leq 15\text{ V}$ , $I_{OUT} = 1\text{ mA}$ $V_S = 4.3\text{ V}$ , $0 \leq I_{OUT} \leq 30\text{ mA}$		4 4	8 8	ppm/V ppm/mA
DROPOUT VOLTAGE	$V_S - V_O$	$V_S = 3.50\text{ V}$ , $I_{LOAD} = 10\text{ mA}$ $V_S = 4.30\text{ V}$ , $I_{LOAD} = 30\text{ mA}$			0.50 1.30	V V
LONG-TERM STABILITY	$\Delta V_O$	1000 Hours @ $+150^\circ\text{C}$		2		mV
NOISE VOLTAGE	$\epsilon_N$	0.1 Hz to 10 Hz		50		$\mu\text{V p-p}$

ELECTRICAL CHARACTERISTICS (@  $V_S = +3.15\text{ V}$ ,  $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$  unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Units
TEMPERATURE COEFFICIENT “G” Grade	$TCV_O/^\circ\text{C}$	$I_{OUT} = 1\text{ mA}$			25	ppm/ $^\circ\text{C}$
LINE REGULATION “G” Grade	$\Delta V_O/\Delta V_{IN}$ $\Delta V_O/\Delta I_{LOAD}$	$3.05\text{ V} \leq V_S \leq 15\text{ V}$ , $I_{OUT} = 1\text{ mA}$ $V_S = 4.3\text{ V}$ , $0 \leq I_{OUT} \leq 25\text{ mA}$		10 10	20 20	ppm/V ppm/mA
DROPOUT VOLTAGE	$V_S - V_O$	$V_S = 3.50\text{ V}$ , $I_{LOAD} = 10\text{ mA}$ $V_S = 4.30\text{ V}$ , $I_{LOAD} = 30\text{ mA}$			0.50 1.30	V V

ELECTRICAL CHARACTERISTICS (@  $V_S = +3.20\text{ V}$ ,  $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$  unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Units
TEMPERATURE COEFFICIENT “G” Grade	$TCV_O/^\circ\text{C}$	$I_{OUT} = 1\text{ mA}$			25	ppm/ $^\circ\text{C}$
LINE REGULATION “G” Grade	$\Delta V_O/\Delta V_{IN}$ $\Delta V_O/\Delta I_{LOAD}$	$3.05\text{ V} \leq V_S \leq 15\text{ V}$ , $I_{OUT} = 1\text{ mA}$ $V_S = 4.3\text{ V}$ , $0 \leq I_{OUT} \leq 20\text{ mA}$		20 20	30 30	ppm/V ppm/mA
DROPOUT VOLTAGE	$V_S - V_O$	$V_S = 3.60\text{ V}$ , $I_{LOAD} = 10\text{ mA}$ $V_S = 4.45\text{ V}$ , $I_{LOAD} = 30\text{ mA}$			0.60 1.45	V V
SHUTDOWN PIN Logic High Input Voltage Logic High Input Current Logic Low Input Voltage Logic Low Input Current	$V_H$ $I_H$ $V_L$ $I_L$	$V_S = 3.3\text{ V}$	2.4		-5 0.8 -5	V $\mu\text{A}$ V $\mu\text{A}$
SUPPLY CURRENT Sleep Mode		$V_S = 3.3\text{ V}$			45 15	$\mu\text{A}$ $\mu\text{A}$

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# REF19x Series

## REF194—SPECIFICATIONS

### ELECTRICAL CHARACTERISTICS (@ $V_S = +4.6\text{ V}$ , $T_A = +25^\circ\text{C}$ unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Units
INITIAL ACCURACY						
“E” Grade	$V_O$	$I_{OUT} = 1\text{ mA}$	4.498	4.5	4.502	V
“F” Grade			4.495		4.505	V
“G” Grade			4.490		4.510	V
LINE REGULATION						
“E” Grade	$\Delta V_O/\Delta V_{IN}$	$4.6\text{ V} \leq V_S \leq 15\text{ V}$ , $I_{OUT} = 1\text{ mA}$		2	4	ppm/V
“F & G” Grades				4	8	ppm/V
“E” Grade	$\Delta V_O/\Delta I_{LOAD}$	$V_S = 5.8\text{ V}$ , $0 \leq I_{OUT} \leq 30\text{ mA}$		2	4	ppm/mA
“F & G” Grades				4	8	ppm/mA
DROPOUT VOLTAGE	$V_S - V_O$	$V_S = 5.00\text{ V}$ , $I_{LOAD} = 10\text{ mA}$ $V_S = 5.8\text{ V}$ , $I_{LOAD} = 30\text{ mA}$			0.50 1.30	V V
LONG-TERM STABILITY	$\Delta V_O$	1000 Hours @ $+150^\circ\text{C}$		2		mV
NOISE VOLTAGE	$e_N$	0.1 Hz to 10 Hz		50		$\mu\text{V p-p}$

### ELECTRICAL CHARACTERISTICS (@ $V_S = +4.65\text{ V}$ , $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$ unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Units
TEMPERATURE COEFFICIENT						
“E” Grade	$TCV_O/^\circ\text{C}$	$I_{OUT} = 1\text{ mA}$		2	5	ppm/ $^\circ\text{C}$
“F” Grade				5	10	ppm/ $^\circ\text{C}$
“G” Grade						25
LINE REGULATION						
“E” Grade	$\Delta V_O/\Delta V_{IN}$	$4.65\text{ V} \leq V_S \leq 15\text{ V}$ , $I_{OUT} = 1\text{ mA}$		2	4	ppm/V
“F & G” Grades				4	8	ppm/V
“E” Grade	$\Delta V_O/\Delta I_{LOAD}$	$V_S = 5.80\text{ V}$ , $0 \leq I_{OUT} \leq 25\text{ mA}$		2	4	ppm/mA
“F & G” Grades				4	8	ppm/mA
DROPOUT VOLTAGE	$V_S - V_O$	$V_S = 5.00\text{ V}$ , $I_{LOAD} = 10\text{ mA}$ $V_S = 5.8\text{ V}$ , $I_{LOAD} = 30\text{ mA}$			0.50 1.30	V V

### ELECTRICAL CHARACTERISTICS (@ $V_S = +4.70\text{ V}$ , $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$ unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Units
TEMPERATURE COEFFICIENT						
“E” Grade	$TCV_O/^\circ\text{C}$	$I_{OUT} = 1\text{ mA}$		2	7	ppm/ $^\circ\text{C}$
“F” Grade				5	15	ppm/ $^\circ\text{C}$
“G” Grade						25
LINE REGULATION						
“E” Grade	$\Delta V_O/\Delta V_{IN}$	$4.70\text{ V} \leq V_S \leq 15\text{ V}$ , $I_{OUT} = 1\text{ mA}$		2	4	ppm/V
“F & G” Grades				4	8	ppm/V
“E” Grade	$\Delta V_O/\Delta I_{LOAD}$	$V_S = 5.80\text{ V}$ , $0 \leq I_{OUT} \leq 20\text{ mA}$		2	4	ppm/mA
“F & G” Grades				4	8	ppm/mA
DROPOUT VOLTAGE	$V_S - V_O$	$V_S = 5.10\text{ V}$ , $I_{LOAD} = 10\text{ mA}$ $V_S = 5.95\text{ V}$ , $I_{LOAD} = 30\text{ mA}$			0.60 1.45	V V
SHUTDOWN PIN						
Logic High Input Voltage	$V_{IH}$	$V_S = 3.3\text{ V}$	2.4			V
Logic High Input Current	$I_{IH}$				-5	$\mu\text{A}$
Logic Low Input Voltage	$V_{IL}$				0.8	V
Logic Low Input Current	$I_{IL}$				-5	$\mu\text{A}$
SUPPLY CURRENT		$V_S = 3.3\text{ V}$			45	$\mu\text{A}$
Sleep Mode					15	$\mu\text{A}$

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## REF195—SPECIFICATIONS

ELECTRICAL CHARACTERISTICS (@  $V_S = +5.10\text{ V}$ ,  $T_A = +25^\circ\text{C}$  unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Units
INITIAL ACCURACY						
“E” Grade	$V_O$	$I_{OUT} = 1\text{ mA}$	4.998	5.0	5.002	V
“F” Grade			4.995		5.005	V
“G” Grade			4.990		5.010	V
LINE REGULATION						
“E” Grade	$\Delta V_O/\Delta V_{IN}$	$5.10\text{ V} \leq V_S \leq 15\text{ V}$ , $I_{OUT} = 1\text{ mA}$	2		4	ppm/V
“F & G” Grades			4		8	ppm/V
“E” Grade	$\Delta V_O/\Delta I_{LOAD}$	$V_S = 6.30\text{ V}$ , $0 \leq I_{OUT} \leq 30\text{ mA}$	2		4	ppm/mA
“F & G” Grades			4		8	ppm/mA
DROPOUT VOLTAGE	$V_S - V_O$	$V_S = 5.50\text{ V}$ , $I_{LOAD} = 10\text{ mA}$ $V_S = 6.30\text{ V}$ , $I_{LOAD} = 30\text{ mA}$			0.50 1.30	V V
LONG-TERM STABILITY	$\Delta V_O$	1000 Hours @ $+150^\circ\text{C}$		2		mV
NOISE VOLTAGE	$e_N$	0.1 Hz to 10 Hz		50		$\mu\text{V p-p}$

ELECTRICAL CHARACTERISTICS (@  $V_S = +5.15\text{ V}$ ,  $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$  unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Units
TEMPERATURE COEFFICIENT						
“E” Grade	$TCV_{O/^\circ\text{C}}$	$I_{OUT} = 1\text{ mA}$		2	5	ppm/ $^\circ\text{C}$
“F” Grade				5	10	ppm/ $^\circ\text{C}$
“G” Grade						25
LINE REGULATION						
“E” Grade	$\Delta V_O/\Delta V_{IN}$	$5.15\text{ V} \leq V_S \leq 15\text{ V}$ , $I_{OUT} = 1\text{ mA}$	2		4	ppm/V
“F & G” Grades			4		8	ppm/V
“E” Grade	$\Delta V_O/\Delta I_{LOAD}$	$V_S = 6.30\text{ V}$ , $0 \leq I_{OUT} \leq 25\text{ mA}$	2		4	ppm/mA
“F & G” Grades			4		8	ppm/mA
DROPOUT VOLTAGE	$V_S - V_O$	$V_S = 5.50\text{ V}$ , $I_{LOAD} = 10\text{ mA}$ $V_S = 6.30\text{ V}$ , $I_{LOAD} = 25\text{ mA}$			0.50 1.30	V V

ELECTRICAL CHARACTERISTICS (@  $V_S = +5.20\text{ V}$ ,  $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$  unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Units	
TEMPERATURE COEFFICIENT							
“E” Grade	$TCV_{O/^\circ\text{C}}$	$I_{OUT} = 1\text{ mA}$		2	7	ppm/ $^\circ\text{C}$	
“F” Grade				5	15	ppm/ $^\circ\text{C}$	
“G” Grade						25	ppm/ $^\circ\text{C}$
LINE REGULATION							
“E” Grade	$\Delta V_O/\Delta V_{IN}$	$5.20\text{ V} \leq V_S \leq 15\text{ V}$ , $I_{OUT} = 1\text{ mA}$	2		4	ppm/V	
“F & G” Grades			4		8	ppm/V	
“E” Grade	$\Delta V_O/\Delta I_{LOAD}$	$V_S = 6.450\text{ V}$ , $0 \leq I_{OUT} \leq 20\text{ mA}$	2		4	ppm/mA	
“F & G” Grades			4		8	ppm/mA	
DROPOUT VOLTAGE	$V_S - V_O$	$V_S = 5.60\text{ V}$ , $I_{LOAD} = 10\text{ mA}$ $V_S = 6.45\text{ V}$ , $I_{LOAD} = 20\text{ mA}$			0.60 1.45	V V	
SHUTDOWN PIN							
Logic High Input Voltage	$V_{IH}$	$V_S = 5.5\text{ V}$	2.4			V	
Logic High Input Current	$I_{IH}$					-5	$\mu\text{A}$
Logic Low Input Voltage	$V_{IL}$					0.8	V
Logic Low Input Current	$I_{IL}$					-5	$\mu\text{A}$
SUPPLY CURRENT		$V_S = 5.5\text{ V}$			45	$\mu\text{A}$	
Sleep Mode					15	$\mu\text{A}$	

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# REF19x Series

## REF196—SPECIFICATIONS

### ELECTRICAL CHARACTERISTICS (@ $V_S = +3.4\text{ V}$ , $T_A = +25^\circ\text{C}$ unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Units
INITIAL ACCURACY "G" Grade	$V_O$	$I_{OUT} = 1\text{ mA}$	3.290	3.3	3.310	V
LINE REGULATION "G" Grade	$\Delta V_O/\Delta V_{IN}$ $\Delta V_O/\Delta I_{LOAD}$	$3.40\text{ V} \leq V_S \leq 15\text{ V}$ , $I_{OUT} = 1\text{ mA}$ $V_S = 3.80\text{ V}$ , $0 \leq I_{OUT} \leq 30\text{ mA}$		4 4	8 8	ppm/V ppm/mA
DROPOUT VOLTAGE	$V_S - V_O$	$V_S = 3.80\text{ V}$ , $I_{LOAD} = 10\text{ mA}$ $V_S = 4.60\text{ V}$ , $I_{LOAD} = 30\text{ mA}$			0.50 1.30	V V
LONG-TERM STABILITY	$\Delta V_O$	1000 Hours @ $+150^\circ\text{C}$		2		mV
NOISE VOLTAGE	$e_N$	0.1 Hz to 10 Hz		50		$\mu\text{V p-p}$

### ELECTRICAL CHARACTERISTICS (@ $V_S = +3.45\text{ V}$ , $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$ unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Units
TEMPERATURE COEFFICIENT "G" Grade	$TCV_O/^\circ\text{C}$	$I_{OUT} = 1\text{ mA}$			25	ppm/ $^\circ\text{C}$
LINE REGULATION "G" Grade	$\Delta V_O/\Delta V_{IN}$ $\Delta V_O/\Delta I_{LOAD}$	$3.45\text{ V} \leq V_S \leq 15\text{ V}$ , $I_{OUT} = 1\text{ mA}$ $V_S = 3.80\text{ V}$ , $0 \leq I_{OUT} \leq 25\text{ mA}$		4 4	8 8	ppm/V ppm/mA
DROPOUT VOLTAGE	$V_S - V_O$	$V_S = 3.80\text{ V}$ , $I_{LOAD} = 10\text{ mA}$ $V_S = 4.60\text{ V}$ , $I_{LOAD} = 25\text{ mA}$			0.50 1.30	V V

### ELECTRICAL CHARACTERISTICS (@ $V_S = +3.50\text{ V}$ , $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$ unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Units
TEMPERATURE COEFFICIENT "G" Grade	$TCV_O/^\circ\text{C}$	$I_{OUT} = 1\text{ mA}$			25	ppm/ $^\circ\text{C}$
LINE REGULATION "G" Grade	$\Delta V_O/\Delta V_{IN}$ $\Delta V_O/\Delta I_{LOAD}$	$3.50\text{ V} \leq V_S \leq 15\text{ V}$ , $I_{OUT} = 1\text{ mA}$ $V_S = 3.80\text{ V}$ , $0 \leq I_{OUT} \leq 20\text{ mA}$		4 4	8 8	ppm/V ppm/mA
DROPOUT VOLTAGE	$V_S - V_O$	$V_S = 3.90\text{ V}$ , $I_{LOAD} = 10\text{ mA}$ $V_S = 4.75\text{ V}$ , $I_{LOAD} = 20\text{ mA}$			0.60 1.45	V V
SHUTDOWN PIN Logic High Input Voltage Logic High Input Current Logic Low Input Voltage Logic Low Input Current	$V_H$ $I_H$ $V_L$ $I_L$	$V_S = 5.5\text{ V}$	2.4		-5 0.8 -5	V $\mu\text{A}$ V $\mu\text{A}$
SUPPLY CURRENT Sleep Mode		$V_S = 5.5\text{ V}$			45 15	$\mu\text{A}$ $\mu\text{A}$

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## REF198—SPECIFICATIONS

ELECTRICAL CHARACTERISTICS (@  $V_S = +4.2\text{ V}$ ,  $T_A = +25^\circ\text{C}$  unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Units
INITIAL ACCURACY						
“E” Grade	$V_O$	$I_{OUT} = 1\text{ mA}$	4.094	4.096	4.098	V
“F” Grade			4.091		4.101	V
“G” Grade			4.086		4.106	V
LINE REGULATION						
“E” Grade	$\Delta V_O/\Delta V_{IN}$	$4.2\text{ V} \leq V_S \leq 15\text{ V}$ , $I_{OUT} = 1\text{ mA}$		2	4	ppm/V
“F & G” Grades				4	8	ppm/V
“E” Grade	$\Delta V_O/\Delta I_{LOAD}$	$V_S = 5.4\text{ V}$ , $0 \leq I_{OUT} \leq 30\text{ mA}$		2	4	ppm/mA
“F & G” Grades				4	8	ppm/mA
DROPOUT VOLTAGE	$V_S - V_O$	$V_S = 4.6\text{ V}$ , $I_{LOAD} = 10\text{ mA}$ $V_S = 5.4\text{ V}$ , $I_{LOAD} = 30\text{ mA}$			0.50 1.30	V V
LONG-TERM STABILITY	$\Delta V_O$	1000 Hours @ $+150^\circ\text{C}$		2		mV
NOISE VOLTAGE	$e_N$	0.1 Hz to 10 Hz		50		$\mu\text{V p-p}$

ELECTRICAL CHARACTERISTICS (@  $V_S = +4.2\text{ V}$ ,  $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$  unless otherwise noted)

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Parameter	Symbol	Condition	Min	Typ	Max	Units
TEMPERATURE COEFFICIENT						
“E” Grade	$TCV_O/^\circ\text{C}$	$I_{OUT} = 1\text{ mA}$		2	5	ppm/ $^\circ\text{C}$
“F” Grade				5	10	ppm/ $^\circ\text{C}$
“G” Grade						25
LINE REGULATION						
“E” Grade	$\Delta V_O/\Delta V_{IN}$	$4.2\text{ V} \leq V_S \leq 15\text{ V}$ , $I_{OUT} = 1\text{ mA}$		2	4	ppm/V
“F & G” Grades				4	8	ppm/V
“E” Grade	$\Delta V_O/\Delta I_{LOAD}$	$V_S = 5.4\text{ V}$ , $0 \leq I_{OUT} \leq 25\text{ mA}$		2	4	ppm/mA
“F & G” Grades				4	8	ppm/mA
DROPOUT VOLTAGE	$V_S - V_O$	$V_S = 4.6\text{ V}$ , $I_{LOAD} = 10\text{ mA}$ $V_S = 5.4\text{ V}$ , $I_{LOAD} = 30\text{ mA}$			0.50 1.30	V V

ELECTRICAL CHARACTERISTICS (@  $V_S = +4.2\text{ V}$ ,  $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$  unless otherwise noted)

Parameter	Symbol	Condition	Min	Typ	Max	Units	
TEMPERATURE COEFFICIENT							
“E” Grade	$TCV_O/^\circ\text{C}$			2	7	ppm/ $^\circ\text{C}$	
“F” Grade				5	15	ppm/ $^\circ\text{C}$	
“G” Grade						25	ppm/ $^\circ\text{C}$
LINE REGULATION							
“E” Grade	$\Delta V_O/\Delta V_{IN}$	$4.2\text{ V} \leq V_S \leq 15\text{ V}$ , $I_{OUT} = 1\text{ mA}$		2	4	ppm/V	
“F & G” Grades				4	8	ppm/V	
“E” Grade	$\Delta V_O/\Delta I_{LOAD}$	$V_S = 5.0\text{ V}$ , $0 \leq I_{OUT} \leq 20\text{ mA}$		2	4	ppm/mA	
“F & G” Grades				4	8	ppm/mA	
DROPOUT VOLTAGE	$V_S - V_O$	$V_S = 4.7\text{ V}$ , $I_{LOAD} = 10\text{ mA}$ $V_S = 5.6\text{ V}$ , $I_{LOAD} = 30\text{ mA}$			0.60 1.50	V V	
SHUTDOWN PIN							
Logic High Input Voltage	$V_H$	$V_S = 4.5\text{ V}$	2.4			V	
Logic High Input Current	$I_L$					-5	$\mu\text{A}$
Logic Low Input Voltage	$V_L$					0.8	V
Logic Low Input Current	$I_L$					-5	$\mu\text{A}$
SUPPLY CURRENT		$V_S = 4.5\text{ V}$			45	$\mu\text{A}$	
Sleep Mode					15	$\mu\text{A}$	

Specifications subject to change without notice.

This information applies to a product under development. Its characteristics and specifications are subject to change without notice. Analog Devices assumes no obligation regarding future manufacture unless otherwise agreed to in writing.

# REF19x Series

## WAFER TEST LIMITS (@ $I_{LOAD} = 0$ mA, $T_A = +25^\circ\text{C}$ unless otherwise noted)

Parameter	Symbol	Condition	Limits	Units
Initial Accuracy	$V_O$		Adjustable	V
REF190			2.043/2.053	V
REF191			2.495/2.505	V
REF192			2.990/3.010	V
REF193			4.495/4.505	V
REF194			4.995/5.005	V
REF195			3.290/3.310	V
REF196			4.091/4.101	V
LINE REGULATION	$\Delta V_O/\Delta V_{IN}$	$V_O + 1.3 \text{ V} < V_{IN} < 15 \text{ V}$ , $I_{OUT} = 30 \text{ mA}$		mV/V
LOAD REGULATION	$\Delta V_O/\Delta I_{LOAD}$	$1 \text{ mA} < I_{LOAD} < 30 \text{ mA}$ , $V_{IN} = V_O + 1.3 \text{ V}$		mV/mA
DROPOUT VOLTAGE	$V_O - V_+$	$I_{LOAD} = 10 \text{ mA}$ $I_{LOAD} = 30 \text{ mA}$	0.5 1.3	V V
STANDBY MODE INPUT	$V_{IH}$ $V_{IL}$		2.4	V
Logic Input High			0.8	V
SUPPLY CURRENT		No Load	45	$\mu\text{A}$
Standby Mode			15	$\mu\text{A}$

### NOTE

For proper operation, a 1  $\mu\text{F}$  capacitor is required between the output pins and the GND pin of the REF19x. Electrical tests and wafer probe to the limits shown. Due to variations in assembly methods and normal yield loss, yield after packaging is not guaranteed for standard product dice. Consult factory to negotiate specifications based on dice lot qualifications through sample lot assembly and testing.

### ABSOLUTE MAXIMUM RATINGS<sup>1</sup>

Supply Voltage	+18 V
Output Short-Circuit Duration	Indefinite
Storage Temperature Range	
P, S Packages	-65°C to +150°C
Operating Temperature Range	
REF19x	-40°C to +85°C
Junction Temperature Range	
P, S Packages	-65°C to +125°C
Lead Temperature Range (Soldering, 60 sec)	+300°C

Package Type	$\theta_{JA}^2$	$\theta_{JC}$	Units
8-Pin Plastic DIP (P)	103	43	$^\circ\text{C}/\text{W}$
8-Pin SOIC (S)	158	43	$^\circ\text{C}/\text{W}$

### NOTES

<sup>1</sup>Absolute maximum ratings apply to both DICE and packaged parts, unless otherwise noted.

<sup>2</sup> $\theta_{JA}$  is specified for the worst case conditions, i.e.,  $\theta_{JA}$  is specified for device in socket for P-DIP, and  $\theta_{JA}$  is specified for device soldered in circuit board for SOIC package.

### CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although these devices feature proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.



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