

Rochester Electronics Manufactured Components

Rochester branded components are manufactured using either die/wafers purchased from the original suppliers or Rochester wafers recreated from the original IP. All recreations are done with the approval of the OCM.

Parts are tested using original factory test programs or Rochester developed test solutions to guarantee product meets or exceed the OCM data sheet.

Quality Overview

- ISO-9001
- AS9120 certification
- Qualified Manufacturers List (QML) MIL-PRF-35835
 - Class Q Military
 - Class V Space Level
- Qualified Suppliers List of Distributors (QSLD)
 - Rochester is a critical supplier to DLA and meets all industry and DLA standards.

Rochester Electronics, LLC is committed to supplying products that satisfy customer expectations for quality and are equal to those originally supplied by industry manufacturers.

The original manufacturer's datasheet accompanying this document reflects the performance and specifications of the Rochester manufactured version of this device. Rochester Electronics guarantees the performance of its semiconductor products to the original OEM specifications. 'Typical' values are for reference purposes only. Certain minimum or maximum ratings may be based on product characterization, design, simulation, or sample testing.

December 1997

2MHz, Micropower Operational Amplifier

Features

- Low Standby Power As Low As 700nW
- Wide Supply Voltage Range $\pm 0.75V$ to $\pm 15V$
- High Peak Output Current 6.5mA (Min)
- Adjustable Quiescent Current
- Output Short Circuit Protection

Applications

- Portable Electronics
- Telemetry
- Medical Electronics
- Intrusion Alarms
- Instrumentation

Ordering Information

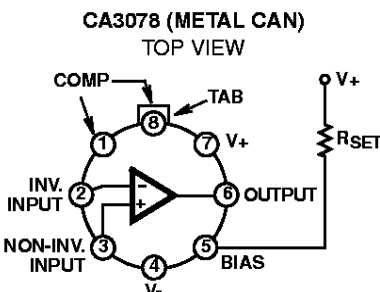
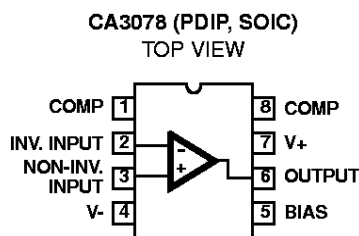
PART NUMBER (BRAND)	TEMP. RANGE (°C)	PACKAGE	PKG. NO.
CA3078AE	-55 to 125	8 Ld PDIP	E8.3
CA3078AM (3078A)	-55 to 125	8 Ld SOIC	M8.15
CA3078AM96 (3078A)	-55 to 125	8 Ld SOIC Tape and Reel	M8.15
CA3078AT	-55 to 125	8 Pin Metal Can	T8.C
CA3078E	0 to 70	8 Ld PDIP	E8.3
CA3078M (3078)	0 to 70	8 Ld SOIC	M8.15
CA3078T	0 to 70	8 Pin Metal Can	T8.C

Description

The CA3078 and CA3078A are high gain monolithic operational amplifiers which can deliver milliamperes of current yet only consume microwatts of standby power. Their operating points are externally adjustable and frequency compensation may be accomplished with one external capacitor. The CA3078 and CA3078A provide the designer with the opportunity to tailor the frequency response and improve the slew rate without sacrificing power. Operation with a single 1.5V battery is a practical reality with these devices.

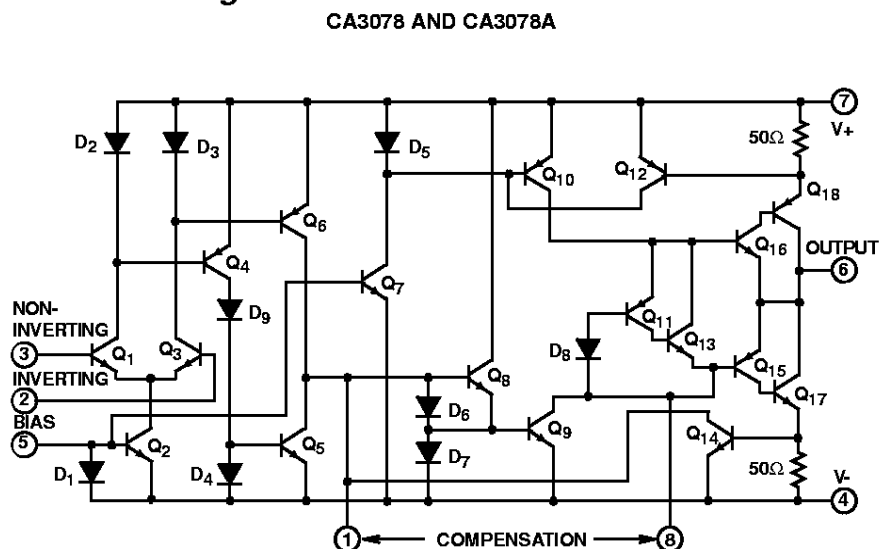
The CA3078A is a premium device having a supply voltage range of $V_{\pm} = 0.75V$ to $V_{\pm} = 15V$. The CA3078 has the same lower supply voltage limit but the upper limit is $V_{+} = +6V$ and $V_{-} = -6V$.

Pinouts



NOTE: Pin 4 is connected to case.

Schematic Diagram



CA3078, CA3078A

Absolute Maximum Ratings

Supply Voltage (Between V+ and V- Terminal)	
CA3078.....	14V
CA3078A.....	36V
Differential Input Voltage.....	6V
Input Voltage.....	V+ to V-
Input Current.....	0.1mA
Output Short Circuit Duration (Note 1).....	No Limitation

Thermal Information

Thermal Resistance (Typical, Note 2)	θ_{JA} (°C/W)	θ_{JC} (°C/W)
PDIP Package.....	130	N/A
SOIC Package.....	170	N/A
Metal Can Package.....	175	100
Maximum Junction Temperature (Metal Can Package).....	175°C	
Maximum Junction Temperature (Plastic Package).....	150°C	
Maximum Storage Temperature.....	-65°C to 150°C	
Maximum Lead Temperature (Soldering 10s).....	300°C	
(SOIC - Lead Tips Only)		

Operating Conditions

Temperature Range	
CA3078.....	0°C to 70°C
CA3078A.....	-55°C to 125°C

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTES:

1. Short circuit may be applied to ground or to either supply.
2. θ_{JA} is measured with the component mounted on an evaluation PC board in free air.

Electrical Specifications For Equipment Design

PARAMETER	TEST CONDITIONS			CA3078 LIMITS					CA3078A LIMITS					UNITS
				$R_{SET} = 1\text{M}\Omega$										
	V+ and V-	R_S (k Ω)	R_L (k Ω)	$T_A = 25^\circ\text{C}$			$T_A = 0^\circ\text{C to } 70^\circ\text{C}$		$T_A = 25^\circ\text{C}$			$T_A = -55^\circ\text{C to } 125^\circ\text{C}$		
				MIN	TYP	MAX	MIN	MAX	MIN	TYP	MAX	MIN	MAX	
V_{IO}	$\pm 6\text{V}$	≤ 10	-	-	1.3	4.5	-	5	-	0.70	3.5	-	4.5	mV
I_{IO}		-	-	-	6	32	-	40	-	0.50	2.5	-	5.0	nA
I_{IB}		-	-	-	60	170	-	200	-	7	12	-	50	nA
A_{OL}		-	≥ 10	88	92	-	86	-	92	100	-	90	-	dB
I_Q		-	-	-	100	130	-	150	-	20	25	-	45	μA
P_D		-	-	-	1200	1560	-	1800	-	240	300	-	540	μW
V_{OM}		-	≥ 10	± 5.1	± 5.3	-	± 5	-	± 5.1	± 5.3	-	± 5	-	V
V_{ICR}		≤ 10	-	-	-5.5 to +5.8	-	-5 to +5	-	-	-5.5 to +5.8	-	-5 to +5	-	V
CMRR		≤ 10	-	80	110	-	-	-	80	115	-	-	-	dB
I_{OM+} or I_{OM-}		-	-	-	12	-	6.5	30	-	12	-	6.5	30	mA
$\Delta V_{IO}/\Delta V_+$		≤ 10	-	76	93	-	-	-	76	105	-	-	-	$\mu\text{V/V}$
$\Delta V_{IO}/\Delta V_-$		≤ 10	-	76	93	-	-	-	76	105	-	-	-	$\mu\text{V/V}$
$R_{SET} = 13\text{M}\Omega$														
V_{IO}	$\pm 15\text{V}$	≤ 10	-	-	-	-	-	-	-	1.4	3.5	-	4.5	mV
A_{OL}		-	≥ 10	-	-	-	-	-	92	100	-	88	-	dB
I_Q		-	-	-	-	-	-	-	-	20	30	-	50	μA
P_D		-	-	-	-	-	-	-	-	600	750	-	1350	μW
V_{OM}		-	≥ 10	-	-	-	-	-	± 13.7	± 14.1	-	± 13.5	-	V
CMRR		≤ 10	-	-	-	-	-	-	80	106	-	-	-	dB
I_{IB}		-	-	-	-	-	-	-	-	7	14	-	55	nA
I_{IO}		-	-	-	-	-	-	-	-	0.50	2.7	-	5.5	nA

CA3078, CA3078A

Electrical Specifications $T_A = 25^\circ\text{C}$, Typical Values Intended Only for Design Guidance

PARAMETER	CA3078		CA3078A		UNITS
	V+ = +1.3V, V- = -1.3V R _{SET} = 2M Ω	V+ = +0.75V, V- = -0.75V R _{SET} = 10M Ω	V+ = +1.3V, V- = -1.3V R _{SET} = 2M Ω	V+ = +0.75V, V- = -0.75V R _{SET} = 10M Ω	
V _{IO}	1.3	1.5	0.7	0.9	mV
I _{IO}	1.7	0.5	0.3	0.054	nA
I _{IB}	9	1.3	3.7	0.45	nA
A _{OL}	80	60	84	65	dB
I _Q	10	1	10	1	μA
P _D	26	1.5	26	1.5	μW
V _{OP-P}	1.4	0.3	1.4	0.3	V
V _{ICR}	-0.8 to +1.1	-0.2 to +0.5	-0.8 to +1.1	-0.2 to +0.5	V
CMRR	100	90	100	90	dB
I _{OM\pm}	12	0.5	12	0.5	mA
$\Delta V_{IO}/\Delta V_{\pm}$	20	50	20	50	$\mu\text{V}/\text{V}$

Electrical Specifications $T_A = 25^\circ\text{C}$ and V_{SUPPLY} = $\pm 6\text{V}$, Typical Values Intended Only for Design Guidance

PARAMETER	TEST CONDITIONS	CA3078	CA3078A		UNITS
		R _{SET} = 1M Ω	R _{SET} = 5.1M Ω	R _{SET} = 1M Ω	
$\Delta V_{IO}/\Delta T_A$	R _S \leq 10k Ω	6	5	6	$\mu\text{V}/^\circ\text{C}$
$\Delta I_{IO}/\Delta T_A$	R _S \leq 10k Ω	70	6.3	70	pA/ $^\circ\text{C}$
GBWP	A _V = 100, C ₁ = 10pF	2	0.3	2	MHz
SR	See Figures 23, 24	0.04	0.027	0.04	V/ μs
		1.5	0.5	1.5	V/ μs
t _R	10% to 90% Rise Time	2.5	3	2.5	μs
R _I	-	0.87	7.4	1.7	M Ω
R _O	-	0.8	1	0.8	k Ω
e _N (10Hz)	R _S = 0	25	40	-	nV/ $\sqrt{\text{Hz}}$
i _N (10Hz)	R _S = 1M Ω	1	0.25	-	pA/ $\sqrt{\text{Hz}}$

Test Circuits

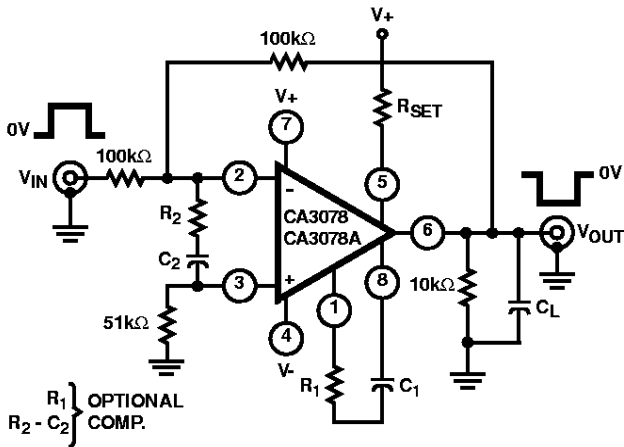


FIGURE 1. TRANSIENT RESPONSE AND SLEW RATE, UNITY GAIN (INVERTING) TEST CIRCUIT

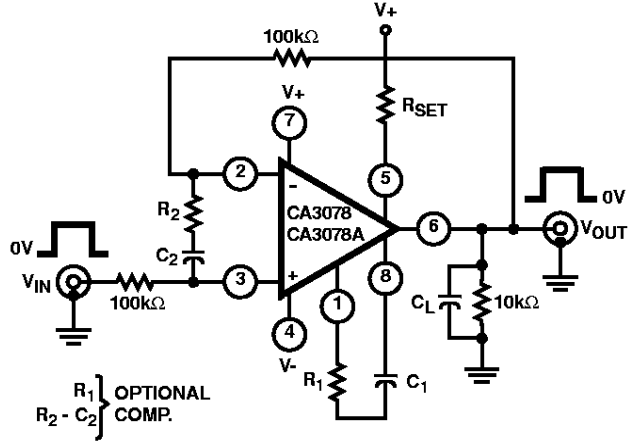


FIGURE 2. SLEW RATE, UNITY GAIN (NON-INVERTING) TEST CIRCUIT

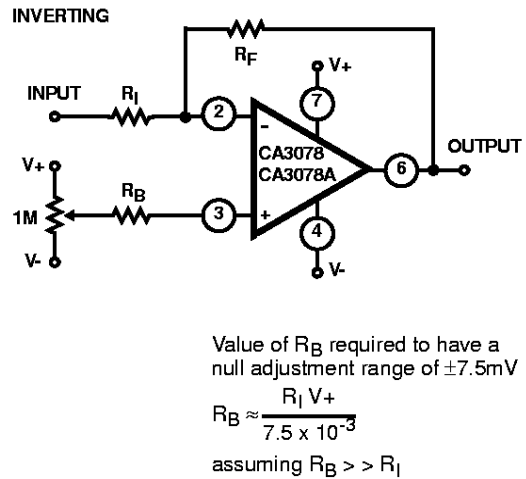
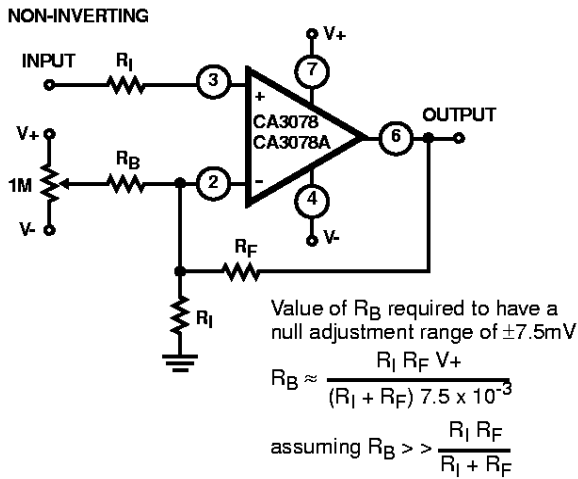


FIGURE 3. OFFSET VOLTAGE NULL CIRCUITS

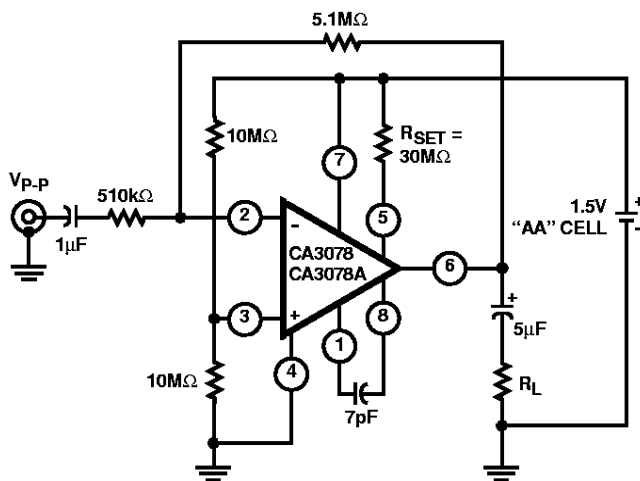


FIGURE 4. INVERTING 20dB AMPLIFIER CIRCUIT

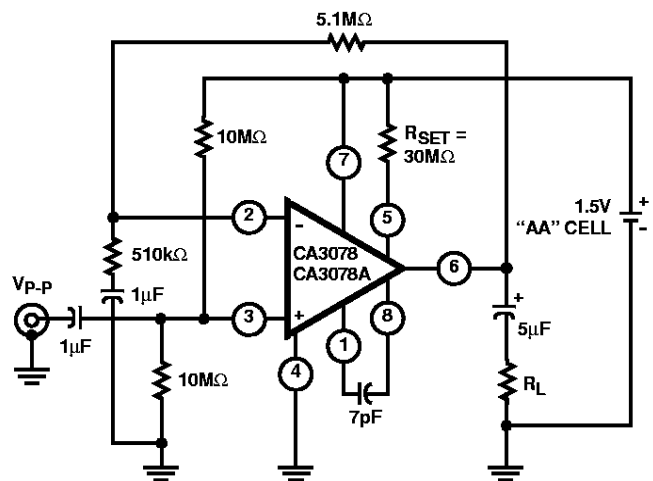


FIGURE 5. NON-INVERTING 20dB AMPLIFIER CIRCUIT

CA3078, CA3078A

TABLE 1. UNITY GAIN SLEW RATE vs COMPENSATION - CA3078 AND CA3078A

$V_{SUPPLY} = \pm 6V$, Output Voltage (V_O) = $\pm 5V$, Load Resistance (R_L) = $10k\Omega$, Transient Response: 10% overshoot for an output voltage of 100mV, Ambient Temperature (T_A) = $25^\circ C$

COMPENSATION TECHNIQUE	UNITY GAIN (INVERTING) FIGURE 1					UNITY GAIN (NON-INVERTING) FIGURE 2				
	R ₁	C ₁	R ₂	C ₂	SLEW RATE	R ₁	C ₁	R ₂	C ₂	SLEW RATE
	k Ω	pF	k Ω	μF	V/ μs	k Ω	pF	k Ω	μF	V/ μs
CA3078 - $I_Q = 100\mu A$										
Single Capacitor	0	750	∞	0	0.0085	0	1500	∞	0	0.0095
Resistor and Capacitor	3.5	350	∞	0	0.04	5.3	500	∞	0	0.024
Input	∞	0	0.25	0.306	0.67	∞	0	0.311	0.45	0.67
CA3078A - $I_Q = 20\mu A$										
Single Capacitor	0	300	∞	0	0.0095	0	800	∞	0	0.003
Resistor and Capacitor	14	100	∞	0	0.027	34	125	∞	0	0.02
Input	∞	0	0.644	0.156	0.29	∞	0	0.77	0.4	0.4

Application Information

Compensation Techniques

The CA3078A and CA3078 can be phase compensated with one or two external components depending upon the closed loop gain, power consumption, and speed desired. The recommended compensation is a resistor in series with a capacitor connected from Terminal 1 to Terminal 8. Values of the resistor and capacitor required for compensation as a function of closed loop gain are shown in Figures 25 and 26. These curves represent the compensation necessary at quiescent currents of $100\mu A$ and $20\mu A$, respectively, for a transient response with 10% overshoot. Figures 23 and 24 show the slew rates that can be obtained with the two different compensation techniques. Higher speeds can be achieved with input compensation, but this increases noise output.

Compensation can also be accomplished with a single capacitor connected from Terminal 1 to Terminal 8, with speed being sacrificed for simplicity. Table 1 gives an indication of slew rates that can be obtained with various compensation techniques at quiescent currents of $100\mu A$ and $20\mu A$.

Single Supply Operation

The CA3078A and CA3078 can operate from a single supply with a minimum total supply voltage of 1.5V. Figures 4 and 5 show the CA3078A or CA3078 in inverting and non-inverting 20dB amplifier configurations utilizing a 1.5V type "AA" cell for a supply. The total consumption for either circuit is approximately 675nW. The output voltage swing in this configuration is 300mV_{P-P} with a 20k Ω load.

Typical Performance Curves

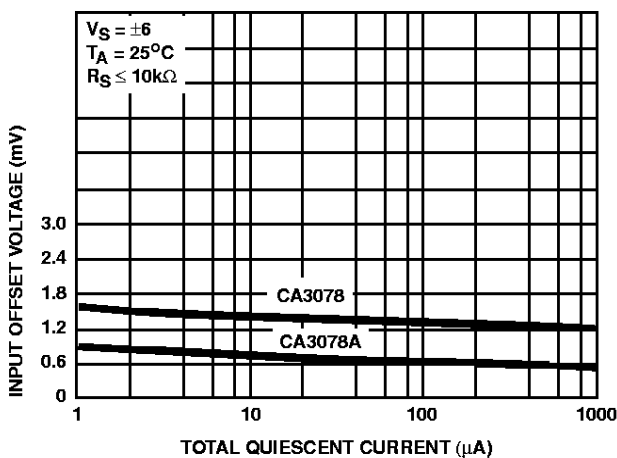


FIGURE 6. INPUT OFFSET VOLTAGE vs TOTAL QUIESCENT CURRENT

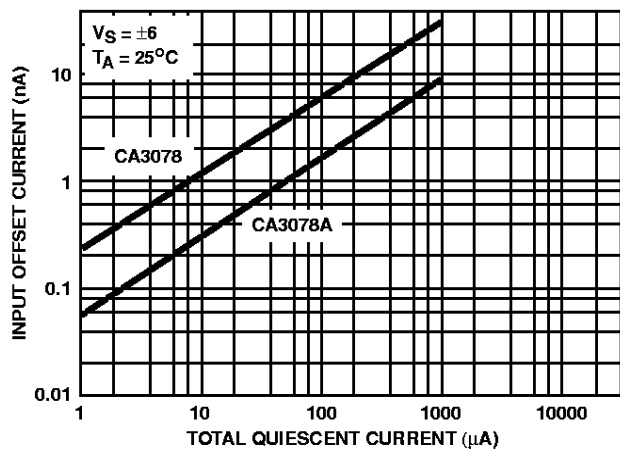


FIGURE 7. INPUT OFFSET CURRENT vs TOTAL QUIESCENT CURRENT

Typical Performance Curves (Continued)

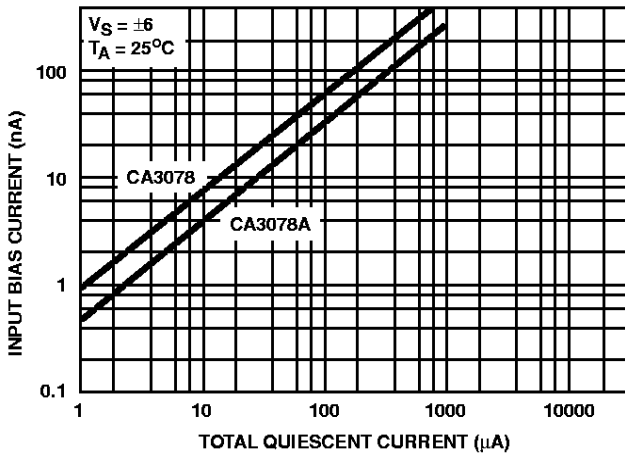


FIGURE 8. INPUT BIAS CURRENT vs TOTAL QUIESCENT CURRENT

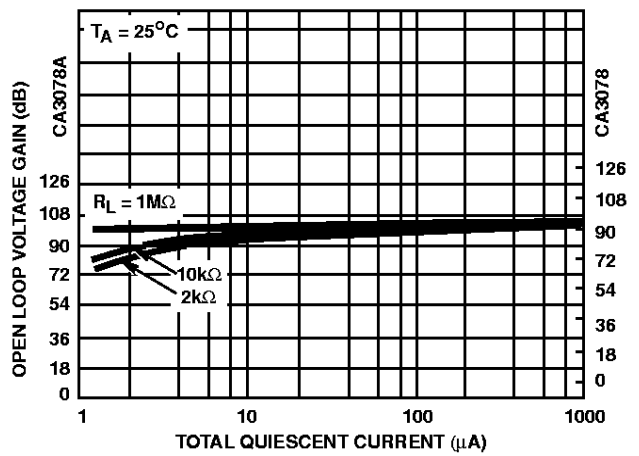


FIGURE 9. OPEN LOOP VOLTAGE GAIN vs TOTAL QUIESCENT CURRENT

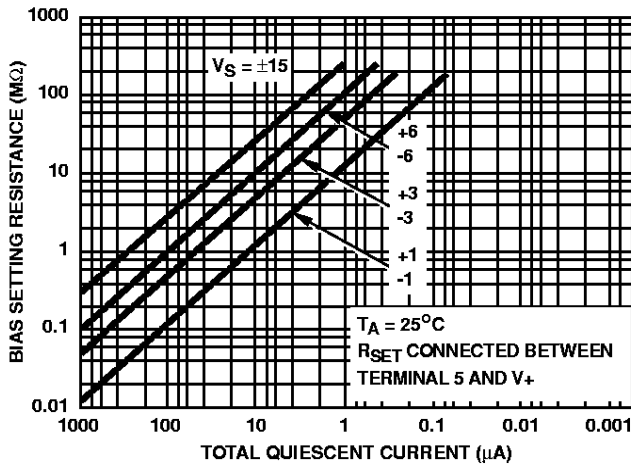


FIGURE 10. BIAS SETTING RESISTANCE vs TOTAL QUIESCENT CURRENT

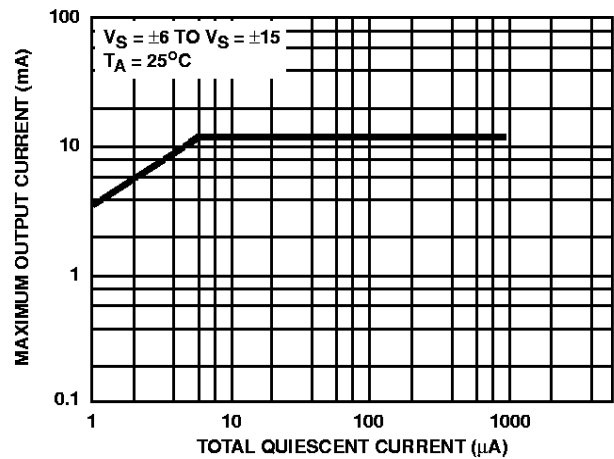


FIGURE 11. MAXIMUM OUTPUT CURRENT vs TOTAL QUIESCENT CURRENT

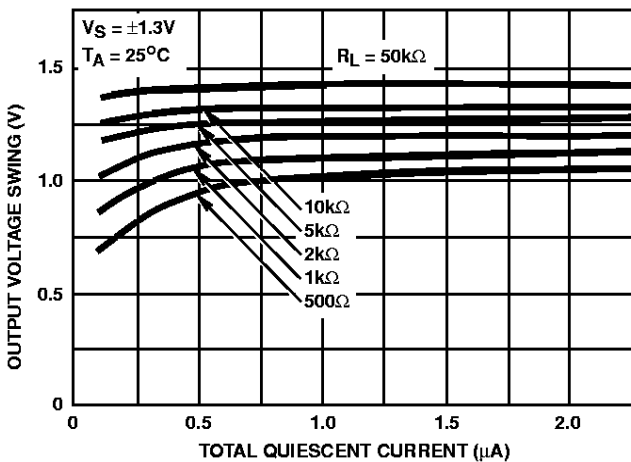


FIGURE 12. OUTPUT VOLTAGE SWING vs TOTAL QUIESCENT CURRENT

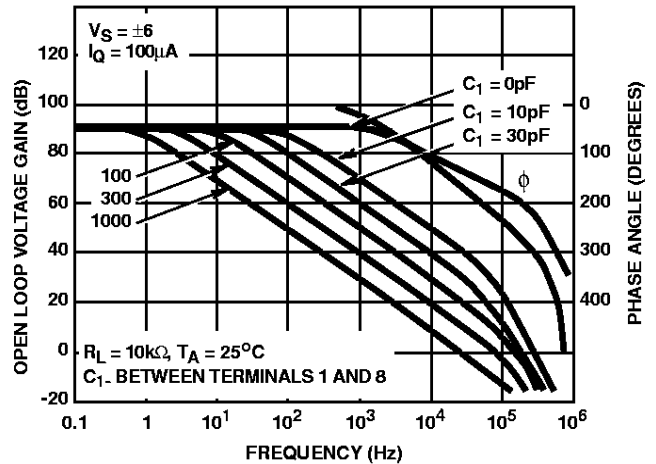


FIGURE 13. OPEN LOOP VOLTAGE GAIN vs FREQUENCY

Typical Performance Curves (Continued)

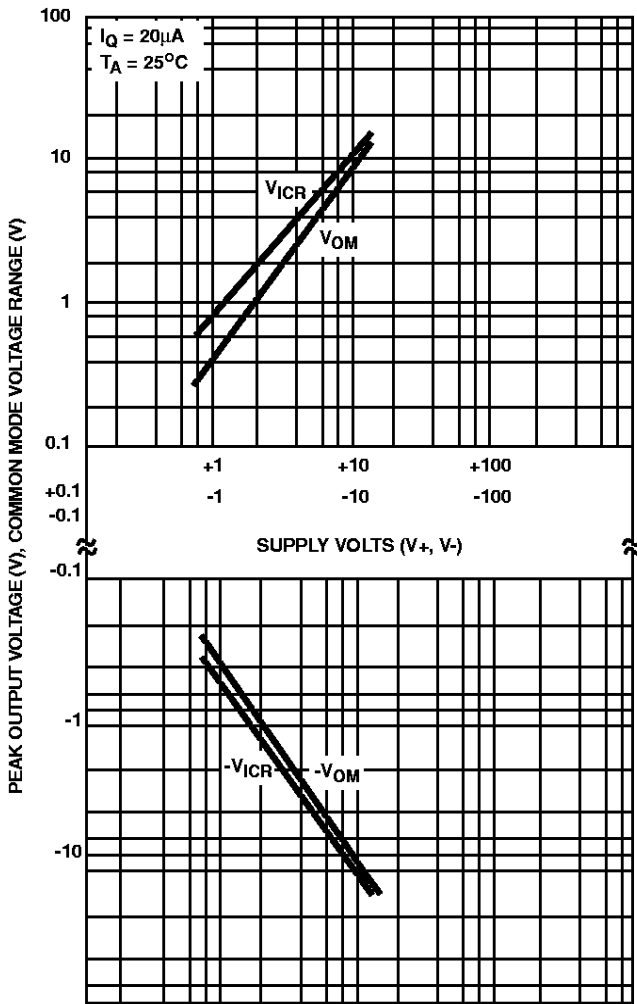


FIGURE 14. OUTPUT AND COMMON MODE VOLTAGE vs SUPPLY VOLTAGE

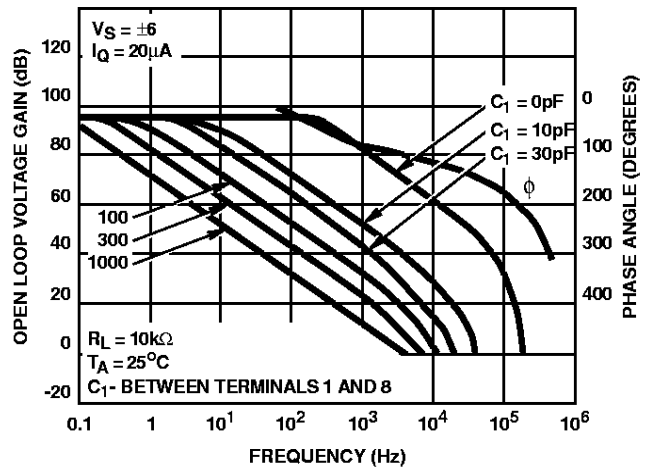


FIGURE 15. OPEN LOOP VOLTAGE GAIN vs FREQUENCY

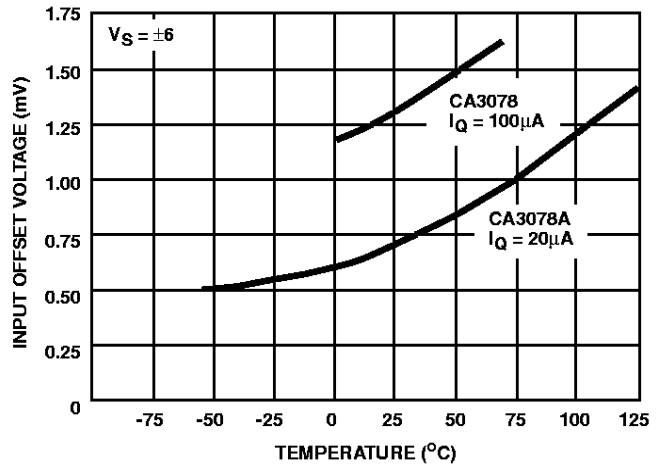


FIGURE 16. INPUT OFFSET VOLTAGE vs TEMPERATURE

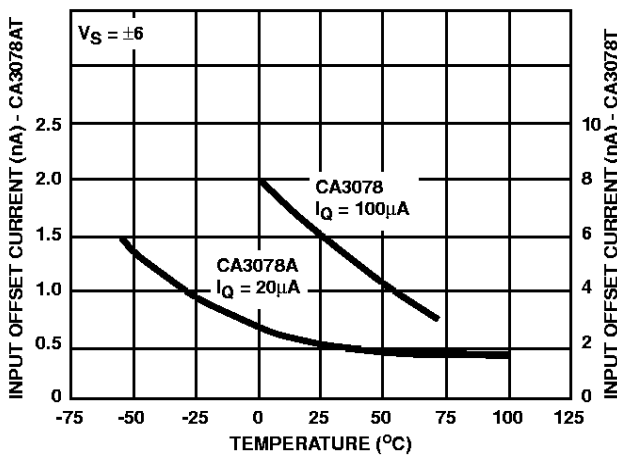


FIGURE 17. INPUT OFFSET CURRENT vs TEMPERATURE

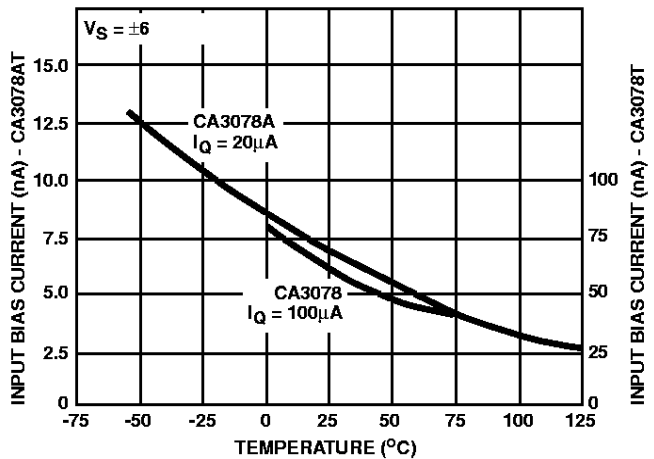


FIGURE 18. INPUT BIAS CURRENT vs TEMPERATURE

CA3078, CA3078A

Typical Performance Curves (Continued)

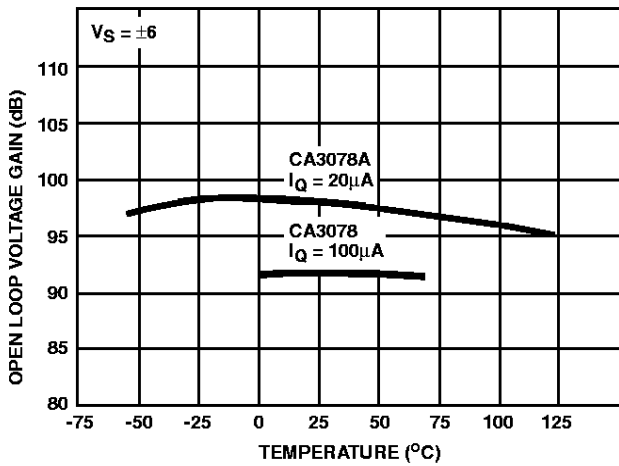


FIGURE 19. OPEN LOOP VOLTAGE GAIN vs TEMPERATURE

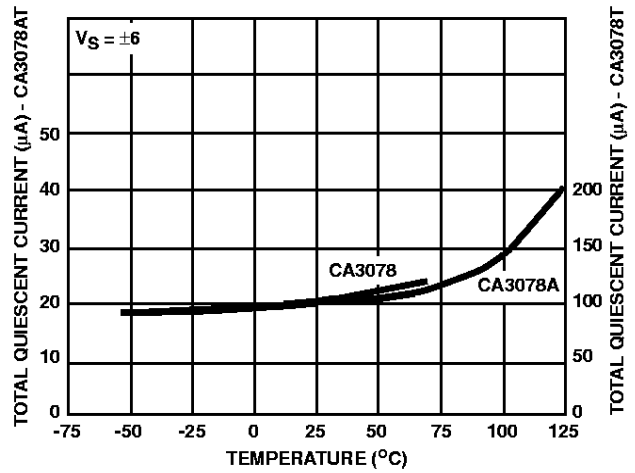


FIGURE 20. TOTAL QUIESCENT CURRENT vs TEMPERATURE

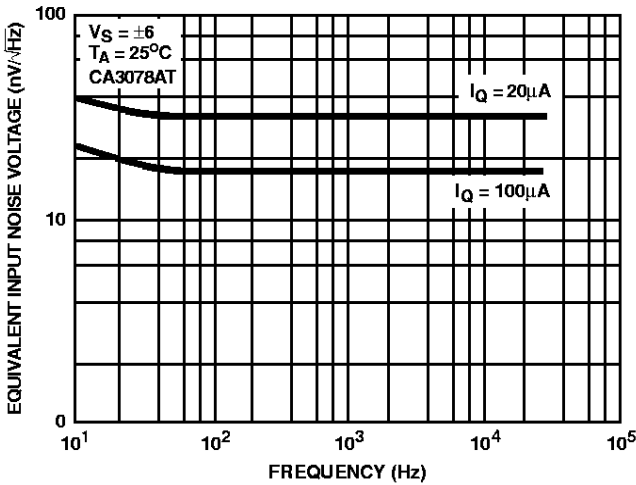


FIGURE 21. EQUIVALENT INPUT NOISE VOLTAGE vs FREQUENCY

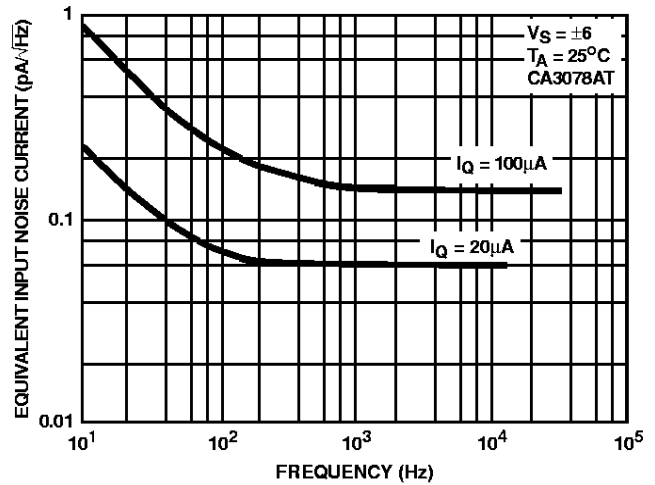
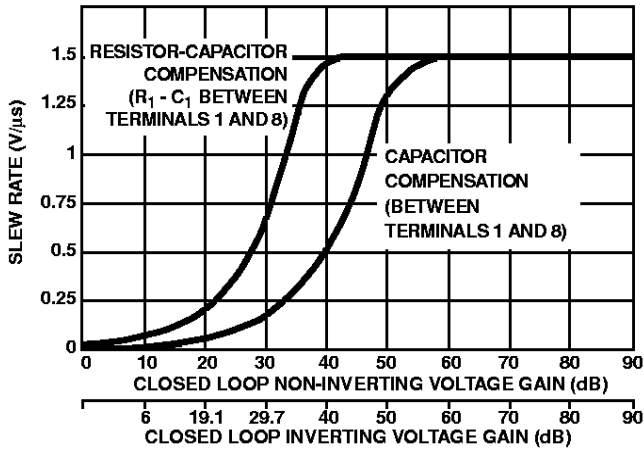


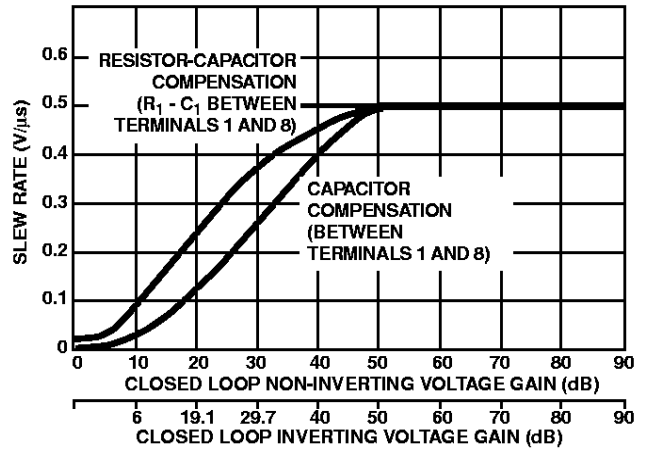
FIGURE 22. EQUIVALENT INPUT NOISE CURRENT vs FREQUENCY

Typical Performance Curves (Continued)



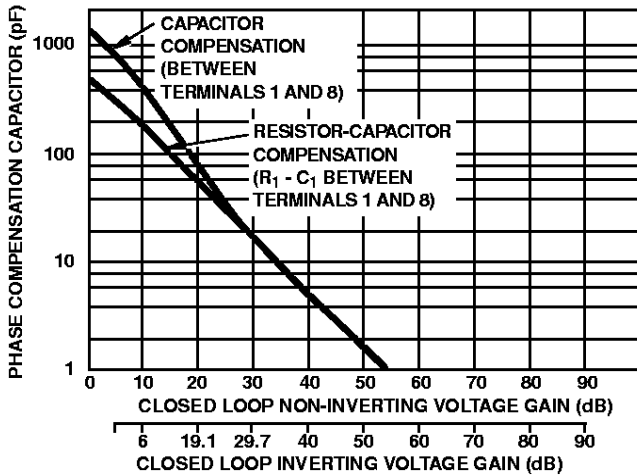
Supply Volts: $V_+ = +6, V_- = -6$
 Quiescent Current (I_Q) = $100\mu A$
 Ambient Temperature (T_A) = $25^\circ C$
 Load Impedance: $R_L = 10k\Omega, C_L = 100pF$
 Feedback Resistance (R_F) = $0.1M\Omega$
 Output Voltage (V_{OP-P}) = $10V$
 R_1 determined for transient response with 10% overshoot on a $100mV$ output signal ($R_1 \times C_1 = 2.5 \times 10^{-6}$)

FIGURE 23. SLEW RATE vs CLOSED LOOP GAIN FOR $I_Q = 100\mu A$ - CA3078



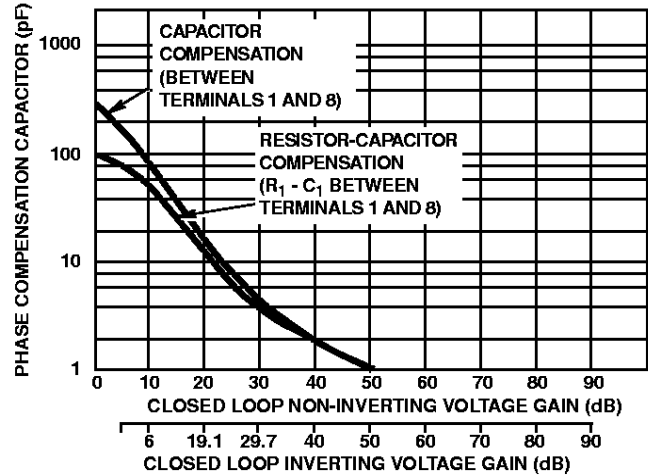
Supply Volts: $V_+ = +6, V_- = -6$
 Quiescent Current (I_Q) = $20\mu A$
 Ambient Temperature (T_A) = $25^\circ C$
 Load Impedance: $R_L = 10k\Omega, C_L = 100pF$
 Feedback Resistance (R_F) = $0.1M\Omega$
 Output Voltage (V_{OP-P}) = $10V$
 R_1 determined for transient response with 10% overshoot on a $100mV$ output signal ($R_1 \times C_1 = 2 \times 10^{-6}$)

FIGURE 24. SLEW RATE vs CLOSED LOOP GAIN FOR $I_Q = 20\mu A$ - CA3078A



Supply Volts: $V_+ = +6, V_- = -6$
 Quiescent Current (I_Q) = $100\mu A$
 Ambient Temperature (T_A) = $25^\circ C$
 Load Impedance: $R_L = 10k\Omega, C_L = 100pF$
 Feedback Resistance (R_F) = $0.1M\Omega$
 Output Voltage (V_{OP-P}) = $100mV$
 R_1 determined for transient response with 10% overshoot on a $100mV$ output signal ($R_1 \times C_1 = 2.5 \times 10^{-6}$)

FIGURE 25. PHASE COMPENSATION CAPACITANCE vs CLOSED LOOP GAIN - CA3078



Supply Volts: $V_+ = +6, V_- = -6$
 Quiescent Current (I_Q) = $20\mu A$
 Ambient Temperature (T_A) = $25^\circ C$
 Load Impedance: $R_L = 10k\Omega, C_L = 100pF$
 Feedback Resistance (R_F) = $0.1M\Omega$
 Output Voltage (V_{OP-P}) = $100mV$
 R_1 determined for transient response with 10% overshoot on a $100mV$ output signal ($R_1 \times C_1 = 2 \times 10^{-6}$)

FIGURE 26. PHASE COMPENSATION CAPACITANCE vs CLOSED LOOP GAIN - CA3078A