ft6203

1.25W Mono Fully Differential Audio Power Amplifier
Datasheet (Rev. 2.0)

Introduction

The ft6203 family is 1.25W mono fully differential audio power amplifier designed for driving a speaker of 8Ω impedance or above with optimized PCB area consumption. The ft6203 can operate from 2.5V to 5.5V, drawing only 1.9mA of quiescent supply current. Available packages include 2mm x 2mm WCSP package and 3mm x 3mm DFN package.

The ft6203 provides multiple features including 85dB PSRR from 90Hz to 5Hz, improved RF-rectification immunity and the optimized PCB consumption which altogether build up an ideal solution for mobile phones, PDAs or other handheld devices.

Features

- 1.25W into 8Ω from a 5-V supply at 1% THD (Typical)
- Supply current: 1.9mA (typical)
- Shutdown current: less than 10μA
- PSSR: 90dB
- Wide supply voltage: 2.5V to 5.5V
- Fully differential design to reduce RF rectification
- Improved CMRR design to save the cost of two input coupling capacitors
- Packages:
  - ft6203W in 2mm x 2mm WCSP package
  - ft6203D in 3mm x 3mm DFN package

Packaging Details

ft6203W

Figure 1. ft6203W WCSP Package Pinout Diagram

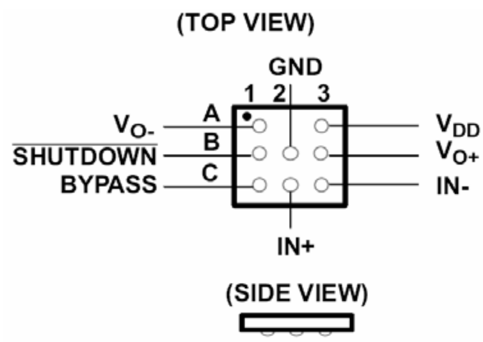
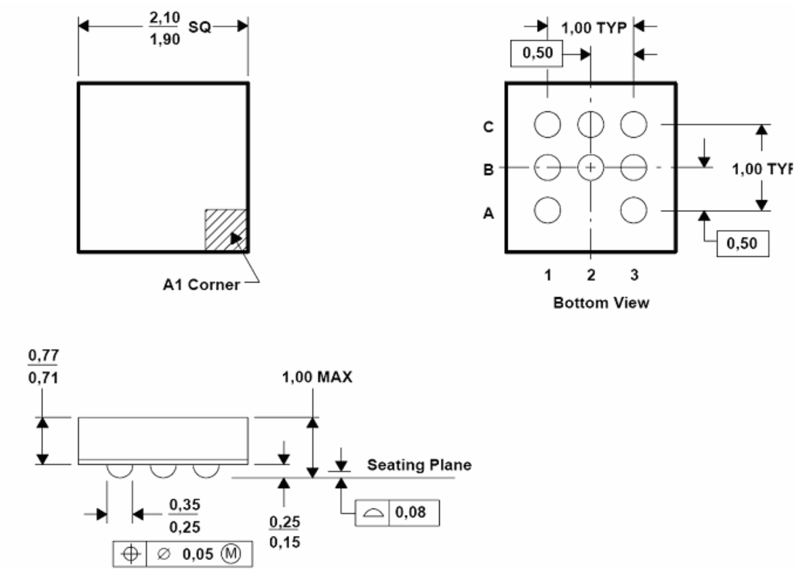


Figure 2. ft6203W WCSP Package Dimensions



ft6203D

Figure 3. ft6203D DFN Package Pinout Diagram

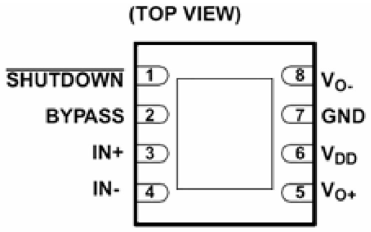
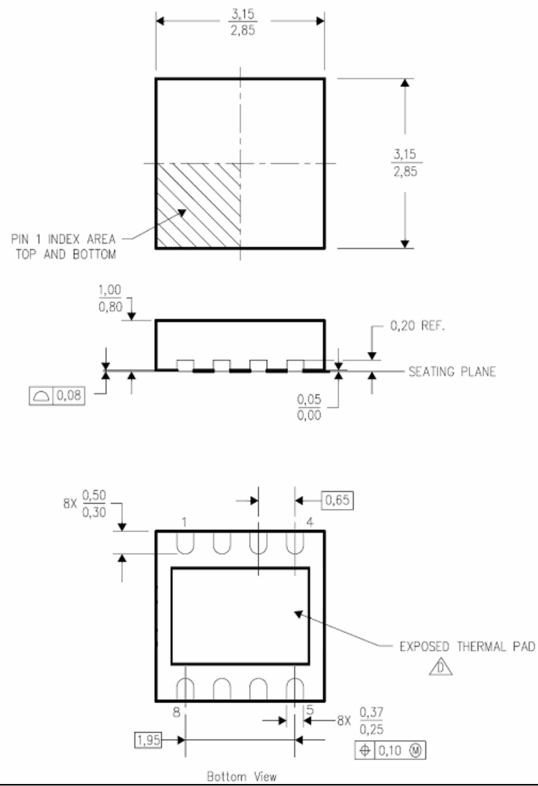


Figure 4. ft6203D DFN Package Dimensions



Pinout Descriptions

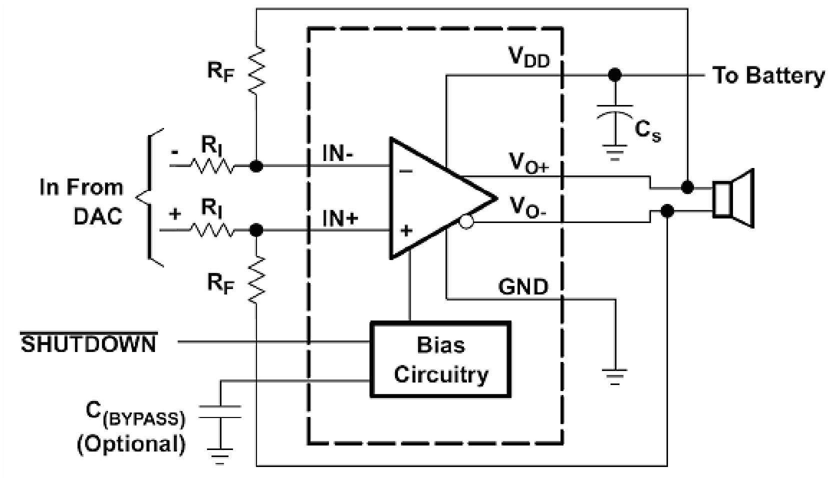
Signal Name	WCSP Pin	DFN Pin	I/O	Descriptions
BYPASS	C1	2	I	Mid-supply voltage. Adding a bypass capacitor improves PSRR.
GND	B2	7	I	High-current ground
IN-	C3	4	I	Negative differential input
IN+	C2	3	I	Positive differential input
$\overline{SHUTDOWN}$	B1	1	I	Shutdown terminal (active low logic)
V_{DD}	A3	6	I	Supply voltage terminal
V_{O+}	B3	5	O	Positive BTL output
V_{O-}	A1	8	O	Negative BTL output
Terminal Pad				Connect to ground. Thermal pad must be soldered down in all applications to property secure device on the PCB.

Application Information

Fully Differential Amplifier

The ft6203 is a fully differential amplifier which can receive and transmit differential signals to ensure signal quality with few external components. The ft6203 consists of one amplifier and one common mode amplifier. The former produces output signal equals input times the gain and the later keep the common mode voltage at half V_{DD} to keep the output signal biased at mid-supply (1/2 V_{DD}). The reference design is illustrated in Figure 5.

Figure 5. Typical Differential Input Application



The ft6203 requires few external components and can save the cost of bypass capacitors and input capacitors. Bypass capacitor can be saved since the shift affects both the positive and negative signals equally and are cancelled at the load. However, if power supply rejection performance is not good enough, bypass capacitor then is required.

Input coupling capacitors can also be saved in the ft6203 application. If the input signals are biased at a voltage different from the common mode voltage, the feedback circuitry then maintains the output voltage at the mid supply. The tolerant bias range is from 0.5V to V_{DD}-0.8V. If the input bias falls outside this range, input capacitors will be required.

The following table provides component specification in reference application with input capacitors and the optional bypass capacitor.

Table 1. Typical Component Specifications

Component	Value
R_I	10kΩ
R_F	10kΩ
C_{BYPASS}*	0.22μF
C_S	1μF
C_I	0.22μF
* C_{BYPASS} is optional in typical design.	

Components

Input and Feedback Resistors

The input and feedback resistors determine the amplifier gain. Signal gain equals feedback resistance divided by input resistance. The input and feedback resistors should range from 1kΩ to 100kΩ, and in typical application, the input and feedback resistors are set to 20kΩ.

Resistor selection is critical for balancing the output in a fully differential amplifier. It influences the CMRR, PSRR and the cancellation of the second harmonic distortion. Therefore, resistors of 1% tolerance or of better performance are recommended for ft6203 application.

Bypass Capacitor

Bypass capacitor in ft6203 application filters noise and increases the K_{SVR}. The bigger the capacitance is, the better noise filtering can be achieved. However, big capacitance slows down the rise time of the amplifier during the power-up or reactivation from SHUTDOWN mode. Therefore, it should be weighed between the noise filtering requirement and the rise time consideration to find out the optimum capacitor specification.

Input Capacitor

Input capacitor is not necessary if the input differential signals are biased within the range from 0.5V to V_{DD}-0.8V. When input signals are outside this range, input capacitor should be used.

When input capacitor is applied, the input capacitor and input resistor determine the corner frequency of the high pass filter. The corner frequency (f_C) is calculated with the equation below.

$$f_C = 1 / 2\pi R_I f_C \qquad (1)$$

The corner frequency directly influences the low frequency signals and consequently determines the output bass quality. When a corner frequency of 100Hz is required given the input resistor of 10kΩ, the input capacitor should be 0.16μF.

Power leakage is another consideration for selecting input capacitors. The leakage current from the input source through the input capacitors, input resistors, and feedback resistors to the load reduces headroom. In this case, ceramic capacitor can apply.

Decoupling Capacitor

Decoupling capacitor helps to stabilize voltage of power supply and thus reduce the total harmonic distortion (THD). It can also be applied to prevent oscillations over long leads between the amplifier and the speaker. Low Equivalent-Series-Resistance (ESR) capacitor is recommended and shall be placed close to the V_{DD} lead.

Parametric Data

Absolute Maximum Ratings

Symbol	Parameter		Value
V_{DD}	Supply Voltage		-0.3V to 6V
V_I	Input Voltage	INx and $\overline{\text{SHUTDOWN}}$ pins	-0.3V to V_{DD} +0.3V
	Continuous Total Power Dissipation		See Dissipation Rating Table
T_A	Operating free-air temperature		-40°C to 85°C
T_J	Junction temperature		-40°C to 125°C
T_{stg}	Storage Temperature		-65°C to 85°C
	Lead temperature 1,6 mm (1/16 Inch) from case for 10 seconds		260°C
Note: The ratings provided in this table are the maximum values. Ratings exceeding these values may cause permanent damage to the device and the board. For operation ratings, please refer to "Recommended Operating Conditions"			

Recommended Operating Conditions

Symbol	Parameter	Test Condition	Min	YP	Max	Unit
V_{DD}	Supply Voltage		2.5		5.5	V
V_{IH}	High-level Input Voltage	$\overline{\text{SHUTDOWN}}$	2			V
V_{IL}	Low-level Input Voltage	$\overline{\text{SHUTDOWN}}$			0.8	V
V_{IC}	Common-mode Input Voltage	V_{DD} = 2.5V, 5.5V, CMRR ≤ -60dB	0.5		V_{DD} - 0.8	V
T_A	Operating free-air temperature		-40		85	°C
Z_L	Load Impedance		6.4	8		Ω

Dissipation Ratings

Part No.	Power Rating ($T_A \le 25°C$)	Derating Factor	Power Rating ($T_A \le 70°C$)	Power Rating ($T_A \le 85°C$)
ft6203W	885mW	8.8Mw /°C	486mW	354mW
ft6203D	2.7W	21.8Mw /°C	1.7W	1.4W

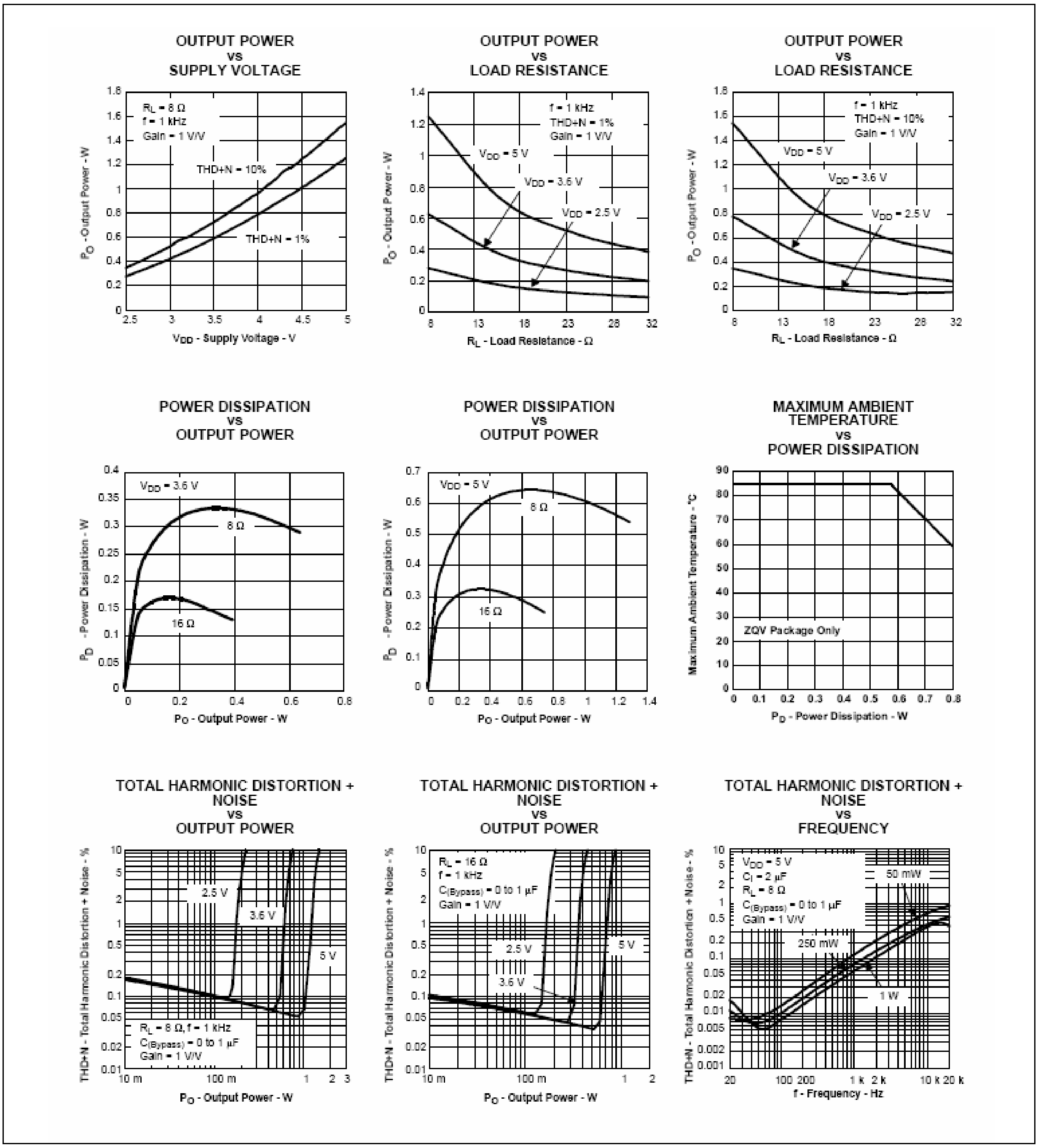
Electrical Characteristics (TA = 25°C, Gain = 1V/V)

Symbol	Parameter	Test Conditions		Min	TYP	Max	Unit
$\|V_{OO}\|$	Output offset voltage (measured differentially)	V_I = 0V, V_{DD}=2.5V to 5.5V		1			mV
PSRR	Power supply rejection ratio	V_{DD} = 2.5V to 5.5V			-90	-70	dB
CMRR	Common-mode rejection ratio	V_{DD} = 3.6 V to 5.5 V, V_{IC} = 0.5 V to V_{DD}-0.8			-70	-65	dB
		V_{DD} = 2.5 V, V_{IC} =0.5V to 1.7V		-62	-55		
V_{OL}	Low-level output voltage	R_L = 8Ω, V_{IN+} =V_{DD}, V_{IN-} = 0V or V_{IN+} = 0V, V_{IN-} =V_{DD}	VDD = 5.5V		0.30	0.46	V
			VDD = 3.6V		0.22		
			VDD = 2.5V		0.19	0.26	
V_{OH}	High-level output voltage	R_L = 8Ω, V_{IN+} =V_{DD}, V_{IN-} = 0V or V_{IN+} = 0V, V_{IN-} =V_{DD}	VDD = 5.5V	4.8	5.12		V
			VDD = 3.6V		3.28		
			VDD = 2.5V	2.1	2.24		
$\|I_{IH}\|$	High-level input current	V_{DD} = 5.5V, V_I = 5.8V				1.2	μA
$\|I_{IL}\|$	Low-level input current	V_{DD} = 5.5V, V_I = -0.3V				1.2	μA
I_{DD}	Supply current	V_{DD} = 2.5V to 5.5V, No load, $\overline{SHUTDOWN}$ = 0.8V			1.9	3	mA
$I_{DD(SD)}$	Supply current in shutdown mode	V_{DD} = 2.5V to 5.5V, No load, $\overline{SHUTDOWN}$ = 0.8V			0.01	0.9	μA

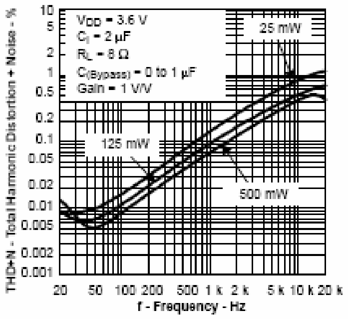
Operating Characteristics (TA = 25°C, Gain = 1V/V, RL = 8Ω)

Symbol	Parameter	Test Conditions		Min	TYP	Max	Unit
P_O	Output power	THD + N = 1%, f = 1 kHz	V_{DD} = 5V		1.25		W
			V_{DD} = 3.6V		0.63		
			V_{DD} = 2.5V		0.3		
THD+N	Total harmonic distortion plus noise	V_{DD} = 5V, P_O = 1W, f = 1kHZ			0.06%		
		V_{DD} = 3.6V, P_O = 0.5W, f = 1kHz			0.07%		
		V_{DD} = 2.5V, P_O = 200mW, f = 1kHz			0.08%		
K_{SVR}	Supply ripple rejection ratio	$C_{(BYPASS)}$ = 0.47μF, V_{DD} = 3.6V to 5.5V, Inputs ac-grounded with C_I = 2μF	f =217Hz to 2kHz, V_{RIPPLE} = 200mV_{PP}		-87		dB
		$C_{(BYPASS)}$ = 0.47μF, V_{DD} = 2.5V to 3.6V, Inputs ac-grounded with C_I =2μF	f = 217Hz to 2kHz, V_{RIPPLE} = 200mV_{PP}		-82		dB
		$C_{(BYPASS)}$ = 0.47μF, V_{DD} = 2.5V to 5.5V, Inputs ac-grounded with C_I = 2μF	f = 40Hz to 20kHz, V_{RIPPLE} = 200mV_{PP}		≤ -74		dB
SNR	Signal-to-noise ratio	V_{DD} = 5V, P_O =1W			104		dB
V_N	Output voltage noise	f = 20Hz to 20kHz	No weighting		17		μV_{RMS}
			A weighting		13		
CMRR	Common-mode rejection ratio	V_{DD} = 2.5V to 5.5V, resistor tolerance = 0.1%, gain = 4V/V, V_{ICM} = 200mV_{PP}	f = 20Hz to 1kHz		≤ -85		dB
			f = 20Hz to 20kHz		≤ -74		
Z_I	Input impedance				2		MΩ
Z_O	Output impedance	Shutdown mode		>10k			
	Shutdown attenuation	f = 20Hz to 20kHz, R_F = R_I = 20kΩ			-80		dB

Typical Characteristics



TOTAL HARMONIC DISTORTION + NOISE vs FREQUENCY



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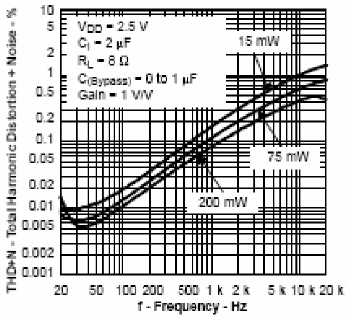

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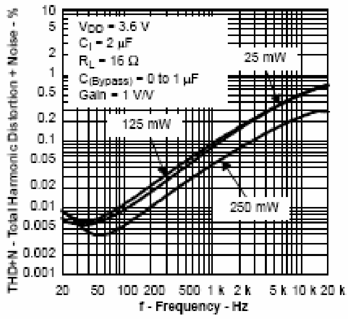
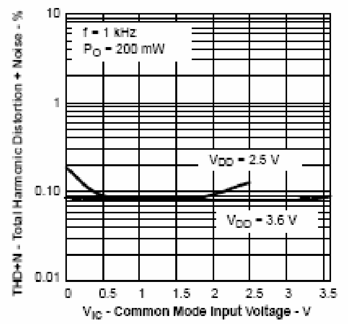
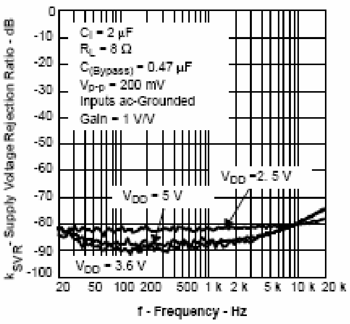


TOTAL HARMONIC DISTORTION + NOISE vs COMMON MODE INPUT VOLTAGE



SUPPLY VOLTAGE REJECTION RATIO vs FREQUENCY



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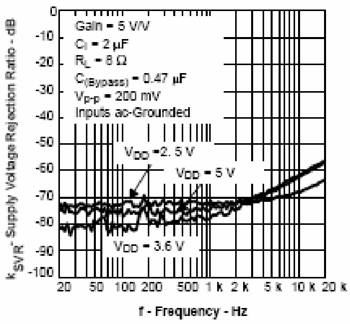

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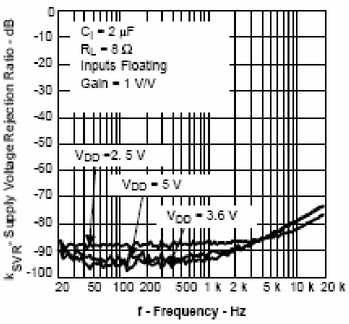

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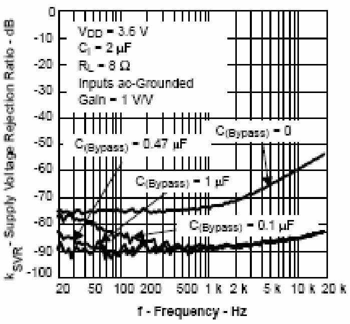
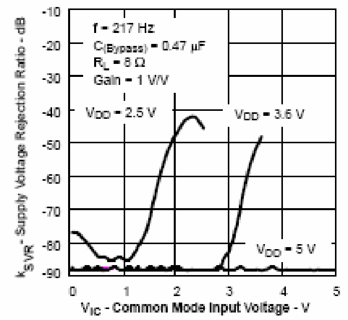
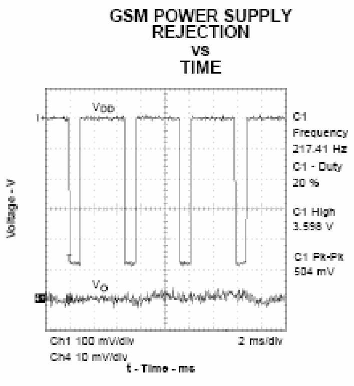
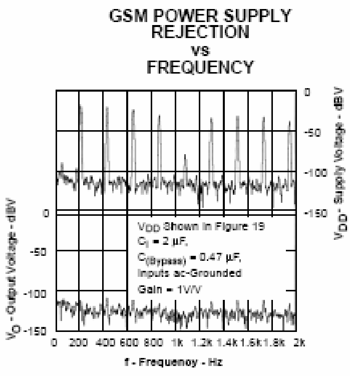
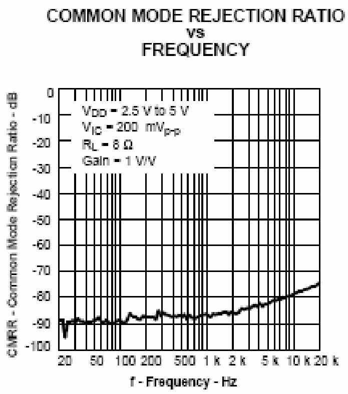


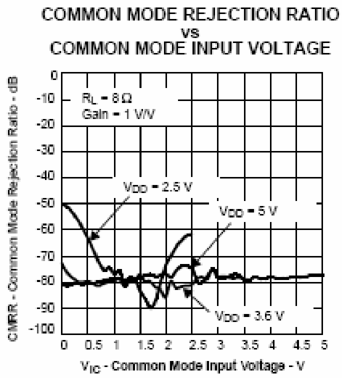
SUPPLY VOLTAGE REJECTION RATIO vs COMMON MODE INPUT VOLTAGE

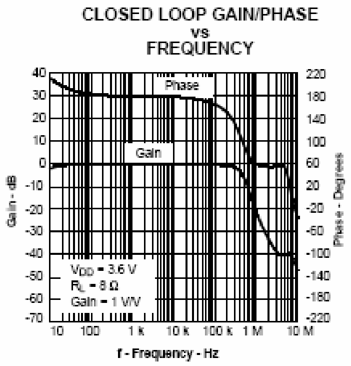


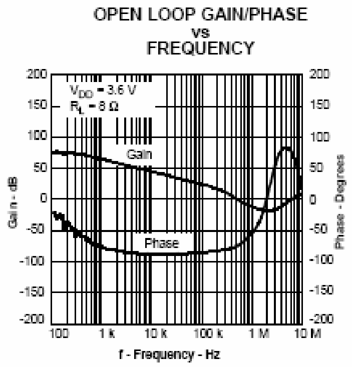


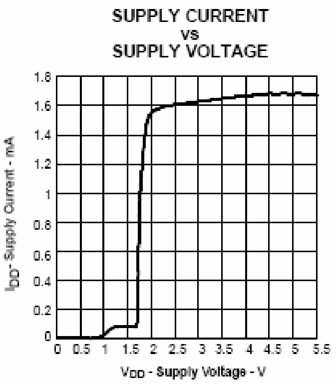


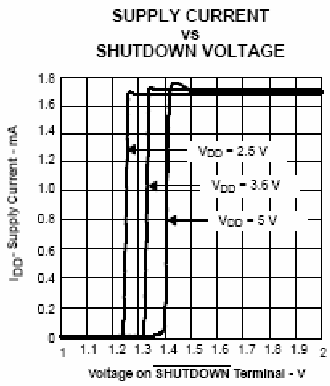


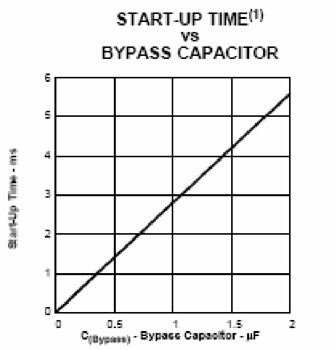












(1) Start-Up time is the time it takes (from a low-to-high transition on SHUTDOWN) for the gain of the amplifier to reach -3 dB of the final gain.