Operational Amplifiers

Low Supply Current Output Full Swing Operational Amplifiers

LMR821G LMR822xxx LMR824xxx

General Description

LMR821G, LMR822xxx, and LMR824xxx are low-voltage low-current full-swing operational amplifiers. These products exhibit high voltage gain and high slew rate, making them suitable for mobile equipment, low voltage application and active filters.

Features

- Low Operating Supply Voltage
- Output Full Swing
- High Large Signal Voltage Gain
- High Slew Rate
- Low Supply Current

Applications

- Mobile Equipment
- Low Voltage Application
- Active Filter
- Buffer
- Consumer Electronics

Key Specifications

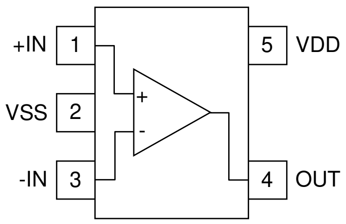
- Operating Supply Voltage (Single Supply): +2.5V to +5.5V
- Voltage Gain (R_L=600Ω): 105dB (Typ)
- Temperature Range: -40°C to +85°C
- Slew Rate: 2.0V/μs (Typ)
- Input Offset Voltage:
  - LMR821G: 3.5mV (Max)
  - LMR822xxx: 5mV (Max)
  - LMR824xxx: 5mV (Max)
- Input Bias Current: 30nA (Typ)

Packages

Packages	W(Typ) x D(Typ) x H(Max)
SSOP5	2.90mm x 2.80mm x 1.25mm
SOP8	5.00mm x 6.20mm x 1.71mm
SOP-J8	4.90mm x 6.00mm x 1.65mm
SSOP-B8	3.00mm x 6.40mm x 1.35mm
TSSOP-B8	3.00mm x 6.40mm x 1.20mm
MSOP8	2.90mm x 4.00mm x 0.90mm
TSSOP-B8J	3.00mm x 4.90mm x 1.10mm
SOP14	8.70mm x 6.20mm x 1.71mm
SOP-J14	8.65mm x 6.00mm x 1.65mm
TSSOP-B14J	5.00mm x 6.40mm x 1.20mm

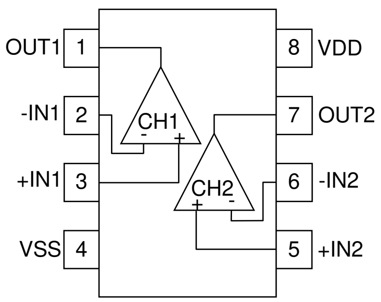
Pin Configuration

LMR821G : SSOP5



Pin No.	Pin Name
1	+IN
2	VSS
3	-IN
4	OUT
5	VDD

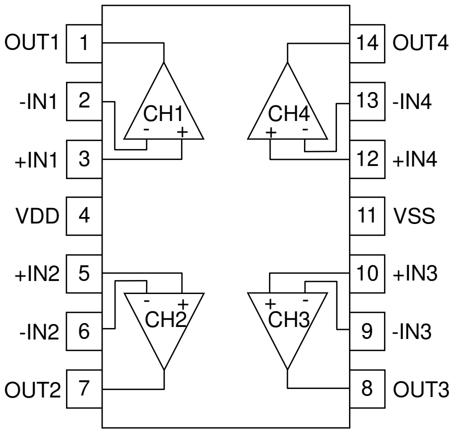
LMR822F : SOP8
LMR822FJ : SOP-J8
LMR822FV : SSOP-B8
LMR822FVT : TSSOP-B8
LMR822FVM : MSOP8
LMR822FVJ : TSSOP-B8J



Pin No.	Pin Name
1	OUT1
2	-IN1
3	+IN1
4	VSS
5	+IN2
6	-IN2
7	OUT2
8	VDD

○Product structure : Silicon monolithic integrated circuit ○This product has no designed protection against radioactive rays.

LMR824F : SOP14
LMR824FJ : SOP-J14
LMR824FVJ : TSSOP-B14J



Pin No.	Pin Name
1	OUT1
2	-IN1
3	+IN1
4	VDD
5	+IN2
6	-IN2
7	OUT2
8	OUT3
9	-IN3
10	+IN3
11	VSS
12	+IN4
13	-IN4
14	OUT4

Ordering Information

L M R 8 2 x x x x - x x

Part Number
LMR821G
LMR822F
LMR822FJ
LMR822FV
LMR822FVT
LMR822FVM
LMR822FVJ
LMR824F
LMR824FJ
LMR824FVJ

Package
G : SSOP5
F : SOP8
: SOP14
FJ : SOP-J8
: SOP-J14
FV : SSOP-B8
FVT : TSSOP-B8
FVM : MSOP8
FVJ : TSSOP-B8J
: TSSOP-B14J

Packaging and forming specification
TR: Embossed tape and reel
(SSOP5/MSOP8)
E2: Embossed tape and reel
(SOP8/SOP-J8/SSOP-B8/TSSOP-B8/
TSSOP-B8J/SOP14/SOP-J14/TSSOP-B14J)

Line-up

Topr	Channels	Package		Orderable Part Number
-40°C to +85°C	1ch	SSOP5	Reel of 3000	LMR821G-TR
	2ch	SOP8	Reel of 2500	LMR822F-E2
		SOP-J8	Reel of 2500	LMR822FJ-E2
		SSOP-B8	Reel of 2500	LMR822FV-E2
		TSSOP-B8	Reel of 3000	LMR822FVT-E2
		MSOP8	Reel of 3000	LMR822FVM-TR
		TSSOP-B8J	Reel of 2500	LMR822FVJ-E2
	4ch	SOP14	Reel of 2500	LMR824F-E2
		SOP-J14	Reel of 2500	LMR824FJ-E2
		TSSOP-B14J	Reel of 2500	LMR824FVJ-E2

Absolute Maximum Ratings (T_A=25°C)

Parameter	Symbol		Ratings			Unit
			LMR821G	LMR822xxx	LMR824xxx	
Supply Voltage	V_{DD}-V_{SS}		+7			V
Power Dissipation	Pd	SSOP5	0.67 (Note 1,8)	-	-	W
		SOP8	-	0.68 (Note 2,8)	-	
		SOP-J8	-	0.67 (Note 1,8)	-	
		SSOP-B8	-	0.62 (Note 3,8)	-	
		TSSOP-B8	-	0.62 (Note 3,8)	-	
		MSOP8	-	0.58 (Note 4,8)	-	
		TSSOP-B8J	-	0.58 (Note 4,8)	-	
		SOP14	-	-	0.56 (Note 5,8)	
		SOP-J14	-	-	1.02 (Note 6,8)	
		TSSOP-B14J	-	-	0.84 (Note 7,8)	
Differential Input Voltage (Note 9)	V_{ID}		V_{DD} – V_{SS}			V
Input Common-mode Voltage Range	V_{ICM}		(V_{SS} - 0.3) to (V_{DD} + 0.3)			V
Input Current (Note 10)	I_I		±10			mA
Operating Supply Voltage	Vopr		+2.5 to +5.5			V
Operating Temperature	Topr		- 40 to +85			°C
Storage Temperature	Tstg		- 55 to +150			°C
Maximum Junction Temperature	Tjmax		+150			°C

(Note 1) Pd is reduced by 5.4mW/°C above T_A= 25°C.
(Note 2) Pd is reduced by 5.5mW/°C above T_A= 25°C.
(Note 3) Pd is reduced by 5.0mW/°C above T_A= 25°C.
(Note 4) Pd is reduced by 4.7mW/°C above T_A= 25°C.
(Note 5) Pd is reduced by 4.5mW/°C above T_A= 25°C.
(Note 6) Pd is reduced by 8.2mW/°C above T_A= 25°C.
(Note 7) Pd is reduced by 6.8mW/°C above T_A= 25°C.
(Note 8) Mounted on an FR4 glass epoxy PCB 70mm×70mm×1.6mm (Copper foil area less than 3%).
(Note 9) Differential Input Voltage is the voltage difference between the inverting and non-inverting inputs. The input pin voltage is set to more than V_{SS}.
(Note 10) An excessive input current will flow when input voltages of more than V_{DD}+0.6V or less than V_{SS}-0.6V are applied. The input current can be set to less than the rated current by adding a limiting resistor.
Caution: Operating the IC over the absolute maximum ratings may damage the IC. The damage can either be a short circuit between pins or an open circuit between pins and the internal circuitry. Therefore, it is important to consider circuit protection measures, such as adding a fuse, in case the IC is operated over the absolute maximum ratings.

Electrical Characteristics

○LMR821G (Unless otherwise specified V_{DD}=+2.5V, V_{SS}=0V)

Parameter	Symbol	Temperature Range	Limits			Unit	Conditions
			Min	Typ	Max		
Input Offset Voltage (Note 11)	V_{IO}	25°C	-	1	3.5	mV	V_{DD}=2.5V to 5.5V
		Full Range	-	-	4		
Maximum Output Voltage(High)	V_{OH}	25°C	2.30	2.37	-	V	R_L=600Ω (Note 12)
			2.40	2.46	-		R_L=2kΩ (Note 12)
Maximum Output Voltage(Low)	V_{OL}	25°C	-	130	200	mV	R_L=600Ω (Note 12)
			-	80	120		R_L=2kΩ (Note 12)

(Note 11) Absolute value
(Note 12) Output load resistance connects to a half of V_{DD}.

○LMR821G (Unless otherwise specified V_{DD}=+2.7V, V_{SS}=0V)

Parameter	Symbol	Temperature Range	Limits			Unit	Conditions
			Min	Typ	Max		
Input Offset Voltage (Note 13,14)	V_{IO}	25°C	-	1	3.5	mV	V_{DD}=2.5V to 5.5V
		Full Range	-	-	4		
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	25°C	-	1	-	μV/°C	-
Input Offset Current (Note 13)	I_{IO}	25°C	-	0.5	30	nA	-
Input Bias Current (Note 13)	I_B	25°C	-	30	90	nA	-
Supply Current (Note 14)	I_{DD}	25°C	-	280	340	μA	A_V=0dB, V_{+IN}=1.35V
		Full Range	-	-	500		
Maximum Output Voltage(High)	V_{OH}	25°C	2.50	2.58	-	V	R_L=600Ω (Note 16)
			2.60	2.66	-		R_L=2kΩ (Note 16)
Maximum Output Voltage(Low)	V_{OL}	25°C	-	130	200	mV	R_L=600Ω (Note 16)
			-	80	120		R_L=2kΩ (Note 16)
Large Signal Voltage Gain	A_V	25°C	-	100	-	dB	R_L=600Ω (Note 16)
			95	100	-		R_L=2kΩ (Note 16)
Input Common-mode Voltage Range	V_{ICM}	25°C	0	-	1.8	V	V_{SS} to (V_{DD}-0.9V)
Common-mode Rejection Ratio	CMRR	25°C	70	85	-	dB	-
Power Supply Rejection Ratio	PSRR	25°C	75	85	-	dB	V_{DD}=2.7V to 5.5V V_{ICM}=1V
Output Source Current (Note 15)	I_{SOURCE}	25°C	12	16	-	mA	V_{OUT}=0V Short Circuit Current
Output Sink Current (Note 15)	I_{SINK}	25°C	12	26	-	mA	V_{OUT}=2.7V Short Circuit Current
Slew Rate	SR	25°C	-	2.0	-	V/μs	C_L=25pF
Gain Bandwidth	GBW	25°C	-	5.0	-	MHz	C_L=25pF, A_V=40dB f=1MHz
Phase Margin	θ	25°C	-	50	-	deg	C_L=25pF, A_V=40dB
Gain Margin	GM	25°C	-	4.5	-	dB	C_L=25pF, A_V=40dB
Input Referred Noise Voltage	V_N	25°C	-	30	-	$nV/\sqrt{Hz}$	f=1kHz
Total Harmonic Distortion + Noise	THD+N	25°C	-	0.01	-	%	V_{OUT}=2.2V_{P-P}, f=1kHz R_L=10kΩ A_V=0dB, DIN-AUDIO

(Note 13) Absolute value
(Note 14) Full Range: T_A=-40°C to +85°C
(Note 15) Consider the power dissipation of the IC under high temperature environment when selecting the output current value.
There may be a case where the output current value is reduced due to the rise in IC temperature caused by the heat generated inside the IC.
(Note 16) Output load resistance connects to a half of V_{DD}.

Electrical Characteristics - continued

○LMR821G (Unless otherwise specified V_{DD}=+5.0V, V_{SS}=0V)

Parameter	Symbol	Temperature Range	Limits Min	Limits Typ	Limits Max	Unit	Conditions
Input Offset Voltage (Note 17,18)	V_{IO}	25°C	-	1	3.5	mV	V_{DD}=2.5V to 5.5V
		Full Range	-	-	4		
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	25°C	-	1	-	μV/°C	-
Input Offset Current (Note 17)	I_{IO}	25°C	-	0.5	30	nA	-
Input Bias Current (Note 17)	I_B	25°C	-	40	100	nA	-
Supply Current (Note 18)	I_{DD}	25°C	-	325	425	μA	A_V=0dB, V_{+IN}=2.5V
		Full Range	-	-	600		
Maximum Output Voltage(High)	V_{OH}	25°C	4.75	4.84	-	V	R_L=600Ω (Note 20)
			4.85	4.90	-		R_L=2kΩ (Note 20)
Maximum Output Voltage(Low)	V_{OL}	25°C	-	170	250	mV	R_L=600Ω (Note 20)
			-	100	150		R_L=2kΩ (Note 20)
Large Signal Voltage Gain	A_V	25°C	-	105	-	dB	R_L=600Ω (Note 20)
			95	105	-		R_L=2kΩ (Note 20)
Input Common-mode Voltage Range	V_{ICM}	25°C	0	-	4.1	V	V_{SS} to (V_{DD}-0.9V)
Common-mode Rejection Ratio	CMRR	25°C	72	90	-		-
Power Supply Rejection Ratio	PSRR	25°C	75	85	-	dB	V_{DD}=2.7V to 5.5V V_{ICM}=1V
Output Source Current (Note 19)	I_{SOURCE}	25°C	20	45	-	mA	V_{OUT}=0V Short Circuit Current
Output Sink Current (Note 19)	I_{SINK}	25°C	20	40	-	mA	V_{OUT}=5V Short Circuit Current
Slew Rate	SR	25°C	-	2.0	-	V/μs	C_L=25pF
Gain Bandwidth	GBW	25°C	-	5.5	-	MHz	C_L=25pF, A_V=40dB f=1MHz
Phase Margin	θ	25°C	-	50	-	deg	C_L=25pF, A_V=40dB
Gain Margin	GM	25°C	-	4.5	-	dB	C_L=25pF, A_V=40dB
Input Referred Noise Voltage	V_N	25°C	-	30	-	$nV/\sqrt{Hz}$	f=1kHz
Total Harmonic Distortion + Noise	THD+N	25°C	-	0.01	-	%	V_{OUT}=4.1V_{P-P}, f=1kHz R_L=10kΩ A_V=0dB, DIN-AUDIO

(Note 17) Absolute value
(Note 18) Full Range: T_A=-40°C to +85°C
(Note 19) Consider the power dissipation of the IC under high temperature environment when selecting the output current value.
There may be a case where the output current value is reduced due to the rise in IC temperature caused by the heat generated inside the IC.
(Note 20) Output load resistance connects to a half of V_{DD}.

Electrical Characteristics - continued

○LMR822xxx (Unless otherwise specified V_{DD}=+2.5V, V_{SS}=0V)

Parameter	Symbol	Temperature Range	Limits			Unit	Conditions
			Min	Typ	Max		
Input Offset Voltage (Note 21)	V_{IO}	25°C	-	1	5	mV	V_{DD}=2.5V to 5.5V
		Full Range	-	-	5		
Maximum Output Voltage(High)	V_{OH}	25°C	2.30	2.37	-	V	R_L=600Ω (Note 22)
			2.40	2.46	-		R_L=2kΩ (Note 22)
Maximum Output Voltage(Low)	V_{OL}	25°C	-	130	200	mV	R_L=600Ω (Note 22)
			-	80	120		R_L=2kΩ (Note 22)

(Note 21) Absolute value
(Note 22) Output load resistance connects to a half of V_{DD}.

○LMR822xxx (Unless otherwise specified V_{DD}=+2.7V, V_{SS}=0V)

Parameter	Symbol	Temperature Range	Limits			Unit	Conditions
			Min	Typ	Max		
Input Offset Voltage (Note 23,24)	V_{IO}	25°C	-	1	5	mV	V_{DD}=2.5V to 5.5V
		Full Range	-	-	5		
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	25°C	-	1	-	μV/°C	-
Input Offset Current (Note 23)	I_{IO}	25°C	-	0.5	30	nA	-
Input Bias Current (Note 23)	I_B	25°C	-	30	90	nA	-
Supply Current (Note 24)	I_{DD}	25°C	-	560	680	μA	A_V=0dB, V_{+IN}=1.35V
		Full Range	-	-	1000		
Maximum Output Voltage(High)	V_{OH}	25°C	2.50	2.58	-	V	R_L=600Ω (Note 26)
			2.60	2.66	-		R_L=2kΩ (Note 26)
Maximum Output Voltage(Low)	V_{OL}	25°C	-	130	200	mV	R_L=600Ω (Note 26)
			-	80	120		R_L=2kΩ (Note 26)
Large Signal Voltage Gain	A_V	25°C	-	100	-	dB	R_L=600Ω (Note 26)
			95	100	-		R_L=2kΩ (Note 26)
Input Common-mode Voltage Range	V_{ICM}	25°C	0	-	1.8	V	V_{SS} to (V_{DD}-0.9V)
Common-mode Rejection Ratio	CMRR	25°C	70	85	-	dB	-
Power Supply Rejection Ratio	PSRR	25°C	75	85	-	dB	V_{DD}=2.7V to 5.5V V_{ICM}=1V
Output Source Current (Note 25)	I_{SOURCE}	25°C	12	16	-	mA	V_{OUT}=0V Short Circuit Current
Output Sink Current (Note 25)	I_{SINK}	25°C	12	26	-	mA	V_{OUT}=2.7V Short Circuit Current
Slew Rate	SR	25°C	-	2.0	-	V/μs	C_L=25pF
Gain Bandwidth	GBW	25°C	-	5.0	-	MHz	C_L=25pF, A_V=40dB f=1MHz
Phase Margin	θ	25°C	-	50	-	deg	C_L=25pF, A_V=40dB
Gain Margin	GM	25°C	-	4.5	-	dB	C_L=25pF, A_V=40dB
Input Referred Noise Voltage	V_N	25°C	-	30	-	$nV/\sqrt{Hz}$	f=1kHz
Total Harmonic Distortion + Noise	THD+N	25°C	-	0.01	-	%	V_{OUT}=2.2V_{P-P}, f=1kHz R_L=10kΩ A_V=0dB, DIN-AUDIO
Channel Separation	CS	25°C	-	100	-	dB	A_V=40dB, V_{OUT}=0.5Vrms

(Note 23) Absolute value
(Note 24) Full Range: T_A=-40°C to +85°C
(Note 25) Consider the power dissipation of the IC under high temperature environment when selecting the output current value.
There may be a case where the output current value is reduced due to the rise in IC temperature caused by the heat generated inside the IC.
(Note 26) Output load resistance connects to a half of V_{DD}.

Electrical Characteristics - continued

○LMR822xxx (Unless otherwise specified V_{DD}=+5.0V, V_{SS}=0V)

Parameter	Symbol	Temperature Range	Limits Min	Limits Typ	Limits Max	Unit	Conditions
Input Offset Voltage (Note 27,28)	V_{IO}	25°C	-	1	5	mV	V_{DD}=2.5V to 5.5V
		Full Range	-	-	5		
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	25°C	-	1	-	μV/°C	-
Input Offset Current (Note 27)	I_{IO}	25°C	-	0.5	30	nA	-
Input Bias Current (Note 27)	I_B	25°C	-	40	100	nA	-
Supply Current (Note 28)	I_{DD}	25°C	-	650	850	μA	A_V=0dB, V_{+IN}=2.5V
		Full Range	-	-	1200		
Maximum Output Voltage(High)	V_{OH}	25°C	4.75	4.84	-	V	R_L=600Ω (Note 30)
			4.85	4.90	-		R_L=2kΩ (Note 30)
Maximum Output Voltage(Low)	V_{OL}	25°C	-	170	250	mV	R_L=600Ω (Note 30)
			-	100	150		R_L=2kΩ (Note 30)
Large Signal Voltage Gain	A_V	25°C	-	105	-	dB	R_L=600Ω (Note 30)
			95	105	-		R_L=2kΩ (Note 30)
Input Common-mode Voltage Range	V_{ICM}	25°C	0	-	4.1	V	V_{SS} to (V_{DD}-0.9V)
Common-mode Rejection Ratio	CMRR	25°C	72	90	-	dB	-
Power Supply Rejection Ratio	PSRR	25°C	75	85	-	dB	V_{DD}=2.7V to 5.5V V_{ICM}=1V
Output Source Current (Note 29)	I_{SOURCE}	25°C	20	45	-	mA	V_{OUT}=0V Short Circuit Current
Output Sink Current (Note 29)	I_{SINK}	25°C	20	40	-	mA	V_{OUT}=5V Short Circuit Current
Slew Rate	SR	25°C	-	2.0	-	V/μs	C_L=25pF
Gain Bandwidth	GBW	25°C	-	5.5	-	MHz	C_L=25pF, A_V=40dB f=1MHz
Phase Margin	θ	25°C	-	50	-	deg	C_L=25pF, A_V=40dB
Gain Margin	GM	25°C	-	4.5	-	dB	C_L=25pF, A_V=40dB
Input Referred Noise Voltage	V_N	25°C	-	30	-	$nV/\sqrt{Hz}$	f=1kHz
Total Harmonic Distortion + Noise	THD+N	25°C	-	0.01	-	%	V_{OUT}=4.1V_{P-P}, f=1kHz R_L=10kΩ A_V=0dB, DIN-AUDIO
Channel Separation	CS	25°C	-	100	-	dB	A_V=40dB, V_{OUT}=0.5Vrms

(Note 27) Absolute value
(Note 28) Full Range: T_A=-40°C to +85°C
(Note 29) Consider the power dissipation of the IC under high temperature environment when selecting the output current value.
There may be a case where the output current value is reduced due to the rise in IC temperature caused by the heat generated inside the IC.
(Note 30) Output load resistance connects to a half of V_{DD}.

Electrical Characteristics - continued

○LMR824xxx (Unless otherwise specified V_{DD}=+2.5V, V_{SS}=0V)

Parameter	Symbol	Temperature Range	Limits			Unit	Condition
			Min.	Typ.	Max.		
Input Offset Voltage (Note 31)	V_{IO}	25°C	-	1	5	mV	V_{DD}=2.5V to 5.5V
		Full Range	-	-	5		
Maximum Output Voltage(High)	V_{OH}	25°C	2.30	2.37	-	V	R_L=600Ω (Note 32)
			2.40	2.46	-		R_L=2kΩ (Note 32)
Maximum Output Voltage(Low)	V_{OL}	25°C	-	130	200	mV	R_L=600Ω (Note 32)
			-	80	120		R_L=2kΩ (Note 32)

(Note 31) Absolute value
(Note 32) Output load resistance connects to a half of V_{DD}.

○LMR824xxx (Unless otherwise specified V_{DD}=+2.7V, V_{SS}=0V)

Parameter	Symbol	Temperature Range	Limits			Unit	Condition
			Min.	Typ.	Max.		
Input Offset Voltage (Note 33,34)	V_{IO}	25°C	-	1	5	mV	V_{DD}=2.5V to 5.5V
		Full Range	-	-	5		
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	25°C	-	1	-	μV/°C	-
Input Offset Current (Note 33)	I_{IO}	25°C	-	0.5	30	nA	-
Input Bias Current (Note 33)	I_B	25°C	-	30	90	nA	-
Supply Current (Note 34)	I_{DD}	25°C	-	1120	1360	μA	A_V=0dB, V_{+IN}=1.35V
		Full Range	-	-	2000		
Maximum Output Voltage(High)	V_{OH}	25°C	2.50	2.58	-	V	R_L=600Ω (Note 36)
			2.60	2.66	-		R_L=2kΩ (Note 36)
Maximum Output Voltage(Low)	V_{OL}	25°C	-	130	200	mV	R_L=600Ω (Note 36)
			-	80	120		R_L=2kΩ (Note 36)
Large Signal Voltage Gain	A_V	25°C	90	100	-	dB	R_L=600Ω (Note 36)
			95	100	-		R_L=2kΩ (Note 36)
Input Common-mode Voltage Range	V_{ICM}	25°C	0	-	1.8	V	V_{SS} to (V_{DD}-0.9V)
Common-mode Rejection Ratio	CMRR	25°C	70	85	-	dB	-
Power Supply Rejection Ratio	PSRR	25°C	75	85	-	dB	V_{DD}=2.7V to 5.5V V_{ICM}=1V
Output Source Current (Note 35)	I_{SOURCE}	25°C	12	16	-	mA	V_{OUT}=0V Short Circuit Current
Output Sink Current (Note 35)	I_{SINK}	25°C	12	26	-	mA	V_{OUT}=2.7V Short Circuit Current
Slew Rate	SR	25°C	-	2.0	-	V/μs	C_L=25pF
Gain Bandwidth	GBW	25°C	-	5.0	-	MHz	C_L=25pF, A_V=40dB f=1MHz
Phase Margin	θ	25°C	-	50	-	deg	C_L=25pF, A_V=40dB
Gain Margin	GM	25°C	-	4.5	-	dB	C_L=25pF, A_V=40dB
Input Referred Noise Voltage	V_N	25°C	-	30	-	$nV/\sqrt{Hz}$	f=1kHz
Total Harmonic Distortion + Noise	THD+N	25°C	-	0.01	-	%	V_{OUT}=2.2V_{P-P}, f=1kHz R_L=10kΩ A_V=0dB, DIN-AUDIO
Channel Separation	CS	25°C	-	100	-	dB	A_V=40dB, V_{OUT}=0.5Vrms

(Note 33) Absolute value
(Note 34) Full Range: T_A=-40°C to +85°C
(Note 35) Consider the power dissipation of the IC under high temperature environment when selecting the output current value.
There may be a case where the output current value is reduced due to the rise in IC temperature caused by the heat generated inside the IC.
(Note 36) Output load resistance connects to a half of V_{DD}.

Electrical Characteristics - continued

○LMR824xxx (Unless otherwise specified V_{DD}=+5V, V_{SS}=0V)

Parameter	Symbol	Temperature Range	Limits			Unit	Condition
			Min.	Typ.	Max.		
Input Offset Voltage (Note 37,38)	V_{IO}	25°C	-	1	5	mV	V_{DD}=2.5V to 5.5V
		Full Range	-	-	5		
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	25°C	-	1	-	μV/°C	-
Input Offset Current (Note 37)	I_{IO}	25°C	-	0.5	30	nA	-
Input Bias Current (Note 37)	I_B	25°C	-	40	100	nA	-
Supply Current (Note 38)	I_{DD}	25°C	-	1130	1700	μA	A_V=0dB, V_{+IN}=2.5V
		Full Range	-	-	2400		
Maximum Output Voltage(High)	V_{OH}	25°C	4.75	4.84	-	V	R_L=600Ω (Note 40)
			4.85	4.90	-		R_L=2kΩ (Note 40)
Maximum Output Voltage(Low)	V_{OL}	25°C	-	170	250	mV	R_L=600Ω (Note 40)
			-	100	150		R_L=2kΩ (Note 40)
Large Signal Voltage Gain	A_V	25°C	-	105	-	dB	R_L=600Ω (Note 40)
			95	105	-		R_L=2kΩ (Note 40)
Input Common-mode Voltage Range	V_{ICM}	25°C	0	-	4.1	V	V_{SS} to (V_{DD}-0.9V)
Common-mode Rejection Ratio	CMRR	25°C	72	90	-	dB	-
Power Supply Rejection Ratio	PSRR	25°C	75	85	-	dB	V_{DD}=2.7V to 5.5V V_{ICM}=1V
Output Source Current (Note 39)	I_{SOURCE}	25°C	20	45	-	mA	V_{OUT}=0V Short Circuit Current
Output Sink Current (Note 39)	I_{SINK}	25°C	20	40	-	mA	V_{OUT}=5V Short Circuit Current
Slew Rate	SR	25°C	1.4	2.0	-	V/μs	C_L=25pF
Gain Bandwidth	GBW	25°C	-	5.5	-	MHz	C_L=25pF, A_V=40dB f=1MHz
Phase Margin	θ	25°C	-	50	-	deg	C_L=25pF, A_V=40dB
Gain Margin	GM	25°C	-	4.5	-	dB	C_L=25pF, A_V=40dB
Input Referred Noise Voltage	V_N	25°C	-	30	-	$nV/\sqrt{Hz}$	f=1kHz
Total Harmonic Distortion + Noise	THD+N	25°C	-	0.01	-	%	V_{OUT}=4.1V_{P-P}, f=1kHz R_L=10kΩ A_V=0dB, DIN-AUDIO
Channel Separation	CS	25°C	-	100	-	dB	A_V=40dB, V_{OUT}=0.5Vrms

(Note 37) Absolute value
(Note 38) Full Range: T_A=-40°C to +85°C
(Note 39) Consider the power dissipation of the IC under high temperature environment when selecting the output current value.
There may be a case where the output current value is reduced due to the rise in IC temperature caused by the heat generated inside the IC.
(Note 40) Output load resistance connects to a half of V_{DD}.

Description of Electrical Characteristics

Described below are the relevant electrical terms used in this datasheet. Items and symbols used are also shown. Note that the item names, symbols, and their meanings may differ from those of another manufacturer's document or a general document.

1. Absolute Maximum Ratings

Absolute maximum rating items indicate the conditions which must not be exceeded. Application of voltage in excess of absolute maximum rating or use out of absolute maximum rated temperature environment may cause deterioration of characteristics.

(1) Supply Voltage (V_{DD}/V_{SS})
Indicates the maximum voltage that can be applied between the VDD terminal and VSS terminal without deterioration of characteristics of internal circuit.

(2) Differential Input Voltage (V_{ID})
Indicates the maximum voltage that can be applied between the non-inverting terminal and inverting terminal without damaging the IC.

(3) Input Common-mode Voltage Range (V_{ICM})
Indicates the maximum voltage that can be applied to the non-inverting and inverting terminals without deterioration of electrical characteristics. The input common-mode voltage range of the maximum ratings does not assure normal operation of IC. For normal operation, use the IC within the input common-mode voltage range.

(4) Power Dissipation (Pd)
Indicates the power that can be consumed by the IC when mounted on a specific board at ambient temperature (normal temperature), 25°C. As for the packaged product, Pd is determined by the temperature that can be permitted by the IC in the package (maximum junction temperature) and thermal resistance of the package.

2. Electrical Characteristics

(1) Input Offset Voltage (V_{IO})
Indicates the voltage difference between the non-inverting terminal and inverting terminal. It can be translated to the input voltage difference required for setting the output voltage to 0 V.

(2) Input Offset Voltage Drift ($\triangle V_{IO}/\triangle T$)
Denotes the ratio of the input offset voltage fluctuation to the ambient temperature fluctuation.

(3) Input Offset Current (I_{IO})
Indicates the difference of input bias current between non-inverting and inverting terminals.

(4) Input Bias Current (I_B)
Indicates the current that flows into or out of the input terminal. It is defined by the average of input bias currents at the non-inverting and inverting terminals.

(5) Supply Current (I_{DD})
Indicates the current that that is consumed by the IC under specified no-load conditions.

(6) Maximum Output Voltage (High) / Maximum Output Voltage (Low) (V_{OH}/V_{OL})
Indicates the output voltage range under a specified load condition. It can be differentiated to maximum output voltage high and low. Maximum output voltage high indicates the upper limit of the output voltage, and maximum output voltage low indicates the lower limit.

(7) Large Signal Voltage Gain (A_V)
Indicates the amplification rate (gain) of output voltage against the voltage difference between the non-inverting and inverting terminal. It is normally the amplification rate (gain) in reference to DC voltage.
A_V = (Output voltage) / (Differential Input voltage)

(8) Input Common-mode Voltage Range (V_{ICM})
Indicates the input voltage range at which the IC operates normally.

(9) Common-mode Rejection Ratio (CMRR)
Indicates the ratio of fluctuation of input offset voltage to the change of common-mode input voltage.
CMRR = (Change of Input common-mode voltage)/(Input offset fluctuation)

(10) Power Supply Rejection Ratio (PSRR)
Indicates the ratio of fluctuation of input offset voltage to the change in supply voltage.
PSRR= (Change of power supply voltage)/(Input offset fluctuation)

(11) Output Source Current/ Output Sink Current (I_{SOURCE} / I_{SINK})
The maximum current that the IC can output under specific conditions. The output source current indicates the current flowing out from the IC, and the output sink current indicates the current flowing into the IC.

(12) Slew Rate (SR)
Indicates the rate of the change in output voltage with time when a step input signal is applied.

(13) Gain Band Width (GBW)
The product of the open-loop voltage gain and the frequency at which the voltage gain decreases by 6dB/octave.

(14) Phase Margin (θ)
Indicates the margin of phase from 180° phase lag at unity gain frequency.

(15) Gain Margin (GM)
Indicates the difference between 0dB and gain where the operational amplifier has 180° phase delay.

(16) Total Harmonic Distortion + Noise (THD+N)
Indicates the fluctuation of input offset voltage or that of output voltage with reference to the change of output voltage of driven channel.

(17) Input Referred Noise Voltage (V_N)
Indicates the noise voltage generated inside the operational amplifier equivalent to an ideal voltage source connected in series with input terminal.

(18) Channel Separation (CS)
Indicates the fluctuation of the output voltage of the driven channel with reference to the change of output voltage of the channel which is not driven.

Typical Performance Curves
○LMR821G

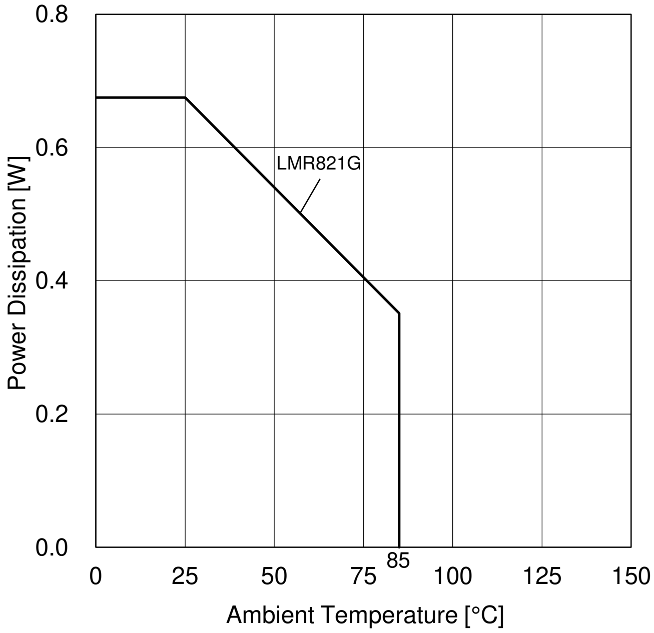


Figure 1. Power Dissipation vs Ambient Temperature (Derating Curve)

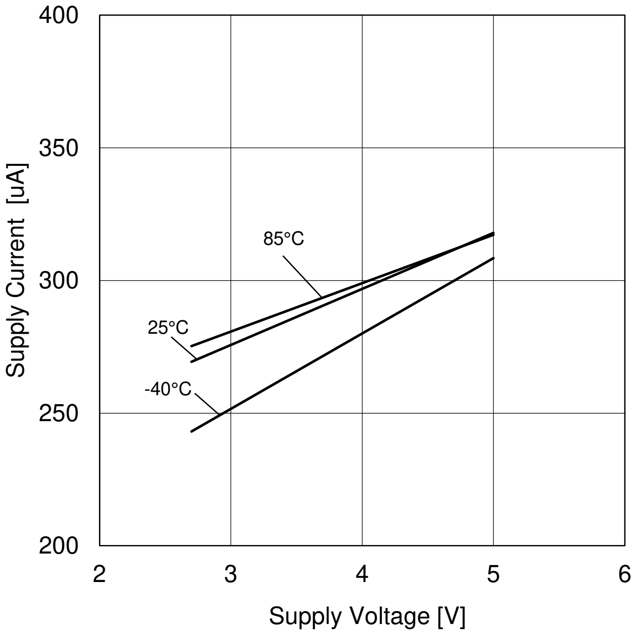


Figure 2. Supply Current vs Supply Voltage

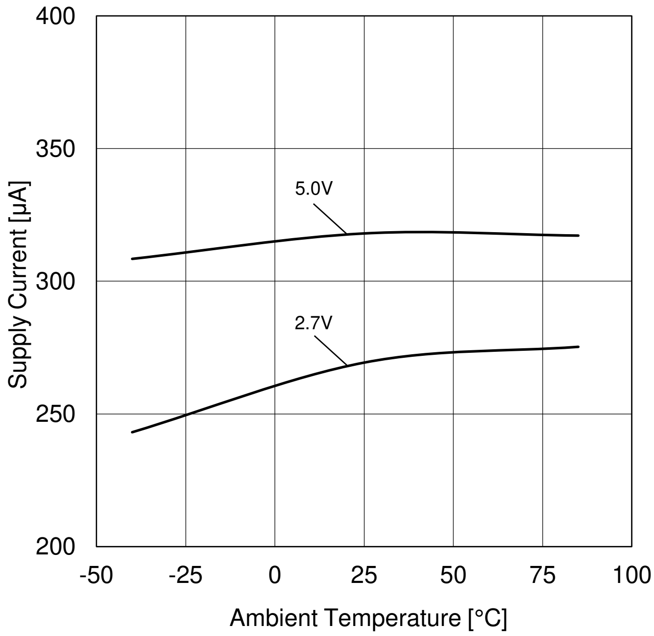


Figure 3. Supply Current vs Ambient Temperature

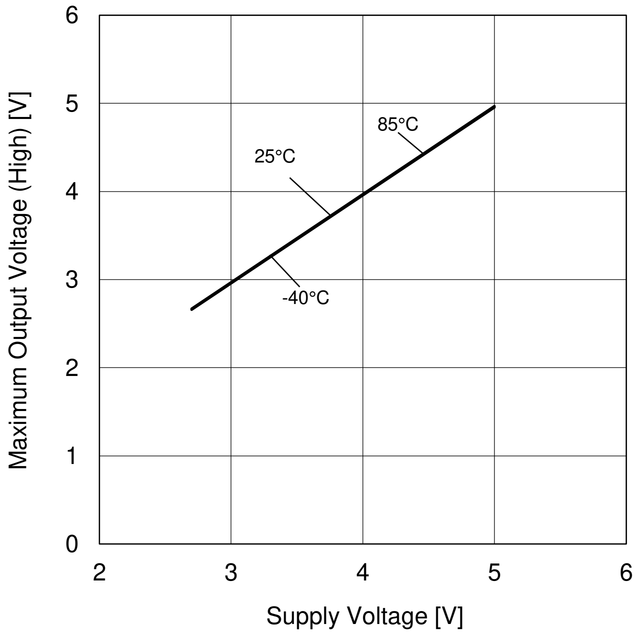


Figure 4. Maximum Output Voltage (High) vs Supply Voltage (R_L=2kΩ)

(*)The data above are measurement values of a typical sample, it is not guaranteed.

Typical Performance Curves – continued

○LMR821G

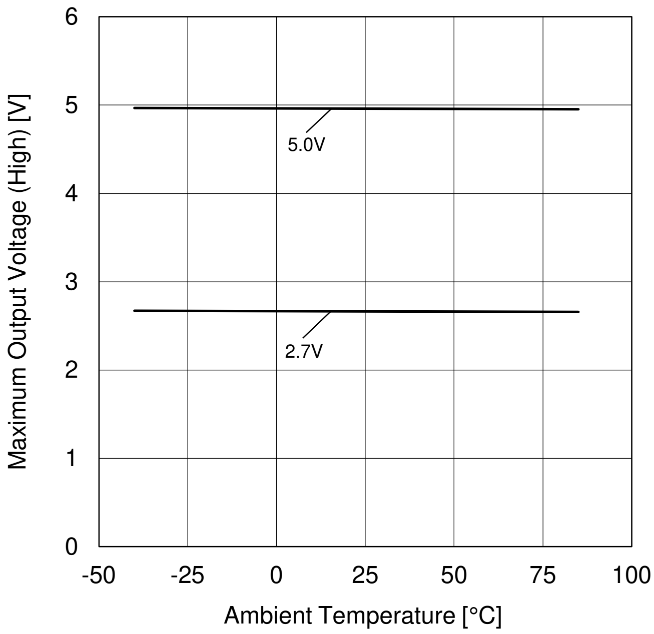


Figure 5. Maximum Output Voltage (High) vs Ambient Temperature (R_L=2kΩ)

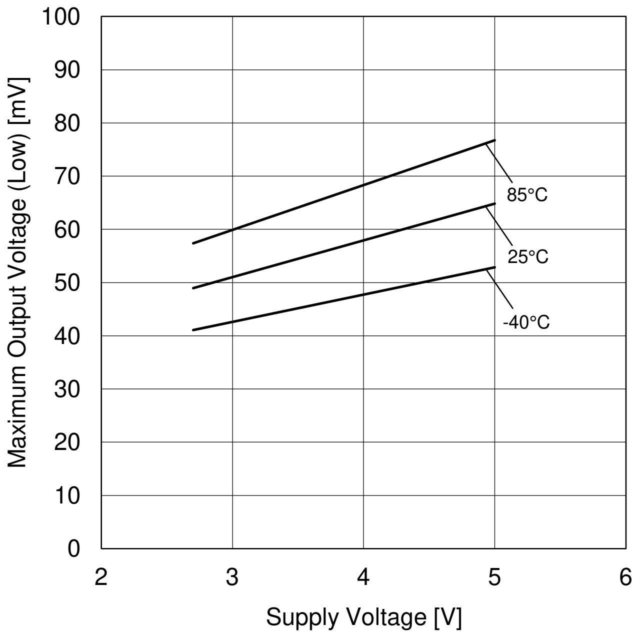


Figure 6. Maximum Output Voltage (Low) vs Supply Voltage (R_L=2kΩ)

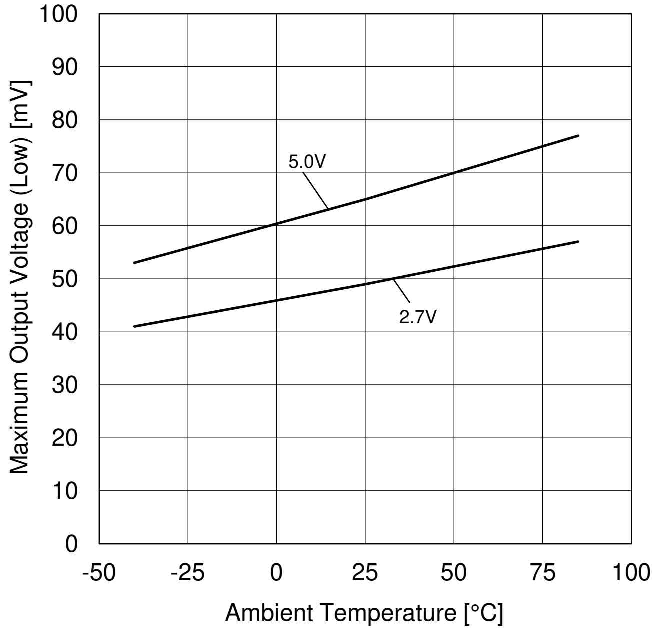


Figure 7. Maximum Output Voltage (Low) vs Ambient Temperature (R_L=2kΩ)

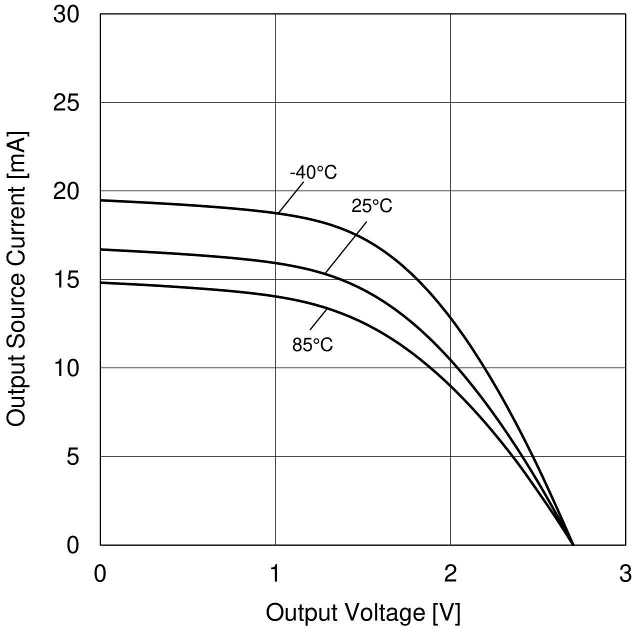


Figure 8. Output Source Current vs Output Voltage (V_{DD}=2.7V)

(*)The data above are measurement values of a typical sample, it is not guaranteed.

Typical Performance Curves – continued

○LMR821G

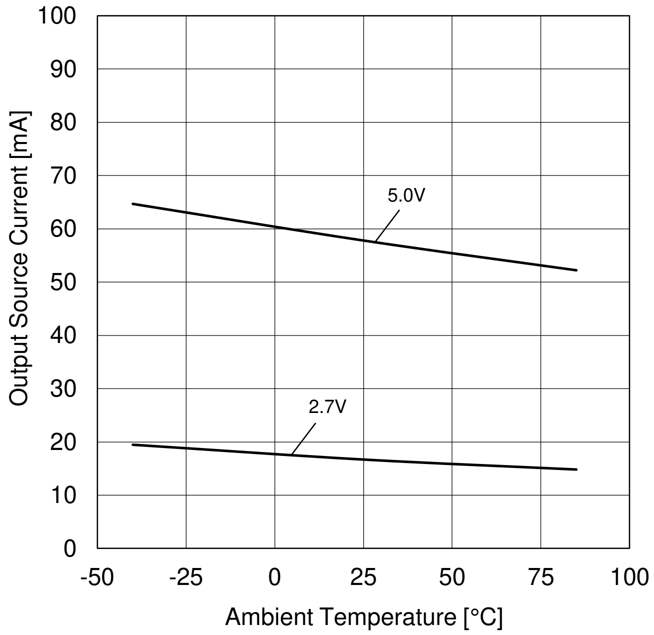


Figure 9. Output Source Current vs Ambient Temperature

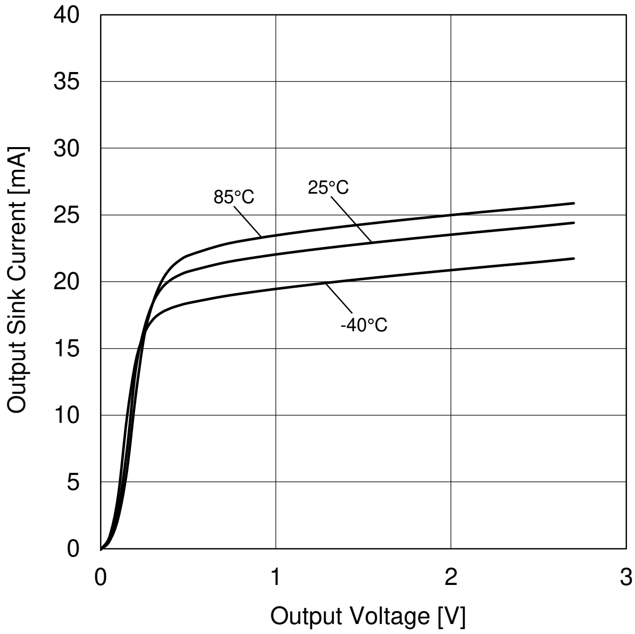


Figure 10. Output Sink Current vs Output Voltage (V_{DD}=2.7V)

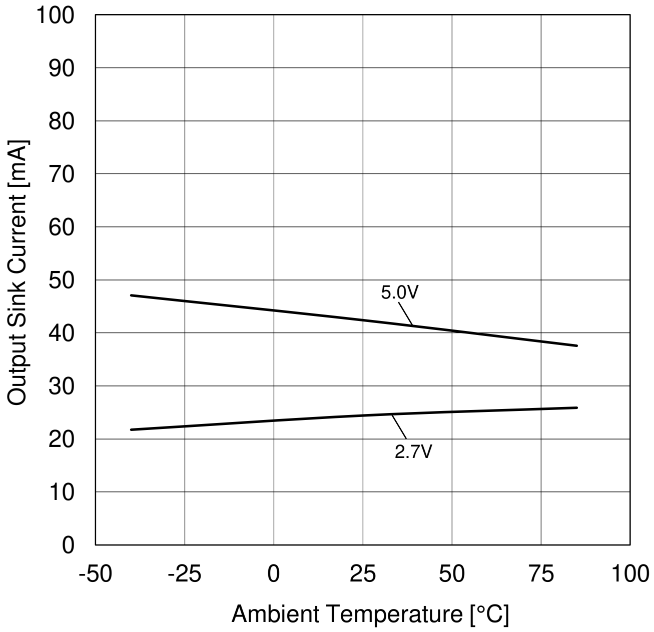


Figure 11. Output Sink Current vs Ambient Temperature

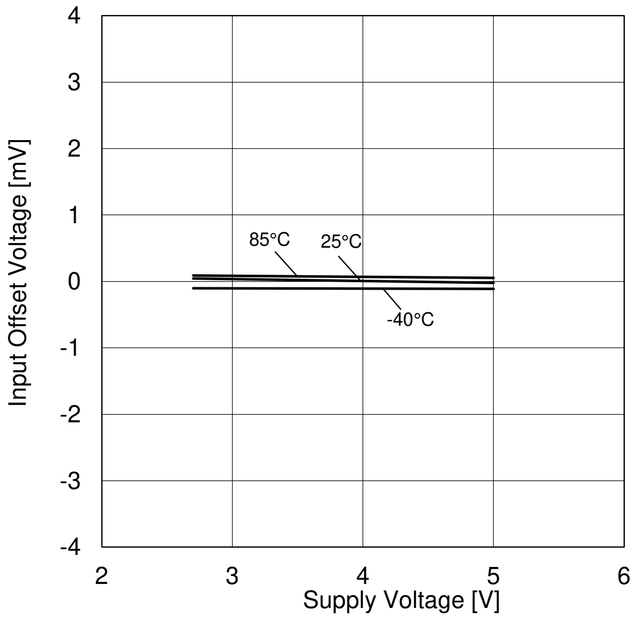


Figure 12. Input Offset Voltage vs Supply Voltage (V_{ICM}=V_{DD}/2, E_K=-V_{DD}/2)

(*)The data above are measurement values of a typical sample, it is not guaranteed.

Typical Performance Curves – continued

○LMR821G

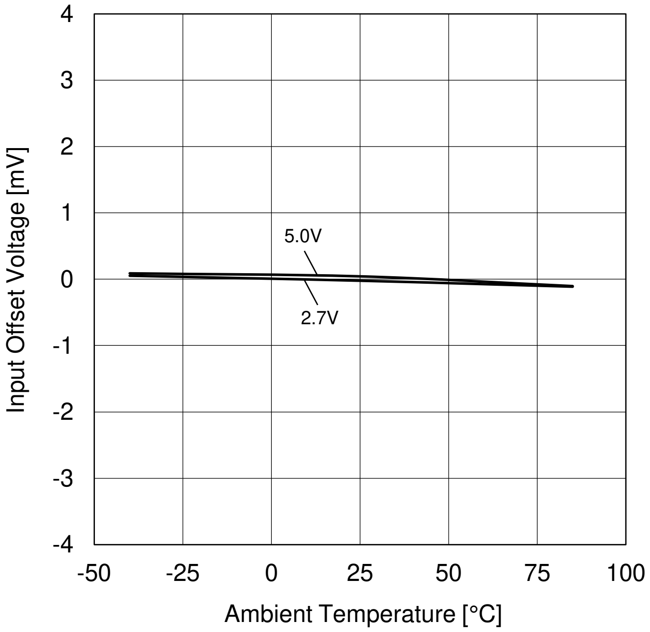


Figure 13. Input Offset Voltage vs Ambient Temperature ($V_{ICM}=V_{DD}/2$, $E_K=-V_{DD}/2$)

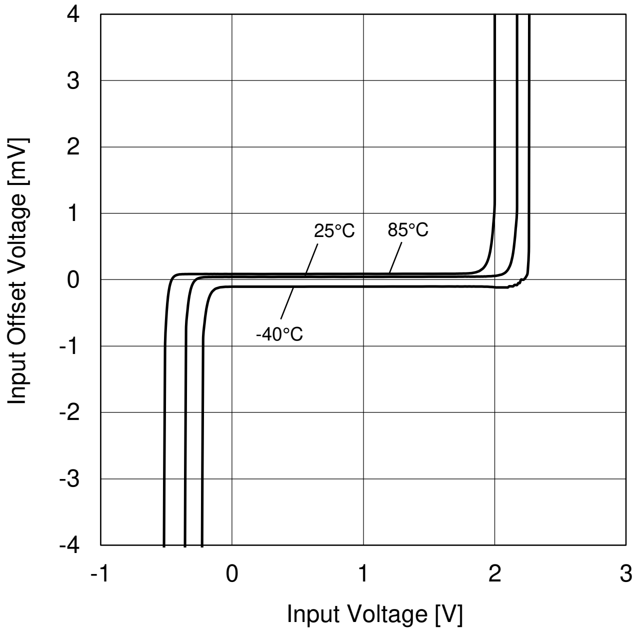


Figure 14. Input Offset Voltage vs Input Voltage (V_{DD}=2.7V)

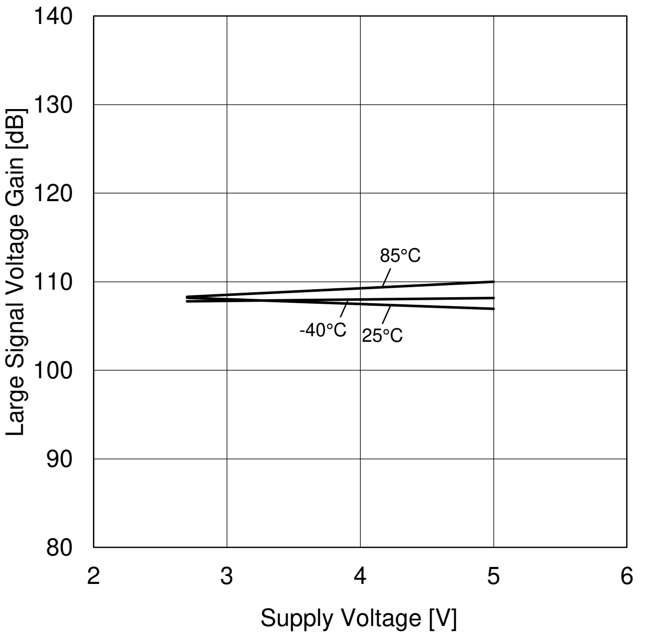


Figure 15. Large Signal Voltage Gain vs Supply Voltage

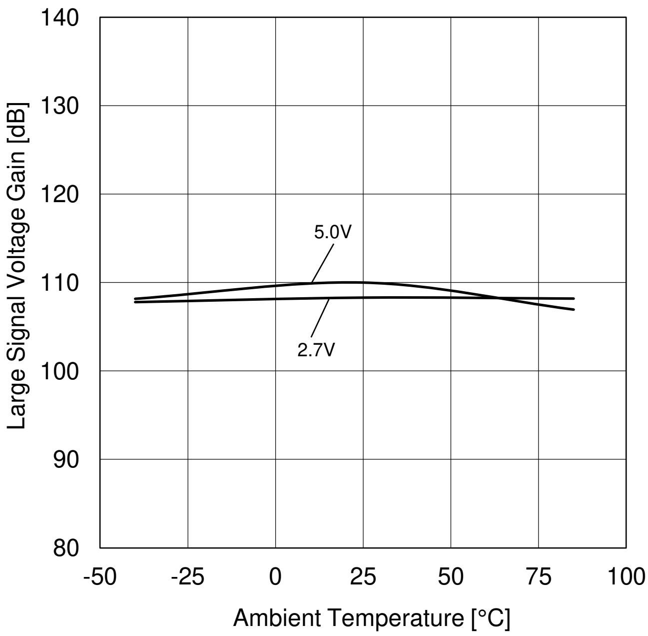


Figure 16. Large Signal Voltage Gain vs Ambient Temperature

(*)The data above are measurement values of a typical sample, it is not guaranteed.

Typical Performance Curves – continued

○**LMR821G**

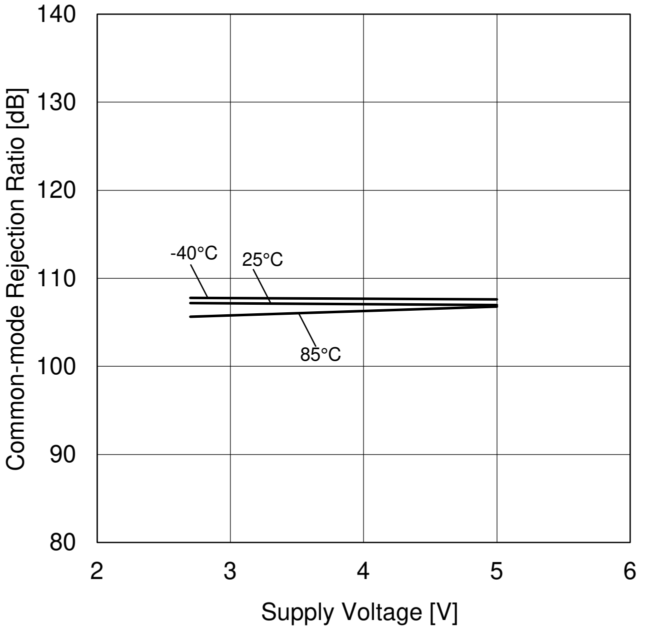


Figure 17. Common-mode Rejection Ratio vs Supply Voltage (V_{DD}=2.7V)

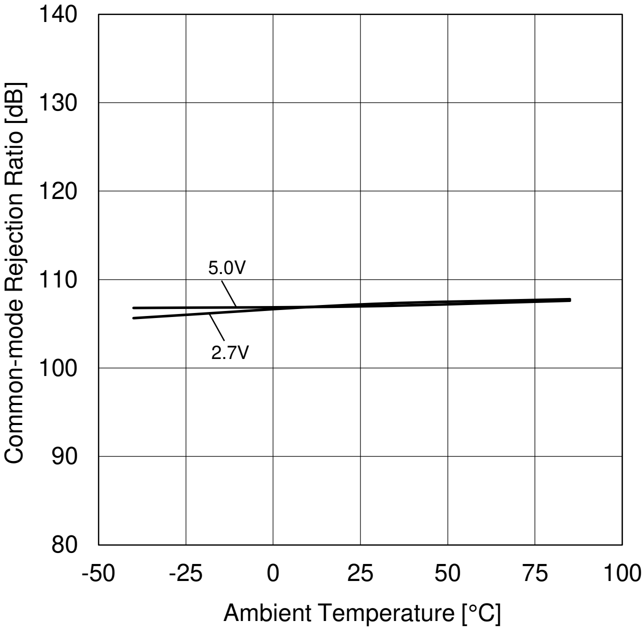


Figure 18. Common-mode Rejection Ratio vs Ambient Temperature

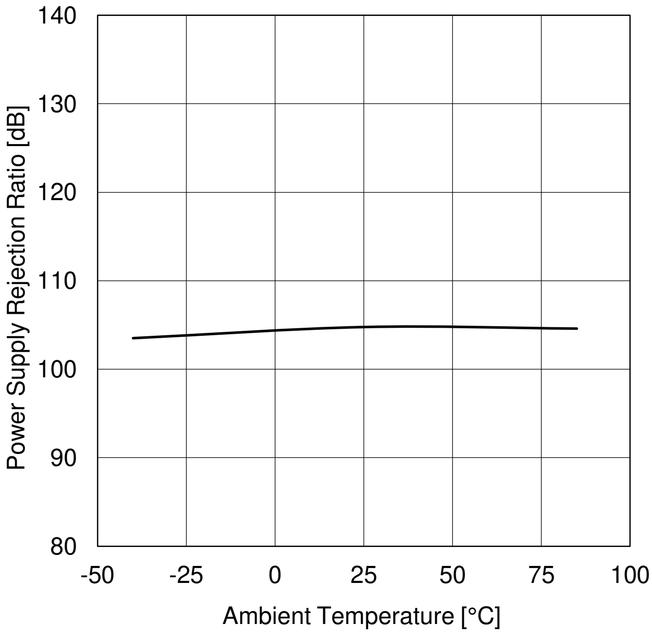


Figure 19. Power Supply Rejection Ratio vs Ambient Temperature (V_{DD}=2.7V to 5.0V)

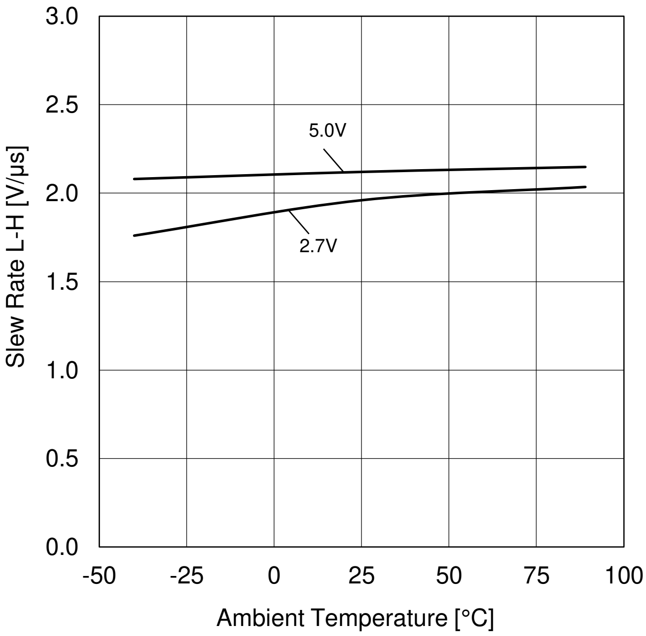


Figure 20. Slew Rate L-H vs Ambient Temperature

(*)The data above are measurement values of a typical sample, it is not guaranteed.

Typical Performance Curves – continued

○LMR821G

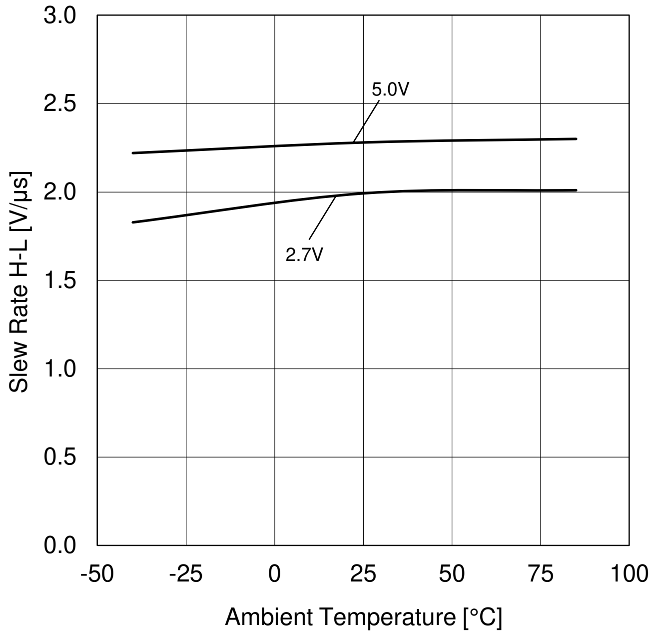


Figure 21. Slew Rate H-L vs Ambient Temperature

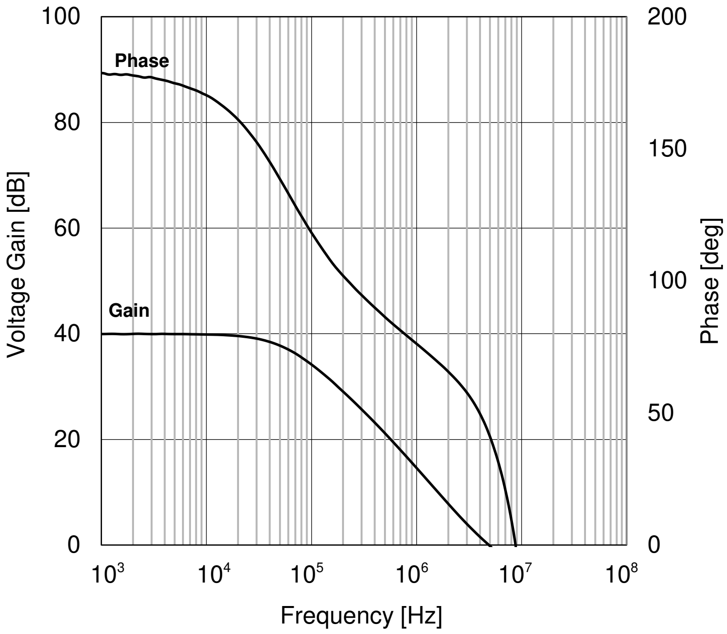


Figure 22. Voltage Gain・Phase vs Frequency

(*)The data above are measurement values of a typical sample, it is not guaranteed.

Typical Performance Curves – continued

○LMR822xxx

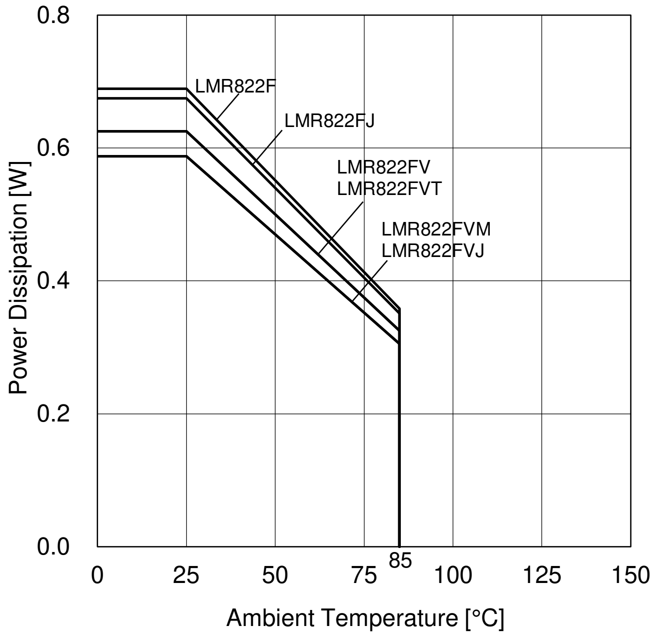


Figure 23. Power Dissipation vs Ambient Temperature (Derating Curve)

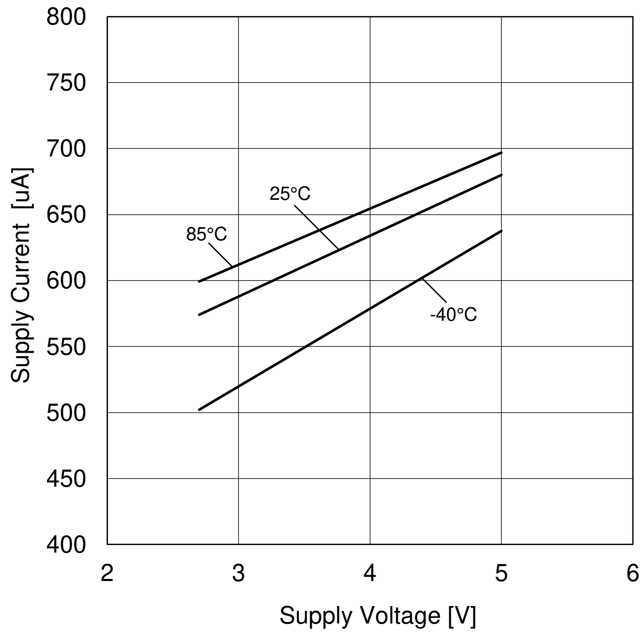


Figure 24. Supply Current vs Supply Voltage

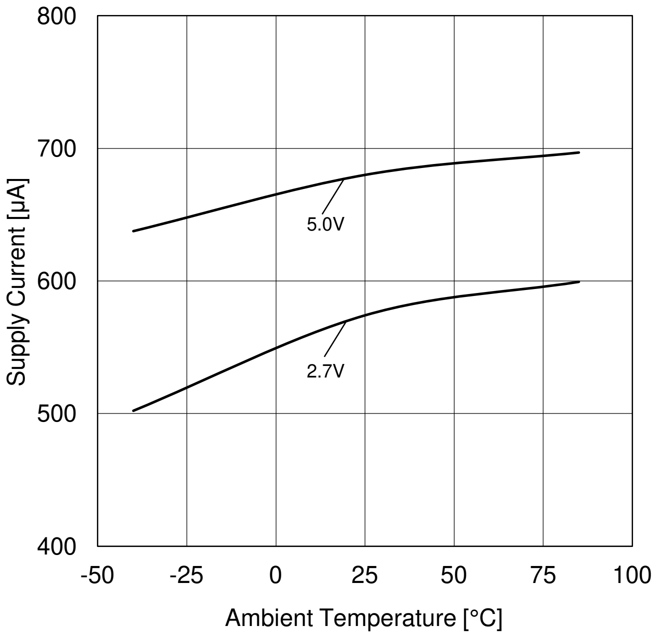


Figure 25.
Supply Current vs Ambient Temperature

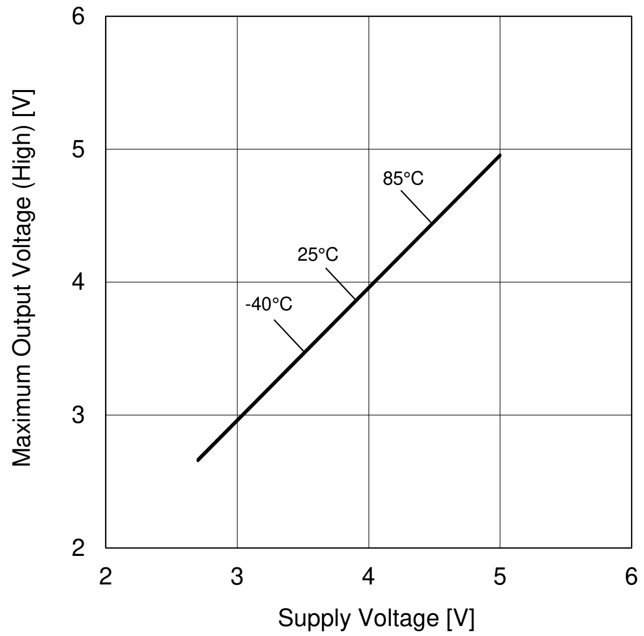


Figure 26. Maximum Output Voltage (High) vs Supply Voltage (R_L=2kΩ)

(*)The data above are measurement values of a typical sample, it is not guaranteed.

Typical Performance Curves – continued

○LMR822xxx

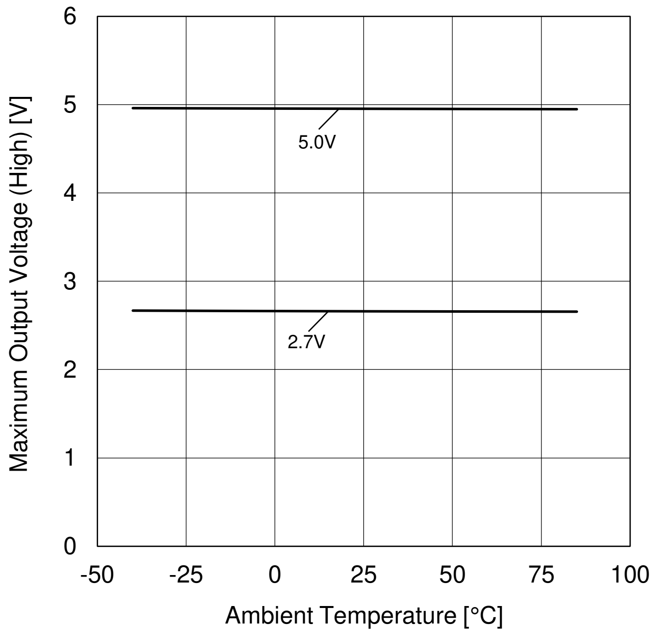


Figure 27. Maximum Output Voltage (High) vs Ambient Temperature (R_L=2kΩ)

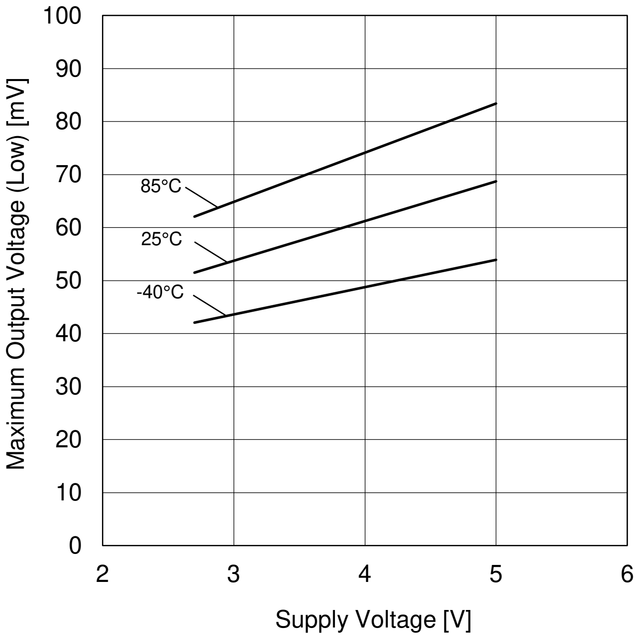


Figure 28. Maximum Output Voltage (Low) vs Supply Voltage (R_L=2kΩ)

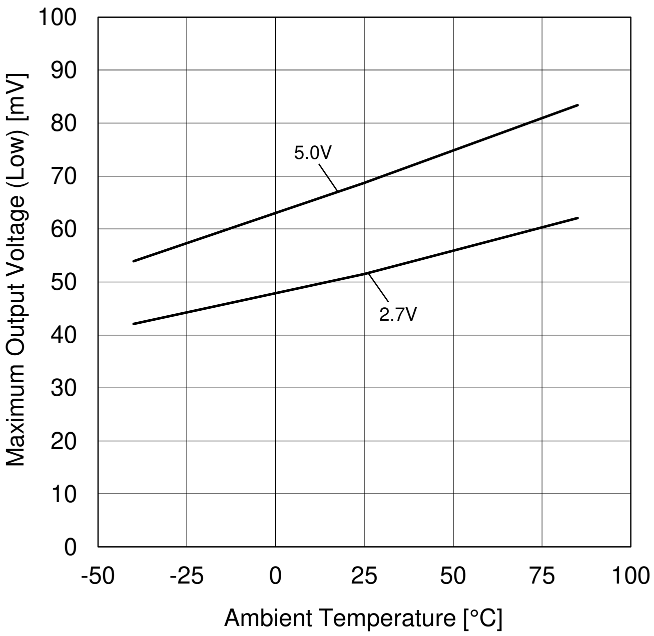


Figure 29. Maximum Output Voltage (Low) vs Ambient Temperature (R_L=2kΩ)

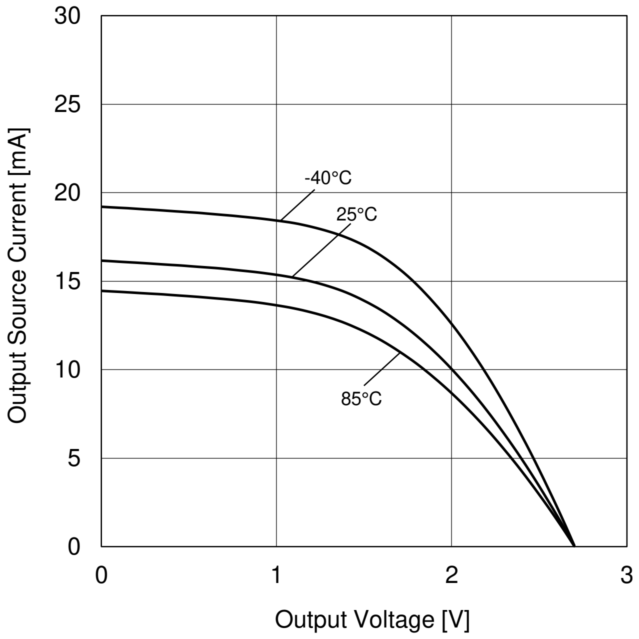


Figure 30. Output Source Current vs Output Voltage (V_{DD}=2.7V)

(*)The data above are measurement values of a typical sample, it is not guaranteed.

Typical Performance Curves – continued

○**LMR822xxx**

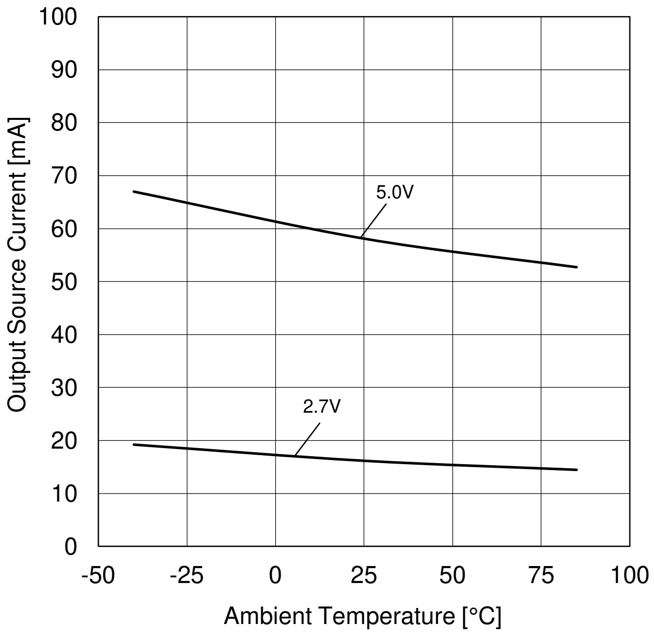


Figure 31. Output Source Current vs Ambient Temperature

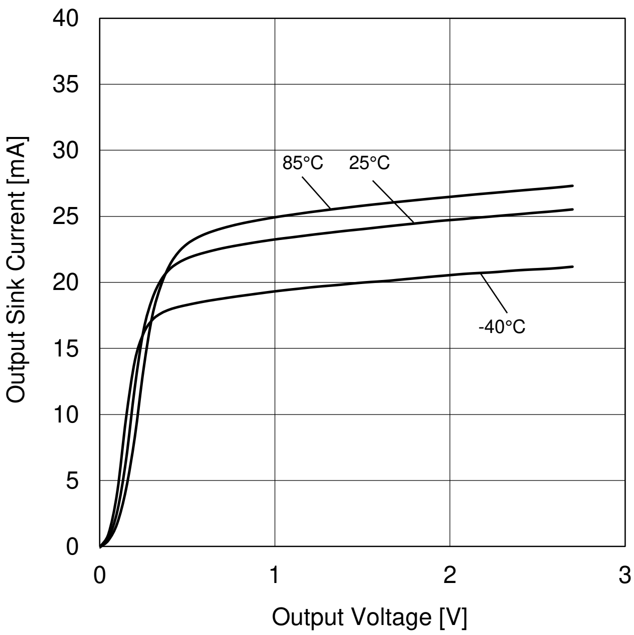


Figure 32. Output Sink Current vs Output Voltage (V_{DD}=2.7V)

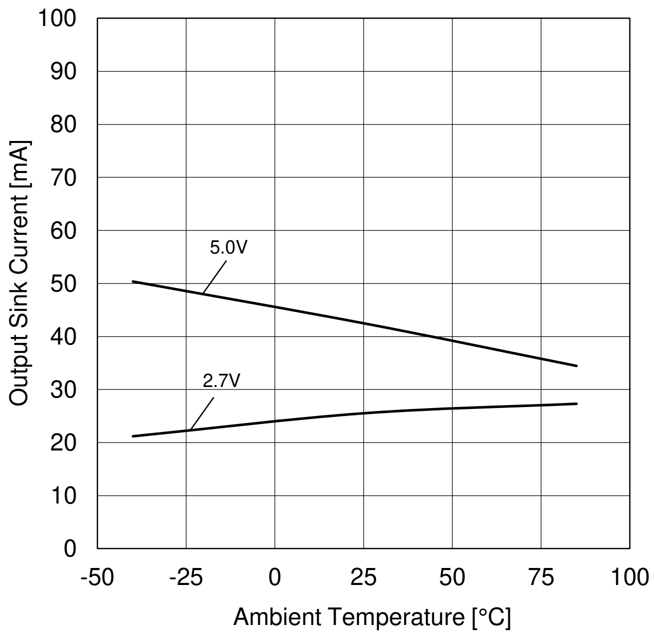


Figure 33. Output Sink Current vs Ambient Temperature

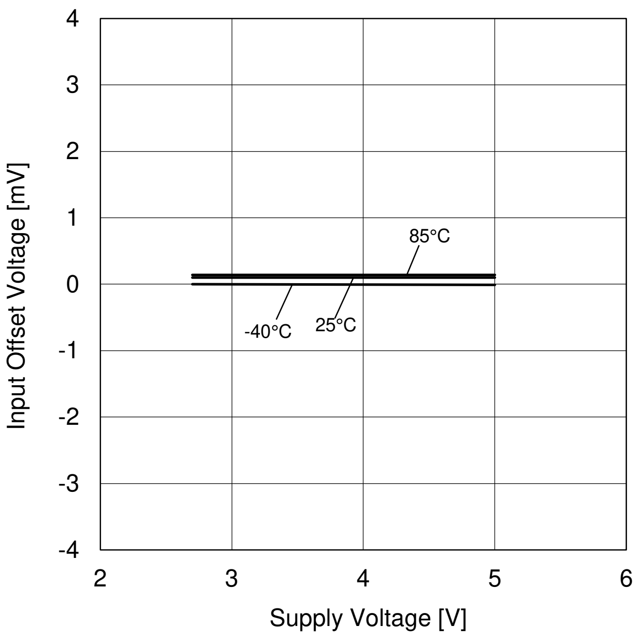


Figure 34. Input Offset Voltage vs Supply Voltage (V_{ICM}=V_{DD}/2, E_K=-V_{DD}/2)

(*)The data above are measurement values of a typical sample, it is not guaranteed.

Typical Performance Curves – continued

○LMR822xxx

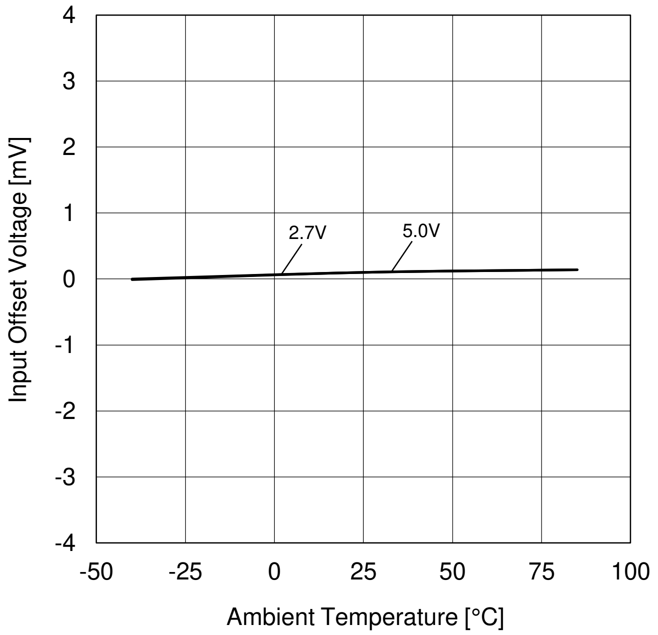


Figure 35. Input Offset Voltage vs Ambient Temperature (V_{ICM}=V_{DD}/2, E_K=-V_{DD}/2)

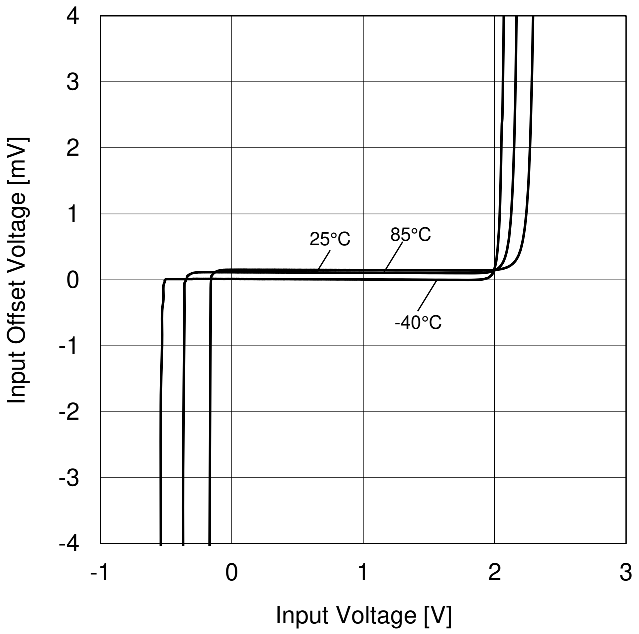


Figure 36. Input Offset Voltage vs Input Voltage (V_{DD}=2.7V)

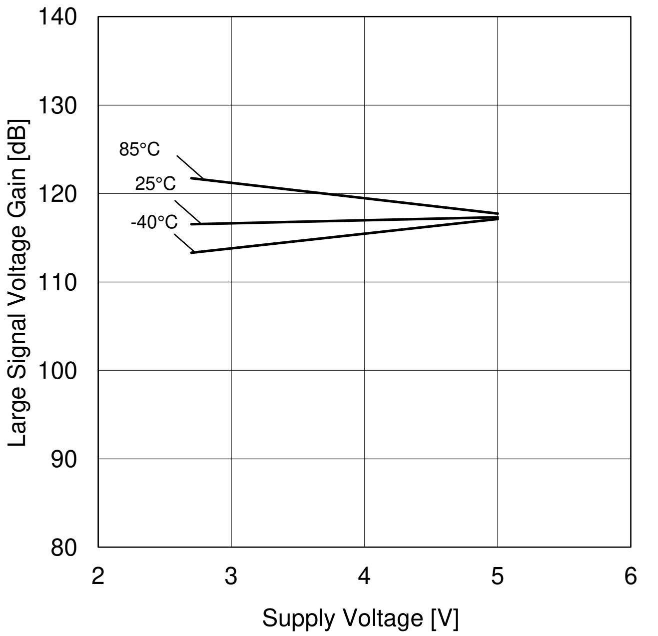


Figure 37. Large Signal Voltage Gain vs Supply Voltage

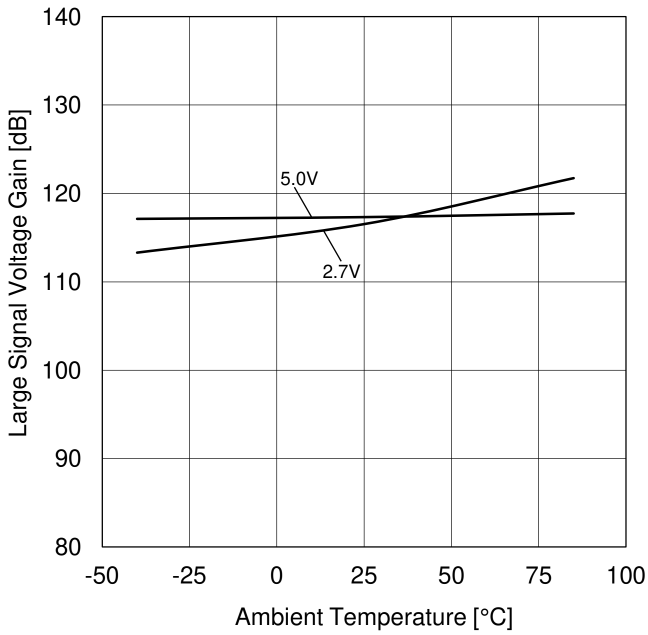


Figure 38. Large Signal Voltage Gain vs Ambient Temperature

(*)The data above are measurement values of a typical sample, it is not guaranteed.

Typical Performance Curves – continued

○LMR822xxx

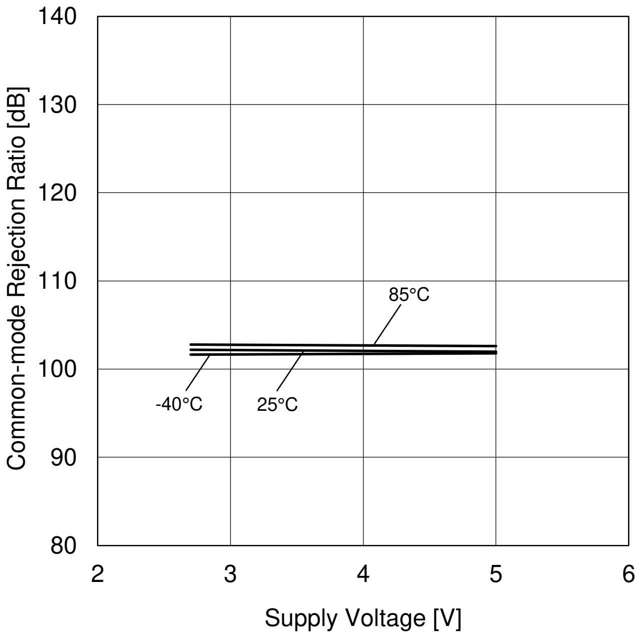


Figure 39. Common-mode Rejection Ratio vs Supply Voltage (V_{DD}=2.7V)

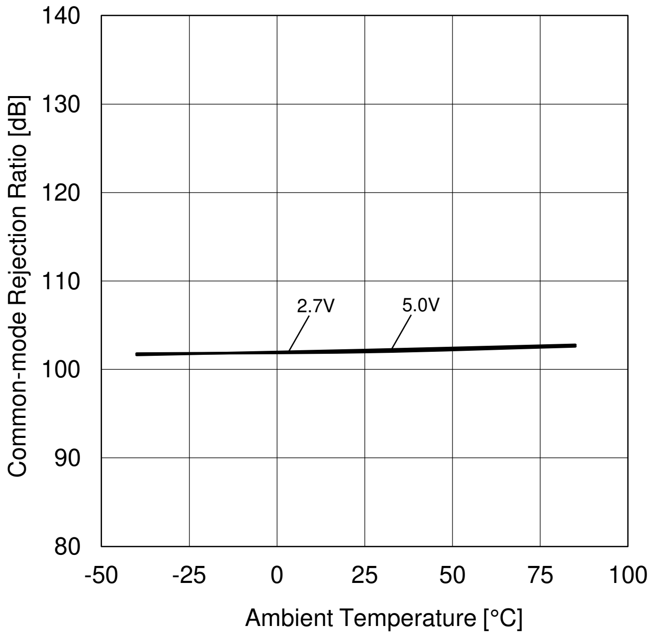


Figure 40. Common-mode Rejection Ratio vs Ambient Temperature

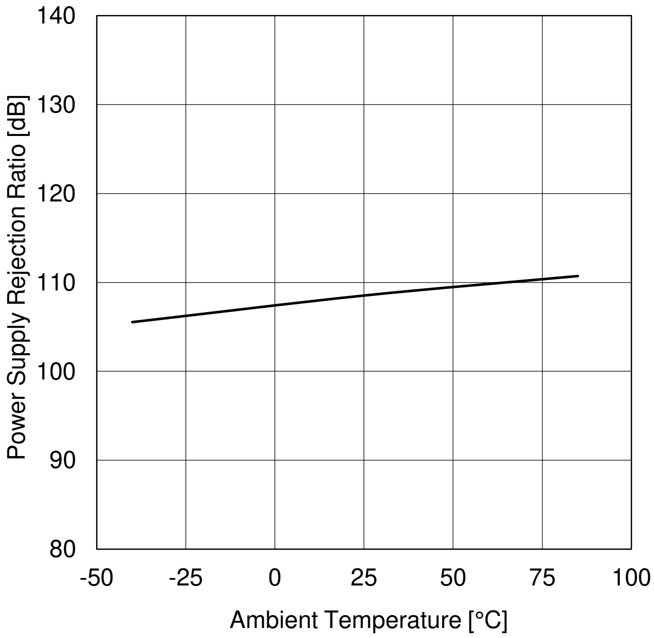


Figure 41. Power Supply Rejection Ratio vs Ambient Temperature (V_{DD}=2.7V to 5.0V)

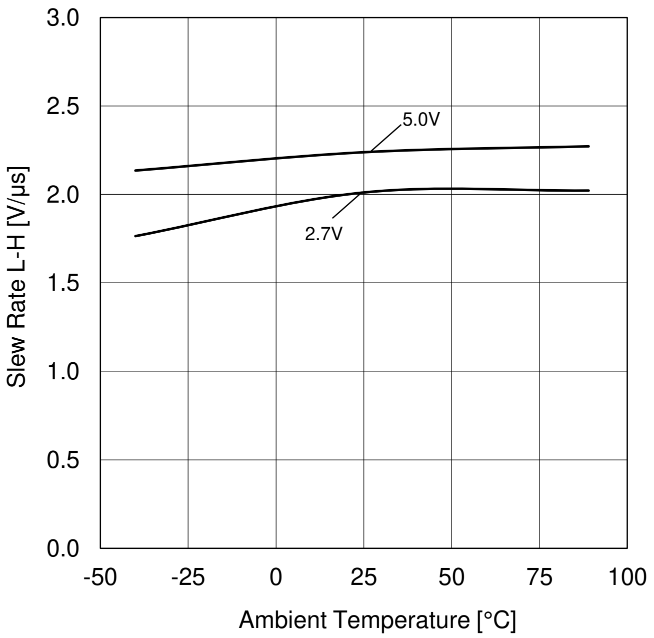


Figure 42. Slew Rate L-H vs Ambient Temperature

(*)The data above are measurement values of a typical sample, it is not guaranteed.

Typical Performance Curves – continued

○LMR822xxx

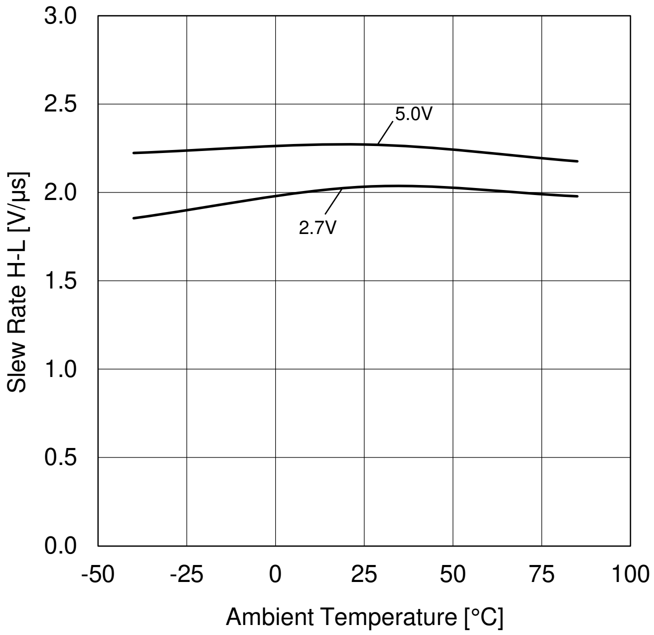


Figure 43. Slew Rate H-L vs Ambient Temperature

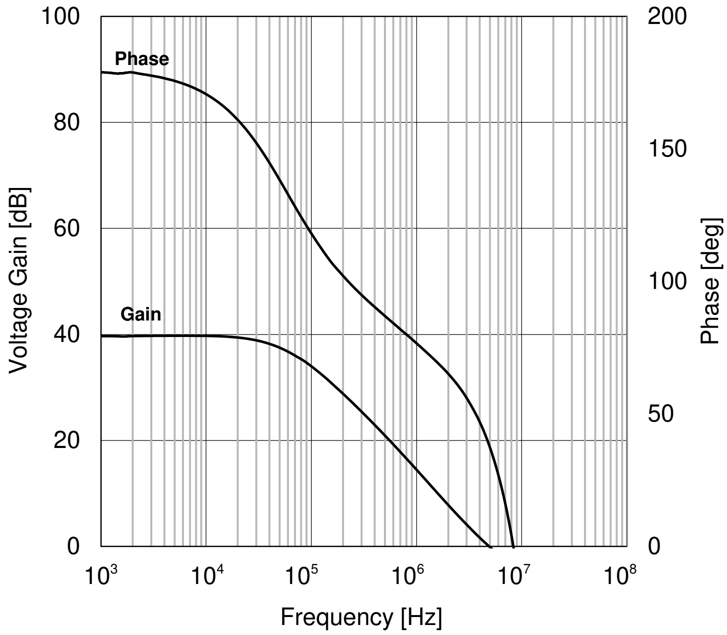


Figure 44. Voltage Gain・Phase vs Frequency

(*)The data above are measurement values of a typical sample, it is not guaranteed.

Typical Performance Curves – continued

○LMR824xxx

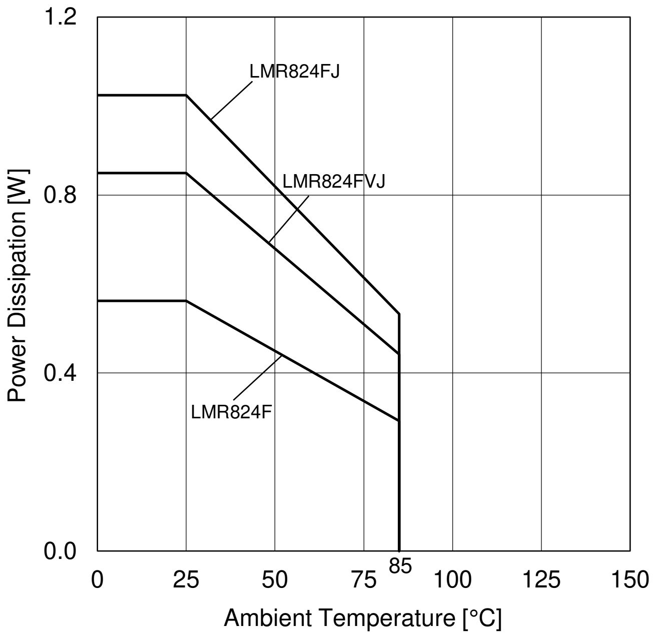


Figure 45. Power Dissipation vs Ambient Temperature (Derating Curve)

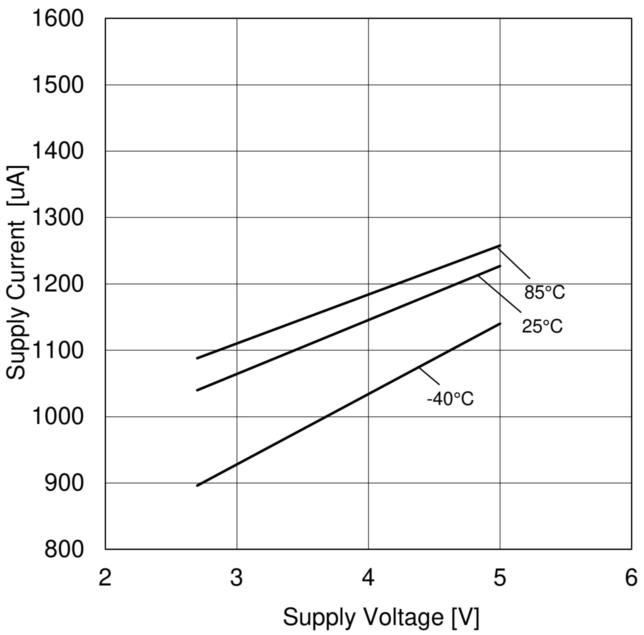


Figure 46. Supply Current vs Supply Voltage

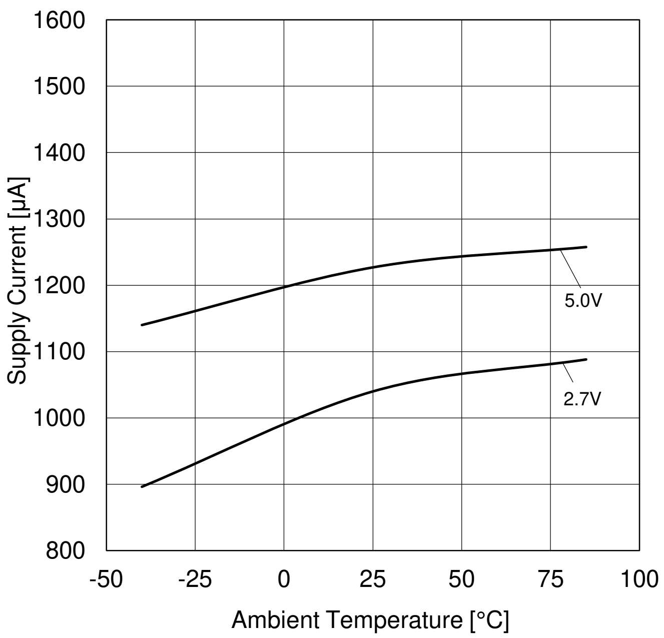


Figure 47. Supply Current vs Ambient Temperature

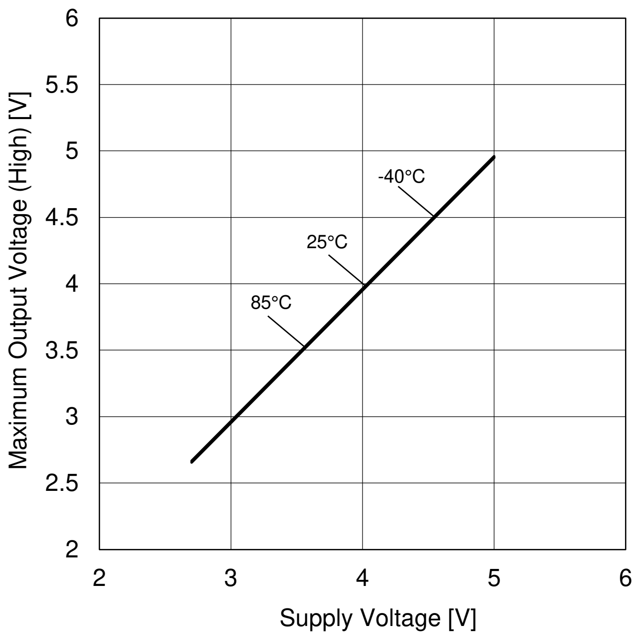


Figure 48. Maximum Output Voltage (High) vs Supply Voltage (R_L=2kΩ)

(*)The data above are measurement values of a typical sample, it is not guaranteed.

Typical Performance Curves – continued

○LMR824xxx

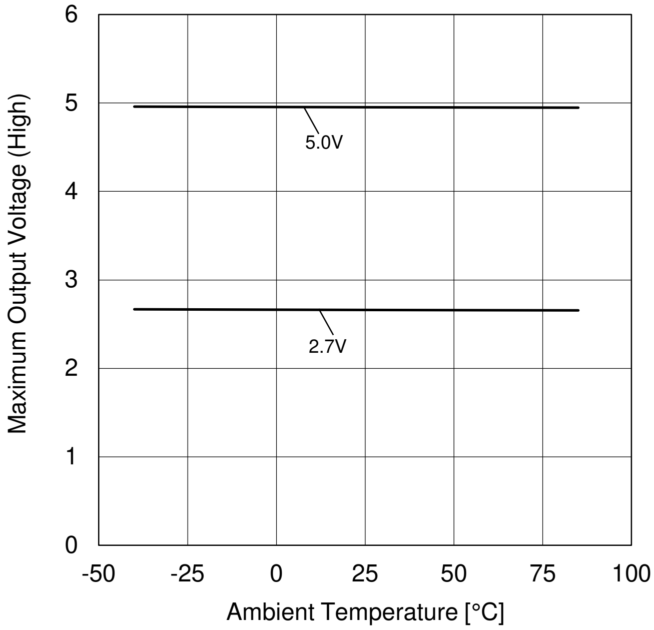


Figure 49. Maximum Output Voltage (High) vs Ambient Temperature (R_L=2kΩ)

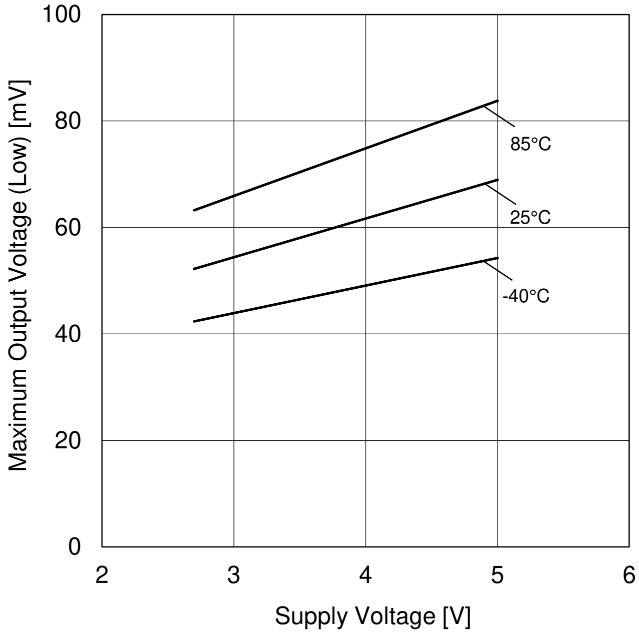


Figure 50. Maximum Output Voltage (Low) vs Supply Voltage (R_L=2kΩ)

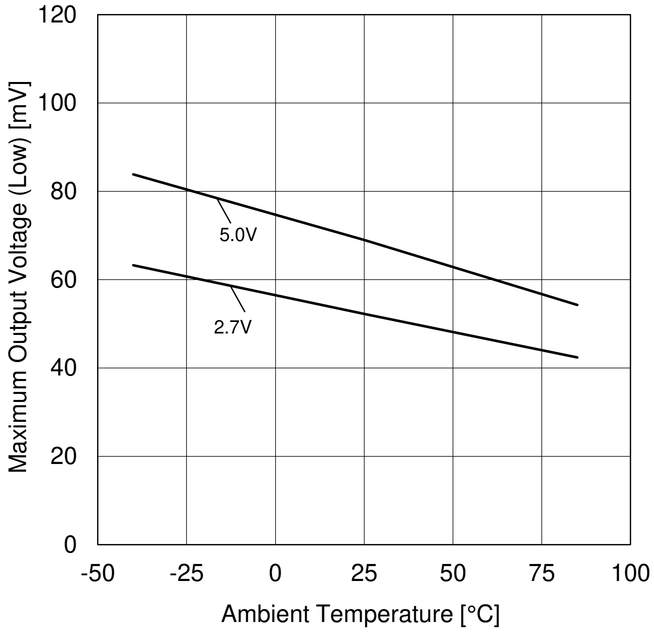


Figure 51. Maximum Output Voltage (Low) vs Ambient Temperature (R_L=2kΩ)

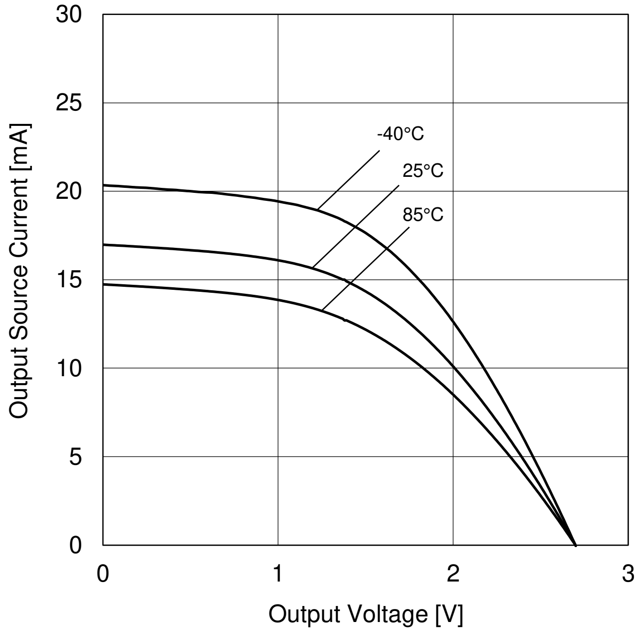


Figure 52. Output Source Current vs Output Voltage (V_{DD}=2.7V)

(*)The data above are measurement values of a typical sample, it is not guaranteed.