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Operational Amplifiers

Low Voltage Operation Ground Sense Operational Amplifier

TLR341G TLR342xxx TLR344xxx

General Description

TLR341G, TLR342xxx, and TLR344xxx series are single, dual, and quad CMOS operational amplifier with low supply voltage operation and full swing output. These are suitable for battery-operated equipment. The MOSFET input stage provides low input bias current. It can be used for sensor applications.
TLR341G includes shutdown function.

Features

- Low Operating Supply Voltage
- Output Full Swing / Input Ground Sense
- High Large Signal Voltage Gain
- Low Input Bias Current
- Low Supply Current
- Low Input Offset Voltage

Applications

- Consumer Electronics
- Buffer
- Sensor Amplifier
- Mobile Equipment
- Battery-Operated Equipment

Key Specifications

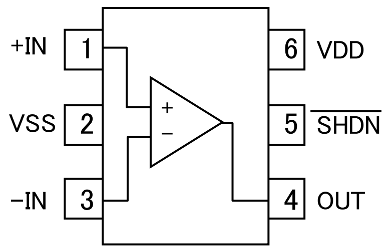
- Operating Supply Voltage (Single Supply): +1.8V to +5.5V
- Supply Current:
  - TLR341G 75uA (Typ)
  - TLR342xxx 150uA (Typ)
  - TLR344xxx 300uA (Typ)
- Voltage Gain (R_L=2kΩ): 105dB (Typ)
- Temperature Range: -40°C to +85°C
- Input Offset Voltage: 4mV (Max)
- Input Bias Current: 1pA (Typ)
- Gain Bandwidth: 2.3MHz (Typ)
- Slew Rate: 1.2V/µs (Typ)
- Turn-on Time from Shutdown: 1.2µs (Typ)

Packages

Packages	W(Typ) x D(Typ) x H(Max)
SSOP6	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
TSSOP-B8	3.00mm x 6.40mm x 1.20mm
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

TLR341G : SSOP6



Pin No.	Pin Name
1	+IN
2	VSS
3	-IN
4	OUT
5	$\overline{SHDN}$
6	VDD

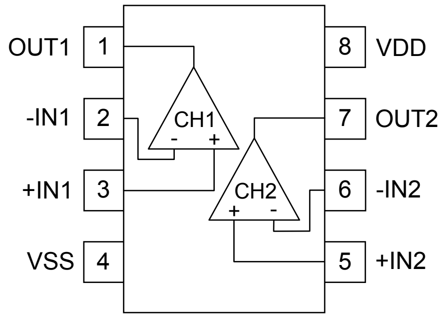
Pin	Input condition	State
$\overline{SHDN}$	V_{SS}	Shutdown
	V_{DD}	Active

Note: Please refer to Electrical Characteristics regarding to Shutdown Voltage Range.

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

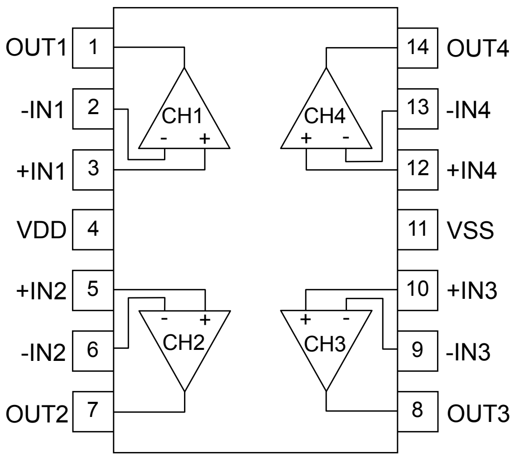
Pin Configuration – continued

TLR342F : SOP8
TLR342FJ : SOP-J8
TLR342FVT : TSSOP-B8
TLR342FVJ : TSSOP-B8J



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

TLR344F : SOP14
TLR344FJ : SOP-J14
TLR344FVJ : 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

Absolute Maximum Ratings (T_A=25°C)

Parameter	Symbol		Rating			Unit
			TLR341G	TLR342xxx	TLR344xxx	
Supply Voltage	V_{DD}-V_{SS}		+7			V
Power Dissipation	P_D	SSOP6	0.67(Note 1,9)	-	-	W
		SOP8	-	0.68(Note 2,9)	-	
		SOP-J8	-	0.67(Note 3,9)	-	
		TSSOP-B8	-	0.62(Note 4,9)	-	
		TSSOP-B8J	-	0.58(Note 5,9)	-	
		SOP14	-	-	0.56(Note 6,9)	
		SOP-J14	-	-	1.02(Note 7,9)	
		TSSOP-B14J	-	-	0.84(Note 8,9)	
Differential Input Voltage(Note 10)	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 11)	I_I		±10			mA
Operating Voltage	V_{opr}		+1.8 to +5.5			V
Operating Temperature	T_{opr}		-40 to +85			°C
Storage Temperature	T_{stg}		-55 to +150			°C
Maximum Junction Temperature	T_{jmax}		+150			°C

(Note 1) Power dissipation is reduced by 5.4mW/°C above T_A=25°C.
(Note 2) Power dissipation is reduced by 5.5mW/°C above T_A=25°C.
(Note 3) Power dissipation is reduced by 5.4mW/°C above T_A=25°C.
(Note 4) Power dissipation is reduced by 5.0mW/°C above T_A=25°C.
(Note 5) Power dissipation is reduced by 4.7mW/°C above T_A=25°C.
(Note 6) Power dissipation is reduced by 4.5mW/°C above T_A=25°C.
(Note 7) Power dissipation is reduced by 8.2mW/°C above T_A=25°C.
(Note 8) Power dissipation is reduced by 6.8mW/°C above T_A=25°C.
(Note 9) Mounted on a FR4 glass epoxy PCB (70mm×70mm×1.6mm).
(Note 10) 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 11) 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

○TLR341G (Unless otherwise specified V_{DD}=+1.8V, V_{SS}=0V, $V_{\overline{SHDN}}$=V_{DD})

Parameter	Symbol	Temperature Range	Limits Min	Limits Typ	Limits Max	Unit	Conditions
Input Offset Voltage(Note 12,13)	V_{IO}	25°C	-	0.3	4	mV	-
		Full Range	-	-	4.5		
Input Offset Voltage Drift(Note 12,13)	$\Delta V_{IO}/\Delta T$	Full Range	-	1.9	-	μV/°C	-
Input Bias Current(Note 12)	I_B	25°C	-	1	200	pA	-
Input Offset Current(Note 12)	I_{IO}	25°C	-	1	200	pA	-
Supply Current(Note 13)	I_{DD}	25°C	-	70	150	μA	-
		Full Range	-	-	200		
Shutdown Current	I_{DD_SD}	25°C	-	0.2	1000	nA	$V_{\overline{SHDN}}$=0V
Common-mode Rejection Ratio	CMRR	25°C	65	90	-	dB	V_{ICM}=0V to 0.7V
Power Supply Rejection Ratio	PSRR	25°C	75	95	-	dB	V_{DD}=1.8V to 5.0V
Input Common-mode Voltage Range	V_{ICM}	25°C	0	-	0.8	V	CMRR ≥ 60 dB
Large Signal Voltage Gain	Av	25°C	70	110	-	dB	R_L=10kΩ, V_{RL}=0.9V
			65	100	-		R_L=2kΩ, V_{RL}=0.9V
Maximum Output Voltage(High)	V_{OH}	25°C	V_{DD}-0.05	V_{DD}-0.03	-	V	R_L=2kΩ, V_{RL}=0.9V
			V_{DD}-0.02	V_{DD}-0.01	-		R_L=10kΩ, V_{RL}=0.9V
Maximum Output Voltage(Low)	V_{OL}	25°C	-	0.022	0.055	V	R_L=2kΩ, V_{RL}=0.9V
			-	0.014	0.02		R_L=10kΩ, V_{RL}=0.9V
Output Source Current(Note 14)	I_{SOURCE}	25°C	6	8	-	mA	V_{OUT}=0V, Short Current
Output Sink Current(Note 14)	I_{SINK}	25°C	10	13	-	mA	V_{OUT}=1.8V, Short Current
Slew Rate	SR	25°C	-	1.2	-	V/μs	R_L=10kΩ, V_{+IN}=0.7V_{P-P}
Gain Bandwidth	GBW	25°C	-	2.2	-	MHz	C_L=200pF, R_L=100kΩ
Unity Gain Frequency	f_T	25°C	-	1.2	-	MHz	C_L=200pF, R_L=100kΩ
Phase Margin	θ_M	25°C	-	55	-	deg	C_L=20pF, R_L=100kΩ
Gain Margin	GM	25°C	-	7	-	dB	C_L=20pF, R_L=100kΩ
Input Referred Noise Voltage	V_N	25°C	-	33	-	$nV/\sqrt{Hz}$	f=1kHz
Total Harmonic Distortion + Noise	THD+N	25°C	-	0.012	-	%	f=1kHz, R_L=600Ω A_V=0dB, DIN-AUDIO
Turn-on Time from Shutdown	t_{ON}	25°C	-	1.8	-	μs	-
Shutdown Voltage Range	V_{SHDN_H}	25°C	1.5	-	1.8	V	(Note 15)
	V_{SHDN_L}		0	-	0.5	V	(Note 16)

(Note 12) Absolute value
(Note 13) Full Range: T_A=-40°C to +85°C
(Note 14) 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 15) This voltage range means active condition.
(Note 16) This voltage range means shutdown condition.

Electrical Characteristics – continued

○TLR341G (Unless otherwise specified V_{DD}=+5V, V_{SS}=0V, $V_{\overline{SHDN}}$=V_{DD})

Parameter	Symbol	Temperature Range	Limits			Unit	Conditions
			Min	Typ	Max		
Input Offset Voltage(Note 17,18)	V_{IO}	25°C	-	0.3	4	mV	-
		Full Range	-	-	4.5		
Input Offset Voltage Drift(Note 17,18)	$\Delta V_{IO}/\Delta T$	Full Range	-	1.9	-	μV/°C	-
Input Bias Current(Note 17)	I_B	25°C	-	1	200	pA	-
Input Offset Current(Note 17)	I_{IO}	25°C	-	1	200	pA	-
Supply Current(Note 18)	I_{DD}	25°C	-	75	150	μA	-
		Full Range	-	-	200		
Shutdown Current	I_{DD_SD}	25°C	-	0.2	1000	nA	$V_{\overline{SHDN}}$=0V
Common-mode Rejection Ratio	CMRR	25°C	75	90	-	dB	V_{ICM}=0V to 3.9V
Power Supply Rejection Ratio	PSRR	25°C	75	95	-	dB	V_{DD}=1.8V to 5.0V
Input Common-mode Voltage Range	V_{ICM}	25°C	0	-	4.0	V	CMRR ≥70 dB
Large Signal Voltage Gain	Av	25°C	80	110	-	dB	R_L=10kΩ, V_{RL}=2.5V
			75	105	-		R_L=2kΩ, V_{RL}=2.5V
Maximum Output Voltage(High)	V_{OH}	25°C	V_{DD}-0.06	V_{DD}-0.03	-	V	R_L=2kΩ, V_{RL}=2.5V
			V_{DD}-0.02	V_{DD}-0.01	-		R_L=10kΩ, V_{RL}=2.5V
Maximum Output Voltage(Low)	V_{OL}	25°C	-	0.04	0.06	V	R_L=2kΩ, V_{RL}=2.5V
			-	0.02	0.03		R_L=10kΩ, V_{RL}=2.5V
Output Source Current(Note 19)	I_{SOURCE}	25°C	60	100	-	mA	V_{OUT}=0V, Short Current
Output Sink Current(Note 19)	I_{SINK}	25°C	80	120	-	mA	V_{OUT}=5V, Short Current
Slew Rate	SR	25°C	-	1.2	-	V/μs	R_L=10kΩ, V_{+IN}=2V_{P-P}
Gain Bandwidth	GBW	25°C	-	2.3	-	MHz	C_L=200pF, R_L=100kΩ
Unity Gain Frequency	f_T	25°C	-	1.3	-	MHz	C_L=200pF, R_L=100kΩ
Phase Margin	θ_M	25°C	-	55	-	deg	C_L=20pF, R_L=100kΩ
Gain Margin	GM	25°C	-	7	-	dB	C_L=20pF, R_L=100kΩ
Input Referred Noise Voltage	V_N	25°C	-	33	-	$nV/\sqrt{Hz}$	f=1kHz
Total Harmonic Distortion + Noise	THD+N	25°C	-	0.012	-	%	V_{+IN}=1V_{P-P}, f=1kHz R_L=600Ω, A_V=0dB, DIN-AUDIO
Turn-on Time from Shutdown	t_{ON}	25°C	-	1.2	-	μs	-
Shutdown Voltage Range	V_{SHDN_H}	25°C	4.5	-	5.0	V	(Note 20)
	V_{SHDN_L}		0	-	0.8	V	(Note 21)

(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) This voltage range means active condition.
(Note 21) This voltage range means shutdown condition.

Electrical Characteristics – continued

○TLR342xxx (Unless otherwise specified V_{DD}=+1.8V, V_{SS}=0V)

Parameter	Symbol	Temperature Range	Limit Min	Limit Typ	Limit Max	Unit	Conditions
Input Offset Voltage(Note 22,23)	V_{IO}	25°C	-	0.3	4	mV	-
		Full Range	-	-	4.5		
Input Offset Voltage Drift (Note22,23)	$\Delta V_{IO}/\Delta T$	Full Range	-	1.9	-	μV/°C	-
Input Bias Current(Note 22)	I_B	25°C	-	1	200	pA	-
Input Offset Current(Note 22)	I_{IO}	25°C	-	1	200	pA	-
Supply Current(Note 23)	I_{DD}	25°C	-	150	300	μA	-
		Full Range	-	-	400		
Common-mode Rejection Ratio	CMRR	25°C	65	90	-	dB	V_{ICM}=0V to 0.7V
Power Supply Rejection Ratio	PSRR	25°C	75	95	-	dB	V_{DD}=1.8V to 5.0V
Input Common-mode Voltage Range	V_{ICM}	25°C	0	-	0.8	V	CMRR ≥ 60 dB
Large Signal Voltage Gain	Av	25°C	70	110	-	dB	R_L=10kΩ, V_{RL}=0.9V
			65	100	-		R_L=2kΩ, V_{RL}=0.9V
Maximum Output Voltage(High)	V_{OH}	25°C	V_{DD}-0.05	V_{DD}-0.03	-	V	R_L=2kΩ, V_{RL}=0.9V
			V_{DD}-0.02	V_{DD}-0.01	-		R_L=10kΩ, V_{RL}=0.9V
Maximum Output Voltage(Low)	V_{OL}	25°C	-	0.022	0.055	V	R_L=2kΩ, V_{RL}=0.9V
			-	0.014	0.02		R_L=10kΩ, V_{RL}=0.9V
Output Source Current(Note 24)	I_{SOURCE}	25°C	6	8	-	mA	V_{OUT}=0V, Short Current
Output Sink Current(Note 24)	I_{SINK}	25°C	10	13	-	mA	V_{OUT}=1.8V, Short Current
Slew Rate	SR	25°C	-	1.2	-	V/μs	R_L=10kΩ, V_{+IN}=0.7V_{P-P}
Gain Bandwidth	GBW	25°C	-	2.2	-	MHz	C_L=200pF, R_L=100kΩ
Unity Gain Frequency	f_T	25°C	-	1.2	-	MHz	C_L=200pF, R_L=100kΩ
Phase Margin	θ_M	25°C	-	55	-	deg	C_L=20pF, R_L=100kΩ
Gain Margin	GM	25°C	-	7	-	dB	C_L=20pF, R_L=100kΩ
Input Referred Noise Voltage	V_N	25°C	-	33	-	$nV/\sqrt{Hz}$	f=1kHz
Total Harmonic Distortion + Noise	THD+N	25°C	-	0.012	-	%	f=1kHz, R_L=600Ω A_V=0dB, DIN-AUDIO
Channel Separation	CS	25°C	-	110	-	dB	A_V=40dB, V_{OUT}=1V_{rms}

(Note 22) Absolute value
(Note 23) Full Range: T_A=-40°C to +85°C
(Note 24) 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.

Electrical Characteristics – continued

○TLR342xxx (Unless otherwise specified V_{DD}=+5V, V_{SS}=0V)

Parameter	Symbol	Temperature Range	Limit Min	Limit Typ	Limit Max	Unit	Conditions
Input Offset Voltage(Note 25,26)	V_{IO}	25°C	-	0.3	4	mV	-
		Full Range	-	-	4.5		
Input Offset Voltage Drift(Note 25,26)	$\Delta V_{IO}/\Delta T$	Full Range	-	1.9	-	μV/°C	-
Input Bias Current(Note 25)	I_B	25°C	-	1	200	pA	-
Input Offset Current(Note 25)	I_{IO}	25°C	-	1	200	pA	-
Supply Current(Note 26)	I_{DD}	25°C	-	150	300	μA	-
		Full Range	-	-	400		
Common-mode Rejection Ratio	CMRR	25°C	75	90	-	dB	V_{ICM}=0V to 3.9V
Power Supply Rejection Ratio	PSRR	25°C	75	95	-	dB	V_{DD}=1.8V to 5.0V
Input Common-mode Voltage Range	V_{ICM}	25°C	0	-	4.0	V	CMRR ≥70 dB
Large Signal Voltage Gain	Av	25°C	80	110	-	dB	R_L=10kΩ, V_{RL}=2.5V
			75	105	-		R_L=2kΩ, V_{RL}=2.5V
Maximum Output Voltage(High)	V_{OH}	25°C	V_{DD}-0.06	V_{DD}-0.03	-	V	R_L=2kΩ, V_{RL}=2.5V
			V_{DD}-0.02	V_{DD}-0.01	-		R_L=10kΩ, V_{RL}=2.5V
Maximum Output Voltage(Low)	V_{OL}	25°C	-	0.04	0.06	V	R_L=2kΩ, V_{RL}=2.5V
			-	0.02	0.03		R_L=10kΩ, V_{RL}=2.5V
Output Source Current(Note 27)	I_{SOURCE}	25°C	60	100	-	mA	V_{OUT}=0V, Short Current
Output Sink Current(Note 27)	I_{SINK}	25°C	80	120	-	mA	V_{OUT}=5V, Short Current
Slew Rate	SR	25°C	-	1.2	-	V/μs	R_L=10kΩ, V_{+IN}=2V_{P-P}
Gain Bandwidth	GBW	25°C	-	2.3	-	MHz	C_L=200pF, R_L=100kΩ
Unity Gain Frequency	f_T	25°C	-	1.3	-	MHz	C_L=200pF, R_L=100kΩ
Phase Margin	θ_M	25°C	-	55	-	deg	C_L=20pF, R_L=100kΩ
Gain Margin	GM	25°C	-	7	-	dB	C_L=20pF, R_L=100kΩ
Input Referred Noise Voltage	V_N	25°C	-	33	-	$nV/\sqrt{Hz}$	f=1kHz
Total Harmonic Distortion + Noise	THD+N	25°C	-	0.012	-	%	V_{+IN}=1V_{P-P}, f=1kHz R_L=600Ω, A_V=0dB, DIN-AUDIO
Channel Separation	CS	25°C	-	110	-	dB	A_V=40dB, V_{OUT}=1V_{rms}

(Note 25) Absolute value
(Note 26) Full Range: T_A=-40°C to +85°C
(Note 27) 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.

Electrical Characteristics – continued

○TLR344xxx (Unless otherwise specified V_{DD}=+1.8V, V_{SS}=0V)

Parameter	Symbol	Temperature Range	Limit Min	Limit Typ	Limit Max	Unit	Conditions
Input Offset Voltage(Note 28,29)	V_{IO}	25°C	-	0.3	4	mV	-
		Full Range	-	-	4.5		
Input Offset Voltage Drift(Note 28,29)	$\Delta V_{IO}/\Delta T$	Full Range	-	1.9	-	μV/°C	-
Input Bias Current(Note 28)	I_B	25°C	-	1	200	pA	-
Input Offset Current(Note 28)	I_{IO}	25°C	-	1	200	pA	-
Supply Current(Note 29)	I_{DD}	25°C	-	280	600	μA	-
		Full Range	-	-	800		
Common-mode Rejection Ratio	CMRR	25°C	65	90	-	dB	V_{ICM}=0V to 0.7V
Power Supply Rejection Ratio	PSRR	25°C	75	95	-	dB	V_{DD}=1.8V to 5.0V
Input Common-mode Voltage Range	V_{ICM}	25°C	0	-	0.8	V	CMRR ≥ 60 dB
Large Signal Voltage Gain	Av	25°C	70	110	-	dB	R_L=10kΩ, V_{RL}=0.9V
			65	100	-		R_L=2kΩ, V_{RL}=0.9V
Maximum Output Voltage(High)	V_{OH}	25°C	V_{DD}-0.05	V_{DD}-0.03	-	V	R_L=2kΩ, V_{RL}=0.9V
			V_{DD}-0.02	V_{DD}-0.01	-		R_L=10kΩ, V_{RL}=0.9V
Maximum Output Voltage(Low)	V_{OL}	25°C	-	0.022	0.055	V	R_L=2kΩ, V_{RL}=0.9V
			-	0.014	0.02		R_L=10kΩ, V_{RL}=0.9V
Output Source Current(Note 30)	I_{SOURCE}	25°C	6	8	-	mA	V_{OUT}=0V, Short Current
Output Sink Current(Note 30)	I_{SINK}	25°C	10	13	-	mA	V_{OUT}=1.8V, Short Current
Slew Rate	SR	25°C	-	1.2	-	V/μs	R_L=10kΩ, V_{+IN}=0.7V_{P-P}
Gain Bandwidth	GBW	25°C	-	2.2	-	MHz	C_L=200pF, R_L=100kΩ
Unity Gain Frequency	f_T	25°C	-	1.2	-	MHz	C_L=200pF, R_L=100kΩ
Phase Margin	θ_M	25°C	-	55	-	deg	C_L=20pF, R_L=100kΩ
Gain Margin	GM	25°C	-	7	-	dB	C_L=20pF, R_L=100kΩ
Input Referred Noise Voltage	V_N	25°C	-	33	-	$nV/\sqrt{Hz}$	f=1kHz
Total Harmonic Distortion + Noise	THD+N	25°C	-	0.012	-	%	f=1kHz, R_L=600Ω A_V=0dB, DIN-AUDIO
Channel Separation	CS	25°C	-	110	-	dB	A_V=40dB, V_{OUT}=1V_{rms}

(Note 28) Absolute value
(Note 29) Full Range: T_A=-40°C to +85°C
(Note 30) 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.

Electrical Characteristics – continued

○TLR344xxx (Unless otherwise specified V_{DD}=+5V, V_{SS}=0V)

Parameter	Symbol	Temperature Range	Limit			Unit	Conditions
			Min	Typ	Max		
Input Offset Voltage(Note 31,32)	V_{IO}	25°C	-	0.3	4	mV	-
		Full Range	-	-	4.5		
Input Offset Voltage Drift(Note 31,32)	$\Delta V_{IO}/\Delta T$	Full Range	-	1.9	-	μV/°C	-
Input Bias Current(Note 31)	I_B	25°C	-	1	200	pA	-
Input Offset Current(Note 31)	I_{IO}	25°C	-	1	200	pA	-
Supply Current(Note 32)	I_{DD}	25°C	-	300	600	μA	-
		Full Range	-	-	800		
Common-mode Rejection Ratio	CMRR	25°C	75	90	-	dB	V_{ICM}=0V to 3.9V
Power Supply Rejection Ratio	PSRR	25°C	75	95	-	dB	V_{DD}=1.8V to 5.0V
Input Common-mode Voltage Range	V_{ICM}	25°C	0	-	4.0	V	CMRR ≥70 dB
Large Signal Voltage Gain	Av	25°C	80	110	-	dB	R_L=10kΩ, V_{RL}=2.5V
			75	105	-		R_L=2kΩ, V_{RL}=2.5V
Maximum Output Voltage(High)	V_{OH}	25°C	V_{DD}-0.06	V_{DD}-0.03	-	V	R_L=2kΩ, V_{RL}=2.5V
			V_{DD}-0.02	V_{DD}-0.01	-		R_L=10kΩ, V_{RL}=2.5V
Maximum Output Voltage(Low)	V_{OL}	25°C	-	0.04	0.06	V	R_L=2kΩ, V_{RL}=2.5V
			-	0.02	0.03		R_L=10kΩ, V_{RL}=2.5V
Output Source Current(Note 33)	I_{SOURCE}	25°C	60	100	-	mA	V_{OUT}=0V, Short Current
Output Sink Current(Note 33)	I_{SINK}	25°C	80	120	-	mA	V_{OUT}=5V, Short Current
Slew Rate	SR	25°C	-	1.2	-	V/μs	R_L=10kΩ, V_{+IN}=2V_{P-P}
Gain Bandwidth	GBW	25°C	-	2.3	-	MHz	C_L=200pF, R_L=100kΩ
Unity Gain Frequency	f_T	25°C	-	1.3	-	MHz	C_L=200pF, R_L=100kΩ
Phase Margin	θ_M	25°C	-	55	-	deg	C_L=20pF, R_L=100kΩ
Gain Margin	GM	25°C	-	7	-	dB	C_L=20pF, R_L=100kΩ
Input Referred Noise Voltage	V_N	25°C	-	33	-	$nV/\sqrt{Hz}$	f=1kHz
Total Harmonic Distortion + Noise	THD+N	25°C	-	0.012	-	%	V_{+IN}=1V_{P-P}, f=1kHz R_L=600Ω, A_V=0dB, DIN-AUDIO
Channel Separation	CS	25°C	-	110	-	dB	A_V=40dB, V_{OUT}=1V_{rms}

(Note 31) Absolute value
(Note 32) Full Range: T_A=-40°C to +85°C
(Note 33) 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.

Description of Electrical Characteristics

Described below are descriptions of the relevant electrical terms used in this datasheet. Items and symbols used are also shown. Note that item name and symbol and their meaning may differ from those on another manufacturer's document or general document.

1. Absolute Maximum Ratings

Absolute maximum rating items indicate the condition 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 pin and VSS pin without deterioration or destruction of characteristics of internal circuit.

(2) Differential Input Voltage (V_{ID})
Indicates the maximum voltage that can be applied between non-inverting and inverting pins 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 pins without deterioration or destruction of electrical characteristics. 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 characteristics.

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

2. Electrical Characteristics

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

(2) Input Offset Voltage drift ($\Delta V_{IO}/\Delta T$)
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 the non-inverting and inverting pins.

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

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

(6) Shutdown current (I_{DD_SD})
Indicates the current when the circuit is shutdown.

(7) Maximum Output Voltage(High) / Maximum Output Voltage(Low) (V_{OH}/V_{OL})
Indicates the voltage range of the output under specified load condition. It is typically divided into maximum output voltage high and low. Maximum output voltage high indicates the upper limit of output voltage. Maximum output voltage low indicates the lower limit.

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

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

(10) Common-mode Rejection Ratio (CMRR)
Indicates the ratio of fluctuation of input offset voltage when the input common-mode voltage is changed. It is normally the fluctuation of DC.
CMRR = (Change of Input Common-mode voltage)/(Input offset fluctuation)

(11) Power Supply Rejection Ratio (PSRR)
Indicates the ratio of fluctuation of input offset voltage when supply voltage is changed.
It is normally the fluctuation of DC.
PSRR = (Change of power supply voltage)/(Input offset fluctuation)

(12) Output Source Current/ Output Sink Current (I_{SOURCE} / I_{SINK})
The maximum current that can be output from the IC under specific output 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.

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

(14) Unity Gain Frequency (f_T)
Indicates a frequency where the voltage gain of operational amplifier is 1.

(15) Gain Bandwidth (GBW)
The product of the open-loop voltage gain and the frequency at which the voltage gain decreases 6dB/octave.

Description of Electrical Characteristics - continued

(16) Phase Margin (θ_M)
Indicates the margin of phase from 180 degree phase lag at unity gain frequency.

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

(18) Input Referred Noise Voltage (V_N)
Indicates a noise voltage generated inside the operational amplifier equivalent by ideal voltage source connected in series with input pin.

(19) 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.

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

(21) Turn On Time From Shutdown (t_{ON})
Indicates the time from applying the voltage to shutdown terminal until the IC is active.

(22) Turn On Voltage / Turn Off Voltage (V_{SHDN_H}/ V_{SHDN_L})
The IC is active if the shutdown terminal is applied more than Turn On Voltage (V_{SHDN_H}).
The IC is shutdown if the shutdown terminal is applied less than Turn Off Voltage (V_{SHDN_L}).

Typical Performance Curves

○TLR341G

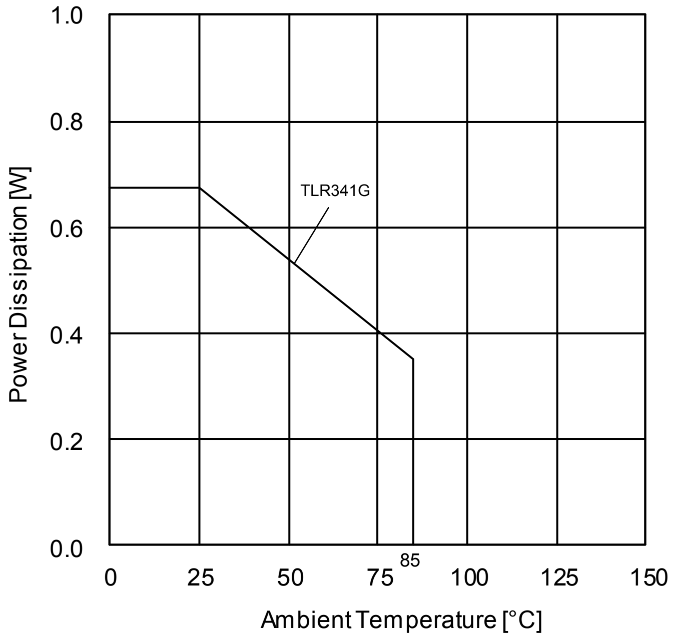


Figure 1. Power Dissipation vs Ambient Temperature (Derating Curve)

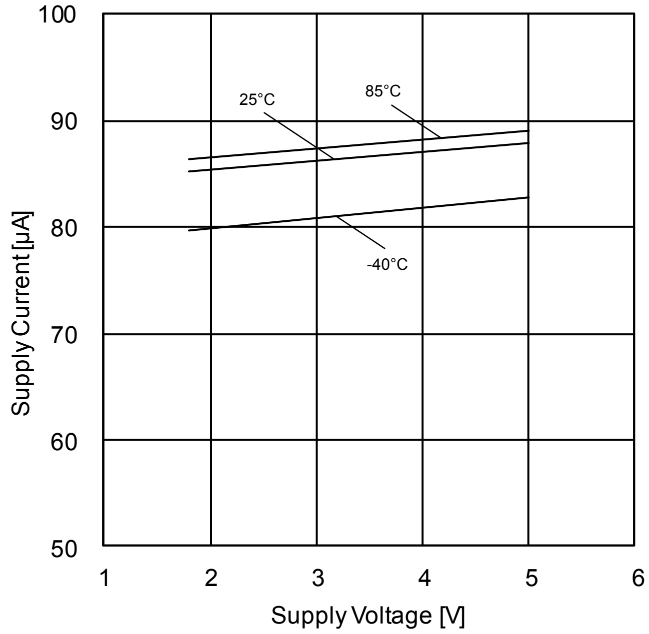


Figure 2. Supply Current vs Supply Voltage

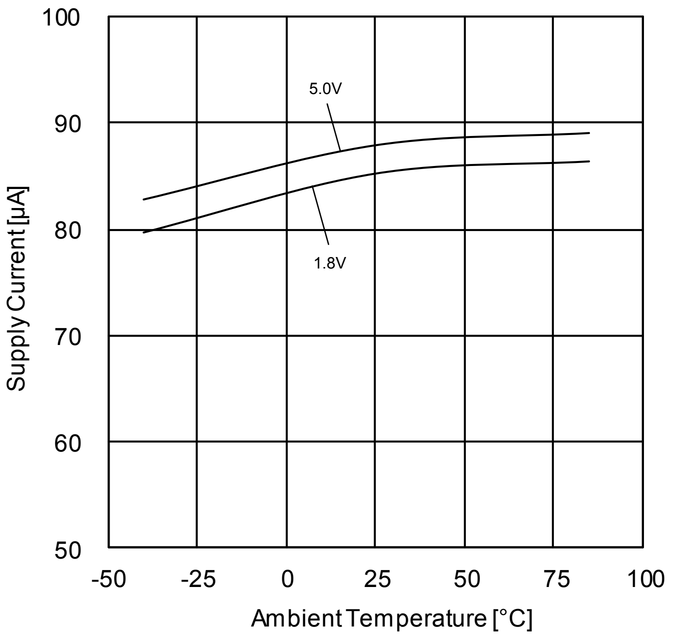


Figure 3. Supply Current vs Ambient Temperature

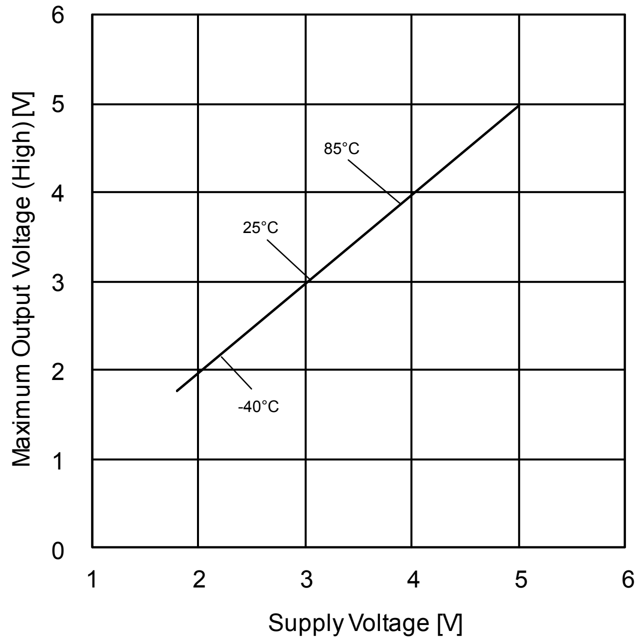


Figure 4. Maximum Output Voltage High vs Supply Voltage (R_L=2kΩ)

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

Typical Performance Curves – continued

○TLR341G

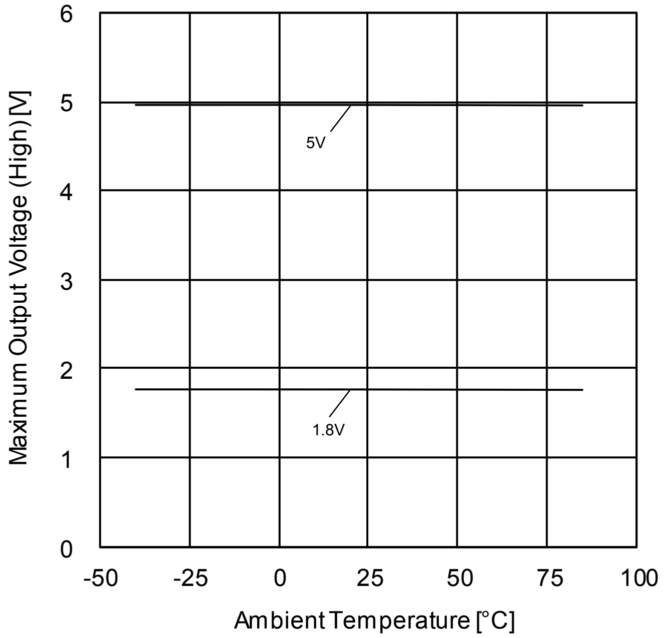


Figure 5. Maximum Output Voltage High vs Ambient Temperature (R_L=2kΩ)

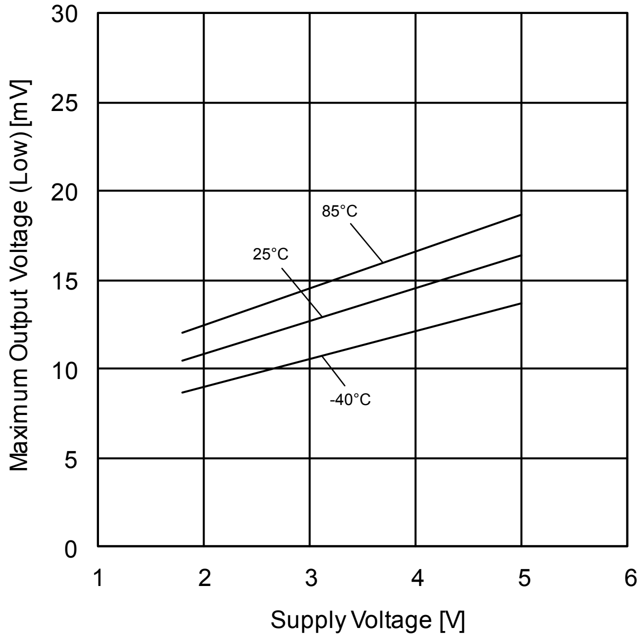


Figure 6. Maximum Output Voltage Low vs Supply Voltage (R_L=2kΩ)

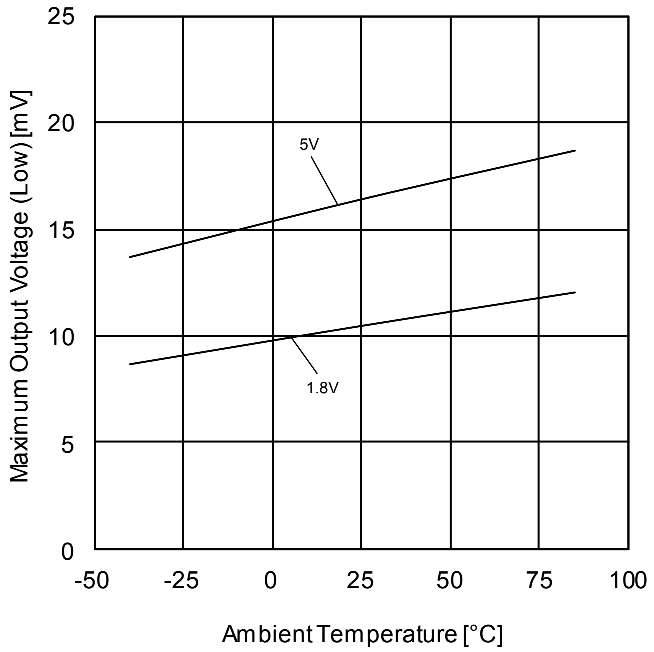


Figure 7. Maximum Output Voltage (Low) vs Ambient Temperature (R_L=2kΩ)

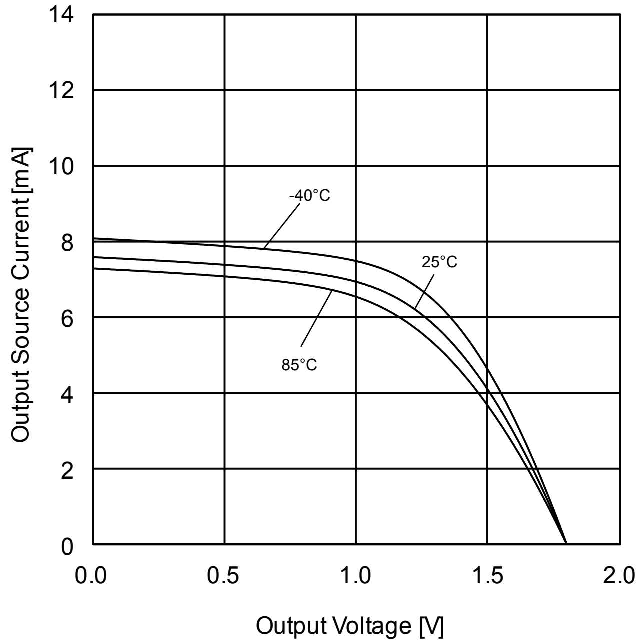


Figure 8. Output Source Current vs Output Voltage (V_{DD}=1.8V)

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

Typical Performance Curves – continued

○TLR341G

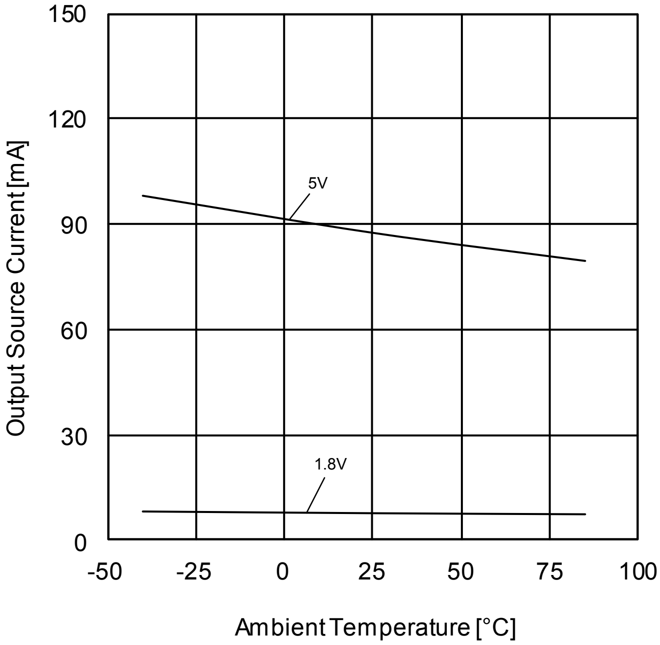


Figure 9. Output Source Current vs Ambient Temperature (V_{OUT}=0V)

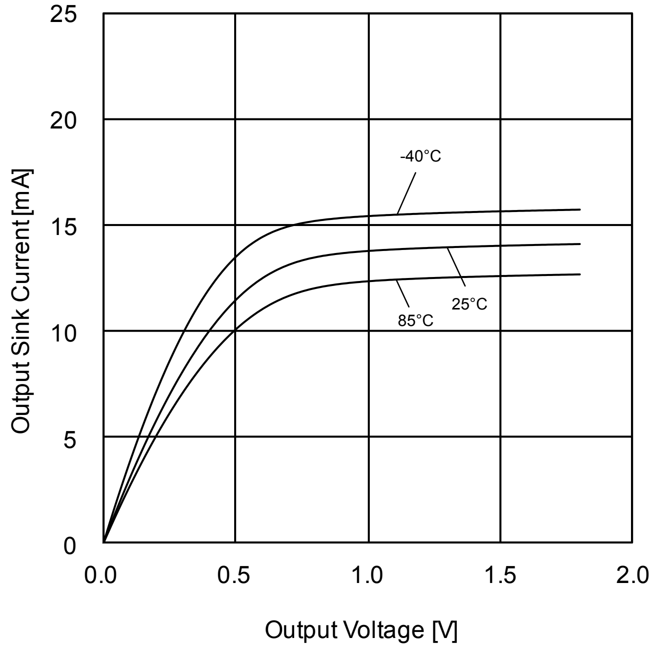


Figure 10. Output Sink Current vs Output Voltage (V_{DD}=1.8V)

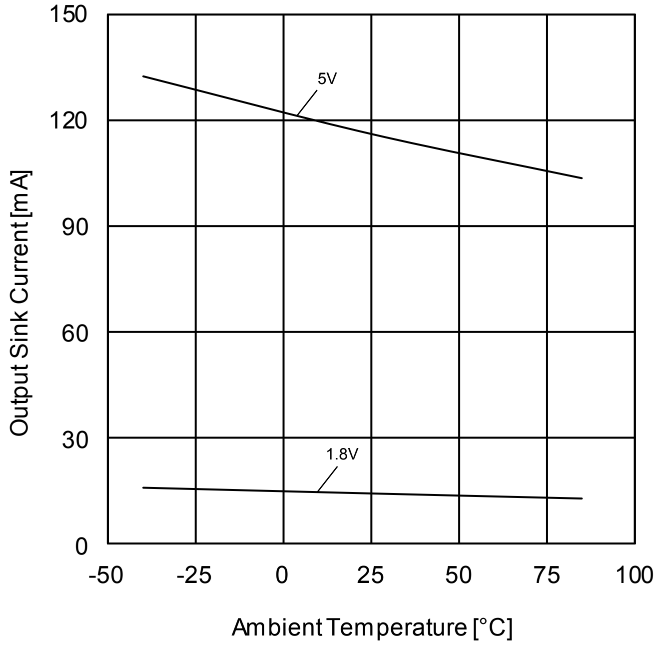


Figure 11. Output Sink Current vs Ambient Temperature (V_{OUT}=V_{DD})

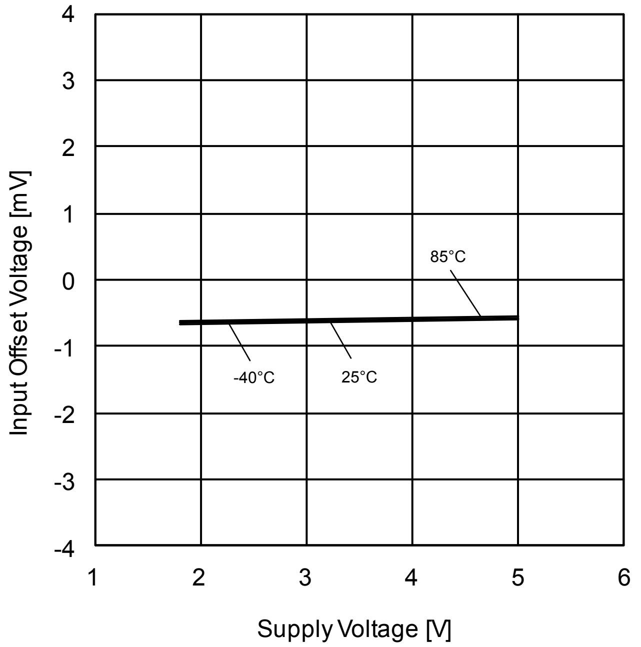


Figure 12. Input Offset Voltage vs Supply Voltage

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

Typical Performance Curves – continued

○TLR341G

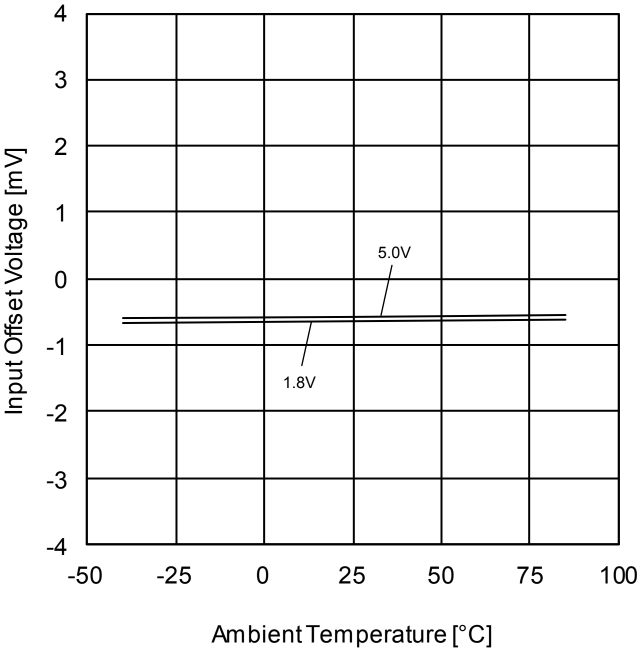


Figure 13. Input Offset Voltage vs Ambient Temperature

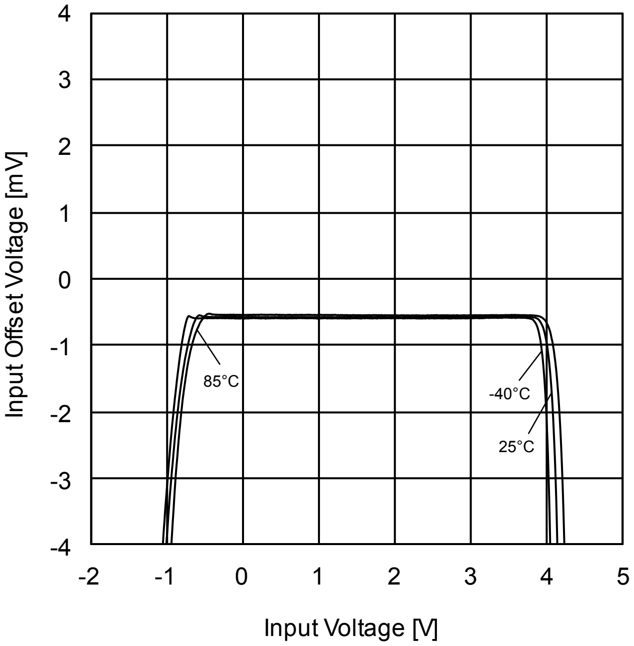


Figure 14. Input Offset Voltage vs Input Voltage (V_{DD}=5V)

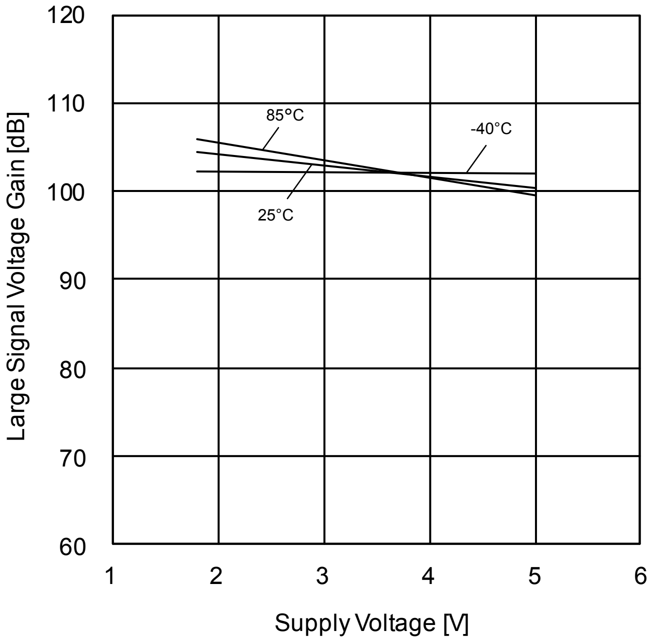


Figure 15. Large Signal Voltage Gain vs Supply Voltage (R_L=2kΩ)

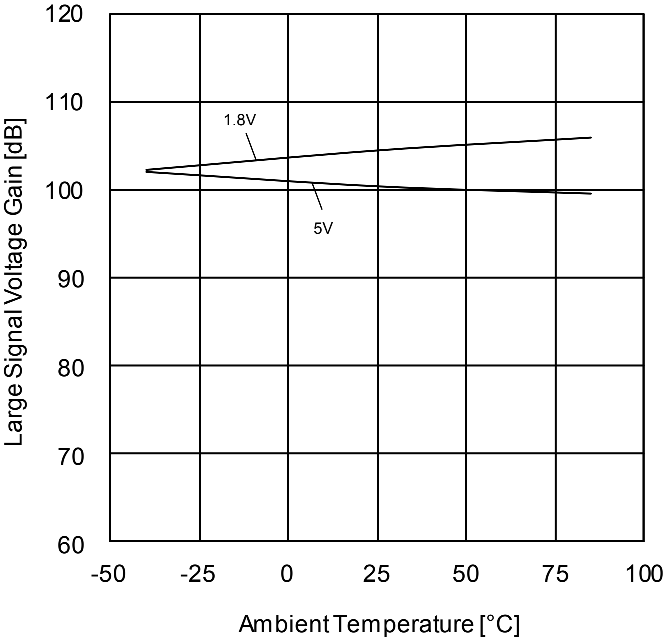


Figure 16. Large Signal Voltage Gain vs Ambient Temperature (R_L=2kΩ)

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

Typical Performance Curves – continued

○TLR341G

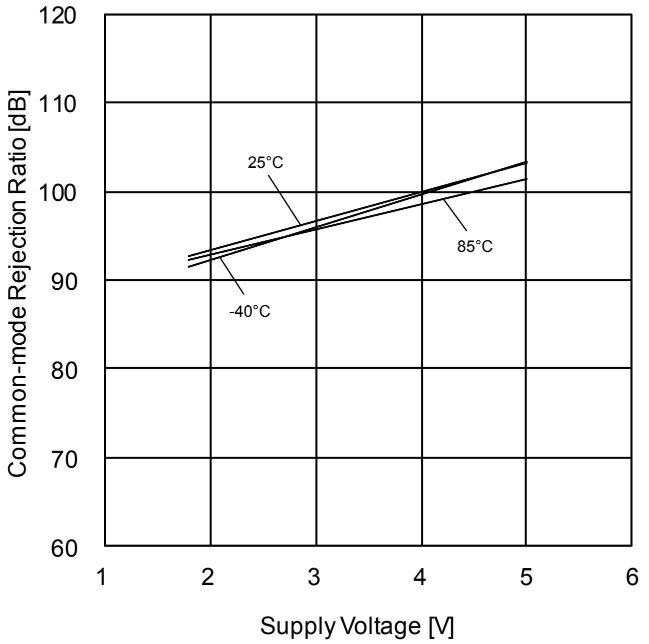


Figure 17. Common-mode Rejection Ratio vs Supply Voltage (V_{DD}=1.8V)

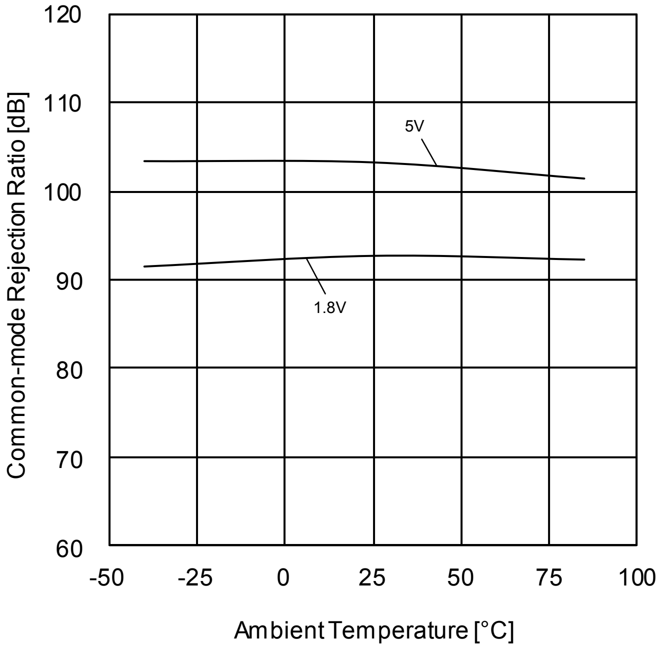


Figure 18. Common-mode Rejection Ratio vs Ambient Temperature

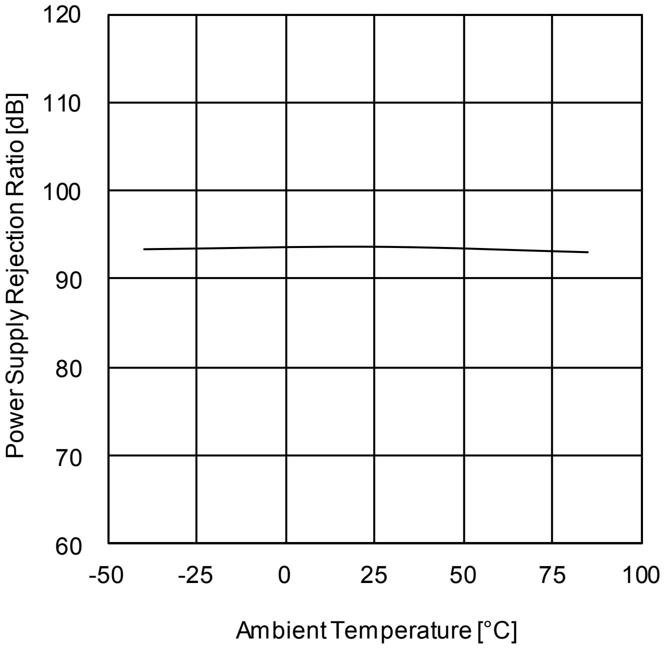


Figure 19. Power Supply Rejection Ratio vs Ambient Temperature (V_{DD}=1.8V to 5.0V)

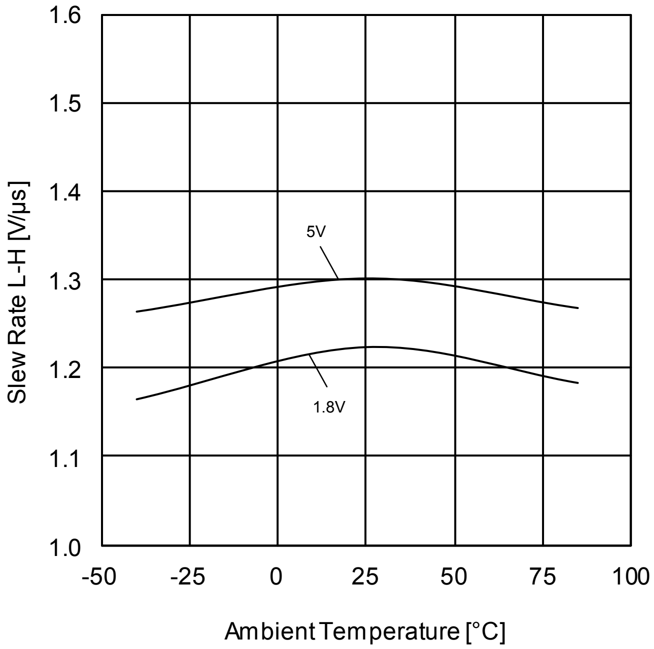


Figure 20. Slew Rate L-H vs Ambient Temperature

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

Typical Performance Curves – continued

○TLR341G

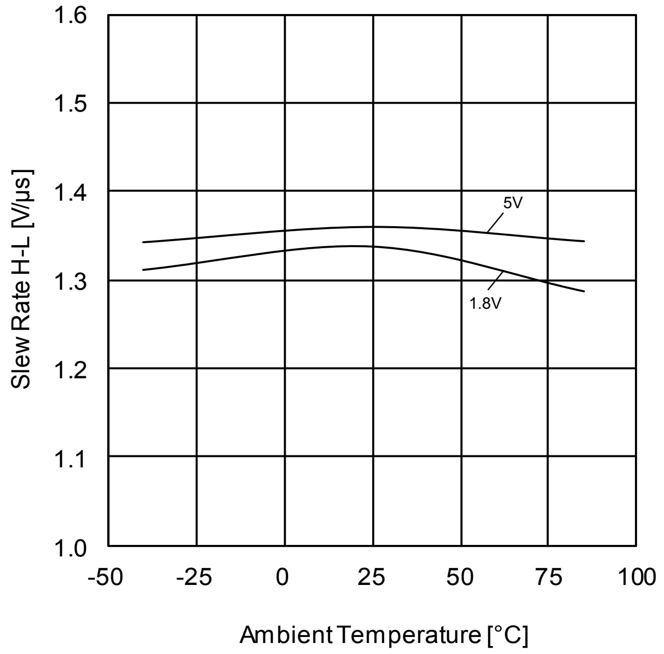


Figure 21. Slew Rate H-L vs Ambient Temperature

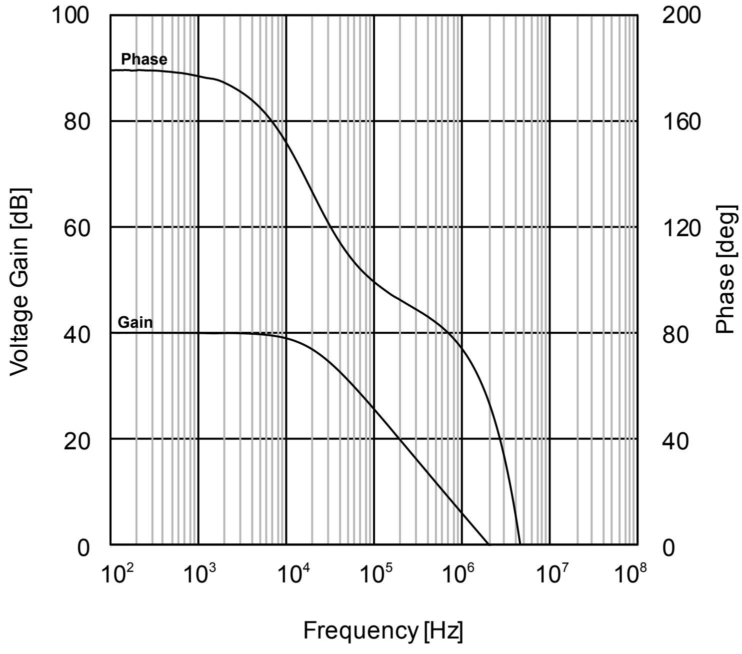


Figure 22. Voltage Gain, Phase vs Frequency (V_{DD}=1.8V, T_A=25°C)

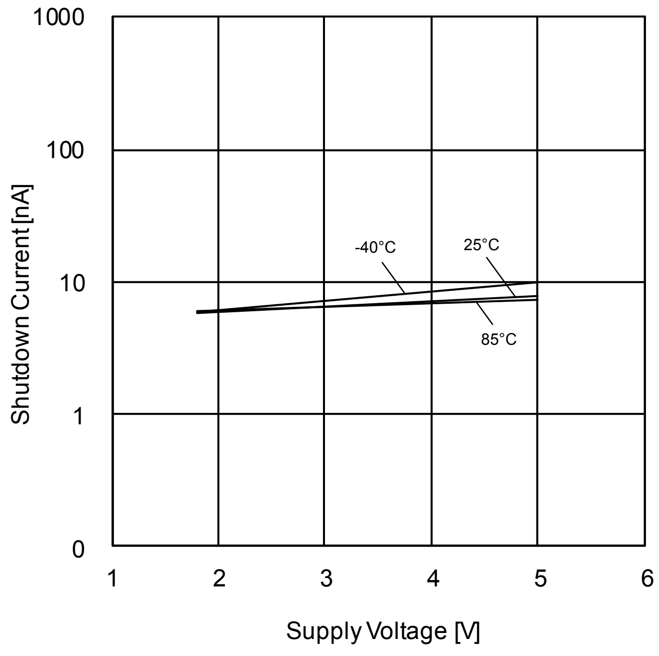


Figure 23. Shutdown Current vs Supply Voltage ($V_{\overline{SHDN}}$=0V)

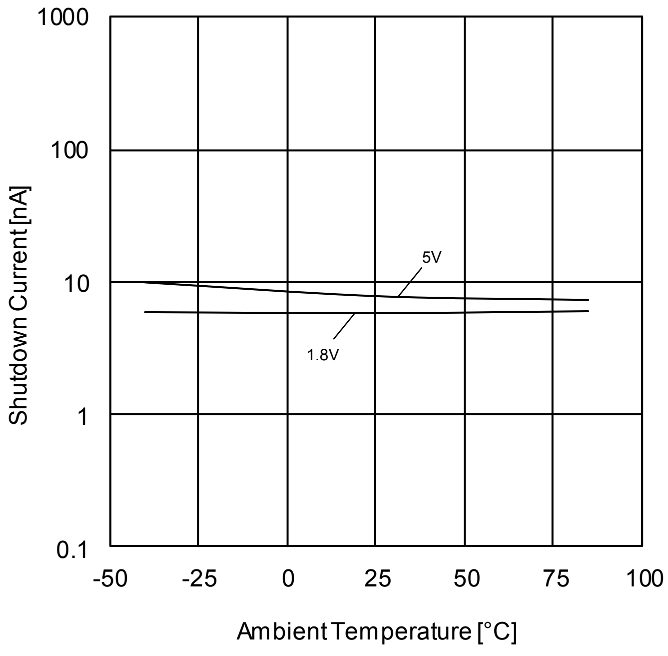


Figure 24. Shutdown Current vs Ambient Temperature ($V_{\overline{SHDN}}$=0V)

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

Typical Performance Curves – continued

○TLR341G

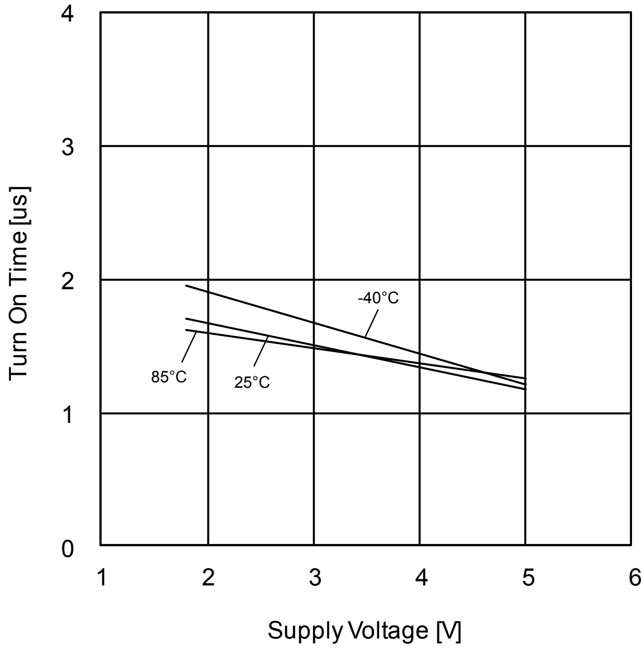


Figure 25. Turn On Time vs Supply Voltage

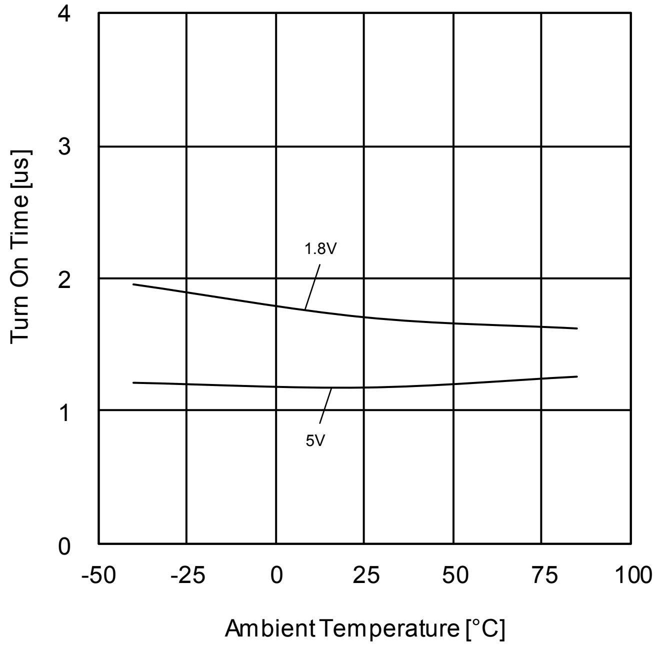


Figure 26. Turn On Time vs Ambient Temperature

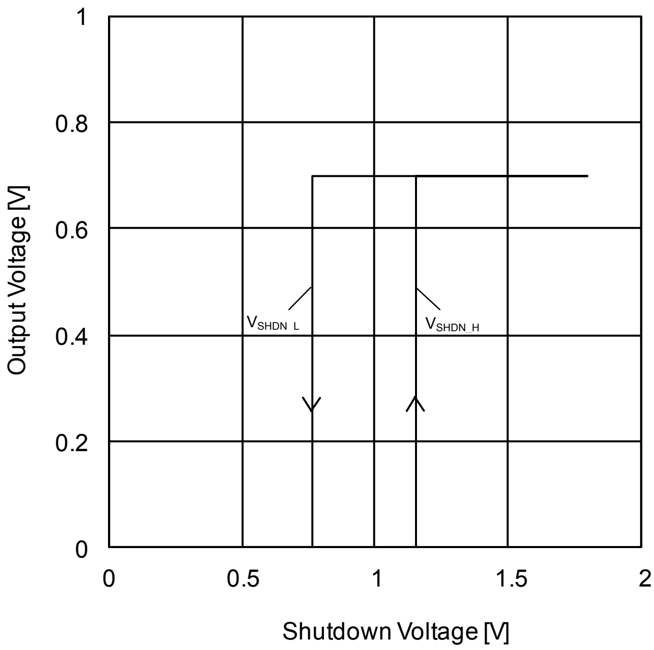


Figure 27. Output Voltage vs Shutdown Voltage
(V_{DD}=1.8V, A_V=0dB, V_{+IN}=0.7V, T_A=25°C)

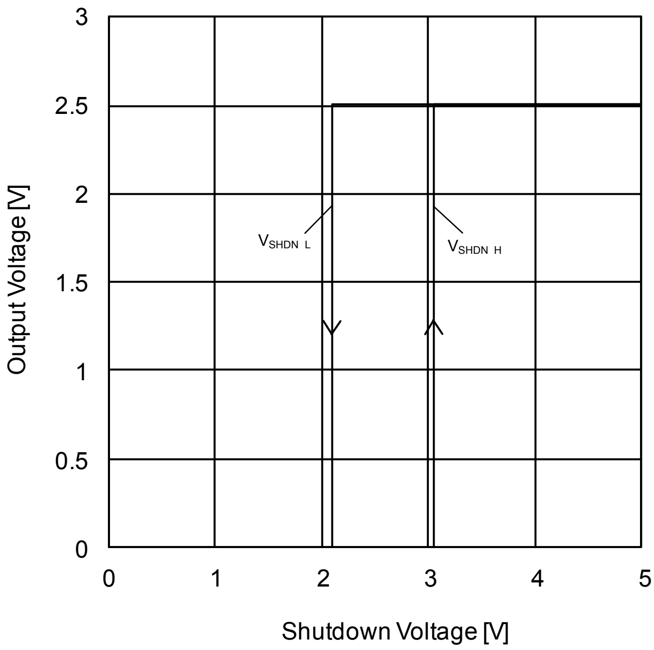


Figure 28. Output Voltage vs Shutdown Voltage
(V_{DD}=5V, A_V=0dB, V_{+IN}=2.5V, T_A=25°C)

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

Typical Performance Curves – continued

○TLR342xxx

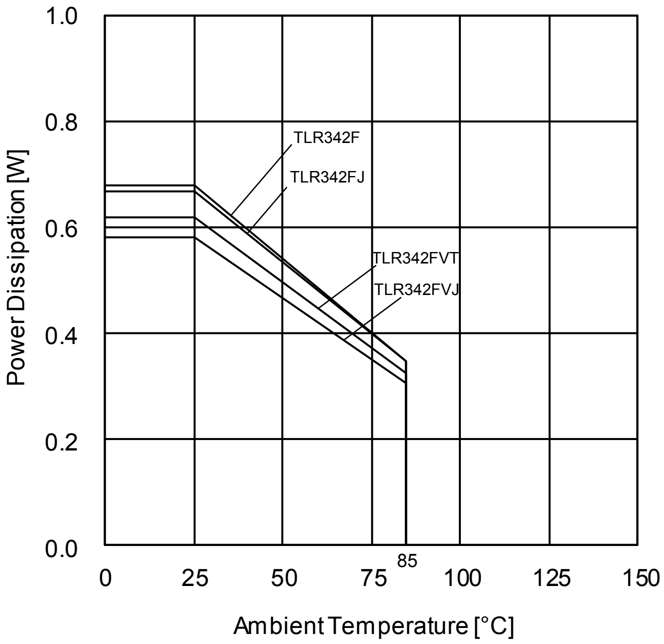


Figure 29. Power Dissipation vs Ambient Temperature (Derating Curve)

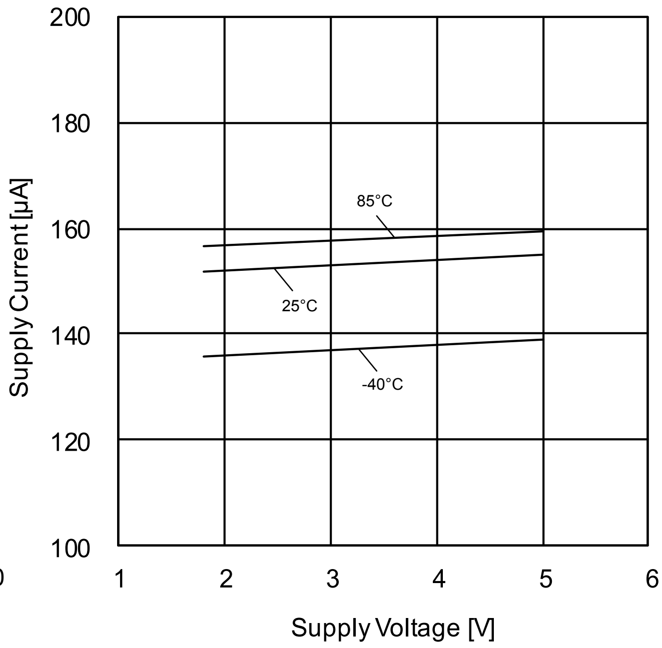


Figure 30. Supply Current vs Supply Voltage

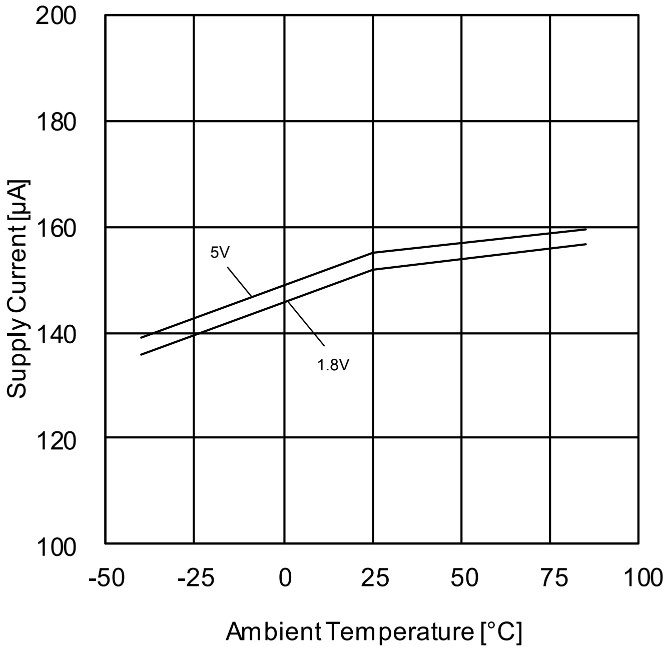


Figure 31. Supply Current vs Ambient Temperature

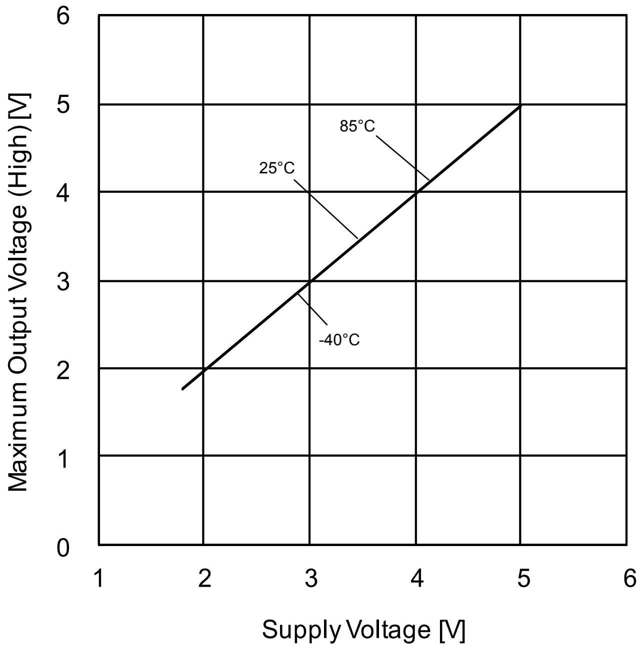


Figure 32. Maximum Output Voltage High vs Supply Voltage (R_L=2kΩ)

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

Typical Performance Curves – continued

○TLR342xxx

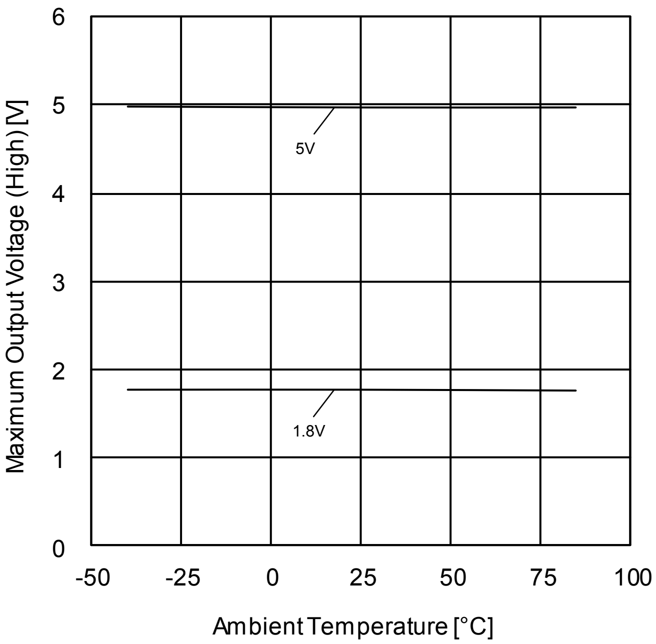


Figure 33. Maximum Output Voltage High vs Ambient Temperature (R_L=2kΩ)

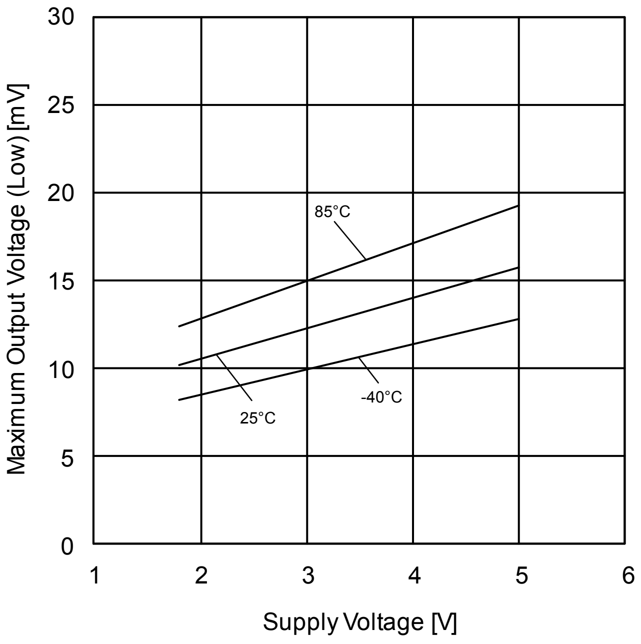


Figure 34. Maximum Output Voltage Low vs Supply Voltage (R_L=2kΩ)

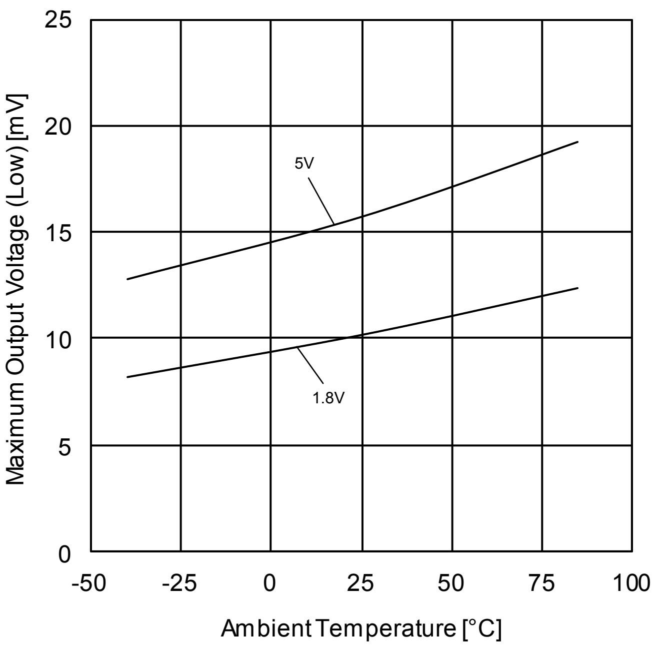


Figure 35. Maximum Output Voltage (Low) vs Ambient Temperature (R_L=2kΩ)

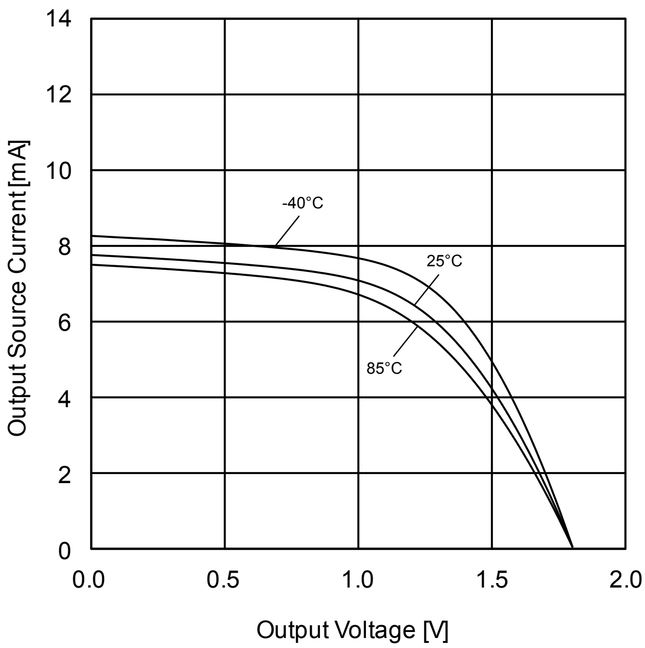


Figure 36. Output Source Current vs Output Voltage (V_{DD}=1.8V)

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

Typical Performance Curves – continued

○TLR342xxx

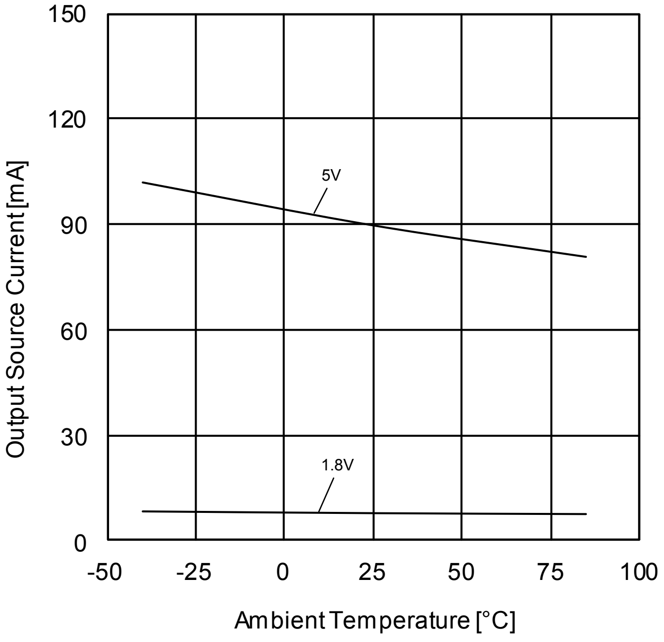


Figure 37. Output Source Current vs Ambient Temperature (V_{OUT}=0V)

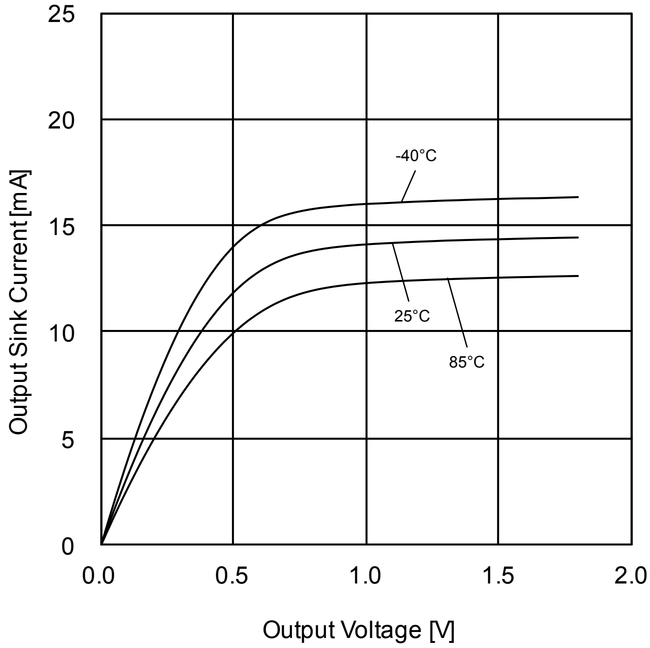


Figure 38. Output Sink Current vs Output Voltage (V_{DD}=1.8V)

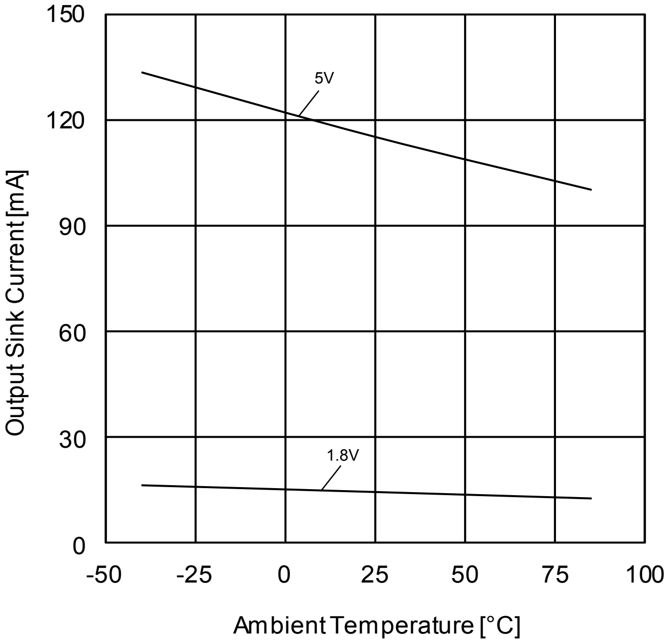


Figure 39. Output Sink Current vs Ambient Temperature (V_{OUT}=V_{DD})

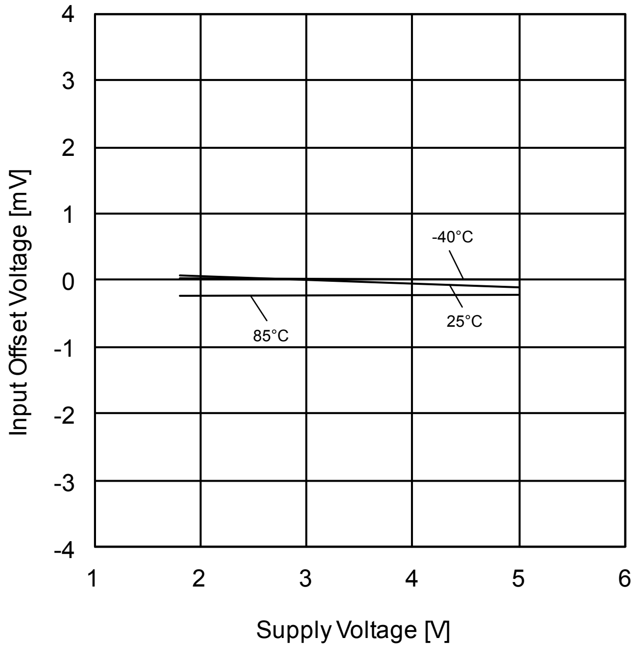


Figure 40. Input Offset Voltage vs Supply Voltage

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

Typical Performance Curves – continued

○TLR342xxx

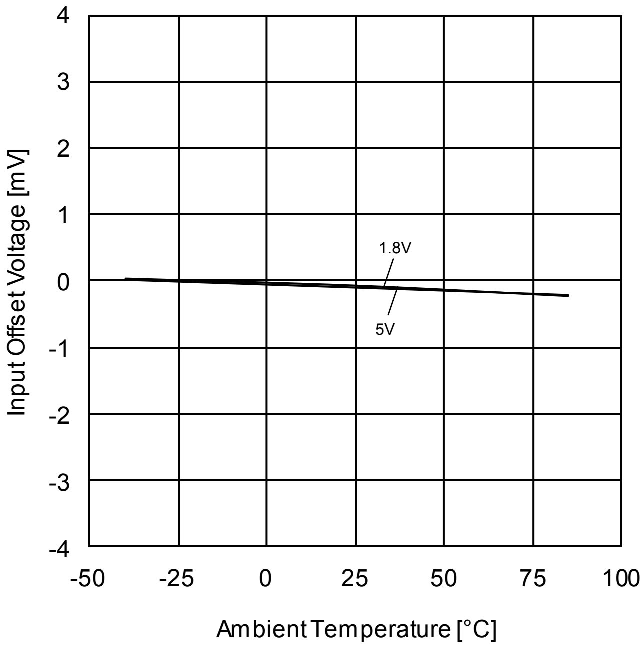


Figure 41. Input Offset Voltage vs Ambient Temperature

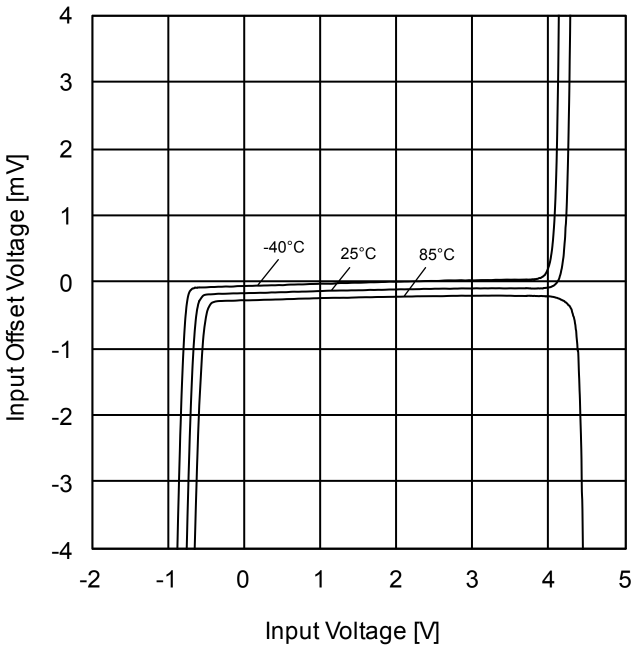


Figure 42. Input Offset Voltage vs Input Voltage (V_{DD}=5V)

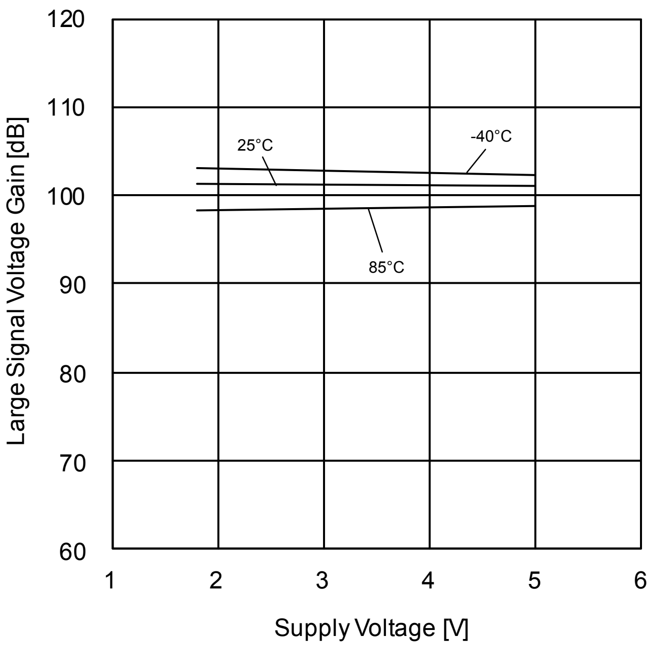


Figure 43. Large Signal Voltage Gain vs Supply Voltage (R_L=2kΩ)

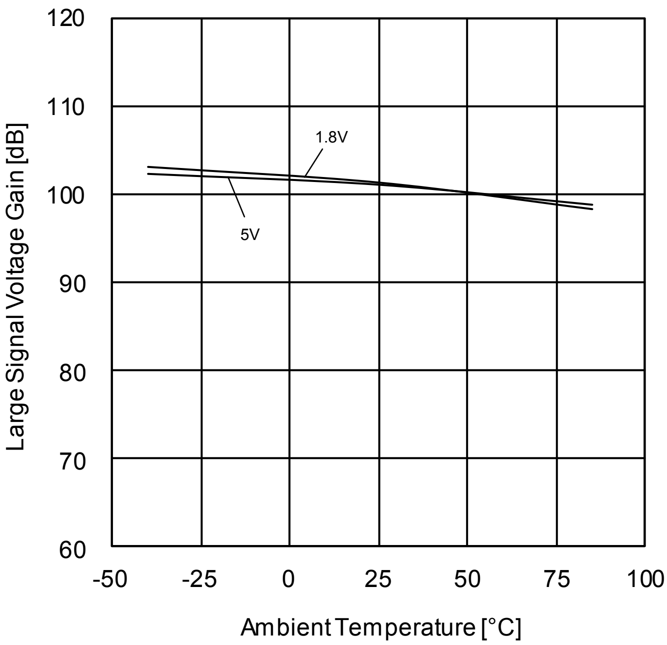


Figure 44. Large Signal Voltage Gain vs Ambient Temperature (R_L=2kΩ)

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

Typical Performance Curves – continued

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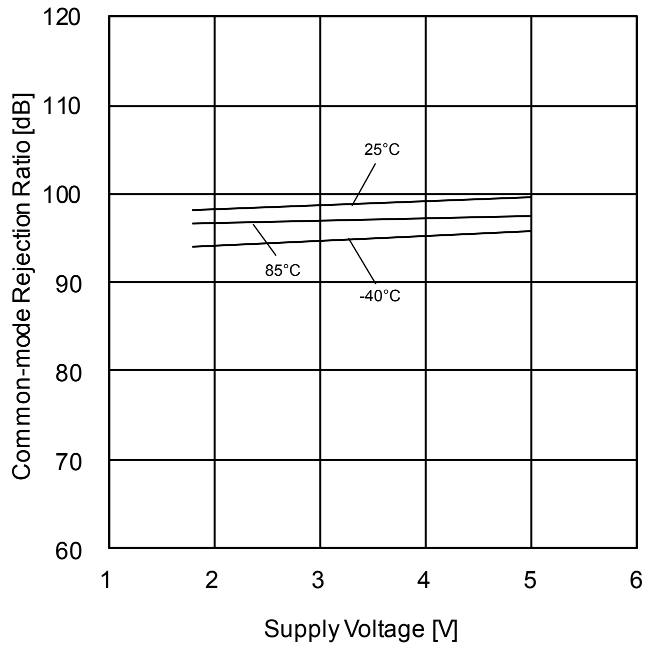

Figure 45. Common-mode Rejection Ratio vs Supply Voltage (V_{DD}=1.8V)

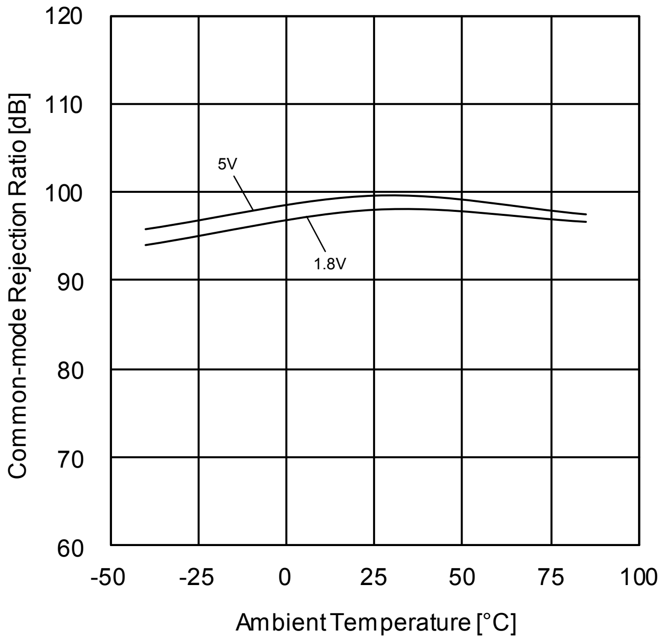

Figure 46. Common-mode Rejection Ratio vs Ambient Temperature

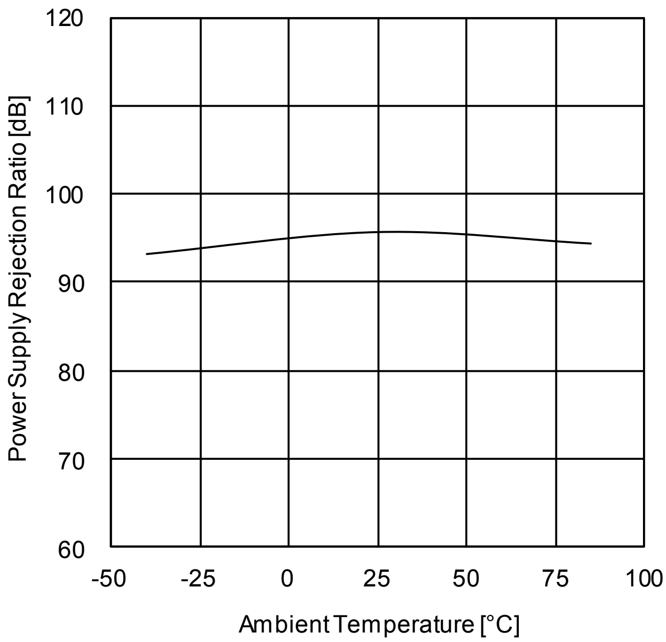

Figure 47. Power Supply Rejection Ratio vs Ambient Temperature (V_{DD}=1.8V to 5.0V)

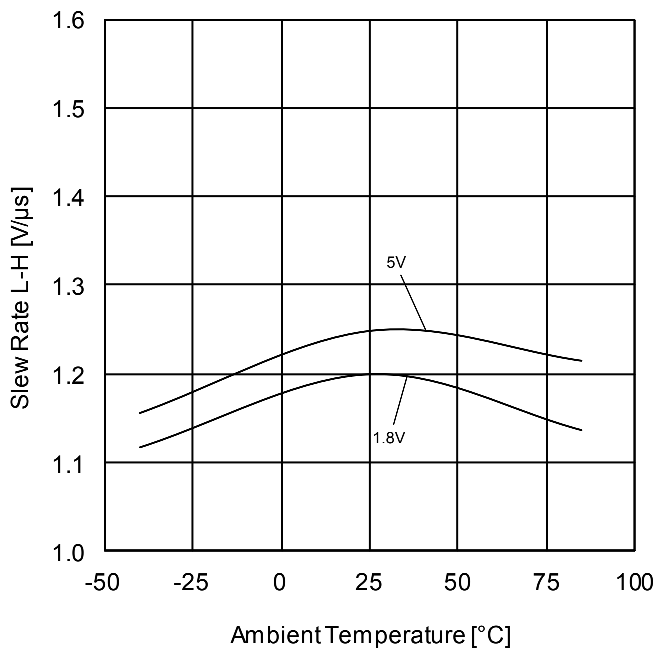

Figure 48. Slew Rate L-H vs Ambient Temperature

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

Typical Performance Curves – continued

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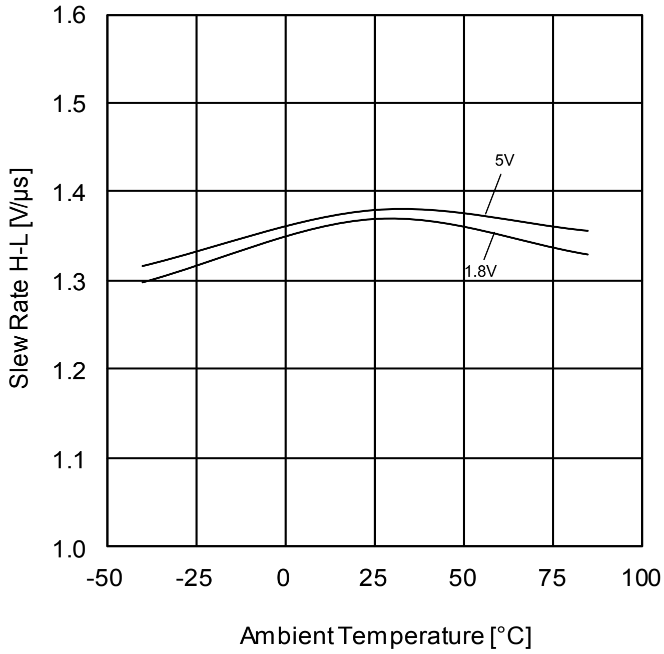

Figure 49. Slew Rate H-L vs Ambient Temperature

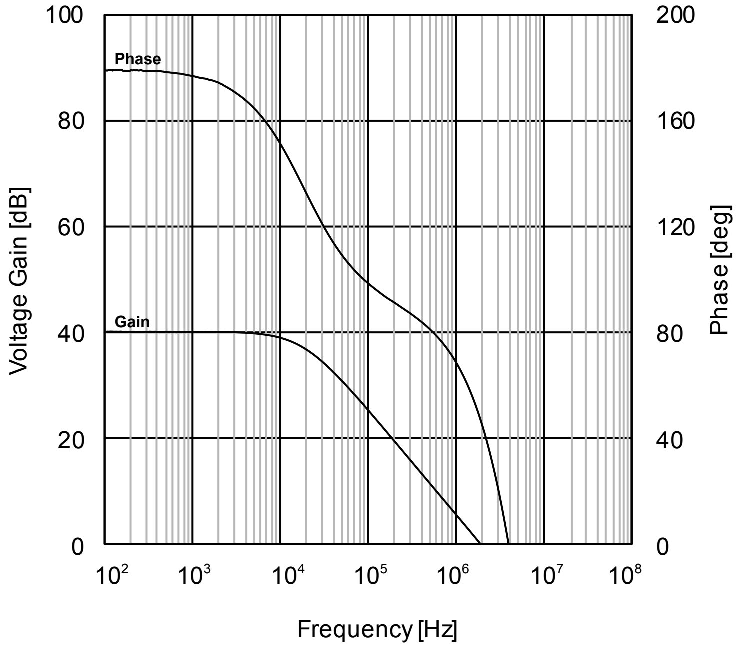

Figure 50. Voltage Gain, Phase vs Frequency (V_{DD}=1.8V, T_A=25°C)

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

Typical Performance Curves – continued

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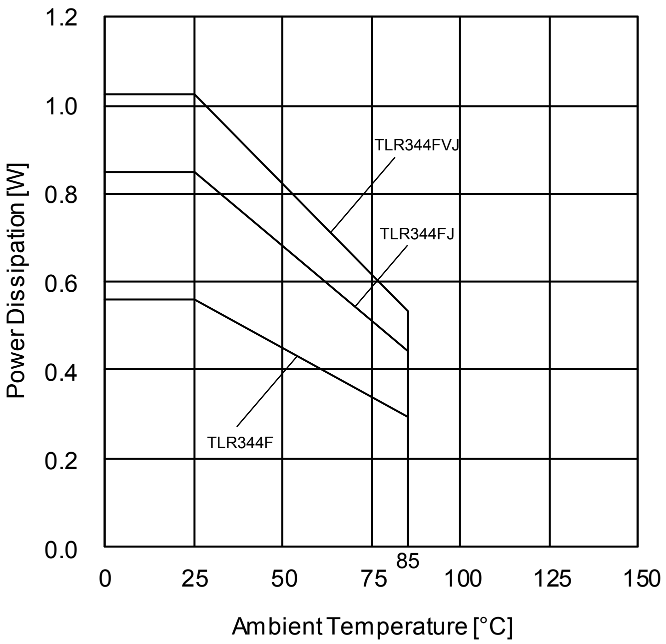

Figure 51. Power Dissipation vs Ambient Temperature (Derating Curve)

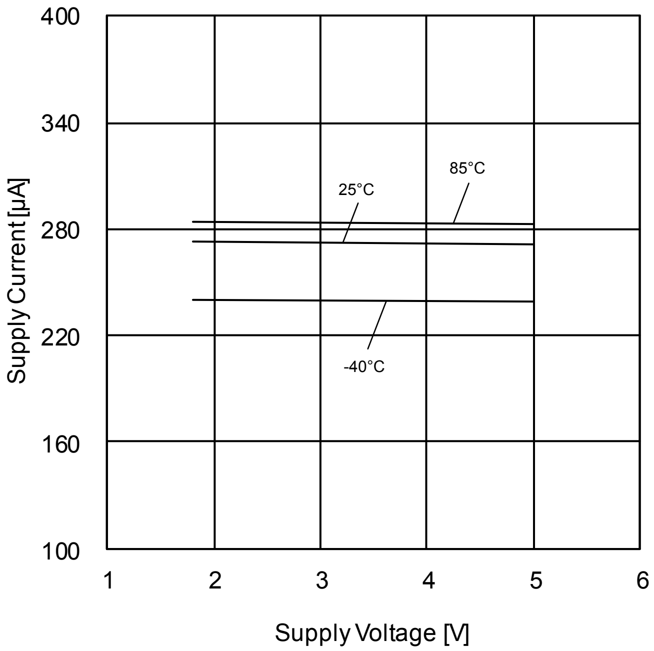

Figure 52. Supply Current vs Supply Voltage

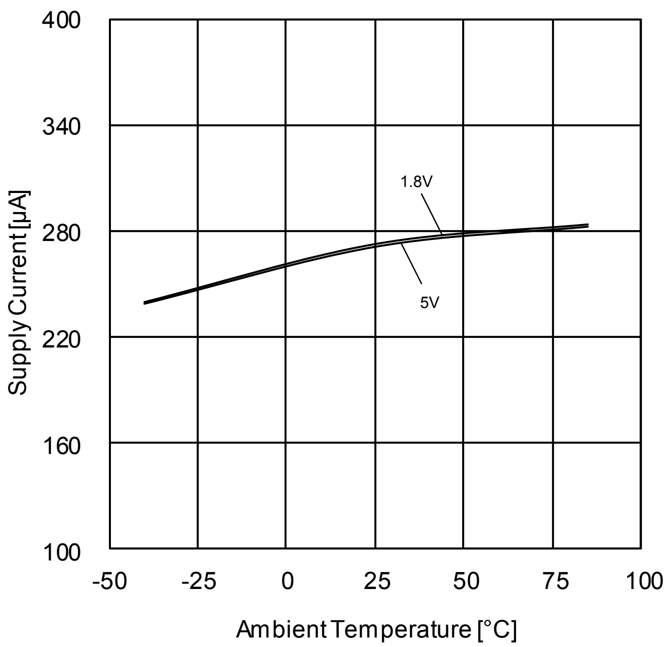

Figure 53. Supply Current vs Ambient Temperature

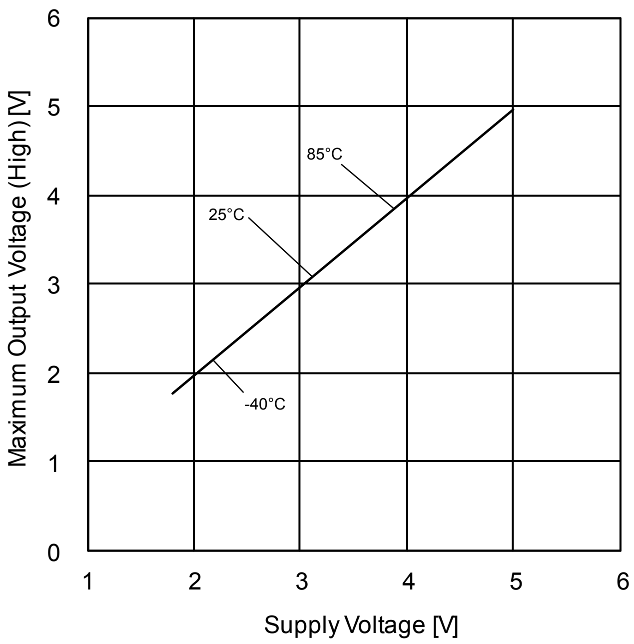

Figure 54. Maximum Output Voltage High vs Supply Voltage (R_L=2kΩ)

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