

# AN8001FHK

## Gradation voltage generation IC for liquid crystal display

### ■ Overview

The AN8001FHK is a gradation voltage generation IC for liquid crystal displays and designed for 64-gradation LCDs. It is incorporating an 1.23 V reference voltage circuit, 10 gradation output buffer amplifier circuits, and a COM amplifier circuit.

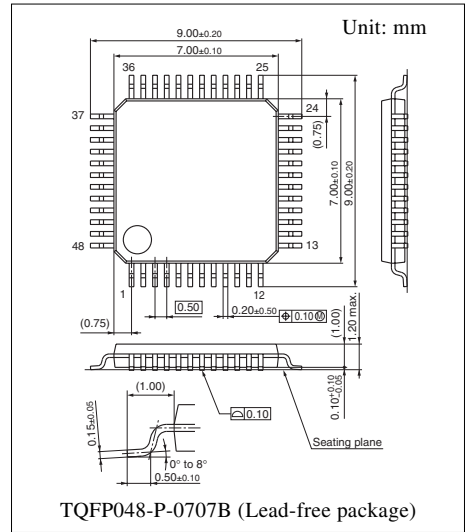
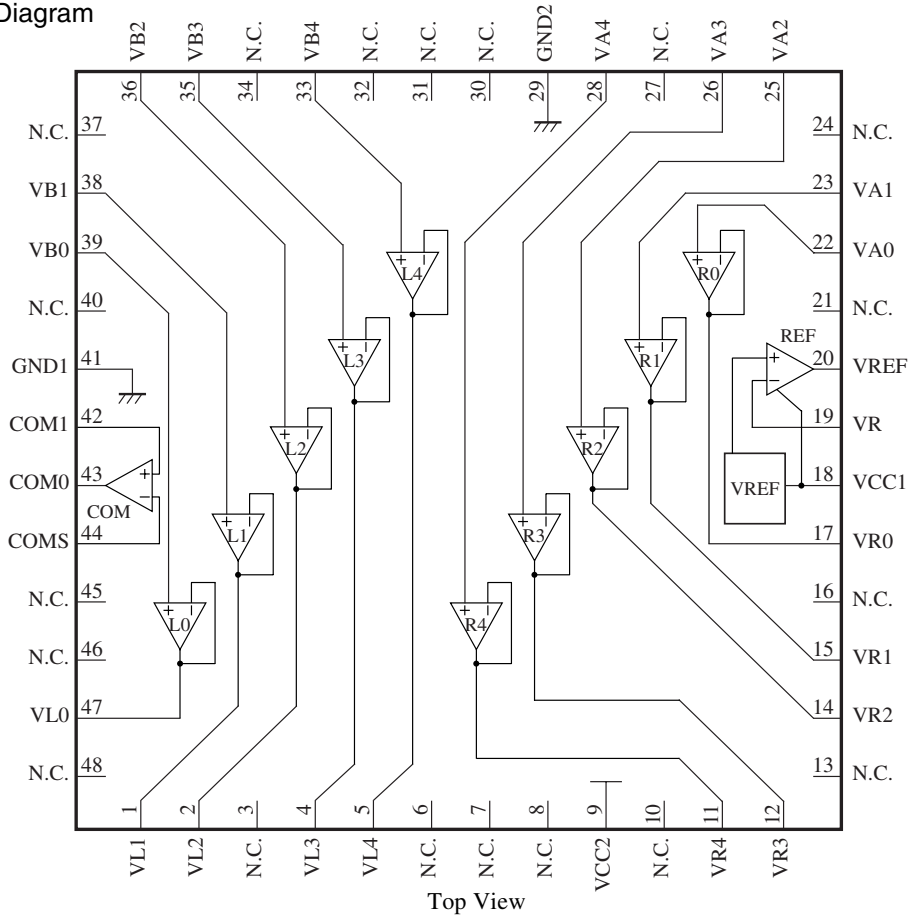
### ■ Features

- Incorporating a high precision reference voltage source: 1.23 V (typ.)
- Wide dynamic range of buffer amplifiers and it is possible to provide an output from  $V_{CC} - 0.2$  V (the highest stage) to GND + 0.2 V (the lowest stage).
- Large COM-amplifier drive current:  $\pm 100$  mA (max.)

### ■ Applications

- Gradation power supply source for LCDs

### ■ Block Diagram



### ■ Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Supply voltage	$V_{CC}$	14.2	V
Supply current	$I_{CC}$	—	mA
REF amplifier output source current	$I_{Osource}$	-5	mA
R0 amplifier output source current	$I_{O-R0}$	-15	mA
R0 amplifier output sink current	$I_{O+R0}$	0.1	mA
R1 amplifier output source current	$I_{O-R1}$	-15	mA
R1 amplifier output sink current	$I_{O+R1}$	0.1	mA
R/2/3/4, L2/3/4 amplifier output source current	$I_{O-R2-L2}$	-15	mA
R/2/3/4, L2/3/4 amplifier output sink current	$I_{O+R2-L2}$	15	mA
L1 amplifier output source current	$I_{O-L1}$	-0.05	mA
L1 amplifier output sink current	$I_{O+L1}$	15	mA
L0 amplifier output source current	$I_{O-L0}$	-0.05	mA
L0 amplifier output sink current	$I_{O+L0}$	15	mA
COM amplifier output source current	$I_{O-COM}$	-100	mA
COM amplifier output sink current	$I_{O+COM}$	100	mA
Power dissipation	$P_D$	400* <sup>2</sup> 220* <sup>3</sup>	mW
Operating ambient temperature* <sup>1</sup>	$T_{opr}$	0 to +70	°C
Storage temperature* <sup>1</sup>	$T_{stg}$	-55 to +150	°C
REF amplifier maximum load capacitance	$C_{OREF}$	0.47	mF
R0/1/2/3/4, L4/3/2/1/0 amplifier maximum load capacitance	$C_{OR/L}$	0.1	μF
COM amplifier maximum load capacitance	$C_{OCOM}$	10	μF

Note) Either current or voltage should not be applied from the outside to any terminals not specified.

For the circuit current, (+) is current flowing into the IC and (-) is current flowing out of the IC.

Set the input voltage of each amplifier within the range of the output voltage.

\*1 : All items are at  $T_a = 25^\circ\text{C}$ , except for the operating ambient temperature and storage temperature parameters.

\*2 :  $T_a = 25^\circ\text{C}$

\*3 :  $T_a = 70^\circ\text{C}$

### ■ Recommended Operating Range

Parameter	Symbol	Range	Unit
Supply voltage	$V_{CC}$	7 to 14	V

**■ Electrical Characteristics at  $T_a = 25^\circ\text{C}$** 

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
All device						
Circuit current	$I_{CC}$		—	3.5	6	mA
Reference voltage	$V_{REF}$		1.19	1.23	1.27	V
Input bias current	$I_B$		—	—	500	nA
REF amplifier block						
Operating upper limit voltage 1	$V_{H1}$	Discharge current : 2 mA Connect 0.1 $\mu\text{F}$ or more for oscillation prevention	$V_{CC}$ - 0.2 V	—	—	V
Operating upper limit voltage 2	$V_{H2}$	Discharge current : 3 mA Connect 0.1 $\mu\text{F}$ or more for oscillation prevention	$V_{CC}$ - 0.3 V	—	—	V
Operating lower limit voltage	$V_L$	Connect 0.1 $\mu\text{F}$ or more for oscillation prevention	—	—	$V_{REF}$	V
R0 amplifier block						
Output upper limit voltage 1	$V_{H,R01}$	Discharge current : 10 mA	$V_{CC}$ - 0.2 V	—	—	V
Output upper limit voltage 2	$V_{H,R02}$	Discharge current : 15 mA	$V_{CC}$ - 0.25V	—	—	V
Output lower limit voltage	$V_{L,R0}$	Sink current : 0.1 mA	—	—	$V_{CC}$ - 3 V	V
Offset voltage	$V_{OFFR0}$		—	—	10	mV
R1 amplifier block						
Output upper limit voltage	$V_{H,R1}$	Discharge current : 15 mA	$V_{CC}$ - 0.7 V	—	—	V
Output lower limit voltage	$V_{L,R1}$	Sink current : 0.1 mA	—	—	$V_{CC}/2$	V
Offset voltage	$V_{OFFR1}$		—	—	10	mV
R2/R3/R4/L2/L3/L4 amplifier block						
Output upper limit voltage 1	$V_{H,R2-R4}$	Discharge current : 15 mA	$V_{CC}$ - 1.5 V	—	—	V
Output lower limit voltage 1	$V_{L,R2-R4}$	Sink current : 15 mA	—	—	2	V
Output upper limit voltage 2	$V_{H,L2-L4}$	Discharge current : 15 mA	$V_{CC}$ - 2 V	—	—	V
Output lower limit voltage 2	$V_{L,L2-L4}$	Sink current : 15 mA	—	—	1.5	V
Offset voltage	$V_{OFF234}$		—	—	10	mV
L1 amplifier block						
Output upper limit voltage	$V_{H,L1}$	Discharge current : 50 $\mu\text{A}$	$V_{CC}/2$	—	—	V
Output lower limit voltage	$V_{L,L1}$	Sink current : 15 mA	—	—	0.7	V
Offset voltage	$V_{OFFL1}$		—	—	15	mV

### ■ Electrical Characteristics at $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
L0 amplifier block						
Output upper limit voltage	$V_{H,L0}$	Discharge current : 50 $\mu\text{A}$	3	—	—	V
Output lower limit voltage	$V_{L,L0}$	Sink current : 15 mA	—	—	0.2	V
Offset voltage	$V_{OFFL0}$		—	—	15	mV
COM amplifier block						
Output upper limit voltage	$V_{H,COM}$	Discharge current : 100 mA	$V_{CC}$ -2.5 V	—	—	V
Output lower limit voltage	$V_{L,COM}$	Sink current : 100 mA	—	—	2.5	V
Offset voltage	$V_{OFFCOM}$		—	—	10	mV

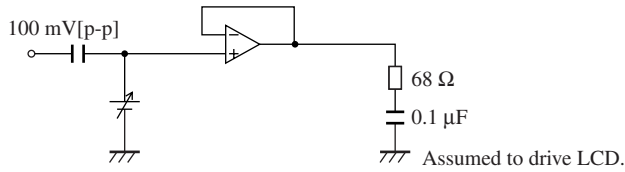
#### • Design reference data

Note) The following characteristics are the reference values for design and not guaranteed values.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Recovery time	Ri-Time COM		—	—	2	$\mu\text{S}$
REF amplifier block Supply voltage rejection ratio	$\text{PSRR}_{\text{REF}}$	f = 10 kHz to 500 kHz 200 mV[p-p], 0.1 $\mu\text{F}$ connection	—	—	-40	dB
R0 amplifier block Supply voltage rejection ratio	$\text{PSRR}_{\text{R0}}$	f = 10 kHz to 500 kHz 200 mV[p-p], 0.01 $\mu\text{F}$ connection	—	—	-10	dB
R1 amplifier block Supply voltage rejection ratio	$\text{PSRR}_{\text{R1}}$	f = 10 kHz to 500 kHz 200 mV[p-p], 0.01 $\mu\text{F}$ connection	—	—	-20	dB
R2/R3R/4 amplifier block Supply voltage rejection ratio	$\text{PSRR}_{\text{R234}}$	f = 10 kHz to 500 kHz 200 mV[p-p], 0.01 $\mu\text{F}$ connection	—	—	-40	dB
R2/R3R/4 amplifier block Supply voltage rejection ratio	$\text{PSRR}_{\text{L234}}$	f = 10 kHz to 500 kHz 200 mV[p-p], 0.01 $\mu\text{F}$ connection	—	—	-40	dB
L1 amplifier block Supply voltage rejection ratio	$\text{PSRR}_{\text{L1}}$	f = 10 kHz to 500 kHz 200 mV[p-p], 0.01 $\mu\text{F}$ connection	—	—	-10	dB
L0 amplifier block Supply voltage rejection ratio	$\text{PSRR}_{\text{L0}}$	f = 10 kHz to 500 kHz 200 mV[p-p], 0.01 $\mu\text{F}$ connection	—	—	-20	dB
COM amplifier block Supply voltage rejection ratio	$\text{PSRR}_{\text{COM}}$	f = 10 kHz to 500 kHz 200 mV[p-p], 0.1 $\mu\text{F}$ connection	—	—	-40	dB

■ Technical Data

● Measurement circuit for gain and phase characteristics

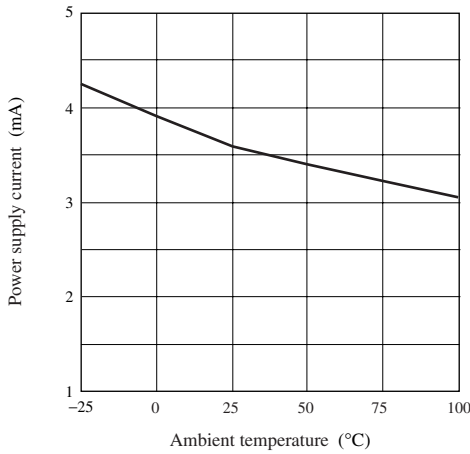


DC voltage

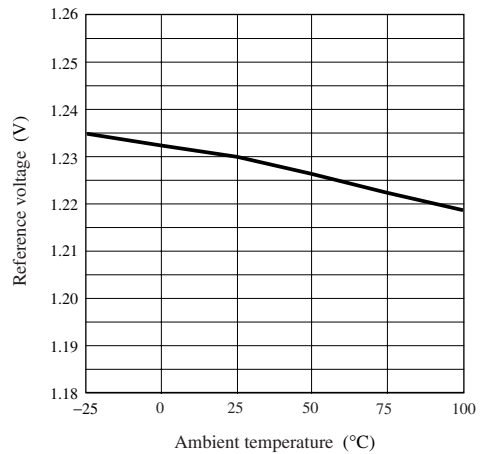
R0 DC = 9.7 V	L4 DC = 4.34 V
R1 DC = 9.01 V	L3 DC = 3.23 V
R2 DC = 7.81 V	L2 DC = 2.32 V
R3 DC = 7.12 V	L1 DC = 980 mV
R4 DC = 6.3 V	L0 DC = 210 mV

● Main characteristics

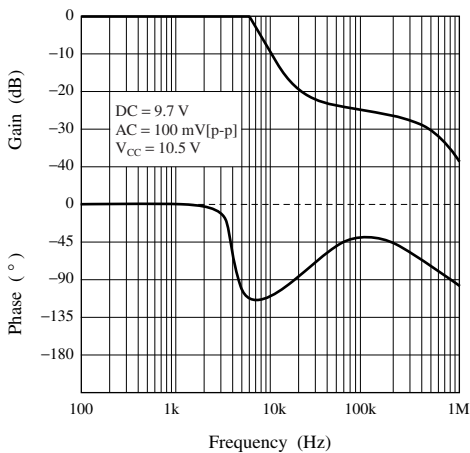
Power supply current — temperature characteristics  
( $I_{CC} - T_a$ )



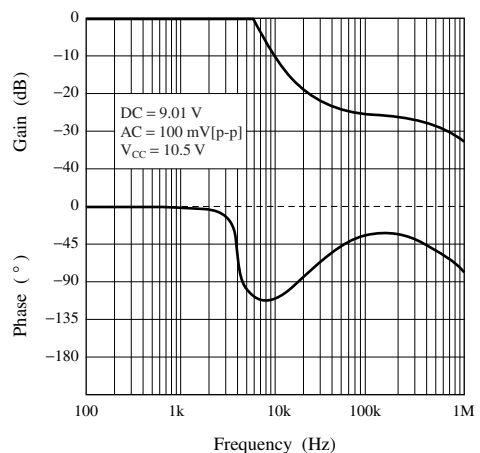
Reference voltage — temperature characteristics  
( $V_{REF} - T_a$ )



R0 amp. Gain, Phase — Frequency



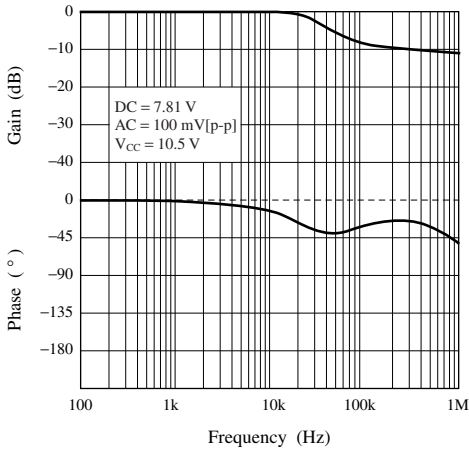
R1 amp. Gain, Phase — Frequency



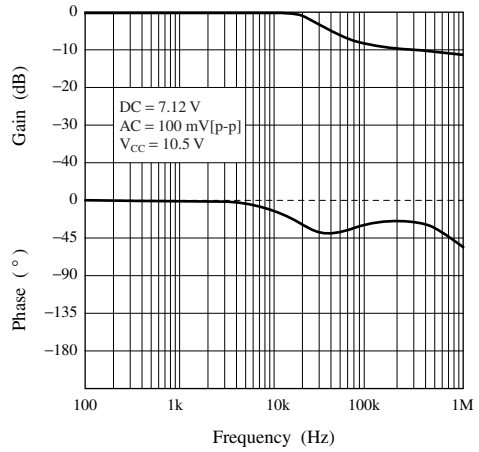
■ Technical Data (continued)

• Main characteristics (continued)

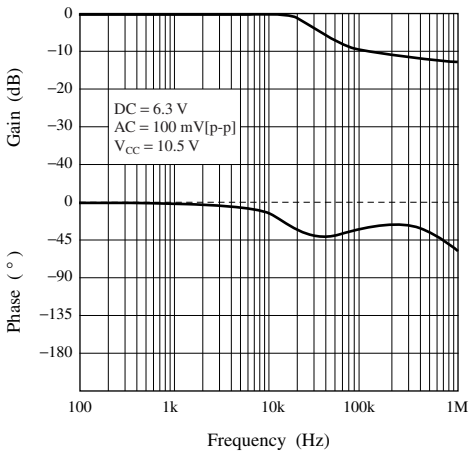
R2 amp. Gain, Phase — Frequency



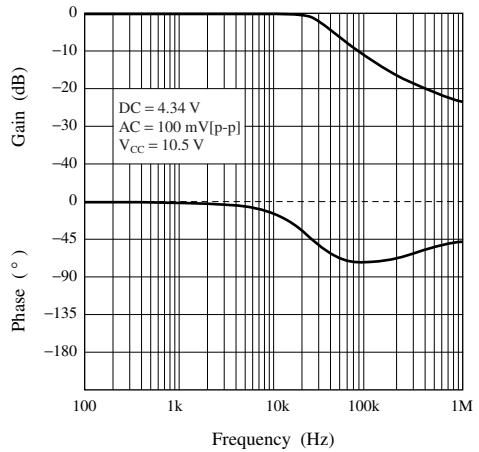
R3 amp. Gain, Phase — Frequency



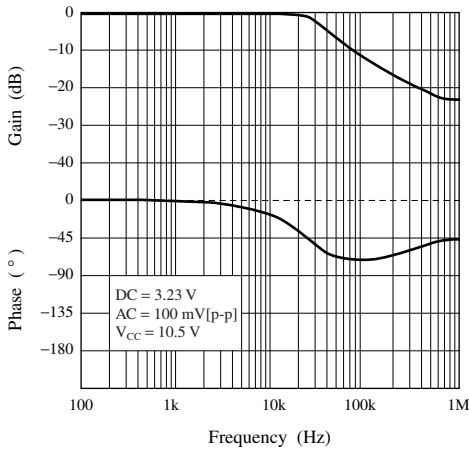
R4 amp. Gain, Phase — Frequency



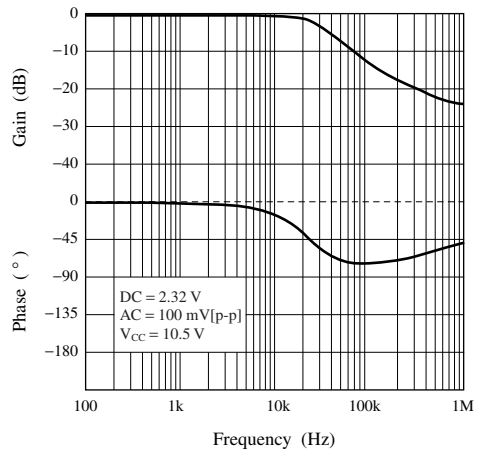
L4 amp. Gain, Phase — Frequency



L3 amp. Gain, Phase — Frequency



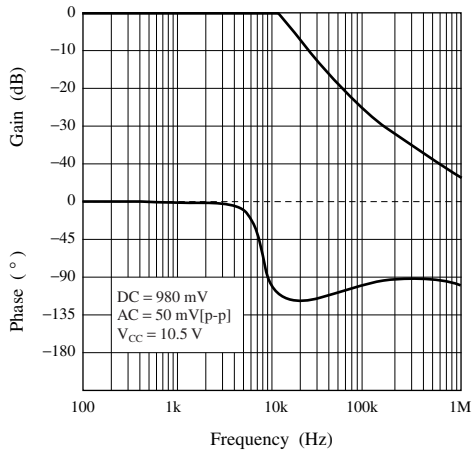
L2 amp. Gain, Phase — Frequency



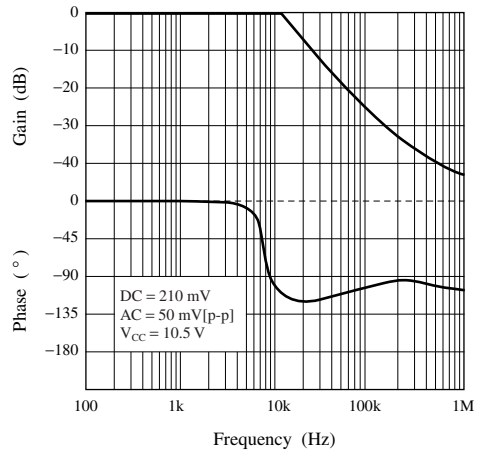
■ Technical Data (continued)

• Main characteristics (continued)

L1 amp. Gain, Phase — Frequency

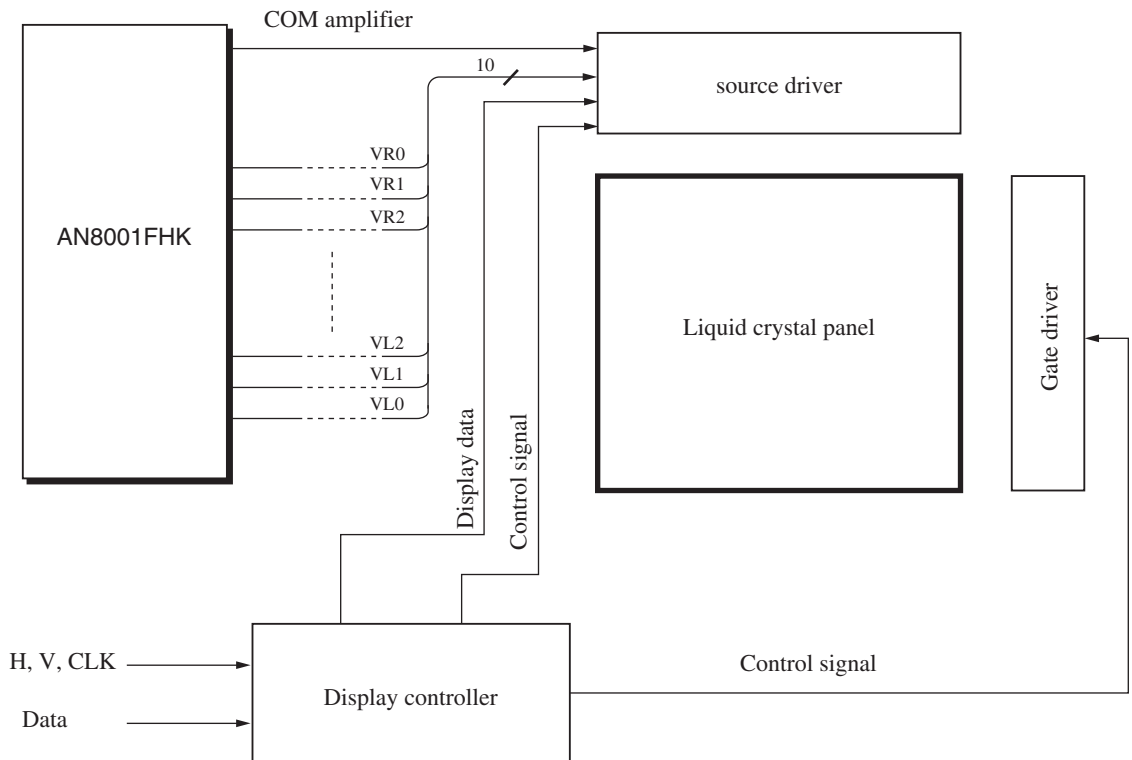


L0 amp. Gain, Phase — Frequency



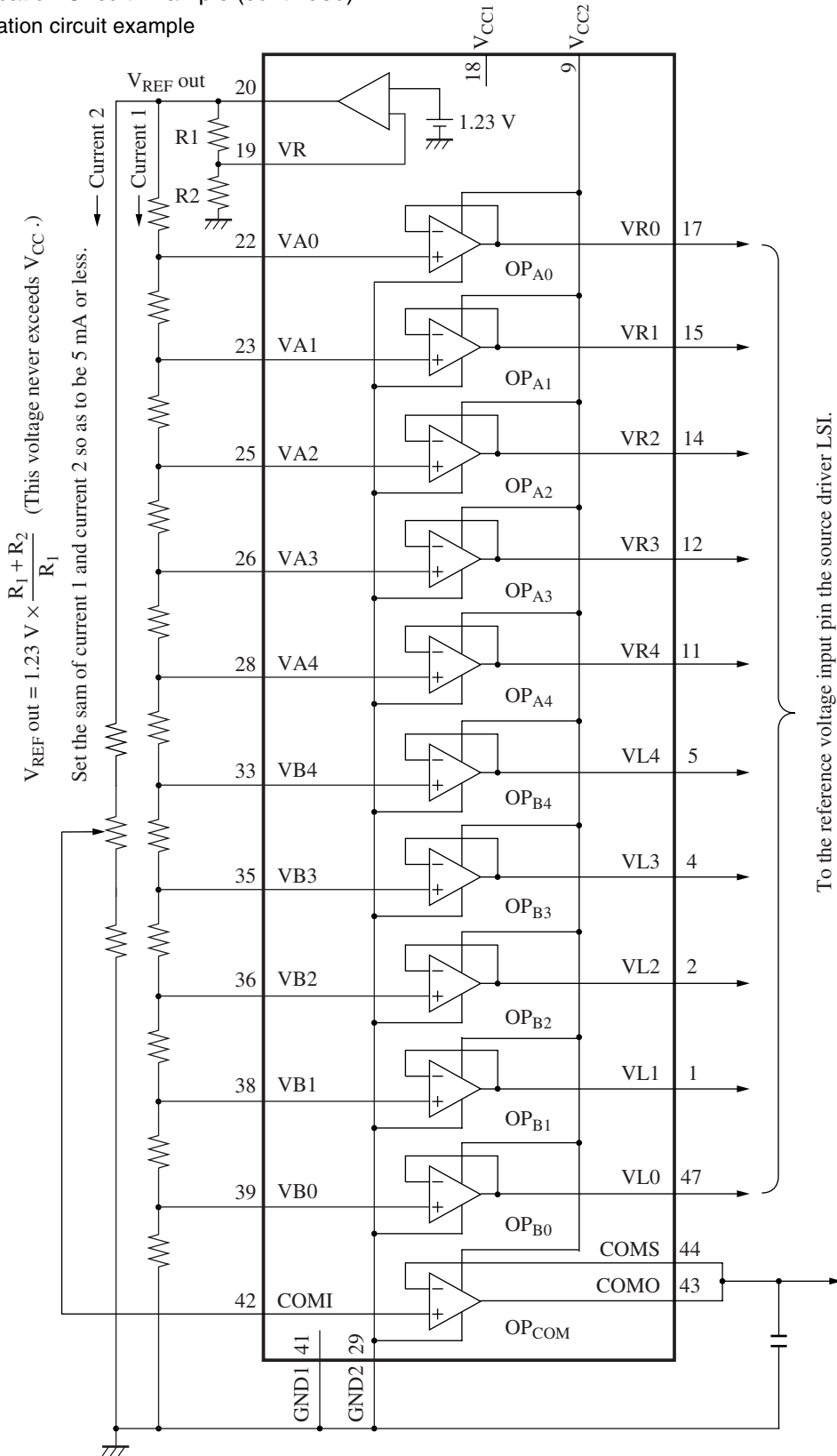
■ Application Circuit Example

• System configuration example



■ Application Circuit Example (continued)

- Application circuit example



## ■ Application Circuit Example (continued)

&lt;Recommended operating conditions&gt;

Parameter	Symbol	Ratings	Unit	Notes
Supply voltage	$V_{CC}$	10.5	V	
Load capacitance	$C_{LOAD}$	0.01	$\mu\text{F}$	VR0 to VL0
		0.1 to 1	$\mu\text{F}$	COM0
		0.1	$\mu\text{F}$	$V_{REF}$

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