

## Input/Output Full-Swing High Output Current Single C-MOS Operational Amplifier with Shutdown

### ■ GENERAL DESCRIPTION

The NJU7045 is a C-MOS operational amplifier permitting a full-swing input and output in full-swing under high load.

Based on C-MOS technology, there are excellent features such as high output current, low current consumption, low operating voltage, and very high input impedance.

### ■ PACKAGE OUTLINE



NJU7045RB1

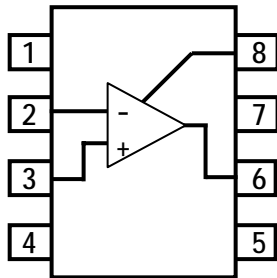


NJU7045F1

### ■ FEATURES

- Operating Voltage: 2.2V to 5.5V
- Input/Output Full-Swing
- High Output Current: 40mA at  $V_O=0V$
- Input Offset Voltage:  $V_{IO}=10mV$  max.
- Wide Input Common Mode: Voltage Range:  $V_{SS}$  to  $V_{DD}$
- Operating Current: (Active)  $I_{DD}=350\mu A$  typ. (at  $V_{DD}=3V$ )  
(Shutdown)  $I_{DD}=0.9\mu A$  typ. (at  $V_{DD}=2.2V$  to  $5.5V$ )
- High Input Impedance:  $1T\Omega$  Typ.
- Low Input Bias Current:  $I_B=1pA$  typ.
- Ground Sensing
- Tiny Package: TVSP8, MTP6

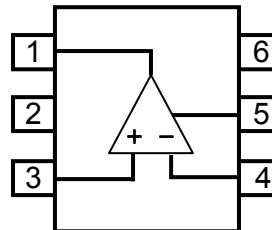
### ■ PIN CONFIGURATION



**NJU7045RB1**  
(Top View)

#### PIN FUNCTION

1. NC
2. -INPUT
3. +INPUT
4.  $V_{SS}$
5. NC
6. OUTPUT
7.  $V_{DD}$
8.  $\overline{SHDN}$



**NJU7045F1**  
(Top View)

#### PIN FUNCTION

1. OUTPUT
2.  $V_{SS}$
3. +INPUT
4. -INPUT
5.  $\overline{SHDN}$
6.  $V_{DD}$

## ■ ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	$V_{DD}$	7	V
Common Mode Input Voltage Range	$V_{ICM}$	0 to 7 (Note 1)	V
Differential Input Voltage Range	$V_{ID}$	$\pm 7$	V
Power Dissipation	$P_D$	320 [TVSP8] 410 [TVSP8] (Note 2) 540 [TVSP8] (Note 3) 200 [MTP6] 410 [MTP6] (Note 2) 580 [MTP6] (Note 3)	mW
Output Current	$I_O$	$\pm 75$ [TVSP8, MTP6]	mA
Operating Temperature Range	$T_{opr}$	-40 to +85	$^{\circ}C$
Storage Temperature Range	$T_{stg}$	-55 to +125	$^{\circ}C$

(Note 1) For supply voltage less than 7V, the absolute maximum input voltage is equal to the supply voltage.

(Note 2) On the PCB " EIA/JEDEC (76.2x11.43x1.6mm, two layers, FR-4) "

(Note 3) On the PCB " EIA/JEDEC (76.2x11.43x1.6mm, four layers, FR-4) "

FIGURE 1-1. Power Dissipation vs. Ambient Temperature

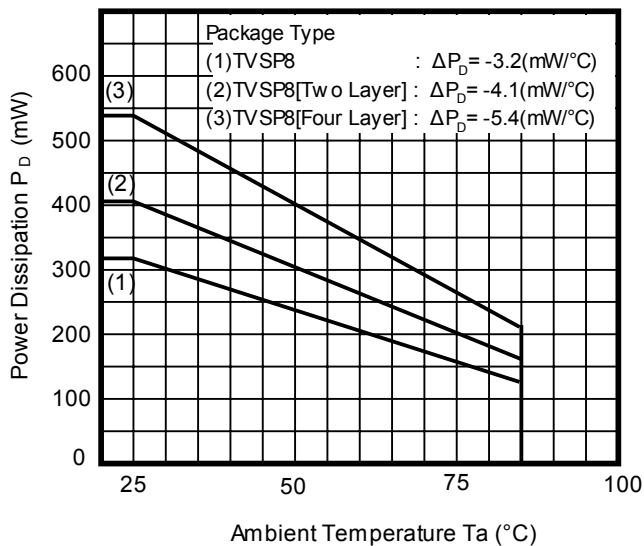
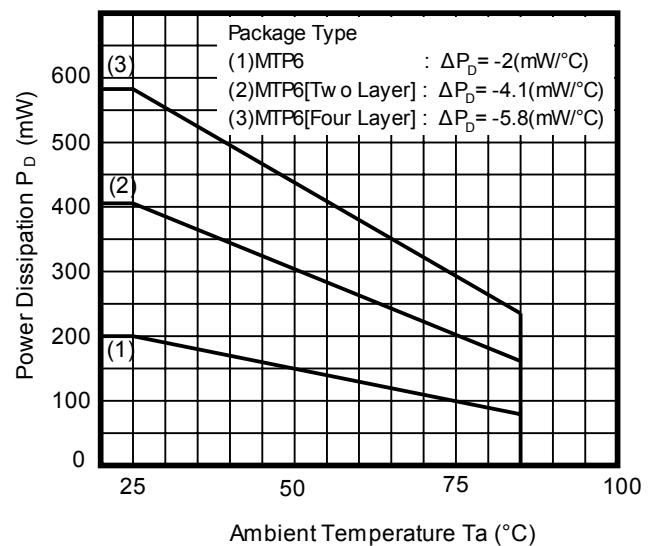


FIGURE 1-2. Power Dissipation vs. Ambient Temperature



(Note 4)

Please do not exceed "Power Dissipation (PD)" the power dissipation in IC is absolutely indicated to be in the maximum rating.

See the figure "Power Dissipation vs. Ambient Temperature" for information on temperature derating of this device.

## ■ OPERATING VOLTAGE (Ta=25°C)

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V <sub>DD</sub>	2.2 to 5.5	V

## ■ STATE DEFINITION OF NJU7045 OPERATION

● "State of NJU7045 Operation" vs. "Turn-on/off Control Voltage V<sub>SD</sub>" (2.2V ≤ V<sub>DD</sub> ≤ 5.5V, Ta=25°C)

State Definition	CONTROL CONDITION	State of NJU7045 Operation
Amplifier Operating	V <sub>SD</sub> =V <sub>IH</sub>	Amplifier is active.
Shutdown	V <sub>SD</sub> =V <sub>IL</sub>	The output impedance is high, output signal is muted and the supply current is reduced.

## ■ ELECTRICAL CHARACTERISTICS [Enable/Shutdown Control Information]

● Turn-on/off Control Voltage Range for SHDN Pin (2.2V ≤ V<sub>DD</sub> ≤ 5.5V, Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Turn-on Voltage to Enable part	V <sub>IH</sub>	(Note 5)	V <sub>DD</sub> × 0.7	-	V <sub>DD</sub>	V
Turn-off Voltage	V <sub>IL</sub>	(Note 5)	0	-	V <sub>DD</sub> × 0.3	V

(Note 5) The SHDN pin can't be left unconnected.

● DC CHARACTERISTICS of "SHDN Pin" (2.2V ≤ V<sub>DD</sub> ≤ 5.5V, Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Input Bias Current of SHDN Pin	I <sub>BSD</sub>	0 ≤ V <sub>SD</sub> ≤ V <sub>DD</sub>	-	-	±2	μA

● Turn-on/off Time (2.2V ≤ V<sub>DD</sub> ≤ 5.5V, Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Amplifier Turn-off Time	T <sub>OFF</sub>	T <sub>VSDHL</sub> ≤ 100ns FIGURE 2,3	-	1	-	μs
Amplifier Turn-on Time	T <sub>ON</sub>	T <sub>VSDLH</sub> ≤ 100ns FIGURE 2,3	-	10	-	μs

FIGURE 2. T<sub>OFF</sub>/T<sub>ON</sub> CONDITION

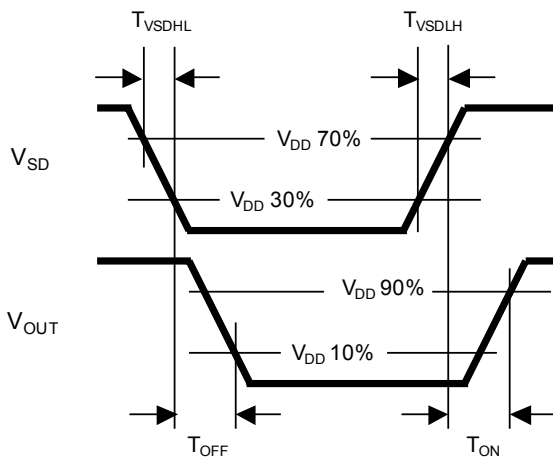
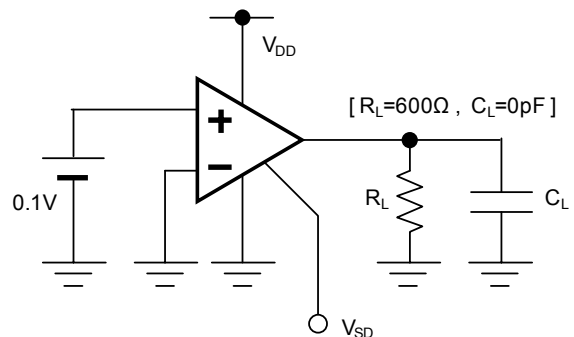


FIGURE 3. T<sub>OFF</sub>/T<sub>ON</sub> TEST CIRCUIT



## ■ELECTRICAL CHARACTERISTICS [Shutdown Characteristics]

### ●DC CHARACTERISTICS

( $2.2V \leq V_{DD} \leq 5.5V$ ,  $T_a=25^\circ C$ )

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Leak Current	$I_{LEAK}$	FIGURE 4	-	-	$\pm 3$	$\mu A$
Operating Current	$I_{DDSD}$	No Signal Apply, No Load, $V_{SD} \leq 0.2V$	-	-	0.9	$\mu A$

### ●AC CHARACTERISTICS

( $2.2V \leq V_{DD} \leq 5.5V$ ,  $T_a=25^\circ C$ )

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Mute Level	MUTE	$V_{IN}=1V_{PP}$ , $f=1kHz$ , FIGURE 5	-	-100	-	dB

FIGURE 4. LEAK CURRENT TEST CIRCUIT

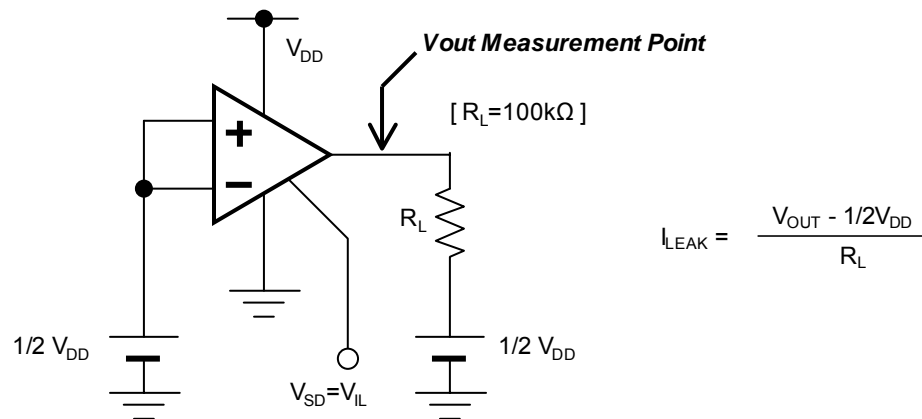
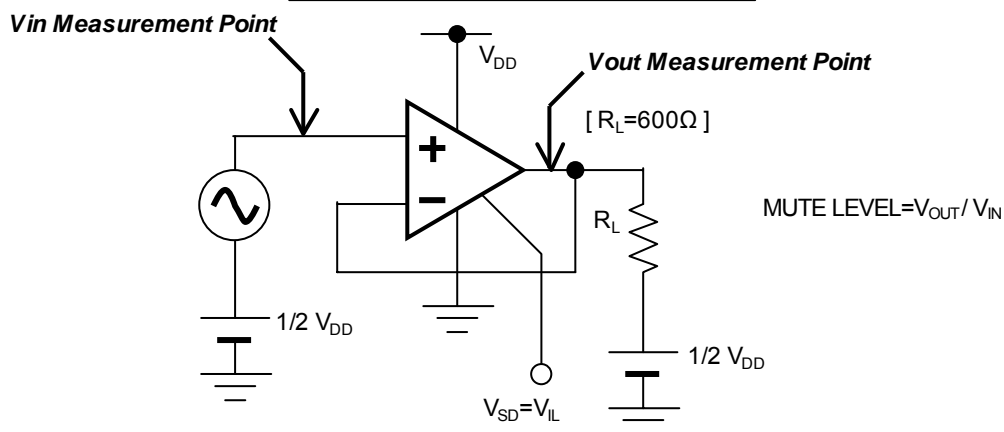


FIGURE 5. MUTE LEVEL TEST CIRCUIT



## ■ELECTRICAL CHARACTERISTICS [Amplifier Operating]

### ●DC CHARACTERISTICS

( $V_{DD}=5V, 3.5V \leq V_{SD} \leq 5V, T_a=25^\circ C$ )

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Current	$I_{DD}$	No signal Apply, $V_{SD}=V_{DD}$	-	450	700	$\mu A$
Input Offset Voltage	$V_{IO}$		-	-	10	mV
Input Bias Current	$I_B$		-	1	-	pA
Input Offset Current	$I_{IO}$		-	1	-	pA
Large Signal Voltage Gain	$A_V$	$R_L=10k\Omega$ to 2.5V, $V_o=2.5V \pm 2.4V$	70	90	-	dB
Common Mode Rejection Ratio	CMR	CMR+: $2.5V \leq V_{CM} \leq 5V$ CMR-: $0V \leq V_{CM} \leq 2.5V$ (Note 6)	44	60	-	dB
Supply Voltage Rejection Ratio	SVR	$4.0V \leq V_{DD} \leq 5.5V$ , $V_{CM}=V_{DD}/2, V_{SD}=V_{DD}$	55	85	-	dB
Output Voltage1	$V_{OH1}$ $V_{OL1}$	$R_L=10k\Omega$ to 2.5V	4.95	-	-	V
Output Voltage2	$V_{OH2}$ $V_{OL2}$	$R_L=600\Omega$ to 2.5V	4.9	-	-	V
Output Source Current	$I_{SOURCE}$	$V_o=2.5V$	70	-	-	mA
Output Sink Current	$I_{SINK}$	$V_o=2.5V$	70	-	-	mA
Input Common Mode Voltage Range	$V_{ICM}$	CMR $\geq 44$ dB	0	-	5	V

(Note 6) CMR is represented by either CMR+ or CMR- has lower value.

### ●AC CHARACTERISTICS

( $V_{DD}=5V, 3.5V \leq V_{SD} \leq 5V, T_a=25^\circ C$ )

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Unity Gain Bandwidth	GB	$R_L=10k\Omega$ to 2.5V	-	0.8	-	MHz
Total Harmonic Distortion	THD	$f=1kHz, V_{IN}=1V_{pp}, A_V=0dB$	-	0.05	-	%
Equivalent Input Noise Voltage	$V_{NI}$	$f=1kHz$	-	40	-	nV/ $\sqrt{Hz}$

### ●TRANSIENT CHARACTERISTICS

( $V_{DD}=5V, 3.5V \leq V_{SD} \leq 5V, T_a=25^\circ C$ )

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Slew Rate	SR	$R_L=10k\Omega$ to 2.5V	-	0.8	-	V/ $\mu s$

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## ■ELECTRICAL CHARACTERISTICS [Amplifier Operating]

### ●DC CHARACTERISTICS

( $V_{DD}=3V, 2.1V \leq V_{SD} \leq 3V, T_a=25^\circ C$ )

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Current	$I_{DD}$	No signal Apply, $V_{SD}=V_{DD}$	-	350	600	$\mu A$
Input Offset Voltage	$V_{IO}$		-	-	10	mV
Input Bias Current	$I_B$		-	1	-	pA
Input Offset Current	$I_{IO}$		-	1	-	pA
Large Signal Voltage Gain	$A_V$	$R_L=10k\Omega$ to 1.5V, $V_O=1.5V \pm 1.4V$	70	90	-	dB
Common Mode Rejection Ratio	CMR	CMR+: $1.5V \leq V_{CM} \leq 3V$ CMR-: $0V \leq V_{CM} \leq 1.5V$ (Note 7)	42	60	-	dB
Supply Voltage Rejection Ratio	SVR	$2.7V \leq V_{DD} \leq 4.0V$ , $V_{CM}=V_{DD}/2, V_{SD}=V_{DD}$	50	80	-	dB
Output Voltage1	$V_{OH1}$	$R_L=10k\Omega$ to 1.5V	2.95	-	-	V
	$V_{OL1}$	$R_L=10k\Omega$ to 1.5V	-	-	0.05	V
Output Voltage2	$V_{OH2}$	$R_L=600\Omega$ to 1.5V	2.9	-	-	V
	$V_{OL2}$	$R_L=600\Omega$ to 1.5V	-	-	0.10	V
Output Source Current	$I_{SOURCE}$	$V_O=1.5V$	30	40	-	mA
Output Sink Current	$I_{SINK}$	$V_O=1.5V$	30	40	-	mA
Input Common Mode Voltage Range	$V_{ICM}$	CMR $\geq 42$ dB	0	-	3	V

(Note 6) CMR is represented by either CMR+ or CMR- has lower value.

### ●AC CHARACTERISTICS

( $V_{DD}=3V, 2.1V \leq V_{SD} \leq 3V, T_a=25^\circ C$ )

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Unity Gain Bandwidth	GB	$R_L=10k\Omega$ to 1.5V	-	0.8	-	MHz
Total Harmonic Distortion	THD	$f=1kHz, V_{IN}=1V_{pp}, A_V=0dB$	-	0.05	-	%
Equivalent Input Noise Voltage	$V_{NI}$	$f=1kHz$	-	40	-	$nV/\sqrt{Hz}$

### ●TRANSIENT CHARACTERISTICS

( $V_{DD}=3V, 2.1V \leq V_{SD} \leq 3V, T_a=25^\circ C$ )

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Slew Rate	SR	$R_L=10k\Omega$ to 1.5V	-	0.7	-	$V/\mu s$

## ■ELECTRICAL CHARACTERISTICS [Amplifier Operating]

### ●DC CHARACTERISTICS

( $V_{DD}=2.2V, 1.54V \leq V_{SD} \leq 2.2V, T_a=25^\circ C$ )

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Current	$I_{DD}$	No Signal Apply, $V_{SD}=V_{DD}$	-	300	500	$\mu A$
Input Offset Voltage	$V_{IO}$		-	-	10	mV
Input Bias Current	$I_B$		-	1	-	pA
Input Offset Current	$I_{IO}$		-	1	-	pA
Large Signal Voltage Gain	$A_V$	$R_L=10k\Omega$ to 1.1V, $V_o=1.1V \pm 1.0V$	70	90	-	dB
Common Mode Rejection Ratio	CMR	CMR+: $1.1V \leq V_{CM} \leq 2.2V$ CMR-: $0V \leq V_{CM} \leq 1.1V$ (Note 7)	30	60	-	dB
Supply Voltage Rejection Ratio	SVR	$2.2V \leq V_{DD} \leq 2.7V$ , $V_{CM}=V_{DD}/2, V_{SD}=V_{DD}$	45	70	-	dB
Output Voltage1	$V_{OH1}$	$R_L=10k\Omega$ to 1.1V	2.15	-	-	V
	$V_{OL1}$	$R_L=10k\Omega$ to 1.1V	-	-	0.05	V
Output Voltage2	$V_{OH2}$	$R_L=600\Omega$ to 1.1V	2.1	-	-	V
	$V_{OL2}$	$R_L=600\Omega$ to 1.1V	-	-	0.1	V
Output Source Current	$I_{SOURCE}$	$V_o=1.1V$	10	15	-	mA
Output Sink Current	$I_{SINK}$	$V_o=1.1V$	10	15	-	mA
Input Common Mode Voltage Range	$V_{ICM}$	CMR $\geq 30dB$	0	-	2.2	V

(Note 7) CMR is represented by either CMR+ or CMR- has lower value.

### ●AC CHARACTERISTICS

( $V_{DD}=2.2V, 1.54V \leq V_{SD} \leq 2.2V, T_a=25^\circ C$ )

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Unity Gain Bandwidth	GB	$R_L=10k\Omega$ to 1.1V	-	0.8	-	MHz
Total Harmonic Distortion	THD	$f=1kHz, V_{IN}=1V_{pp}, A_V=0dB$	-	0.05	-	%
Equivalent Input Noise Voltage	$V_{NI}$	$f=1kHz$	-	40	-	$nV/\sqrt{Hz}$

### ●TRANSIENT CHARACTERISTICS

( $V_{DD}=2.2V, 1.54V \leq V_{SD} \leq 2.2V, T_a=25^\circ C$ )

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Slew Rate	SR	$R_L=10k\Omega$ to 1.1V	-	0.6	-	$V/\mu s$

**[CAUTION]**

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