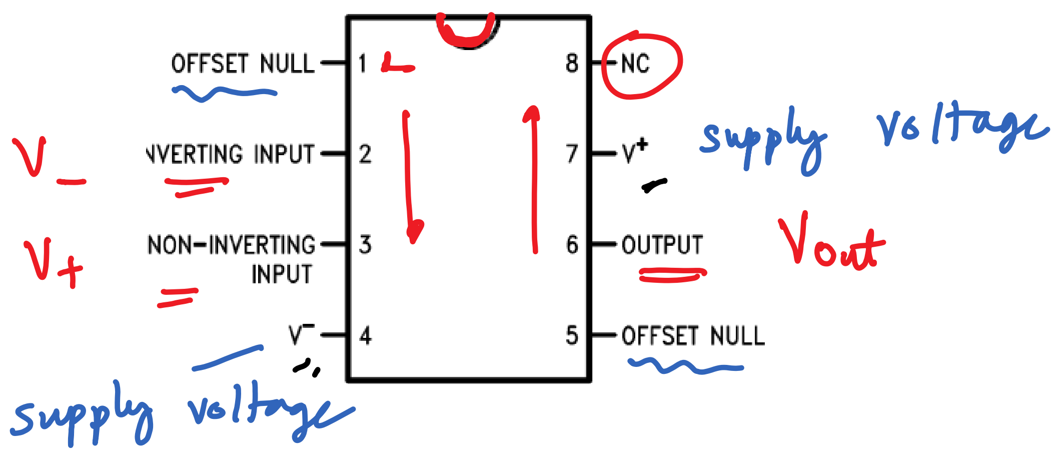
pinout

Real op-amp

Google search for LM741 specs sheet

① Pin outs for LM741

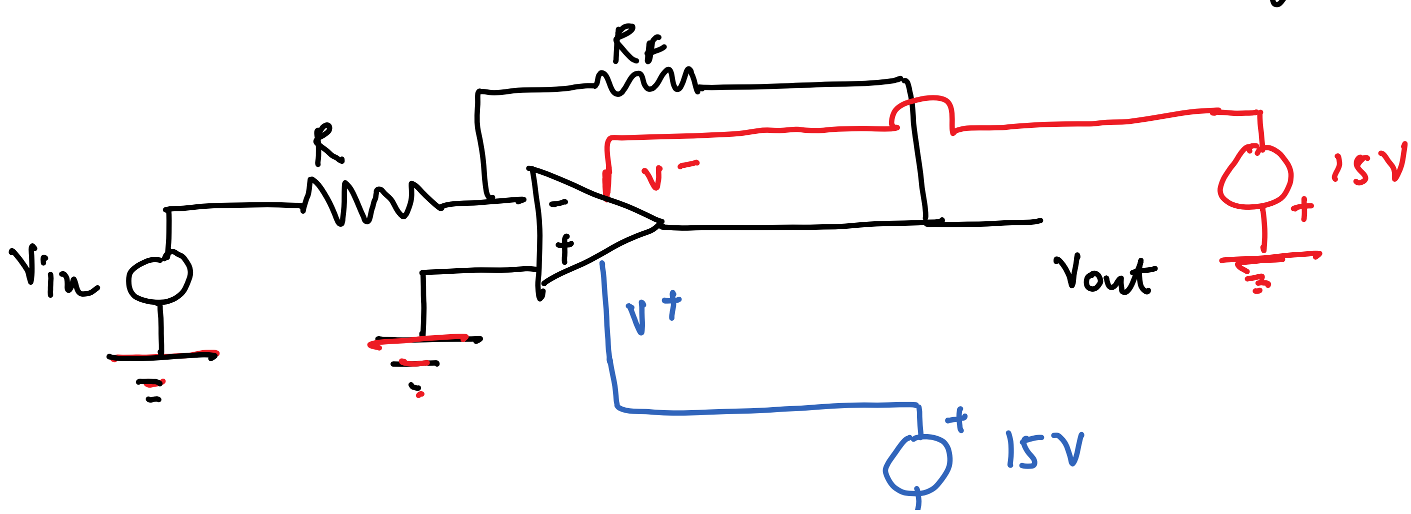


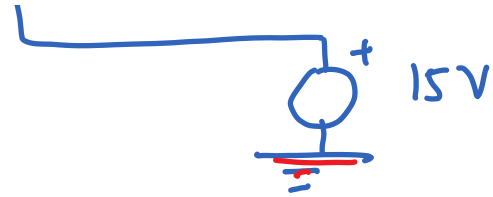
6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

		MIN	NOM	MAX	UNIT
Supply voltage (VDD-GND)	LM741, LM741A	±10	±15	±22	V
	LM741C	±10	±15	±18	
Temperature	LM741, LM741A	–55		125	°C
	LM741C	0		70	

V^+ & V^- to 15 V & −15 V respectively.




+
15V

$$\frac{V_{out}}{V_{in}} = \frac{-R_f}{R}$$

We choose R_f, R such that $R_f/R = 100$

$$\frac{V_{out}}{V_{in}} = -100$$

If $V_{in} = 1V \Rightarrow V_{out} = -100(1) = -100\,V$

↓ theoretical

In reality

$V_{out} = -15 + 1.4$

$= -13.6$

V_{out} saturates to $+13.6$ or -13.6

Max ratings

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)[(1)(2)(3)]

		MIN	MAX	UNIT
Supply voltage	LM741, LM741A		±22	V
	LM741C		±18	
Power dissipation [(4)]			500	mW
Differential input voltage			±30	V
Input voltage [(5)]			±15	V
Output short circuit duration		Continuous		
Operating temperature	LM741, LM741A	–50	125	°C
	LM741C	0	70	
Junction temperature	LM741, LM741A		150	°C
	LM741C		100	
Soldering information	PDIP package (10 seconds)		260	°C
	CDIP or TO-99 package (10 seconds)		300	°C
Storage temperature, T_{stg}		–65	150	°C

$V_{in}(max) = \pm 15V$

6.5 Electrical Characteristics, LM741[1]

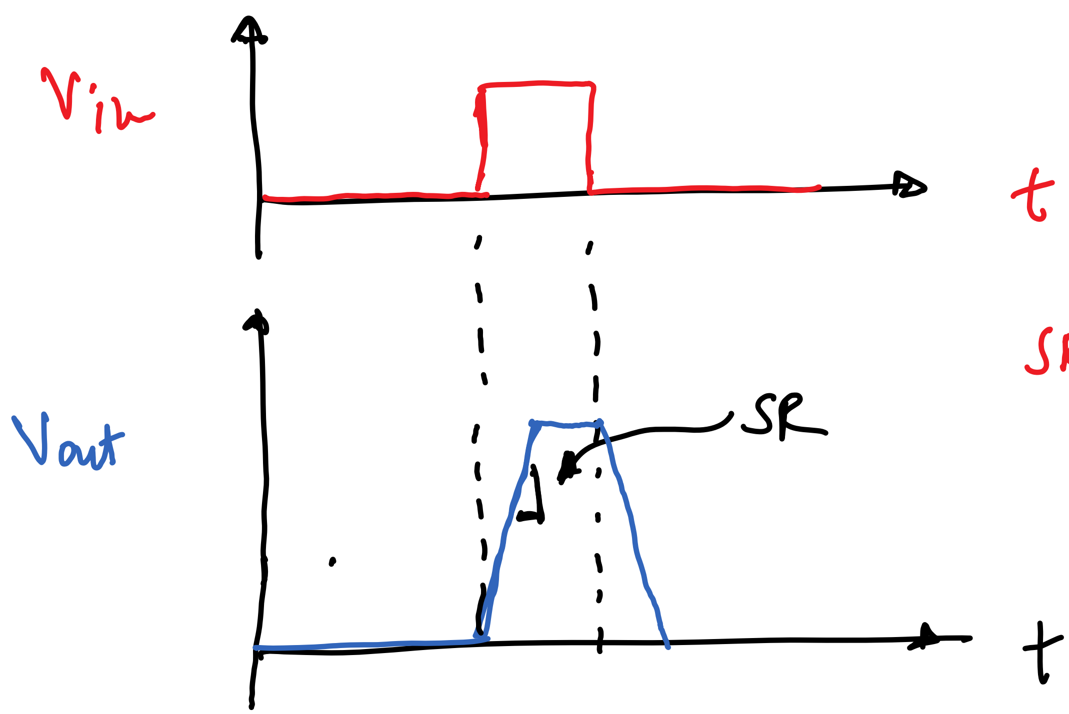
PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
Input offset voltage		$R_S \le 10$ kΩ	$T_A = 25°C$		1	5	mV
			$T_{AMIN} \le T_A \le T_{AMAX}$			6	mV
Input offset voltage adjustment range		$T_A = 25°C$, $V_S = \pm 20$ V			±15		mV
Input offset current		$T_A = 25°C$			20	200	nA
		$T_{AMIN} \le T_A \le T_{AMAX}$			85	500	
Input bias current		$T_A = 25°C$			80	500	nA
		$T_{AMIN} \le T_A \le T_{AMAX}$				1.5	μA
Input resistance		$T_A = 25°C$, $V_S = \pm 20$ V		0.3	2		MΩ
Input voltage range		$T_{AMIN} \le T_A \le T_{AMAX}$		±12	±13		V
Large signal voltage gain		$V_S = \pm 15$ V, $V_O = \pm 10$ V, $R_L \ge 2$ kΩ	$T_A = 25°C$	50	200		V/mV
			$T_{AMIN} \le T_A \le T_{AMAX}$	25			
Output voltage swing		$V_S = \pm 15$ V	$R_L \ge 10$ kΩ	±12	±14		V
			$R_L \ge 2$ kΩ	±10	±13		
Output short circuit current		$T_A = 25°C$			25		mA
Common-mode rejection ratio		$R_S \le 10$ Ω, $V_{CM} = \pm 12$ V, $T_{AMIN} \le T_A \le T_{AMAX}$		80	95		dB
Supply voltage rejection ratio		$V_S = \pm 20$ V to $V_S = \pm 5$ V, $R_S \le 10$ Ω, $T_{AMIN} \le T_A \le T_{AMAX}$		86	96		dB
Transient response	Rise time	$T_A = 25°C$, unity gain			0.3		μs
	Overshoot				5%		
Slew rate		$T_A = 25°C$, unity gain			0.5		V/μs
Supply current		$T_A = 25°C$			1.7	2.8	mA
Power consumption		$V_S = \pm 15$ V	$T_A = 25°C$		50	85	mW
			$T_A = T_{AMIN}$		60	100	
			$T_A = T_{AMAX}$		45	75	

③ Slew rate (SR)

LM741 SR = 0.5 V/µs

It is the rate at which the output voltage increases as a function of time

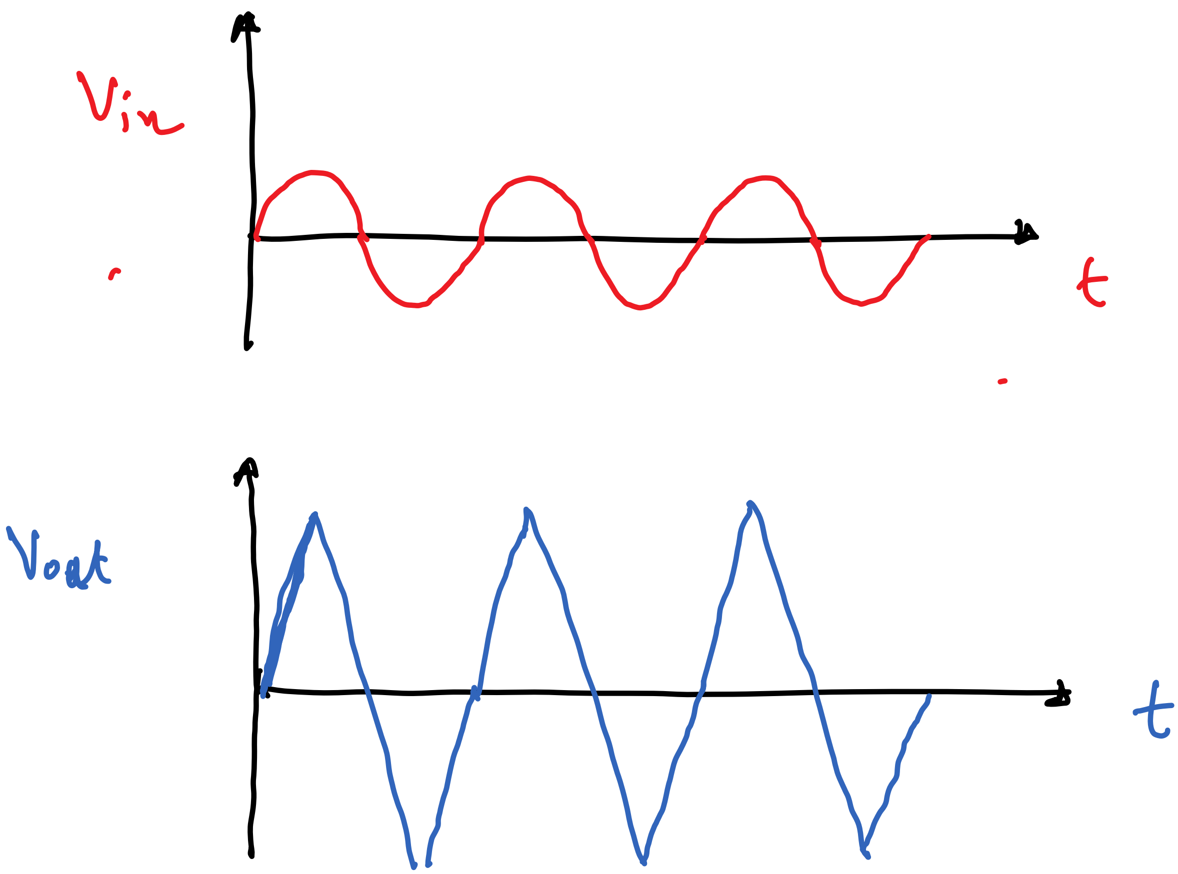
$$SR = \frac{\Delta V}{\Delta t}$$



$SR = \frac{\Delta V}{\Delta t} \to \infty$

SR is problematic with an input which is frequency dependent

e.g. sine wave



How to avoid clipping in the frequency response.

SR for a sine wave

$$SR = 2\pi f V$$

f = maximum signal frequency Hz

V = maximum peak Voltage in V

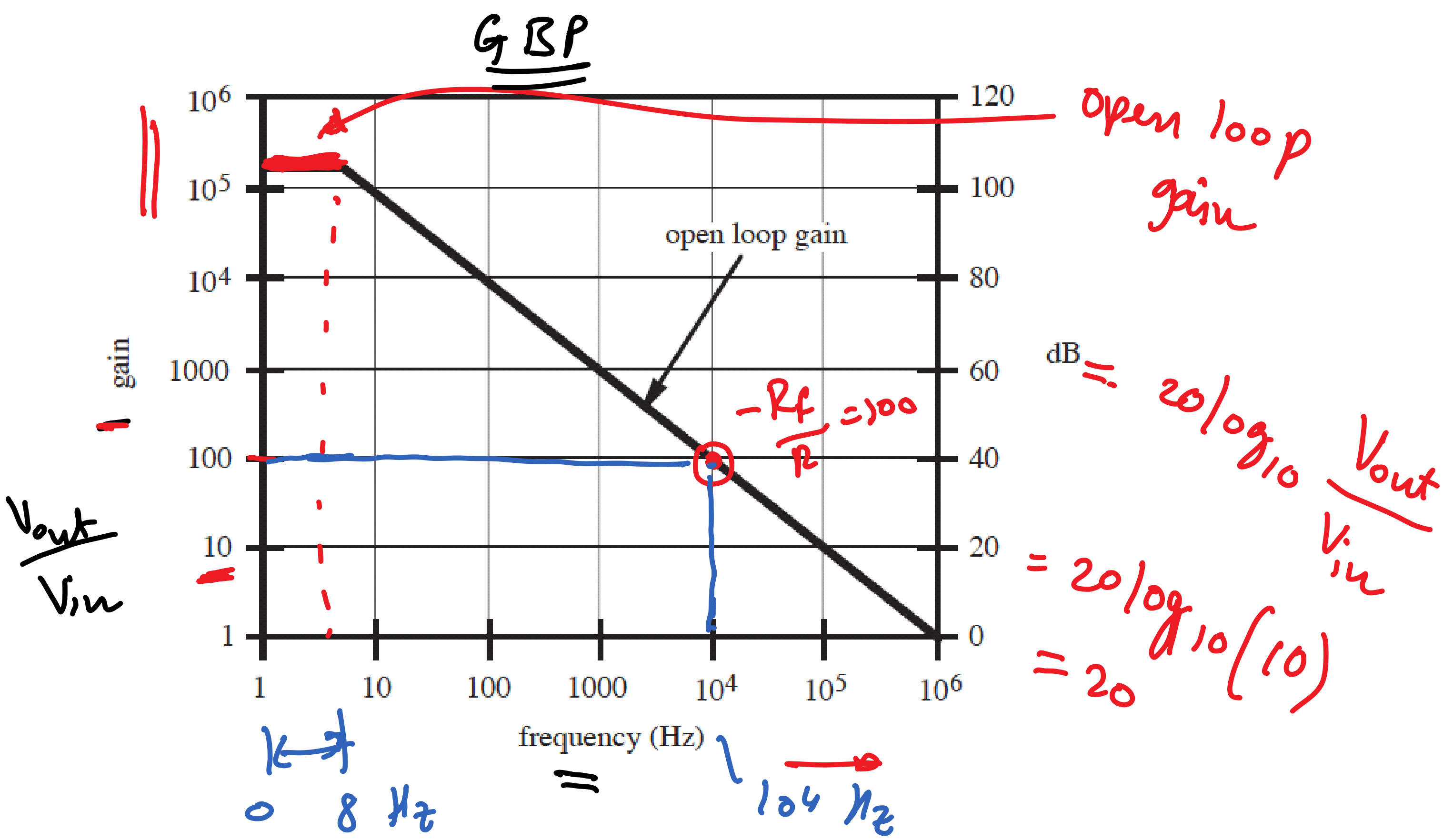
Example: Compute the desired slew rate for an amplifier to handle a peak voltage of 10 V at a frequency of 15 KHz

$$SR = 2\pi f V = 2\pi (15 \times 10^3)(10)$$

$$= 942 \times 10^3 \text{ V/s}$$

$$\boxed{SR = 0.94 \text{ V}/\mu s}$$

Gain vs frequency



$$\frac{V_{out}}{V_{in}} = A_v \text{ (open loop gain)} \qquad A_v \approx 10^5, 10^6$$

$$\frac{V_{out}}{V_{in}} = -\frac{R_f}{R} \text{ (closed loop, inverting)}$$

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(5) Gain Bandwidth product

This is the ratio of open loop gain to the bandwidth at that gain from specs sheet GBP = 200 V/mV

$$= \frac{200}{10^{-3}} V/V$$

$$= 2(10^5) \; V/V$$

open loop

For inverting amplifier $\frac{V_{out}}{V_{in}} = \frac{-R_f}{R}$

$$\simeq -100$$

closed loop

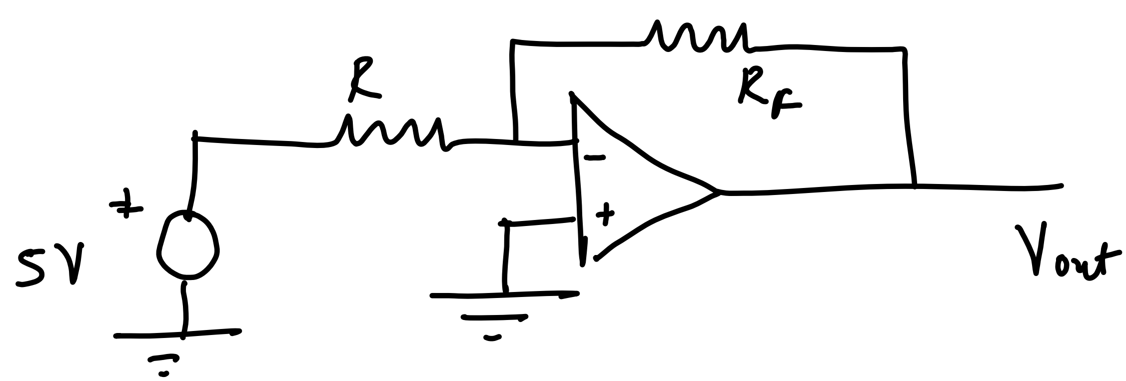
Bandwidth for the particular amplifier gain is $0 - 10^4$ Hz

0 – 10 KHz

⑤ Output short circuit current

$$(I_{out})_{max} \simeq 25\,mA.$$

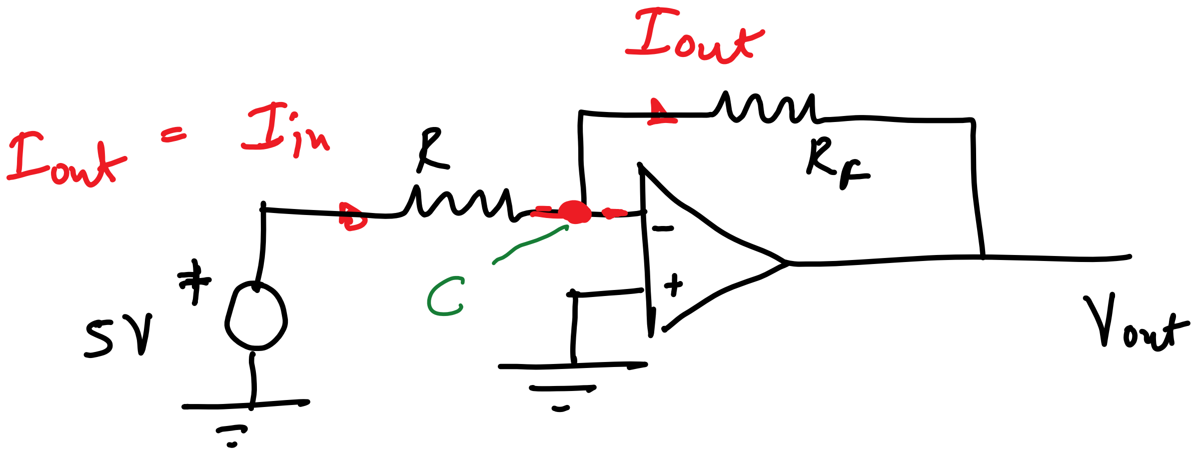
Example on how to use this spec



Compute the values of R_f, R such that voltage gain is -2.. The output short circuit current is 25 mA.

We derived $\frac{V_{out}}{V_{in}} = -\frac{R_f}{R} = -2$

$$R_f = 2R$$



$$(I_{out})_{max} = 25\ mA$$

$$5 - V_c = I_{in} R = I_{out} R$$

$$V_c = V_- = V_+ = 0$$

$$R = \frac{5}{I_{out}} = \frac{5}{25\ 10^{-3}} = 200\ \Omega$$

$R = 200\ \Omega$ (minimum)

$R_f = 2R = 400\ \Omega$ (minimum)