

LINEAR INTEGRATED CIRCUITS

PART-07 Operational Amplifier ICs

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Operational Amplifier



Block Diagram



Input Stage: Dual Input Balanced Output Differential Amplifier Intermediate Stage: Dual Input Unbalanced Output Differential Amplifier Level Translator/shift Stage: Emitter follower with Constant Current Source Output Stage: Push-Pull Amplifier

OpAmp Internal Circuit Structure



OpAmp IC Packaging





(Metal Can or TO Package)





IC 741 Pin Diagram



Temperature Ranges

□ Performance and cost are important parameters in selecting ICs & other semiconductor. All electronic components can be classified in three temperature

ranges:

1.	Military Temperature Range	-55°C	+125°C
2.	Industrial Temperature Range	-20°C	+85°C
3.	Commercial Temperature Range	0°C	+70°C

Military-grade components are always of superior quality with tightly controlled parameters, therefore, cost more.

Commercial-grade ICs have worst tolerance among all, hence are cheapest.

Device number & brief description: On the datasheet is device number and its brief description is given e.g., low power op-amp.

General n	urnose operational amplifie	er u	A74-		SA741C
General p		μ		ΠμΑΓΕΙΟ	541410
ESCRIPTION	formation and a second formation of the second second	PIN CONFIGURATI	ION		
ne µA741 is a nign j ben-loop gain, inter	D), F, N P	ackages		
nd exceptional temp	perature stability. The μA741 is				
short-circuit-protected and allows for nulling of offset voltage.		OFFSET NULL	1	8 NC	
		INVERTING INPUT	2	7 V+	
EATURES		NON-INVERTING INPUT	3	- 6 OUT	PUT
Internal frequency	compensation	v_ [۲	5 055	SET NULL
Chart eizeuit protos	tion		-L		SETTOLE
anon circuit protec			то	P VIEW	SL0009
Excellent temperat	ure stability	Figu	re 1. Pi	n Configuration	
High input voltage	range				
	ORMATION				
	DESCRIPTION		IGE	ORDER CODE	DWG #
Pin Plastic Dual Ir	I ine Package (DIP)	-55°C to +125°C		uA741N	SOT97-1
B-Pin Plastic Dual Ir	-Line Package (DIP)	0 to +70°C		uA741CN	SOT97-1
B-Pin Plastic Dual Ir	-Line Package (DIP)	-40°C to +85°C	SA741CN		SOT97-1
3-Pin Ceramic Dual	In-Line Package (CERDIP)	-55°C to +125°C	μA741F		0580A
			μA741CF		
3-Pin Ceramic Dual	In-Line Package (CERDIP)	0 to +70°C		μA741CF	0580A
3-Pin Ceramic Dual 3-Pin Small Outline	In-Line Package (CERDIP) (SO) Package	0 to +70°C 0 to +70°C	_	μΑ741CF μΑ741CD	0580A SOT96-1
8-Pin Ceramic Dual 3-Pin Small Outline	In-Line Package (CERDIP) (SO) Package	0 to +70°C 0 to +70°C		μΑ741CF μΑ741CD	0580A SOT96-1
3-Pin Ceramic Dual 3-Pin Small Outline	In-Line Package (CERDIP) (SO) Package	0 to +70°C 0 to +70°C		µА741CF µА741CD	0580A SOT96-1
B-Pin Ceramic Dual B-Pin Small Outline BSOLUTE MA	In-Line Package (CERDIP) (SO) Package XIMUM RATINGS	0 to +70°C 0 to +70°C		μΑ741CF μΑ741CD	0580A SOT96-1
3-Pin Ceramic Dual 3-Pin Small Outline BSOLUTE MA SYMBOL	In-Line Package (CERDIP) (SO) Package XIMUM RATINGS Supply voltage	0 to +70°C 0 to +70°C		μΑ741CF μΑ741CD RATING	0580A SOT96-1
B-Pin Ceramic Dual B-Pin Small Outline BSOLUTE MA SYMBOL /s	In-Line Package (CERDIP) (SO) Package XIMUM RATINGS PARAMETER Supply voltage uA741C	0 to +70°C 0 to +70°C		μΑ741CF μΑ741CD RATING	0580A SOT96-1
B-Pin Ceramic Dual B-Pin Small Outline BSOLUTE MA SYMBOL /S	In-Line Package (CERDIP) (SO) Package XIMUM RATINGS Supply voltage µA741C µA741	0 to +70°C 0 to +70°C		μΑ741CF μΑ741CD RATING ±18 ±22	0580A SOT96-1 UNIT V V
3-Pin Ceramic Dual 3-Pin Small Outline BSOLUTE MA SYMBOL /s	In-Line Package (CERDIP) (SO) Package XIMUM RATINGS Supply voltage μA741 Internal power dissipation	0 to +70°C 0 to +70°C		μΑ741CF μΑ741CD RATING ±18 ±22	0580A SOT96-1 UNIT V V
3-Pin Ceramic Dual 3-Pin Small Outline BSOLUTE MA SYMBOL /s	In-Line Package (CERDIP) (SO) Package XIMUM RATINGS Supply voltage μA741C μA741 Internal power dissipation D package	0 to +70°C 0 to +70°C		μΑ741CF μΑ741CD RATING ±18 ±22 780	0580A SOT96-1 UNIT V V W
3-Pin Ceramic Dual 3-Pin Small Outline BSOLUTE MA SYMBOL /s	In-Line Package (CERDIP) (SO) Package XIMUM RATINGS Supply voltage µA7410 µA741 Internal power dissipation D package N package	0 to +70°C 0 to +70°C		μΑ741CF μΑ741CD RATING ±18 ±22 780 1170	0580A SOT96-1 UNIT V V W W
3-Pin Ceramic Dual 3-Pin Small Outline BSOLUTE MA SYMBOL Vs	In-Line Package (CERDIP) (SO) Package XIMUM RATINGS PARAMETER Supply voltage µA741C µA741 Internal power dissipation D package N package F package	0 to +70°C 0 to +70°C		μΑ741CF μΑ741CD RATING ±18 ±22 780 1170 800	UNIT V V W W W W W W W
3-Pin Ceramic Dual 3-Pin Small Outline BSOLUTE MA SYMBOL 75 70 /IN	In-Line Package (CERDIP) (SO) Package XIMUM RATINGS Supply voltage μA741C μA741 Internal power dissipation D package N package F package F package Differential input voltage	0 to +70°C 0 to +70°C		μΑ741CF μΑ741CD #18 ±22 780 1170 800 ±30	0580A SOT96-1 V V V W mW mW W W V
3-Pin Ceramic Dual 3-Pin Small Outline BSOLUTE MA SYMBOL /s 2D /IN //N	In-Line Package (CERDIP) (SO) Package XIMUM RATINGS Supply voltage μA741C μA741 Internal power dissipation D package N package F package Differential input voltage Input voltage ¹	0 to +70°C 0 to +70°C		μΑ741CF μΑ741CD *18 ±18 ±22 780 1170 800 ±30 ±15	0580A SOT96-1 V V W W W W W W V V V
I-Pin Ceramic Dual I-Pin Small Outline BSOLUTE MA SYMBOL /s 2 2 - 2 - 2 - - - - - - - - - - - - -	In-Line Package (CERDIP) (SO) Package XIMUM RATINGS PARAMETER Supply voltage μA741C μA741 Internal power dissipation D package F package F package Differential input voltage Input voltage ¹ Output short-circuit duration	0 to +70°C 0 to +70°C		μΑ741CF μΑ741CD #ATING ±18 ±22 780 1170 800 ±15 continuous	0580A SOT96-1 V V V W W W W W W W V V V V
I-Pin Ceramic Dual I-Pin Small Outline BSOLUTE MA SYMBOL /s 2D /IN N SC A	In-Line Package (CERDIP) (SO) Package XIMUM RATINGS Supply voltage μA741C μA741 Internal power dissipation D package F package Differential input voltage Input voltage1 Output short-circuit duration Operating temperature range	0 to +70°C 0 to +70°C		μΑ741CF μΑ741CD RATING ±18 ±22 780 1170 800 ±30 ±15 iontinuous	0580A SOT96-1 V V V W MW mW mW W V V V
3-Pin Ceramic Dual 3-Pin Small Outline BSOLUTE MA SYMBOL 7s 5 0 7 1 1 1 1 5 5 2 7 1 1 1 5 5 7 1 1 1 1 1 1 1 1 1 1 1 1 1	In-Line Package (CERDIP) (SO) Package XIMUM RATINGS Supply voltage μA741C D package N package P package Differential input voltage Inferrut protecting temperature range μA741C	0 to +70°C 0 to +70°C		μΑ741CF μΑ741CD #18 ±22 780 1170 800 ±30 ±15 500ntinuous 0 to +70	0580A SOT96-1 V V W W W W W W W W V V V V
3-Pin Ceramic Dual 3-Pin Small Outline BSOLUTE MA SYMBOL /s ² D /IN KIN SG 	In-Line Package (CERDIP) (SO) Package XIMUM RATINGS Supply voltage μA741C μA741 Internal power dissipation D package N package F package Differential input voltage Input voltage ¹ Output short-circuit duration Operating temperature range μA741C SA741C	0 to +70°C 0 to +70°C		μΑ741CF μΑ741CD RATING ±18 ±22 780 1170 800 ±15 500 ±15 155 160 100 +70 40 to +85	0580A SOT96-1 V V W W W W W W W W W V V V V V V
I-Pin Ceramic Dual I-Pin Small Outline BSOLUTE MA SYMBOL /s ?D /IN SC A	In-Line Package (CERDIP) (SO) Package XIMUM RATINGS Supply voltage μA741C μA741 Internal power dissipation D package N package F package F package Differential input voltage Input voltage ¹ Output short-circuit duration Operating temperature range μA741C SA741C SA741C	0 to +70°C 0 to +70°C		μΑ741CF μΑ741CD RATING ±18 ±22 780 1170 800 ±30 ±15 continuous 0 to +70 40 to +85 55 to +125	0580A SOT96-1 V V W W W W W W W V V V V V C C C C C
3-Pin Ceramic Dual 3-Pin Small Outline BSOLUTE MA SYMBOL /s 2-D //IN 5- 5- 5- 5- 5- 5- 5- 5- 5- 5-	In-Line Package (CERDIP) (SO) Package XIMUM RATINGS Supply voltage μA741C μA741 Internal power dissipation D package F package F package Differential input voltage Input voltage ¹ Output short-circuit duration Operating temperature range μA741 SA741 Storage temperature range	0 to +70°C 0 to +70°C		μΑ741CF μΑ741CD RATING ±18 ±22 780 1170 800 ±30 ±15 icontinuous 0 to +70 40 to +85 55 to +125 55 to +150	0580A SOT96-1 V V V MW mW mW W W V V V V V C C C C C
3-Pin Ceramic Dual 3-Pin Ceramic Dual 3-Pin Small Outline BSOLUTE MA SYMBOL 7/s 5 0 7/IN 7/N 5 5 5 7 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	In-Line Package (CERDIP) (SO) Package XIMUM RATINGS Supply voltage μA741C μA741 Internal power dissipation D package N package F package Differential input voltage Input voltage ¹ Output short-circuit duration Operating temperature range μA741C SA741C SA741C μA741 Storage temperature range Lead soldering temperature (10sec max)	0 to +70°C 0 to +70°C		μΑ741CF μΑ741CD RATING ±18 ±22 780 1170 600 ±15 500 ±15 0 to +70 40 to +85 55 to +125 55 to +150 300	0580A SOT96-1 V V V W W W W W W W V V V V V V V C C C C

- **1. Device number & brief description:** On the datasheet is device number and its brief description is given e.g., low power op-amp.
- 2. Features & General description: It includes device construction process, major features & intended applications.

Genera	al purpose operational ampli	fier	μ	A74	۳۰۵ /µ A741C /	luct specifica
DESCRIPTI The µA741 is a poen-loop gipen-loop gipen-loop gip and exceptiona short-circuit-pro FEATURES Internal freque Short circuit p Excellent terr High input vo	ON high performance operational amplifier with high internal compensation, high common mode range I temperature stability. The μA741 is tected and allows for nulling of offset voltage. ency compensation protection uperature stability itage range		PIN CONFIGURAT	ION D, F, N F 1 2 	Packages B NC 7 V+ 6 OUT 5 OFF In Configuration	PUT SET NULL SLOC
ORDERING				IGE		DWG
8-Pin Plastic F	Dual In-Line Package (DIP)		55%C to 125%C			SOTOT
8-Pin Plastic Dual In-Line Package (DIP)			0 to +70°C		uA741CN SOT	
8-Pin Plastic Dual In-Line Package (DIP)			-40°C to +85°C	+85°C SA741CN		SOT97
8-Pin Ceramic	Dual In-Line Package (CERDIP)		-55°C to +125°C	C μΑ741F		0580A
8-Pin Ceramic	Dual In-Line Package (CERDIP)		0 to +70°C	μA741CF		0580A
8-Pin Small Or	utline (SO) Package		0 to +70°C		μA741CD	SOT96
	MAXIMUM RATINGS				RATING	UNIT
Vs	Supply voltage					
	μA741C				±18	v
	μΑ741				±22	V
PD	Internal power dissipation					
	D package				780	mW
	N package				1170	mW
	F package			800		mW
VIN	Differential input voltage			±30		V
VIN	Input voltage'				±15	v
ISC	Output short-circuit duration			(Jontinuous	
A	Operating temperature range				0.4070	
	μΑ/410 SA7410				010+/0	.0
	0.741				-40 (0 +65	-0
Terre	Storage temperature range				65 to + 120	•0
'SIG	Load coldering temperature (10ccc mov)				200	•0
NOTES: I. For supply v	Lead soldering temperature (10sec max) voltages less than ±15V, the absolute maximum input v	voltage	is equal to the supply v	oltage.	300	℃

- Device number & brief description: On the datasheet is device number and its brief description is given e.g., low power op-amp.
- 2. Features & General description: It includes device construction process, major features & intended applications.
- **3. Pin & Packaging:** It describes available IC package types and their pin diagrams.

Philips Semicond	uctors			Prod	luct specificati	
General purpose operational amplifier					SA741C	
DESCRIPTION The µA741 is a high performance operational amplifier with high open-loop gain, internal compensation, high common mode range and exceptional temperature stability. The µA741 is short-circuit-protected and allows for nulling of offset voltage. FEATURES • Internal frequency compensation • Short circuit protection • Excellent temperature stability. • Excellent temperature stability. • High input voltage range						
ORDERING IN	FORMATION	-				
	DESCRIPTION	TEMPERATURE RAN	IGE	ORDER CODE	DWG #	
8-Pin Plastic Dual	In-Line Package (DIP)	-55°C to +125°C		μΑ/41Ν	SU197-1	
8-Pin Plastic Dual	In-Line Package (DIP)	0 to +/0°C	μΑ/41CN		S0197-1	
8-Pin Plastic Dual	In-Line Package (DIP)	-40°C to +85°C	C 3A7410N		SU197-1	
8-Pin Ceramic Du	al In-Line Package (CERDIP)	-55*0 t0 +125*0		μΑ/41F	0580A	
8-Pin Ceramic Du	a In-Line Fackage (CERDIF)	0 to +70°C		μΑ741CF	AU8CU	
ABSOLUTE MA	AXIMUM RATINGS			RATING	UNIT	
Vs	Supply voltage					
	μA741C			±18	v	
	μΑ741			±22	٧	
PD	Internal power dissipation					
	D package			780	mW	
	N package			1170	mW	
	F package			800	mW	
VIN	Universitian Input Voltage		±30		V	
VIN	Input voltage'			±15 V		
'SC	Output short-circuit duration			Sominuous		
'A	uA741C			0 to +70	•	
	SA741C		0 to +/0		•0	
	uA741			-55 to +125	°C	
Toro	Storage temperature range			65 to ±150		
ISIG	otorage temperature range			0010 + 130		

NOTES:

. For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.

- Device number & brief description: On the datasheet is device number and its brief description is given e.g., low power op-amp.
- 2. Features & General description: It includes device construction process, major features & intended applications.
- **3. Pin & Packaging:** It describes available IC package types and their pin diagrams.
- **4. Ratings:** Absolute maximum ratings are specified for proper operation of the device.



0 to +70

-40 to +85

-55 to +125

-65 to +150

300

°C

°C

°C °C

°C

Dperating temperature range µA741C

Storage temperature range Lead soldering temperature (10sec max)

For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.

SA741C

μA741

NOTES

5. Functional Schematic: Approximate internal circuit is given to explain functionality.

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7 Detailed Description

7.1 Overview

The μ A741 has been a popular operational amplifier for over four decades. Typical open loop gain is 106 dB while driving a 2000- Ω load. Short circuit tolerance, offset voltage trimming, and unity-gain stability makes the μ A741 useful for many applications.



7.3 Feature Description

7.3.1 Offset-Voltage Null Capability

The input offset voltage of operational amplifiers (op amps) arises from unavoidable mismatches in the differential input stage of the op-amp circuit caused by mismatched transistor pairs, collector currents, current-gain betas (β), collector or emitter resistors and so forth. The input offset pins allow the designer to adjust for

- **5. Functional Schematic:** Approximate internal circuit is given to explain functionality.
- **6. Electrical Characteristics:** Parameter values under specific conditions are tabulated.

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6.5 at spe	6.5 Electrical Characteristics: μΑ741Y at specified virtual junction temperature, V _{CCs} = ±15 V, T _A = 25°C (unless otherwise noted) ⁽¹⁾									
	PARAMETER	TEST CONDITIONS (2)	MIN	TYP	MAX	UNIT				
Vio	Input offset voltage	V ₀ = 0		1	5	mV				
ΔV _{ID(ad)}) Offset voltage adjust range	V _O = 0		±15		mV				
ho	Input offset current	V ₀ = 0		20	200	nA				
I _{IB}	Input bias current	V ₀ = 0		80	500	nA				
VICR	Common-mode input voltage range		±12	±13		v				
V	Meximum peak output voltage awing	R _L = 10 kΩ	±12	±14		v				
YOM	Maximum peak output voitage swing	R _L = 2 kΩ	±10	±13		×				
Avo	Large-signal differential voltage amplification	R _L ≥ 2 kΩ	20	200		V/mV				
r,	Input resistance		0.3	2		MΩ				
r _o	Output resistance	V ₀ = 0; see ⁽¹⁾		75		Ω				
Ci	Input capacitance			1.4		pF				
CMRR	Common-mode rejection ratio	VIC = VICRmin	70	90		dB				
k _{SVS}	Supply voltage sensitivity $(\Delta V_{IO}/\Delta V_{CC})$	V _{CC} = ±9 V to ±15 V		30	150	μ٧/٧				
los	Short-circuit output current			±25	±40	mA				
lcc	Supply current	Vo = 0; no load		1.7	2.8	mA				
PD	Total power dissipation	Vo = 0; no load		50	85	mW				

This typical value applies only at frequencies above a few hundred hertz because of the effects of drift and thermal feedback.
 All characteristics are measured under open-loop conditions with zero common-mode voltage unless otherwise specified.

6.6 Switching Characteristics: µA741C

over operating free-air temperature range, V_{CC±} = ±15 V, T_A = 25°C (unless otherwise noted)

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t,	Rise time	$V_1 = 20 \text{ mV}, R_1 = 2 \text{ k}\Omega$		0.3		μs
	Overshoot factor	C _L = 100 pF; see Figure 1		5%		
SR	Slew rate at unity gain	$V_I = 10 V$, $R_L = 2 k\Omega$ $C_L = 100 pF$; see Figure 1		0.5		V/µs

6.7 Switching Characteristics: µA741Y

over operating free-air temperature range, V_{CC±} = ±15 V, T_A = 25°C (unless otherwise noted)

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t _r	Rise time	V ₁ = 20 mV, R _L = 2 kΩ C _L = 100 pF; see Figure 1		0.3		μs
	Overshoot factor			5%		
SR	Slew rate at unity gain	$ \begin{array}{l} V_{i} = 10 \; V, \; R_{L} = 2 \; k\Omega \\ C_{L} = 100 \; pF; \; see \; Figure \; 1 \end{array} $		0.5		V/µs
-						

- **5. Functional Schematic:** Approximate internal circuit is given to explain functionality.
- **6. Electrical Characteristics:** Parameter values under specific conditions are tabulated.
- 7. Performance curves: Parametric changes with respect to supply voltage, frequency and temperature, etc. are described with graphs.



- **5. Functional Schematic:** Approximate internal circuit is given to explain functionality.
- **6. Electrical Characteristics:** Parameter values under specific conditions are tabulated.
- 7. Performance curves: Parametric changes with respect to supply voltage, frequency and temperature, etc. are described with graphs.
- 8. Applications & Test Circuits: Typical applications & test circuits are illustrated usually in last.



LINEAR INTEGRATED CIRCUITS

Thank You

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