MCP6021/1R/2/3/4

Rail-to-Rail Input/Output, 10 MHz Op Amps

Features

- Rail-to-Rail Input/Output
- Wide Bandwidth: 10 MHz (typ.)
- Low Noise: 8.7 nV/√Hz, at 10 kHz (typ.)
- Low Offset Voltage:
  - Industrial Temperature: ±500 µV (max.)
  - Extended Temperature: ±250 µV (max.)
- Mid-Supply V_{REF}: MCP6021 and MCP6023
- Low Supply Current: 1 mA (typ.)
- Total Harmonic Distortion: 0.00053% (typ., G = 1)
- Unity Gain Stable
- Power Supply Range: 2.5V to 5.5V
- Temperature Range:
  - Industrial: -40°C to +85°C
  - Extended: -40°C to +125°C

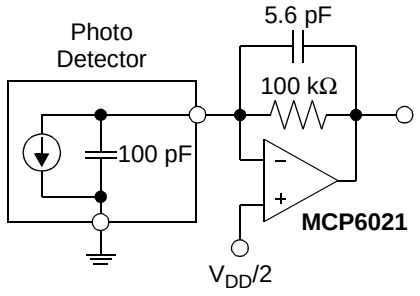
Typical Applications

- Automotive
- Driving A/D Converters
- Multi-Pole Active Filters
- Barcode Scanners
- Audio Processing
- Communications
- DAC Buffer
- Test Equipment
- Medical Instrumentation

Available Tools

- SPICE Macro Model (at www.microchip.com)
- FilterLab® software (at www.microchip.com)

Typical Application



Transimpedance Amplifier

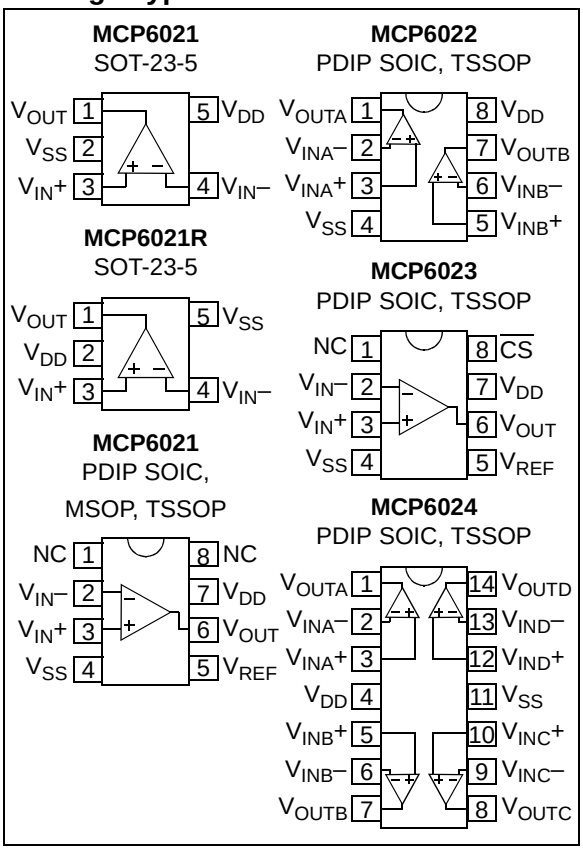
Description

The MCP6021, MCP6021R, MCP6022, MCP6023 and MCP6024 from Microchip Technology Inc. are rail-to-rail input and output op amps with high performance. Key specifications include: wide bandwidth (10 MHz), low noise (8.7 nV/√Hz), low input offset voltage and low distortion (0.00053% THD+N). The MCP6023 also offers a Chip Select pin ($\overline{CS}$) that gives power savings when the part is not in use.

The single MCP6021 and MCP6021R are available in SOT-23-5. The single MCP6021, single MCP6023 and dual MCP6022 are available in 8-lead PDIP, SOIC and TSSOP. The Extended Temperature single MCP6021 is available in 8-lead MSOP. The quad MCP6024 is offered in 14-lead PDIP, SOIC and TSSOP packages.

The MCP6021/1R/2/3/4 family is available in Industrial and Extended temperature ranges. It has a power supply range of 2.5V to 5.5V.

Package Types



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

$V_{DD} - V_{SS}$ 7.0V
All Inputs and Outputs..... $V_{SS} - 0.3V$ to $V_{DD} + 0.3V$
Difference Input Voltage ..... $|V_{DD} - V_{SS}|$
Output Short Circuit Current .....continuous
Current at Input Pins .....±2 mA
Current at Output and Supply Pins .....±30 mA
Storage Temperature.....-65°C to +150°C
Junction Temperature.....+150°C
ESD Protection on all pins (HBM; MM)..... ≥ 2 kV; 200V

† **Notice:** Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

DC ELECTRICAL CHARACTERISTICS

Electrical Specifications: Unless otherwise indicated, T_A = +25°C, V_{DD} = +2.5V to +5.5V, V_{SS} = GND, $V_{CM} = V_{DD}/2$, $V_{OUT} \approx V_{DD}/2$ and R_L = 10 kΩ to $V_{DD}/2$.

Parameters	Sym	Min	Typ	Max	Units	Conditions
Input Offset						
Input Offset Voltage:						
Industrial Temperature Parts	V_{OS}	-500	—	+500	µV	V_{CM} = 0V
Extended Temperature Parts	V_{OS}	-250	—	+250	µV	V_{CM} = 0V, V_{DD} = 5.0V
Extended Temperature Parts	V_{OS}	-2.5	—	+2.5	mV	V_{CM} = 0V, V_{DD} = 5.0V T_A = -40°C to +125°C
Input Offset Voltage Temperature Drift	$\Delta V_{OS}/\Delta T_A$	—	±3.5	—	µV/°C	T_A = -40°C to +125°C
Power Supply Rejection Ratio	PSRR	74	90	—	dB	V_{CM} = 0V
Input Current and Impedance						
Input Bias Current	I_B	—	1	—	pA	
Industrial Temperature Parts	I_B	—	30	150	pA	T_A = +85°C
Extended Temperature Parts	I_B	—	640	5,000	pA	T_A = +125°C
Input Offset Current	I_{OS}	—	±1	—	pA	
Common-Mode Input Impedance	Z_{CM}	—	10^{13}||6	—	Ω||pF	
Differential Input Impedance	Z_{DIFF}	—	10^{13}||3	—	Ω||pF	
Common-Mode						
Common-Mode Input Range	V_{CMR}	V_{SS}-0.3	—	V_{DD}+0.3	V	
Common-Mode Rejection Ratio	CMRR	74	90	—	dB	V_{DD} = 5V, V_{CM} = -0.3V to 5.3V
	CMRR	70	85	—	dB	V_{DD} = 5V, V_{CM} = 3.0V to 5.3V
	CMRR	74	90	—	dB	V_{DD} = 5V, V_{CM} = -0.3V to 3.0V
Voltage Reference (MCP6021 and MCP6023 only)						
V_{REF} Accuracy ($V_{REF} - V_{DD}/2$)	V_{REF_ACC}	-50	—	+50	mV	
V_{REF} Temperature Drift	$\Delta V_{REF}/\Delta T_A$	—	±100	—	µV/°C	T_A = -40°C to +125°C
Open-Loop Gain						
DC Open-Loop Gain (Large Signal)	A_{OL}	90	110	—	dB	V_{CM} = 0V, V_{OUT} = V_{SS}+0.3V to V_{DD}-0.3V
Output						
Maximum Output Voltage Swing	V_{OL}, V_{OH}	V_{SS}+15	—	V_{DD}-20	mV	0.5V output overdrive
Output Short Circuit Current	I_{SC}	—	±30	—	mA	V_{DD} = 2.5V
	I_{SC}	—	±22	—	mA	V_{DD} = 5.5V
Power Supply						
Supply Voltage	V_S	2.5	—	5.5	V	
Quiescent Current per Amplifier	I_Q	0.5	1.0	1.35	mA	I_O = 0

AC ELECTRICAL CHARACTERISTICS

Electrical Specifications: Unless otherwise indicated, T_A = +25°C, V_{DD} = +2.5V to +5.5V, V_{SS} = GND, V_{CM} = V_{DD}/2, V_{OUT} ≈ V_{DD}/2, R_L = 10 kΩ to V_{DD}/2 and C_L = 60 pF.

Parameters	Sym	Min	Typ	Max	Units	Conditions
AC Response						
Gain Bandwidth Product	GBWP	—	10	—	MHz	
Phase Margin at Unity-Gain	PM	—	65	—	°	G = +1
Settling Time, 0.2%	t_{SETTLE}	—	250	—	ns	G = +1, V_{OUT} = 100 mV_{p-p}
Slew Rate	SR	—	7.0	—	V/µs	
Total Harmonic Distortion Plus Noise						
f = 1 kHz, G = +1 V/V	THD+N	—	0.00053	—	%	V_{OUT} = 0.25V to 3.25V (1.75V ± 1.50V_{PK}), V_{DD} = 5.0V, BW = 22 kHz
f = 1 kHz, G = +1 V/V, R_L = 600Ω	THD+N	—	0.00064	—	%	V_{OUT} = 0.25V to 3.25V (1.75V ± 1.50V_{PK}), V_{DD} = 5.0V, BW = 22 kHz
f = 1 kHz, G = +1 V/V	THD+N	—	0.0014	—	%	V_{OUT} = 4V_{P-P}, V_{DD} = 5.0V, BW = 22 kHz
f = 1 kHz, G = +10 V/V	THD+N	—	0.0009	—	%	V_{OUT} = 4V_{P-P}, V_{DD} = 5.0V, BW = 22 kHz
f = 1 kHz, G = +100 V/V	THD+N	—	0.005	—	%	V_{OUT} = 4V_{P-P}, V_{DD} = 5.0V, BW = 22 kHz
Noise						
Input Noise Voltage	E_{ni}	—	2.9	—	µVp-p	f = 0.1 Hz to 10 Hz
Input Noise Voltage Density	e_{ni}	—	8.7	—	nV/√Hz	f = 10 kHz
Input Noise Current Density	i_{ni}	—	3	—	fA/√Hz	f = 1 kHz

MCP6023 CHIP SELECT ($\overline{CS}$) ELECTRICAL CHARACTERISTICS

Electrical Specifications: Unless otherwise indicated, T_A = +25°C, V_{DD} = +2.5V to +5.5V, V_{SS} = GND, V_{CM} = V_{DD}/2, V_{OUT} ≈ V_{DD}/2, R_L = 10 kΩ to V_{DD}/2 and C_L = 60 pF.

Parameters	Sym	Min	Typ	Max	Units	Conditions
$\overline{CS}$ Low Specifications						
$\overline{CS}$ Logic Threshold, Low	V_{IL}	V_{SS}	—	0.2 V_{DD}	V	
$\overline{CS}$ Input Current, Low	I_{CSL}	-1.0	0.01	—	µA	$\overline{CS}$ = V_{SS}
$\overline{CS}$ High Specifications						
$\overline{CS}$ Logic Threshold, High	V_{IH}	0.8 V_{DD}	—	V_{DD}	V	
$\overline{CS}$ Input Current, High	I_{CSH}	—	0.01	2.0	µA	$\overline{CS}$ = V_{DD}
GND Current	I_{SS}	-2	-0.05	—	µA	$\overline{CS}$ = V_{DD}
Amplifier Output Leakage	$I_{O(LEAK)}$	—	0.01	—	µA	$\overline{CS}$ = V_{DD}
$\overline{CS}$ Dynamic Specifications						
$\overline{CS}$ Low to Amplifier Output Turn-on Time	t_{ON}	—	2	10	µs	G = +1, V_{IN} = V_{SS}, $\overline{CS}$ = 0.2V_{DD} to V_{OUT} = 0.45V_{DD} time
$\overline{CS}$ High to Amplifier Output High-Z Time	t_{OFF}	—	0.01	—	µs	G = +1, V_{IN} = V_{SS}, $\overline{CS}$ = 0.8V_{DD} to V_{OUT} = 0.05V_{DD} time
Hysteresis	V_{HYST}	—	0.6	—	V	V_{DD} = 5.0V, Internal Switch

TEMPERATURE CHARACTERISTICS

Electrical Specifications: Unless otherwise indicated, V_{DD} = +2.5V to +5.5V and V_{SS} = GND.						
Parameters	**Sym**	**Min**	**Typ**	**Max**	**Units**	**Conditions**
Temperature Ranges						
Industrial Temperature Range	T_A	-40	—	+85	°C	
Extended Temperature Range	T_A	-40	—	+125	°C	
Operating Temperature Range	T_A	-40	—	+125	°C	**Note 1**
Storage Temperature Range	T_A	-65	—	+150	°C	
Thermal Package Resistances						
Thermal Resistance, 5L-SOT-23	θ_{JA}	—	256	—	°C/W	
Thermal Resistance, 8L-PDIP	θ_{JA}	—	85	—	°C/W	
Thermal Resistance, 8L-SOIC	θ_{JA}	—	163	—	°C/W	
Thermal Resistance, 8L-MSOP	θ_{JA}	—	206	—	°C/W	
Thermal Resistance, 8L-TSSOP	θ_{JA}	—	124	—	°C/W	
Thermal Resistance, 14L-PDIP	θ_{JA}	—	70	—	°C/W	
Thermal Resistance, 14L-SOIC	θ_{JA}	—	120	—	°C/W	
Thermal Resistance, 14L-TSSOP	θ_{JA}	—	100	—	°C/W	

Note 1: The industrial temperature devices operate over this extended temperature range, but with reduced performance. In any case, the internal junction temperature (T_J) must not exceed the absolute maximum specification of 150°C.

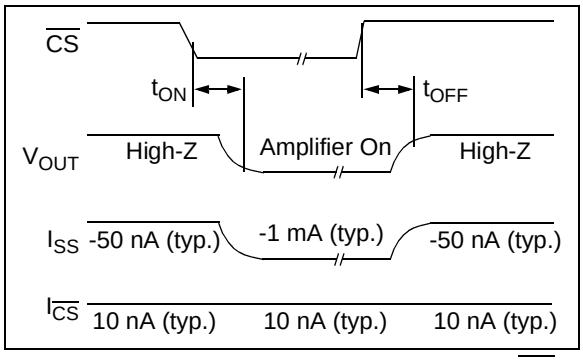
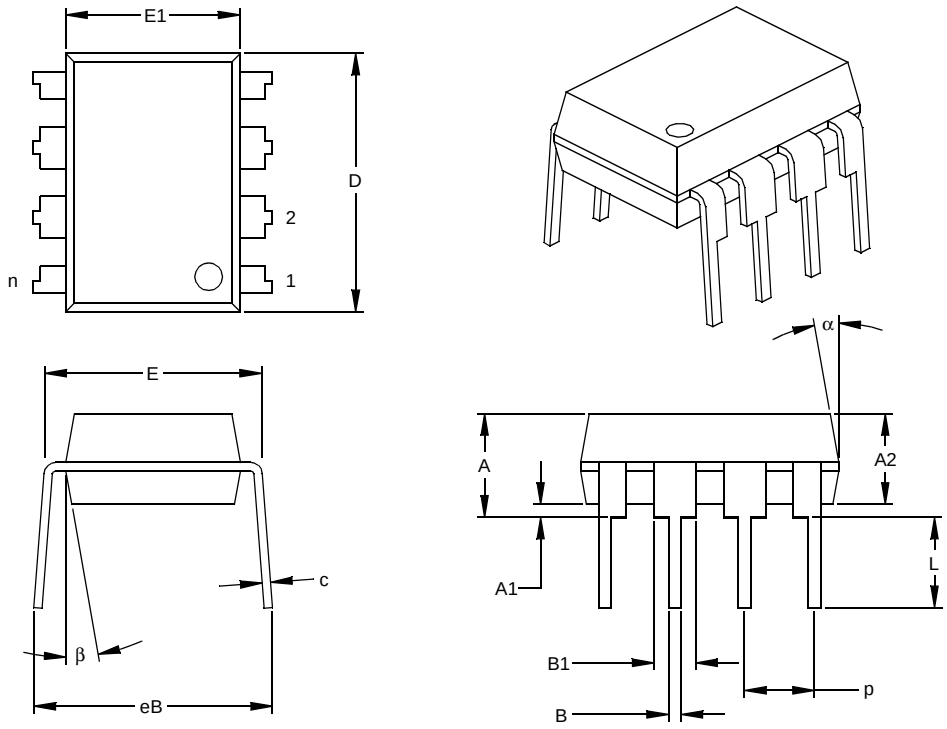


FIGURE 1-1: *Timing diagram for the $\overline{CS}$ pin on the MCP6023.*

8-Lead Plastic Dual In-line (P) – 300 mil (PDIP)



Units		INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		8			8	
Pitch	p		.100			2.54	
Top to Seating Plane	A	.140	.155	.170	3.56	3.94	4.32
Molded Package Thickness	A2	.115	.130	.145	2.92	3.30	3.68
Base to Seating Plane	A1	.015			0.38		
Shoulder to Shoulder Width	E	.300	.313	.325	7.62	7.94	8.26
Molded Package Width	E1	.240	.250	.260	6.10	6.35	6.60
Overall Length	D	.360	.373	.385	9.14	9.46	9.78
Tip to Seating Plane	L	.125	.130	.135	3.18	3.30	3.43
Lead Thickness	c	.008	.012	.015	0.20	0.29	0.38
Upper Lead Width	B1	.045	.058	.070	1.14	1.46	1.78
Lower Lead Width	B	.014	.018	.022	0.36	0.46	0.56
Overall Row Spacing §	eB	.310	.370	.430	7.87	9.40	10.92
Mold Draft Angle Top	α	5	10	15	5	10	15
Mold Draft Angle Bottom	β	5	10	15	5	10	15

* Controlling Parameter
§ Significant Characteristic

Notes:
Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010” (0.254mm) per side.
JEDEC Equivalent: MS-001
Drawing No. C04-018

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

PART NO.	X	/XX
Device	Temperature Range	Package

Device:	MCP6021	Single Op Amp
	MCP6021T	Single Op Amp (Tape and Reel for SOT-23, SOIC, TSSOP, MSOP)
	MCP6021R	Single Op Amp
	MCP6021RT	Single Op Amp (Tape and Reel for SOT-23)
	MCP6022	Dual Op Amp
	MCP6022T	Dual Op Amp (Tape and Reel for SOIC and TSSOP)
	MCP6023	Single Op Amp w/ $\overline{CS}$
	MCP6023T	Single Op Amp w/ $\overline{CS}$ (Tape and Reel for SOIC and TSSOP)
	MCP6024	Quad Op Amp
	MCP6024T	Quad Op Amp (Tape and Reel for SOIC and TSSOP)
Temperature Range:	I =	-40°C to +85°C
	E =	-40°C to +125°C
Package:	OT =	Plastic Small Outline Transistor (SOT-23), 5-lead (MCP6021, E-Temp; MCP6021R, E-Temp)
	MS =	Plastic MSOP, 8-lead (MCP6021, E-Temp)
	P =	Plastic DIP (300 mil Body), 8-lead, 14-lead
	SN =	Plastic SOIC (150mil Body), 8-lead
	SL =	Plastic SOIC (150 mil Body), 14-lead
	ST =	Plastic TSSOP, 8-lead (MCP6021,I-Temp; MCP6022, I-Temp, E-Temp; MCP6023, I-Temp, E-Temp;)
	ST =	Plastic TSSOP, 14-lead

Examples:

a)	MCP6021T-E/OT:	Tape and Reel, Extended temperature, 5LD SOT-23.
b)	MCP6021-E/P:	Extended temperature, 8LD PDIP.
c)	MCP6021-E/SN:	Extended temperature, 8LD SOIC.
a)	MCP6021RT-E/OT:	Tape and Reel, Extended temperature, 5LD SOT-23.
a)	MCP6022-I/P:	Industrial temperature, 8LD PDIP.
b)	MCP6022-E/P:	Extended temperature, 8LD PDIP.
c)	MCP6022T-E/ST:	Tape and Reel, Extended temperature, 8LD TSSOP.
a)	MCP6023-I/P:	Industrial temperature, 8LD PDIP.
b)	MCP6023-E/P:	Extended temperature, 8LD PDIP.
c)	MCP6023-E/SN:	Extended temperature, 8LD SOIC.
a)	MCP6024-I/SL:	Industrial temperature, 14LD SOIC.
b)	MCP6024-E/SL:	Extended temperature, 14LD SOIC.
c)	MCP6024T-E/ST:	Tape and Reel, Extended temperature, 14LD TSSOP.