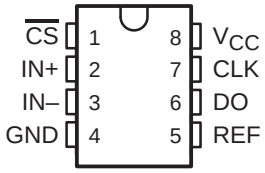
8-BIT ANALOG-TO-DIGITAL CONVERTERS WITH SERIAL CONTROL

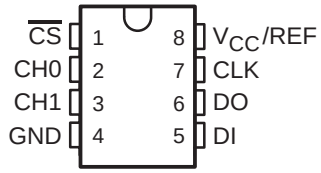
SLAS107B – JANUARY 1995 – REVISED APRIL 1996

- **8-Bit Resolution**
- **Easy Microprocessor Interface or Standalone Operation**
- **Operates Ratiometrically or With 5-V Reference**
- **Single Channel or Multiplexed Twin Channels With Single-Ended or Differential Input Options**
- **Input Range 0 to 5 V With Single 5-V Supply**
- **Inputs and Outputs Are Compatible With TTL and MOS**
- **Conversion Time of 32 μs at f_{clock} = 250 kHz**
- **Designed to Be Interchangeable With National Semiconductor ADC0831 and ADC0832**
- **Total Unadjusted Error . . . ±1 LSB**

TLC0831 . . . D OR P PACKAGE
(TOP VIEW)



TLC0832 . . . D OR P PACKAGE
(TOP VIEW)



description

These devices are 8-bit successive-approximation analog-to-digital converters. The TLC0831 has single input channels; the TLC0832 has multiplexed twin input channels. The serial output is configured to interface with standard shift registers or microprocessors.

The TLC0832 multiplexer is software configured for single-ended or differential inputs. The differential analog voltage input allows for common-mode rejection or offset of the analog zero input voltage value. In addition, the voltage reference input can be adjusted to allow encoding any smaller analog voltage span to the full 8 bits of resolution.

The operation of the TLC0831 and TLC0832 devices is very similar to the more complex TLC0834 and TLC0838 devices. Ratiometric conversion can be attained by setting the REF input equal to the maximum analog input signal value, which gives the highest possible conversion resolution. Typically, REF is set equal to V_{CC} (done internally on the TLC0832).

The TLC0831C and TLC0832C are characterized for operation from 0°C to 70°C. The TLC0831I and TLC0832I are characterized for operation from –40°C to 85°C.

AVAILABLE OPTIONS

T_A	PACKAGE			
	SMALL OUTLINE (D)		PLASTIC DIP (P)	
0°C to 70°C	TLC0831CD	TLC0832CD	TLC0831CP	TLC0832CP
–40°C to 85°C	TLC0831ID	TLC0832ID	TLC0831IP	TLC0832IP

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absolute maximum ratings over recommended operating free-air temperature range (unless otherwise noted)†

Supply voltage, V_{CC} (see Note 1) . . . . . 6.5 V
Input voltage range, V_I: Logic . . . . . –0.3 V to V_{CC} + 0.3 V
Analog . . . . . –0.3 V to V_{CC} + 0.3 V
Input current, I_I . . . . . ±5 mA
Total input current . . . . . ±20 mA
Operating free-air temperature range, T_A: C suffix . . . . . 0°C to 70°C
I suffix . . . . . –40°C to 85°C
Storage temperature range, T_{stg} . . . . . –65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: P package . . . . . 260°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: All voltage values, except differential voltages, are with respect to the network ground terminal.

recommended operating conditions

		MIN	NOM	MAX	UNIT
Supply voltage, V_{CC}		4.5	5	5.5	V
High-level input voltage, V_{IH}		2			V
Low-level input voltage, V_{IL}				0.8	V
Clock frequency, f_{clock}		10		600	kHz
Clock duty cycle (see Note 2)		40%		60%	
Pulse duration, $\overline{CS}$ high, $t_{wH(CS)}$		220			ns
Setup time, $\overline{CS}$ low or TLC0832 data valid before CLK↑, t_{su}		350			ns
Hold time, TLC0832 data valid after CLK↑, t_h		90			ns
Operating free-air temperature, T_A	C suffix	0		70	°C
	I suffix	–40		85	

NOTE 2: The clock-duty-cycle range ensures proper operation at all clock frequencies. When a clock frequency is used outside the recommended duty-cycle range, the minimum pulse duration (high or low) is 1 µs.

electrical characteristics over recommended range of operating free-air temperature, V_{CC} = 5 V, f_{clock} = 250 kHz (unless otherwise noted)

digital section

PARAMETER		TEST CONDITIONS†		C SUFFIX			I SUFFIX			UNIT
				MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{OH}	High-level output voltage	V_{CC} = 4.75 V,	I_{OH} = –360 µA	2.8			2.4			V
		V_{CC} = 4.75 V,	I_{OH} = –10 µA	4.6			4.5			
V_{OL}	Low-level output voltage	V_{CC} = 4.75 V,	I_{OL} = 1.6 mA	0.34			0.4			V
I_{IH}	High-level input current	V_{IH} = 5 V			0.005	1		0.005	1	µA
I_{IL}	Low-level input current	V_{IL} = 0			–0.005	–1		–0.005	–1	µA
I_{OH}	High-level output (source) current	V_{OH} = V_O,	T_A = 25°C	–6.5	–24		–6.5	–24		mA
I_{OL}	Low-level output (sink) current	V_{OL} = V_{CC},	T_A = 25°C	8	26		8	26		mA
I_{OZ}	High-impedance-state output current (DO)	V_O = 5 V,	T_A = 25°C		0.01	3		0.01	3	µA
		V_O = 0,	T_A = 25°C		–0.01	–3		–0.01	–3	
C_i	Input capacitance				5			5		pF
C_o	Output capacitance				5			5		pF

† All parameters are measured under open-loop conditions with zero common-mode input voltage.
‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.

analog and converter section

PARAMETER			TEST CONDITIONS†	MIN	TYP‡	MAX	UNIT
V_{IC}	Common-mode input voltage		See Note 3	–0.05 to V_{CC}+0.05			V
$I_{I(stdby)}$	Standby input current (see Note 4)	On channel	V_I = 5 V			1	µA
		Off channel	V_I = 0			–1	
		On channel	V_I = 0			–1	
		Off channel	V_I = 5 V			1	
$r_{i(REF)}$	Input resistance to REF			1.3	2.4	5.9	kΩ

† All parameters are measured under open-loop conditions with zero common-mode input voltage.
‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.

NOTES: 3. When channel IN– is more positive than channel IN+, the digital output code is 0000 0000. Connected to each analog input are two on-chip diodes that conduct forward current for analog input voltages one diode drop above V_{CC}. Care must be taken during testing at low V_{CC} levels (4.5 V) because high-level analog input voltage (5 V) can, especially at high temperatures, cause the input diode to conduct and cause errors for analog inputs that are near full scale. As long as the analog voltage does not exceed the supply voltage by more than 50 mV, the output code is correct. To achieve an absolute 0- to 5-V input range requires a minimum V_{CC} of 4.95 V for all variations of temperature and load.

4. Standby input currents go in or out of the on or off channels when the A/D converter is not performing conversion and the clock is in a high or low steady-state conditions.

total device

PARAMETER			MIN	TYP‡	MAX	UNIT
I_{CC}	Supply current	TLC0831		0.6	1.25	mA
		TLC0832		2.5	4.7	

‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.

operating characteristics $V_{CC} = V_{ref} = 5$ V, $f_{clock} = 250$ kHz, $t_r = t_f = 20$ ns, $T_A = 25°C$ (unless otherwise noted)

PARAMETER			TEST CONDITIONS†	MIN	TYP	MAX	UNIT
	Supply-voltage variation error		V_{CC} = 4.75 V to 5.25 V		±1/16	±1/4	LSB
	Total unadjusted error (see Note 5)		V_{ref} = 5 V, T_A = MIN to MAX			±1	LSB
	Common-mode error		Differential mode		±1/16	±1/4	LSB
t_{pd}	Propagation delay time, output data after CLK↑ (see Note 6)	MSB-first data	C_L = 100 pF		650	1500	ns
		LSB-first data			250	600	
t_{dis}	Output disable time, DO after $\overline{CS}$↑		C_L = 10 pF, R_L = 10 kΩ		125	250	ns
			C_L = 100 pF, R_L = 2 kΩ			500	
t_{conv}	Conversion time (multiplexer-addressing time not included)					8	clock periods

† All parameters are measured under open-loop conditions with zero common-mode input voltage. For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

NOTES: 5. Total unadjusted error includes offset, full-scale, linearity, and multiplexer errors.
6. The MSB-first data is output directly from the comparator and, therefore, requires additional delay to allow for comparator response time. LSB-first data applies only to TLC0832.

PACKAGING INFORMATION

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
TLC0831CD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC0831CDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC0831CP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
TLC0831CPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
TLC0831ID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC0831IDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC0831IDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC0831IP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
TLC0831IPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
TLC0832CD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC0832CDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC0832CDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC0832CP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
TLC0832CPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
TLC0832ID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC0832IDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC0832IDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC0832IP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
TLC0832IPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC

[1] The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

[2] Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered