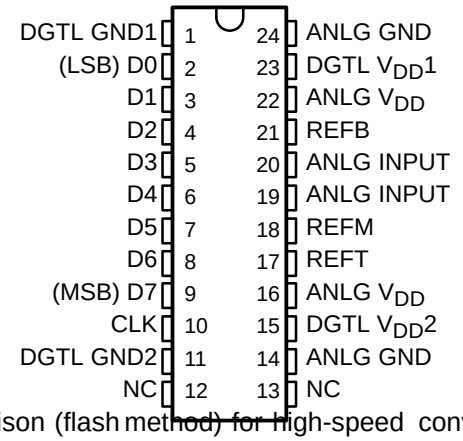
- **LinEPIC™ 1-μm CMOS Process**
- **8-Bit Resolution**
- **Differential Linearity Error . . . ±0.2% Max**
- **Maximum Conversion Rate . . . 20 MHz Typ**
  . . . 10 MHz Min
- **Analog Input Voltage Range . . . 0 V to V_{DD}**
- **TTL Digital I/O Level**
- **Low Power Consumption . . . 150 mW Typ**
- **5-V Single-Supply Operation**

J PACKAGE
(TOP VIEW)



NC – No internal connection

description

The TLC5502-5M is a low-power ultra-high-speed 8-bit analog-to-digital converter that uses the LinEPIC™ CMOS process. It utilizes the full parallel comparison (flash method) for high-speed conversion. Because of such high-speed capability, the TLC5502-5M is suitable for motor control, high-speed signal processing, and video or radar signal processing.

Separate analog and digital supply pins are provided to reduce coupling between the high-speed digital switching sections and the lower-frequency analog signal comparators. This pin partitioning minimizes crosstalk and unwanted spurious signals.

The TLC5502-5M is characterized for operation from –55°C to 125°C.

During storage or handling, the device leads should be shorted together or the device should be placed in conductive foam. In a circuit, unused inputs should always be connected to an appropriated logic voltage level, preferably either V_{CC} or ground. Specific guidelines for handling devices of this type are contained in the publication *Guidelines for Handling Electrostatic-Discharge-Sensitive (ESDS) Devices and Assemblies* available from Texas Instruments.

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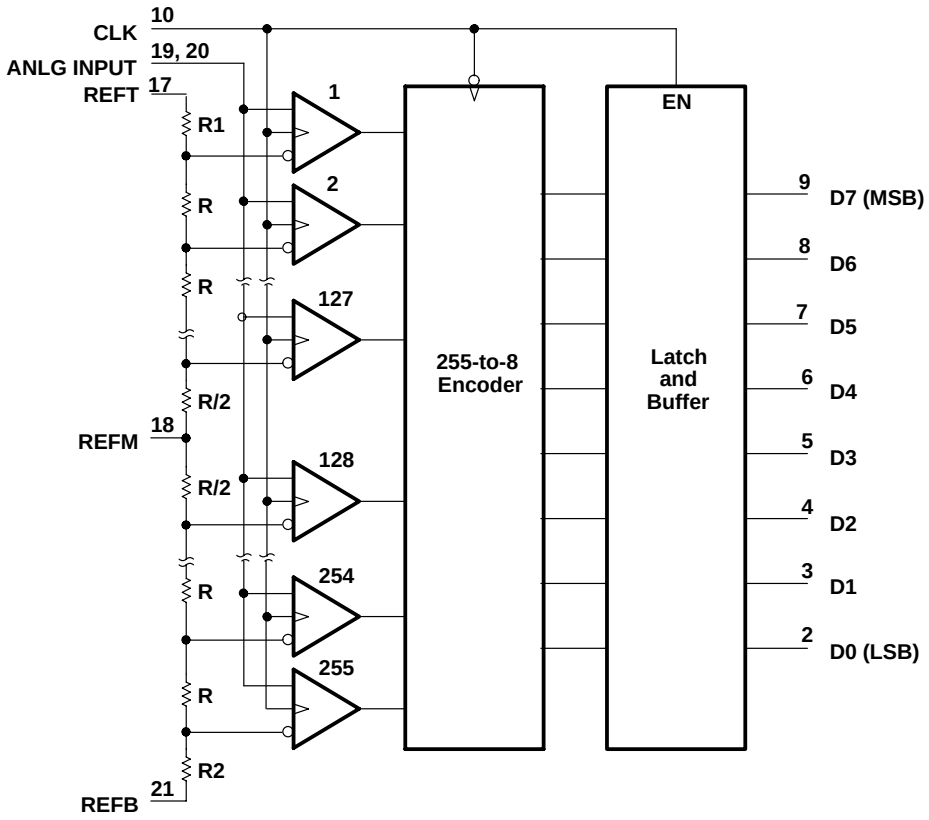
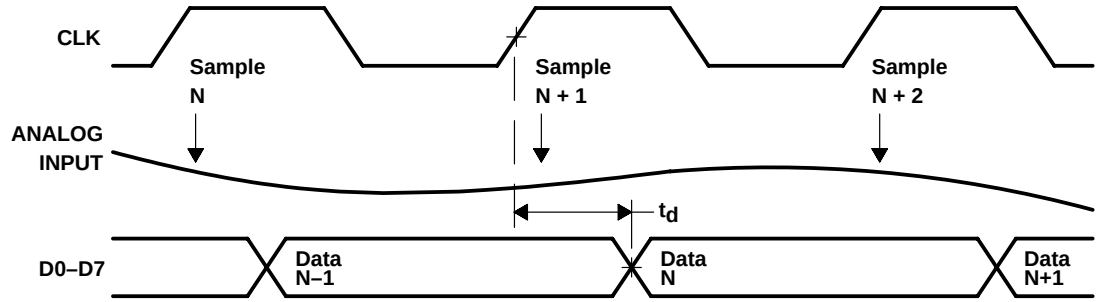
functional block diagram

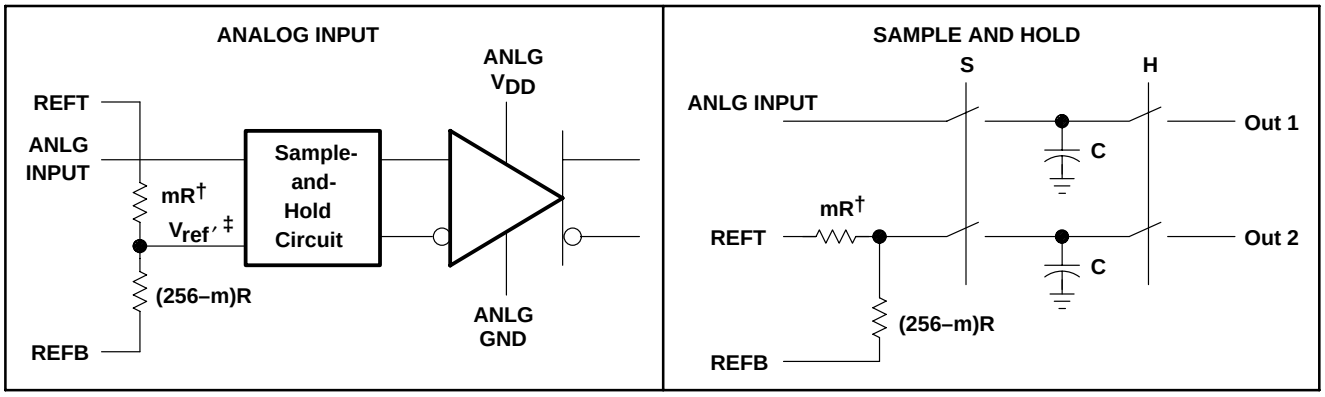


operating sequence



Following the operating sequence above, the rising edge of the clock samples the analog input (sample N) at time t_N and latches sample N–1 at the output. Sample N is encoded to eight digital lines on the next falling edge of the clock and then the following high clock level latches these eight bits to the outputs (with a delay t_d) and acquires sample N + 1. Conversion is completed in one clock cycle and continues the sequence for the next cycle.

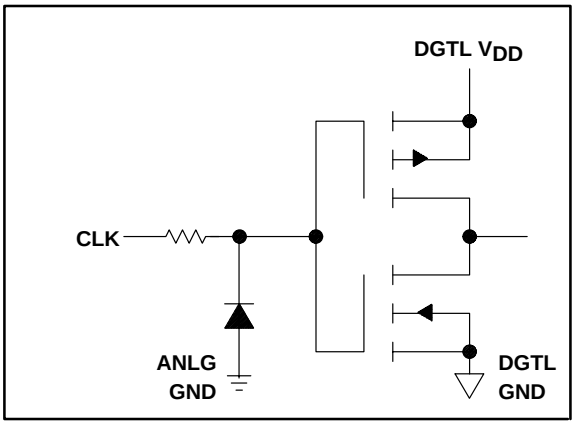
equivalents of analog input circuit



† m = comparator position along the resistor string

‡ $V_{ref}' = \left[V_{refT} - V_{refB}\right]\left[1 - \frac{M}{256}\right] + V_{refB}$

equivalent of digital input circuit



FUNCTION TABLE

STEP	ANALOG INPUT VOLTAGE†	DIGITAL OUTPUT CODE
0	0.000 V	L L L L L L L L
1	0.019 V	L L L L L L L H
. . .	. . .	. . .
127	2.413 V	L H H H H H H H
128	2.432 V	H L L L L L L L
129	2.451 V	H L L L L L L H
. . .	. . .	. . .
254	4.826 V	H H H H H H H L
255	4.845 V	H H H H H H H H

† These values are based on the assumption that V_{refB} and V_{refT} have been adjusted so that the voltage at the transition from digital 0 to 1 (V_{ZT}) is 0 V and the transition to full scale (V_{FT}) is 4.8545 V. 1 LSB = 19 mV.

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

Supply voltage range, ANLG V_{DD} (see Note 1) . . . . . –0.5 V to 7 V
Supply voltage range, DGTL V_{DD} (see Note 1) . . . . . –0.5 V to 7 V
Input voltage range at CLK, V_I . . . . . –0.3 V to DGTL V_{DD} + 0.3 V
Input voltage range at analog input, V_I . . . . . –0.5 V to ANLG V_{DD} + 0.5 V
Analog reference voltage range, V_{ref} . . . . . –0.5 V to ANLG V_{DD} + 0.5 V
Operating free-air temperature range, T_A . . . . . –55°C to 125°C
Storage temperature range . . . . . –55°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds . . . . . 260°C

NOTE 1: Voltages at analog inputs and ANLG V_{DD} are with respect to the ANLG GND terminals. Voltages at the digital outputs and DGTL V_{DD} are with respect to the DGTL GND terminals.

recommended operating conditions

	MIN	NOM	MAX	UNIT
Supply voltage, ANLG V_{DD}	4.75	5	5.25	V
Supply voltage, DGTL V_{DD}	4.75	5	5.25	V
High-level input voltage, V_{IH}, CLK	2			V
Low-level input voltage V_{IL}, CLK			0.8	V
Input voltage at analog input, V_I	0		5	V
Analog reference voltage (top side), V_{refT}		ANLG V_{DD}		V
Analog reference voltage (midpoint), V_{refM}		$\frac{V_{refT} - V_{refB}}{2}$		V
Analog reference voltage (bottom side), V_{refB}		0		V
Differential reference voltage, $V_{refT} - V_{refB}$		5		V
High-level output current, I_{OH}			–400	µA
Low-level output current, I_{OL}			4	mA
Clock pulse duration, high or low, t_{wH} or t_{wL}	50			ns
Operating free-air temperature, T_A	–55		125	°C

electrical characteristics over operating supply voltage range, T_A = 25°C

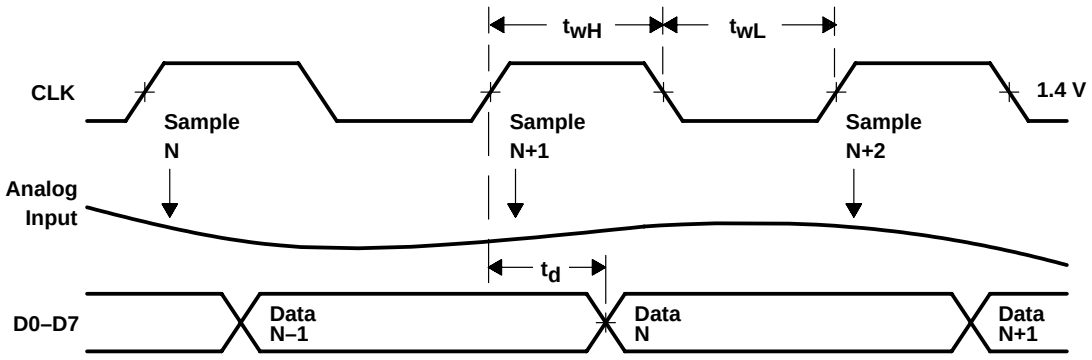
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{OH}	High-level output voltage	I_{OH} = –400 µA	2.4			V
V_{OL}	Low-level output voltage	I_{OL} = 4 mA			0.4	V
I_I	Analog input current	V_I = 0 to 5 V, f_{clock} = 10 MHz		±0.5		mA
I_{IH}	Digitial high-level input current	V_I = 5 V			1	µA
I_{IL}	Digital low-level input current	V_I = 0			–1	µA
I_{refB}	Reference current	V_{refB} = 0		–10	–20	mA
I_{refT}	Reference current	V_{refT} = 5 V		10	20	mA
C_i	Analog input capacitance			50		pF
I_{DD}	Supply current	f_{clock} = 10 MHz		30	60	mA

operating characteristics over operating supply voltage range, T_A = 25°C

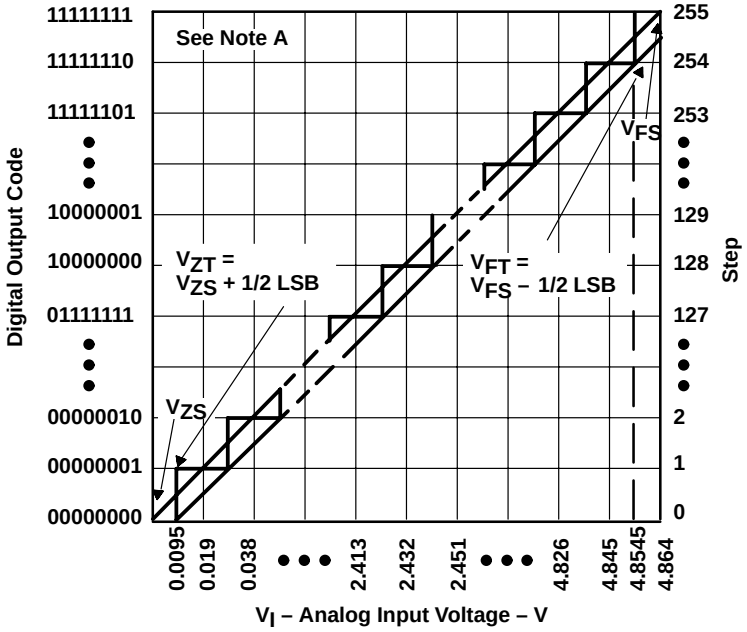
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$f_{c(max)}$	Maximum conversion rate		10	20		MHz
E_D	Linearity error, differential	V_I = 0 to 5 V		±0.1	±0.2	%FSR
E_L	Linearity error, best straight line	V_I = 0 to 5 V			±0.4	%FSR
SNR†	Signal to noise ratio	f_{clock} = 9.9 MHz, f_{IN} = 97 kHz,		–50		dB
THD	Total harmonic distortion	BW = 5 MHz		51		dB
BW	Analog input bandwidth (3 dB)	f_{clock} = 10 MHz		5		MHz
t_d	Delay time, digital output	C_L = 15 pF		10	30	ns

† SNR is total noise without THD.

timing diagram



TYPICAL CHARACTERISTICS



NOTE A: This curve is based on the assumption that V_{refB} and V_{refT} have been adjusted so that the voltage at the transition from digital 0 to 1 (V_{ZT}) is 0 and the transition to full scale (V_{FT}) is 4.8545 V. 1 LSB = 19 mV.

Figure 1. Ideal Conversion Characteristics

SUPPLY CURRENT vs OPERATING FREE-AIR TEMPERATURE

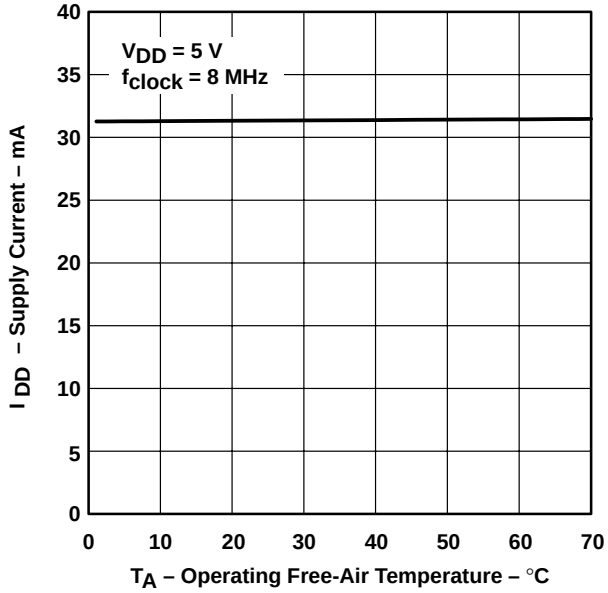


Figure 2

REFERENCE CURRENT vs OPERATING FREE-AIR TEMPERATURE

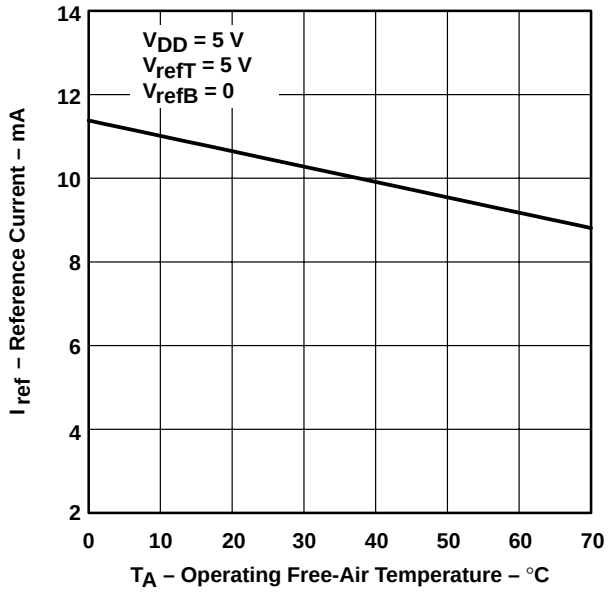


Figure 3

TYPICAL CHARACTERISTICS

TOTAL HARMONIC DISTORTION vs OPERATING FREE-AIR TEMPERATURE

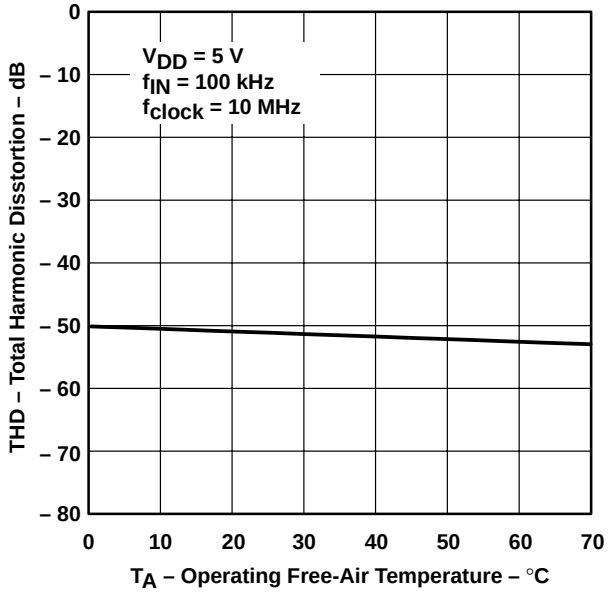


Figure 4

TOTAL HARMONIC DISTORTION vs OPERATING FREE-AIR TEMPERATURE

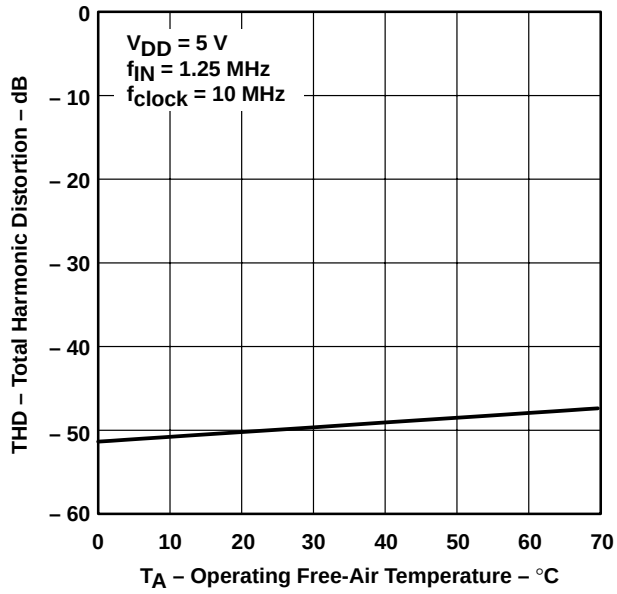


Figure 5

DIFFERENTIAL LINEARITY ERROR vs SUPPLY VOLTAGE

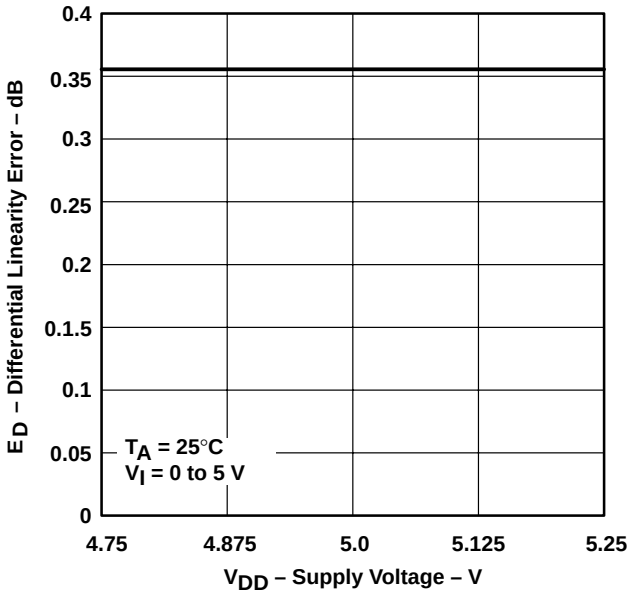


Figure 6

DIFFERENTIAL LINEARITY ERROR vs OPERATING FREE-AIR TEMPERATURE

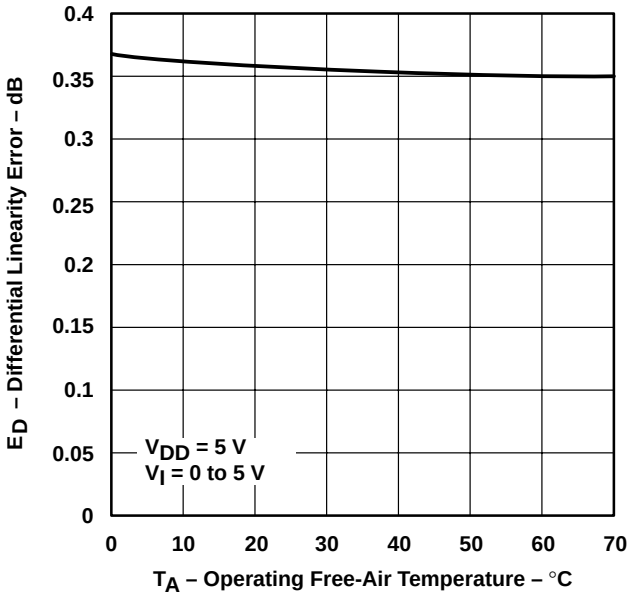


Figure 7

TYPICAL CHARACTERISTICS

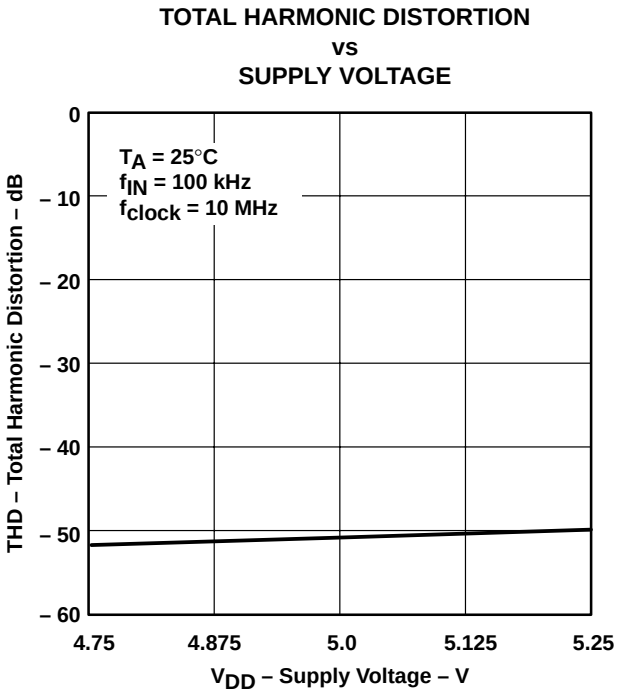


Figure 8

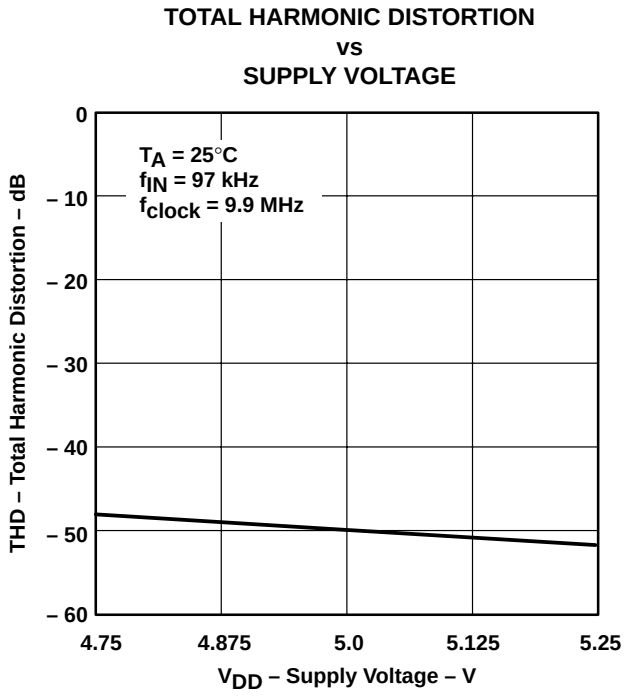


Figure 9

PARAMETER MEASUREMENT INFORMATION

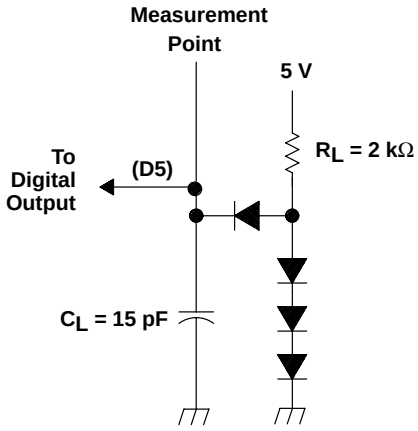


Figure 10. Load Circuit

APPLICATION INFORMATION

The following design recommendations will benefit the TLC5502-5M user:

1. External analog and digital circuitry should be physically separated and shielded as much as possible to reduce system noise.
2. RF breadboarding or PCB techniques should be used throughout the evaluation and production process. Breadboards should be copper clad for bench evaluation.
3. Since the ANLG GND, DGTL GND1, and DGTL GND2 are not connected internally, these pins need to be connected externally. With breadboards, these ground lines should be connected through separate leads with proper supply bypassing. A good method to use is a separate twisted-pair cable for the supply lines to minimize noise pickup. An analog and digital ground plane should be used on PCB layouts.
4. Since the ANLG V_{DD}, DGTL $V_{DD}1$, and DGTL $V_{DD}2$ are not connected internally, these pins also need to be connected externally. To connect ANLG V_{DD}, DGTL $V_{DD}1$, and DGTL $V_{DD}2$, a 50-Ω resistor should be placed in series with DGTL $V_{DD}1$ and then a 0.1-μF capacitor to ground before being connected to ANLG V_{DD} and DGTL V_{DD2}.
5. ANLG V_{DD} to ANLG GND, DGTL $V_{DD}1$ to DGTL GND1, and DGTL $V_{DD}2$ to DGTL GND2 should be decoupled with 1-μF and 0.01-μF capacitors, respectively, as close as possible to the appropriate device pins. A ceramic-chip capacitor is recommended for the 0.01-μF capacitor. Care should be exercised to assure a solid noise free ground connection for the analog and digital grounds.
6. The no connection (NC) pins on the J package should be connected to ground.
7. ANLG V_{DD}, ANLG GND, and ANLG INPUT should be shielded from the higher-frequency pins, CLK and D0–D7. If possible, ANLG GND traces should be placed on both sides of the ANLG INPUT traces on the PCB.
8. In testing or application of the device, the resistance of the driving source connected to the analog input should be 10 Ω or less within the analog frequency range of interest.

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