

Quadruple Operational Amplifiers**1 Features**

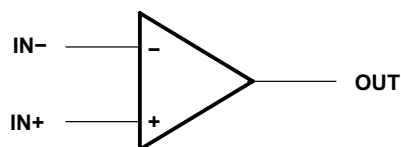
- Wide Supply Ranges
 - Single Supply: 3 V to 32 V (26 V for LM2902)
 - Dual Supplies: ± 1.5 V to ± 16 V (± 13 V for LM2902DR-EV)
- Low Supply-Current Drain Independent of Supply Voltage: 0.8 mA Typical
- Common-Mode Input Voltage Range Includes Ground, Allowing Direct Sensing Near Ground
- Low Input Bias and Offset Parameters
 - Input Offset Voltage: 3 mV Typical
 - Input Offset Current: 2 nA Typical
 - Input Bias Current: 20 nA Typical
- Differential Input Voltage Range Equal to Maximum-Rated Supply Voltage: 32 V (26 V for LM2902DR-EV)
- Open-Loop Differential Voltage Amplification: 100 V/mV Typical
- Internal Frequency Compensation
- On Products Compliant to MIL-PRF-38535, All Parameters are Tested Unless Otherwise Noted. On All Other Products, Production Processing Does Not Necessarily Include Testing of All Parameters.

2 Applications

- Blu-ray Players and Home Theaters
- Chemical and Gas Sensors
- DVD Recorders and Players
- Digital Multimeter: Bench and Systems
- Digital Multimeter: Handhelds
- Field Transmitter: Temperature Sensors
- Motor Control: AC Induction, Brushed DC, Brushless DC, High-Voltage, Low-Voltage, Permanent Magnet, and Stepper Motor
- Oscilloscopes
- TV: LCD and Digital
- Temperature Sensors or Controllers Using Modbus
- Weigh Scales

3 Description

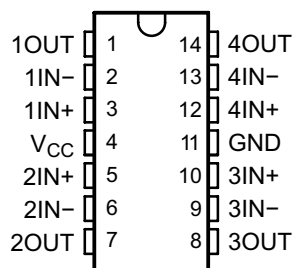
These devices consist of four independent high-gain frequency-compensated operational amplifiers that are designed specifically to operate from a single supply or split supply over a wide range of voltages.

Symbol (Each Amplifier)

Quadruple Operational Amplifiers

4 Pin Configuration and Functions

DR
14-Pin SOP, DIP



Pin Functions

PIN			I/O	DESCRIPTION
NAME	LCCC NO.	SOP, DIP		
1IN-		2	I	Negative input
1IN+		3	I	Positive input
1OUT		1	O	Output
2IN-		6	I	Negative input
2IN+		5	I	Positive input
2OUT		7	O	Output
3IN-		9	I	Negative input
3IN+		10	I	Positive input
3OUT		8	O	Output
4IN-		13	I	Negative input
4IN+		12	I	Positive input
4OUT		14	O	Output
GND		11	—	Ground
V _{CC}	6	4	—	Power supply

Quadruple Operational Amplifiers

5 Specifications

5.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)⁽¹⁾

	LM2902		LM124, LM224		UNIT
	MIN	MAX	MIN	MAX	
Supply voltage, V_{CC} ⁽²⁾	±13	26	±16	32	V
Differential input voltage, V_{ID} ⁽³⁾		±26		±32	V
Input voltage, V_I (either input)	-0.3	26	-0.3	to 32	V
Duration of output short circuit (one amplifier) to ground at (or below) $T_A = 25^\circ\text{C}$, $V_{CC} \leq 15\text{ V}$ ⁽⁴⁾	Unlimited		Unlimited		
Operating virtual junction temperature, T_J		150		150	°C
Storage temperature, T_{stg}	-65	150	-65	150	°C

- (1) 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.
- (2) All voltage values (except differential voltages and V_{CC} specified for the measurement of I_{OS}) are with respect to the network GND.
- (3) Differential voltages are at $IN+$, with respect to $IN-$.
- (4) Short circuits from outputs to V_{CC} can cause excessive heating and eventual destruction.

5.2 ESD

LM124, LM224, LM2902				
$V_{(ESD)}$ Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾		±500	V
	Charged-device model (CDM), per JEDEC specification JESD22-C101		±1000	

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

5.3 Recommended Operating Conditions

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

		LM2902		LM124, LM224		UNIT
		MIN	MAX	MIN	MAX	
V_{CC} Supply voltage		3	26	3	30	V
V_{CM} Common-mode voltage		0	$V_{CC} - 2$	0	$V_{CC} - 2$	V
T_A Operating free air temperature	LM124			-55	125	°C
	LM2902	-40	105			
	LM224			-20	85	

Quadruple Operational Amplifiers

5.4 Thermal Information

THERMAL METRIC ⁽¹⁾	LM124DR-EV, LM224DR-EV, LM2902DR-EV		
	(SOP)	(DIP)	UNIT
	14 PINS	14 PINS	
$R_{\theta JA}$ ⁽²⁾⁽³⁾ Junction-to-ambient thermal resistance	86	80	°C/W
$R_{\theta JC}$ ⁽⁴⁾ Junction-to-case (top) thermal resistance	—	—	

- (1) Short circuits from outputs to VCC can cause excessive heating and eventual destruction.
(2) Maximum power dissipation is a function of $T_{J(max)}$, $R_{\theta JA}$, and T_A . The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_{J(max)} - T_A)/R_{\theta JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
(3) Maximum power dissipation is a function of $T_{J(max)}$, $R_{\theta JA}$, and T_C . The maximum allowable power dissipation at any allowable case temperature is $P_D = (T_{J(max)} - T_C)/R_{\theta JC}$. Operating at the absolute maximum T_J of 150°C can affect reliability.

5.5 Electrical Characteristics for LMx24

at specified free-air temperature, $V_{CC} = 5$ V (unless otherwise noted)

PARAMETER	TEST CONDITIONS ⁽¹⁾	T_A ⁽²⁾	LM124DR-EV, LM224DR-EV			UNIT
			MIN	TYP ⁽³⁾	MAX	
V_{IO} Input offset voltage	$V_{CC} = 5$ V to MAX, $V_{IC} = V_{ICRmin}$, $V_O = 1.4$ V	25°C	3	5	5	mV
		Full range			7	
I_{IO} Input offset current	$V_O = 1.4$ V	25°C	2	30	30	nA
		Full range			100	
I_{IB} Input bias current	$V_O = 1.4$ V	25°C	–20	–150	–150	nA
		Full range			–300	
V_{ICR} Common-mode input voltage range	$V_{CC} = 5$ V to MAX	25°C	0 to $V_{CC} - 1.5$			V
		Full range	0 to $V_{CC} - 2$			
V_{OH} High-level output voltage	$R_L = 2$ kΩ	25°C	$V_{CC} - 1.5$			V
	$R_L = 10$ kΩ	25°C				
	$V_{CC} = MAX$, $R_L = 2$ kΩ	Full range	26			
	$R_L \geq 10$ kΩ	Full range	27	28		
V_{OL} Low-level output voltage	$R_L \leq 10$ kΩ	Full range	5	20		mV
A_{VD} Large-signal differential voltage amplification	$V_{CC} = 15$ V, $V_O = 1$ V to 11 V, $R_L \geq 2$ kΩ	25°C	50	100		V/mV
		Full range	25			
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$	25°C	70	80		dB
k_{SVR} Supply-voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)		25°C	65	100		dB
V_{OI}/V_{O2} Crosstalk attenuation	$f = 1$ kHz to 20 kHz	25°C	120			dB
I_O Output current	$V_{CC} = 15$ V, $V_{ID} = 1$ V, $V_O = 0$	Source	25°C	–20	–30	mA
		Full range	–10			
	$V_{CC} = 15$ V, $V_{ID} = -1$ V, $V_O = 15$ V	Sink	25°C	10	20	
		Full range	5			
	$V_{ID} = -1$ V, $V_O = 200$ mV	25°C	12	30		μA
I_{OS} Short-circuit output current	V_{CC} at 5 V, $V_O = 0$, GND at –5 V	25°C		±40	±60	mA
I_{CC} Supply current (four amplifiers)	$V_O = 2.5$ V, no load	Full range	0.7	1.2		mA
	$V_{CC} = MAX$, $V_O = 0.5 V_{CC}$, no load	Full range	1.4	3		

- (1) All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified. MAX V_{CC} for testing purposes is 26 V for LM2902DR-EV and 30 V for the others.
(2) Full range is –55°C to 125°C for LM124DR-EV, –20°C to 85°C for LM224DR-EV
(3) All typical values are at $T_A = 25^\circ\text{C}$

Quadruple Operational Amplifiers

5.6 Operating Conditions

$V_{CC} = \pm 15\text{ V}$, $T_A = 25^\circ\text{C}$

PARAMETER		TEST CONDITIONS	TYP	UNIT
SR	Slew rate at unity gain	$R_L = 1\text{ M}\Omega$, $C_L = 30\text{ pF}$, $V_I = \pm 10\text{ V}$ (see Figure 7)	0.5	V/ μ s
B ₁	Unity-gain bandwidth	$R_L = 1\text{ M}\Omega$, $C_L = 20\text{ pF}$ (see Figure 7)	1.2	MHz
V _n	Equivalent input noise voltage	$R_S = 100\text{ }\Omega$, $V_I = 0\text{ V}$, $f = 1\text{ kHz}$ (see Figure 8)	35	nV/ $\sqrt{\text{Hz}}$

Quadruple Operational Amplifiers

5.7 Typical Characteristics

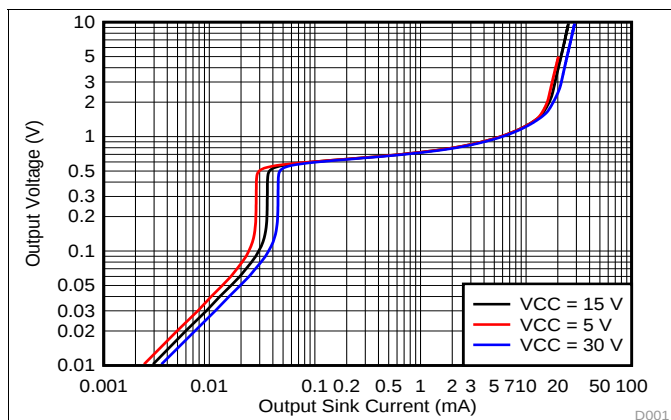


Figure 1. Output Sinking Characteristics

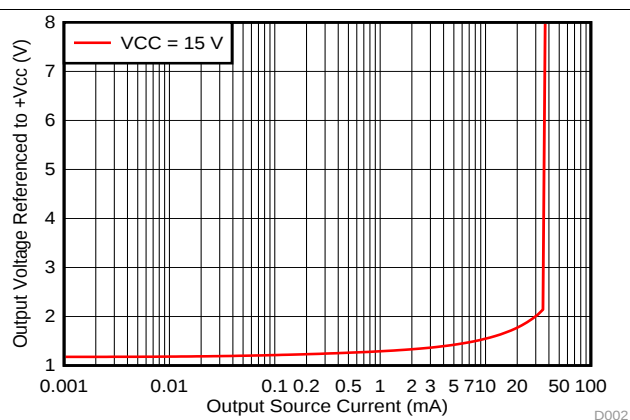


Figure 2. Output Sourcing Characteristics

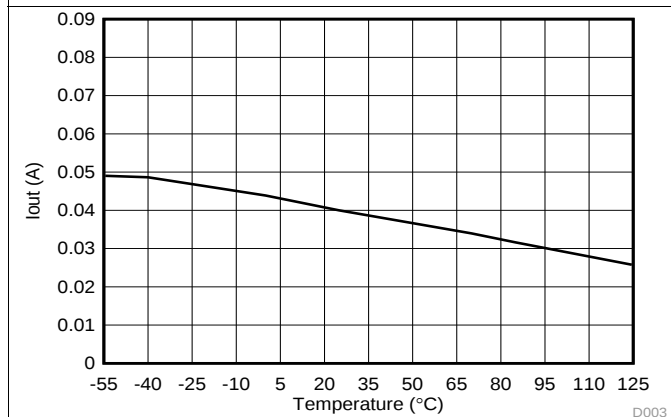


Figure 3. Source Current Limiting

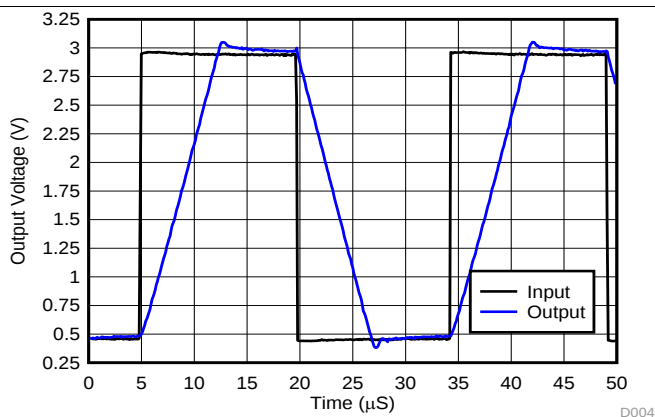


Figure 4. Voltage Follower Large Signal Response (50 pF)

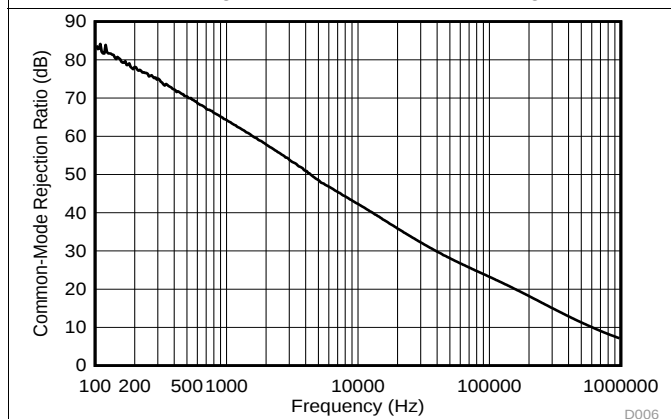


Figure 5. Common-Mode Rejection Ratio

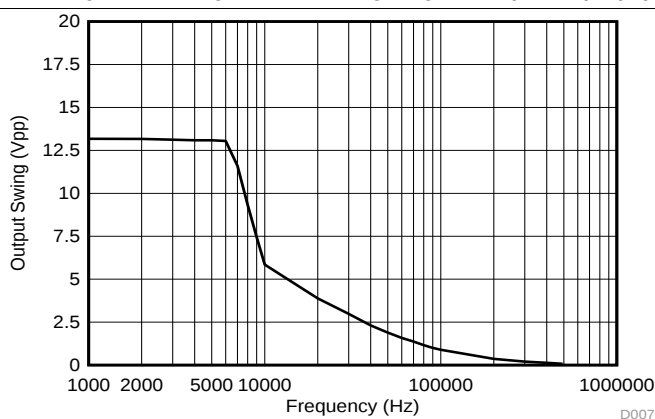


Figure 6. Maximum Output Swing vs. Frequency
(VCC = 15 V)

Quadruple Operational Amplifiers

6 Parameter Measurement Information

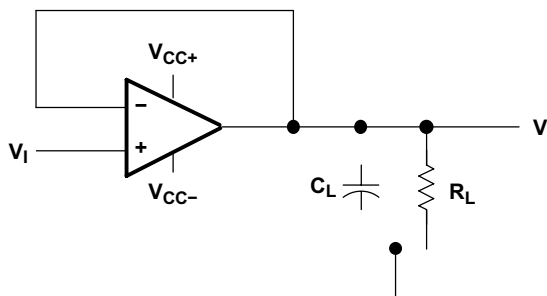


Figure 7. Unity-Gain Amplifier

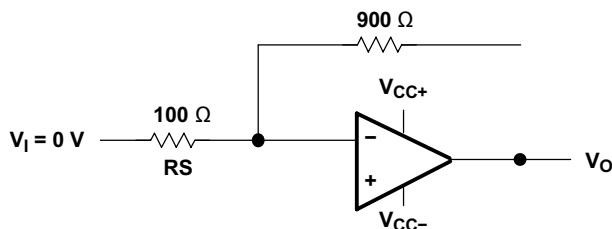


Figure 8. Noise-Test Circuit

7 Detailed Description

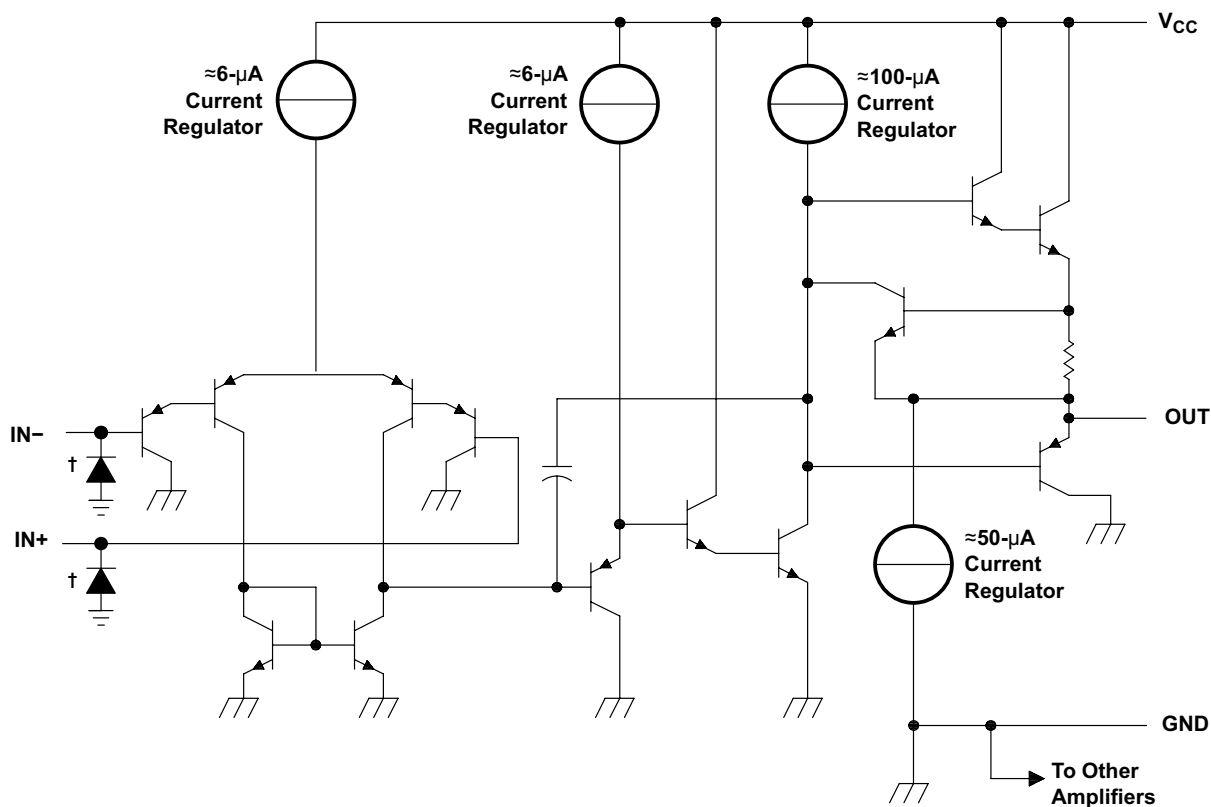
7.1 Overview

These devices consist of four independent high-gain frequency-compensated operational amplifiers that are designed specifically to operate from a single supply over a wide range of voltages. Operation from split supplies also is possible if the difference between the two supplies is 3 V to 32 V (3 V to 26 V for the LM2902DR-EV device), and V_{CC} is at least 1.5 V more positive than the input common-mode voltage. The low supply-current drain is independent of the magnitude of the supply voltage.

Applications include transducer amplifiers, DC amplification blocks, and all the conventional operational-amplifier circuits that now can be more easily implemented in single-supply-voltage systems. For example, the LM124DR-EV device can be operated directly from the standard 5-V supply that is used in digital systems and provides the required interface electronics, without requiring additional ± 15 -V supplies.

Quadruple Operational Amplifiers

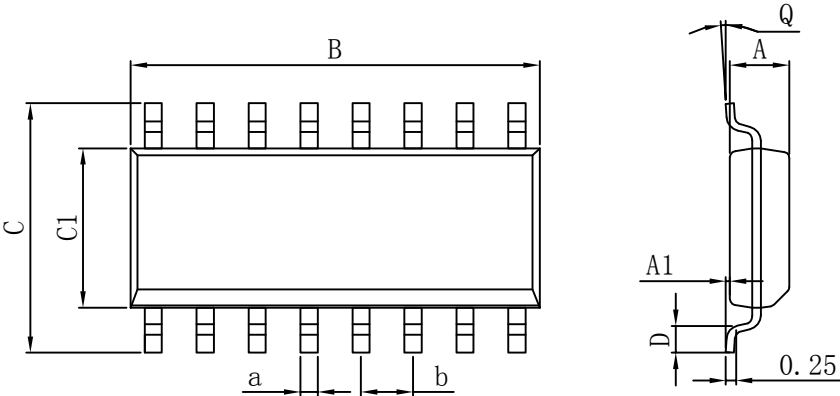
7.2 Functional Block Diagram



COMPONENT COUNT (total device)	
Epi-FET	1
Transistors	95
Diodes	4
Resistors	11
Capacitors	4

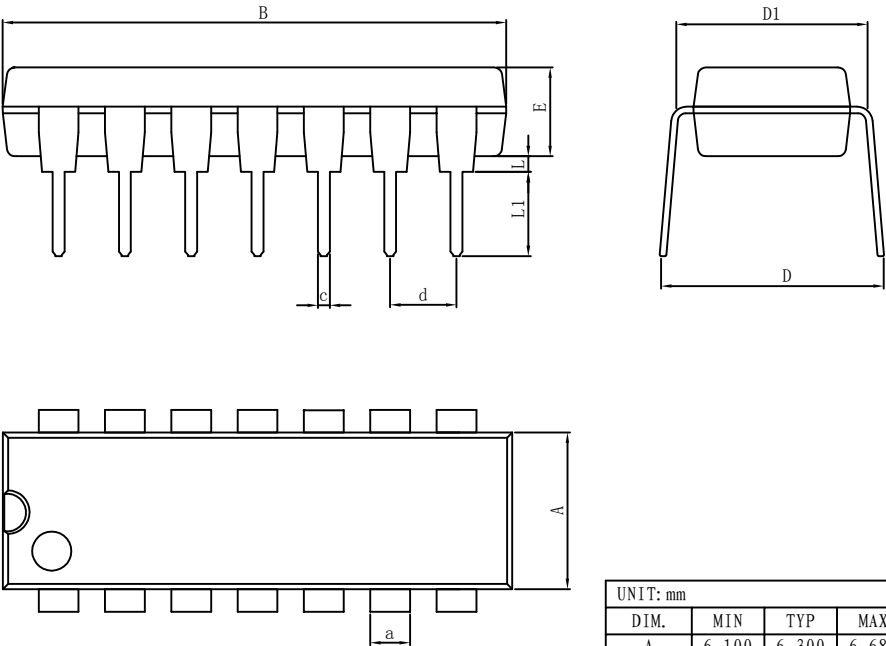
PACKAGE

SOP14



UNIT: mm							
DIM.	MIN	TYP	MAX	DIM.	MIN	TYP	MAX
A	4.520	4.570	4.620	a	0.400	0.420	0.440
A1	0.100	—	0.250	b	1.260	1.270	1.280
B	8.500	8.750	9.000	Q	0°	—	8°
C	5.800	6.100	6.250				
C1	3.800	3.900	4.000				
D	0.400	—	0.950				

DIP14



UNIT: mm							
DIM.	MIN	TYP	MAX	DIM.	MIN	TYP	MAX
A	6.100	6.300	6.680	a	1.504	1.524	1.544
B	18.940	19.200	19.560	c	0.437	0.457	0.477
D	8.200	8.700	9.200	d	2.530	2.540	2.550
D1	7.42	7.62	7.82	L	0.500	—	0.800
E	3.100	3.300	3.550	L1	3.000	3.200	3.600