Universidad del País Vasco Euskal Herriko Unibertsitatea
BILBOKO INGENIARITZA ESKOLA
ESCUELA DE INGENIERÍA DE BILBAO

GRADO EN ELECTRÓNICA INDUSTRIAL Y AUTOMÁTICA

TRABAJO FIN DE GRADO

ADQUISICIÓN, PROCESAMIENTO Y MONITORIZACIÓN DE SEÑALES VÍA XBEE EN EL ENTORNO LABVIEW

DOCUMENTO 6- *DOCUMENTACIÓN*

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Fecha: 23/07/2018

Índice

1 SENSOR TEMPERATURA LM35

National Semiconductor

December 1994

LM35/LM35A/LM35C/LM35CA/LM35D Precision Centigrade Temperature Sensors

General Description

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a −55° to +150°C temperature range, while the LM35C is rated for a −40° to +110°C range (−10° with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-202 package.

Features

- Calibrated directly in ° Celsius (Centigrade)
- Linear + 10.0 mV/°C scale factor
- 0.5°C accuracy guaranteeable (at +25°C)
- Rated for full −55° to +150°C range
- Suitable for remote applications
- Low cost due to wafer-level trimming
- Operates from 4 to 30 volts
- Less than 60 µA current drain
- Low self-heating, 0.08°C in still air
- Nonlinearity only ±¼°C typical
- Low impedance output, 0.1 Ω for 1 mA load

Connection Diagrams

TO-46
Metal Can Package*

TL/H/5516–1

*Case is connected to negative pin (GND)

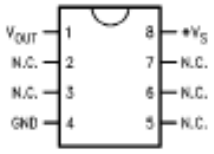
Order Number LM35H, LM35AH, LM35CH, LM35CAH or LM35DH
See NS Package Number H03H

TO-92
Plastic Package

TL/H/5516–2

Order Number LM35CZ, LM35CAZ or LM35DZ
See NS Package Number Z03A

SO-8
Small Outline Molded Package

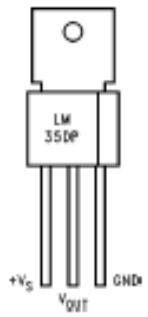


TL/H/5516–21

Top View
N.C. = No Connection

Order Number LM35DM
See NS Package Number M08A

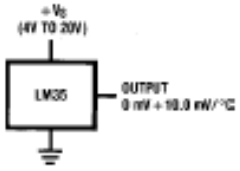
TO-202
Plastic Package



TL/H/5516–24

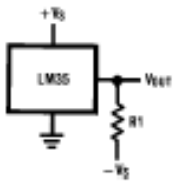
Order Number LM35DP
See NS Package Number P03A

Typical Applications



TL/H/5516–3

FIGURE 1. Basic Centigrade Temperature Sensor (+2°C to +150°C)



TL/H/5516–4

Choose $R_1 = -V_S/50\ \mu A$

$V_{OUT} = +1,500$ mV at +150°C
$= +250$ mV at +25°C
$= -550$ mV at −55°C

FIGURE 2. Full-Range Centigrade Temperature Sensor

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RRD-B30M75/Printed in U.S.A.

Absolute Maximum Ratings (Note 10)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage	+35V to −0.2V
Output Voltage	+6V to −1.0V
Output Current	10 mA
Storage Temp., TO-46 Package,	−60°C to +180°C
TO-92 Package,	−60°C to +150°C
SO-8 Package,	−65°C to +150°C
TO-202 Package,	−65°C to +150°C
Lead Temp.:	
TO-46 Package, (Soldering, 10 seconds)	300°C
TO-92 Package, (Soldering, 10 seconds)	260°C
TO-202 Package, (Soldering, 10 seconds)	+230°C
SO Package (Note 12):	
Vapor Phase (60 seconds)	215°C
Infrared (15 seconds)	220°C
ESD Susceptibility (Note 11)	2500V
Specified Operating Temperature Range: T_{MIN} to T_{MAX} (Note 2)	
LM35, LM35A	−55°C to +150°C
LM35C, LM35CA	−40°C to +110°C
LM35D	0°C to +100°C

Electrical Characteristics (Note 1) (Note 6)

Parameter	Conditions	LM35A			LM35CA			Units (Max.)
		Typical	Tested Limit (Note 4)	Design Limit (Note 5)	Typical	Tested Limit (Note 4)	Design Limit (Note 5)	
Accuracy (Note 7)	T_A = +25°C	±0.2	±0.5		±0.2	±0.5		°C
	T_A = −10°C	±0.3			±0.3		±1.0	°C
	T_A = T_{MAX}	±0.4	±1.0		±0.4	±1.0		°C
	T_A = T_{MIN}	±0.4	±1.0		±0.4		±1.5	°C
Nonlinearity (Note 8)	$T_{MIN} \le T_A \le T_{MAX}$	**±0.18**		**±0.35**	**±0.15**		**±0.3**	°C
Sensor Gain (Average Slope)	$T_{MIN} \le T_A \le T_{MAX}$	**+10.0**	**+9.9, +10.1**		**+10.0**		**+9.9, +10.1**	mV/°C
Load Regulation (Note 3) $0 \le I_L \le 1$ mA	T_A = +25°C	±0.4	±1.0		±0.4	±1.0		mV/mA
	$T_{MIN} \le T_A \le T_{MAX}$	**±0.5**		**±3.0**	**±0.5**		**±3.0**	mV/mA
Line Regulation (Note 3)	T_A = +25°C	±0.01	±0.05		±0.01	±0.05		mV/V
	$4V \le V_S \le 30V$	**±0.02**		**±0.1**	**±0.02**		**±0.1**	mV/V
Quiescent Current (Note 9)	V_S = +5V, +25°C	56	67		56	67		µA
	V_S = +5V	**105**		**131**	**91**		**114**	µA
	V_S = +30V, +25°C	56.2	68		56.2	68		µA
	V_S = +30V	**105.5**		**133**	**91.5**		**116**	µA
Change of Quiescent Current (Note 3)	$4V \le V_S \le 30V$, +25°C	0.2	1.0		0.2	1.0		µA
	$4V \le V_S \le 30V$	**0.5**		**2.0**	**0.5**		**2.0**	µA
Temperature Coefficient of Quiescent Current		**+0.39**		**+0.5**	**+0.39**		**+0.5**	µA/°C
Minimum Temperature for Rated Accuracy	In circuit of *Figure 1*, I_L = 0	+1.5		+2.0	+1.5		+2.0	°C
Long Term Stability	T_J = T_{MAX}, for 1000 hours	±0.08			±0.08			°C

Note 1: Unless otherwise noted, these specifications apply: $-55°C \le T_J \le +150°C$ for the LM35 and LM35A; $-40° \le T_J \le +110°C$ for the LM35C and LM35CA; and $0° \le T_J \le +100°C$ for the LM35D. V_S = +5Vdc and I_{LOAD} = 50 µA, in the circuit of *Figure 2*. These specifications also apply from +2°C to T_{MAX} in the circuit of *Figure 1*. Specifications in **boldface** apply over the full rated temperature range.

Note 2: Thermal resistance of the TO-46 package is 400°C/W, junction to ambient, and 24°C/W junction to case. Thermal resistance of the TO-92 package is 180°C/W junction to ambient. Thermal resistance of the small outline molded package is 220°C/W junction to ambient. Thermal resistance of the TO-202 package is 65°C/W junction to ambient. For additional thermal resistance information see table in the Applications section.

Electrical Characteristics (Note 1) (Note 6) (Continued)

Parameter	Conditions	LM35			LM35C, LM35D			Units (Max.)
		Typical	Tested Limit (Note 4)	Design Limit (Note 5)	Typical	Tested Limit (Note 4)	Design Limit (Note 5)	
Accuracy, LM35, LM35C (Note 7)	$T_A = +25°C$	±0.4	±1.0		±0.4	±1.0		°C
	$T_A = -10°C$	±0.5			±0.5		±1.5	°C
	$T_A = T_{MAX}$	±0.8	±1.5		±0.8		±1.5	°C
	$T_A = T_{MIN}$	±0.8		±1.5	±0.8		±2.0	°C
Accuracy, LM35D (Note 7)	$T_A = +25°C$				±0.6	±1.5		°C
	$T_A = T_{MAX}$				±0.9		±2.0	°C
	$T_A = T_{MIN}$				±0.9		±2.0	°C
Nonlinearity (Note 8)	$T_{MIN} \le T_A \le T_{MAX}$	**±0.3**		**±0.5**	**±0.2**		**±0.5**	°C
Sensor Gain (Average Slope)	$T_{MIN} \le T_A \le T_{MAX}$	**+10.0**	**+9.8, +10.2**		**+10.0**		**+9.8, +10.2**	mV/°C
Load Regulation (Note 3) $0 \le I_L \le 1$ mA	$T_A = +25°C$	±0.4	±2.0		±0.4	±2.0		mV/mA
	$T_{MIN} \le T_A \le T_{MAX}$	**±0.5**		**±5.0**	**±0.5**		**±5.0**	mV/mA
Line Regulation (Note 3)	$T_A = +25°C$	±0.01	±0.1		±0.01	±0.1		mV/V
	$4V \le V_S \le 30V$	**±0.02**		**±0.2**	**±0.02**		**±0.2**	mV/V
Quiescent Current (Note 9)	$V_S = +5V, +25°C$	56	80		56	80		µA
	$V_S = +5V$	**105**		**158**	**91**		**138**	µA
	$V_S = +30V, +25°C$	56.2	82		56.2	82		µA
	$V_S = +30V$	**105.5**		**161**	**91.5**		**141**	µA
Change of Quiescent Current (Note 3)	$4V \le V_S \le 30V, +25°C$	0.2	2.0		0.2	2.0		µA
	$4V \le V_S \le 30V$	**0.5**		**3.0**	**0.5**		**3.0**	µA
Temperature Coefficient of Quiescent Current		**+0.39**		**+0.7**	**+0.39**		**+0.7**	µA/°C
Minimum Temperature for Rated Accuracy	In circuit of *Figure 1*, $I_L = 0$	+1.5		+2.0	+1.5		+2.0	°C
Long Term Stability	$T_J = T_{MAX}$, for 1000 hours	±0.08			±0.08			°C

Note 3: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output due to heating effects can be computed by multiplying the internal dissipation by the thermal resistance.

Note 4: Tested Limits are guaranteed and 100% tested in production.

Note 5: Design Limits are guaranteed (but not 100% production tested) over the indicated temperature and supply voltage ranges. These limits are not used to calculate outgoing quality levels.

Note 6: Specifications in boldface apply over the full rated temperature range.

Note 7: Accuracy is defined as the error between the output voltage and 10mv/°C times the device's case temperature, at specified conditions of voltage, current, and temperature (expressed in °C).

Note 8: Nonlinearity is defined as the deviation of the output-voltage-versus-temperature curve from the best-fit straight line, over the device's rated temperature range.

Note 9: Quiescent current is defined in the circuit of *Figure 1*.

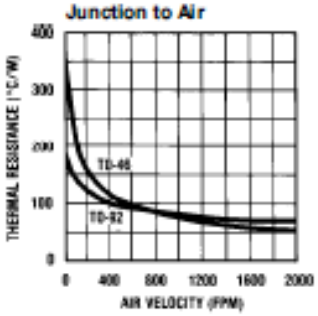
Note 10: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. DC and AC electrical specifications do not apply when operating the device beyond its rated operating conditions. See Note 1.

Note 11: Human body model, 100 pF discharged through a 1.5 kΩ resistor.

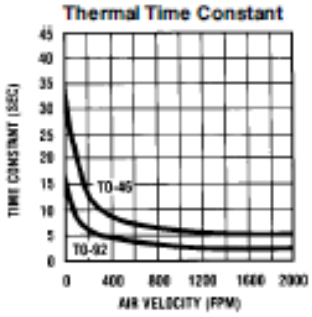
Note 12: See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" or the section titled "Surface Mount" found in a current National Semiconductor Linear Data Book for other methods of soldering surface mount devices.

Typical Performance Characteristics

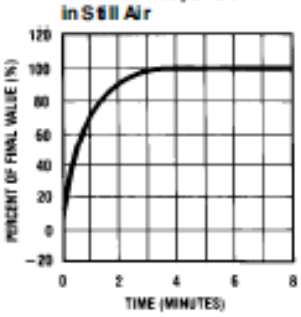
Thermal Resistance Junction to Air



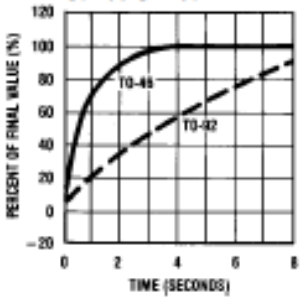
Thermal Time Constant



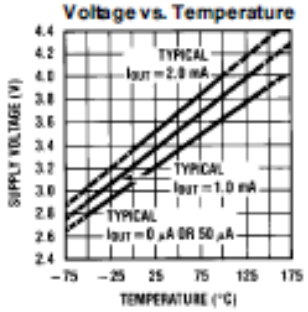
Thermal Response in Still Air



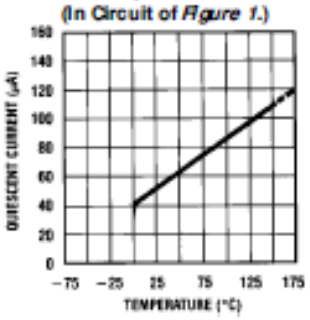
Thermal Response in Stirred Oil Bath



Minimum Supply Voltage vs. Temperature

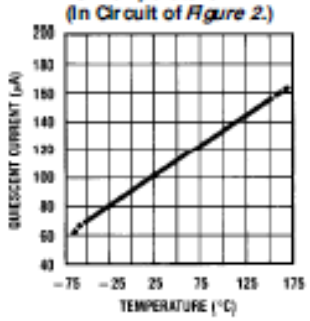


Quiescent Current vs. Temperature (In Circuit of *Figure 1.*)

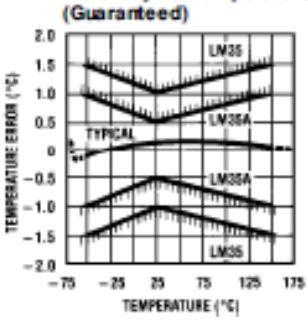


TL/H/5516–17

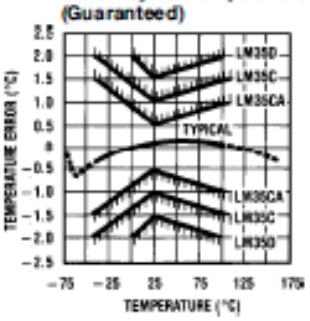
Quiescent Current vs. Temperature (In Circuit of *Figure 2.*)



Accuracy vs. Temperature (Guaranteed)

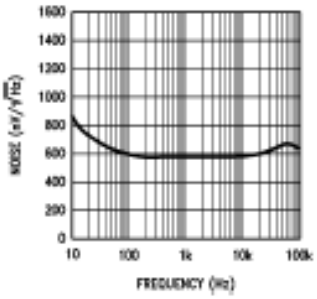


Accuracy vs. Temperature (Guaranteed)

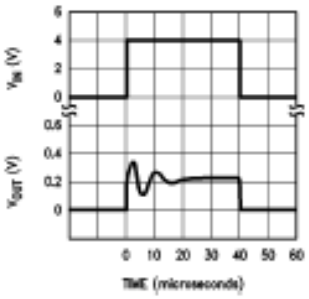


TL/H/5516–18

Noise Voltage



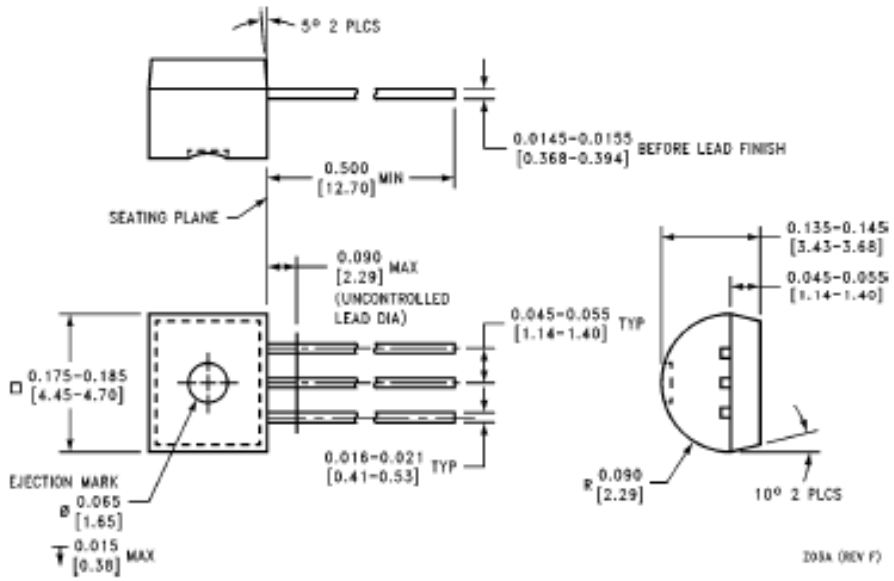
Start-Up Response



TL/H/5516–22

LM35/LM35A/LM35C/LM35CA/LM35D
Precision Centigrade Temperature Sensors

Physical Dimensions inches (millimeters) (Continued)



TO-92 Plastic Package (Z)
Order Number LM35CZ, LM35CAZ or LM35DZ
NS Package Number Z03A

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2 AMPLIFICADOR OPERACIONAL LM358

TEXAS INSTRUMENTS

LM158, LM158A, LM258, LM258A
LM358, LM358A, LM2904, LM2904V
SLOS068U – JUNE 1976 – REVISED JANUARY 2017

LM358, LM258, LM158, LM2904 Dual Operational Amplifiers

1 Features

- Wide Supply Ranges
  - Single Supply: 3 V to 32 V (26 V for LM2904)
  - Dual Supplies: ±1.5 V to ±16 V (±13 V for LM2904)
- Low Supply-Current Drain, Independent of Supply Voltage: 0.7 mA Typical
- Wide Unity Gain Bandwidth: 0.7 MHz
- Common-Mode Input Voltage Range Includes Ground, Allowing Direct Sensing Near Ground
- Low Input Bias and Offset Parameters
  - Input Offset Voltage: 3 mV Typical
    A Versions: 2 mV Typical
  - Input Offset Current: 2 nA Typical
  - Input Bias Current: 20 nA Typical
    A Versions: 15 nA Typical
- Differential Input Voltage Range Equal to Maximum-Rated Supply Voltage: 32 V (26 V for LM2904)
- Open-Loop Differential Voltage Gain: 100 dB 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 Recorder 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

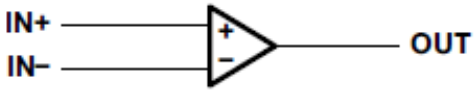
These devices consist of two independent, high-gain frequency-compensated operational amplifiers designed to operate from a single supply or split supply over a wide range of voltages.

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
LMx58, LMx58x, LM2904, LM2904V	VSSOP (8)	3.00 mm × 3.00 mm
	SOIC (8)	4.90 mm × 3.90 mm
	SO (8)	5.20 mm × 5.30 mm
	TSSOP (8)	3.00 mm × 4.40 mm
	PDIP (8)	9.81 mm × 6.35 mm
LMx58, LMx58x, LM2904V	CDIP (8)	9.60 mm × 6.67 mm
	LCCC (20)	8.89 mm × 8.89 mm

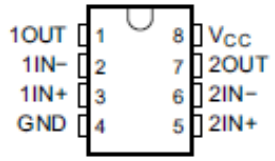
(1) For all available packages, see the orderable addendum at the end of the data sheet.

Symbol (Each Amplifier)

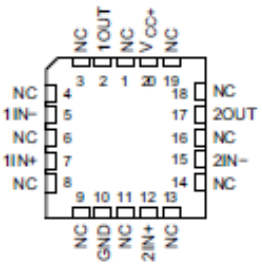


5 Pin Configuration and Functions

D, DGK, P, PS, PW and JG Package
8-Pin SOIC, VSSOP, PDIP, SO, TSSOP and CDIP
(Top View)



FK Package
20-Pin LCCC
(Top View)



NC - No internal connection

Pin Functions

PIN			I/O	DESCRIPTION
NAME	LCCC NO.	SOIC, SSOP, CDIP, PDIP SO, TSSOP, CFP NO.		
1IN–	5	2	I	Negative input
1IN+	7	3	I	Positive input
1OUT	2	1	O	Output
2IN–	15	6	I	Negative input
2IN+	12	5	I	Positive input
2OUT	17	7	O	Output
GND	10	4	—	Ground
NC	1	—	—	Do not connect
	3			
	4			
	6			
	8			
	9			
	11			
	13			
	14			
	16			
	18			
	19			
V_{CC}	—	8	—	Power supply
V_{CC+}	20	—	—	Power supply

6 Specifications

6.1 Absolute Maximum Ratings

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

				LMx58, LMx58x, LM2904V		LM2904		UNIT
				MIN	MAX	MIN	MAX	
V_{CC}		Supply voltage(2)		–0.3	±16 or 32	–0.3	±13 or 26	V
V_{ID}		Differential input voltage(3)		–32	32	–26	26	V
V_I	either input	Input voltage		–0.3	32	–0.3	26	V
		Duration of output short circuit (one amplifier) to ground at (or below) T_A = 25°C, V_{CC} ≤ 15 V(4)			Unlimited		Unlimited	s
T_A		Operating free air temperature	LM158, LM158A	–55	125			°C
			LM258, LM258A	–25	85			
			LM358, LM358A	0	70			
			LM2904	–40	125	–40	125	
T_J		Operating virtual junction temperature			150		150	°C
		Case temperature for 60 seconds	FK package		260			°C
		Lead temperature 1.6 mm (1/16 inch) from case for 60 seconds	JG package		300		300	°C
T_{stg}		Storage temperature		–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.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±500	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101(2)	±1000	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

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

			LMx58, LMx58x, LM2904V		LM2904		UNIT
			MIN	MAX	MIN	MAX	
V_{CC}	Supply voltage		3	30	3	26	V
V_{CM}	Common-mode voltage		0	V_{CC} – 2	0	V_{CC} – 2	V
T_A	Operating free air temperature	LM158	–55	125			°C
		LM2904	–40	125	–40	125	
		LM358	0	70			
		LM258	–25	85			

6.4 Thermal Information

THERMAL METRIC[1]		LMx58, LMx58x, LM2904V, LM2904					LMx58, LMx58x, LM2904 V	LMx58, LMx58x, LM2904 V	UNIT
		D (SOIC)	DGK (VSSOP)	P (PDIP)	PS (SO)	PW (TSSOP)	FK (LCCC)	JG (CDIP)	
		8 PINS	8 PINS	8 PINS	8 PINS	8 PINS	20 PINS	8 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	97	172	85	95	149	—	—	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	72.2	—	—	—	—	5.61	14.5	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report.

6.5 Electrical Characteristics for LMx58

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

PARAMETER		TEST CONDITIONS[1]		T_A[2]	LM158 LM258			LM358			UNIT
					MIN	TYP[3]	MAX	MIN	TYP[3]	MAX	
V_{IO}	Input offset voltage	V_{CC} = 5 V to MAX, V_O = $V_{IC(min)}$, V_O = 1.4 V		25°C		3	5		3	7	mV
				Full range			7			9	
αV_{IO}	Average temperature coefficient of input offset voltage			Full range		7			7		µV/°C
I_{IO}	Input offset current	V_O = 1.4 V		25°C		2	30		2	50	nA
				Full range			100			150	
αI_{IO}	Average temperature coefficient of input offset current			Full range		10			10		pA/°C
I_{IB}	Input bias current	V_O = 1.4 V		25°C		−20	−150		−20	−250	nA
				Full range			−300			−500	
V_{ICR}	Common-mode input voltage range	V_{CC} = 5 V to MAX		25°C	0 to V_{CC} − 1.5			0 to V_{CC} − 1.5			V
				Full range	0 to V_{CC} − 2			0 to V_{CC} − 2			
V_{OH}	High-level output voltage	R_L ≥ 2 kΩ		25°C	V_{CC} − 1.5			V_{CC} − 1.5			V
		R_L ≥ 10 kΩ		25°C							
		V_{CC} = MAX	R_L = 2 kΩ	Full range	26			26			
			R_L ≥ 10 kΩ	Full range	27	28		27	28		
V_{OL}	Low-level output voltage	R_L ≤ 10 kΩ		Full range		5	20		5	20	mV
A_{VD}	Large-signal differential voltage amplification	V_{CC} = 15 V, V_O = 1 V to 11 V, R_L ≥ 2 kΩ		25°C	50	100		25	100		V/mV
				Full range	25			15			
CMRR	Common-mode rejection ratio	V_{CC} = 5 V to MAX, V_O = $V_{IC(min)}$		25°C	70	80		65	80		dB
k_{SVR}	Supply-voltage rejection ratio (ΔV_{CC}/ΔV_{IO})	V_{CC} = 5 V to MAX		25°C	65	100		65	100		dB
V_{O1}/ V_{OD}	Crosstalk attenuation	f = 1 kHz to 20 kHz		25°C		120			120		dB
I_O	Output current	V_{CC} = 15 V, V_{ID} = 1 V, V_O = 0	Source	25°C	−20	−30		−20	−30		mA
				Full range	−10			−10			
		V_{CC} = 15 V, V_{ID} = −1 V, V_O = 15 V	Sink	25°C	10	20		10	20		
				Full range	5			5			
		V_{ID} = −1 V, V_O = 200 mV		25°C	12	30		12	30		µA
I_{OS}	Short-circuit output current	V_{CC} at 5 V, GND at −5 V, V_O = 0		25°C		±40	±60		±40	±60	mA

(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 LM2902 and 30 V for the others.
(2) Full range is −55°C to 125°C for LM158, −25°C to 85°C for LM258, and 0°C to 70°C for LM358, and −40°C to 125°C for LM2904.
(3) All typical values are at T_A = 25°C

Electrical Characteristics for LMx58 (continued)

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

PARAMETER		TEST CONDITIONS[1]	T_A[2]	LM158 LM258			LM358			UNIT
				MIN	TYP[3]	MAX	MIN	TYP[3]	MAX	
I_{CC}	Supply current (two amplifiers)	V_O = 2.5 V, No load	Full range		0.7	1.2		0.7	1.2	mA
		V_{CC} = MAX, V_O = 0.5 V_{CC}, No load	Full range		1	2		1	2	

6.6 Electrical Characteristics for LM2904

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

PARAMETER		TEST CONDITIONS[1]		T_A[2]	LM2904			UNIT
					MIN	TYP[3]	MAX	
V_{IO}	Input offset voltage	V_{CC} = 5 V to MAX, V_{IC} = $V_{ICR(min)}$, V_O = 1.4 V	Non-A-suffix devices	25°C		3	7	mV
				Full range			10	
			A-suffix devices	25°C		1	2	
				Full range			4	
αV_{IO}	Average temperature coefficient of input offset voltage			Full range		7		μV/°C
I_{IO}	Input offset current	V_O = 1.4 V	Non-V device	25°C		2	50	nA
				Full range			300	
			V-suffix device	25°C		2	50	
				Full range			150	
αI_{IO}	Average temperature coefficient of input offset current			Full range		10		pA/°C
I_{IB}	Input bias current	V_O = 1.4 V		25°C		–20	–250	nA
				Full range			–500	
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 ≥ 10 kΩ		25°C	V_{CC} – 1.5			V
		V_{CC} = MAX, Non-V device	R_L = 2 kΩ	Full range	22			
			R_L ≥ 10 kΩ	Full range	23	24		
		V_{CC} = MAX V-suffix device	R_L = 2 kΩ	Full range	26			
			R_L ≥ 10 kΩ	Full range	27	28		
V_{OL}	Low-level output voltage	R_L ≤ 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 ≥ 2 kΩ		25°C	25	100		V/mV
				Full range	15			
CMRR	Common-mode rejection ratio	V_{CC} = 5V to MAX, V_{IC} = $V_{ICR(min)}$	Non-V device	25°C	50	80		dB
			V-suffix device	25°C	65	80		
k_{SVR}	Supply-voltage rejection ratio (ΔV_{CC}/ΔV_{IO})	V_{CC} = 5 V to MAX		25°C	65	100		dB
V_{O1}/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	Non-V device	25°C		30		μA
			V-suffix device	25°C	12	40		
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	2	

(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 LM2902 and 32 V for LM2902V.
(2) Full range is –55°C to 125°C for LM158, –25°C to 85°C for LM258, 0°C to 70°C for LM358, and –40°C to 125°C for LM2904.
(3) All typical values are at T_A = 25°C.

Electrical Characteristics for LM358A (continued)

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

PARAMETER		TEST CONDITIONS[1]		T_A[2]	LM358A			UNIT
					MIN	TYP[3]	MAX	
αV_{IO}	Average temperature coefficient of input offset voltage			Full range		7	20	µA/°C
I_{IO}	Input offset current	V_O = 1.4 V		25°C		2	30	nA
				Full range			75	
αI_{IO}	Average temperature coefficient of input offset current			Full range		10	300	pA/°C
I_{IB}	Input bias current	V_O = 1.4 V		25°C		–15	–100	nA
				Full range			–200	
V_{ICR}	Common-mode input voltage range	V_{CC} = 30 V		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
		V_{CC} = 30 V	R_L = 2kΩ	Full range	26			
			R_L ≥ 10kΩ	Full range	27	28		
V_{OL}	Low-level output voltage	R_L ≤ 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 ≥ 2 kΩ		25°C	25	100		V/mV
				Full range	15			
CMRR	Common-mode rejection ratio			25°C	65	80		dB
k_{SVR}	Supply-voltage rejection ratio (ΔV_{CC}/ΔV_{IO})			25°C	65	100		dB
V_O/ V_{os}	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	–60	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		30		µA
I_{OS}	Short-circuit output current	V_{CC} at 5 V, GND at –5 V, V_O = 0		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, V_O = 0.5 V, No load		Full range		1	2	

6.9 Operating Conditions

V_{CC} = ±15 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	TYP	UNIT
SR	Slew rate at unity gain	R_L = 1 MΩ, C_L = 30 pF, V_I = ±10 V (see Figure 11)	0.3	V/µs
B_1	Unity-gain bandwidth	R_L = 1 MΩ, C_L = 20 pF (see Figure 11)	0.7	MHz
V_n	Equivalent input noise voltage	R_S = 100 Ω, V_I = 0 V, f = 1 kHz (see Figure 12)	40	nV/√Hz

6.10 Typical Characteristics

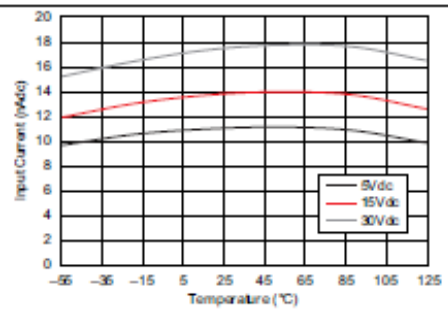


Figure 1. Input Current vs. Temperature

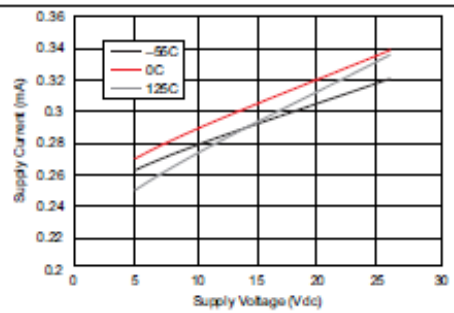


Figure 2. Supply Current vs. Supply Voltage

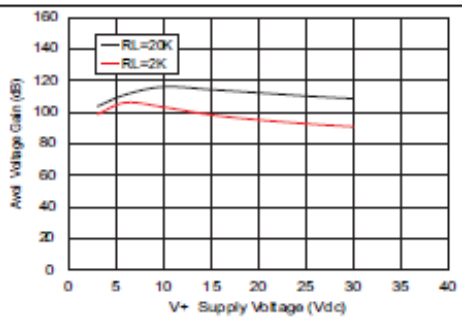


Figure 3. Voltage Gain vs. Supply Voltage

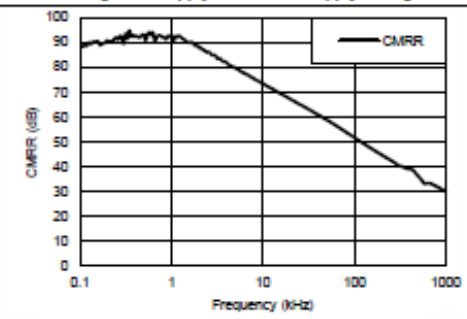


Figure 4. Common-mode Rejection Ratio vs. Frequency

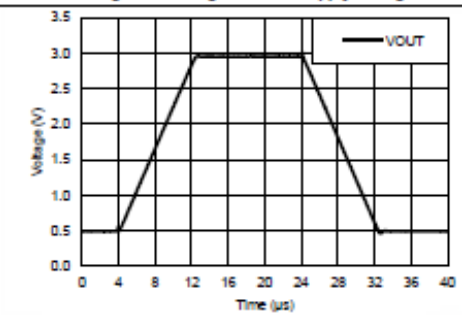


Figure 5. Voltage Follower Large Signal Response (50 pF)

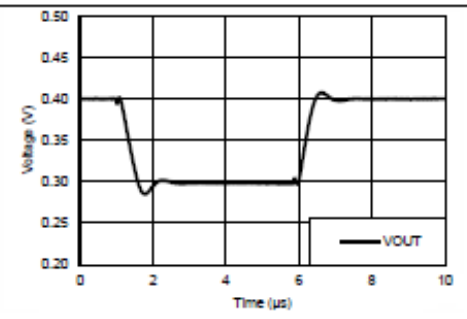


Figure 6. Voltage Follower Small Signal Response (50 pF)

Typical Characteristics (continued)

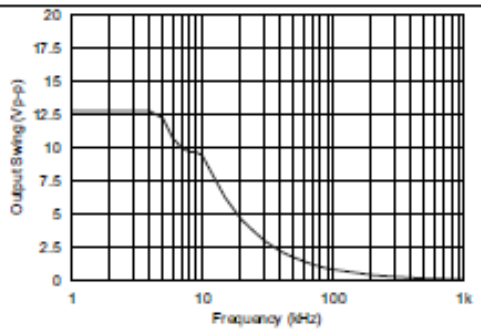


Figure 7. Maximum Output Swing vs. Frequency (V_{CC} = 15 V)

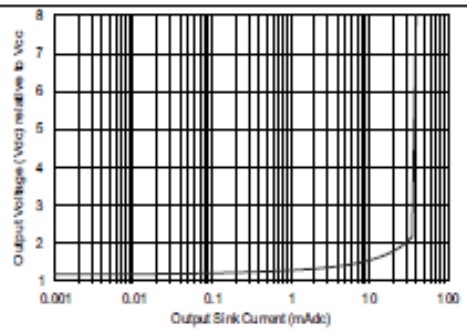


Figure 8. Output Sourcing Characteristics

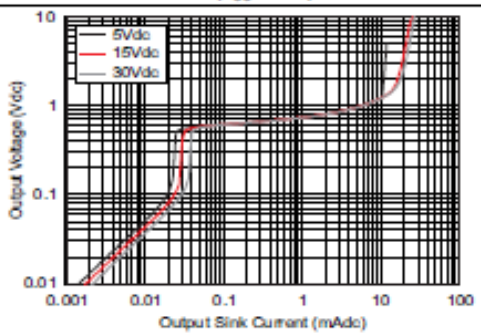


Figure 9. Output Sinking Characteristics

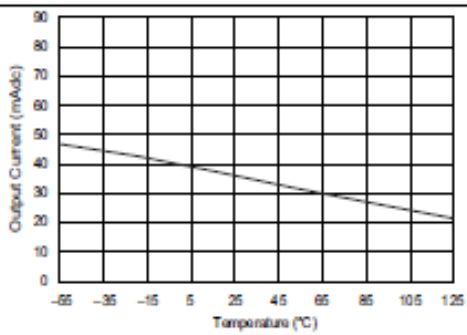
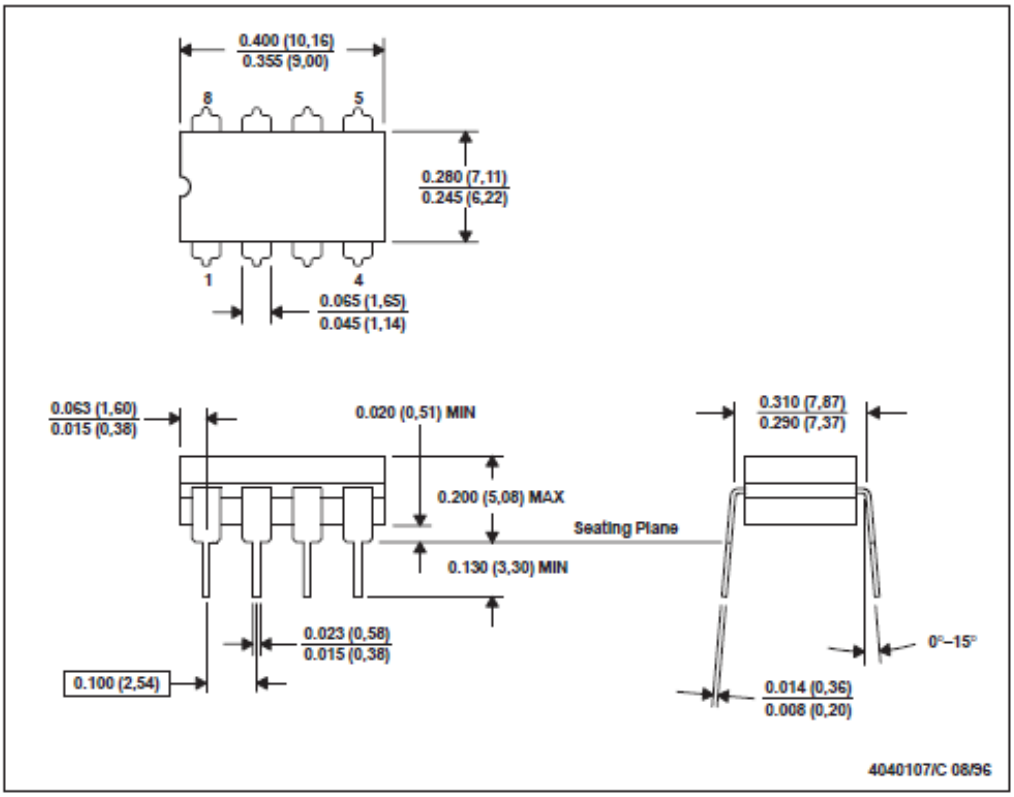


Figure 10. Source Current Limiting

MECHANICAL DATA

MCER001A – JANUARY 1995 – REVISED JANUARY 1997

JG (R-GDIP-T8) **CERAMIC DUAL-IN-LINE**



NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification.
E. Falls within MIL STD 1835 GDIP1-T8

TEXAS INSTRUMENTS
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

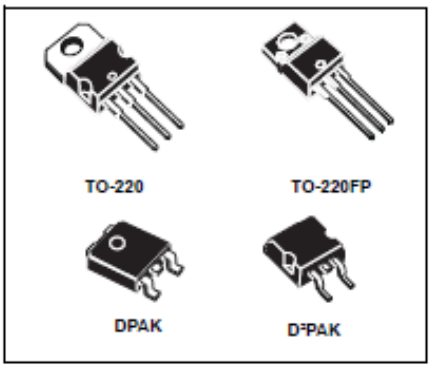
3 REGULADOR DE TENSIÓN L7805

life.augmented

L78

Positive voltage regulator ICs

Datasheet - production data



Features

- Output current up to 1.5 A
- Output voltages of 5; 6; 8; 8.5; 9; 12; 15; 18; 24 V
- Thermal overload protection
- Short circuit protection
- Output transition SOA protection
- 2 % output voltage tolerance (A version)
- Guaranteed in extended temperature range (A version)

Description

The L78 series of three-terminal positive regulators is available in TO-220, TO-220FP, D²PAK and DPAK packages and several fixed output voltages, making it useful in a wide range of applications.

These regulators can provide local on-card regulation, eliminating the distribution problems associated with single point regulation. Each type embeds internal current limiting, thermal shut-down and safe area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1 A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltage and currents.

2 Pin configuration

Figure 2. Pin connections (top view)

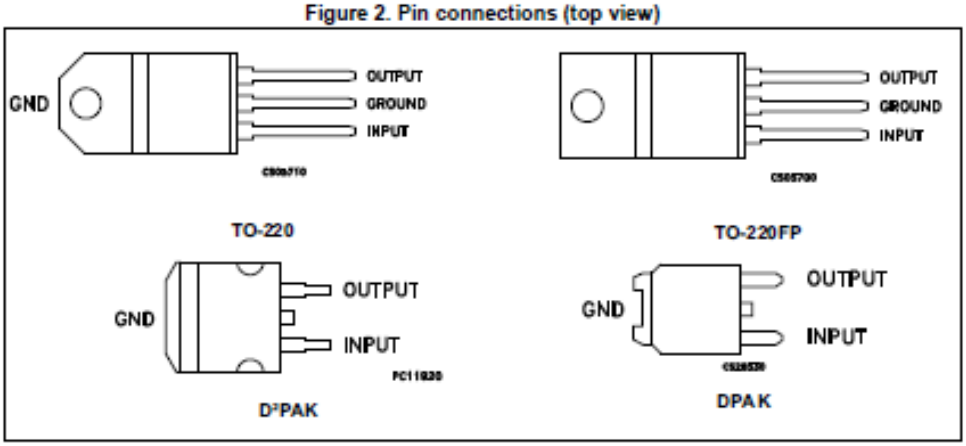
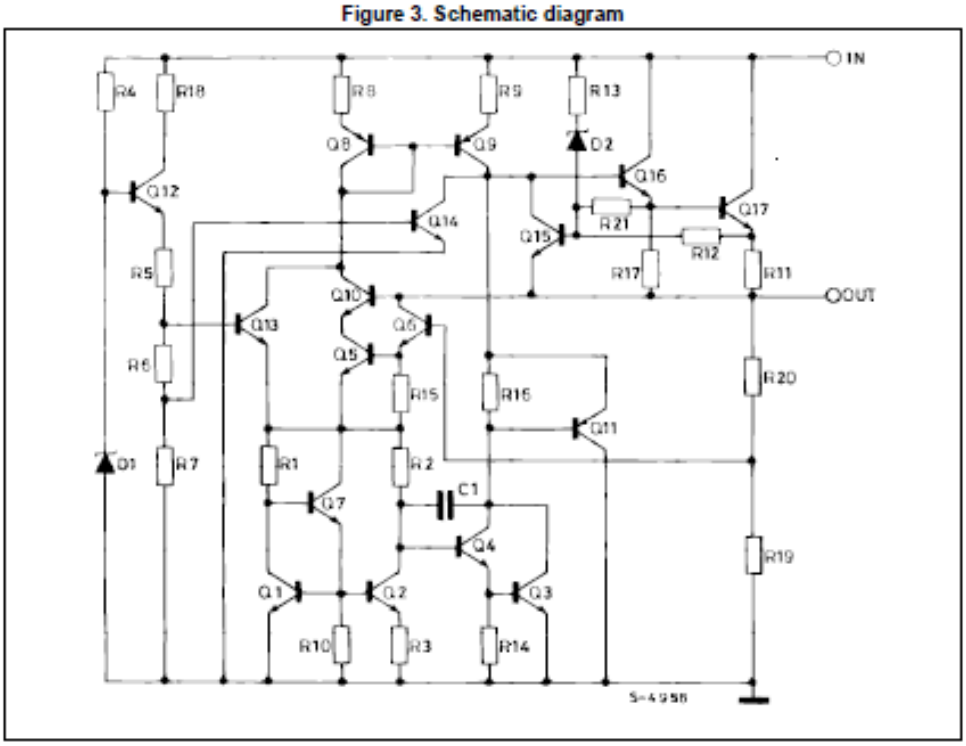


Figure 3. Schematic diagram



3 Maximum ratings

Table 1. Absolute maximum ratings

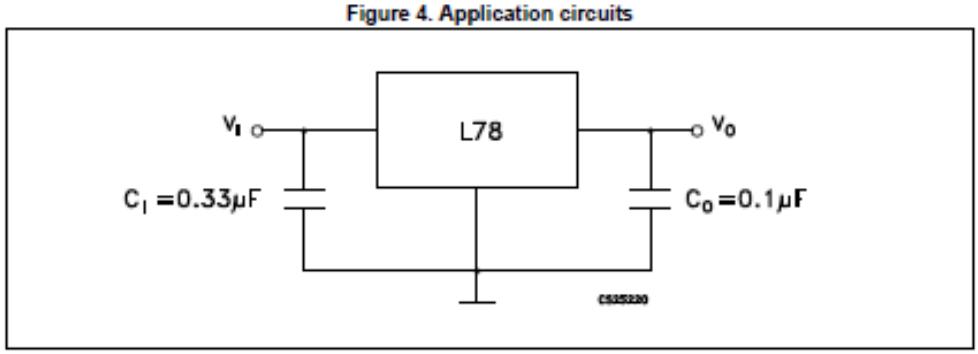
Symbol	Parameter		Value	Unit
V_I	DC Input voltage	for V_O= 5 to 18 V	35	V
		for V_O= 20, 24 V	40	
I_O	Output current		Internally limited	
P_D	Power dissipation		Internally limited	
T_{STG}	Storage temperature range		-65 to 150	°C
T_{OP}	Operating junction temperature range	for L78xxC, L78xxAC	0 to 125	°C
		for L78xxAB	-40 to 125	

Note: Absolute maximum ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.

Table 2. Thermal data

Symbol	Parameter	D²PAK	DPAK	TO-220	TO-220FP	Unit
R_{thJC}	Thermal resistance junction-case	3	8	5	5	°C/W
R_{thJA}	Thermal resistance junction-ambient	62.5	100	50	60	°C/W

Figure 4. Application circuits



5 Electrical characteristics

V_I = 10 V, I_O = 1 A, T_J = 0 to 125 °C (L7805AC), T_J = -40 to 125 °C (L7805AB), unless otherwise specified[a].

Table 3. Electrical characteristics of L7805A

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage	T_J = 25°C	4.9	5	5.1	V
V_O	Output voltage	I_O = 5 mA to 1 A, V_I = 7.5 to 18 V	4.8	5	5.2	V
V_O	Output voltage	I_O = 1 A, V_I = 18 to 20 V, T_J = 25°C	4.8	5	5.2	V
ΔV_O (1)	Line regulation	V_I = 7.5 to 25 V, I_O = 500 mA, T_J = 25°C		7	50	mV
		V_I = 8 to 12 V		10	50	mV
		V_I = 8 to 12 V, T_J = 25°C		2	25	mV
		V_I = 7.3 to 20 V, T_J = 25°C		7	50	mV
ΔV_O (1)	Load regulation	I_O = 5 mA to 1 A		25	100	mV
		I_O = 5 mA to 1.5 A, T_J = 25°C		30	100	
		I_O = 250 to 750 mA		8	50	
I_q	Quiescent current	T_J = 25°C		4.3	6	mA
					6	mA
ΔI_q	Quiescent current change	V_I = 8 to 23 V, I_O = 500 mA			0.8	mA
		V_I = 7.5 to 20 V, T_J = 25°C			0.8	mA
		I_O = 5 mA to 1 A			0.5	mA
SVR	Supply voltage rejection	V_I = 8 to 18 V, f = 120 Hz, I_O = 500 mA		68		dB
V_d	Dropout voltage	I_O = 1 A, T_J = 25°C		2		V
eN	Output noise voltage	T_A = 25°C, B = 10 Hz to 100 kHz		10		$\mu V/V_O$
R_O	Output resistance	f = 1 kHz		17		mΩ
I_{sc}	Short circuit current	V_I = 35 V, T_A = 25°C		0.2		A
I_{scp}	Short circuit peak current	T_J = 25°C		2.2		A
$\Delta V_O/\Delta T$	Output voltage drift			-1.1		mV/°C

1. Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

Electrical characteristics **Positive voltage regulator ICs**

Refer to the test circuits, T_J = 0 to 125 °C, V_I = 10 V, I_O = 500 mA, C_I = 0.33 µF, C_O = 0.1 µF unless otherwise specified[h].

Table 10. Electrical characteristics of L7805C

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage	T_J = 25°C	4.8	5	5.2	V
V_O	Output voltage	I_O = 5 mA to 1 A, V_I = 7 to 18 V	4.75	5	5.25	V
V_O	Output voltage	I_O = 1 A, V_I = 18 to 20V, T_J = 25°C	4.75	5	5.25	V
ΔV_O[1]	Line regulation	V_I = 7 to 25 V, T_J = 25°C		3	100	mV
		V_I = 8 to 12 V, T_J = 25°C		1	50	
ΔV_O[1]	Load regulation	I_O = 5 mA to 1.5 A, T_J = 25°C			100	mV
		I_O = 250 to 750 mA, T_J = 25°C			50	
I_d	Quiescent current	T_J = 25°C			8	mA
ΔI_d	Quiescent current change	I_O = 5 mA to 1 A			0.5	mA
		V_I = 7 to 23 V			0.8	
$\Delta V_O/\Delta T$	Output voltage drift	I_O = 5 mA		-1.1		mV/°C
eN	Output noise voltage	B = 10 Hz to 100 kHz, T_J = 25°C		40		$\mu V/V_O$
SVR	Supply voltage rejection	V_I = 8 to 18 V, f = 120 Hz	62			dB
V_d	Dropout voltage	I_O = 1 A, T_J = 25°C		2		V
R_O	Output resistance	f = 1 kHz		17		mΩ
I_{sc}	Short circuit current	V_I = 35 V, T_J = 25°C		0.75		A
I_{scp}	Short circuit peak current	T_J = 25°C		2.2		A

1. Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

h. Minimum load current for regulation is 5 mA.

Positive voltage regulator ICs **Electrical characteristics**

Refer to the test circuits, T_J = 0 to 125 °C, V_I = 11 V, I_O = 500 mA, C_I = 0.33 µF, C_O = 0.1 µF unless otherwise specified[1].

Table 11. Electrical characteristics of L7806C

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage	T_J = 25°C	5.75	6	6.25	V
V_O	Output voltage	I_O = 5 mA to 1 A, V_I = 8 to 19 V	5.7	6	6.3	V
V_O	Output voltage	I_O = 1 A, V_I = 19 to 21 V, T_J = 25°C	5.7	6	6.3	V
ΔV_O(1)	Line regulation	V_I = 8 to 25 V, T_J = 25°C			120	mV
		V_I = 9 to 13 V, T_J = 25°C			60	
ΔV_O(1)	Load regulation	I_O = 5 mA to 1.5 A, T_J = 25°C			120	mV
		I_O = 250 to 750 mA, T_J = 25°C			60	
I_d	Quiescent current	T_J = 25°C			8	mA
ΔI_d	Quiescent current change	I_O = 5 mA to 1 A			0.5	mA
		V_I = 8 to 24 V			1.3	
$\Delta V_O/\Delta T$	Output voltage drift	I_O = 5 mA		-0.8		mV/°C
eN	Output noise voltage	B = 10 Hz to 100 kHz, T_J = 25°C		45		$\mu V/V_O$
SVR	Supply voltage rejection	V_I = 9 to 19 V, f = 120 Hz	59			dB
V_d	Dropout voltage	I_O = 1 A, T_J = 25°C		2		V
R_O	Output resistance	f = 1 kHz		19		mΩ
I_{sc}	Short circuit current	V_I = 35 V, T_J = 25°C		0.55		A
I_{scp}	Short circuit peak current	T_J = 25°C		2.2		A

1. Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

1. Minimum load current for regulation is 5 mA.

7 Typical performance

Figure 28. Dropout voltage vs. junction temperature

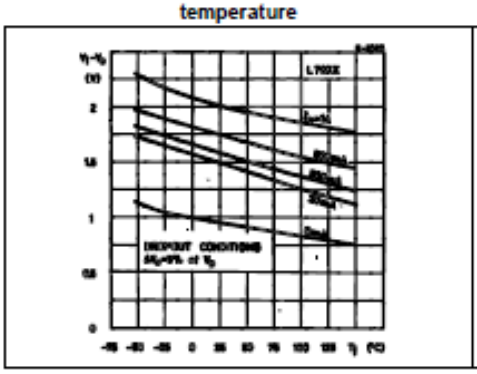


Figure 29. Peak output current vs. input/output differential voltage

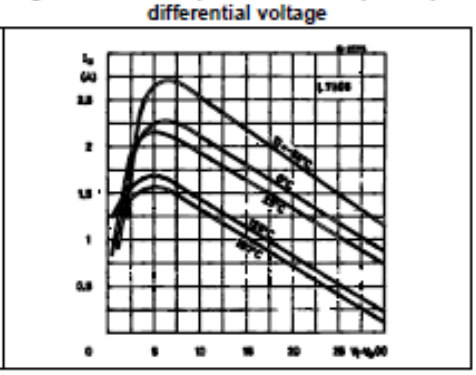


Figure 30. Supply voltage rejection vs. frequency

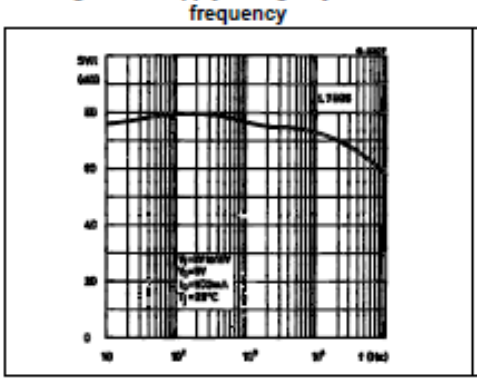


Figure 31. Output voltage vs. junction temperature

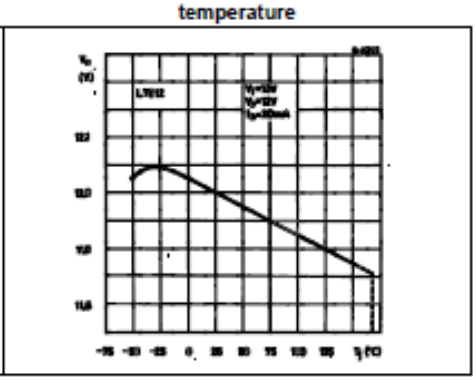


Figure 32. Output impedance vs. frequency

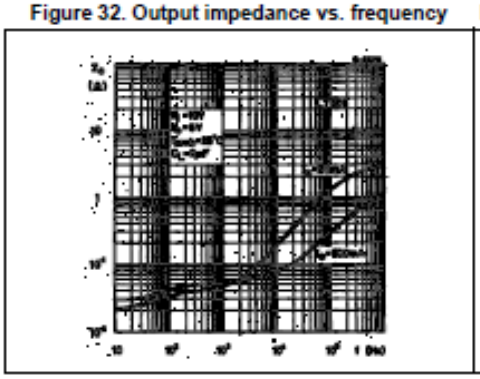


Figure 33. Quiescent current vs. junction temp.

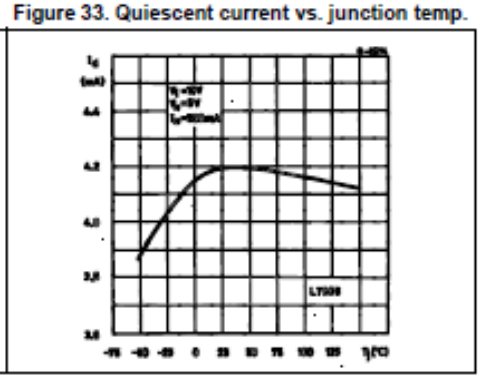


Figure 34. Load transient response

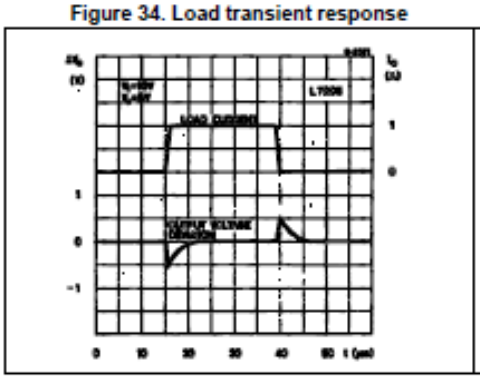


Figure 35. Line transient response

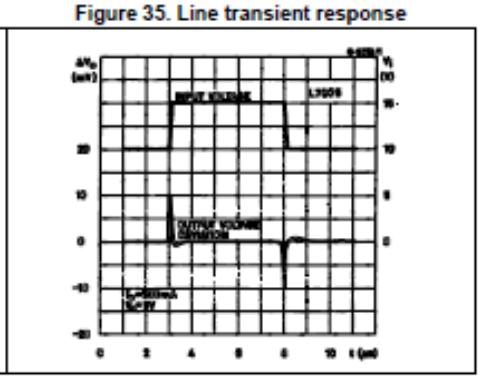


Figure 36. Quiescent current vs. input voltage

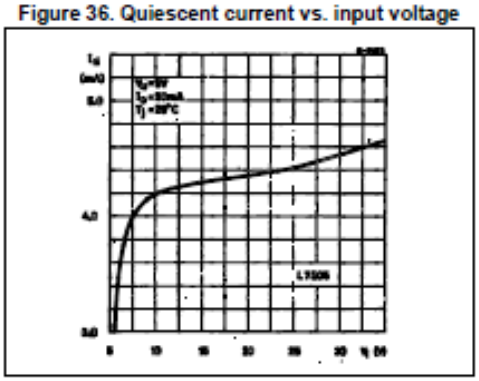


Figure 37. TO-220 (dual gauge) drawing

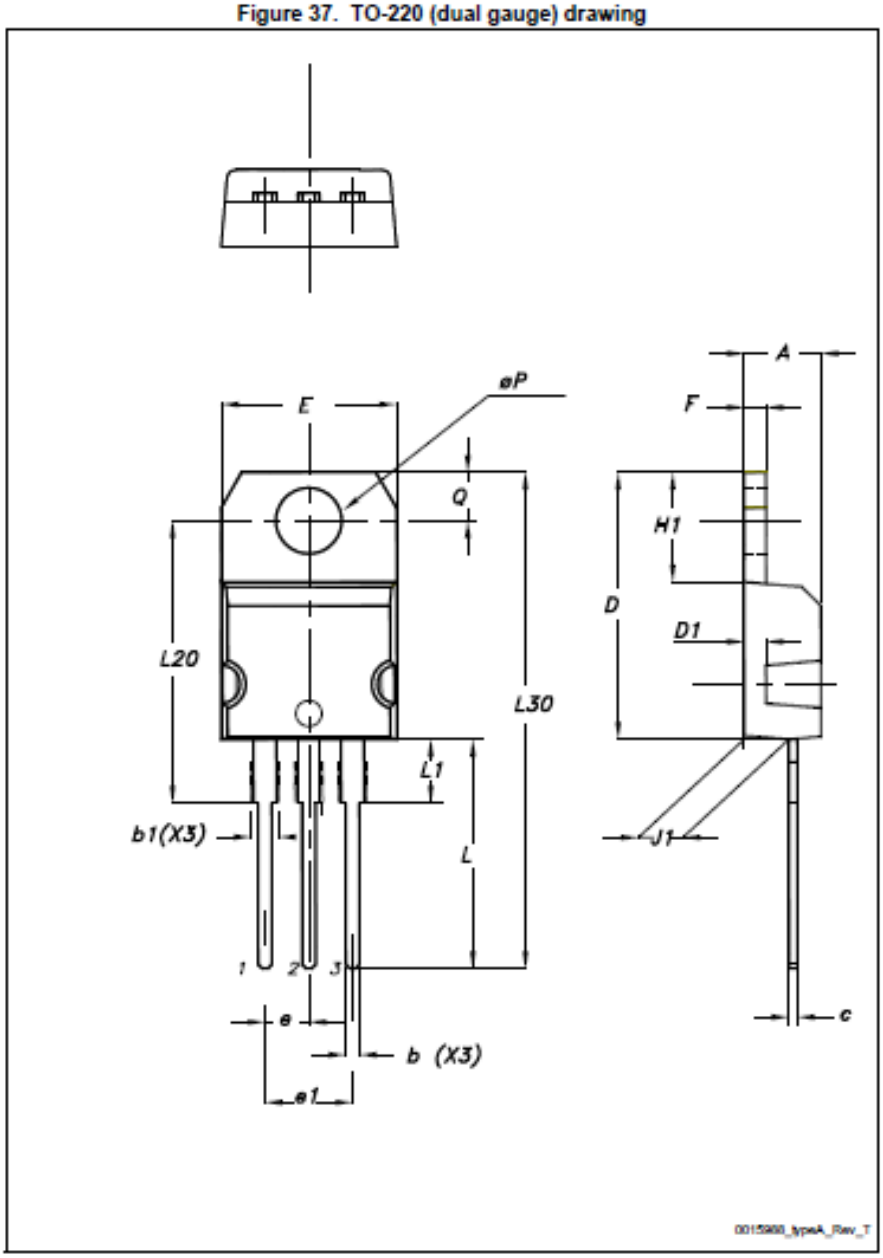


Table 19. TO-220 (dual gauge) mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10		10.40
e	2.40		2.70
e1	4.95		5.15
F	1.23		1.32
H1	6.20		6.60
J1	2.40		2.72
L	13		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
ØP	3.75		3.85
Q	2.65		2.95

4 CONDENSADOR CERÁMICO 100pF

VISHAY

HV LDF 0.2 %

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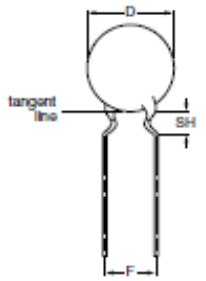
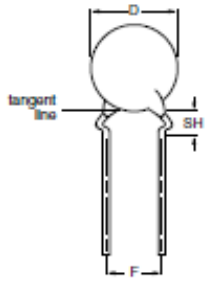
Ceramic Disc DC Capacitors Class 2, Low Loss 500 V, 1 kV, 2 kV and 3 kV



Capacitors with inside kink lead spacing



Capacitors with outside kink lead spacing

FEATURES

- High reliability
- Low losses
- High capacitance in small size
- Kinked leads
- Compliant to RoHS directive 2002/95/EC

Pb e3 RoHS COMPLIANT

APPLICATIONS

In electronic circuits where low losses and high capacitance per volume are essential, for example:

- SMPS
- HF ballast
- Snubber and high voltage circuits

DESIGN

The capacitors consist of a ceramic disc both sides of which are silver-plated. Connection leads are made of tinned copper having a diameter of 0.6 mm or 0.8 mm.

The capacitors are supplied with kinked leads and lead spacings of 5 mm or 7.5 mm and 10 mm. Encapsulation is made of epoxy-resin, flammable resistant in accordance with *"UL94V-0"*.

CAPACITANCE RANGE

100 pF to 4700 pF

RATED DC VOLTAGE

500 V; 1 kV; 2 kV; 3 kV

DIELECTRIC STRENGTH

200 % of rated voltage

INSULATION RESISTANCE AT 500 V (DC)

≥ 10 000 MΩ min.

TOLERANCE ON CAPACITANCE

± 10 %; ± 20 %

DISSIPATION FACTOR

0.2 % max.

OPERATING TEMPERATURE RANGE

- 30 °C to + 125 °C

TEMPERATURE COEFFICIENT Y5R (2C4) - 30 °C TO + 85 °C:

± 15 %

SECTIONAL SPECIFICATIONS

IEC 60384-9, EIA 198

AGING

Typical 0.5 % per time decade

MARKING

Marking indicates capacitance value and tolerance in accordance with "EIA 198" and voltage marks.

EXAMPLES OF MARKING CODE

Disc size ($D_{max.}$) ≤ 6.5 mm:
RR = Low loss with T.C.
Y5R
101 K
2 kV

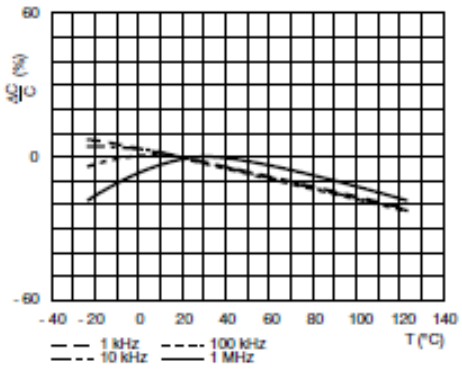
Disc size ($D_{max.}$) ≥ 7.5 mm:
BC
RR
102 K
3 kV

Note
The capacitors meet the essential requirements of "IEC 60384-9 and EIA 198". Unless stated otherwise all electrical values apply at an ambient temperature of 25 ± 3 °C, at normal atmospheric conditions

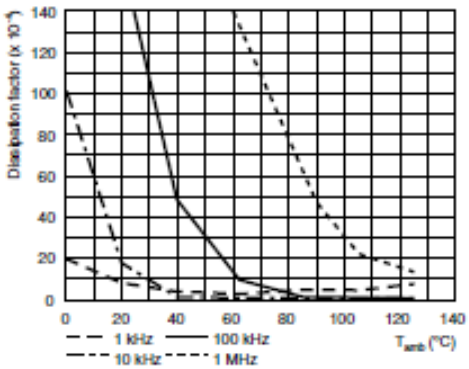
HV LDF 0.2 %

Vishay

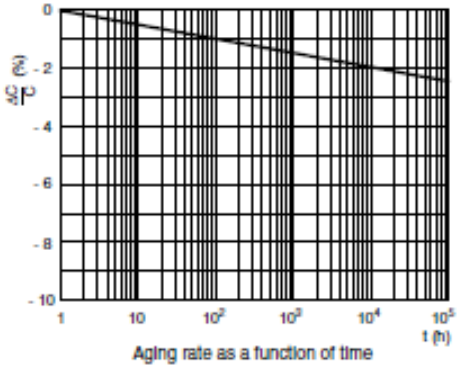
Ceramic Disc DC Capacitors Class 2,
Low Loss 500 V, 1 kV, 2 kV and 3 kV



Typical capacitance change as a function of temperature and frequency



Typical dissipation factor as a function of temperature and frequency



Aging rate as a function of time

ORDERING INFORMATION					
C (pF)	TOL. (%)	$D_{max.}$ (mm)	LEAD SPACING S (mm)	SH [2] (mm)	CLEAR TEXT CODE 13TH DIGIT: T = REEL; U = AMMO; 3 = BULK 16TH DIGIT: R = RoHS COMPLIANT
500 V					
100	± 10	5.0	5.0	4.0	F101K20Y5RL6.J5.
120					F121K20Y5RL6.J5.
150					F151K20Y5RL6.J5.
180					F181K20Y5RL6.J5.
220					F221K20Y5RL6.J5.
270					F271K20Y5RL6.J5.
330					F331K20Y5RL6.J5.
390		6.5			F391K25Y5RL6.J5.
470					F471K25Y5RL6.J5.
560					F561K25Y5RL6.J5.
680					F681K25Y5RL6.J5.
820		7.5			F821K29Y5RL6.J5.
1000					F102K29Y5RL6.J5.
1200		8.5			F122K33Y5RL6.J5.
1500					F152K33Y5RL6.J5.
1800		10.0			F182K39Y5RL6.J5.
2200					F222K39Y5RL6.J5.
2700		12.0	7.5		F272K47Y5RL63J7.

VISHAY.

HV LDF 0.2 %

Ceramic Disc DC Capacitors Class 2,
Low Loss 500 V, 1 kV, 2 kV and 3 kV

Vishay

ORDERING INFORMATION					
C (pF)	TOL. (%)	$D_{max.}$ (mm)	LEAD SPACING S (mm)	SH [2] (mm)	CLEAR TEXT CODE 13TH DIGIT: T = REEL; U = AMMO; 3 = BULK 16TH DIGIT: R = RoHS COMPLIANT
1 kV					
100	± 10	6.5	5.0	4.0	F101K25Y5RN6.J5.
120					F121K25Y5RN6.J5.
150					F151K25Y5RN6.J5.
180					F181K25Y5RN6.J5.
220					F221K25Y5RN6.J5.
270		7.5			F271K29Y5RN6.J5.
330					F331K29Y5RN6.J5.
390					F391K29Y5RN6.J5.
470					F471K29Y5RN6.J5.
560		8.5			F561K33Y5RN6.J5.
680					F681K33Y5RN6.J5.
820		10.0			F821K39Y5RN6.J5.
1000					F102K39Y5RN6.J5.
1200		11.0			F122K43Y5RN6.J5.
1500					F152K43Y5RN6.J5.
1800		12.5	7.5		F182K47Y5RN63J7.
2200		13.5			F222K53Y5RN63J7.
2700					F272K53Y5RN63J7.
3300		17.5			F332K69Y5RN63J7.
3900					F392K69Y5RN63J7.
4700		19.0	10.0		F472K75Y5RN83J0.
2 kV					
100	± 10	6.5	5.0	4.0	F101K25Y5RP6.K5.
120					F121K25Y5RP6.K5.
150					F151K25Y5RP6.K5.
180		7.5			F181K29Y5RP6.K5.
220					F221K29Y5RP6.K5.
270					F271K29Y5RP6.K5.
330					F331K29Y5RP6.K5.
390		8.5			F391K33Y5RP6.K5.
470					F471K33Y5RP6.K5.
560		10.0			F561K39Y5RP6.K5.
680					F681K39Y5RP6.K5.
820		11.0			F821K43Y5RP6.K5.
1000					F102K43Y5RP6.K5.
1200		12.0	7.5	4.8	F122K47Y5RP63K7.
1500		13.5			F152K53Y5RP63K7.
1800					F182K53Y5RP63K7.
2200		17.5			F222K69Y5RP63K7.
2700		19.0	10.0		F272K75Y5RP83K0.
3300					F332K75Y5RP83K0.
3900		24.5			F392K75Y5RP83K0.
4700					F472K96Y5RP83K0.

HV LDF 0.2 %

Vishay

Ceramic Disc DC Capacitors Class 2,
Low Loss 500 V, 1 kV, 2 kV and 3 kV

ORDERING INFORMATION					
C (pF)	TOL. (%)	$D_{max.}$ (mm)	LEAD SPACING S (mm)	SH [2] (mm)	CLEAR TEXT CODE 13TH DIGIT: T = REEL; U = AMMO; 3 = BULK 16TH DIGIT: R = RoHS COMPLIANT
3 kV					
100	± 10	8.5	7.5	4.0	F101K33Y5RR6.K7.
120					F121K33Y5RR6.K7.
150					F151K33Y5RR6.K7.
180					F181K33Y5RR6.K7.
220					F221K33Y5RR6.K7.
270					F271K33Y5RR6.K7.
330					F331K33Y5RR6.K7.
390		10			F391K39Y5RR6.K7.
470					F471K39Y5RR6.K7.
560		11			F561K43Y5RR6.K7.
680					F681K43Y5RR6.K7.
820		13.5		4.8	F821K53Y5RR63K7.
1000					F102K53Y5RR63K7.
1200		15			F122K59Y5RR63K7.
1500					F152K59Y5RR63K7.
1800		19	10.0		F182K75Y5RR83K0.
2200					F222K75Y5RR83K0.
2700		21			F272K84Y5RR83K0.

Notes
[1] Maximum thickness: 500 V = 3.5 mm; 1 kV = 4.5 mm; 2 kV = 5.0 mm; 3 kV = 6.0 mm.
[2] SH = seated height.

PACKAGING					
PACKAGING TYPE	SIZE CODE	LEAD SPACE (mm)	VOLTAGE (VDC)	SPQ	BOX DIMENSIONS L x W x H (mm)
Bulk (long lead L ≥ 25.4 mm	20 to 25	all	all	1000	245 x 120 x 65
	29 to 39			1000	
	43 to 47			1000	
	53 to 75			500	
	84 to 96			250	
Tape and reel	≤ 47	≤ 6.4	< 500	2500	370 x 370 x 60
			500 ≤ WV ≤ 2000	2000	
			3000	1000	
		≥ 7.5	all	1000	
	≥ 53	all	all	1000	
Ammopack	≤ 47	≤ 6.4	< 500	2000	335 x 240 x 50
			500 ≤ WV < 2000	2000	335 x 290 x 50
			2000 and 3000	1500	
		≥ 7.5	all	1500	360 x 330 x 55
	≥ 53	all	all	1500	335 x 290 x 50

Note
• The capacitors are supplied in bulk packaging (cardboard boxes), in tape on reel or in ammopack

VISHAY

HV LDF 0.2 %

Ceramic Disc DC Capacitors Class 2,
Low Loss 500 V, 1 kV, 2 kV and 3 kV

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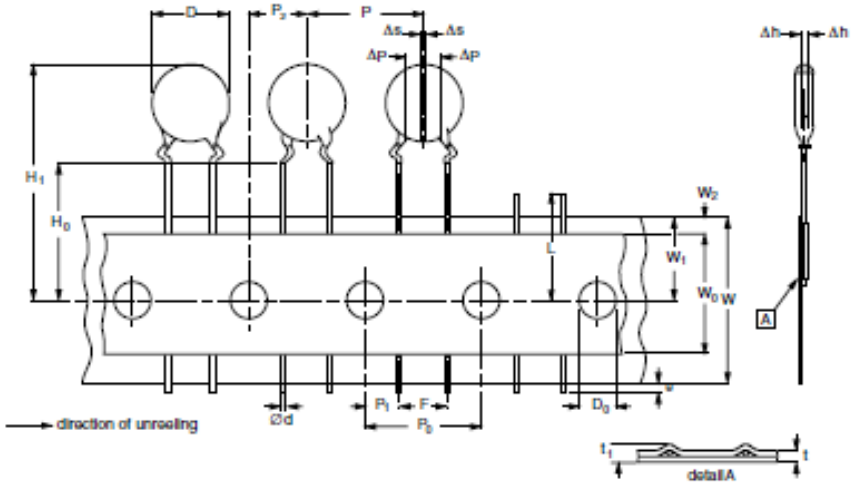


Kinked capacitors on tape, lead spacing 5.0 mm (0.2") or 7.5 mm (0.3")

DIMENSIONS OF TAPE			
SYMBOL	PARAMETER	DIMENSIONS (mm)	
		Feed-hole pitch P_0 = 12.7	Feed-hole pitch P_0 = 15.0
D	body diameter	11.0 max.	14.0 max.
d	lead diameter	0.6 ± 0.05	0.6 ± 0.05
P	pitch between capacitors	12.7 ± 1.0	15.0 ± 1.0
P_0	feed-hole pitch	12.7 ± 0.3; (1)	15.0 ± 0.3; (1)
ΔP	plane deviation	1.0 max.	1.0 max.
P_1	feed-hole centre to lead centre	3.85 ± 0.7; (2)	3.75 ± 0.7; (2)
P_2	feed-hole centre to component centre	6.35 ± 1.3; (2)	7.5 ± 1.5; (2)
F	lead spacing	5.0 + 0.6/- 0.4	7.5 + 0.6/- 0.4
Δh	component alignment	0 ± 1.0	0 ± 1.0
W	tape width	18.0 + 1.0/- 0.5	18.0 + 1.0/- 0.5
W_0	hold-down tape width	5.0 min.	5.0 min.
W_1	hole position	9.0 + 0.75/- 0.5	9.0 + 0.75/- 0.5
W_2	hold-down tape margin	3.0 max.	3.0 max.
H_0	height to seating plane	16.0 ± 0.5	16.0 ± 0.5
H_1	maximum component height	32.0	40.0
e	lead end protrusion	1.0 max.	1.0 max.
L	maximum length of snipped lead	11.0	11.0
D_0	feed-hole diameter	4.0 ± 0.2	4.0 ± 0.2
t	total tape thickness	0.9 max.	0.9 max.
t_1	maximum thickness of tape and wires	1.5 max.	1.5 max.

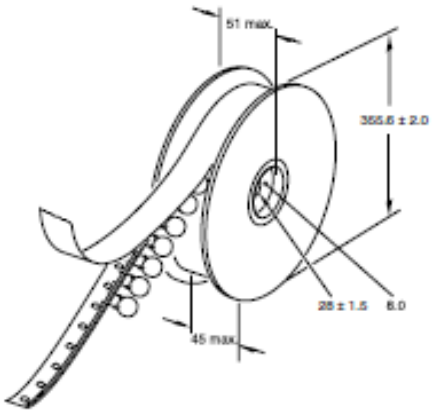
Notes
(1) Cumulative pitch error: ± ≤ 1 mm/20 pitches
(2) Obliquity maximum 3°.

HV LDF 0.2 %

Vishay

Ceramic Disc DC Capacitors Class 2,
Low Loss 500 V, 1 kV, 2 kV and 3 kV

REEL AND TAPE DATA IN MILLIMETERS



Reel with capacitors on tape

Ammopack with capacitors on tape

DIMENSIONS OF AMMOPACK			
PARAMETER	DISC SIZE ($D_{max.}$)		UNIT
	6.5 mm to 11.0 mm	12.0 mm to 13.5 mm	
Taping pitch	12.7	15.0	mm
L	335	360	mm
W	290	330	mm
H	50	55	mm

5 LDR (Fotorresistencia)

LUNA OPTOELECTRONICS

To-18 Ceramic Package Photocells

NSL-19M51

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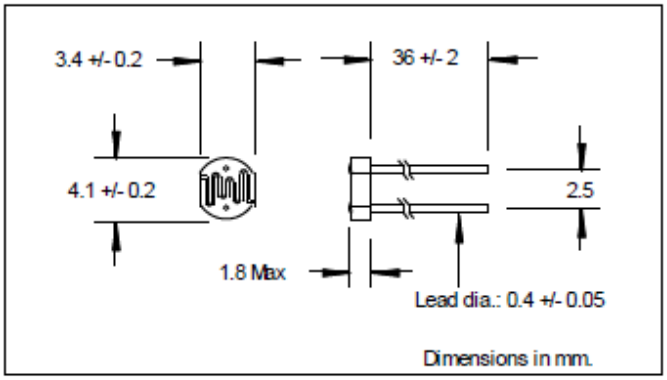

DESCRIPTION

The NSL-19M51 is a light dependent resistor with sensitivity in the visible light region. The CdS photoconductive cell is on a TO-18 ceramic and the photocell surface is plastic encapsulated for moisture resistance.

FEATURES

- Passive resistance output
- Ceramic package

RELIABILITY

Contact Luna for recommendations on specific test conditions and procedures.

APPLICATIONS

- Industrial

ABSOLUTE MAXIMUM RATINGS

SYMBOL	MIN		MAX	UNITS	(TA)= 23°C UNLESS OTHERWISE NOTED
Voltage (peak AC or DC)	-	-	100	V	-
Power Dissipation @ 25°C[1]	-	-	50	mW	-
Operation Temperature	-60	to	+75	°C	-
Storage Temperature	-60	to	+75	°C	-
Soldering Temperature[2]	-	-	+260	°C	-

NOTES:

1. Derate linearly to 0 at 75°C
2. >0.05" from case for <10 sec.

Luna Optoelectronics, 1240 Avenida Acaso, Camarillo CA 93012 • Phone (805) 987-0146 • Fax (805) 484-9935

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To-18 Ceramic Package Photocells

NSL-19M51

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OPTO-ELECTRICAL PARAMETERS

T_a = 23°C unless noted otherwise

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Light Resistance	10 lux., 2854°K[3]	20	-	100	KΩ
	100 lux., 2854°K[3]	-	5	-	
Dark Resistance	10 sec after removal of test light.	20	-	-	MΩ
Spectral Peak	-	-	550	-	nm
Gamma	1-10 Lux	-	0.7	-	-
Gamma	10-100 Lux	-	0.7	-	-

NOTE:
3. Cells light adapted at 30 to 50 Ftc for 16 hrs minimum prior to electrical tests.

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6 MICROCONTROLADOR ARDUINO UNO

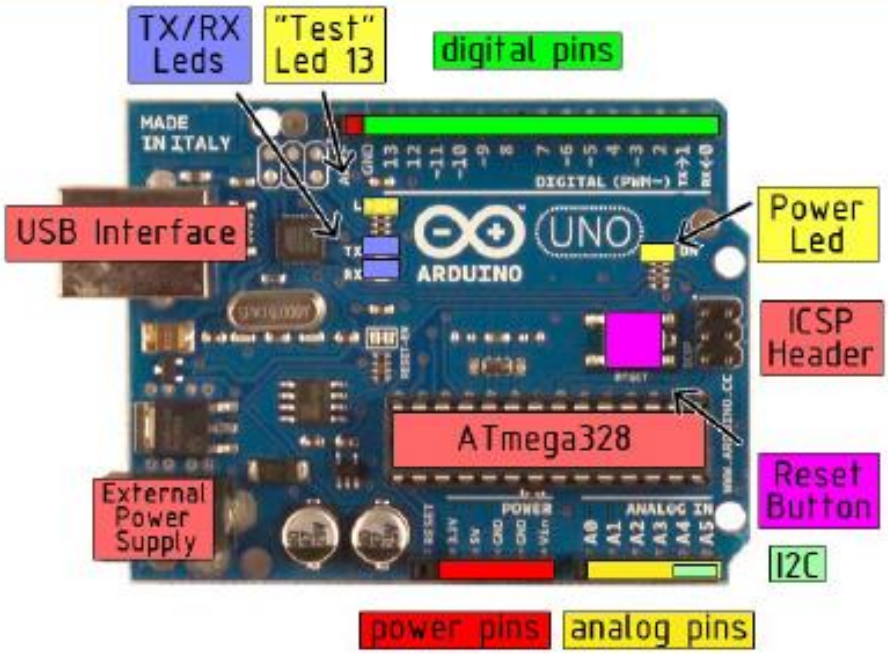
Technical Specification

EAGLE files: arduino-duemilanove-uno-design.zip Schematic: arduino-uno-schematic.pdf

Summary

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB of which 0.5 KB used by bootloader
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz

the board



Power

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

- **VIN.** The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V.** The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.
- **3V3.** A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND.** Ground pins.

Memory

The Atmega328 has 32 KB of flash memory for storing code (of which 0,5 KB is used for the bootloader); It has also 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- **Serial: 0 (RX) and 1 (TX).** Used to receive (RX) and transmit (TX) TTL serial data. TThese pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip .
- **External Interrupts: 2 and 3.** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.
- **PWM: 3, 5, 6, 9, 10, and 11.** Provide 8-bit PWM output with the analogWrite() function.
- **SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK).** These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.

- **LED: 13.** There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Uno has 6 analog inputs, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference() function. Additionally, some pins have specialized functionality:

- **I²C: 4 (SDA) and 5 (SCL)**. Support I²C (TWI) communication using the Wire library.

There are a couple of other pins on the board:

- **AREF**. Reference voltage for the analog inputs. Used with analogReference().
- **Reset**. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

See also the mapping between Arduino pins and Atmega328 ports.

Communication

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega8U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '8U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, an *.inf file is required..

The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A SoftwareSerial library allows for serial communication on any of the Uno's digital pins.

The ATmega328 also support I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation for details. To use the SPI communication, please see the ATmega328 datasheet.

Programming

The Arduino Uno can be programmed with the Arduino software (download). Select "Arduino Uno w/ ATmega328" from the **Tools** > **Board** menu (according to the microcontroller on your board). For details, see the reference and tutorials.

The ATmega328 on the Arduino Uno comes preburned with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files).

You can also bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header; see these instructions for details.

The ATmega8U2 firmware source code is available . The ATmega8U2 is loaded with a DFU bootloader, which can be activated by connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2. You can then use Atmel's FLIP software (Windows) or the DFU programmer (Mac OS X and Linux) to load a new firmware. Or you can use the ISP header with an external programmer (overwriting the DFU bootloader).

Automatic (Software) Reset

Rather than requiring a physical press of the reset button before an upload, the Arduino Uno is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the bootloader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload.

This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data.

The Uno contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line; see this forum thread for details.

USB Overcurrent Protection

The Arduino Uno has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

Physical Characteristics

The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Three screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100 mil spacing of the other pins.

How to use Arduino

Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, MaxMSP).

Arduino is a cross-platoform program. You'll have to follow different instructions for your personal OS. Check on the Arduino site for the latest instructions. *http://arduino.cc/en/Guide/HomePage*

Linux Install Windows Install Mac Install

Once you have downloaded/unzipped the arduino IDE, you can Plug the Arduino to your PC via USB cable.

Blink led

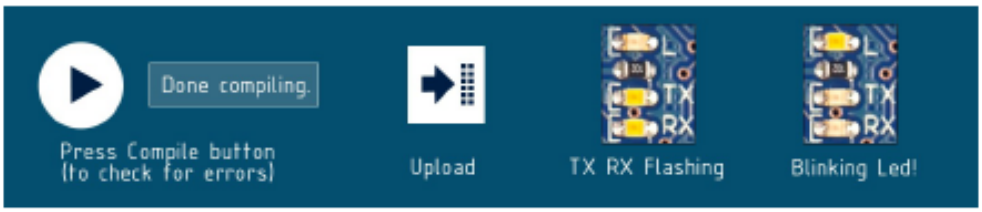
Now you're actually ready to "burn" your first program on the arduino board. To select "blink led", the physical translation of the well known programming "hello world", select

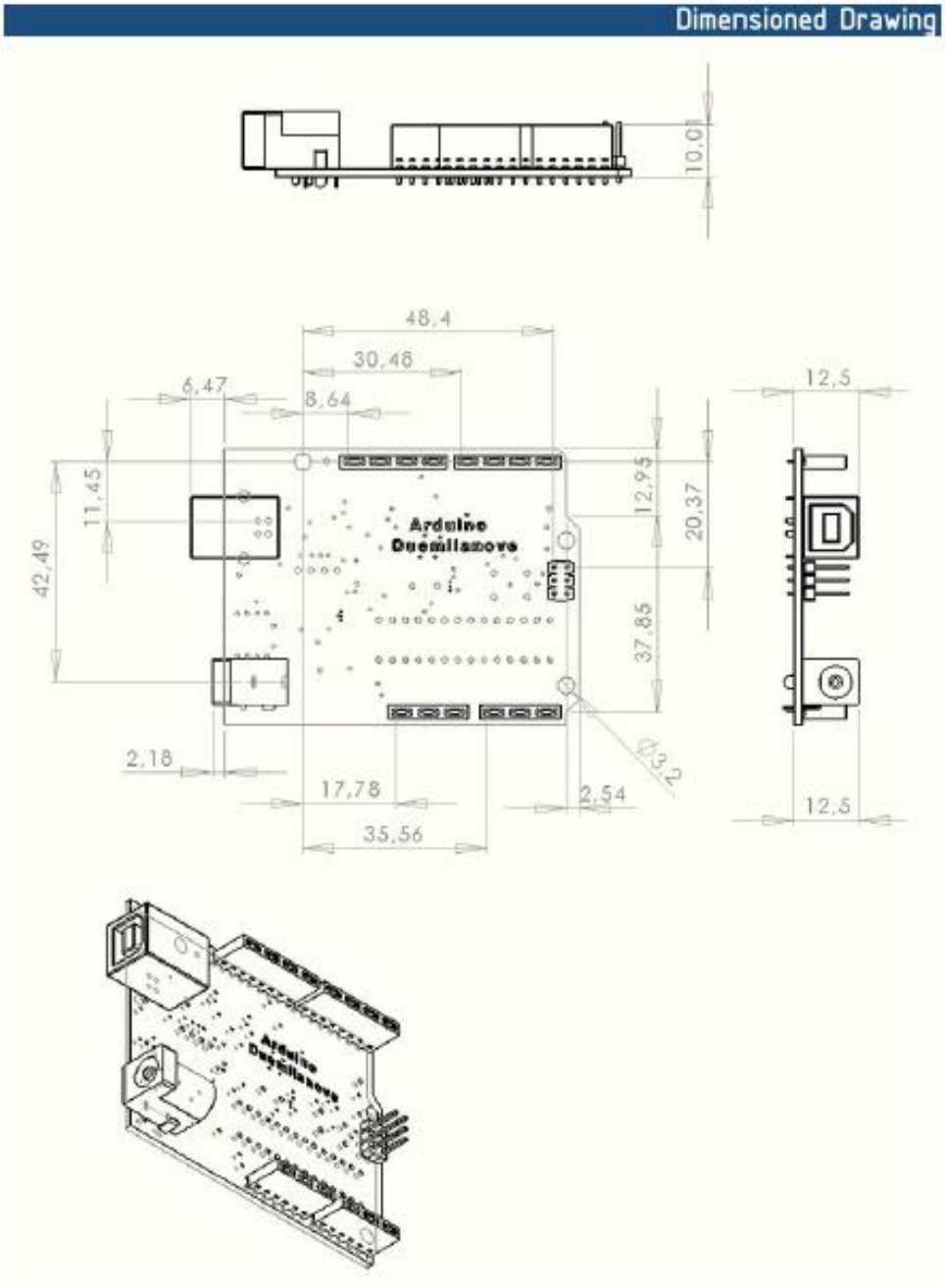
File>Sketchbook>
Arduino-0017>Examples>
Digital>Blink

Once you have your skecth you'll see something very close to the screenshot on the right.

In **Tools>Board** select

Now you have to go to
Tools>SerialPort
and select the right serial port, the one arduino is attached to.




Dimensioned Drawing
10,01
48,4
30,48
6,47
8,64
12,5
11,45
42,49
12,95
20,37
37,85
Arduino
Duemilanove
2,18
17,78
35,56
2,54
Ø3,2
12,5

7 BIBLIOGRAFÍA

En lo relativo a referencias de páginas web empleadas en la búsqueda de componentes son las siguientes:

[1] https://es.rs-online.com/

[2] https://www.amazon.es/