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MOTOROLA

LM2935

Low Dropout Dual Voltage Regulator

The LM2935 is a dual positive 5.0 V low dropout voltage regulator, designed for standby power systems. The main output is capable of supplying 750 mA for microprocessor power, and can be turned “on” and “off” by the switch/reset input. The other output is dedicated for standby operation of volatile memory, and is capable of supplying up to 10 mA loads. The total device features a low quiescent current of 3.0 mA or less when supplying 10 mA from the standby output.

This part was designed for harsh automotive environments and is therefore immune to many input supply voltage problems such as reverse battery (–12 V), double battery (+24 V), and load dump transients (+60 V).

- Two Regulated 5.0 V Outputs
- Main Output Current in Excess of 750 mA
- On/Off Control of Main Output
- Standby Output Current in Excess of 10 mA
- Low Input/Output Differential of Less than 0.6 V at 500 mA
- Short Circuit Current Limiting
- Internal Thermal Shutdown
- Low Voltage Indicator Output
- Designed for Automotive Environment Including
  - Reverse Battery Protection
  - Double Battery Protection
  - Load Dump Protection
  - Reverse Transient Protection
- Economical 5–Lead TO–220 Package with Two Optional Leadforms
- Also Available in Surface Mount D^2PAK Package

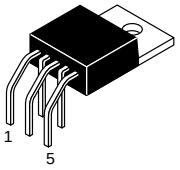
ORDERING INFORMATION

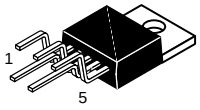
Device	Operating Temperature Range	Package
LM2935D2T	T_J = –40° to +125°C	Surface Mount
LM2935T		Plastic Power
LM2935TH		Horizontal Mount
LM2935TV		Vertical Mount

LOW DROPOUT DUAL VOLTAGE REGULATOR

SEMICONDUCTOR TECHNICAL DATA

TH SUFFIX
PLASTIC PACKAGE
CASE 314A

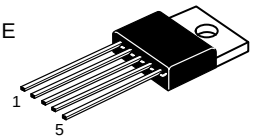




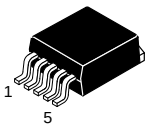
TV SUFFIX
PLASTIC PACKAGE
CASE 314B

Heatsink surface connected to Pin 3.

T SUFFIX
PLASTIC PACKAGE
CASE 314D



Pin 1. Input Voltage/V_{CC}
2. Main Output
3. Ground
4. Switch/Reset
5. Standby/Output

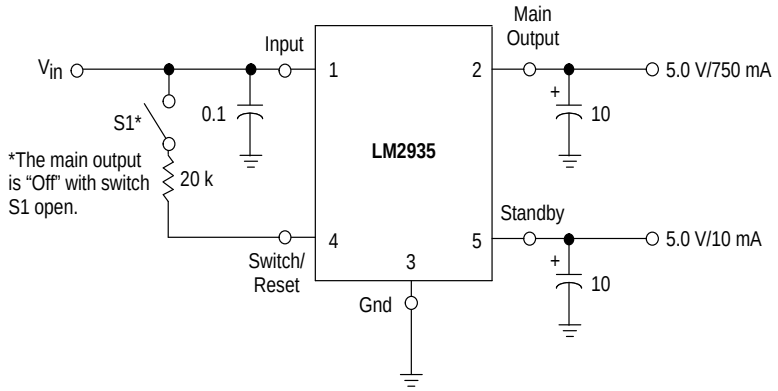


D2T SUFFIX
PLASTIC PACKAGE
CASE 936A
(D^2PAK)

Heatsink surface (shown as terminal 6 in case outline drawing) is connected to Pin 3.

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Typical Application Circuit



An input bypass capacitor is recommended if the regulator is located more than 4″ from the supply input filter. The LM2935 is not internally compensated and thus requires an external output capacitor for stability. A minimum capacitance of 10 μF is recommended. The actual capacitance value is dependent upon load current, temperature, and the capacitor's equivalent series resistance (ESR). The least stable condition is encountered at maximum load current and minimum ambient temperature.

This device contains 29 active transistors.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input Voltage Continuous	V_I	60	Vdc
Transient Reverse Polarity Input Voltage 1.0% Duty Cycle, $\tau \leq 100$ ms	$-V_I(\tau)$	−50	Vpk
Switch/Reset Input Current	I_{in}	5.0	mA
Power Dissipation Case 314A, 314B and 314D (TO–220 Type) T_A = 25°C Thermal Resistance, Junction–to–Ambient Thermal Resistance, Junction–to–Case Case 936A (D^2PAK) T_A = 25°C Thermal Resistance, Junction–to–Ambient Thermal Resistance, Junction–to–Case	 P_D $R_{\theta JA}$ $R_{\theta JC}$ P_D $R_{\theta JA}$ $R_{\theta JC}$	 Internally Limited 65 5.0 Internally Limited Per Figure 1 5.0	 W °C/W °C/W W °C/W °C/W
Operating Junction Temperature Range	T_J	−40 to +150	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS (V_{in} = 14 V, I_O = 500 mA, I_{stby} = 0 mA, C_O = 10 μF, C_{stby} = 10 μF, T_J = 25°C [Note 1].)

Characteristic	Symbol	Min	Typ	Max	Unit
MAIN OUTPUT					
Output Voltage (V_{in} = 6.0 V to 26 V, I_O = 5.0 mA to 500 mA, T_J = −40 to +125°C)	V_O	4.75	5.0	5.25	V
Line Regulation V_{in} = 9.0 V to 16 V, I_O = 5.0 mA V_{in} = 6.0 V to 26 V, I_O = 5.0 mA	Reg_{line}	 – –	 4.0 10	 25 50	mV
Load Regulation (I_O = 5.0 mA to 500 mA)	Reg_{load}	–	10	50	mV
Output Impedance I_O = 500 mAdc and 10 mArms, f = 100 Hz to 10 kHz	Z_O	 –	 200	 –	mΩ
Output Noise Voltage (f = 10 Hz to 100 kHz)	V_n	–	100	–	μVrms
Long Term Stability	S	–	20	–	mV/kHR

ELECTRICAL CHARACTERISTICS (V_{in} = 14 V, I_O = 500 mA, I_{stby} = 0 mA, C_O = 10 µF, C_{stby} = 10 µF, T_J = 25°C [Note 1].)

Characteristic	Symbol	Min	Typ	Max	Unit
MAIN OUTPUT (continued)					
Ripple Rejection (f = 120 Hz)	RR	–	66	–	dB
Dropout Voltage I_O = 500 mA I_O = 750 mA	$V_I–V_O$	 – –	 0.45 0.82	 0.6 –	V
Short Circuit Current Limit	I_{SC}	0.75	1.2	–	A
Over–Voltage Shutdown Threshold	$V_{th(OV)}$	26	31	–	V
SWITCH/RESET					
Output Sink Current (V_{OL} = 1.2 V)	I_{Sink}	–	5.0	–	mA
Output Voltage ($R_{on/off}$ = 20 kΩ) Low State, V_{in} = 4.0 V High State, V_{in} = 14 V	 V_{OL} V_{OH}	 – 4.5	 0.9 5.0	 1.2 6.0	V
Output Pull–Up Resistor, “On”/“Off” (Note 2)	$R_{on/off}$	–	20	30	kΩ
Output Voltage with Reverse Polarity Input (V_{in} = –15 V, R_L = 10 Ω)	$–V_O$	–0.6	0	–	V

ELECTRICAL CHARACTERISTICS (V_{in} = 14 V, I_O = 0 mA, I_{stby} = 10 mA, C_O = 10 µF, C_{stby} = 10 µF, T_J = 25°C [Note 1].)

Characteristic	Symbol	Min	Typ	Max	Unit
STANDBY OUTPUT					
Output Voltage (V_{in} = 6.0 V to 26 V, I_{stby} = 1.0 mA to 10 mA, T_J = –40 to +125°C)	$V_{O(stby)}$	4.75	5.0	5.25	V
Tracking Voltage	$V_O–V_{O(stby)}$	–200	0	200	mV
Line Regulation (V_{in} = 6.0 V to 26 V)	Reg_{line}	–	4.0	50	mV
Load Regulation (I_{stby} = 1.0 mA to 10 mA)	Reg_{load}	–	10	50	mV
Output Impedance $I_{(stby)}$ = 10 mAdc and 1.0 mArms, f = 100 Hz to 10 kHz	$Z_{O(stby)}$	 –	 1.0	 –	Ω
Output Noise Voltage (f = 10 Hz to 100 kHz)	V_n	–	300	–	µVrms
Long Term Stability	S	–	20	–	mV/kHR
Ripple Rejection (f = 120 Hz)	RR	–	66	–	dB
Dropout Voltage (I_{stby} = 10 mA)	$V_I–V_{O(stby)}$	–	0.55	0.7	V
Short Circuit Current Limit	I_{SC}	25	70	–	mA
Output Voltage with Reverse Polarity Input V_{in} = –15 V, R_L = 510 Ω	$–V_O$	 –0.3	 0	 –	V
Output Voltage with Maximum Positive Input V_{in} = 60 V, R_L = 510 Ω	$V_{O(max)}$	 –	 5.0	 6.0	V
TOTAL DEVICE					
Bias Current I_O = 10 mA, I_{stby} = 0 mA I_O = 500 mA, I_{stby} = 0 mA I_O = 750 mA, I_{stby} = 0 mA Main Output “Off”, I_{stby} = 10 mA	I_B	 – – – –	 3.0 40 90 2.0	 – 100 – 3.0	mA

NOTES: 1. Low duty cycle pulse techniques are used during test to maintain junction temperature as close to ambient as possible.
2. The maximum switch/reset current must not exceed 5.0 mA.

TYPICAL CIRCUIT WAVEFORMS

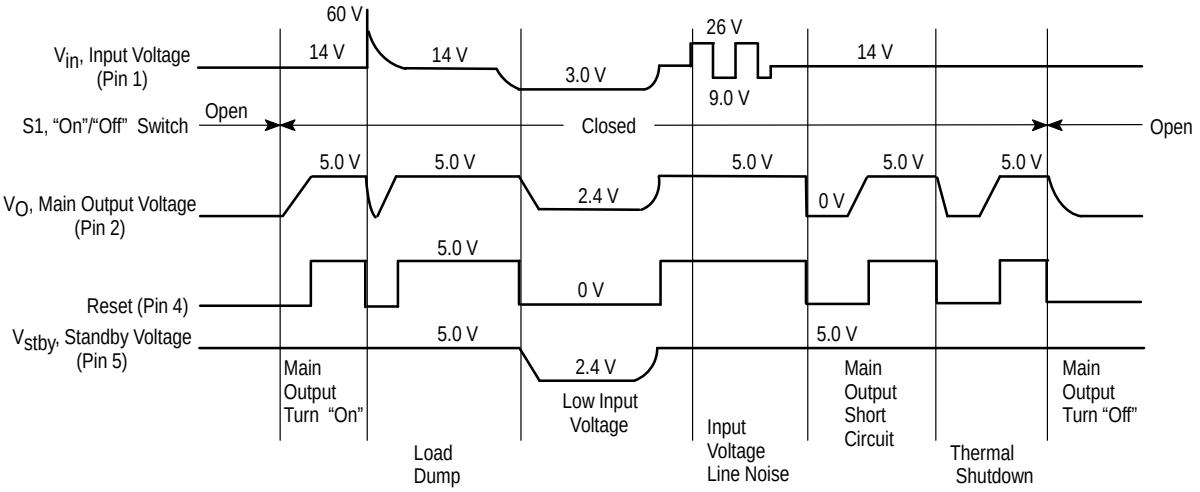
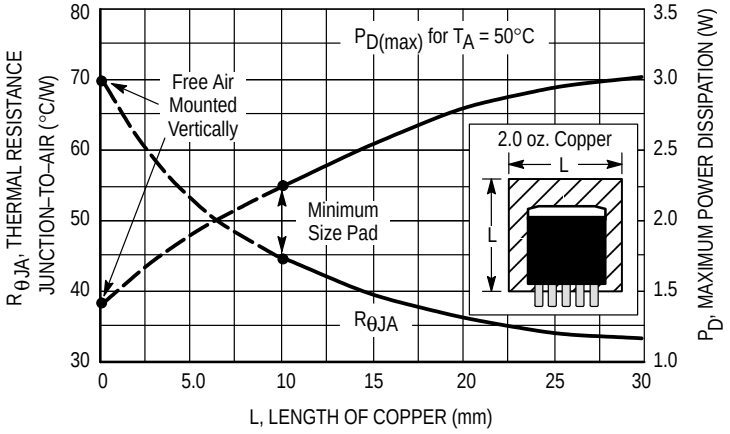
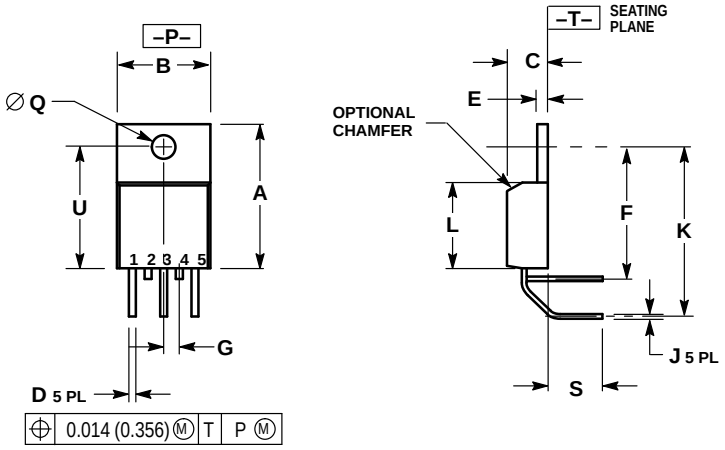


Figure 1. D²PAK Thermal Resistance and Maximum Power Dissipation versus P.C.B. Copper Length



OUTLINE DIMENSIONS

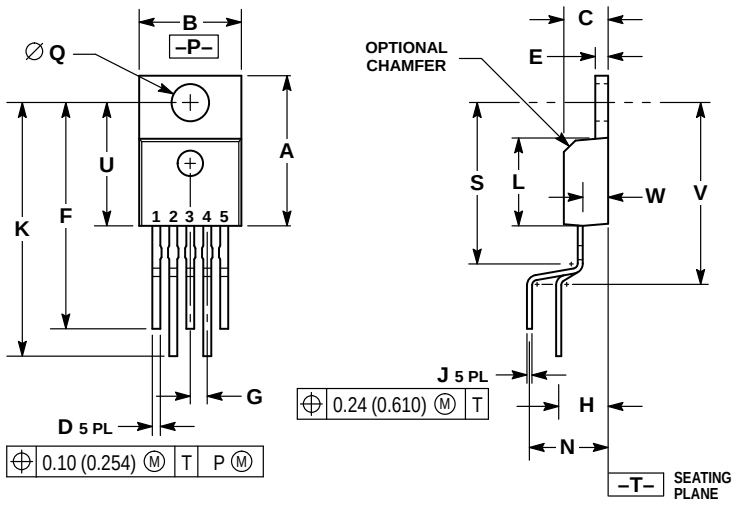
TH SUFFIX
PLASTIC PACKAGE
CASE 314A–03
ISSUE D



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION D DOES NOT INCLUDE INTERCONNECT BAR (DAMBAR) PROTRUSION. DIMENSION D INCLUDING PROTRUSION SHALL NOT EXCEED 0.043 (1.092) MAXIMUM.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.572	0.613	14.529	15.570
B	0.390	0.415	9.906	10.541
C	0.170	0.180	4.318	4.572
D	0.025	0.038	0.635	0.965
E	0.048	0.055	1.219	1.397
F	0.570	0.585	14.478	14.859
G	0.067 BSC		1.702 BSC	
J	0.015	0.025	0.381	0.635
K	0.730	0.745	18.542	18.923
L	0.320	0.365	8.128	9.271
Q	0.140	0.153	3.556	3.886
S	0.210	0.260	5.334	6.604
U	0.468	0.505	11.888	12.827

TV SUFFIX
PLASTIC PACKAGE
CASE 314B–05
ISSUE J

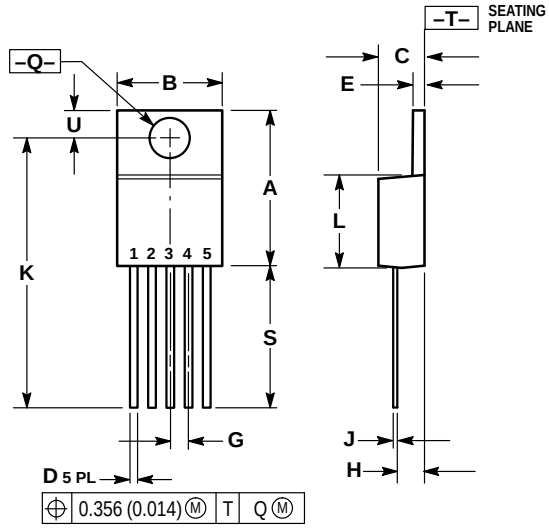


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION D DOES NOT INCLUDE INTERCONNECT BAR (DAMBAR) PROTRUSION. DIMENSION D INCLUDING PROTRUSION SHALL NOT EXCEED 0.043 (1.092) MAXIMUM.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.572	0.613	14.529	15.570
B	0.390	0.415	9.906	10.541
C	0.170	0.180	4.318	4.572
D	0.025	0.038	0.635	0.965
E	0.048	0.055	1.219	1.397
F	0.850	0.935	21.590	23.749
G	0.067 BSC		1.702 BSC	
H	0.166 BSC		4.216 BSC	
J	0.015	0.025	0.381	0.635
K	0.900	1.100	22.860	27.940
L	0.320	0.365	8.128	9.271
N	0.320 BSC		8.128 BSC	
Q	0.140	0.153	3.556	3.886
S	–	0.620	–	15.748
U	0.468	0.505	11.888	12.827
V	–	0.735	–	18.669
W	0.090	0.110	2.286	2.794

OUTLINE DIMENSIONS

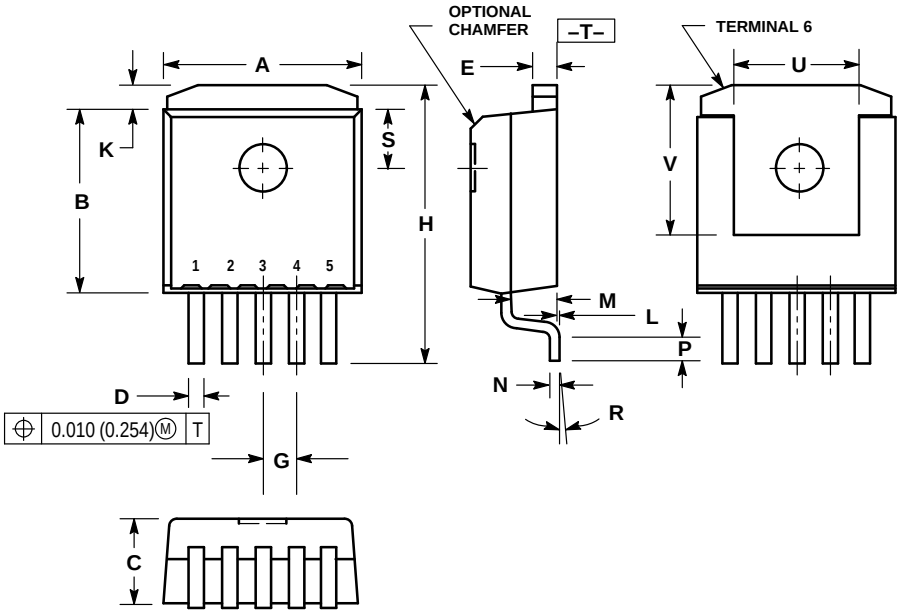
T SUFFIX
PLASTIC PACKAGE
CASE 314D–03
ISSUE D



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION D DOES NOT INCLUDE INTERCONNECT BAR (DAMBAR) PROTRUSION. DIMENSION D INCLUDING PROTRUSION SHALL NOT EXCEED 10.92 (0.043) MAXIMUM.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.572	0.613	14.529	15.570
B	0.390	0.415	9.906	10.541
C	0.170	0.180	4.318	4.572
D	0.025	0.038	0.635	0.965
E	0.048	0.055	1.219	1.397
G	0.067 BSC		1.702 BSC	
H	0.087	0.112	2.210	2.845
J	0.015	0.025	0.381	0.635
K	1.020	1.065	25.908	27.051
L	0.320	0.365	8.128	9.271
Q	0.140	0.153	3.556	3.886
U	0.105	0.117	2.667	2.972
S	0.543	0.582	13.792	14.783

D2T SUFFIX
PLASTIC PACKAGE
CASE 936A–02
(D^2PAK)
ISSUE A



NOTES:
1 DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2 CONTROLLING DIMENSION: INCH.
3 TAB CONTOUR OPTIONAL WITHIN DIMENSIONS A AND K.
4 DIMENSIONS U AND V ESTABLISH A MINIMUM MOUNTING SURFACE FOR TERMINAL 6.
5 DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH OR GATE PROTRUSIONS. MOLD FLASH AND GATE PROTRUSIONS NOT TO EXCEED 0.025 (0.635) MAXIMUM.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.386	0.403	9.804	10.236
B	0.356	0.368	9.042	9.347
C	0.170	0.180	4.318	4.572
D	0.026	0.036	0.660	0.914
E	0.045	0.055	1.143	1.397
G	0.067 BSC		1.702 BSC	
H	0.539	0.579	13.691	14.707
K	0.050 REF		1.270 REF	
L	0.000	0.010	0.000	0.254
M	0.088	0.102	2.235	2.591
N	0.018	0.026	0.457	0.660
P	0.058	0.078	1.473	1.981
R	5 ° REF		5 ° REF	
S	0.116 REF		2.946 REF	
U	0.200 MIN		5.080 MIN	
V	0.250 MIN		6.350 MIN	

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