National Semiconductor

LM341, LM78MXX Series
3-Terminal Positive Voltage Regulators

General Description

The LM341 and LM78MXX series of three-terminal positive voltage regulators employ built-in current limiting, thermal shutdown, and safe-operating area protection which makes them virtually immune to damage from output overloads.

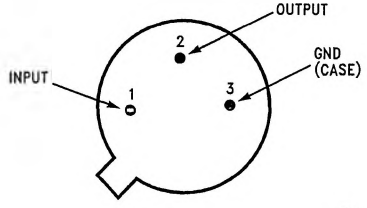
With adequate heatsinking, they can deliver in excess of 0.5A output current. Typical applications would include local (on-card) regulators which can eliminate the noise and degraded performance associated with single-point regulation.

Features

- Output current in excess of 0.5A
- No external components
- Internal thermal overload protection
- Internal short circuit current-limiting
- Output transistor safe-area compensation
- Available in TO-220, TO-39 and TO-202 packages
- Output voltages of 5V, 6V, 8V, 12V, 15V, and 24V

Connection Diagrams

TO-39 Metal Can Package (H)



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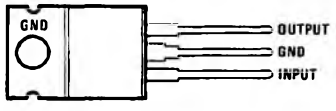
Bottom View

Order Number LM78M05CH, LM78M06CH, LM78M08CH, LM78M12CH, LM78M15CH or LM78M24CH
See NS Package Number H03B

TO-220 Power Package (T)



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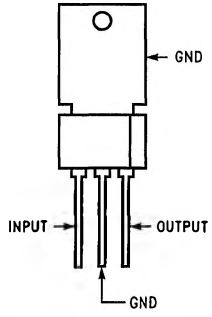
Top View

Order Number LM78M05CT, LM78M06CT, LM78M08CT, LM78M12CT, LM78M15CT, LM78M24CT, LM341T-5.0, LM341T-12 or LM341T-15
See NS Package Number T03B

TO-202 (P)
Plastic Package



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Order Number LM341P-5.0, LM341P-12 or LM341P-15
See NS Package Number P03A

DUAL MARKING: The **LM341T-5.0** and the **LM78M05CT** parts are "dual marked" (these parts are marked with both part numbers) because they have the same specifications. The same is true for the **LM341T-12/LM78M12CT** and the **LM341T-15/LM78M15CT** part number sets.

Absolute Maximum Ratings (Note 1)

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

Lead Temperature (Soldering, 10 seconds)

TO-39 Package (H)	300°C
TO-220 Package (T)	260°C
TO-202 Package (P)	230°C

Storage Temperature Range	−65°C to +150°C
Operating Junction Temperature Range	−40°C to +125°C
Power Dissipation (Note 2)	Internally Limited
Input Voltage	
$5V \le V_O \le 15V$	35V
$V_O = 24V$	40V
ESD Susceptibility	TBD

Electrical Characteristics

Limits in standard typeface are for $T_J = 25°C$, and limits in **boldface type** apply over the −40°C to +125°C operating temperature range. Limits are guaranteed by production testing or correlation techniques using standard Statistical Quality Control (SQC) methods.

LM341-5.0, LM78M05C Unless otherwise specified: $V_{IN} = 10V$, $C_{IN} = 0.33\ \mu F$, $C_O = 0.1\ \mu F$

Symbol	Parameter	Conditions		Min	Typ	Max	Units
V_O	Output Voltage	$I_L = 500$ mA		4.8	5.0	5.2	V
		5 mA ≤ I_L ≤ 500 mA $P_D \le 7.5W$, $7.5V \le V_{IN} \le 20V$		**4.75**	**5.0**	**5.25**	
$V_{R\ LINE}$	Line Regulation	$7.2V \le V_{IN} \le 25V$	$I_L = 100$ mA			50	mV
			$I_L = 500$ mA			100	
$V_{R\ LOAD}$	Load Regulation	5 mA ≤ I_L ≤ 500 mA				100	
I_Q	Quiescent Current	$I_L = 500$ mA			4	10.0	mA
ΔI_Q	Quiescent Current Change	5 mA ≤ I_L ≤ 500 mA				0.5	
		$7.5V \le V_{IN} \le 25V$, $I_L = 500$ mA				1.0	
V_n	Output Noise Voltage	f = 10 Hz to 100 kHz			40		μV
$\frac{\Delta V_{IN}}{\Delta V_O}$	Ripple Rejection	f = 120 Hz, $I_L = 500$ mA			78		dB
V_{IN}	Input Voltage Required to Maintain Line Regulation	$I_L = 500$ mA		7.2			V
ΔV_O	Long Term Stability	$I_L = 500$ mA				**20**	mV/khrs

Electrical Characteristics

Limits in standard typeface are for T_J = 25°C, and limits in **boldface type** apply over the −40°C to +125°C operating temperature range. Limits are guaranteed by production testing or correlation techniques using standard Statistical Quality Control (SQC) methods. (Continued)

LM78M06C Unless otherwise specified: V_{IN} = 11V, C_{IN} = 0.33 µF, C_O = 0.1 µF

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_O	Output Voltage	I_L = 350 mA	5.75	6.0	6.25	V
		5 mA ≤ I_L ≤ 350 mA 8V ≤ V_{IN} ≤ 21V	**5.7**	**6.0**	**6.3**	
$V_{R\ LINE}$	Line Regulation	9V ≤ V_{IN} ≤ 20V, I_L = 200 mA		1.5	50	mV
		8V ≤ V_{IN} ≤ 25V, I_L = 200 mA		5	100	
$V_{R\ LOAD}$	Load Regulation	5 mA ≤ I_L ≤ 200 mA		10	60	
		5 mA ≤ I_L ≤ 500 mA		20	120	
I_Q	Quiescent Current	I_L = 350 mA		4.5	8.0	mA
ΔI_Q	Quiescent Current Change	5 mA ≤ I_L ≤ 350 mA			**0.5**	
		9V ≤ V_{IN} ≤ 25V, I_L = 200 mA			**0.8**	
V_n	Output Noise Voltage	f = 10 Hz to 100 kHz		45		µV
$\frac{\Delta V_{IN}}{\Delta V_O}$	Ripple Rejection	f = 2400 Hz, I_L = 125 mA	59	80		dB
V_{IN}	Input Voltage Required to Maintain Line Regulation	I_L = 350 mA		V_O + 2		V
I_{OS}	Output Short Circuit Current	V_{IN} = 35V		270		mA
I_{PK}	Output Peak Current			700		
$\frac{\Delta V_O}{\Delta T}$	Average Temperature Coefficient of Output Voltage	I_L = 5 mA		**0.5**		mV/°C

Electrical Characteristics

Limits in standard typeface are for T_J = 25°C, and limits in **boldface type** apply over the −40°C to +125°C operating temperature range. Limits are guaranteed by production testing or correlation techniques using standard Statistical Quality Control (SQC) methods. (Continued)

LM78M08C Unless otherwise specified: V_{IN} = 14V, C_{IN} = 0.33 μF, C_O = 0.1 μF

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_O	Output Voltage	I_L = 350 mA	7.7	8.0	8.3	V
		5 mA ≤ I_L ≤ 350 mA 10.5V ≤ V_{IN} ≤ 23V	**7.6**	**8.0**	**8.4**	
$V_{R\ LINE}$	Line Regulation	11V ≤ V_{IN} ≤ 20V, I_L = 200 mA		2	50	mV
		10.5V ≤ V_{IN} ≤ 25V, I_L = 200 mA		6	100	
$V_{R\ LOAD}$	Load Regulation	5 mA ≤ I_L ≤ 200 mA		10	80	
		5 mA ≤ I_L ≤ 500 mA		25	160	
I_Q	Quiescent Current	I_L = 350 mA		4.6	8.0	mA
ΔI_Q	Quiescent Current Change	5 mA ≤ I_L ≤ 350 mA			**0.5**	
		10.5V ≤ V_{IN} ≤ 25V, I_L = 200 mA			**0.8**	
V_n	Output Noise Voltage	f = 10 Hz to 100 kHz		52		μV
$\frac{\Delta V_{IN}}{\Delta V_O}$	Ripple Rejection	f = 2400 Hz, I_L = 125 mA	56	80		dB
V_{IN}	Input Voltage Required to Maintain Line Regulation	I_L = 350 mA		V_O + 2		V
I_{OS}	Output Short Circuit Current	V_{IN} = 35V		250		mA
I_{PK}	Output Peak Current			700		
$\frac{\Delta V_O}{\Delta T}$	Average Temperature Coefficient of Output Voltage	I_L = 5 mA		**0.5**		mV/°C

Electrical Characteristics

Limits in standard typeface are for T_J = 25°C, and limits in **boldface type** apply over the −40°C to +125°C operating temperature range. Limits are guaranteed by production testing or correlation techniques using standard Statistical Quality Control (SQC) methods. (Continued)

LM341-12, LM78M12C Unless otherwise specified: V_{IN} = 19V, C_{IN} = 0.33 µF, C_O = 0.1 µF

Symbol	Parameter	Conditions		Min	Typ	Max	Units
V_O	Output Voltage	I_L = 500 mA		11.5	12	12.5	V
		5 mA ≤ I_L ≤ 500 mA P_D ≤ 7.5W, 14.8V ≤ V_{IN} ≤ 27V		**11.4**	**12**	**12.6**	
$V_{R\ LINE}$	Line Regulation	14.5V ≤ V_{IN} ≤ 30V	I_L = 100 mA			120	mV
			I_L = 500 mA			240	
$V_{R\ LOAD}$	Load Regulation	5 mA ≤ I_L ≤ 500 mA				240	
I_Q	Quiescent Current	I_L = 500 mA			4	10.0	mA
ΔI_Q	Quiescent Current Change	5 mA ≤ I_L ≤ 500 mA				0.5	
		14.8V ≤ V_{IN} ≤ 30V, I_L = 500 mA				1.0	
V_n	Output Noise Voltage	f = 10 Hz to 100 kHz			75		µV
$\frac{\Delta V_{IN}}{\Delta V_O}$	Ripple Rejection	f = 120 Hz, I_L = 500 mA			71		dB
V_{IN}	Input Voltage Required to Maintain Line Regulation	I_L = 500 mA		14.5			V
ΔV_O	Long Term Stability	I_L = 500 mA				**48**	mV/khrs

LM341-15, LM78M15C Unless otherwise specified: V_{IN} = 23V, C_{IN} = 0.33 µF, C_O = 0.1 µF

Symbol	Parameter	Conditions		Min	Typ	Max	Units
V_O	Output Voltage	I_L = 500 mA		14.4	15	15.6	V
		5 mA ≤ I_L ≤ 500 mA P_D ≤ 7.5W, 18V ≤ V_{IN} ≤ 30V		**14.25**	**15**	**15.75**	
$V_{R\ LINE}$	Line Regulation	17.6V ≤ V_{IN} ≤ 30V	I_L = 100 mA			150	mV
			I_L = 500 mA			300	
$V_{R\ LOAD}$	Load Regulation	5 mA ≤ I_L ≤ 500 mA				300	
I_Q	Quiescent Current	I_L = 500 mA			4	10.0	mA
ΔI_Q	Quiescent Current Change	5 mA ≤ I_L ≤ 500 mA				0.5	
		18V ≤ V_{IN} ≤ 30V, I_L = 500 mA				1.0	
V_n	Output Noise Voltage	f = 10 Hz to 100 kHz			90		µV
$\frac{\Delta V_{IN}}{\Delta V_O}$	Ripple Rejection	f = 120 Hz, I_L = 500 mA			69		dB
V_{IN}	Input Voltage Required to Maintain Line Regulation	I_L = 500 mA		17.6			V
ΔV_O	Long Term Stability	I_L = 500 mA				**60**	mV/khrs

Electrical Characteristics

Limits in standard typeface are for T_J = 25°C, and limits in **boldface type** apply over the −40°C to +125°C operating temperature range. Limits are guaranteed by production testing or correlation techniques using standard Statistical Quality Control (SQC) methods. (Continued)

LM78M24C Unless otherwise specified: V_{IN} = 33V, C_{IN} = 0.33 μF, C_O = 0.1 μF

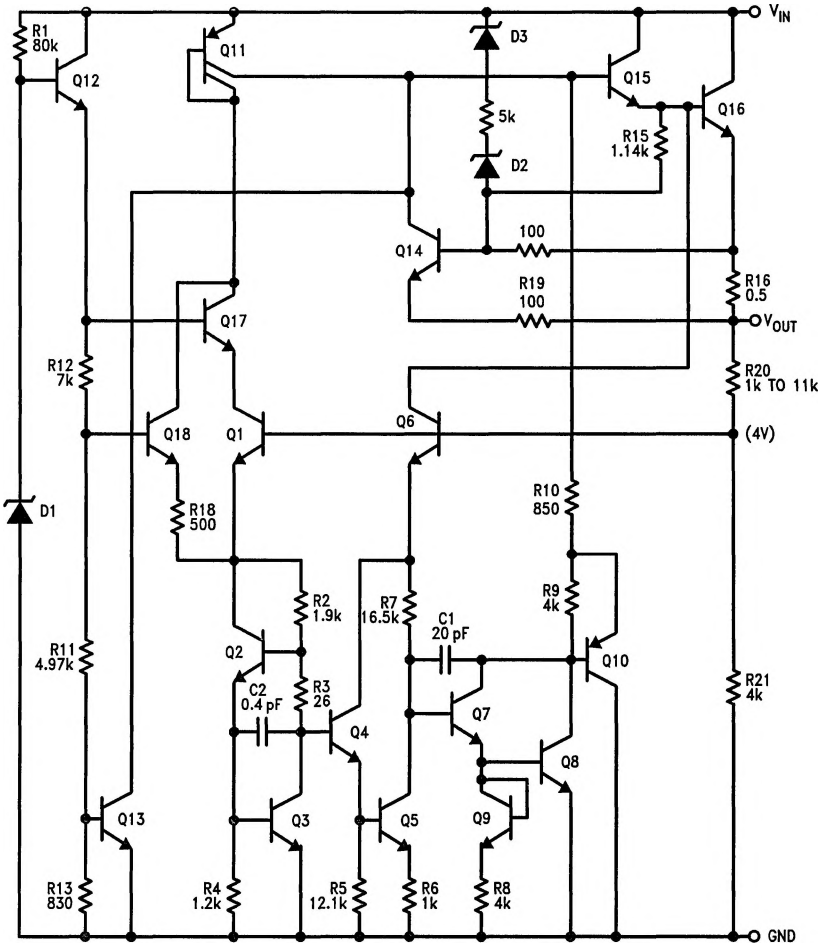
Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_O	Output Voltage	I_L = 350 mA	23.0	24.0	25.0	V
		5 mA ≤ I_L ≤ 350 mA 27V ≤ V_{IN} ≤ 38V	**22.8**	**24.0**	**25.2**	
$V_{R\ LINE}$	Line Regulation	28V ≤ V_{IN} ≤ 36V, I_L = 200 mA		5	50	mV
		27V ≤ V_{IN} ≤ 38V, I_L = 200 mA		10	100	
$V_{R\ LOAD}$	Load Regulation	5 mA ≤ I_L ≤ 200 mA		10	240	
		5 mA ≤ I_L ≤ 500 mA		30	480	
I_Q	Quiescent Current	I_L = 350 mA		5.0	8.0	mA
ΔI_Q	Quiescent Current Change	5 mA ≤ I_L ≤ 350 mA			**0.5**	
		27V ≤ V_{IN} ≤ 38V, I_L = 200 mA			**0.8**	
V_n	Output Noise Voltage	f = 10 Hz to 100 kHz		170		μV
$\frac{\Delta V_{IN}}{\Delta V_O}$	Ripple Rejection	f = 2400 Hz, I_L = 125 mA, V_{IN} = 30V	50	70		dB
V_{IN}	Input Voltage Required to Maintain Line Regulation	I_L = 350 mA		V_O + 2		V
I_{OS}	Output Short Circuit Current	V_{IN} = 35V		240		mA
I_{PK}	Output Peak Current			700		
$\frac{\Delta V_O}{\Delta T}$	Average Temperature Coefficient of Output Voltage	I_L = 5 mA		**1.2**		mV/°C

Note 1: Absolute maximum ratings indicate limits beyond which damage to the component may occur. Electrical specifications do not apply when operating the device outside of its rated operating conditions.

Note 2: The typical thermal resistance of the three package types is:

T (TO-220) package: $\theta_{(J\text{-}A)}$ = 60 °C/W, $\theta_{(J\text{-}C)}$ = 5 °C/W
P (TO-202) package: $\theta_{(J\text{-}A)}$ = 70 °C/W, $\theta_{(J\text{-}C)}$ = 12 °C/W
H (TO-39) package: $\theta_{(J\text{-}A)}$ = 120 °C/W, $\theta_{(J\text{-}C)}$ = 18 °C/W

Schematic Diagram



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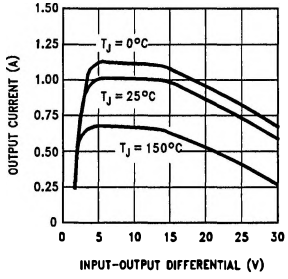
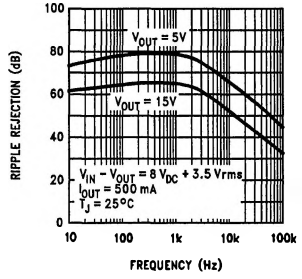
Typical Performance Characteristics

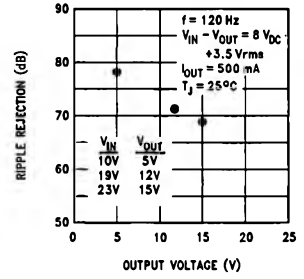
Peak Output Current



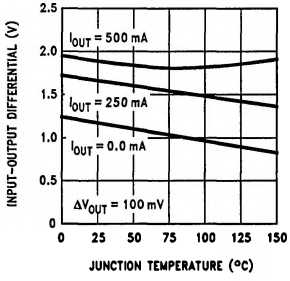
Ripple Rejection



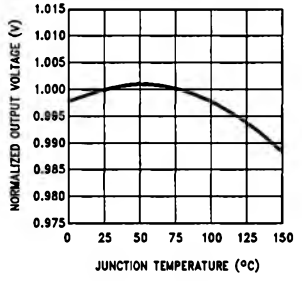
Ripple Rejection



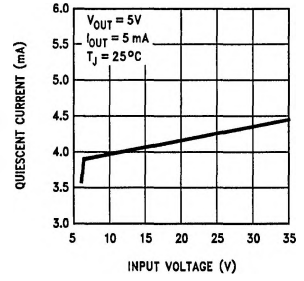
Dropout Voltage



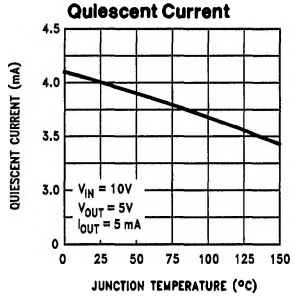
Output Voltage (Normalized to 1V at T_J = 25°C)



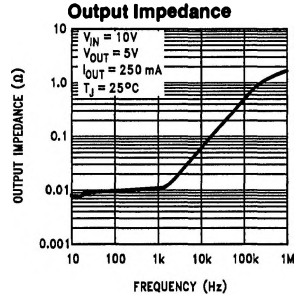
Quiescent Current



Quiescent Current



Output Impedance



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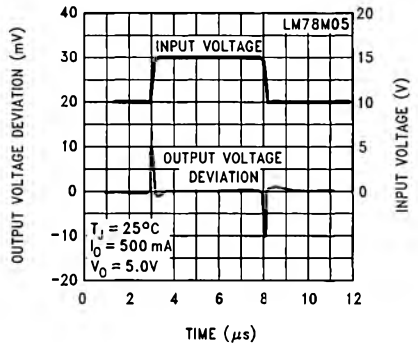
Typical Performance Characteristics (Continued)

Line Transient Response



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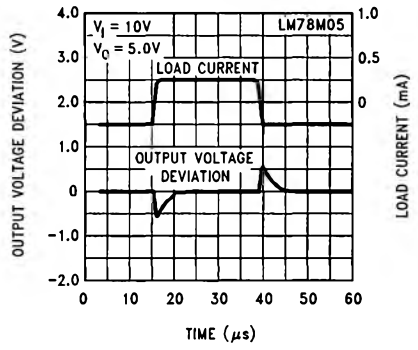
Load Transient Response



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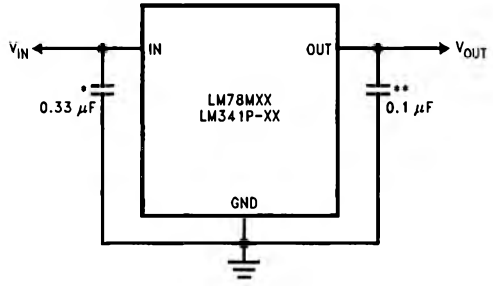
Design Considerations

The LM78MXX/LM341XX fixed voltage regulator series has built-in thermal overload protection which prevents the device from being damaged due to excessive junction temperature.

The regulators also contain internal short-circuit protection which limits the maximum output current, and safe-area protection for the pass transistor which reduces the short-circuit current as the voltage across the pass transistor is increased.

Although the internal power dissipation is automatically limited, the maximum junction temperature of the device must be kept below +125°C in order to meet data sheet specifications. An adequate heatsink should be provided to assure this limit is not exceeded under worst-case operating conditions (maximum input voltage and load current) if reliable performance is to be obtained.

Typical Application



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*Required if regulator input is more than 4 inches from input filter capacitor (or if no input filter capacitor is used).

**Optional for improved transient response.