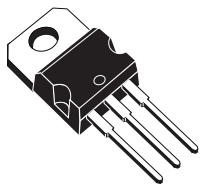
L78MxxC

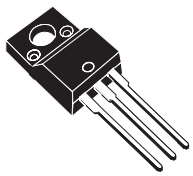
Positive voltage regulators

Features

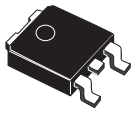
- Output current to 0.5 A
- Output voltages of 5; 6; 8; 9; 12; 15; 24 V
- Thermal overload protection
- Short circuit protection
- Output transition SOA protection



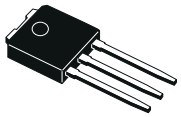
TO-220



TO-220FP



DPAK



IPAK

Description

The L78MxxC series of three-terminal positive regulators is available in TO-220, TO-220FP, DPAK and IPAK packages and with 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 employs internal current limiting, thermal shutdown and safe area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 0.5 A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltage and currents.

Table 1. Device summary

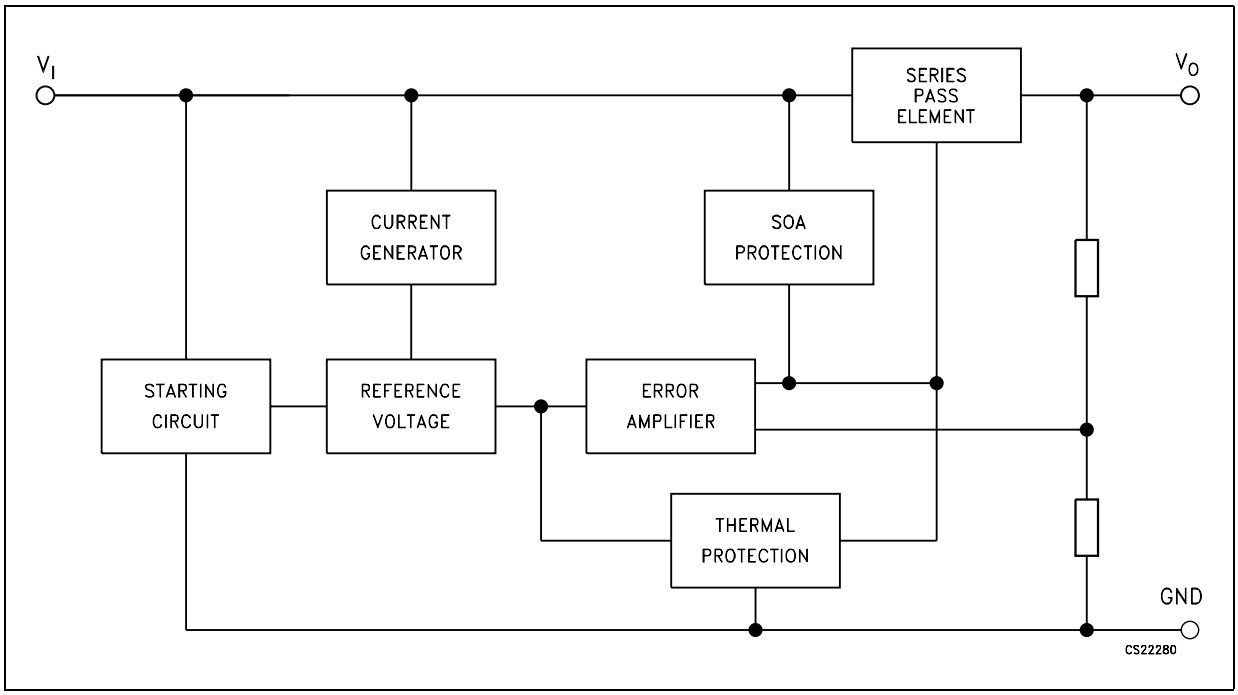
Part numbers	Order codes					Output voltages
	TO-220	TO-220 (1)	TO-220FP	DPAK	IPAK	
L78M05C	L78M05CV	L78M05CV-DG	L78M05CP	L78M05CDT-TR	L78M05CDT-1	5 V
L78M06C				L78M06CDT-TR	L78M06CDT-1 (2)	6 V
L78M08C	L78M08CV			L78M08CDT-TR	L78M08CDT-1 (2)	8 V
L78M09C	L78M09CV			L78M09CDT-TR	L78M09CDT-1 (2)	9 V
L78M12C	L78M12CV	L78M12CV-DG		L78M12CDT-TR		12 V
L78M15C	L78M15CV	L78M15CV-DG		L78M15CDT-TR		15 V
L78M24C	L78M24CV		L78M24CP (2)	L78M24CDT-TR	L78M24CDT-1 (2)	24 V

1. TO-220 Dual Gauge frame
2. Available on request

Contents

1 Diagram

Figure 1. Block diagram



2 Pin configuration

Figure 2. Pin connections (top view)

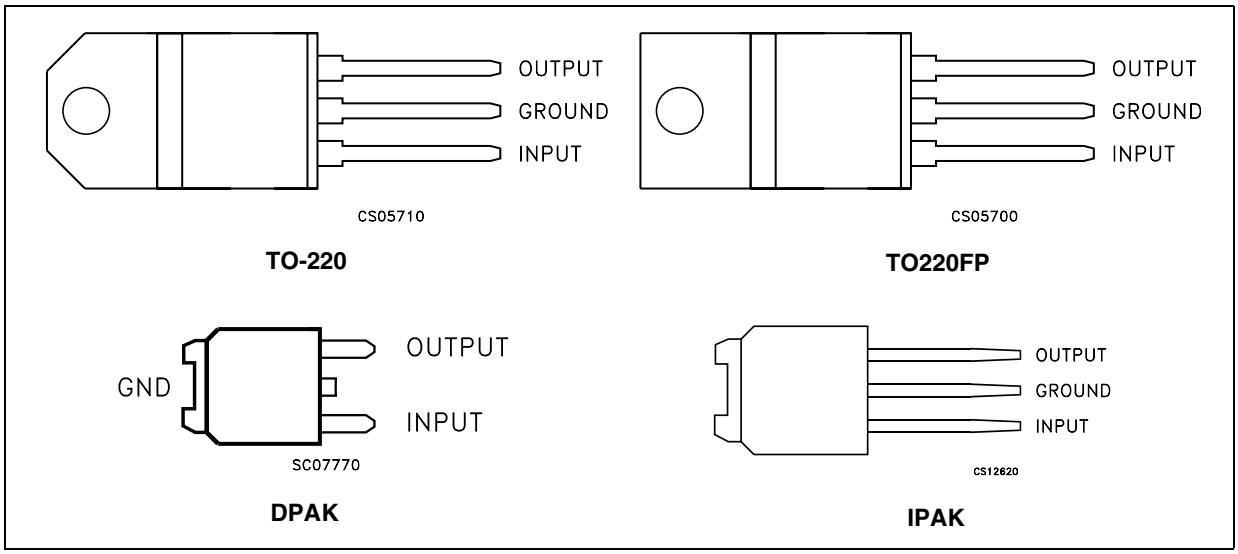
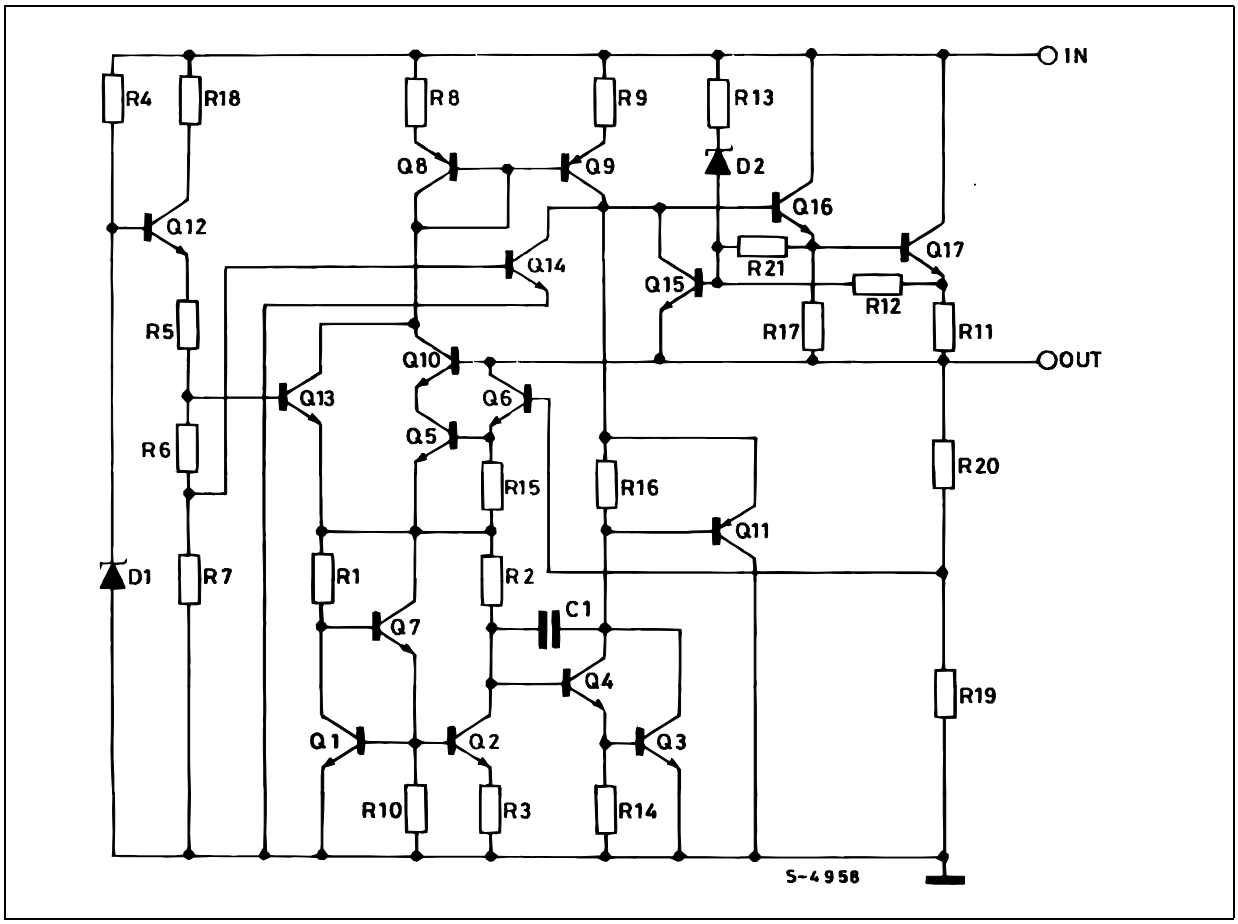


Figure 3. Schematic diagram



3 Maximum ratings

Table 2. Absolute maximum ratings

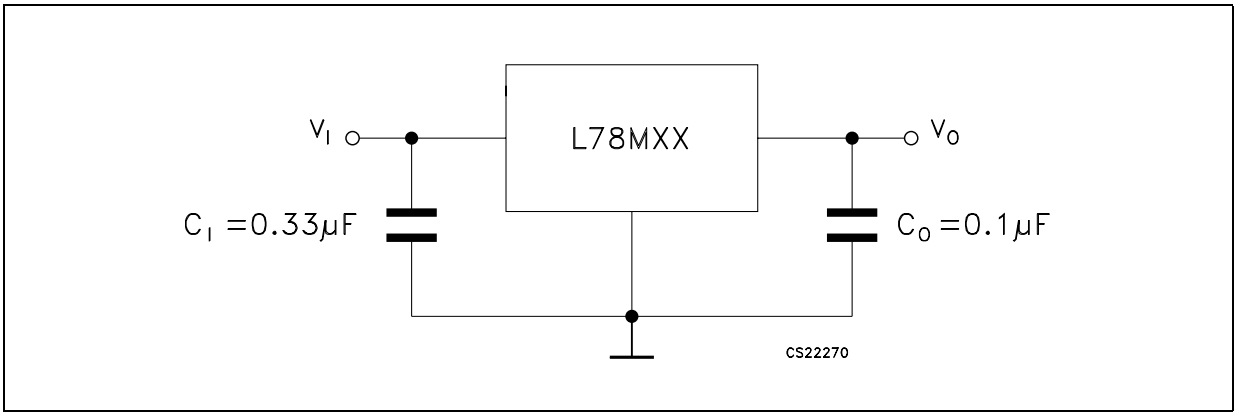
Symbol	Parameter		Value	Unit
V_I	DC input voltage	for V_O = 5 to 18 V	35	V
		for V_O = 20, 24 V	40	
I_O	Output current		Internally limited	mA
P_D	Power dissipation		Internally limited	mW
T_{STG}	Storage temperature range		- 65 to 150	°C
T_{OP}	Operating junction temperature range		0 to 150	°C

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

Table 3. Thermal data

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

Figure 4. Application circuit



4 Test circuits

Figure 5. DC parameter

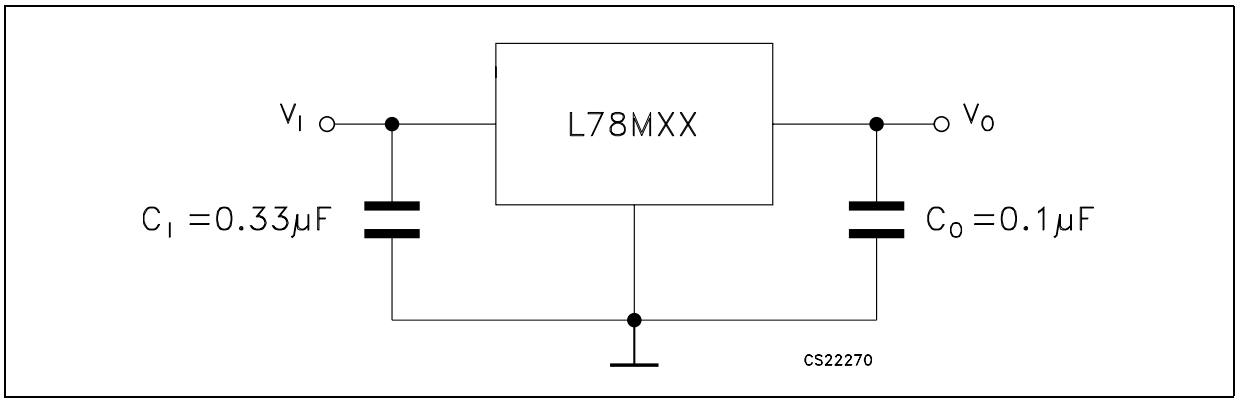


Figure 6. Load regulation

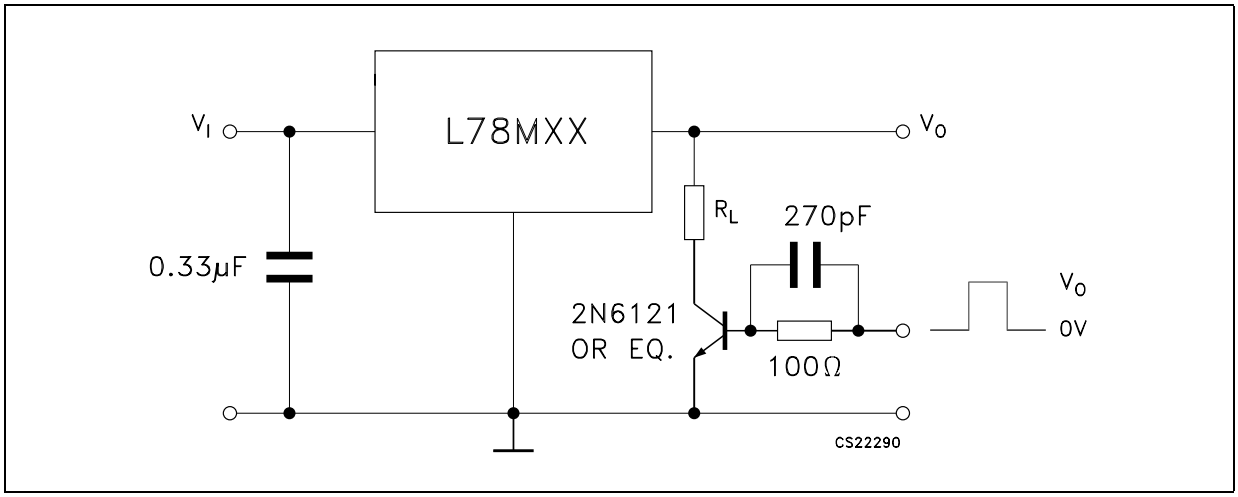
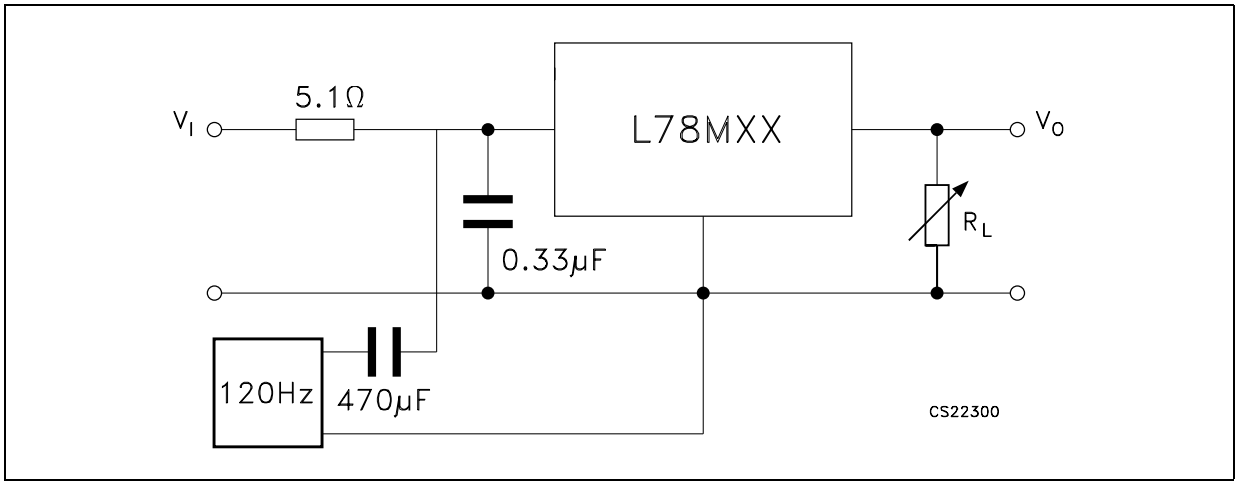


Figure 7. Ripple rejection



5 Electrical characteristics

Refer to the test circuits, T_J = 25 °C, V_I = 10 V, I_O = 350 mA, C_I = 0.33 µF, C_O = 0.1 µF unless otherwise specified.

Table 4. Electrical characteristics of L78M05C

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage		4.8	5	5.2	V
V_O	Output voltage	I_O = 5 to 350 mA, V_I = 7 to 20 V	4.75	5	5.25	V
ΔV_O	Line regulation	V_I = 7 to 25 V, I_O = 200 mA			100	mV
		V_I = 8 to 25 V, I_O = 200 mA			50	
ΔV_O	Load regulation	I_O = 5 to 500 mA, T_J = 25 °C			100	mV
		I_O = 5 to 200 mA, T_J = 25 °C			50	
I_d	Quiescent current				6	mA
ΔI_d	Quiescent current change	I_O = 5 to 350 mA			0.5	mA
		I_O = 200 mA, V_I = 8 to 25 V			0.8	
$\Delta V_O/\Delta T$	Output voltage drift	I_O = 5 mA, T_J = 0 to 125 °C		-0.5		mV/°C
SVR	Supply voltage rejection	V_I = 8 to 18 V, f = 120 Hz, I_O = 300 mA	62			dB
eN	Output noise voltage	B = 10 Hz to 100 kHz		40		µV
V_d	Dropout voltage			2		V
I_{sc}	Short circuit current	V_I = 35 V		300		mA

Refer to the test circuits, T_J = 25 °C, V_I = 11 V, I_O = 350 mA, C_I = 0.33 µF, C_O = 0.1 µF unless otherwise specified.

Table 5. Electrical characteristics of L78M06C

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage		5.75	6	6.25	V
V_O	Output voltage	I_O = 5 to 350 mA, V_I = 8 to 21 V	5.7	6	6.3	V
ΔV_O	Line regulation	V_I = 8 to 25 V, I_O = 200 mA			100	mV
		V_I = 9 to 25 V, I_O = 200 mA			50	
ΔV_O	Load regulation	I_O = 5 to 500 mA, T_J = 25 °C			120	mV
		I_O = 5 to 200 mA, T_J = 25 °C			60	
I_d	Quiescent current				6	mA
ΔI_d	Quiescent current change	I_O = 5 to 350 mA			0.5	mA
		I_O = 200 mA, V_I = 9 to 25 V			0.8	
$\Delta V_O/\Delta T$	Output voltage drift	I_O = 5 mA, T_J = 0 to 125 °C		-0.5		mV/°C
SVR	Supply voltage rejection	V_I = 9 to 19 V, f = 120 Hz, I_O = 300 mA	59			dB
eN	Output noise voltage	B = 10 Hz to 100 kHz		45		µV
V_d	Dropout voltage			2		V
I_{sc}	Short circuit current	V_I = 35 V		270		mA

Refer to the test circuits, T_J = 25 °C, V_I = 14 V, I_O = 350 mA, C_I = 0.33 µF, C_O = 0.1 µF unless otherwise specified.

Table 6. Electrical characteristics of L78M08C

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage		7.7	8	8.3	V
V_O	Output voltage	I_O = 5 to 350 mA, V_I = 10.5 to 23 V	7.6	8	8.4	V
ΔV_O	Line regulation	V_I = 10.5 to 25 V, I_O = 200 mA			100	mV
		V_I = 11 to 25 V, I_O = 200 mA			50	
ΔV_O	Load regulation	I_O = 5 to 500 mA, T_J = 25 °C			160	mV
		I_O = 5 to 200 mA, T_J = 25 °C			80	
I_d	Quiescent current				6	mA
ΔI_d	Quiescent current change	I_O = 5 to 350 mA			0.5	mA
		I_O = 200 mA, V_I = 10.5 to 25 V			0.8	
$\Delta V_O/\Delta T$	Output voltage drift	I_O = 5 mA, T_J = 0 to 125 °C		-0.5		mV/°C
SVR	Supply voltage rejection	V_I = 11.5 to 21.5 V, f = 120 Hz, I_O = 300 mA	56			dB
eN	Output noise voltage	B = 10 Hz to 100 kHz		52		µV
V_d	Dropout voltage			2		V
I_{sc}	Short circuit current	V_I = 35 V		250		mA

Refer to the test circuits, T_J = 25 °C, V_I = 15 V, I_O = 350 mA, C_I = 0.33 µF, C_O = 0.1 µF unless otherwise specified.

Table 7. Electrical characteristics of L78M09C

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage		8.65	9	9.35	V
V_O	Output voltage	I_O = 5 to 350 mA, V_I = 11.5 to 24 V	8.55	9	9.45	V
ΔV_O	Line regulation	V_I = 11.5 to 25 V, I_O = 200 mA			100	mV
		V_I = 12 to 25 V, I_O = 200 mA			50	
ΔV_O	Load regulation	I_O = 5 to 500 mA, T_J = 25 °C			180	mV
		I_O = 5 to 200 mA, T_J = 25 °C			90	
I_d	Quiescent current				6	mA
ΔI_d	Quiescent current change	I_O = 5 to 350 mA			0.5	mA
		I_O = 200 mA, V_I = 11.5 to 25 V			0.8	
$\Delta V_O/\Delta T$	Output voltage drift	I_O = 5 mA, T_J = 0 to 125 °C		-0.5		mV/°C
SVR	Supply voltage rejection	V_I = 12.5 to 23 V, f = 120 Hz, I_O = 300 mA	56			dB
eN	Output noise voltage	B = 10 Hz to 100 kHz		58		µV
V_d	Dropout voltage			2		V
I_{sc}	Short circuit current	V_I = 35 V		250		mA

Refer to the test circuits, T_J = 25 °C, V_I = 19 V, I_O = 350 mA, C_I = 0.33 µF, C_O = 0.1 µF unless otherwise specified.

Table 8. Electrical characteristics of L78M12C

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage		11.5	12	12.5	V
V_O	Output voltage	I_O = 5 to 350 mA, V_I = 14.5 to 27 V	11.4	12	12.6	V
ΔV_O	Line regulation	V_I = 14.5 to 30 V, I_O = 200 mA			100	mV
		V_I = 16 to 30 V, I_O = 200 mA			50	
ΔV_O	Load regulation	I_O = 5 to 500 mA, T_J = 25 °C			240	mV
		I_O = 5 to 200 mA, T_J = 25 °C			120	
I_d	Quiescent current				6	mA
ΔI_d	Quiescent current change	I_O = 5 to 350 mA			0.5	mA
		I_O = 200 mA, V_I = 14.5 to 30 V			0.8	
$\Delta V_O/\Delta T$	Output voltage drift	I_O = 5 mA, T_J = 0 to 125 °C		-1		mV/°C
SVR	Supply voltage rejection	V_I = 15 to 25 V, f = 120 Hz, I_O = 300 mA	55			dB
eN	Output noise voltage	B = 10 Hz to 100 kHz		75		µV
V_d	Dropout voltage			2		V
I_{sc}	Short circuit current	V_I = 35 V		240		mA

Refer to the test circuits, T_J = 25 °C, V_I = 23 V, I_O = 350 mA, C_I = 0.33 µF, C_O = 0.1 µF unless otherwise specified.

Table 9. Electrical characteristics of L78M15C

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage		14.4	15	15.6	V
V_O	Output voltage	I_O = 5 to 350 mA, V_I = 17.5 to 30 V	14.25	15	15.75	V
ΔV_O	Line regulation	V_I = 17.5 to 30 V, I_O = 200 mA			100	mV
		V_I = 20 to 30 V, I_O = 200 mA			50	
ΔV_O	Load regulation	I_O = 5 to 500 mA, T_J = 25 °C			300	mV
		I_O = 5 to 200 mA, T_J = 25 °C			150	
I_d	Quiescent current				6	mA
ΔI_d	Quiescent current change	I_O = 5 to 350 mA			0.5	mA
		I_O = 200 mA, V_I = 17.5 to 30 V			0.8	
$\Delta V_O/\Delta T$	Output voltage drift	I_O = 5 mA, T_J = 0 to 125 °C		-1		mV/°C
SVR	Supply voltage rejection	V_I = 18.5 to 28.5 V, f = 120 Hz, I_O = 300 mA	54			dB
eN	Output noise voltage	B = 10 Hz to 100 kHz		90		µV
V_d	Dropout voltage			2		V
I_{sc}	Short circuit current	V_I = 35 V		240		mA

Refer to the test circuits, T_J = 25 °C, V_I = 23 V, I_O = 350 mA, C_I = 0.33 µF, C_O = 0.1 µF unless otherwise specified.

Table 10. Electrical characteristics of L78M24C

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage		23	24	25	V
V_O	Output voltage	I_O = 5 to 350 mA, V_I = 27 to 38 V	22.8	24	25.2	V
ΔV_O	Line regulation	V_I = 27 to 38 V, I_O = 200 mA			100	mV
		V_I = 28 to 38 V, I_O = 200 mA			50	
ΔV_O	Load regulation	I_O = 5 to 500 mA, T_J = 25 °C			480	mV
		I_O = 5 to 200 mA, T_J = 25 °C			240	
I_d	Quiescent current				6	mA
ΔI_d	Quiescent current change	I_O = 5 to 350 mA			0.5	mA
		I_O = 200 mA, V_I = 27 to 38 V			0.8	
$\Delta V_O/\Delta T$	Output voltage drift	I_O = 5 mA, T_J = 0 to 125 °C		-1.2		mV/°C
SVR	Supply voltage rejection	V_I = 28 to 38 V, f = 120 Hz, I_O = 300 mA	50			dB
eN	Output noise voltage	B = 10 Hz to 100 kHz		170		µV
V_d	Dropout voltage			2		V
I_{sc}	Short circuit current	V_I = 35 V		240		mA

6 Typical performance

Figure 8. Dropout voltage vs. junction temp.

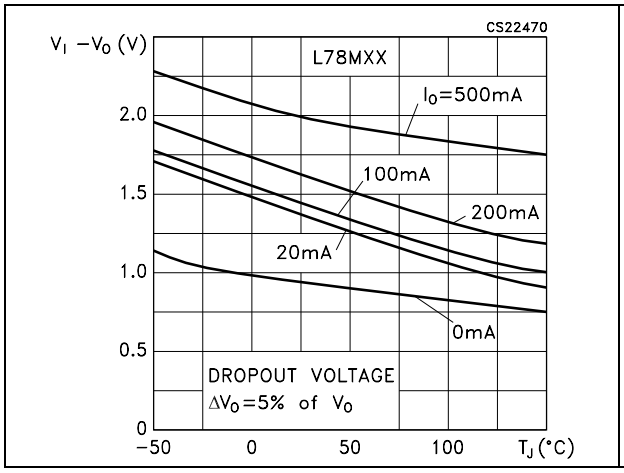


Figure 9. Dropout characteristics

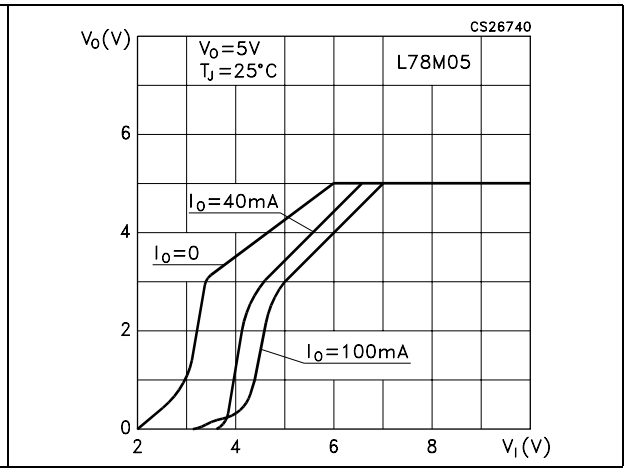


Figure 10. Peak output current vs. input-output differential voltage

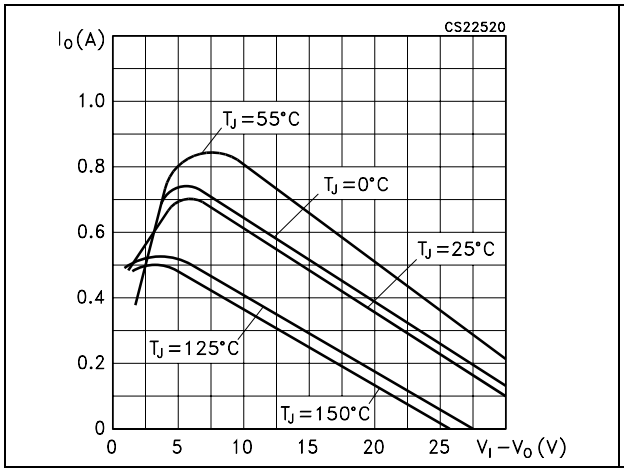


Figure 11. Output voltage vs. junction temperature

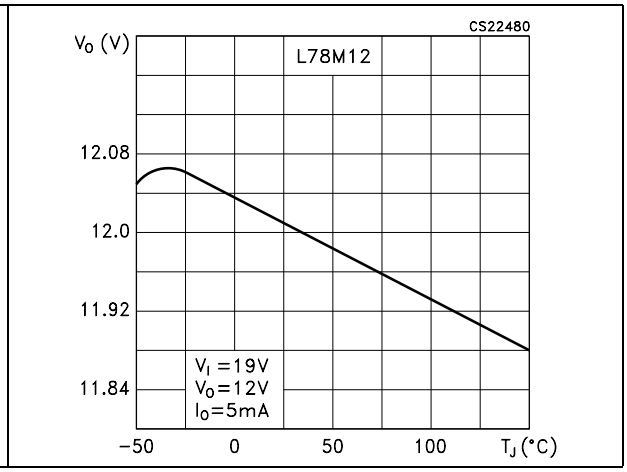


Figure 12. Supply voltage rejection vs. frequency

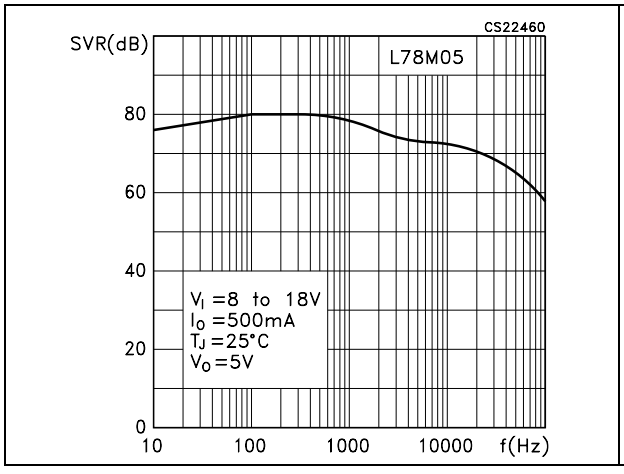


Figure 13. Quiescent current vs. junction temperature

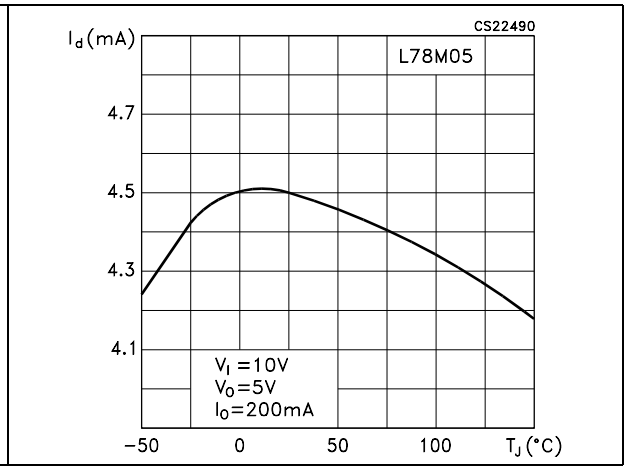


Figure 14. Load transient response

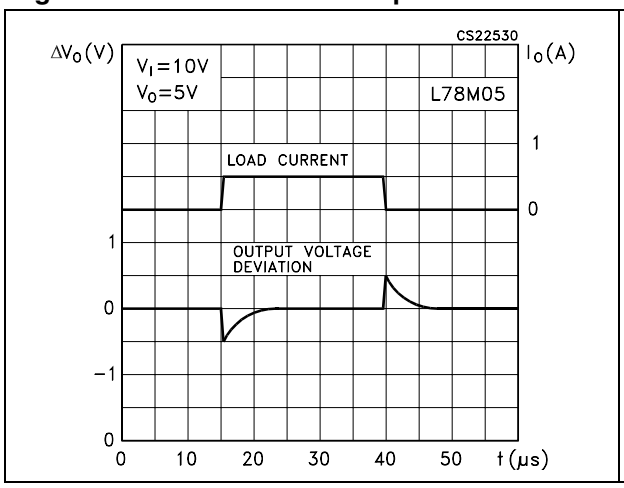


Figure 15. Line transient response

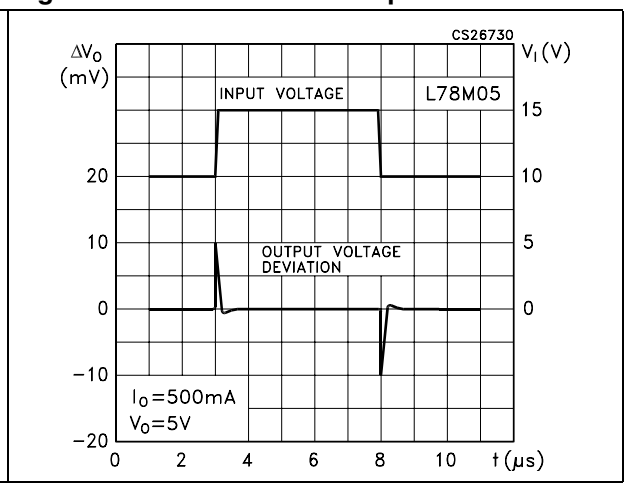


Figure 16. Quiescent current vs. input voltage

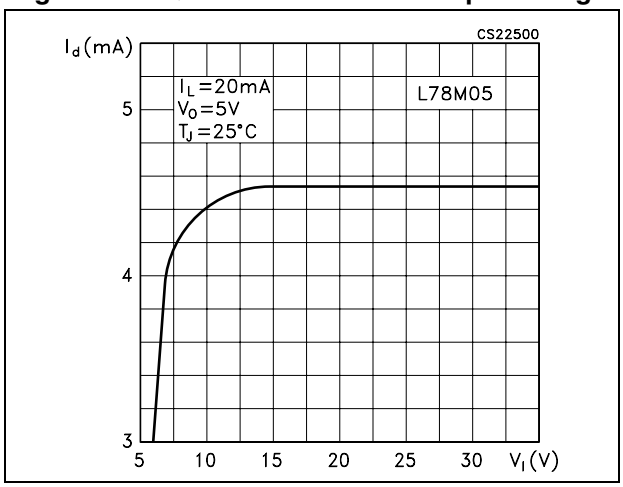
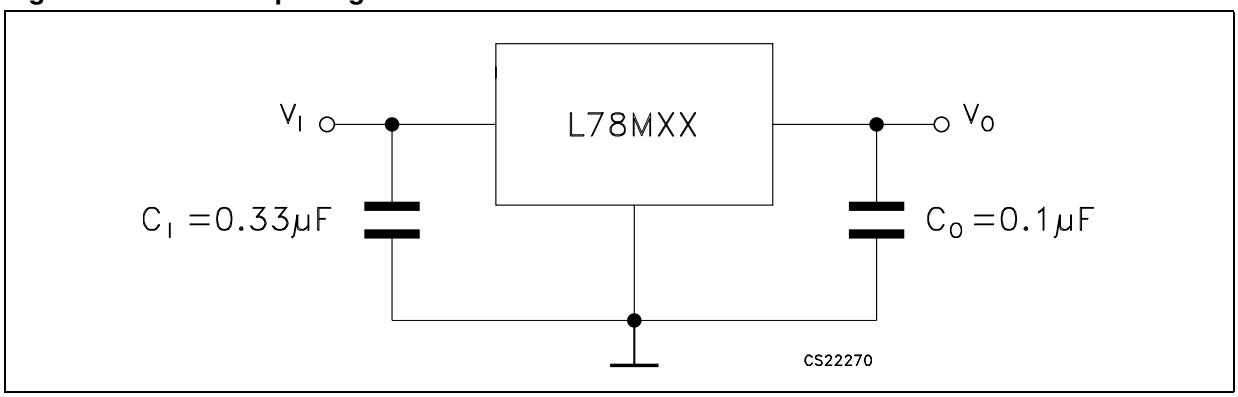


Figure 17. Fixed output regulator



1. To specify an output voltage, substitute voltage value for "XX".
2. Although no output capacitor is need for stability, it does improve transient response.
3. Required if regulator is locate an appreciable distance from power supply filter.

Figure 18. Constant current regulator

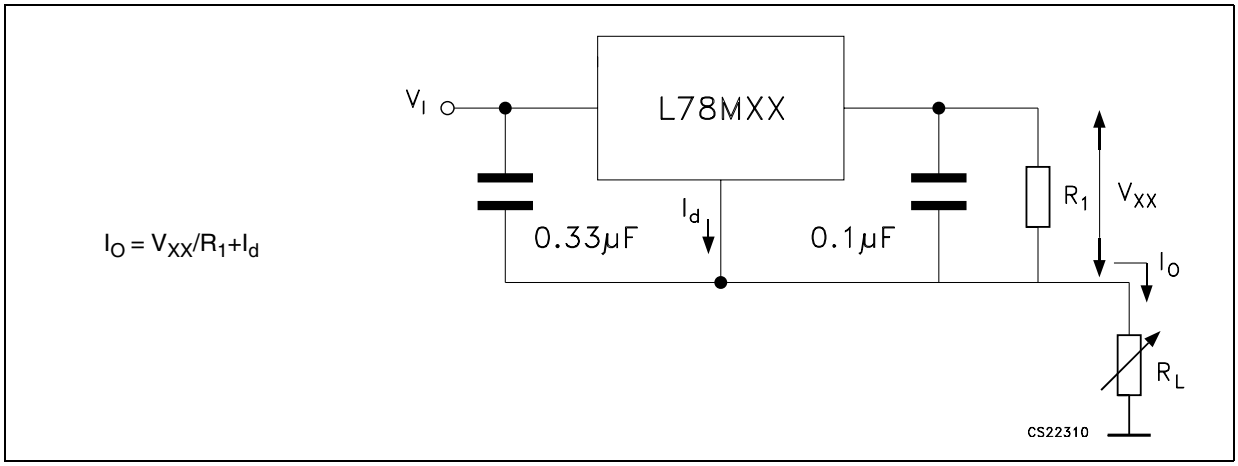


Figure 19. Circuit for increasing output voltage

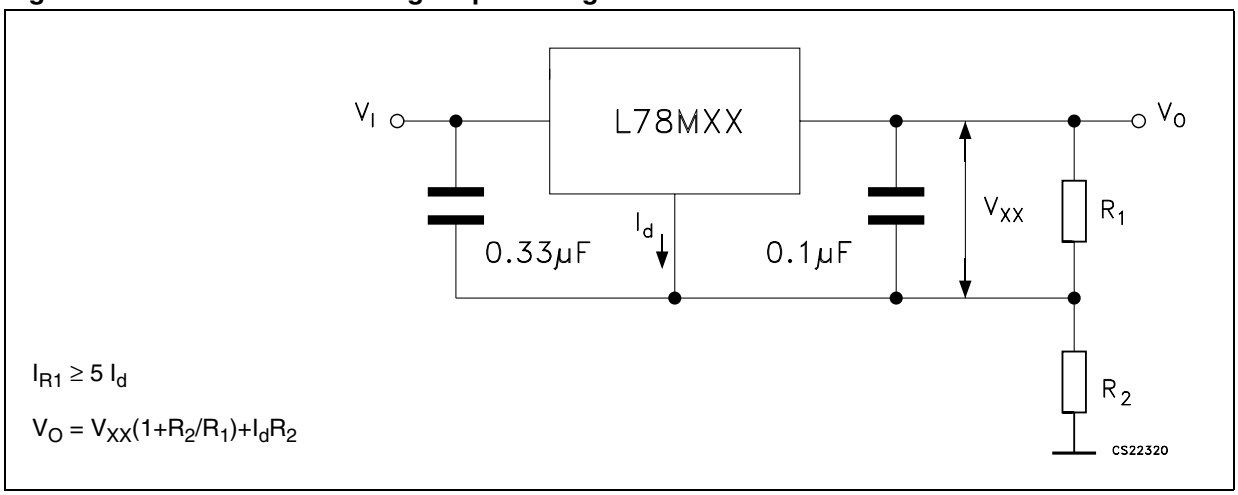


Figure 20. Adjustable output regulator (7 to 30 V)

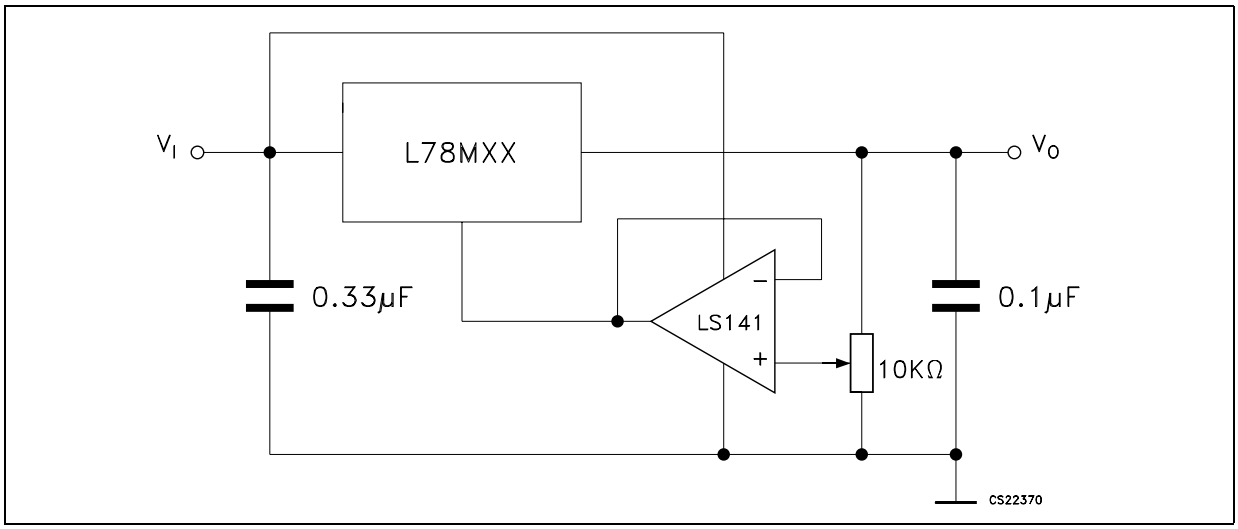


Figure 21. 0.5 to 10 V regulator

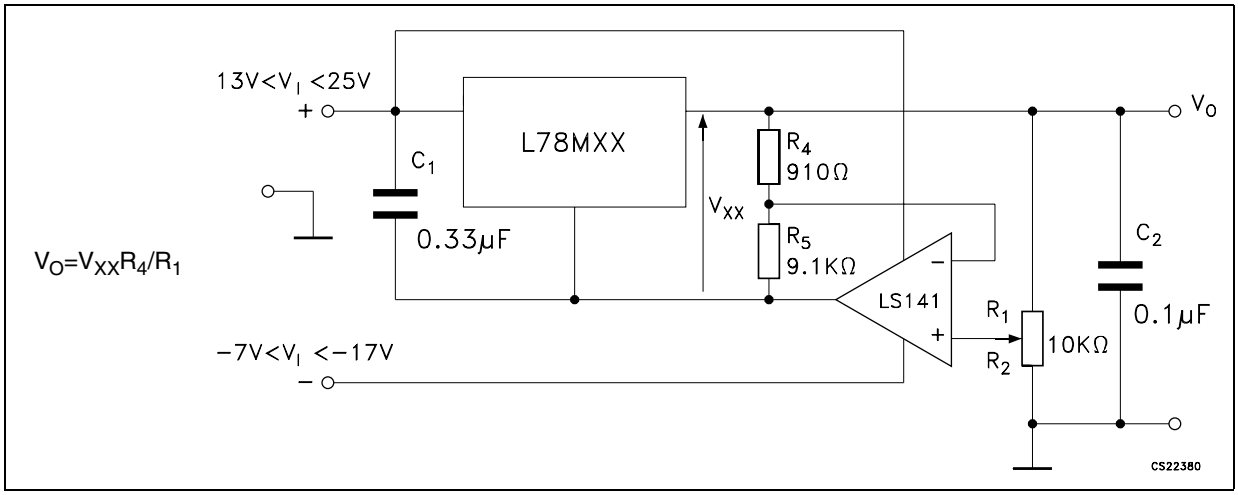


Figure 22. High current voltage regulator

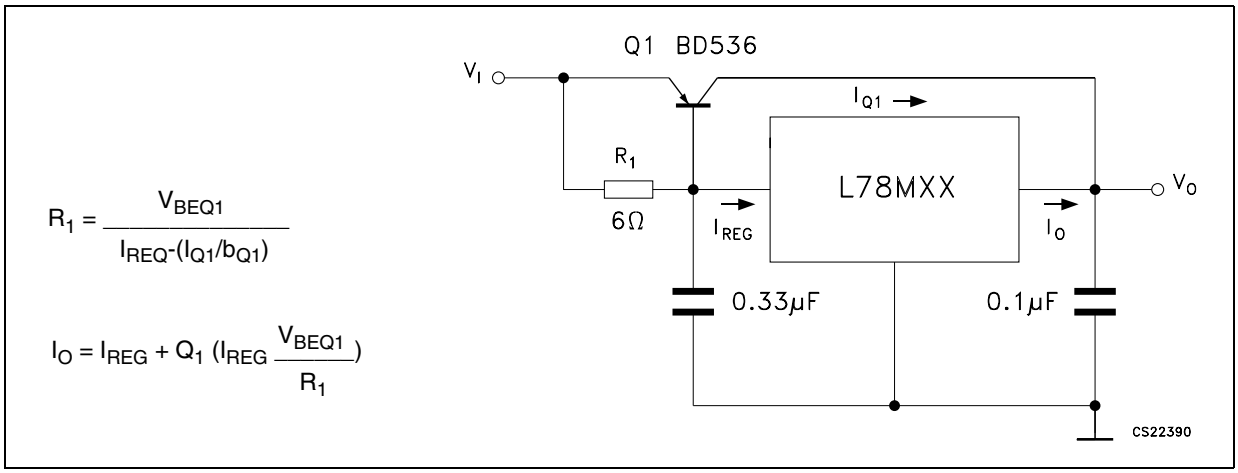


Figure 23. High output current with short circuit protection

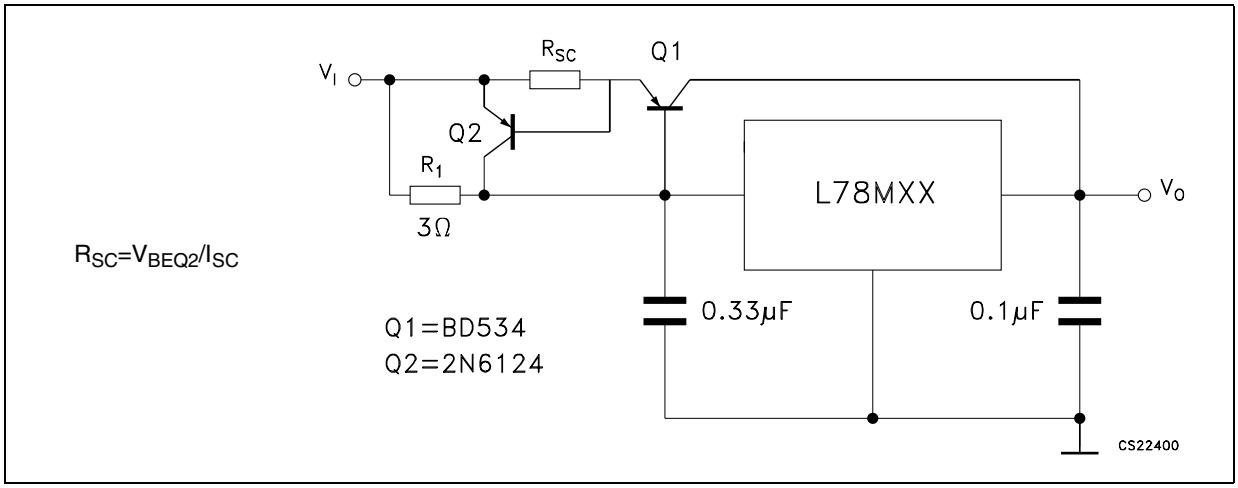


Figure 24. Tracking voltage regulator

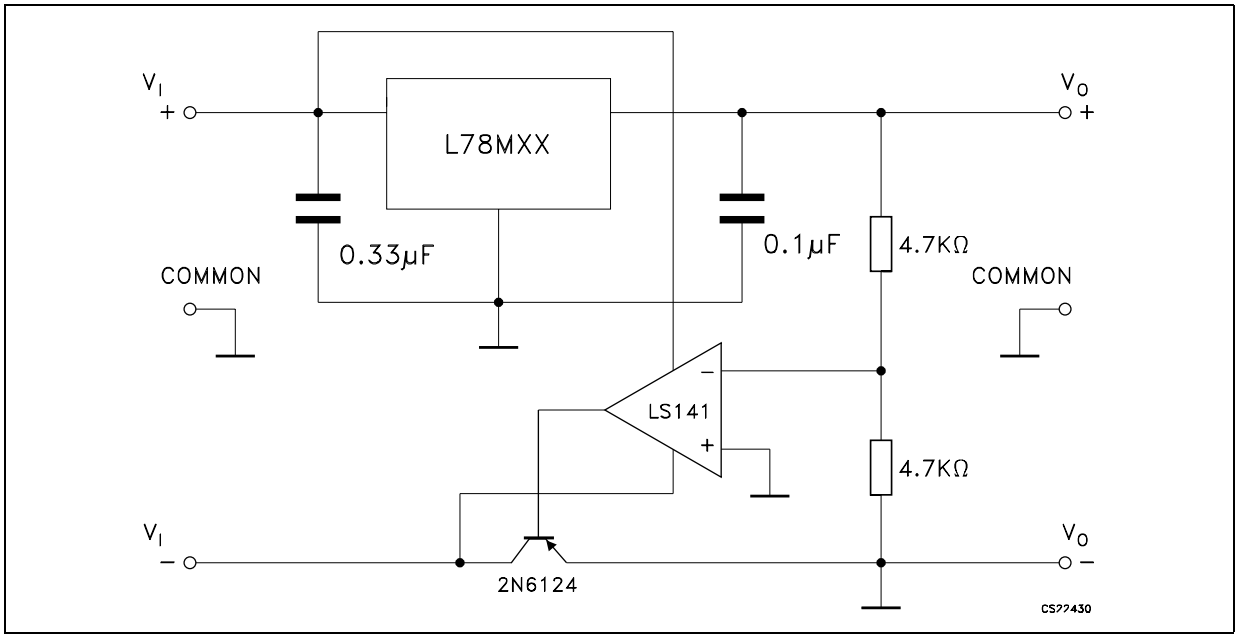


Figure 25. High input voltage circuit

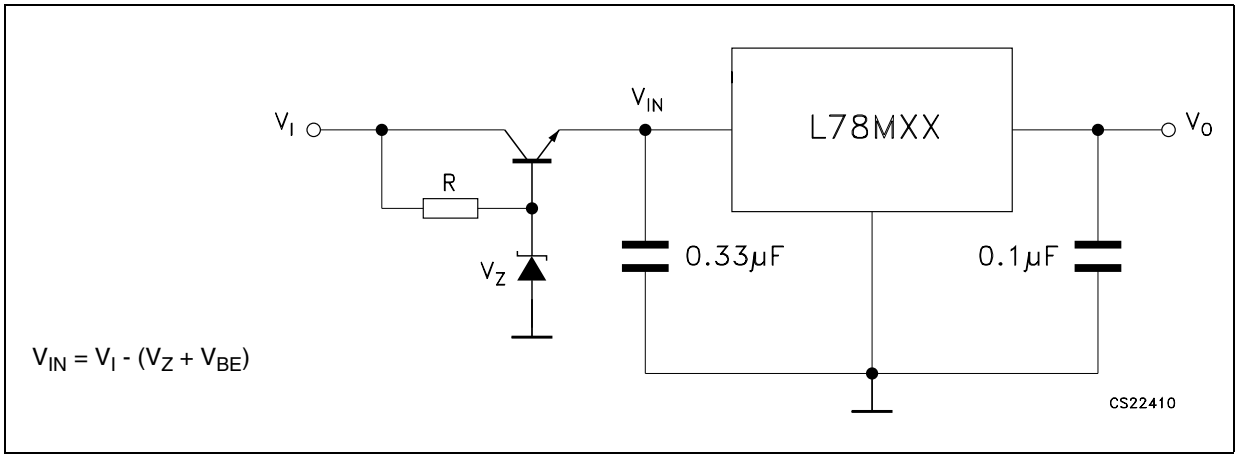


Figure 26. Reducing power dissipation with dropping resistor

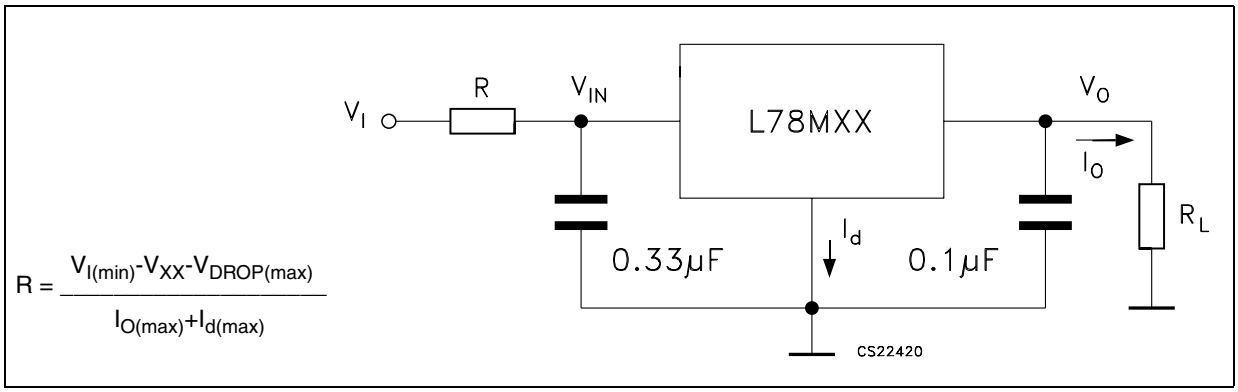
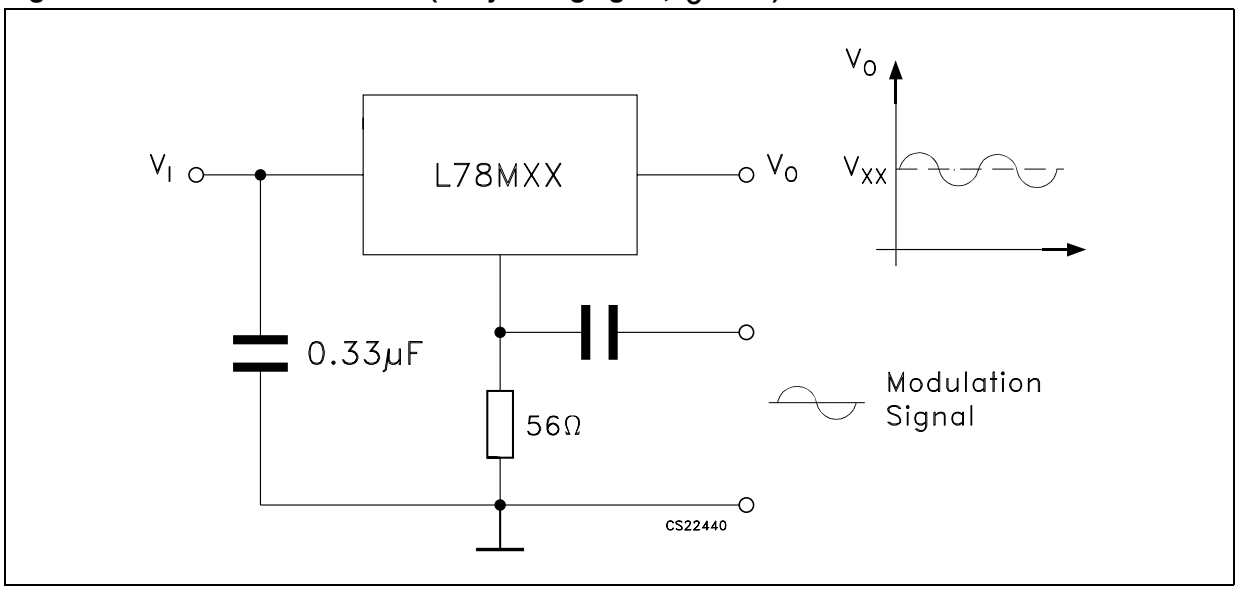
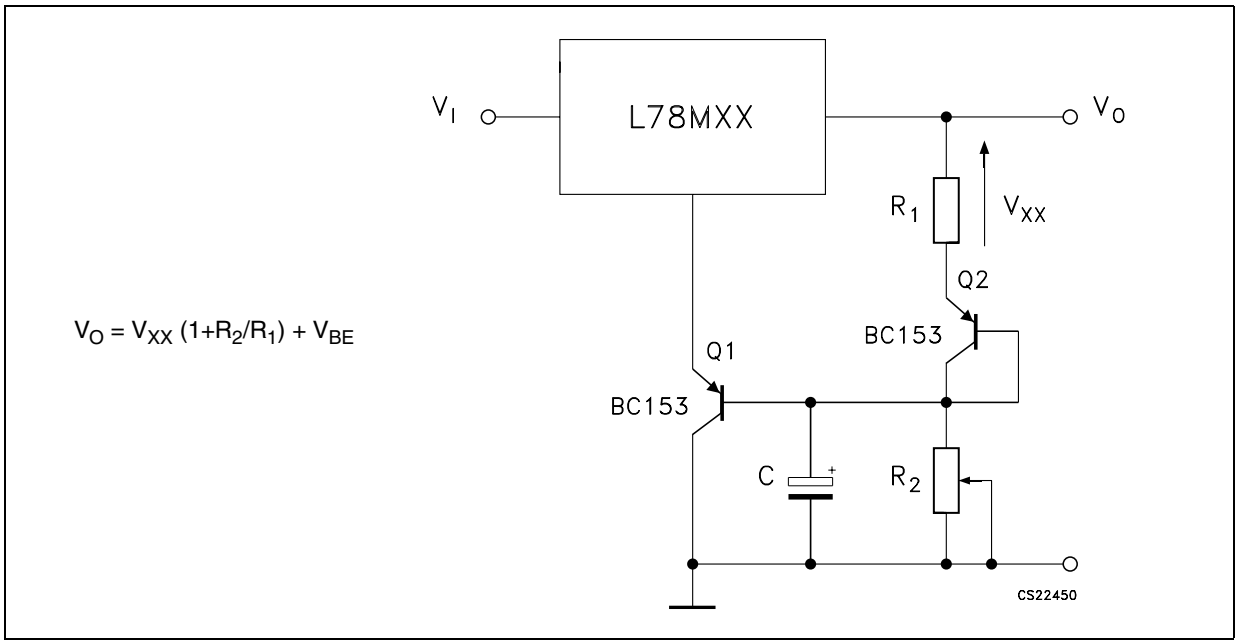


Figure 27. Power AM modulator (unity voltage gain, $I_O \leq 0.5$)



Note: The circuit performs well up to 100 kHz.

Figure 28. Adjustable output voltage with temperature compensation



$V_O = V_{XX} (1+R_2/R_1) + V_{BE}$

Note: Q_2 is connected as a diode in order to compensate the variation of the Q_1 V_{BE} with the temperature. C allows a slow rise time of the V_O.

7 Package mechanical data

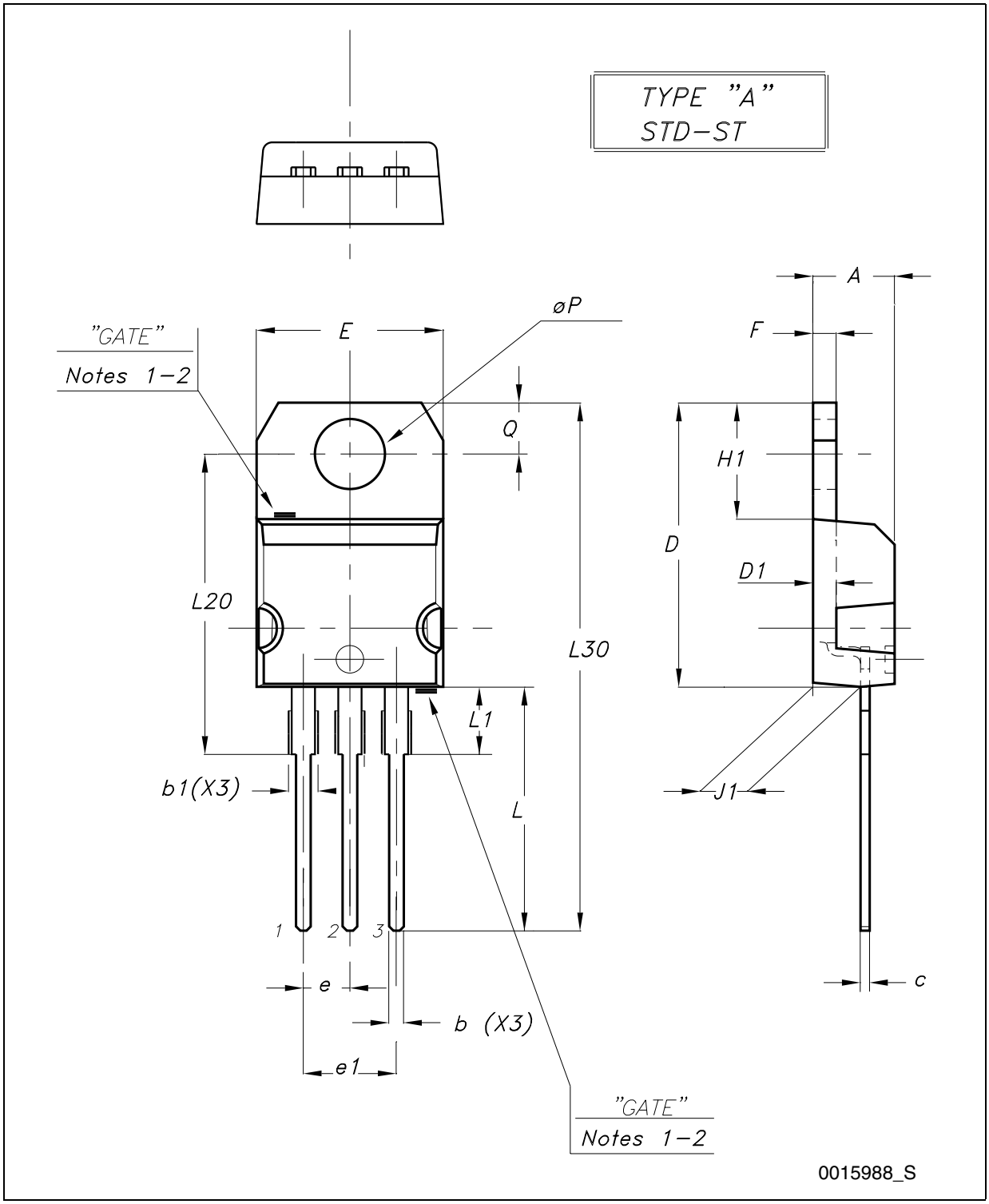
In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK is an ST trademark.

Table 11. TO-220 mechanical data

Dim.	Type STD - ST Dual Gauge			Type STD - ST Single Gauge		
	mm.			mm.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	4.40		4.60	4.40		4.60
b	0.61		0.88	0.61		0.88
b1	1.14		1.70	1.14		1.70
c	0.48		0.70	0.48		0.70
D	15.25		15.75	15.25		15.75
D1		1.27				
E	10.00		10.40	10.00		10.40
e	2.40		2.70	2.40		2.70
e1	4.95		5.15	4.95		5.15
F	1.23		1.32	0.51		0.60
H1	6.20		6.60	6.20		6.60
J1	2.40		2.72	2.40		2.72
L	13.00		14.00	13.00		14.00
L1	3.50		3.93	3.50		3.93
L20		16.40			16.40	
L30		28.90			28.90	
∅P	3.75		3.85	3.75		3.85
Q	2.65		2.95	2.65		2.95

In spite of some difference in tolerances, the packages are compatible.

Figure 29. Drawing dimension TO-220 (type STD-ST Dual Gauge)



Note: 1 Maximum resin gate protrusion: 0.5 mm.

2 Resin gate position is accepted in each of the two positions shown on the drawing, or their symmetrical.

Figure 30. Drawing dimension TO-220 (type STD-ST Single Gauge)

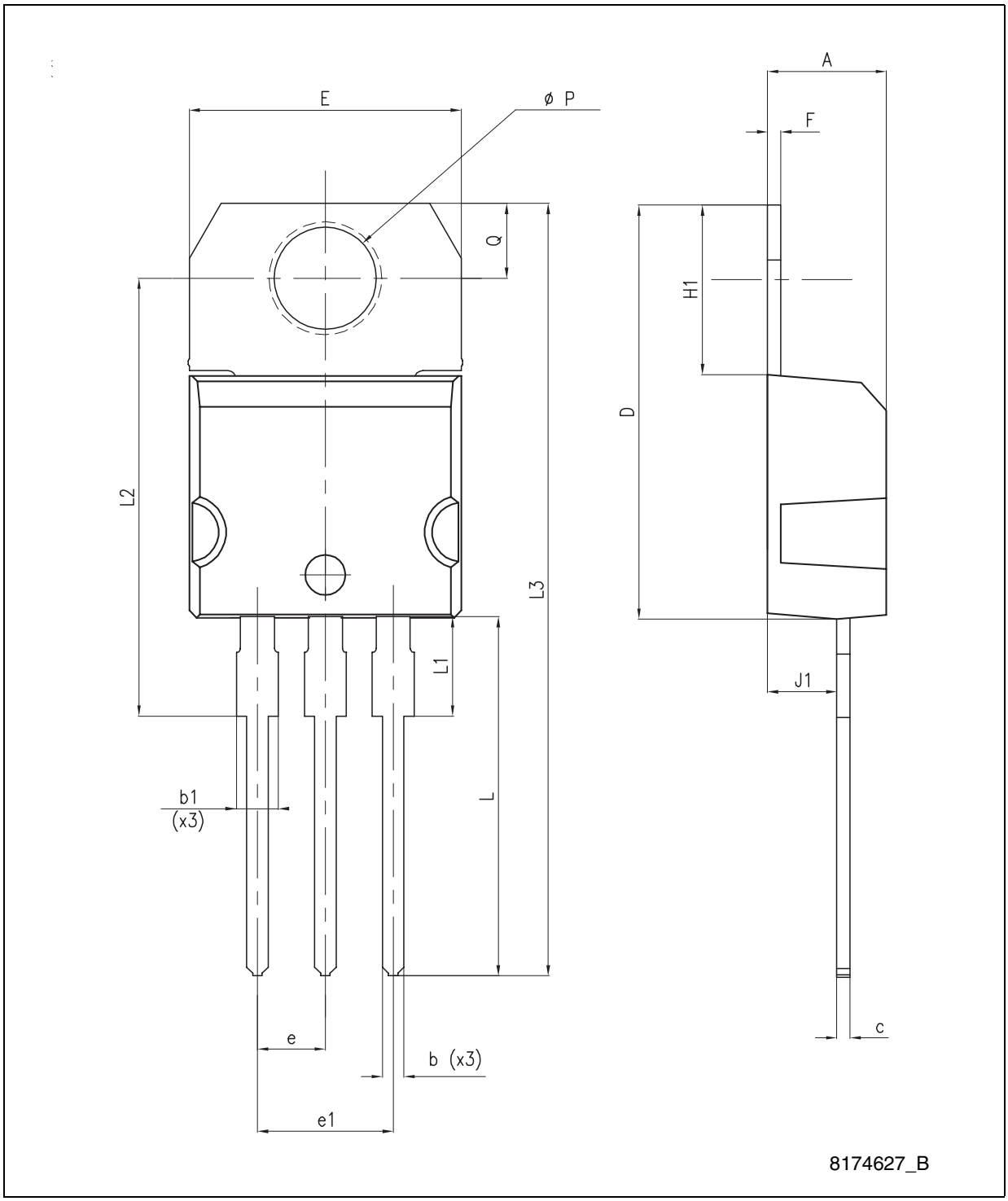


Figure 31. Drawing dimension tube for TO-220 Dual Gauge (mm.)

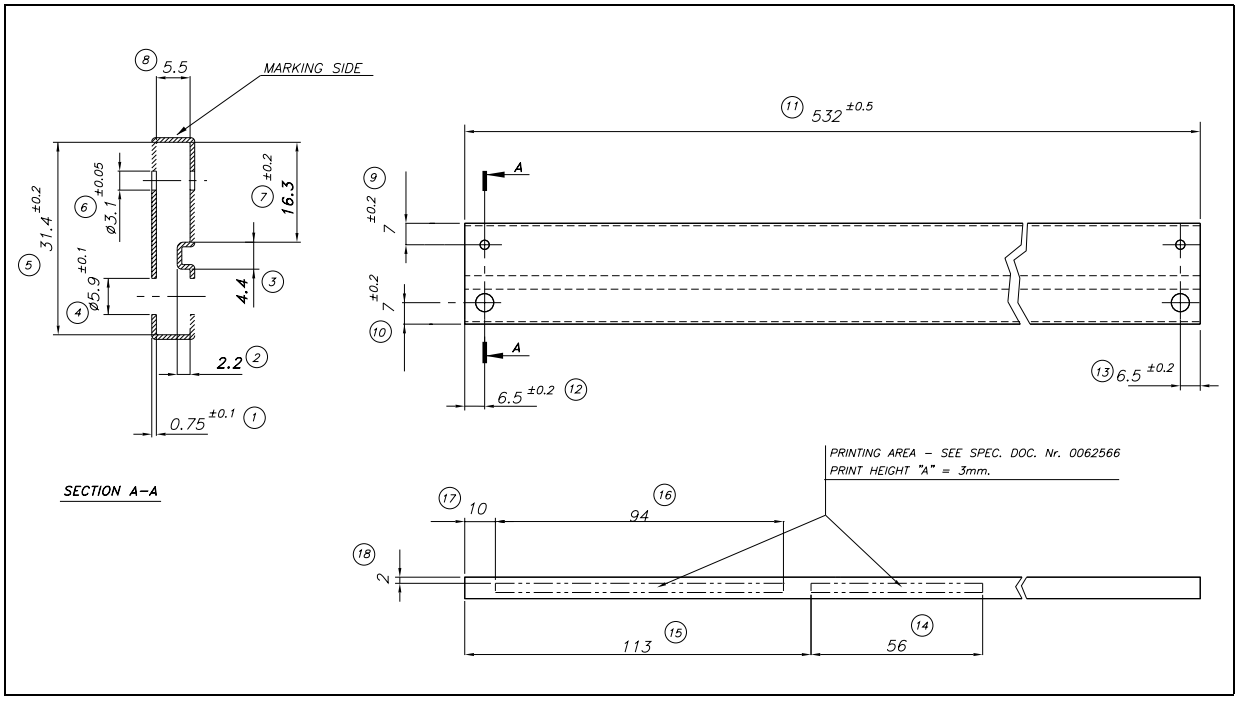
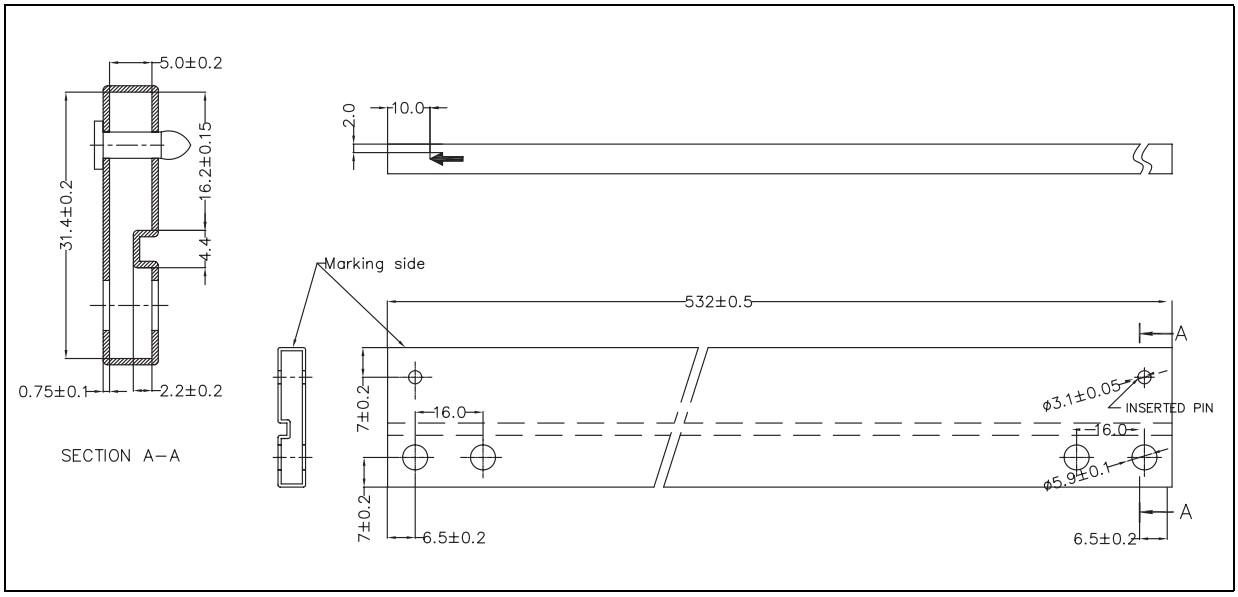


Figure 32. Drawing dimension tube for TO-220 Single Gauge (mm.)



TO-220FP mechanical data

Dim.	mm.			inch.		
	Min.	Typ	Max.	Min.	Typ.	Max.
A	4.40		4.60	0.173		0.181
B	2.5		2.7	0.098		0.106
D	2.5		2.75	0.098		0.108
E	0.45		0.70	0.017		0.027
F	0.75		1	0.030		0.039
F1	1.15		1.50	0.045		0.059
F2	1.15		1.50	0.045		0.059
G	4.95		5.2	0.194		0.204
G1	2.4		2.7	0.094		0.106
H	10.0		10.40	0.393		0.409
L2		16			0.630	
L3	28.6		30.6	1.126		1.204
L4	9.8		10.6	0.385		0.417
L5	2.9		3.6	0.114		0.142
L6	15.9		16.4	0.626		0.645
L7	9		9.3	0.354		0.366
DIA.	3		3.2	0.118		0.126

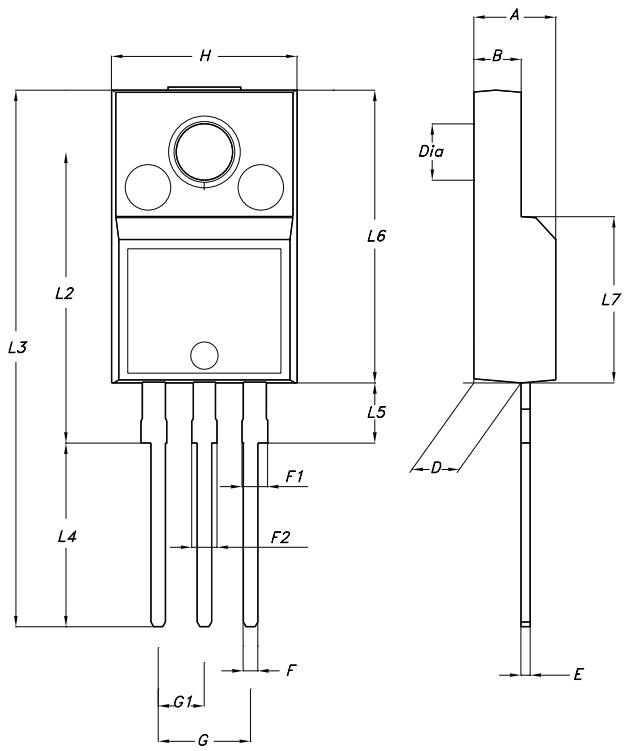


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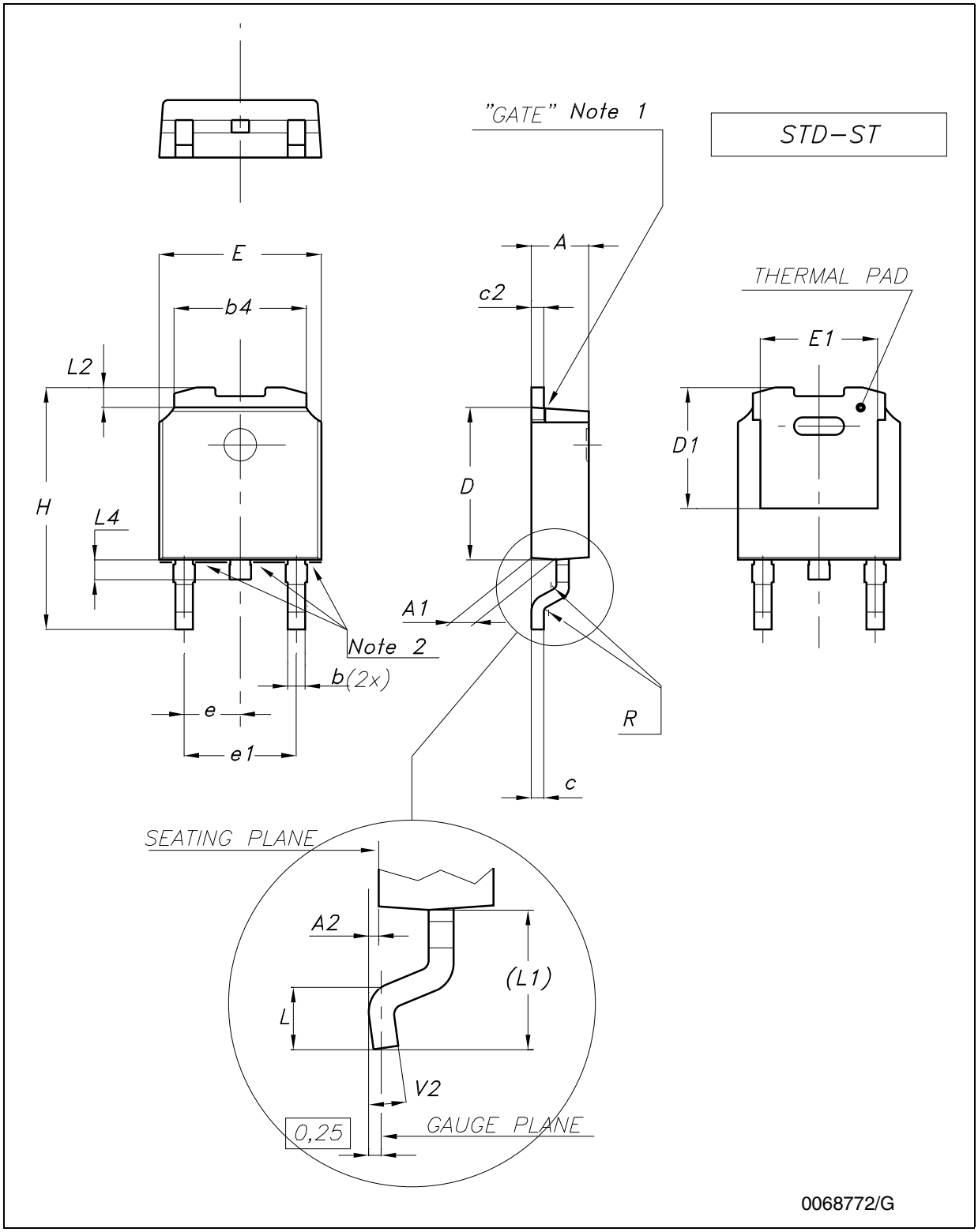
Figure 33. Drawing dimension DPAK (type STD-ST)



Note: 1 Max resin gate protrusion: 0.5 mm.

2 Max resin protrusion: 0.25 mm.

Figure 34. Drawing dimension DPAK (type FUJITSU-subcon.)

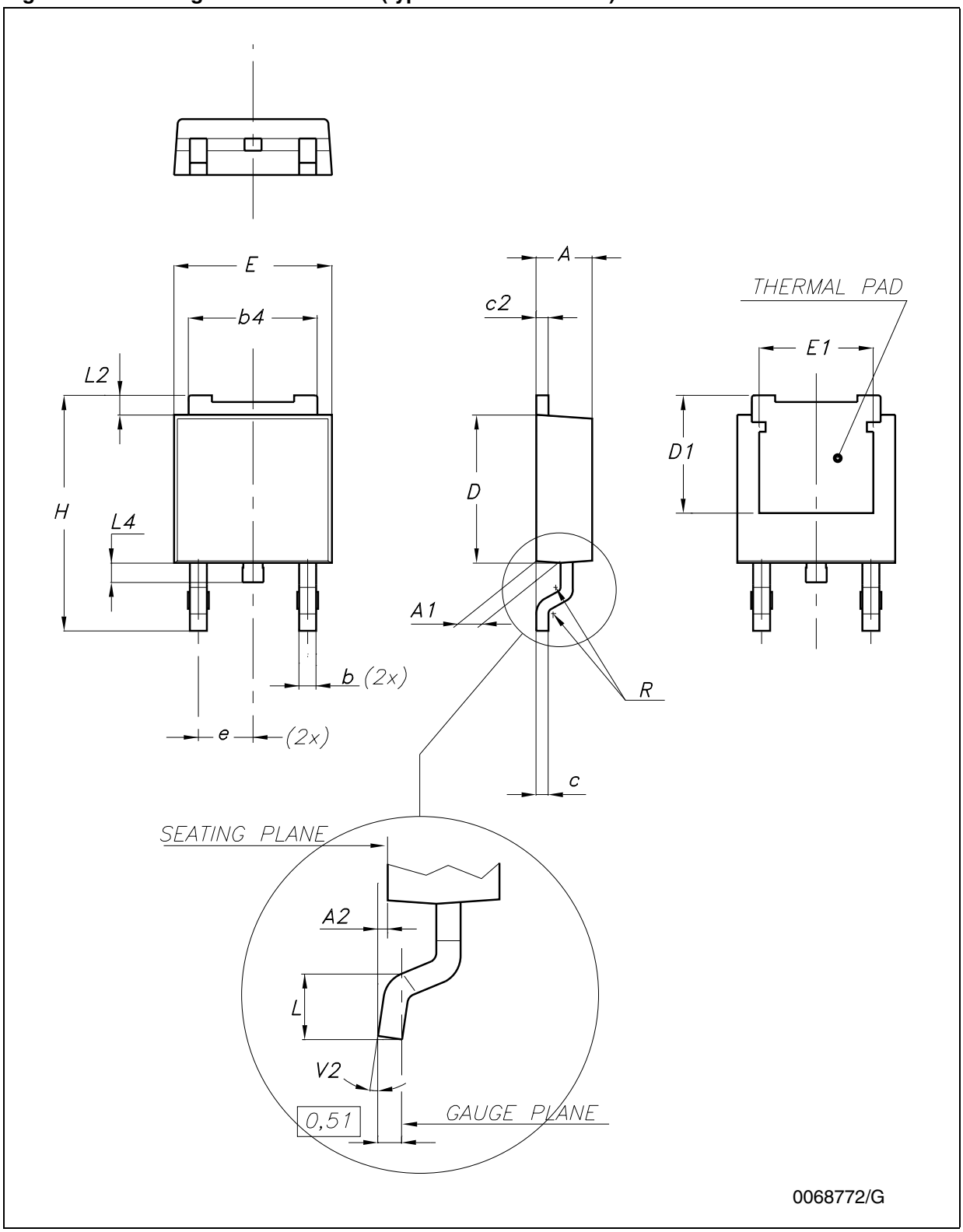


Figure 35. Drawing dimension DPAK (type IDS-subcon.)

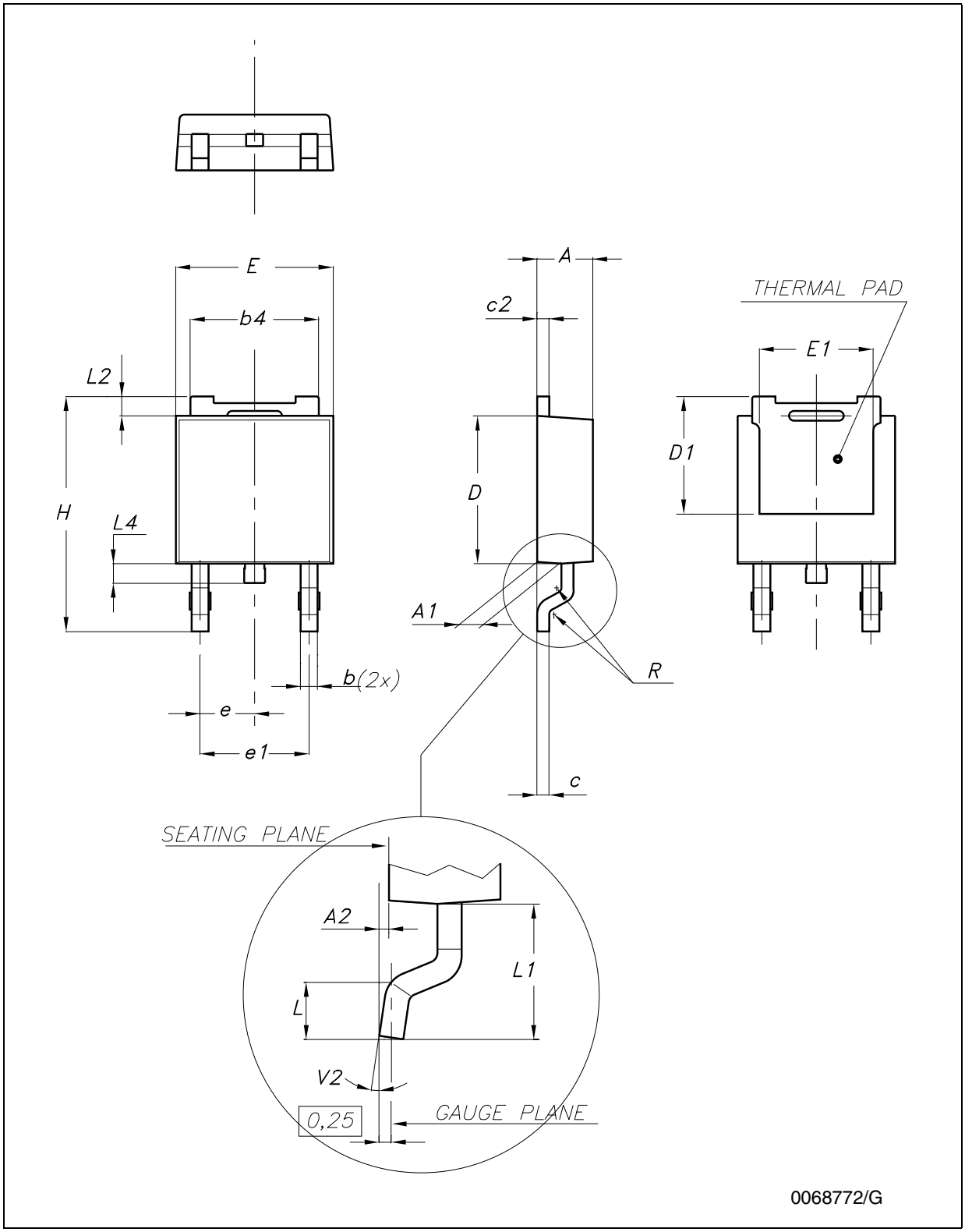


Table 12. DPAK mechanical data

Dim.	Type STD-ST			Type FUJITSU-Subcon.			Type IDS-Subcon		
	mm.			mm.			mm.		
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.20		2.40	2.25	2.30	2.35	2.19		2.38
A1	0.90		1.10	0.96		1.06	0.89		1.14
A2	0.03		0.23	0		0.10	0.03		0.23
b	0.64		0.90	0.76		0.86	0.64		0.88
b4	5.20		5.40	5.28		5.38	5.21		5.46
c	0.45		0.60	0.46		0.56	0.46		0.58
c2	0.48		0.60	0.46		0.56	0.46		0.58
D	6.00		6.20	6.05		6.15	5.97		6.22
D1		5.10		5.27		5.47		5.20	
E	6.40		6.60	6.55	6.60	6.65	6.35		6.73
E1		4.70			4.77			4.70	
e		2.28		2.23	2.28	2.33		2.28	
e1	4.40		4.60				4.51		4.61
H	9.35		10.10	9.90		10.30	9.40		10.42
L	1.00			1.40		1.60	0.90		
L1		2.80					2.50		2.65
L2		0.80		1.03		1.13	0.89		1.27
L4	0.60		1.00	0.70		0.90	0.64		1.02
R		0.20			0.40			0.20	
V2	0°		8°	0°		8°	0°		8°

Note: The DPAK package coming from the two subcontractors (Fujitsu and IDS) are fully compatible with the ST's package suggested footprint.

Figure 36. DPAK footprint recommended data

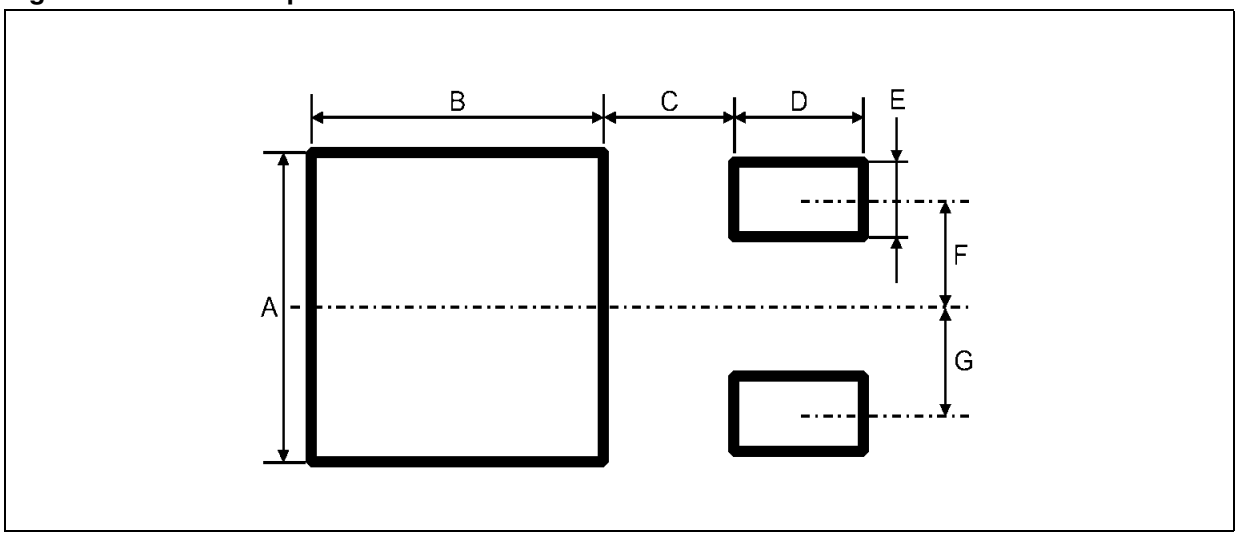
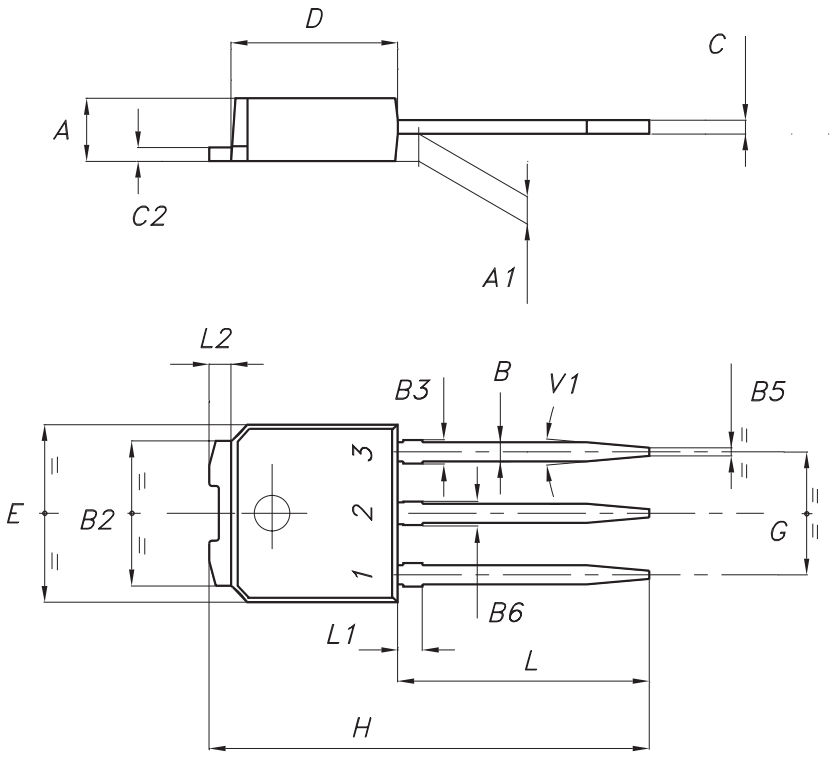


Table 13. Footprint data

Values		
Dim.	**mm.**	**inch.**
A	6.70	0.264
B	6.70	0.64
C	1.8	0.070
D	3.0	0.118
E	1.60	0.063
F	2.30	0.091
G	2.30	0.091

IPAK mechanical data

Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.2		2.4	0.086		0.094
A1	0.9		1.1	0.035		0.043
B	0.64		0.9	0.025		0.035
B2	5.2		5.4	0.204		0.212
B3			0.95			0.037
B5		0.3			0.012	
B6			0.95			0.037
C	0.45		0.6	0.017		0.023
C2	0.48		0.6	0.019		0.023
D	6		6.2	0.236		0.244
E	6.4		6.6	0.252		0.260
G	4.4		4.6	0.173		0.181
H	15.9		16.3	0.626		0.641
L	9		9.4	0.354		0.370
L1	0.8		1.2	0.031		0.047
L2		0.8	1		0.031	0.039



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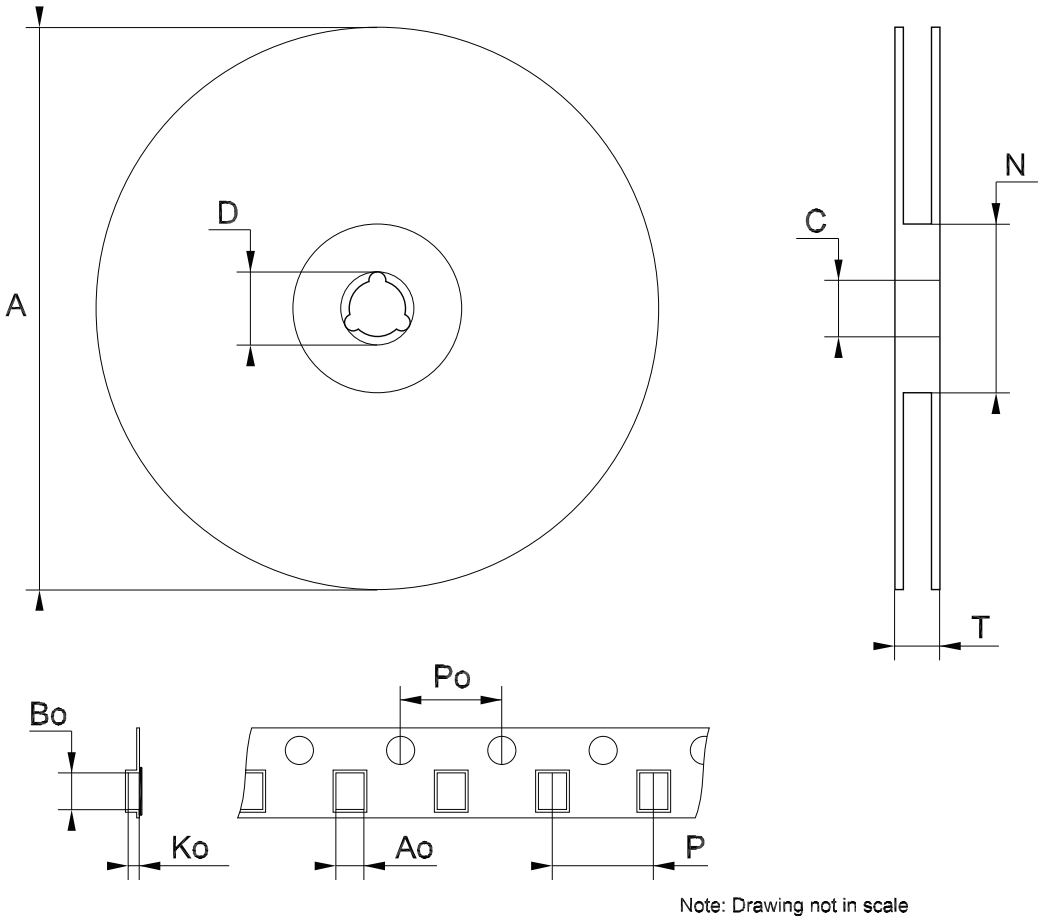
Tape & reel DPAK-PPAK mechanical data

Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			330			12.992
C	12.8	13.0	13.2	0.504	0.512	0.519
D	20.2			0.795		
N	60			2.362		
T			22.4			0.882
Ao	6.80	6.90	7.00	0.268	0.272	0.2.76
Bo	10.40	10.50	10.60	0.409	0.413	0.417
Ko	2.55	2.65	2.75	0.100	0.104	0.105
Po	3.9	4.0	4.1	0.153	0.157	0.161
P	7.9	8.0	8.1	0.311	0.315	0.319



Note: Drawing not in scale

8 Revision history

Table 14. Document revision history

Date	Revision	Changes
21-Jun-2004	6	Document updating.
30-Aug-2006	7	Order codes updated.
29-Nov-2006	8	DPAK mechanical data updated and add footprint data.
06-Jun-2007	9	Order codes updated.
10-Dec-2007	10	Added *Table 1*.
19-Feb-2008	11	Modified: *Table 1 on page 1*.
15-Jul-2008	12	Modified: *Table 1 on page 1* and *Table 14 on page 29*.
07-Apr-2009	13	Modified: *Figure 9 on page 11* and *Figure 15 on page 12*.
14-Jun-2010	14	Added: *Table 11 on page 17*, *Figure 29 on page 18*, *Figure 30 on page 19*, *Figure 31* and *Figure 32 on page 20*.
11-Nov-2010	15	Modified: R_{thJC} value for TO-220 *Table 3 on page 5*.
08-Feb-2012	16	Added: order codes L78M05CV-DG, L78M12CV-DG and L78M15CV-DG *Table 1 on page 1*.