

AN6535, AN6536

4-Terminal Negative Adjustable Voltage Regulators

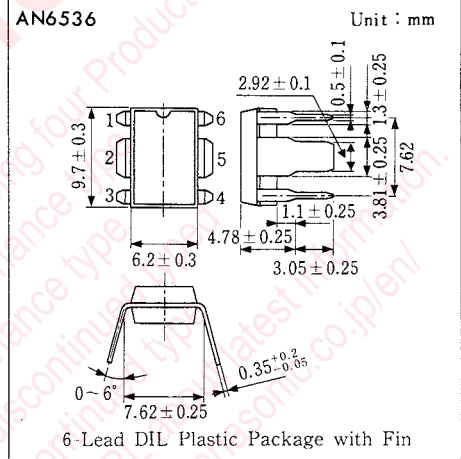
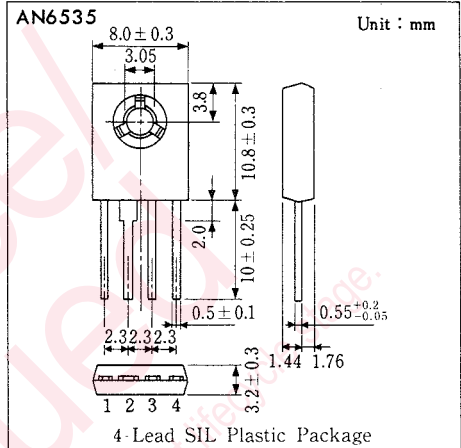
Outline

The AN6535 and the AN6536 are monolithic 4-terminal negative adjustable voltage regulators. They provide any stabilized output voltage between $-5V$ and $-30V$ with external resistance, and are best suited for power circuits with current capacity up to $0.5A$. Moreover, these voltage regulators are highly reliable with various internal protection circuits.

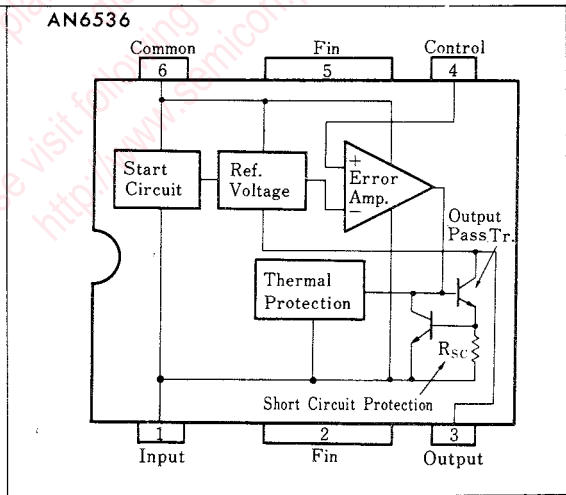
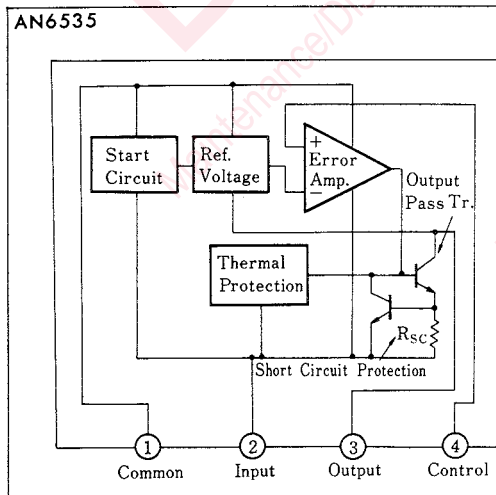
The AN6535 is in a 4-lead SIL plastic package, and the AN6536 is in a 6-lead DIL plastic package.

Features

- Wide range of output voltage : $-5 \sim -30V$
- Output current in excess of $500mA$
- Internal thermal overload protection
- Internal short-circuit protection
- Output transistor safe area compensation



Block Diagrams



Absolute Maximum Ratings (Ta=25°C)

Item	Symbol	Rating	Unit
Supply Voltage	V _{CC}	40	V
Supply Current	I _{CC} *1	1	A
Power Dissipation	AN6535	P _D	W
	AN6536		
Operating Ambient Temperature	T _{opr}	-20~+80	°C
Storage Temperature	T _{stg}	-55~+150	°C

*1 The internal circuit is provided with a current limiting circuit.

*2 Maximum power dissipation value in the case where there is no heat sink (The value varies with the external heat dissipation state.)

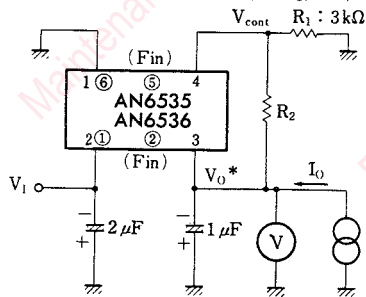
Electrical Characteristics (Ta=25°C)

Item	Symbol	Test Circuit	Condition	min.	typ.	max.	Unit
Output Voltage Tolerance	V _O	1	V _I =V _O -3~V _O -15V, T _J =25°C			4	%
Line Regulation	REG _{IN}	1	V _O =-5V, I _O =200mA, V _I =-7.5~-25V, T _J =25°C			1	%
			V _O =-18V, I _O =5mA, V _I =-21~-33V, T _J =25°C			0.75	%
			V _O =-18V, I _O =200mA, V _I =-21~-25V, T _J =25°C			0.67	%
Load Regulation	REG _L	1	I _O =5~500mA, T _J =25°C	V _O =-5V, V _I =-12V V _O =-18V, V _I =-25V		1	%
Bias Current	I _{Bias}	2	T _J =25°C		1.5	3	mA
Control Pin Current	I _{cont}	3	T _J =25°C			3	μA
Ripple Rejection Ratio	RR	4	V _I =-8~-18V, V _O =-5V, f=120Hz	60			dB
Output Noise Voltage	V _{no}	1	V _O =-5V, f=10Hz~100kHz		40		μV
Minimum Input/Output Voltage Difference	V _{DIF(min.)}	1	I _O =500mA, T _J =25°C		1.1		V
Short Circuit Current	I _{OS}	1	V _I =-35V, V _O =-5V, T _J =25°C		100	600	mA
Peak Output Current	I _{OP}	1	V _O =-5V, T _J =25°C	0.4	0.8	1.4	A
Output Voltage Temperature Coefficient	ΔV _O /T _a	1	V _O =-5V, I _O =5mA	T _J =-20~25°C	0.2		mV/°C
				T _J =25°C~150°C	-0.3		
Control Pin Voltage	V _{cont}	1	T _J =25°C	-3.12	-3	-2.88	V

Note 1) The specified condition T_J=25°C means that the test should be carried out with the test time so short (within 10ms) that the drift in characteristic value due to the rise in chip junction temperature can be ignored.

Note 2) When not specified, V_I=-10V, V_O=-5V, I_O=350mA, C₁=2μF and C_O=1μF.

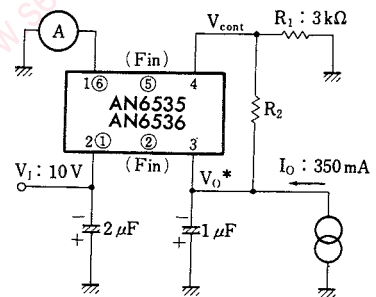
Test Circuit 1 (V_O, REG_{IN}, REG_L, V_{no}, V_{DIF(min.)}, I_{OS}, I_{OP}, ΔV_O/T_a, V_{cont})



Note) The test time should be within 10ms.

$$* V_O = \frac{R_1 + R_2}{R_1} V_{cont}$$

Test Circuit 2 (I_{Bias})

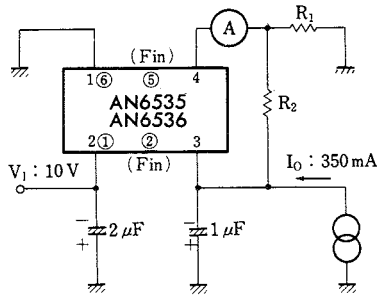


Note) The test time should be within 10ms.

$$* V_O = \frac{R_1 + R_2}{R_1} V_{cont}$$

Pin No. in circle for AN6536 only. Other No. common to both types.

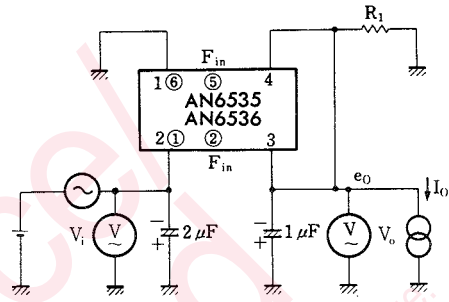
Test Circuit 3 (I_{cont})



Note) The test time should be within 10ms.

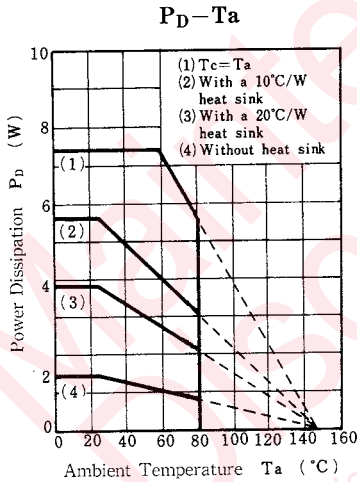
Test Circuit 4 (RR)

$$RR = 20 \log \left(\frac{|V_i|}{|V_o|} \right)$$

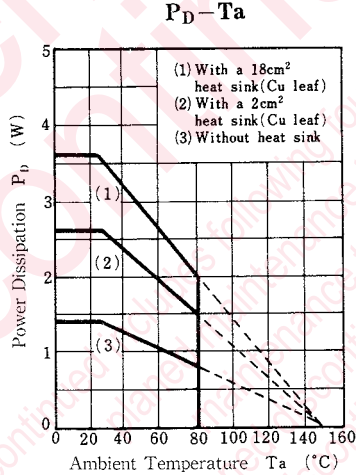


Pin No. in circle for AN6536 only. Other No. common to both types.

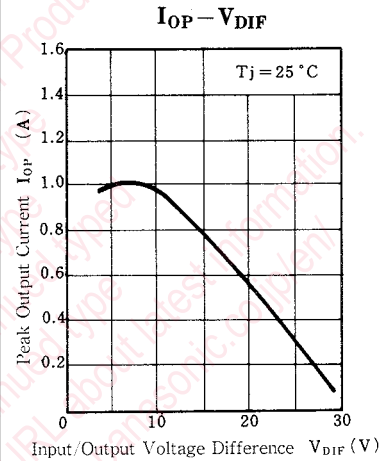
AN6535 Character Chart



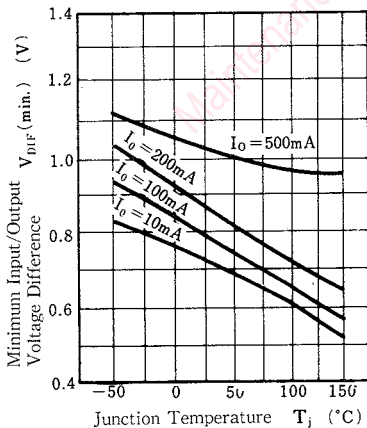
AN6536 Character Chart



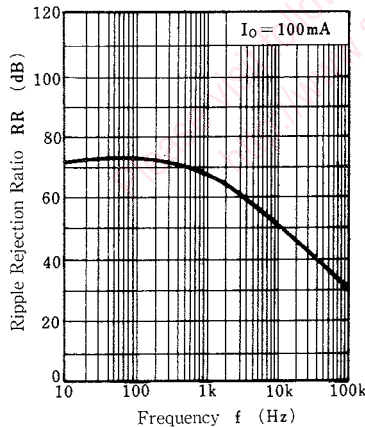
Common Character Chart



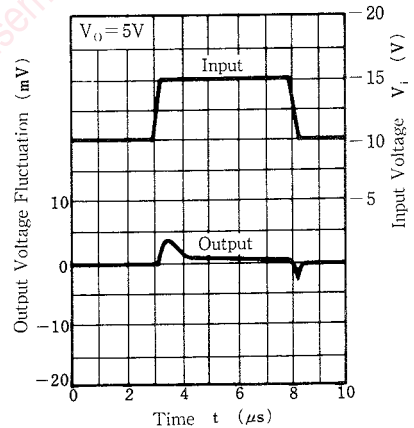
$V_{DIF} (min.) - T_j$



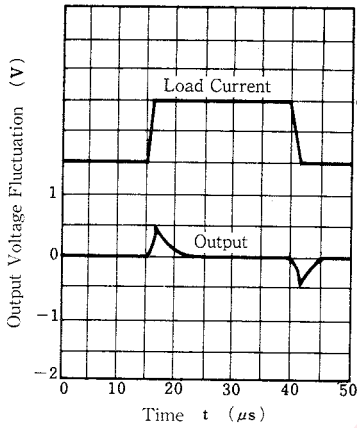
RR - f



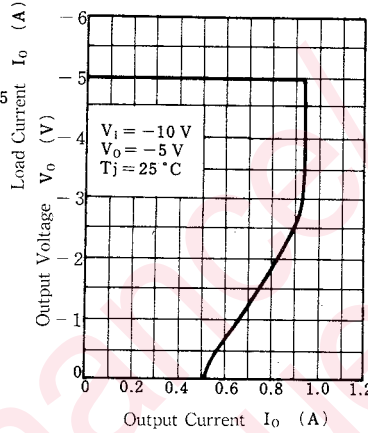
Line Transient Response



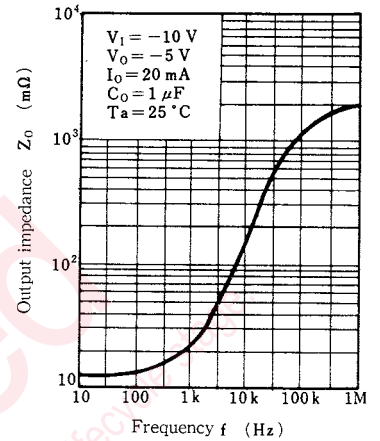
Load Transient Response



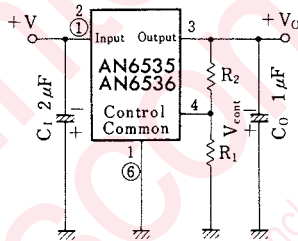
Output Current Limit



Z₀-f



Basic Regulator Circuit



Note) Pin No. in ○ are for AN6536.

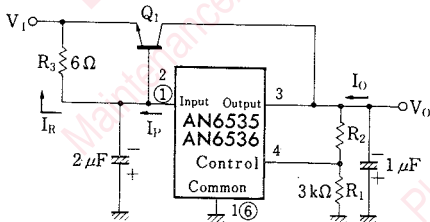
$$V_0 = V_{cont} \left(\frac{R_1 + R_2}{R_1} \right)$$

$$(V_{cont} \approx 3V, R_1 = 3k\Omega)$$

C₁ is necessary when the line of V₁ is long.
C₀ improves the transient response.

Application Circuits

(1) Current Boost Circuit

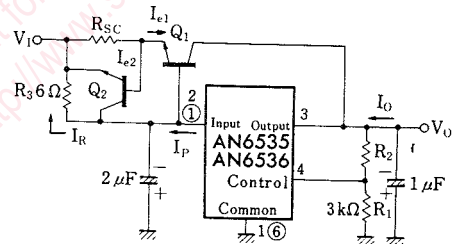


$$R_3 = \frac{V_{BE(Q1)} \cdot \beta}{(\beta + 1) I_P - I_0}$$

Note) Pin No. in ○ are for AN6536.

(2) Current Boost Circuit

(With Current Limiting Circuit)



$$R_{SC} = \frac{V_{BE(Q2)}}{I_{e1(max.)}}$$

$$R_3 = \frac{V_{BE(Q1)} + I_{e1} R_{SC}}{I_0 - I_{e1}}$$

$$I_{e2(max.)} = I_P(max.) - \frac{V_{BE(Q1)} + V_{BE(Q2)}}{R_3}$$

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