AN6535, AN6536

4-Terminal Negative Adjustable Voltage Regulators

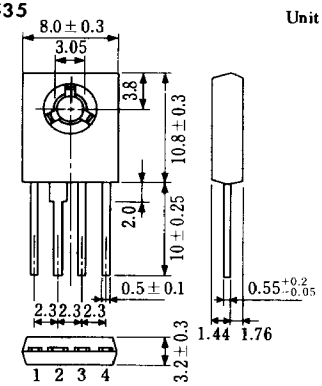
■ Outline

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

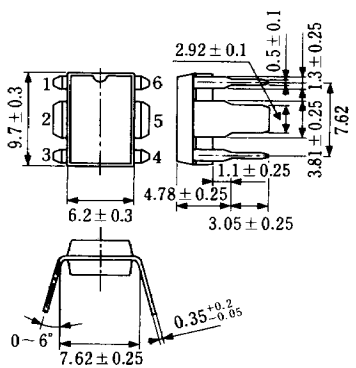
- Wide range of output voltage : −5~−30V
- Output current in excess of 500mA
- Internal thermal overload protection
- Internal short-circuit protection
- Output transistor safe area compensation

AN6535 Unit : mm



4-Lead SIL Plastic Package

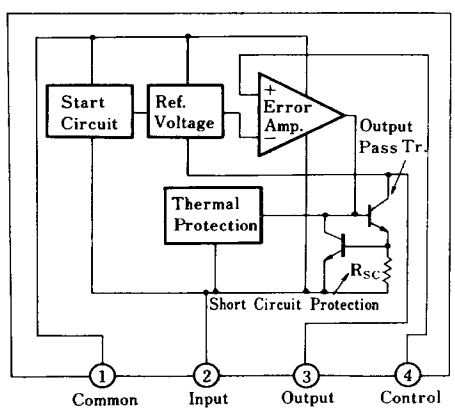
AN6536 Unit : mm



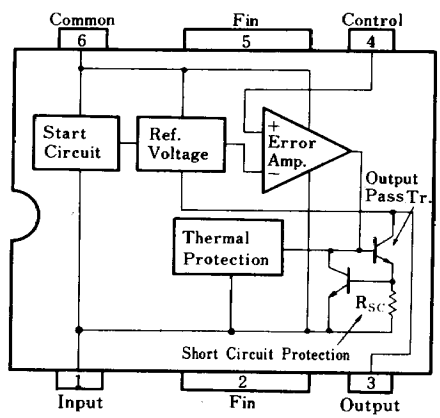
6-Lead DIL Plastic Package with Fin

■ Block Diagrams

AN6535



AN6536



■ Absolute Maximum Ratings (Ta=25℃)

Item		Symbol	Rating	Unit
Supply Voltage		V_{CC}	40	V
Supply Current		I_{CC}*1	1	A
Power Dissipation	AN6535	P_D	7.5	W
	AN6536		1.5*2	
Operating Ambient Temperature		T_{opr}	−20～+80	℃
Storage Temperature		T_{stg}	−55～+150	℃

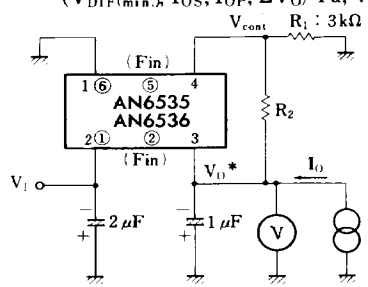
*1 The internal circuit is provided with a current limiting circuit.
*2 Maximum power dissipation value in the case where there is no heat sink (The value varies with the external heat dissipation state.)

■ Electrical Characteristics (Ta=25℃)

Item	Symbol	Test Circuit	Condition	min.	typ.	max.	Unit
Output Voltage Tolerance	V_O	1	$V_I=V_O-3\sim V_O-15V$, $T_j=25℃$			4	%
Line Regulation	REG_{IN}	1	$V_O=-5V$, $I_O=200mA$, $V_I=-7.5\sim-25V$, $T_j=25℃$			1	%
			$V_O=-18V$, $I_O=5mA$, $V_I=-21\sim-33V$, $T_j=25℃$			0.75	%
			$V_O=-18V$, $I_O=200mA$, $V_I=-21\sim-25V$, $T_j=25℃$			0.67	%
Load Regulation	REG_L	1	$I_O=5\sim500mA$, $T_j=25℃$, $V_O=-5V$, $V_I=-12V$			1	%
			$I_O=5\sim500mA$, $T_j=25℃$, $V_O=-18V$, $V_I=-25V$				
Bias Current	I_{Bias}	2	$T_j=25℃$		1.5	3	mA
Control Pin Current	I_{cont}	3	$T_j=25℃$			3	μA
Ripple Rejection Ratio	RR	4	$V_I=-8\sim-18V$, $V_O=-5V$, 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	$I_O=500mA$, $T_j=25℃$		1.1		V
Short Circuit Current	I_{OS}	1	$V_I=-35V$, $V_O=-5V$, $T_j=25℃$		100	600	mA
Peak Output Current	I_{OP}	1	$V_O=-5V$, $T_j=25℃$	0.4	0.8	1.4	A
Output Voltage Temperature Coefficient	$\Delta V_O/T_a$	1	$V_O=-5V$, $I_O=5mA$, $T_j=-20\sim25℃$		0.2		mV/℃
			$V_O=-5V$, $I_O=5mA$, $T_j=25℃\sim150℃$		−0.3		
Control Pin Voltage	V_{cont}	1	$T_j=25℃$	−3.12	−3	−2.88	V

Note 1: The specified condition $T_j=25℃$ 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, $V_I=-10V$, $V_O=-5V$, $I_O=350mA$, $C_I=2\mu F$ and $C_O=1\mu F$.

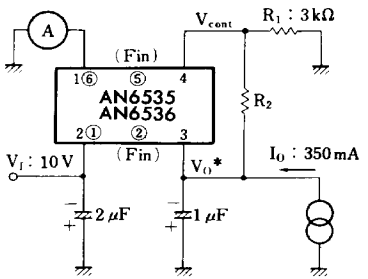
Test Circuit 1 (V_O, REG_{IN}, REG_L, V_{no}, $V_{DIF(min.)}$, I_{OS}, I_{OP}, $\Delta V_O/Ta$, V_{cont})



Note: The test time should be within 10ms.

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

Test Circuit 2 (I_{Bias})

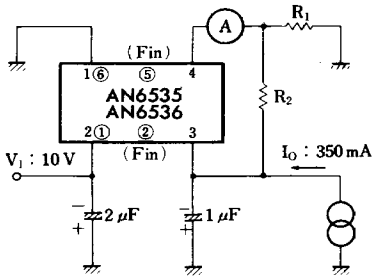


Note: The test time should be within 10ms.

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

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

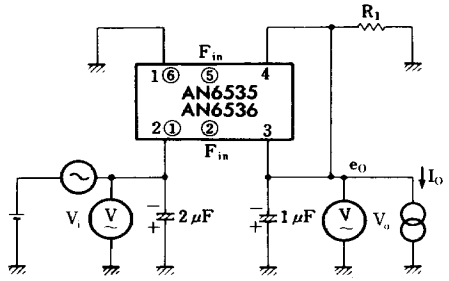
Test Circuit 3 (I_{cont})



Note) The test time should be within 10ms.

Test Circuit 4 (RR)

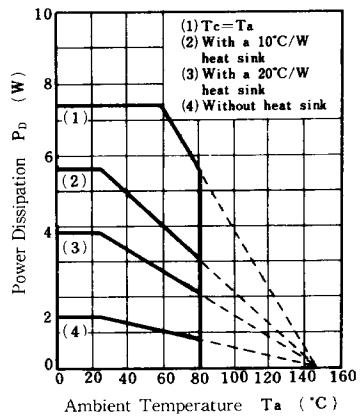
$$RR = 20\log\left(\frac{|V_i|}{|V_o|}\right)$$



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

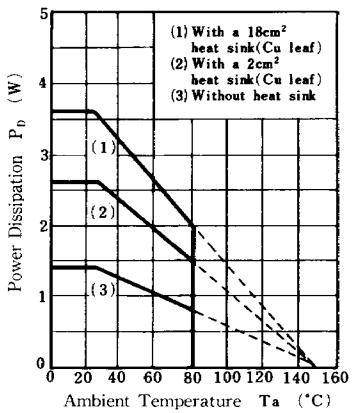
AN6535Character Chart

$P_D - Ta$



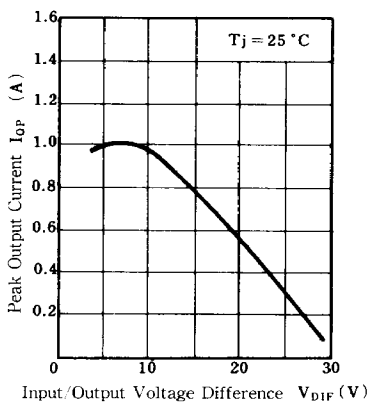
AN6536Character Chart

$P_D - Ta$

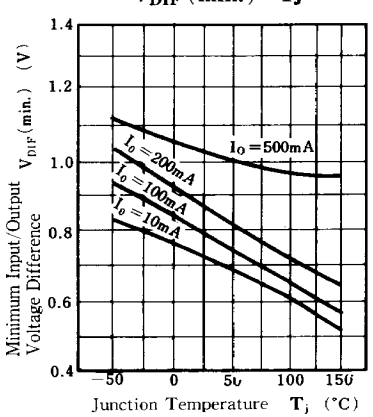


Common Character Chart

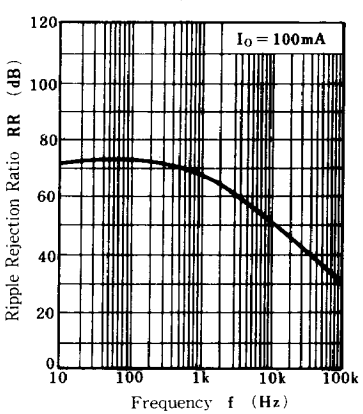
$I_{OP} - V_{DIF}$



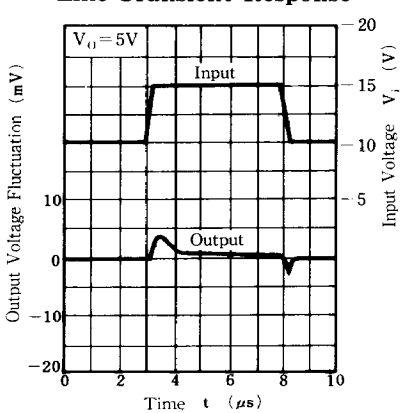
V_{DIF} (min.) $- Tj$



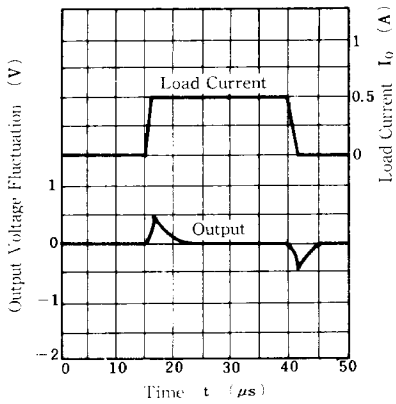
$RR - f$



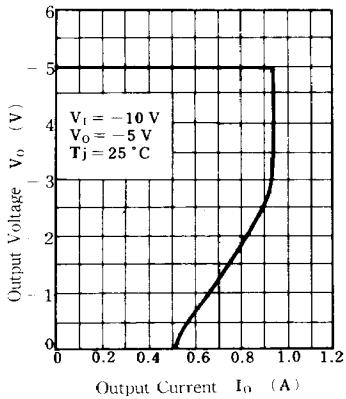
Line Transient Response



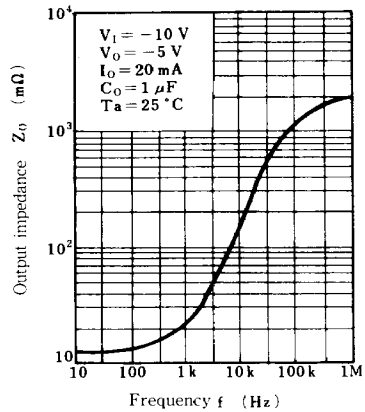
Load Transient Response



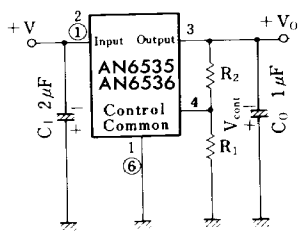
Output Current Limit



Z_O − f



■ Basic Regulator Circuit



Note Pin No. in ( ) are for AN6536.

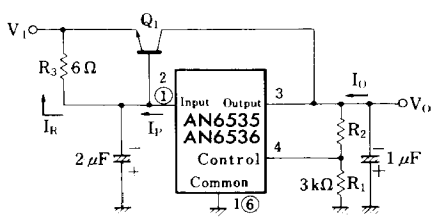
$$V_O = V_{cont}\left(\frac{R_1+R_2}{R_1}\right)$$

($V_{cont} \simeq 3$ V, $R_1 = 3$ kΩ)

C_I is necessary when the line of V_I is long.
C_O improves the transient response.

■ Application Circuits

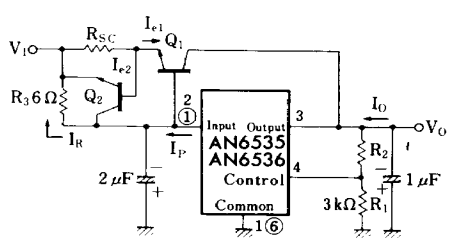
(1) Current Boost Circuit



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

Note Pin No. in ( ) are for AN6536.

(2) Current Boost Circuit (With Current Limiting Circuit)



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

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

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