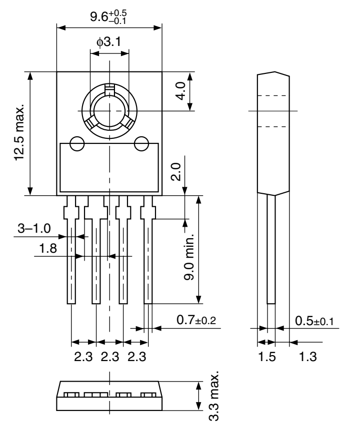
AN6535

4-pin variable negative output voltage regulator

■ Overview

The AN6535 is a monolithic 4-pin variable negative output voltage regulator. With an external resistor, it provides any stabilized output voltages between −5V and −30V, and is optimum for the power circuits with a current capacity of up to 0.5A. This IC incorporates various protection circuits.



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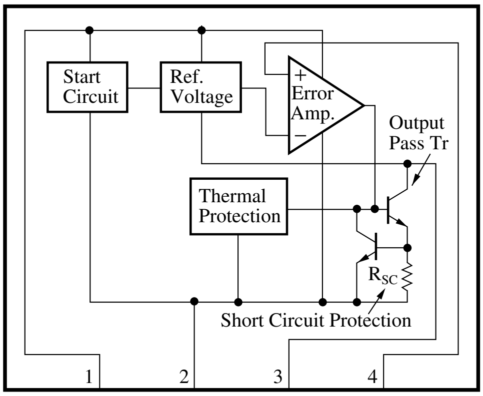
■ Features

- Wide range of output voltages: V_O = −5 to −30V
- Built-in thermal overload protection circuit
- Built-in overcurrent protection circuit
- Built-in ASO (area of safe operation) protection circuit

■ Block Diagram



■ Absolute Maximum Ratings at $T_a = 25°C$

Parameter	Symbol	Rating	Unit
Supply voltage	V_{CC}	−40	V
Supply current	I_{CC} *1	1	A
Power dissipation	P_D	7.5	W
Operating ambient temperature	T_{opr}	−20 to +80	°C
Storage temperature	T_{stg}	−55 to +150	°C

*1 The internal circuit is provided with a current limiting circuit.
*2 Maximum power dissipation value when there is no heat sink (The value varies depending on the external heat radiation state)

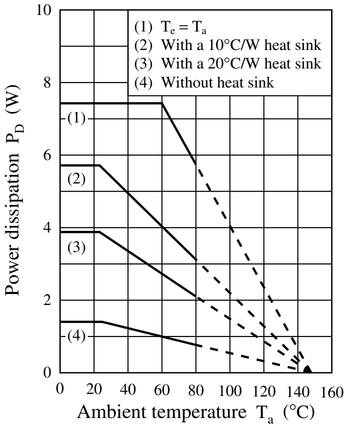
■ Electrical Characteristics at $T_a = 25°C$

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Output voltage tolerance	V_O	$V_I = V_O - 3V$ to $V_O - 15V$, $I_O = 5$ to 350mA, $T_j = 25°C$		—	—	4	%
Line regulation	REG_{IN}	$V_O = -5V$, $I_O = 200mA$, $V_I = -7.5$ to $-25V$, $T_j = 25°C$		—	—	1	%
		$V_O = -18V$, $I_O = 5mA$, $V_I = -21$ to $-33V$, $T_j = 25°C$		—	—	0.75	%
		$V_O = -18V$, $I_O = 200mA$, $V_I = -21$ to $-25V$, $T_j = 25°C$		—	—	0.67	%
Load regulation	REG_L	$I_O = 5$ to 500mA, $T_j = 25°C$	$V_O = -5V$, $V_I = -12V$	—	—	1	%
			$V_O = -18V$, $V_I = -25V$				
Bias current	I_{Bias}	$T_j = 25°C$		—	1.5	3	mA
Control pin current	I_{cont}	$T_j = 25°C$		—	—	3	µA
Ripple rejection ratio	RR	$V_I = -8$ to $-18V$, $V_O = -5V$, f = 120Hz		60	—	—	dB
Output noise voltage	V_{no}	$V_O = -5V$, f = 10Hz to 100kHz		—	40	—	µV
Minimum input/output voltage difference	$V_{DIF(min)}$	$I_O = 500mA$, $T_j = 25°C$		—	1.1	—	V
Output short-circuit current	I_{OS}	$V_I = -35V$, $V_O = -5V$, $T_j = 25°C$		—	100	600	mA
Peak output current	I_{OP}	$V_O = -5V$, $T_j = 25°C$		0.4	0.8	1.4	A
Output voltage temperature coefficient	$\Delta V_O/T_a$	$V_O = -5V$, $I_O = 5mA$	$T_j = -20$ to $+25°C$	—	0.2	—	mV/°C
			$T_j = 25$ to 150°C	—	− 0.3	—	
Control pin voltage	V_{cont}	$T_j = 25°C$		−3.12	−3	−2.88	V

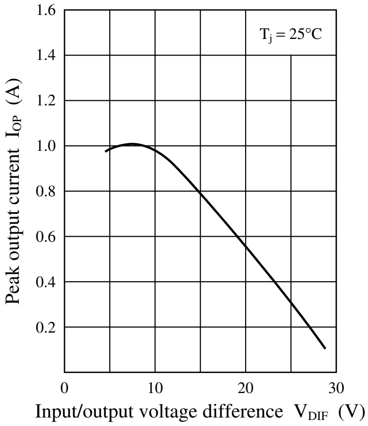
Note 1) The specified condition $T_j = 25°C$ means that the test should be carried out within so short a test time (within 10ms) that the characteristic value drift due to the chip junction temperature rise can be ignored.
Note 2) Unless otherwise specified, $V_I = -10V$, $V_O = -5V$, $I_O = 350mA$, $C_I = 2µF$ and $C_O = 1µF$

■ Main Characteristics

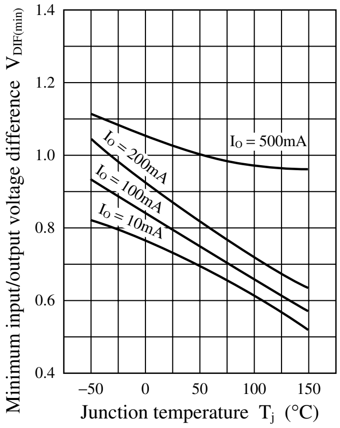
P_D — T_a



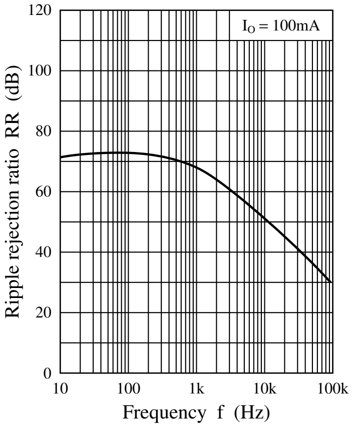
I_{OP} — V_{DIF}



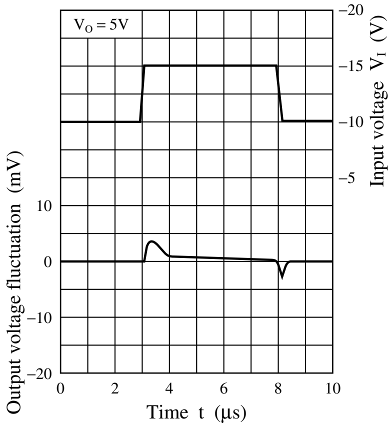
$V_{DIF(min)}$ — T_j



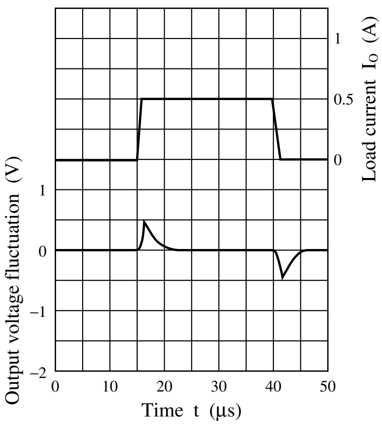
RR — f



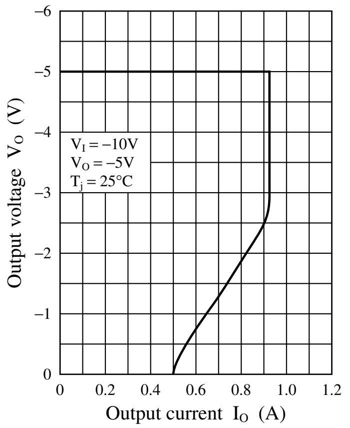
Transient response to input variation



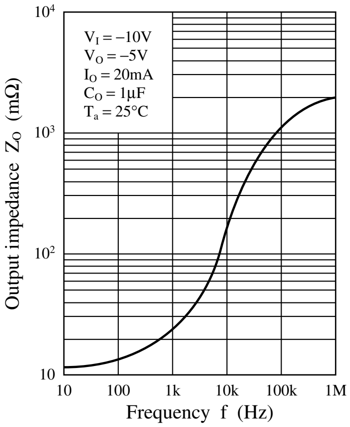
Transient response to load variation



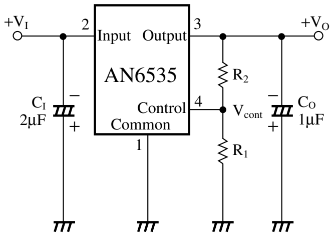
Current limiting characteristic



Z_O — f



■ Basic Regulator Circuit



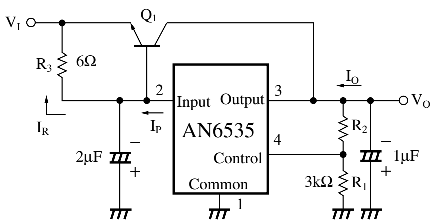
$$V_O = V_{cont}\left(\frac{R_1 + R_2}{R_1}\right)$$

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

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

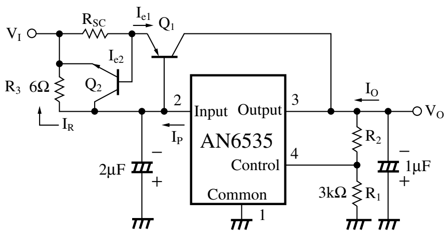
■ Application Circuit Example

1. Current bootstrap circuit



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

2. Current bootstrap circuit (with current limiting circuit)



$$R_{SC} = \frac{V_{BE(Q1)}}{I_{e1(max)}}$$

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

$$I_{e1(max)} = I_{P(max)} - \frac{V_{BE(Q1)} + V_{BE(Q1)}}{R_3}$$

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