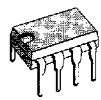
ADJUSTABLE VOLTAGE REGULATOR PLUS FILTER

- OUTPUT VOLTAGE ADJUSTABLE FROM 4 TO 11V
- HIGH OUTPUT CURRENT (UP TO 250mA)
- HIGH RIPPLE REJECTION
- HIGH LOAD REGULATION
- HIGH LINE REGULATION
- SHORT CIRCUIT PROTECTION
- THERMAL SHUT DOWN WITH HYSTERESIS
- DUMP PROTECTION

This circuit combines both a filter and a voltage regulator in order to provide a high ripple rejection over a wide input voltage range.

A supervisor low-pass loop of the element prevents the output transistor from saturation at low input voltage.

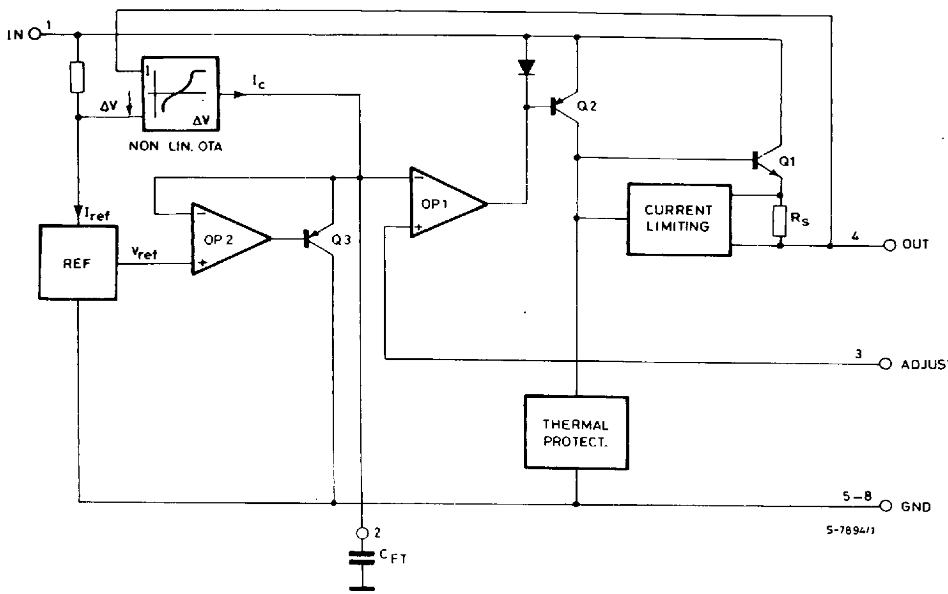
The non linear behaviour of this control circuitry allows a fast settling of the filter.



Power Minidip (4 + 4)

ORDERING NUMBER: L4915

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

V_i	Peak input voltage (300ms)	40	V
V_i	DC input voltage	28	V
I_o	Output current	internally limited	
P_{tot}	Power dissipation	internally limited	
T_{stg}	Storage and junction temperature	-40 to 150	°C

CONNECTION DIAGRAM
(Top view)

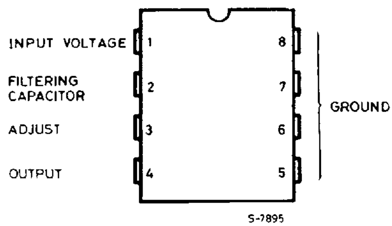
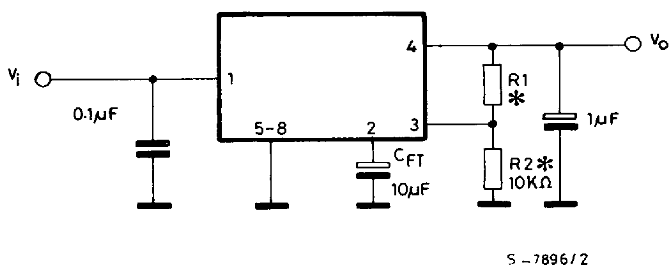


Fig. 1 – Application circuit



$$✻\ \text{OUTPUT VOLTAGE } V_O = \frac{2.5(R1 + R2)}{R2}$$

THERMAL DATA

$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	80	°C/W
$R_{th\ j\text{-}pins}$	Thermal resistance junction-pins	max	20	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25°C, V_i = 13.5V, V_o = 8.5V, circuit of Fig. 1, unless otherwise specified)

	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_i	Input voltage				20	V
V_o	Output voltage	V_i = 6 to 18V I_o = 5 to 150mA	4		11	V
$\Delta V_{I/O}$	Controlled input-output dropout voltage	I_o = 5 to 150mA V_i = 6 to 10V		1.6	2.1	V
ΔV_o	Line regulation	V_i = 12 to 18V I_o = 10mA		1	20	mV
ΔV_o	Load regulation	I_o = 5 to 250mA t_{on} = 30μs t_{off} = ≥ 1ms		50	100	mV
ΔV_o	Load regulation (filter mode)	V_i = 8.5V I_o = 5 to 150mA t_{on} = 30μs t_{off} = ≥ 1ms		150	250	mV
V_{ref}	Internal voltage reference			2.5		V
I_q	Quiescent current	I_o = 5mA		1	2	mA
ΔI_q	Quiescent current change	V_i = 6 to 18V I_o = 5 to 150mA		0.05		mA
I_{AD}	Adjust input current			40		nA
$\frac{\Delta V_o}{\Delta T}$	Output voltage drift	I_o = 10mA		1.2		mV/°C
SVR	Supply voltage rejection	V_{iac} = 1V_{rms} f = 100Hz I_o = 150mA Regulator		71		dB
		Filter mode		35 (*)		dB
I_{SC}	Short circuit current		250	300		mA
T_{on}	Switch on time	I_o = 150mA Filter mode		500 (*)		ms
		Regulator		300		ms
T_j	Thermal shutdown junction temperature			145		°C

(*) Depending of the C_{FT} capacitor.

PRINCIPLE OF OPERATION

During normal operation (input voltage upper than $V_{I\,MIN} = V_{OUT\,NOM} + \Delta V_{I/O}$). The device works as a normal voltage regulator built around the OP1 of the block diagram.
The series pass element uses a PNP-NPN connection to reduce the dropout. The reference voltage of the OP1 is derived from a REF through the OP2 and Q3, acting as an active zener diode of value V_{REF}.
In this condition the device works in the range (1) of the characteristic of the non linear drop control unit (see fig. 2).
The output voltage is fixed to its nominal value:

$$V_{OUT\,NOM} = V_{REF}\ (1 + \frac{R1}{R2}) =$$

$$V_{CFT}\ (1 + \frac{R1}{R2})$$

The ripple rejection is quite high (70dB) and independent to C_{FT} value.
On the usual voltage regulators, when the input voltage goes below the nominal value, the regulation transistors (series element) saturate bringing the system out of regulation and making it very sensible to every variation of the input voltage.
On the contrary, a control loop on the L4915 consents to avoid the saturation of the series element by regulating the value of the reference voltage (pin 2). In fact, whenever the input voltage decreases below ($V_{I\,MIN}$ the supervisor loop, utilizing a non linear OTA, forces the reference voltage at pin 2 to decrease by discharging C_{FT}.
So, during the static mode, when the input voltage goes below V_{MIN} the drop out is kept fixed to about 1.6V. In this condition the device works as a low pass filter in the range (2) of the OTA characteristic. The ripple rejection is externally adjustable acting on C_{FT} as follows:

$$SVR\ (j\Omega) = \left| \frac{V_i\ (j\Omega)}{V_{out}\ (j\Omega)} \right| =$$

$$\left| 1 + \frac{10^{-6}}{\frac{gm}{jwC_{FT}}\ (1 + \frac{R1}{R2})} \right|$$

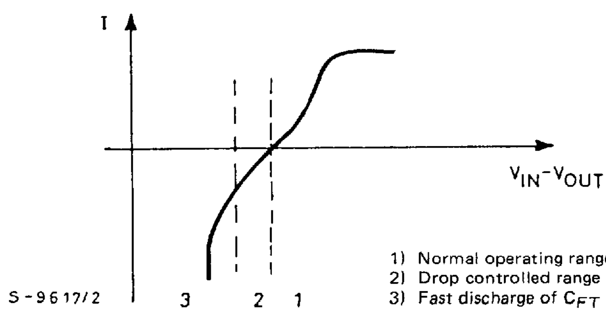
Where:
$gm = 2 \cdot 10^{-5}\ \Omega^{-1}$ = OTA'S typical transconductance value on linear region

$\frac{R1}{R2}$ = fixed ratio

C_{FT} = value of capacitor in μF

The reaction time of the supervisor loop is given by the transconductance of the OTA and by C_{FT}.
When the value of the ripple voltage is so high and its negative peak is fast enough to determine an istantaneous decrease of the dropout till 1.2V, the OTA works in a higher transconductance condition [range (3) of the characteristic] and discharges the capacitor rapidously.
If the ripple frequency is high enough the capacitor won't charge itself completely, and the output voltage reaches a small value allowing a better ripple rejection; the device's again working as a filter (fast transient range).
With C_{FT} = 10μF; f = 100Hz; V_o = 8.5V a SVR of 35 is obtained.

Fig. 2 - Nonliner transfer characteristic of the drop control unit



1) Normal operating range (high ripple rejection)
2) Drop controlled range (medium ripple rejection)
3) Fast discharge of C_{FT}

Fig. 3 - Supply voltage rejection vs. input voltage

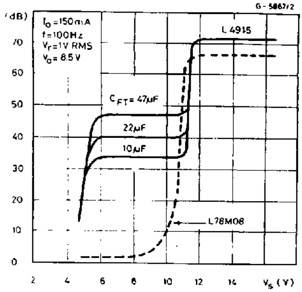


Fig. 4 - Supply voltage rejection vs. frequency

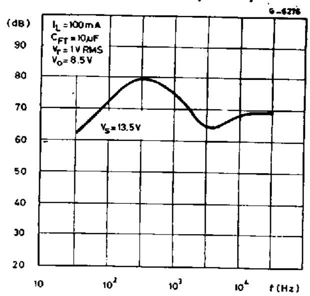


Fig. 5 - V_o vs. supply voltage (V_o = 8.5V)

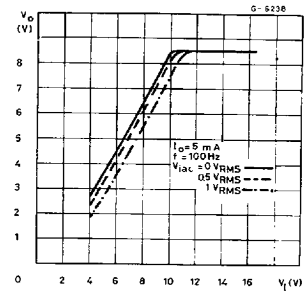


Fig. 6 - Quiescent current vs. input voltage (V_o = 8.5V)

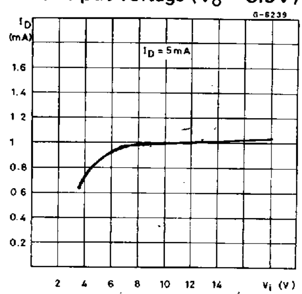


Fig. 7 - Dropout vs. load current