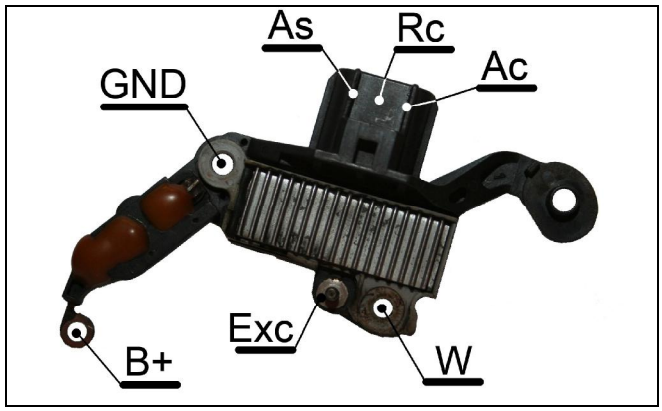
PCM-Controlled Alternator Voltage Regulator E23-14V

Feature overview

- HIGH SIDE FIELD DRIVER
  R_{on} 150mΩ at $T_{junction}$ =150°C
- THERMAL PROTECTION
- FIELD DRIVER SHORT CIRCUIT PROTECTION
- PCM INTERFACE
- OVERVOLTAGE PROTECTION
- COMPLEX DIAGNOSTICS
- BATTERY VOLTAGE SENSING



Description

The L9913 is a monolithic multifunction Alternator Voltage Regulator intended for use in automotive applications.

This device regulates the output of an automotive alternator by controlling the field winding current by means of a fixed frequency PWM high side driver.

The set-point voltage reference is selected by the ENGINE CONTROL UNIT via PCM protocol. Continuous feedback to the ECU is provided by a PWM logic signal. Default mode operations are maintained in case of PWM signal loss.

The regulators have an integrated filter in the voltage sensing path guaranteeing the correct behaviour of the devices also when the rectifier diodes feature very high switching spikes.

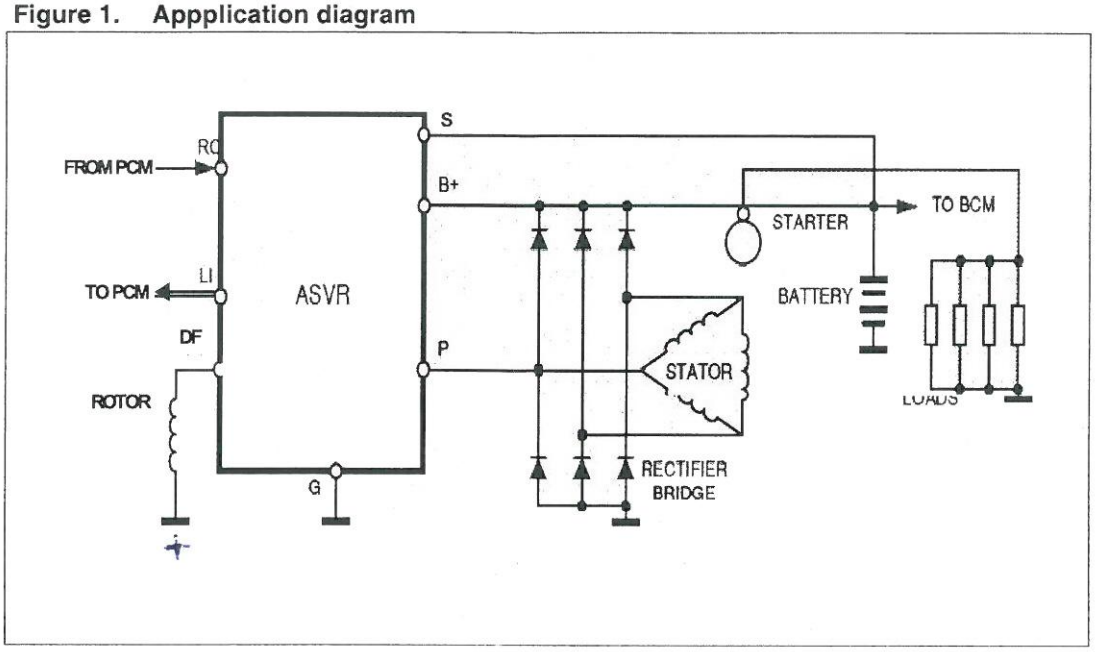
The internal filtering allows the usage of the device also with very long cables connecting the alternator to the battery with an impedance so high to cause a superimposed ripple on the alternator voltage higher than 6-7V.

Consequently it doesn't need, in the standard application, any external component.

Anyway an external capacitor (1.5µF or 2.2µF) must be inserted between B+ and ground when using the device with very long cables.

1 Application Diagram

Figure 1. Appplication diagram



2 Electrical Specification

2.1 Voltage maximum ratings

Table 5. Voltage maximum ratings

Pin	Operating Range (full spec guaranteed)	Maximum Range (basic functionality guaranteed)	Absolute Maximum Range (no damage guaranteed)"1
B+	8V / 18V	8V / 24V	Max 40V
LI	0V / B+	0V / B+	Max 40V
RC	0V / B+	0V / B+	Max 40V
SNS	8V / 18V	8V / 24V	Max 40V
P	-1V / B+ + 1V	-1V / B+ + 1V	Max 40V
DF	-2V / B+	-2V / B+	Max 40V

"1. Translent Supply Voltage (load dump) t<500ms"

2.2 Electrical characteristics

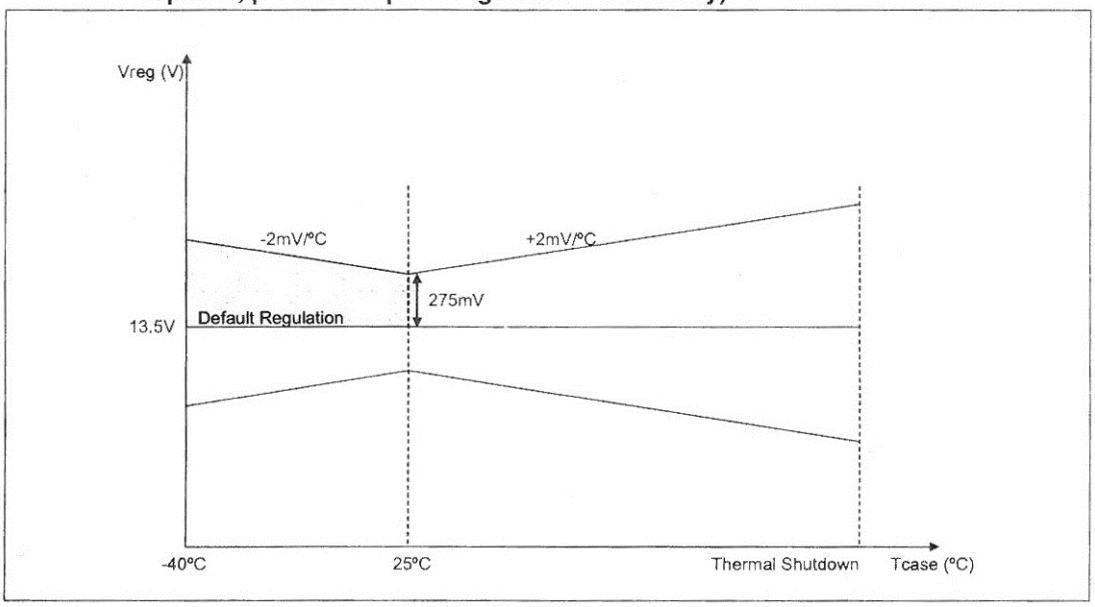
Table 6. Electrical Characteristcs
($T_{junction}$ = -40 to 150°C, unless otherwise specified).

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
I_{SB}	Stand-by Current [1]	V_S = 12.6V			250	µA
V_{SF}	Regulator Set-Point in Default Mode	PWM signal loss	13.35	13.5	13.65	V
V_{P1}	Initiation of regulation detection phase voltage threshold [2]	I_P = 1mA (sinking current)	1	1.5	2	V
f_{IFR}	Initiation of field regulation frequency	Start with protocol		800		rpm
		Start with phase		6000		
T_C	Thermal compensation	See Figure 4				V
V_{LR}	Load Regulation	6000 grpm, 5% to 90% load			±75	mV
V_{SR}	Speed Regulation	50% load, 1500 to 18000 rpm			±50	mV
R_{ON}	Field Driver ON Resistance	I_F= 6A, Tcase=150°C			150	mΩ
I_{FLIM}	Field limit current	F shorted to gnd, Tcase< = 25°C	10			A
		F shorted to gnd, Tcase= 150 °C	6			A
V_F	Field Discharge Rectifier	I_F=6A, Tcase= 25° C			2	V
I_R	Diode Reverse Current	V_R = 16 V			1	mA
RC_f	RC input frequency range		100	125	150	Hz
LI_f	LI output frequency range		100	125	150	Hz
f_{OSC}	Field driver frequency		320	375	430	Hz

Notes:

1. Stand-by current measured with LI, RC open; DF connected to gnd; P open or tied to gnd.
2. This threshold on the phase signal is used to detect the phase frequency, fIFR, for the Initiation of field regulation.

Figure 4. Total variation of the regulation voltage with temperature (includes 1% V_{SF} spread, plus load/speed regulation inaccuracy)



3 RC Interface Description

The regulator is controlled by the PCM via a PWM signal applied to RC pin which defines the regulation set point, proportional to the signal duty cycle (see Figure 5).

The PCM provides L9913 an open collector PWM signal. Because of the pull-up (internal as an option) connected between RC and B+, resulting signal is between ground and battery voltage. When no signal is applied on L9913, RC pin is then on high level; the default regulation voltage of 13.5 V must be taken as voltage set point

Figure 5. RC and LI interfaces description

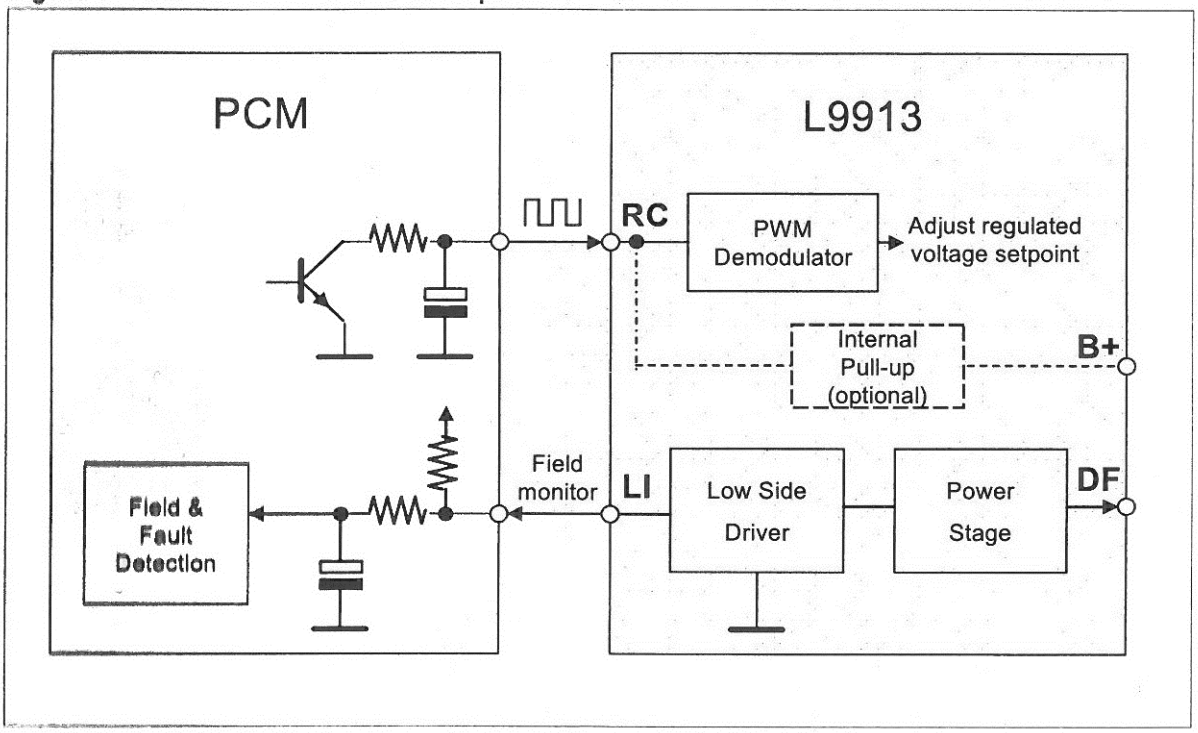


Table 7. RC electrical Parameters

Symbol	Description	Min	Typ	Max	Unit
$R^{*}_{pu,rc}$	Pull-up current generator (optional)	7		17	mA
$f_{PWM,RC}$	Input frequency of PWM signal From PCM	100	125	150	Hz
P_{dc}	Accuracy on duty cycle			1	%
V_{STEP}	Resolution of PCM Voltage Regulation		44		mV
D_{LRC}	lower fault level, Interpreted by alternator as fault condition. Field is shut off.	0		4	%
RCr	Range for the set point	5		96	%
D_{HRC}	upper fault level, Interpreted by alternator as fault condition (short to battery). Regulator goes to default mode.	97		100	%
$t_{r,RC}$	RC rising and falling time From 10 to 90%	2	15	25	µs
$V_{LH,RC}$	Low to High voltage level	2.6	2.9	3.2	V
$V_{HL,RC}$	High to Low voltage level	1.9	2.2	2.5	V
Tma	Maximum time between two burst of PCM duty cycle	6	7	8	s

If the high voltage level of the RC signal is lower than VLH,RC , the RC signal is understood as a 0% duty cycle.

If the low voltage level of the RC signal is upper than VHL,RC, the RC signal is understood as a 100% duty cycle.

The PWM signal has a frequency of fPWM,RC; but the PCM will change "RC" frequency to match LI frequency with a tolerance of ±1 Hz, and update it quicker than once a second. PWM RC signal can be sent continuously or in burst mode. In burst mode, between two burst, the set point voltage is latched referred to the latest RC% value. LI is the image of the excitation.

Figure 6. RC in burst mode operation

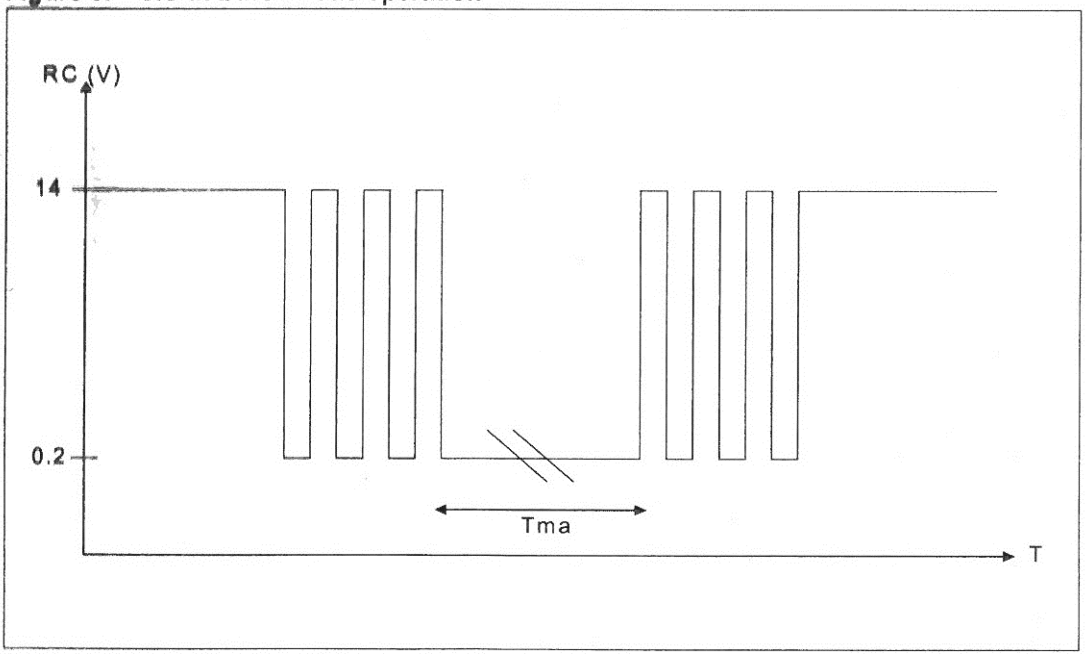
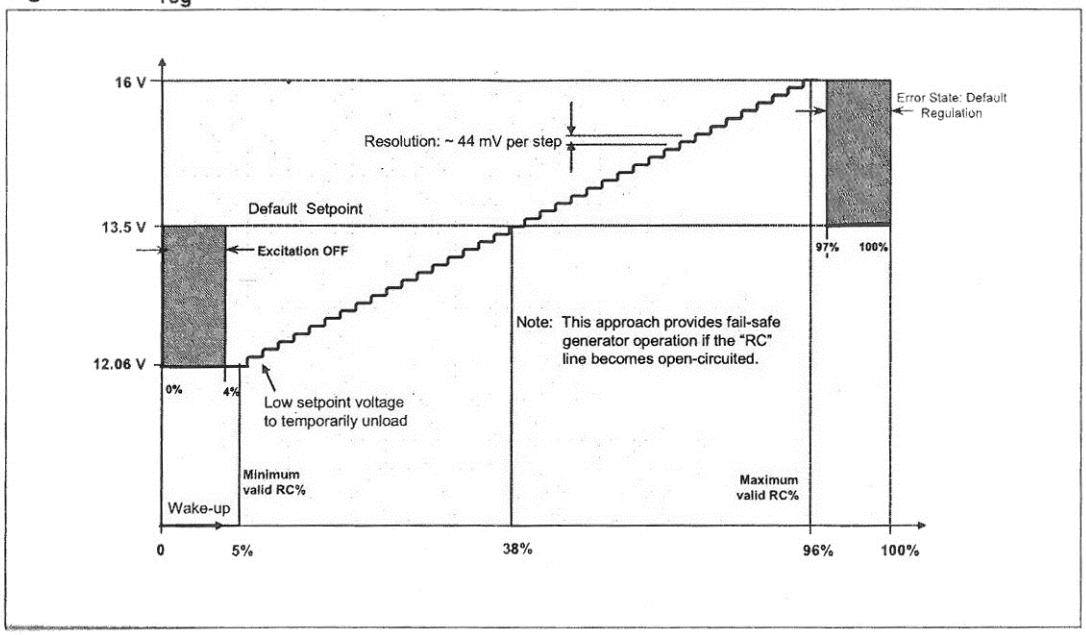


Figure 7. V_{reg} versus RC%



Remark: The case RC%=0% is either the case where we are in burst mode or if we have (RC%=0% and tma elapsed) then the regulator go to default mode.

4 LI Interface Description

The regulator sends on LI pin an image of the excitation signal applied to the rotor with a precision of 1% on duty cycle. This signal is a PWM logic signal that stops when defect information is detected. This signal is read by the PCM.

Table 8. LI electrical Parameters

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
DC characteristics						
Ron_{LI}	LI output stage RDSon			10	50	Ohm
$I_{lim,LI}$	LI Ilimit		100	150	200	mA
$I_{peak,LI}$	Peak LI input current during t=0.05 s				1	A
	LI low voltage	I_{LI} (sunk current) = 20mA			1	V
Dynamic characteristics						
$f_{PWM,LI}$	Output frequency of PWM signal		100	125	150	Hz
d_{LL}	LI lower fault level		0		1	%
d_{HL}	LI high fault level		99		100	%
$d_{FC,L}$	LI full charge indicator		96	98	99	%
do_{LI}	Normal charging range		5		98	%
f_{LI}	Accuracy on duty cycle			1	2	%